## List of Cyclotrons

**Cyclotrons, Individual Designs**

<table>
<thead>
<tr>
<th>ID</th>
<th>Country</th>
<th>Institution</th>
<th>Machine name</th>
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<tbody>
<tr>
<td>C1</td>
<td>Belgium</td>
<td>UCL, Centre de Recherches du Cyclotron</td>
<td>CYCLONE 110</td>
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<td>UCL, Centre de Recherches du Cyclotron</td>
<td>CYCLONE 44</td>
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<td>TRIUMF Cyclotron</td>
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<td>HIRFL Main Cyclotron-SSC</td>
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<td>U-120M</td>
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<td>University of Jyväskylä</td>
<td>K-130 cyclotron</td>
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<td>ZAG Zyklotron AG</td>
<td>Karlsruher Compakt Anlage, KAZ</td>
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<td>University of Warsaw, Heavy Ion Laboratory</td>
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**Commercial Cyclotrons, Manufacturers**

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<td>DLNP JINR Russia</td>
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ENTRY NO:C01
Date: 08 FEB 2008
Machine Name: CYCLONE 110
Institution: UCL, Centre de Recherches du Cyclotron
Address: 2, Chemin du Cyclotron 1348 Louvain-la-Neuve, Belgium
Telephone: +32(10)472998
Fax: +32(10)452183
Web Address: http://www.cyc.ucl.ac.be
Person in Charge of Cyclotron: Marc Loiselet
Person Reporting Information: Marc Loiselet
E-mail Address: Marc.Loiselet@uclouvain.be

HISTORY
Designed by: Thomson-CSF
Construction Dates: 1969-1972
First Beam Date: 1972
Characteristic Beams
Protons 20-75 MeV/N 2 x 10^14 pps 1500W
deutons 2.3-27 MeV/N 2 x 10^14 pps 1500W
heavy ions 0.6-27 MeV/N 1 x 10^13 pps
radioactive ions 0.6-5 MeV/N 1 x 10^9 pps
Transmission Efficiency (source to extracted beam)
Typical (%): 0.5 - 10
Best (%): 16

EMITANCE
Emittance Definition: RMS
Vertical (pi mm mrad): 15
Horizontal (pi mm mrad): 23
Longitudinal (dE/E[%] x RF[deg.]): 0.3(%) X 6(deg.)

USES
Basic Research (%): 39.1
Development (%): 2.5
Therapy (%): 39.1
Isotope Production (%): 40.0
Other Application (%): 8.1 + 2.3 (unscheduled shutdown)

TECHNICAL DATA
(a) Magnet
Type: Compact
Kb (MeV): 110
Kf (MeV): 80
Average Field (min./max. T): 0.6-1.6
Number of Sectors: 4
Hill Angular Width (deg.): variable
Spiral (deg.): 53
Pole Diameter (m): 2.156
Injection Radius (m):
Extraction Radius (m): 0.923
Hill Gap (m): 0.165
Trim Coils
Number: 12 X 2 (for upper and lower poles)
Maximum Current (A): 700

(b) RF
Frequency Range (MHz): 10.6-23
Harmonic Modes: 1, 2, 3, 6
Number of Dees: 2
Number of Cavities: 2
Dee Angular Width (deg.): 86
Voltage
At Injection (peak to ground, KV): 35
At Extraction (peak to ground, KV): 35
Peak (peak to ground, KV): 35
Line Power (max, KW): 50
Phase Stability (deg.): 0.1
Voltage Stability (%): 0.01

(c) Injection
Ion Source: Filament / ECR
Source Bias Voltage (kV): 6-15
External Injection: Axial
Buncher Type: double gap sinusoidal
Injection Energy (MeV/n):
Component:
Injection Efficiency (%): 5-20
Injector:

(d) Extraction
Elements, Characteristic: Electrostatic deflector
Active magnetic channel
Passive focusing channel
Typical Efficiency (%): 60
Best Efficiency (%): 85

(e) Vacuum
Pumps: Oil diffusion + Cryopumps
Achieved Vacuum (Pa): 10-4

EXPERIMENTAL FACILITIES: LEDA, solid state
detector array; LISOL, Leuven Isotope Separator On Line; DEMON, Detecteur Modulaire de Neutrons; HIF, Heavy ions Irradiation Facility; LIF, Light ion Irradiation Facility; NIF, Neutron Irradiation Facility

**ENTRY NO:C02**

**Date:** 08 FEB 2008  
**Machine Name:** CYCLONE 44  
**Institution:** UCL, Centre de Recherches du Cyclotron  
**Address:** 2, Chemin du Cyclotron 1348 Louvain-la-Neuve, Belgium  
**Telephone:** +32(10)472998  
**Fax:** +32(10)452183  
**Web Address:** [http://www.cyc.ucl.ac.be](http://www.cyc.ucl.ac.be)  
**Person in Charge of Cyclotron:** Marc Loiselet  
**Person Reporting Information:** Marc Loiselet  
**E-mail Address:** Marc.Loiselet@uclouvain.be

**HISTORY**  
**Designed by:** UCL  
**Construction Dates:** 1995-1998  
**First Beam Date:** June 1998

### Characteristic Beams
- Radioactive ions, 0.4-0.8 Mev/N, $10^{11}$ pps

#### Transmission Efficiency (source to extracted beam)
- **Typical (%):** 5  
- **Best (%):** 10

### Emittance
- **Emittance Definition:** RMS  
  - **Vertical:** $24 \pi \text{mm mrad}$  
  - **Horizontal:** $13 \pi \text{mm mrad}$  
  - **Longitudinal:** $(dE/E[\%] \times RF[\text{deg}])$:

### USES
- **Basic Research (%):**  
- **Development (%):**  
- **Therapy (%):**  
- **Isotope Production (%):**  
- **Other Application (%):**  
- **Maintenance (%):**  
- **Beam Tuning (%):**  
- **Total Time (h/year):** 0 (in 2007)

### TECHNICAL DATA

#### (a) Magnet
- **Type:** Compact  
- **$K_b$ (MeV):** 44  
- **$K_f$ (MeV):** 2.0  
- **Average Field (min./max. T):** 0.8-1.54  
- **Number of Sectors:** 4  
- **Hill Angular Width (deg.):** 60-65  
- **Spiral (deg.):** -  
- **Pole Diameter (m):** 1.56  
- **Injection Radius (m):**  
- **Extraction Radius (m):** 0.633  
- **Hill Gap (m):** 0.12  
- **Valley Gap (m):** 0.24  
- **Trim Coils**  
  - **Number:** 12 X 2 (for upper and lower poles)  
  - **Maximum Current (A):** 20  
- **Harmonic Coils**  
  - **Number:** 2 X 4 (sectors) X 2 (for upper and lower poles)  
  - **Maximum Current (A):** 10  
- **Main Coils**  
  - **Number:** 1 X 2 (for upper and lower poles)  
  - **Total Ampere Turns:** 210000  
  - **Maximum Current (A):** 500  
  - **Stored Energy (MJ):**  
  - **Total Iron Weight (tons):** 56  
  - **Total Coil Weight (tons):** 2  

#### Power
- **Main Coils (total KW):** 52  
- **Trim Coils (total, maximum, KW):** 1  
- **Refrigerator (cryogenic, KW):**

#### (b) RF
- **Frequency Range (MHz):** 13.3-17.5  
- **Harmonic Modes:** 5, 6  
- **Number of Dees:** 2  
- **Number of Cavities:** 2  
- **Dee Angular Width (deg.):** 22  

#### Voltage
- **At Injection (peak to ground, KV):** 20  
- **At Extraction (peak to ground, KV):** 20  
- **Peak (peak to ground, KV):** 20  
- **Line Power (max, KW):** 2  
- **Phase Stability (deg.):** 0.1  
- **Voltage Stability (%):** 0.01

#### (c) Injection
- **Ion Source:** ECR  
- **Source Bias Voltage (kV):** 7-20  
- **External Injection:** axial  
- **Buncher Type:** double gap sinusoidal  
- **Injection Energy (MeV/n):** variable  
- **Component:**  
  - **Injection Efficiency (%):** 20

#### (d) Extraction
- **Elements, Characteristic:** electrostatic deflector passive magnetic focusing channel  
- **Typical Efficiency (%):** 50  
- **Best Efficiency (%):** 65

#### (e) Vacuum
- **Pumps:** Turbopumps + Cryopumps  
- **Achieved Vacuum (Pa):** 10-5

### EXPERIMENTAL FACILITIES
- **ARES (Astrophysics Recoil Separator)**
ENTRY N° C03
Date: 9th December 2007
Machine name: TRIUMF Cyclotron
Institution: TRIUMF
Address: 4004 Wesbrook Mall, Vancouver BC V6T 2A3
Canada
Telephone: 604.222.1047
Fax: 604.222.1074
Web Address: www.triumf.ca
Person in charge of cyclotron: Paul Schmor
Person reporting information: Yuri Bylinski
E-mail address: bylinsky@triumf.ca

HISTORY
Designed by: In house, various engineering firms
Constructed by: In house, various engineering firms
Construction dates: April 1968 – December 1975
First beam date: December 14, 1975
Characteristic beam, energy and current:
p+ 180 – 520 MeV  210 µA
p+ 65 – 115 MeV  100 µA
Transmission efficiency (source to extracted beam)
Typical (%): 63
Best (%): 70
Emittance
Vertical (π mm mrad): 2
Horizontal (π mm mrad): 2
Longitudinal (dE/E[%] x RF[deg.]): 0.2
USES:
Basic research (%): 62
Development(%): 2
Therapy(%): 2
Isotope production (%): 21
Other application (%): 4
Maintenance (%): 7 (shutdowns excluded)
Beam tuning(%): 2
Total time (h/year): 5600

TECHNICAL DATA
(a) Magnet:
Type: Section focused, laminated low carbon steel
Kb (MeV): 
Kf: (MeV):
Average field (min./max. T): 0.3 – 0.46
Number of magnet sectors: 6
  hill angular width (deg.): 35 at inner 200 inches
  spiral (max): 70
Pole parameters
  Diameter: 17.17
  Injection radius (m): 0.25
  Extraction radius (m): 3.8 to 7.90
  Hill gap (m): 0.528
  Valley gap (m):
Trim coils
  Number: 54
  Maximum current (A-turns): 7000
Harmonic coils
Number: 13xN sectors x 2
Maximum current (A-turns): 300
Main coils
Number: 1 x 2
Total current (A-turns): 552,000
Maximum current (A): 18,400
Stored energy (MJ): 16.5
Total iron weight (tons): 4400
Total coil weight (tons): 170
Power
Main coils (total KW): 1380
Trim coils (total, maximum, KW): 68
Refrigerator (cryogenic, KW):
(b) RF
Frequency range (MHz): 23.05
Harmonic modes: 5
Number of dees: 2
Number of cavities: 80 Mechanically independent segments
Dec angular width (deg.): 180
Voltage * (see comment)
  at injection (peak to ground, KV): 96
  at extraction (peak to ground, KV): 96
  peak (peak to ground, KV): 96
Line Power (max, KW): 2000
Phase Stability (deg.): +/-1
Voltage Stability (%): 0.001
(c) Injection
Ion Source: CUSP
Source Bias Voltage (kV): 12
External Injection: axial injector elements: spiral inflector, electrostatic transport
Buncher Type: 2 cavities (Fundamental frequency and second harmonic bunchers)
Injection Energy (MeV/n): 0.300
Injection Efficiency (%): 95
(d) Extraction
Elements, Characteristic: Stripping in pyrolytic graphite foils, simultaneous extraction to 4 beam lines
Typical Efficiency (%): 99.95
Best Efficiency (%): 
(e) Vacuum
Pumps: 2 He cooled cryo-panels (2.8 m square), 6 cryo-pumps, 2 turbo pumps
Achieved Vacuum (Pa): 4 x 10⁻⁸
EXPERIMENTAL FACILITIES:
Proton therapy; proton and neutron irradiation; RIB source and accelerator, low energy (<1.8 MeV/µ) and high energy (< 5 MeV/u) experimental halls (ISAC); pion production targets (10+8 pps)
COMMENTS:
Accelerating voltage is formed by opposite potentials of the dee electrodes and thus is double of the peak to ground voltage. i.e. 192 kV
ENTRY N° C04
Date: Nov. 9th, 2007
Machine name: HIRFL injector cyclotron-SFC
Institution: Institute of Modern Physics (IMP), CAS
Address: Nanchang Road 509, Lanzhou, 730000
Telephone: 86 931 4969226
Fax: 86 931 8272100
Web Address: http://www.impcas.ac.cn/
Person in charge of cyclotron: Baowen Wei
Person reporting information: Hongwei ZHAO
E-mail address: zhaohw@impcas.ac.cn

HISTORY
Designed by: Accelerator group of IMP, Lanzhou
Constructed by: Accelerator group of IMP
Construction dates: Upgraded in 1984-1987
First beam date: the first beam after upgrading: 1987

Characteristic beam, energy and current:
- $^{16}$O  8.0 (MeV/n)  $1.5 \times 10^{13}$ (pps)  300 (w)
- $^{40}$Ar  2.35 (MeV/n)  $1.2 \times 10^{13}$ (pps)  176 (w)
- $^{26}$Mg  6.54 (MeV/n)  $1.5 \times 10^{12}$ (pps)  43 (w)
- $^{129}$Xe  2.9 (MeV/n)  $1.4 \times 10^{12}$ (pps)  83 (w)
- $^{208}$Pb  1.1 (MeV/n)  $3 \times 10^{11}$ (pps)  11 (w)
- $^{238}$U  0.807(MeV/n)  $8.5 \times 10^{10}$ (pps)  3 (w)

Transmission efficiency (source to extracted beam)
Typical (%): 7-10
Best (%): 15

Emittance
- Emittance definition: 50%
- Vertical (π mm mrad): 20
- Horizontal (π mm mrad): 20
- Longitudinal (dE/E[%] x RF[deg.]): 1.8 (%) *10°

USES
- Basic research (%): 55%
- Development(%): 10%
- Other application (%): 15%
- Maintenance (%): 10%
- Beam tuning(%): 10%
- Total time (h/year): 6000

TECHNICAL DATA
(a) Magnet: AVF  Type: compact
Kb: 69  Kf: 30
- Average field (min./max. T): 1.6
- Number of magnet sectors: 3
  - hill angular width (deg.): 33 deg
Pole parameters
- Diameter: 1.7m
- Injection radius (m): 0.025, 0.03
- Extraction radius (m): 0.75
- Hill gap (m): 0.19  Valley gap (m): 0.33

(b) RF
- Frequency range (MHz): 5.5 - 16.5
- Harmonic modes: 1, 3
- Number of dees: 1
- Number of cavities: 1
- Dee angular width (deg.): 180
- Voltage at injection (peak to ground, KV): 80 Max
- Voltage at extraction (peak to ground, KV): 80 Max
- Line Power (max, KW): 60
- Phase Stability (deg.): +/- 0.3
- Voltage Stability (%): 0.1%

(c) Injection
- Ion Source: ECR
- Source Bias Voltage (kV): 25
- External Injection: axial
- Buncher Type: linear buncher
- Injection Energy (MeV/n): 0.0015 - 0.0094 MeV/n
- Component: Solenoid lens, spiral inflector
- Injection Efficiency (%): 30

(d) Extraction
- Elements, Characteristic: Two electrostatic deflector
- Typical Efficiency (%): 30 - 60
- Best Efficiency (%): 75

(e) Vacuum
- Pumps: Cryogenic pump
- Achieved Vacuum (Pa): $4 \times 10^{-6}$ Pa  $8 \times 10^{-6}$ Pa

REFERENCES: W.L.Zhan et al. 18th ICCA

EXPERIMENTAL FACILITIES
One target station (SFC can share the five target setups of SSC by bypass beam line)

COMMENTS: Laboratory layout attached at next
ENTRY No C05
Date: Nov. 9th, 2007
Machine name: HIRFL main cyclotron-SSC
Institution: Institute of Modern Physics (IMP), CAS
Address: Nanchang Road 509, Lanzhou, 730000.
Telephone: 86 931 4969226
Fax: 86 931 8272100
Web Address: http://www.impcas.ac.cn/
Person in charge of cyclotron: Baowen Wei
Person reporting information: Hongwei ZHAO
E-mail address: zhaohw@impcas.ac.cn

HISTORY
Designed by: Accelerator group of IMP, Lanzhou
Constructed by: Accelerator group of IMP
First beam date: Dec. 1988

Characteristic beam, energy and current:
\[ ^{12}\text{C} \quad 80\,\text{(MeV/n)} \quad 5.0 \times 10^{11}\,\text{(pps)} \quad 80\,\text{(W)} \]
\[ ^{12}\text{C} \quad 100\,\text{(MeV/n)} \quad 2.0 \times 10^{11}\,\text{(pps)} \quad 40\,\text{(W)} \]
\[ ^{22}\text{Ne} \quad 70\,\text{(MeV/n)} \quad 2.8 \times 10^{11}\,\text{(pps)} \quad 70\,\text{(W)} \]
\[ ^{36}\text{Ar} \quad 69\,\text{(MeV/n)} \quad 1.4 \times 10^{11}\,\text{(pps)} \quad 55\,\text{(W)} \]
\[ ^{36}\text{Ar} \quad 22\,\text{(MeV/n)} \quad 2.7 \times 10^{12}\,\text{(pps)} \quad 346\,\text{(W)} \]
\[ ^{129}\text{Xe} \quad 19.5\,\text{(MeV/n)} \quad 1.6 \times 10^{11}\,\text{(pps)} \quad 65\,\text{(W)} \]

Transmission efficiency (source to extracted beam)
Typical (%): 10-30
Best (%): 50

Emittance
Emittance definition: 50%
Vertical (\(\pi\) mm mrad): 10
Horizontal (\(\pi\) mm mrad): 10
Longitudinal (dE/E[%] x RF[deg.]): 0.2 (%) * 40°

USES
Basic research (%): 36.3%
Development(%): 5.7%
Therapy(%) : 24.2%
Isotope production (%):
Other application (%):
Maintenance (%): 24%
Beam tuning(%): 9.8%
Total time (h/year): 2840.1

TECHNICAL DATA
(a) Magnet: Separated sector Type: compact
Kb: 450
Kf: 230
Average field (min./max. T): 0.6/1.7
Number of magnet sectors: 4
hill angular width (deg.): 52
spiral (max):
Pole parameters
Diameter: 7.17m
Injection radius (m): 1.0
Extraction radius (m): 3.21
Hill gap (m): 0.1
Valley gap (m):
Trim coils
HIRFL Layout
Number: 26
Maximum current (A-turns): 480
Harmonic coils
Number: 9
Maximum current (A-turns): 240
Main coils
Number: 1
Total current (A-turns): 192000
Maximum current (A): 4000
Stored energy (MJ):
Total iron weight (tons): 2000
Total coil weight (tons): 16
Power
Main coils (total KW): 740
Trim coils (total, maximum, KW): 497
Refrigerator (cryogenic, KW):
(b) RF
Frequency range (MHz): 6.5 - 14.0
Harmonic modes: 2, 4, 6
Number of dees: 2
Number of cavities: 2
Dee angular width (deg.): 30
Voltage
at injection (peak to ground, KV): 150 Max
at extraction (peak to ground, KV): 180 Max
peak (peak to ground, KV): 180 Max
Line Power (max, KW): 60
Phase Stability (deg.): +/- 0.7
Voltage Stability (%): 0.1%
(c) Injection
Ion Source: ECR
Source Bias Voltage (kV): 25
External Injection: axial
Buncher Type: linear buncher
Injection Energy (MeV/n): 0.0015 - 0.0094 MeV/n
Component: Solenoid lens, spiral inflector
Injection Efficiency (%): 30
Injector: HIRFL SFC as an injector
(d) Extraction
Elements, Characteristic: Bump channel, electrostatic deflector, magnetic channels, two bending magnets
Typical Efficiency (%): 30 - 60
Best Efficiency (%): 75
(e) Vacuum
Pumps: Cryogenic pump
Achieved Vacuum (Pa): 2 \times 10^{-5} \text{ Pa}

REFERENCES: W.L.Zhan, et.al, 18th ICCA.

EXPERIMENTAL FACILITIES
There are 6 experimental setups.
ENTRY N° C06
Date: 09/Nov/2007
Machine name: U-120M
Institution: Nuclear Physics Institute, Czech Academy of Sciences, p. r. i.
Address: 250 68 Rez, Czech Republic
Telephone: +420266173613
Fax: +4202 2094152
Web Address: http://mx.ujf.cas.cz/~ou-www/
Person in charge of cyclotron: J. Stursa
Person reporting information: J. Stursa
E-mail address: stursa@ujf.cas.cz

HISTORY
Designed by: JINR Dubna, Russia
Constructed by: JINR Dubna, Russia
Construction dates:
First beam date: June 1977

Characteristic beam, energy and current:
<table>
<thead>
<tr>
<th>Ions, energy(MeV/n), current(pps), power(W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>p+ 6 - 37 6 x 10^{14} 3000</td>
</tr>
<tr>
<td>H- 6 - 37 1.6 x 10^{14} 800</td>
</tr>
<tr>
<td>D+ 6 - 10 4 x 10^{14} 2000</td>
</tr>
<tr>
<td>3He++ 6 - 18 1.3 x 10^{14} 1080</td>
</tr>
</tbody>
</table>

Transmission efficiency (source to extracted beam)
Typical (%): 52(H-)
Best (%): 75

Emittance
Emittance definition:
Vertical (π mm mrad): 8
Horizontal (π mm mrad): 30
Longitudinal (dE/E[%] x RF[deg.]):

USES
Basic research (%): 33
Development(%): 2
Therapy(%):
Isotope production (%): 61
Other application (%): 2
Maintenance (%): 2
Beam tuning(%):
Total time (h/year): 3500

TECHNICAL DATA
(a) Magnet:
Type: compact
Kb: 40
Kf: 1.85
Average field (min./max. T): 1
Number of magnet sectors: 4
hill angular width (deg.): 70
Pole parameters
Diameter (m): 1.2
Injection radius (m): 0.026
Extraction radius (m): 0.5
Hill gap (m): 0.082
Valley gap (m): 0.12
Trim coils
Number: 18x2

Maximum current (A-turns): 500x5
Harmonic coils
Number: 2xNsectorsx2
Maximum current (A-turns): 200 x 5

Main coils
Number: 1x2
Total current (A-turns): 4 x 105
Maximum current (A): 650
 Stored energy (MJ):
Total iron weight (tons): 110
Total coil weight (tons): 11.6

Power
Main coils (total KW): 220
Trim coils (total, maximum, KW): 150
Refrigerator (cryogenic, KW):

(b) RF
Frequency range (MHz): 10.7 - 26
Harmonic modes: 1
Number of dees: 1
Number of cavities:
Dee angular width (deg.): 180
Voltage
at injection (peak to ground, KV): 36
at extraction (peak to ground, KV): 36
peak (peak to ground, KV): 36
Line Power (max, KW): 150
Phase Stability (deg.):
Voltage Stability (%): 1

(c) Injection
Ion Source: PIG cold cath. (int.), CUSP (ext.)
Source Bias Voltage (kV): 10 - 30
External Injection: axial
Buncher Type: first harmonic
Injection Energy (MeV/n): 0.03
Component: solenoids
Injection Efficiency (%): 6
Injector:

(d) Extraction
Elements, Characteristic:
3 section electrostatic deflection system (positive ions)/ stripping (H-, D-)
Typical Efficiency (%): 25/99
Best Efficiency (%): 35/100

(e) Vacuum
Pumps: diffusion, turbomolecular pumps
Achieved Vacuum (Pa): 1 x 10^{-4}

EXPERIMENTAL FACILITIES
Achromatic magneto-optical system AMOS, 900, 5m
Fast neutron generators (p+37MeV, D2O, Li targets), 3x10^{13} (n/ster), 3x10^{11} (n/cm2/s)
Layout of Nuclear Physics Institute, Czech Academy
ENTRY N° C07
Date: December 10, 2007
Machine name: K130 cyclotron
Institution: University of Jyväskylä, Department of Physics
Address: P.O. Box 35, FI-40014 University of Jyväskylä, Finland
Telephone: +358-14-2602 400
Fax: +358-14-2602 4001
Person in charge of cyclotron: Pauli Heikkinen
Person reporting information: Pauli Heikkinen
E-mail address: pheikkin@jyu.fi

HISTORY
Designed by: Scanditronix AB, JYFL
Constructed by: Scanditronix AB, JYFL
First beam date: January 1992
Characteristic beam, energy and current:
Protons 20 – 60 MeV, 50 µA
Heavy ions 2 – 32.5 MeV/u, 2 µA
Transmission efficiency (source to extracted beam)
Typical (%): 5 – 10
Best (%): 15
Emittance
Emittance definition: rms
Vertical (π mm mrad): <10
Horizontal (π mm mrad): <10
Longitudinal (dE/E[%] x RF[deg.]): 10

USES
Basic research (%): 77
Development(%): 5
Therapy(%):
Isotope production (%): 4
Other application (%): 10
Maintenance (%): 1.5
Beam tuning(%): 2.5
Total time (h/year): 7500

TECHNICAL DATA
(a) Magnet: normal conducting Type: compact
Kb: 130 MeV Kf: 90 MeV/u
Average field (min./max. T): 1.77 (1.3-2.1)
Number of magnet sectors: 3
hill angular width (deg.): variable (51-81)
spiral (max): 58
Pole parameters
Diameter: 2.40
Injection radius (m): 0.0131-0.0188
Extraction radius (m): 0.94
Hill gap (m): 0.174 Valley gap (m): 0.330
Trim coils
Number: 15
Maximum current (A-turns): 2000

(b) RF
Frequency range (MHz): 10 - 21
Harmonic modes: 1, 2, 3
Number of dees: 2
Number of cavities: 2
Dee angular width (deg.): 78
Voltage
at injection (peak to ground, kV):
at extraction (peak to ground, kV):
peak (peak to ground, kV): 50
Line Power (max, kW): 100
Phase Stability (deg.):
Voltage Stability (%):

(c) Injection
Ion Source: 6.4 GHz & 14 GHz ECR, Multicusp
Source Bias Voltage (kV): 0 – 20
External Injection: Axial
Buncher Type: single gap (1st and 2nd harmonic)
Injection Energy (MeV/n):
Component:
Injection Efficiency (%): 30 – 70
Injector:

(d) Extraction
Elements, Characteristic:
• Electrostatic deflector, 50 kV
• Electromagnetic channel, 1250 A
Typical Efficiency (%): 50
Best Efficiency (%): 70

(e) Vacuum
Pumps: 2 cryo pumps (5000 l/s)
Achieved Vacuum (Pa): 5 x 10^-6

EXPERIMENTAL FACILITIES:
Isotope separator on line IGISOL, gas filled recoil separator RITU, gamma detector arrays, high efficiency neutron detector system HENDES, 1.5 m diam. scattering chamber, chamber for radiation defects studies
Layout of JYFL, University of Jyväskylä, Department of Physics
ENTRY N° C08
Date: 1989
Machine name: Orleans isochronous cyclotron
Institution: CNRS
Address: CERI
Telephone: 33 2 38 25 54 05
Fax: 33 2 38 63 02 71
Web Address: 
Person in charge of cyclotron: Briaud
Person reporting information: Briaud
E-mail address: briaud@cnrs-orleans.fr

HISTORY
Designed by: CGR MeV
 Constructed by: CGR MeV
 Construction dates: 1972
 First beam date: 1974

Characteristic beam, energy and current:
Protons  5-38MeV  50µA
Deutons  5-25MeV  50µA
Alphas     10-48MeV   30µA

Transmission efficiency (source to extracted beam)
Typical (%): 10
Best (%): 20

Emittance
Emittance definition:
Vertical (µm mrad):
Horizontal (µm mrad):
Longitudinal (dE/E[%] x RF[deg.]):

USES
Basic research (%): 60
Development(%): 5
Therapy(%): 
Isotope production (%): 20
Other application (%): 10
Maintenance (%): 5
Beam tuning(%):
Total time (h/year): 1800

TECHNICAL DATA
(a) Magnet:
Type: compact
Kb: Kf:
Average field (min./max. T): 1.1/1.9
Number of magnet sectors: 4
 hill angular width (deg.): 53
 spiral (max):
Pole parameters
 Diameter: 1.6
Injection radius (m): internal source
Extraction radius (m): 0.6
Hill gap (m): 0.13 Valley gap (m): 0.27

(b) RF
Frequency range (MHz): 20-40
Harmonic modes: 1-2-3-4
Number of dees: 2
Number of cavities: 2
Dee angular width (deg.): 60
Voltage
 at injection (peak to ground, KV): 40
 at extraction (peak to ground, KV): 40
 peak (peak to ground, KV):
Line Power (max, KW):
Phase Stability (deg.): 0.1
Voltage Stability (%): 10-3

(c) Injection
 Ion Source: PIG internal
 Source Bias Voltage (kV):
 External Injection:
 Buncher Type:
 Injection Energy (MeV/n):
 Component:
 Injection Efficiency (%):
 Injector:

(d) Extraction
 Elements, Characteristic: electrostatic
 Typical Efficiency (%): 55
 Best Efficiency (%): 60

(e) Vacuum
Pumps: oil diffusion 2*8000l/s
Achieved Vacuum (Pa): 8.10-6
Layout of Orleans isochronus cyclotron
ENTRY N° C09
Date: 1 Feb 2008
Machine name: C01
Institution: GANIL
Address: B.P. 5027-14076 CAEN Cedex 5-FRANCE
Telephone: (33)0231454647
Fax: (33)0231454665
Web Address: www.ganil.fr
Person in charge of cyclotron: G. Senecal
Person reporting information: P. Bertrand
E-mail address: savalle@ganil.fr, bertrand@ganil.fr

HISTORY
Designed by: GANIL
Construction dates: 1976-1980
Constructed by GANIL
First beam date: 1980

Characteristic beam, energy and current:
- C12: 1 (MeV/n) 1.E14 (pps) 1 (W)
- Ar36: 1 (MeV/n) 1.E14 (pps) 1 (W)
- U238: 0.3 (MeV/n) 1.E11 (pps) <1 (W)

Transmission efficiency (source to extracted beam):
Typical (%): 50
Best (%): 65

Emittance
Emittance definition: 90%
Vertical (π mm mrad): 40
Horizontal (π mm mrad): 40
Longitudinal (dE/E[%] x RF[deg.]): 0.5*6

USES
Basic research (%): 65
Development (%): 10
Therapy (%): 0
Isotope production (%): 0
Other application (%): 0
Maintenance (%): 10
Beam tuning (%): 15
Total time (h/year): 3000

TECHNICAL DATA
(a) Magnet: Type: compact
Kb: 28
Kf: 28
Average field (min./max. T): 1.565/1
Number of magnet sectors: 1
  hill angular width (deg.): none
  spiral (max): none
Pole parameters
  Diameter:
  Injection radius (m): 0.076
  Extraction radius (m): 0.488
  Hill gap (m): 0.021 Valley gap (m):

Trim coils
  Number: 6*2
  Maximum current (A-turns):

Harmonic coils
  Number:

Maximum current (A-turns):
Main coils
  Number: 1*2
Total current (A-turns):
Max current (A): 1000

(b) RF
Frequency range (MHz): 7 to 13.45
Harmonic modes: 3
Number of dees: 1
Number of cavities: 1
Dee angular width (deg.): 180
Voltage
  at injection (peak to ground, KV): 50 to 90
  at extraction (peak to ground, KV): peak (peak to ground, KV):
  Line Power (max, KW): 30
  Phase Stability (deg.): 0.1
  Voltage Stability (%): 0.01

(c) Injection
Ion Source: ECR4
Source Bias Voltage (kV): 100
External Injection: axial
Buncher Type: two harmonic buncher
Injection Energy (MeV/n): <0.024
Component: Spiral inflector
Injection Efficiency (%): 65
Injector:

(d) Extraction
Elements, Characteristic:
  1 electrostatic deflector, 1 electrostatic quadrupole
Typical Efficiency (%): 90
Best Efficiency (%): 100

(e) Vacuum
Pumps: 3 cryopumps
Achieved Vacuum (Pa): 5.10-6

EXPERIMENTAL FACILITIES:
Injector of SSC1, IRRSUD
ENTRY N° C10
Date: 1 Feb 2008
Machine name: C02
Institution: GANIL
Address: B.P 5027-14076 CAEN Cedex 5-FRANCE
Telephone: (33)0231454647
Fax: (33)0231454665
Web Address: www.ganil.fr
Person in charge of cyclotron: G. Senecal
Person reporting information: P. Bertrand
address: savalle@ganil.fr, bertrand@ganil.fr

HISTORY
Designed by: GANIL
Constructed by: GANIL
Construction dates: 1976-1980
First beam date: 1980
Characteristic beam, energy and current:
C12      1 (MeV/n)      5E13 (pps)      100 (w)
U238    0.3 (MeV/n)     1E+11 (pps)     <1 (w)
Transmission efficiency (source to extracted beam)
Typical (%): 20
Best (%): 30
Emittance
Emittance definition: 90%
Vertical (π mm mrad): 40
Horizontal (π mm mrad): 40
Longitudinal (dE/E [%] x RF[deg.]): 0.5*6

USES
Basic research (%): 65
Development(%): 10
Therapy(%): 0
Isotope production (%): 0
Other application (%): 0
Maintenance (%): 10
Beam tuning(%): 15
Total time (h/year): 3000

TECHNICAL DATA
(a) Magnet: compact      Type: compact
Kb: 28                      Kf: 28
Average field (min./max. T): 1.565/1
Number of magnet sectors: 1
  hill angular width (deg.): spiral (max): none
Pole parameters
  Diameter:
  Injection radius (m): 0.036
  Extraction radius (m): 0.488
  Hill gap (m): 0.021 Valley gap (m):
Trim coils
  Number: 6*2
  Maximum current (A-turns):
Harmonic coils
  Number:
  Maximum current (A-turns):

Main coils
  Number: 1*2
  Total current (A-turns):
  Maximum current (A):
  Stored energy (MJ):
  Total iron weight (tons):
  Total coil weight (tons):
  Power
  Main coils (total KW): 500
  Trim coils (total, maximum, KW):
  Refrigerator (cryogenic, KW):

(b) RF
  Frequency range (MHz): 7 to 13.45
  Harmonic modes: 3
  Number of dees: 1
  Number of cavities: 1
  Dee angular width (deg.): 180
  Voltage
    at injection (peak to ground, KV): 50 to 90
    at extraction (peak to ground, KV):
    peak (peak to ground, KV):
      Line Power (max, KW): 30
      Phase Stability (deg.): 0.1
      Voltage Stability (%): 0.01

(c) Injection
  Ion Source: ECR4M
  Source Bias Voltage (kV): 25
  External Injection: axial
  Buncher Type: two harmonic buncher
  Injection Energy (MeV/n):
    <0.0054
  Component: 1 Muller inflector
  Injection Efficiency (%): 25
  Injector:

(d) Extraction
  Elements, Characteristic:
    1 electrostatic deflector, 1 electrostatic quadrupole
  Typical Efficiency (%): 90
  Best Efficiency (%): 100

(e) Vacuum
  Pumps3 cryopumps
  Achieved Vacuum (Pa): 5.10-6

EXPERIMENTAL FACILITIES:
  Injector of SSC1, IRRSUD
ENTRY N° C11
Date: 1 Feb 2008
Machine name: CIME
Institution: GANIL
Address: B.P 5027-14076 CAEN Cedex 5-FRANCE
Telephone: (33)0231454647
Fax: (33)0231454665
Web Address: www.ganil.fr
Person in charge of cyclotron: G. Senecal
Person reporting information: A. Savalle
address: savalle@ganil.fr, bertrand@ganil.fr

HISTORY
Designed by: GANIL
Constructed by GANIL
First beam date: April 1998
RIB : September 2001

Characteristic beam, energy and current:
RIB 1,2-25 (MeV/n) <5.10**11 (pps)
Transmission efficiency (source to extracted beam)
Typical (%): 25
Best (%): 40

Emittance
Emittance definition:
Vertical (pi mm mrad): 20
Horizontal (pi mm mrad): 20
Longitudinal (dE/E[%] x RF[deg.]): 0.3*10

USES
Basic research (%): 50
Development(%): 25
Therapy(%): 
Isotope production (%):
Other application (%):
Maintenance (%): 15
Beam tuning(%): 10
Total time (h/year): 3000

TECHNICAL DATA
(a) Magnet:
Type:
Kb: 265
Average field (min./max. T): 1.56/0.75
Number of magnet sectors: 4
hill angular width (deg.): 44
spiral (max): none
Pole parameters
Diameter: 3.5
Injection radius (m): 0.034/0.045
Extraction radius (m): 1.5
Hill gap (m): 0.12
Valley gap (m): 0.3
Trim coils
Number: 11*2planes
Maximum current (A-turns): 400

Harmonic coils
Number: 2
Maximum current (A-turns): 200

Main coils
Number: 1*2planes
Total current (A-turns): 272000
Maximum current (A): 900
Stored energy (MJ):
Total iron weight (tons): 550
Total coil weight (tons): 4.5
Power
Main coils (total KW): 100
Trim coils (total, maximum, KW): 40
Refrigerator (cryogenic, KW):
(b) RF
Frequency range (MHz): 9.6 – 14.4
Harmonic modes: 2, 3, 4, 5, 6
Number of dees: 2
Number of cavities: 2
Dee angular width (deg.): 40
Voltage
at injection (peak to ground, KV): 100
at extraction (peak to ground, KV): 95
peak (peak to ground, KV):
Line Power (max, KW): 42*2
Phase Stability (deg.): 0.1
Voltage Stability (%): 0.02

(c) Injection
Ion Source: ECR
Source Bias Voltage (kV): 34
External Injection: axial
Buncher Type: saw tooth type
Injection Energy (MeV/n):
Component: Muller (Ri=0.034m)/ spiral(Ri=0.045m)
inflector
Injection Efficiency (%): 60
Injector:

(d) Extraction
Elements, Characteristic:
2 electrostatic deflectors 17 deg. 80 KV/cm2
magnetostatic channels 16 deg. CM1 = 5.2T/m; CM2 = 12.9T/m
Typical Efficiency (%): 60
Best Efficiency (%): 80

(e) Vacuum
Pumps: 1 cryogenic panel, 2 turbomolecular
Achieved Vacuum (Pa): 5.10-6

REFERENCES: M.Lieuvin et al. "Commissioning of SPIRAL, the GANIL radioactive beam facility", Int. conf. on Cyclotrons and their Applications, East Lansing, USA, may 2001

EXPERIMENTAL FACILITIES:
9 experiment rooms of the GANIL facility
ENTRY N° C12
Date: 1 Feb 2008
Machine name: CSS1
Institution: GANIL
Address: B.P 5027-14076 CAEN Cedex 5-FRANCE
Telephone: (33)0231454647
Fax: (33)0231454665
Web Address: www.ganil.fr
Person in charge of cyclotron: G. Senecal
Person reporting information: P. Bertrand
address: savalle@ganil.fr, bertrand@ganil.fr

HISTORY
Designed by: GANIL
Constructed by: GANIL
Construction dates: 1976-1982
First beam date: nov 1982
Characteristic beam, energy and current:
C12 13.7 (MeV/n) 2E13 (pps) 500 (w)
U238 5.5 (MeV/n) 5E10 (pps) <1 (w)
Transmission efficiency (source to extracted beam)
Typical (%): 90
Best (%): 100

Emittance
Emittance definition: 90%
Vertical (pi mm mrad): 7
Horizontal (pi mm mrad): 7
Longitudinal (dE/E[%] x RF[deg.]): 0.2*4

USES
Basic research (%): 70
Development(%): 5
Therapy(%):
Isotope production (%):
Other application (%):
Maintenance (%): 15
Beam tuning(%): 10
Total time (h/year): 5000

TECHNICAL DATA
(a) Magnet: Type: separated sectors
Kb: 380
Kf: 380
Average field (min./max. T): 0.95/0.39
Number of magnet sectors: 4
hill angular width (deg.): 52
spiral (max): none
Pole parameters
Diameter: 7
Injection radius (m): 0.81
Extraction radius (m): 3
Hill gap (m): 0.01 Valley gap (m):
Trim coils
Number: 32*4*2 (42 power supply)
Maximum current (A-turns):
Harmonic coils
Number: 4*2
Maximum current (A-turns):
Main coils
Number: 1*2
Total current (A-turns): 190000
Maximum current (A): 1850
Stored energy (MJ):
Total iron weight (tons): 1700
Total coil weight (tons): 14
Power
Main coils (total KW): 950
Trim coils (total, maximum, KW): 140
Refrigerator (cryogenic, KW): none

(b) RF
Frequency range (MHz): 7 – 13.45
Harmonic modes: 5
Number of dees: 2
Number of cavities: 2
Dee angular width (deg.): 34
Voltage
at injection (peak to ground, KV): 160
at extraction (peak to ground, KV):
peak (peak to ground, KV):
Line Power (max, KW): 100
Phase Stability (deg.): 0.1
Voltage Stability (%): 0.01

(c) Injection
Ion Source:
Source Bias Voltage (kV):
External Injection: radial
Buncher Type: harmonic 1
Injection Energy (MeV/n):
Component: 4 mag. Channels , 1 inflector
Injection Efficiency (%): 100
Injector: C01 or C02

(d) Extraction
Elements, Characteristic:
1 electrostatic deflector 4 magnetic channels
Typical Efficiency (%): 90
Best Efficiency (%): 98

(e) Vacuum
Pumps: 8 cryopumps and 4 turbopumps
Achieved Vacuum (Pa): 6 10-6

EXPERIMENTAL FACILITIES:
Injector of SSC2, Medium Energy room (SME) + 9 experimental rooms
ENTRY Nº C13

Date: 1 Feb 2008
Machine name: CSS2
Institution: GANIL
Address: B.P 5027-14076 CAEN Cedex 5-FRANCE
Telephone: (33)0231454647
Fax: (33)0231454665
Web Address: www.ganil.fr

Person in charge of cyclotron: G. Senecal
Person reporting information: A. Savalle
address: savalle@ganil.fr, bertrand@ganil.fr

HISTORY
Designed by: GANIL
Constructed by: GANIL
Construction dates: 1976-1982
First beam date: 1982

Characteristic beam, energy and current:
- C12 95 MeV.A 2E13 pps
- U238 24 MeV.A 1E10 pps

Transmission efficiency (source to extracted beam)
Typical (%): 90
Best (%): 100

Emittance
Emittance definition:
Vertical (pi mm mrad): 5
Horizontal (pi mm mrad): 5
Longitudinal (dE/E[%] x RF[deg.]): 0.3*6

USES
Basic research (%): 70
Development(%): 5
Therapy(%): 0
Isotope production (%): 0
Other application (%): 0
Maintenance (%): 15
Beam tuning(%): 10
Total time (h/year): 5000

TECHNICAL DATA
(a) Magnet
- Magnet: separated sectors
- Type: Kb: 380 Kf: 380
- Average field (min./max. T): 0.95/0.39
- Number of magnet sectors: 4
  - hill angular width (deg.): 52
    - spiral (max): none
- Pole parameters
  - Diameter: 7
  - Injection radius (m): 1.2
  - Extraction radius (m): 3
  - Hill gap (m): 2
  - Valley gap (m): 2

Trim coils
- Number: 32*4sec*2Planes (42 power supply)
- Maximum current (A-turns): 190000

Harmonic coils
- Number: 4*2 planes
- Maximum current (A-turns): 1850

(b) RF
- Frequency range (MHz): 7 – 13.45
- Harmonic modes: 2
- Number of dees: 2
- Number of cavities: 2
- Dee angular width (deg.): 34
- Voltage
  - at injection (peak to ground, KV): 220
  - at extraction (peak to ground, KV): 140
- Line Power (max, KW): 100
- Phase Stability (deg.): 0.1
- Voltage Stability (%): 0.01

(c) Injection
- Ion Source:
  - Source Bias Voltage (kV):
  - External Injection: radial
- Buncher Type:
  - Injection Energy (MeV/n):
  - Component: 4 mag. Channels , 1 inflector
- Injection Efficiency (%): 100

(d) Extraction
- Elements, Characteristic:
  - 1 electrostatic deflector 4 magnetic channels
- Typical Efficiency (%): 90
- Best Efficiency (%): 100

(e) Vacuum
- Pumps: 8 cryopumps and 4 turbopumps
- Achieved Vacuum (Pa): 6 10-6

EXPERIMENTAL FACILITIES:
9 experiment rooms of the GANIL. + Facility Production of radioactive beams using fragmentation and ISOL techniques
ENTRY N° C14
Date: 12.11.2007
Machine name: JULIC
Institution: Institut für Kernphysik
Address: Forschungszentrum Jülich GmbH
Leo Brandt Straße, 52428 Jülich, Germany
Telephone: +49 2461 61 3097
Fax: +49 2461 61 2854
Web Address: www.fz-juelich.de/ikp
Person in charge of cyclotron: R. Gebel
Person reporting information: R. Gebel
E-mail address: r.gebel@fz-juelich.de

HISTORY
Designed by: AEG
Constructed by: AEG
Construction dates: 1966-1968
First beam date: 1968
Characteristic beam, energy and current:
45 MeV H−, 75 MeV D− (10 µA unpol., 1 µA pol.)
Transmission efficiency (source to extracted beam)
Typical (%): 5
Best (%): 15
Emittance
Emittance definition: RMS
Vertical (π mm mrad): 6.4
Horizontal (π mm mrad): 3.2
Longitudinal (dE/E[%] x RF[deg.]): 0.3

USES
Basic research (%): 95
Development(%): 1
Therapy(%): 0
Isotope production (%): 1
Other application (%): 0
Maintenance (%): 2
Beam tuning(%): 1
Total time (h/year): 7500

TECHNICAL DATA
(a) Magnet: Type: solid pole
Kb: 180 Kf:
Average field (min./max. T): (0.95/1.35)
Number of magnet sectors: 3
well angular width (deg.): 60
spiral (max): 20
Pole parameters
Diameter: 3.3 m
Injection radius (m): 0.03
Extraction radius (m): 1.54
Hill gap (m): 0.084 Valley gap (m): 0.24
Trim coils
Number: 9
Maximum current (A-turns): 960
Harmonic coils
Number: -
Maximum current (A-turns):
Main coils
Number: 1
Total current (A-turns): 151200
Maximum current (A): 360
Stored energy (MJ):
Total iron weight (tons): 700
Total coil weight (tons): 12
Power
Main coils (total KW): 50
Trim coils (total, maximum, kW): 12
Refrigerator (cryogenic, KW): -
(b) RF
Frequency range (MHz): 20-30
Harmonic modes: 3
Number of dees: 3
Number of cavities:
Dee angular width (deg.): 40
Voltage
at injection (peak to ground, KV): 45
at extraction (peak to ground, KV): 30
peak (peak to ground, KV):
Line Power (max, KW): 100
Phase Stability (deg.): <0.5
Voltage Stability (%): <0.05
(c) Injection
Ion Source:
2 multicusp ion sources, polarized ion sources
Source Bias Voltage (kV): 4.5/n
External Injection: yes
Buncher Type: harmonic, sawtooth
Injection Energy (MeV/n): 0.0045/n
Component: hyperboloid inflector
Injection Efficiency (%): 30
Injector: -
(d) Extraction
Elements, Characteristic:
Electrostatic deflector, focusing channel,
Multiturn extraction
Typical Efficiency (%): 60
Best Efficiency (%): 75
(e) Vacuum
Pumps: 2 TMP (each 2800 l/s),
3 Cryo pumps (each 10000 l/s)
Achieved Vacuum (mbar): <2.0 × 10⁻⁷

EXPERIMENTAL FACILITIES
Cooler synchrotron facility COSY/Jülich
ENTRY Nº C15
Date: January 2008
Machine name: PT (former ISL, former VICKSI)
Institution: Hahn-Meitner-Institut Berlin GmbH
Address: Glienicker Str. 100
Telephone: ++49-30-8062-2415
Fax: ++49-30-8062-2097
Web Address: www.hmi.de/pt
Person in charge of cyclotron: A. Denker
Person reporting information: A. Denker
E-mail address: denker@hmi.de

HISTORY
Designed by: in house, Scanditronix and other
Constructed by: in house, Scanditronix and other
Construction dates: design: 1973-74
Construction: 1974-76
First beam date: June 1977

Characteristic beam, energy and current:
\[
p = 72 \text{ MeV} \quad 6 \times 10^{12} \text{ pps}
\]
in principle also other beams possible…..

Transmission efficiency (source to extracted beam)
Typical (%): 10%
Best (%): 30%

Emittance
Emittance definition: normalised
Vertical (\(\text{pi mm mrad}\)): 0.4 \(\text{pi mm mrad}\)
Horizontal (\(\text{pi mm mrad}\)): 0.4 \(\text{pi mm mrad}\)
Longitudinal (\(\Delta E/E[\%] \times \text{RF[deg.]}\)): 0.1 \(\times \) 6

USES
Basic research (%):
Development(%):
Therapy(%): 100%
Isotope production (%):
Other application (%):
Maintenance (%): outside beam time
Beam tuning(%):
Total time (h/year): \(~ 1200\)

TECHNICAL DATA
(a) Magnet:
Type: separated sector
Kb: 132
Kf:
Average field (\(\text{min./max. T}\)): 0.89 \(T_{\text{max}}\)
Number of magnet sectors: 4
hill angular width (deg.): 50
spiral (max): -
Pole parameters
Diameter: -
Injection radius (m): 0.43 m
Extraction radius (m): 1.71 m
Hill gap (m): 0.06 m Valley gap (m): open

Trim coils
Number: 9 x 2
Maximum current (A-turns): 100 A turns

Harmonic coils
Number: 3 x n_sector x 2

Maximum current (A-turns): 150 A turns
Main coils
Number: 1 x 2
Total current (A-turns): 2000 x 30 A turns
Maximum current (A): 2000 A
Stored energy (MJ): -
Total iron weight (tons): 360 t
Total coil weight (tons): 6 t
Power
Main coils (total KW): 400 kW
Trim coils (total, maximum, KW): 60 kW
Refrigerator (cryogenic, KW): -

(b) RF
Frequency range (MHz): 10-20 MHz
Harmonic modes: 2-8
Number of dees: 2
Number of cavities: 2
Dee angular width (deg.): 26
Voltage
at injection (peak to ground, KV): 140 kV
at extraction (peak to ground, KV): 100 kV
peak (peak to ground, KV): 140 kV
Line Power (max, KW): 200 kW
Phase Stability (deg.): < 0.1°
Voltage Stability (%): < 0.05%

(c) Injection
Ion Source: external injector: Van-de-Graaff
Source Bias Voltage (kV):
External Injection: radial
Buncher Type: external, 60% in 6°
Injection Energy (MeV/n): 0.09 – 4 MeV/u
Component: 2 magnetic, 1 electrostatic
Injection Efficiency (%): > 70%
Injector: 5.5 MV Van-de-Graaff

(d) Extraction
Elements, Characteristic: 2 magnetic, 1 electrostatic
Typical Efficiency (%): 95%
Best Efficiency (%): 100%

(e) Vacuum
Pumps: 2 cryogenic, 2 turbomolecular
Achieved Vacuum (Pa): 1e5 Pa

EXPERIMENTAL FACILITIES
Treatment area for eye tumours, dosimetry check, quality control, energy analysis

COMMENTS: The facility undergoes the transformation from a flexible, multi-ion and energy variable facility for basic and applied research to a dedicated eye tumour facility.
ENTRY N° C16
Date: 14 Feb 2008
Machine Name: Karlsruher Compakt Anlage, KAZ
Institution: ZAG Zyklotron AG
Address: D-76344 Eggenstein-Leopoldshafen, Hermannvon. Helmholz-Platz 1
Telephone: +49-7247-823383
Fax: +49-7247-823156
Web Address: www.zyklotron-ag.de <http://www.zyklotron-ag.de/>
Person in Charge of Cyclotron: H.Schweickert
Person Reporting Information: H.Schweickert
E-mail Address: Hermann.Schweickert@zyklotron-ag.de

HISTORY
Designed by: TCC, The Cyclotron Corporation, CP42H
Construction Dates: 1979 - 1982
First Beam Date: 1983
Characteristic Beams
ions / energy(MeV/N)/current(pps)/power(w)
p 42 1.25 E15 8400
Transmission Efficiency (source to extracted beam)
Typical (%): 80
Best (%): 90
Emittance
Emittance Definition: 90%
Vertical (pi mm mrad): 10
Horizontal (pi mm mrad): 10
Longitudinal (dE/E[%] x RF[deg.]):
USES
Basic Research (%): 5
Development (%): 10
Therapy (%): Isotope Production (%): 30
Other Application (%): 30
Maintenance (%): 3
Beam Tuning (%): 2
Total Time (h/year): ca. 5000

TECHNICAL DATA
(a)Magnet
Type: compact
Kb (MeV): 42
Kf (MeV):
Average Field (min./max. T): 1.84
Number of Sectors: 3
Hill Angular Width (deg.):
Spiral (deg.): 64
Pole Diameter (m): 1.20
Injection Radius (m):
Extraction Radius (m): 0.53
Hill Gap (m): 0.05
Valley Gap (m): 0.12
Trim Coils
Number: 3x2
Maximum Current (A-turns):

(b)RF
Frequency Range (MHz): 26.5
Harmonic Modes: 1
Number of Dees: 1
Number of Cavities:
Dee Angular Width (deg.): 90
Voltage
At Injection (peak to ground, KV):
At Extraction (peak to ground, KV):
Peak (peak to ground, KV): 35
Line Power (max, KW): 100
Phase Stability (deg.):
Voltage Stability (%): 0.01

(c)Injection
Ion Source: internal cold cathode penning
Source Bias Voltage (kV): 1.200
External Injection:
Buncher Type:
Injection Energy (MeV/n):
Component:
Injection Efficiency (%):
Injector:

(d)Extraction
Elements, Characteristic: Charge exchange Foil efficiency
Typical Efficiency (%): 90
Best Efficiency (%): 95

(e)Vacuum
Pumps: 4 diffusion pumps
Achieved Vacuum (Pa): 1.33*E10-5
ENTRY N° C17

Date: 08 November 2007 16:39:49
Machine Name: Variable Energy Cyclotron
Institution: Variable Energy Cyclotron Centre, Department of Atomic Energy.
Address: 1/AF, BIDHAN NAGAR, CALCUTTA-700064, INDIA
Telephone: +91 33 2337-1230
Fax: +91 33 2334-6871
Web Address: http://veccal.ernet.in

Person in Charge of Cyclotron: Bikash Sinha
Person Reporting Information: C. Mallik / R. K. Bhandari
E-mail Address: mallik@veccal.ernet.in, bhandari@veccal.ernet.in

HISTORY

Designed by: in house
Constructed by: in house
Construction Dates: 1969-77
First Beam Date: June 1977 (Internal), July 1978 (External)

Characteristic Beams

<table>
<thead>
<tr>
<th>Ions</th>
<th>Energy (MeV)</th>
<th>Current (ppps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proton</td>
<td>7-20 MeV</td>
<td>3E13</td>
</tr>
<tr>
<td>Deuteron</td>
<td>14 MeV</td>
<td>5E12</td>
</tr>
<tr>
<td>Alpha</td>
<td>25-80 MeV</td>
<td>3E13</td>
</tr>
<tr>
<td>Oxygen</td>
<td>115-180 MeV</td>
<td>1.2E12</td>
</tr>
<tr>
<td>Neon</td>
<td>140-240 MeV</td>
<td>3E11</td>
</tr>
<tr>
<td>Sulphur</td>
<td>230 MeV</td>
<td>3E10</td>
</tr>
<tr>
<td>Argon</td>
<td>280-350 MeV</td>
<td>5E10</td>
</tr>
</tbody>
</table>

Transmission Efficiency (source to extracted beam)
Typical (%): 1.5 for external ECR Source
Best (%): 5
Emittance

Emittance Definition:
Vertical (π mm mrad): 17 (90%)
Horizontal (π mm mrad): 22 (90%)
Longitudinal (dE/E[%] x RF[deg.]): 0.8x30

USES

Basic Research (%): 40
Development (%): 15
Therapy (%):
Isotope Production (%):
Other Application (%):
Maintenance (%): 30
Beam Tuning (%): 15
Total Time (h/year): 6000 (Average)

TECHNICAL DATA

(a) Magnet
Type: compact
Kb (MeV): 130
Kf (MeV): 70
Average Field (min./max. T): 1.7
Number of Sectors: 3
Hill Angular Width (deg.): 60
Spiral (deg.): 55 max

Pole Diameter (m): 2.24
Injection Radius (m): 0
Extraction Radius (m): 0.99
Hill Gap (m): 0.19
Valley Gap (m): 0.30
Trim Coils
Number: 17x2
Maximum Current (A-turns): 2000
Harmonic Coils
Number: 5xNsectorsx2
Maximum Current (A-turns): 300
Main Coils
Number: 1x2
Total Ampere Turns: 400000
Maximum Current (A): 2000
Power
Main Coils (total KW): 230
Trim Coils (total, maximum, KW): 250
Refrigerator (cryogenic, KW):
(b) RF
Frequency Range (MHz): 5.5-15.5
Harmonic Modes: 1, 3
Number of Dees: 1 with Dummy Dee
Number of Cavities: 1
Dee Angular Width (deg.): 180
Voltage
At Injection (peak to ground, KV): 50
At Extraction (peak to ground, KV): 50
Peak (peak to ground, KV): 50
Line Power (max, KW): 300
Phase Stability (deg.):
Voltage Stability (%): 0.2

(c) Injection
Ion Source: PIG, ECRIS
Source Bias Voltage (kV): 8-10
External Injection: axial
Buncher Type: First harmonic, Double Drift
Injection Energy (MeV/n): 0.003-0.004 (typical)
Component: 90 degree Analysing magnet, glaser lenses, Quadrupoles, 2x45 degree Dipoles
source bias voltage: 8-10kV
Injection Efficiency (%): 30 to 40
Injector: Mirror Inflector

(d) Extraction
Elements, Characteristic: 2 Electrostatic deflectors
Typical Efficiency (%): 25
Best Efficiency (%): 40

(e) Vacuum
Pumps: Oil Diffusion, Cryopump on Dee tank
Achieved Vacuum (Pa): 5E-4 (typical)

REFERENCES
Conf. Proceedings of Intl. Cyclotron Conferences
EXPERIMENTAL FACILITIES
915mm Scattering chamber, Target and Detector Lab., Radiochemistry, Radio-Isotope Lab., ISOL System, Rabbit, Online Data analysing computer. RIB facility, Indian National Gamma Array Facility

COMMENTS
Cyclotron has been delivering heavy Ion beams to experimentalists. A number of sub-systems are being upgraded presently. After the upgradation work the cyclotron will also deliver light ion beams for Radioactive Ion Beam Facility.
ENTRY N° C18
Date: 08 November 2007
Machine Name: Kolkata Superconducting Cyclotron
Institution: Variable Energy Cyclotron Centre, Department of Atomic Energy.
Address: 1/AF, BIDHAN NAGAR, KOLKATA-700064,INDIA
Telephone: +91 33 2337-1230
Fax: +91 33 2334-6871
Web Address: http://veccal.ernet.in
Person in Charge of Cyclotron: Bikash Sinha
Persons Reporting Information: R. K. Bhandari / C. Mallik
E-mail Address: bhandari@veccal.ernet.in , mallik@veccal.ernet.in

HISTORY
Designed by: Design adapted from MSU and Texas A&M K500 cyclotron
Constructed by: in house
First Beam Date: Scheduled to be commissioned April 2008

Characteristic Beams
Ions Energy(MeV) Current(pps) Transmission Efficiency (source to extracted beam)
Typical (%):
Best (%):
Emittance
Emittance Definition:
Vertical (pi mm mrad):
Horizontal (pi mm mrad):
Longitudinal (dE/E[\%] x RF[deg.]):

USES
Basic Research (%):
Development (%):
Therapy (%):
Isotope Production (%):
Other Application (%):
Maintenance (%):
Beam Tuning (%):
Total Time (h/year):

TECHNICAL DATA
(a)Magnet
Type: compact superconducting
Kb (MeV): 520
Kf (MeV): 160
Average Field (min./max. T): 3.0/4.9
Number of Sectors: 3
Hill Angular Width (deg.): 60
Spiral (deg.): 118 (magnetic)
Pole Diameter (m): 1.42
Injection Radius (m): 0.008
Extraction Radius (m): 0.67
Hill Gap (m): 0.0635
Valley Gap (m): 0.914

Trim Coils square coils, horizontal axis
Number: (13x3 sectors)+1circular x 2

Maximum Current (A-turns): 400x20/2
Harmonic Coils
Number: 2xNsectorsx2
Maximum Current (A-turns): 400x20/2
Main Coils
Number: 2x2
Total Ampere Turns: 4.4E6

Maximum Current (A): 800
Stored Energy (MJ): 18
Total Iron Weight (tons): 90
Total Coil Weight (tons): 7
Power
Main Coils (total KW): 0
Trim Coils (total, maximum, KW): 130
Refrigerator (cryogenic, KW): 0.25

(b)RF
Frequency Range (MHz): 9-27.5
Harmonic Modes: 1
Number of Dees: 3
Number of Cavities: 3
Dee Angular Width (deg.): 60
Voltage
At Injection (peak to ground, KV): 90
At Extraction (peak to ground, KV): 90
Peak (peak to ground, KV): 90
Line Power (max, KW): 300
Phase Stability (deg.): 0.5
Voltage Stability (%): 0.01

(c)Injection
Ion Source: Two 14 GHz ECR ion sources
Source Bias Voltage (kV): 2-20
External Injection: axial
Buncher Type: First harmonic,Double Drift
Injection Energy (MeV/n): 0.0005-0.0007
Component: 4x 90° magnet, solenoid lenses, quadrupoles, 1x45 degree Dipoles
Injection Efficiency (%):
Injector: Spiral Inflector

(d)Extraction
Elements, Characteristic: Electrostatic deflectors(2), moveable magnetic passive Channels(8), compensating bars (2), active combined function magnet(1)
Typical Efficiency (%):
Best Efficiency (%):

(e)Vacuum
Pumps: 3 cryopanels and 3 TMP
Achieved Vacuum (Pa):

EXPERIMENTAL FACILITIES
Multipurpose scattering chamber, $4\pi$ charged particle detector array, $4\pi$ neutron multiplicity detector, High energy gamma detector array, superconducting penning ion trap, Irradiation facility for nuclear chemistry and condensed matter physics

COMMENTS
The superconducting magnet of the Cyclotron has been commissioned and field mapping completed. Installation of other systems/components is going on. Beam trials are expected during April 2008.
ENTRY N° C19
Date: 9 Nov 2007
Machine name: LNS Superconducting Cyclotron
Institution: Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali del Sud
Address: via S. Sofia 62, 95123 Catania, Italy
Telephone: +39-095-542111
Fax: +39-095-7141815
Web Address: www.lns.infn.it
Person in charge of cyclotron: Danilo Rifuggiato
Person reporting information: Danilo Rifuggiato
E-mail address: rifuggiato@lns.infn.it

HISTORY
Designed by: F. Resmini
Constructed by: in house
Construction dates: start in 1981, assembled in 1993
First beam date: 1994

Characteristic beam, energy and current:
- H2+ 80 AMeV 10 enA
- 13C4+ 45 AMeV 1000 enA
- 112Sn31+ 43.5 AMeV 5 enA
- 197Au36+ 23 AMeV 5 enA

Transmission efficiency (source to extracted beam)
- Typical (%): 6
- Best (%): 15

Emittance
- Emittance definition: 90%
- Vertical (π mm mrad): 1
- Horizontal (π mm mrad): 2
- Longitudinal (dE/E[%) x RF[deg.]): 4.5

USES
- Basic research (%): 35
- Development(%): 5
- Therapy(%): 15
- Isotope production (%): 15
- Other application (%): 15
- Maintenance (%): 10
- Beam tuning (%): 20
- Total time (h/year): 4500

TECHNICAL DATA
(a) Magnet:
- Type: compact
- Kb: 800
- Kf: 200
- Average field (min./max. T): 2.2/4.8
- Number of magnet sectors: 3
  - Hill angular width (deg.): 60
  - Spiral (max): 69
- Pole parameters
  - Diameter (m): 1.8
  - Injection radius (m): 0.018
  - Extraction radius (m): 0.87
  - Hill gap (m): 0.086
  - Valley gap (m): 0.916
- Trim coils
  - Number: 20

(b) RF
- Frequency range (MHz): 15-48
- Harmonic modes: 2
- Number of dees: 3
- Number of cavities: 3
- Dee angular width (deg.): 60

(c) Injection
- Ion Source: 2 ECR sources
- Source Bias Voltage (kV): 26
- External Injection: axial
- Buncher Type: single drift
- Injection Energy (MeV/n): 0.010-0.026*q/A
- Component: magn. quad. and solenoids, dipoles
- Injection Efficiency (%): 15
- Injector:

(d) Extraction
- Elements, Characteristic: 2 electrost. defl., 7 passive magnetic channels
- Typical Efficiency (%): 30
- Best Efficiency (%): 65

(e) Vacuum
- Pumps: rotative, turbomolecular, cryo-split
- Achieved Vacuum (Pa): 2*10E-4

REFERENCES: L. Calabretta and D. Rifuggiato, Status and future plans at LNS Catania, Proc. of the XVI Int. Conf. on Cyclotrons and their Appl., 2001, p. 79

EXPERIMENTAL FACILITIES: Chimera and Medea (4πi detectors), Catana (proton therapy facility), Magnex (magnetic spectrometer)
ENTRY N° C20
Date: 6 Dec. 2007
Machine name: CYRIC AVF Cyclotron
Institution: CYRIC, Cyclotron and Radioisotope Center, Tohoku University
Address: Aramaki, Aoba, Sendai, 980-8578, Japan
Telephone: +81-(0)22-217-7800
Fax: +81-(0)22-217-7997
Web Address: http://www.cyric.tohoku.ac.jp/
Person in charge of cyclotron: Tsutomu Shinozuka
Person reporting information: Tsutomu Shinozuka
E-mail address: shino@cyric.tohoku.ac.jp

HISTORY
Designed by: Sumitomo Heavy Industry and CYRIC, Tohoku University
Constructed by: Sumitomo Heavy Industry and CYRIC, Tohoku University
First beam date: March 6 2000

Characteristic beam, energy and current:
<table>
<thead>
<tr>
<th>Particle</th>
<th>Energy (MeV)</th>
<th>Current (micro A)</th>
<th>Power (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>10-90</td>
<td>10</td>
<td>900</td>
</tr>
<tr>
<td>d</td>
<td>10-55</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>4He</td>
<td>20-110</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>12C</td>
<td>6-12</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>H-</td>
<td>10-50</td>
<td>300 microA (goal)</td>
<td>(1.5 kW)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30 microA (present)</td>
<td></td>
</tr>
</tbody>
</table>

Transmission efficiency (source to extracted beam):
Typical (%): 50
Best (%): 80
Emittance
Vertical (π mm mrad): 12
Horizontal (π mm mrad): 15
Longitudinal (dE/E[%] x RF[deg.]):

USES
Basic research (%): 40
Development(%): 10
Therapy(%): 0
Isotope production (%): 20
Other application (%): 20
Maintenance (%): 5
Beam tuning(%): 5
Total time (h/year): 4100

TECHNICAL DATA
(a) Magnet: Type: compact
Kb: 110 (MeV) Kb: 90 (MeV)
Average field (min./max. T): 1.66/1.96
Number of magnet sectors: 4
hill angular width (deg.):
spiral (max): 53
Pole parameters
Diameter: 2.16
Injection radius (m): 0.025
Extraction radius (m): 0.93
Hill gap (m): 0.166 Valley gap (m): 0.405
Trim coils

Number: 12 x 2
Maximum current (A-turns): 1500

Harmonic coils
Number: 8x2 ( Upper and Lower )
Maximum current (A-turns): 1000

Main coils
Number: 1 x 2 ( Upper and Lower )
Total current (A-turns):
Maximum current (A): 900
Stored energy (MJ):
Total iron weight (tons): 220
Total coil weight (tons): 9

Power
Main coils (total KW): 230
Trim coils (total, maximum, KW): 80
Refrigerator (cryogenic, KW):

(b) RF
Frequency range (MHz): 10.6 – 22.0
Harmonic modes: 1st, 2nd and 3rd
Number of dees: 2
Number of cavities: 2
Dee angular width (deg.): 86
Voltage
peak (peak to ground, KV): 60
Line Power (max, KW): 70x2
Phase Stability (deg.): 0.5
Voltage Stability (%): 0.1

(c) Injection
Ion Source: Ext. sources ( ECR x 2, multi-cusp for H-)
Source Bias Voltage (kV):
External Injection: axial
Buncher Type: single-gap, saw-tooth
Injection Energy (MeV/n): 0.003-0.02
Component: 90-deg, BM and other 3 BMs, Q(6), solenoid(4), spiral-inflcetor
Injection Efficiency (%): 30
Injector:

(d) Extraction
Elements,Characteristic:ES-deflector and stripper foil
Typical Efficiency (%): 60 deflector, 90 for stripper
Best Efficiency (%): 85

(e) VacuumPumps:
CRYO x 4 ( 4000 l/s for N2) TMP(2000 l/s x 6)
Achieved Vacuum (Pa): 1.0E-4


EXPERIMENTAL FACILITIES
10 target stations: short/long lived RI production, onlne mass-separator, fast neutron time of facility, fast neutron beam source, general purpose, bio-physics etc. small cyclotron(12 MeV proton) for PET RI production.
K=110 MeV AVF cyclotron

Three Ion Sources
1) 4GHz ECR (All Permanent Magnets)
2) Compact ECR
3) Cusp-type negative ion source
ENTRY No C21

Date: 12 Feb. 2008
Machine name: JAEA AVF Cyclotron
Institution: Japan Atomic Energy Agency
Address: 1233 Watanuki, Takasaki, Gunma 370-1292, Japan
Telephone: +81-27-346-9630
Fax: +81-27-346-9690
Web Address: http://www.jaea.go.jp
Person in charge of cyclotron: T. Nara
Person reporting information: W. Yokota
E-mail address: yokota.wataru@jaea.go.jp

HISTORY
Designed by: Sumitomo Heavy Industries, Ltd.
Constructed by: Sumitomo Heavy Industries, Ltd.
First beam date: 17 March, 1991

Characteristic beam, energy and current:
- \(^{1}H^+\) 90 MeV/N 10 eµA
- \(^{4}He^{2+}\) 30 10
- \(^{12}C^{5+}\) 18.3 1.0
- \(^{40}Ar^{13+}\) 11.5 0.045
- \(^{129}Xe^{23+}\) 3.5 0.20
- \(^{197}Au^{31+}\) 2.5 0.038

Transmission efficiency (source to extracted beam)
Typical (%): 15
Best (%): 30

Emittance
Emittance definition: 80 %
Vertical (π mm mrad): 13
Horizontal (π mm mrad): 9
Longitudinal (dE/E[ % ] x RF[deg.]):

USES
Basic research (%): 13
Development(%): 10
Therapy(%): 0
Isotope production (%): 2
Other application (%): 55
Maintenance (%): 0
Beam tuning(%): 20
Total time (h/year): 3459

TECHNICAL DATA
(a) Magnet:
- Type: compact
- Kb: 110
- Kf: 95
- Average field (min./max. T): 1.67
- Number of magnet sectors: 4
- Hill angular width (deg.):
  - spiral (max): 53
- Pole parameters
  - Diameter: 2.156
  - Injection radius (m): 0.013, 0.016, 0.019 (h=1,2,3)
  - Extraction radius (m): 0.923
  - Hill gap (m): 0.166
  - Valley gap (m): 0.405
- Trim coils
  - Number: 12 x 2
  - Maximum current (A-turns): 800 A

Harmonic coils
- Number: 8 x 2
- Maximum current (A-turns): 50 A

Main coils
- Number: 1 x 2
- Total current (A-turns): 432000
- Maximum current (A): 900
- Stored energy (MJ):
- Total iron weight (tons): 220
- Total coil weight (tons): 5
- Power
  - Main coils (total KW): 250
  - Trim coils (total, maximum, KW): 52
  - Refrigerator (cryogenic, KW):

(b) RF
- Frequency range (MHz): 10.6-22.0
- Harmonic modes: 1,2,3
- Number of dees: 2
- Number of cavities: 2
- Dee angular width (deg.): 86
- Voltage
  - at injection (peak to ground, KV): 60
  - at extraction (peak to ground, KV): 57
  - peak (peak to ground, KV): 60
- Line Power (max, KW): 50
- Phase Stability (deg.): +0.5
- Voltage Stability (%): +0.1

(c) Injection
- Ion Source: Multi-cusp x 1, ECR x 2
- Source Bias Voltage (kV): 3-20
- External Injection: axial
- Buncher Type: twin gaps, sine wave
- Injection Energy (MeV/n): 0.017 (max.)
- Component:
  - Injection Efficiency (%):
  - Injector:

(d) Extraction
- Elements, Characteristic:
  - Electrostatic deflector:60kV, Electromagnetic coil:1430A,
  - Passive-type field gradient corrector
- Typical Efficiency (%): 60
- Best Efficiency (%): 95

(e) Vacuum
- Pumps: cryo(4000L/s) x 2, TMP(2000L/s) x 2
- Achieved Vacuum (Pa): 1.2e-5 Pa

REFERENCES:

EXPERIMENTAL FACILITIES: Wide-area ion irradiation chamber, Positron emitting tracer imaging system (PETIS),
Heavy ion microbeam System, Quasi-monoenergetic neutron source, Beam chopping system (pulsed type + sinusoidal type),
Beam scanner
ENTRY N° C22
Date: 11 Feb 2008
Machine name: RCNP AVF Cyclotron
Institution: Research Center for Nuclear Physics
Address: 10-1 Mihogaoka, Ibaraki, Osaka 567-0047, Japan
Telephone: +81-6-6879-8830
Fax: +81-6-6879-8899
Web Address: http://www.rcnp.osaka-u.ac.jp
Person in charge of cyclotron: Kichiji Hatanaka
Person reporting information: Kichiji Hatanaka
E-mail address: hatanaka@rcnp.osaka-u.ac.jp

HISTORY
Designed by: RCNP, Osaka University
Constructed by: Sumitomo Heavy Industries, Ltd.
Construction dates: 1971-1973
First beam date: 1974

Characteristic beam, energy and current:
- H+ 80 MeV/N 5 e-μA
- 3He2+ 53 5
- 4He2+ 35 5
- 18O6+ 13.7 6
- 86Kr23+ 8.5 0.1

Transmission efficiency (source to extracted beam)
Typical (%): 5
Best (%): 10

Emittance
Emittance definition: RMS
Vertical (μm mrad): 5
Horizontal (μm mrad): 5
Longitudinal (dE/E[%] x RF[deg.]): 0.1 x 6

USES
Basic research (%): 43
Development(%): 31
Therapy(%): 0
Isotope production (%): 0
Other application (%): 4
Maintenance (%): 16
Beam tuning(%): 6
Total time (h/year): 7000

TECHNICAL DATA
(a) Magnet: Type: Normal Conductor
Kb: 140 Kf: 80
Average field (min./max. T): max. 1,6
Number of magnet sectors: 3
hill angular width (deg.): 52
Pole parameters
Diameter (m): 2.3
Injection radius (m): 0.016
Extraction radius (m): 1.0
Hill gap (m): 0.207 Valley gap (m): 0.347
Trim coils
Number: 16 x 2

Maximum current (A-turns): 3000
Harmonic coils
Number: 3/sector x 2
Maximum current (A-turns): 1000
Main coils
Number: 1 x 2
Total current (A-turns): 4x10^4
Maximum current (A): 1430
Stored energy (MJ):
Total iron weight (tons): 400
Total coil weight (tons): 13
Power
Main coils (total KW): 265
Trim coils (total, maximum, KW): 450
Refrigerator (cryogenic, KW):

(b) RF
Frequency range (MHz): 6-18
Harmonic modes: 1, 3
Number of dees: 1
Number of cavities: 1
Dee angular width (deg.): 180
Voltage
at injection (peak to ground, KV): 100
at extraction (peak to ground, KV): 100
peak (peak to ground, KV): 100
Line Power (max, KW): 400
Phase Stability (deg.): 0.1
Voltage Stability (%): 0.1

(c) Injection
Ion Source: Atomic beam PIS, 10GHz & 18GHz ECRIS
Source Bias Voltage (kV): 20kV max.
External Injection: Axial Injection
Buncher Type: f+2f+3f Mesh Buncher
Injection Energy (MeV/n):
Component: Spiral Inflector
Injection Efficiency (%): 12

Inector:

(d) Extraction
Elements, Characteristic: 2 Electrostatic Deflectors
Typical Efficiency (%): 50-100
Best Efficiency (%): 100

(e) Vacuum
Pumps: Diffusion Pumps
Achieved Vacuum (Pa): 4x10^-5

EXPERIMENTAL FACILITIES
Injector to the Ring Cyclotron, Magnetic Spectrometer,
RI Production System for Nuclear Chemistry

COMMENTS
Upgraded in 2004. A flat-topping system and new beam line to experimental halls of Ring Cyclotron were added.
ENTRY N° C23
Date: Feb. 12, 2008
Machine name: RCNP Ring Cyclotron
Institution: Research Center for Nuclear Physics
Address: 10-1 Mihogaoka, Ibaraki, Osaka 567-0047, Japan
Telephone: +81-6-6879-8830
Fax: +81-6-6879-8899
Web Address: http://www.rcnp.osaka-u.ac.jp
Person in charge of cyclotron: Kichiji Hatanaka
Person reporting information: Kichiji Hatanaka
E-mail address: hatanaka@rcnp.osaka-u.ac.jp

HISTORY
Designed by: RCNP, Osaka University
Constructed by: Sumitomo Heavy Industries, Ltd.
First beam date: 1991

Characteristic beam, energy and current:
- H+        420 MeV/N    1 e-μA
- 3He2+     150            0.5
- 4He2+     100            0.5
- 18O6+     60             0.06

Transmission efficiency (source to extracted beam)
Typical (%): 80
Best (%): 100

Emittance
Emittance definition: RMS
Vertical (π mm mrad): 1
Horizontal (π mm mrad): 1
Longitudinal (dE/E[%] x RF[deg.]): 0.05 x 10

USES
Basic research (%): 43
Development(%): 31
Therapy(%): 0
Isotope production (%): 0
Other application (%): 4
Maintenance (%): 16
Beam tuning(%): 6
Total time (h/year): 7000

TECHNICAL DATA
(a) Magnet:
Type: Normal Conductor
Kb: 400          Kf: 400
Average field (min./max. T): max. 0.76
Number of magnet sectors: 6
  hill angular width (deg.): 22-27.5
  spiral (deg.): 30

Pole parameters
  Diameter (m):
  Injection radius (m): 2.0
  Extraction radius (m): 4.0
  Hill gap (m): 0.06       Valley gap (m):

Trim coils
Number: 36 x 2
Maximum current (A-turns): 500

Harmonic coils
  Number: 2/sector x 2
  Maximum current (A-turns): 500

Main coils
  Number: 1/sector x 2
  Total current (A-turns): 1.4x10^5
  Maximum current (A): 900
  Stored energy (MJ):
  Total iron weight (tons): 2200
  Total coil weight (tons): 32
  Power
  Main coils (total KW): 440
  Trim coils (total, maximum, KW): 350

Refrigerator (cryogenic, KW):
  (b) RF
  Frequency range (MHz): 30-52
  Harmonic modes: 6, 10, 12, 18
  Number of dees: 3
  Number of cavities: 3
  Dee angular width (°): Single Gap
  Voltage
    at injection (peak to ground, KV): 200
    at extraction (peak to ground, KV): 500
    peak (peak to ground, KV): 500
  Line Power (max, KW): 250/cavity
  Phase Stability (deg.): 0.1
  Voltage Stability (%): 0.01

(c) Injection
  Ion Source:
  Source Bias Voltage (kV):
  External Injection: Radial
  Buncher Type: 6 and 10 Harmonic Rebuncher
  Injection Energy (MeV/n): 7.5-65
  Component: 2 Magnetic & 2 Electrostatic (ES) Channels
  Injection Efficiency (%): 100
  Injector: RCNP AVF Cyclotron

(d) Extraction
  Elements, Characteristic: 2 Magnetic & 2ES Channels
  Typical Efficiency (%): 80
  Best Efficiency (%): 100

(e) Vacuum
  Pumps: Cryo Pumps
  Achieved Vacuum (Pa): 1.5x10^-5

EXPERIMENTAL FACILITIES
Double-arm Magnetic Spectrometer, 100 m TOF tunnel and Beam Swinger, RI Beam Separator, UCN Source, White Neutron Source

COMMENTS
A variable frequency Flat-topping system is equipped.
ENTRY Nº C24
Date: Feb. 12, 2008
Machine Name: RIKEN AVF CYCLOTRON
Institution: RIKEN
Address: Wako, Saitama 351-0198, Japan
Telephone: +81-48-462-1111
Fax: +81-48-461-5301
Web Address: http://www.rarf.riken.go.jp
Person in Charge of Cyclotron: Kase, M.
Person Reporting Information: Kase, M.
E-mail Address: mkase@riken.jp

HISTORY
Designed by: RIKEN/SHI
Construction Dates: 1987-1989
First Beam Date: April 1989

Characteristic Beams
ions / energy(MeV/N)/current(pps)/power(w)
p 4-14.5 6e13 40-150
d 4-9.5 6e13 80-200
12C,14N,16O,20Ne 4-7 1e13 300
40Ar 4.5-5.2 3e12 100

Transmission Efficiency (source to extracted beam)
Typical (%): 10
Best (%): 20

Emittance
Emittance Definition: RMS
Vertical (pi mm mrad): 0.9
Horizontal (pi mm mrad): 0.9
Longitudinal (dE/E[%] x RF[deg.]):

USES
Basic Research (%): 14
Development (%):
Therapy (%):
Isotope Production (%): 6
Other Application (%): 81 (Injection to RRC C-23)

Maintenance (%):
Beam Tuning (%):
Total Time (h/year): 3300

TECHNICAL DATA
(a)Magnet
Type: AVF
Kb (MeV): 70q**2/A**2
Kf (MeV): 2
Average Field (min./max. T): 0.5-1.7
Number of Sectors: 4
Hill Angular Width (deg.):
Spiral (deg.): 50
Pole Diameter (m): 1.726
Injection Radius (m): 0.0163
Extraction Radius (m): 0.714
Hill Gap (m): 0.128
Valley Gap (m): 0.300
Trim Coils
Number: 9x2
Maximum Current (A-turns): 70-300
Harmonic Coils

(b)RF
Frequency Range (MHz): 12-24
Harmonic Modes: 2,3
Number of Dees: 2
Number of Cavities: 2
Dee Angular Width (deg.): 85

Voltage
At Injection (peak to ground, KV):
At Extraction (peak to ground, KV):
Peak (peak to ground, KV): 50
Line Power (max, KW): 30*2
Phase Stability (deg.): +0.2
Voltage Stability (%): +0.05

(c)Injection
Ion Source: ECR, PIS
Source Bias Voltage (kV): Max. 10
External Injection: axial
Buncher Type: saw tooth(1,2,3f)
Injection Energy (MeV/n):
Component: solenoid, spiral inflector
Injection Efficiency (%): 20-30

Injection:

(d)Extraction
Elements, Characteristic: electrostatic deflector, magnetic channel, passive focusing channel efficiency
Typical Efficiency (%): 40
Best Efficiency (%): 70

(e)Vacuum
Pumps: 1500l/s TMP, 400l/s cryogenic, 6500l/s cryogenic
Achieved Vacuum (Pa): 1.5e-10

REFERENCES:
A.Goto et.al., ibid, (1989) p439

EXPERIMENTAL FACILITIES
ENTRY NO: C25  
Date: Feb. 12, 2008  
Machine Name: RIKEN RING CYCLOTRON  
Institution: RIKEN  
Address: WAKO, SAITAMA 351-0198, Japan  
Telephone: +81-48-462-1111  
Fax: +81-48-461-5301  
Web Address: http://www.rarf.riken.go.jp  
Person in Charge of Cyclotron: Kase, M.  
Person Reporting Information: Kase, M.  
E-mail Address: mkase@riken.jp

HISTORY  
Designed by: RIKEN  
Construction Dates: 1980-1986  
First Beam Date: Dec 16, 1986  

Characteristic Beams  
<table>
<thead>
<tr>
<th>ions / energy(MeV/N)</th>
<th>current(pps)</th>
<th>power(w)</th>
</tr>
</thead>
<tbody>
<tr>
<td>p 210 2e11</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>d,12C,20Ne 135</td>
<td>1-3e12</td>
<td></td>
</tr>
<tr>
<td>40Ar 95 4e11</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>40Ar 24 1.3e13</td>
<td>2000</td>
<td></td>
</tr>
<tr>
<td>136Xe 26 6e11</td>
<td>350</td>
<td></td>
</tr>
</tbody>
</table>

Transmission Efficiency (source to extracted beam)  
Typical (%): 70  
Best (%): 90  

Emittance  
Emittance Definition: RMS  
Vertical (π mm mrad): 0.7  
Horizontal (π mm mrad): 0.7  
Longitudinal (dE/E[%] x RF[deg.]):

USES  
Basic Research (%): 51  
Development (%): 4  
Therapy (%):  
Isotope Production (%):  
Other Application (%):  
Maintenance (%): 24  
Beam Tuning (%): 21  
Total Time (h/year): 6730

TECHNICAL DATA  
(a) Magnet  
Type: straight sector  
Kb (MeV): 540q**2/A**2  
KF (MeV):  
Average Field (min./max. T): 0.97  
Number of Sectors: 4  
Hill Angular Width (deg.): 50  
Spiral (deg.):  
Pole Diameter (m):  
Injection Radius (m): 0.89  
Extraction Radius (m): 3.56  
Hill Gap (m): 0.08  
Valley Gap (m):  
Trim Coils

(b) RF  
Frequency Range (MHz): 18-45  
Harmonic Modes: 5,9,10,11  
Number of Dees: 2  
Number of Cavities: 2  
Dee Angular Width (deg.): 23.5  
Voltage  
At Injection (peak to ground, KV): 300  
At Extraction (peak to ground, KV): 300  
Peak (peak to ground, KV): 300*2  
Phase Stability (deg.): +0.2  
Voltage Stability (%): +0.015

(c) Injection  
Ion Source:  
Source Bias Voltage (kV):  
External Injection: radial  
Buncher Type:  
Injection Energy (MeV/n): 0.5-7  
Component: magnetic channel, electrostatic channel  
Injection Efficiency (%): 70  
Injector: 715 cyclotron, heavy ion linac

(d) Extraction  
Elements, Characteristic: electrostatic channel  
magnetic channel efficiency  
Typical Efficiency (%): 80  
Best Efficiency (%): 100

(e) Vacuum  
Pumps: 5000l/s(cryogenic)*4,10000l/s(cryogenic)*10  
Achieved Vacuum (Pa): 8e-11

REFERENCES  

EXPERIMENTAL FACILITIES  
14 target stations: projectile fragment separator (RIPS)  
QQD-QD spectrometer (SMART)
ENTRY NO: C26
Date: Feb. 12, 2008
Machine name: fixed-frequency Ring Cyclotron
Institution: RIKEN Nishina Center
Address: Wako, Saitama 351-0198, Japan
Telephone: +81-48-462-1111
Fax: +81-48-461-5301
Web Address: http://www.nishina.riken.jp
Person in Charge of Cyclotron: Kase, M.
Person Reporting Information: Kase, M.
E-mail Address: mkase@riken.jp

HISTORY
Designed by: RIKEN
Constructed by: Sumitomo Heavy Industries, Ltd.
Construction dates: 2002-2006
First beam date: Sep. 29th, 2006
Characteristic beam, energy and current:
238U71+  50.2MeV/n  2.8pnA
Transmission efficiency (source to extracted beam)
Typical (%): 88
Best (%): 88
Emittance
Emittance definition:
Vertical (\pi \text{ mm mrad}):
Horizontal (\pi \text{ mm mrad}):
Longitudinal (dE/E[\%] x RF[\text{deg.}]):
USES
Basic research (%):
Development():
Therapy();
Isotope production ():
Other application ( ):
Maintenance ():
Beam tuning():
Total time (h/year):
TECHNICAL DATA
(a) Magnet:
Type: straight sector
Kb: 570*q^2/A^2
Kf:
Average field (min./max. T): 1.68
Number of magnet sectors: 4
  hill angular width (deg.): 58
  spiral (max):
Pole parameters
  Diameter:
  Injection radius (m): 1.55
  Extraction radius (m): 3.30
  Hill gap (m): 0.05  Valley gap (m):
Trim coils
  Number: 10*2*4
  Maximum current (A-turns): 100, 200
Harmonic coils
  Number: *Nsectors*2
  Maximum current (A-turns):
Main coils
Number: 2*4
Total current (A-turns): 650*70*2*4
Maximum current (A): 650
Stored energy (MJ):
Total iron weight (tons): 1480
Total coil weight (tons):
Power
Main coils (total KW): 240
Trim coils (total, maximum, KW):
Refrigerator (cryogenic, KW):
(b) RF
Frequency range (MHz): 54.75
Harmonic modes: 12
Number of dees: 2 (main) + 1 (flattop)
Number of cavities: 2 (main) + 1 (flattop)
Dee angular width (deg.):
Voltage
  at injection (peak to ground, KV):
  at extraction (peak to ground, KV):
    peak (peak to ground, KV): 500 (main), 180 (flattop)
Line Power (max, KW): 100 (main), 30 (flattop)
Phase Stability (deg.): +0.1
Voltage Stability (%): +5E-2
(c) Injection
Ion Source:
  Source Bias Voltage (kV):
  External Injection: radial
  Buncher Type:
  Injection Energy (MeV/n): 10.4
  Component: magnetic channel, electrostatic channel
  Injection Efficiency (%):
  Injector: RRC
(d) Extraction
Elements, Characteristic: magnetic channel, electrostatic channel
Typical Efficiency (%):
  Best Efficiency (%):
(e) Vacuum
Pumps: cryopumps(10m^3/s)*6
Achieved Vacuum (Pa): 1.5E-6
REFERENCES:
EXPERIMENTAL FACILITIES
ENTRY NO: C27
Date: Feb. 12, 2008
Machine name: Intermediate-stage Ring Cyclotron
Institution: RIKEN Nishina Center
Address: Wako, Saitama 351-0198, Japan
Telephone: +81-48-462-1111
Fax: +81-48-461-5301
Web Address: http://www.nishina.riken.jp
Person in Charge of Cyclotron: Kase, M.
Person Reporting Information: Kase, M.
E-mail Address: mkase@riken.jp

HISTORY
Designed by: RIKEN
Constructed by: Sumitomo Heavy Industries, Ltd.
Construction dates: 1998-2006
First beam date: Nov. 25th, 2006
Characteristic beam, energy and current:
86Kr34+  114MeV/n
238U86+  114MeV/n
Transmission efficiency (source to extracted beam)
Typical (%): 67
Best (%): 67
Emittance
Emittance definition:
Vertical (π mm mrad):
Horizontal (π mm mrad):
Longitudinal (dE/E[%] x RF[deg.]):

USES
Basic research (%):
Development():
Therapy():
Isotope production ():
Other application ( ) :
Maintenance () :
Beam tuning():
Total time (h/year):

TECHNICAL DATA
(a) Magnet: Type: straight sector
Kb: 980q^2/A^2
Kf:
Average field (min./max. T): 1.9
Number of magnet sectors: 4
hill angular width (deg.): 53
spiral (max):
Pole parameters
Diameter:
Injection radius (m): 2.77
Extraction radius (m): 4.15
Hill gap (m): 0.08 Valley gap (m):

Trim coils
Number: 20*4*2
Maximum current (A-turns): 400, 500, 600

Harmonic coils
Number: *Nsectors*2
Maximum current (A-turns):

Main coils
Number: 6 + 5
Total current (A-turns): 450*396
Maximum current (A): 450A

(b) RF
Frequency range (MHz): 18-40.5 (main), 72-121.5 (flattop)
Harmonic modes: 7
Line Power (max, KW): 150 (main), 300 (flattop)
Voltage at injection (peak to ground, KV):
at extraction (peak to ground, KV):
peak (peak to ground, KV): 600 (main), 150 (flattop)

(c) Injection
Ion Source:
Source Bias Voltage (kV):
External Injection: radial
Buncher Type:
Injection Energy (MeV/n): 45.9
Component: magnetic channel, electrostatic channel
Injection Efficiency (%):
Injector: RRC, fRC

(d) Extraction
Elements, Characteristic: magnetic channel, electrostatic channel
Typical Efficiency (%):
Best Efficiency (%):

(e) Vacuum
Pumps: cryopumps(10m^3/s)*12, cryopumps(4m^3/s)*2, TMP
Achieved Vacuum (Pa): 1.0E-6

REFERENCES:
J. Ohnishi et al., Proc. 17th Int. Conf. on Cyclotrons and Their Applications (2005) 197.
ENTRY NO: C28
Date: Feb. 12, 2008
Machine name: Superconducting Ring Cyclotron
Date: Feb. 12, 2008
Machine name: fixed-frequency Ring Cyclotron
Institution: RIKEN Nishina Center
Address: Wako, Saitama 351-0198, Japan
Telephone: +81-48-462-1111
Fax: +81-48-461-5301
Web Address: http://www.nishina.riken.jp
Person in Charge of Cyclotron: Kase, M.
Person Reporting Information: Kase, M.
E-mail Address: mkase@riken.jp

HISTORY
Designed by: RIKEN
Constructed by: Sumitomo Heavy Industries, Ltd.
Construction dates: 2001-2006
First beam date: Dec 28, 2006
Characteristic beam, energy and current:
- 86Kr34+ 345MeV/n 32pnA
- 238U86+ 345MeV/n 0.2pnA
Transmission efficiency (source to extracted beam)
Typical (%): 63
Best (%): 63
Emittance
Emittance definition:
Vertical (pi mm mrad):
Horizontal (pi mm mrad):
Longitudinal (dE/E[%%] x RF[deg.]):
USES
Basic research (%):
Development():
Therapy():
Isotope production ():
Other application ():
Maintenance ():
Beam tuning():
Total time (h/year):

TECHNICAL DATA
(a) Magnet: Type: straight sector
Kb: 2600q^2/A^2  Kf: 2600q^2/A^2
Average field (min./max. T): 3.8
Number of magnet sectors: 6
  hill angular width (deg.): 25
  spiral (max):
Pole parameters
  Diameter:
  Injection radius (m): 3.56
  Extraction radius (m): 5.36
  Hill gap (m): Valley gap (m):
Trim coils
  Number: 4*2*6 (Superconducting), 22*2*6 (Normal)
  Maximum current (A-turns): 3000,
Harmonic coils
  Number: *Nsectors*2
  Maximum current (A-turns):
    Main coils
      Number: 2*6
      Total current (A-turns): 5000*396*2*6
      Maximum current (A): 5000
    Stored energy (MJ): 235
    Total iron weight (tons): 8300
    Total coil weight (tons):
    Power
      Main coils (total KW):
      Trim coils (total, maximum, KW):
      Refrigerator (cryogenic, KW): 700
(b) RF
  Frequency range (MHz): 18-38
  Harmonic modes: 6
  Number of dees: 4 (main) + 1 (flattop)
  Number of cavities: 4 (main) + 1 (flattop)
  Dee angular width (deg.):
    Voltage
      at injection (peak to ground, KV):
      at extraction (peak to ground, KV):
      peak (peak to ground, KV): 600 (main),
    Line Power (max, KW): 150 (main),
    Phase Stability (deg.): +-0.1
    Voltage Stability (%): +-5E-2
(c) Injection
  Ion Source:
    Source Bias Voltage (kV):
    External Injection: radial
  Buncher Type:
    Injection Energy (MeV/n): 114
  Component: magnetic channel, electrostatic channel
  Injection Efficiency (%):
    Injector: RRC, IRC
(d) Extraction
  Elements, Characteristic: magnetic channel, electrostatic channel
  Typical Efficiency (%):
  Best Efficiency (%):
(e) Vacuum
  Pumps:
    16*cryopump(10m^3/s),
    2*cryopumps(2.3m^3/s), TMP
  Achieved Vacuum (Pa): 3.0E-6
REFERENCES:
H. Okuno et al., Proc. 17th Int. Conf. on Cyclotrons and Their Applications (2005) 373.
**ENTRY N° C29**

**Date:** 12 November 2007  
**Machine name:** AGOR  
**Institution:** Kernfysisch Versneller Instituut (KVI)  
**Address:** Zernikelaan 25, 9747AA Groningen, the Netherlands  
**Telephone:** +31503633599  
**Fax:** +31503634003  
**Web Address:** www.kvi.nl  
**Person in charge of cyclotron:** dr. S. Brandenburg  
**Person reporting information:** dr. S. Brandenburg  
**E-mail address:** brandenburg@kvi.nl

**HISTORY**

**Designed by:** IPN Orsay (France) and KVI  
**Constructed by:** IPN Orsay (France) and KVI  
**Construction dates:** 1986-1994 design and construction IPN Orsay; 1994 - 1995 transport and reassembly at KVI  
**First beam:** April 1994 IPN Orsay; January 1996 KVI  
**Characteristic beam, energy and current:**  
- Protons: 120 - 190 MeV 6e12 pps  
- Q/A = 0.5: 35 - 90 MeV 6e11 pps  
- Q/A = 0.25: 10 - 30 MeV 6e12 pps  
- Q/A = 0.1: 6 MeV 6e11 pps  
**Transmission efficiency (source to extracted beam):**  
- Typical (%): 15%  
- Best (%): 30% for protons and α-particles  
**Emittance**  
- Vertical (π mm mrad): 6  
- Horizontal (π mm mrad): 3  
- Longitudinal (dE/E[%] x RF[deg.]): 0.2% x 15°RF  

**USES**

- Basic research (%): 60%  
- Development (%): 10%  
- Therapy (%): 0%  
- Isotope production (%): 0%  
- Other application (%): 10%  
- Maintenance (%): 15%  
- Beam tuning (%): 10%  
- Total time (h/year): 3000 hours/year

**TECHNICAL DATA**

(a) Magnet:  
- Type: compact  
- Kb: 600  
- Kf: 200  
- Average field (min./max. T): 1.7 - 4.1 T  
- Number of magnet sectors: 3  
- Hill angular width (deg.): 54°  
- Spiral (max): 70°  
**Pole parameters**  
- Diameter: 1.9 m  
- Injection radius (m): 0.015 m  
- Extraction radius (m): 0.89 m  
- Hill gap (m): 0.07 m Valley gap (m): 1.68 m  
**Trim coils**  
- Number: 15 sets of six coils (on each hill sector)  
- Maximum current (A-turns): 3000 A-turns  
- Harmonic coils  
- Number: 4 sets  
- Maximum current (A-turns): 3000 A-turns  
**Main coils**  
- Number: 2  
- Total current (A-turns): 5.1e6 and 1.2e6  
- Maximum current (A): 1800 and 900  
- Stored energy (MJ): 56  
- Total iron weight (tons): 330  
- Total coil weight (tons): 30 incl. cryostat  
**Power**  
- Main coils (total kW): < 1 kW  
- Trim coils (total, maximum, kW): 30 kW  
- Refrigerator (cryogenic, kW): electric power 250 kW; cooling power 50 W at 4 K and 600 W at 80 K, additional liquid He production 50 liter/hour  
(b) RF  
- Frequency range (MHz): 24 - 62 MHz  
- Harmonic modes: 2; 3 and 4  
- Number of dees: 3  
- Number of cavities: 3  
- Dee angular width (deg.): 60°  
**Voltage**  
- at injection (peak to ground, kV): 80 kV  
- at extraction (peak to ground, kV): 100 kV  
- peak (peak to ground, kV): 100 kV  
**Line Power (max, KW):** <60 kW per cavity  
**Phase Stability (deg.):** 0.1°  
**Voltage Stability (%):** 10⁻⁴

(c) Injection  
**Ion Source:** multicups for protons, 14.5 GHz ECR for heavy ions, polarized protons and deuteron source  
**Source Bias Voltage (kV):** 10 - 35 kV  
**External Injection:** axial  
**Buncher Type:** double gap sinusoidal  
**Injection Energy (MeV/n):** 0.002 - 0.03  
**Component:**  
**Injection Efficiency (%):** 30%  

(d) Extraction  
**Elements, Characteristic:**  
- ESD; electrostatic; 4 movements; 55 kV; 10.5 MV/m  
- EMC1; electromagnetic; room temperature;  
- EMC2; electromagnetic; superconducting;  
- QPOLE; electromagnetic; superconducting;  
**Typical Efficiency (%):** 70%  
**Best Efficiency (%):** 90%  

(e) Vacuum  
**Pumps:** 2 1500 l/s turbo molecular pumps; 3 1000 l/s cryogenic pumps  
**Achieved Vacuum (Pa):** 3 x 10⁻⁵

**REFERENCES:** H.W. Schreuder et al.; Proc. 15th Conf. on Cyclotrons and their Applications, IOP Bristol (1999) pg. 592 and references therein
EXPERIMENTAL FACILITIES
QQD magnetic spectrometer + focal plane polarimeter fragment separator + low energy setup irradiation setup scattering chamber diameter 1.2 m
ENTRY Nº C30
Date: 06-02-2008
Machine name: C-30
Institution: SINS (A. Sołtan Institute for Nuclear Studies)
Address: 05-400 Otwock-Świerk
Telephone: +48 22 718 0554
Fax: +48 22 7793481
Web Address:
Person in charge of cyclotron: dr E.Plawski
Person reporting information: dr E.Plawski
E-mail address: plawski@ipj.gov.pl

HISTORY
Designed by: 1983
Constructed by:
Construction dates: time 6 years
First beam date: 1989 (1991-full energy)
Characteristic beam, energy and current:
\[ H^-, 28 \text{ MeV} \]
Transmission efficiency (source to extracted beam)
Typical (%): 80%
Best (%):
Emittance
Emittance definition:
Vertical (\( \pi \text{ mm mrad} \)):
Horizontal (\( \pi \text{ mm mrad} \)):
Longitudinal (\( \Delta E/E \times RF[\text{deg.}]):

USES
Basic research (%): 90%
Development(%):
Therapy(%):
Isotope production (%): 10%
Other application (%):
Maintenance (%):
Beam tuning(%):
Total time (h/year): 500h/y

TECHNICAL DATA
(a) Magnet: Type: compact
\( K_b: 30 \text{ MeV/A} \)
\( K_f: 50 \text{ MeV/A} \)
Average field (min./max. T):
Number of magnet sectors: 4
hill angular width (deg.): 45°
spiral (max): 0
Pole parameters
\( \text{Diameter: } 1.05 \text{ m} \)
Injection radius (m):
Extraction radius (m): 0.42 max
\( \text{Hill gap (m): } 0.02 \quad \text{Valley gap (m): } 0.1 \)
Trim coils
Number:
Maximum current (A-turns):
Harmonic coils
Number:
Maximum current (A-turns):

Main coils
Number: 2
Total current (A-turns): 164000
Maximum current (A): 300
 Stored energy (MJ):
Total iron weight (tons): 38
Total coil weight (tons): 1.38
Power
Main coils (total KW): 65
Trim coils (total, maximum, KW):
Refrigerator (cryogenic, KW):

(b) RF
Frequency range (MHz): 52.3
Harmonic modes: 2
Number of dees: 2
Number of cavities:
Dee angular width (deg.): 45°
Voltage
at injection (peak to ground, KV): 50
at extraction (peak to ground, KV): 48
peak (peak to ground, KV):
Line Power (max, KW): RF=25KW in pulse
Phase Stability (deg.):
Voltage Stability (%):

(c) Injection
Ion Source: internal PIG
Source Bias Voltage (kV):
External Injection:
Buncher Type:
Injection Energy (MeV/n):
Component:
Injection Efficiency (%):
Injector:

(d) Extraction
Elements, Characteristic: stripping on Al foil
Typical Efficiency (%): 80%
Best Efficiency (%):

(e) Vacuum
Pumps: 2* 2500l/s, oil diffusion pumps
Achieved Vacuum (Pa):

REFERENCES:
Nukleonika 2007;52(1);3-5
Nukleonika 2007;52(1);17-27

COMMENTS
Cyclotron RF is operated in pulse mode.
ENTRY N° C31
Date: 9 Nov 2007
Machine name: U-200P
Institution: University of Warsaw, Heavy Ion Laboratory
Address: Pasteura 5 A, 02-093 Warszawa, Poland
Telephone: +48 (22) 8222 123, +48 (22) 55 46 342
Fax: +48 (22) 659 27 14
Web Address: www.slcj.uw.edu.pl
Person in Charge of Cyclotron: Jaroslaw Choinski
Person Reporting Information: Jaroslaw Choinski
E-mail Address: jch@nov.slcj.uw.edu.pl

HISTORY
Designed by: Designed based on Dubna U-200 cyclotron modified and put into operation by the Heavy Ion Laboratory staff
Constructed by: the staff of the Heavy Ion Laboratory (HIL), the Institute of Nuclear Research (INS) in Swierk, the Joint Institute for Nuclear Research (JINR) in Dubna
Construction Dates: 1988-1992
First Beam Date: Nov. 1993 (internal beam), Apr. 1994 (extracted beam)

Characteristic Beams
Ion / Energy [MeV] / Extracted current [enA]
11B+2  55  20
12C+3  112  80
16O+3  80  1400
20Ne+5  190  100
40Ar+7  172  40

Transmission Efficiency (source to extracted beam)
Typical (%): 2%
Best (%): 17%

Emittance
Emittance Definition: RMS
Vertical (pi mm mrad): ~32
Horizontal (pi mm mrad): ~34
Longitudinal (dE/E[%] x RF[deg.]): 1% x 30 deg.
(harmonic number dependent)

USES
Basic Research (%): 75
Development (%): 10
Therapy (%):
Isotope Production (%):
Other Application (%):
Maintenance (%): 10
Beam Tuning (%): 5
Total Time (h/year): ~3000

TECHNICAL DATA
(a) Magnet
Type: compact
Kb (MeV): max. 160
Kf (MeV): 35
Average Field (min./max. T): 1.7 / 2.7
Number of Sectors: 4
Hill Angular Width (deg.): 42
Spiral (deg.): 32

Pole Diameter (m): 2
Injection Radius (m): 0.04
Extraction Radius (m): 0.60 - 0.86
Hill Gap (m): 0.026
Valley Gap (m): 0.15
Trim Coils
Number: 10
Maximum Current (A-turns): 600
Harmonic Coils
Number:
Maximum Current (A-turns):
Main Coils
Number: 1
Total Ampere Turns: 546000
Maximum Current (A): 1200
Stored Energy (MJ):
Total Iron Weight (tons): 240
Total Coil Weight (tons):
Power
Main Coils (total KW): 300
Trim Coils (total, maximum, KW): 30
Refrigerator (cryogenic, KW): 3 x 5.5

(b) RF
Frequency Range (MHz): 12 - 20
Harmonic Modes: 1, 2, 3, 4, 5, 6
Number of Dees: 2
Number of Cavities: 2
Dee Angular Width (deg.): 45
Voltage
At Injection (peak to ground, KV): 70
At Extraction (peak to ground, KV): 67
Peak (peak to ground, KV): 70
Line Power (max, KW): 60
Phase Stability (deg.): 1
Voltage Stability (%): 1.4

(c) Injection
Ion Source: ECR
Source Bias Voltage (kV): 11
External Injection: axial
Buncher Type: sine wave
Injection Energy (MeV/n): beam dependent
Component:
Injection Efficiency (%): 70
Injector: electrostatic mirror

(d) Extraction
Elements, Characteristic: stripper, adjustable
Typical Efficiency (%): beam and charge state dependent
Best Efficiency (%): 87

(e) Vacuum
Pumps: cryogenic
Achieved Vacuum (Pa): 0.000133

REFERENCES:
EXPERIMENTAL FACILITIES
- “JANOSIK”, a multidetector system to study Giant Dipole Resonances.
- “OSIRIS II”, a ball consisting of 12 BGO-shielded high-purity Ge detectors.
- “CUDAC”, Coulomb Excitation chamber equipped with an array of silicon detectors-PIN diodes.
- “IGISOL”, Scandinavian-type ion guide separator on-line.
- Large universal 80 cm scattering chamber, “SYRENA”.
- Internal and external irradiation chambers for material research with target cooling possibilities.
ENTRY NO: C32  
Date: 12 Feb 2008  
Machine Name: U-200  
Institution: FLNR JINR  
Address: 141980 Moscow region, Dubna, Joliot Curie 6, Russia  
Telephone: +7 (09621) 62261  
Fax: +7 (09621) 65083  
Web Address: www.jinr.ru  
Person in Charge of Cyclotron: Yu.Ts.Oganesian  
Person Reporting Information: G.G. Gulbekian  
E-mail Address: post@flnr.jinr.ru

**HISTORY**

Designed by: FLNR JINR  
Construction Dates: 1966-67  
First Beam Date: 1968

**Characteristic Beams**

<table>
<thead>
<tr>
<th>ions</th>
<th>energy(MeV/N)</th>
<th>current(pps)</th>
<th>power(W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4He1+</td>
<td>9</td>
<td>3x10+14</td>
<td>1800</td>
</tr>
<tr>
<td>12C3+</td>
<td>9</td>
<td>3x10+13</td>
<td>540</td>
</tr>
</tbody>
</table>

Transmission Efficiency (source to extracted beam):

Typical (%):  
Best (%):  

**Emittance**

Emittance Definition:  
Vertical (pi mm mrad): 10  
Horizontal (pi mm mrad): 30  
Longitudinal (dE/E[%] x RF[deg.]): 1%

**USES**

Basic Research (%):  
Development (%):  
Therapy (%):  
Isotope Production (%): 50  
Other Application (%): 50  
Maintenance (%):  
Beam Tuning (%):  
Total Time (h/year): 500

**TECHNICAL DATA**

(a) Magnet

Type: compact  
Kb (MeV):  
Kf (MeV):  
Average Field (min./max. T): 2/1.93  
Number of Sectors: 4  
Hill Angular Width (deg.): 45  
Spiral (deg.):  
Pole Diameter (m): 2  
Injection Radius (m):  
Extraction Radius (m):  
Hill Gap (m): 0.03  
Valley Gap (m): 0.15  
Trim Coils Number: 7x2  
Maximum Current (A-turns):  
Harmonic Coils Number: 2xNsectorsx2

Maximum Current (A-turns):  
Main Coils Number: 1x2  
Total Ampere Turns: 3.6x10 5  
Maximum Current (A): 1300  
Stored Energy (MJ):  
Total Iron Weight (tons):  
Total Coil Weight (tons):  
Power  
Main Coils (total KW): 350  
Trim Coils (total, maximum, KW): 20  
Refrigerator (cryogenic, KW):  
(b) RF  
Frequency Range (MHz): 12-21.8  
Harmonic Modes: 2-4  
Number of Dees: 2  
Number of Cavities: 2  
Dee Angular Width (deg.): 42  
Voltage  
At Injection (peak to ground, KV):  
At Extraction (peak to ground, KV):  
Peak (peak to ground, KV): 75  
Line Power (max, KW): 180-240  
Phase Stability (deg.):  
Voltage Stability (%): 1

(c) Injection  
Ion Source: PIG  
Source Bias Voltage (kV):  
External Injection:  
Buncher Type:  
Injection Energy (MeV/n):  
Component:  
Injection Efficiency (%):  
 Injector:

(d) Extraction  
Elements, Characteristic: Stripping foil  
Typical Efficiency (%):  
Best Efficiency (%):  

(e) Vacuum  
Pumps: oil pumps  
Achieved Vacuum (Pa): 2.7e-4

**REFERENCES**

1. Entry NC43 in Proc. of the 13th Int. Conf., Cyclotrons and Their Applications, Vancouver, 1992, p. 821  
ENTRY NO: C33
Date: 12 Feb 2008
Machine Name: U-400M
Institution: FLNR JINR
Address: 141980 Moscow region, Dubna, Joliot Curie 6, Russia
Telephone: +7 (09621) 62261
Fax: +7 (09621) 65083
Web Address: www.jinr.ru
Person in Charge of Cyclotron: Yu. Ts. Oganessian
Person Reporting Information: G. G. Gulbekian
E-mail Address: post@flnr.jinr.ru

History
Designed by: FLNR JINR
First Beam Date: 1991

Characteristic Beams

<table>
<thead>
<tr>
<th>ions</th>
<th>energy(MeV/N)</th>
<th>current(pps)</th>
<th>power(W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7Li2+</td>
<td>35</td>
<td>6*10^13</td>
<td>2350</td>
</tr>
<tr>
<td>11B3+</td>
<td>32</td>
<td>4*10^13</td>
<td>225</td>
</tr>
<tr>
<td>12C4+</td>
<td>47</td>
<td>4*10^13</td>
<td>3610</td>
</tr>
<tr>
<td>18O5+</td>
<td>33</td>
<td>2.5*10^13</td>
<td>2376</td>
</tr>
<tr>
<td>36S10+</td>
<td>33</td>
<td>6*10^11</td>
<td>114</td>
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<tr>
<td>40Ar12+</td>
<td>40</td>
<td>7*10^11</td>
<td>180</td>
</tr>
</tbody>
</table>

Transmission Efficiency (source to extracted beam)
Typical (%): 20
Best (%):

Emittance
Emittance Definition:
Vertical (pi mm mrad): 17
Horizontal (pi mm mrad): 50
Longitudinal (dE/E[\%] x RF[deg.]): 0.5%

USES
Basic Research (%): 60
Development (%): 20
Therapy (%):
Isotope Production (%):
Other Application (%):
Maintenance (%): 10
Beam Tuning (%): 10
Total Time (h/year): 3000

TECHNICAL DATA
(a)Magnet
Type: compact
Kb (MeV): 
Kf (MeV):
Average Field (min./max. T): 1.95
Number of Sectors: 4
Hill Angular Width (deg.): 45
Spiral (deg.): 40 deg
Pole Diameter (m): 4
Injection Radius (m):
Extraction Radius (m): 1.75
Hill Gap (m): 0.1
Valley Gap (m): 0.5
Trim Coils

Number: 15x2
Maximum Current (A-turns):
Harmonic Coils
Number: 5xNsectorsx2
Maximum Current (A-turns):
Main Coils
Number: 1x2
Total Ampere Turns: 1.26*10^6
Maximum Current (A): 2500
Stored Energy (MJ):
Total Iron Weight (tons): 2100
Total Coil Weight (tons): 115
Power
Main Coils (total KW): 750
Trim Coils (total, maximum, KW): 120
Refrigerator (cryogenic, KW):

(b)RF
Frequency Range (MHz): 15 - 25
Harmonic Modes: 2-4
Number of Dees: 4
Number of Cavities: 4
Dee Angular Width (deg.):
Voltage
At Injection (peak to ground, KV):
At Extraction (peak to ground, KV):
Peak (peak to ground, KV): 150
Line Power (max, KW): 4x100
Phase Stability (deg.):
Voltage Stability (%): 0.1

(c)Injection
Ion Source: ECR DECRIS14-2
Source Bias Voltage (kV):
External Injection: axial
Buncher Type: sine
Injection Energy (MeV/n):
Component:
Injection Efficiency (%): 20
Injector:

(d)Extraction
Elements, Characteristic:
Typical Efficiency (%): 70
Best Efficiency (%):

(e)Vacuum
Pumps: 6 oil pumps with nitrogen traps
Achieved Vacuum (Pa): 4*10^-5

REFERENCES 1. Entry NC44 in Proc. of the 13th Int. Conf., Cyclotrons and Their Application, Vancouver, 1992, p.822
2.B.Gikal, G.Gulbekian, V.Kutner in Proc. of Int. Conf., Cyclotrons and Their Application, Caen, 1998, pp. 587-591

EXPERIMENTAL FACILITIES
COMBAS, FOBOS, ACCULINNA, DRIbs
ENTRY NO: C34
Date: 12 Feb 2008
Machine Name: U-400
Institution: FLNR JINR
Address: 141980 Moscow region, Dubna, Joliot Curie 6, Russia
Telephone: +7 (09621) 62261
Fax: +7 (09621) 65083
Web Address: www.jinr.ru
Person in Charge of Cyclotron: Yu. Ts. Oganessian
Person Reporting Information: G. G. Gulbekian
E-mail Address: post@flnr.jinr.ru

HISTORY
Designed by: FLNR JINR
Construction Dates: 1975-1978
First Beam Date: 16.10.78

Characteristic Beams

<table>
<thead>
<tr>
<th>ions</th>
<th>energy(MeV/N)</th>
<th>current(pps)</th>
<th>power(W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7Li1+</td>
<td>8.6</td>
<td>6 x 10 E13</td>
<td>578</td>
</tr>
<tr>
<td>22Ne2+</td>
<td>4.5</td>
<td>2 x 10 E13</td>
<td>317</td>
</tr>
<tr>
<td>48Ca5+</td>
<td>5.4</td>
<td>7 x 10 E12</td>
<td>207</td>
</tr>
<tr>
<td>84Kr8+</td>
<td>3</td>
<td>6.3 x 10 E11</td>
<td>25</td>
</tr>
<tr>
<td>208Bi19+</td>
<td>3.4</td>
<td>3.6 x 10 E10</td>
<td>4</td>
</tr>
</tbody>
</table>

Transmission Efficiency (source to extracted beam)
Typical (%): 35
Best (%): 60

Emittance

Emittance Definition:
Vertical (pi mm mrad): 40
Horizontal (pi mm mrad): 80
Longitudinal (dE/E[%] x RF[deg.]): 1 %

USES

Basic Research (%): 70
Development (%): 8
Therapy (%):
Isotope Production (%):
Other Application (%): 12
Maintenance (%): 9
Beam Tuning (%): 1
Total Time (h/year): 5000

TECHNICAL DATA

(a) Magnet
Type: compact
Kb (MeV):
Kf (MeV):
Average Field (min./max. T): 21.1/ 1.98
Number of Sectors: 4
Hill Angular Width (deg.): 45
Spiral (deg.): 0
Pole Diameter (m): 4
Injection Radius (m): 0.05
Extraction Radius (m): 1.2 - 1.8
Hill Gap (m): 0.042
Valley Gap (m): 0.3
Trim Coils
Number: 10x2

Maximum Current (A-turns): 500 A
Harmonic Coils
Number: 4xNsectorsx2
Maximum Current (A-turns): 500 A
Main Coils
Number: 1x2
Total Ampere Turns:
Maximum Current (A): 2500
Stored Energy (MJ): 2100
Total Iron Weight (tons): 2100
Total Coil Weight (tons):
Power
Main Coils (total KW): 850
Trim Coils (total, maximum, KW): 56
Refrigerator (cryogenic, KW):

(b) RF
Frequency Range (MHz): 5.42-12.2
Harmonic Modes: 2
Number of Dees: 2
Number of Cavities: 2
Dee Angular Width (deg.): 42
Voltage
At Injection (peak to ground, KV): 25
At Extraction (peak to ground, KV):
Peak (peak to ground, KV): 80
Line Power (max, KW): 140
Phase Stability (deg.):
Voltage Stability (%):

(c) Injection
Ion Source: ECR4M
Source Bias Voltage (kV): 0.2
External Injection: axial
Buncher Type: linear, since
Injection Energy (MeV/n):
Component: selenoids
Injection Efficiency (%): 20-60
Injector:

(d) Extraction
Elements, Characteristic: Stripping foil efficiency
Typical Efficiency (%): 25-100
Best Efficiency (%):

(e) Vacuum
Pumps: 5 oil pumps with nitrogen traps
Achieved Vacuum (Pa): 2.7 x 10^-5

REFERENCES
1. Yu. Ts. Oganessian et al. in Proc. of IVAll-Union Accelerator Conf., Dubna, 1985 pp. 47-53

EXPERIMENTAL FACILITIES
VASSILISSA, GFRS, CORSET - DEMON, U-600, MSP-144, DRIBs
ENTRY NO: C35
Date: 12 Feb 2008
Machine Name: IC-100
Institution: FLNR JINR
Address: 141980 Moscow region, Dubna, Joliot Curie 6, Russia
Telephone: +7 (09621) 62261
Fax: +7 (09621) 65083
Web Address: www.jinr.ru
Person in Charge of Cyclotron: Yu. Ts. Oganessian
Person Reporting Information: G. G. Gulbekian
E-mail Address: post@flnr.jinr.ru

HISTORY
Designed by: FLNR JINR
Construction Dates: 2003 - 2005
First Beam Date: 2006

Characteristic Beams
ions energy(MeV/N) current(pps) power(W)
40Ar7+ 1.1 1.8*10E12 13
86Kr15+ 1.1 8.5*10E11 13
132Xe23+ 1.1 3*10E11 7

Transmission Efficiency (source to extracted beam)
Typical (%): 7
Best (%): 8

Emittance
Emittance Definition:
Vertical (pi mm mrad): 25
Horizontal (pi mm mrad): 25
Longitudinal (dE/E[%] x RF[deg.]): 2%

USES
Basic Research (%):
Development (%):
Therapy (%):
Isotope Production (%):
Other Application (%):
Maintenance (%):
Beam Tuning (%):
Total Time (h/year):

TECHNICAL DATA
(a) Magnet
Type: compact
Kb (MeV): 
Kf (MeV): 
Average Field (min./max. T): 1.78 - 1.93
Number of Sectors: 4
Hill Angular Width (deg.): 56
Spiral (deg.): 0
Pole Diameter (m): 1.05
Injection Radius (m): 0.019
Extraction Radius (m): 0.47
Hill Gap (m): 0.02
Valley Gap (m): 0.11

(b) Power
Main Coils (total KW):
Number: 1x2
Total Ampere Turns: 145000
Maximum Current (A): 575
Stored Energy (MJ):
Total Iron Weight (tons): 43
Total Coil Weight (tons):
Power
Main Coils (total KW): 94
Trim Coils (total, maximum, KW):
Refrigerator (cryogenic, KW):

(b)RF
Frequency Range (MHz): 19.8 – 20.6
Harmonic Modes: 4;6
Number of Dees: 2
Number of Cavities: 2
Dee Angular Width (deg.): 34
Voltage
At Injection (peak to ground, KV): 12 - 15
At Extraction (peak to ground, KV): 35 - 50
Peak (peak to ground, KV): 50
Line Power (max, KW): 30
Phase Stability (deg.):
Voltage Stability (%):

(c) Injection
Ion Source: ECR DECRIS-SC
Source Bias Voltage (kV):
External Injection: axial
Buncher Type: sine
Injection Energy (MeV/n):
Component: Solenoids
Injection Efficiency (%): 25
Injector:

(d) Extraction
Elements, Characteristic: Deflector Magnetic channels
Typical Efficiency (%): 50 - 60
Best Efficiency (%):

(e) Vacuum
Pumps: Turbopumps
Achieved Vacuum (Pa): 4*10^-6

REFERENCES
ENTRY Nº C36
Date: 5 Dec 2007
Machine name: Gatchina Isochronous Cyclotron
Institution: Petersburg Nuclear Physics Institute
Address: 188300 Gatchina, Leningrad district, Russia
Telephone: 8 813 71 30857
Fax: +7 813 71 30346
Web Address: http://www.pnpi.spb.ru/
Person in charge of cyclotron: N.K. Abrossimov
Person reporting information: G.A. Riabov
E-mail address: riabov@mail.pnpi.spb.ru

HISTORY
Constructed by:
First beam date:
Characteristic beam, energy and current:
$H^-$, 80 MeV, 100µA
Transmission efficiency (source to extracted beam)
Typical (%):
Best (%):
Emittance
Emittance definition:
Vertical (π mm mrad):
Horizontal (π mm mrad):
Longitudinal (dE/E[%] x RF[deg.]):

USES
Basic research (%):
Development(%):
Therapy(%):
Isotope production (%):
Other application (%): Maintenance (%):
Beam tuning(%):
Total time (h/year):

TECHNICAL DATA
(a) Magnet:
Type: H-tipe
Number of magnet sectors:
- hill angular width (deg.): 42.75-51
- spiral (max): 65
Pole parameters
Diameter: 2.05
Injection radius (m):
Extraction radius (m): 0.9
Hill gap (m): 0.170 Valley gap (m): 0.386
Trim coils
Number:
Maximum current (A-turns):
Harmonic coils
Number: 16
Maximum current (A-turns):
Main coils
Number: 2×210

Total current (A-turns): 3.15*10^5
Maximum current (A): 750
Stored energy (MJ):
Total iron weight (tons): 220
Total coil weight (tons): 12.8
Power
Main coils (total KW): 120
Trim coils (total, maximum, KW):
Refrigerator (cryogenic, KW):
(b) RF
Frequency range (MHz): 41.2
Harmonic modes: 2
Number of dees: 2
Number of cavities:
Dee angular width (deg.): 60
Voltage
- at injection (peak to ground, KV):
- at extraction (peak to ground, KV):
- peak (peak to ground, KV): 60
Line Power (max, KW): 2*40
Phase Stability (deg.):
Voltage Stability (%):
(c) Injection
Ion Source:
Source Bias Voltage (kV):
External Injection: axial
Buncher Type:
Injection Energy (MeV/n): 0.026
Component:
Injection Efficiency (%):
Injector:
(d) Extraction
Elements, Characteristic: stripping
Typical Efficiency (%):
Best Efficiency (%):
(e) Vacuum
Pumps: 2 Cryo-pumps, 2*5000 l/s
Achieved Vacuum (Pa):

REFERENCES:
N.K. Abrossimov, G.A. Riabov
Construction of Gatchina Isochronous Cyclotron

EXPERIMENTAL FACILITIES
Medical isotope production. P-therapy of the ocular melanoma.
ENTRY N° C37

Date: 05.12.2007
Machine name: R7
Institution: SINP MSU, (Russia)
Address: SINP MSU, 1/2, Leninskie Gory, Moscow, Russia, 119991
Telephone: (095) 939-18-18
Fax: (095) 939-08-96
Web Address: http://www.sinp.msu.ru
Person in charge of cyclotron: E. Kiryanov
Person reporting information: E. Kiryanov
E-mail address: WG@anna19.sinp.msu.ru

HISTORY
Designed by: NII EFA, Leningrad, USSR
Constructed by: NII EFA, Leningrad, USSR
Construction dates: First beam date: 1958

Characteristic beam, energy and current:
H_2^+, D^+, He_3^{++}, He_4^{++}; 7.5 MeV/nucleon, 10 µA

Transmission efficiency (source to extracted beam):
Typical (%): 20 - 50
Best (%):

Emittance
Emittance definition:
Vertical (π mm mrad):
Horizontal (π mm mrad):
Longitudinal (dE/E[ %] x RF[ deg.]):

USES
Basic research (%): 30
Development(%): 10
Therapy(%): -
Isotope production (%): 15
Other application (%): 20
Maintenance (%): 15
Beam tuning(%): 10
Total time (h/year): 1400

TECHNICAL DATA
(a) Magnet: Type:
Kb: Kf: 15 T
Average field (min./max. T):
Number of magnet sectors: -
hill angular width (deg.):
spiral (max):
Pole parameters
Diameter: 120 cm
Injection radius (m):
Extraction radius (m): 0.53
Hill gap (m):
Valley gap (m):
Main coils
Number: 430 A / 336×2
Total current (A-turns):
Maximum current (A):
Stored energy (MJ):
Total iron weight (tons): 120
Total coil weight (tons): 10
Power
Main coils (total KW): 60
Trim coils (total, maximum, KW):
Refrigerator (cryogenic, KW):

(b) RF
Frequency range (MHz): 11.6
Harmonic modes: 1, 3
Number of dees: 2
Number of cavities: 2
Dee angular width (deg.): 180
Voltage
at injection (peak to ground, KV):
at extraction (peak to ground, KV): 40
peak (peak to ground, KV):
Line Power (max, KW):
Phase Stability (deg.):
Voltage Stability (%):

(c) Injection
Ion Source:
Source Bias Voltage (kV):
External Injection:
Buncher Type:
Injection Energy (MeV/n):
Component:
Injection Efficiency (%):
Injector:

(d) Extraction
Elements, Characteristic:
Typical Efficiency (%):
Best Efficiency (%):

(e) Vacuum
Pumps:
Achieved Vacuum (Pa): 7×10^{-4}

REFERENCES:
Л.А. Саркиянц, Е.Ф. Кирьянов, Ю.А. Воробьев.
Вестн. МГУ, сер. физ. 1979 г., № 2, с.63.
Л.А. Саркиянц, Е.Ф. Кирьянов, Ю.А. Воробьев. ПТЭ, №1, 1979, с.19
ENTRY Nº C38
Date: November 1, 2007
Machine name: VINCY Cyclotron
Institution: TESLA Accelerator Installation, Laboratory of Physics, Vinča Institute of Nuclear Sciences
Address: P. O. Box 522, 11001 Belgrade, Serbia
Telephone: +381-11-244-7700 or +381-11-806-6521
Fax: +381-11-244-7963
Web address: http://www.tesla-sc.org
Person in charge of cyclotron: Dr. Nebojša Nešković, Head of TESLA Project
Person reporting information: Ms. Jelena Cagić, Scientific Secretary of TESLA Project
E-mail address: mjelena@vin.bg.ac.yu

HISTORY
Designed by: Vinča Institute of Nuclear Sciences, Belgrade, Serbia, and Joint Institute for Nuclear Research, Dubna, Russia
Constructed by: Vinča Institute of Nuclear Sciences, Belgrade, Serbia, and Joint Institute for Nuclear Research, Dubna, Russia
First beam date: June 30, 2009 (estimated)
Characteristic beam, energy and current:
65 MeV H+, 28 MeV 4He2+, 120 MeV 40Ar15+
Transmission efficiency (source to extracted beam)
Typical (%):
Best (%):
Emittance
Emittance definition: 90 %
Vertical (π mm mrad): 8-34 (estimated)
Horizontal (π mm mrad): 10-38 (estimated)
Longitudinal (dE/E (%) × RF (deg)):
USES
Basic research (%): 20 (planned)
Development (%): 10 (planned)
Therapy (%): 10 (planned)
Isotope production (%): 20 (planned)
Other application (%): 10 (planned)
Maintenance (%): 15 (planned)
Beam tuning (%): 15 (planned)
Total time (h/year): 5,000 (planned)
TECHNICAL DATA
(a) Magnet
Type: Compact
K0: 134 MeV
Kf: 73 MeV
Average field (min.-max.) (T): 1.29-1.94
Number of magnet sectors: 4
Hill angular width (deg): 42
Spiral (max.) (deg): 0
Pole parameters
   Diameter (m): 2
   Injection radius (m): 0.033
   Extraction radius (m): 0.84
Hill gap (m): 0.036
Valley gap (m): 0.19
Trim coils
   Number: 2 × 10
   Maximum current (A): 300
   Number of Ampere-turns (A-turns): 48,600
Harmonic coils
   Number: 2 × (4 + 4)
   Maximum current (A): 300
   Number of Ampere-turns (A-turns): 12,000
Main coils
   Number: 2
   Maximum current (A): 1,000
   Number of Ampere-turns (A-turns): 512,000
Power
   Main coils (KW): 131
   Trim coils (KW): 36
Refrigerator (cryogenic) (KW): (b) RF
   Frequency range (MHz): 17-31
   Harmonic modes: 1, 2, 3 and 4
   Number of dees: 2
   Number of cavities: 2
   Dee angular width (deg): 34 (average)
Voltage
   Injection (peak to ground) (KV): 100
   Extraction (peak to ground) (KV): 96.3-88.5
   Peak (peak to ground) (KV): 100
   Line power (max.) (KW): 50
   Phase stability (deg): ±0.5
   Voltage stability (%): 0.05
(c) Injection
   Ion source: volume positive or negative light ion source or electron cyclotron resonance heavy ion source
   Source bias voltage (kV): 40 for pVINIS and 25 for nVINIS
   External injection: axial
   Buncher type: two-grid sinusoidal
   Injection energy (MeV/n): 0.002 - 0.025
Component
   Injection efficiency (%):
   Injector:
(d) Extraction
   Elements: foil stripping, electrostatic deflection system
   Typical efficiency (%):
   Best efficiency (%):
(e) Vacuum
   Pumps: two 10,000 l/s cryopumps, four 920 l/s turbopumps and one 210 l/s turbopump
   Achieved vacuum (Pa): 3 × 10^-5 (estimated)
EXPERIMENTAL FACILITIES: solid target irradiation systems for production of radionuclides, channel for production of radionuclides, channel for proton therapy, and channel for radiation research.
ENTRY № C39
Date: 23 October 2007
Machine name: iThemba LABS Injector Cyclotron 1
Institution: iThemba LABS
Address: PO Box 722, Somerset West, 7129, South Africa
Telephone: +27 21 8431000
Fax: +27 21 8433525
Web Address: http://www.tlabs.ac.za
Person in charge of cyclotron: JL Conradie
Person reporting information: JL Conradie
E-mail address: lowry@tlabs.ac.za

HISTORY
Designed by: National Accelerator staff
Constructed by: National Accelerator staff
Construction dates: 1978 - 1983
First beam date: December 1983

Characteristic beam, energy and current:
Ions / energy(MeV/N)/current(pps)
p 3.15 2.5E15
p 8.0 8.2E13
d 1.9 1.9E13
He 2.5 9.3E12

Transmission efficiency (source to extracted beam)
Typical (%):
Best (%):

Emittance
Emittance definition: RMS
Vertical (pi mm mrad): 10
Horizontal (pi mm mrad): 15
Longitudinal (dE/E[%] x RF[deg.]): 0.042

USES
Basic research (%): 10
Development(%): 0
Therapy(%) : 35
Isotope production (%): 40
Other application (%):
Maintenance (%): 3
Beam tuning(%): 12
Total time (h/year): 7000

TECHNICAL DATA
(a) Magnet:
Type: sector magnets
Kb: 8
Kf: 8
Average field (min./max. T): 0.3-1.0
Number of magnet sectors: 4
hill angular width (deg.): 45
spiral (max):
Pole parameters
Diameter: 1.16
Injection radius (m):
Extraction radius (m): 0.476
Hill gap (m): 0.156
Valley gap (m): 0.250
Trim coils
Number: 5x2
Maximum current (A-turns): 180

Harmonic coils
Number: 2xNsectorsx2
Maximum current (A-turns): 20

Main coils
Number: 1x2
Total current (A-turns): 154560
Maximum current (A): 690
Stored energy (MJ): 0.1
Total iron weight (tons): 54.5
Total coil weight (tons): 1.85
Power
Main coils (total KW): 46
Trim coils (total, maximum, KW): 9
Refrigerator (cryogenic, KW):
(b) RF
Frequency range (MHz): 8.6 -26
Harmonic modes: 2 and 6
Number of dees: 2
Number of cavities: 4
Dee angular width (deg.): 90
Voltage
at injection (peak to ground, KV):
at extraction (peak to ground, KV):
peak (peak to ground, KV): 60
Line Power (max, KW): 2x25
Phase Stability (deg.): 0.1
Voltage Stability (%): 0.1

(c) Injection
Ion Source: PIG
Source Bias Voltage (kV):
External Injection:
Buncher Type:
Injection Energy (MeV/n):
Component:
Injection Efficiency (%):
Injector:
(d) Extraction
Elements, Characteristic: electrostatic channel, 2x magnetic channels
Typical Efficiency (%): 57
Best Efficiency (%): 96

(e) Vacuum
Pumps: turbo 4.8 cub m/s, roots 350 cub m/h and rotary vanes
Achieved Vacuum (Pa): 1.5e-3

ENTRY Nº C40

Date: 23 October 2007

Machine name: iThemba LABS Injector Cyclotron 2

Institution: iThemba LABS

Address: PO Box 722, Somerset West, 7129, South Africa

Telephone: +27 21 8431000

Fax: +27 21 8433525

Web Address: http://www.tlabs.ac.za

Person in charge of cyclotron: JL Conradie

Person reporting information: JL Conradie

E-mail address: lowry@tlabs.ac.za

HISTORY

Designed by: National Accelerator staff

Constructed by: National Accelerator staff

Construction dates: 1989 - 1993

First beam date: December 1993

Characteristic beam, energy and current:

<table>
<thead>
<tr>
<th>Ions</th>
<th>Energy(MeV/N)</th>
<th>Current(pps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>p</td>
<td>3.15</td>
<td>5.1E14</td>
</tr>
<tr>
<td>p</td>
<td>8.0</td>
<td>8.2E13</td>
</tr>
<tr>
<td>40Ar8+</td>
<td>0.36</td>
<td>2.1E12</td>
</tr>
<tr>
<td>129Xe22+</td>
<td>0.32</td>
<td>5.7E10</td>
</tr>
</tbody>
</table>

Transmission efficiency (source to extracted beam)

Typical (%): 15
Best (%): 30

Emittance

Emittance definition: RMS

Vertical (pi mm mrad): 10
Horizontal (pi mm mrad): 15
Longitudinal (dE/E[%] x RF[deg.]): 0.042

USES

Basic research (%): 80
Development(%): 9
Therapy(%): 0.5
Isotope production (%): 0.5
Other application (%): Maintenance (%): 3
Beam tuning(%): 7
Total time (h/year): 4000

TECHNICAL DATA

(a) Magnet:

Type: sector magnets

Kb: 8
KF: 8

Average field (min./max. T): 0.3-1.0

Number of magnet sectors:

- hill angular width (deg.): 45
- spiral (max):

Pole parameters

Diameter: 1.16
Injection radius (m):

- Extraction radius (m): 0.476
- Hill gap (m): 0.156
- Valley gap (m): 0.250

Trim coils

Number: 6x2
Maximum current (A-turns): 200

Harmonic coils

- Number: 2xNsectorsx2
- Maximum current (A-turns): 20

Main coils

- Number: 1x2
- Total current (A-turns): 154560
- Maximum current (A): 690
- Stored energy (MJ): 0.1
- Total iron weight (tons): 54.5
- Total coil weight (tons): 1.85

Power

- Main coils (total KW): 46
- Trim coils (total, maximum, KW): 12

Refrigerator (cryogenic, KW):

(b) RF

- Frequency range (MHz): 8.6 - 26
- Harmonic modes: 2 and 6
- Number of dees: 2
- Number of cavities: 4
- Dee angular width (deg.): 90

Voltage

- at injection (peak to ground, KV): 55 - 70
- at extraction (peak to ground, KV):

Voltage Stability (%): 0.1

(c) Injection

- Ion Source: ECR and Polarized ion source

Source Bias Voltage (kV): 9-20

External Injection:

- Buncher Type: Double-gap, sine wave

Injection Energy (MeV/n):

- 1.4e-3 – 20e-3
- Component: 3 spiral inflectors (interchangeable)

Injection Efficiency (%): 55 - 70

(d) Extraction

- Elements, Characteristic: electrostatic channel, 2 x magnetic channels

Typical Efficiency (%): 70
Best Efficiency (%): 90

(e) Vacuum

- Pumps: turbo 2.2 cub m/s, cryopump 10 cub m/s and 2 LN cr

Achieved Vacuum (Pa): 1.7e-5

REFERENCES:

- Proc. 11th Int. Conf. on Cyclotrons and their Appl. (1986)515
- Proc. 15th Int. Conf. on Cyclotrons and their Appl. (1998)625
ENTRY Nº C41
Date: 23 October 2007
Machine name: iThemba LABS Separated-Sector Cyclotron
Institution: iThemba LABS
Address: PO Box 722, Somerset West, 7129, South Africa
Telephone: +27 21 8431000
Fax: +27 21 8433525
Web Address: http://www.tlabs.ac.za
Person in charge of cyclotron: JL Conradie
Person reporting information: JL Conradie
E-mail address: lowry@tlabs.ac.za

HISTORY
Designed by: National Accelerator staff
Constructed by: National Accelerator staff
Construction dates: 1979 - 1985
First beam date: October 1985

Characteristic beam, energy and current:
Ions / energy(MeV/N)/current(pps)

<table>
<thead>
<tr>
<th>Ion</th>
<th>Energy</th>
<th>Current</th>
</tr>
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<tbody>
<tr>
<td>p</td>
<td>200</td>
<td>1.87E13</td>
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<tr>
<td>p</td>
<td>66</td>
<td>1.87E15</td>
</tr>
<tr>
<td>18O4+</td>
<td>4.7</td>
<td>3.1E11</td>
</tr>
<tr>
<td>129Xe22+</td>
<td>6.1</td>
<td>1.4E10</td>
</tr>
</tbody>
</table>

Transmission efficiency (source to extracted beam)
Typical (%): 99.8
Best (%): 100

Emittance
Emittance definition: RMS
Vertical (pi mm mrad): 2.7
Horizontal (pi mm mrad): 0.8
Longitudinal (dE/E[\%] x RF[deg.]): 0.07

USES
Basic research (%): 17
Development(%): 0.8
Therapy(%): 16
Isotope production (%): 27.7
Other application (%): 0
Maintenance (%): 17
Beam tuning(%): 8.5
Total time (h/year): 8477

TECHNICAL DATA
(a) Magnet: Type: sector magnets
Kb: 200
Kf: 200
Average field (min./max. T): 0.517 (0/1.2560)
Number of magnet sectors: 4
Hill angular width (deg.): 34
Spiral (max.):

Pole parameters
Diameter: 4.43
Injection radius (m): 0.952
Extraction radius (m): 4.156
Hill gap (m): 0.066
Valley gap (m): inf

Trim coils
Number: 29 x 2
Maximum current (A-turns): 500

Harmonic coils
Number: 2xNsectors x 2
Maximum current (A-turns):
Main coils
Number: 1x2
Total current (A-turns): 80 000
Maximum current (A): 1600
Stored energy (MJ): 1.5
Total iron weight (tons): 1400
Total coil weight (tons): 5.8
Power
Main coils (total KW): 650
Trim coils (total, maximum, KW):
Refrigerator (cryogenic, KW):

(b) RF
Frequency range (MHz): 6 - 26
Harmonic modes: 4 and 12
Number of dees: 2
Number of cavities: 4
Dee angular width (deg.): 49
Voltage
at injection (peak to ground, KV): 184
at extraction (peak to ground, KV): 230
peak (peak to ground, KV): 230
Line Power (max, KW): 2 x 80
Phase Stability (deg.): 0.1
Voltage Stability (%): 0.1

(c) Injection
Ion Source:
Source Bias Voltage (kV):
External Injection: radial
Buncher Type: Double gap, sine wave
Injection Energy (MeV/n): 1.4 - 8
Component: 2 bending magnets, 1 magnetic inflection channel
Injection Efficiency (%): 100
Injector: solid pole injector cyclotrons SPC1, SPC2

(d) Extraction
Elements, Characteristic: 2 septum magnets
Typical Efficiency (%): 99.8
Best Efficiency (%): 100

(e) Vacuum
Pumps: 4 Rotary vane 120 cub m/h, 4 Roots 350 cub m/h, 6 turbo pumps and 2 cryopumps
Achieved Vacuum (Pa): 7e-5

REFERENCES:
Proc. 11th Conf on Cyclotrons and their Appl. (1986)p6
Proc. 12th Conf. on Cyclotrons and their Appl.(1989)p80

EXPERIMENTAL FACILITIES: A 66 Mev isocentric gantry for neutron therapy, a fixed horizontal beamline for proton therapy, a high- energy gamma-ray detectors array, a 1.5m scattering chamber, a neutron beam facility, and a K600 QDD magnet spectrometer.
ENTRY No C42
Date: Nov 10th, 2007
Machine name: Gustaf Werner Cyclotron
Institution: The Svedberg Laboratory
Address: Box 533, S-75121 Uppsala, Sweden
Telephone: +46-184713845
Fax: +46-184713833
Web Address: www.tsl.uu.se

Person in charge of cyclotron: Bengt Lundström
Person reporting information: Bengt Lundström
E-mail address: bengt.lundstrom@tsl.uu.se

HISTORY
Designed by: in house
Constructed by: in house
Construction dates: 1946-51, 1977-86
First beam date: 1951,1986

Characteristic beam, energy and current
\[p \quad 180 \text{ MeV} \quad 200 \text{ nA}\]
\[p \quad 98 \text{ MeV} \quad 6 \mu \text{A}\]
\[14 \text{N7}^+ \quad 45 \text{MeV/A} \quad 8 \times 10^9 \text{pps}\]
\[129 \text{Xe27}^+ \quad 8.33 \text{ MeV/A} \quad 7 \times 10^8 \text{pps}\]

Transmission efficiency (source to extracted beam)
Typical (%): 1
Best (%): 5

Emittance
Emittance definition: rms
Vertical (\(\pi \text{ mm mrad}\)): 9
Horizontal (\(\pi \text{ mm mrad}\)): 9
Longitudinal (\(\text{dE/E} \times \text{RF(deg.)}\)): varies

USES
Basic research (%): 70
Development(%): 5
Isotope production (%): 5
Other application (%): 20
Maintenance (%): 5
Total time (h/year): ca 2700

TECHNICAL DATA
(a) Magnet: Type: compact
Kb: 200 MeV/A
Kf: 100 MeV/A
Average field (min./max. T): 1.75/0.6
Number of magnet sectors: 3
  hill angular width (deg.): varies
  spiral (max.): 55 deg

Pole parameters
  Diameter: 2.8 m
  Injection radius (m): 0.038
  Extraction radius (m): 1.175
  Hill gap (m): 0.2
  Valley gap (m): 0.38

Trim coils
  Number: 13 pairs
  Maximum current (A-turns): ca 5000

Harmonic coils
  Number: 2 sets
  Maximum current (A-turns): ca 8000

Main coils
  Number: 1x2
  Total current (A-turns): 814000
  Maximum current (A): 1000
  Stored energy (MJ): 9
  Total iron weight (tons): 600
  Total coil weight (tons): 50

Power
  Main coils (total KW): 275
  Trim coils (total, maximum, KW): 70
  Refrigerator (cryogenic, KW):
  (b) RF
  Frequency range (MHz): 12.3-25
  Harmonic modes: 1,2,3,4
  Number of dees: 2
  Number of cavities:
  Dee angular width (deg.): 72-42
  Voltage
    at injection (peak to ground, KV):
    at extraction (peak to ground, KV):
    peak (peak to ground, KV):
  Line Power (max, KW): 280 kW
  Phase Stability (deg.): +/- 0.5
  Voltage Stability : +/- 0.1 %

(c) Injection
  Ion Source: int PIG, ext ECR
  Source Bias Voltage (kV): 20
  External Injection: axial
  Buncher Type: h=1 double gap
  Injection Energy (MeV/n):
    Component:
    Injection Efficiency (%): 5
    Injector:

(d) Extraction
  isochronous mode: precessional
  Synchrocyclotron mode: regenerative
  Elements, Characteristic:
    El. stat. deflector 65 kV (0.5 mm septum, 5 mm gap)
    Electromagnetic channel 5000 A
  Regenerative mode: peeler, regenerator
  Typical Efficiency (%): 50
  Best Efficiency (%): 75

(e) Vacuum
  Pumps: 2+1 diff pumps, 2 Meissner traps
  Achieved Vacuum (Pa): 10^{-5}

REFERENCES:
  S. Holm 13th Int.Conf, Vancouver 1992 p. 106

EXPERIMENTAL FACILITIES
  1) Quasi-monoenergetic neutron beam
  2) White spectrum neutron beam
COMMENTS
Combination of synchrocyclotron (protons > 100 MeV) and isochronous cyclotron. After decommissioning of CELSIUS fundamental research has been stopped and main activities are now patient therapy with protons combined with applied activities with neutron beams, often in beam sharing mode.
**ENTRY N° C43**

**Date:** November 10, 2007  
**Machine Name:** PSI Philips Cyclotron "Injector 1"  
**Institution:** Paul Scherrer Institute  
**Address:** CH-5232 Villigen PSI, Switzerland  
**Telephone:** ++41-56-310 40 73  
**Fax:** ++41-56-310 33 83  
**Web Address:** www.psi.ch  
**Person in Charge of Cyclotron:** Mike Seidel  
**Person Reporting Information:** Mike Seidel  
**E-mail Address:** mike.seidel@psi.ch

**HISTORY**

- **Designed by:** Philips, Eindhoven, NL  
- **Construction Dates:** 1970-73  
- **First Beam Date:** 1974  
- **Characteristic Beams:**  
  - *p* 72 MeV  
  - Heavy Ions *k=120*  
- **Transmission Efficiency (source to extracted beam):**  
  - Typical (%):  
  - Best (%): 93  
- **Emittance:**  
  - Emittance Definition: *rms*  
  - Vertical (π mm mrad): 2  
  - Horizontal (π mm mrad): 3  
  - Longitudinal (dE/E[%] x RF[deg.]): 0.5

**USES**

- **Basic Research (%):**  
- **Development (%):**  
- **Therapy (%):** 20  
- **Isotope Production (%):**  
- **Other Application (%):** 80  
- **Maintenance (%):**  
- **Beam Tuning (%):**  
- **Total Time (h/year):** 2500

**TECHNICAL DATA**

**(a) Magnet**

- Type: H-Magnet with spiral shims  
- *Kb (MeV):* 135  
- *Kf (MeV):* 135  
- **Average Field (min./max. T):** 1.65  
- **Number of Sectors:** 4  
- **Hill Angular Width (deg.):** 55  
- **Pole Diameter (m):** 2.5  
- **Injection Radius (m):** 0.015  
- **Extraction Radius (m):** 1.05  
- **Hill Gap (m):** 0.24  
- **Valley Gap (m):** 0.45  
- **Trim Coils**  
  - Number: 2 x 12  
  - **Maximum Current (A-turns):** 250 A  
- **Harmonic Coils**  
  - Number: 2 x 2 x 4  
  - **Maximum Current (A-turns):** 200 A

**Main Coils**

- **Number:** 2  
- **Total Ampere Turns:** 1.5 e5  
- **Maximum Current (A):** 700  
- **Stored Energy (MJ):**

**Power**

- **Main Coils (total KW):**
- **Trim Coils (total, maximum, KW):**
- **Refrigerator (cryogenic, KW):**

**(b) RF**

- **Frequency Range (MHz):** 4.6 - 17  
- **Harmonic Modes:** 1, 3  
- **Number of Dees:** 1  
- **Number of Cavities:**  
  - **Dee Angular Width (deg.):** 180  
- **Voltage**  
  - **At Injection (peak to ground, KV):** 20 - 100  
  - **At Extraction (peak to ground, KV):**  
  - **Peak (peak to ground, KV):**  
  - **Line Power (max, KW):** 100  
  - **Phase Stability (deg.):** 0.1 - 1  
  - **Voltage Stability (%):** 0.01 - 1

**Injection**

- **Source Bias Voltage (kV):**
- **External Injection:** axial  
- **Buncher Type:** 2 gaps  
- **Injection Energy (MeV/n):** < 14 keV  
- **Component:** ECR, e.m.quads, spherical deflector, el. stat. mirror, buncher  
- **Injection Efficiency (%):** < 25  
- **Injector:**

**Extraction**

- **Elements, Characteristic:** el. stat. extr. channel, el. magn. extr. channel  
- **Typical Efficiency (%):** 60  
- **Best Efficiency (%):** 93

**Vacuum**

- **Pumps:** Diff. + Cryo 77K / 24K  
- **Achieved Vacuum (Pa):** 5 e-5

**REFERENCES**

P.A. Schmelzbach et al., 14th Int. Cycl. Conf., Cape Town, (1995)404

**EXPERIMENTAL FACILITIES**

- gas-jet target, material irradiation, OPTIS eye cancer treatment

**COMMENTS**

Part time Operation, PSI internal use only
ENTRY N° C44
Date: November 10, 2007
Machine Name: PSI Injector 2 Cyclotron
Institution: Paul Scherrer Institute
Address: CH-5232 Villigen PSI, Switzerland
Telephone: ++41-56-310 33 93
Fax: ++41-56-310 33 83
Web Address: www.psi.ch
Person in Charge of Cyclotron: Mike Seidel
Person Reporting Information: Mike Seidel
E-mail Address: mike.seidel@psi.ch

HISTORY
Designed by: PSI
Construction Dates: 1978-83
First Beam Date: 1984

Characteristic Beams
p, 72 MeV, 2.2 mA, 160 kW

Transmission Efficiency (source to extracted beam)
Typical (%): 
Best (%): 

Emittance
Emittance Definition: rms 
Vertical (π mm mrad): 1 
Horizontal (π mm mrad): 1 
Longitudinal (dE/E[%] x RF[deg.]): 0.1 

USES
Basic Research (%): 75
Development (%): 10
Therapy (%):
Isotope Production (%): parasitic
Other Application (%):
Maintenance (%): 9
Beam Tuning (%): 5
Total Time (h/year): 6000

TECHNICAL DATA
(a) Magnet
Type: separated sectors
Kb (MeV): 72
Kf (MeV): 72
Average Field (min./max. T): 0.33-0.36
Number of Sectors: 4
Hill Angular Width (deg.): 27
Spiral (deg.): 0
Pole Diameter (m): 7
Injection Radius (m): 0.44
Extraction Radius (m): 3.3
Hill Gap (m): 0.035
Valley Gap (m):
Trim Coils
Number: 2 x 4
Maximum Current (A-turns): 40 A
Harmonic Coils
Number: 2 x 4
Maximum Current (A-turns): 200 A
Main Coils
Number: 4 x 2
Total Ampere Turns: 3.4 e4
Maximum Current (A): 400
Stored Energy (MJ):
Total Iron Weight (tons): 4 x 180
Total Coil Weight (tons): 4 x 0.96
Power
Main Coils (total KW):
Trim Coils (total, maximum, KW):
Refrigerator (cryogenic, KW):

(b) RF
Frequency Range (MHz): 50.633
Harmonic Modes: 10
Number of Dees:
Number of Cavities: 2 + 2 flattop used for acc.
Dee Angular Width (deg.):
Voltage
At Injection (peak to ground, KV): 125
At Extraction (peak to ground, KV): 250
Peak (peak to ground, KV):
Line Power (max, KW): 2 x 180
Phase Stability (deg.): 0.01
Voltage Stability (%): 0.03

(c) Injection
Ion Source: Multiscusp
Source Bias Voltage (kV): 60
External Injection: radial, conical injection shim
Buncher Type: 1 + 3 harm., sinus
Injection Energy (MeV/n): 0.870
Component:
Injection Efficiency (%): 20
Injector: Cockcroft-Walton

(d) Extraction
Elements, Characteristic: el. stat channel, septum magnet
Typical Efficiency (%): 99.97
Best Efficiency (%):

(e) Vacuum
Pumps: cryo + turbopumps
Achieved Vacuum (Pa): 1.3 e-4

REFERENCES
Contributions to these Proceedings by Mike Seidel, Joachim Grillenberger, L. Stingelin

EXPERIMENTAL FACILITIES
Injector for the PSI Ring Cyclotron, Isotope production with splitted beam
ENTRY Nº C45
Date: November 10. 2007
Machine Name: PSI 590 MeV Ring Cyclotron
Institution: Paul Scherrer Institute
Address: CH-5232 Villigen PSI, Switzerland
Telephone: ++41-56-310 33 93
Fax: ++41-56-310 33 83
Web Address: www.psi.ch
Person in Charge of Cyclotron: Mike Seidel
Person Reporting Information: Mike Seidel
E-mail Address: mike.seidel@psi.ch

HISTORY
Designed by: H.A. Willax + PSI-team
Construction Dates: 1968-74
First Beam Date: 1974

Characteristic Beams
p, 590 MeV, \( \leq 2 \) mA, 1.2 MW
Transmission Efficiency (source to extracted beam)
Typical (%): 99.97
Best (%):
Emittance
Emittance Definition: \( \text{rms} \)
Vertical (\( \pi \) mm mrad): 1
Horizontal (\( \pi \) mm mrad): 1
Longitudinal (\( dE/E \) [\%] x RF[deg.]): 0.4

USES
Basic Research (%): 70
Development (%): 3
Therapy (%):
Isotope Production (%):
Other Application (%):
Maintenance (%): 11
Beam Tuning (%): 5
Total Time (h/year): 6000

TECHNICAL DATA
(a) Magnet
Type: separated sectors
Kb (MeV): 592
Kf (MeV): 592
Average Field (min./max. T): 0.58 - 0.78
Number of Sectors: 8
Hill Angular Width (deg.): 18
Spiral (deg.): 35
Pole Diameter (m): 9
Injection Radius (m): 2.1
Extraction Radius (m): 4.45
Hill Gap (m): 0.05 - 0.09
Valley Gap (m):
Trim Coils
Number: 2 x 18
Maximum Current (A-turns): 30 / 200 A
Harmonic Coils
Number: 2 x 5 + 2x8
Maximum Current (A-turns): 200 A
Main Coils
Number: 2 x 8

Total Ampere Turns: \( 1.5 \ e^5 \)
Maximum Current (A): 930
Stored Energy (MJ):
Total Iron Weight (tons): 1960
Total Coil Weight (tons): 28
Power
Main Coils (total KW): 620
Trim Coils (total, maximum, KW): 30
Refrigerator (cryogenic, KW):

(b) RF
Frequency Range (MHz): 50.633
Harmonic Modes: 6
Number of Dees:
Number of Cavities: 4 + 1 flattop
Dee Angular Width (deg.):
Voltage
At Injection (peak to ground, KV): 500 (650)
At Extraction (peak to ground, KV): 630 (820)
Peak (peak to ground, KV): 730 (950)
Line Power (max, KW): 4 x 520
Phase Stability (deg.): 0.01
Voltage Stability (%): 0.03

(c) Injection
Ion Source:
Source Bias Voltage (kV):
External Injection: radial, magnetic channel and el. stat. inflector
Buncher Type:
Injection Energy (MeV/n): 72
Component:
Injection Efficiency (%): 99.93
Injector: PSI Injector 2 Cyclotron

(d) Extraction
Elements, Characteristic: el. stat. channel, septum magnet
Typical Efficiency (%): 99.97
Best Efficiency (%): 99.98

(e) Vacuum
Pumps: Kryo + Turbopumps
Achieved Vacuum (Pa): 2.7 e-4

REFERENCES
Contribution to these Proceedings by Mike Seidel

EXPERIMENTAL FACILITIES
pi- and mu-meson areas, n-Spallation Source SINQ,
ENTRY N° C46
Date: 12.12.2007
Machine name: COMET
Institution: Paul Scherrer Insititut
Address: 5232 Villigen-PSI, Switzerland
Telephone: 0041 56 310 2111
Fax: 0041 56 310 2199
Web Address: www.psi.ch
Person in charge of cyclotron: J.M. Schippers
Person reporting information: J.M. Schippers
E-mail address: marco.schippers@psi.ch

HISTORY
Designed by: Henry Blosser (NSCL), ACCEL instr.
Constructed by: ACCEL Instruments GmbH (D)
Construction dates: 2002-2004
First beam date: April 1, 2005

Characteristic beam, energy and current:
250 MeV protons, 500 nA (1000 nA possible)

Transmission efficiency (source to extracted beam)
Typical (%):
Best (%):

Emittance
Emittance definition: contains 95% of particles
Vertical (π mm mrad): 5
Horizontal (π mm mrad): 3
Longitudinal (dE/E[%] x RF[deg.]):

USES
Basic research (%): 0
Development(%): 5
Therapy(%): 95
Isotope production (%): 0
Other application (%): component irradiations

Maintenance (h): 500
Beam tuning(%): 50
Total time (h/year): 3000

TECHNICAL DATA
(a) Magnet: sc Type: cylindrical yoke
Kb: Kw:
Average field (min./max. T): 2.4/3.8 T
Number of magnet sectors: 4
hill angular width (deg.): 45
spiral (max):
Pole parameters
Diameter: 1.6 m
Injection radius (m): internal source
Extraction radius (m): 0.8
Hill gap (m): 0.05 Valley gap (m):

Trim coils
Number: 0, only trim rods
Maximum current (A-turns):

Harmonic coils
Number: 0
Maximum current (A-turns):

Main coils

Number: 1 pair
Total current (A-turns):
Maximum current (A): 158
Stored energy (MJ):
Total iron weight (tons): 90
Total coil weight (tons):

Power
Main coils (total KW): 0.1 (sc)
Trim coils (total, maximum, KW):
Refrigerator (cryogenic, KW): 23

(b) RF
Frequency range (GHz): 72
Harmonic modes: 2
Number of dees: 4
Number of cavities:
Dee angular width (deg.): 40
Voltage
at injection (peak to ground, KV): 100
at extraction (peak to ground, KV): 100
peak (peak to ground, KV):
Line Power (max, KW): 125
Phase Stability (deg.):
Voltage Stability (%):

(c) Injection
Ion Source: cold cathode PIG, internal source
Source Bias Voltage (kV):

External Injection:
Buncher Type:
Injection Energy (MeV/n):
Component:
Injection Efficiency (%):
Injector:

(d) Extraction
Elements, Characteristic:
Typical Efficiency (%): 80
Best Efficiency (%): 85

(e) Vacuum
Pumps: 8 Turbo
Achieved Vacuum (Pa): 5E-7 mb

REFERENCES:
ENTRY NO C47
Date: Feb. 12, 2008
Machine name: TR30/15
Institution: Institute of Nuclear Energy Research
Address: No. 1000, Wunhua Rd., Jiaan Village, Longtan Township, Taoyuan County 32546, Taiwan (R.O.C.)
Telephone: 886-2-82317717 886-3-4711400 ext.7141
Fax: 886-3-4711416
Web Address: http://www.iner.gov.tw
Person in charge of cyclotron: Wuu-Jyh Lin
Person reporting information: Ting Shien Duh
E-mail address: tsduh@iner.gov.tw

HISTORY
Designed by: TRIUMF, CANADA
Constructed by: EBCO, CANADA
Construction dates: 1991 - 1993
First beam date: May, 1993
Characteristic beam, energy and current:
- Proton, 15-30 MeV, 800 μA
- Deuteron, 7.5 – 15 MeV, 150 μA

Transmission efficiency (source to extracted beam)
Typical (%): 20
Best (%): 22
Emittance: 0.34 π mm-mrad
Emittance definition:
- Vertical (π mm mrad):
- Horizontal (π mm mrad):
- Longitudinal (dE/E[%] x RF[deg.]):

USES
Basic research (%): 4
Development(%): 4
Therapy(%): 4
Isotope production (%): 35
Other application (%) :43
Maintenance (%): 15
Beam tuning(%):3
Total time (h/year): 8760

TECHNICAL DATA
(a) Magnet: Type: sector
Kb: Kb:
Average field (min./max. T): 1.2 (0.55/1.9)
Number of magnet sectors: 4
- hill angular width (deg.): 45
- spiral (max):
Pole parameters
- Diameter: 1.52
- Injection radius (m):
- Extraction radius (m):0.661
- Hill gap (m):0.04  Valley gap (m):0.15
Trim coils (for deuteron mode only)
Number: 8

Maximum current (A-turns):
Harmonic coils
- Number:
- Maximum current (A-turns):
Main coils
- Number: 2
Total current (A-turns): 7.2×10^4
Maximum current (A): 500
Stored energy (MJ):
Total iron weight (tons): 46
Total coil weight (tons):
Power
Main coils (total KW):32
Trim coils (total, maximum, KW):19.2
Refrigerator (cryogenic, KW):
(b) RF
- Frequency range (MHz): 73.129
- Harmonic modes: 4
- Number of dees: 2
- Number of cavities: 1
- Dee angular width (deg.): 45
Voltage
- at injection (peak to ground, KV):
- at extraction (peak to ground, KV):
- peak (peak to ground, KV): 50
Line Power (max, KW):244
Phase Stability (deg.):
Voltage Stability (%):
(c) Injection
- Ion Source: 12 mA H’ multi-cusp source
- Source Bias Voltage (kV): -25
External Injection:
- Buncher Type: drift tube
- Injection Energy (MeV/n): 0.025
- Component: Einzel lens Buncher-SQQ
- Injection Efficiency (%): 20(at 1 mA) –30 (at 0.33 mA)
- Injector: 90 degree ± 8 kV inflector
(d) Extraction
Elements, Characteristic: stripping carbon foils
- Typical Efficiency (%): 95-96
- Best Efficiency (%):
(e) Vacuum
Pumps: Cryo pumps
Achieved Vacuum (Pa): 2.67×10^5
ENTRY N° C48
Date: 12 February, 2008
Machine name: Kharkov Compact Cyclotron CV 28
Institution: National Science Center “Kharkov Institute of Physics & Technology” (NSC KIPT)
Address: 61108 Kharkov, Ukraine
Telephone: +38 057 335 44 44
Fax: +38 057 335 44 44
Web Address: http://www.kipt.kharkov.ua
Person in charge of cyclotron: Dr. Yuri Petrusenko
Person reporting information: Dr. Yuri Petrusenko
E-mail address: petrusenko@kipt.kharkov.ua

HISTORY
Designed by: The Cyclotron Corporation, Berkeley, Calif., USA
Constructed by: The Cyclotron Corporation, Berkeley, USA
Construction dates: 1970
First beam date: 1975-Forschungszentrum Juelich, (D)
2010 - Expected second beam date at NSC KIPT

Characteristic beam, energy and current:
p 2-24 MeV, extern 70 A
d 3-14 MeV, extern 100 A
3He 5-36 MeV, extern 70 A
4He 6-28 MeV, extern 50 A

Transmission efficiency (source to extracted beam)
Typical (%): 60
Best (%): 80

Emittance
Emittance definition:
Vertical (π mm mrad): 15
Horizontal (π mm mrad): 15
Longitudinal (dE/E[%] x RF[deg.]):

USES
Basic research (%, estimated): 30
Development (%, estimated): 30
Therapy():
Isotope production (%, estimated): 40
Other application ():
Maintenance ():
Beam tuning():
Total time (h/year): 2000 (estimated)

TECHNICAL DATA
(a) Magnet:
Type: Compact
Kb: Kf:
Average field (min./max. T): 1.85T
Number of magnet sectors:
hill angular width (deg.):
spiral (max.):
Pole parameters
Diameter (m): 0.96
Injection radius (m):
Extraction radius (m): 0.42
Hill gap (m): 0.05 Valley gap (m): 0.1
Trim coils
Number: 4

Maximum current (A-turns):
Harmonic coils
Number: 2 sets of 3
Maximum current (A-turns):
Main coils
Number: 1
Total current (A-turns):
Maximum current (A): 450
Stored energy (MJ):
Total iron weight (tons): 23
Total coil weight (tons):
Power
Main coils (total KW): 60
Trim coils (total, maximum, KW): 50
Refrigerator (cryogenic, KW):
(b) RF
Frequency range (MHz): 6 to 26
Harmonic modes: fundamental
Number of dees: 2
Number of cavities:
Dee angular width (deg.): 90
Voltage
at injection (peak to ground, KV):
at extraction (peak to ground, KV):
peak (peak to ground, KV): 30
Line Power (max, KW):
Phase Stability (deg.):
Voltage Stability ():
(c) Injection
Ion Source: “cold cathode” Penning mode
Source Bias Voltage (kV):
External Injection:
Buncher Type:
Injection Energy (MeV/n):
Component:
Injection Efficiency (%):
Injector:
(d) Extraction
Elements, Characteristic:
dc electrostatic deflector and magnet channel
Typical Efficiency (%): 60
Best Efficiency (%): 80
(e) Vacuum
Pumps:
Achieved Vacuum (Pa): \(6 \times 10^{-5}\)

EXPERIMENTAL FACILITIES
Radiation Materials Science, Nuclear Physics, Isotope Production

COMMENTS
Compact Cyclotron CV 28 has been transferred by Forschungszentrum Juelich, Germany to National Science Center “Kharkov Institute of Physics & Technology” (NSC KIPT), Kharkov, Ukraine at the end of 2006.
ENTRY N° C49
Date: February 2008
Machine name: Indiana University Cyclotron Facility
Institution: Indiana University
Address: Milo B. Sampson Ln, Bloomington, IN 47408
Telephone: +1 (812) 855-9365
Fax: +1 (812) 855-6645
Web Address: http://www.iucf.indiana.edu/
Person in charge of cyclotron: V. Derenchuk
Person reporting information: V. Derenchuk
E-mail address: vderench@indiana.edu

HISTORY
Designed by: R.E. Pollock
Constructed by: Indiana University
Construction dates: 1968-1774
First beam date: August 1975

Characteristic beam, energy and current:
...Protons 208 MeV 0.1pA–200nA.

Transmission efficiency (15MeV to extracted beam)
Typical (%): 50–70%
Best (%): 90%

Emittance
Emittance definition: RMS
Vertical (π mm mrad): 2.0
Horizontal (π mm mrad): 3.0
Longitudinal (dE/E[%, x RF(deg.,']): 0.1% x 4deg

USES
Basic research (%): 0%
Development(%): 0%
Therapy(%): 2 shifts/day
Isotope production (%): 0%
Other application (%): 10%
Maintenance (%): every weekend
Beam tuning(%): each maintenance
Total time (h/year): 6240 h

TECHNICAL DATA
(a) Magnet: Type: Separated Sector
Average field (min./max. T): 1.3 / 1.65 T
Number of magnet sectors: 4
hill angular width (deg.): 36
spiral (max): n/a

Pole parameters
Diameter:
Injection radius (m): 1.01
Extraction radius (m): 3.3

Hill gap (m): 0.076 Valley gap (m): ∞

Trim coils
Number: 21x2
Maximum current (A-turns): 950

Harmonic coils
Number: 4x2 and 1x"Figure8"
Maximum current (A-turns): 40

Main coils
Number: 4x2
Total current (A-turns): 62,000

Maximum current (A): 1000
Stored energy (MJ):
Total iron weight (tons): 2200
Total coil weight (tons): 10

Power
Main coils (total KW): 275
Trim coils (total, maximum, KW): 120
Refrigerator (cryogenic, KW): n/a

(b) RF
Frequency range (MHz): 35.58 (fixed)
Harmonic modes: 4
Number of dees: 2
Number of cavities: 2
Dee angular width (deg.): 38

Voltage
at injection (peak to ground, KV): 130
at extraction (peak to ground, KV): 200
peak (peak to ground, KV): 200

Line Power (max, KW): 200
Phase Stability (deg.): 0.1
Voltage Stability (%): 8E-5

(c) Injection
Ion Source: Microwave
Source Bias Voltage (kV): 20
External Injection: Radial
Buncher Type: RF-chopper+RFQ+K-15
Injection Energy (MeV/n): 15 MeV
Component: Electrostatic inflector
Injection Efficiency (%): 90%
 Injector: K-15 cyclotron

(d) Extraction
Elements, Characteristic:
70kV Electrostatic septum + Magnetic deflector

Typical Efficiency (%): 75%
Best Efficiency (%): 100%

(e) Vacuum
Pumps: 4 cryogenic, 2 diffusion
Achieved Vacuum (Pa): 0.002

REFERENCES:

EXPERIMENTAL FACILITIES
a) Radiation Effects Research Program
b) Bio-Medical Research line (in planning)
ENTRY N° C50
Date: 8 Feb 2008
Machine name: 88-Inch Cyclotron
Institution: Lawrence Berkeley National Laboratory
Address: 1 Cyclotron Rd, MS88 Berkeley, CA 94720
Telephone: 510-486-7826
Fax: 510-486-7983
Web Address: http://cyclotron.lbl.gov/
Person in charge of cyclotron: Claude M. Lyneis
Person reporting information: Claude M. Lyneis
E-mail address: cmlyneis@lbl.gov

HISTORY
Designed by: LBNL
Constructed by: LBNL
Construction dates: 1959-1962
First beam date: 1962

Characteristic beam, energy and current (pps):
Protons 1-55 MeV/n 1.6x10e14
16O6+ 10 MeV/n 2x10e13
40Ar9+ 5 MeV/n 2x10e13
48Ca10+ 6 MeV/n 6x10e12
86Kr19+ 5 MeV/n 2.5x10e12
129Xe28+ 5 MeV/n 6.9x10e11
124Xe34+ 10 MeV/n 2.9x10e11
124Xe42+ 16 MeV/n 8.7x10e8
238U+47 4.5 MeV/n 8x10e9

Transmission efficiency (source to extracted beam)
Typical (%): 10
Best (%): 30

Emittance
Emittance definition: 90%
Vertical (pi mm mrad): 22 pi mm mRad
Horizontal (pi mm mrad): 16 pi mm mRad
Longitudinal (dE/E[%] x RF[deg.]): 3x30 deg dE/E x RF deg

USES
Basic research (%): 40
Development (%): 5
Therapy (%): 0
Isotope production (%): 0
Other application (%): 37
Maintenance (%): 7
Beam tuning (%): 11
Total time (h/year): 5200

TECHNICAL DATA
(a) Magnet:
Kb(MeV): 160
Kf(MeV): 70
Average field (min./max. T): 1.7
Number of magnet sectors:
  hill angular width (deg.): 60
  spiral (deg): 55
Pole parameters
  Diameter(m): 2.24
  Injection radius (m): 0
  Extraction radius (m): 1
Hill gap (m): .19
Valley gap (m): .3

(b) RF
Frequency range (MHz): 5.5-16.0
Harmonic modes: 1,3,5,7
Number of dees: 1
Number of cavities: 1
Dee angular width (deg.): 180
Voltage
  at injection (peak to ground, KV): 50
  at extraction (peak to ground, KV): 50
  peak (peak to ground, KV): 50
Line Power (max, KW): 300
Phase Stability (deg.): .2
Voltage Stability (%): .2

(c) Injection
Ion Source: 3 ECR
Source Bias Voltage (kV): 10-18
External Injection: axial
Buncher Type: first and second harmonic
Injection Energy (MeV/n): .001-.01
Components: Magnetic solenoids, Quadrupoles, bends, buncher (fundamental and harmonic)
Injection Efficiency (%): 30-50
Injector: gridded electrostatic mirror

(d) Extraction
Elements, Characteristic: 3 section electrostatic deflector, 108 degree, 90kV across 6.35 mm , channel shape control all electrodes are moveable
Typical Efficiency (%): 60
Best Efficiency (%): 90

(e) Vacuum
Pumps: Diffusion pumps with LN baffle, 3 Cryo panels
Achieved Vacuum (Pa): 4x10-5 Pa


EXPERIMENTAL FACILITIES
BGS Berkeley Gas Separator, FEAT Facility for Exotic Atom Trapping Particle Gamma-ray Facility, BASE Berkeley Accelerator Space Effects Facility, LIBERACE Livermore Berkeley Collaboration
ENTRY № C51
Date: 5 November 2007
Machine Name: K500
Institution: Michigan State University
Address: NSCL/ Cyclotron Laboratory, E. Lansing, 48824 MI
Telephone: 517-355-9671
Fax: 517-353-5967
Web Address: www.nscl.msu.edu
Person in Charge of Cyclotron: C.K. Gelbke
Person Reporting Information: P.S. Miller
E-mail Address: miller@nscl.msu.edu

HISTORY
Designed by: Michigan State University
Construction Dates: 77-81 (rebuilt 95-99)
First Beam Date: 8/82 (rebuilt 7/98)

Characteristic Beams
ions  energy(MeV/N)   current(pnA)
16O3+  13.05   1500
40Ar7+  12.34    400
48Ca8+ 12.23    300
124Xe20+  12.25     137
124Sn19+ 10.83     30
238U69+ 7.68      10

Transmission Efficiency (source to extracted beam)
Typical (%): 15
Best (%): 21.5

Emittance
Emittance Definition: 50%
Vertical (pi mm mrad): 5 - 12
Horizontal (pi mm mrad): 5 - 8
Longitudinal ([dE/E]% x RF[deg.]):

USES
Basic Research (%):
Development (%):
Therapy (%):
Isotope Production (%):
Other Application (%):
Maintenance (%):
Beam Tuning (%):
Total Time (h/year):

TECHNICAL DATA
(a)Magnet
Type: compact superconducting
Kb (MeV): 500
Kf (MeV): 160
Average Field (min./max. T): 3.0-5.0
Number of Sectors: 3
Hill Angular Width (deg.): 60
Spiral (deg.): 120
Pole Diameter (m): 1.42
Injection Radius (m): 0.015
Extraction Radius (m): 0.66
Hill Gap (m): 0.0635
Valley Gap (m): 0.914
Trim Coils (square coil, Axis horizontal):
Number: (13x3 sectors)
Maximum Current (A-turns): 400x20/2

(b)RF
Frequency Range (MHz): 11-27
Harmonic Modes: 2
Number of Dees: 3
Number of Cavities: 3
Dee Angular Width (deg.): 60
Voltage
At Injection (peak to ground, KV): 70
At Extraction (peak to ground, KV): 70
Peak (peak to ground, KV): 70
Line Power (max., KW): 300
Phase Stability (deg., KW): 0.1
Voltage Stability (%): 0.01

(c)Injection
Ion Source: ECR
Source Bias Voltage (kV): 30 kV max
External Injection: axial
Buncher Type: 2 grid, h=1
Injection Energy (MeV/n): 4 to 6 keV/n typical
Component: solenoid and electrostatic lenses, electric and magnetic dipoles
Injection Efficiency (%): 30% to 50%
Injector: none

(d)Extraction
Elements, Characteristic: electrostatic deflectors (2), 7 mm gap, 100 kV/cm, moveable passive magnetic dipole and 2 compensators, movable focusing bars (8) and compensators (2) precessional
Typical Efficiency (%): 75
Best Efficiency (%): 90

(e)Vacuum
Pumps: 3 cryopanels, 7K, Cu+charcoal, 1 TMP
Achieved Vacuum (Pa): 5.2E-5

REFERENCES
R.C. York et. al., Proc. 15th Int. Conf. on Cyclotrons, E. Baron and M. Lieuvin, eds. (1999)687

EXPERIMENTAL FACILITIES
See K1200 cyclotron data for coupled cyclotron experimental facilities.
ENTRY Nº C52
Date: 5 November 2007
Machine Name: K1200
Institution: Michigan State University
Address: NSCL/ Cyclotron Laboratory, E. Lansing, Mi 48824
Telephone: 517-355-9671
Fax: 517-353-5967
Web Address: www.nscl.msu.edu
Person in Charge of Cyclotron: C. K. Gelbke
Person Reporting Information: P. S. Miller
E-mail Address: miller@nscl.msu.edu

HISTORY
Designed by: Michigan State University 1976-86
Construction Dates: 80-87
First Beam Date: 6/88; Coupled Cyc. 10/2000

Characteristic Beams
<table>
<thead>
<tr>
<th>ions</th>
<th>energy(MeV/N)</th>
<th>current(pnA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16O8+</td>
<td>150</td>
<td>125</td>
</tr>
<tr>
<td>18O8+</td>
<td>20</td>
<td>125</td>
</tr>
<tr>
<td>48Ca20+</td>
<td>140</td>
<td>80</td>
</tr>
<tr>
<td>78Kr34+</td>
<td>150</td>
<td>25</td>
</tr>
<tr>
<td>86Kr34+</td>
<td>140</td>
<td>20</td>
</tr>
<tr>
<td>124Xe48+</td>
<td>140</td>
<td>10</td>
</tr>
<tr>
<td>124Sn45+</td>
<td>120</td>
<td>1.5</td>
</tr>
<tr>
<td>209Bi63+</td>
<td>80</td>
<td>1</td>
</tr>
<tr>
<td>238U69+</td>
<td>80</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Transmission Efficiency (source to extracted beam)
Typical (%): 7
Best (%): 10 (coupled cyc. system)

Uses
Basic Research (%):
Development (%):
Therapy (%):
Isotope Production (%):
Other Application (%):
Maintenance (%):
Beam Tuning (%):
Total Time (h/year):

TECHNICAL DATA
(a) Magnet
Type: compact
Kb (MeV): 1200
Kf (MeV): 400
Average Field (min./max. T): 3.0 - 5.3
Number of Sectors: 3
Hill Angular Width (deg.): 60
Spiral (deg.): 176
Pole Diameter (m): 2.197
Injection Radius (m): 0.32
Extraction Radius (m): 1.03

Hill Gap (m): 0.076
Valley Gap (m): 0.914
Trim Coils (square coil, axis horizontal)
Number: (21x3 sectors)
Maximum Current (A-turns): 400x20/2
Harmonic Coils (use trim coils)
Number: 3 (trim coil #1,5,21)
Maximum Current (A-turns): 400x20/2
Main Coils
Number: 2x2
Total Ampere Turns: 7E6
Maximum Current (A): 900
Stored Energy (MJ): 60
Total Iron Weight (tons): 240
Total Coil Weight (tons): 20

Power
Main Coils (total KW): 0
Trim Coils (total, maximum, KW): 100
Refrigerator (cryogenic, KW): 1300

(b) RF
Frequency Range (MHz): 9-27
Harmonic Modes: 1
Number of Dees: 3
Number of Cavities: 3
Dee Angular Width (deg.): 60
Voltage
At Injection (peak to ground, KV): 150
At Extraction (peak to ground, KV): 200
Peak (peak to ground, KV): 169
Line Power (max, KW): 920
Phase Stability (deg.): 1
Voltage Stability (%): 0.01

(c) Injection
Ion Source: ECR
Source Bias Voltage (kV): 30 kV max
External Injection: radial
Buncher Type: none
Injection Energy (MeV/n): approx. Efinal/11
Component: K500 cyc., internal stripper foil
Injection Efficiency (%): 65%
Injector: K500 Cyclotron

(d) Extraction
Elements, Characteristic: electrostatic deflectors (2), 6mm gap, 130 kV/cm; movable passive magnetic dipole and 2 compensators, movable focusing bars (8) and compensators (5), precessional
Typical Efficiency (%): 70
Best Efficiency (%): 90

(e) Vacuum
Pumps: 2 cryopanels, 7K, Cu+charcoal, 2500 l/s/panel, 3 TMP’s
Achieved Vacuum (Pa): 9.3e-5

REFERENCES
MSU Reports MSUCP 29 (June 80) and MSUCP35 (June 81) MSUCP-939 (July 94) “The K500 x K1200” Proc. 11th Int. Conf. on Cyclotrons (1986)157
EXPERIMENTAL FACILITIES
Magnetic spectrometer S800, Segmented Germanium Array, RF Separator, Modular Neutron Array, Neutron Wall, Sweeper magnet, Gas stopping target, Low energy beam ion transport, Ion trap.
ENTRY N° C53

Date: 2/6/08
Machine name: Oak Ridge Isochronous Cyclotron (ORIC)
Institution: Oak Ridge National Laboratory
Address: P.O. Box 2008, MS 6368, Oak Ridge, TN 37831
Telephone: (865) 574-4759
Fax: (865) 574-1268
Web Address: http://www.phy.ornl.gov/hribf/accelerator/oricweb/
Person in charge of cyclotron: B. Alan Tatum
Person reporting information: B. Alan Tatum
E-mail address: tatumba@ornl.gov

HISTORY
Designed by: ORNL
Constructed by: ORNL
Construction dates: 1959-1962
First beam date: 1963

Characteristic beam, energy and current:
Proton 54 MeV  50euA
Deuteron  50 MeV 30euA
Alpha   105 MeV   20euA

Transmission efficiency (source to extracted beam)
Typical (%): 60
Best (%): 80

Emittance
Emittance definition:
Vertical (pi mm mrad): 30 (radial)
Horizontal (pi mm mrad): 10 (axial)
Longitudinal (dE/E[%] x RF[deg.]):

USES
Basic research (%): 70
Development(%): 10
Therapy(%): 0
Isotope production (%): 0
Other application (%): 0
Maintenance (%): 10
Beam tuning(%): 10
Total time (h/year): 2000

TECHNICAL DATA
(a) Magnet: Type: Conventional Isochronous
Kb: 105 MeV/A   Kf: 75 MeV/A
Average field (min./max. T): 1.92T
Number of magnet sectors: 3
  hill angular width (deg.): 72  deg at extraction
  spiral (max): 30 deg
Pole parameters
  Diameter: 1.93 m
  Injection radius (m): .80
  Extraction radius (m): .80
  Hill gap (m): .19m  Valley gap (m): .71
Trim coils
  Number: 10x2
Maximum current (A-turns): 7200
Harmonic coils
  Number: 4xNsectorsx2
Maximum current (A-turns):
  Main coils
  Number: 1x2
  Total current (A-turns): 1,600,000
  Maximum current (A): 5000
  Stored energy (MJ): ~10
  Total iron weight (tons): 200
  Total coil weight (tons): 9
Power
  Main coils (total, maximum, KW): 1750
  Trim coils (total, maximum, KW): 250
Refrigerator (cryogenic, KW): not applicable

(b) RF
  Frequency range (MHz): 6.8-20.1
  Harmonic modes: 1,3
  Number of dees: 1
  Number of cavities: 1
  Dee angular width (deg.): 180
  Voltage
    at injection (peak to ground, KV): N/A
    at extraction (peak to ground, KV): 60
    peak (peak to ground, KV): 60
  Line Power (max, KW): 200
  Phase Stability (deg.): ±1
  Voltage Stability (%): 0.05%

(c) Injection
  Ion Source: Penning
  Source Bias Voltage (kV): 5
  External Injection: not applicable
  Buncher Type:
  Injection Energy (MeV/n):
  Component:
  Injection Efficiency (%):
  Injector: none

(d) Extraction
  Elements, Characteristic: Electrostatic Deflector,
  Coaxial Magnetic Channel, Iron-Compensated Lower
  Magnetic Channel
  Typical Efficiency (%): 55
  Best Efficiency (%): 85

(e) Vacuum
  Pumps: 3 diffusion, 1 cryogenic
  Achieved Vacuum (Pa): 2.66x10^-4

EXPERIMENTAL FACILITIES
Recoil Mass Spectrometer (RMS), Daresbury Recoils
Separator, Enge Spectrograph, CLARION Array, High
Power Target Laboratory
ENTRY NO: C54
Date: 15 Feb 2005 15:04:31
Machine Name: Texas A&M K500 Cyclotron
Institution: Texas A&M University
Address: Cyclotron Institute, College Station 77843
Telephone: 979/845-1411
Fax: 979/8451899
Web Address: http://cyclotron.tamu.edu
Person in Charge of Cyclotron: R. E. Tribble
Person Reporting Information: D. P. May
E-mail Address: may@comp.tamu.edu
History
Designed by: Michigan State & Texas A&M
First Beam Date: June 15, 1988
Characteristic Beams
ions / energy(MeV/N)/current(pps)/power(w)
16O8+ 60 1.3E11 20
40Ar13+ 40 7.2E11 185
84Kr27+ 40 2.3E8 0.12
197Au33+ 10.5 3.3E1 0 11
Transmission Efficiency (source to extracted beam)
Typical (%): 6
Best (%): 12.9
Emittance
Emittance Definition: RMS
Vertical (pi mm mrad): 5
Horizontal (pi mm mrad): 5
Longitudinal (dE/E[%] x RF[deg.]):
USES
Basic Research (%): 41
Development (%): 12
Therapy (%): 0
Isotope Production (%): 0
Other Application (%): 18
Maintenance (%): 18
Beam Tuning (%): 11
Total Time (h/year): 8000
TECHNICAL DATA
(a)Magnet
Type: Compact superconducting
Kb (MeV): 520
Kf (MeV): 160
Average Field (min./max. T): 3.1/4.9
Number of Sectors: 3
Hill Angular Width (deg.): 60
Spiral (deg.): 169.4
Pole Diameter (m): 1.42
Injection Radius (m): 0.008
Extraction Radius (m): 0.67
Hill Gap (m): 0.0635
Valley Gap (m): 0.914
Trim Coils
Number: 13x2
Maximum Current (A-turns): 4000
Harmonic Coils
Number: 2xNsectorsx2
Maximum Current (A-turns): 4000
Main Coils
Number: 2x2
Total Ampere Turns: 4.4E6
Maximum Current (A): 800
Stored Energy (MJ): 16.9
Total Iron Weight (tons): 100
Total Coil Weight (tons):
Power
Main Coils (total KW):
Trim Coils (total, maximum, KW): 200
Refrigerator (cryogenic, KW): 0.2
(b)RF
Acceleration
Frequency Range (MHz): 9-28
Harmonic Modes: 1, 2
Number of Dees: 3
Number of Cavities: 6
Dee Angular Width (deg.): 60
Voltage
At Injection (peak to ground, KV): 20-90
At Extraction (peak to ground, KV): 20-90
Peak (peak to ground, KV): 20-90
Line Power (max, KW): 240
Phase Stability (deg.): 0.1
Voltage Stability (%): 0.01
(c)Injection
Ion Source: 6.4 GHz High-B ECRIS
Source Bias Voltage (kv): 2-15
External Injection: axial
Buncher Type: 1st & 2nd harm., 1 gap
Injection Energy (MeV/n): 0.0005-0.007
Component: 3 dipoles, 5 solenoids
Injection Efficiency (%): 10-25
Injector:
(d)Extraction
Elements, Characteristic: 2 electrostatic deflectors, 5 passive
moveable magnetic channels, and 1 passive fixed magnetic
channel.
Typical Efficiency (%): 50-60
Best Efficiency (%): 90
(e)Vacuum
Pumps: 3 turbos & 3 internal LHe cryopanels
Achieved Vacuum (Pa): 1.0E-5
REFERENCES
EXPERIMENTAL FACILITIES
Neutron Ion Multidetector (NIMROD), BaF2 Array,
MDM-2
Spectrometer, Momentum Achromat Recoil
Spectrometer
(MARS), Radiation Effects Facility
COMMENTS

ENTRY N° CM1
Date: 12-02-2008
Machine Name: IBA C10 Cyclotron
Institution: Ion Beam Applications (IBA)
Address: Chemin du Cyclotron 3 - 1348 Louvain-La-Neuve Belgium
Telephone: +32-10-475811 Fax Number: +32-10-475810
Web Address: www.iba-worldwide.be
Person in Charge of Cyclotron: S. Zaremba
Person Reporting Information: W. Kleeven
Email Address: info-cyclo@iba-group.com

HISTORY
Designed by: Ion Beam Applications (IBA)
Construction Date: 2003-2004
First Beam Date: November 2004

Characteristic Beams
ion proton; energy 10 MeV; current 100 microA; power 1 kWatt
Transmision Efficiency (source to extracted beam)
Typical (%): 60 %
Best (%): 65 %
Emittance
Emittance definition:
Vertical (pi mm mrad): -
Horizontal (pi mm mrad): -
Longitudinal (dE/E[%] x RF[deg.]): -

USES
Basic Research (%):
Development (%):
Therapy (%):
Isotope Production (%): 100 %
Other Application (%):
Maintenance (%):
Beam Tuning (%):
Total Time (h/year):

TECHNICAL DATA
(a) Magnet
Type: compact
Kb (MeV/A): 10 MeV/A
Kf (MeV/A): 10 MeV/A
Average Field (min./max. T): 1.35 (0.4/1.9) T
Number of Sectors: 4 Hill
angular width (deg.): 54 deg
Spiral (deg.): 0 deg
Pole diameter (m): 0.76 m
Injection Radius (m): 0.02 m
Extraction Radius (m): 0.35 m
Hill Gap (m): 0.03
Valley Gap (m): 0.8
Trim Coils
Number: 0
Maximum Current (A-turns): N/A
Harmonic Coils
Number: 0
Maximum Current (A-turns): N/A
Main Coils Number: 2
Total Ampere Turns: 112000
Maximum Current (A): 200
Stored Energy (MJ): 0.015 MJ
Total Iron Weight (tons): 12 Tons
Total Coil Weight (tons): 1.25 Tons
Power
Main Coins (total KW): 17 kWatt
Trim Coins (total, maximum, KW): N/A
Refrigerator (cryogenic, KW): N/A

(b)RF
Frequency Range (MHz): 40 MHz
Harmonic Mode: 2
Number of Dees: 2
Number of Cavities: 2
Dee Angular Width (deg.): 30 deg
Voltage
At Injection (peak to ground, KV): 32 kV
At Extraction (peak to ground, KV): 32 kV
Peak (peak to ground, KV): 32 kV
Line Power (max, KW): 10 kW
Phase Stability (%): 0.1
Voltage Stability (%): 0.1

(c) Injection
Ion Source: PIG
Source Bias Voltage (kV): N/A
External Injection: N/A
Buncher Type: N/A
Injection Energy (MeV/n): N/A
Component: N/A
Injection Efficiency (%): N/A
Injector: N/A

(d) Extraction
Elements, Characteristic: Stripping
Typical Efficiency (%): 100 %
Best Efficiency (%): 100 %

(e) Vacuum
Pumps: 1 ODP
Achieved Vacuum (Pa): 5*10^-5

COMMENTS
self-shielded version available
ENTRY N° CM2
Date: 12-02-2008
Machine Name: Cyclone 10/5
Institution: Ion Beam Applications (IBA)
Address: chemin du cyclotron, 31348 Louvain neuve, Belgium la
Telephone: + 32 10 47 58 11
Fax Number: + 32 10 475810
Web Address: www.iba-worldwide.com
Person in Charge of Cyclotron: Yves Jongen
Person Reporting Information: Geets jean-michel
Email Address: info-cyclo@iba-group.com

HISTORY
Designed by: IBA
Construction Date: 1989
First Beam Date: 1990

Characteristic Beams
10 MeV proton 100 microA external
5 MeV deuton 50 microA

Transmission Efficiency (source to extracted beam)
Typical (%): 55
Best (%): 60

Emittance
Emittance definition: -
Vertical (pi mm mrad):
Horizontal (pi mm mrad):
Longitudinal (dE/E[%] x RF[deg.]):

USES
Basic Research (%):
Development (%):
Therapy (%):
Isotope Production (%): 100
Other Application (%):
Maintenance (%):
Beam Tuning (%):
Total Time (h/year):

TECHNICAL DATA
(a) Magnet Type: compact
Kb (MeV/A): 10
Kf (MeV/A): 10
Average Field (min./max. T): 1.3 (0.4/1.9)
Number of Sectors: 4
Hill angular width (deg.): 54
Spiral (deg.): 0
Pole diameter (m): 0.76
Injection Radius (m): 0.02
Extraction Radius (m): 0.35
Hill Gap (m): 0.03
Valley Gap (m): 0.80
Trim Coils Number: 0
Maximum Current (A-turns): N/A
Harmonic Coils Number: 0
Maximum Current (A-turns): N/A
Main Coils Number: 2
Total Ampere Turns: 112000
Maximum Current (A): 200
Stored Energy (MJ):

Total Iron Weight (tons): 12
Total Coil Weight (tons): 1.25

Power
Main Coils (total KW): 17
Trim Coils (total, maximum, KW):
Refrigerator (cryogenic, KW):

(b)RF
Frequency Range (MHz): 40
Harmonic Mode: 2 p/ 4 d
Number of Dees: 2
Number of Cavities: 2
Dee Angular Width (deg.): 30
Voltage
At Injection (peak to ground, KV): 32
At Extraction (peak to ground, KV): 32
Peak (peak to ground, KV): 32
Line Power (max, KW): 10
Phase Stability (%): 0.1
Voltage Stability (%): 0.1

(c) Injection
Ion Source: 2 internal PIG
Source Bias Voltage (kV): N/A
External Injection: N/A
Buncher Type: N/A
Injection Energy (MeV/n): N/A
Component:
Injection Efficiency (%):
Injector:

(d) Extraction
Elements, Characteristic: carbon stripper
Typical Efficiency (%): 100
Best Efficiency (%):

(e) Vacuum Pumps: oil diffusion pump
Achieved Vacuum (Pa): 1 e-5

REFERENCES
EPAC 1990, Y Jongen et al., Nice 1990

COMMENTS
(2007) 22 units sold, self-shielded version available
ENTRY N° CM3
Date: 12-02-2008
Machine name: Cyclone 14 +
Institution: Ion Beam Application
Address: ch cyclotron, 3
1348 louvain la neuve, Be
Telephone: +32 10 475 811
Fax: + 32 475 810
Web Address: www.iba-worldwide.com
Person in charge of cyclotron: IBA TG
Person reporting information: Geets Jean-michel
E-mail address: info-cyclo@iba-group.com

HISTORY
Designed by: IBA
Constructed by: 1996
Construction dates: 1997
First beam date: 1997
Characteristic beam, energy and current:
P 14 MeV  5.e15 pps 14 kW
Transmission efficiency (source to extracted beam)
Typical (%):
Best (%):
Emittance
Emittance definition:
Vertical (pi mm mrad):
Horizontal (pi mm mrad):
Longitudinal (dE/E[%] x RF[deg.]):

USES
Basic research (%):
Development():
Therapy():
Isotope production (): 100 %
Other application ( ) :
Maintenance ():
Beam tuning():
Total time (h/year):

TECHNICAL DATA
(a) Magnet:
Type: compact
Kb: 18
Kf: 18
Average field (min./max. T): 1.15
Number of magnet sectors: 4
hill angular width (deg.): 56
spiral (max): 0
Pole parameters
Diameter: 1.08
Injection radius (m): 0
Extraction radius (m):
Hill gap (m): 0.03
Valley gap (m): 0.65
Trim coils
Number: 0
Maximum current (A-turns):
Harmonic coils
Number: 0

Maximum current (A-turns):
Main coils
Number: 1X 2
Total current (A-turns): 86400
Maximum current (A): 120
Stored energy (MJ):
Total iron weight (tons): 24
Total coil weight (tons): 2
Power
Main coils (total KW): < 10
Trim coils (total, maximum, KW):
Refrigerator (cryogenic, KW):

(b) RF
Frequency range (MHz): 83
Harmonic modes: 4
Number of dees: 2
Number of cavities : 2
Dee angular width (deg.): 30
Voltage
at injection (peak to ground, KV): 45
at extraction (peak to ground, KV):
peak (peak to ground, KV): 45
Line Power (max, KW): < 25
Phase Stability (deg.):
Voltage Stability (): 5 e.-3

(c) Injection
Ion Source: PIG
Source Bias Voltage (kV):
External Injection:
Buncher Type:
Injection Energy (MeV/n):
Component:
Injection Efficiency (%):
Injector:

(d) Extraction
Elements, Characteristic: internal target
Typical Efficiency (%):
Best Efficiency (%):

(e) Vacuum
Pumps: oil diffusion
Achieved Vacuum (Pa): 2 e-3

REFERENCES:
EXPERIMENTAL FACILITIES
2 units at IBt- Belgium
ENTRY N° CM4
Date: 12-02-2008
Machine name: Cyclone 14 SE
Institution: Ion Beam Application
Address: ch cyclotron, 3
1348 louvain la neuve, Be
Telephone: +32 10 475 811
Fax: + 32 475 810
Web Address: www.iba-worldwide.com
Person in charge of cyclotron: Lambert Bernard
Person reporting information: Geets Jean-michel
E-mail address: info-cyclo@iba-group.com

HISTORY
Designed by: IBA
Constructed by: IBA
Construction dates: Jan 98- Dec 2000
First beam date: Dec 2000
Characteristic beam, energy and current:
P 14 MeV   5 mA  70 kW
Transmission efficiency (source to extracted beam)
Typical (%): 75
Best (%): 80
Emittance
Emittance definition:
Vertical (\pi mm mrad):
Horizontal (\pi mm mrad):
Longitudinal (dE/E[%] x RF[deg.]):

USES
Basic research (%):
Development():
Therapy():
Isotope production (): 100 %
Other application ():
Maintenance ():
Beam tuning ():
Total time (h/year):

TECHNICAL DATA
(a) Magnet:
Type: compact
Kb: 14
Kf: 14
Average field (min./max. T): 1.1 (1.8/ 0.3)
Number of magnet sectors: 4
  hill angular width (deg.): 45
  spiral (max): 0
Pole parameters
  Diameter: 1.08
  Injection radius (m): 0.02
  Extraction radius (m): 0.48
  Hill gap (m): 0.04 – 0.015
  Valley gap (m): 0.67
Trim coils
  Number: 0
  Maximum current (A-turns):
Harmonic coils
  Number: 2X2
  Maximum current (A-turns): 300
Main coils
  Number: 1X 2
  Total current (A-turns): 126000
  Maximum current (A): 175
Stored energy (MJ): 0.03
Total iron weight (tons): 20
Total coil weight (tons): 2
Power
  Main coils (total KW): 22
  Trim coils (total, maximum, KW):
  Refrigerator (cryogenic, KW):

(b) RF
  Frequency range (MHz): 67
  Harmonic modes: 4
  Number of dees: 2
  Number of cavities : 4
  Dee angular width (deg.): 40
Voltage
  at injection (peak to ground, KV): 45
  at extraction (peak to ground, KV): 55
  peak (peak to ground, KV): 55
Line Power (max, KW): < 100
Phase Stability (deg.): 0.1
Voltage Stability (%): 0.1

(c) Injection
  Ion Source: PIG
  Source Bias Voltage (kV):
  External Injection:
  Buncher Type:
  Injection Energy (MeV/n):
  Component:
  Injection Efficiency (%):
  Injector:

(d) Extraction
  Elements, Characteristic:
  Self-extraction principle
  Typical Efficiency (%): 75
  Best Efficiency (%): 80

(e) Vacuum
  Pumps: oil diffusion
  Achieved Vacuum (Pa): 2 e-3

REFERENCES:
EPAC 2000, Self-extraction in a compact high intensity cyclotron, Kleeven et al.
Cyclotron 2001, the self-extracting cyclotron, Lucas et al.
Cyclotron 2001, Magnetic field calculation and shimming of the self-extracting cyclotron, Jongen et al.

EXPERIMENTAL FACILITIES
IBA isotopes production facility, Fleurus, Belgium
Maximum Current (A): 200
Stored Energy (MJ): -
Total Iron Weight (tons): 20
Total Coil Weight (tons): 2
Power Main Coils (total KW): 15
Trim Coils (total, maximum, KW): -
Refrigerator (cryogenic, KW): -

(b)RF
Frequency Range (MHz): 42
Harmonic Mode: 2p/4d
Number of Dees: 2
Number of Cavities: 4
Dee Angular Width (deg.): 30
Voltage
At Injection (peak to ground, KV): 32
At Extraction (peak to ground, KV): 32
Peak (peak to ground, KV): 32
Line Power (max, KW): 10
Phase Stability (%): 0.1
Voltage Stability (%): 0.1

(c)Injection Ion Source: 2 PIG internal
Source Bias Voltage (kV): 0
External Injection: N/A
Buncher Type: N/A
Injection Energy (MeV/n): N/A
Component:
Injection Efficiency (%):
Injector:

(d)Extraction Elements,
Characteristic: carbon stripper
Typical Efficiency (%): 100
Best Efficiency (%): 100

(e)Vacuum Pumps: 4 x Oil diffusion
Achieved Vacuum (Pa): 7 e-5

REFERENCES
EPAC 1990, Y Jongen, Nice 1990

EXPERIMENTAL FACILITIES
(2007) 90 units sold, self-shielded version available
ENTRY N° CM6
Date: 12-02-2008
Machine Name: Cyclone 30
Institution: Ion Beam Applications (IBA)
Address: chemin du cyclotron, 31348 Louvain la Neuve, Belgium
Telephone: +32 10 47 58 11
Fax Number: +32 10 475810
Web Address: www.iba-worldwide.com
Person in Charge of Cyclotron: Yves Jongen
Person Reporting Information: Geets jean-michel
Email Address: info-cyclo@iba-group.com

HISTORY
Designed by:
Construction Date: 1986
First Beam Date: 1986

Characteristic Beams
15-30 MeV proton 400-750-1200 microA

Transmission Efficiency (source to extracted beam)
Typical (%): 30
Best (%): 35

Emittance
Emittance definition:
Vertical (π mm mrad): 10
Horizontal (π mm mrad): 5
Longitudinal (dE/E[%] x RF[deg.]): 1

USES
Basic Research (%): 5
Development (%):
Therapy (%):
Isotope Production (%): 95
Other Application (%):
Maintenance (%):
Beam Tuning (%):
Total Time (h/year):

TECHNICAL DATA
(a) Magnet Type: compact
Kb (MeV/A): 30
Kf (MeV/A): 30
Average Field (min./max. T): 1(0.12/1.7)
Number of Sectors: 4
Hill angular width (deg.): 54-58
Spiral (deg.): 0
Pole diameter (m): 1.6
Injection Radius (m): 0.03
Extraction Radius (m): 0.5 - 0.75
Hill Gap (m): 0.03
Valley Gap (m): 0.1
Trim Coils Number: 0
Maximum Current (A-turns): N/A
Harmonic Coils Number: 0
Maximum Current (A-turns): N/A
Main Coils Number: 2
Total Ampere Turns: 60 000
Maximum Current (A): 110
Stored Energy (MJ):
Total Iron Weight (tons): 45
Total Coil Weight (tons): 4
Power Main Coils (total KW): 7.2
Trim Coils (total, maximum, KW): N/A
Refrigerator (cryogenic, KW): N/A

(b) RF
Frequency Range (MHz): 66
Harmonic Mode: 4
Number of Dees: 2
Number of Cavities: 4
Dee Angular Width (deg.): 30
Voltage
At Injection (peak to ground, KV): 50
At Extraction (peak to ground, KV): 50
Peak (peak to ground, KV): 50
Line Power (max, KW): 40
Phase Stability (%): 0.1
Voltage Stability (%): 0.1

(c) Injection
Ion Source: multicusp
Source Bias Voltage (kV): 30
External Injection:
axial Buncher Type: wire
Injection Energy (MeV/n): 0.03
Component:
Injection Efficiency (%): 35
Injector: inflector

d) Extraction
Elements, Characteristic: carbon stripper
Typical Efficiency (%): 100
Best Efficiency (%):
(e) Vacuum Pumps: cryo pump 4000l/s (N2)
Achieved Vacuum (Pa): 1 E-5

REFERENCES
ACC92, Y Jongen et al., St-Petersburg 1992
EPAC 1990, Y Jongen et al., Nice 1990

COMMENTS
(2007) 24 units in operation
ENTRY N° CM7
Date: 12-02-2008
Machine name: Cyclone 70
Institution: Ion Beam Applications (IBA)
Address: Chemin du Cyclotron 3, 1348 Louvain-La-Neuve, Belgium
Telephone: +32 10 47 58 11
Fax: +32 10 47 58 10
Web Address: www.iba-worldwide.com
Person in charge of cyclotron: Yves Jongen
Person reporting information: Wiel Kleeven
E-mail address: info-cyclo@iba-group.com

HISTORY
Designed by: IBA
Constructed by: IBA
Construction dates: facility under construction, ‘06-‘08
First beam date: planned end of 2008

Characteristic beam, energy and current:
- 30-70 MeV, 750 µA H-minus
- 15-35 MeV, 50 µA D-minus
- 35 MeV, 50 µA H2+
- 70 MeV, 70 µA alpha

Transmission efficiency (source to extracted beam):
- Typical (%): not yet known
- Best (%): not yet known

Emittance:
- Emittance definition:
  - Vertical (π mm mrad): not yet known
  - Horizontal (π mm mrad): not yet known
  - Longitudinal (dE/E[\%] x RF[deg.]): not yet known

USES
Basic research (%): yes, not yet known
Development(%): not yet known
Therapy(%): no
Isotope production (%): yes, not yet known
Other application (%) : yes, not yet known
Maintenance (%): not yet known
Beam tuning(%): not yet known
Total time (h/year): not yet known

TECHNICAL DATA
(a) Magnet:
  - Type: compact
  - Kb: 70
  - Kf: 70
  - Average field (min./max. T): 1.0

Number of magnet sectors: 4
  - hill angular width (deg.): 56
  - spiral (max): 0

Pole parameters:
  - Diameter: 2.48
  - Injection radius (m): 0.03
  - Extraction radius (m): variable
  - Hill gap (m): 0.03
  - Valley gap (m): 0.8

Trim coils
  - Number: 3
  - Maximum current (A-turns): 300 A

Harmonic coils
  - Number: 0

Maximum current (A-turns):
- Main coils
  - Number: 2
- Total current (A-turns): 62100
- Maximum current (A): 260

Stored energy (MJ):
- Total iron weight (tons): 120 T
- Total coil weight (tons): 4 T

Power
- Main coils (total KW): 60
- Trim coils (total, maximum, KW): 54
- Refrigerator (cryogenic, KW): na

(b) RF
- Frequency range (MHz): 30.4
- Harmonic modes: 2 (H-minus), 4 (other particles)
- Number of dees: 2
- Number of cavities: 4
- Dee angular width (deg.): 30

Voltage
- at injection (peak to ground, KV): 65
- at extraction (peak to ground, KV): 70
- peak (peak to ground, KV): 70
- Line Power (max, KW): 150
- Phase Stability (deg.): 0.1
- Voltage Stability (%): 0.1

(c) Injection
- Ion Source: ECR & multicusp
- Source Bias Voltage (kV): 20 kV & 40 kV
- External Injection: axial/spiral inflector
- Buncher Type: 2-gap
- Injection Energy (MeV/n): 40 keV
- Component:
  - Injection Efficiency (%): 30
  - Injector:

(d) Extraction
- Elements,
  - Characteristic: stripping (H-,D-), ESD (H2+,alpha)
  - Typical Efficiency (%): not yet known
  - Best Efficiency (%): not yet known

(e) Vacuum
- Pumps: 4* cryopumps
- Achieved Vacuum (Pa):

REFERENCES: 18th International Conference on Cyclotrons and their Applications, 2007
1) IBA C70 Cyclotron Development MOZCR06,
2) Extraction Simulations for the IBA C70 Cyclotron MOPPRB14, (IBA, Louvain-la-Neuve)
3) Injection and Central Region Design for the IBA C70 cyclotron MOPPRB15, (IBA, Louvain-la-Neuve)
4) Magnetic Field Design and Calculations for the IBA C70 Cyclotron TUPPRA06
5) The Magnetic Field Mapping System for the IBA C70 Cyclotron TUPPRA07, (IBA, Louvain-la-Neuve)

EXPERIMENTAL FACILITIES
ARRONAX ; http://www.arronax-nantes.fr/
ENTRY N° CM8
Date: 12-02-2008
Machine name: C230
Institution: Ion Beam Applications
Address: Chemin du Cyclotron, 3
B-1348 Louvain-la-Neuve
Telephone: +32 10 475811
Fax: +32 10 475810
Web Address: http://www.iba-worldwide.com
Person in charge of cyclotron: Patrick Verbruggen
Person reporting information: Patrick Verbruggen
E-mail address: patrick.verbruggen@iba-group.com

HISTORY
Designed by: IBA
Constructed by: IBA
Construction dates:
First beam date:
Characteristic beam, energy and current:
230MeV 500nA proton beam
Transmission efficiency (source to extracted beam)
Typical (%): 40%
Best (%): 50%
Emittance
Emittance definition: 1 sigma
Vertical (pi mm mrad): 5.5
Horizontal (pi mm mrad): 4
Longitudinal (dE/E[%] x RF[deg.]): +/-7

USES
Basic research (%): 0
Development(%): 0
Therapy(%): 97
Isotope production (%): 0
Other application (%): 0
Maintenance (%): 2
Beam tuning(%): 1
Total time (h/year): 5000

TECHNICAL DATA
(a) Magnet: Type: Compact
Kb: 235
Kf: 230
Average field (min./max. T): 1.7 / 2.15
Number of magnet sectors: 4
  hill angular width (deg.): 54°
  spiral (max): 60°
Pole parameters
  Diameter: 2.24
  Injection radius (m): 0.02
  Extraction radius (m): 1.056
  Hill gap (m): 0.096 / 0.009 Valley gap (m): 0.6
Trim coils
  Number: 0
  Maximum current (A-turns):
Harmonic coils
  Number: 8
  Maximum current (A-turns): 828
Main coils
  Number: 2
  Total current (A-turns): 523720
  Maximum current (A): 800A
  Stored energy (MJ): 2.2
  Total iron weight (tons): 210T
  Total coil weight (tons): 20T
Power
  Main coils (total KW): 200kW
  Trim coils (total, maximum, KW):
    Refrigerator (cryogenic, KW):
(b) RF
  Frequency range (MHz): 106MHz
  Harmonic modes: 4
  Number of dees: 2
  Number of cavities: 2
  Dee angular width (deg.): 30°
  Voltage
    at injection (peak to ground, KV): 55kV
    at extraction (peak to ground, KV): 150kV
    peak (peak to ground, KV): 150kV
  Line Power (max, KW): 100kW
  Phase Stability (deg.): NA
  Voltage Stability (%): 5.e-2
(c) Injection
  Ion Source: internal PIG source
  Source Bias Voltage (kV): 0
  External Injection: NA
  Buncher Type: NA
  Injection Energy (MeV/n):
  Component:
    Injection Efficiency (%): NA
    Injector:
(d) Extraction
  Elements, Characteristic: electrostatic deflector
  18MV/m, passive gradient corrector, permanent magnet quadrupole doublet.
  Typical Efficiency (%): 60%
  Best Efficiency (%): 70%
(e) Vacuum
  Pumps: Oil diffusion pumps (optional cryogenic pumping)
  Achieved Vacuum (Pa): 1.e-4
ENTRY N° CM9

Date: 26/Feb/08

Machine Name: ECLIPSE
Institution: Siemens Medical Solutions USA, Inc

Address: 810 Innovation Dr., Knoxville, TN, 37934
Telephone: +1-865-218-2000
Fax Number: +1-865-218-3000
Web Address: www.siemens.com/mi

Person in Charge of Cyclotron: Michael Reitermann
Person Reporting Information: Rudi Verbruggen
Email Address: rudi.verbruggen@siemens.com

History
Designed by: SIEMENS
Construction Date: September 1990
First Beam Date: December 1991

Characteristic
Beamsion energy (MeV) current (µA) power (W)
H- 11 120 1320

Transmission Efficiency (source to extracted beam)
Typical (%): 17 % Best (%): 20

Emittance definition:
Vertical (µ m mrad): -
Horizontal (µ m mrad): -
Longitudinal (dE/E [%] x RF[deg.]): -

USES
Basic Research (%): Development (%):
Therapy (%): Isotope Production (%): Other Application (%): Maintenance (%): Beam Tuning (%): Total Time (h/year): 500 – 2800

TECHNICAL DATA
(a) Magnet Type: compact
Kb (MeV/A): 11 MeV/A
Kf (MeV/A): 11 MeV/A
Average Field (min./max. T): 1.2 T
Number of Sectors: 4
Hill angular width (deg.): 56
dSpiral (deg.): 0 deg
Pole diameter (m): 0.90
Injection Radius (m): N/A
Extraction Radius (m): 0.40
Hill Gap (m): 0.015
Valley Gap (m): 0.40

Trim Coils Number: 0
Maximum Current (A-turns): N/A
Main Coils Number: 1
Total Ampere Turns: 37,400

Maximum Current (A): 300
Stored Energy (MJ): N/A
Total Iron Weight (tons): 10 Tons
Total Coil Weight (tons): 1 Ton
Power (Main Coils total, maximum, KW): 3
Kwatt

Trim coils (total, maximum, KW): N/A
Refrigerator (cryogenic, KW): N/A

(b) RF Frequency Range (MHz): 72 MHz
Harmonic Mode: 4
Number of Dees: 4
Number of Cavities: 4
Dee Angular Width (deg.): 30
Voltage
At Injection (peak to ground, KV): 20
At Extraction (peak to ground, KV): 20
Peak (peak to ground, KV): 20
Line Power (max., KW): 10 kW
Phase Stability (%): N/A
Voltage Stability (%): N/A

(c) Injection
Ion Source: PIG
Source Bias Voltage (kV): 15 kV
External Injection: N/A
Buncher Type: N/A
Injection Energy (MeV/n): N/A
Component: N/A
Injector: N/A
Injection Efficiency (%): N/A

(d) Extraction
Elements, Characteristic:
Striping
Typical Efficiency (%): 100 %
Best Efficiency (%): 100 %
(e) Vacuum
Pumps: Achieved Vacuum (Pa): 5*10⁻⁷

COMMENTS
The Eclipse HP and RD are 11 MeV proton-only, self-shielded, cyclotron systems for commercial PET isotope production. Over 190 systems have been sold worldwide.
ENTRY N° CM10

Date: 15/Dec/07
Machine name: 370V
Institution: Sumitomo Heavy Industries, Ltd.
Address: ThinkPark Tower, 1-1, Osaki 2-chome
Shinagawa-ku, Tokyo 141-6025, Japan
Telephone: +81-3-6737-2000
Fax: +81-3-6866-5104
Web Address: www.shi.co.jp/quantum/index.htm1
Person in charge of cyclotron: Y.kumata
Person reporting information: Y.kumata
E-mail address: Yko_kumata@shi.co.jp

HISTORY
Designed by: Sumitomo Heavy Industries, Ltd.
Constructed by: Sumitomo Heavy Industries, Ltd.
Construction dates: 1995
First beam date: 1996
Characteristics, energy, current:
p:2MeV 5uA, p:17MeV 50uA, d:9MeV 40uA
4He2+:4.5MeV/n 5uA, 3He2+:8MeV/n 10uA
Transmission efficiency (source to extracted beam):
Typical (%): Best (%):
Emittance:
Vertical (pi mm mrad):
Horizontal (pi mm mrad):
Longitudinal (dE/E[%] x RF[deg.]):

USES
Basic research (%):
Development(%):
Therapy(%) :
Isotope production (%):
Other application (%) :
Maintenance (%):
Beam tuning(%):
Total time (h/year):

TECHNICAL DATA
(a) Magnet:
Type:
Kb:
Kf:
Average field (min./max. T): 0.55/1.66
Number of magnet sectors: 4
hill angular width (deg.):
spirals (max):
Pole parameters
Injection radius (m):
Extraction radius (m): 0.37
Hill gap (m): 0.07 Valley gap (m): 0.12
Trim coils
Number: 5 pairs
Maximum current (A-turns): Maximum current (A):
Number:
Total current (A-turns):
Stored energy (MJ):
Total iron weight (tons):
Total coil weight (tons):
Power
Main coils (total KW):
Trim coils (total, maximum, KW):
Refrigerator (cryogenic, KW):
(b) RF
Frequency range (MHz): 17-38MHz
Harmonic modes: 1 and 3
Number of dees: 1
Number of cavities: 1
Dee angular width (deg.): 180
Voltage
at injection (peak to ground, KV):
at extraction (peak to ground, KV):
peak (peak to ground, KV):
Line Power (max, KW):
Phase Stability (deg.):
Voltage Stability (%):
(c) Injection
Ion Source: Livingston
Source Bias Voltage (kV):
External Injection:
Buncher Type:
Injection Energy (MeV/n):
Component:
Injection Efficiency (%):
Injector:
(d) Extraction
Elements, Characteristic: Electrostatic deflector +
gradient corrector
Typical Efficiency (%):
Best Efficiency (%):
(e) Vacuum
Pumps:
Achieved Vacuum (Pa):
ENTRY N° CM11

Machine name: HM-7S-A
Institution: Sumitomo Heavy Industries, Ltd.
Address: ThinkPark Tower, 1-1, Osaki 2-chome
Shinagawa-ku, Tokyo 141-6025, Japan
Telephone: +81-3-6737-2000
Fax: +81-3-6866-5104
WebAddress: www.shi.co.jp/quantum/index.html
Person in charge of cyclotron: Y.kumata
Person reporting information: Y.kumata
E-mail address: Yko_kumata@shi.co.jp

HISTORY
Designed by: Sumitomo Heavy Industries, Ltd.
Constructed by: Sumitomo Heavy Industries, Ltd.
Construction dates: 2006
First beam date: 2006

Characteristic beam, energy and current:
Ions / energy(MeV/N) / current (pps) / power (w)
H-  7.5   70micro-ampere
D-(option)  3.75     30micro-ampere

Transmission efficiency (50mm radius to extracted beam)
Typical (%): 50
Best (%): 60

Emittance
Emittance definition:
Vertical (pi mm mrad):
Horizontal (pi mm mrad):
Longitudinal (dE/E[\%] x RF[deg.]):

USES
Basic research (%):
Development(%):
Therapy(%):
Isotope production (%):100
Other application (%):
Maintenance (%):
Beam tuning(%):
Total time (h/year):

TECHNICAL DATA
(a) Magnet: Type: compact
Kb: Kf:
Average field (min./max. T): 1.69
Number of magnet sectors: 4
  hill angular width (deg.):
  spiral (max):
Pole parameters
  Diameter (m): 0.610
  Injection radius (m):
  Extraction radius (m):0.233
  Hill gap (m): 0.025 Valley gap (m): 0.090

Trim coils
  Number: None
  Maximum current (A-turns):
Harmonic coils

Number: None
Maximum current (A-turns):
Main coils
  Number: 1x 2
  Total current (A-turns): 74800
  Maximum current (A): 180
Store energy (MJ):
  Total iron weight (tons): 5.4
  Total coil weight (tons): 0.6
Power
Main coils (total KW): 9.6
Trim coils (total, maximum, KW):
  Refrigerator (cryogenic, KW):
(b) RF
  Frequency range (MHz): 51.5
  Harmonic modes: 2(H-) / 4(D-)
Number of dees: 2
Number of cavities: 2
Dee angular width (deg.): 45
Voltage
  at injection (peak to ground, KV): 34
  at extraction (peak to ground, KV): 34
  peak (peak to ground, KV): 34
Line Power (max, KW):
  Phase Stability (deg.):
  Voltage Stability (%):
(c) Injection
  Ion Source: PIG
  Source Bias Voltage (kV):
External Injection:
  Buncher Type:
  Injection Energy (MeV/n):
  Component:
  Injection Efficiency (%):
Inector:
(d) Extraction
  Elements, Characteristic: Carbon foil, Stripping
  Typical Efficiency (%): 100
  Best Efficiency (%):
(e) Vacuum
  Pumps: Cryopump
  Achieved Vacuum (Pa): 2*10-5 Pa

COMMENTS
Clinical PET Facilities
ENTRY N° CM12
Date: 15/Dec/07
Machine name: HM-10S-C
Institution: Sumitomo Heavy Industries, Ltd.
Address: ThinkPark Tower, 1-1, Osaki 2-chome
Shinagawa-ku, Tokyo 141-6025, Japan
Telephone: +81-3-6737-2000
Fax: +81-3-6866-5104
Web Address: www.shi.co.jp/quantum/index.html
Person in charge of cyclotron: Y. Kumata
Person reporting information: Y. Kumata
E-mail address: Yko_kumata@shi.co.jp

HISTORY
Designed by: Sumitomo Heavy Industries, Ltd.
Constructed by: Sumitomo Heavy Industries, Ltd.
Construction dates:
First beam date:
Characteristic beam, energy and current:
Ions / energy(MeV/N) / current (pps) / power (w)
H- 10 70 micro-ampere
D-(option) 5 15 micro-ampere
Transmission efficiency (50mm radius to extracted beam)
Typical (%): 50
Best (%): 60
Emittance
Emittance definition:
Vertical (pi mm mrad):
Horizontal (pi mm mrad):
Longitudinal (dE/E[%] x RF[deg.]):

USES
Basic research (%):
Development(%) :
Therapy(%):
Isotope production (%): 100
Other application (%):
Maintenance (%):
Beam tuning(%):
Total time (h/year):

TECHNICAL DATA
(a) Magnet:
Type: compact
Kb:
Kf:
Average field (min./max. T): 1.65
Number of magnet sectors: 4
hill angular width (deg.):
spiral (max.):
Pole parameters
Diameter (m): 0.680
Injection radius (m):
Extraction radius (m): 0.268
Hill gap (m): 0.025 Valley gap (m): 0.090
Trim coils
Number: None
Maximum current (A-turns):
Harmonic coils

Number: 1x2
Total current (A-turns): 74016
Maximum current (A): 180
Stored energy (MJ):
Total iron weight (tons): 8.5
Total coil weight (tons): 0.8
Power
Main coils (total KW): 8
Trim coils (total, maximum, KW):
Refrigerator (cryogenic, KW):
(b) RF
Frequency range (MHz): 50.5
Harmonic modes: 2(H-) / 4(D-)
Number of dees: 2
Number of cavities: 2
Dee angular width (deg.): 45
Voltage
at injection (peak to ground, KV): 35
at extraction (peak to ground, KV): 35
peak (peak to ground, KV): 35
Line Power (max, KW):
Phase Stability (deg.):
Voltage Stability (%):

(c) Injection
Ion Source: PIG
Source Bias Voltage (kV):
External Injection:
Buncher Type:
Injection Energy (MeV/n):
Component:
Injection Efficiency (%):
Injector:
(d) Extraction
Elements, Characteristic: Carbon foil, Stripping
Typical Efficiency (%): 100
Best Efficiency (%):

(e) Vacuum
Pumps: Diffusion pump
Achieved Vacuum (Pa): 2*10^-5 Pa

COMMENTS
Clinical PET Facilities
ENTRY N° CM13
Date: 15/Dec/07
Machine name: HM-12
Institution: Sumitomo Heavy Industries, Ltd.
Address: ThinkPark Tower, 1-1, Osaki 2-chome
Shinagawa-ku, Tokyo 141-6025, Japan
Telephone: +81-3-6737-2000
Fax: +81-3-6866-5104
Web Address: www.shi.co.jp/quantum/index.htm1
Person in charge of cyclotron: K.kumata
Person reporting information: K.kumata
E-mail address: Yko_kumata@shi.co.jp

HISTORY
Designed by: Sumitomo Heavy Industries, Ltd
Constructed by: Sumitomo Heavy Industries Ltd.
Construction dates: 1993
First beam date: 1996

Characteristic beam, energy and current:
p: 12MeV  150uA
  d:  6MeV     40uA
Transmission efficiency (source to extracted beam)
Typical (%):
Best (%):
Emittance
Emittance definition:
Vertical (pi mm mrad):
Horizontal (pi mm mrad):
Longitudinal (dE/E[%] x RF[deg.]):

USES
Basic research (%):
Development(%):
Therapy(%):
Isotope production (%):
Other application (%):
Maintenance (%):
Beam tuning(%):
Total time (h/year):

TECHNICAL DATA
(a) Magnet: Type:
Kb: Kf:
Average field (min./max. T): 1.5
Number of magnet sectors: 4
hill angular width (deg.):
spiral (max): 0deg
Pole parameters
  Diameter: 0.8m
  Injection radius (m): 3
  Extraction radius (m): 04
  Hill gap (m): 0.036  Valley gap (m): 0.144

Trim coils
  Number: 2 pairs
  Maximum current (A-turns):

Harmonic coils
  Number: none

Maximum current (A-turns):
Main coils
Number:
Total current (A-turns):
Maximum current (A):
Stored energy (MJ):
Total iron weight (tons):
Total coil weight (tons):
Power
Main coils (total KW):
Trim coils (total, maximum, KW):
Refrigerator (cryogenic, KW):

(b) RF
Frequency range (MHz): 45MHz
Harmonic modes: 2 and 4
Number of dees: 2
Number of cavities: 2
Dee angular width (deg.): 45
Voltage
  at injection (peak to ground, KV):
  at extraction (peak to ground, KV):
  peak (peak to ground, KV):
Line Power (max, KW):
Phase Stability (deg.):
Voltage Stability (%):

(c) Injection
Ion Source: PIG
Source Bias Voltage (kV):
External Injection:
Buncher Type:
Injection Energy (MeV/n):
Component:
Injection Efficiency (%):
Injector:

(d) Extraction
Elements, Characteristic: stripping (carbon foil)
Typical Efficiency (%):
Best Efficiency (%):

(e) Vacuum
Pumps:
Achieved Vacuum (Pa):
ENTRY N° CM14
Date: 15/Dec/07
Machine name: HM-18
Institution: Sumitomo Heavy Industries, Ltd.
Address: ThinkPark Tower, 1-1, Osaki 2-chome
          Shinagawa-ku, Tokyo 141-6025, Japan
Telephone: +81-3-6737-2000
Fax: +81-3-6866-5104
Web Address: www.shi.co.jp/quantum/index.htm1
Person in charge of cyclotron: Y.kumata
Person reporting information: Y.kumata
E-mail address: Yko_kumata@shi.co.jp

HISTORY
Designed by: Sumitomo Heavy Industries, Ltd.
Constructed by: Sumitomo Heavy Industries, Ltd.
Construction dates: 1989
First beam date: 1990

Characteristic beam, energy and current:
p: 18MeV  90uA
d: 10MeV  50uA

Transmission efficiency (source to extracted beam)
Typical (%):
Best (%):

Emittance
Emittance definition:
Vertical (π mm mrad):
Horizontal (π mm mrad):
Longitudinal (dE/E[%] x RF[deg.]):

USES
Basic research (%):
Development(%):
Therapy(%):
Isotope production (%):
Other application (%):
Maintenance (%):
Beam tuning(%):
Total time (h/year):

TECHNICAL DATA
(a) Magnet:
   Type:
   Kb:
   Kf:
   Average field (min./max. T): 1.56
   Number of magnet sectors: 4
   Hill angular width (deg.):
   Spiral (max): 0deg
   Pole parameters:
   Diameter: 1.04m
   Injection radius (m):
   Extraction radius (m): 0.43
   Hill gap (m): 0.036  Valley gap (m): 0.154
Trim coils:
   Number: 4 pairs
   Maximum current (A-turns):
Harmonic coils:
   Number: none

Maximum current (A-turns):
Main coils
   Number:
   Total current (A-turns):
   Maximum current (A):
   Stored energy (MJ):
   Total iron weight (tons):
   Total coil weight (tons):
   Power
   Main coils (total KW):
   Trim coils (total, maximum, KW):
   Refrigerator (cryogenic, KW):

(b) RF
   Frequency range (MHz): 45MHz
   Harmonic modes: 2 and 4
   Number of dees: 2
   Number of cavities: 2
   Dee angular width (deg.): 45
   Voltage
      at injection (peak to ground, KV):
      at extraction (peak to ground, KV):
      peak (peak to ground, KV):
   Line Power (max, KW):
   Phase Stability (deg.):
   Voltage Stability (%):

(c) Injection
   Ion Source: PIG
   Source Bias Voltage (kV):
   External Injection:
   Buncher Type:
   Injection Energy (MeV/n):
   Component:
   Injection Efficiency (%):
   Injector:

(d) Extraction
   Elements, Characteristic: stripping (carbon foil)
   Typical Efficiency (%):
   Best Efficiency (%):

(e) Vacuum
   Pumps:
   Achieved Vacuum (Pa):
ENTRY N° CM15
Date: 15/Dec/07
Machine name: 930
Institution: Sumitomo Heavy Industries, Ltd.
Address: ThinkPark Tower, 1-1, Osaki 2-chome
Shinagawa-ku, Tokyo 141-6025, Japan
Telephone: +81-3-6737-2000
Fax: +81-3-6866-5104
Web Address: www.shi.co.jp/quantum/index.htm
Person in charge of cyclotron: Y.kumata
Person reporting information: Y.kumata
E-mail address: Yko_kumata@shi.co.jp

HISTORY
Designed by: Sumitomo Heavy Industries, Ltd.
Constructed by: Sumitomo Heavy Industries, Ltd.
Construction dates:
First beam date:
Characteristic beam, energy and current:
p: 90MeV 10uA, d: 50MeV 20uA
40Ar8+: 195MeV 3uA
Transmission efficiency (source to extracted beam)
Typical (%):
Best (%):
Emittance
Emittance definition:
Vertical (pi mm mrad):
Horizontal (pi mm mrad):
Longitudinal (dE/E[\%] x RF[deg.]):

USES
Basic research (%):
Development(%):
Therapy(%):
Isotope production (%):
Other application (%):
Maintenance (%):
Beam tuning(%):
Total time (h/year):

TECHNICAL DATA
(a) Magnet: Type:
Kb: 110MeV/A Kf: 95MeV/A
Average field (min./max. T): 1.64
Number of magnet sectors: 4
hill angular width (deg.):
spiral (max):
Pole parameters
Diameter: 2.16m
Injection radius (m): 0.923
Extraction radius (m): 0.166
Hill gap (m): 0.166 Valley gap (m): 0.405

Maximum current (A-turns):
Main coils
Number:
Total current (A-turns): 408,000
Maximum current (A): 900

(b) RF
Frequency range (MHz): 11-22MHz
Harmonic modes: 1, 2 and 3
Number of dees: 2
Number of cavities: 2
Dee angular width (deg.): 90 .
Voltage
at injection (peak to ground, KV): 60
at extraction (peak to ground, KV): 60
peak (peak to ground, KV):
Line Power (max, KW): 2*70
Phase Stability (deg.):
Voltage Stability (%):

(c) Injection
Ion Source:
Source Bias Voltage (kV): 20
External Injection: axial
Buncher Type: Krystron and sawtooth
Injection Energy (MeV/n):
Component:
Injection Efficiency (%): 20
Injector:

(d) Extraction
Elements, Characteristic: Electrostatic deflector + magnetic channel + gradient corrector
Typical Efficiency (%): 60-70
Best Efficiency (%):

(e) Vacuum
Pumps: 4 sets of cryopumps + 1 turbomolecular pump
Achieved Vacuum (Pa): 5*10-5
ENTRY N° CM16
Date: 15/Dec/07
Machine name: C235
Institution: Sumitomo Heavy Industries, Ltd.
Address: ThinkPark Tower, 1-1, Osaki 2-chome
Shinagawa-ku, Tokyo 141-6025, Japan
Telephone: +81-3-6737-2000
Fax: +81-3-6866-5104
Web Address: www.shi.co.jp/quantum/index.htm1
Person in charge of cyclotron: Y.kumata
Person reporting information: Y.kumata
E-mail address: Yko_kumata@shi.co.jp

HISTORY
Designed by:
Constructed by: Sumitomo Heavy Industries, Ltd.
Construction dates: 1997
First beam date: 1998
Characteristic beam, energy and current:
p: 235MeV 300nA
Transmission efficiency (source to extracted beam)
Typical (%):
Best (%):
Emittance
Emittance definition:
Vertical (pi mm mrad):
Horizontal (pi mm mrad):
Longitudinal (dE/E[%] x RF[deg.]):

USES
Basic research (%):
Development(%):
Therapy(100):
Isotope production (%):
Other application (%):
Maintenance (%):
Beam tuning(%):
Total time (h/year):

TECHNICAL DATA
(a) Magnet: Type:
Kb: Kf:
Average field (min./max. T): 2.2
Number of magnet sectors: 4
  hill angular width (deg.):
  spiral (max):
Pole parameters
  Diameter:
  Injection radius (m):
  Extraction radius (m): 1.07
  Hill gap (m): elliptical  Valley gap (m): 0.6

Trim coils
  Number: none
  Maximum current (A-turns):

Harmonic coils
  Number: none
  Maximum current (A-turns):

Main coils
  Number:
  Total current (A-turns):
  Maximum current (A):
  Stored energy (MJ):
  Total iron weight (tons):
  Total coil weight (tons):
  Power
  Main coils (total KW):
  Trim coils (total, maximum, KW):
  Refrigerator (cryogenic, KW):

(b) RF
  Frequency range (MHz): 106MHz
  Harmonic modes: 4
  Number of dees: 2
  Number of cavities: 2
  Dee angular width (deg.): 30 deg.
  Voltage
    at injection (peak to ground, KV):
    at extraction (peak to ground, KV):
    peak (peak to ground, KV):
    Line Power (max, KW):
    Phase Stability (deg.):
    Voltage Stability (%):

(c) Injection
  Ion Source: Livingston
  Source Bias Voltage (kV):
  External Injection:
  Buncher Type:
  Injection Energy (MeV/n):
  Component:
  Injection Efficiency (%):
  Injector:

(d) Extraction
  Elements, Characteristic: Electrostatic deflector
gradient corrector + permanent quadrupoles
  Typical Efficiency (%):
  Best Efficiency (%):

(e) Vacuum
  Pumps:
  Achieved Vacuum (Pa):

ENTRY N° CU1
Date: 11 Feb 2008
Machine Name: Cyclone 30
Institution: UCL, Centre de Recherches du Cyclotron
Address: 2, Chemin du Cyclotron 1348 Louvain-la-Neuve, Belgium
Telephone: +32(10)472998
Fax: +32(10)452183
Web Address: http://www.cyc.ucl.ac.be
Person in Charge of Cyclotron: Marc Loiselet
Person Reporting Information: Marc Loiselet
E-mail Address: Marc.Loiselet@uclouvain.be

HISTORY
Designed by: IBA
Construction Dates:
First Beam Date:
Characteristic Beams
30 MeV proton 350 microA
Transmission Efficiency (source to extracted beam)
Typical (%): 30
Best (%): 35
Emittance
Emittance Definition:
Vertical (pi mm mrad): 10
Horizontal (pi mm mrad): 5
Longitudinal (dE/E[%] x RF[deg.]): 1

USES
Basic Research (%): 50
Development (%):
Therapy (%):
Isotope Production (%): 50
Other Application (%):
Maintenance (%):
Beam Tuning (%):
Total Time (h/year):

TECHNICAL DATA
(a) Magnet
Type: compact
Kb (MeV): 30
Kf (MeV/A): 30
Average Field (min./max. T): 1(0.12/ 1.7)
Number of Sectors: 4
Hill Angular Width (deg.): 54-58
Spiral (deg.): 0
Pole Diameter (m): 1.6
Injection Radius (m): 0.03
Extraction Radius (m): 0.5 - 0.75
Hill Gap (m): 0.03
Valley Gap (m): 0.1
Trim Coils
Number: 0
Maximum Current (A-turns): N/A

Harmonic Coils
Number: 0
Maximum Current (A-turns): N/A

Main Coils
Number: 2
Total Ampere Turns: 60 000
Maximum Current (A): 110
Stored Energy (MJ):
Total Iron Weight (tons): 45
Total Coil Weight (tons): 4
Power
Main Coils (total, maximum, KW): 7.2
Trim Coils (total, maximum, KW): N/A
Refrigerator (cryogenic, KW): N/A

(b) RF
Frequency Range (MHz): 66
Harmonic Modes: 4
Number of Dees: 2
Number of Cavities: 4
Dee Angular Width (deg.): 30
Voltage
At Injection (peak to ground, KV): 50
At Extraction (peak to ground, KV): 50
Peak (peak to ground, KV): 50
Line Power (max, KW): 40
Phase Stability (deg.): 0.1
Voltage Stability (%): 0.1

(c) Injection
Ion Source: multicusp
Source Bias Voltage (kV): 30
External Injection: axial
Buncher Type: wire
Injection Energy (MeV/n): 0.03
Component:
Injection Efficiency (%): 35
Injector: inflector

(d) Extraction
Elements, Characteristic: carbon stripper
Typical Efficiency (%): 100
Best Efficiency (%): 100

(e) Vacuum
Pumps: cryo pump 4000l/s (N2)
Achieved Vacuum (Pa): 1 E-5
ENTRY Nº CU2
Date: 12 Feb 2008
Machine name: Cyclone 30 Cyclotron
Institution: Energetic and Nuclear Research Institute
Address: Av. Prof. Lineu Prestes, 2242 – Cidade Universitária, São Paulo - SP - Brasil
Telephone: +55 11 3133-9000
Fax: +55 11 3812-3546
Web Address: http://www.ipen.br
Person in charge of cyclotron: Valdir Sciani
Person reporting information: Hylton Matsuda
E-mail address: hmatsuda@ipen.br

HISTORY
Designed by: IBA - Ion Beam Applications - Belgium
Constructed by: IBA – Ion Beam Applications - Belgium
Construction dates: 1997-1998
First beam date: 1998
Characteristic beam, energy and current: H-/H+, 15-30 MeV, 350 µA
Transmission efficiency (source to extracted beam)
Typical (%): 10%
Best (%): Emittance
Definition:
Vertical (π mm mrad): <5
Horizontal (π mm mrad): <10
Longitudinal (dE/E[%] x RF[deg.]):
USES
Basic research (%): 1
Development(%):
Therapy(%):
Isotope production (%): 75
Other application (%):
Maintenance (%): 2
Beam tuning(%): 22
Total time (h/year): 1500
TECHNICAL DATA
(a) Magnet: Type: Compact
Kb: Kf:
Average field (min./max. T): 0.12 / 1.7
Number of magnet sectors: 4
hill angular width (deg.):
spiral (max.):
Pole parameters
Diameter:
Injection radius (m):
Extraction radius (m):
Hill gap (m): Valley gap (m):
Trim coils
Number:
Maximum current (A-turns):
Harmonic coils

(b) RF
Acceleration
Frequency range (MHz): 65.5
Harmonic modes: 4
Number of dees: 2
Number of cavities:
Dee angular width (deg.): 30
Voltage
at injection (peak to ground, KV):
at extraction (peak to ground, KV):
peak (peak to ground, KV):
Line Power (max, KW):
Phase Stability (deg.):
Voltage Stability (%):
(c) Injection
Ion Source: Multicusp
Source Bias Voltage (kV):
External Injection:
Buncher Type:
Injection Energy (MeV/n):
Component:
Injection Efficiency (%):
Injector: Axial
(d) Extraction
Elements, Characteristic: Carbon stripper foil
Typical Efficiency (%): 70
Best Efficiency (%): 95
(e) Vacuum
Pumps: Cyclotron: cryopumps (2), Beam lines: diffusion pumps (3), Ion source: diffusion pumps (1)
Achieved Vacuum (Pa): 1E-05
EXPERIMENTAL FACILITIES
External beam lines (2), target stations (4)
ENTRY Nº CU3
Date: Feb 2007
Machine Name: TR13
Institution: TRIUMF
Address: 4004 Wesbrook Mall, Vancouver BC, CANADA
Telephone: 604-222-7529
Fax: 604-222-1074
Web Address: www.triumf.ca
Person in Charge of Cyclotron: Ken Buckley
Person Reporting Information: Ken Buckley
E-mail Address: Ken.Buckley@triumf.ca

HISTORY
Designed by: TRIUMF & Ebco Technologies Ltd.
Construction Dates: 1992
First Beam Date: 1993
Characteristic Beams
protons 13 MeV, 100 microAmp
Transmission Efficiency
Typical (%): 6
Best (%):
Emittance
Emittance Definition:
Vertical (\pi \text{ mm mrad}): 
Horizontal (\pi \text{ mm mrad }): 
Longitudinal (dE/E[\%] \times RF[\text{deg.}]):
USES
Basic Research (%):
Development (%):
Therapy (%):
Isotope Production (%): 93
Other Application (%):
Maintenance (%): 7
Beam Tuning (%):
Total Time (h/year): total beam time in 2006: ca. 700

TECHNICAL DATA
(a) Magnet
Type: compact, deep valley design
Kb (MeV):
Kf (MeV):
Average Field (min./max. T): 1.3
Number of Sectors: 4
Hill Angular Width (deg.):
Spiral (deg.):
Pole Diameter (m): 1.08
Injection Radius (m):
Extraction Radius (m): 0.445 - 0.465
Hill Gap (m): 0.031
Valley Gap (m): 0.665
Trim Coils
Number:

Maximum Current (A-turns):
Harmonic Coils
Number:
Maximum Current (A-turns):
Main Coils
Number: 2
Total Ampere Turns:
Maximum Current (A): 200
Stored Energy (MJ):
Total Iron Weight (tons): 20
Total Coil Weight (tons): 2
Power
Main Coils (total KW): 24
Trim Coils (total, maximum, KW):
Refrigerator (cryogenic, KW):
(b) RF
Frequency Range (MHz): 41.8, fixed frequency
Harmonic Modes: protons: 2  deuterons: 4
Number of Dees: 2
Number of Cavities:
Dee Angular Width (deg.): 30
Voltage
At Injection (peak to ground, KV):
At Extraction (peak to ground, KV):
Peak (peak to ground, KV): 32
Line Power (max, KW): 10
Phase Stability (deg.):
Voltage Stability (%):
(c) Injection
Ion Source: 2×PIG IS (one for p, one for d)
Source Bias Voltage (kV):
External Injection:
Buncher Type:
Injection Energy (MeV/n):
Component:
Injection Efficiency (%):
Injector:
(d) Extraction
Elements, Characteristic: carbon stripper foils
Typical Efficiency (%): (40 - 60)
Best Efficiency (%): 70
(e) Vacuum
Pumps:
4 x Edwards ODP diff stack 160/700p
1 x Edwards ODP diff stack 100/300p for external beam transport line
Achieved Vacuum (Pa): stand-by: 7E-05
ENTRY N° CU4
Date: 30.10.2007
Machine Name: CYCLONE 18/9
Institution: Forschungszentrum Dresden-Rossendorf/PET Center
Postal Address: PF 51 01 19, 01314 Dresden, Germany
Site Address: Bautzner Landstr. 128, 01328 Dresden, Germany
Telephone: +49 (0)351 260 - 2221 or - 3269
Fax: +49 (0)351 260 3232
Web Address: http://www.fzd.de
Person in Charge of Cyclotron: Dipl.-Ing. Stephan Preusche
Person Reporting Information: Dipl.-Ing. Stephan Preusche
E-mail Address: s.preusche@fzd.de

HISTORY
Designed by: Ion Beam Applications, s.a., Belgium
Construction Dates:
First Beam Date: Routine operation for radionuclide production since 1996
Characteristic Beams
 p, 18 MeV, 30 µA on the targets
d, 9 MeV, 18 µA on the targets
Transmission Efficiency
 Typical (%): From internal probe to targets outside the yoke → p: 25; d: 20
Best (%): p: 30; d: 28
Emittance
Emittance Definition:
Vertical (π mm mrad):
Horizontal (π mm mrad):
Longitudinal (dE/E[%] x RF[deg.]):
USES
Basic Research (%):
Development (%):
Therapy (%):
Isotope Production (%): 93
Other Application (%):
Maintenance (%): 7
Beam Tuning (%):
Total Time (h/year): total beam time in 2006: ca. 700

TECHNICAL DATA
(a)Magnet
Type: compact, deep valley design
Kb (MeV):
Kf (MeV):
Average Field (min./max. T): 1.3
Number of Sectors: 4
Hill Angular Width (deg.):
Spiral (deg.):
Pole Diameter (m): 1.08
Injection Radius (m):
Extraction Radius (m): 0.445 - 0.465
Hill Gap (m): 0.031
Valley Gap (m): 0.665
Trim Coils
Number:
Maximum Current (A-turns):
Harmonic Coils
Number:
Maximum Current (A-turns):
Main Coils
Number: 2
Total Ampere Turns:
Maximum Current (A): 200
Stored Energy (MJ):
Total Iron Weight (tons): 20
Total Coil Weight (tons): 2
Power
Main Coils (total KW): 24
Trim Coils (total, maximum, KW):
Refrigerator (cryogenic, KW):
(b)RF
Frequency Range (MHz): 41.8, fixed frequency
Harmonic Modes: protons: 2   deuterons: 4
Number of Dees: 2
Number of Cavities:
Dee Angular Width (deg.): 30
Voltage
At Injection (peak to ground, KV):
At Extraction (peak to ground, KV):
Peak (peak to ground, KV): 32
Line Power (max, KW): 10
Phase Stability (deg.):
Voltage Stability (%):
(c)Injection
Ion Source: 2×PIG IS (one for p, one for d)
Source Bias Voltage (kV):
External Injection:
Buncher Type:
Injection Energy (MeV/n):
Component:
Injection Efficiency (%):
Injector:
(d)Extraction
Elements, Characteristic: carbon stripper foils
Typical Efficiency (%): (40 - 60)
Best Efficiency (%): 70
(e)Vacuum
Pumps: 4 x Edwards ODP diff stack 160/700p
1 x Edwards ODP diff stack 100/300p for external beam transport line
Achieved Vacuum (Pa): stand-by: 7E-05
COMMENTS
1. Premises
Cyclotron building and radiochemistry/radiopharmaceutical/ nuclear medicine buildings are separated by 500 meters.
Radionuclide transport system (RATS): Pneumatic transport system for liquids, Copper tubes for gases

Layout of the Rossendorf PET cyclotron facility  RATS = Radionuclide transport system

2. Production of non-standard radionuclides:  Y-86, Cu-64, Co-56
ENTRY N° CU5
Date: 18.01.2008
Machine name: MGC-20
Institution: Institute of Nuclear Research (ATOMKI)
Address: Bem ter 18/c., H-4026 Debrecen, Hungary
Telephone: +36 (52) 509-200
Fax: +36 (52) 416-181
Web Address: www.atomki.hu
Person in charge of cyclotron: F. Tarkanyi
Person reporting information: Z. Kormany
E-mail address: kormany@atomki.hu

HISTORY
Designed by: NIIEFA, St. Petersburg, Russia
Constructed by: NIIEFA, St. Petersburg, Russia
Construction dates: 1984-85
First beam date: Nov. 1985

Characteristic beam, energy and current:
proton, 18 MeV, 40 µA
alpha, 20 MeV, 20 µA

Transmission efficiency (source to extracted beam)
Typical (%):
Best (%):

Emittance
Emittance definition:
Vertical (π mm mrad): 15
Horizontal (π mm mrad): 30
Longitudinal (dE/E[%] x RF[deg.]):

USES
Basic research (%): 38
Development(%): 5
Therapy(%) : 1
Isotope production (%): 6
Other application ( %) : 16
Maintenance (%): 24
Beam tuning(%): 11
Total time (h/year): 1600

TECHNICAL DATA
(a) Magnet:
Type: compact
Kb: 20 MeV/A
Kf: Average field (min./max. T): 1.4/0.7
Number of magnet sectors: 3
hill angular width (deg.): spiral (max):
Pole parameters
Diameter(m): 1.03
Injection radius (m):
Extraction radius (m): 0.45
Hill gap (m): 0.072 Valley gap (m): 0.12
Trim coils
Number: 4 x 2
Maximum current (A-turns): 15 A

Harmonic coils
Number: 2 sets x 2
Maximum current (A-turns): 15 A

Main coils
Number: 1 x 2
Total current (A-turns):
Maximum current (A): 400

Stored energy (MJ):
Total iron weight (tons): 25
Total coil weight (tons):

Power
Main coils (total KW): 32
Trim coils (total, maximum, KW): 1
Refrigerator (cryogenic, KW):

(b) RF
Frequency range (MHz): 8 – 24
Harmonic modes: 1, 3
Number of dees: 2
Number of cavities: 2
Dee angular width (deg.): 180
Voltage
at injection (peak to ground, KV):
at extraction (peak to ground, KV):
peak (peak to ground, KV): 30
Line Power (max, KW): 80
Phase Stability (deg.):
Voltage Stability (%): 0.1

(c) Injection
Ion Source: internal, Livingstone-Jones
Source Bias Voltage (kV):
External Injection:
Buncher Type:
Injection Energy (MeV/n):
Component:
Injection Efficiency (%):
Injector:

(d) Extraction
Elements, Characteristic: electrostatic deflector, passive magnetic channel
Typical Efficiency (%): 40
Best Efficiency (%): 50

(e) Vacuum
Pumps: oil diffusion
Achieved Vacuum (Pa): 2E-04
ENTRY No. CU6
Date: 14 Feb 2007
Machine Name: Scanditronix MC40
Institution: European Commission - Institute for Health and Consumer Protection T. P. 500
Address: Ispra (VA) 21020 Italy
Telephone: ++390332785194
Fax: ++390332789385
Web Address:
Person in Charge of Cyclotron: Uwe Holzwarth
Person Reporting Information: Uwe Holzwarth
E-mail Address: uwe.holzwarth@jrc.it

HISTORY
Designed by: Scanditronix
Construction Dates:
First Beam Date: 1982
Characteristic Beams:
- ions / energy(MeV/N)/current(pps)/power(w)
  - protons 39 MeV 60 uA max
deuteron 20 MeV 60 uA max
  - alphas 39 MeV 30 uA max
Transmission Efficiency (source to extracted beam):
  Typical (%): 65
  Best (%): 85
Emittance:
  Emittance Definition:
  - Vertical (pi mm mrad):
  - Horizontal (pi mm mrad):
  - Longitudinal (dE/E[%] x RF[deg.]):

USES
- Basic Research (%): 5
- Development (%): 35
- Isotope Production (%): 0
- Other Application (%):
- Maintenance (%): 15
- Beam Tuning (%): 10
- Total Time (h/year): 2100

TECHNICAL DATA
(a) Magnet:
- Type:
  - Kb (MeV): 0.05
  - Kf (MeV): 0.08
- Average Field (min./max. T): 1.79
- Number of Sectors: 3
- Hill Angular Width (deg.):
- Spiral (deg.):
- Pole Diameter (m): 1.35
- Injection Radius (m): 0
- Extraction Radius (m): 0.51
- Hill Gap (m): 0.1
- Valley Gap (m): 0.18
- Trim Coils:
- Number: 8x2
- Maximum Current (A-turns):
- Harmonic Coils:
- Number: 4xNsectorsx2
- Maximum Current (A-turns):
- Main Coils
- Number: 1x2
- Total Ampere Turns:
- Maximum Current (A): 890
- Stored Energy (MJ):
- Total Iron Weight (tons): 60
- Total Coil Weight (tons): 2.276
- Power:
- Main Coils (total KW): 150
- Trim Coils (total, maximum, KW): 13
- Refrigerator (cryogenic, KW): 400
(b) RF:
- Acceleration
  - Frequency Range (MHz): 12.5 -28
  - Harmonic Modes: 1,2
  - Number of Dees: 2
  - Number of Cavities: 2
  - Dee Angular Width (deg.): 90
  - Voltage 8.5 – 35.5 kV
  - At Injection (peak to ground, KV):
  - At Extraction (peak to ground, KV):
  - Peak (peak to ground, KV):
  - Line Power (max, KW): 25
  - Phase Stability (deg.):
  - Voltage Stability (%): 0.1
(c) Injection:
- Ion Source: cold cathode plasma ion source
- Source Bias Voltage (kV):
- External Injection:
- Buncher Type:
- Injection Energy (MeV/n):
- Component:
- Injection Efficiency (%):
- Injector:
(d) Extraction:
- Elements, Characteristic:
- Typical Efficiency (%):
- Best Efficiency (%):
(e) Vacuum:
- Pumps: 2 x Leybold TURBOVAC 3500
- Achieved Vacuum (Pa): 2e10-6 mbar
ENTRY N° CU7
Date: 1/28/08
Machine name: Cyclone 30 (two machines)
Institution: FUJIFILM RI Pharma Co., Ltd.
Address: 453-1, Shimo-Okura, Matsuo-machi, Sanmu-shi, Chiba, 289-1592, Japan
Telephone: 81-479-86-4721
Fax: 81-479-86-5112
Web Address: http://fri.fujifilm.co.jp
Person in charge of cyclotron: Yoshikazu Hirunuma
Person reporting information: Asaki Yamamoto
E-mail address: yasaki@ffri.co.jp

HISTORY
Designed by: Ion Beam Applications (IBA)
Constructed by: 
Construction dates: 1991 / 2005
Characteristic beam, energy and current:
H-, 30MeV, 350μA ……………………..
Transmission efficiency (source to extracted beam)
Typical (%):
Best (%):
Emittance
Emittance definition:
Vertical (π mm mrad):
Horizontal (π mm mrad):
Longitudinal (dE/E[%] x RF[deg.]):
USES
Basic research (%):
Development(%):
Therapy(%):
Isotope production (%): 95
Other application (%):
Maintenance (%): 5
Beam tuning(%):
Total time (h/year): 4000 / 4500

TECHNICAL DATA
(a) Magnet:
Type:
Kb:
Kf:
Average field (min./max. T):
Number of magnet sectors:
hill angular width (deg.):
spiral (max):
Pole parameters
Diameter:
Injection radius (m):
Extraction radius (m):
Hill gap (m): Valley gap (m):
Trim coils
Number:
Maximum current (A-turns):
Harmonic coils
Number:
Maximum current (A-turns):
ENTRY N° CU8
Date: 1/28/08
Machine name: MC-40
Institution: FUJIFILM RI Pharma Co., Ltd.
Address: 453-1, Shimo-Okura, Matsuo-machi, Sanmu-shi, Chiba, 289-1592, Japan
Telephone: 81-479-86-4721
Fax: 81-479-86-5112
Web Address: http://fri.fujifilm.co.jp
Person in charge of cyclotron: Yoshikazu Hirunuma
Person reporting information: Asaki Yamamoto
E-mail address: yasaki@ffri.co.jp

HISTORY
Designed by: Scanditronix
Constructed by:
Construction dates: 1984
First beam date: Nov. 1984
Characteristic beam, energy and current:
- p, 30MeV, 180uA
Transmission efficiency (source to extracted beam)
Typical (%):
Best (%):
Emittance
Emittance definition:
Vertical (pi mm mrad):
Horizontal (pi mm mrad):
Longitudinal (dE/E[%] x RF[deg.]):

USES
Basic research (%):
Development(%):
Therapy(%):
Isotope production (%): 95
Other application (%):
Maintenance (%): 5
Beam tuning(%):
Total time (h/year): 3000

TECHNICAL DATA
(a) Magnet:
Type:
Kb: Kf:
Average field (min./max. T):
Number of magnet sectors:
- hill angular width (deg.):
- spiral (max):
Pole parameters
- Diameter:
  - Injection radius (m):
  - Extraction radius (m):
- Hill gap (m):
- Valley gap (m):
Trim coils
Number:
Maximum current (A-turns):
Harmonic coils
Number:
Maximum current (A-turns):

Main coils
Number:
Total current (A-turns):
Maximum current (A):
Stored energy (MJ):
Total iron weight (tons):
Total coil weight (tons):
Power
Main coils (total KW):
Trim coils (total, maximum, KW):
Refrigerator (cryogenic, KW):
(b) RF
Frequency range (MHz):
Harmonic modes:
Number of dees:
Number of cavities:
Dee angular width (deg.):
Voltage
- at injection (peak to ground, KV):
- at extraction (peak to ground, KV):
- peak (peak to ground, KV):
Line Power (max, KW):
Phase Stability (deg.):
Voltage Stability (%):
(c) Injection
Ion Source:
Source Bias Voltage (kV):
External Injection:
Buncher Type:
Injection Energy (MeV/n):
Component:
Injection Efficiency (%):
Injector:
(d) Extraction
Elements, Characteristic:
Typical Efficiency (%):
Best Efficiency (%):
(e) Vacuum
Pumps:
Achieved Vacuum (Pa):
ENTRY N° CU9
Date: 25 Oct 2007
Machine name: NIRS-HM-18
Institution: National Institute of Radiological Science
Address: Anagawa, Inage-ku, Chiba, 263-8555, Japan
Telephone: +81-(0)43-206-3173
Fax: +81-(0)43-206-6146
Web Address: 
Person in charge of cyclotron: T. Honma
Person reporting information: T. Honma
E-mail address: honma_t@nirs.go.jp

HISTORY
Designed by: Sumitomo Heavy Industries
Constructed by: Sumitomo Heavy Industries
Construction dates: 1994
First beam date: Mar. 1994
Characteristic beam, energy and current:
  p: 18MeV, 2.E+14
  d: 9MeV, 2.E+14
Transmission efficiency (source to extracted beam)
Typical (%): 95
Best (%): 100
Emittance
Emittance definition:
  Vertical (pi mm mrad): 55
  Horizontal (pi mm mrad): 27
Longitudinal (dE/E[%] x RF[deg.]):

USES
Isotope production (%): 90
Maintenance (%): 5
Beam tuning(%): 5
Total time (h/year): 1300

TECHNICAL DATA
(a) Magnet
  Room temp., Type: H-type
  Average field (T): 1.56
  Number of magnet sectors: 4
    hill angular width (deg.):
    spiral (max): 0
  Pole parameters
    Diameter: 1.08
    Injection radius (m):
    Extraction radius (m): 0.46
    Hill gap (m): 0.036
    Valley gap (m): 0.154
  Trim coils
    Number: 4
    Maximum current (A-turns): 1600
Harmonic coils
  Number: 0
  Maximum current (A-turns):
Main coils
  Number: 1
  Total current (A-turns): 9.72E+4
  Maximum current (A): 180
  Stored energy (MJ):

Total iron weight (tons): 27
Total coil weight (tons):
Power
Main coils (total KW): 24.3
Trim coils (total, maximum, KW): 2.82

(b) RF
  Frequency range (MHz): 45
  Harmonic modes: 2, 4
  Number of dees: 2
  Number of cavities: 1
  Dee angular width (deg.): 35
  Voltage
    at injection (peak to ground, KV):
    at extraction (peak to ground, KV):
    peak (peak to ground, KV): 25
  Line Power (max, KW):
  Phase Stability (deg.): 0.5
  Voltage Stability (%): 0.1

(c) Injection
  Ion Source: cold-cathode PIG

(d) Extraction
  Elements, Characteristic: carbon-foil, charge-exchange
  Typical Efficiency (%): 90
  Best Efficiency (%): 100

(e) Vacuum
  Pumps:
  Achieved Vacuum (Pa): TMP 1000l/s x1, CRYO x2

EXPERIMENTAL FACILITIES
  3-port for internal,
  2-port for external.

COMMENTS
NIRS-Cyclotron Facility
ENTRY N° CU10
Date: 25 Oct 2007
Machine name: NIRS-930 Cyclotron
Institution: National Institute of Radiological Science
Address: Anagawa, Inage-ku, Chiba, 263-8555, Japan
Telephone: +81-(0)43-206-3173
Fax: +81-(0)43-206-6146
Web Address: honma_t@nirs.go.jp

HISTORY
Designed by: Thomson-CSF (CGR-MeV)
Constructed by: Thomson-CSF (CGR-MeV)
Construction dates: 1972-1973
First beam date: Dec. 1973

Characteristic beam, energy and current:
- p: 6-70(MeV), 1.2E+14(pps), 700(W)
- d: 6-25(MeV/u), 2.E+14(pps), 900(W)
- 3He: 6-48(MeV/u), 3.E+13(pps), 700(W)
- 4He: 6-25(MeV/u), 3.E+13(pps), 700(W)
- H.I.: 12C4+, 6-12(MeV/u), 7.E+12(pps), 700(W)

Transmission efficiency (source to extracted beam)
Typical (%): 60
Best (%): 85

Emittance
Emittance definition: 90 %
Vertical (pi mm mrad): 12
Horizontal (pi mm mrad): 15
Longitudinal (dE/E[%] x RF[deg.]):

USES
Basic research (%): 15
Development(%): 5
Therapy(%): 0
Isotope production (%): 40
Other application (%): 15
Maintenance (%): 10
Beam tuning(%): 15
Total time (h/year): 1600

TECHNICAL DATA
(a) Magnet: Room Temp. Type: H-type
Kb: 110 MeV, Kf: 90 MeV(Proton)
Average field (min./max. T): 0.35 / 1.65
Number of magnet sectors: 4
hill angular width (deg.):
spiral (max): 53
Pole parameters
Diameter: 2.15
Injection radius (m): 0.025
Extraction radius (m): 0.93
Hill gap (m): 0.166 Valley gap (m): 0.405
Trim coils
Number: 12
Maximum current (A-turns): 3.6E+5

Harmonic coils
Number: 8
Maximum current (A-turns): 1000

Main coils
Number: 1
Total current (A-turns): 3.6E+5
Maximum current (A): 1100
Stored energy (MJ):
Total iron weight (tons): 200
Total coil weight (tons):
Power
Main coils (total KW): 80
Trim coils (total, maximum, KW): 22
Refrigerator (cryogenic, KW):
(b) RF
Frequency range (MHz): 10.7-21.4
Harmonic modes: 1, 2
Number of dees: 2
Number of cavities: 2
Dee angular width (deg.): 86
Voltage
at injection (peak to ground, KV):
at extraction (peak to ground, KV): 45
peak (peak to ground, KV): 45
Line Power (max, KW): 60
Phase Stability (deg.): 0.5
Voltage Stability (%): 0.2
(c) Injection
Ion Source: ECR(for external)
Source Bias Voltage (kV):
External Injection: Axially-Injection
Buncher Type: Double gap, sin-wave
Injection Energy (MeV/n): 0.005-0.02
Component: 90-deg. BMx2, ESQ-doublet, ESQ-triplet,
Solenoid (4)
Injection Efficiency (%): 30(Max)
Injector: Spiral-inflector
(d) Extraction
Elements, Characteristic:
ES-deflector, Magnetic-channel, Gradient-corrector
Charge exchange (H, D')
Typical Efficiency (%): 60
Best Efficiency (%): 85
(e) Vacuum
Pumps: TMP(2000 l/s x6), CRYO x 2
Achieved Vacuum (Pa): 2.E-4

EXPERIMENTAL FACILITIES
9-Beam line & target stations

COMMENTS
NIRS-Cyclotron Facility
ENTRY N° CU11
Date: FEB 06, 2008
Machine name: MC17F
Institution: University Medical Center Groningen
Address: Hanzeplein 1, 9713 GZ Groningen, NL
Telephone: +31 50 261 2205
Fax: +31 50 361 9207
Web Address: www.ngmb.umcg.nl
Person in charge of cyclotron: A.M.J. Paans
E-mail address: a.m.j.paans@ngmb.umcg.nl

HISTORY
Designed by: Scanditronix
Constructed by: Scanditronix
Construction dates: 1990
First beam date: April, 1991
Characteristic beam, energy and current:
Proton, 17 MeV, 80 µA.
Deuteron, 8.5 MeV, 50 µA.
Transmission efficiency (source to extracted beam)
Typical (%): p 80%, d 70%
Best (%): p, 90%, d 80%
Emittance
Emittance definition:
Vertical (π mm mrad):
Horizontal (π mm mrad):
Longitudinal (dE/E[%] x RF[deg.]):

USES
Basic research (%): 0
Development(%): 0
Therapy(%): 0
Isotope production (%): 46% (2006)
Other application (%): 0
Maintenance (%): 20% (2006)
Beam tuning(%): 0
Total time (h/year): 2000

TECHNICAL DATA
(a) Magnet:
Type: R
Kb: Kf:
Average field (min./max. T): 1.3/1.7 T
Number of magnet sectors:
hill angular width (deg.): 0
spiral (max.):
Pole parameters
Diameter: 70 cm
Injection radius (m): na
Extraction radius (m): 32 cm
Hill gap (m): 32 cm
Valley gap (m):
Trim coils
Number:
Maximum current (A-turns):
Harmonic coils
Number:
Maximum current (A-turns):
Main coils

Number:
Total current (A-turns):
Maximum current (A):
Stored energy (MJ):
Total iron weight (tons): 20
Total coil weight (tons):
Power
Main coils (total KW):
Trim coils (total, maximum, KW):
Refrigerator (cryogenic, KW):
(b) RF
Frequency range (MHz): 24 fixed
Harmonic modes:
Number of dees:
Number of cavities:
Dee angular width (deg.):
Voltage
at injection (peak to ground, KV):
at extraction (peak to ground, KV):
peak (peak to ground, KV):
Line Power (max, KW):
Phase Stability (deg.):
Voltage Stability (%):
(c) Injection
Ion Source:
Source Bias Voltage (kV):
External Injection:
Buncher Type:
Injection Energy (MeV/n):
Component:
Injection Efficiency (%):
Injector:
(d) Extraction
Elements, Characteristic: electrostatic, magnetic channel
Typical Efficiency (%): 85%
Best Efficiency (%): 90%
(e) Vacuum
Pumps: oil diffusion
Achieved Vacuum (Pa): 1. E-06

EXPERIMENTAL FACILITIES
PET scanners and microPET scanner
**ENTRY Nº CU12**

**Date:** 16 Feb 2008  
**Machine Name:** TU/e cyclotron, IBA Cyclone 30  
**Institution:** Technische Universiteit Eindhoven (TU/e)/AccTec BV  
**Address:** Den Dolech, P.O. Box 513  
TU/e Eindhoven Cyclotron Building  
NL - 5600 MB Eindhoven  
**Telephone:** + 31 40 2474048  
**Fax:** + 31 40 2438060  
**Web Address:** http://www.tue.nl/de_universiteit/tue_holding_BV/  
**Person in Charge of Cyclotron:** M.J.A. de Voigt  
**Person Reporting Information:** M.J.A.de Voigt  
**E-mail Address:** acctecbv@tue.nl  
**HISTORY**  
**Designed by:** IBA, Louvain-la-Neuve (B)  
**Construction Dates:**  
First Beam Date: 2003  
**Characteristic Beams**  
15-30 MeV proton 500 microA  
**Transmission Efficiency (source to extracted beam)**  
Typical (%): 30  
Best (%): 35  
**Emittance**  
Emittance Definition:  
Vertical (pi mm mrad): 10  
Horizontal (pi mm mrad): 5  
Longitudinal (dE/E[%] x RF[deg.]): 1  
**USES**  
Basic Research (%): 10  
Development (%): 0  
Therapy (%): 0  
Isotope Production (%): 80  
Other Application (%): 0  
Maintenance (%): 7  
Beam Tuning (%): 3  
Total Time (h/year): 3000  
**TECHNICAL DATA**  
**(a)Magnet**  
Type: compact  
Kb (MeV): 30  
Kf (MeV/A): 30  
Average Field (min./max. T): 1(0.12/1.7)  
Number of Sectors: 4  
Hill Angular Width (deg.): 54-58  
Spiral (deg.): 0  
Pole Diameter (m): 1.6  
Injection Radius (m): 0.03  
Extraction Radius (m): 0.5 - 0.75  
Hill Gap (m): 0.03  
Valley Gap (m): 0.1  
**Main Coils**  
Number: 2  
Total Ampere Turns: 60 000  
Maximum Current (A): 110  
Stored Energy (MJ):  
Total Iron Weight (tons): 45  
Total Coil Weight (tons): 4  
**Power**  
Main Coils (total KW): 7.2  
Trim Coils (total, maximum, KW): N/A  
**Refrigerator (cryogenic, KW): N/A**  
**(b)RF**  
Frequency Range (MHz): 66  
Harmonic Modes: 4  
Number of Dees: 2  
Number of Cavities: 4  
Dee Angular Width (deg.): 30  
Voltage  
At Injection (peak to ground, KV): 50  
At Extraction (peak to ground, KV): 50  
Peak (peak to ground, KV): 50  
Line Power (max, KW): 40  
Phase Stability (deg.): 0.1  
Voltage Stability (%): 0.1  
**(c)Injection**  
Ion Source: multicusp  
Source Bias Voltage (kV): 30  
External Injection: axial  
Buncher Type: wire  
Injection Energy (MeV/n): 0.03  
Component:  
Injection Efficiency (%): 35  
Injector: inflector  
**(d)Extraction**  
Elements, Characteristic: carbon stripper  
Typical Efficiency (%): 100  
Best Efficiency (%):  
**(e)Vacuum**  
Pumps: cryo pump 4000l/s (N2)  
Achieved Vacuum (Pa): 1 E-5
ENTRY N° CU13

Date: 19th February 2008
Machine name: Scanditronix MC35
Institution: SAFE-centre, Univ. of Oslo
Address: P.O.Box 1038 – Blindern, N-0315 Oslo, Norway
Telephone: +47 228 55 076
Fax: 
Web Address: www.safe.uio.no

Person in charge of cyclotron: Jon Petter Omtvedt
Person reporting information: Jon Petter Omtvedt
E-mail address: j.p.omtvedt@kjemi.uio.no

HISTORY

Designed by:
Constructed by:
First beam date: 15th August 1979

Characteristic beam, energy and current:

- Protons: 2-35 MeV, 30 µA (max)
- Deuterons: 4-18 MeV, 30 µA (max)
- He-3: 6-45 MeV, 3 µA (max)
- He-4: 8-35 MeV, 10 µA (max)

Transmission efficiency (source to extracted beam)
Typical (%): p: 65%, d: 60%, He-3: 58%, He-4: 58%
Best (%): p: 80%, d: 65%, He-3: 65%, He-4: 65%

Emittance

- Vertical (π mm mrad): 12π mm mrad
- Horizontal (π mm mrad): 3π mm mrad
- Longitudinal (dE/E[%] x RF[deg.]):

USES

- Basic research (%): 70%
- Development(): 5%
- Therapy():
- Isotope production (): 10%
- Other application (): 5%
- Maintenance (): 5%
- Beam tuning(): 5%
- Total time (h/year): 1500

TECHNICAL DATA

(a) Magnet:
Type: H
Kb: Kf:
Average field (min./max. T): 0.5 – 2 T
Number of magnet sectors: 3
- hill angular width (deg.): 60
- Spiral (max):

Pole parameters
- Diameter: 1.2 m
- Injection radius (m): 0
- Extraction radius (m): 0.5 m
- Hill gap (m): 0.1
- Valley gap (m): 0.18

Trim coils
- Number: 8
- Maximum current (A-turns): 80 A

Harmonic coils

Number: 4
- Maximum current (A-turns): 20 A

Main coils
- Number: 28
- Total current (A-turns): 810 A
- Maximum current (A): 810 A

Stored energy (MJ):
- Total iron weight (tons): 53
- Total coil weight (tons): 2

Power
- Main coils (total KW): 130
- Trim coils (total, maximum, KW):
- Refrigerator (cryogenic, KW):

(b) RF
- Frequency range (MHz): 10-25
- Harmonic modes: 2
- Number of dees: 2
- Number of cavities: 2
- Dee angular width (deg.): 45
- Voltage
  - at injection (peak to ground, KV): 50
  - at extraction (peak to ground, KV):
  - Line Power (max, KW):
  - Phase Stability (deg.): < 0.5%
  - Voltage Stability (): < 1.0%

(c) Injection
- Ion Source: Reflex Arc (PIG)
- Source Bias Voltage (kV):
- External Injection:
  - Buncher Type:
  - Injection Energy (MeV/n): Component:
  - Injection Efficiency (%):
  - Injector:

(d) Extraction
- Elements, Characteristic: Electrostatic deflector
- Typical Efficiency (%): 60%
- Best Efficiency (%): 85%

(e) Vacuum
- Pumps: 2
- Achieved Vacuum (Pa): 1.0x10^{-8}
ENTRY N° CU14
Date: December 3, 2007
Machine name: PETtrace Johns Hopkins
Institution: Johns Hopkins University
Address: c/o Robert F. Dannals, Division of Nuclear Medicine, Johns Hopkins Medicine, 600 North Wolfe Street, Baltimore, Maryland USA   21287
Telephone: 410-955-2916
Fax:
Web Address: http://pet.rad.jhmi.edu/
Person in charge of cyclotron: Robert F. Dannals, Ph.D.
Person reporting information: same
E-mail address: rfd@jhu.edu

HISTORY
Designed by: General Electric
Constructed by:
Construction dates:
First beam date: January 2000
Characteristic beam, energy and current:
18 MeV protons, 9 MeV deuterons
Transmission efficiency (source to extracted beam)
Typical (%):
Best (%):
Emittance
Emittance definition:
Vertical (π mm mrad):
Horizontal (π mm mrad):
Longitudinal (dE/E[%%] x RF[deg.]):

USES
Basic research (%):
Development(%):
Therapy(%):
Isotope production (%):
Other application (%):
Maintenance (%):
Beam tuning(%):
Total time (h/year):

TECHNICAL DATA
(a) Magnet: Type:
Kb: Kf:
Average field (min./max. T):
Number of magnet sectors:
    hill angular width (deg.):
    spiral (max):
Pole parameters
    Diameter:
    Injection radius (m):
    Extraction radius (m):
    Hill gap (m)
    Valley gap (m):
Trim coils
    Number:
    Maximum current (A-turns):
Harmonic coils
Number:
    Maximum current (A-turns):
Main coils
Number:
    Total current (A-turns):
    Maximum current (A):
    Stored energy (MJ):
    Total iron weight (tons):
    Total coil weight (tons):
Power
Main coils (total KW):
Trim coils (total, maximum, KW):
Refrigerator (cryogenic, KW):
(b) RF
Frequency range (MHz):
Harmonic modes:
Number of dees:
Number of cavities:
Dee angular width (deg.):
Voltage
    at injection (peak to ground, KV):
    at extraction (peak to ground, KV):
    peak (peak to ground, KV):
Line Power (max, KW):
Phase Stability (deg.):
Voltage Stability (%):
(c) Injection
Ion Source:
Source Bias Voltage (kV):
External Injection:
Buncher Type:
Injection Energy (MeV/n):
Component:
Injection Efficiency (%):
Injector:
(d) Extraction
Elements, Characteristic:
Typical Efficiency (%):
Best Efficiency (%):
(e) Vacuum
Pumps:
Achieved Vacuum (Pa):
ENTRY N° CU15
Date: December 4, 2007
Machine name: NIH Cyclotron Corp. CS-30
Institution: National Institutes of Health
Address: Bldg 10, Rm 1C450, MSC 1180
Bethesda, Maryland 20892
Telephone: (301) 496-0345
Fax: (301) 402-6361
Web Address: www.nih.gov
Person in charge of cyclotron: Paul Plascjak
Person reporting information: Paul Plascjak
E-mail address: pp5s@nih.gov

HISTORY
Designed by: Cyclotron Corporation
Constructed by: Cyclotron Corporation
Construction dates: 1985
First beam date: 1986

Characteristic beam, energy and current:
P   26.5 MeV    200 µA int.  60 µA ext.
d   14.8 MeV    300 µA int, 100 µA ext.
He-3 38.1 MeV   135 µA int, 60 µA ext.
He-4 29.6 MeV   90 µA int, 40 µA ext.

Transmission efficiency (source to extracted beam)
Typical (%):
Best (%):

Emittance
Emittance definition:
Vertical (π mm mrad):
Horizontal (π mm mrad):
Longitudinal (dE/E[%] x RF[deg.]):

USES
Basic research (%): 5%
Development(%): 5%
Therapy(%): 5%
Isotope production (%): 90%
Other application (%): Maintenance (%): 5%
Beam tuning(%):
Total time (h/year): 1000

TECHNICAL DATA
(a) Magnet: Type:
Kb: Kf:
Average field (min./max. T):
Number of magnet sectors:
   hill angular width (deg.):
   spiral (max):
Pole parameters
   Diameter:
   Injection radius (m):
   Extraction radius (m):
   Hill gap (m): Valley gap (m):
Trim coils
   Number:
   Maximum current (A-turns):

REFERENCES:

EXPERIMENTAL FACILITIES
Internal target system. External beam line, 5 legs, multiple target changer. Targets: [C-11]-CO₂, [N-13]-NH₃aq, O-15, [F-18]-HF, [F-18]-F₂, powder cup.
Shared 6 radiochemistry hot cells and 4 minicells.
ENTRY Nº CU16

Date: December 4, 2007
Machine name: NIH GE PETtrace I
Institution: National Institutes of Health
Address: Bldg 10, Rm 1C450, MSC 1180
Bethesda, Maryland 20892
Telephone: (301) 496-0345
Fax: (301) 402-6361
Web Address: www.nih.gov
Person in charge of cyclotron: Paul Plascjak
Person reporting information: Paul Plascjak
E-mail address: pp5s@nih.gov

HISTORY
Designed by: GE/Scanditronix
Constructed by: GE/Scanditronix
Construction dates: 1999
First beam date: 2000
Characteristic beam, energy and current:
  H- 16.5 MeVp 75 µA ext.
  D- 8.4 MeVd 60 µA ext.
Transmission efficiency (source to extracted beam):
  Typical (%):
  Best (%):
Emittance
Emittance definition:
  Vertical (π mm mrad):
  Horizontal (π mm mrad):
  Longitudinal (dE/E[%] x RF[deg.]):
USES
Basic research (%):
Development(%): 5%
Therapy(%) :
Isotope production (%): 90%
Other application (%):
Maintenance (%): 5%
Beam tuning(%):
Total time (h/year): 1000
TECHNICAL DATA
(a) Magnet:       Type:
  Kb:            Kf:
Average field (min./max. T):
Number of magnet sectors:
  hill angular width (deg.):
  spiral (max):
Pole parameters
  Diameter:
  Injection radius (m):
  Extraction radius (m):
  Hill gap (m):    Valley gap (m):
Trim coils
  Number:
  Maximum current (A-turns):

EXPERIMENTAL FACILITIES

6 external target ports, dual extraction:
[C-11]-CO₂, [N-13]-NH₃, [F-18]-HF, [C-11](CH₃), plate tgt, cup tgt.
Shared 6 radiochemistry hot cells and 4 minicells.

EXPERIMENTAL FACILITIES

B-3 Level
Cyclotrons and Radiochemistry
ENTRY Nº CU17
Date: December 4, 2007
Machine name: NIH GE PETtrace 2
Institution: National Institutes of Health
Address: Bldg 10, Rm 1C450, MSC 1180
Bethesda, Maryland 20892
Telephone: (301) 496-0345
Fax: (301) 402-6361
Web Address: www.nih.gov
Person in charge of cyclotron: Paul Plascjak
Person reporting information: Paul Plascjak
E-mail address: pp5s@nih.gov

HISTORY
Designed by: GE/Scanditronix
Constructed by: GE/Scanditronix
Construction dates: 2007
First beam date: 2007

Characteristic beam, energy and current:
H- 16.5 MeVp 100 µA ext.
D- 8.4 MeVd 60 µA ext.

Transmission efficiency (source to extracted beam)
Typical (%):
Best (%):

Emittance
Emittance definition:
Vertical (π mm mrad):
Horizontal (π mm mrad):
Longitudinal (dE/E[%] x RF[deg.]):

USES
Basic research (%):
Development(%): 5%
Therapy(%):
Isotope production (%): 90%
Other application (%):
Maintenance (%): 5%
Beam tuning(%):
Total time (h/year): 1000

TECHNICAL DATA
(a) Magnet: Type:
Kb:
Kf:
Average field (min./max. T):
Number of magnet sectors:
  hill angular width (deg.):
  spiral (max):
Pole parameters
  Diameter:
  Injection radius (m):
  Extraction radius (m):
  Hill gap (m): Valley gap (m):
Trim coils
  Number:
  Maximum current (A-turns):

REFERENCES:

EXPERIMENTAL FACILITIES

6 external target ports, dual extraction:
[C-11]-CO₂, O-15, (2) [F-18]-HF, [F-18]-F₂ (via O-18).
Shared 6 radiochemistry hot cells and 4 minicells.
ENTRY Nº CU18
Date: 20-NOV-07
Machine name: Clinical Cyclotron
Institution: University of Washington Medical Center
Address: Radiation Oncology, Room NN-136, 1959 NE Pacific Street, Seattle WA 98195-6043, USA
Telephone: (206) 598-4136
Fax: (206) 598-6218
Web Address: http://www.radonc.washingon.edu
Person in charge of cyclotron: R. Risler
Person reporting information: R. Risler
E-mail address: risler@u.washington.edu

HISTORY
Designed by: Scanditronix AB, Uppsala, Sweden
Constructed by: Scanditronix
Construction dates: 1981/82
First beam date: Factory: June 82, Facility: June 83
Characteristic beam, energy and current:
Protons: 28 to 50.5 MeV, 80µA extracted at 50.5 MeV
He4++: 28 to 47.4 MeV, 60 µA extracted
Transmission efficiency (source to extracted beam)
Typical (%): 65
Best (%): 70
Emittance
Emittance definition: 50%
Vertical (pi mm mrad): protons: 14
Horizontal (pi mm mrad): protons: 12
Longitudinal (dE/E[%] x RF[deg.]):
USES
Basic research (%): 1
Development(%): 4
Therapy(%): 80
Isotope production (%): 4
Other application (%): 1
Maintenance (%): 5
Beam tuning(%): 5
Total time (h/year): 1500

TECHNICAL DATA
(a) Magnet: Type: Compact H Frame
Kb: 51 MeV
Kf:
Average field (min./max.): 1.75/2.05
Number of magnet sectors: 3
hill angular width (deg.):
spiral (max): 55 deg.
Pole parameters
Diameter (m): 1.55
Injection radius (m):
Extraction radius (m): 0.57
Hill gap (m): 0.115 Valley gap (m): 0.205
Trim coils
Number: 10 pairs
Maximum current (A-turns):

Harmonic coils
Number: 4 sets of 3 pairs
Maximum current (A-turns): 900
Main coils
Number: 1 pair
Total current (A-turns): 288000
Maximum current (A): 900
Stored energy (MJ):
Total iron weight (tons): 90
Total coil weight (tons):
Power
Main coils (total KW): 120
Trim coils (total, maximum, KW): 3
Refrigerator (cryogenic, KW):
(b) RF
Frequency range (MHz): 19.5 to 26.0
Harmonic modes: 1, 2
Number of dees: 2
Number of cavities: 2
Dee angular width (deg.): 90
Voltage
at injection (peak to ground, KV):
at extraction (peak to ground, KV):
peak (peak to ground, KV): 40
Line Power (max, KW): 60
Phase Stability (deg.): 0.1
Voltage Stability (%): 0.1
(c) Injection
Ion Source: Dual Chimney, Internal PIG
Source Bias Voltage (kV): 0
External Injection:
Buncher Type:
Injection Energy (MeV/n):
Component:
Injection Efficiency (%):
Injector:
(d) Extraction
Elements, Characteristic: Electrostatic Deflector, 46 kV max, Electromagnetic Channel, two passive focusing channels
Typical Efficiency (%): 85 (protons)
Best Efficiency (%): 90
(e) Vacuum
Pumps: Two oil diffusion pumps, 2 x 4300 l/s
Achieved Vacuum (Pa): 3.10E-04
REFERENCES: R.Risler et al. these proceedings
ENTRY № FM1
Date: 4th feb 2008
Machine name: synchro-cyclotron SC200
Institution: Institut Curie –Centre de Protonthérapie
Address: Campus Orsay – Bat 101-F-91898 Orsay
Telephone: 33 1 69 29 87 00
Fax: 33 1 69 07 55 00
Web Address: http://protontherapie.curie.info/en/
Person reporting information: Samuel Meyroneinc
E-mail address: samuel.meyroneinc@curie.net

HISTORY
Designed by: Institut Physique Nucléaire d’Orsay (IN2P3/CNRS)
Constructed by: Institut Physique Nucléaire d’Orsay
Construction dates: 1970-1977
First beam date: 1977

Characteristic beam, energy and current:
201 MeV –protons up to 2 micro amperes

Transmission efficiency (source to extracted beam)
Typical (%): 70
Best (%): 75

Emittance:
Emittance definition:
Vertical (pi mm mrad):
Horizontal (pi mm mrad):
Longitudinal (dE/E[%] x RF[deg.]):

USES
Basic research (%): 0
Development(%): 0
Therapy(%): 92%
Isotope production (%): 0
Other application (%):
Maintenance (%): 4%
Beam tuning(%): 4%
Total time (h/year): 2880

TECHNICAL DATA
(a) Magnet:
Type:
Kb:
Kf:
Average field (min./max. T): 1.53 – 1.6.
Number of magnet sectors:
hill angular width (deg.):
spiral (max):
Pole parameters
Diameter: 3.2
Injection radius (m): 0.01
Extraction radius (m): 1.4
Hill gap (m):
Valley gap (m):
Trim coils
Number:
Maximum current (A-turns):
Harmonic coils
Number:
Maximum current (A-turns):

Main coils
Number: 4
Total current (A-turns): 630 000
Maximum current (A): 630
Stored energy (MJ):
Total iron weight (tons): 900
Total coil weight (tons): 200
Power:
Main coils (total KW): 360
Trim coils (total, maximum, KW):
Refrigerator (cryogenic, KW):
(b) RF
Frequency range (MHz): 25.6 , 19,2
Harmonic modes:
Number of dees: 2
Number of cavities: 0
Dee angular width (deg.):
Voltage
at injection (peak to ground, KV):
at extraction (peak to ground, KV):
peak (peak to ground, KV):
Line Power (max, KW):
Phase Stability (deg.):
Voltage Stability (%):
(c) Injection
Ion Source: PIG hot filament
Source Bias Voltage (kV):
External Injection:
Buncher Type:
Injection Energy (MeV/n):
Component:
Injection Efficiency (%):
Injector:
(d) Extraction
Elements, Characteristic: Electromagnetic channel, magnetic channels (5)
Typical Efficiency (%): 70
Best Efficiency (%): 75
(e) Vacuum
Pumps: oil diffusion galileo 16 kl/s
Achieved Vacuum (Pa): 5. 10-6

COMMENTS:
http://protontherapie.curie.info/en/
ENTRY N° FM2
Date: 5, Dec. 2007
Machine name: Synchrocyclotron on 1Gev
Institution: Petersburg Nuclear Physics Institute
Address: 188300. Gatchina, Leningrad region, Russia
Telephone: 8 813 71 30857
Fax: +713 71 30346
Web Address: http://www.pnpi.spb.ru/
Person in charge of cyclotron: N.K. Abrossimov
Person reporting information: G.A. Riabov
E-mail address: riabov@mail.pnpi.spb.ru

HISTORY
Designed by: Efremov Institute
Constructed by:
Construction dates: 1959-1965
First beam date: Nov. 1967
Characteristic beam, energy and current:
Extracted P-beam, E=1000 MeV, 1µA
Sec. beams: π-µ mesons, n-neutrons, p-variable energy
Transmission efficiency (source to extracted beam)
Typical (%):
Best (%):
Emittance
Emittance definition:
Vertical (π mm mrad):
Horizontal (π mm mrad):
Longitudinal (dE/E[%] x RF[deg.]):

USES
Basic research (%):
Development(%):
Therapy(%): 12%
Isotope production (%):
Other application (%):
Maintenance (%):
Beam tuning(%):
Total time (h/year): 2500

TECHNICAL DATA
(a) Magnet: Iron Type: H-tipe
Kb:
Kf:
Average field (max/min., T): 1.9-1.78
Number of magnet sectors:
hill angular width (deg.):
spiral (max):
Pole parameters
Diameter: 6.85m
Injection radius (m):
Extraction radius (m): 3.15m
Hill gap (m):
Valley gap (m):
Trim coils
Number:
Maximum current (A-turns):
Harmonic coils
Number:
Maximum current (A-turns):
Main coils
Number: 2×132
Total current (A-turns): 1.3×10^6
Maximum current (A): 4800
Stored energy (MJ):
Total iron weight (tons): 7800
Total coil weight (tons): 120 (Al)
Power
Main coils (total KW): 1000
Trim coils (total, maximum, KW):
Refrigerator (cryogenic, KW):
(b) RF
Frequency range (MHz): 29-13.3
Harmonic modes: 1
Number of dees: 1
Number of cavities:
Dee angular width (deg.): 180
Voltage
at injection (peak to ground, KV): 10
at extraction (peak to ground, KV): 10
Line Power (max, KW):
Phase Stability (deg.):
Voltage Stability (%):
(c) Injection
Ion Source: internal
(d) Extraction
Elements, Characteristic: Regenerative extraction with the iron channel
Typical Efficiency (%): 30%
Best Efficiency (%):
(e) Vacuum
Pumps: 2p. on 2×10^4 l/s, 3p. on 4×10^3 l/s
Achieved Vacuum (Pa): 2.7×10^-4

REFERENCES:
Status of PNPI Synchrocyclotron.
PNPI XXX. High Energy Physics Division.
. p 6-14.

EXPERIMENTAL FACILITIES
Proton spectrometer with resolution 10^-3; π-µ channels;
3-proton beam lines; P therapy; TOF neutron spectrometer
On-line short lived isotope production facility
**ENTRY Nº FM3**
Date: 5 Dec. 2007
Machine name: PHASOTRON
Institution: DLNP JINR  Russia
Address: Dubna Joliot Curie 6 Moscow Reg.
Telephone: 7 49621 65887
Fax: 7 49621 66666
Web Address: Person in charge of cyclotron: M.Kazarinov
Person reporting information: L.Onischenko
E-mail address: olm@jinr.ru

**HISTORY**
Designed by: DLNP and Efremov Institute(NIIEFA)
 Constructed by: NIIEFA and LES (Leningrad)
Construction dates: 1979-1985
First beam date: Febr.1985
Characteristic beam, energy and current:
Protons 660MeV 3.2mA (2*E13pps).....

Transmission efficiency (source to extracted beam)
Typical (%):  Best (%):
Emittance
Emittance definition: 2sigma
Vertical (pi mm mrad): 33
Horizontal (pi mm mrad): 54
Longitudinal (dE/E[%) x RF[deg.]): 0.5%*120deg.

**USES**
Basic research (%):
Development(%):
ProtonTherapy 90%
Isotope production (%):
Other application (%):
Maintenance (%): 10%
Beam tuning(%):
Total time (h/year): 1000

**TECHNICAL DATA**
(a) Magnet: H Type: compact
Kb: 660
Kf:
Average field (min./max. T): 1.19/1.63 T
Number of magnet sectors: 4
hill angular width (deg.): 30/70
spiral (max): 77deg.
Pole parameters
Diameter: 6m
Injection radius (m): 0.025
Extraction radius (m): 2.7
Hill gap 0.12/0.3m Valley gap 0.3/0.8/0.5m
Trim coils
Number:
Maximum current (A-turns):
Harmonic coils
Number:
Maximum current (A-turns):
Main coils

<table>
<thead>
<tr>
<th>Number:</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total current (A-turns):</td>
<td></td>
</tr>
<tr>
<td>Maximum current (A):</td>
<td>4000A</td>
</tr>
<tr>
<td>Stored energy (MJ):</td>
<td></td>
</tr>
<tr>
<td>Total iron weight (tons):</td>
<td>7000t</td>
</tr>
<tr>
<td>Total coil weight (tons):</td>
<td>165t</td>
</tr>
<tr>
<td>Power</td>
<td></td>
</tr>
<tr>
<td>Main coils (total KW):</td>
<td>700kW</td>
</tr>
<tr>
<td>Trim coils (total, maximum, KW):</td>
<td></td>
</tr>
<tr>
<td>Refrigerator (cryogenic, KW):</td>
<td></td>
</tr>
</tbody>
</table>

(b) RF
Frequency range (MHz): 18.6-14.4
Harmonic modes: 1
Number of dees: 1
Number of cavities:
Dee angular width (deg.): 180deg
Voltage
at injection (peak to ground, KV): 40
at extraction (peak to ground, KV): 28
peak (peak to ground, KV):
Line Power (max, KW): 300
Phase Stability (deg.): |
Voltage Stability (%): |

(c) Injection
Ion Source: Internal PIG source
Source Bias Voltage (kV): 0.5cont./1.0kV pulsed mode
External Injection:
Buncher Type:
Injection Energy (MeV/n):
Component:
Injection Efficiency (%):
Injector:

(d) Extraction
Elements, Characteristic: Regenerative type, current magnetic channel
Typical Efficiency (%): 50
Best Efficiency (%): 60

(e) Vacuum
Pumps: 5 diffusion pumps
Achieved Vacuum (Pa): 1*E-6mm.Hg

**EXPERIMENTAL FACILITIES**
TRITON,DUBTO,muSR, 6 cabin hadron therapy complex