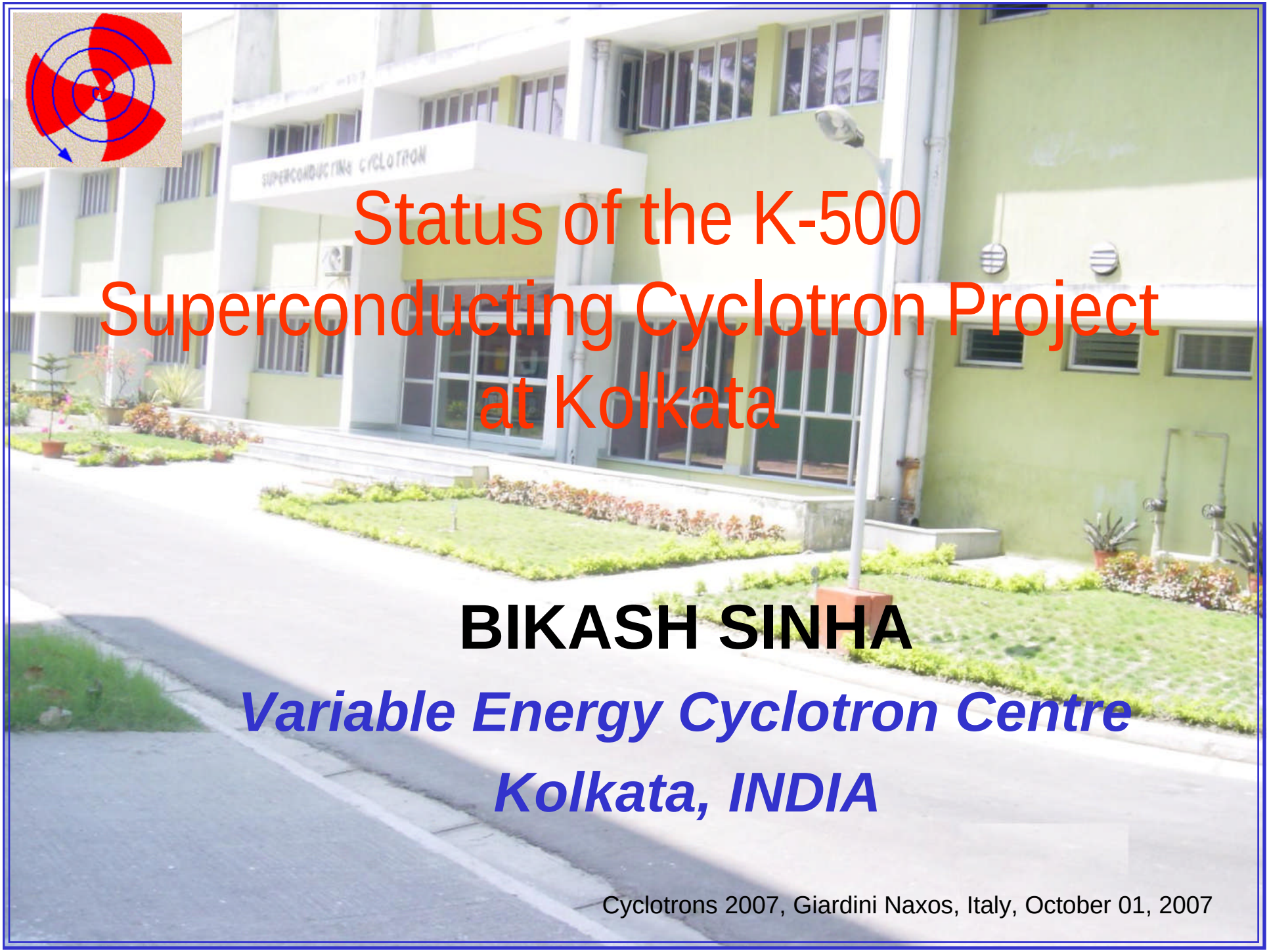


Status of the K-500 Superconducting Cyclotron Project at Kolkata

BIKASH SINHA

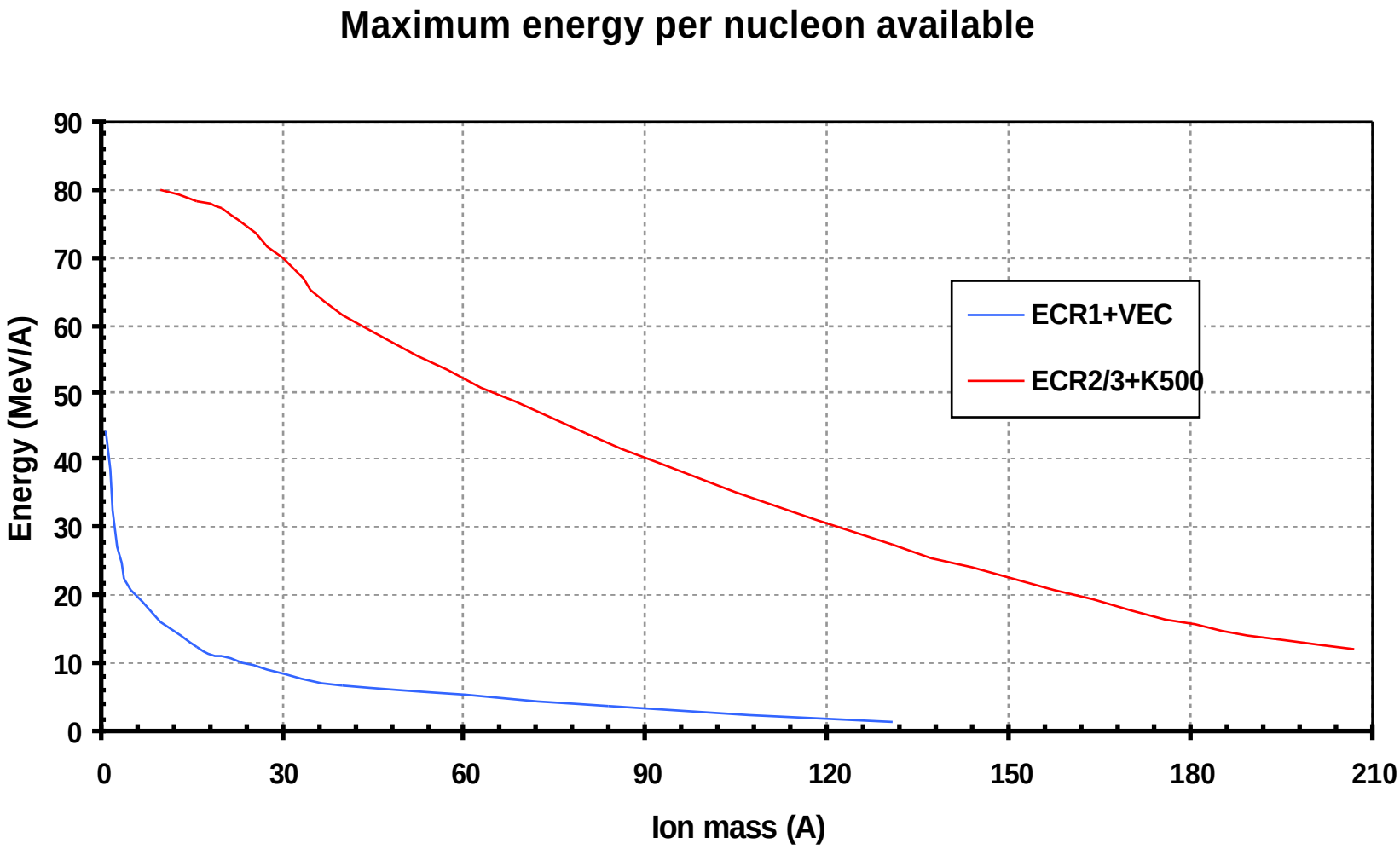
Variable Energy Cyclotron Centre

Kolkata, INDIA

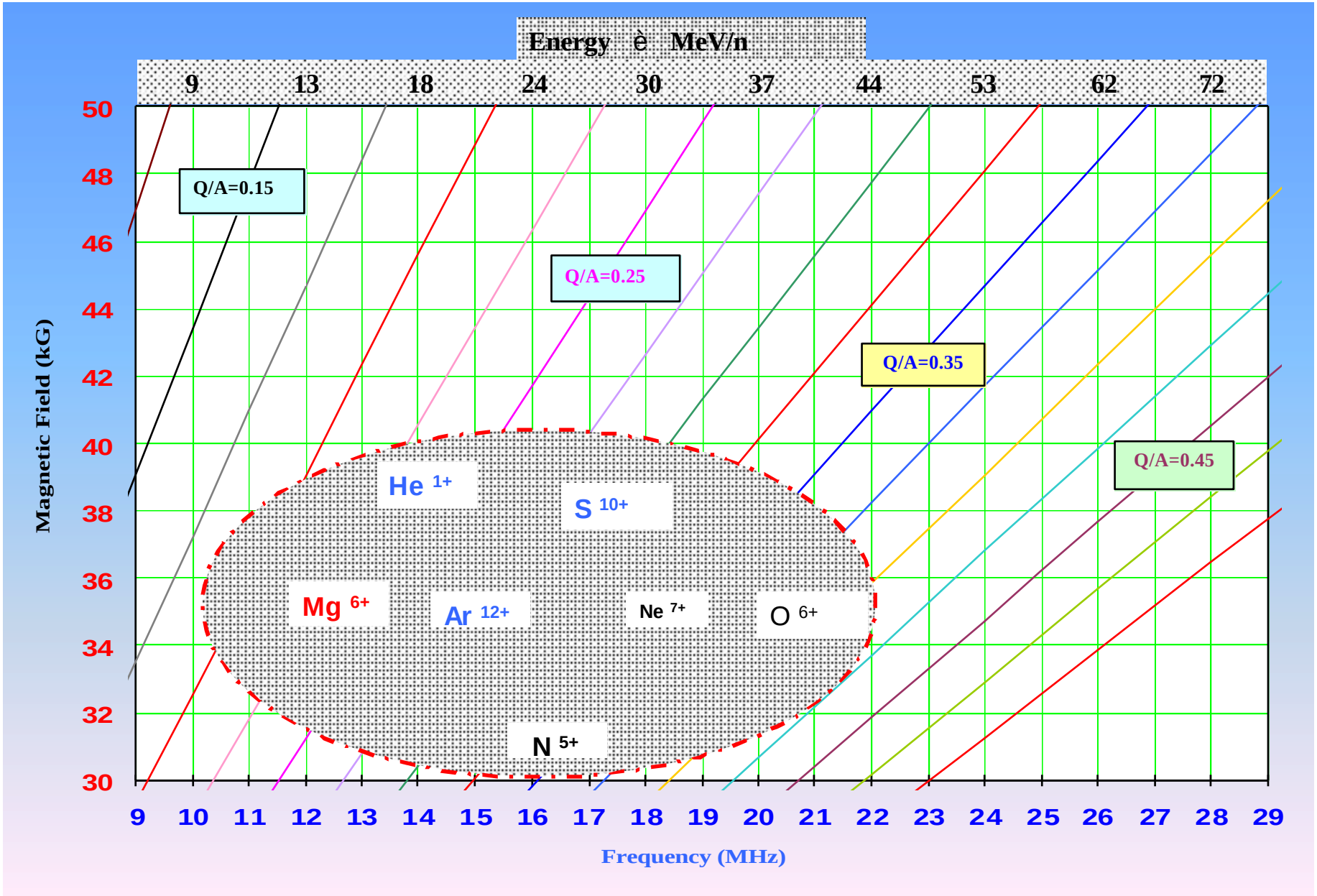
Cyclotrons 2007, Giardini Naxos, Italy, October 01, 2007

Expected Ion Beams from K 500

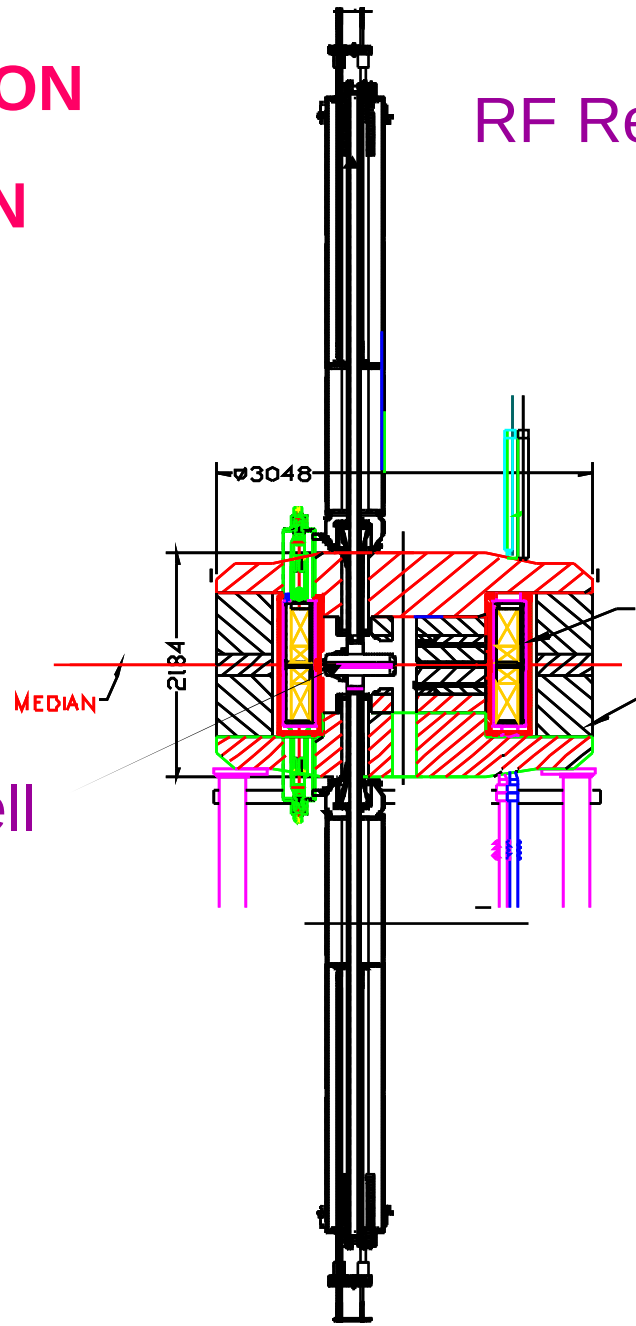
(based on 10 microamperes extracted from ion source)



Operating Diagram & Initial Ions Expected



VERTICAL SECTION OF CYCLOTRON



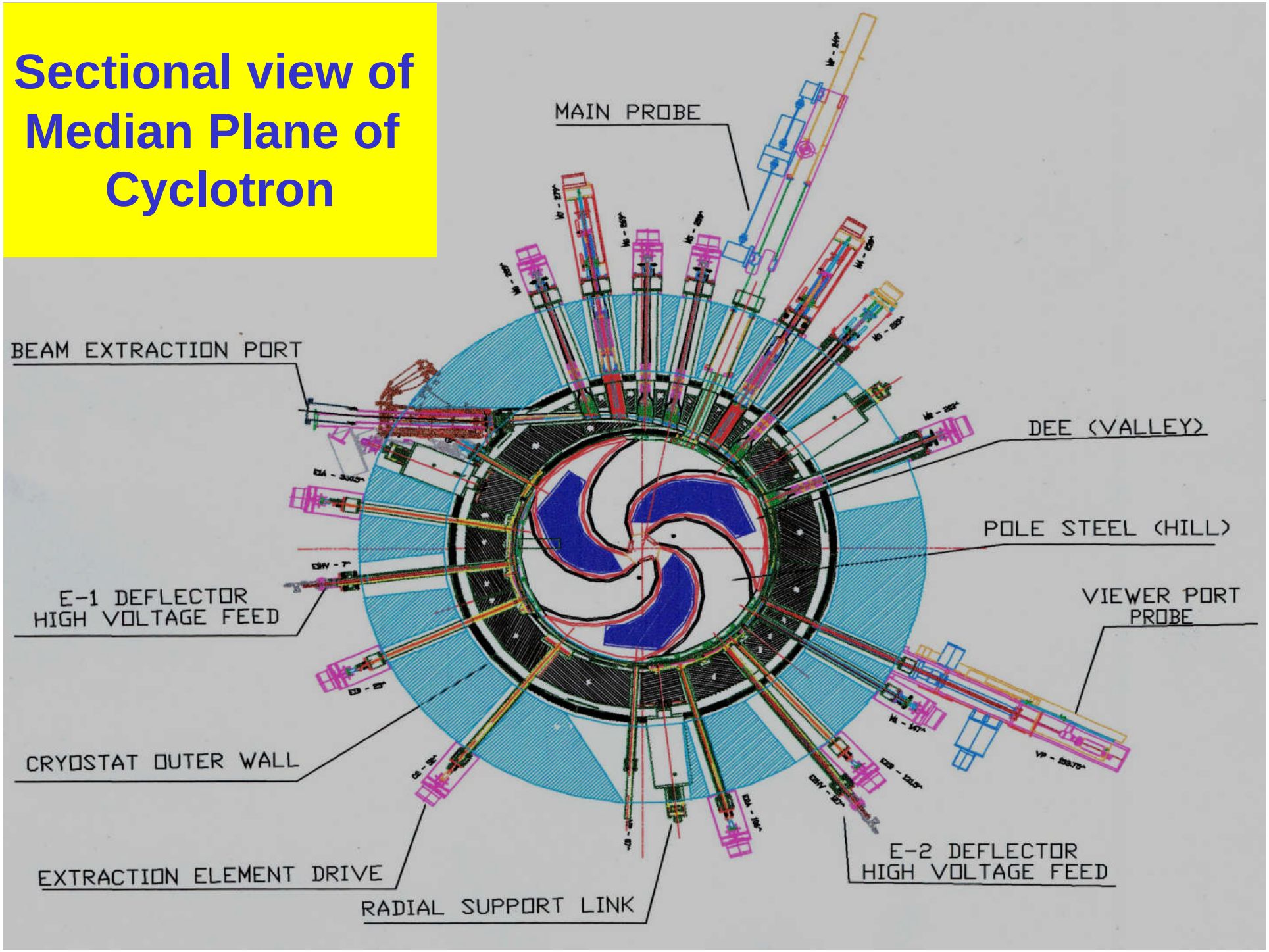
RF Resonator Cavity

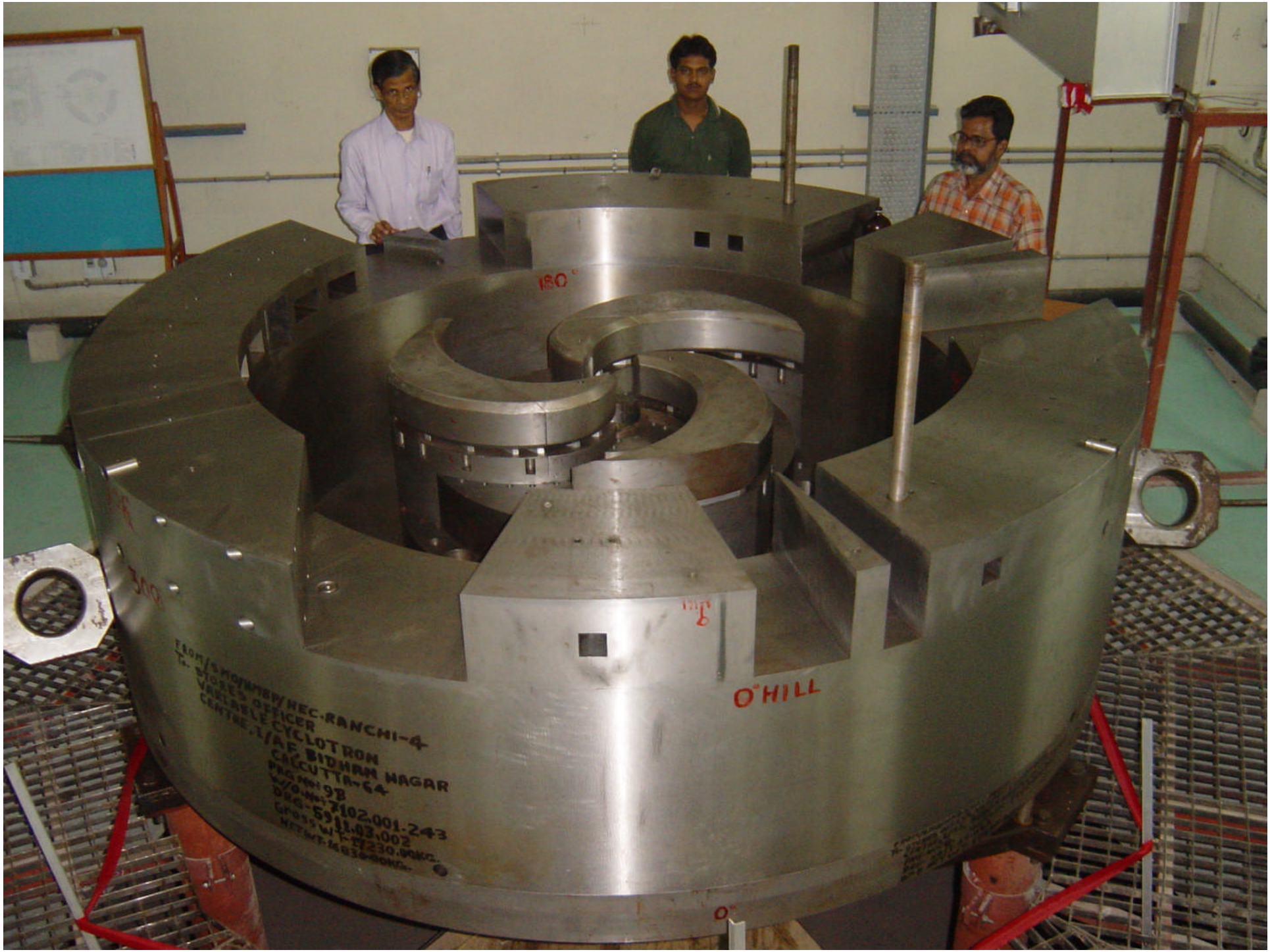
Cryostat

Magnet

DEE shell

Sectional view of Median Plane of Cyclotron




180°
0°HILL
0°

SUPERCONDUCTING COIL

Coil winding in progress

Pressure arm assembly of Coil Winding Machine

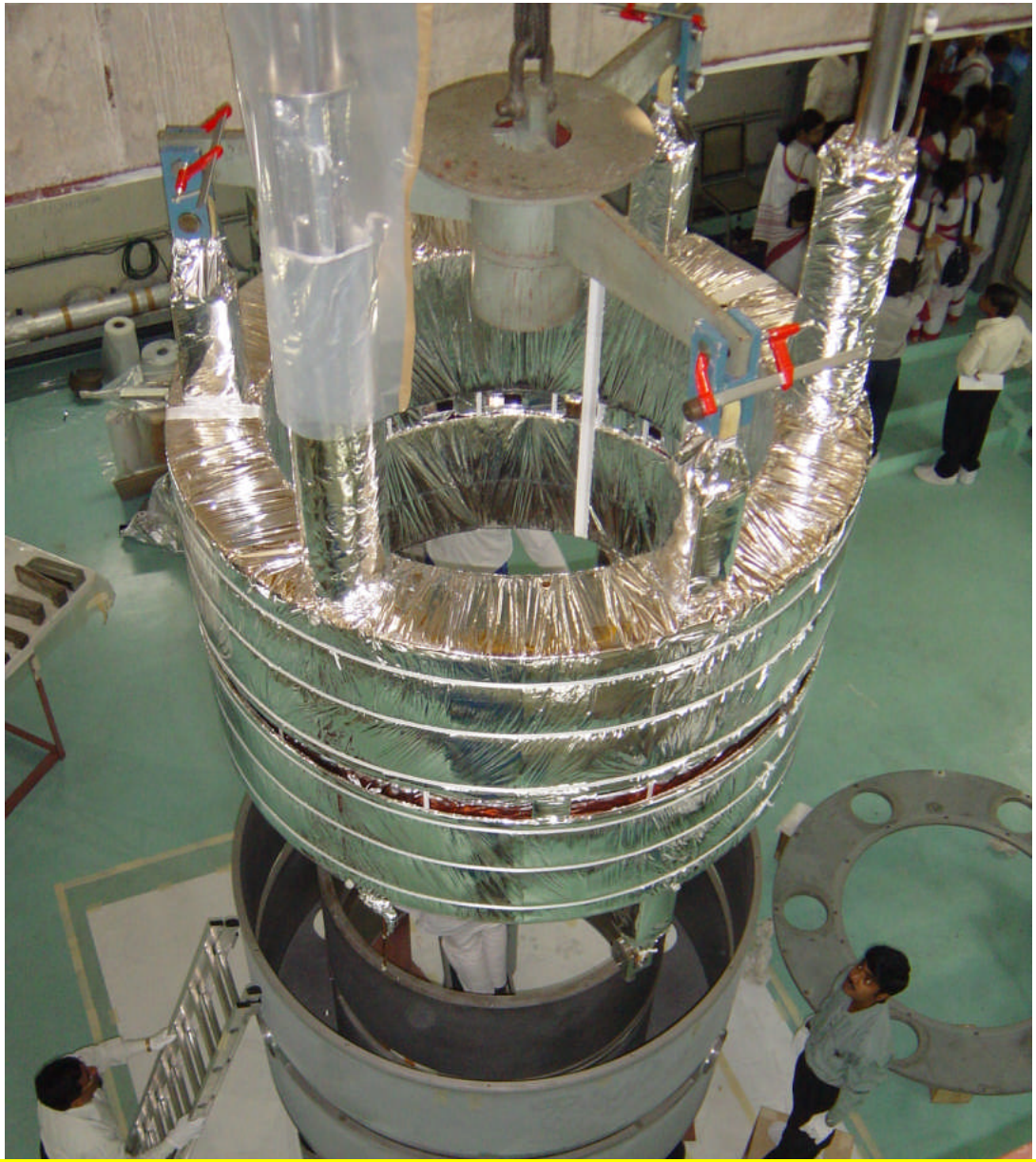
Cryostat with Vapour cooled current lead and Refrigeration Port.

CRYOSTAT FABRICATION


Bobbin with helium lines


Insulated Bobbin assembly

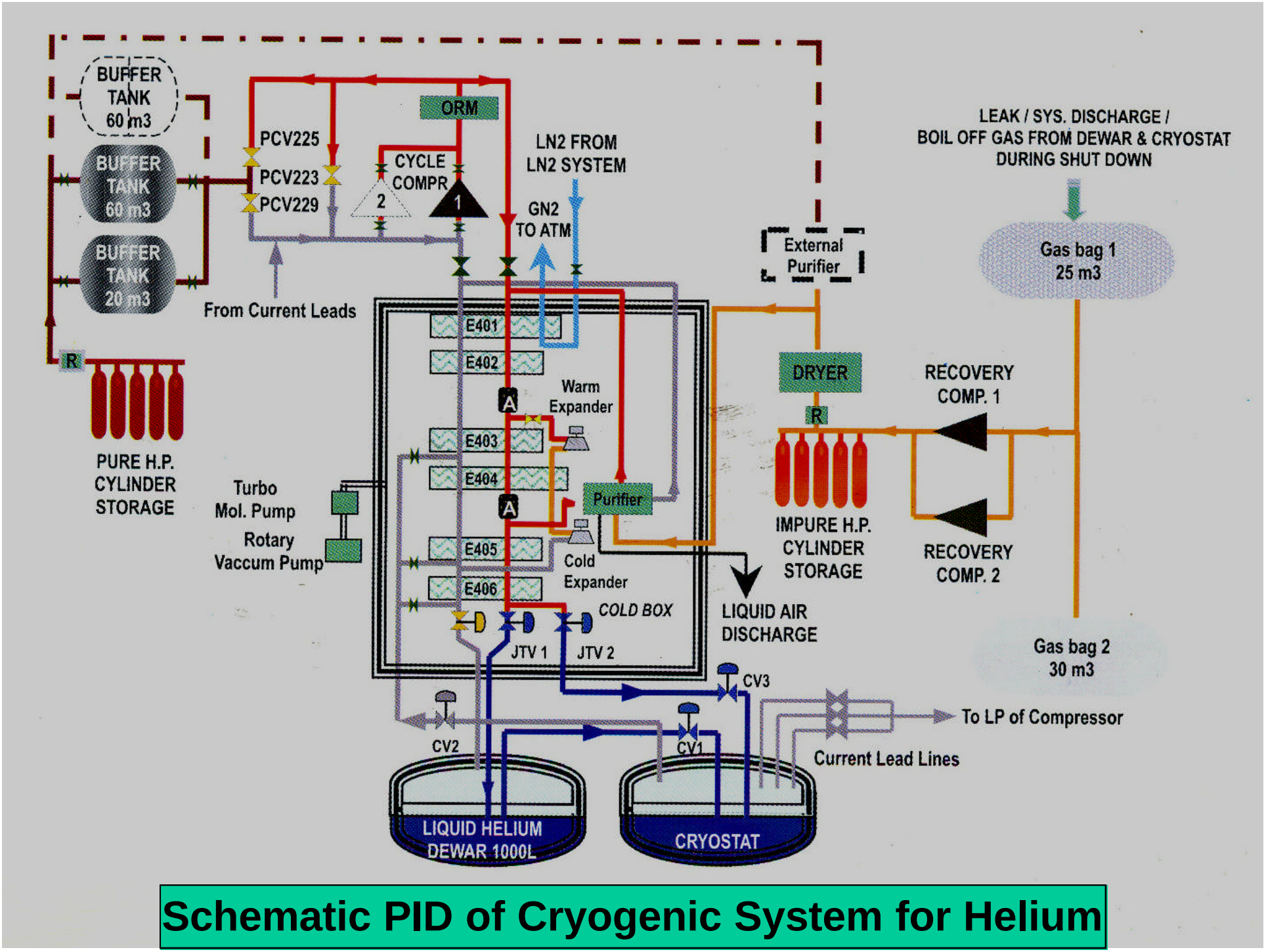
Bobbin and Radiation shield assembly



Insulated bobbin & radiation shield being inserted to vacuum chamber

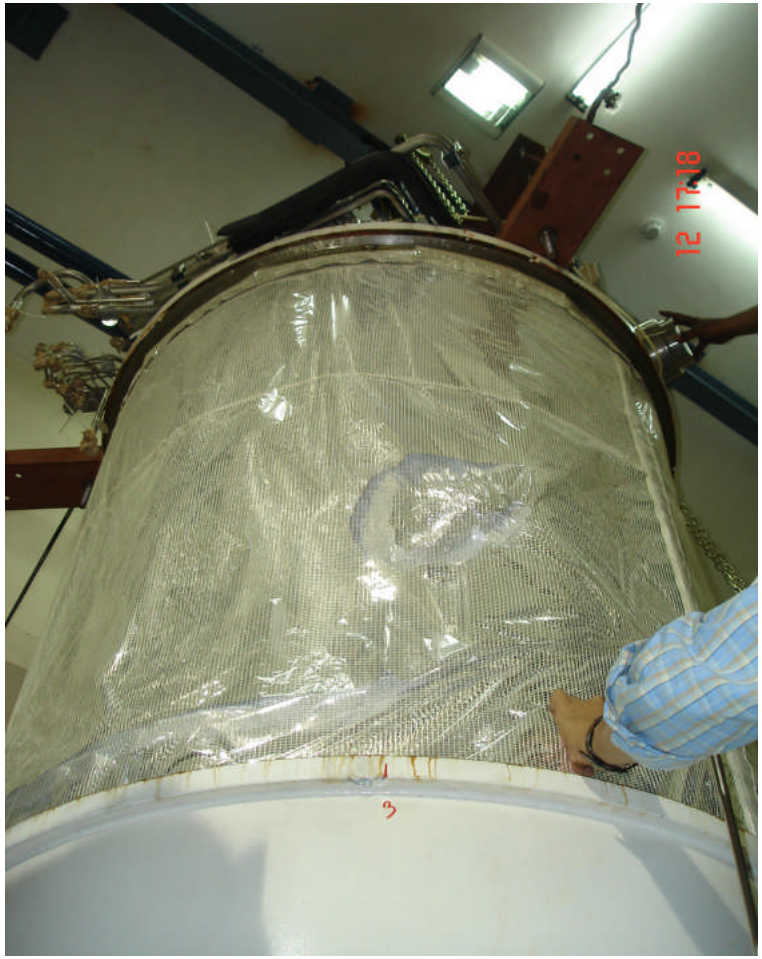
Cryostat assembly

CRYOGENIC PLANT
&
CRYOGEN DELIVERY SYSTEM



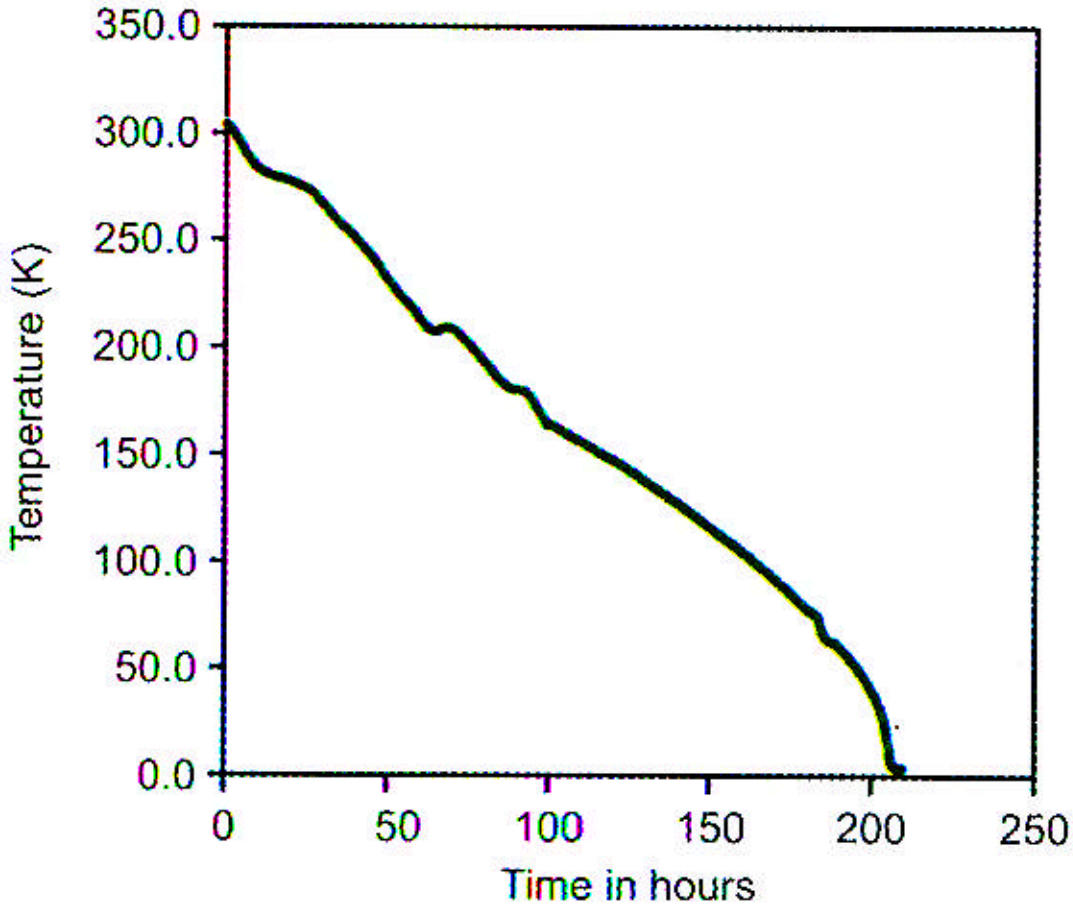
Schematic PID of Cryogenic System for Helium

Overhauling of Liquid Helium Plant



Cold Box With Exterior MLI

Cold Box Without MLI



Cool-down of superconducting cyclotron magnet

Connections to magnet

ENERGISATION OF MAGNET

Main Magnet Power Supplies

GENERAL FEATURES

§1000 A / 20 V, 10 ppm (current regulated)

§Series pass element - transistor bank

§12-pulse thyristor-based controlled rectifier

§SCR pre-regulator

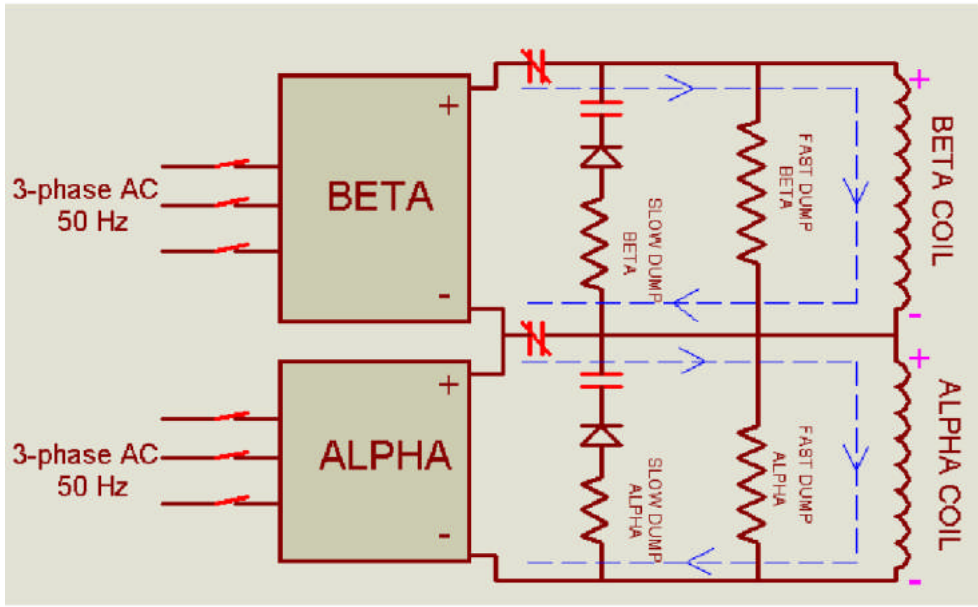
§RF shielding and filters

§Safety interlocks

§18-bit D/A Converter

§16-bit A/D Converter

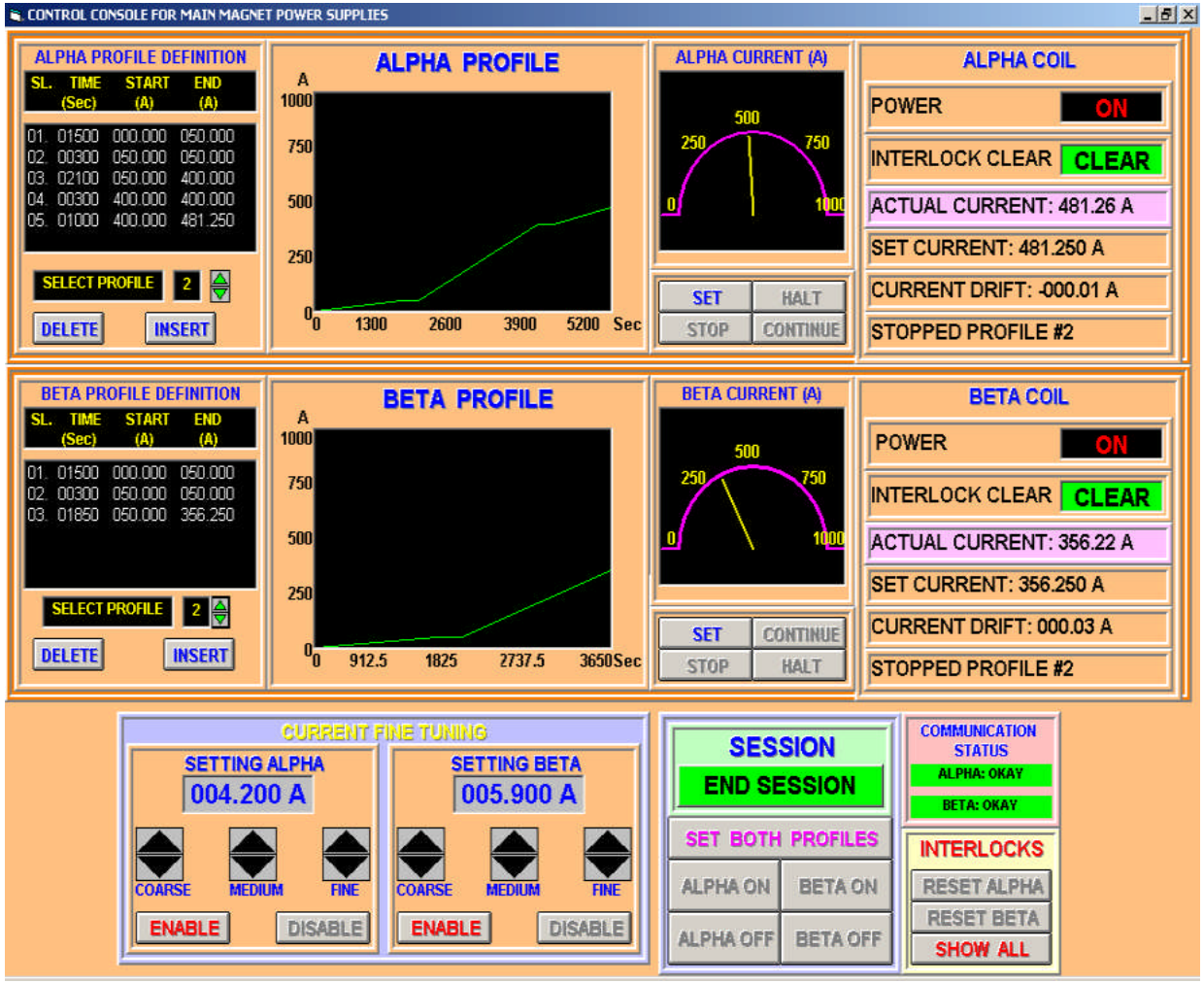
§Computer interface (RS-232 / 422)



SPECIAL FEATURES

§*Slow dump resistors* and *fast dump resistors* are provided for dissipating the energy stored in the coils outside the cryostat

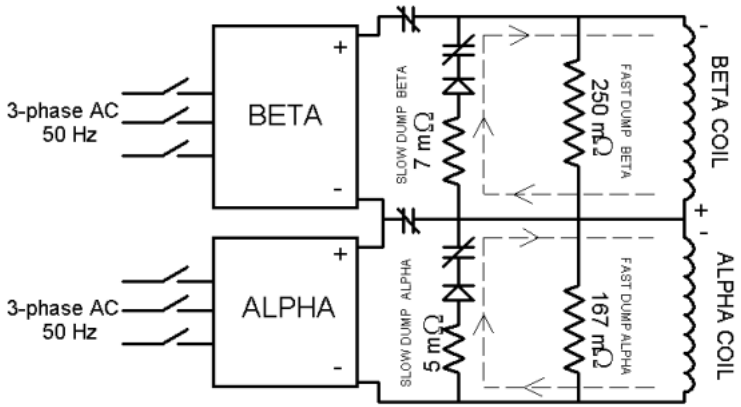
Operator's Console for Main Magnet Power Supplies



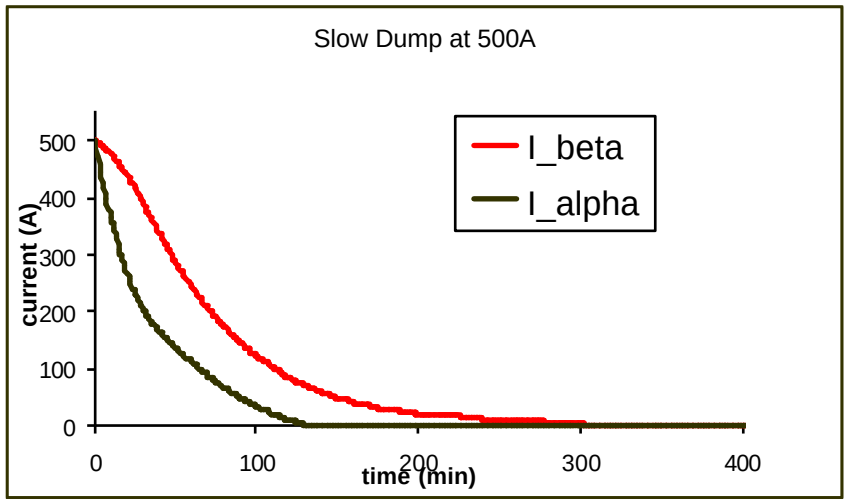
FACILITIES

- Remote operation (ON/OFF, HALT, STOP)
- Current setting
- Status and parameter monitoring
- Online data logging with time stamp

Slow Dump

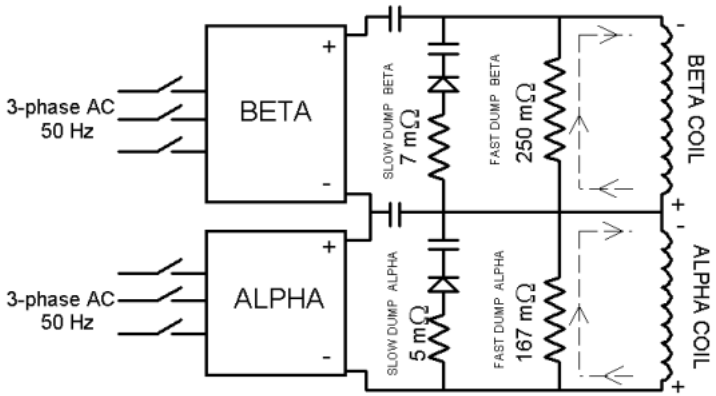


The states of the four contacts when slowdump is in progress

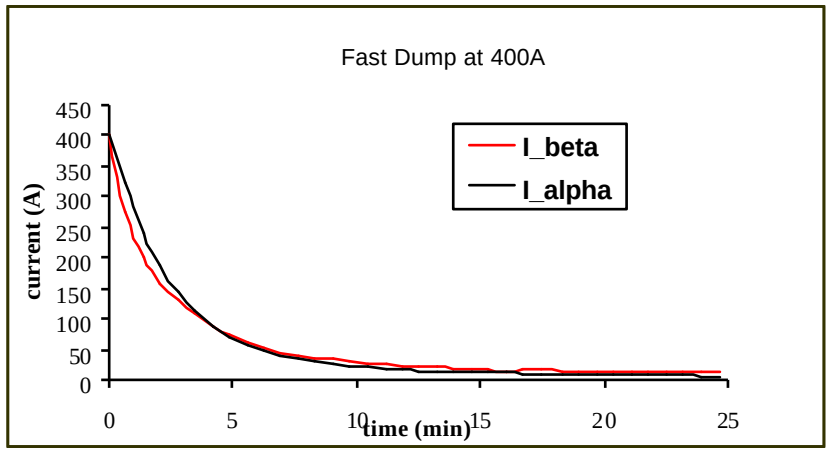


Profile of current decay for slow dump initiated at 500 A

Fast Dump

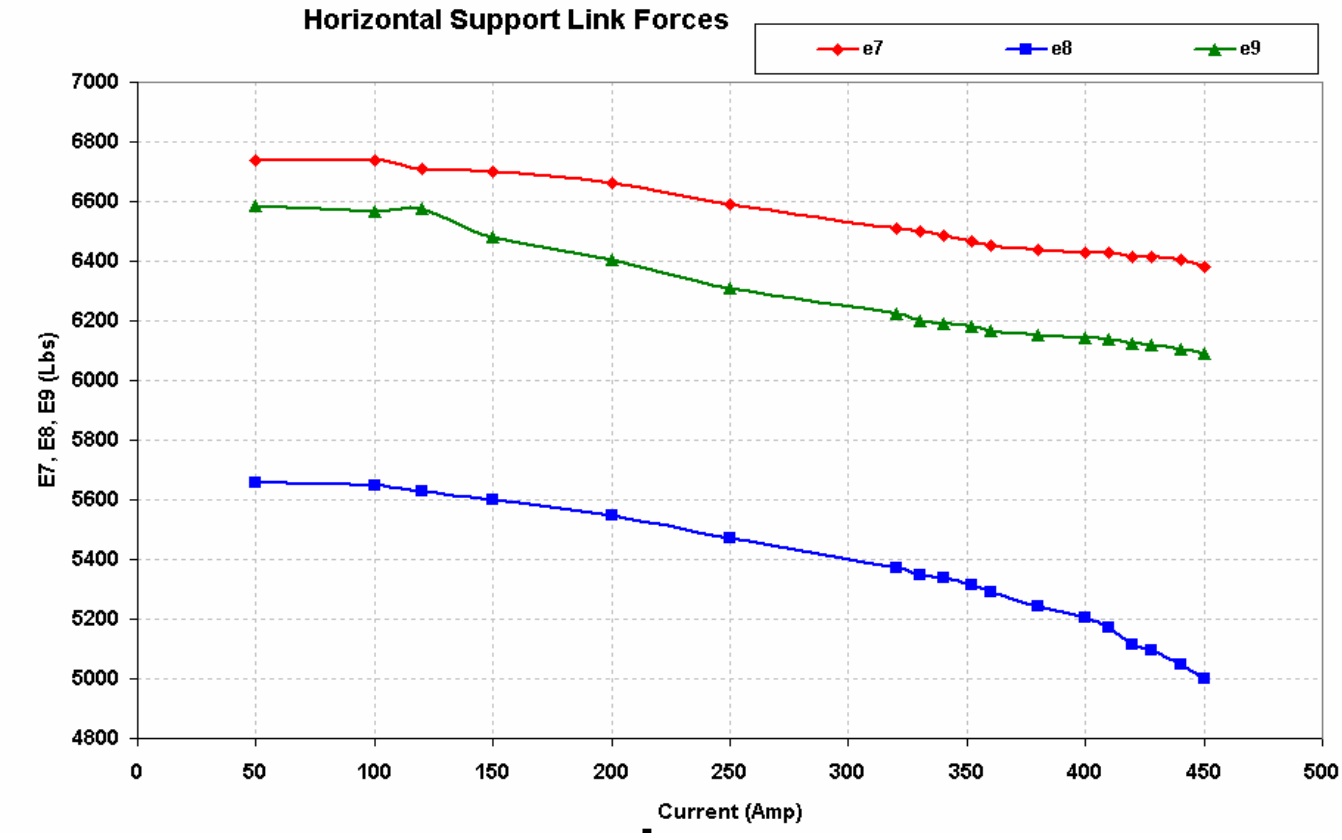


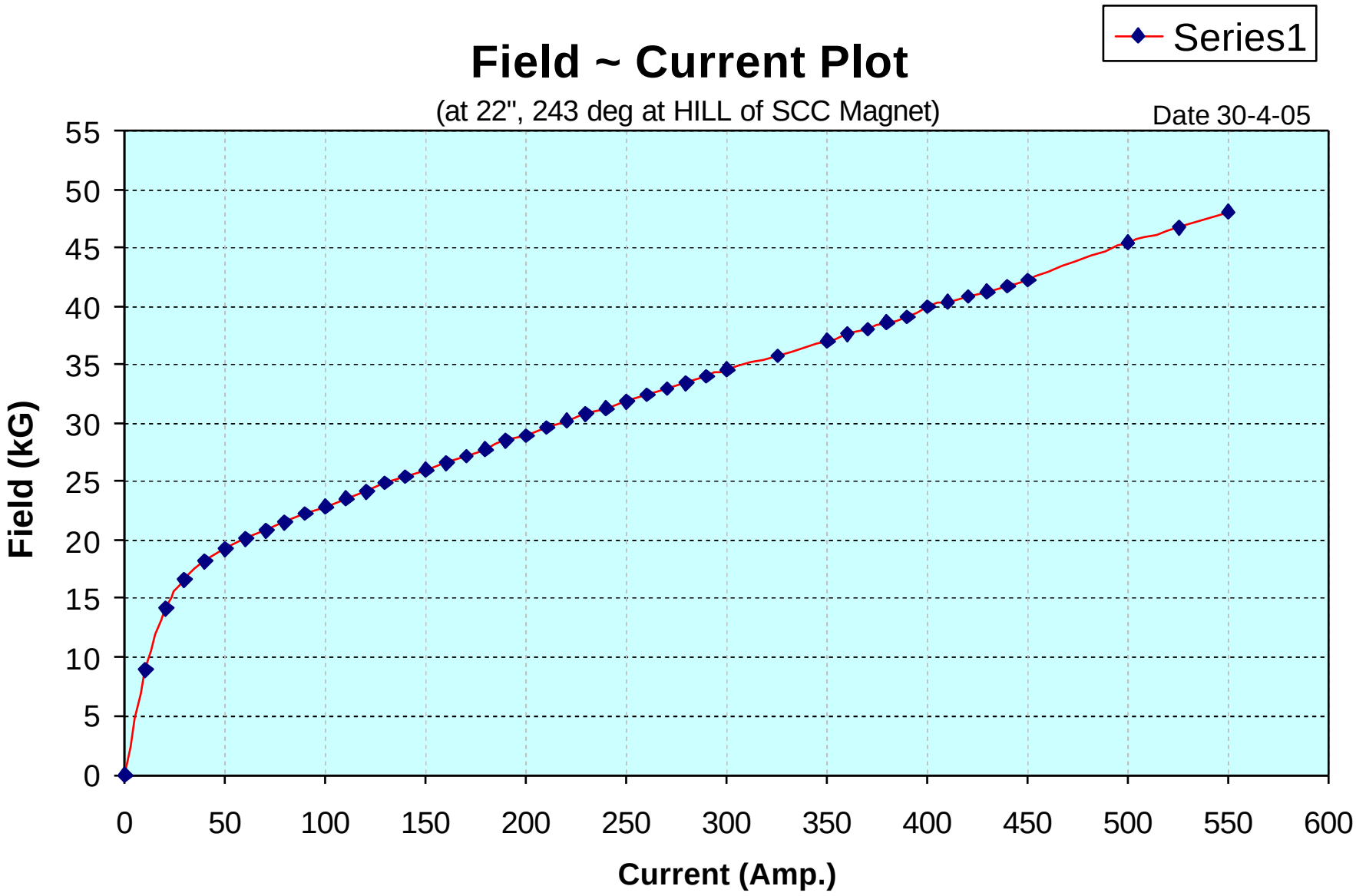
The states of the two contacts when fast dump is in progress



Profile of current decay for fast dump initiated at 400 A

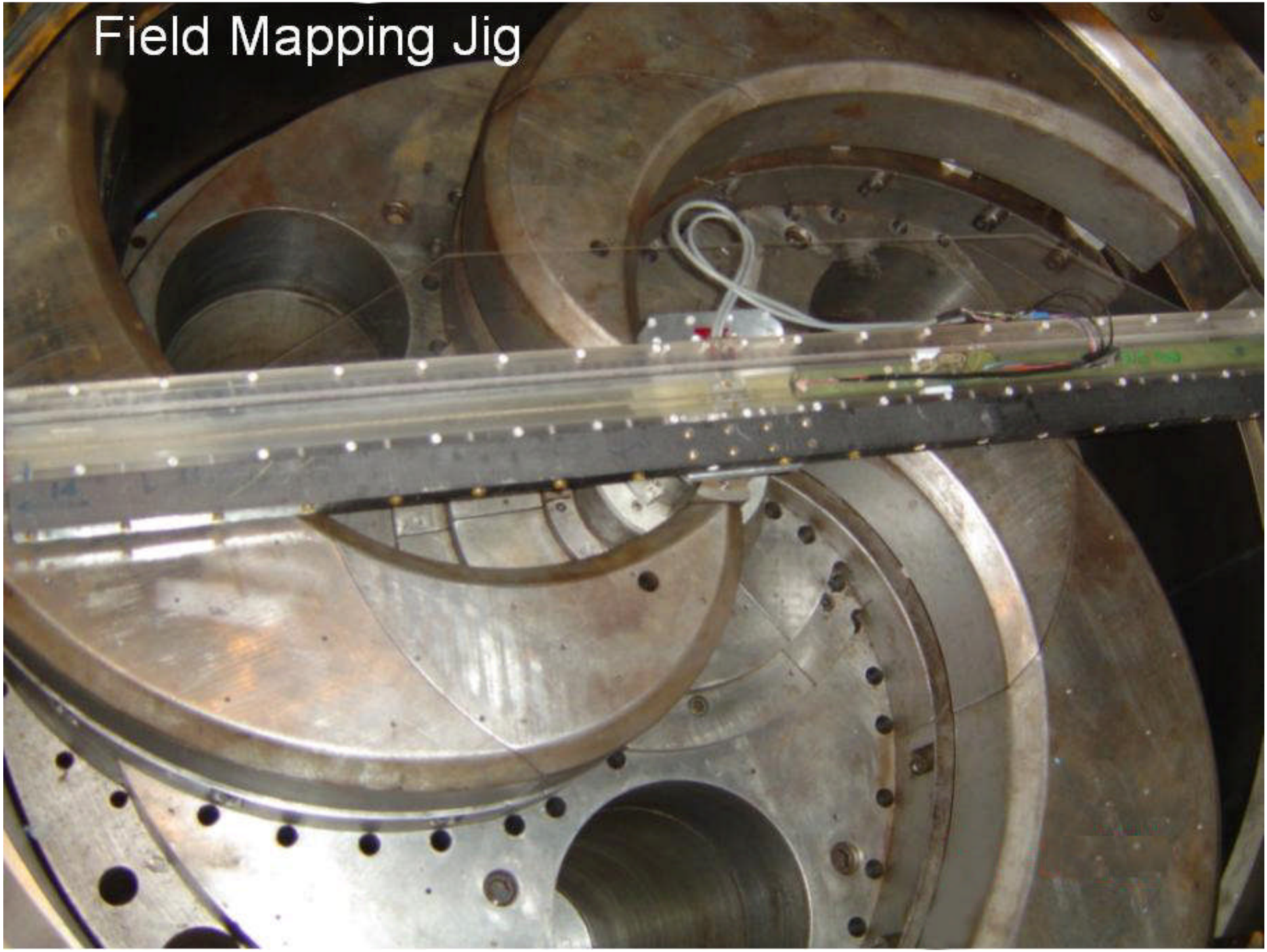
E9 Support Link was tightened to +145 degrees



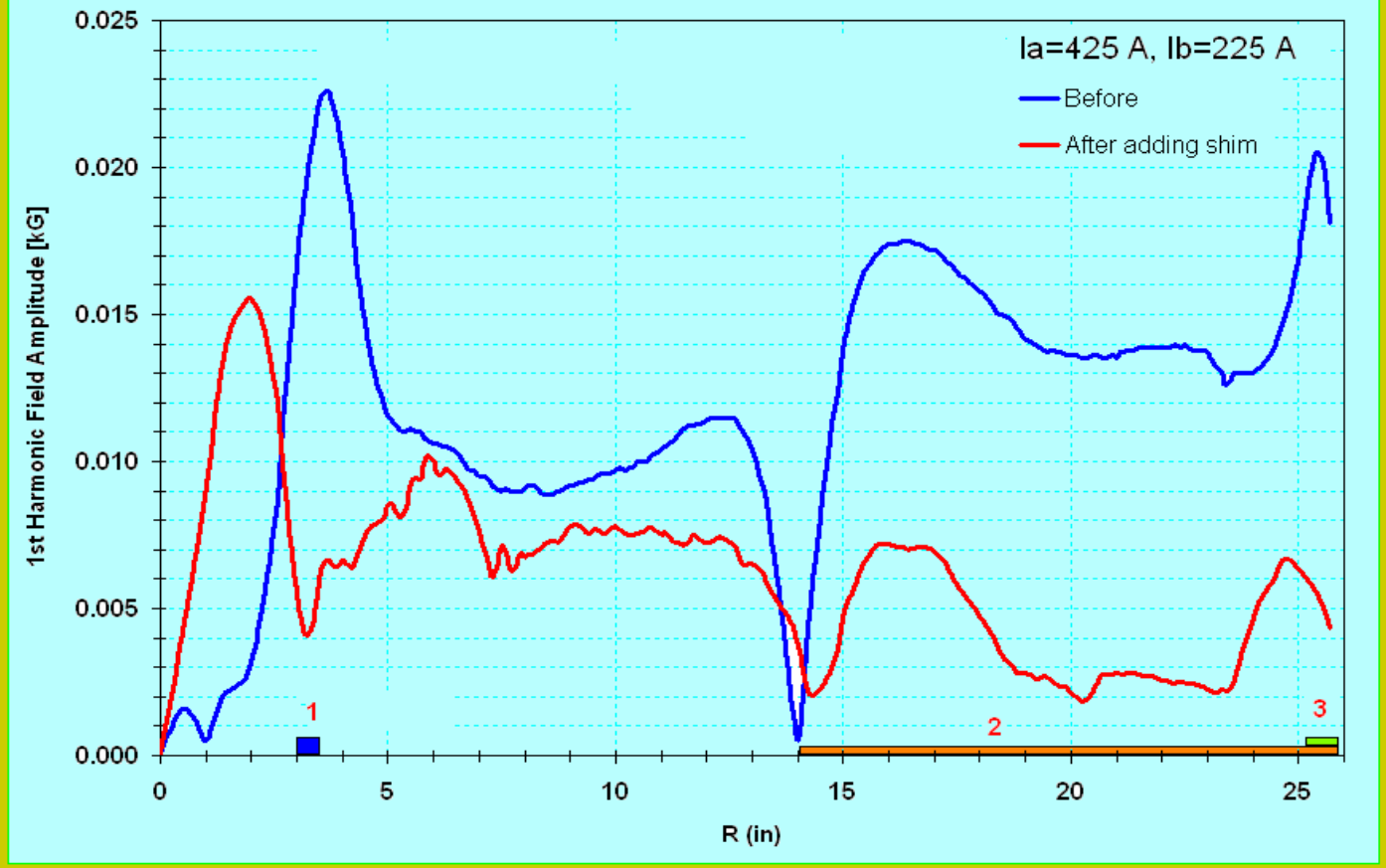


Max. Current: 750 A

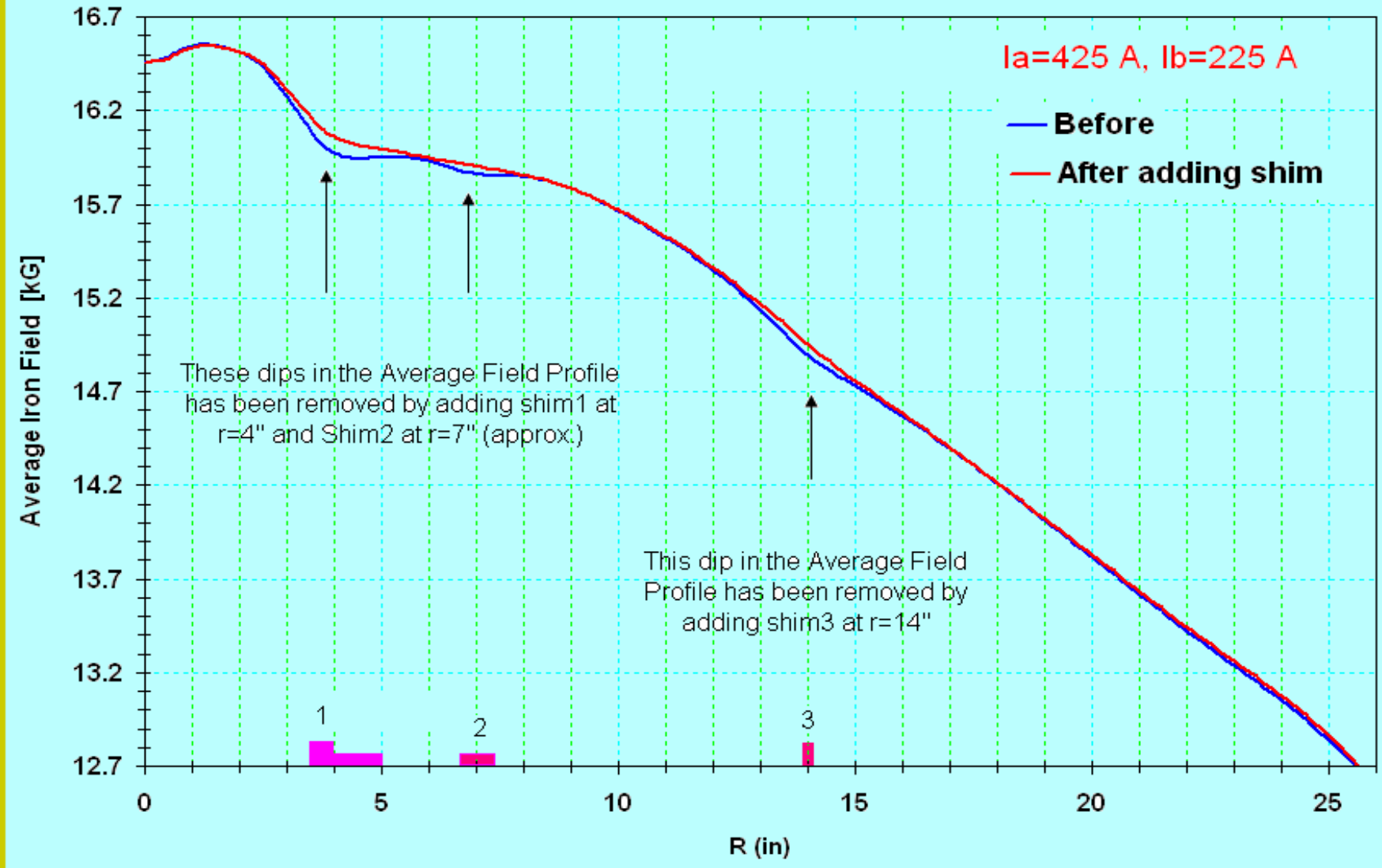
Magnetic Field Measurements and Analysis


Field Mapping Jig

1st Harmonic minimization



First Harmonic Minimization By Adding Iron Shims



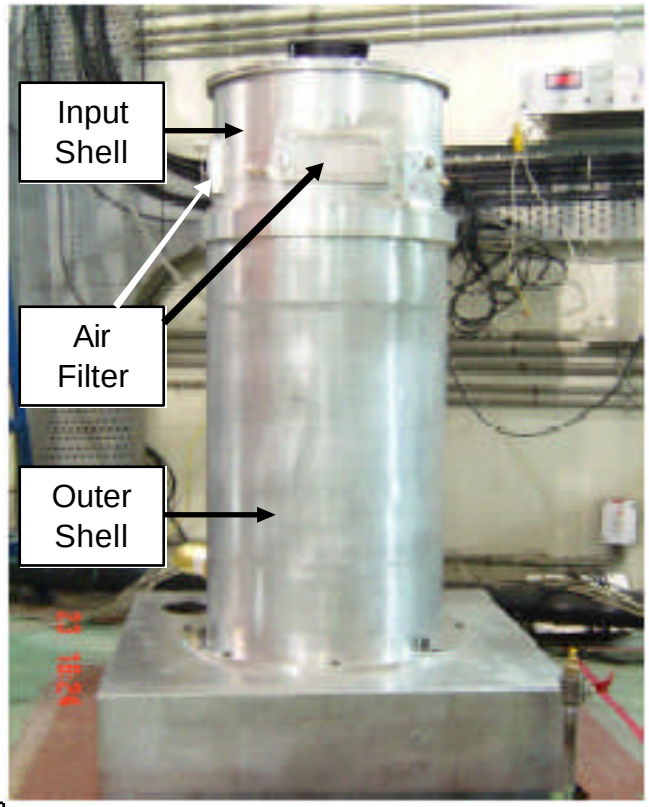
Shiming To Correct Average Field Profile

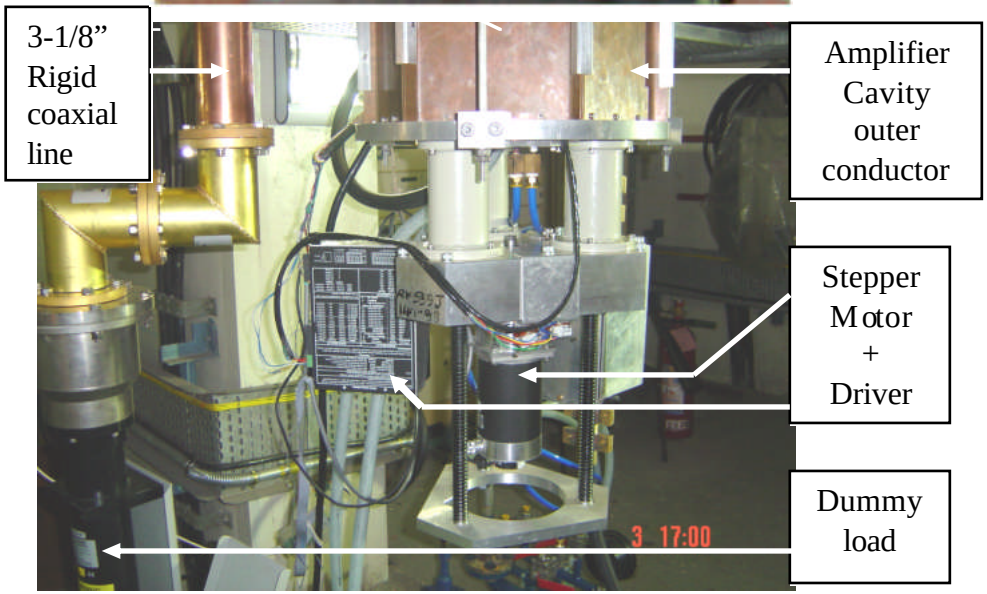
RF SYSTEM
&
RF POWER SUPPLIES

RF SYSTEM SPECIFICATION

- Frequency range: 9 to 27 MHz
- Harmonic Modes: 1,2,3,4,5,7
- Peak Dee Voltage: 100 kV
- Frequency Stability: 1×10^{-7}
- Amplitude Stability: 1×10^{-4}
- Phase Stability: $\pm 0.5^{o}$

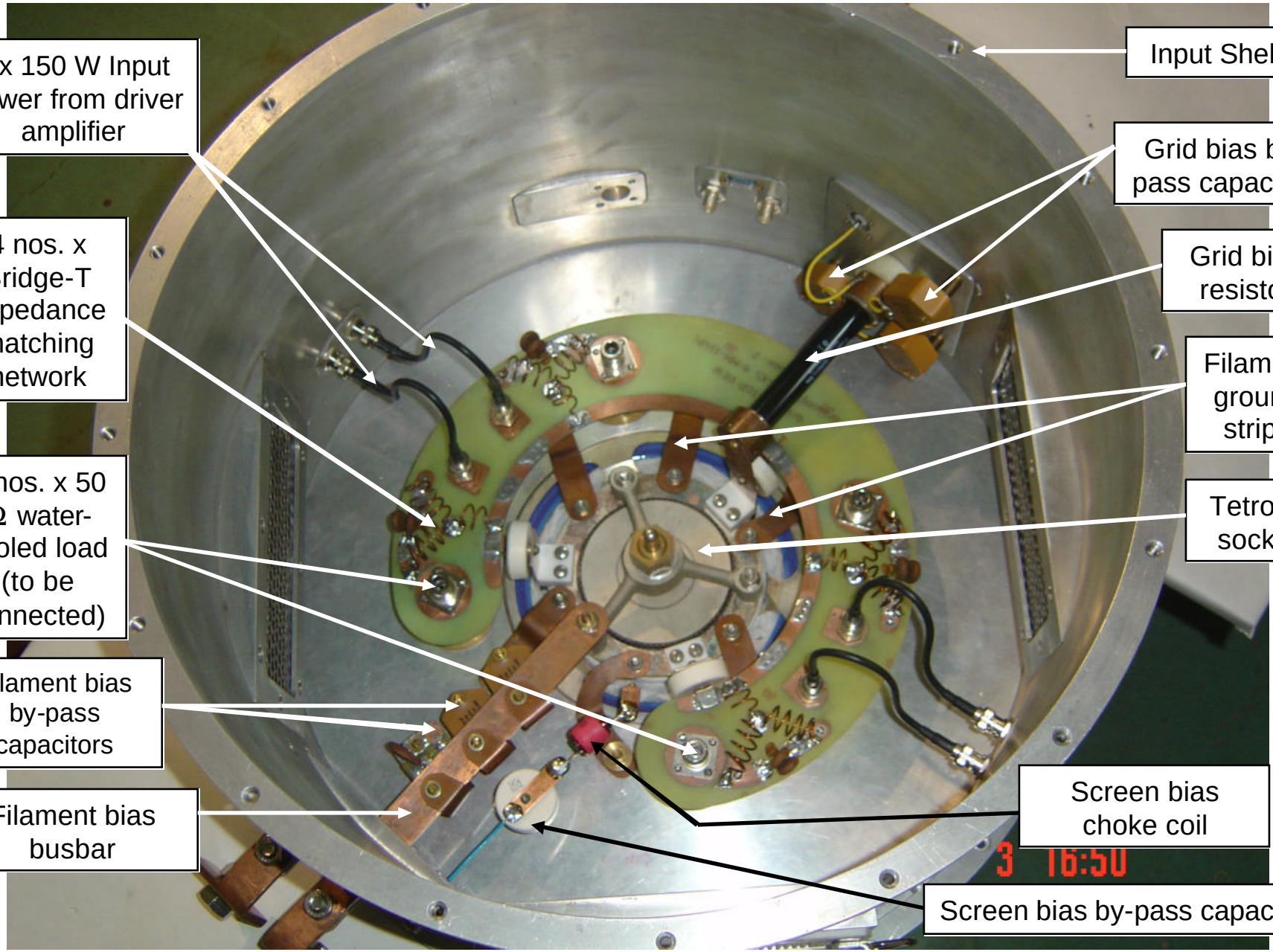
FINAL RF AMPLIFIER





- **Eimac 4CW 150000E Tetrode based power amplifier**
- **Output Power: 100 kW max. at 50 Ohm**
- **Power gain ~ 22 dB**
- **Input Power: 600 W at 50 Ohm**
- **Mode of operation: Class AB**
- **Ⅰ/4 Resonant cavity similar to main Dee-cavity**
- **Tunable from 9 MHz to 27 MHz by movable Sliding short**
- **Sliding short travel ~ 2184 mm. max.**
- **Precise movement of sliding short by PC-based stepper motor controlled system**

INPUT CIRCUIT FOR RF AMPLIFIER



RF Power Supplies Fabricated at VECC

250 KVA Transformer

Rectifier Bank Assembly

Anode Power Supply

(0 to 20KV DC, 22.5A, 7% load regulation, fast crowbar protection)

Filament Power Supply

(0 to 15.5 V ± 0.75 V DC, 215A at 15.5 V)

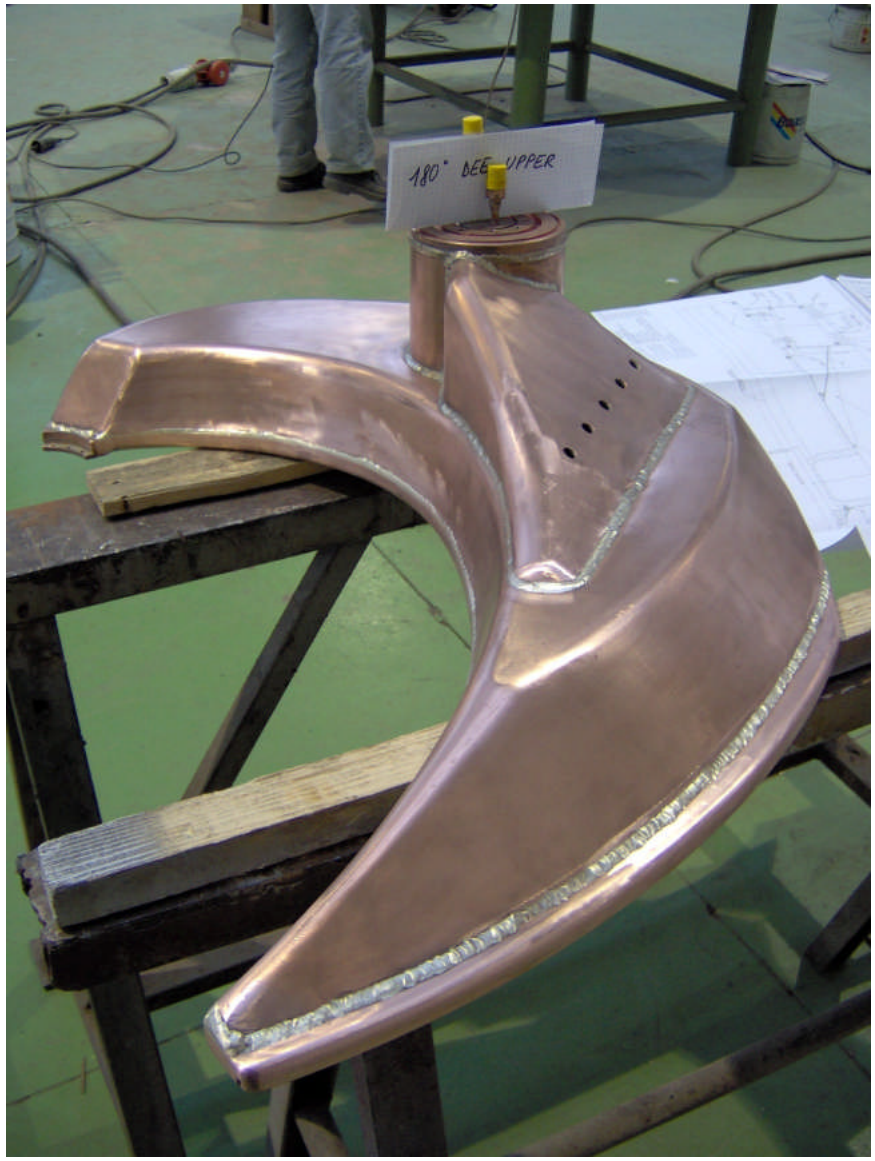
Control Grid Power Supply

(-400 to -500 V DC, 100 mA, 0.01% load regulation)

Screen Grid Power Supply

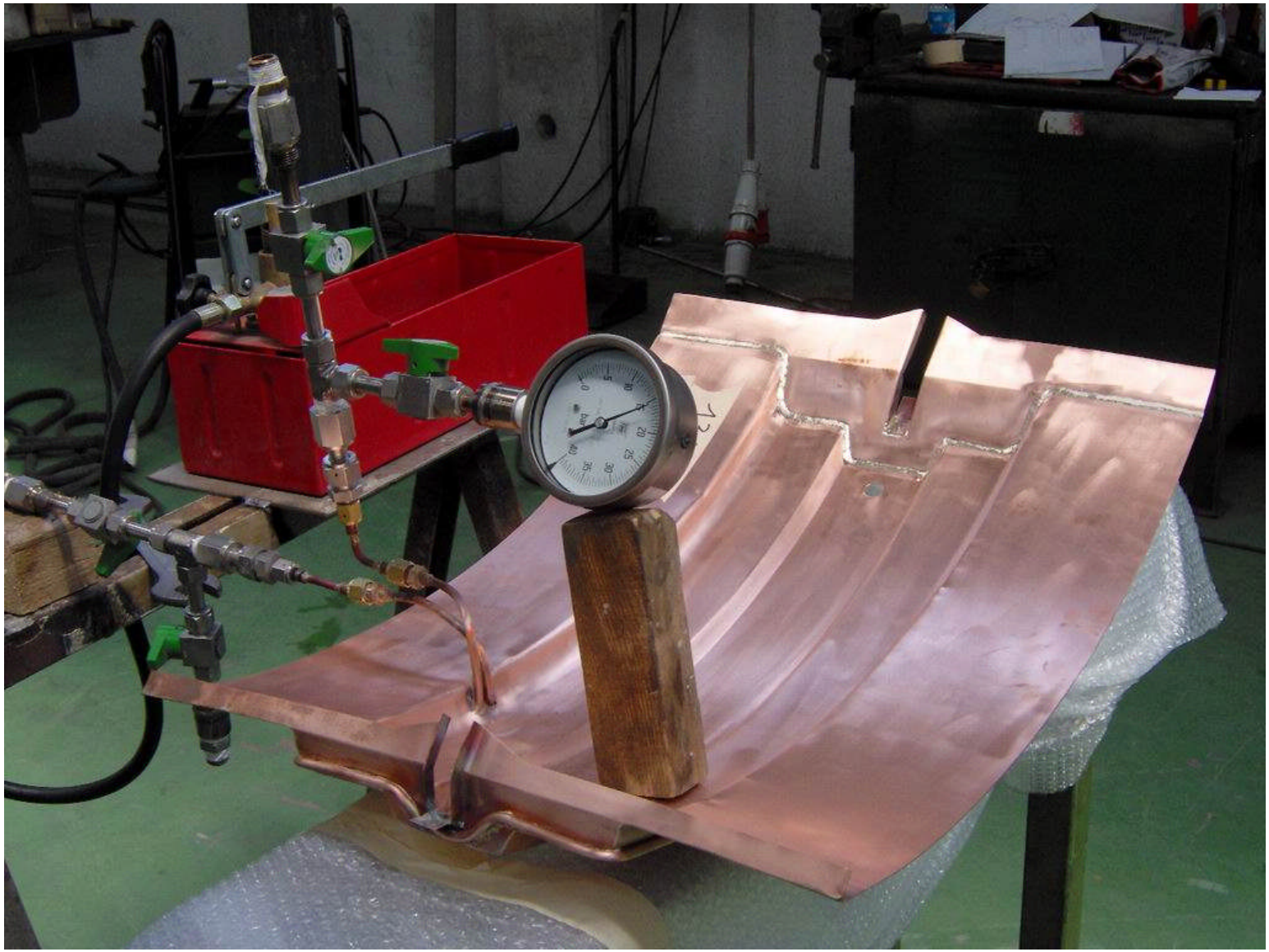
(500 to 1600 V DC, 0.5A, 0.006% load regulation)

RF SYSTEM
(Mechanical)

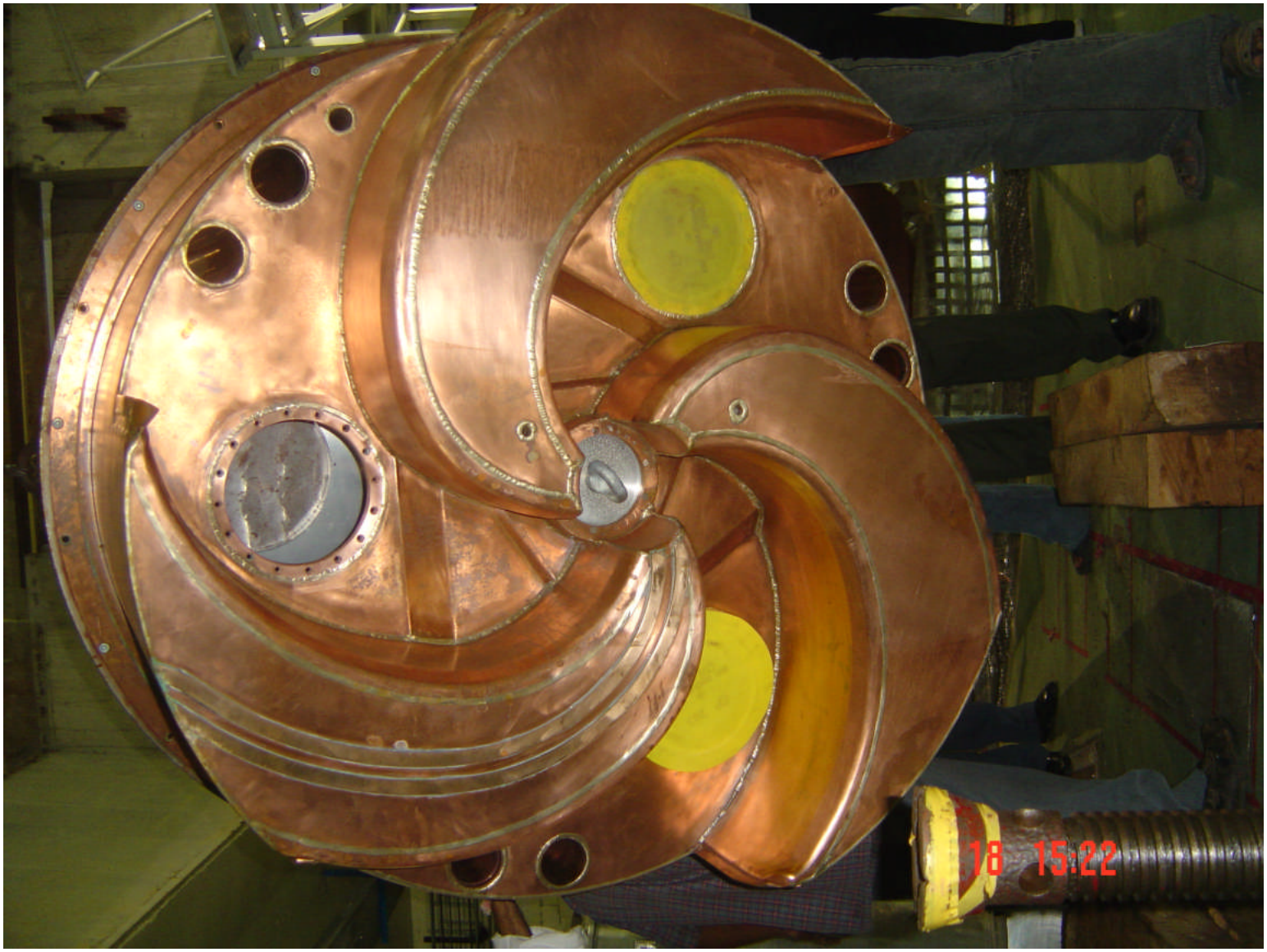


DEE

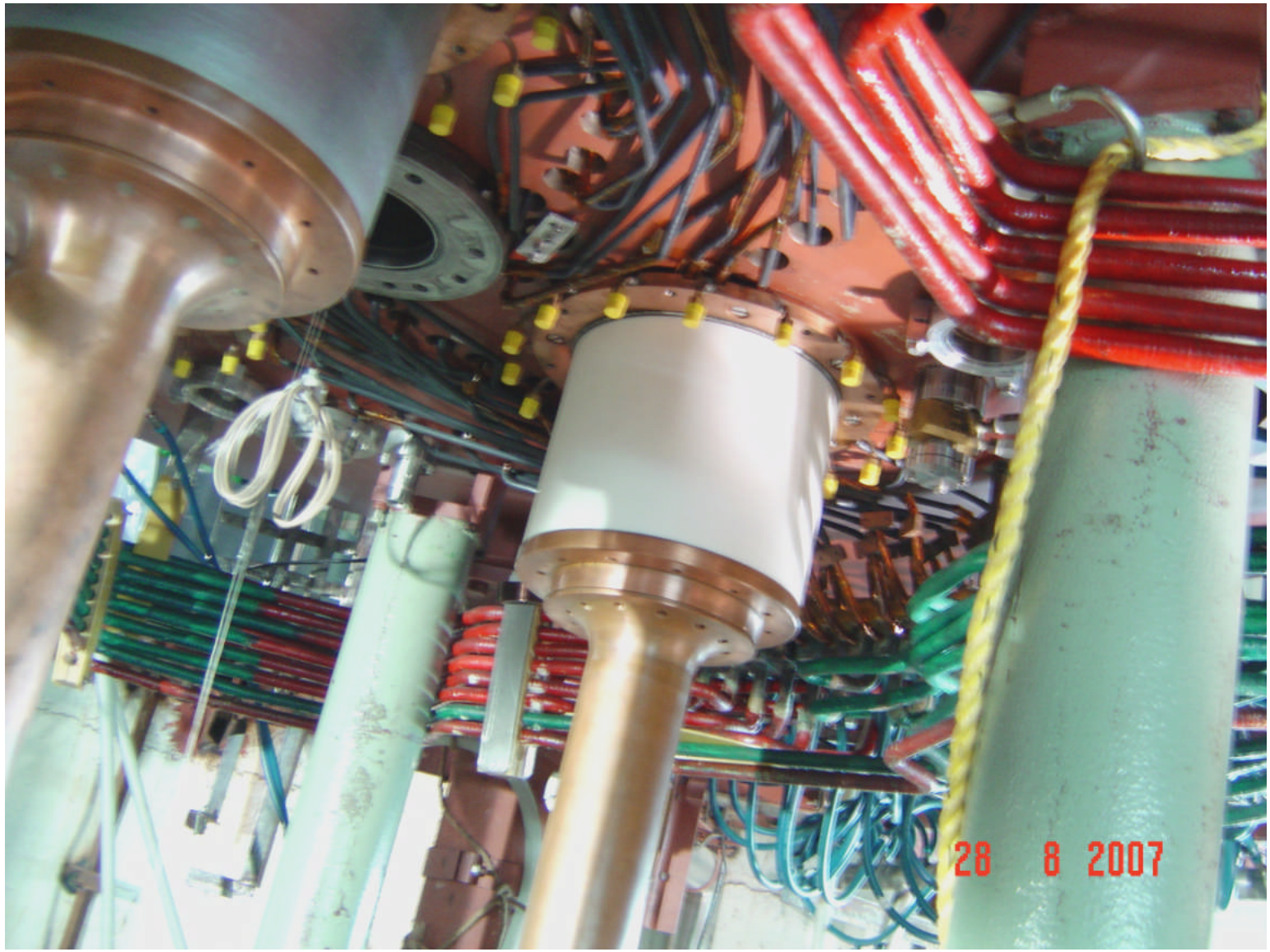
OUTER CONDUCTOR SPINNING



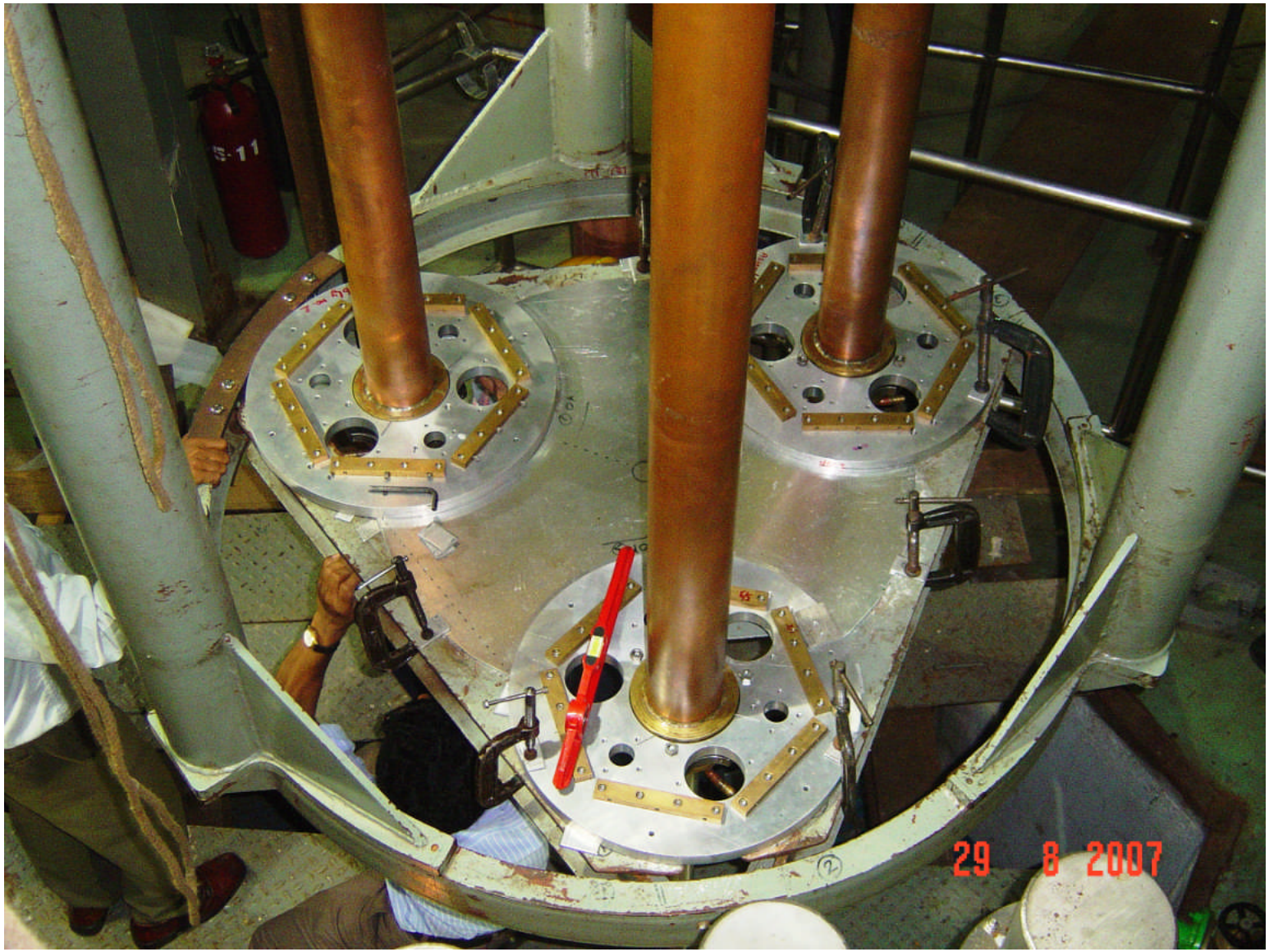
Hydro-test of coil tank liner cooling tubes



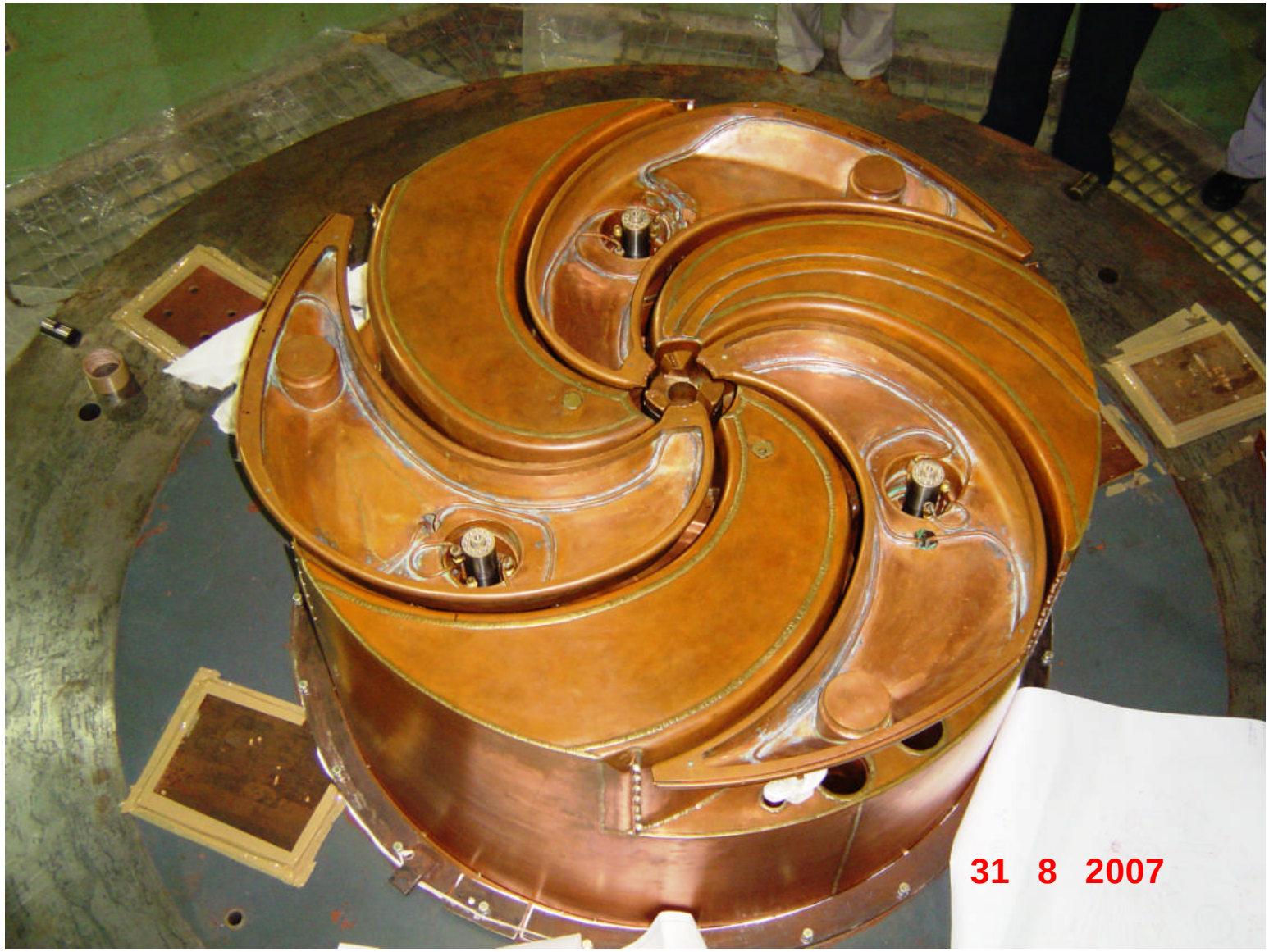
Lower RF Liner



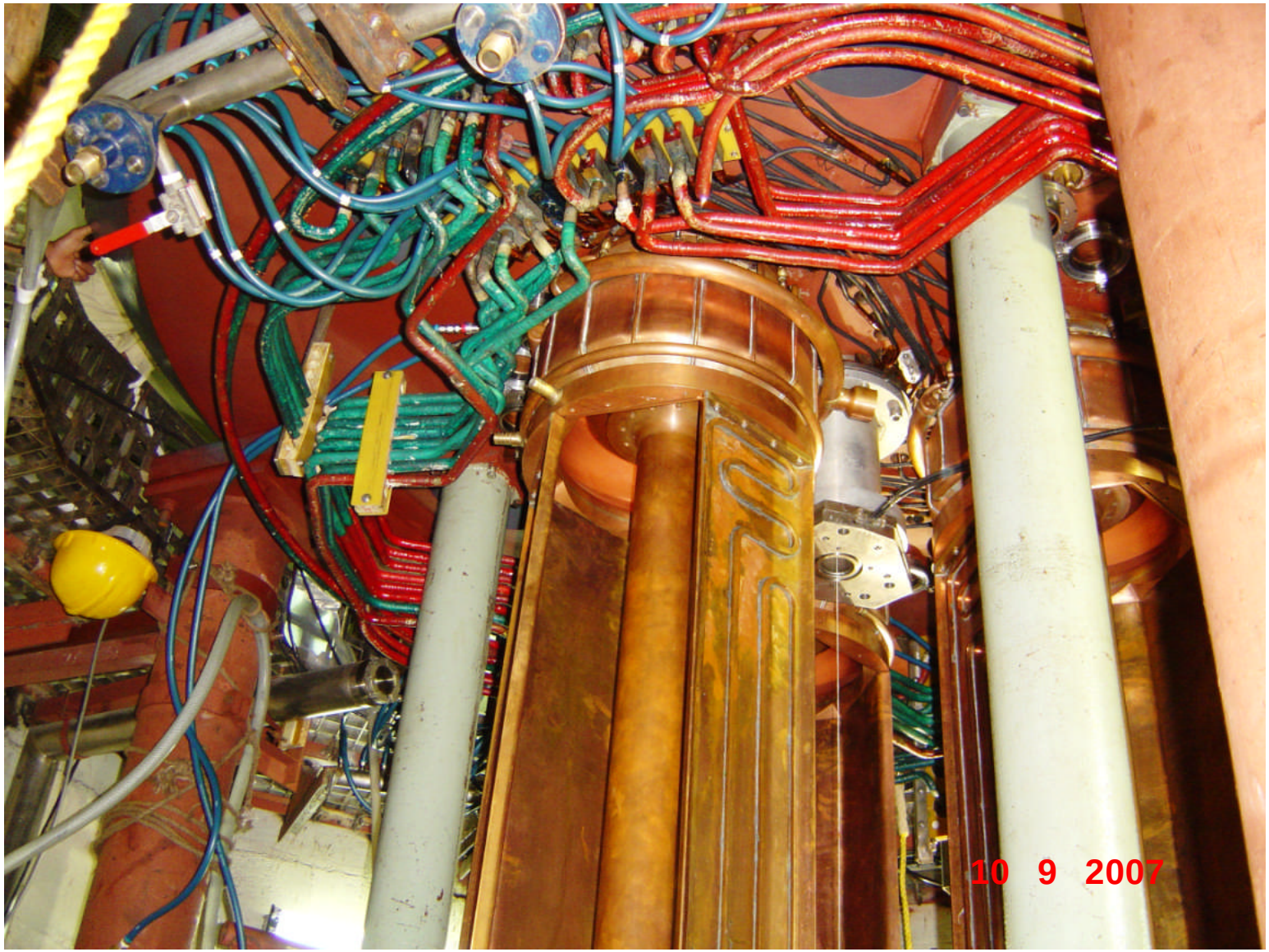
Installation of inner conductors below the magnet



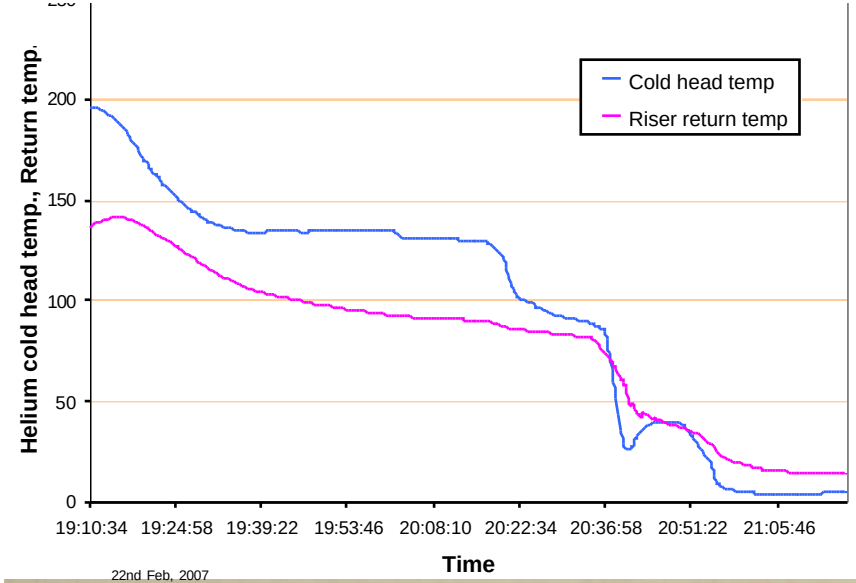
Three inner conductor assemblies on lower support structure

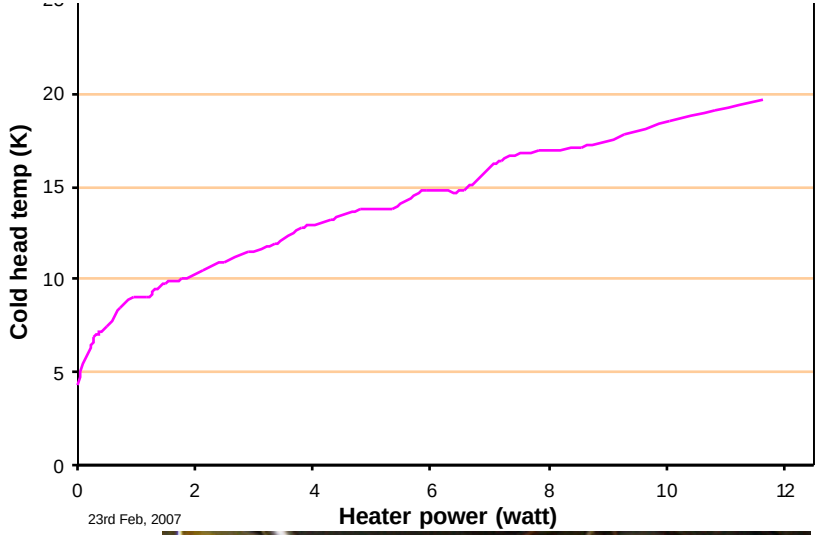


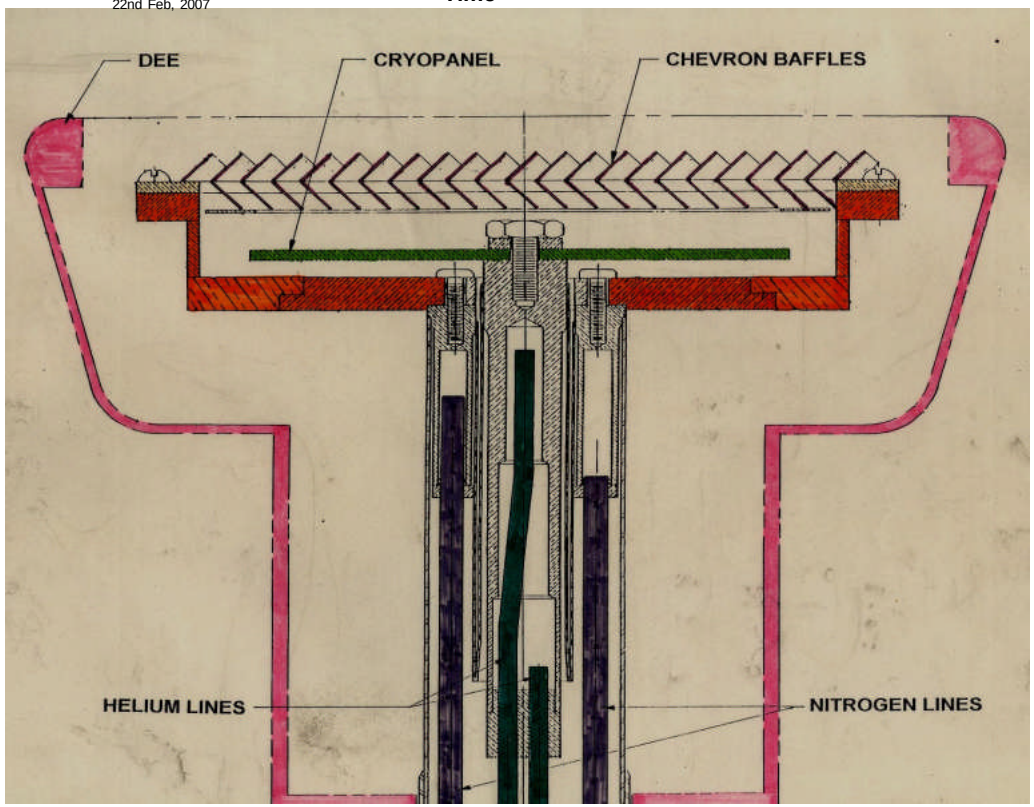
Dees with lower RF liner in position



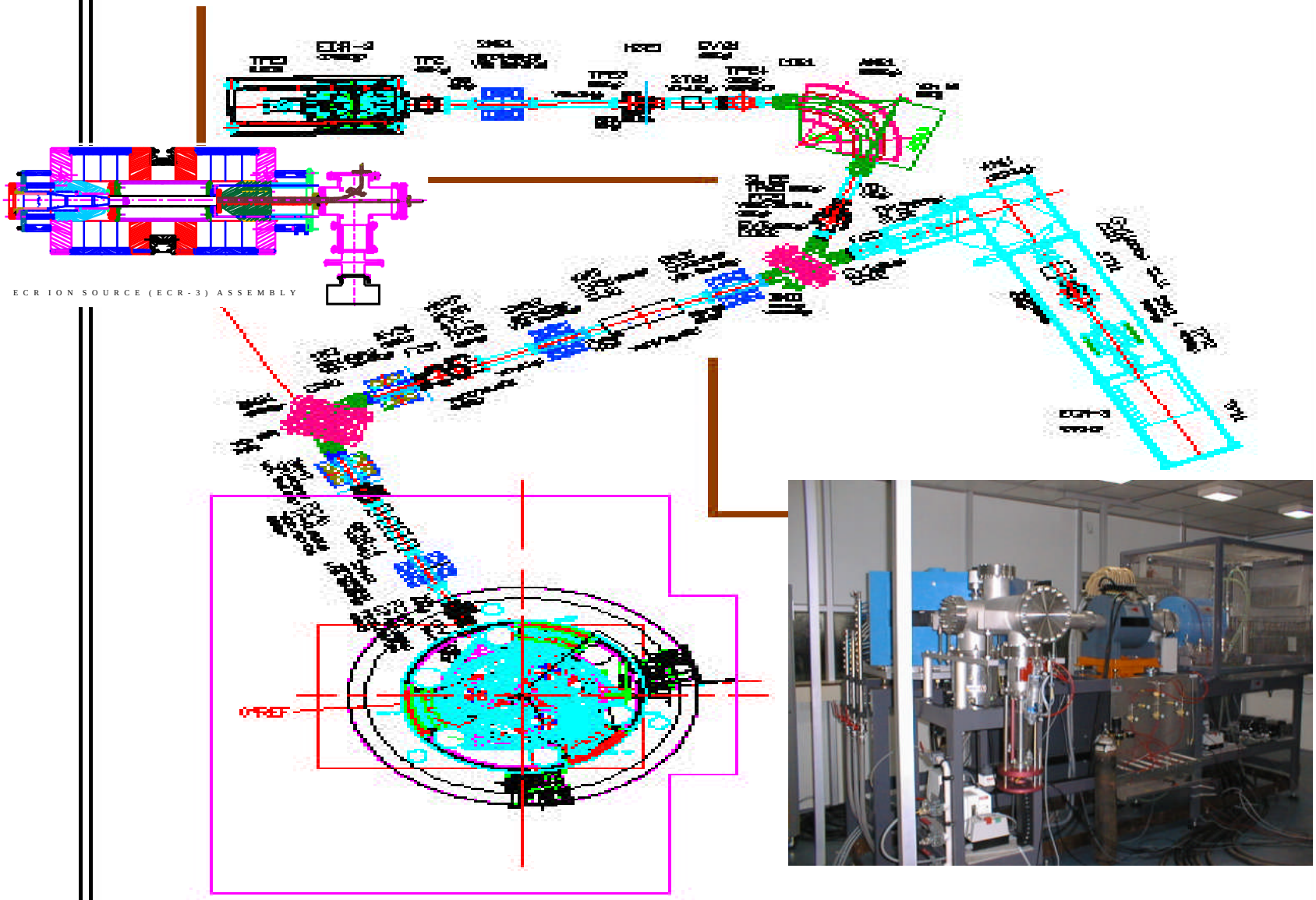
Lower outer conductor spinning assemblies


Helium cold head temp., Return temp.
200
150
100
50
0
Cold head temp
Riser return temp
19:10:34
19:24:58
19:39:22
19:53:46
20:08:10
20:22:34
20:36:58
20:51:22
21:05:46
Time
22nd Feb, 2007


Cold head temp (K)
20
15
10
5
0
0
2
4
6
8
10
12
Heater power (watt)
23rd Feb, 2007


DEE
CRYOPANEL
CHEVRON BAFFLES
HELIUM LINES
NITROGEN LINES

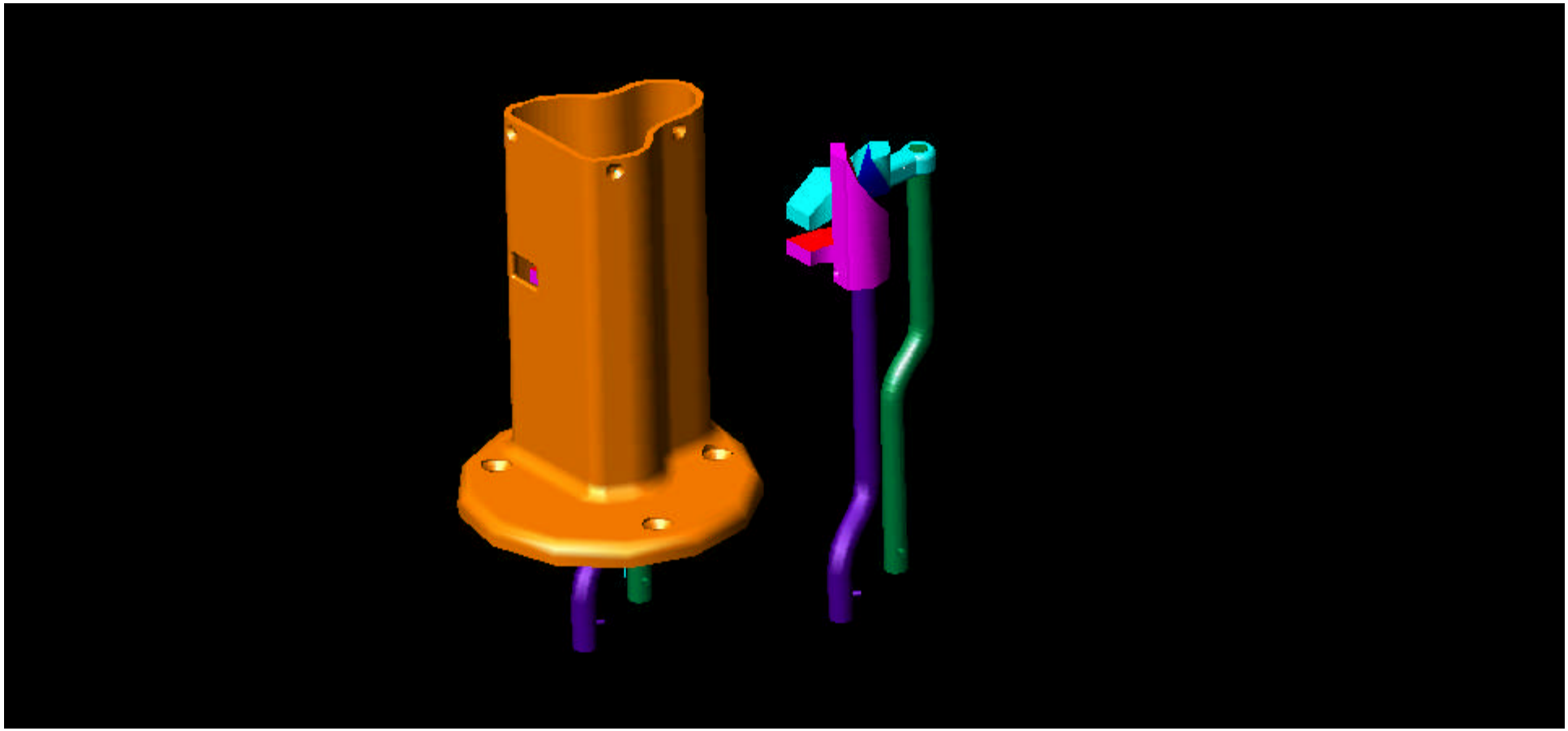

Basement manifold
for circulation of LHe and
LN2
to cryopanels



LAYOUT OF HORIZONTAL SECTION OF INJECTION LINE FOR VEC K-500 SUPERCONDUCTING CYCLOTRON

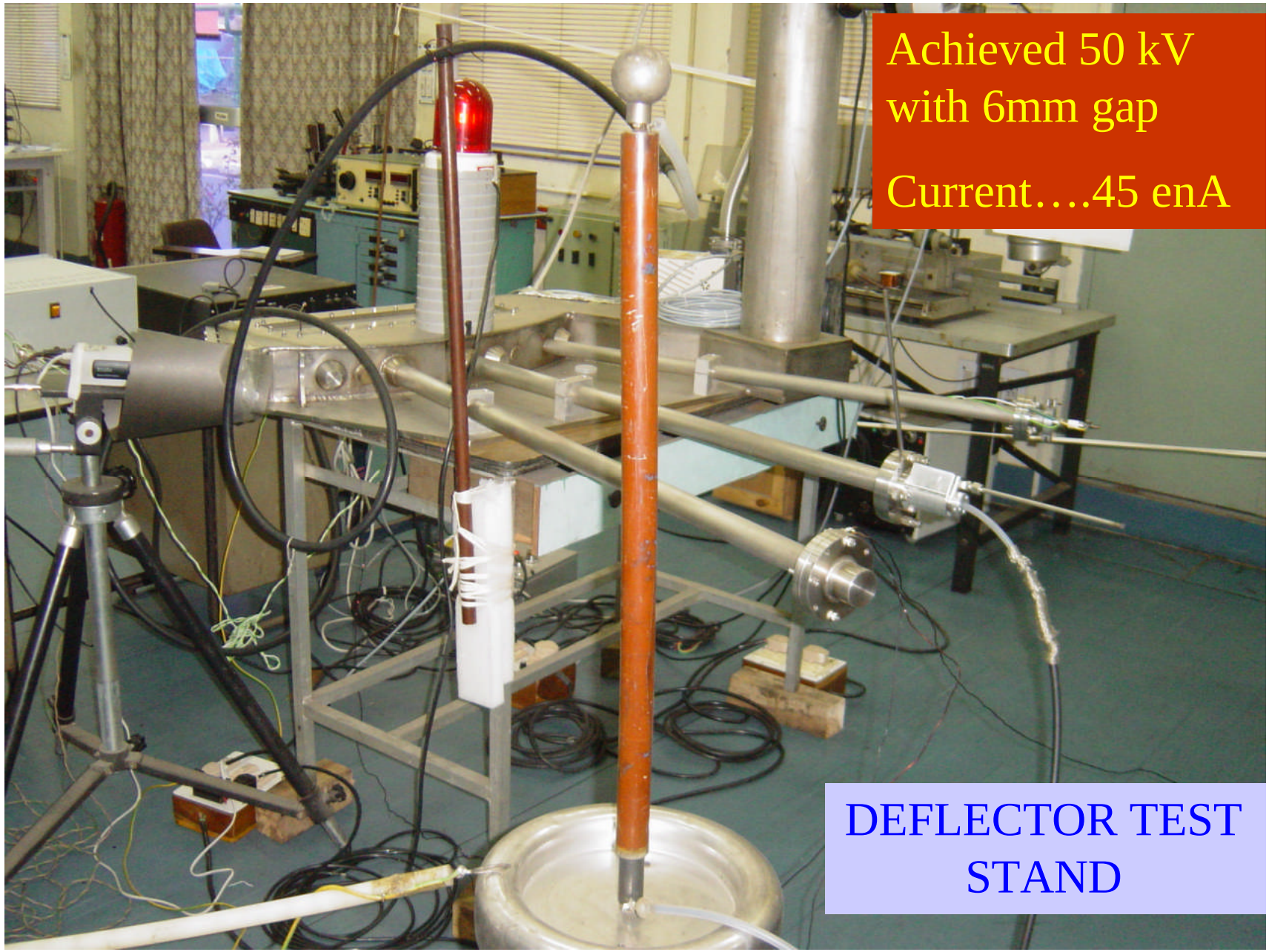
14 GHz ECR ION SOURCE

SPIRAL INFLECTOR

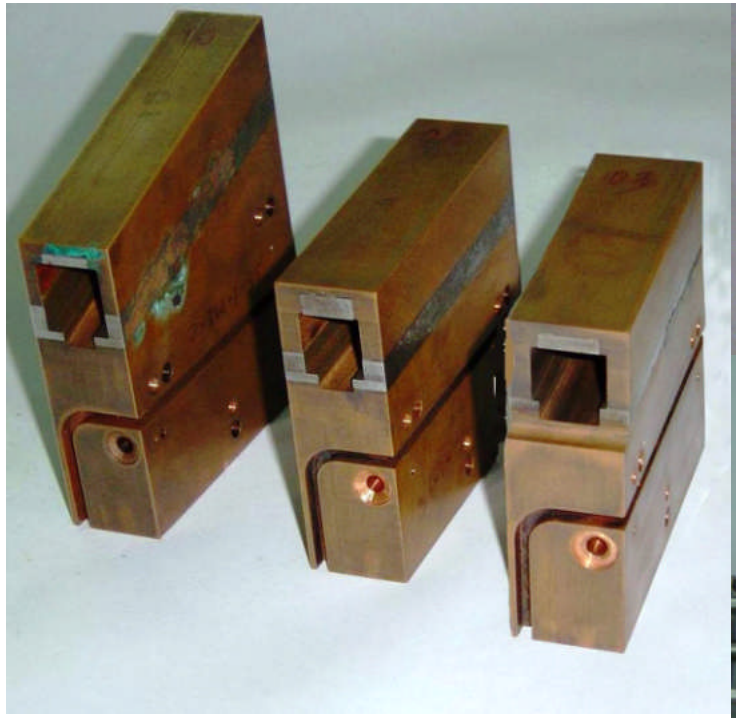


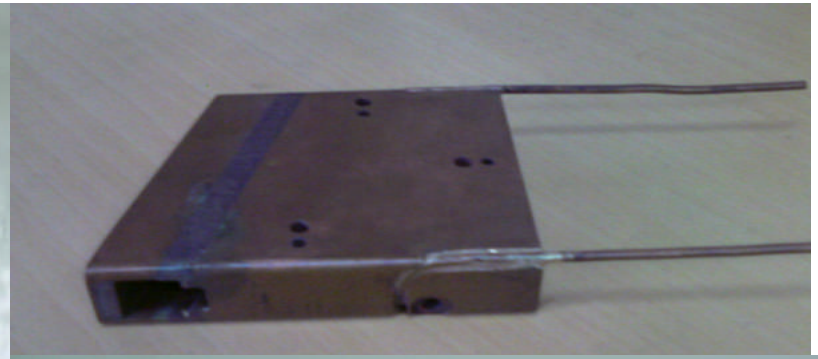
Fabrication work at Central Workshop/NFTDC

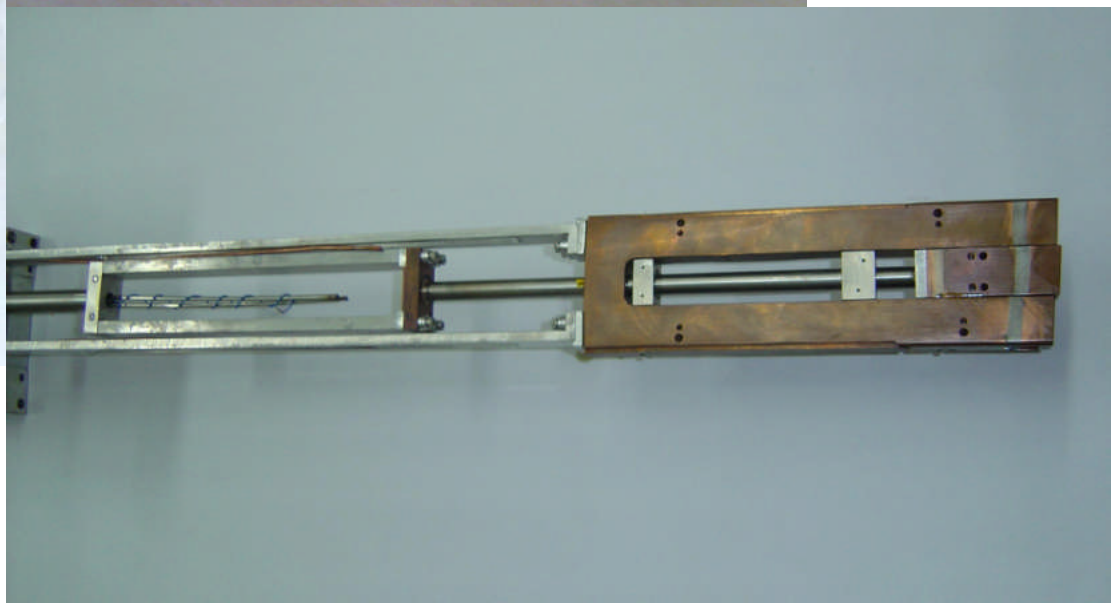
Delivery in June


Achieved 50 kV
with 6mm gap
Current….45 enA
DEFLECTOR TEST
STAND

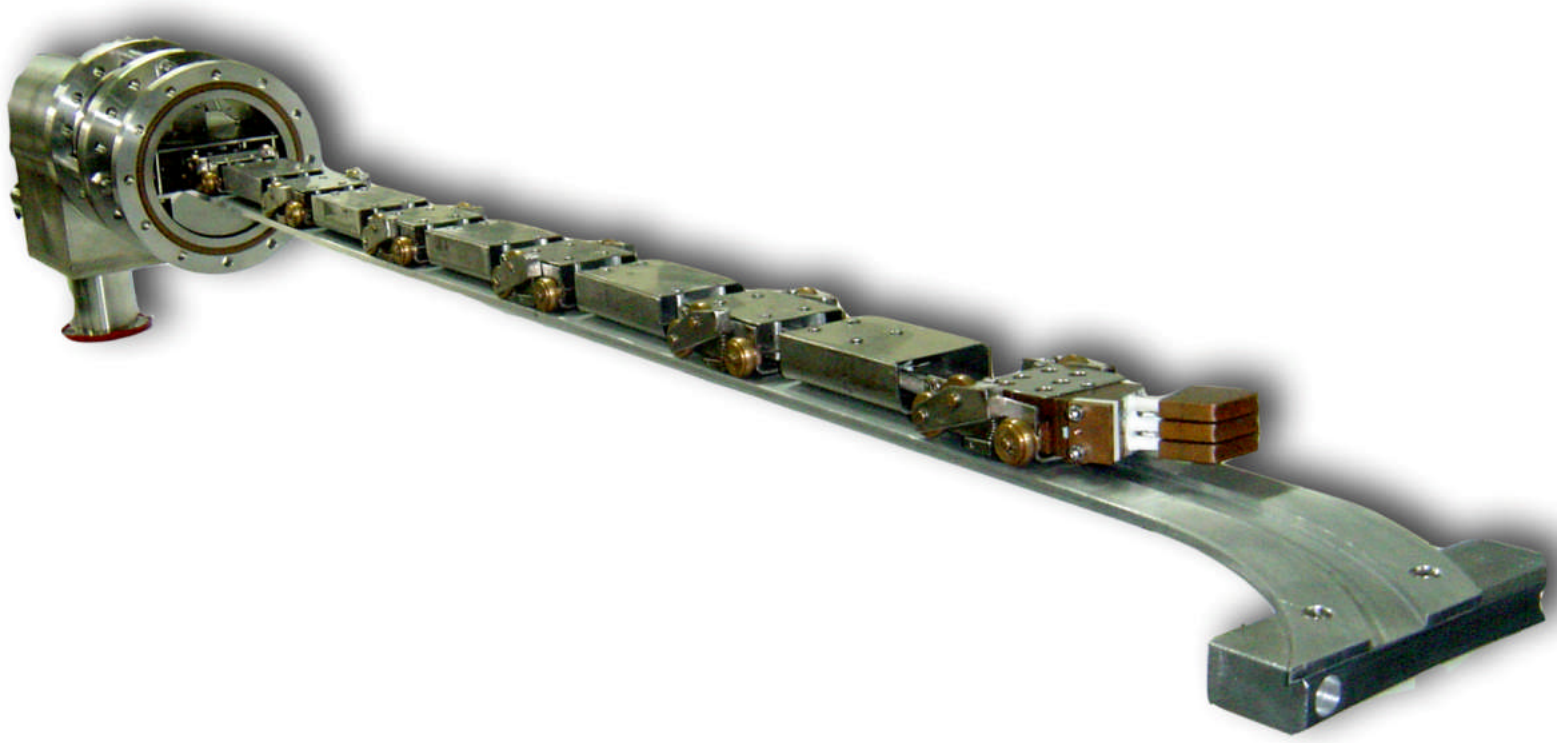
Passive magnetic channels



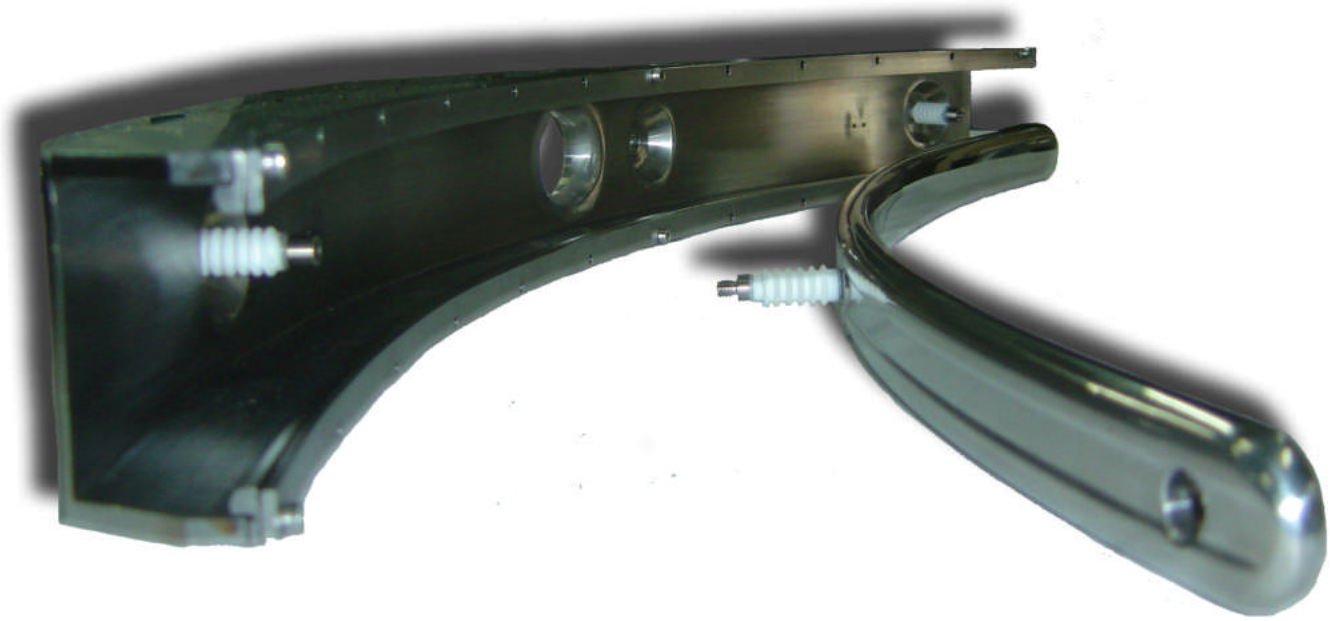




Beam Diagnostic Probe



Electrostatic Deflector

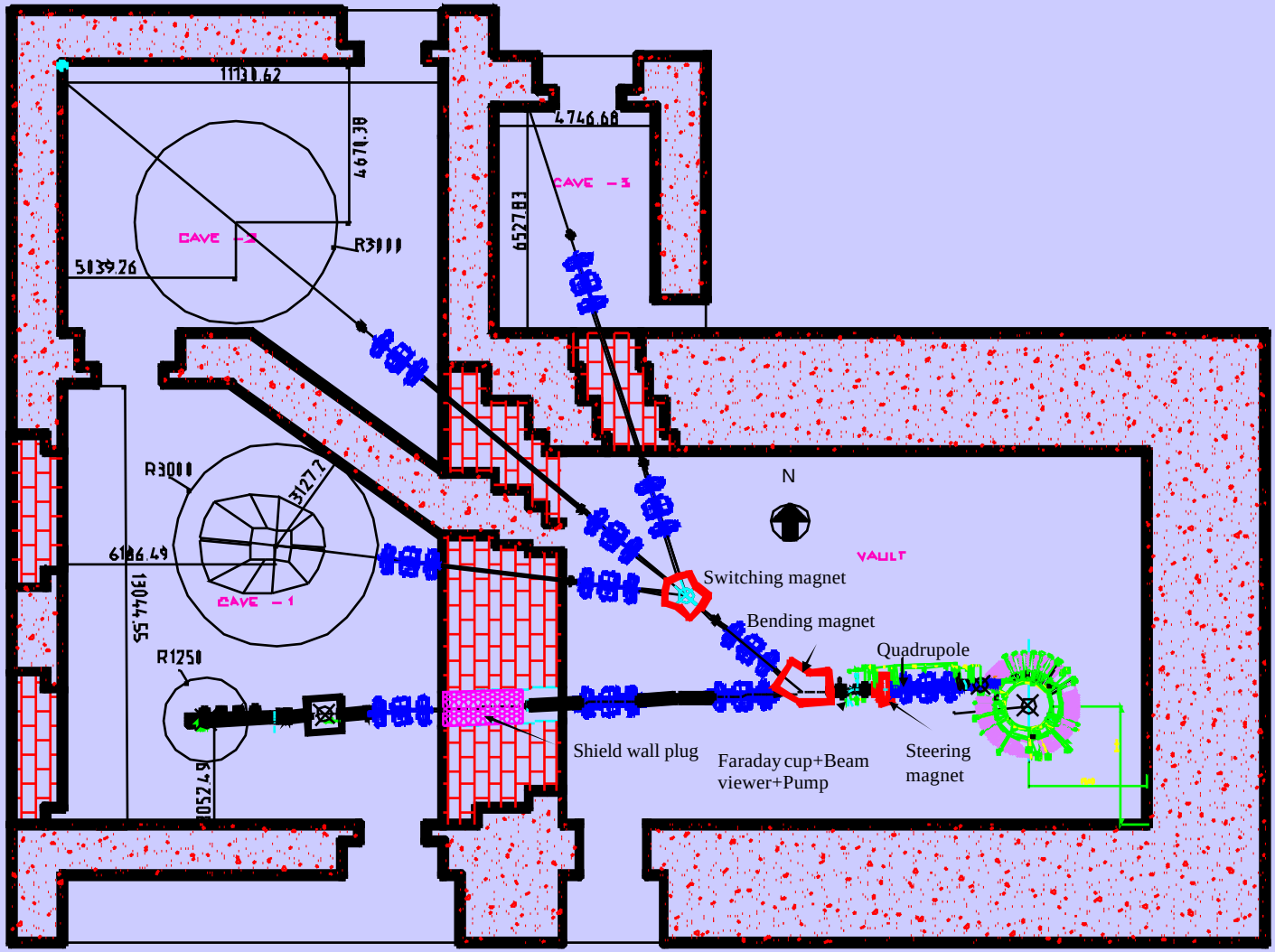


TRIM COIL WATER TEMPERATURE CONTROL SYSTEM

- **Redundant standalone controller architecture along with redundant temperature sensors**
- **Maintain temperature difference *within ±0.5°C* between pole tips and magnet yoke**
- **Minimise relative thermal expansion or contraction of pole tips with respect to magnet yoke of Superconducting Cyclotron**
- **Control conductivity by feed-bleed mechanism with main LCW system**

Utilization of the superconducting Cyclotron

K500 SUPERCONDUCTING CYCLOTRON
EXTERNAL BEAMLINE LAYOUT



Major Facilities

Nuclear Physics

- **Scattering Chamber**
- **Charged Particle Detector Array**
- **Neutron Detector Array**
- **High Energy Gamma Ray Array**
- **Ion Trap**

Condensed Matter

- X-ray Diffractometer
- Acoustic emission setup
- Vibrating sample magnetometer

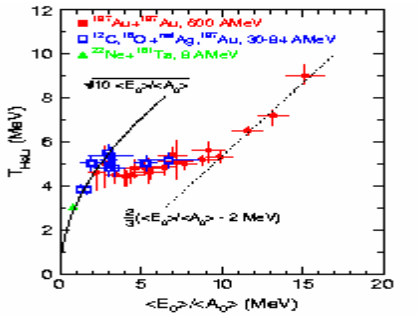
Nuclear Chemistry

- Activation analysis
- Pneumatic carrier facility
- Multitracer studies

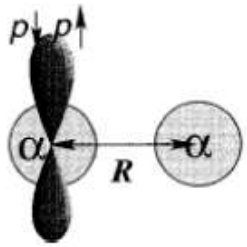
Nuclear Physics with superconducting cyclotron

Physics Goals :

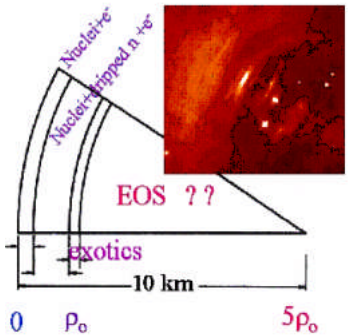
Liq. – gas Phase transition



Exotic Nuclear structures



Evolution of neutron star, supernovae



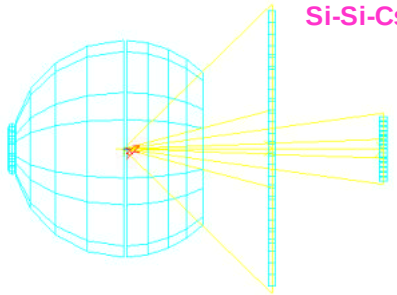
- Temperature
- Thermalisation
- Dynamics
- Deformation
- EOS
- Nuclear Compressibility
- Asymmetric Nuclear matter And Stellar Evolution
- Super Heavy Nuclei

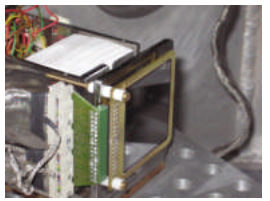
Facilities

Charged particle detector array

Back-ward Array
Si-CsI(Tl)

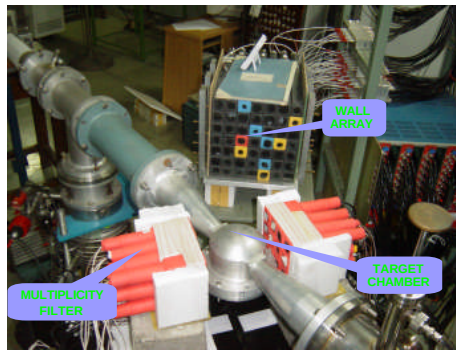
Forward Array
Si-Si-CsI(Tl)



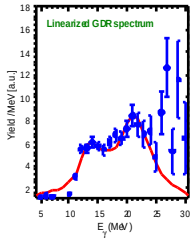


Prototype Si-Si-CsI(Tl) array

High energy gamma ray detector array

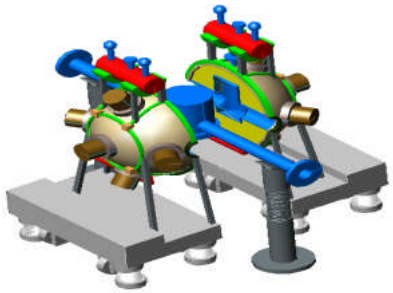


Gamma array at Exptl hall

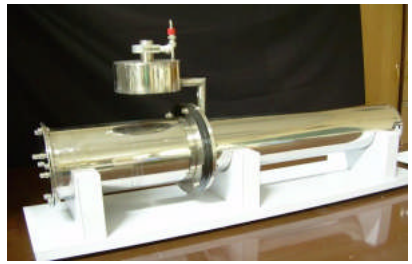


Deformed configuration of 32S* Studied by GDR splitting

Neutron Multiplicity detector



4p neutron multiplicity detector



Prototype neutron detector

Commissioning: March – April 2008