The Experimental Research of Cyclotron DC-280 Beam Parameters

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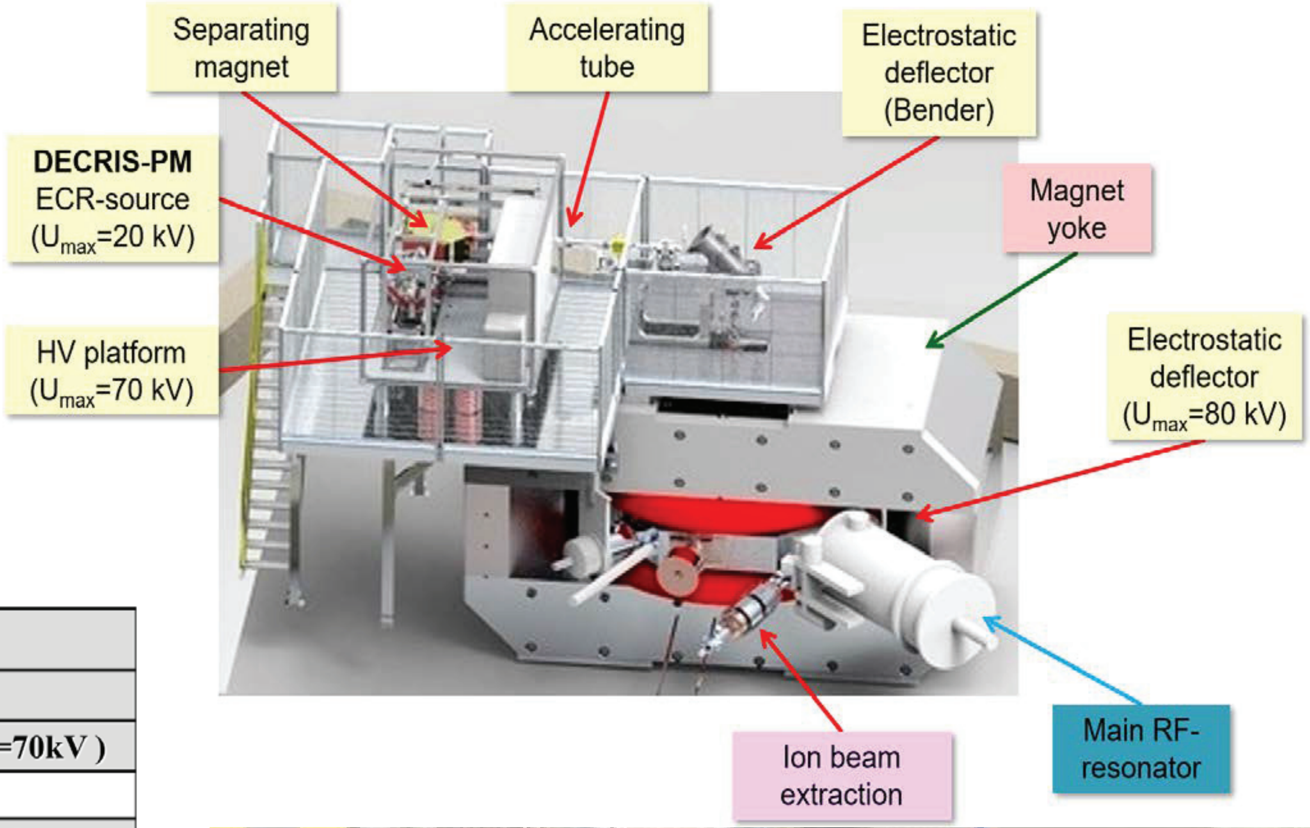
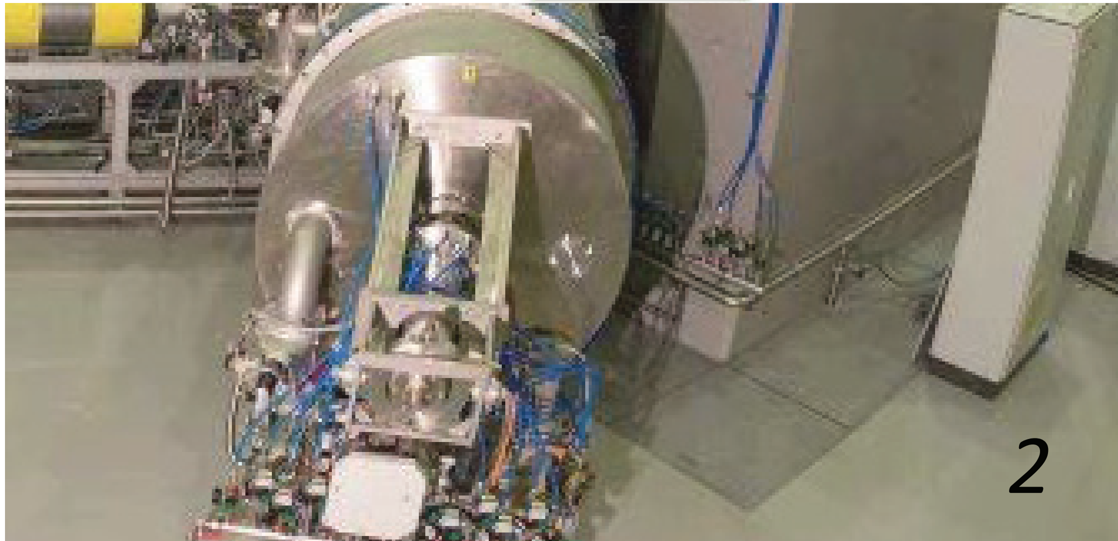
Cyclotron DC-280

Configuration of the DC-280

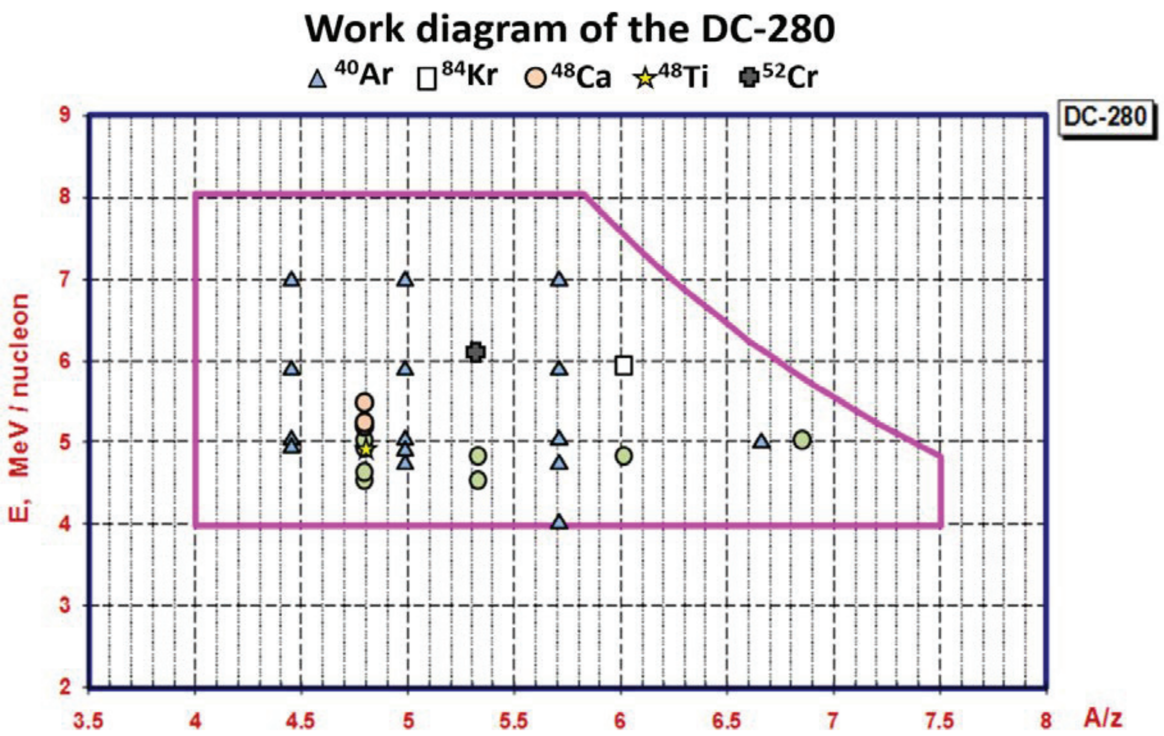


Main parameters of the DC-280

parameters	design	realized
Power consumption	700 kW (Main magnet - 350 kW)	
Ion source	DECRIS-PM - 14 GHz on the HV platform (U_{max}=70kV)	
Injecting beam potential	Up to 80 keV/Z	38,04 – 72,89 keV/Z
A/Z	4÷7.5	4,44 ($^{40}Ar^{+7}$) – 6,86 ($^{48}Ca^{+7}$)
Energy	4÷8 MeV/n	4,01 – 7 MeV/n
Ion (for DECRIS-PM)	4-136	12 ($^{12}C^{+2}$) – 84 ($^{84}Kr^{+14}$)
Intensity (A~50)	>10 pμA	10,4 pμA ($^{40}Ar^{+7}$), 7,1 pμA ($^{48}Ca^{+10}$)
Magnetic field level	0.6÷1.3 T	0.8÷1.23 T
K factor	280	
Dee voltage	2x130 kV	130 kV
Power of RF generator	2x30 kW	
Flat-top dee voltage	2x13 kV	---
Power of Flat-top generator	2x2 kW	
Emittance	less than 30 π mm·mrad	
Accelerator effectivity	>50%	51,9 % ($^{48}Ca^{+10}$ 5 MeV/n 5 pmkA)



Year	Total work time	Ions
2018	First Beam	^{84}Kr
2019	3377	^{12}C, ^{40}Ar, ^{48}Ca, ^{84}Kr
2020	3705	^{40}Ar, ^{48}Ca, ^{48}Ti
2021	3794	^{48}Ca, ^{48}Ti, ^{52}Cr



Efficiency of acceleration in cyclotron DC-280

Ion	Energy (MeV)	Intensity (puA)					Efficiency (%)				
		axial injection		cyclotron		Transport Channel					
		After separation	vertical part	r=400	r=1770		Axial injection	capture	Cyclotron	Extraction	Total
$^{40}Ar^{+7}$	195	28,7	24,7	17,1	14,2	10,4	86%	69%	83%	73%	36%
$^{48}Ca^{+7}$	240	10,9	9,8	6,9	6,1	5,2	90%	71%	88%	85%	48%
$^{48}Ca^{+10}$	240	9	8,07	5,58	5,1	4,7	90%	69%	91%	91%	51%
$^{48}Ca^{+10}$	240	23	19	12,8	10,6	7,1	82%	67%	83%	67%	31%
$^{48}Ti^{+10}$	244	2,0	1,9	1,4	1,25	1,0	92%	72%	92%	83%	50%
$^{52}Cr^{+10}$	320	5,8	5,1	3,3	3,1	2,4	89%	64%	93%	78%	41%
$^{84}Kr^{+14}$	496	3,1	2,8	1,7	1,6	1,4	91%	60%	93%	92%	47%

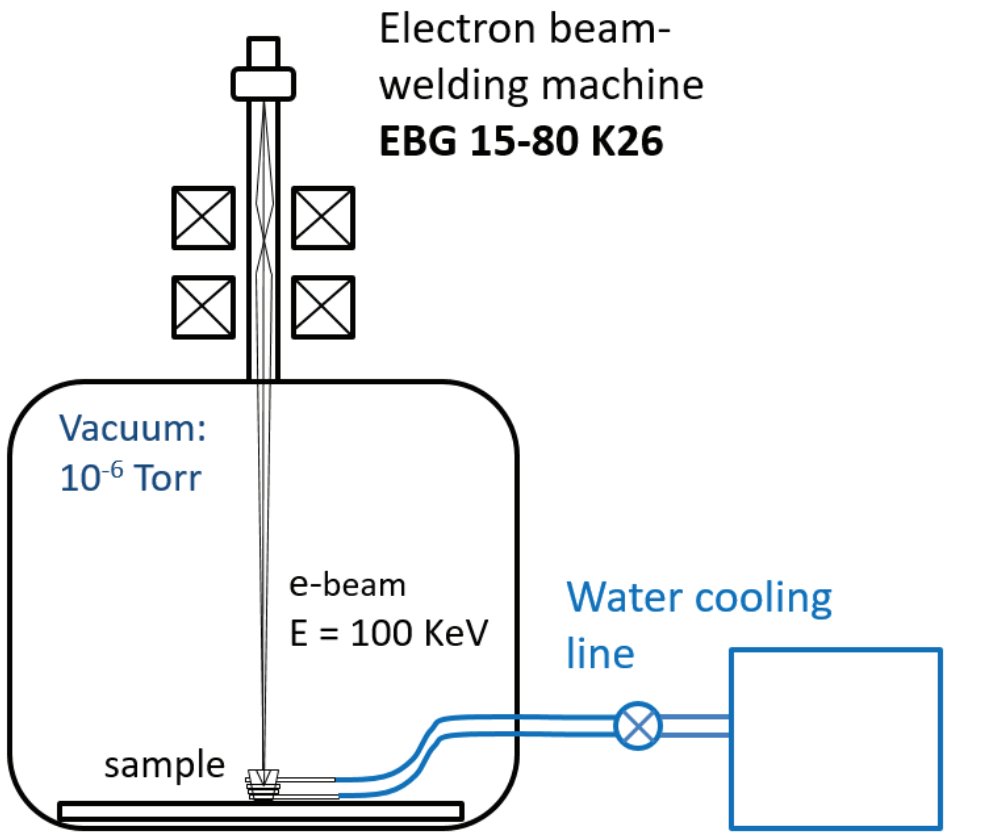
The test of thermal loads resistance

the diagnostic and safety elements of the DC-280.

Accelerated Ion beam power is 3,5 kW

List of tested elements:

- The Faraday cup
- The Aperture diaphragm
- The Protect window

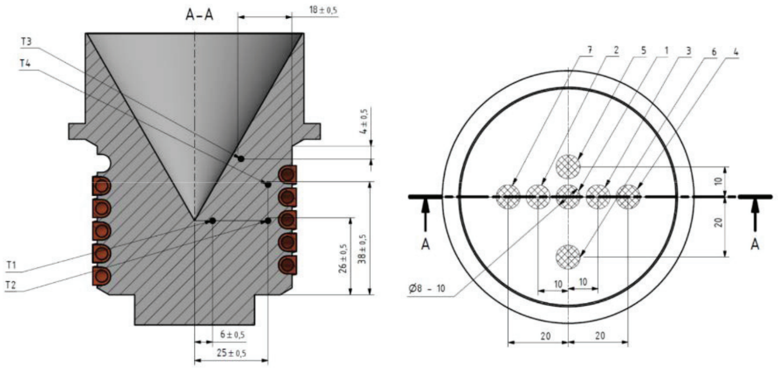


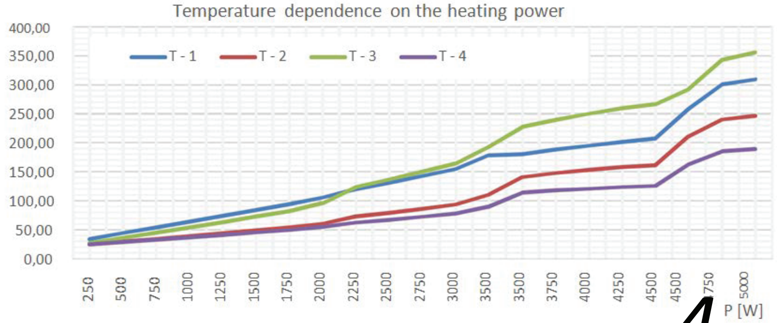
scheme of testing bench

Test of Faraday cup

Faraday cup after testing

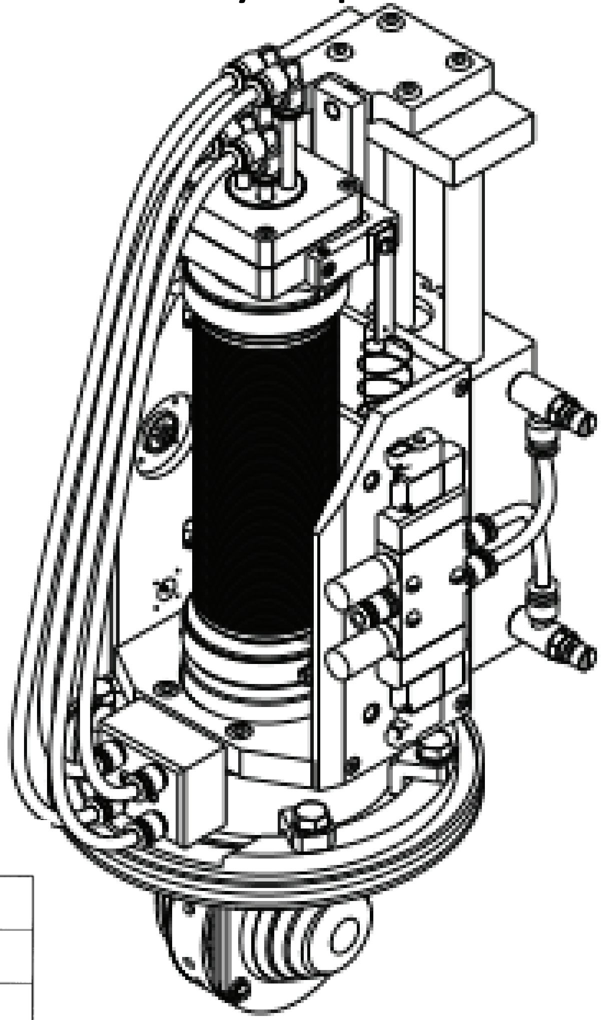
Scheme of thermo-control placing



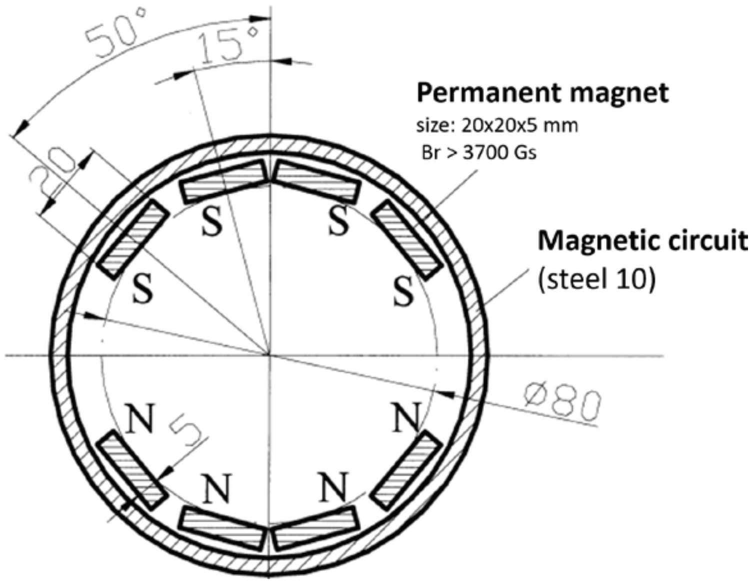


Ion beam current. Faraday Cup

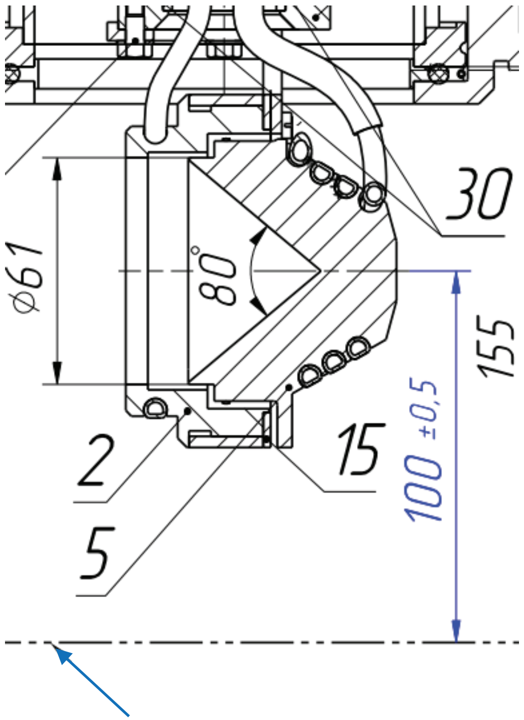
Faraday cup view



Scheme of formation of magnetic field

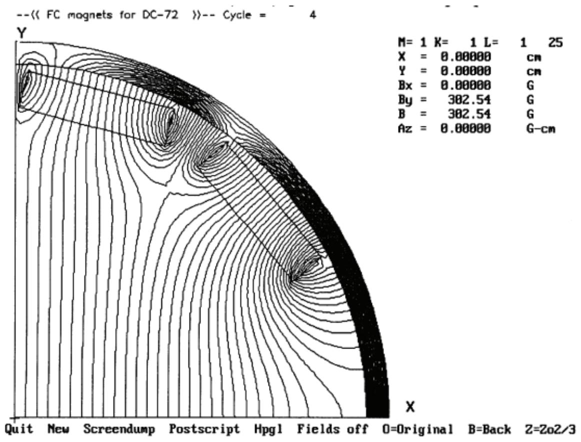


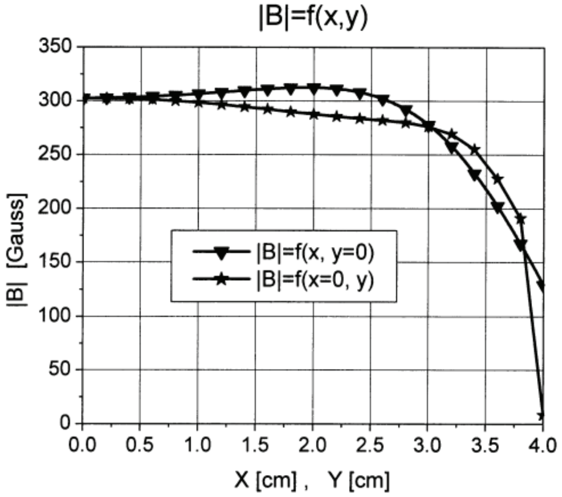
Schema of Faraday cup head



Centre of a beam line

Map of magnetic field in Faraday cup





Analysis of production ions beam from ECR source.

48Ca10+, 40Ca8+, 14N3+

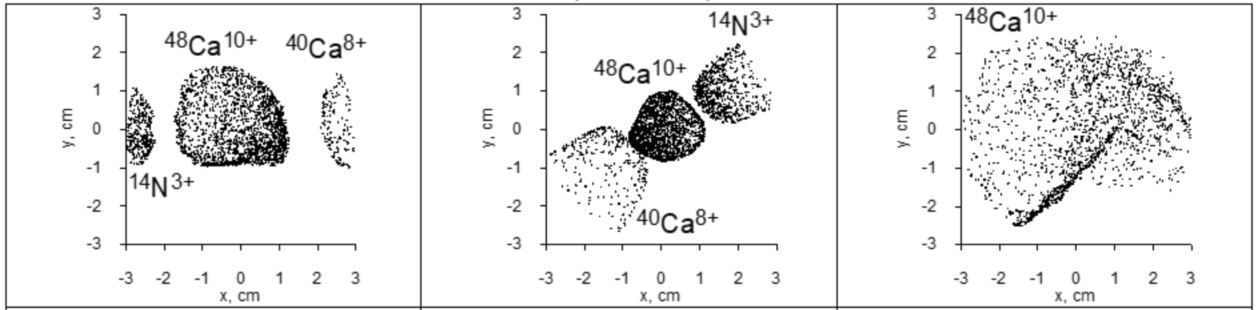
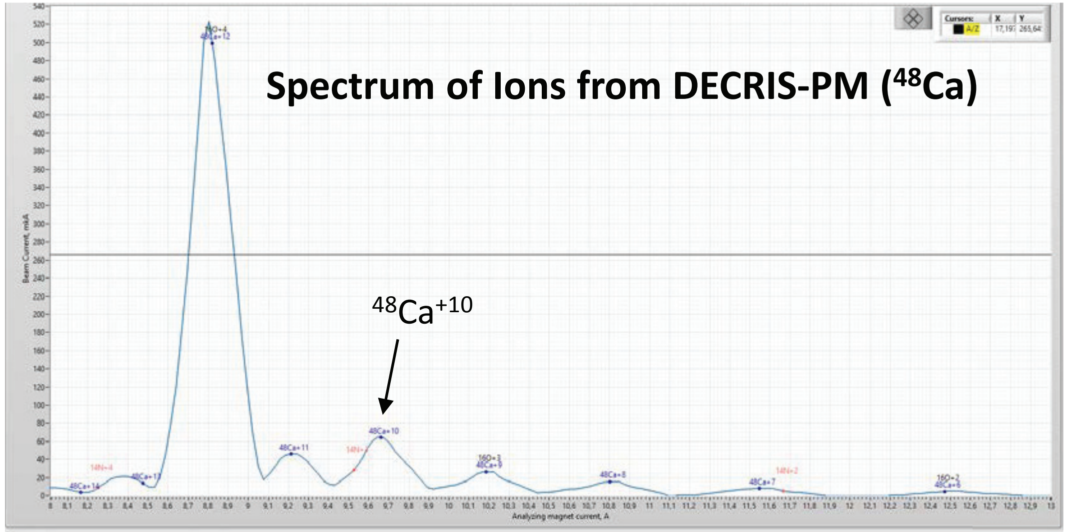
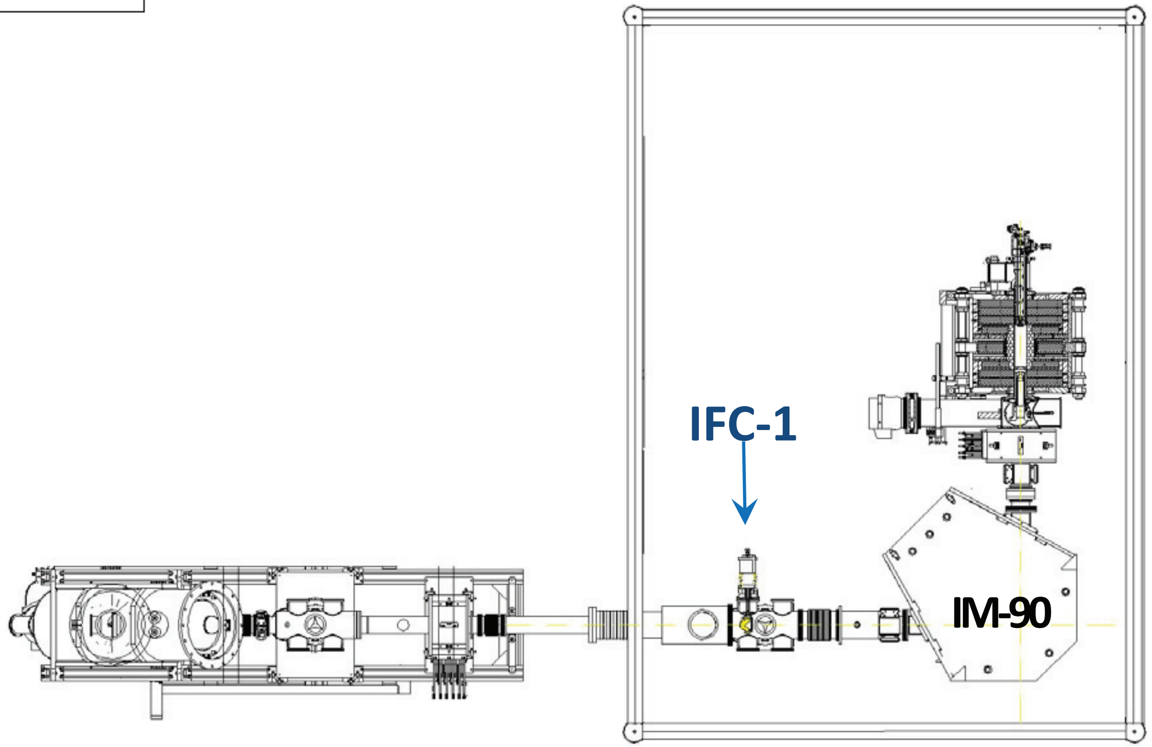
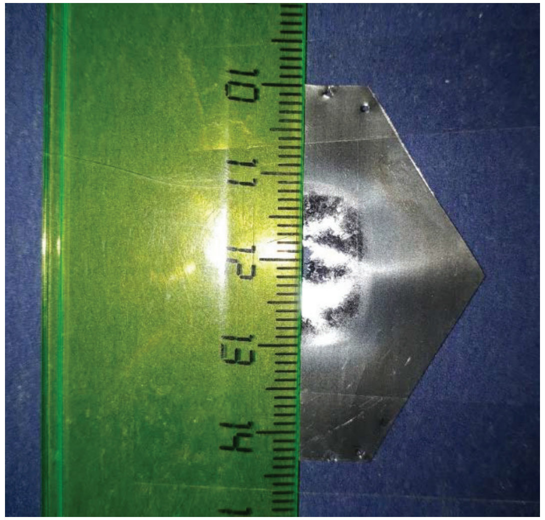


Рис.3а) FC1 $^{48}Ca^{10+}$-100%, $^{40}Ca^{8+}$-15.5%, $^{14}N^{3+}$-34%	Рис.3б) FC2 $^{48}Ca^{10+}$-100%, $^{40}Ca^{8+}$-32.1%, $^{14}N^{3+}$-70.4%	Рис.3в) FC3 $^{48}Ca^{10+}$-87.75%, $^{40}Ca^{8+}$-0%, $^{14}N^{3+}$-0%

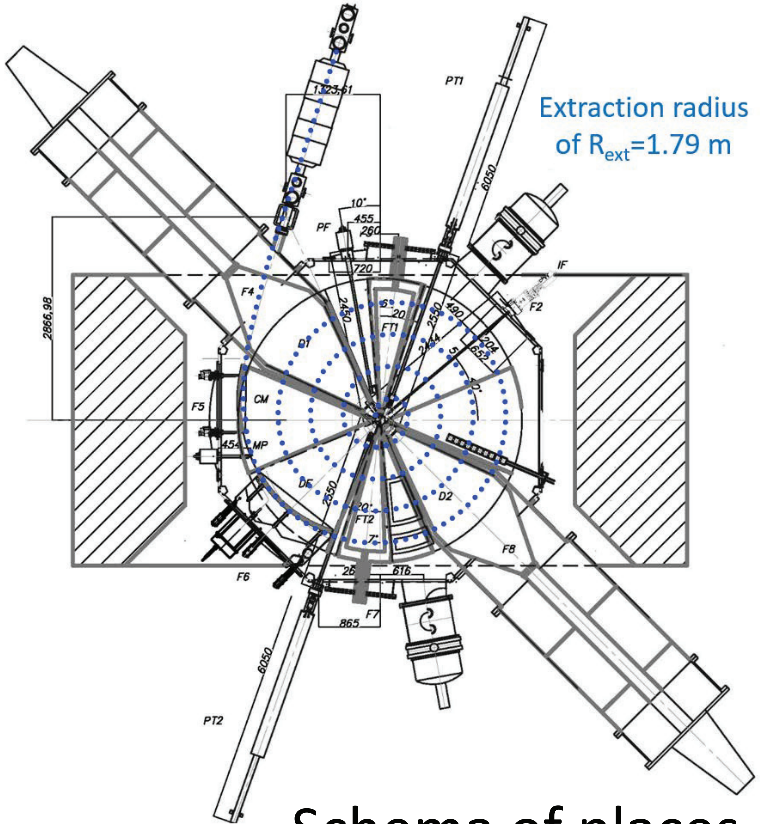


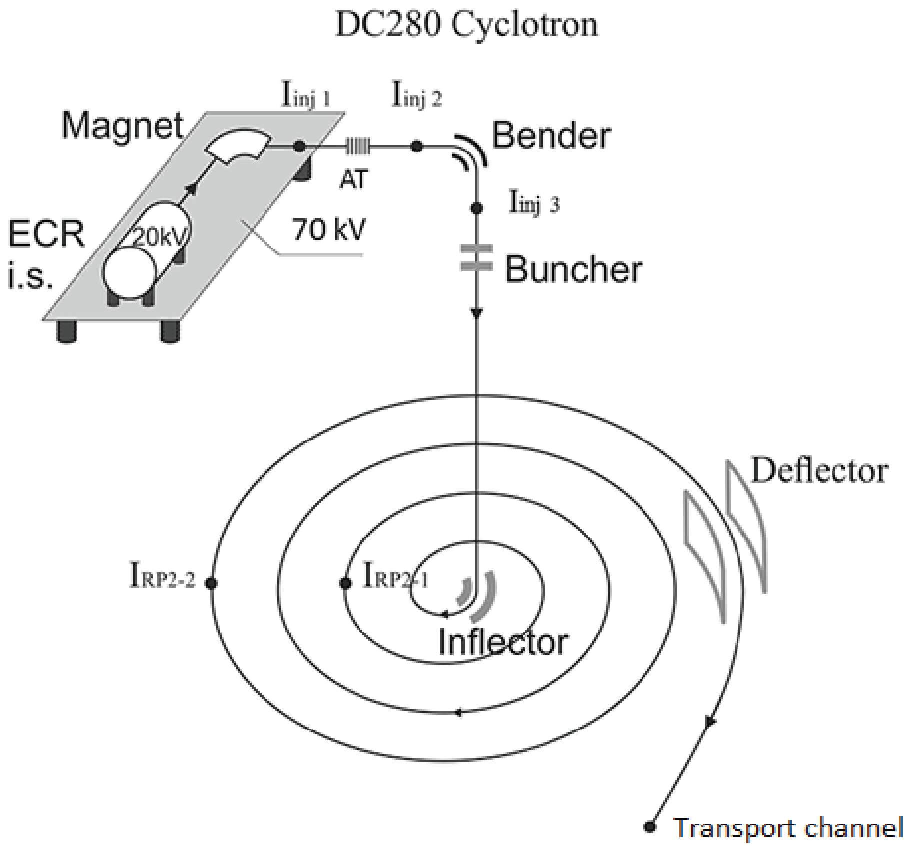


Ion beam current. Inner moving probe.

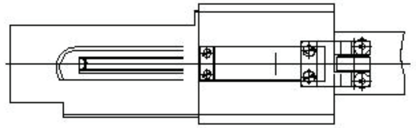


Mark on Ta foil
from accelerated ions of Kr

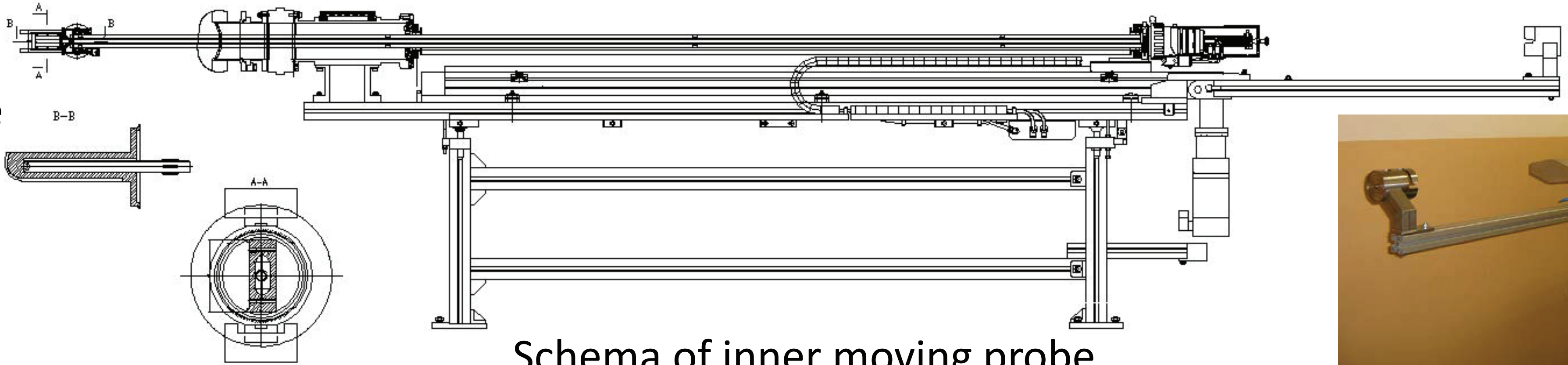




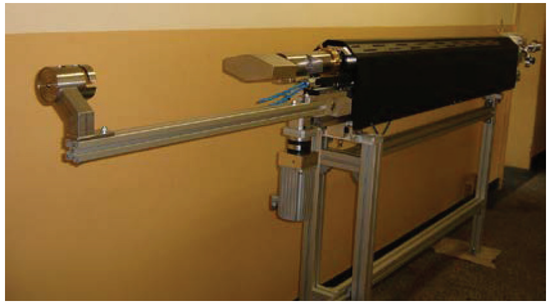
Schema of places of diagnostic elements on DC-280



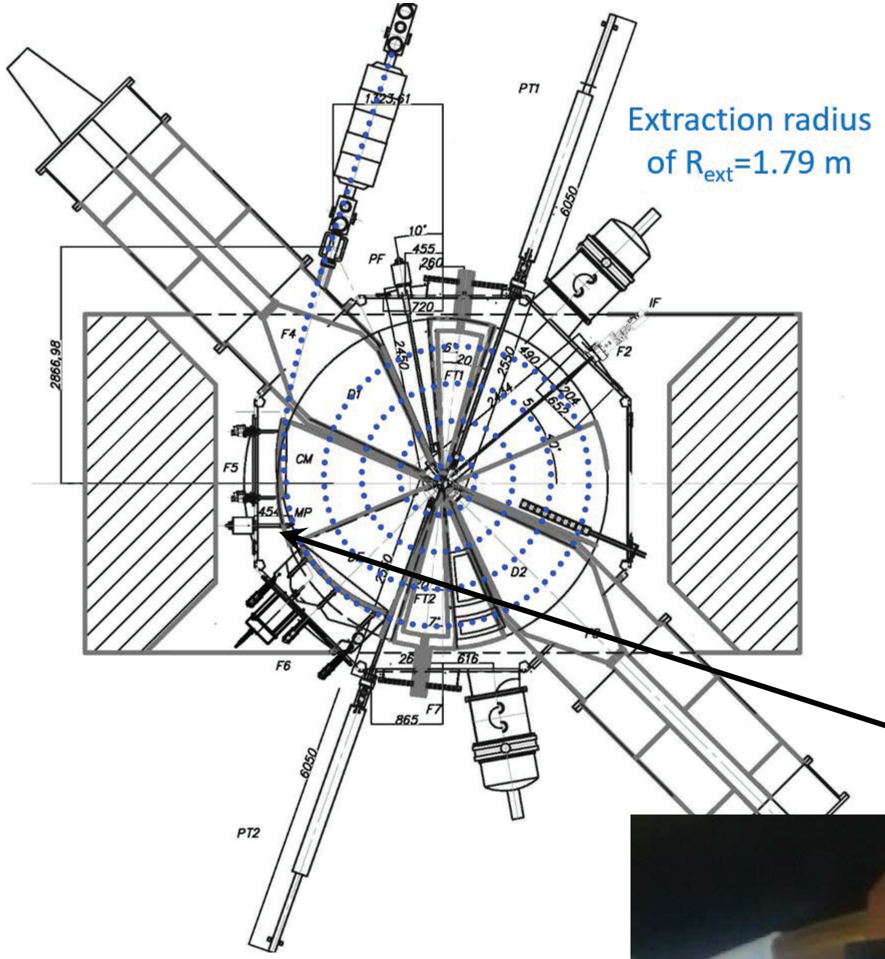
Schema
of head part
of the probe

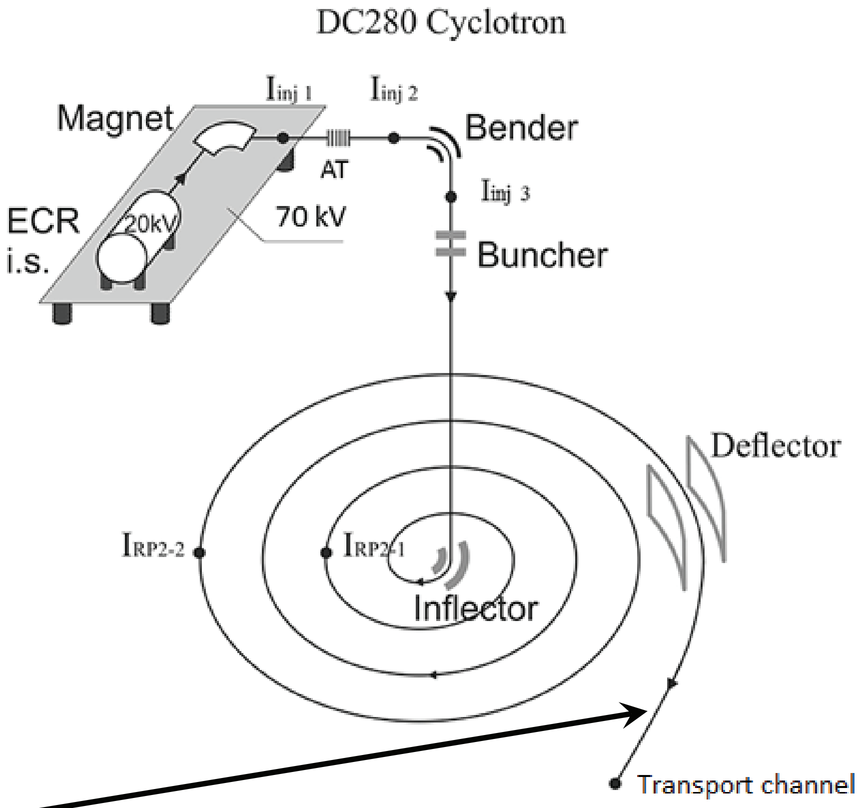


Schema of inner moving probe

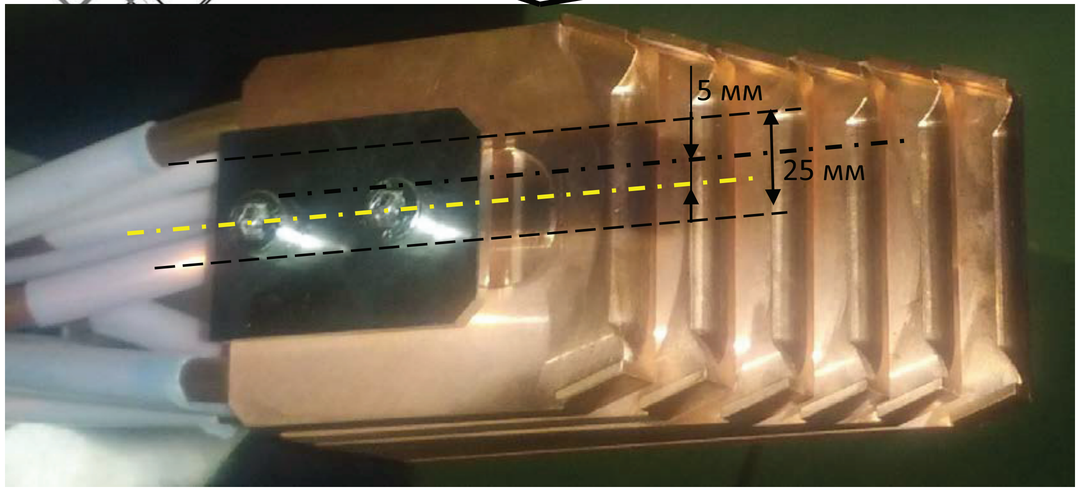


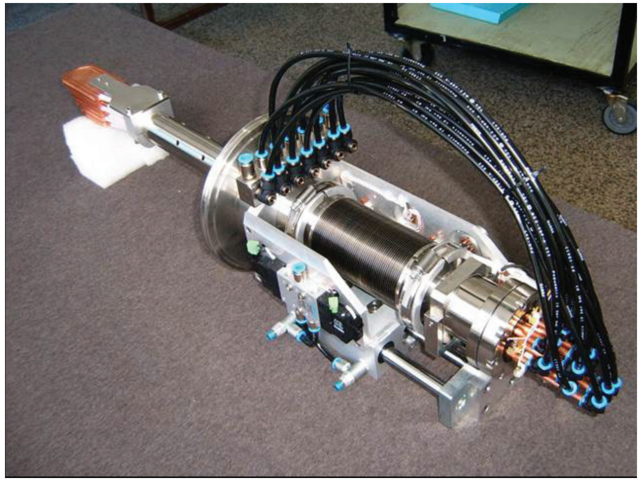
Ion beam current. Inner moving probe.

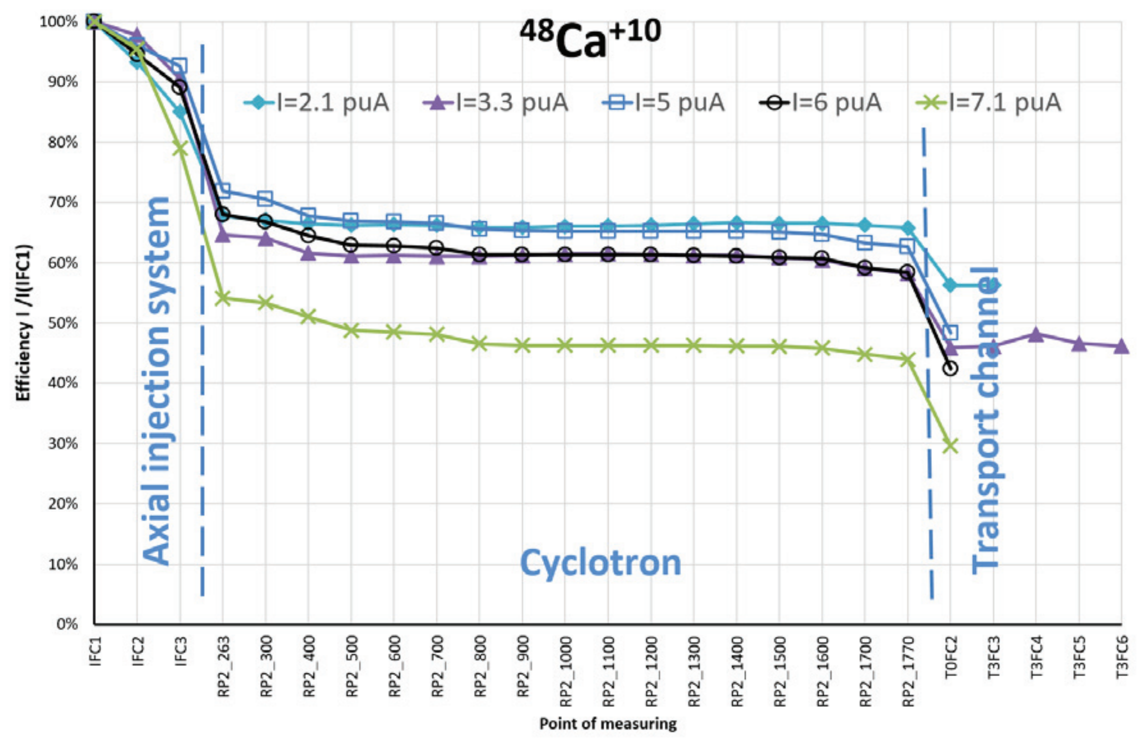


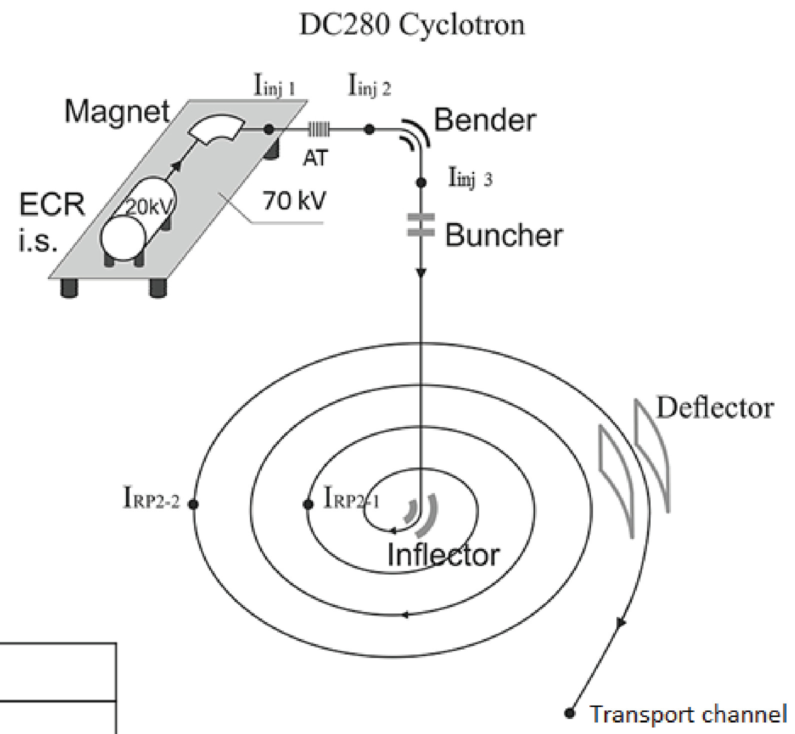


Moving
Multi Lamellar probe.





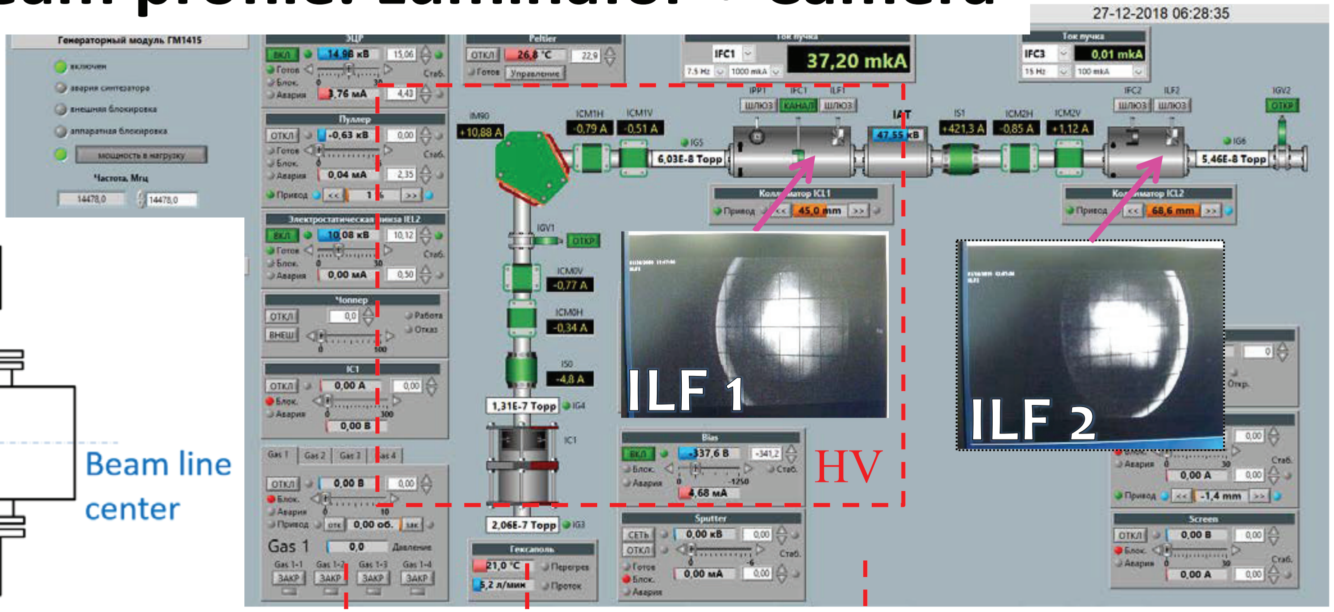


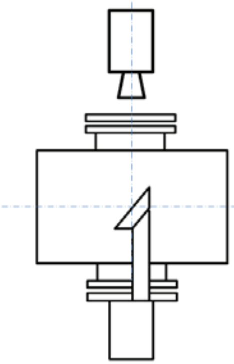


intensity (puA)	Efficiency				
	Axial injection system	Capture	Acceleration	Extraction	Total
2.1	85%	78%	97%	86%	55%
3.3	91%	68%	94%	79%	46%
3.3	91%	73%	88%	75%	44%
4.8	93%	73%	92%	77%	48%
6	89%	72%	91%	73%	42%
7.1	79%	68%	86%	67%	31%

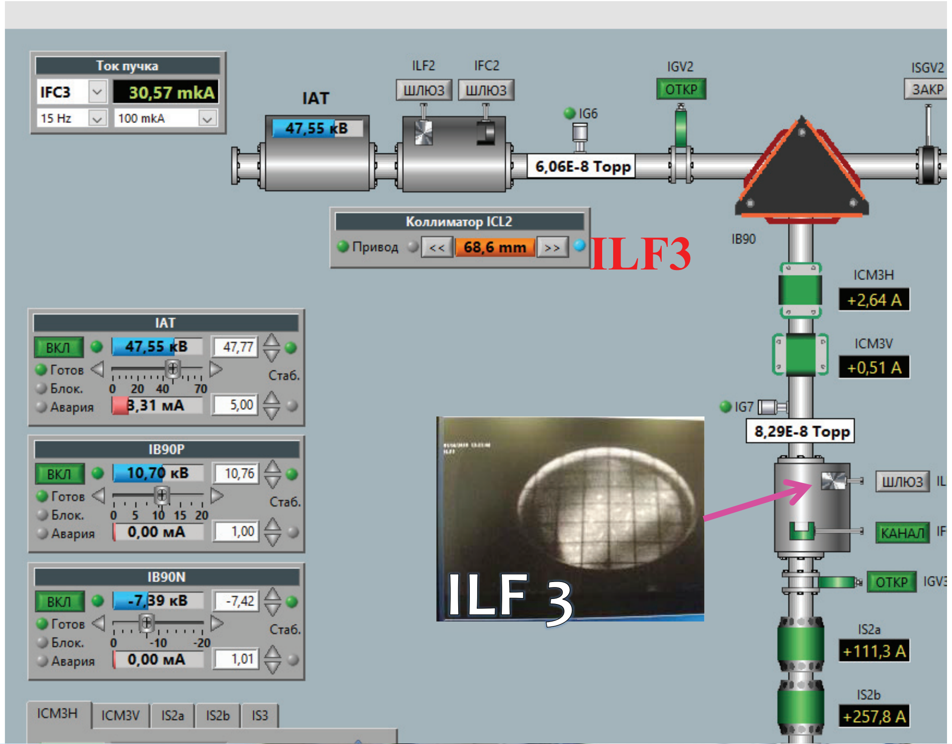
Ion beam profile. Luminafor + Camera

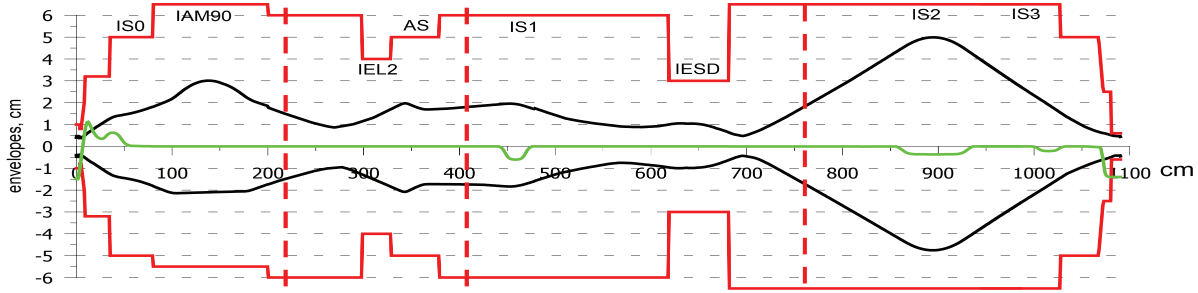
Transport of $_{84}Kr^{+14}$ beam through injection system

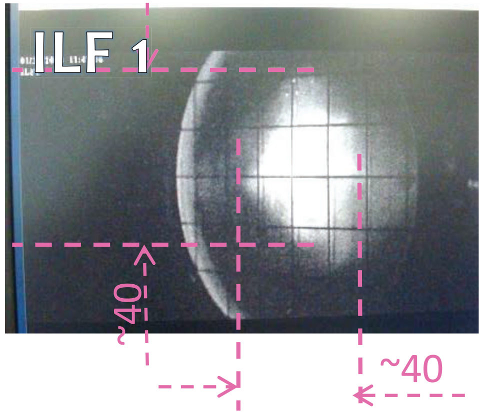


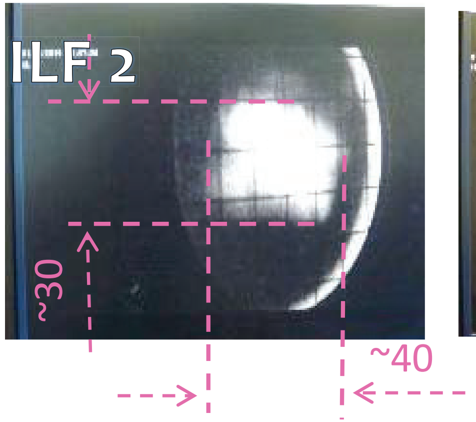


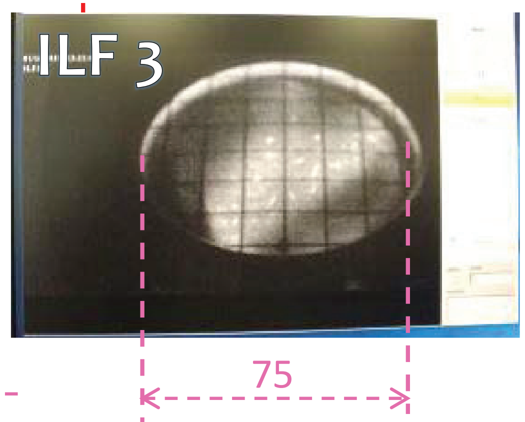
Beam line center

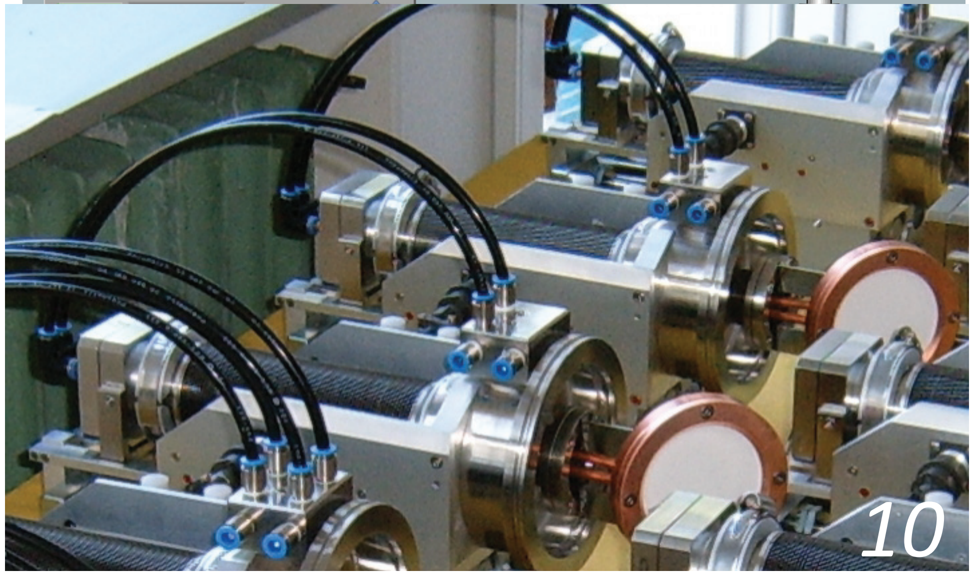




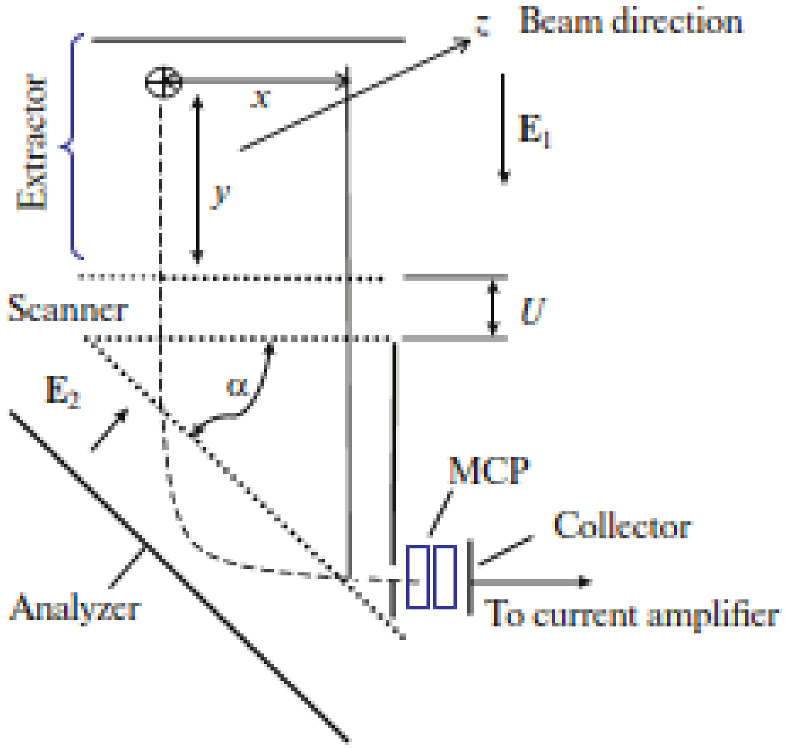


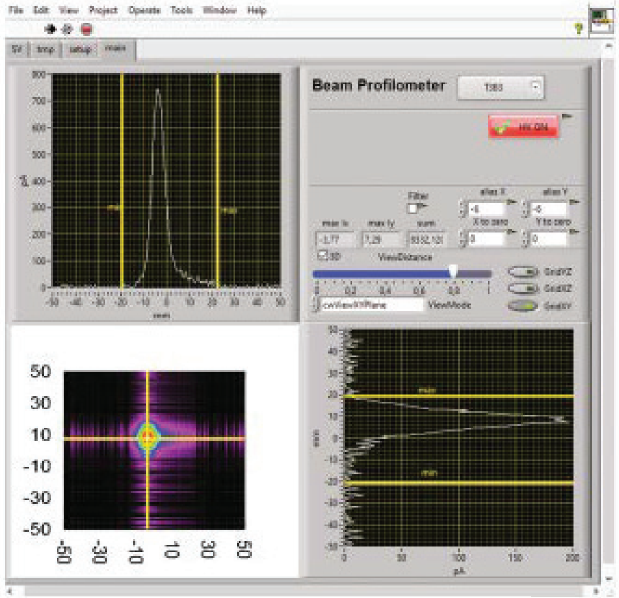




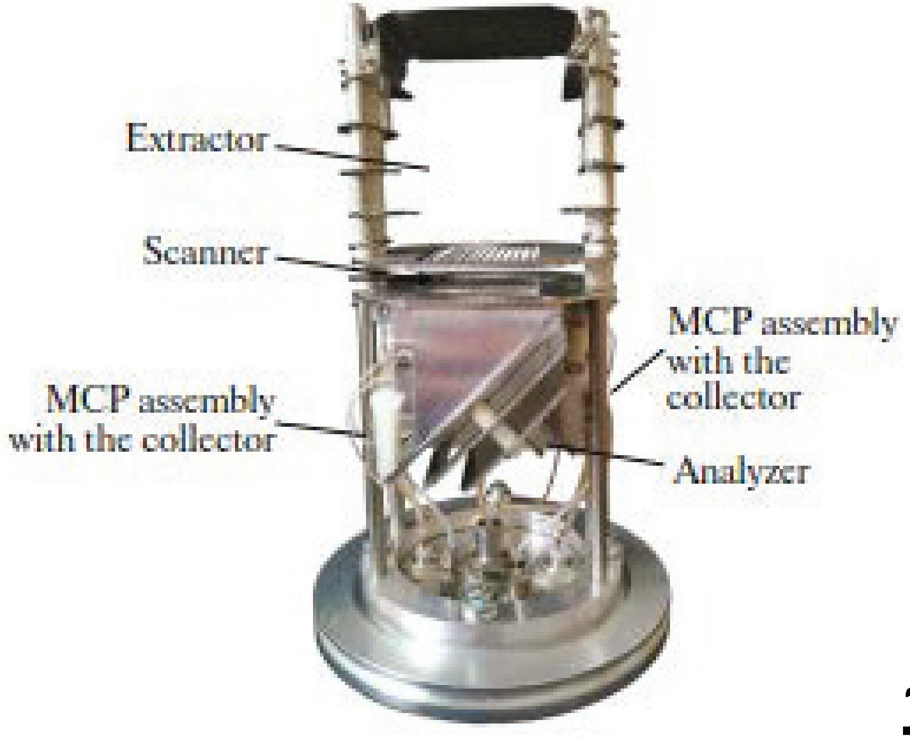


Ion beam profile. The ionization profile monitor

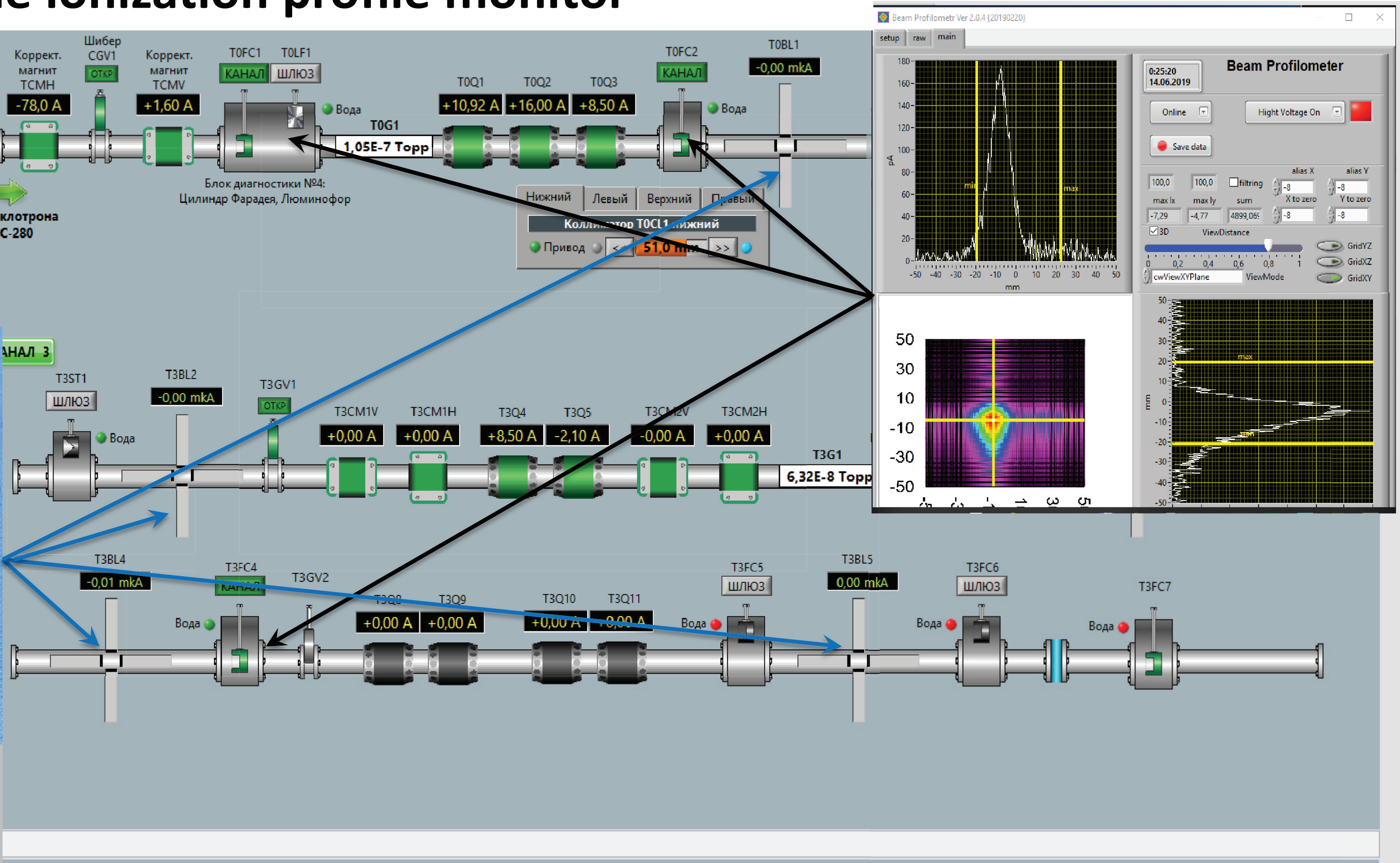


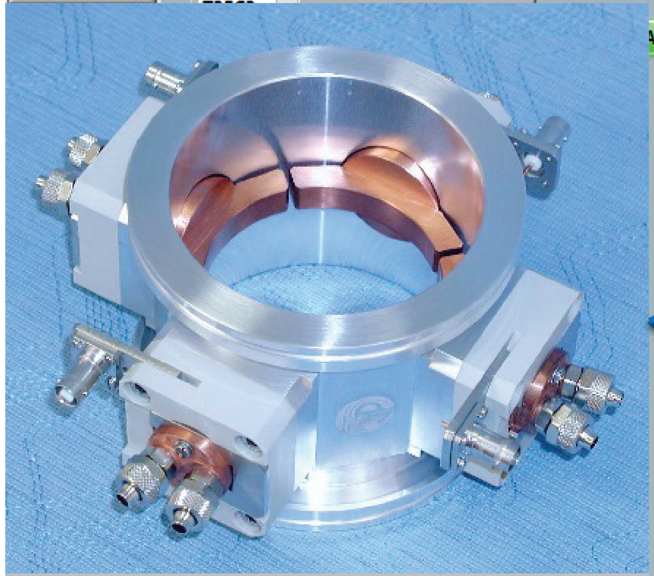


The schema of ionization profile monitor:
E1, E2 vectors of the electric field strength between the plates of the extractor and the analyzer, respectively;
U potential difference between the scanner electrodes;
α is the angle at which the analyzer electrodes are rotated with respect to the scanner electrodes;
x, y coordinates of the point of electron−ion pair production on a plane that is perpendicular to the beam axis.



Ion beam profile. The ionization profile monitor

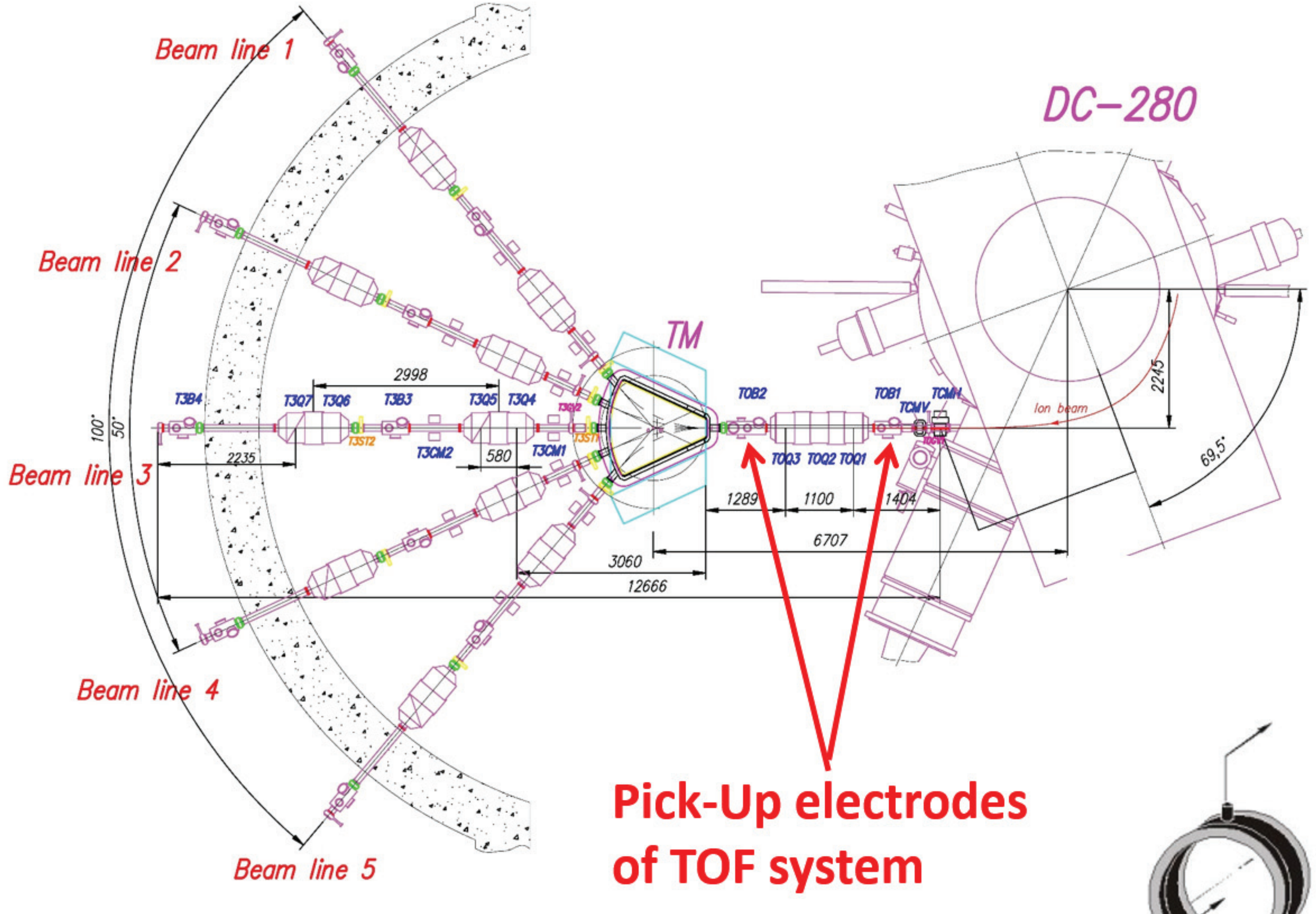




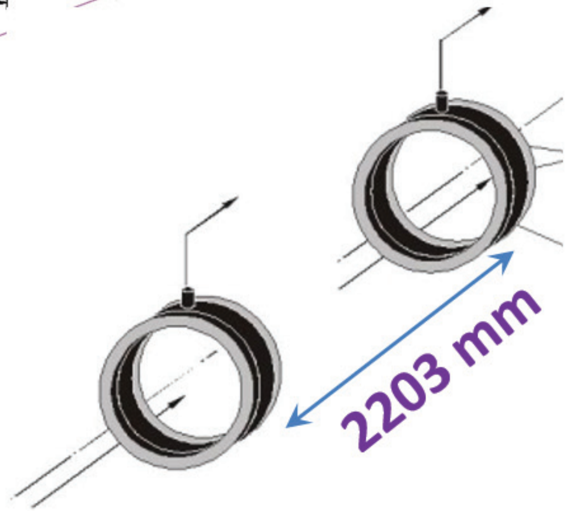
4-section loss monitor
Ø 60 mm

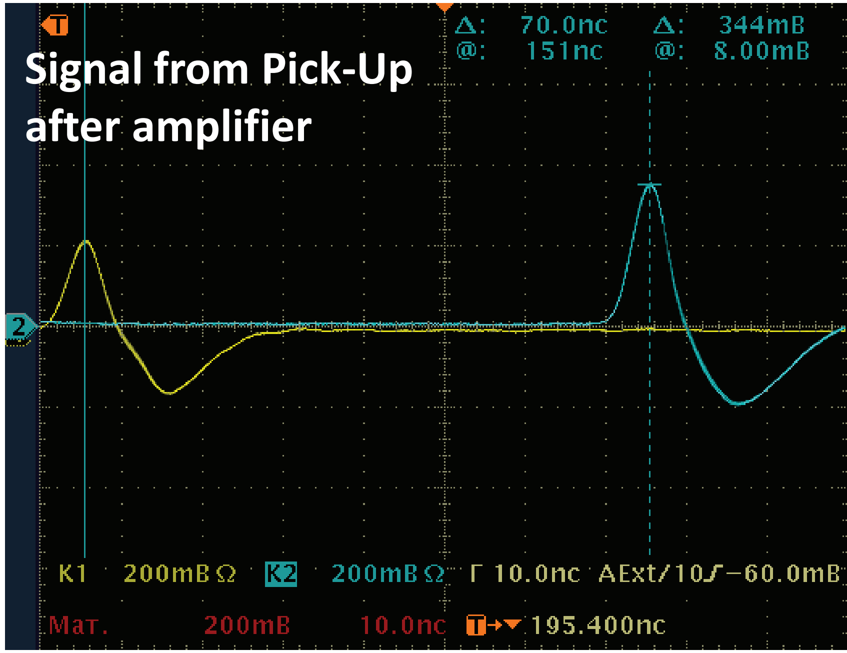
T0FC1 11,875 mkA CG3 1,05E-7 Торр

Energy. TOF system

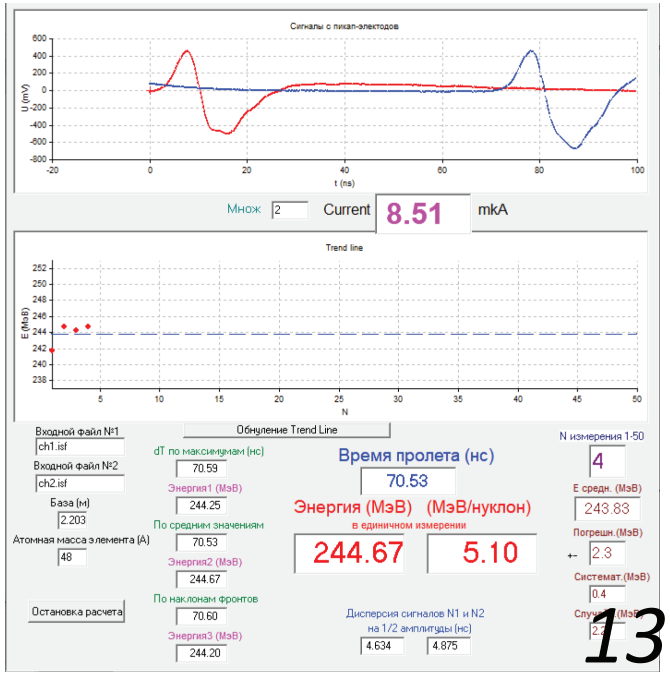


Pick-Up electrodes
of TOF system

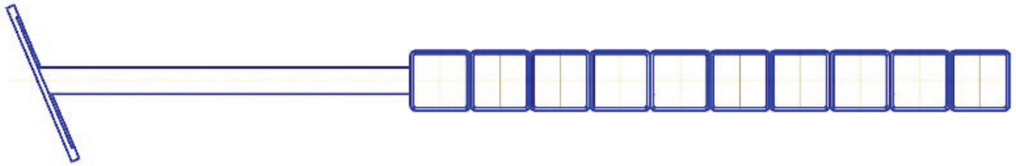


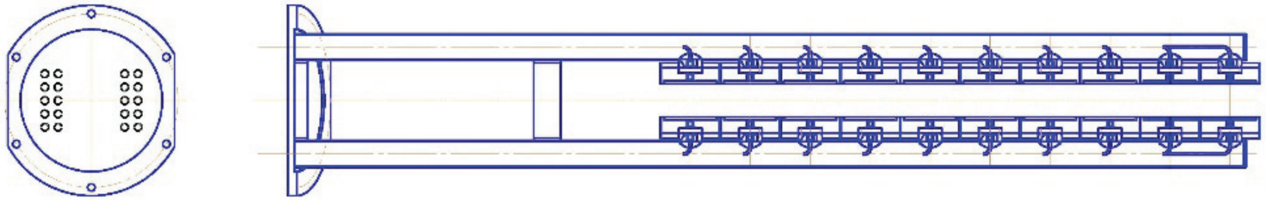


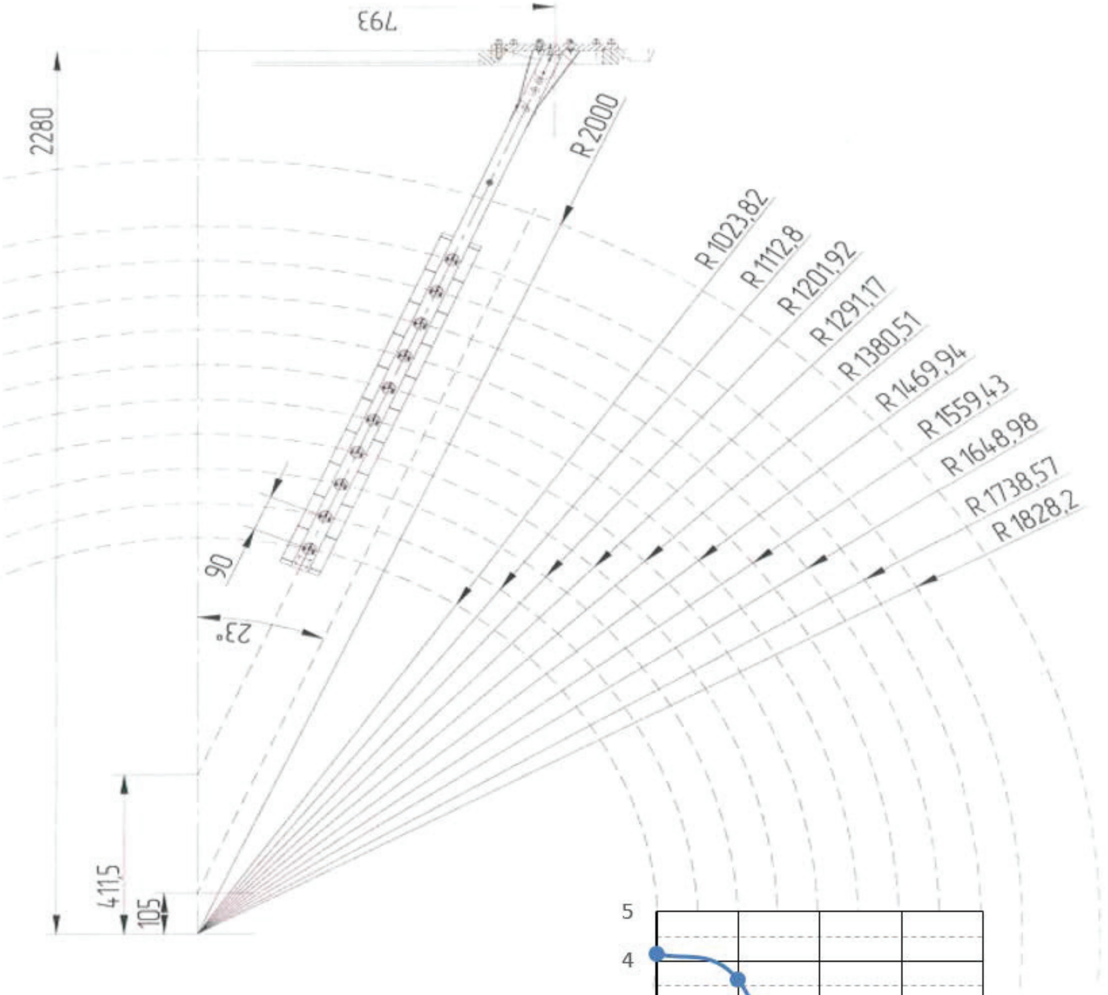
Measured energy of $^{48}Ti^{10+}$



Phase moving in cyclotron. Inner Pick-Up electrodes.

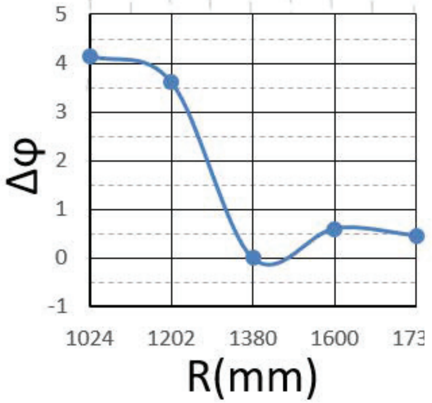






- 10 couple of Pick-Up electrodes
- Square 70 x 70 mm^2
- Second harmonic filter

$^{40}Ar^{+7}$ **F=8.51 Hhz;**
E=5.2 MeV/n



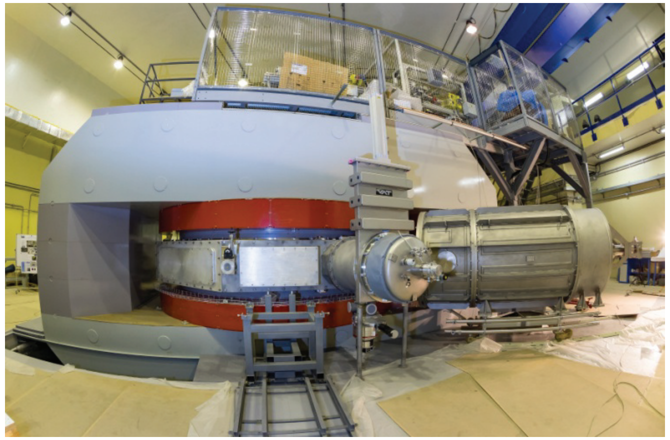
Conclusion and plans to development

- Non-destructive control of beam intensity
- Commission of phase moving monitor system

  evaluation of bunch length

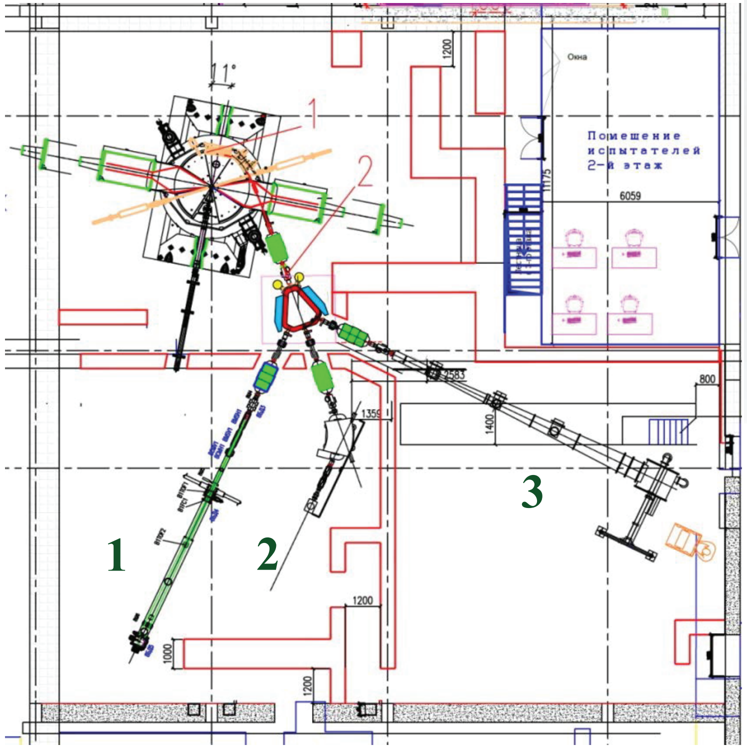
- Evaluation of emittance of ion beam


DC-280
SHE factory
U-400
Heavy and superheavy nuclei
U-400M
Light exotic nuclei
IC-100
Applied research
NanoLab
DRIBs gallery
MT-25
Microtron

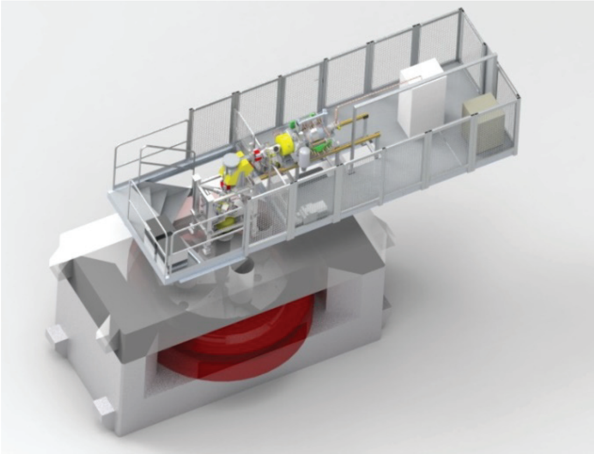


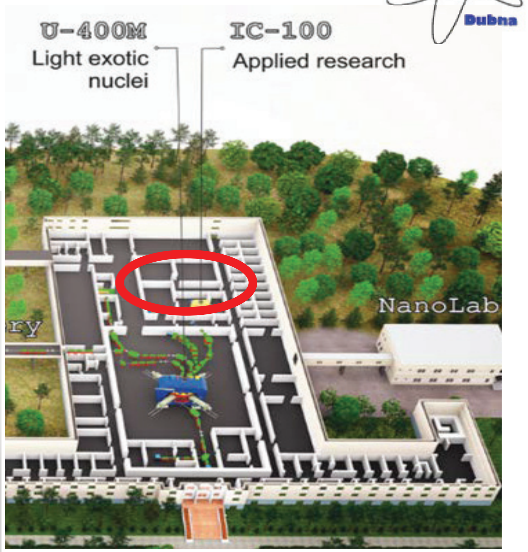
Циклотрон ДЦ-140

В ЛЯР ОИЯИ создается ускорительный комплекс для прикладного использования ионных пучков на базе циклотрона ДЦ-140



Эскиз комплекса ДЦ-140





Технические параметры ДЦ-140:

Магнитное поле в центре 1.377 - 1.554 Тл;

Частота ускорения ионов: 8.452 МГц;

Ускоряемые ионы элементов: O – Bi;

Инжекция ионов от ЭЦР- источника;

Энергии ионов:

2.124 МэВ/нукл. (A/Z=7.35 – 8.25)

4.8 МэВ/нукл. (A/Z=4.9 - 5.5)

$10^5 \div 10^{12}$ ионов/с

Планируемое использование пучков ДЦ-140:

1. Канал тестирования электронных компонентов ~3000 час/год.
2. Канал радиационного материаловедения ~1500 час/год;
3. Канал облучения полимерных пленок ~1500 час/год;