DECRIS-PM ion source for DC-280 cyclotron

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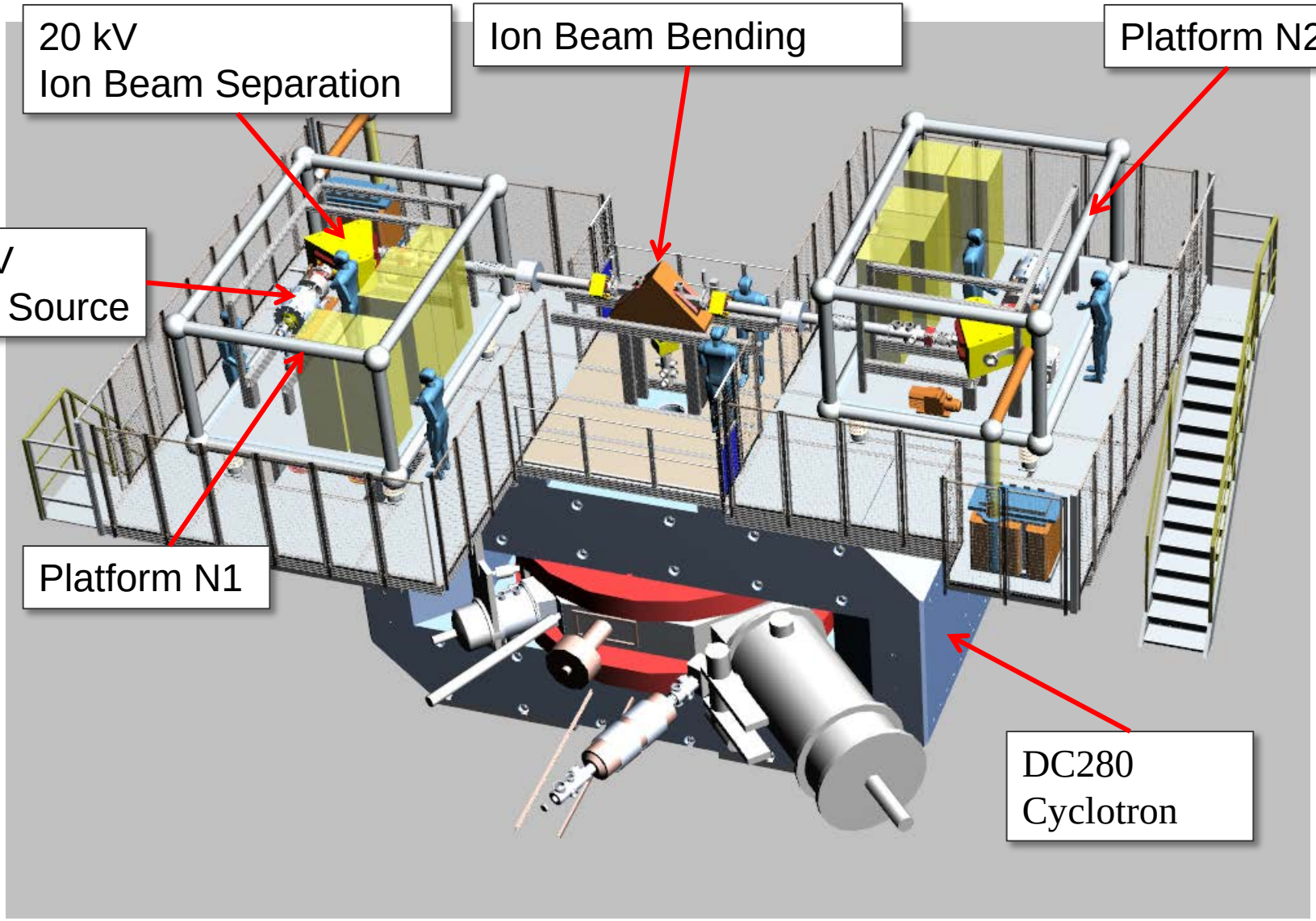
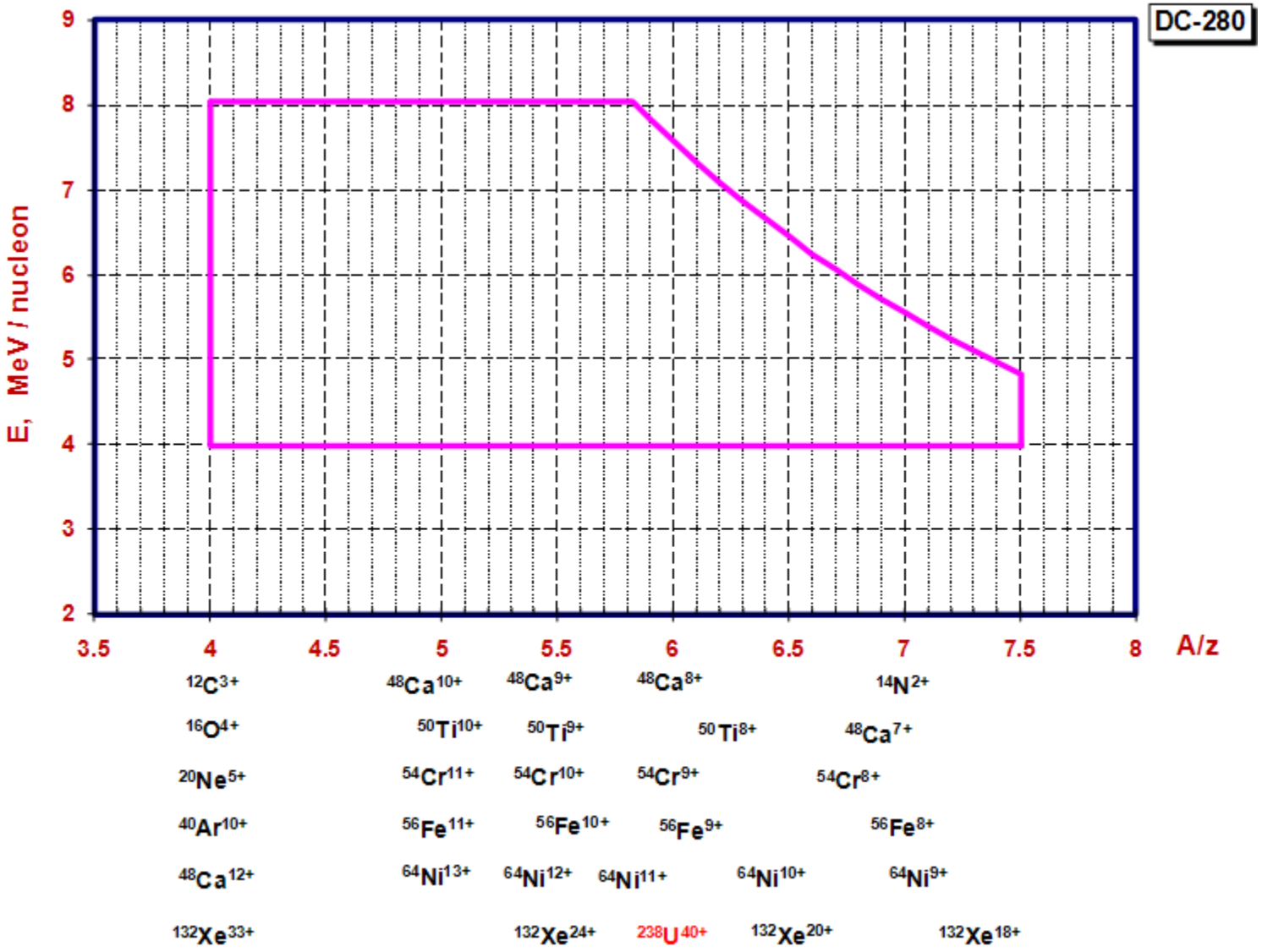
ION SOURCE

DC-280 Cyclotron



Working Diagram of the DC280 Cyclotron



DECRIS - Dubna ECR Ion Sources

DECRIS-2, DECRIS-2m, DECRIS-3, DECRIS-4, DECRIS-5 are "room temperature" ECR ion sources. The axial magnetic field is created by the coils with independent power supplies. The radial magnetic field is created by permanent magnet hexapole, made from NdFeB.

DECRIS-SC, DECRIS-SC2 – axial magnetic field is created by superconducting solenoids

DECRIS-2 – U-400M cyclotron – 1995

ECR-4M – U-400 cyclotron – 1996 (modernization - 2012)

DECRIS-3 – TESLA Accelerator Installation (Belgrade) -1997

DECRIS-2m – BIONT Inc. (Bratislava) – 2003

DECRIS-SC – CI-100 cyclotron - 2004

DECRIS-4 – in operation at the test bench - 2005

DECRIS-3 - DC-60 accelerator complex (Astana, Kazakhstan) – 2006

DECRIS-2m –DC-72 cyclotron (Bratislava) – 2007

DECRIS-5 – for DC-110 cyclotron – 2012

DECRIS-SC2 – new ion source for U-400M cyclotron – *2014*

DECRIS-PM for DC-280 cyclotron – 2017 under the test

All PM ECRIS advantages:

•low power consumption,

•low pressure in the cooling water system,

•simplified operation, etc.

All PM ECRIS drawbacks:

• the fixed distribution of the magnetic field and comparatively low field strength

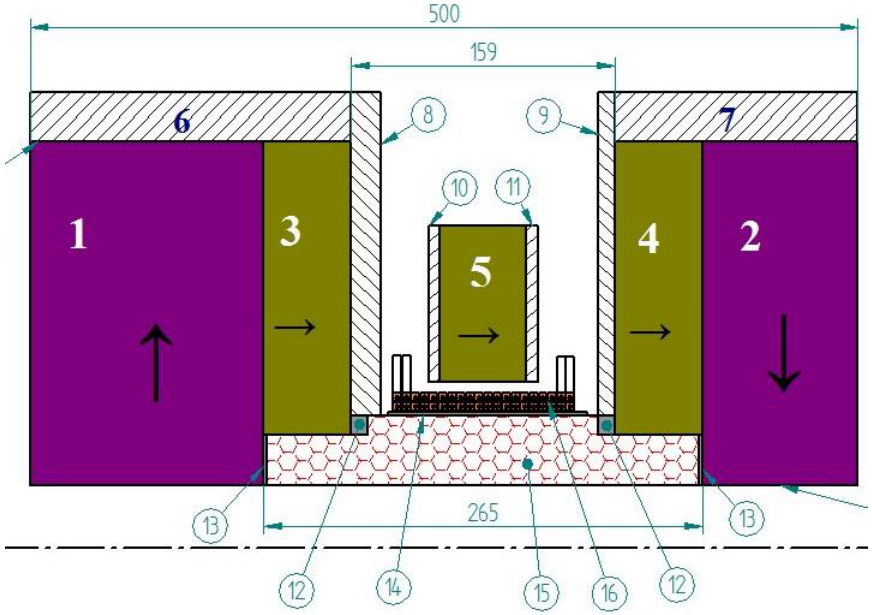
• system should be strongly optimized for the desired operation mode.

• Strong forces between the individual parts of the system the correction of the magnetic field after the assembly of the magnetic system is practically impossible without the degaussing of it.

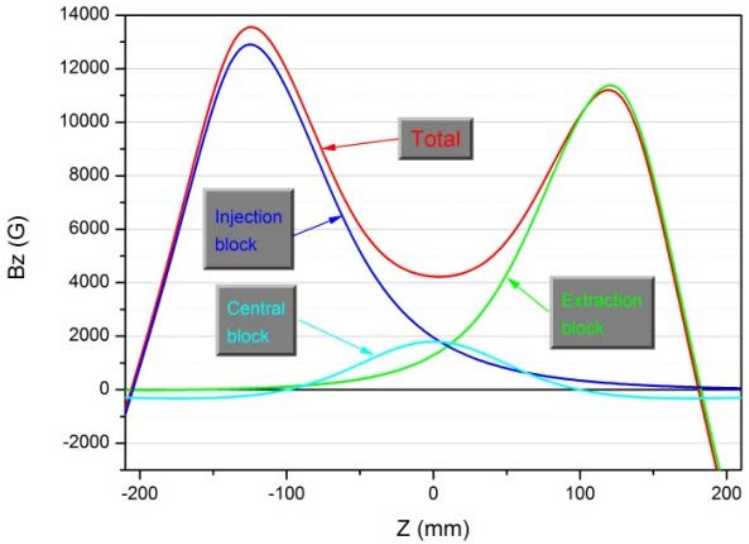
Parameters of DECRIS-PM

UHF frequency	**14 GHz**
Binj	$\geq$ 1.3 T
Bmin	0.4 T
Bextr	1.0 ÷1.1 T
Br	1.05÷1.15 T
Plasma chamber internal diameter	70 mm

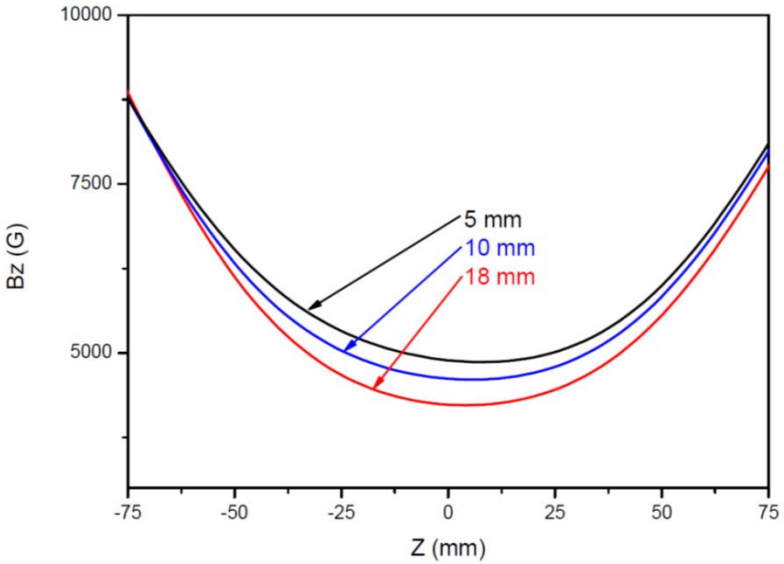
DECRIS-PM magnet system



Magnetic structure of DERIS-PM.
1÷5 – PM rings; 6, 7 – soft iron rings;
8÷11 – soft iron plates,
12÷14 - auxiliary elements,
15 - hexapole, 16 – coil.



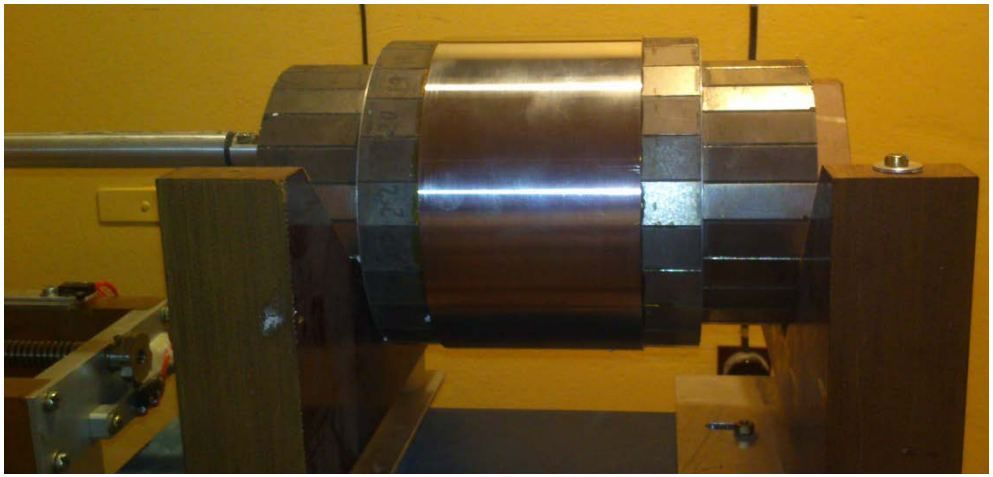
Axial magnetic field

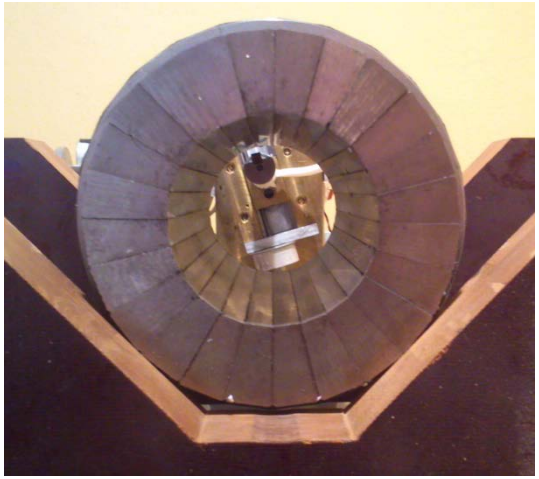


Correction of Bmin with soft iron plates

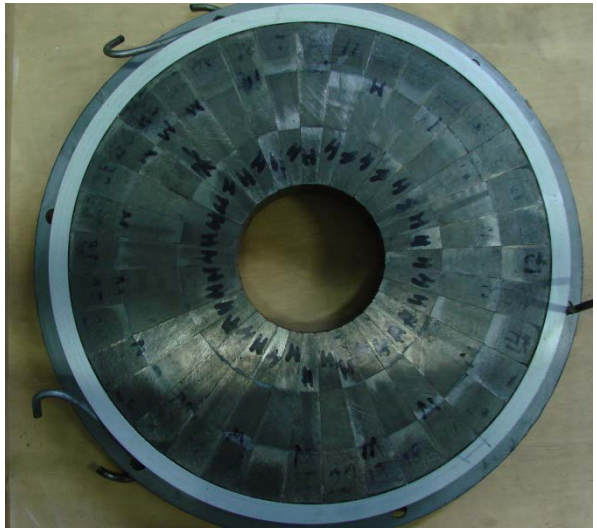
Components of magnetic system

Hexapole at the measuring test bench





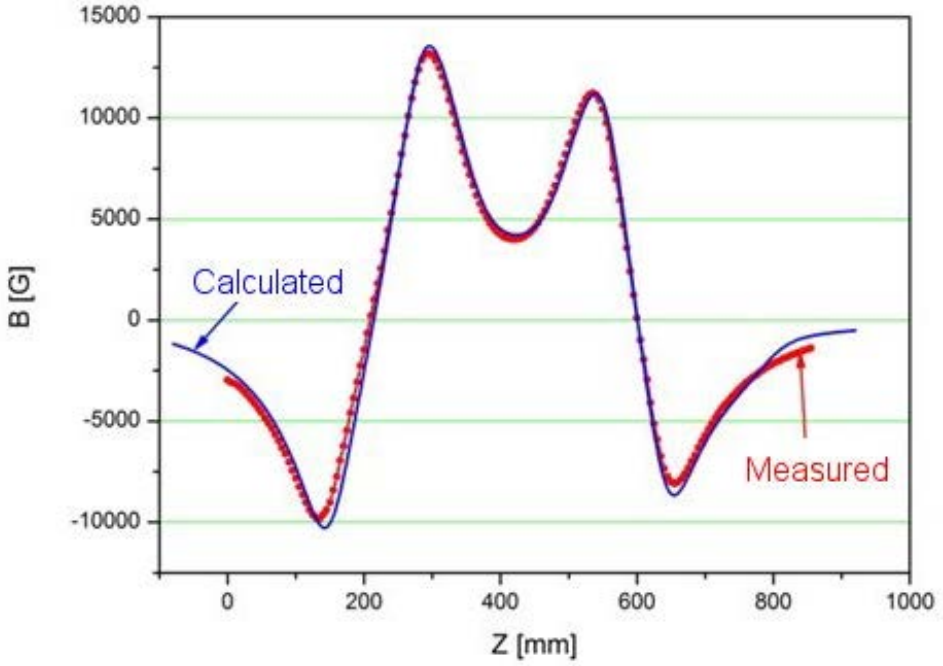
Axially magnetized ring



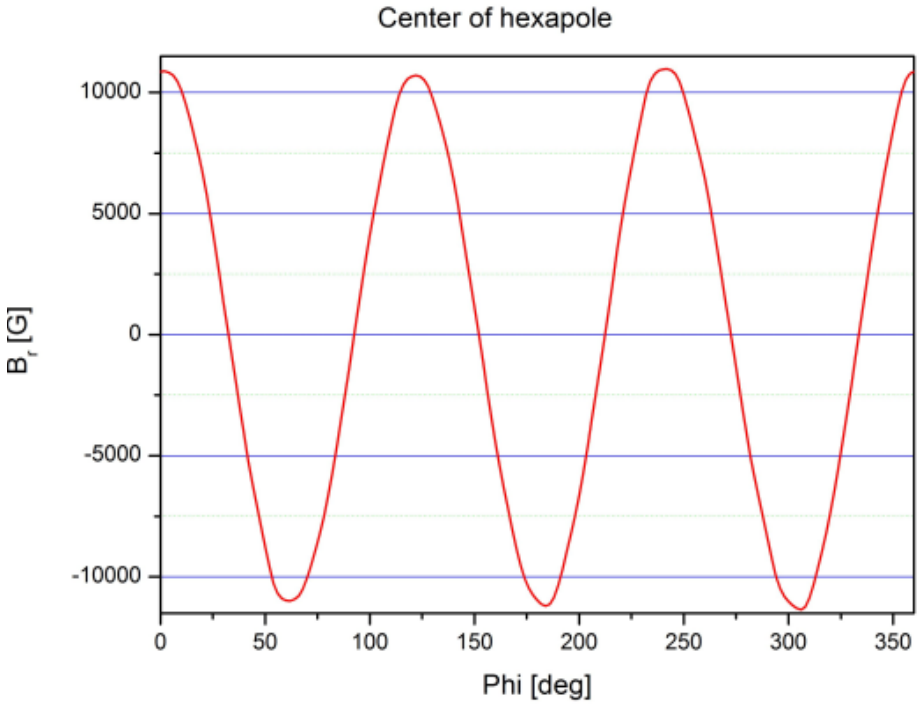
Assembled magnetic system

Magnetic field of DECRIS-PM

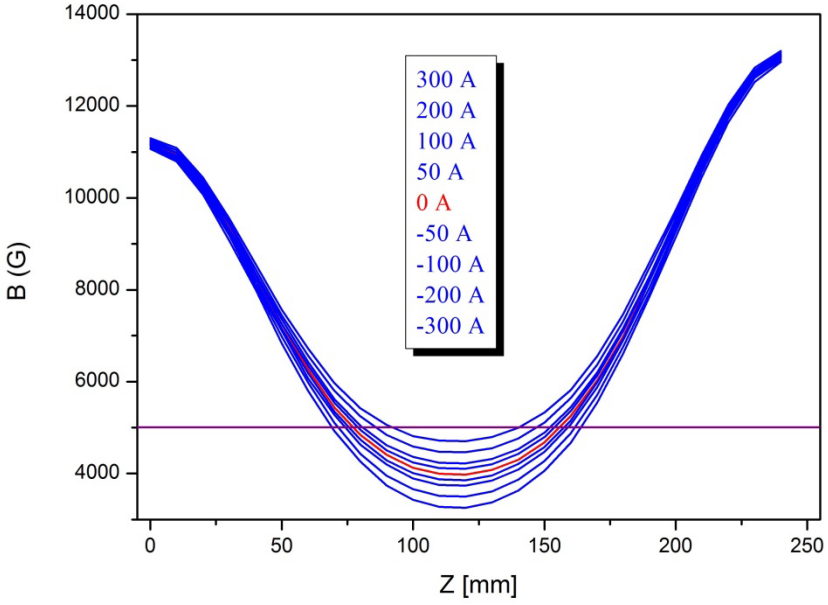
Axial magnetic field

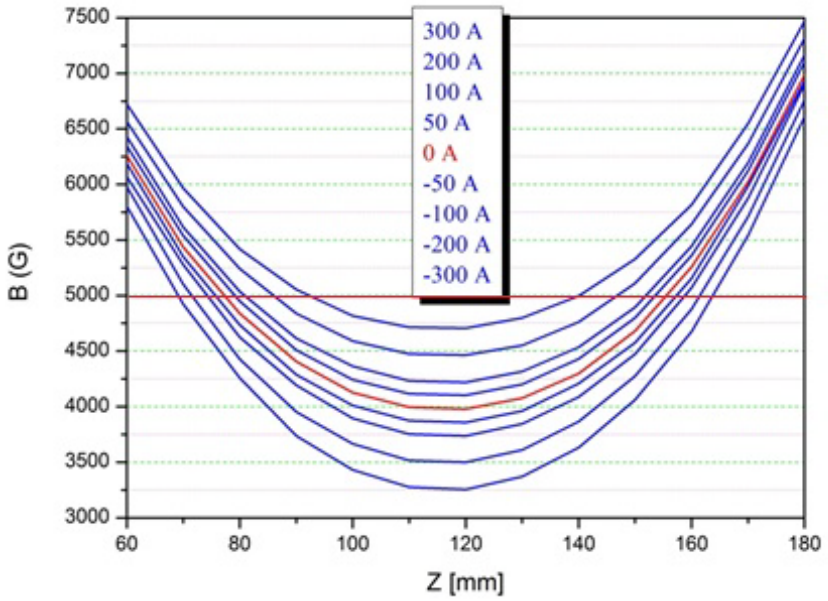


Radial magnetic field



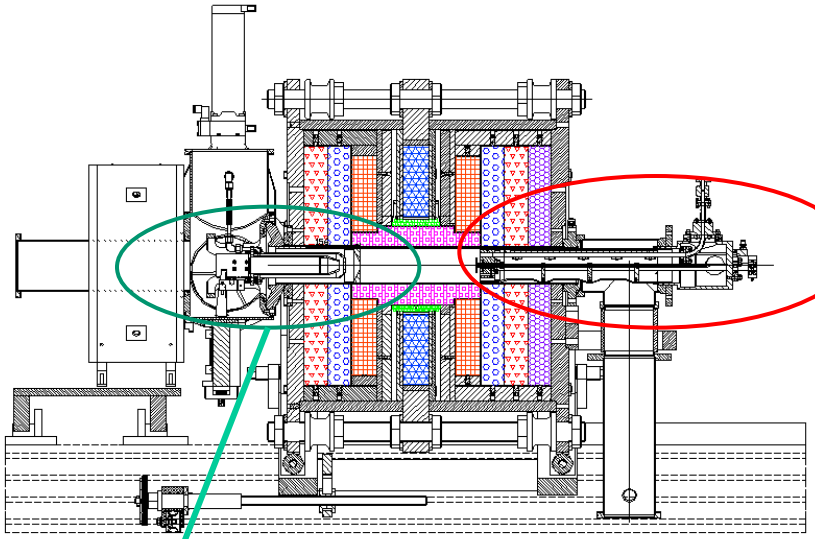
Coil effect





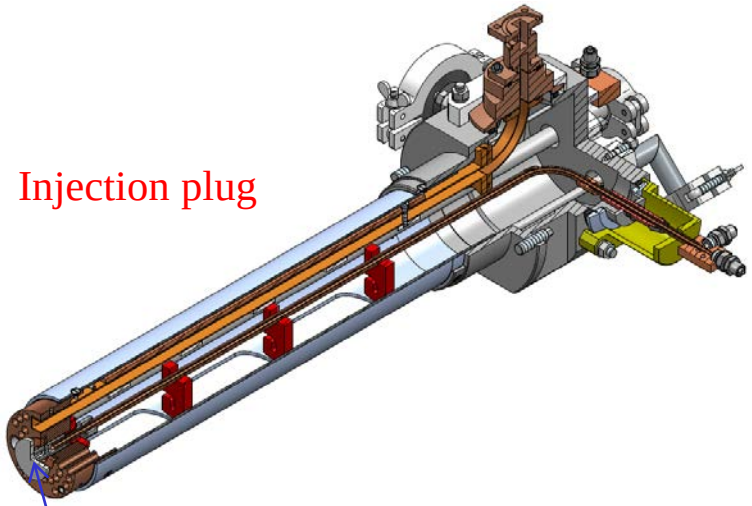
Adjustment of B_{min} ± 750 G

Cross sectional view of DECRIS-PM



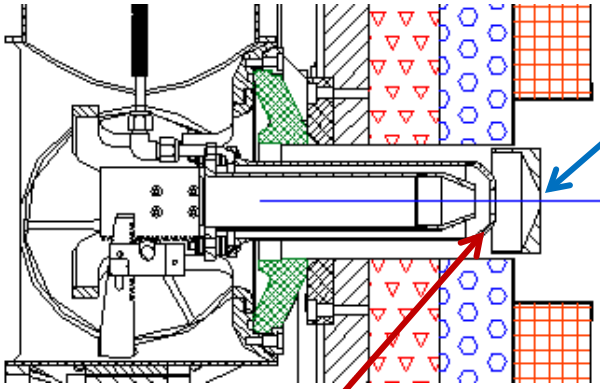
UHF injection

Injection plug



Biased disk (water cooled)

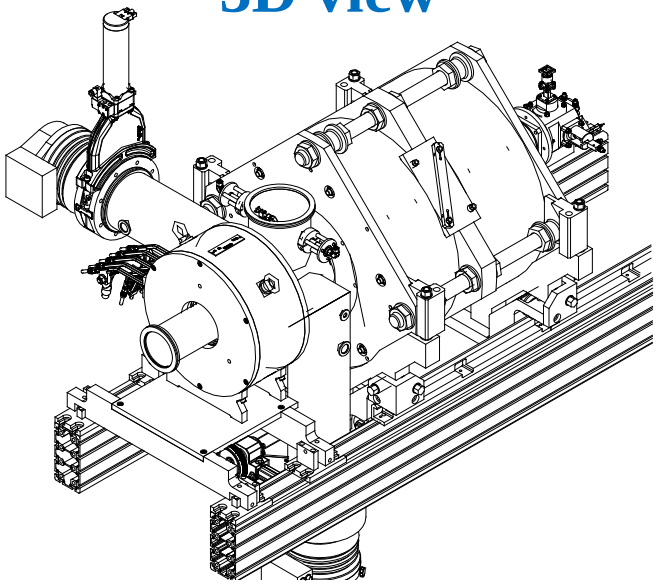
Extraction system



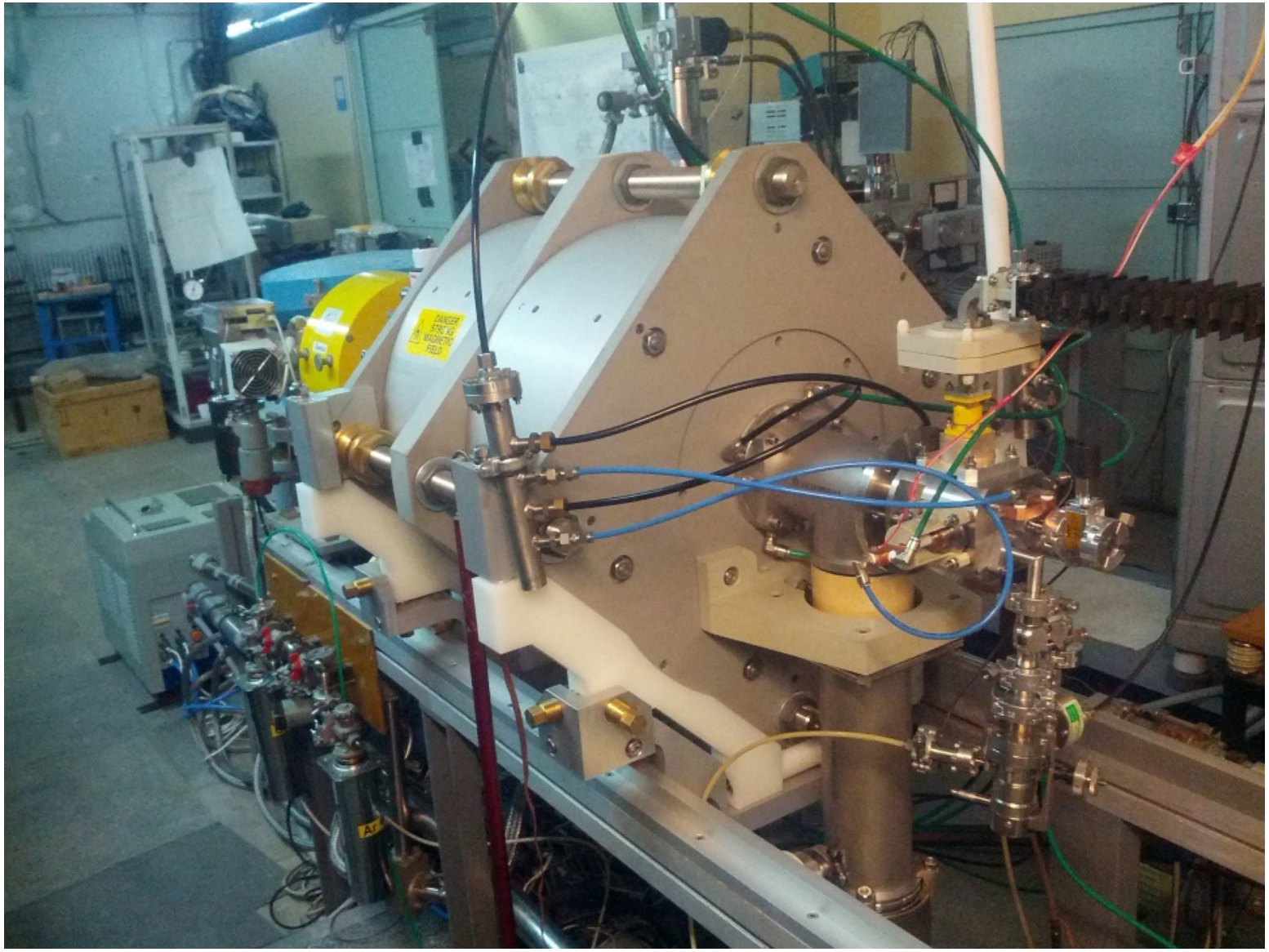
Plasma electrode

Puller electrode- negatively biased and water cooled

3D view

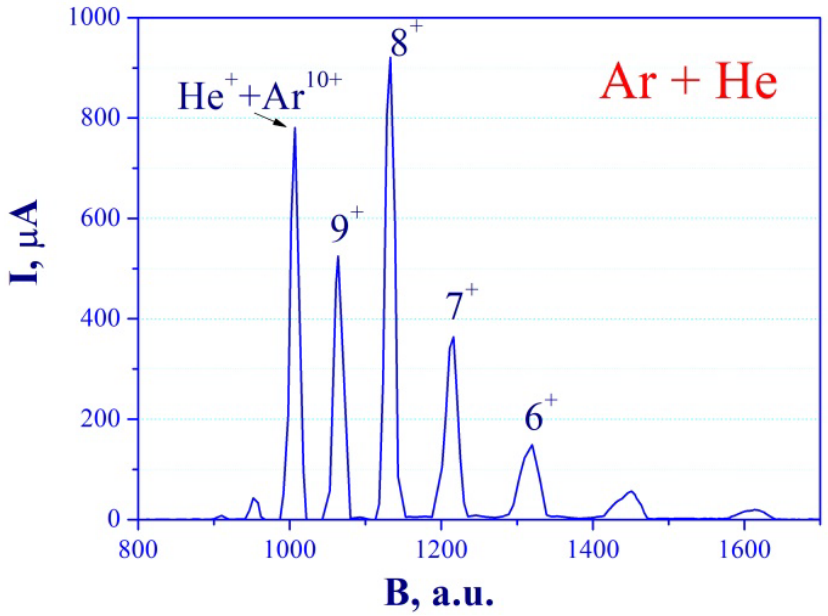


DECRIS-PM at the test bench

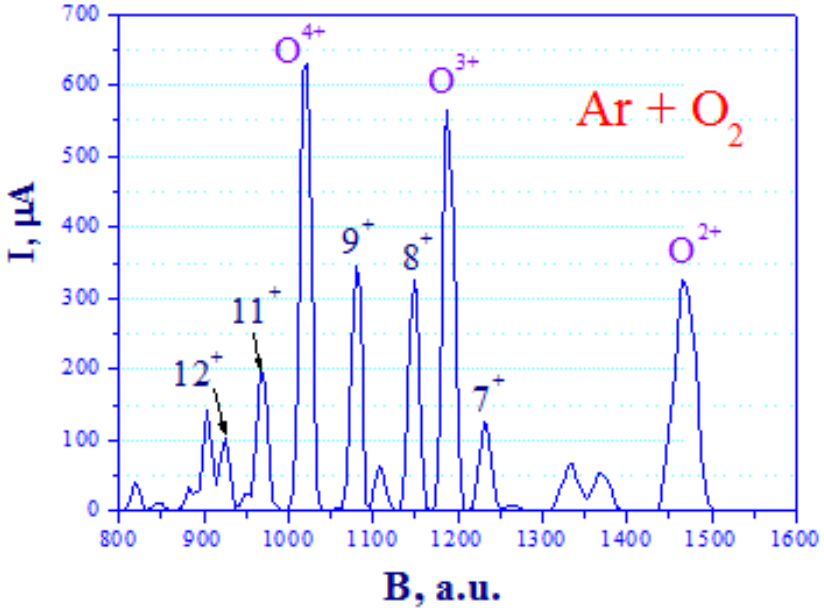


Ar charge state spectra

Ar^{8+} =926 μA

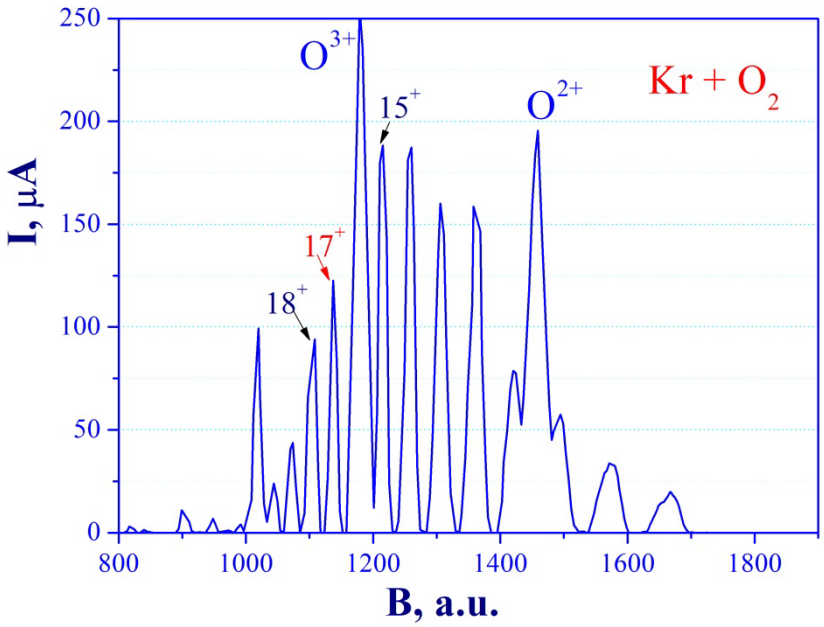


Ar^{11+} = 210 μA

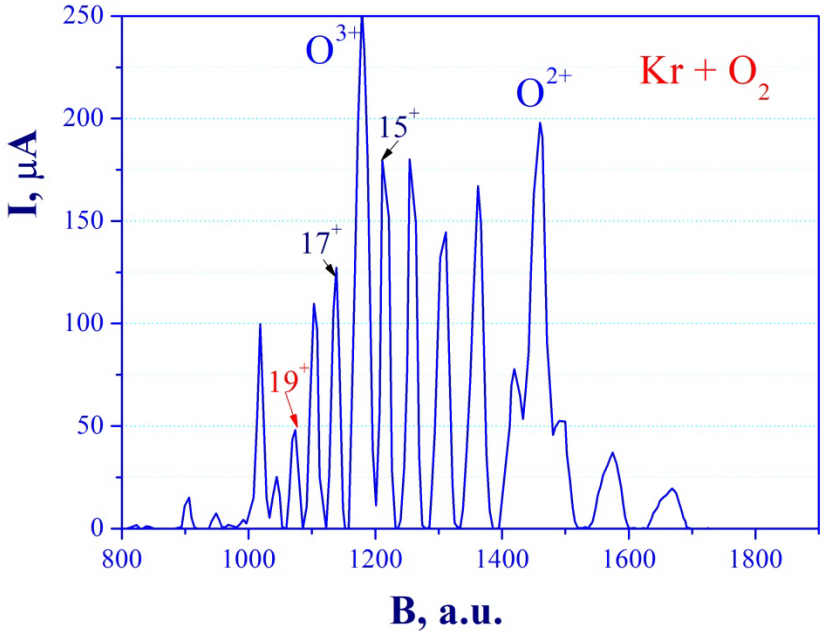


Kr charge state spectra

Kr^{17+} =125 μA

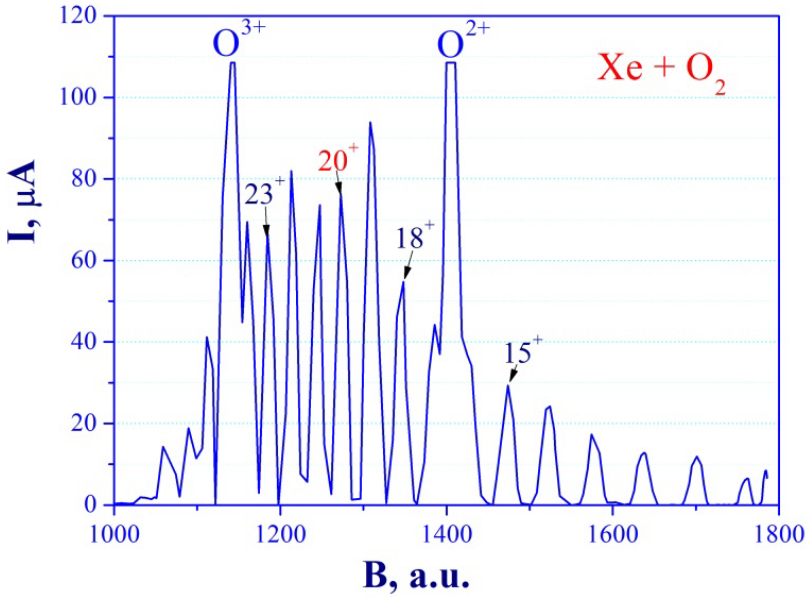


Kr^{19+} =50 μA

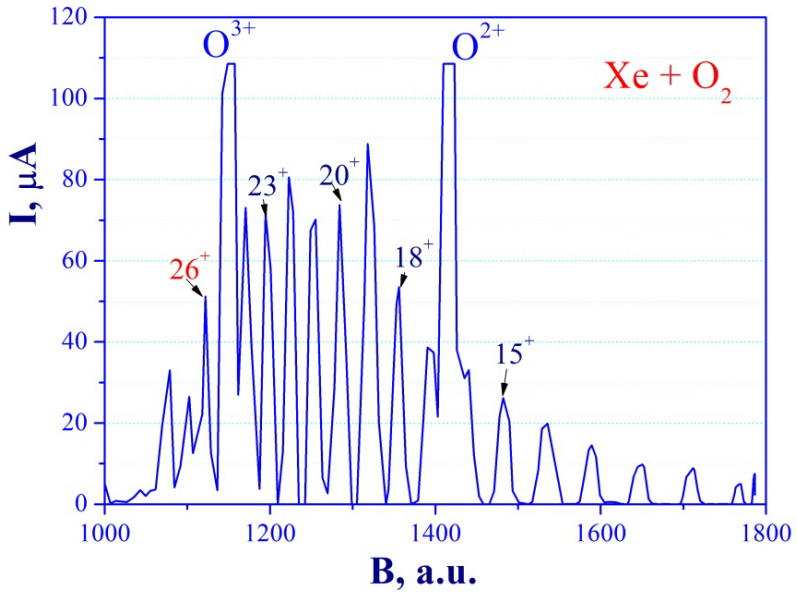


Xe charge state spectra

Xe^{20+}=77 μA

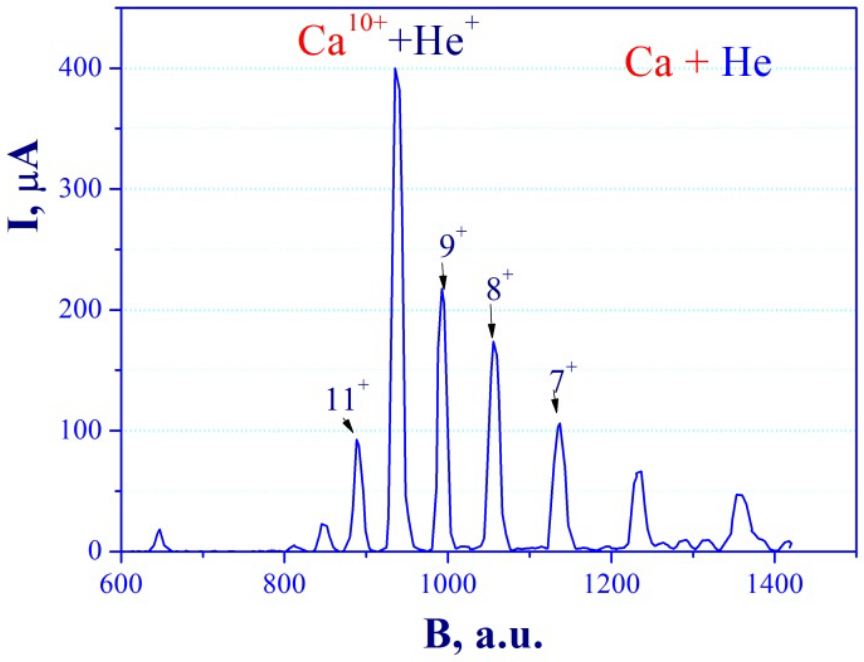


Xe^{26+} =50 μA

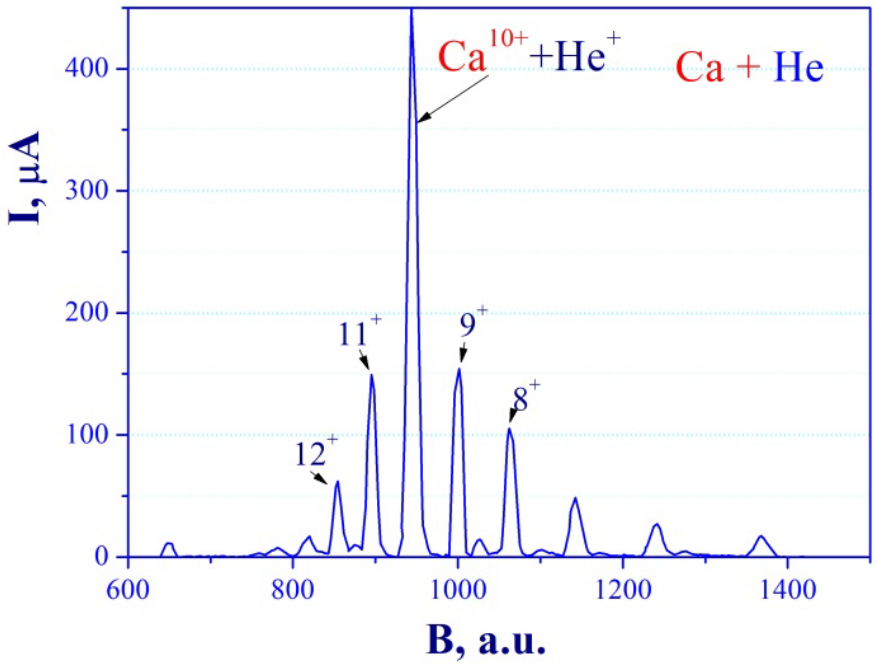


Ca charge state spectra

Ca^{9+} =210 μA

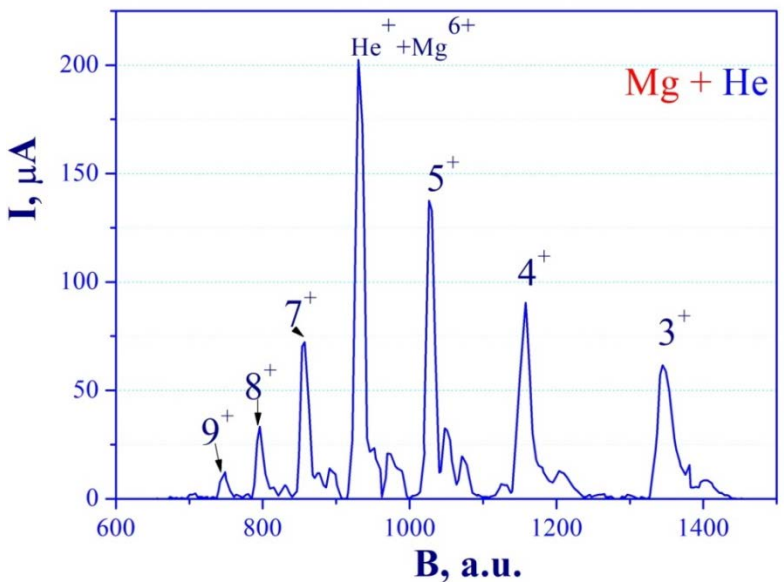


Ca^{11+} =150 μA

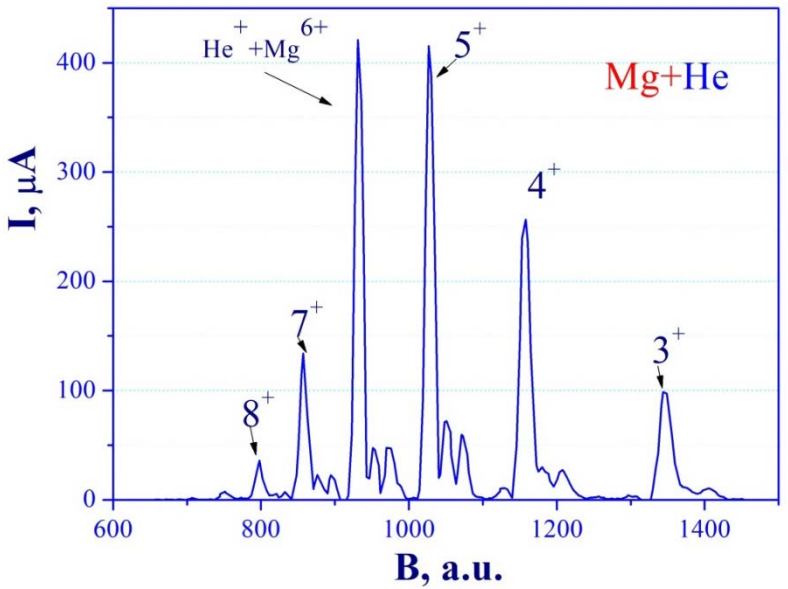


Mg, Fe and Ti charge state spectra

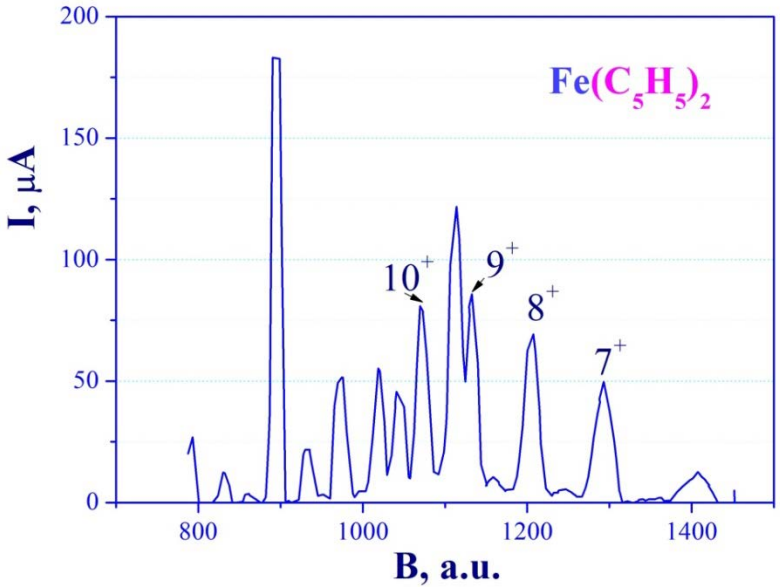
Mg^{9+} =15 μA



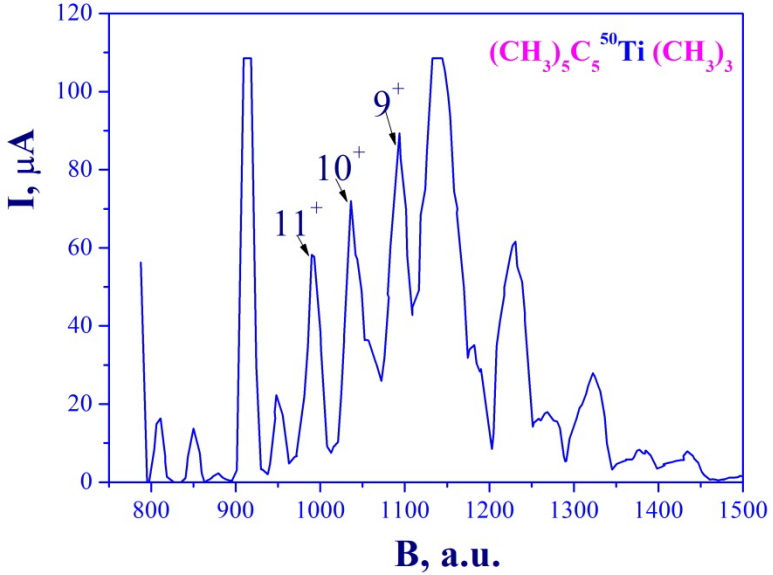
Mg^{5+} =400 μA



Fe^{10+} =80 μA



$^{50}Ti^{10+}$ =72 μA



DECRIS-PM: results of the test

Ion currents, eμA													
Q+	5+	7+	8+	9+	10+	11+	12+	15+	17+	19+	20+	23+	26+
Ar			926	500		210	154						
Kr							160	180	125	50			
Xe											77	70	50
^{24}Mg	450	140	40	15									
^{40}Ca		110	175	220		158	58						
^{50}Ti				90	72	60	23						
^{56}Fe			70	85	80	55							

Assembled high voltage platform

October 2017 – installation of DECRIS-PM at the cyclotron is planned

CONCLUSION

- The new DECRIS-PM ion source can provide intense ion beams of gaseous and solid substances.
- During the tests the operation of the DECRIS-PM ion source was very stable and reproducible.
- The beam intensity produced by DECRIS-PM meets the requirements of DC-280 cyclotron.

THANKS FOR YOUR ATTENTION!