Development of the New DECRIS-PM Ion Source

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To enhance the efficiency of experiments for next few years it is necessary to obtain accelerated ion beams with the following parameters:

Ion energy	4÷8 MeV/n
Ion masses	10÷238
Beam intensity (up to A=50)	10 pμA
Beam emittance	less 30 π mm×mrad
Efficiency of beam transfer	>50%

DC-280 Cyclotron

The axial injection system of the DC-280 cyclotron will include two high voltage platforms which will allow for efficient injection of ions from helium to uranium with an atomic mass to charge ratio in the range of 4÷7. High energy of the injected beam (up to 100 kV) will shift the space charge limits by a factor of 30. Each HV-platform will be equipped with the low power consuming ECR ion source. For production of ions with the medium masses (from He to Kr) the all permanent magnet (PM) ECR ion source will be used.

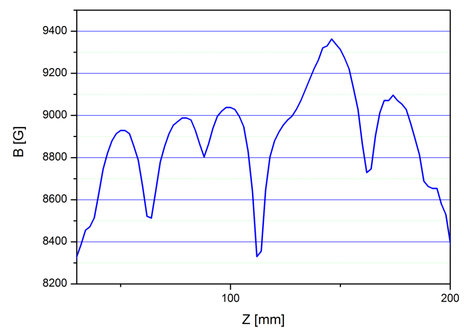
Parameters of DECRIS-PM

Frequency	14 GHz
B_{inj}	≥ 1.3 T
B_{min}	0.4 T
B_{extr}	1.0 ÷1.1 T
B_r	1.05÷1.15 T
Plasma chamber internal diameter	70 mm

Some drawbacks of all PM ECR ion sources:

- Inflexibility of the magnetic system ⇒ system should be strongly optimized for the desired operation mode.
- Strong forces acting between the individual parts of the system ⇒ almost impossible to correct errors in the magnetic field distribution without system degaussing

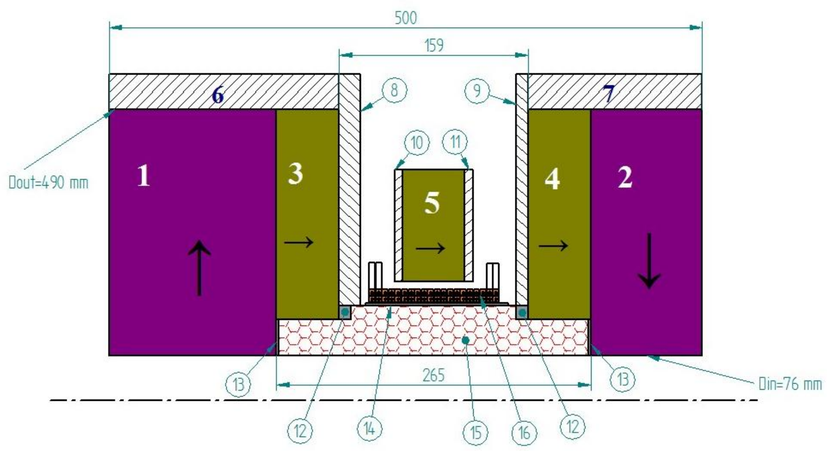
Some deviations from the required field distribution can occur for many reasons. The magnetic material itself has scatter in parameters of up to 5%. Furthermore, the magnetic rings that form the axial magnetic field consist of several blocks. In calculations of the magnetic field it is almost impossible to take into account the influence of gaps between individual blocks.

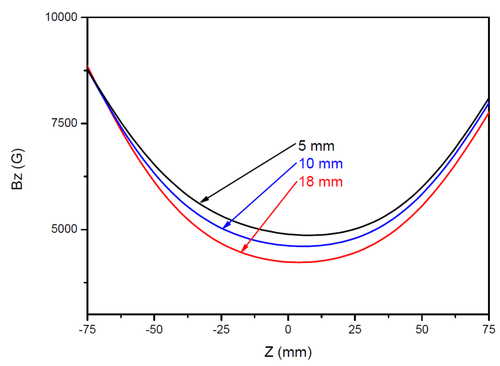


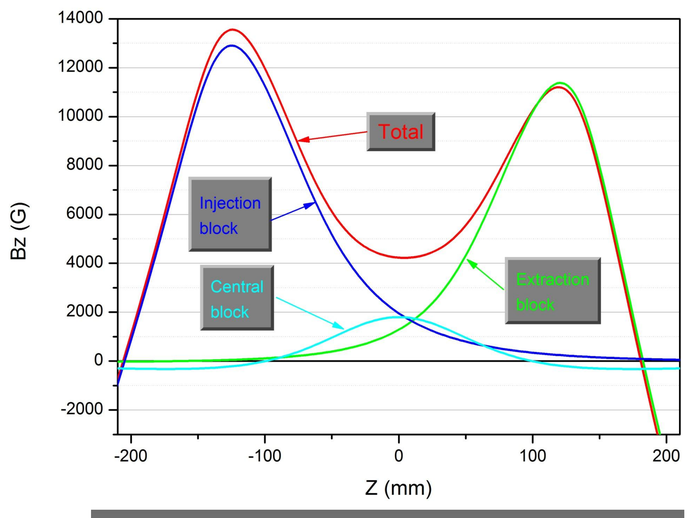
Measured magnetic field distribution along the hexapole pole. With the gaps of about 0.1 mm the oscillations in the magnetic field measured at a distance of 3 mm from the pole are around 10%.

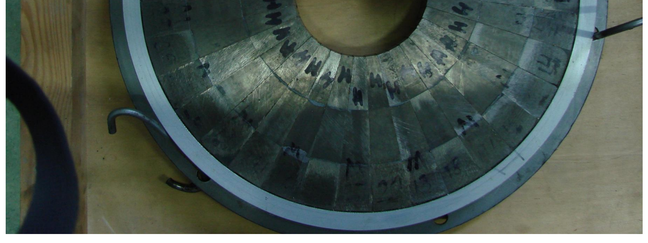
The soft iron plates around the PM rings with the axial magnetization play an important role in the final magnetic field distribution. By changing the thickness, it is possible to tune the minimum field when necessary.

Magnetic structure of DECRIS-PM

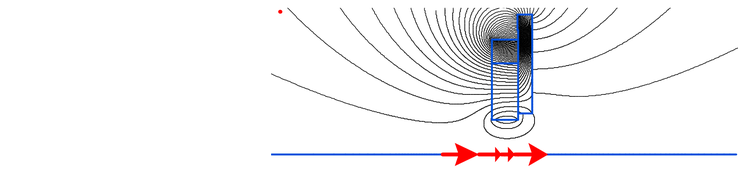


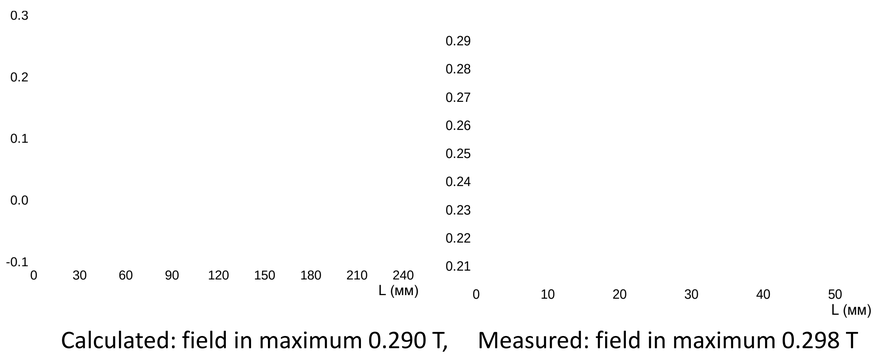






First magnetic field measurements:





Calculated: field in maximum 0.290 T, Measured: field in maximum 0.298 T

Coil effect

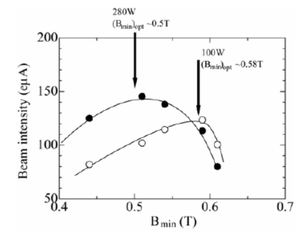


Fig.3 Beam intensity of Ar^{9+} as a function of B_{min} at the RF power of 100 and 280 W.