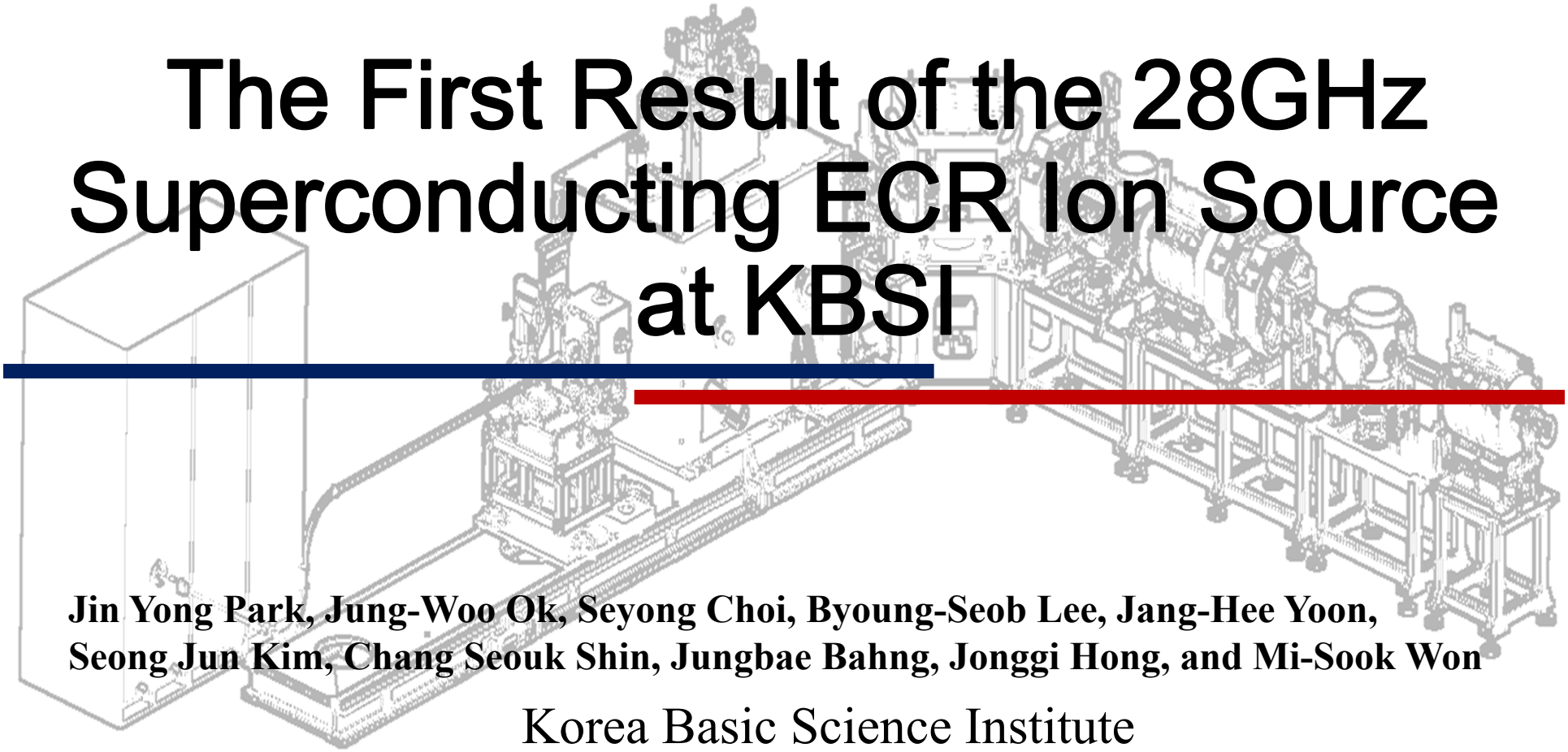
The First Result of the 28GHz Superconducting ECR Ion Source at KBSI



Jin Yong Park, Jung-Woo Ok, Seyong Choi, Byoung-Seob Lee, Jang-Hee Yoon, Seong Jun Kim, Chang Seouk Shin, Jungbae Bahng, Jonggi Hong, and Mi-Sook Won

Korea Basic Science Institute

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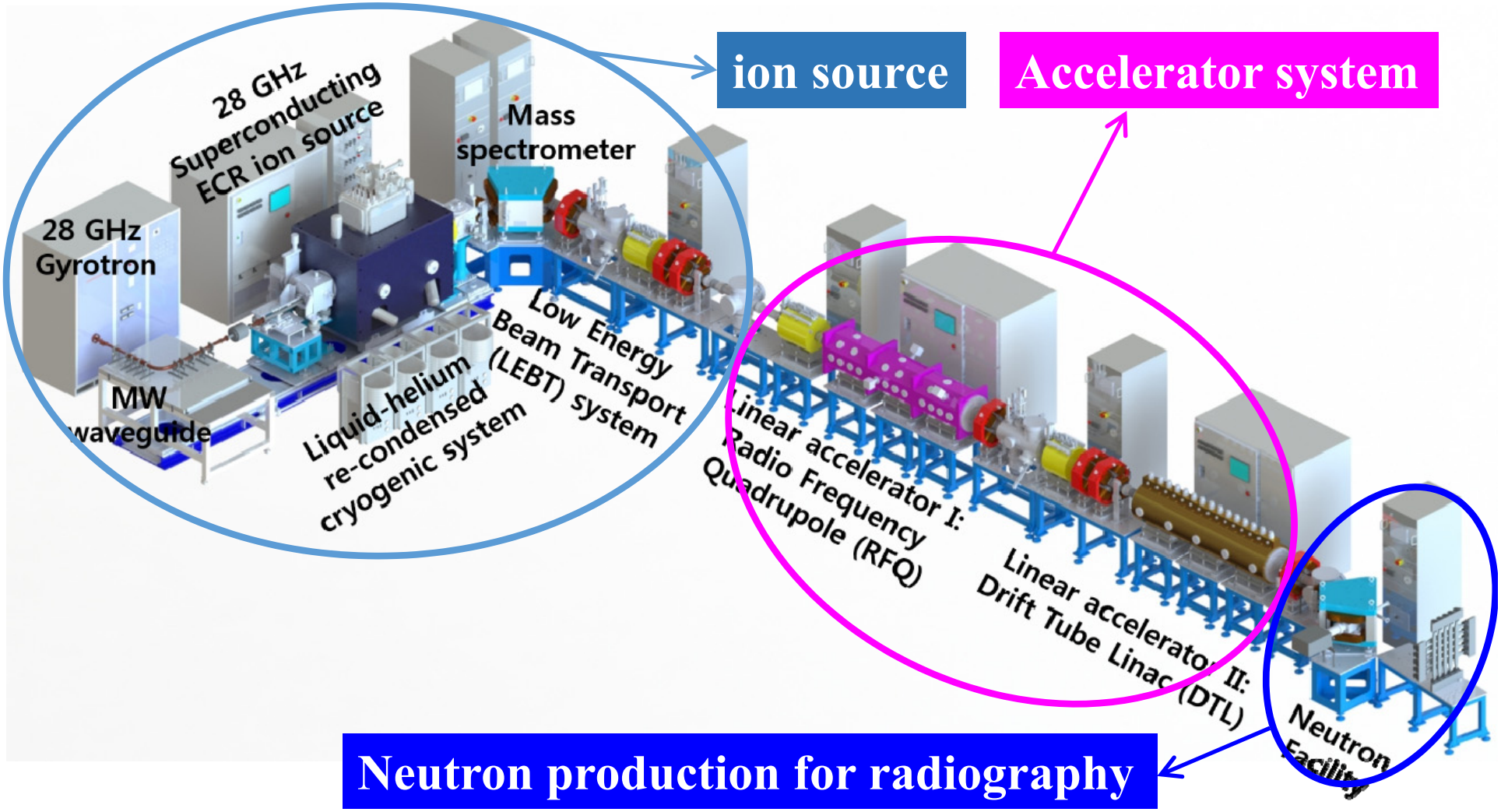
KBSI Accelerator System for Neutron Facility



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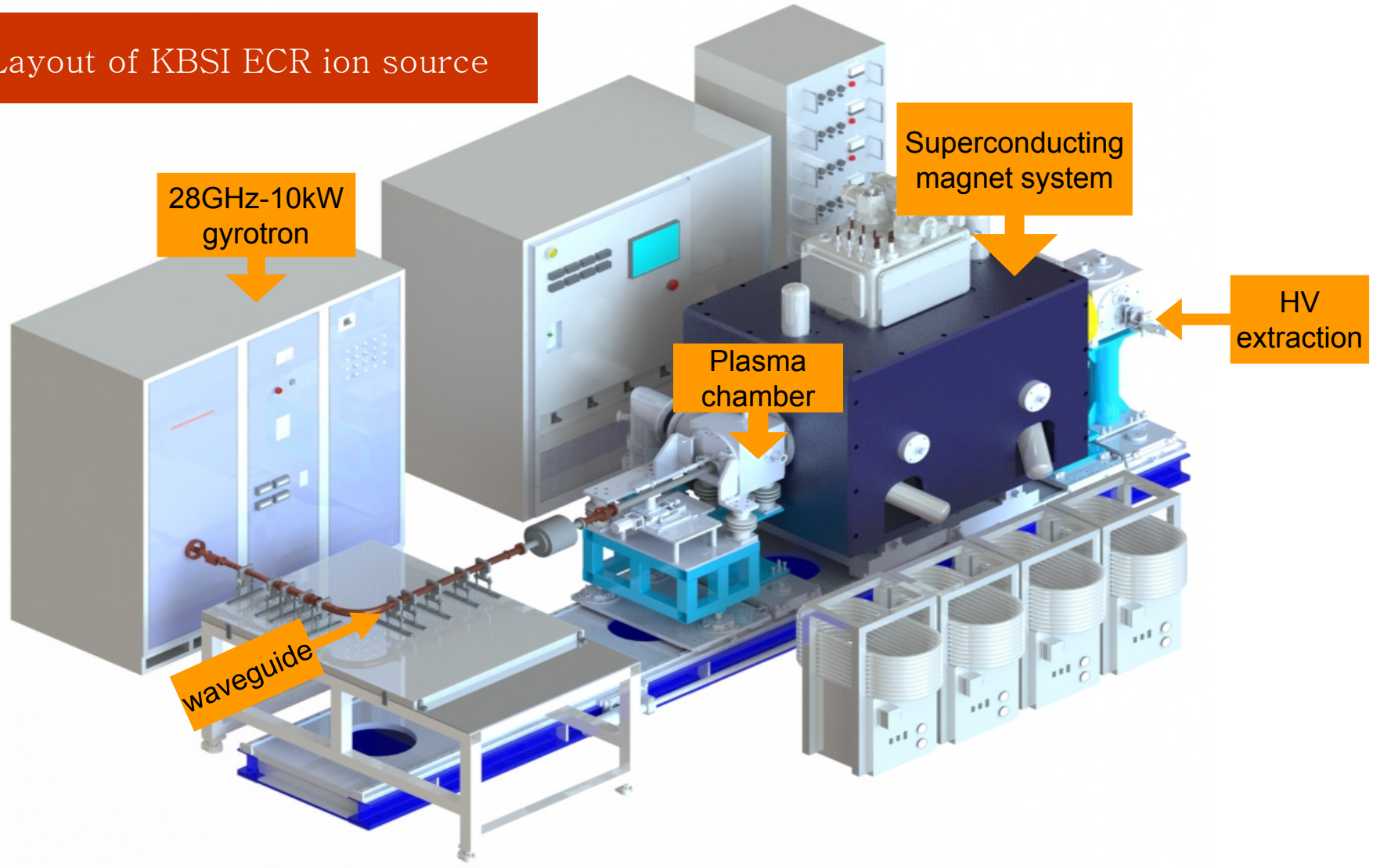
Configuration of KBSI 28 GHz ECR Ion Source

Layout of KBSI ECR ion source



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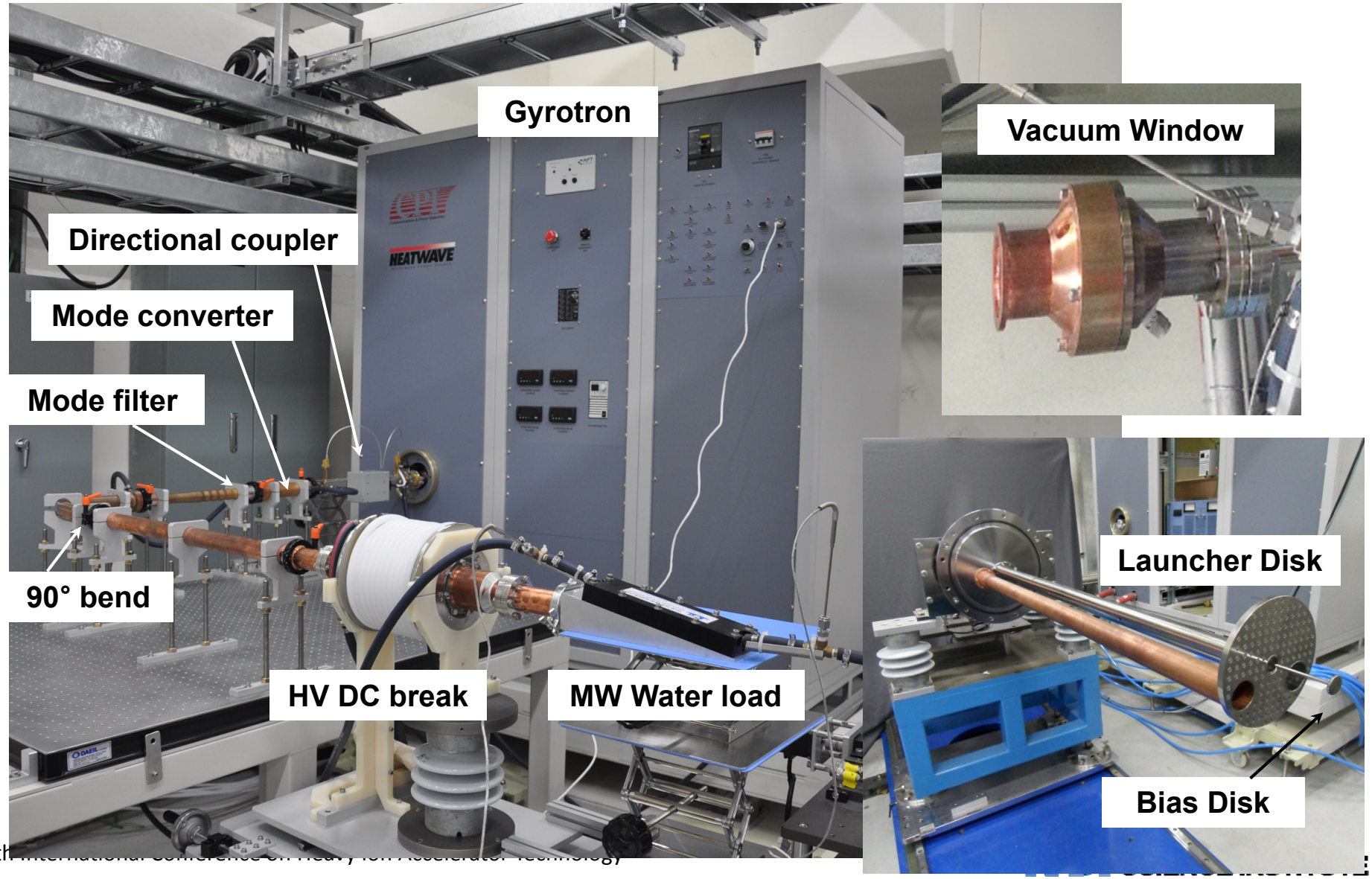
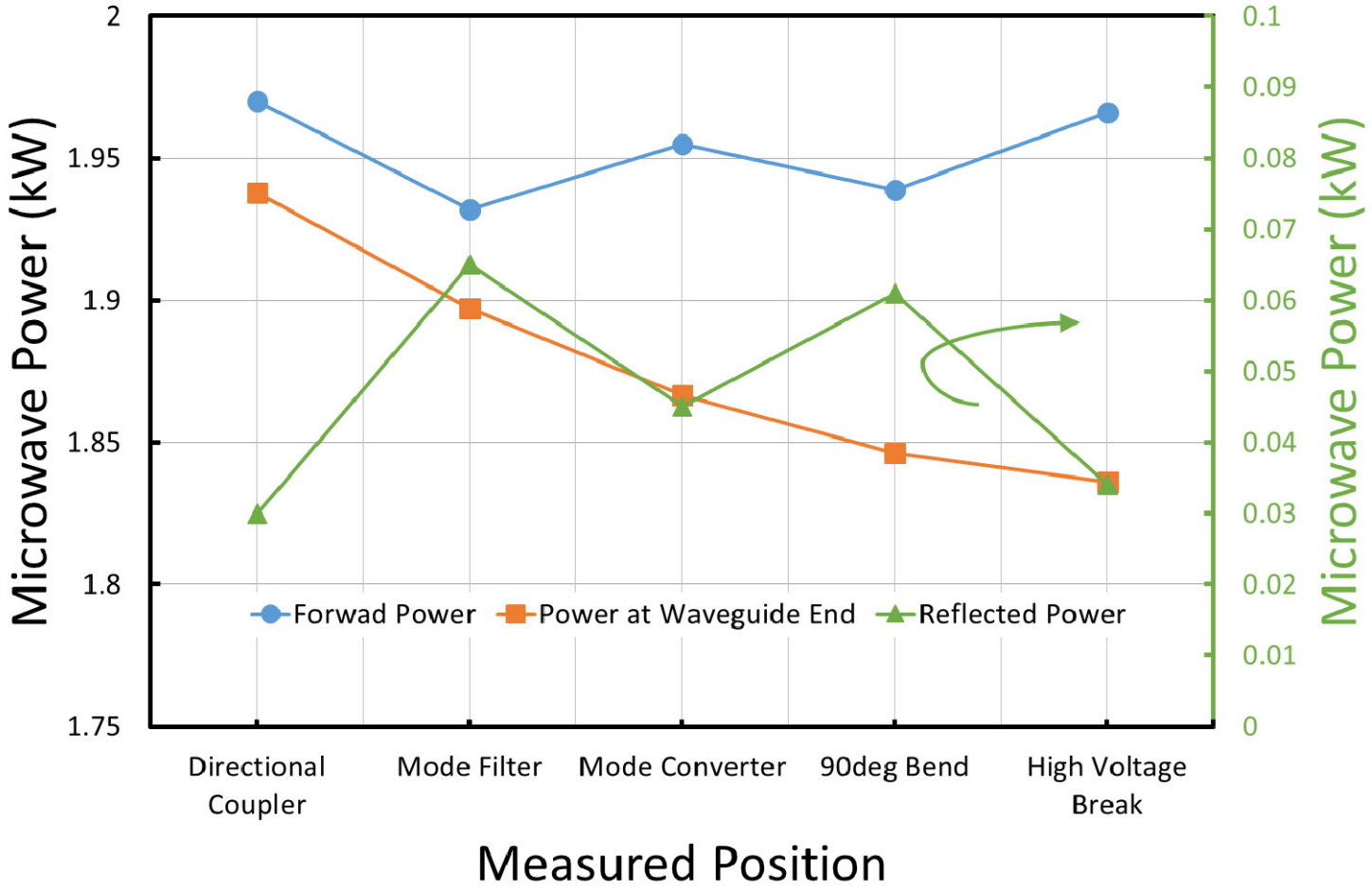
28GHz Microwave System

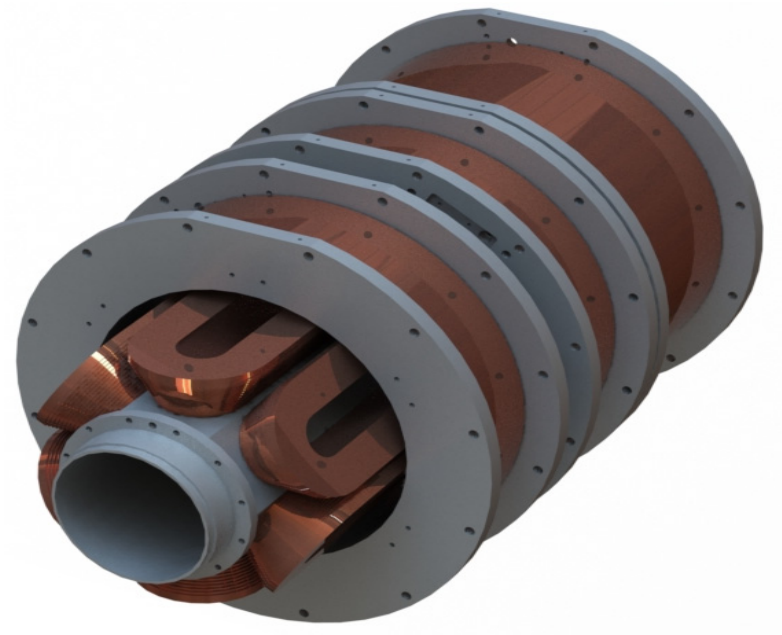


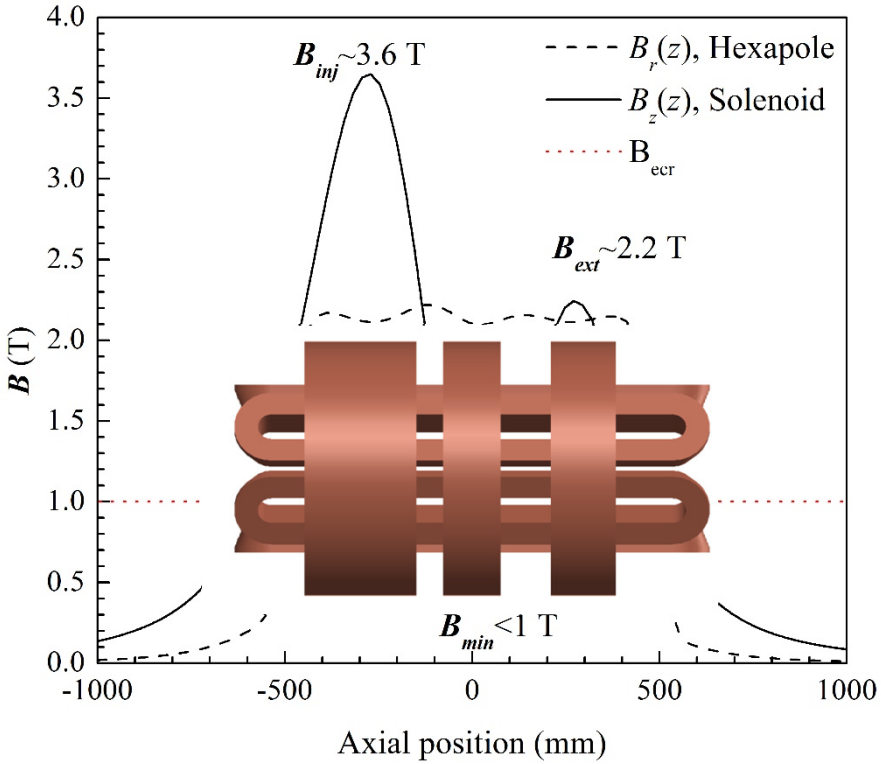
Microwave Power Transmission System



- **The transmitted power to plasma chamber is above 92% at 2 kW**

Superconducting magnet system: Design results

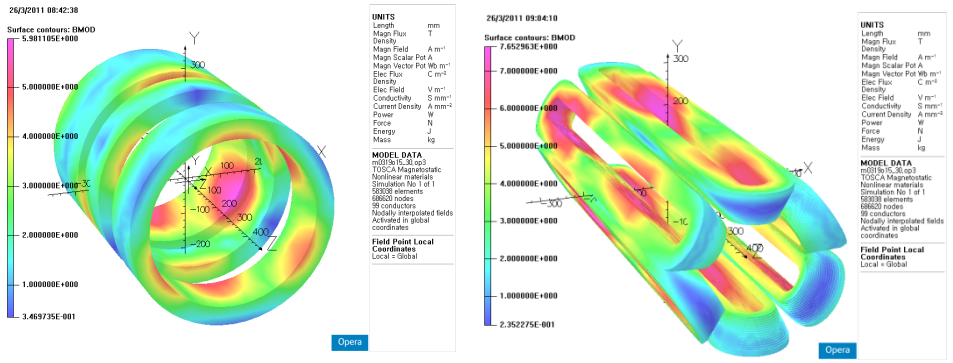


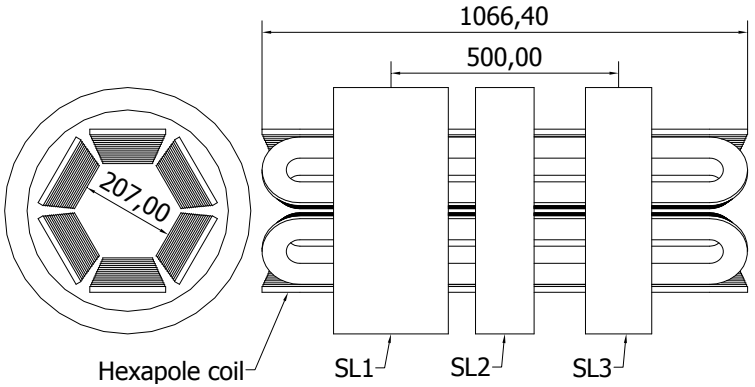


3 Solenoid + 1 hexapole magnet (6 step-type coils)

- **The axial field: ~3.6 T at injection, ~2.2 T at extraction.**
- **The minimum axial field (variable): 0.4 ~ 0.8 T.**
- **The radial design field on the plasma chamber wall: 2.1 T**

Superconducting magnet system: Design results



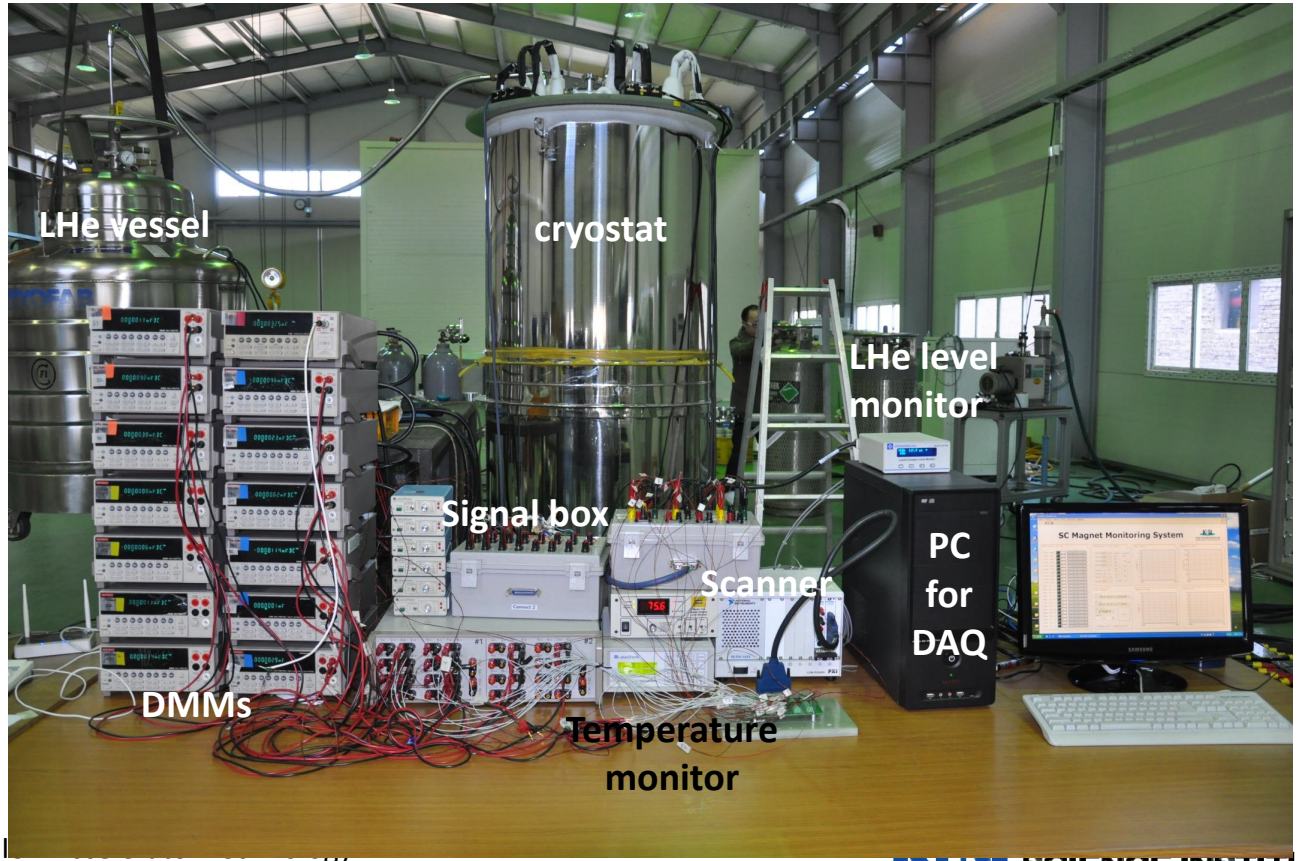


	SL1	SL2	SL3	Hexapole
Axial position of center (mm)	-250	+250	0	0
Inner diameter (mm)	442	442	442	207
Outer diameter (mm)	540.8	540.8	540.8	394.96
Depth (mm)	49.4	49.4	49.4	75.6
Width (mm)	252	128.8	145.6	53.2
Hexapole length (mm)	-	-	-	1066.4
Hexapole inner radius (mm)	-	-	-	30
Conductor size (mm)	0.95 x 1.4	0.95 x 1.4	0.95 x 1.4	0.95 x 1.4
Cu/NbTi ratio	4.9	4.9	4.9	2.32
Turns/coil	9360	4784	5408	2304
Wire lengths/coil (km)	14.5	7.4	8.4	4.9
Current (A)	197	198	197	263
B_{max} (T)	5.98	5.35	4.72	7.65
Inductance (H)	39	13.5	16.5	23

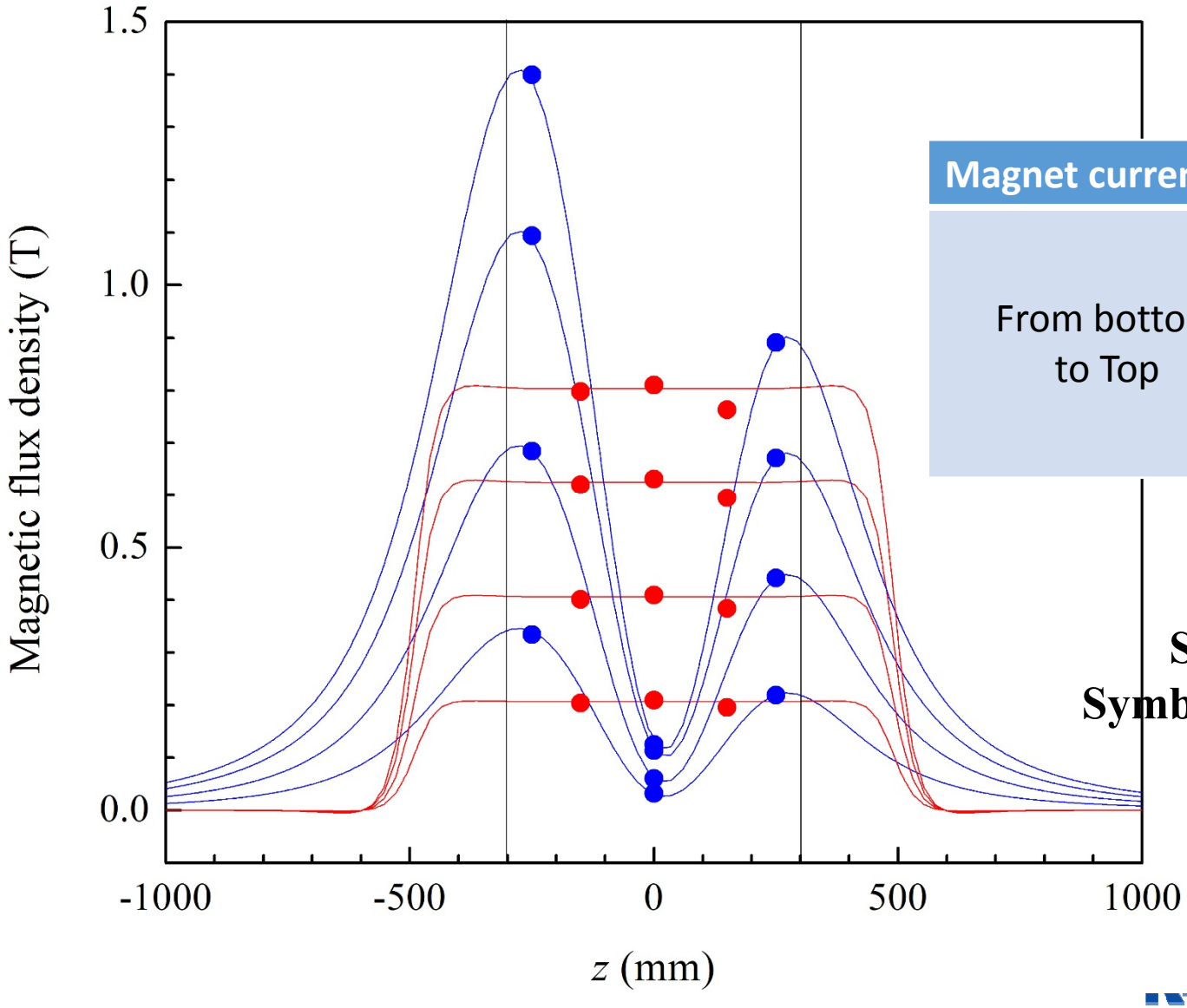
Initial performance test of superconducting magnet

Magnet test at open-type cryostat

- Separate coil performance was checked before final assembly
- Vertical cryostat(open type) was prepared for convenient test
- Magnet status, temperature, magnetic field were observed



The comparison of magnet field between design and experimental values



Magnet current	HP	Sol
From bottom to Top	38A	20A
	51A	40A
	78A	60A
	100A	80A

Blue: HP,
Reds: Sol.
Solid lines: design,
Symbols: experimental

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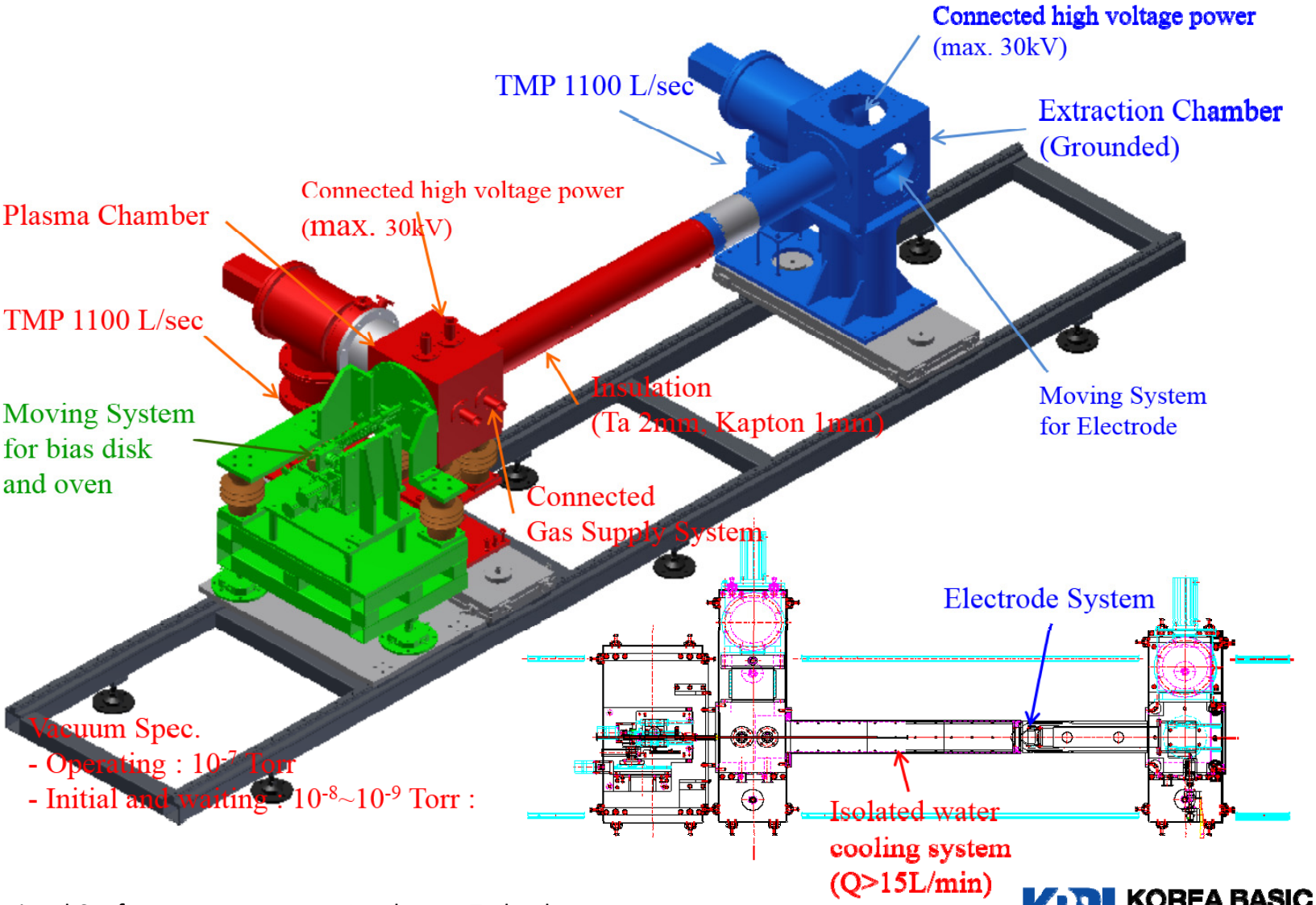
Plasma Chamber & Extraction System



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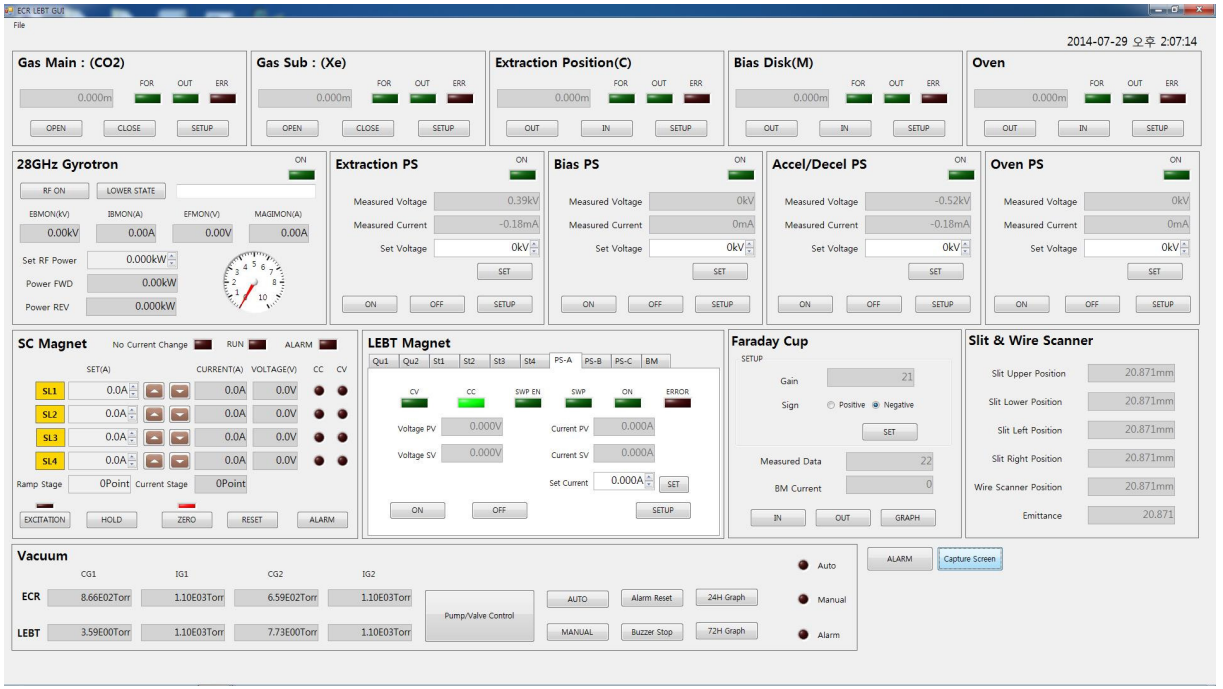
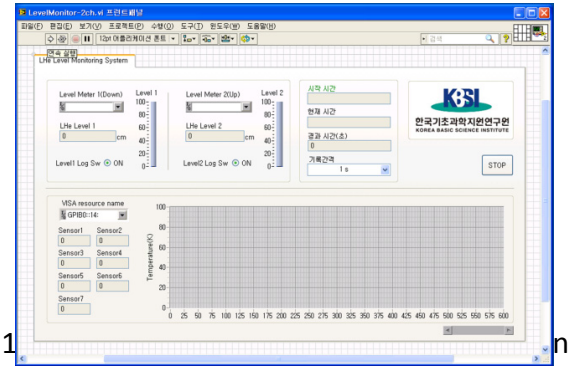
Remote control Program

■ Control Cabinet

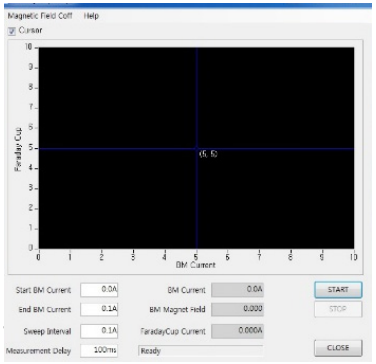
■ Main Control Program



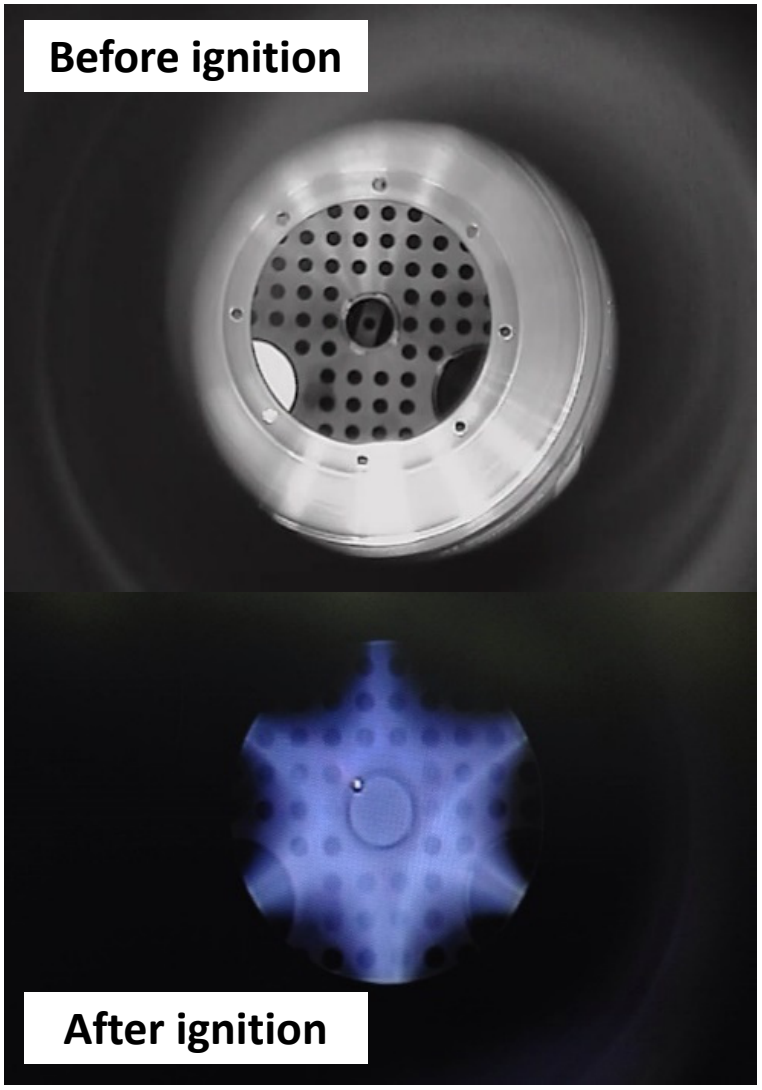
■ SC magnet monitoring

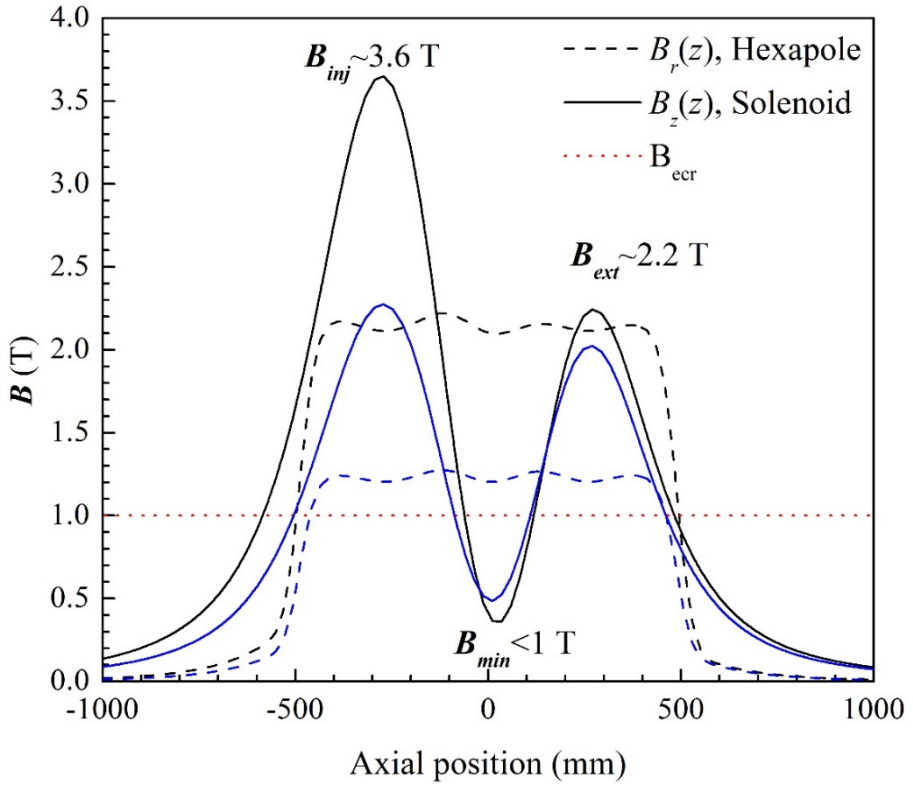


■ Beam Diagnostic Program



First plasmas ignition





Black lines: Design values,

Blue lines: Plasma ignition condition

※ Training of superconducting magnet has been much delayed due to LHe shock.

※ Solenoids performance is now limited by yet-trained Hexapole-magnet.

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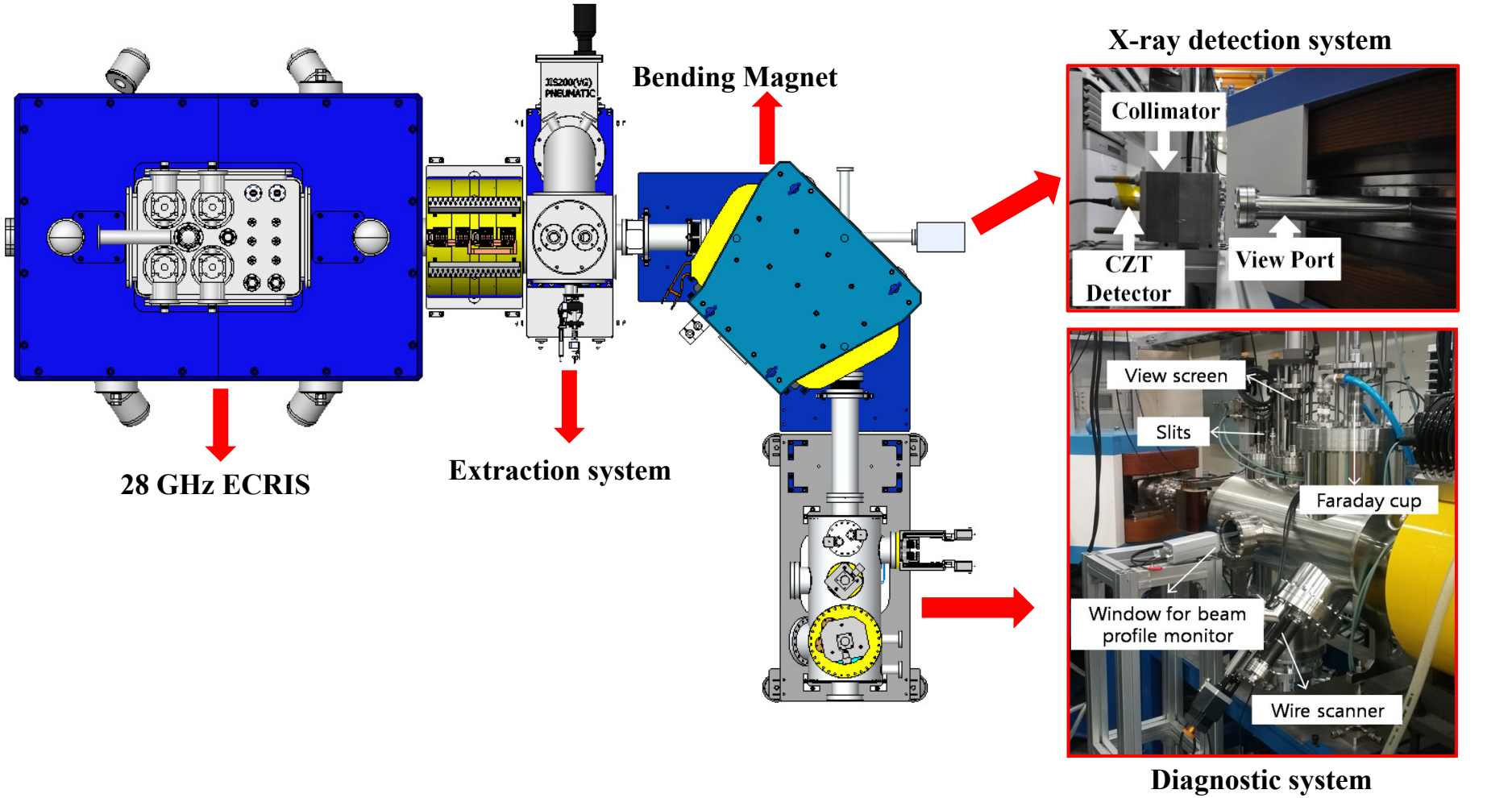
X-ray and Ion beam measurement system



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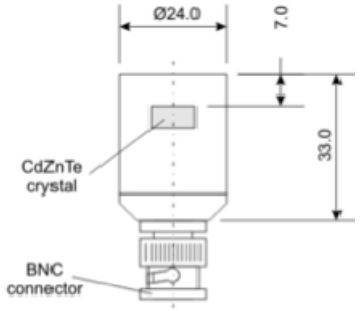
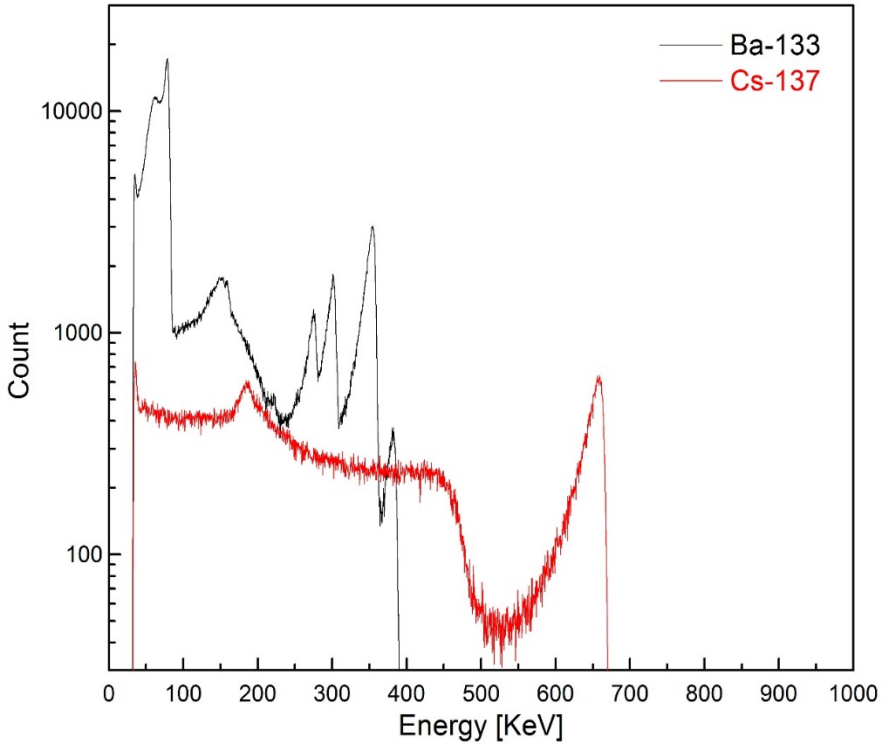
Calibration of the CZT detector

❖ Specification of the CZT detector



Specification	
Detector name	CZT/500 S
Vendor	Ritec Ltd.
Year of fabrication	1998
Basic	
Detector type	CdZnTe
Detector geometry	Quasi-hemispherical
Detector sensitive volume	500 mm^3
Bias voltage requirements	
Detector high voltage	1000 V
Detector high-voltage polarity	Positive
Dimensions	
Diameter	23 mm
Length	33 mm
Distance between a top plane of the housing cover and sensitive surface of the detector	7 mm
Connector	
Detector bias voltage	BNC or SHV type

❖ Calibrated energy distribution



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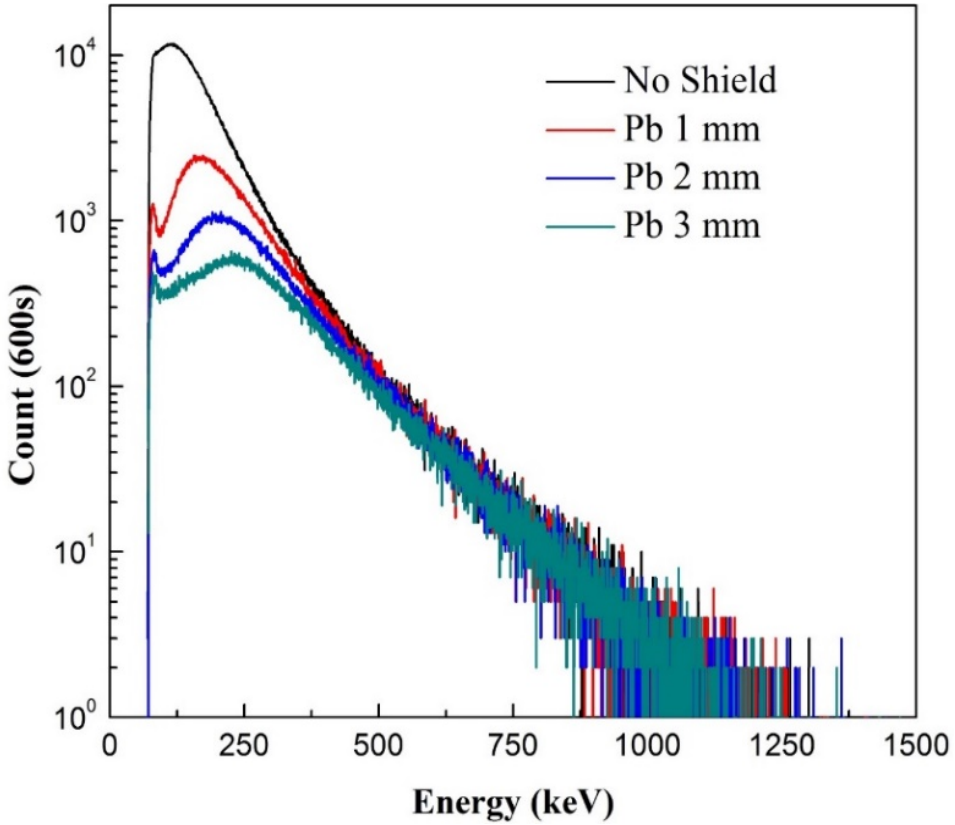
Measured x-ray spectra with respect to the thickness of Pb sheets

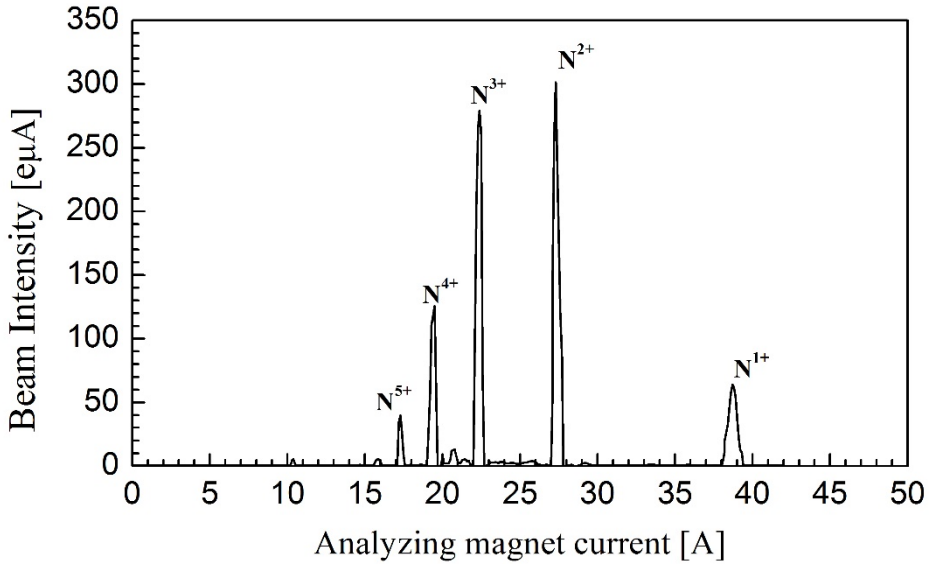
- a comparison of x-ray energy distribution as a function of the thickness of the lead shielding



Pb Sheet	Shielding rate(<600 keV)
1 mm	60 %
2 mm	75 %
3 mm	82 %

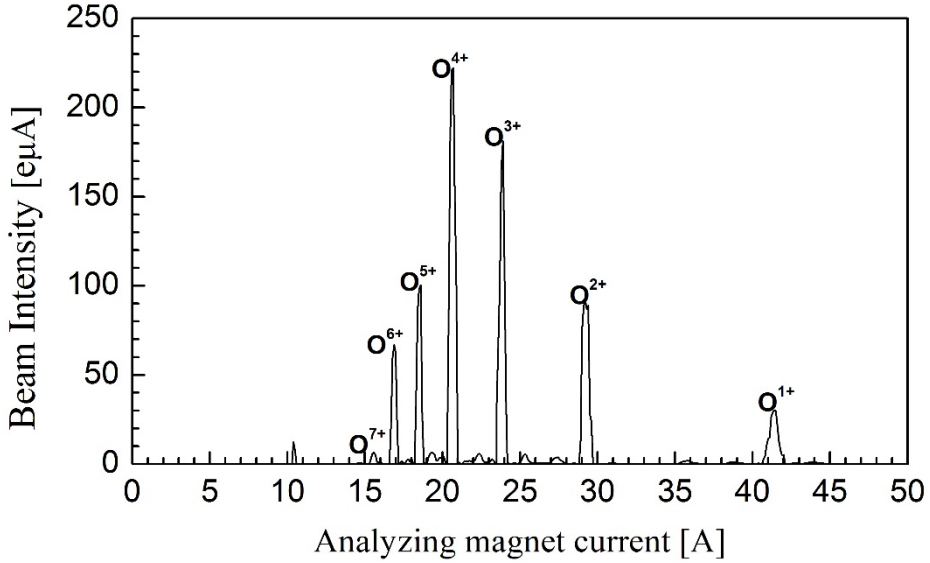
- The x-ray shielding rate was found to be 80 % for 3 mm thick lead shielding

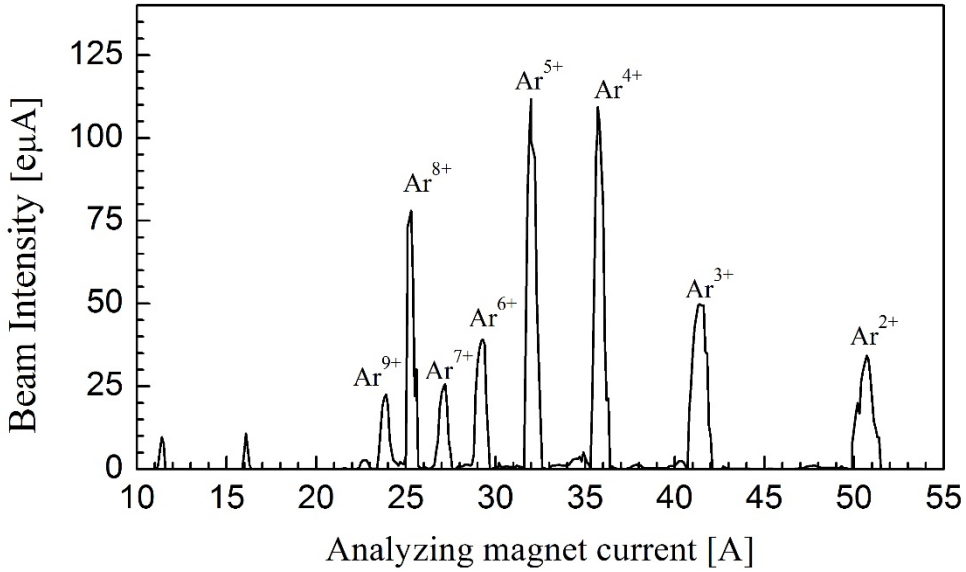
Ion Beam charge spectra



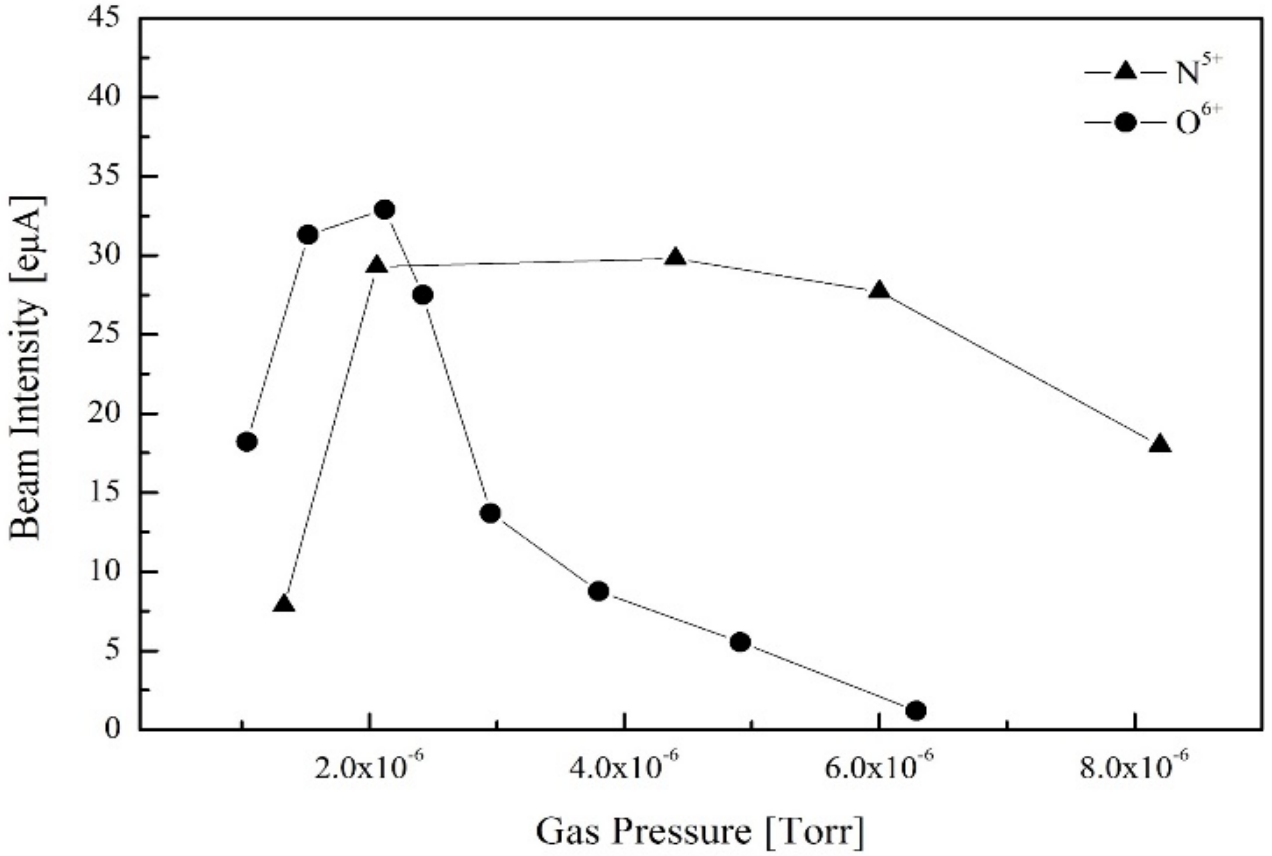
Operation conditions

- Microwave Power =1 kW
- B_{inj}= 2.3 T , B_r= 1.2 T , B_{ext}= 2 T
- 13 kV (extraction voltage was fixed)



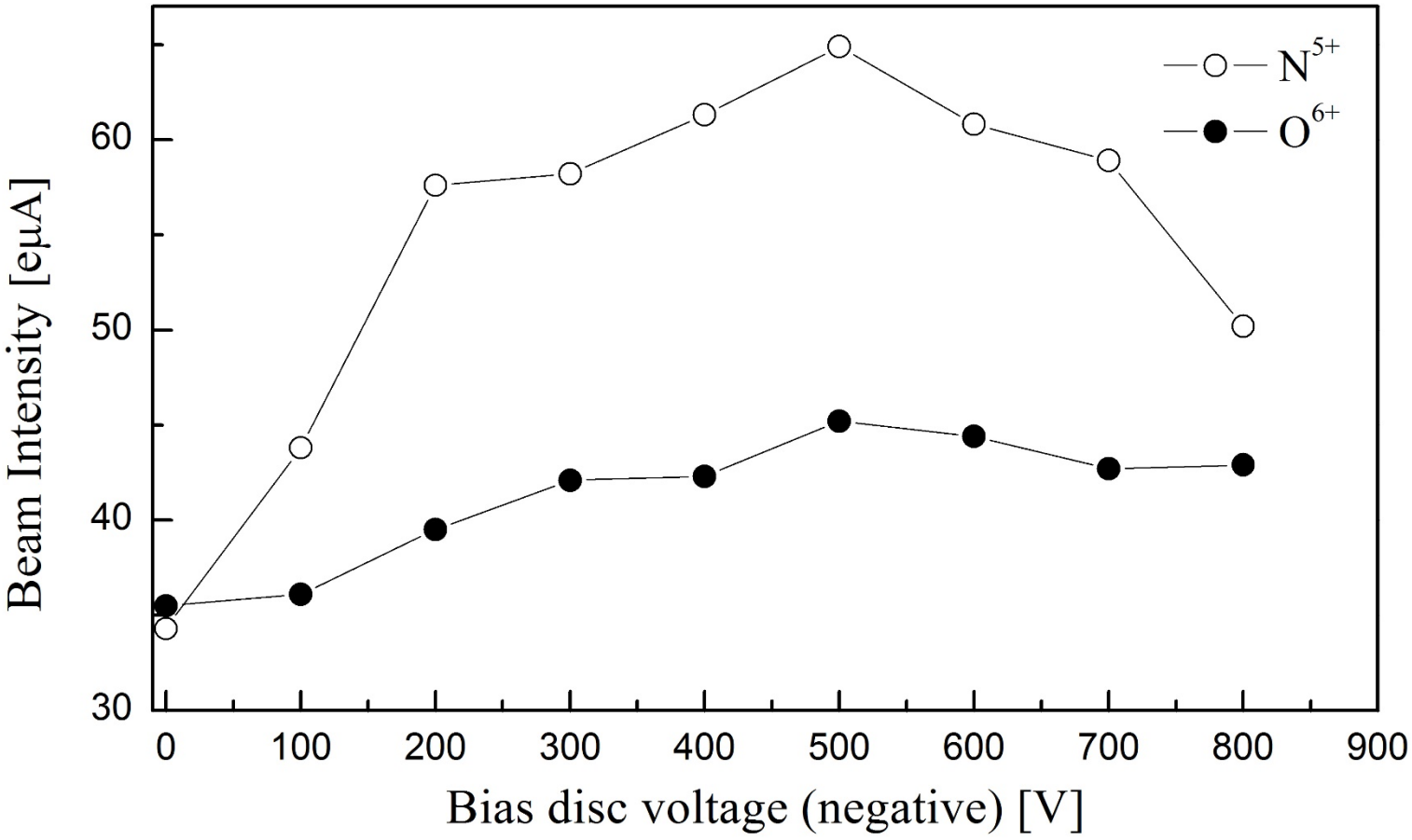


Result as a function of gas pressure



- The gas pressure represents the vacuum range of plasma chamber at the injection side after supplying the gas.
- The optimum beam intensities is found when the gas pressure is supplied around 2×10^{-6} Torr.

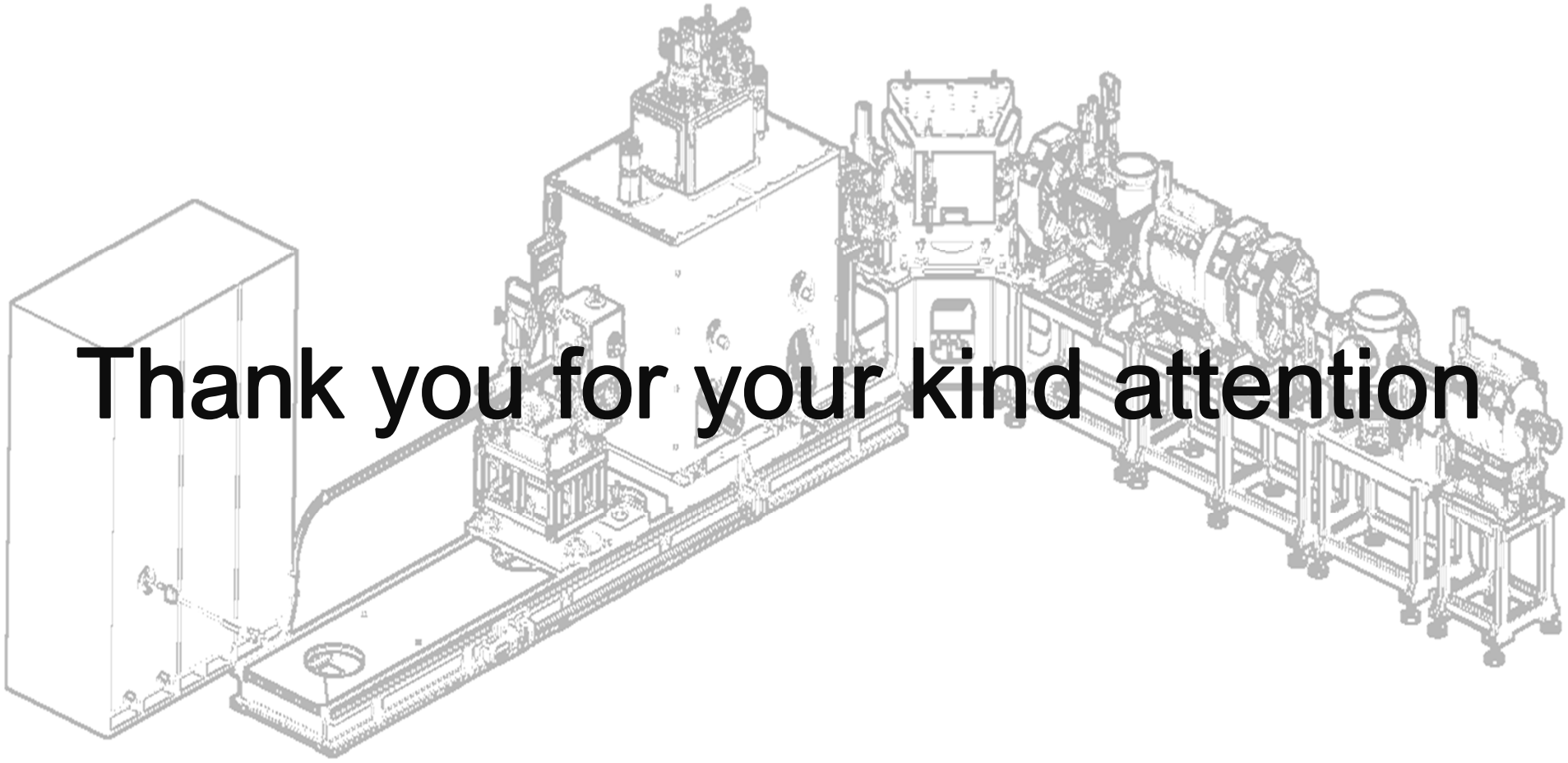
Result as a function of bias disc voltage



- the beam intensities of N^{5+} and O^{6+} as a function of biased disc voltage (negative)
- The beam intensities are increased at the voltage about -500 V.

Conclusion & Future Plan

- **We successfully produced charged heavy ions at microwave power 1 kW with 28 GHz microwave.**
- **We measured x-ray spectra from KBSI 28GHz ECR ion source.**
- **We will shield the plasma chamber by use the Pb or Ta sheet, which thickness is more than 2 mm.**
- **The magnetic field must be increased to the design value**
- **We need further improvement of the performance of 28GHz KBSI ECR ion source.**



Thank you for your kind attention