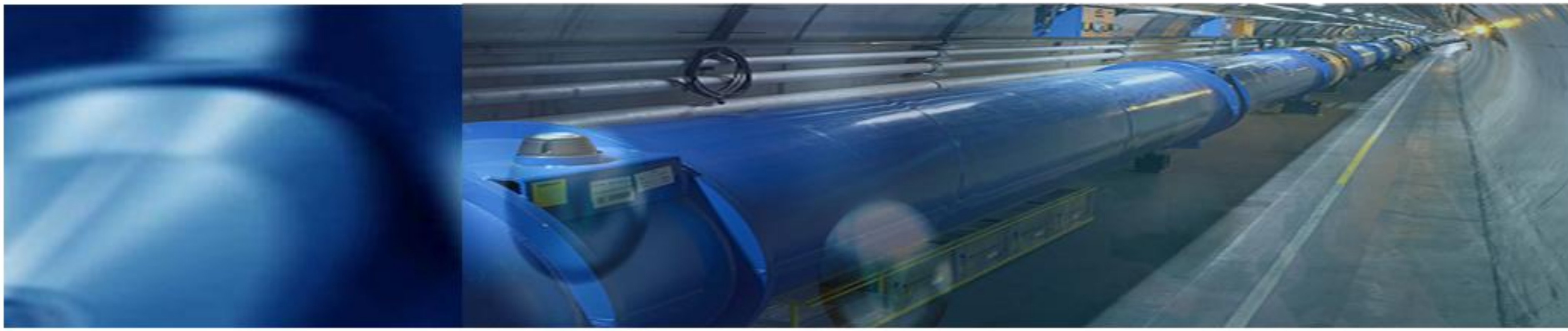
AnME Lab. of Accelerator & Medical Engineering

Design study of 8 Mev Injector Cyclotron for K 100 SSC



Sungkyunkwan Univ.
OH JINWHAN

SKKU UNIVERSITY

Sungkyunkwan University

SKKU is the oldest university in KOREA

It is founded by Lee Dynasty since 1398

SYMBOL : Ginkgo tree

1398

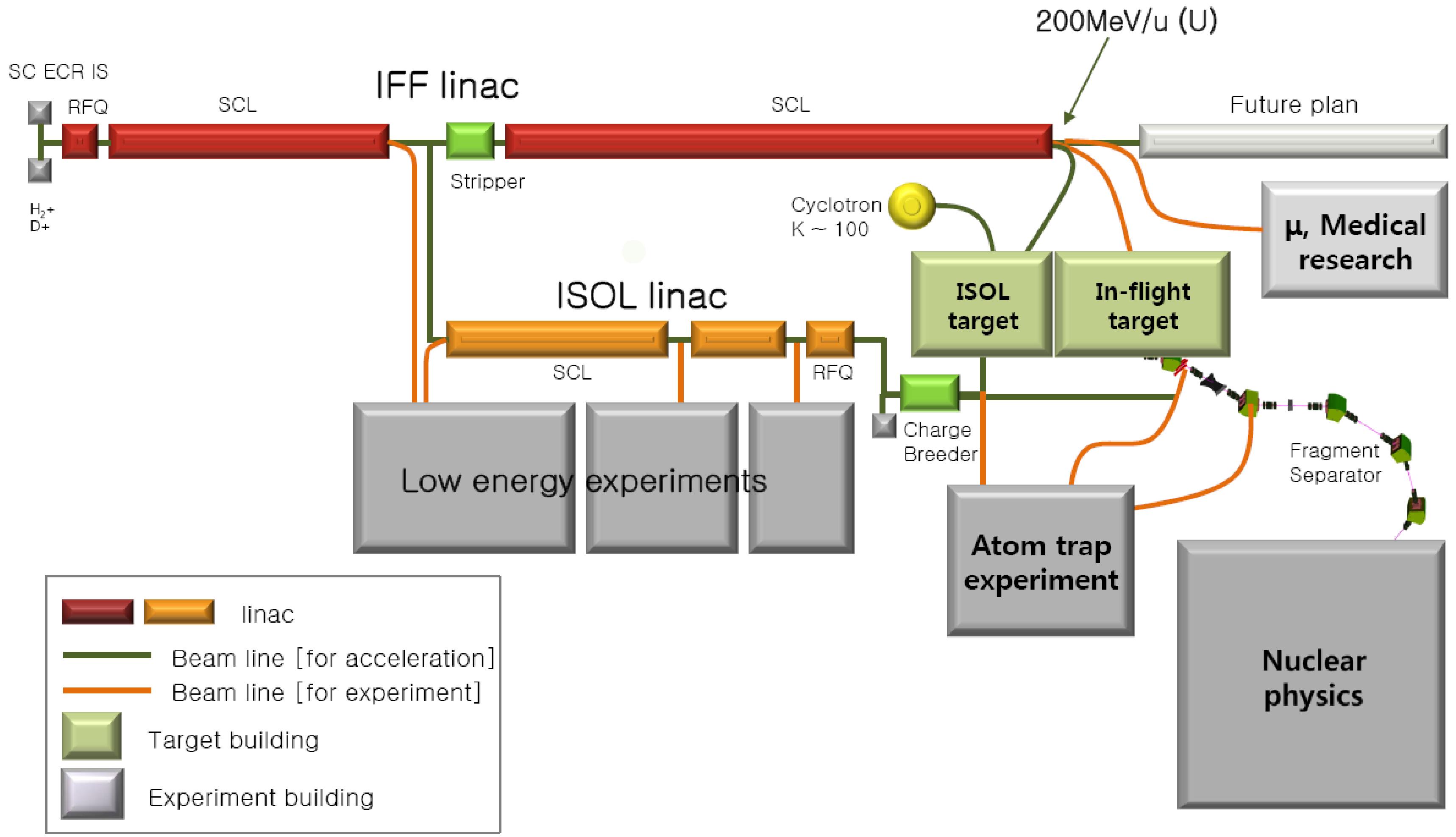
Sungkyunkwan University

Humanity and Social science campus (Seoul)

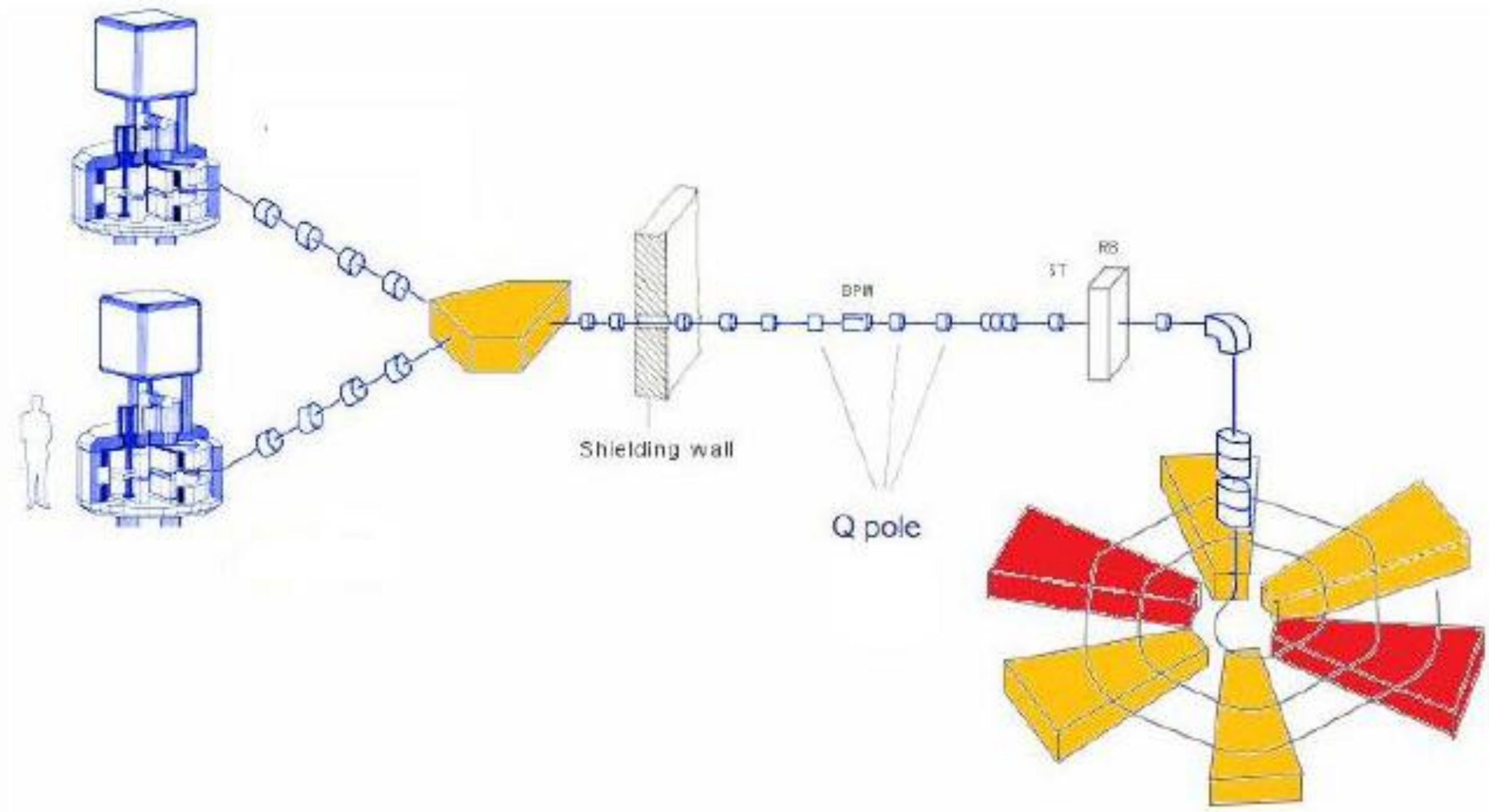
Accelerator and Medical engineering Lab.

Natual science campus (Suwon)

KoRIA layout

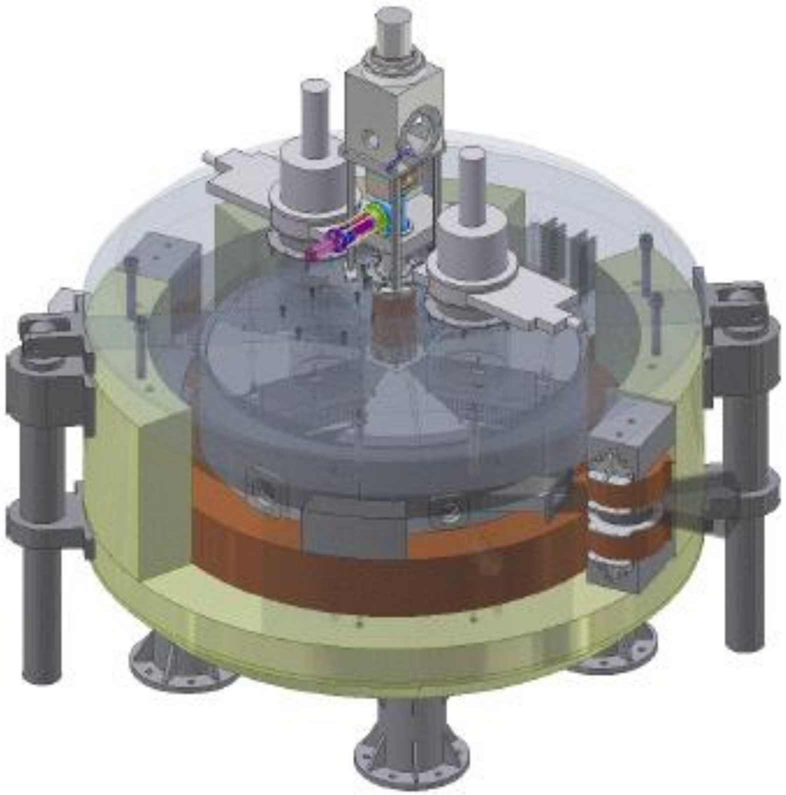


Layout of ISOL Driver



8 MeV Injector Cyclotron

8 MeV SF Cyclotron
4 Sector Magnet
Deep Valley
4 th Harmonics
Expected Beam Intensity
500uA ~ 1 mA

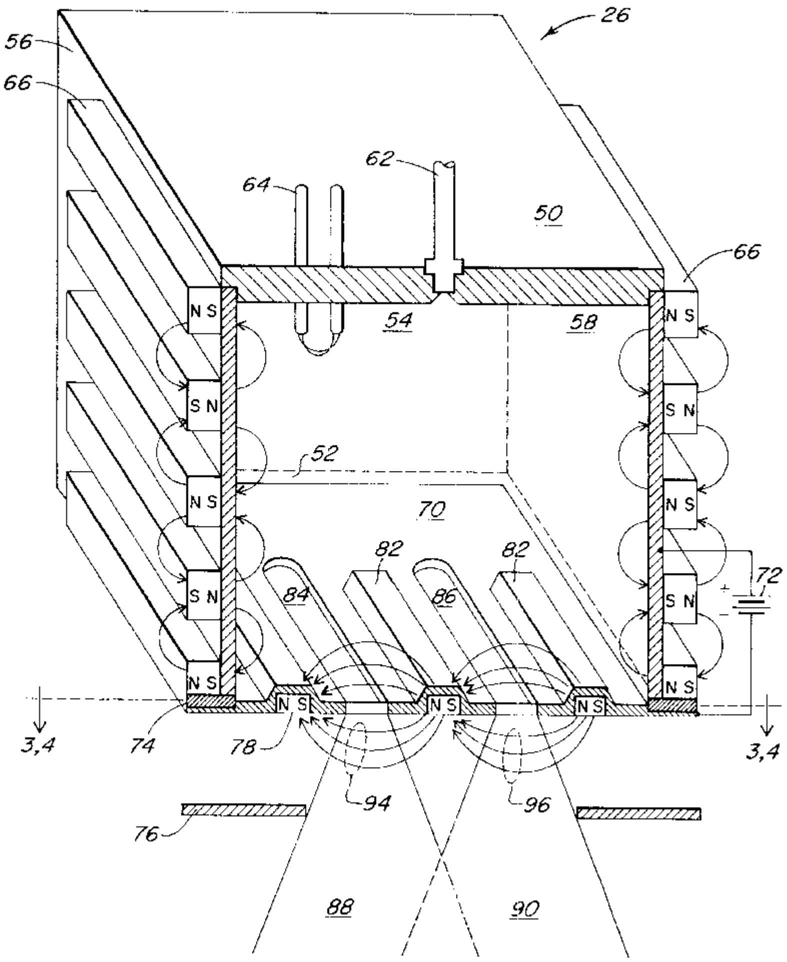


Specifications of SF Cyclotron

	Parameters	Values
Ion source	Multi-cusp DC Type	
	Max. Extracted Beam Current	15mA
	Max. Arc Volt.	150V
	Type of Extracted Ion	H-, D-
Injector System	Buncher Max. E-potential	200 V
	Solenoid-Q doublet OP. power	35W
	Inflector electrode potential	10 kV
Magnet	Pole/Extraction Radius	0.4m / 0.35m
	Diameter	0.8 m
	Hill Angle	48°
	Center field	1.15T
	Max./Min B field	0.3T / 1.95T
RF System	Frequency/ Harmonics Number	74.3MHz/4^{th}
	Dee Number/Dee angles	2 /40°
	Dee Voltage/Q-value	50kV/5981

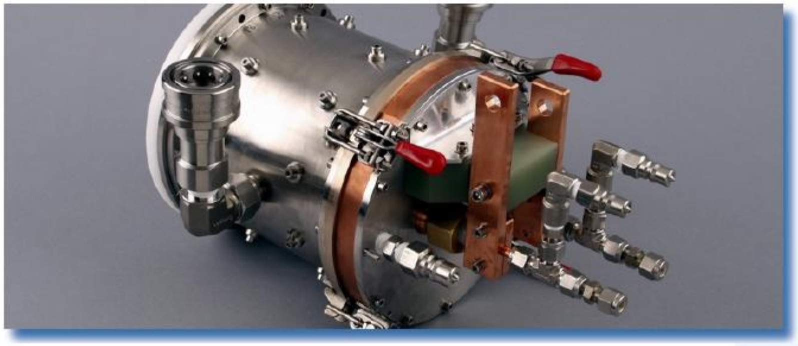
MultiIon source

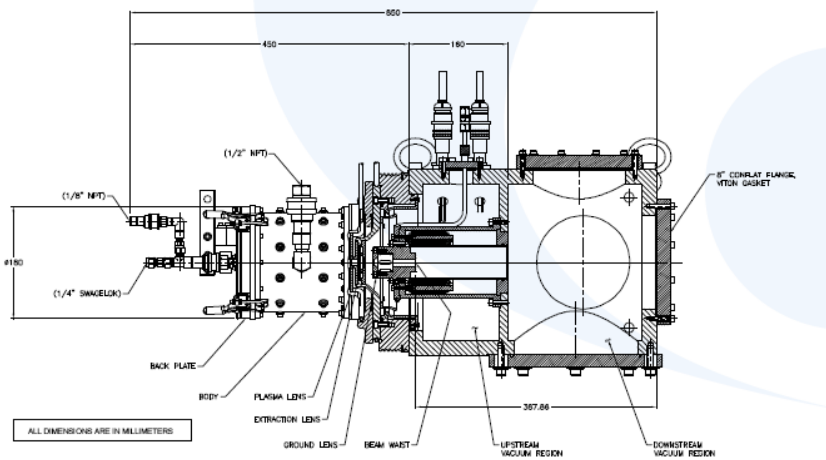
- The primary ionizing electrons are emitted from tungsten-filament cathodes
- The source chamber walls form the anode
- The surface magnetic field generated by rows for permanent magnets



Ion source

Parameters	Values
Particle type	H-
Beam Current	0 to 15mA
Beam K.E.	20 to 30 keV
Normalized 4rms Emittance	<1mm*mrad
Beam Purity	>98%
Filament Lifetime	>350 hours at peak current





Ion source

It consists of three major parts: body assembly, lens assembly and vacuum box assembly.

Lenses are plasma lens (first electrode) and extraction lens (second electrode) with magnet filter to remove the extracted electron and re-enter beam.

Vacuum box is the third electrode and it consists of steering magnet for plasma confinement.

The ion source is filled with hydrogen gas. When the filament current flows, the thermal electron is extracted from filament.

This extracted thermal electron is accelerated to the cusp-body. In this situation thermal electrons are collided with cusp-body's hydrogen and generate H^- ions

Injection region

Buncher

The aim of Buncher is bunching of negative hydrogen from ion-source.

It is composed of RF signal generator, RF amplifier, RF matching circuit, double gap buncher and frequency tuner.

Maximum electric potential at the centre pole is 200 V. Distance between gap is 18.7mm which is calculated by $(\beta \cdot \lambda)/2$.

When the DC negative hydrogen beam incident into buncher, the energy distribution of ions is formed by double gap.

It becomes a kind of bunch shape with condensation and rarefaction of ion at specific distance by the difference of energy.

Injection region

SQQ

Solenoid-Q doublet is located at the centre hole of upper magnet yoke.

Solenoid lens is used to convert the rapid magnetic field variation to gradual one.

Spiral inflector accepts reasonable beam size and transverse distribution by Q-doublet lens.

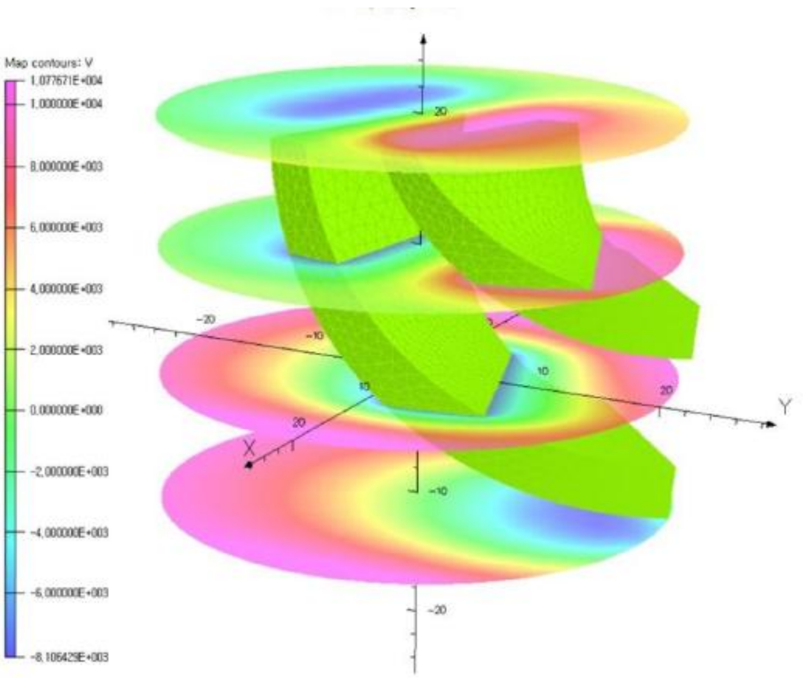
The Maximum beam size in SQQ occurs at the centre of solenoid along the axial direction.

Injection region

Inflector

To inject the pulsed beam which given in the magnetic field along the SQQ located at the upper yoke of magnet in horizontal orbit plane, we use spiral inflector.

It is the main factor that minimizing distortion and loss of quantity with safe arrival in the middle plane including proper matching when the beam change its orbit.



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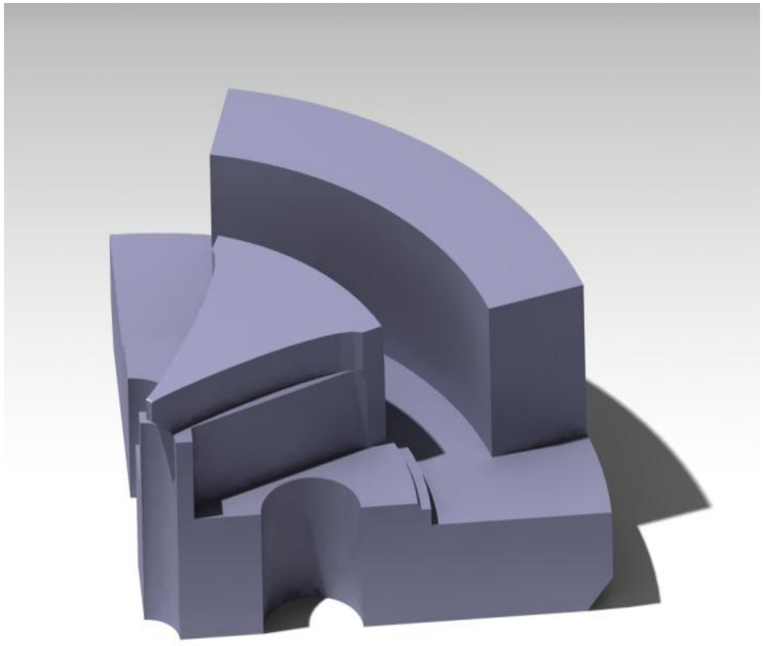
Magnet

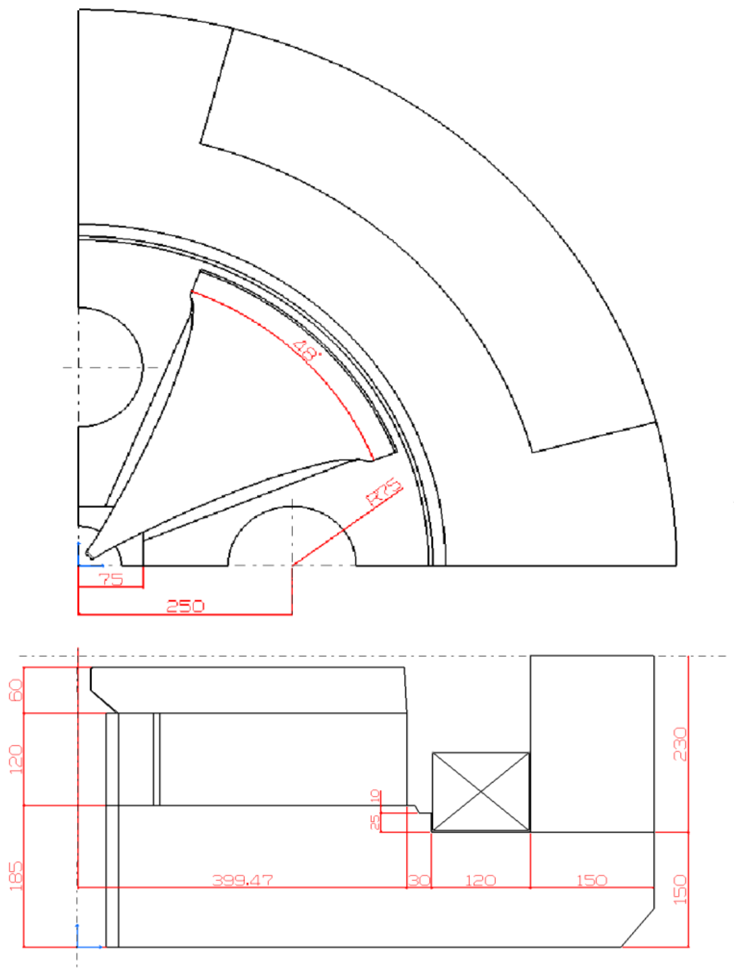
Parameters	Values
Maximum energy	8 MeV / 4 MeV
Beam species	H-, D-
Central field	1.15 T
Pole radius	0.40 m
Extraction radius	0.35 m
Number of sectors	4
Hill / Valley gap	0.03 / 0.39 m
Hill angle	48°
B-field (min.,max)	0.30, 1.95 T

Parameters of magnet

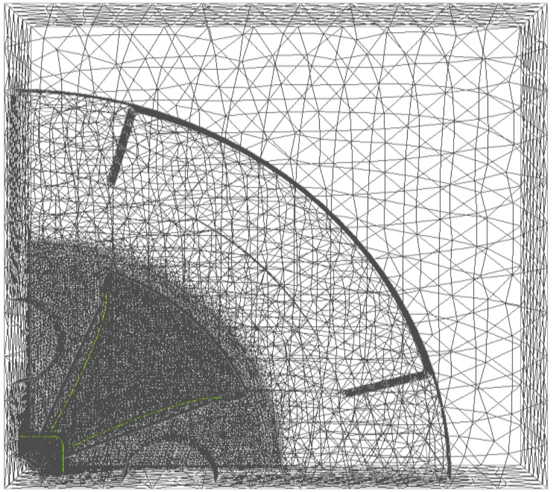


1/8 model of designed magnet.

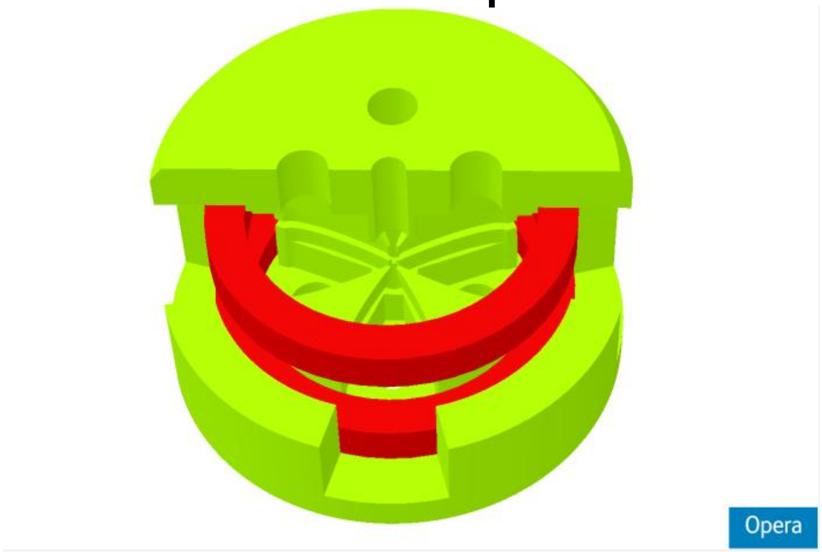
Magnet



2D drawings converted from 3D drawing

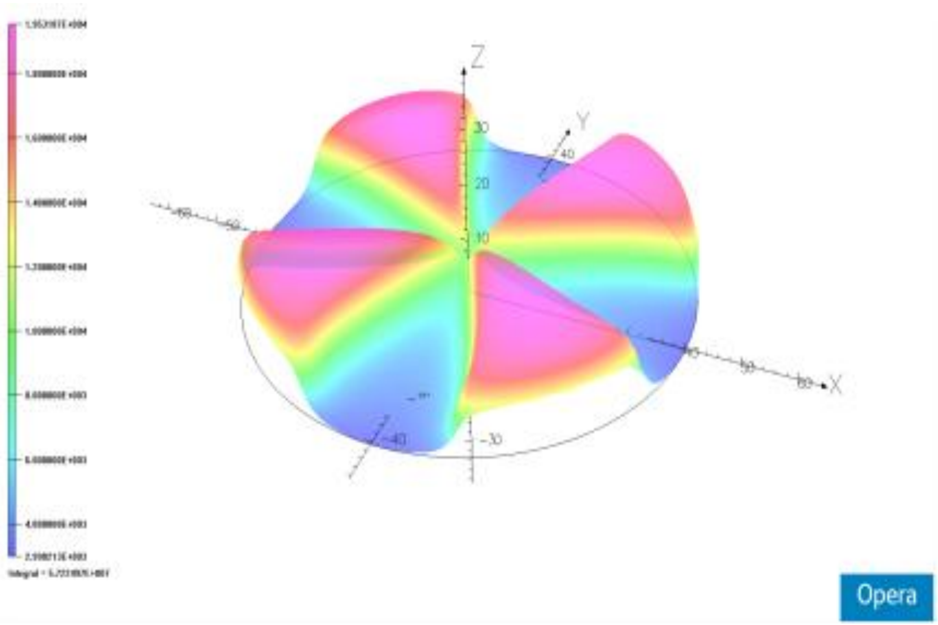


Local meshed model for precise simulation.

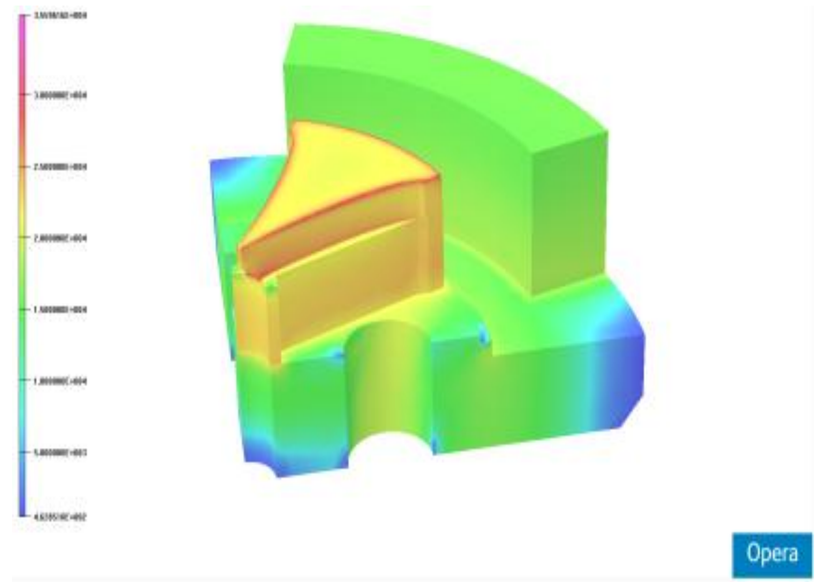


Model of magnet system and main coils.

Magnet

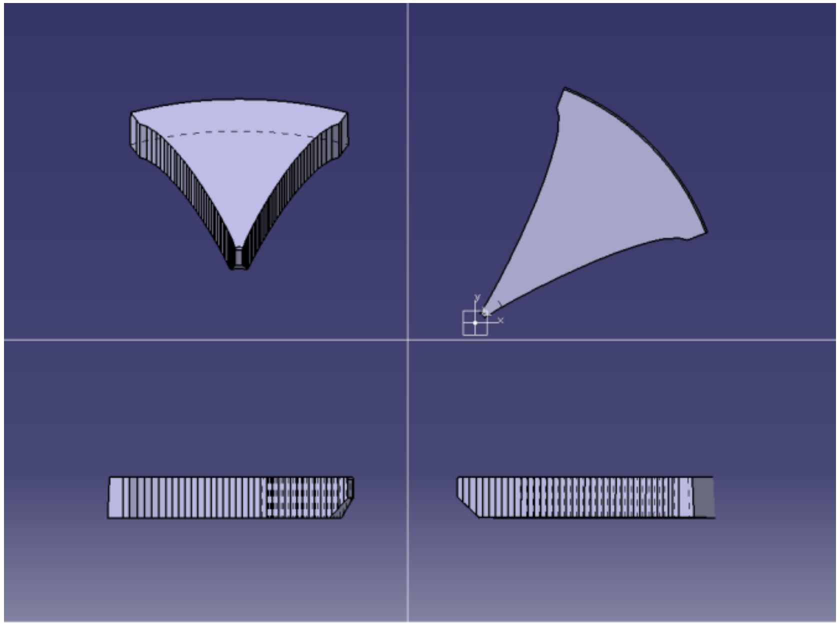


histogram of magnetic field on mid-gap

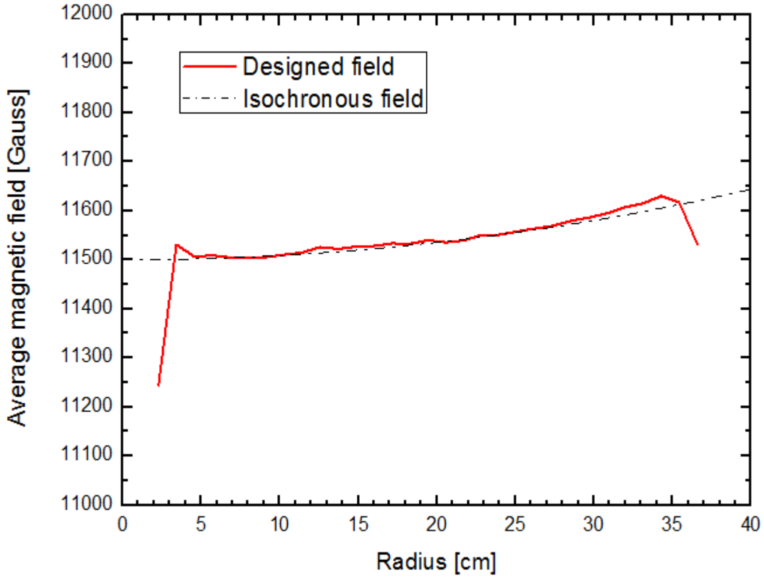


field on the surface of model

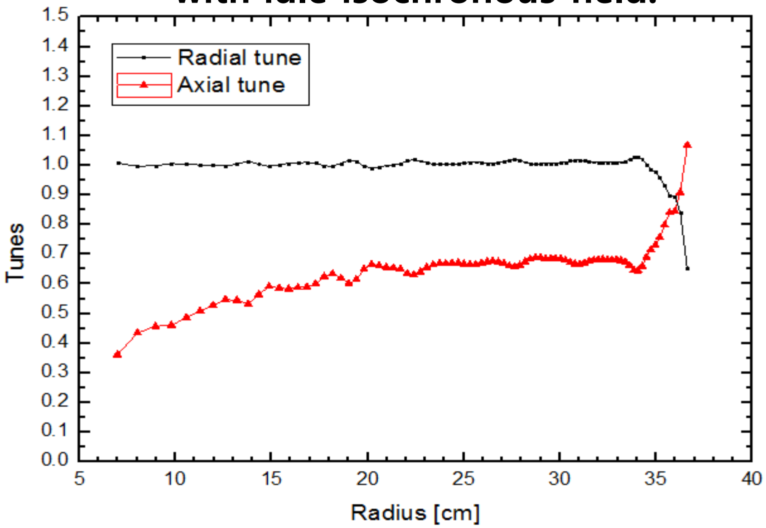
Magnet



Side shim design using CATIA V5



Average magnetic field graph of designed magne with idle isochronous field.

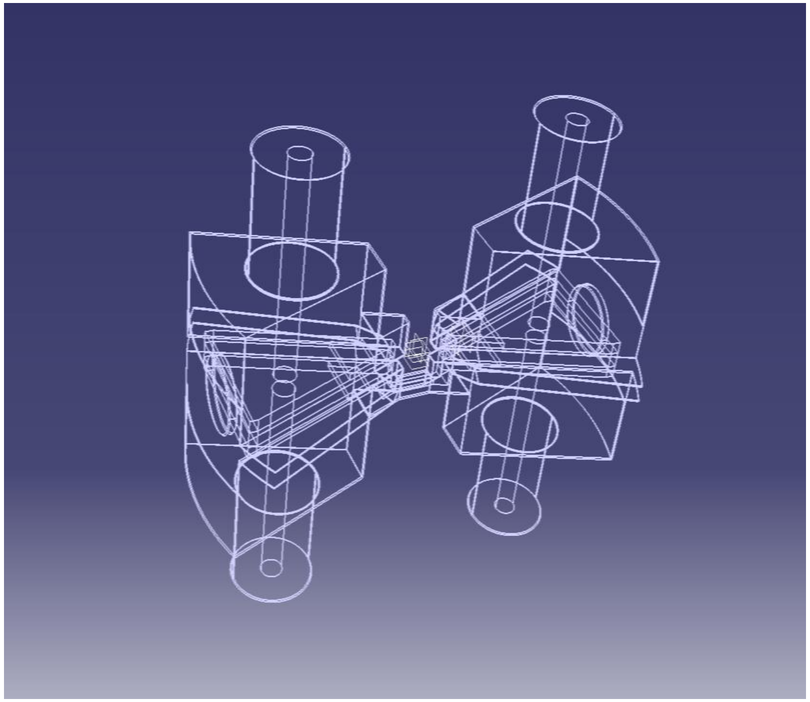


Radial and axial beam tunes.

RF cavity

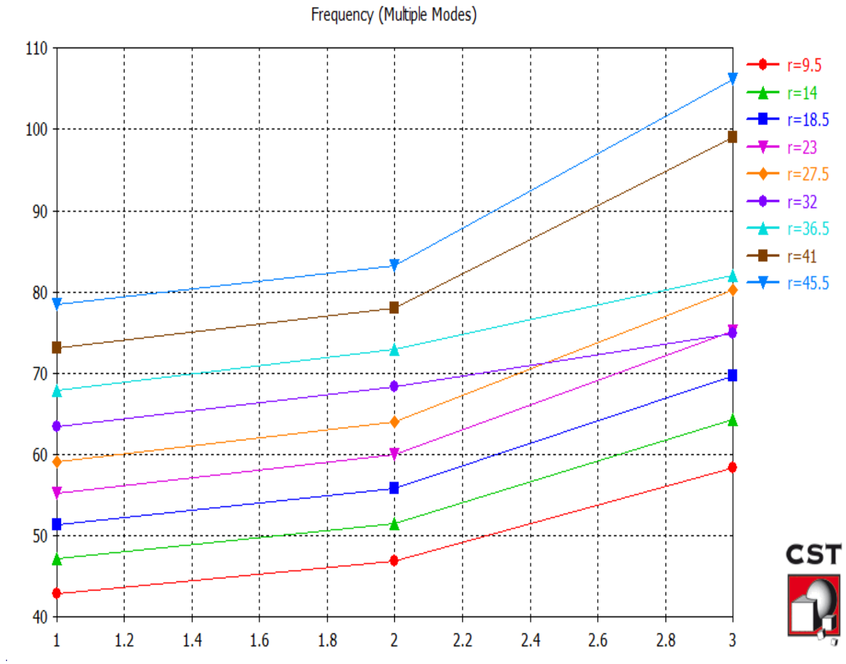
Parameters	Values
Resonant Frequency	74.33MHz
Harmonic Number	4^{th}
Dee Voltage	50kV
Resonant mode	λ/2
Material	OFHC Copper
Pole radius	0.40 m
Hill/Valley gap	0.03 / 0.39 m
Dee angle	40°
Number of Sector/Dee	4 / 2

Specification of RF system for 8MeV Cyclotron

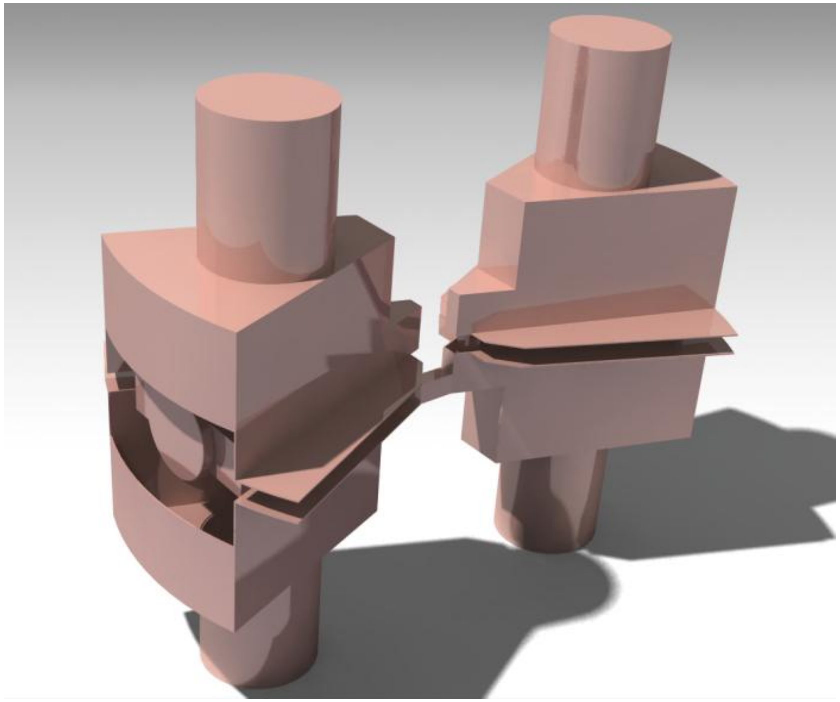


Wireframe of RF cavity basic model

RF cavity

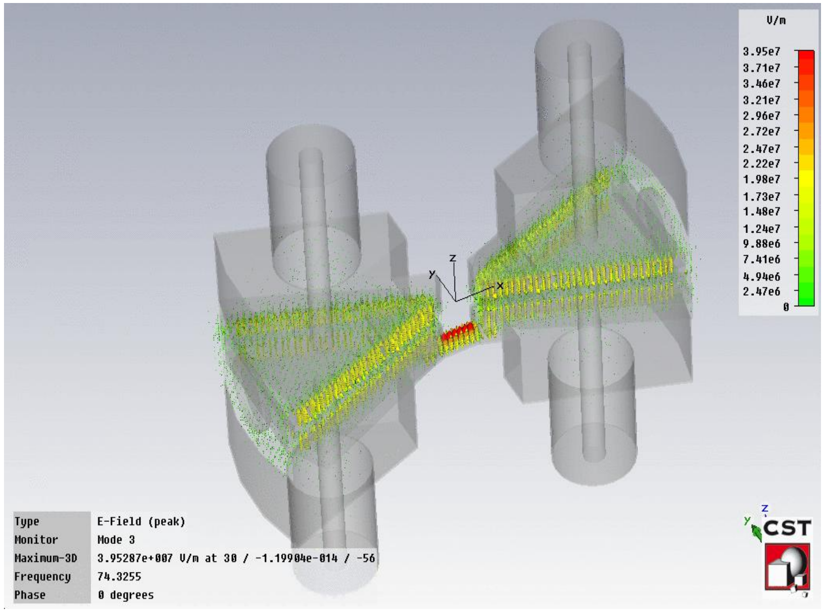


Frequency range following the radius of stem.

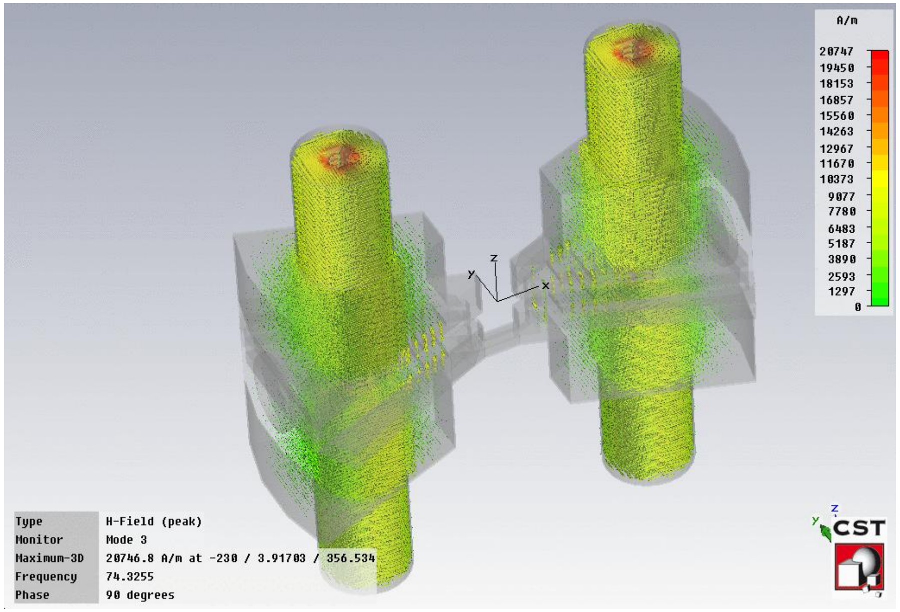


Final RF cavity design using CATIA V5

RF cavity



Electric field distribution



Magnetic field distribution

Q vale is 5981

Summary

- We've designed main part of 8 Mev Injector cyclotron
- Now, we're doing about beam dynamics
- We're going to finish conceptual design for cyclotron until next January