

# Overview of a Rare Isotope Accelerator Facility KoRIA

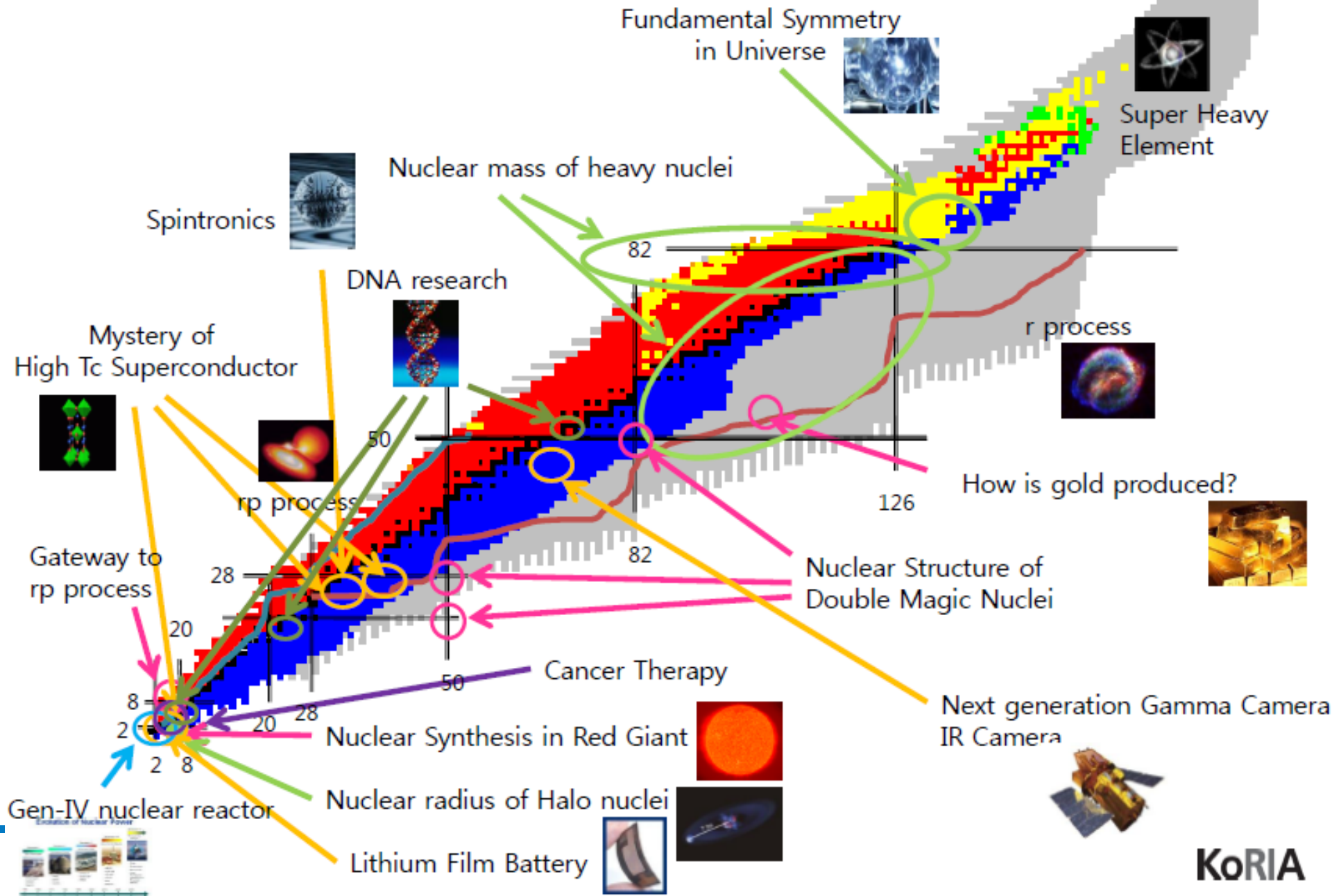
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Sungkyunkwan University

# KoRIA

- Name of the facility
  - In Korea we just call it "**Heavy Ion Accelerator**".
  - **A tentative name that scientists use: "KoRIA".**  
(Korea Rare Isotope Accelerator).
  - **The official name needs further discussions.**
- Multipurpose
- Start from scratch
- Proposed Construction Budget : ~ 0.45 BUSD
- Design and R&D: 2009 ~ 2012
- Construction: 2012 ~ 2016
- **Conceptual design project started in April, 2010.**

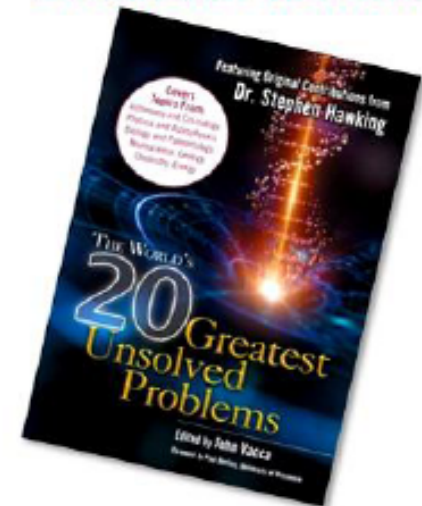
# Possible Sciences with KoRIA



# Multipurpose Facility

- Nuclear Physics and Nuclear Astrophysics
- Material Science using stable HI & RIB
- Bio and Medical Sciences with HI & RIB
- Atomic Physics & Fundamental Symmetry
- Nuclear Data Production for Energy
- Nuclear Fusion (Plasma)

**The World's  
20 Greatest  
Unsolved Problems**

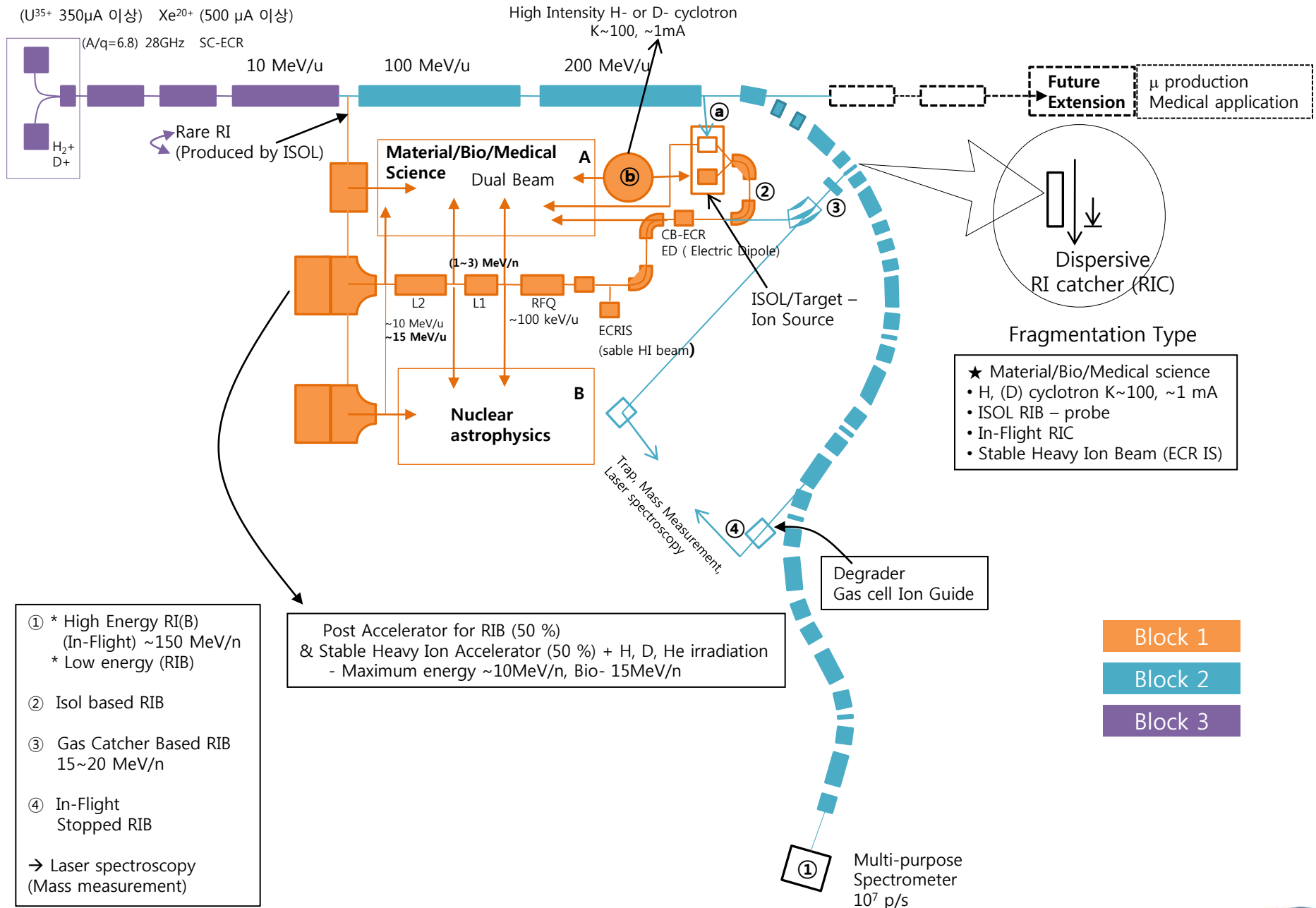


# Key Elements of KoRIA

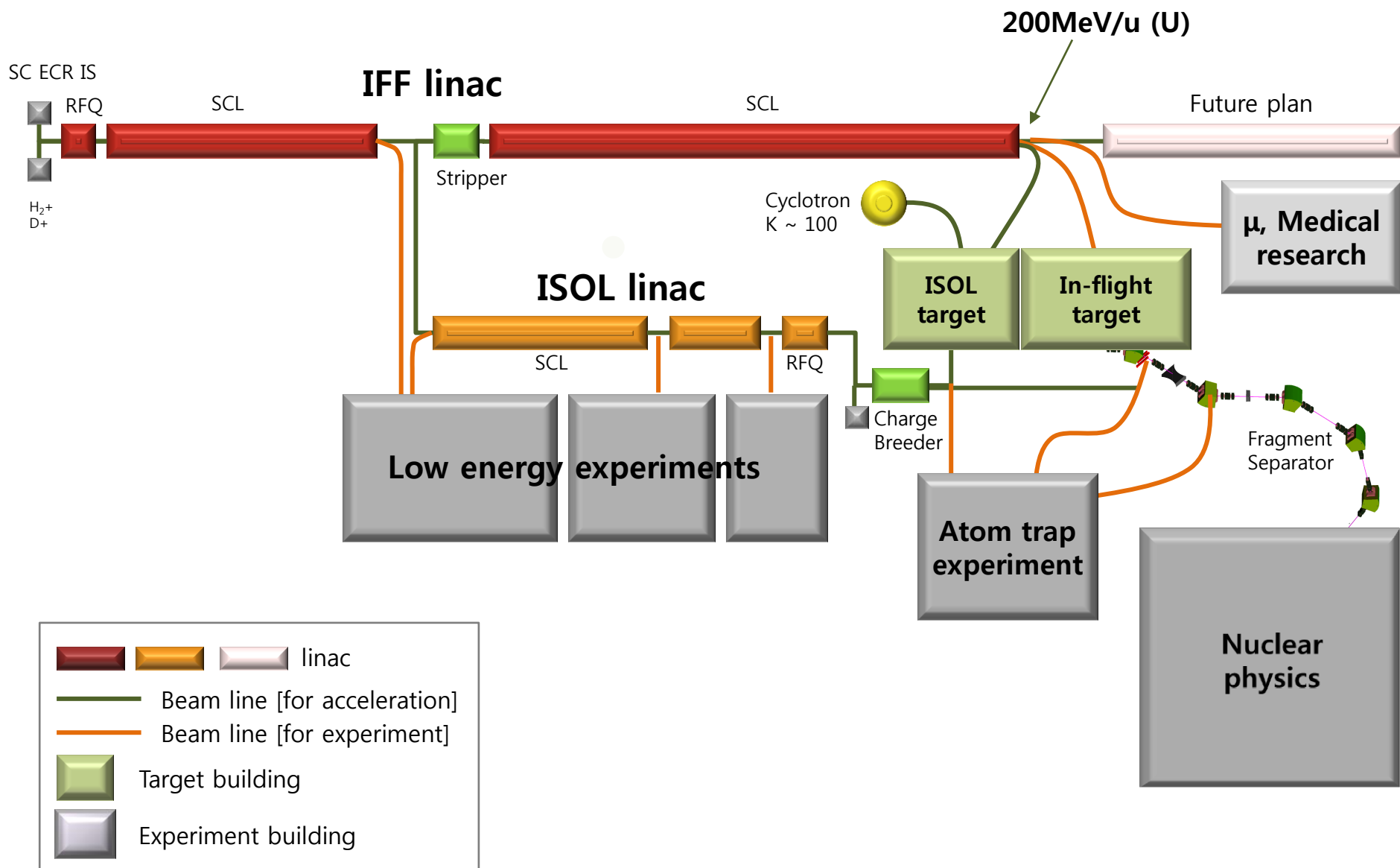
- 200MeV/u, 2pμA Superconducting Heavy Ion Linac
- Particles : H ~ U, Stable Heavy Ion and Unstable Radioactive Isotope
- **Both ISOL & In Flight Fragmentation**

for production of rare isotope beams

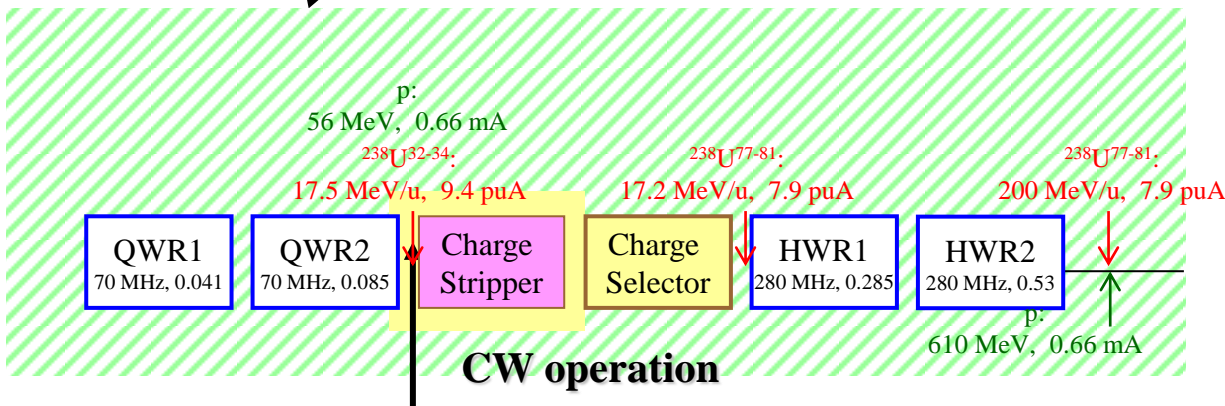
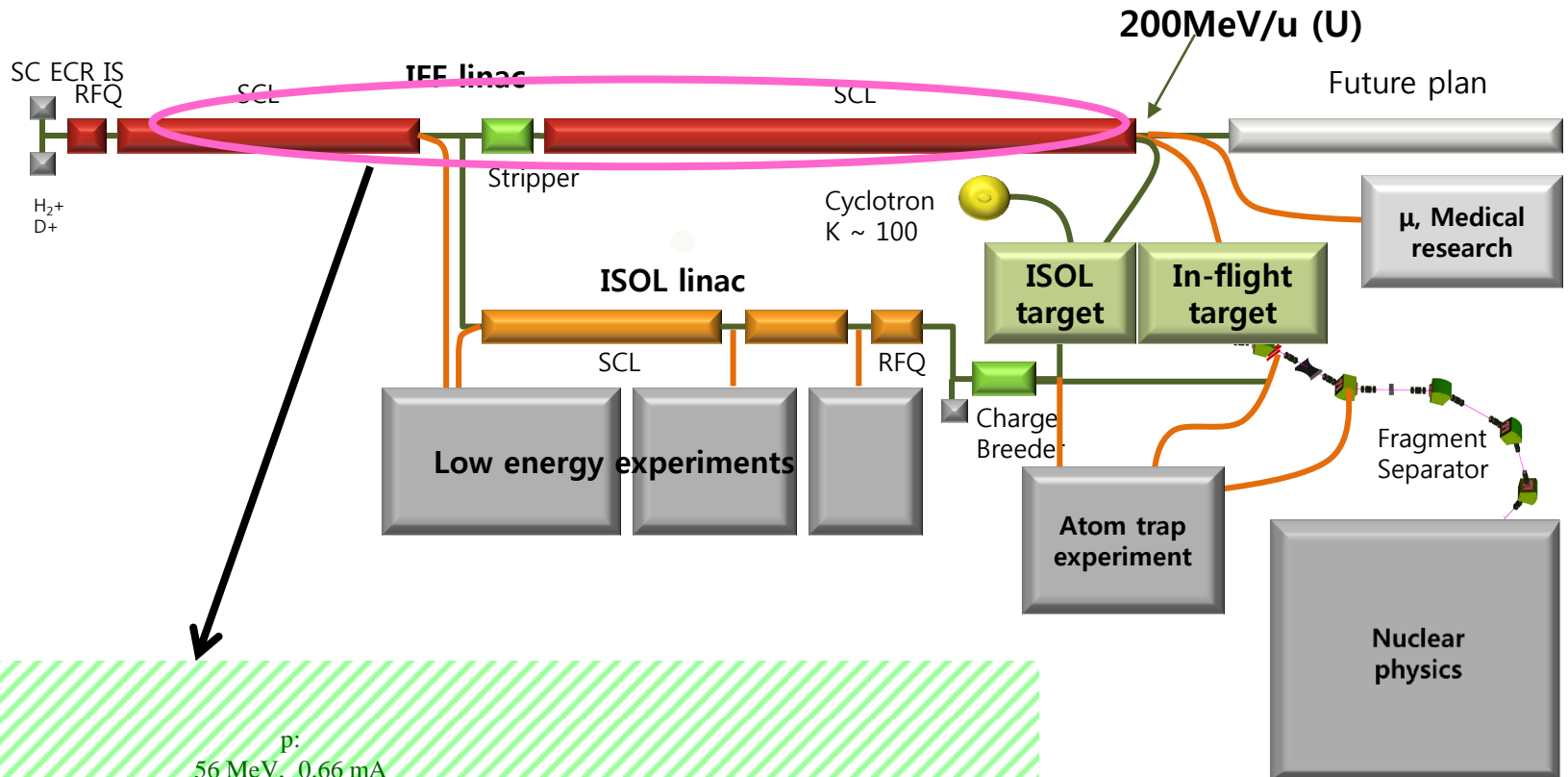
(In Flight Fragmentation after ISOL: more exotic beams)



# KoRIA layout

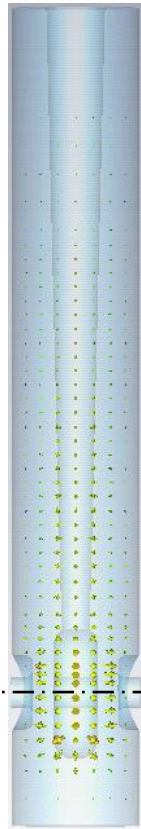


# IFF Linac [ S.K. Ko, KAPRA ]



# IFF Linac [ S.K. Ko, KAPRA ]

**QWR-1**  
(Quarter-Wave Resonator)



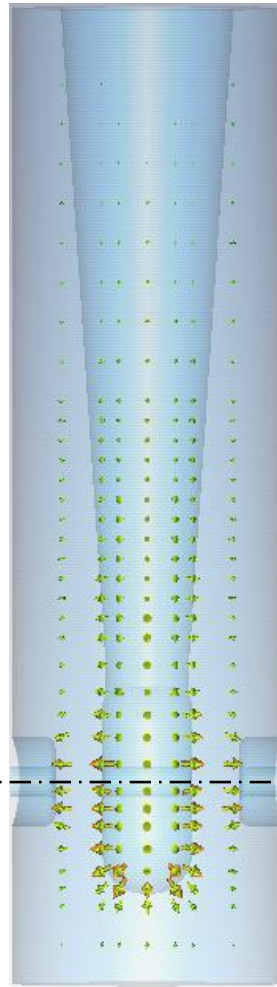
1 m

Beam  
axis

$$\beta_G = 0.041,$$

$$f_{res} = 70 \text{ MHz}$$

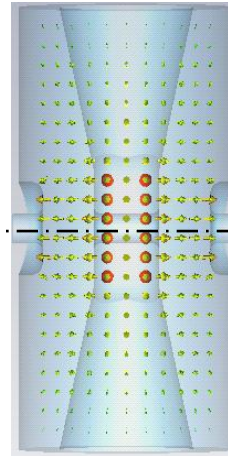
**QWR-2**



$$\beta_G = 0.085,$$

$$f_{res} = 70 \text{ MHz}$$

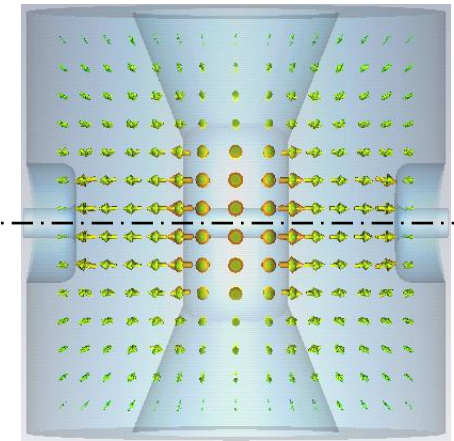
**HWR-1**  
(Half-Wave Resonator)



$$\beta_G = 0.285,$$

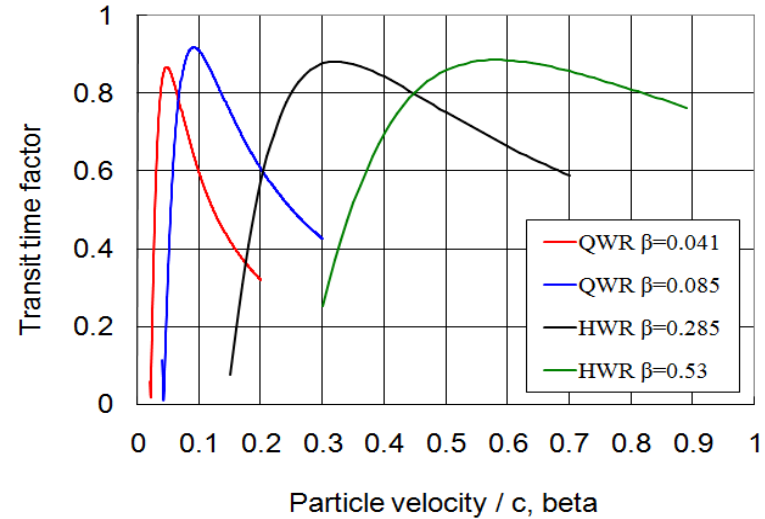
$$f_{res} = 280 \text{ MHz}$$

**HWR-2**

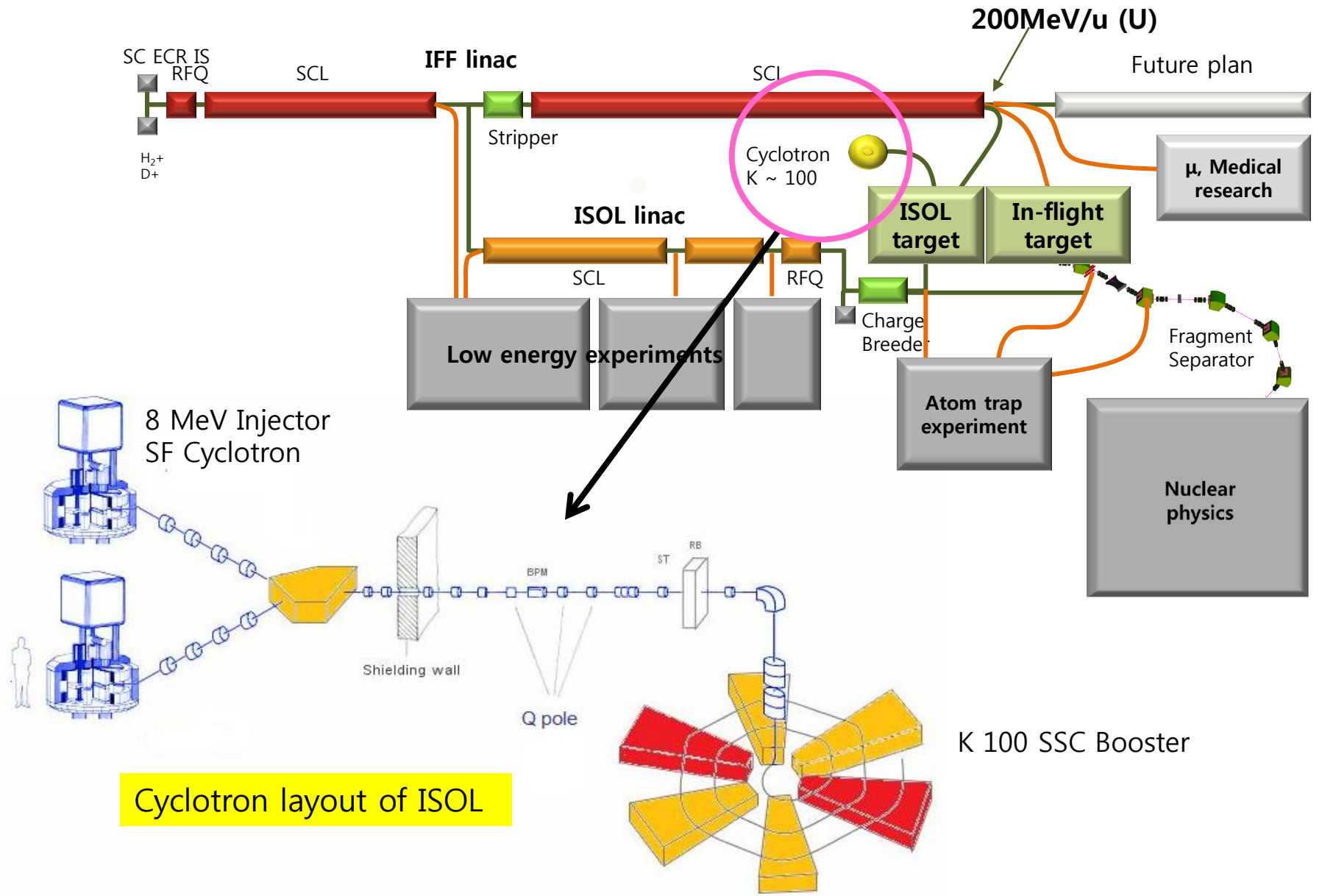


$$\beta_G = 0.53,$$

$$f_{res} = 280 \text{ MHz}$$



# Cyclotron [ J.S. Chai, SKKU ]

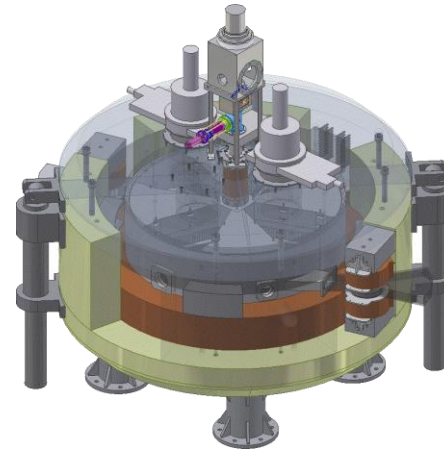


Cyclotron layout of ISOL

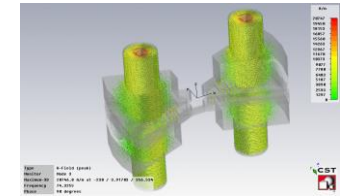
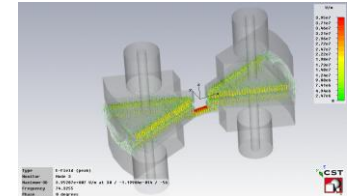
# Cyclotron [J.S.CHAI, SKKU]

## Injector SF Cyclotron

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



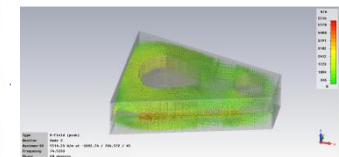
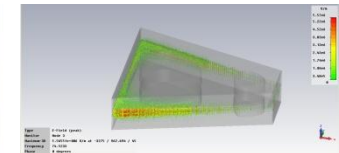
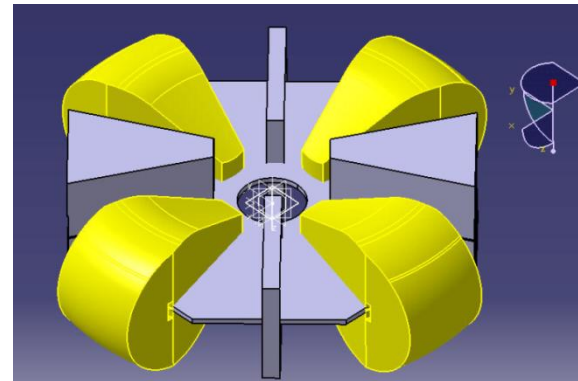
Layout



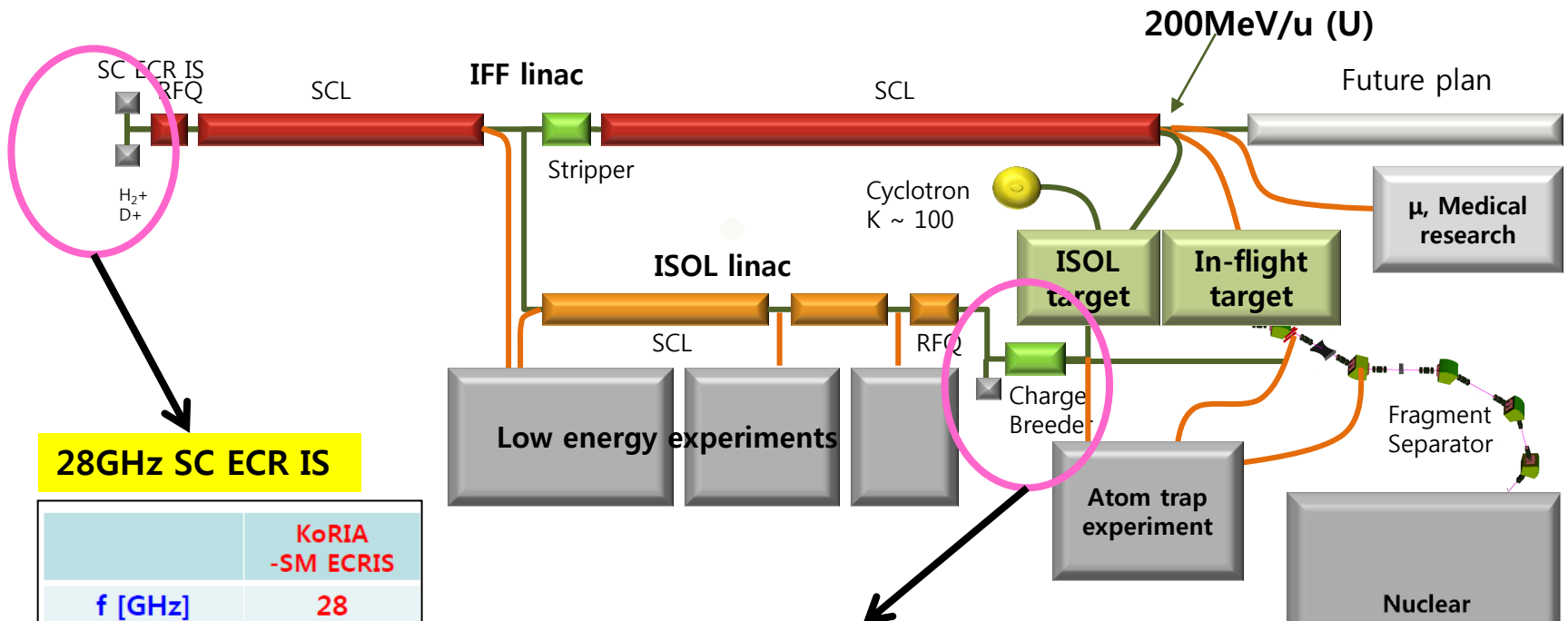
Field analysis

## K100 SSC Cyclotron

Injection Energy	8 MeV
Extraction Energy	70-100 MeV
Beam intensity	1 mA
RF- Frequency	60 MHz
External diameter	6 m



# Ion Source [ B.H. Oh, KAERI ]



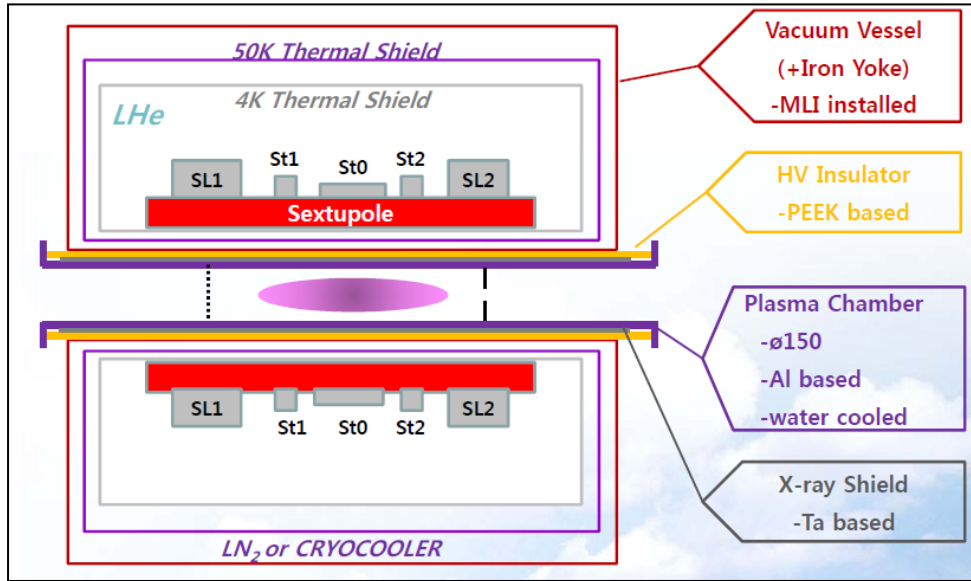
## 28GHz SC ECR IS

	KoRIA -SM ECRIS
f [GHz]	28
P [kW]	10
$\phi_{\text{chamber}}$ [mm]	150
$L_{\text{plasma}}$ [mm]	500
$V_{\text{ext}}$ [kV]	30
$B_{\text{RES}}$ [T]	1
$B_{\text{inj}}$	> 4
$B_{\text{ext}}$	> 2.5
$B_{\text{rad}}$	2.2
$B_{\text{min}}$	0.3~0.8

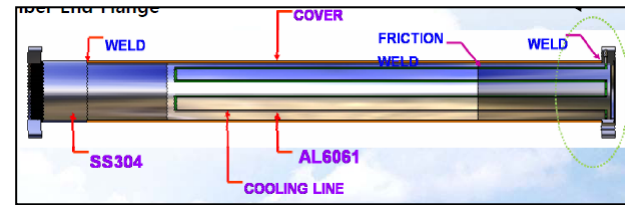
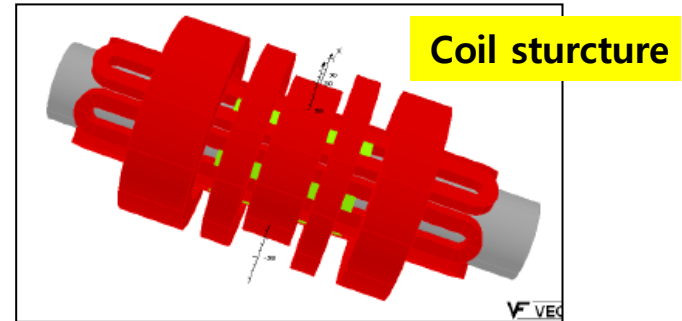
- electron beam current > 2 A DC
- electron beam energy > 10 keV
- electron beam current density > 600 A/cm<sup>2</sup>
- breeding time 30 ~ 40 ms
- efficiency > 15 %
- solenoid field strength > 5 T
- solenoid bore diameter > 155 mm
- trap length > 700 mm
- drift tube diameter > 31 mm
- cathode material/ life LaB<sub>6</sub> or CeB<sub>6</sub>
- vacuum ~10<sup>-9</sup> torr

## EBIS for charge breeder

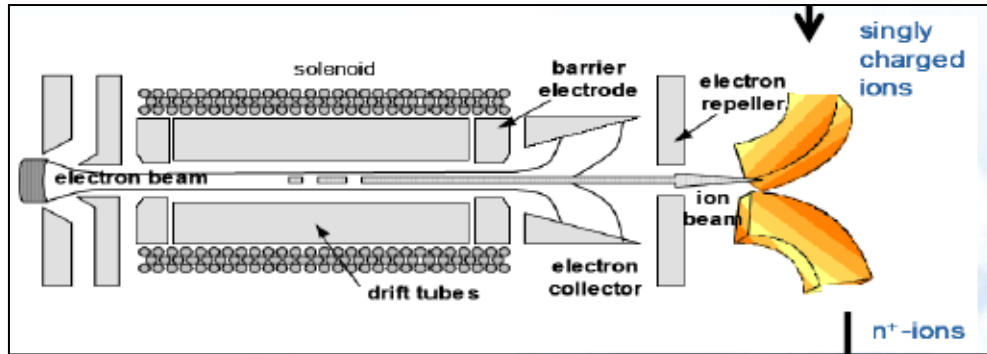
# Ion Source



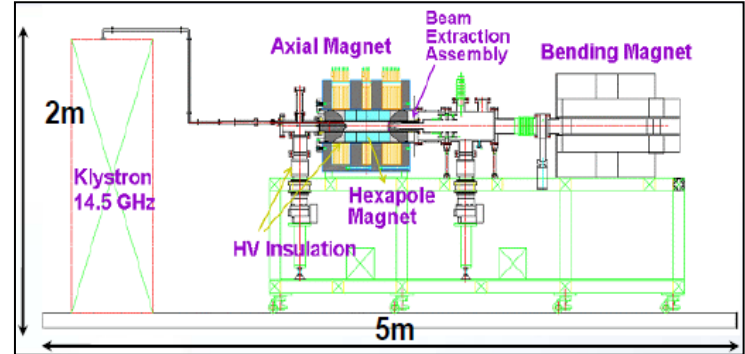
SM magnet system for 28GHz SC ECR IS



Plasma chamber for 28GHz SC ECR IS

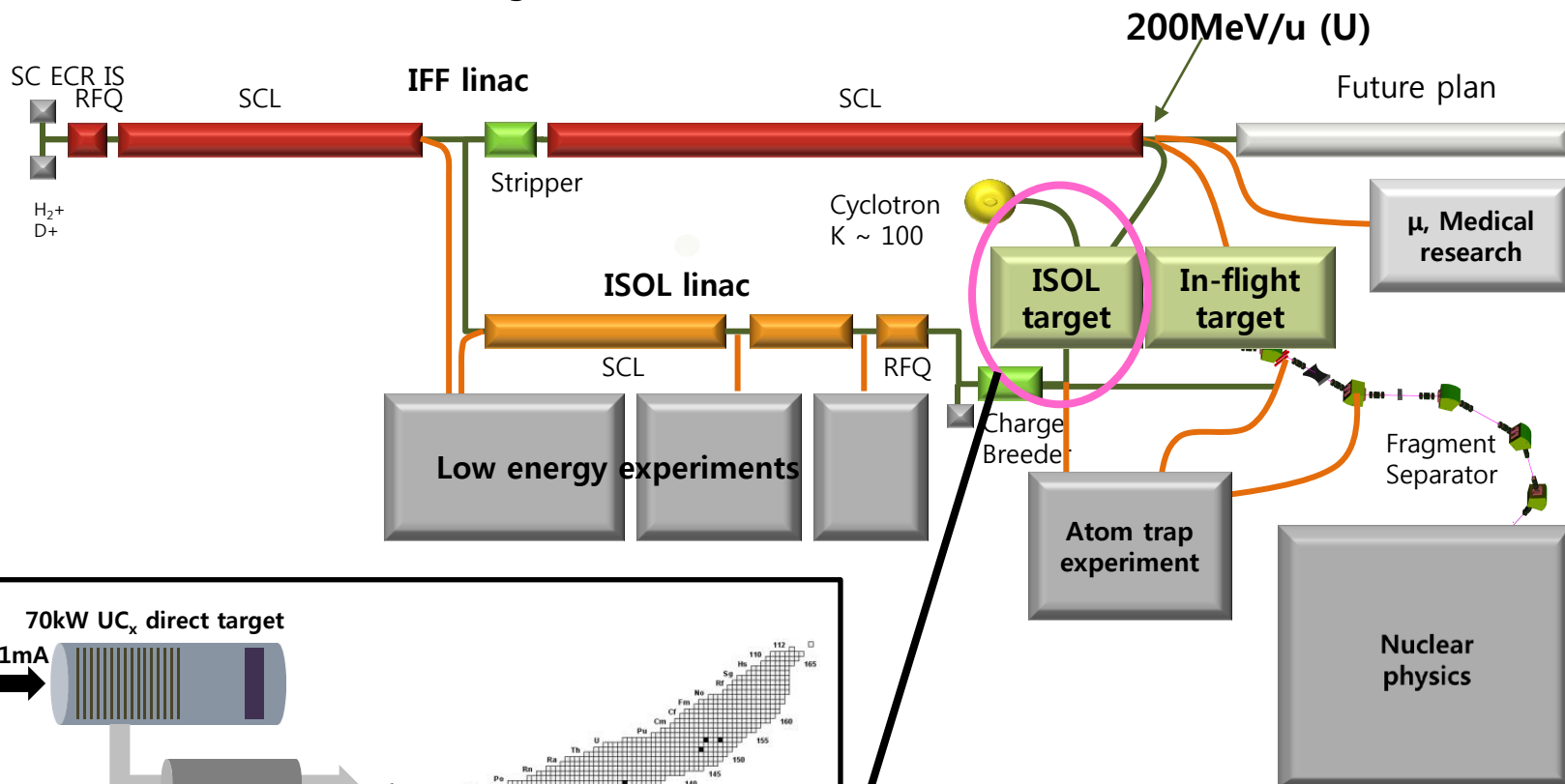


EBIS layout

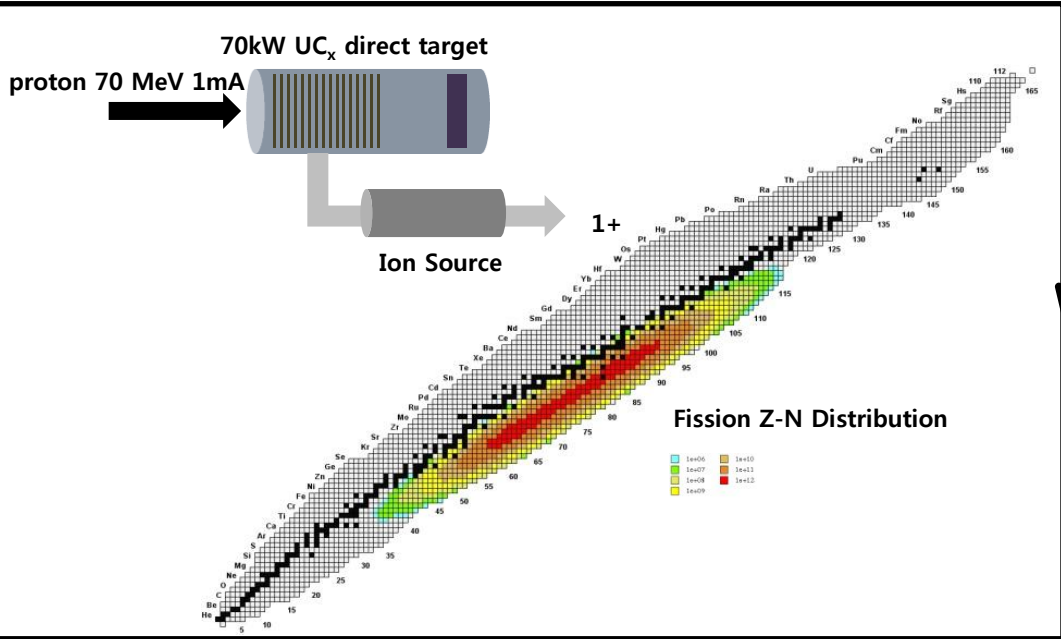


14.5GHz SC ECR IS layout

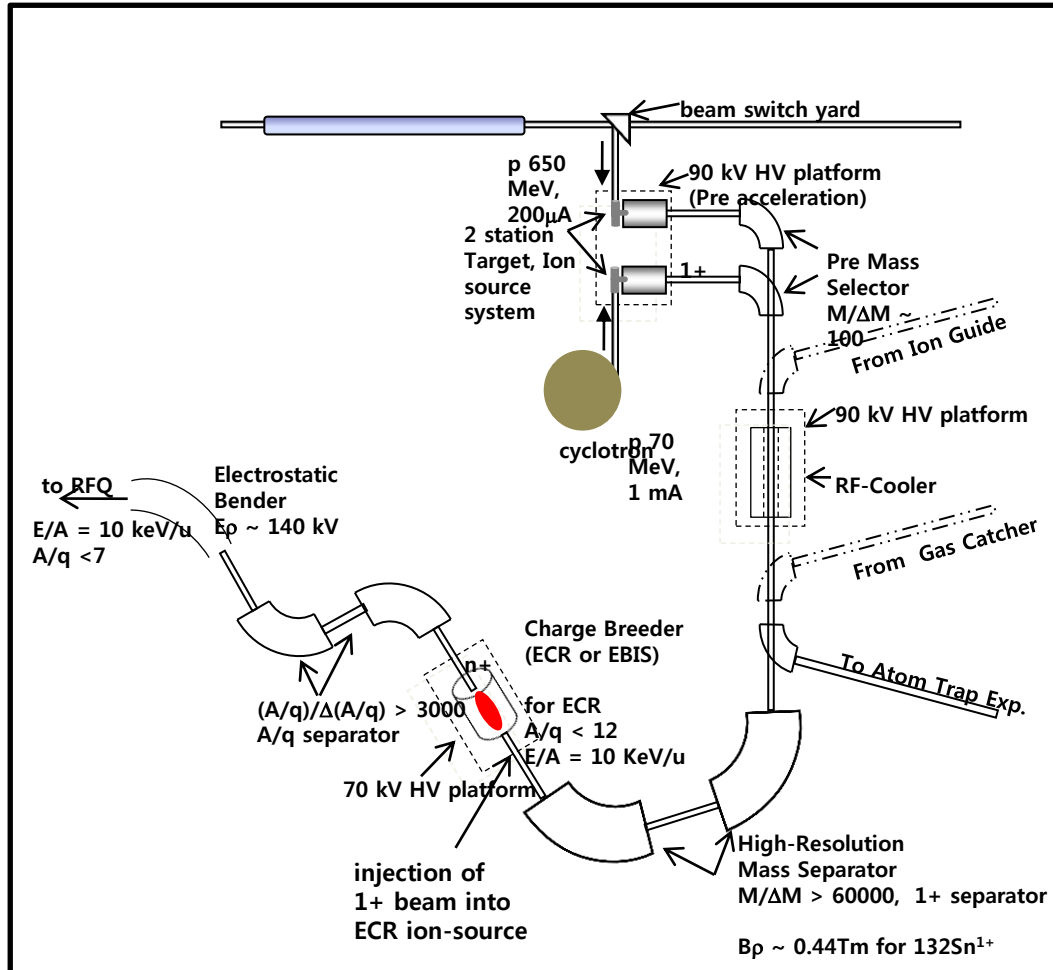
# ISOL System [ B.H. Kang, SYU ]



**ISOL target & yield**



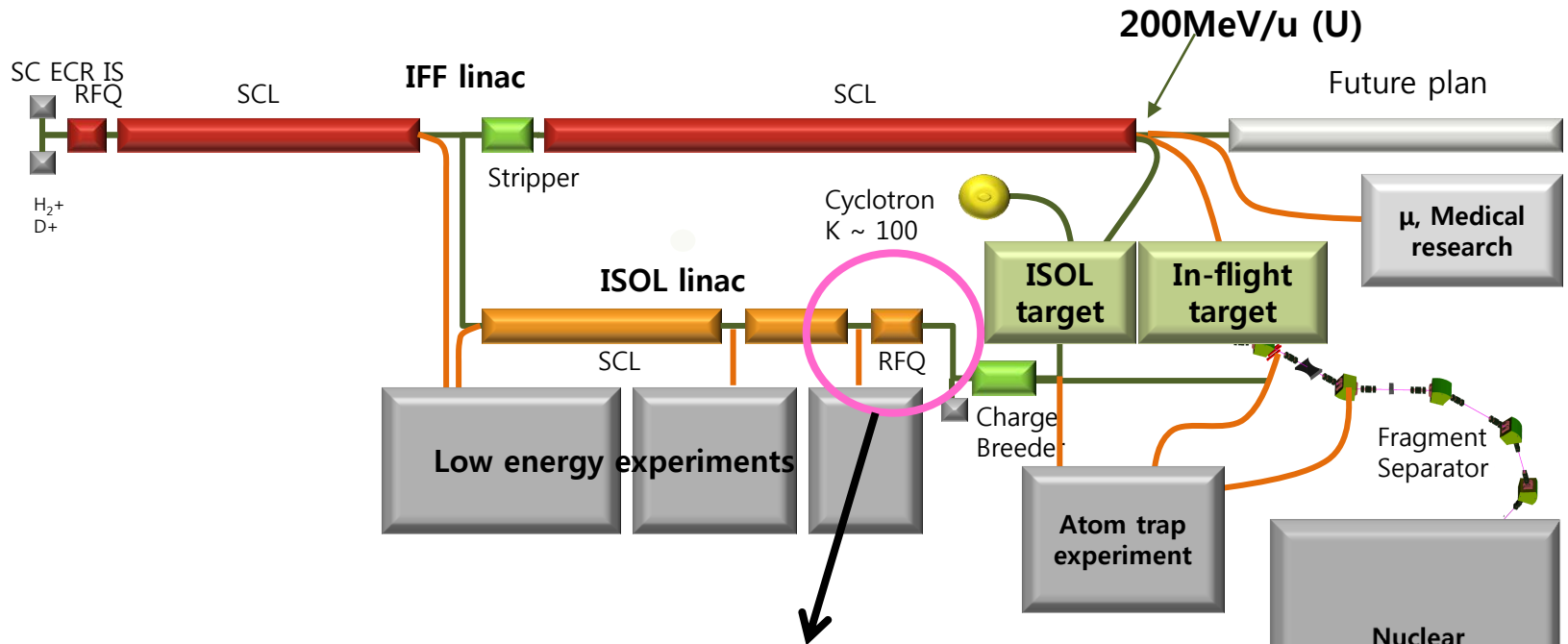
# ISOL System



ISOL system layout

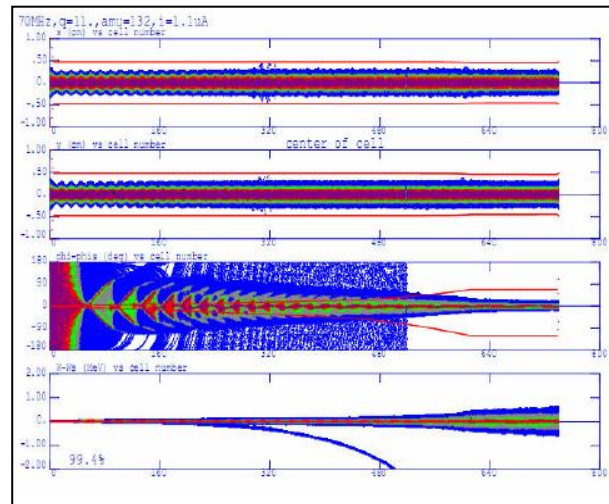
Primary Beam	70 MeV, p, 1mA
Production Target	70kW, direct multi-layered Disk UC <sub>x</sub> , 2.5 g/cm <sup>3</sup>
Yield on Target	1.2 x 10 <sup>14</sup> fission/s, neutron-rich, 4 x 10 <sup>11</sup> /s for <sup>132</sup> Sn
ISOL IS	FEBIAD, Surface Ionization both RI except for refractory element
ISOL system	attach/detach system of IS/Target module
pre mass selector	M/ΔM ~ 100 to increase beam quality, ~3p mm mrad
RFQ-Cooler	Energy spread < 4eV, Emittance ~3 π mm mrad Online transmission >60 %
High Resolution Mass Separator	M/ΔM > 60000
Charge Breeder	ECR and/or EBIS
A/q separator	(a/q)/Δ(a/q) > 3000
beam injection on RFQ	A/q < 12 for ECR, mostly 4 < A/q < 8 E/A = 10 keV/u <sup>132</sup> Sn ~10 <sup>8</sup> /s, <sup>138</sup> Xe ~10 <sup>11</sup> /s
Typical beam on experimental target	<sup>132</sup> Sn ~10 <sup>8</sup> /s

# RFQ Linac [ Y.S. Cho, KAERI ]

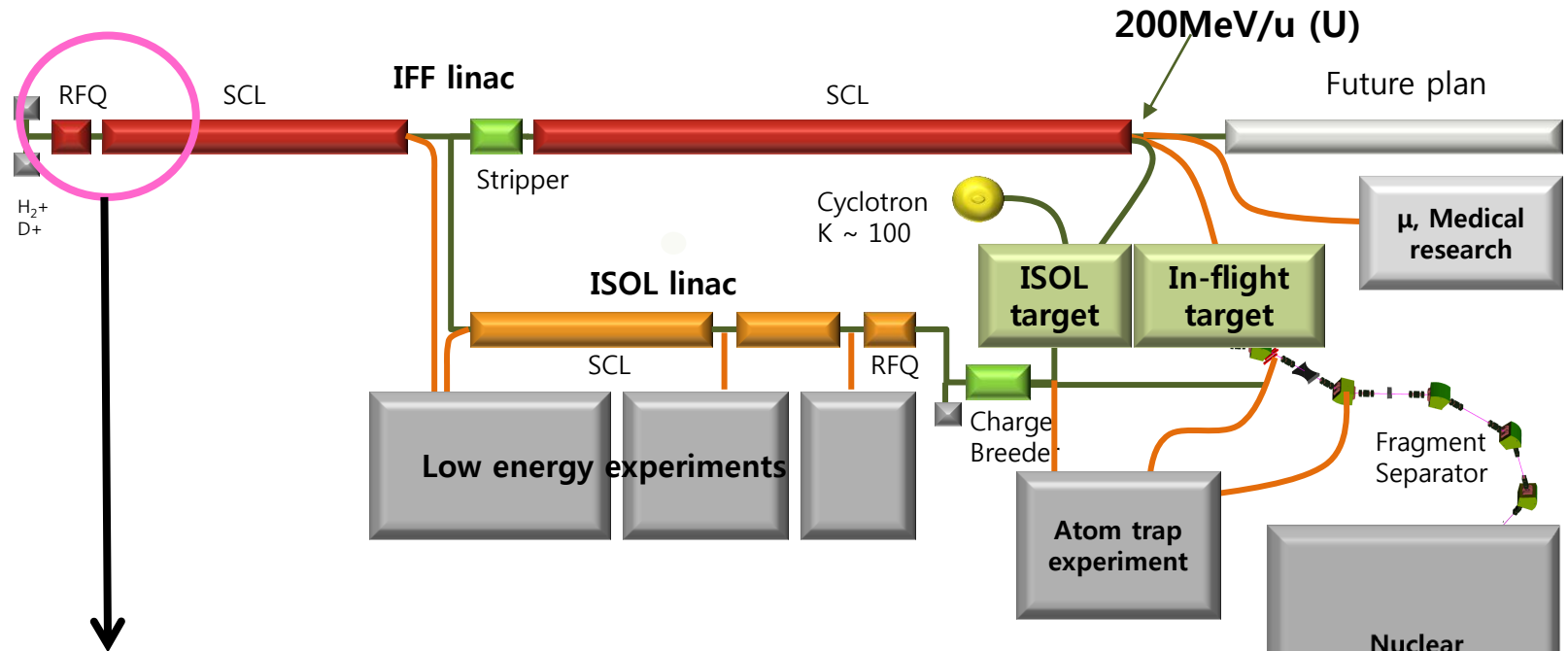


## □ Design Parameters

- Reference Particle:  $^{132}\text{Sn}^{11+}$  ( $A/q = 12$ )
- Input Energy: 5 keV/u
- Output Energy: 300 keV/u
- Beam Current: 0.1  $\mu\text{A}$  (assumption)
- Input Emittance: 0.1  $\pi$  mm-mrad (normalized rms)
- Duty: 100% (CW)
- Frequency: 70MHz
- Kilpatrick: < 1.6

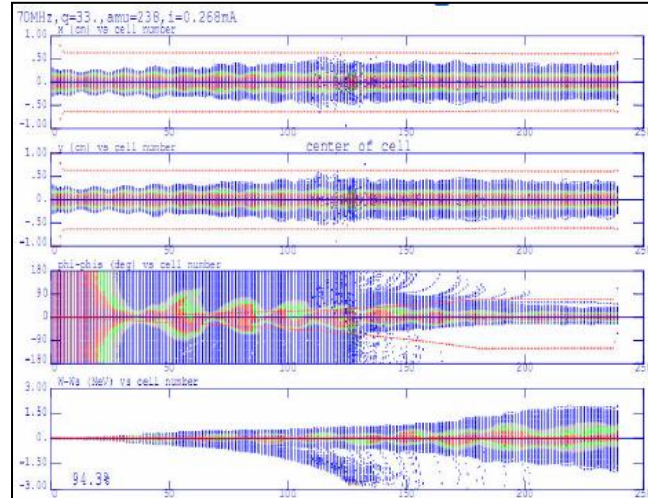


# RFQ Linac

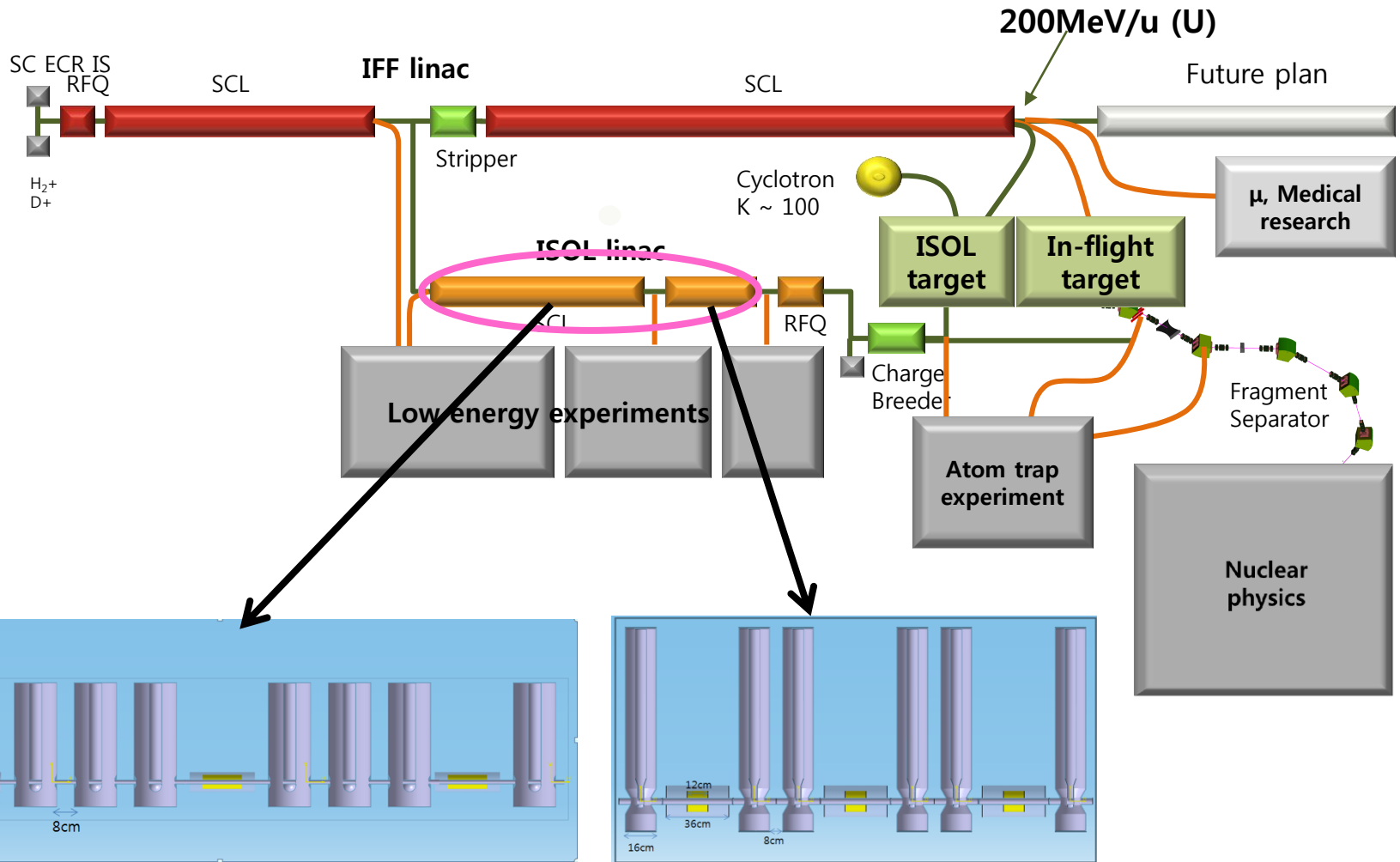


## □ Design parameters

- Reference Particle:  $^{238}\text{U}^{33+}$
- Input Energy: 10 keV/u
- Output Energy: 300 keV/u
- Beam Current: 8 pμA
- Input Emittance:  $0.1 \pi$  mm-mrad
- Duty: 100% (CW)
- Frequency: 70MHz
- Kilpatrick: < 1.6



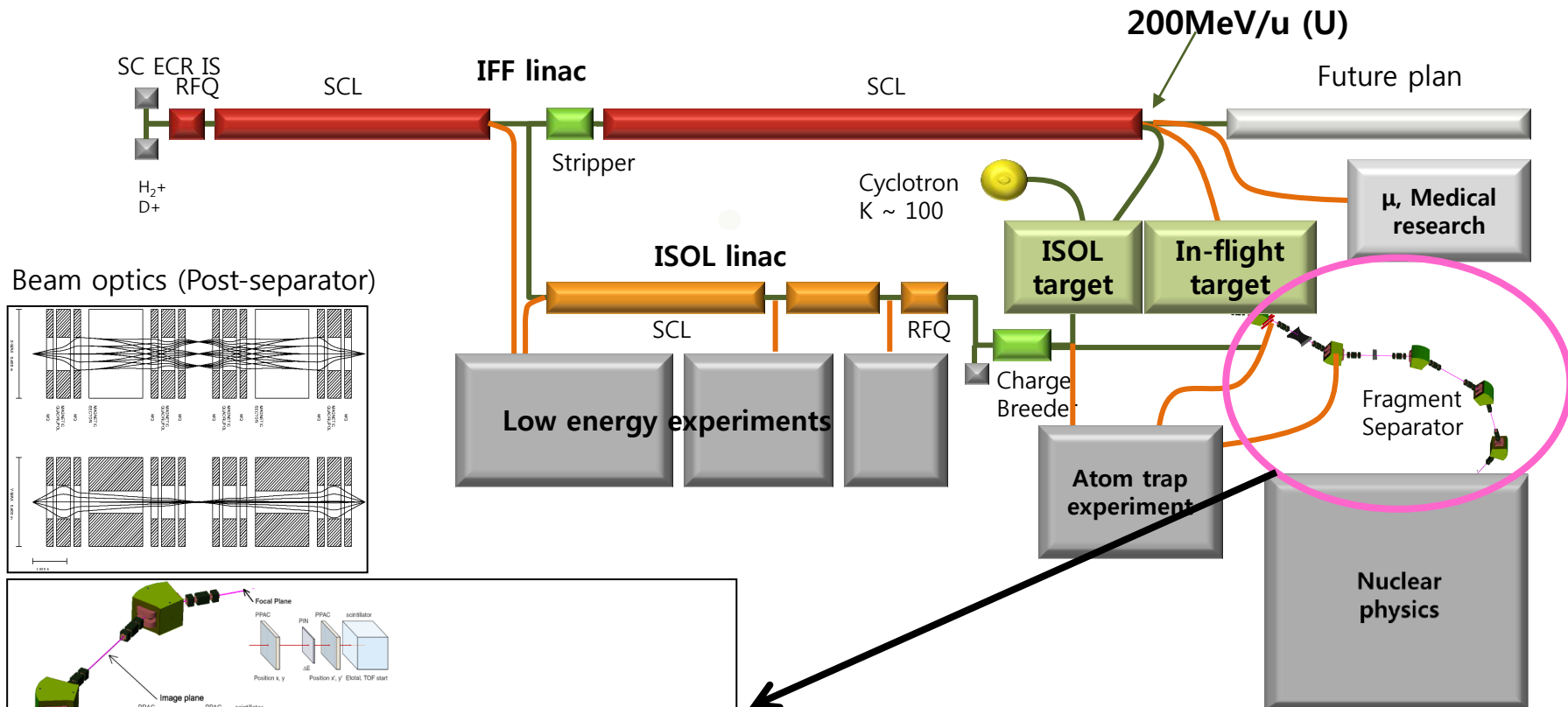
# SC Linac [ T.S. Park, SKKU ]



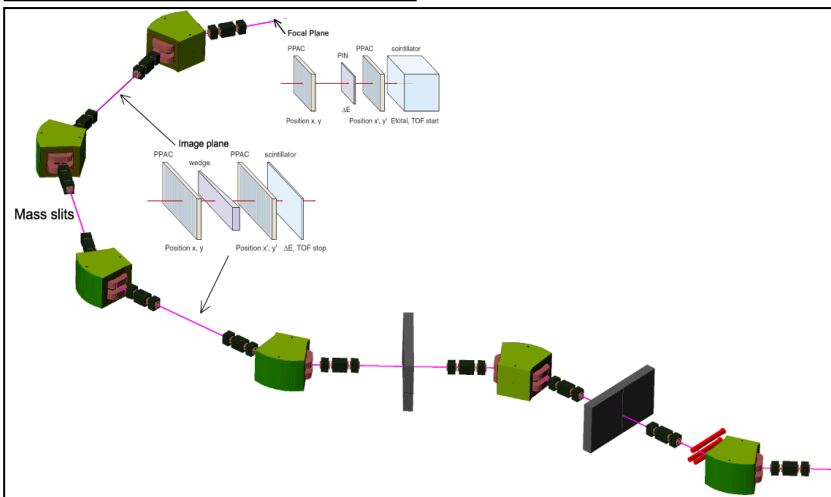
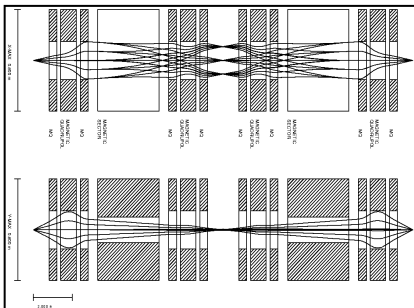
**SC QWR (2.0-18 MeV/u)**

**SC QWR (0.3-2 MeV/u)**

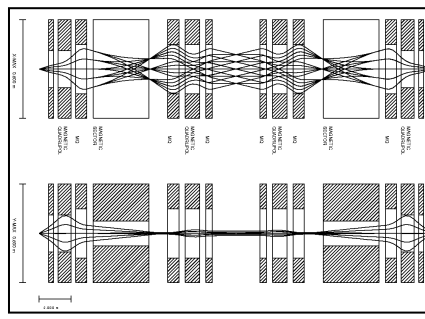
# Fragment separator [ J.W. Kim, NCC ]



Beam optics (Post-separator)

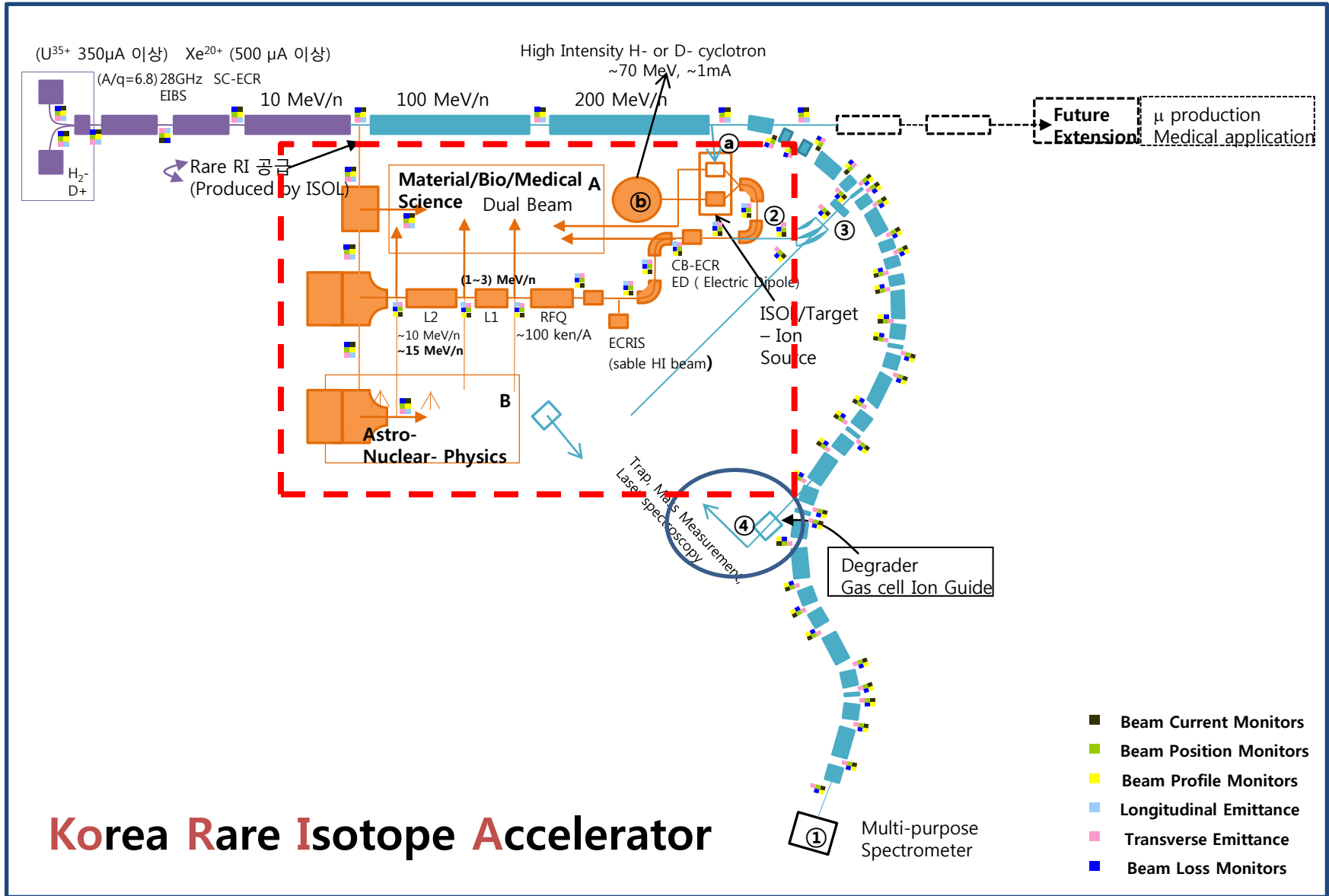


Fragment separator layout



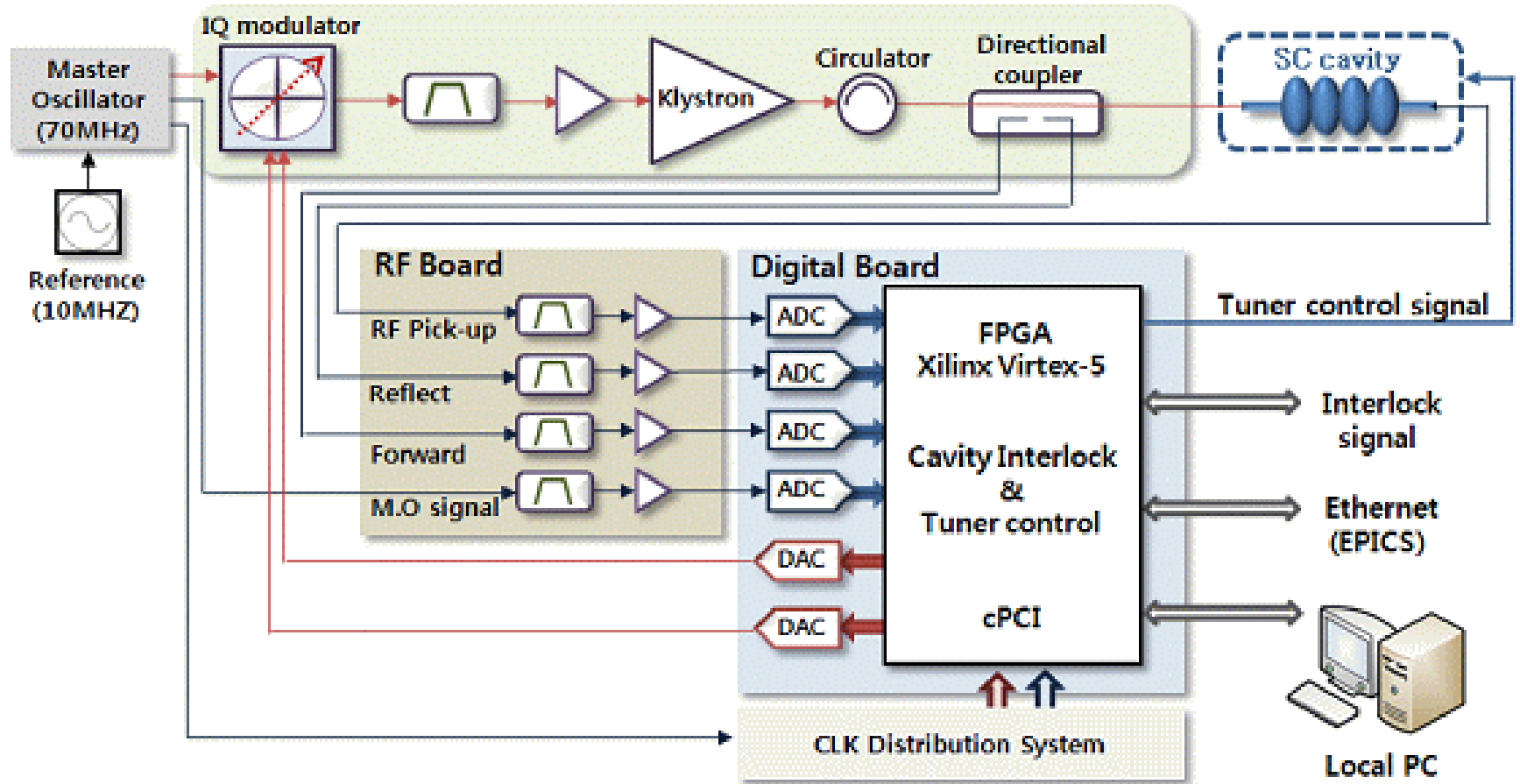
Beam optics (pre-separator)

# Diagnosics [ J.H. Ha , KAERI ]



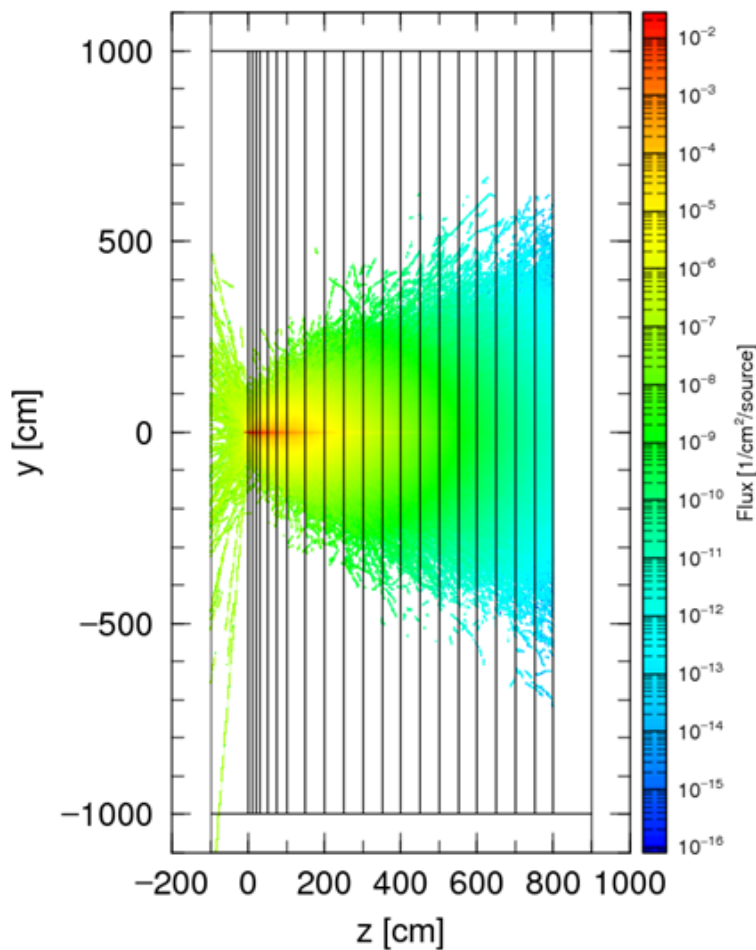
## Korea Rare Isotope Accelerator

# Control system [ K.H. Park, PAL ]

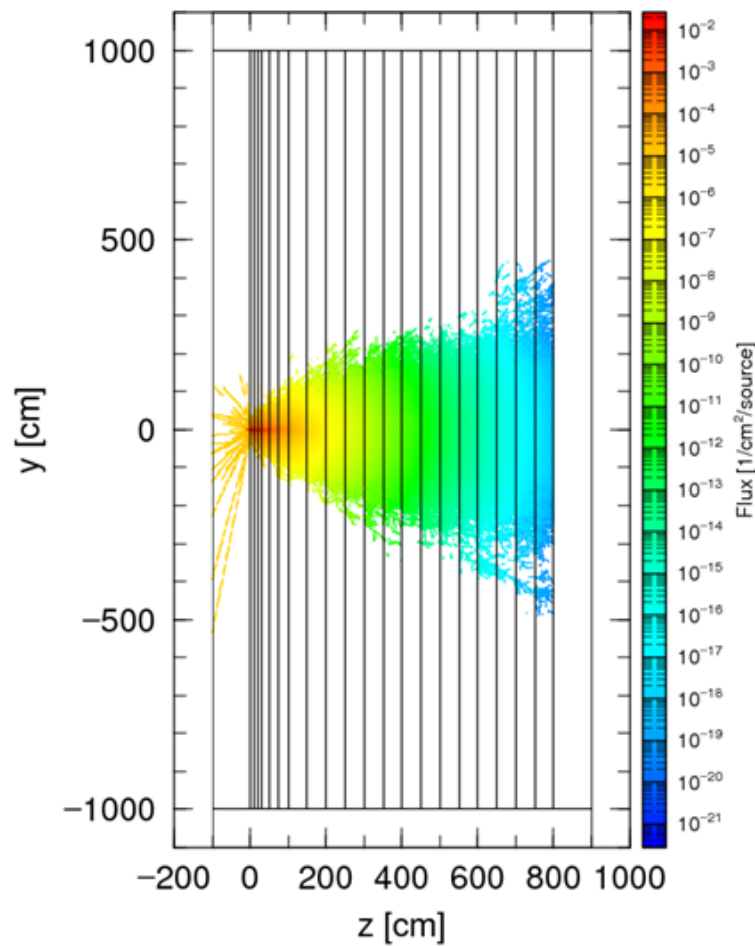


# Shielding system [ H.S. Lee, PAL ]

Neutron track of shielding transmission to evaluate attenuation length

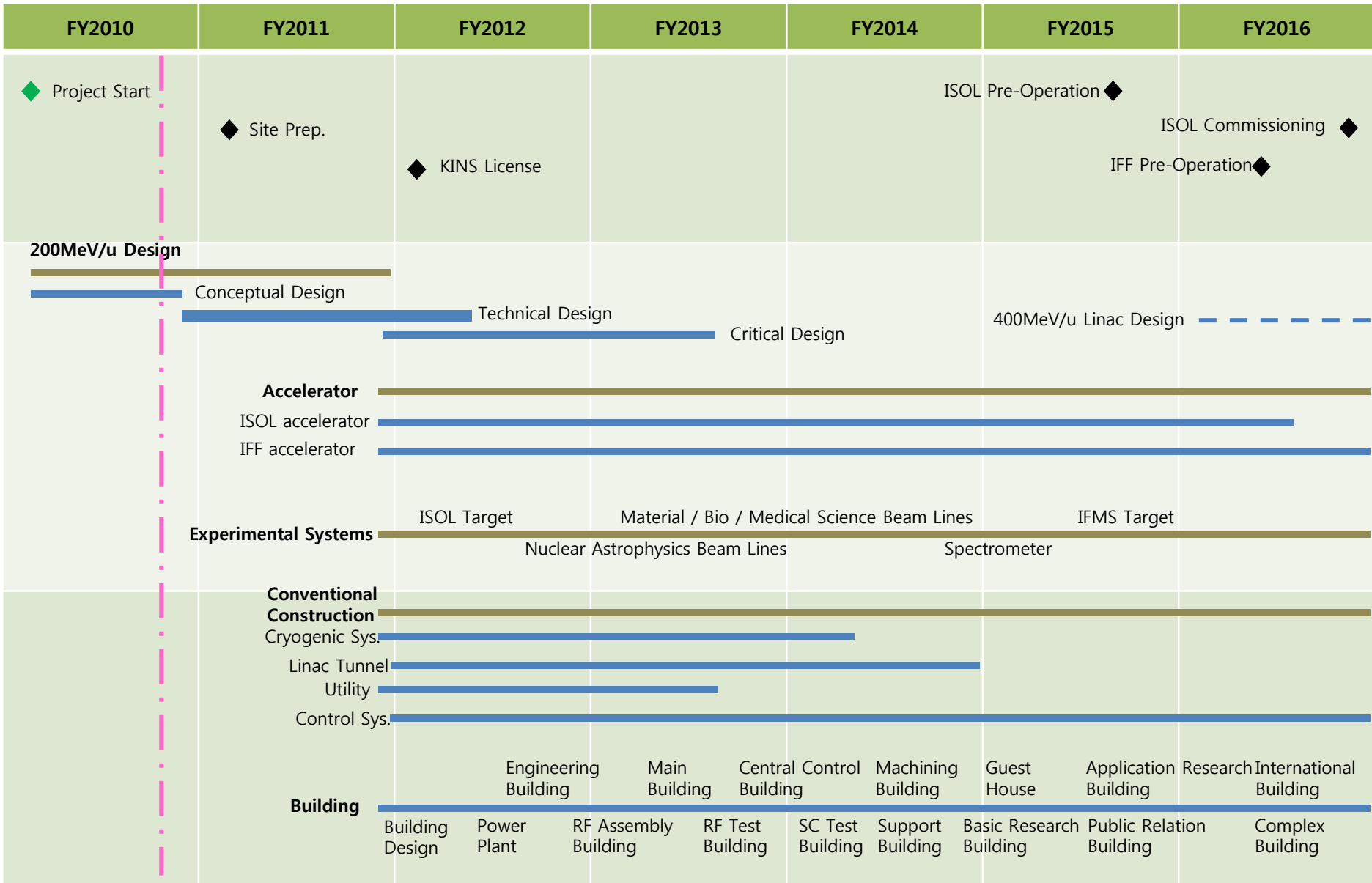


(a) Concrete shield



(b) Iron shield

# KoRIA Project Schedule





**Thank you for your Attention**