The Design of 28 GHz ECR Ion Source for the Compact Linear Accelerator in Korea

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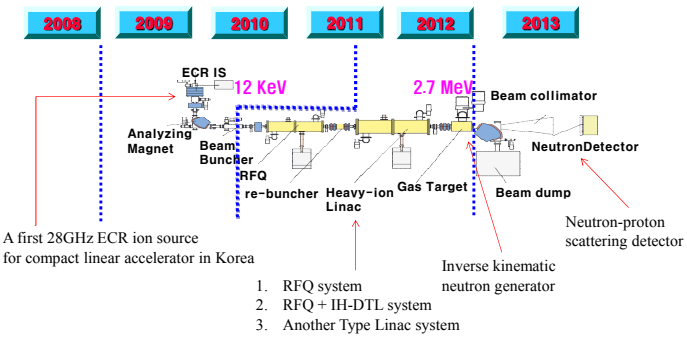
Abstract

The construction of a compact linear accelerator is in progress by Korea Basic Science Institute. The main capability of this facility is the production of multiply ionized metal clusters and the generation much intense beams of highly charged ions for material, medical and nuclear physical research. To produce the intense beam of highly charged ions, we will construct an Electron Cyclotron Resonance Ion Source (ECRIS) using 28GHz microwaves. For this ECRIS, the design of a superconducting magnet, microwave inlet, beam extraction, and plasma chamber were in progress. Also we are constructing a superconducting magnet system. In this presentation, we will report the current status of our 28GHz ECRIS development.

Project Roadmap

-We will construct a compact linear accelerator in the year 2013

Compact linear accelerator ? low cost, compact, less electric power consuming, without restriction of space, user-friendly



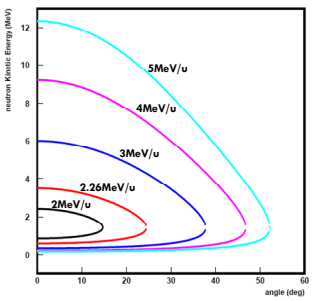
1. RFQ system
2. RFQ + IH-DTL system
3. Another Type Linac system

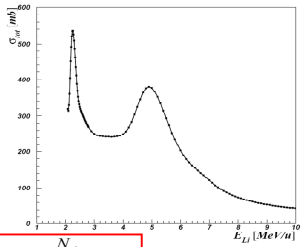
First End Part Station : Neutron Imaging

Required Beam Current

– The Beam Current & Energy for Neutron Radiography

- Beam flux: Production of 10^{12}/s (fast neutrons)
- Beam intensity: $Li^{2\sim3+}$ higher than 1mA
- Beam energy : > about 2 MeV/u
- Gas target : > 350 Torr
- Neutron detection : High efficiency for fast neutron



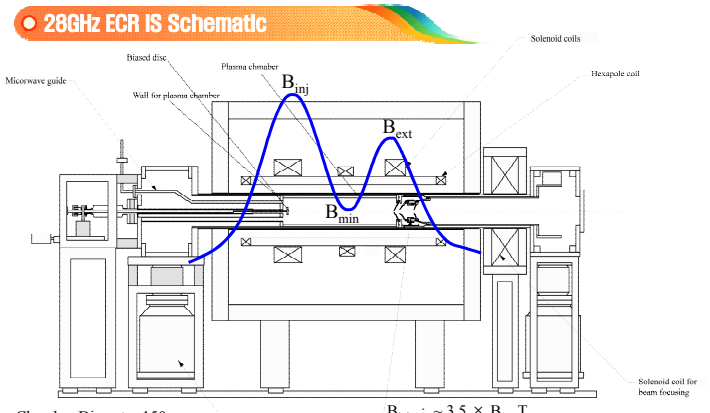


$$Y_n = F_{Li} \times \rho \frac{N_A}{A} \times L \times \sigma$$

Y : neutron Yield
F_{Li} : Beam Flux
ρ : Density
N_A : Avogadro constant
A : Atomic Number
L : Target Length
σ : Cross section

Fast neutron flux is 5.3×10^{13} / s At $^7Li^{+3}$ beam current of 1mA

28GHz ECR IS Schematic



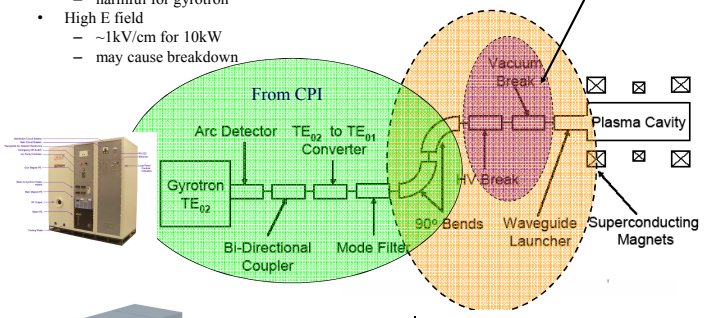
Chamber Diameter 150 mm
Length 500 mm

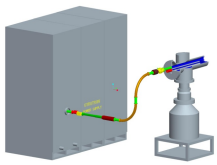
B_{inj} ; ~ 3.5 × B_{ecr} T
B_{min} ; 0.8 ~ 0.4 × B_{ecr} T
B_{ext} ; ~ 2 × B_{ecr} T
B_r ; ~ 2 T at the plasma chamber wall

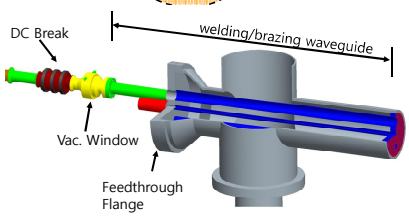
RF Generator System (10kW, 28GHz)

- Power loss
  - ohmic/dielectric power loss should be minimized, <1kW
  - localized loss should be removed for CW operation
- Reflection, Mode pollution
  - arisen from discontinuity of waveguide
  - power loss
  - harmful for gyrotron
- High E field
  - ~1kV/cm for 10kW
  - may cause breakdown

A basic design was completed.





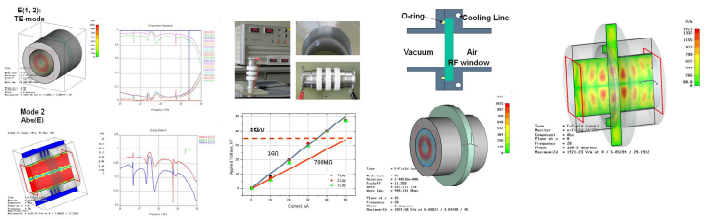


– DC Breaker Prototype

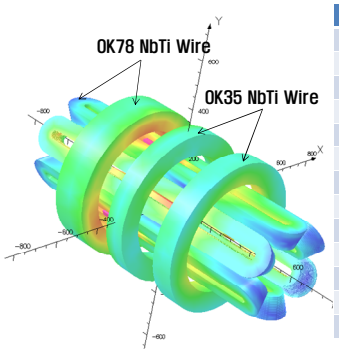
- Break 30 kV of accel. voltage
- Prevent wave leakage
- Additional mode filter
  - transmits TE_{0n} mode (no axial current)
  - damps residual reflected modes

– RF Window

• Varian 2-3/4" CONFLAT

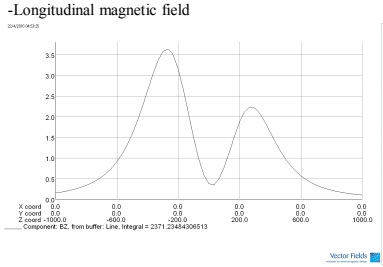


Magnetic Field Design

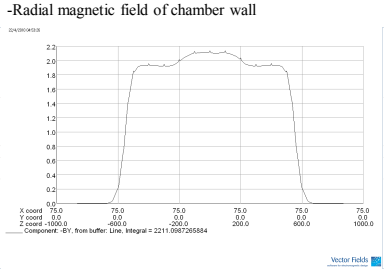


Type		OK35	OK78
Insulated Width W	mm	1.40	1.40
Insulated Thickness T	mm	0.95	0.95
Tolerance on W or T	mm	+−0.25	+−0.25
Corner Radius	mm	0.2−0.4	0.2−0.4
Insulation		PVA	PVA
Cu/Sc Ratio		4.9	2.32
No. of Filaments		35	78
Filament Diameter	microns	83	75
Critical Current at 3T	A	>775	>1257
Critical Current at 5T	A	>500	>875
Critical Current at 7T	A	>290	>511
Critical Current at 8T	A		>321
RRR		>70	>70

-Longitudinal magnetic field



-Radial magnetic field of chamber wall



Remarks

-We will install 28 GHz ECR ion source until next year, 2011.
-A plasma chamber design is in progress.
-Detailed magnet & ECR ion source designs are shown at MOPOT15 poster

Working Group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