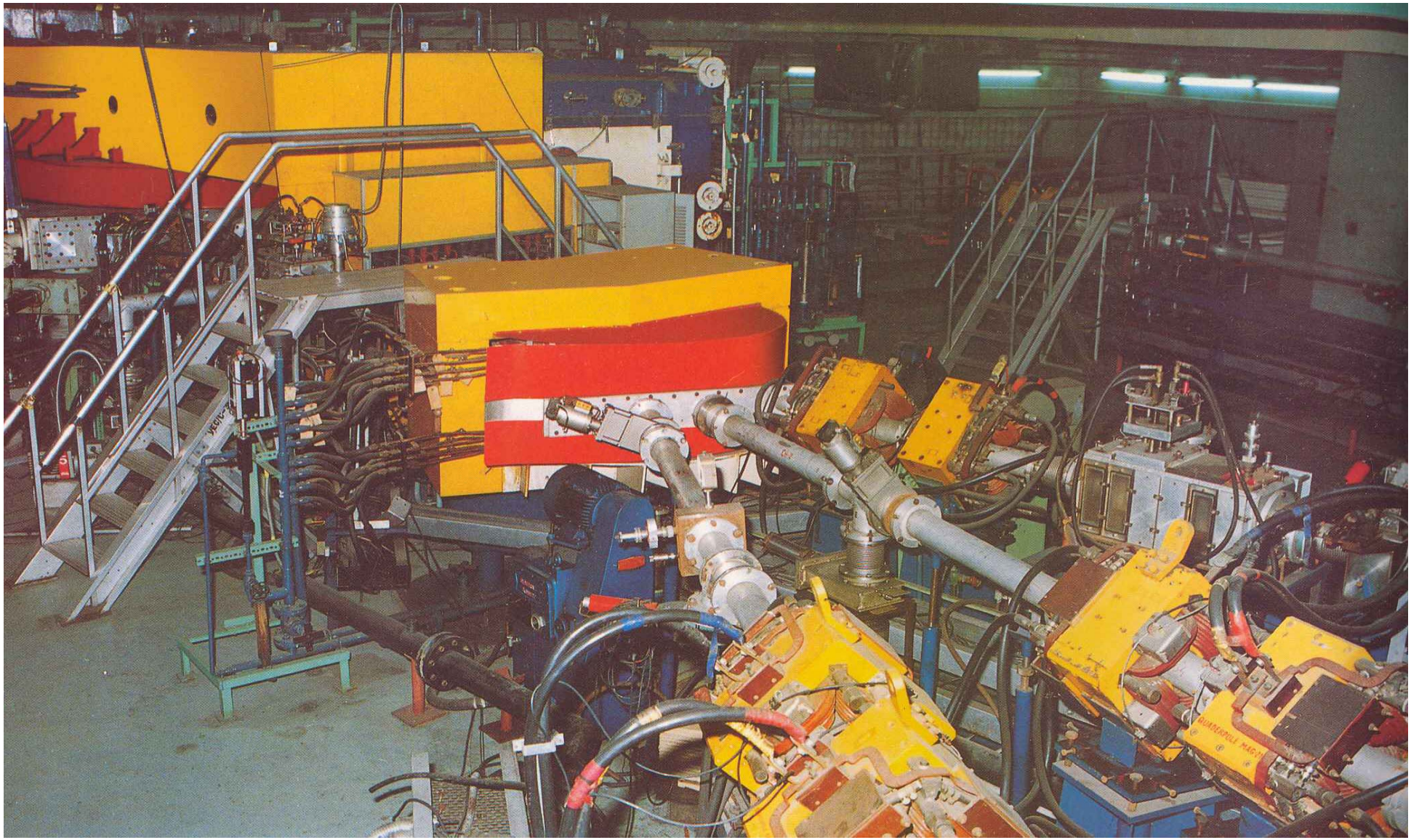
SUPERCONDUCTING CYCLOTRON PROJECT AT KOLKATA

R.K. Bhandari (for the VECC Staff)

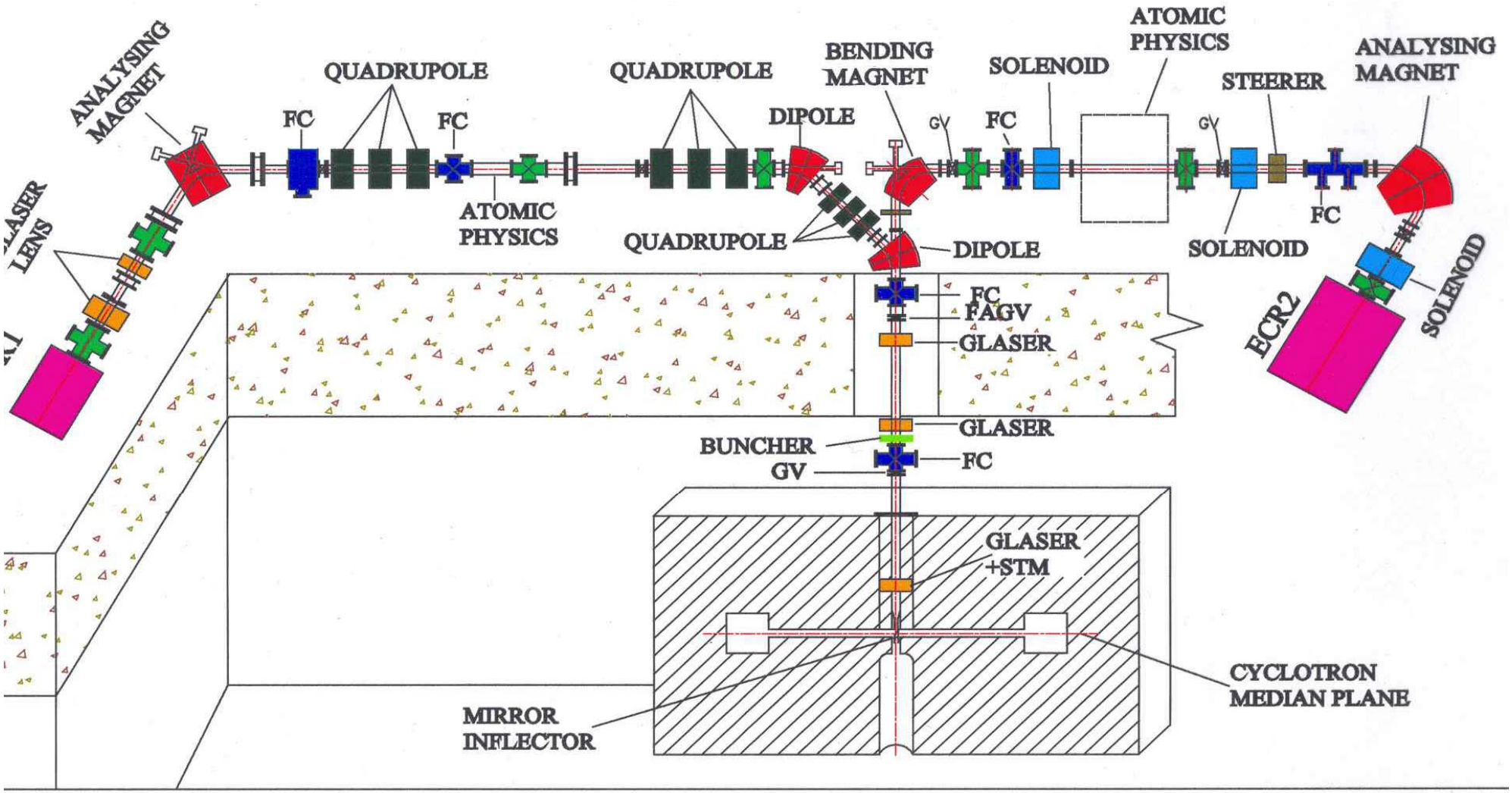
Variable Energy Cyclotron Centre/DAE

APAC07, RRCAT, Indore
Jan. 29-Feb. 2, 2007

224cm Variable Energy Cyclotron



AXIAL INJECTION SYSTEM USING ECR-1 & ECR-2



HEAVY ION ACCELERATION WITH SUPERCONDUCTING CYCLOTRON

Bending Limit : $K_{bend} = 520$ $(\sim B^2R^2)$

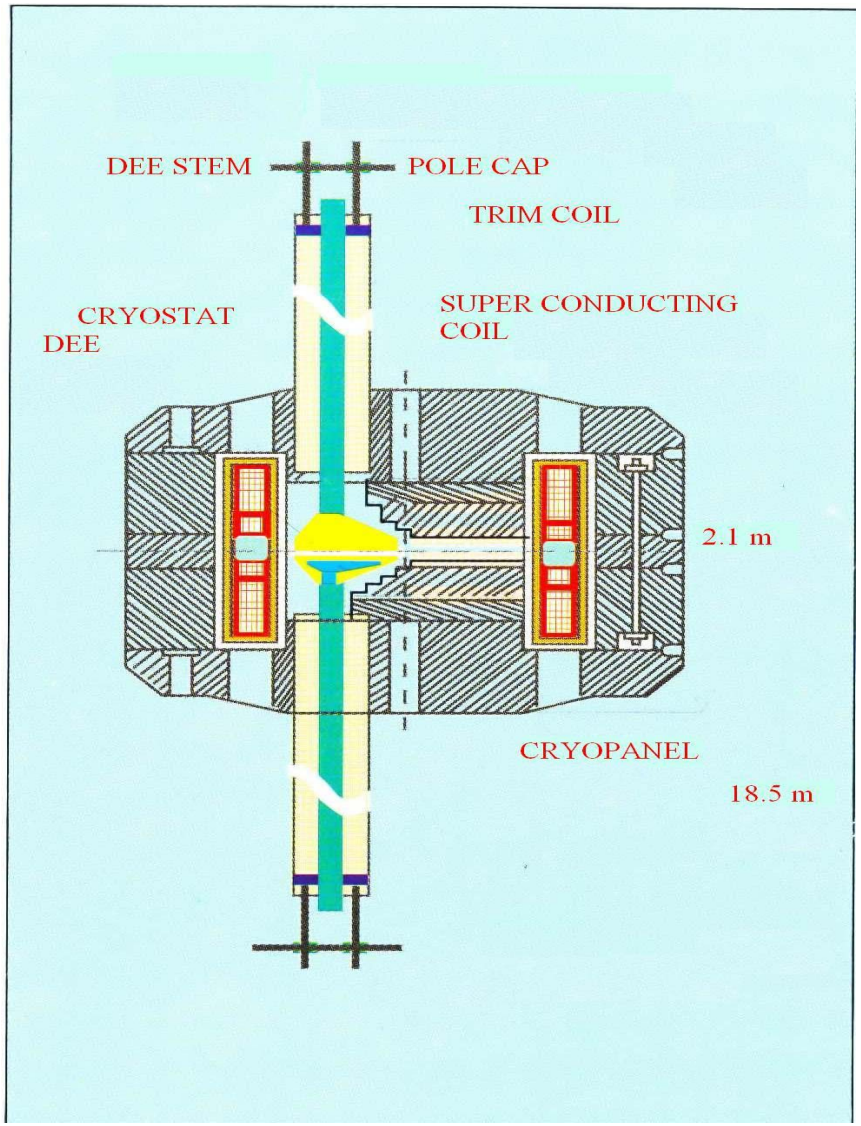
Focusing Limit : $K_{foc} = 160$

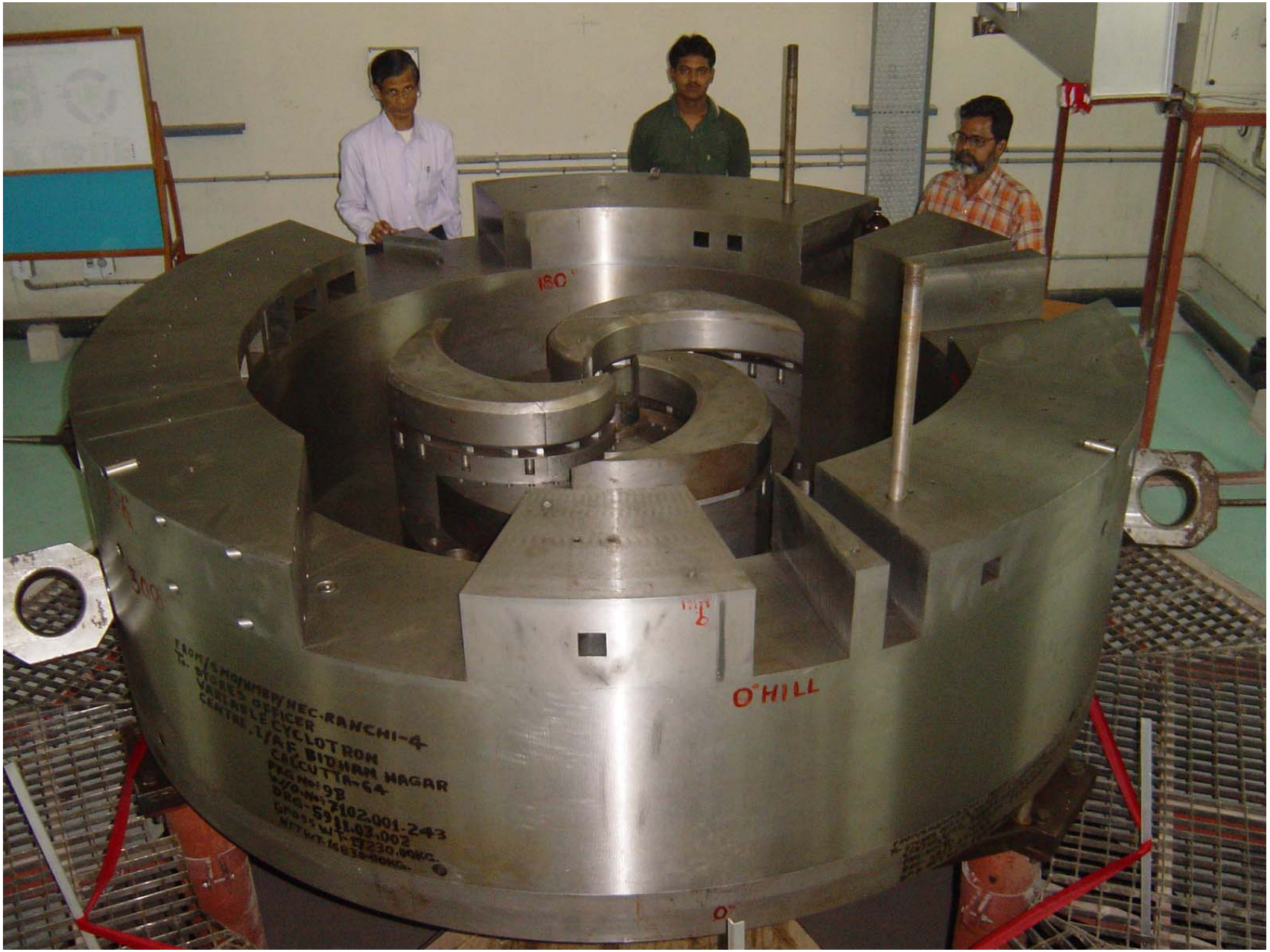
Fully stripped heavy ion beams up to energy ~160.Q/A MeV/nucleon

For medium and heavier mass ions the energy is limited to ~520.Q^2/A^2 MeV/nucleon

- **Research in:**
  - **Nuclear Physics, Condensed Matter Physics**
  - **Material Sciences, Radiochemistry, Analytical Chemistry**

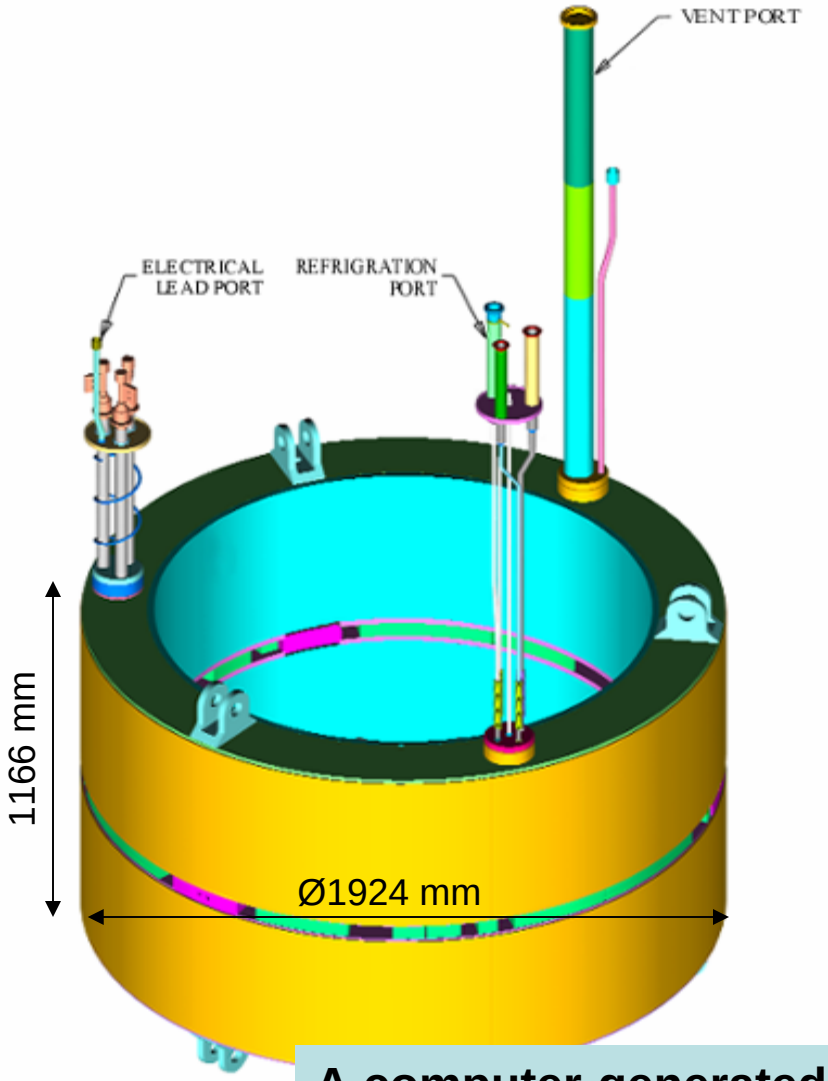
VERTICAL CROSS-SECTIONAL VIEW OF THE K500 SUPERCONDUCTING CYCLOTRON





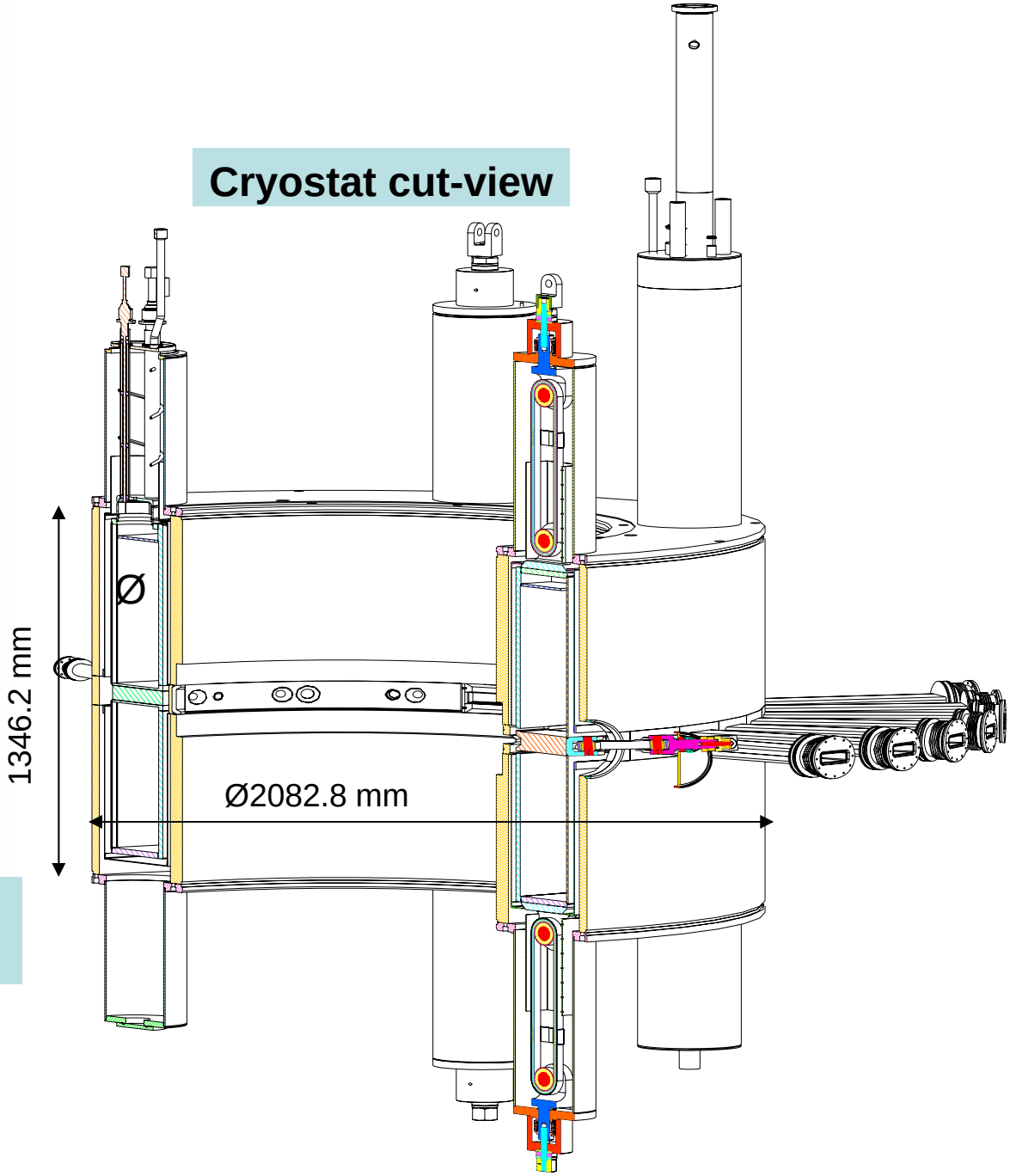
MAGNET ASSEMBLY IS IN PROGRESS

Coil winding in progress

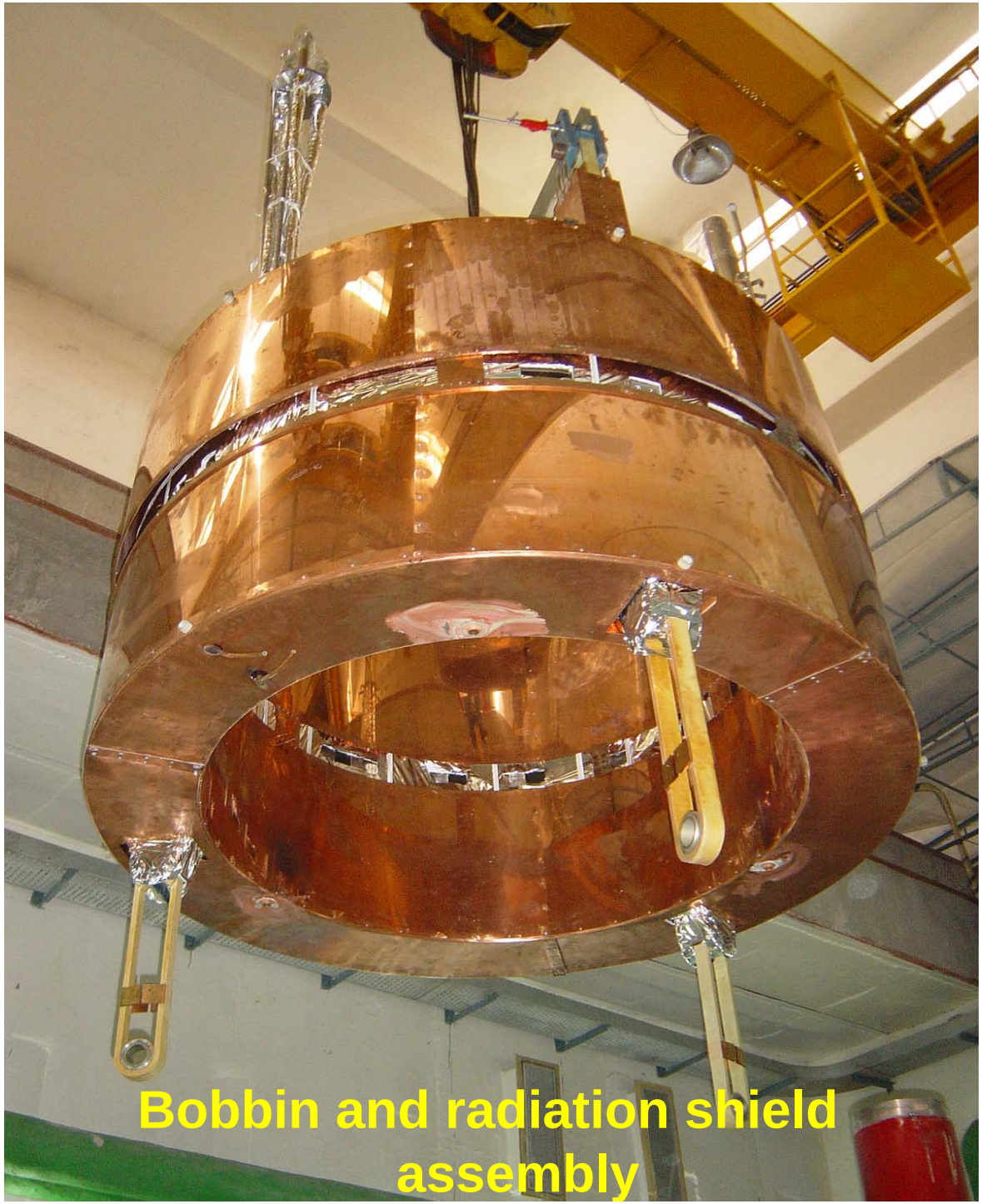


A computer-generated bobbin assembly

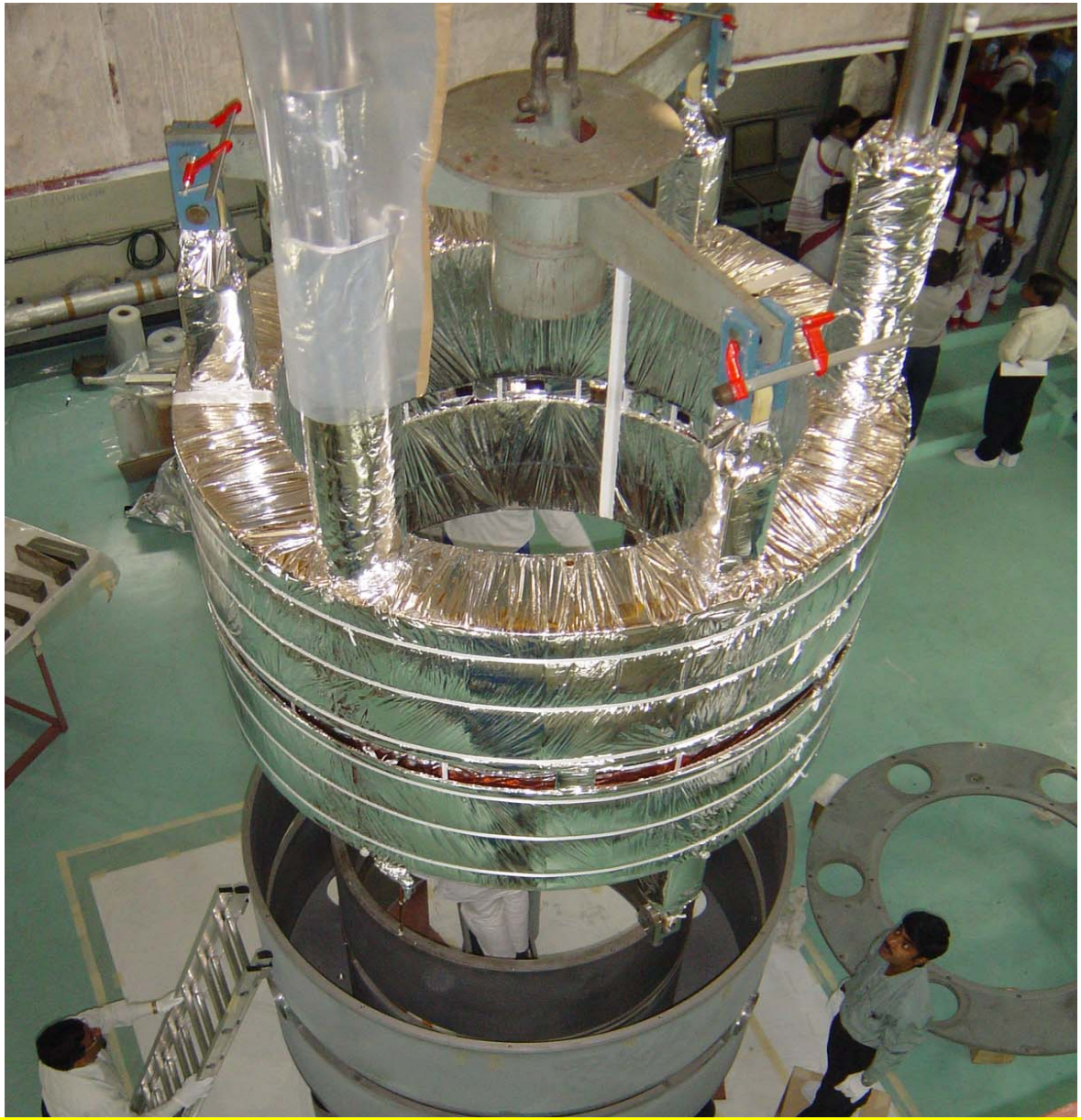
Cryostat cut-view




Insulated bobbin assembly



Bobbin and radiation shield assembly



Insulated bobbin & radiation shield being inserted to vacuum chamber

Cryostat assembly being transported to vault

Magnet assembly with pole cap lifted position - maximum lifting height of upper pole cap is 1143mm.

K500 Superconducting Cyclotron Magnet

LHe PLANT CAPACITY

LIQUEFACTION MODE

50LPH & 100 LPH, without and with LN_2 pre-cooling respectively

REFRIGERATION MODE

160W & 200 W, without and with LN_2 pre-cooling respectively

SYSTEM DESCRIPTION

A) Helium compressor : Screw type operating at 14 bar (abs) Mass flow 49.35 g/s

B) Oil removal module : Aerosol up to 0.001 mm

C) Cold box : Warm expander speed = 5500 rps, cold expander speed = 2800 rps,

D) Dewar : 1000 litre capacity

E) Buffer tank : 20 NM^3 and 60 NM^3 capacity

F) Gas bag : 25 NM^3 capacity

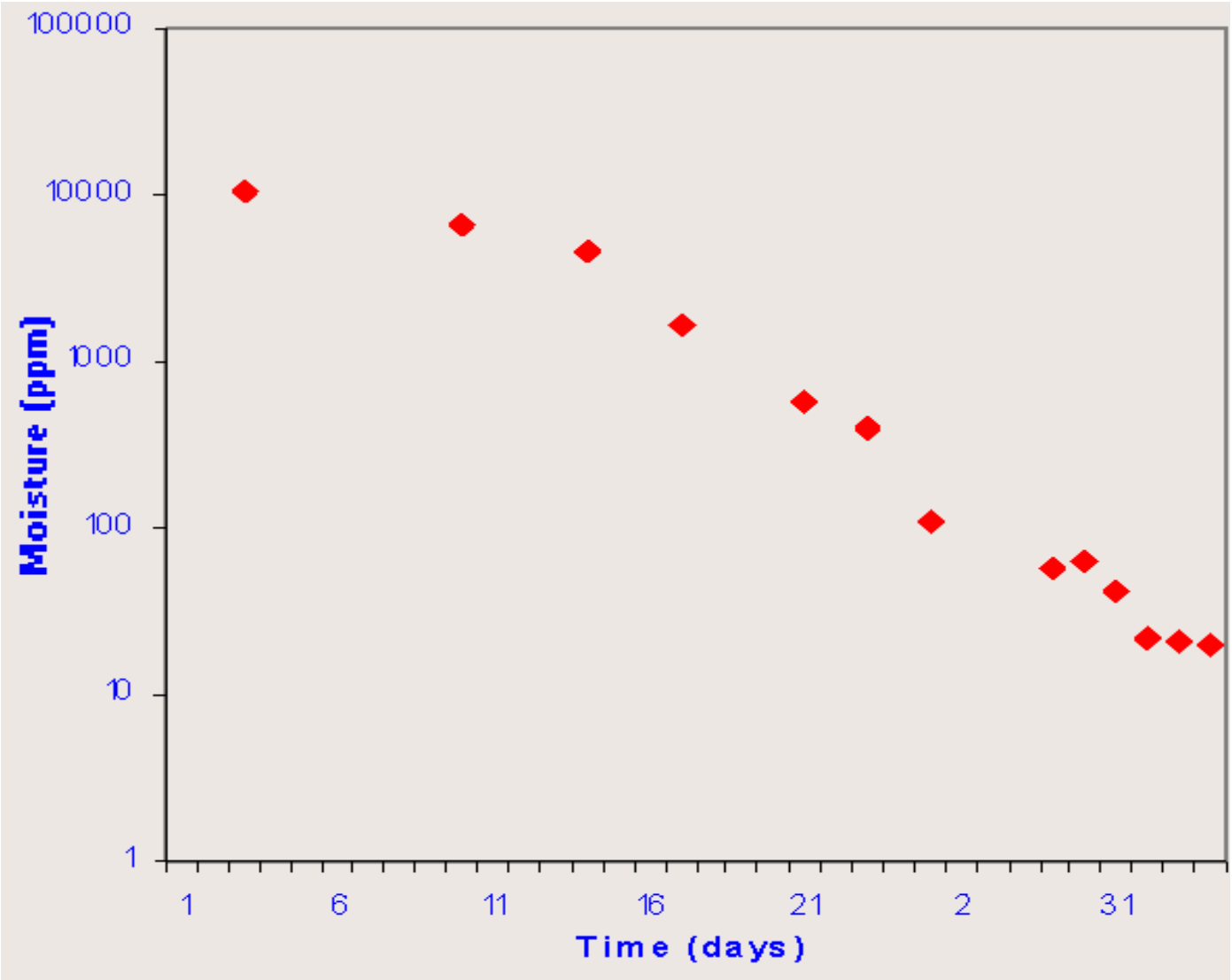
G) Recovery compressor : 20 NM^3 / hr at 150 bar

H) Gas manifold pure : 150 cylinder at 150 bar, Impure 100 at 50bar.

I) Utilities i) LN_2 : Storage of 2 x 2KL and 12.5 KL with plant producing 90 litre / hr.

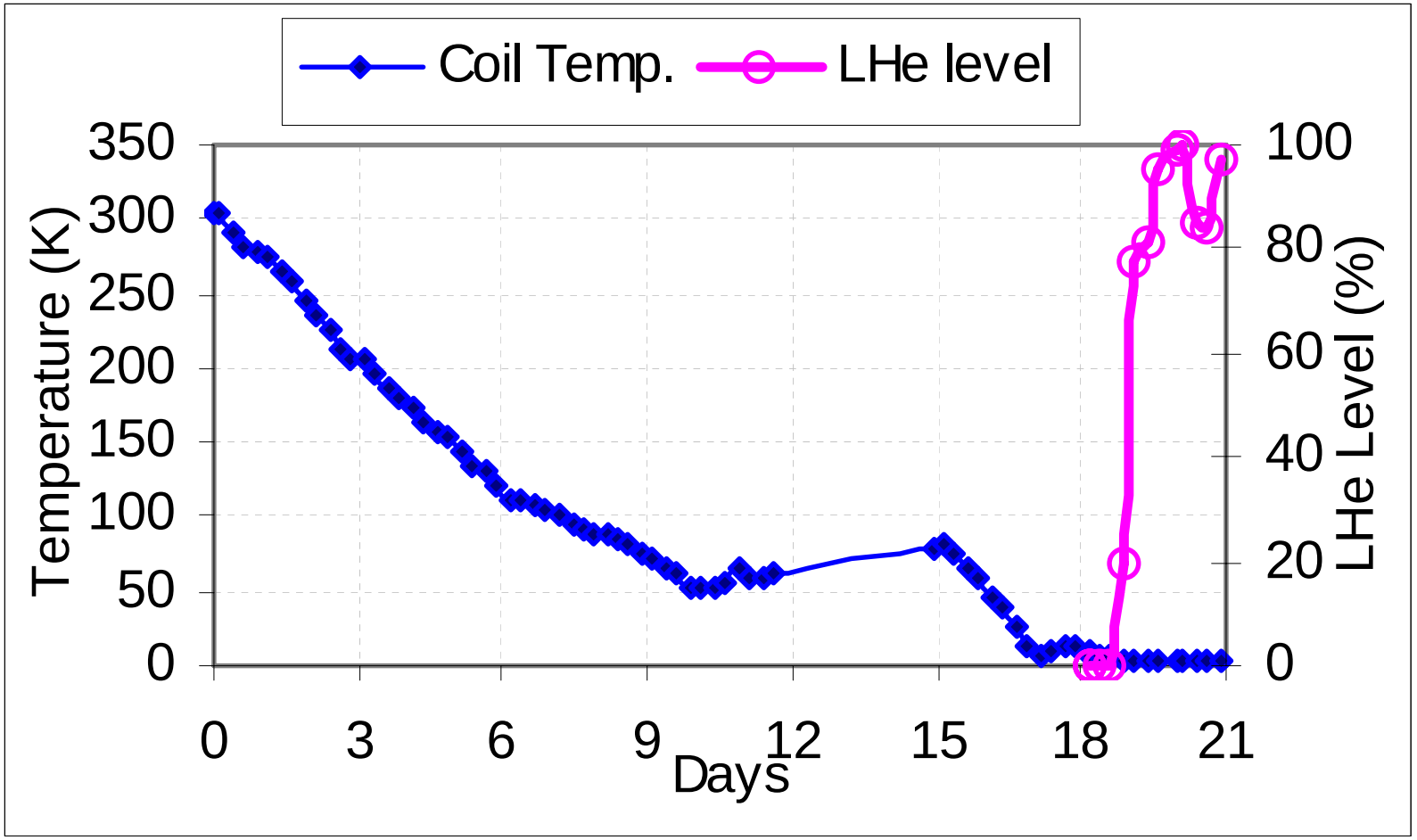
ii) Chilled water : 70TR plant for cooling compressor & turbine in cold box.

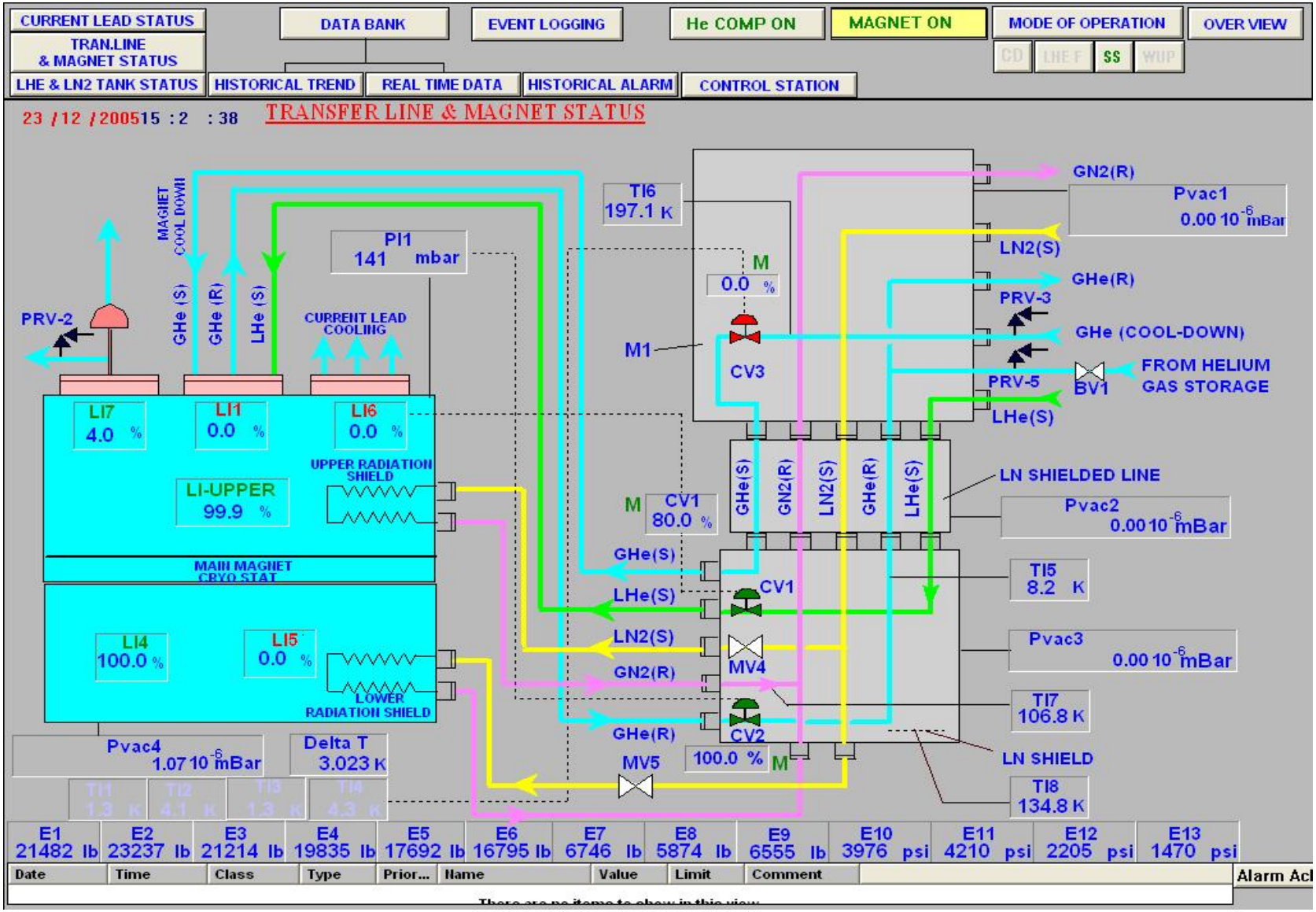
iii) Instrument air : 5 M^3 / hr at 7 bar (g)



Reduction of moisture level in the cryostat

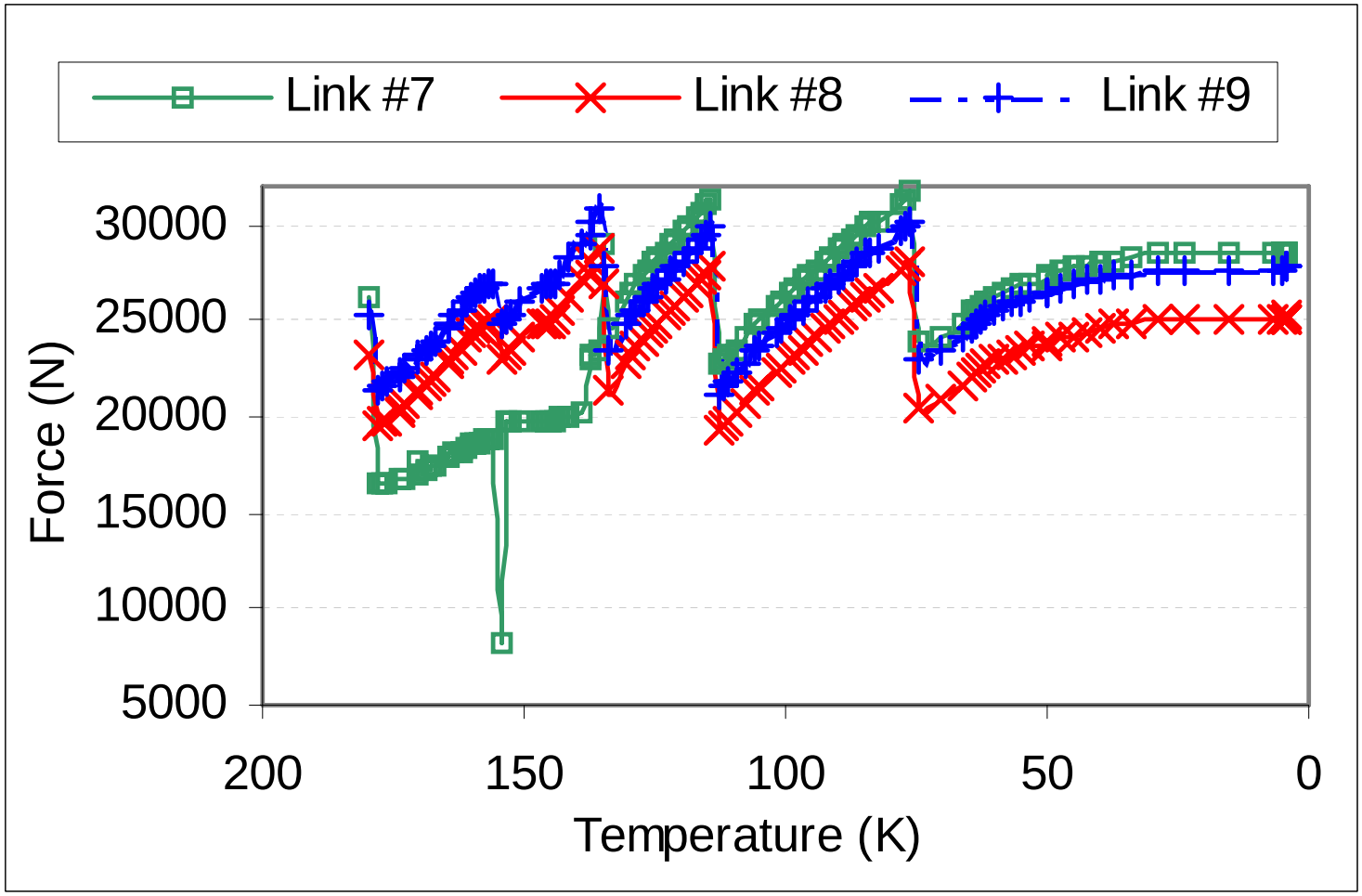
Cool down of the K-500 superconducting cyclotron magnet

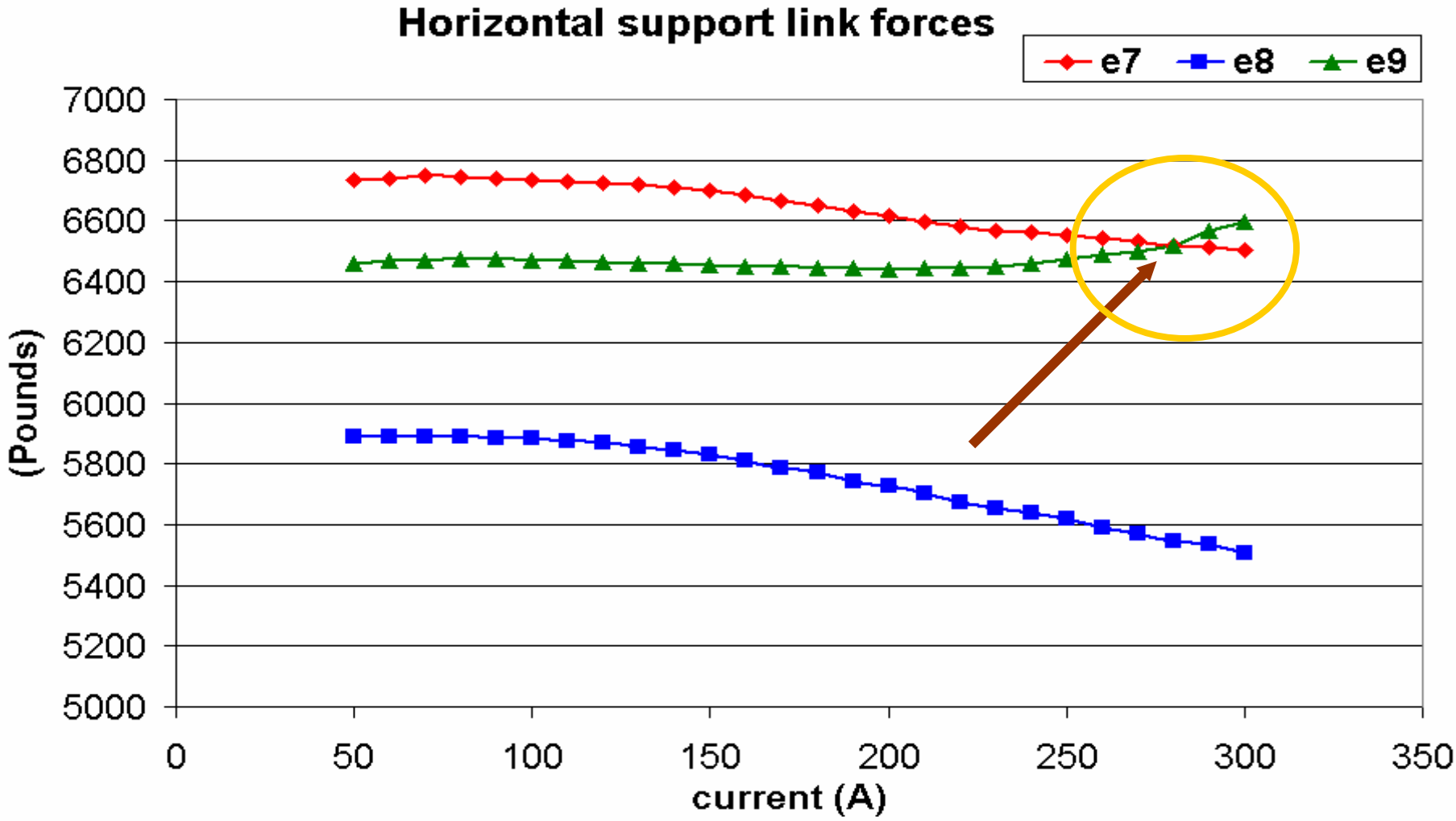




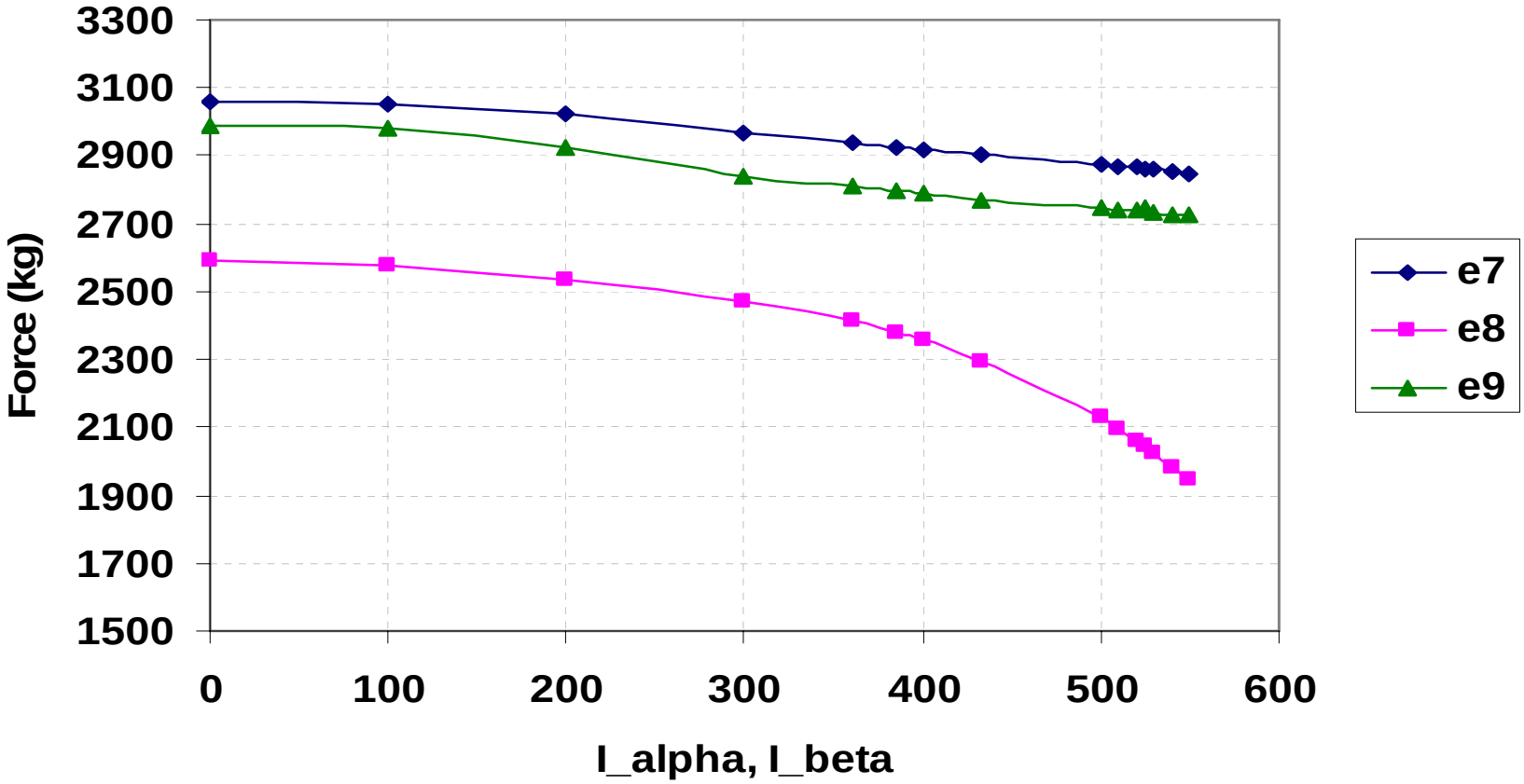
MMI of Cryogen Delivery System

Forces on the support links during cool down



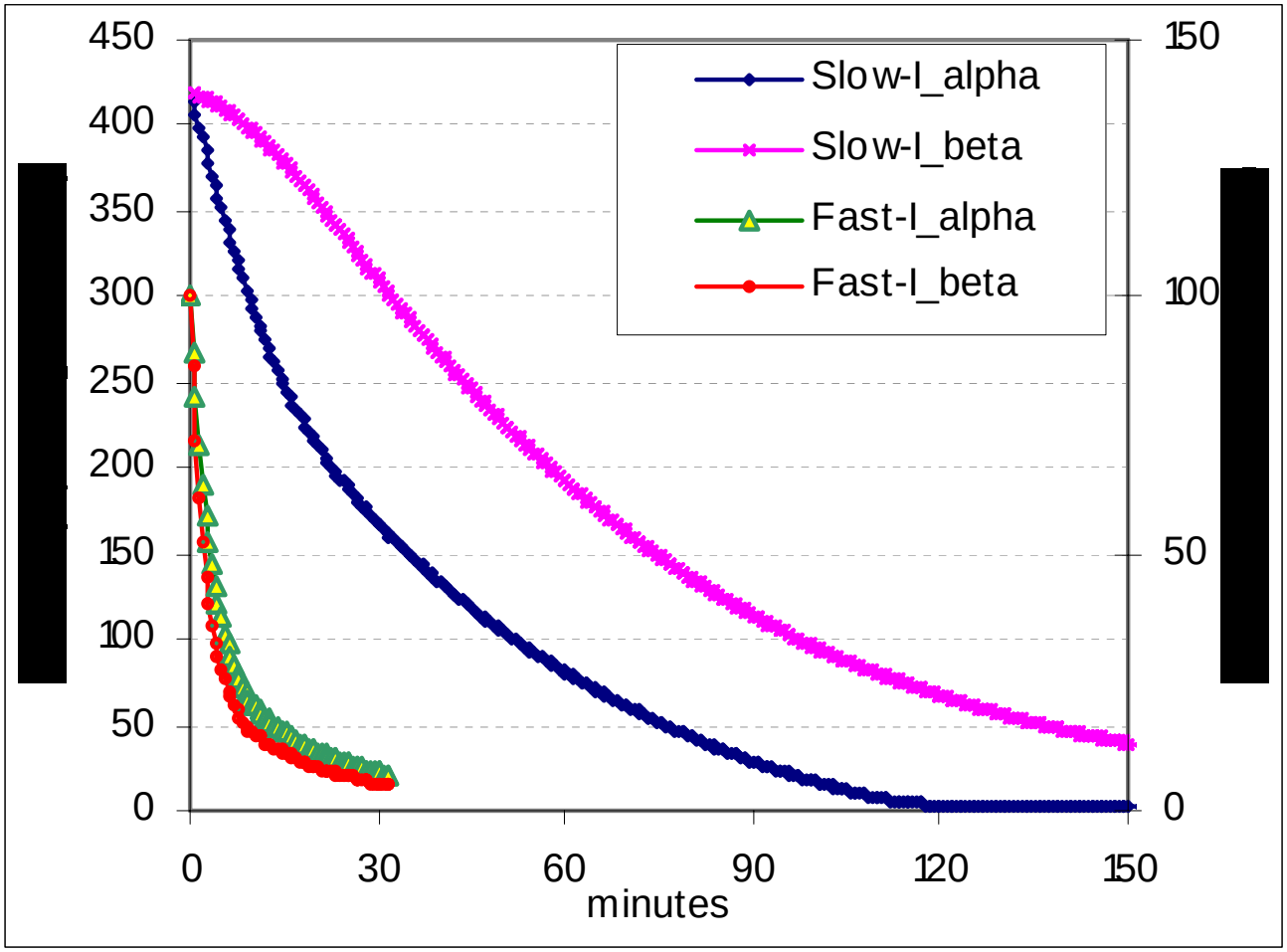


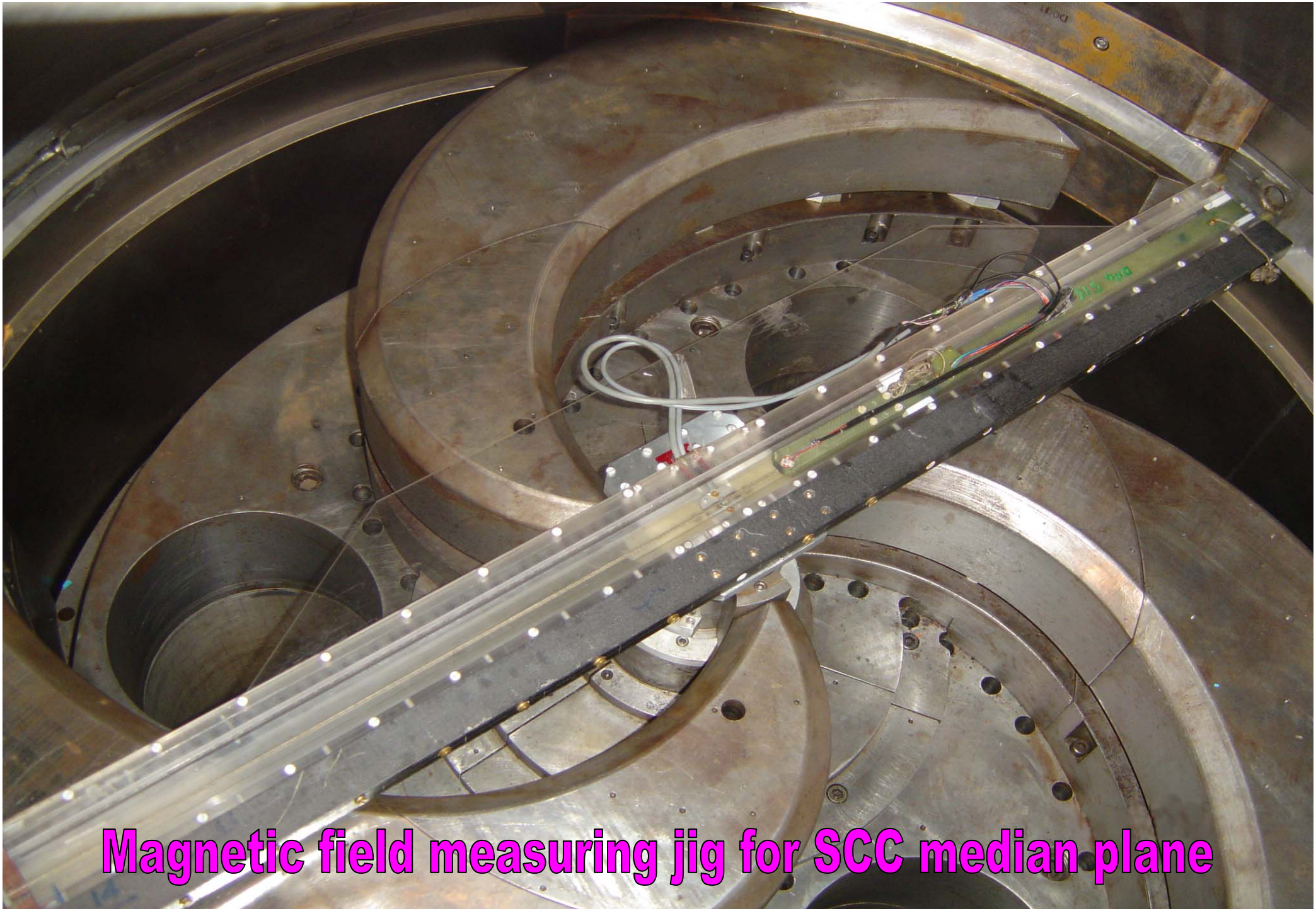
March 30, 2005



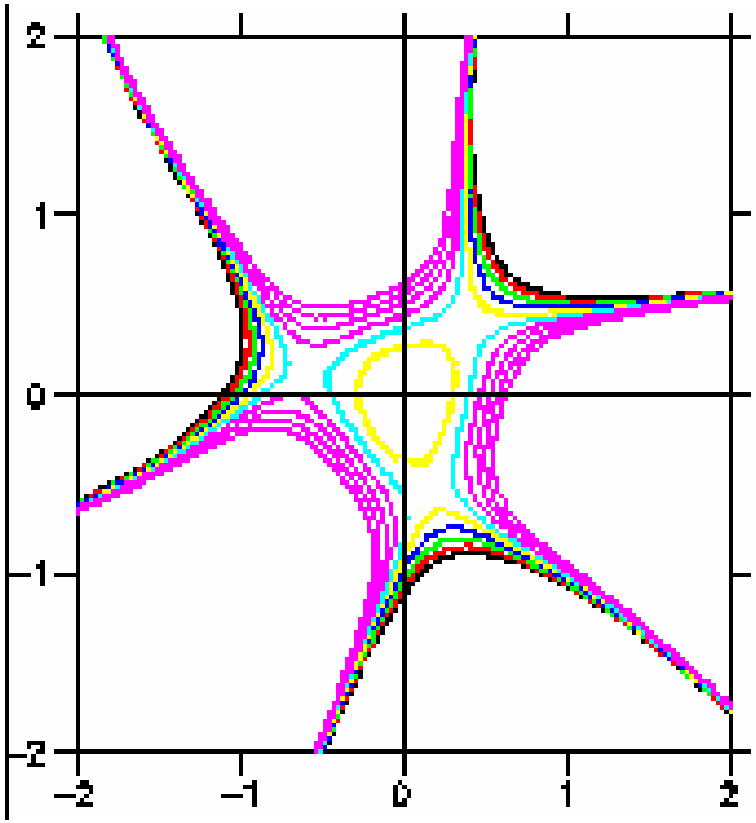
Forces on the support links during energization

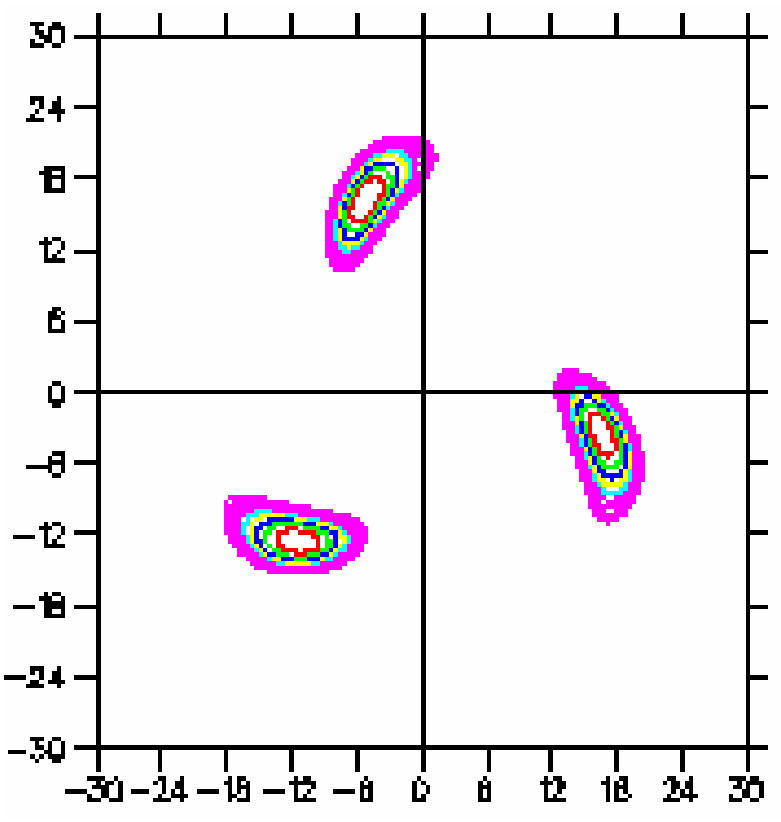
Decay of current during fast and slow dump operations



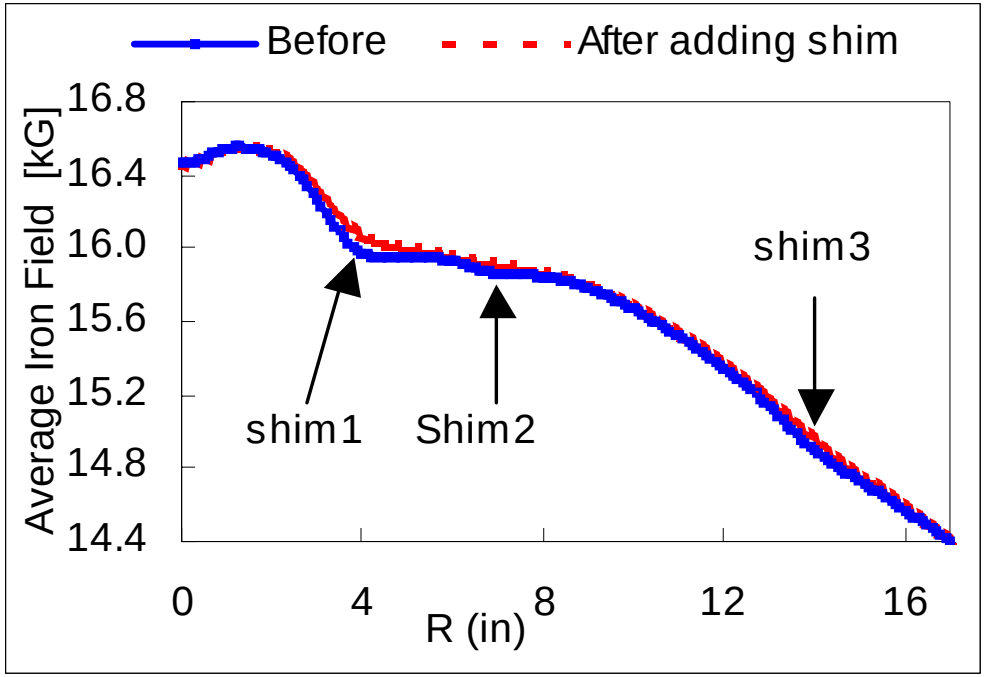

Magnetic field measuring jig for SCC median plane

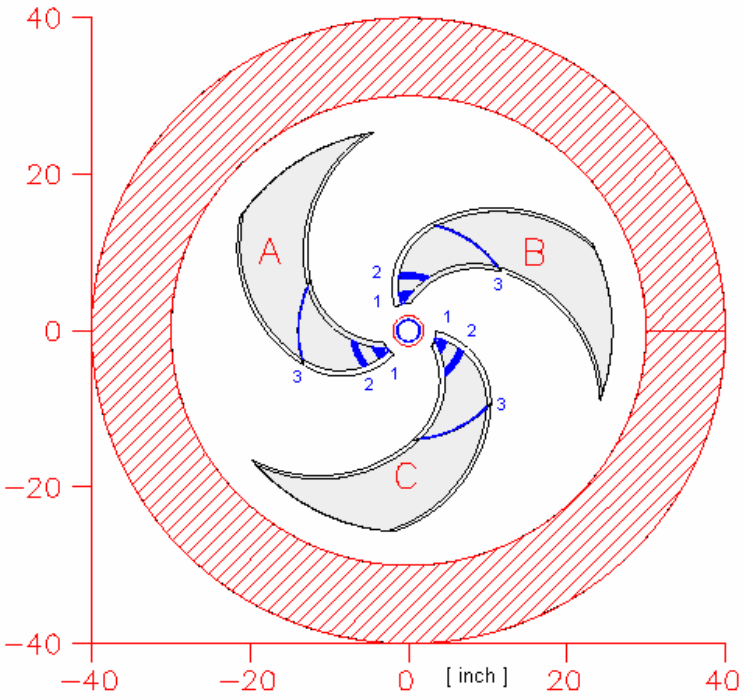
Magnetic field contours plotted in the cyclotron central region and RF holes for the purpose of locking the NMR signal



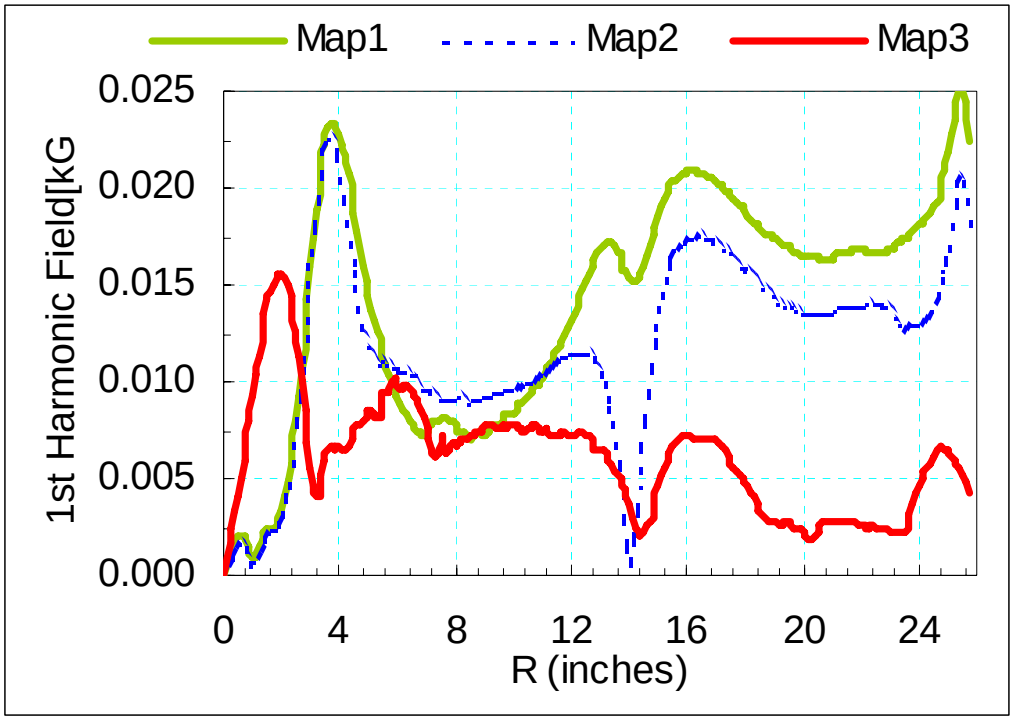


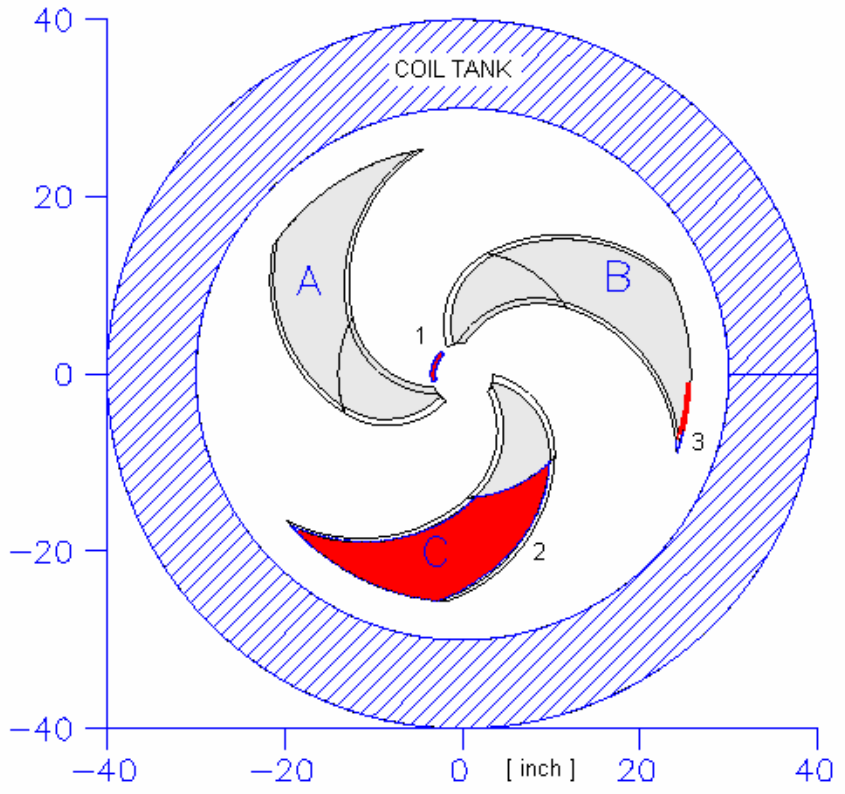
Average field correction for the K-500 superconducting cyclotron magnet

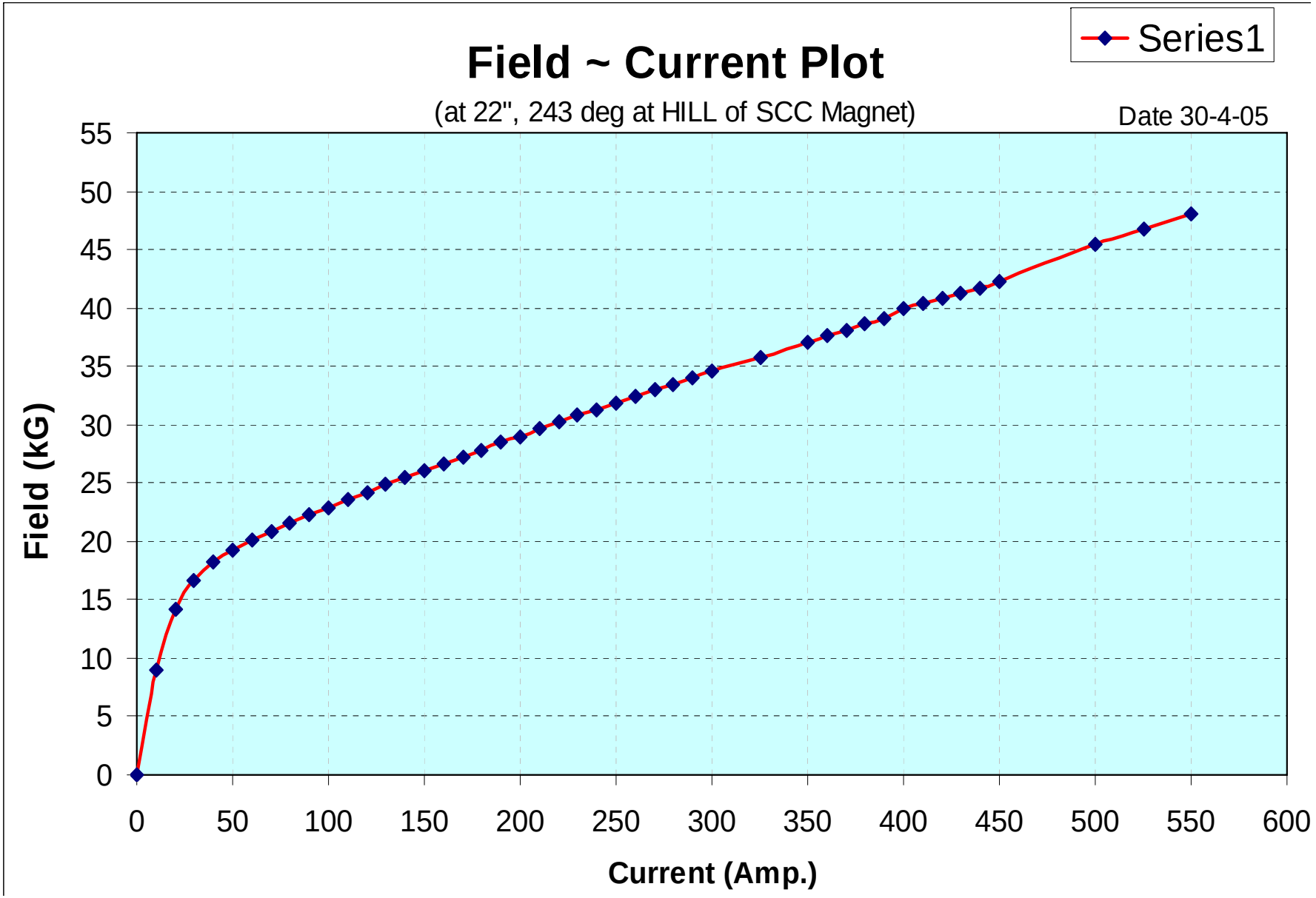




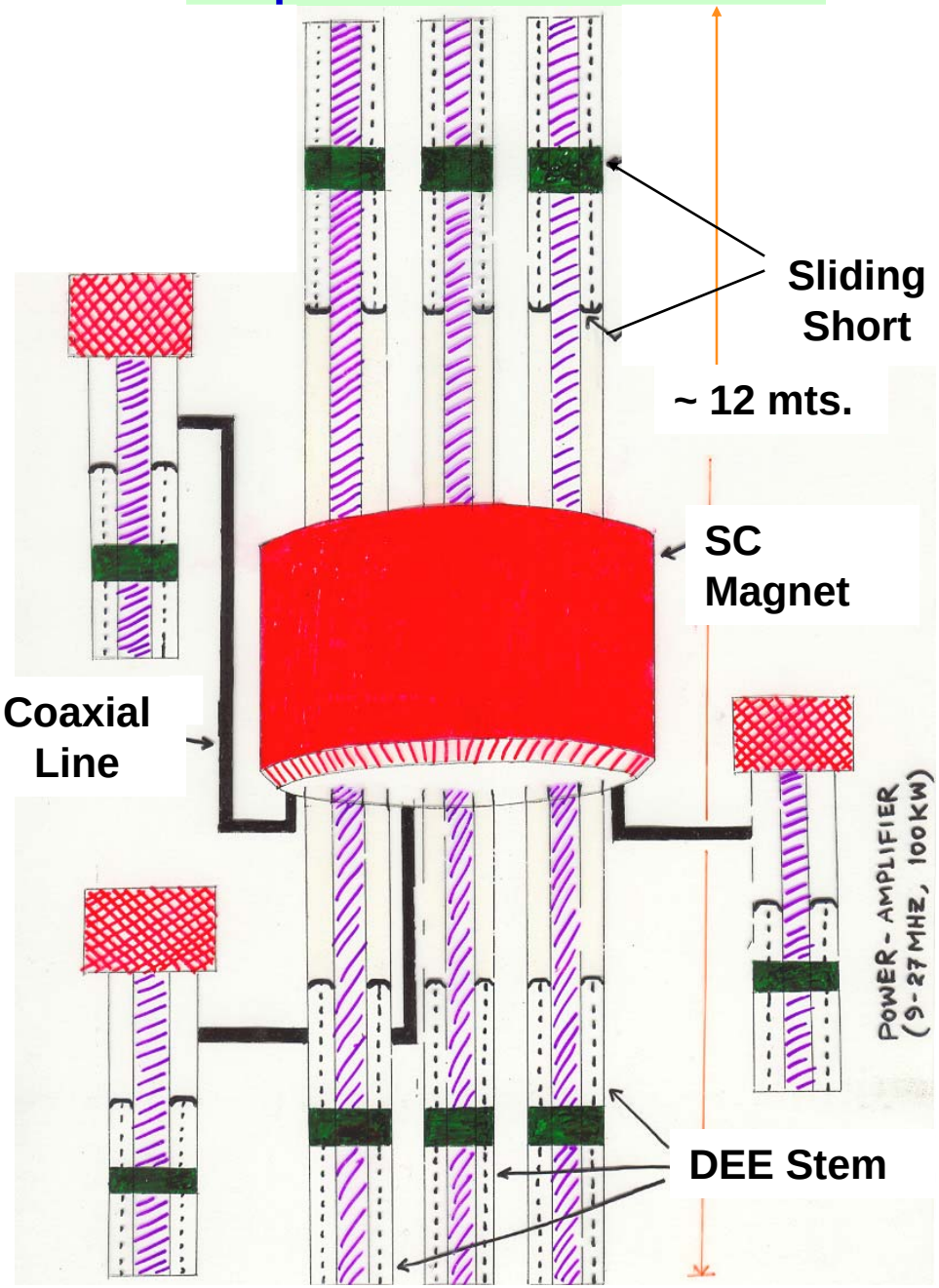
First Harmonic Correction



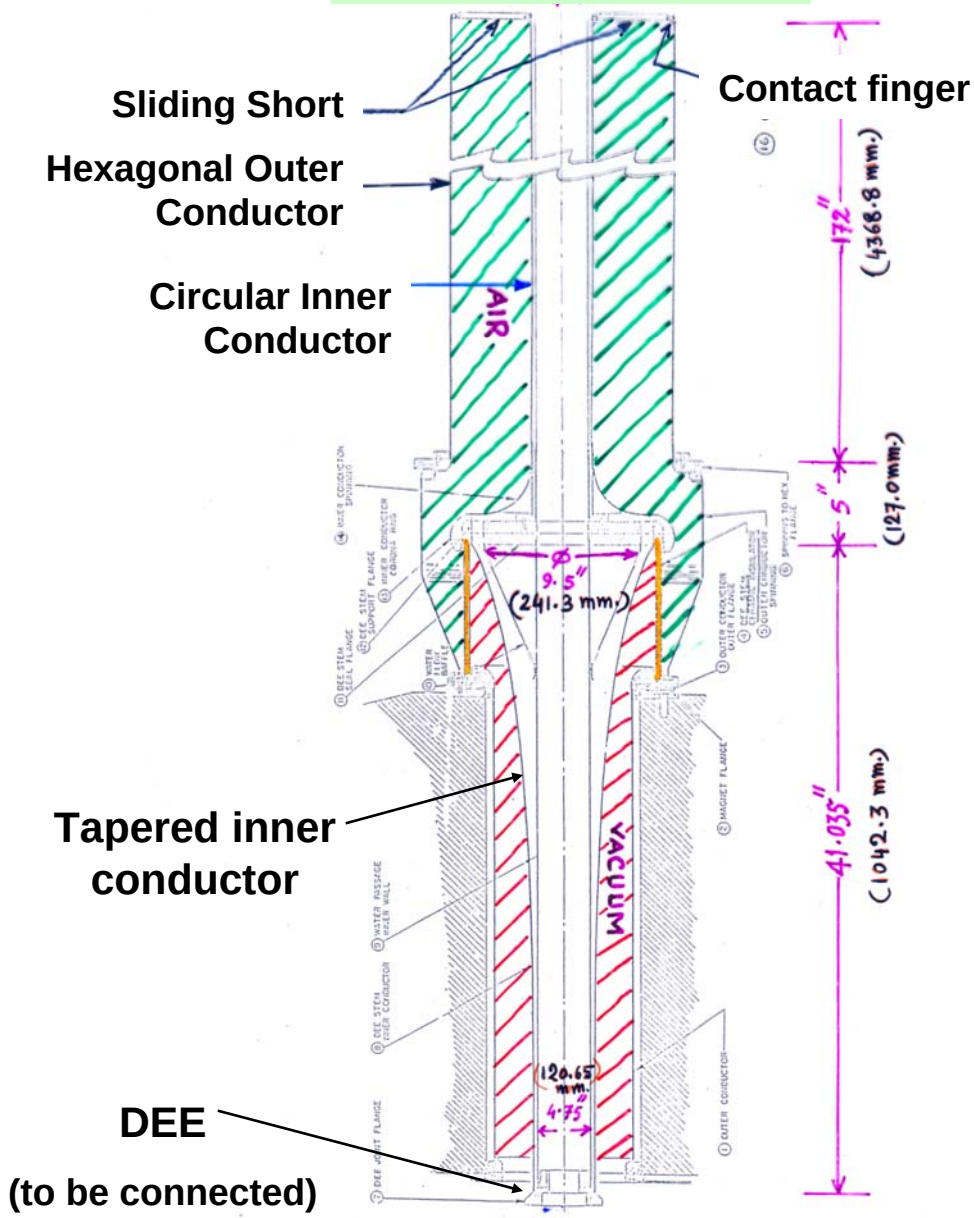



Field ~ Current Plot
(at 22", 243 deg at HILL of SCC Magnet)
Date 30-4-05
Series1
Field (kG)
Current (Amp.)
0
5
10
15
20
25
30
35
40
45
50
55
0
50
100
150
200
250
300
350
400
450
500
550
600

3ϕ RF SYSTEM



λ/4 section of cavity



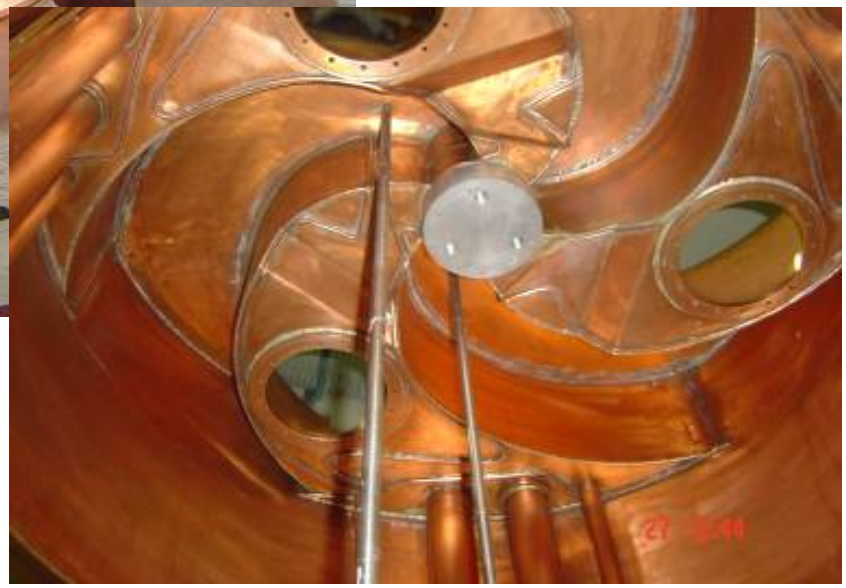
One of the six RF resonators being assembled at VECC

Outer conductor spinning

Upper and lower DEE assemblies

Dee vacuum testing

RF liner check assembly over pole cap

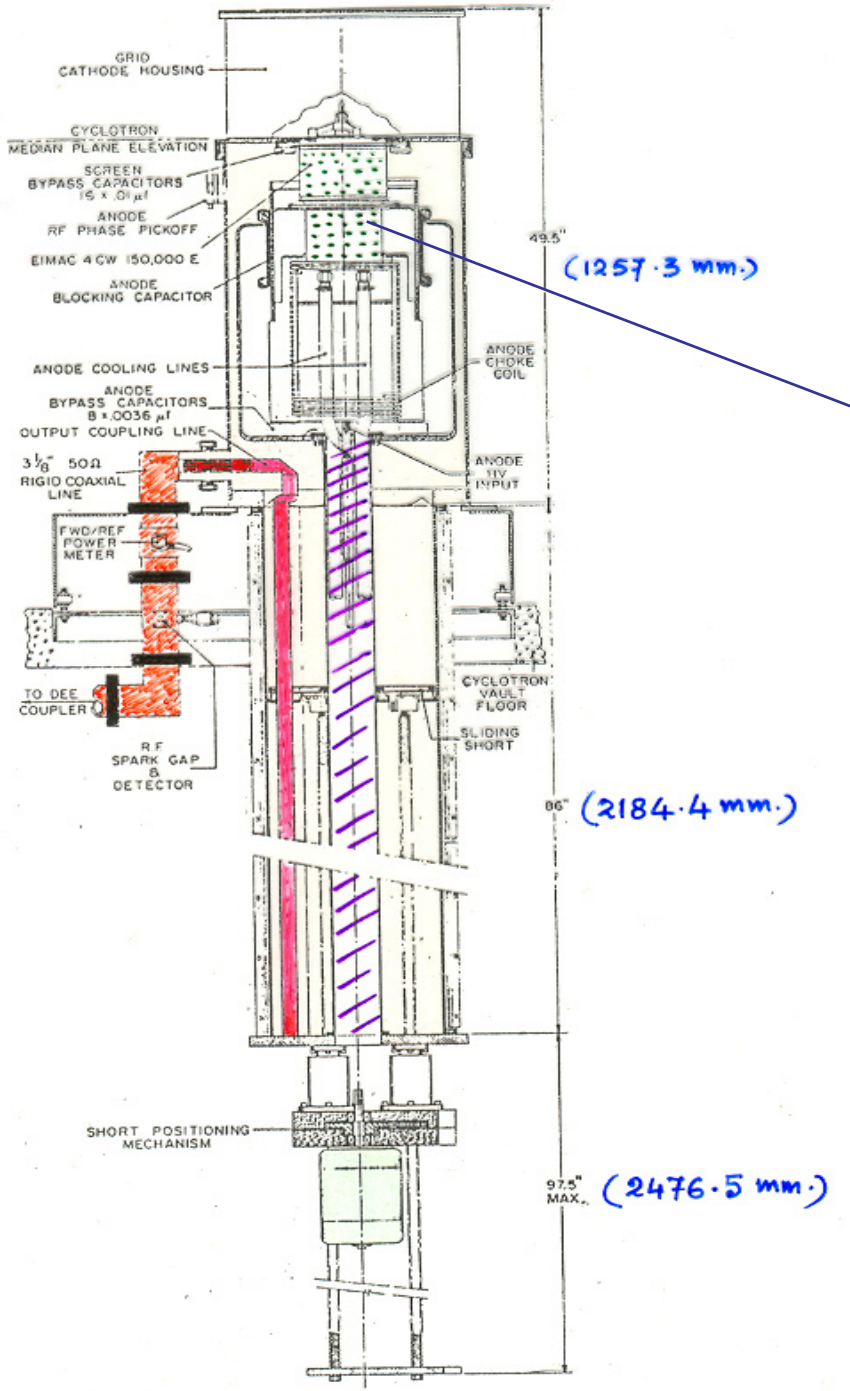


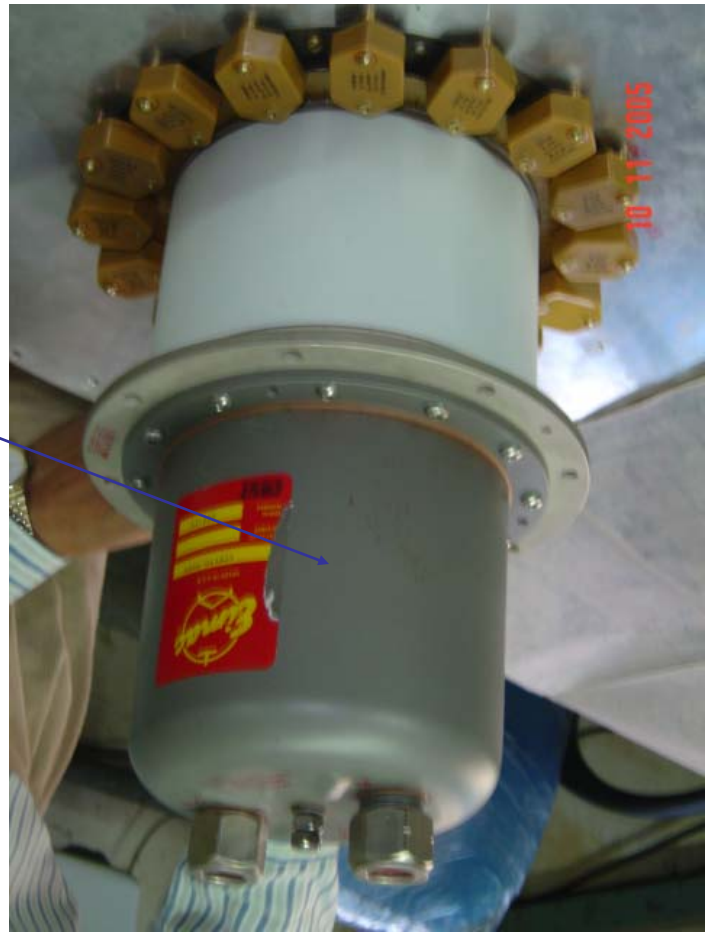
Inside view of RF Liner

TRIM COIL INSTALLATION

RF liner check assembly

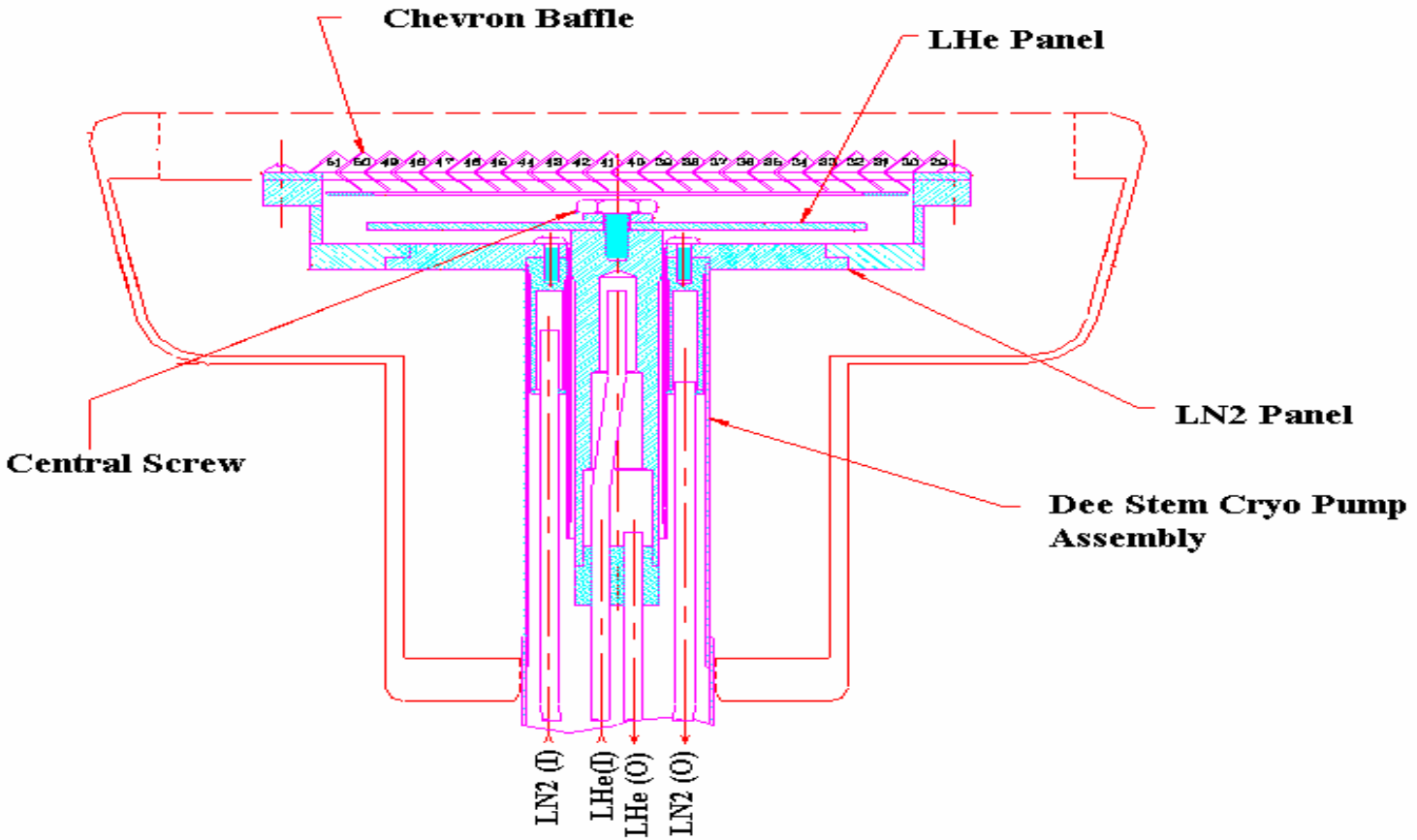
High power (100kW) RF Amplifier (Schematic) for Superconducting Cyclotron



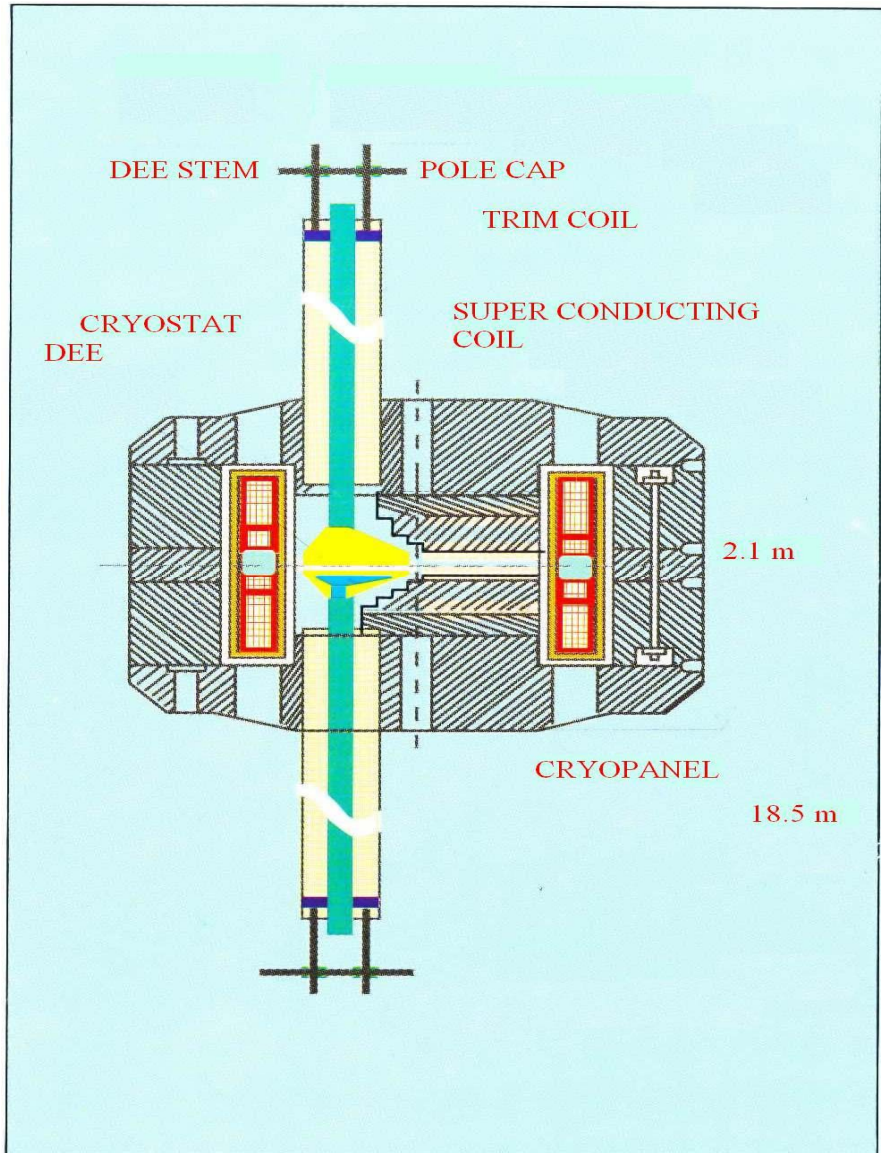


Assembly of Screen By-pass Capacitor with Tetrode

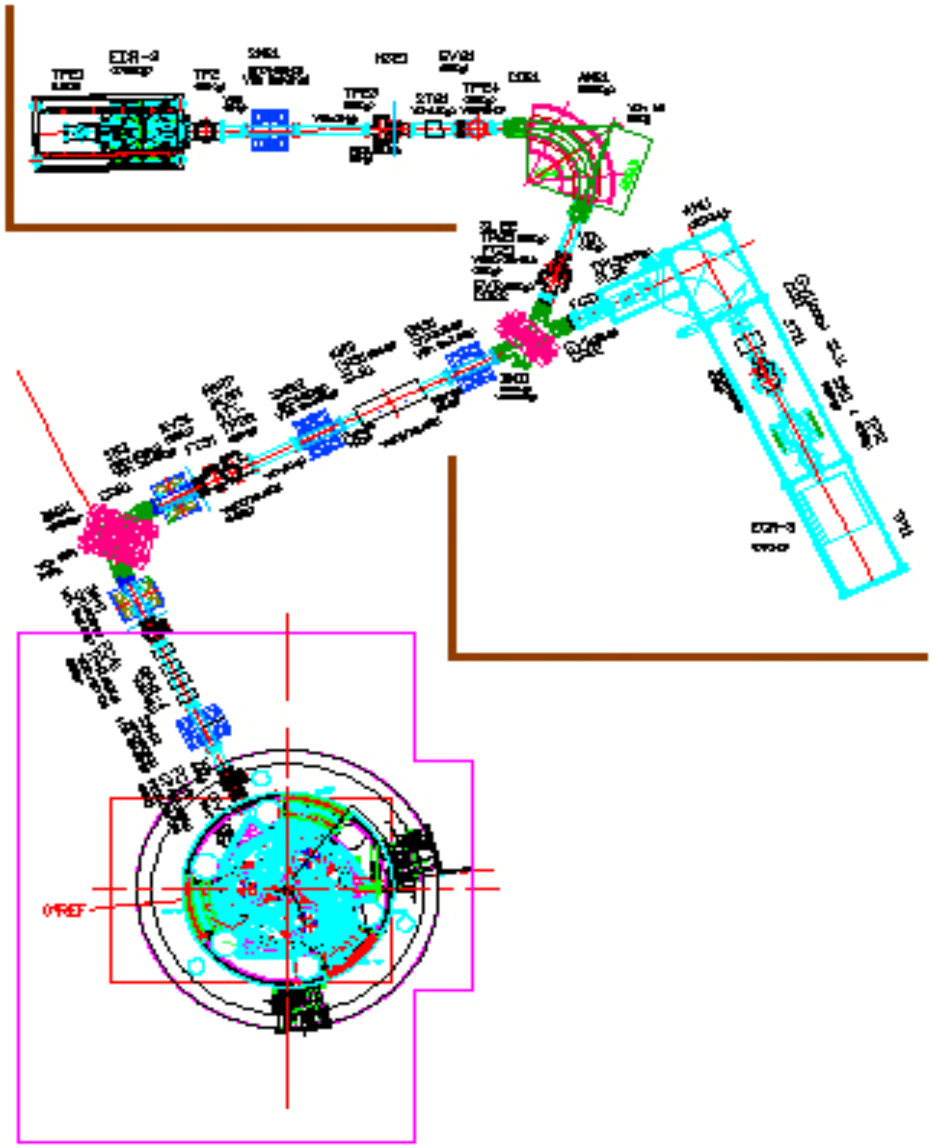
Cryo-Panel Pump



VERTICAL CROSS-SECTIONAL VIEW OF THE K500 SUPERCONDUCTING CYCLOTRON

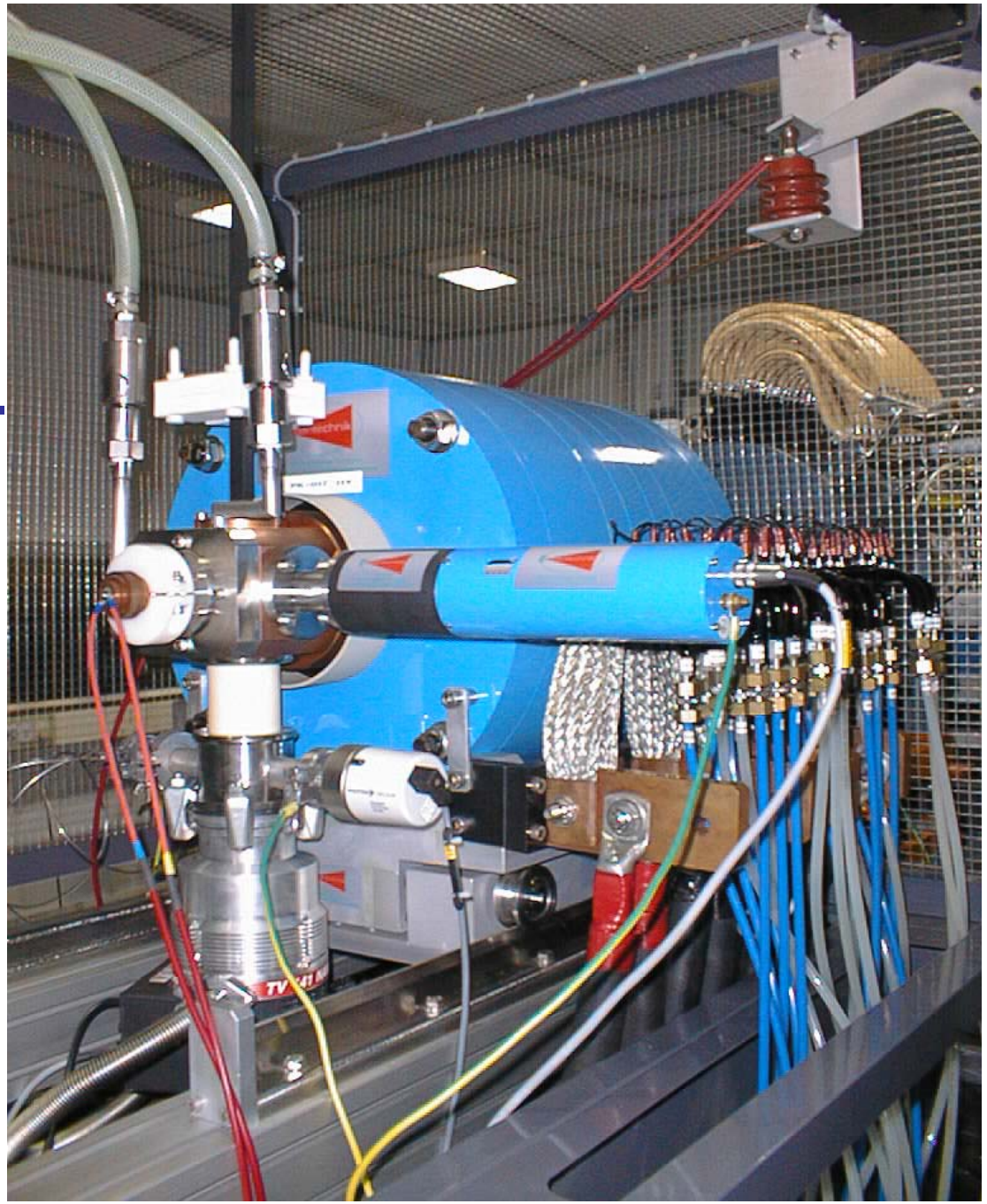


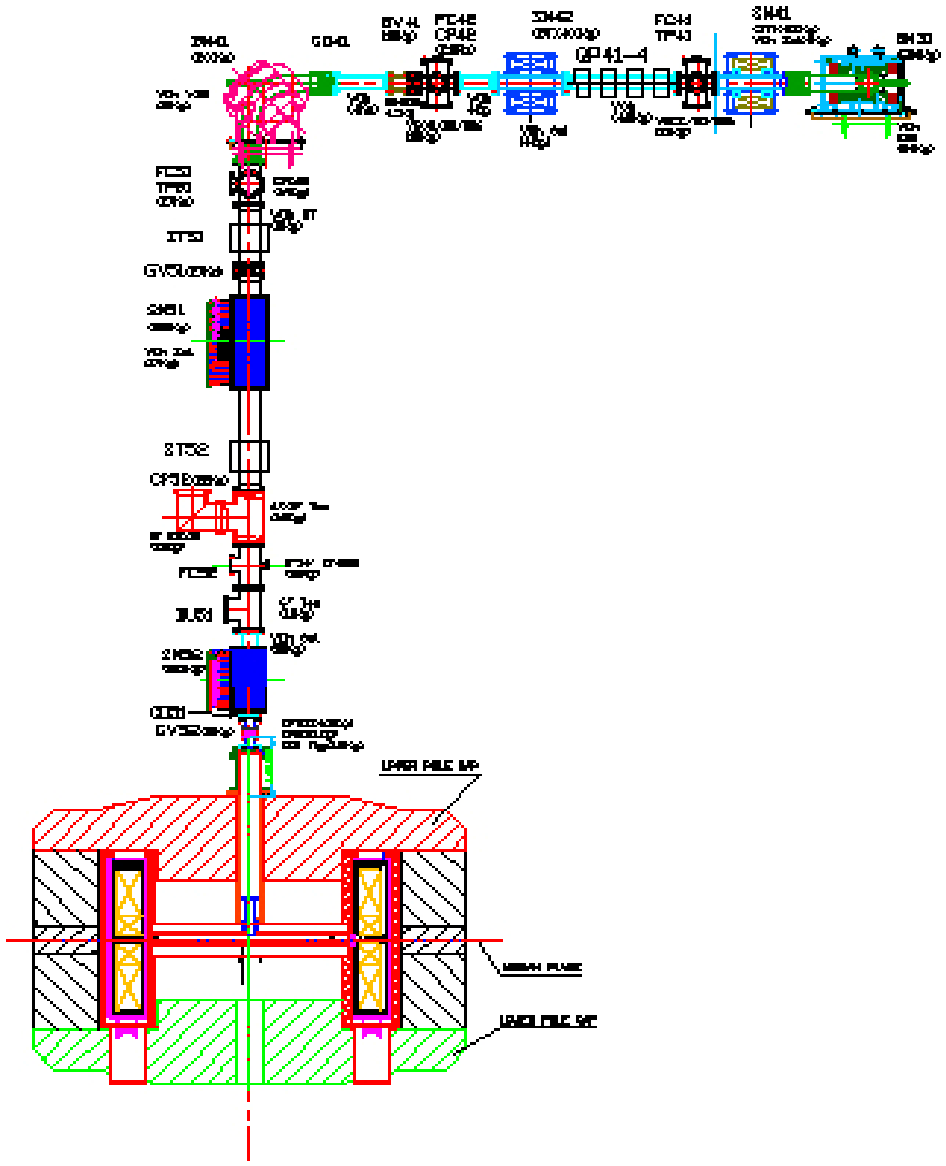
Pump cryostat for LHe delivery to the cryopanels



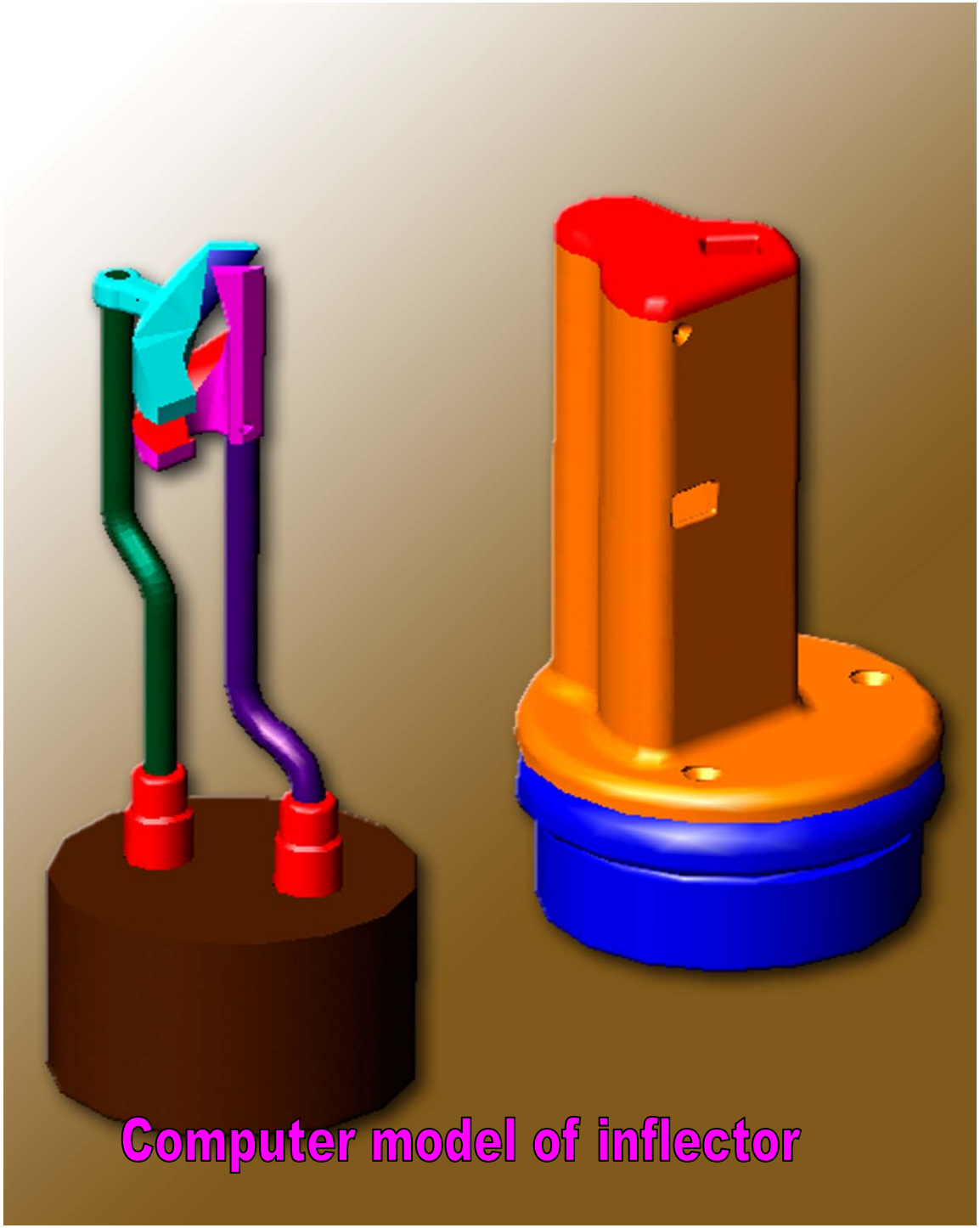
LAYOUT OF HORIZONTAL SECTION OF INJECTION LINE FOR VEC K-500 SUPERCONDUCTING CYCLOTRON

ECR Source for the Superconducting Cyclotron

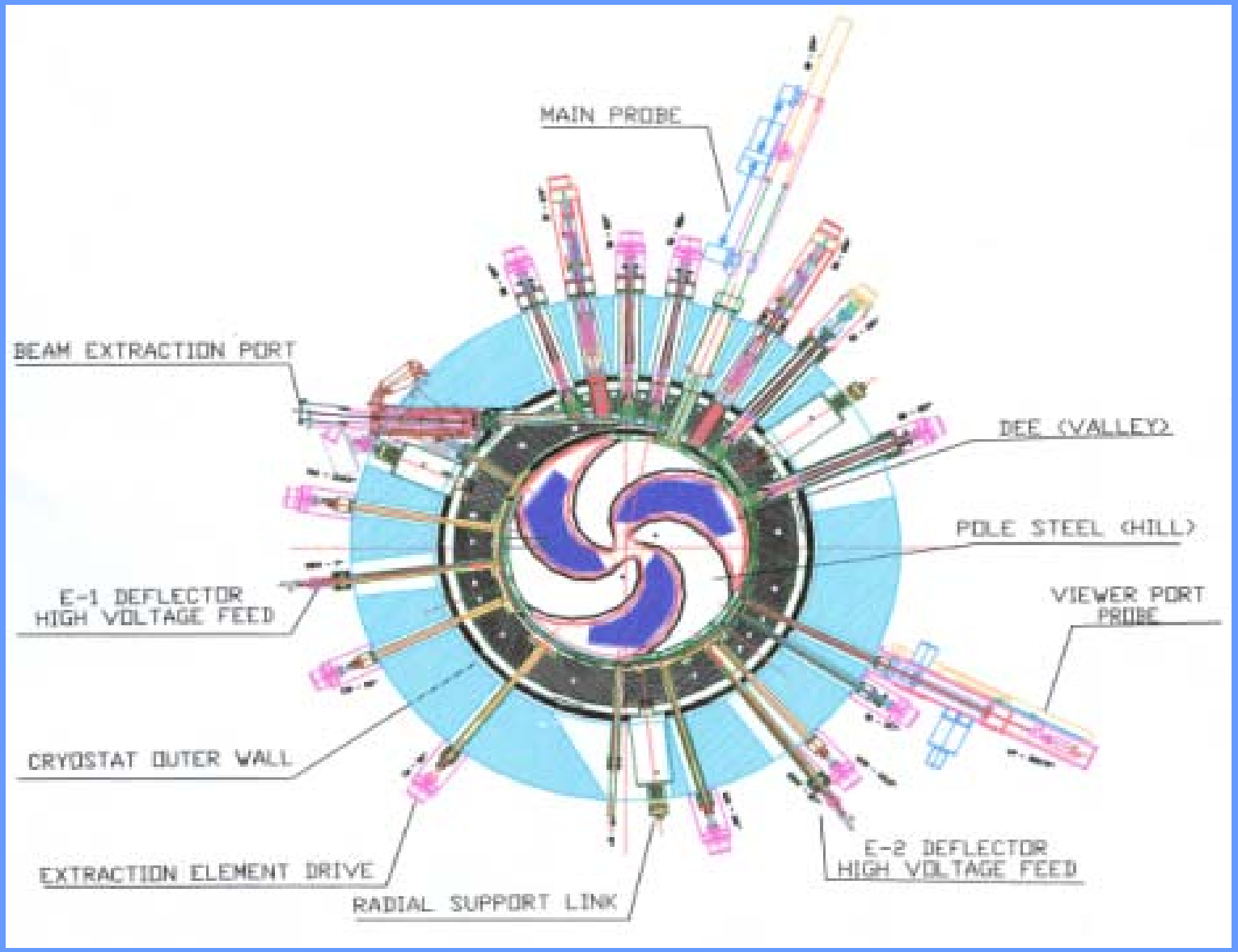




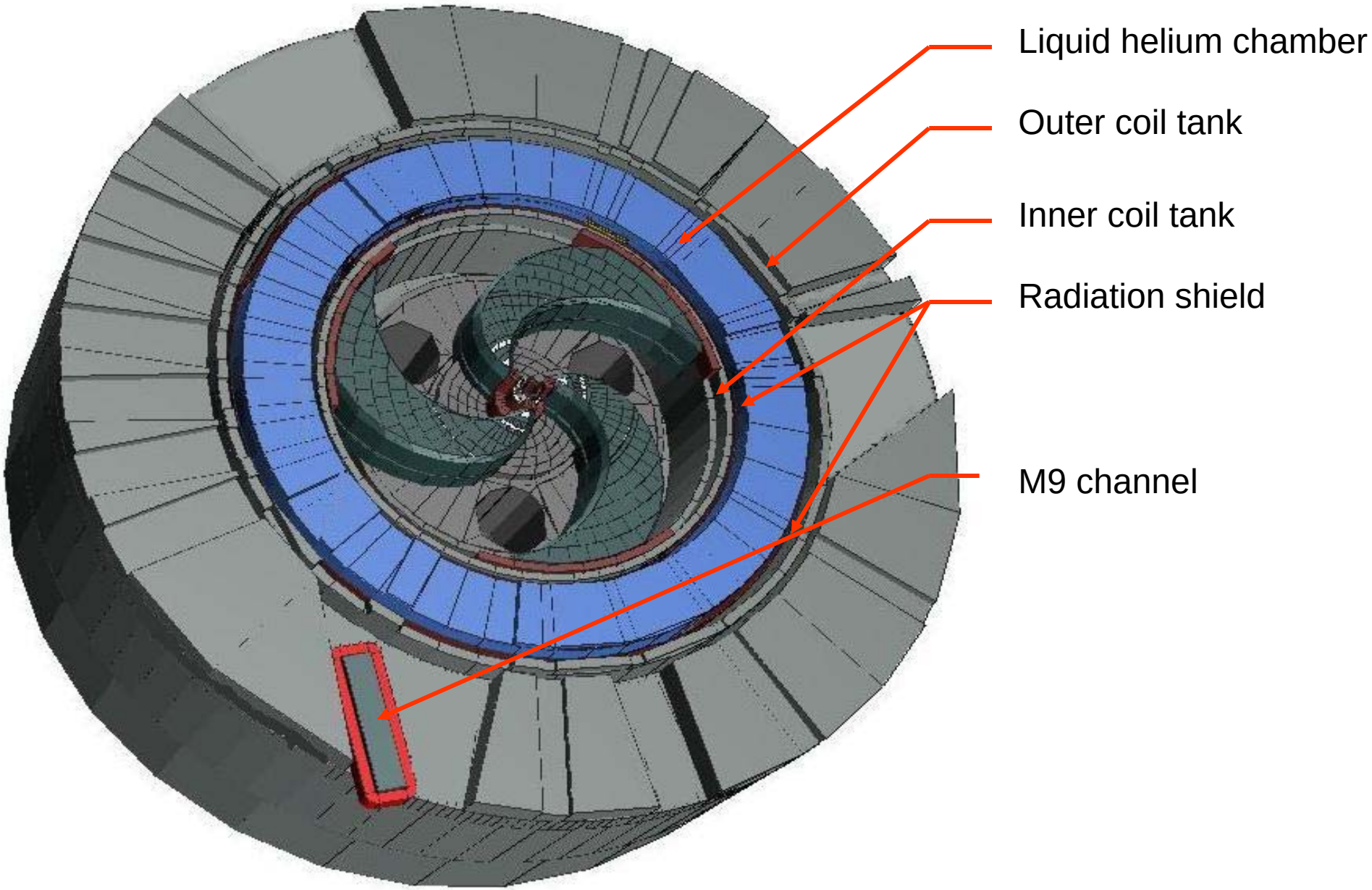
LAYOUT OF VERTICAL SECTION OF INJECTION LINE
FOR VEC K-500 SUPERCONDUCTING CYCCLOTRON

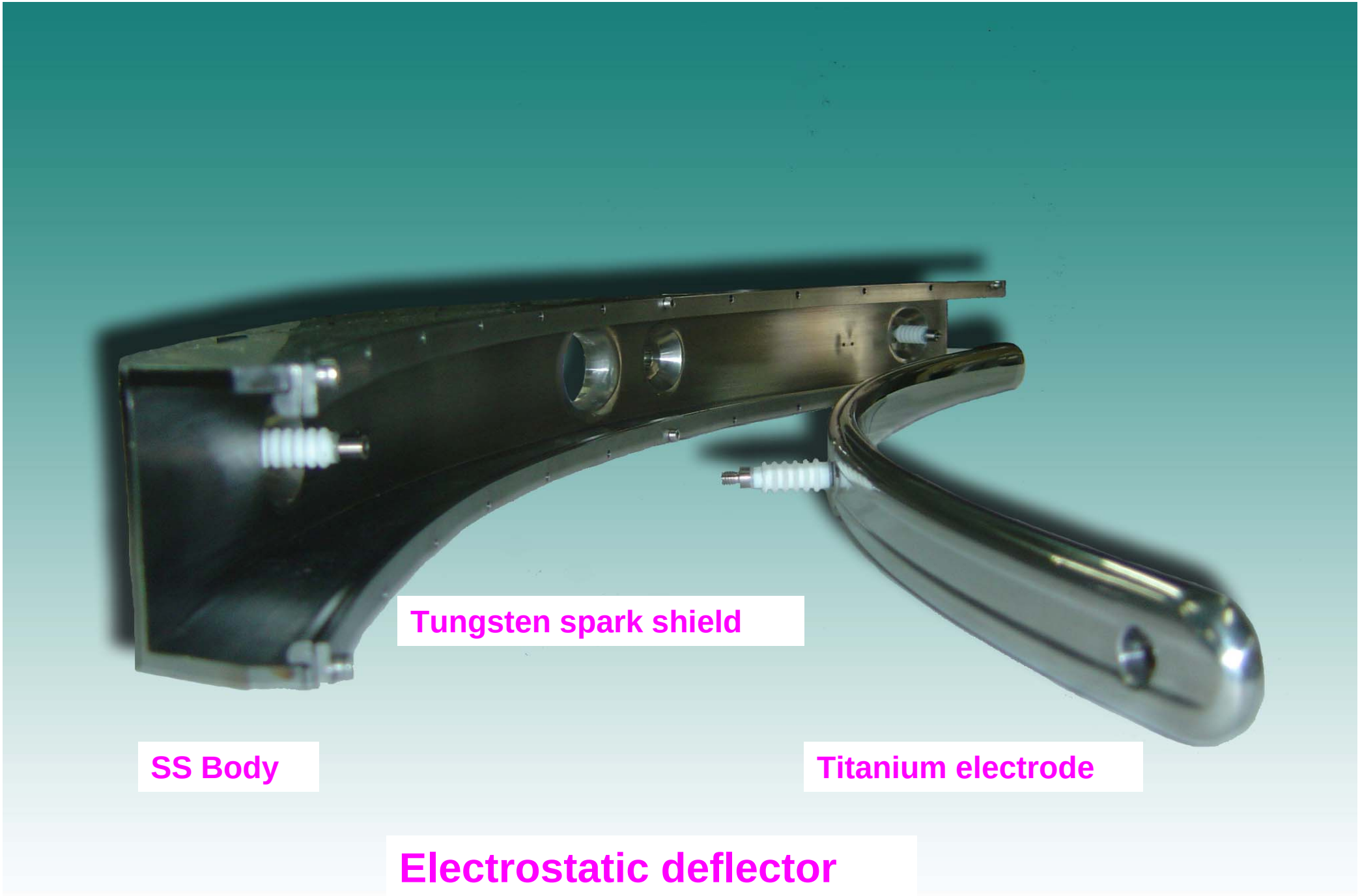

Computer model of inflector

MEDIAN PLANE VIEW OF THE K500 CYCLOTRON



MEDIAN PLANE VIEW





Electrostatic deflector

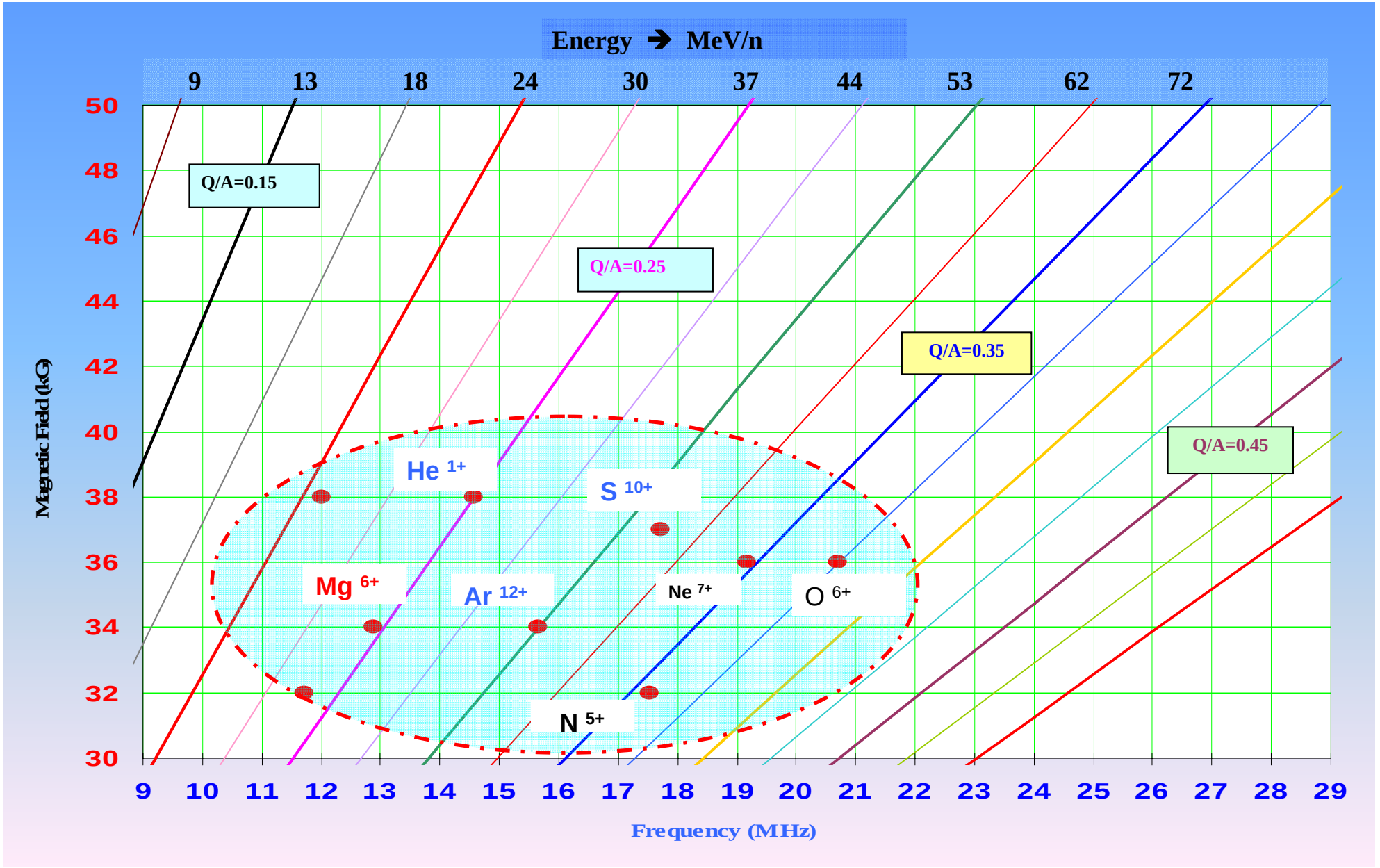
Computer Control

- Setting and monitoring of all Magnet power supplies
- Distributed monitoring of process parameters of LCW system
- External & internal beam current monitoring and profile visualisation
- Vacuum pressure & Ambient temperature monitoring
- Secured archiving and web-service for monitoring parameters of all systems
- Development of Soft-knob, Encoder Reader, Embedded controller, etc..
- Magnetic channel position read-out system

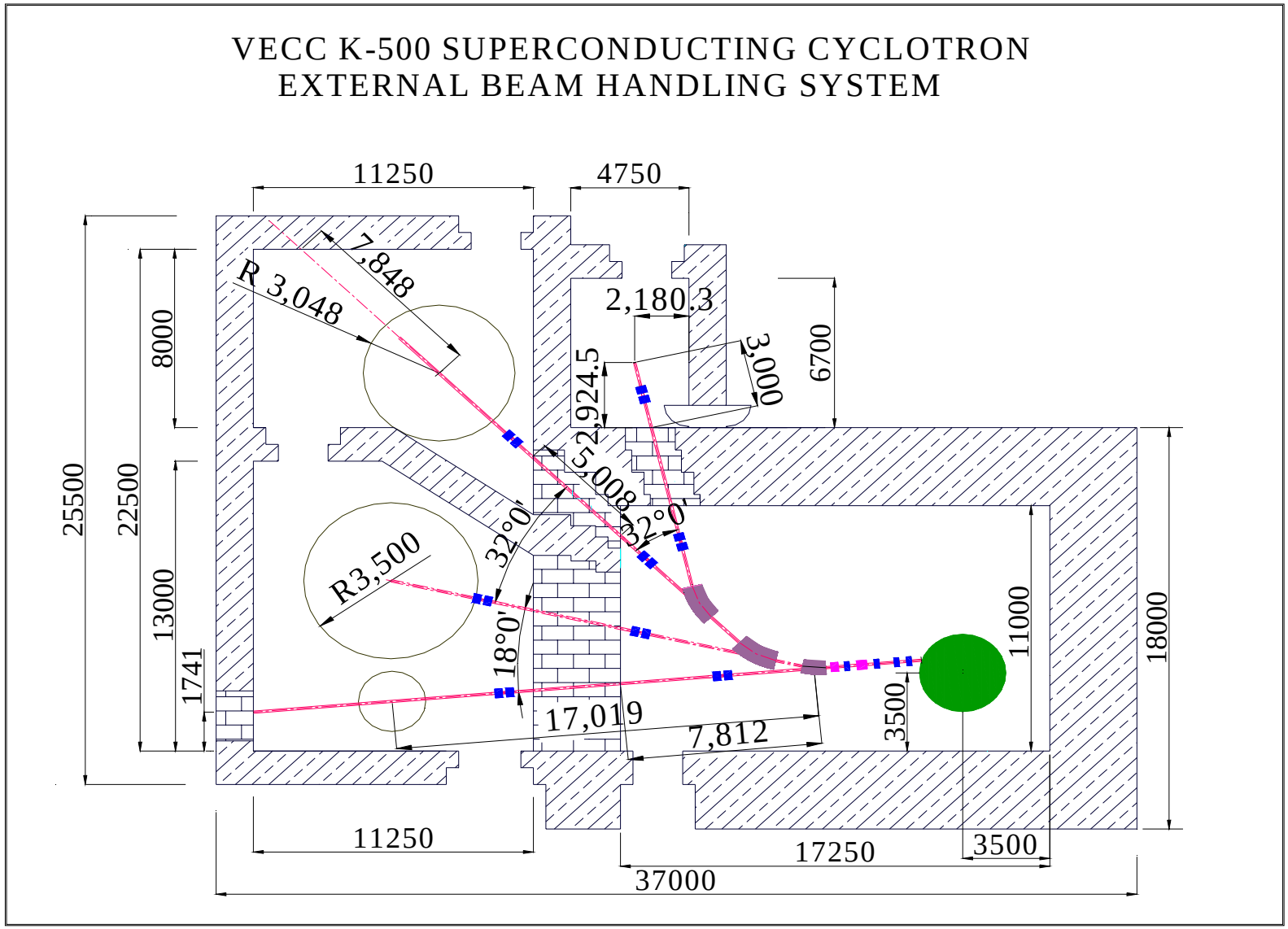
On-going activities

- Development of total automation of LCW system
- Trim coil temperature control system
- Scintillator detector based phase measurement system
- Development of embedded system based on RT Linux
- Implementation of EPICS based monitoring and control systems

Operating Diagram & Initial Ions Expected



BEAM LINES LAYOUT



Scope of the Superconducting Cycltron Utilization Project

- Scattering chamber
- Charged particle detector array
- Neutron multiplicity detector
- High energy gamma ray array
- Ion trap
- Non nuclear physics facilities
- Beam lines

Multidisciplinary Research with Superconducting Cyclotron

- **Condensed Matter Research**
  - **Radiation damage of nuclear structural materials**
  - **High Tc superconductors**
  - **Exotic materials (conducting polymers etc.)**
- **Nuclear Chemistry**
  - **Reaction mechanism studies**
  - **Short lived nuclides**
  - **Multitracers for bio-medical use**
  - **Fullerenes & nanotubes**
  - **Proton radiography**


Thank you all !