# WBS 1.1 Structural Components Status

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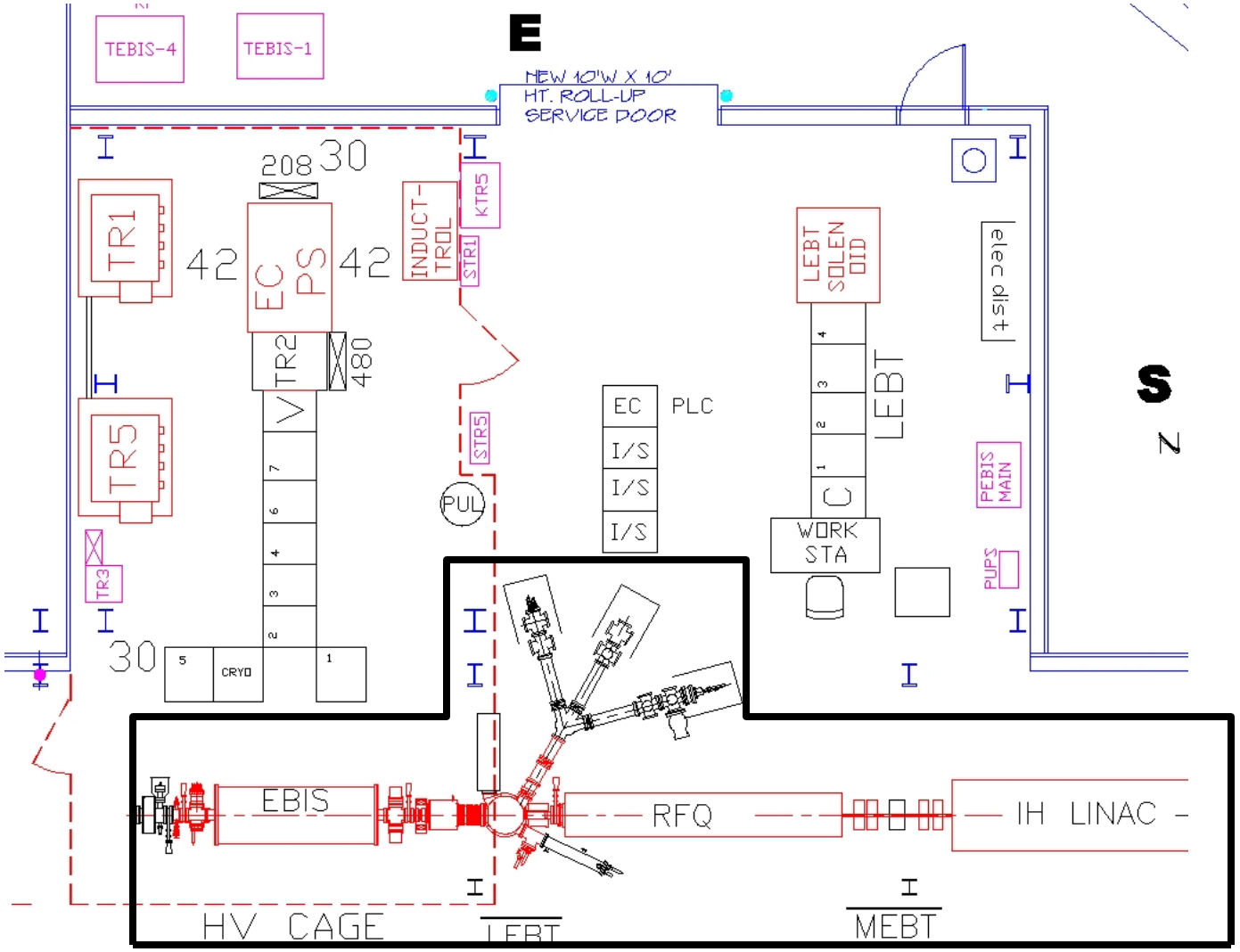
September 19-20, 2007

# WBS 1.1 Structural Components

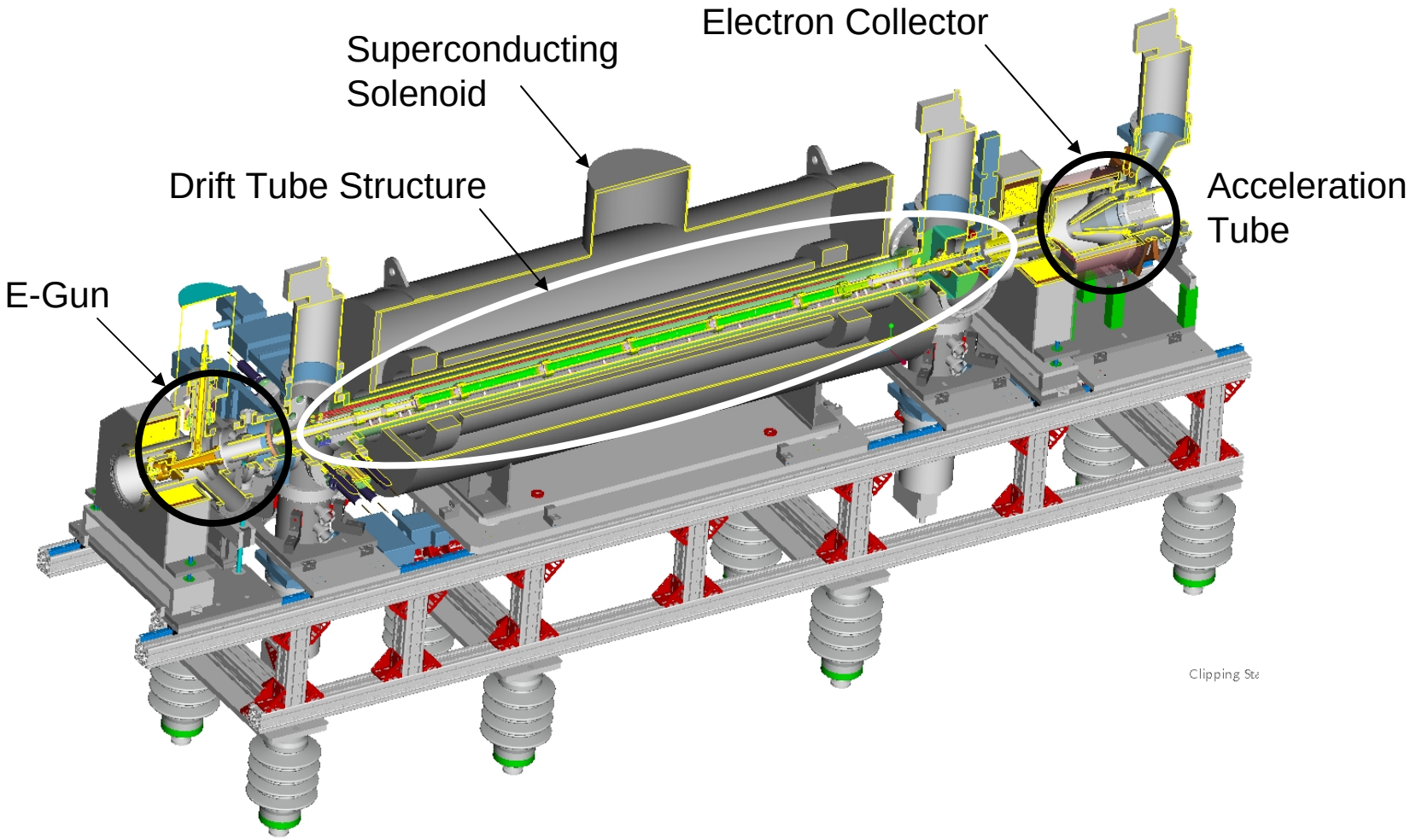
ELECTRON BEAM ION SOURCE

| EBIS | RF Structures | LEBT Region |
|---|---|---|
| - Electron Gun | - RFQ | - LEBT Chamber |
| - SC Solenoid | - Linac | - Electrostatic Devices |
| - Drift Tube Structure | - Bunchers | - I/S Switch Chamber |
| - Vacuum Chambers | | |
| - Electron Collector | | |
| - Acceleration Tube | | |

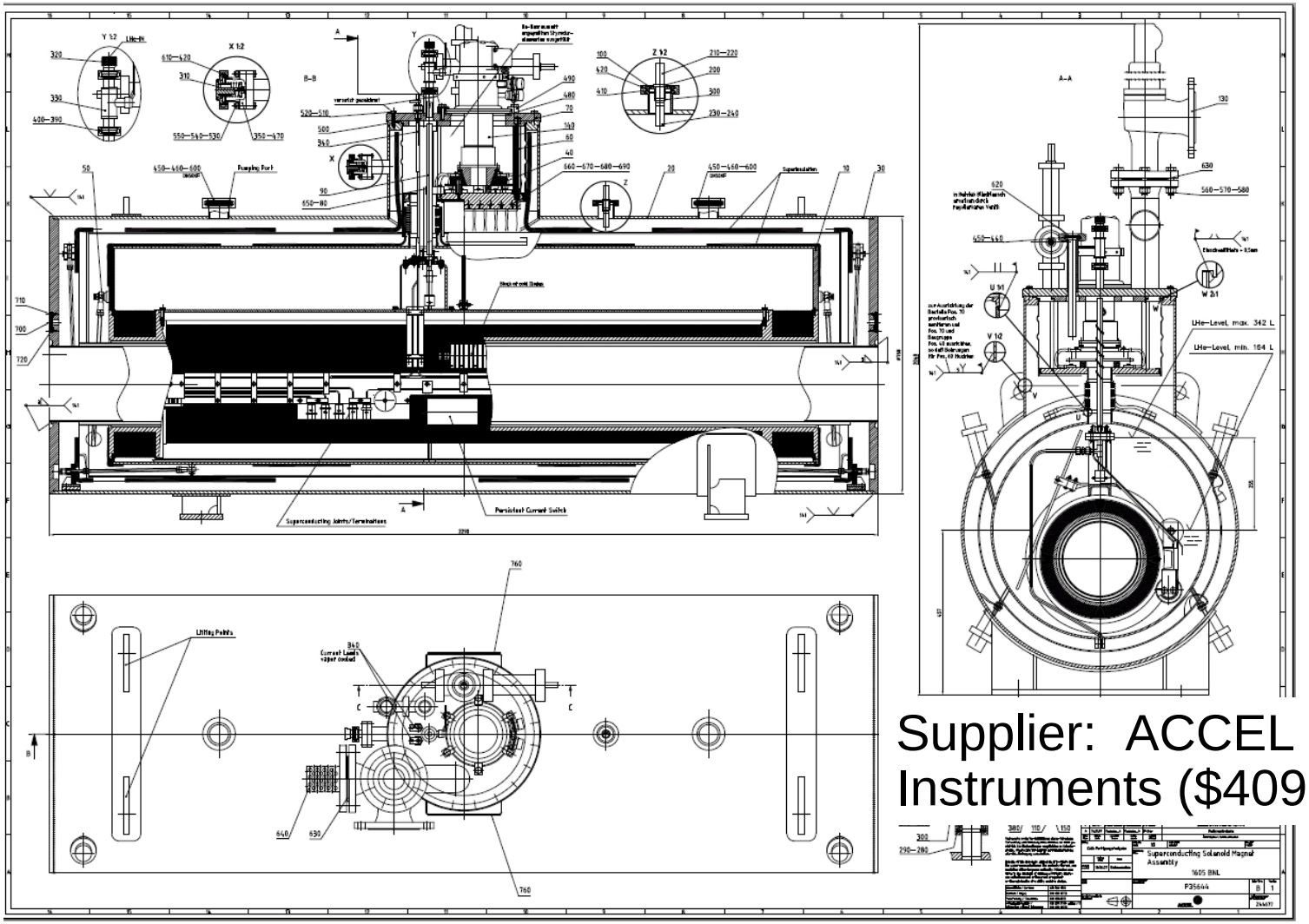
# Structural Components



# EBIS Assembly



# Superconducting Solenoid Magnet System




Supplier: ACCEL Instruments ($409K)

# Superconducting Solenoid Magnet System

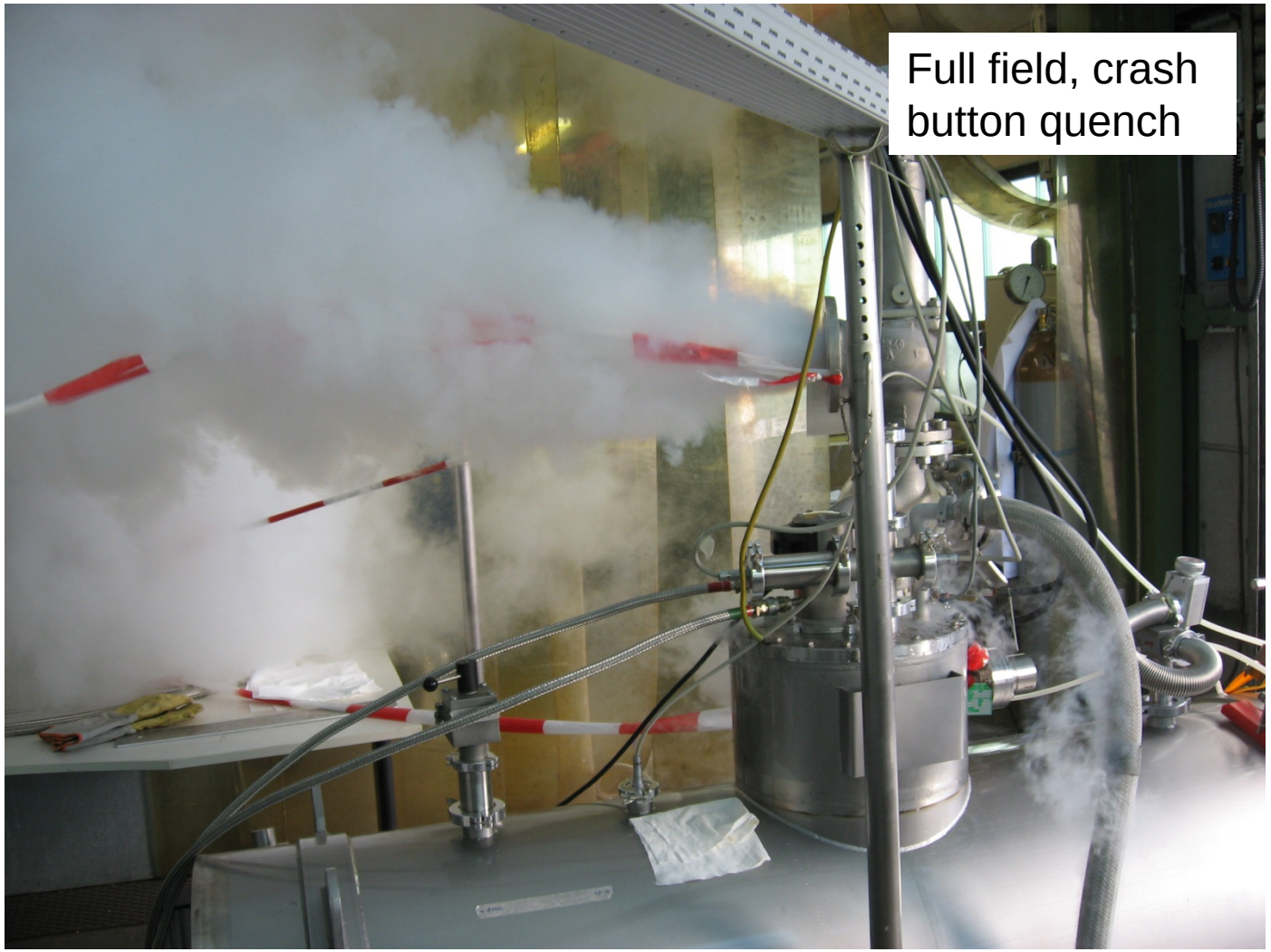
- June, 2006 - two engineers from ACCEL came to BNL for a detailed design review of the superconducting solenoid and a review by the Laboratory Cryogenic Safety Review Committee.
- July, 2007, prior to factory acceptance testing, the superconducting solenoid was operated at ACCEL at 5% over the design field of 6 T.
  - The helium evaporation rate was in an acceptable range
  - The measured field decay rate was satisfactory.
  - The magnet had successfully quenched at 99% of full field during training without damage.
  - The crash button (inducing a quench) was tested successfully at half field.

# Superconducting Solenoid Magnet System

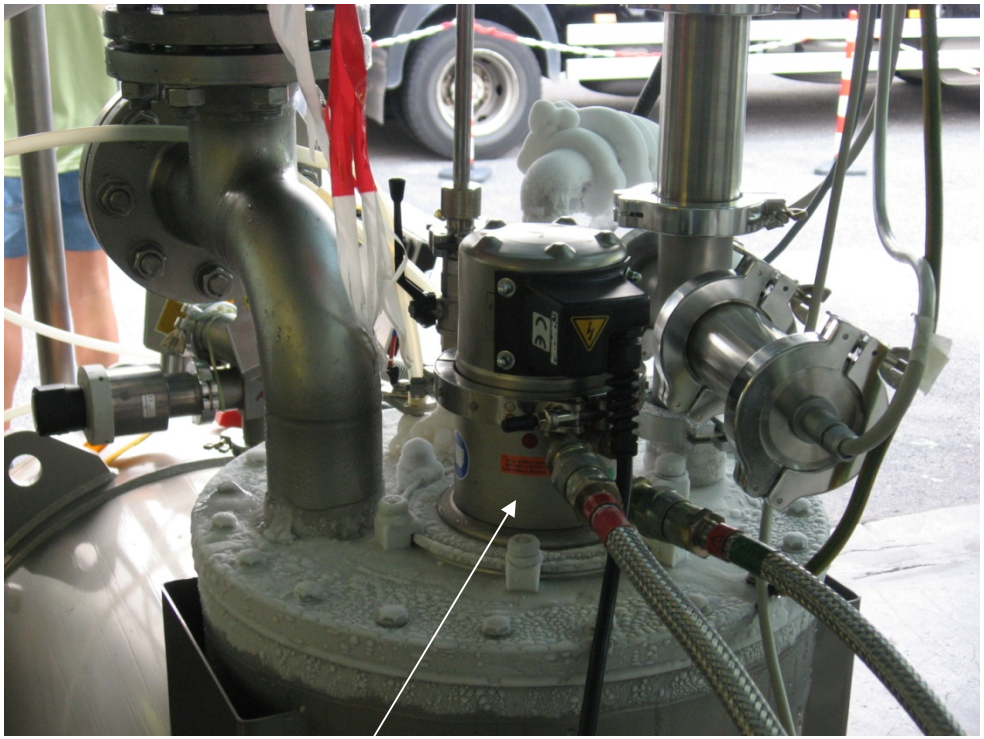
- Factory Test at Accel - 17-20 July
  - Performed a full field (6T) quench on 2nd day. Upon repowering the magnet quenched at about 60% field (4 times). Factory test ended
  - Field measurements indicated misalignment of magnetic axis with warm bore axis
- Week of 13 August
  - ACCEL found damage on removable lead contacts. The leads were repaired. On ramp up, the magnet quenched at 73% (3X).
- Week of 10 September
  - ACCEL ramped magnet with high resolution data recording. Quench at 70% field localized to compensation coil.

# Superconducting Solenoid Magnet System

# Superconducting Solenoid Magnet System



# Superconducting Solenoid Magnet System



Cryocooler for Heat Shield

Retractable Power Leads

# Superconducting Solenoid Magnet System

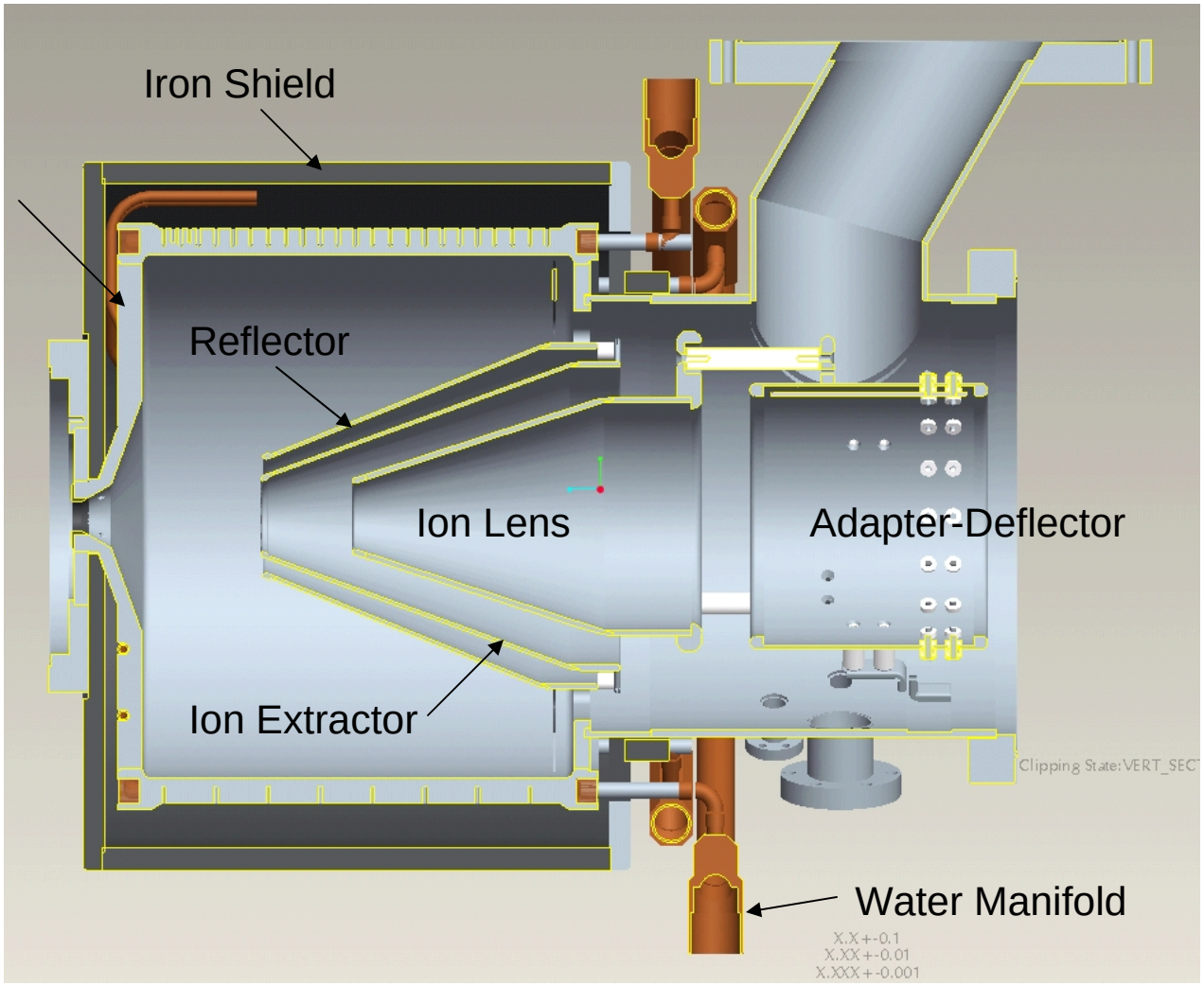
- Immediate Plan:
  - ACCEL to open limited area of the magnet to look for any visible problem in the next week.
  - BNL Review Committee formed including management and our resident experts in superconducting magnet systems.

Summary

- Magnet system is now 10 months late due to various causes.

- Best case scenario would be to perform a repair through the limited access opening (1-2 months). A repair requiring full opening of the magnet would take many months. ACCEL to confirm the time for these repair efforts.

# Electron Collector Assembly



# Electron Collector

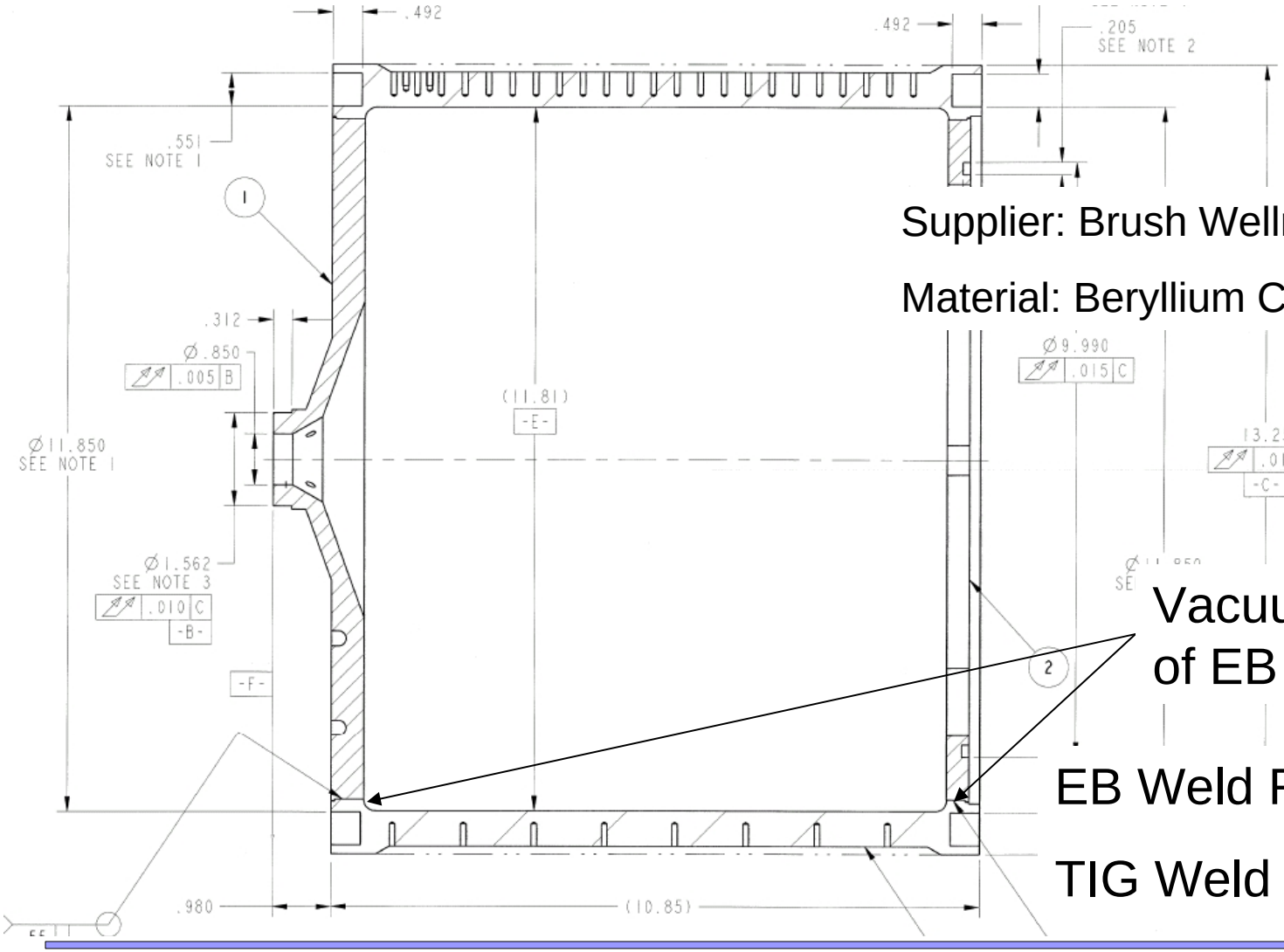
The collector procurement was started during R&D due to the recognized risk of possible difficulties in fabrication.

Causes of Late Delivery:

1. Production delays of proprietary Hycon 3 beryllium copper cylinder and plate
2. Logistical difficulties handling BeCu material (0.35% Be)

   (Routing of EC to BNL for leak testing and to Elmore plant for cleaning.)
3. Welding problem

# Electron Collector




Supplier: Brush Wellman ($82K)

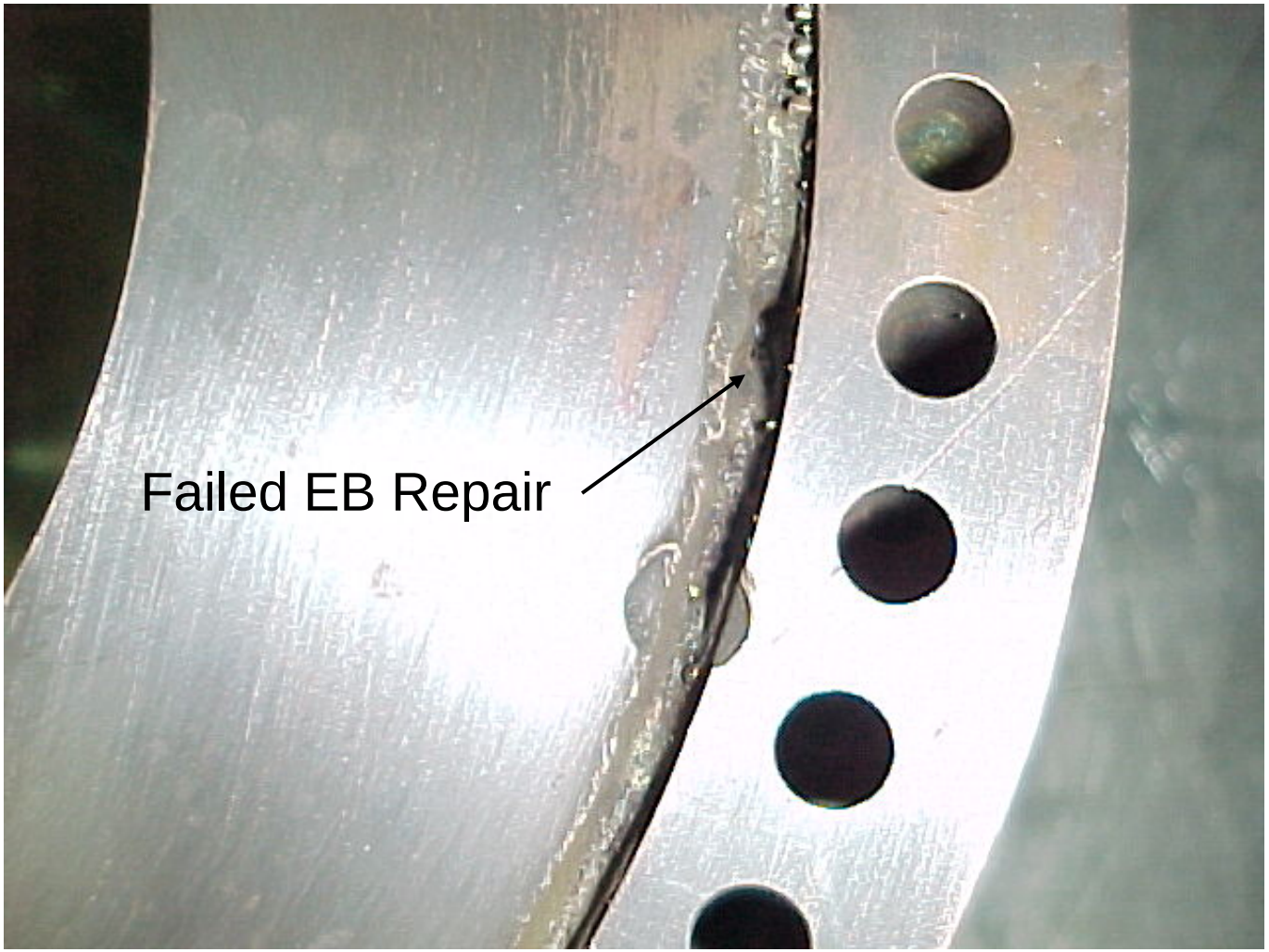
Material: Beryllium Copper

Vacuum Leak of EB Weld

EB Weld Repair failed

TIG Weld Repair failed

# Electron Collector



# Electron Collector

Plan for Manufacture of EC:

1. Brush Wellman will continue to repair existing unit by installing a new back disk by brazing. Annealing and loss of material strength during brazing will be accepted by BNL.

2. BNL is manufacturing a second unit using zirconium chromium copper instead of beryllium copper. Test welding has been successfully completed.

# Electron Collector

Metallurgy of BeCu versus ZrCrCu

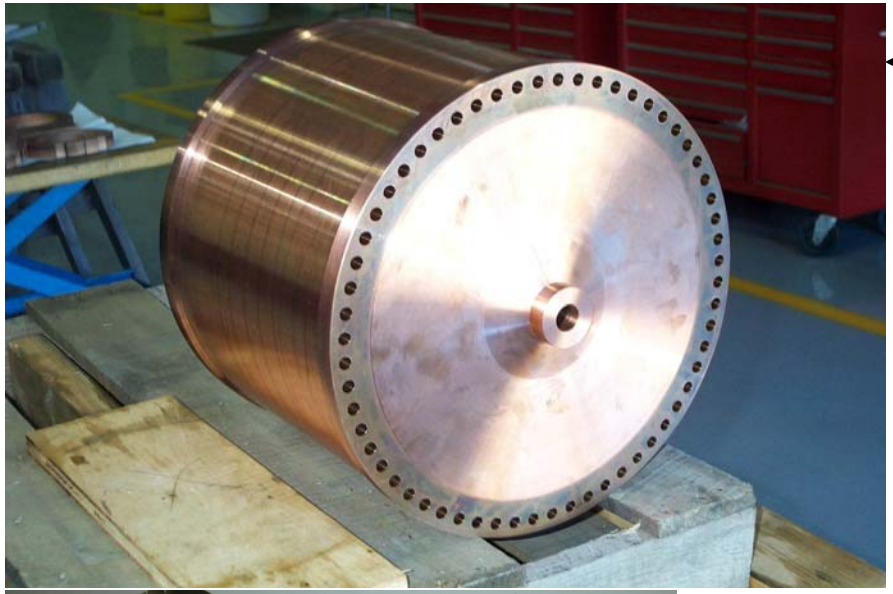
•Both materials are used in high heat flux applications (e.g., ITER Fusion Reactor).

•The design goal is to minimize the life cycle cost of the electron collector.

- BeCu has a high initial cost, but an expected longer life due to its high fatigue strength.

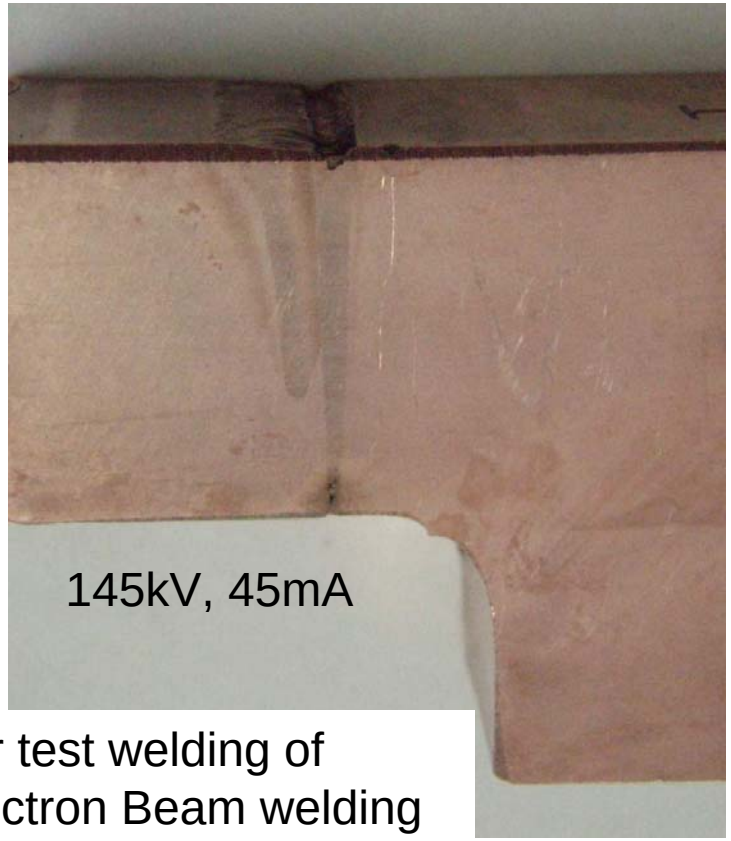
-ZrCrCu has a high thermal conductivity (up to 85% of pure copper and four times the strength of pure copper), resulting in lower stresses from thermal loading. ZrCrCu does not have a published fatigue strength.

# Second Electron Collector (BNL manufacturing)



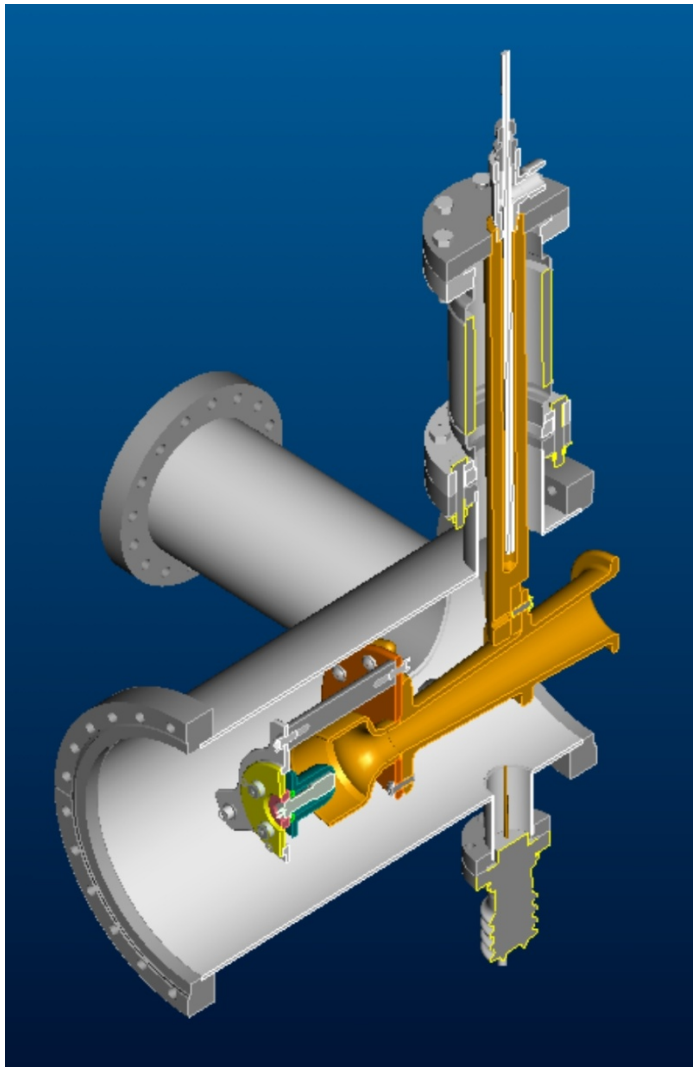
ZrCrCu Electron Collector cylinder – post gun-drilling

Metallographic Examination




Specimens for test welding of ZrCrCu by Electron Beam welding

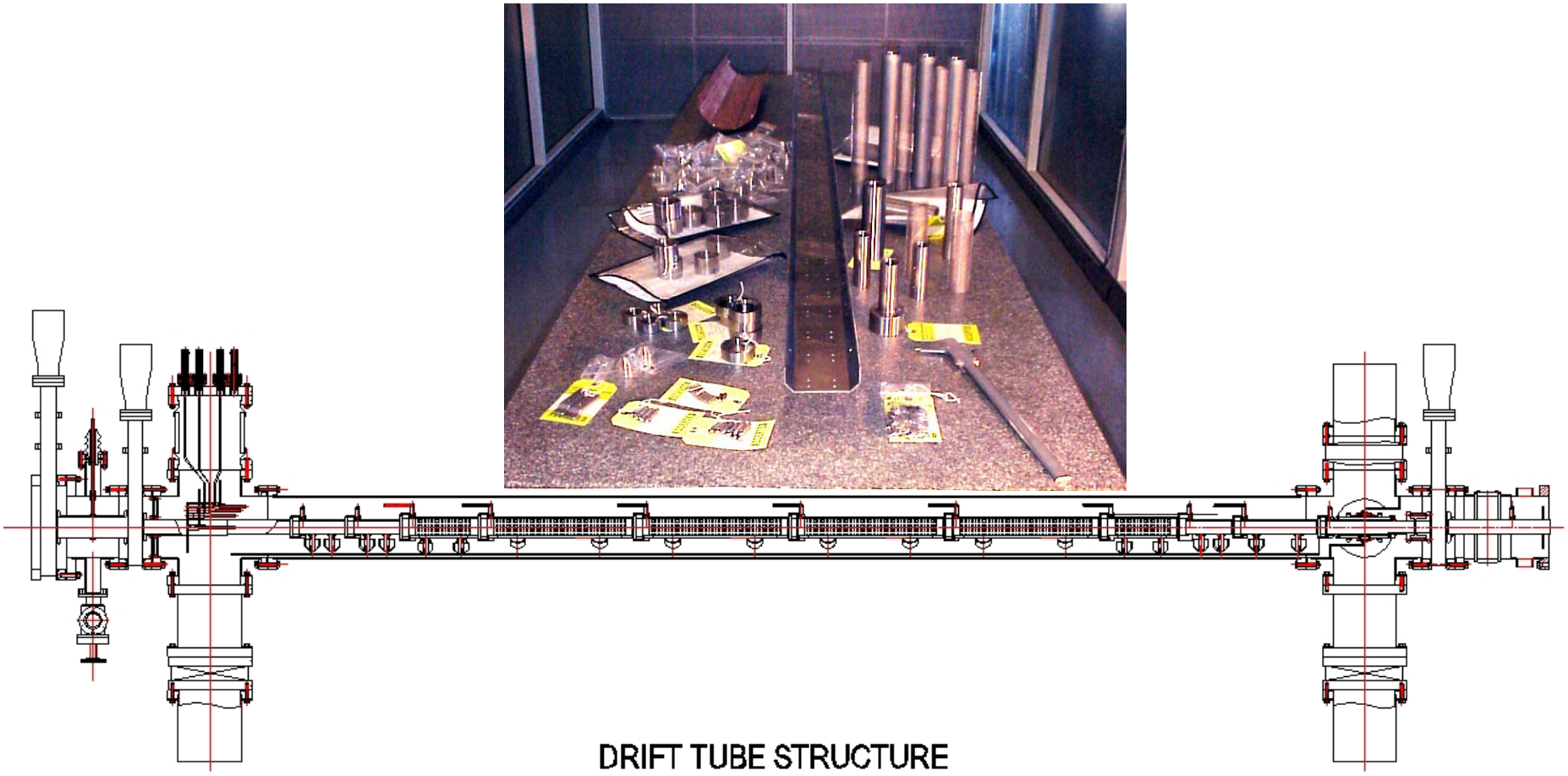
# E-Gun



•First E-gun unit has been manufactured, and is currently being tested in the R&D EBIS

• Second unit will be made after testing is complete

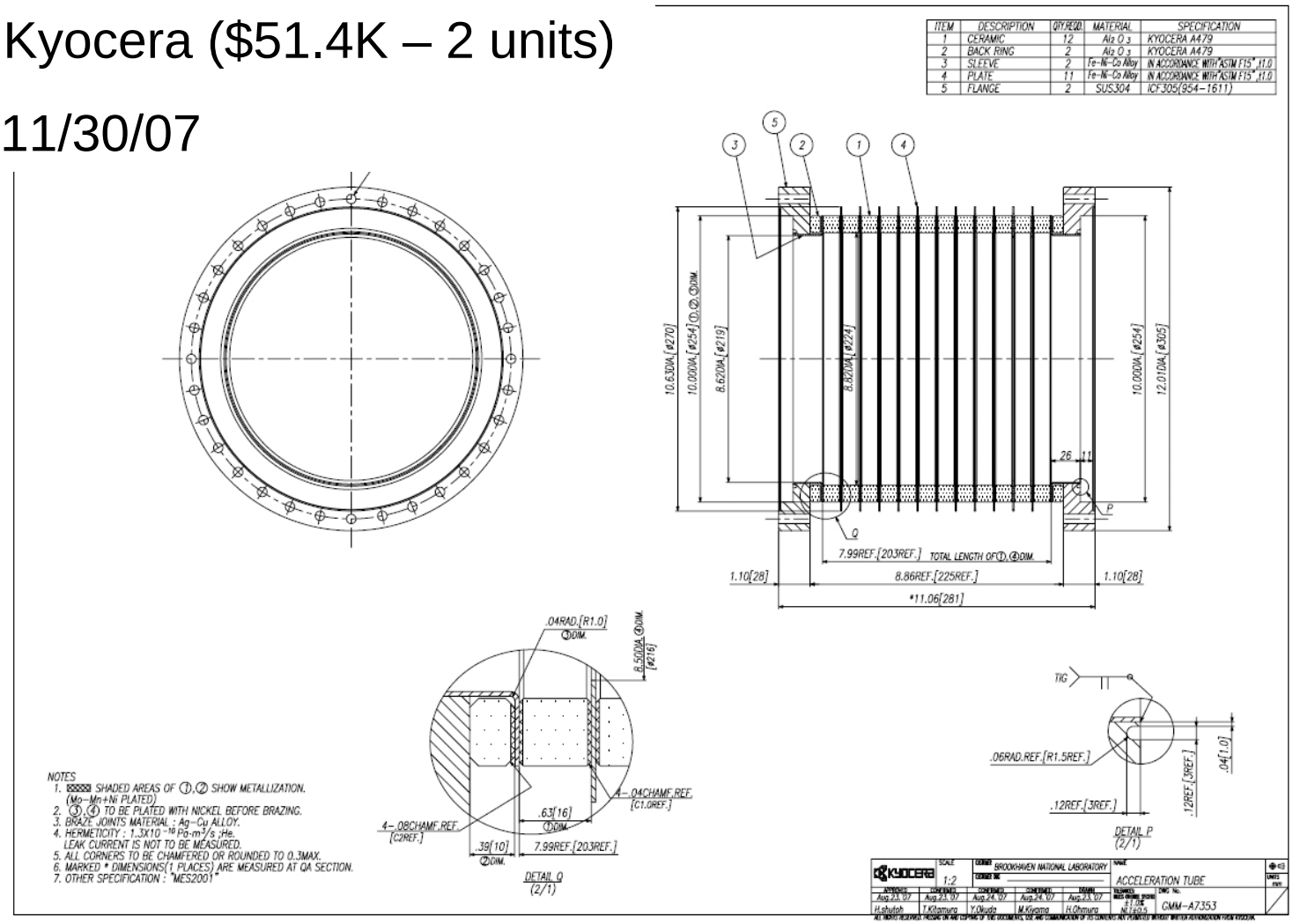
# Drift Tube Structure



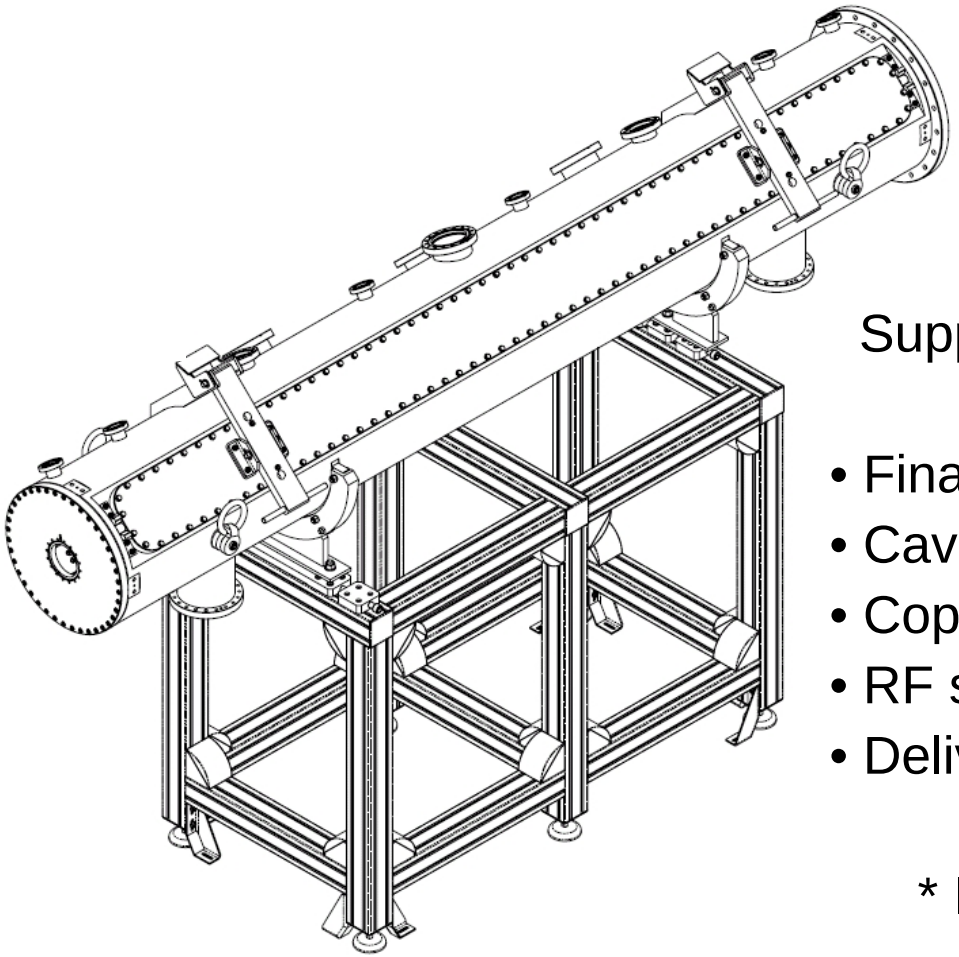
# Acceleration Tube

Supplier: Kyocera ($51.4K – 2 units)

Delivery: 11/30/07



# Radio Frequency Quadrupole



Supplier: IAP* ($403K)

- Final Design at BNL on 23 November 06
- Cavity machining completed
- Copper plating at GSI by end of Sept
- RF structure machining by end of Sept
- Delivery expected by January 2008

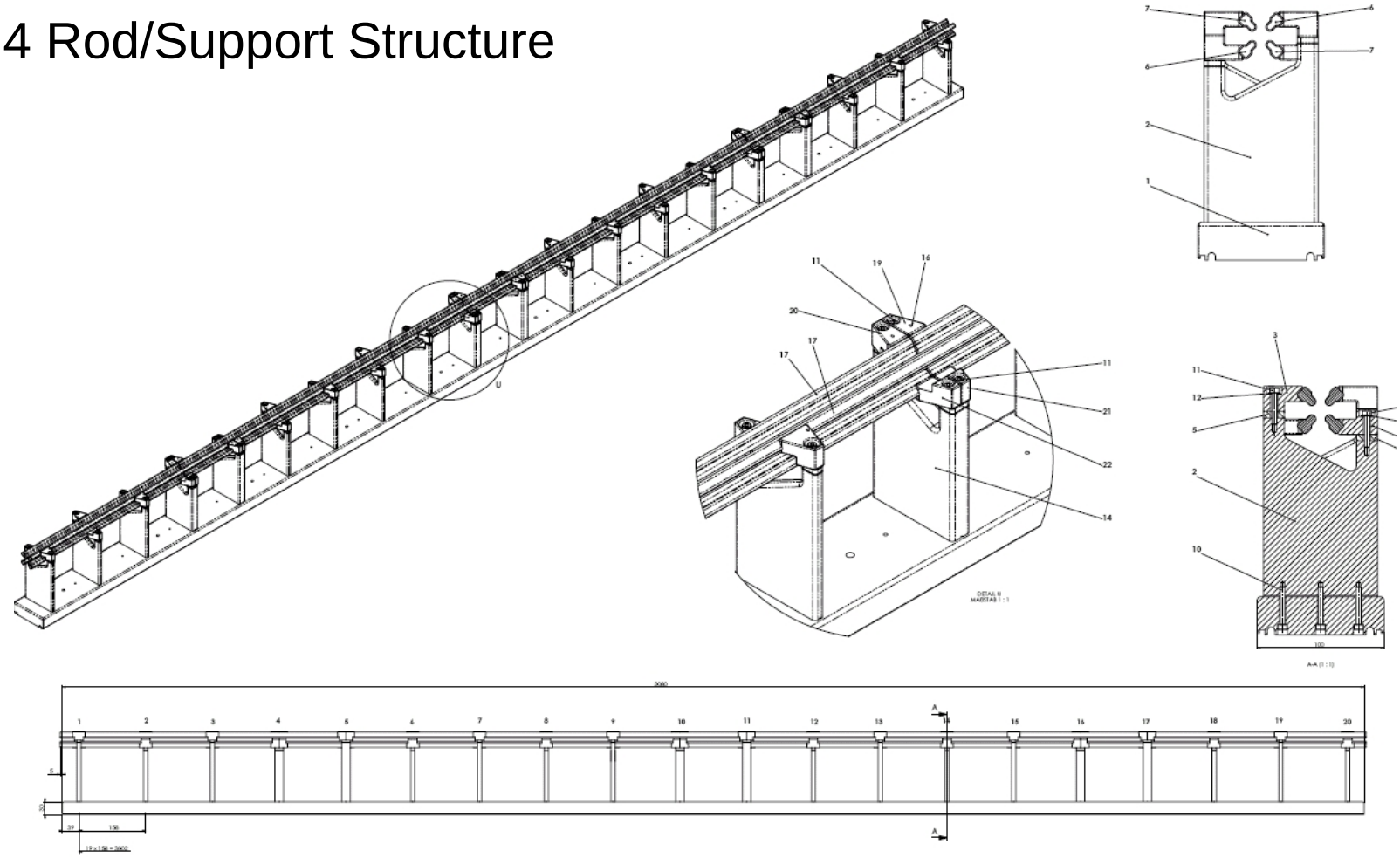
* Institut für Angewandte Physik (IAP), U. of Frankfurt

# RFQ

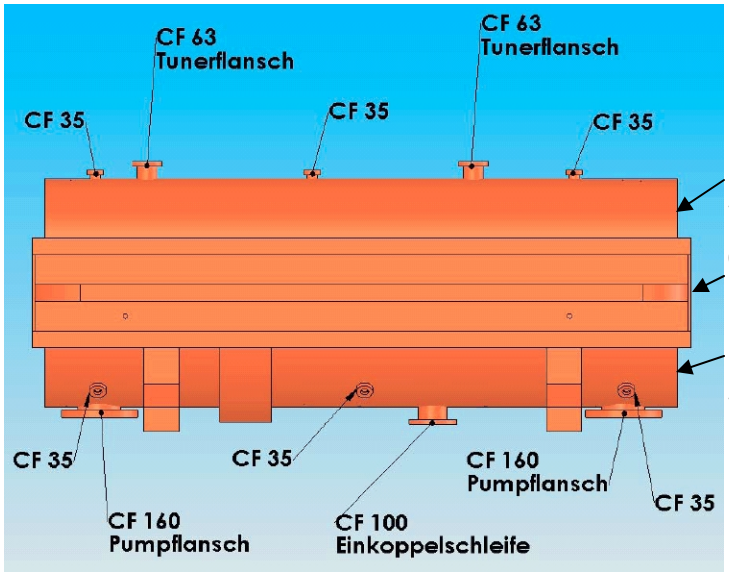
Cavity Machining Completed

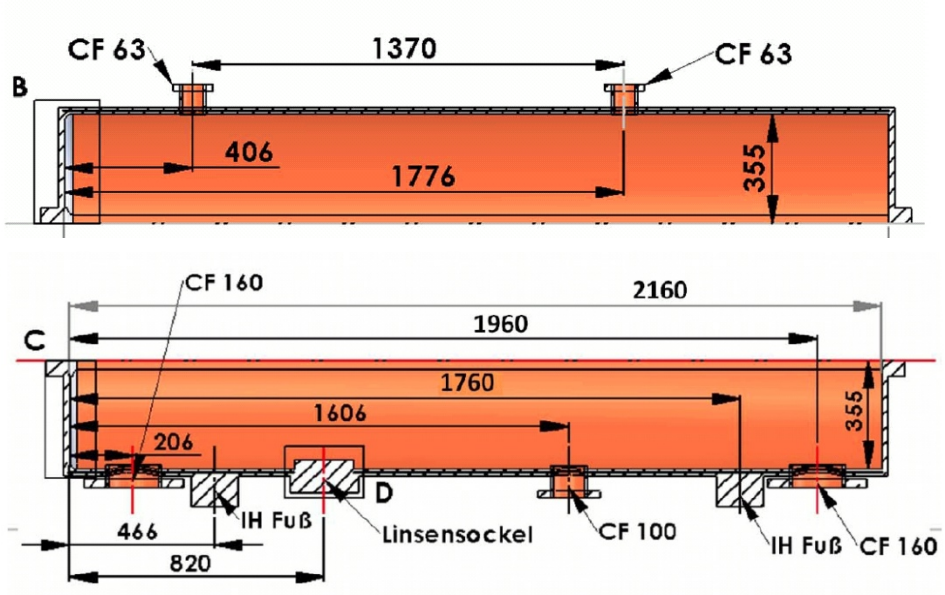
# RFQ

## 4 Rod/Support Structure



# Linac



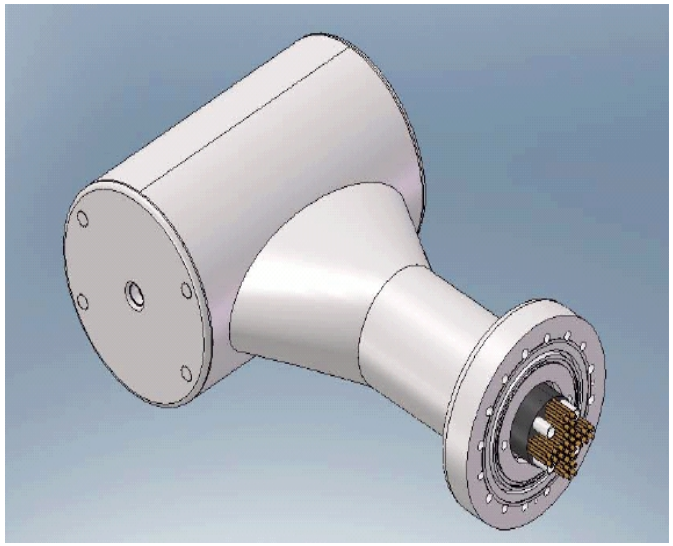

Supplier: IAP* ($724K)

- Preliminary Design received from Ratzinger in August
- Telephone conference on 23 August on PD
- IAP expects to place order for Final Design and Production in September
- Present schedule has Linac shipment in March 2009, but IAP working to shorten production.
- Linac delivery is on the critical path.

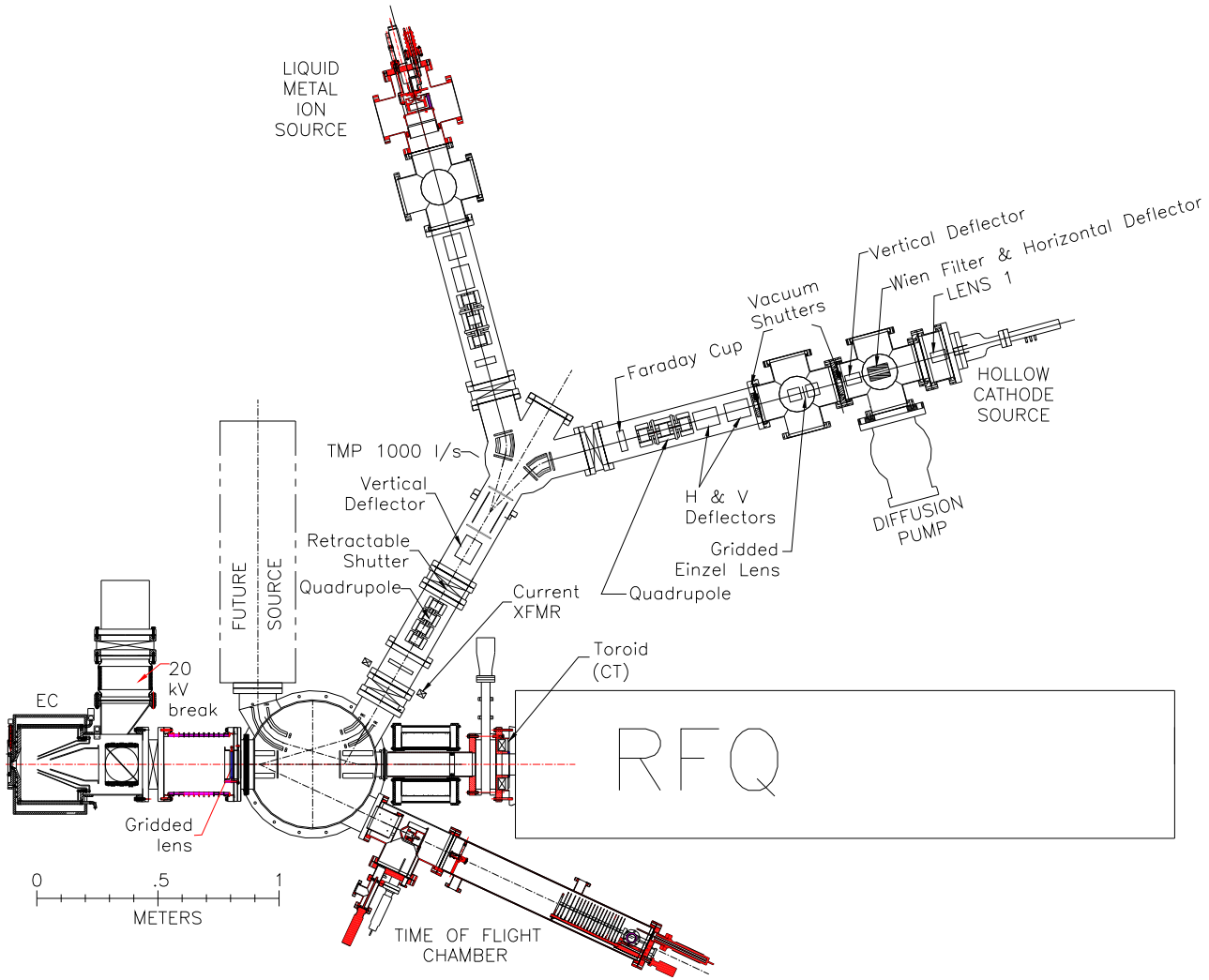
# Linac – Preliminary Design

- Initial plan for two internal quadrupole triplets has been changed to one internal and one external triplet.
- Internal triplet design exists, having been produced by Danfysik for other IH-Linacs.

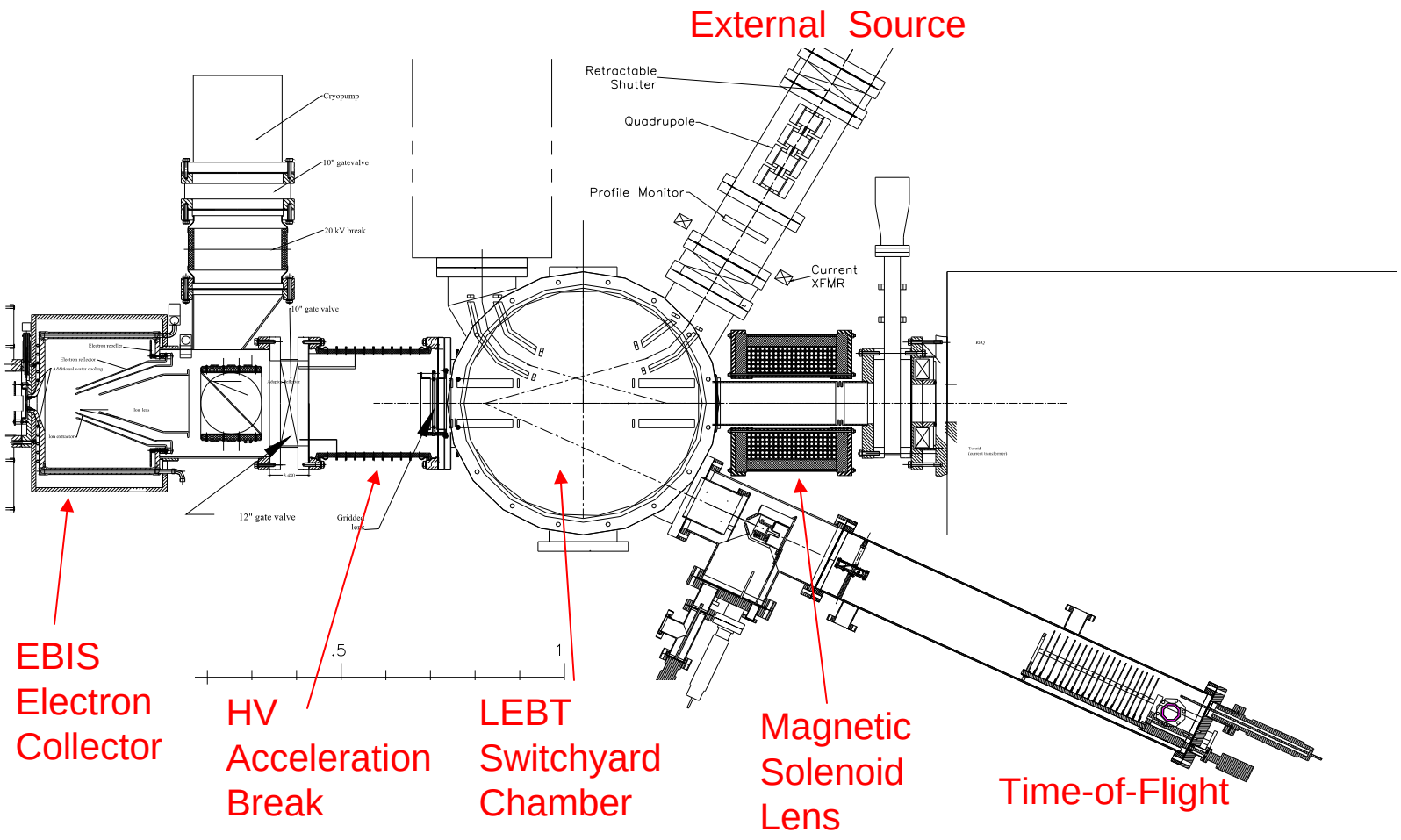
**Internal Quadrupole Triplet**



# LEBT/Ion Source Region

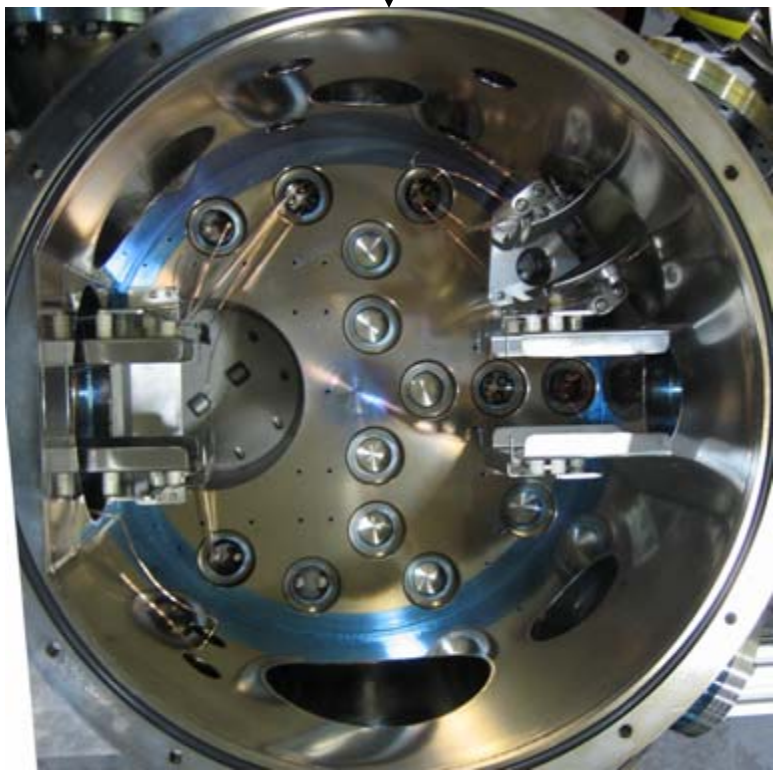


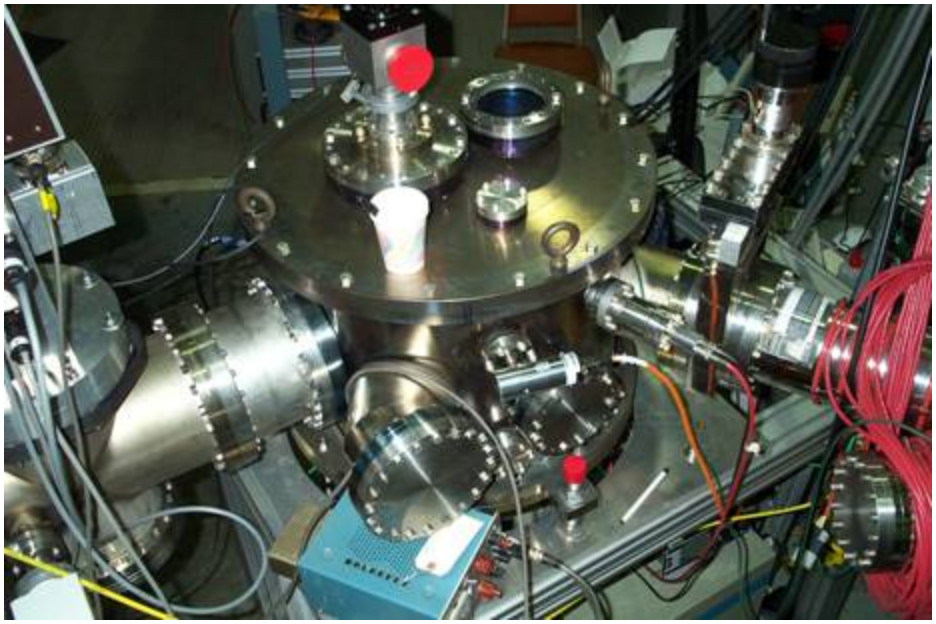
# LEBT Chamber



# LEBT Chamber

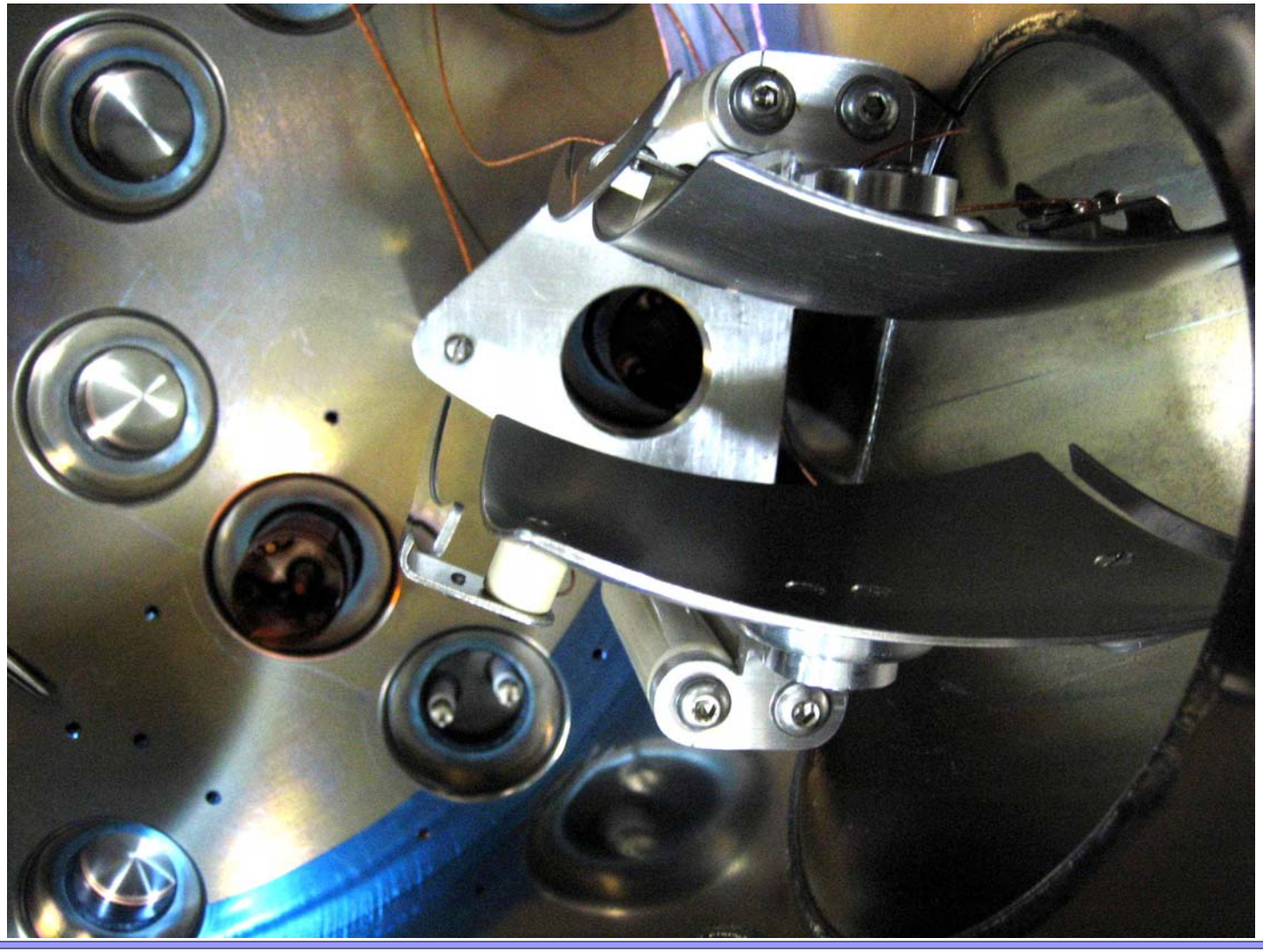
Top view showing deflectors



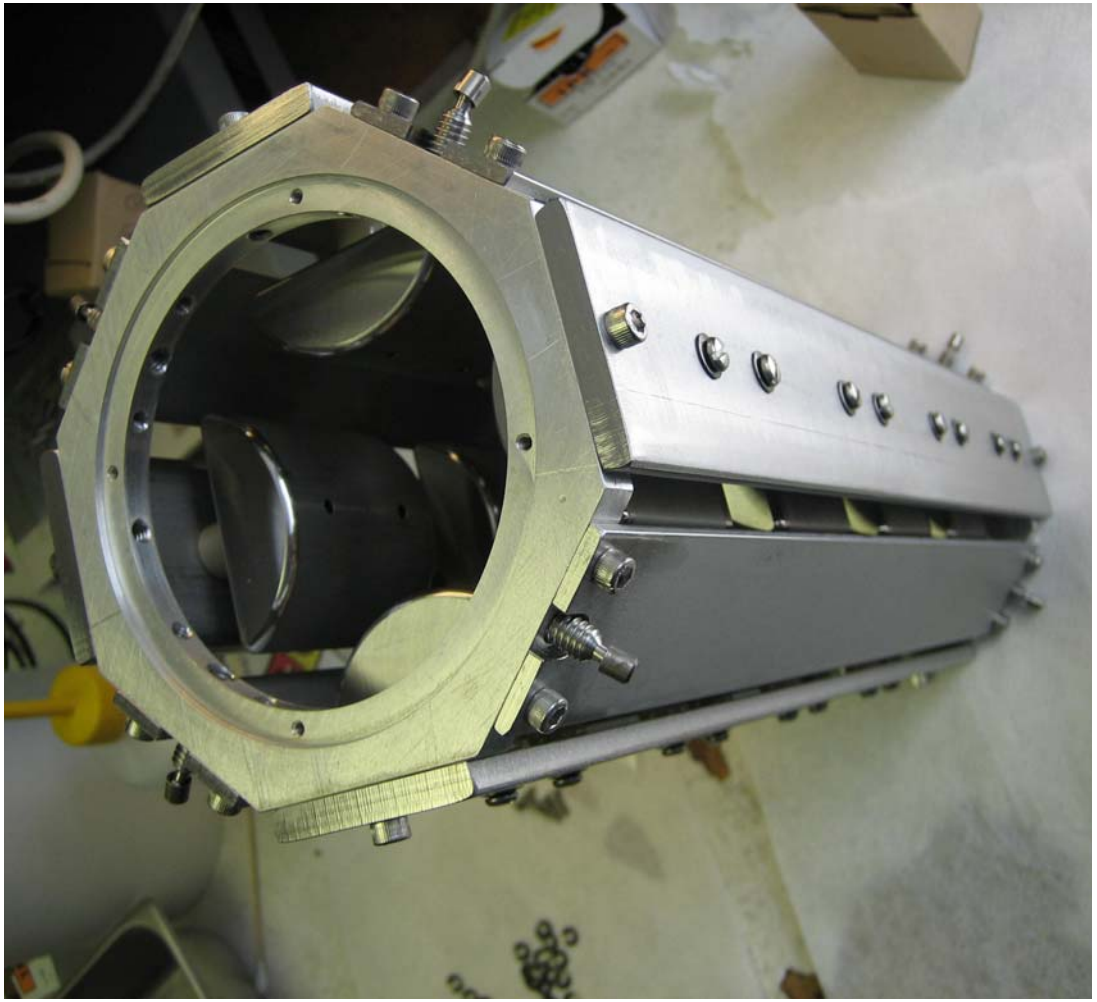


- Proto unit manufactured for test and evaluation on R&D EBIS
- Second unit to be made upon completion of testing.

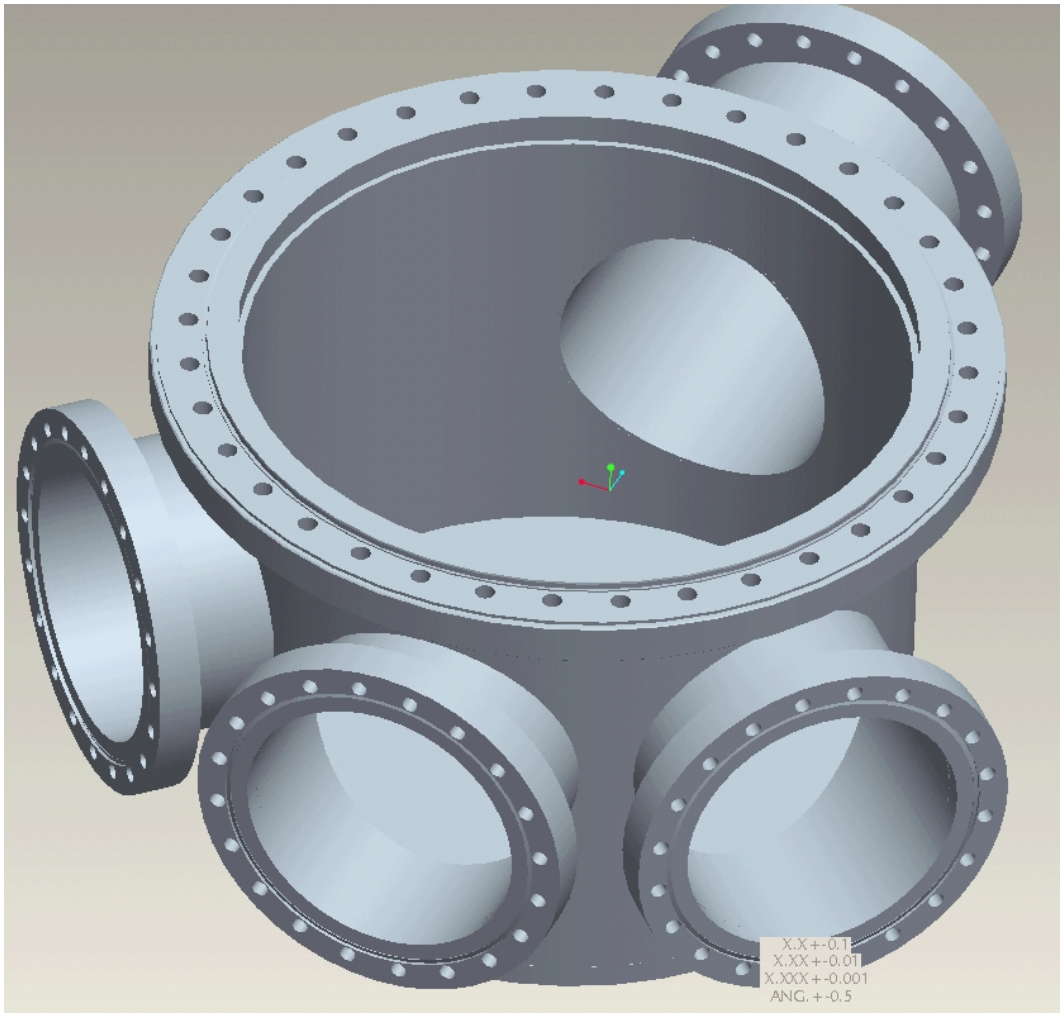
# LEBT Chamber – Spherical Deflector



# E/S Quadrupole



# Ion Source Switch Chamber




- Physics simulation on switch chamber to be performed prior to completion of manufacturing drawing
- Deflector geometry identical to LEBT chamber deflectors being tested.

# LEBT Component Acquisition Plan

| Component | Prototype | Acquisition |
|---|---|---|
| LEBT Chamber | Done | Mach Shop |
| E/S Deflectors | Done | Mach Shop |
| E/S Quadrupoles | Done | Mach Shop |
| I/S Switch Chamber | | Mach Shop |
| Einsel Lens | | Mach Shop |
| Wien Filter | | Purchase |

# Summary for Structural Components

ELECTRON BEAM ION SOURCE

•Good progress has been made on most of the major technical components.

• Procurement contracts for major components have been placed: superconducting solenoid, RFQ, Linac, and acceleration tube.

| | |
|---|---|
| –Total Spent/Committed | $1,718K |
| –Total Expected Material Cost | $2,157K |
| –Percentage Spent/Committed | 80% |

•The primary challenges remaining relate to the delivery schedules of the Superconducting Solenoid (SSMS) and the Linac.

- If SSMS problems are solved soon, the assembly and test of the EBIS in the final site could be accomplished ahead of schedule. If it must be remanufactured, then although the date for project completion won't slip, the slack time during which EBIS system testing could have been occurring will be reduced.

- Linac progress will be monitored carefully to reduce the risk of further Linac schedule slips relative to the original contract.