Status of 201-MHz Prototype Cavity for MUCOOL

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Muon Collaboration Meeting at LBNL
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Multi-Institute Collaboration

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Overview

A brief review: status at last MC meeting

- ✓ Four half shells have been formed by spinning
- ✓ Cu stiffener rings were e-beam welded to two half shells
- ✓ The shells are being mechanically cleaned at J-Lab
- ✓ Shells are ready for machining prior to e –beam welding of equator joint
- ✓ Equator weld fixtures have been fabricated at LBNL
- ✓ Cavity nose piece rings (Univ. of Mississippi) have been brazed at LBNL
- ☐ Conceptual design of RF loop coupler
- ☐ E-beam welding of equator joint
- ☐ Extruding four ports
- ☐ Water cooling tubes and tuners
- ☐ Chemical cleaning and electro-polishing of the cavity
- ☐ Pre-curved Be windows (succeeded for 805-MHz cavity)

Overview (cont'd)

Where we are now and what's remaining?

- ✓ Welding of cooling tube to cavity
- ✓ Extruding of four ports and vacuum leak tight
- ✓ Placed purchase order of curved Be windows
- ☐ Cavity interior buffing
- ☐ Chemical cleaning and high pressure water rinse of the cavity interior surface + electro-polishing
- – High power RF conditioning of RF windows (very soon)
- – Low power microwave measurements with windows: frequency, Q and couplings
- – RF coupler tuning (low power measurements)
- – Packing and shipping to MTA, FNAL

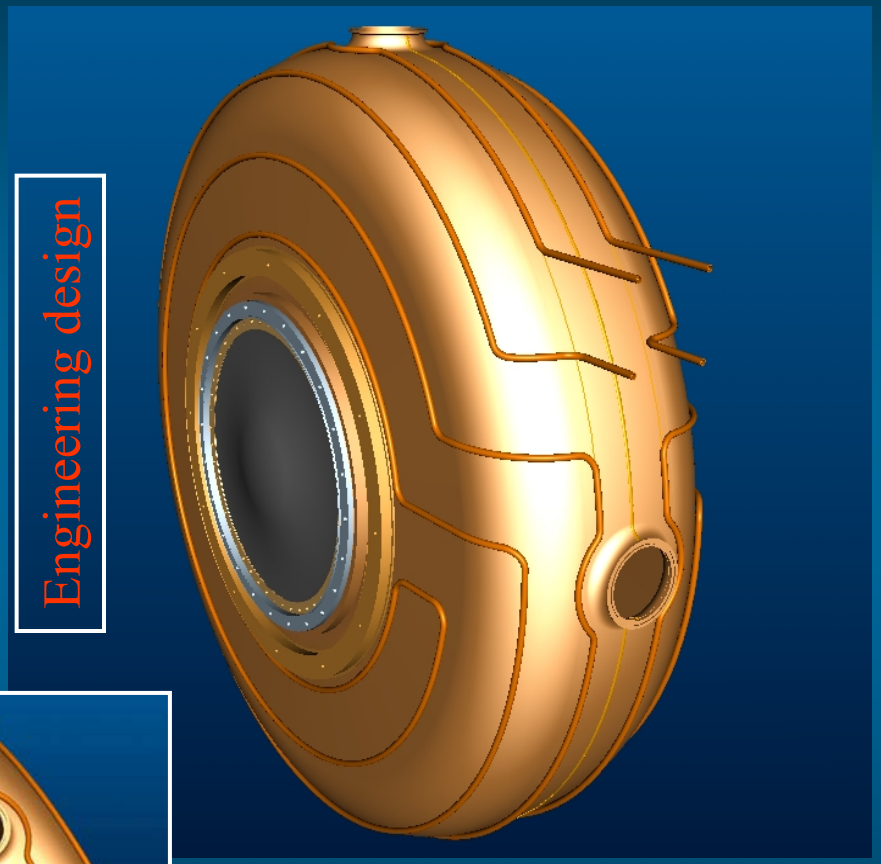
Progress Report: Cavity Design

Goal: 201-MHz at ~ 16 MV/m with a few-Tesla magnetic field

Cavity and its sub-components

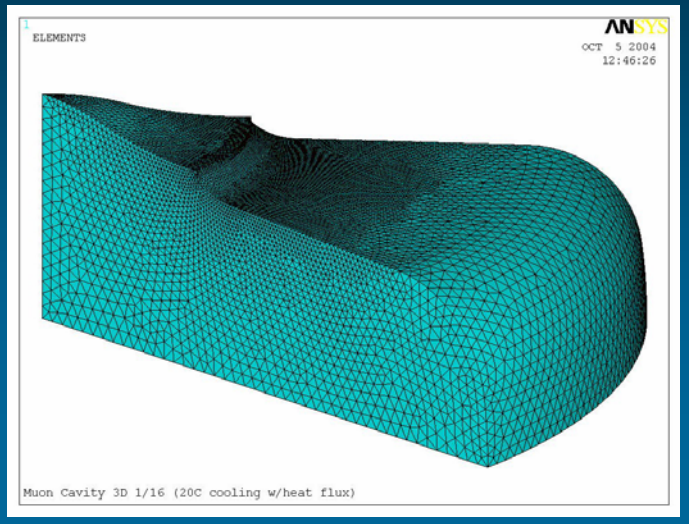
- Cavity body + water cooling lines
- Ports and flanges
- RF loop couplers
- Cavity support structure
- Cavity tuners
- Ceramic RF windows (~ 4")
- Curved Be windows
- LN temperature operation
- …

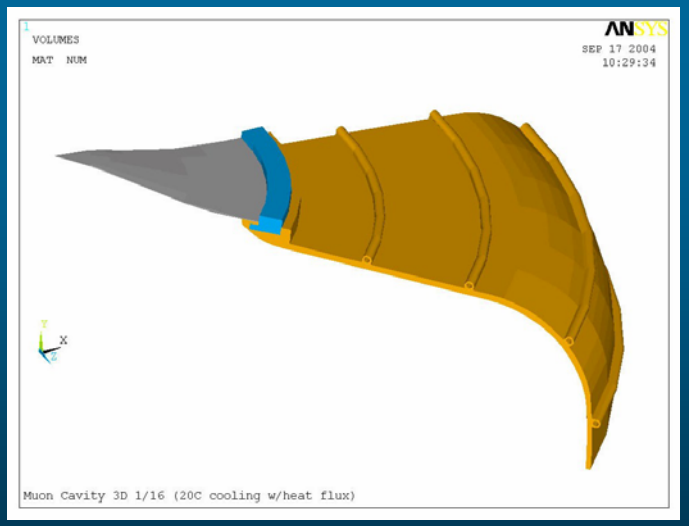
Engineering design



Layout of water cooling lines

FEA of the Cavity

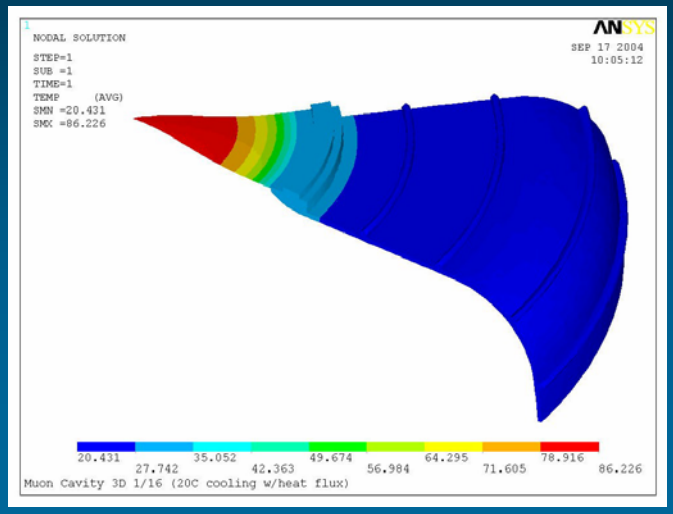


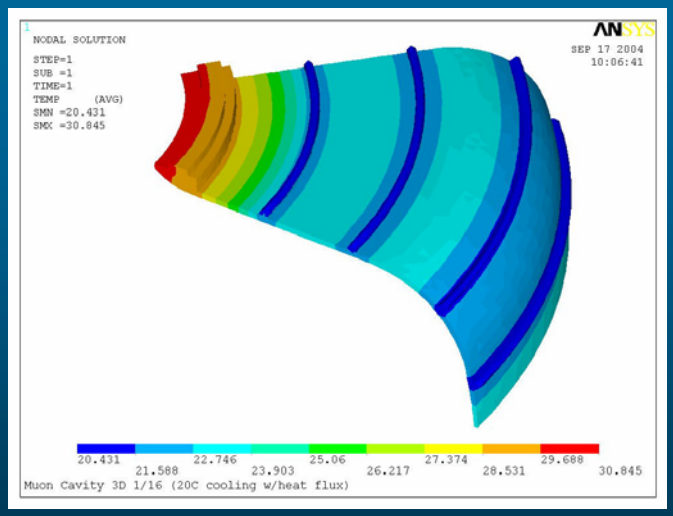


The thermal solution provides the temperature distribution throughout the cavity window and beryllium window

The peak temperature occurs at the center of the beryllium window (86 °C)

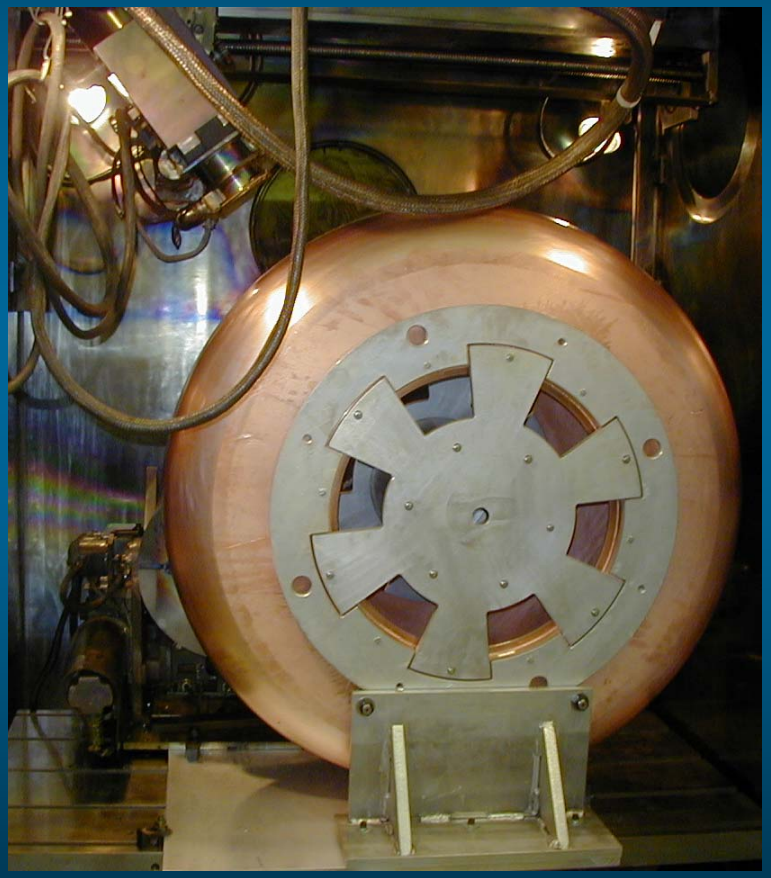
- Cooling tubes
- Be window thickness





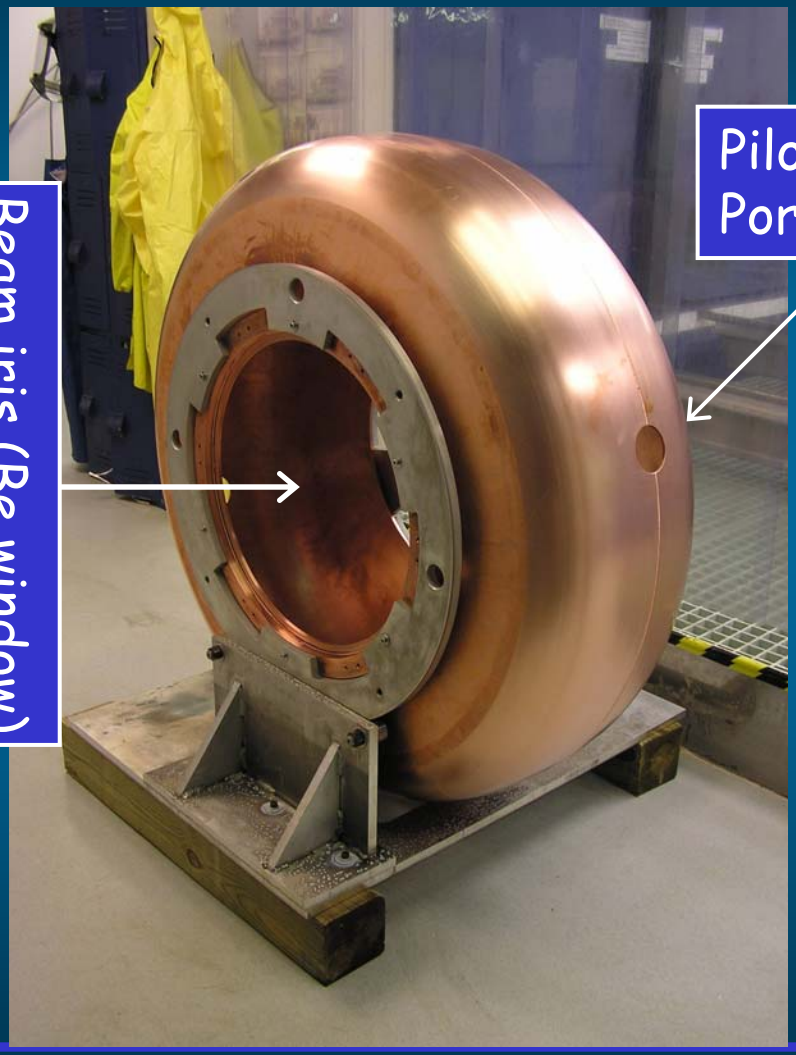
Equator Welding

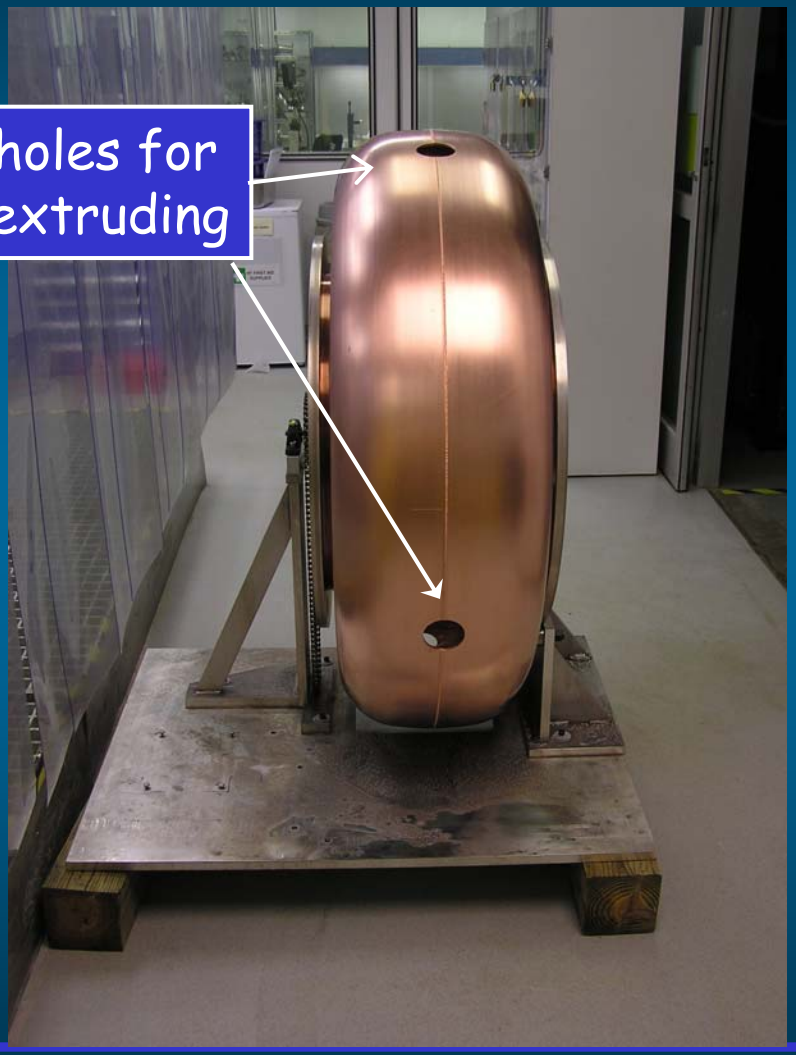
E-beam welding of cavity equator joints



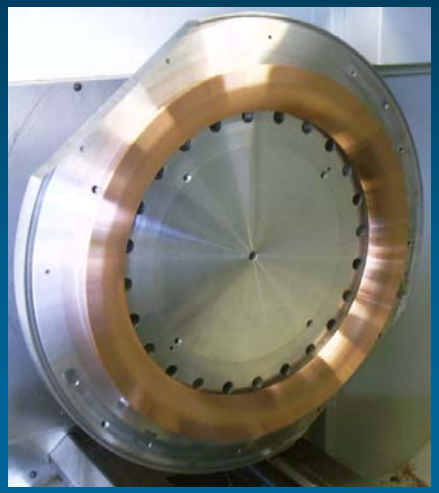
Finished cavity weld

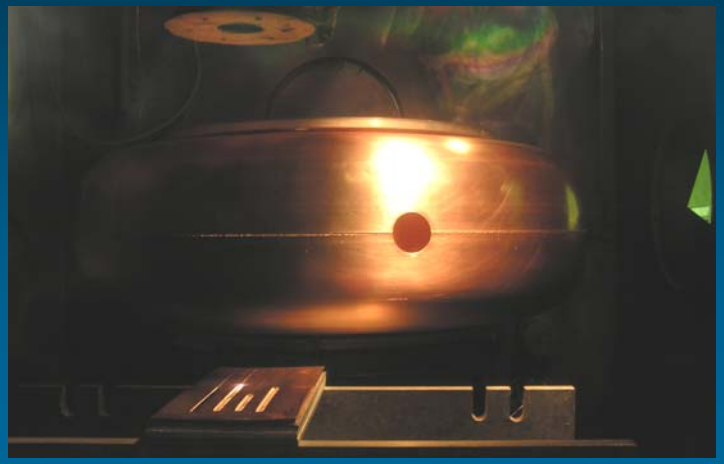
Nose welding and Port extruding





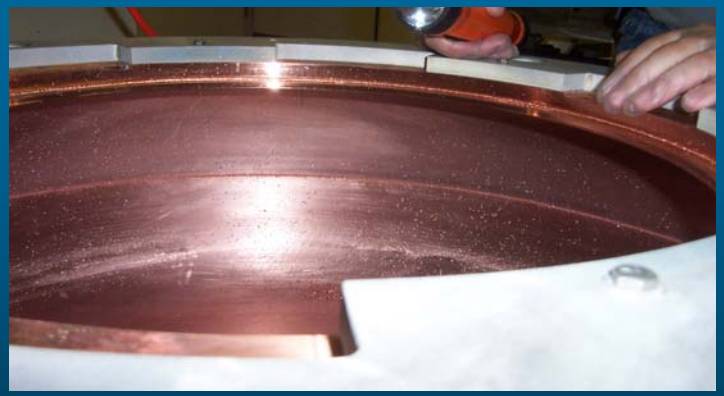
Nose Fabrication and Weld





Nose ring joint welding

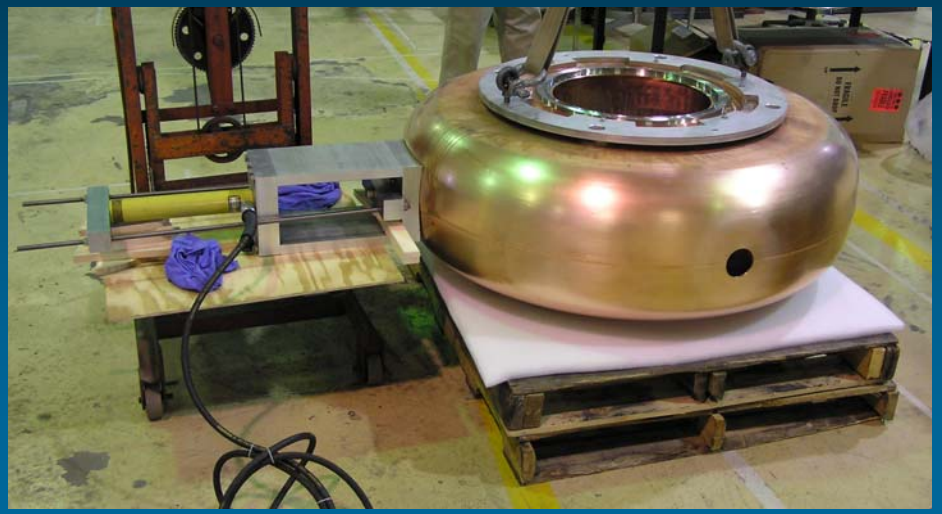
Nose ring machining



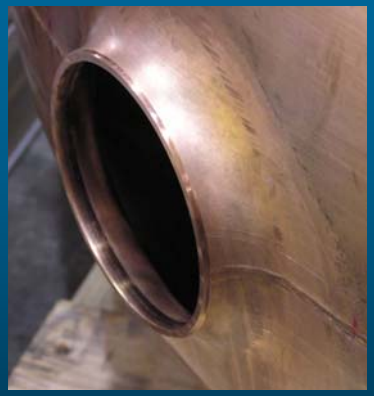
Finished nose ring weld joint

Ports and Flanges

Local annealing of ports



Cavity ports being extruded (pulled)

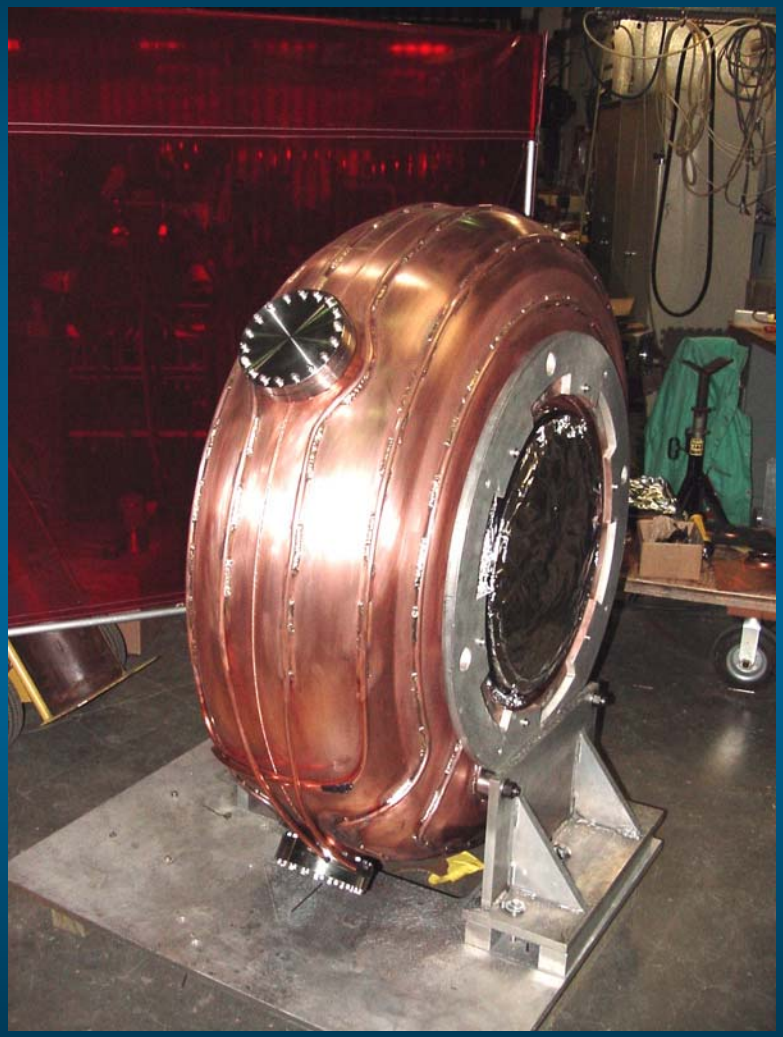


Extruded port

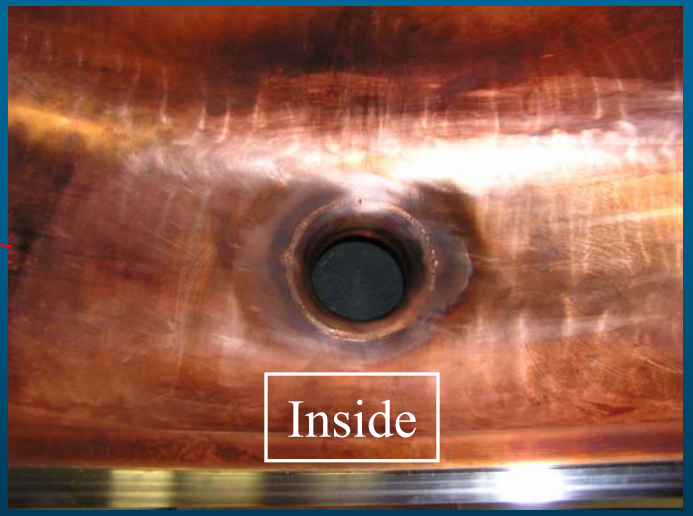
Port flange e-beam weld

Finished cavity port

Current Status

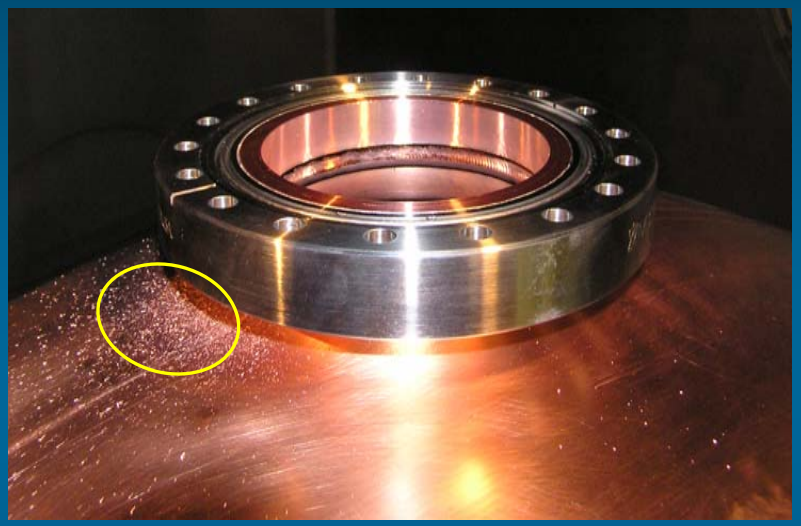


- ✓ cavity body
- ✓ cooling tube
- ✓ ports and flanges
- ✓ leak tight



Vacuum Leak at a Port

- A leak was identified at one of the ports
  - How to repair?
  - Many options:
    - Soft, hard solders, e-beam welding, …
  - Delays (~ six weeks)



- What have we done to fix it:
  - Cut out the port from cavity
  - Extruded another port and machined joints
  - TIG welded the port to cavity body (back to original plan)
  - Leak tight now!
- This port will be used for RF probes and a view port

TIG Braze of Cooling Tubes

- Good thermal conduction
- No distortion on the cavity body
- Welding material
- Welding speed and temperature

We have developed the technique and achieved the design goal!
Slicon-Bronze with helium gas torch + argon gas flowing in the tube

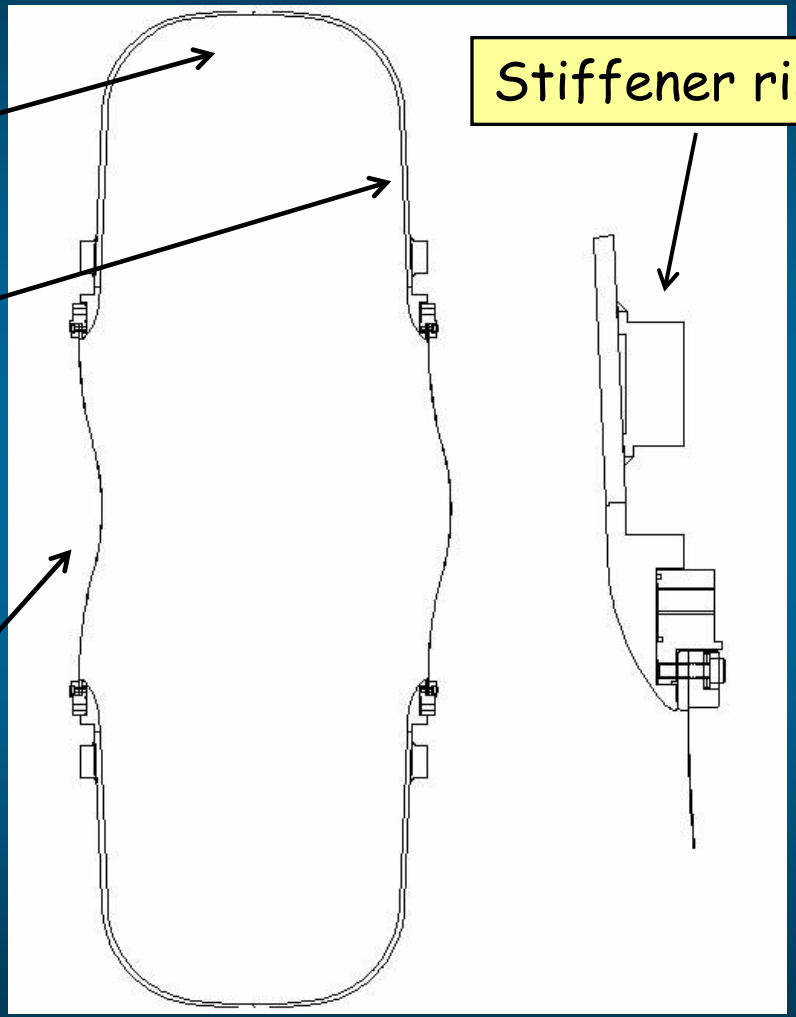
The Cavity Body Profile

Spherical section at the equator to ease addition of ports ($\pm$ ~ 6°)
Elliptical-like (two circles) nose to reduce peak surface field

2° tilt angle

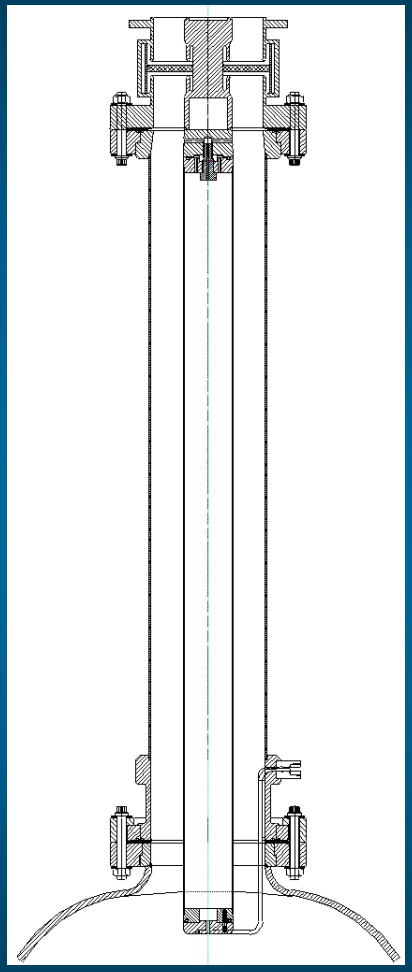
6-mm Cu sheet allows for uses of spinning technique and mechanical tuners

De-mountable Pre-curved Be windows to terminate RF fields at the iris



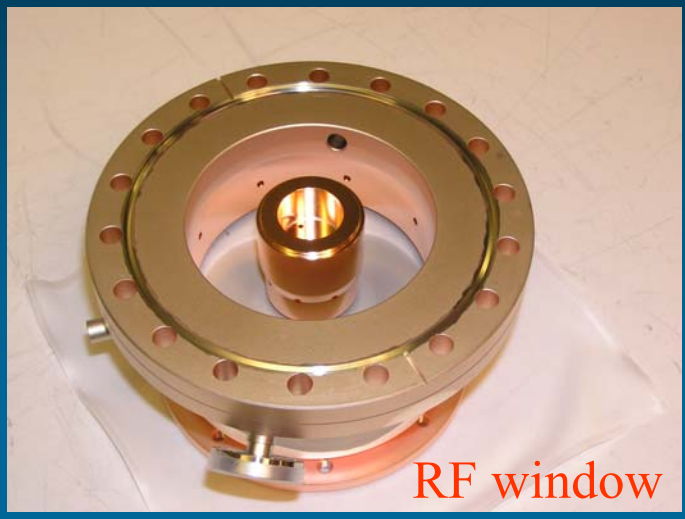
RF Coupler Design

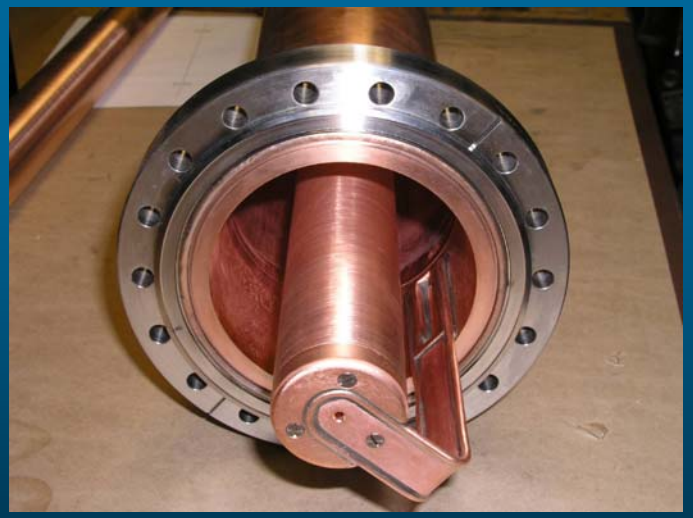
- Loop coupler at critical coupling
- Prototype coupling loop design uses standard off-the-shelf copper co-ax
- Parts to be joined by torch brazing
- Coupling loop has integrated cooling
- Two SNS style RF windows mfg. by Toshiba received (no cost to us !)
- Two couplers with RF windows are complete and ready for high power
- Bellows connection required on MICE cooling channel (Study-II) for thermal and dimensional reasons



Loop Coupler Design

Fabrication of the Coupler

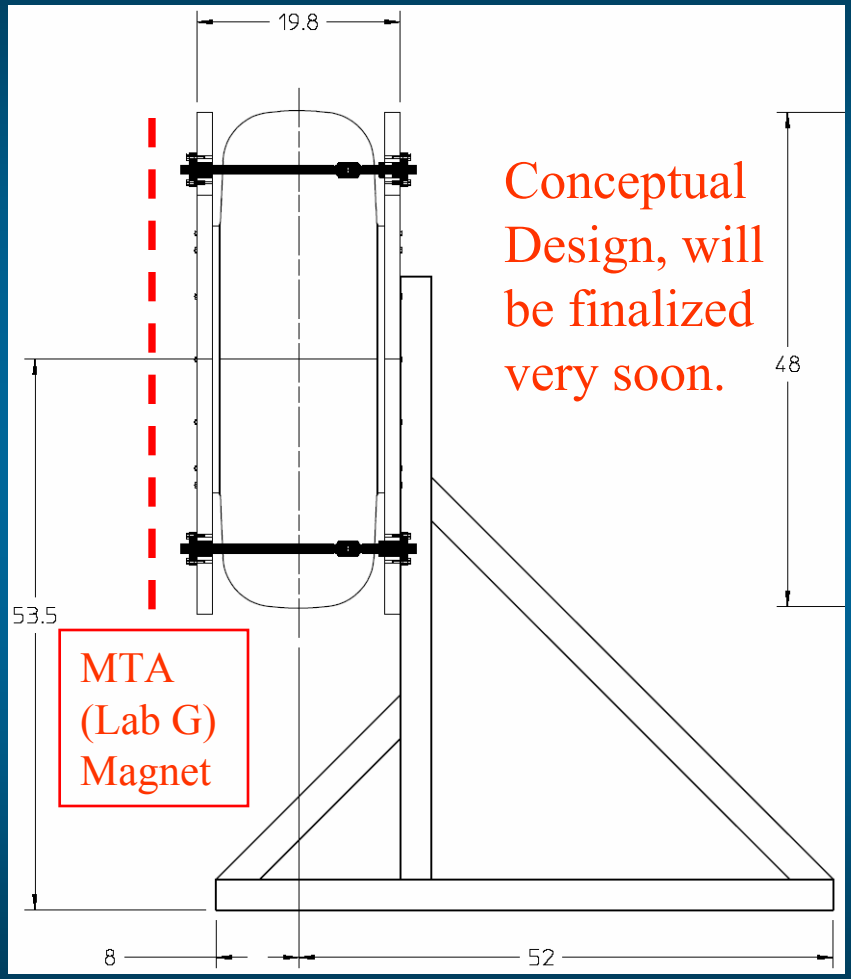




- The coupling can be adjusted by rotating the loop
- Water cooling line goes around the loop

Support Stand/Manual Tuner

- Manual tuner consists of thick aluminum plates connected by adjustable struts
- Tuner allows cavity frequency adjustment while providing support for interior vacuum load
- Parts for tuner fabricated in U. of Miss. Shop, and now at J-Lab
- Support stand attaches to one tuner plate and allows cavity to be placed adjacent to MTA magnet
- Support design is nearly complete, parts have been ordered



Curved Beryllium Windows

- After making two curved Be windows for the 805-MHz cavity successfully, we placed purchase order of Be windows for 201-MHz cavity:

  Three 0.38 mm thick, 420 mm diameter curved Be windows at Brush-Wellman (~185 watts heating per window with ΔT~ 100 degrees at nominal Study-II parameters)
- Window is formed by applying a die at elevated temperature
- Copper frame is brazed to Be window
- Be will be TiN coated

Brush-Wellman failed twice so far:
- warping (1st one)
- cracking (2nd one)

They promise to be successful in next

160 mm diameter curved Be window for 805 MHz cavity made by Brush-Wellman. The window is TiN-coated now and will be used for high power test at MTA

Curved Be window for the 805-MHz pillbox cavity

Controls & Preparation at MTA

In addition to RF test plans (to be discussed during the meeting), here is a list for monitors and controls

- Packing and shipping (from J-Lab to MTA)
- MAT layout, transmission lines and installation (gaskets, supports,…)
- Vacuum and pumps
- RF signals: forward and reflected power (raw signals)
- RF signal from the cavity (through RF probe)
- Two couplers per cavity (phase)
- Cooling water (flow meter and temperature)
- Manual tuner and dynamic tuners (MICE, can be tested in air)
- RF windows
- Be windows
- Pressure in pressurized transmission lines (N_2)
- Dark current, x-rays
- Magnetic fields and forces

Summary

- 201-MHz cavity status
- RF windows will be conditioned first at SNS in weeks
- Curved Be windows are expected to arrive soon
- Cavity cleaning and assembly with RF couplers within two months
- Expect to ship the cavity to MTA in April-2005!
- Continue working on RF test plans