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Status of 201 MHz Cavity

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HG Cavity at 201 MHz

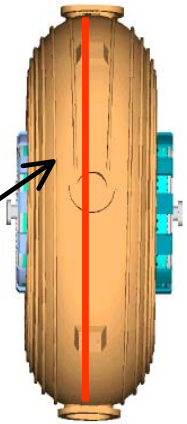
- Cooling channels require 201 MHz RF cavities at high gradient of ~ 12-16 MV/m (~ 1.07 Kilpatrick)
- The cavity has to be normal conducting
- High cavity shunt impedance is achieved by terminating open beam iris with thin and low Z conducting materials
  - Pillbox-like closed profile
  - Reduced peak surface field versus accelerating field, less dark currents
  - Incorporating thin and low Z Be foils (or other options) to the cavity body: engineering challenges
  - Thin Be foil is the baseline choice for the window
- Technical approach: 201 MHz cavity prototype and experimental studies using the 805 MHz cavity at Lab G

201 MHz Cavity Progress

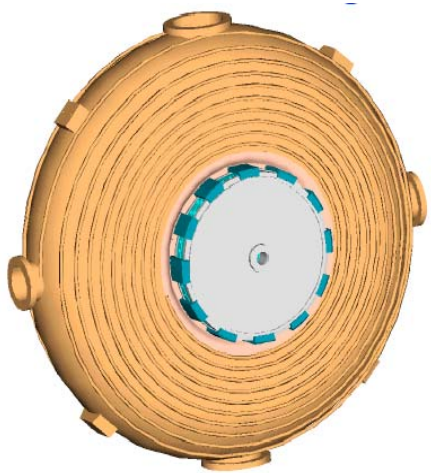
- Collaborators :
  - LBNL: A. Ladran, D. Li, J. Staples, S. Virostek, M. Zisman
  - JLab: R. Rimmer, L. Philips
  - FNAL: A. Moretti
  - Oxford University: W. Lau, S. Yang

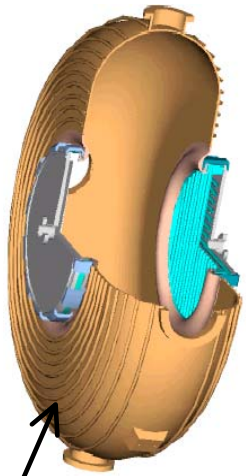
- Cavity design status and progress
  - RF design: cavity profile (√)
  - Window design and FEA simulations (√)
  - Engineering design (√ →)
  - Fabrication plan (√)
    - Identified vendors
    - Spinning of cavity half-shells
    - E-beam welding to join the half shells
    - Tuners, couplers, ports and cooling channels
  - Schedule (√)
- Order for copper plates has been placed last month!

3-D View: 201 MHz Cavity



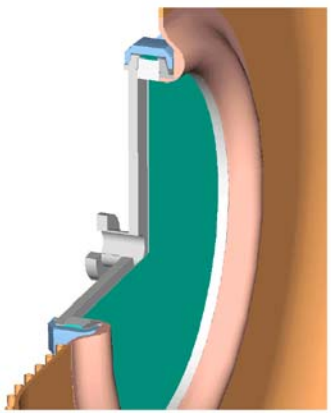
Spinning of half shells and e-beam welding

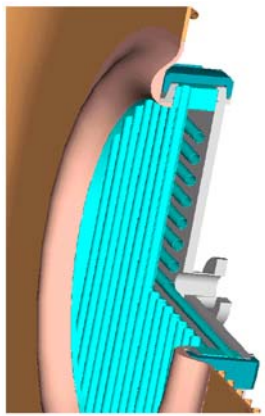




201.25 MHz cavity conceptual design

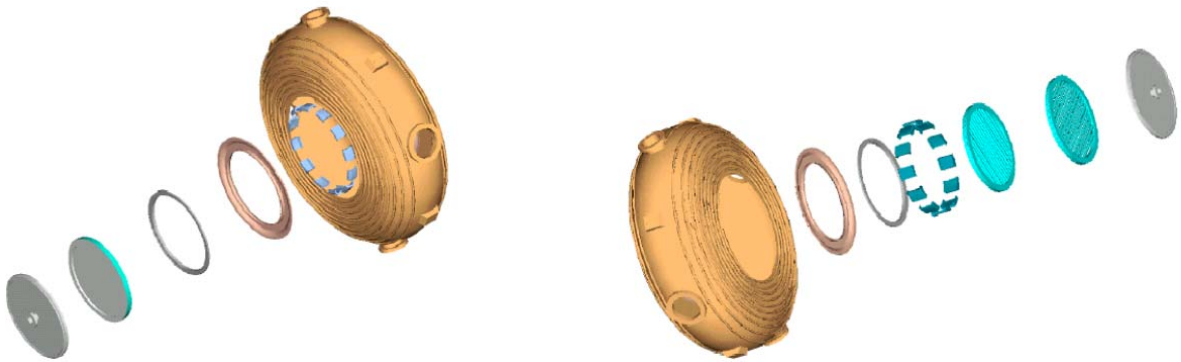
Water cooling channels

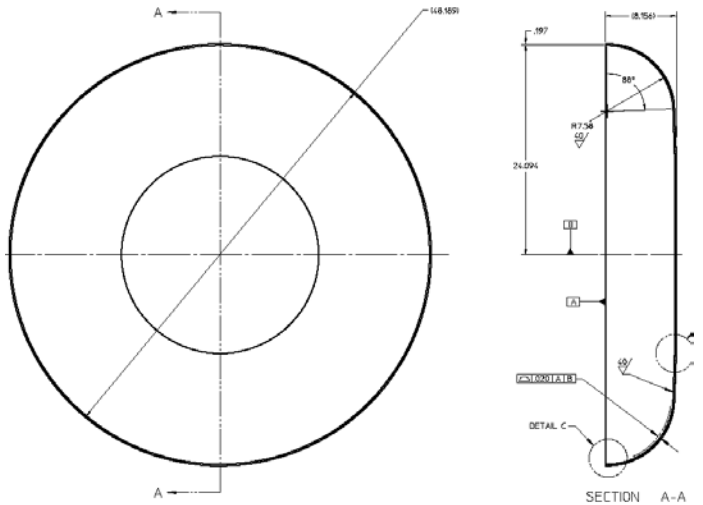


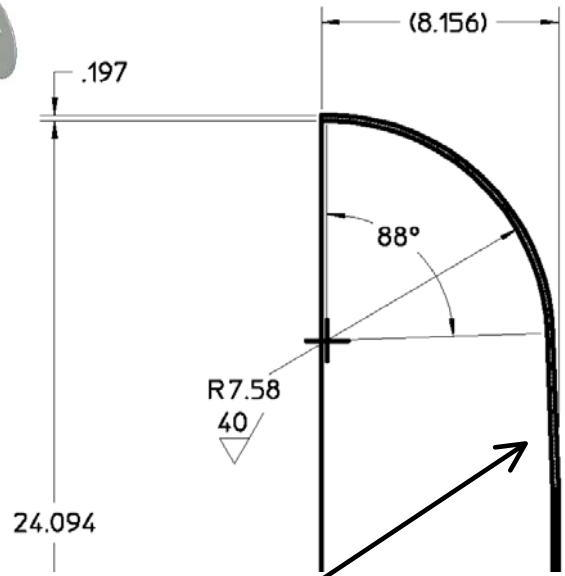


Cavity design accommodates different windows

The Cavity Body Profile







2° tilt angle

Iris for windows

~ 6 mm Cu plates, spinning + e-beam welding

Cavity fabrication techniques

- Active collaboration
  - Weekly meeting at LBNL
  - Video conferences with JLab and Oxford University
  - Visit to vendors
  - Email exchanges
- Cavity body:
  - Spinning half-shells (four of them) with 6-mm thick Cu plates using wood (or bakelite) molds at ACME, a company in Minnesota. Mechanical cleaning or electrical polishing (at JLab)
  - E-beam welding to join half shells to form the cavity (JLab)
  - Nose-cone pieces are fabricated separately (Mississippi) and joined by e-beam welding (JLab)
- Six ports on the cavity body
  - RF power couplers (2)
  - Vacuum ports (2)
  - Probes and view ports (2)

Spinning at ACME Company

Spinning bowl

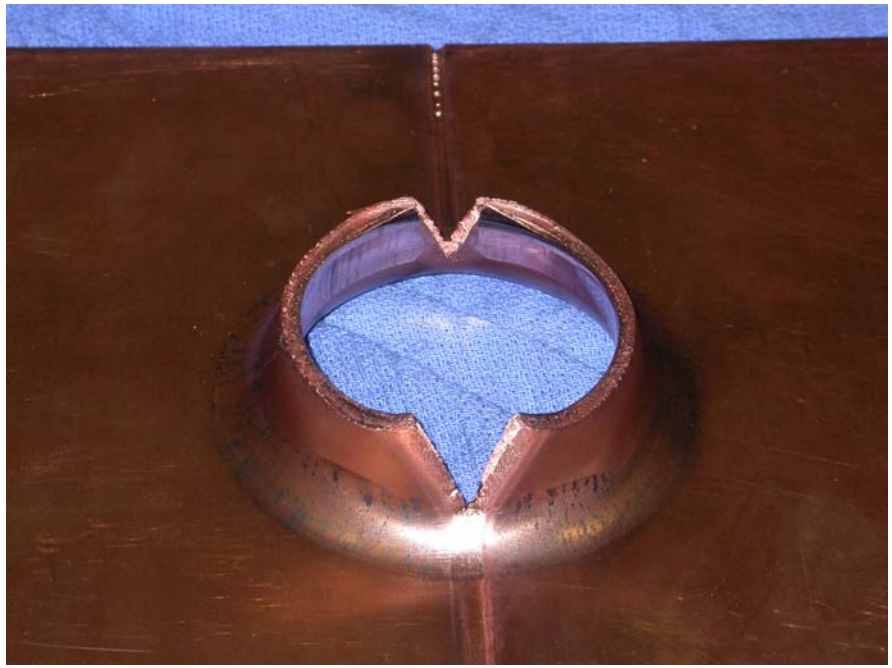
Spinning tools

Cavity Fab. (cont'd)

- E-beam welding to join the ports to the cavity
  - Current design has two ports (4' diameter) for RF power coupler; two ports (4' diameter) for vacuum and two smaller ports (TBD) for probes
  - Ports can be machined or using extruding (pulling) techniques (give smooth curvature on the ports)
    - Technical difficulties: extruding through e-beam joints
    - Pulling tests have done at JLab (failed) and will continue with new ideas and improved method
  - Machining ports and e-beam welding are the baseline choice
- Cavity measurement and tuning (JLab)
  - Form cavity by clapping two half shells, terminating irises with pre-made Cu windows (plates with ports for probes)
  - Machining flat-top [5 mm lip] of the half shells before e-beam welding [~ 80 kHz/mm sensitivity]
  - Machining nose-cone pieces [~ 200 kHz/mm]

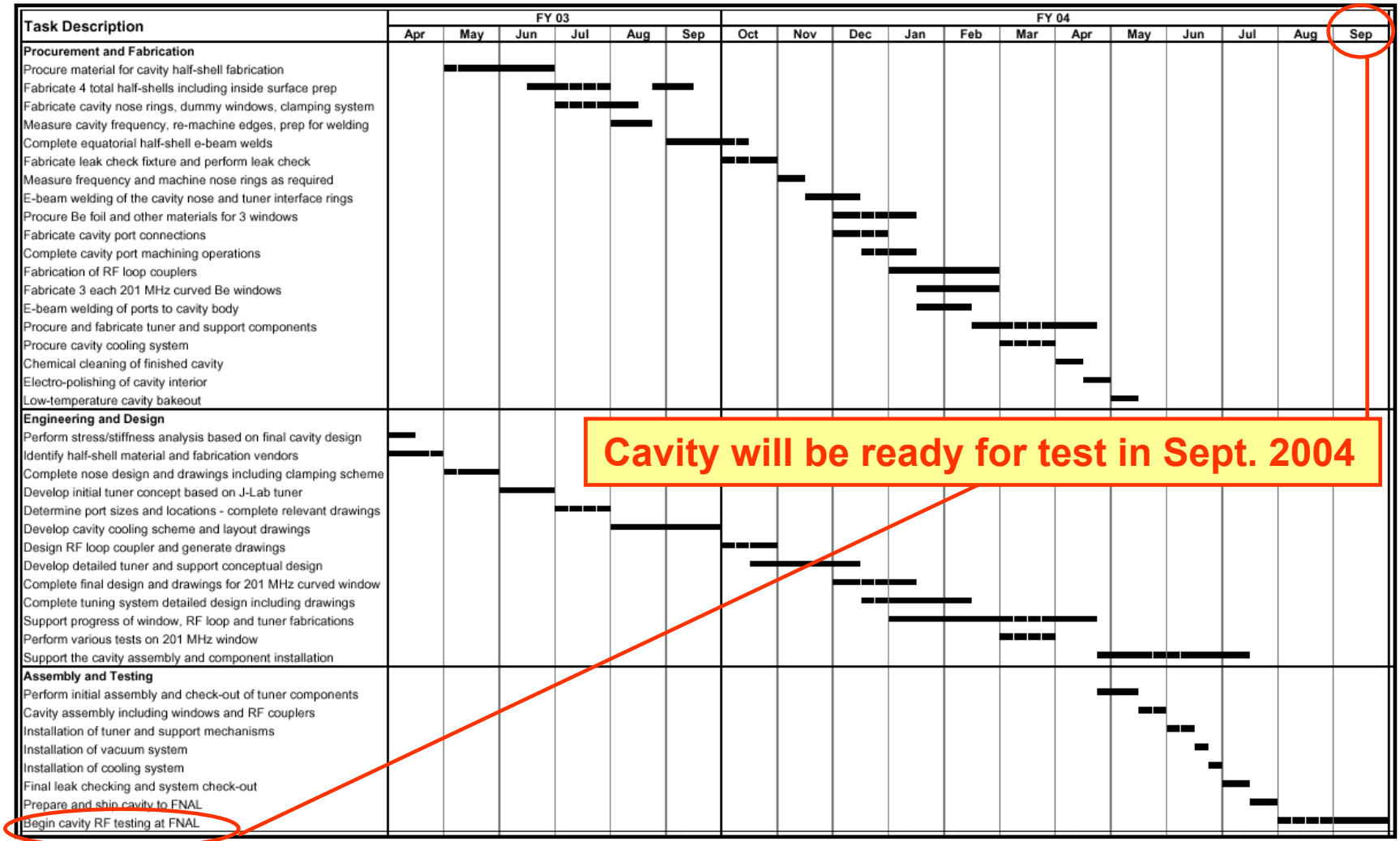
Extruding tests at JLab

Extruding tests on a flat Cu plate
Going through e-beam joint



Possible improvement:
Anneal around the extruding area or combination between pilot hole dimensions and lid heights, …

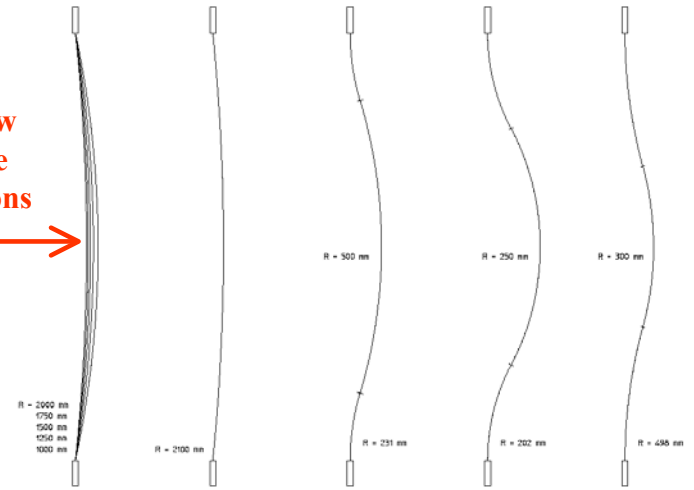
201 MHz Cavity Schedule

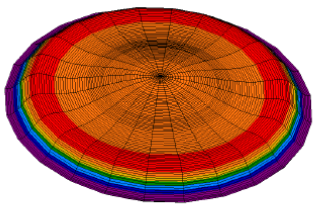


Be Windows R&D

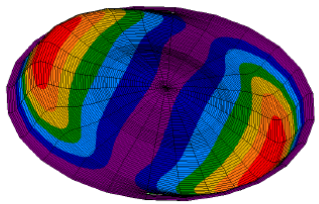
- Ideal windows
  - Transparent to muon beams
  - Perfect electric boundary to RF field
  - No detuning to cavity frequency
- Engineering solutions
  - Pre-stressed flat Be windows
  - **Pre-curved Be windows**
  - Grids

Window profile evolutions

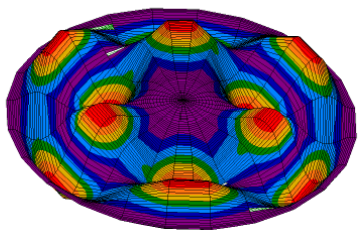




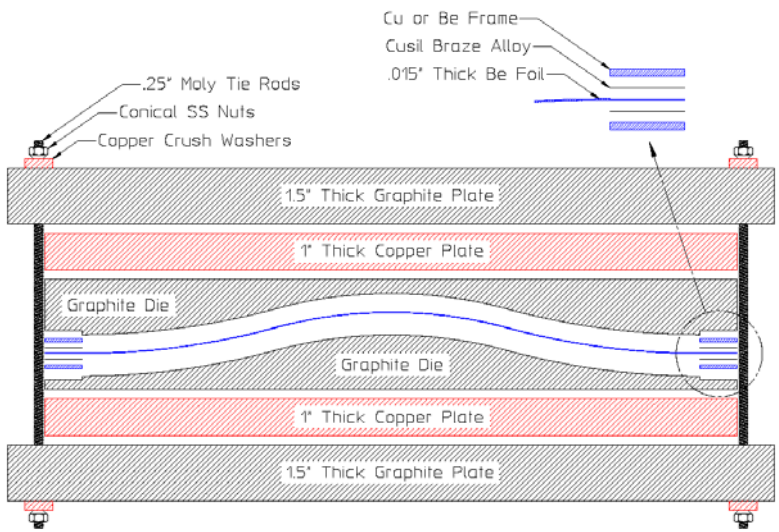
1st natural frequency: 530 Hz.



2nd natural frequency: 673 Hz



A pre-curved Be window: 0.25 mm thick and 21 cm in radius



Pre-curved Be windows

- FEA modeling shows (W. Lau, S. Yang) that the pre-curved windows perform better than pre-tension ones
  - Thinner (0.38 mm as baseline value now)
  - Low thermal stress with RF heating power for FS-II parameters
  - Good mechanical behavior (RF heating makes the window stiffer)
  - Predictable buckling (frequency detuning) directions (~ 2 mm max.)
- Develop a concept of pre-forming the Be foils
- The thick Be annular supporting frame may be replaced by copper
- Thinner and cheaper Be windows without losing performance!

Window Prototype

- Pre-curved windows
  - Pre-form the windows by using graphite die

Window Prototype (cont'd)

- The graphite die in Al fixture (room or high temperatures)
- 10 S.S sheets (10 mils) and 3 Be foils (10 mils) have been ordered for the pre-form tests
- Halogen lamp heating tests may be conducted at the 805 MHz low power test cavity to benchmark the FEA models

Be Window R&D (cont'd)

- Window is a critical part of the cavity
- Progress on FEA modeling and engineering design
- Window prototype and experimental studies

Muon Cavity Window R&D Schedule - April '03 to November '03

Task Description	FY 03						FY 04	
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
201 MHz Window Design & Prototype Fabrication								
Complete curved Be window conceptual design and analysis								
Develop fabrication method for 201 MHz curved window								
Test fabrication methods for 201 MHz curved window								
Procure Be foil for one 201 MHz prototype								
Fabricate fixturing for 201 MHz window shaping and brazing								
Fabricate prototype 201 MHz curved Be window								
Perform various tests on prototype 201 MHz window								
805 MHz Window Design & Fabrication								
Design an equivalent 805 MHz curved window								
Procure material for 805 MHz windows								
Fabricate fixturing for 805 MHz window shaping and brazing								
Fabricate 805 MHz curved Be windows								
Perform various tests on 805 MHz window								

Summary

- Good progress on 201 MHz cavity prototype with close collaborations with JLab, Oxford University, FNAL and …
- The cavity fabrication started
- Significant progress of FEA modeling on pre-curved Be windows
  - thinner and cheaper Be windows
  - better performance
- Window prototype started for 805 MHz cavity
  - Fixtures
  - S.S. and Be windows