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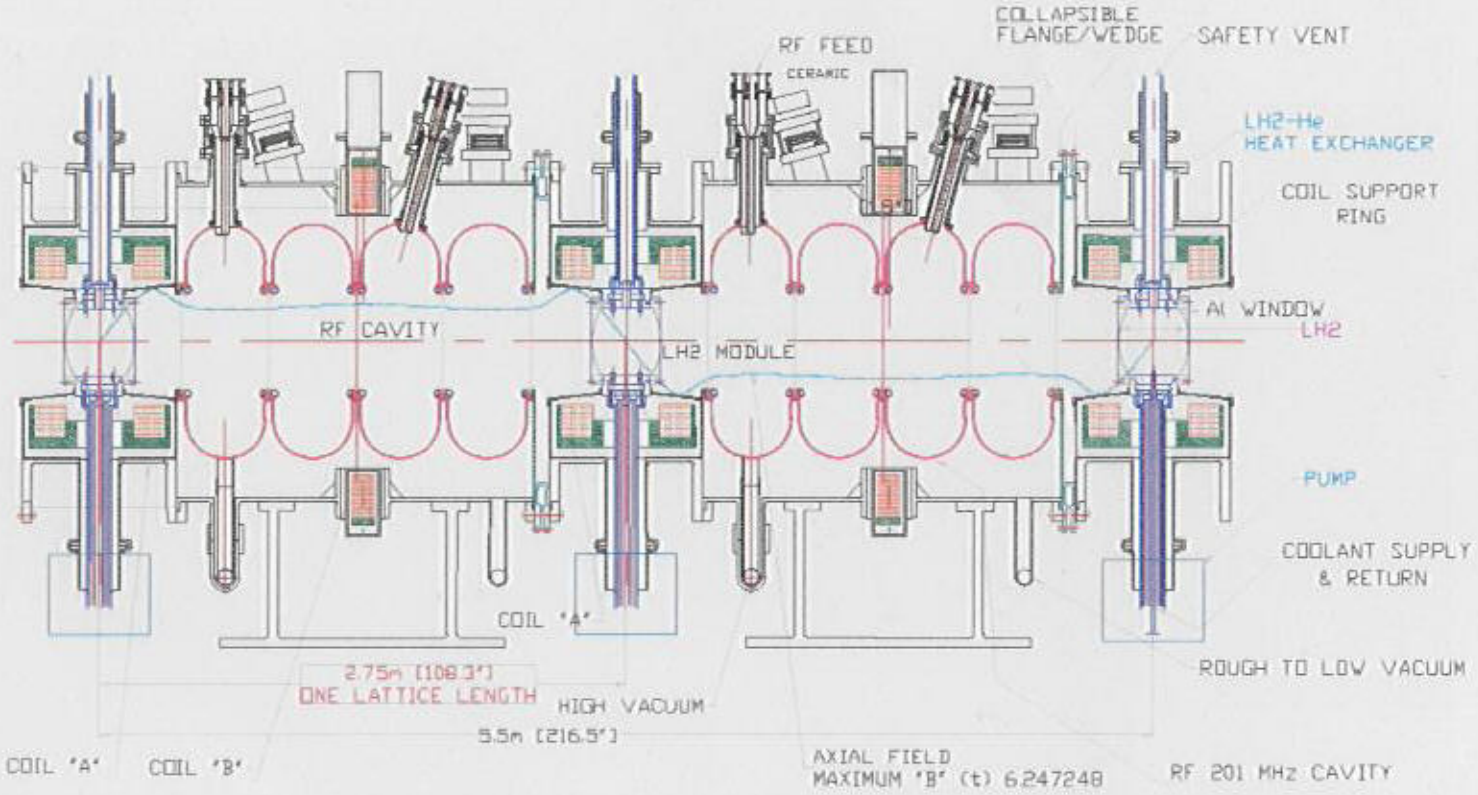
NCRF R&D Program and Plans

201.25 MHz cavity



Section of study-II cooling channel including 201.25 MHz cavities
(proposed as a possible configuration for IMICE)

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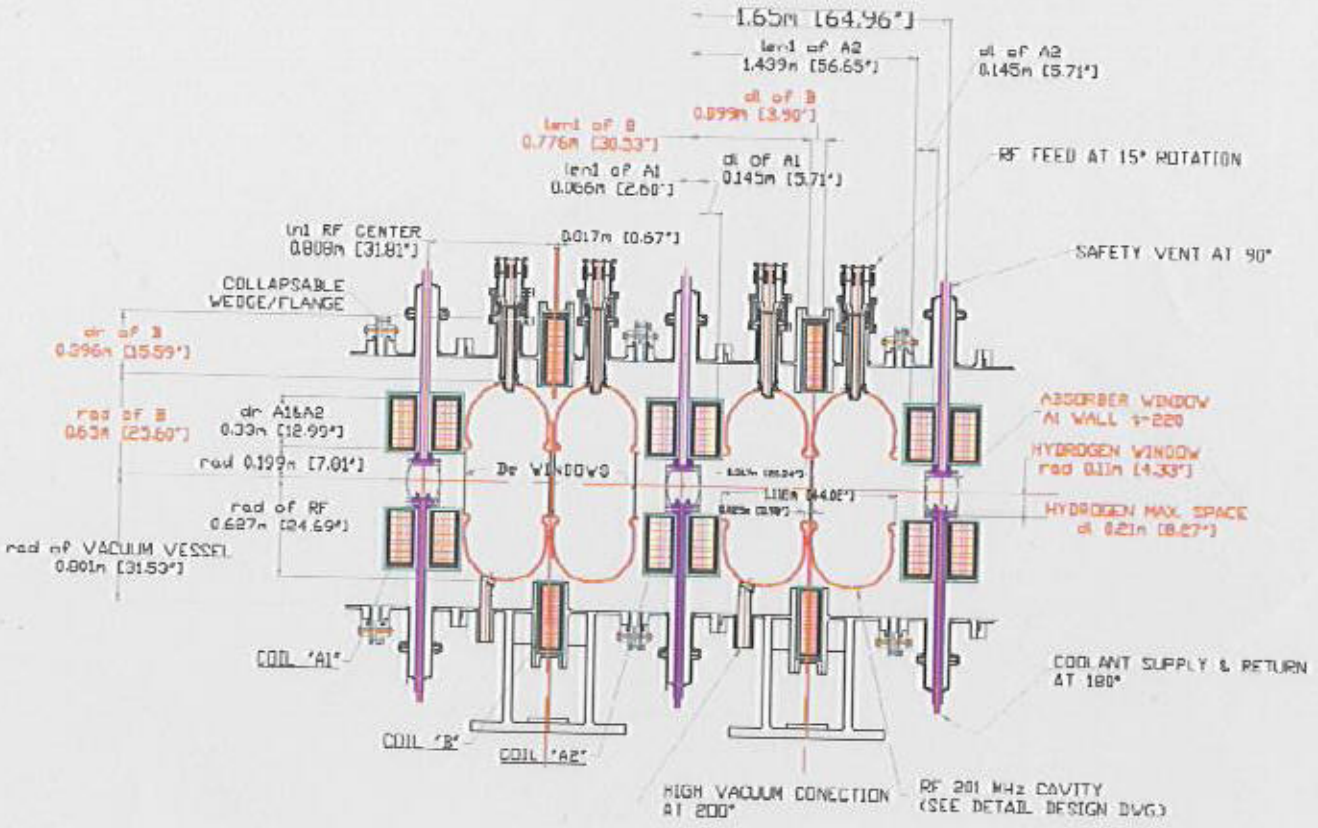
lattice 2

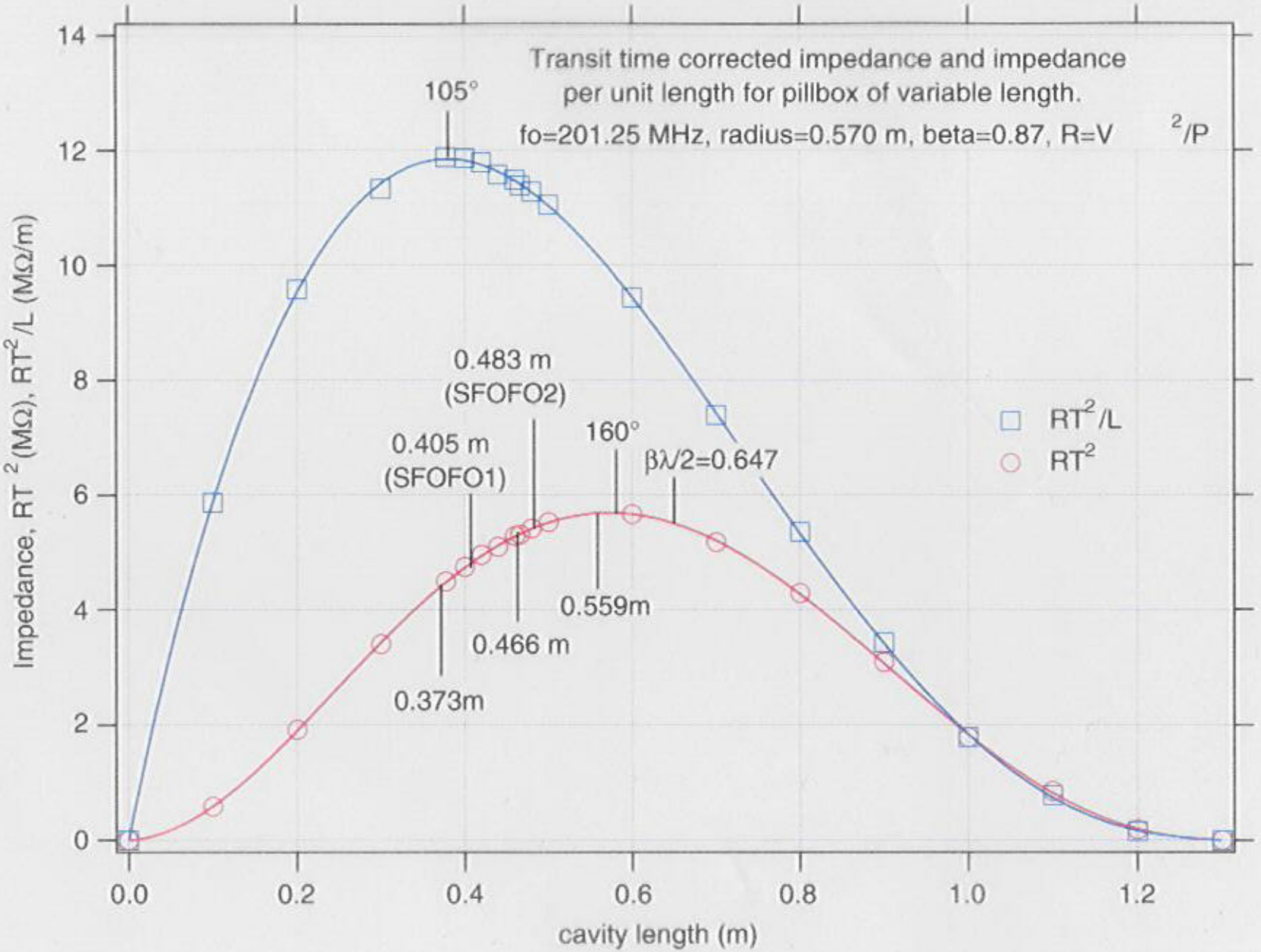


SFOFOLATTICE2 rev5

SFOFO 1.65 m LATTICE
SCTIONS: 2.1 TO 2.3

E.L.Black 01/21/2001
Rev.5

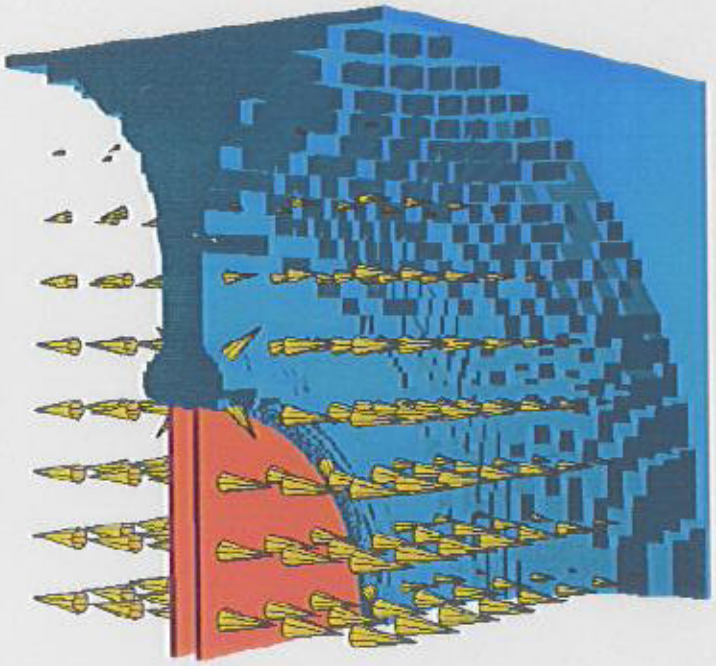
interference with cryostat eliminated by shorter cavity



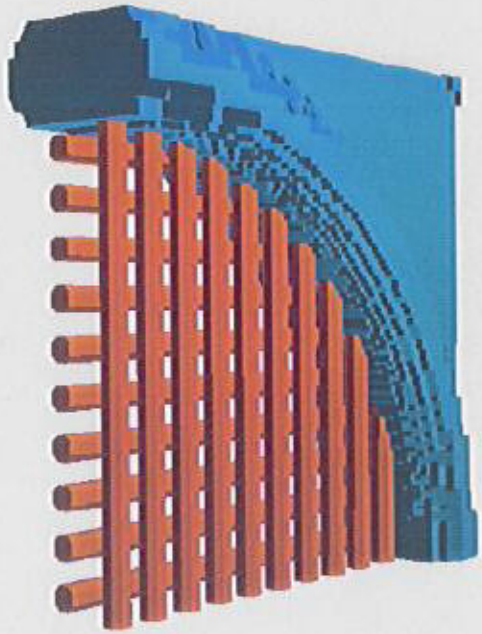
Cavity impedance verses length for ideal pillbox, beta=0.87

Foils and Grids

Set of foils now in parameter list acceptable for temperature and scattering
Tapered foils, multi-stepped foils, alternative materials, coatings under consideration
Some will be tried in high power tests at 805 MHz
Preliminary estimates show scattering from material and local fields may be OK
Surface heating and gas cooling should be evaluated (eventually)
Mechanical assembly needs thought, could be tested at 805 MHz?
Other hollow structures (not for study II)



Cavity with double foil configuration



grid of small tubes

"air-bed" array of tubes


#1

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Conceptual design in study-II has beed developed further.

Dimensions modified slightly for mechanical clearance (tuner etc.).

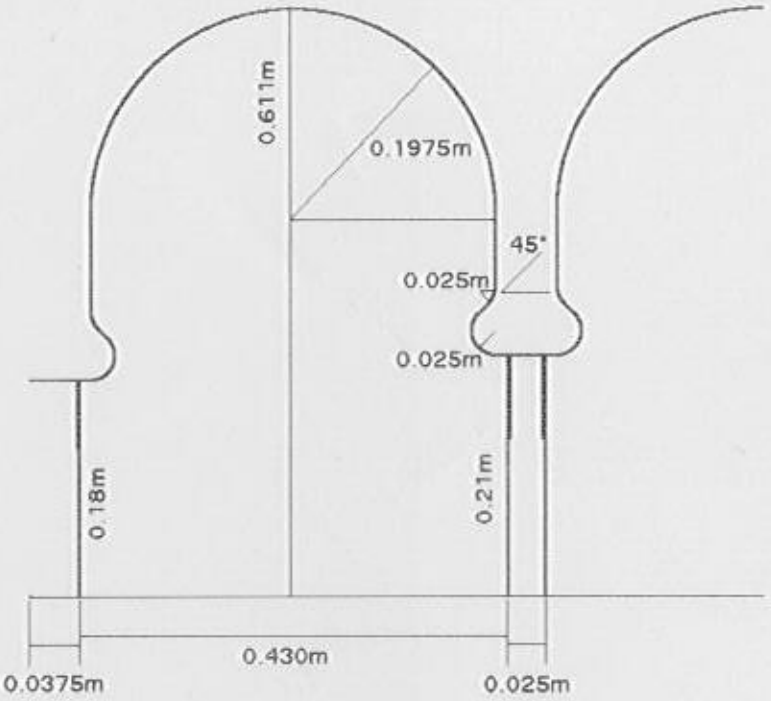
Focus now on first **high-power test model.** Two year fabrication plan before testing in **Linac Test Area** at FNAL.

FY02: e-beam welding deveolpment, spinning, tuner design, foil and grid development, fabrication of parts.

FY03: assembly of body, tuner fabrication, purchase RF window, foils &/or grids.

First cavity can be tested with foils or grids.

First cavity should be suitable for use in **IMICE** experiment.



IMICE cavity, modified from study-II

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RF Parameters for 201.25 MHz IMICE

Table 1. Ideal Pillbox cavities for IMICE

	2.75m cell	1.65m cell
Pillbox E_0 (=E_{pk} on surface)	**15.48 MV/m**	**16.72 MV/m**
Length, L	**0.466 m**	**0.559 m**
Transit time factor, T	0.798	0.718
V_{eff} (on crest, on axis)	5.76 MV	6.71 MV
Est. loss per absorber	~12 MeV	~7 MV
Est. loss in Be foils (cent,edge)	0.75 (1.48) MeV	0.42 (0.84)MeV
Number of cavities, n	4	2
Total energy loss per cell	12.75 (13.5) MeV	7.42 (7.84) MeV
Req. energy gain per cavity	3.19 (3.38) MV	3.71 (3.92) MV
Approximate phase angle, Θ	33.6-35.9°	33.6-35.7°
Peak power per cavity	3.646 MW	4.635 MW
Forward power (3τ filling)	4.038 MW	5.134 MW
Total per cooling cell	16.15 MW	10.27 MW

Table 2. Omega shaped cavities for IMICE

V_{eff} (on crest)	**5.76 MV** .927	**6.71 MV**
Length .930	0.~~405~~ m (T=0.~~845~~)	0.~~483~~ m (T=0.~~784~~)
E_0equivalent	16.8~~8~~2 MV/m	~~17.72~~ MV/m
E_{pk} on surface	24.5 ~~20.62~~ MV/m	23.06 MV
Peak power per cavity	4.18 ~~3.818~~ MW	~~4.491~~ MW
Forward power (3τ filling)	4.63 ~~4.228~~ MW	4.974MW
Total per cooling cell	18.5 ~~16.91~~ MW	9.95 MW

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201.25 MHz cavity conceptual design

Exploded views showing foil and grid mounting hardware

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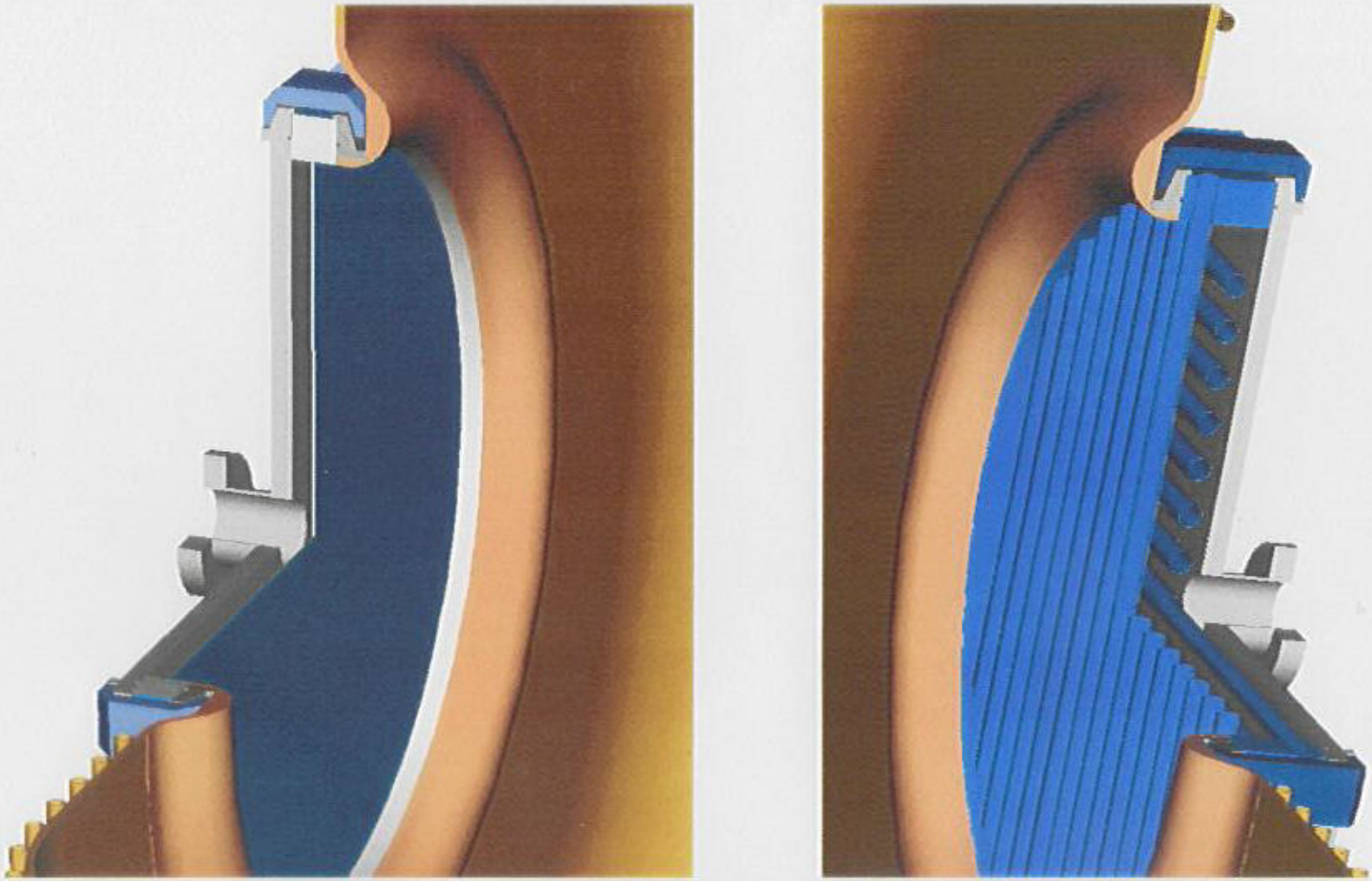

detail views of foil and grid mounting assemblies

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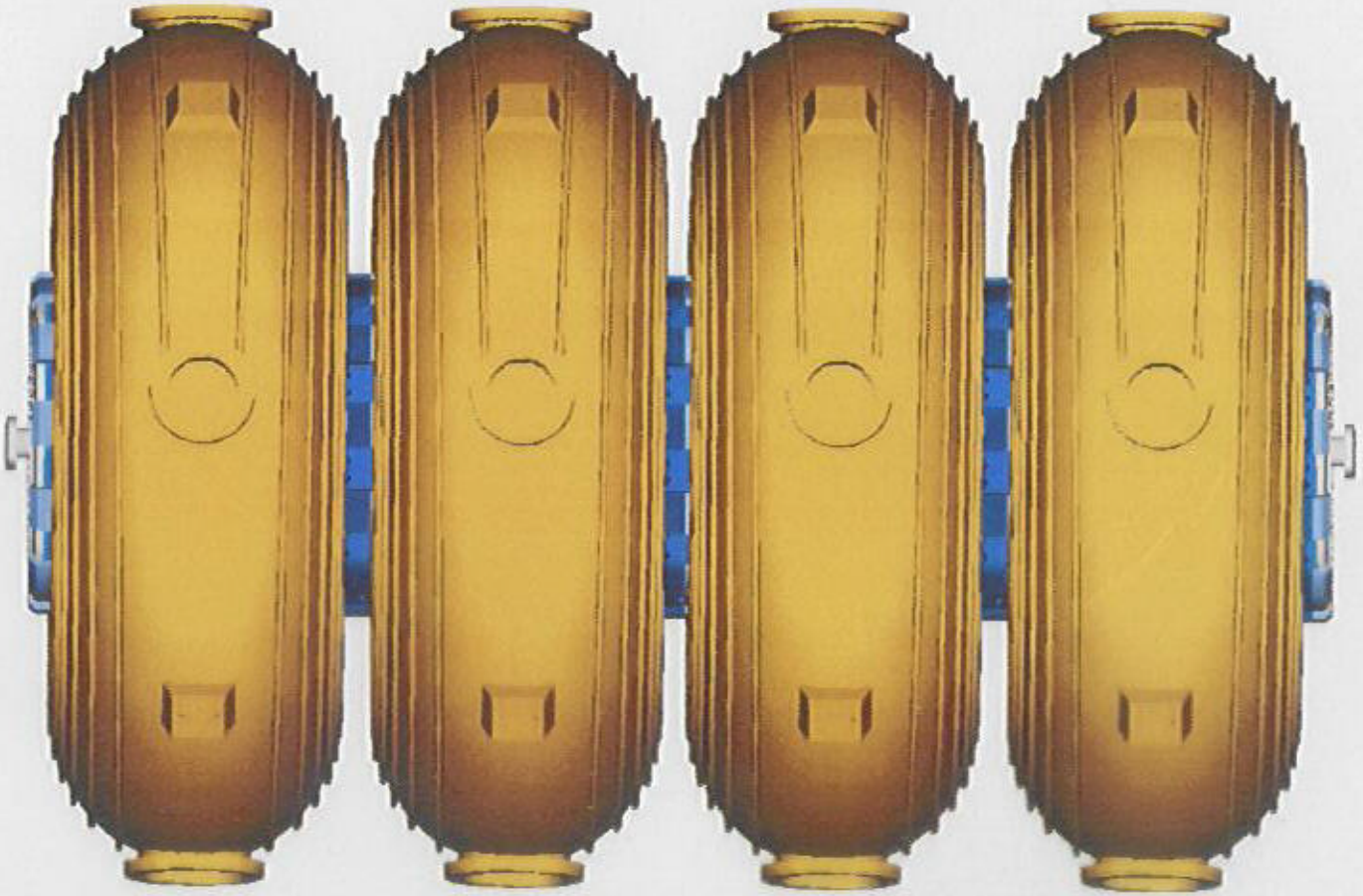

This design can form the basis of the IMICE channel

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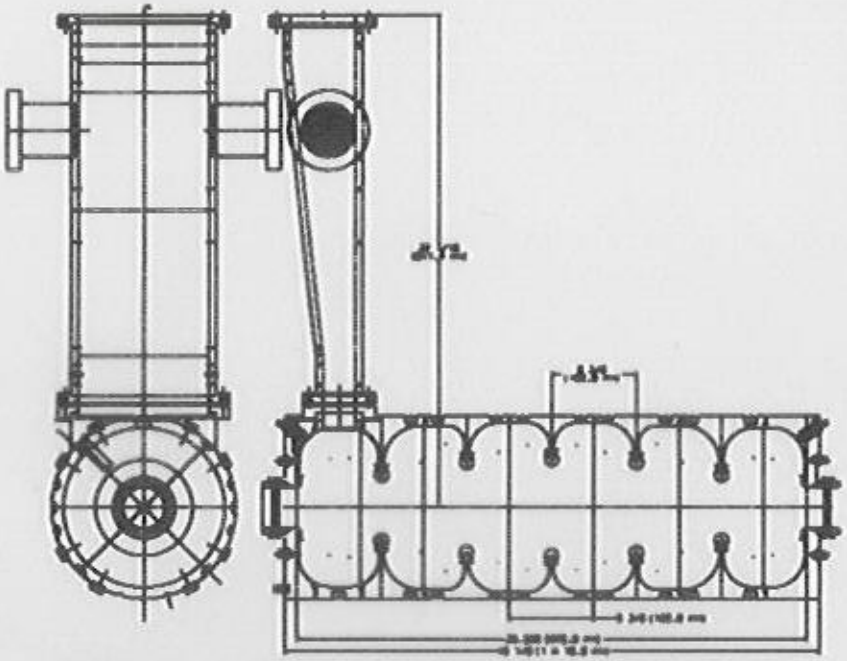
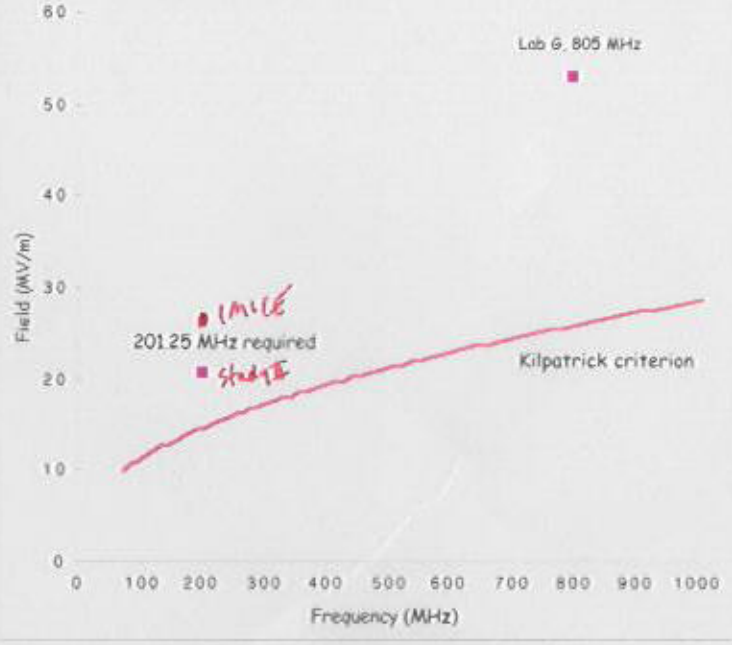


805 MHz open cell cavity tested in Lab G



Gradient achieved

53 MV/m surface field achieved at 13 MW (23.5 MV/m on axis).
Magnet quench moved the cavity off axis.
Conditioning with magnetic field led to puncture of Ti Foil.
Inspection revealed evidence of concentrated arcing.
Strong dark currents and X-rays.

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805 MHz single-cell cavity (Derun Li)

- Cavity fabrication was on schedule for testing in Lab G in FY01.
- Several thicknesses of Be foils have been procured.
- Leak detected in braze joint in an awkward place during final assembly.
- Repeated attempts to seal the leak have been unsuccessful.
- Now trying to install guard vacuum, test if base pressure is acceptable.
  - If so RF testing can begin soon :)
  - If not major rework will be required :(- May need reserve funds

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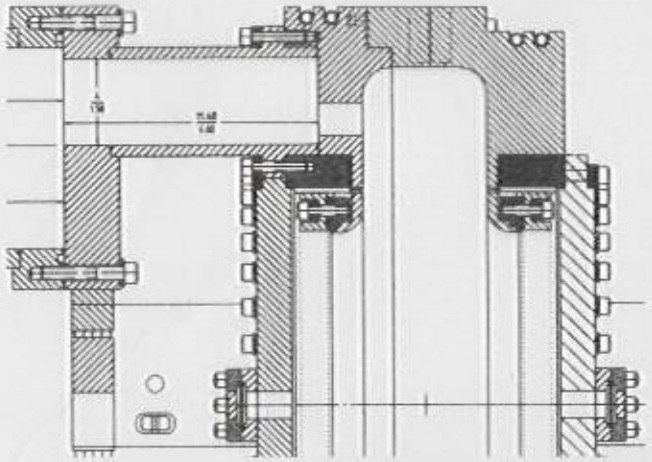
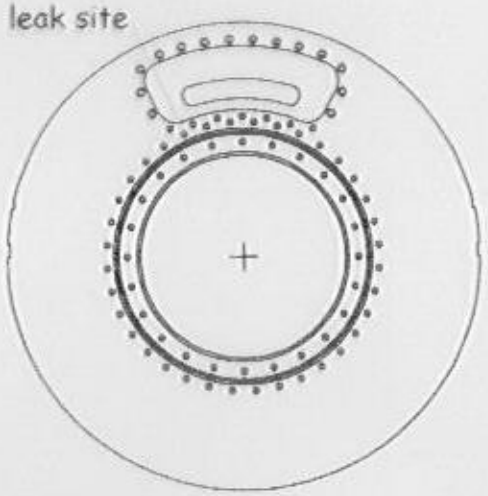
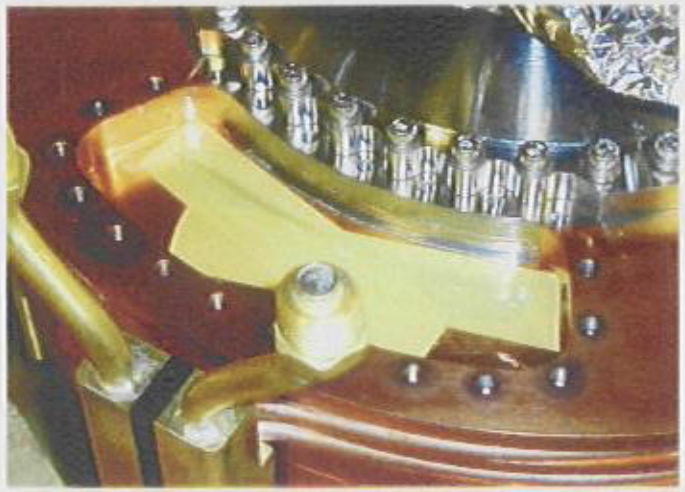






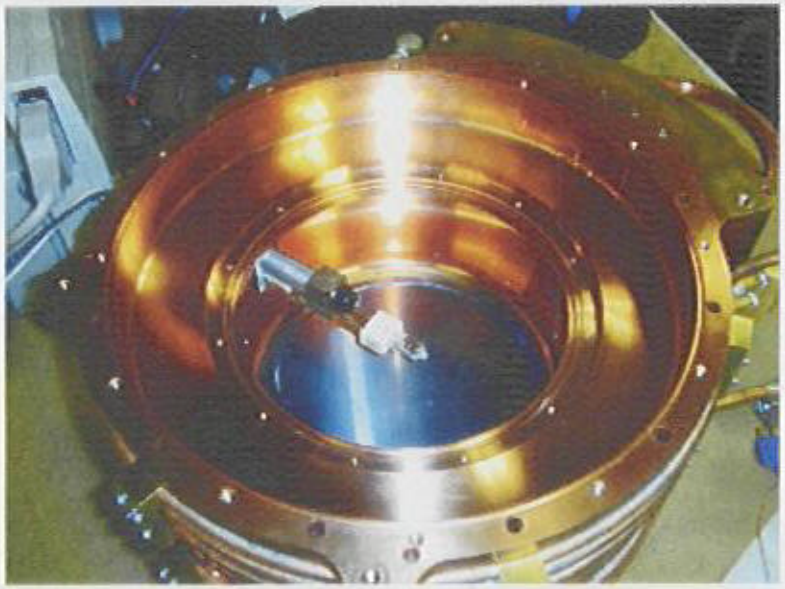
Geometry of coupler region. Leak is between copper and Stainless steel at the bottom of the recess. (Slot was cut after leak-checking at vendor).

Be Foil R&D

Various tests have been performed on the Be foils to measure pre-stress

- Halogen lamp tests repeated on new foils
- Acoustic tests at LLNL with accelerometer on foil
- Acoustic tests at LBNL with microphone

(Two foils from Brush-Wellman that failed in brazing were also tested)



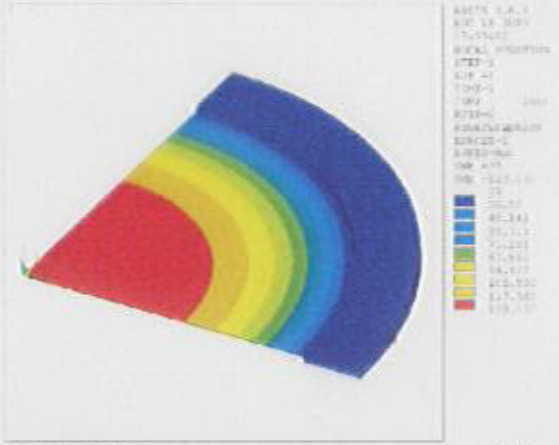
Halogen lamp test

acoustic test

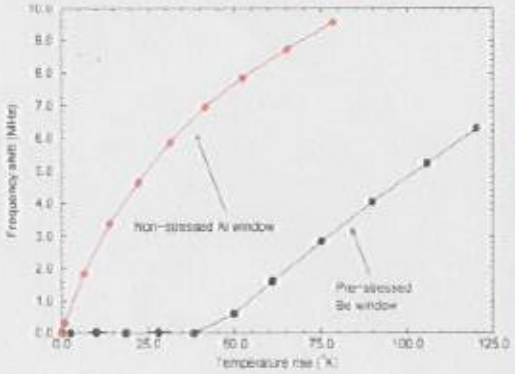
805 MHz closed-cell cavity

MAFIA model

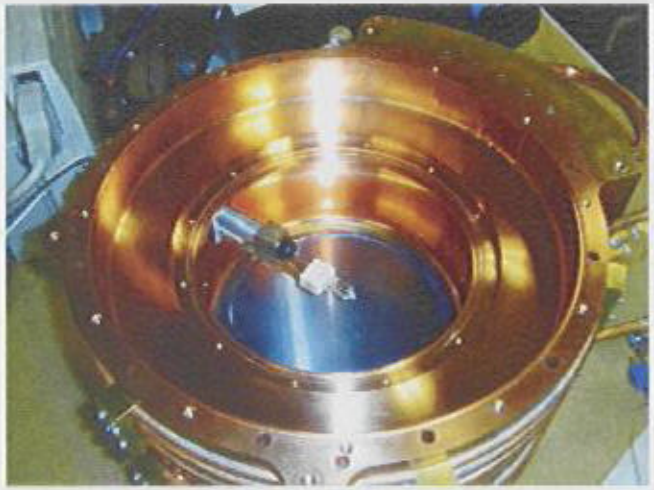
ANSYS model of buckling



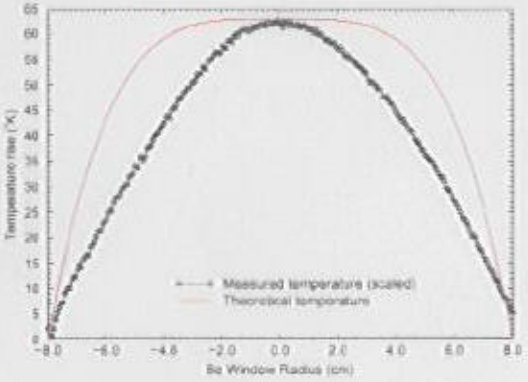
ANSYS calc. temperature profile



Measured temp. threshold



Low-power test model



Measured temp. profile

- Low-power cavity designed by LBNL, made by Univ. of Mississippi
- Testing has validated expected foil behavior
  - Heated by halogen lamp and low-power RF
  - Temperatures and deflections consistent with ANSYS analysis
- Demonstrated pre-stress can hold foils flat despite heating

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work in progress to turn these numbers into pre-stress

Conclusions

- Lab G operations have been very valuable in the study of surface field, dark currents, X-ray flux, breakdown and conditioning and effects of strong magnetic fields on all of the above.
- Single-cell 805 MHz cavity will continue this work, including the effects of Be foils of different thicknesses, surface coatings, etc.
- 201.25 MHz cavity conceptual design is complete. Detailed design work continues.

FY02 plans

- 805 MHz open cell cavity

  Keep running in Lab G to study effect of magnetic field.
- 805 MHz closed cavity

  Run in Lab G to test gradient, foils, multipactor, breakdown, w/wo magnetic fields.
- 201.25 MHz cavity

  Finish detailed design, begin mechanical tests for fabrication, e-beam welding, spinning, tuner design, foils/grids etc.