805 MHz Box Cavity Status
Fridays Collaboration Meeting
03/13/09
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Outline:

• Description of the Box cavity Concept.
• HFSS Model of the cavity.
• Box Cavity Summary Plans.
• CAD Drawings.
• Specifications.
• Qo, Resonant Impedance, Power requirements, peak surface fields.
• Conclusion.
Simplified View of Box Cavity for Field Orientation Studies

Waveguide Flange Perpendicular Orientation or could be at different angle

RF Electric Field Direction Max in center

Min ConFlat pickup (3) places

DC magnetic field direction.
Orthogonal E and H Case

Rectangular Coupling aperture with rounded edges

Original LBL WG RF power Coupler section

Coupling Cell

This Aperture not present in final design

HFSS Model showing only inside dimensions of the RF cavity and WG coupler
Box Cavity Summary Plans:

• Rectangular box cavity will be made of 101 OFE copper plates. First the sides will be screwed and foil hydrogen brazed together.

• This will come back to Fermilab and be finish machined; Coupling aperture will be machined in after a RF cold test to determine fo, Qo and coupling hole size.

• Top and bottom plates, SS flange and viewing ports will be jigged in place and foil brazed together. This will be sealed and shipped back to Fermilab.

• Cooling tubes will be soft soldered on to the cavity.

• Another cold RF test will be made to determine fo, Qo and coupling. Coupling aperture will be trimmed for near match condition if required.

• The rotating support fixture (upto 15 degrees) will be attached onto the current support frame.

• Vacuum system, drive waveguides, RF cavity pick-ups and after calibration testing will begin at 90 Degrees.
First Braze Cycle
Completed box cavity after Second Braze cycle and soldering on the Cooling Tubes.
Box Cavity Attached to Waveguide and rotation Assembly.
Specifications

The following are some of the specs for the square cavity:

Tolerance of parts  = ± 0.005"

Inside finish  = 30 u inches

Average power  = 5 kW with half the power dissipated equally on the Top and bottom plates the remainder almost equally on the 4 sides.

Pick-up ports: Three min-ConFlat vacuum feed-thru ports in the side opposite the coupling aperture, 2 with field pick-up loops and one with a Sapphire vacuum viewing window on a mini Con Flat flange.

Temperature: max temperature rise on inside surface of the un-cooled coupler aperture side is + 58 °C at 5 kW with room temperature water circulating in the cooling tubes on 5 sides (page 7).

Rotation Angle: 90 + Δ15 degrees.
Schedule and Cost estimate

Schedule

- Detailed drawings completed ----- 1 week from now
- Procurement of materials Cu plates ----- 2 weeks
- Machining parts for first braze cycle ----- 4 weeks
- First hydrogen braze cycle ----- 2 weeks
- Machine parts for second braze cycle ----- 1 week
- Second braze cycle ----- 2 weeks
- Attaching the cooling and rotation structure ----- 1 week
- Installation in magnet with vacuum and RF ----- 1 week

Total 14 weeks with high priority!

Material copper plate ----- $2000
2 braze cycle ----- 4000
Machining of parts ----- 10000
Miscellaneous material and parts ----- 4000

Total = $ 20,000.
Calculated Parameters of the cavity and cavity dimensions

HFSS normalizes all parameters to 1 W of input power to the waveguide coupler and solves for the frequency, gradient, coupling factor, Qo (in cavity mode) etc.

1 W produces a gradient of 25 kV/m by scaling:

25 MV/m would take 1 MW ideal.

The Impedance across the center of the cavity is

\[ \text{Imp} = 9.5 \, \text{M}\Omega. \]

This is the resistance across the center of the cavity given by

\[ \text{Imp} = (\text{gap Voltage})^2 / 1 \, \text{W}. \]

This uses the peak voltage and is in agreement with SuperFish and most published accelerator designs.

Qo = 27,400.
Conclusion

• A team headed by Joel Misek of AD Mechanical department, Tim Hamerla, designer and Mark Lebrun, Co-Op student IU have been working on the design and fabrication methods for the orthogonal cavity. The design is complete; detailed drawings in about one week.

• The design for rotating the cavity in place by 15 degrees has been completed.

• The design of the water cooling tubes assembly has been completed.
• Preliminary schedule and cost estimate have been developed.

• A list of specification has been developed from the HFSS modeling and MAFIA.

• HFSS designs have been completed. The dimensions have been transferred directly from HFSS to the drafting department.