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Integration of Cavities and Coupling Coil Modules

MICE Collaboration Meeting

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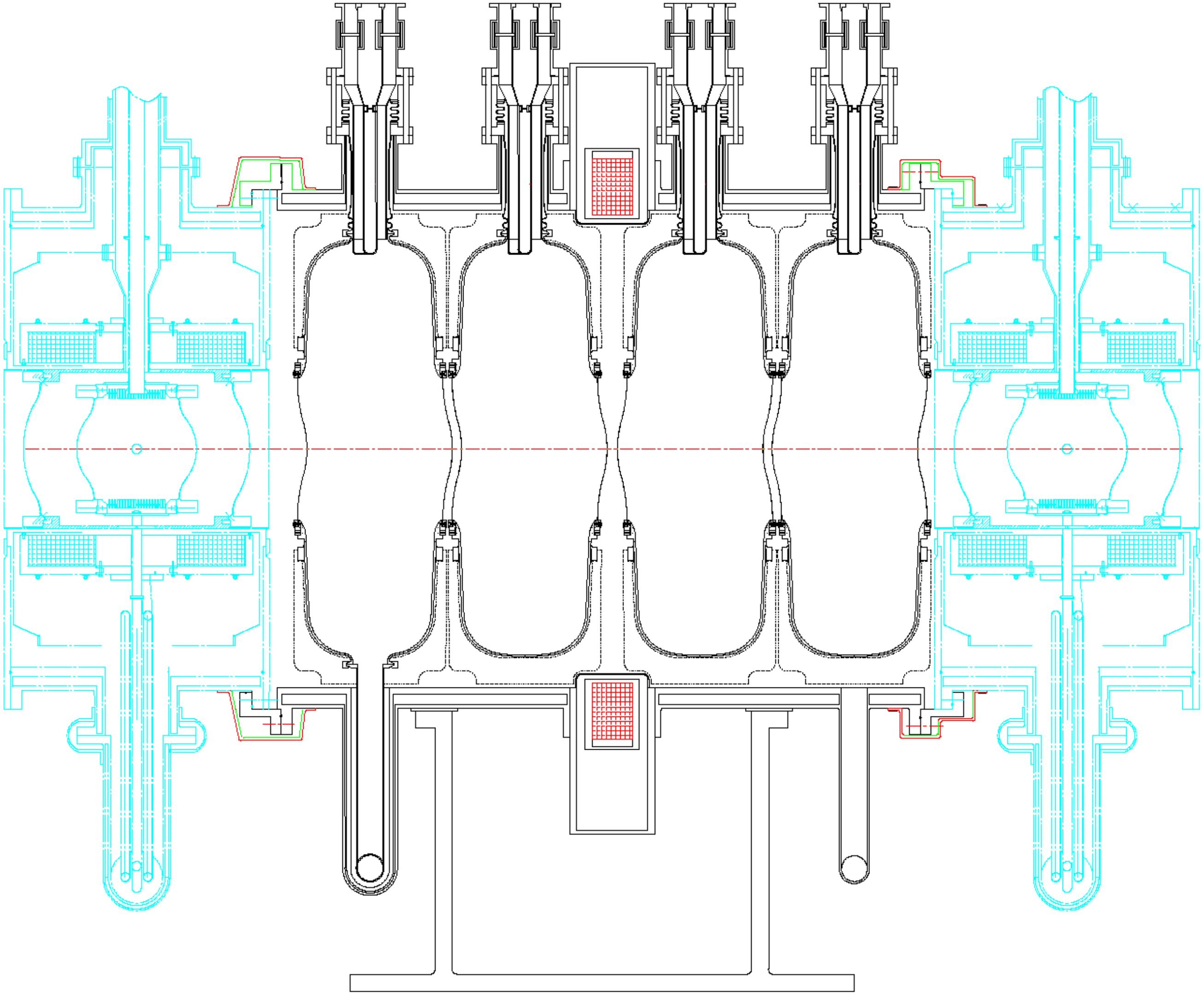
Cavity/Coil Module Layout



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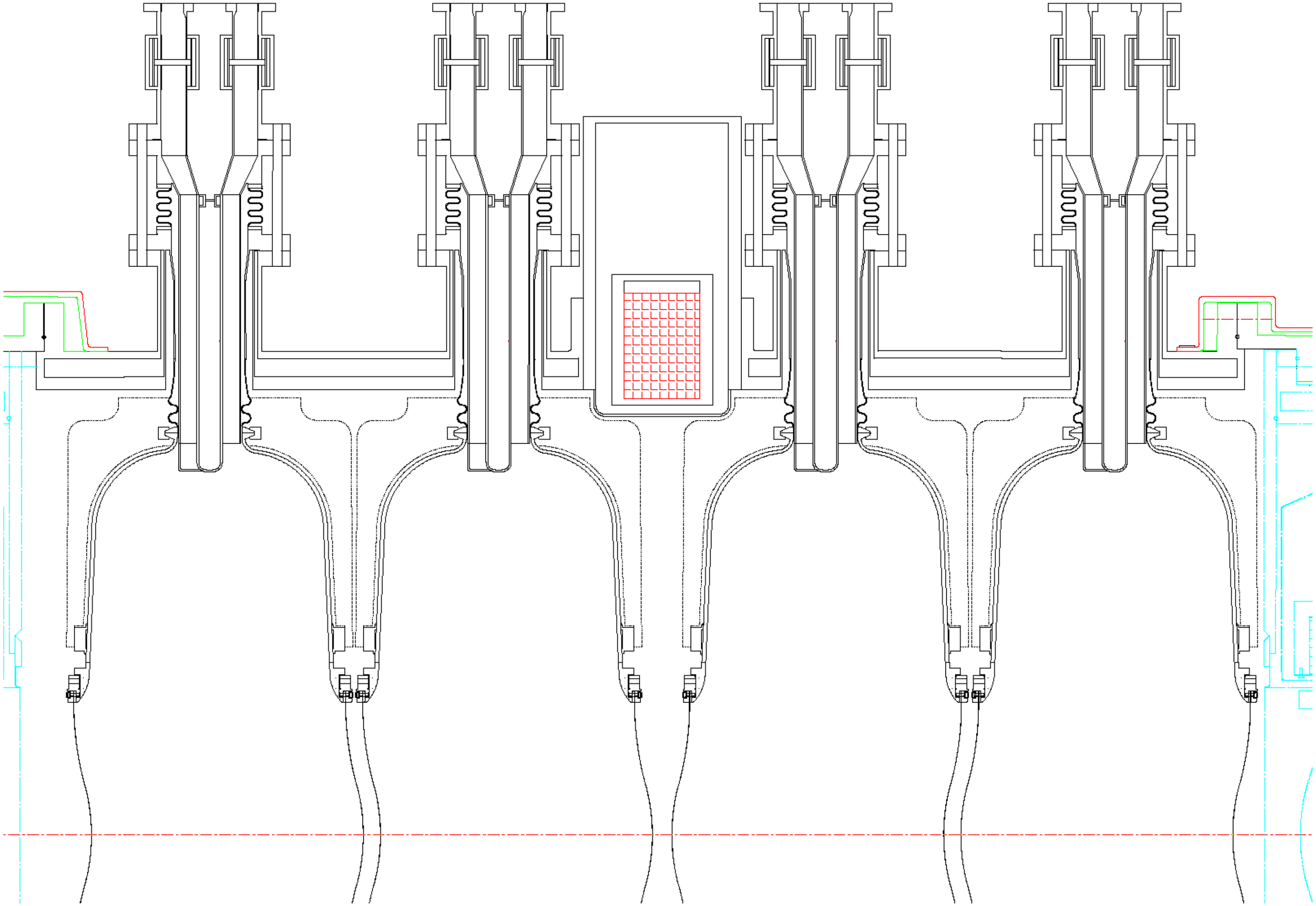
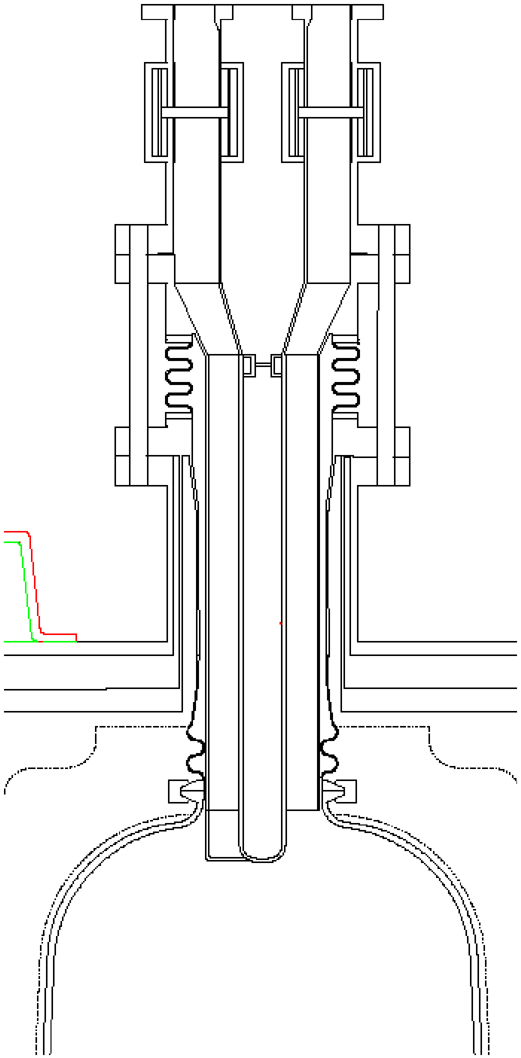
Close-up View of Module



Summary of Integration Issues

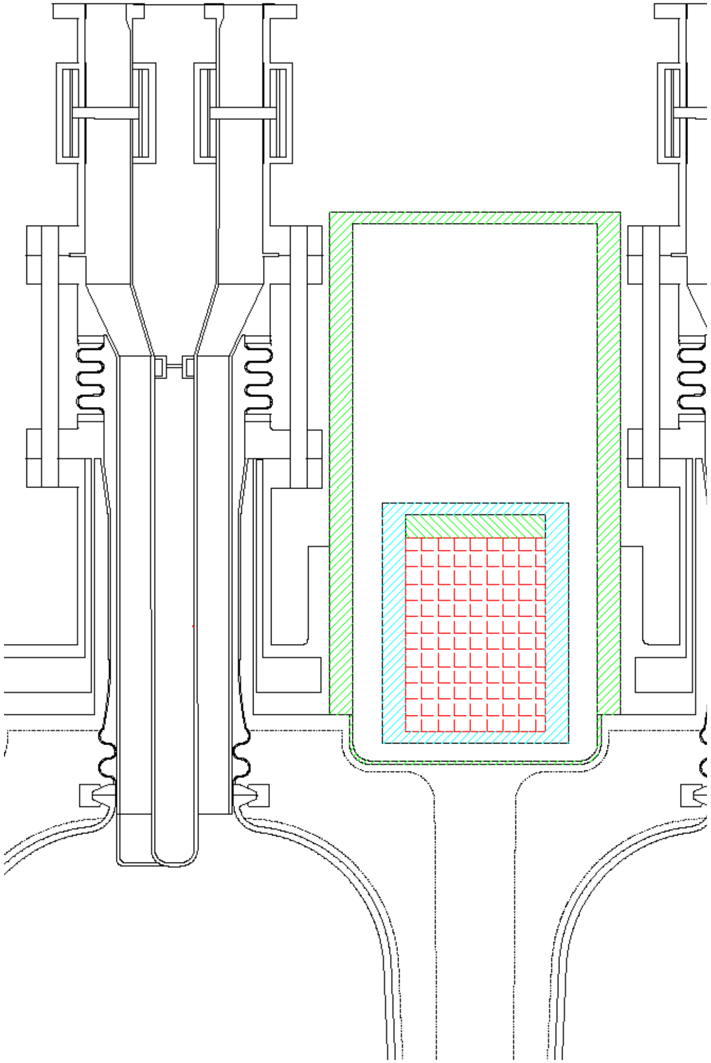
- RF coupler configuration
- Coupling coil geometry
- Cavity tuning mechanism
- Cavity mounting scheme
- Cavity port connections
- Vacuum vessel flange joints
- Module assembly scheme

RF Coupler Configuration



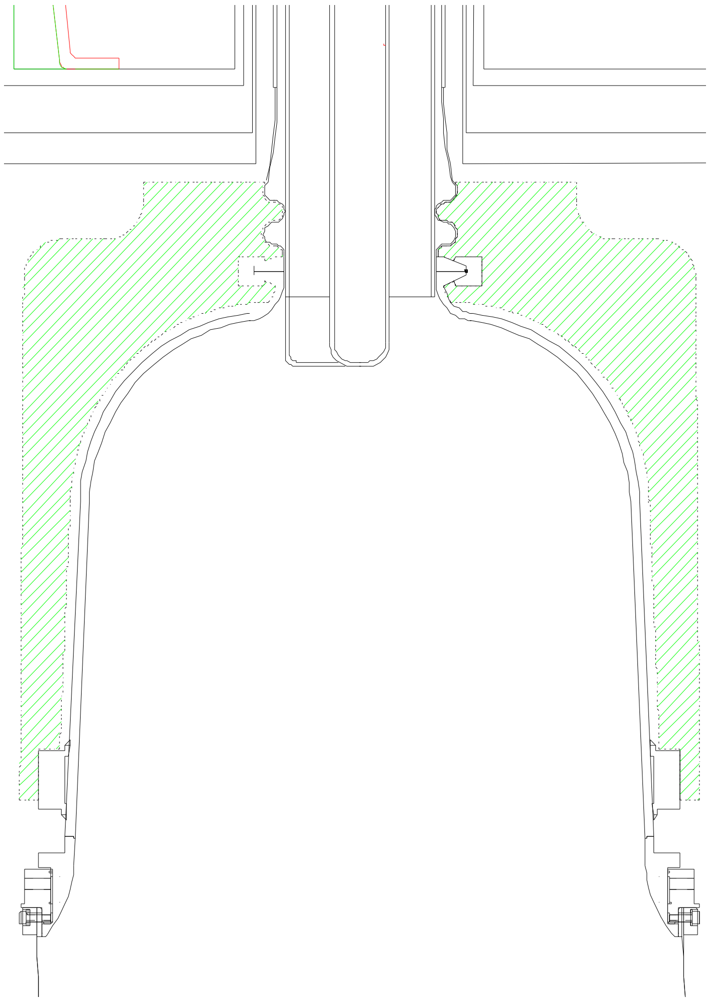
- Proposed layout allows all couplers to be oriented normal to vacuum shell
- All cavities are identical
- All couplers are identical
- Normal orientation facilitates cavity alignment and installation
- Tolerance stack-up effect reduced
- Cavities, couplers & vacuum shell are simpler and less expensive

Coupling Coil Geometry



- Revised coil design (per Mike Green) is much narrower than the previous design
- New design allows normal coupler geometry and increases interior clearance for tuners
- Minimal impact on cost of coupling coil fabrication

Cavity Tuning Mechanism



- Finite element analysis of cavity stiffness, stress and frequency sensitivity is complete
- Six discrete tuning mechanisms mounted on each cavity
- Tuners synchronized through control of actuators
- Conceptual design in progress
- Envelope defined as shown

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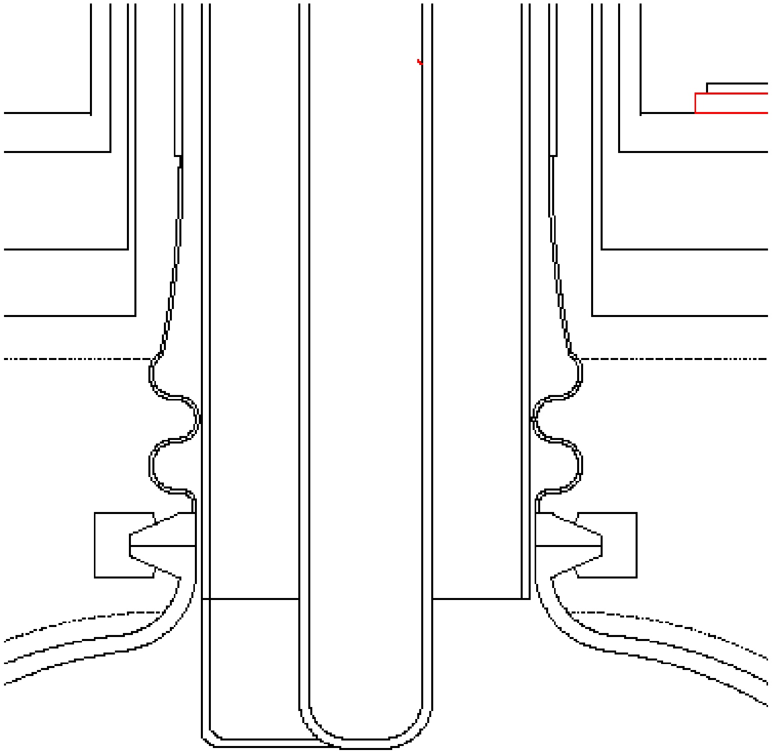
Cavity Mounting Scheme

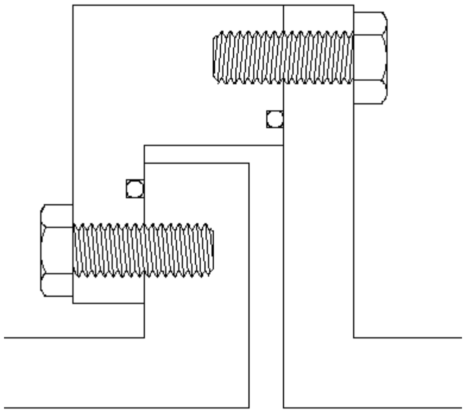
- No interconnection between adjacent cavities
- Cavities are mounted to vacuum vessel walls through tuner mechanisms
- Cavity centers do not shift during tuning
- RF coupler and vacuum cavity connections can be rigid
- Allows a much simpler approach to module assembly

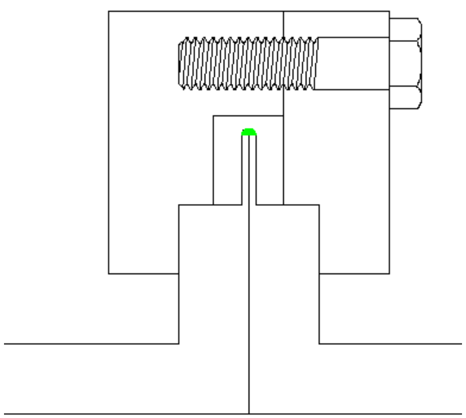
Cavity Port Connections



- All ports are on the cavity equator
- Local cavity shape is spherical to facilitate port construction
- Flange clamp applied after cavity is installed in vacuum shell
- Perfect vacuum seal not required
- Good RF contact will be achieved by using a spring ring or a lip seal

Vacuum Vessel Flange Joints





- O-ring or tin seal flange design allows removal without dragging of seal surface
- O-ring seal is less reliable than other options and adds to vessel vacuum load
- Tin seal has advantages of O-ring without gas load or limited lifetime issues
- Welded joint provides a clean, reliable seal
- Small weld bead allows easier removal
- Clamping flange provides strength
- Welded flange doesn't allow gap and limits the number of removals

Module Assembly Scheme

- Curved beryllium windows are installed on cavities
- Tuner mechanisms are applied to cavities
- Coupling coil can is welded to module vacuum vessels
- Assembled cavities are inserted into vacuum vessel from the ends, one at a time
- Tuner mechanisms are connected to vessel wall
- RF couplers are installed and flange clamps are applied
- Vacuum, cooling and electrical connections are made

LN2 Operation Issues

- Frequency shift caused by thermal contraction
- Thermal losses to vacuum vessel through cavity mounts and other connections
- Mechanical stresses at connections between cavity and vessel (tuner mounts, RF couplers, vacuum, etc.) caused by thermal contraction of cavity

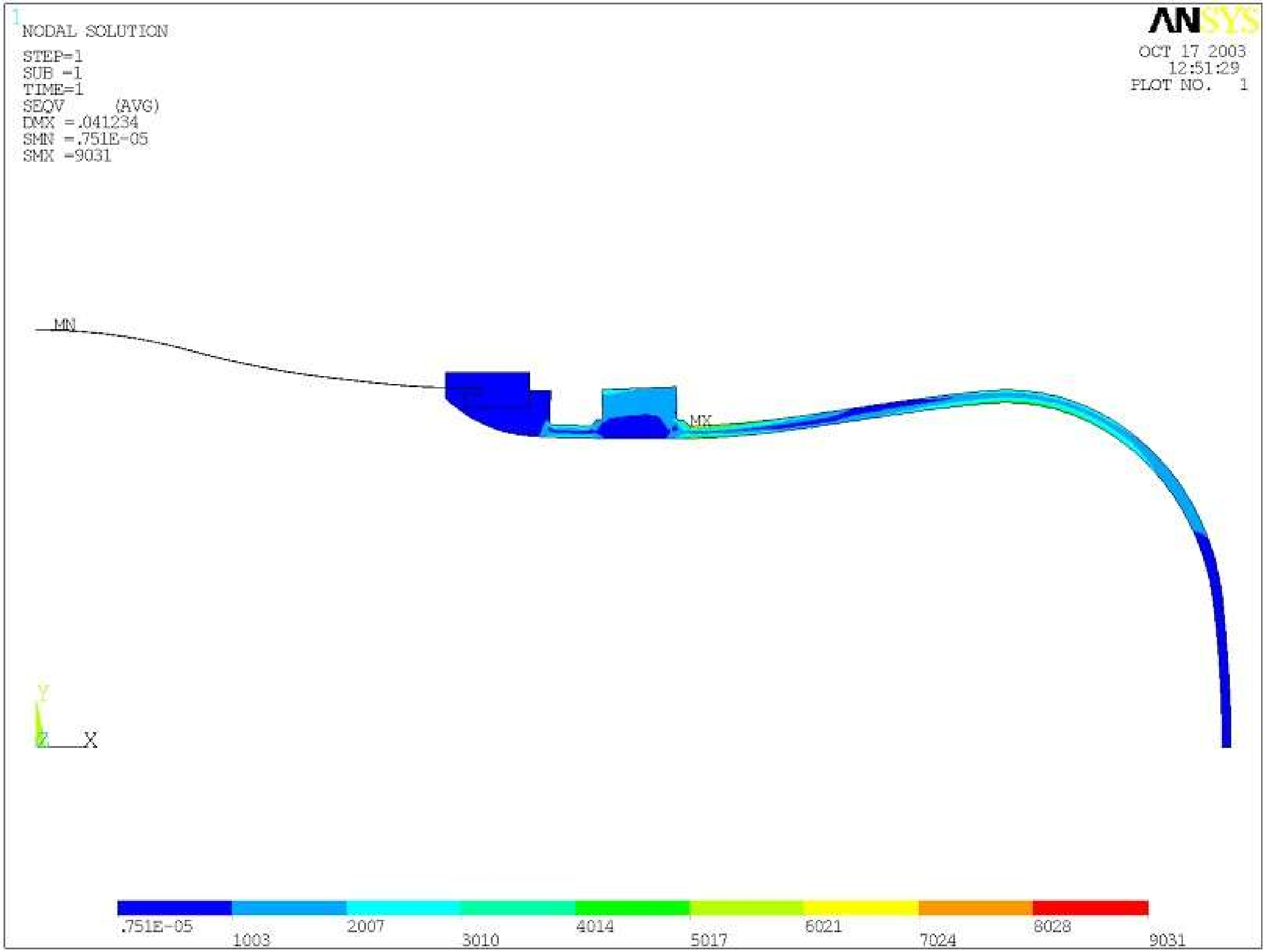
Possible Solutions:

- Apply force on tuner rings to permanently deform cavity & lower frequency
- Use low thermal conductivity isolator material for cavity-vessel connections
- Design flexibility in cavity connections to allow thermal contraction

Cavity Stiffness Analysis

- An analysis was carried out to determine the response of the cavity to tuning and vacuum loads
- A 2D axisymmetric structural model (ANSYS) was used to calculate the cavity stresses, forces and deformed shape when subjected to tuner ring displacements
- The displaced shape for each case was fed into an ANSYS RF model to determine the resonant frequency
- Comparison to results for the undeformed cavity gives the net frequency shift
- Parameters to be used for tuner mechanism design

Cavity Finite Element Analysis



Summary of Cavity Analysis

Ring Displ. (mm)	Freq. Shift (kHz)	Total Ring Load (lb)	Ring Load per Pt. (lb)	Stress @ Weld (ksi)	Next Highest Stress (ksi)
+1	+228	2,750	458	17.7	9.3
+2	+456	5,500	917	35.4	18.6
-1	-230	-2,750	-458	17.7	9.3
-2	-460	-5,500	-917	35.4	18.6

Frequency Sensitivity: 229 kHz/mm @ stiffener ring

Cavity Stiffness: 2750 lb/mm @ stiffener ring