Crab Cavity Design for the ILC*

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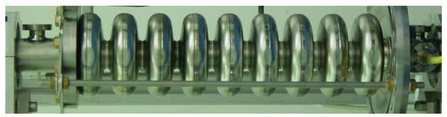
Abstract: The FNAL 9-cell 3.9GHz deflecting cavity designed for the CKM experiment was chosen as the baseline design for the ILC BDS crab cavity. Effective damping is required for the lower-order TM010 modes (LOM), the same-order TM110 π-mode (SOM) as well as the higher-order modes (HOM) to minimize the beam loading and beam centroid steering due to wakefields. Simulation results of the original CKM design using the eigensolver Omega3P showed that both the notch filters of the HOM/LOM couplers are very sensitive to the notch gap, and the damping of the SOM is insufficient for the ILC. To meet the ILC requirements, the couplers were redesigned to improve the damping and tuning sensitivity. With the new design, the damping of the LOM/SOM/HOM modes is significantly improved, the sensitivity of the notch filter for the HOM coupler is reduced by one order of magnitude and mechanically feasible, and the LOM coupler is simplified by aligning it on the same plane as the SOM coupler and by eliminating the notch filter. In this poster, we will present the coupler optimization, tolerance studies and multipacting analysis for the crab cavity.

3.9 GHz Deflecting Mode Cavity Baseline Design



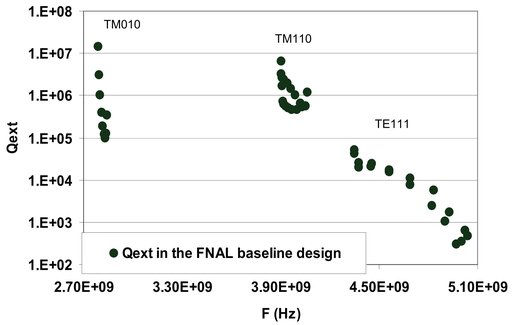
9-cell without LOM/HOM/SOM couplers

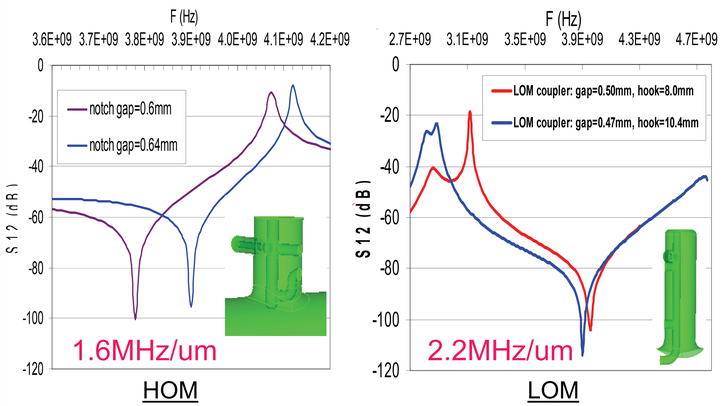
3-cell with LOM/HOM/SOM couplers

Computational analysis of the FNAL prototype using Omega3P and S3P shows

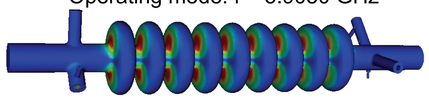
- **Inadequate damping for LOM, SOM and HOM**
- **High sensitivity of HOM and LOM notch filters**
- **Significant x-y coupling of SOM**

Omega3P damping results

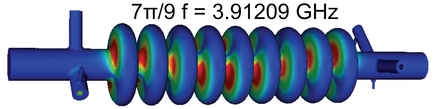




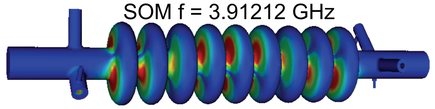
Operating mode: f = 3.9030 GHz



7π/9 f = 3.91209 GHz



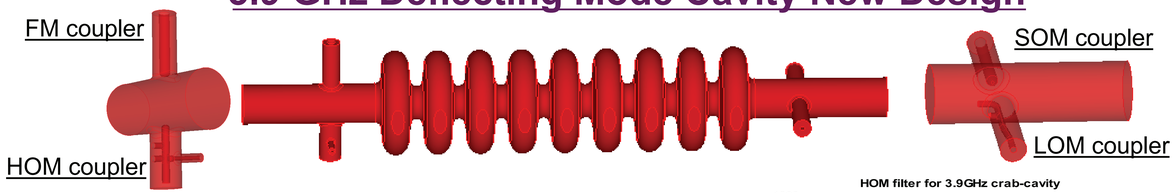
SOM f = 3.91212 GHz



Sensitive notch filter due to small gap

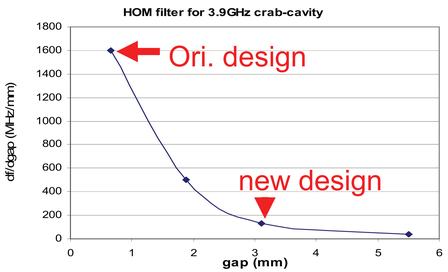
Small frequency separation between the SOM mode and nearby mode leads to x-y coupling

3.9 GHz Deflecting Mode Cavity New Design



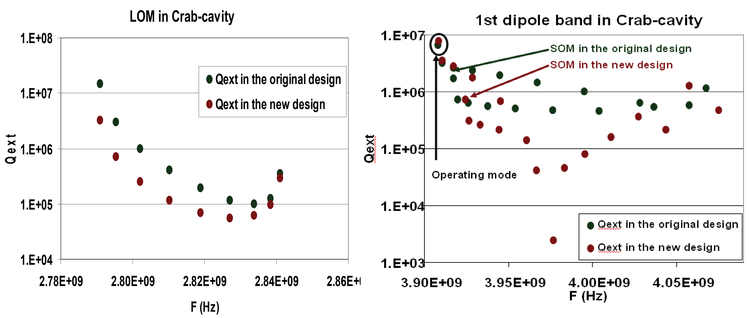
Improved FNAL design

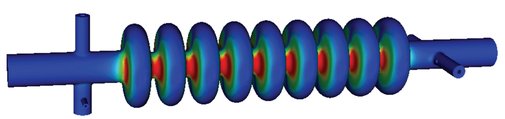
- **leads to better LOM, SOM and HOM damping**
- **reduces HOM notch filter gap sensitivity**
- **eliminates LOM notch filter**
- **avoids SOM x-y coupling**
- **exhibits no multipacting activities**



Larger notch gap reduces sensitivity by 10 times

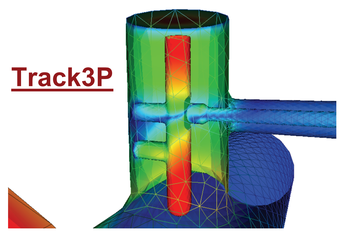
Omega3P damping calculations for the LOM, HOM and SOM

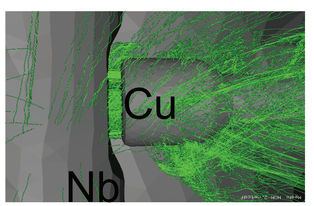




SOM polarization aligned well vertically by introducing larger cell asymmetry through increased cell horizontal indentation (from 1.5 mm to 1.9 mm)

Track3P





Resonant particle trajectories found, but electron impact energy too low for MP

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