3.9 GHz Deflecting Mode Cavity

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History of 3.9 GHz DMC

Cavity Simulations

The "Other Modes" concern and modeling

R/Q

Wake Field Simulations

Design: OM couplers

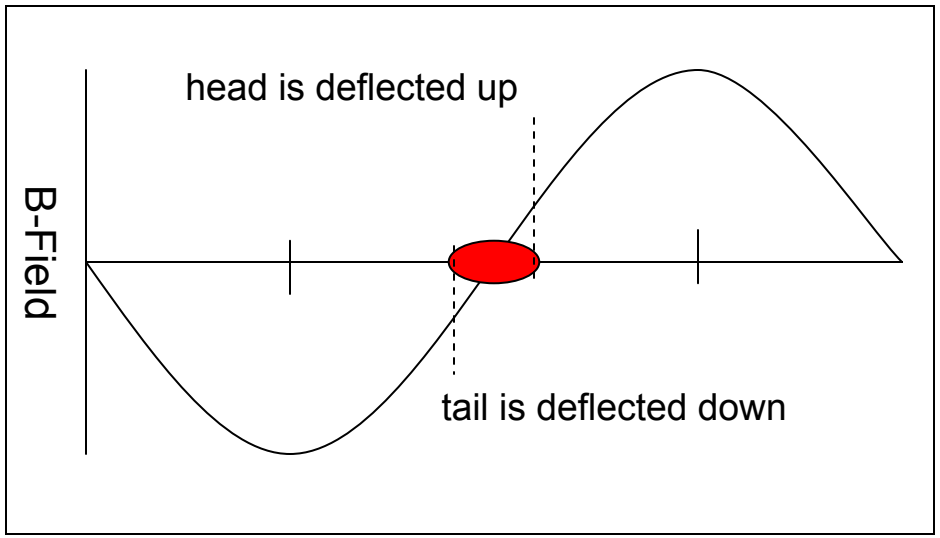
Testing: Vertical Dewar Test Results

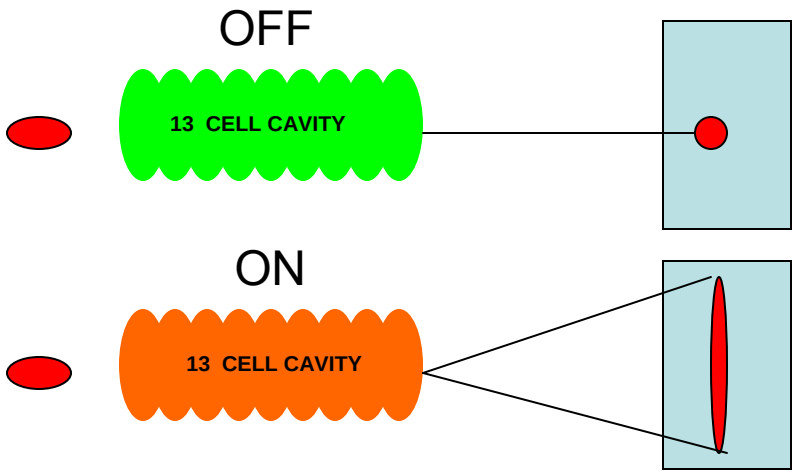
Status: ready to build !

Rutgers The State University of New Jersey

DEFLECTING MODE CAVITY HISTORY

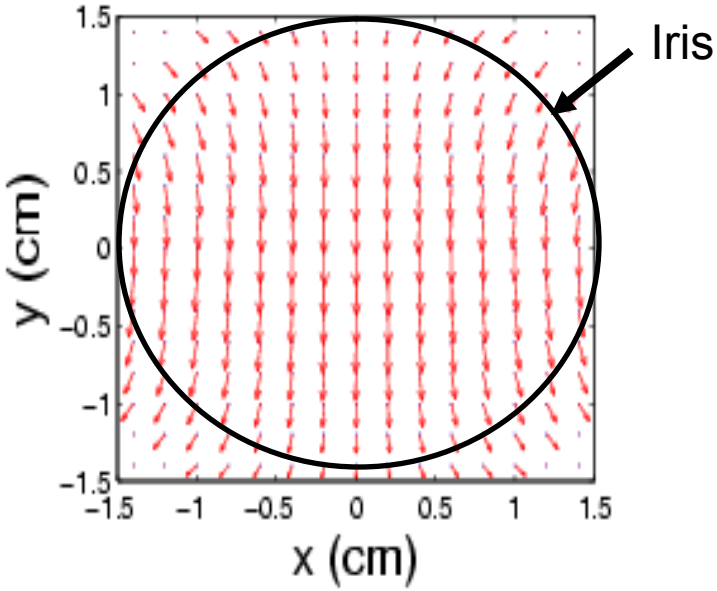
The Deflecting Mode Cavity (DMC) was initially planned for use in the CKM fixed target experiment's beam line, but now it finds it's primary use as a diagnostic tool. The operating frequency, 3.9 GHz, was chosen to be a multiple of the A0 facility's 1.3 GHz system. This will permit the use of the cavity as a beam-slicing device that can measure the longitudinal profile of a short bunch.





BEAM LINE SIMULATIONS

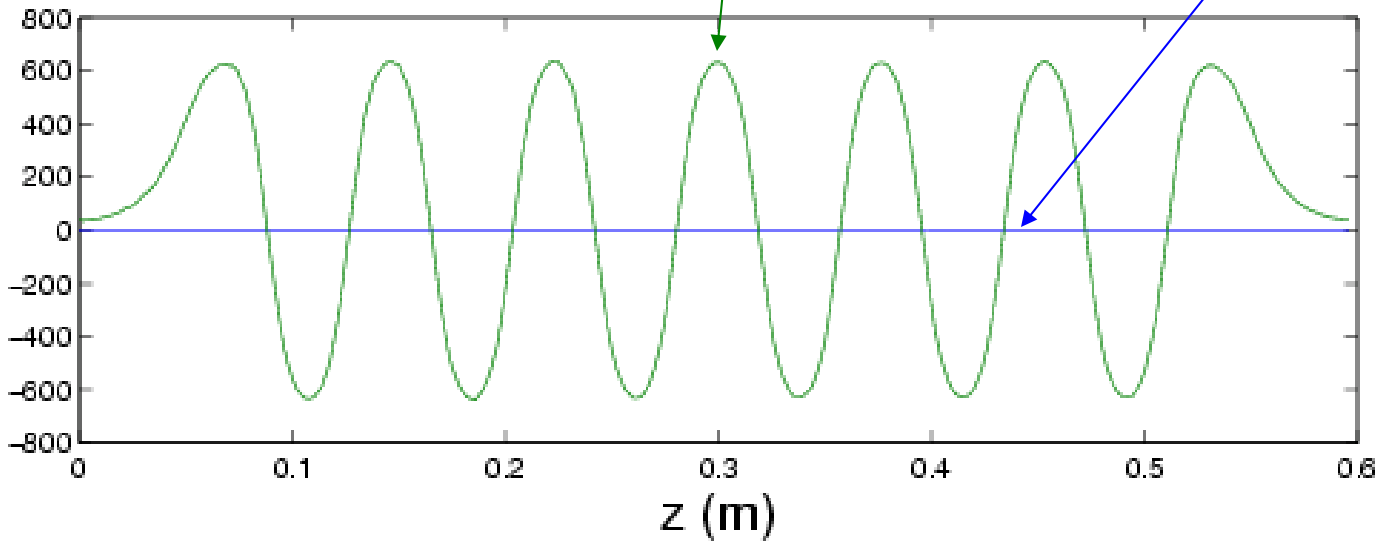
Full 3-D E-M field made for 13 cell polarized model was generated in HFSS



Uniformity map of the the integrated transverse kick along the the 13 cell cavity

The peak magnetic field along the cavity.

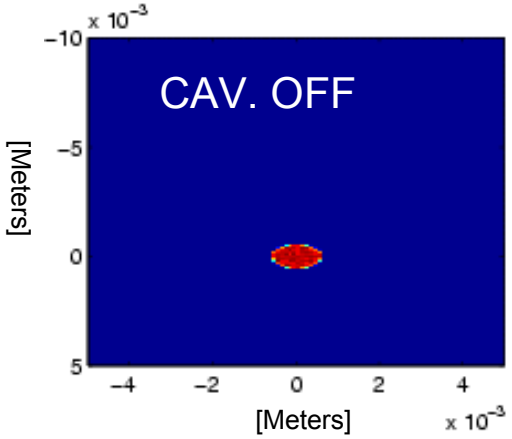
The electric field along axis is zero



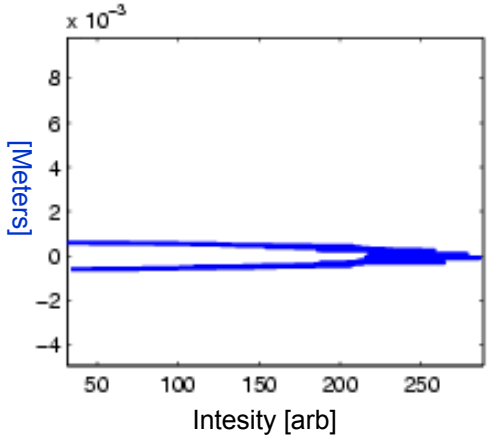
BEAM LINE SIMULATIONS

The 3-D field map was used with the ASTRA code to understand the cavity's time resolution

Viewing screen



Vertical Projection



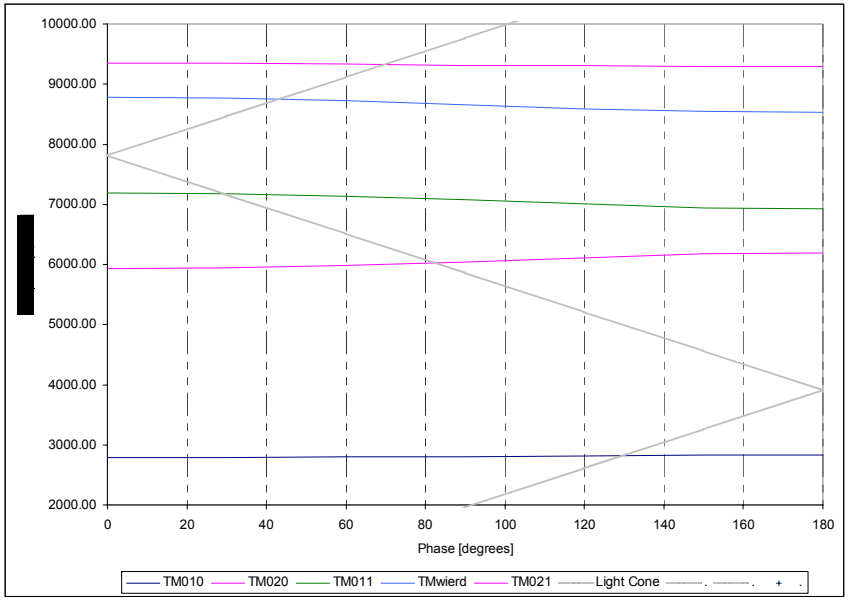
The simulation consisted of a bunch composed of two Gaussian peaks of different intensity and generation time. This enabled us to compare the time to spacial correlation preservance.

LOWER, SAME, AND HIGHER ORDER MODES

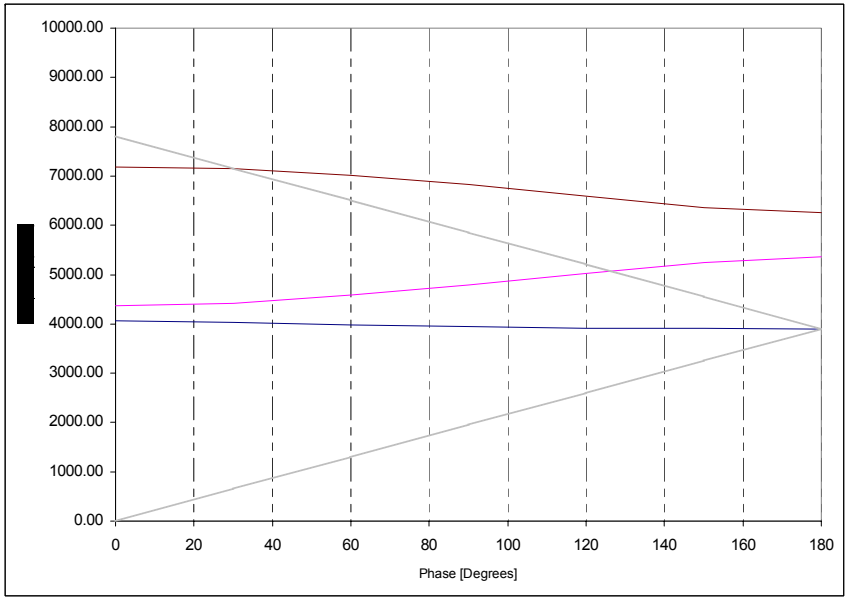
Requirement: to be maintain the DMC in “standby” in the beam line at 4.5 K.

Does the cavity have any “problematic” modes sitting near the light cone ?

Using MAFIA, dispersion curves for modes up to cut-off were checked



m = 0 modes



m = 1 modes

m = 2 modes not shown, but modeled.

DETERMINATION OF R/Q

$$R^{(m)}/Q = \frac{1}{r^{2m}}\frac{2k^{(m)}(r)}{\omega} = \frac{2}{r^{2m}\omega}\frac{\left|\int dz\ \tilde{E}_z^{(m)}(r,z)e^{-i\omega z/c}\right|^2}{4U^{(m)}}$$

We show the *R*(m)/*Q* values for all the modes found in the 13 cell MAFIA simulation, in units of Ω for $m = 0$, Ω/m^2 for $m = 1$, and Ω/m^4 for $m = 2$.

Possible Modes of Concern:

TM_{010}:

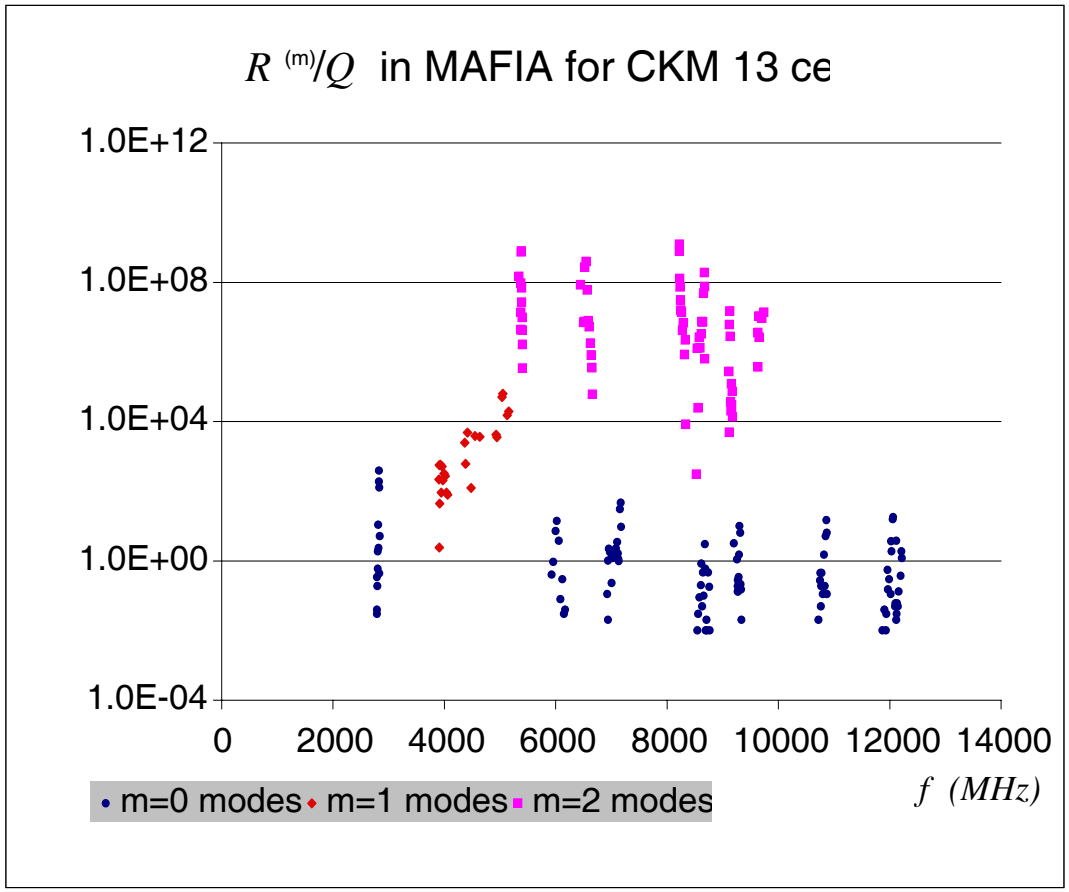
$-9\pi/13$ R/Q:187

$-10\ \pi/13$ R/Q:354

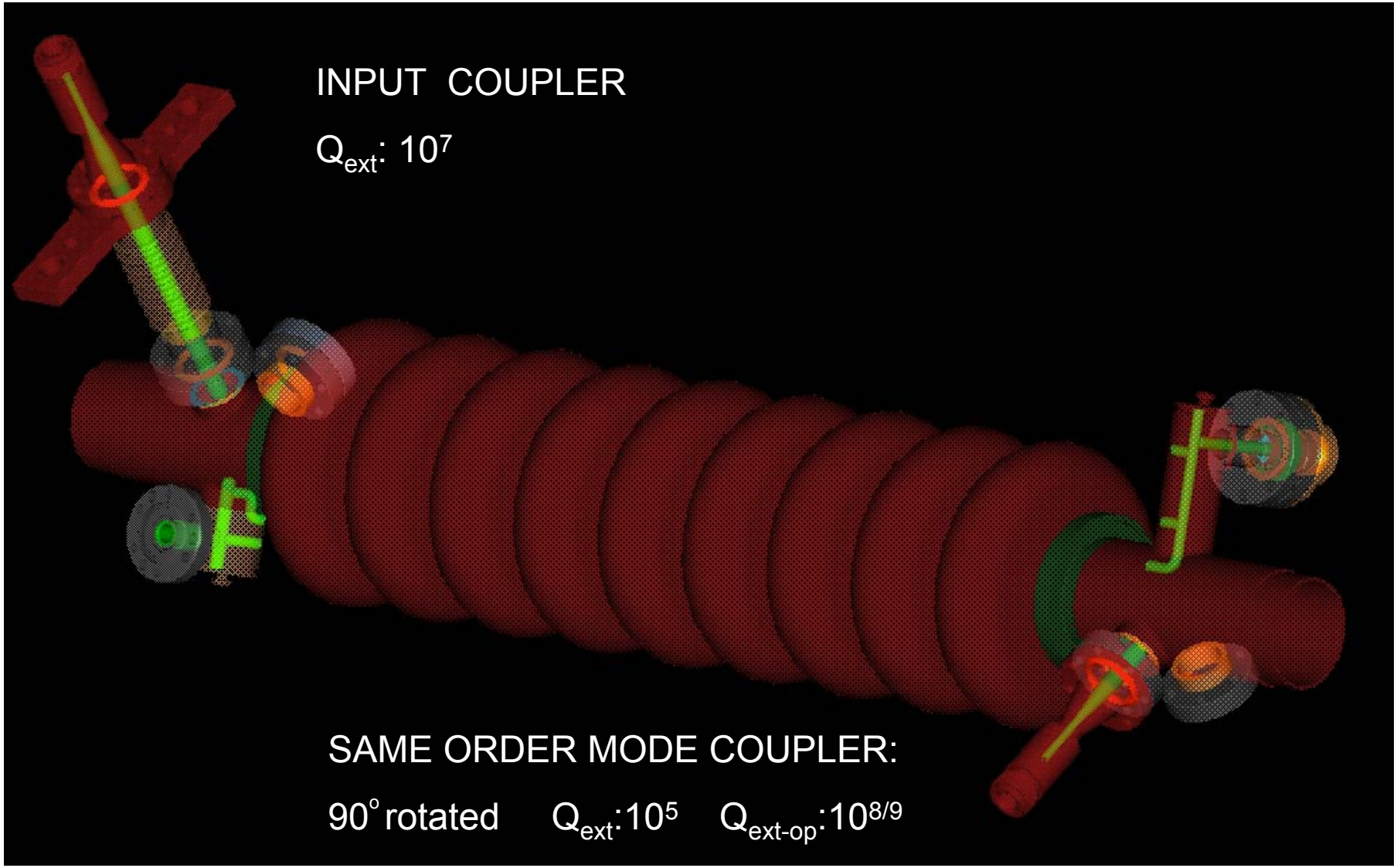
$-11\ \pi/13$ R/Q:129

TM_{110}:

$-\ \pi$ (2nd Polr.) R/Q:2.3x10^6



LOM, SOM, HOM COUPLERS

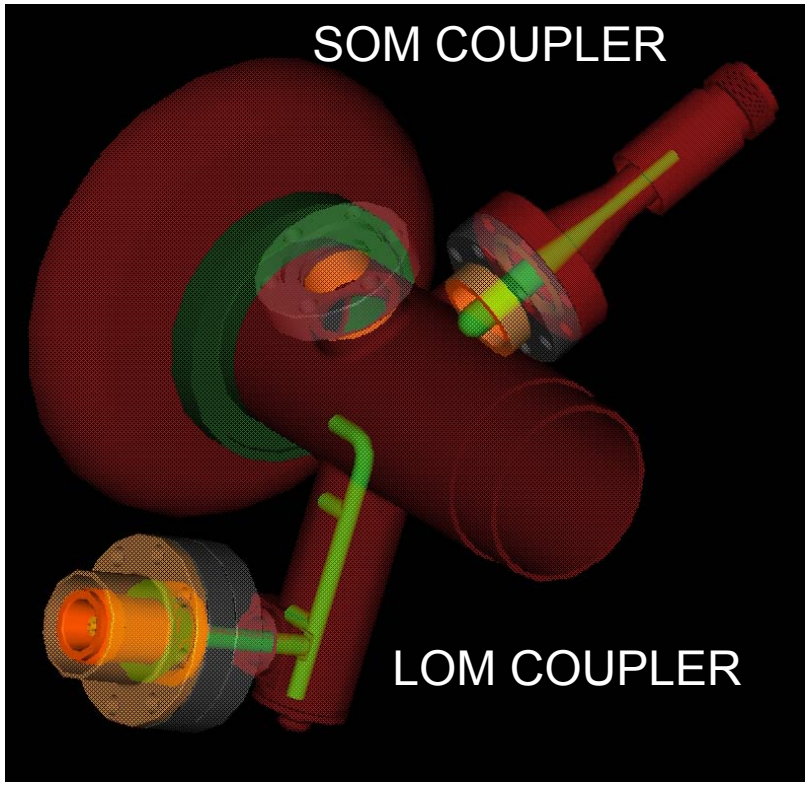


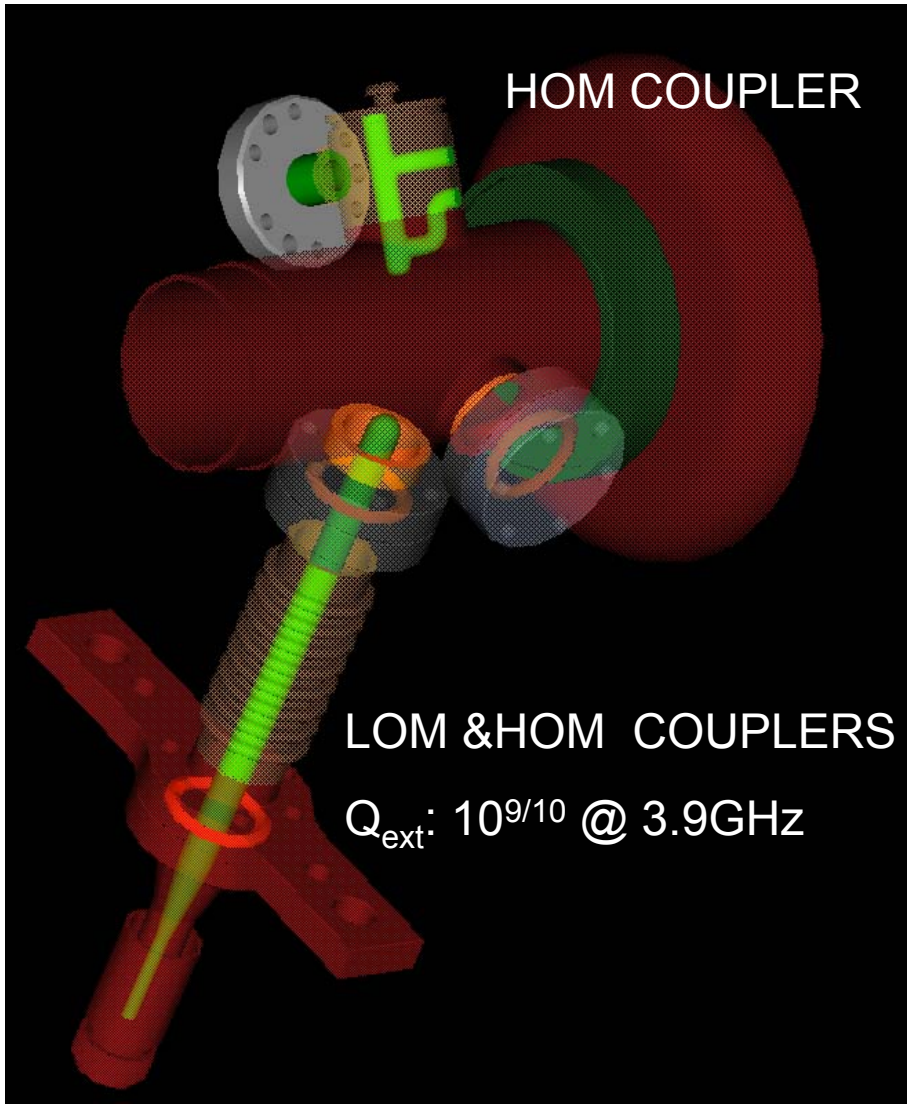
LOM, SOM, HOM COUPLERS

HOM coupler a modification of DESY design

SOM coupler will be mechanically adjusted to find the node of the TM_{110} mode

LOM at opposite end of input coupler

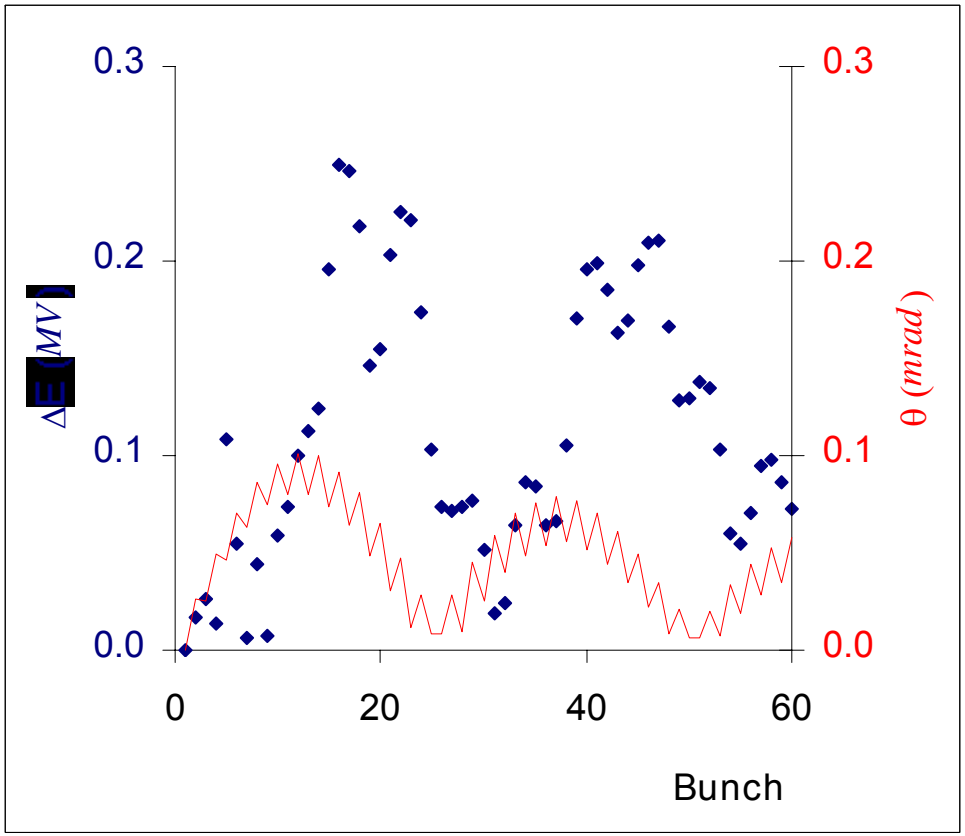


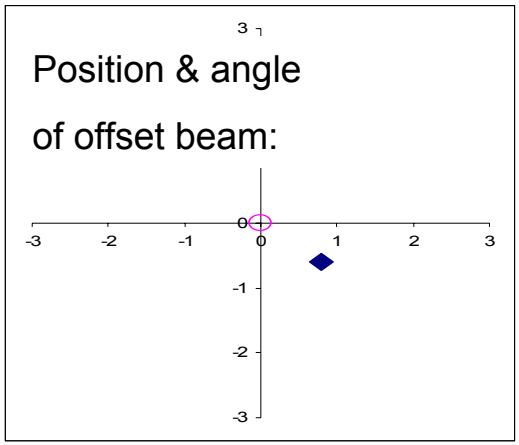


WAKE FIELD SIMULATIONS

Typical Input Parameters:

Bunch Spacing	1μSec
Bunch Charge	12nC
Bunch Length	3pSec
E_{beam}	40 MeV
Operating $V_{\perp}$	3 MV/cavity
Q_{ext}	$1x10^6$
R_{surf} at 3.9 GHz	100nΩ





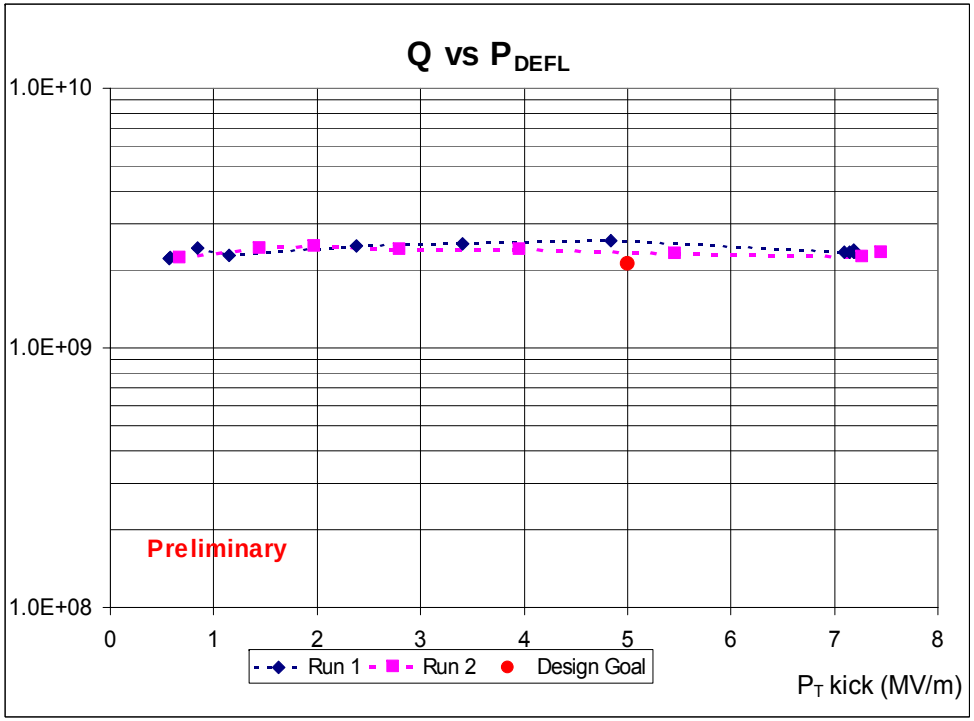
i.e. The 17th bunch, entering 0.5 mm away from the center looses ~200keV and is kicked 32 μrad

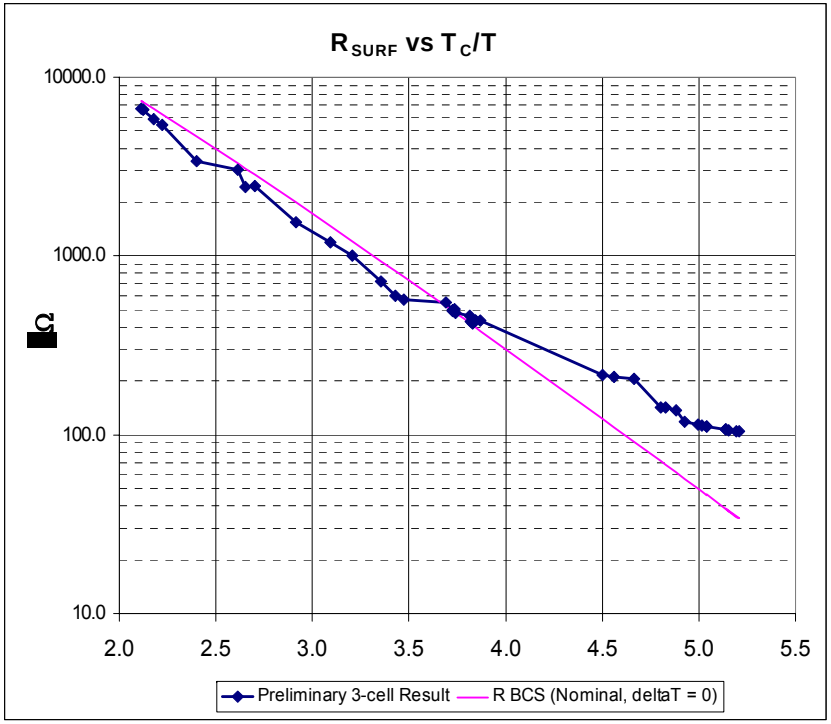
A WORK IN PROGRESS !

VERTICAL DEWAR TEST RESULTS

Cavity design parameters

13 cells
BMAX = 80 mT
EMAX = 18.6 MV/m
L EFF = 0.5 m
P⊥ = 5 M V/m





VERTICAL DEWAR TEST RESULTS

Brief Testing History:

Cavity: "*Short*"

Date	R_{res}(nΩ)	Peak Field (MV/m)
Early 2003	250	5.1
Feb, 2003	120	3.6
Feb, 2004	1300	5.4
Dec, 2004	1000	5.4
April, 2005	200	3.3
June, 2005	10,000	N/A

Cavity: "*Soft*"

Date	R_{res}(nΩ)	Peak Field (MV/m)
June, 2005	190	N/A
March, 2005	220	3.3

Cavity: "*Thick*"

Date	R_{res}(nΩ)	Peak Field (MV/m)
August, 2004	60	7.5 !

Possible cause for poor surface resistance:

-Contaminated water system(s)

-Hydrogen poisoning from long acid etch

-Cavity orientation wrt to environmental flux lines ?

-Hydrogen in welded region at about 1ppm ?

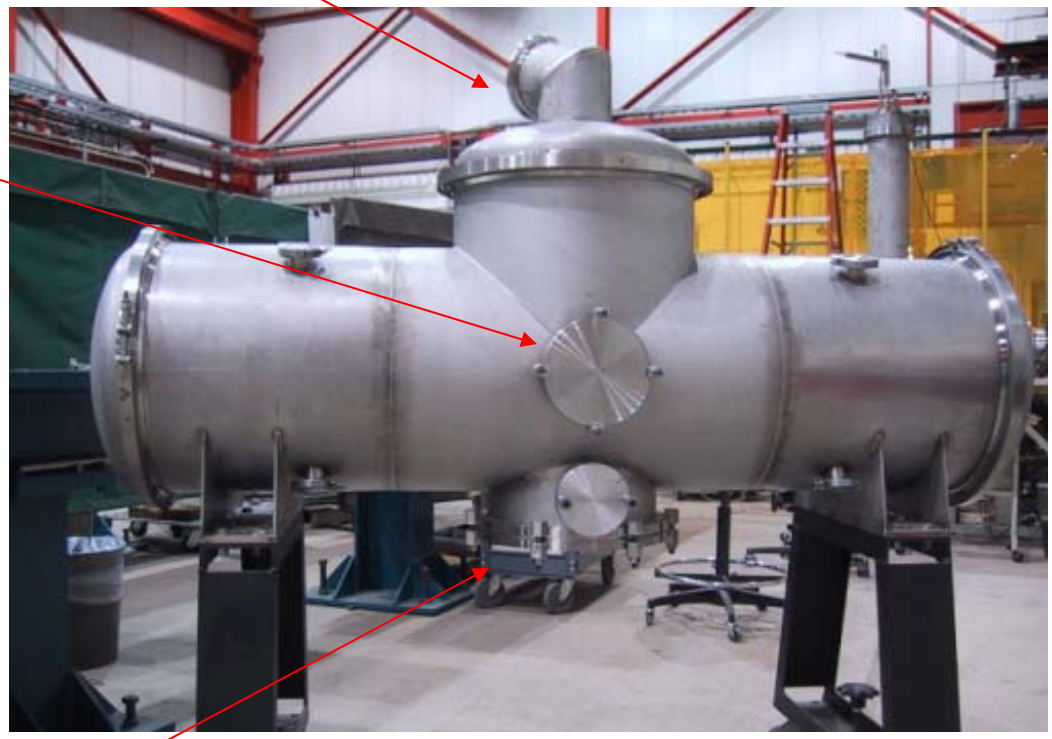
HORIZONTAL CRYOVESSEL

FNAL already has a prototype horiztonal cryovessel that will host two 3.9 GHz cavities. With minor modification, we will retrofit for use in the PhotoInjector Beam line.

Cryogenics Feed

Thermometry, LOM, SOM, HOM ports

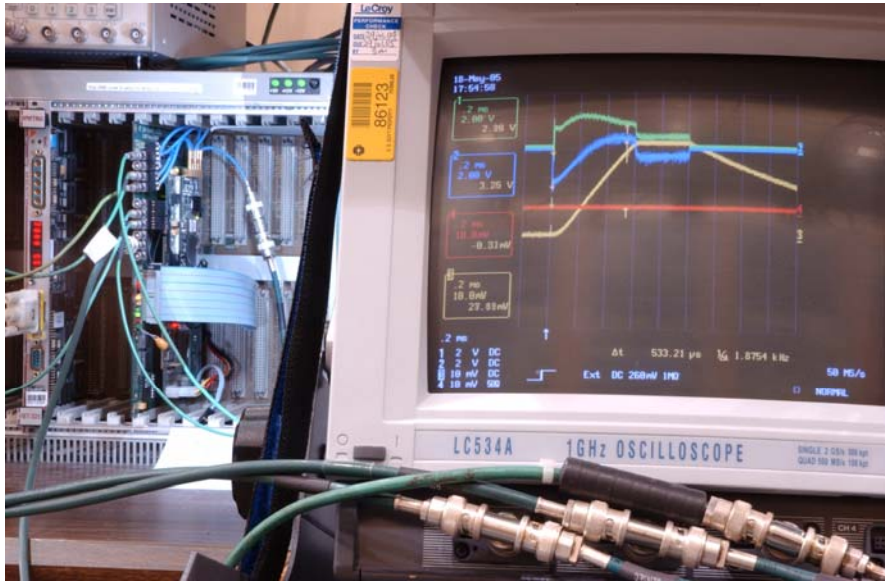
Capable of hosting two 3.9 GHz cavities.



RF input Coupler(s)

DMC HLRF & LLRF

3kW CW 3.9 GHz Klystron



Using DESY's SimCon Series for LLRF control.

Developement and testing with Superconducting cavities underway at DESY and Fermilab.

DEFLECTING MODE CAVITY STATUS:

Summer 2005:	Fine tuning L/S/HOM design
December 2005:	Cavity assemblies in construction
Summer 2006:	Finish cavity production
Fall 2006 :	Assembled cavity in cryovessel
Winter/Spring 2007:	Commission with beam

Acknowledgements

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