FNAL 3.9 GHz Deflecting Cavity

- Originally planned for K^+ beamline to feed the CP/T, CKM experiments
- From the outset, the use of a TM_{110} as a time-slicing device for studying bunch structure was anticipated
- Prototypes have been used extensively to drive/commission FNAL SRF infrastructure
- Leading candidate for use as an ILC crab cavity
- I'll describe the cavity design & the project status

Leo Bellantoni
Snowmass 05

Deflecting Cavity Design

- Primary Document: McAshan & Wanzenberg, FNAL-TM-2144

  http://lss.fnal.gov/ird/fermilab_spires.html

- Some specs are:

  TM_{110} π mode 13 cell ⇒ *B field limited*

  2.2mm thick wall

  1/2m active length, 0.1m O.D.

$$\left(R/Q\right)' = \frac{1}{2}\frac{\left|V_L(r)\right|^2}{\omega U}\left(\frac{c}{\omega r}\right)^2 = 351\Omega$$

  Δf (π *vs* 12π/13) ~ 1MHz

  Q = 2.1 x 10^9 at R_{SURF} = 110nΩ

  4.25W into LHe (CW) & minimal beam loading

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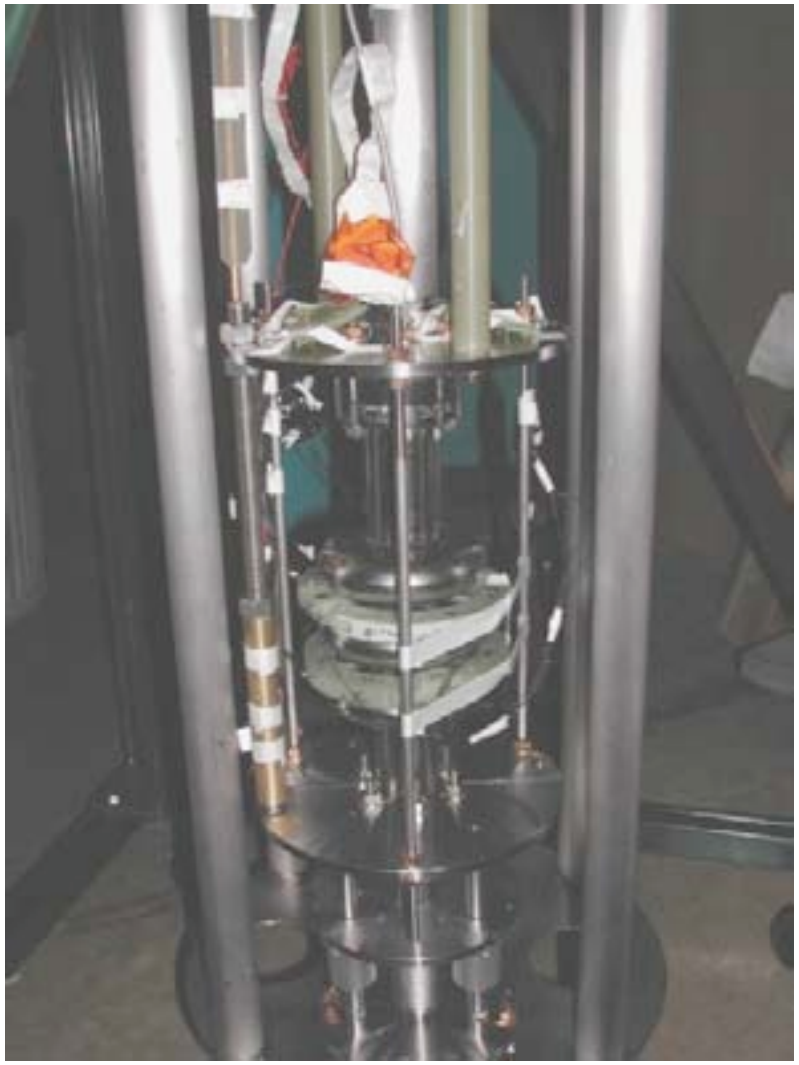
Prototype tests

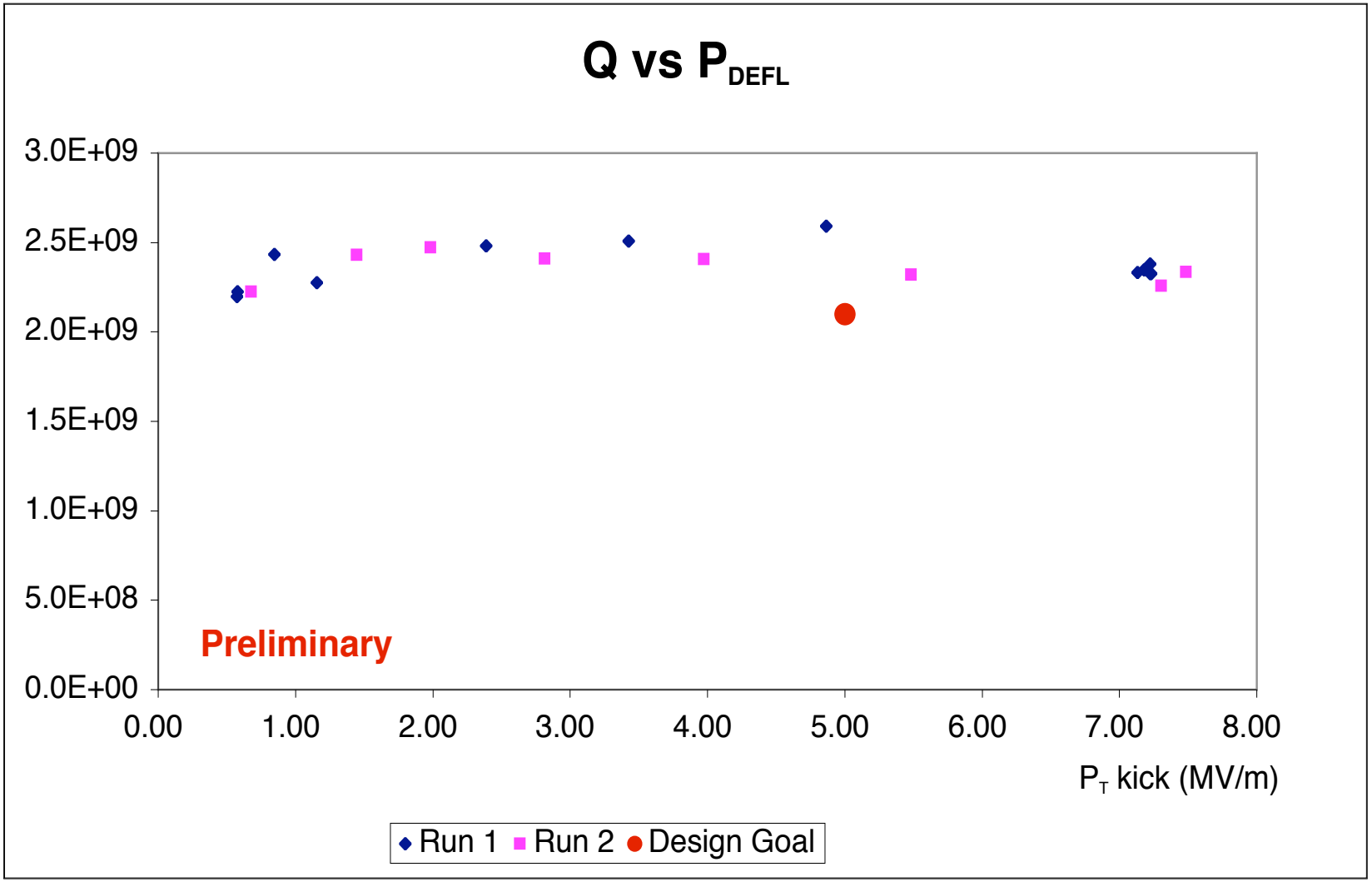


Most tests have been on 3 cell prototypes

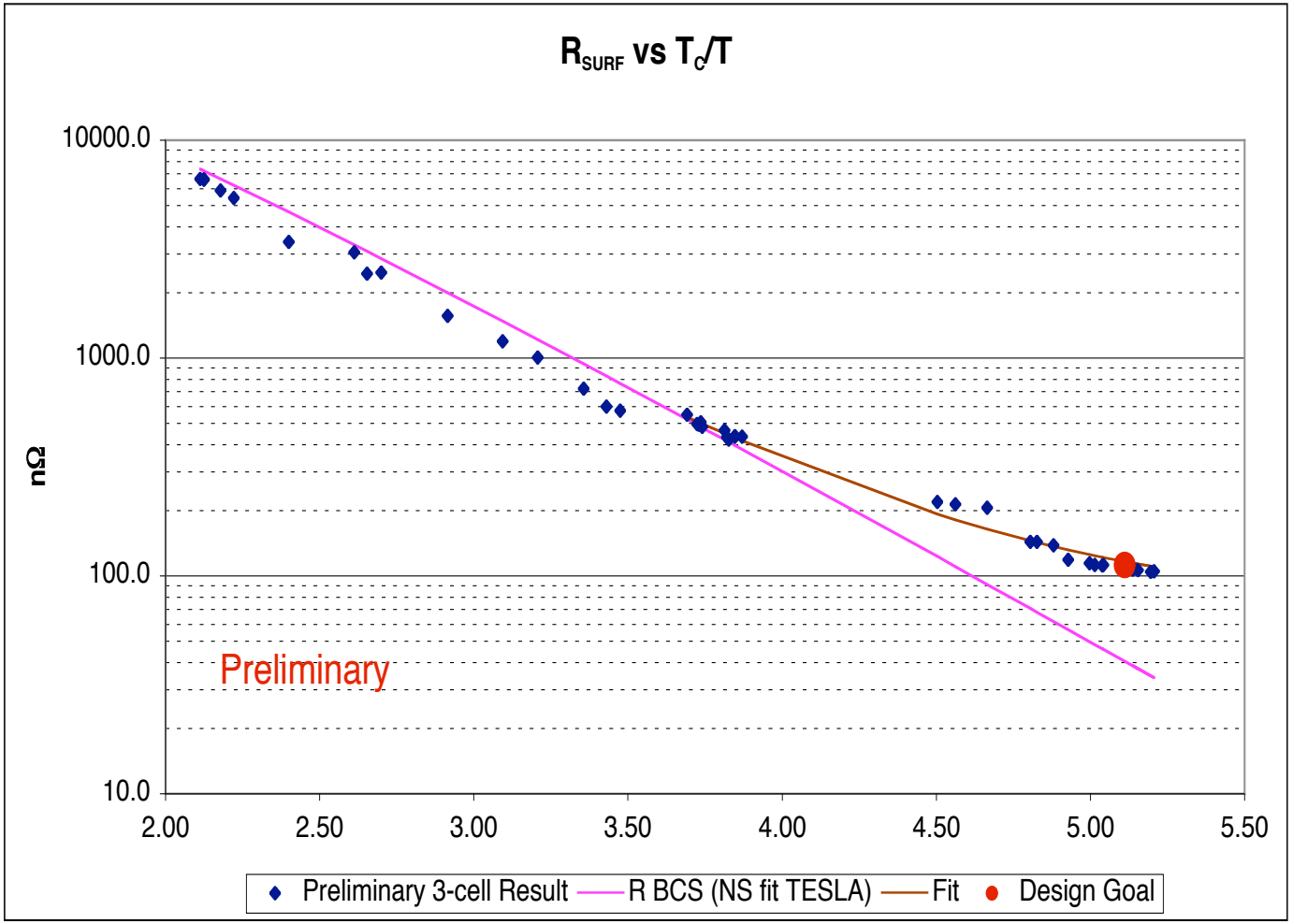
Many were oriented towards commissioning SRF infrastructure

We have nice results from a three-cell that was acid etched and rinsed with ultrapure water at high pressure for us by Peter Kneisel of JLab

Q_0 vs. $P_\perp$


Q vs P_DEFL
3.0E+09
2.5E+09
2.0E+09
1.5E+09
1.0E+09
5.0E+08
0.0E+00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
P_T kick (MV/m)
Preliminary
Run 1
Run 2
Design Goal

R_{SURF} vs. T Result

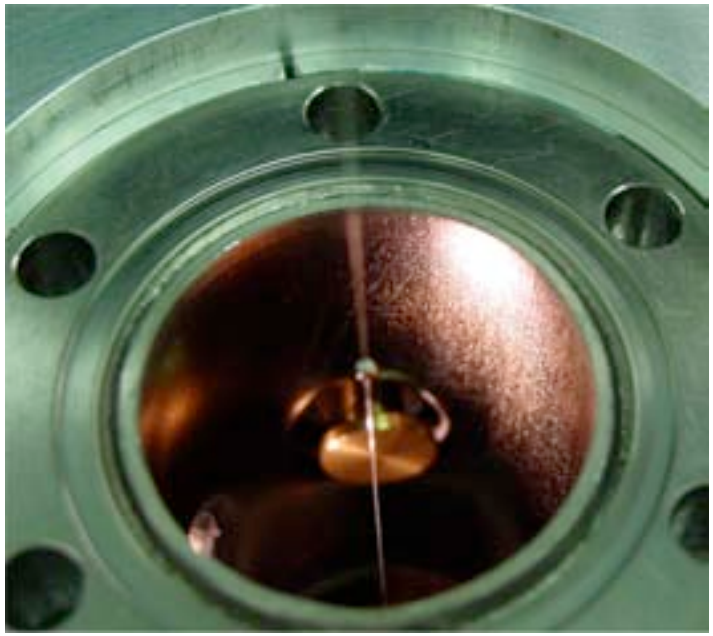


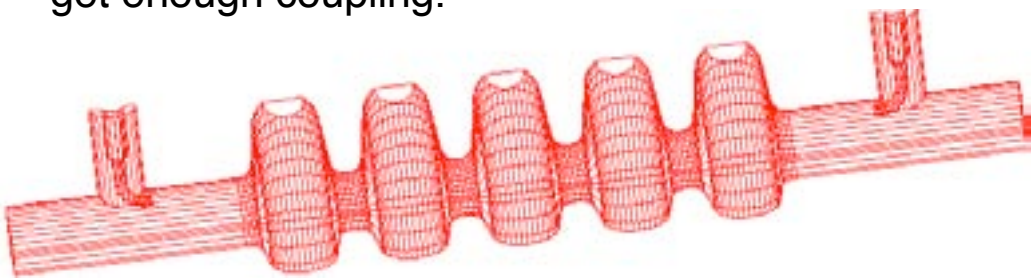
Fit to this data, below T_λ, gives
A = 1.45 x10^6
Δ = 17.8
R_0 = 75.5 nΩ

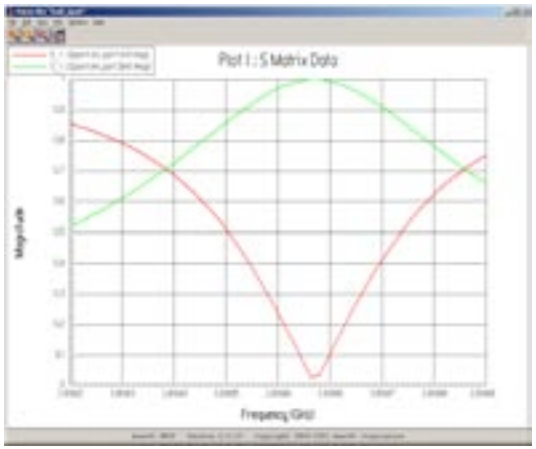
R_{SURF} not an engineering issue for immediate intended application

Other-Mode Couplers

- For HOMs, take a solution similar to what is planned for the 3.9GHz “3rd Harmonic design” *But!* Closely spaced modes means R/Q values are very sensitive to mechanical deformations.
- For LOM, a hook-type of electric probe is being planned
- For SOM, we have measured a “button type” coupler. We think we will have to change the polarization deformation of the cavity; we are still not certain that we can get enough coupling.





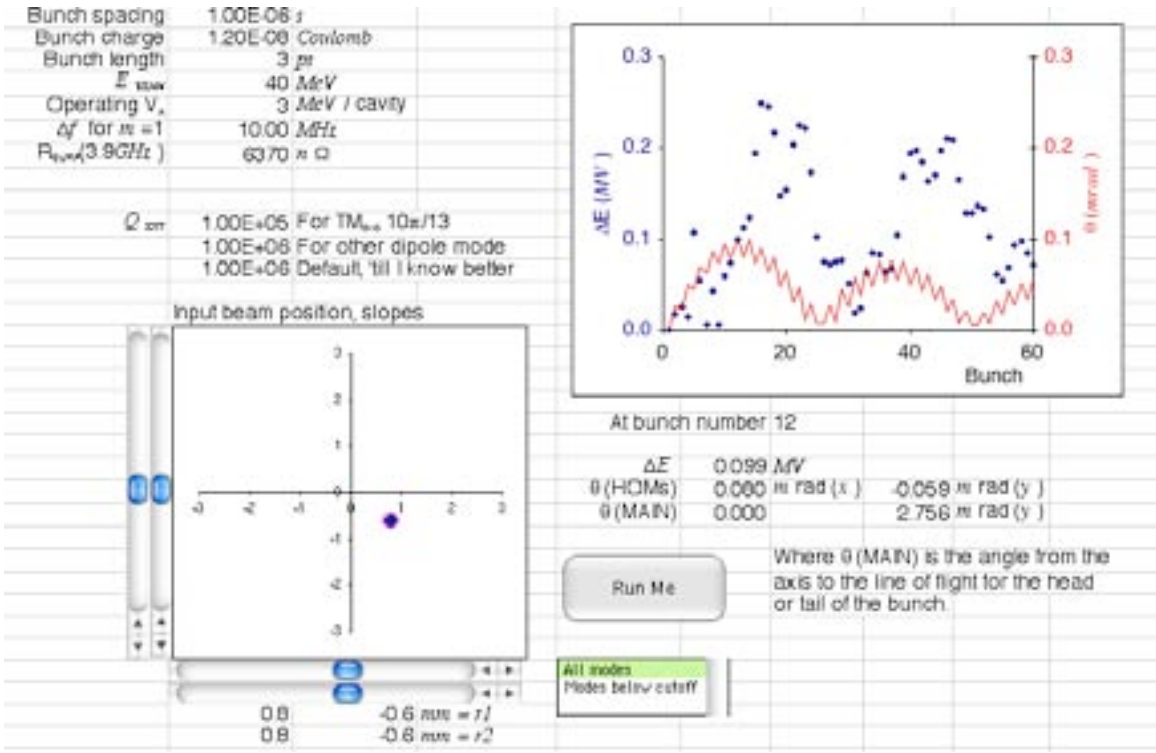


Wakefields

A calculation of induced wakefields and their effect on subsequent bunches in a beam is in progress. Modes up to 12.2, 4.8, 9.7GHz (mono, di, quadrupole) are included.

There might be considerable energy loss due to 9π/13, 10π/13 & 11π/13 monopole modes

Angular deflection is almost entirely due to off-axis beam hitting the main deflection mode



Status/Plans

- The wakefield calculation needs to be written up; and we should try a few time-domain calculations as well
- S-parameter and Q_{EXT} values for the couplers need to be computed, and then prototypes suitable for a clean environment be designed
- Manufacturing of end assemblies of 1 cavity planned for end CY 2005
- Have cryovessel, need to assemble and test the cold tuner
- Need to assemble RF power supply
- Move of FNAL A0 beamline to New Muon (SMTF facility) is planned for spring of 2006 $\Rightarrow$ install in beamline after the move