



October 22-26, 2007

Fermilab, Batavia, Illinois, USA

<http://ilc.fnal.gov/conf/alcp07/>

Joint meeting of the American Linear Collider Physics Group and ILC Global Design Effort

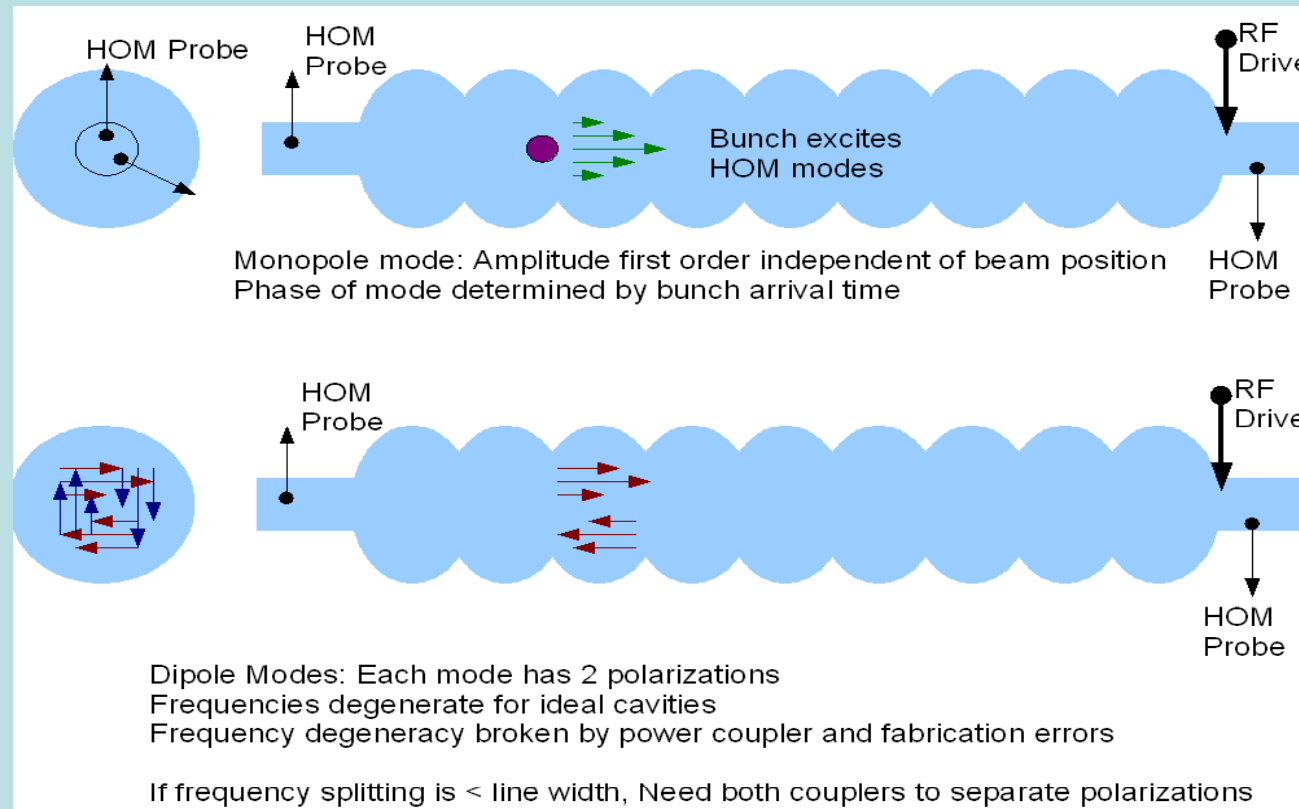
High Order Mode Instrumentation

*Fermilab, SLAC, DESY,
Saclay, KEK, Cockcroft*

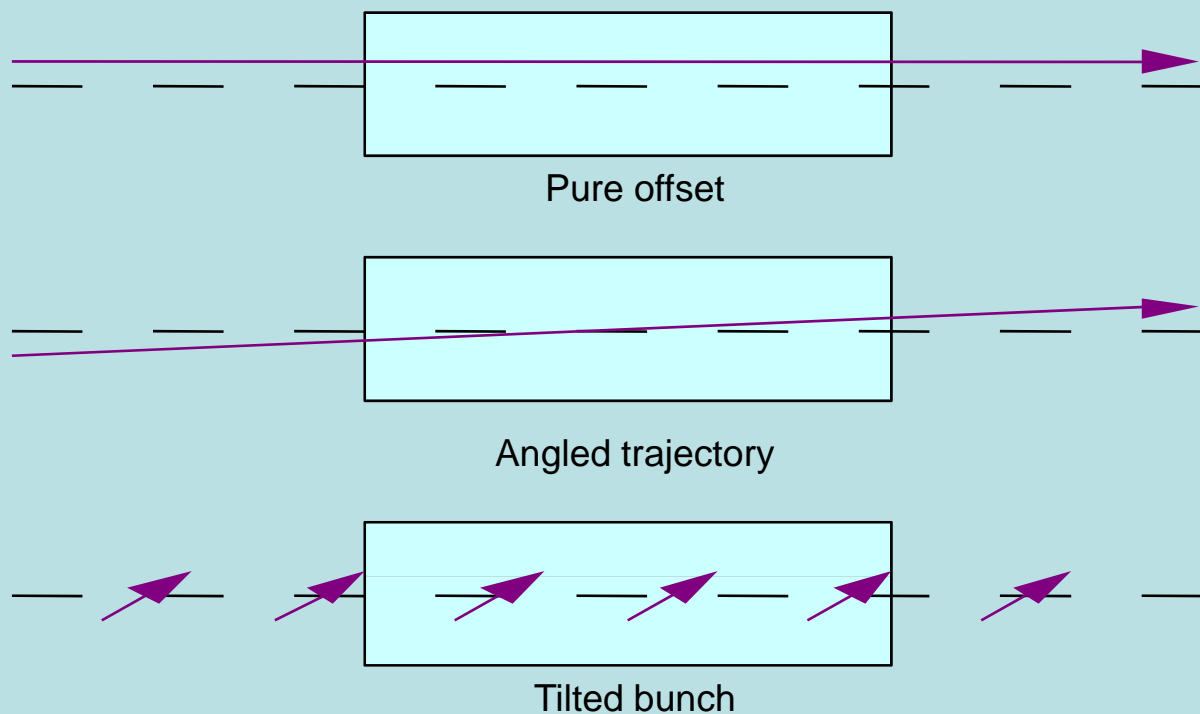
10/29/2007

Nathan Eddy, Fermilab

HOMs generated by Beam

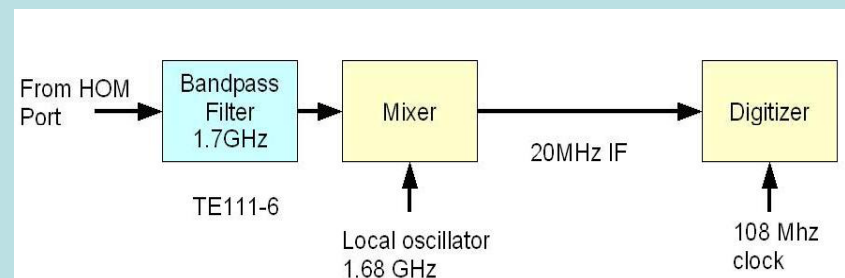


Dipole Mode Response



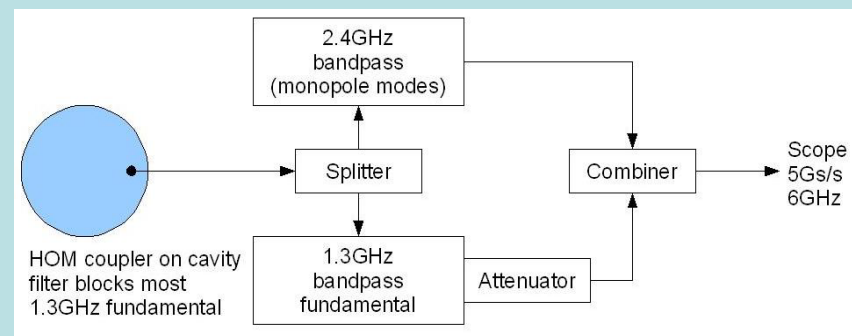
- **Narrowband (Downmix) system**

- Specific to TE111-6 Dipole mode (1.7GHz)
- All cavities, both couplers monitored simultaneously
- High dynamic range (14 bit), good linearity
- High resolution HOM-based BPMs
- Use for cavity alignment

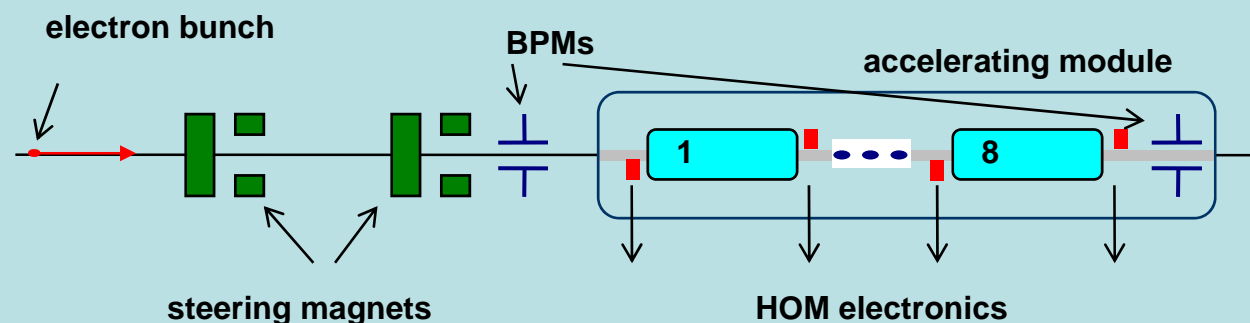


- **Broadband (scope-based) system**

- Monitor HOM modes up to 5GHz
- Several simultaneous channels (4 or 8)
- Limited dynamic range (8 bit scope)
- Use for Phase measurement
- Use for cavity diagnostics

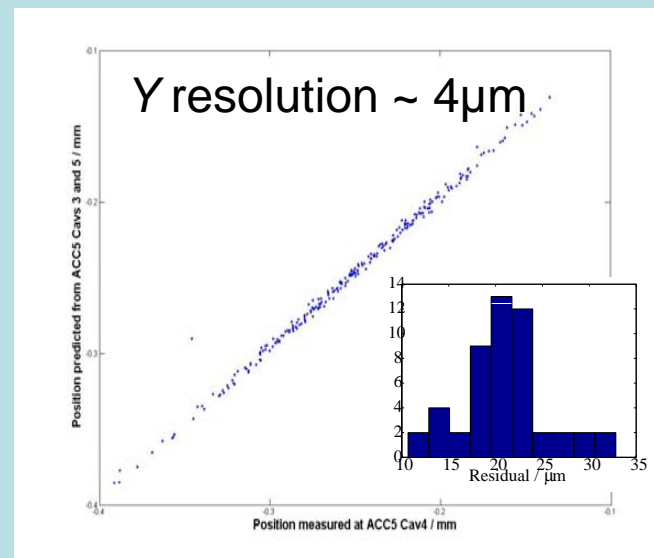
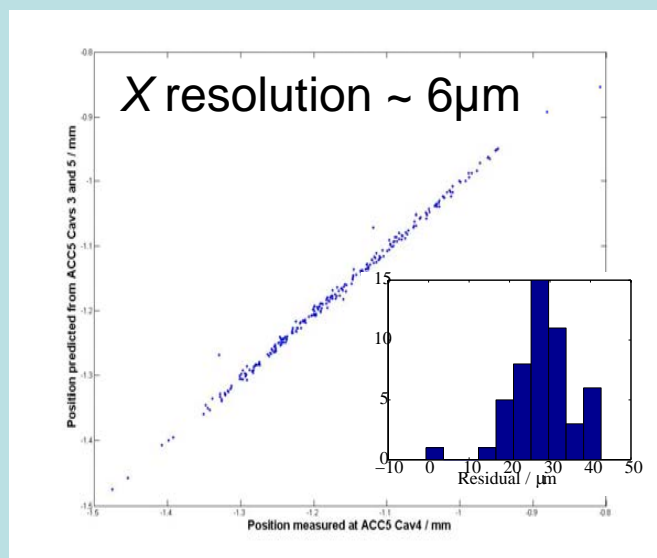


Calibration Procedure



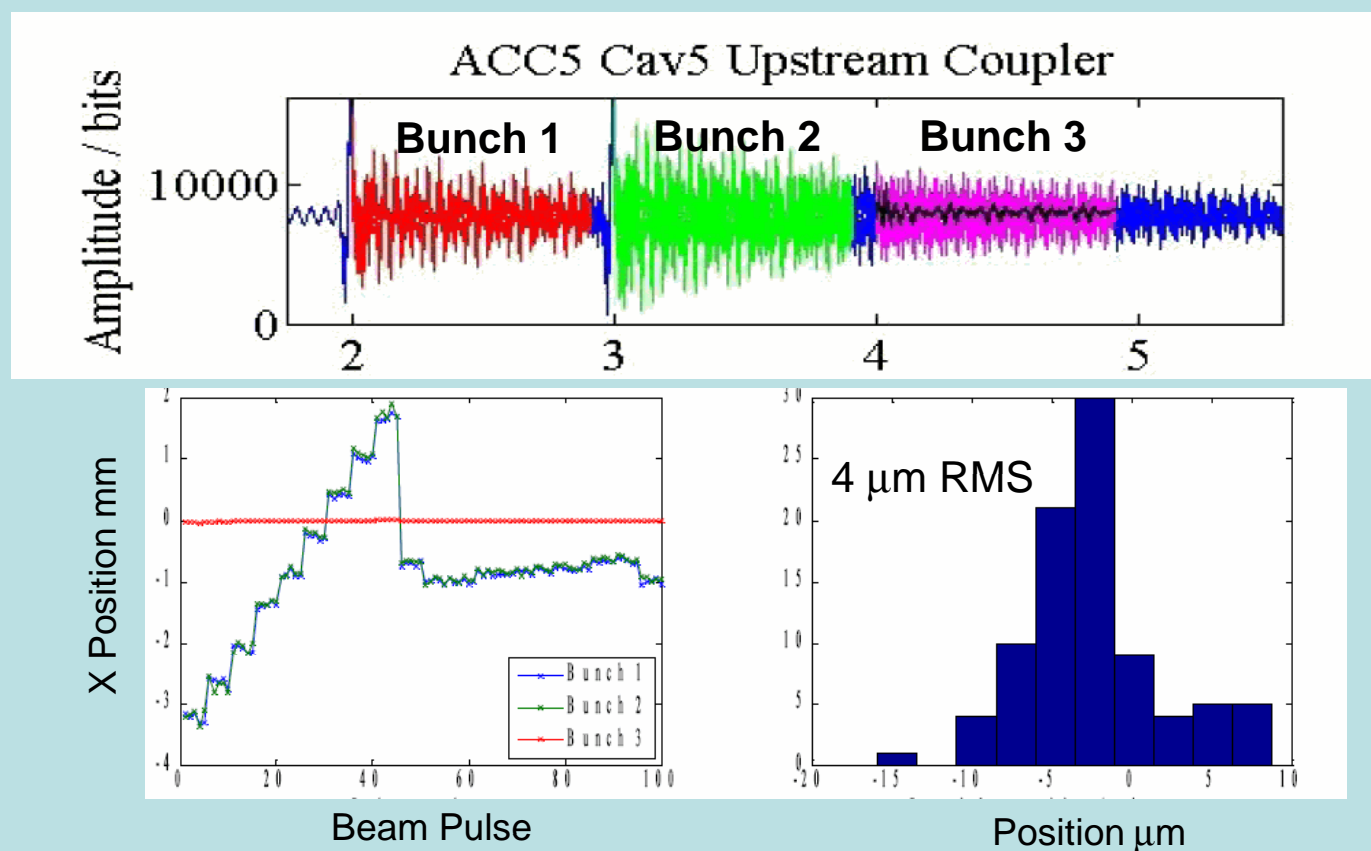
- Calibrate each module by steering the beam and recording the raw HOM signal
- Best calibration when beam is moved through electrical center of the mode
- Still studying how often calibration needs to be performed

Single Bunch Results

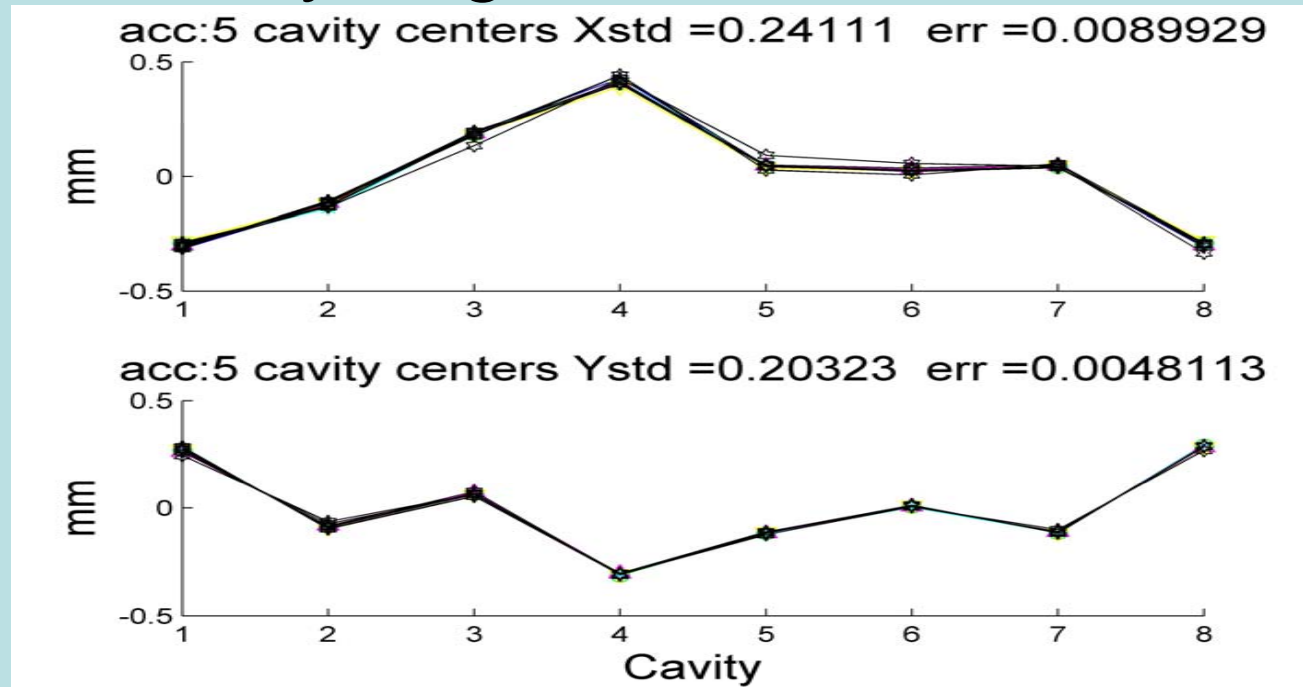


- Measured vs Predicted Position as beam is moved during scan
 - Predict position at cavity 4 from cavities 3 and 5
- Theoretical resolution of several hundred nm
 - Jitter on the LO for the downmix electronics and charge normalization

Multi-Bunch Initial Results



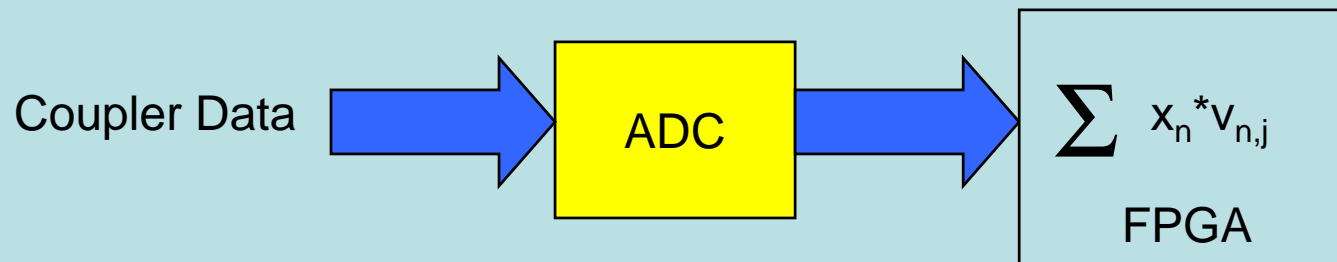
Cavity Alignment from HOMs



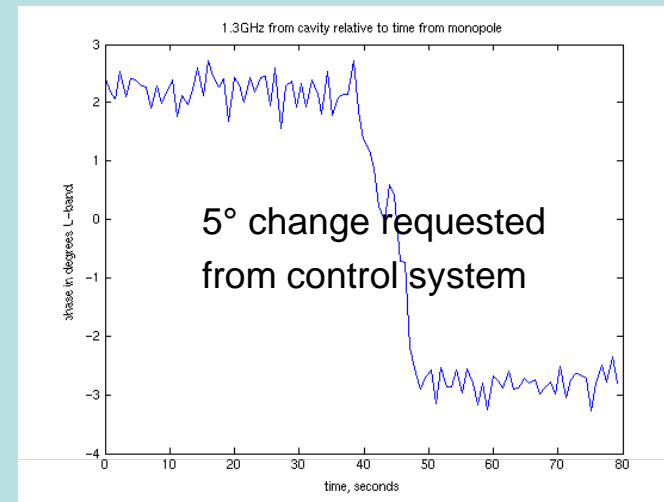
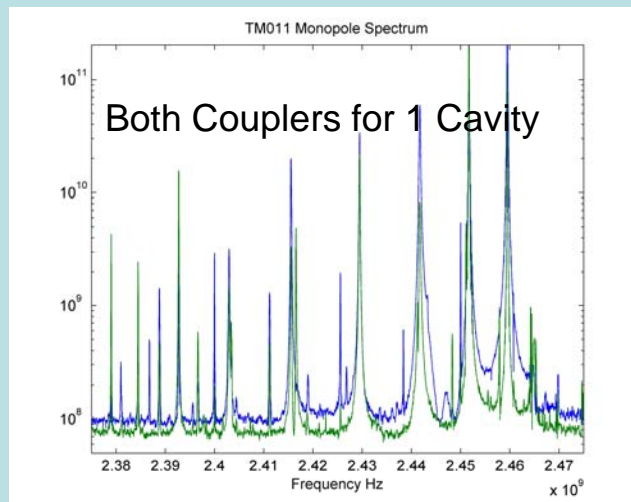
- Measure the axis of a dipole mode for many cavities within a structure.
 - Gives in situ alignment data on the internals of the accelerating module.

HOM Custom Digitizer

- Current online system has an I/O bottleneck in the VME front-end
 - Starts to miss beam pulses when more than a few cavities are enabled
 - Only gets worse for multi-bunch operation
- Can greatly increase the bandwidth of the system by calculating the mode amplitudes on the digitizer
 - Load mode vectors into FPGA and process in parallel
 - I/O still limiting factor but gain 4-5 orders of magnitude in BW
- Proto-type successfully tested at DESY

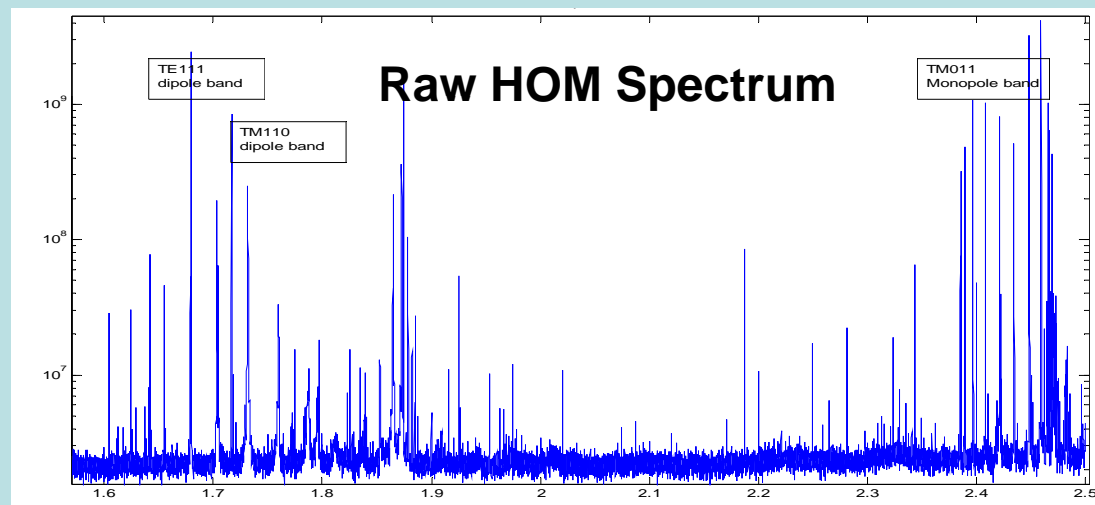


Beam Phase Measurement



- Able to directly measure the beam phase with respect to RF by determining beam time of arrival from monopole
 - The 1.3GHz drive signal leaks through the HOM coupler
 - Have monopole and RF signal on the same cable
- Initial results look very promising
 - Currently see about 0.1 degrees of RMS at L Band
 - Can perform bunch by bunch phase measurement

HOMs as a Cavity Diagnostic



- Many modes in the spectrum.
 - Monopole, dipole, quadrupole, etc.
 - Frequency, Q, R/Q, etc. dependent on cavity construction.
- HOM spectrum directly influenced by the internal cavity shape.
 - Effect of couplers can offset the modes from the cavity centre.