Plans and Timetable of LLRF at NML

B. Chase

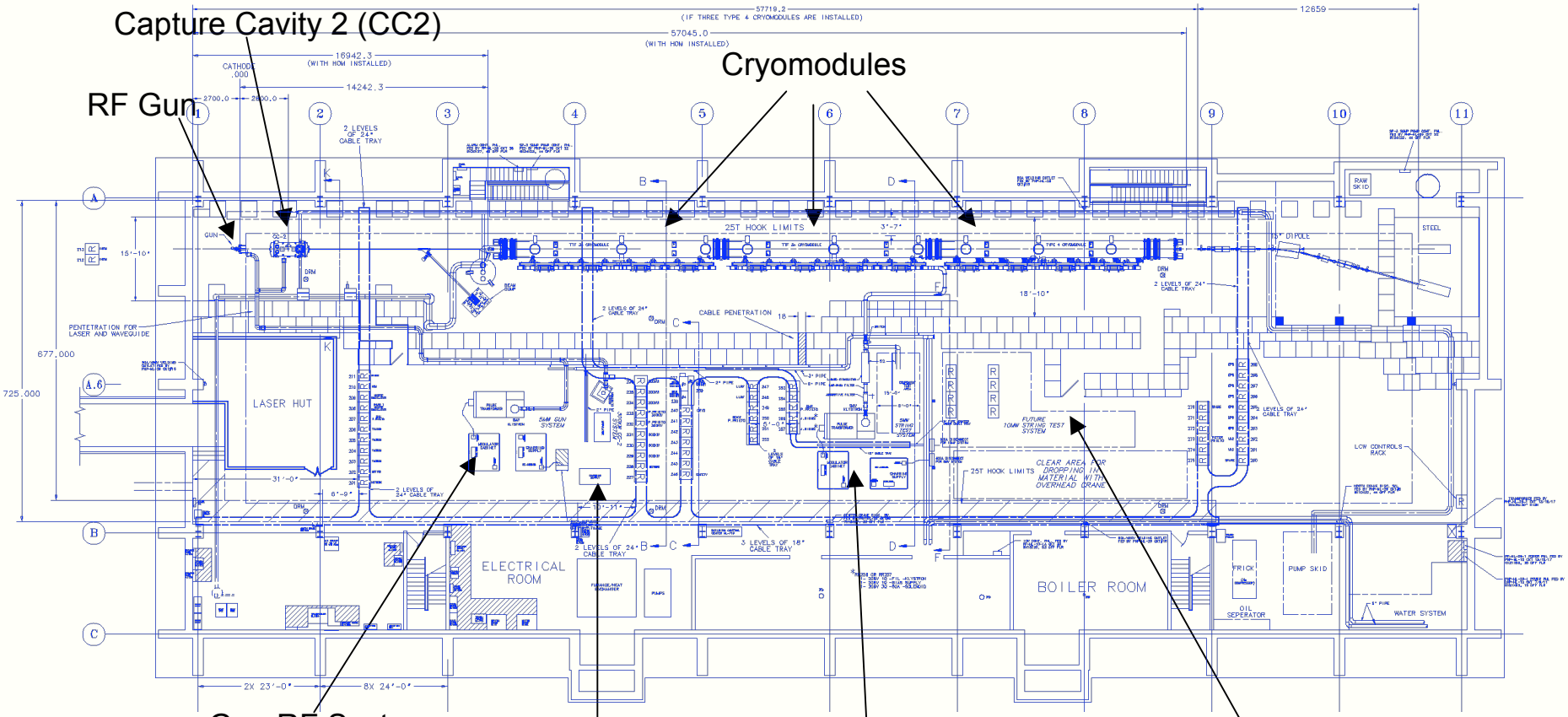
April 24, 2008

Revised NML Technical Plan

J. Leibfritz

- Budget Reduction
  - FY08 Funding Cuts, Manpower Reduction, Uncertain Funding Profile
  - Changed Overall Scope/Plans
- New Goals/Scope
  - Meet RF Test Requirements for one RF Unit for ILC & Project-X
  - Fit Everything Within Existing Building
    - Cryomodules shifted upstream approximately 8 meters
    - Space for Injector and Test Beamline reduced
  - Capability to Expand to our Original ILCTA Plan is Maintained
- Large Overall Cost Reduction
  - Elimination of Building Extension (~$5M)
  - Elimination of Cryoplant (~$13M)
  - Initial Injector design does not include Laser Hut, Laser System, CC1, 3.9 GHz Cavities and associated RF systems and Cryogenic connections.
  - Simpler Injector Design (Does not require moving Photoinjector)

New Overall Layout of NML



Current Picture of NML Facility

Redefined Short Term Goals

- **Budget cuts**
  - Less money and manpower
  - Many unknowns
  - Change in directions
  - Change in Control system >ACNET
- **Focus**
  - Basic LLRF support for cryomodule testing is highest priority
  - Resonance control - LFD
  - Reference line
  - Electronics self calibration
  - QI and Pk setup
  - Station to station error pass forward
  - System integration
  - Cost reduction
- **Beam tests when available**
  - Beam loading compensation
  - Beam based calibration

LLRF Plans for 08

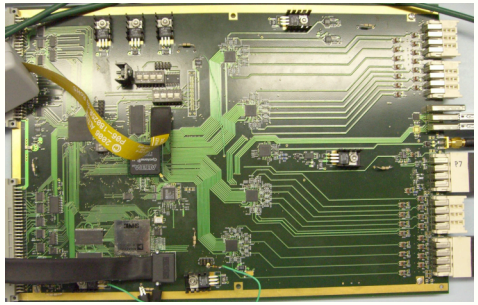
- Install Master Oscillator and Reference line (6/08)
  - Test stability of line
  - Interface MO diagnostics into the control system
- Delivery of Waveguide from SLAC (6/08)
  - Measurement of waveguide couplers
- 1st Cryomodule Delivery to NML (7/08)
  - Install cable plant and measure all cables
- Install LLRF systems and cable plant for CM1 (8/08)
  - Test calibration schemes for cables and electronics
- Begin 1st Cryomodule RF Tests (Warm) (9/08)
  - Support warm testing
- CM1 Ready for Cooldown (12/08)
- Begin Cold RF testing (2/09)
  - Piezo control testing
  - QI and Pk calibration

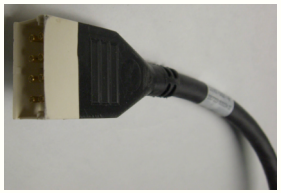
LLRF Hardware

- 1st Cryomodule
  - Master Oscillator and Distribution
  - (3) MFC cards
  - (4) Downconverters
  - (1) VXI crate
  - (1) 5500 CPU
  - (1) PMC-UCD
  - Timing system interface
- CC2 & RF Gun - shares the crate
  - (2) MFC or ESECON cards
  - (2) Downconverters
  - (1) VXI or VME crate
  - (1) 5500 CPU
  - (1) PMC-UCD
  - Timing system interface

8 Ch Receiver and MFC

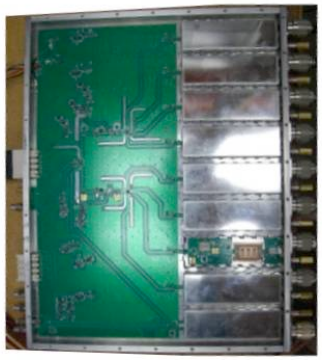
Multi-Channel Field Control Module

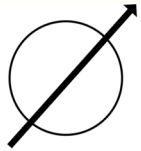




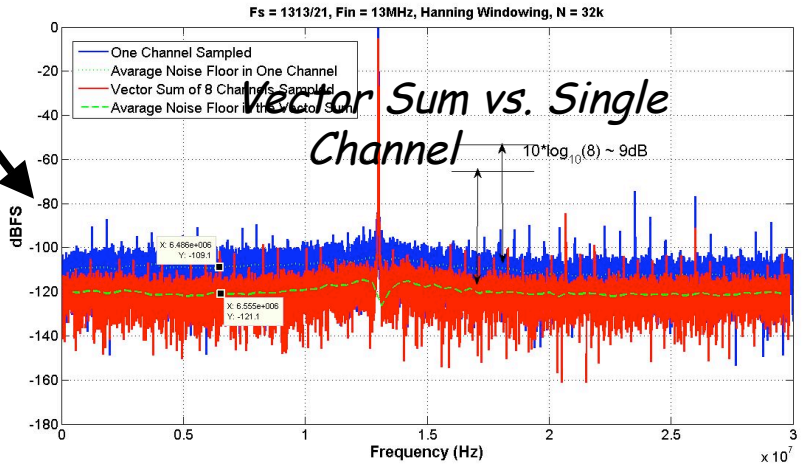
Harting IF Mini-coax Connector

8 Channel Rc





Phase Adjustment



Vector Sum vs. Single Channel

Measured SNR for one channel (12bit ADC):

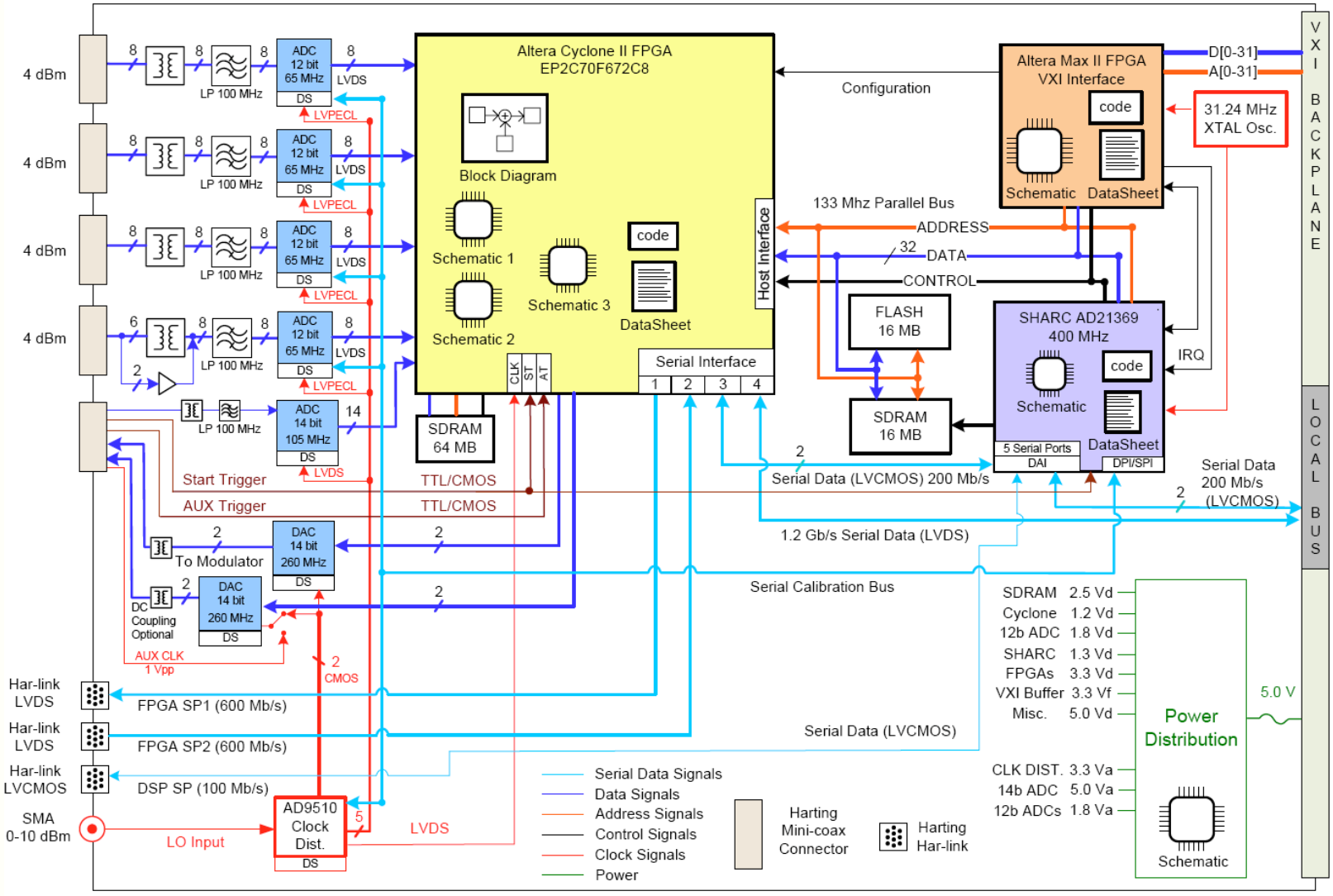
SNR@fs/2 = 112dB - 10log10(32k/2) = 70dB

Measured SNR for vector sum (8x12bit ADC):

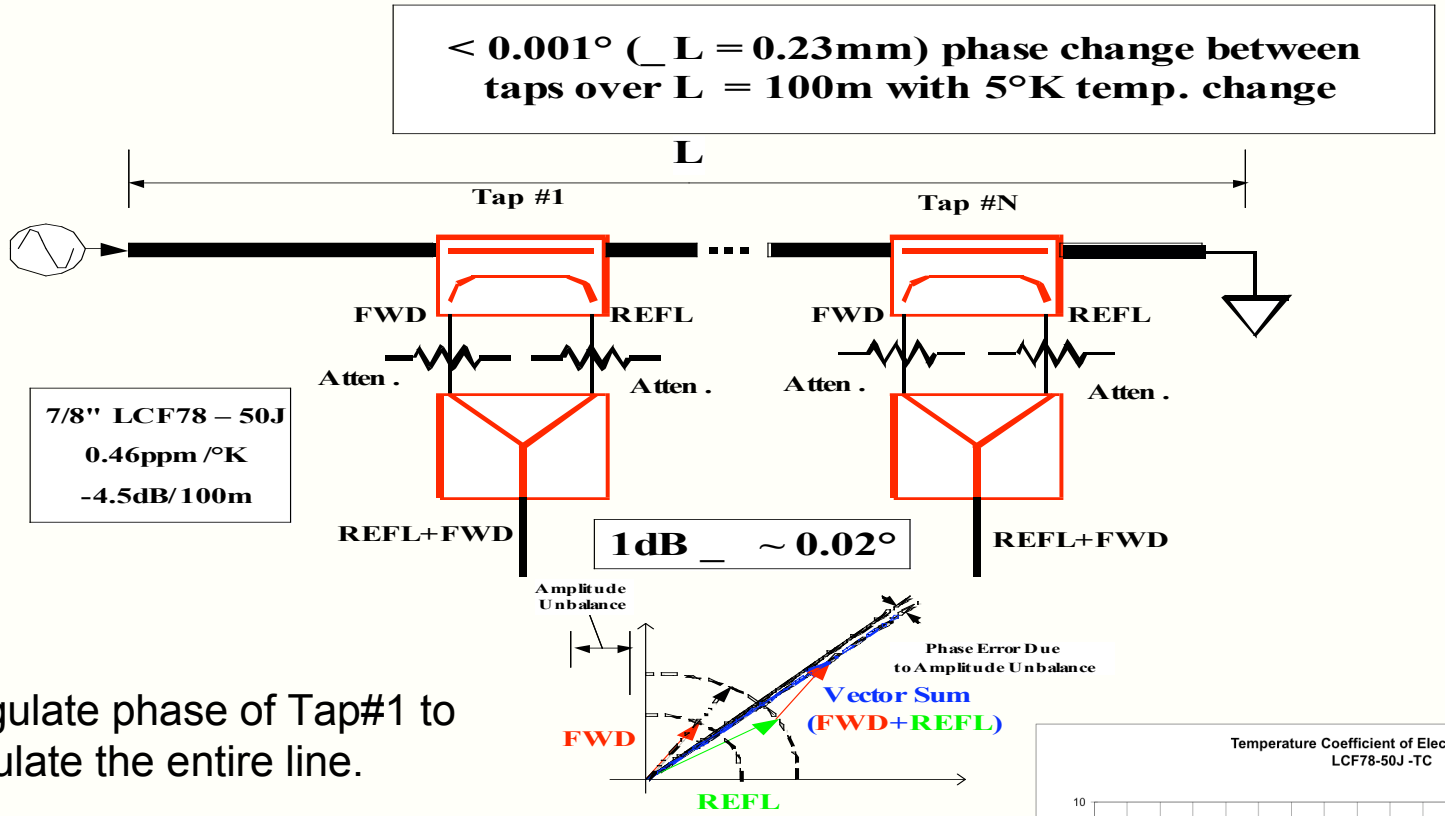
SNR@fs/2 + 10log10(8) = 79dB

The SNR -156dBc/Hz (0.0016% BW:1MHz) is expected.

33 Channel Controller (MFC)

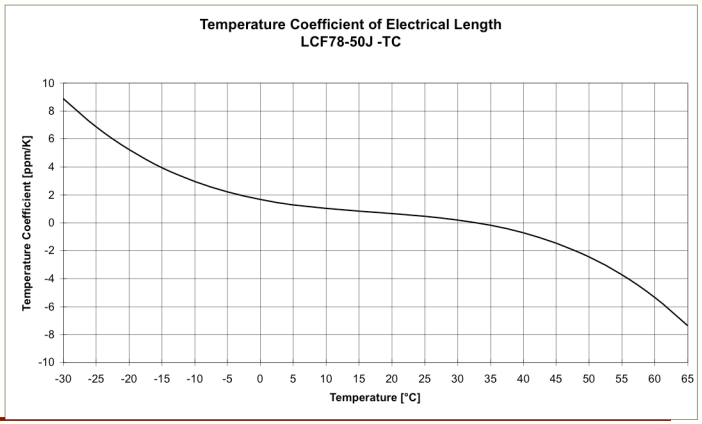


High Stability Reference Line

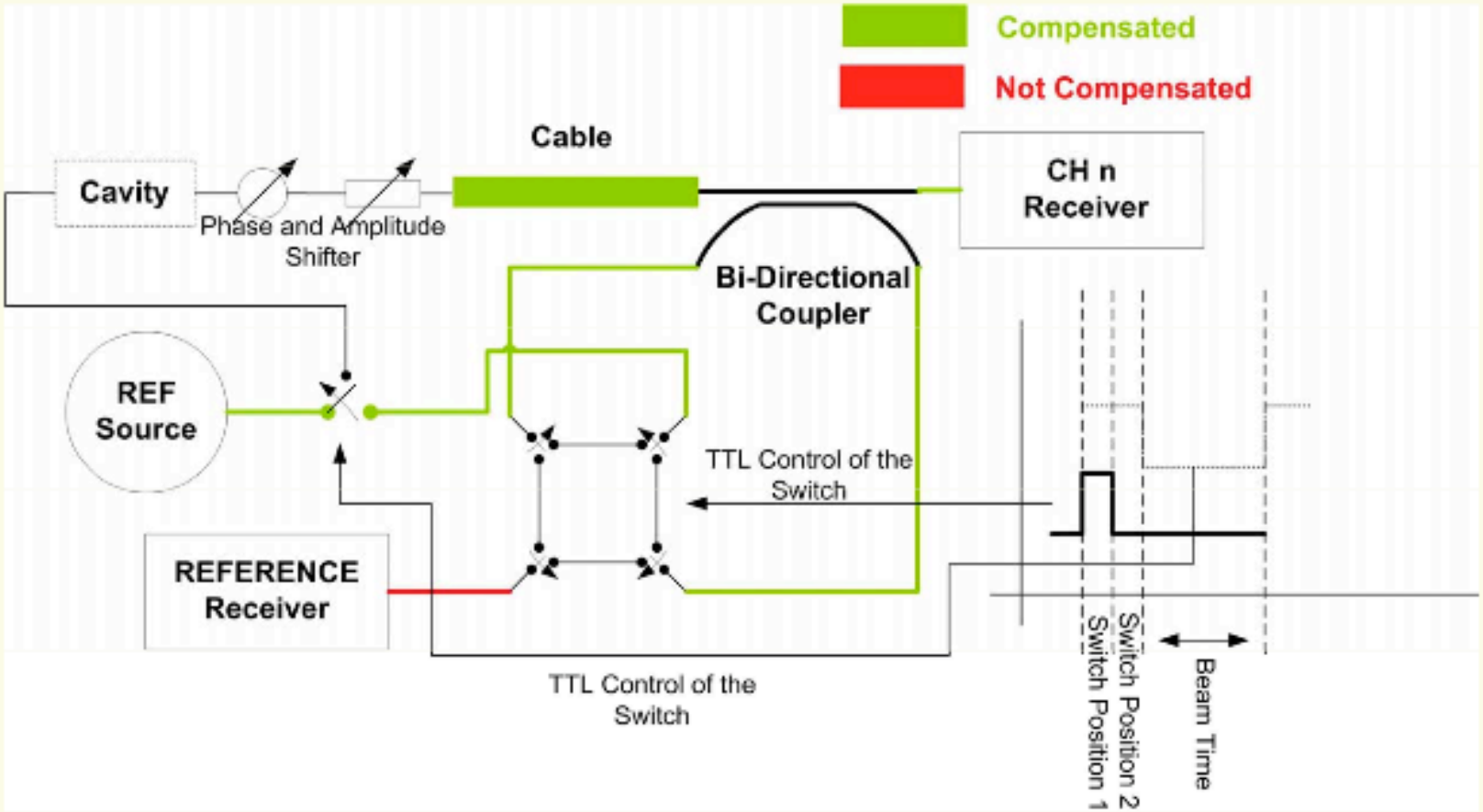


Regulate phase of Tap#1 to regulate the entire line.

Control by phase shift of forward power or temperature control of Line.



Drift Calibration



Final Observations

- **NML while reduced in scope is still a very important test bed**
- **FNAL LLRF efforts will be spread over HINS, ProjectX, ILC and other internal projects.**
- **LLRF R&D successes will translate to performance improvements and cost reductions**