# High Precision Accelerator Synchronization Activities at LBNL

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# People

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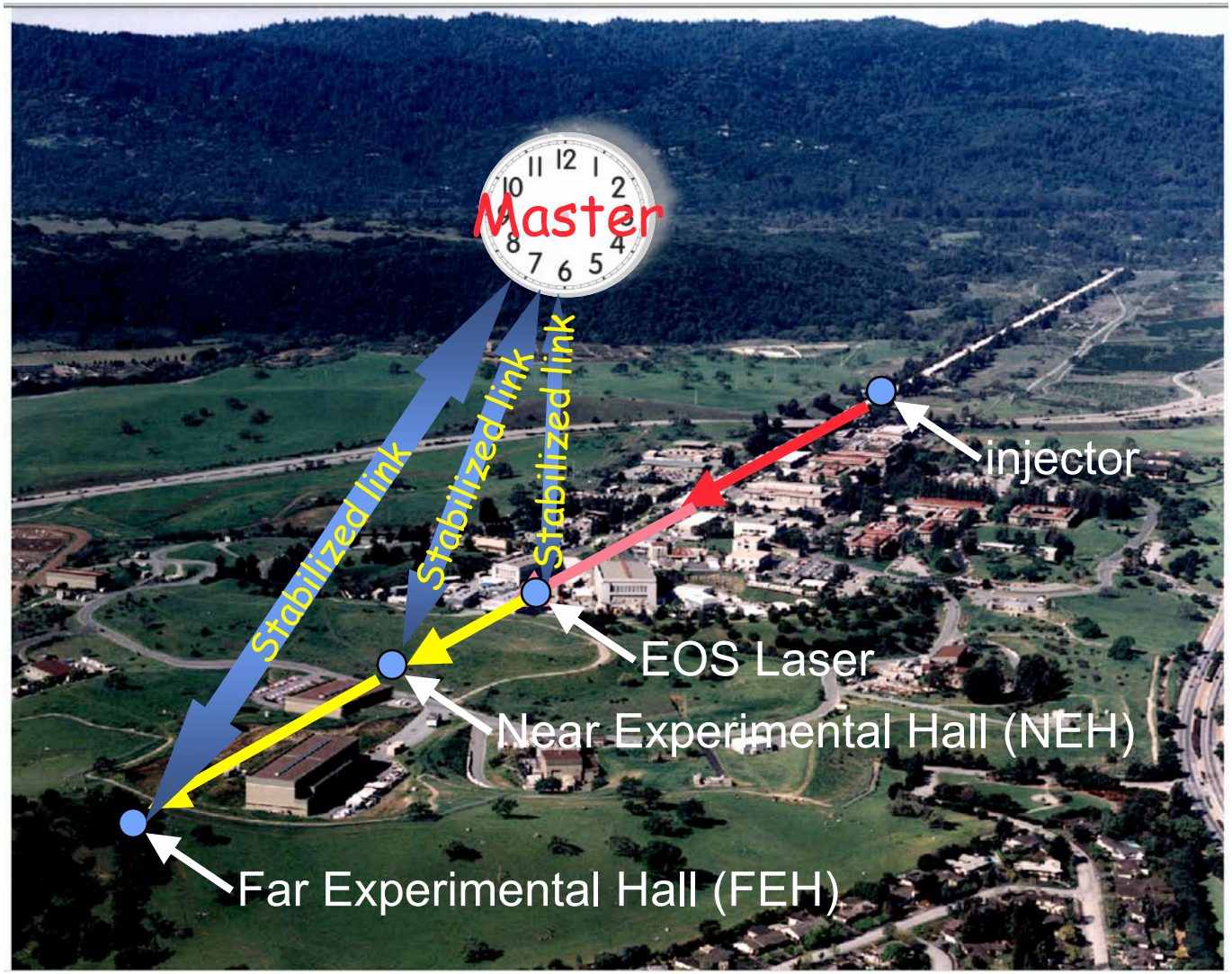
# Berkeley Synchronization Activities

- As part of our own ultrafast light source R&D efforts, LBNL invested in high precision timing and synchronization.
- We became early adopters of interferometrically stabilized optical fibers. This approach has been very successful and has led to a demonstration of transmission of a S-band clock signal over 2 km fiber with <40 fsec (RMS) stability over >1 day.
- We believe this technology is critical for providing timing and synchronization for accelerator applications which require high synchronization.

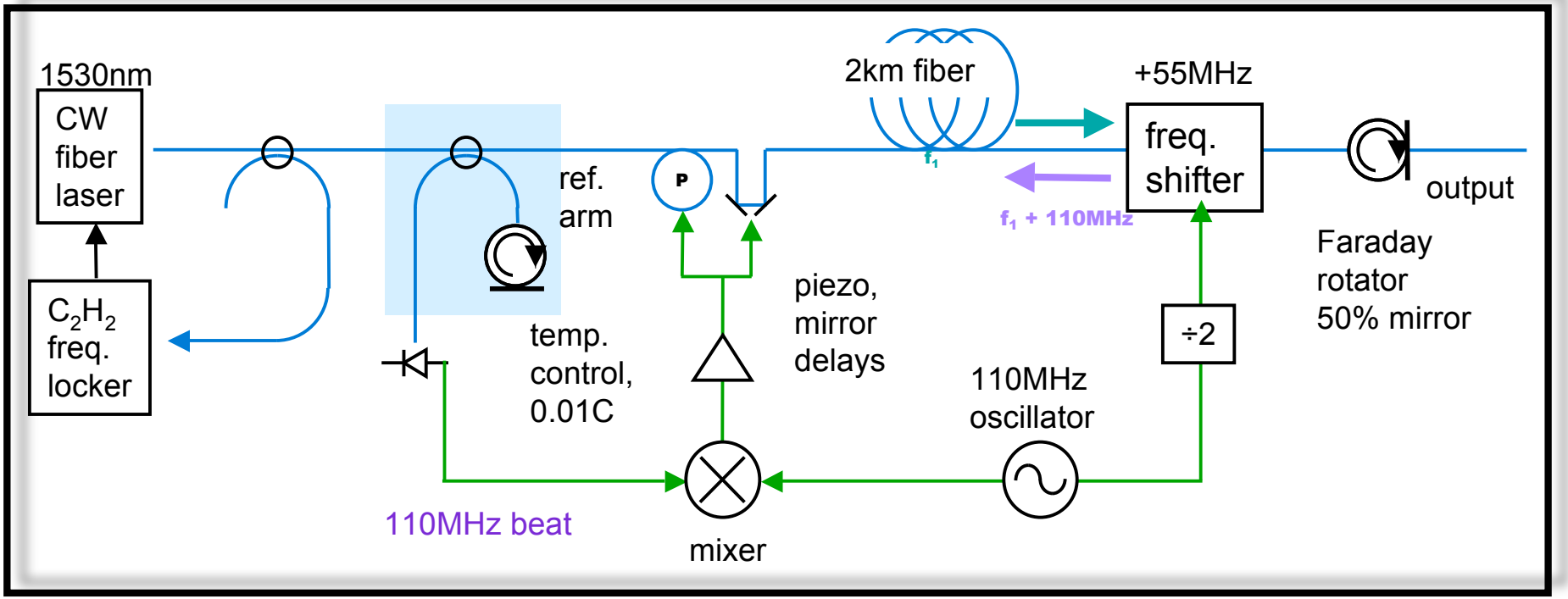
# Berkley Synchronization Activities


- Building 16-channel system for distribution of master oscillator for LCLS
  - —Primarily for synch'ing remote laser systems
  - —Spec of <100 fsec relative drift
  - —>2 km links
- Building prototype RF controls for FERMI@Elettra FEL project at Sincrotrone Trieste.
  - —Local digital control of RF station
  - —Phase reference distributed via stabilized links
  - —~50 fsec relative drift

# Synchronization concept

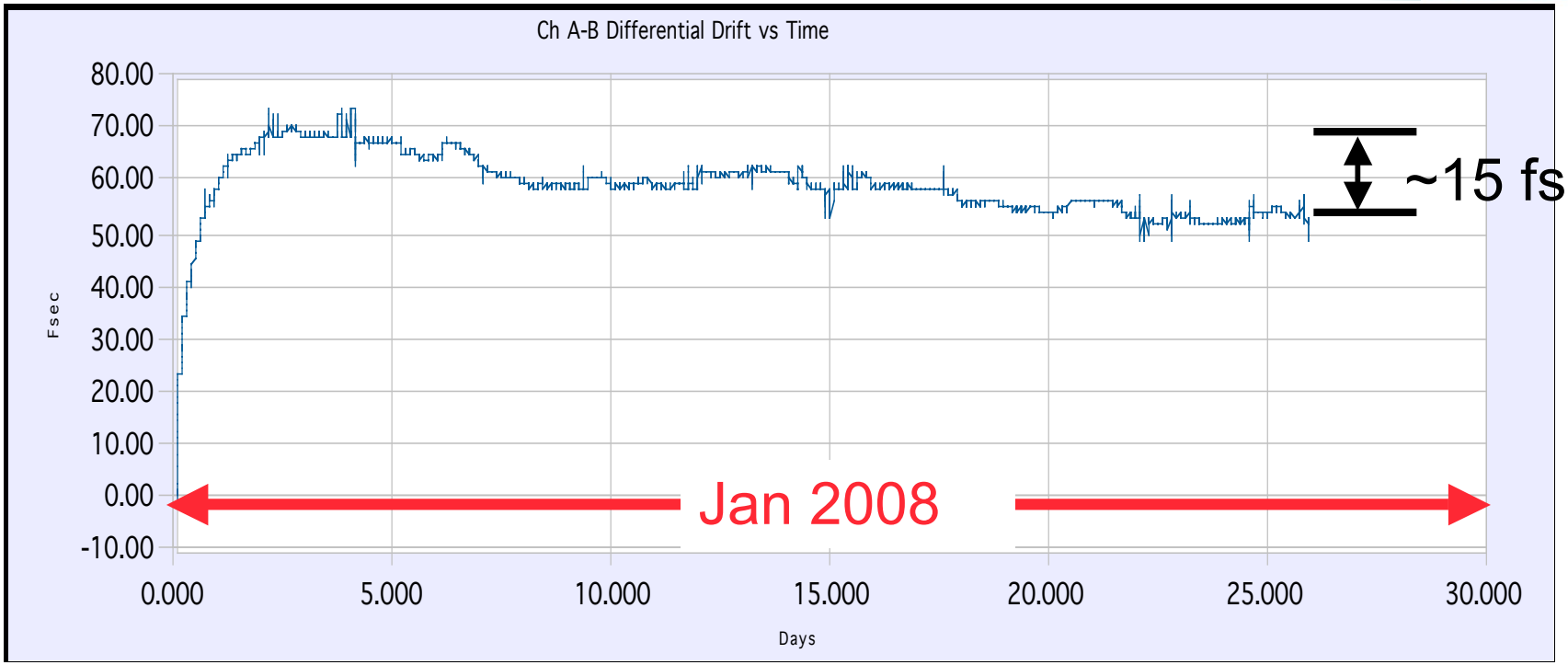


# Stabilized Fiber Links



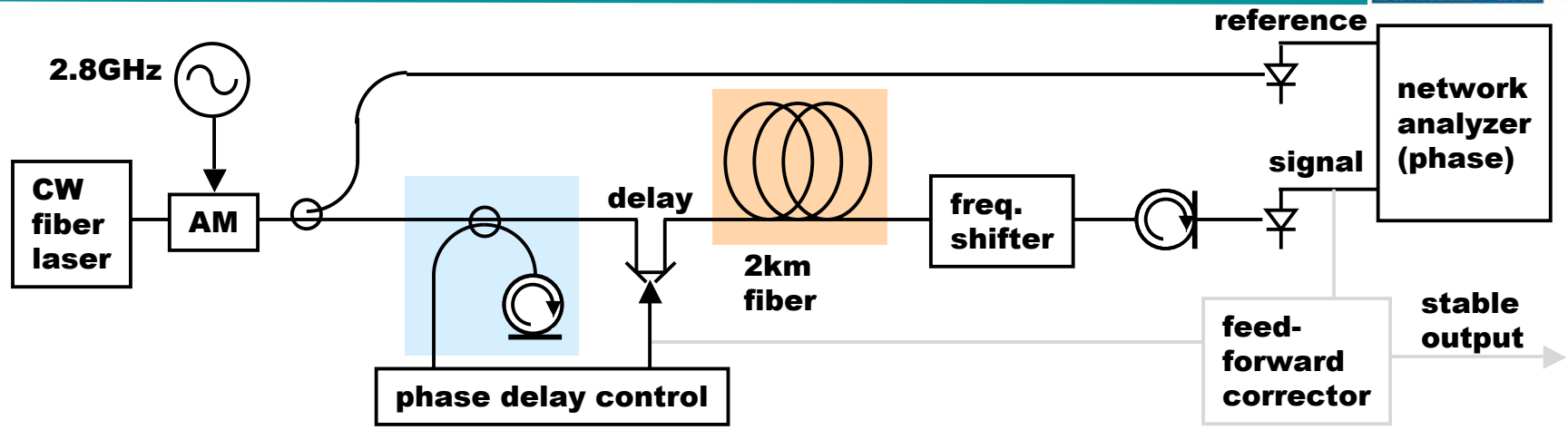

- **Maintain constant phase of optical carrier in fiber link**
  - **Measured with respect to temperature controlled reference arm**
  - **Relative phase measured at intermediate frequency**
  - **Use feedback to compensate for thermal and acoustic length changes**

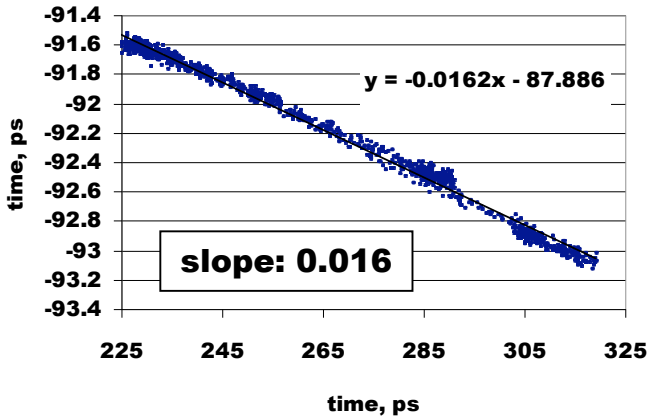
# First SLAC Results

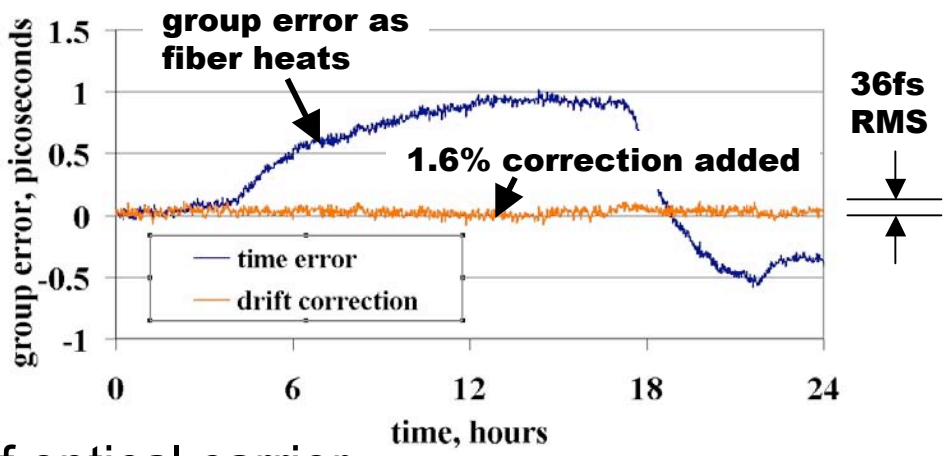



- **Relative drift of long tunnel fiber (~2.1 km) and short fiber in laser room.**
- **Total drift of ~15 fsec over 24 days (<0.7 fsec/day)**
- **Jitter appears to be <1 fsec.**

# RF transmission over stabilized links

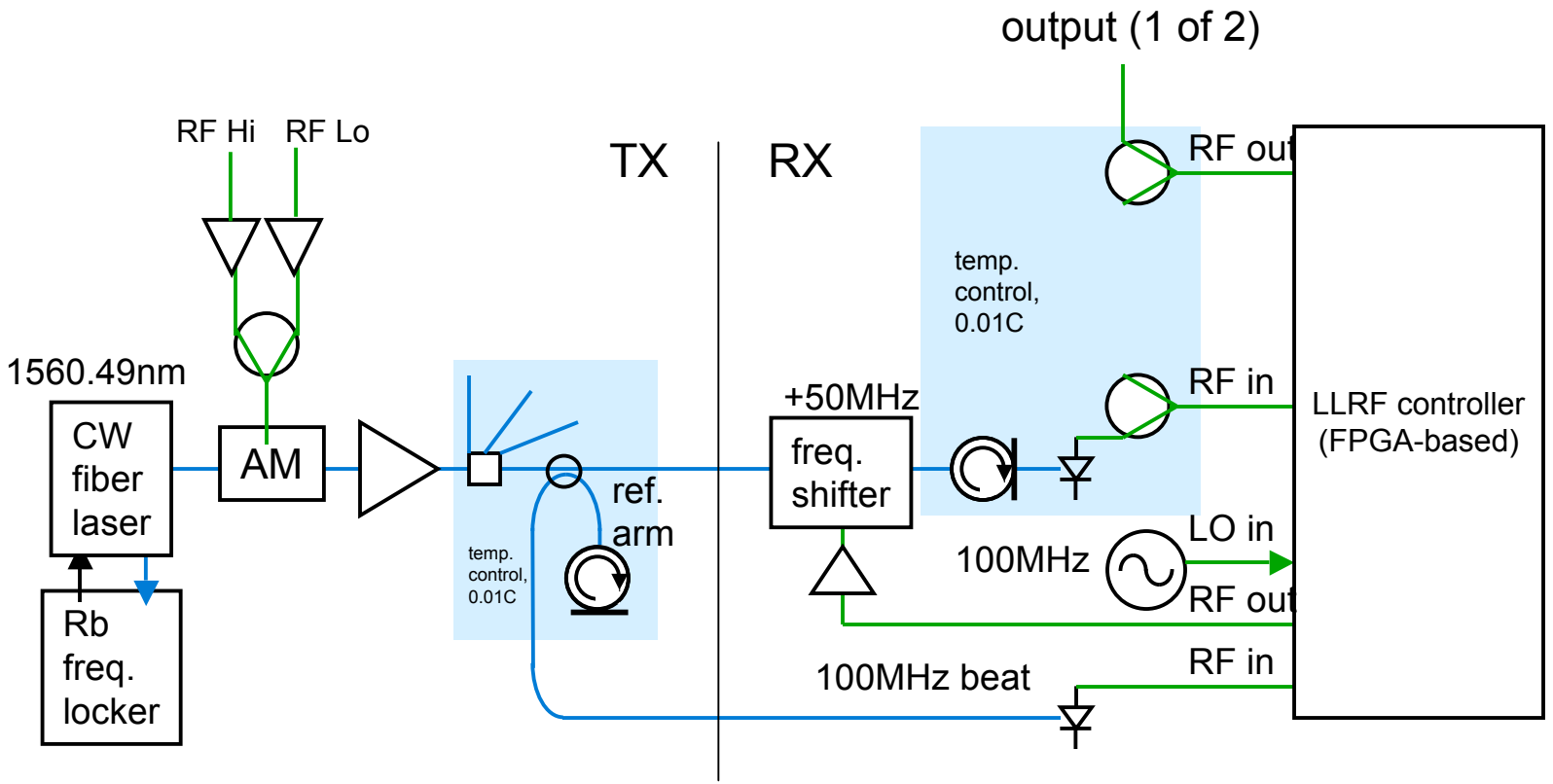


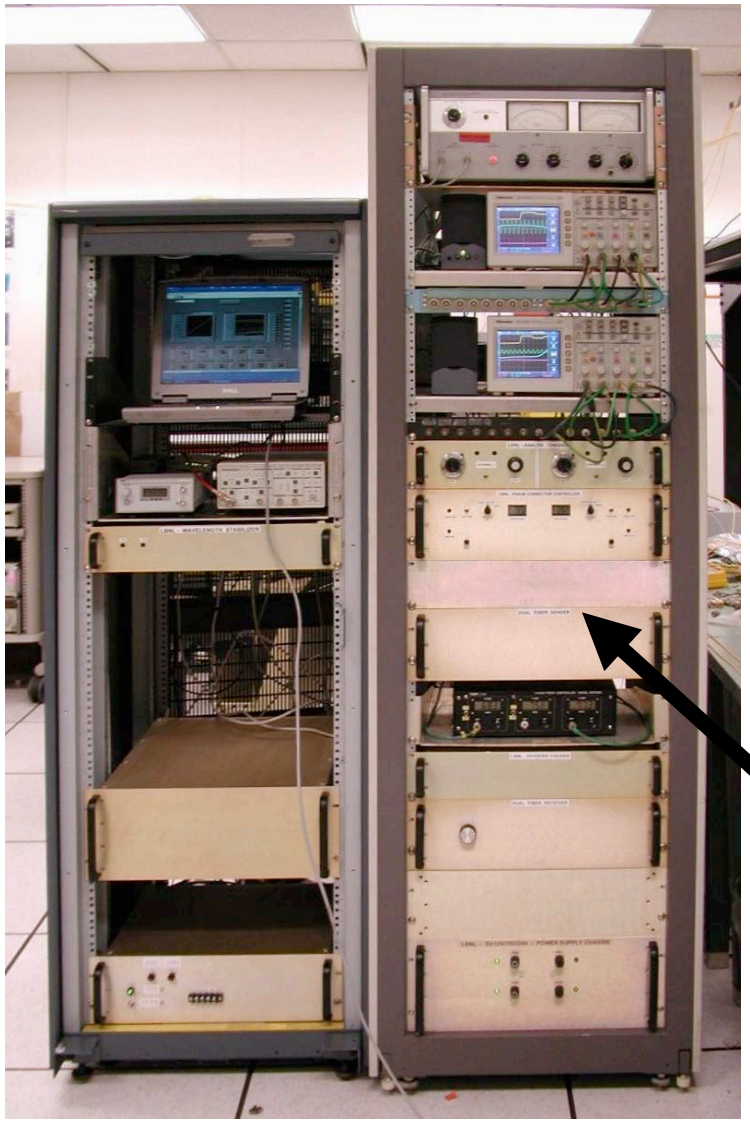

- RF transmitted as modulation of optical carrier
- RF signal requires “small” correction to compensated for group velocity dispersion-to be implemented as feed-forward

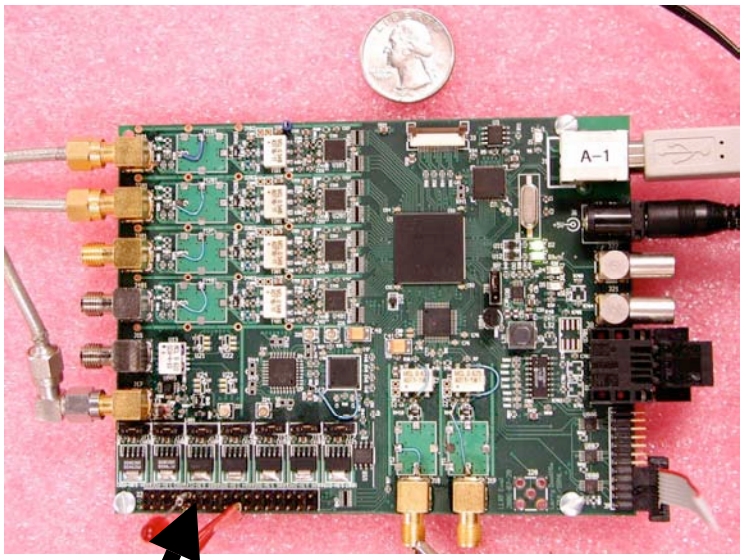
# Design Concept




- **Central master oscillator distributed to local RF controller**
- **Local controller sets amplitude, phase.**

# Hardware






- RF controller
- Link stabilizer

# Summary


- We have a deep interest in timing and synchronization issues in accelerators.
- LBNL is willing to help with high precision RF controls for deflecting cavities.
- Demonstration of relative phase stability at 800(?) MHz could be made as part of existing developments.