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SLAC NATIONAL ACCELERATOR LABORATORY

PERFORMANCE OF THE SPEAR3 LLRF SYSTEMS

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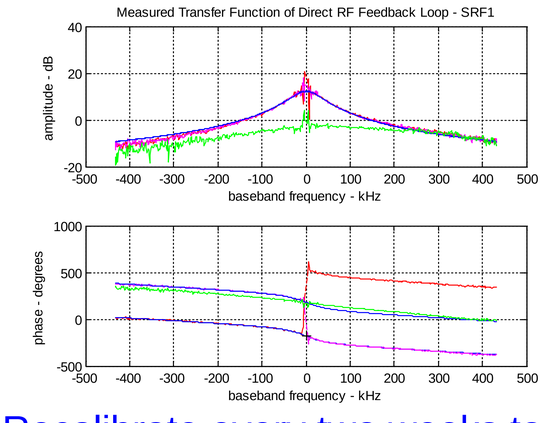
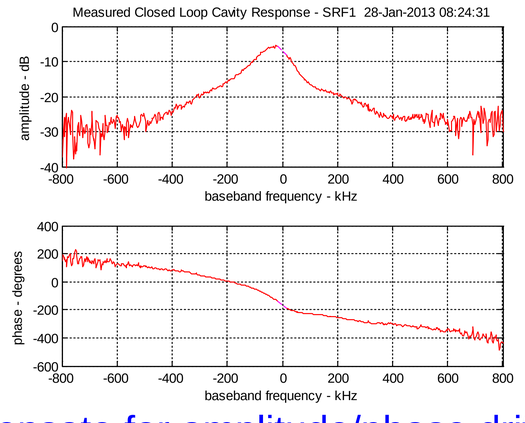
Abstract SPEAR3 is a 3 GeV electron storage ring used as a synchrotron light source, with a nominal current of 500 mA. The beam originates in an s-band RF gun. It is then accelerated through a linac to 120 MeV, into a booster in which it as accelerated to 3 GeV and then injected into SPEAR. Injection occurs every 5 minutes to keep the storage ring constant to within 1% of its average value. The two most important RF systems are those for SPEAR and the injector. The SPEAR RF system is derived from the PEP-II RF system. The linac LLRF has evolved to the performance level required for stable injection.

SPEAR3 LLRF System

- Uses PEP-II RF system
- LLRF designed in 1996 (Corredoura, Browne, Ross, Dusatko)
- Combination analog/digital system
  - Analog transfer function provides gain to reduce HVPS ripple
  - 800 Hz high gain bandwidth
  - Digital ripple loop also suppresses harmonics
- Wideband feedback loop
  - Intended for uniform response for PEP-II
  - Modified coefficients to give “Robinson damping” for SPEAR3

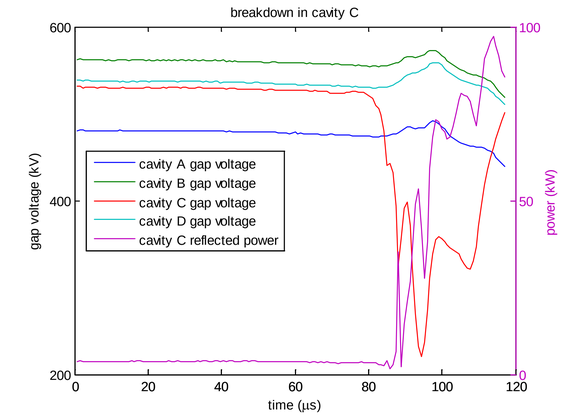




- Recalibrate every two weeks to compensate for amplitude/phase drifts
  - 2% amplitude drifts
  - 5° phase drifts

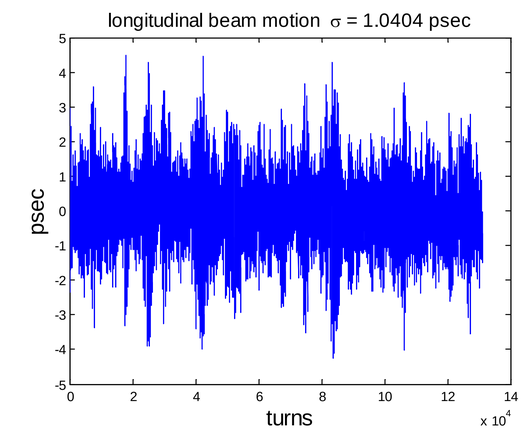
Fast History Buffer Diagnostics

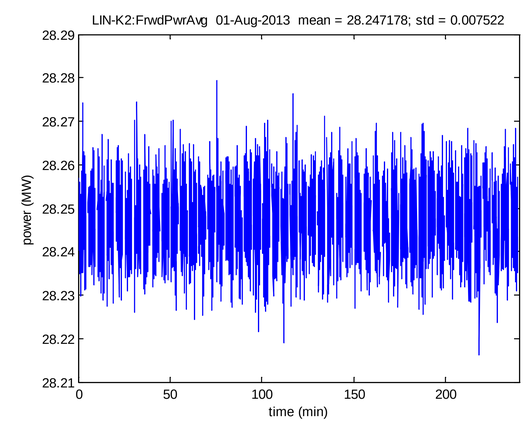
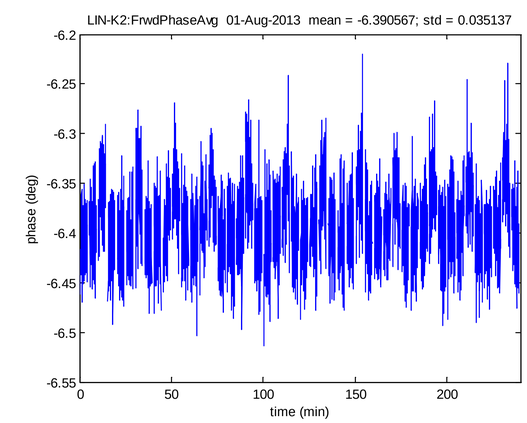
- Signals digitized at 10MS/s rate
- Ability to determine cause of trips
- Example of cavity breakdown
  - Gap voltage drops in cavity
  - Feedback raises other cavities
  - Reflected power trips station



System Performance

- System robust and reliable
- Dominant cause of beam motion is HVPS ripple
- Residual phase beam phase motion measured on turn by turn BPM
- LLRF keeps longitudinal motion to about 1ps rms



LINAC

- Beam energy out of LINAC needs to be stable to 0.1%
- Digitize power measurement from ovenized diodes (σ=0.05°C)
- Digitize phase measurements from AD8302
- Slow (EPICS based) feedback stabilizes energy to 133ppm
- Slow feedback stabilizes phase to 0.035° of an s-band period