

# Towards Ultra-Stable Operation of SRF Linacs with Beam-Based Feedback

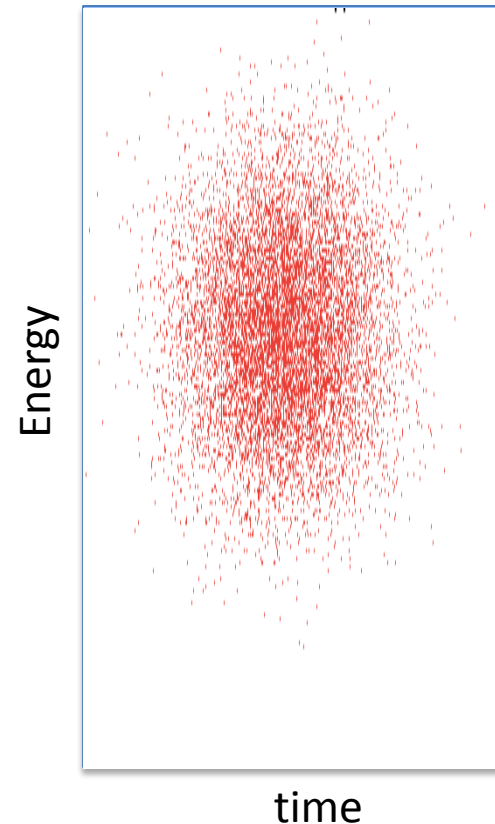
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Claudio Rivetta, Carlos Serrano

1<sup>st</sup> ASTA User meeting and PAC Meeting  
2013.7.23



# Ultra stable

- Stabilize beam longitudinal phase space
- Bunch arrival time jitter
  - 25fs
- Bunch energy jitter
  - $10^{-4}$
- Bunch length
- energy spread



# Jitter/Drift Source

- Beam property after gun
  - Laser
    - Timing/Power/Pointing
  - RF
- RF system
  - Amplitude/phase
- Others

# Feedback control

- RF amplitude and phase through LLRF system

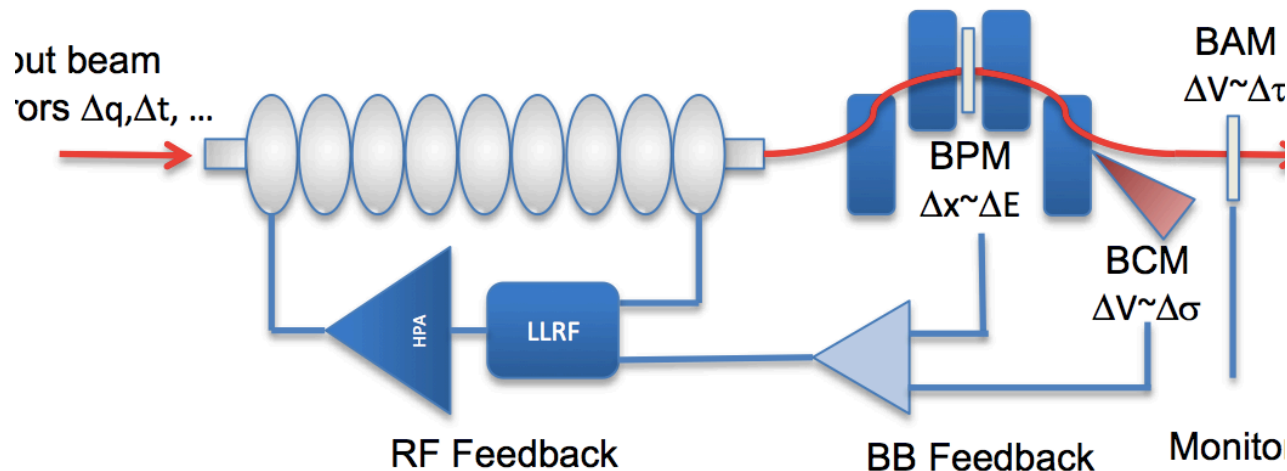


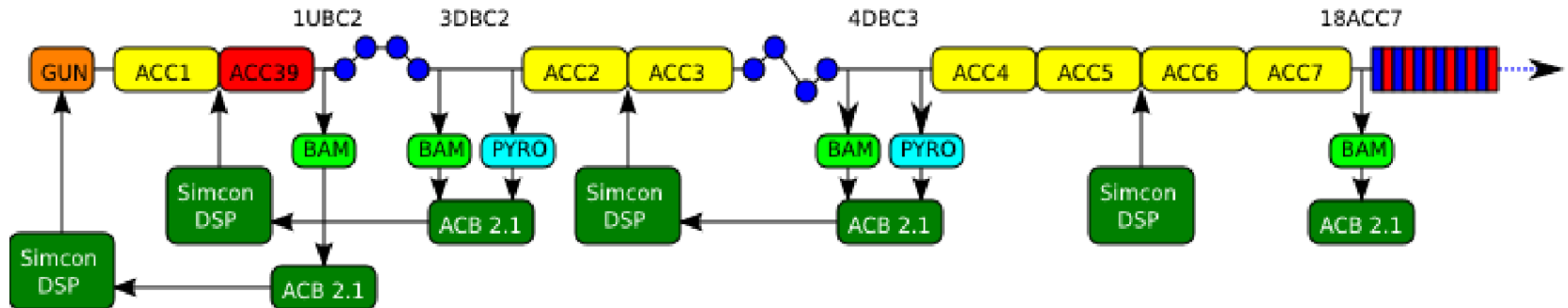
Fig. 1. Conceptual schematic view of RF and beam-based feedback control. Energy, bunch length, and arrival time measurements can provide set point modulation to the RF sections preceding the bunch compressor.

- Laser timing amplitude pointing ...

# Bandwidth

- CW or long RF pulse
  - LLRF feedback bandwidth
- High beam repetition rate
  - Beam based feedback bandwidth
    - Bunch train duration 1 ms
    - Bunch frequency within train 3 MHz

# FLASH beam based feedback system



- BAMs:

- 1UBC2
- 3DBC2
- 4DBC3
- 18ACC7

- PYROs:

- 3DBC2
- 4DBC3

- Electronic devices:

- ACB2.1  
(for BFB)
- SimconDSP  
(for LLRF)

# Overview of Longitudinal Beam Based Feedback at FLASH.  
Jarosław Szewiński NCBJ Świerk 4th RFTech Workshop,  
Annecy, 25-26.03.2013

# FLASH beam based feedback system

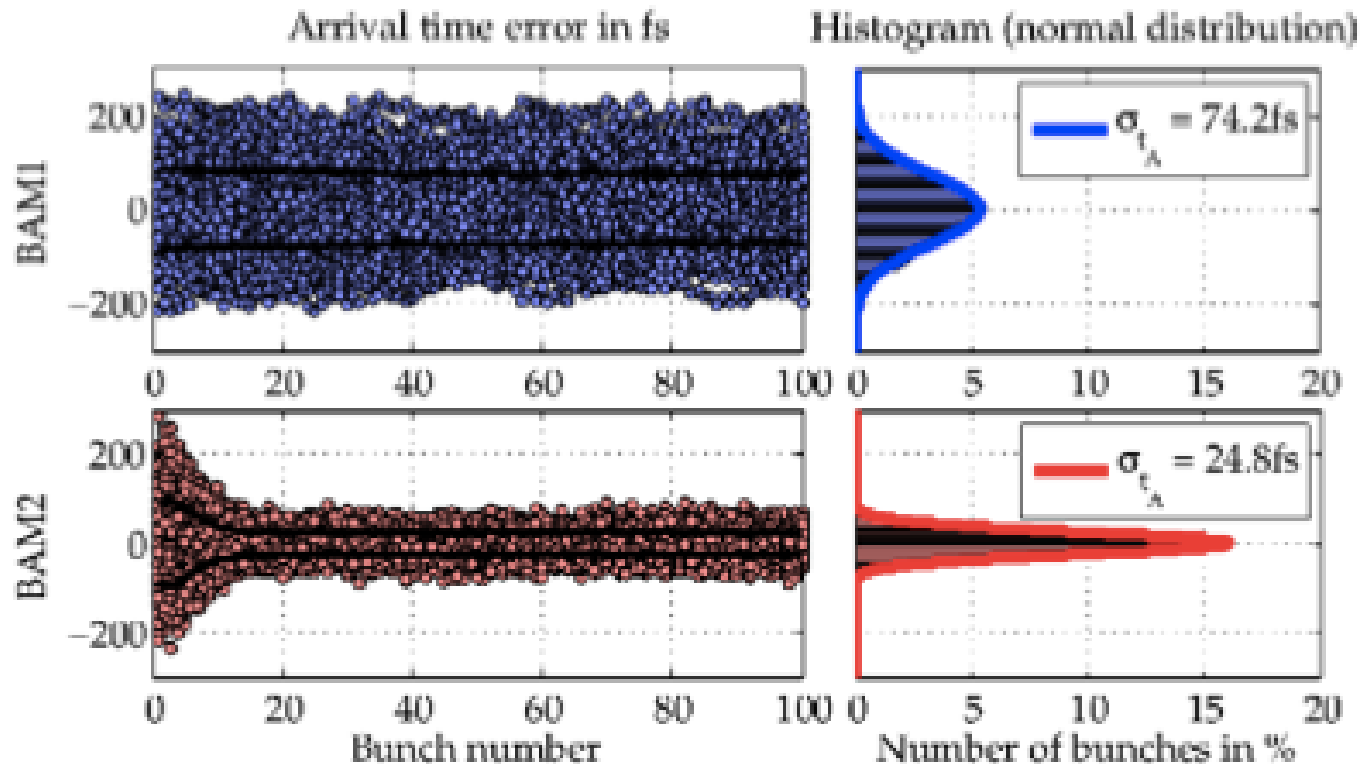
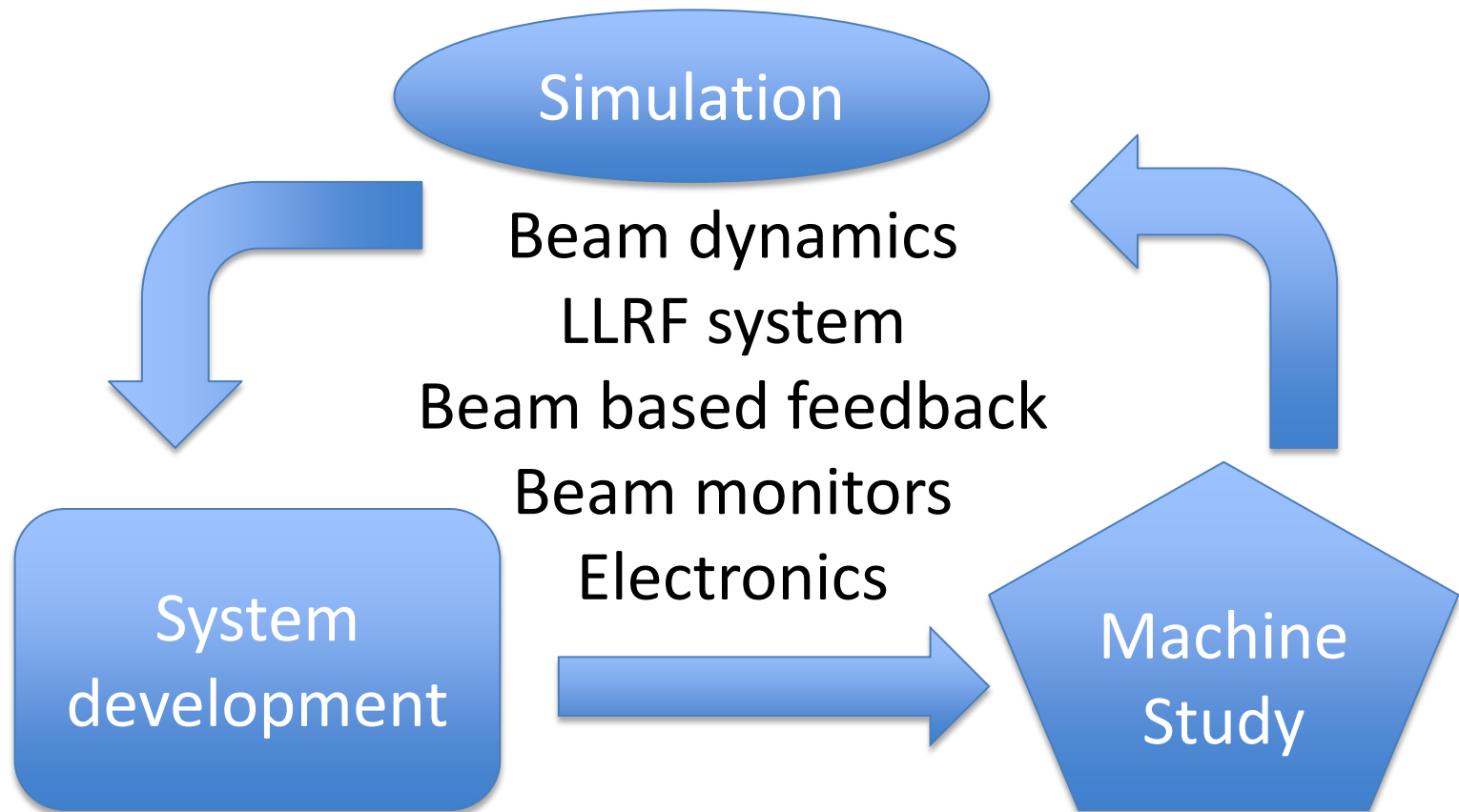


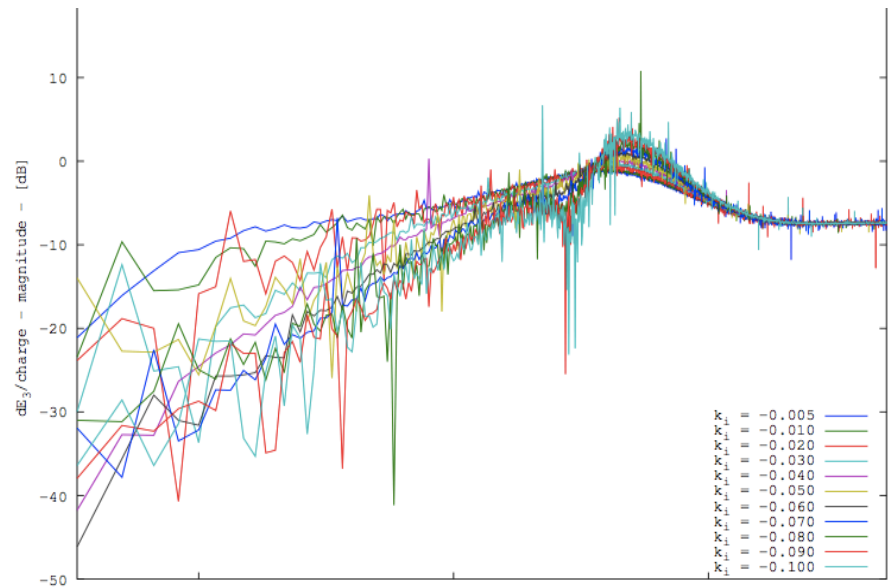
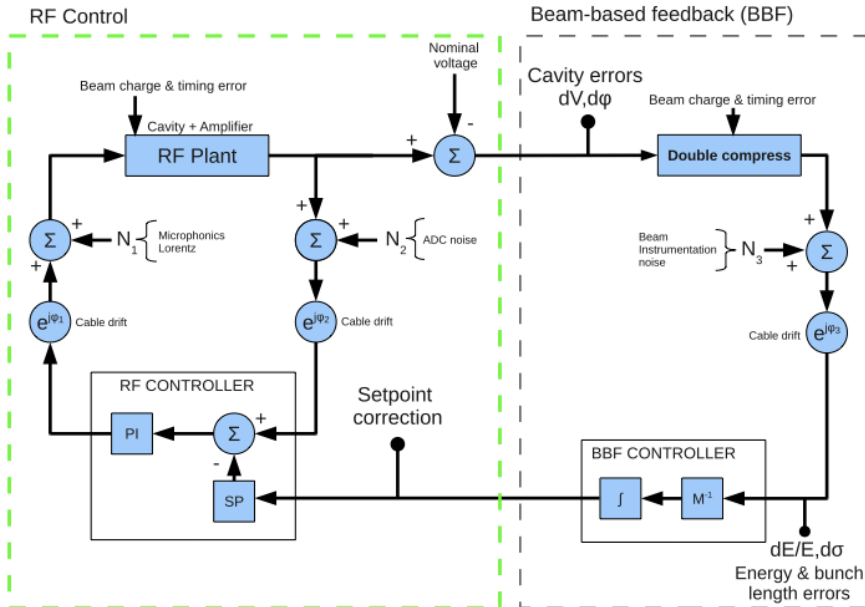
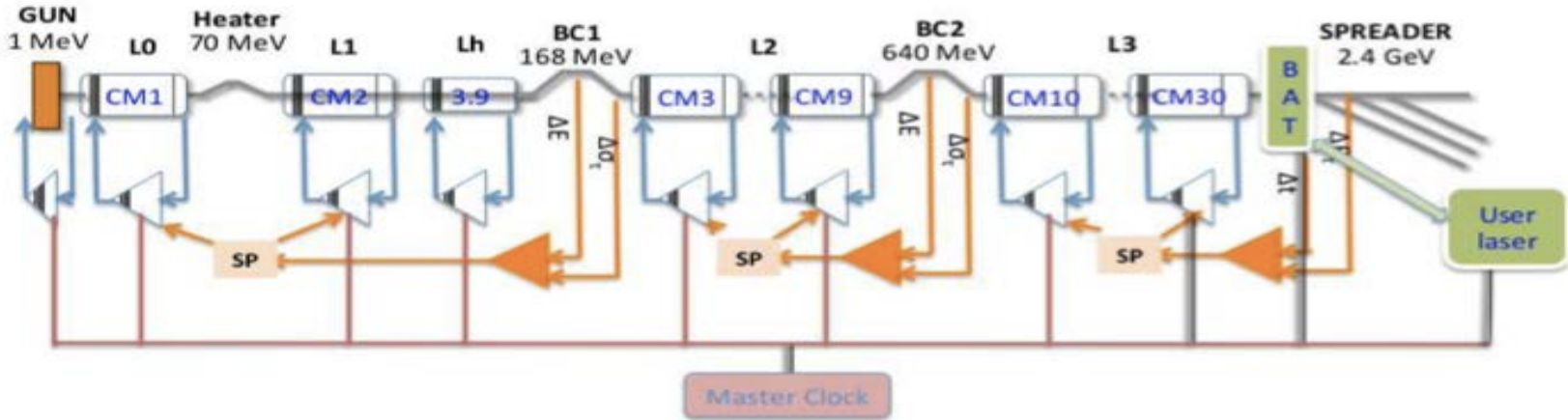
Figure 7: Usual bunch arrival time jitter and standard deviation with beam based feedback.

# Methodology



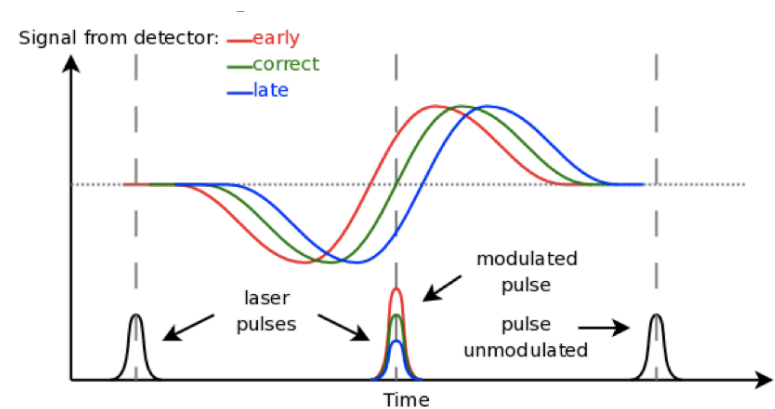
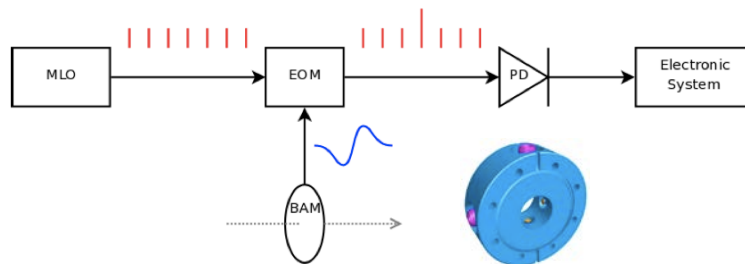


# Simulation model



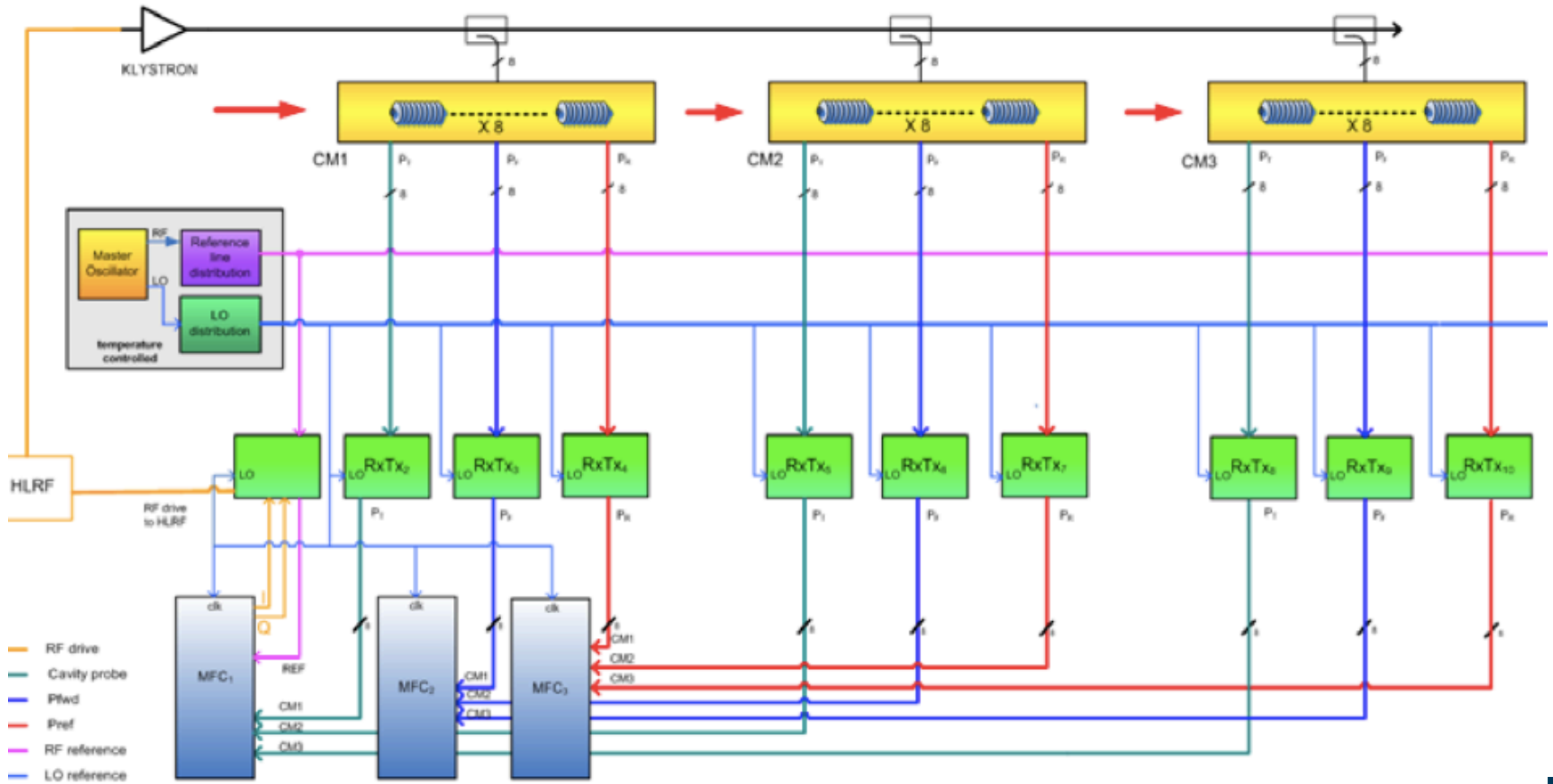
# Beam monitors development

- Bunch Energy
  - relative energy measurement, BPM @ BC1
- Bunch Arrival Time

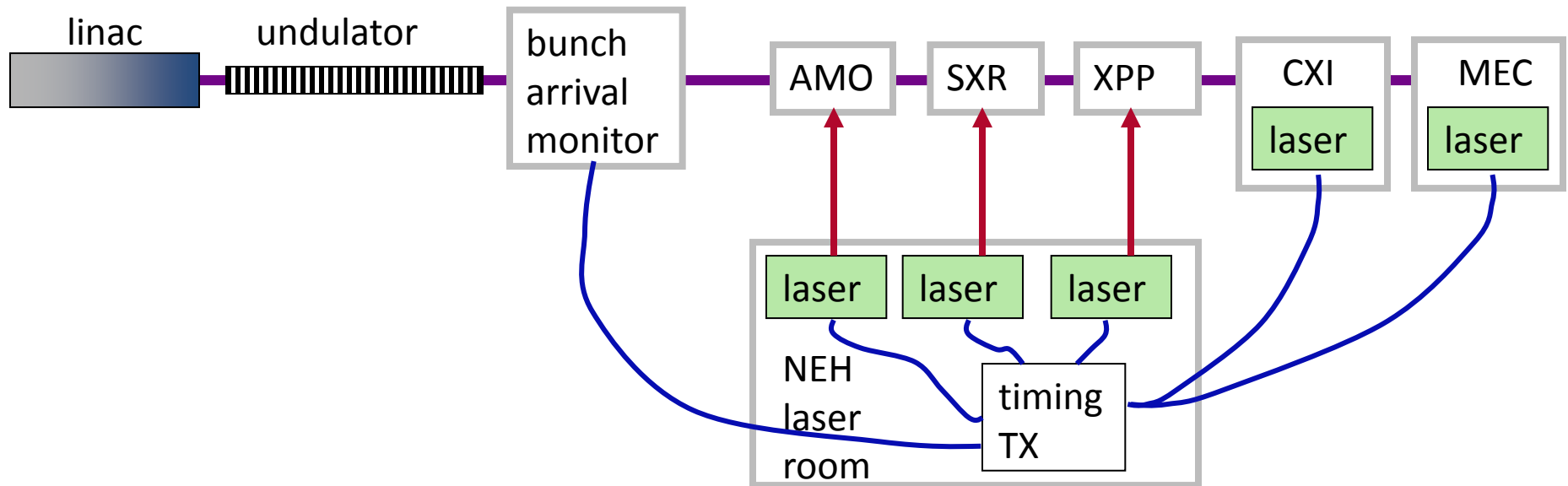


- Bunch Compression
  - Coherent edge/synchrotron/diffraction radiation
  - pyro- electric detector (PYRO)

# ASTA LLRF

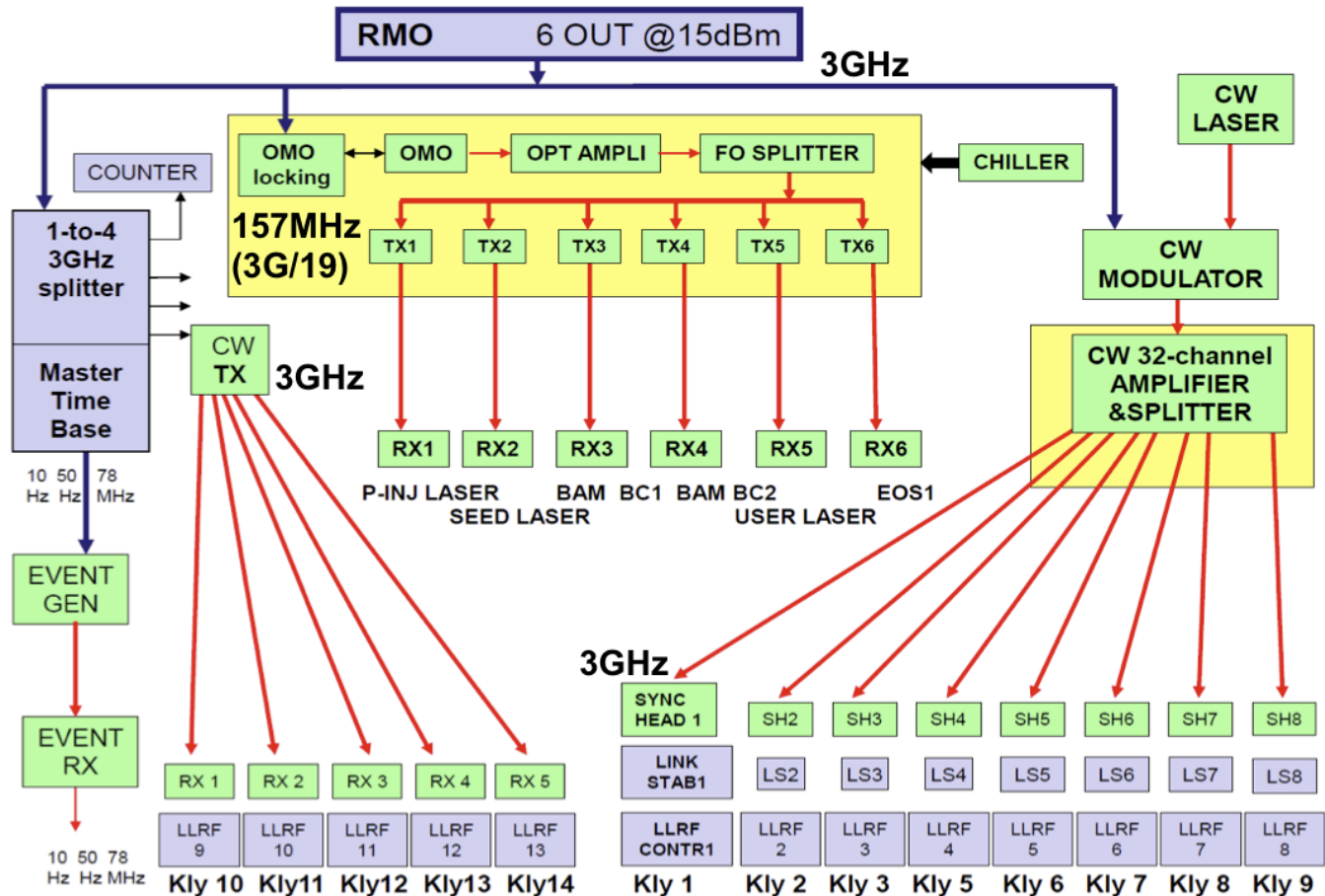


# LCLS laser timing configuration



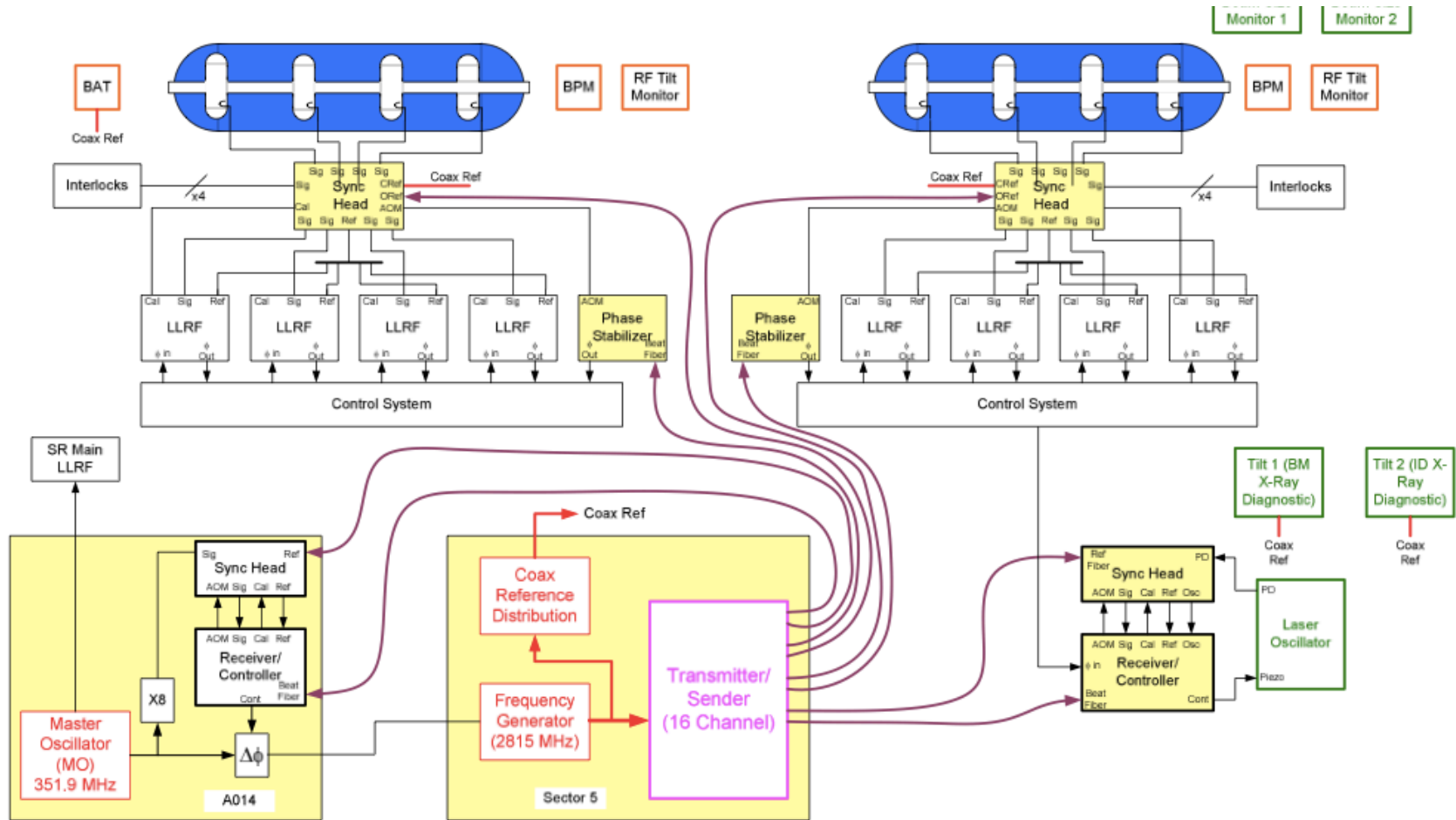
- System has 16 channel capability, 6 used
- Typical 300m fibers, 10ps correction (thermal)

# Fermi@Elettra RF timing configuration



- 11 links now used, 32 possible
  - Separate 3GHz system being replaced channel by channel

# APS upgrade/ Short Pulse X-ray deflecting cavity timing and LLRF



# Implement feedback controls at ASTA

- Stage I
  - Characterize the beam energy, charge, timing and bunch length jitter
    - using the planned diagnostics
  - Characterize phase and amplitude jitter of the RF gun
  - Minimize the beam jitter from the injector
    - Control the photocathode drive laser
    - Control of the RF gun
  - Refine simulation code
- Stage II ...
  - Stabilize the ASTA linac
- Goal
  - Micro-pulse phase stability
    - the 25 fs regime or better
  - The energy stability
    - the  $10^{-5}$  range

# Scientific Opportunities

- emittance exchange
- reversible beam heating
- laser-beam interactions in electro-optical sampling or microbunching studies
- free-electron laser experiments.



Thanks

