

Update of EXT Stripline BPM Electronics with LCLS-style Digital BPM Processors

Glen White, with slides by Steve Smith
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ATF2

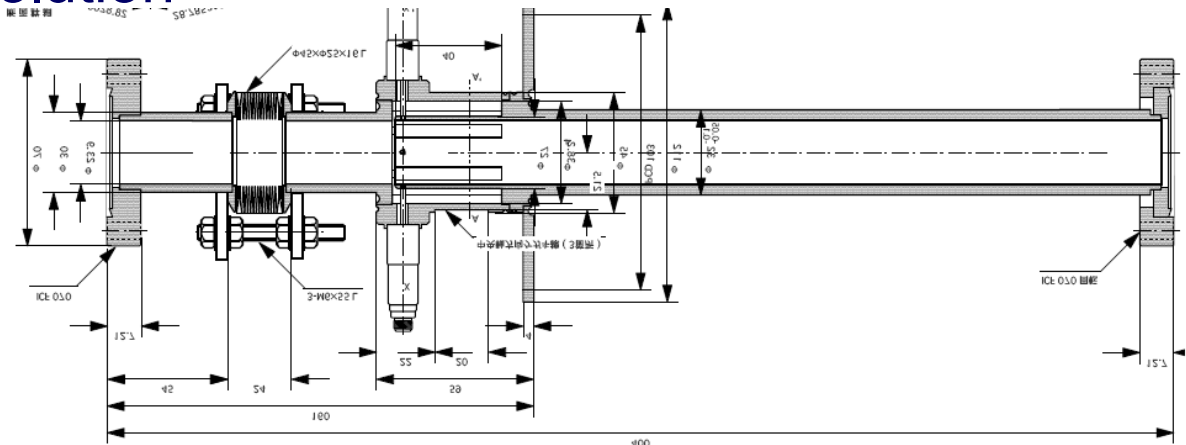


Overview

- 14 BPM processing modules of the same style used in LCLS currently being assembled for use in ATF2 extraction line.
- Aim to install electronics and test during February 2 week run period.
- Install for 12 stripline BPMs MQF1X through MQF15X (+ 2 spare).
- Aim to provide better resolution readout with improved centre stability and charge insensitivity.

ATF2 Extraction Line BPMs

- 12 Stripline BPMs in ATF2 extraction line
 - 3 types:
 - a) 3 each with L= 40 mm, d=27mm
 - b) 5 each with L= 40 mm, d=37mm
 - c) 4 each with L= 120 mm, d=27mm
- Angular coverage 70 degree/ strip
- Charge range $1\text{-}10 \times 10^9 \text{ e}^-$ / bunch
- Single bunch or 3 – 20 bunches at 357 MHz separation
- Requirements:
 - Several-micron resolution
 - Good stability over bunch charge



LCLS Stripline BPMs

- ~ 200 BPMs
- Most common type has $L = 100$ mm, $d = 24$ mm
- Angular coverage 26 degree/ strip
- Charge range $1.2 - 16 \times 10^9$ e⁻ / bunch
- Single bunch
- Requirements:
 - < 5 micron resolution at 200 pC
 - Good stability over bunch charge
- Similar signal, similar requirements

Estimate Resolution by Comparison

Resolution:

Proportional to diameter

Inversely to length, coverage:

$$\sigma \propto \frac{d}{\theta L}$$

ATF2

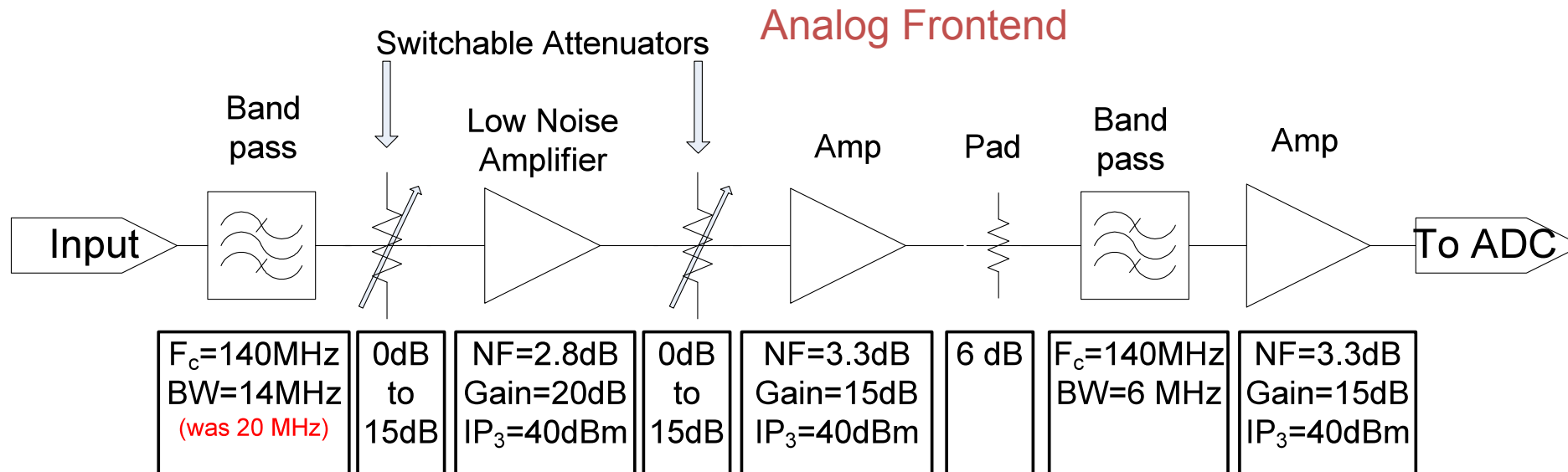
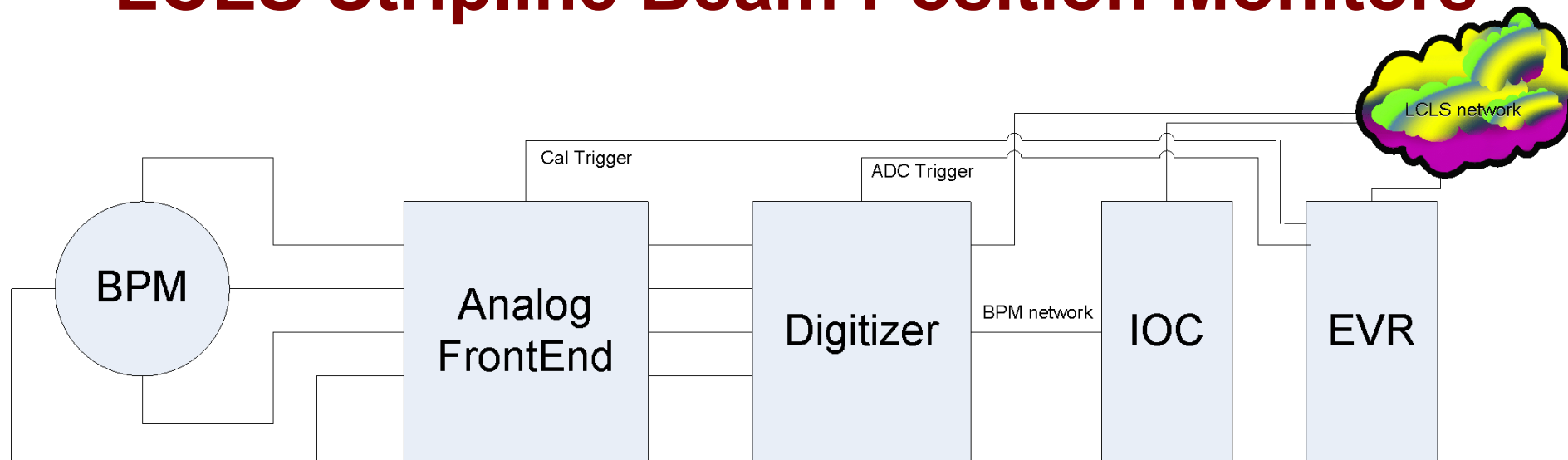
- Length ≥ 40 mm
- Angular coverage 70 deg
- Diameter 27 - 37 mm
- Greater coverage, less length \rightarrow comparable resolution

Larger diameter BPMs will have slightly worse resolution

LCLS

- Length = 100 mm
- Angular coverage 26 deg
- Diameter 24 mm

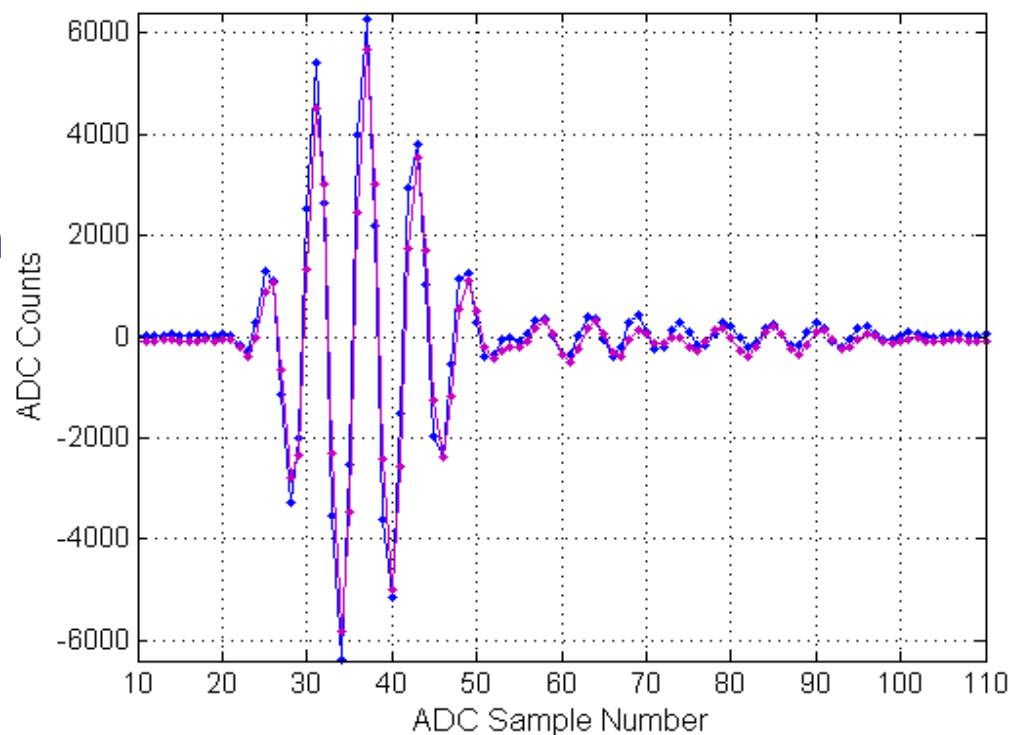
LCLS Stripline Beam Position Monitors



Signal is ~8 MHz band centered at 140 MHz

Algorithm

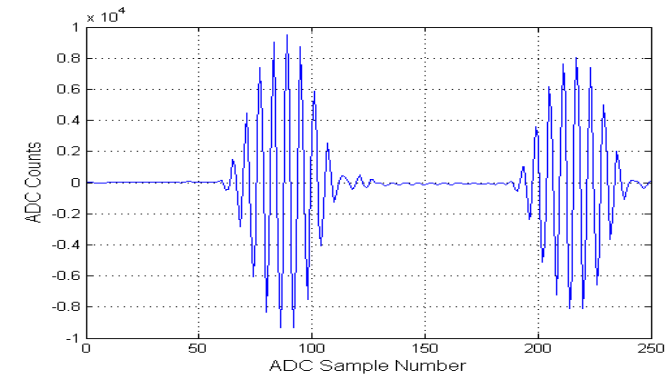
- IOC (VME processor) calculates position and beam charge from ADC waveforms
- Position:
 - Estimate amplitude from each strip
 - $V_i = \text{rms}(\text{ADC}_i)$
 - Correct for calibrated gain ratio
 - $X = R/2 \Delta/\Sigma$



BPM raw digitized waveforms. Sampling frequency 120 MHz.

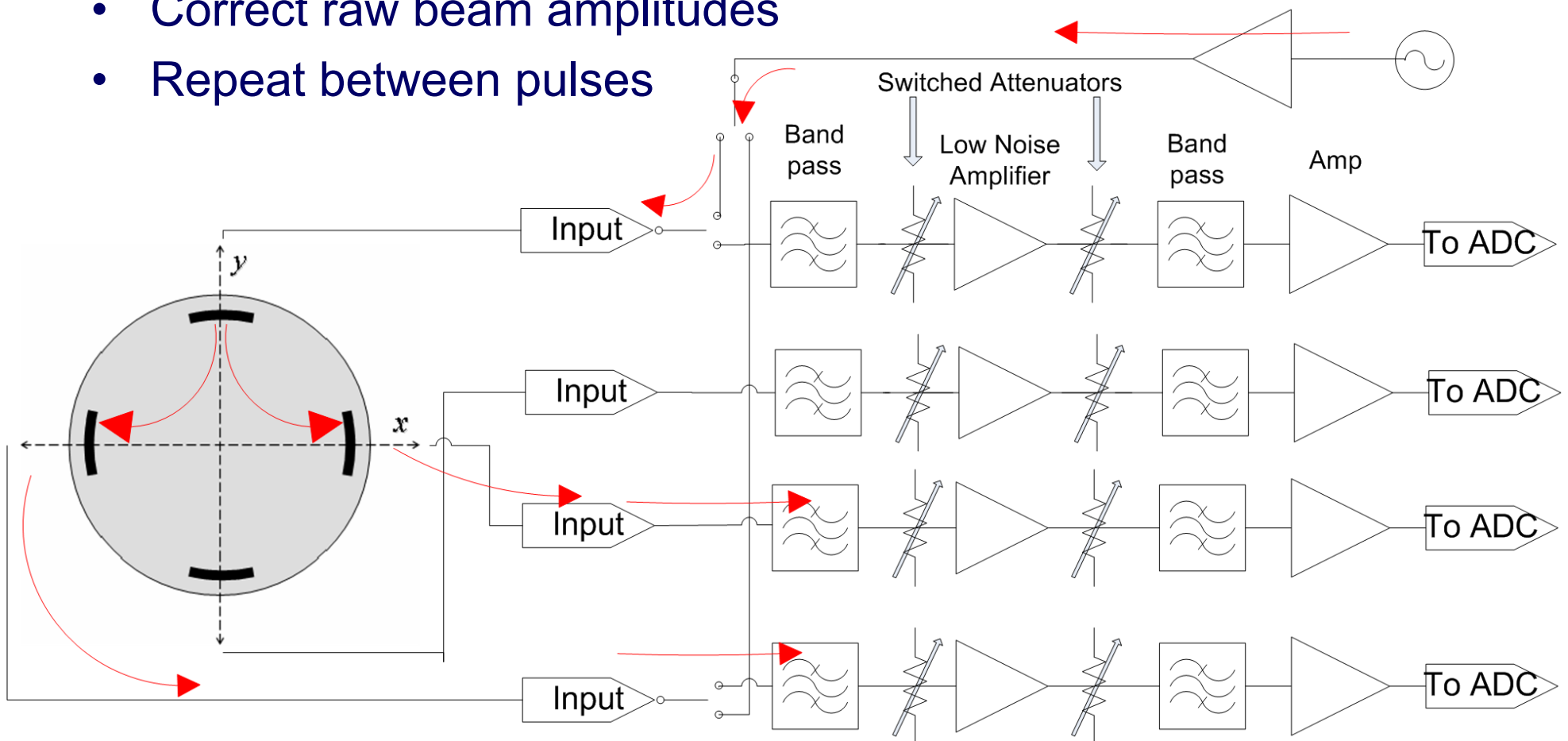
Online Calibration

- Launch tone burst into one strip
- Receive on adjacent strips
- Estimate amplitudes as above
- Calculate gain ratio
- Correct raw beam amplitudes
- Repeat between pulses

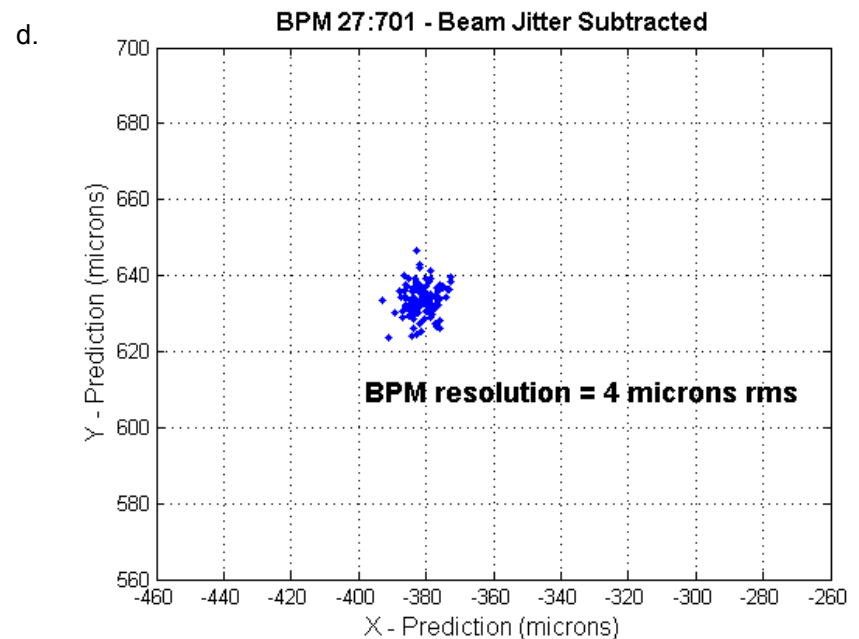
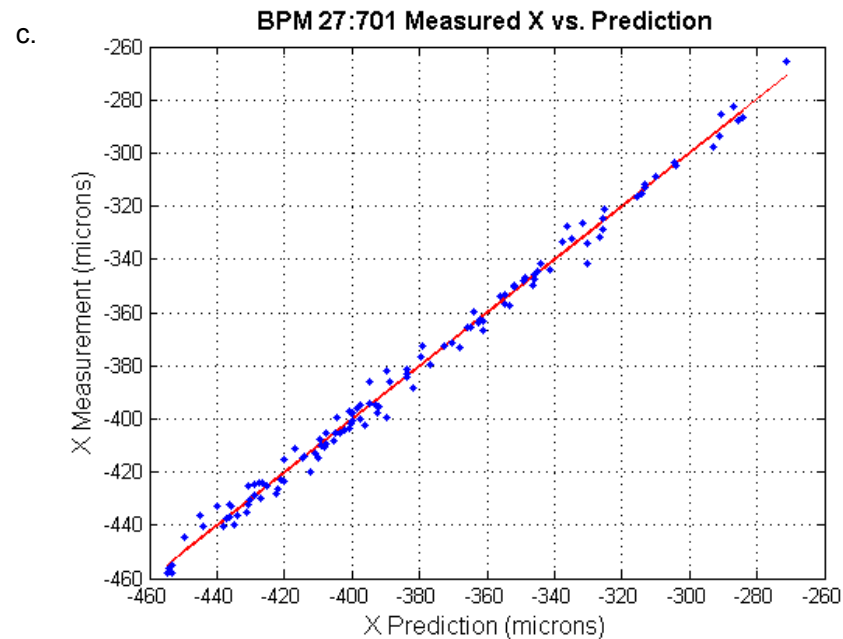
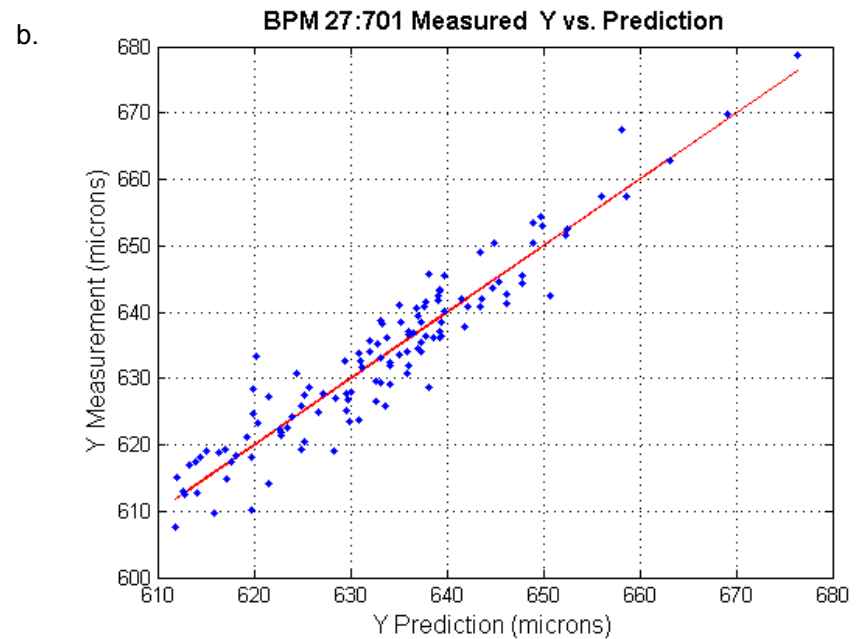
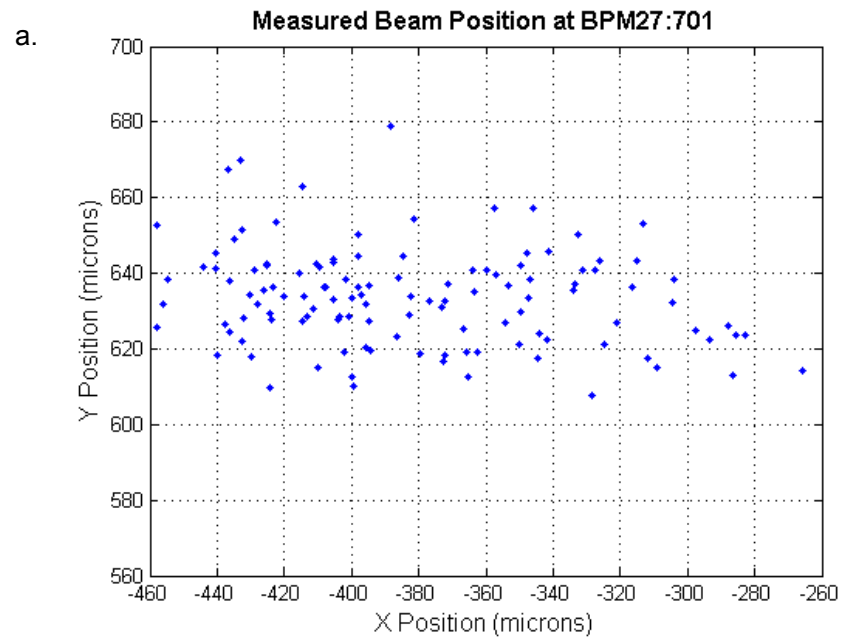


Calibrator tone burst detected on adjacent strips

Calibration Drive Amp



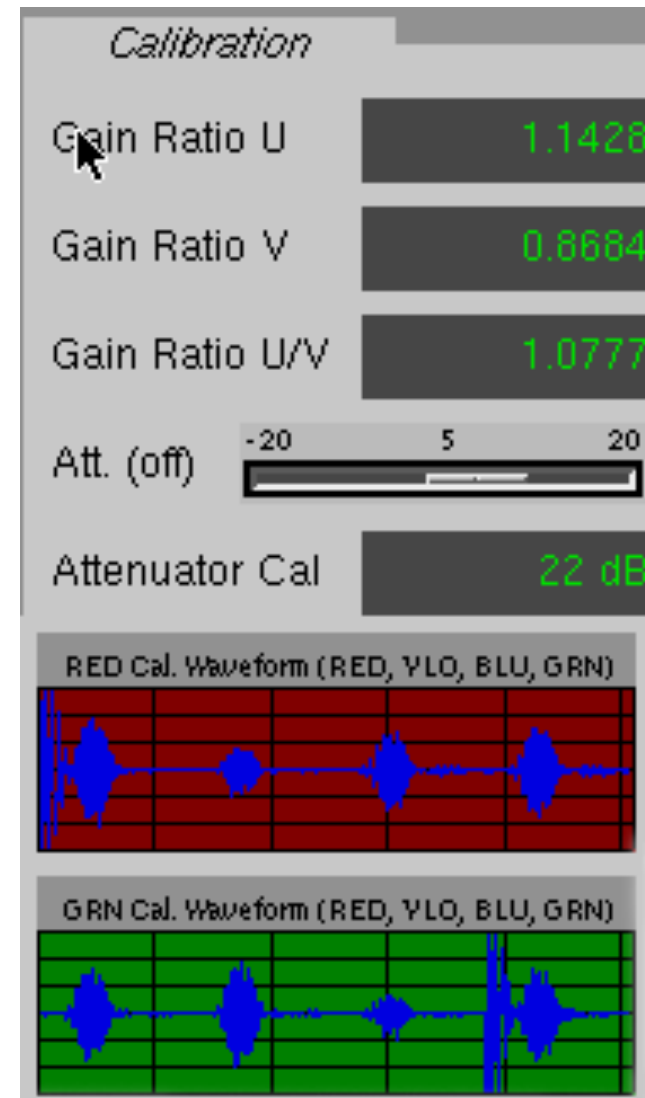
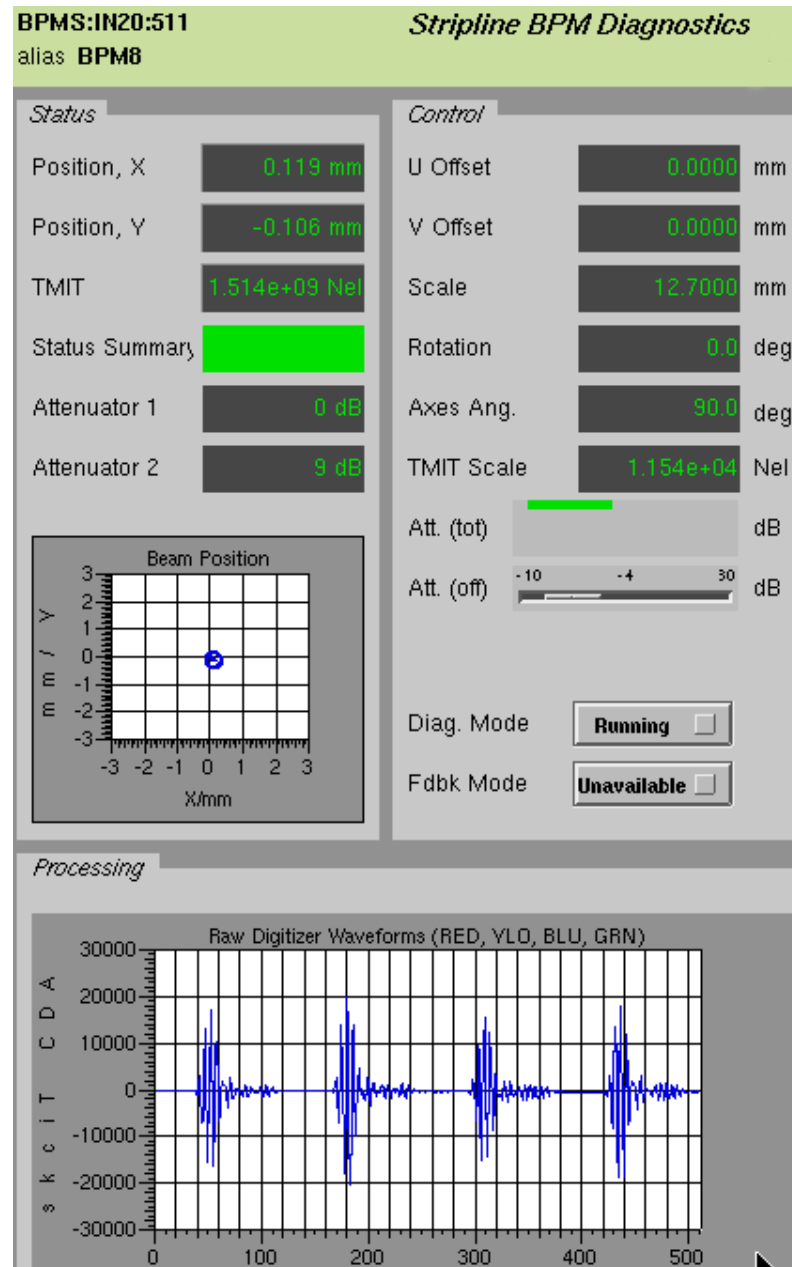
Resolution at 200 pC



Installation

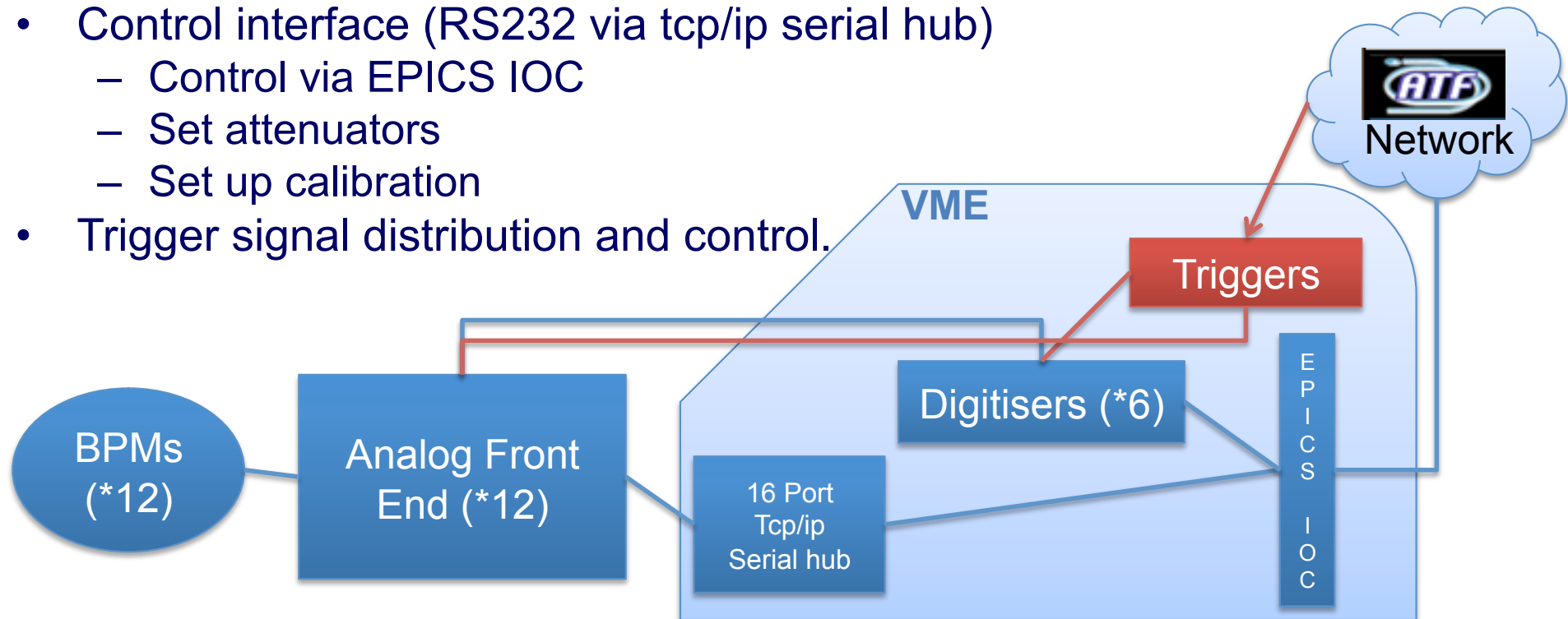


Online Diagnostic Displays



Configuration for ATF2

- Processor chassis containing Analog Frontend.
- Included:
 - Analog Frontend
 - Clock
- Functions:
 - All analog processing
 - Including calibration
- ADC (6 * 8-channel 14-bit 105MHz SIS3301 VME cards)
- Digital processing (EPICS db)
- Control interface (RS232 via tcp/ip serial hub)
 - Control via EPICS IOC
 - Set attenuators
 - Set up calibration
- Trigger signal distribution and control.



ATF2 Multibunch Operation

- BPM averages over train in multibunch mode
- Resolution is approximately the same as single bunch for the same charge per bunch
- Unless bunch spacing is near a subharmonic of BPM processing frequency