Stripline BPM Electronics Upgrade Report

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30 June 2010

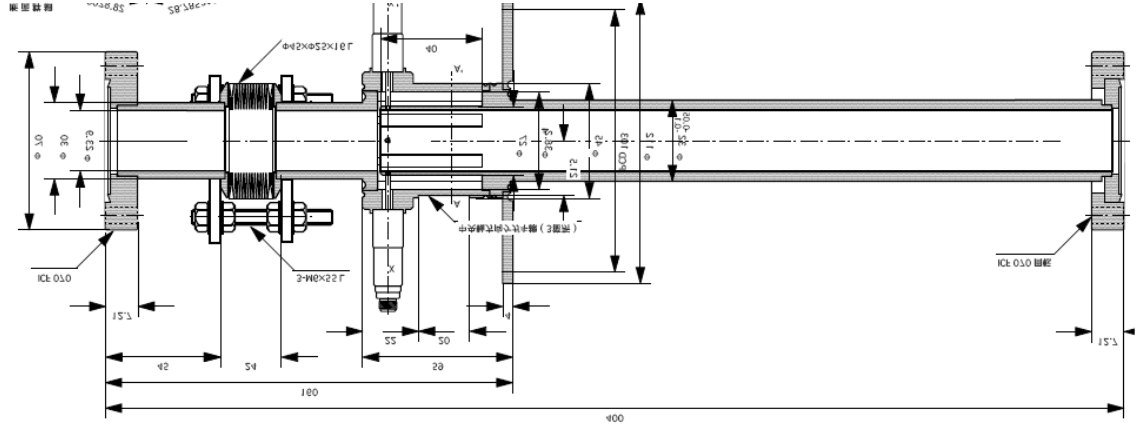
10th ATF2 Collaboration Meeting

Overview

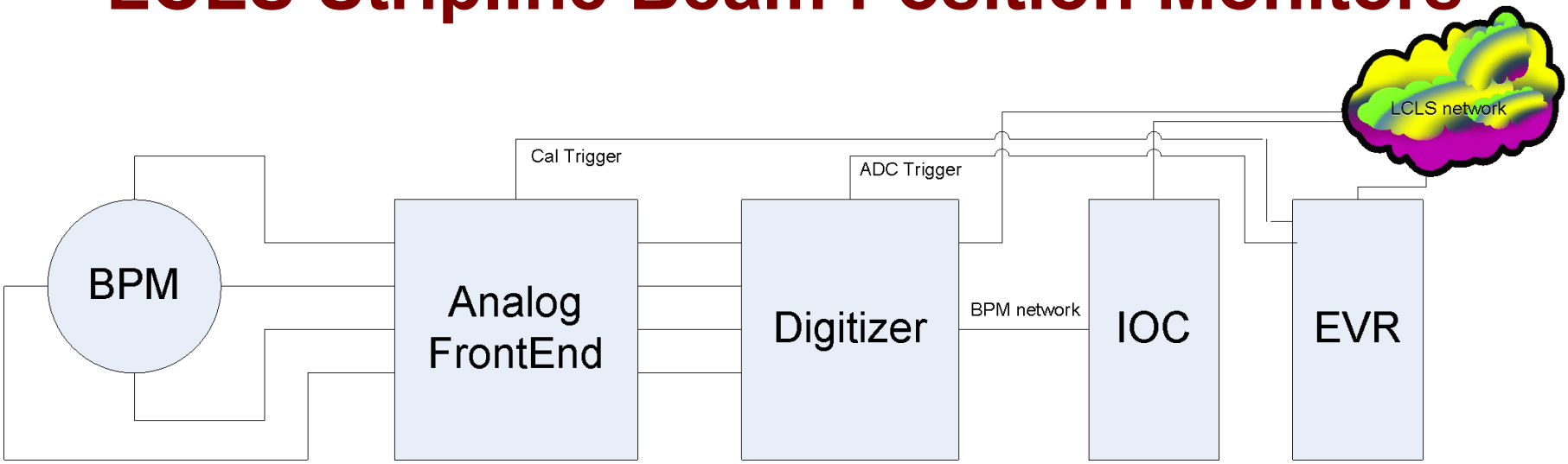
- 14 BPM processing modules of the same style used in LCLS currently were assembled for use in ATF2 extraction line.
- Installed electronics and tested during February 2010 2 week run period.
- Installed for 12 EXT stripline BPMs MQF1X through MQF15X + MFB1FF stripline BPM in FFS (+ 1 spare).
- Show overview of system and some results from tests after installation in February.

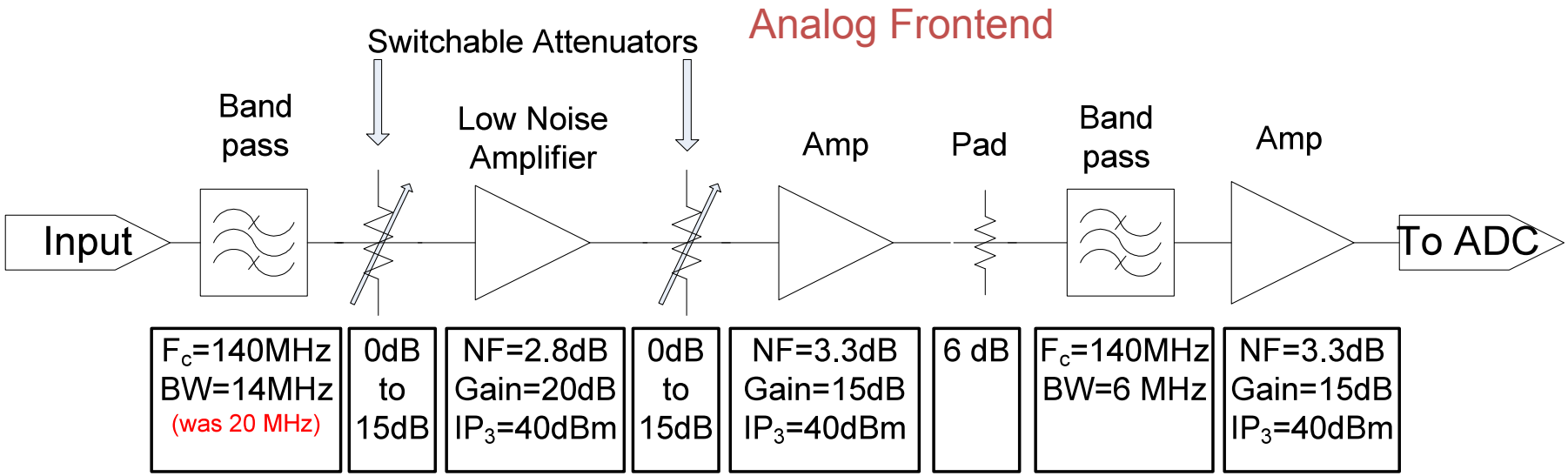
ATF2 Extraction Line BPMs

- 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 1-10 x 10^9 e^- / bunchRequirements:
  - Several-micron resolution
  - Good stability over bunch charge



LCLS Stripline Beam Position Monitors

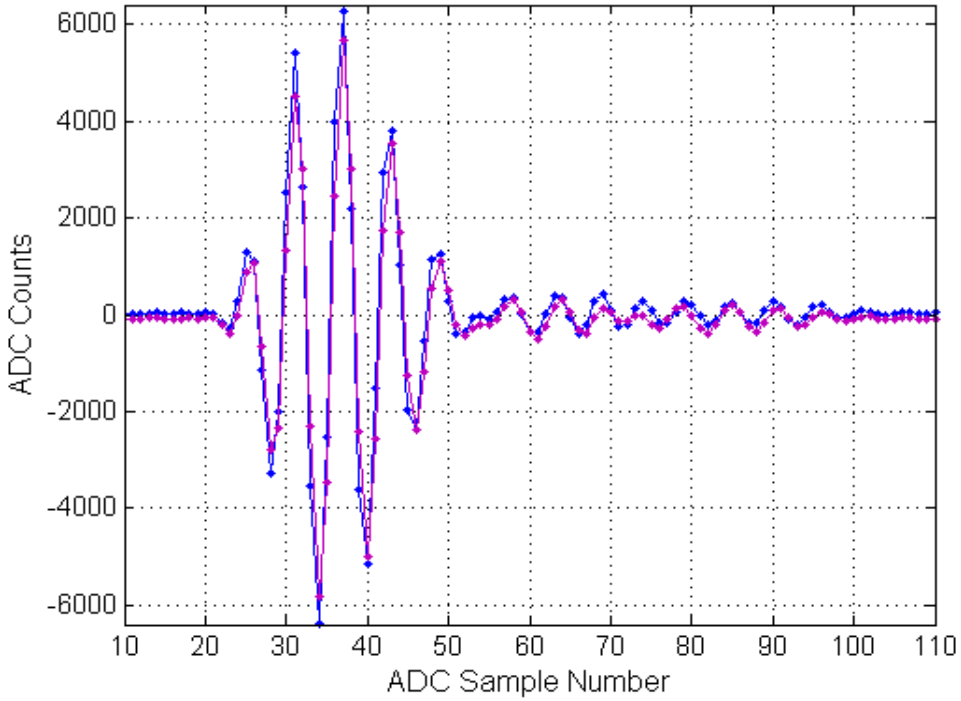




Signal is ~8 MHz band centered at 140 MHz

Algorithm

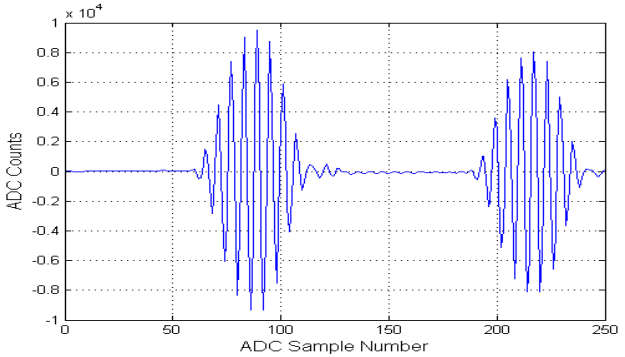
- IOC (VME processor) calculates position and beam charge from ADC waveforms
- Position:
  - Estimate amplitude from each strip
    - $V_i = \mathrm{rms}(ADC_i)$
    - Correct for calibrated gain ratio



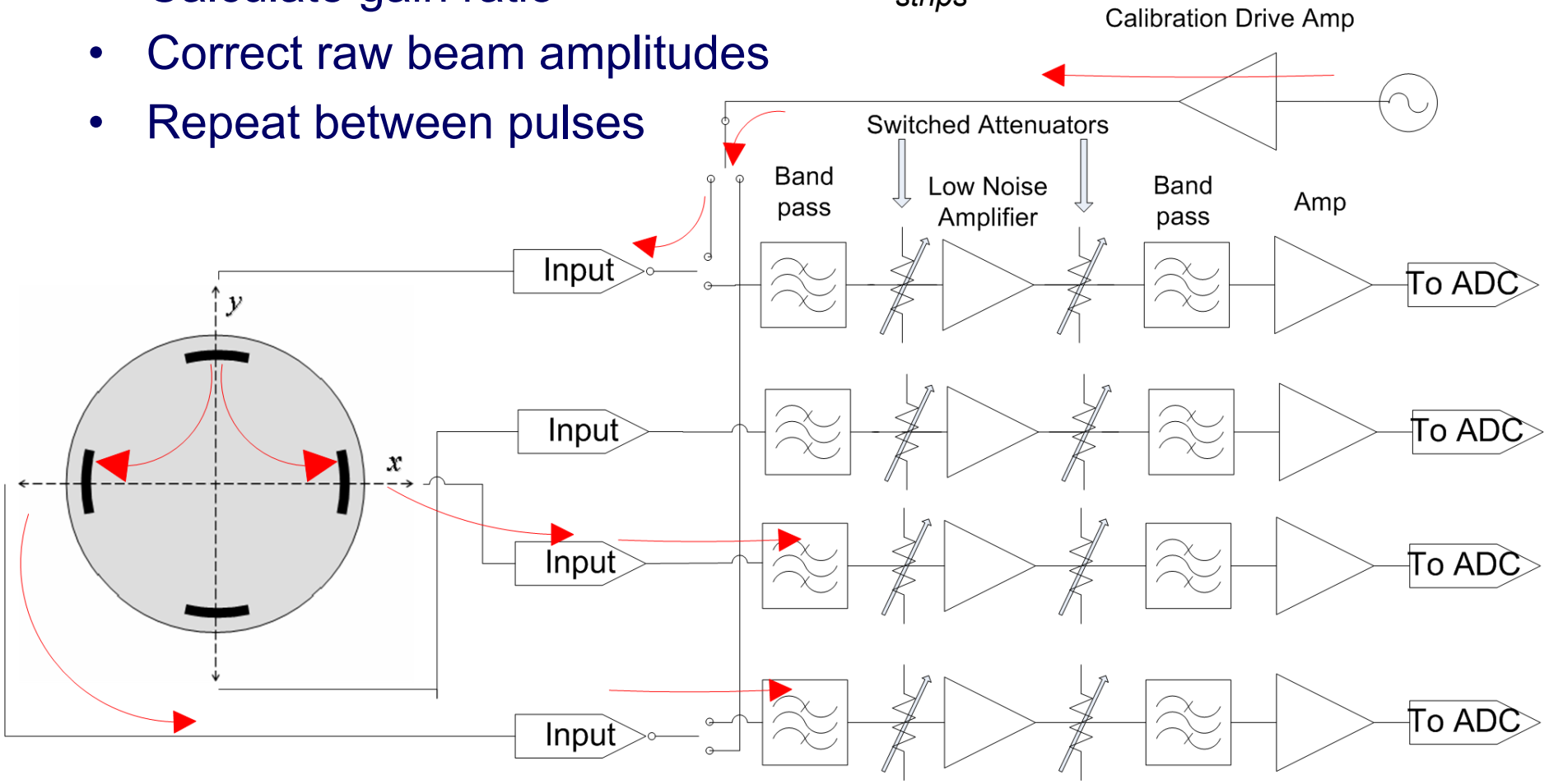
BPM raw digitized waveforms. Sampling frequency 120 MHz.

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

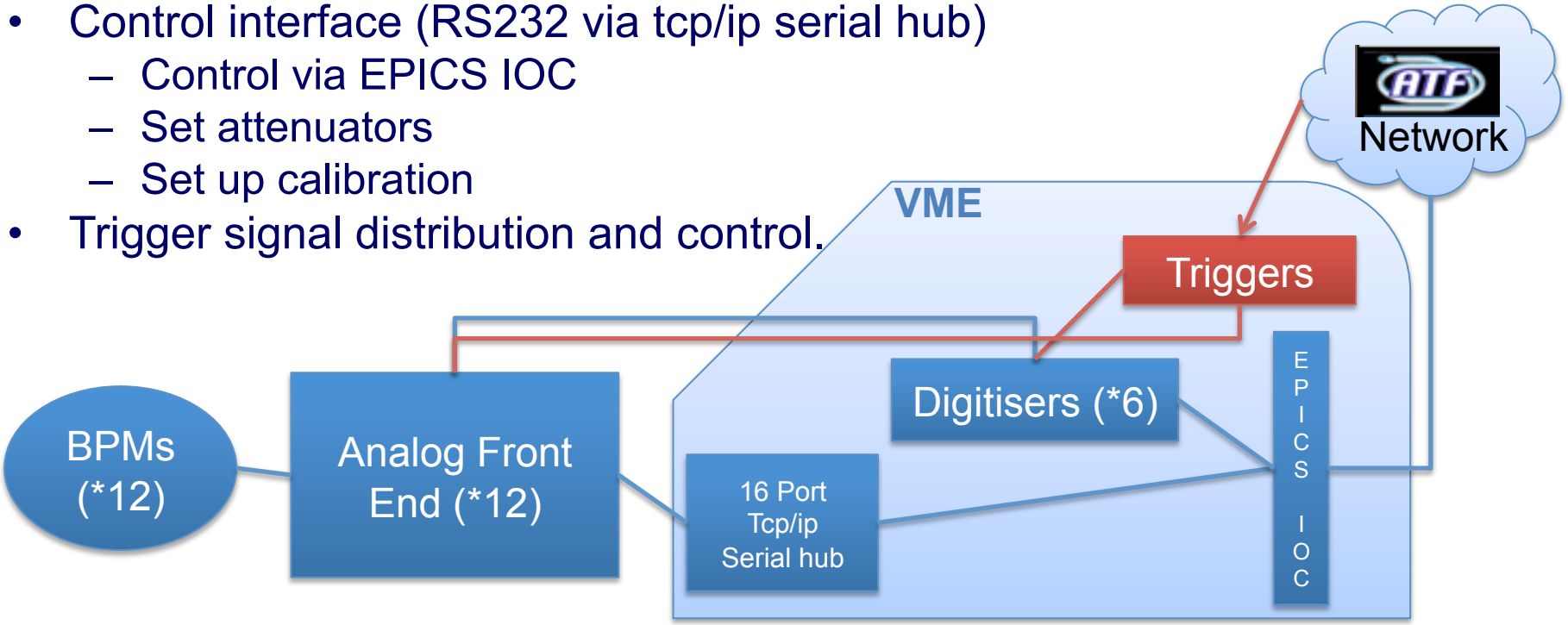


Calibrator tone burst detected on adjacent strips

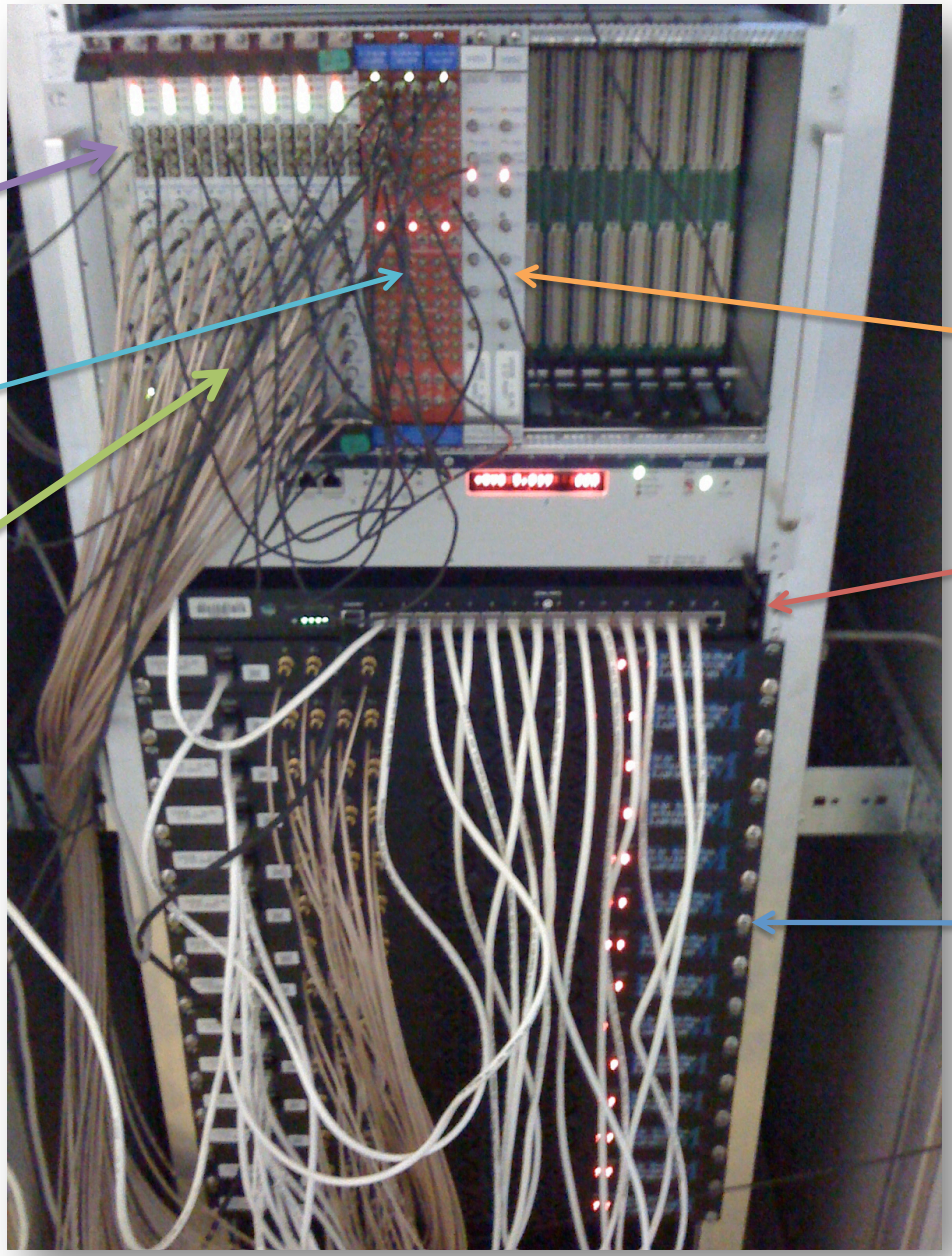


Configuration for ATF2

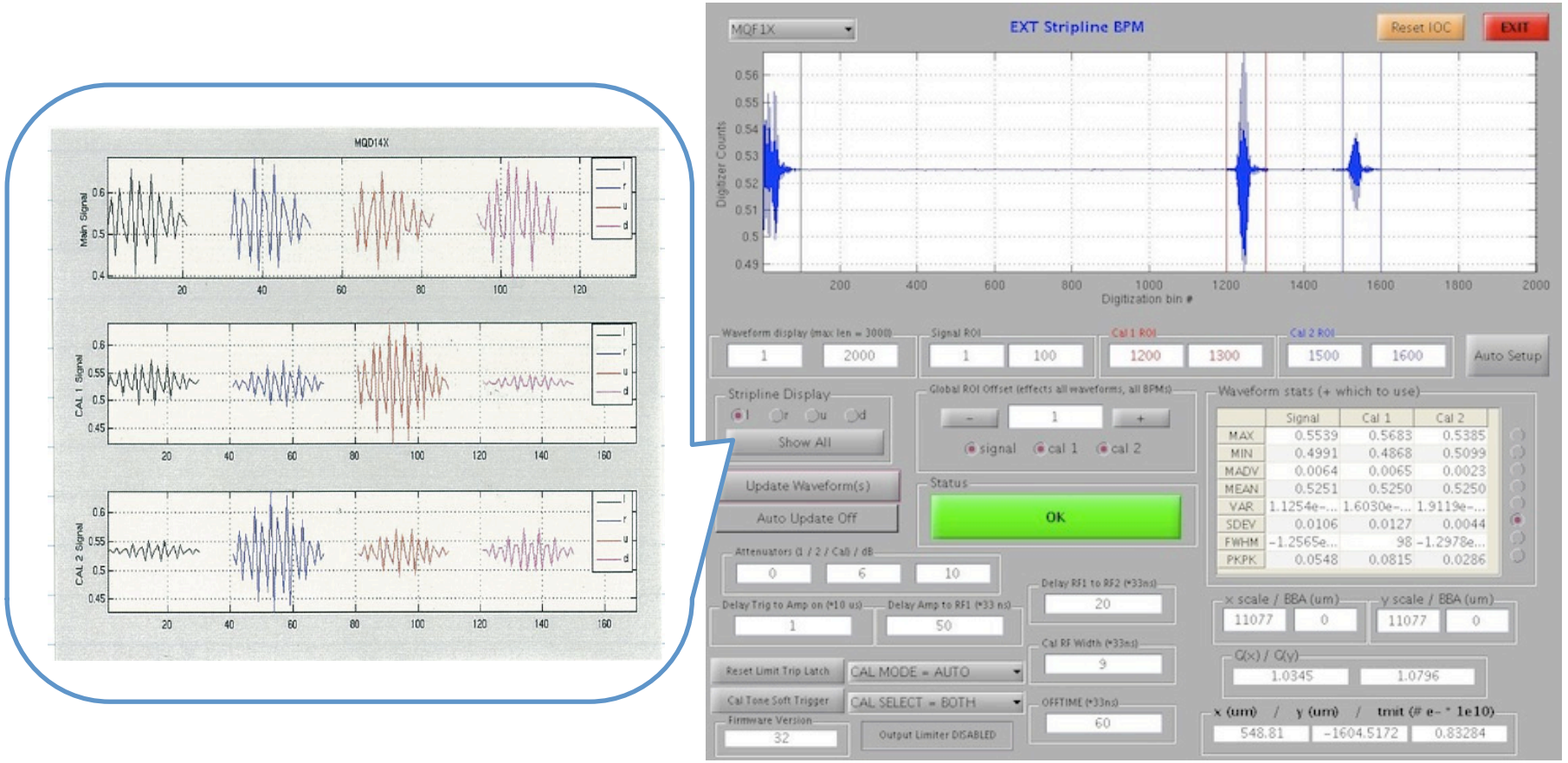
- Processor chassis containing Analog Frontend.
- Included:
  - Analog Frontend
  - Clock
- Functions:
  - All analog processing
  - Including calibration
- ADC (6 * 8-channel 14-bit 105MHz SIS3301 VME cards)
- Digital processing (EPICS db)
- Control interface (RS232 via tcp/ip serial hub)
  - Control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



ATF2 Installation



Setup GUI



- BPM system setup and monitoring available through standalone Matlab GUI.
- All system accessible also directly through EPICS PVs.

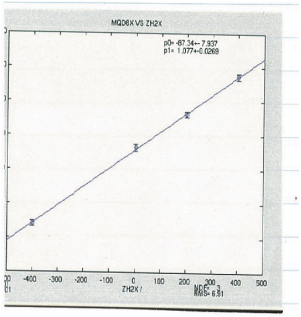
ATF2 Multibunch Operation

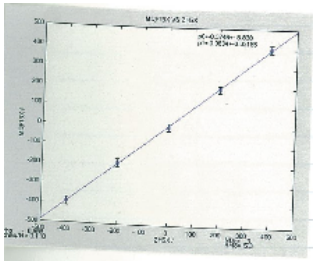
- BPM averages over train in multibunch mode
- Resolution is approximately the same as single bunch for the same charge per bunch
- Unless bunch spacing is near a subharmonic of BPM processing frequency

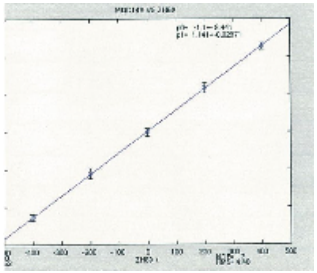
Measurements

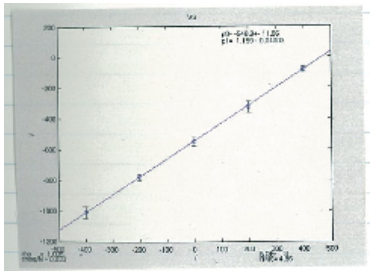
- Use 1,000 continuous stable pulses.
- Calibration slopes from corrector scans.
- Resolution measurement
  - Use SVD to subtract correlated jitter modes.
- Gains monitored in EPICS archiver.

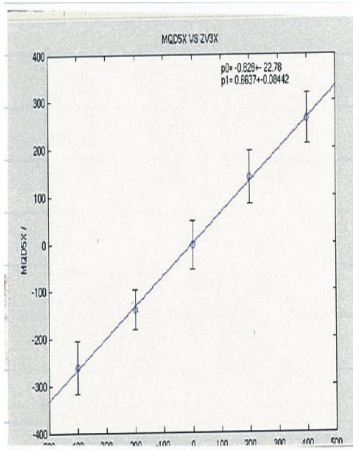
Calibration Slopes

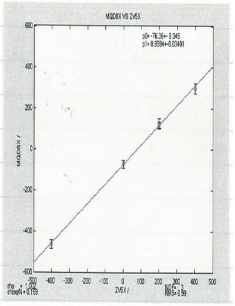


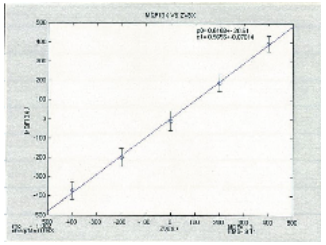


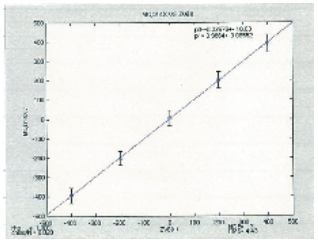


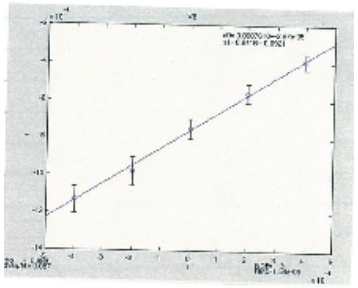


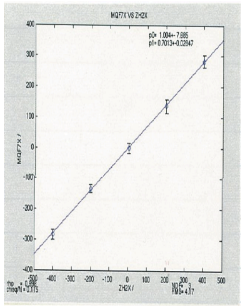


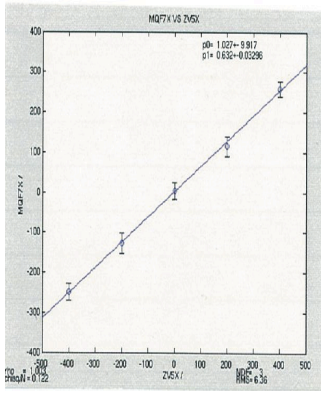


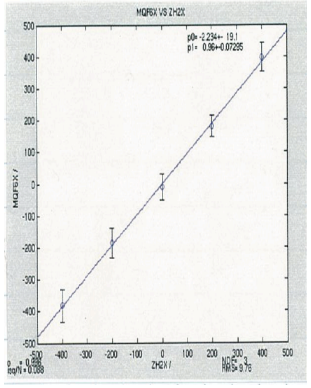


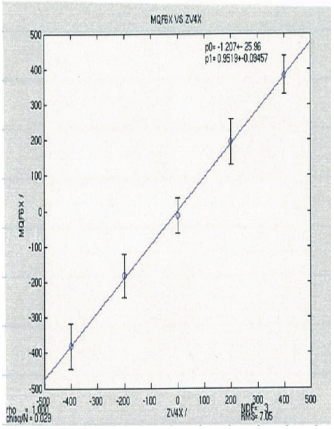


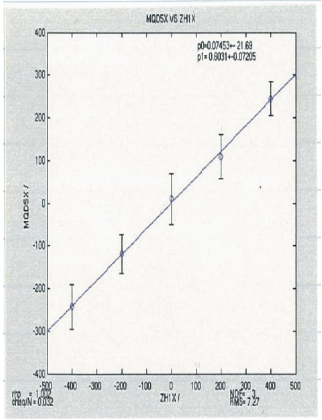




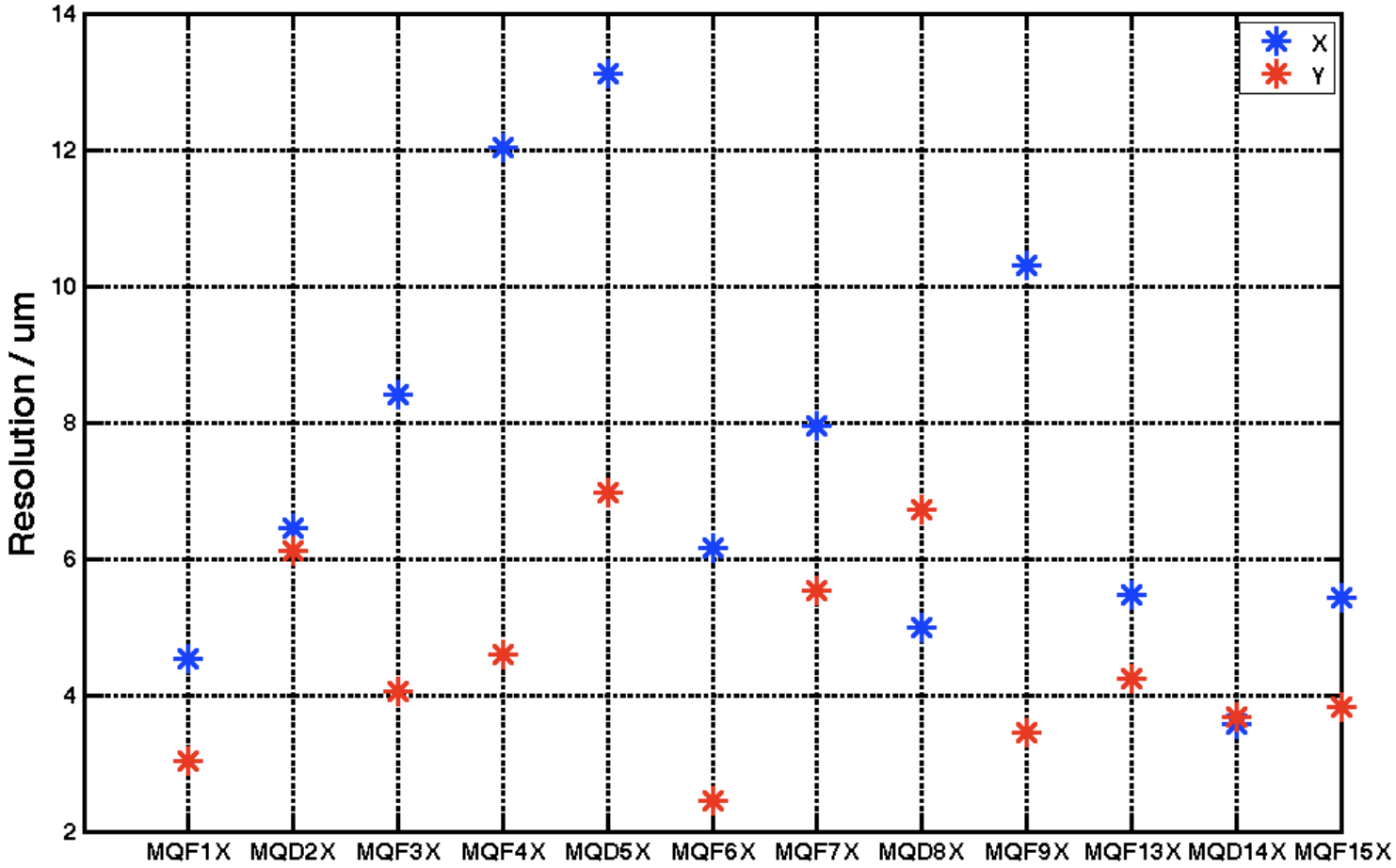






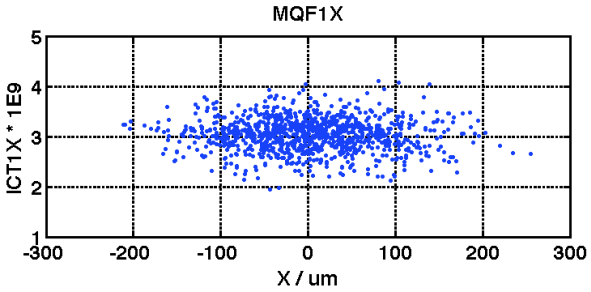


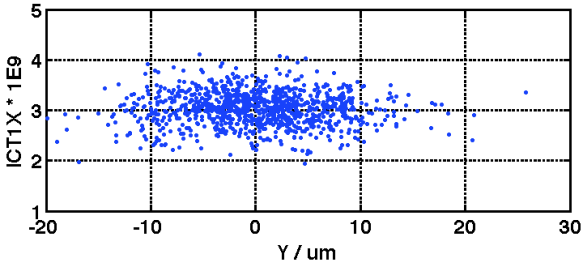
Resolution Results

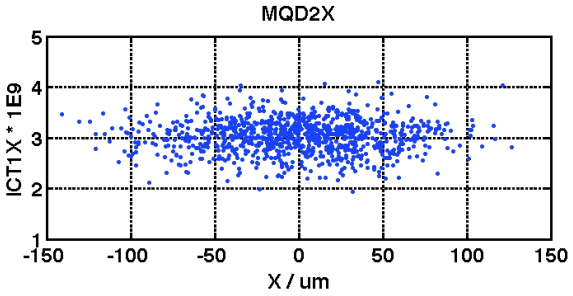


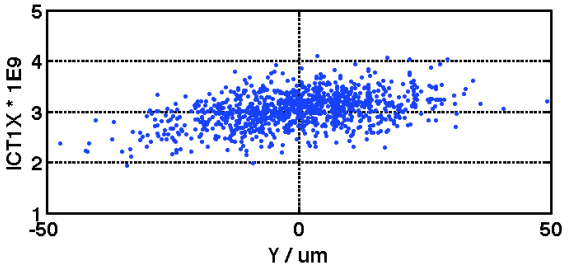
- Use SVD analysis to subtract correlated jitter modes from 1000 pulse data set, assume rest due to BPM resolution.

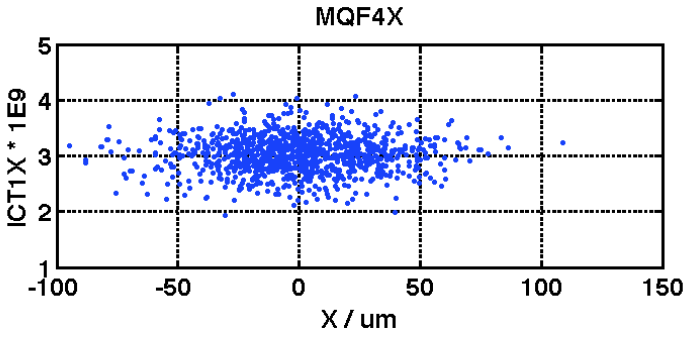
Q vs. Pos

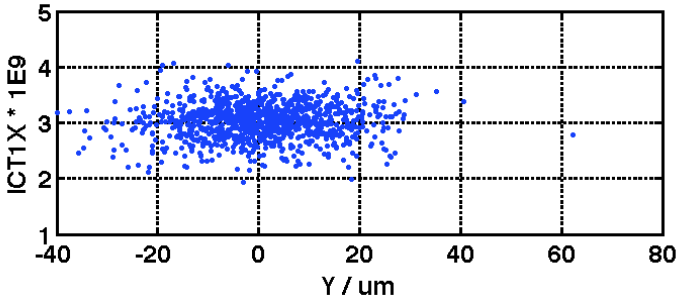

MQF1X
ICT1X * 1E9
X / um

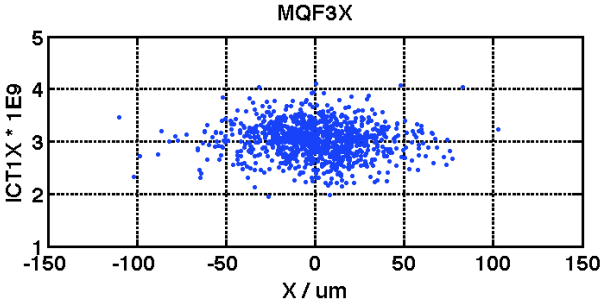

ICT1X * 1E9
Y / um

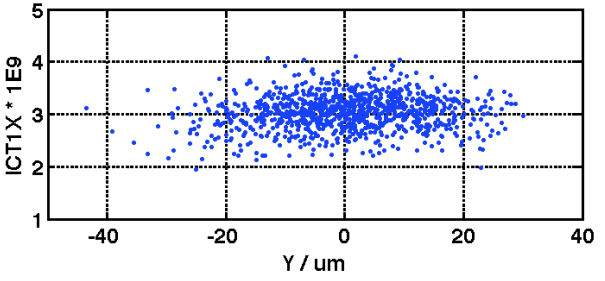

MQD2X
ICT1X * 1E9
X / um


ICT1X * 1E9
Y / um

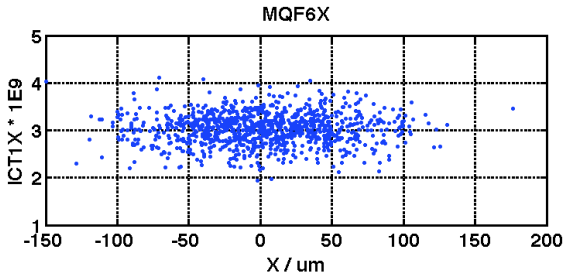

MQF4X
ICT1X * 1E9
X / um

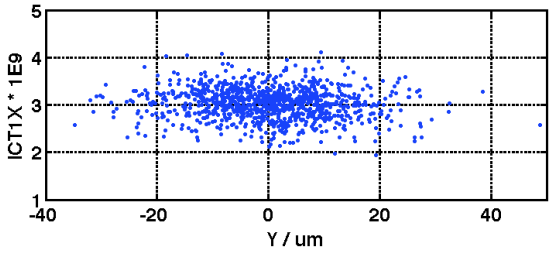

ICT1X * 1E9
Y / um

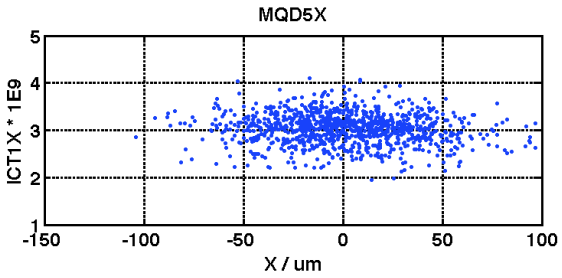

MQF3X
ICT1X * 1E9
X / um

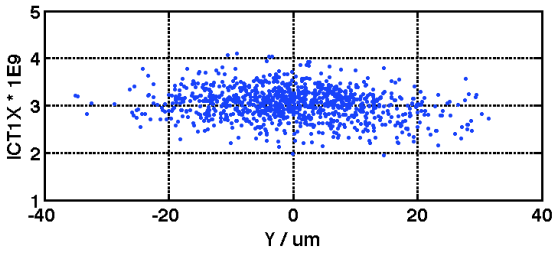

ICT1X * 1E9
Y / um

Q vs. Pos


MQF6X
ICT1X * 1E9
X / um


ICT1X * 1E9
Y / um


MQD5X
ICT1X * 1E9
X / um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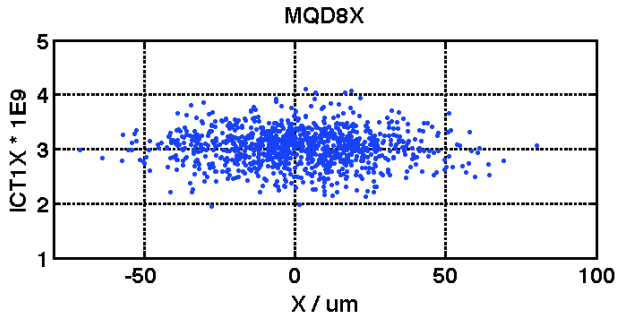
Y / um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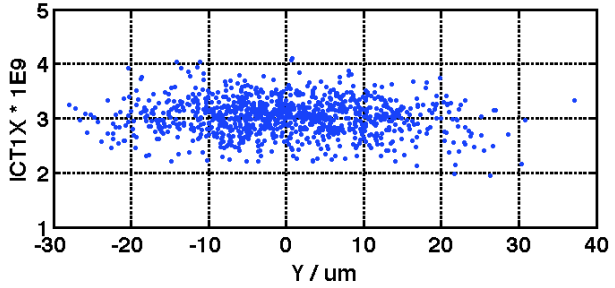
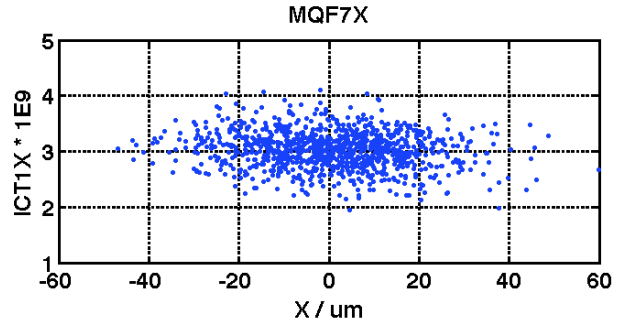
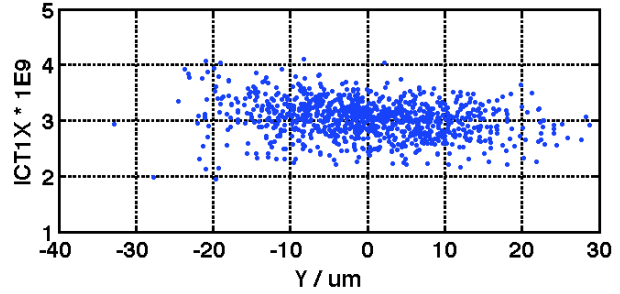
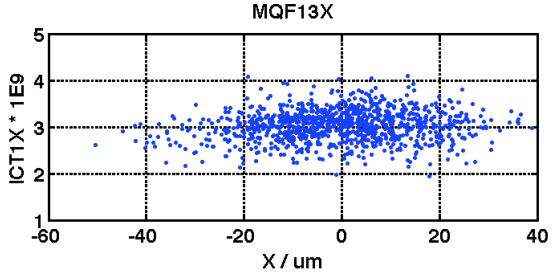
ICT1X * 1E9
X / um

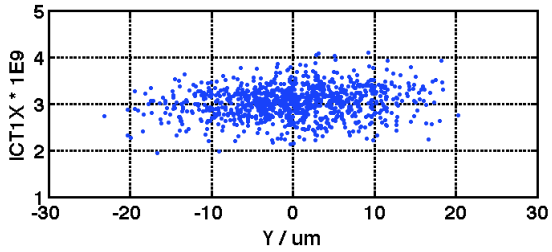

ICT1X * 1E9
Y / um

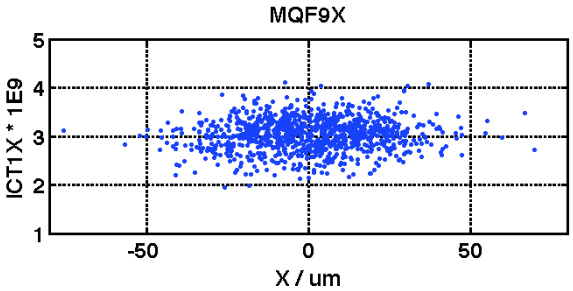

MQF7X
ICT1X * 1E9
X / um

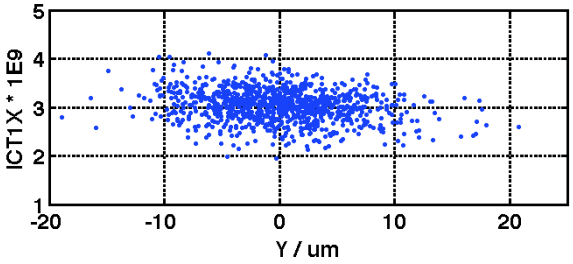

ICT1X * 1E9
Y / um

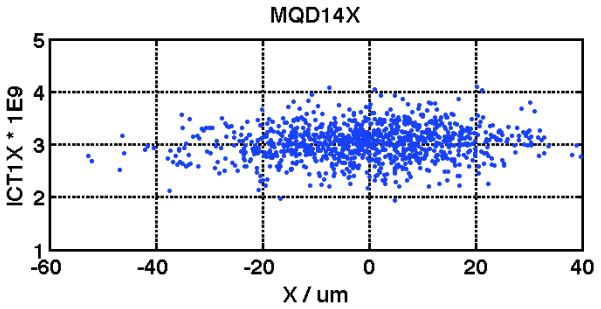
Q vs. Pos

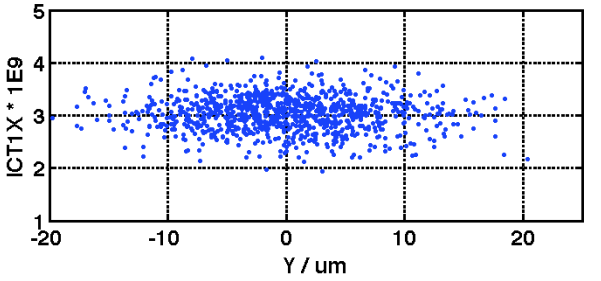

MQF13X
ICT1X * 1E9
X / um

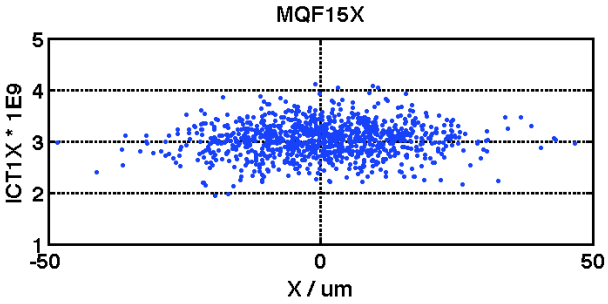

ICT1X * 1E9
Y / um

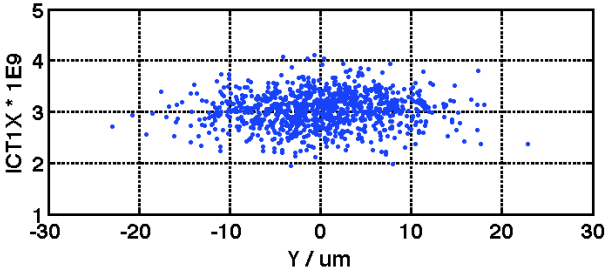

MQF9X
ICT1X * 1E9
X / um


ICT1X * 1E9
Y / um

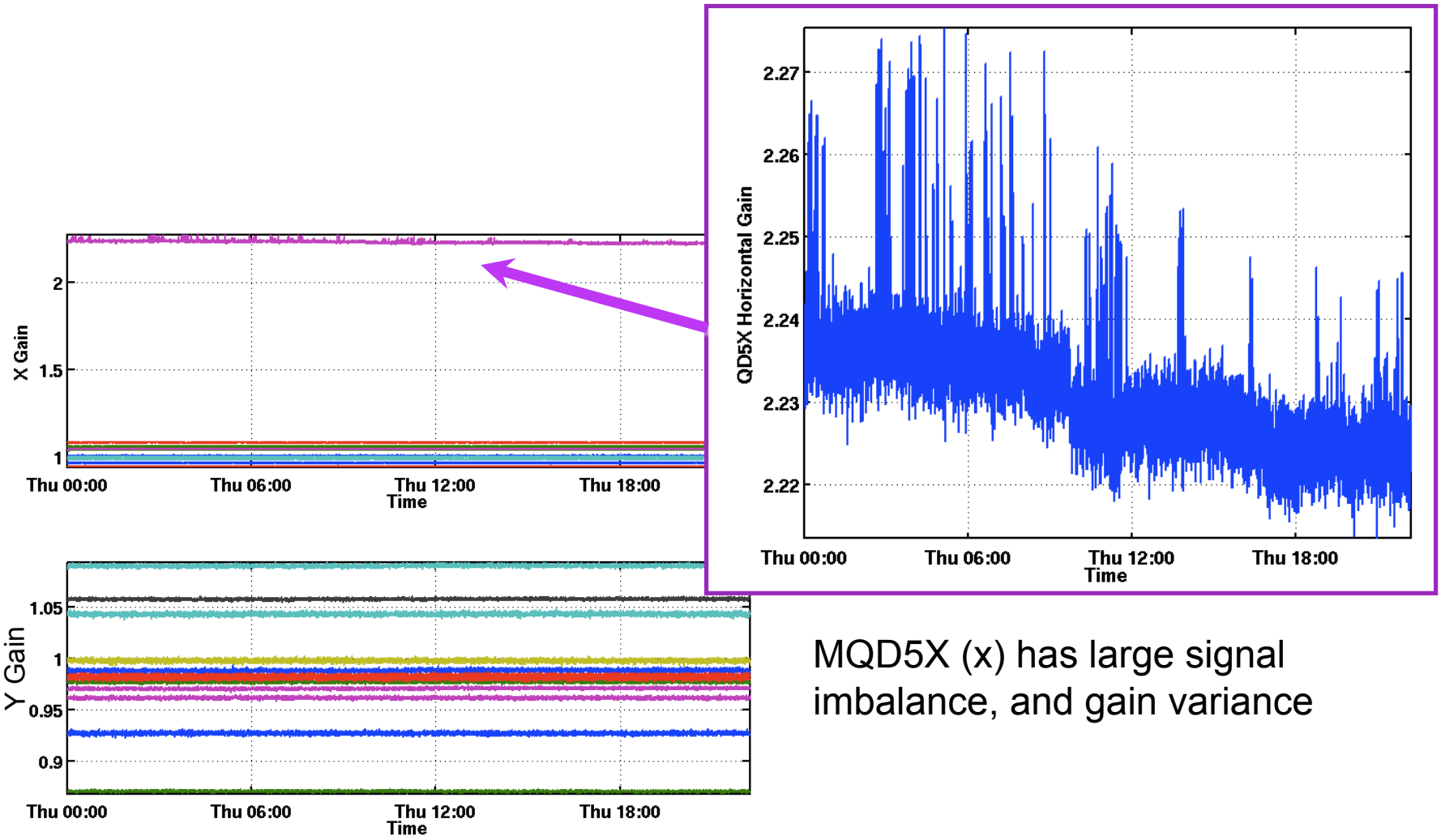

MQD14X
ICT1X * 1E9
X / um


ICT1X * 1E9
Y / um


MQF15X
ICT1X * 1E9
X / um

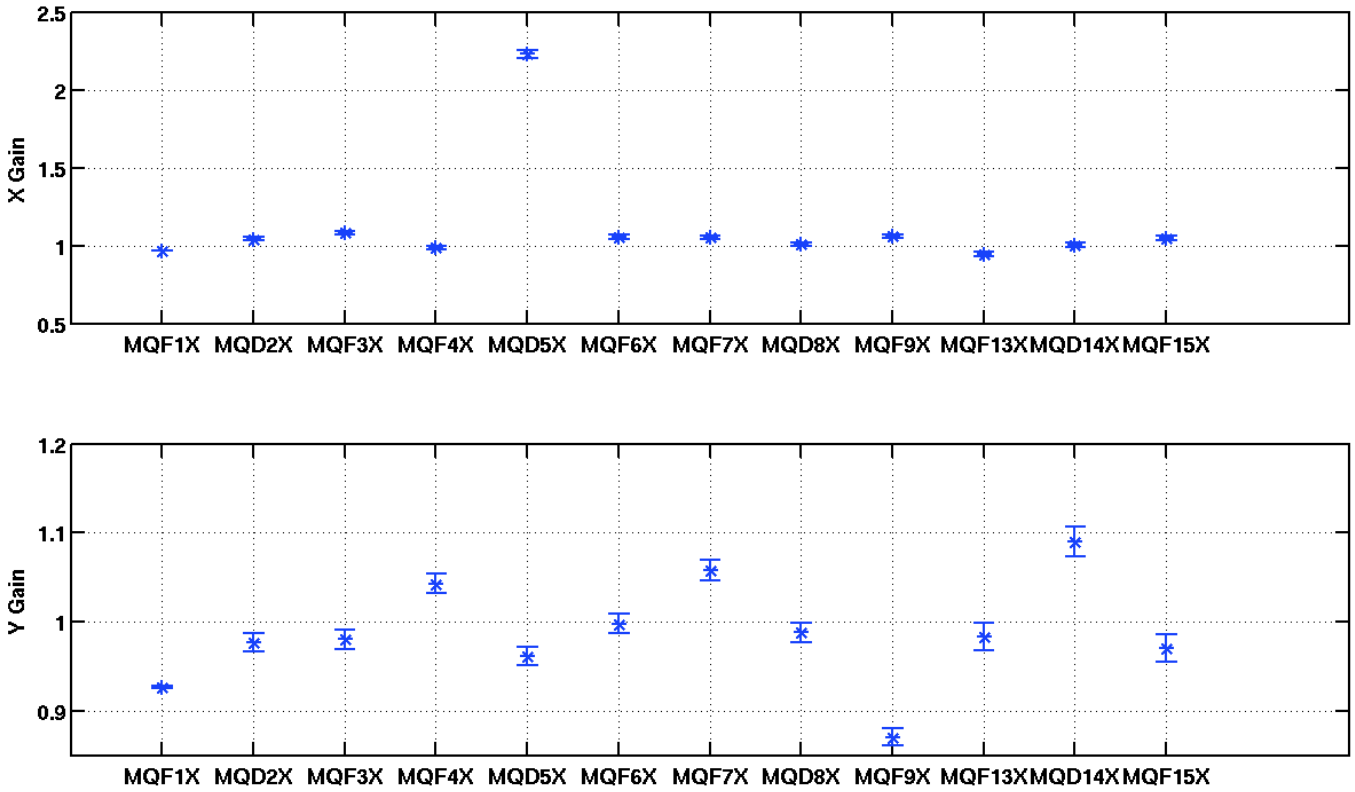

ICT1X * 1E9
Y / um

BPM Gains



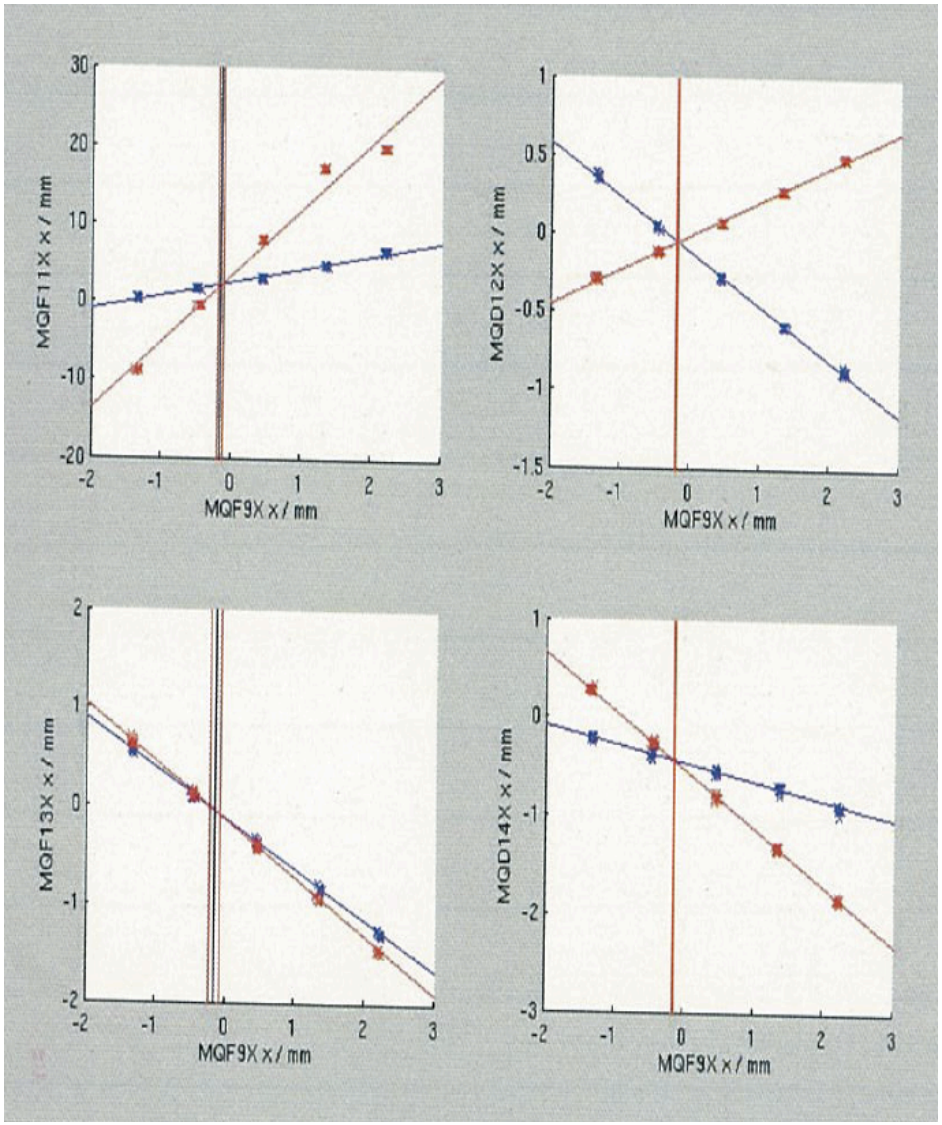
MQD5X (x) has large signal imbalance, and gain variance

Gain Summary



- Mean and RMS gains over 1 day period

BBA Test (QF9X)



- Quad shunting BBA for QF9X.
- For quad at 100% and 80% nominal strength.
- Alignment from crossing of steered beam position at MQF9X vs. downstream magnet BPMs.

Summary

- New EXT stripline BPMs all setup and available for use.
- Resolutions ~<10um, insensitive to Q.
- MQF4X now working ok after disconnecting and re-connecting cables!
- MQD5X, suspect cables responsible for high gain in x channel (and drift?).
- Configuration, monitoring and control through Matlab GUI
  - Instructions on wiki.