ATF2 Cavity BPM systems

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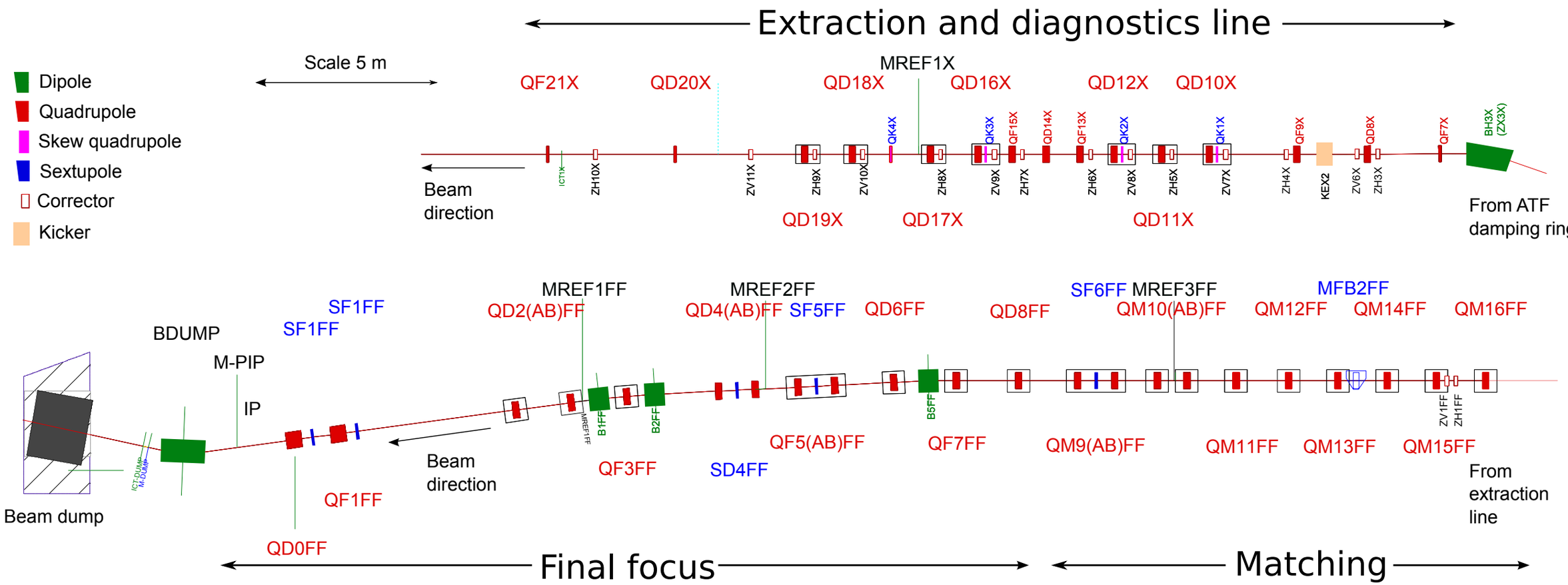
SLAC, KNU, PAL, KEK, JAI-RHUL, KEK, ATF

https://www.pp.rhul.ac.uk/twiki/bin/view/JAI/BeamPosition

Introduction

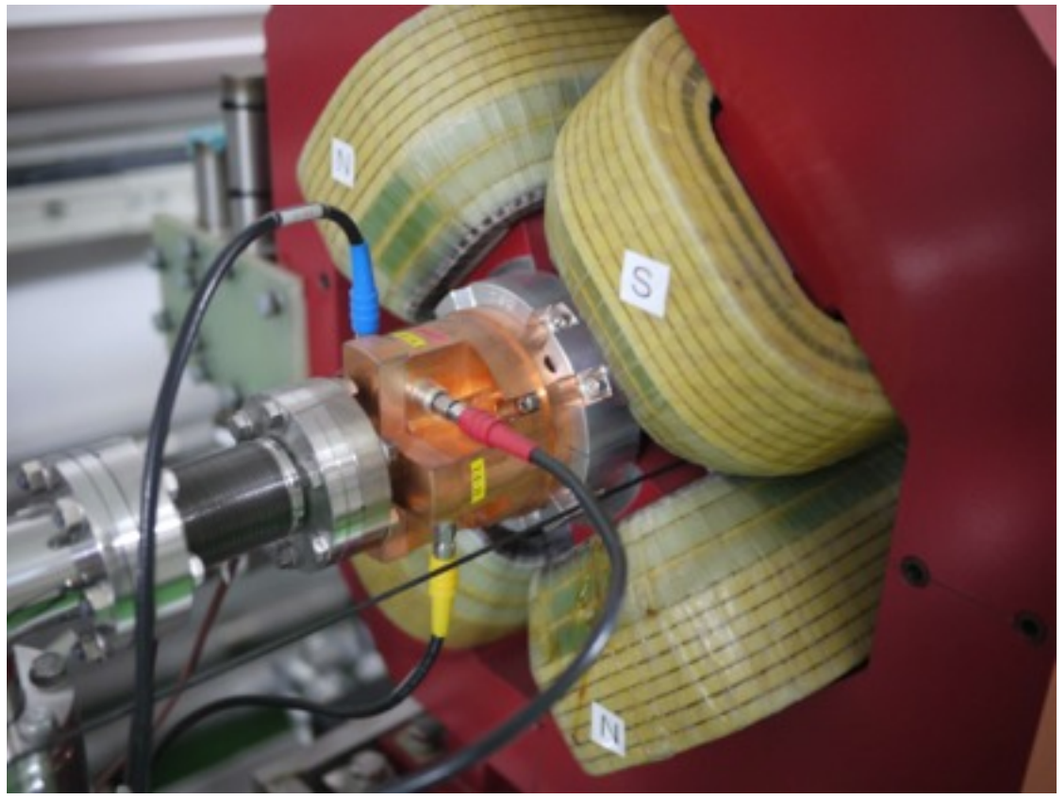
- Introduction
- Progress on normal C and S-band BPMs
  - Stability
    - What changed?
  - BBA and orbit feedback?
  - Dispersion and model check out
- Interaction region
  - Program at the interaction point
  - Alignment and operation
- Summary

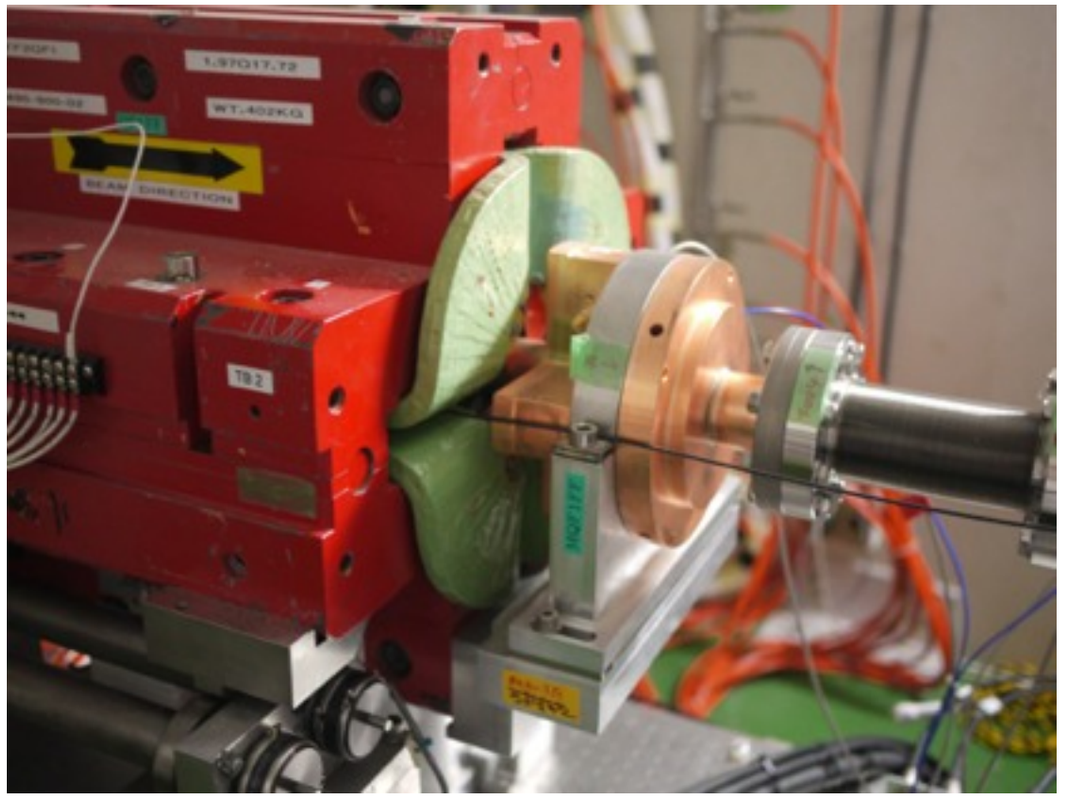
ATF2 BPM system



- 35 C-band (3 references)
  - 20 on movers 15 static
- 4 S-band (1 reference, at image frequency)
- 2 IP C-band (1 reference)

C and S-band BPMs

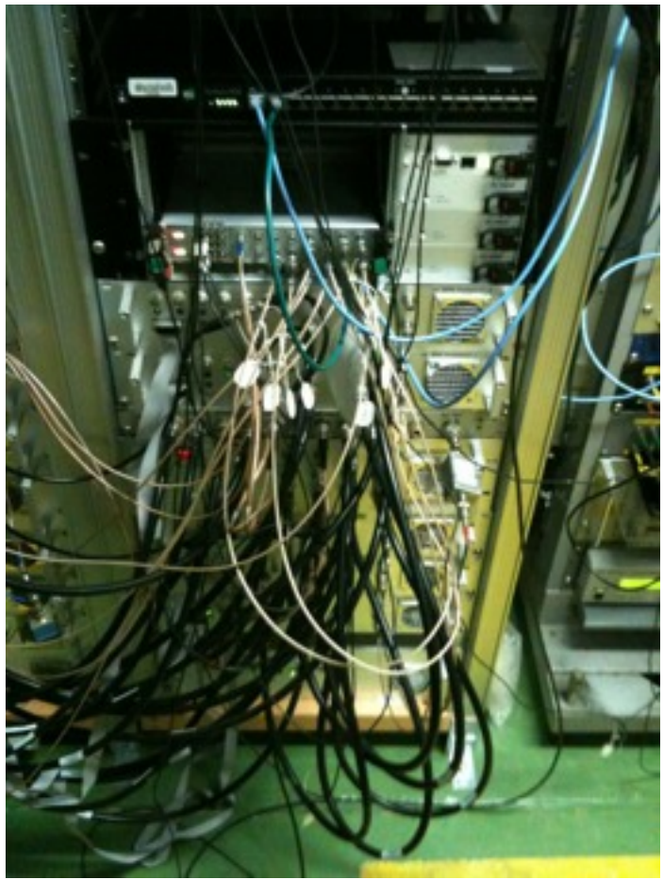


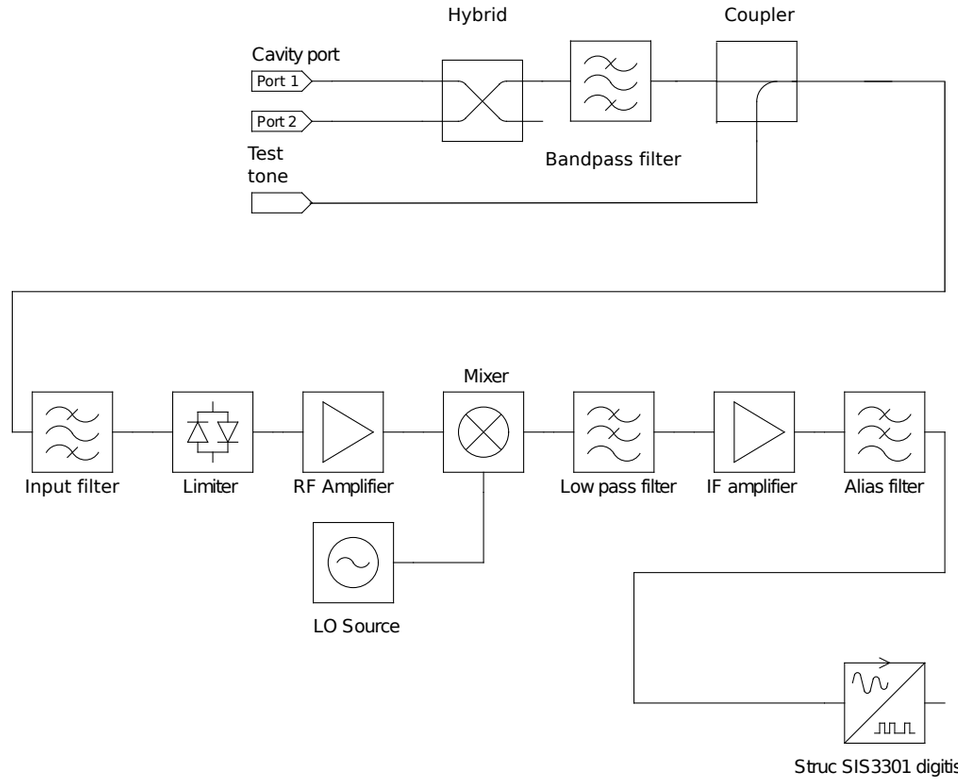


- C-band BPM
  - Dipole F : 6.426 GHz
  - Sensitivity : 0.8 V/mm/nC

- S-band BPM
  - Dipole F : 2.888 GHz
  - Sensitivity : 0.15 V/mm/nC

Processing RF electronics

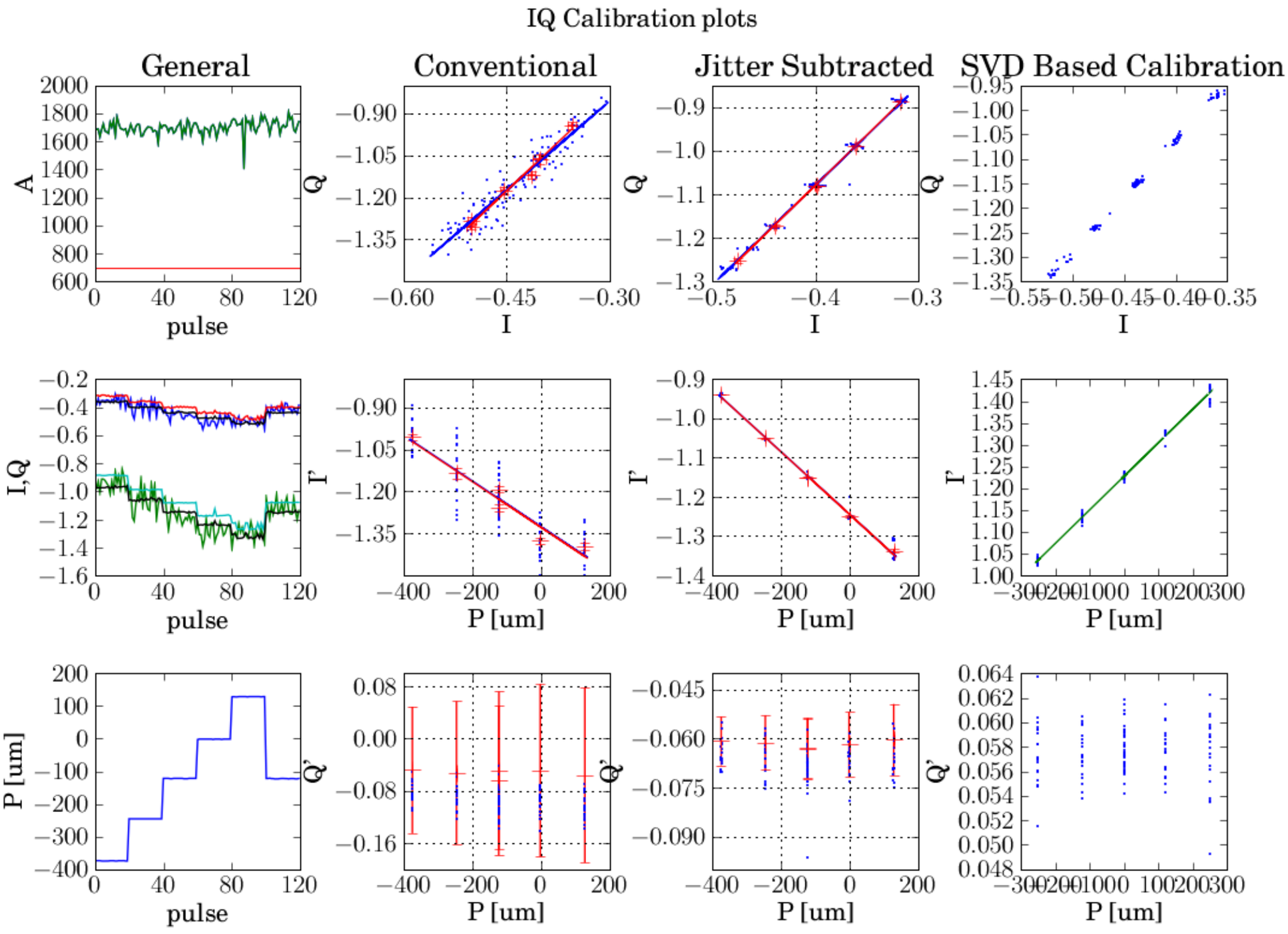




- Signal stage, image rejection down-converters/amplifiers
  - Intermediate frequency ~ 25 MHz
  - 100 MHz digitizer (14 or 16 bit)
  - C-band electronics : in tunnel
  - S-band electronics : outside shielding blocks

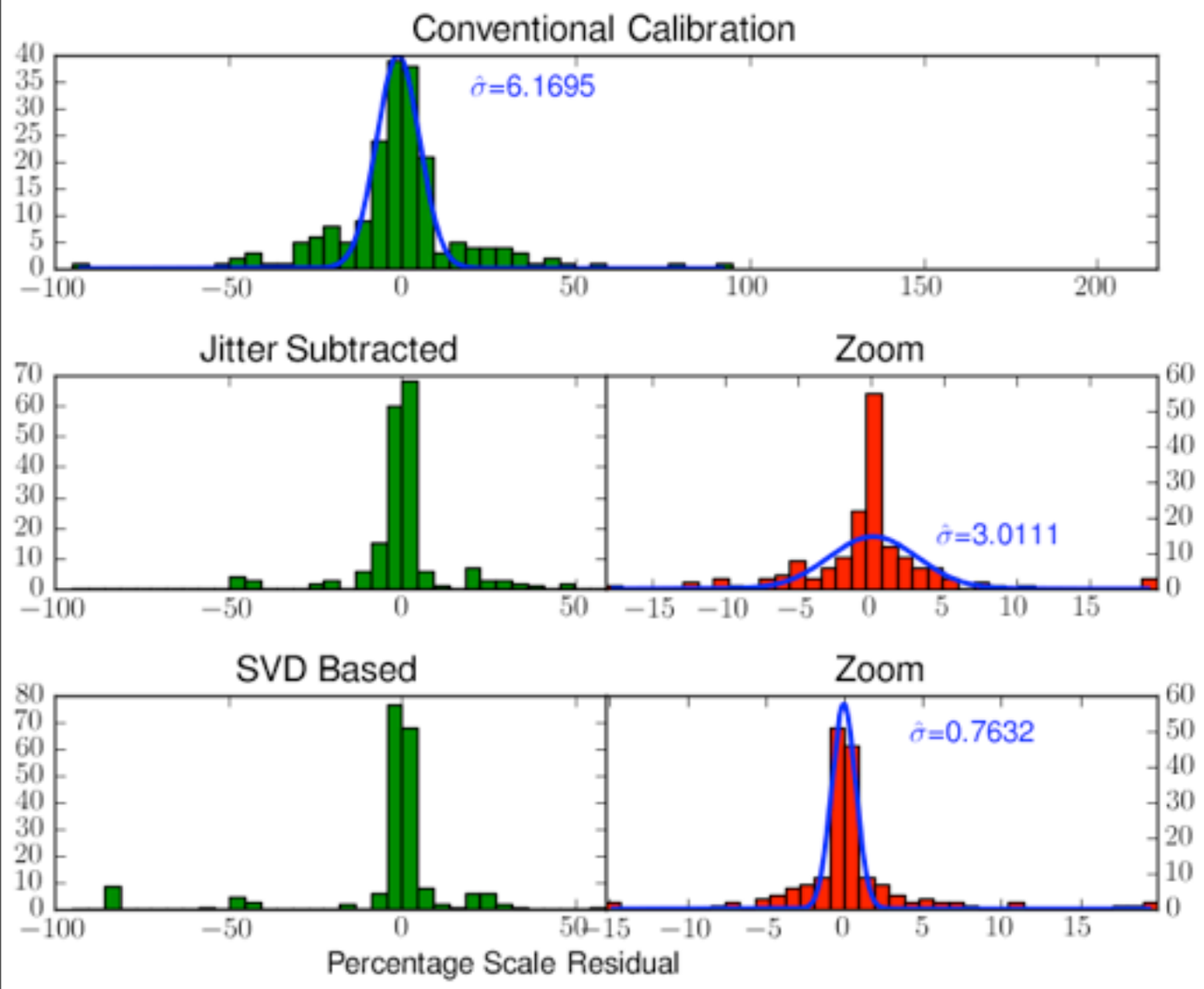
Calibration stability

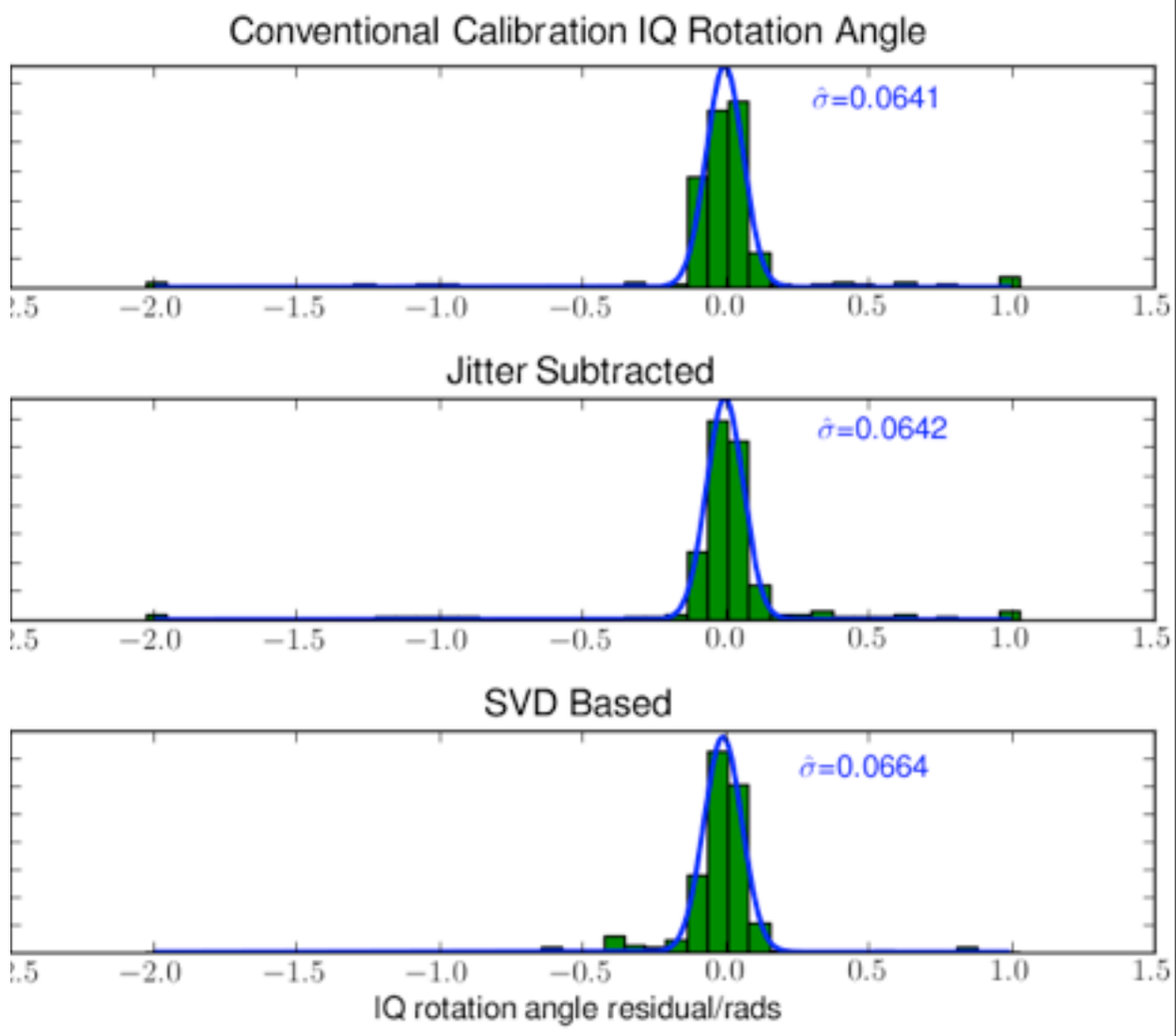
- Calibration performed each week for 3 weeks in April



A. Lyapin

Calibration stability April





- Calibration performed each week for 3 weeks in April

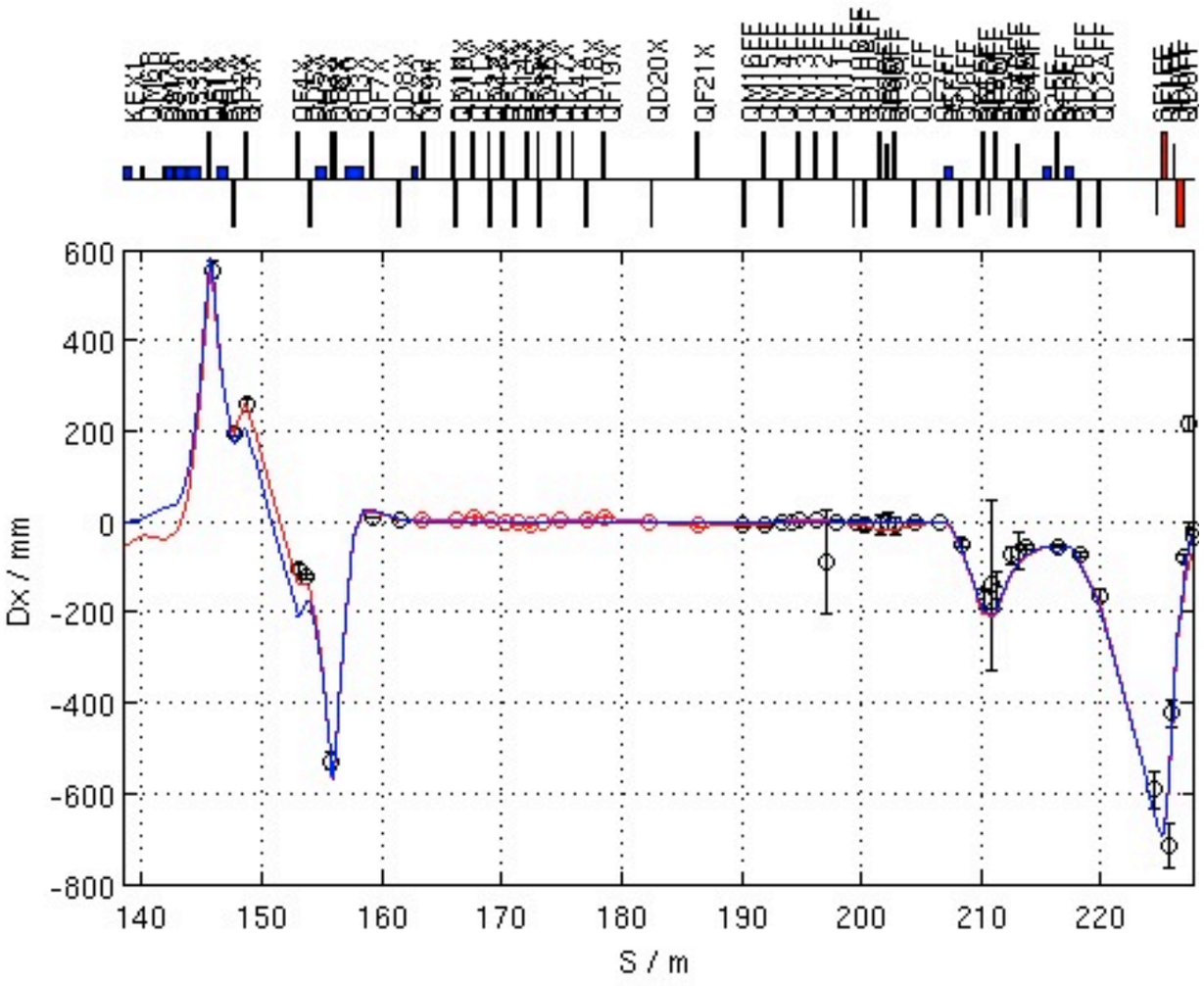
F. Cullinan

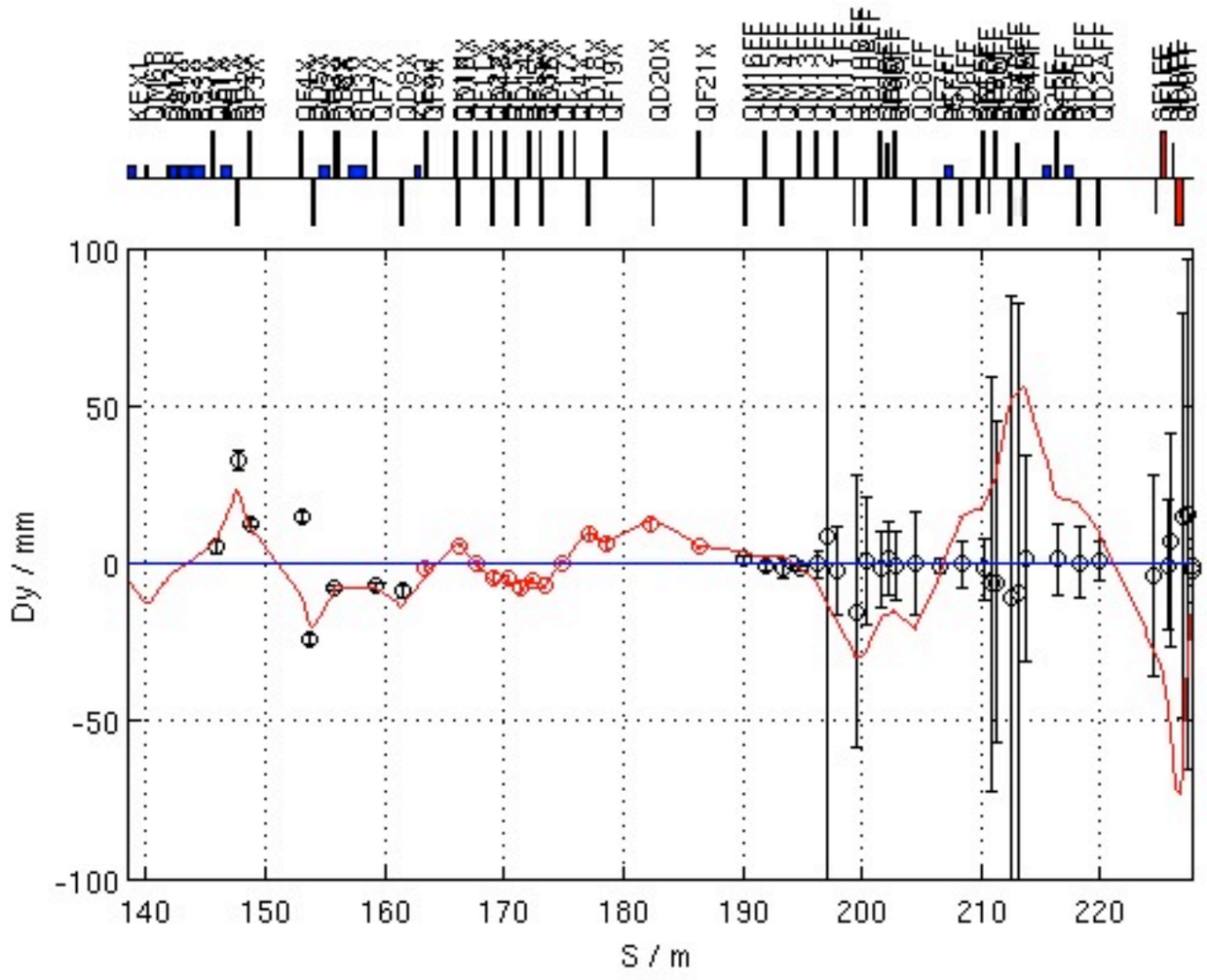
Orbit feedbacks and BBA

- Lack of information on this topic
  - Which BPMs are used?
  - How are they used?
  - Is there a performance requirement?
- Beam based alignment
  - Who should hold the BBA offsets?
  - Currently EPICS variable in the BPM system
  - New BBA codes appear to be available
  - Some people use data direct from the BPM system due to synchronisation issues

- **Need specifications for both of these procedures**

Model checkout and dispersion



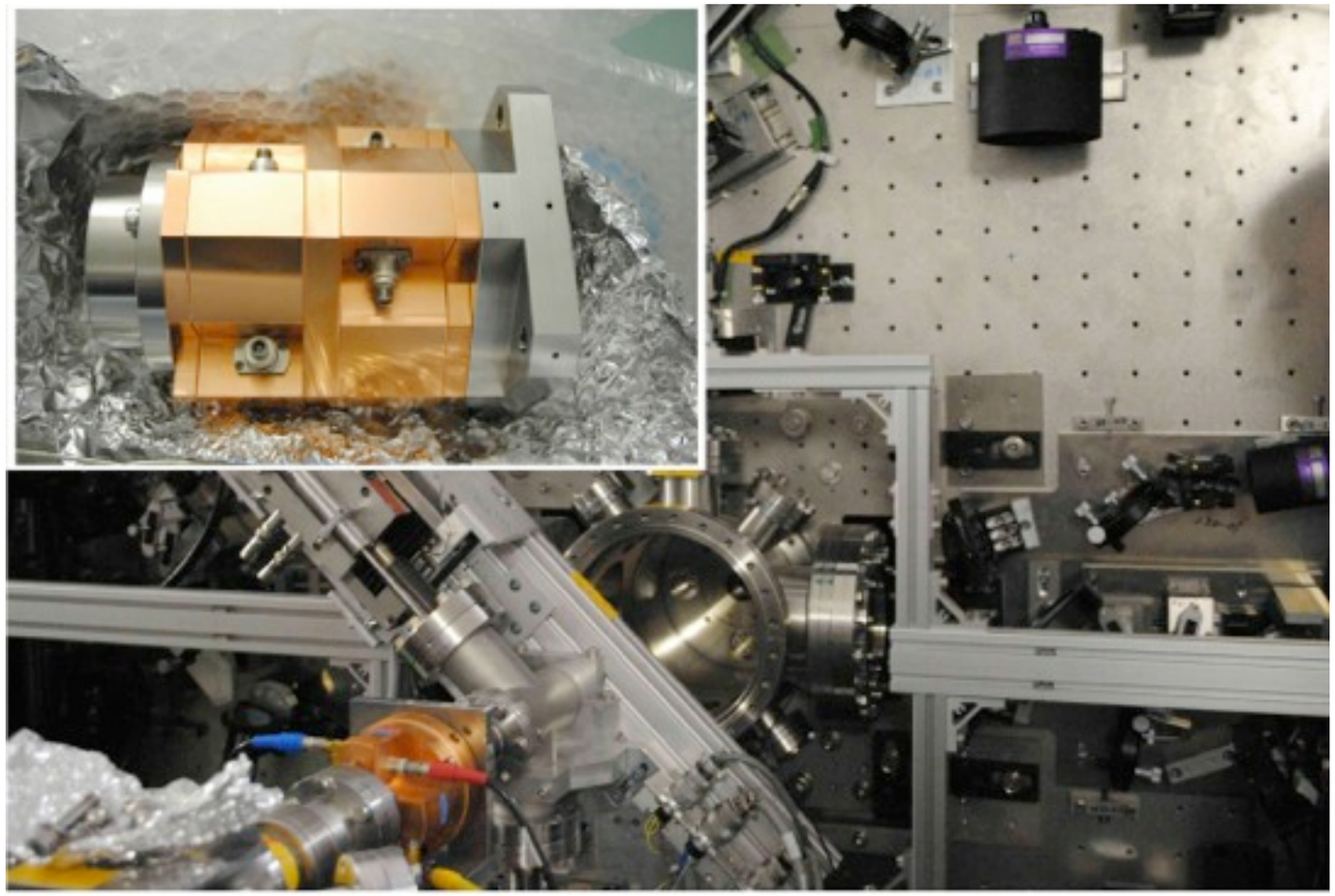


- Dispersion measurement from June 2012
- Reasonable agreement between model and BPM measurements
- Calibration from April 2012

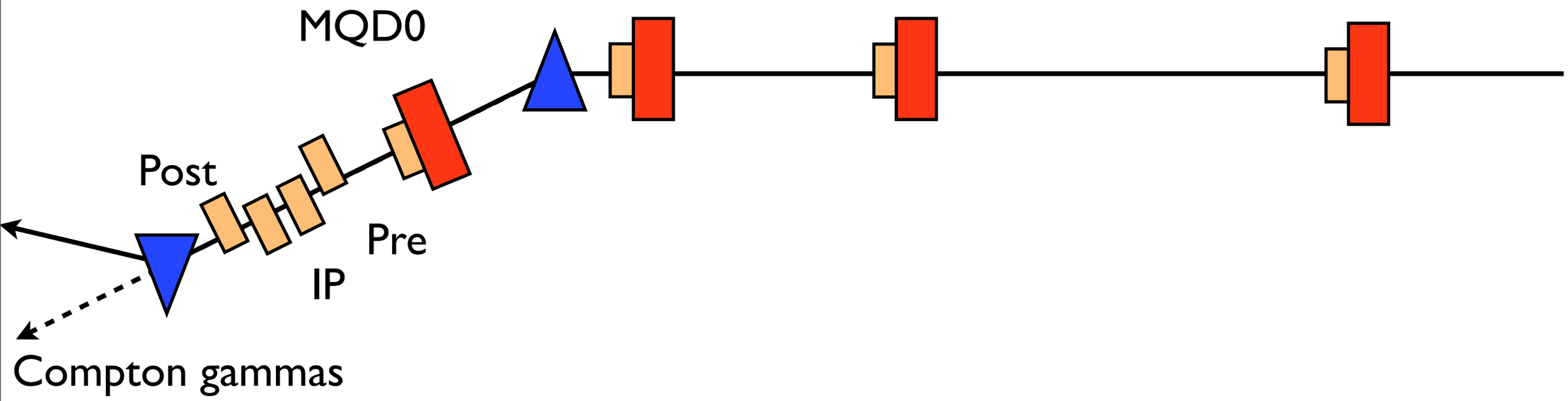
G. White

Interaction region

- 2 X-Y sensor block installed in the IPBSM chamber
  - Signals split between SLAC (heterodyne) and Honda-san's (homodyne) electronics
  - Basic problem is alignment through the system compatible with IPBSM operation operation
- Need to get system operational in Sept/Oct for Nov/Dec operation

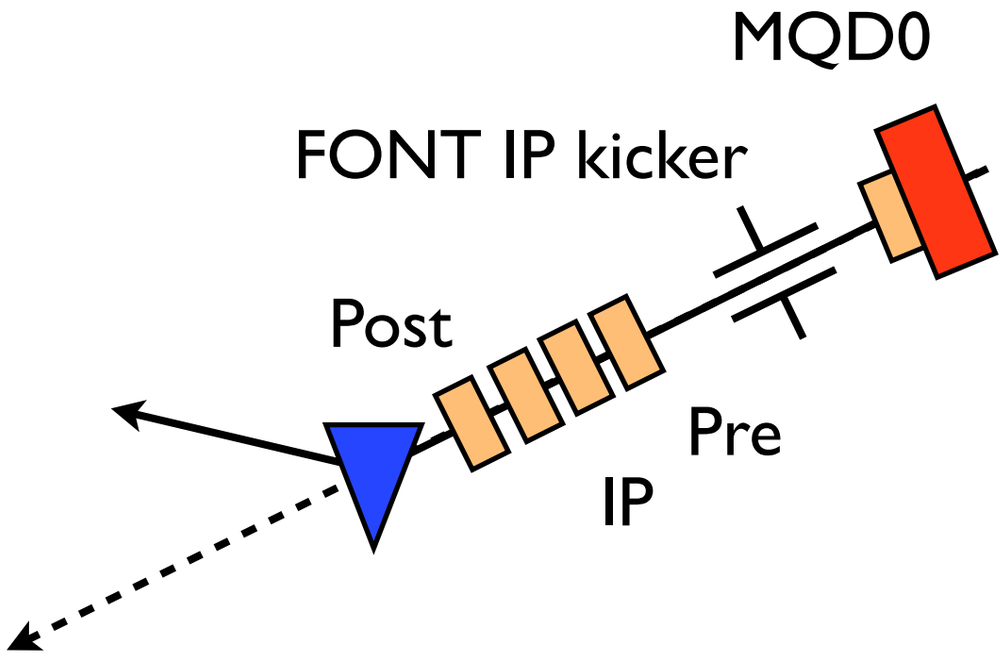


Interaction region alignment



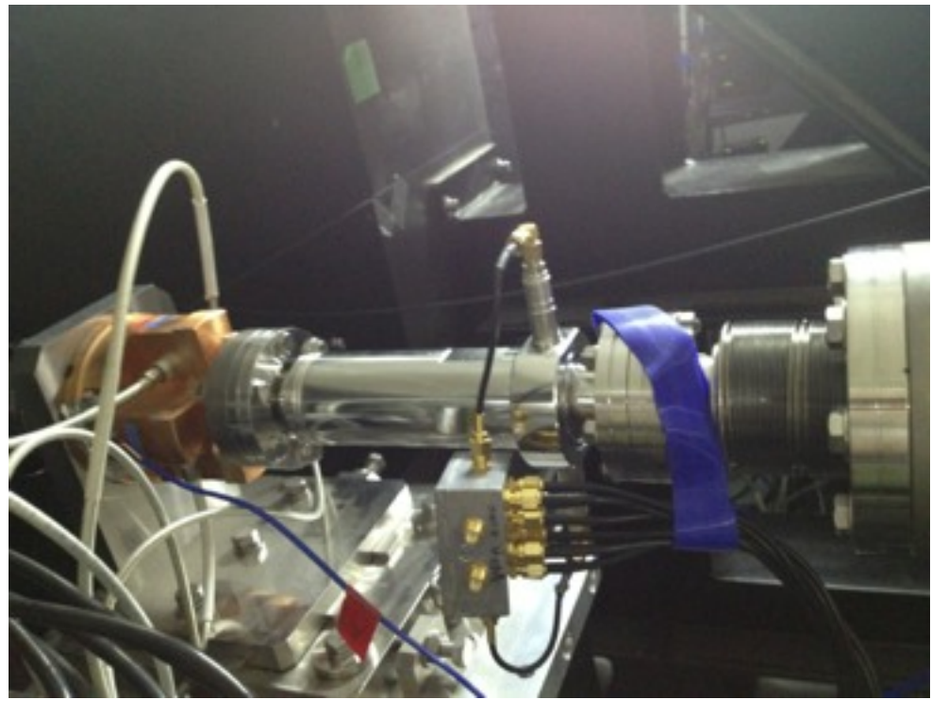
- Use ballistic IPBPMs and Pre and Post-IP to define reference orbit for IPBSM Compton signal
  - Large angular jitter problematic, need jitter subtraction
- Define target feedback "golden orbit" for rest of ATF2 line.
- **An outline strategy for this needs to be discussed and documented**

Interaction region calibration



Pre

FONT IP kicker

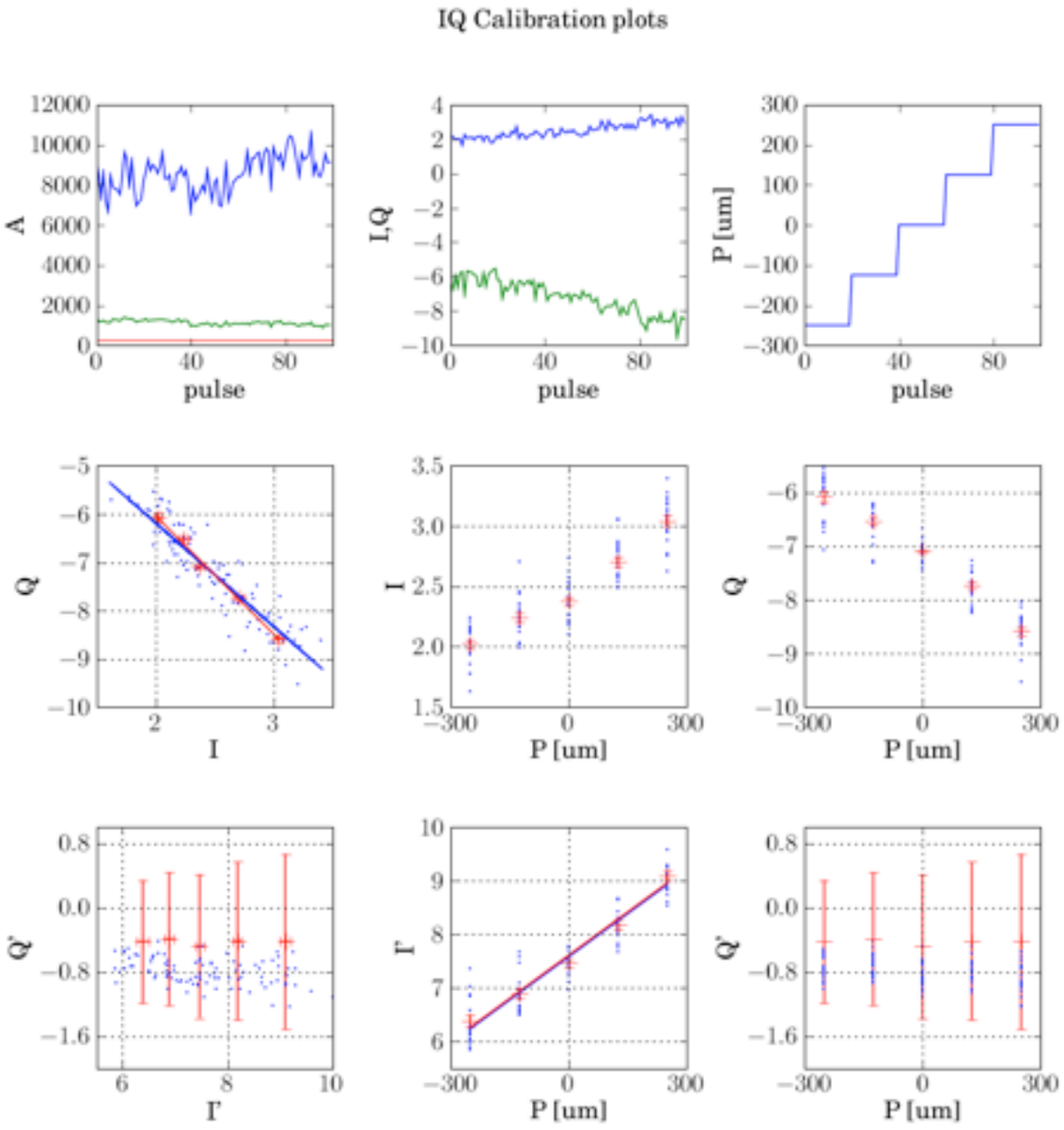


- Now use two upstream quadrupoles to perform open bump at IP
  - Possibility of driving the "FONT" kicker to perform calibration?
  - Significant speed increase compared with the quadrupole movers
  - Dynamic range show in June acceptable for calibration without attenuation

Y. I. Kim

IP BPM calibration

- IPBPMs calibrated using orbit bump
  - Precision ~5%, jitter subtraction still needed



- Calibration repeated in same shift
- Consistent calibrations

BPM	Scale		IQ rotation angle	
	1	2	1	2
IPAx	185.7	181.7	-1.184	-1.155
IPBx	-174.8	-195.3	-0.743	-0.668
IPAy	51.46	49.68	-0.580	-0.584
IPBy	30.78	34.79	-1.528	-1.532

IP region discussion

- Need a complete strategy for IP region
  - Alignment
  - Calibration
  - Iteration of calibration, alignment and correction
- Switching between different electronics modes without loss of resolution
  - Remote RF switches and attenuators
  - Integration of the Honda-sans electronics
  - Control of the kicker for quick calibrations
  - Integration of calibration for FONT and IPBSM shifts
- **Dedicated beam time, 0.25 shift/week, operators, plan**

Summary and conclusions

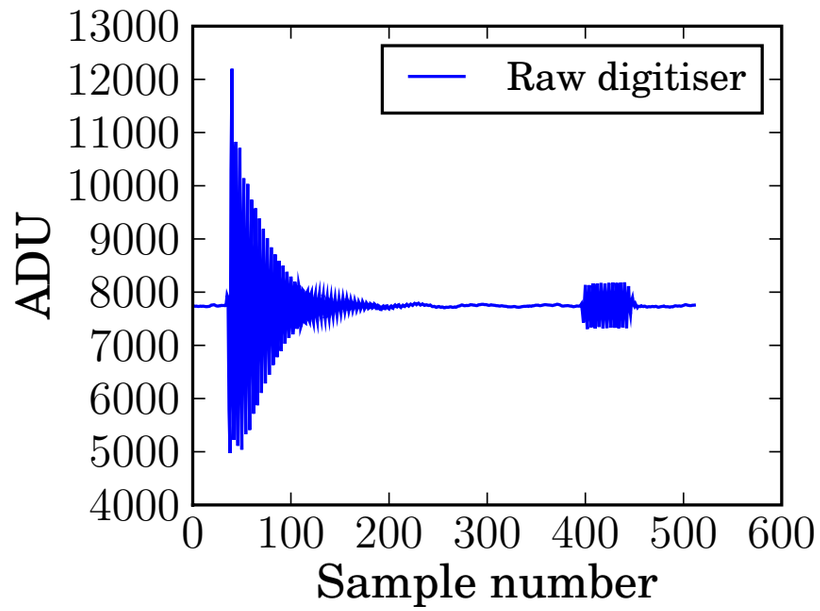
- C- and S-band system operating well
  - Problems with the S-band system resolved
  - Beam arrival time measurement can be improved
- Focus now at interaction region
  - Need coherent and planned strategy to get IPBPMs working to full capability
  - Complicated by dual readout system (Heterodyne and Homodyne)
  - Solution for the Fall/winter operation, new IP BPM hardware arriving Jan 2013

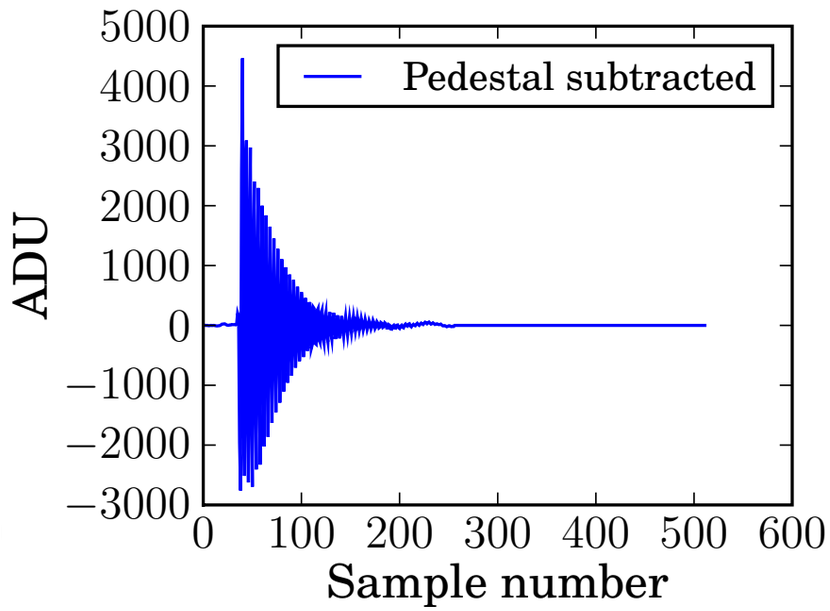
Backup slides

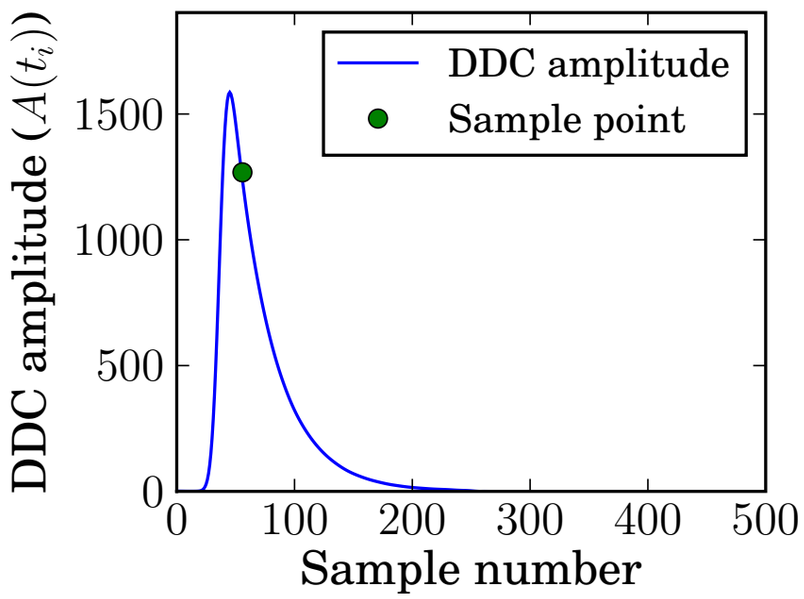
Signal processing

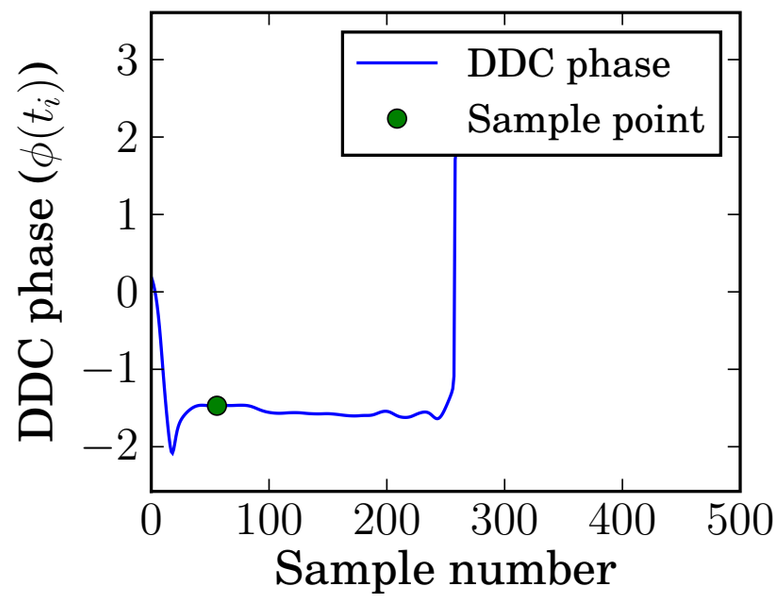
$$\tilde{V}_{\mathrm{d}} = [A_x x + jA_\theta \theta - jA_\alpha \alpha]\, q e^{-t/\tau_d} e^{j(\omega_d t + \phi_d)}$$

- Signal from electronics
  - 25 MHz decaying oscillation
  - Mixed with digital local oscillator
    - Starts at ADC trigger start
  - Measure amplitude and phase





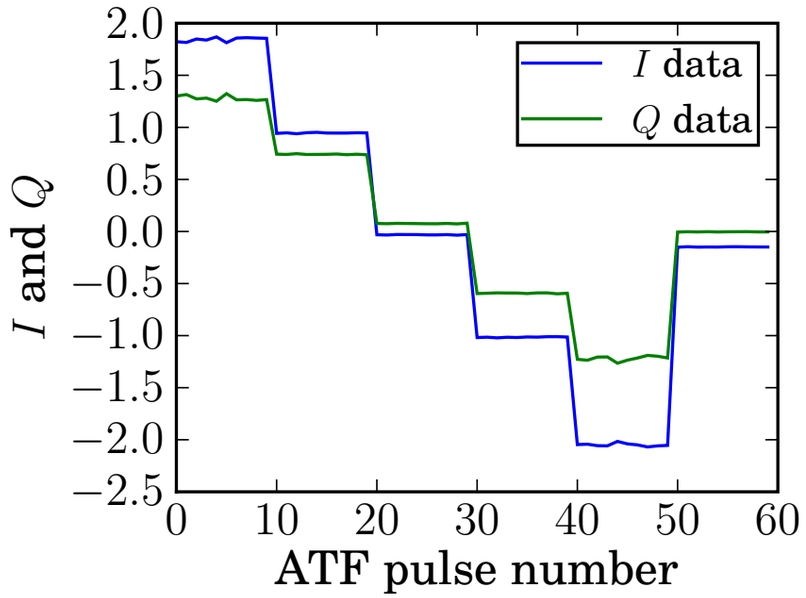


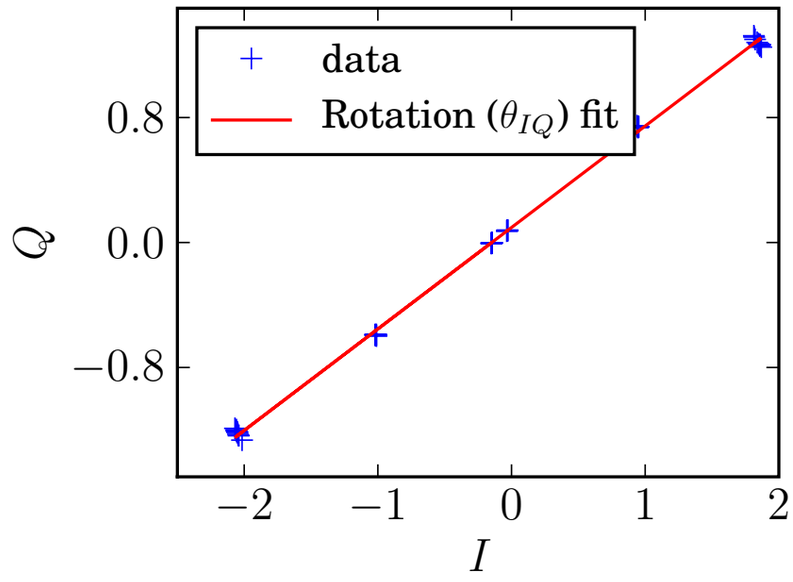


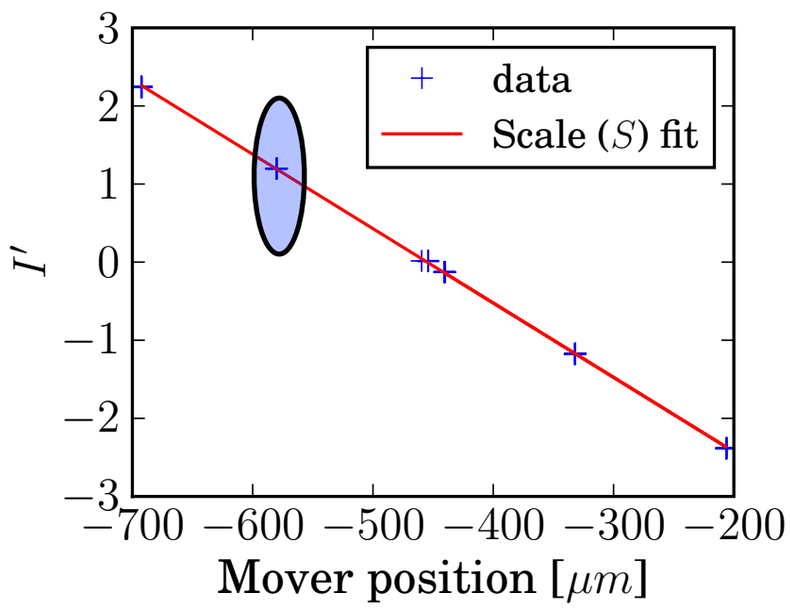
ATF2 BPM calibration

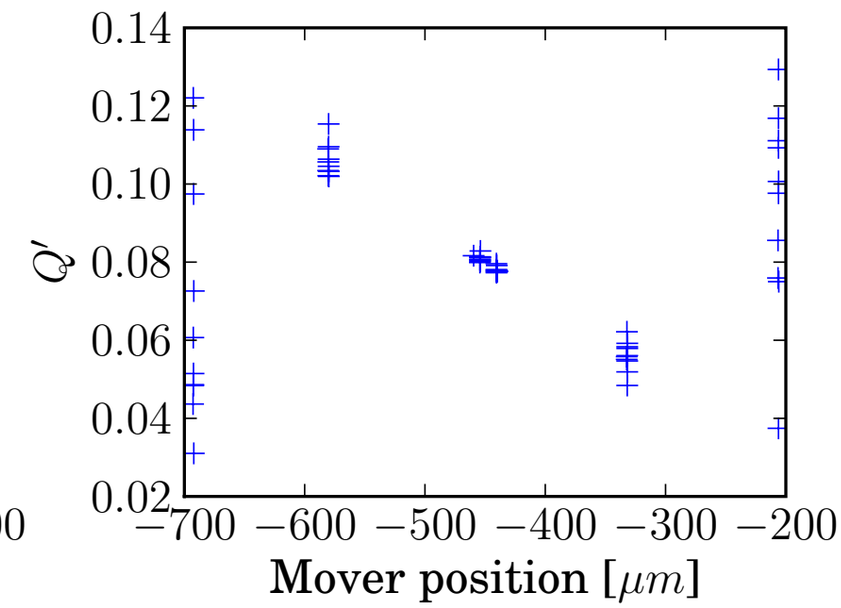
- Move BPM order 100s of um
- Measure I and Q
  - Angle of I-Q line is rotation
- Slope of rotated I is scale

Example has low beam jitter







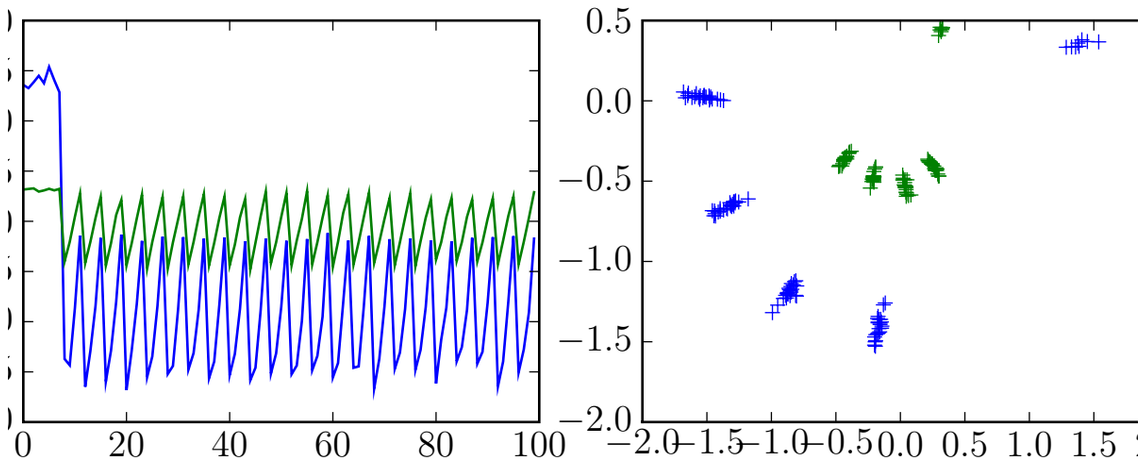


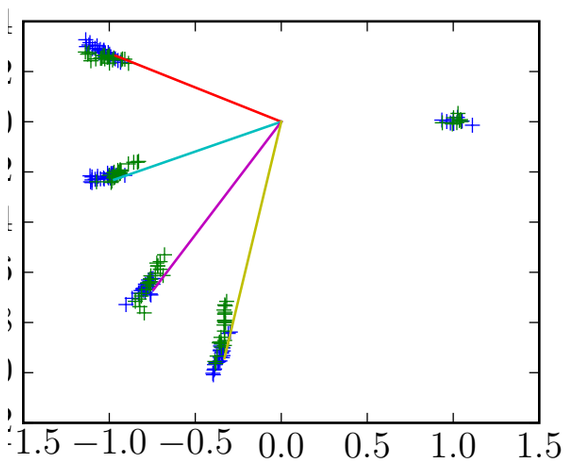
$$d = Se^{i\theta_{IQ}}\sqrt{I^2+Q^2}e^{j\tan^{-1}Q/I}$$

S-band problem introduction

- Problem for both C and S band systems, root is
  - Dipole and reference cavity frequencies not the same
    - Time of signal arrival in digitisers is not constant
      - Digitisers are locked to 714 MHz
    - Problem with DR-RF ramp

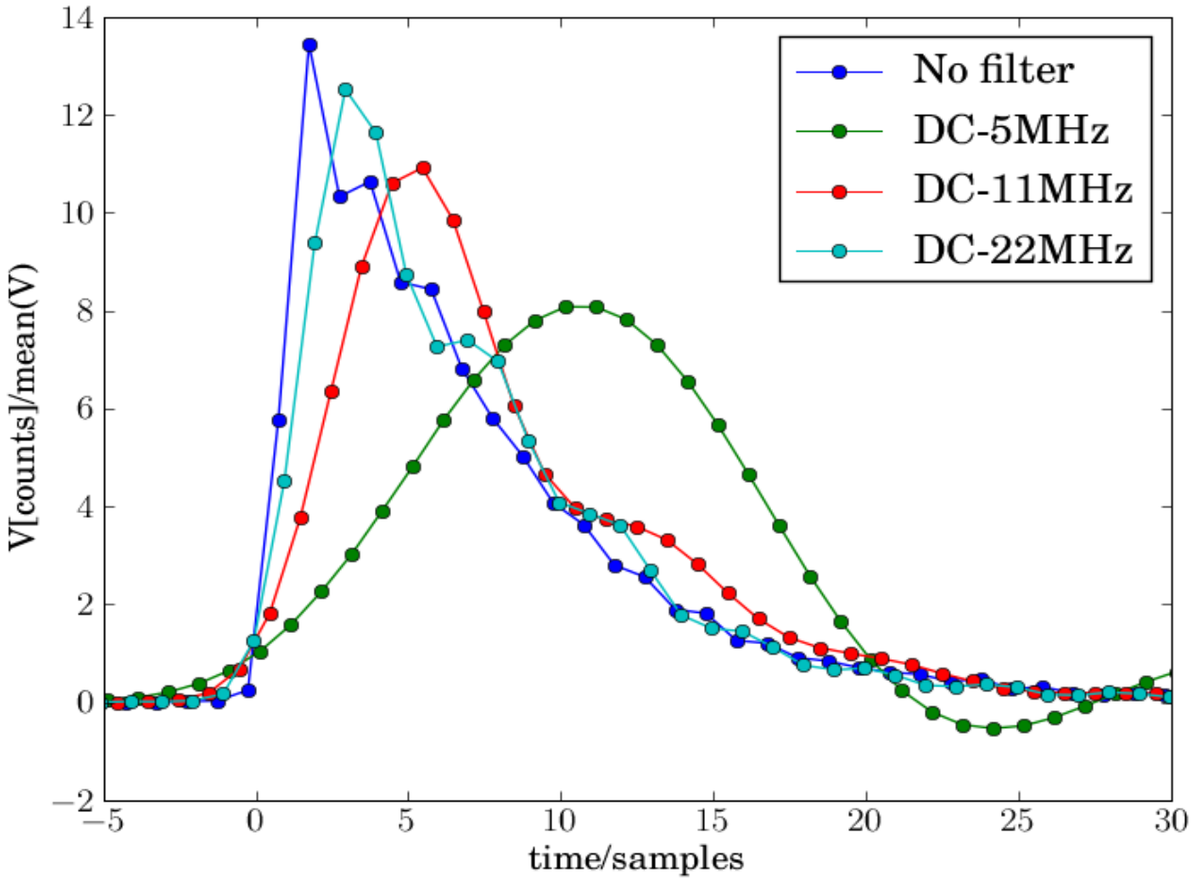
$$\frac{V_p}{V_r} = \frac{A_p}{A_r} e^{-\Delta\Gamma(t_s - t_0)} e^{j\Delta\omega(t_s - t_0)}$$





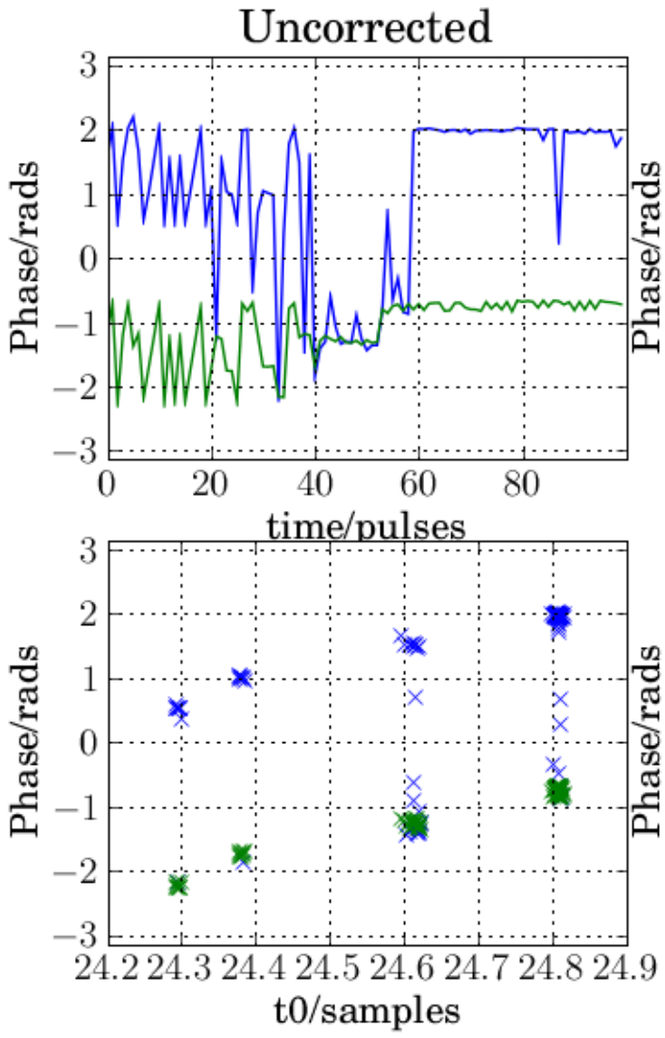
S-band problem measurements

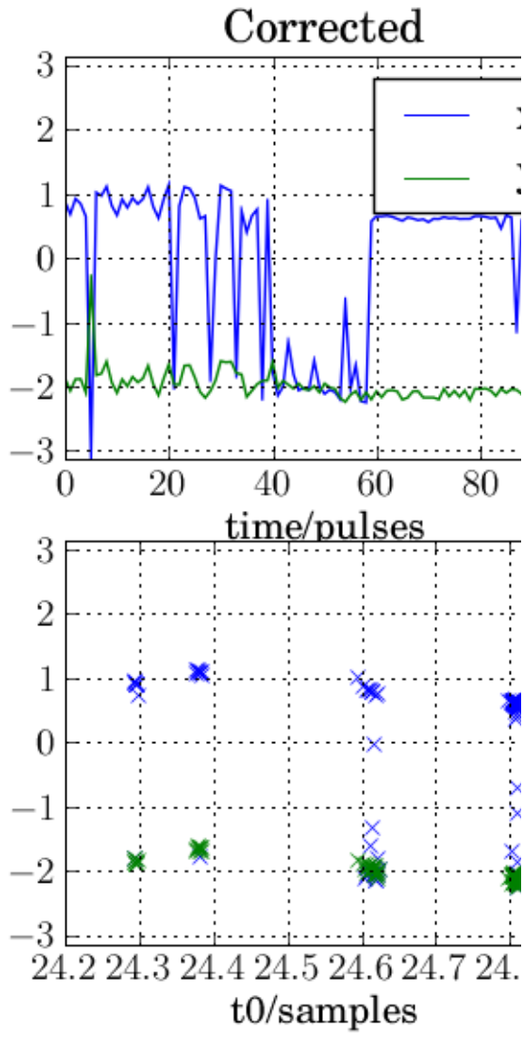
- Used S-band diode (C-band reference diode was being used) to investigate effect
  - Changed filter to change rise time
    - Need 2-3 points on linear rising edge to extract time
- No filtering rises too quickly
  - Need to optimise filter

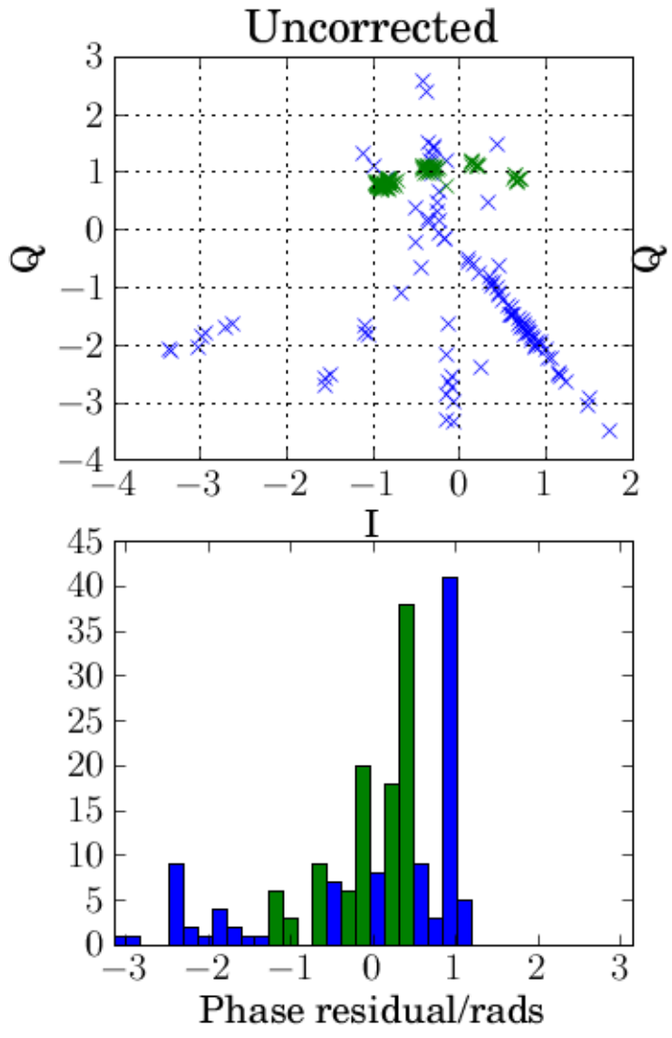


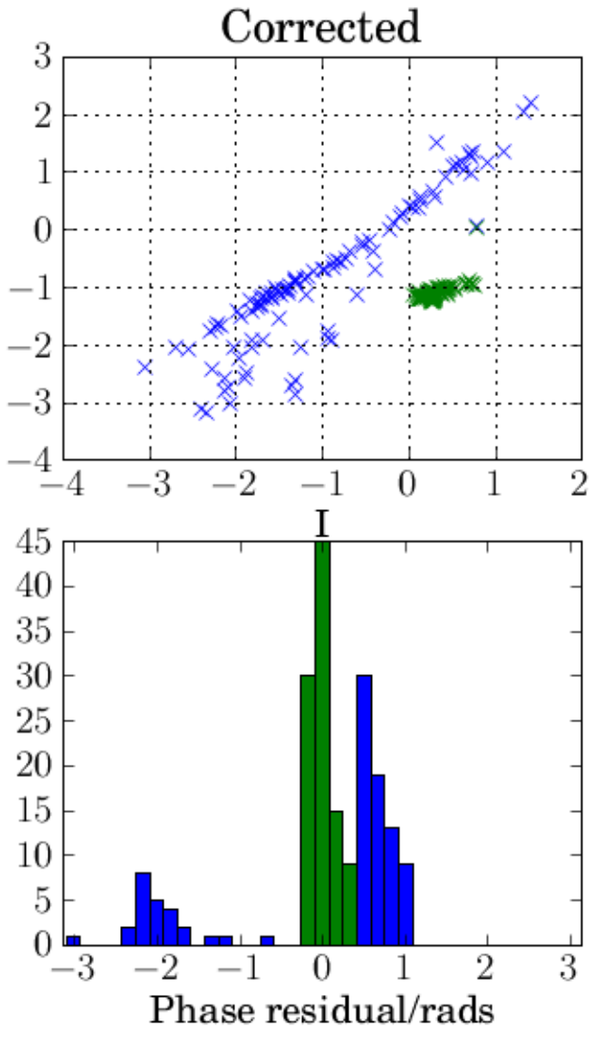
S-band problem cont.

- Significant improvement when correction is applied correctly
  - Still some residual effect, but smaller









S-band solutions

- Possible solutions
  - Build new S-band refernce (should have done a while ago)
  - Or unlock entire system with a synthesised 714MHz signal independent of DR-RF
    - EXT line trigger will always shift with DR-RF clocks, so will always be a problem
- Dispersion measurements will be improved for C and S band systems if signal arrival time in the digitiser is better monitored
  - So new S-band monopole is not the entire solution