

C/S-band cavity BPMs

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

[https://www.pp.rhul.ac.uk/twiki/bin/view/JAI/
BeamPosition](https://www.pp.rhul.ac.uk/twiki/bin/view/JAI/BeamPosition)

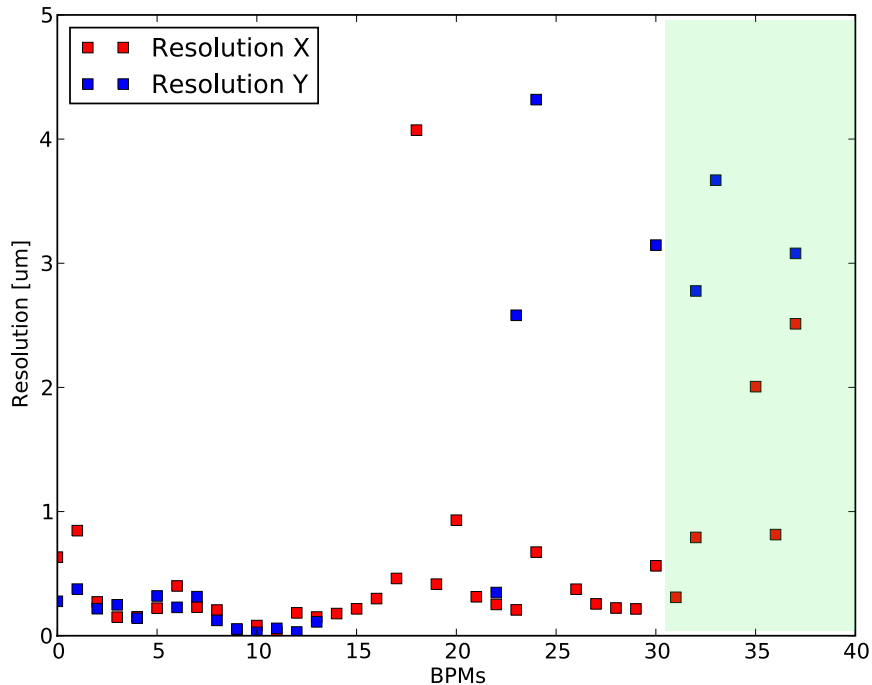
Introduction

- Goals
 - C-band
 - Stable C-band operation (calibrations currently seem reasonable for a week)
 - Need reliable and stable operation for 3 weeks (calibration tone)
 - S-band
 - Still has some problems (electronics, reference cavity and digital systems all fine)
 - Suspect some intrinsic problem with cavity (cross coupling)

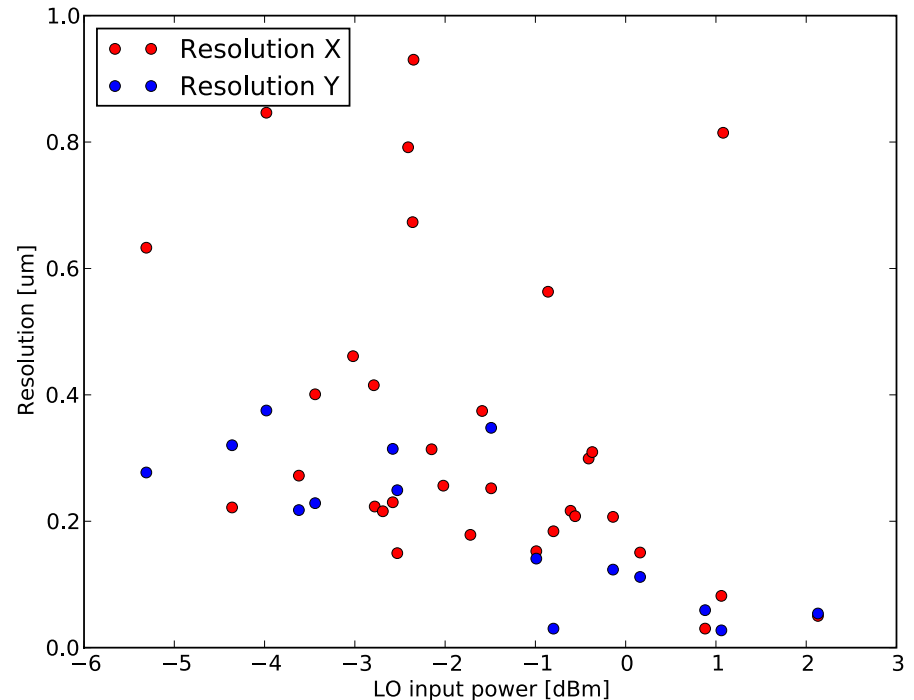
Overall BPM performance

- Typical C-band performance with attenuators
 - Between 400 to 200 nm
 - 25 nm for BPMs without attenuators
 - Depends on Local Oscillator power
 - Variation in resolution depends on electrons gain

All BPMs Resolution



LO input power vs. Resolution

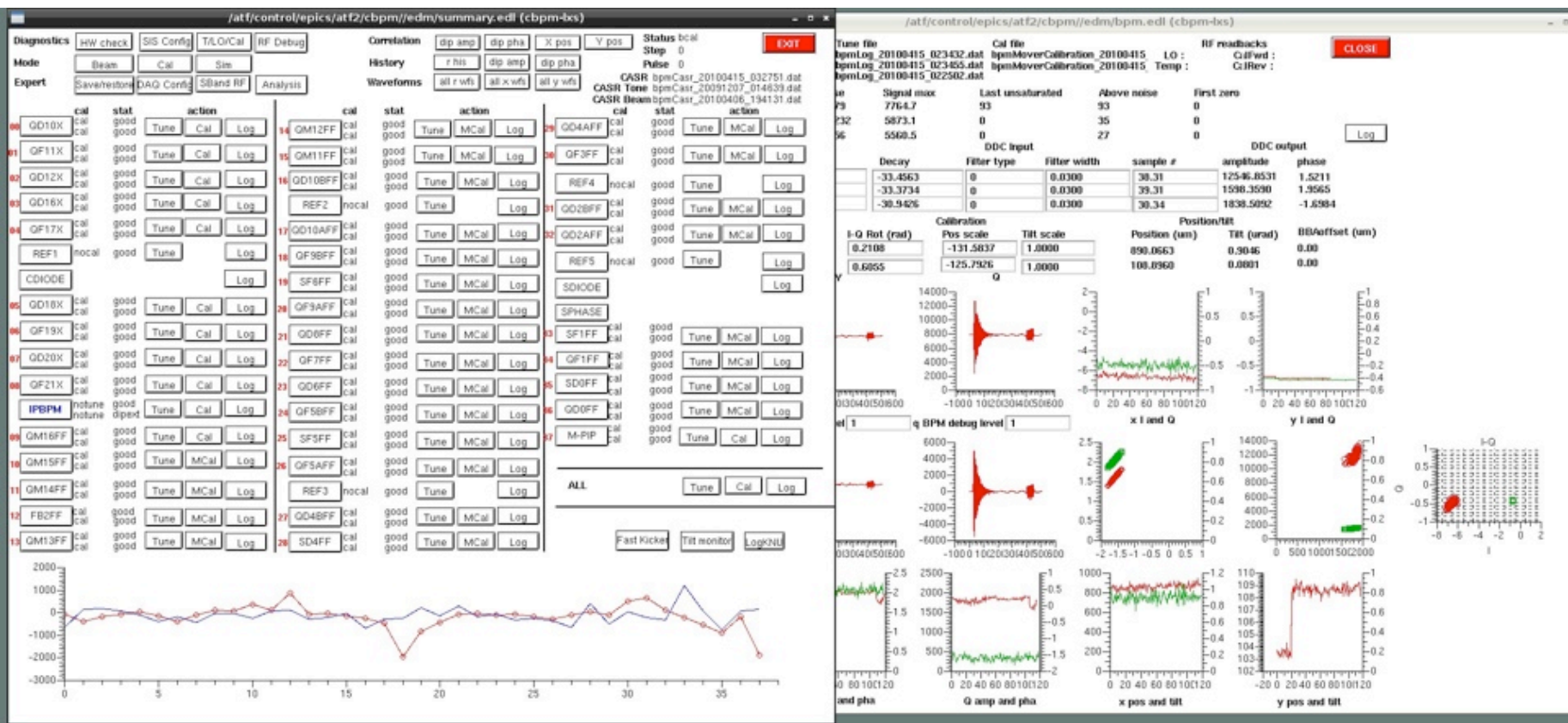


C-band summary

- Overall good performance during this last operations year but
 - LO and CAL power too low to drive electronics
 - Non-linearities, gain variations etc.
 - LO : Upgrade LO distribution amplifier (4-5 W)
 - CAL : Remove cal tone attenuator (Tests promising)
 - Problems with trigger clock for MFB2FF and M-PIP
 - Will investigate over summer

MFB2FF (IP vertical image point)

BPM system online display for high resolution BPM



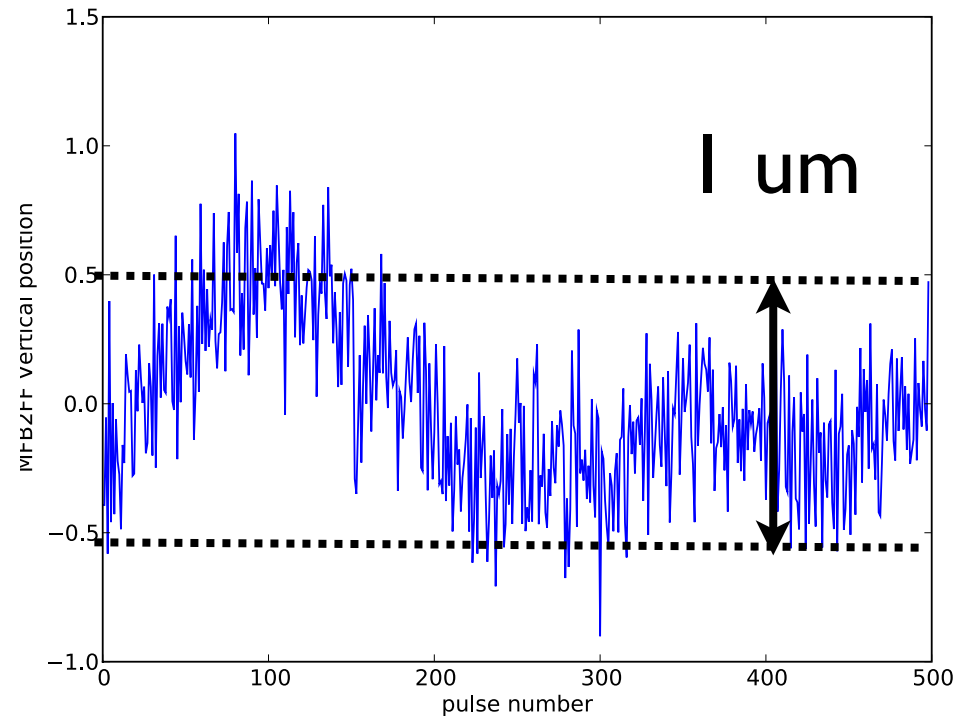
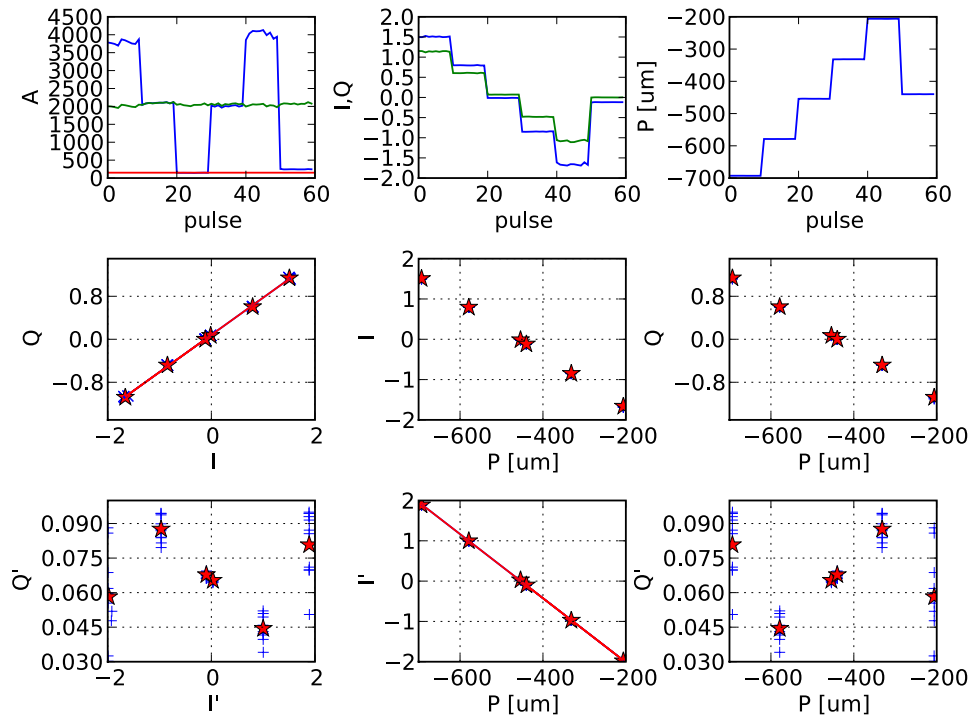
Cavity BPM orbit

Single BPM display

MFB2FF results

- Calibration of BPM looks excellent
- Dispersion nominally zero, beta function smallest (apart from IP location)
- Most slow drift beam orbit changes etc

IQ Calibration plots



BPM stability

IQ rotation

BPM	April week 1	April week 2	April week 3
MQD10Xx	-1.4323		-1.513 (-1.508)
MQD10Xy	-0.5645		-0.676 (-0.6785)
MQM16FFx	-0.8139	-0.749 (-0.749)	-0.801 (-0.833)
MQM16FFy	-0.4781	-0.361 (-0.335)	-0.382 (-0.397)
MQD10BFFx	-0.9471	-0.877	-1.109 (-1.033)
MQD10BFFy	-0.5026	-0.427	-0.610 (0.526)
MQD6FFx	-0.6671	-0.622	-0.851 (0.782)
MQD6FFy	1.4815	1.584	1.331 (1.407)
QD4AFFx	-0.391	-0.368	-0.527 (-0.527)
QD4AFFy	-0.494	-0.446	-0.661 (-0.609)

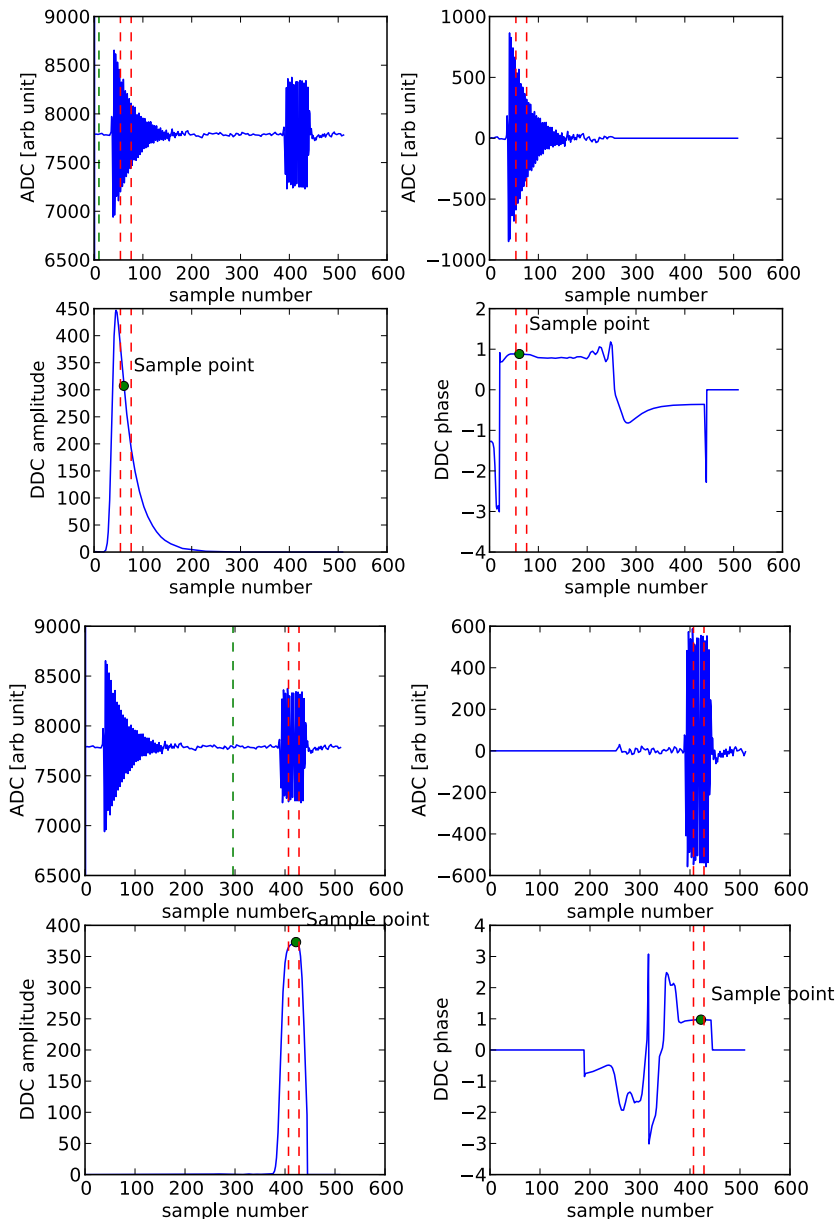
Scale

MQD10Xx	6694.130		12424 (13025)
MQD10Xy	1800.35		1883 (1873)
MQM16FFx	105.725	86.5 (104.8)	103.9 (99.1)
MQM16FFy	138.317	111.9 (108.8)	111.1 (108.6)
MQD10BFFx	929.856	906.4	1255 (1208)
MQD10BFFy	1203.745	1013.3	1410 (1278)
MQD6FFx	918.314	776.1	1137 (942)
MQD6FFy	-1131.819	-1125.9	-1554 (-1499)
QD4AFFx	-1151.2	-1012.6	-1489 (-1540)
QD4AFFy	-1261.2	-1098.69	-1682 (-1661)

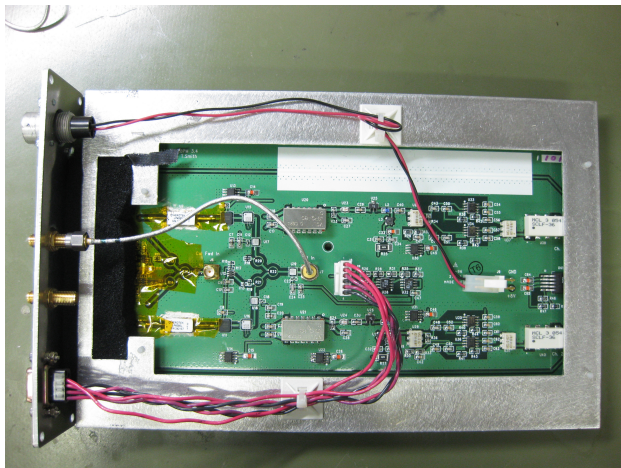
- BPM system needs to be stable over long periods of time
- Previously ~1 day was possible
- Re-calibrated system during April running to check calibration stability
- Some small jump after week 2 but generally consistent

Calibration tone

- Inject calibration tone into every signal just after beam transit signal
- Continuous tone, with RF switch
- Two analysis for each beam pulse
- Slightly different frequency

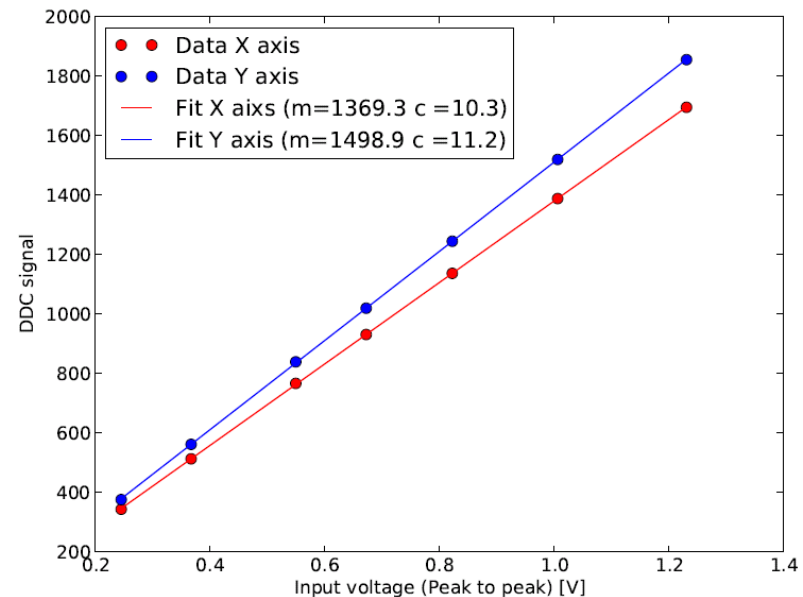
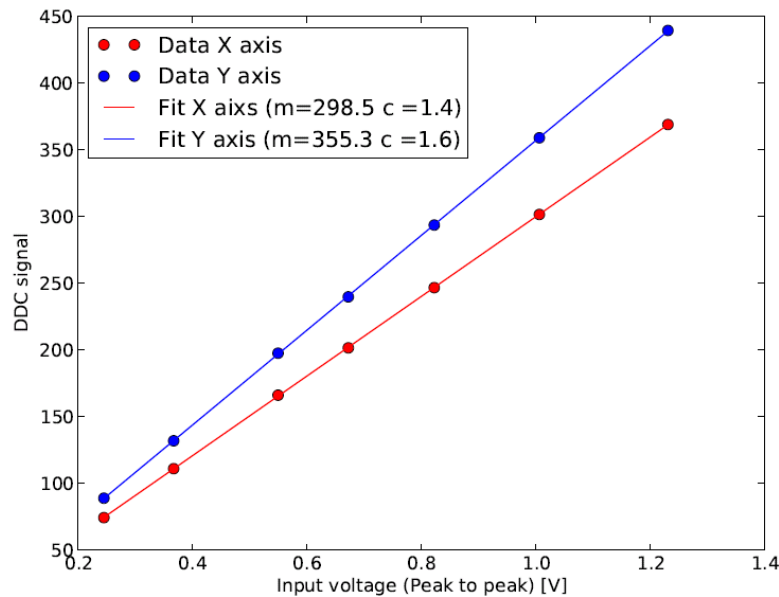
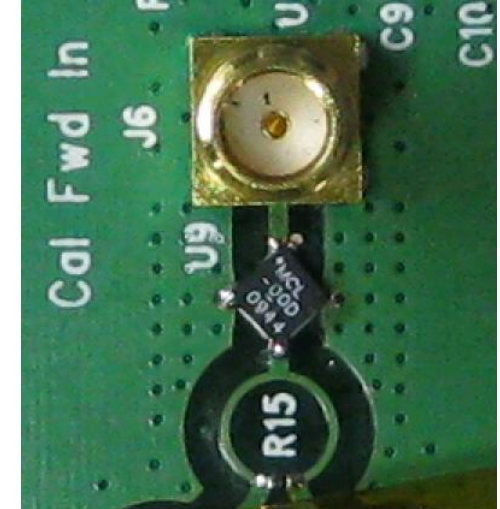
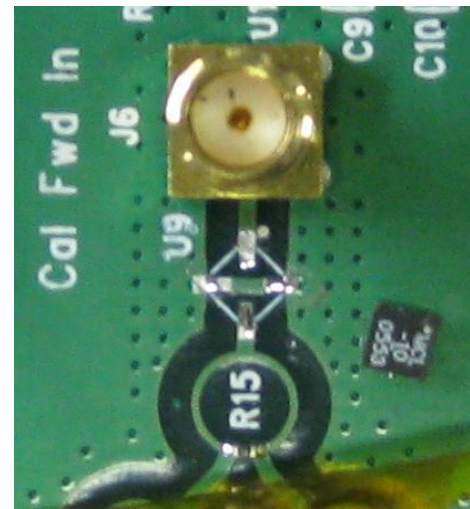
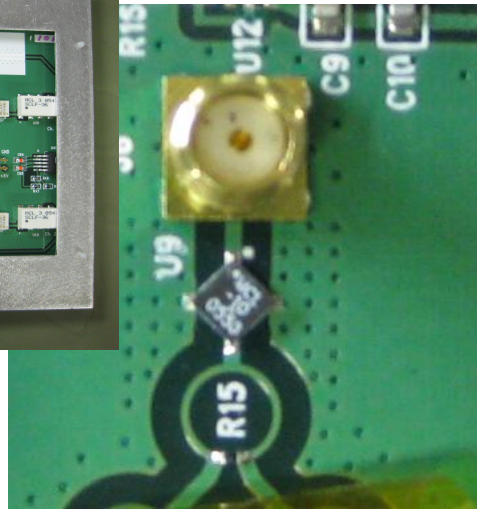


C-band attenuator tests



C-band electronics box

Calibration tone input



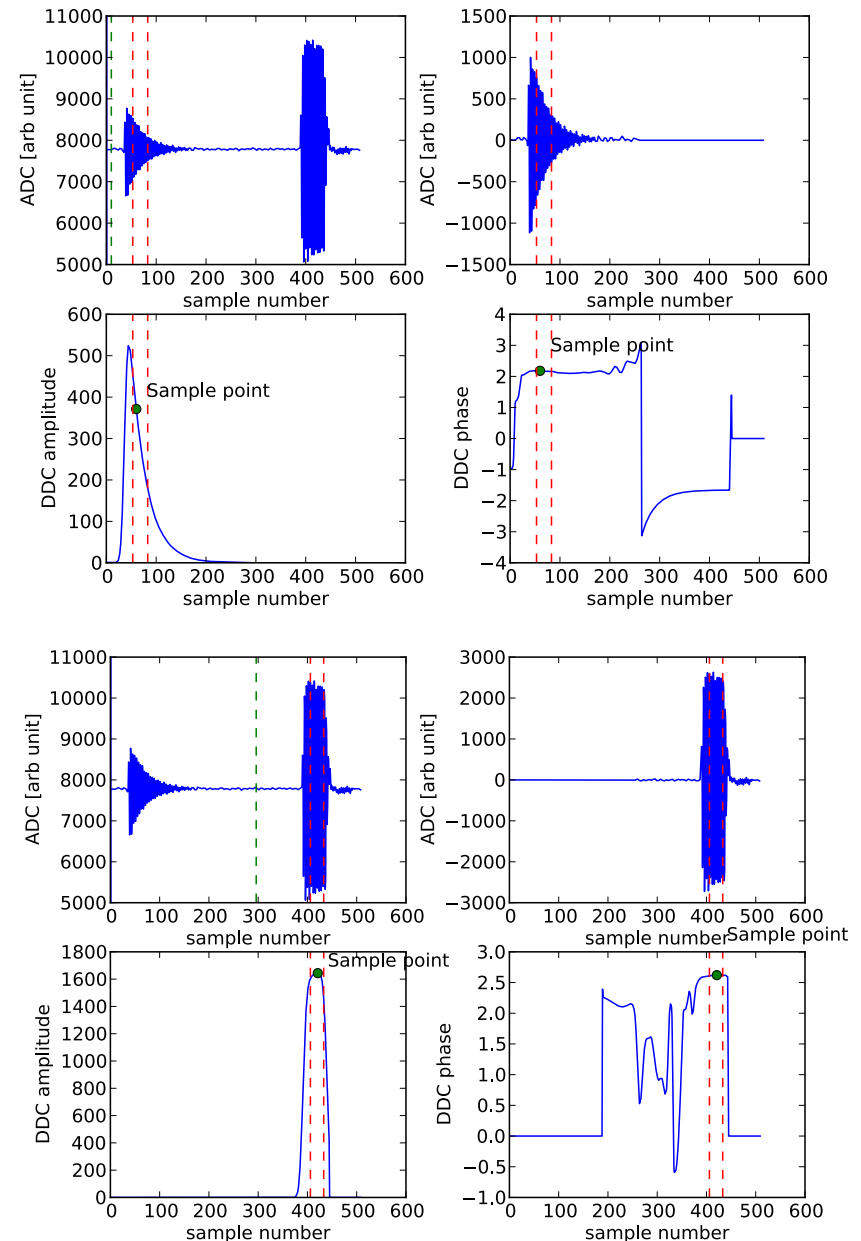
Cross coupling unchanged

Calibration tone

$$I = \frac{A_d}{A_r} \cos(\phi_d - \phi_r)$$

$$Q = \frac{A_d}{A_r} \sin(\phi_d - \phi_r)$$

- Monitor I and Q in exactly the same way for beam signal
- Compare changes in calibration signal and change calibration constants



S-band problems

- X-Y cross coupling is quite bad
 - -20 dB compared with -30 to 40 dB for C-band system
 - Can mechanically tune BPMs in situ (to be investigated over the summer)
 - How much of the problem can be removed in software
 - Difficult needs major rewrite of the control software
- Probably not the entire story
 - 2 or three effects probably operating, electronics phase instability, cross coupling all confused by the difficult beam conditions (large jitter, from beta functions and dispersion)

Work plan for BPM systems

- Fix residual problems with C-band systems
 - Frees Boogert and Kim
 - Possibility to add more personnel Tonee Smith and Alexey Lyapin for more hardware and analysis support
- S-band cavities need more work
 - Cross coupling bad, so confuses digital downconversion which expects clearer signal
 - Main focus of operations in new year
- Aim for fully functioning S-band system and long term calibrated C-band system Sept/Oct 2010