

# IP FB tests at ATF2

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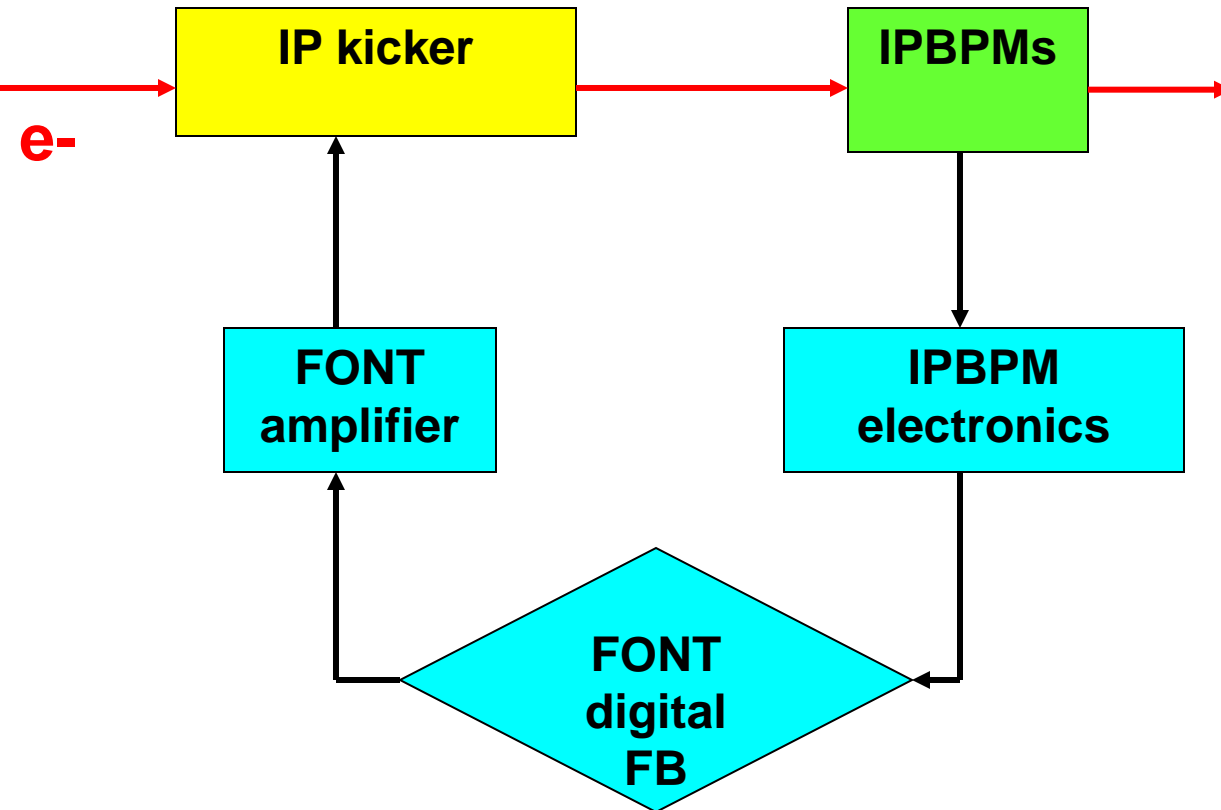
**Glenn Christian, Michael Davis, Young Im Kim,**

**Colin Perry**

*John Adams Institute*

*Oxford University*

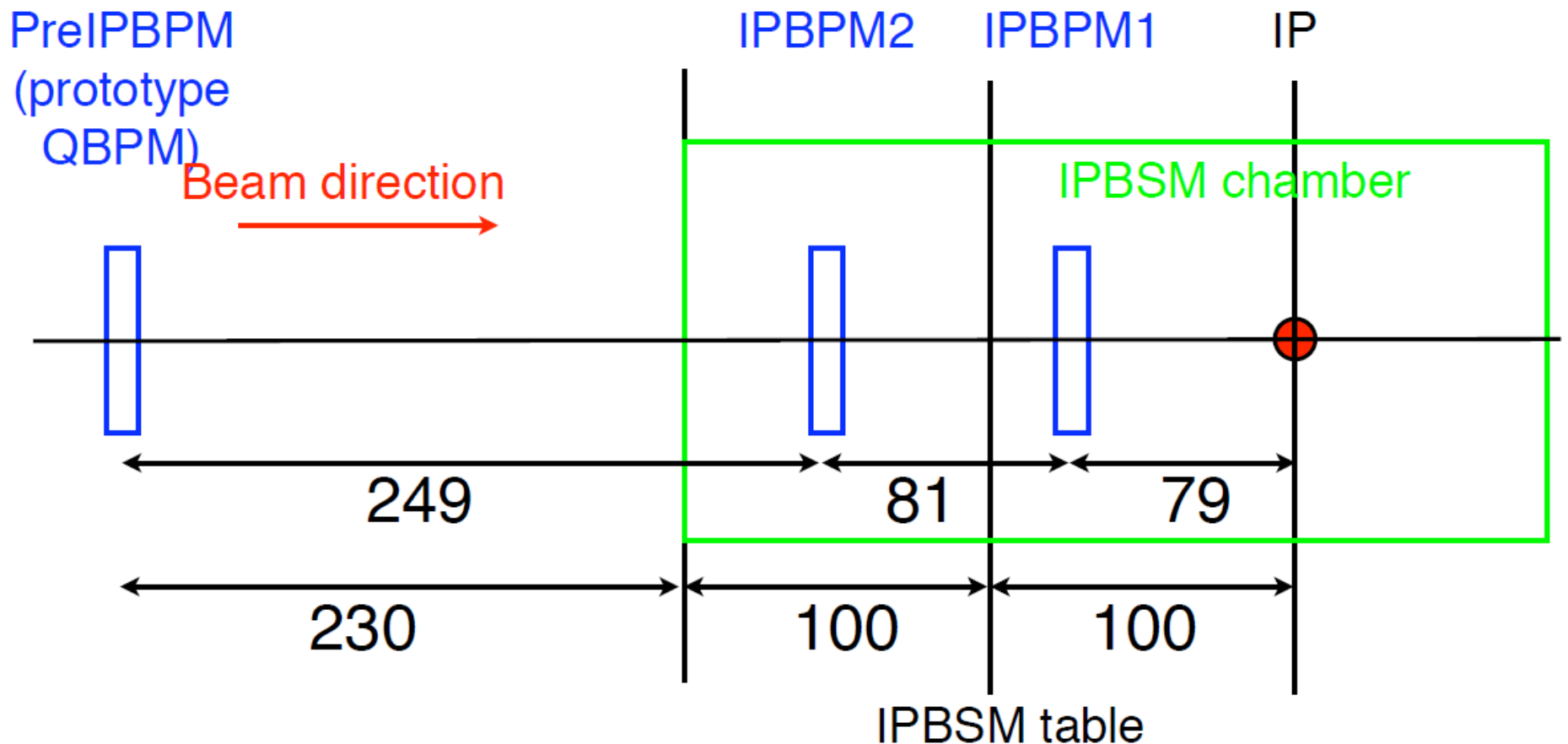
# IP FB loop scheme



# Existing IP-BPM geometry

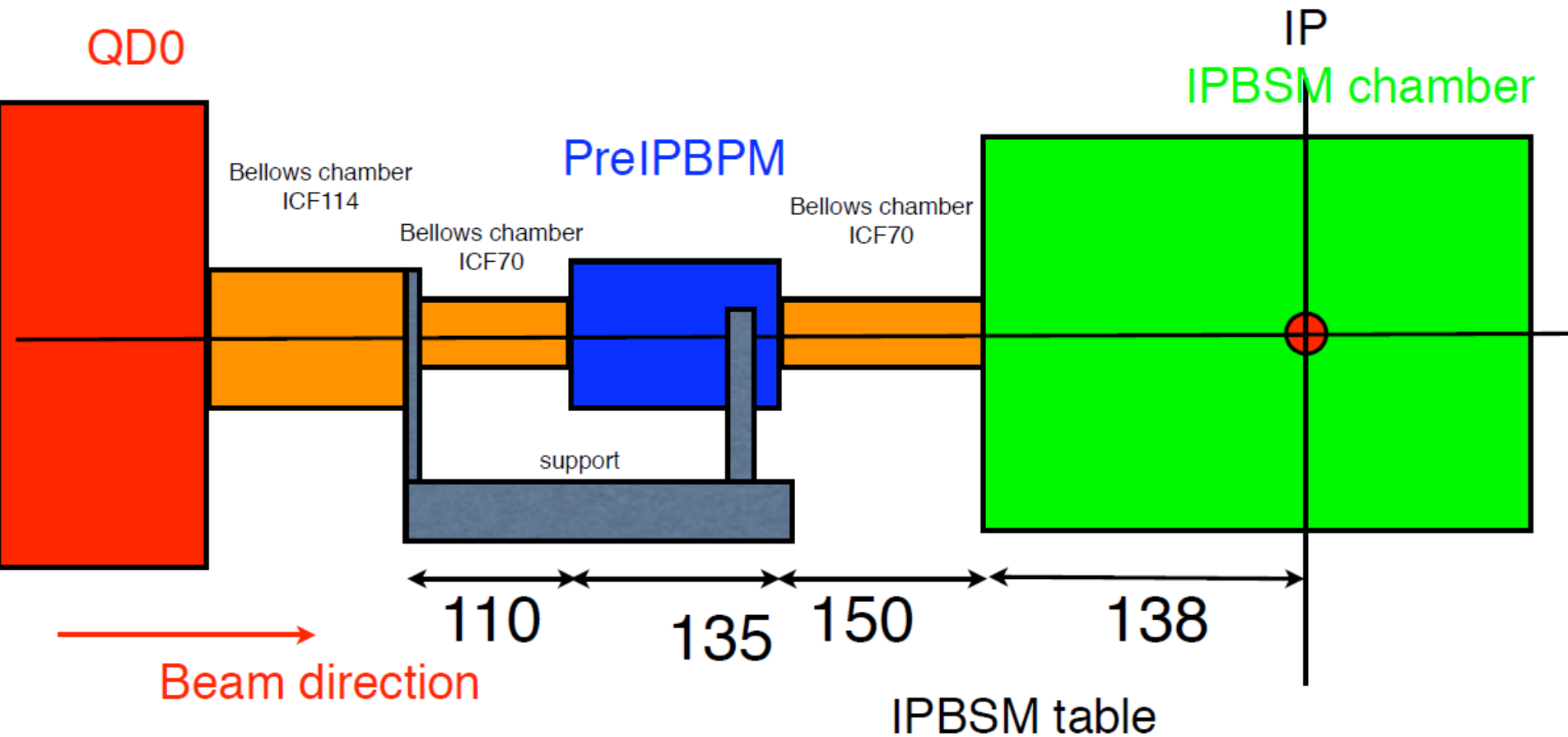
2011.6.29 Y.Honda

- Relative location of IP and two IPBPMs in BSM chamber and PreIPBPM.
- Accuracy of the number should be a few mm.

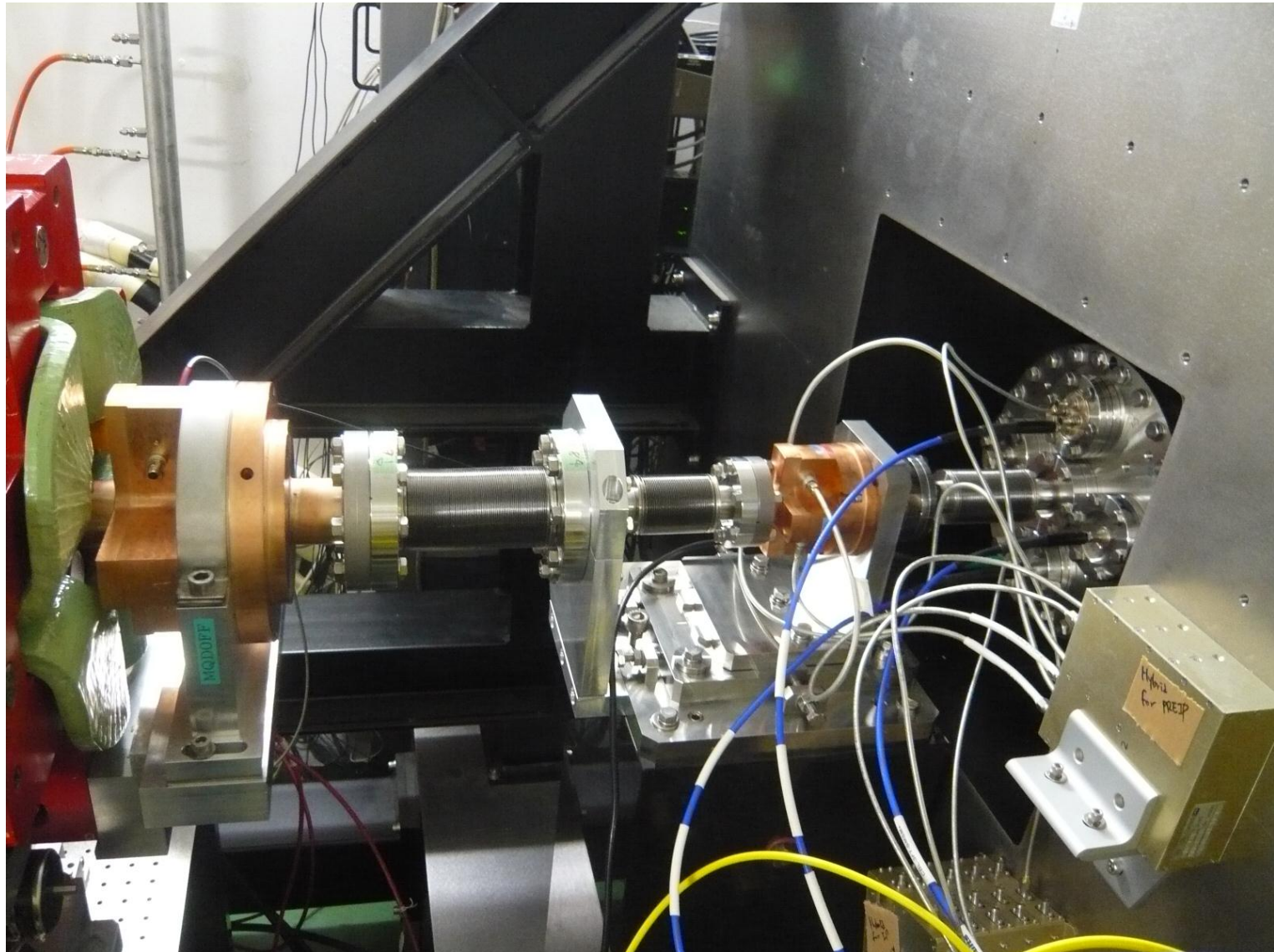


# Chamber geometry

- PreIPBPM is connected with ICF70 bellows at both ends for position adjustment.
- QDO is with ICF114 bellows for its position adjustment. (Since it needs to balance vacuum force for both ends, this should be ICF114 size.)
- ICF70-114 bellows joint is supported from PreIPBPM table.



# Layout (before May 2012)



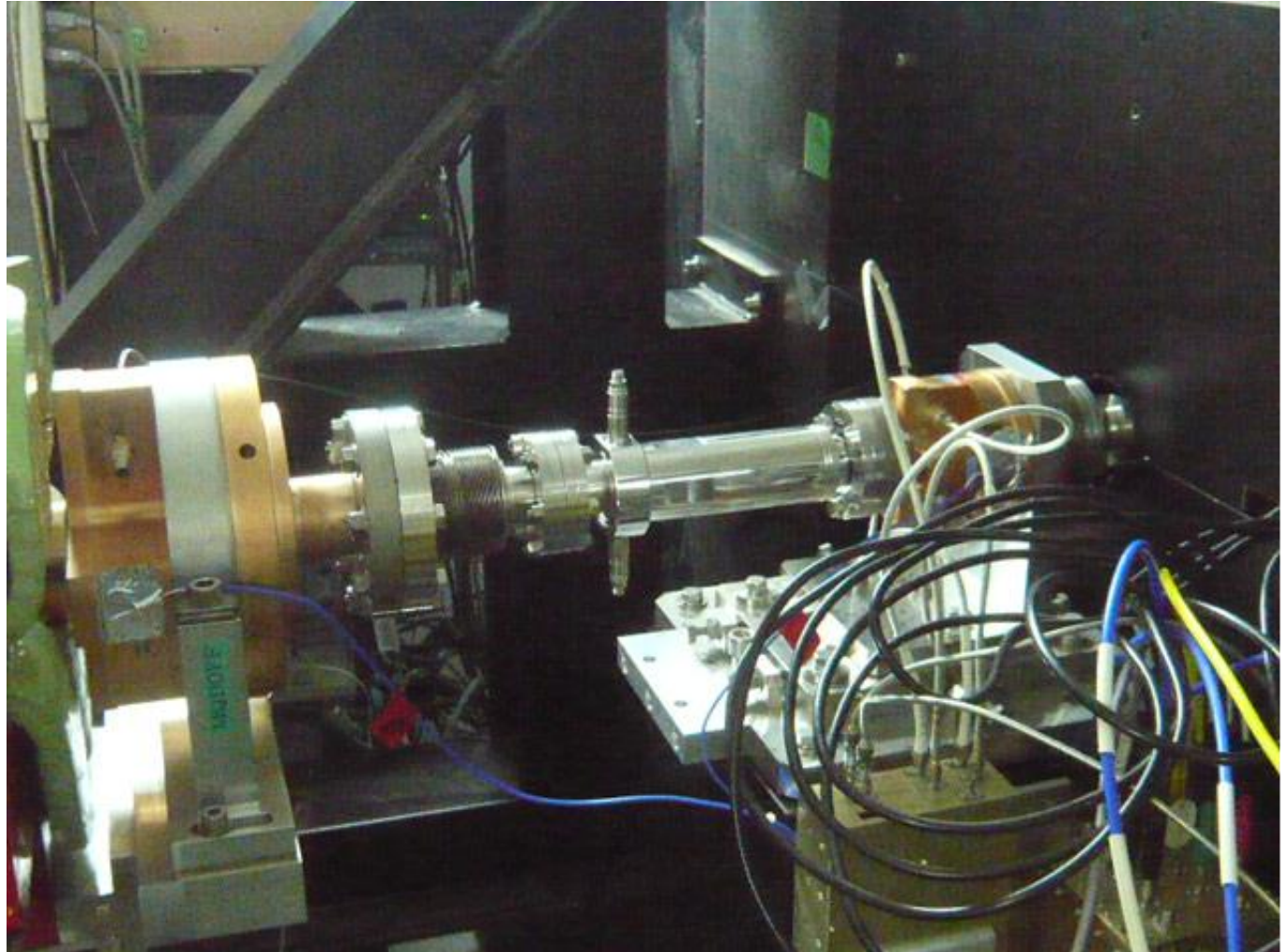


# New IP kicker

**Designed  
by Oxford**

**Fabrication  
arranged  
by KEK**

**Installed  
May 2012**



# First preparations (June 2012)

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- **Test new IP kicker with FONT amplifier:**
  - ensure functionality**
  - measure dynamic range of kick**
- **Instrument existing IPBPMs w. Honda electronics, for 2-bunch readout:**
  - digitise signals with FONT5 board**
  - cross check with EPICS in 1-bunch mode**
  - understand cavity BPM signals w. 2 bunches**
  - exercise system in preparation for IPFB**

# FONT drive amplifier

FONT5 amplifier, built by TMD Technologies

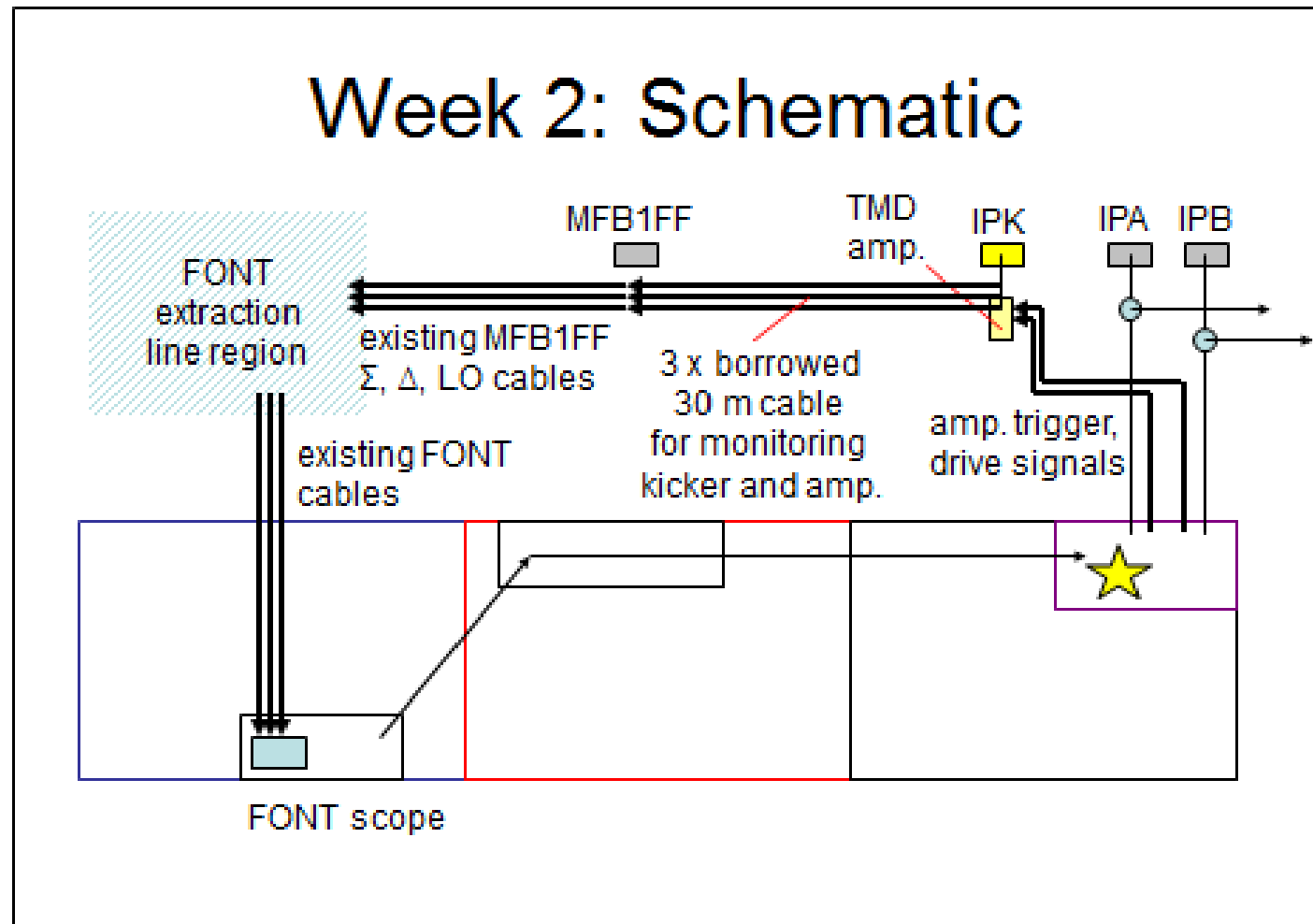
## Specifications:

- **+ - 15A (kicker terminated with 50 Ohm)**
- **+ - 30A (kicker shorted at far end)**
- **35ns risetime (to 90%)**
- **pulse length 10 us**
- **repetition rate 10 Hz**



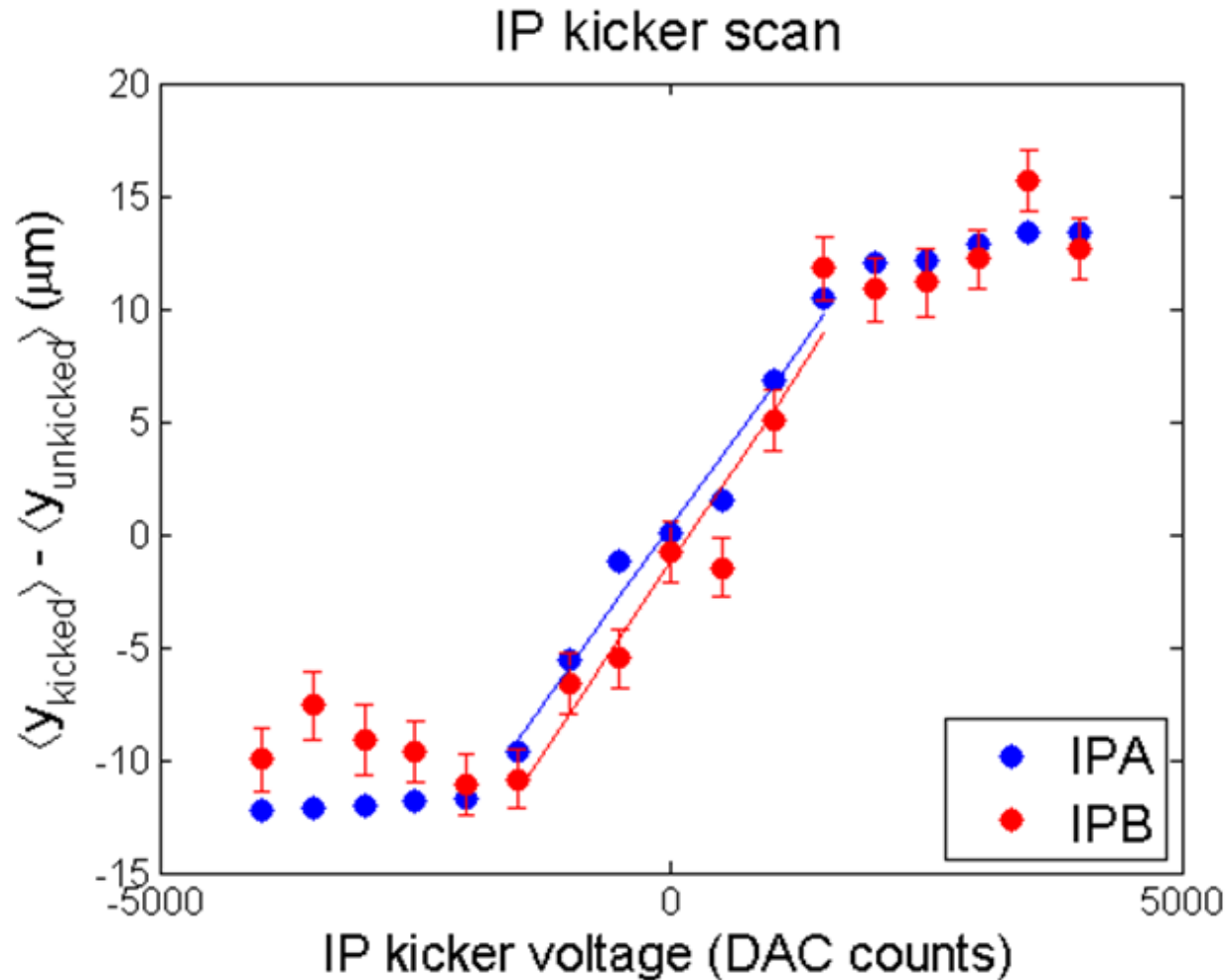


# Experimental setup (June 2012)



# IP kicker drive scan

EPICS  
readout  
of IPBPMs



# IP kicker conclusions

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- **Kicker is working well**
- **FONT amplifier is able to drive kicker**
- **Dynamic kick range almost  $\pm 15$   $\mu\text{m}$  at IPBPMs**
- **Linear kick range  $> \pm 10$   $\mu\text{m}$** 
  - $\rightarrow$  plenty of drive for beam stabilisation @ IP**

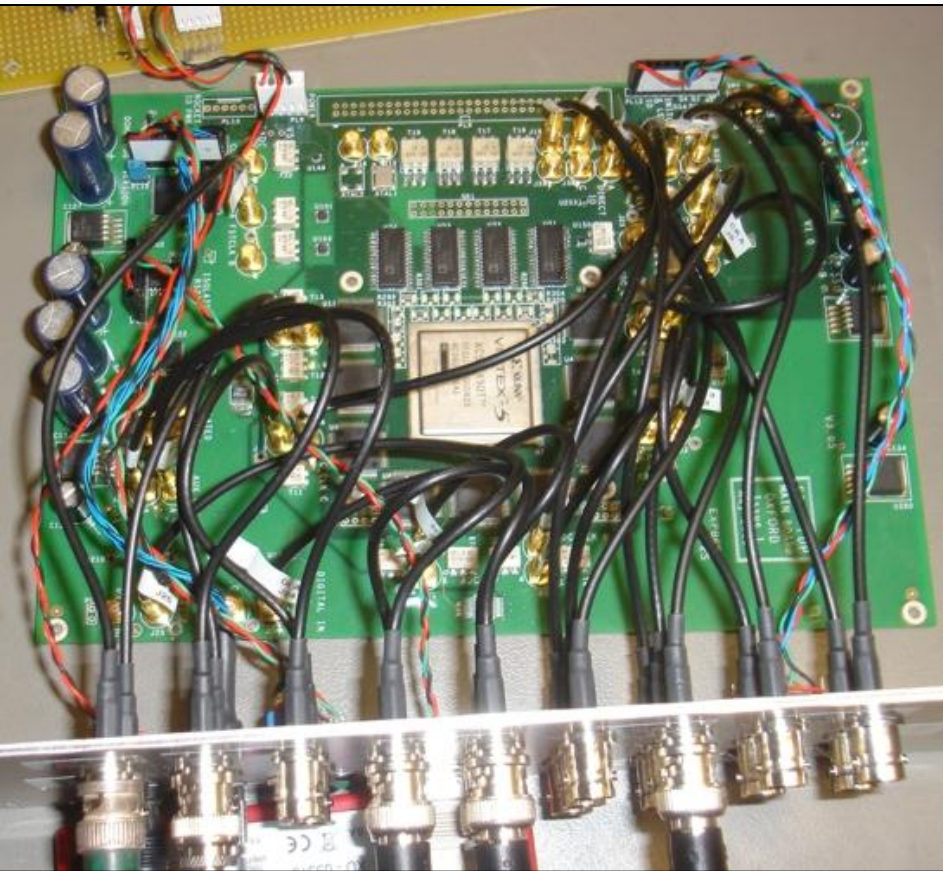
# IPBPM tests (single bunch)

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- **IPBPM A+B signals split:**
  - 1) **SLAC electronics → ATF EPICS controls**
  - 2) **Honda-san electronics → FONT5 board**

**allowed cross-check of standard electronics and FONT digitised readout**
- **Temporary cabling and setup used for tests**

# FONT5 digital FB board



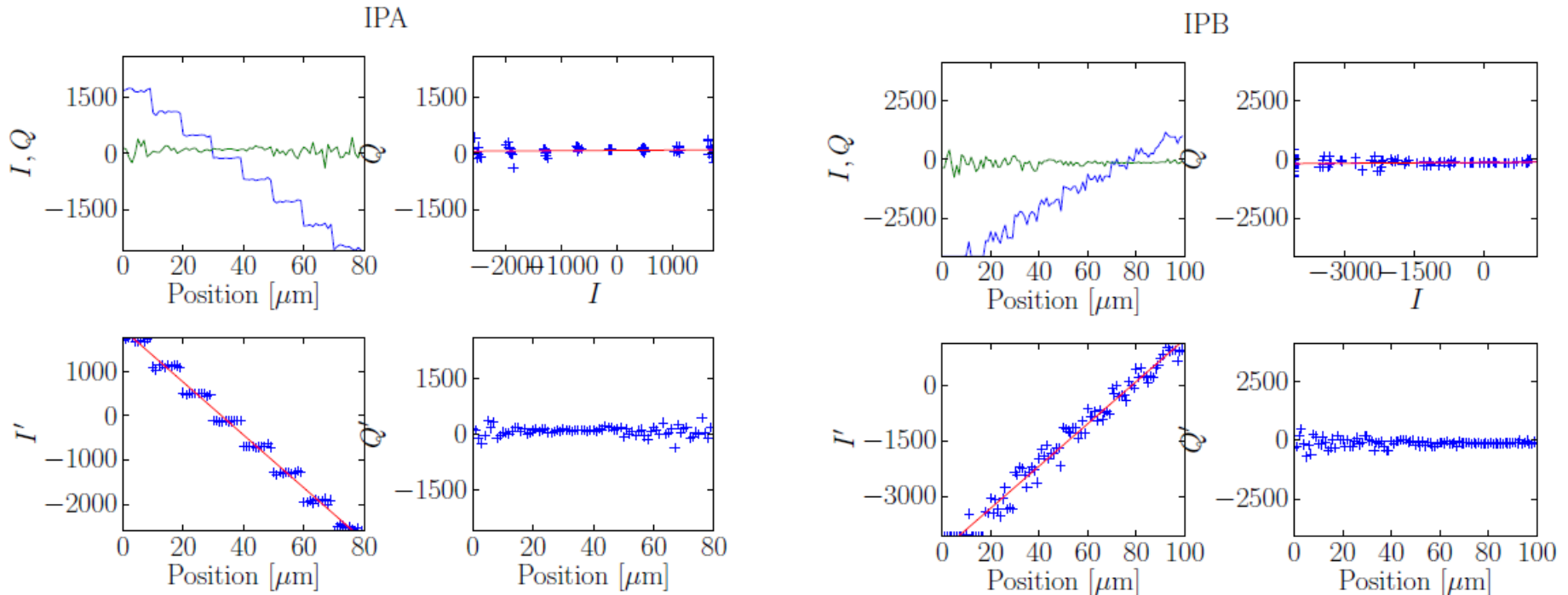
**Xilinx Virtex5 FPGA**

**9 ADC input channels  
(TI ADS5474)**

**4 DAC output channels  
(AD9744)**

**Clocked at 357 MHz  
phase-locked to beam**

# FONT digitisation of IPBPMs

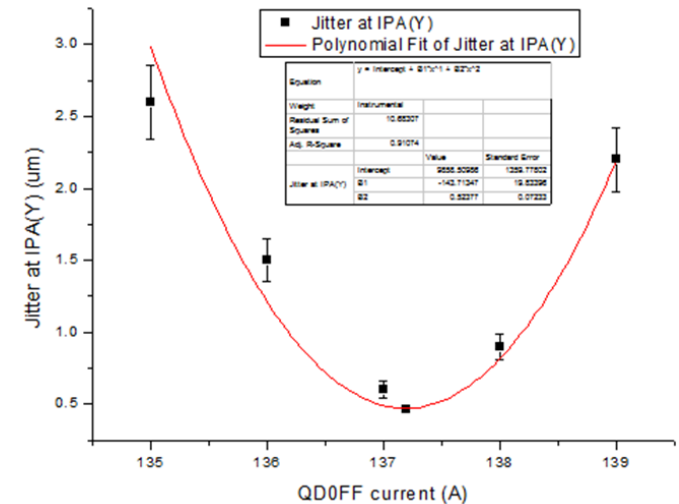


**Digitisation and calibration successful,  
with single-bunch beam**



# Upstream FONT kicker tests

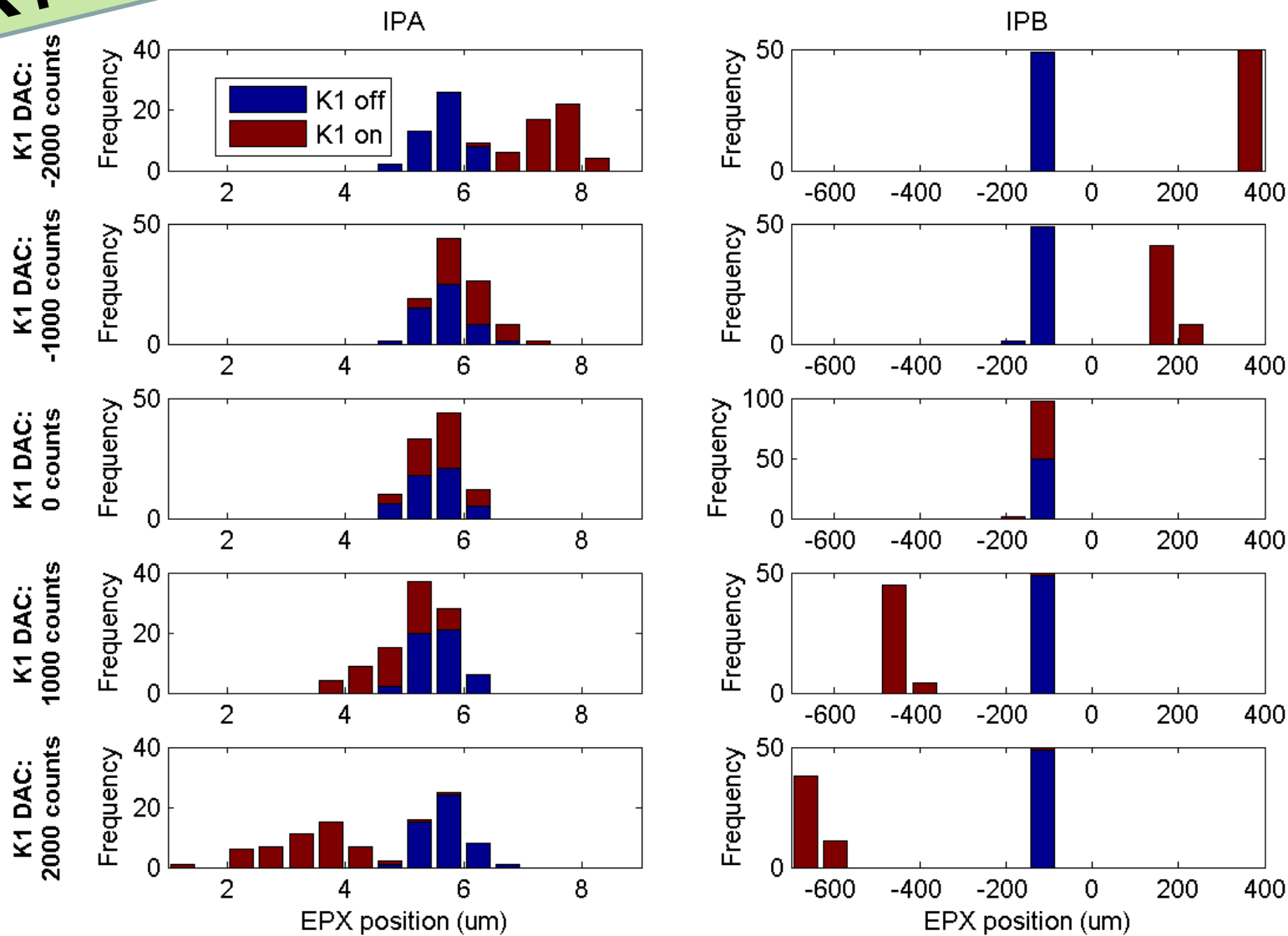
- **Beam waist set to IPBPM A**
- **Jitter minimised**



- **Upstream FONT kickers K1, K2 scanned**
- **Beam position recorded in IPBPMs**

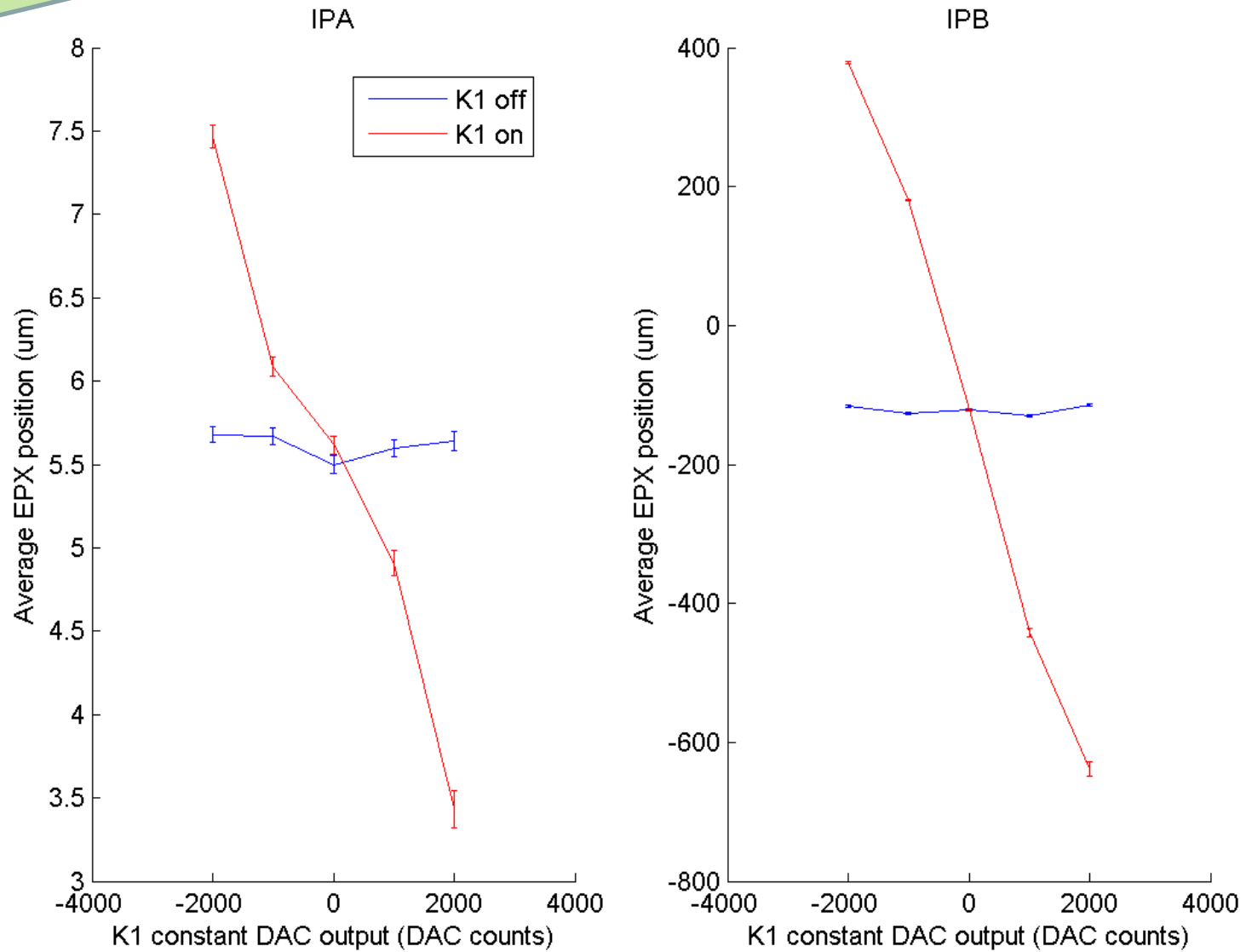
# K1 scan

## EPX position distributions at IP BPMs over K1 scan



# K1 scan

## EPX position at IP BPMs over K1 scan



# Upstream FONT kicker tests

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- **Position change at IPBPMs clearly observed**
  - upstream FONT FB can stabilise beam @ IP**

# Test Programme

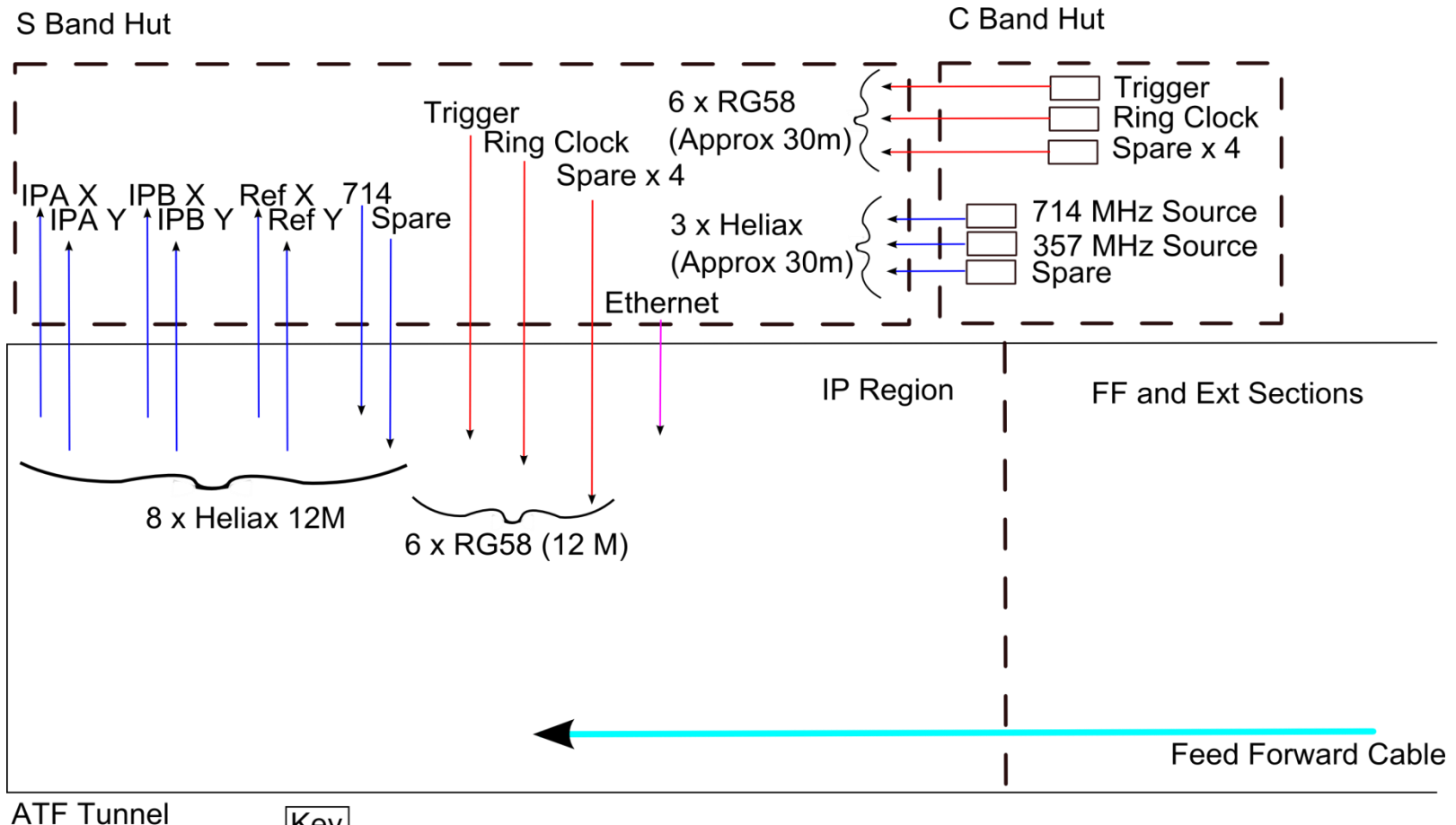
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Preparations for beam stability in IP region with

2-bunch beam:

1. Readout of IPBPMs with **2-bunch** beam
2. **Upstream FONT FB**: record beam in IPBPMs
3. **Feed-forward** from upstream FONT BPMs → IP  
kicker: record beam in IPBPMs
4. **IP FB** using IPBPM signal and IP kicker

# Setup (September 2012)



Key

RG58	←	Red line
Heliax	←	Blue line
Andrews Heliax LDF4-50A (or any of its variants)	←	Cyan line
Ethernet	←	Purple line



# Issues (October 2012 – 4 shifts)

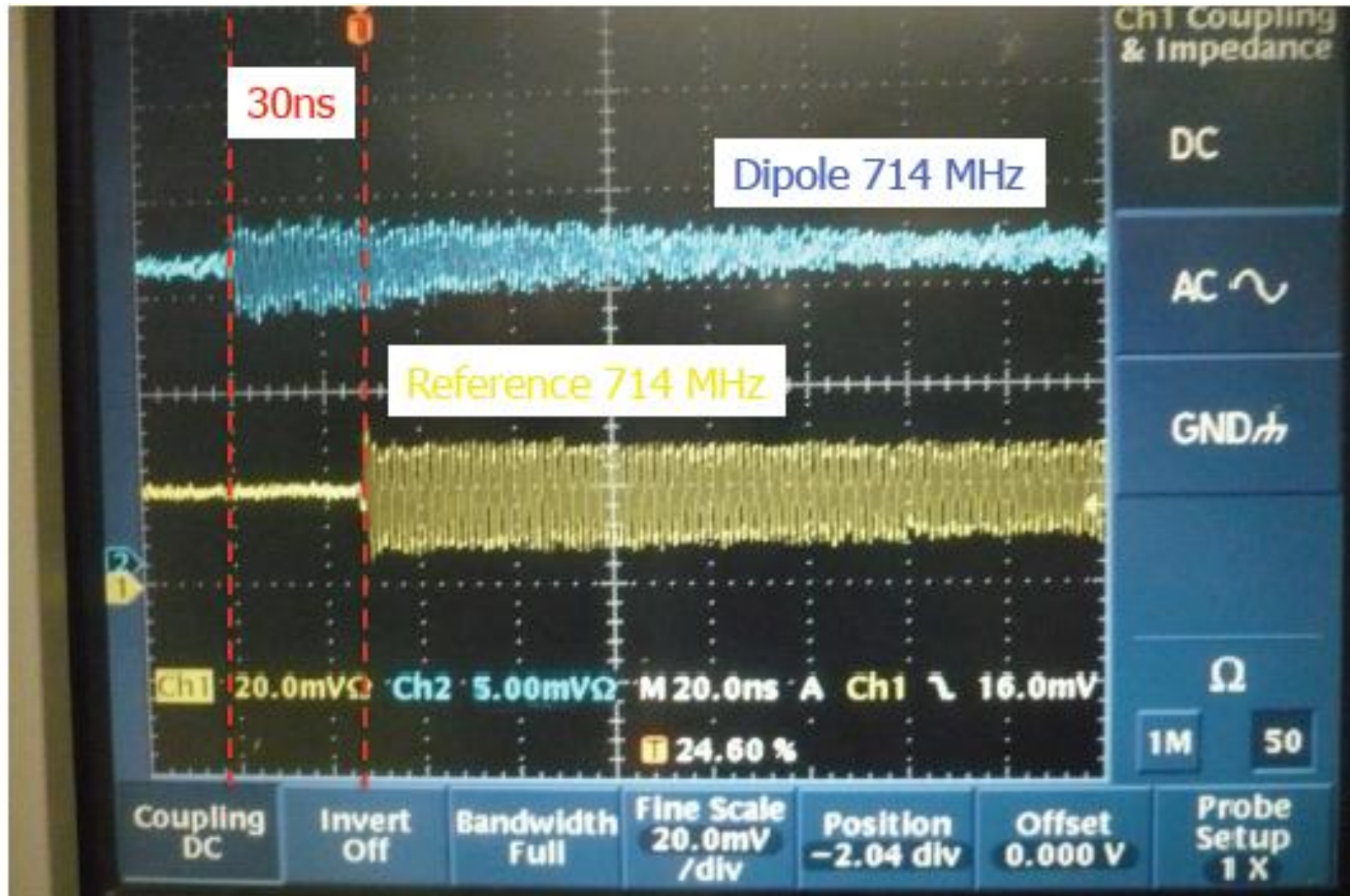
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- **First experience with Honda electronics connected locally to IPBPMs (previously tested upstream, with low-Q BPMs)**
- **Required extensive recabling/setup of electronics near IP**
- **Signal levels + attenuation need careful attention:**
  - saturation of IPBPM electronics: 1<sup>st</sup> stage mixer**
  - signal variation with bunch charge and position**
  - bunches 1 and 2 not necessarily on same orbit**
- **Arrival time of reference cavity signal is 'late' by 30ns due to cabling**

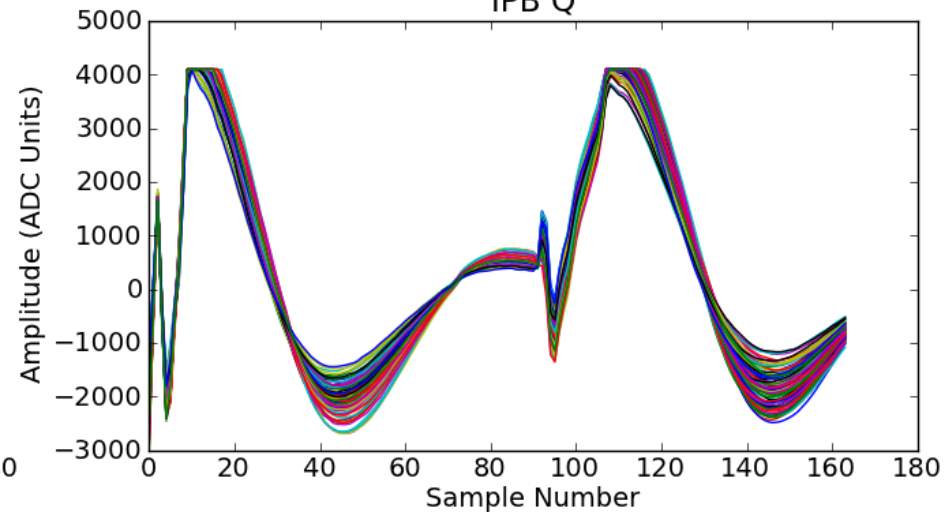
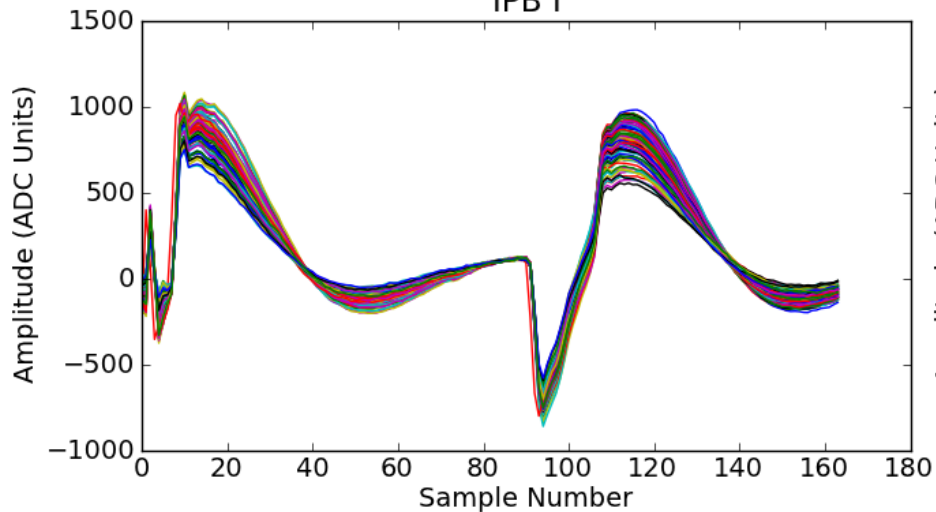
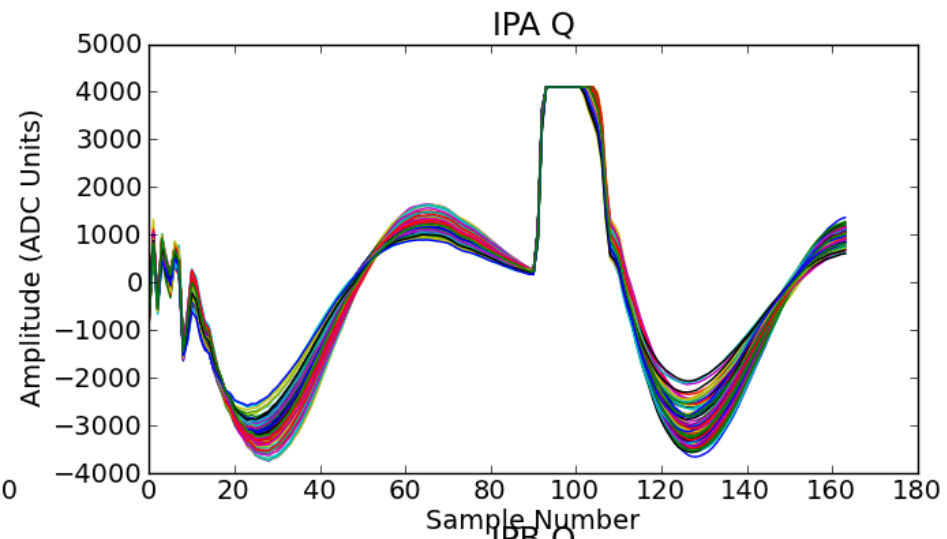
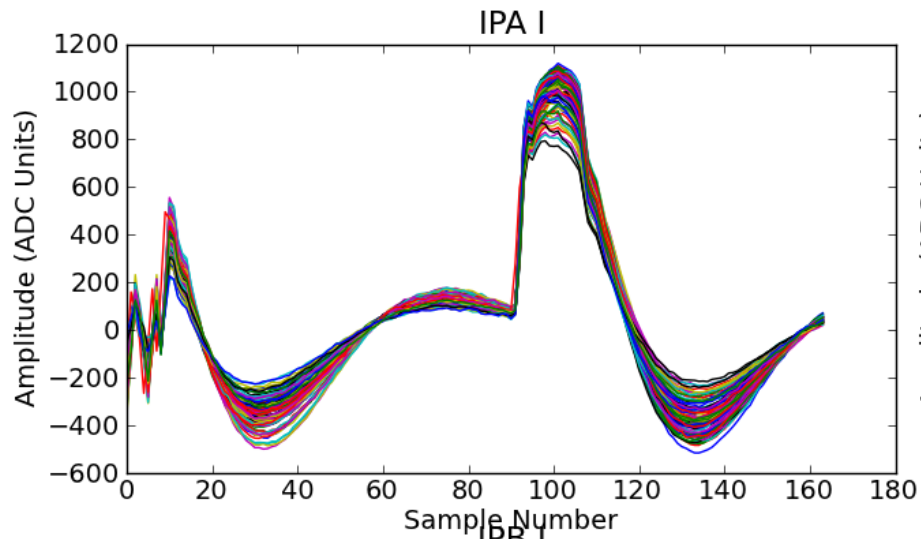
# Attenuation

Attenuation (dB)	Range (um)
0	+− 4 (no calibration, suppressed data?)
10	+− 13 (calibration ? with beam centre ?)
20	+− 40 (calibration !)
30	+− 130 (calibration !)

# Arrival of reference for 2<sup>nd</sup> stage

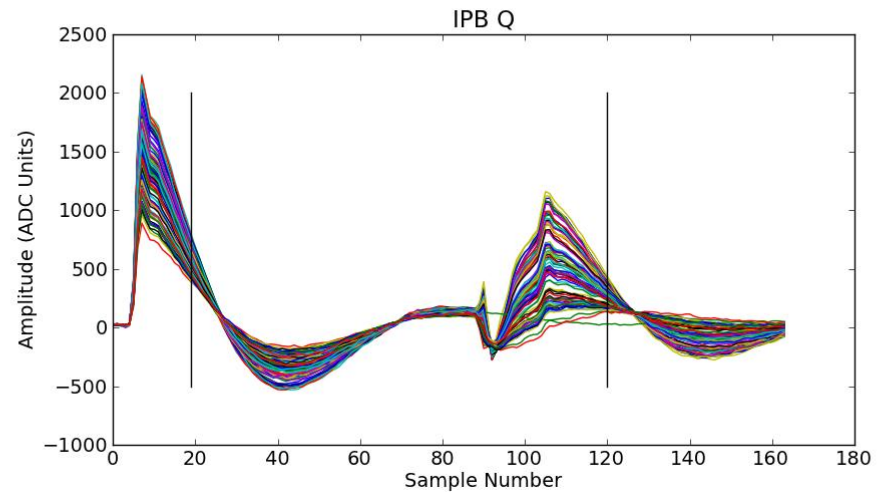
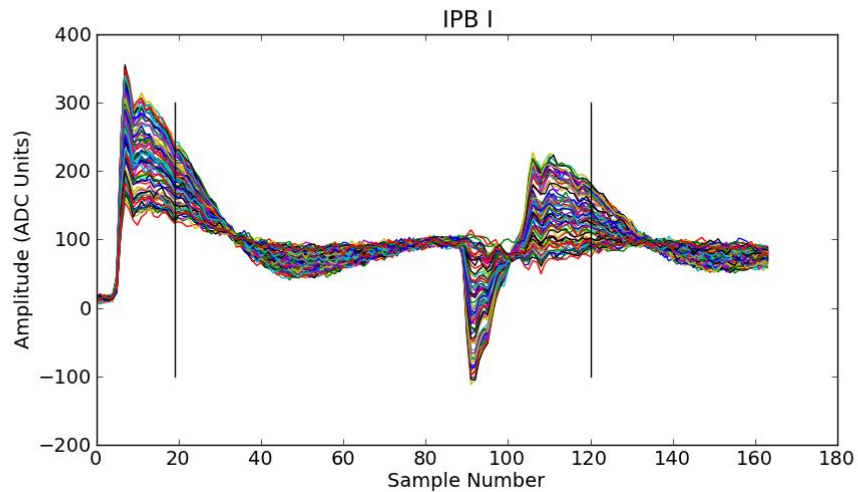
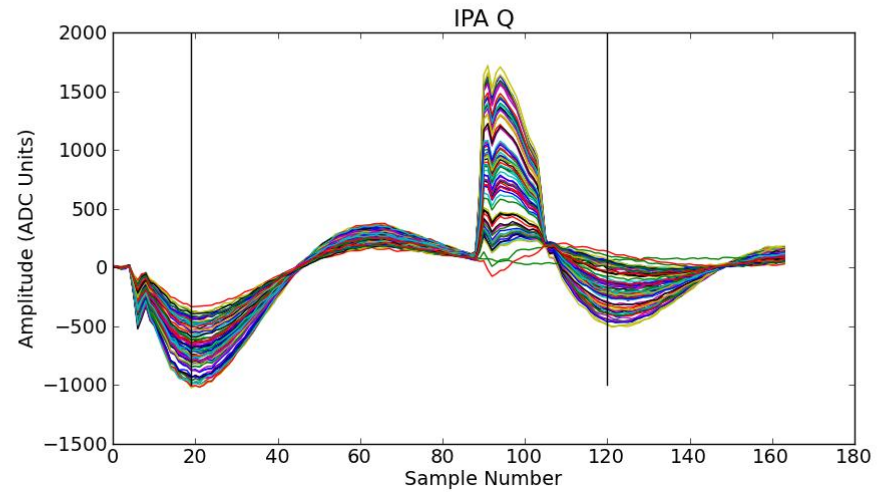
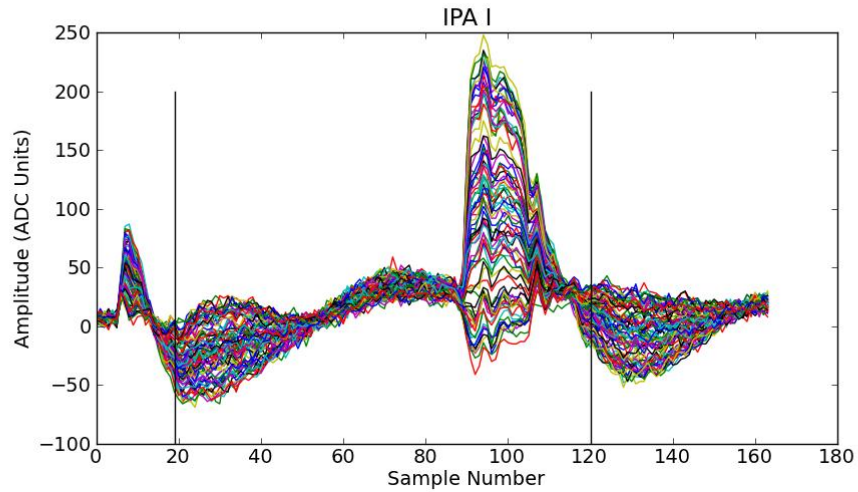


# Digitised waveform examples



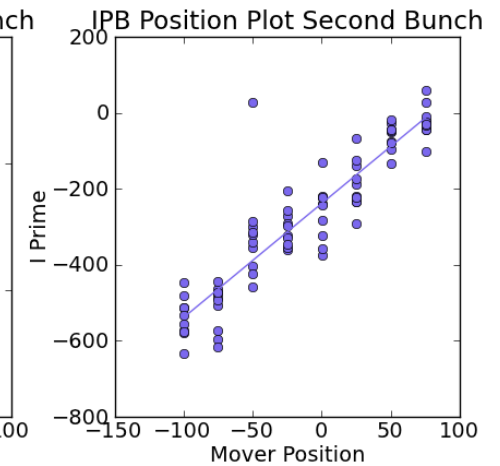
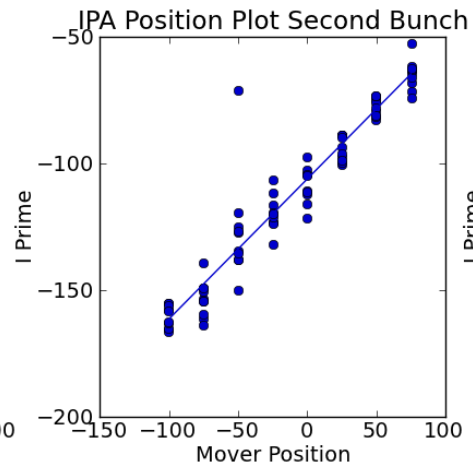
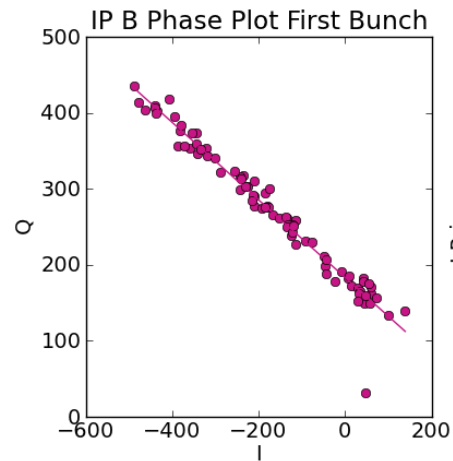
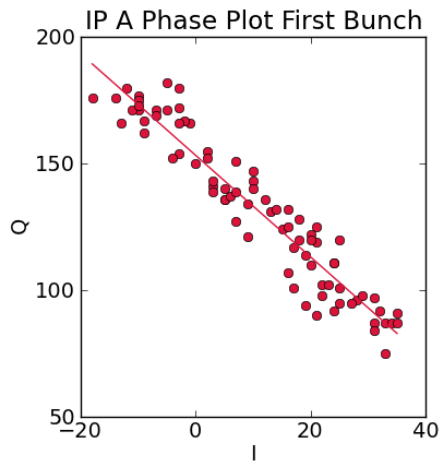
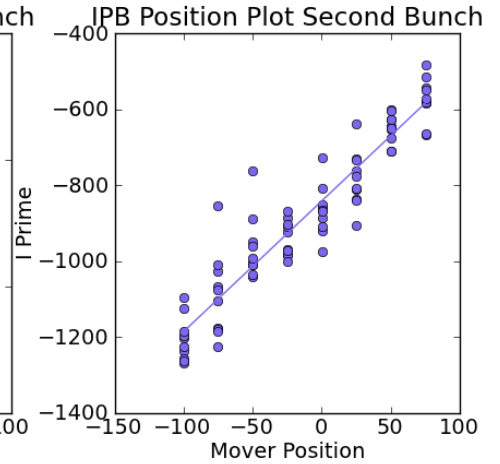
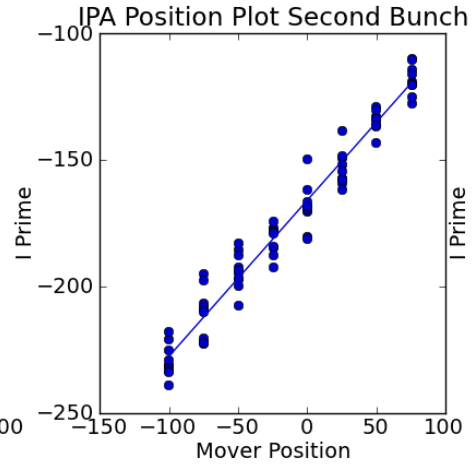
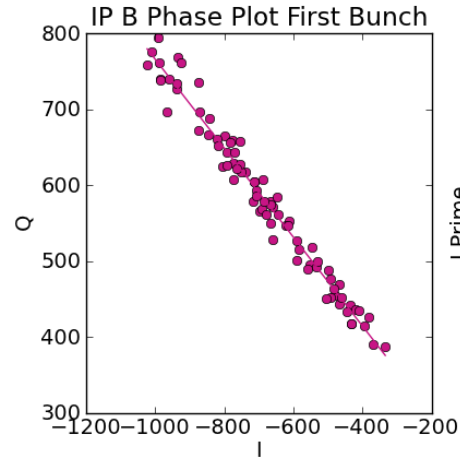
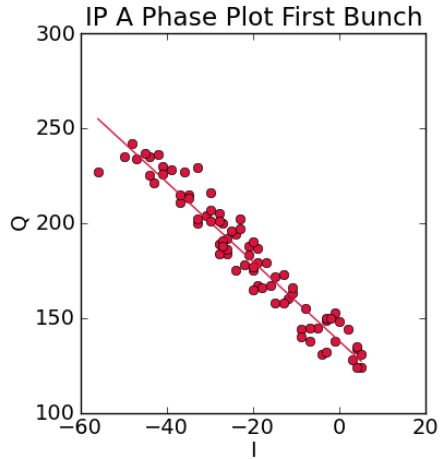
# Digitised waveforms: calibration

Raw Waveforms with Sample Number Selections for 20db Calibration



# Calibrations

A Set of Calibrations for 20dB at Sample Point 19 FB and 120 SB





# 2-bunch beam

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- **Sampling and digitisation working well**
- **Single-sample calibration procedure works**

# Test programme

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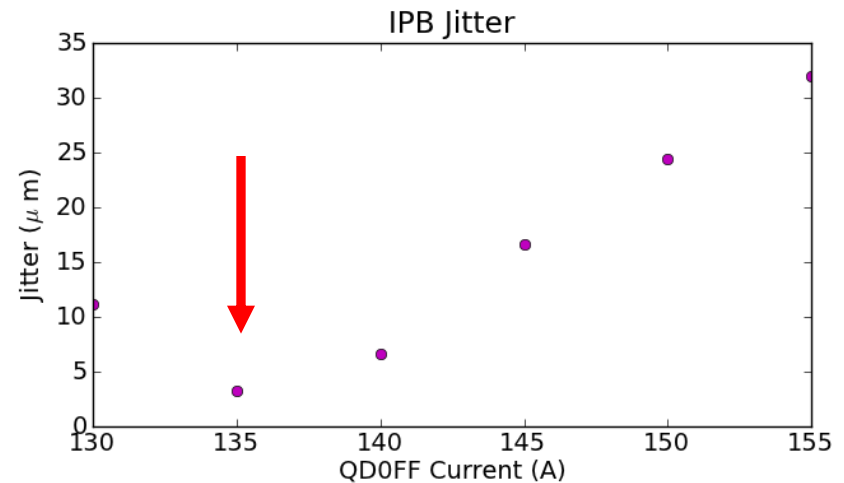
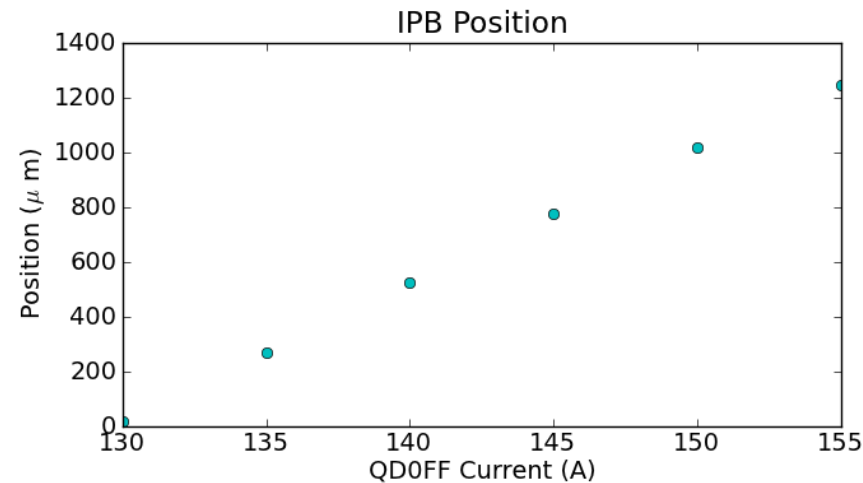
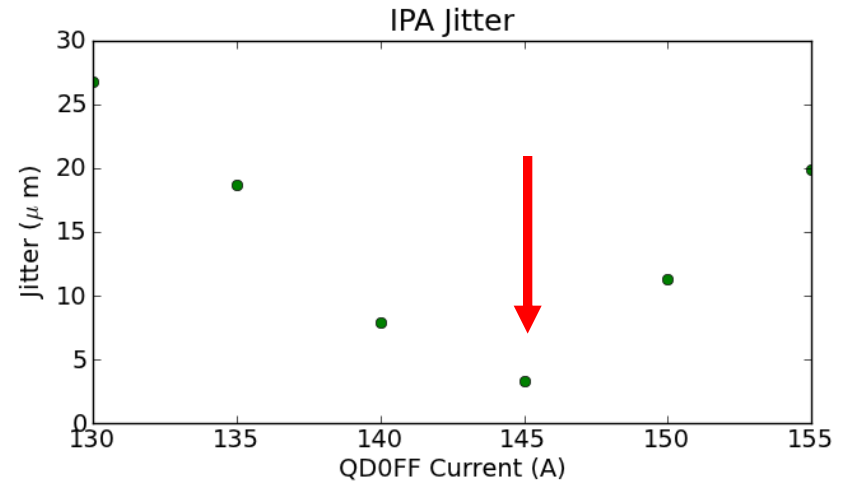
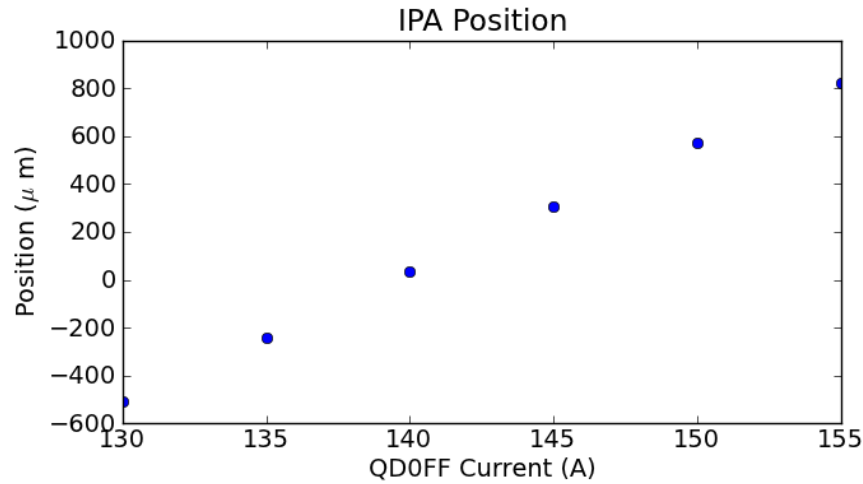
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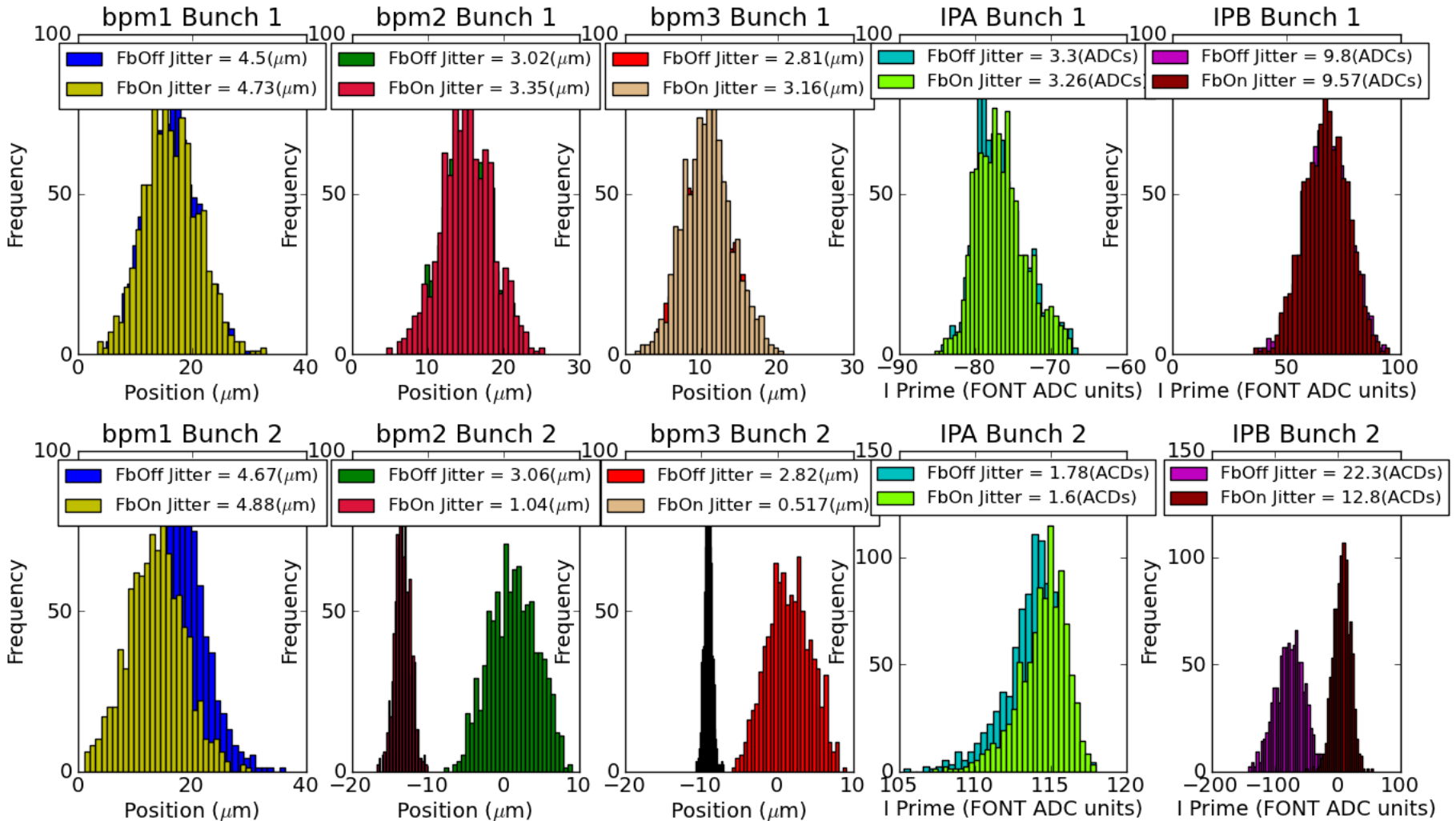
# Beam waist scans: IPA, IPB

IP Waist Scan (19/10/12)



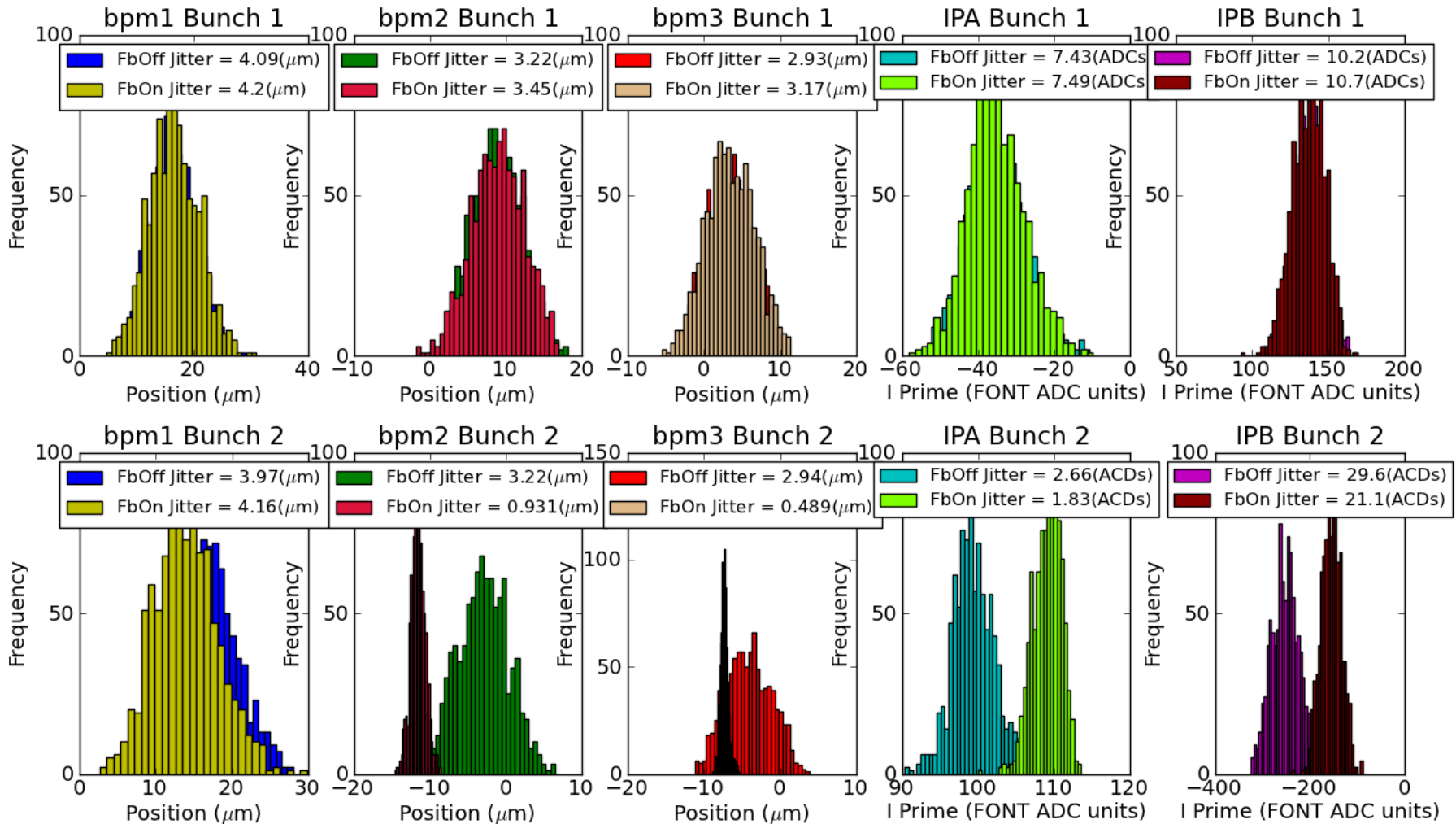
# Beam waist at IPB: FB off/on

Jitter Histograms (fbRun10) Waste at IP



# Beam waist at IPA: FB off/on

Jitter Histograms (fbRun16) Waste at IP





# Test programme

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Preparations for beam stability in IP region with

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# Shift 23/1/13

Re-established IBPM readout: calibrations, 1-bunch beam

Many ATF problems, large bunch charge variation

IPA Calibration 1 Fb Sample No. 33, Atten. 30 dB and IPB Calibration 3, Fb Sample No. 33, Atten. 10 dB

IP A Phase Plot

IP B Phase Plot

IPA Position Plot

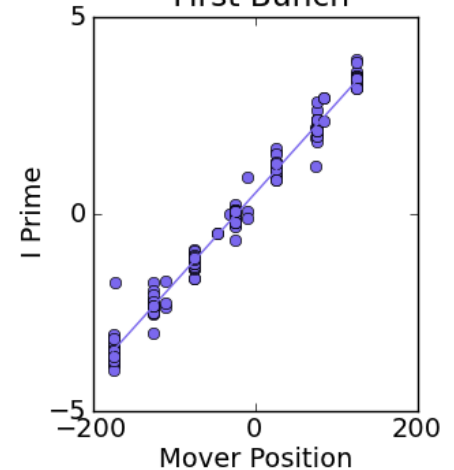
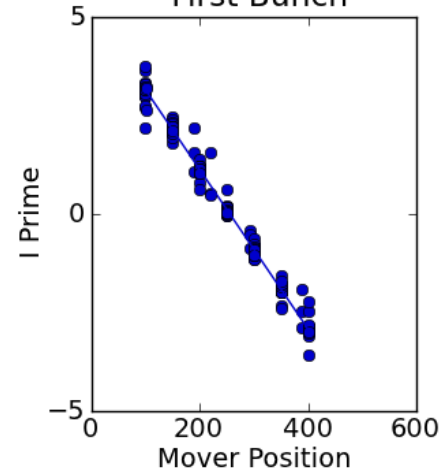
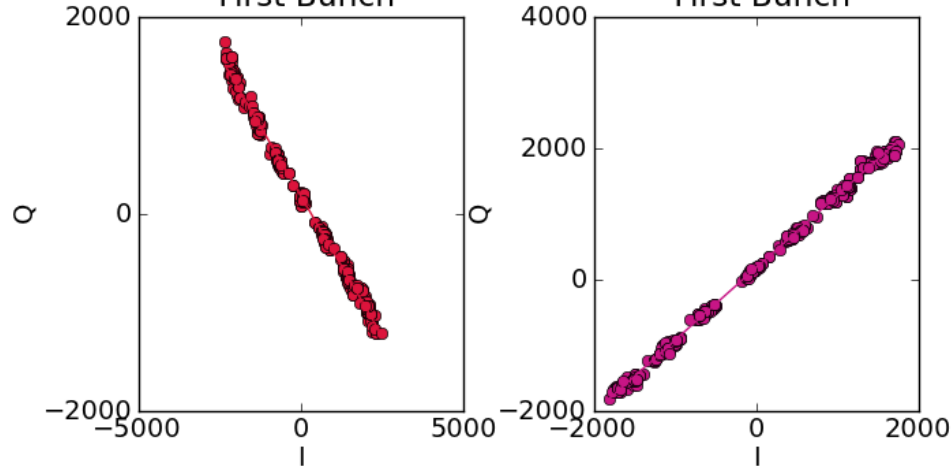
IPB Position Plot

First Bunch

First Bunch

First Bunch

First Bunch



25/1/13 shift in progress ...

# IP FB loop scheme

