IP Feedback Status

Feedback On Nanosecond Timescales (FONT):

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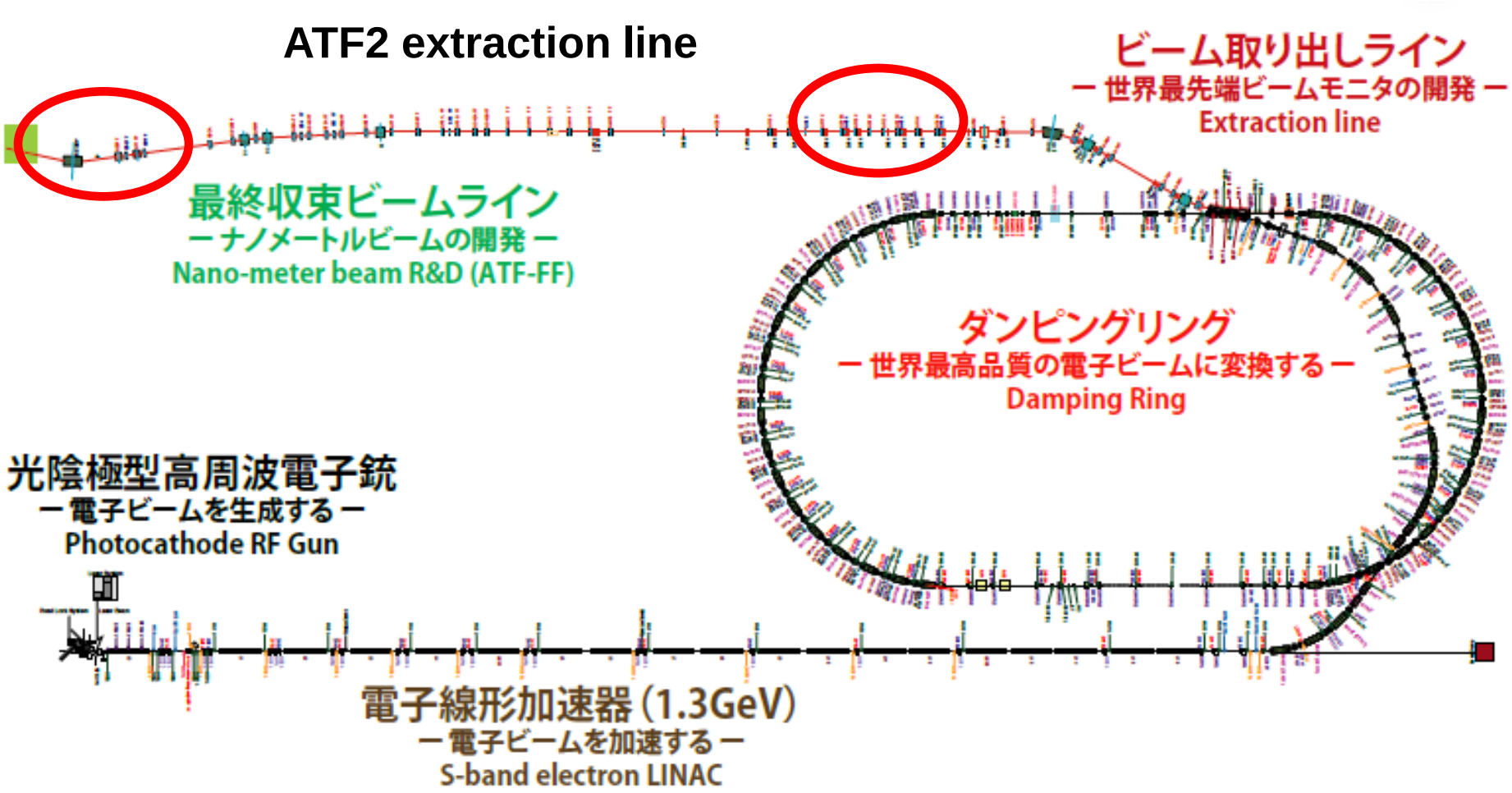
John Adams Institute

Oxford University

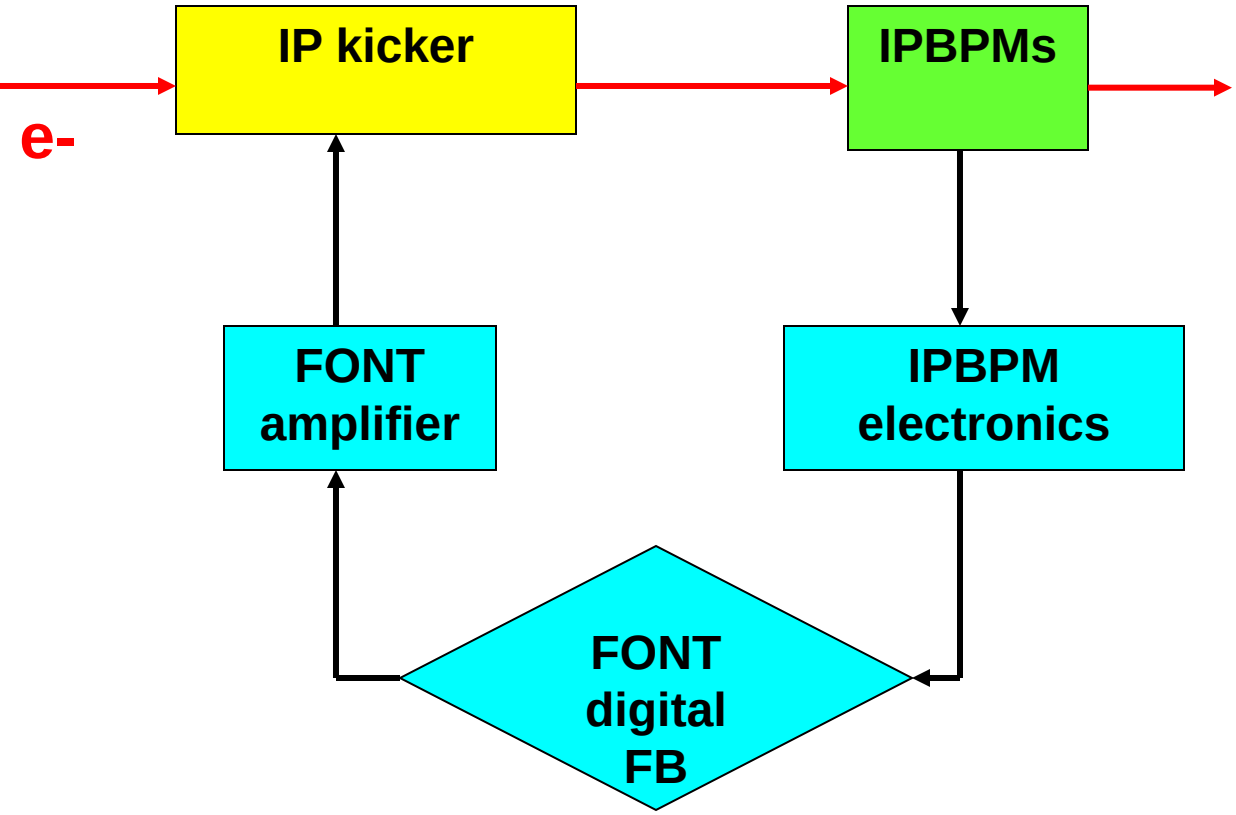
Outline

- **Reminder of ATF2 IPFB**
- **Preparatory tests for IPFB**
- **Results of June 2013 beam tests**
- **Summary + outlook**

FONT5 installation at ATF2



ATF2 IP FB loop scheme



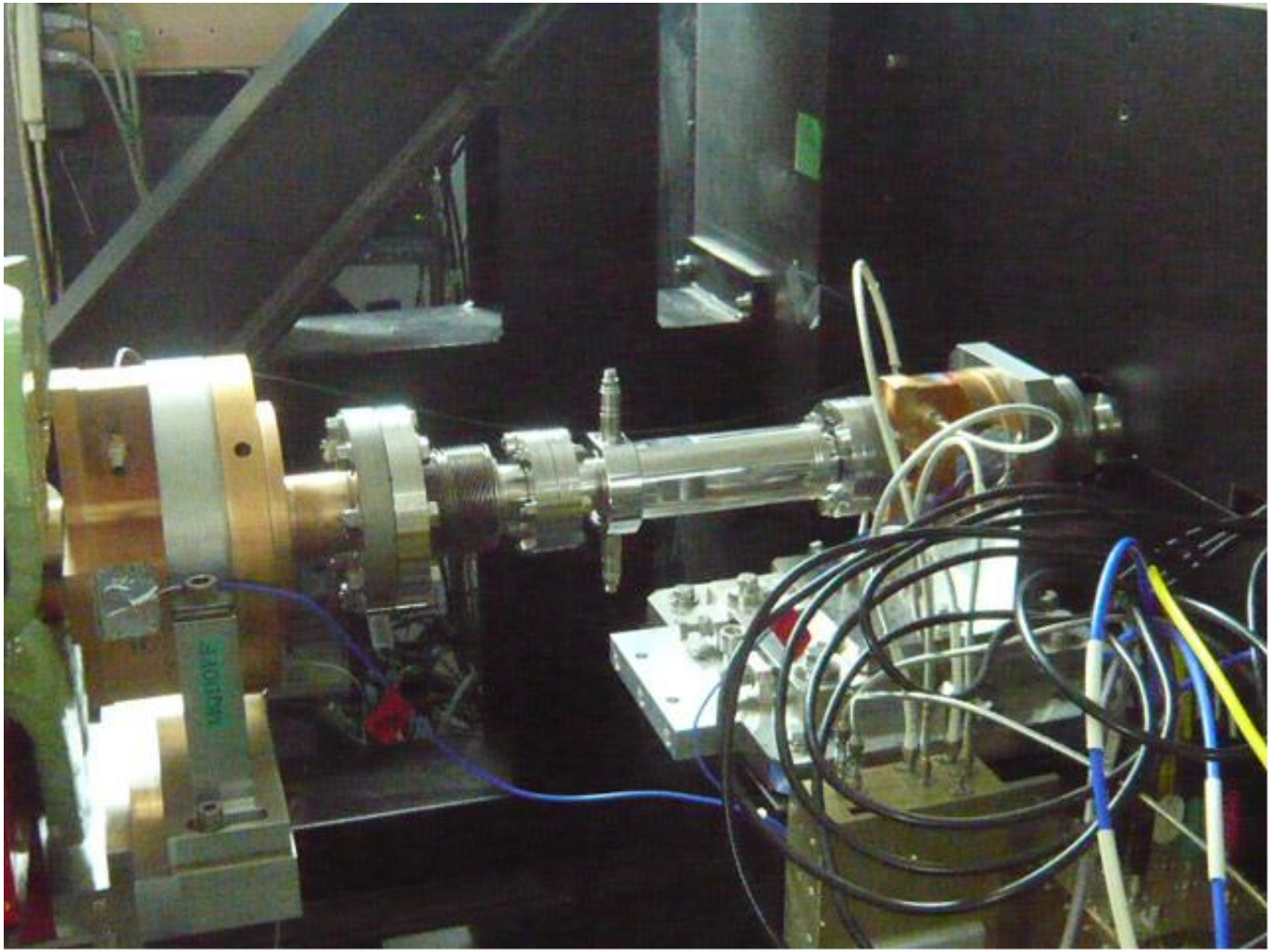
Eventual goal is to stabilise the small ATF2 beam (design 37nm) at the nanometer level

Layout with new IP kicker

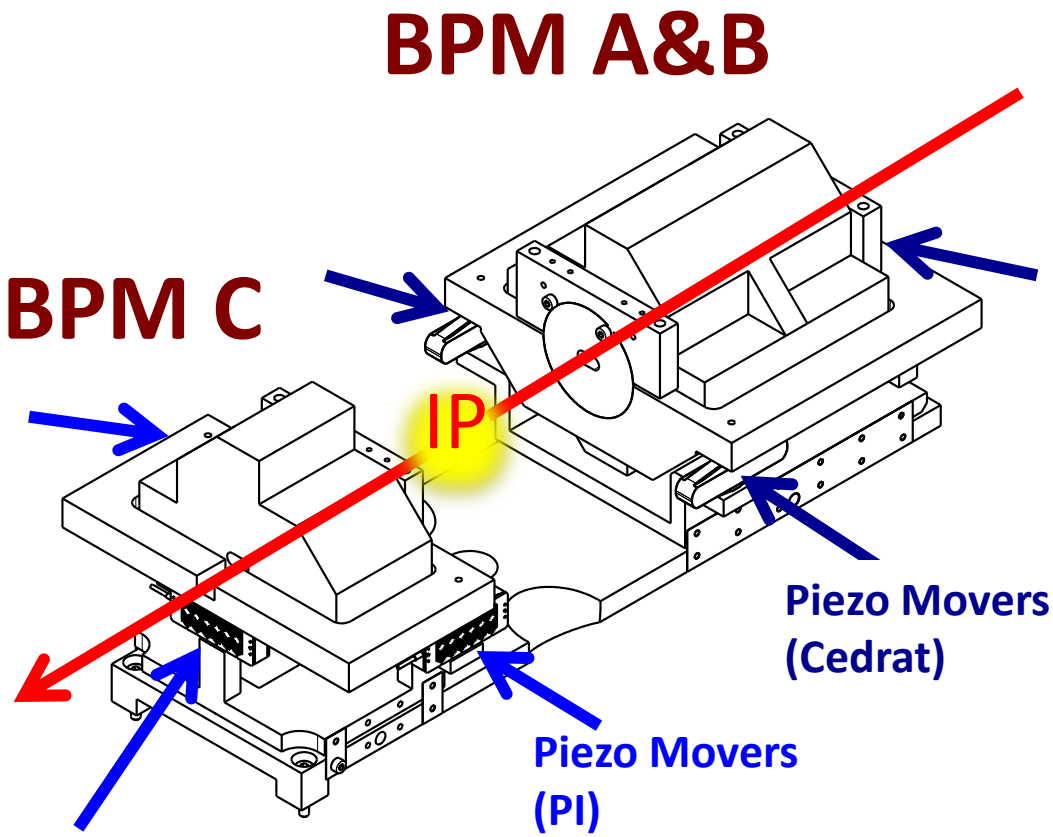
Designed by Oxford

Fabrication arranged by KEK

Installed May 2012



In vacuum IP-BPMs and piezo movers



BPMs

- Bolted aluminum plates, no brazing because of In-vacuum.
- BPM A&B bolted together.
- BPM C is independent.

Piezo mover

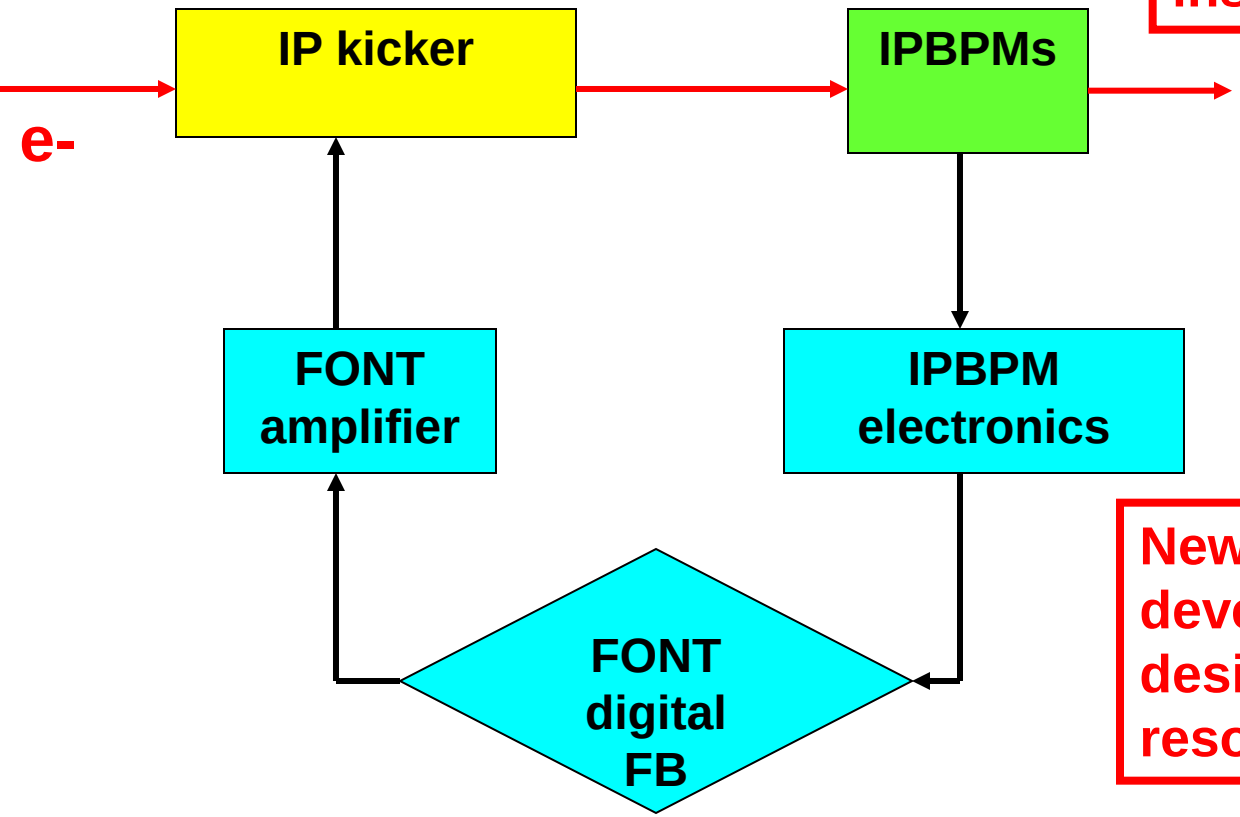
- BPM units are mounted on the base with three piezo movers.
- **Dynamic range of each mover is +/- 150 um.**

  Initial alignment need to be better than this.

Slide from Terunuma

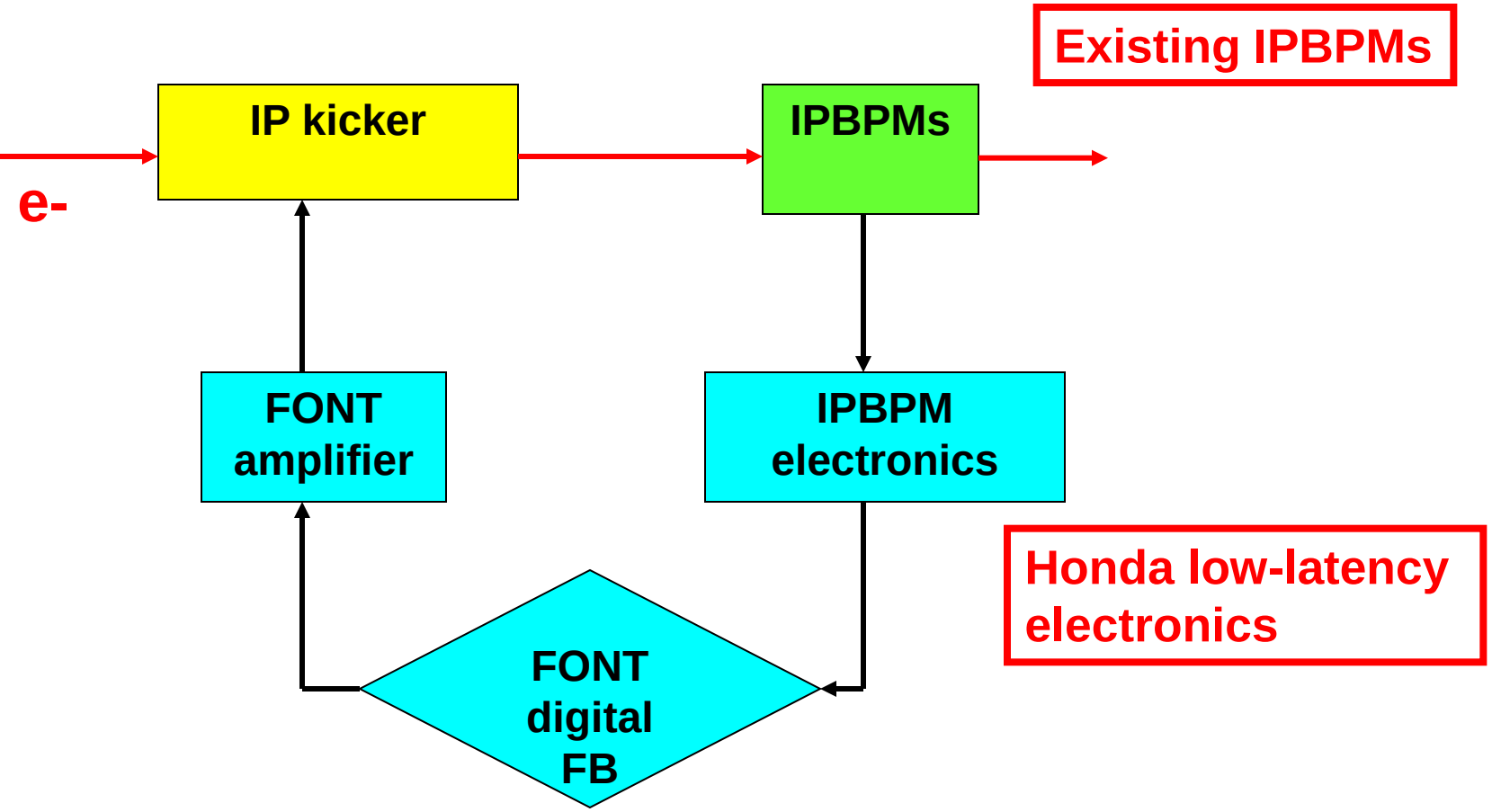
Commissioning started Nov 2013

New IP chamber installed Summer 2013



New IPBPM electronics developed by KNU, designed for few nm resolution

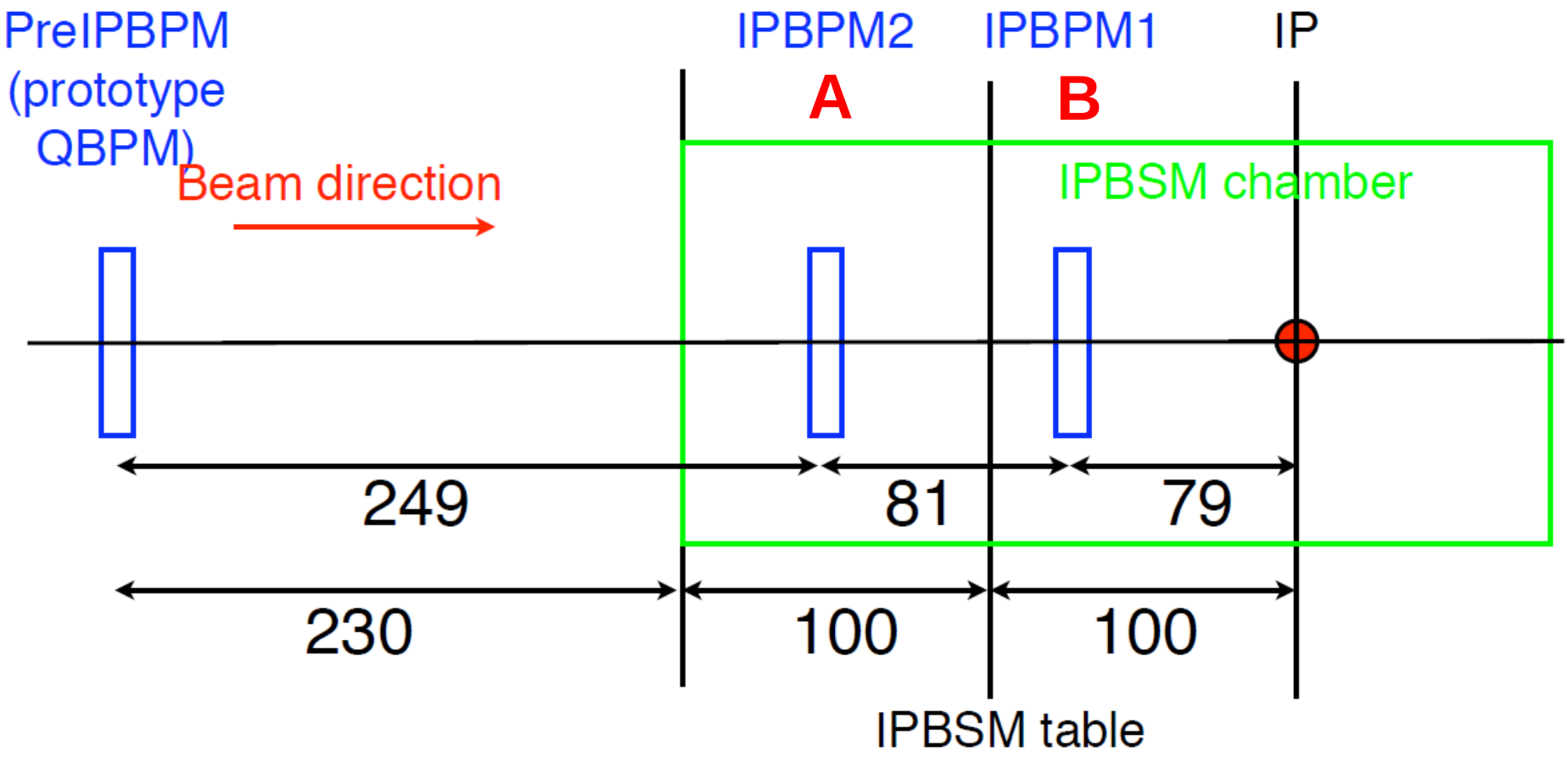
Preparatory tests June 2013



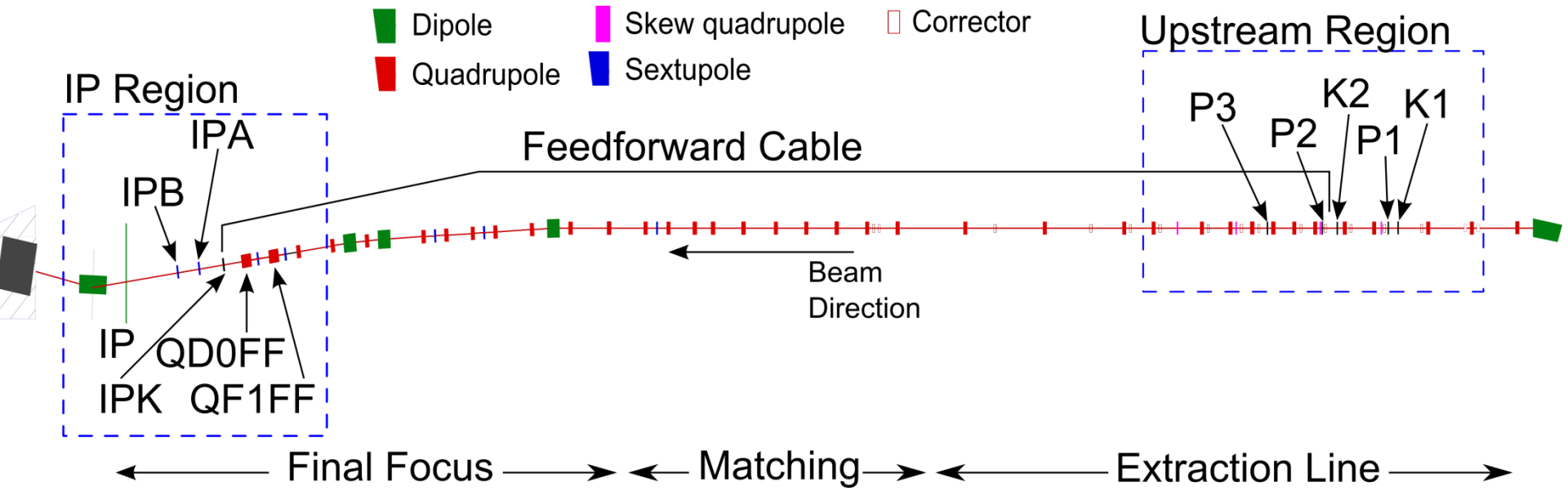
Existing IP-BPM geometry

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.



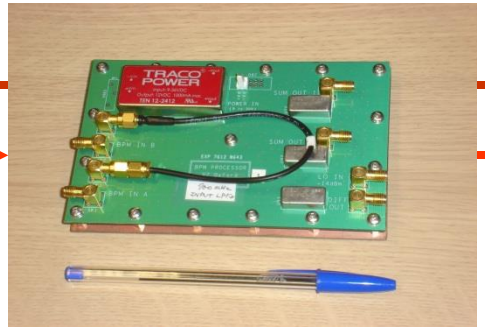
FONT5 operation at ATF2



Aim to stabilise beam in IP region using 2-bunch spill:

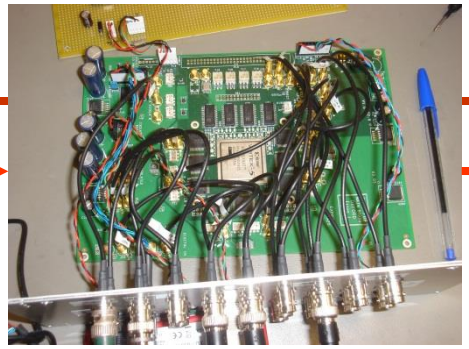
1. **Upstream FB: monitor beam at IP**
2. **Feed-forward from upstream BPMs → IP kicker**
3. **Local IP FB using IPBPM signal and IP kicker**

Upstream FONT5 System



Analogue Front-end

BPM processor

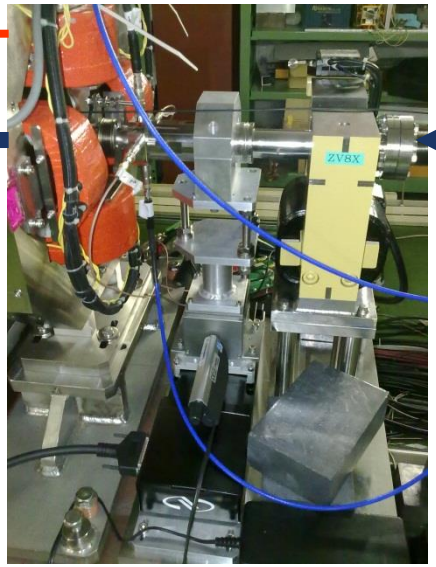


FPGA-based digital processor

Kicker drive amplifier

Beam

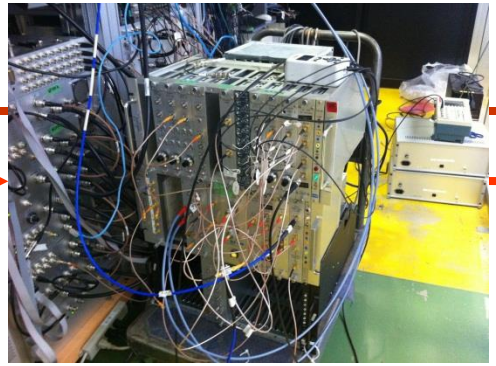
Strip-line kicker



Stripline BPM with mover system

BPM Resolution	< 350nm
Dynamic range of the BPM system	+/-500µm
System Latency	<150 ns
Amplifier Bandwidth	~30 MHz

Interaction Point FONT System



Analogue Front-end

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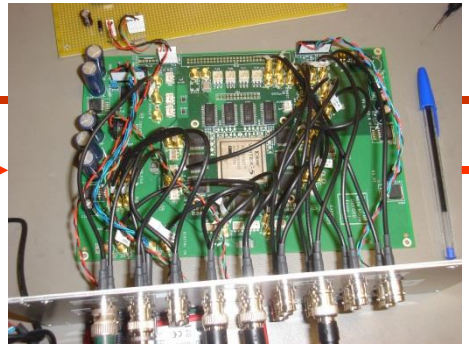
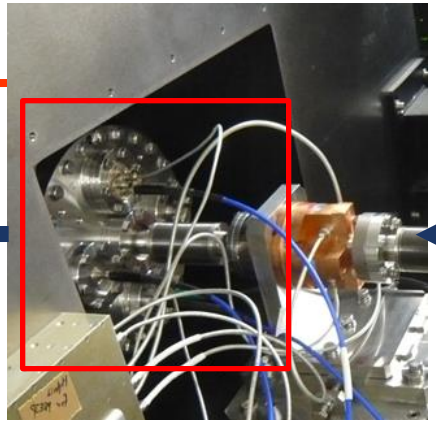


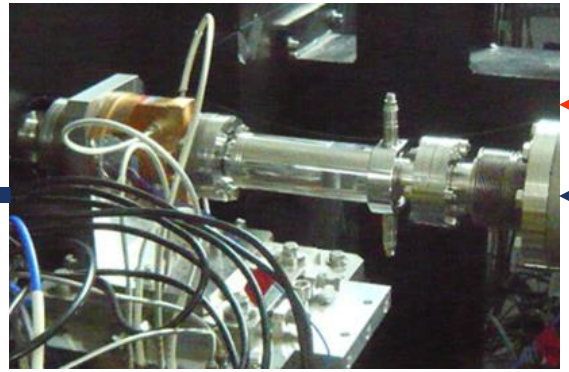
FPGA-based digital processor

Kicker drive amplifier



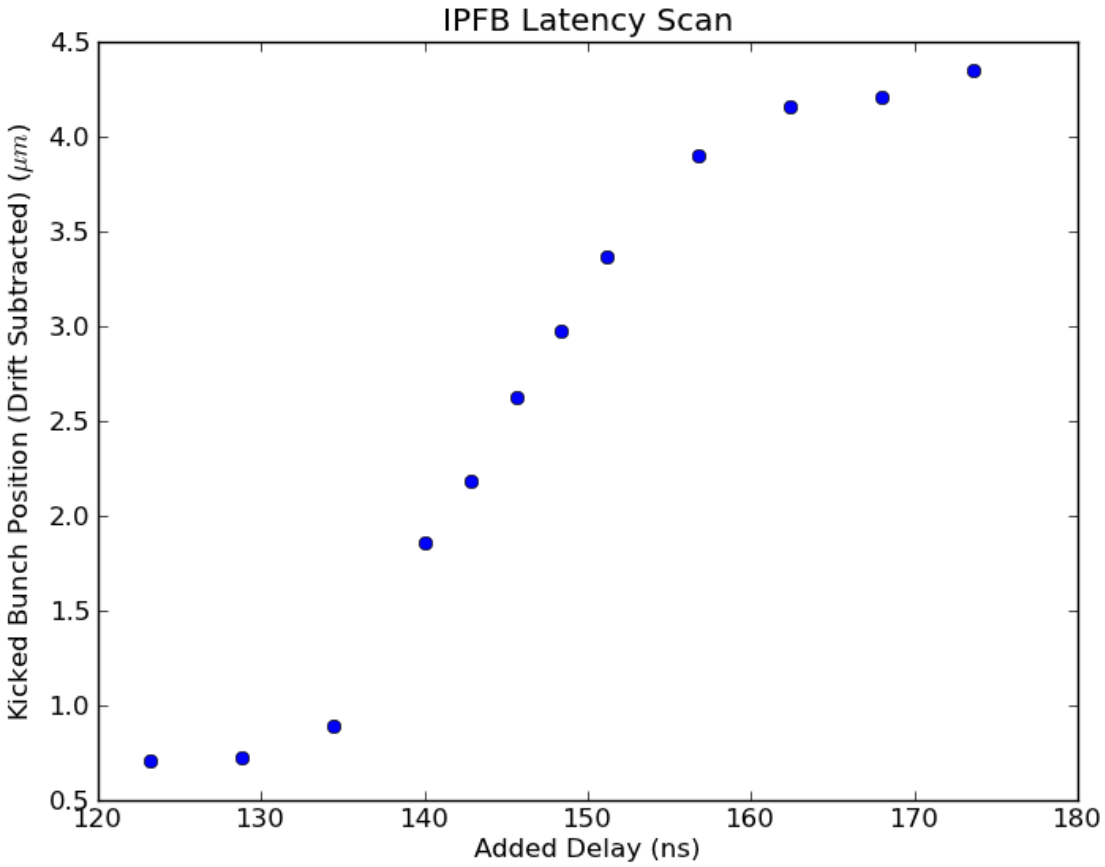
Cavity BPM

Beam



Strip-line kicker

IP FB latency measurement



Latency ~ 160ns

Test programme

Preparations for beam stability in IP region with 2-bunch beam, bunch separation 270ns:

1. Readout of IPBPMs with 2-bunch beam

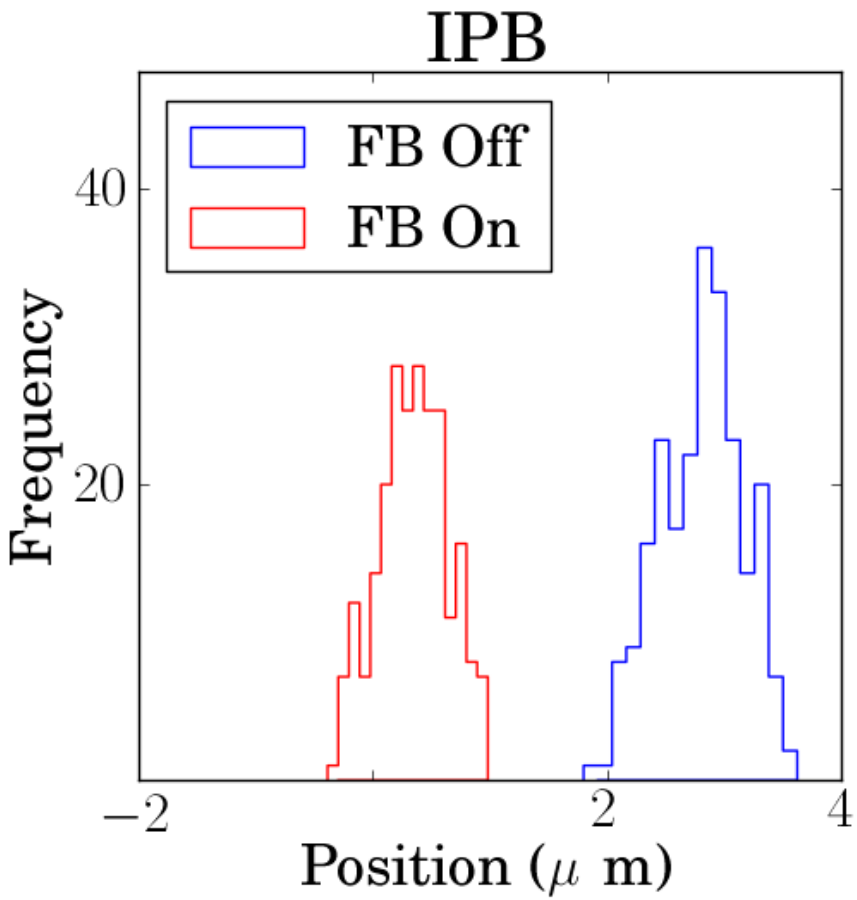
2. Upstream FONT FB: record beam in IPBPMs

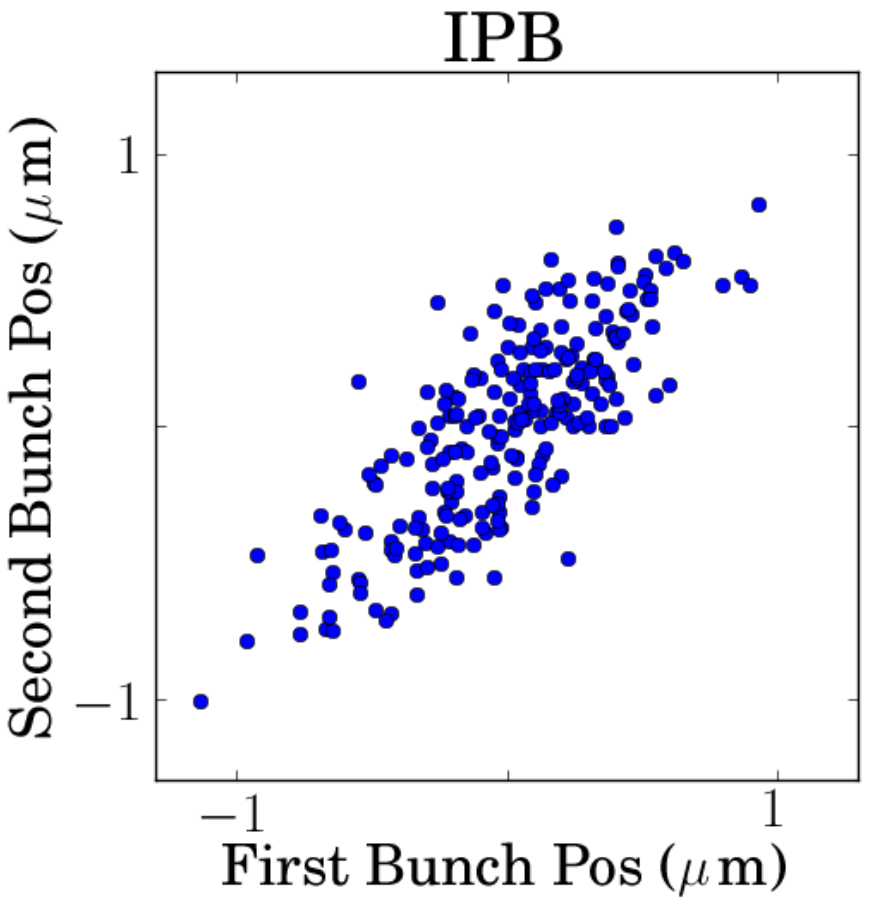
3. Feed-forward from upstream FONT BPMs → IP kicker: record beam in IPBPMs

4. IP FB using IPBPM signal and IP kicker

Standard procedure is to correct beam in y at IPB

Upstream FB (Measured at IPB)

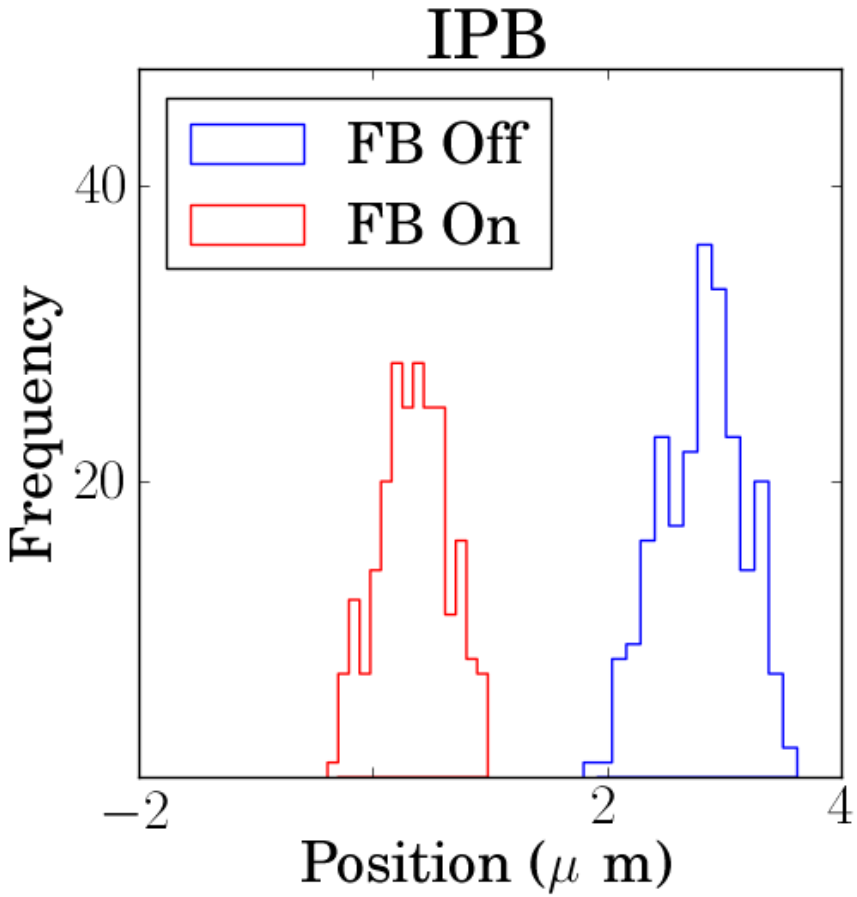


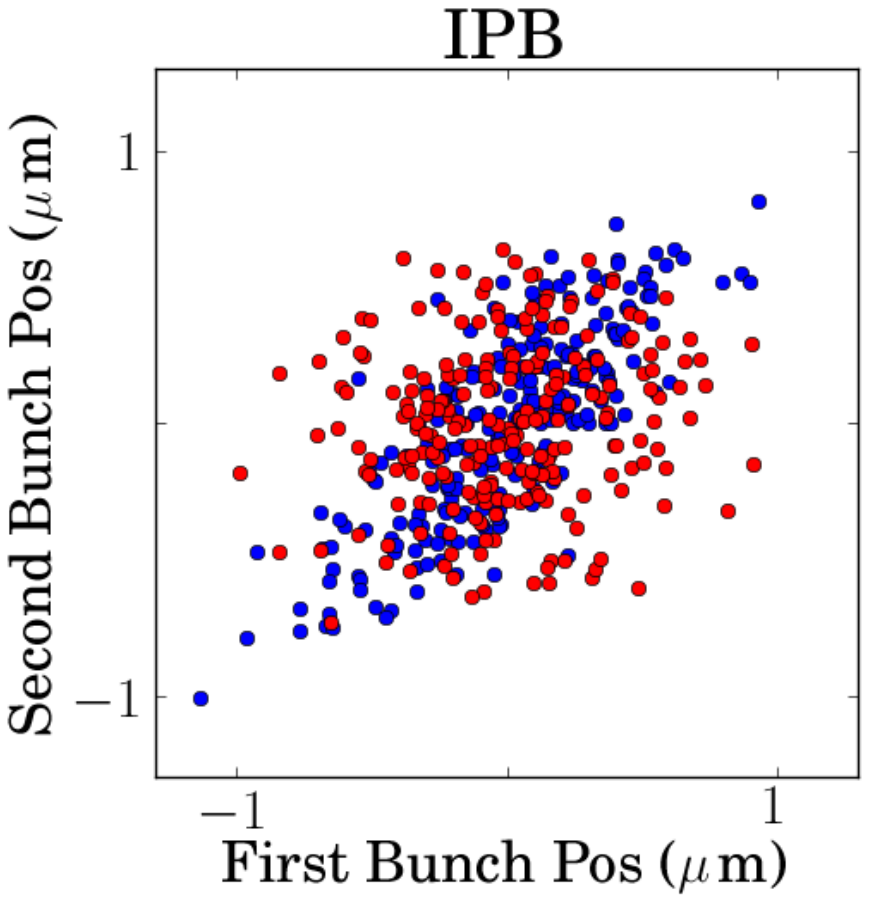


FB Off Jitter: 0.35 ± 0.02 μm
FB On Jitter: 0.30 ± 0.01 μm

FB Off Correlation: 79%

Upstream FB (Measured at IPB)

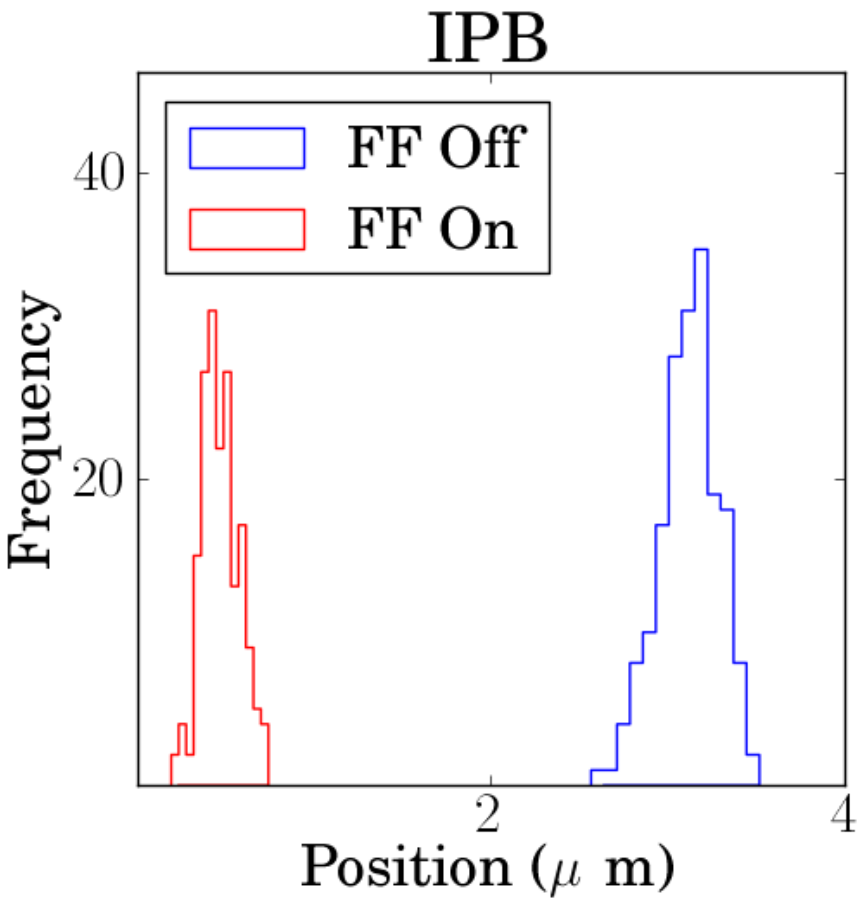


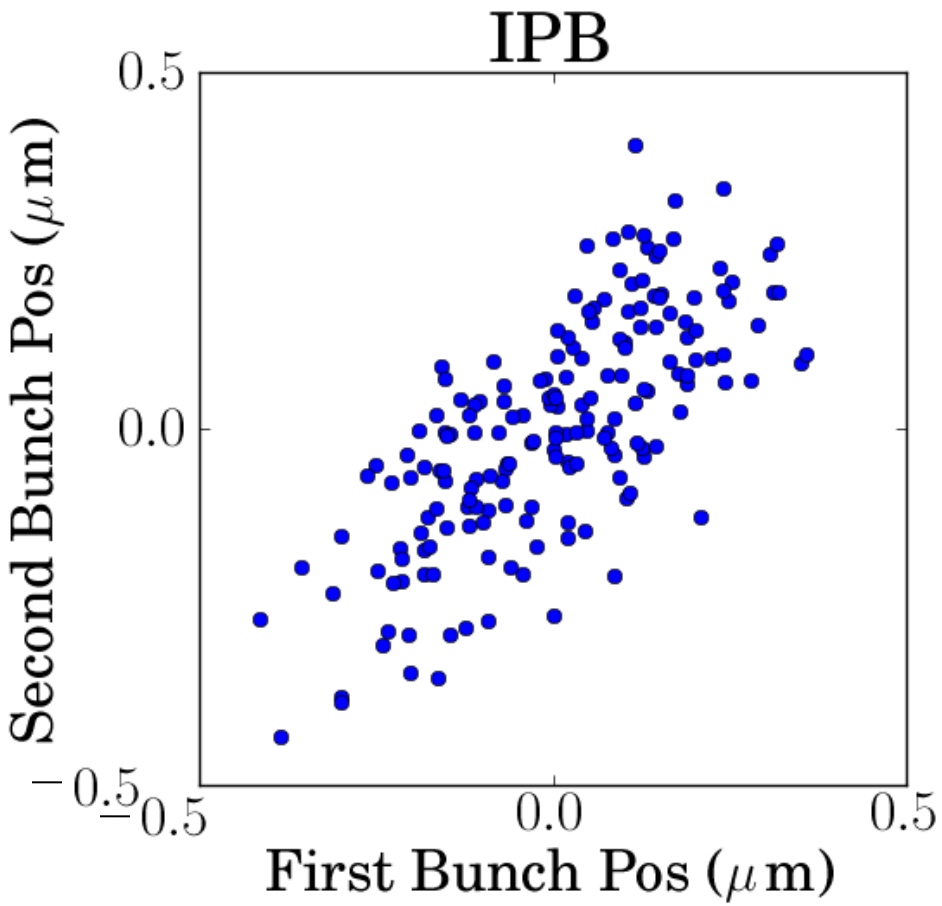


FB Off Jitter: 0.35 ± 0.02 μm
FB On Jitter: 0.30 ± 0.01 μm

FB Off Correlation: 79%
FB On Correlation: 14%

Feedforward Results



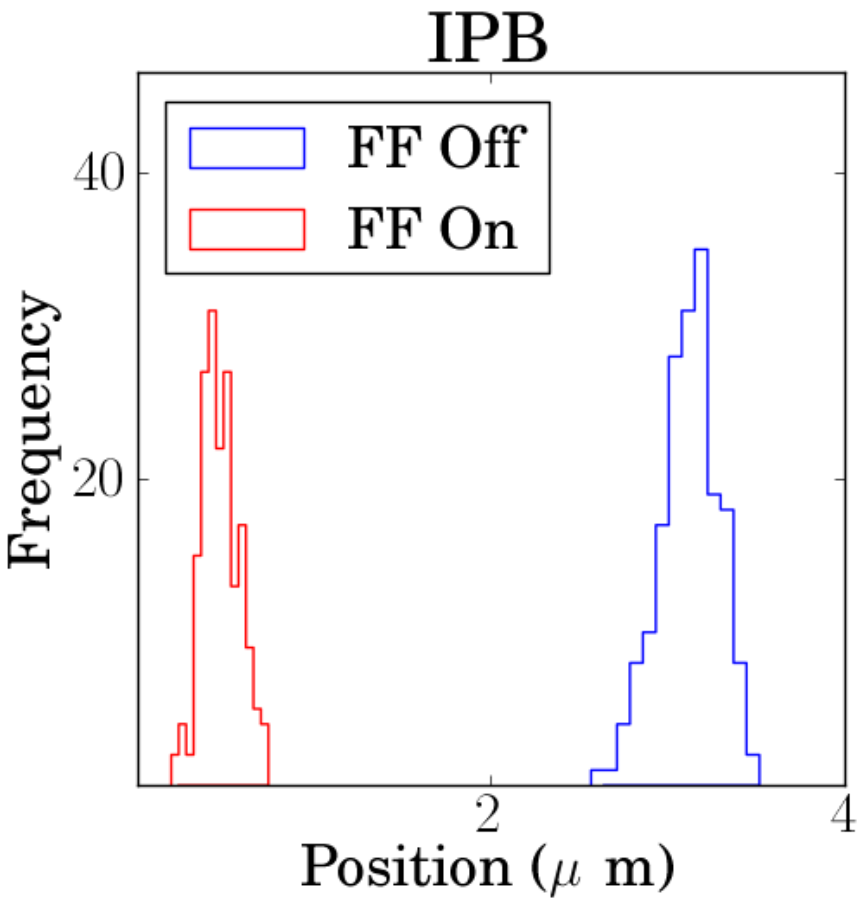


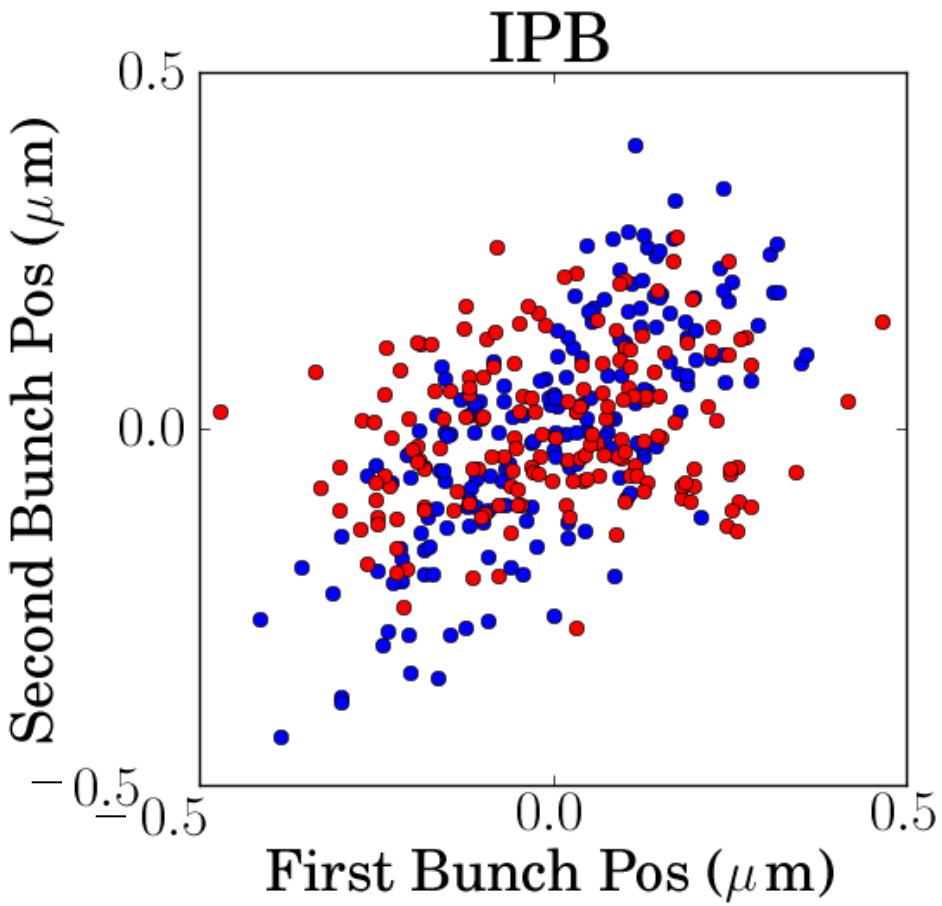
FF Off Jitter: 160 ± 10 nm

FF On Jitter: 106 ± 10 nm

FF Off Correlation: 73%

Feedforward Results



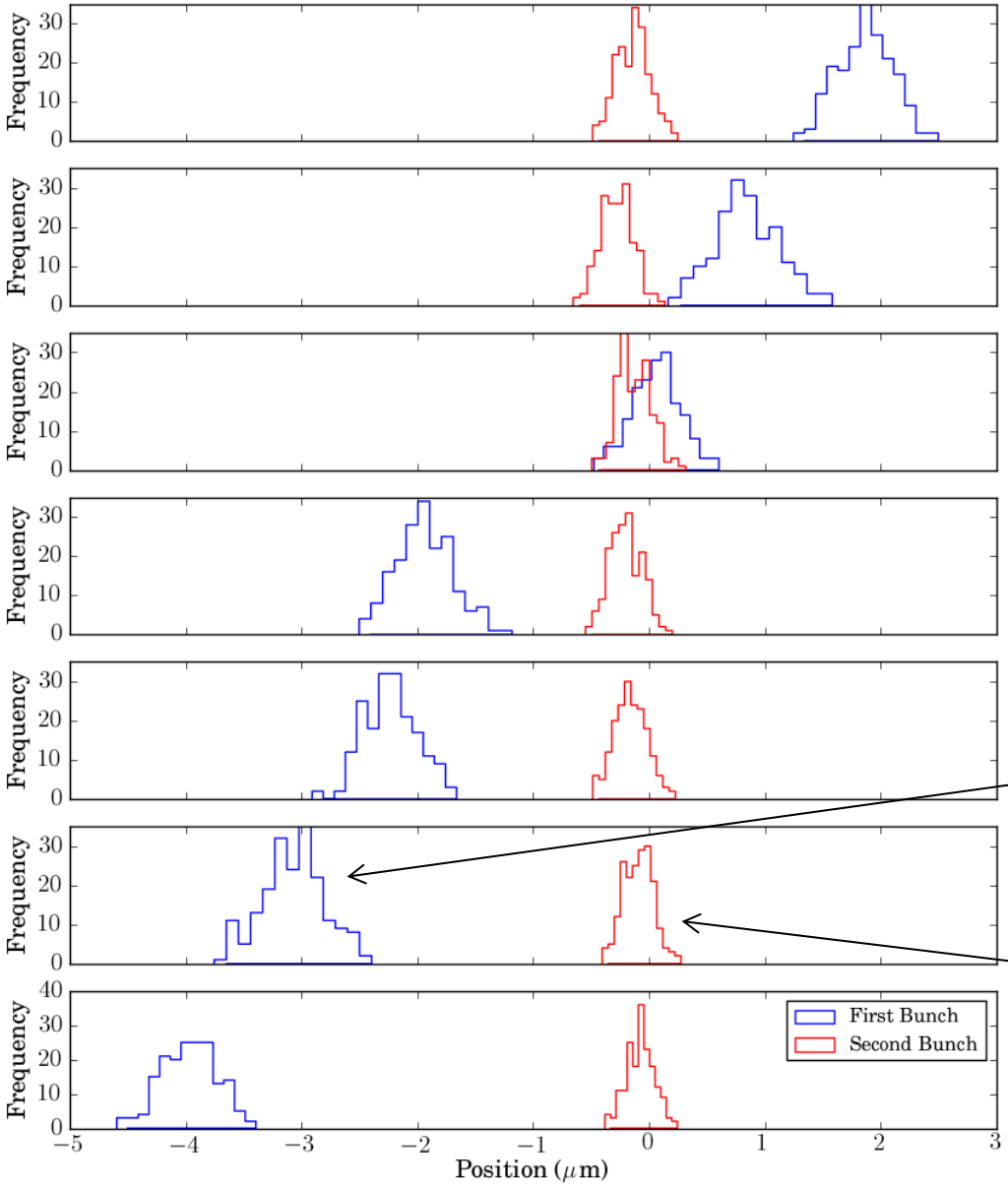


FF Off Jitter: 160 ± 10 nm
FF On Jitter: 106 ± 10 nm

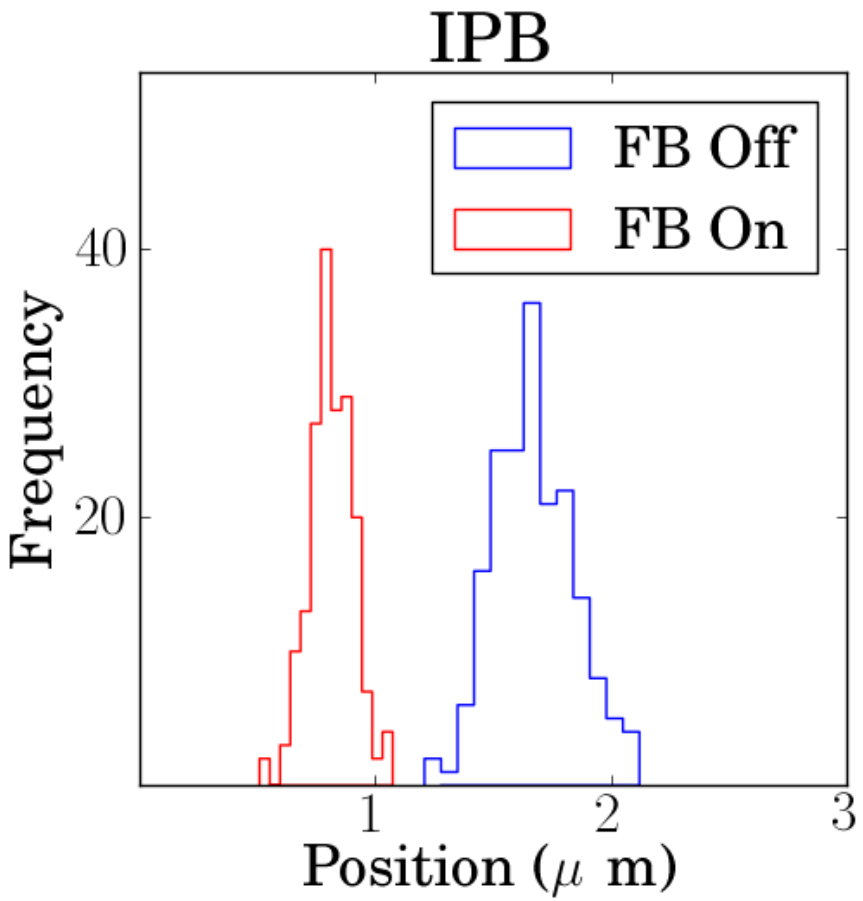
FF Off Correlation: 73%
FF On Correlation: 23%

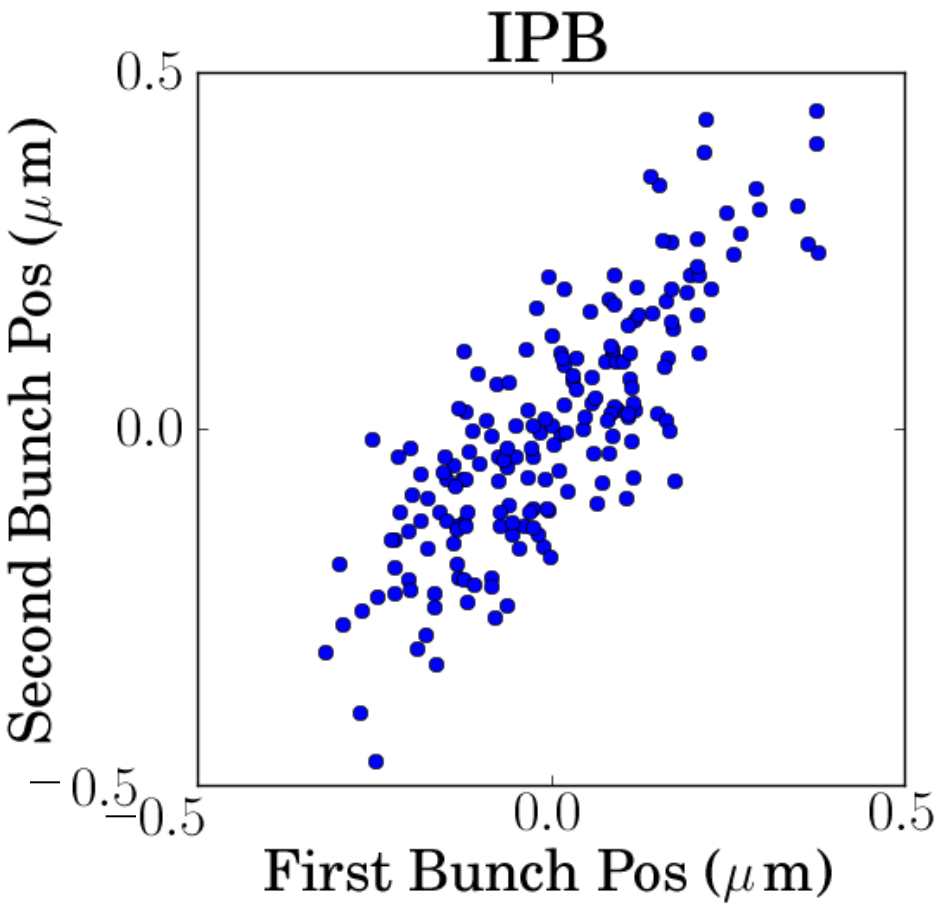
Incoming Beam Position Scan

6 µm pos. scan



IP Feedback Results



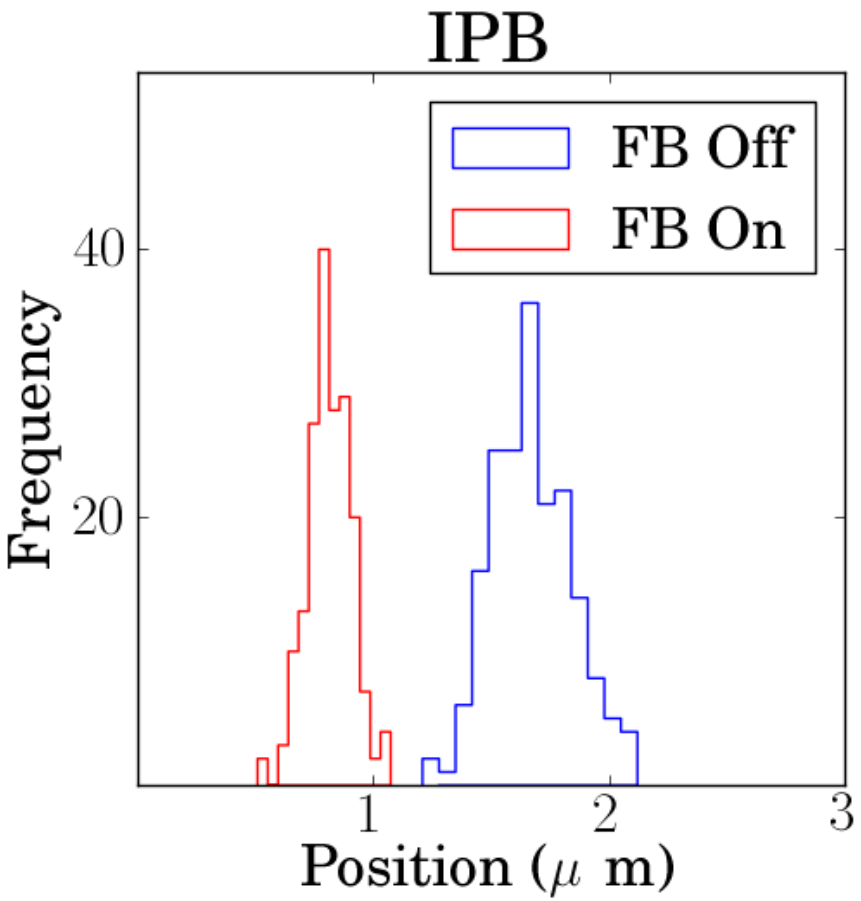


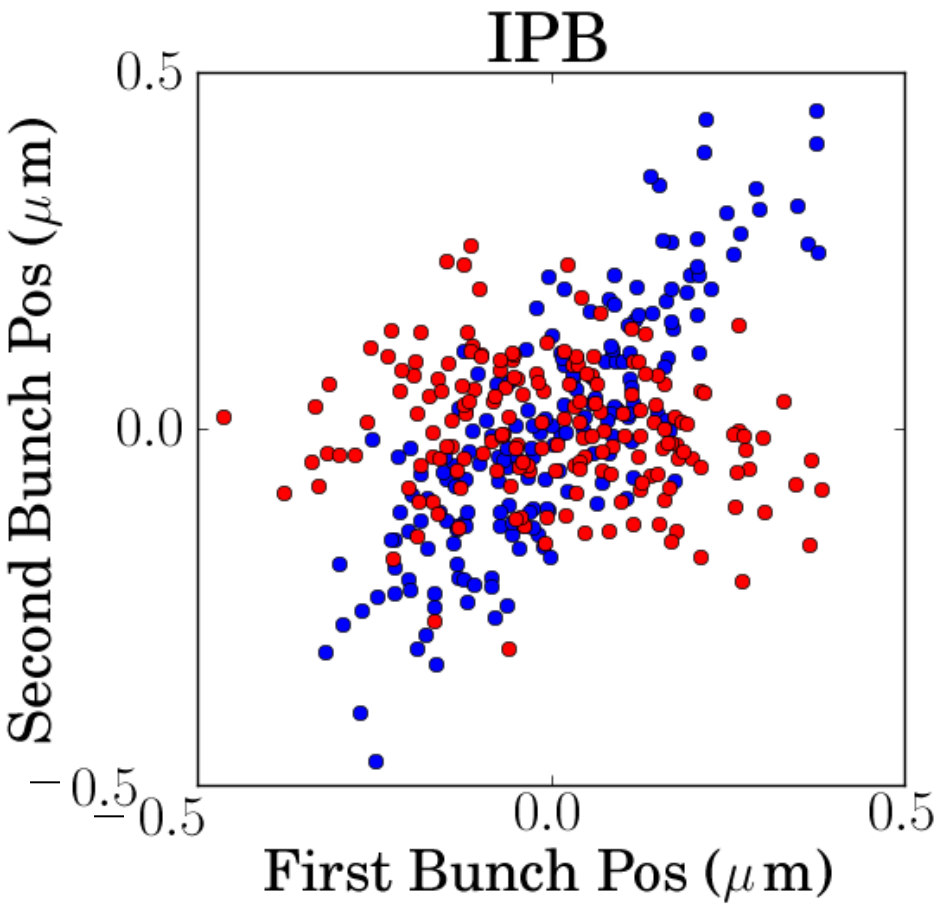
FB Off Jitter: 170 ± 10 nm

FB On Jitter: 93 ± 4 nm

FB Off Correlation: 81%

IP Feedback Results





FB Off Jitter: 170 ± 10 nm

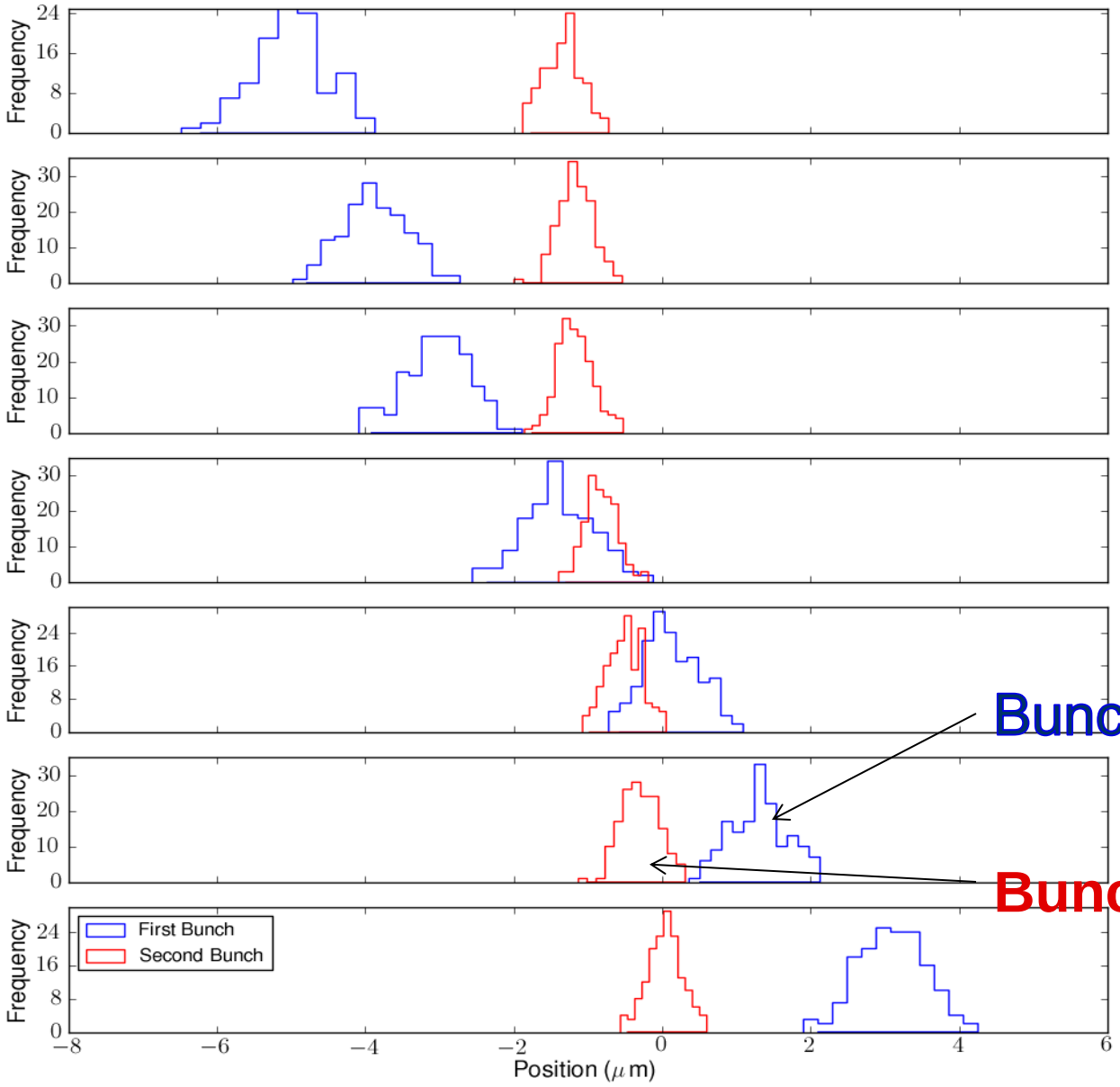
FB On Jitter: 93 ± 4 nm

FB Off Correlation: 81%

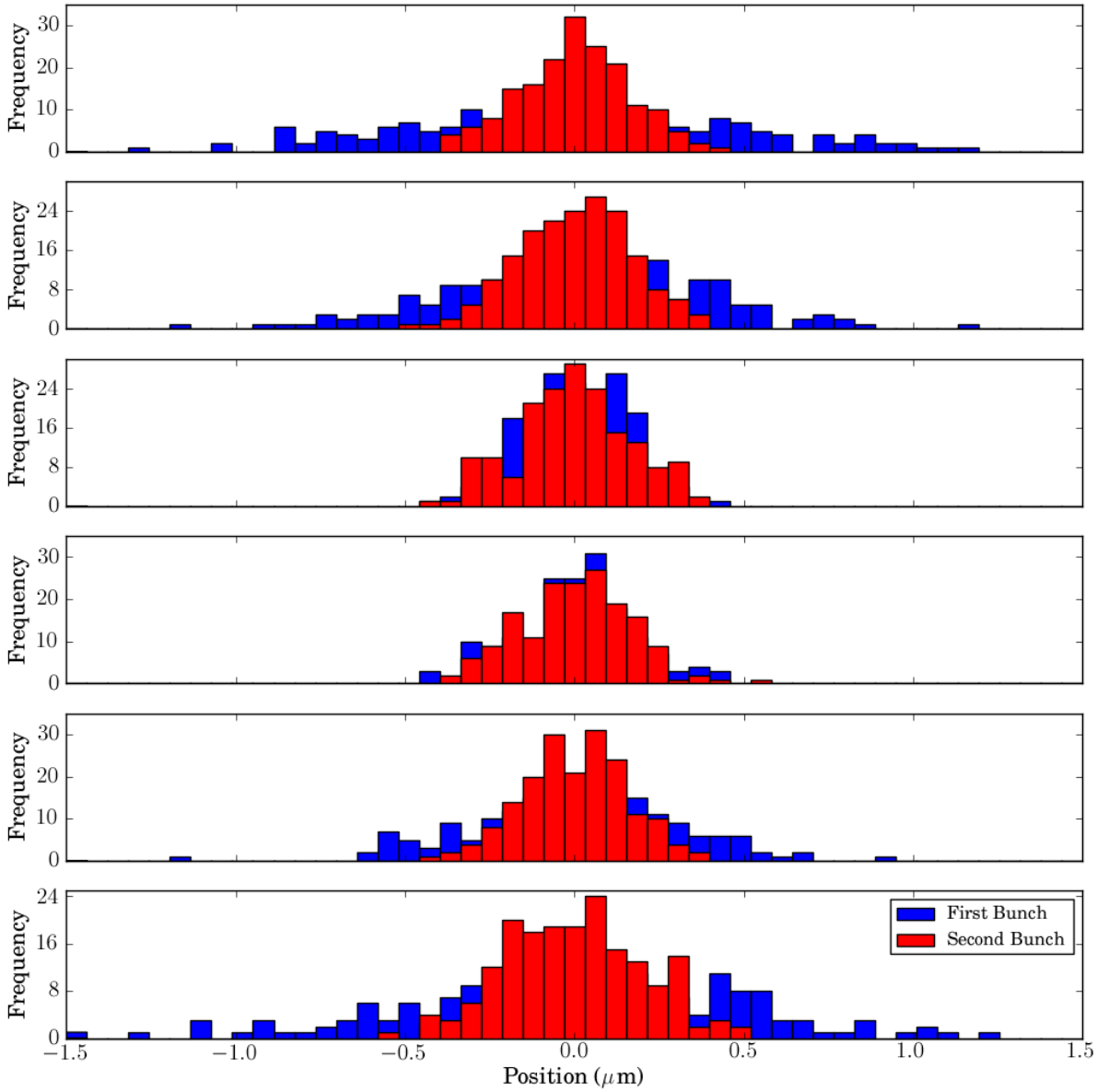
FB On Correlation: -16%

Incoming Beam Position Scan

10 µm pos. scan



Beam Waist Scan Through IPB



ATF2 beam stabilisation results

1. Upstream FB: beam stabilised at IP to ~ 300 nm

2. Feed-forward: beam stabilised at IP to ~ 106 nm

3. IP FB: beam stabilised at IP to ~ 93 nm

IP BPM resolution

- **Beam size during measurements ~ 100 nm**
- **Model → beam jitter ~ 20% of beam size, i.e. 20nm**
- **Assuming results are resolution limited …**
- **Resolution = 93 nm / sqrt(2) ~ 65 nm**

(no direct resolution measurement possible)

IP correction test programme

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** ✓

→ ready for tests with high-resolution IPBPMs

Proposal for next steps

- **Split IPBPM signals after KNU electronics**
- **Siwon's studies/analysis proceed**
- **Check digitisation of IPBPM signals w. FONT FB board**
- **Check results for different attenuations of input signals**
- **Exercise system in FB mode as basic check of functionality**