

2008 FONT Report and Status

Philip Burrows

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Feedback On Nanosecond Timescales

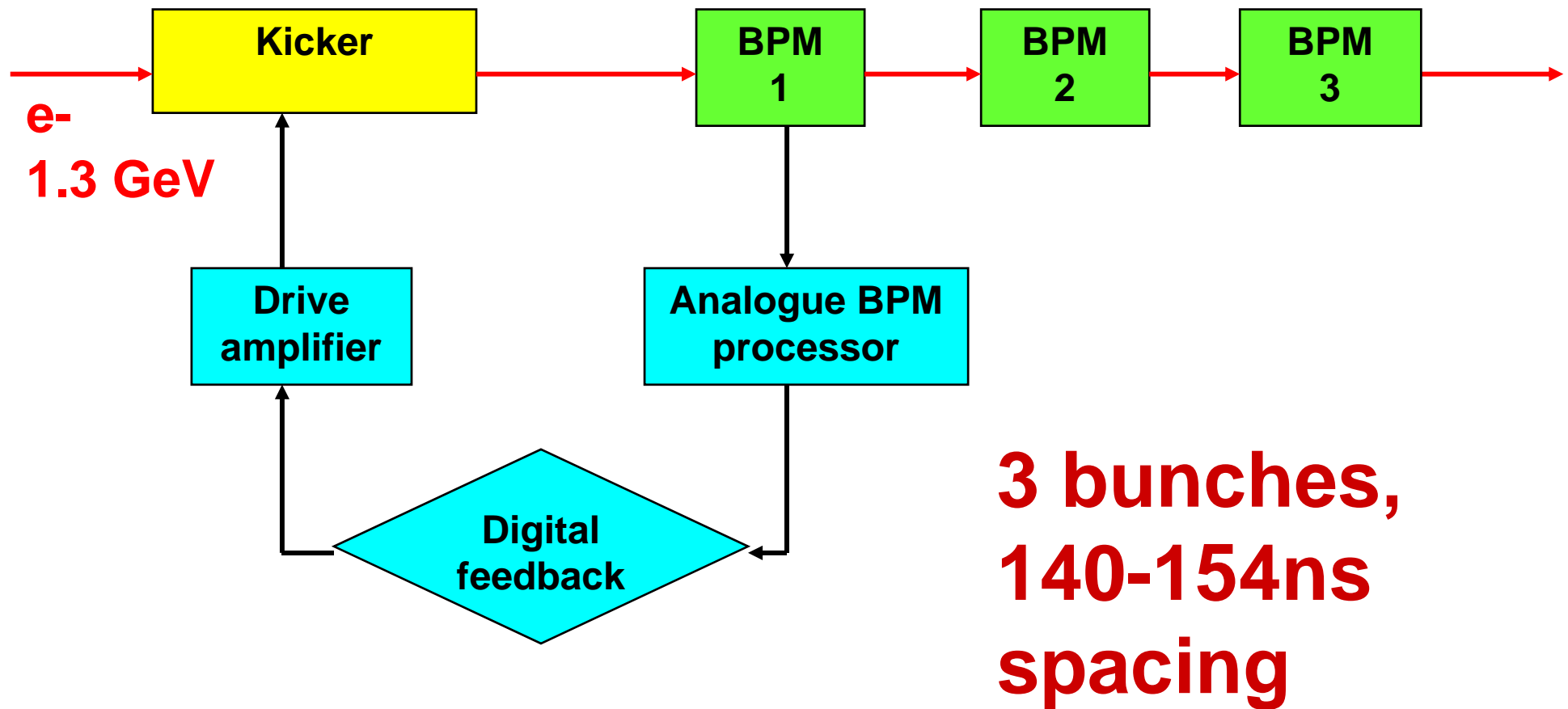
Philip Burrows
Glenn Christian
Hamid Dabiri Khah
Tony Hartin
Javier Resta Lopez
Colin Perry

Graduate students:
Christine Clarke
Christina Swinson
Ben Constance
Robert Apsimon
Douglas Bett

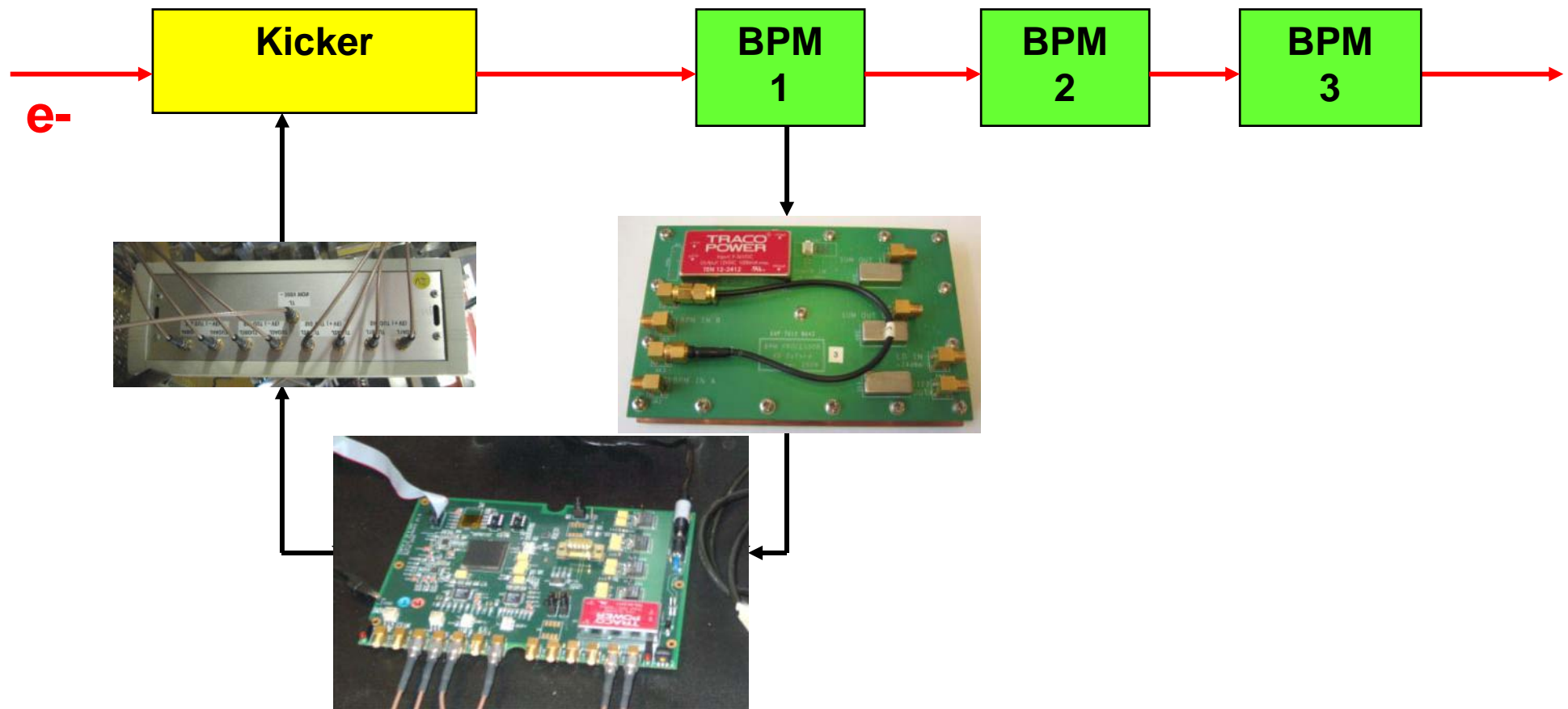
SLAC, KEK, DESY, CERN
P.N. Burrows



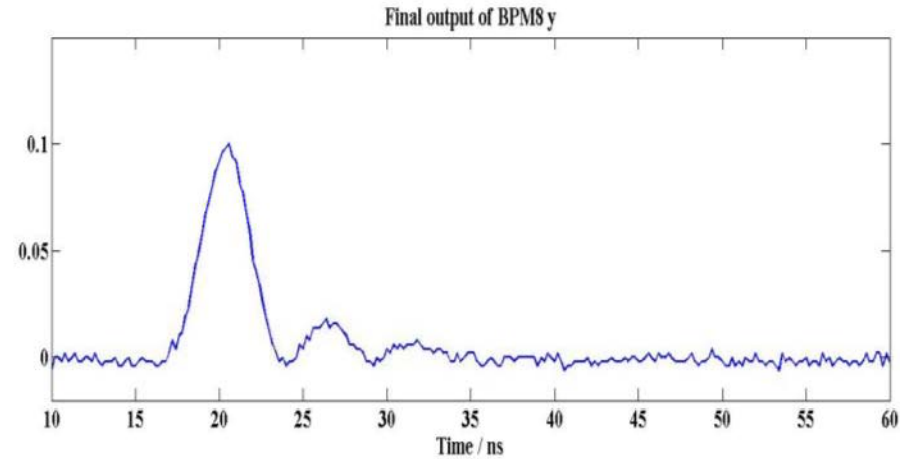
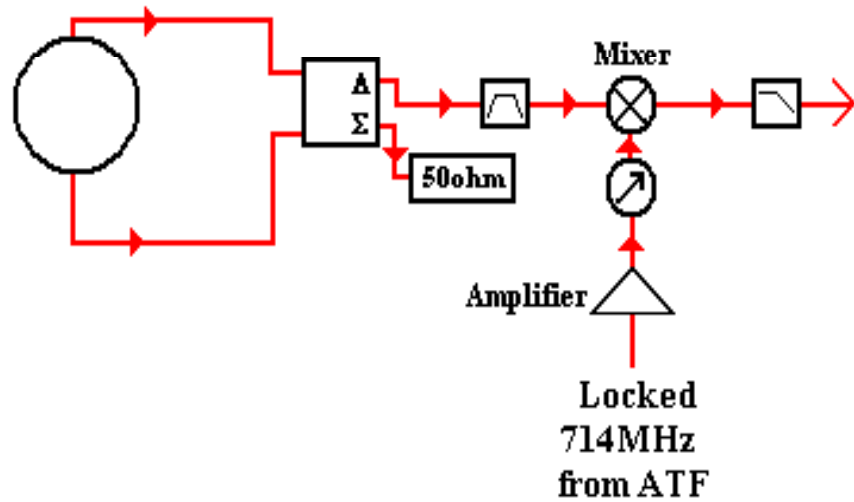
FONT4 ILC prototype at KEK/ATF



FONT4 ILC prototype at KEK/ATF



BPM processor



2005

P.N. Burrows



2006

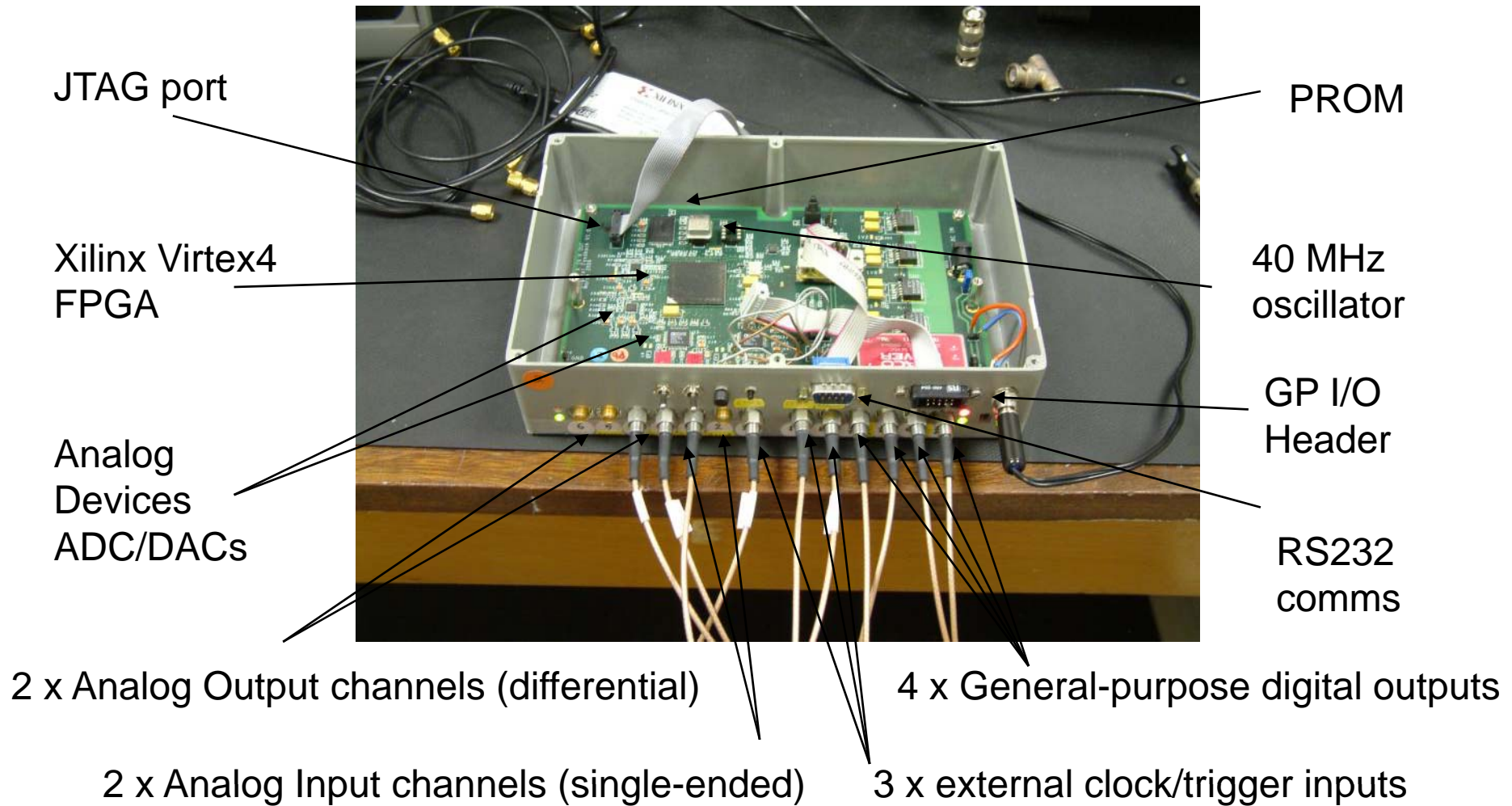
5



2007

ATF TB/SGC Meeting KEK 18/12/08

Digital Feedback Board



Kicker driver amplifier

Specifications:

- **+/- 15A (kicker terminated with 50 Ohm)**
- **+/- 30A (kicker shorted at far end)**
- **35ns risetime (to 90%)**
- **pulse length 10 us (specified for 20-60 bunches)**
- **repetition rate 10 Hz**

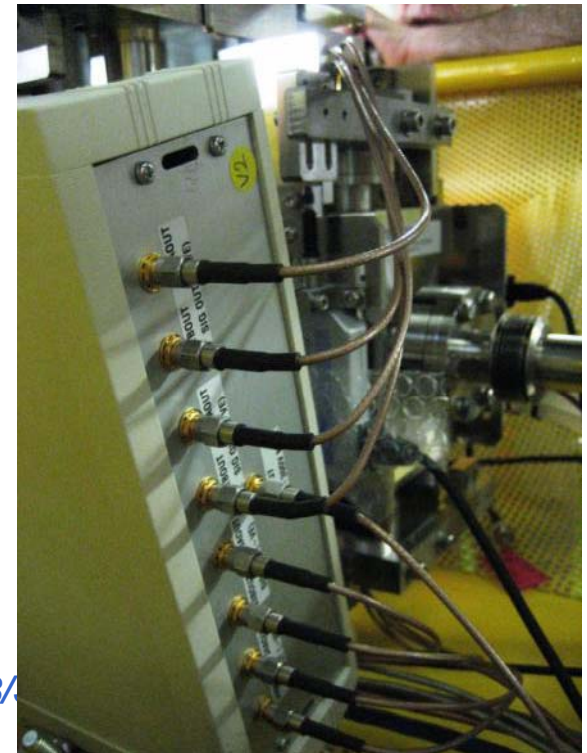
Outline design done in Oxford

Order placed with TMD Technologies Sept 06

Two prototype units delivered Dec 06

**Tested numerous times with beam in 2007
and 2008**

Third unit delivered December 2008



Latency estimate

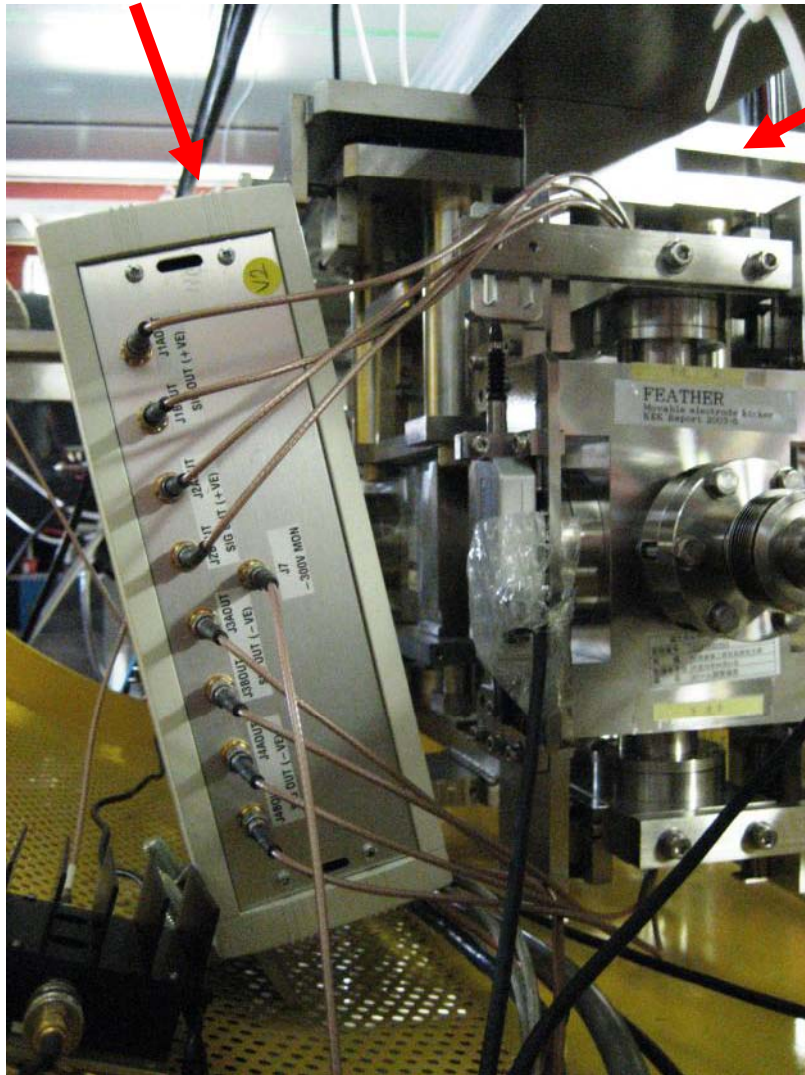
- Time of flight kicker – BPM: 4ns
- Signal return time BPM – kicker: 10ns
- **Irreducible latency: 14ns**

- BPM processor: 10ns
- **ADC/DAC (3.5 89 MHz cycles) 40ns**
- **Signal processing (9 357 MHz cycles) 28ns**
- **FPGA i/o 3ns**
- Amplifier 35ns
- Kicker fill time 3ns
- **Electronics latency: 119ns**

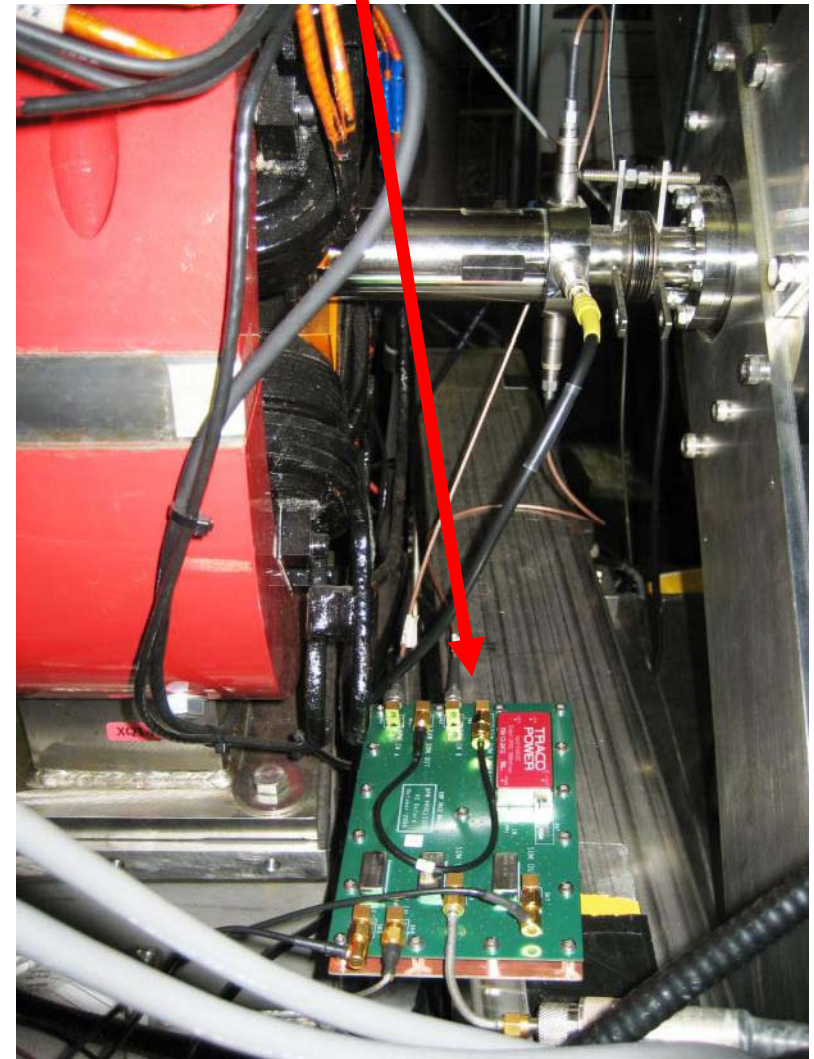
- **Total latency budget: 133ns**

FONT beamline section

Amplifier



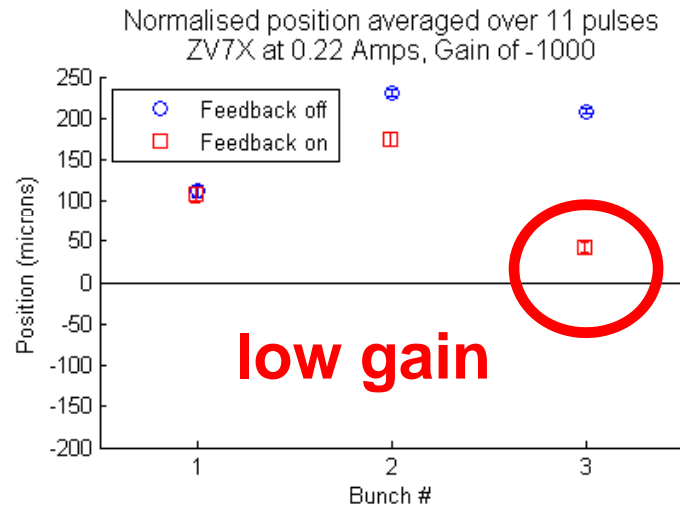
FEATHER Kicker



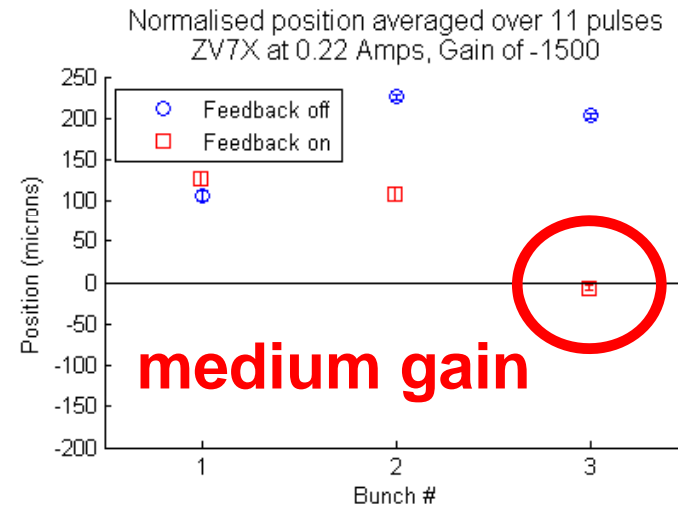
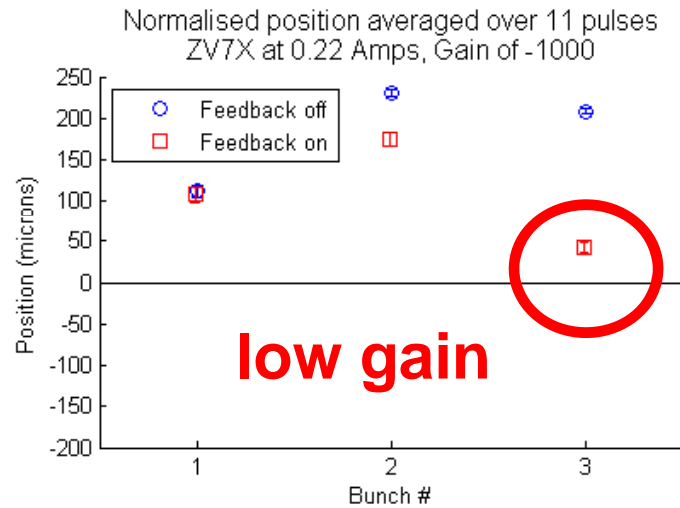
May 2008 Feedback Tests

1. **Beam in fixed position: vary FB loop gain**
2. **Vary incoming beam position: optimise FB gain
nominal +/-150 um range around zero**
3. **Leave beam free-running and correct w. optimal gain**
 - **gain settings: 1000 (low), 1500 (medium), 1700 (high), 2000 (v. high)**
 - **Two modes of feedback:
no delay loop, with delay loop**
 - **Data analysis in progress – all results preliminary!**

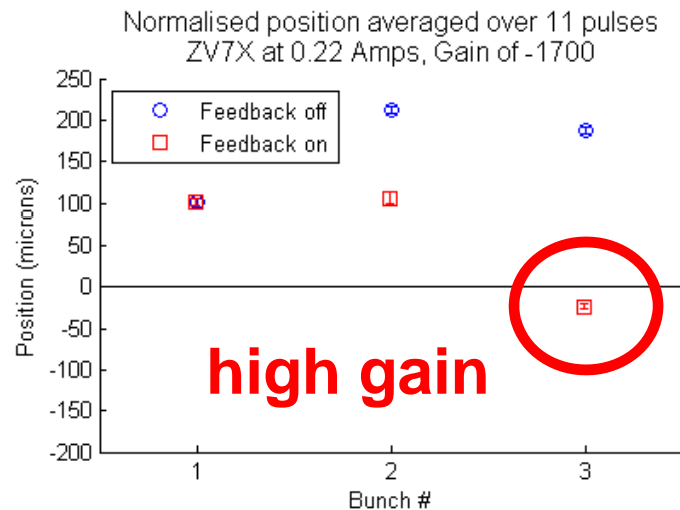
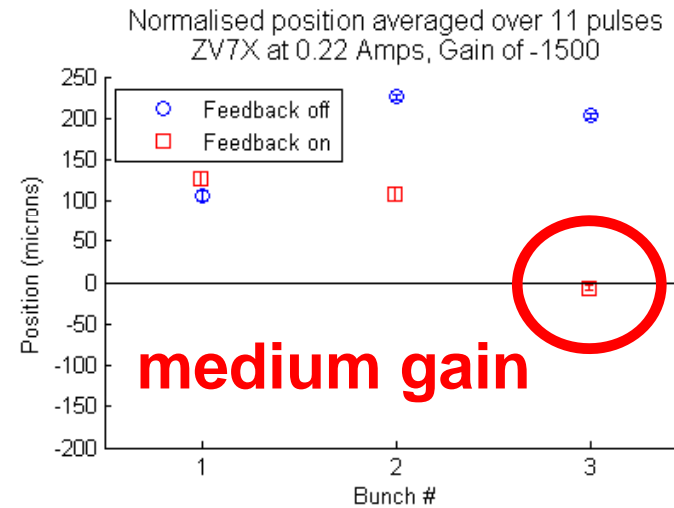
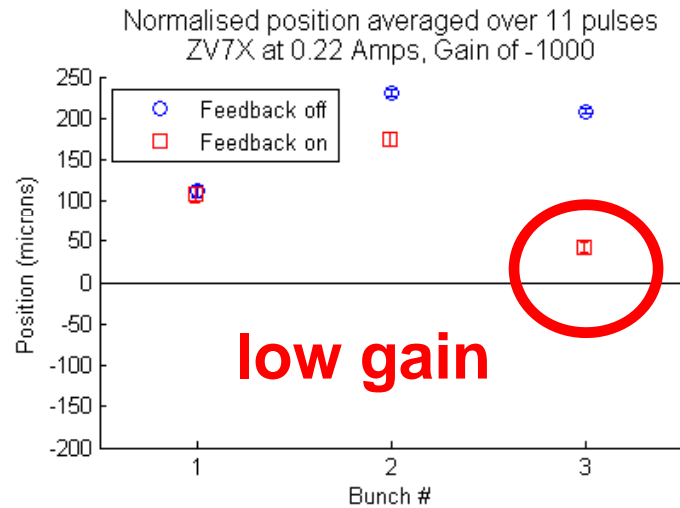
Example (1) of May 2008 Results



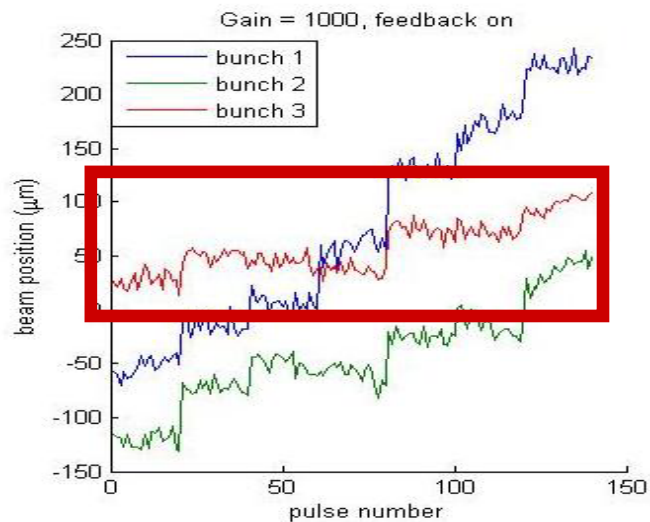
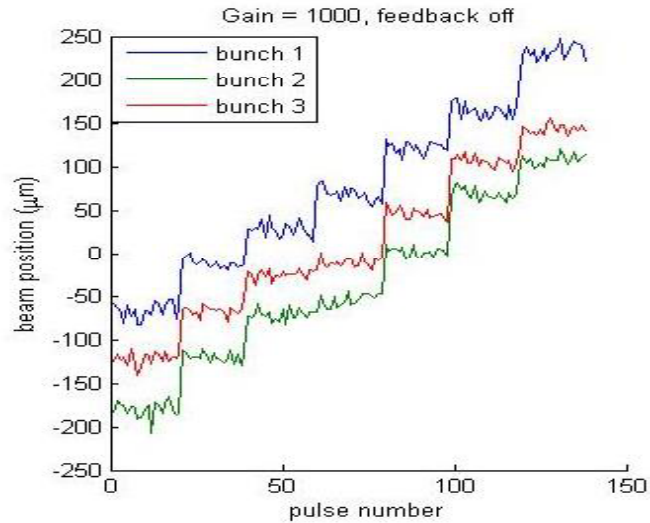
Example (1) of May 2008 Results



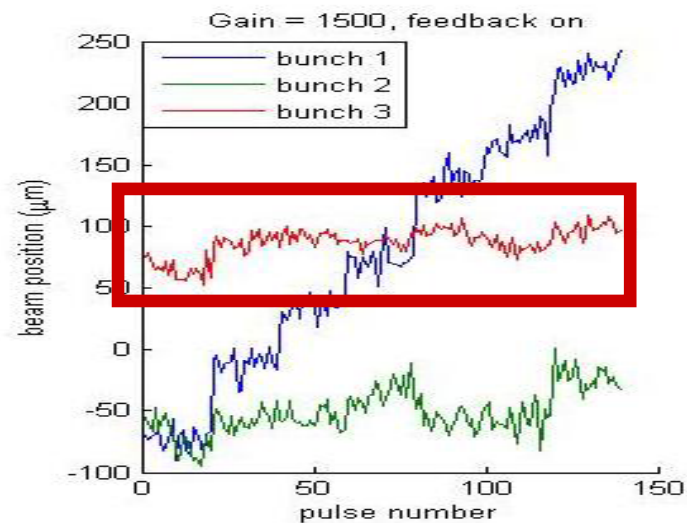
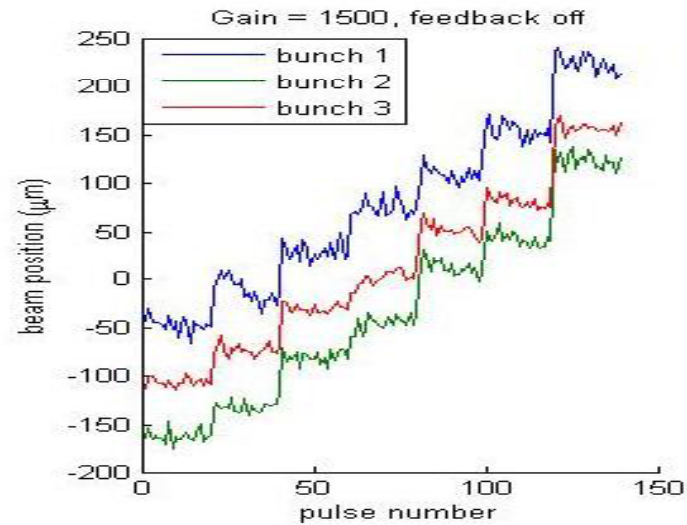
Example (1) of May 2008 Results



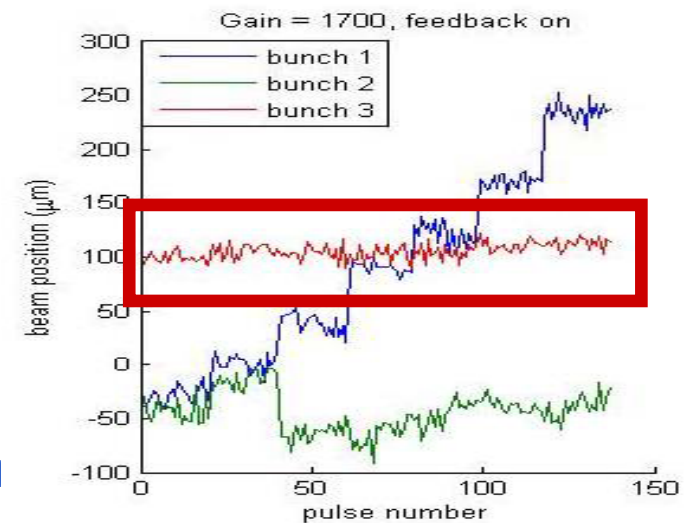
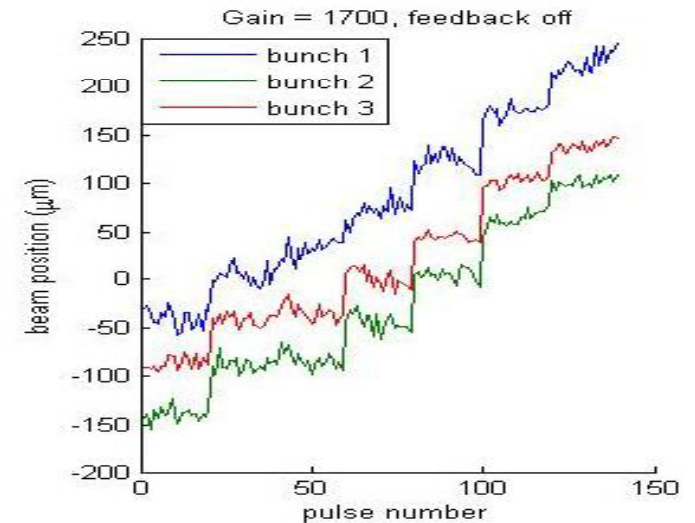
Example (2) of May 2008 Results



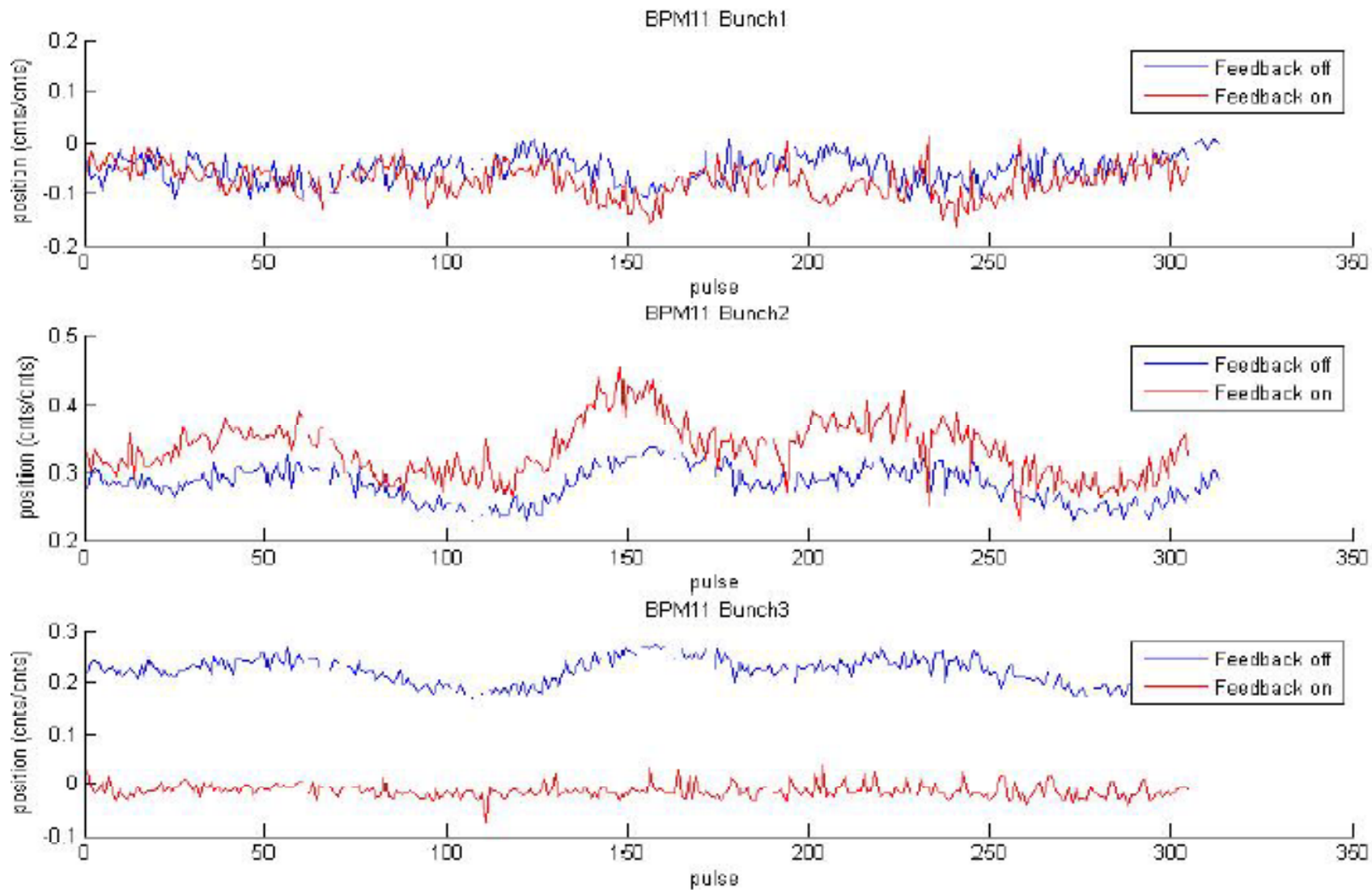
Example (2) of May 2008 Results



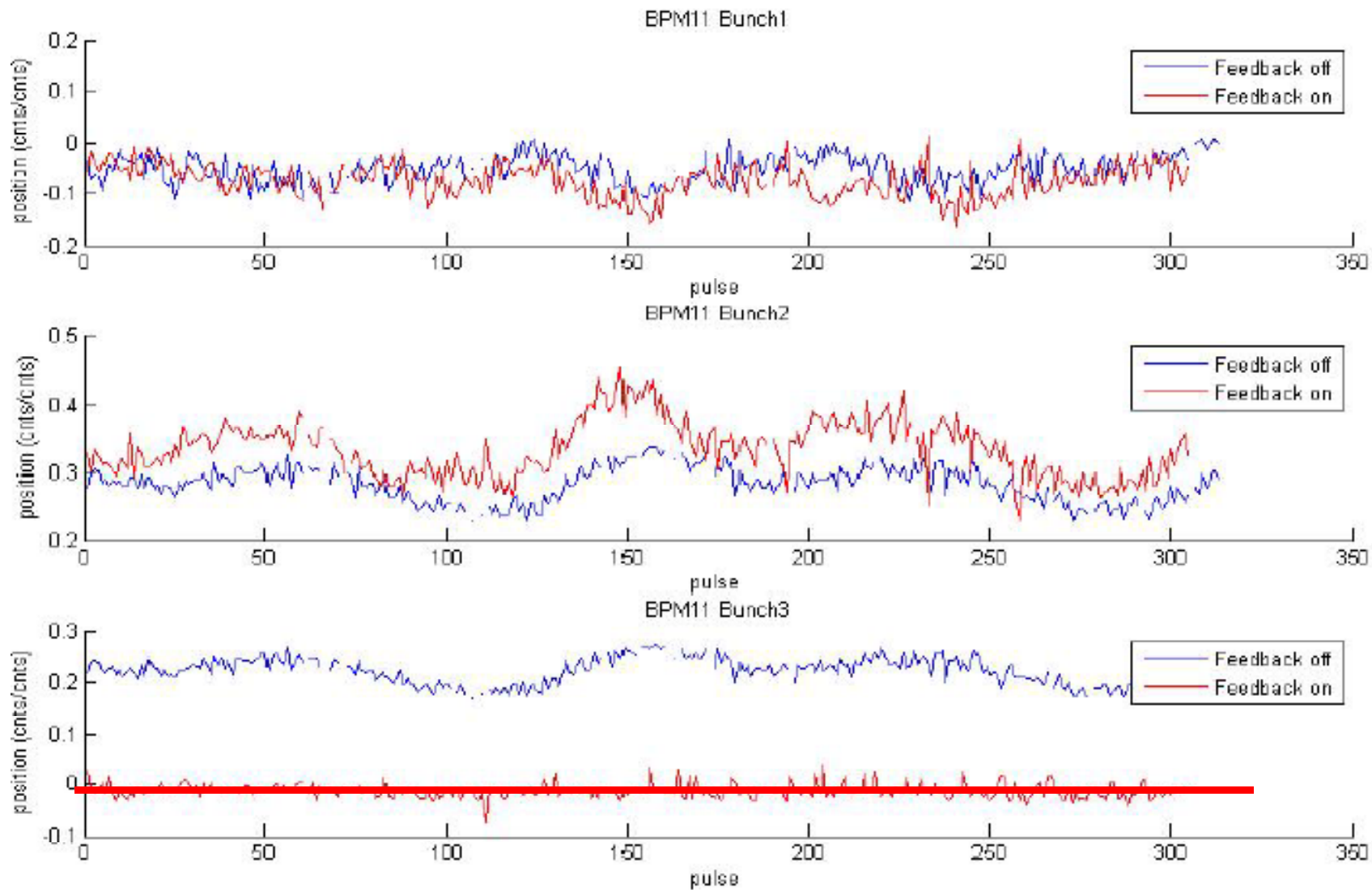
Example (2) of May 2008 Results



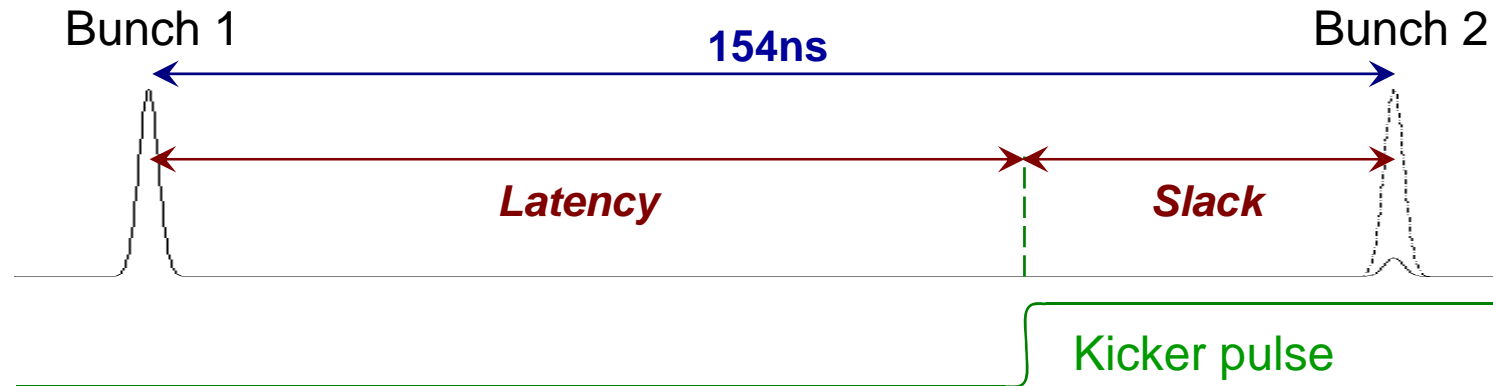
Example (3) of May 2008 Results



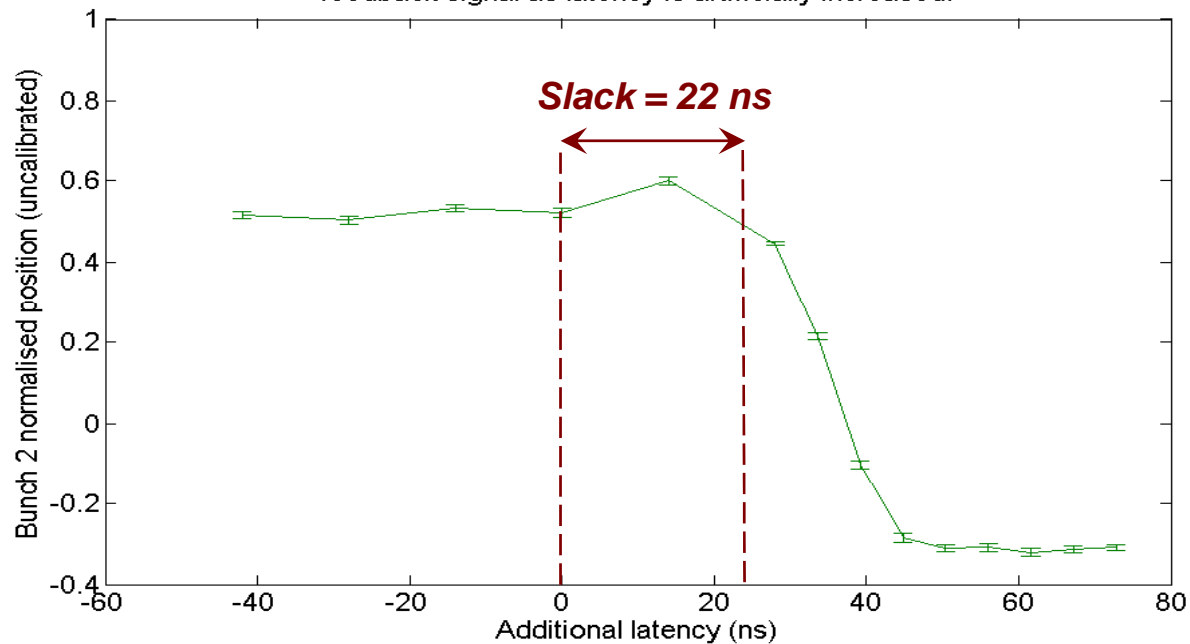
Example (3) of May 2008 Results



Latency measurement



Position of bunch 2 in response to a constant magnitude feedback signal as latency is artificially increased.



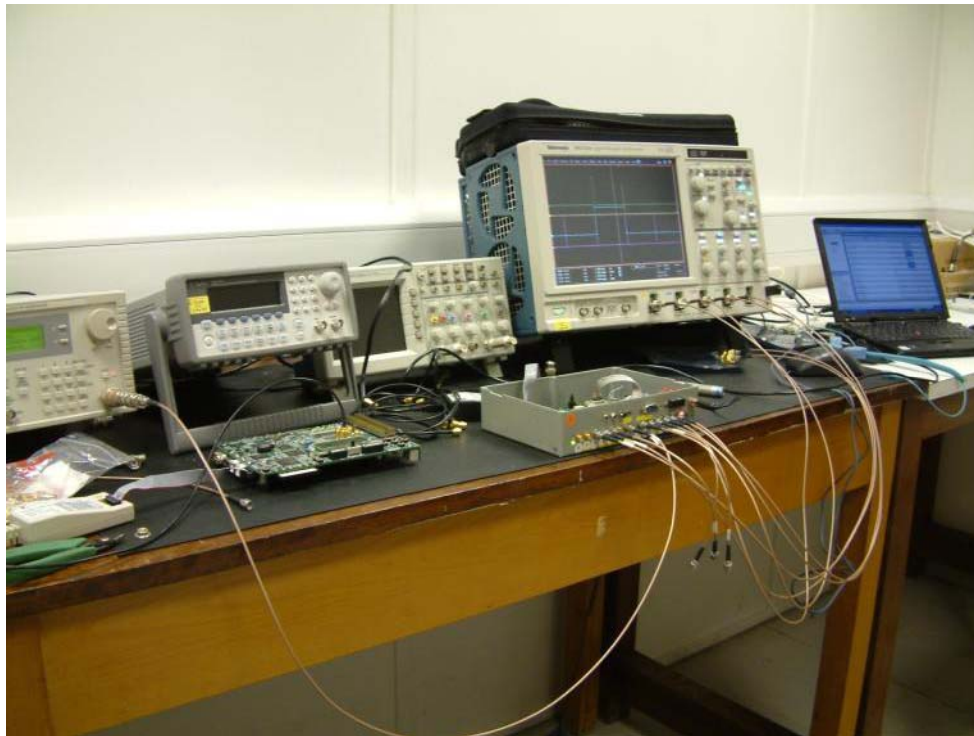
Latency
= 154 - slack
= 132 ns
+ 8ns (1/Q)

FONT bench test system

Manufacture synchronised ILC bunch-train, clocks, and trigger

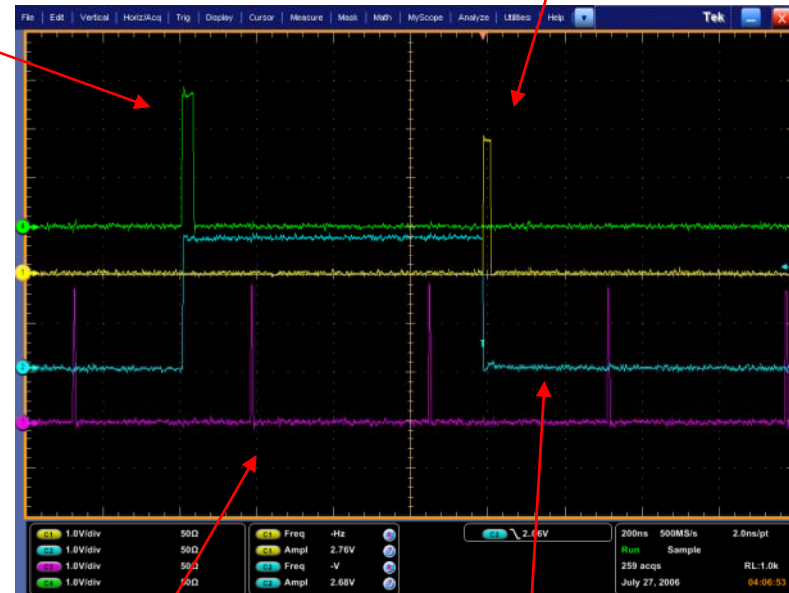
Develop algorithms and program FPGA

Close loop



Trigger

Bunch



2.16 MHz

Diagnostic

ATF TB/SGC Meeting KEK 18/12/08

FONT plans (1)

New ATF2 beamline being commissioned

Providing 'turn-key' bunch-by-bunch FB system for achievement of ATF2 goals:

35 nm beam spot

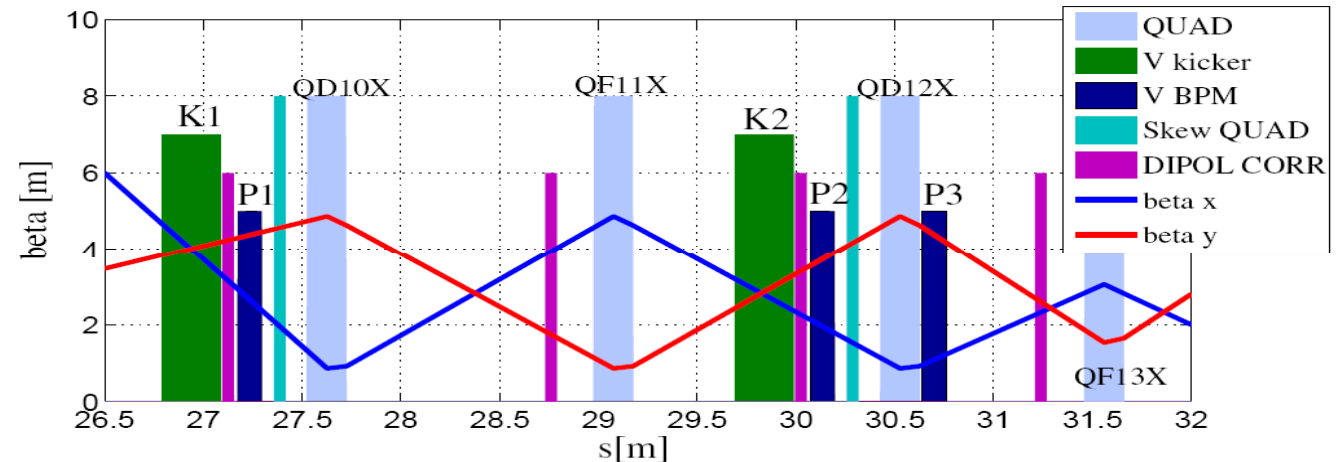
stabilisation at nanometer level at IP

**VITAL DEMONSTRATION OF FINAL-FOCUS
CAPABILITY FOR ANY FUTURE LINEAR
COLLIDER!**

ATF2 FB system

Dedicated system:

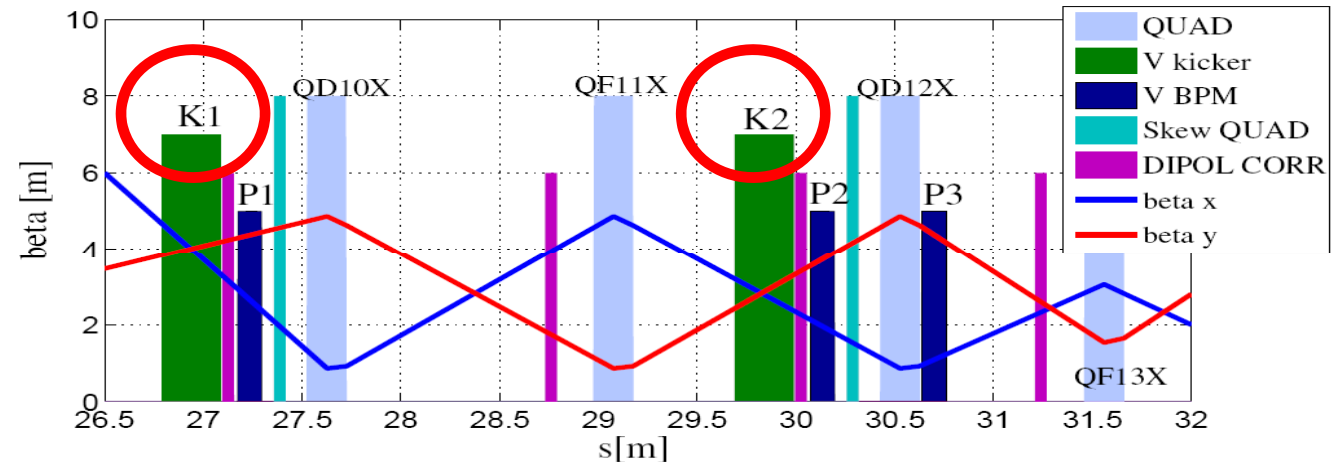
- **2 stripline kickers + fast drive amplifiers**
- **3 stripline BPMs + fast analogue front-end electronics**
- **9-channel digital FB processor**



ATF2 FB system

Dedicated system:

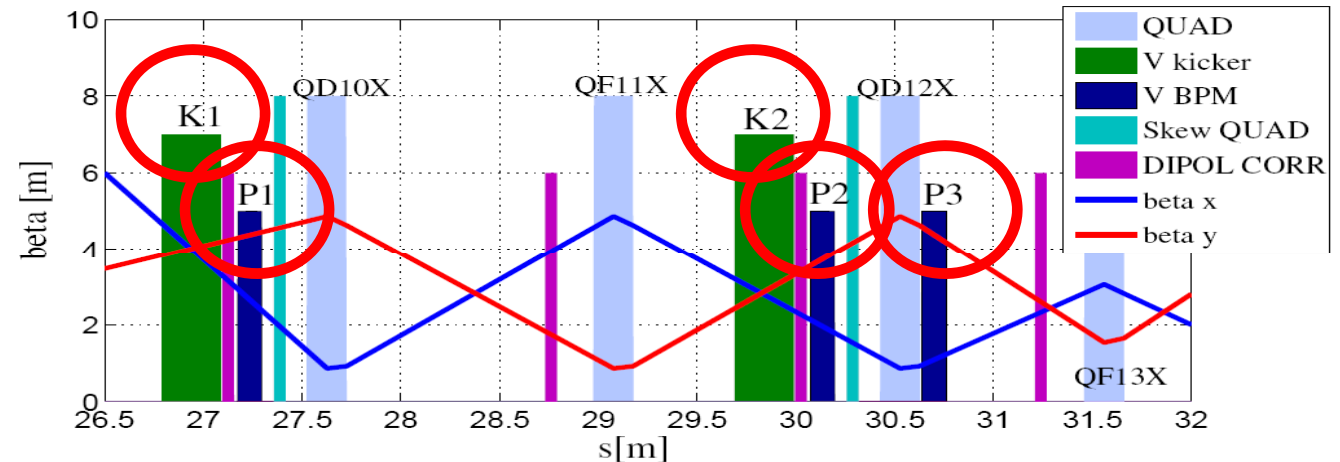
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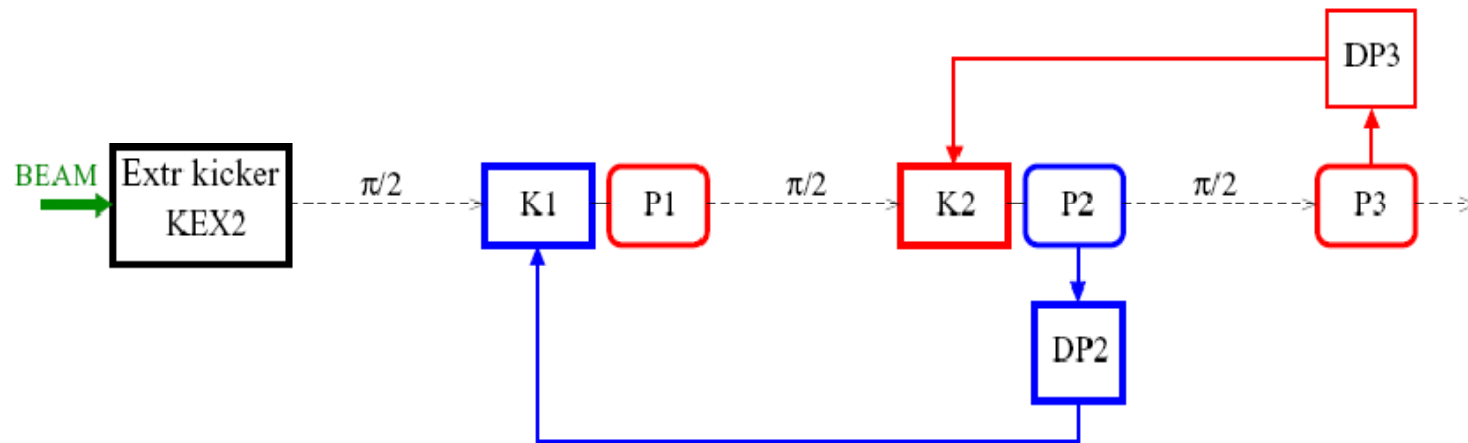
ATF2 FB system

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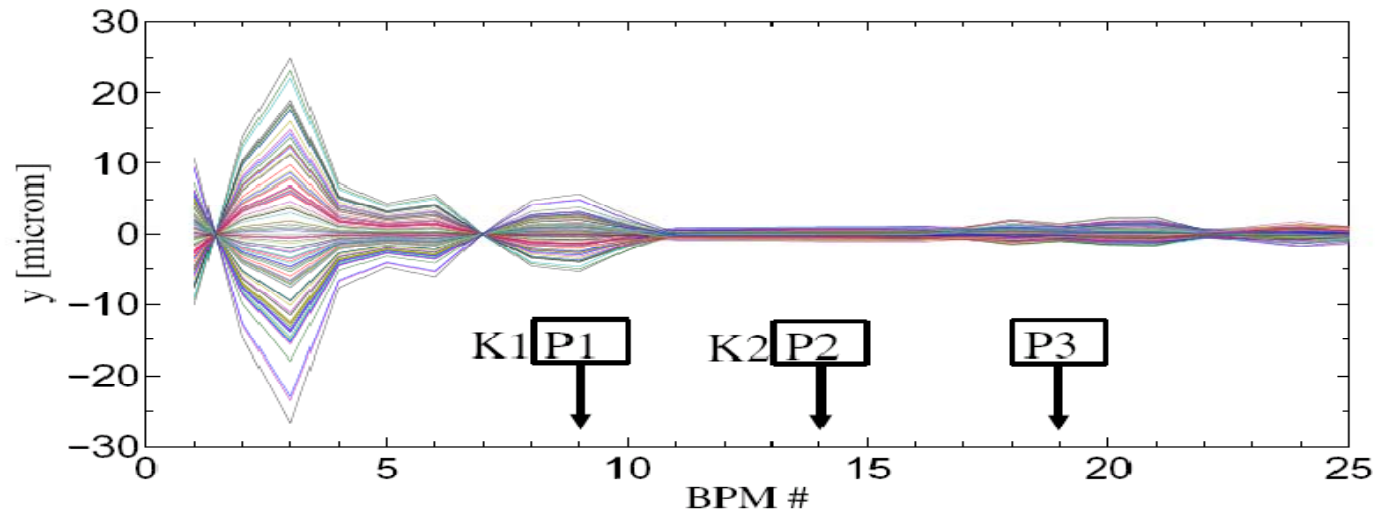
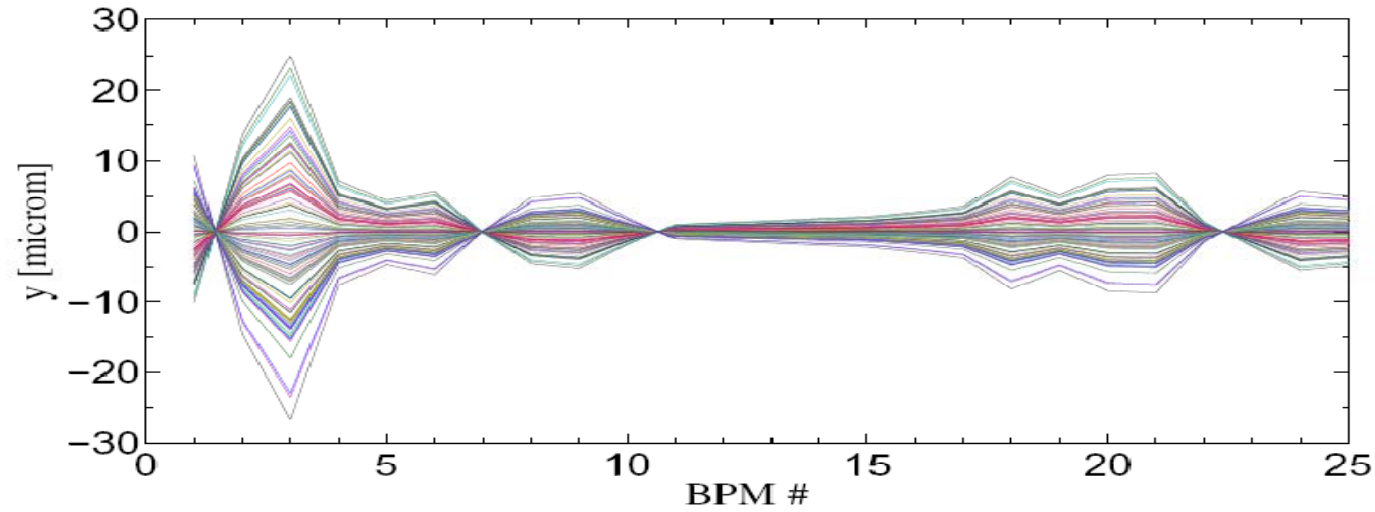
Flexible FB / FF operation



Time of flight P2-K1 = 10.7 ns

Time of flight P3-K2 = 10.5 ns

Results of vertical position correction



Resta Lopez

Status of FONT @ ATF2

- **2 kickers (SLAC) ready**
- **3 BPMs (KEK) ready**
- **Expect to install in beamline February 2009**
- **3 amplifiers (2 + spare) ready**
- **In progress:**
 - new 9-channel digital FB board**
 - (improved BPM processors)**
- **First tests Feb/March 2009**
- **Aim: system commissioned end 2009**

FONT plans (2)

The next major development would be FB tests using a **long ILC-like train of 20-60 bunches**

(FONT4 amplifier was specified to allow this)

- **Would allow us to make FB algorithms robust:
deal with bunch-bunch correlations along train
adaptive gain as beam conditions change (drift)
incorporate feed-forward information from upstream
beam-related 'luminosity' signal for fast scanning?**