Feedback System Scheduling Issues

Philip Burrows

John Adams Institute

Oxford University

UK resource request for ILC FB systems

Currently (1/4/04 – 31/3/07):

1 faculty (Burrows)

3 research associates (Christian, Hartin, White)

2.1 electronic engineers (Dabiri Khah, Kalinin, Perry)

0.6 technical support (Oxford, Daresbury)

2 graduate students (Clarke, Swinson)

travel, consumables: 3 years, $600k

New *request* (1/4/07 – 31/3/10):

as above + 1 new engineer + 1 new research associate

These resources will be available for work on ATF2

ATF2 Beam Stability Requirements

Goal A: 35nm spot size

Jitter < 30% sigma_y

-> few um stability at ATF2 FF entrance

Goal B: control of beam position at nm level

Jitter < 5% sigma_y

-> better than 1 um stability at ATF2 FF entrance

How to achieve required stability?

Feedforward ring -> extraction line

Single or multibunch beam

Feedback/feedforward in extraction line

Multibunch beam

In either case probably want to correct y and y'

Few um stability: stripline BPM resolution probably ok

Sub-um stability: probably need cavity BPM resolution

Example: single bunch vertical jitter

Slow drift + fast jitter. Fast jitter ~ 5 micron amplitude

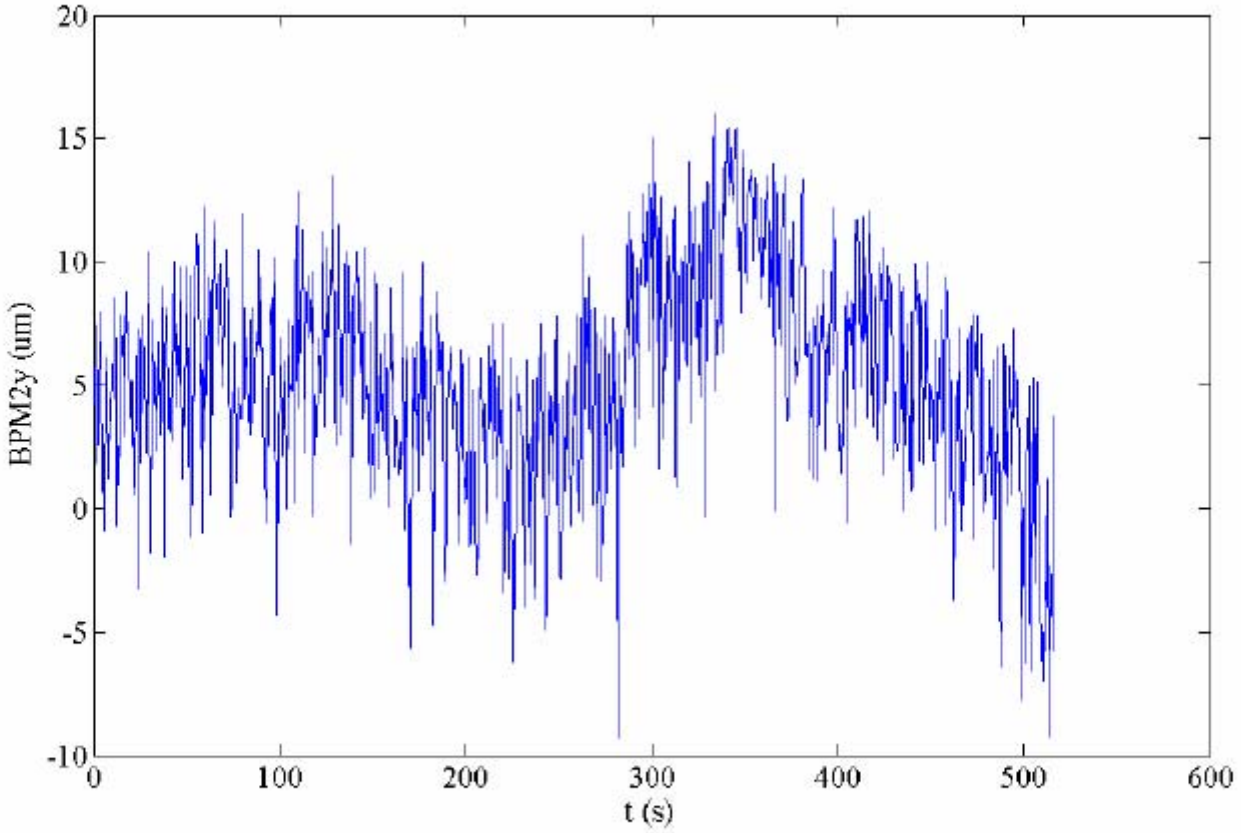
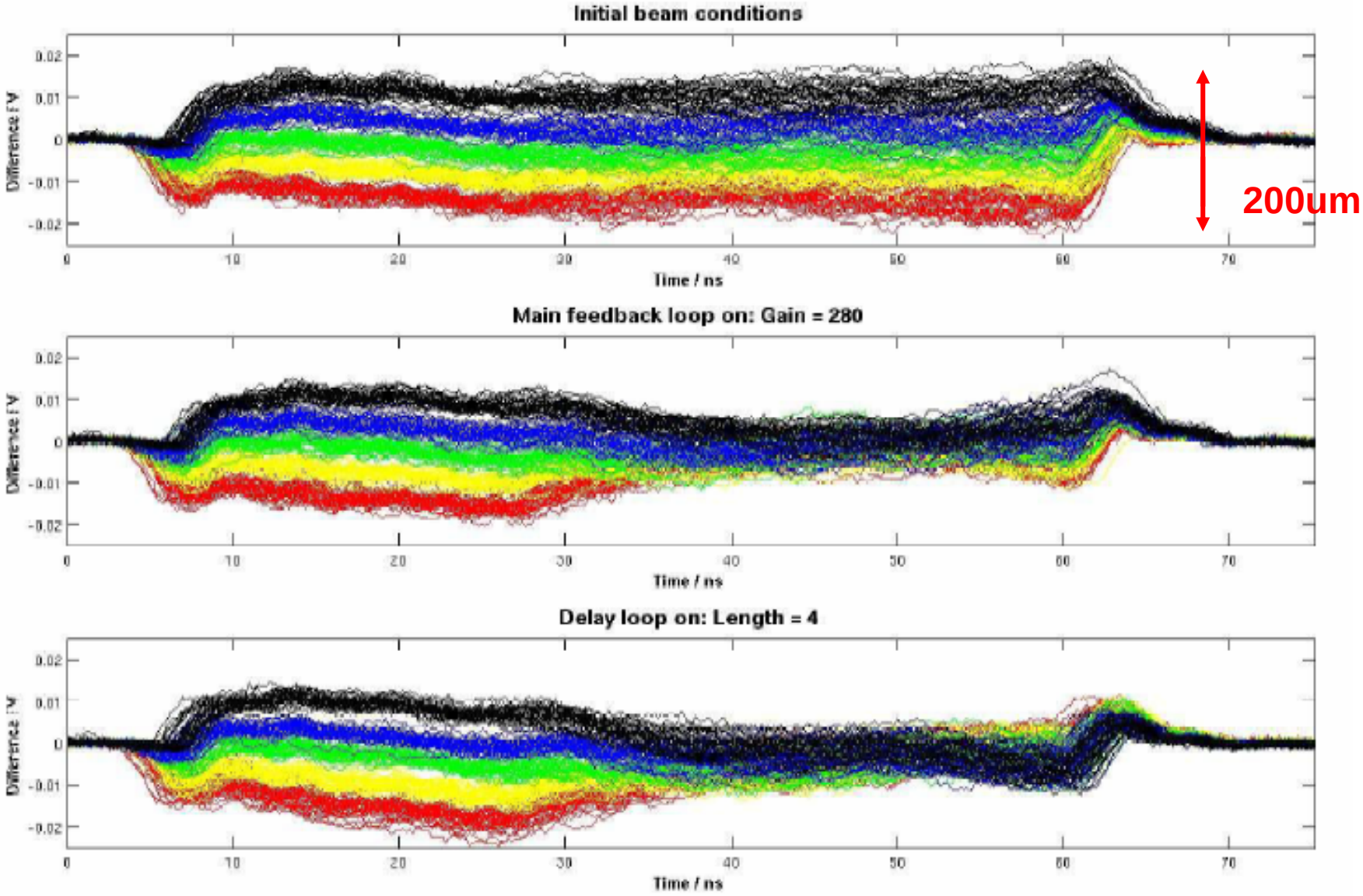


Figure 16: Position stability at BPMy2. The period of the oscillation is about 4 minutes.

M.Ross et.al., ATF-03-05

Example: multibunch vertical jitter

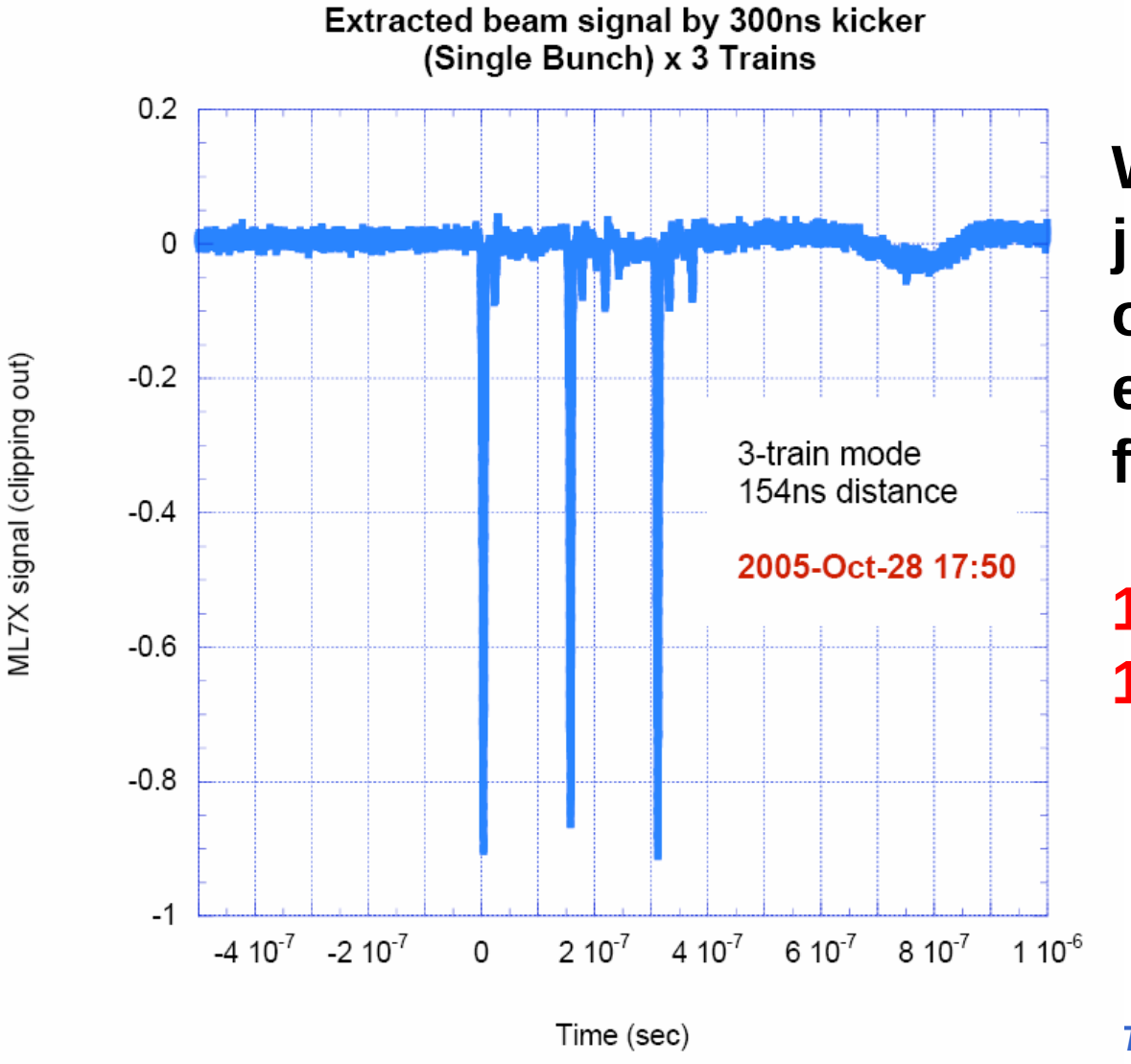
20-bunch ‘old’ beam, June 2005



New extraction kicker system

FONT Group now has some experience with 3-bunch beam extracted with new 300ns output pulse kicker

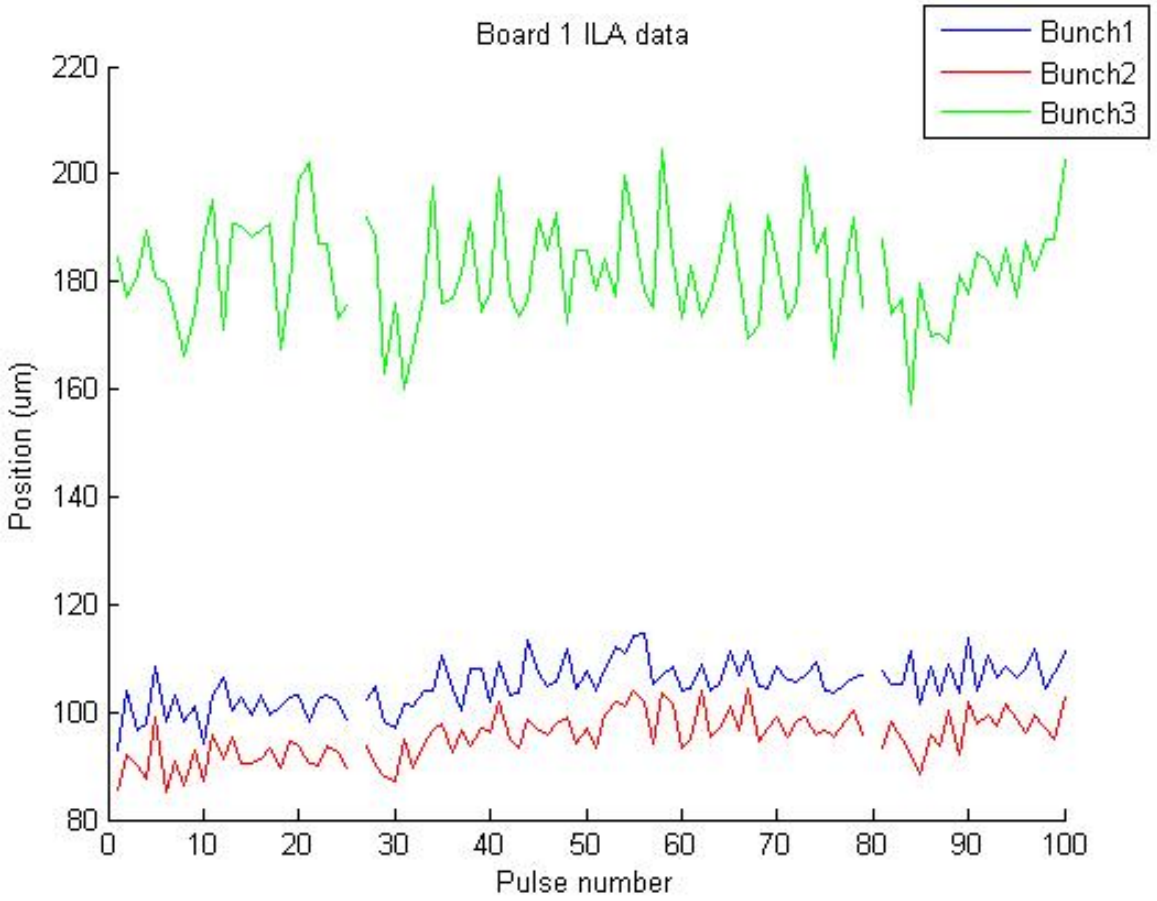
3-bunch extraction



We studied vertical jitter properties of multibunch extraction in April 06 for bunch spacing:

140ns
154ns

3-bunch extraction: 140ns spacing



RMS y jitter
w.r.t bunch 1:

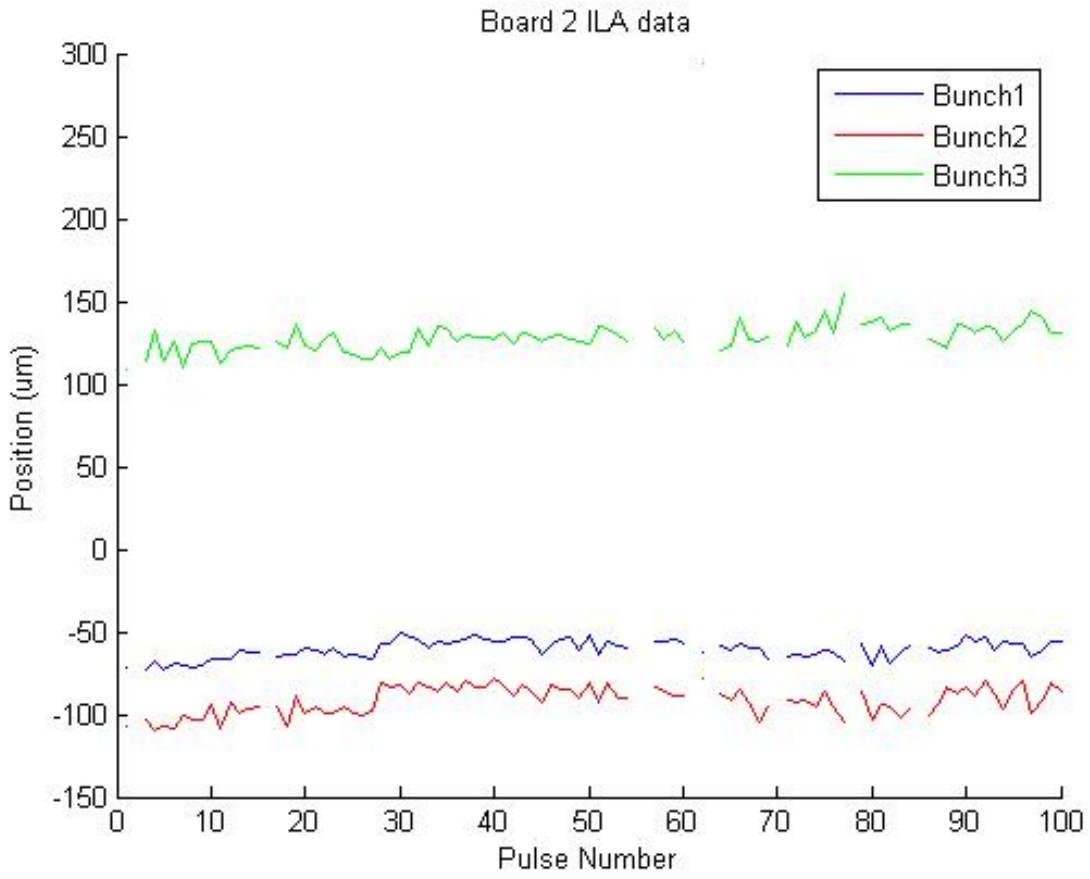
3 um (bunch 2)

11 um (bunch 3)

Train-train jitter:
5 um

Banana: 100um

3-bunch extraction: 154ns spacing



RMS y jitter w.r.t bunch 1:

5 um (bunch 2)

20 um (bunch 3)

Train-train jitter: 8 um

Banana: 220um

Comments on current jitter

Jitter of bunch 2 w.r.t. bunch 1 ~ train-train jitter

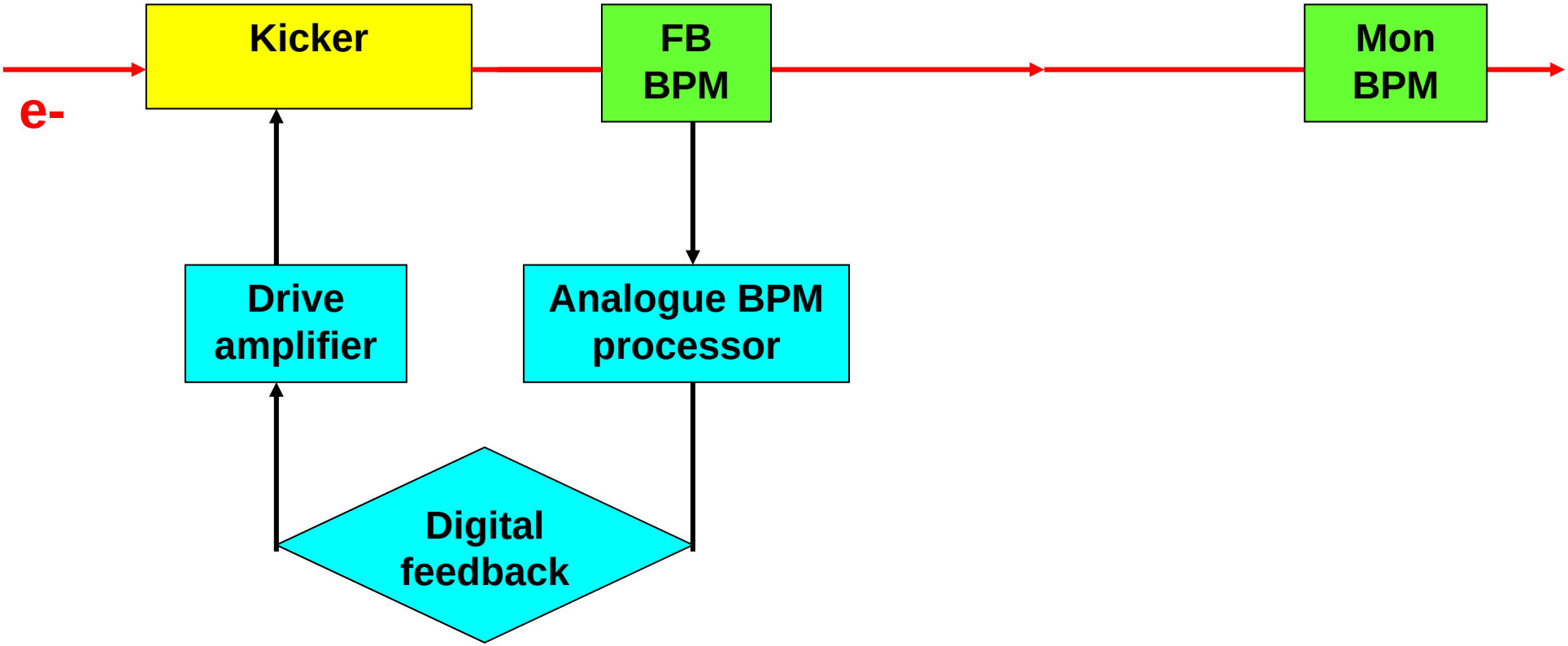
Jitter of bunch 3 w.r.t. bunch 1 >> train-train jitter

Train-train jitter cannot be corrected by FB because intra-train jitter is comparable in size (larger)

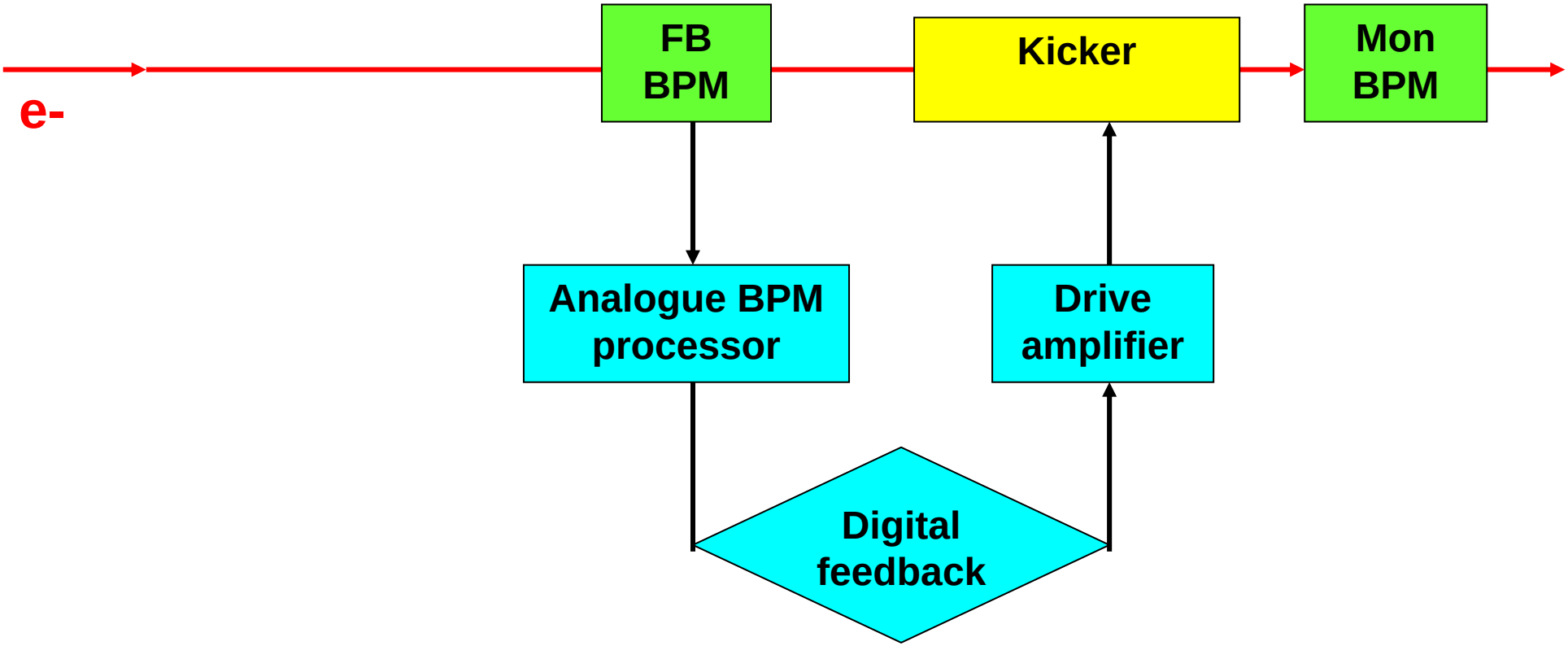
Banana effect >> jitter: requires large dynamic range of kicker amplifier to straighten train

Can extraction kicker pulse shape be flattened and stabilised?

Where to put hardware? FB mode



Where to put hardware? FF mode



What type of BPM + where?

Dedicated stripline:

- **resolution limited to c. 1 um – marginal for goal B?**
- **fast signal (< 10ns) - good for latency**

Cavity BPM:

- **resolution << 100nm now 'standard' at ATF**
- **signal processing >> 100ns – not good for multibunch**
- **significant rethink of signal processing needed**

Decide locations and either install or leave space

- **(ditto kickers) – presumably upstream of final focus**

Note also that

For nanometre beam stability at 'IP' beam feedback seems required to stabilise jitter to sub micron level at ATF2 entrance

Beam feedback requires MULTIBUNCH beam

Current NanoBPMs work with SINGLE bunch beam

– signal processing time > 100ns

Need to think about how to handle multi-bunch operation in IP BPMs at ATF2