

Plans for ATF2 IP Feedback

Philip Burrows, Colin Perry

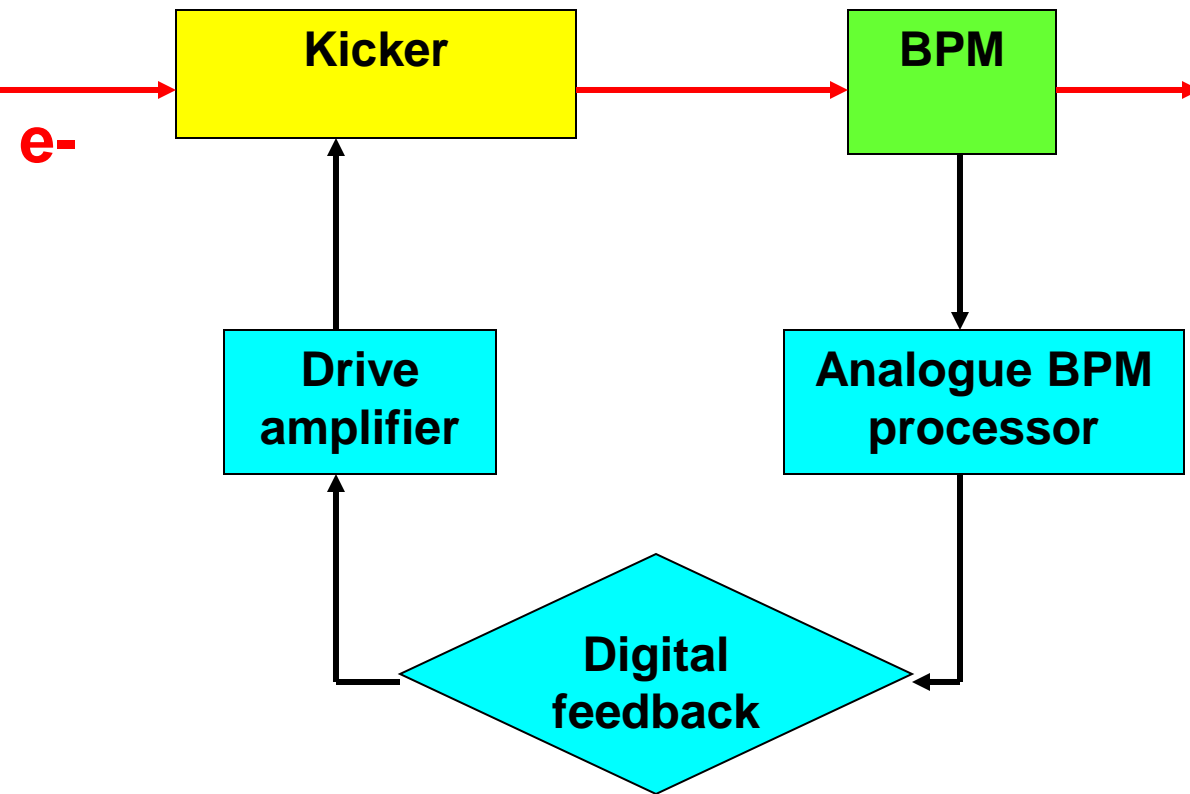
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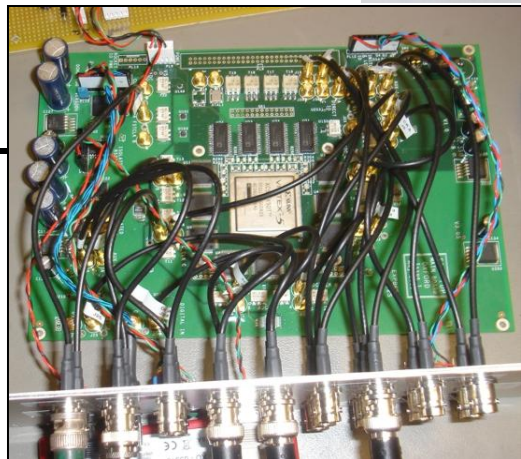
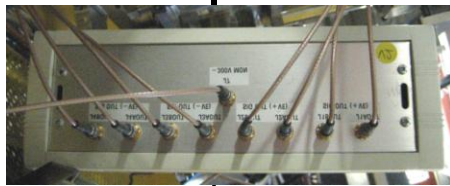
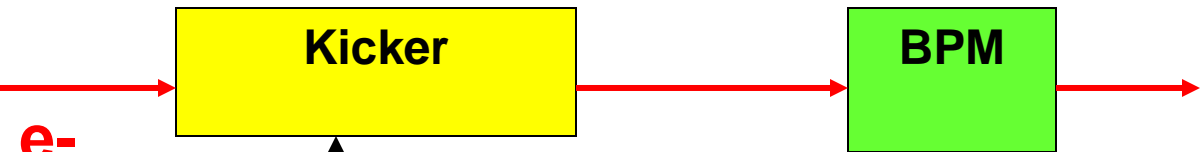
Outline

- **General considerations for FB system**
- **Working assumptions**
- **Conceptual system design**
- **Reminder of latency issues**
- **Requirements on BPM signals**
- **Summary**

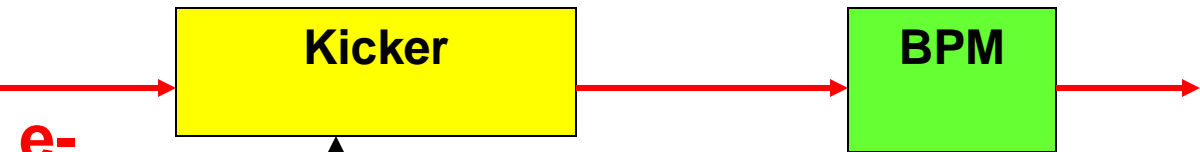
FONT system loop (schematic)



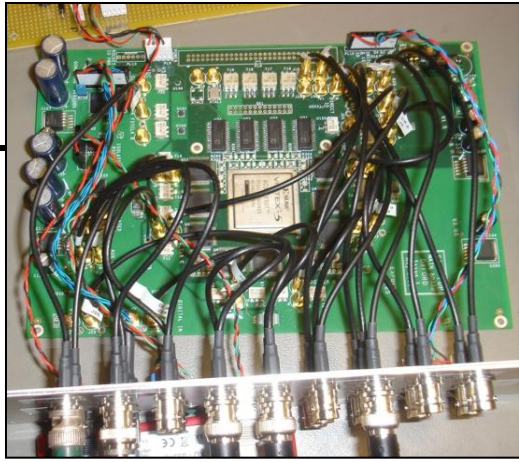
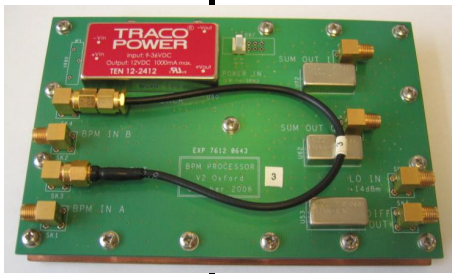
FONT5 system loop (schematic)



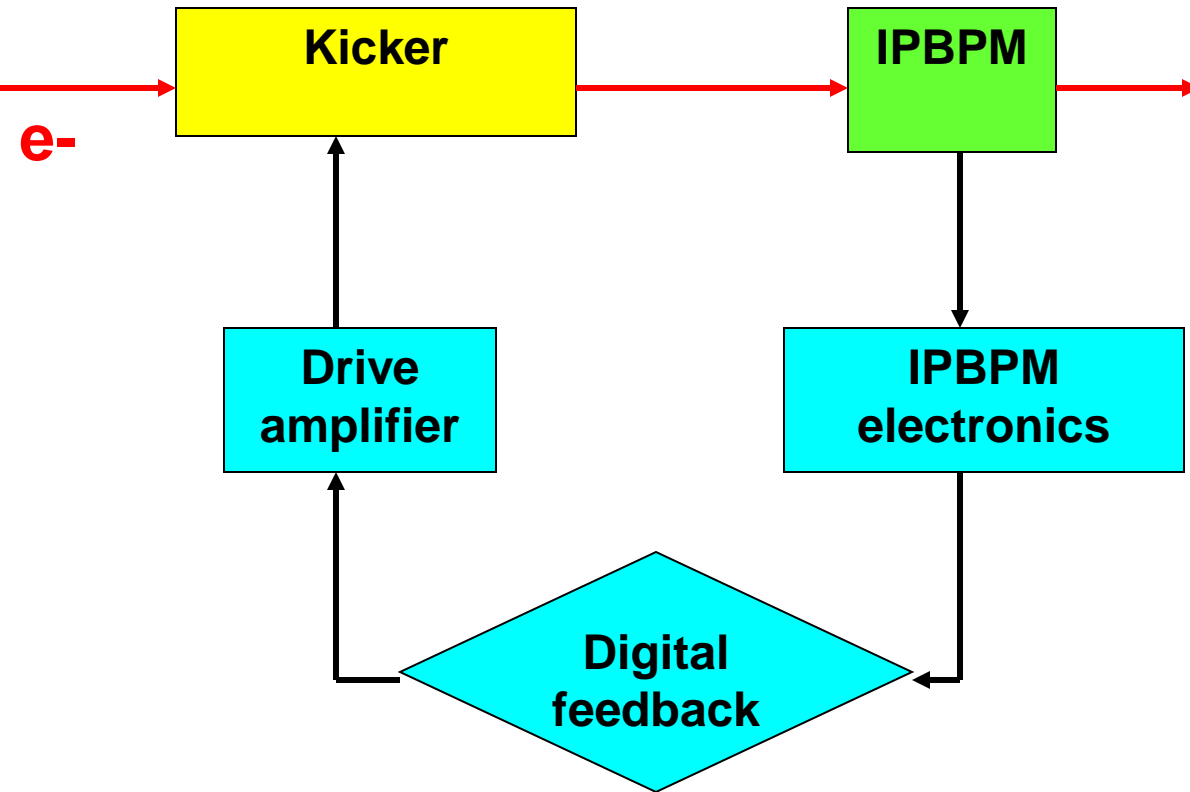
FONT5 system loop (schematic)



There should be no problem (in principle) to build a similar system for operation at the ATF2 IP



IP system loop (schematic)



General considerations

Many details need to be worked out:

- Dynamic correction range required (**amplifier power**)
- Precise location of IP BPM (it will NOT be at IP!)
- Location (**lever arm**) and length (**kick**) allowed for kicker
- Kicker aperture (**amplifier power**)
- Details of cabling (**latency**):
 IPBPM → IPBPM electronics → FONT
- Output signal of IPBPM electronics (**latency, digitisation**)

Some working assumptions (1)

- Kicker 1m upstream of IPBPM
 - Kicker aperture 40mm (?)
 - Kicker length ~ 15 cm (?)
 - Matched 50 Ohm terminations
- Half of current FONT5 sensitivity:

0.5 urad / Amp

(can easily scale from above assumptions)

Some working assumptions (2)

Dynamic correction range:

- Beam size 37 nm
- Beam y jitter ~ beam size (?)
- 2 sigma correction
 - 70 nm @ IP = 70 nrad kick
 - drive current = $0.07/0.5 \sim 0.1$ A (per strip)

Some working assumptions (3)

Amplifier:

- **Peak power = $0.1^{**2} \times 50 = 0.5$ W per strip**
 - eg. Minicircuits: 10W, 5 → 500 MHz**
- **Good margin for kick (x 5 per strip)**
- **Low latency (5 ns)**
- **(Output can be pulsed for long bunch train)**

Caveat

If the IP beam size, and hence the beam jitter, were significantly larger, the amplifier power requirements would be more serious, and the latency correspondingly longer ...

Present FONT amplifier provides 30 urad kick and takes 35ns to do so!

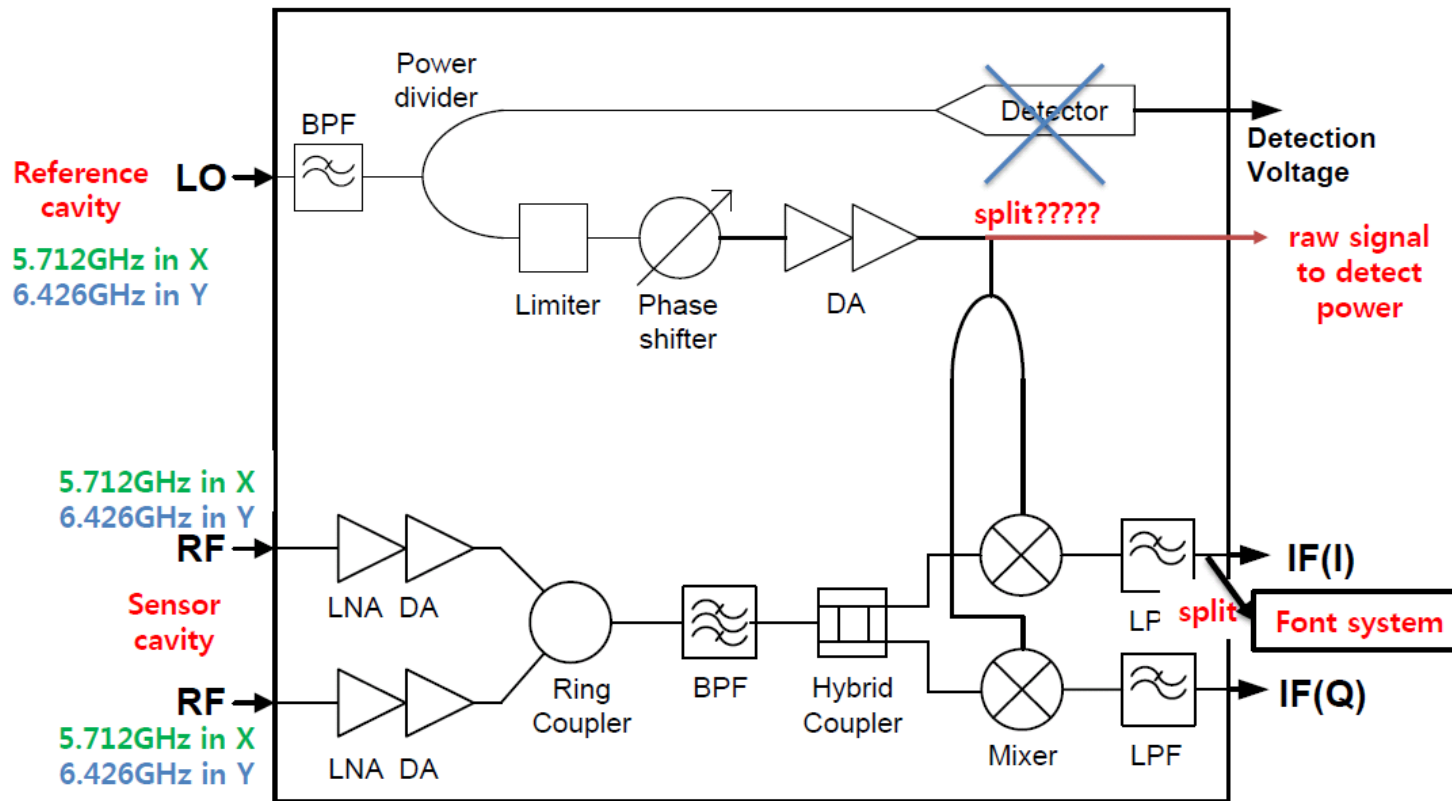
Latency estimate

• Amplifier (as described)	5ns
• Kicker fill (15cm)	0.5ns
• Beam flight time amplifier → IPBPM	4ns
• Cables (3 x 1.5m?)	23ns
• FONT digital board	60ns
• IPBPM electronics	40ns?
Total	133ns

IPBPM electronics

(Aeyoung Heo)

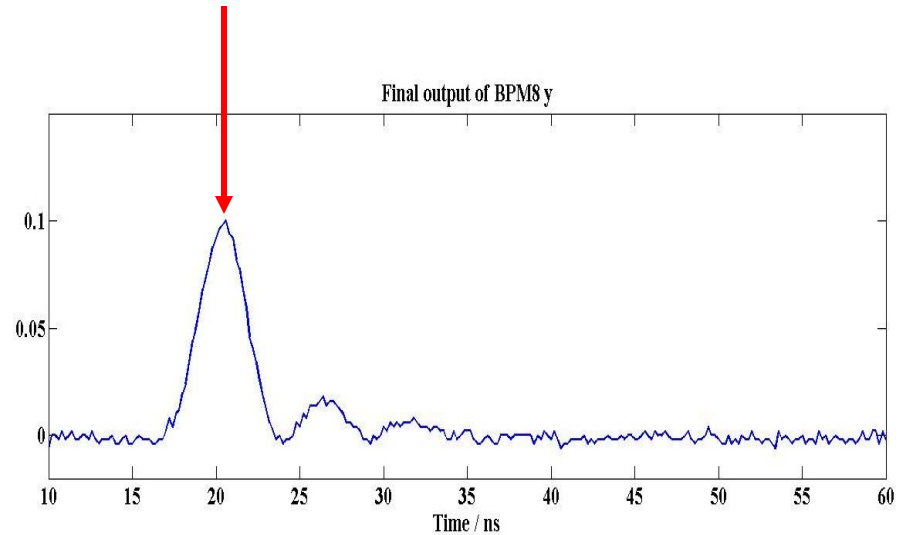
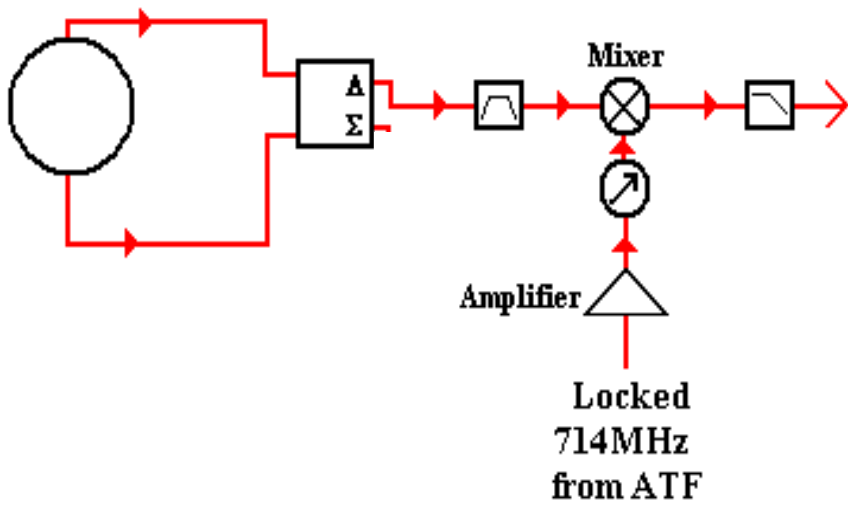
1. Improved conversion gain
2. Low Noise Figure
3. Narrow Bandwidth
4. Latency: less than 20ns



Digitisation of IPBM signal

- **Could treat cavity I and Q signals like Difference and Sum signals from stripline BPM**
digitise and divide
→ charge-independent position signal
- **FONT5 ADCs (TI ADS5474) clocked at 357 MHz**
- **Very high bandwidth sample point**
- **Sample time adjustment sensitivity c. 100ps**

FONT Digitisation



IPBPM signal requirements

- **Prefer 'baseband' signal**
could deal with up to 100 MHz
- **Ideally I, Q signal levels ~ 100 mV**
could deal with almost any power levels (by amplification)

Summary

- **Conceptual design for IP FB system**
- **System parameters look feasible**
- **Critical parameters:**
 - dynamic correction range, bunch spacing**
- **Digitisation of IPBPM I and Q signals is easiest approach → baseband signals**
- **Many technical details need to be decided:**
 - locations of BPM + kicker, kicker aperture, cable runs ...**

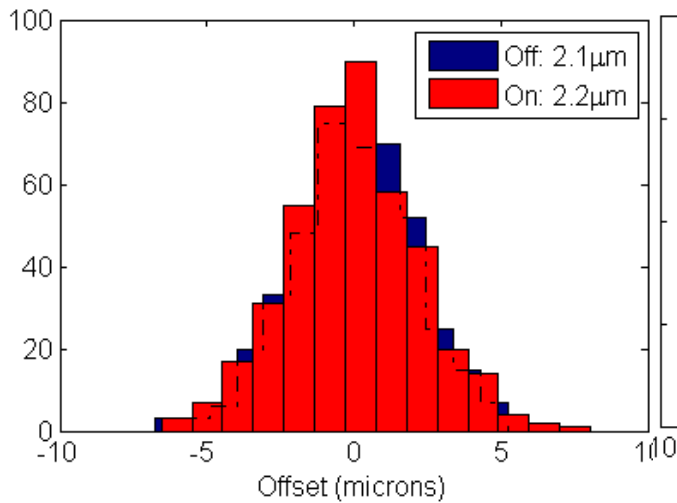
Postscript

- **Intra-train beam feedback requires extremely high degree of spatial correlation between the bunches**
- **With the current ATF2 setup (existing kicker system and 3 bunches) we occasionally see good correlations, usually after a lot of tuning**

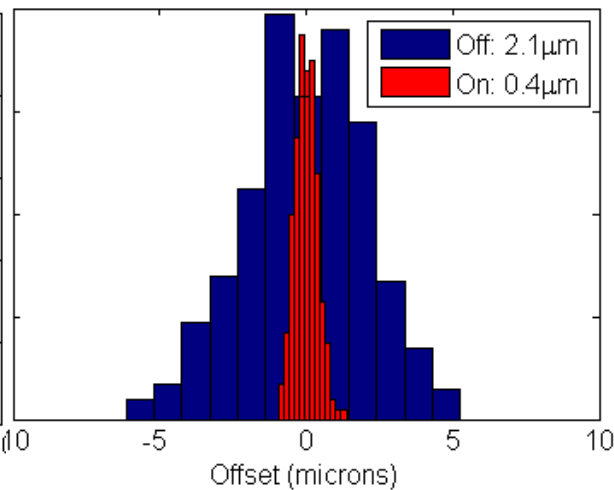
P2 → K1 loop jitter reduction

(April 16 2010)

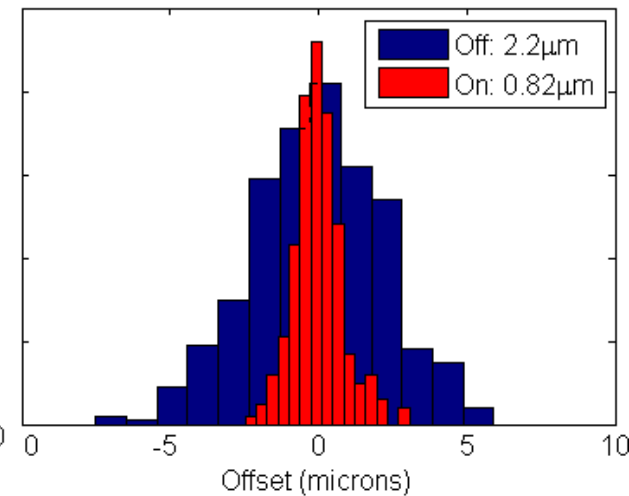
Bunch 1



Bunch 2



Bunch 3



2.1 µm



0.4 µm



0.8 µm

Postscript

- **Intra-train beam feedback requires extremely high degree of spatial correlation between the bunches**
- **With the current ATF2 setup (existing kicker system and 3 bunches) we occasionally see good correlations, usually after a lot of tuning**
- **The new fast extraction kicker system, and a multibunch beam, will certainly require significant experience and machine time in order to provide trains of well-correlated bunches**