

Upgrade of signal processing circuits for Beam Position Monitors

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KEK / J-PARC

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Motivation

- Improve position accuracy

described later

- Discontinued products, out of spare parts

- Latency, throughput

limiting factor in a restricted machine time for parametric scan in studies
or tuning

Collaboration subjects

KEK / J-PARC

New signal acquisition system for high precision beam position measurement

- o Design, production of new front end analog load.
- o Perform beam tests with J-PARC's new front end analog load and FNAL's digitizer.
- o Discussions on next generation BPM system.

Fermilab

- o Perform beam tests with J-PARC's new front end analog load and FNAL's digitizer.
- o Discussions on next generation BPM system.
- o Consultation on design of new digitizer for J-PARC.

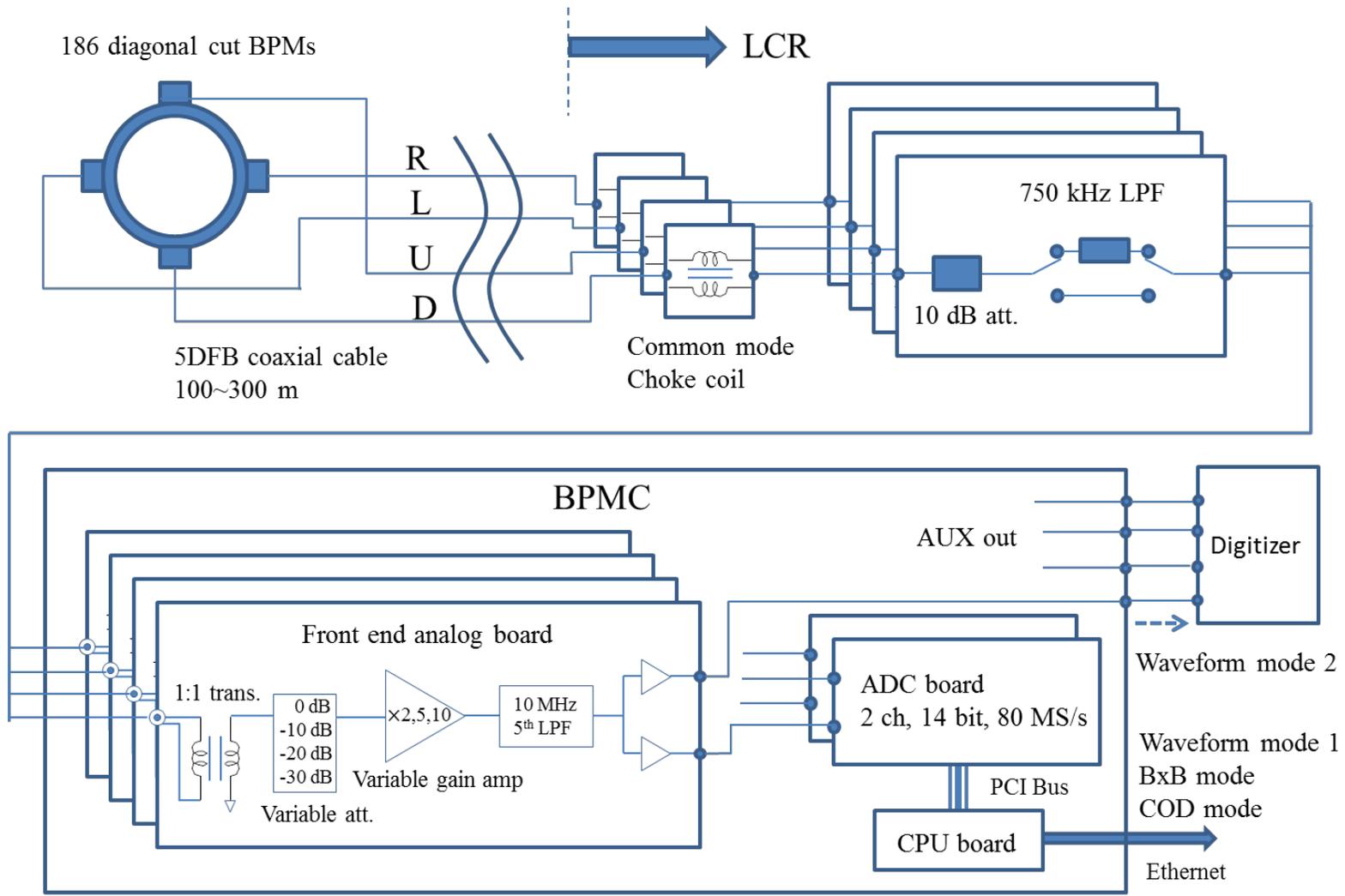
Technical detail of the processing circuit of J-PARC MR

Present and Upgraded version

Parameter Summary	Present	New version
Position accuracy		
COD mode	~ 30 μm	< 10 μm
BxB mode	~ 300 μm	100 μm
→ β measurement	2 %	< 1 %
Input voltage (50 Ω)	~ ± 100 V	~ ± 100 V
VSWR	< 1.03	< 1.005
Reflection	< 1.5 %	< 0.25 %
Analog bandwidth	10 MHz	10 MHz
ADC	14 bit, 80 MSPS	16 bit, 250 MHz
SNR (quantization noise)	92 dB	109 dB
Bus system	stand alone (internal PCI-bus)	VME64x, the $\mu\text{TCA.4}$ or ?
Data length COD mode (max) ^[1]	every 10 ms*2000, single 1 ms*10000	
Waveform mode (max)	shot 2400 points, shot 1 M points	described later

[1] One set of position data (x, y) is generated in every 1 / 10 ms.

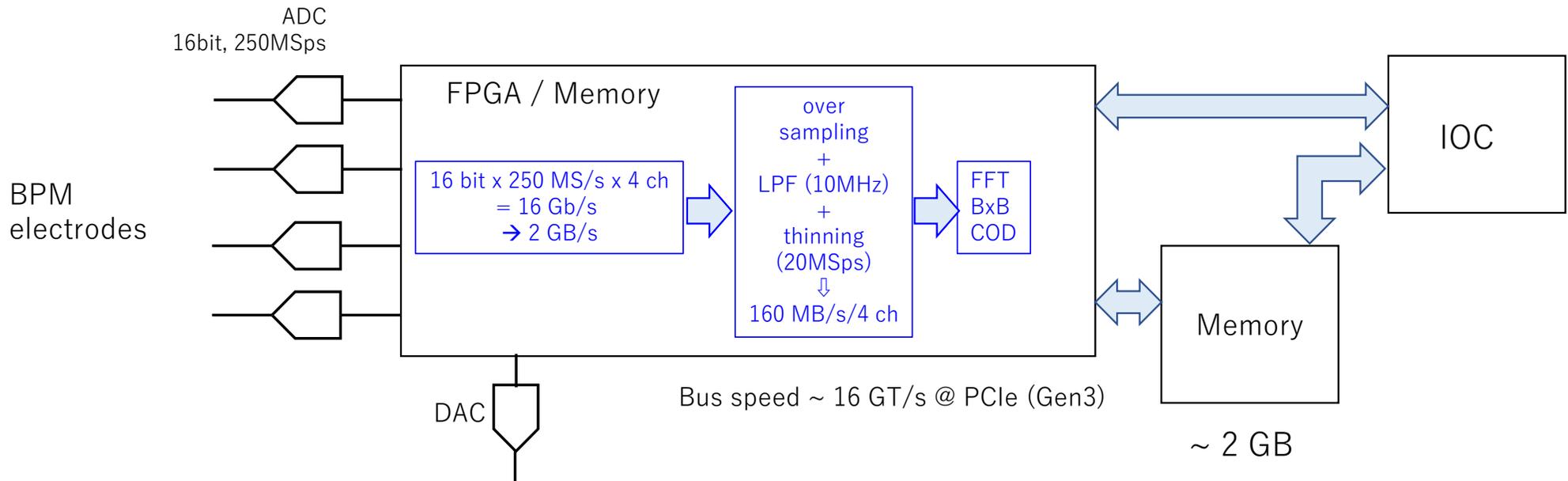
Present BPM system



Data flow of new version

MR cycle	
1.16 – 1.3 s	5.2 s

Waveform mode 250 MSps x 2 B/ch x 4 ch = 2 GB/s / BPM	FX (~1s) 2 GB / BPM	SX (5s) 10 GB / BPM	
	→ take the memory size as large as BxB, COD mode ~ 2 GB/BPM ?		
BxB mode 8 bunches / (5 μs) x 2 (x, y positions) x 2 B / s = 6.4 MB / s	6.4 MB / BPM	32 MB / BPM	every shot
FFT mode 4 (electrode #) x 4096/2 x 4 B x 2 (Re, Im) / (0.5 ms) = 130 MB/s	130 MB / BPM	650 MB / BPM	cutout a part of whole data on the BPMC board
COD mode 2 (x, y position) x 4 B / (0.5 ms) = 16 kB/s	16 kB / BPM	80 kB / BPM	every shot



Data flow (2)

For postmortem analysis : store 3 shots x (16k or 80kB / BPM) in COD mode
(6.4 M or 32 MB / BPM) in BxB mode

Data processing

➤ Issues

- ADC sampling with RF clock (1.67M – 1.72MHz; multiplied by 128 ~ 214M - 220MHz)
- Choice of the bus, VME64x, MicroTCA.4, or direct connection (Ethernet?)
- Data processing, FFT, or other methods, peak-peak, waveform ?
- Alarm / MPS by BPM

Plan

JFY2019

JFY2020

JFY2021

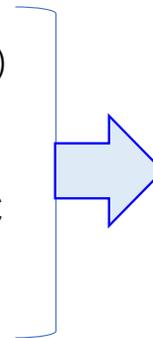
Meeting / discussion

Learn the FNAL BPM digitizer by J-PARC

Production of front end analog load (J-PARC)

Test at test bench
with the FNAL BPM digitizer in J-PARC

Beam test in both



Fed back to
the design of new BPM digitizer
for J-PARC

Mini-workshop on on high precision BPM system
Discuss crucial requirements and performances for
BPM systems used in next generation high power hadron machines.