Digit500 Tests on SXFEL

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SSRF

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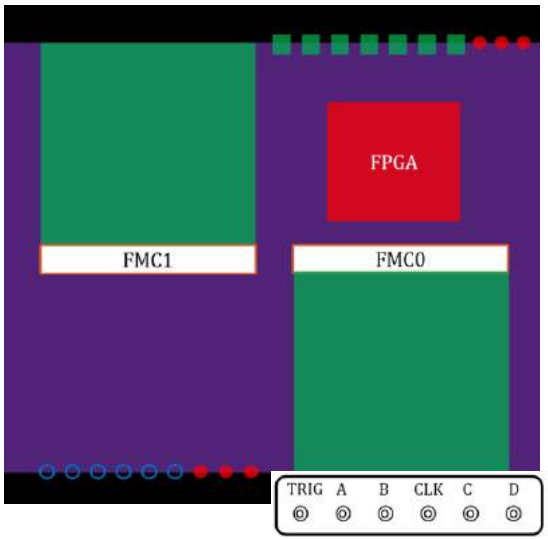
Recent status on SSRF

- Synchrotron radiation facility: upgrade in progress(beam lines construction)
- Soft X-FEL Test Facility: completed in this June. User Facility: will start in August
- SHINE: tunnel construction in progress, and key-technologies research stage

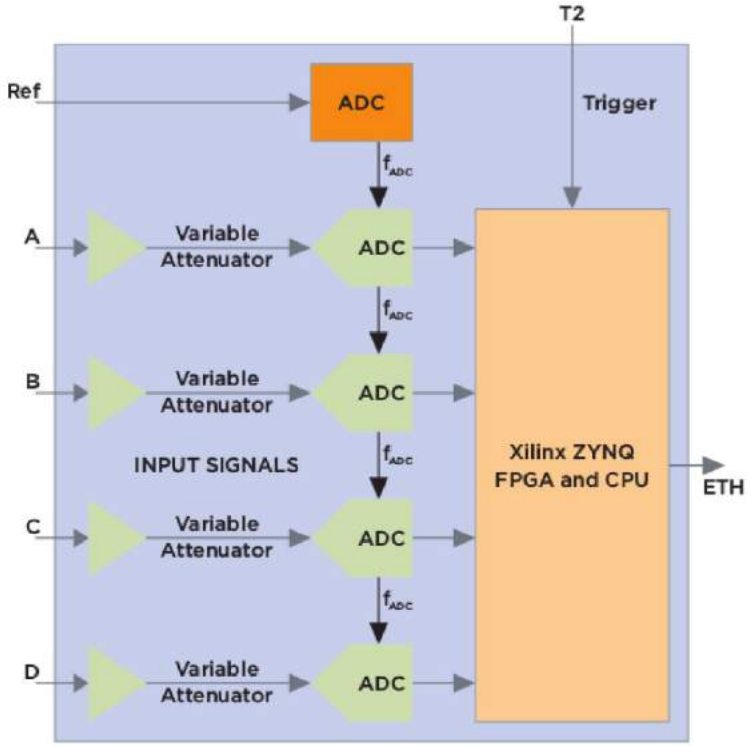
BPM processors for SHINE

- Signal processing for Cold Button, Stripline, Cavity BPMs
- Standalone structure based on Xilinx SOC FPGA, 1U' height
- FPGA mother board, FMC ADC and timing mezzanine cards
- ≥500MSPS, ≥14bits , also can be used as bunch by bunch processor on synchrotron facility
- 1MHz repetition rate
- Digit500 is applied as a test platform to check the design.



Pre-research with Digit 500

Libera Digit 500 - overview

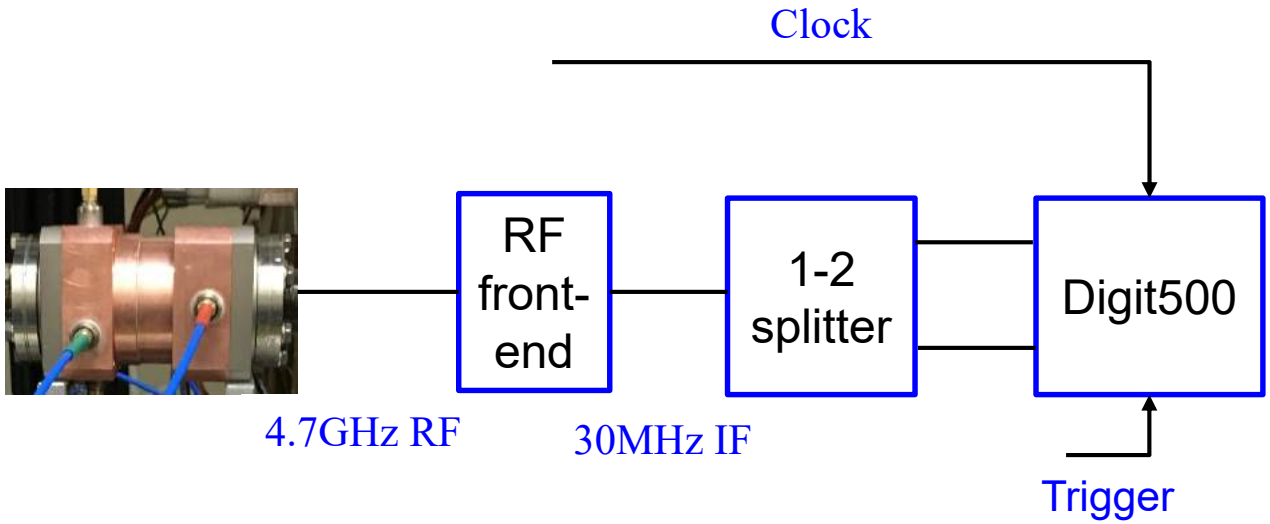


- 4 input channels – 50Ohm
- ADC: 500MHz – 14bit
- Sampling clock: free running or externally locked with HW PLL
- 32 dB of variable gain (channel independent)
- 3x LVTTL trigger lines

DC~250MHz BW

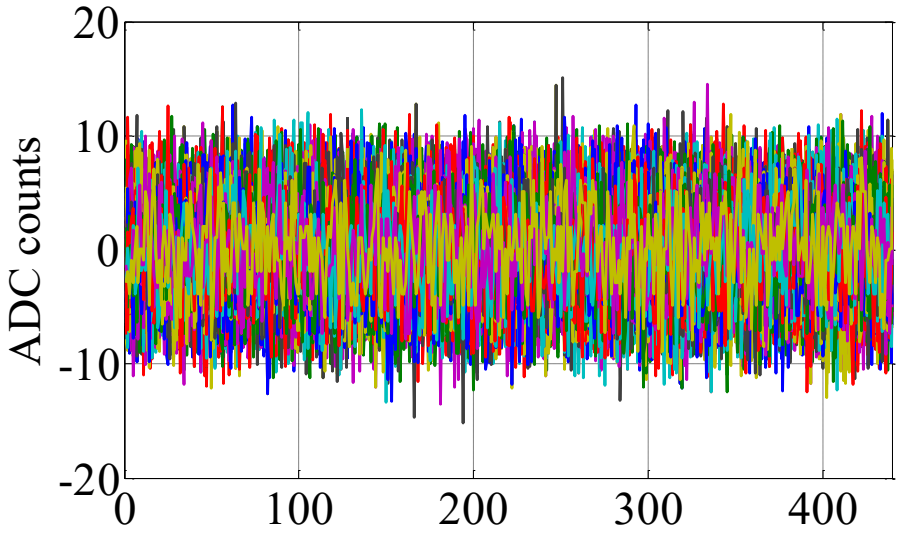
Cavity BPM test

- Cavity BPM reference IF signal @700pC was split to 2 ways and fed into Digit500 2 channels
- External 476MHz sampling clock
- Off-line data evaluation: noise level and resolution

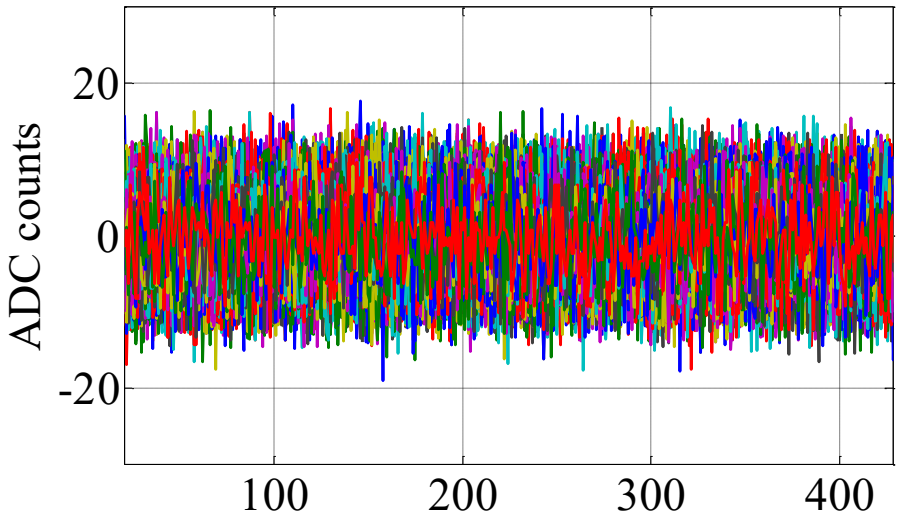


Noise level

no input signal
Mean[std(noise)] = 3.3



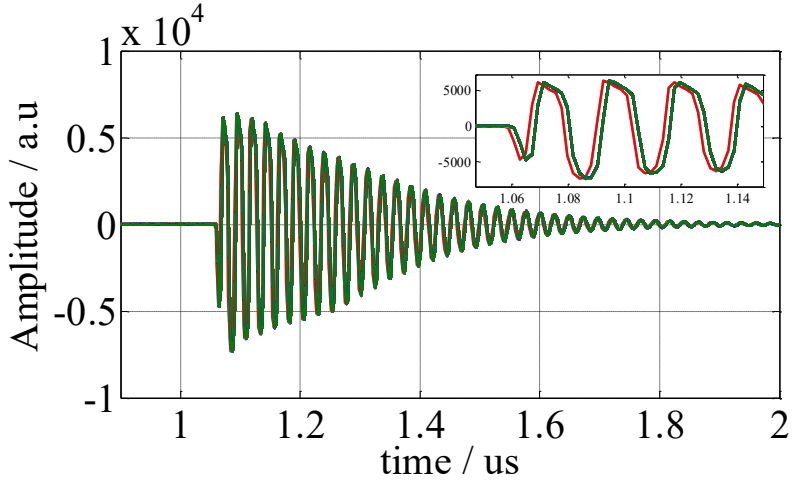
With signal
Mean[std(noise)] = 4.2

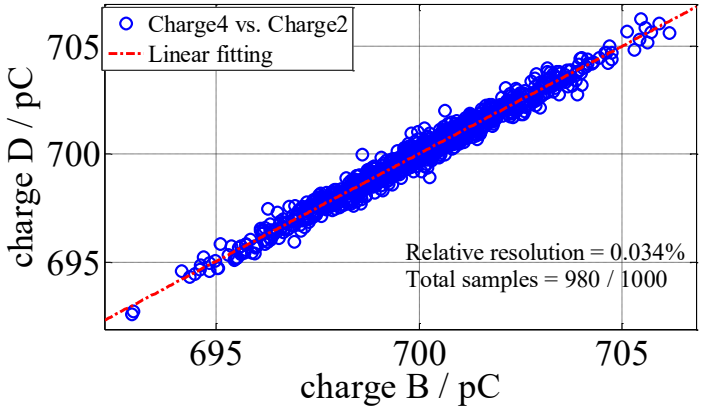


Amplitude and phase resolution

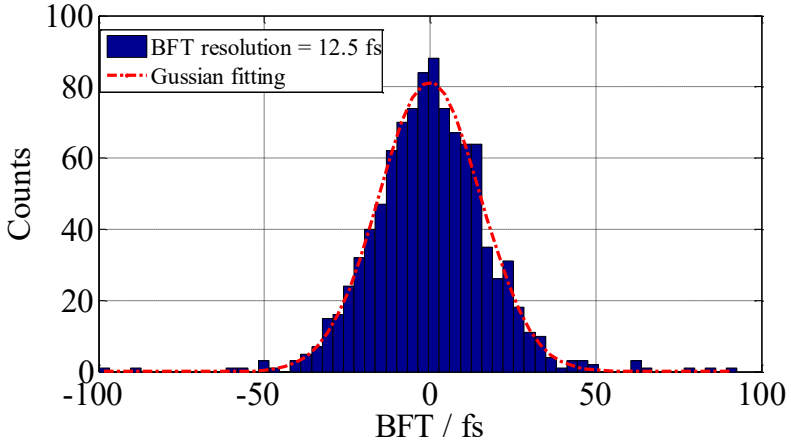
中国科学院上海高等研究院
SHANGHAI ADVANCED RESEARCH INSTITUTE, CHINESE ACADEMY OF SCIENCES

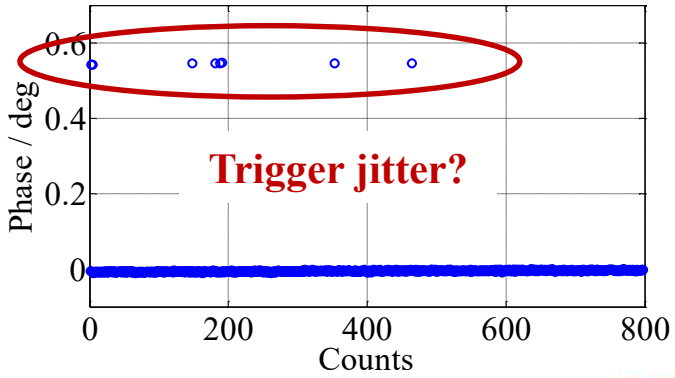
- Relative amplitude resolution 0.034%





- Relative phase resolution **12.5fs**





Beam charge measurement

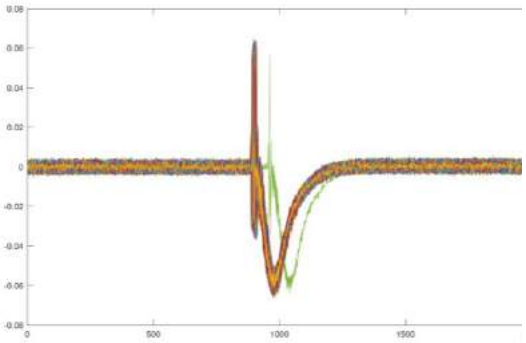
ICT

1-2 splitter

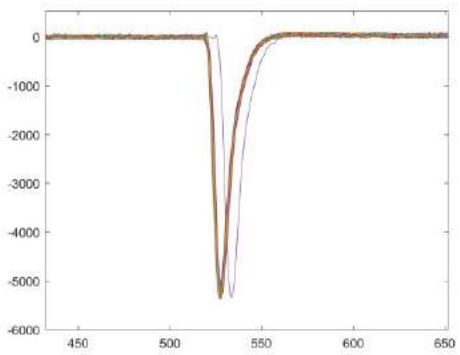
Digit500 /OSC.

Trigger

DSO9064A
600MHz BW
10GSa/S



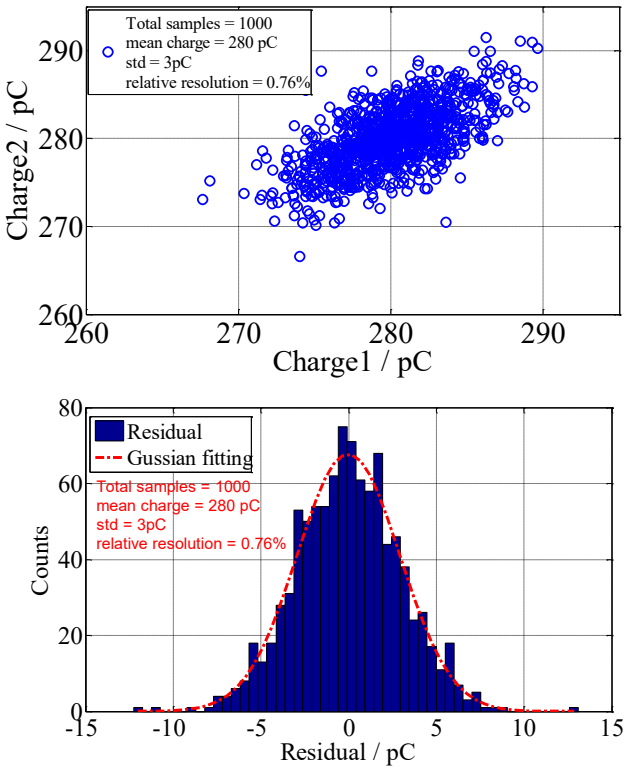
Data from oscilloscope



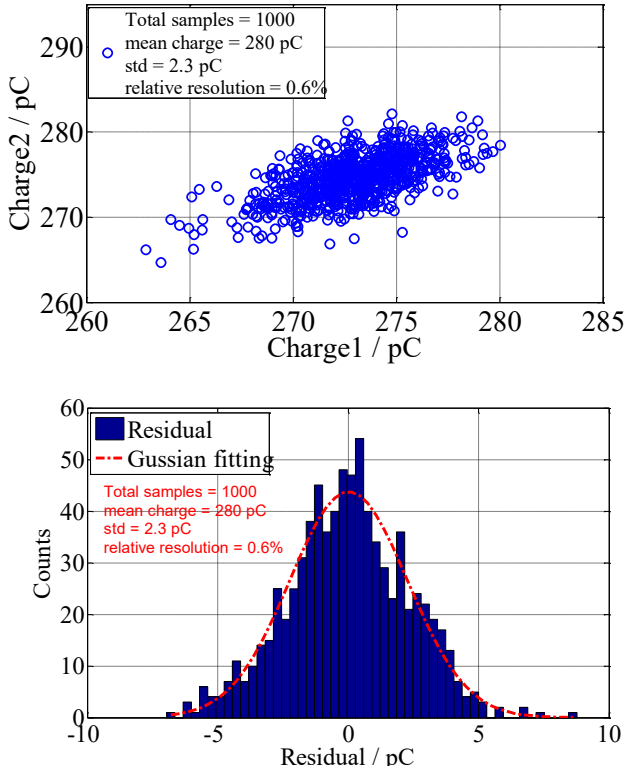
Data from Digit500

Current calculation directly

- The Digit500 relative resolution is 0.76% compared to 0.6% of oscilloscope.



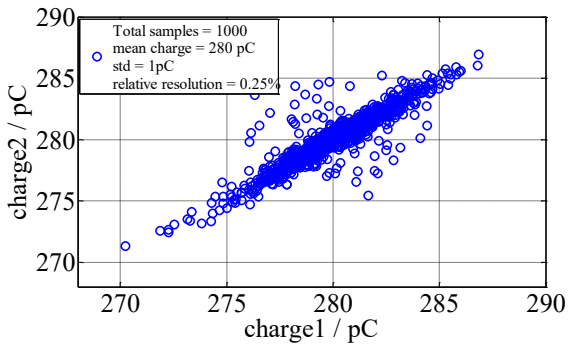
Digit 500

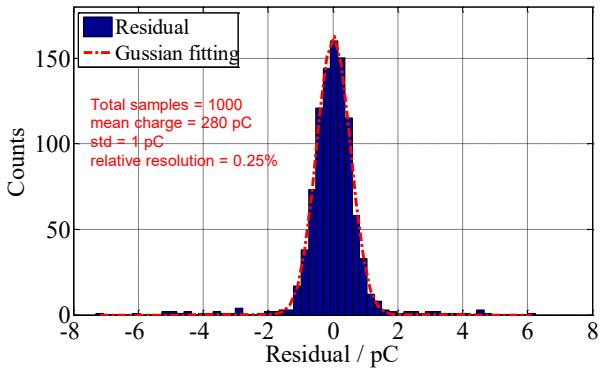


Oscilloscope

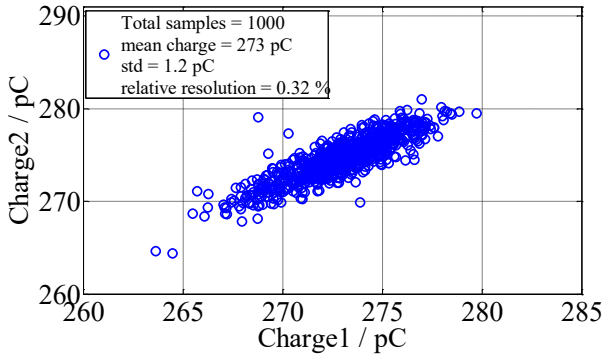
Charge measurement--PCA

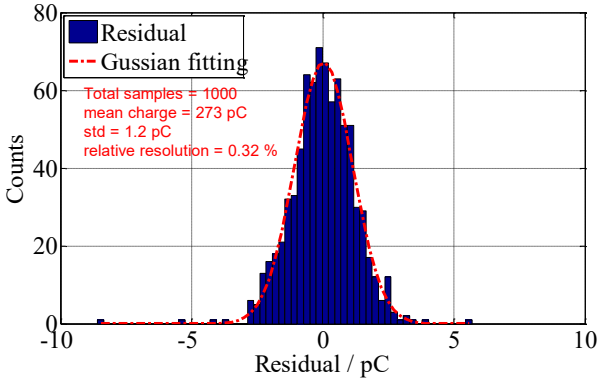
- After applying PCA, the Digit500 relative resolution is improved to 0.25% compared to 0.32% of oscilloscope.





Digit 500





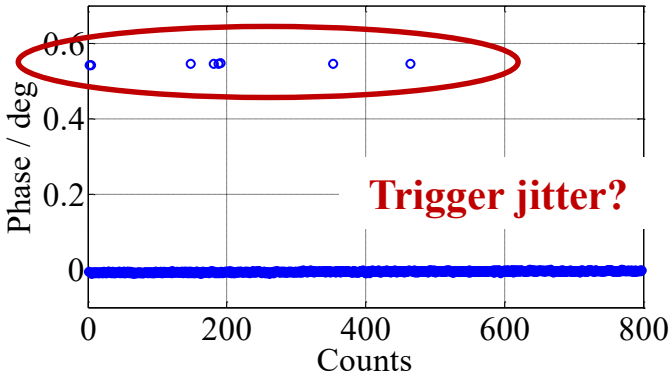
Oscilloscope

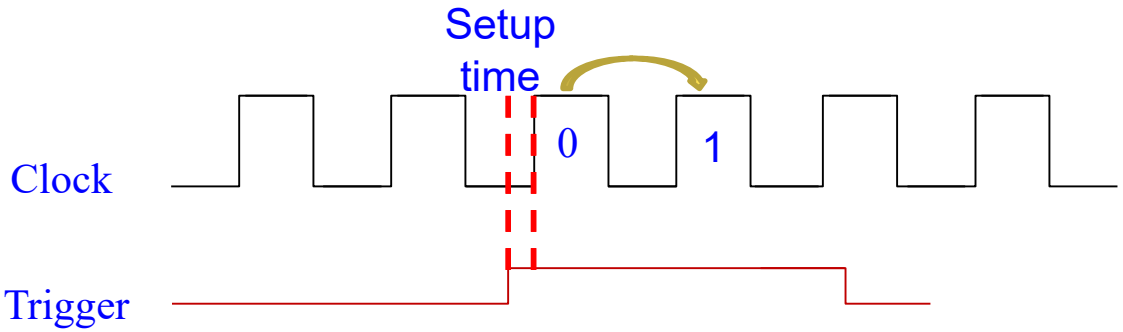
Conclusions

- Digit500 hardware shows good performance, can be used for cavity BPM signal acquisition. Also stripline BPM can be used.

- SXFEL is using oscilloscope for ICT charge measurement. Digit500 shows comparable performance, could be used for charge measurement after calibration.

Question: How to resolve the clock and trigger jitter?





One possible explanation:

- Trigger signal arrives on the edge of clock.
- Trigger signal may be captured 1 clock delayed.
- Phase result will be different after one sample point.

How to resolve this problem?