IP-BSM - 2 bunch operation

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Outline

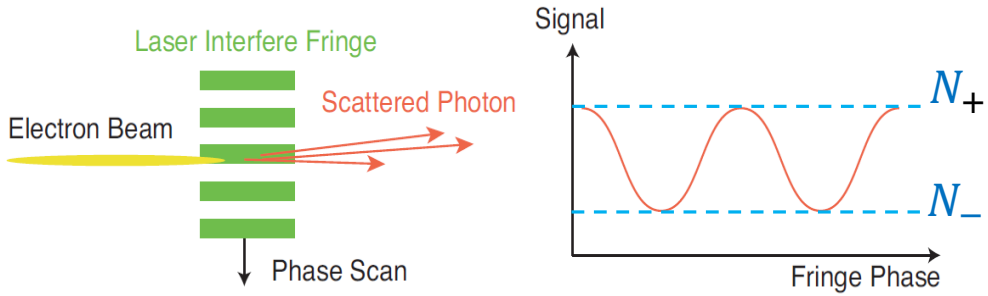
- Introduction
- Detector optimization for 2 bunch beam size measurement
- Test of 2 bunch measurement

Introduction

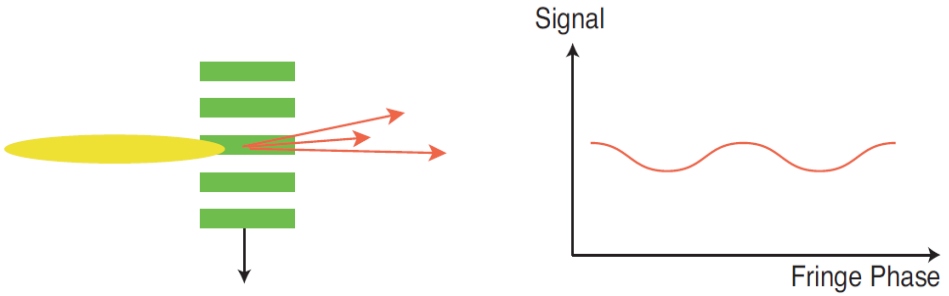
Concept of IPBSM

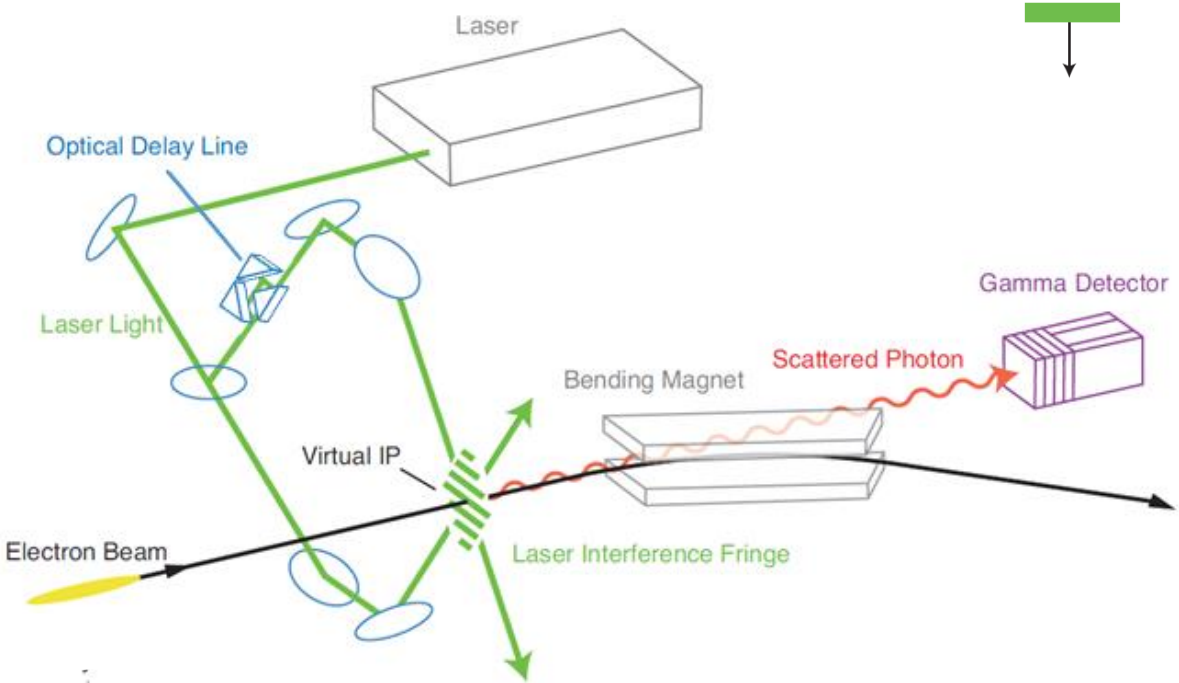
Modulation depth $M = \frac{N_+ - N_-}{N_+ + N_-}$

Small beam size ⇒ large M



Large beam size ⇒ small M





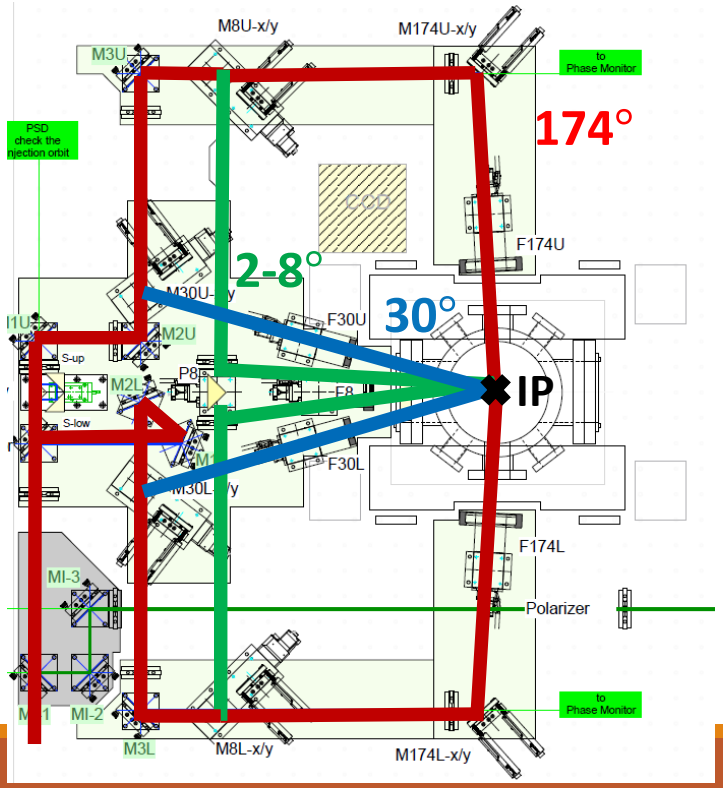
IPBSM setup at ATF2

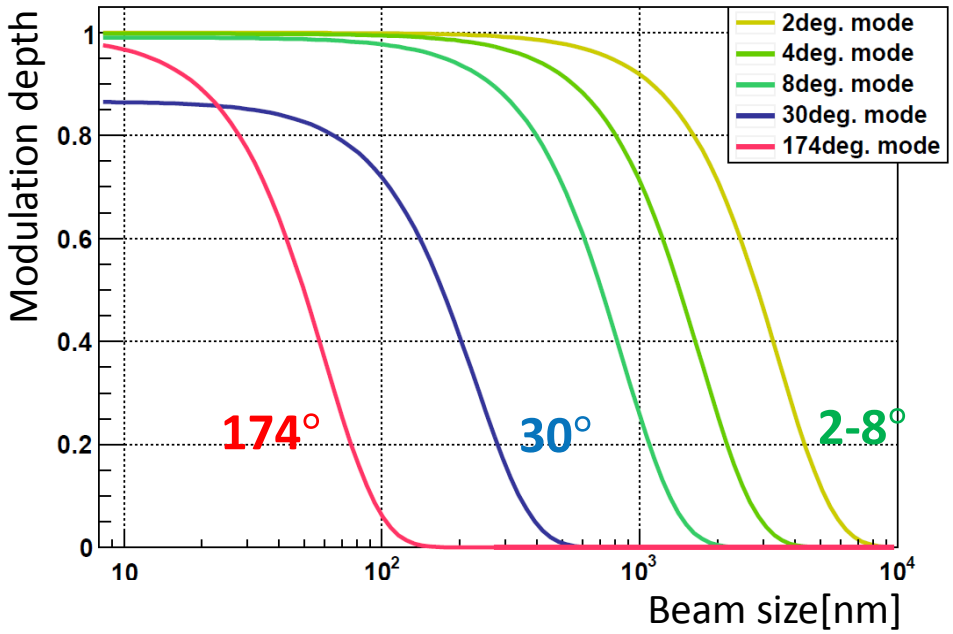
- 3 angle modes at ATF2:

  $\theta = 2\sim8°,\ 30°,$ and $174°$

- Expected measurement range:

  $\sigma_y \sim 20\text{–}30\text{nm}$ to $\sigma_y \sim \mu\text{m}$





Vertical table at IP

Detector optimization for 2-bunch beam size measurement

Motivation

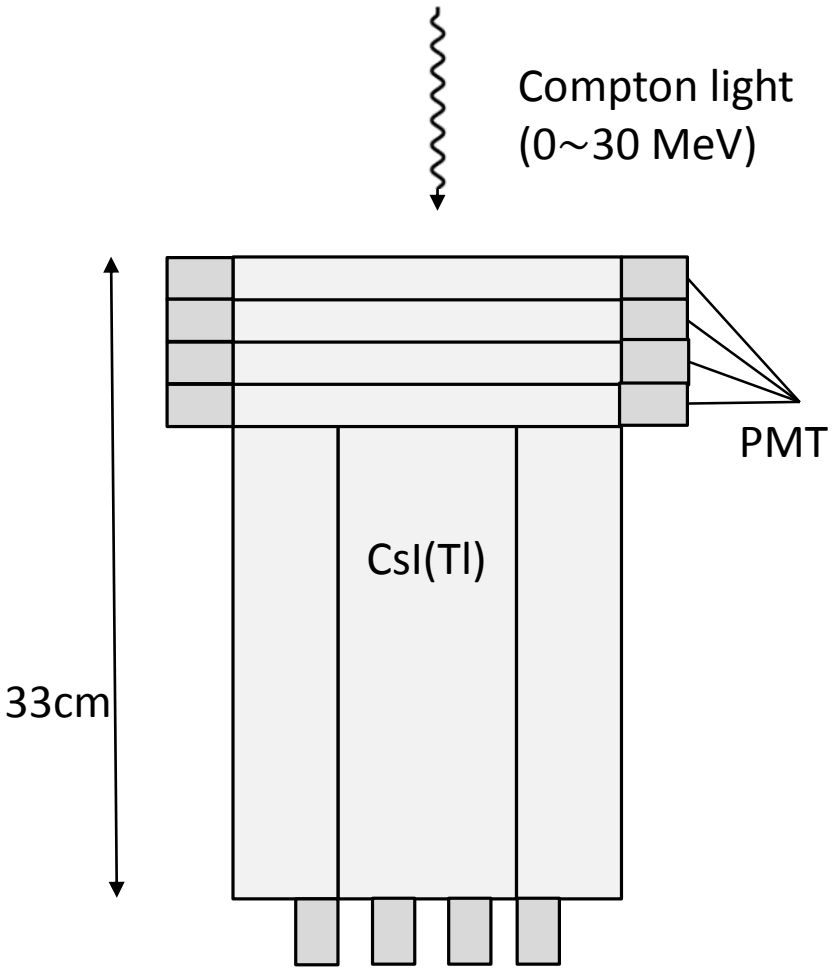
Motivation: Beam size measurement of separate bunch

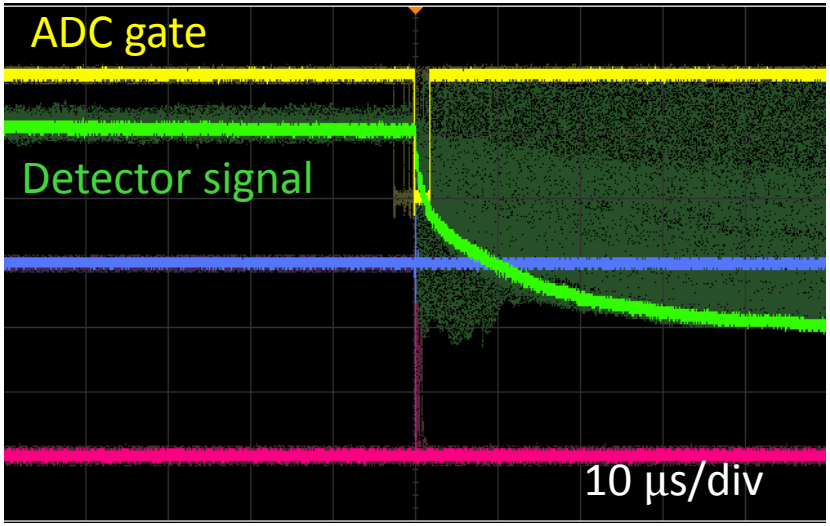
By using FONT, suppressing the effect of beam position jitter on 2nd bunch beam size measurement may be possible

2 bunch operation at ATF2:

Bunch separation: 215 ns

Presently used gamma detector: CsI(Tl) scintillator

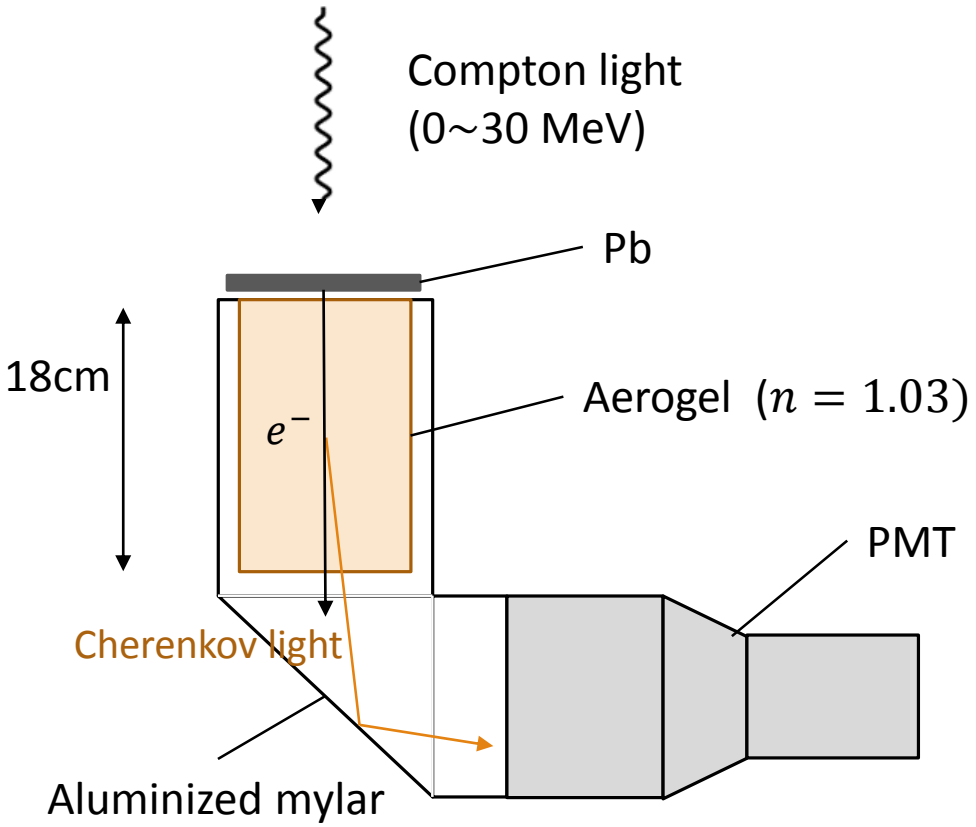


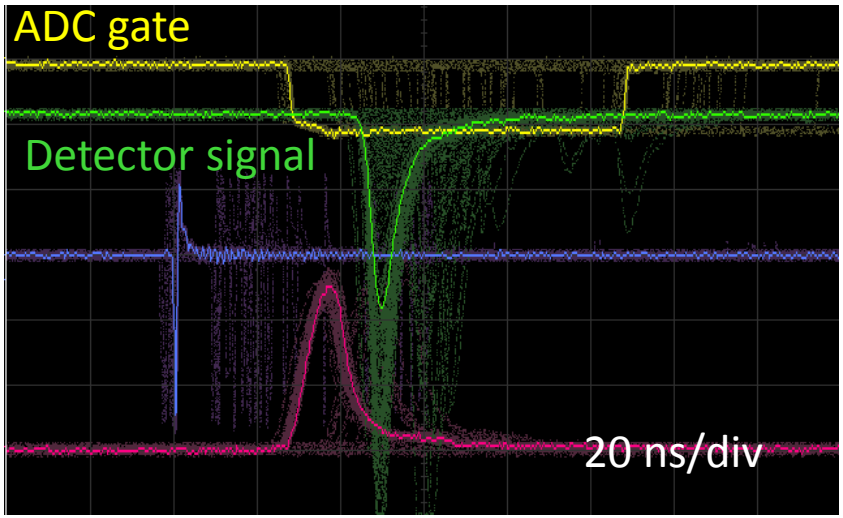


- Because of slow neutron background, time response is slow

- Background from 1st bunch will overlap with 2nd bunch

Cherenkov detector with aerogel

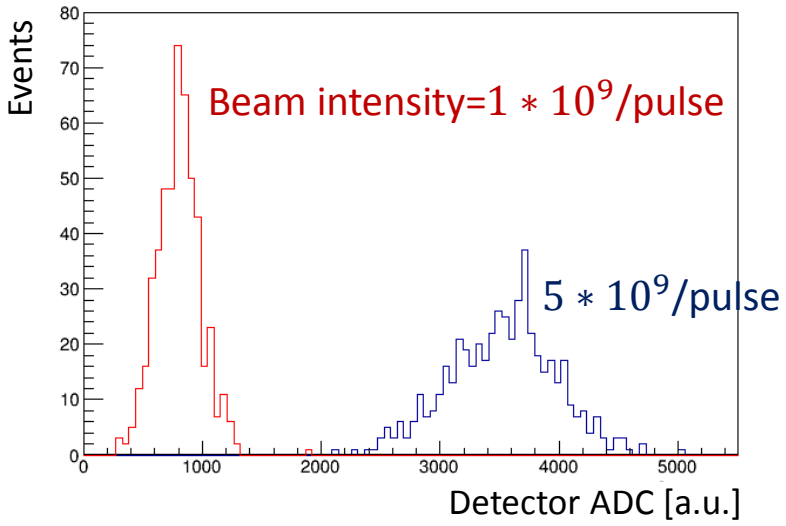




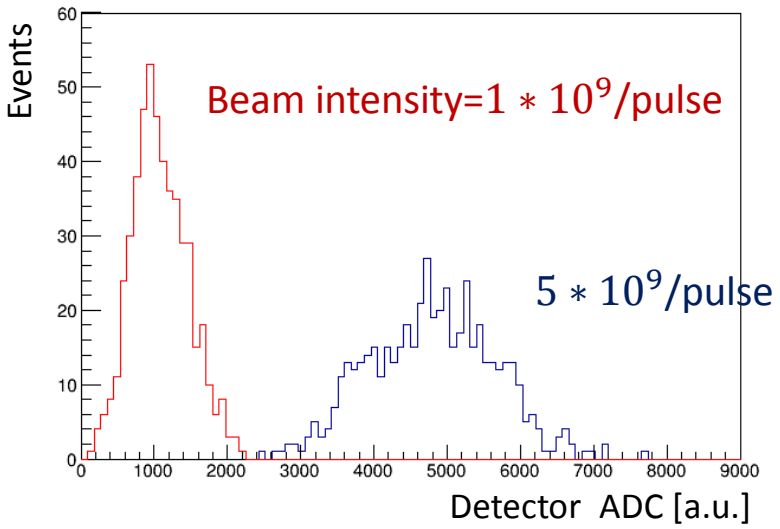
- Time response is faster
- Pulses from different bunches can be separated

Comparison of signal fluctuation of 2 detectors

CsI(Tl) scintillator



Aerogel Cherenkov



Intensity [/pulse]	CsI(Tl)	Aerogel Cherenkov
$1 * 10^9$	0.25	0.39
$5 * 10^9$	0.14	0.20

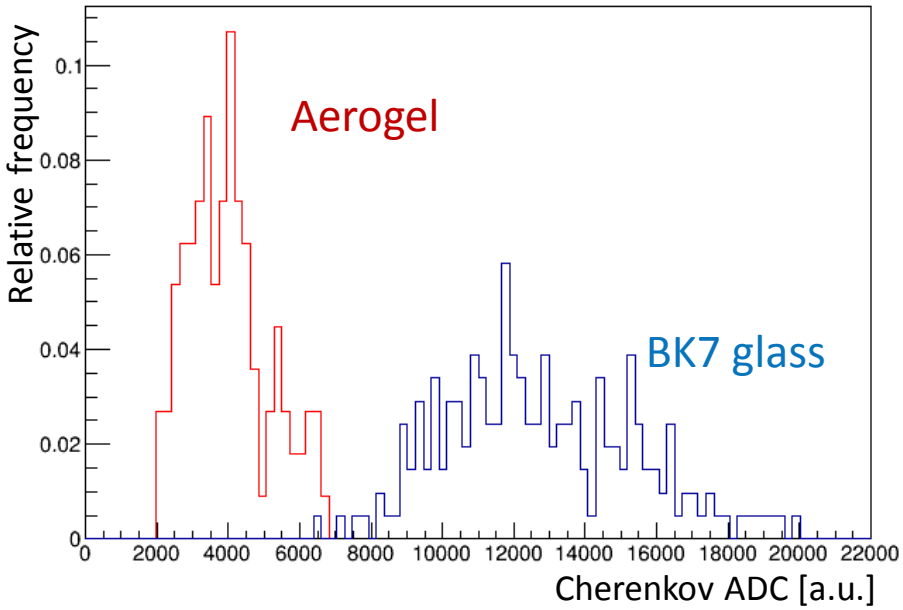
RMS/Mean at different beam intensity
(contribution of background is subtracted)

Signal fluctuation of Aerogel Cherenkov detector is larger than CsI(Tl) scintillator

⇒ Optimization is needed

Radiator comparison for Cherenkov detector

- We compared 2 substances which we had in hand
- BK7 glass mirror is used as a test of radiator with large refractive index



(beam intensity is normalized)
(Event selection on CsI(Tl) scintillator signal is applied)

	Aerogel	BK7 glass
Thickness [cm]	18	0.95
n	1.03	1.52
Light absorption length [mm]	~ 40	Significantly large
X_0[cm]	~ 100	~ 10
Mean [a.u.]	4000	13000
RMS/Mean	0.28	0.21

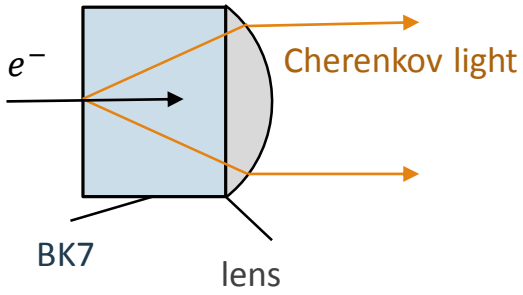
$\Rightarrow$ *Detector yield increased, fluctuation decreased*

Planned tests to increase Cherenkov yield

- Aim:
  - Increase detector signal
  - Collect Cherenkov radiation light

- Use thicker glass as radiator to increase radiation

- Use lens to collect radiation light
  - BK7: $n = 1.5 \Rightarrow$ angle of radiation $\theta \sim 0.8$ rad

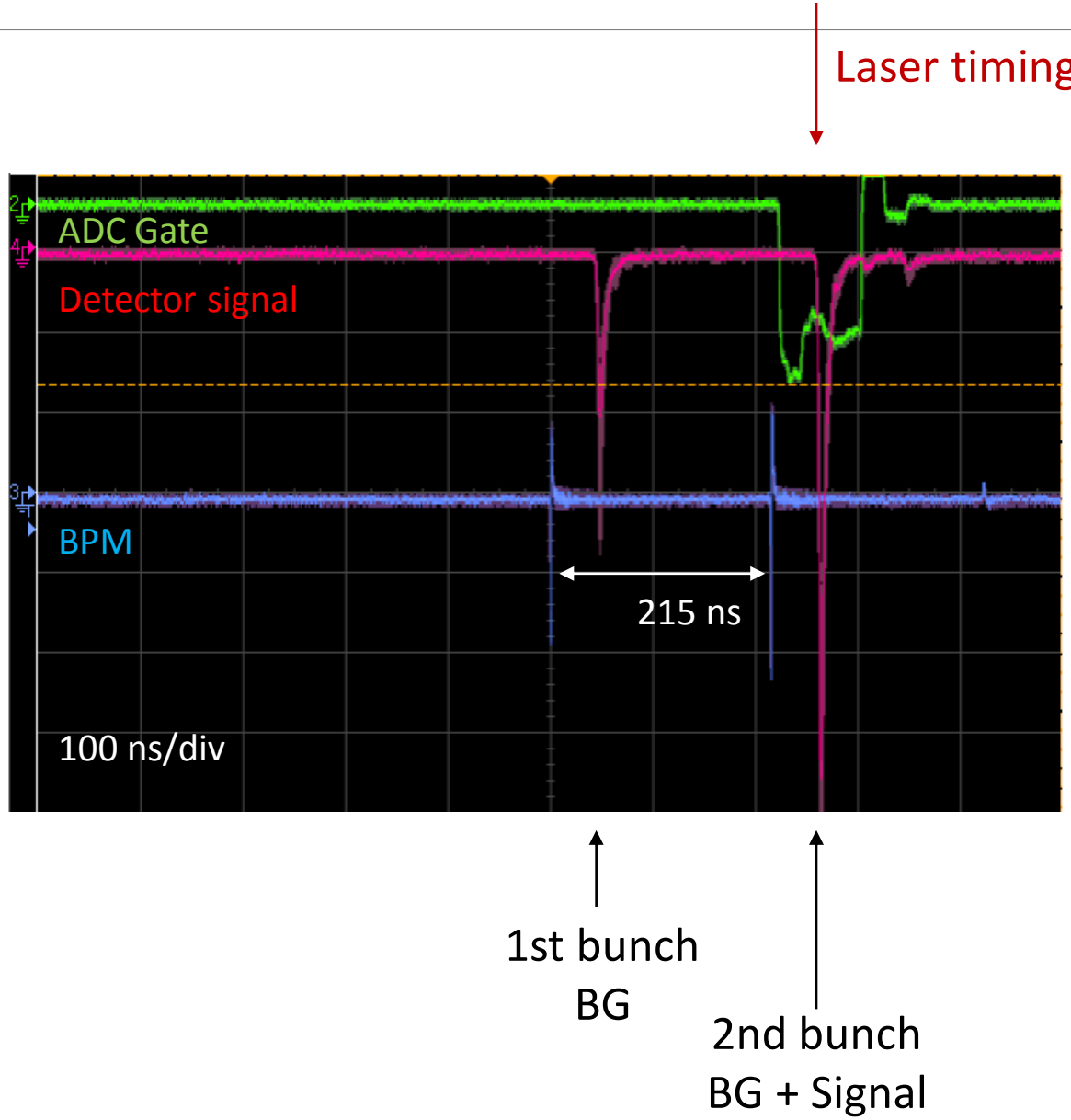


- Test different reflector to increase reflectivity

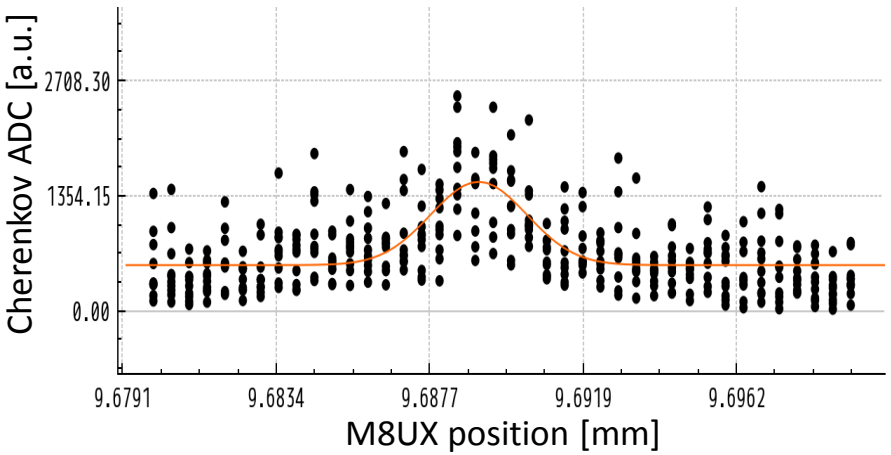
etc.

Test of 2 bunch measurement

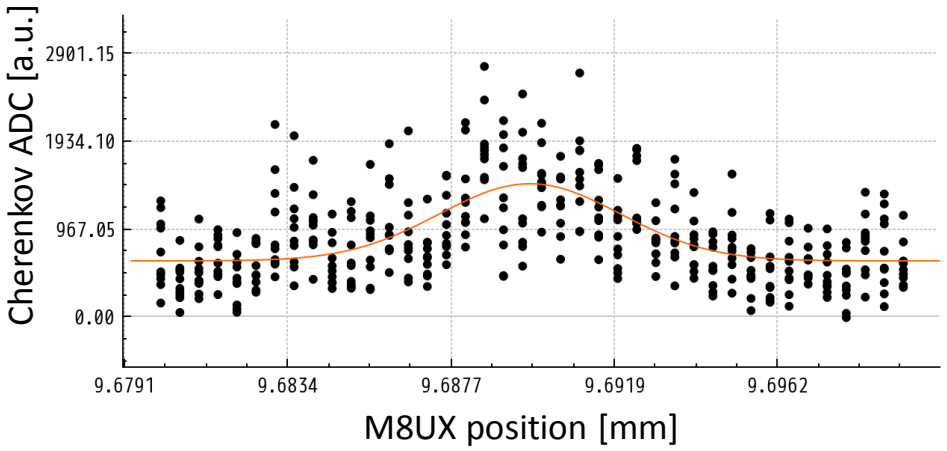
Setup


Laser timing
ADC Gate
Detector signal
BPM
215 ns
100 ns/div
1st bunch
BG
2nd bunch
BG + Signal

Test of measurement of individual bunch



Laser wire scan on 1st bunch:
Center=9.6890 mm
Sigma=1.34 μm



2nd bunch:
Center=9.6897 mm
Sigma=2.39 μm

- Laser and gate timing is altered to match each bunch
- In this measurement, the beam is not tuned
  - The beam is tuned at single bunch operation
  - The beam cannot be tuned at 2 bunch, because the extraction setup is different from single bunch
- This is only a test to measure each bunch

Summary

- Further optimization of the detector is needed for 2 bunch measurement
- Beam tuning and feedback for 2 bunch operation are planned
- 2 bunch beam size measurement is planned for next spring run