

Charge Distribution Measurements at ALBA

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ALBA-CELLS



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ALBA

MEASUREMENTS

APPLICATIONS

ALBA

MEASUREMENTS

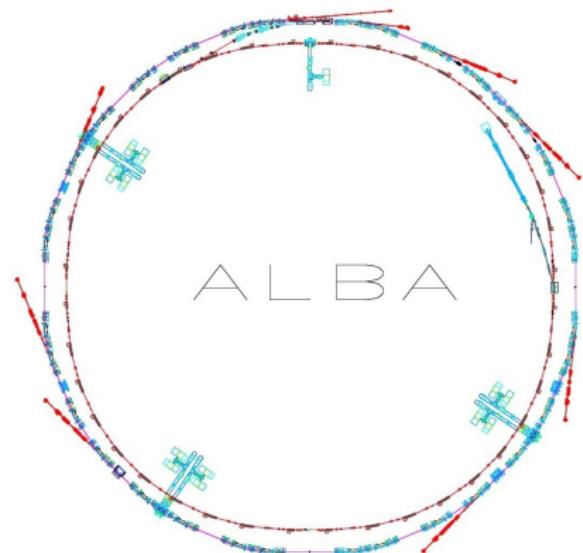
APPLICATIONS

ALBA



The Facility

- ▶ Energy: 3 GeV
- ▶ Current: up to 400 mA
- ▶ Seven active beamlines
 - ▶ +1 Optical beamline for beam diagnostic



LONGITUDINAL STRUCTURE

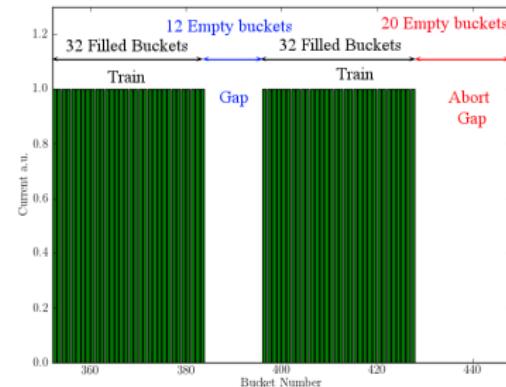
Beam longitudinal
structure



Characteristics of
synchrotron radiation

ALBA Filling Pattern

- ▶ 448 Buckets (500 MHz)
 - ▶ 10 Trains
 - ▶ 32 Bunches
 - ▶ 9 Gaps
 - ▶ 12 Empty buckets
 - ▶ 1 Abort Gap
 - ▶ 20 Empty buckets



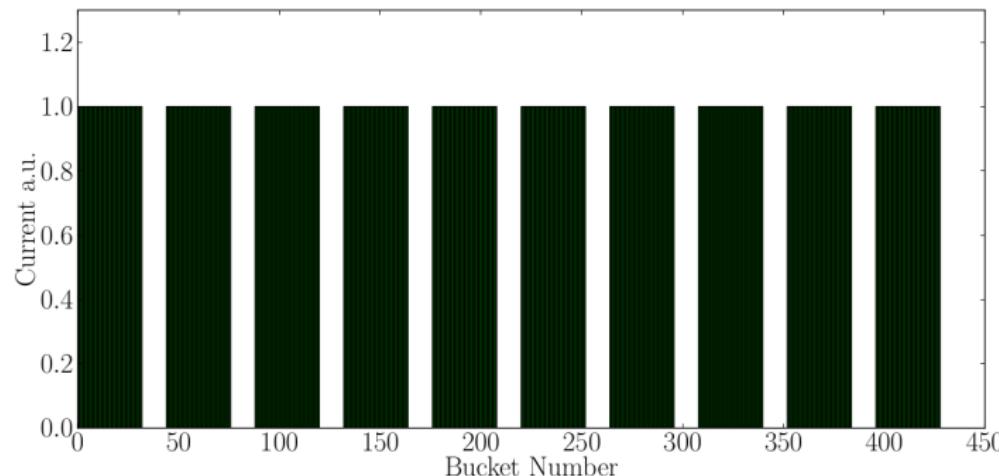
LONGITUDINAL STRUCTURE

Beam longitudinal
structure



Characteristics of
synchrotron radiation

Quantitative estimation of the current in each bucket



ALBA

MEASUREMENTS

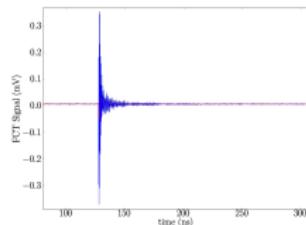
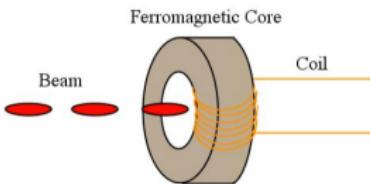
APPLICATIONS

FILLING PATTERN MEASUREMENTS

ANALOG

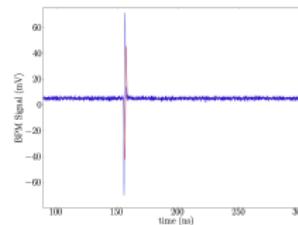
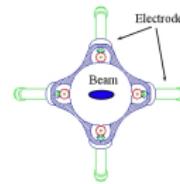
Fast Current Transformer (FCT)

- $\tau_{\text{rise}} = 400 \text{ ps}$
- $f_H = 850 \text{ MHz}$



Beam Position Monitor (BPM)

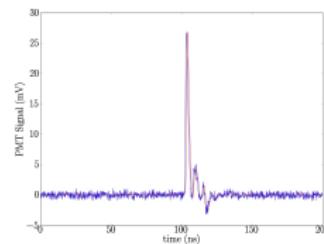
- $\tau_{\text{rise}} = 300 \text{ ps}$
- $f_H = 1.5 \text{ GHz}$



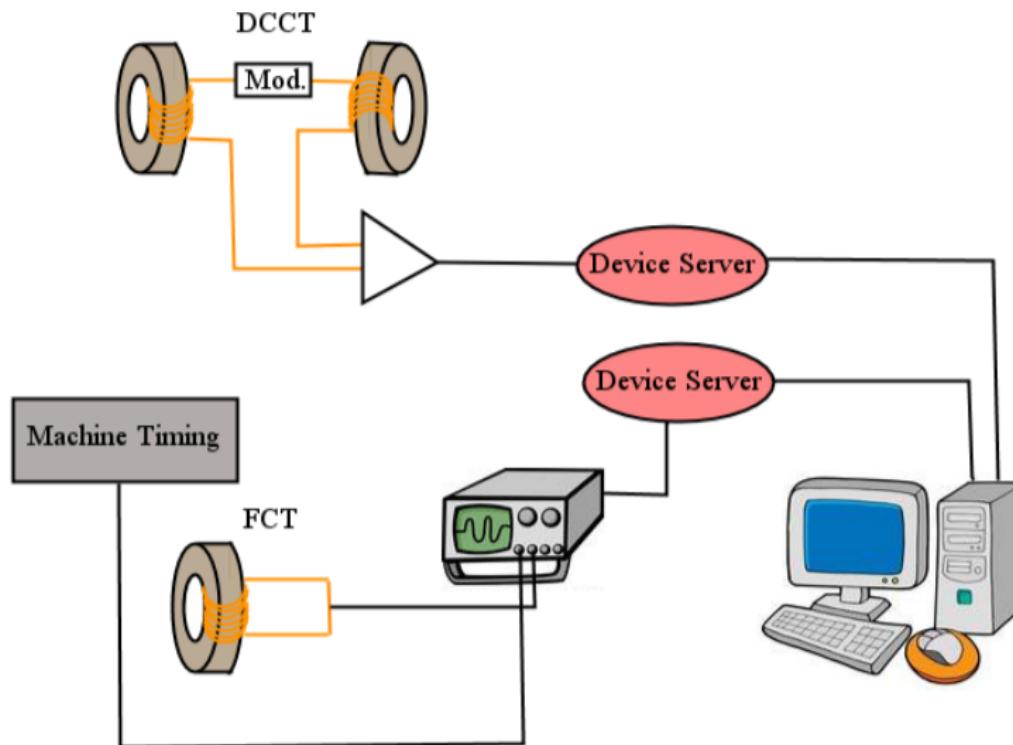
ELECTRO-OPTICAL

Photomultiplier (PMT)

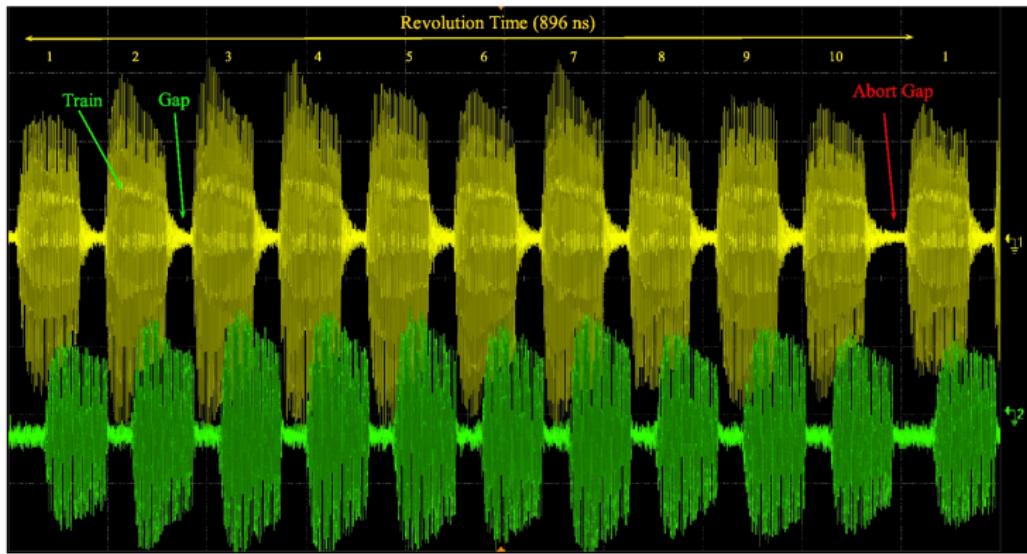
- $\tau_{\text{rise}} = 500 \text{ ps}$
- $\Delta\lambda = 230 : 700 \text{ nm}$



ANALOG DEVICES



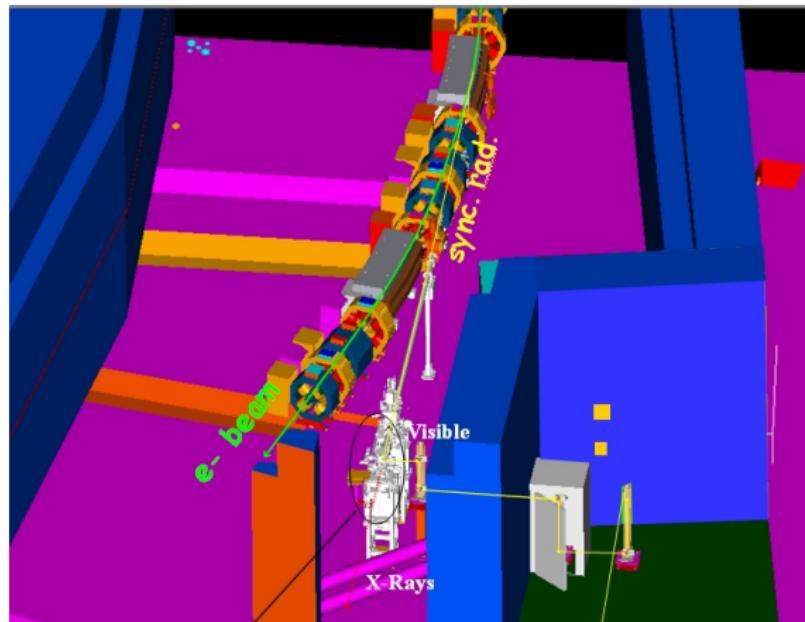
RAW RESULTS FCT-BPM



No quantitative informations about the current per buckets!
⇒ Data analysis is needed.

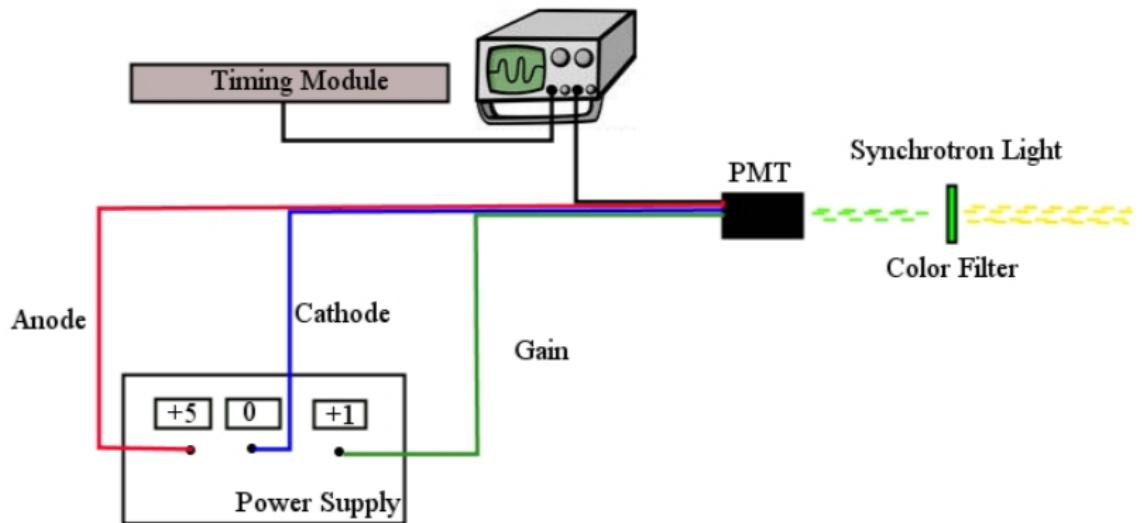
PHOTOMULTIPLIER

Optical Beamlne Xanadu

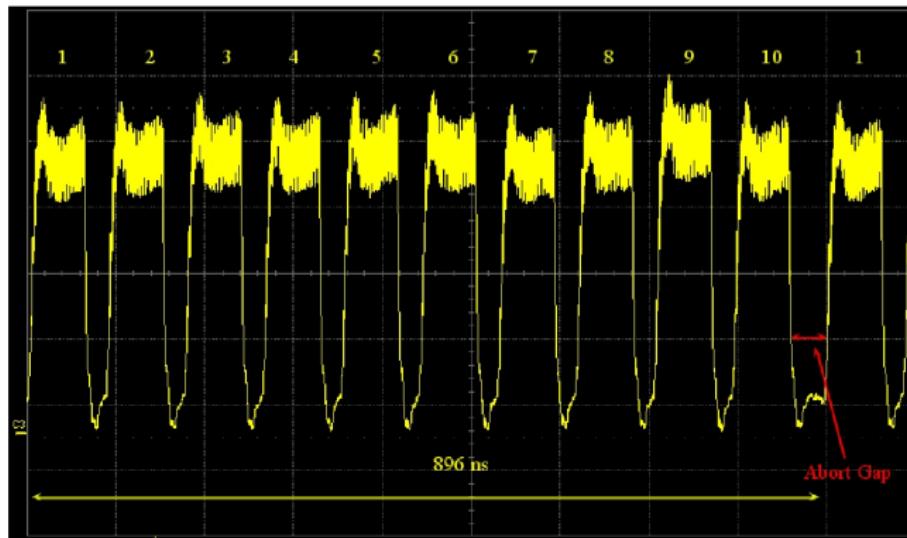


PHOTOMULTIPLIER

Optical Beamline Xanadu

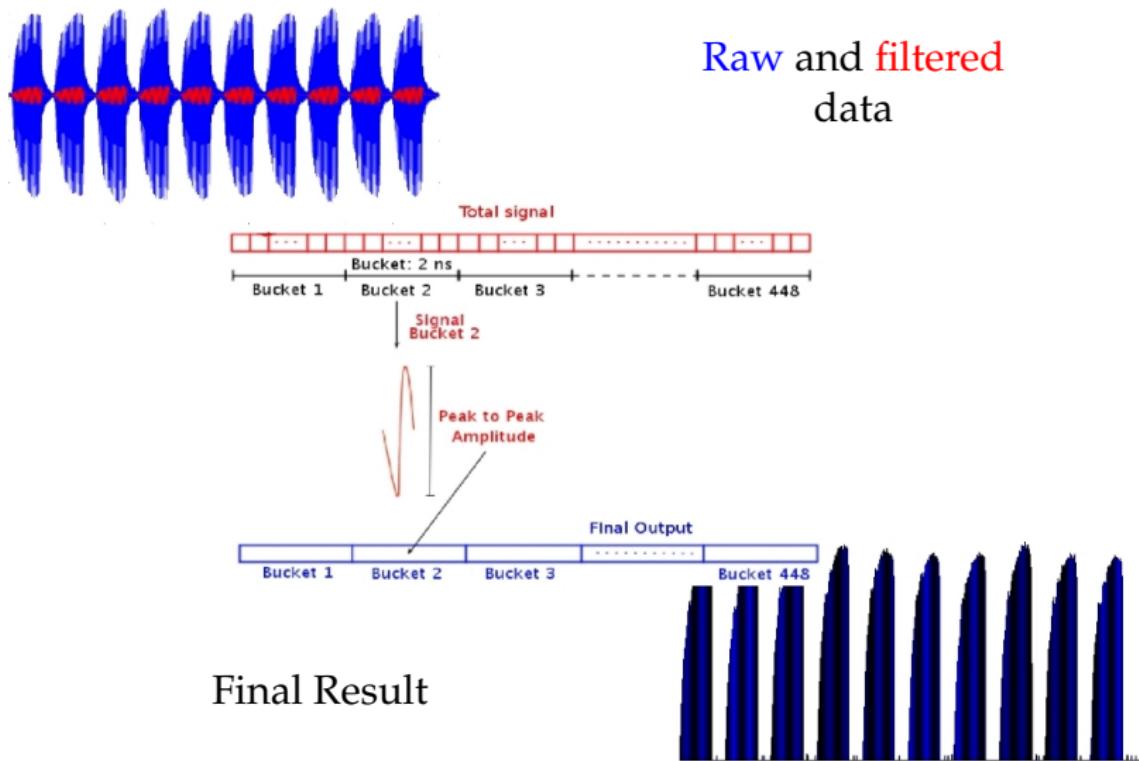


RAW RESULTS PMT

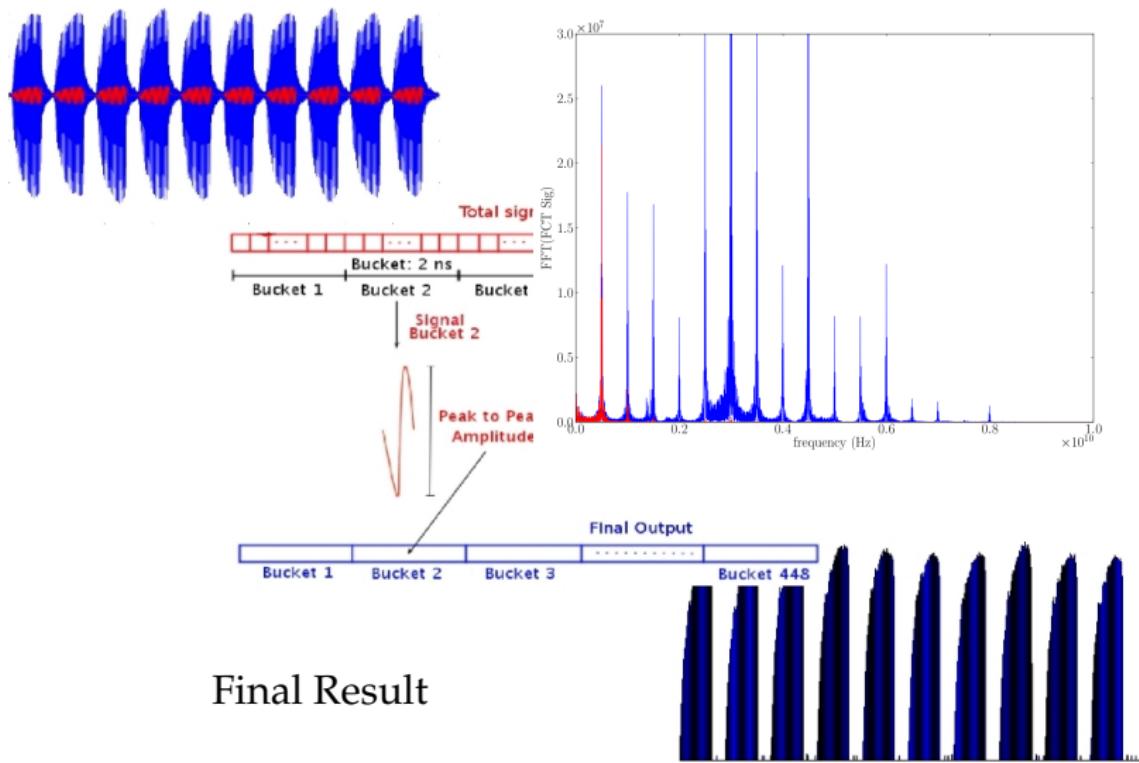


No quantitative informations about the current per buckets!
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DATA ANALYSIS

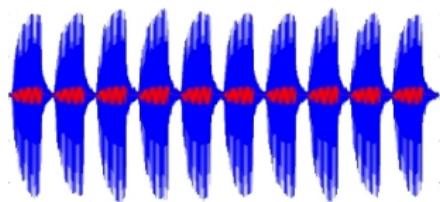


DATA ANALYSIS

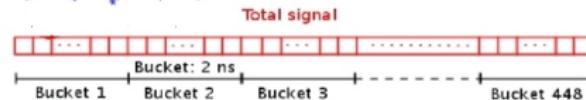


Final Result

DATA ANALYSIS

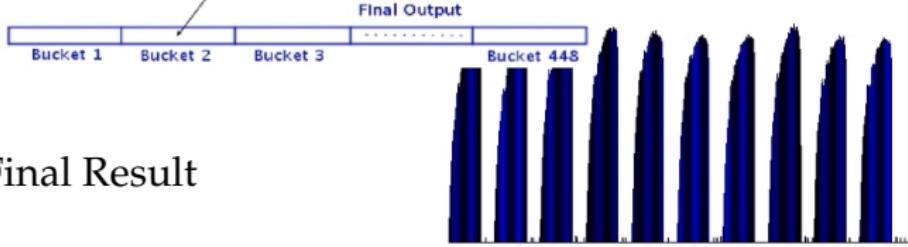


Raw and **filtered**
data



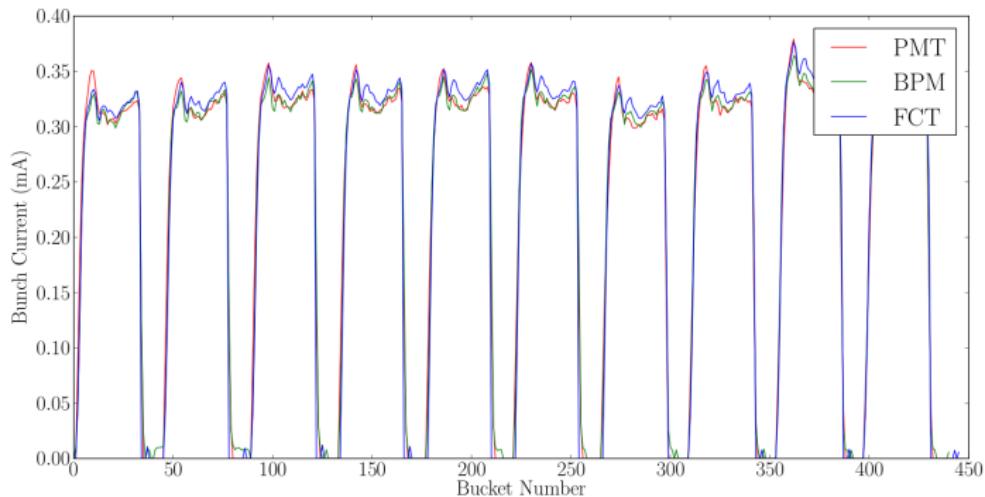
Signal
Bucket 2

Peak to Peak
Amplitude

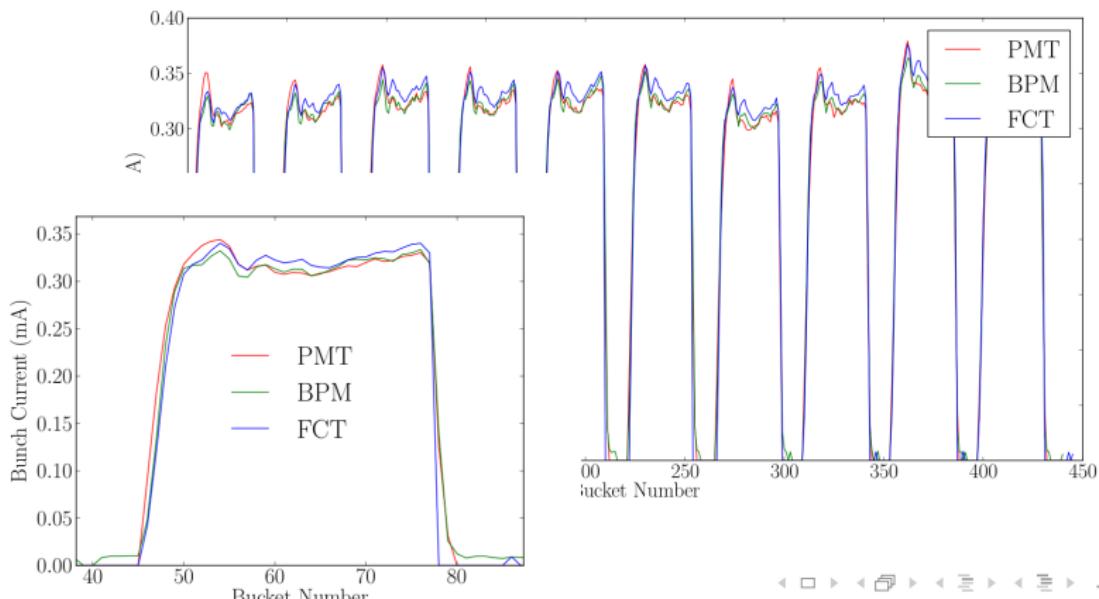


Final Result

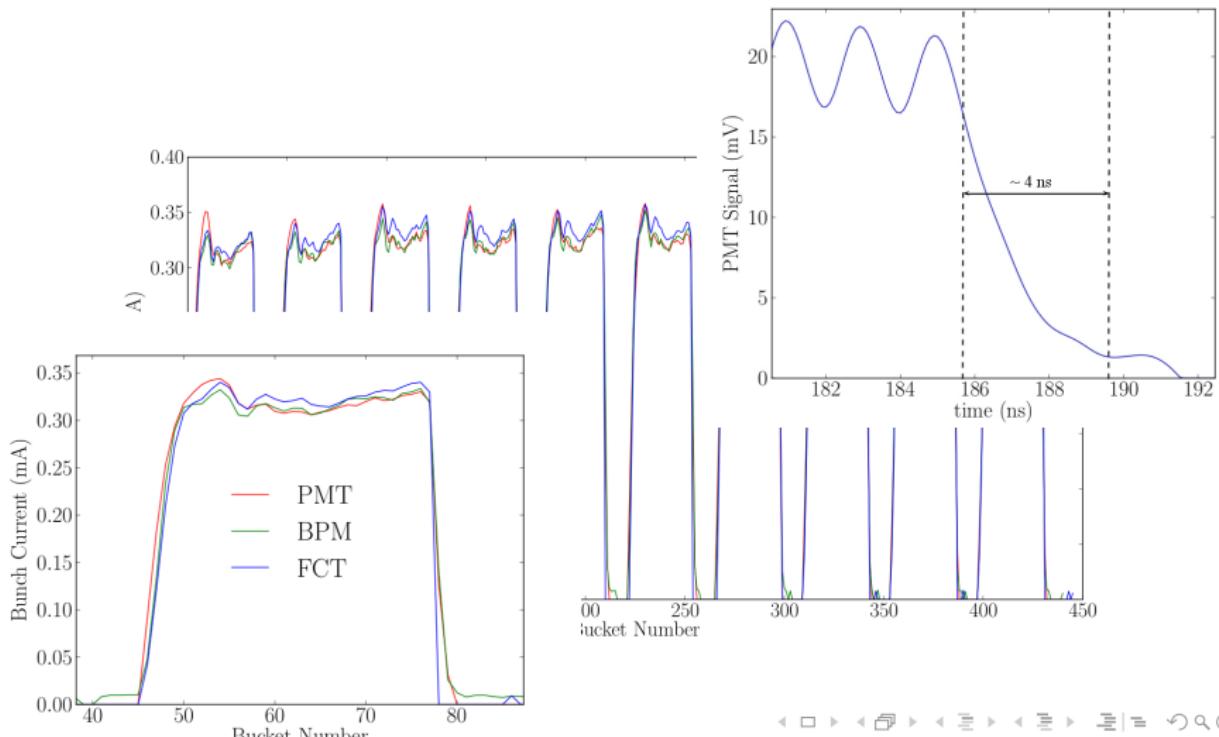
COMPARISONS BETWEEN RESULTS



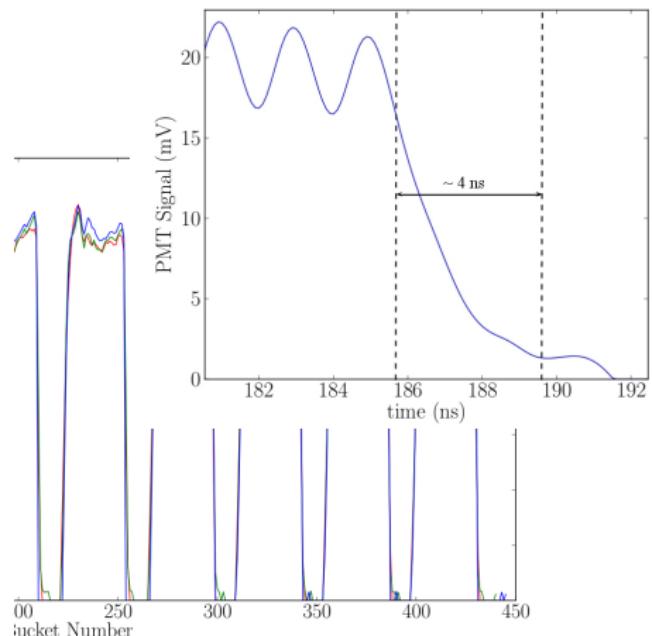
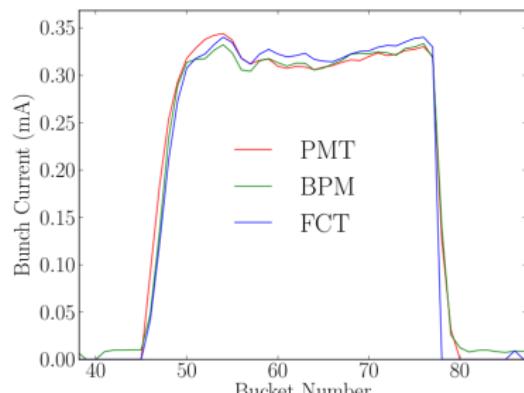
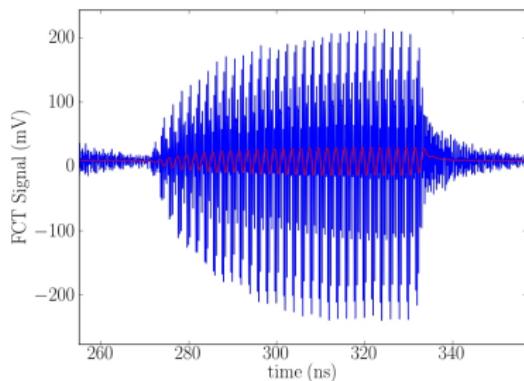
COMPARISONS BETWEEN RESULTS



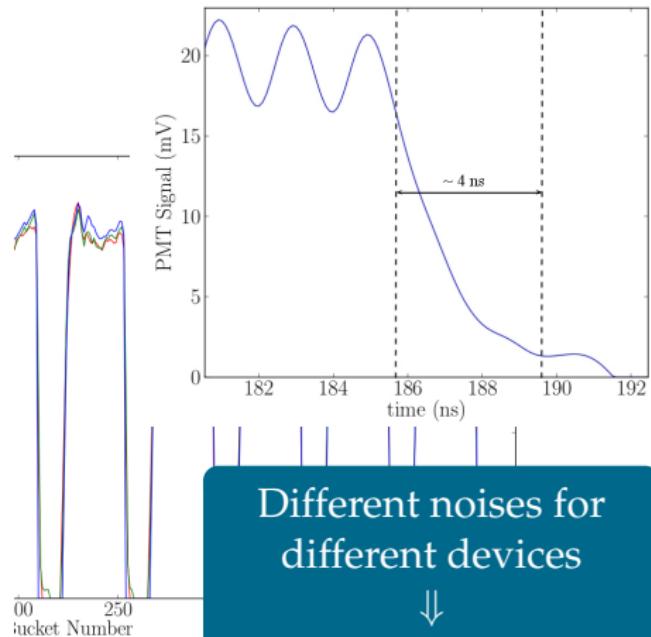
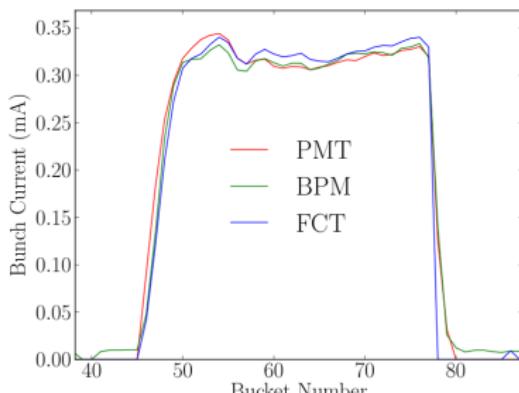
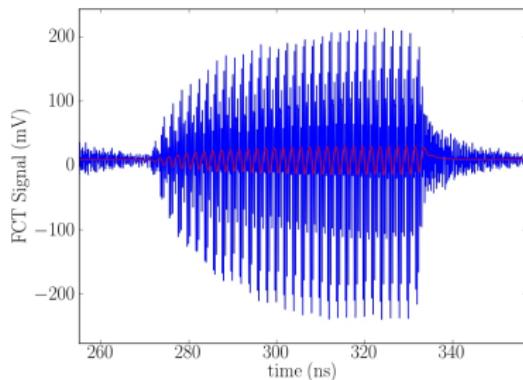
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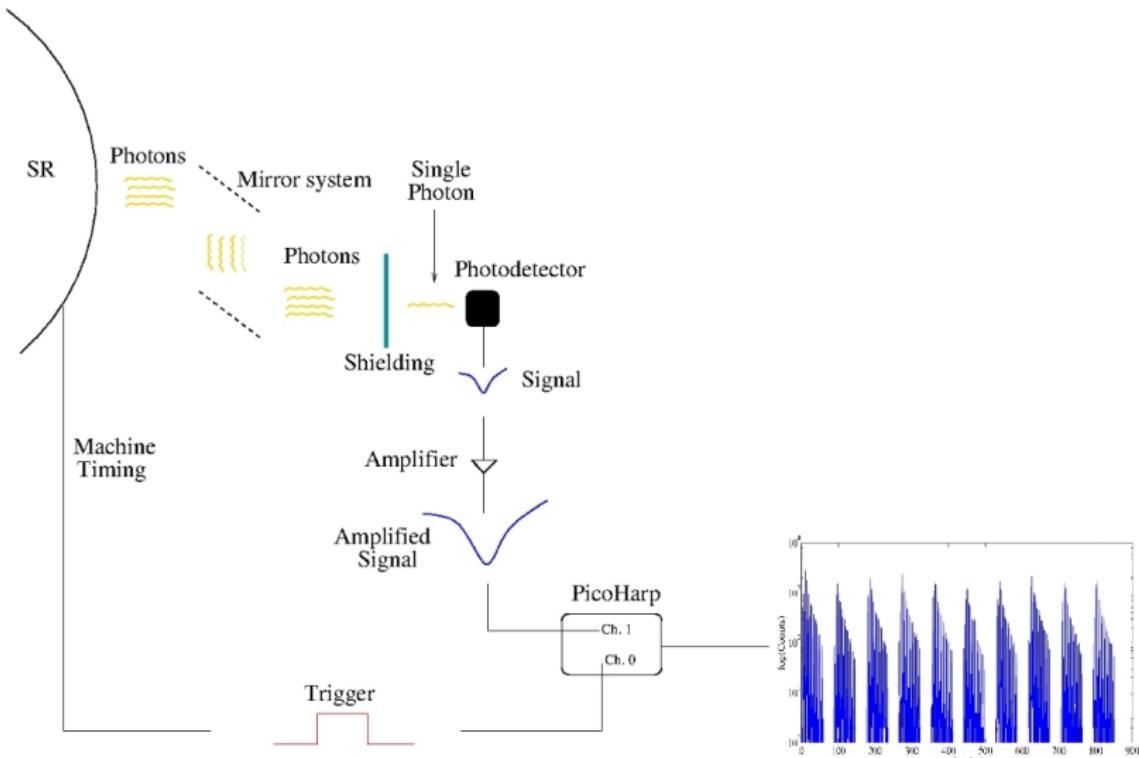


Different noises for
different devices

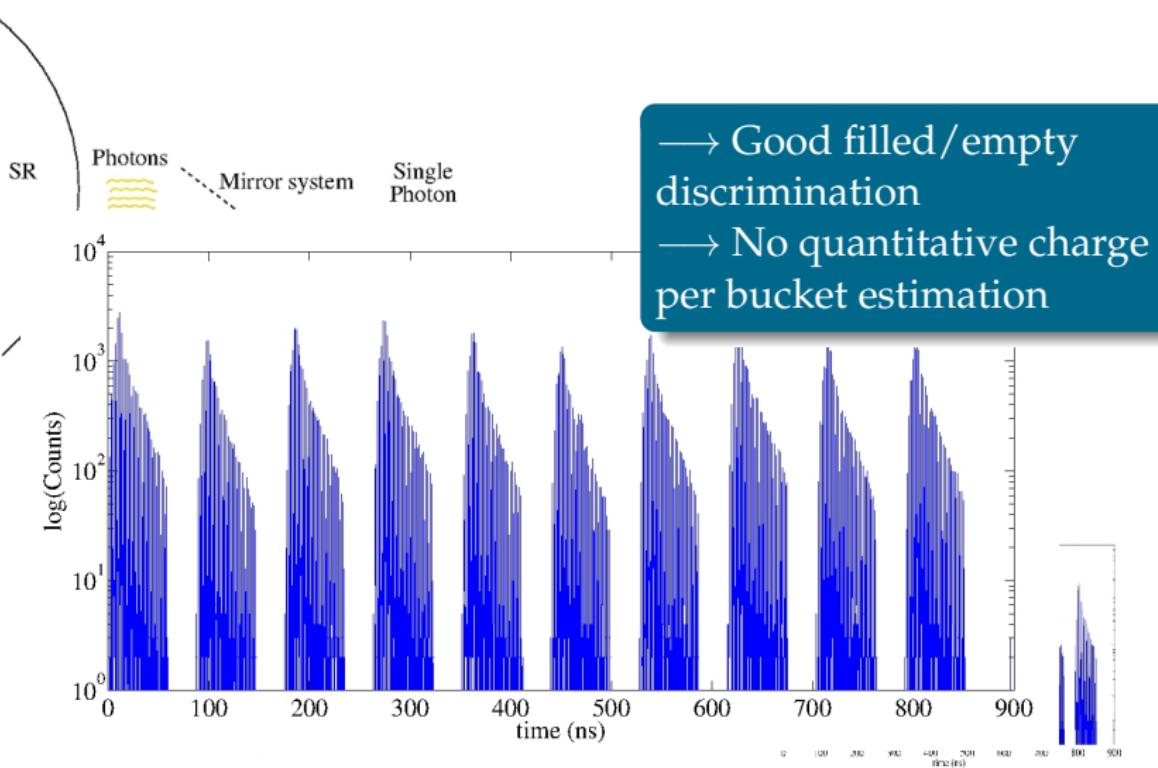


Combination of results
to exclude the noise

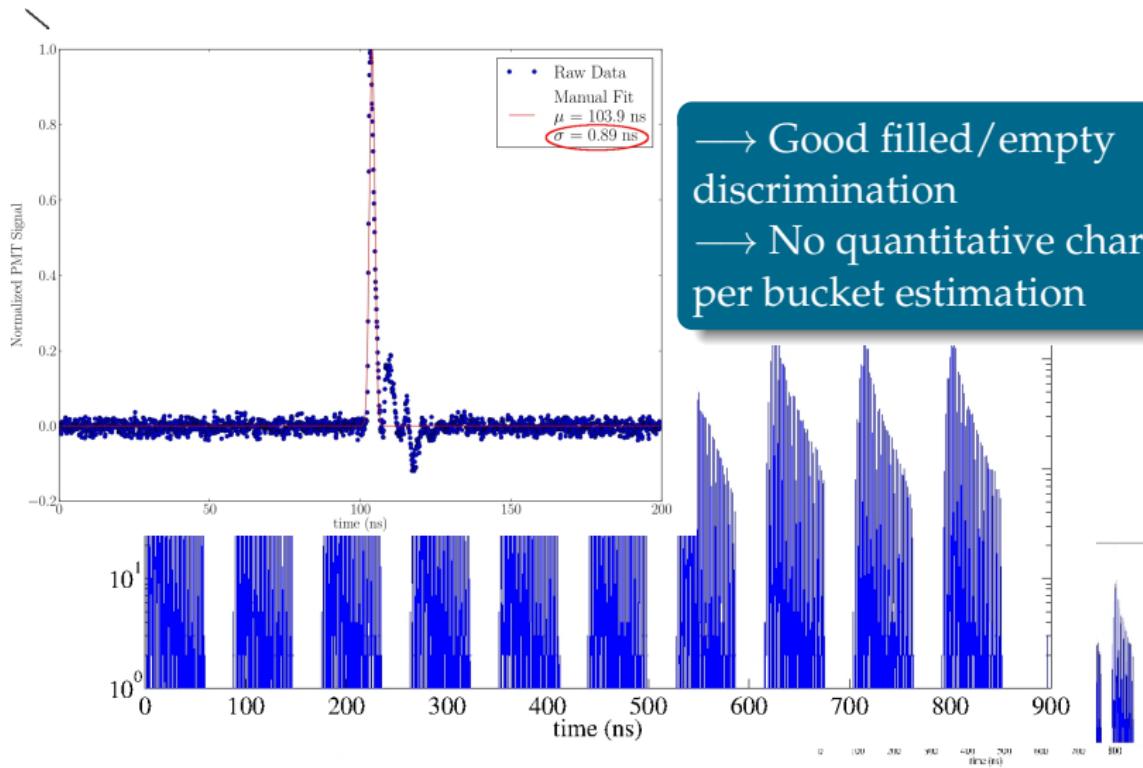
TIME CORRELATED SINGLE PHOTON COUNTING



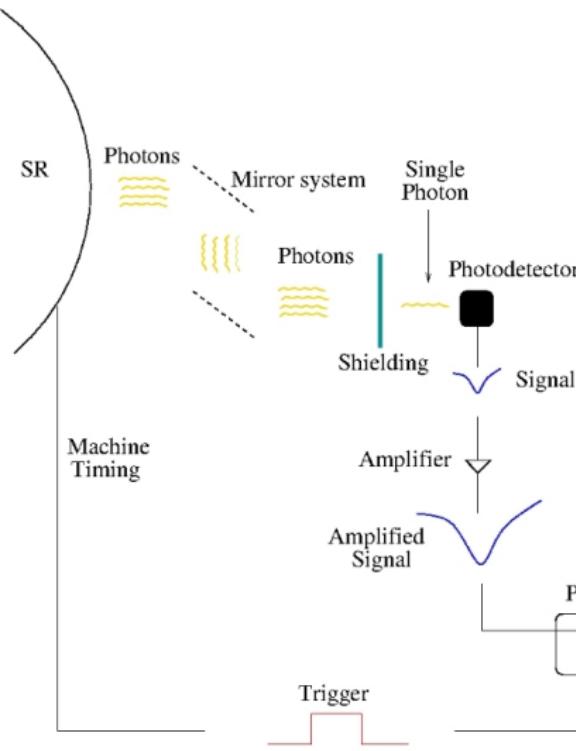
TIME CORRELATED SINGLE PHOTON COUNTING



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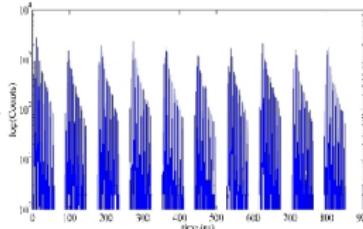


TIME CORRELATED SINGLE PHOTON COUNTING

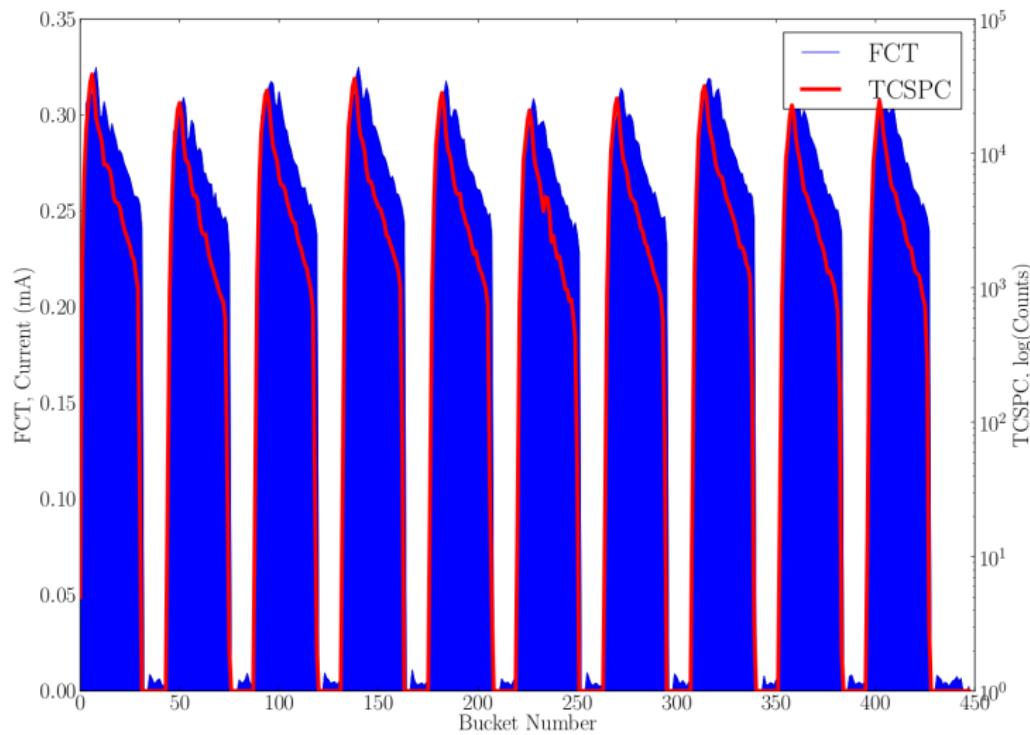


→ Good filled/empty discrimination
 → No quantitative charge per bucket estimation

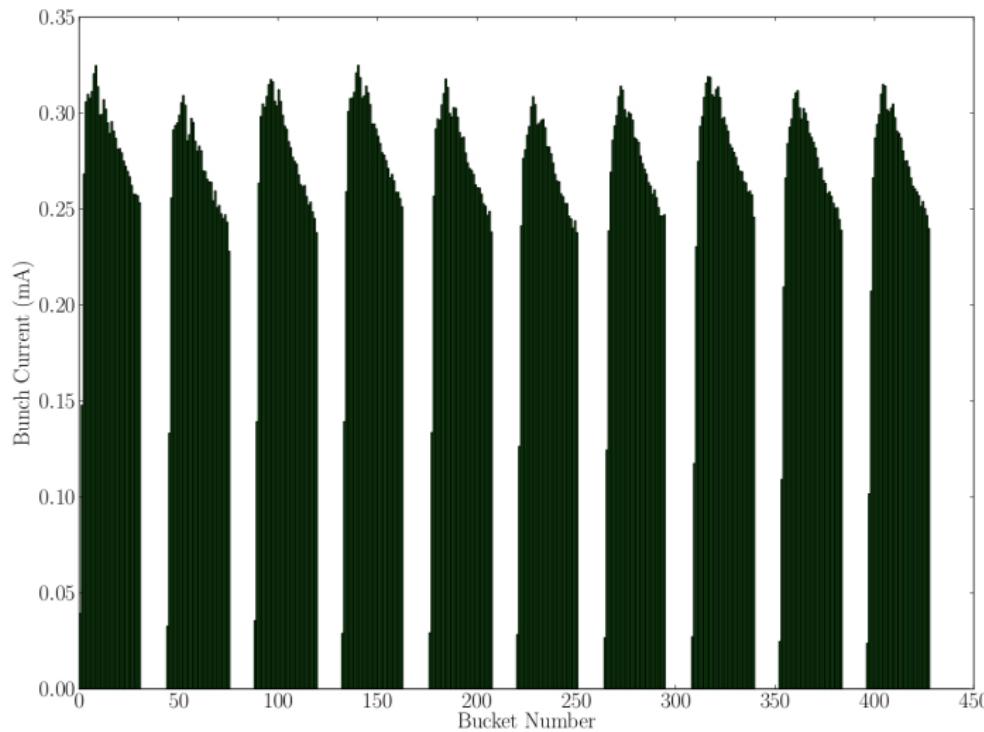
Used as “mask” for FCT data



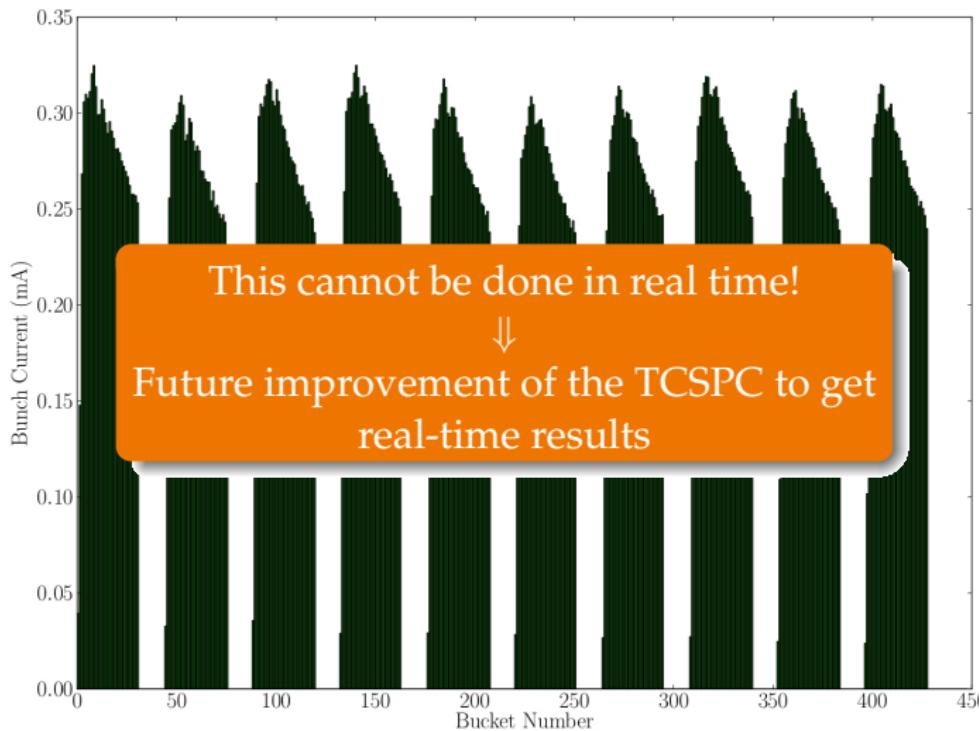
BEST RESULTS



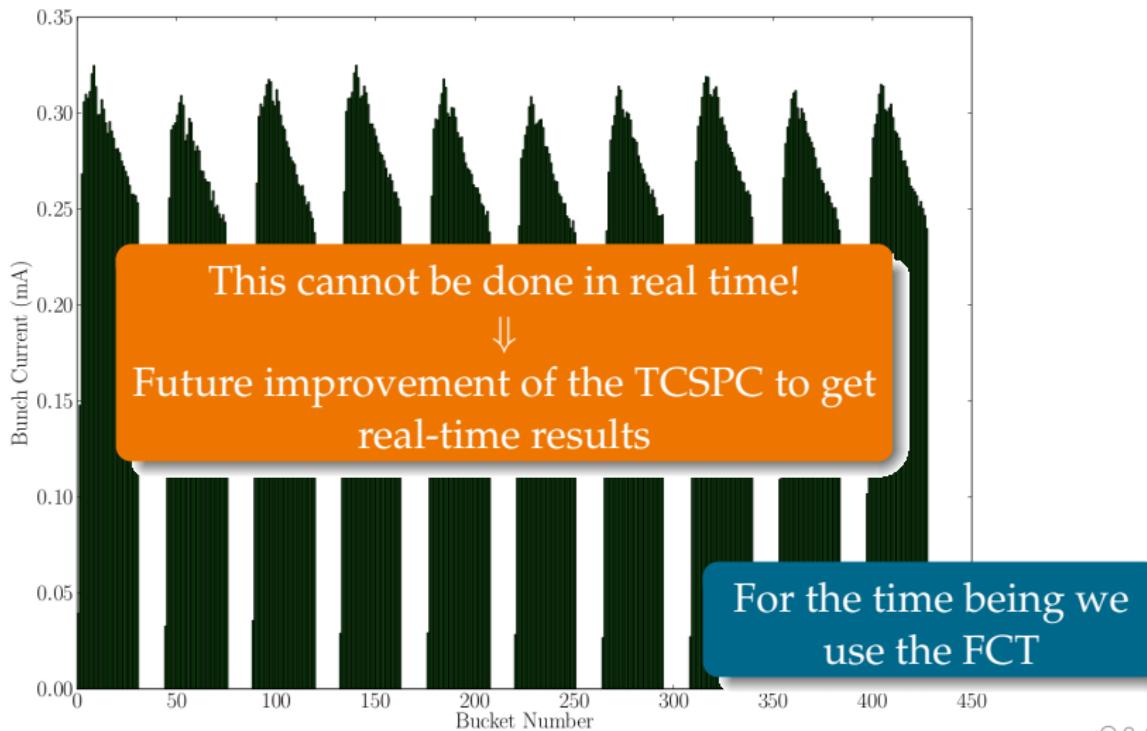
BEST RESULTS



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BEST RESULTS



ALBA

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APPLICATIONS

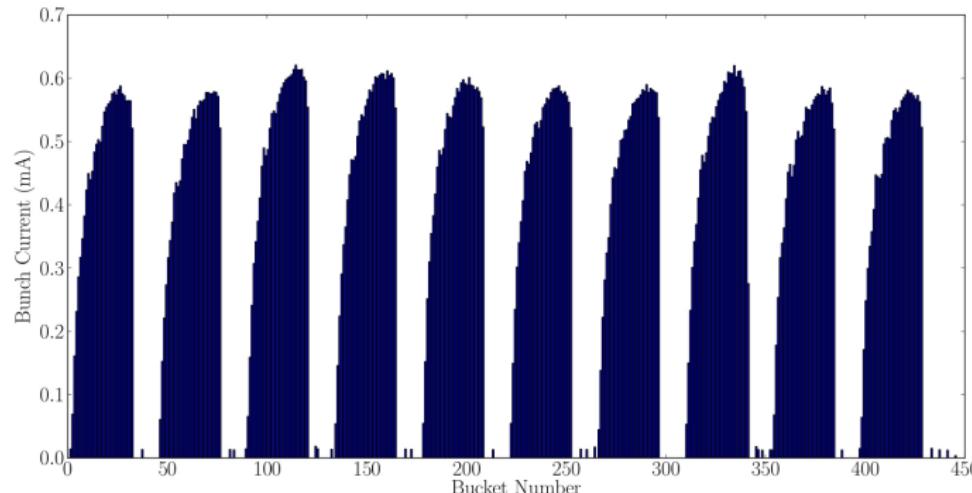
TOP-UP

Decay Mode

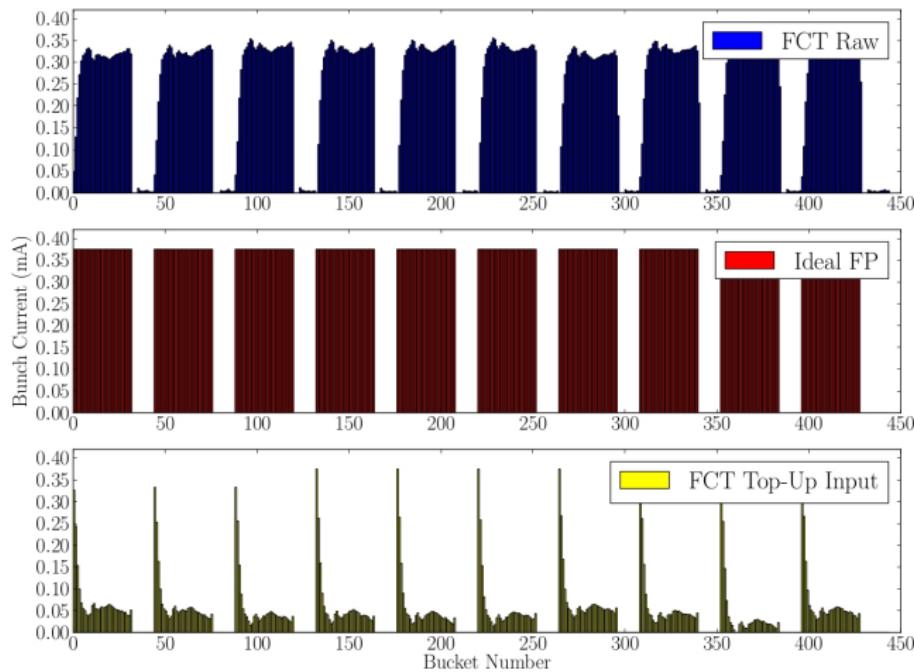


Top-Up Mode

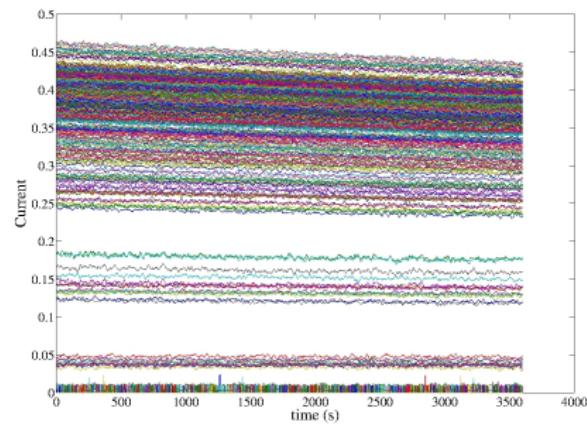
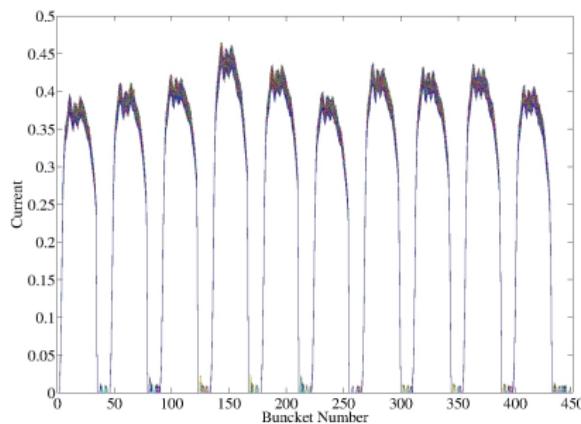
Selective refilling of the emptiest buckets to obtain a uniform filling pattern and a constant current.



TOP-UP



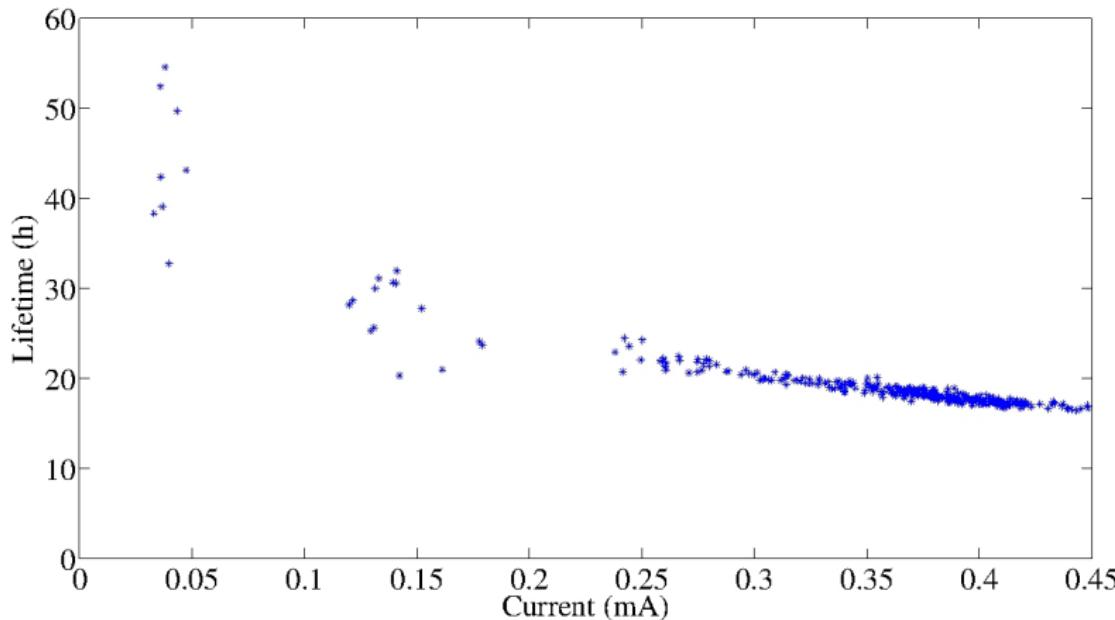
BUNCH BY BUNCH LIFETIME



We are able to estimate the lifetime of each single bunch and relate it with the total beam lifetime.

BUCH BY BUNCH LIFETIME

Emptiest bunches has the longer lifetime.



SUMMARY AND OUTLOOK

- ▶ Filling pattern measurements were performed with different devices and techniques;
- ▶ An on-line data analysis was developed for analog devices;
- ▶ Precise results were found combining FCT and TCSPC data;

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- ▶ Filling pattern measurements were performed with different devices and techniques;
- ▶ An on-line data analysis was developed for analog devices;
- ▶ Precise results were found combining FCT and TCSPC data;
- ▶ **Improvements of the TCSPC using a faster PMT are foreseen.**

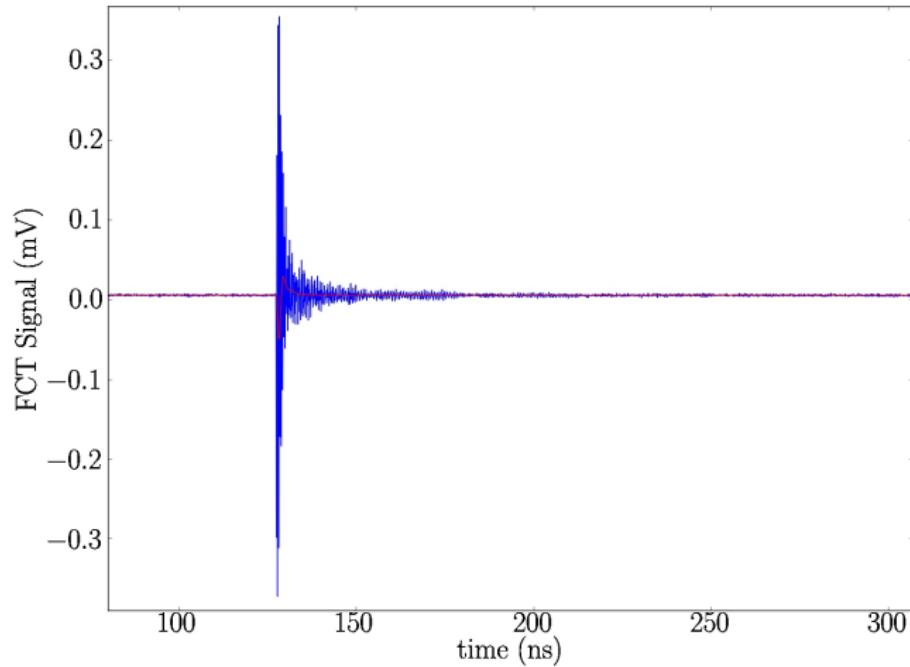


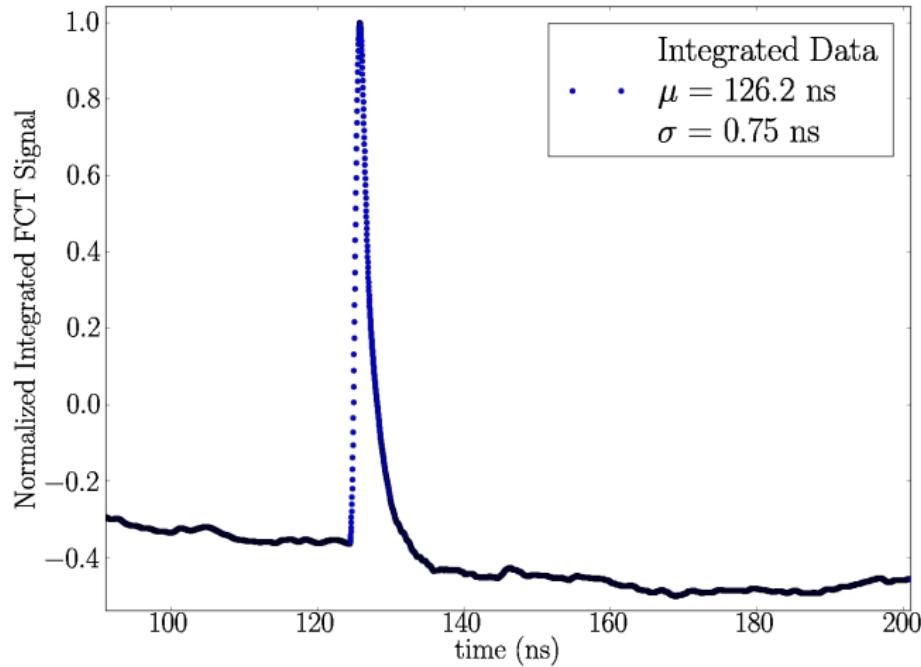
Acknowledgment

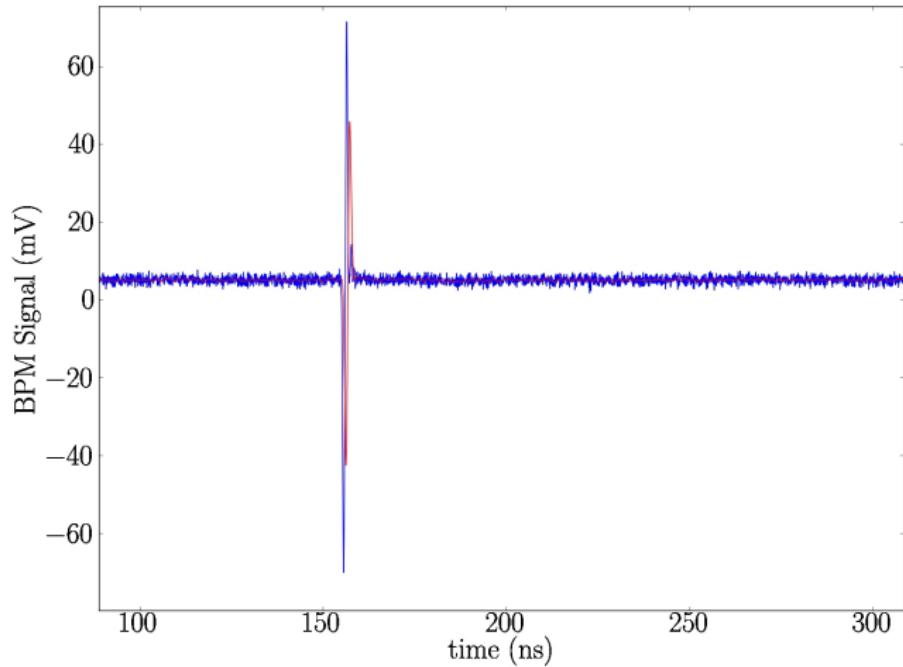
I must thanks U. Iriso, S. Blanch, S. Rubio and O. Matilla (CELLS) for their valuable help and F. Cervelli (Università di Pisa) for his support.

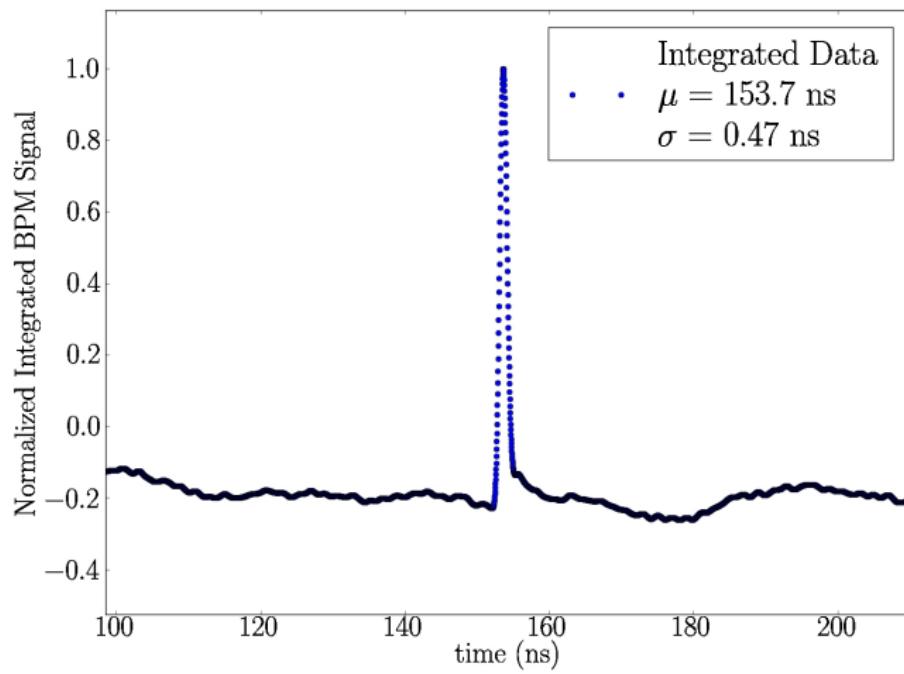
*This project is funded by the European Union under contract
PITN-GA-2011-289485*

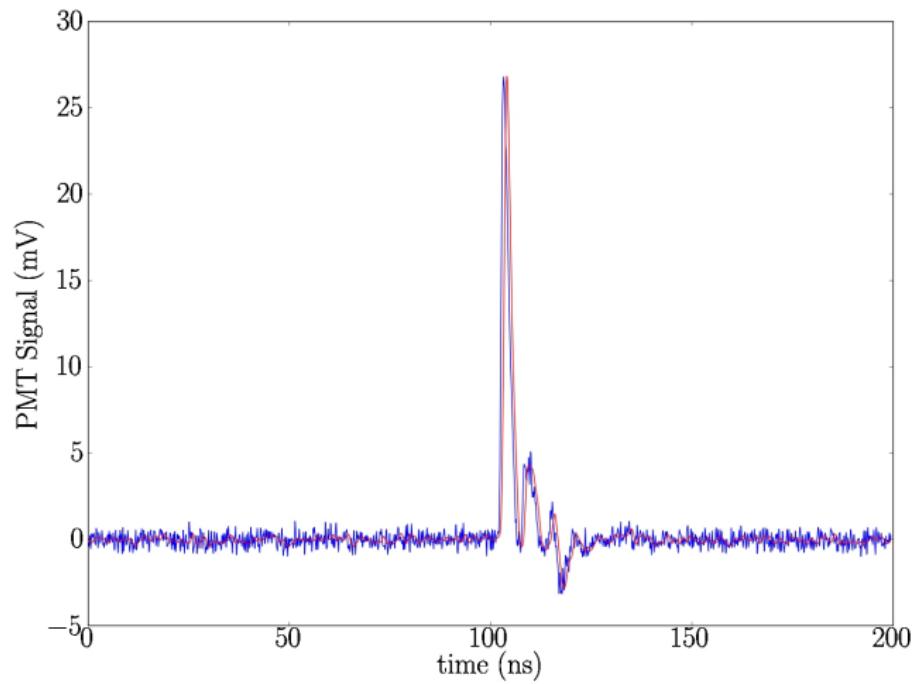
BACKUP SLIDES

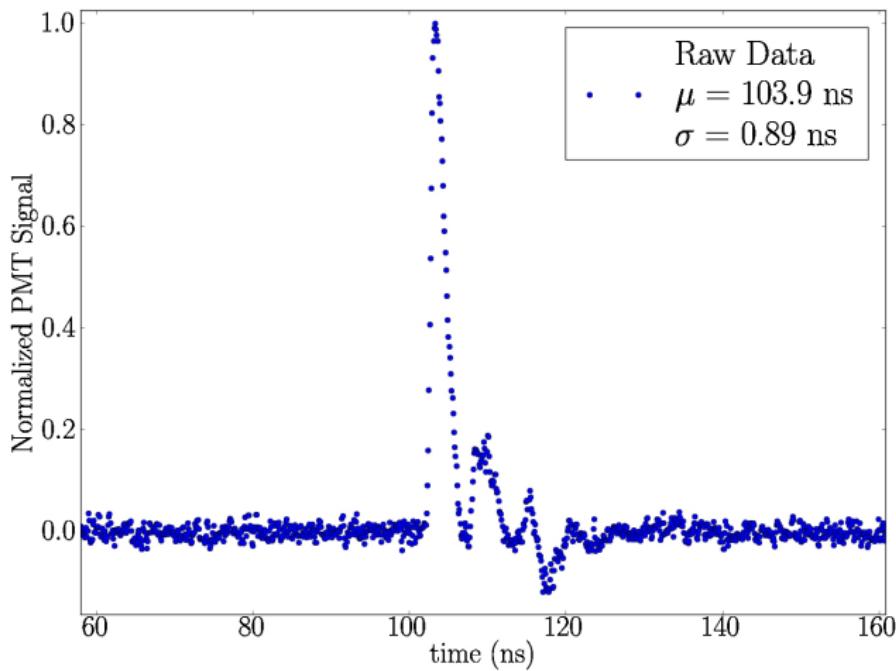












PMT Hamamatsu H10721-210

Photocathode Material	Ultra Bialkali
Spectral Response	230-700 nm
Input Voltage	4.5-5.5 V
Max. Input Current	2.7 mA
Max Output Signal Current	100 μ A
Control Voltage Range	0.5 – 1.1 V
Cathode Radiant Sensitivity (400 nm)	130 $\frac{\text{mA}}{\text{W}}$
Anode Radiant Sensitivity (400 nm)	$2.6 \times 10^5 \frac{\text{A}}{\text{W}}$
Gain (Control Voltage: 1 V)	10^6
Dark Current	10 nA
Rise Time	0.57 ns
Ripple Noise (peak to peak)	0.3 mV
