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Updates on Beam Loss Monitoring System

Aleš Vigali, May 15th 2023

WWW.I-TECH.SI

Outline

- Beam Loss Monitoring System overview
- New functionalities
- Examples from machines



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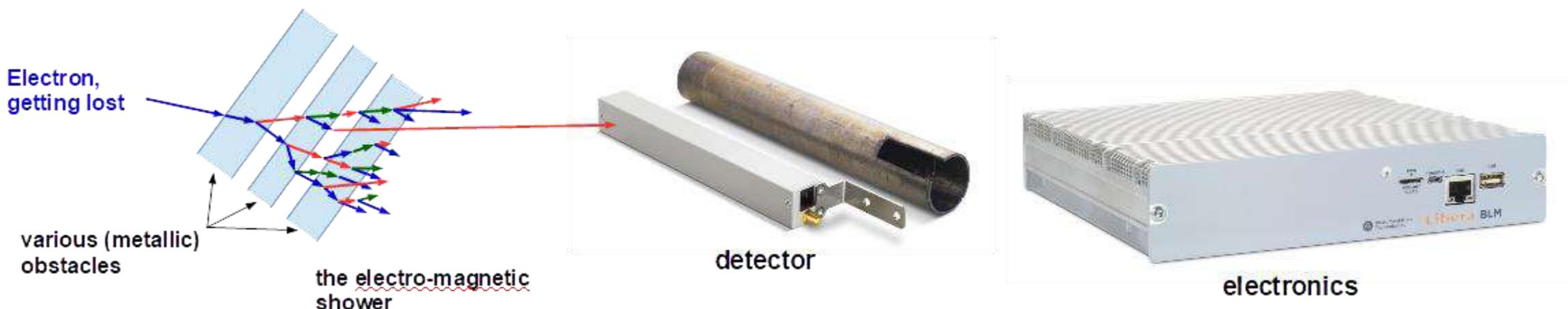
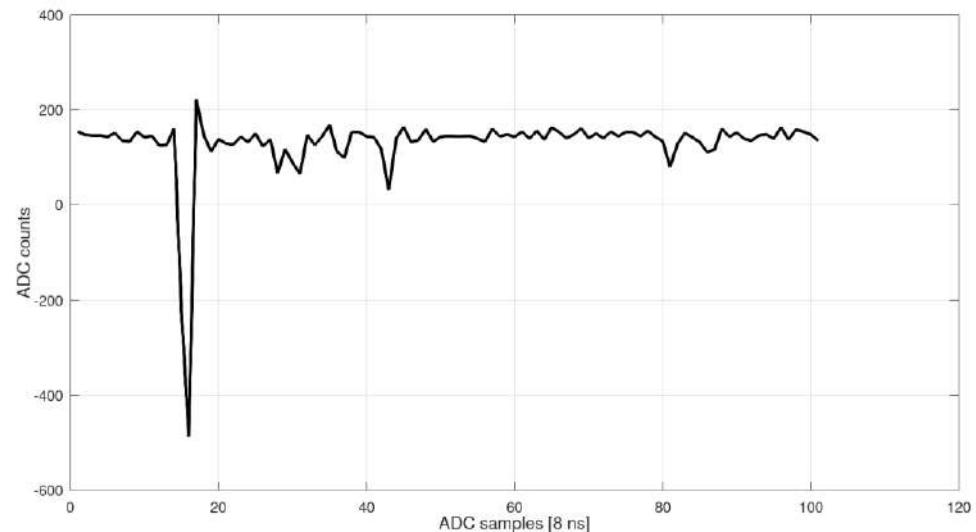
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Beam Loss Monitoring

Particle is considered lost if it doesn't follow design trajectory and interacts with matter.

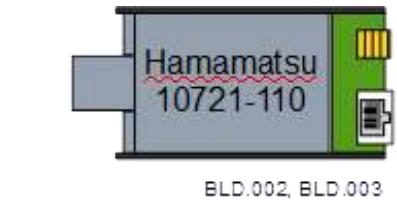
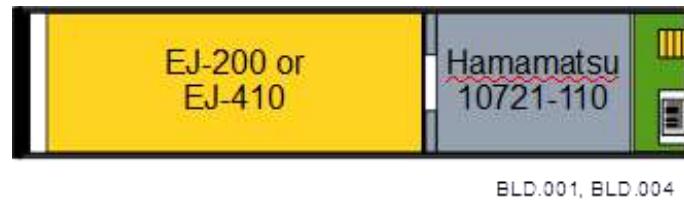


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Libera BLD



Specification			
Product code	BLD.001	BLD.002 BLD.003	BLD.004
Scintillator material	EJ-200	Optical fiber	EJ-410
Sensitivity to particles	gamma, X-ray		neutron
Peak wavelength of the scintillator	425 nm		450 nm
Photo multiplier tube (PMT)	Hamamatsu 10721-110		
Peak wavelength of the PMT	400 nm		
Rise time of the PMT	0.57 ns		
Supply voltage	5 V		
Gain control voltage	0 to 1 V		

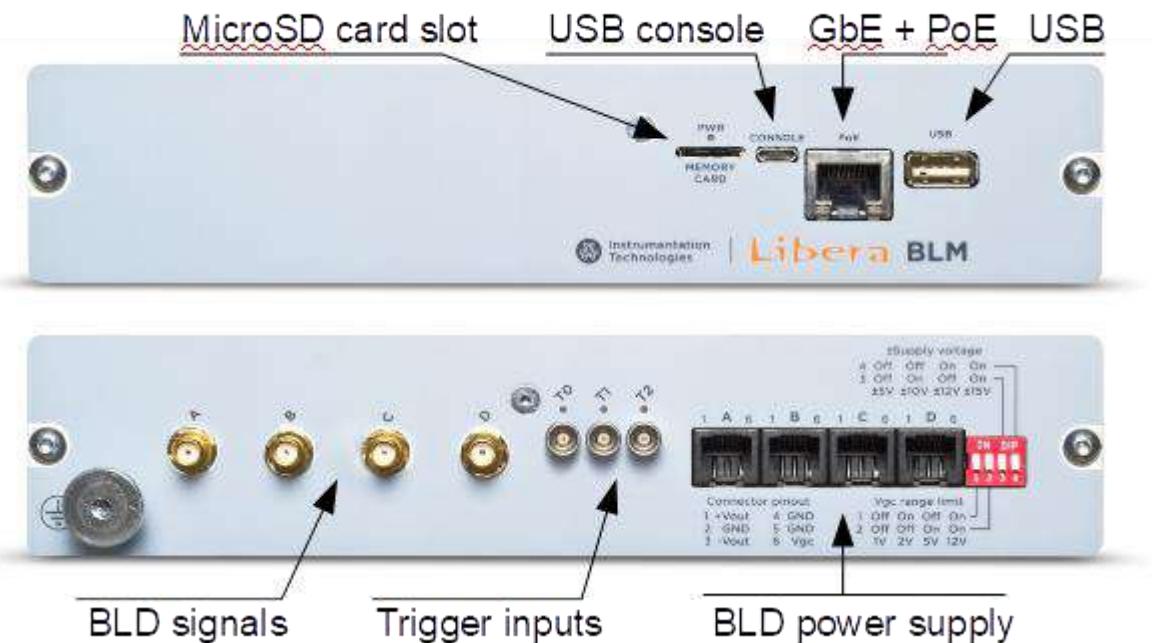


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Libera BLM



Specification	
FPGA / CPU	Zynq-7020 / ARM
Input channels	4
A/D conversion	125 MHz / 14 bit
Timing signals	3
Input amplitude range	$\pm 150 \text{ mV}$ to $\pm 5 \text{ V}$ @ 50Ω $\pm 30 \text{ mV}$ to $\pm 1 \text{ V}$ @ $1 \text{ M}\Omega$
Input frequency range	DC to 50 MHz @ 50Ω DC to 1 MHz @ $1 \text{ M}\Omega$
Photo-multiplier control	Power supply: up to $\pm 15 \text{ V}$ Gain control: 0 to 15 V

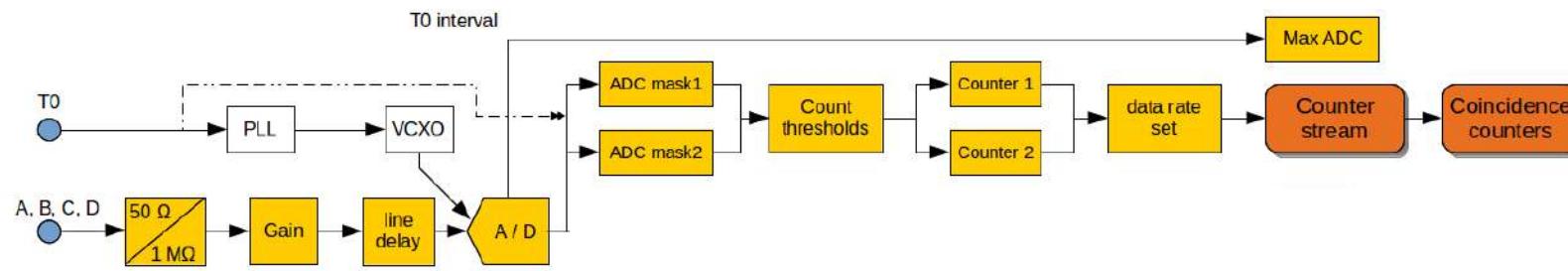


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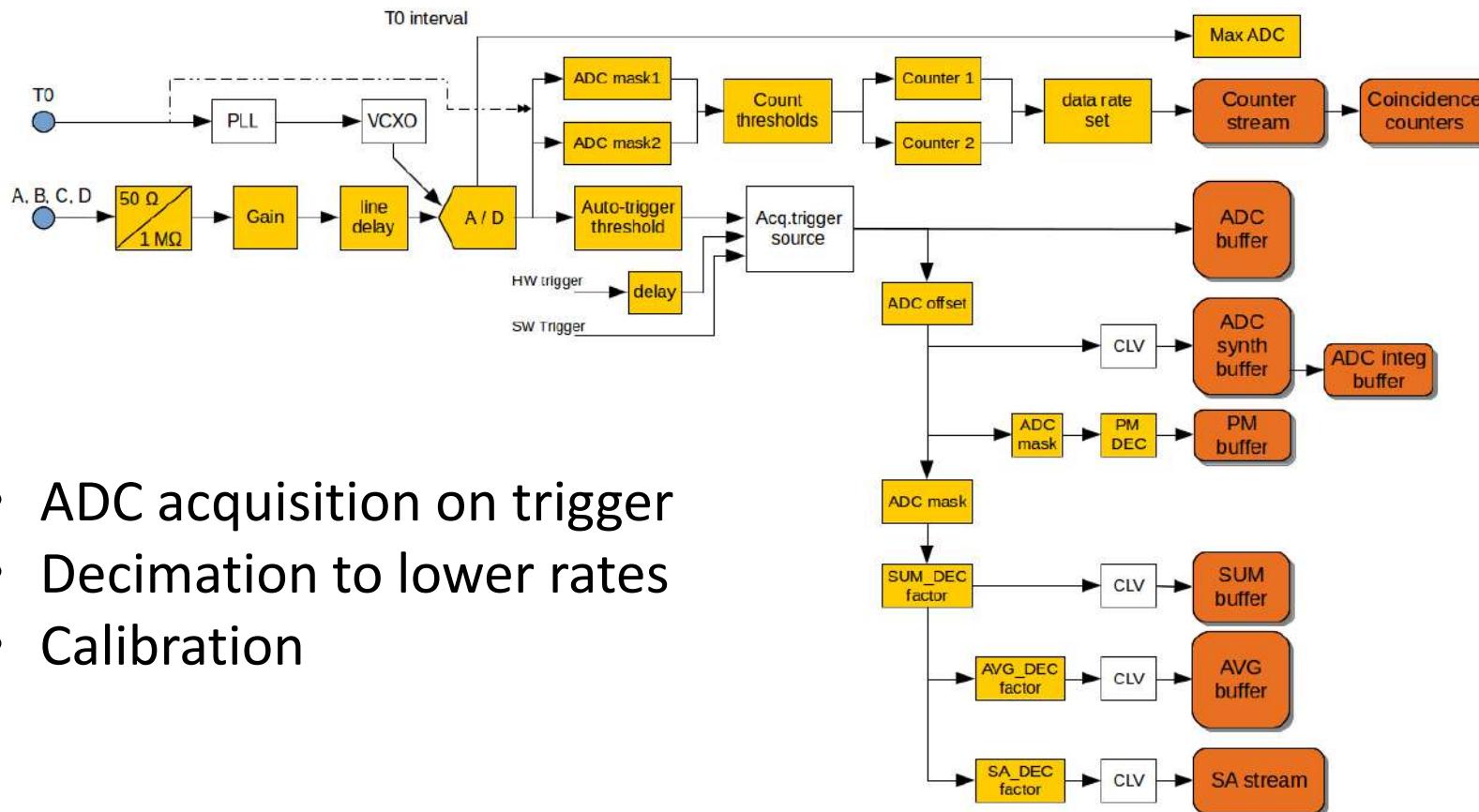
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Signal Processing Scheme



- Continuous monitoring of ADC data
- Comparing to thresholds
- Counting losses
- Coincidence counter
- ADC masks

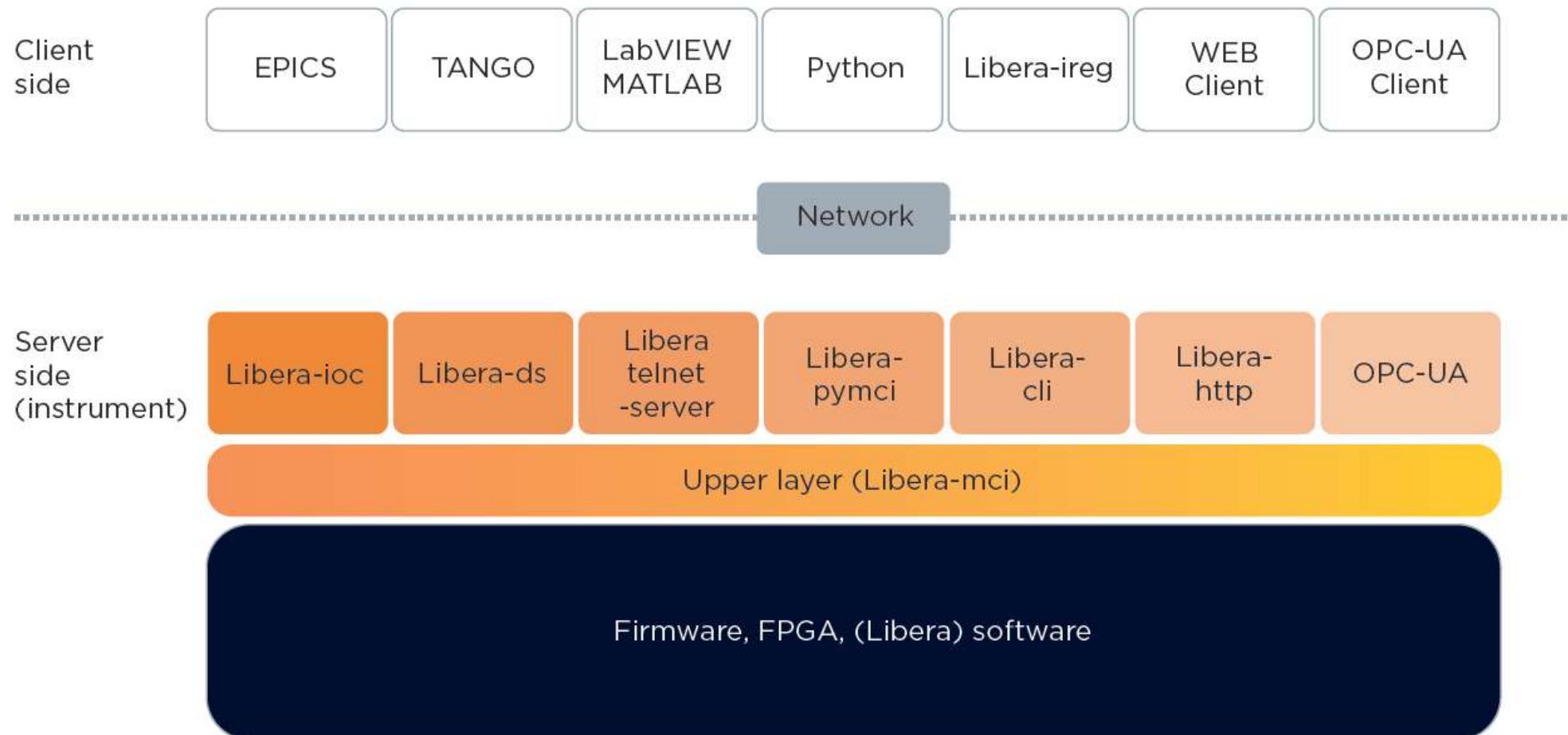
Signal Processing Scheme



- ADC acquisition on trigger
- Decimation to lower rates
- Calibration



Control System Interface



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Interlock

- Continuous monitoring of the raw ADC samples (8 ns period)
- Two modes of operation – Integration or Counting
- The Interlock is reported when threshold is reached
- The hardware signal (LVTTL) is output on a LEMO connector



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Interlock – ADC integration mode

General settings

	ENABLE	STATUS	CURRENT VALUE
A	<input type="checkbox"/> Disabled		0
B	<input type="checkbox"/> Disabled		0
C	<input type="checkbox"/> Disabled		0
D	<input type="checkbox"/> Disabled		0

Calibration is DISABLED

Clear latched

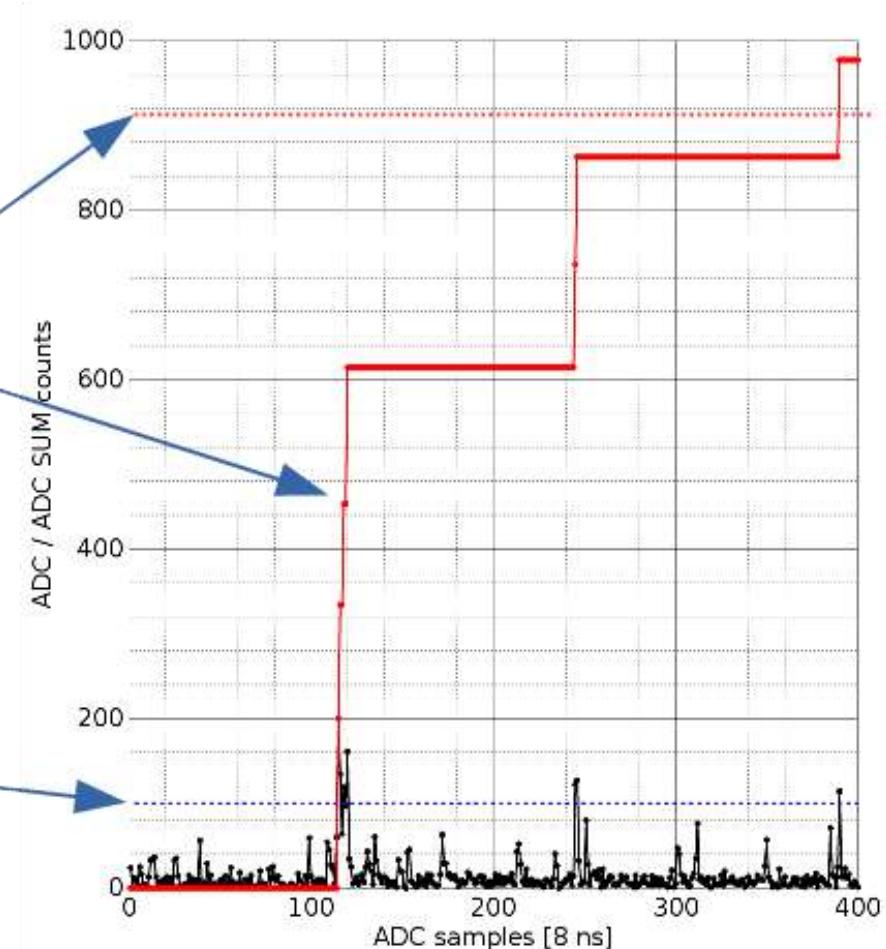
Big circle shows a latched interlock status
Small circle shows a current interlock status

ADC offset for Interlock

A	0	0 ADC cnt
B	0	0 ADC cnt
C	0	0 ADC cnt
D	0	0 ADC cnt

Interlock threshold settings

	UNDERFLOW	ILK LIMIT	ILK FILTER			
A	150	150 ADC cnt	1000000	1000000	1	1
B	150	150 ADC cnt	1000000	1000000	1	1
C	150	150 ADC cnt	1000000	1000000	1	1
D	150	150 ADC cnt	1000000	1000000	1	1

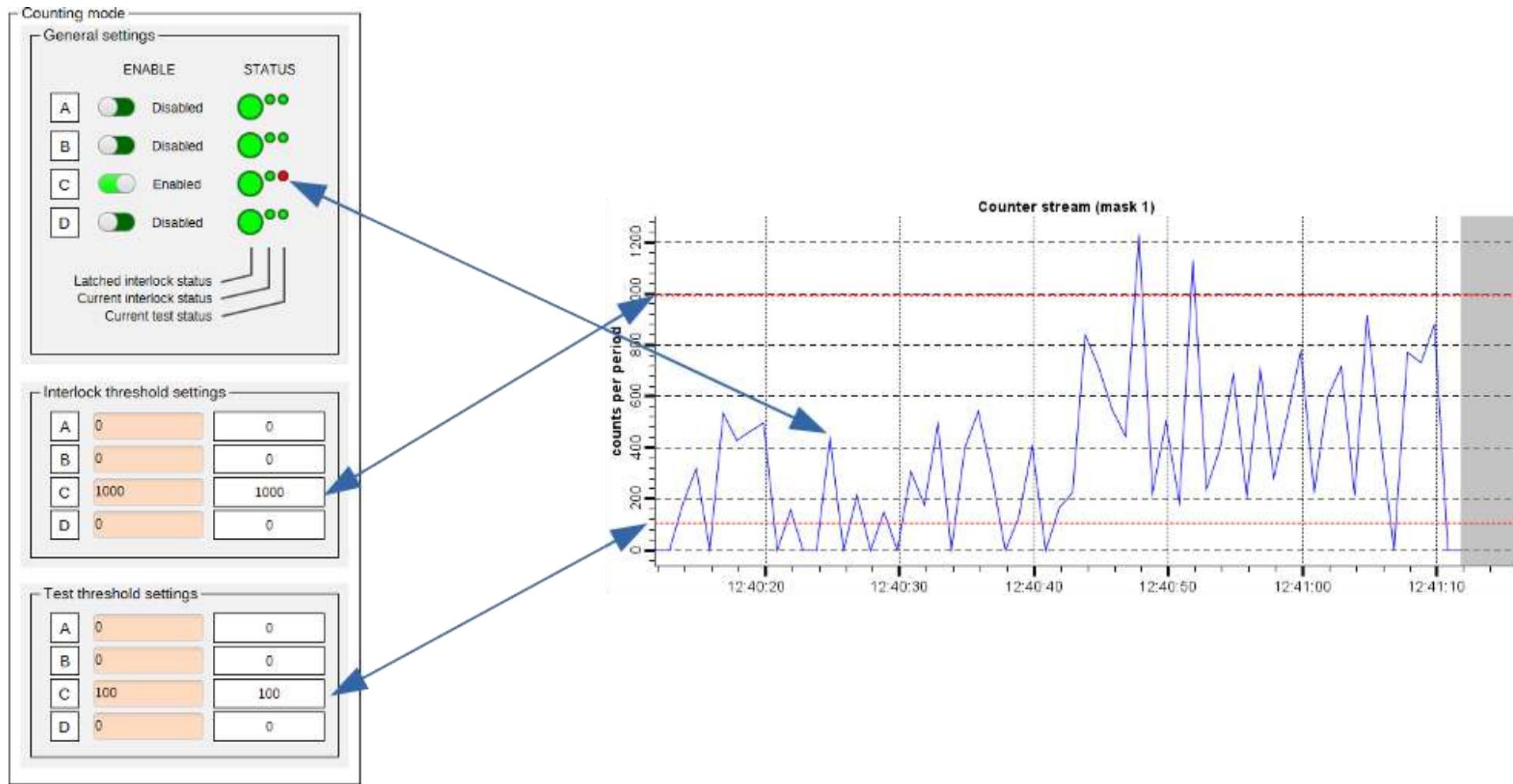


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Interlock – counting mode



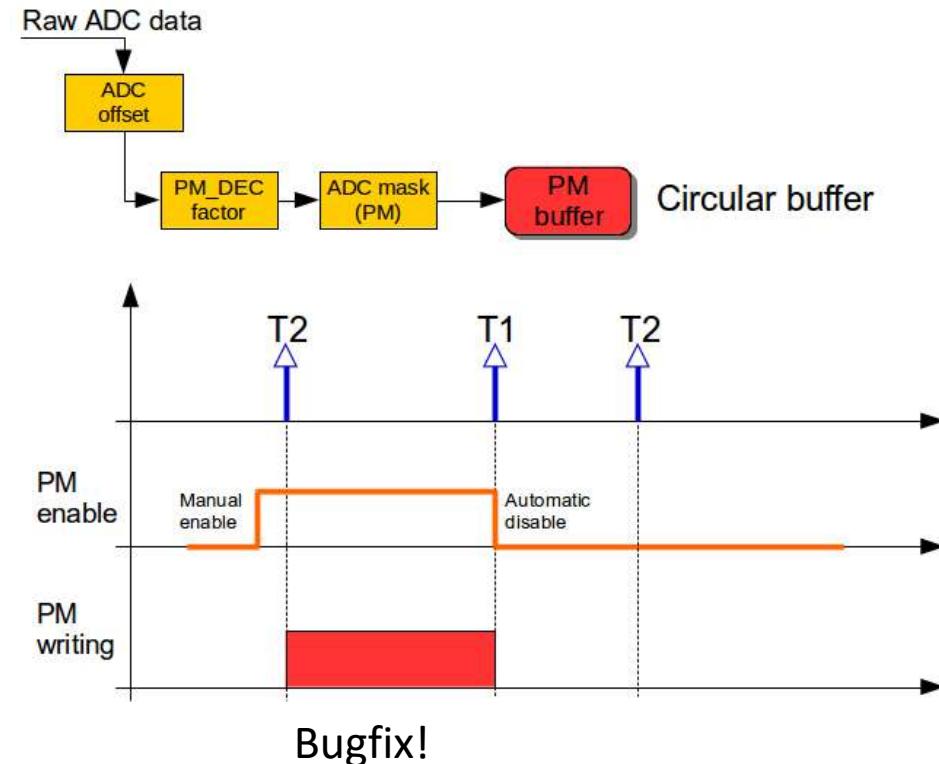
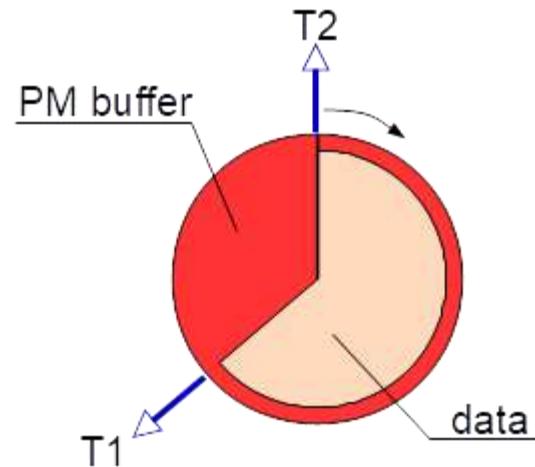
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Postmortem

- Historical data (before T1 event/interlock) is available to be read
- Dedicated connector (T1) receives a Postmortem event or interlock
- Buffer stops writing



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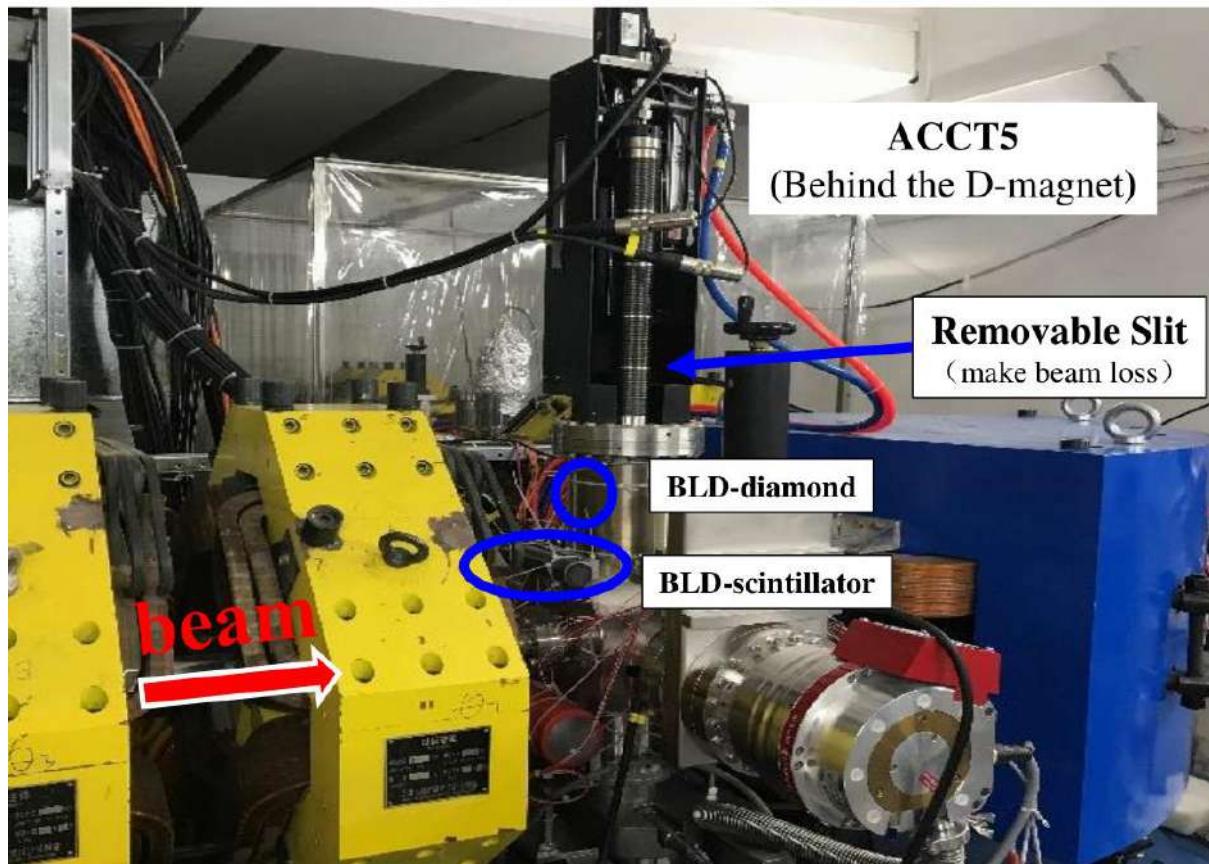


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Examples (proton) C-ADS injector

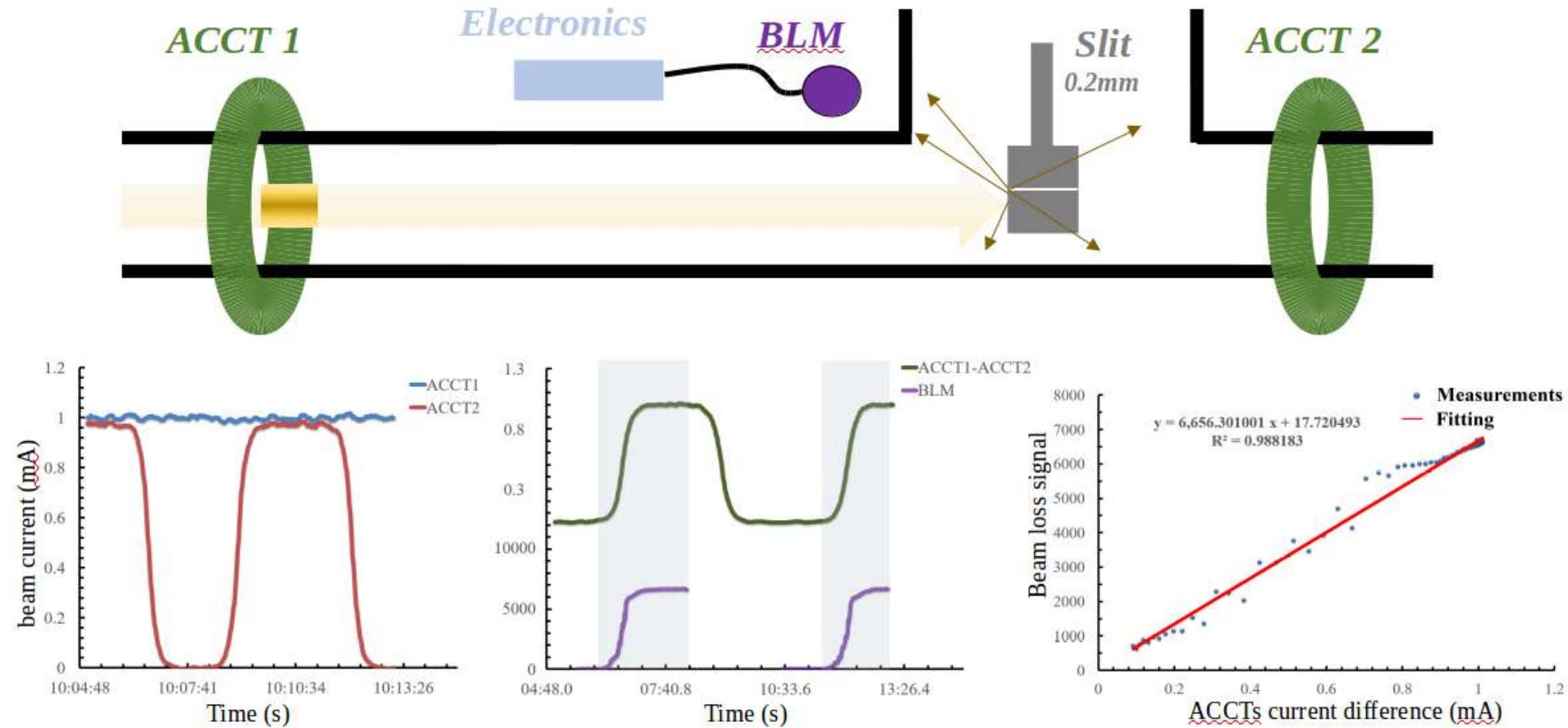


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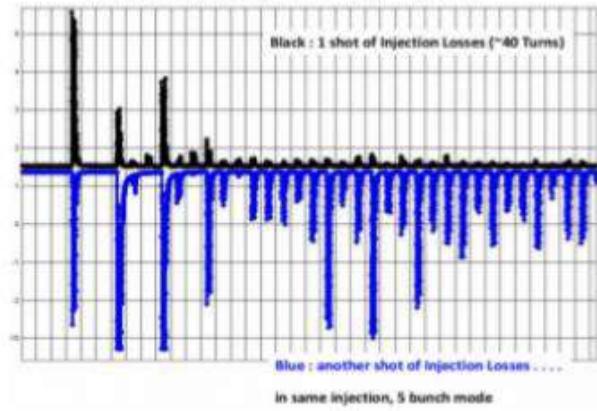
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Examples (proton) C-ADS injector

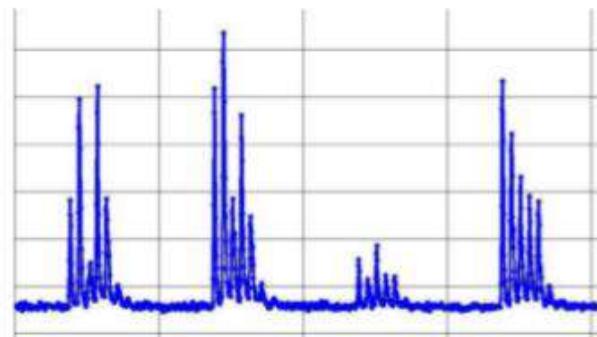


Examples (light source)

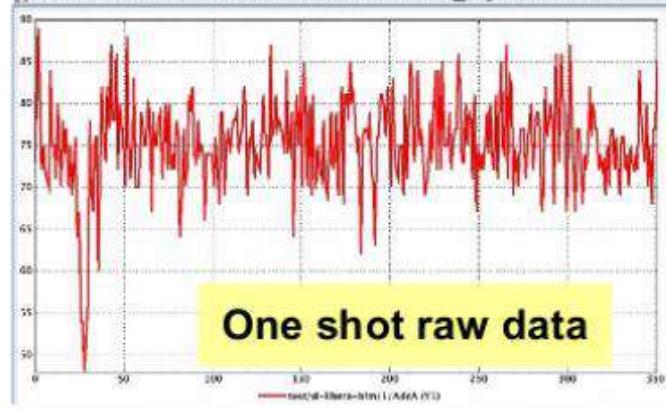
Losses turn-by-turn



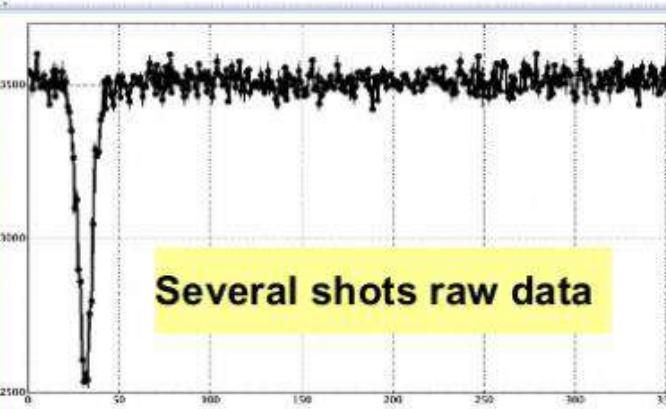
Losses bunch-by-bunch



Reconstruct the filling pattern



One shot raw data



Several shots raw data

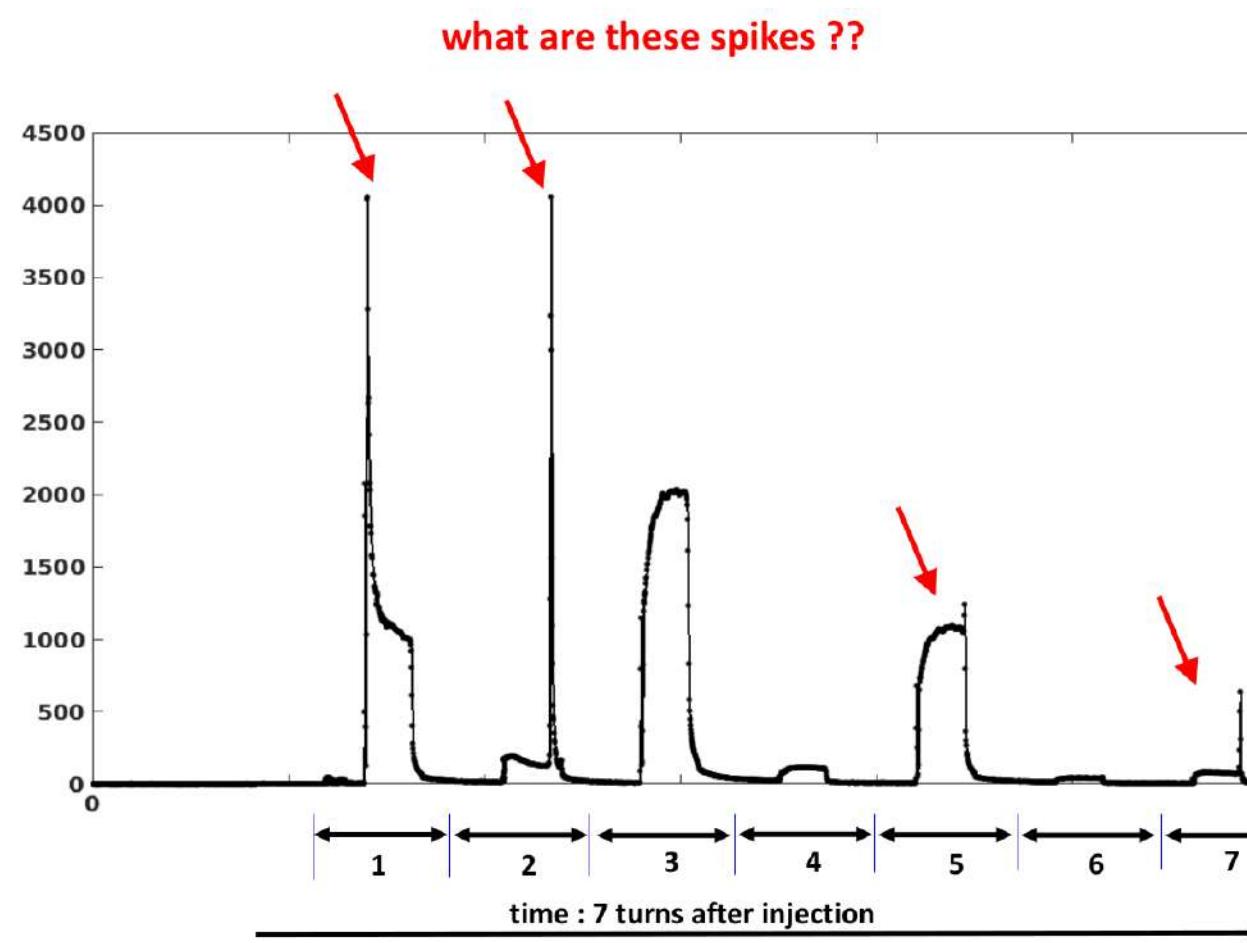


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Examples (light source) – losses at injection



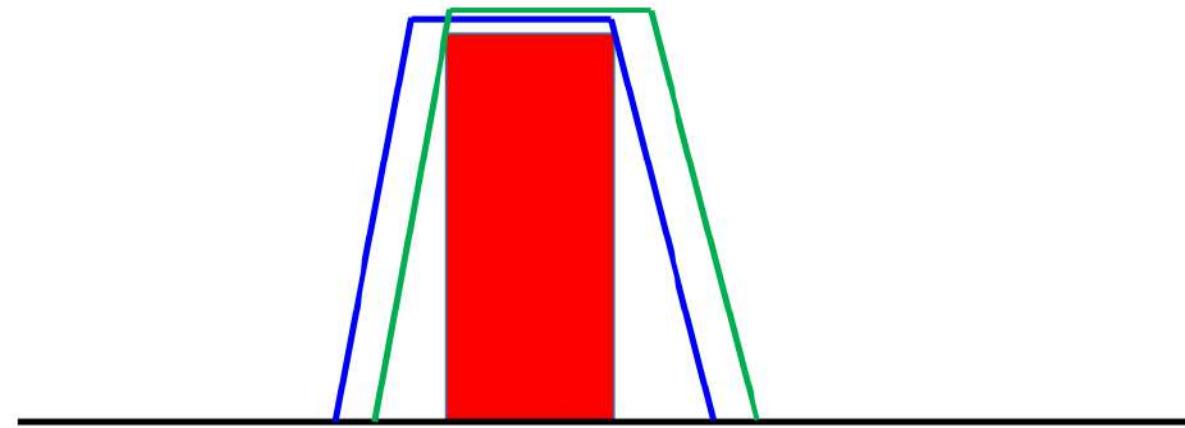
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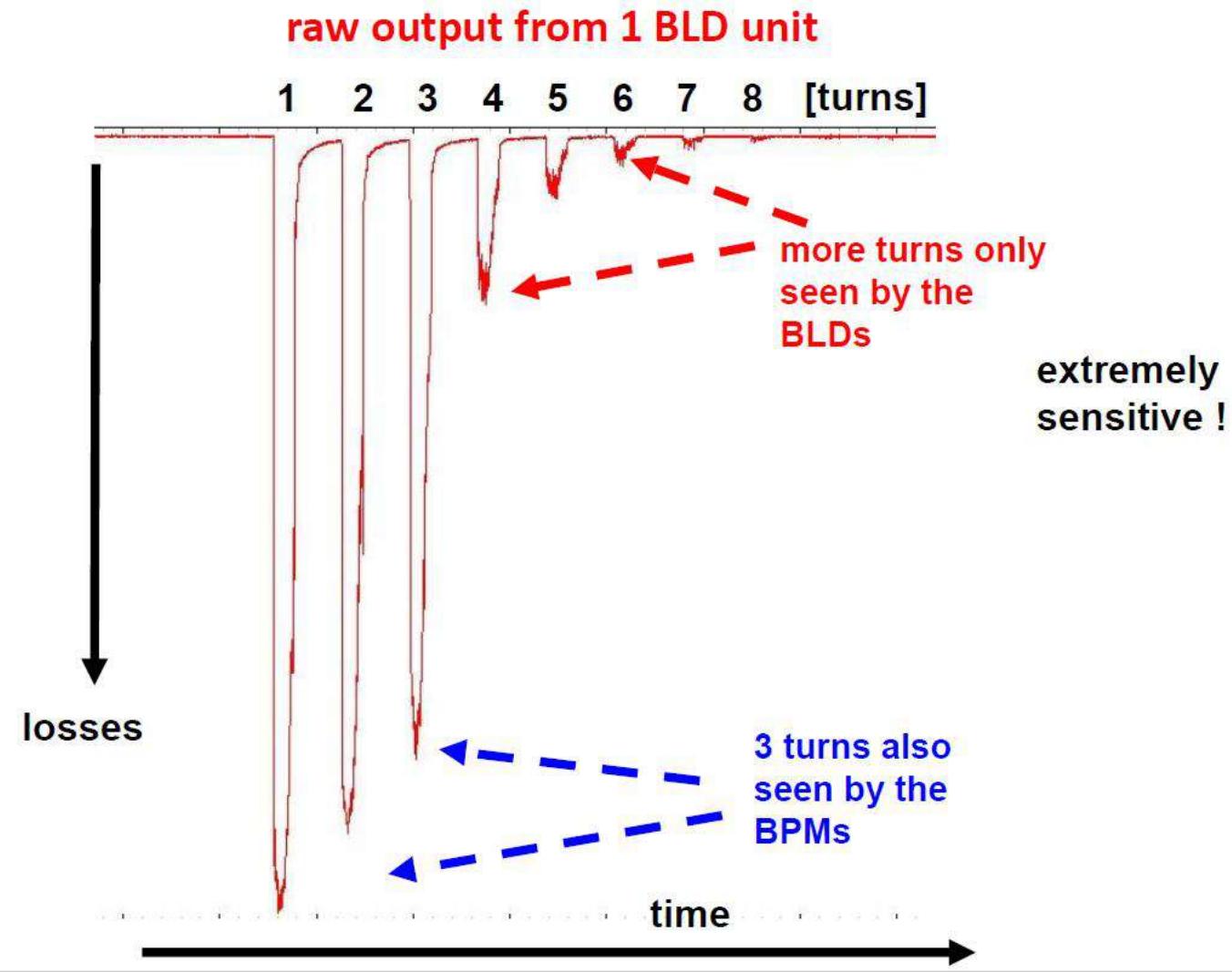
Examples (light source) – losses at injection

4 fast kickers, all 4 should be synchronized & stable :
with the flat kick well-centered on the injected **beam**



if not : edges of the injected **beam**
will get a (strongly) distorted injection path,
causing more losses at these edges

Examples (light source) – Sensitivity



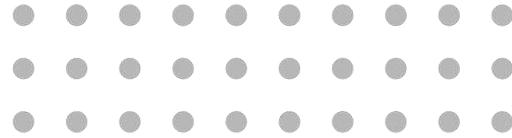
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Thanks for your attention!

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