The European Synchrotron

The New Beam Loss Detection Sytem at ESRF

Laura Torino

ESLS 2017, 22/11/2017

Beam Loss Detection

Monitor and localize the particle losses around the machine to protect the accelerator from damages, see "hidden" obstacles, and improve the machine parameters

- **Fast Losses:** Beam losses over (almost) bunch by bunch or turn by turn base
- **Slow Losses:** Beam losses integrated over time

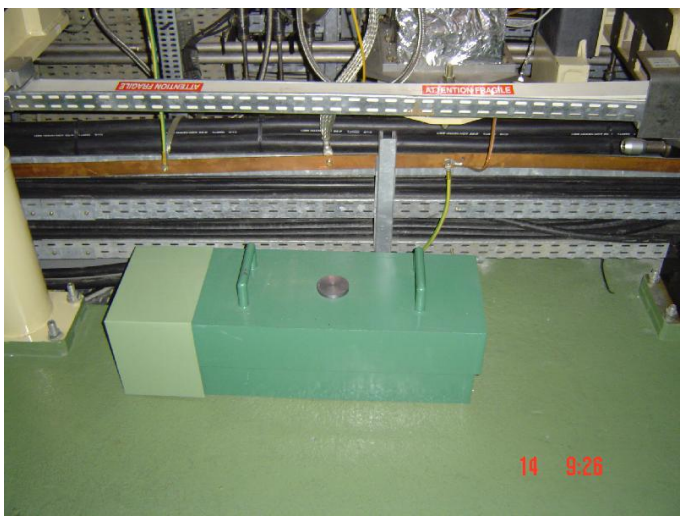
Beam Loss Detection

Monitor and localize the particle losses around the machine to protect the accelerator from damages, see "hidden" obstacles, and improve the machine parameters

- Current ESRF system is getting obsolete
- Design a new system for EBS
- Commissioning of the new system on ESRF current machine to have it ready for EBS

Current ESRF System

- 64 Beam Loss Detectors
  - PMT + scintillator
  - Read out $<$ 1Hz
- 64 Ionization Chambers



Obsolete, unpractical and quite "old"

Requirements for the new system

- Slow and fast losses
- Compact
- System "off shelf"
- Calibration in-situ

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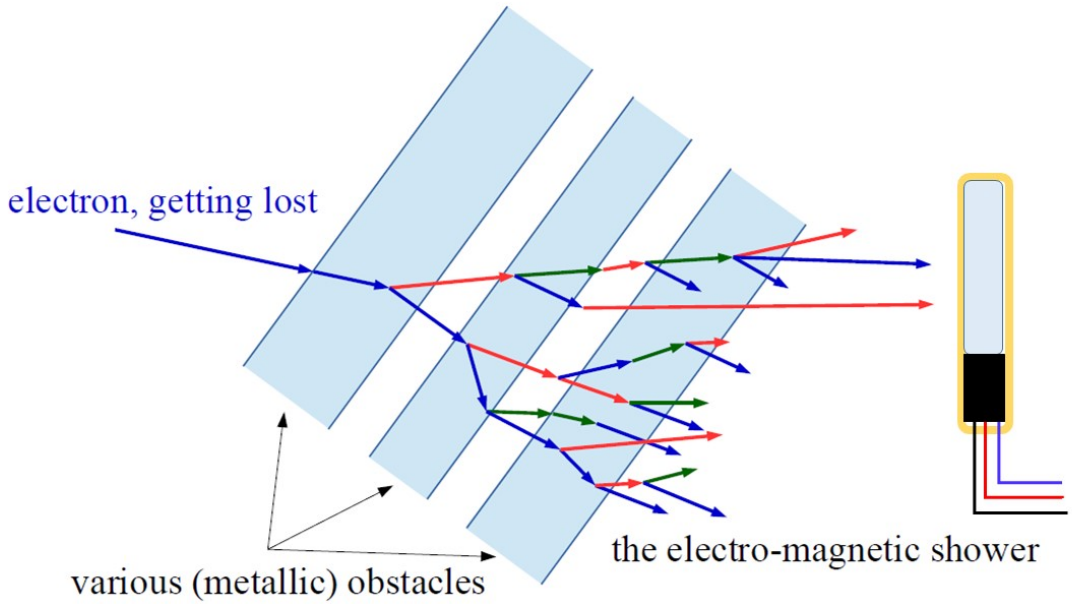
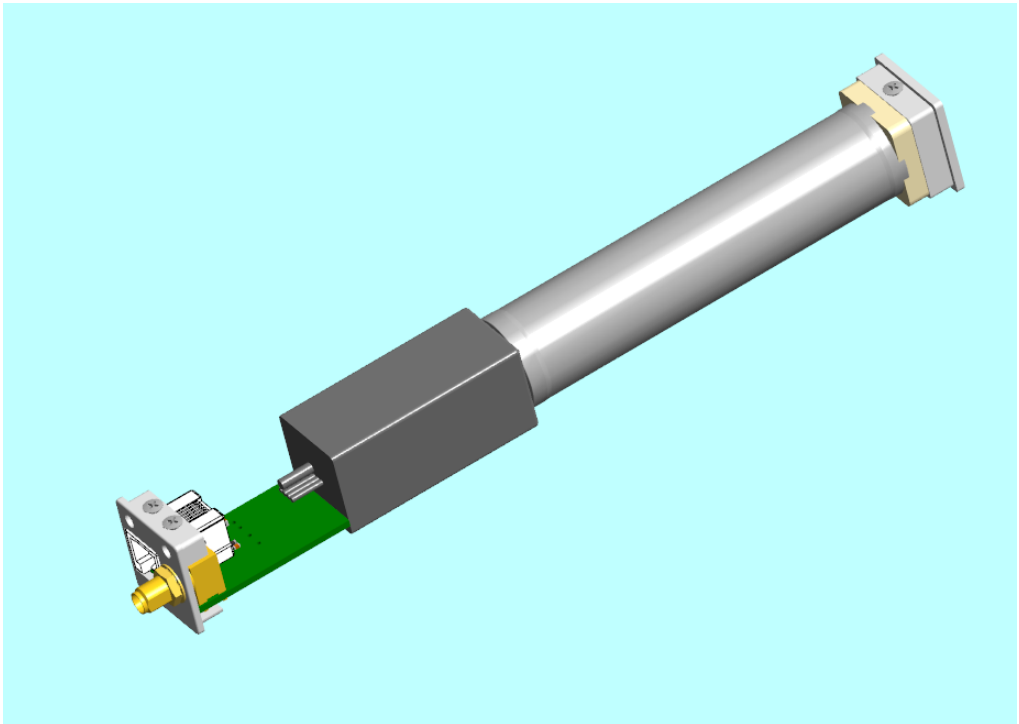


New BLD System

Off-shelf PMT coupled with a scintillator and commercial electronic to control and read the results

New ESRF BLM System – BLD



- PMT Hamamatsu H10721-110
  - 8 mm active area
  - Powered 5 V
  - 0-1 V gain control
- EJ-200 scintillator rod (100x22mm)
  - Wrapped in reflective foil
- "Light" lead shielding

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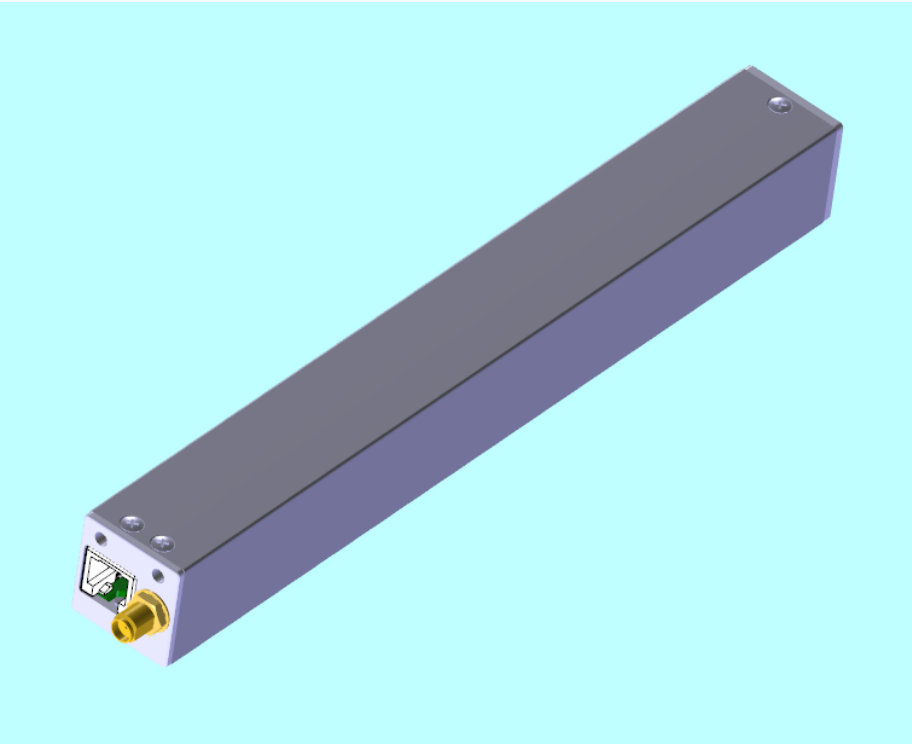

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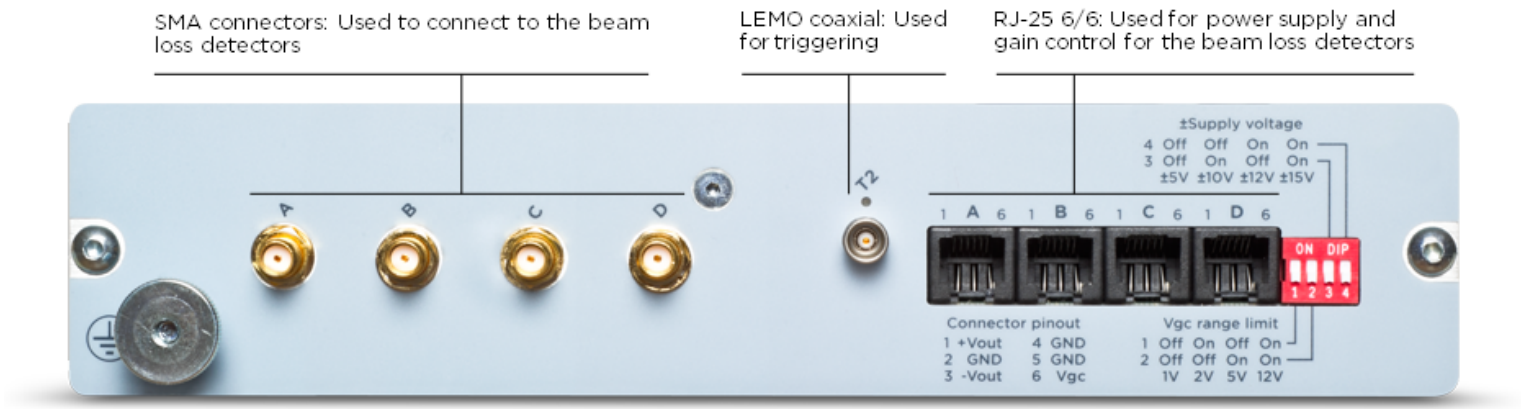
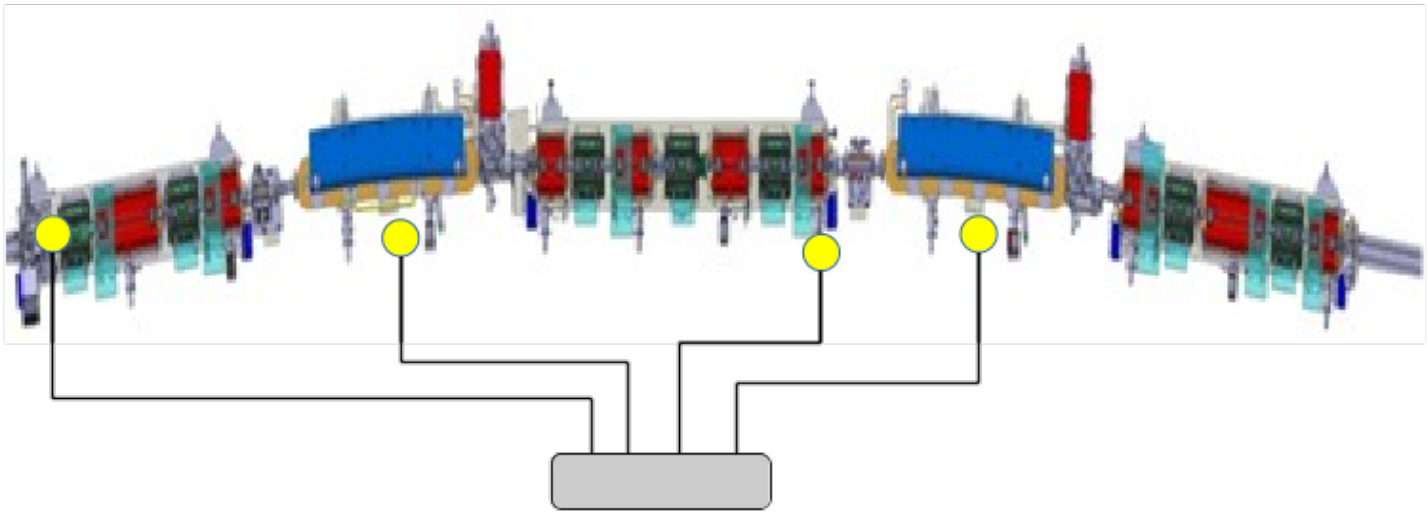
New ESRF BLM System – BLM



- 4 independent 5 V power supplies
- 4 independent gain control channels
- 4 independent read out channels
- 4 independent impedance settings (50 Ω/1 MΩ)
- Trigger input
- $>$ 10 MHz readout
- 8 ns ADC sample

BLDs Location



32 ESRF cells ⇒ 32 Libera BLM units
4 BLDs per cell ⇒ 128 BLDs

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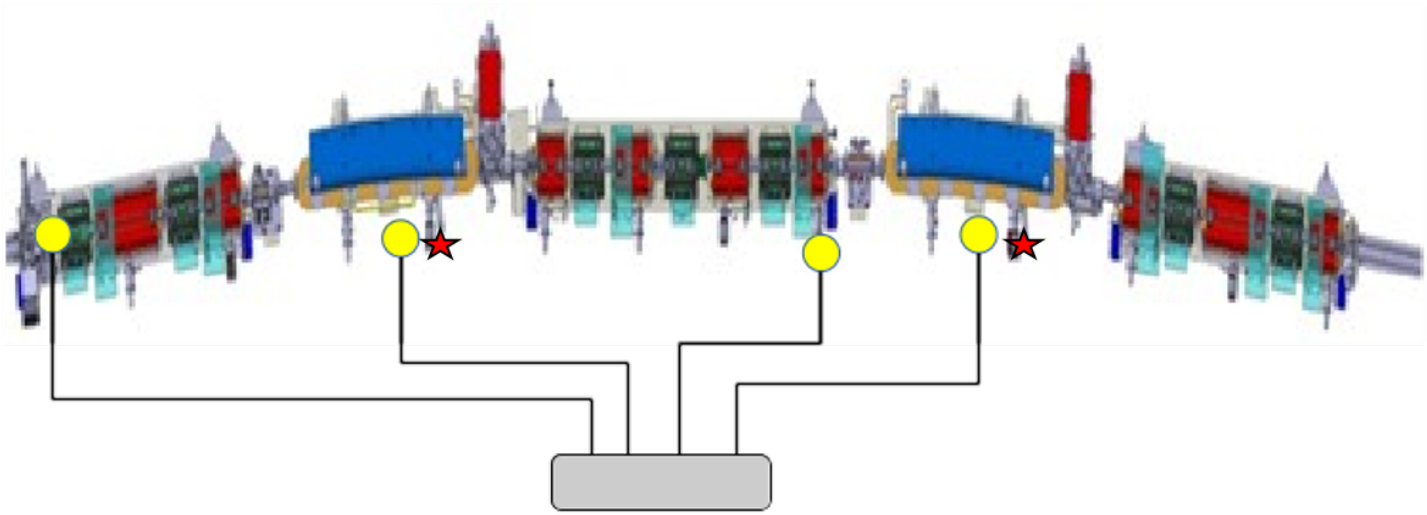

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Direct comparison with the current BLD system

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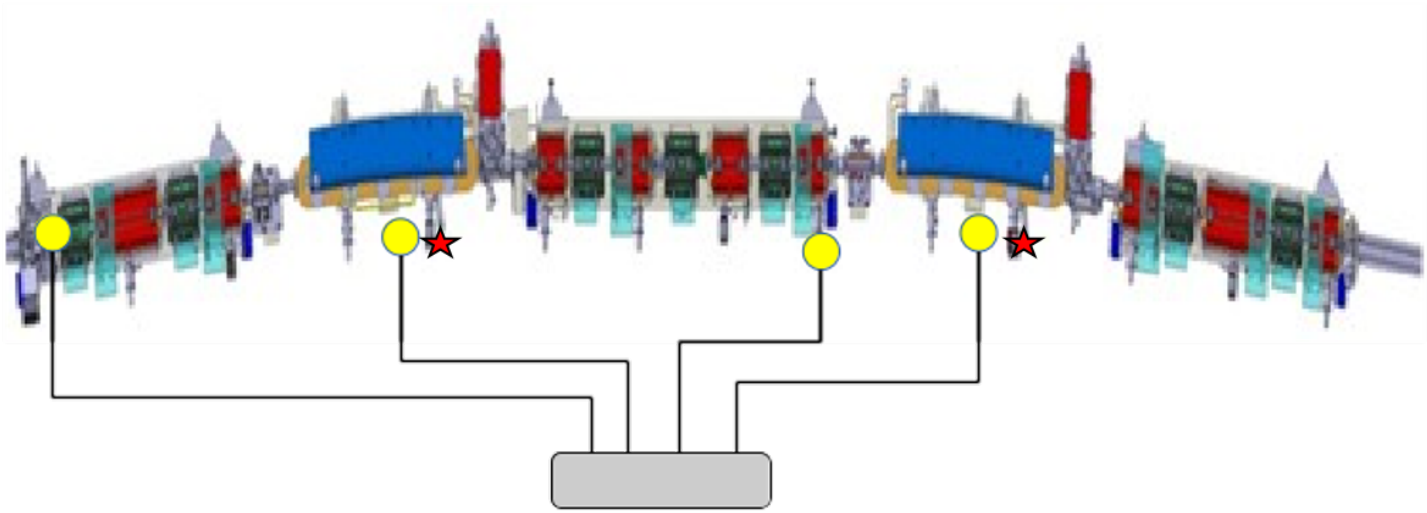
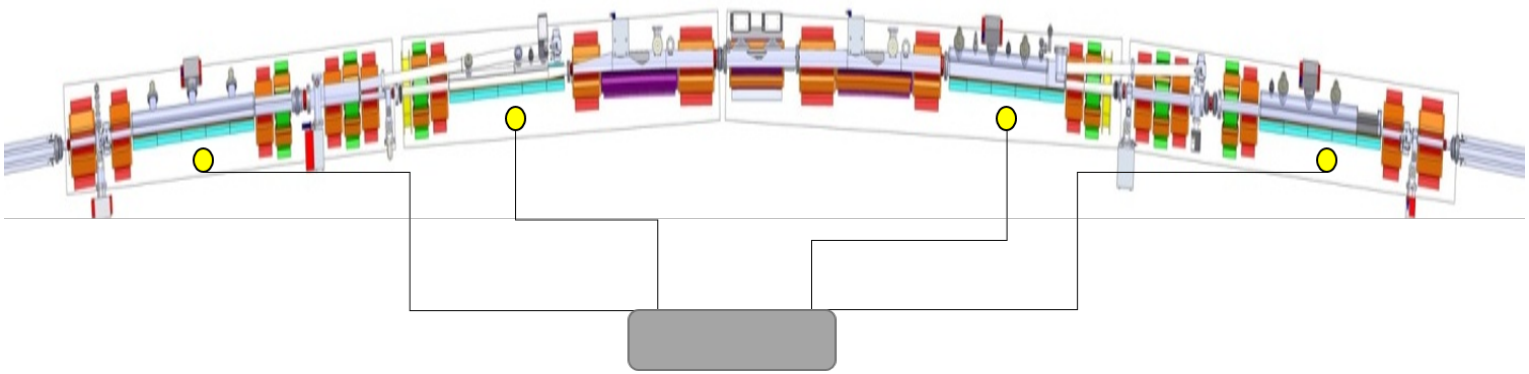
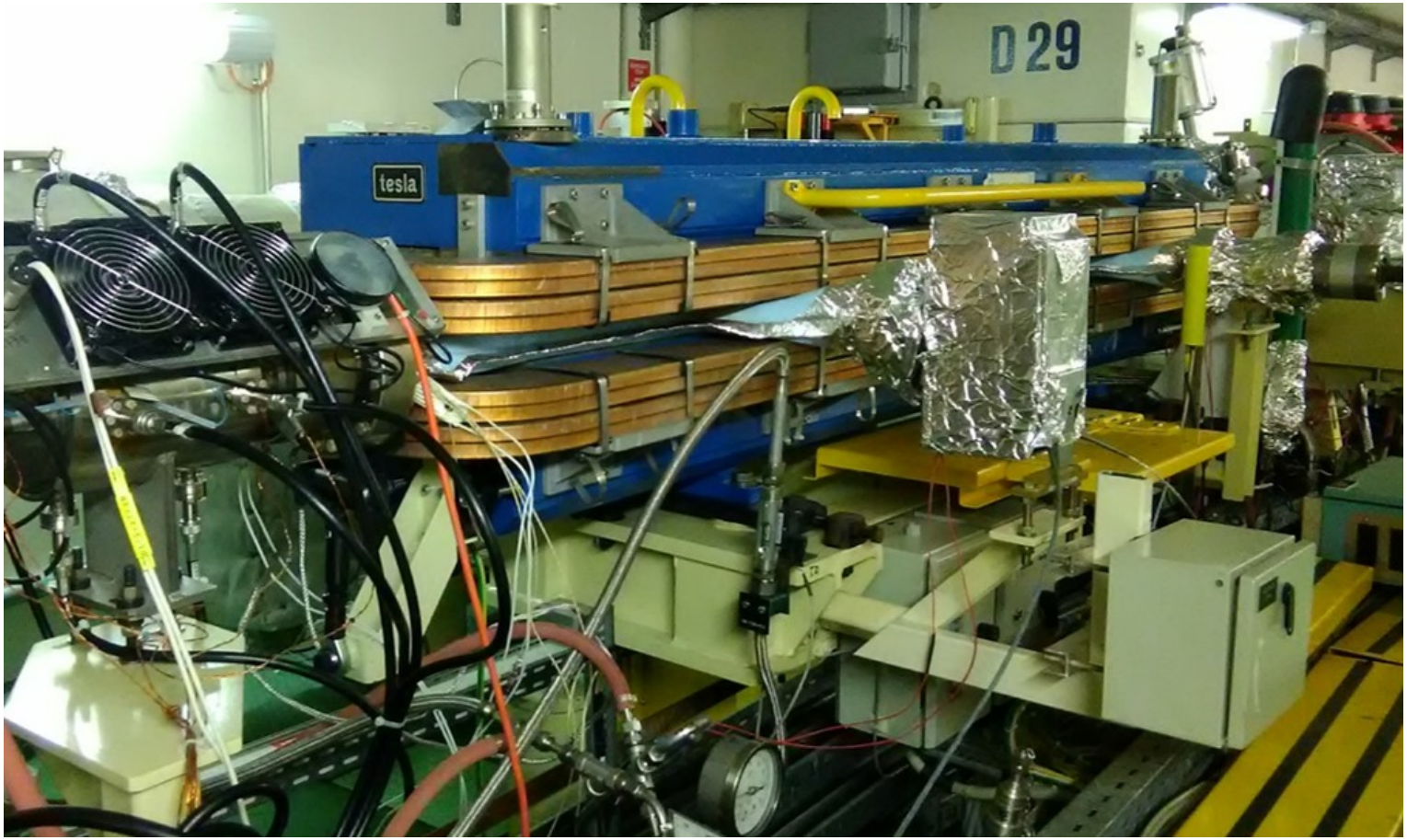




Example



In-Situ Calibration

Using a radioactive source (Ce137) it is possible to *relatively* calibrate the PMT-scintillator system directly in the tunnel.

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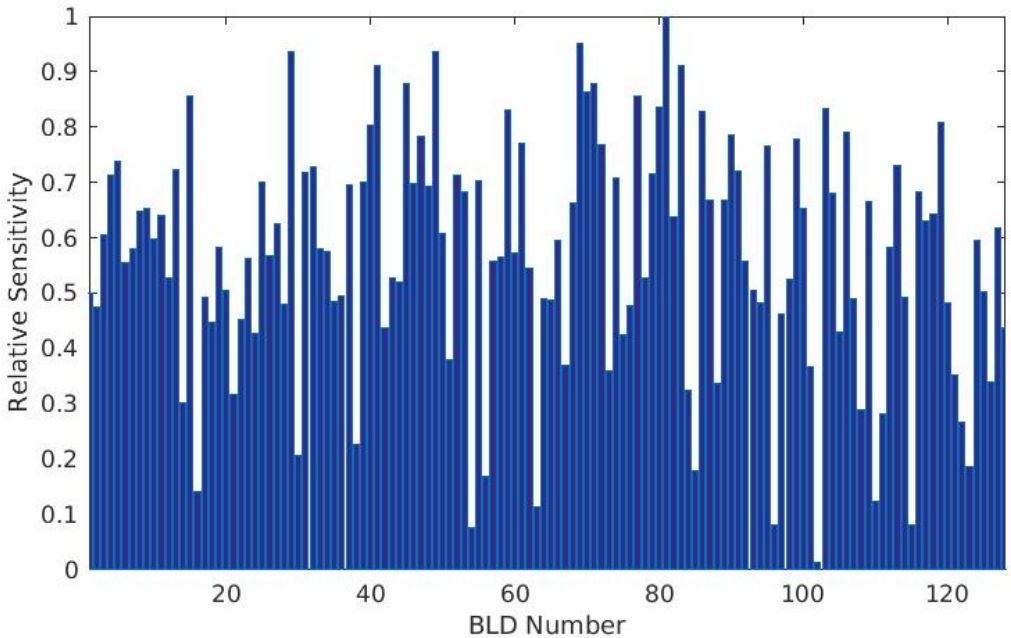


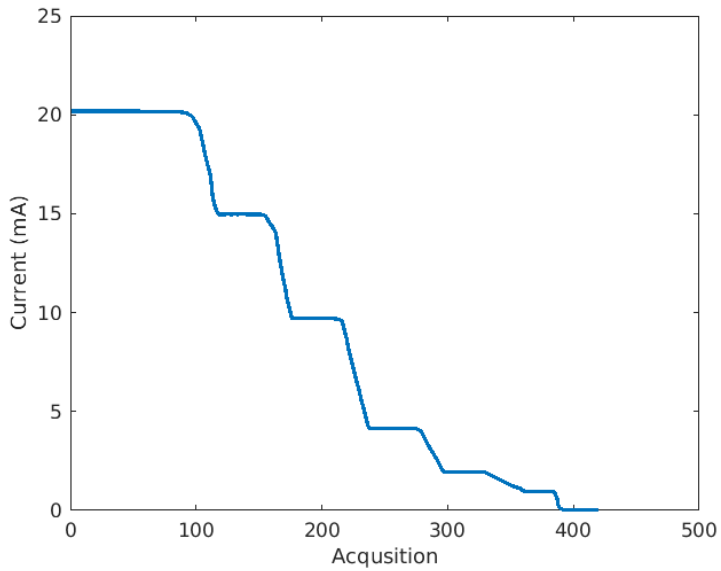
Synchrotron Radiation Influence – Test

X-rays produced by synchrotron radiation interact with the BLD scintillator and produce unwanted background

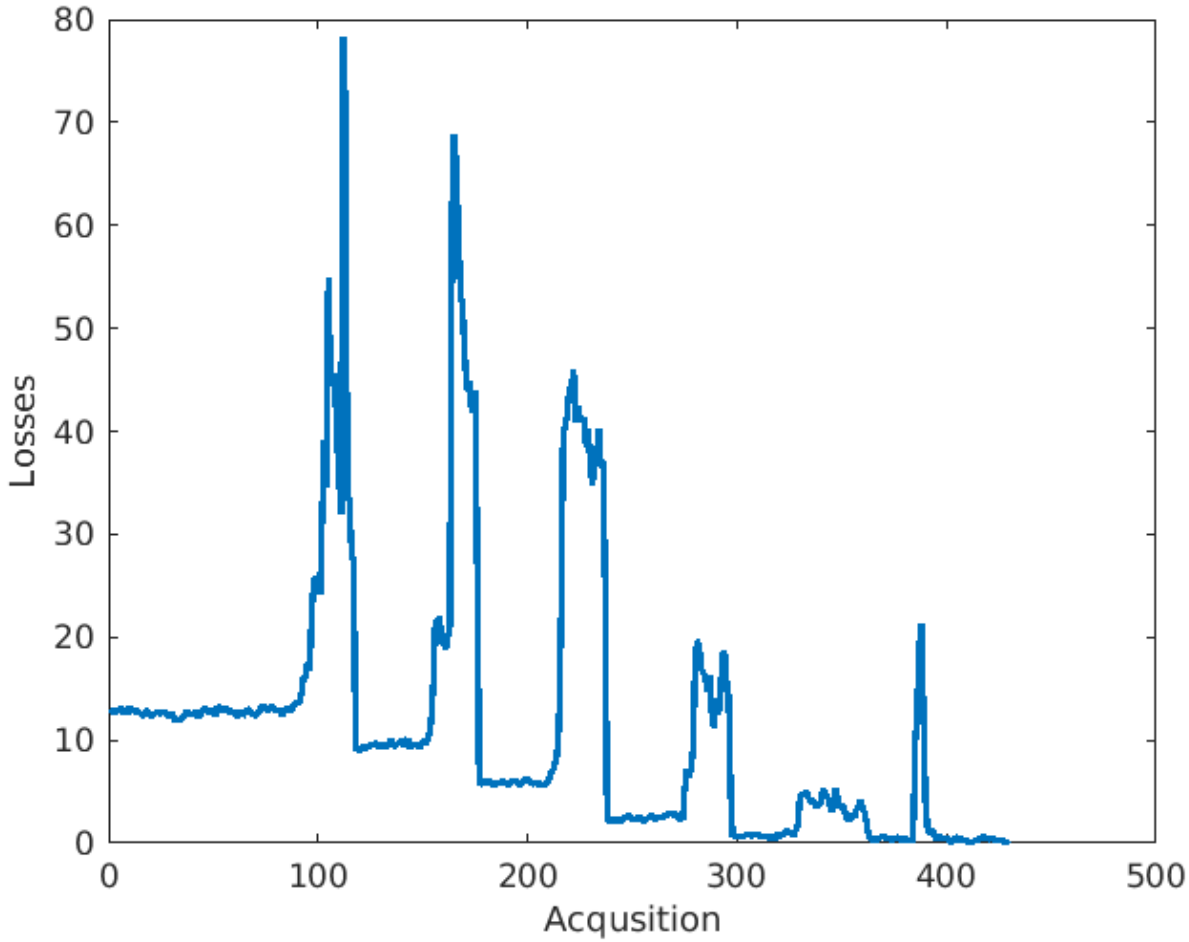
Low losses condition (Low current/High Lifetime)

⇓

Only synchrotron radiation is detected



Synchrotron Radiation Influence – Evidence



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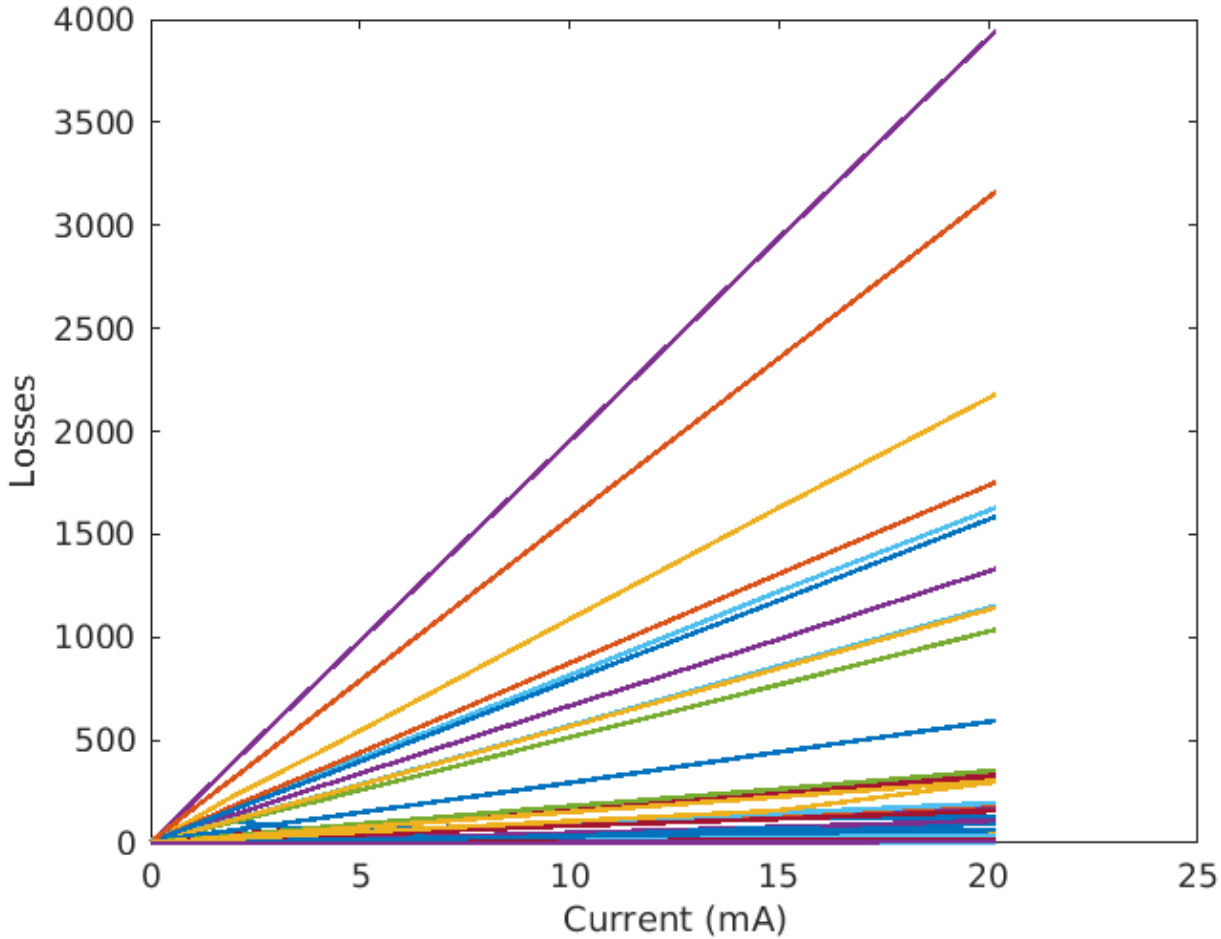

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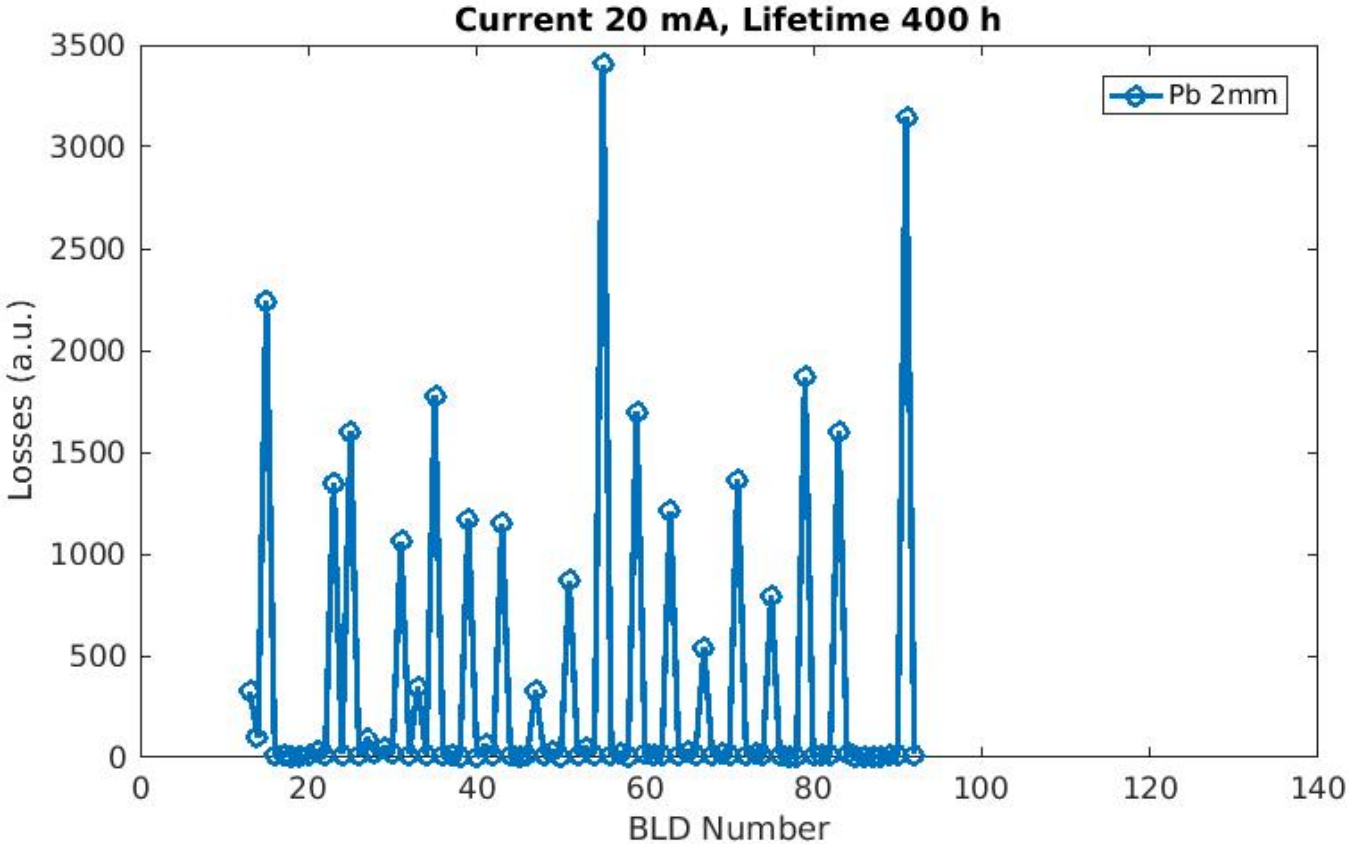
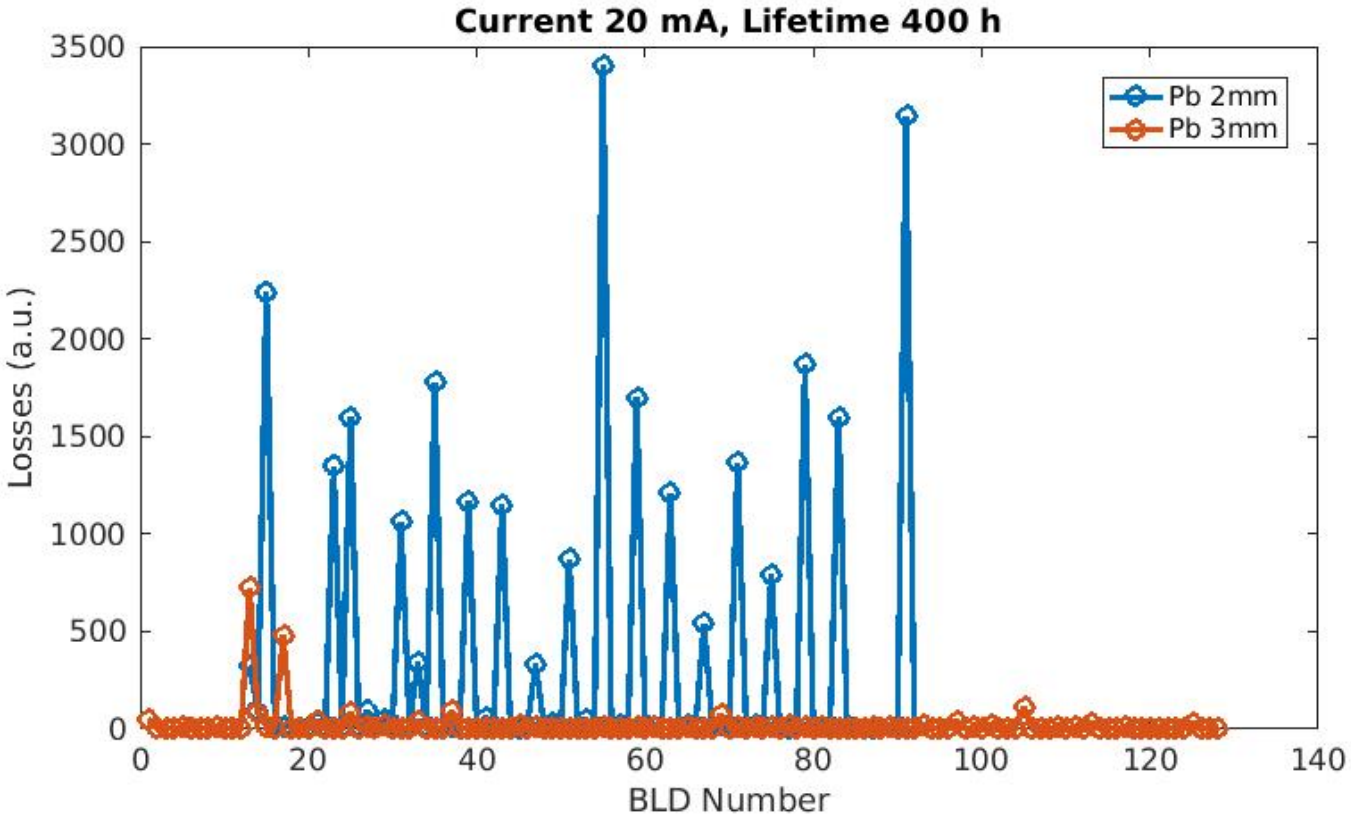


Synchrotron Radiation Influence – Solution



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- 128 BLDs installed
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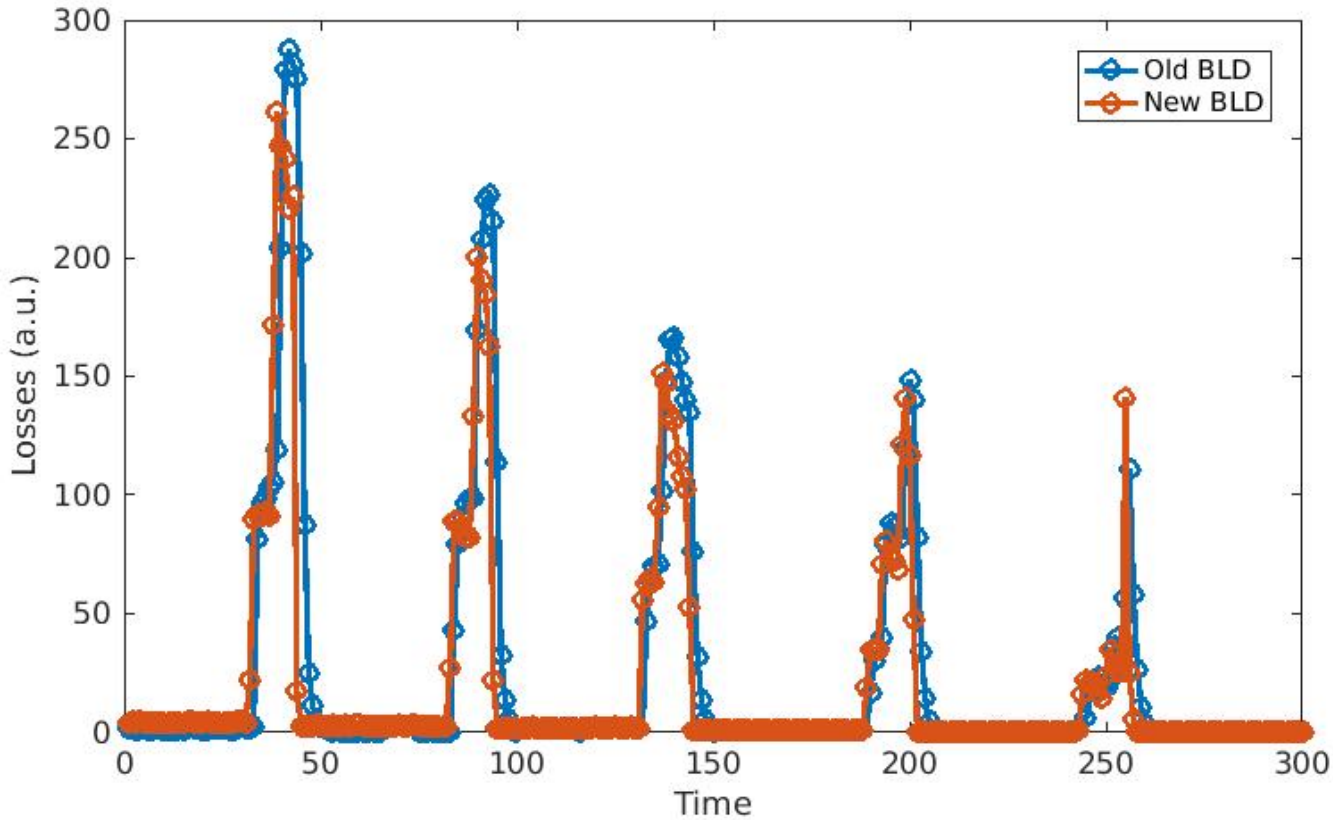
$\Rightarrow$ Slow Losses

$\Rightarrow$ Fast Losses

$\Rightarrow$ Turn by Turn Losses

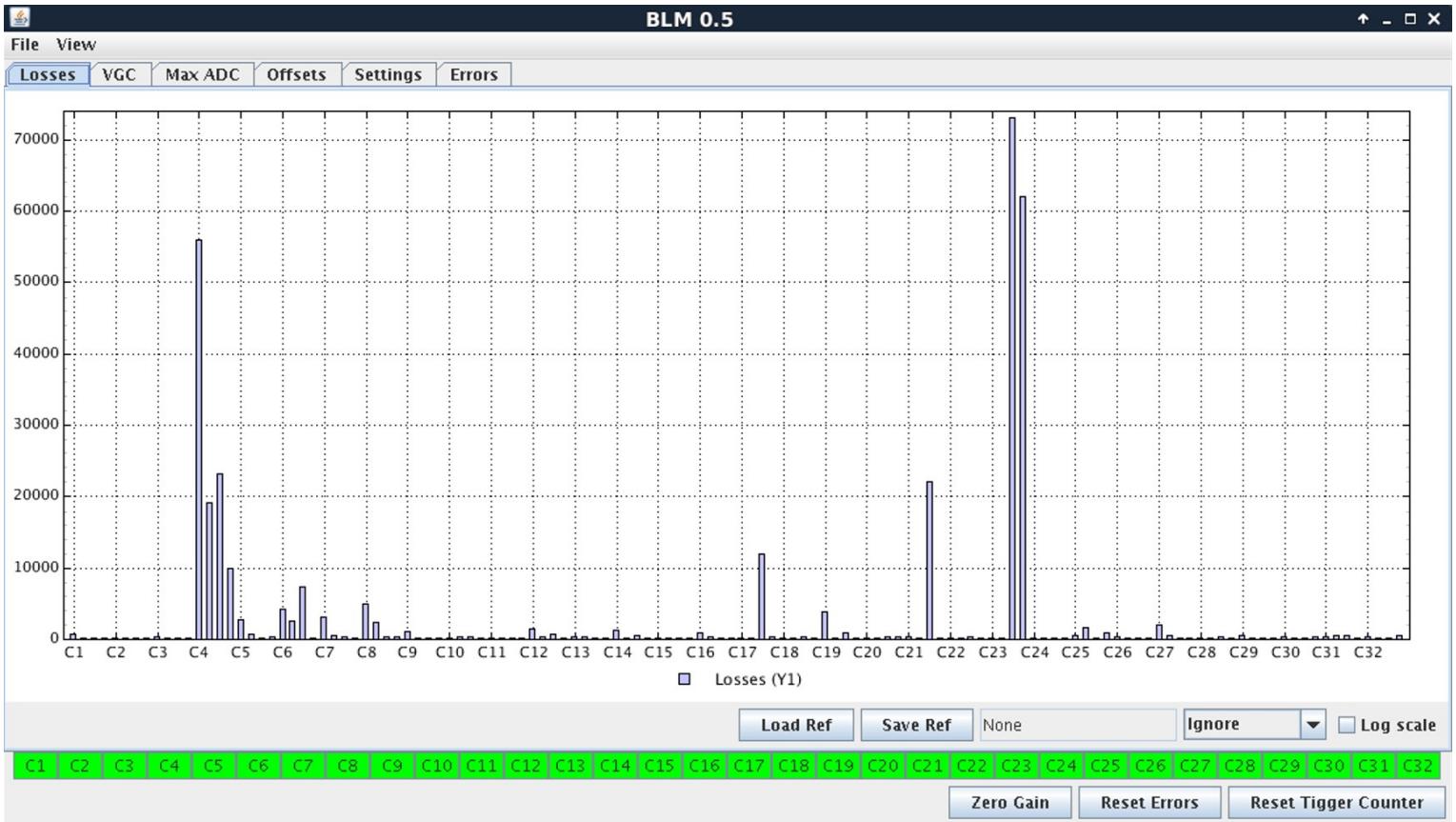
Slow Losses – Comparison

Impedance = 1 MΩ Not triggered Long integration



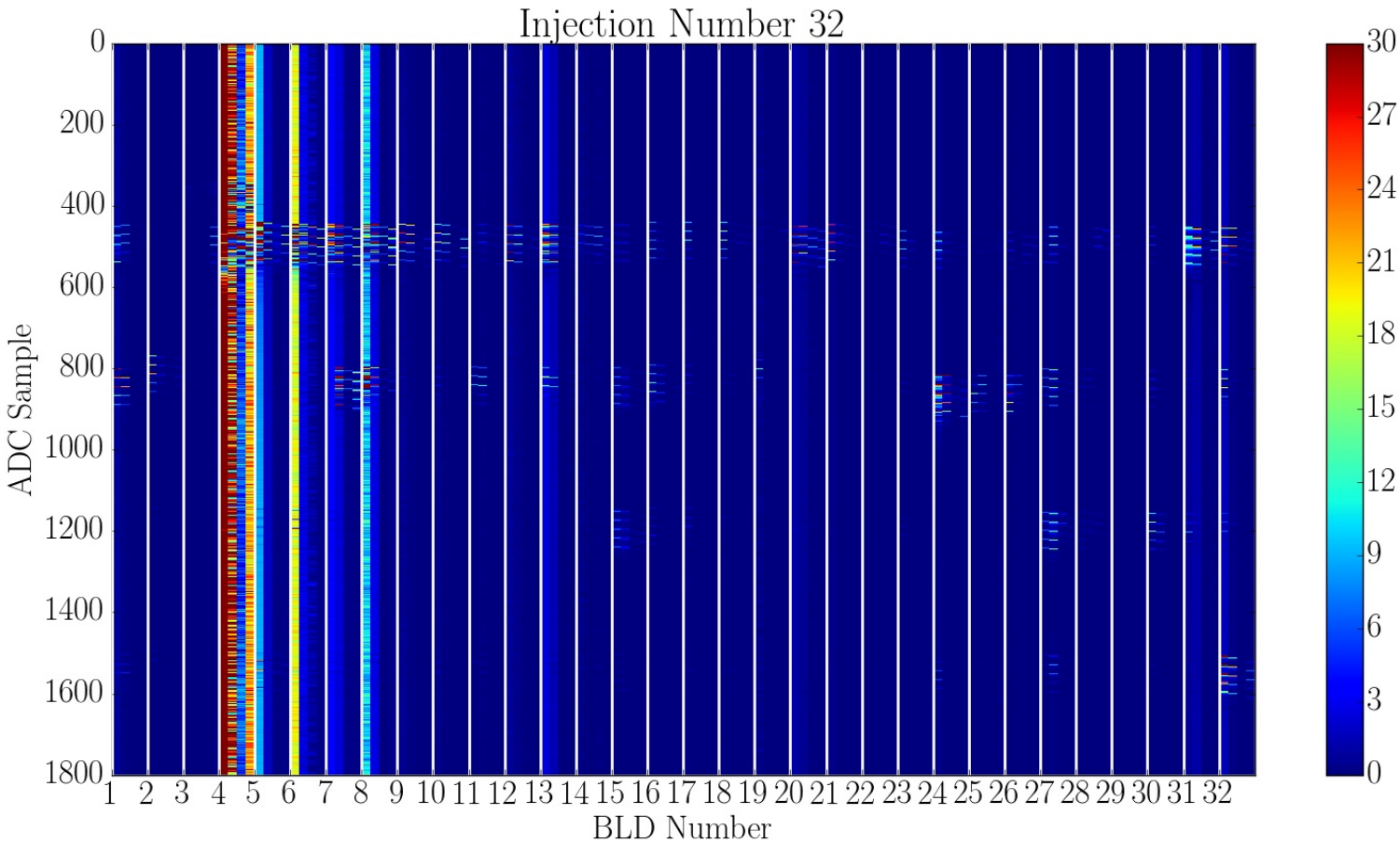
Data acquired during top-up injection

Slow Losses – Device Server



Fast Acquisition – Injection Monitoring

Impedance = 50 Ω Triggered Few turns integration



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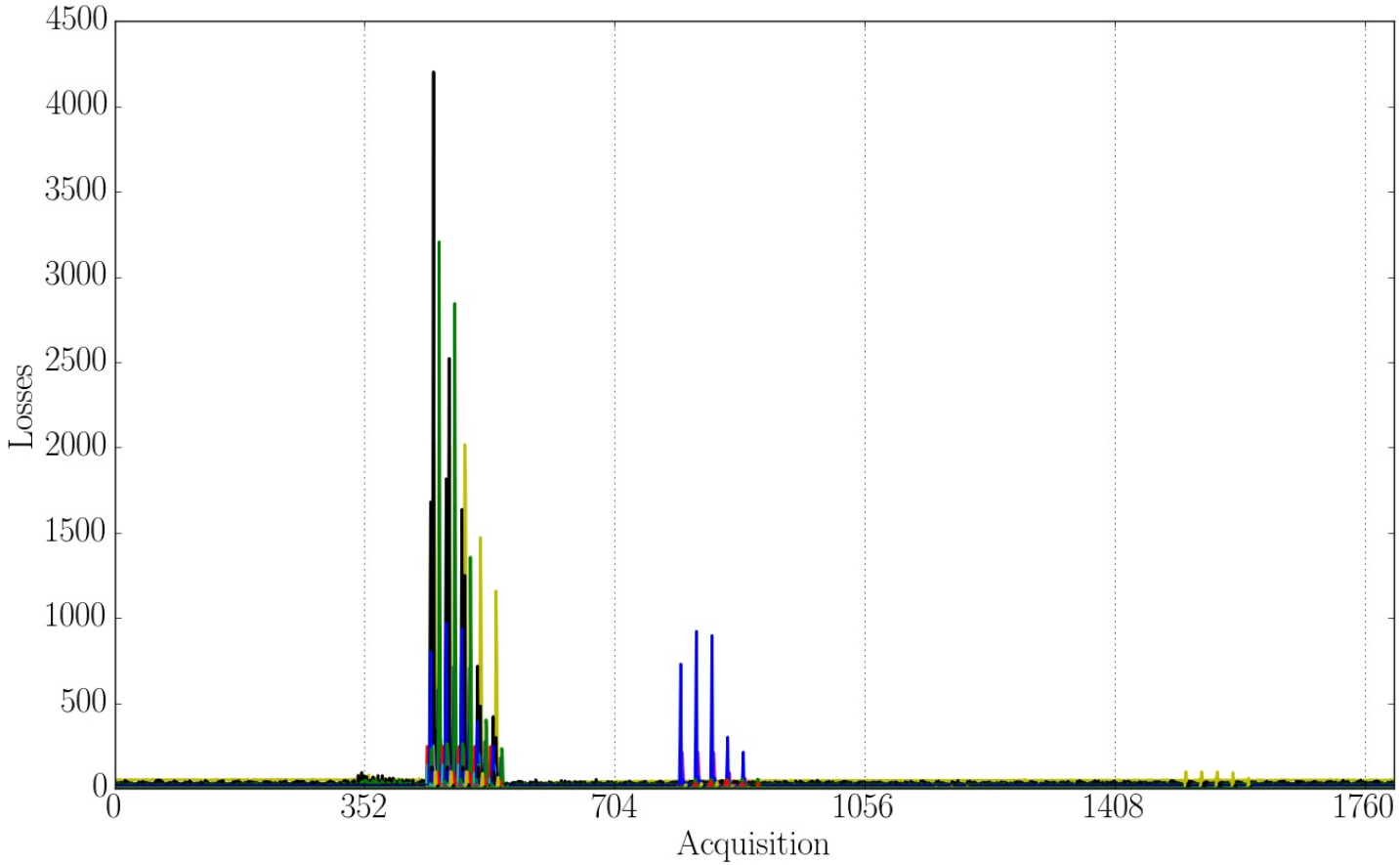

Summary

- 128 BLDs and 32 BLMs installed at ESRF
- In-situ calibration performed
- Synchrotron Radiation related problems solved
- Possibility of slow, fast and turn by turn measurements
- Operation software and application (almost) ready

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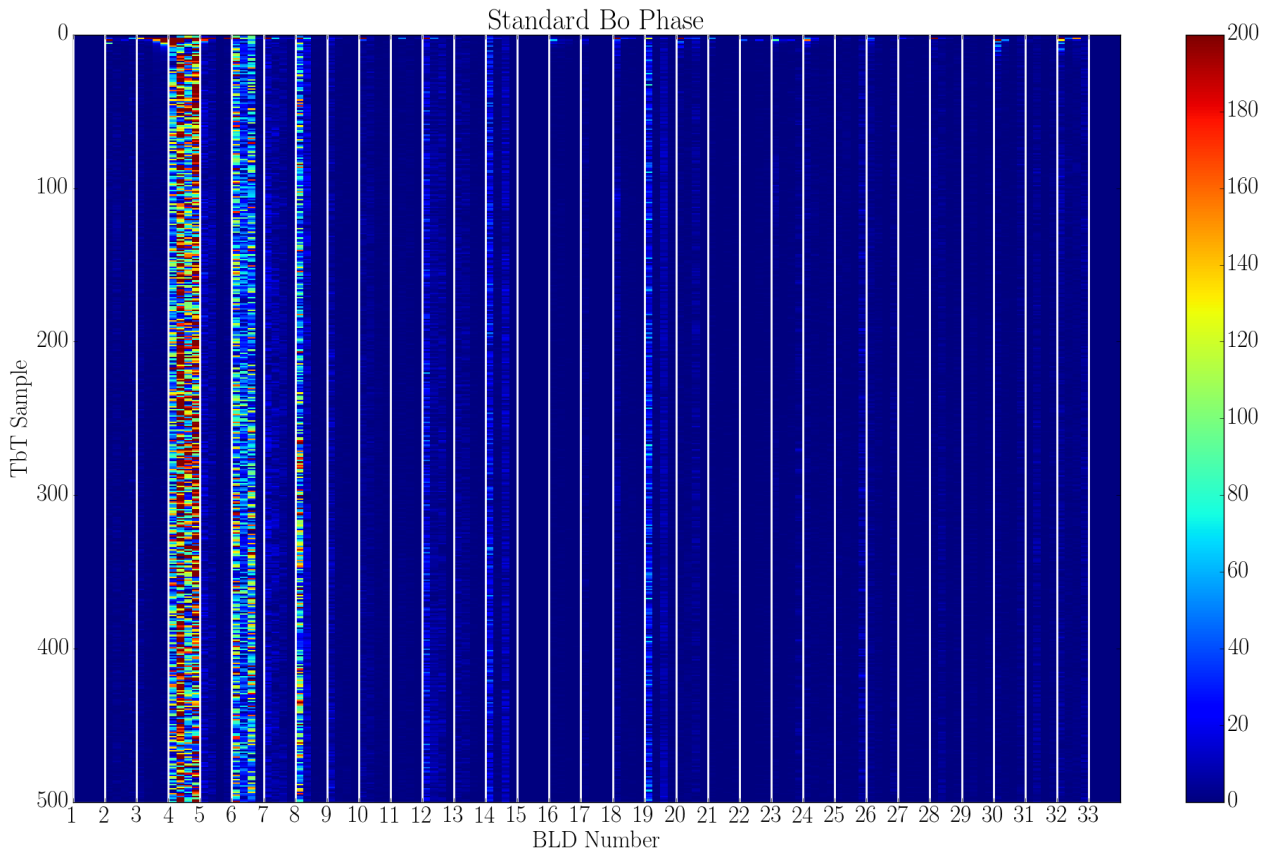
Next Step: Start to store data to have a reference for EBS

Many thanks to K. Scheidt, F. Taoutaou, N. Benoist, JL. Pons

Back-up Slides

Turn by Turn – Booster Phase Shift

Impedance = 50 Ω Triggered Hundreds turns integration



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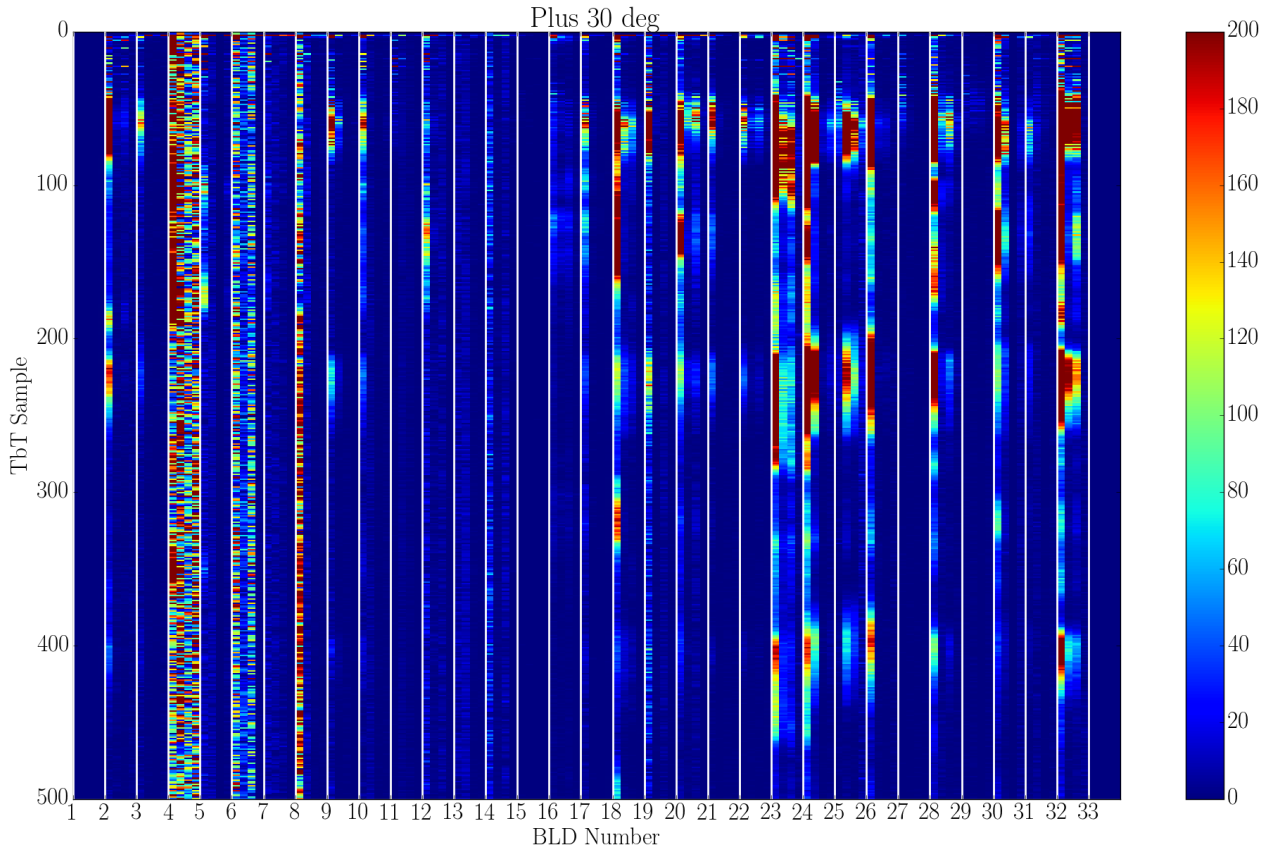

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