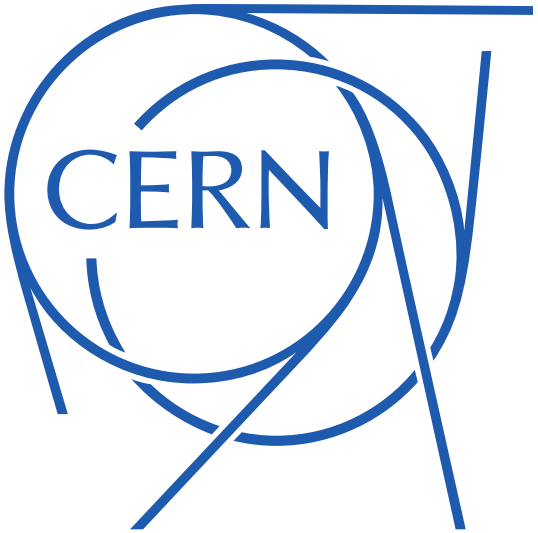


ČVUT

ČESKÉ VYSOKÉ
UČENÍ TECHNICKÉ
V PRAZE

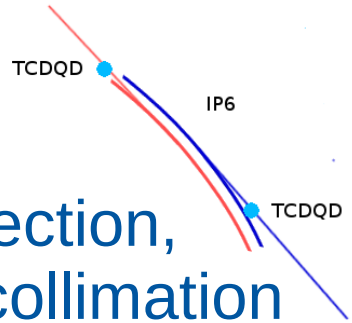
Jiri Kral for the BE-BI-BL

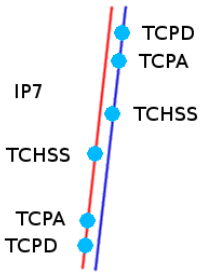
Diamond Beam Loss Monitors in Run 3

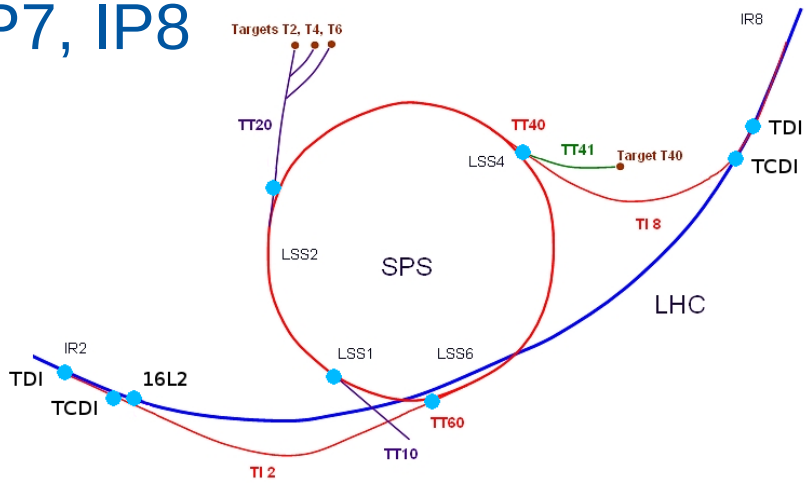
Thanks to: Arek Gorzawski, Bjorn Lindstrom, Stefano Redaelli, Belen Salvachua, Magdalena Stachon, Mika Vaananen, Christos Zamantzas

Diamond BLMs

- Solid state ionization chamber (~cm2)
- Linear response, dynamic range 5e9
- Fast response time (ns)
- Per bunch losses
- Installed at LHC and SPS injection, extraction and LHC primary collimation
  - P1, P2, P4, P6, IP2, IP6, IP7, IP8
  - 16L2
- PSB installation during LS2
- Supplier: Cividec

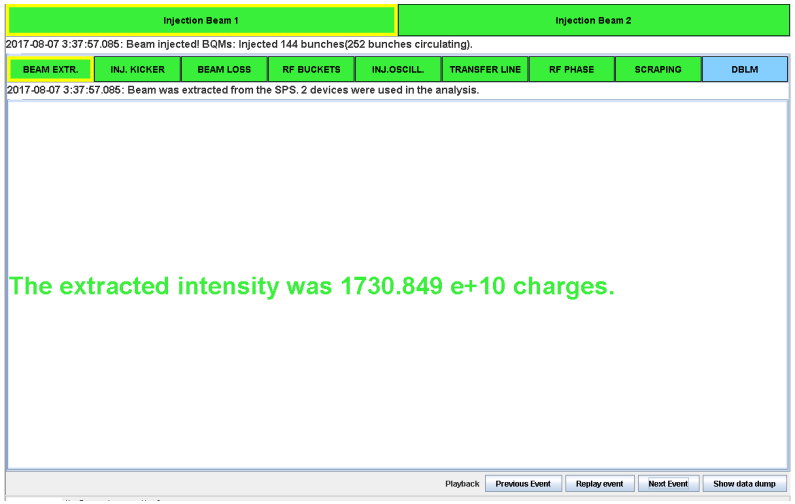


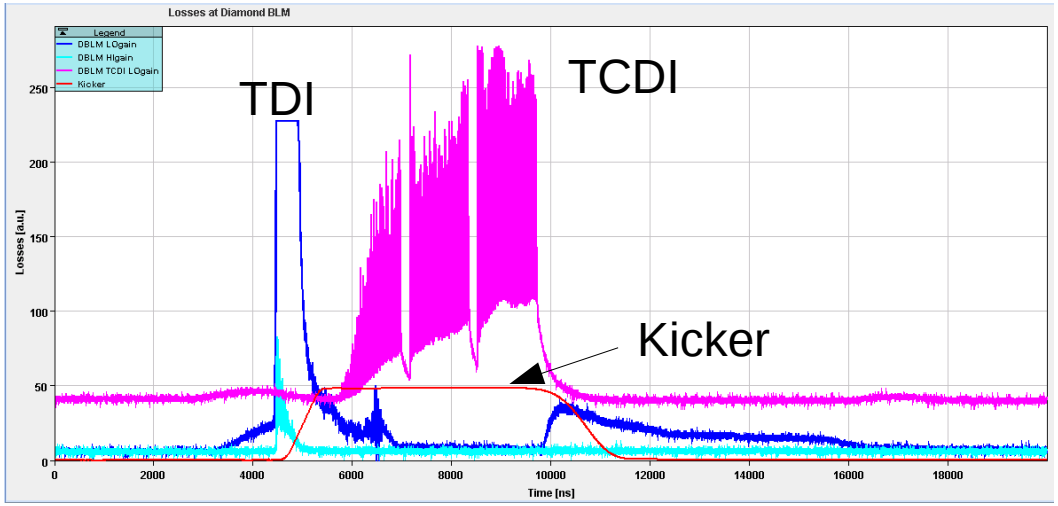




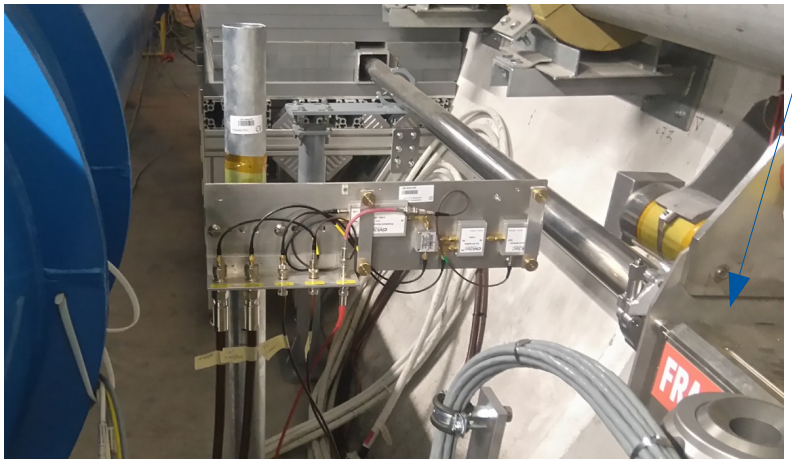
Injection losses

- LHC IP2, IP8: TDI and TCDI diamonds
- Readout: Scope + FESA class
- Data in IQC and PM

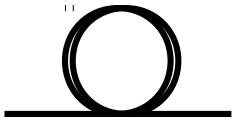


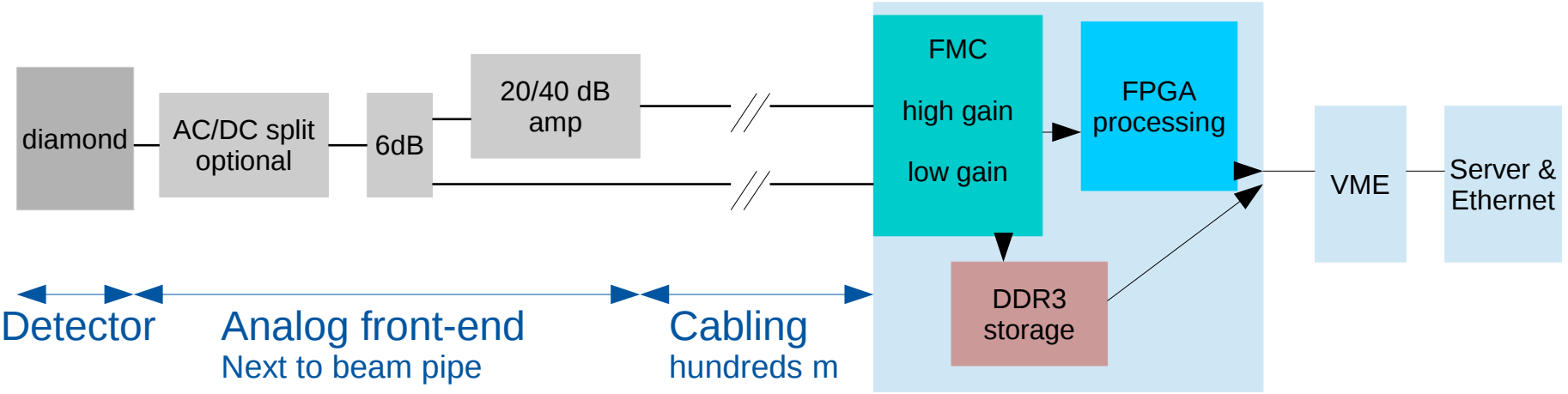


New readout



Observed collimator



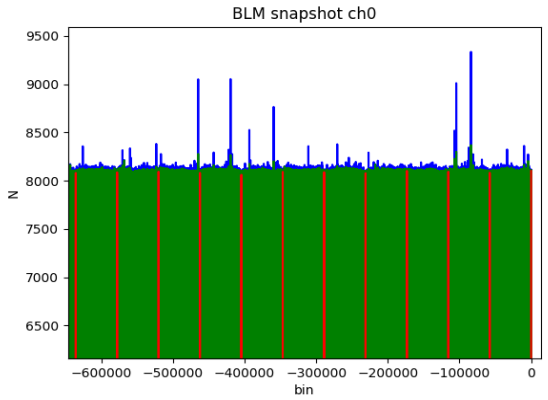


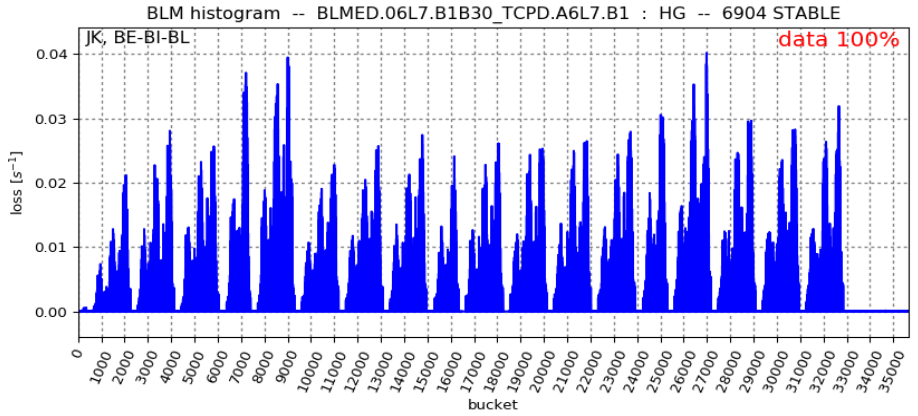
- Unify with standard HW

Available measurements

- Counter (Histogram)

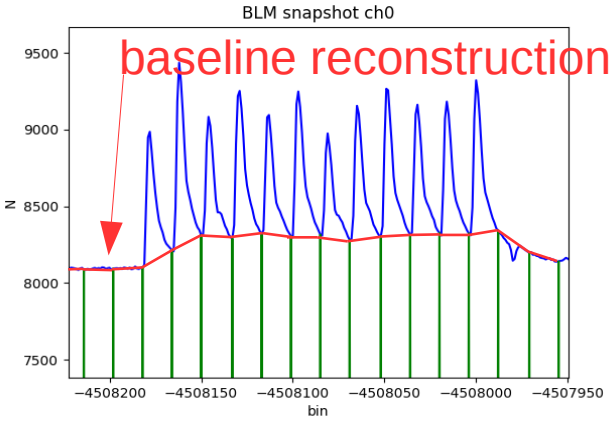
1.5 ns resolution, ~1s integration

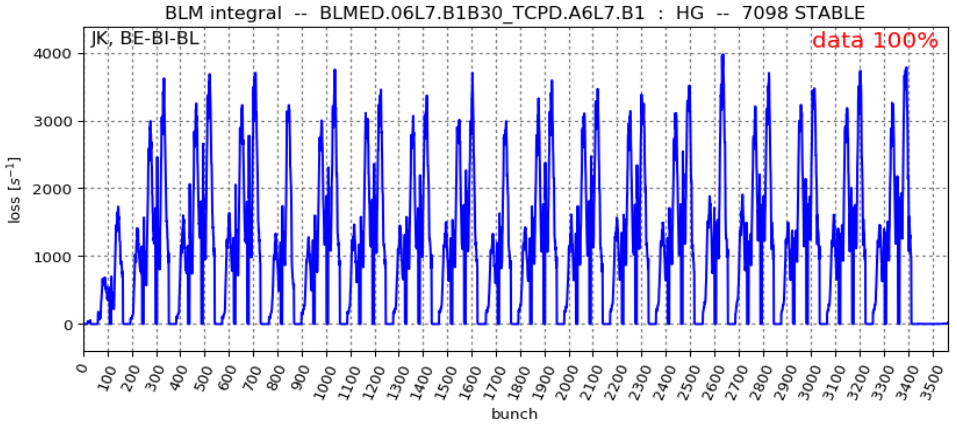




- Integrator

per bunch, ~1s integration

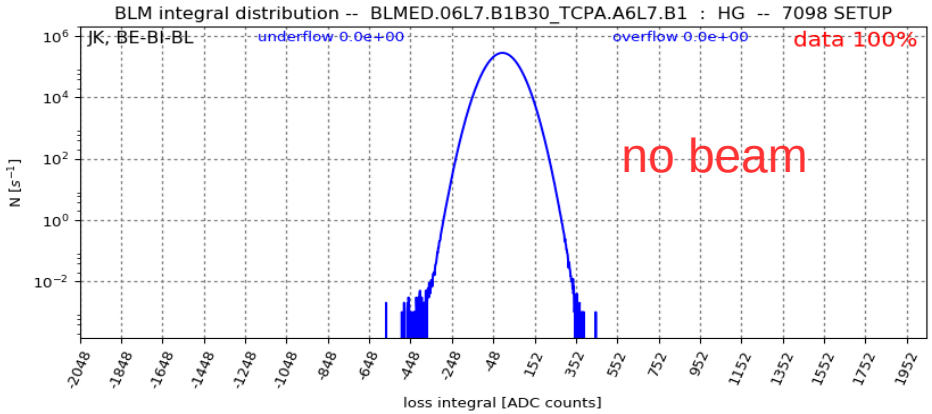


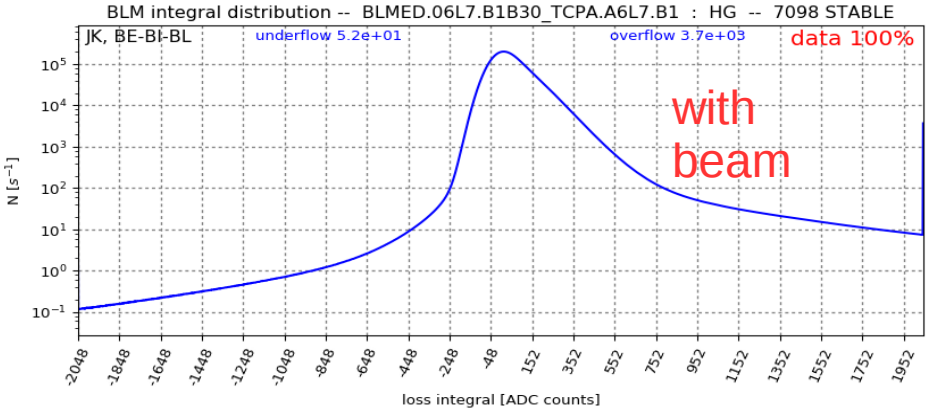


Available measurements II

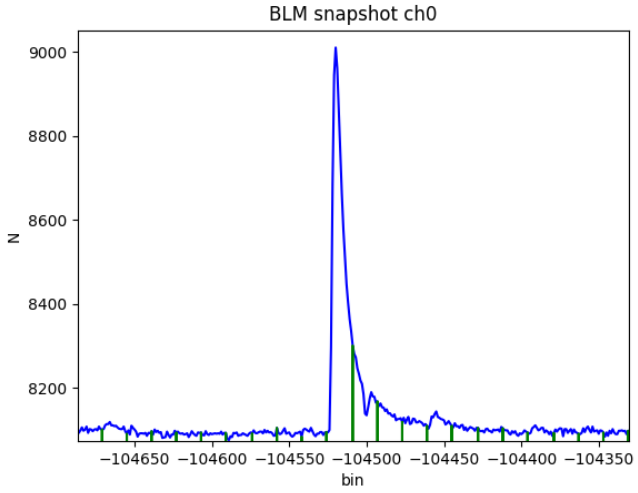
- Loss distribution

~1s integration



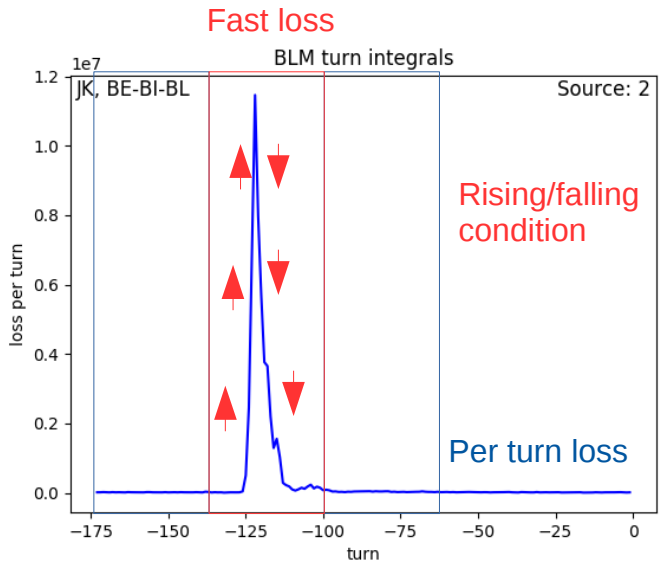


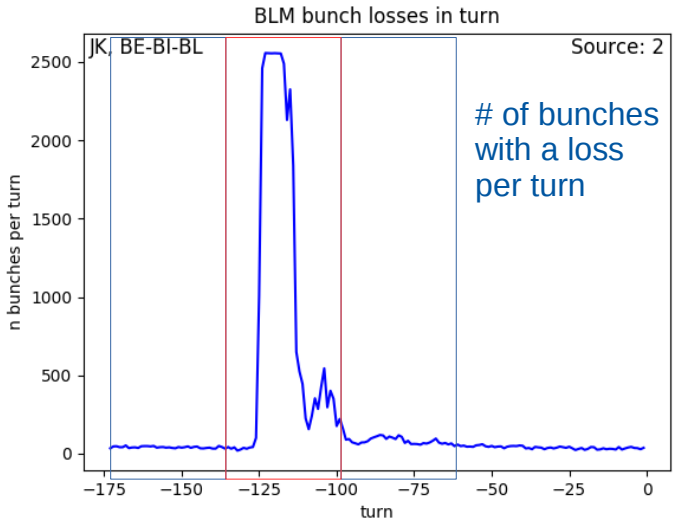
- Raw sample data (waveform)
  - 650 MHz sampling, 14-bit
  - 400/800 ms depth
  - Saves in DDR3



Internal trigger

- Loss amplitude
- Signal shape of per turn losses
- Number of bunches with a loss within a turn

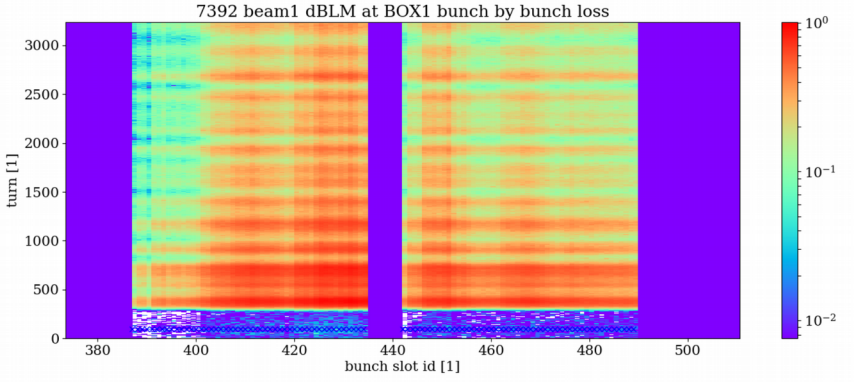




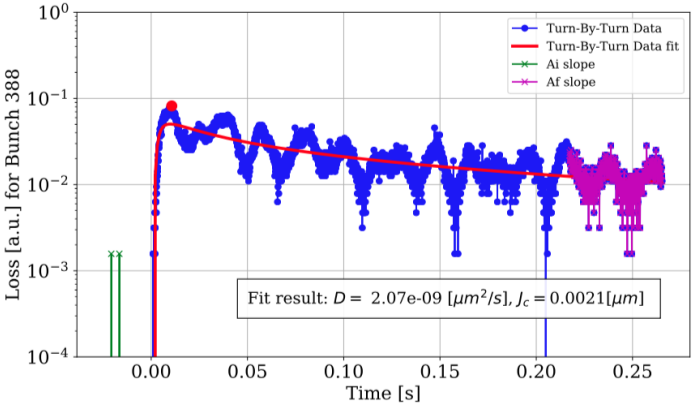
Beam diffusion measurements

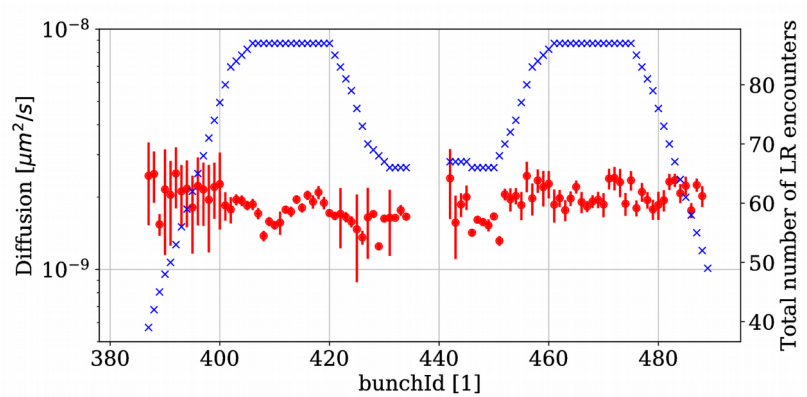
- Mesurement done with a collimator scan (stepwise jaw move towards the beam)
- Loss pattern observed with IC-BLM (100Hz) and with dBLM (at histogram and raw waveform mode)
- Good synchronization needed for the snapshot (raw waveform) acquisition mode!
- Eventually it was possible to compute diffusion speed for each bunches individually.

Raw waveform (turn-by-turn loss) recorded for 3000 turns for two 48b trains during the jaw in step



Each bunch loss evolution undergo fit



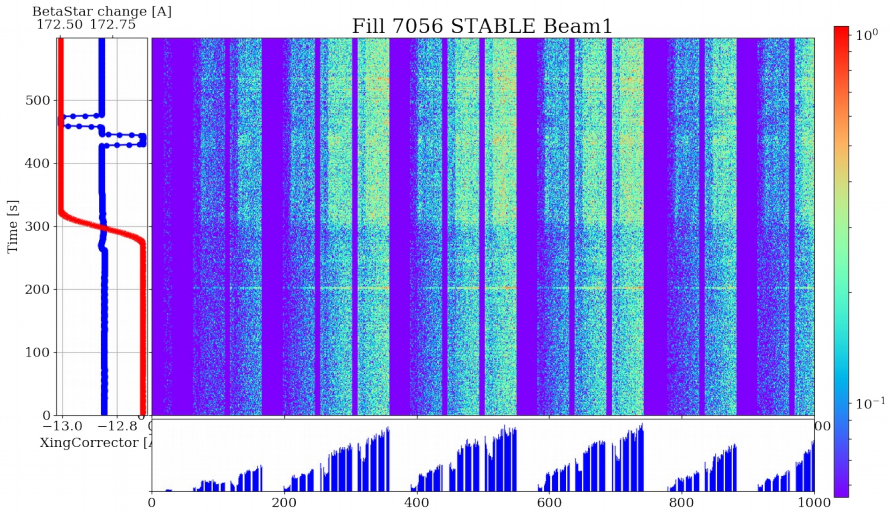


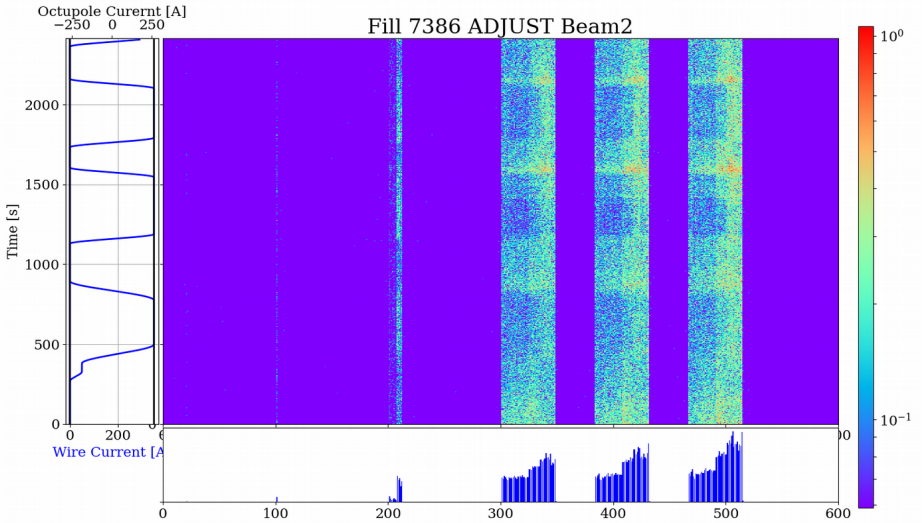
Bunch-by-bunch diffusion speed difference

Arek & Stefano

During LHC operation

- B-b-b monitoring for loss patters during regular operation
  - SQUEEZE, ADJUST, RAMP
  - Also for configuration changes during STABLE BEAMS ie. Xing or β* leveling (figure left)
- Also for dedicated MDs where differentiation between bunch losses is crucial (eg. LRBB MD, figure right)

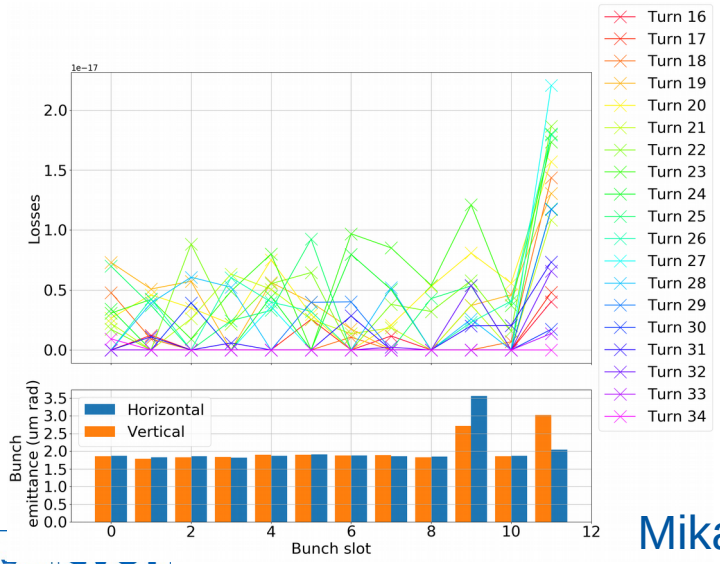


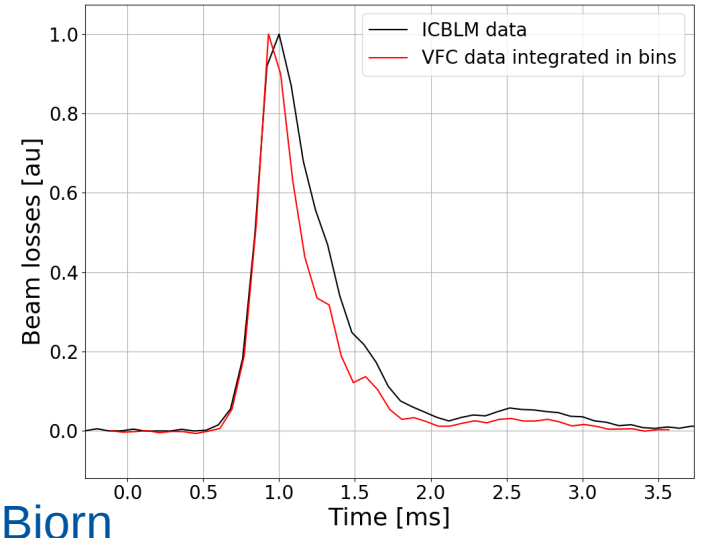


Arek & Stefano

UFO studies

- Use of the new readout trigger (12 events captured)
  - Blown up (h/v) non-colliding bunches during physics
  - Additional 14 events
- Location of UFO, movement
- Comparison to simulation (size, element)

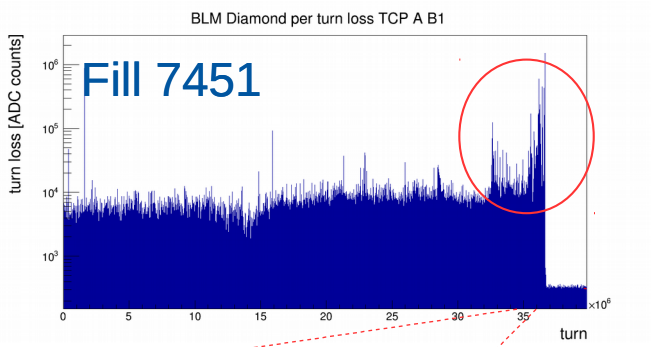


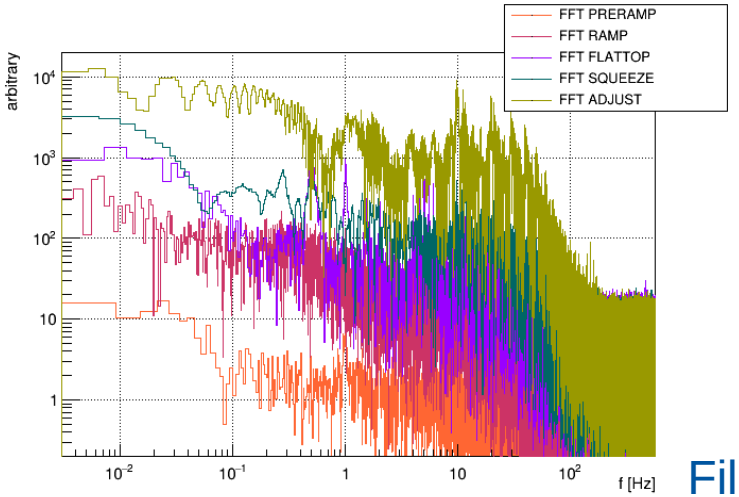


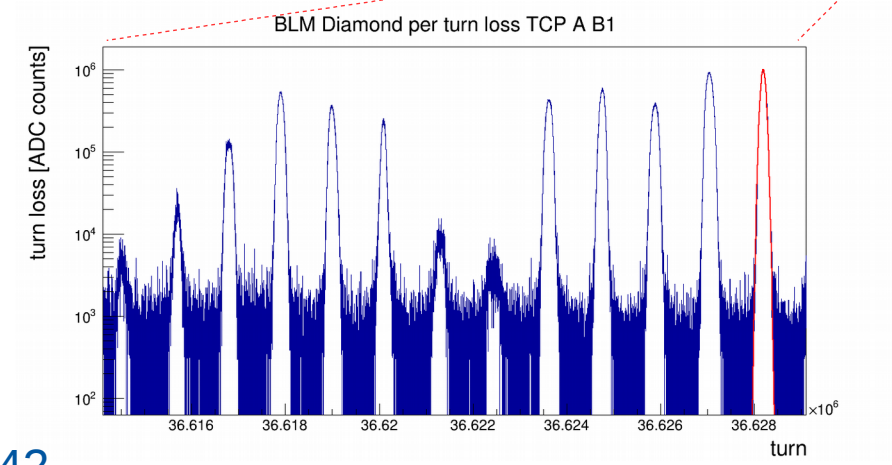
Mika & Bjorn
https://indico.cern.ch/event/815997/

10 Hz oscillation

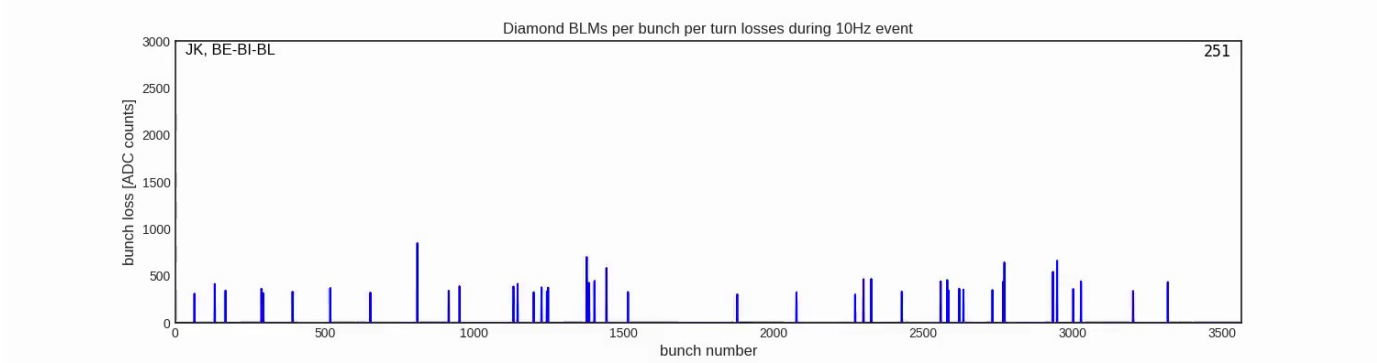
- Waveform data
- Per turn integrated loss FFT





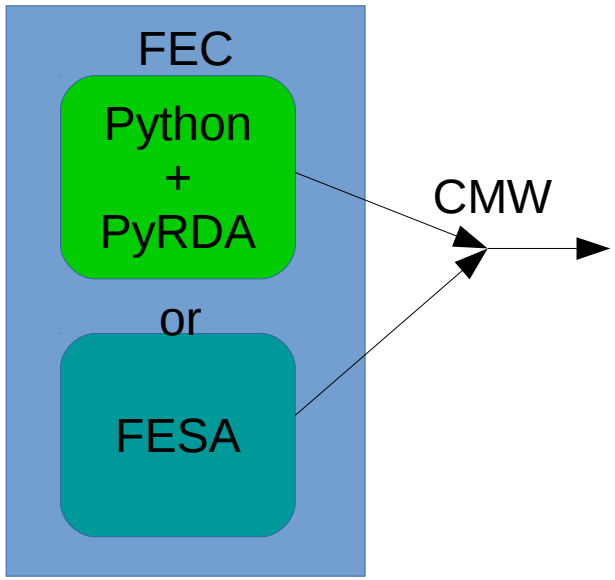


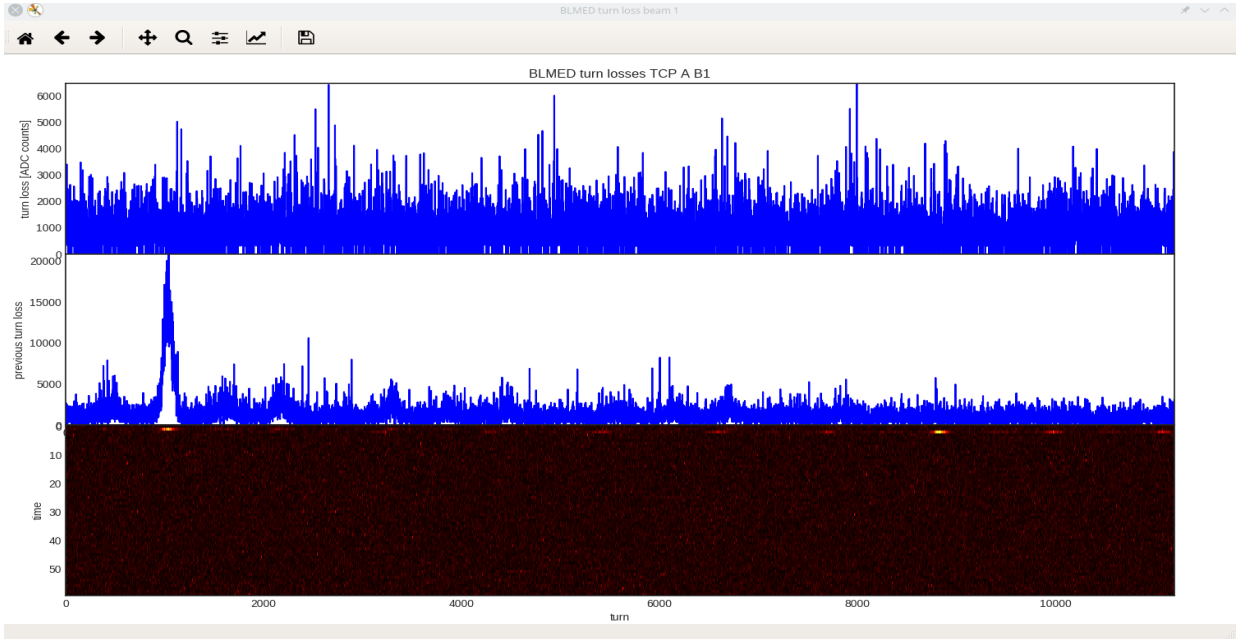
Fill 7442



LHC online monitoring

- IP7 TCPA, TCPD and 17L2 operated with PyRDA
  - On-line monitoring and NXCALS archival
- IP7 TCHSS devoted to FESA development Manuel
- UI running at CCC Magdalena
  - Data from all monitors

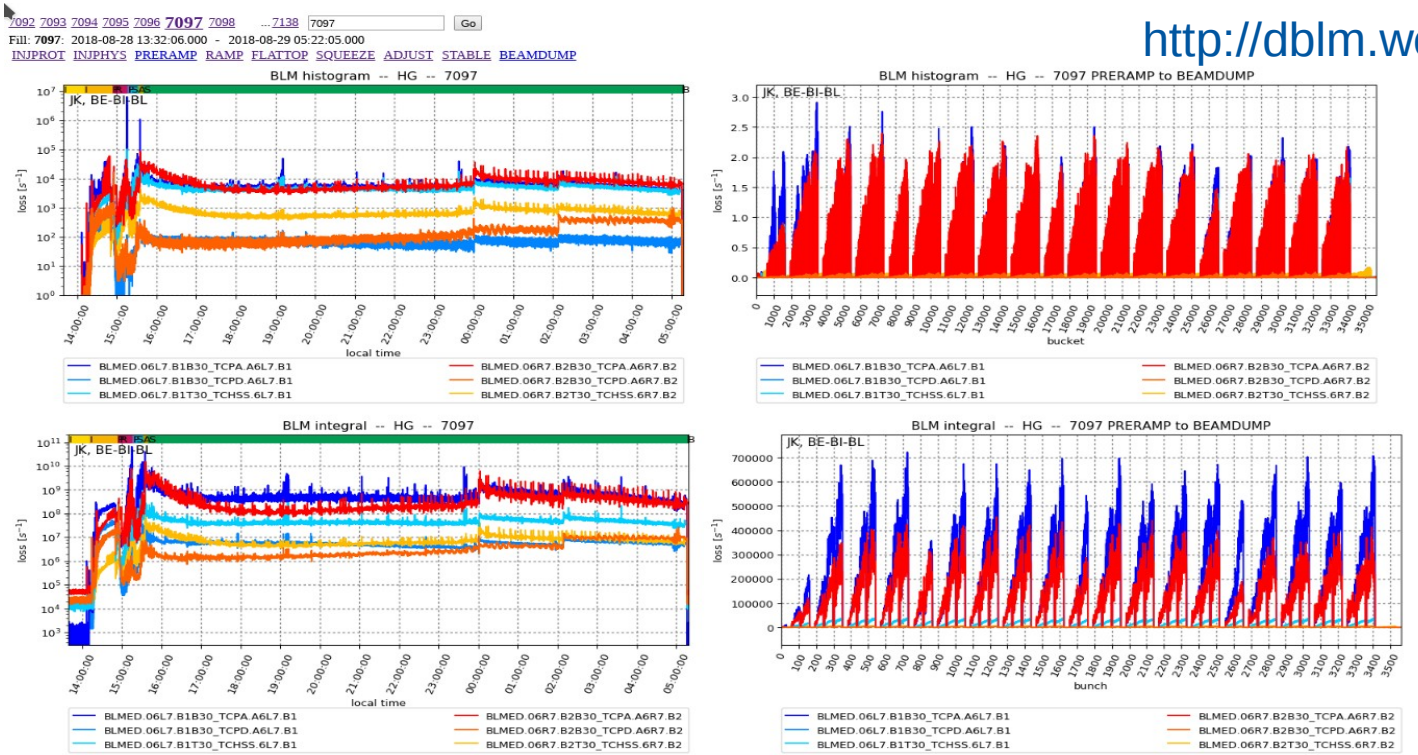




Data availability in NXCALS

- Wiki:
  https://wikis.cern.ch/display/BEBI/BLM+Diamonds+Data+Analysis
  https://wikis.cern.ch/display/BEBI/NXCALS+How+to
- Per bunch (~1s integration), Per turn, Histogram (counter), Distribution

http://dblm.web.cern.ch



Before Run 3

- Install at PSB
- Improve and calibrate analog chain
- FESA development

Summary

- Diamond Beam Loss Monitors proved to be functional loss detection system
  - Per bunch loss measurement
- Readout HW was upgraded during 2018
  - Triggered waveform and per bunch data already used for studies (2018 still in development)
- Pioneered data archival in NXCALS and heavy PyRDA usage