



# New dIdt interlock for SPS: planned technical implementation, thresholds and protection scenario

Kevin Li

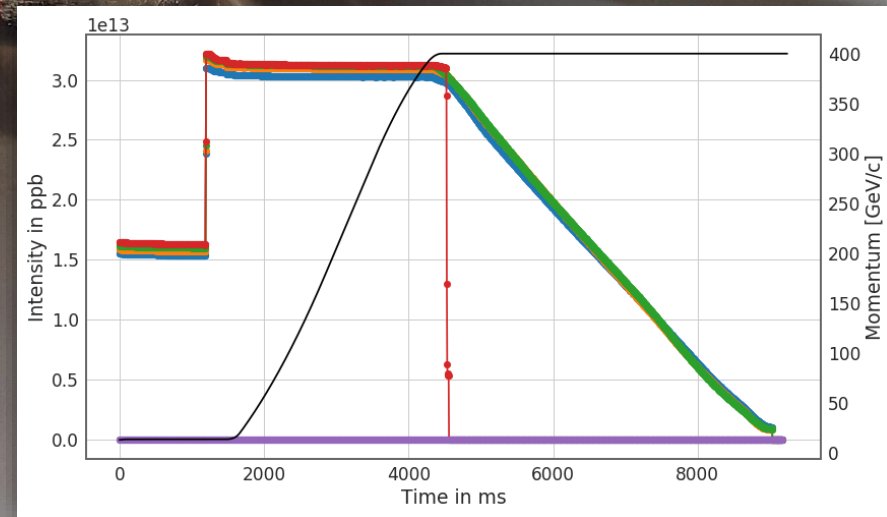
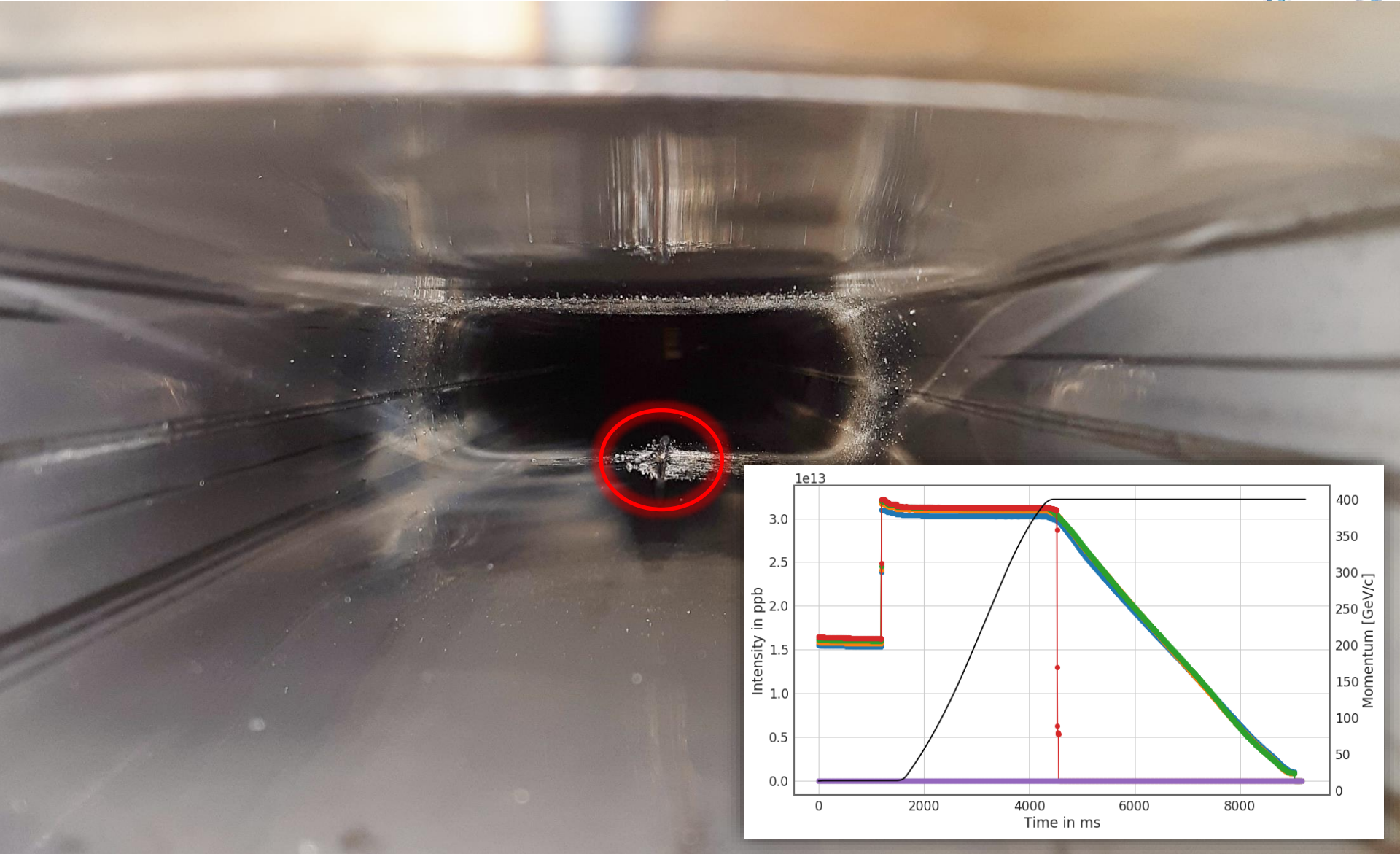
**14. December 2018**

# Summary



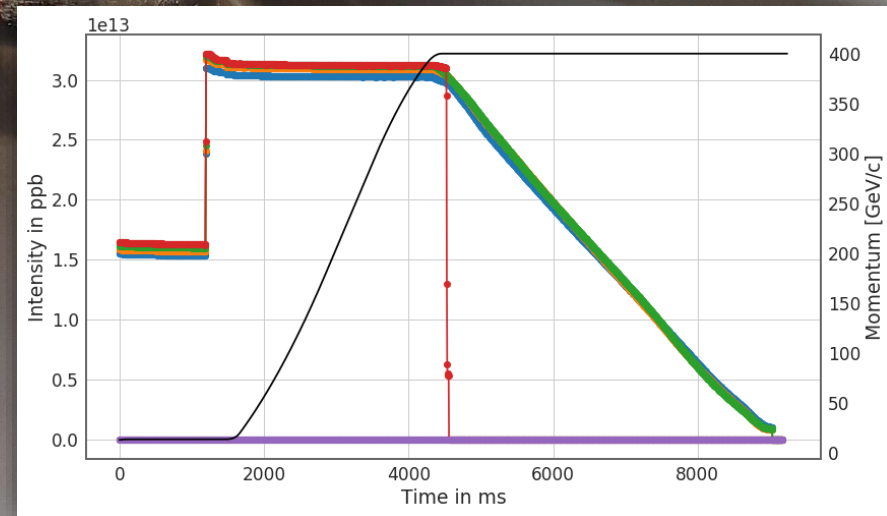
- Follow-up from the meeting on 31<sup>st</sup> August at the 168th SPS and LHC Machine Protection Panel Meeting (<https://indico.cern.ch/event/780348>)
- Discussion with BI at the BI-TB on 15<sup>th</sup> November at the BI-TB (<https://indico.cern.ch/event/765294>):
  - dl/dt interlock
  - BLM software upgrade
  - BPM ALPS upgrade
- Specification document in preparation:
  - SPS-B-ES-0005-00-10 (<https://edms.cern.ch/document/2038204/0.2>)

# Why?



# Why?

- Only diagnostics for general fast failures in the ring are our ring BLMs. These have a very low response time of 20 ms.
- For extraction, we also have the extraction BPMs. There is the 30 mm interlock, but not sure whether this is actually still working.



# dl/dt interlock

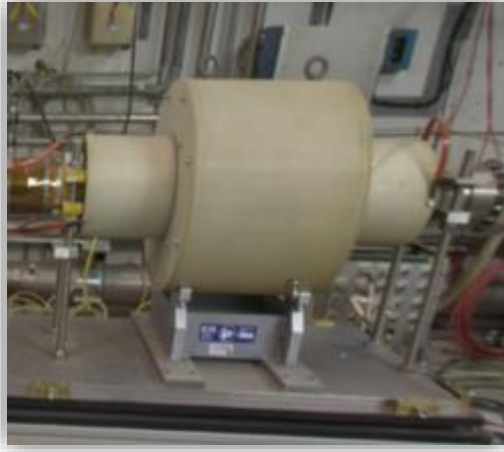


- Spot fast changes in intensity – could use the BCT(?)

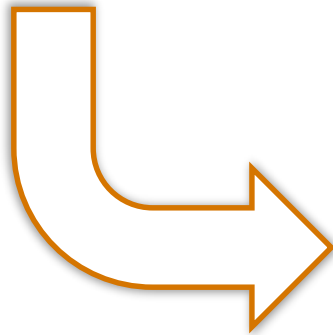
Integration time	Total loss threshold	Average loss rate	Comments
1 ms	3e11 p+	3e11 p+/ms	ppm
10 ms	1e12 p+	1e11 p+/ms	ppm

- Two different integration times with **configurable threshold settings** (ppm).
- Response time **of 1ms**.
- Dedicated **input to the BIS** and maskable at this level.
- Fire when threshold levels are crossed; simultaneously latch the SIS.
- Problematic with **programmed dumps or fast extraction** can be handled by implementing additional logic on the SIS (interlock is fine but prevent latching).

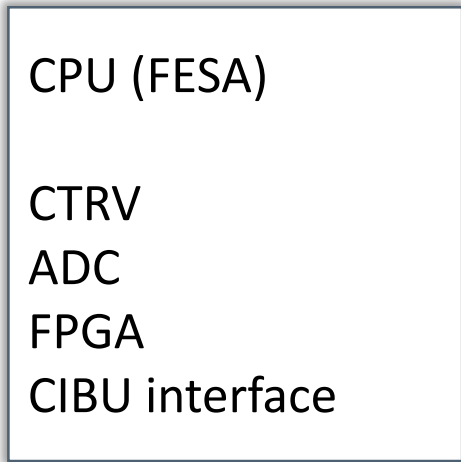
# Technical implementation for beam intensity loss interlock



DC BCT detector in LSS5

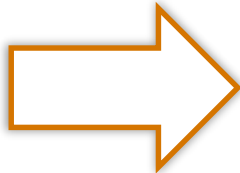


**Analogue output proportional to beam intensity**  
**(calibrated mV / 1E10 charges)**



BI VME crate in BA5

**Requested and expected during LS2**



Courtesy L. Jensen



[www.cern.ch](http://www.cern.ch)



# BLM software upgrade



- Reduce response time of BLMs to become practical; implementation of running sums to narrow down thresholds.

Integration time	Adjustable threshold	Veto	Enable/disable
1 tick	Yes (ppm)	1 per device (ppm)	ppm
5 ticks	Yes (ppm)	1 per device (ppm)	ppm
200 ticks	Yes (ppm)	1 per device (ppm)	ppm
500 ticks	Yes (ppm)	1 per device (ppm)	ppm
Full cycle	Yes (ppm)	1 per device (ppm)	ppm

- Response time **of 2ms is highly desirable** as clearly indicated by the use cases that occurred during this year.
- One veto ppm per running sum and per device → would **effectively add a factor 4 to today's number** of veto fields.
- One channel **input into the BIS** which will be maskable (signals combined in OR configuration; a veto from any running sum on any device will trigger an interlock)



# ALPS interlocks

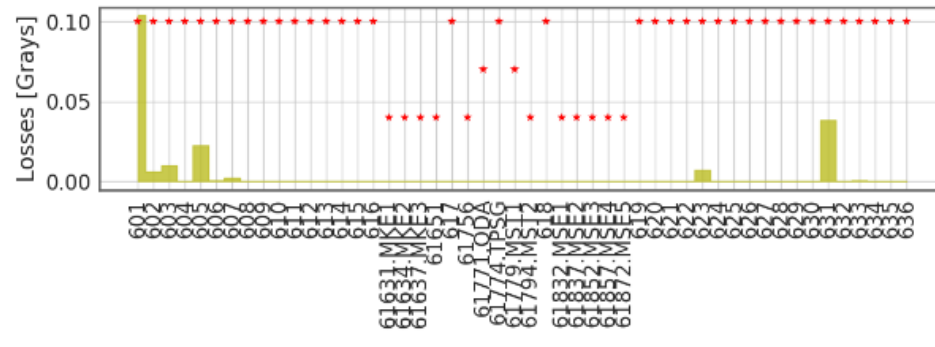
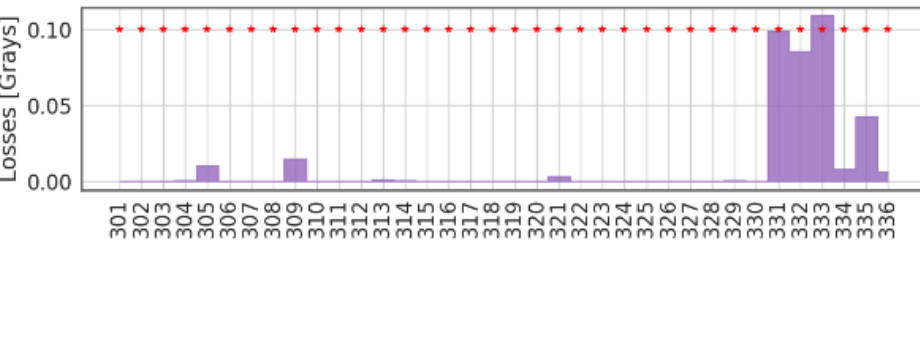
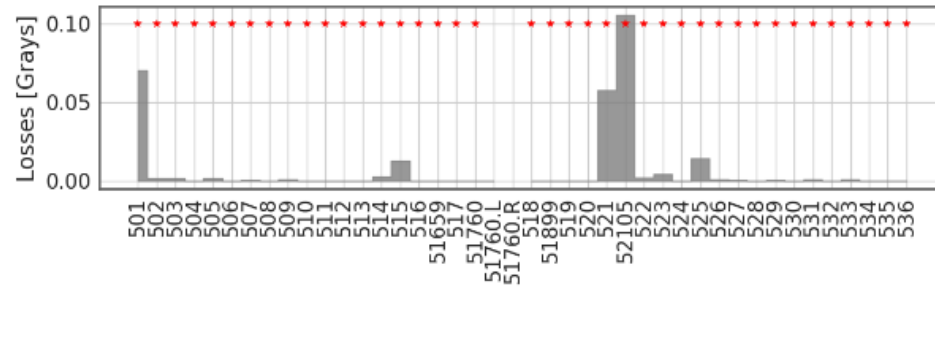
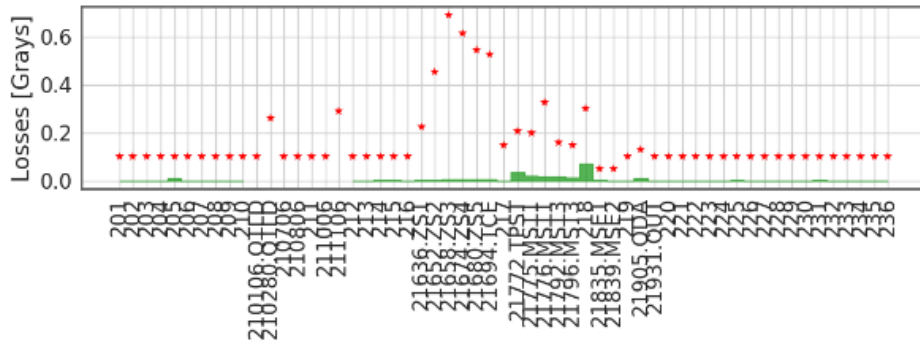
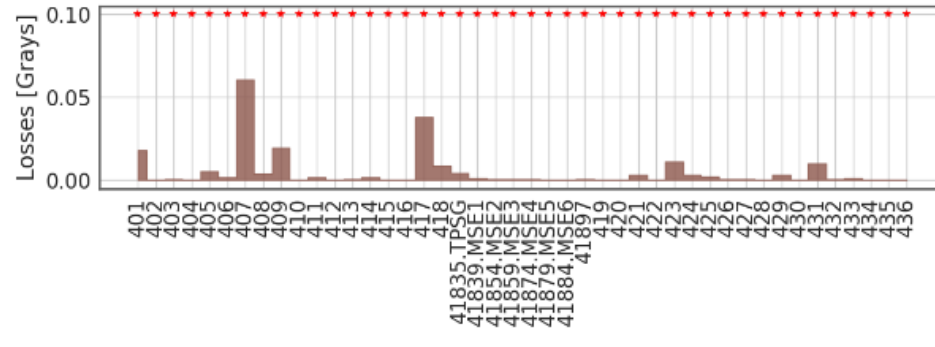
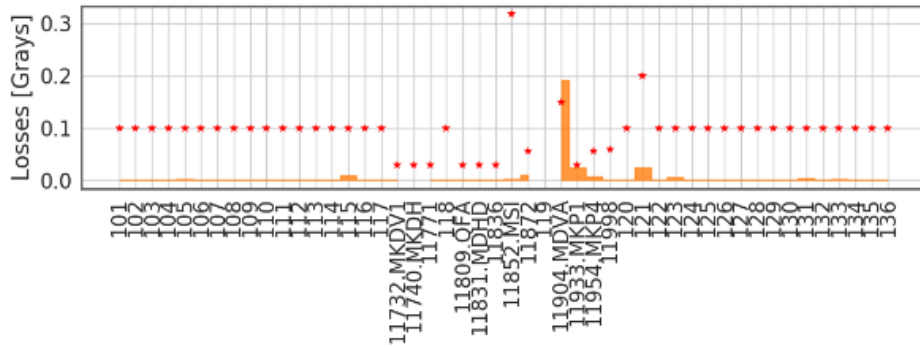


- Spot excessive excursions from orbit – very fast response time at the level of turns.
- Currently for the extraction interlock BPMs, **we allow a 0.5 mm RMS window**. The extraction beam permit must be given no later than 15 ms before extraction takes place.
- We normally give a time **when to measure** in the cycle (delay from some event) and **the number of turns to measure** (typically between 220 and 440 turns). It would be **more practical to have this in ms before extraction or in ms after injection**. Total measurement time can be up to 20ms.

LHC.BPMXA416.B1	LHC.BPMSLA4R6.B1	LHC.BPMSLA416.B2	LHC.BPMXA4R6.B2	ALL
User: ALL	User: ALL	User: ALL	User: ALL	User: User
horMinDumpPosition: -3.6	horMinDumpPosition: -3.3	horMinDumpPosition: -2.7	horMinDumpPosition: -3.8	0
horMaxDumpPosition: 3.4	horMaxDumpPosition: 3.7	horMaxDumpPosition: 4.3	horMaxDumpPosition: 3.2	0
verMinDumpPosition: -3.7	verMinDumpPosition: -3.3	verMinDumpPosition: -3.3	verMinDumpPosition: -3.6	0
verMaxDumpPosition: 3.3	verMaxDumpPosition: 3.7	verMaxDumpPosition: 3.7	verMaxDumpPosition: 3.4	0
bunchCntWin1: 70	bunchCntWin1: 70	bunchCntWin1: 70	bunchCntWin1: 70	0
bunchCntWin2: 250	bunchCntWin2: 250	bunchCntWin2: 250	bunchCntWin2: 250	0
turnCntWin1: 100	turnCntWin1: 100	turnCntWin1: 100	turnCntWin1: 100	0
turnCntWin2: 10	turnCntWin2: 10	turnCntWin2: 10	turnCntWin2: 10	0

- For the future system to be effective, **a reaction time of the order of 1-2 SPS turns** is required. The system should directly dump the beam by providing an input to the SPS Ring Beam Interlock loop. To avoid issues with injection, the **position interlock must not be active in a window of a few ms around each SPS injection**.
- It must be possible to define the maximum amplitude for the interlock and a simple filter on the data (even if at the expense of the reaction speed).
- The exact BPMs to be equipped are being identified. For the moment we have is one BIC channel in BA1.

# Loss profiles from half-integer



# Loss profiles from damper trip

