Analysis of SIS interlock triggering in 2017 run and outcome of dedicated beam tests

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LHC Collimation Working Group #221 - Joint MPP

Outline

1. Interlocking concept and motivation **RECAP**

2. Validation status **RECAP**

   - Log file **RECAP**

   - Log file NEW

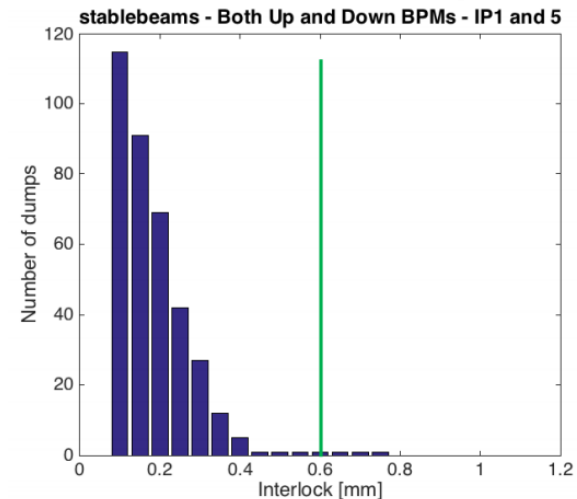   - Dedicated Tests with a beam

3. Summary

Motivation

SIS follows the **collimator beam center** measured from the **embedded BPMs**.

Following the TCT BPM performance analysis *(A.Mereghetti et.al, Evian2016)*

- 600 μm interlock limit was set (from 2016)

In addition to the analysis of orbit quality/stability, this **new analysis of sis logs will also provide an assessment of the overall chain**, addressing the complete implementation (status of acquisitions, etc) and **the reliability**.

Motivation

- The SIS produces the log file for **EVERY** interlocking case.

Current SIS implementation:

- ❏ All collimator BPM interlocks are running reliably (at least on the SIS side).
- ❏ All interlocks are in the interlock tree, but are currently <u>masked</u>.
- ❏ The interlock limits are currently set to 4σ except for:
  - ○ 1σ in IR1 and IR5 at $\beta^* = 40$ cm,
  - ○ 1.5σ in IR6 at $\beta^* = 40$ cm (linked to IR5 β^*),
  - ○ 2.5σ in IR8 at $\beta^* = 3$ m.

J.Wenninger, 127th MPP meeting

How many (false?) dumps we would have, if in 2017 we use 2016 analysis result?

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The SIS Log File

```
2017-05-25 22:49:43,004 [EventUpdaterThread-null-5] ERROR BpmCollimatorCenterValueCondition...
adc97491-418b-11e7-843f-0f3eb12d931c =>
*** Collimator beam center [SISREF_TCTPV_4R2B2 / BPTUV_A4R2B2_ACQ - BPTDV_A4R2B2_ACQ] :
 Beta @ collimator         =      101.7 [m] for beta* =     10.00 [m] @ IR2
 Beam sigma @ collimator =    0.232 [mm] with tolerance = 4.00 [sigma] @ E =   6499 [GeV] - emit =
3.5 [um]
 Up   BPM position =   -1.123 [mm] -   -121 [tol %] status = true
 Down BPM position =   -1.193 [mm] -   -129 [tol %] status = true
 Dump count =
2017-05-25 22:49:45,003 [EventUpdaterThread-null-5] ERROR
BpmCollimatorCenterValueConditionExtImpl aefaa191-418b-11e7-843f-0f3eb12d931c =>
*** Collimator beam center [SISREF_TCTPH_4R8B2 / BPTUH_A4R8B2_ACQ - BPTDH_A4R8B2_ACQ] :
 Beta @ collimator          =      234.5 [m] for beta* =       3.00 [m] @ IR8
 Beam sigma @ collimator =     0.352 [mm] with tolerance = 2.50 [sigma] @ E =   6499 [GeV] -
emit =    3.5 [um]
 Up   BPM position =     2.899 [mm] -     329 [tol %] status = true
 Down BPM position =     3.101 [mm] -     352 [tol %] status = true
 Dump count =
2017-05-25 22:49:45,003 [EventUpdaterThread-null-5] ERROR BpmCollimatorCenterValueConditionExtImpl aefaa191-
418b-11e7-843f-0f3eb12d931c =>
*** Collimator beam center [SISREF_TCTPV_4R2B2 / BPTUV_A4R2B2_ACQ - BPTDV_A4R2B2_ACQ] :
 Beta @ collimator          =      101.7 [m] for beta* =     10.00 [m] @ IR2
 Beam sigma @ collimator =     0.232 [mm] with tolerance = 4.00 [sigma] @ E =   6499 [GeV] - emit =   3.5 [um]
 Up   BPM position =   -1.123 [mm] -   -121 [tol %] status = true
 Down BPM position =   -1.194 [mm] -   -129 [tol %] status = true
 Dump count =
```
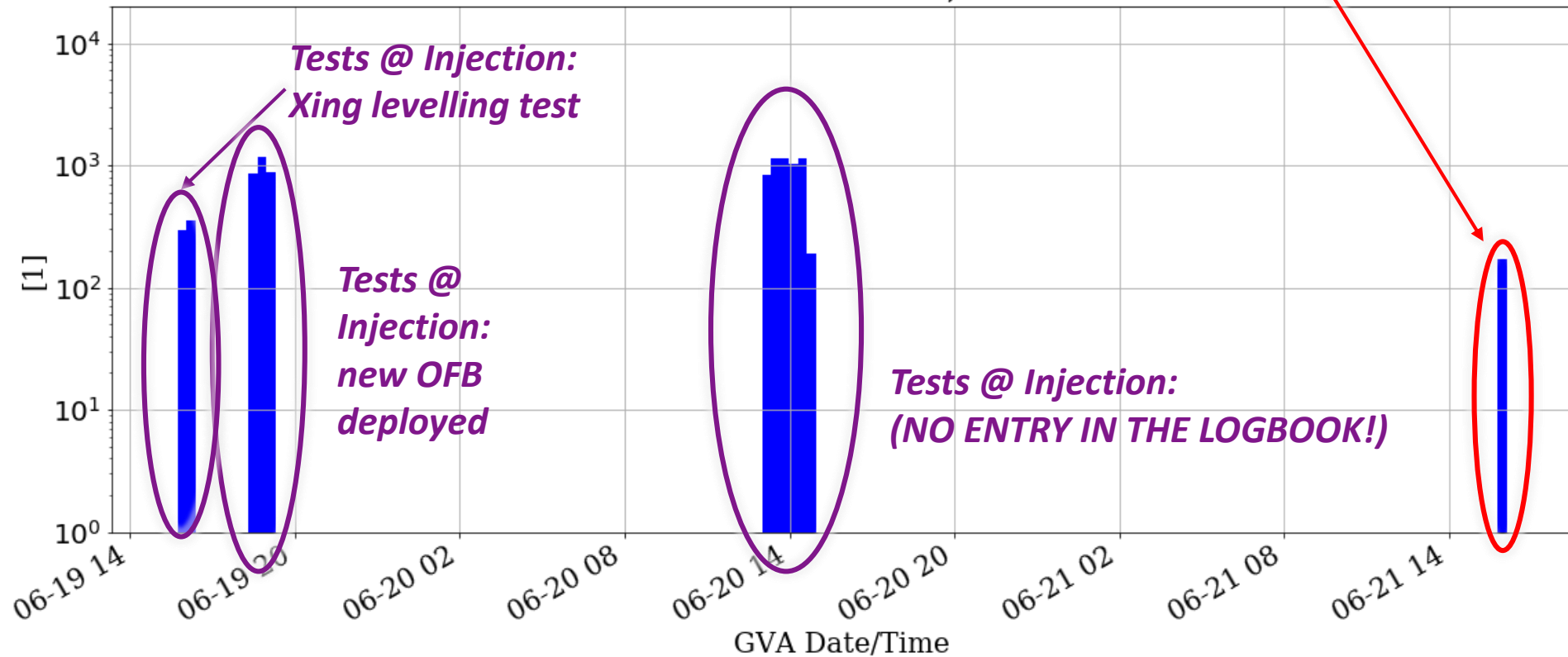
June (as from 4th)

Operation related interlocks - potential dump cause?

RECAP

TCTPH, R2 B2
*(orbit excursion, **5850** Dumped by **IR6 BPM**)*
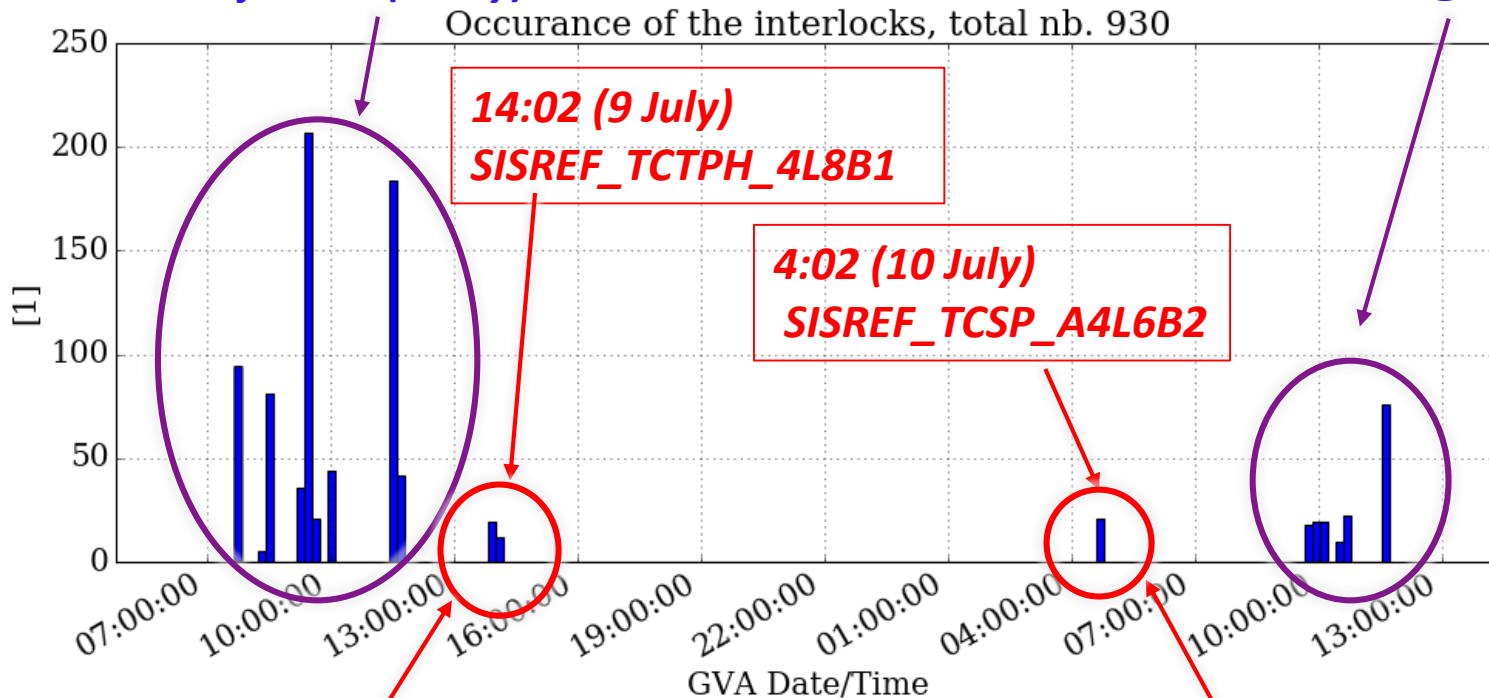

Occurance of the interlocks, total nb. 9265

Tests @ Injection:
Xing levelling test

Tests @
Injection:
new OFB
deployed

Tests @ Injection:
(NO ENTRY IN THE LOGBOOK!)

July 9-10

Operation related interlocks - potential dump cause!

SIS Tests @ Injection (9 July)

SIS Tests @ FT (10 July)

14:02 (9 July)
SISREF_TCTPH_4L8B1

4:02 (10 July)
SISREF_TCSP_A4L6B2

LogBook 14:06: *RCBH16.R8B1 tripped with feedback off.* **Lost beam 1 therefore***.*
We will refill directly and re-attempt.

No Logbook entry about orbit drifts etc.
no beam dump by something else

Both cases a gentle rise of the tolerance exceed is recorded... orbit drift.

July, after SIS test, before the 24ᵗʰ

- SIS server left with logging option ON
  - That means **ALL logged checks** also the ones with not tolerance exceed were saved…
  - … therefore log file was flooded with 'normal checks' and over rotate the buffer…
  - **No representative data can be found!**

Procedure for the beam tests

- We moved collimators by 3.5s (or ~90% of the interlock) to not trigger the interlock.

  - *Noted down the meassured vs expected tolerance budget used,*

- We moved another 15% (remaining 10 plus some to trigger)

  - *When interlock was triggerd we moved back to original position and moved to another channel*

- If needed repeated with small steps of ~5% to hit the triggering levels.

Results from the beam tests

- Injection (Sun 9 July) tests:

  - All channels passed the test, with one remark.

  - IP2 tolerance difference: 4σ expected ~6.5σ found.

    - Discrepancy comes from the ATS optics in IP2:

      - Beta* does not change while beta at TCT goes from 40m to 80m.

      - SIS mechanics follows the beta* change, and was only with one value (80m)

    - To decide: change the limits?

Results from the beam tests

- ## Flat top/ squeezed (Mon 10 Jul):

  - ### **All channels passed the test!**

  - ## One channel (IP1 B2 V) had wrong tolerance: 1σ was expected 4σ found

    - ### Fixed!

  - ## IP8 tolerance (logged by SIS) found at 2.95σ...

    - The optics correction was applied and it modified the β^*: 3.03m instead of 3.0m,

    - thus the interpolation from SIS modified the initial 2.5σ to 2.95σ

    - Understood, to be changed!

Miscellanea (1)

- As another outcome of the test we propose to consider to include more smooth change of the limits:
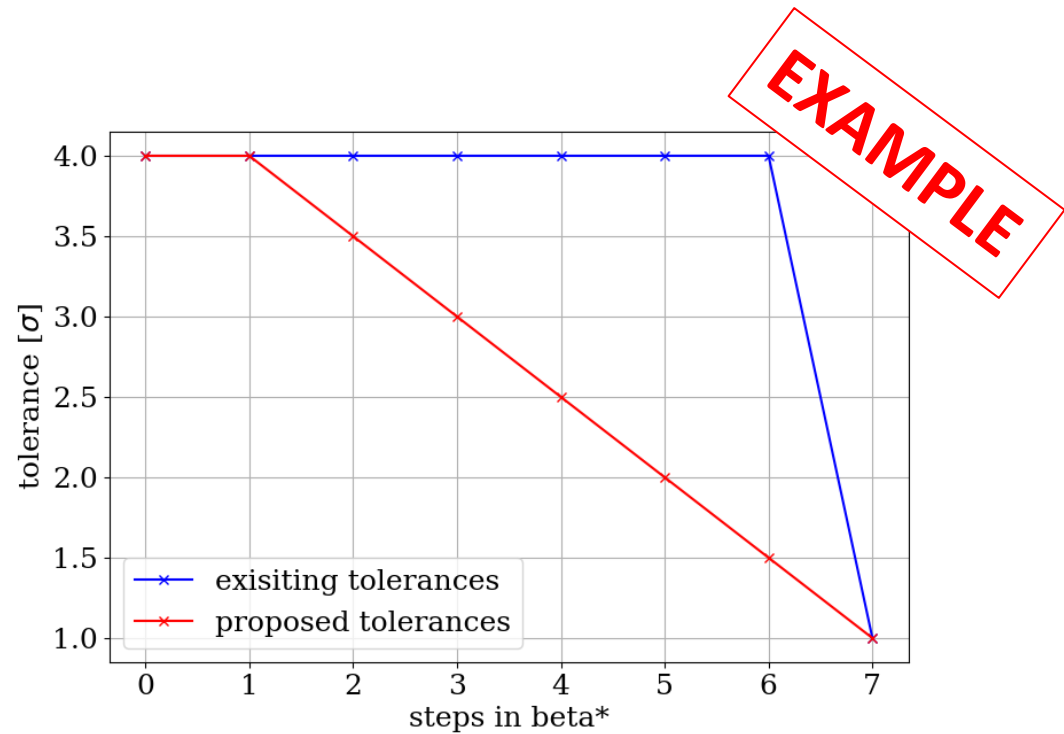
Miscellanea (2)

- **No** signature of **IP1 TCTPH (B1/B2)** being logged (in the data from month of June)

    - *Check if imported to SIS!*

    UPDATE (after the SIS test):
    IP1 TCTPH (L1/R1) did appear in the logs from the tests!

Summary

- No spurious triggers, however:

  - **One dump trigger** (back in June) case where beam was dumped by another interlock (IR6).

  - Another two in July (SIS WE tests), **one dumped** by another means **one unknown**…

- Dedicated beam tests ultimately qualified the supervised channels.

  - Revealing some inconsistencies that are fixed by now!

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