What is missing for higher intensity injection?

SPS EXTRACTION, TRANSFER LINES, INJECTION

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Introduction

- Many things are already well covered

- Will discuss...
  - ...dangerous failures not covered yet
  - ...failures which are covered but stress the protection system unnecessarily

- ! indicates that should be done before next step in intensity

SPS Extraction

- Bumpers pulsing on destination

If during trial for overinjection: BQM in SPS interlock (wrong attenuation, blow-up but threshold not changed, re-phasing,...), FMCMs in the TL, BPF flickering,...

→ kick out the circulating pilot →

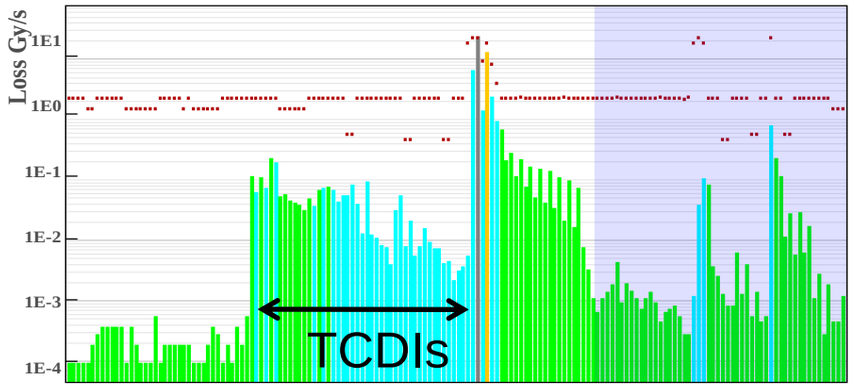
- SPS beam permit and extraction permit to injection BICs
  - ...repetition is error prone (copy of steering,...)
  - Must be failsafe solution: not to risk dumping full batch on the TDI (“don’t stress the MPS”)

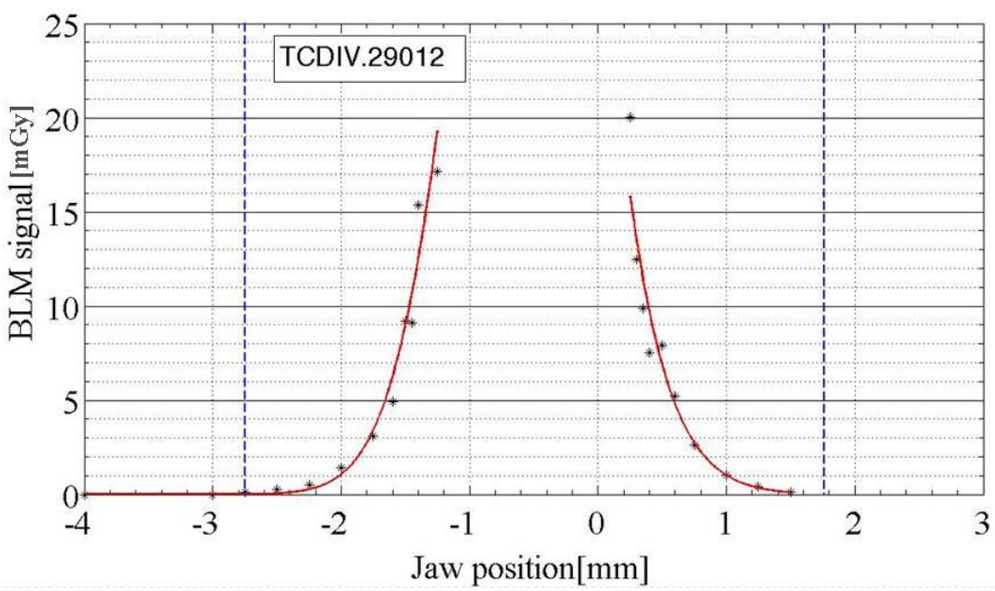
- Master BIC
  - Still need to test the LHC SBF -> master BIC
  - Still need to test and prepare our tools for forcing the LHC SBF

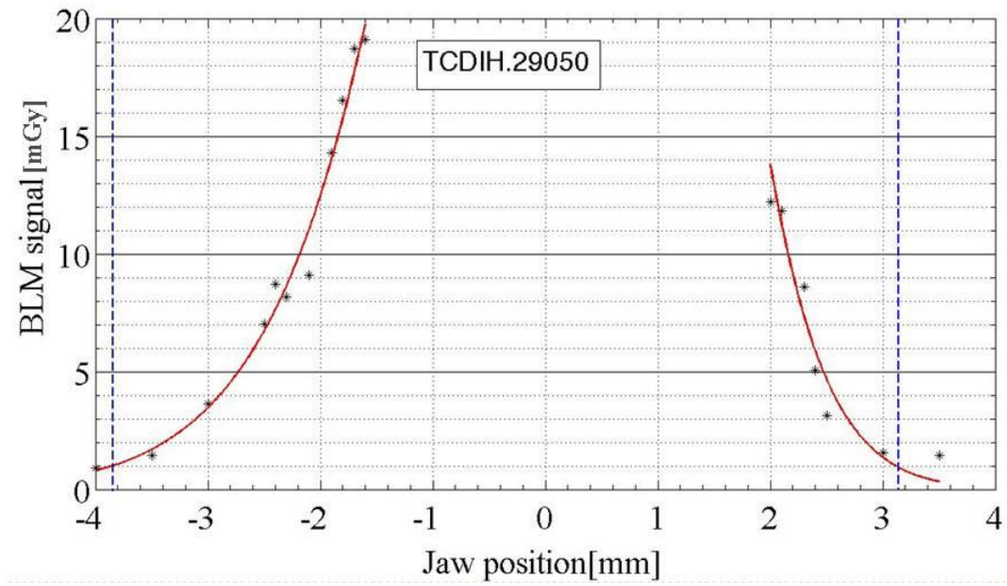
!

Transfer Lines (1)

- Transfer line collimators TCDI
  - Still need to verify specified protection level !
  - Automatic TCDI setup/optimisation tool
  - Problem of losses on adjacent BLMs to be solved in a safe way for higher intensities
  - Adjusting IQC thresholds on adjacent LHC BLMs... !
    - Will trigger in case of large emittances from the SPS or setup no longer good:
      - To distinguish between the two (after SPS checks), run quick optimisation in inject & dump !
  - Multi-bunch extraction should be checked as well: MKE ripple with very tight settings of TCDIs







Tail scans with the TCDIs in vertical and horizontal plane. Horizontally potential issue with high intensity

Transfer Lines (2)

- TCDIs do not have energy gaps!!
  - The TCDIs are moved out before each fill – and the thresholds as well.
    - If there are parking settings loaded, the TCDIs do not interlock.
  - Would prefer to go across the thresholds without blocking but interlocks for the TCDIs ONLY

- Injection Steering !
  - Need to be careful...moves trajectory at TCDIs as well.
    - Need to define proper reference and proper tolerances for steering at the TCDIs
    - Possibly restrict the correctors used for steering: operational injection damping could also help us with larger oscillations allowed
  - COPY...LHCFAST1 -> LHCFAST2 !
    - This is part of the procedure, but no additional check or interlock.
    - ...single pass failure

LHC on & LHC @ Injection Settings (1)

- Power converter hardware settings and state: many things covered through SIS (doglegs, separation dipoles, experimental magntes+compensators,...), BETS LBDS, task in sequencer, PIC.
  - BUT: Orbit corrector trips just before injection of high intensity? BPF. But: distorted orbit + injection oscillations? Orbit surveillance in SIS does not work when sensitivity switched. !
  - Quadrupoles,...higher order stuff (sextupoles)?

- Undulator for abort gap monitor (plus PM) !
  - Checked in SIS

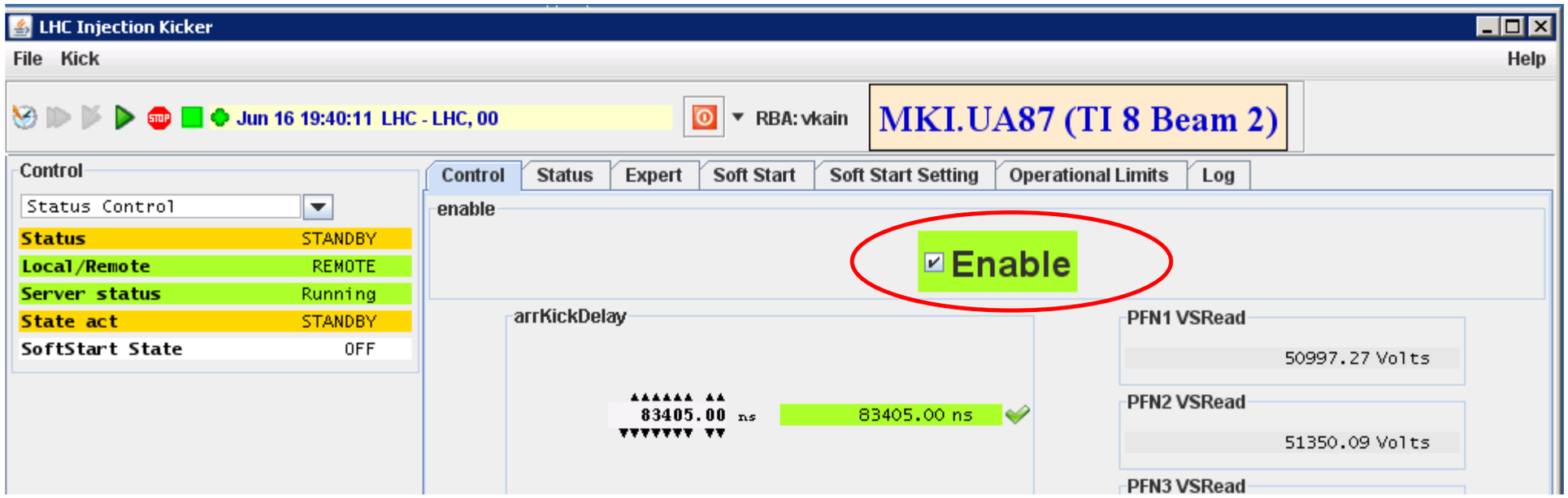
LHC on & LHC @ Injection Settings (2)

- No checks for RF
  - No check for settings (not enforced to ramp RF to injection settings...would not re-phase).
  - Need interlock on RF on/off...through the ring permit (maskable for asynch dump tests). !
  - Could be on local frequency in the SPS...is the BQM covering us against this?

- No checks for injection protection
  - TDI and TCLIs do not have energy gaps
    - Are moved to parking before each fill. With parking settings they do not generate an interlock
  - All relies on following the sequence strictly
  - Could we think of doing something short term? !

Injection Kickers

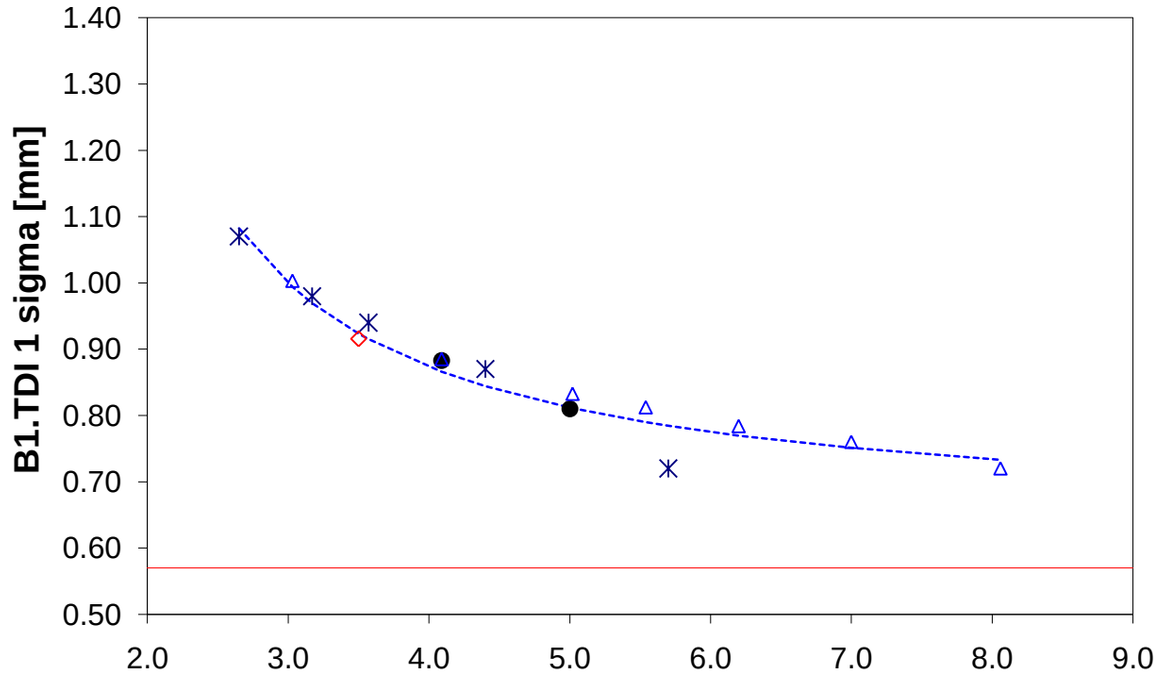
- Can ask for full intensity injection with kickers disabled. !
  - can easily check this in the SIS
  - do we need the possibility to disable the kicks in operational mode, could be only expert mode (RBAC)

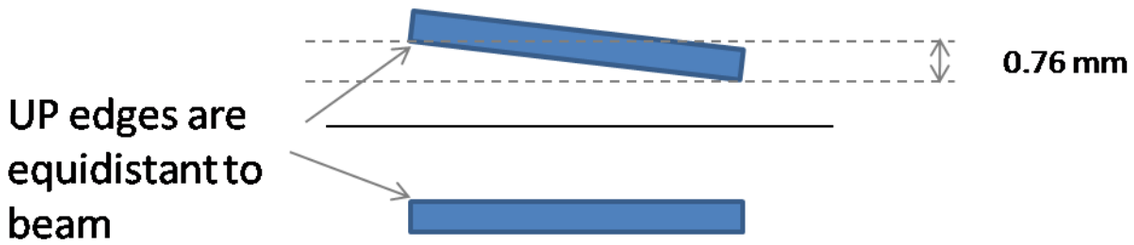


- MKI BETS error or AGK interlock do not remove the injection permit, but just inhibit the kicker.
  - ...beam ends up on the TDI
  - Should we not rather the remove the injection permit. This would also remove the extraction permit.

Injection Protection

- TDI+TCLIs
  - TDI gap discrepancies
    - Explanation so far misaligned jaw
  - Still needs to be checked for B1 !
  - Adjustment then needs to be checked with beam. !





- Verify required protection level !

- Need to make sure to use correct reference orbit. Which tolerances? !

Beam Instrumentation

- Screens
  - Go again through SIS interlock logic, make sure that is not too constraining and make it unmaskable
- BPMs – high/low sensitivity
  - Before the first high intensity injection we take out our excursion interlocks and are essentially blind positionwise

- BLMs
  - Still masking BLMs around the injection points to do overinjection. Is that working now or not?
  - BLM thersholds close to the TCDIs ↔ scraping in the SPS

Injection Sequencing

- Can overinject on a nominal intensity bunch.
  - Otherwise SIS injection bucket interlock

- Injection scheme editor:
  - Can program anything...we need the flexibility
    - E.g. Injection into abort gap
  - Maybe sanity check for entered schemes would be good (checks for abort gap, injection kick lengths + rise times,...)

- Injection sequencer:
  - Can jump around and clear the circulating bunch configs...
  - Injection schemes interleave beam 1 and beam 2...error prone if you lose one beam and have to refill only one.
  - The interaction with the IQC helps not to get lost in case beam was not injected or lost on the TDI, but it does not prevent from overinjection. SIS injection bucket interlock

Summary

- Many things are covered
- Some holes still in our protection against failures during injection.
- Some of them should be addressed as soon as possible:
  - Problem of sensitivity switching
  - TCDIs, TDI+TCLI: finish remaining issues
  - Multibunch injection: beam losses...
  - Injection steering issue