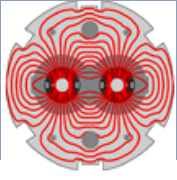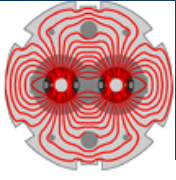# AGK situation and improvements

W. Bartmann, N. Magnin, L. Ponce, C. Schwick, J. Wenninger, C. Wiesner

MPP, 22-Sept 2017

8b4e: implications on injection

Morning meetings – M.Zerlauth

22/09/2017

- 8b4e has 56 bunches in 80 bunch slots per PS batch
  - two PS batches injected into LHC: 112 bunches in 168 bunch slots

- The MKI was set up for 144 bunches (3 x 48 BCMS) which require 160 bunch slots

- This caused the MKI to be too short by 8 bunches - injection still within tolerances
  - Losses on TDI from satellites good < 12%
  - Losses transversely also good
  - Injection oscillations show increasing oscillations for the last ~6 bunches, better visible for B1 than for B2

Courtesy W.Bartmann, N.Magnin et al
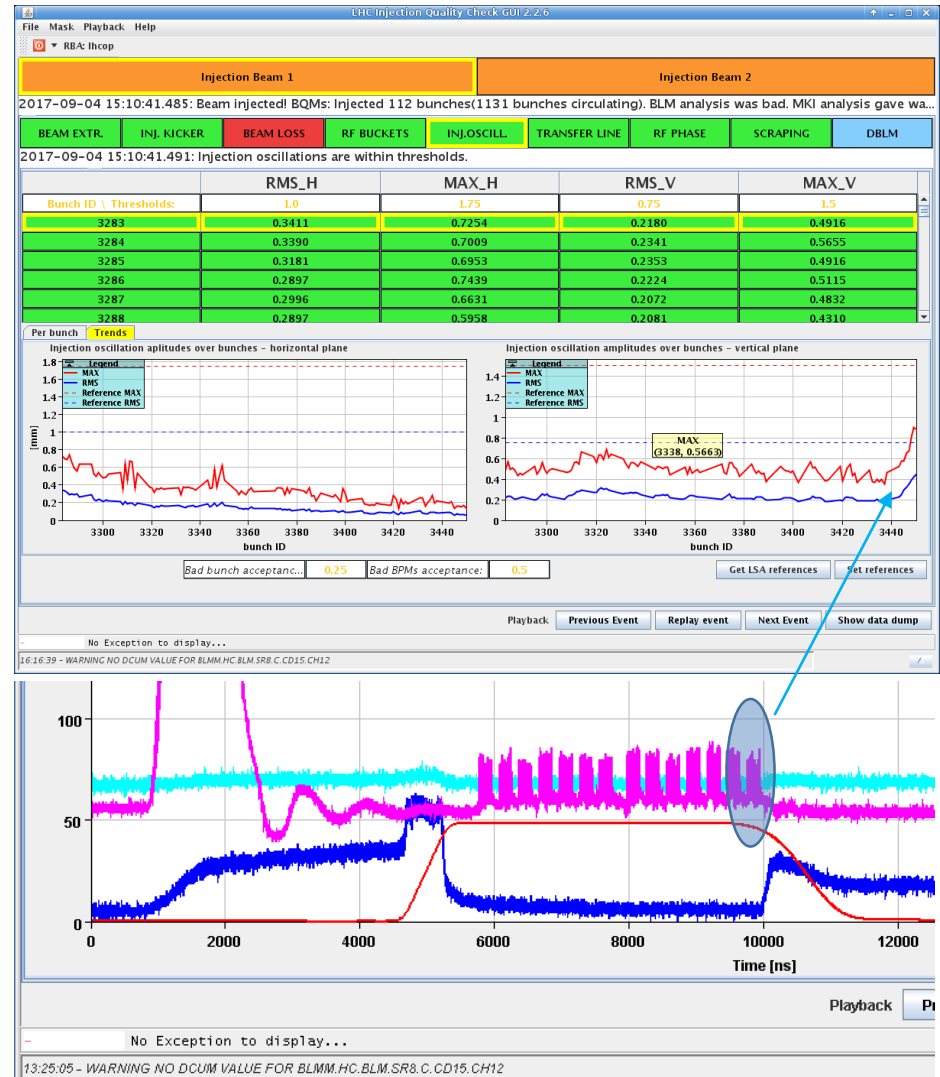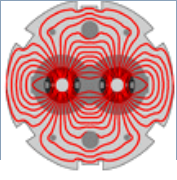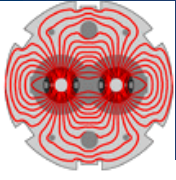
- The 8 bunches of the too long train entered into the abort gap
  - First bucket of last train is protected by HW – was respected and therefore not interlocked
  - Filling scheme of LHC requested the beam which was prepared in the injectors – OK
  - While requesting beam, warning message from injection sequencer that requested train is longer than MKI pulse – wrongly being confident that MKI length is sufficient, message was ignored

- Several e11 AG population (normally e9) → beam manually dumped by operator at the beginning of the ramp

- Dump clean in XPOC – AG population is monitored but not taken into account in the XPOC check

- TCDS shows higher losses than TCDQ during dump – assumption that the few bunches entering the AG were slightly kicked by the MKD rising edge - tbc
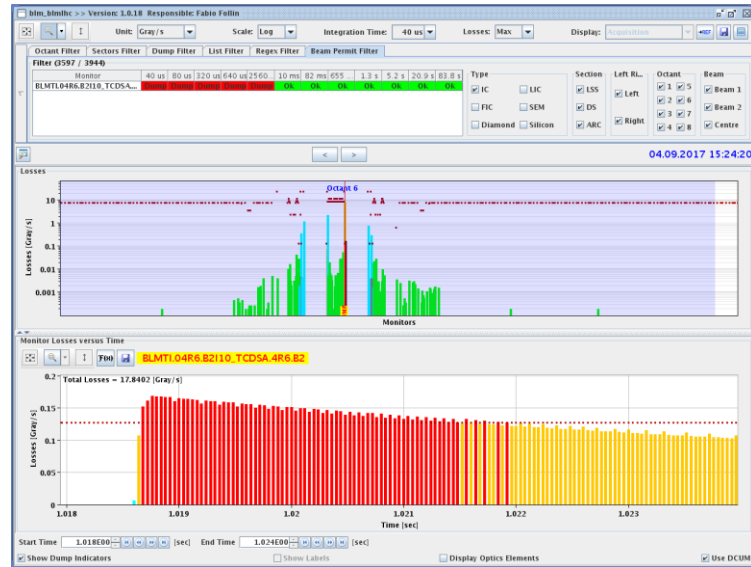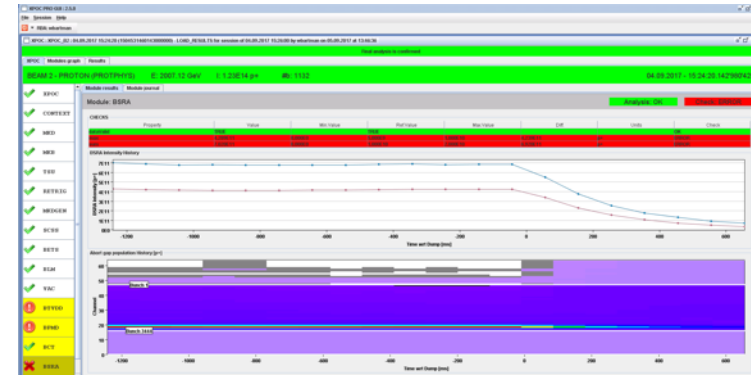
Courtesy W.Bartmann, N.Magnin et al

8b4e:implications on injection – Follow-up

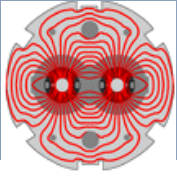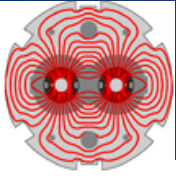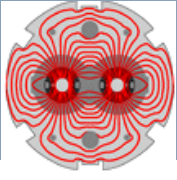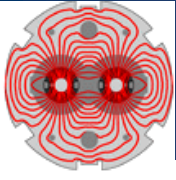- On spot discussion between coordination, machine protection, LPC and ABT with decision to clean up the situation immediately
  - Increased the MKI length and the AGK by 200 ns
  - Validated the new AGK edges --> OK
  - Filling scheme modified accordingly
  - Checked 112 bunch injections – injection oscillations not anymore increasing for last bunches
  - Injection of full train into last legal injection bucket worked, AG population normal (few e9)

- Message of train too long for MKI had to be overwritten also for this fill since the filling scheme used exactly what was allowed and SW checks for train < MKI length
  - Modified on TUE by Jorg and Delphine on following day to allow also exact match
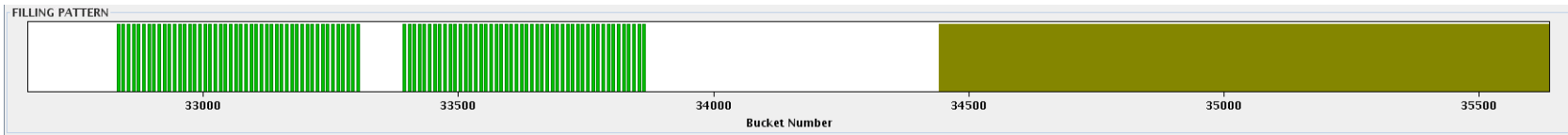 - Instead of pop-up window from now on injection is blocked

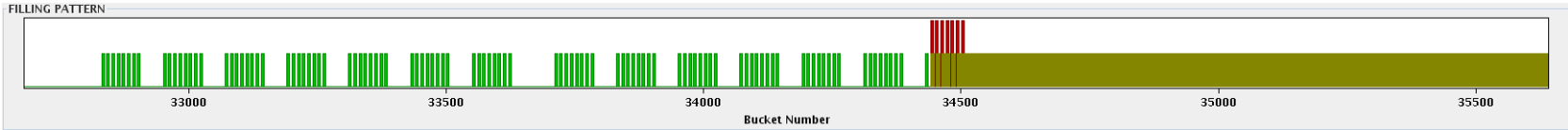Status now:

Safe and lumi optimised for 8b4e

Safe but conservative for 144 b (BCMS or standard beam) – lose 8 bunches of freedom

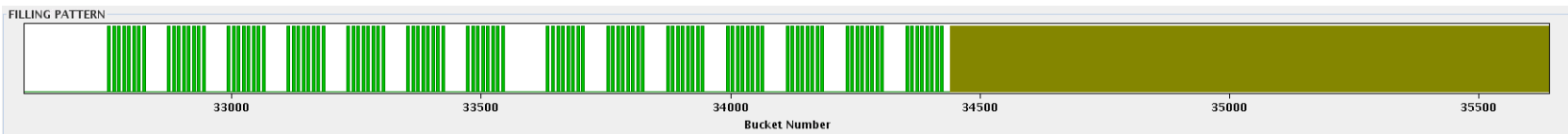Safer than before for any similar exercise due to blocked injection

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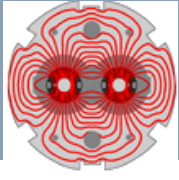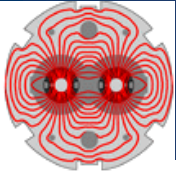**144b BCMS: 2x 72/25ns + 225ns:**

112b 8b4e: 2x80/25ns + 225ns:

112b 8b4e: Corrected filling scheme

22/09/2017

Further improvements?

- Immediate improvements already implemented
  - SIS blocks on the MKI length only (+ requested bunch), it does not know about the details of the injection request. The injection sequencer now blocks anyhow incorrect requests.
  - Sanity checks at time of filling scheme creation – done by Christoph

- Useful to be implemented?
  - Check AG population before start of ramp – very useful check, should this go in the sequencer, is this safe enough or can it easily be jumped over?
  - Anything we can add on SPS side? E.g using BPMs to count #bunches and compare with SIS settings?
    - Does not add anything wrt BQM SPS, BPMs publish too late in SPS cycle, reliability ??? SPS BCTs not reliable / accurate enough. BQM publication could be used in LHC, but is too late to act.
    - Presently bunch patterin is checked at flattop around rephasing; if we could check at beginning of the ramp should be early enough to block extraction
  - XPOC to clearly display and interlock on AG population – can be deployed; won't help when we inject but it gives at least a warning that something was wrong
  - Can we do anything on HW side?
    - …tough
  - Minor thing to be solved: IQC has a "last bucket for injection" which looks mysterious to me where it is coming from

- Procedural
  - Switching between beams always bears certain risks and must be subject to a
    minimum of validation!
    Presently need at least two people (critical roles for SIS and MKI) to do changes → probably better to keep
  - Should we establish something like a formal procedure with certain steps like rMPP approval of beam type/filling scheme changes? Annoying in operation but would very likely have caught the 8b4e case