LSA and the Lumi Server

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on behalf of the LHC Software and the LSA Teams

with thanks to M. Di Castro, A. Masi, D. Mirarchi, S. Redaelli, J. Wenninger

outline

- LSA Settings protection
  - current (Run II) state
  - possible loopholes to close

- Lumi Server and beta* levelling
  - recap: how does it work
  - what we did in Run II (and MDs)
  - requirements for Run III

LSA settings protection

settings protection: the current situation

LSA method RBAC protection

- restricts settings changes to the CCC LHC island
  - prevent mis-manipulation behind the operators back
  - temporary "piquet" role to allow outside changes
- protected
  - trim
  - generation
  - change of resident context/hypercycle

critical settings (MCS)

- implemented in CMW/frontends
- restricts trims of "critical" settings to role-holders
- settings are digitally signed
- used for interlock limits
  - collimator limits
  - BLM limits and factors
  - SIS settings
  - etc.

settings protection: existing loopholes

- LSA actions not protected
  - creating, editing, deleting beam processes and types
  - editing incorporation rules
  - optics-related modifications
    - optics, twiss tables, elements
    - knob definitions and their factors
  - potential for hard-to-detect mishaps

- PCInterlock references are not critical settings
  - references are stored in the same parameters as PC settings
    - "reference beamprocess": just a regular beamprocess, cloned from the operational one
    - references are not (and can not be made) critical settings (MCS)
  - can be trimmed by anyone from the LHC CCC island

settings protection: closing loopholes

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- **restrict to CCC LHC island**
- **require personal operator/EIC login?**

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store as "reference settings" in LSA, and method-protect reference API

RBAC is (not) a security system

- RBAC is designed to protect against accidental mis-manipulations, not against malicious access

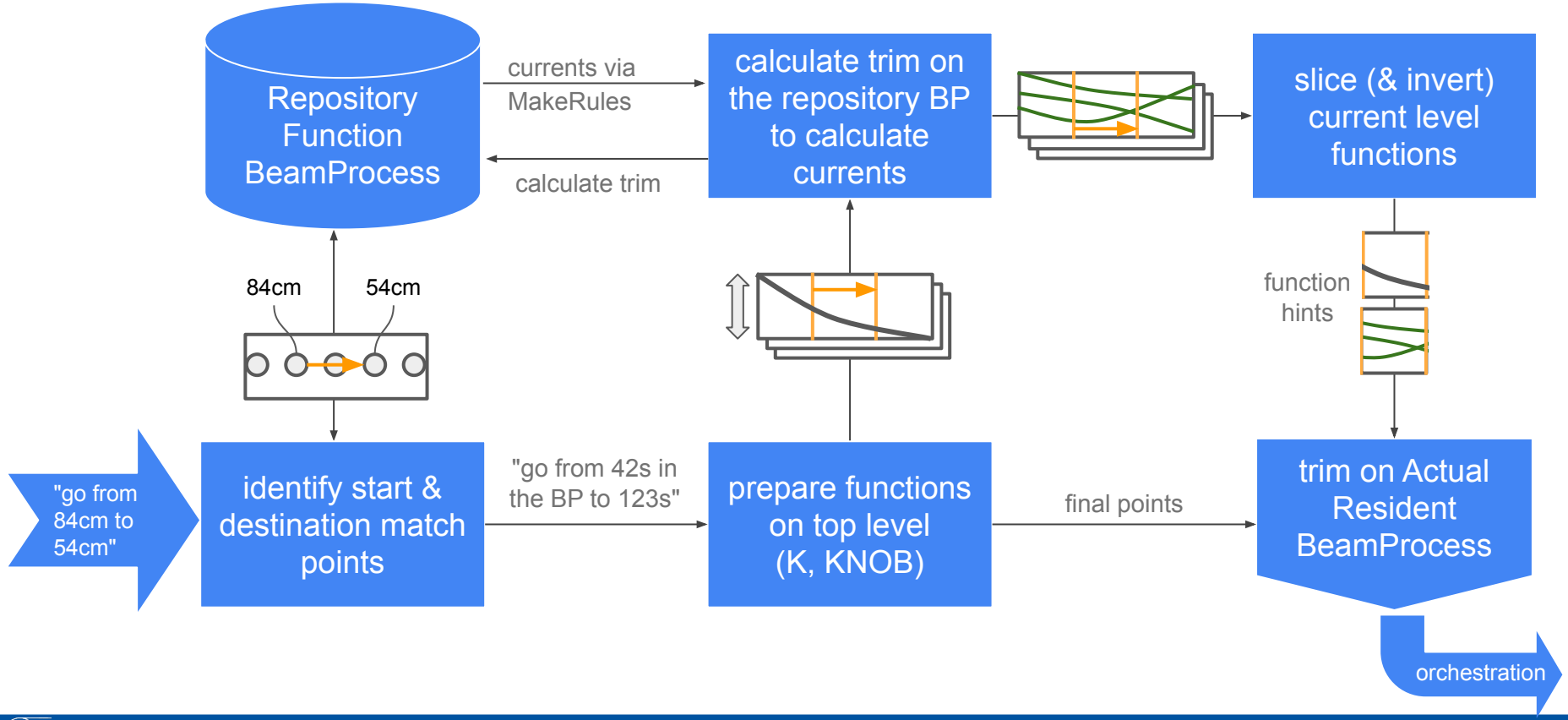
  It is important to mention that RBAC is not a security system against hackers; it is designed only to prevent well meaning people from making the wrong setting

  "Role-based Access Control for the Accelerator Control System at CERN", ICALEPCS'07

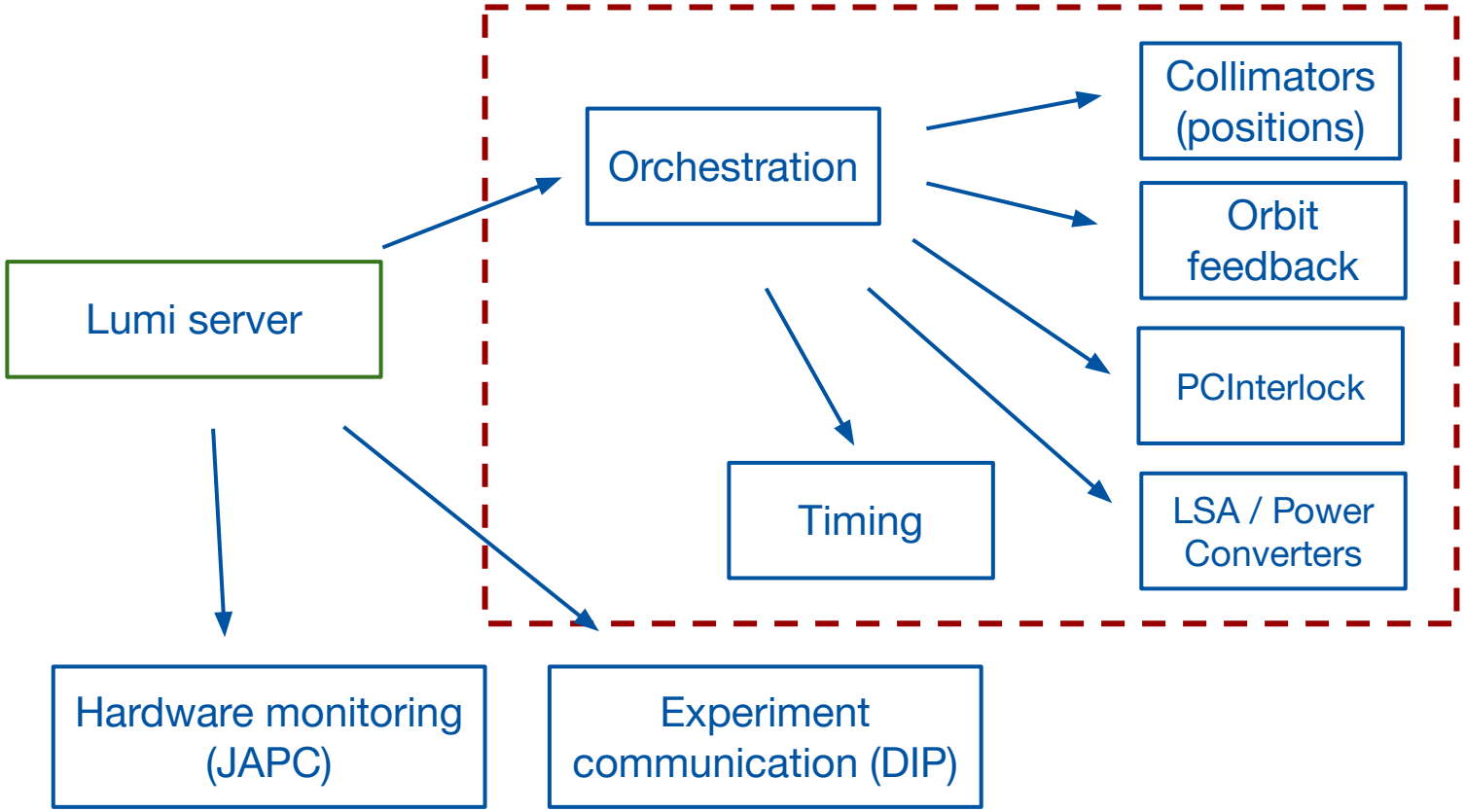
- **not** covered here:
  - LSA running in "2-tier" mode (direct DB access)
  - DB passwords in LSA client jars
  - some RBAC checks are client-side
  - ssh to LHC island console, then login by location
  - etc.

beta* levelling and the lumi server

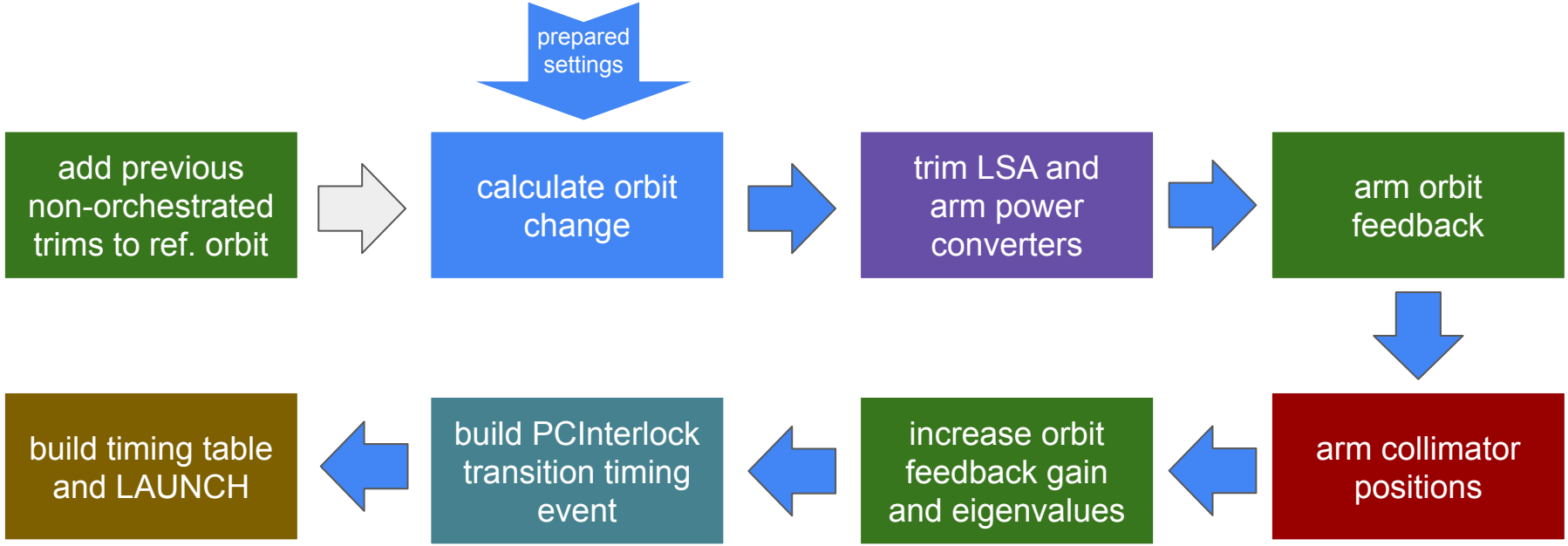
beta* levelling & settings: a block diagram



lumi server trim "orchestration"



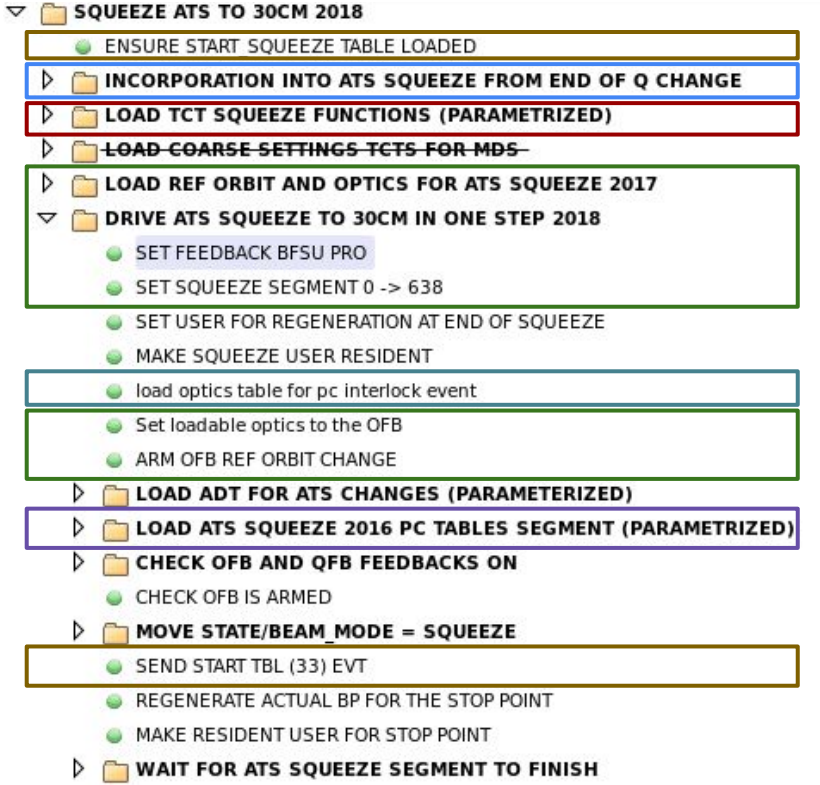
beta* levelling orchestration sequence

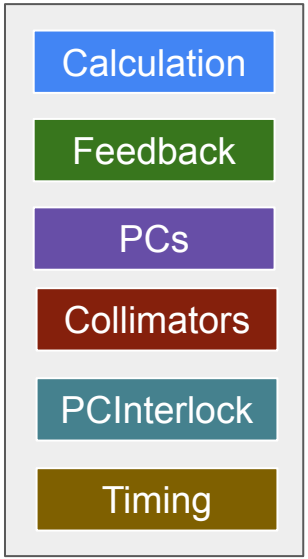


comparison: squeeze by the sequencer

- **SQUEEZE ATS TO 30CM 2018**
  - ENSURE START_SQUEEZE TABLE LOADED
  - **INCORPORATION INTO ATS SQUEEZE FROM END OF Q CHANGE**
  - **LOAD TCT SQUEEZE FUNCTIONS (PARAMETRIZED)**
  - ~~**LOAD COARSE SETTINGS TCTS FOR MD5**~~
  - **LOAD REF ORBIT AND OPTICS FOR ATS SQUEEZE 2017**
  - **DRIVE ATS SQUEEZE TO 30CM IN ONE STEP 2018**
    - SET FEEDBACK BFSU PRO
    - SET SQUEEZE SEGMENT 0 -> 638
    - SET USER FOR REGENERATION AT END OF SQUEEZE
    - MAKE SQUEEZE USER RESIDENT
    - load optics table for pc interlock event
    - Set loadable optics to the OFB
    - ARM OFB REF ORBIT CHANGE
    - **LOAD ADT FOR ATS CHANGES (PARAMETERIZED)**
    - **LOAD ATS SQUEEZE 2016 PC TABLES SEGMENT (PARAMETRIZED)**
    - **CHECK OFB AND QFB FEEDBACKS ON**
    - CHECK OFB IS ARMED
    - **MOVE STATE/BEAM_MODE = SQUEEZE**
    - SEND START TBL (33) EVT
    - REGENERATE ACTUAL BP FOR THE STOP POINT
    - MAKE RESIDENT USER FOR STOP POINT
    - **WAIT FOR ATS SQUEEZE SEGMENT TO FINISH**

comparison: squeeze by the sequencer





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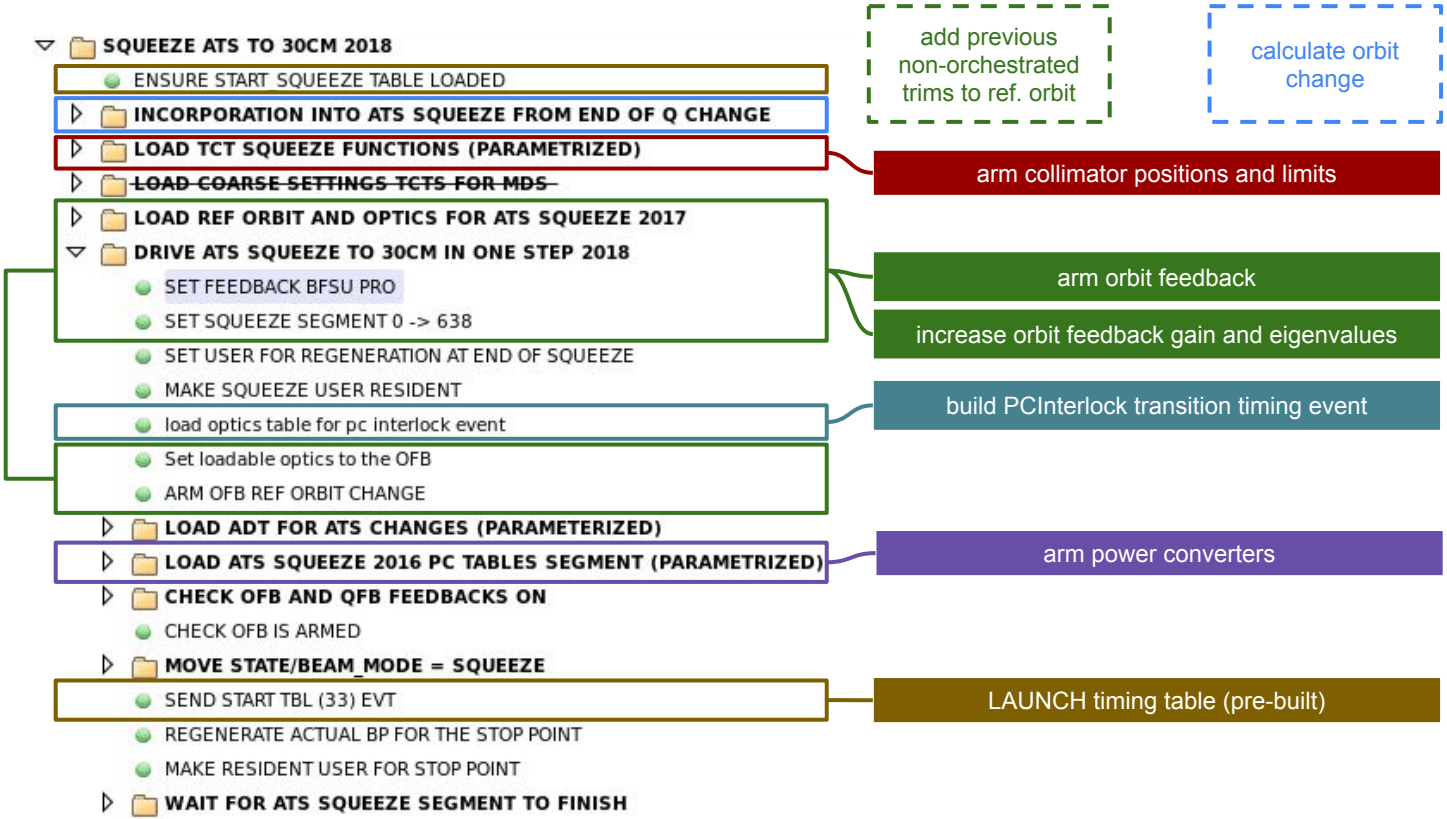


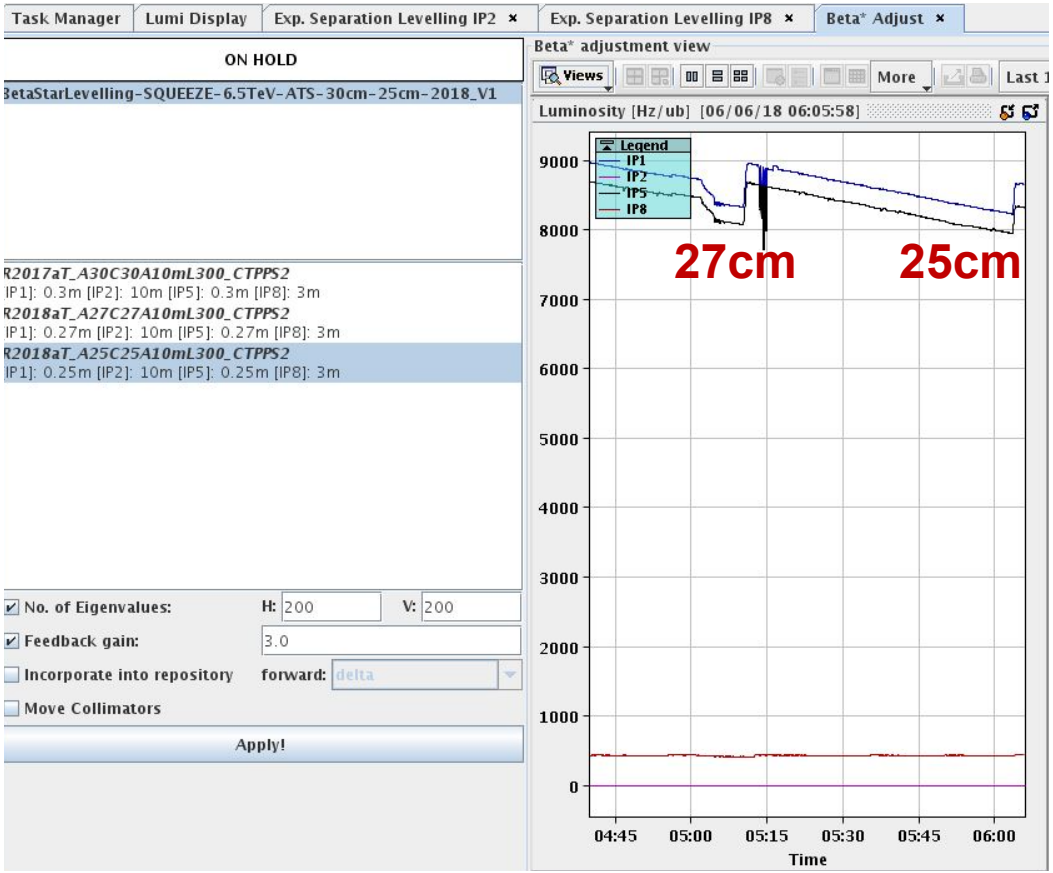
machine protection during beta* levelling

- currents, OFB reference & collimator centres: calculated from orbit response
  - need dynamically calculated, measured reference orbit
    - in squeeze: some 10um of transients are OK
    - in collisions: 10um @ IP = 1 sigma separation
  - can not make other beam processes resident
    - would interfere with levelling and other activities
- safe envelope protected by external systems
  - collimator limits
  - PCInterlock (pre-programmed reference and limit functions)
    - orbit correctors
    - all quadrupoles including optics and MKD-TCT phase advance

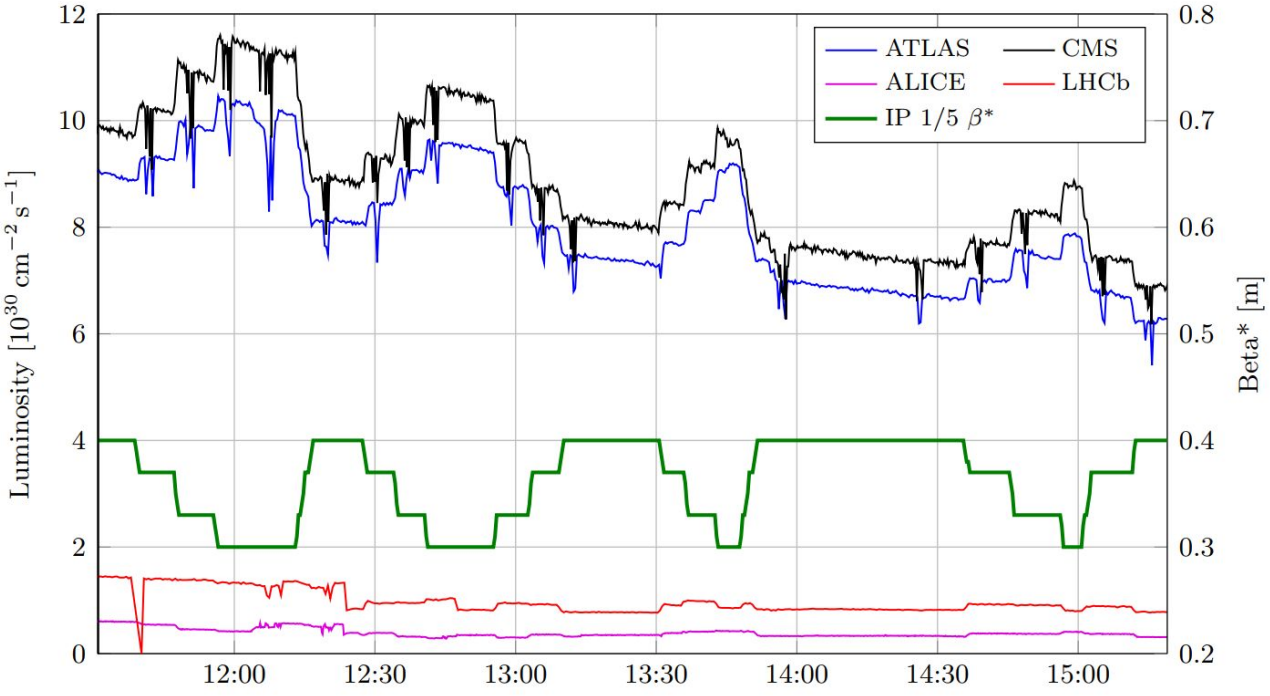
➔ The Lumi Server should **not** be critical for machine protection:
a safe envelope is monitored and enforced by outside systems

beta* levelling in Run II - operationally

- anti-levelling late in fills
  - 30cm → 27cm
  - 27cm → 25cm
- beams kept well in collision
- small transients on IP2/8
  - traced to "old" ref. orbit
  - mitigated by acquiring a fresh reference orbit
- collimators not moved
  - constant gap
  - minimal centre changes (collimators were moved during crossing angle levelling)



beta* levelling in Run II - MD results

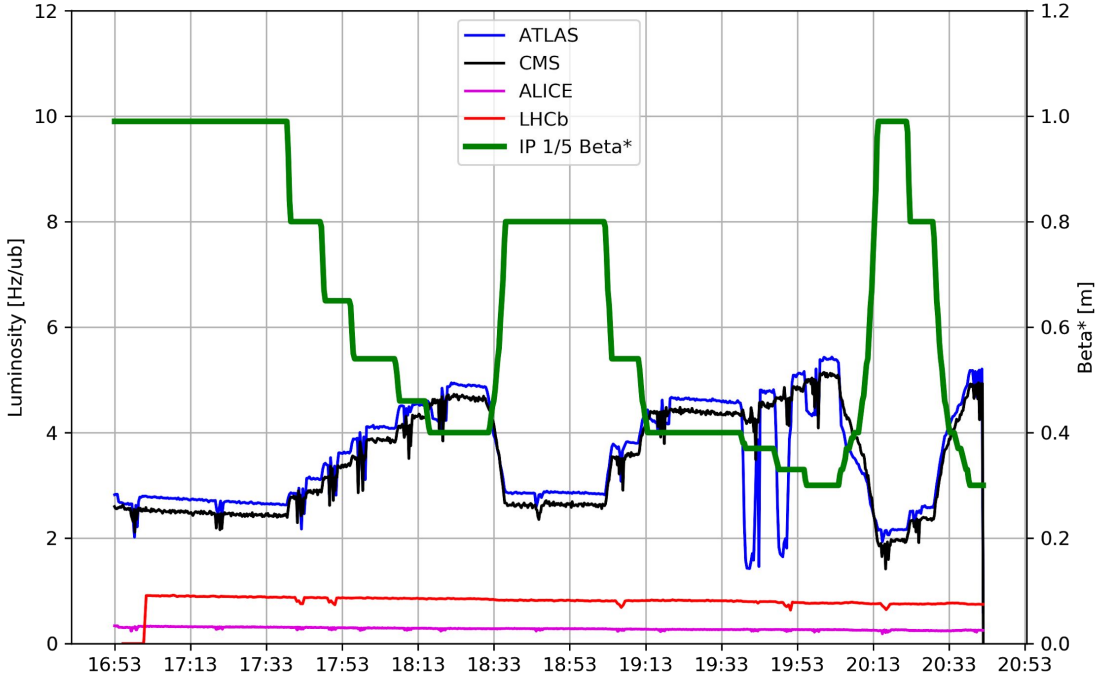


2017 MD: demonstrated multiple levelling cycles between 40cm and 30cm beta*

beta* levelling in Run II - MD results II

2018 MD: colliding at 1m beta*, then squeeze to 30cm (and back again)

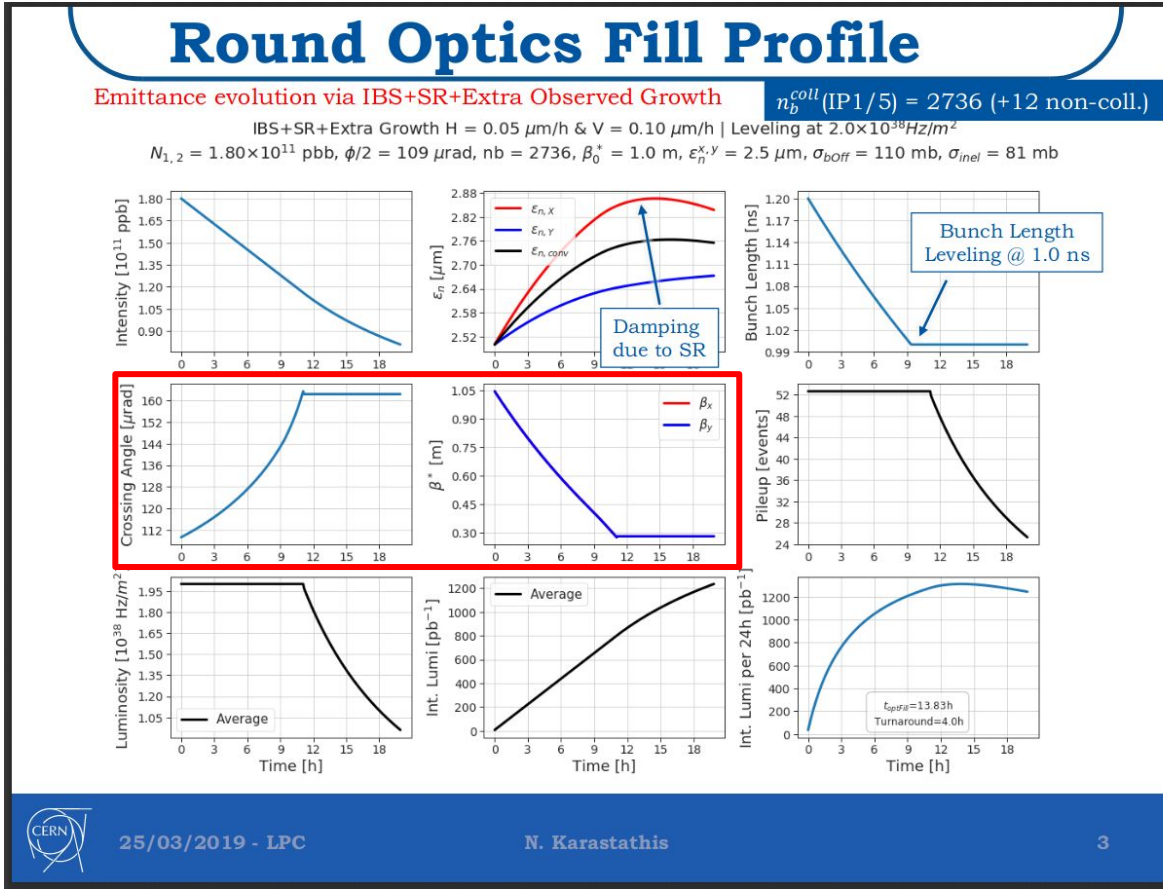
- moving collimators
  - centres: from orbit
  - gaps: pre-programmed
  - verified offline by Daniele: looked OK
- collimator limits opened/masked



See A. Calia at LSWG 2018-07-03 and analysis by D. Mirarchi for details.

beta* levelling in Run III - an outlook

- **simultaneous** crossing angle and beta* levelling proposed by Run III WG
  - motivated by reducing the radiation to triplets
  - levelling at 2 10^{34} cm^{-2} s^{-1}
- no issue for PCs, OFB
- collimator handling
  - constant gaps (in mm)
  - TCT centres to follow crossing angle (~100um per 10 urad)
  - **collimator limits?**



beta* levelling and collimator limits in Run III

- expected TCT center displacement in Run III: ~0.6mm
  - crossing angle range: ~165urad → ~110urad
  - exact transfer to TCT is (slightly) optics dependent

- 2018 situation: ~0.3mm during crossing angle levelling

- collimator **limits** are **critical settings (MCS)**
  - signed functions stored in LSA
  - 1 single function for the whole squeeze range
  - can only be played as a whole

options for collimator limits in Run III

- use discrete limits
  - provide a set of "open" limits to allow for centre changes
  - 1-3 sets of limits
  - need to validate that the limits are safe for the full beta*/crossing angle range
  - supported today - no hardware or software changes
- support arming partial limit functions
  - send the full signed function + range to arm to collimators
  - "cut" the function in the FESA class
  - would allow same functional limits as during regular squeeze
  - **uncertain if feasible** for collimation

    An eventual modification during LS2 would imply a complete revalidation of a robust control system that has been successfully in operation for the previous 2 RUNs. *(M. Di Castro)*
- make position limits non-critical
  - could prepare/cut the limit functions in Lumi Server or dedicated service
  - machine protection implications ...

conclusions & outlook

conclusions & outlook

- LSA settings protection: good with a few loopholes
  - protection for context editing & optics related actions to be added
  - PCInterlock references to be protected
  - protect against accidental mis-manipulations, not against malice

- Lumi Server & beta* levelling
  - successfully demonstrated in 2018
  - combined beta* & crossing angle levelling proposed by Run III WG
    - OK for power converters, feedbacks, PCInterlock
    - constant TCT gaps, centres following crossing angle
    - handling of collimator limits to be defined

spares

levelled IP stability, squeeze from 1m

- Levelled IPs stable within a few %