Status of LHC Operations

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for the LHC Commissioning team,
equipment and support groups

Outline

- Goals
- Overview of the major steps during the past two weeks
- Present performance
- Conclusions and plans

Goals for the past 2 weeks

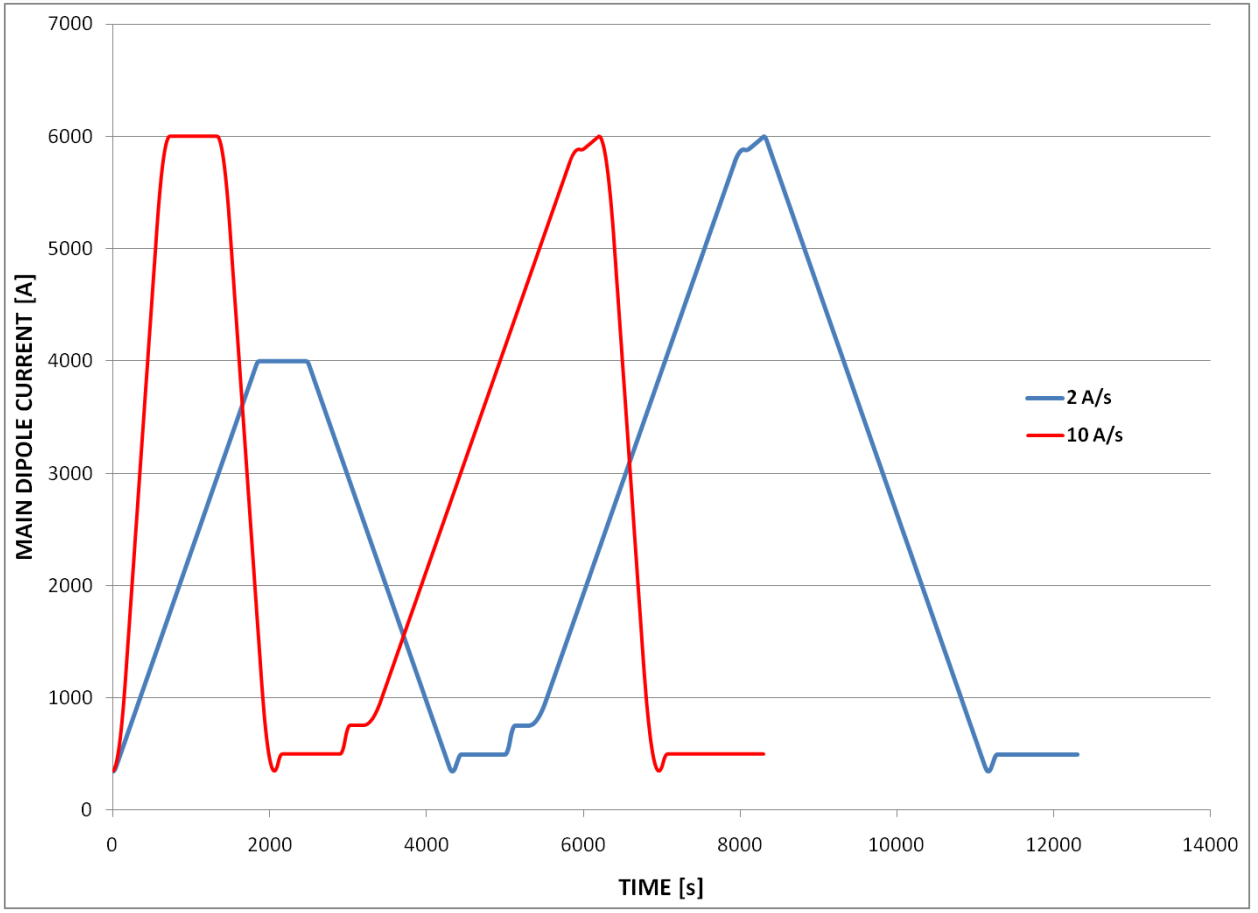
- Re-establish physics conditions after the technical stop
- Run pre-cycles with faster ramp-rates
- Increase number of bunches (double it)
- Increase stored beam energy to >1 MJ and start to acquire experience in this regime
- Achieve $L_{tot} = 1\ pb^{-1}$

Faster pre-cycles

- At the beginning of June the hardware modifications to be able to (safely) ramp the magnets at 10 A/s were completed and tested.
  - *Delayed opening of the energy extraction switches to avoid spurious (fake) quench triggers*
- Changing the ramp rate has a significant impact on operation (persistent current effects) through larger perturbations of tune, chromaticity at injection and in the first part of the ramp.

  Decided to implement the faster ramp rate in steps starting from the pre-cycle and ramp-down after having completed the effort of increasing the nominal bunch intensity profiting of the re-start after the technical stop
- The first days following the technical stop were used to re-establish good ramps and squeeze and perform verifications of optics and collimation.

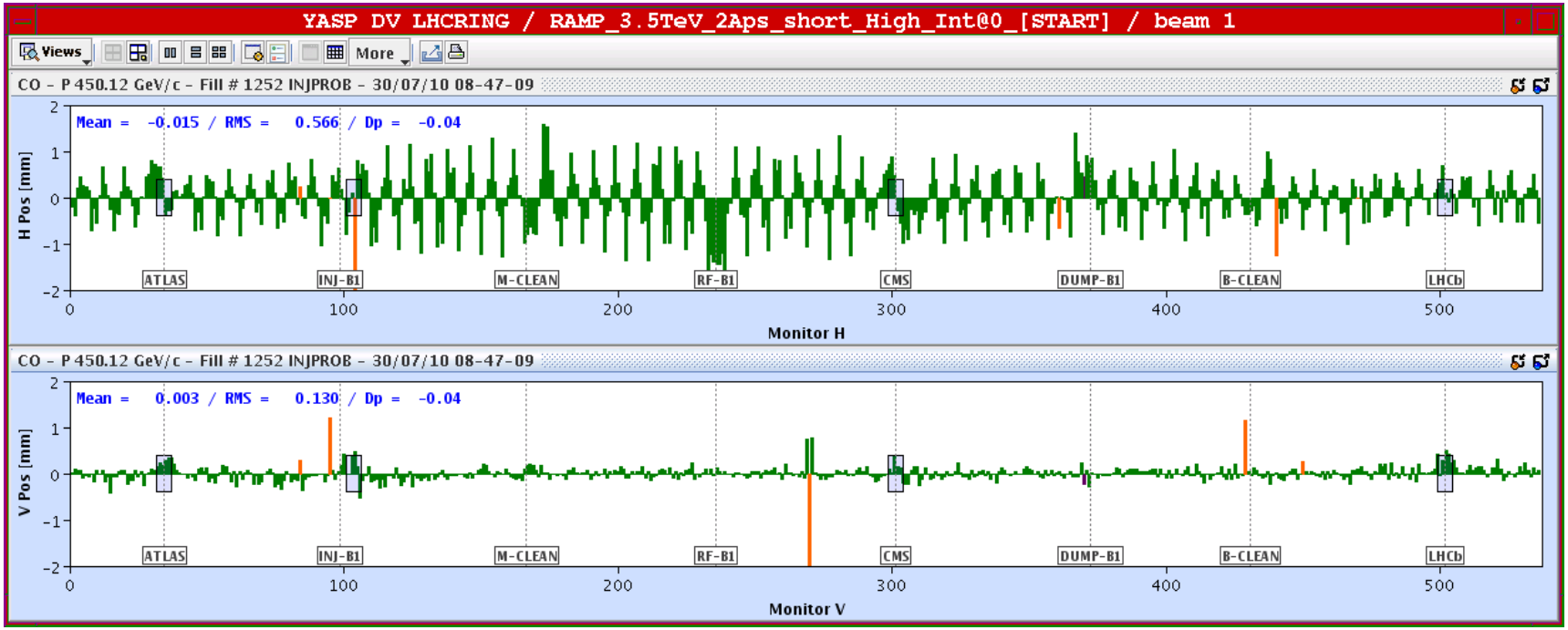
Faster pre-cycles



- Advantages:
  - Faster turn-around
  - Pre-cycle to 6 kA of the main circuits (previously limited to 4 kA) ➔ same conditions after a ramp down after physics and after a pre-cycle ➔ better machine reproducibility

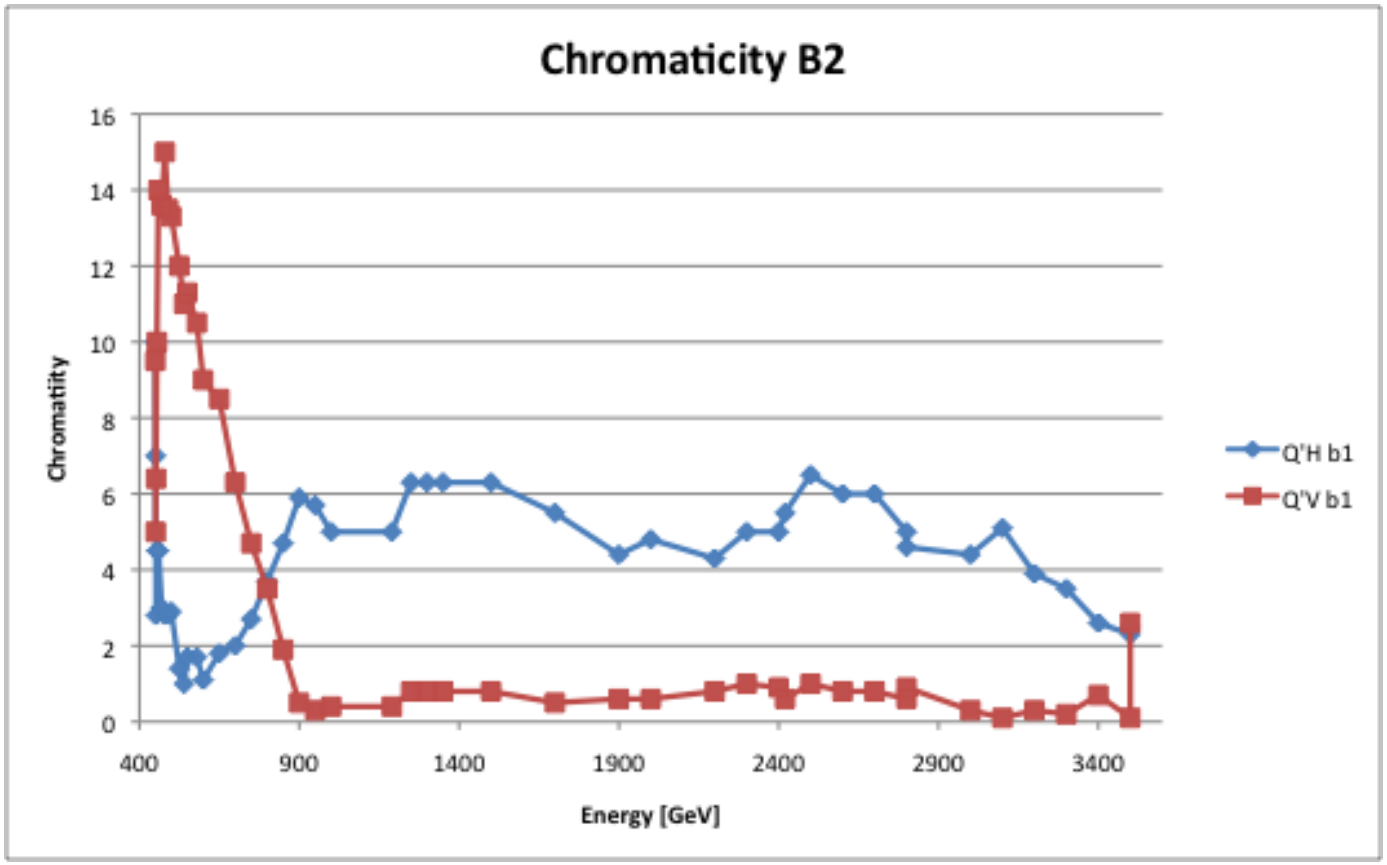
Effect of faster pre-cycle (orbit)

- Since the introduction of the 10 A/s, much larger orbit variations are observed fill to fill at injection in the horizontal plane – signature of random b1 (dipole) error. Due to larger persistent currents. Expected and correctable
  - 0.3-0.6 mm RMS

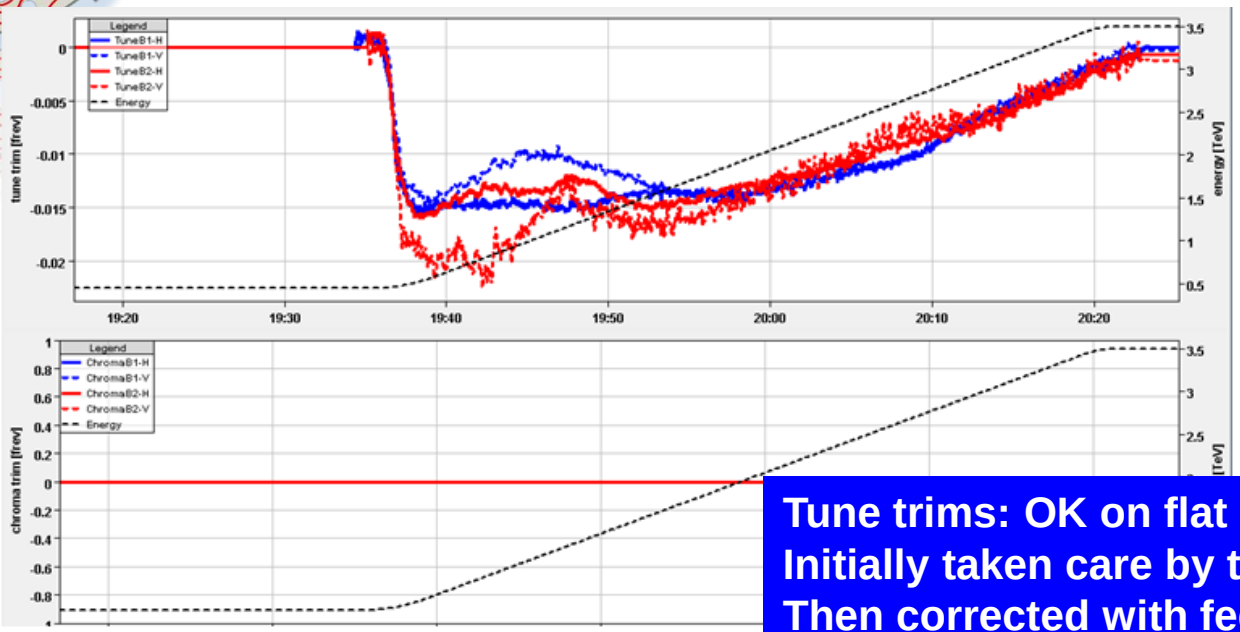


Effect of faster pre-cycle (chromaticity)

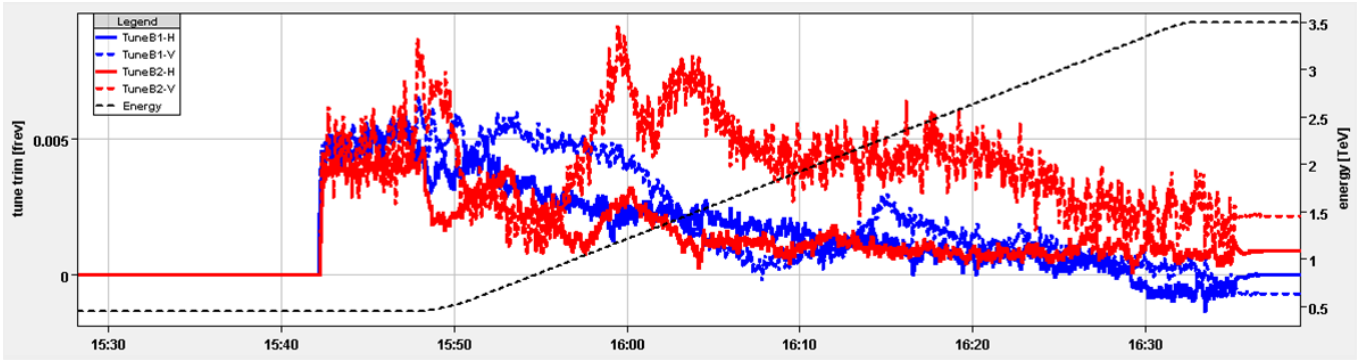
- Large chromaticty swing at the beginning of the ramp (snap-back effect)
- Corrected iteratively



Effects of faster pre-cycle (tune)

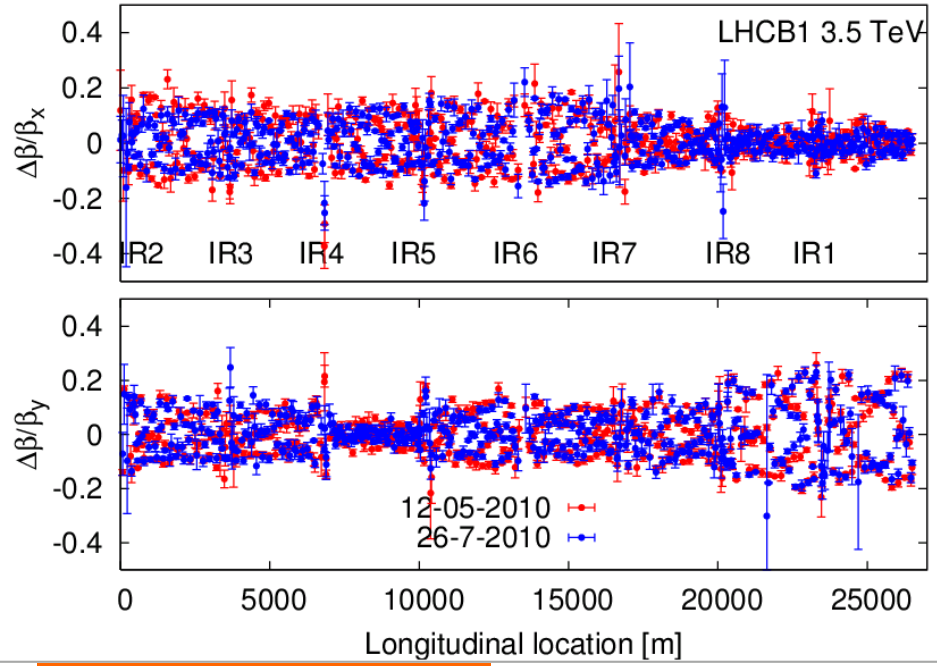


Tune trims: OK on flat top, large in ramp
Initially taken care by the tune feedback
Then corrected with feed-forward



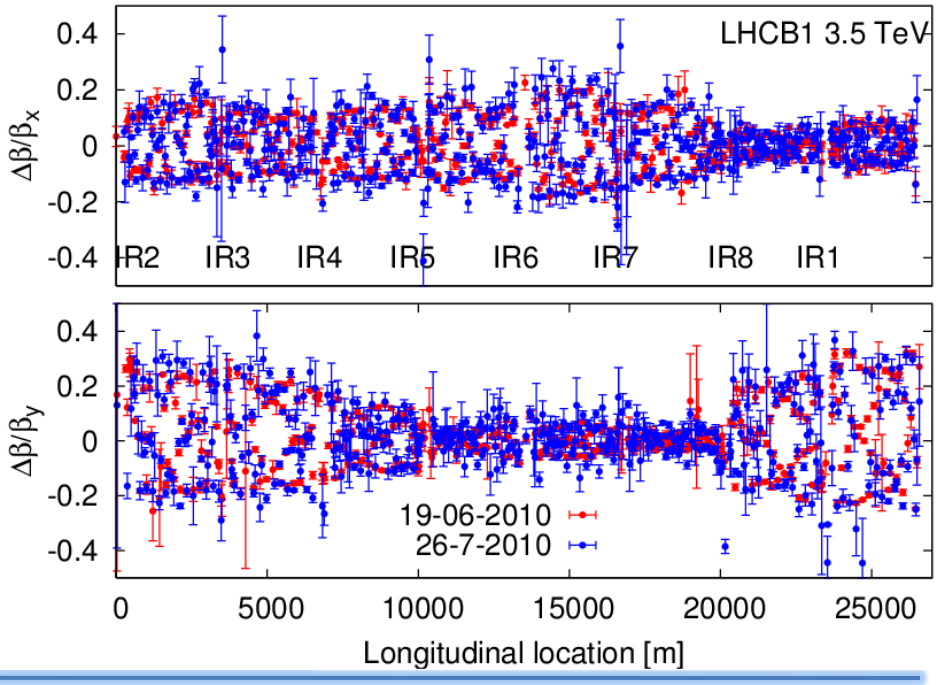
Effects of faster pre-cycle (Optics)

Optics measurements show excellent reproducibility



Injection optics

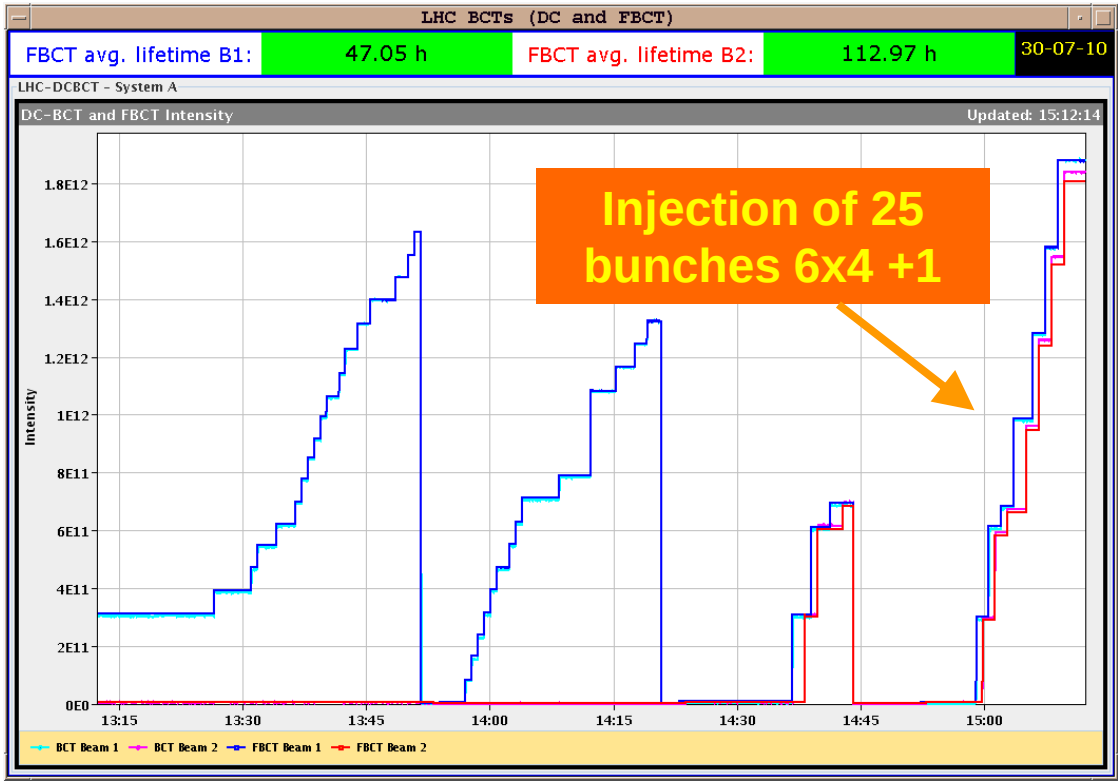
Squeezed optics



R. Tomas et al.

Increasing Intensity (injection)

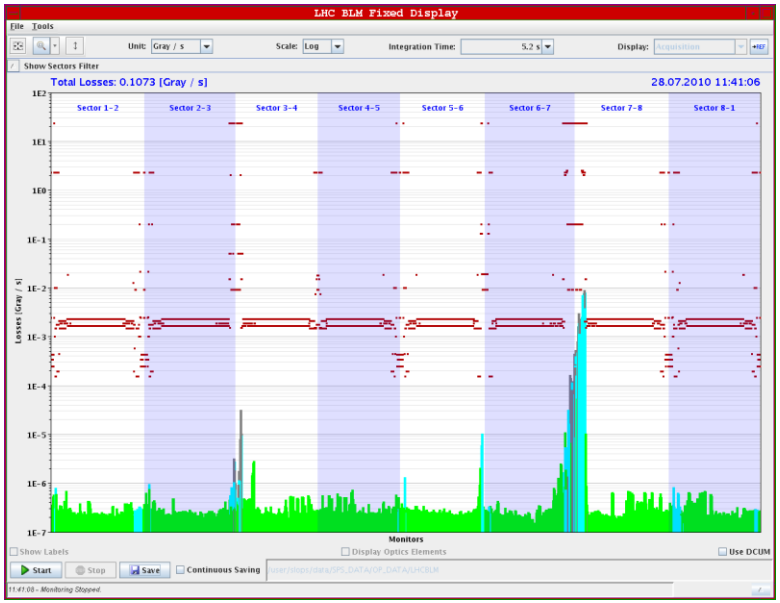
- Multi-bunch injection set-up:
  - Fine energy matching of both rings using closed orbit correctors to adapt the two circumferences (correction of $\Delta p/p \sim 5 \times 10^{-5}$) : and improve RF capture efficiency
  - Steering and collimator settings had to be adjusted for B1
  - Still some issues with the reproducibility of the trajectory of the beam in the injection line being investigated



B. Goddard, M. Meddahi et al.

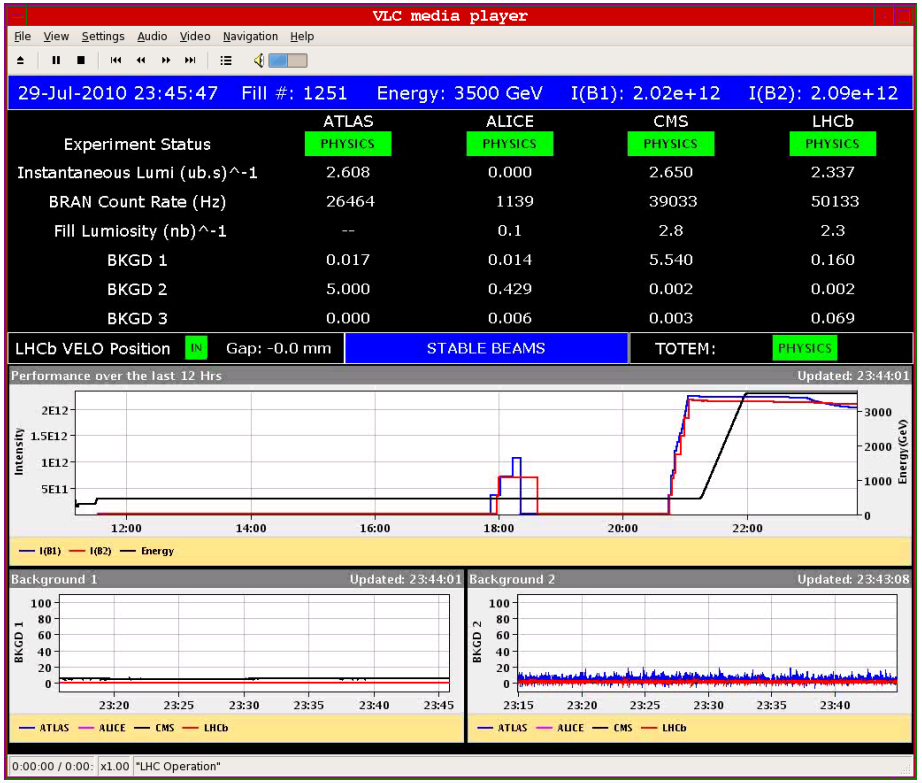
Periodic machine protection verification

- Validation of collimation setup for stable beams (ongoing):
  - collimators set up for high intensity one month ago!
  - with TOTEM RPs at 25 (V)/ 30 (H) sigma.



Collisions with 25 bunches

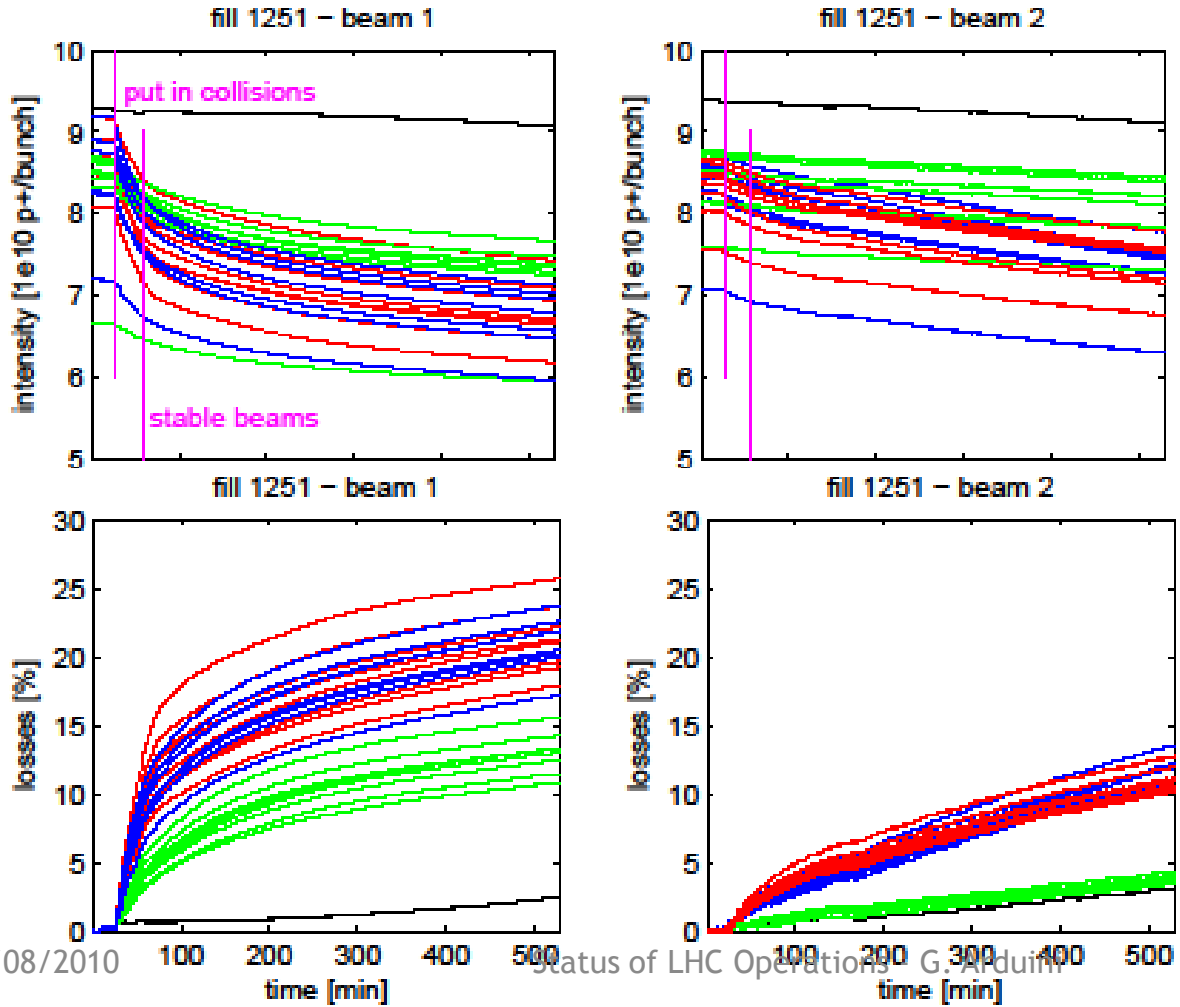
- First fill (1251) with 25 bunches
  - Peak L seen just after colliding ~2.8×10^{30} $cm^{-2}s^{-1}$
  - In STABLE BEAMS peak L ~2.6×10^{30} $cm^{-2}s^{-1}$
  - TOTEM RPs at 30/25 sigma (H/V)



~1.2 MJ of stored beam energy!!!!

Collisions with 25 bunches

- 0 collisions
- 3 collisions IP 1 5 and 2 (with offset in IP2)
- 3 collisions IP 1 5 and 8
- 2 collisions IP 2 and 8 (with offset in IP2).



Low lifetime on B1 just after colliding.

B1 and B2 different.

G. Papotti, W. Herr

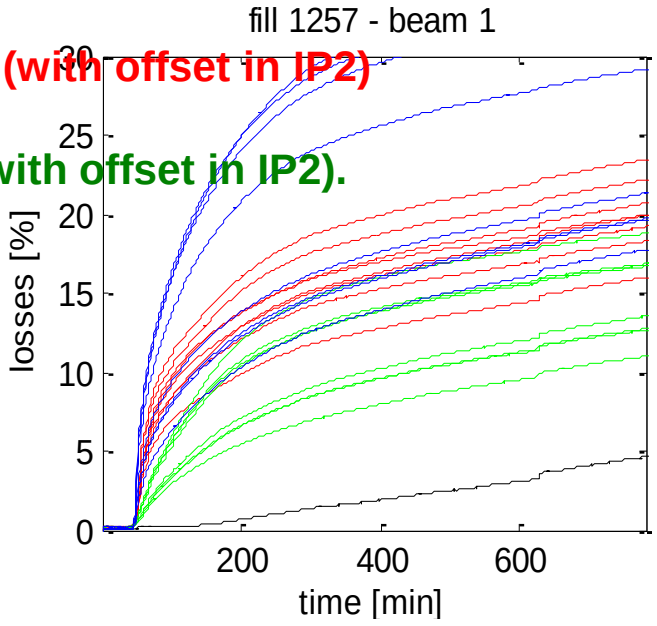
Collisions with 25 bunches

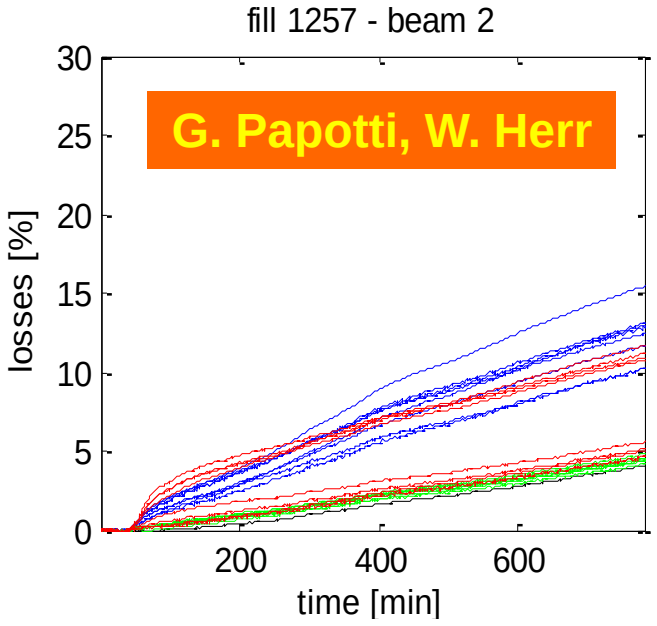
- 0 collisions
- 3 collisions IP 1 5 and 2 (with offset in IP2)
- 3 collisions IP 1 5 and 8
- 2 collisions IP 2 and 8 (with offset in IP2).

- Relative losses for B1 and B2:
  Fill 1257
  Q split

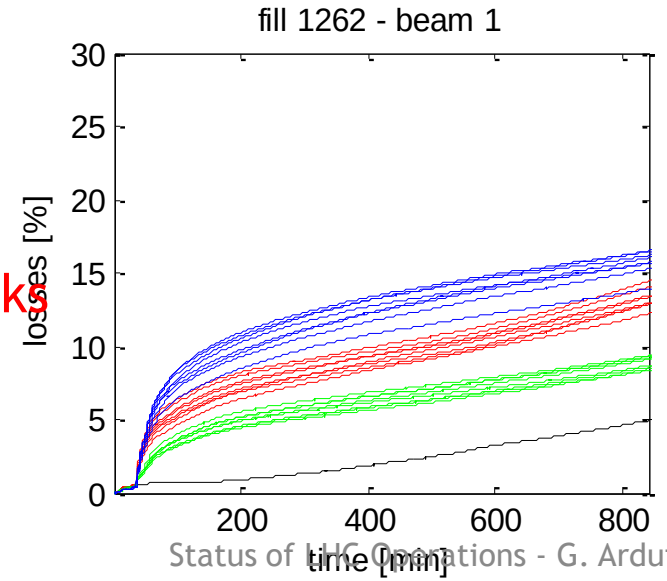
Vs.

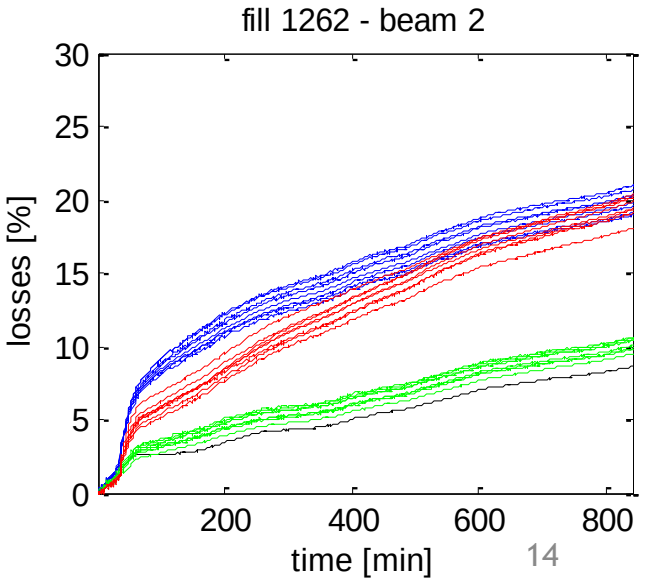
Fill 1262
with no Q split
Now possible thanks to the transverse feedback





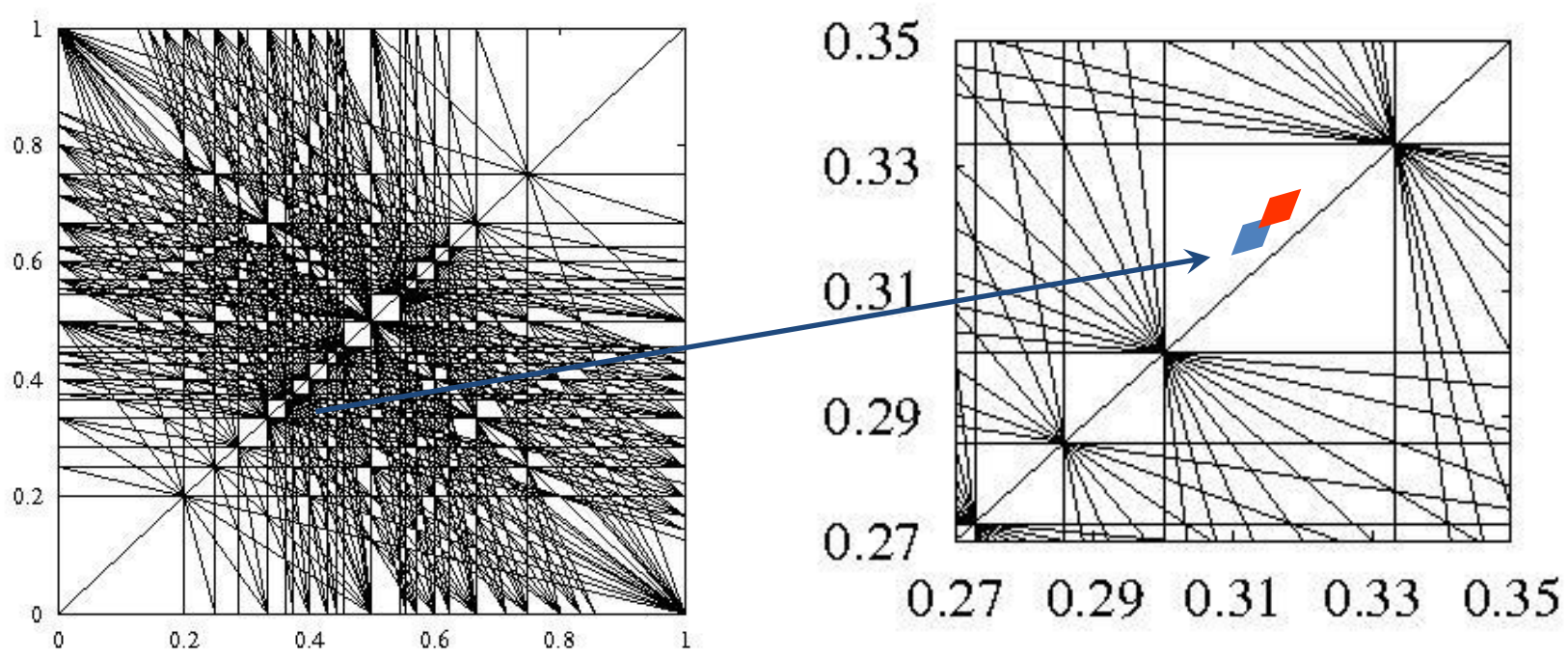
G. Papotti, W. Herr





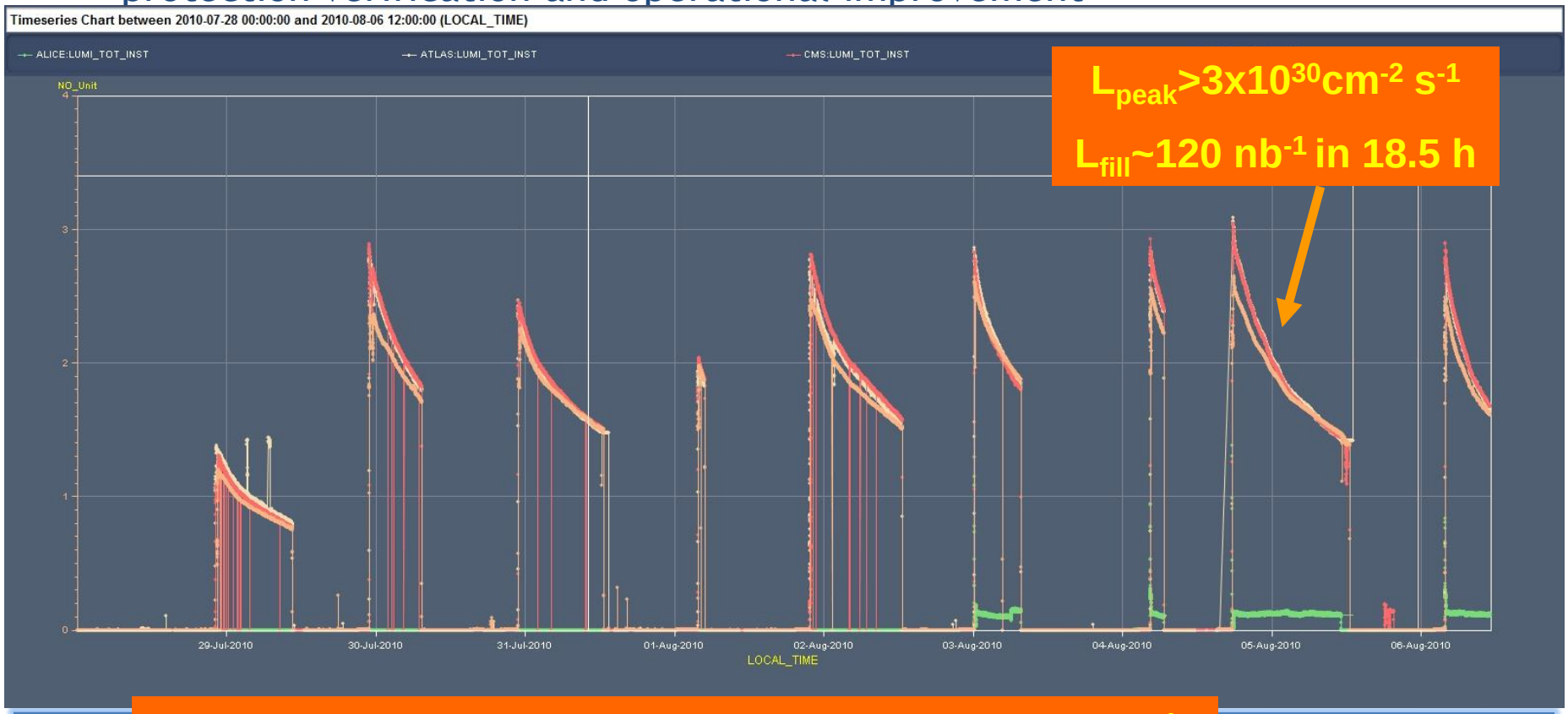
Collisions with 25 bunches

- We have to fit the working point here
- So we are interested in maximizing the overlap between the two beams working points



Luminosity

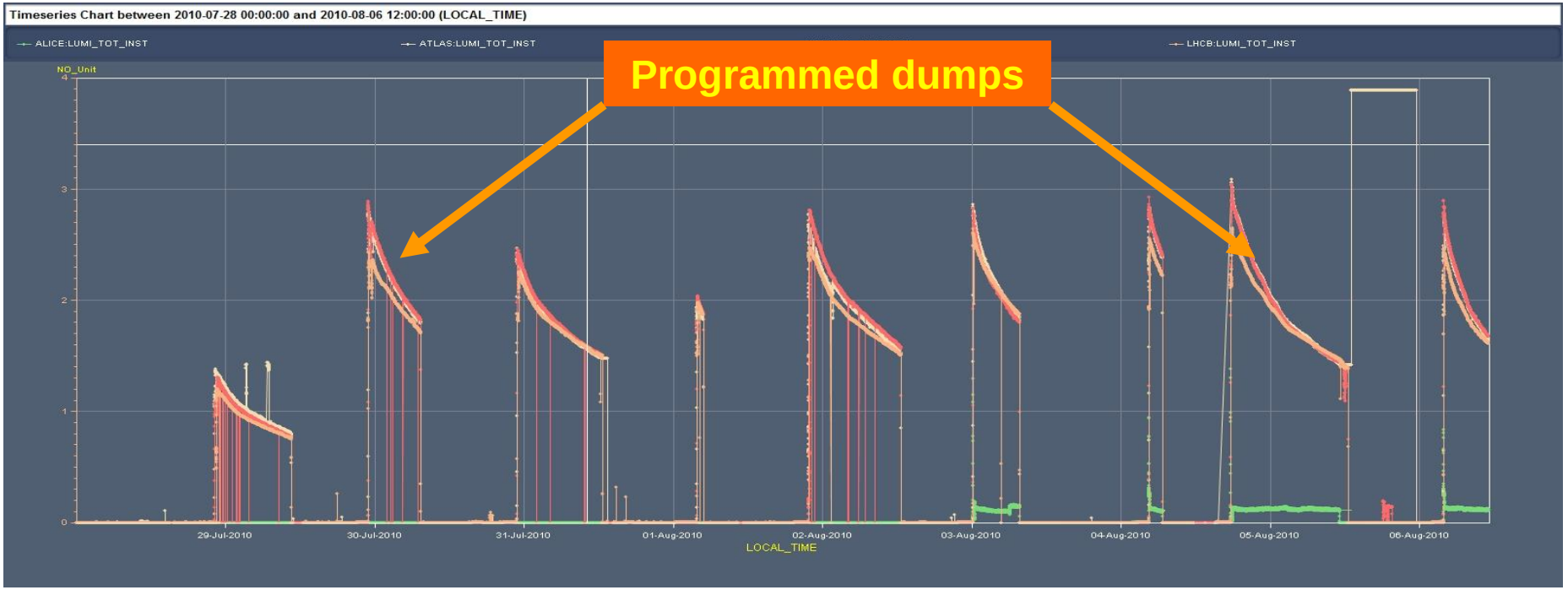
- After the completion of the commissioning of the shorter pre-cycle and first machine protection verifications:
  - At least 1 fill for physics/day interleaved with remaining tests for machine protection verification and operational improvement



L_{tot} delivered in STABLE BEAMS condition >910 nb^{-1}

Luminosity

- No more sudden losses observed during stable beam operation thanks to the operation of the transverse feedback in collision
- Coast duration not yet optimized mainly limited by unprogrammed (but non-spurious) dumps so far. Only 2 programmed dumps in the past 2 weeks.



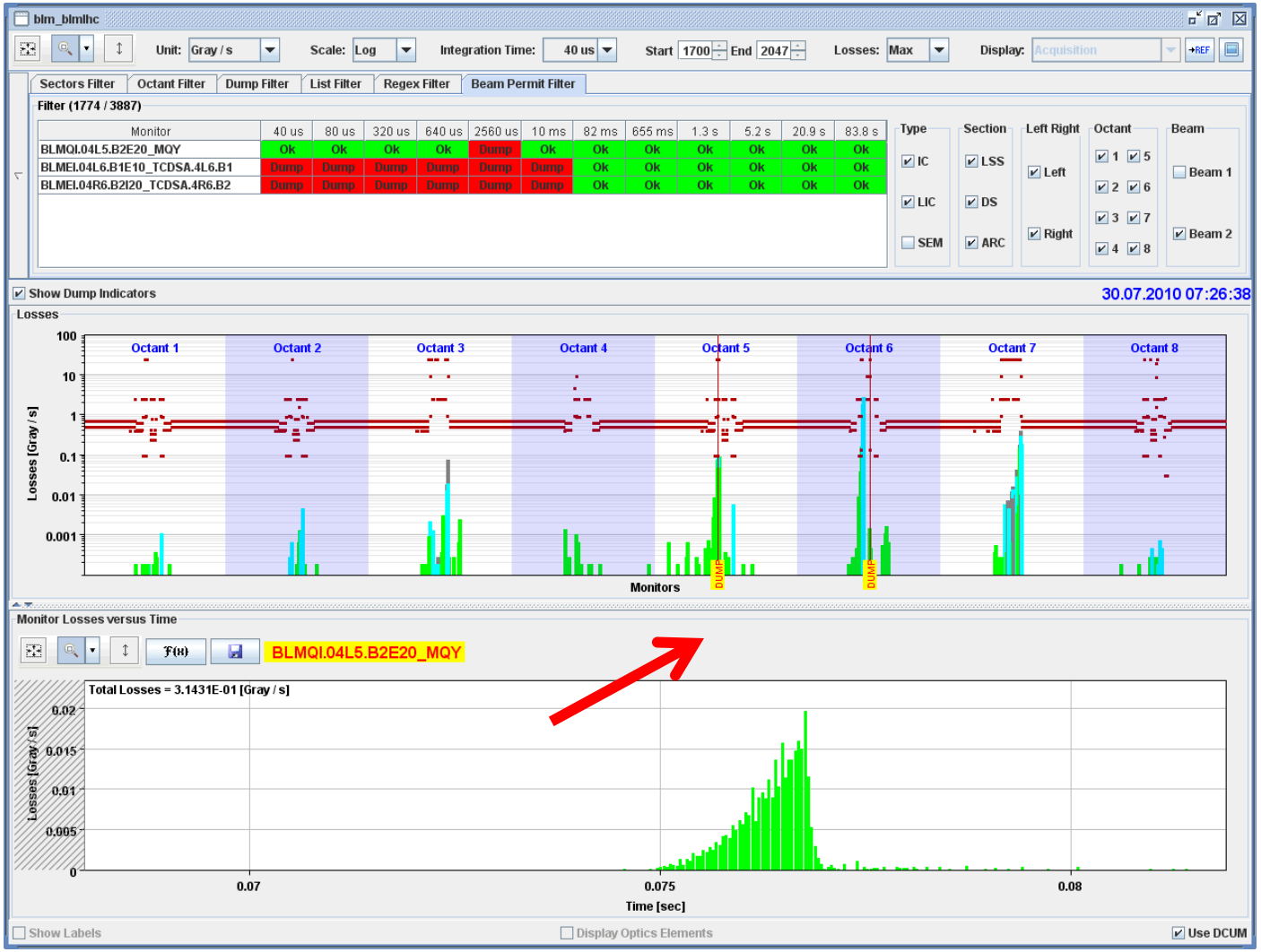
MPS statistics

- We have accumulated ~180 dumps above 450 GeV.
- In all cases the MPS reacted correctly, even for yet un-explained events.
- There are 2 events where the cause is not understood, on July 7th (BLM IR7) and July 30th (BLM IR5).
  - Common features:
    - Fast loss at cold element
    - Loss time scale ~2 milliseconds ~20 turns.
    - Loss after a bending section (DS IR7, D1 IR5).
    - Orbit and trajectory stable.
  - Event July 30th:
    - All PC currents rock stable – no trims etc.
    - Orbit stable to few microns, trajectory to few tens of microns (resolution!).

J. Wenninger

Event 30th July

Loss on Q4 L5 from beam 2.



Conclusions & Plans

- We have achieved an important milestone in the road towards increasing the complexity of the operation step-wise and without compromising on safe operation: > 1 MJ stored beam energy
- New record peak luminosity ($3x10^{30}$ cm^{-2} s^{-1}) and fill luminosity (120 nb^{-1}) although we have still a long way to go..

- Next steps
  - Consolidation of the operational procedures with 25 bunches and nominal bunch intensity ➔ turn-around time
  - Gain experience and monitor machine and machine protection performance at >1 MJ stored energy during the month of August
  - Luminosity production and further understanding of the performance in collision

- Thanks to all the teams involved
- Thanks to the Physics Coordinator and to the experiments for the fruitful collaboration and feedback