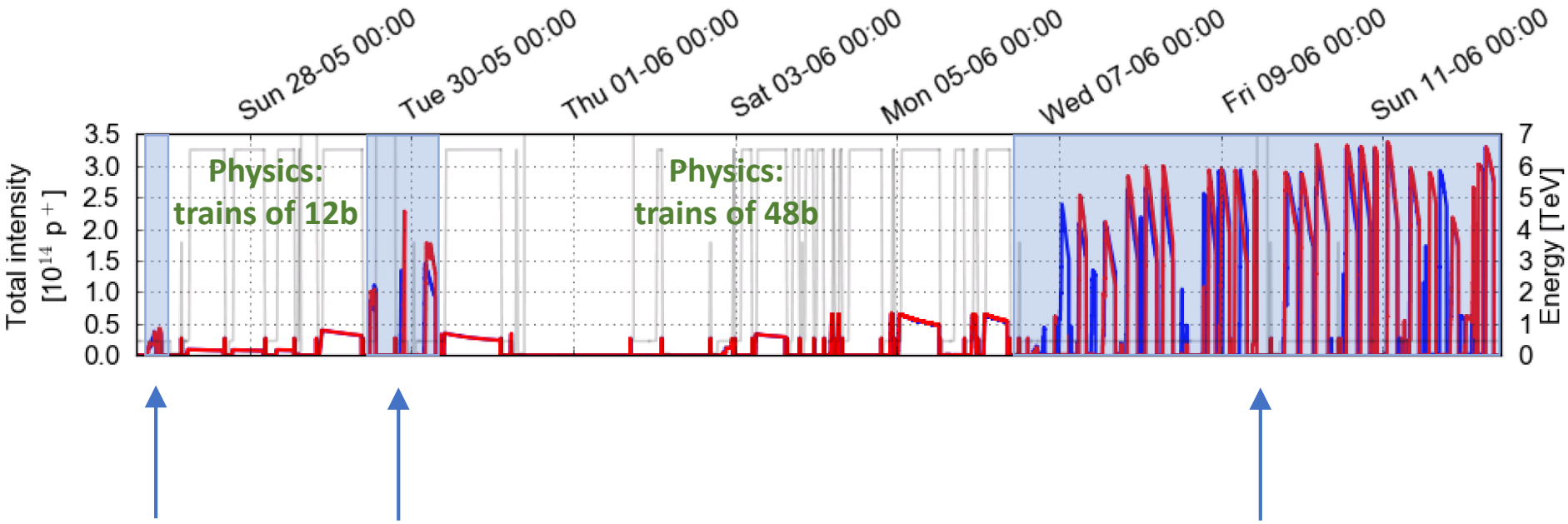
Scrubbing run summary

G. Iadarola, L. Mether and G. Rumolo for the e-cloud team

Many thanks to: LHC-MC, LHC-OP, LHC-MP, BE-ABP, EN-STI, TE-ABT, TE-CRG, TE-VSC,
S. Antipov, G. Arduini, T. Argyropoulos, M. Barnes, H. Bartosik, C. Bracco, E.Belli, G. Bragliozzi, B. Bradu,
Y. Brischetto, L. Carver, P. Chiggiato, P. Dijkstal, A. Lechner, I. Lamas Garcia, A. Lechner, K. Li, E. Metral,
D. Mirarchi, M. Pascale, A. Romano, S. Redaelli, B. Salvant, M. Schenk, G. Skripka, H. Timko, C. Yin Vallgren,
D. Valuch, F. Velotti, J. Wenninger, D. Wollmann, C. Zamantzas

Electron Cloud Meeting – July 14th 2017

Overview

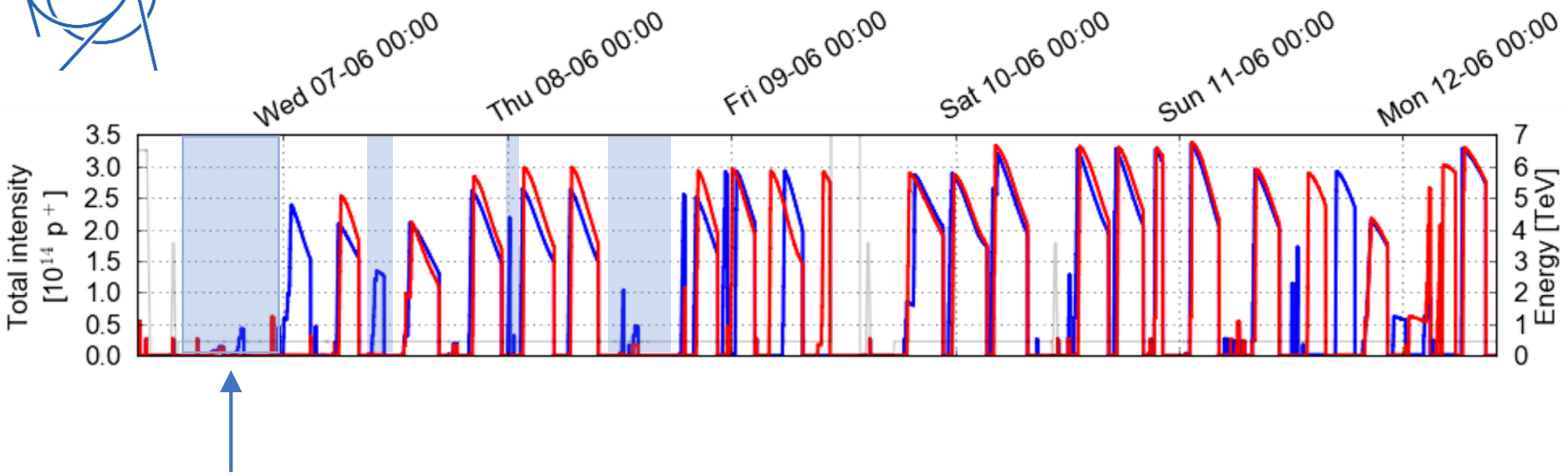


First tests with trains of 72b

Scrubbing with trains of 72b

Scrubbing run with longer trains (up to 288b)

Overview



Injection setup for long trains

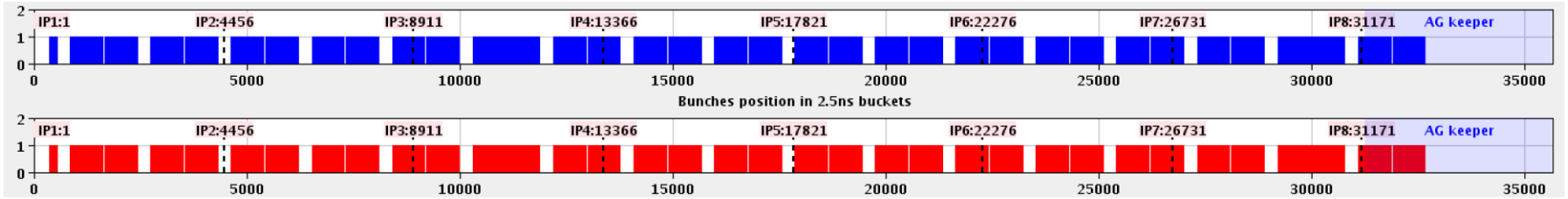
- **No problem with Beam 2** up to 288 b/injection
- Strong **losses at the first turn for Beam 1**
  - In spite of several hours devoted to investigating the issue, the cause could not be fully identified

Thanks to C. Bracco and the injection team for the extensive support!

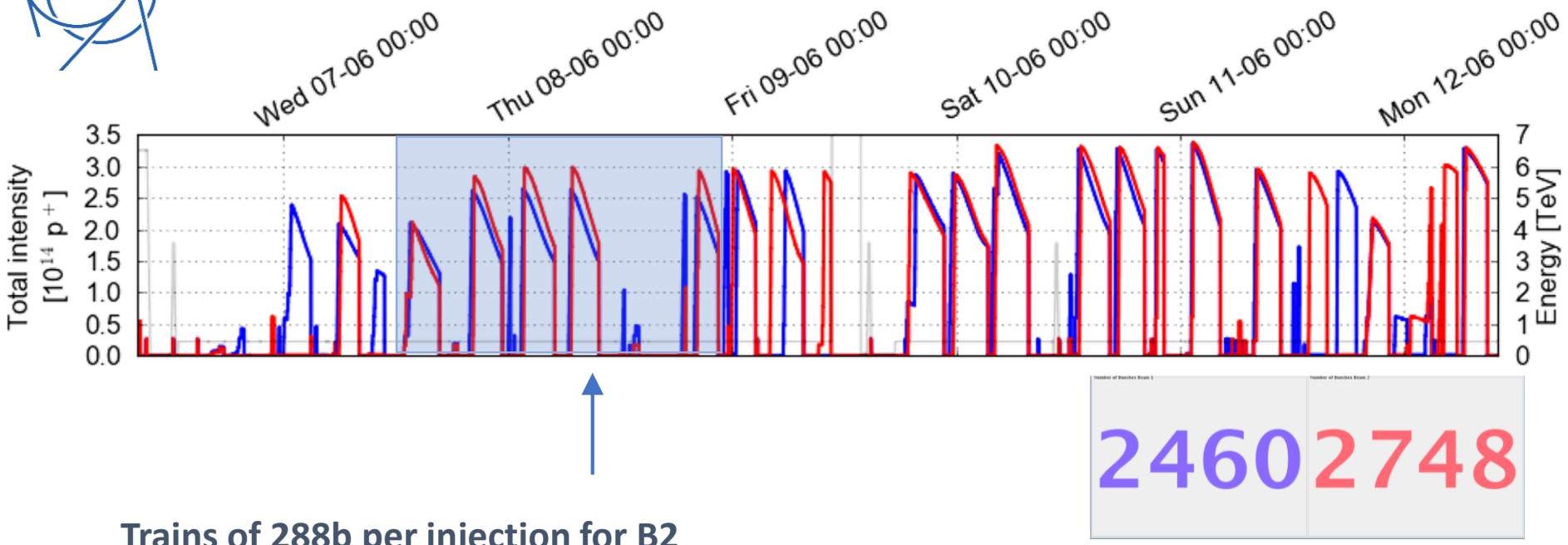
Overview

Scrubbing fills with trains of 144 bunches

- Up to **2460 bunches** per beam
- Bunch intensity: **~1.05e11 p/bunch** (limited by SPS longitudinal stability)

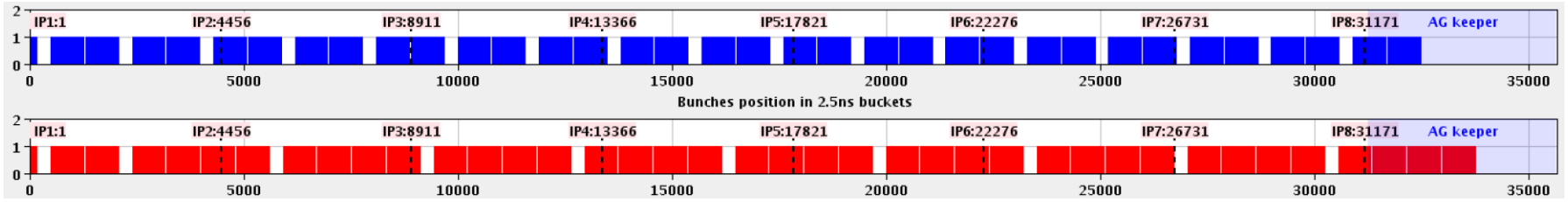


Overview



Trains of 288b per injection for B2

- Trains of **288b still not possible for B1**
- **Filling asymmetrically** with 2460b in B1 and 2748b in B2



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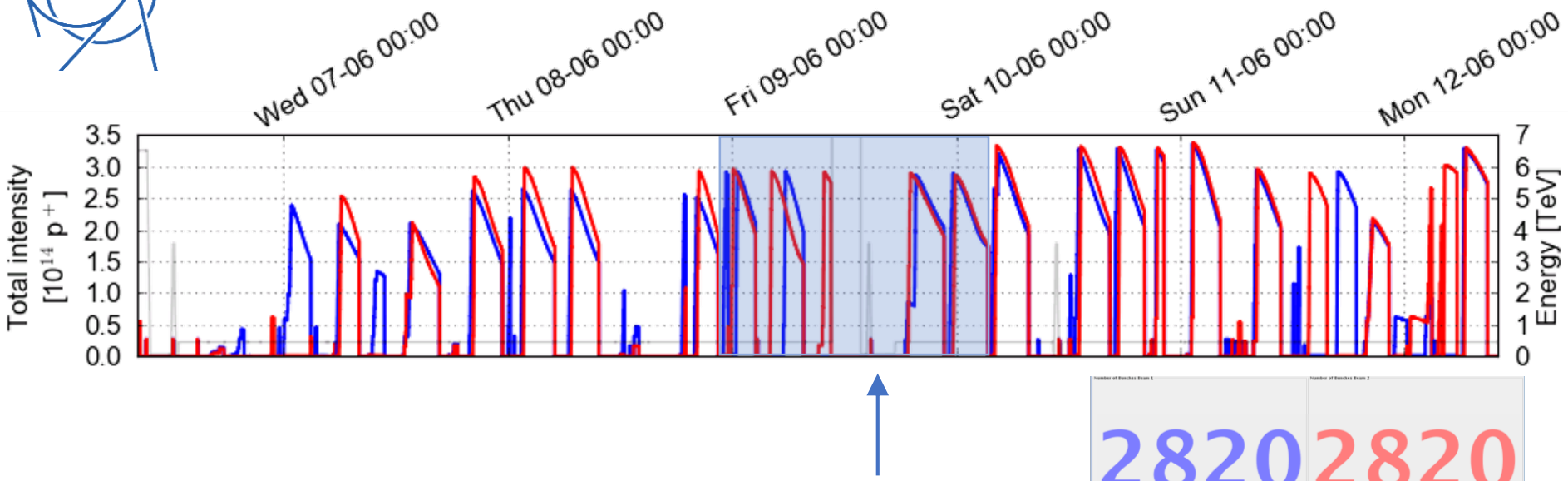
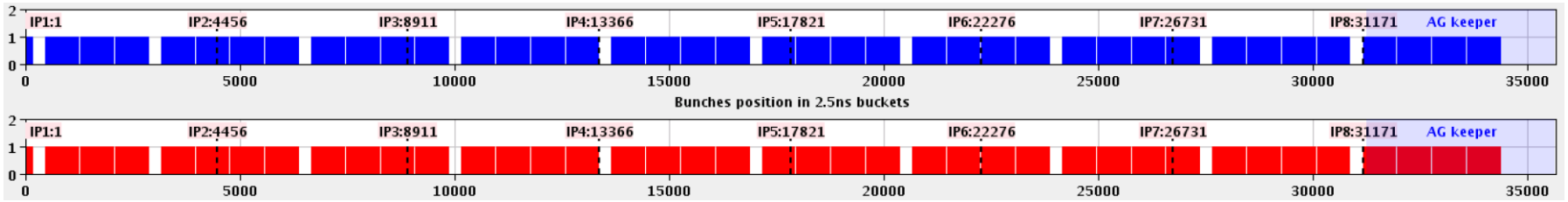
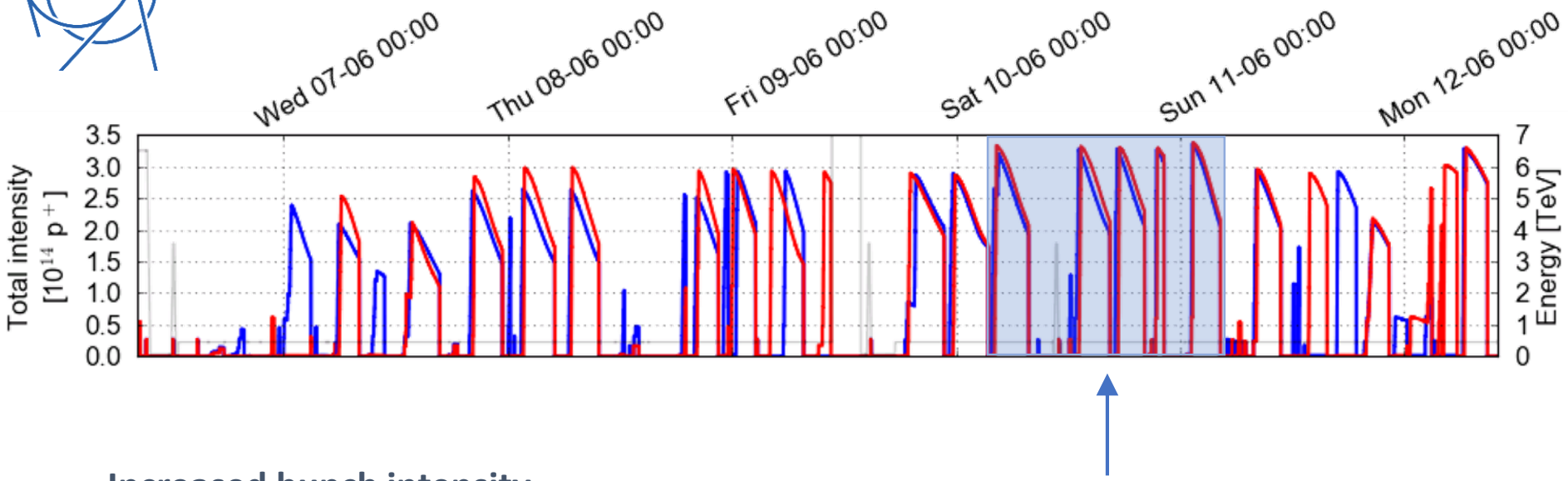


Trains of 288b per injection for both beams

- Possible to inject 288 bpi **also in Beam 1 only after:**
  - Increasing selected BLM thresholds in the injection region and at TCPs in IR7
  - Improved stability at SPS flat-top
  - Increasing scraping before SPS extraction
- Losses stayed **close to the increased dump threshold** (occasionally exceeding it)
- Filling with **up to 2820b in both beams** (maximum reached in the LHC)

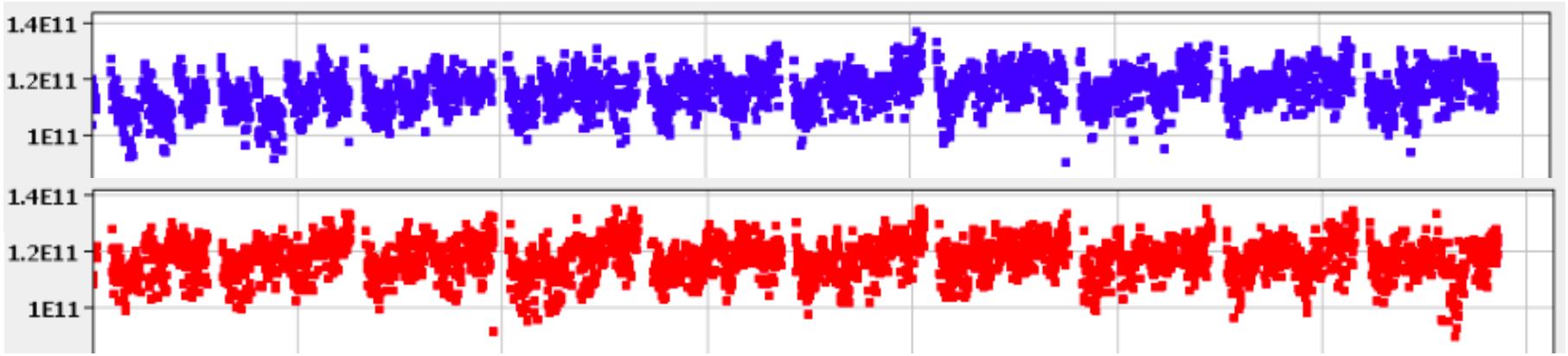


Overview

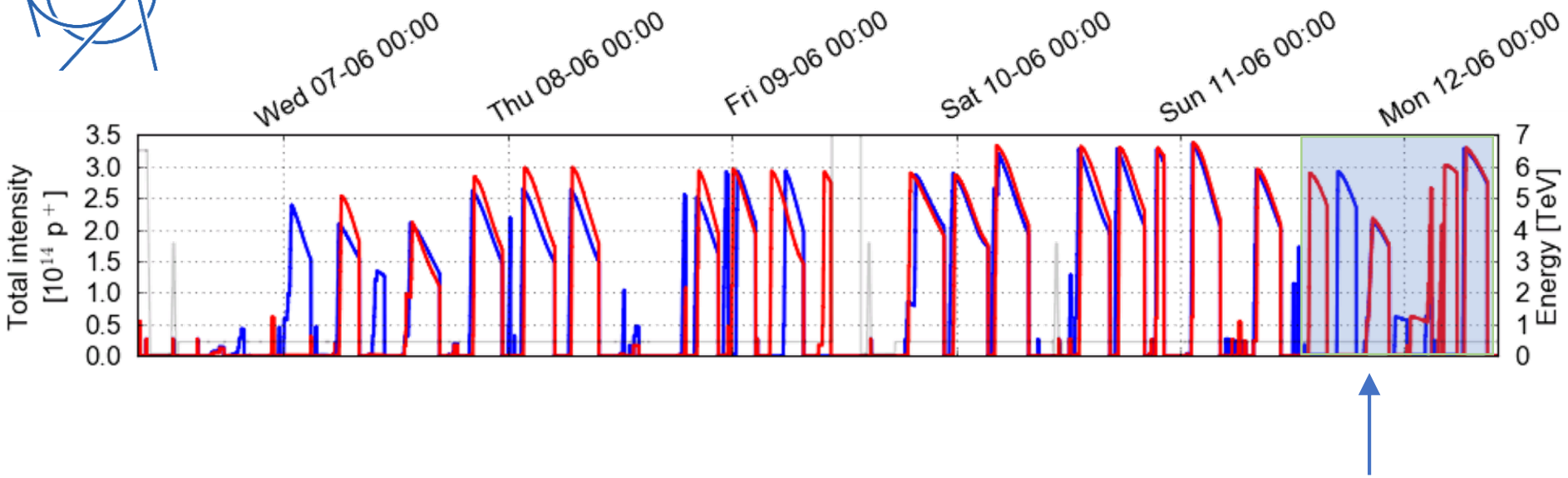


Increased bunch intensity

- Average bunch intensity from the SPS **~1.2e11 p/bunch** (possible only after relaxing beam quality requirements at SPS extraction)
- Intensity for both beams reached **3.3e14 p** (largest achieved in the LHC)



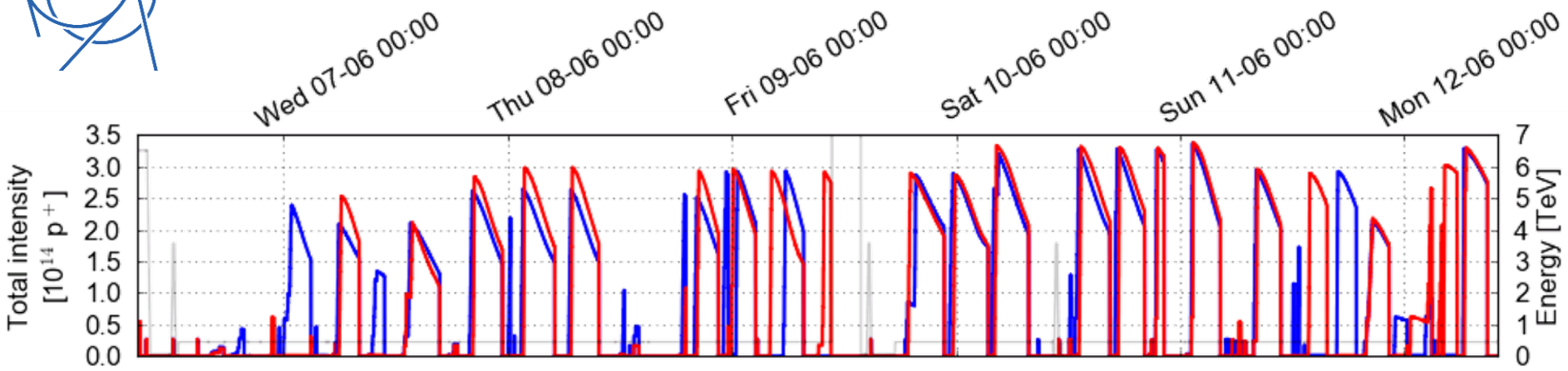
Overview



Reference heat load measurements and other tests (with further scrubbing):

- **B1 and B2 separately** for comparison against fills 5783, 5785 (from Thursday)
- **Trains of 72b** for comparison against end-2016 and beginning-2017
- **Single beam (144 bpi)** comparison against data collected on Tuesday
- Identification of **stability margins** w.r.t. Q', octupoles and ADT gain
- Fill with **full beam with optimized settings**

Overview



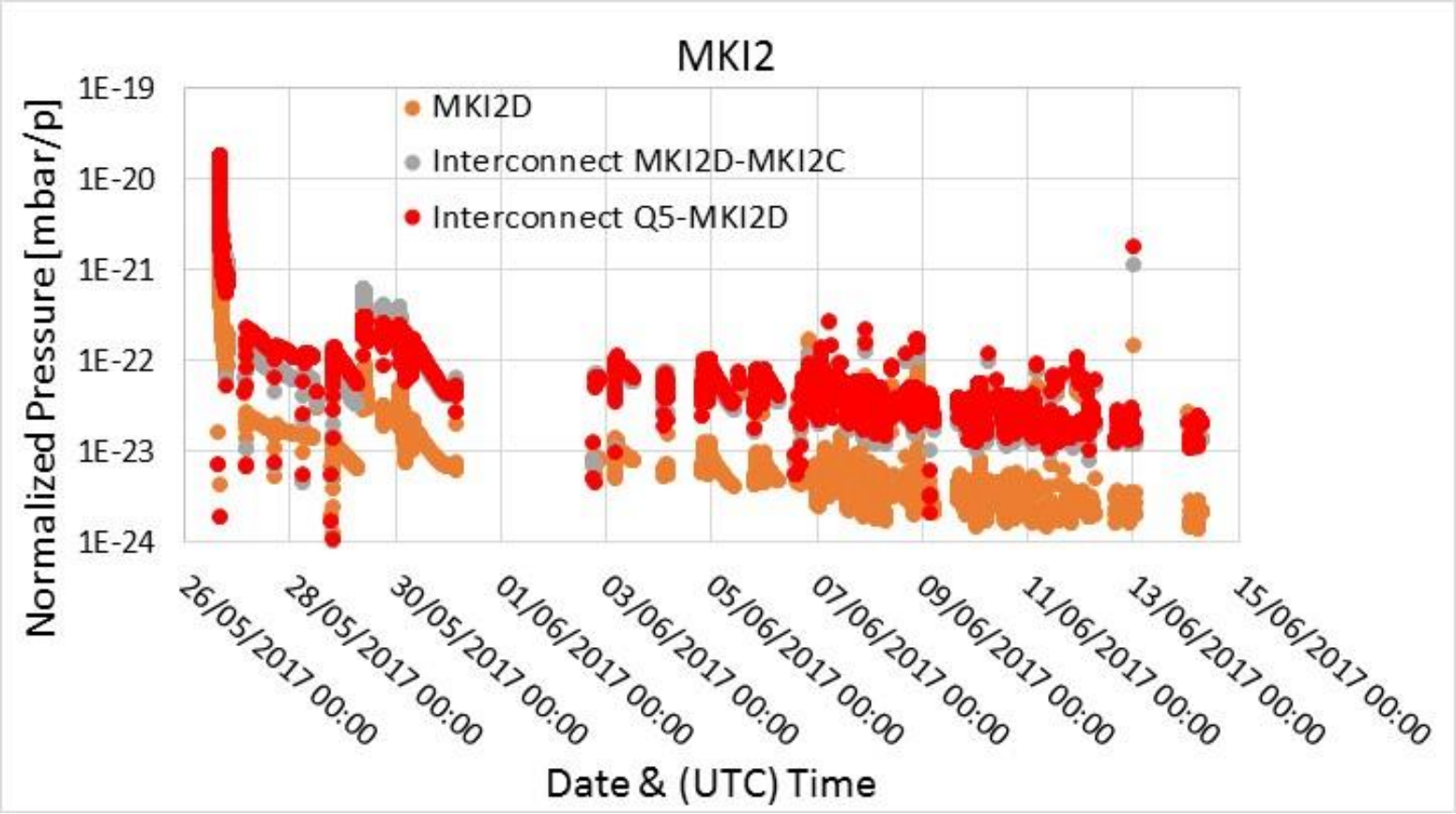
The **experience from 2015-16** and **actions taken during EYETS** were clearly beneficial:

- **Excellent cryogenics performance:** not a single loss of CryoMaintain during Scrubbing Run and no need to wait between injections (injected 2820b/beam in 15')
- **Instabilities well under control**, thanks to scrubbing accumulated in the previous years and to the stabilization recipe defined in 2015-16 (ADT configuration, Q', octupoles, tunes)
- **The pressure rise in the MKI8D-Q5 interconnect**, which was limiting the intensity in 2016, **is largely reduced** by the pumping module installed during EYETS

Pressure rise in the injection kicker regions

The **newly installed MKI2D** limited the stored intensity only in the first days but then it conditioned rather quickly:

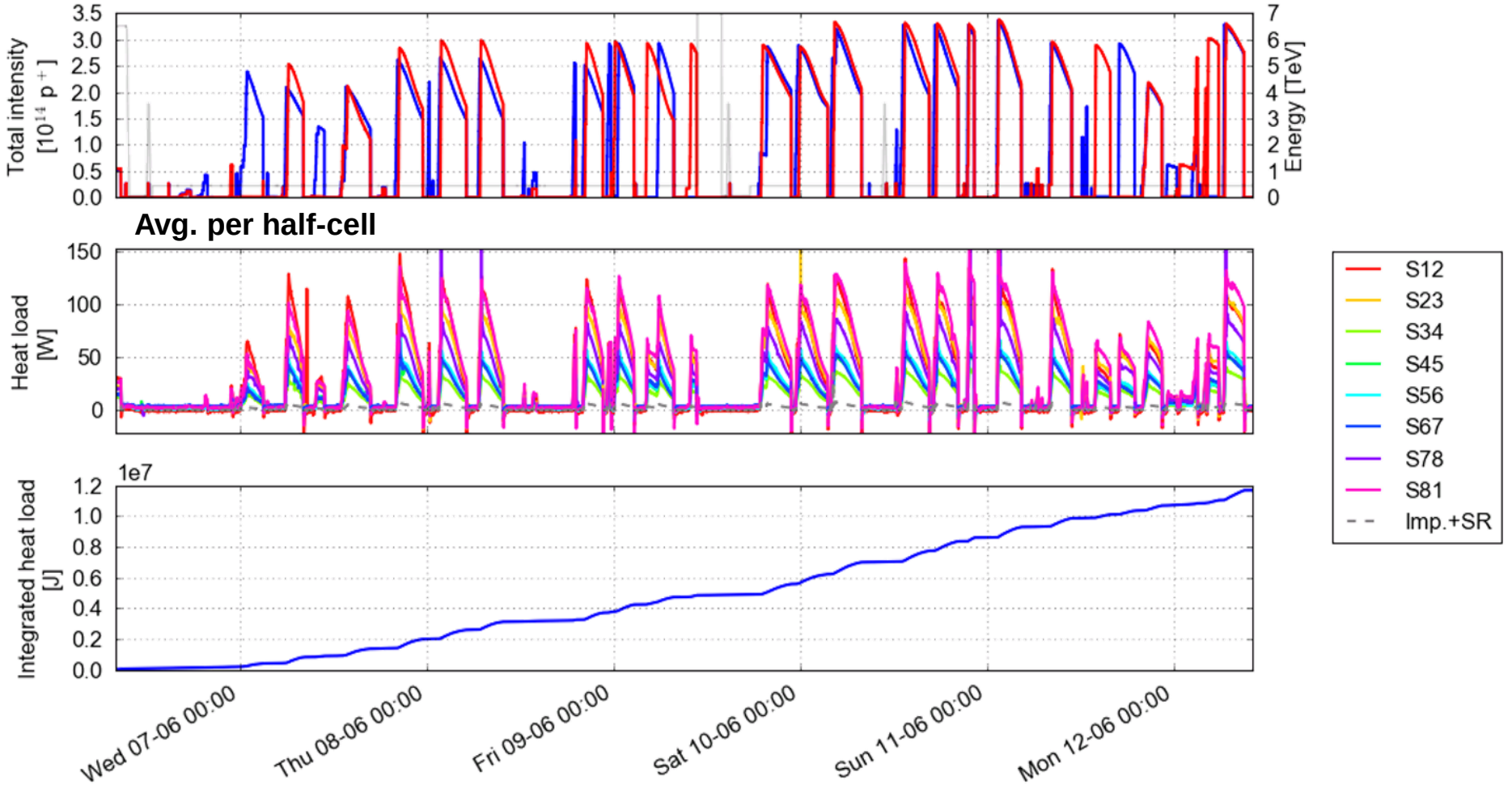
→ it should not be a limitation for physics operation



Thanks to C. Belver Aguilar and M. Barnes

Heat load overview

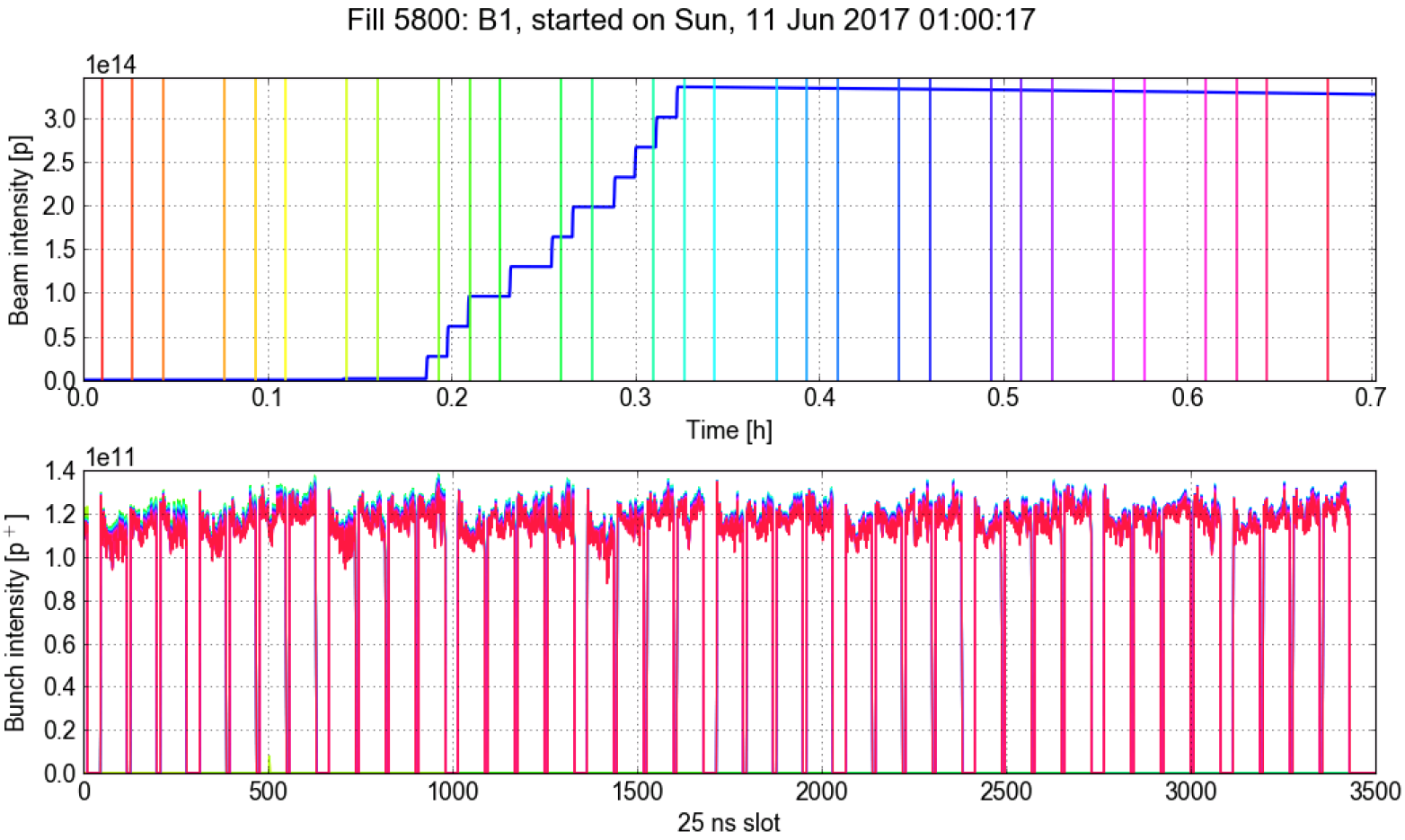
- We **did not reach heat load limit** (160 W/hcell) for any sector
- Maximum heat load **~140 W/half-cell** (S12, S81)
- **Integrated heat load over 6 days** comparable to the amount accumulated in 14 days of scrubbing in 2015



Beam quality observations

Stability well under control, thanks to scrubbing accumulated in the previous years and to the recipe defined in 2015-16 (ADT configuration, Q', octupoles, tunes)

- **No fast blow-up nor losses** are observed after injection
- **Beam quality is well preserved** over the length of a typical physics injection period (even with 2800b)



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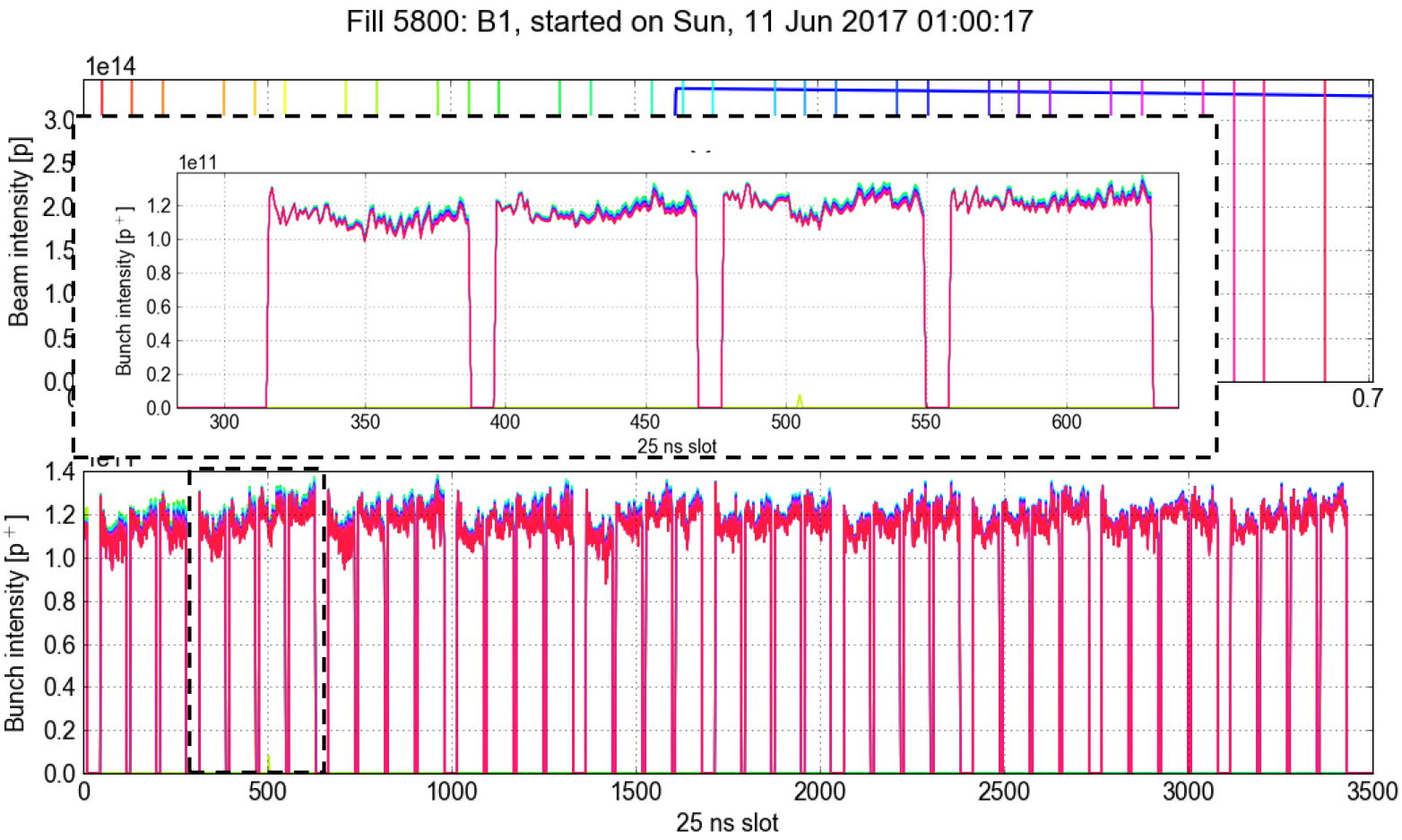

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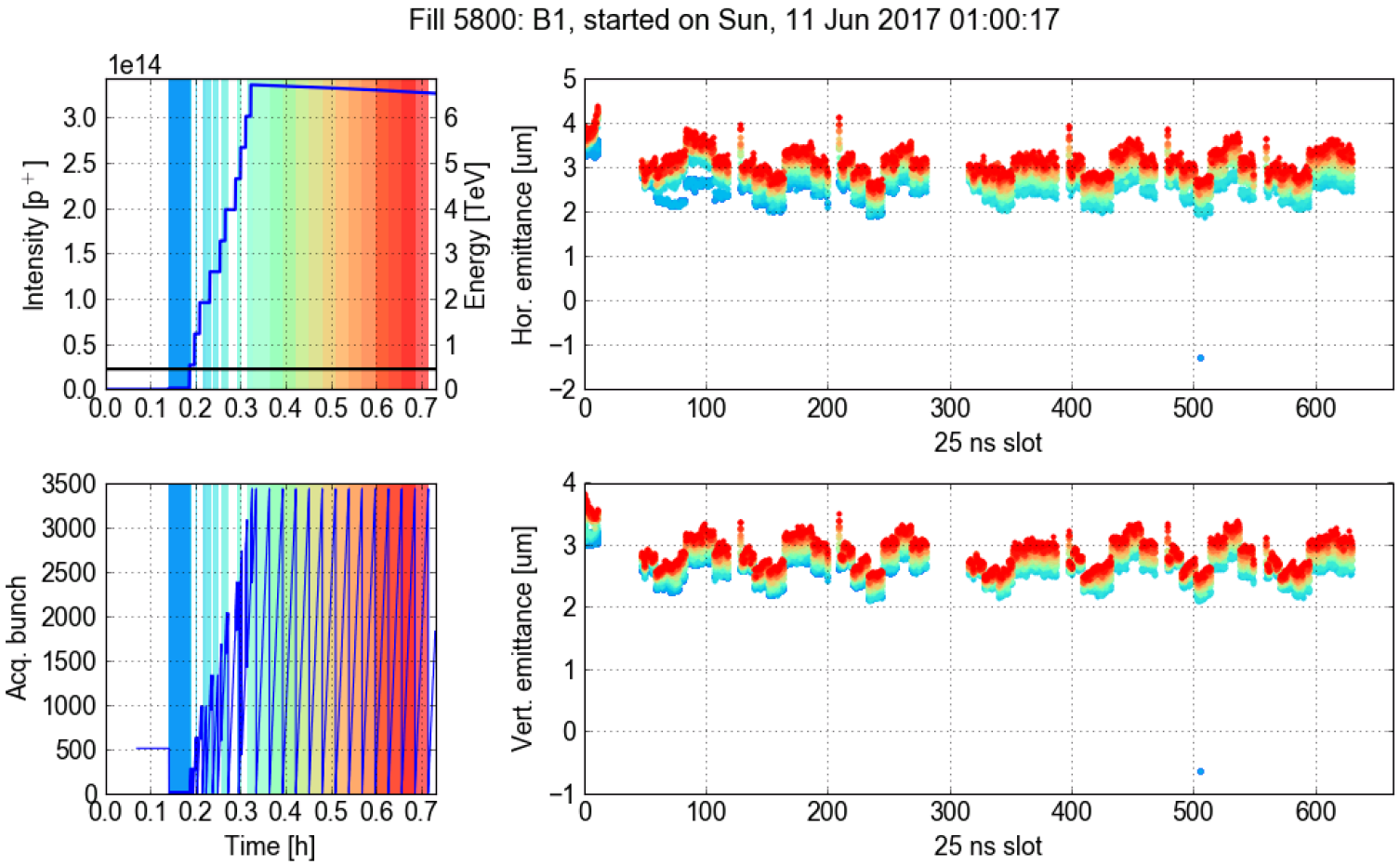
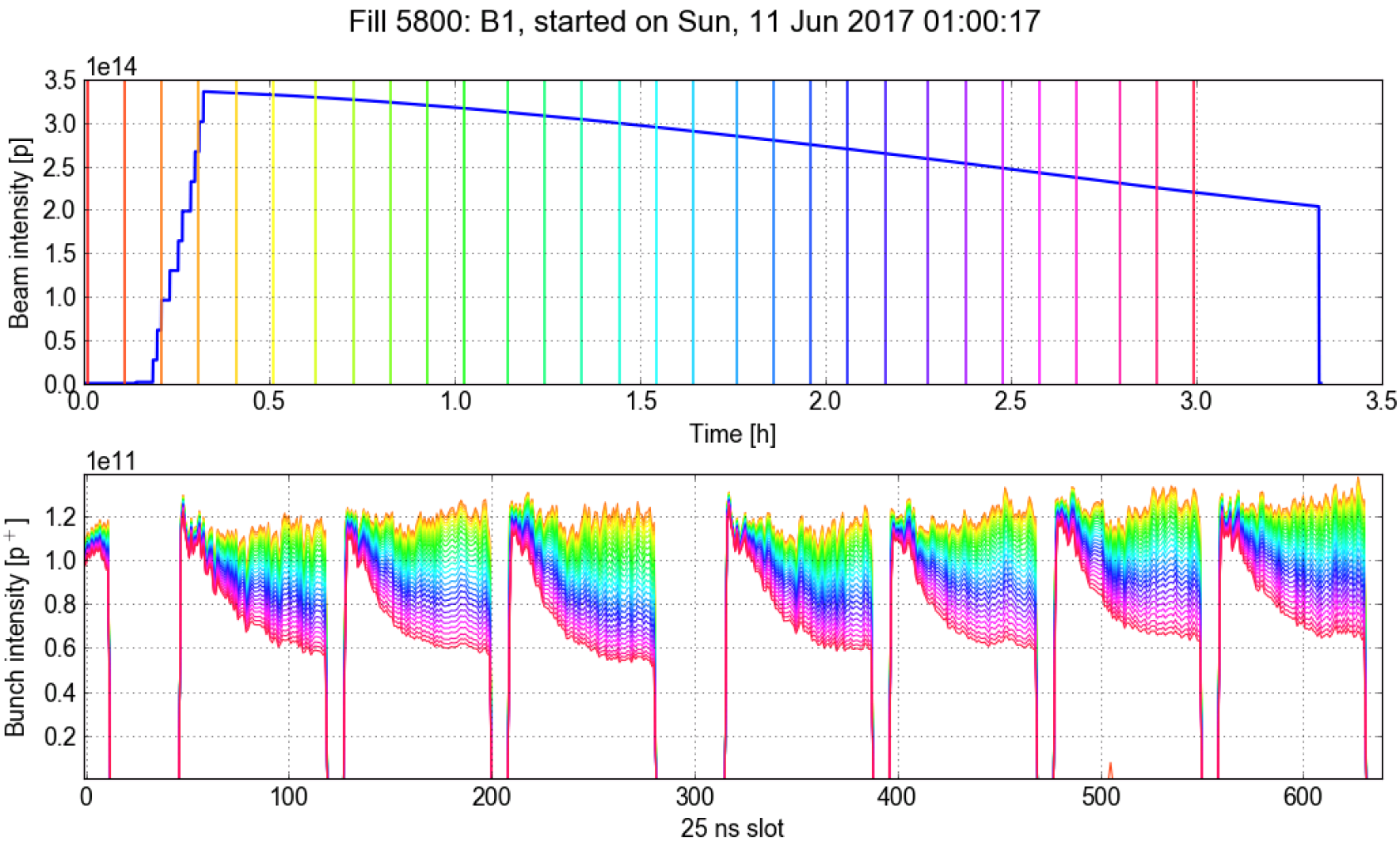


Beam quality observations

Losses driven by e-cloud are clearly observed when storing the beam **long time at injection energy**

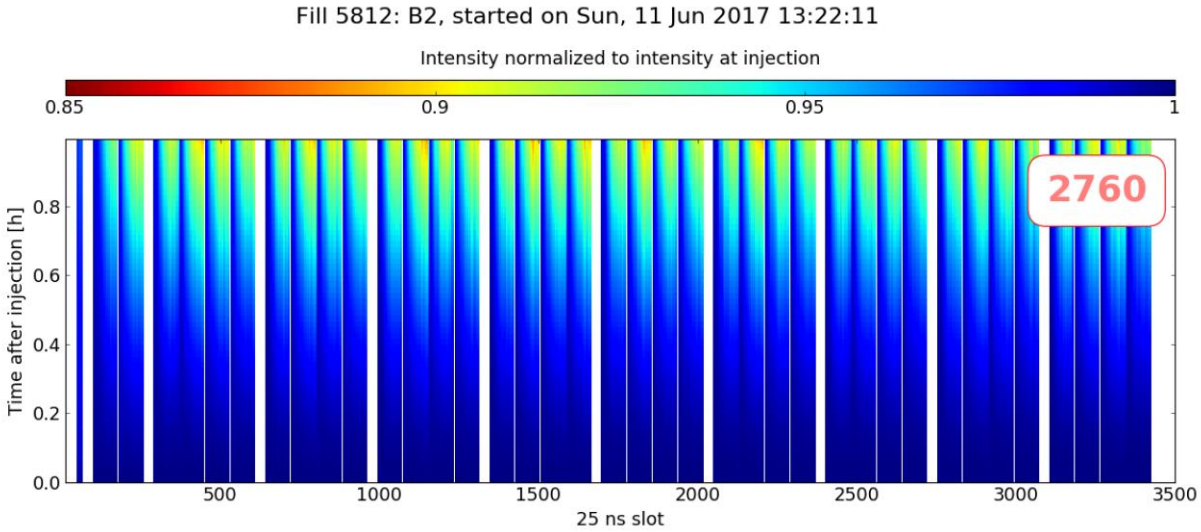


Stability margins

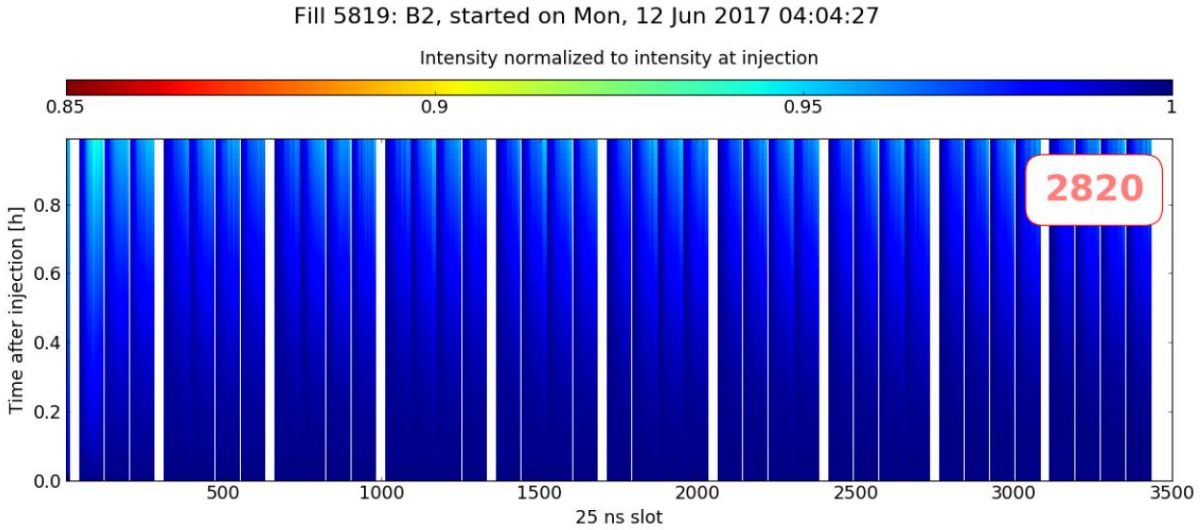
At the end of the scrubbing run **stability margins** were explored:

- **Q'=7/7, Oct=-1.0, ADT Gain= 0.1** found to be sufficient to ensure stability
- A beneficial effect on beam **lifetime** is clearly observed

Q'=20/20, Oct=-1.5
ADT Gain 0.2

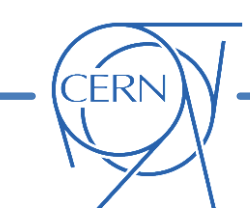


Q'=7/7, Oct=-1.0
ADT Gain 0.1



Summary and first conclusions

- Overall **quite efficient period**: the intensity in the LHC could be rapidly increased up to **~3.4e14 p/beam** in **2820b** (present records at 450 GeV)
- The **experience from 2015-16** and **actions taken during EYETS** clearly beneficial:
  - → No difficulty from the **cryogenics** side, **instabilities** well under control, improved pumping in **MKI areas**
- The newly installed **MKI2D conditioned quickly** → should not limit physics in 2017
- The **beam quality** over the length of an operational injection period **looks good even with 2800b**:
  - Degradation driven by e-cloud is observed only over longer time scales
  - Some **margin is available w.r.t. chromaticity and octupole settings** → situation seems to be different with BCMS beams



Thanks for your attention!