LHC operational experience and view towards 2024

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Outline

- Machine configuration in 2023
  - What was different from 2022?
- Operational improvements in 2023 and 2024
  - Virtual luminosity
  - Faster reaching luminosity target
  - Conditional sequencer
- High beta-run
- Ions
  - Configuration
  - 10Hz dump
- What can we expect in 2024?
  - Potential improvements to the cycle
    - Combine LHCb rotation and pre-squeeze
    - Continue to squeeze beyond 30 cm

2022

- Injection
- Ramp
- Pre-squeeze to 60cm
- Tune change
- Adjust
- β* levelling from 60cm to 30cm (tele-index 2)

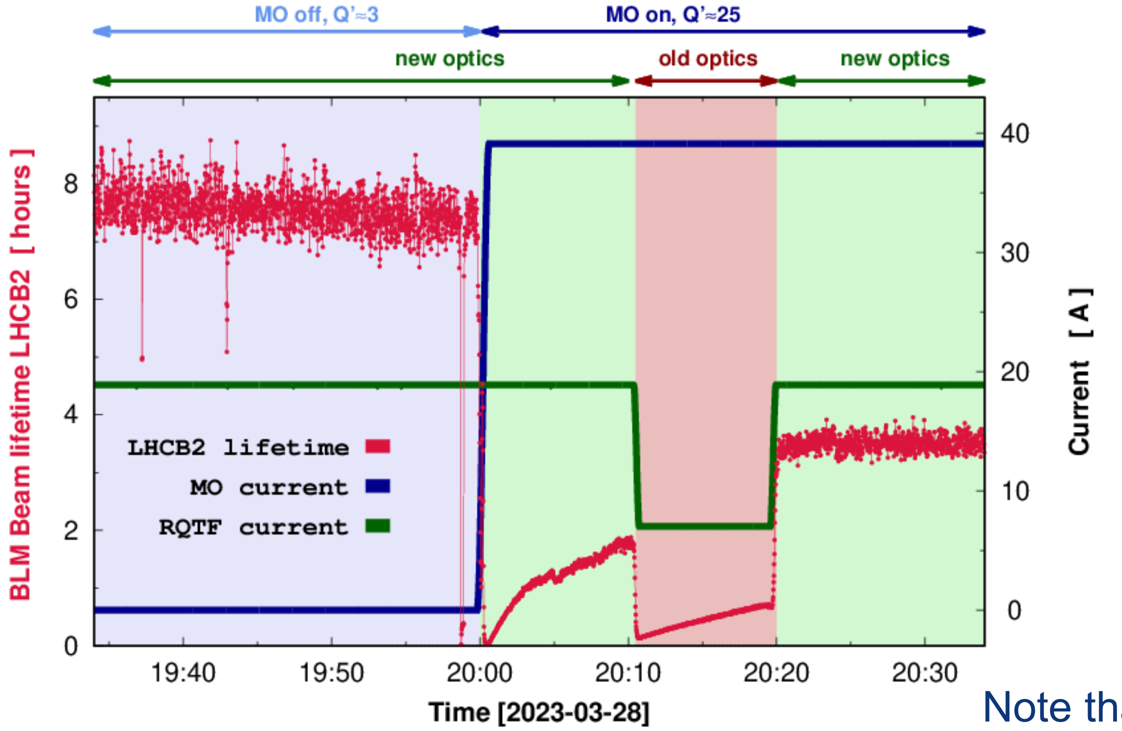
2023

- Injection
- Ramp to 4 TeV
- Ramp from 4TeV to 6.8TeV (tele-index from 1 to 0.5)
- Pre-squeeze to 1.2 m (constant tele-index)
- LHCb rotation
- Tune change
- Adjust
- β* levelling from 1.2m to 60 cm
- β* levelling from 60cm-30cm

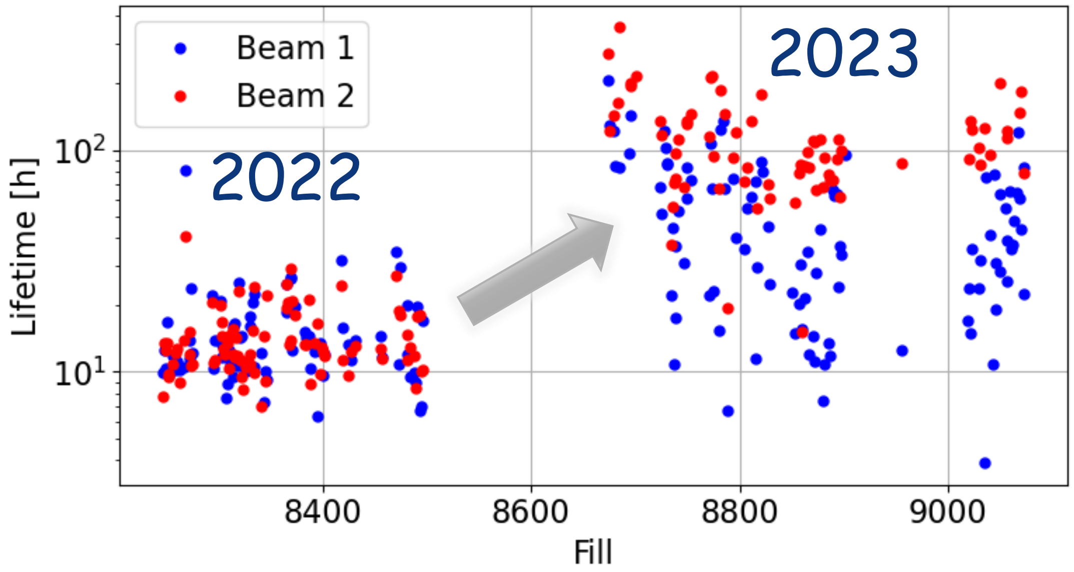
Colour code explanation:
Green means it is a new part of the cycle
Yellow that it is partially changed
Blue that it is the same as in 2022

New phase knobs at injection

A new phase knob was introduced to change the phase advance between the arcs to **reduce the negative impact of the main octupoles**
-> Increased lifetime at injection



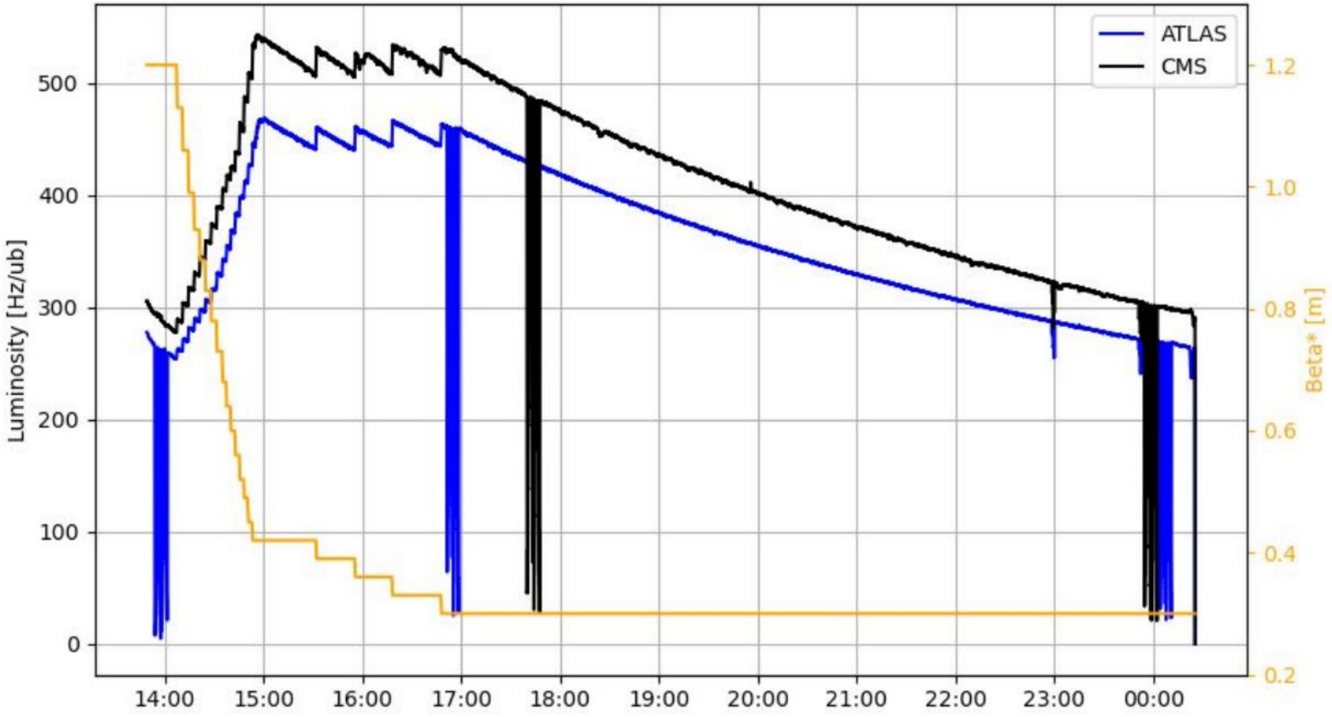
Lifetime start of ramp



Note that emittance was larger than in 2022! (see Ilia's talk)!

Luminosity in the early fills

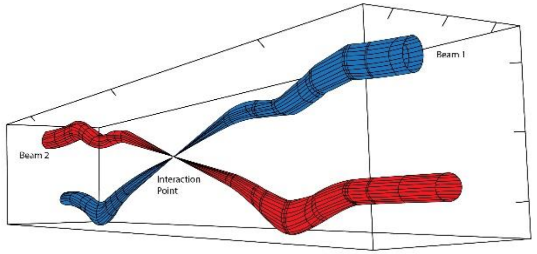
- Significant difference between ATLAS and CMS
- When staying at 30 cm the relative difference decreased as the bunch length shortened
  - Sign that part of difference was due to crossing angle
  - The DOROS BPMs as well as the standard BPM system also showed crossing angle was larger in ATLAS
  - The reported luminosity z-width region was also different between ATLAS and CMS



Crossing angle adjustment

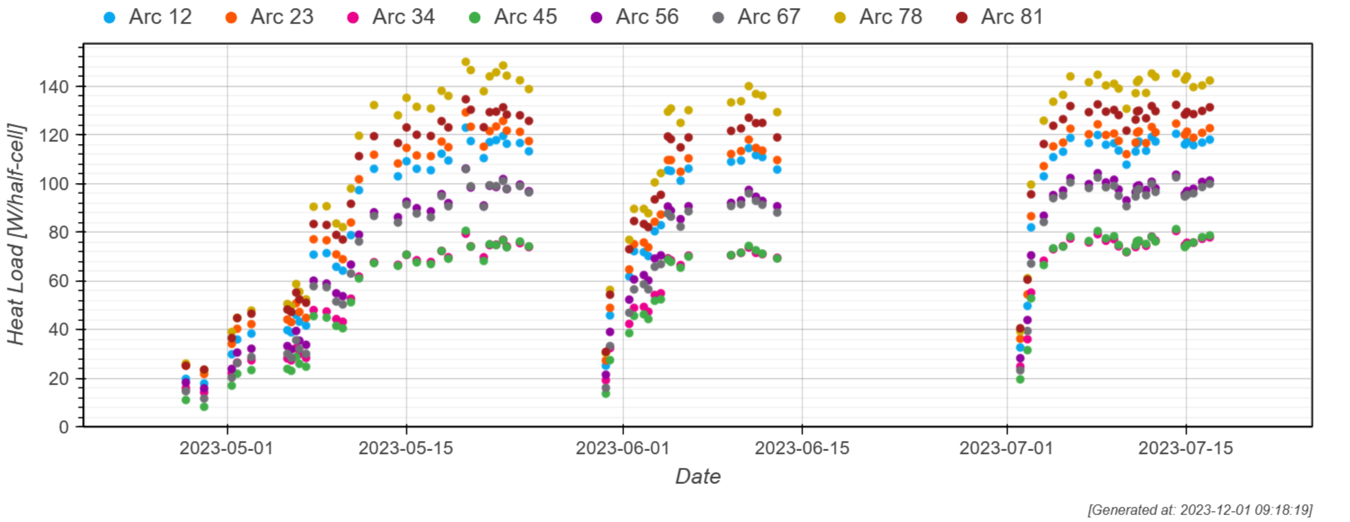
- We need the crossing angle to reduce the parasitic encounters
- Has an impact on the luminosity
  - Larger crossing angle -> Less luminosity
- We adjusted **down the crossing angle for ATLAS by 10u rad** which fixed the imbalance between ATLAS and CMS
  - Done at the same **time as retracting the collimator (see David's talk)**
    - Saved time in terms of validation needed
  - The correction was based on the **DOROS BPMs at the Q1**
    - **Plan to do use the DOROS to check the crossing next startup**

- The **earlier** we can get the **z width of lumi-region** from the experiments the better
  - An independent observables to
  - Big changes need revalidation so causes lost time
- New agreement with MPP allows for modifications of 5 urad in 2023
  - Want to keep this also in 2024



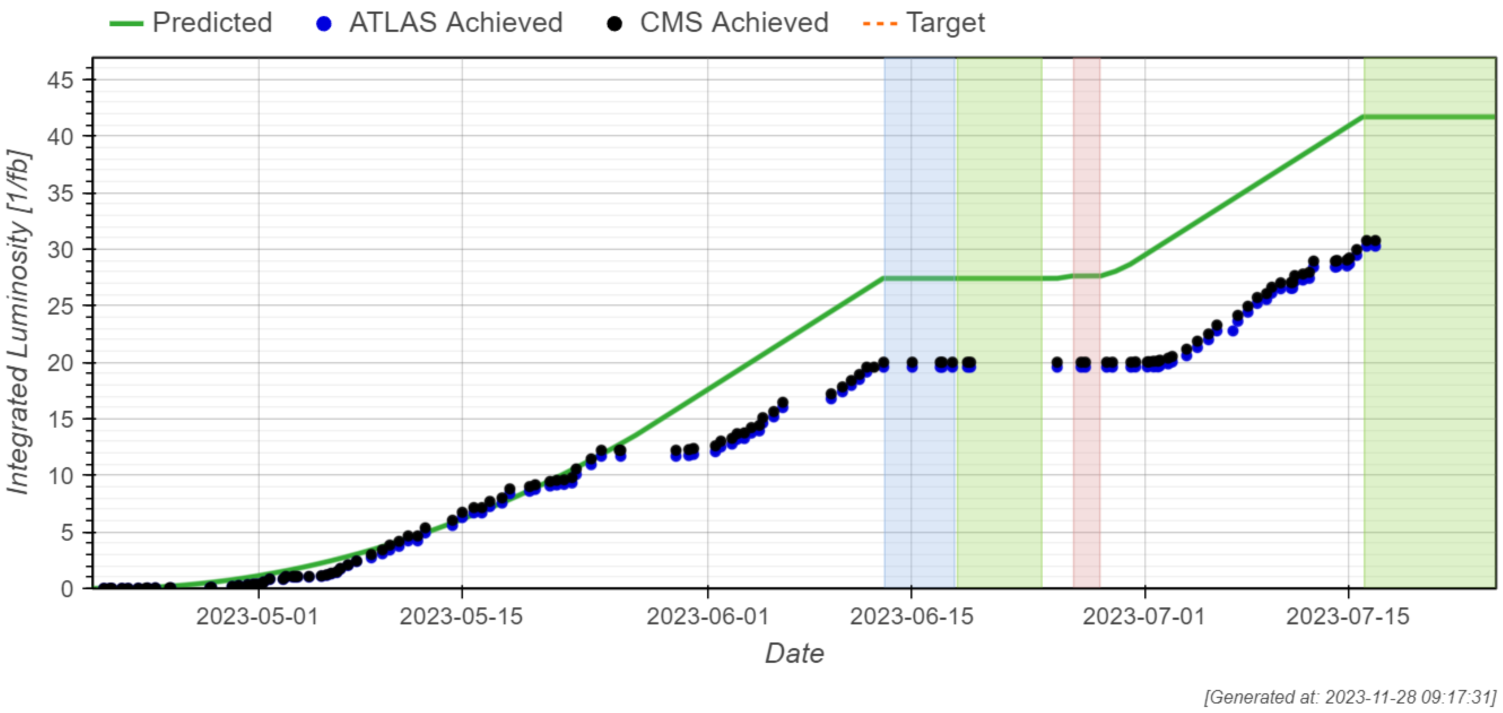
Heat Load and Filling scheme

- The heat load is under control even for the highest intensity fill we are below 150W/half cell (2454 bunches)
  - Up to 183W/half-cell in 2022 even though the total intensity was very similar
- Thanks to **hybrid filling scheme** (mixture of 8b4e and 36 bunch train)
  - First time we use it in normal operation
  - Significant effort from the injectors to make this happen!



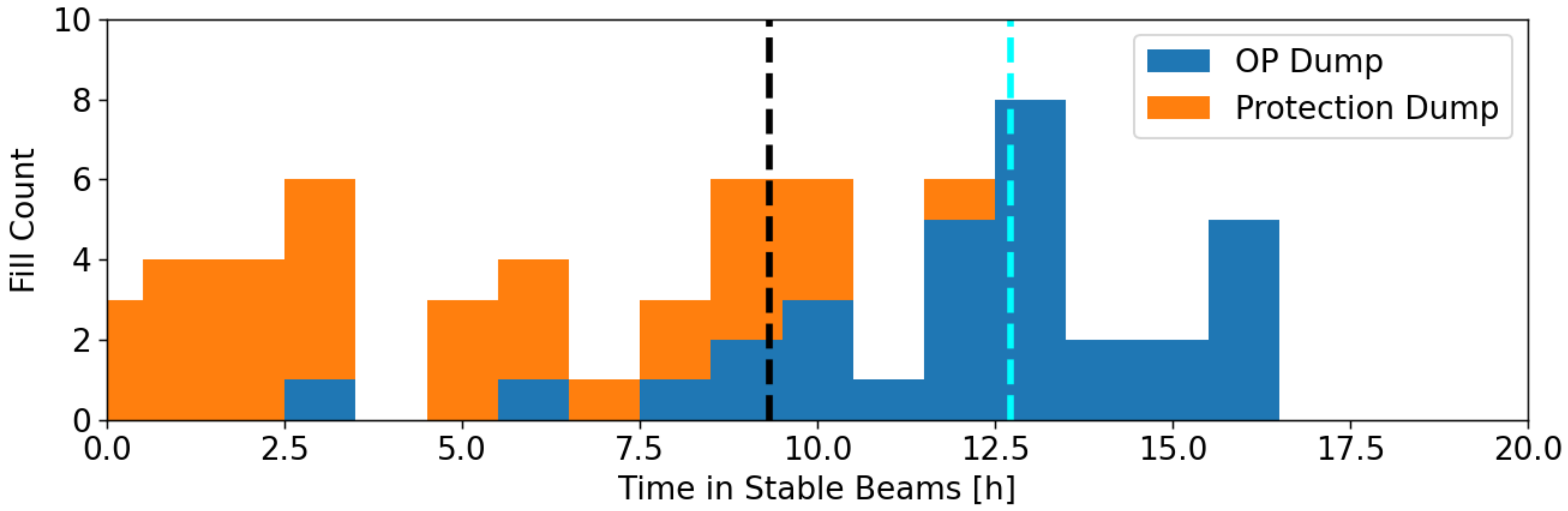
Luminosity production

- At the time of the incident, we had just passed **32 fb-1**.
- Slope was around **~0.8 fb-1/day**, we could not do much better with the bunch intensity (**1.6E11** limited to avoid another RF-finger incident, see Mateo's talk), given emittance and the stable beams fraction



Why and when do we dump?

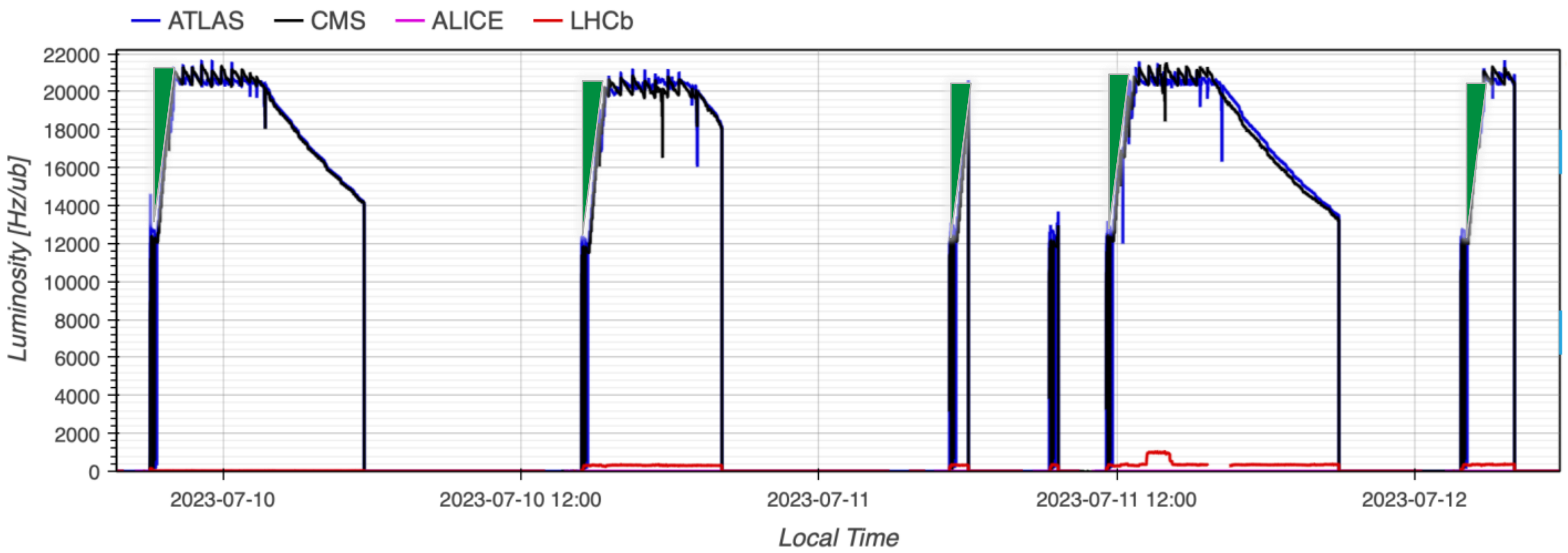
- In the proton physics run, **we had 63** dumps with more than 1200 bunches
  - 33 were protection dumps
  - 30 were OP dumps
- In 2022 we had
  - 60 Protection dumps
  - 42 OP dumps



Impact of 1.6e11 and larger than expected emittance

At start of fill it takes **~45 minutes** to level to target configuration which is designed for **1.8E11** vs **1.6E11** **ppb** and for **~10% smaller emittances** (nominal vs BCMS)

➔ Lumi lost, in particular, for the shorter fills



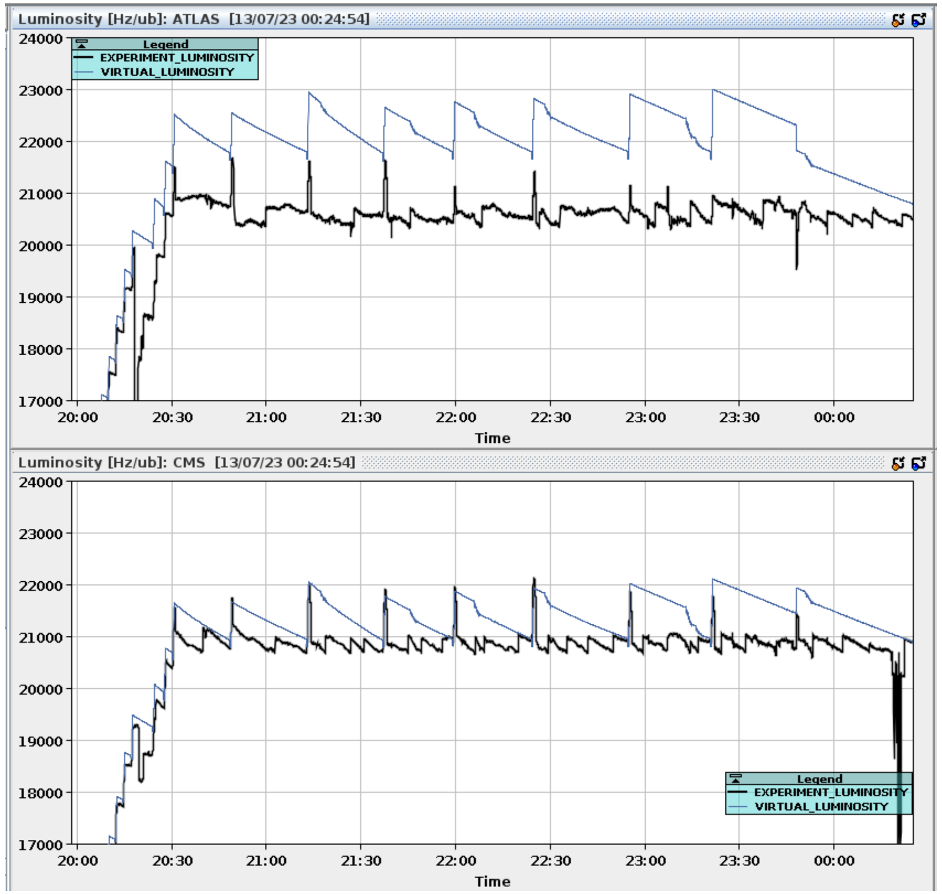
The green triangles show the potential gain of squeezing directly to the requested luminosity

The expected gain in integrated luminosity is **around ~2-3%** more for shorter fills

Squeeze in one step to target luminosity

- The previous limitation was that we had to take every β* step
  - Every step takes a few minutes due to the arming procedure of feedbacks, power converters and collimators
- New method allows for one **big first step** to reach the desired β* giving the desired luminosity
  - Much faster since orbit feedback, collimator etc can be played in one step
  - Was tested successfully in 2023 with 3 bunches just before the incident
  - Plan to use in 2024
- Should we change the start of the collision, e.g. to 90cm?
  - **After the implementation of the "squeeze and collide"** we would lose on decreasing the β* where we start to collide
  - Squeeze takes always some time and now we will be already producing at this squeeze
    - In particular for LHCb and ALICE where integrated lumi is directly determined by time in Stable beams
    - One could envisage at some point colliding at the end of the ramp (rotation could be done above 5.5 TeV)

Pile-up à la carte



- Most of the year we were β-levelling on CMS and then separating ATLAS
- Last week of proton operation “virtual lumi” was introduced
  - It is based on machine and beam parameters and gives the expected luminosity if they were heads-on
  - **Lumi-imbalance** will be determined by the **experimental calibration (**as long as we are in levelling)
- Use the virtual luminosity for β* levelling and separate to the requested pile-up
  - Potential improvements for 2024
    - ATLAS and CMS could request the pileup over dip (LHCb and ALICE already doing this)
    - Try to anticipate the increase of luminosity by separating the beam at the same time

OP cycle in the very High-β run

Injection (no phase knob) → **Ramp&DeSqueeze $\beta^* \sim 75/17/75/17$ m (IP1/2/5/8)** → **DeSqueeze to $\beta^* = 120$ m in IP1&5** → **DeSqueeze to $\beta^* = 3/6$ km! in H/V in IP1&5**

→ **Q change** → **Establish and optimize collisions** → **Deploy physics conf. of collimation and XRPs** → **Data tacking**

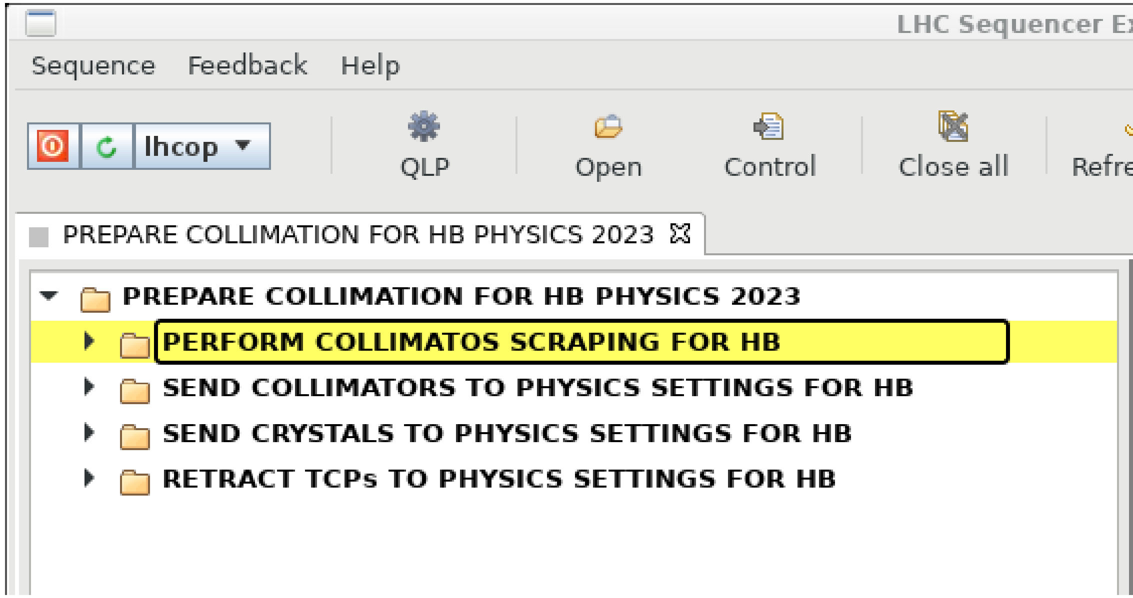
- Optics measured and corrected at 120m and 3/6km
- All fills were below 3e11 in total bunch intensity so we could have the safe flag
- The **requested 300ub^{-1} to TOTEM and 329ub^{-1} to ALFA** was delivered at 3km/6km during a total of 70h in 9 fills

Automated collimation handling for the High-β run

Previously all tasks had to be manually. For the first time they were included in a sequence -> Less expert intervention was needed during the run

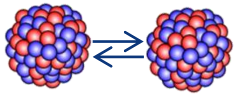
Sequence of tasks:

1. **Scraping** using TCP.7
2. **Move standard collimators** to physics settings
3. **Move crystals** to physics settings
4. **Retract TCP.7** to physics settings
5. **Move XRPs** to physics settings (dedicated seq.)



Very good reproducibility of the orbit fill-to-fill

Ion Run



- A full ramp and squeeze down to β* of 50 cm in IP1, IP2 and IP8
  - Squeeze to the lowest β* in the ramp so far
  - The crystal collimation was used for the first time with ions (see collimation talk)
- A very **challenging operation**
  - Many technical issues
    - Background (Matteo)
    - Losses in the ramp (Sara)
    - QPS (Jens)
    - **10Hz (**Maria's**)**
  - Long time to fill, short time in stable beams
  - Very dynamic run in terms of crystal optimization, filling schemes, levelling

Injection

Ramp and squeeze to β* 50cm

Tune change

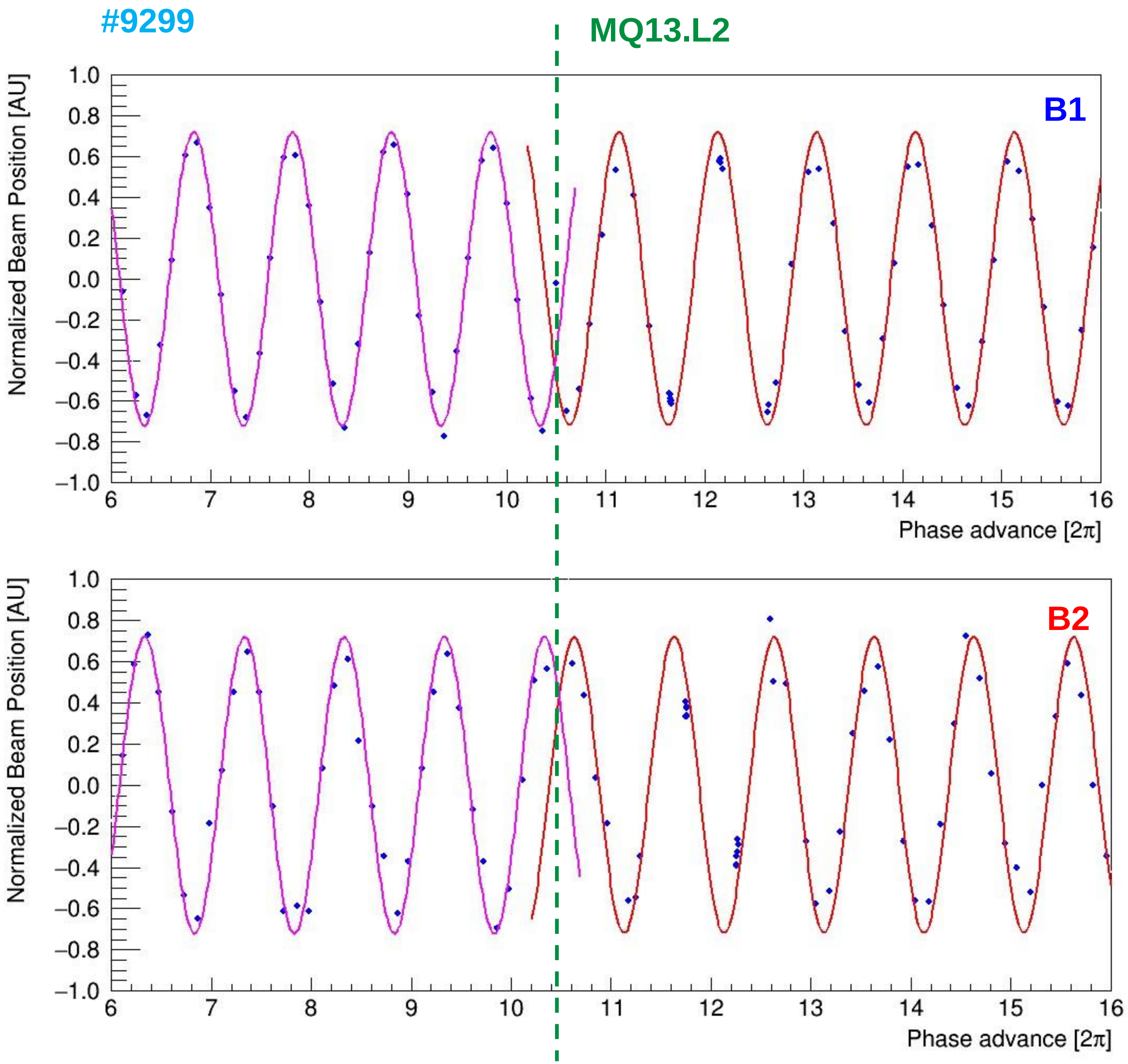
Adjust

Stable beams

*Additional step of inverting crossing angle after end of ramp for neg-polarity (IP2)

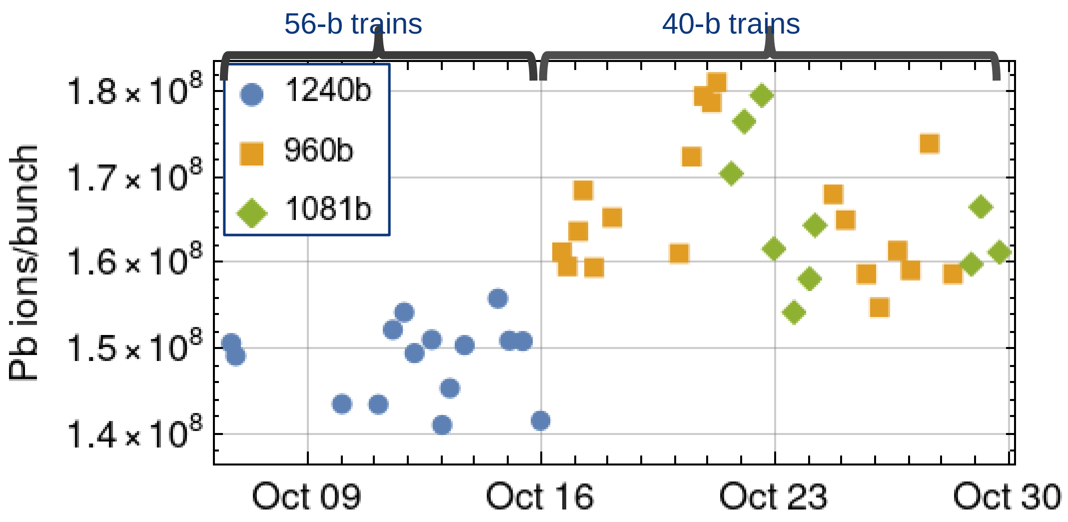
10Hz losses

- Two locations stand out:
  - 13L.2 and 13.L8
  - The reason we don’t see Q6 this run is difference of location of the crystals vs normal collimation
- **Several Investigations are ongoing**
  - Having high-rate data when the beams are not dumped
    - On demand like Post-mortem is investigated
  - Proposal to equip **MQ13.L8** and the two surrounding dipoles with an array of vibration sensors
    - Survey for 4 weeks during commissioning



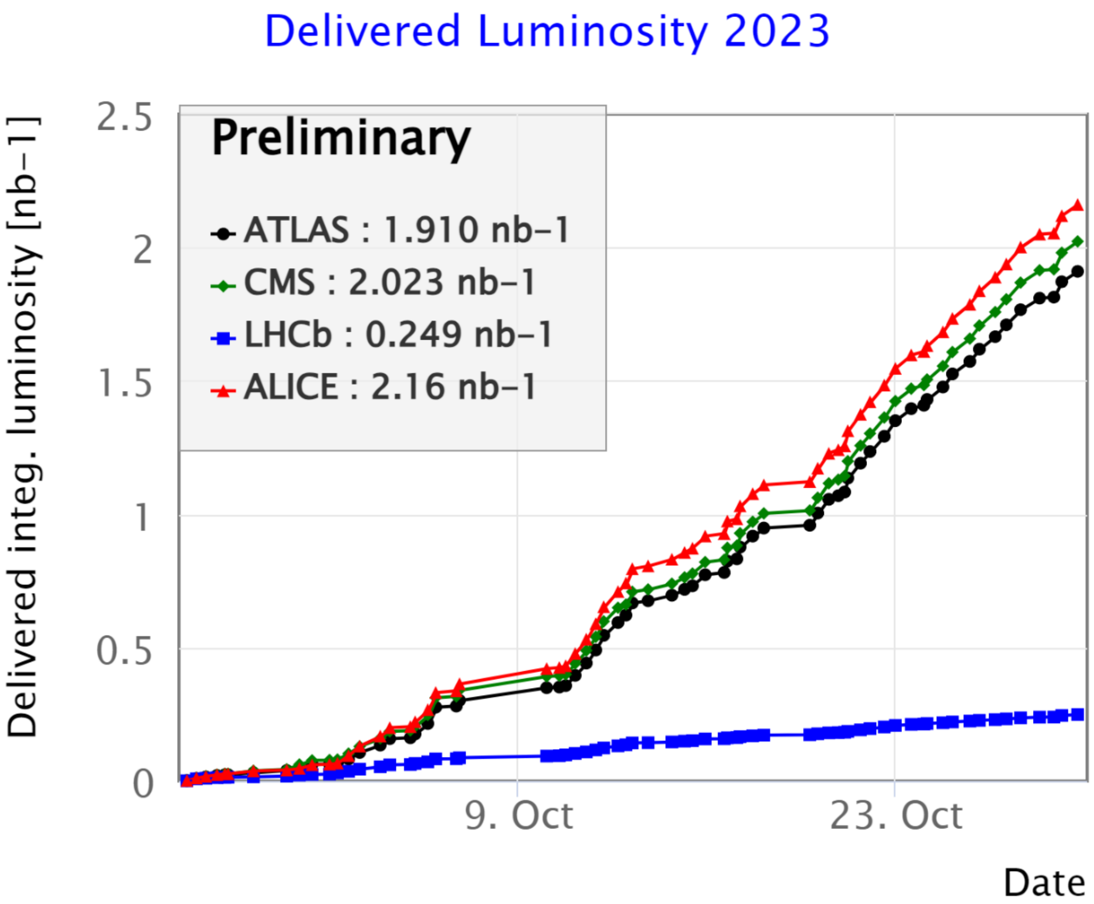
Beam quality

- **Bunch intensity at start of stable beams:**
  - 56-bunch trains: 1.49×10^8 Pb/bunch
  - 40-bunch trains: 1.66×10^8 Pb/bunch
  - **Target: 1.8×10^8 Pb/bunch – reached only in a few fills with 40b-trains**
- **Observed degradation in injected intensity over time**
  - Could partially be recovered by injector optimization, then degrading again
  - **Crucial that enough time to setup is given to the team**
- **Emittance**
  - BSRT not calibrated, so not reliable (not available at injection)
  - From emittance scans, **εx=2.5 μm εy=1.9 μm**
  - **Target before the run: 1.65 μm average**
- **Less impact on the integrated luminosity compared to the technical issues but potential room for improvement in the next ion run**



Integrated luminosity

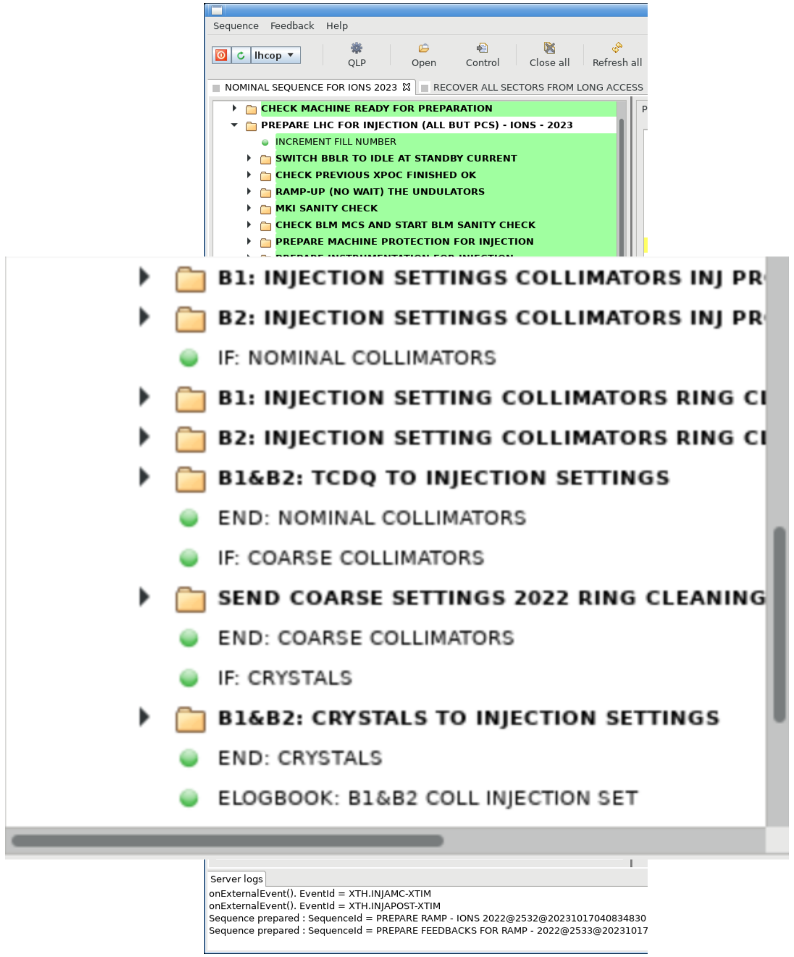
- Despite all the issues we manage to deliver a substantial amount of luminosity!
- Comparison 2018:
  - ATLAS: 1.797 nb^{-1}
  - CMS: 1.802 nb^{-1}
  - LHCb: 0.235 nb^{-1}
  - ALICE: 0.905 nb^{-1}

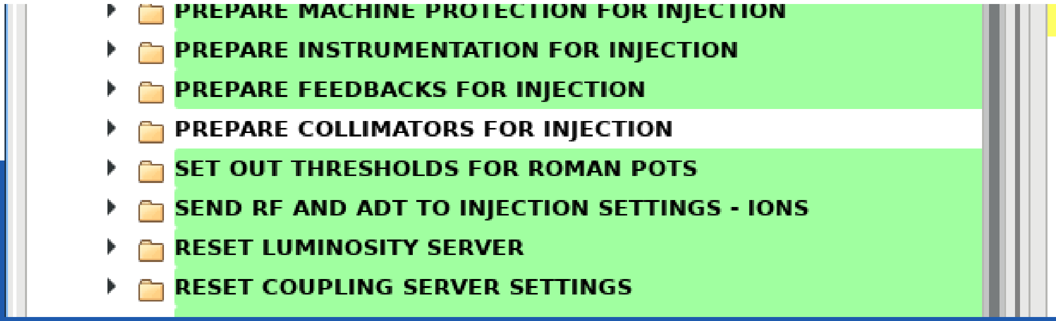


ALICE luminosity without background issues:1.96 nb^{-1}

Conditional sequencer

- The Sequencer is the most used application in the LHC
  - New feature with **conditions tried** this year during the ion Run
  - The most common use case for the LHC is when we want to run with **coarse collimator settings** (i.e. more open for optics measurements or other tests)
    - Previously we had to skip and unskip part of the sequence every time -> easy to make mistakes
    - Now there is a condition and condition, collimator in coarse and only that part played
- The current implementation is a workaround
  - An upgrade is needed to have it fully operational
  - Feedback:
    - Generally, very positive but some still some room for improvements
    - In the overview it is not possible to see that the subsequence has been played

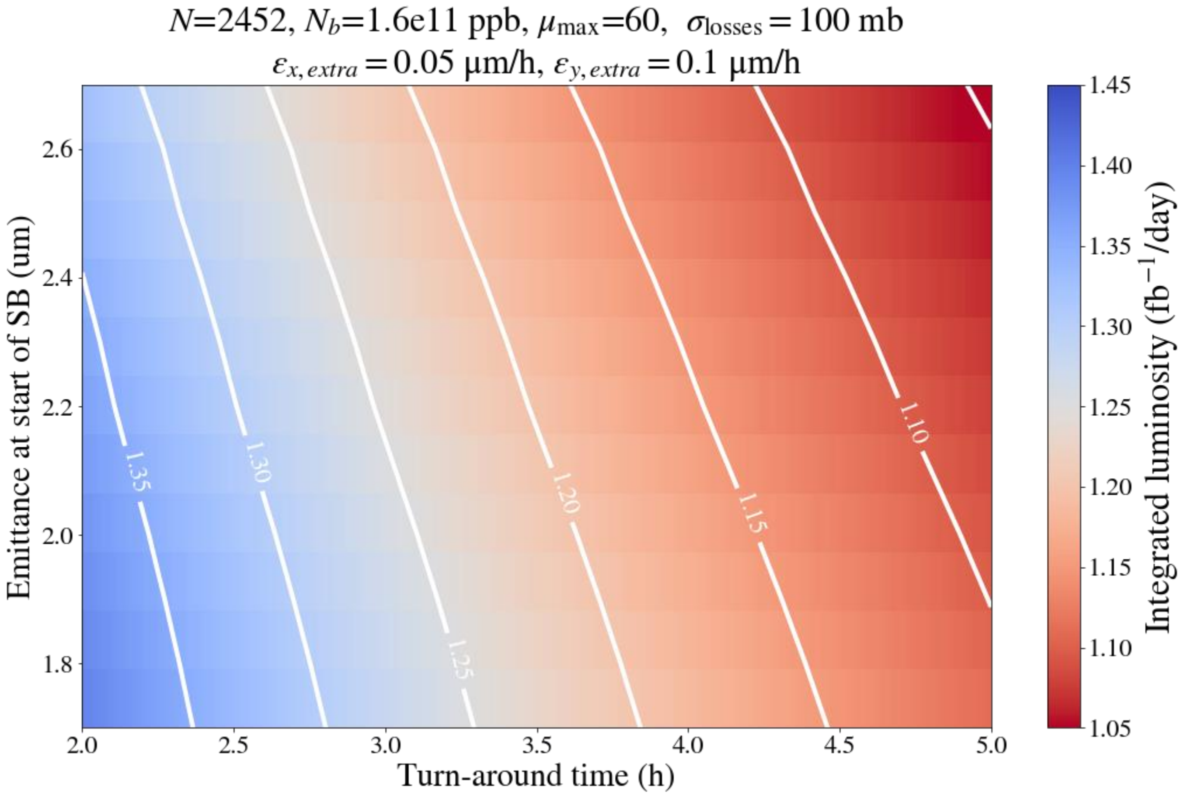




2024 proton cycle and estimates

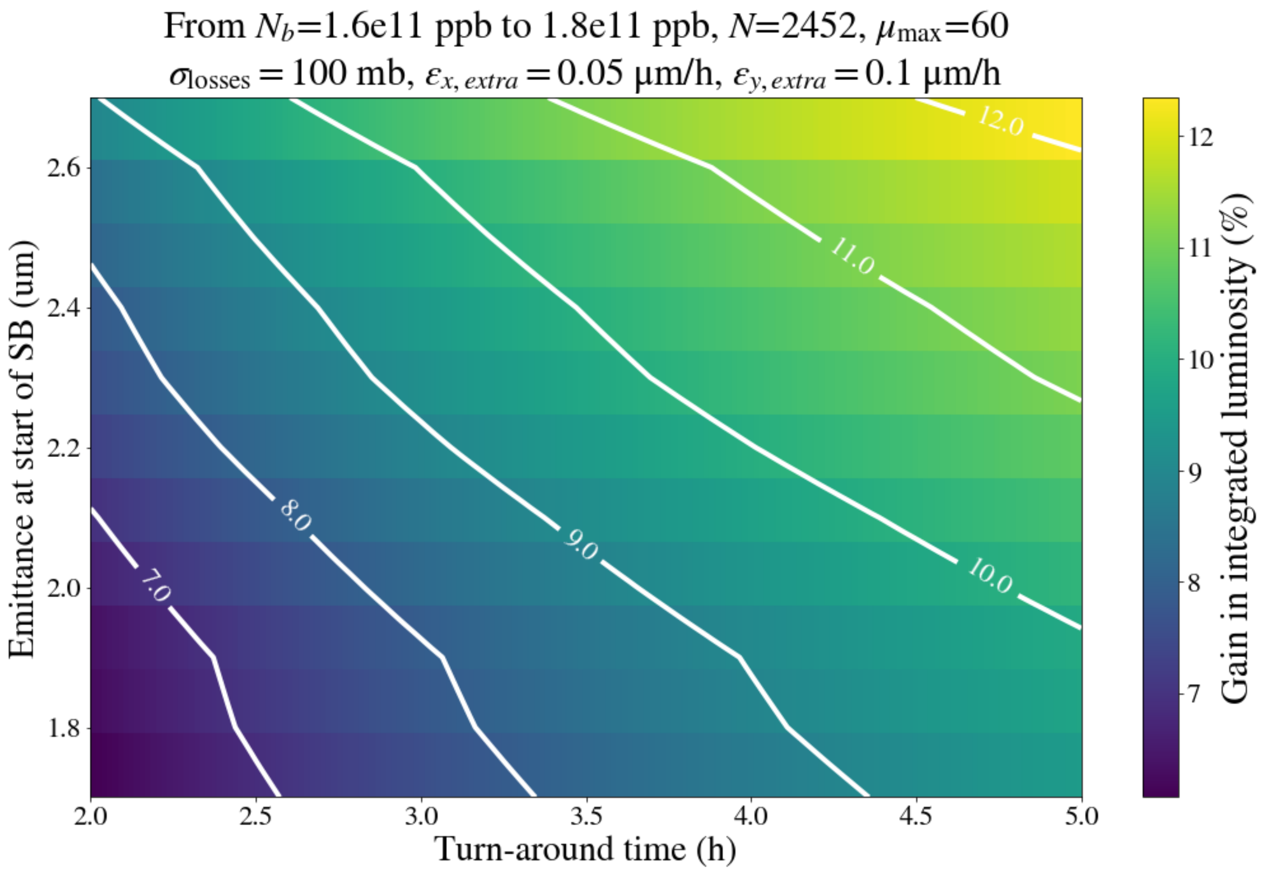
Luminosity production in 2024

- Assumes the same **configuration as 2023** but that we can reach the target straight away
  - Of course if the cry reconfiguration would be successful the 36bunch trains would be very attractive!
  - Assumes **ideal levelling time** (no technical faults)
  - One could reach around 1.3 inverse femtobarn on a very good day
    - Note that numbers are all at the beginning of stable beams
    - In 2023 only a few fills we were at 1.6e11 at the beginning of stable beams

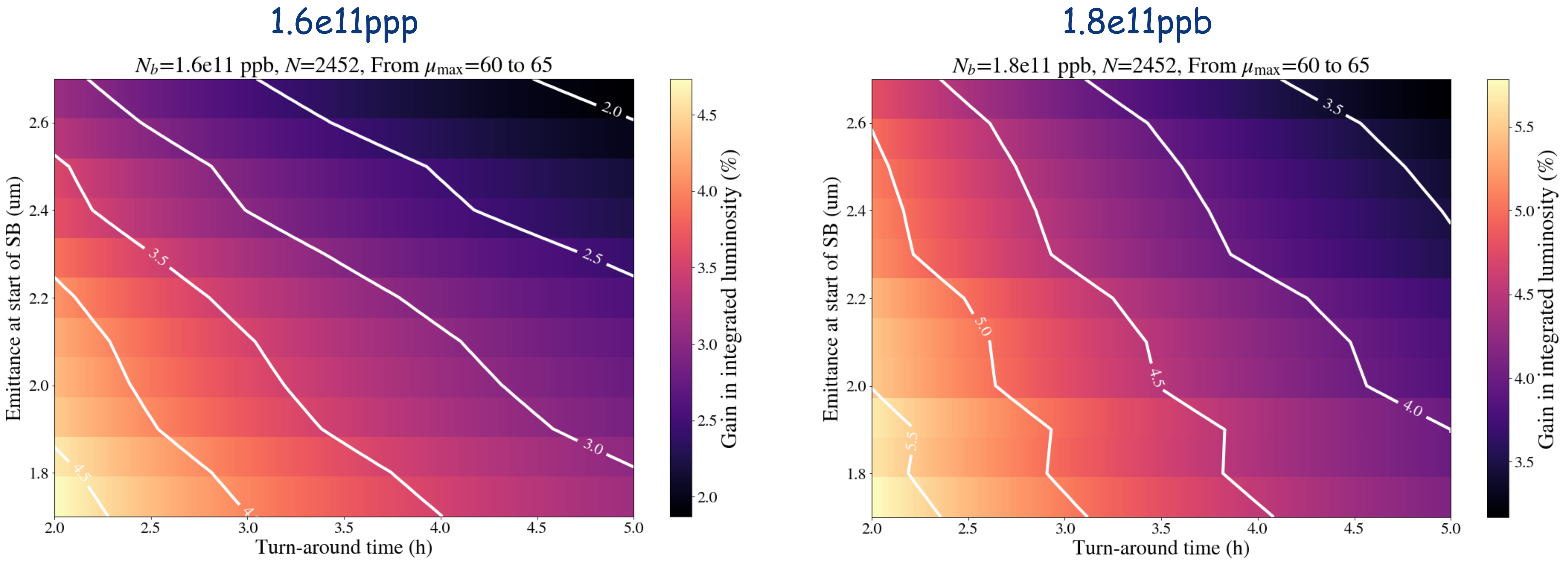


What is the impact of going to 1.8e11?

- If we can reach 1.8e11
  - Gives an increase of integrated luminosity of **around 9%** for realistic scenarios



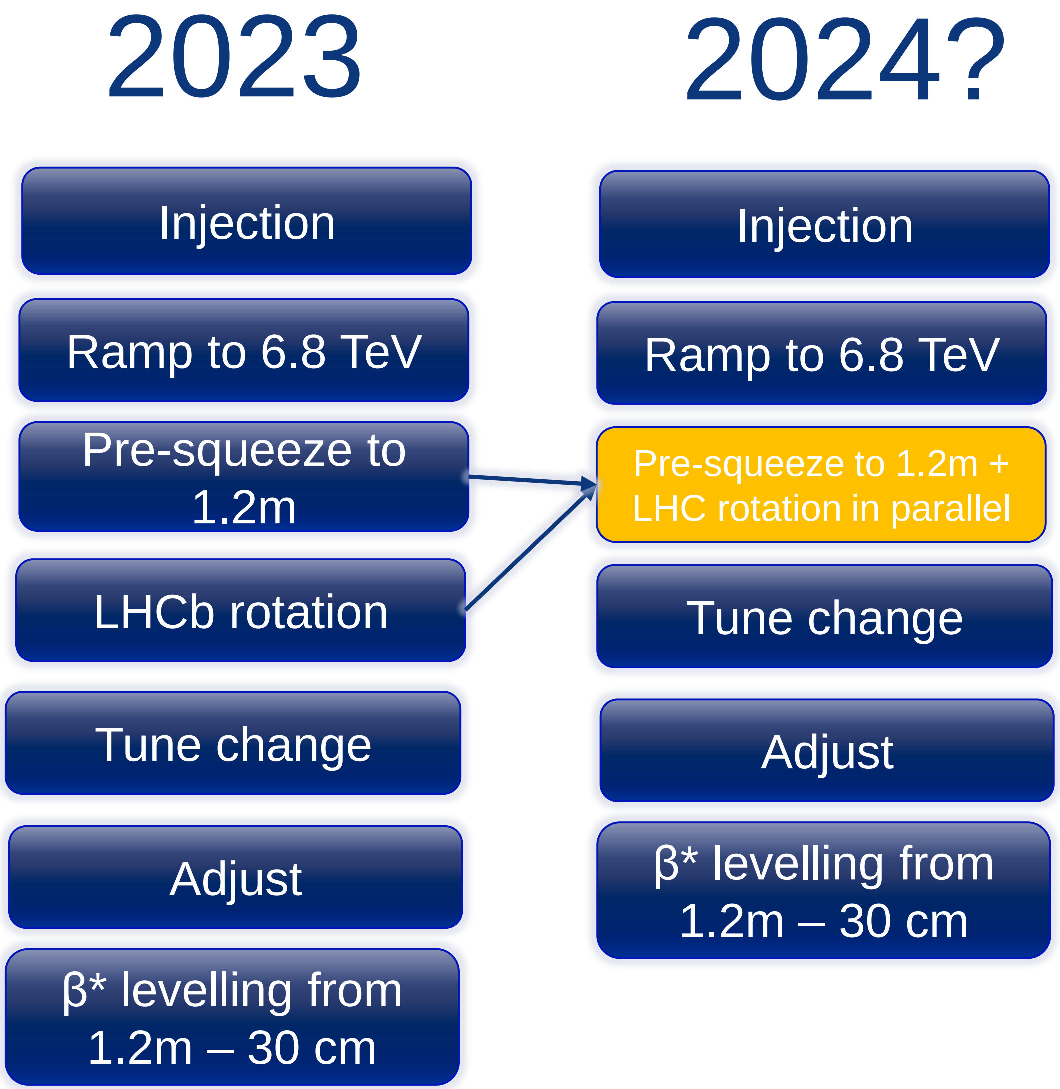
What about the pile-up (60 -> 65)?



Results in an increase of integrated luminosity in the **range of 3-4%**

Can we shorten the with cycle?

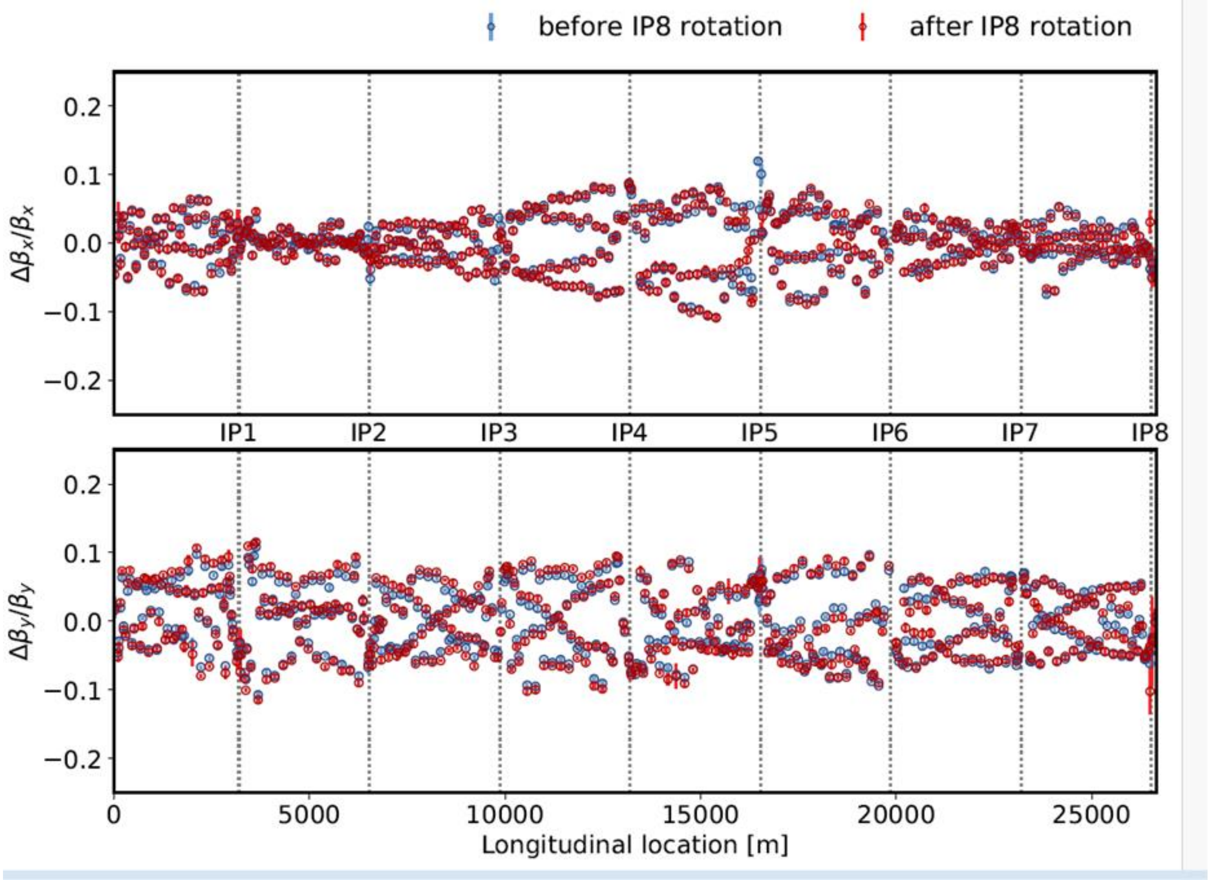
- Combing the pre-squeeze and LHCb rotation
  - Saves **around 5 min per fill**
    - Gives around 0.5%-0.6% more integrated luminosity for ideal fills
    - More for shorter fills!
  - Remember this **is for all fills**:
    - Optics measurements
    - Loss maps
    - Intensity ramp-up
  - Seen differently the LHCb rotation was played ~150 this year including commissioning, intensity ramp-up
    - 150*5 min = 750 min
    - Factor 2 more fills in 2024 -> **Rotating LHCb crossing angle for a full day (24h) in 2024!**



LHCb Rotation!

Any issues combining the pre-squeeze and LHCb rotation?

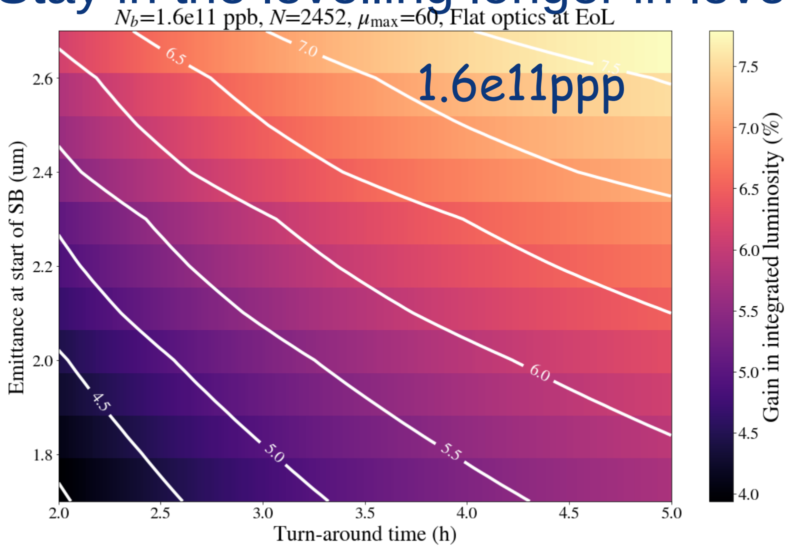
- Only small changes to tune, coupling and chroma (1e-3) from the LHCb crossing angle rotation
- No significant change in the optics from the rotation
- No aperture limitation identified
- Two different parts of the machine changed
- -> No issue was identified in combining the two beam processes

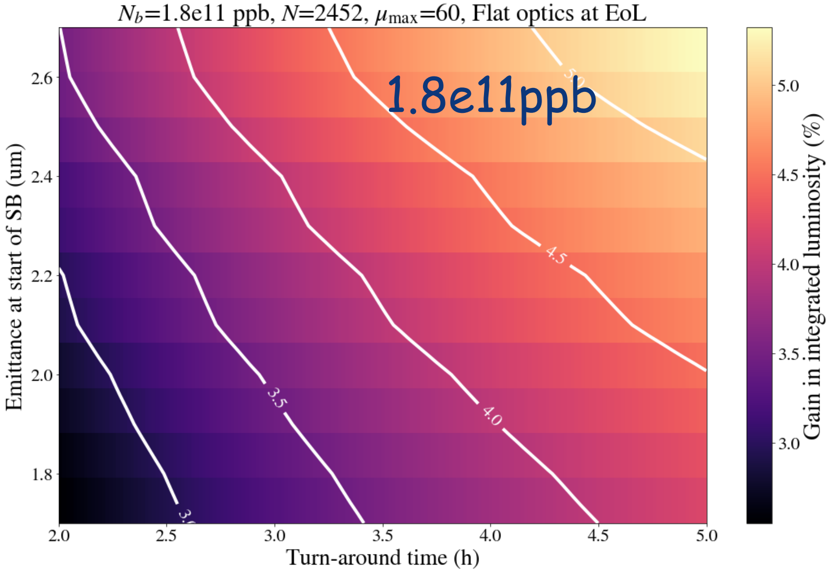


Squeeze further?

2024?

- The most beneficial is to squeeze in the separation plane
  - More available aperture and larger luminosity gain per squeeze centimetre
- 4 additional β* steps would be available to reach a full **30cm/20cm** (xing/sep)
  - Stay in the levelling longer in levelling





This would increase **integrated luminosity by ~4-5% in**, assuming the ideal fill length. Not all fills reach the end-> smaller impact in reality

- Injection
- Ramp to 6.8 TeV
- Pre-squeeze to 1.2m + LHC rotation in parallel
- Tune change
- Adjust
- β* levelling from 1.2m – 30 cm
- β* levelling from 30cm/30cm – 30 cm/20cm

What is needed and is there a risk?

- The collimation team is investigating the possibility to tighten collimators at 30cm/30cm
  - TCT and TCLA IR7, TCDQ/TCSP IR6, TCS IR7 (see collimation talk)
    - Some technical work is needed since the beta* levelling can only move the TCT and TCL
      - Change strategy would need the agreement with MPP
      - Could create two beam separate levelling beam processes (1.2m - 30cm and 30cm/30cm – 20cm/30cm)
  - Would demonstrate the operation of **flat optics and a tele-index of 3** for the first time in the LHC -> **Pave the way for other flat optics**, e.g. “full RP optics” (see Stephane’s talk)
  - First-time estimate would be an additional **~24 hours of commissioning** (split between OMC and collimation)
    - Would be a **net gain in terms of** integrated luminosity
- If there are issues not originally seen, **we can stop the levelling at 30/30**

Conclusion (2023)

- The total integrated luminosity was mainly limited due to the faults
  - The intensity limitation to 1.6e11 together with the larger-than-expected emittance also had an impact
  - The 6x36b or 5x36b pure 25ns looks very attractive!
    - Should we consider returning to **BCMS in 2024** to get smaller emittance?
  - The new **“collide and squeeze”** will enable us to go in one step to the requested luminosity
    - No reason to change the start of colliding **even if we would stay at 1.6e11**
- Ion run was extremely challenging with many different technical issues but still managed to produce good amount of luminosity

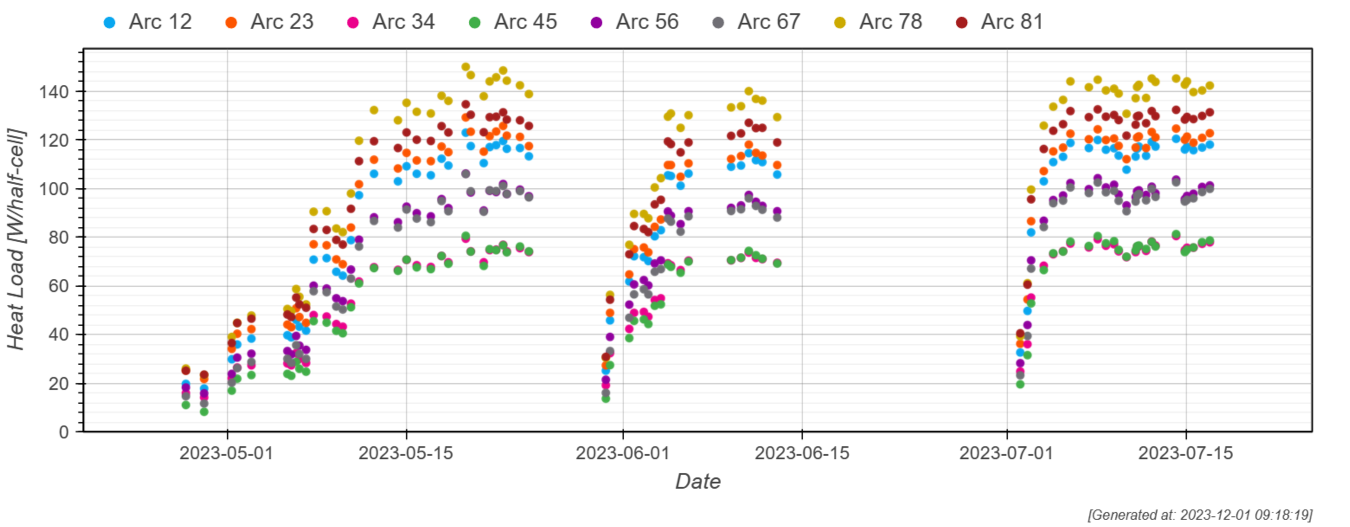
Outlook

- **Changes to the 2024** proton cycle could be:
  - Inclusion of the **LHCb rotation** in the pre-squeeze **(~1 day of beam time saved)**
  - **Continue squeezing the beta*** from 30cm down to **20cm in the separation plane**
    - **Predicted gain in luminosity**
    - **More time in levelling**
    - **Low risk**, only potentially ~1 day lost in commissioning
    - **Gain valuable experience** with higher tele-index and flat optics!

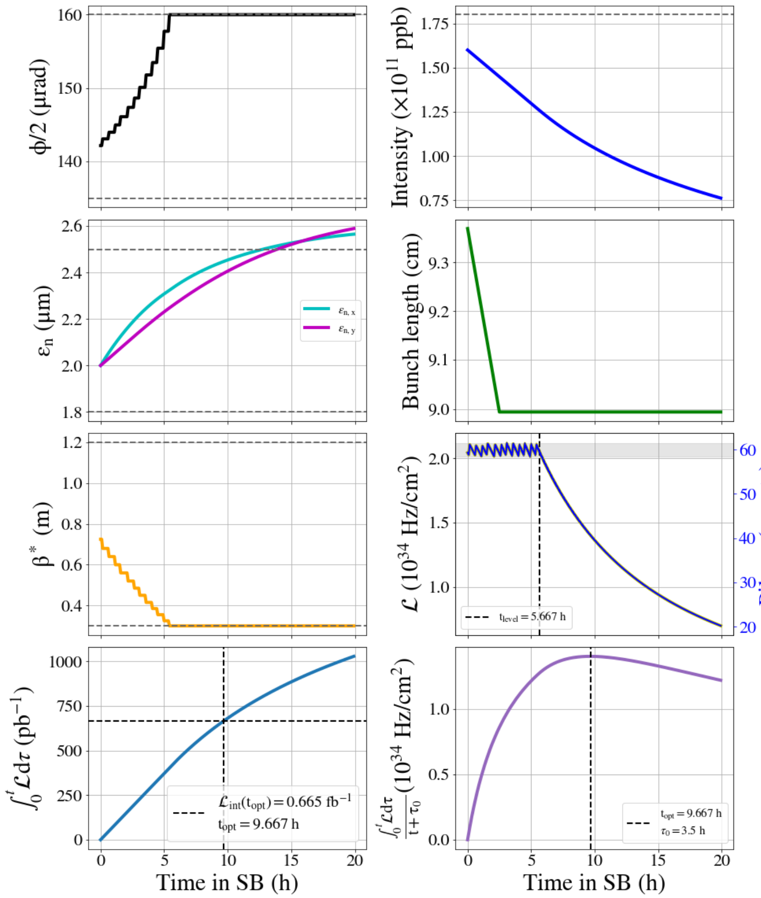
Backup

Heat Load and Filling scheme

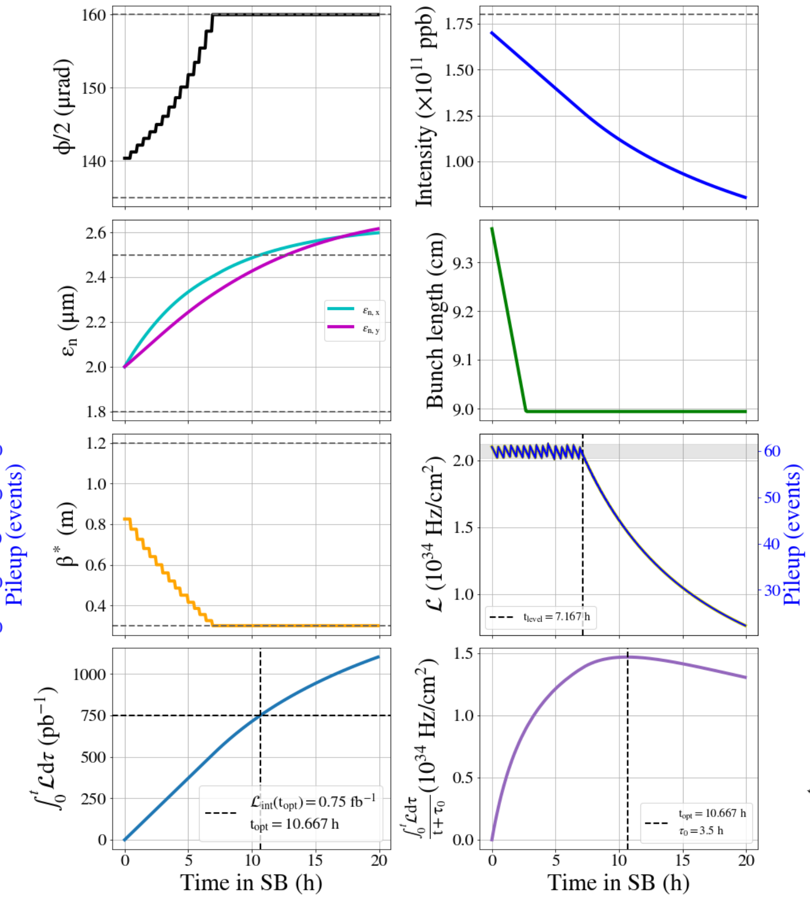
- The heat load is under control even for the highest intensity fill we are below 150W/half cell (2454 bunches)
  - Up to 183W/half-cell in 2022 even though the total intensity was very similar
- Thanks to **hybrid filling scheme** (mixture of 8b4e and 36 bunch train)
  - First time we use it in normal operation
  - Significant effort from the injectors to make this happen!



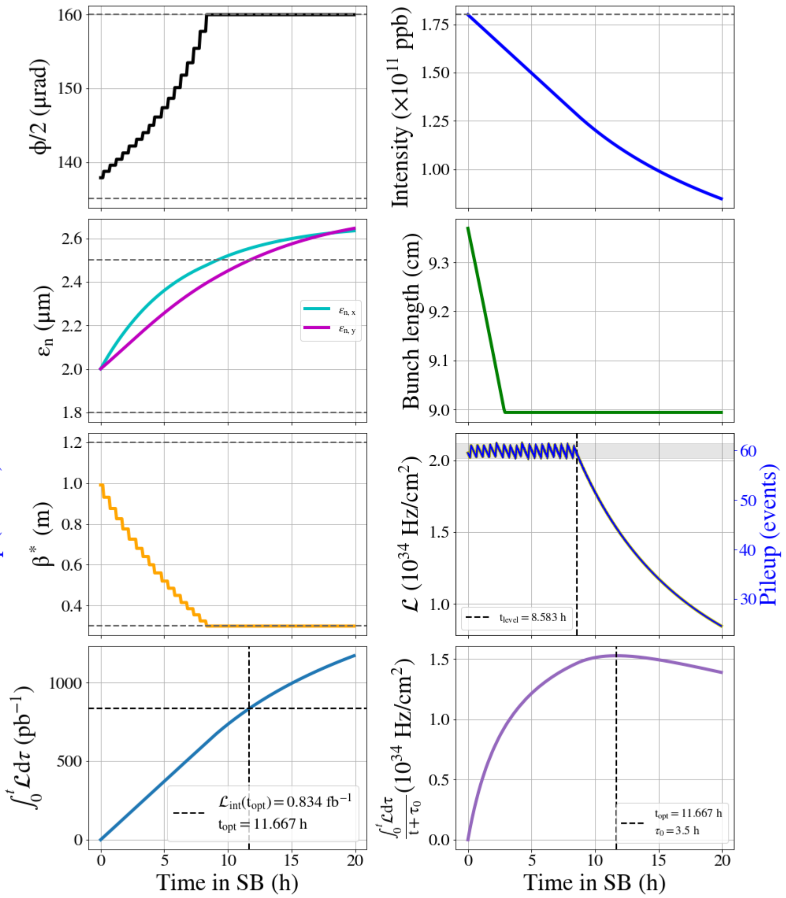
1.6e11ppb, 1.212 fb-1/day



1.7e11ppb, 1.27 fb-1/day



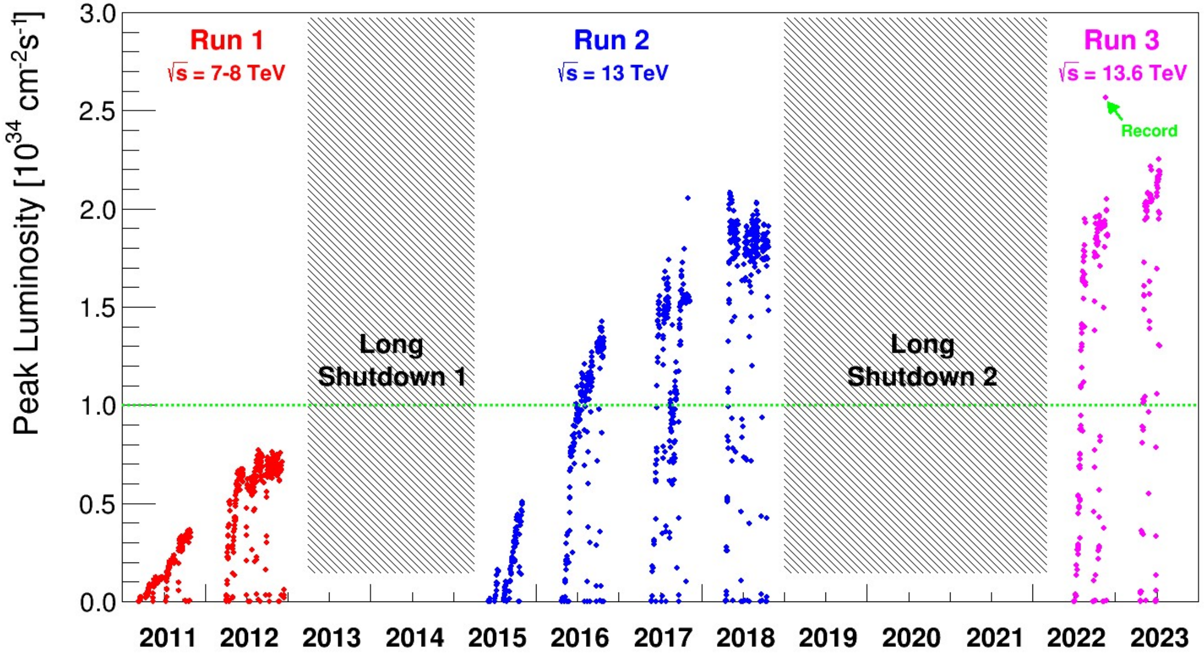
1.8e11ppb, 1.319 fb-1/day

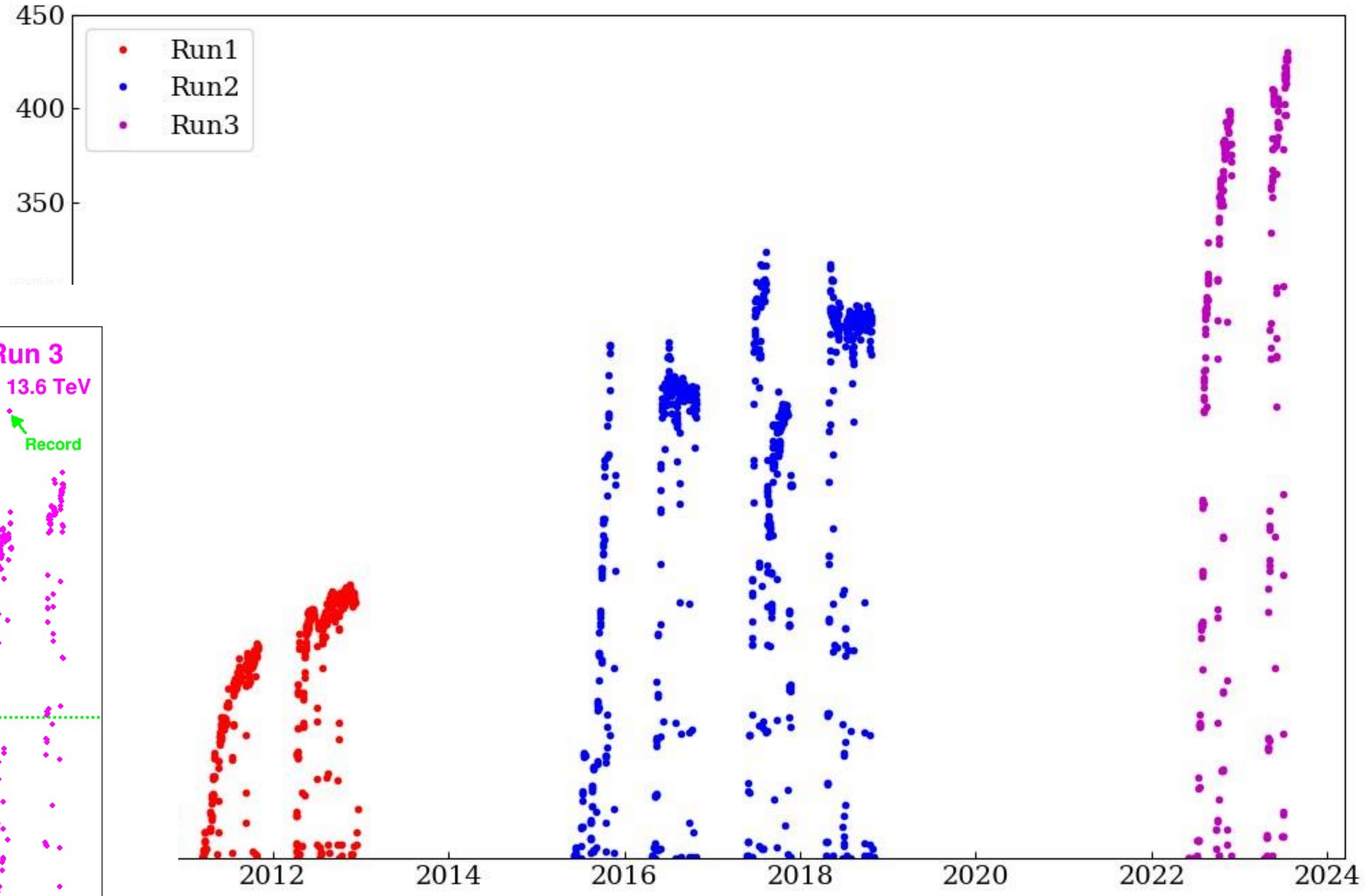


1.6e11 to 1.7e11, +5%
1.6e11 to 1.8e11, +9%

The bigger picture

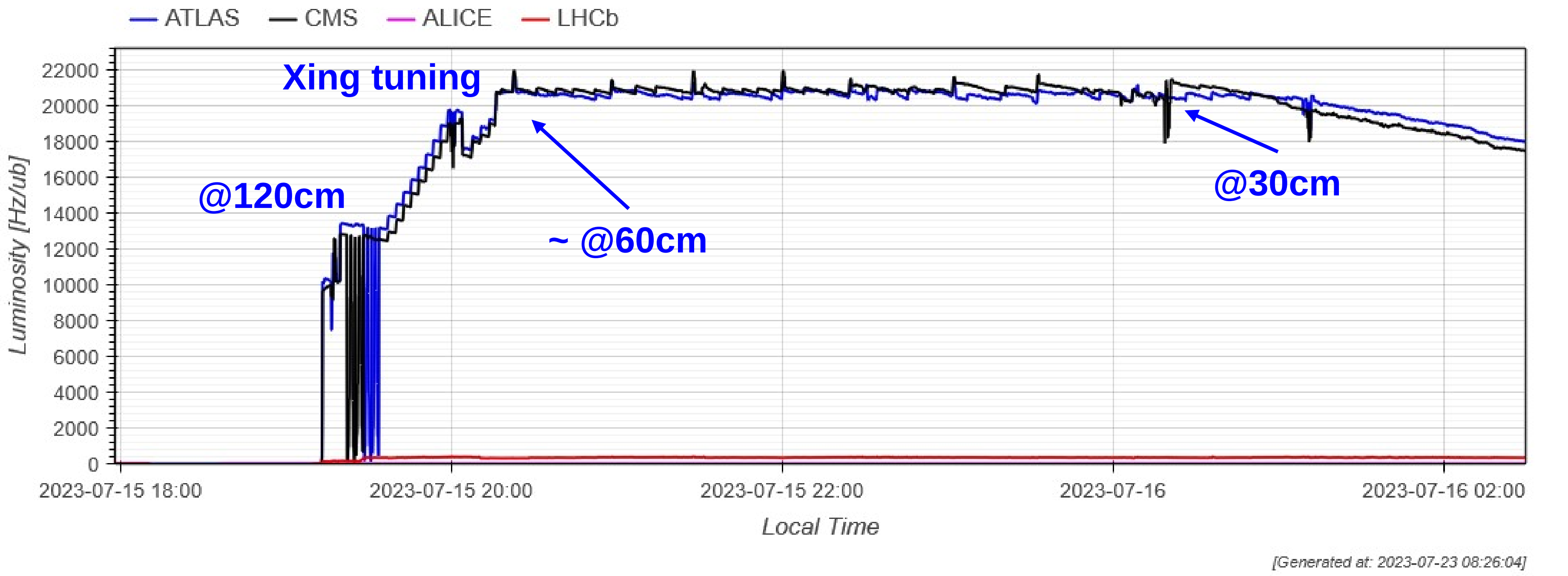
Stored energy record of 425 MJ
with 2464 bunches @ 1.6E11 ppb
(@ start of SB) .





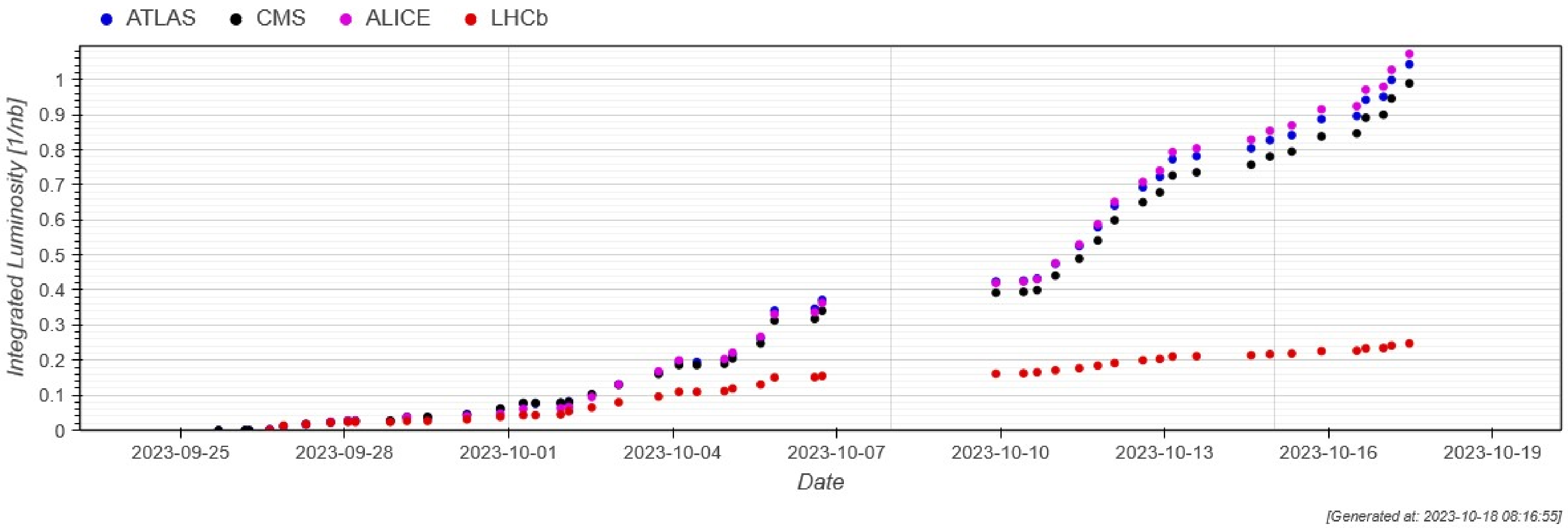
Levelling

- Xing angle adjustment of ± 5 microrad to tune ATLAS vs CMS luminosities for levelling.
- Just before the incident we agreed on and tested faster levelling to target on low intensity cycle (just over intermediate matched points). We did not have time to apply it.



Production

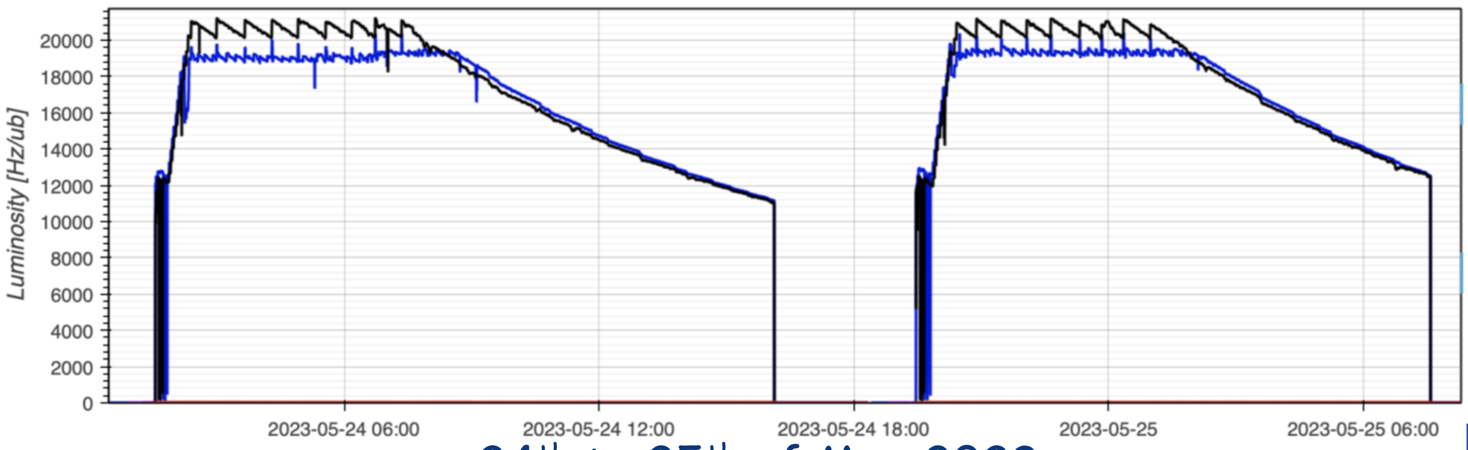
- Last week's good slope with 4-5h fills producing ~50 ub/fill was disrupted by the WE quenches due to SEEs. Trying to recover the slope this week.
- 10 days left in this run, with ALICE in -/- polarity →expect to accumulate ~ 2.2 – 2.6 nb-1.



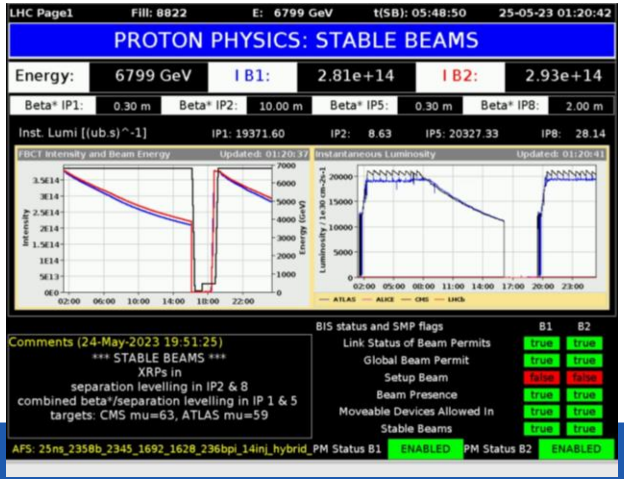
Physics fills performance end of May

- **New record:** Integrated luminosity: **~1.2 fb^{-1} in 24h !**
- Peak levelling just above 2.0 x 10^{34}cm^{-2}s^{-1}
- Pileup targets ATLAS/CMS = 63 / 59
  - Thanks to combined separation β* levelling and separation levelling we can deliver different pile up to ATLAS and CMS!
- Luminosity difference also reduce due to updated calibration factors

Max at start of stable beams:
409 MJ
1.59 x 10^{11} p/b (Injected: 1.61)



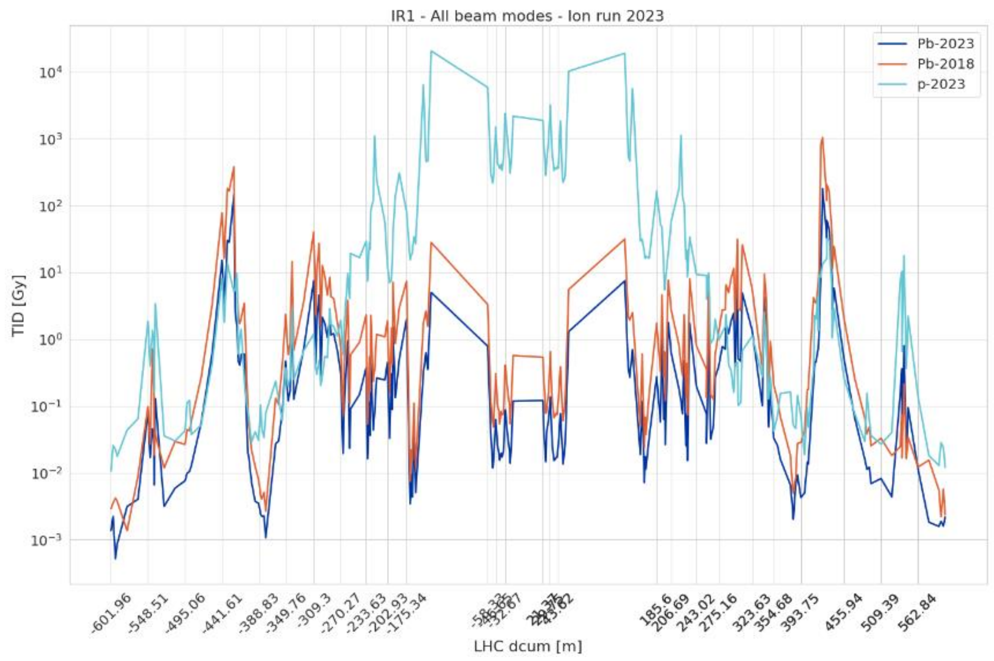
24th to 25th of May 2023



Radiation levels

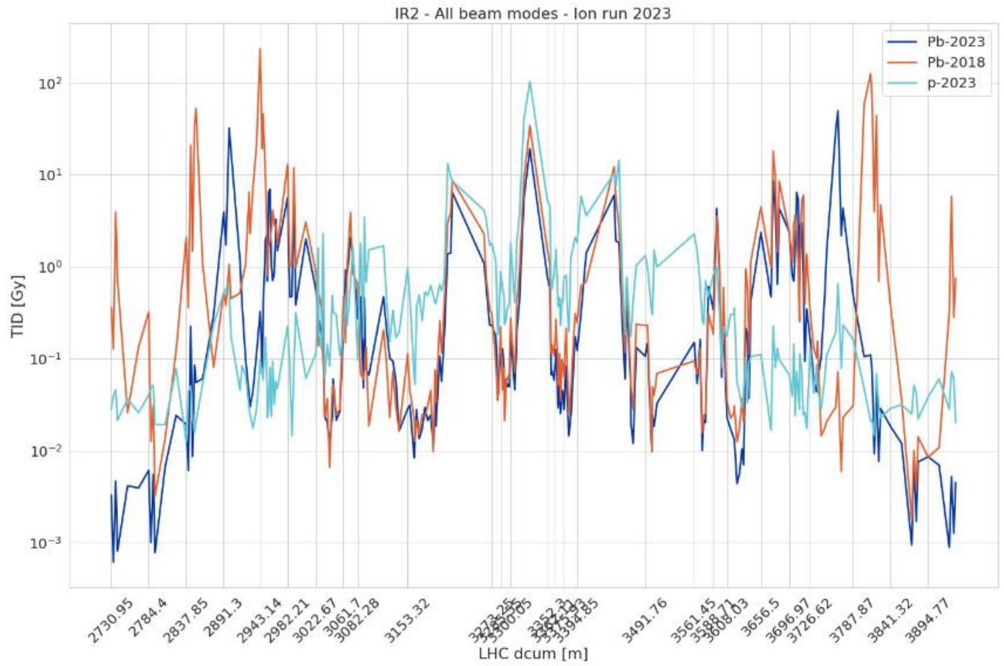
Ion and proton run doses in IR1

IR1: ~ no change.



Ion and proton run doses in IR2

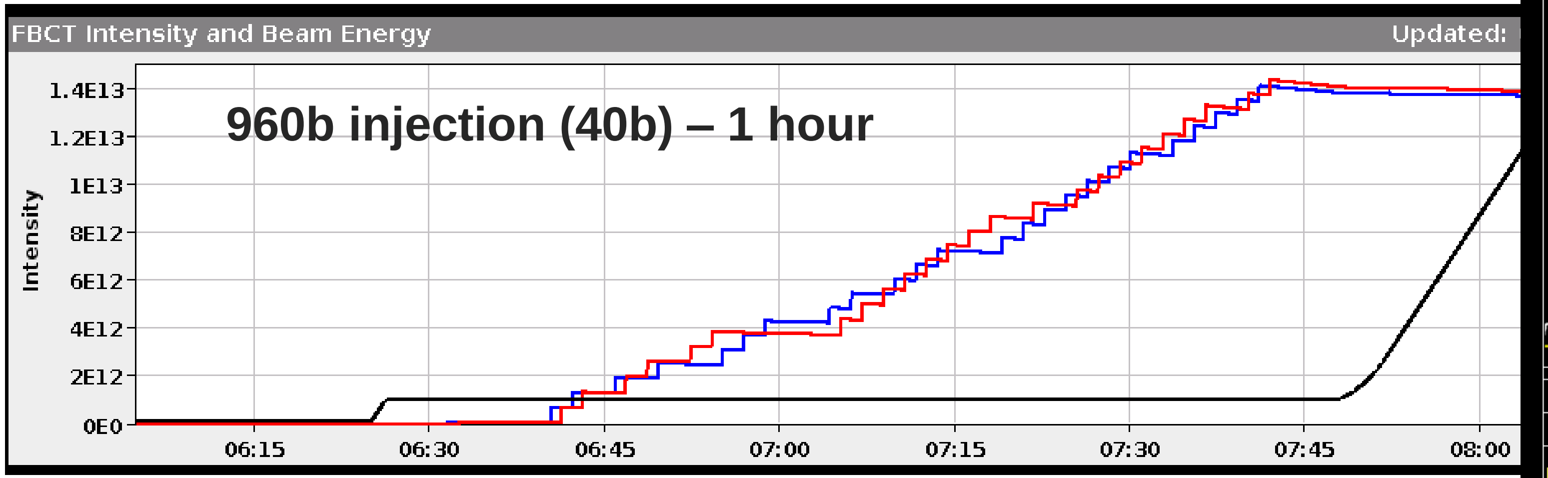
IR2: shift of the BFPP loss peak due to TCLD

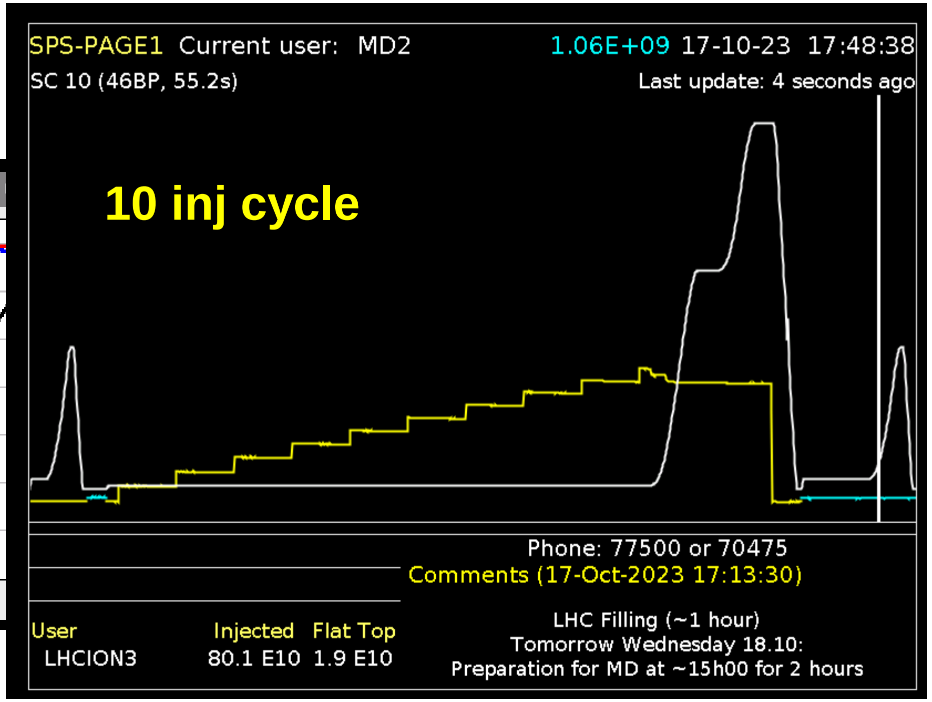


R2E team

Injection

- Long SPS **14 injection cycle (56 bunches)** with slip-stacking is working well.
  - Shorter **10 injection (40 bunches)** version in service since Monday.
- Sometimes injection is tedious when beams are rejected due to quality (bunch length, parameter spread), but overall, it is not our main issue.
- Typical injection time for 1240b: ~1h15m.



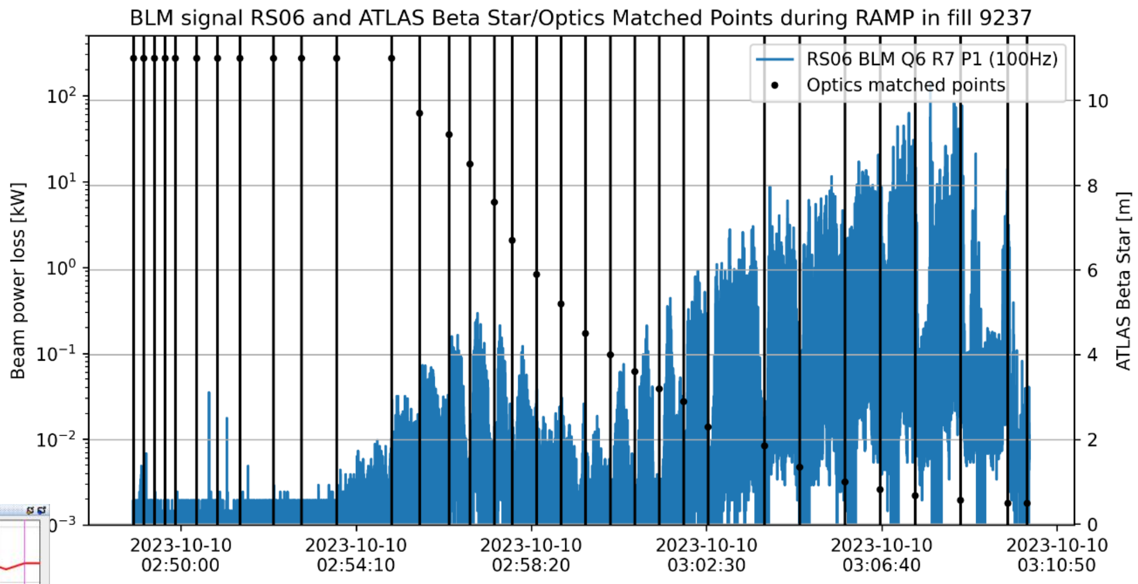


Ramp losses (1)

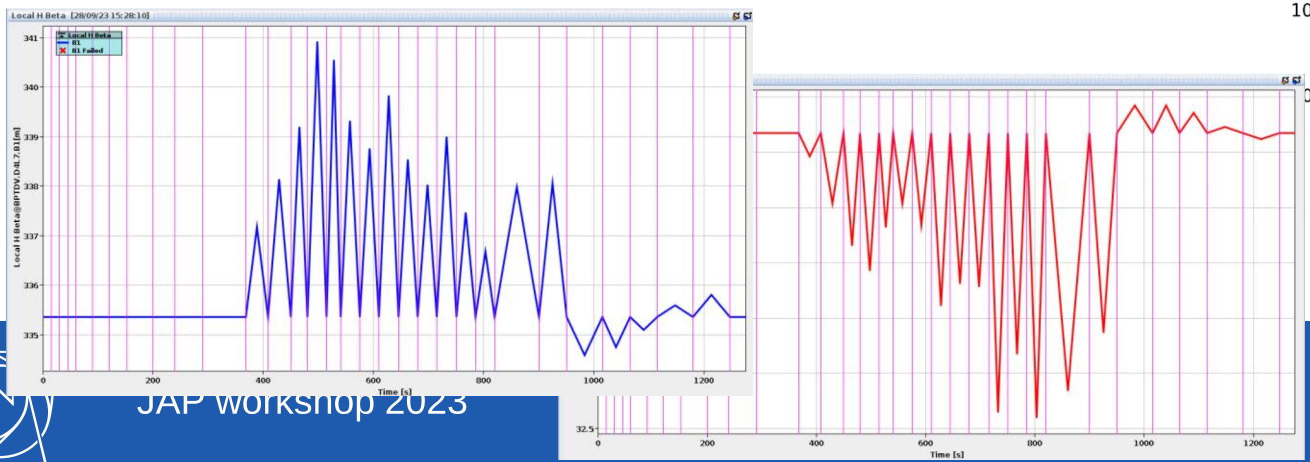
- CRS to 50 cm (no FT squeeze): works well technically, lifetime drops (spikes) above 5.5 TeV coupled to the lower ion cleaning efficiencies are in issue in terms of losses.
  - **Lifetime drops not visible during setting up** with coarse collimator settings.

B1 ramp power loss

- Lifetime drops **between matched points**, losses peak in region of 5.5 to 6.3 TeV, typically **30-70% of dump threshold**.
  - **Ramp to ramp fluctuations**, loss moving spikes. 10 Hz modulation on top of ramp structures? Beam quality fluctuations ?



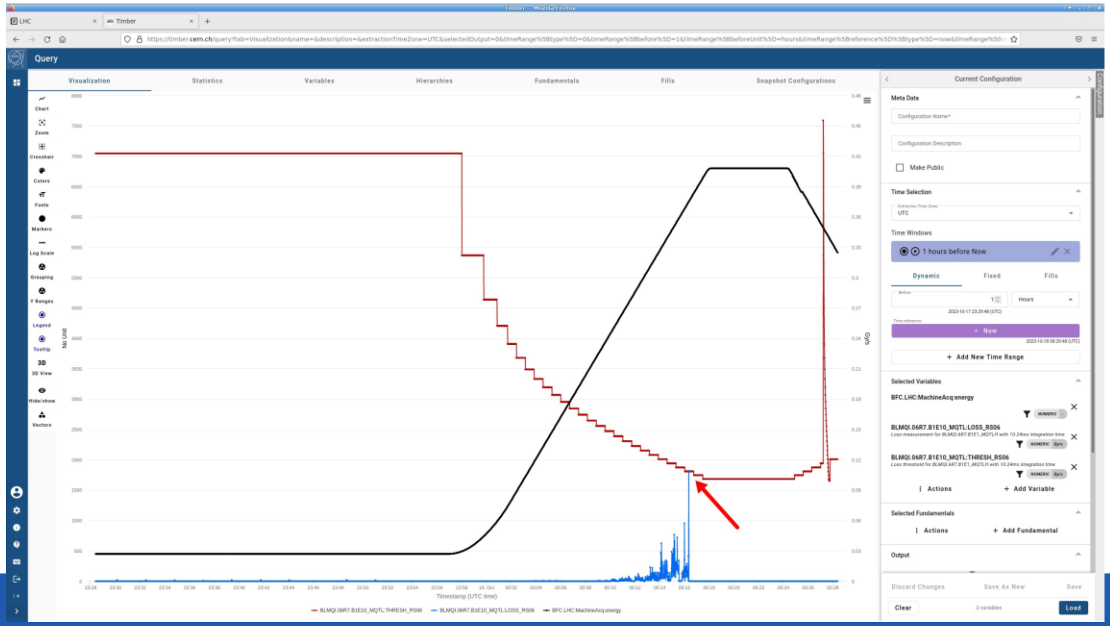
Simulated beat-beating between matched points (ideal model)

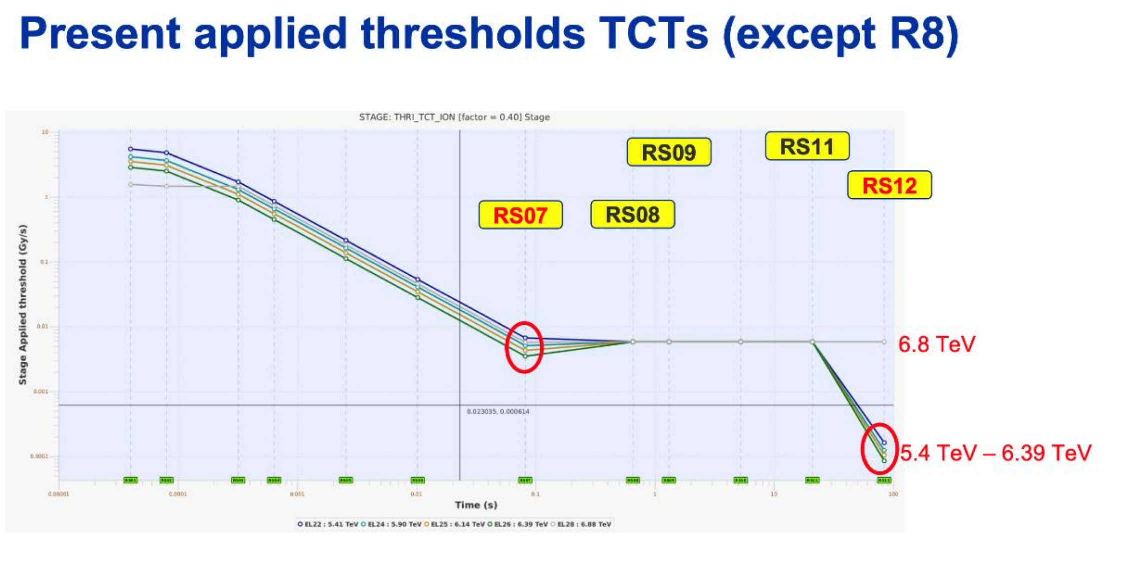


S. Morales

Ramp losses (2)

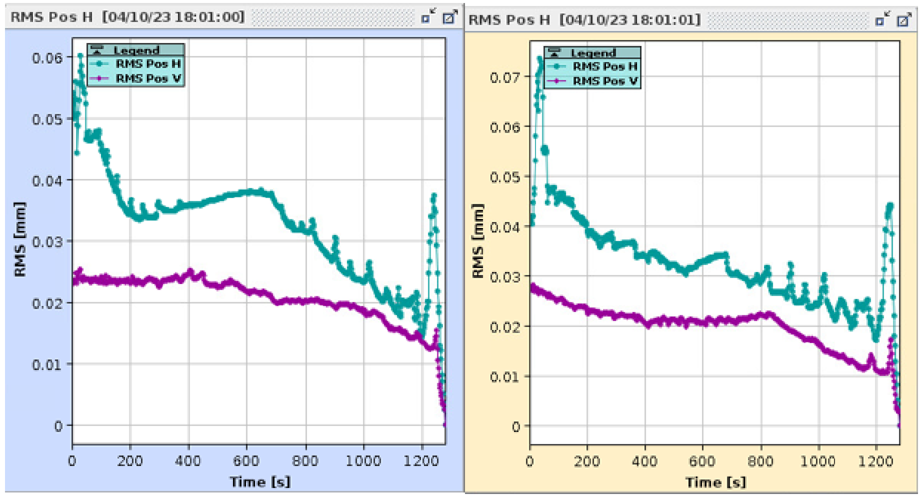
- Dumps on losses – fast losses < 1 s – in the ramp mitigated by:
  - **Adapting BLM thresholds** with “flat top” corrections applied at lower energies (avoids pushing thresholds too low in the ramp) and adjustment of monitor factors. Last iteration done yesterday…
  - **Smoothing out orbit feed-forward corrections**. First step done; further improvements require changes in the settings generation that we do not want to push out now. Does not seem to be the main loss mechanism.
- **Operated successfully more than a week with 1240b with losses 30-70% of dump thresholds**. Last Monday sudden increase leading to dumps → reduced # bunches to ~960.



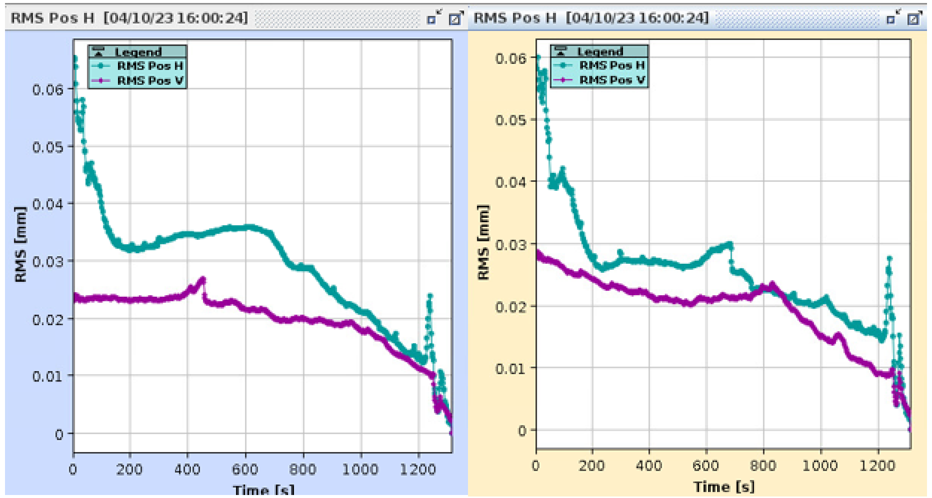


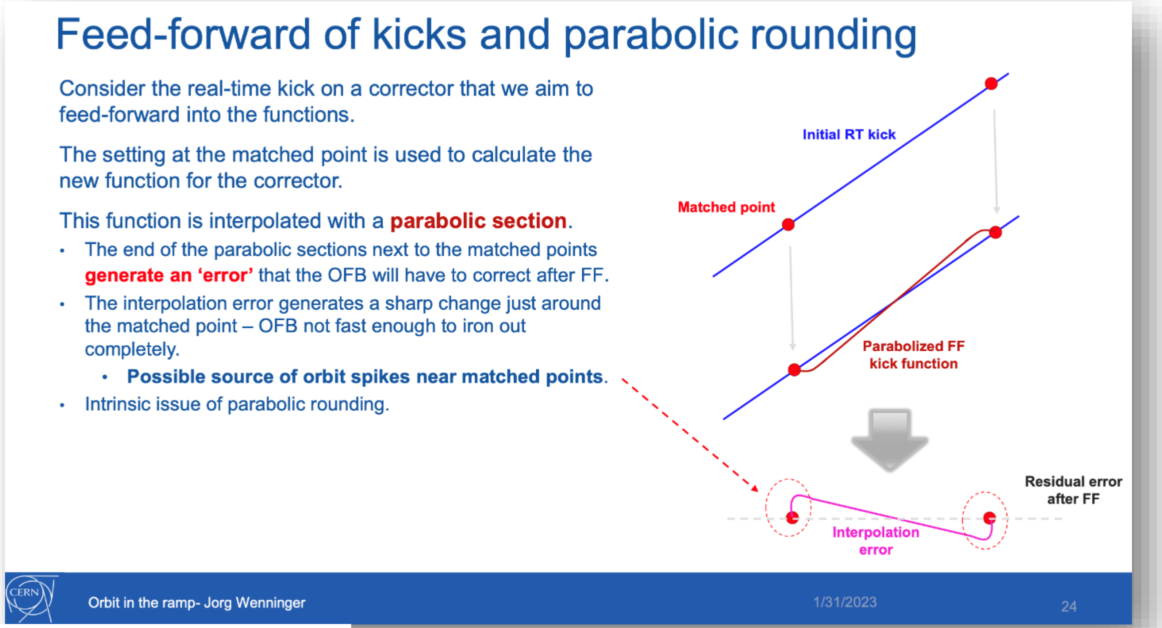
Orbit - smoothed ramp

With K correction only (9222)



With K and K-smooth correction (9224)





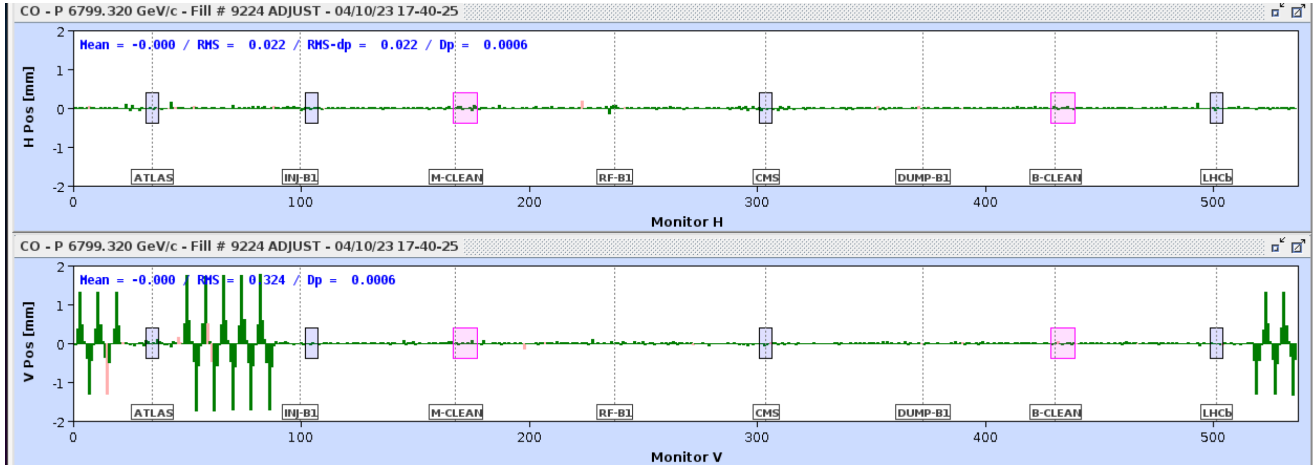
LBOC @31.01.2023

- Originally planned as pp MD, it was introduced as attempt to **mitigate the losses** in the ramp.
- **First iteration** reduced by a factor ~2 the orbit spikes and seemed to help.
- Very reproducible from ramp to ramp, largest losses are not at places of orbit excursions.

ALICE background

- After many tests, the spurious dispersion **knob for B1** (ATLAS xing compensation) was identified as an efficient cure.
  - Optimum setting at 250 urad equivalent (~2.5 mm orbit bump in the arc).
- Spurious dispersion in IR1 knob applied **for both beams** gave no further improvement.
- **Losses shifted from TCTPV.L2 to TCLD.R2**.

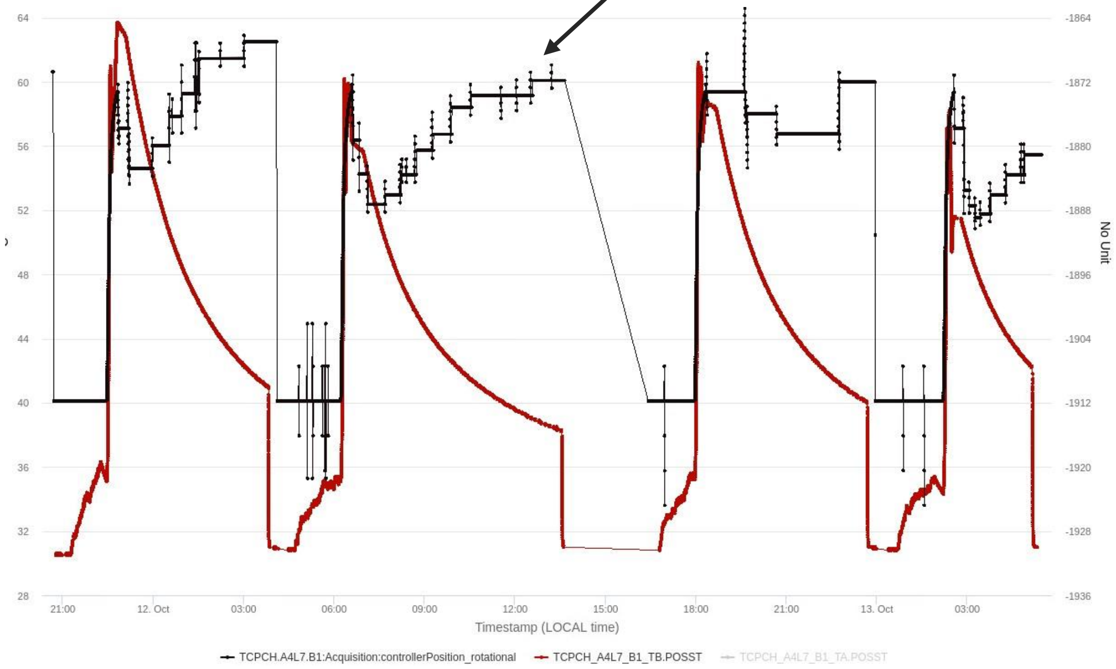
```
-> SDISP-B1 @ 170 urad   => ~ gain 40
-> SDISP-B1 @ 200 urad   => ~ gain 49
-> SDISP-B1 @ 250 urad   => ~ gain 57
-> SDISP-B1 @ 275 urad   => ~ gain 57
```

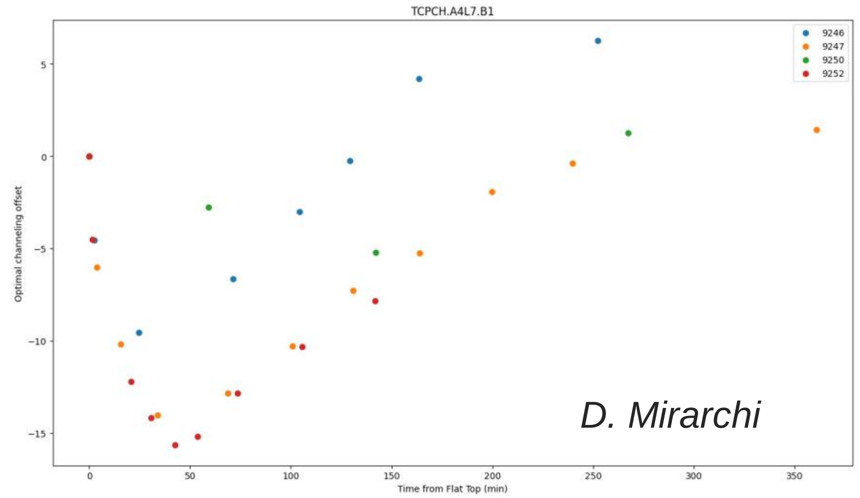


Xtal channeling (stability)

- **Drifts of the Xtal angles by ~10-15 urad** for a **channeling acceptance of 2 urad**, in particular B1H.
  - Systematic evolution in physics fills.
  - Xtals can be in amorphous state, i.e. no channeling.
- Regular **Xtal channeling optimizations** at injection, at FT and in SB.
  - Since yesterday automated optimizations in SB.
- Suspicion of temperature effects. Effort in progress between impedance, mechanics, controls and collimation.

Xtal optimum





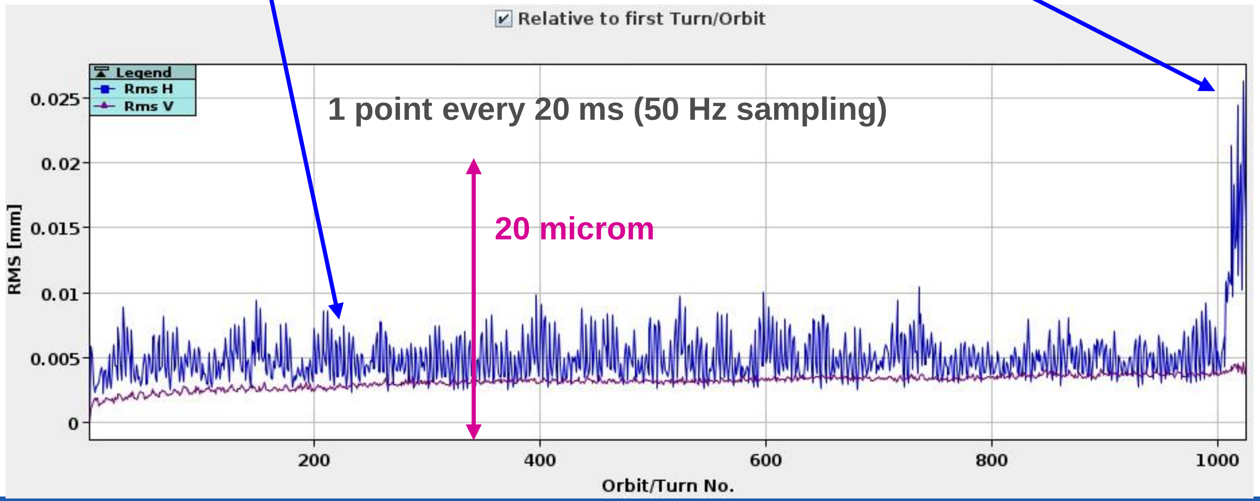
D. Mirarchi

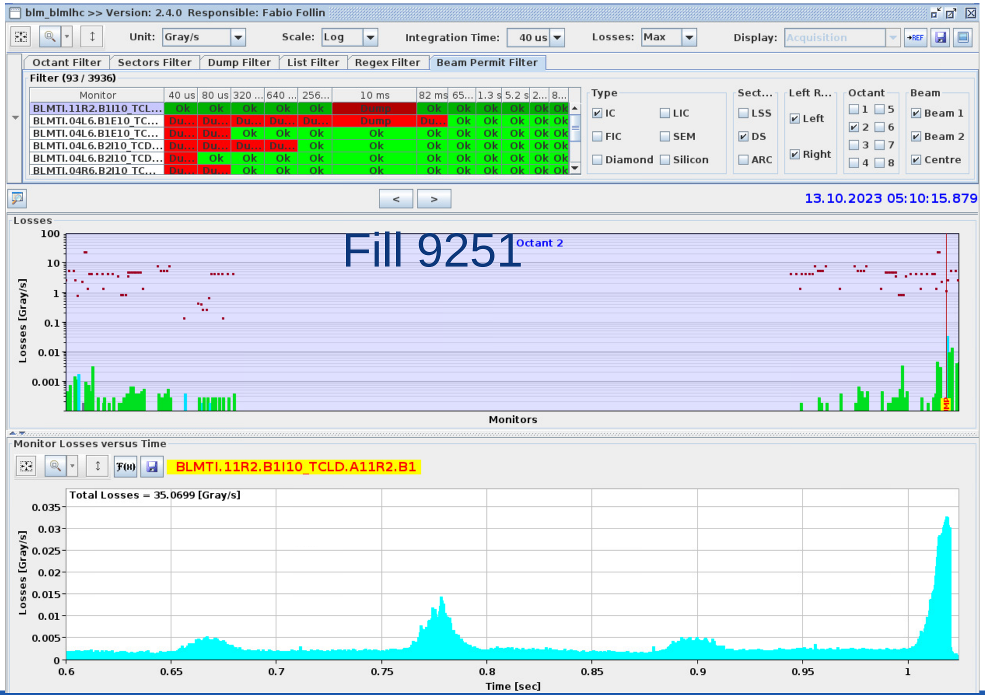
Dumps on TCLDs in SB

- **3 dumps on TCLD R2 BLMs** in stable beams in conjunction with **increased "10 Hz" activity**.
  - Beam loss in IR7 → leaking to TCLDs in IR2.
- In the horizontal plane there is **permanent activity around 10 Hz** – in **proton and ion runs**. Occasional bursts of activity leads to dumps with ions.
  - NB: triplet, Q6R2… horizontal modes : in the range 8 - 12 Hz.

"Noise" in H plane is activity around 10 Hz.

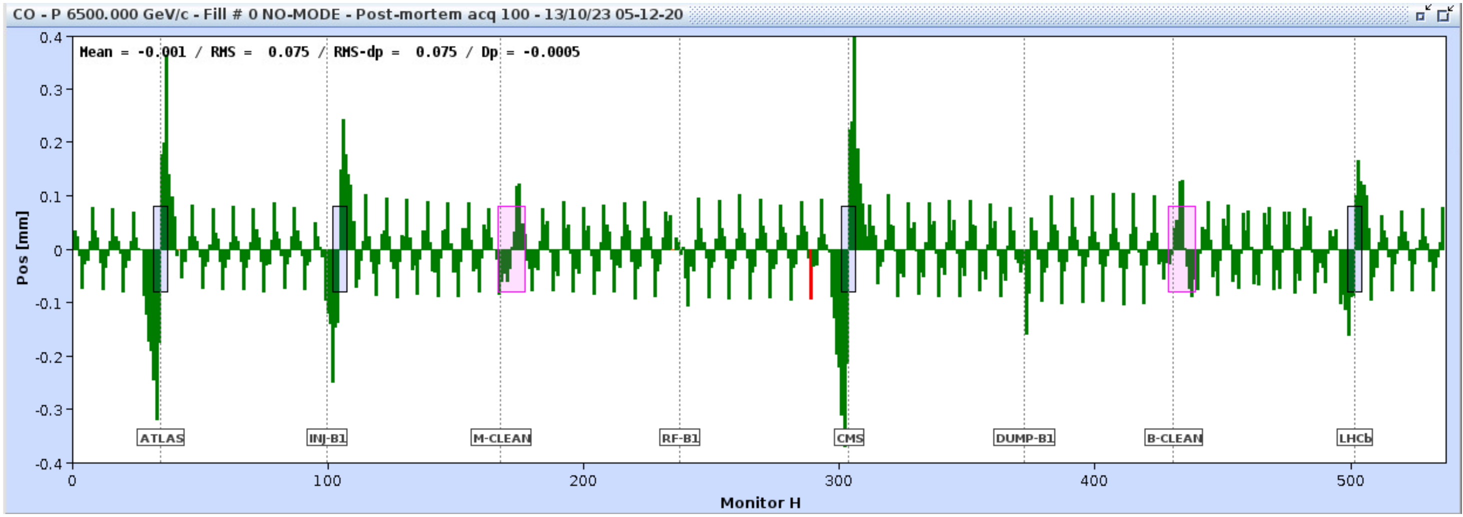
Increased activity → dump



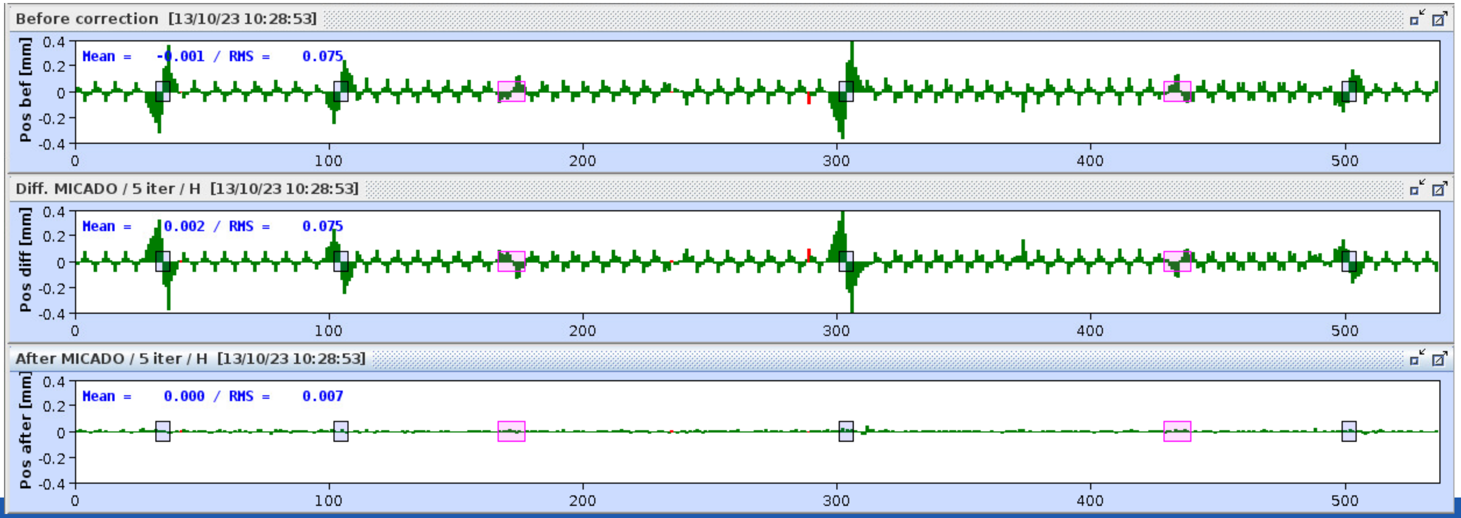


Dumps on TCLDs in SB

- Peak-2-peak oscillation amplitude ~80 um (arc), frequency **~8.5 Hz**.
- For two cases, oscillation compatible with single (i.e. dominant) source in cell **13L8**, kick amplitude ~0.4 microrad.



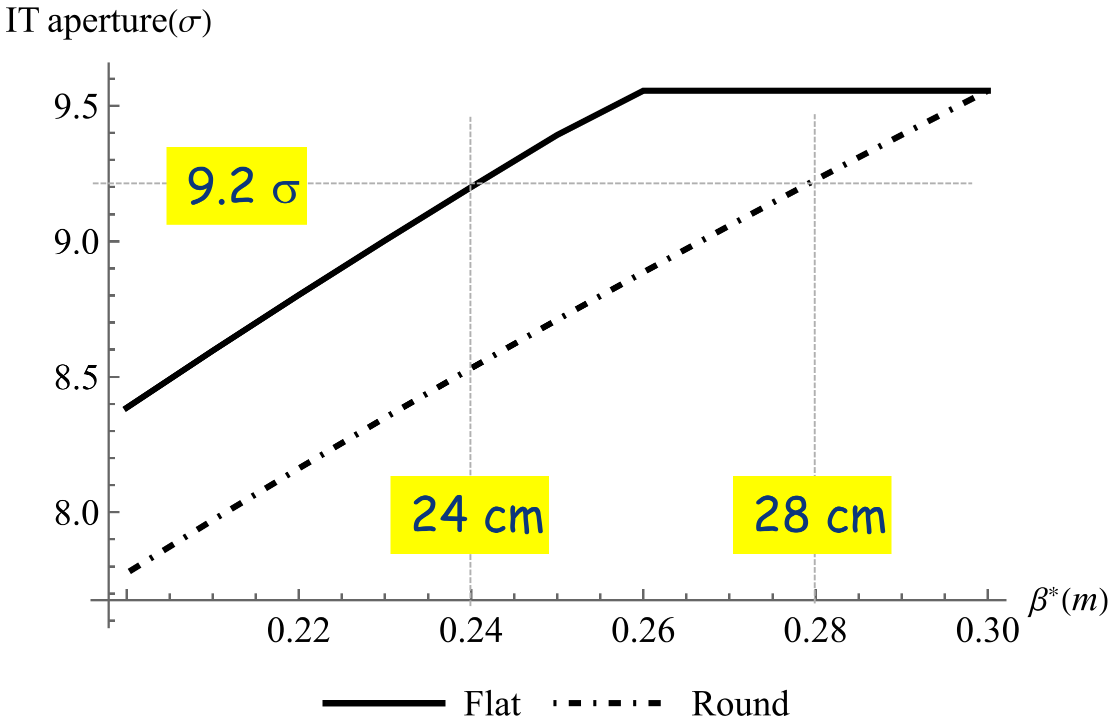
- With – ALICE polarity, **re-optimization of the TCLD jaw settings** will be attempted to move losses to IR3.



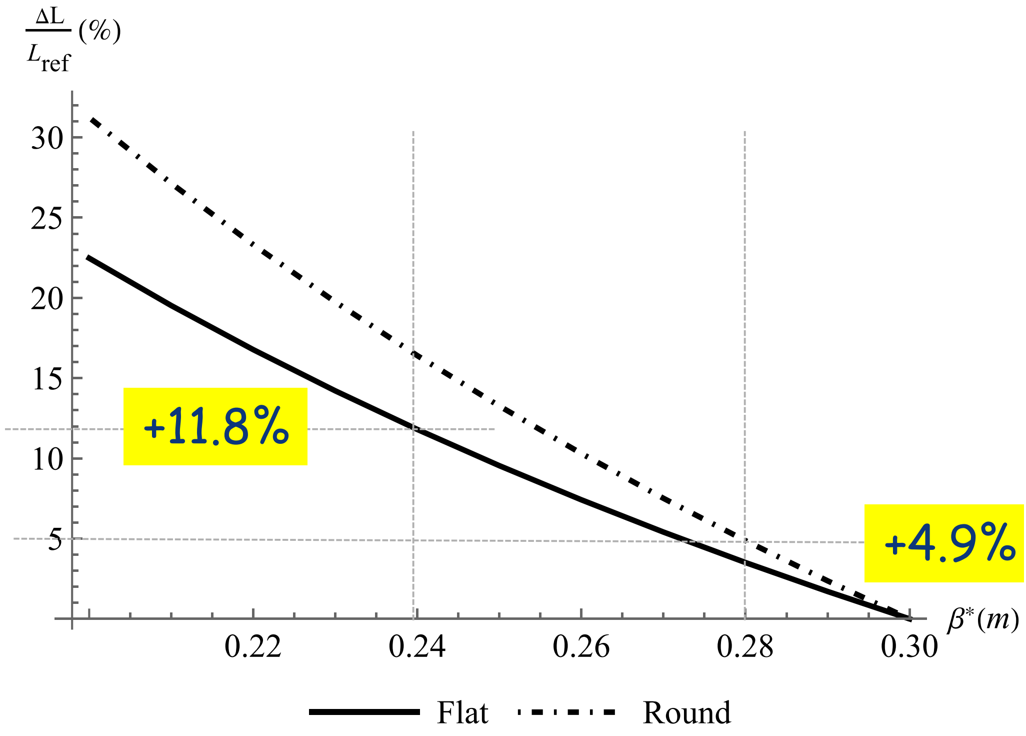
Extending β*-levelling in flat mode down to 24 cm in the || plane

[aperture estimate for 6.8 TeV & <u>fixed</u> $\theta_x/2$=160 μrad; lumi estimate for $\gamma\varepsilon$=2.5 μm, σ_z=8cm]

IT aperture [σ]



Peak lumi gain [%]



×2.4 more efficient than round optics at constant IT aperture

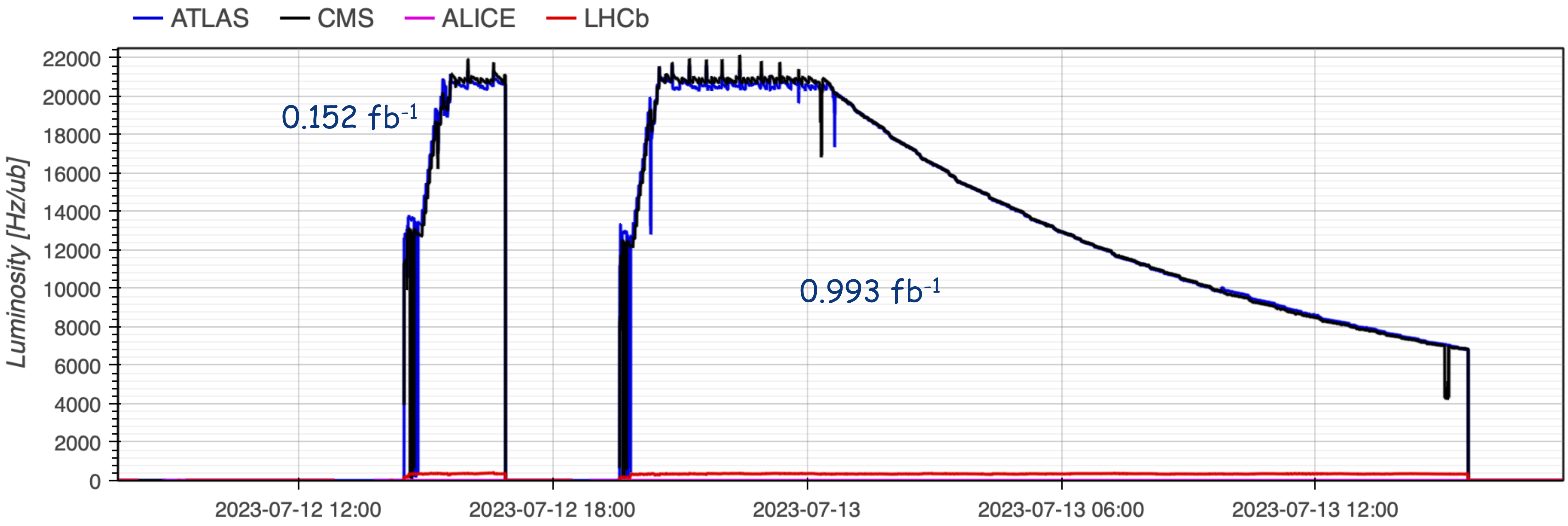
Overview of “10 Hz-like” dumps

- Run 2 and run 3, all dumps due to **B1 horizontal plane**.
- All but 2 cases in 2018 in Pb operation – reduced cleaning efficiency !
- Cell 13L8 was candidate for 2 dumps in pPb in 2016, alive again in 2023.

All oscillations are in the horizontal plane !

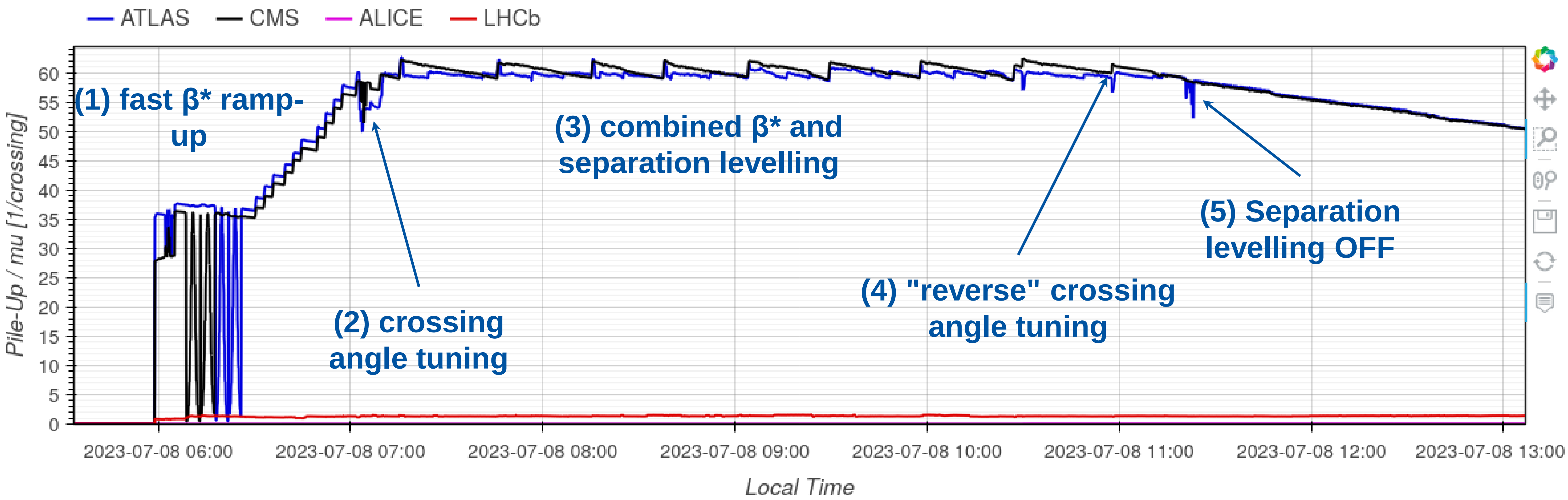
Fill	Run	Mode	Date	Time	Beam dump	Phase	f (Hz)	Dump BLM	Observation
5562	2016	pPb	01.12.2016	00:39:32	B1	Stable	~7	TCSG RS08	Kick in 13L8, beta* 1.5m in LHCb, 2m in ALICE
5567	2016	pPb	02.12.2016	10:07:09	B1	Stable	~7	TCSG RS08	Kick in 13L8, beta* 1.5m in LHCb, 2m in ALICE
6952	2018	pp	20.07.2018	14:04:46	B1	End of squeeze	~8-9	TCLA RS01/02	Kick in 21L4, consistent for both beams
7235	2018	pp	29.09.2018	18:10:35	B1	Stable	~8-9	TCLA RS01/02	Kick in 21L4, consistent for both beams
7442	2018	PbPb	13.11.2018	23:45:49	B1	Stable	~8-9	TCSG RS08/09	Kick around Q6R2
7447	2018	PbPb	16.11.2018	05:56:58	B1	Stable	~8-9	TCT RS07	Kick around Q6R2
7451	2018	PbPb	17.11.2018	14:54:09	B1	Stable	~8-9	TCSG RS09	Kick around Q6R2
7458	2018	PbPb	20.11.2018	20:34:33	B1	Stable	~8-9	TCSG RS08/09, Q13 RS08	Kick around Q6R2
7459	2018	PbPb	21.11.2018	00:17:57	B1	Stable	~8-9	TCSG RS08/09, TCT RS07, Q13 RS08	Kick around Q6R2
7465	2018	PbPb	22.11.2018	13:26:00	B1	Flat top	7?	TCSG RS10	No real trajectory oscillation visible
7482	2018	PbPb	28.11.2018	23:38:35	B1	Stable	~8-9	TCSG RS08, Q13 RS08	Kick around Q6R2
9234	2023	PbPb	06.10.2023	19:34:02	B1	Stable	~5-6 Hz	TCLD.R2 RS06	Kick in 12L8,13L8 + IT.2/Q6R2
9251	2023	PbPb	13.10.2023	05:12:20	B1	Stable	~8.5	TCLD.R2 RS06	Kick in 13L8
9267	2023	PbPb	16.10.2023	18:14:46	B1	Stable	~8.8	TCLD.R2 RS06	Kick in 13L8

Luminosity

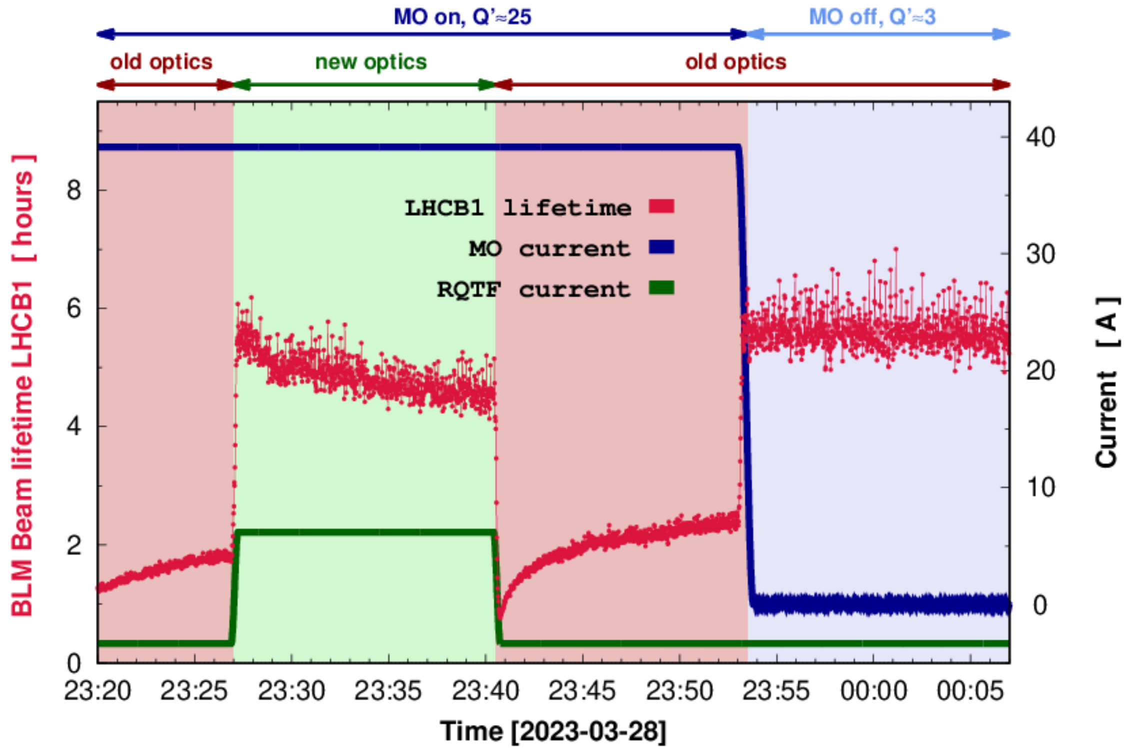


ATLAS
CMS
ALICE
LHCb
Luminosity [Hz/ub]
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
2023-07-12 12:00
2023-07-12 18:00
2023-07-13
2023-07-13 06:00
2023-07-13 12:00
0.152 fb-1
0.993 fb-1

Orchestration of collisions



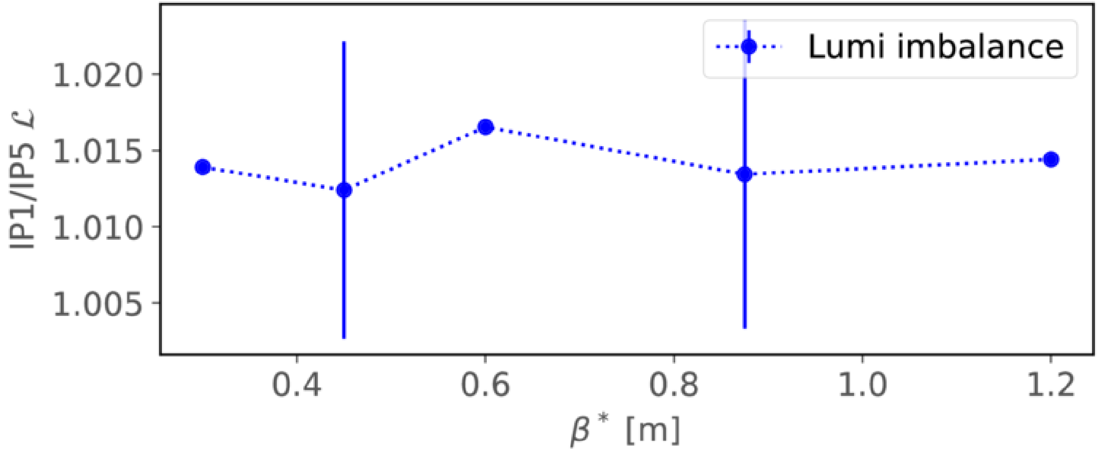
1. fast β* levelling ramp up to mu=38 in ATLAS (~40mins @ 1.6E11 ppb)
2. crossing angle tuning to reduce ATLAS wrt CMS (-10urad once ATLAS @ max PU)
3. combined β*/separation levelling
4. crossing angle tuning back to nominal (once β* = 30cm)
5. ATLAS levelling not effective anymore - back head-on



MO on, Q'≈25
MO off, Q'≈3
old optics
new optics
old optics
LHCB1 lifetime
MO current
RQTF current
BLM Beam lifetime LHCB1 [hours]
Current [A]
0
2
4
6
8
0
10
20
30
40
23:20
23:25
23:30
23:35
23:40
23:45
23:50
23:55
00:00
00:05
Time [2023-03-28]

β* and luminosity

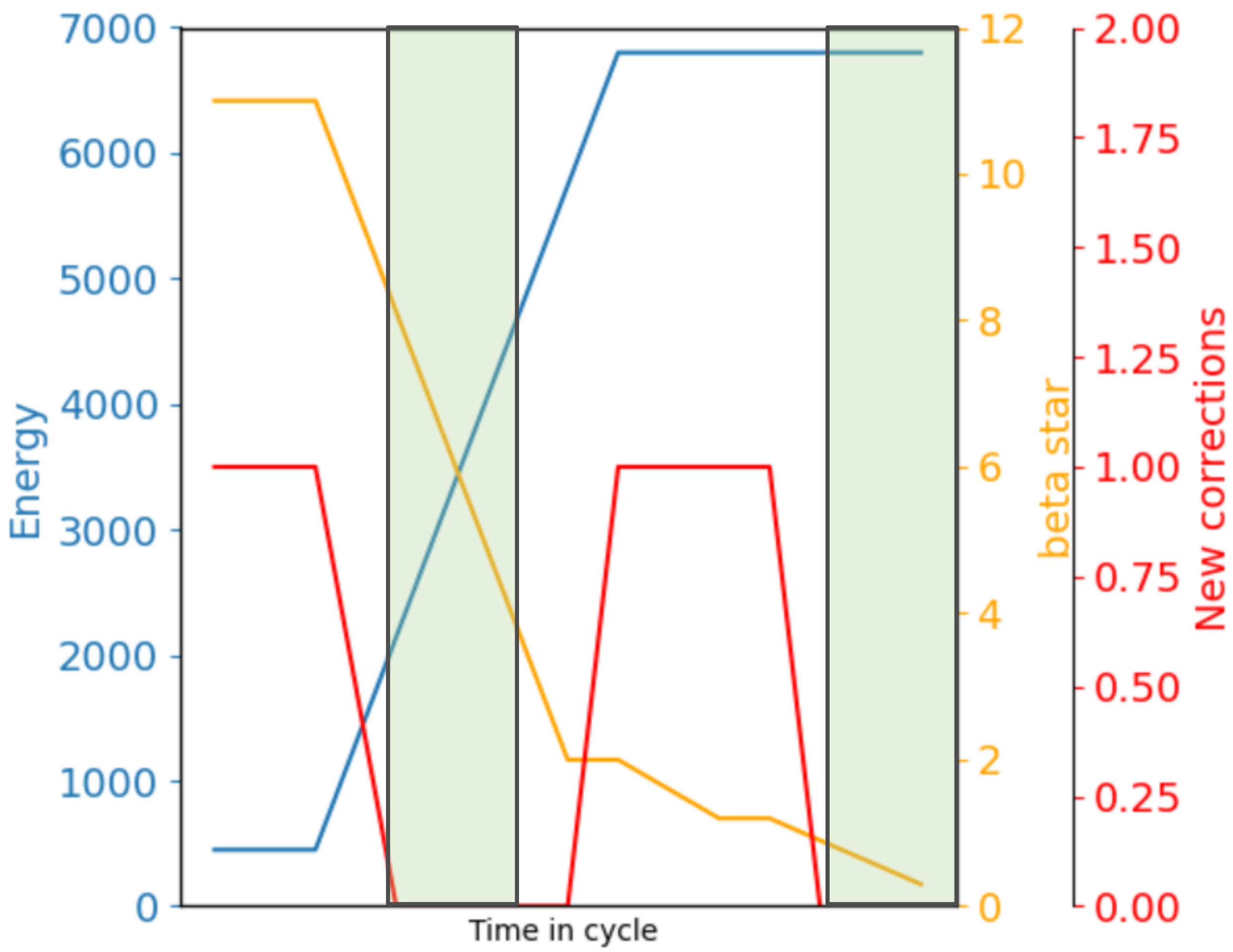
- The β* was measured from 1.2m down to 30 cm
  - Offline analysis to align timing between the current reading and tune has been applied
- Analysis indicates a ~1.5% higher luminosity from β* for ATLAS
  - Large error-bar, or none where we only have a single measurement
  - To reduce uncertainty we would need to perform more measurements



LNO section meeting, F. Carlier

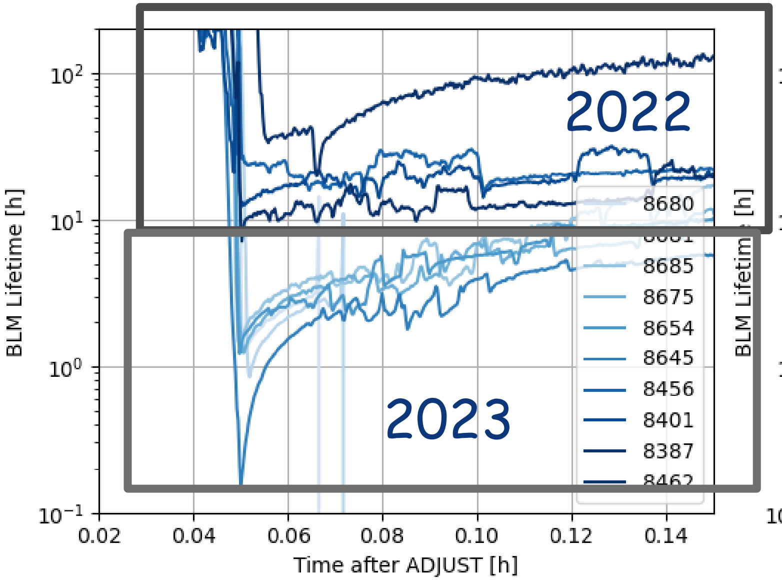
2023 cycle

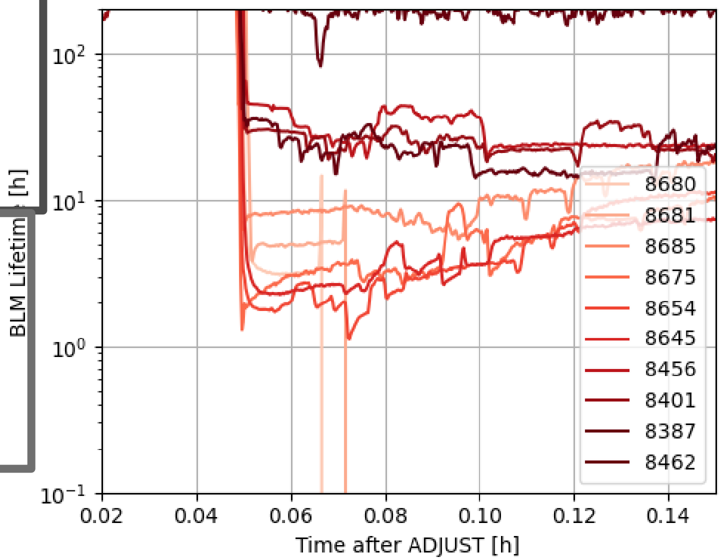
- Part of the cycle is the same as in 2022
  - In particular the most challenging part: β* between 60-30cm
- The new cycle was already measured during MDs in 2022

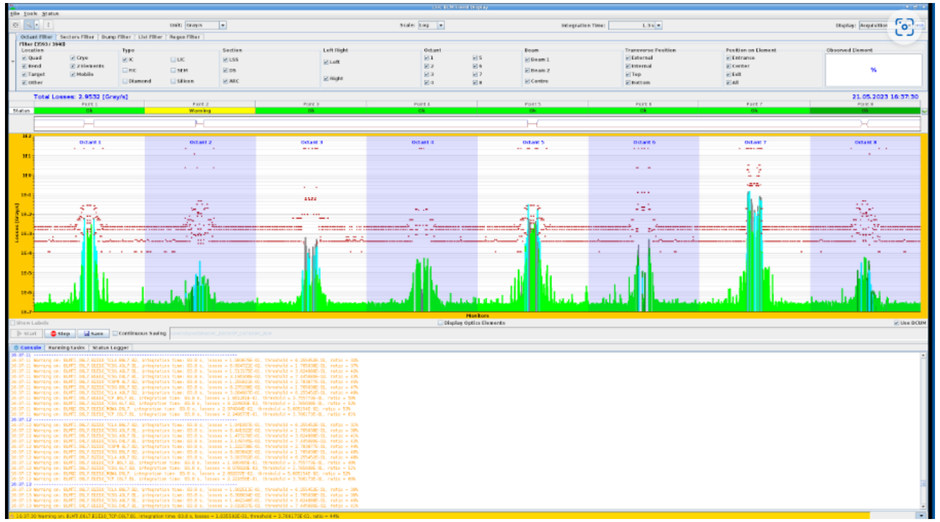


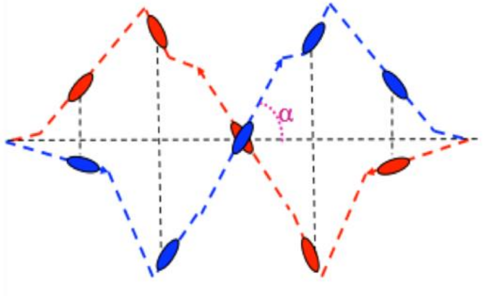
Losses going to collision (Adjust)

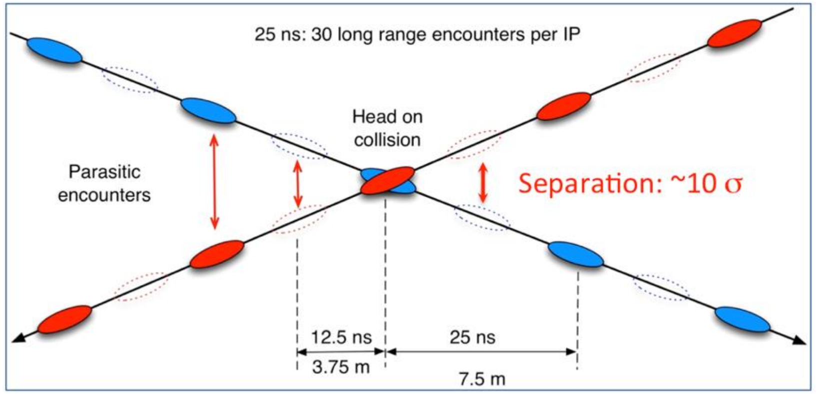
- During the intensity ramp-up we got dumped due to losses when we went into collision
  - Collimator with an angle was retracted (TCSPM.E5R7.B1 to 8.2 sigma) which fixed the issues **with the dumps coming from high losses** going in collisions
  - Total losses were reduced by
    - Optimizing the tunes, different values depending on which BBQ that was used
    - Systematic effect of the trains on lead to non-perfect centring in the TCP
      - Effect compensated in orbit feedback -> Less losses in particular for beam 1.











$$\mathcal{L} = \frac{N_1 N_2 f N_b}{2\pi \sqrt{\sigma_{1x}^2 + \sigma_{2x}^2} \sqrt{\sigma_{2y}^2 + \sigma_{2y}^2}} .$$

In case of a crossing angle one can calculate an approximative effective beam size following this formula

$$\sigma_{eff} = \sigma \cdot \sqrt{1 + (\frac{\sigma_s}{\sigma_x} \frac{\phi}{2})^2} .$$