
The European Synchrotron

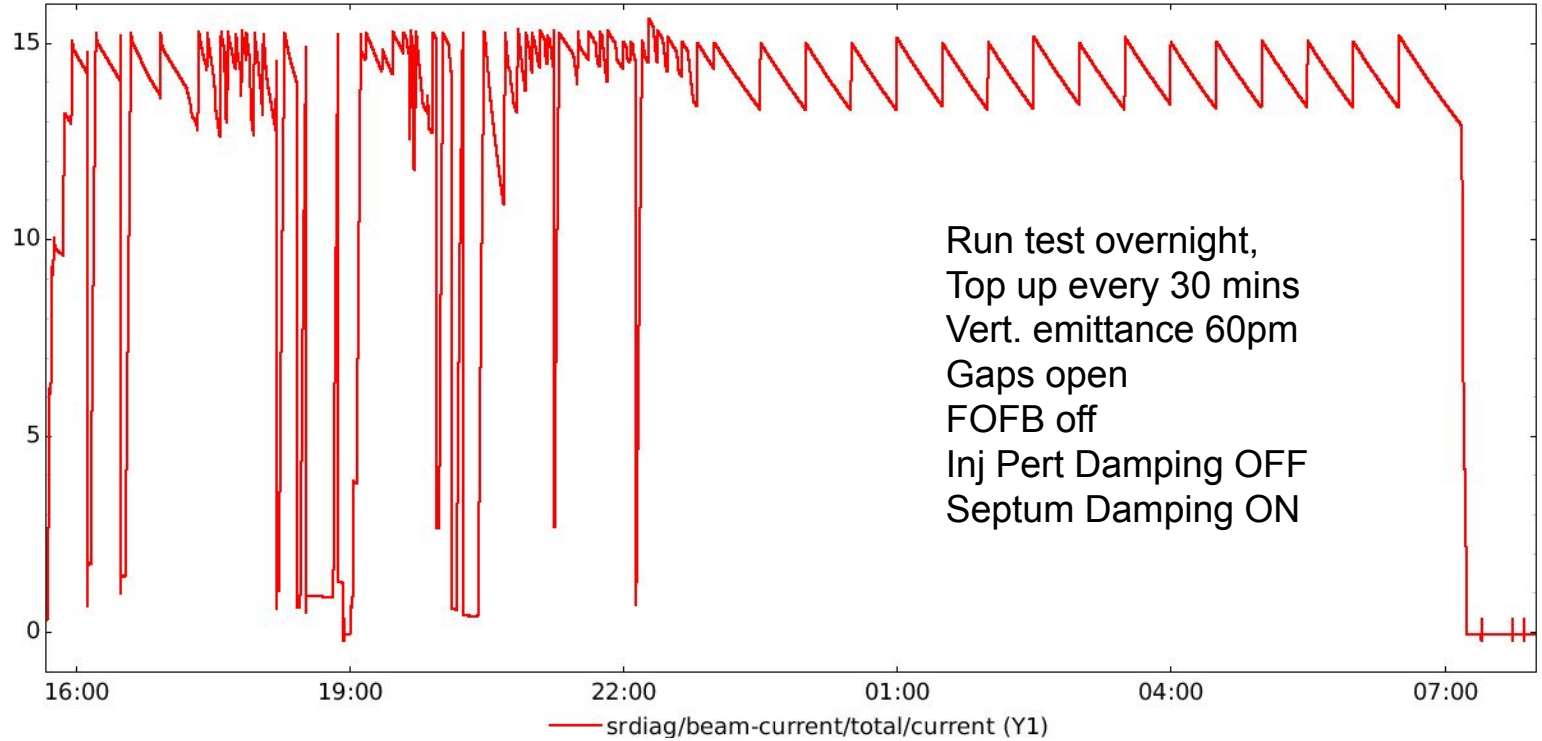
# High Single Bunch Current

Lee Carver

Acknowledgements: Benoit Roche

# OVERVIEW

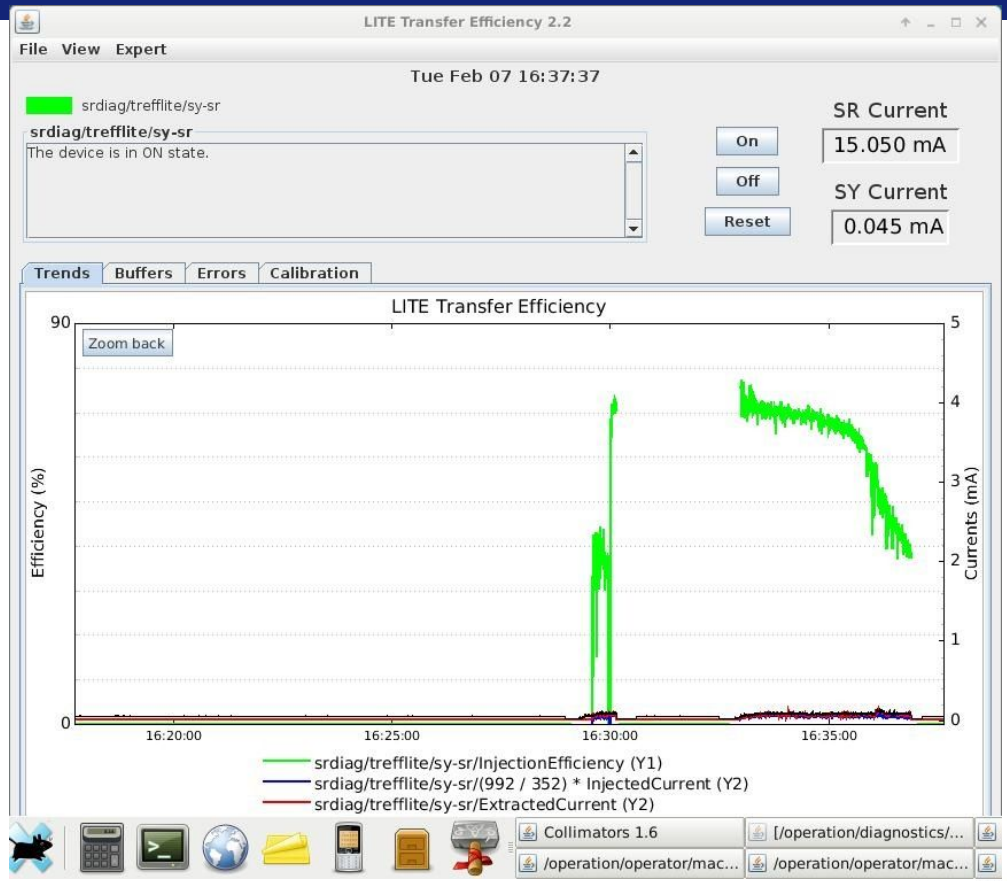
Test and Optimisation




Run test overnight,
Top up every 30 mins
Vert. emittance 60pm
Gaps open
FOFB off
Inj Pert Damping OFF
Septum Damping ON

# INJECTION EFFICIENCY MEASUREMENT

- We spent a few hours thinking the reduction of I.E. shown on the right was injection saturation.
- It was saturation of the spark BPMs used for the application.
- NOT managed by the BPM attenuator settings.

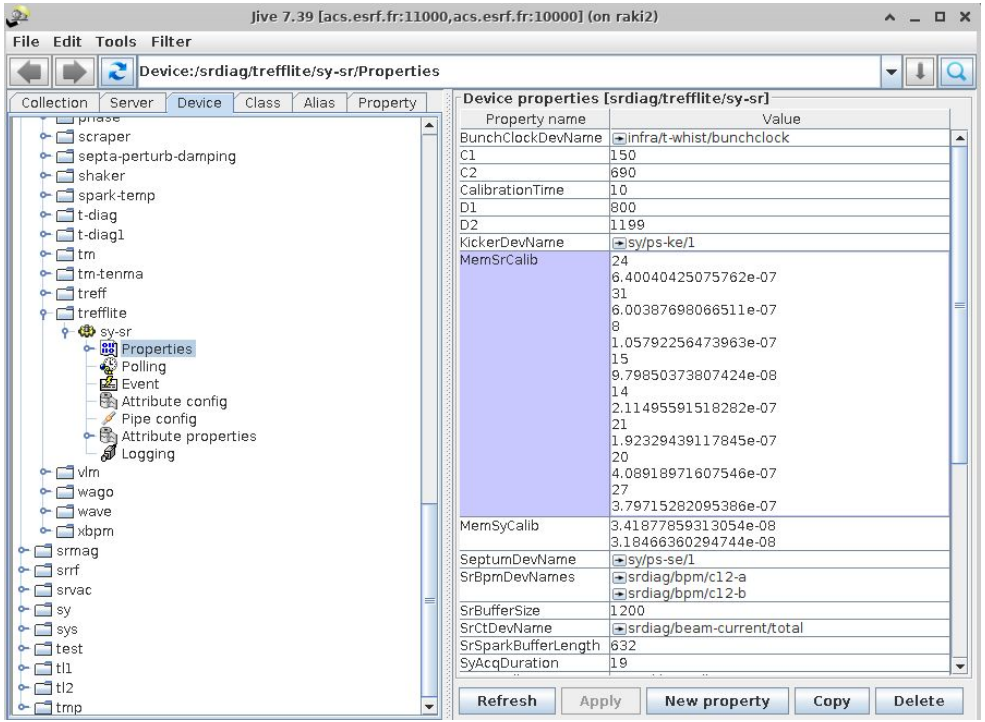


# INJECTION EFFICIENCY MEASUREMENT

- 2 BPMs used for treff, srdiag/bpm/c12-a, c12-b.
- Attenuation level can be varied directly on the BPM.
- BUT, the attenuation settings needs to be measured with a calibration factor. Trefflite switches off if bad attenuation settings loaded.

- Benoit managed to find the procedure to do this, and generated attenuator settings for high values, allowing us to use the I.E. appli at high single bunch currents.

- Kees has redone these calibrations.
- NO automatic switching based on current, needs to be done by hand.



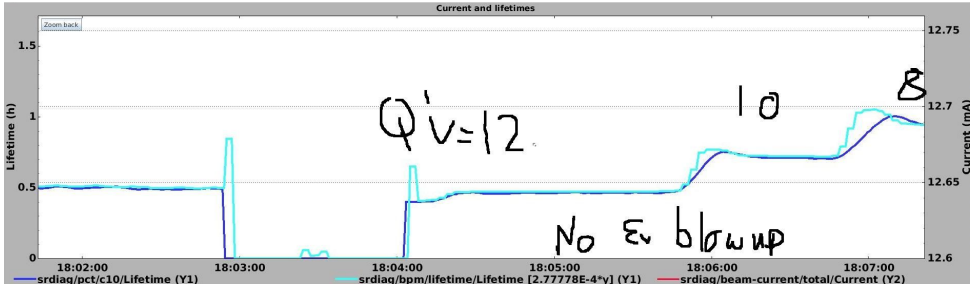
# OTHER SETTINGS THAT NEEDED TO BE CHANGED

- There was some specific settings needed for the tune monitor (moving the windowing and various attenuators).
- I don't think a file was saved with these settings. Should be created and saved next time.
- Note from Benoit: This is not trivial, and may require some software changes.

- BPM attenuation settings: libera=-31, sparks=20
- No collimator scan performed. For overnight running put the 4b settings from Dec2022.

- FOFB was not tested.

- Chromaticity was varied but before the treff problem was fixed. Didn't want to spend more time on a full scan with chromaticity. However here is the difference in lifetime for a few steps.



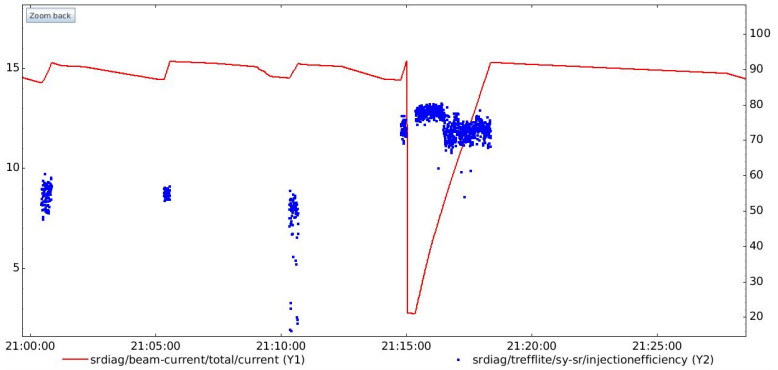
# INJECTION EFFICIENCY TUNING

- After Treff was fixed, we found I.E. of 70% at low current, reducing to 60% at 15mA.
- Performed a tune scan. Some extra tune points that are not shown here were tested, but had very bad machine performance.
- High Qv (0.36) could not survive with kickers pulsing.
- Low Qh (0.14) caused bad I.E. and incredibly noise Treff signal.

| Qh | Qv | I.E. @15mA |
|---|---|---|
| 0.16 | 0.34 | 63 % |
| 0.16 | 0.32 | 72% |
| 0.16 | 0.3 | 64% |
| 0.18 | 0.3 | 56% |
| 0.22 | 0.26 | 54% |
| 0.24 | 0.25 | 50% v noisy |
| 0.16 | 0.32 | Weird kicker bump loss meant refill from scratch. Above 70% for the whole time |

Best injection bump setting was -12.9mm. For -13.1mm we lost current while pulsing kickers.

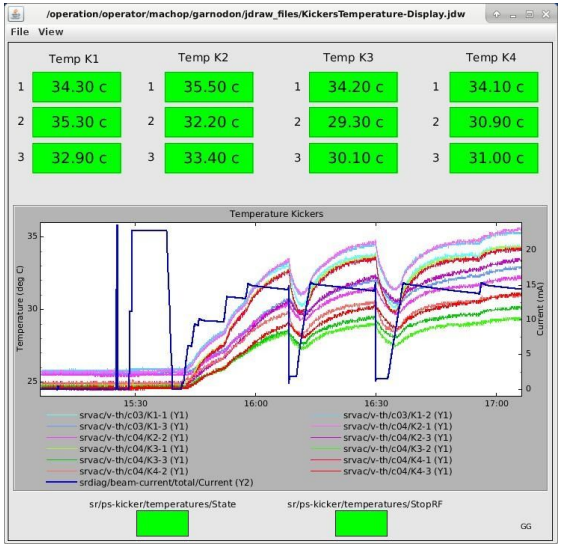
72% at 15mA with collimators open.
Nominal chromaticity.
Closing collimator to 4b position reduced I.E. by 10% to ~60%.

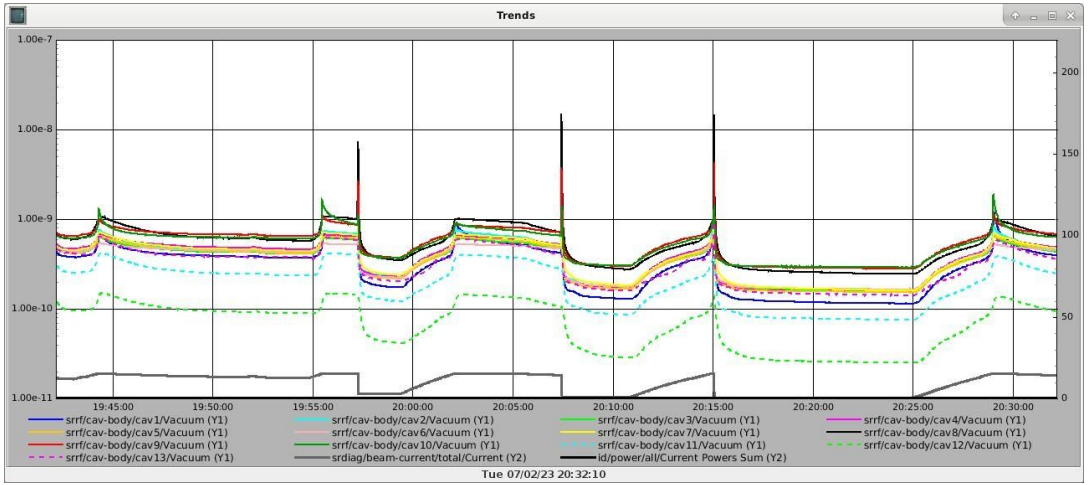


# EQUIPMENT PERFORMANCE

- RF vacuum was quiet. No problems.
- Vacuum in general was quiet with no activity to mention.
- Gaps were closed for approximately 10 minutes, no activity seen. Gaps were then reopened and kept open for the rest of the MDT.
- Kicker temperature was all below 37 degrees. No issues there.

- One major limitation we would see, is that sometimes, while pulsing the kickers but with gun off, we would kill almost the entire bunch in one kick. Associated vacuum spike, but cause and effect order not clear.



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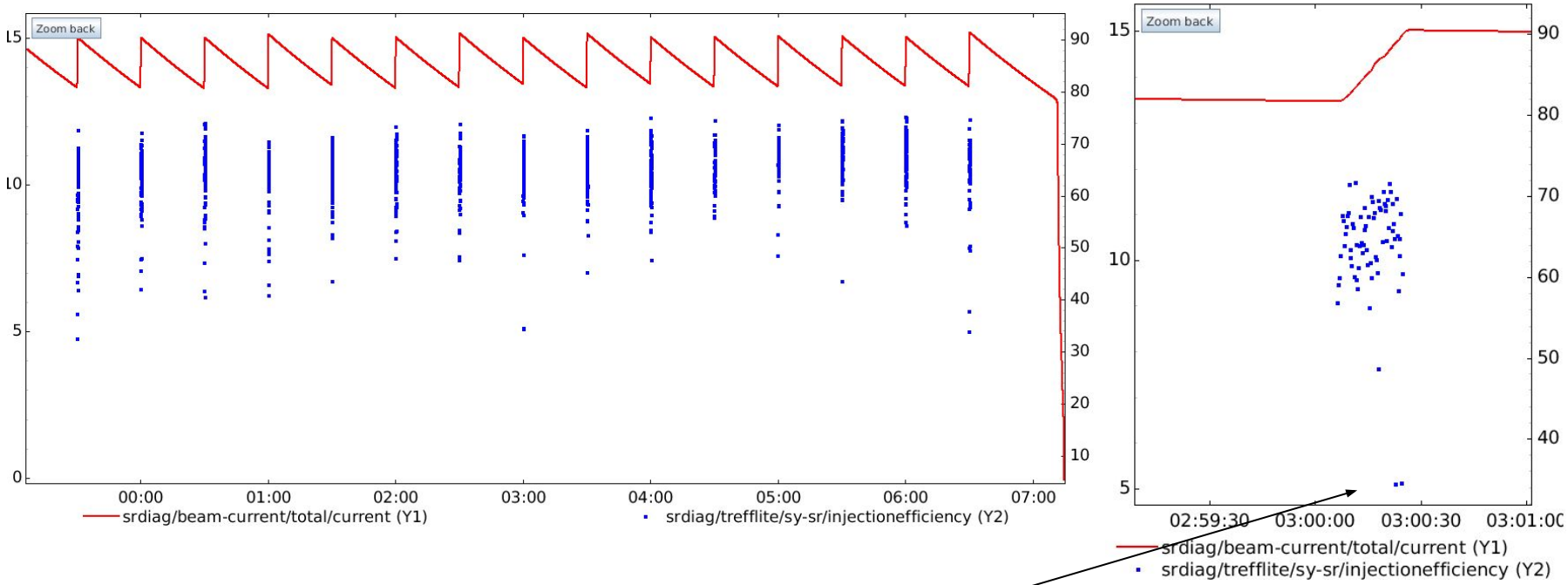
# EQUIPMENT PERFORMANCE - BBB FEEDBACK

- **For the striplines of the BBB feedback and for the tune monitor.**
- **They were all disconnected at the start of the MDT:**
  - After some time at 15mA, the tune monitor was reconnected. We waited half an hour or so. No problem
  - After some more time, the amplifiers for the feedback were reconnected, after a bit more time waiting. No problems seen.
- **BBB feedback and tune monitor were able to run at these currents with no problems (some setup was of course needed).**

- **Nonetheless, as they were not needed. The amplifiers were switched off for overnight running.**

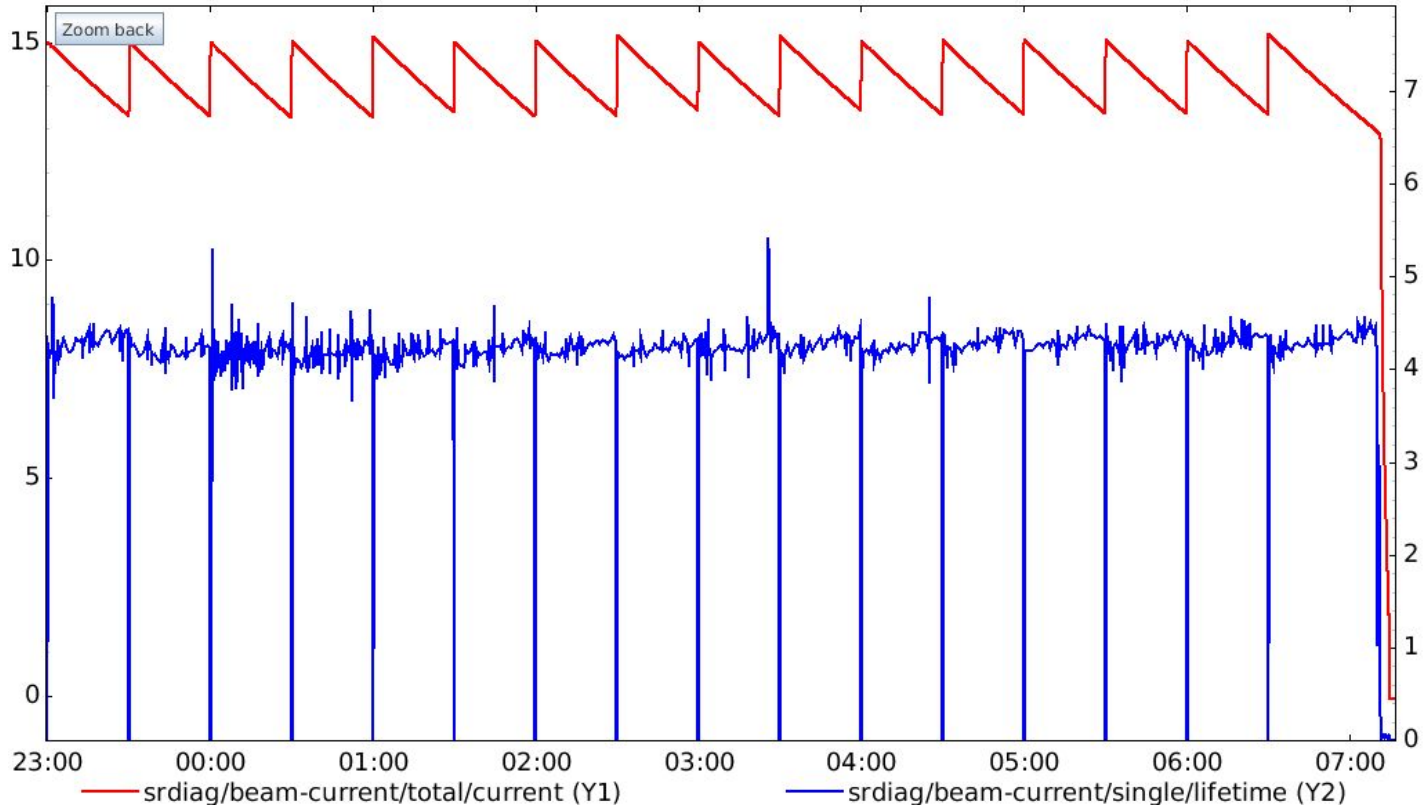
# PARAMETERS FOR OVERNIGHT RUNNING - INJECTION EFFICIENCY

Energy spread measurement: 2.4e-3 at 15mA.

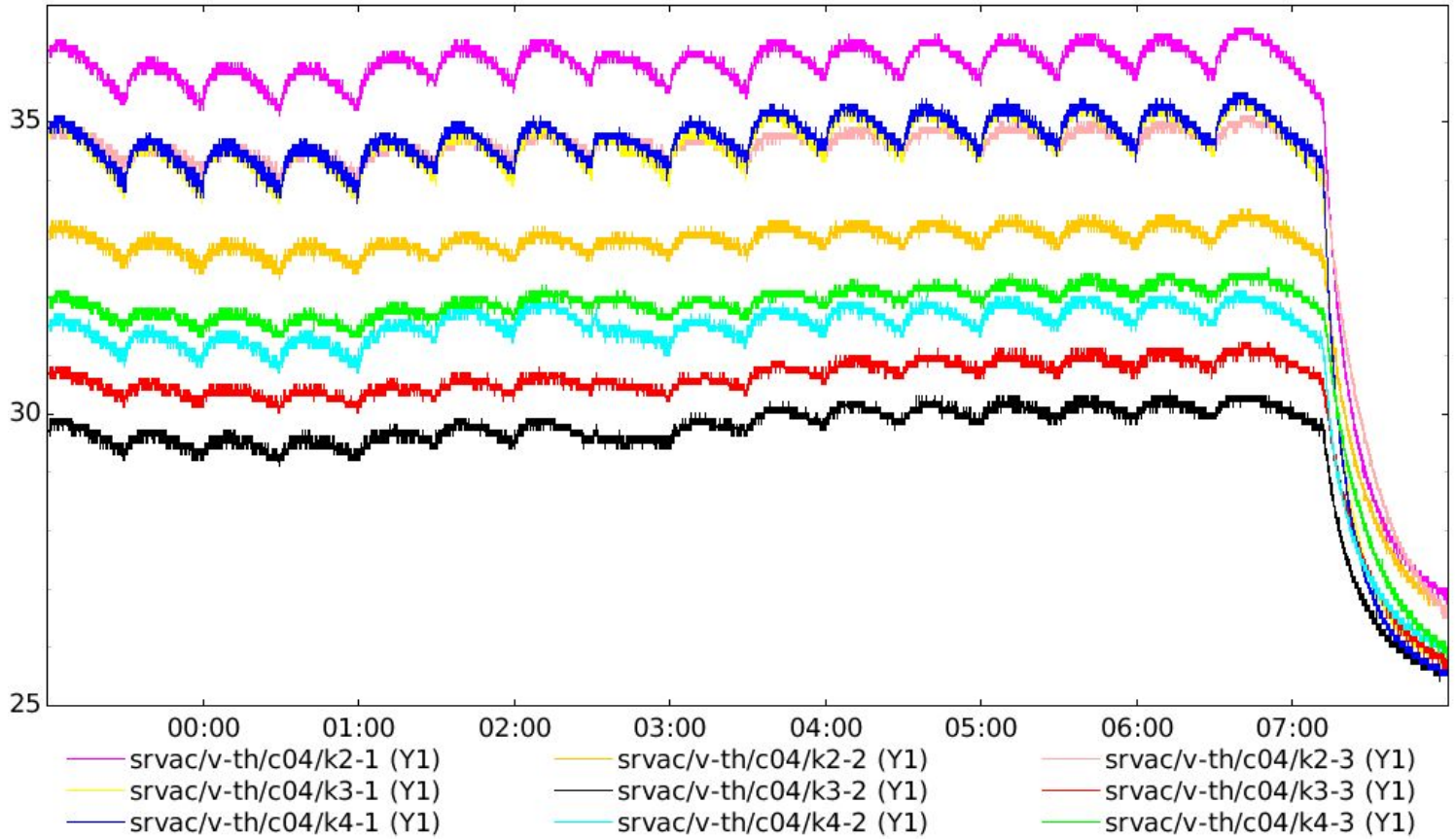



Real or artefact?

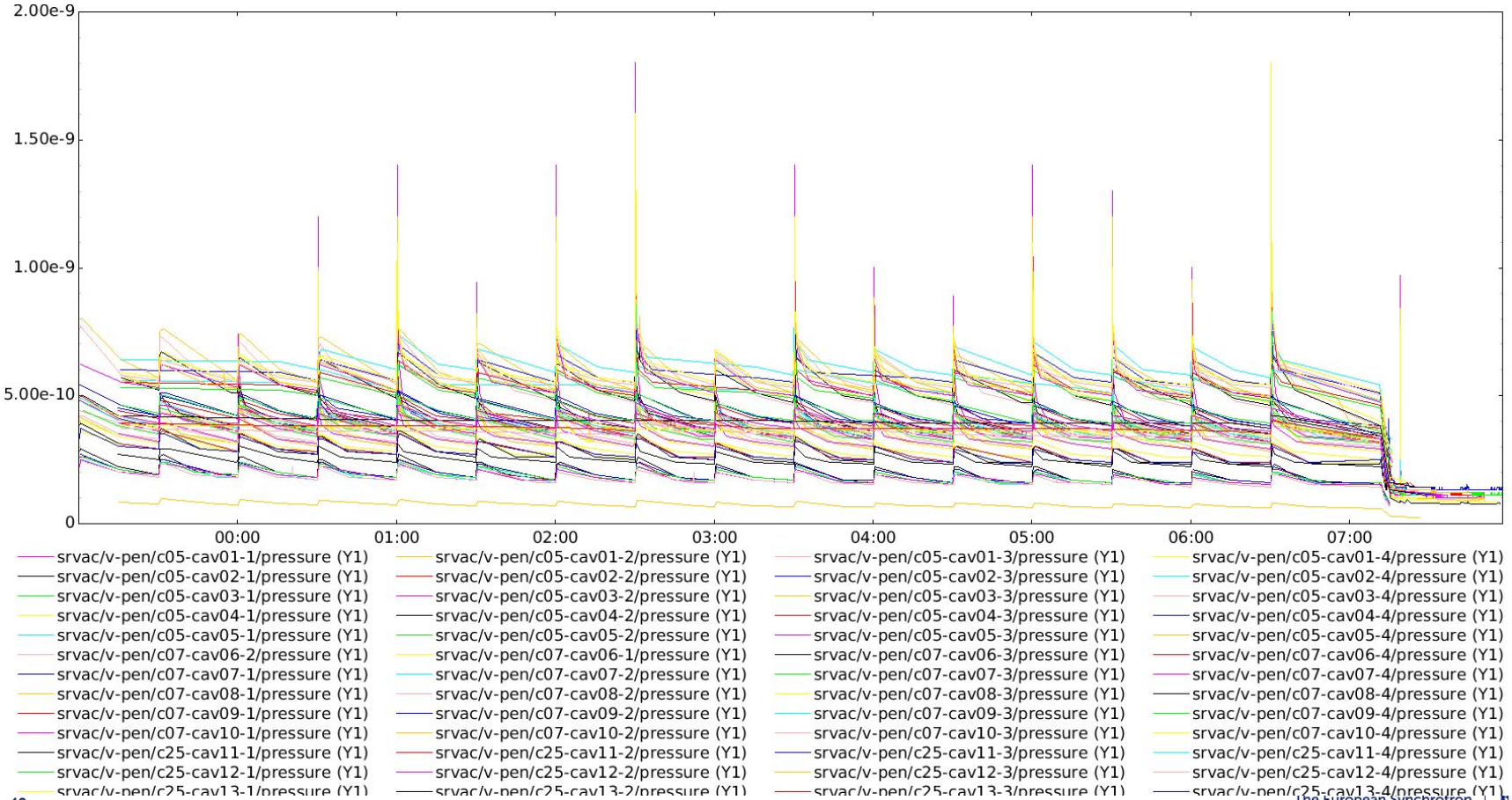
# PARAMETERS FOR OVERNIGHT RUNNING - LIFETIME



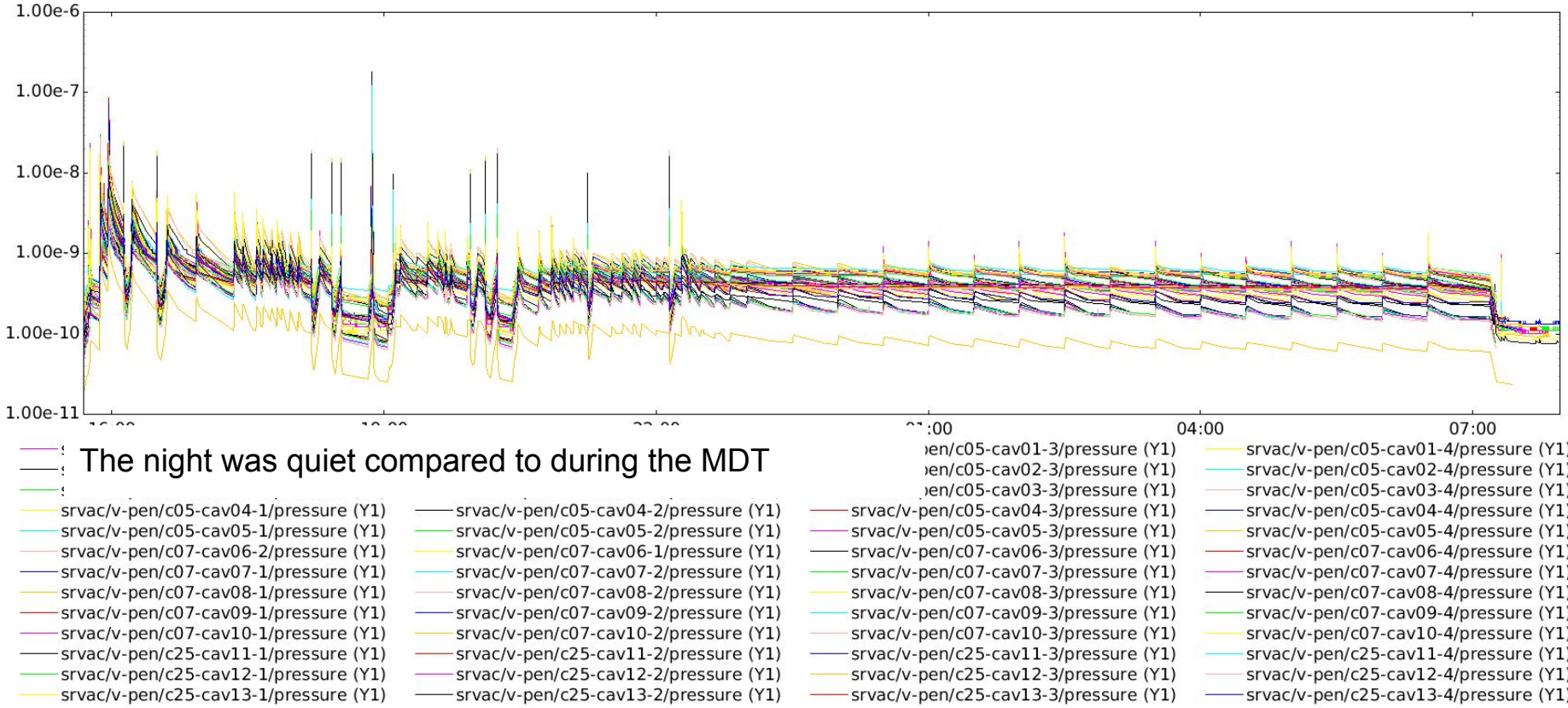
# PARAMETERS FOR OVERNIGHT RUNNING - KICKER TEMPERATURES



# PARAMETERS FOR OVERNIGHT RUNNING - CAVITY VACUUM

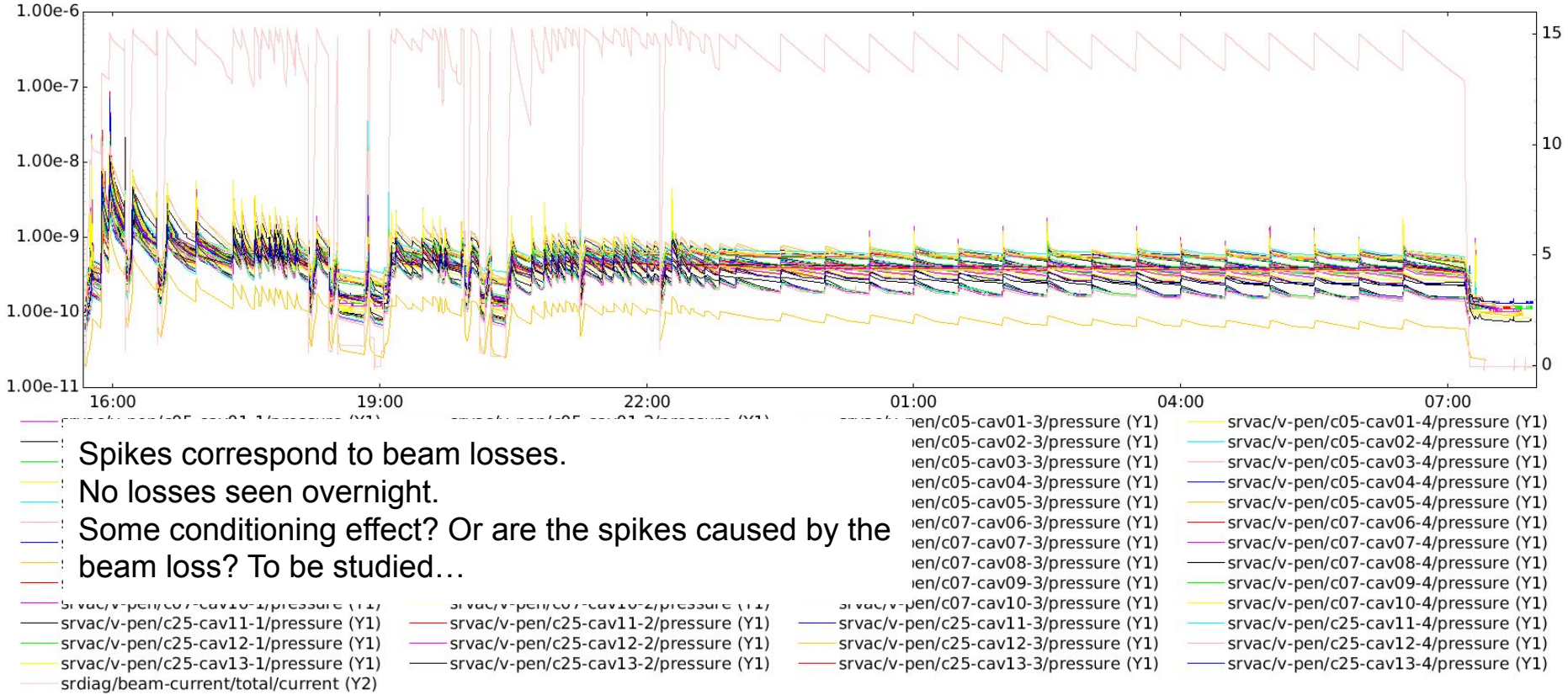


# PARAMETERS FOR OVERNIGHT RUNNING - CAVITY VACUUM INC MDT




The night was quiet compared to during the MDT

# PARAMETERS FOR OVERNIGHT RUNNING - CAVITY VACUUM INC MDT & CURRENT




Spikes correspond to beam losses.
No losses seen overnight.
Some conditioning effect? Or are the spikes caused by the beam loss? To be studied…

# FUTURE STEPS

- Measure bunch length up to 15mA.
- Measure sync phase shift up to 15mA
- Lifetime optimisation
- Anything to be done on the booster to help?
- Optimize injection with gaps closed.
- Test FOFB
- Injection perturbation - is anything possible?
- Understand this beam loss problem.

- For sure, we will be able to increase the current to higher than 15mA, I think 18mA is feasible, 20mA possibly. But I am not sure how easy it will be to make these currents operational.
- We should see where the maximum is, then decide what is best?
- New MDT?