



DAΦNE Activity Report



Catia Milardi
on behalf of the DAΦNE Team

66th Scientific Committee Meeting Nov 8th, 2023



DAΦNE Team

C. Milardi, D. Alesini, M. Behtouei, S. Bilanishvili, S. Bini, M. Boscolo, B. Buonomo, S. Cantarella, F. Cardelli, A. Ciarma, A. De Santis, E. Di Pasquale, D. Di Giovenale, C. Di Giulio, G. Di Pirro, A. Drago, A. D'Uffizi, *O. Etisken*, L. Foggetta, G. Franzini, A. Gallo, R. Gargana, S. Incremona, A. Liedl, A. Michelotti, L. Pellegrino, L. Piersanti, R. Ricci, U. Rotundo, *S. Spampinati*, A. Stecchi, A. Stella, A. Vannozzi, M. Zobov

P. Raimondi, CERN, and SLAC (visiting LNF in April 2023)



Outline

Run overview

Uptime

Fault analysis

Collision run

Achievements

Short term plan



Run Overview

May 4th

Scientific Committee,
run had started on mid March.

Jul 24th

Summer shutdown after 81 days of run.

Sep 15th

Periodical maintenance,
subsystems consolidation activities, mainly cooling systems,
collider wamup,
radioprotection tests.

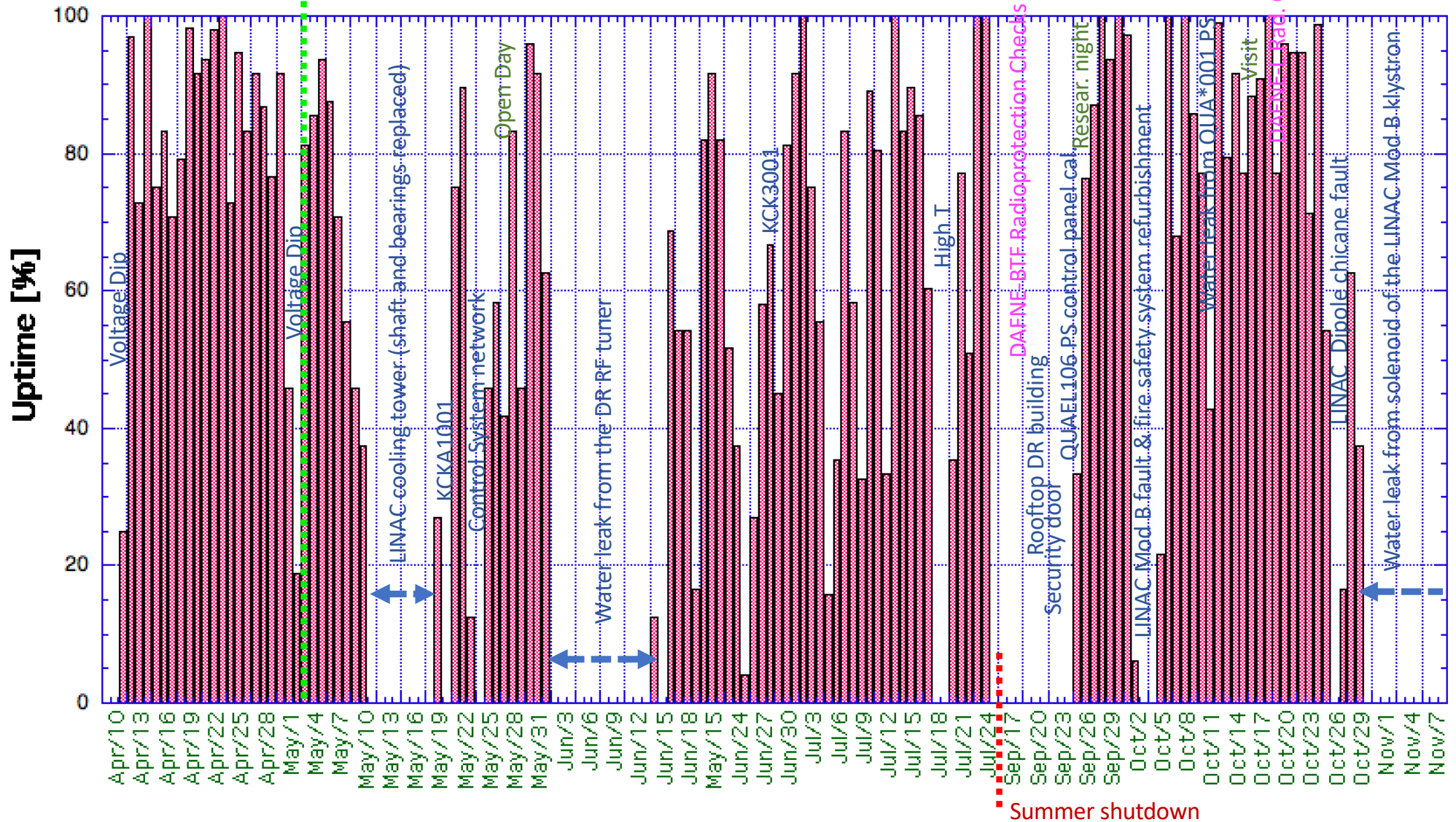
Sep 25th

Collisions and data delivery.

Luminosity-delivery Efficiency (Uptime)

$luminosity \geq 1 \cdot 10^{32} \text{ cm}^{-2}$

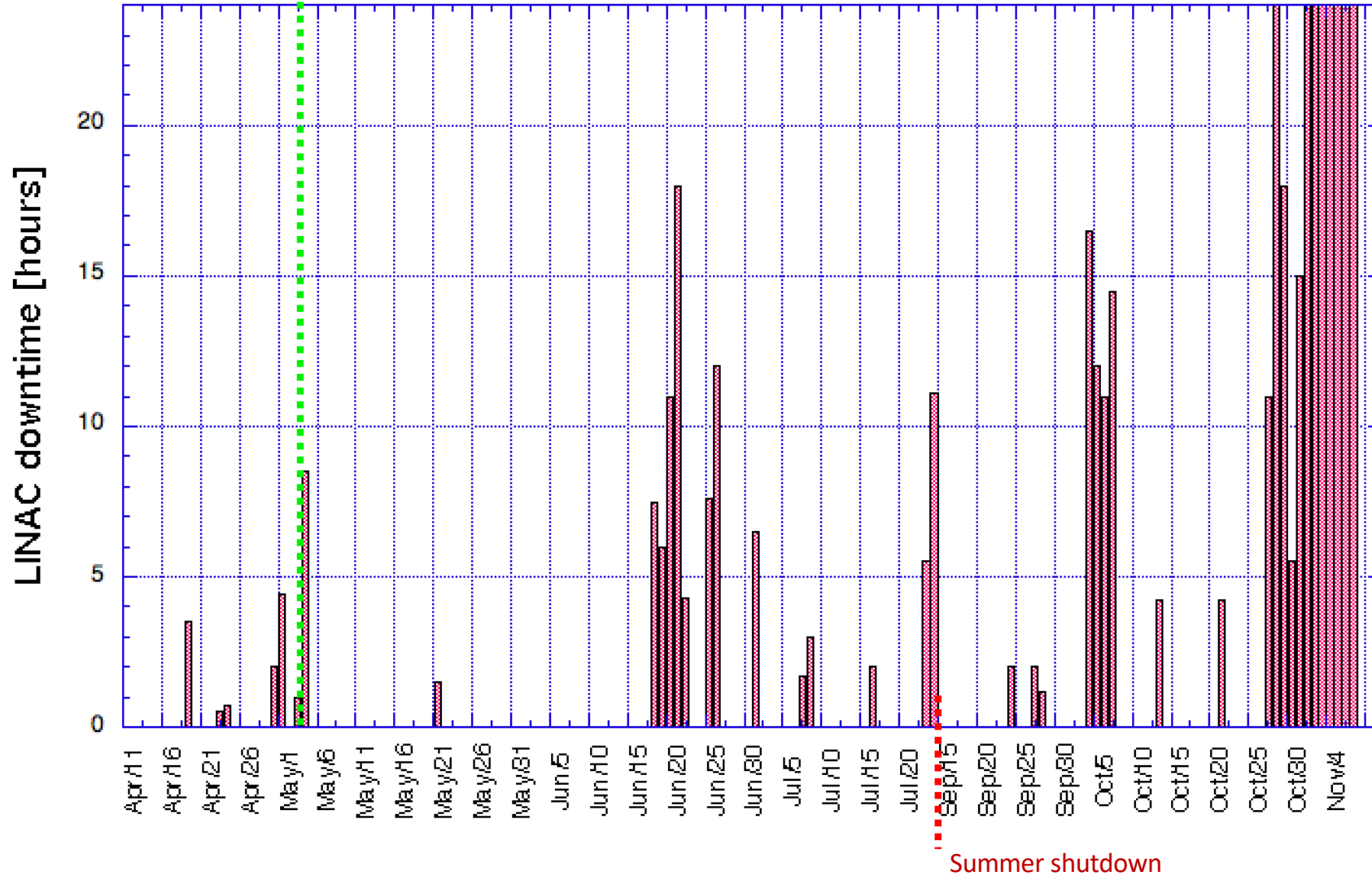
65th Scientific Committee



LINAC Faults

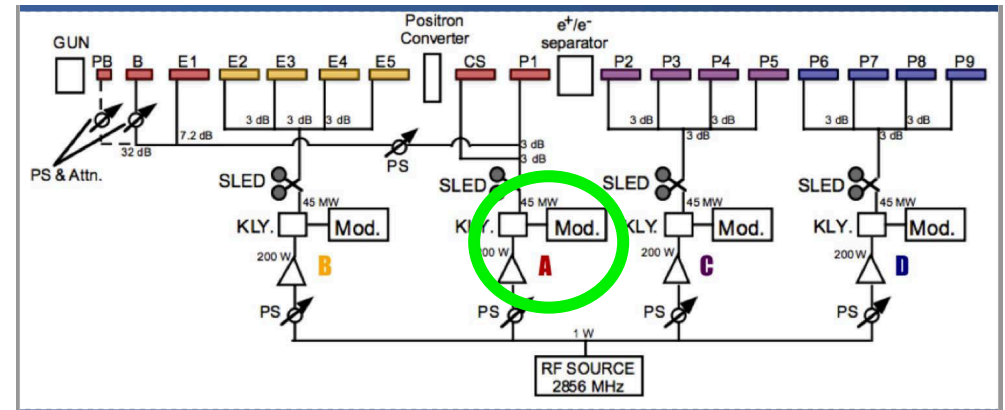
$$\sum LINAC_{faults} = 431 [h]$$

65th Scientific Committee



LINAC Faults

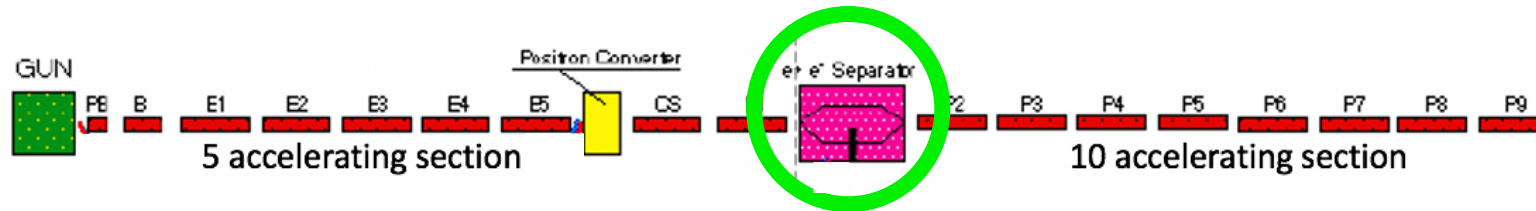
Klystron of RF plant A fault
 Anomalous reflected power about
 28 % of the input one
 Water leak from the solenoid



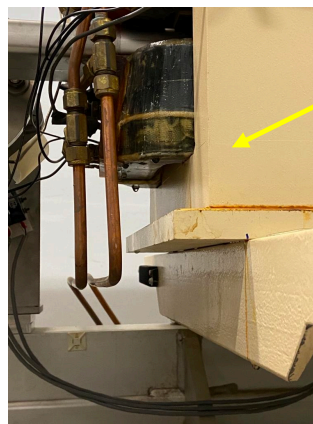
Klystron dismantled,
 elbow isolated and maintained in good,
 vacuum conditions,
 solenoid replaced,
 klystron was reassembled,
 vacuum and RF connections restored,
Conditioning is still in progress.



LINAC Faults



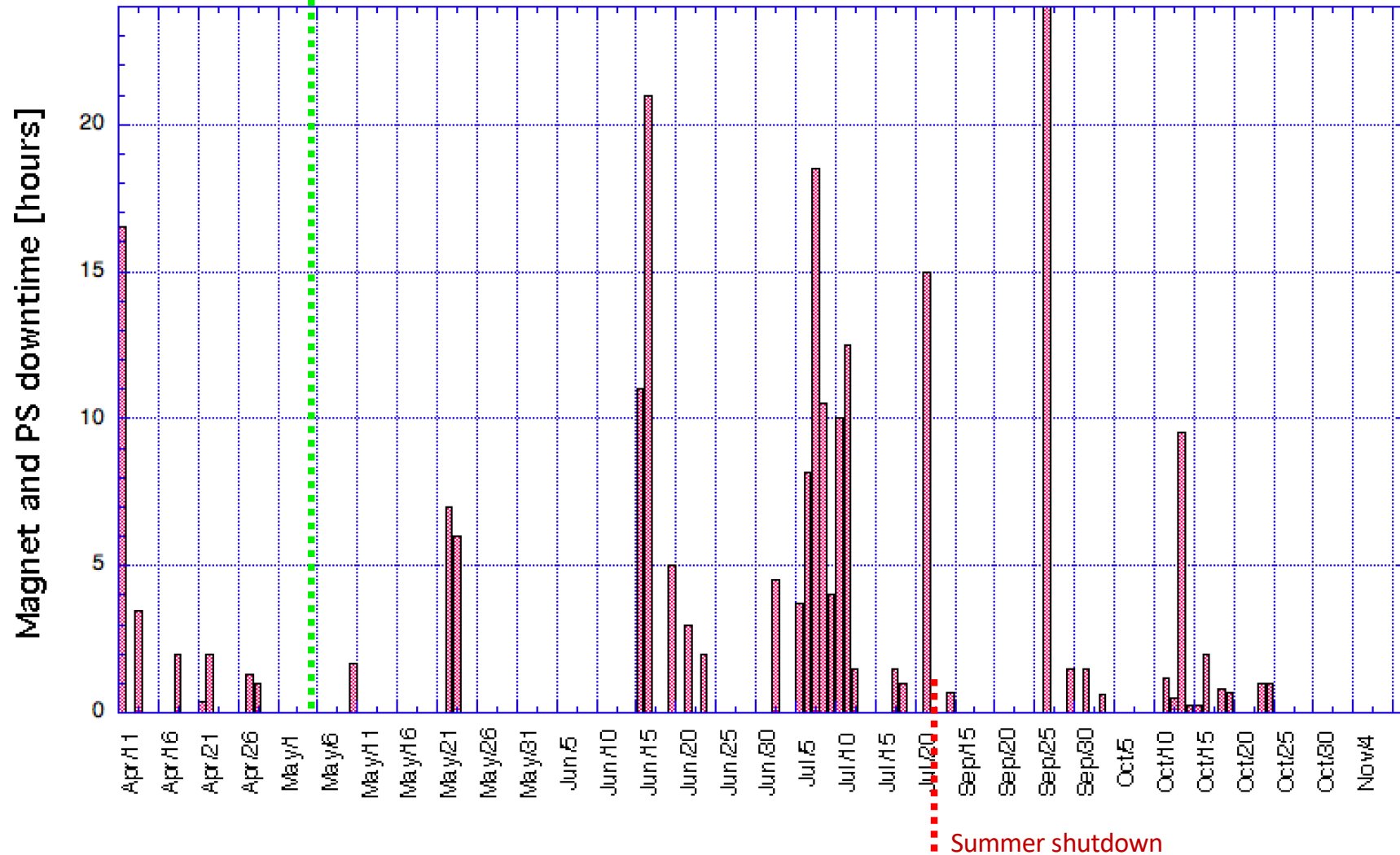
Water leak from the lower coil of a dipole in the LINAC chicane after the positron converter.



Magnet and PS Faults

65th Scientific Committee

$$\sum PS_{faults} = 193 [h]$$





Magnet and PS faults

The high fault rate peak due to failure of IGBT drive boards part of the the DanFisik PS family was fixed.

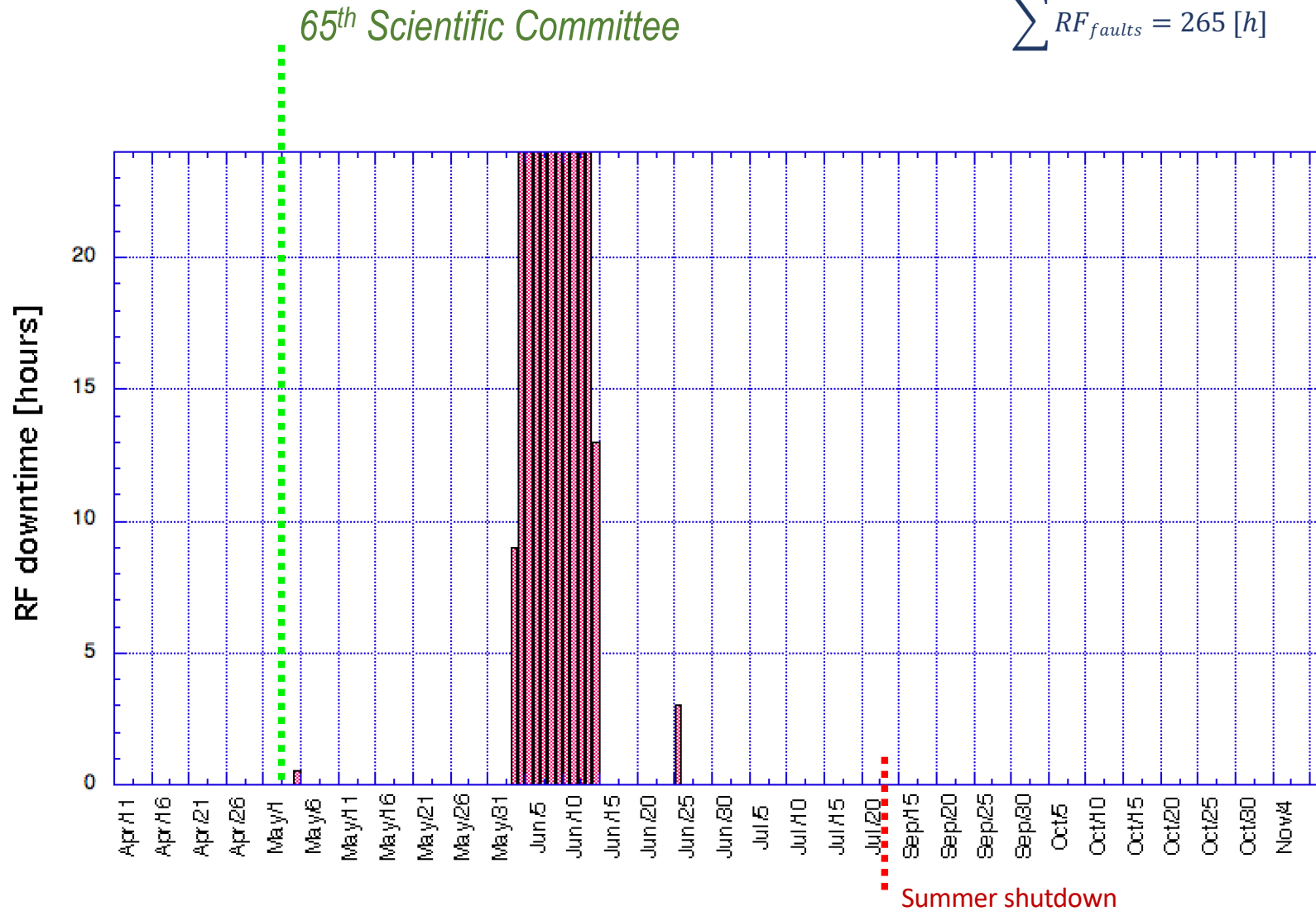
New spare parts have been purchased.

Diagnostics tools and quick mending procedures have been established also thank to the collaboration with colleagues of the Research Division.

Presently fault rate is mainly due to minor failures uniformly distributed. Few more harmful faults come from the six PSs equipping the DR magnets.

Ring RF Plant Faults

$$\sum RF_{faults} = 265 [h]$$



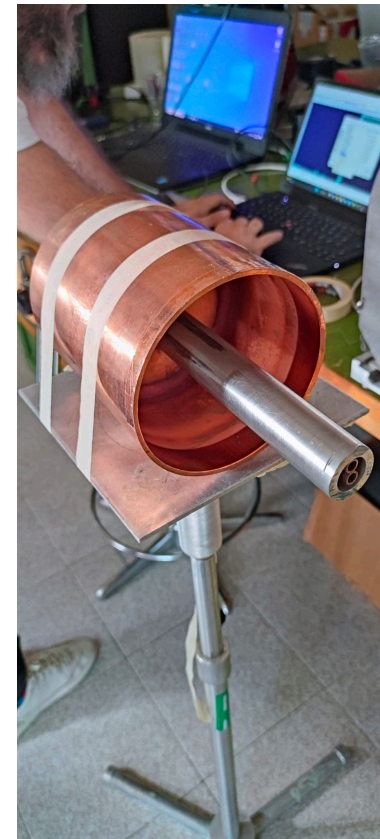
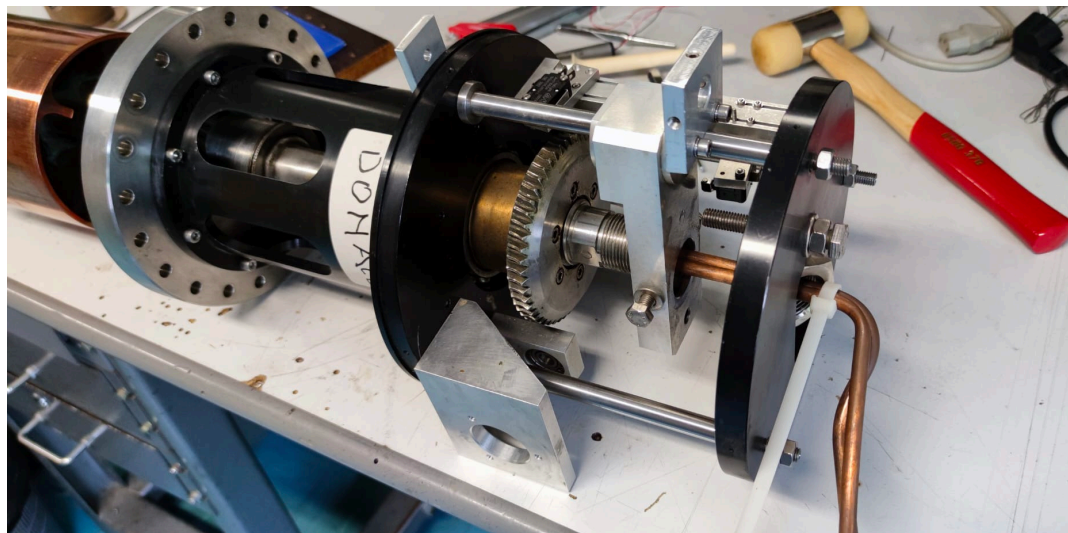
Ring RF Plant Faults

Water leak from the tuner of the DR RF cavity

Never happened before.

Spare part needed cleaning treatment.

Damaged tuner is going to be repaired and stored as spare part itself.





DAΦNE Uptime

DAΦNE gross uptime throughout 123 days of operations has been of the order of ~ 53%, this regardless:

- unprecedented atmospheric temperatures since the second half of Jun,
- the heavy fault rate affecting the LINAC in the last month.

However, considering:

- machine stops caused by external events independent from the DAFNE reliability:

- radioprotection tests (4 days),
- LNF infrastructure serving the DAFNE accelerator complex,
- voltage dips costing about 20 hours each (May 1st),
- outreach activities

- Experiment requirements:

- target gas refill,
- calibrations,
- dewar refill on weekly base,
- apparatus and acquisition faults.

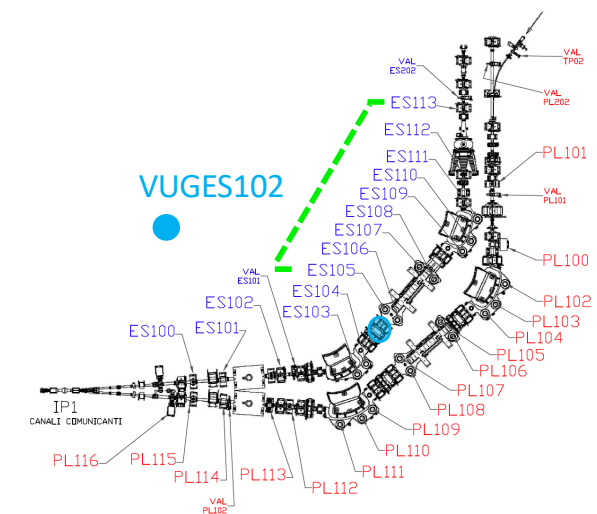
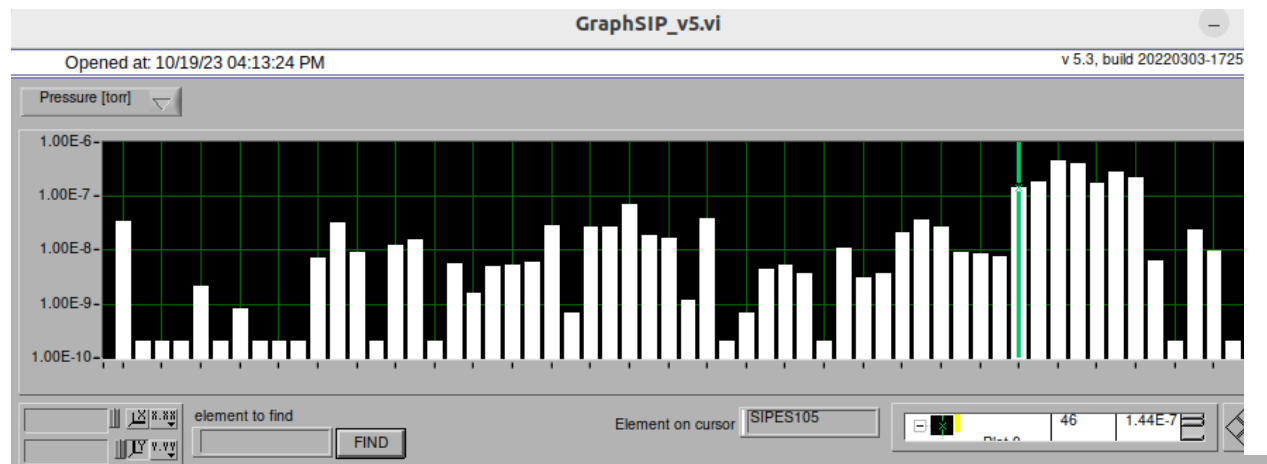
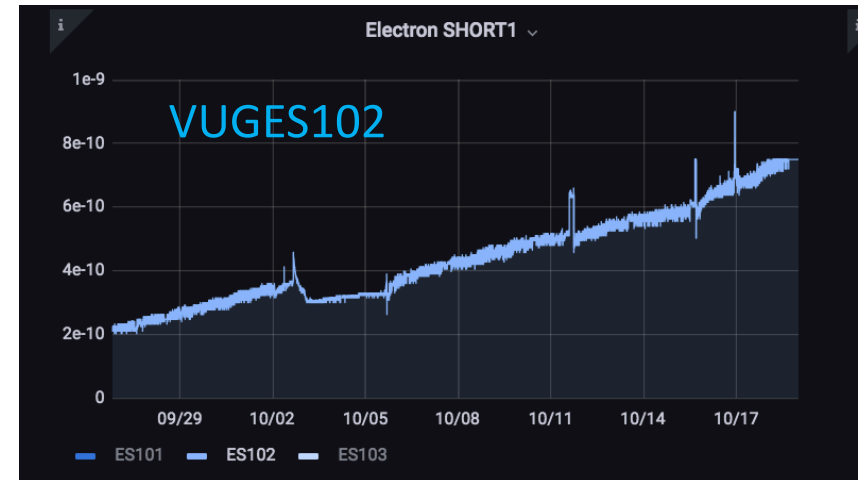
DAΦNE net uptime was about 68%

Electron beam dynamics observations

- Vertical tune had to be lowered wrt the nominal one.
- Strong vertical instability appeared, even in single beam mode, it was damped by beam-beam only for current of the e+ beam lower than 750 mA, above this threshold the e- beam blew up vertically, luminosity dropped as background increased suddenly.
- Poor lifetime.
- Flip-flop.
- Sudden beam losses above 1.5 A.

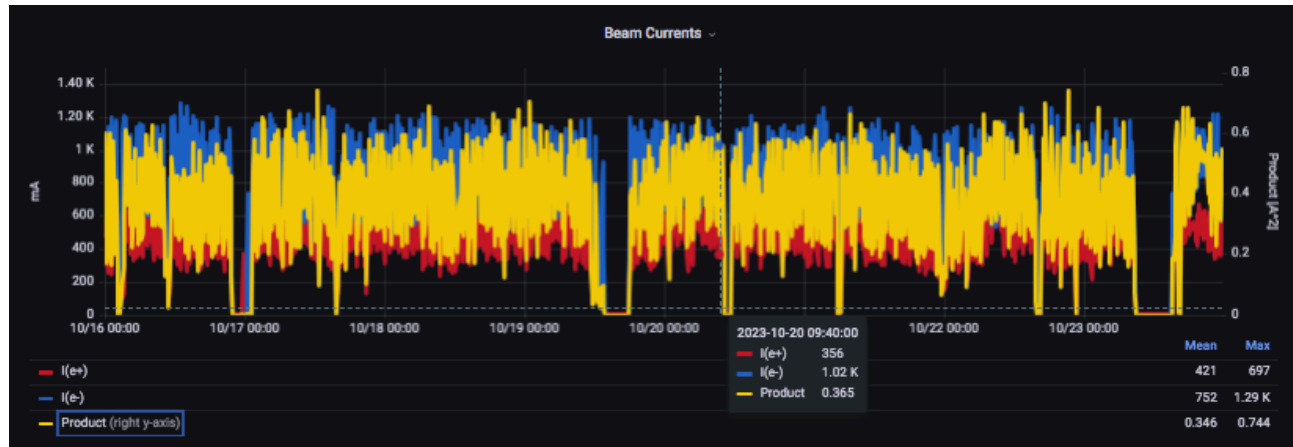
All these effects were largely mitigated by decreasing the number of bunches from 110 to 95.

Electron beam was clearly affected by ion trapping although there was no clear evidence of vacuum issues.



Collisions

the intervention to fix the elusive vacuum leak was prepared in the week 16 - 23 October



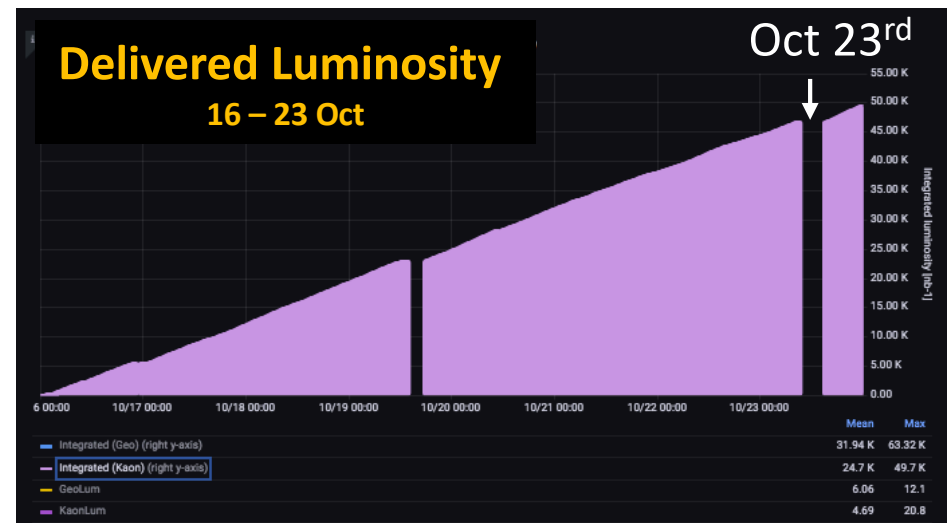
Maximum beam currents in 95 bunches:

$$I^+ = 0.7 \text{ A}$$

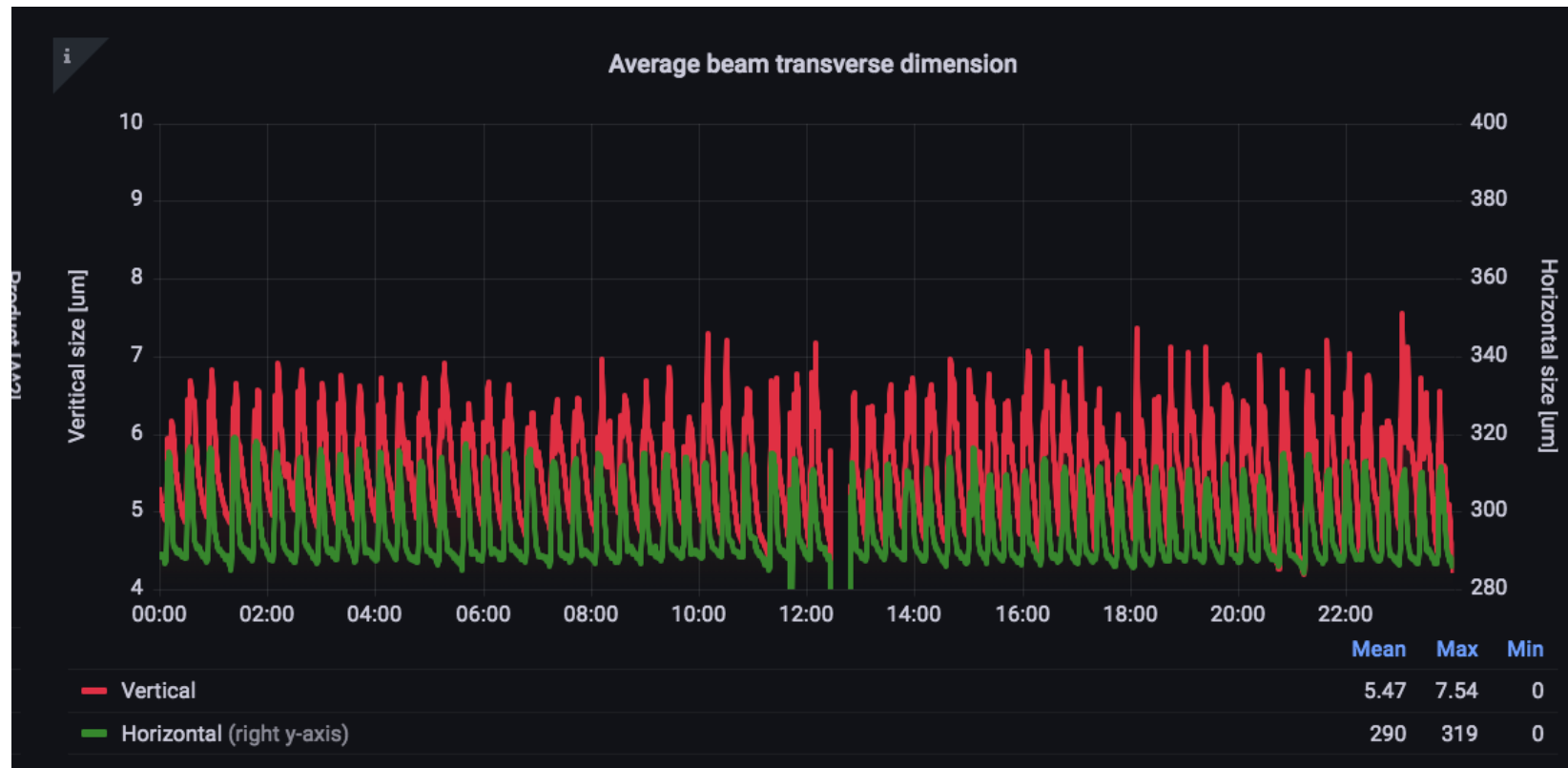
$$I^- = 1.3 \text{ A}$$

Few interruptions were planned in order to:
 check vacuum equipment,
 install tools to search for the leak,
 find out the leak, which was on a flange of an absorber in the ES1 arc.

50 pb⁻¹ delivered with a 89% uptime.



Average Beam Transverse Size

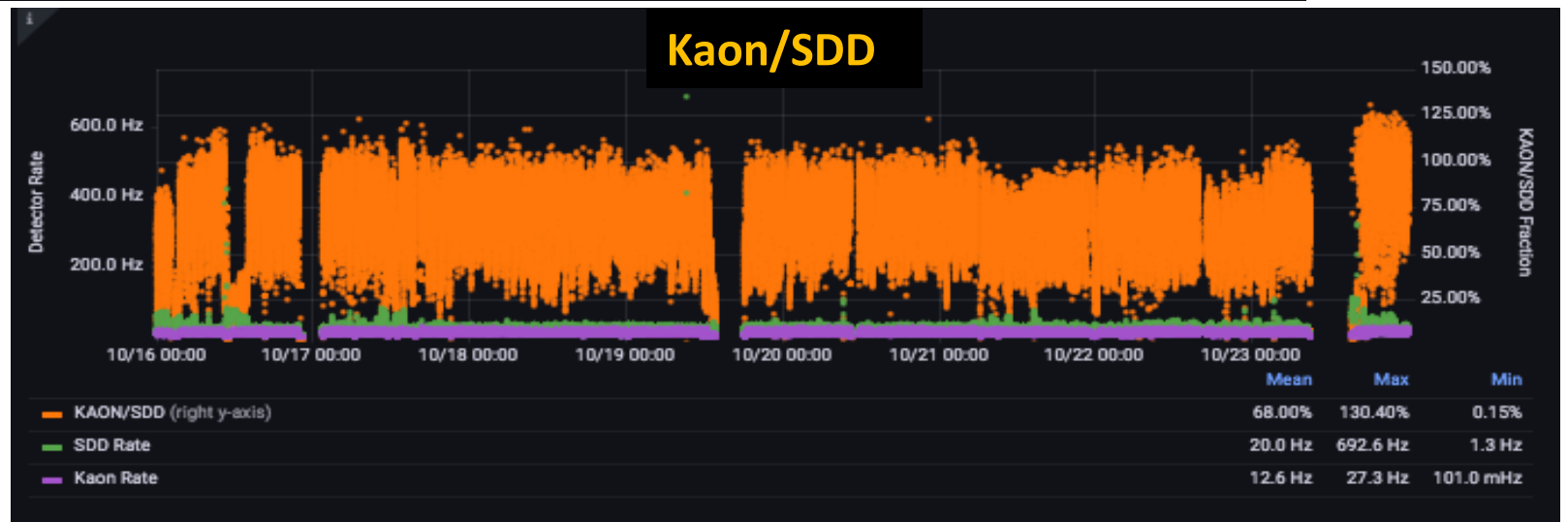
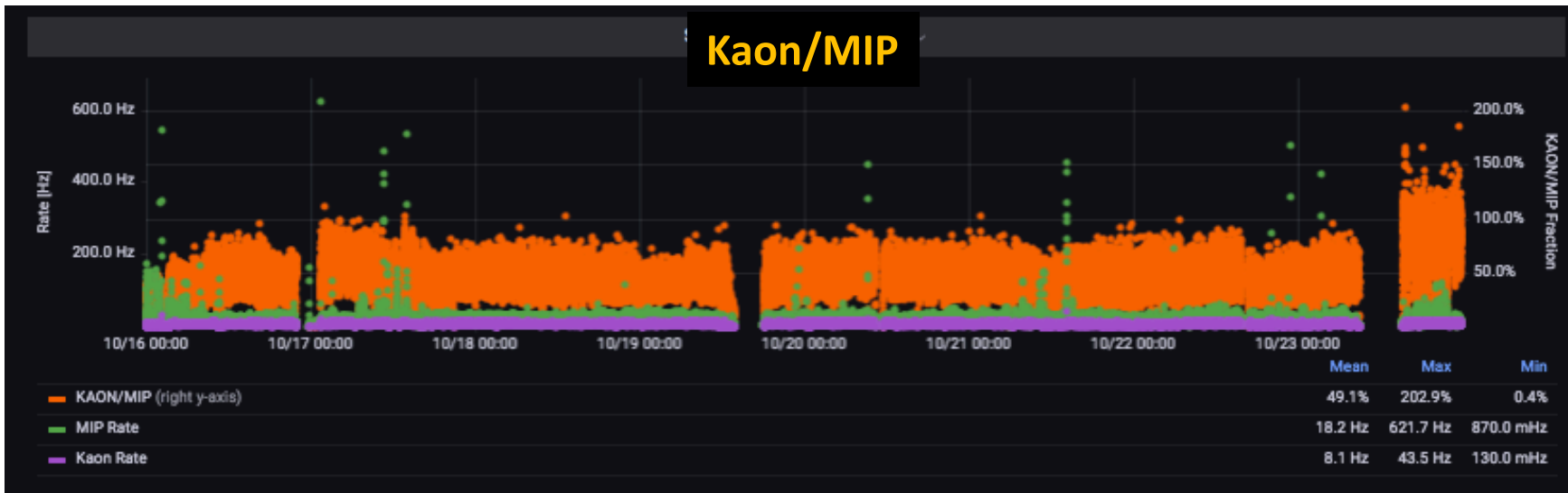


Oct 24th run

Convolutated transverse dimension of colliding beams are under control

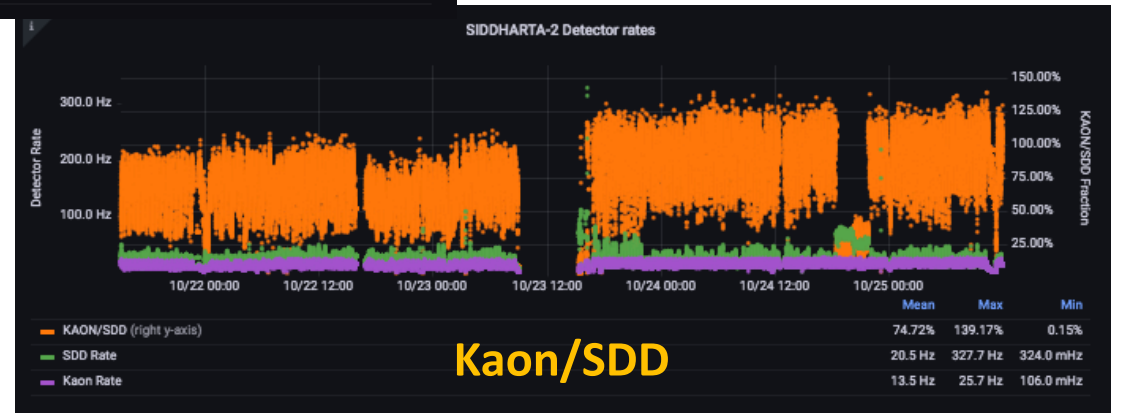
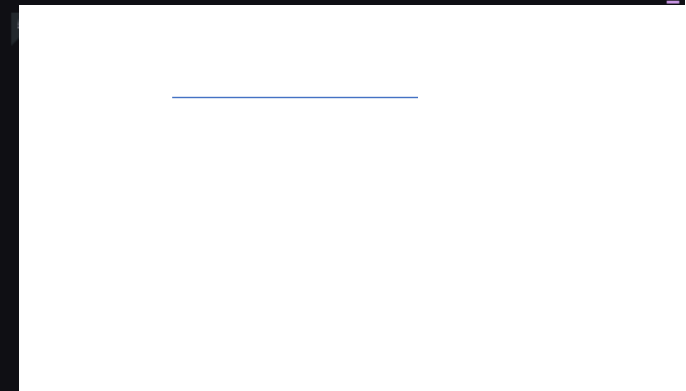
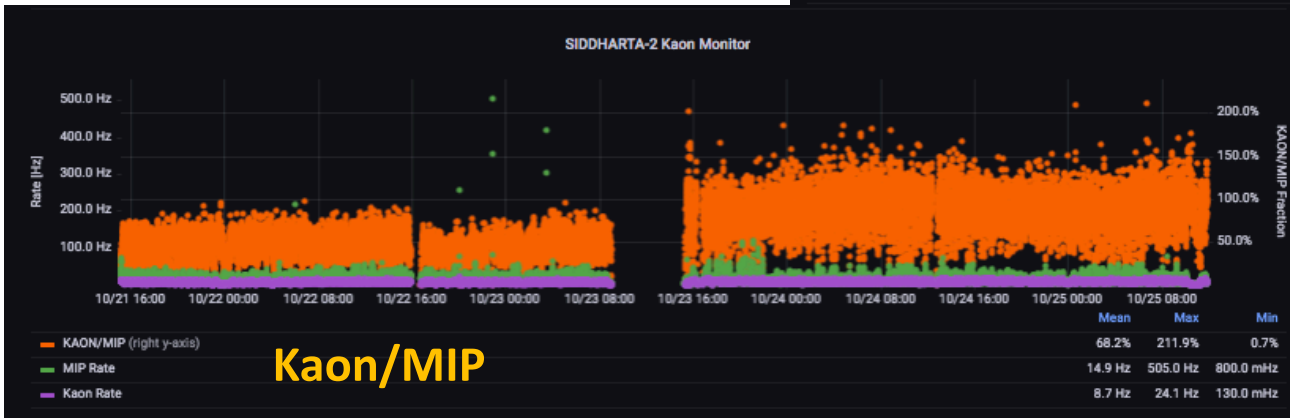
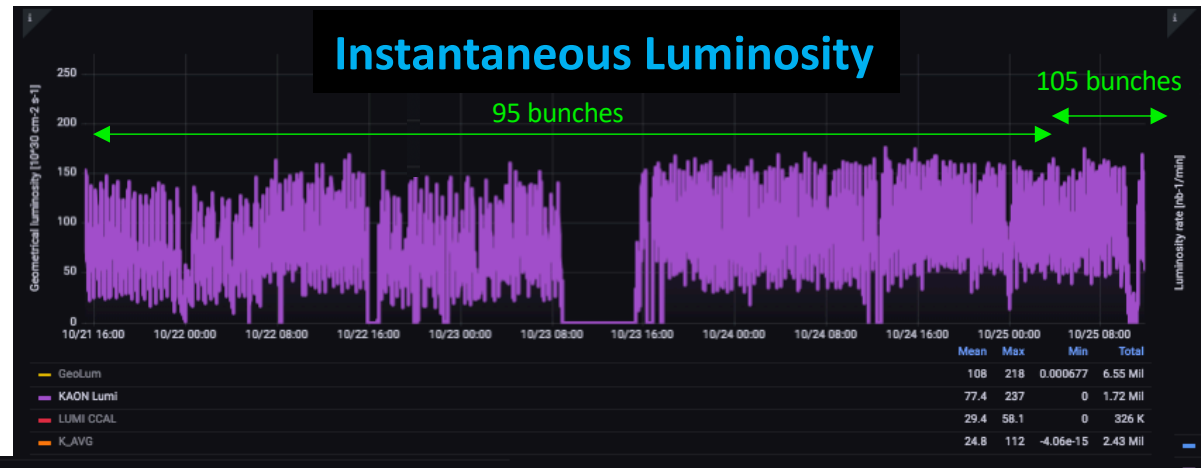
Signal to noise ratio

Long trend evolution showing the improvements after fixing vacuum leak in the MRe



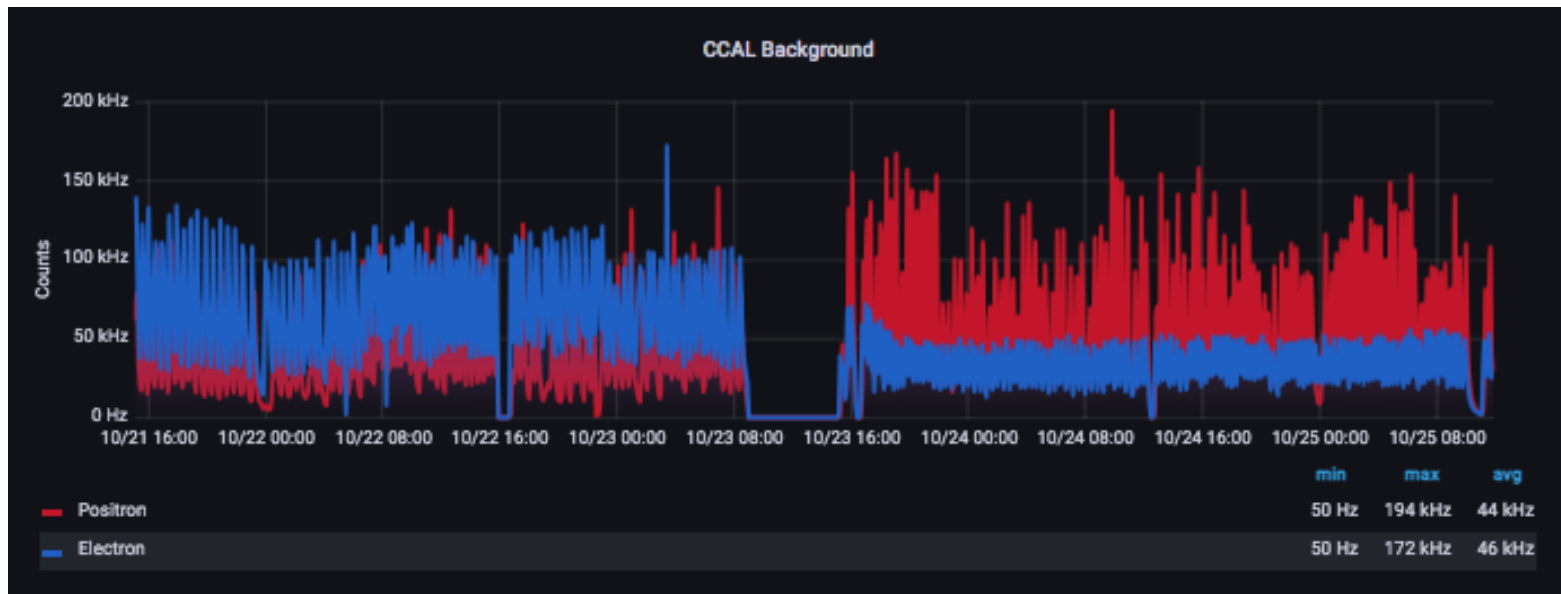
Data quality after fixing vacuum leak

$$L_{peak} = 1.8 \cdot 10^{32} \text{ cm}^{-2}\text{s}^{-1}$$



Data quality after fixing vacuum leak

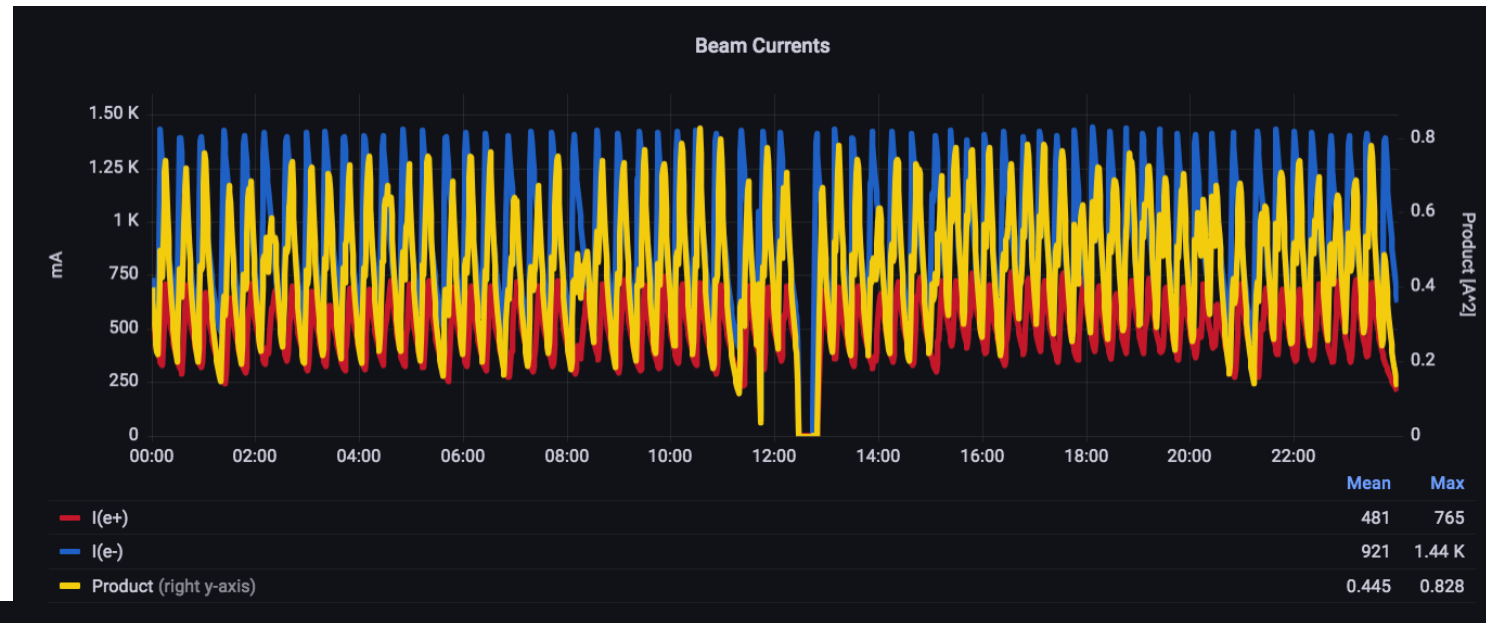
Positive trend in the background is confirmed by the counting rate aout of coincidence measured by the CCAL luminosity monitor



After fixing the small vacuum leak ion trapping effects disappeared.



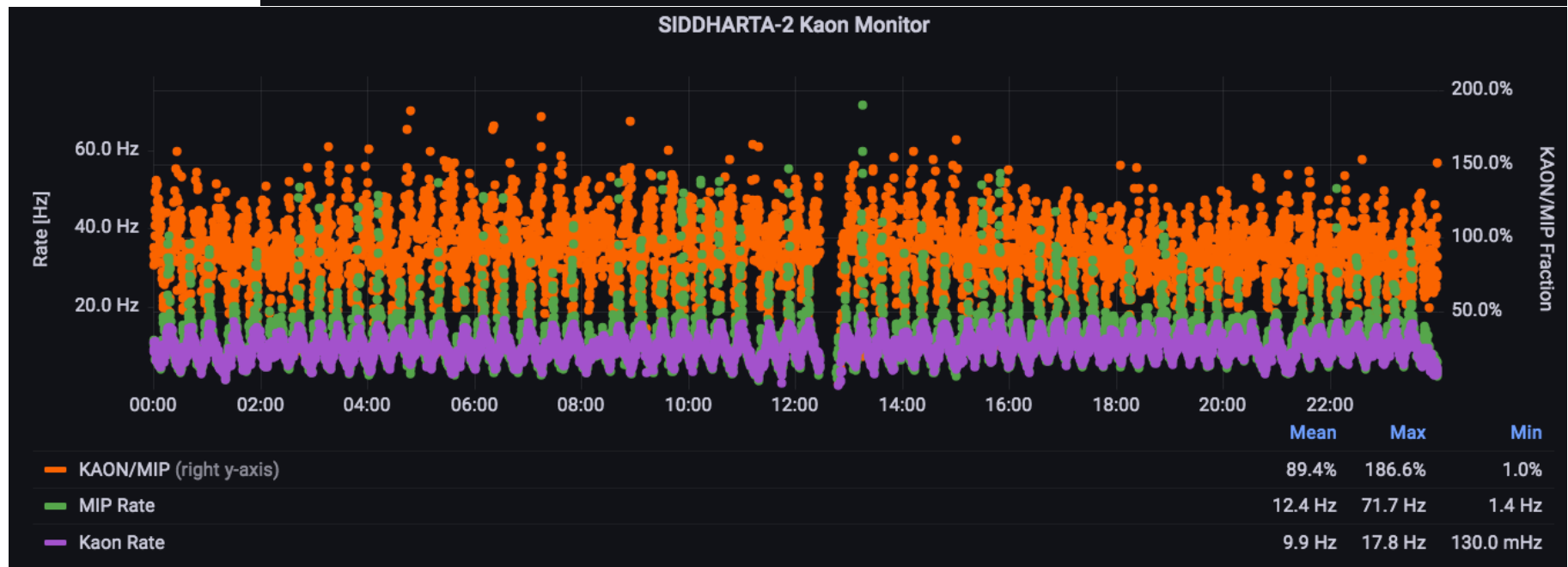
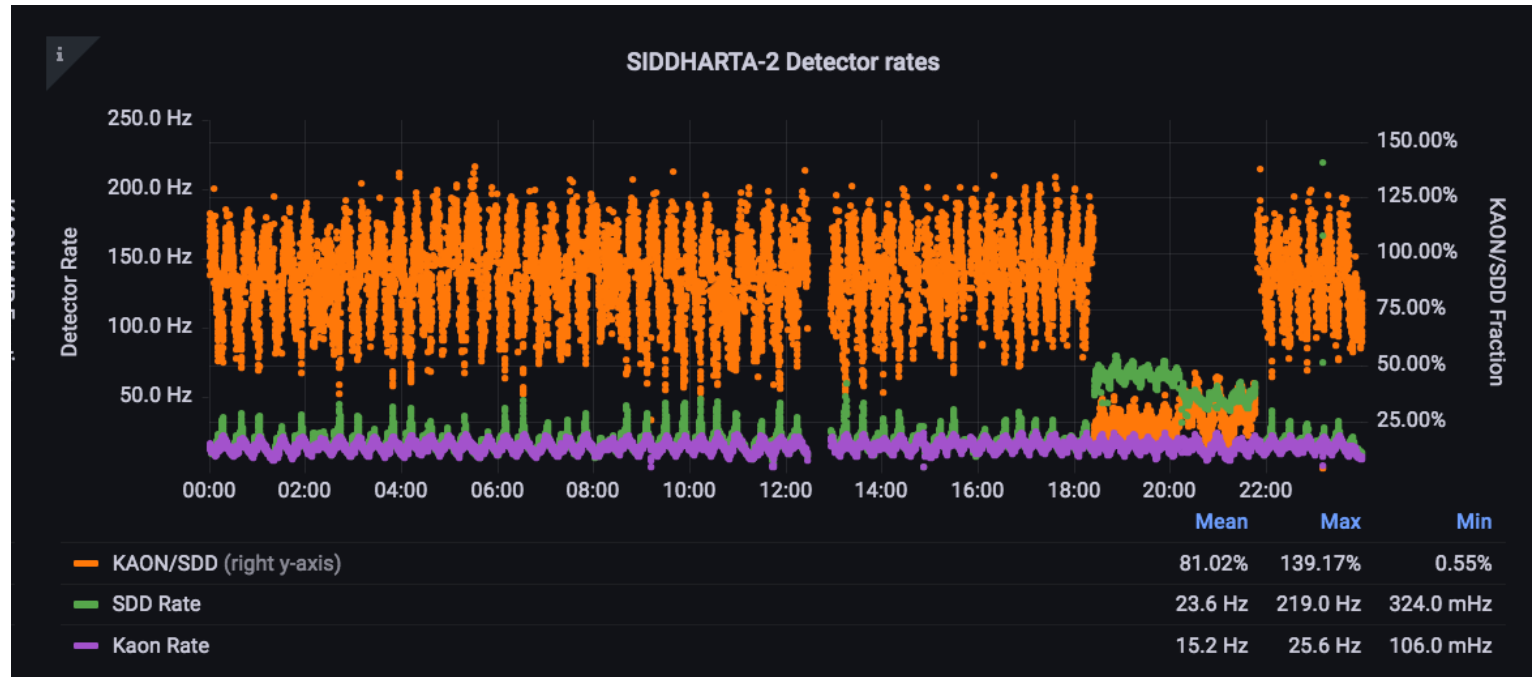
Best DAFNE Performances (Oct 24th)



$$L_{daily} = 8.3 \text{ pb}^{-1}$$



Best DAFNE Performances (Oct 24th)

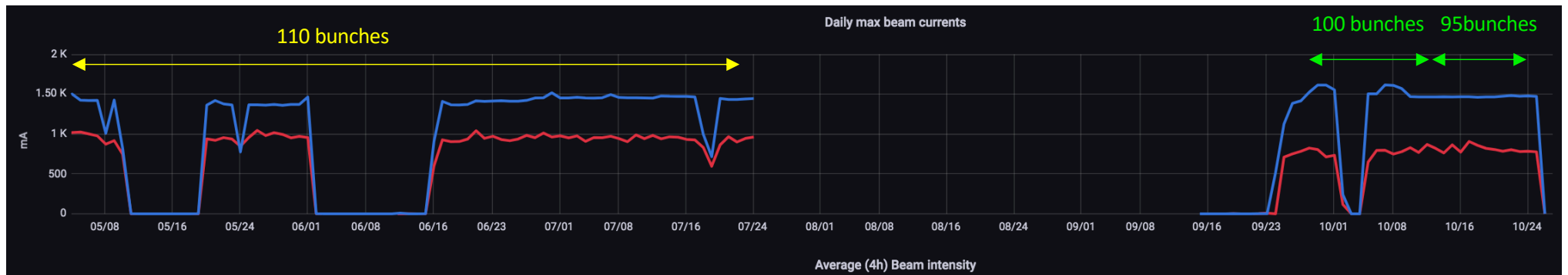


Stored Beam Currents

Maximum **stable** beam currents stored in collision are now significantly higher if compared with the ones achieved during the previous run in 2022.

$$I^+ \simeq 1.0 \text{ A}$$

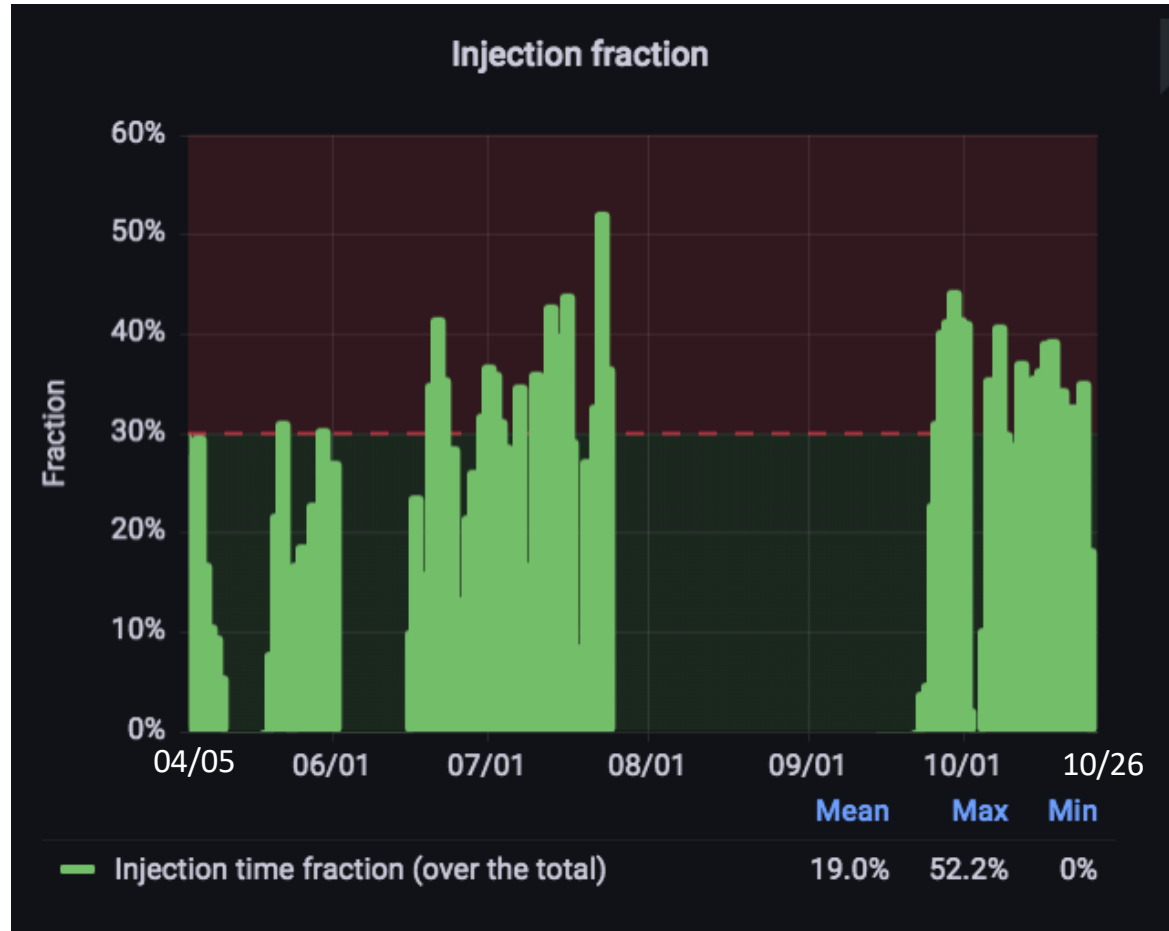
$$I^- \simeq 1.6 \text{ A}$$



Maximum bunch current stored filling 100 bunches was $\sim 16 \text{ mA}$

	min	max	avg
Positron	-0.712	1.05 K	628
Electron	0.193	1.62 K	997

Injection



LINAC working at 25 Hz

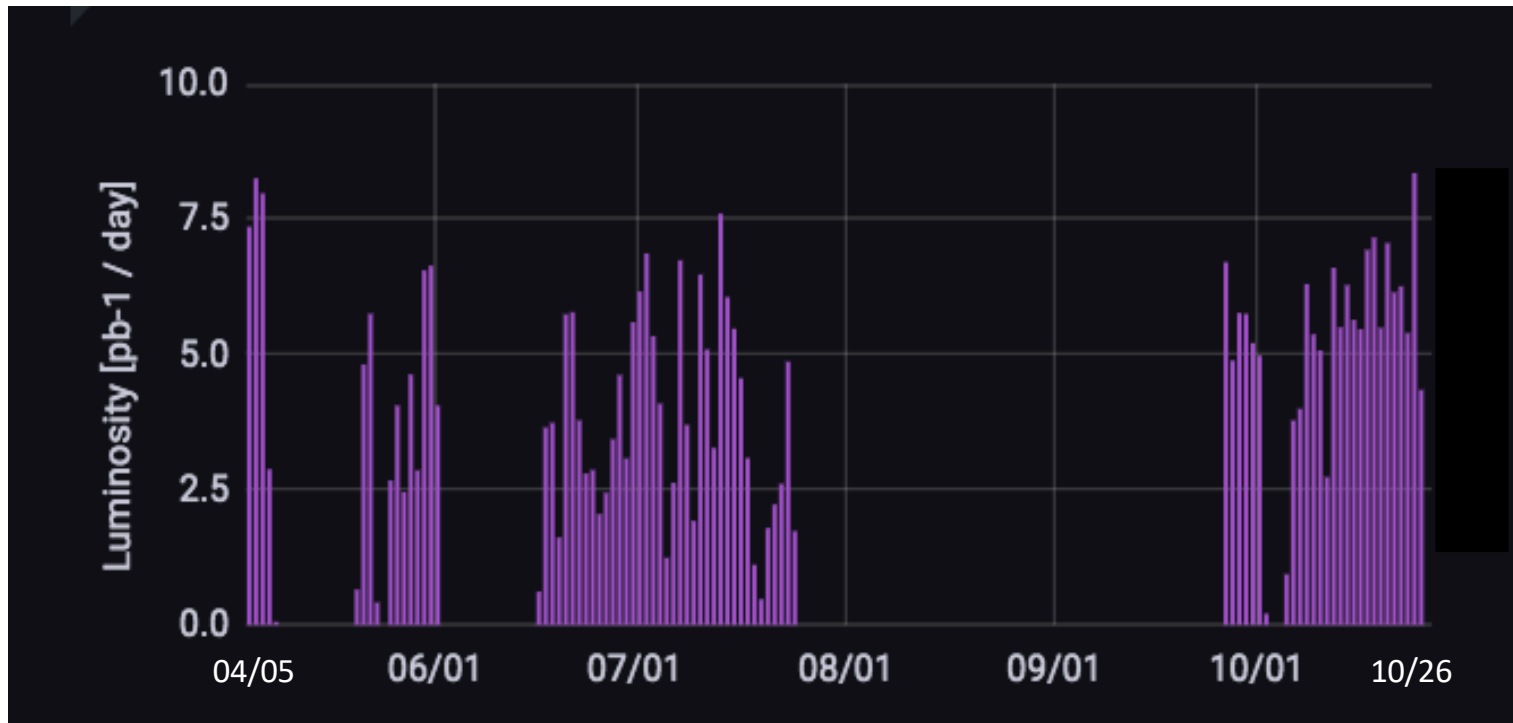
Injection in MRs:

2 Hz for e-

1 Hz for e+

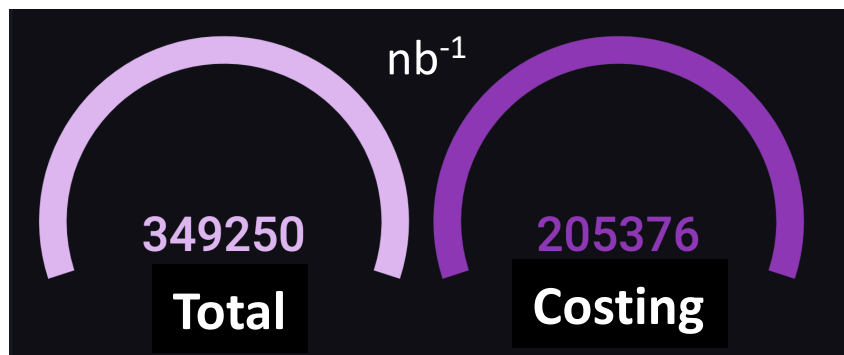
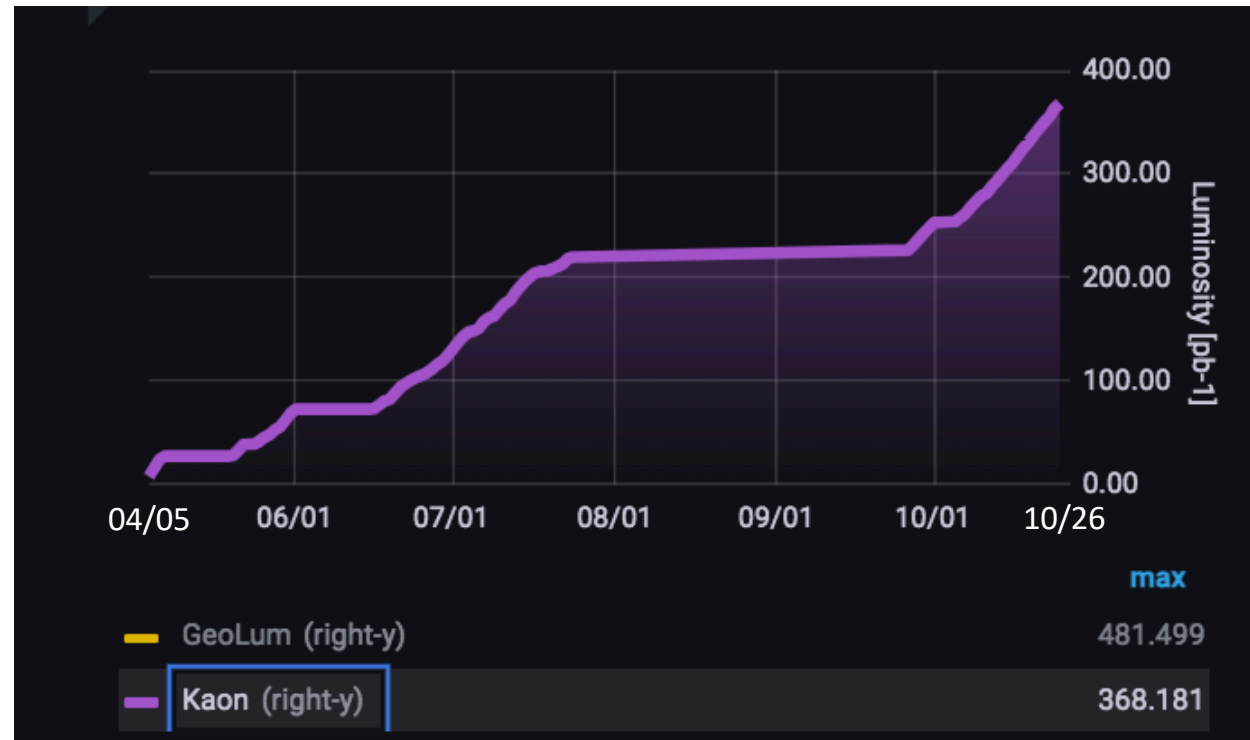


Daily integrated luminosity



Delivered Integrated luminosity

After Deuterium target installation



About 60% of the total delivered luminosity was given in costing.



Short Term Plan

Dec 21st h 6:00

End of the present SIDDHARTA-2 run

Jan 8th

LINAC warmup

Jan 11th 2024

LINAC operation shifts (2 operators)

Jan 18th 2024

DAΦNE progressively on and in operation, shift with 4 operators.

A general maintenance program has been planned before restarting operation in 2024.

The idea is to stop the run by the end of June in order to avoid unaffordable weather conditions.



Update about Operation Group

The **LNFAccelerator Operation Group** provides support systematically to the experimental activities on:

DAΦNE collider,
BTF (2 lines),
TEX,
SPARCLab.

In the last 3 years the **Accelerator Operation Group** lost several highly experienced Technicians.

Shifts relies on 7 crews of 4 technicians each

In the last two months 4 operators were missing

Since November 2 members got back

Unfortunately and by end of the year one more colleague will retire.

According recent contacts 2 technicians from RD might join Operation Group.



Conclusions

The SIDDHARTA-2 run is well established.

Ion trapping effects on the electron beam have been kept under control while being identifying their origin.

Optimal performances in terms of luminosity and signal to noise ratio have been recovered.

A data sample in excess of 350 pb^{-1} has been delivered to the SIDDHARTA-2 experiment.

A short term plan has been proposed to continue the work.



Acknowledgments

Many thanks to the **Staff of the Accelerator and Technical Divisions**. Their commitment allowed to achieve the present DAΦNE performances.

Special thanks to the **Operators** for taking care of the collider and BTF runs 24h a day.

Warm acknowledgment to the SIDDHARTA Team for their fruitful cooperation.

Thanks to **Colleagues of the Scientific Research Division** for the support provided so far and for the one that might give in the future.

Thank you