Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Frascati

DAΦNE run for SIDDHARTINO

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on behalf of the DAΦNE Team

62nd Scientific Committee Meeting November 8th, 2021

DAΦNE Team

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Outline

- *Machine Operation*
- *SIDDHARTINO run*
- *Consolidation and upgrade activities*
- *Plans*

Operations Overview

DAΦNE operations for SIDDHARTINO restarted on February 4th

Collisions provided by the end of April

Previous SciCom on May 6th

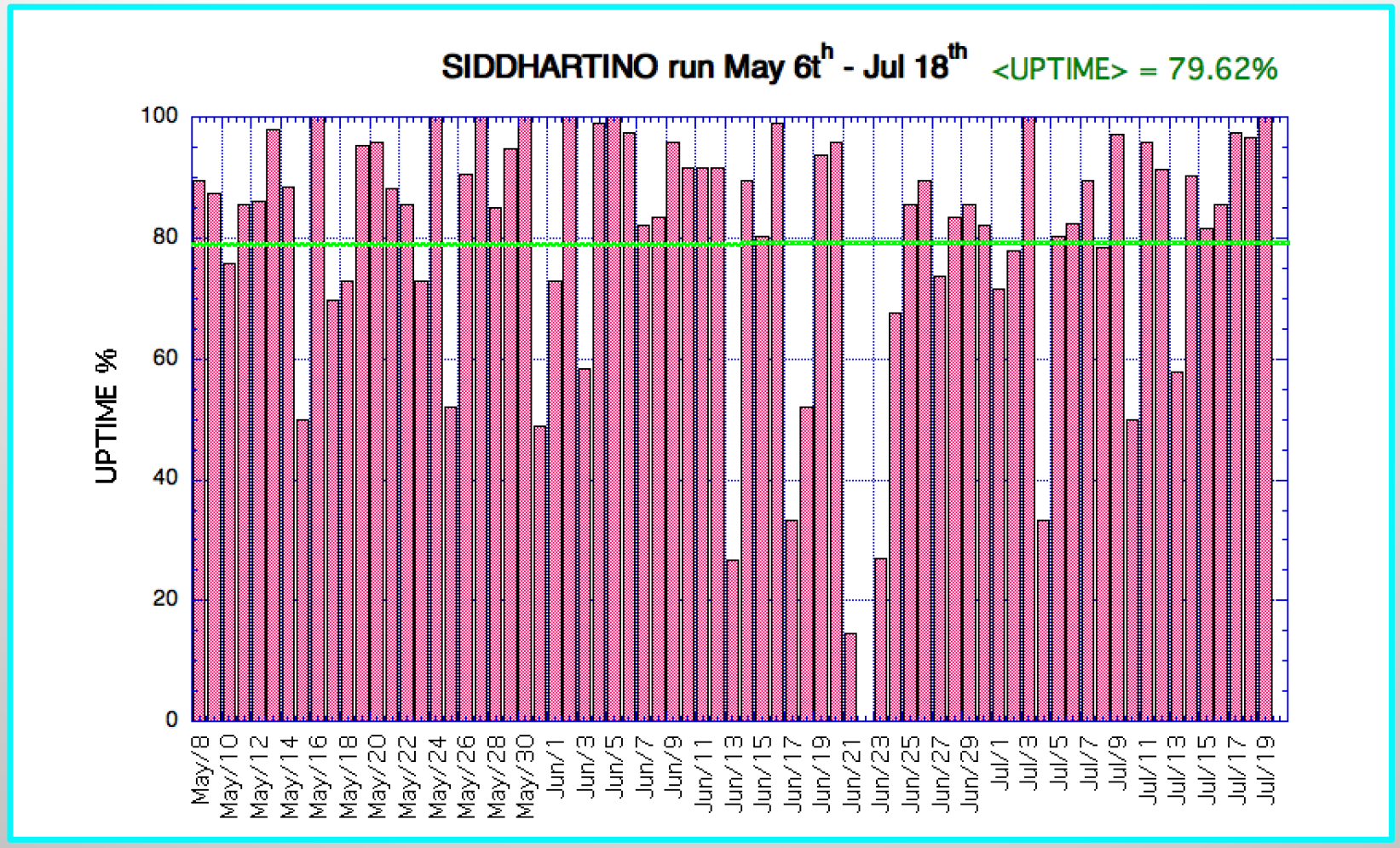
DAΦNE shutdown on July 18th
DAΦNE LINAC operated one more week for BTF

DAΦNE operations were planned to resume on October 18th the long shutdown was motivated by the man power requirements due to

- *TEX facility installation,*
- *SPARC upgrade,*

and by urgent maintenance works on the LINAC building.

DAΦNE Uptime



Uptime is defined as the daily time percentage the collider has been storing both beams.

Major Source of Failure during Past Run

Water leakage from hoses of the wiggler magnet cooling system and wiggler coil damage

LINAC

Cooling system (affect LINAC, magnet, power supply and diagnostics performances)

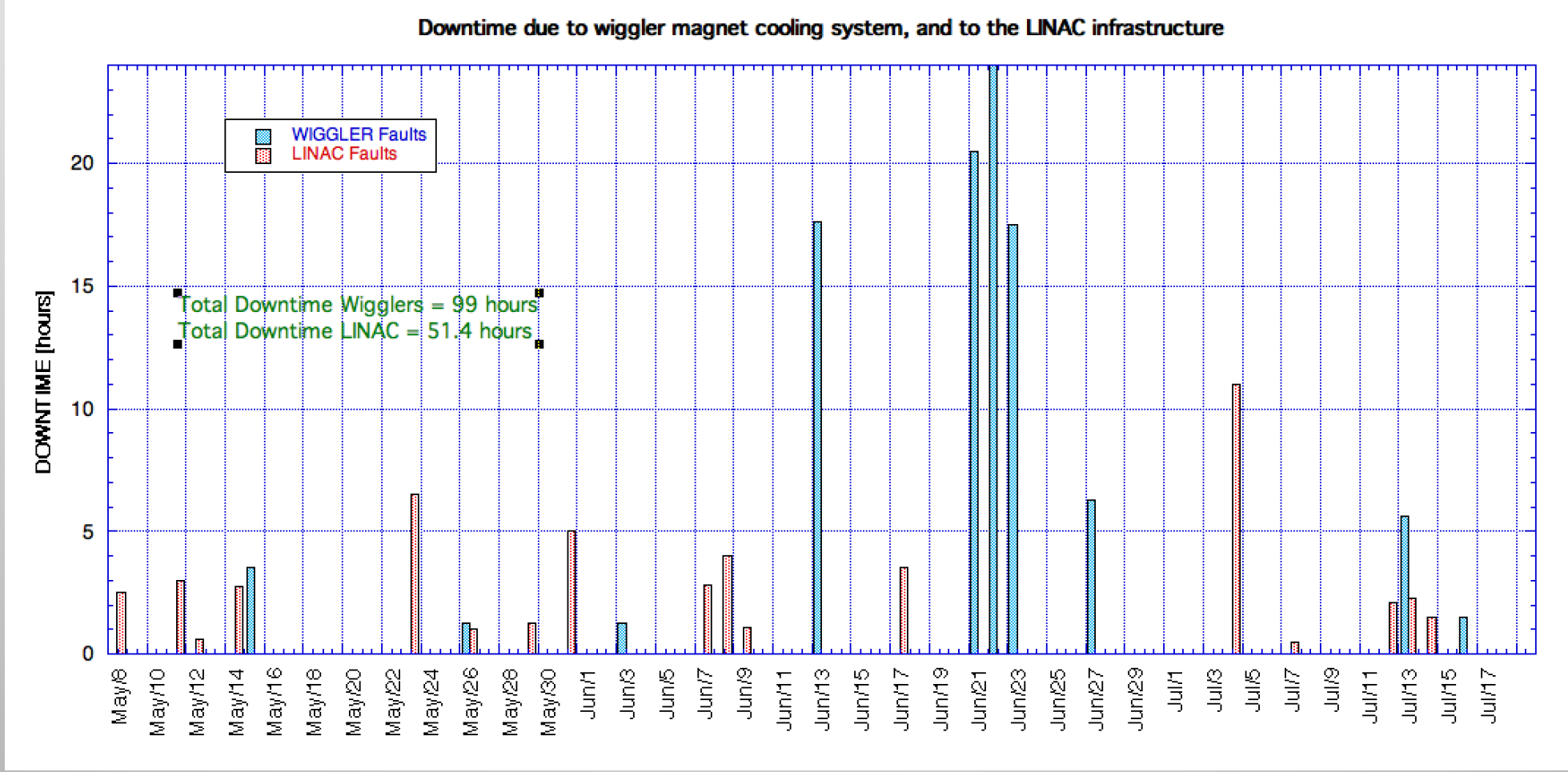
Magnet Power supply

Several severe voltage dip affected DAFNE operations during the last two months

Vacuum vent in the electron ring

A detailed maintenance plan has been prepared, it has been implemented during the summer shutdown
For the SIDDHARTA run will be necessary to operate the LINAC at 50 Hz and inject in the main rings at 2 Hz

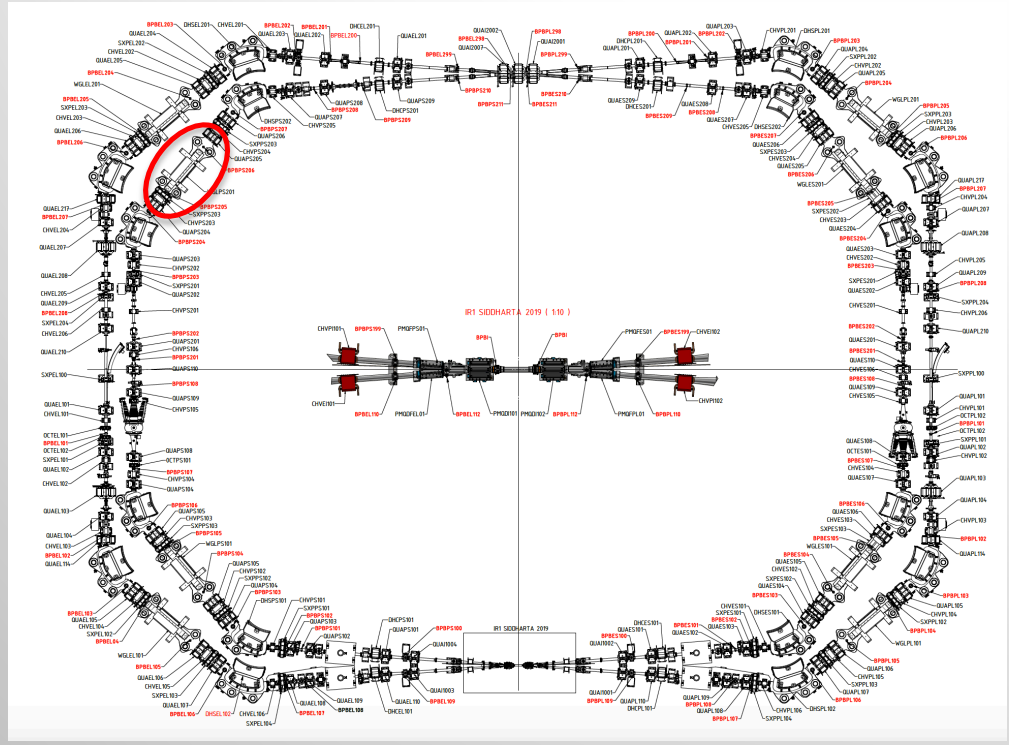
Downtime due to Wiggler and LINAC Faults



LINAC has been operating at 25 Hz

WIGGLER Coil Fault

June 21st 2021



Hole in a WGLES101 upper coil
Wiggler opened
Coil disassembled soldered and reinstalled in house in one and half day work

Ring Optics

Latest working point adopted during the SIDDHARTINO data taking and corresponding to the best signal to noise ratio measured so far is:

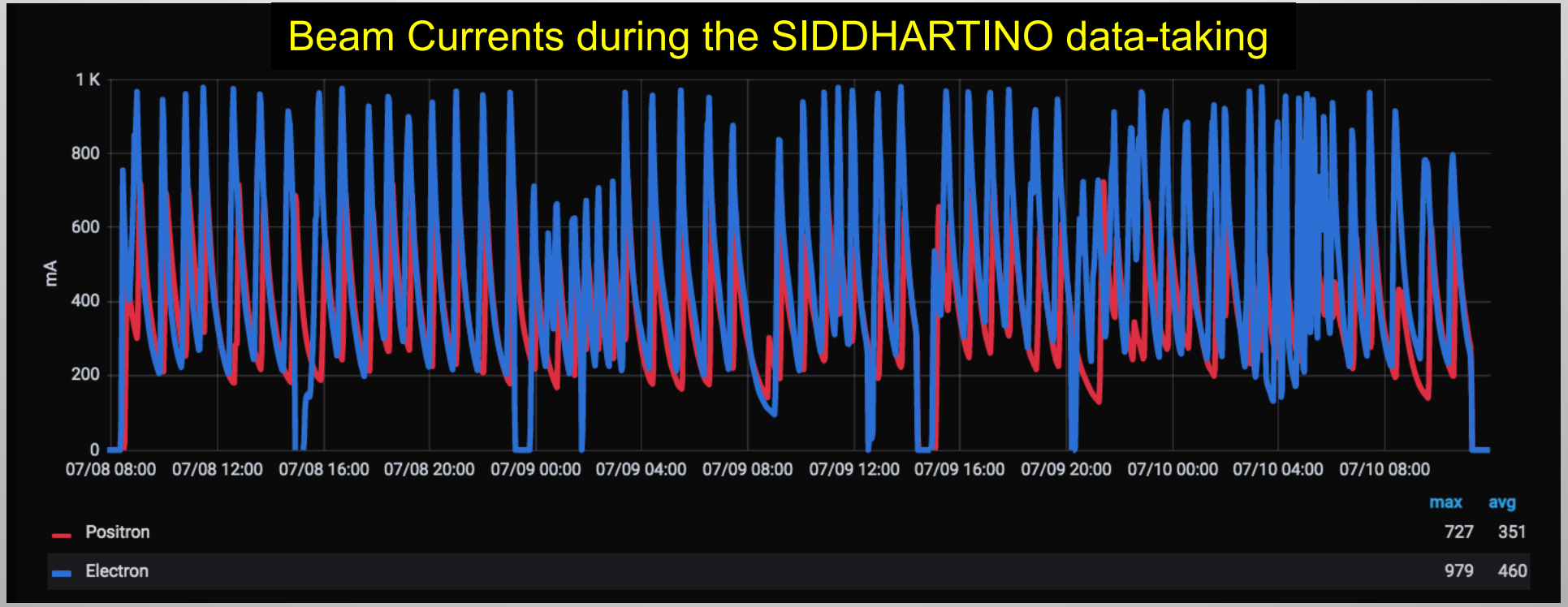
$Q_x^- = 0.1082$ $Q_y^- = 0.1533$
$Q_x^+ = 0.0972$ $Q_y^+ = 0.1648$

Crab-Waist Sextupoles are not yet set to the nominal value.

Their strengths are a factor 2.45 and 1.54 lower for the electron and positron beam respectively.

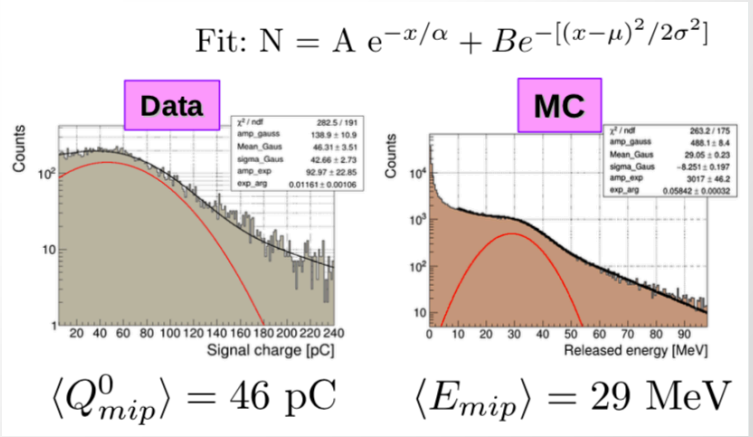
Beam Currents

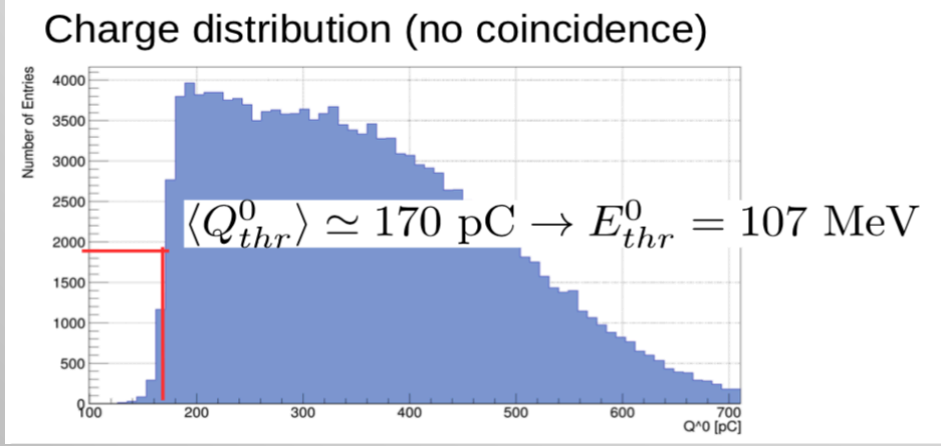
Maximum stable currents stored in collision have been **1 A for the electron** and **800 mA for positron one**.
Limitations are mainly due to feedback system setup and configuration still not optimal, although clearly improved along time.
This requires dedicated machine studies during next run.
Another limitation comes from the LINAC operation at a 25 Hz repetition rate, a conservative choice to prevent possible hardware failures.

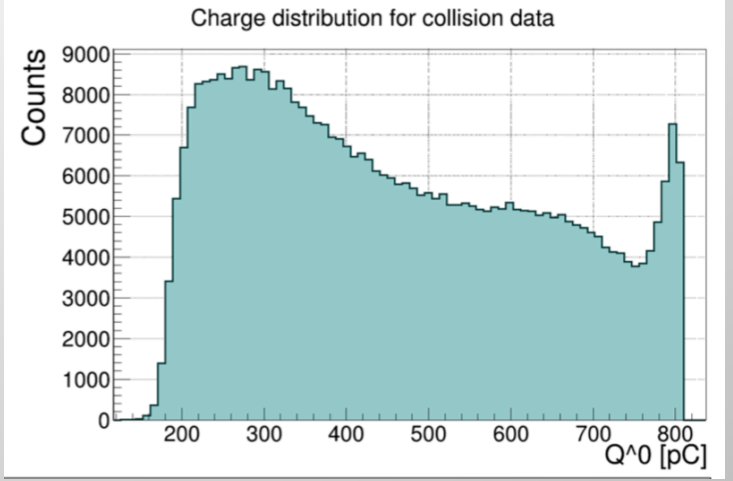


CCAL Energy Calibration

Accuracy in the luminosity measurements is strongly affected by the detector energy calibration.
CCAL calibration with cosmic rays was possible only for a limited number of sector.
Detector assembly has been rearranged in order to have at least a couple of sector pairs calibrated.
Energy threshold induced by discriminators used to fire the trigger have been evaluated and included in the MC simulation.
The corresponding **effective Bhabha cross section** have been used to scale signal rate from collisions.







The *SiPM voltage* has been set as high as possible to clearly observe the MIP values. A saturation of the charge spectrum for collision data has been observed.
The highest part of the spectrum is dominated by Bhabha events.
The SiPM voltage and the voltage threshold have been revised during the run (May-July) in order to eliminate this effect retaining the signal as much as possible. Further study are ongoing to use the derived charge spectrum to calibrate the energy scale.

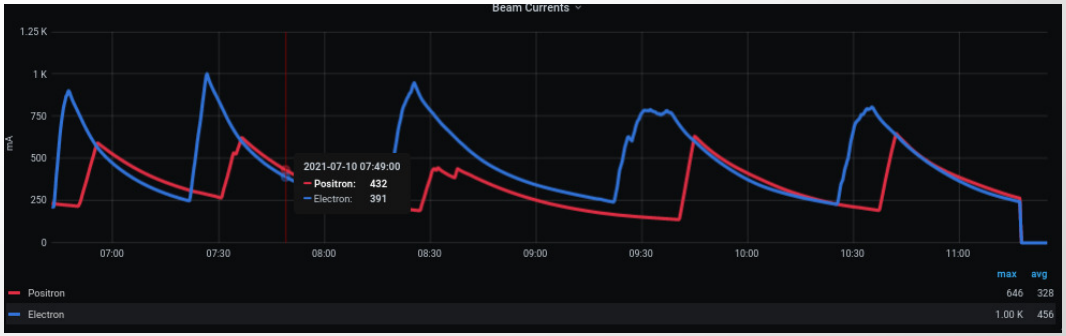
Luminosity

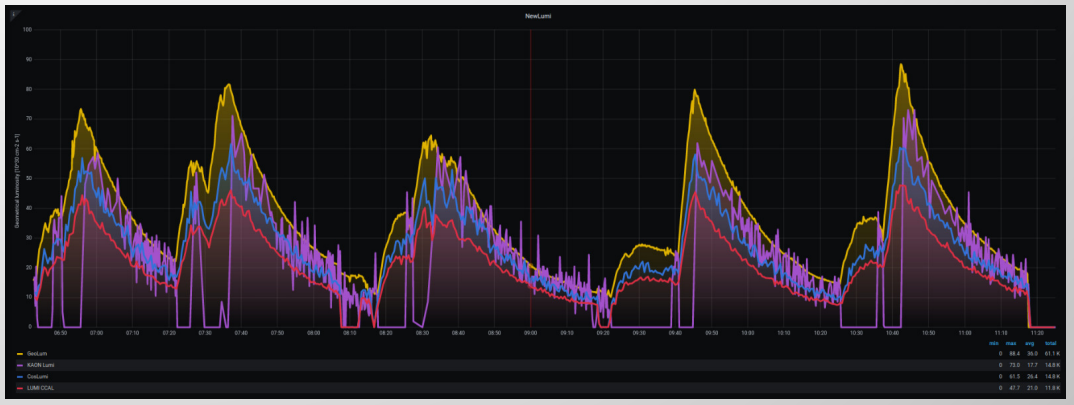
Peak instantaneous luminosity, L_{peak}, observed so far is about

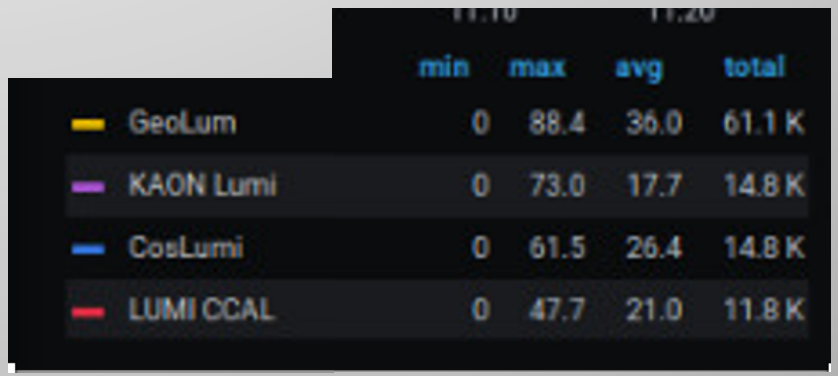
$$L_{peak} = 0.88\ 10^{32}\ cm^{-2}\ s^{-1}$$

This value is confirmed, with good agreement, by two independent measurements, one based on Bhabha scattering the other on Kaon trigger rate.

However, L_{peak} is about a 30% less than the estimated geometrical luminosity, and about a factor of 2 lower than the one measured in 2008-9, with similar currents in collision, but after one year of machine studies and optimization.







Luminosity

Observed limiting factors:

slow injection and low injection efficiency,
limit in the maximum achievable current mainly for the electron beam,

non optimal coupling correction for the positron beam,
growth of the positron beam transverse dimensions with current,

beam orbit dependence on beam currents

All these aspects have been detected, but dedicated studies have been postponed in order to complete the SIDDHARTINO test run.

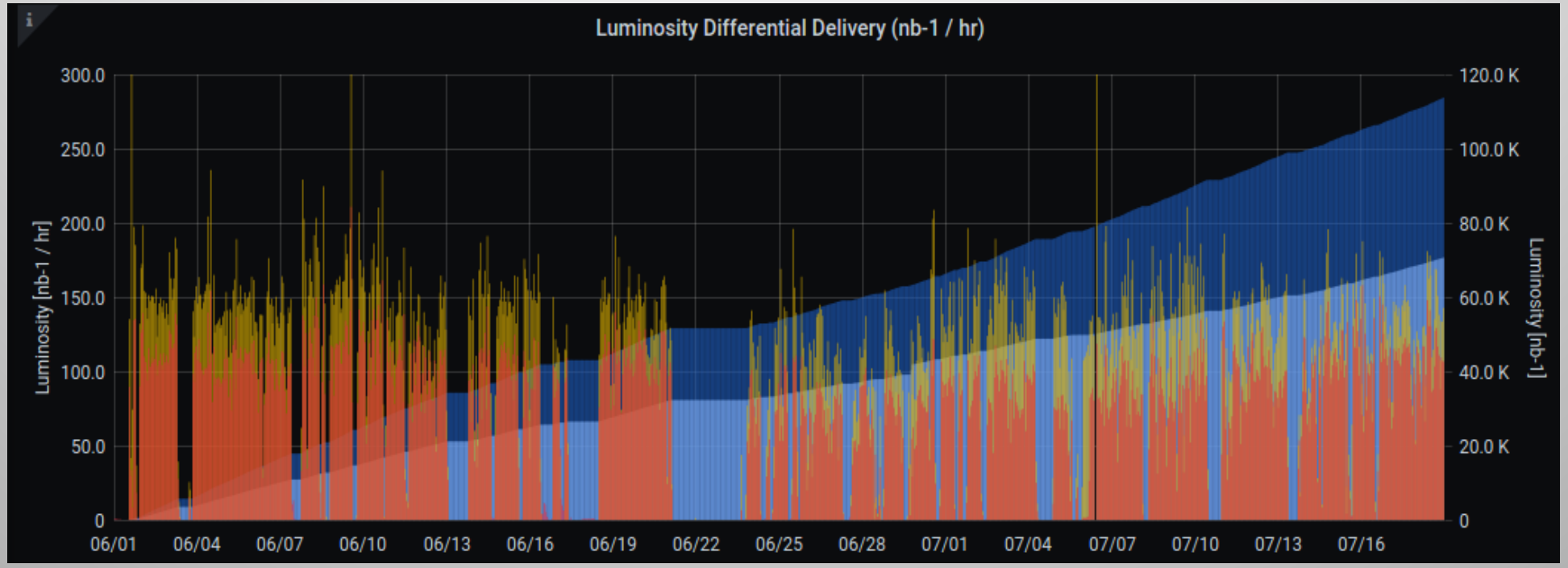
Integrated Luminosity

Differential Luminosity (1 hour)
- Geometrical
- CCAL (Ecalib)

Integrated Luminosity
- Geometrical
- CCAL (Ecalib)

Total Integrated Luminosity measured by CCAL is about 71 pb^{-1} .

Differential Luminosity, evaluated in 1 hour, rarely exceeds 150 nb^{-1}



Background Optimization

Background has been studied and reduced using an experimental approach

Initially

- setting *collimators* relying on the DAΦNE **γ-monitor;**
- optimizing the main ring *working point* in terms of betatron tunes;
- increasing progressively the *strength of the Crab-Waist Sestupole;*
- refining collimator insertion looking at the background signal (counting rate out of coincidence) returned by the DAFNE **luminosity monitor CCAL**, which has proved to be very sensitive and fast in detecting background variations.

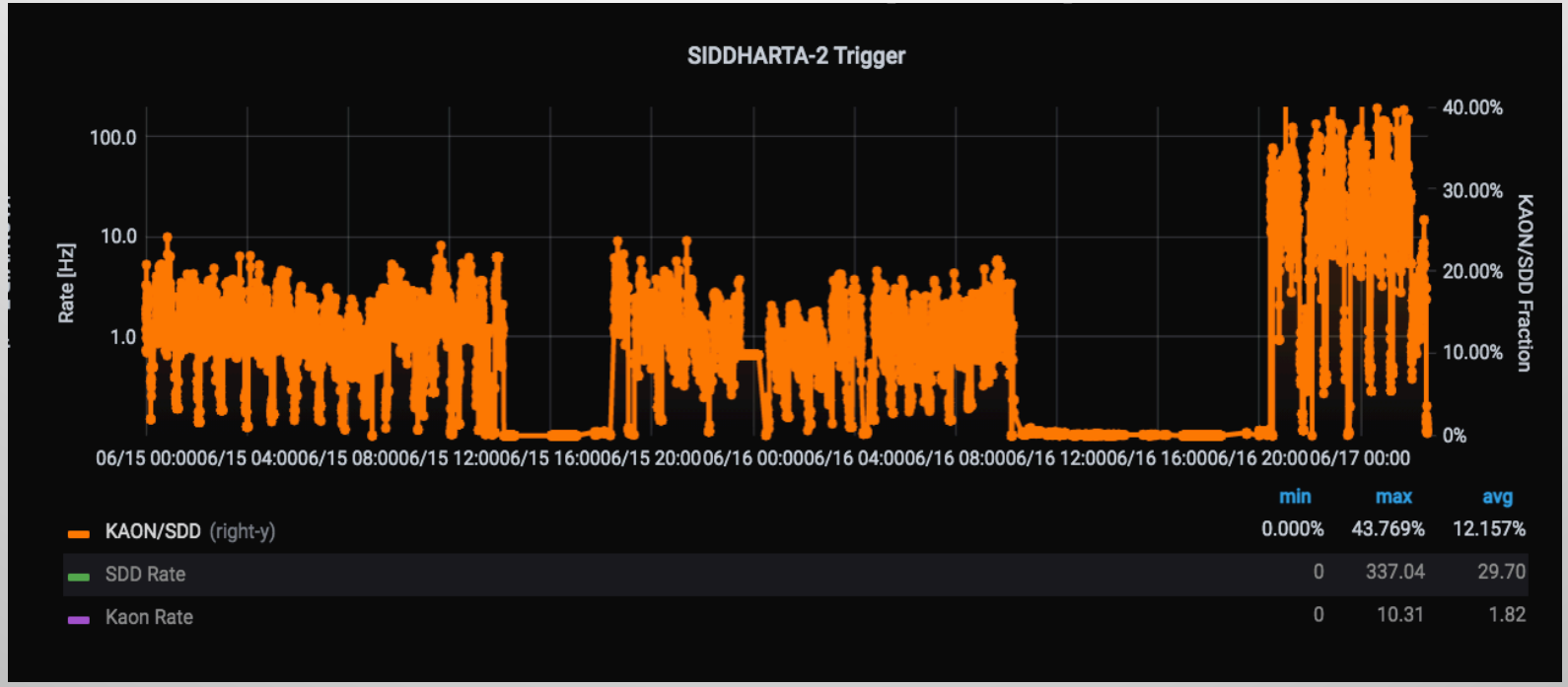
Since **Jun** background optimization process could also rely on:

- **Kaon/MIP** counting rate provided by the SIDDHARTA luminosity monitor;
- **Kaon/SDD** rate coming from the SIDDHARTA trigger monitor.

These measurements gave a relevant boost to the signal to noise optimization process leading to improve the **detector shielding.**

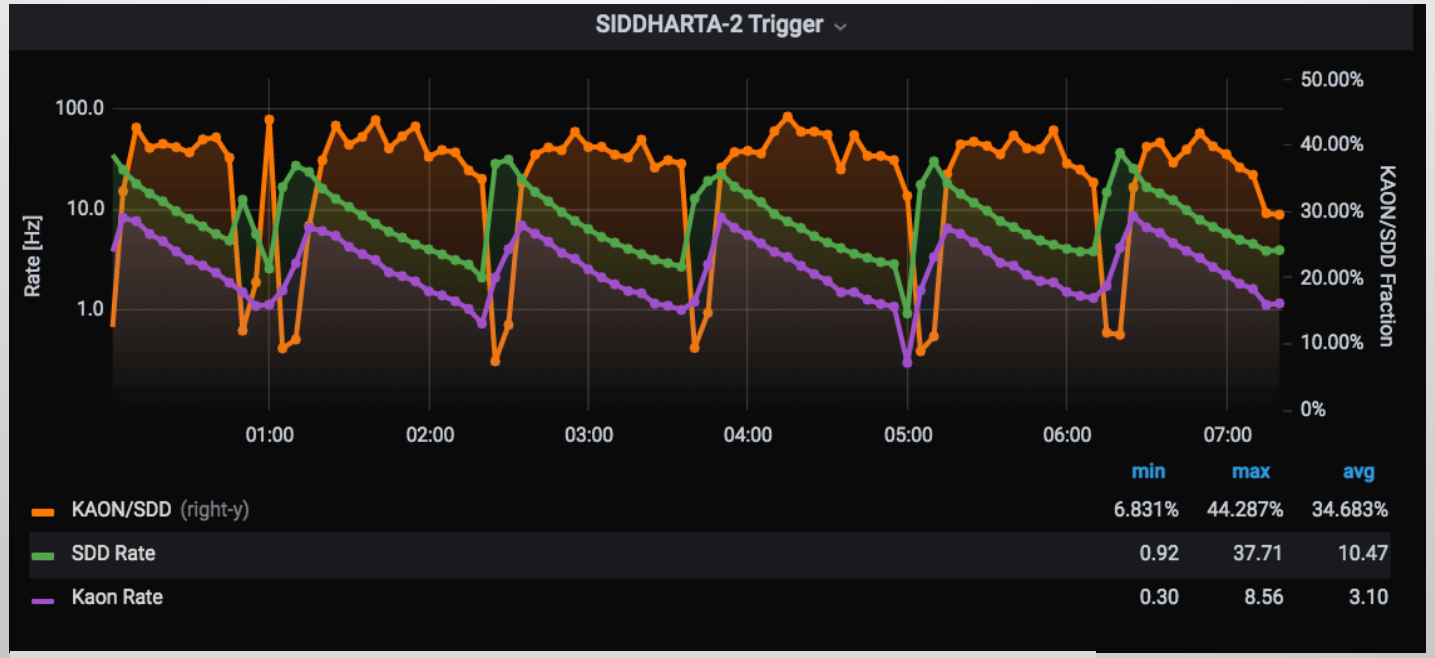
New Detector Shielding

A relevant improvement in terms of signal to noise ratio has been achieved by mid June adding new shielding components around the detector.



Background Optimization

SIDDHARTA measurements have been included in the dashboard summarizing the DAΦNE luminosity measurements and have been routinely used for tuning collisions.



average value of Kaon/SDD average ~ 34.68%

Background has been lowered by a factor of 2 ÷ 2.5 since the beginning of the run

Background Optimization

The central aperture on the lead wall installed in front of the DAFNE γ-monitor has been reduced to the minimum size compatible with the IR beam pipe dimension.

This was intended to protect the detector from beam shower produced by the incoming beams.

The new shield configuration produced only modest improvements in terms of Kaon/SDD ratio measured by SIDDHARTA, but allowed to increase by a 20% the ratio between the signal measured on the γ-monitor for beams in and out of collision.

A relevant achievement since the γ-monitor is routinely used for real time luminosity tuning.

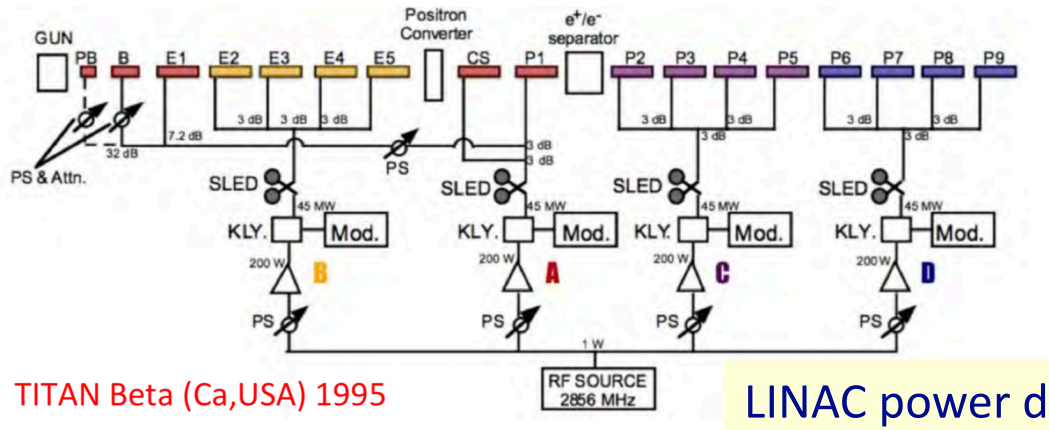
DAΦNE Subsystem Consolidation and Upgrade

WIGGLER Cooling System

The cooling system of the DAFNE WIGGLER magnets has been revamped.

The **1184 hoses** installed on the 8 WIGGLERS have been replaced.

LINAC



TITAN Beta (Ca,USA) 1995

LINAC power distribution

LINAC Building consolidation

Main LINAC: Mod C HVPS installation, scheduled maintenance, PFN tune up, Thyratron box A,B,C,D.

LINAC UFS upgrade: new power supply installation and test (collaboration with magnet experts)

LINAC diagnostic maintenance: slits and flags (collaboration with magnet experts)

LINAC power up: checks, Beam on 700MeV electron, 507 Positron @50 Hz.

DAFNE Transfer Line power up: partial for LINAC and BTF.

LINAC Vacuum & Cooling: vacuum pipe and bellows replaced in the positron converter, QUADs fluid circuit, primary pumps (unscheduled)

LINAC and BTFEH1&2 safety checks

Control System

Installation on Virtual Machine and setup of the development environment for a cRIO front-end crate for the ***new Orbit acquisition system***.
The complete system will employ 4 front-end crates and the software will be developed by 20/06/2022.

To improve the Control System uptime, a completely automatized procedure has been developed to performs – in case of fault – **a fast restart of the legacy VME-based part of the system**.

A **fully operational console in OS Linux is now running in the BTF** Control Room

To speed up fault identification, an advanced prototype of a service procedure that scan devices for problems (**Hunter Dog**) has been developed and is going to be tested in the upcoming DAFNE run.

Vacuum

Damping Ring

- **Injection Kicker**: Design and Installation of a new adapter for Electrical Feedthrought (in collaboration with «Serv. Elettronica» DA)
- **Vacuum Gauges**: Cabling installation to allow the repositioning of the guages controller outside the Accumulator area (in collaboration with «Serv. Impianti Elettrici DT»)

LINAC

- **Valves**: few damaged Electro-valves Replacement (in collaboration with «serv. LINAC»)
- **Diagnostic Chambers**: few damaged Electrovalves Replacement
- **Ion Pumps**: Repositioning of the ion pumps controllers controllers outside the beam area (in collaboration with «Serv. Impianti Elettrici» DT and «Serv. Elettronica» DA)
- **Vacuum Leak on the positron Converter area:** Replacement of the vacuum chamber close to the Positron Converter (unscheduled).

DAΦNE

- **e^- RF Cavity vacuum leak**: Leak test and sealing
- **Valves:** New PLC installation for Valve Control (in collaboration with «Serv. Impianti Elettrici» DT)
- **EL2 Arc:** Leak test and sealing on scrapers chamber SCHEL201_INT (unscheduled).

Magnet Power Supplies

All Power Supplies which had faulty behaviour during the run have been maintained.
New spare parts (control panel, IGBT, DCCT) have been acquired especially for DanFysic PS family which are running out of production.
Ground fault affecting the electron ring wiggler family has been identified and fixed

Main Ring RF plants

Klystron filament Power Supply of the positron ring RF cavity has been repaired (unscheduled)

DAFNE Operation Plan

DAΦNE was expected to restart by mid October.

Some fault and several external circumstances forced to change the schedule:

- two general electric network shutdown (Spt. 25 - 26, Oct. 10)
- Water supply interruption (Oct. 15 – 18).

Operation will be resumed after periodical Radioprotection check-up which is scheduled on November 9 – 11.

DAΦNE Activity Plan

- Transfer Lines studies in order to improve Injection efficiency;
- LINAC optimization at 50 HZ;
- Closed orbit refinement an CHV strength minimization in MRs;
- Twiss function measurements in MRs in order to check the optics setup and to further improve the agreement between model and measurements;
- Beam spectra measurements at some BPMs;
- Bunch length, tune measurements, and vertical beam size as a function of bunch current for different RF voltage and for different chromaticity;
- Feedback system measurements and optimization

Man Power

Scientific Staff

Man power working on the DAFNE collider remains a main **unsolved issue,** main accelerator topics such as optics and beam dynamics do not have adequate manpower.

- Selection to hire an accelerator physicist has not yet been completed
- Studies on background simulation and optimization are still pending;
- Feedback activities would benefit from additional expert support.

Technical Staff

- One technicians working in the operation group retired.
- Two more operators will retire in the next 3 months.
- 5 new hired young technicians might be involved in operations, but they need training.

Presently Operation Group provides support to DAΦNE, BTF1, BTF2, SPARC and TEX.

Conclusions

SIDDHARTINO test run has been successfully completed.

The experiment has acquired 54 pb^{-1} of data from June 1^{st} to July 18^{th}.

Since the beginning of the SIDDHARTINO run Background has been further reduced by a factor of 2 ÷ 2.5.

DAΦNE Luminosity monitor provides increasingly reliable measurements, and enhanced diagnostics tools.

Peak Luminosity measured so far is in about $0.8 \cdot 10^{32}$ $cm^{-2}s^{-1}$, at intermediate currents, several possible limiting factors have been identified and will be addressed in the next run.

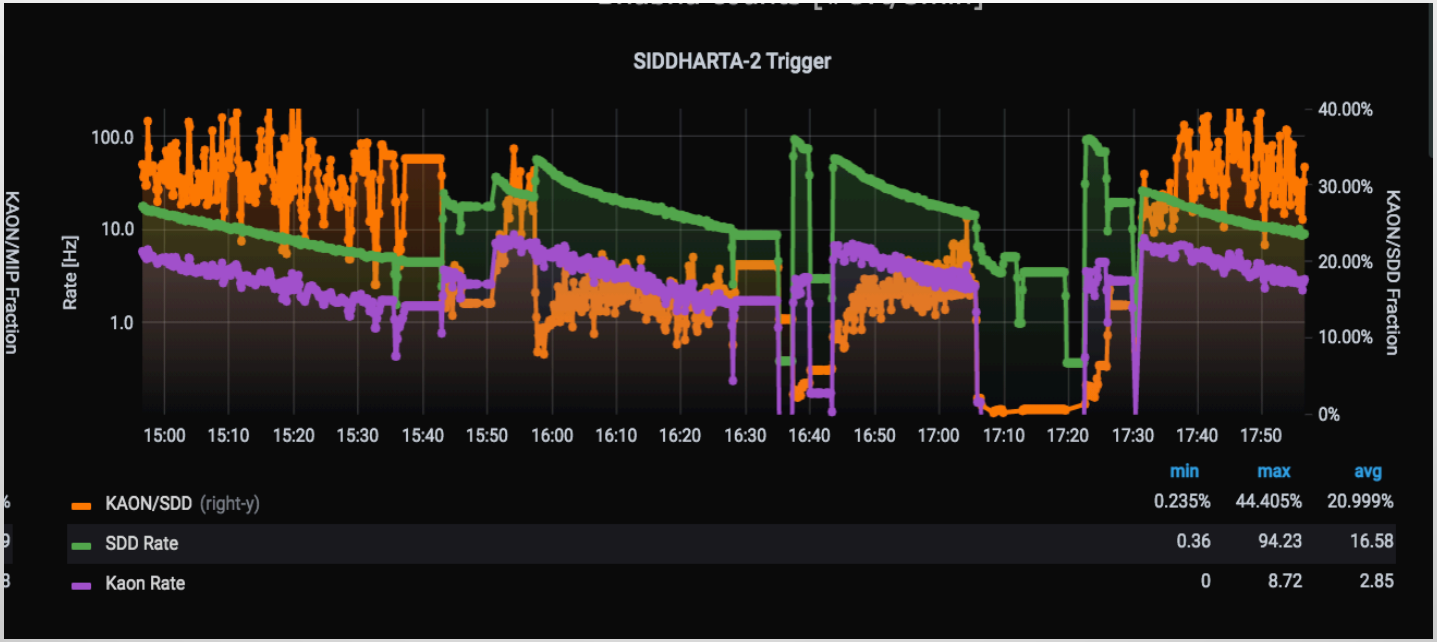
An extensive program of consolidation and upgrade has been completed during the summer shutdown.

Scientific Manpower remains an issue.

Thank you for your attention

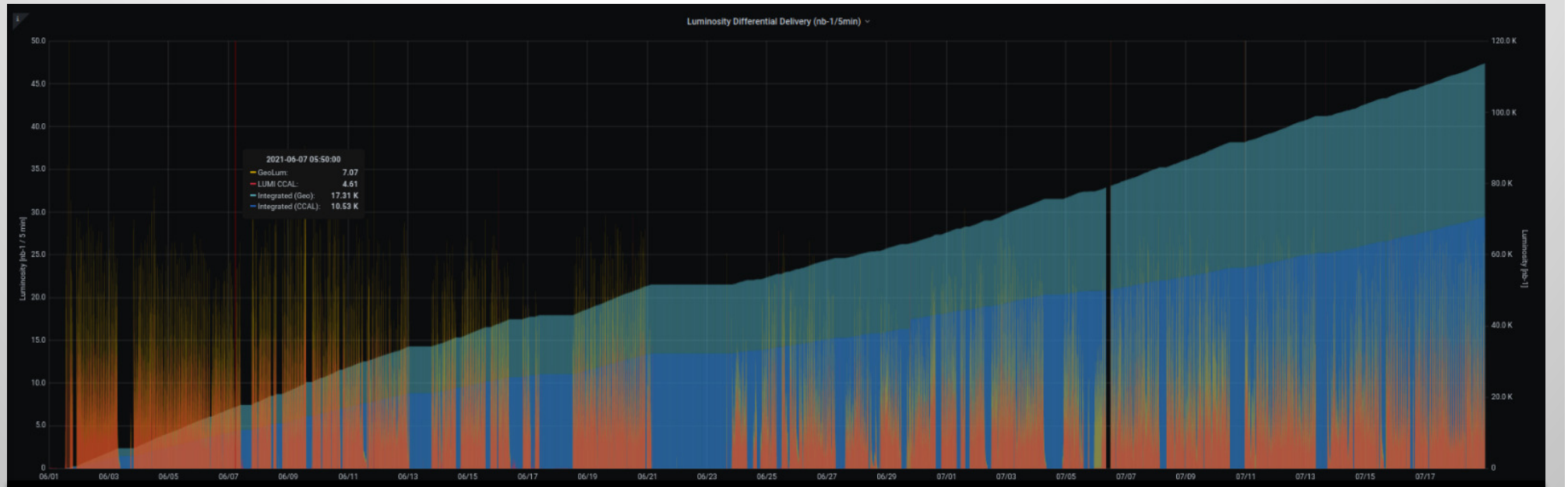
Backup slides

Background increase due to chromaticity mismatch in Mre
SXPEL103 off



Luminosity

Differential and integrated Luminosity during the SIDDHARTINO data taking



	min	max	avg	total
Integrated (Geo) (right-y)	0	113.72 K	56.30 K	775.70 Mil
Integrated (CCAL) (right-y)	0.01	70.64 K	35.04 K	481.51 Mil
GeoLum	0.00	440.13	11.05	114.41 K
LUMI CCAL	0.00	2.66 K	6.28	71.75 K