DAΦNE

Alessandro Drago
on behalf of the DAΦNE Team

54rd LNF Scientific Committee, Frascati, 13-14 November 2017

The DAΦNE Team

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(note: Run Coordinators are underlined)

DAΦNE Operation Team

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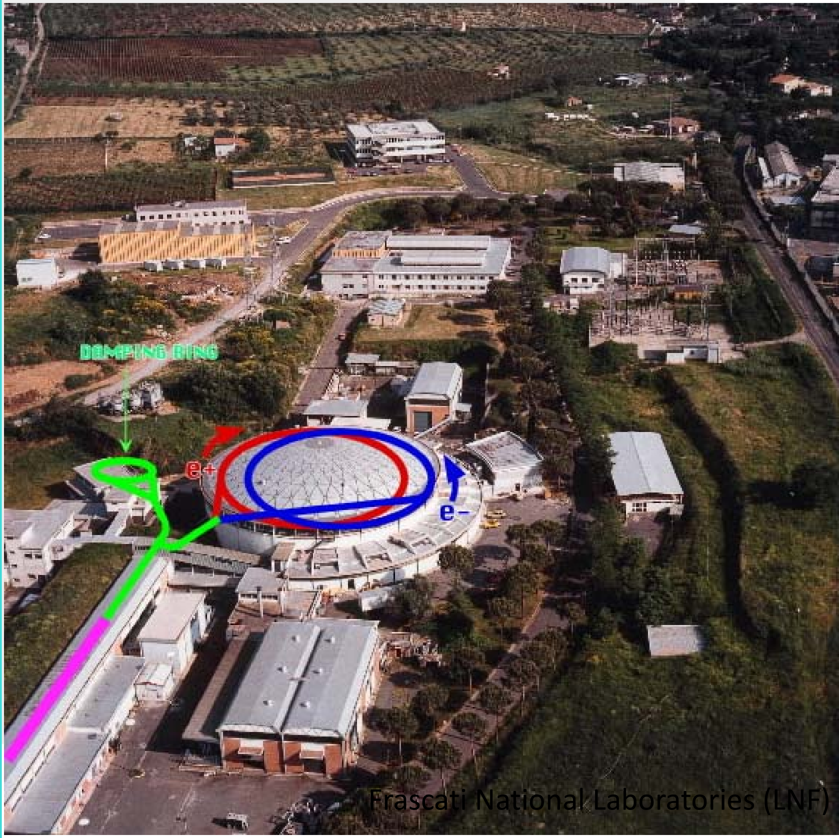
Outlines

- *DAΦNE overview*
- *KLOE-2 operations*
- *Beam current tests & achievements*
- *Maintenance and consolidation activities*
- *SIDDHARTA-2 studies and plans*
- *Conclusions*

The DAΦNE Accelerator Complex

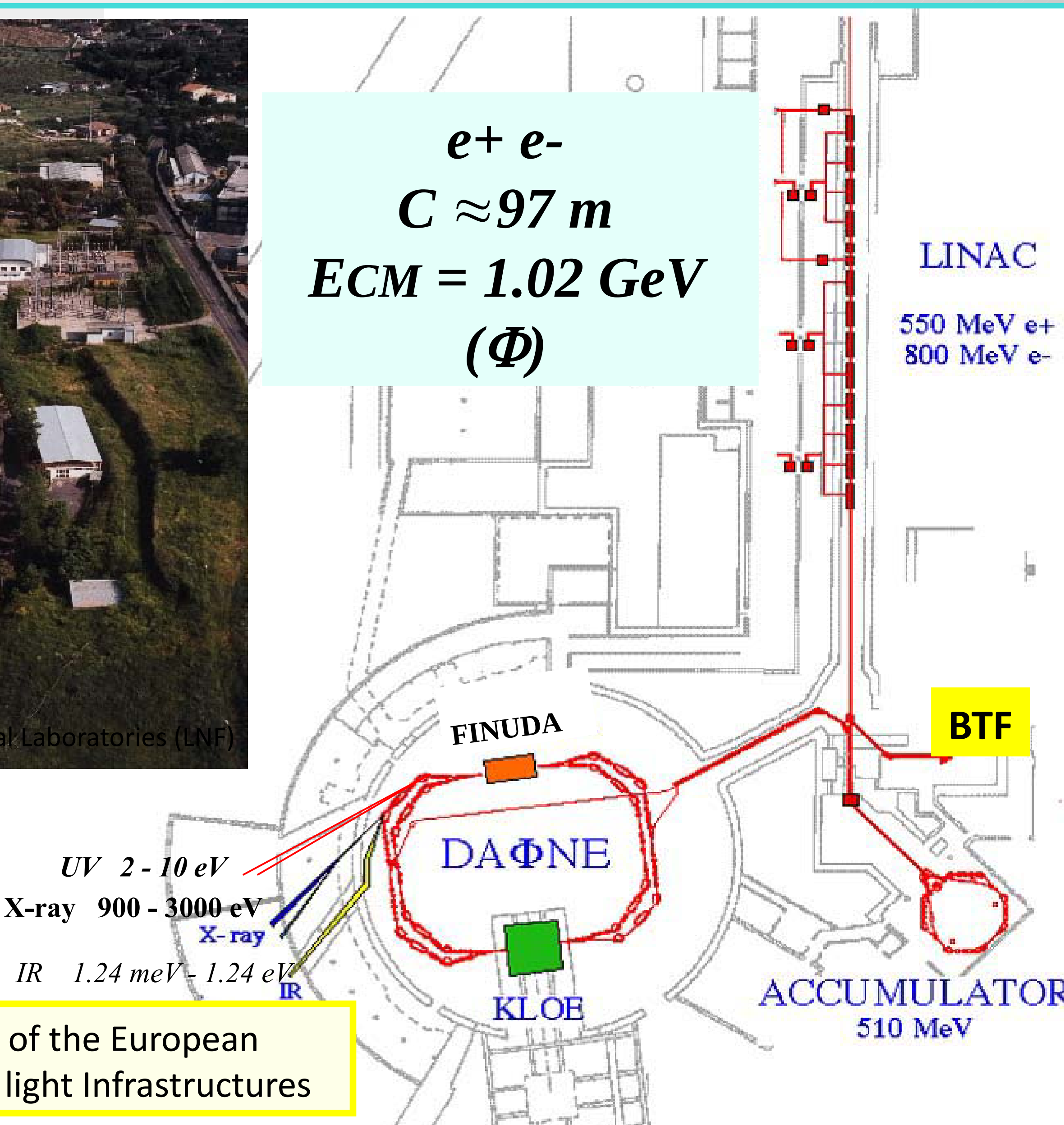


e+ e-

C ≈97 m

ECM = 1.02 GeV

(Φ)



LNF are part of the European synchrotron light Infrastructures

KLOE-2 Data Taking Program

I Run Nov 16th 2014 ÷ Jul 3rd 2015

achieved goal $\int L_{del}$ **> 1 fb-1**

II Run Spt 28th 2015 ÷ Jun 29th 2016

achieved goal $\int L_{del}$ **> 1.5 fb-1**

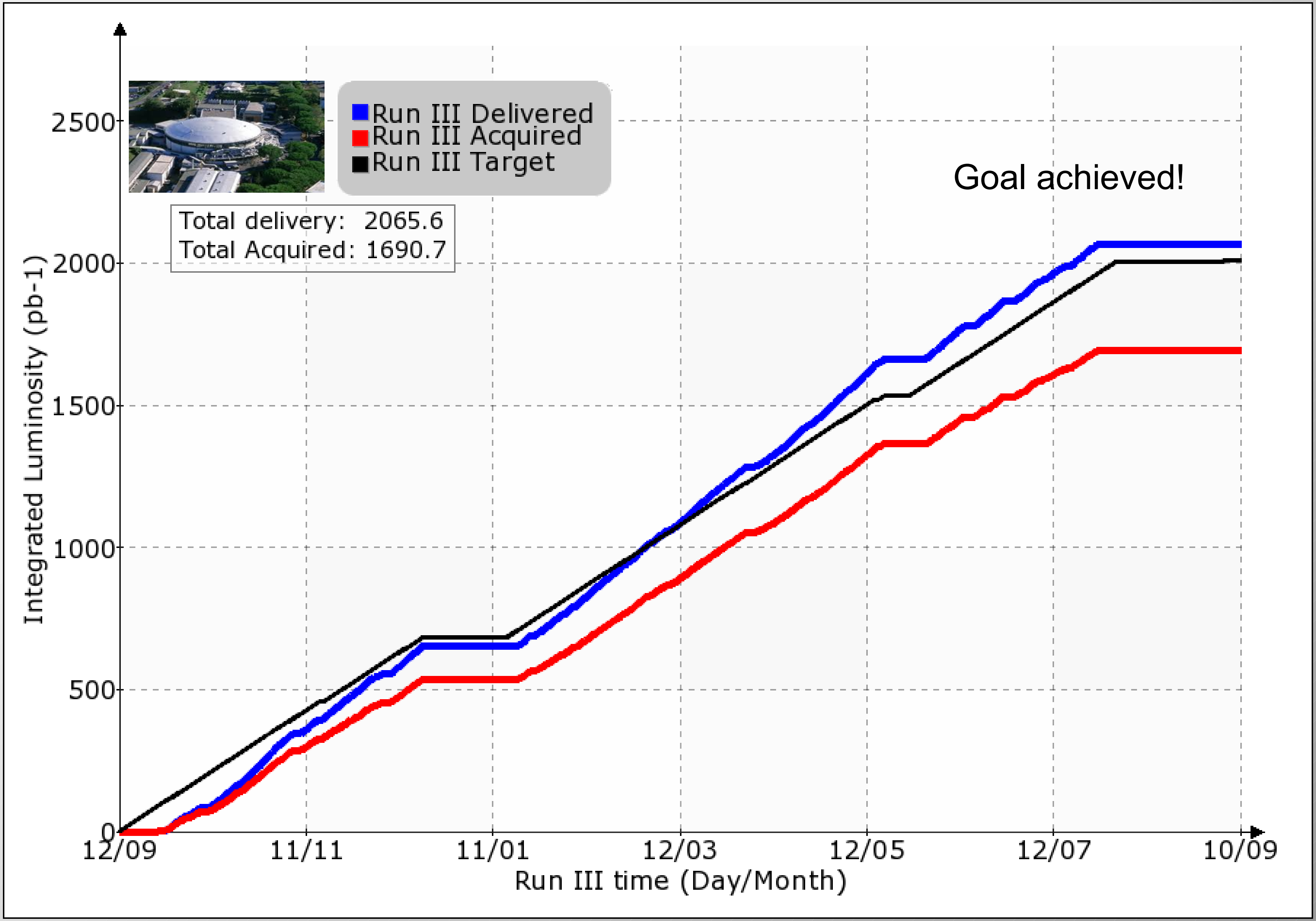
III Run Spt 12nd 2016 ÷ Aug 1st 2017

achieved goal $\int L_{del}$ **> 2 fb-1**

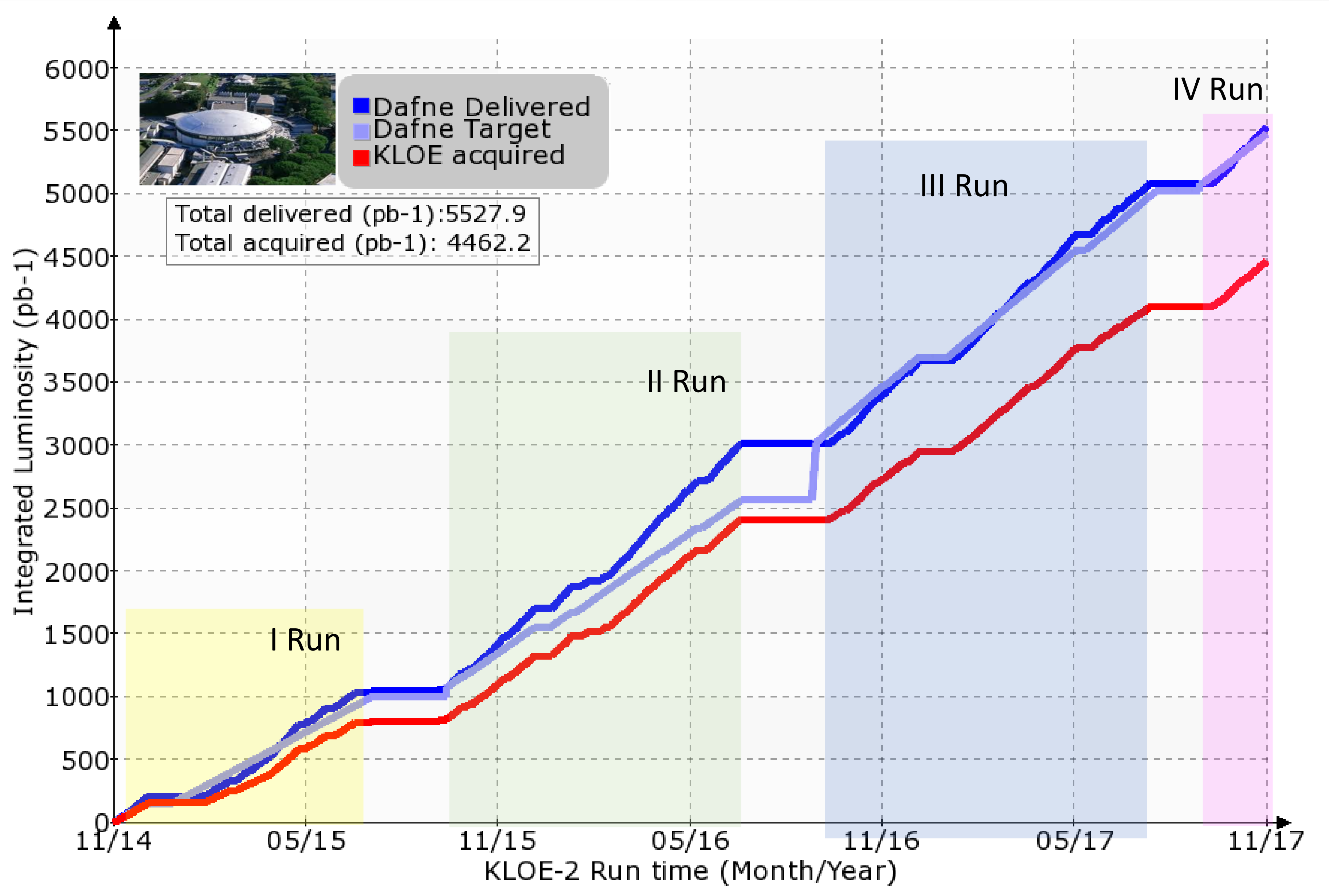
IV Run Spt 6th 2017 ÷ Mar 31st 2018 goal $\int L_{del}$ **~ 1.5 fb-1**

End of the DAΦNE activities for the KLOE-2 detector

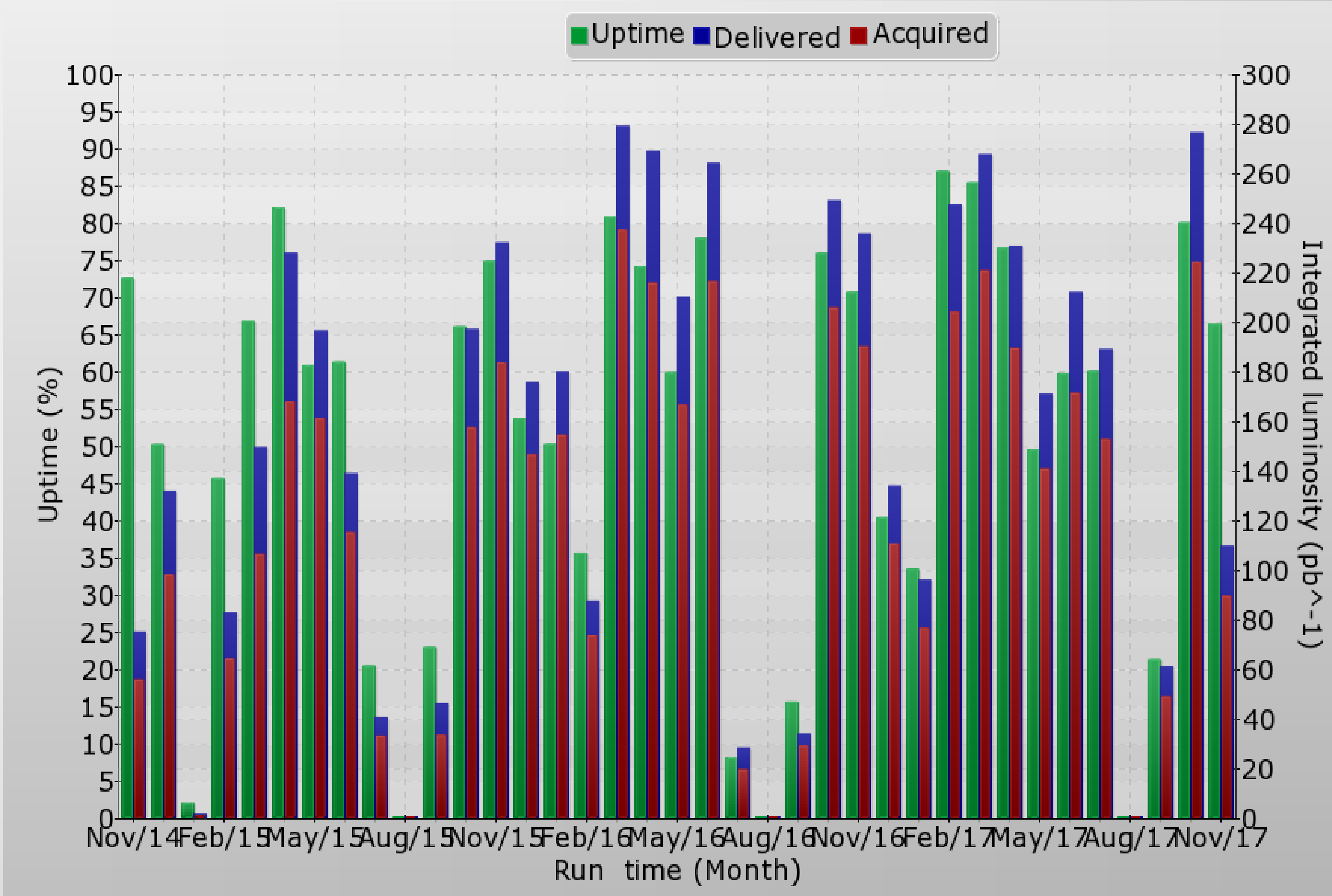
III Run (Sep/2016-July/2017)



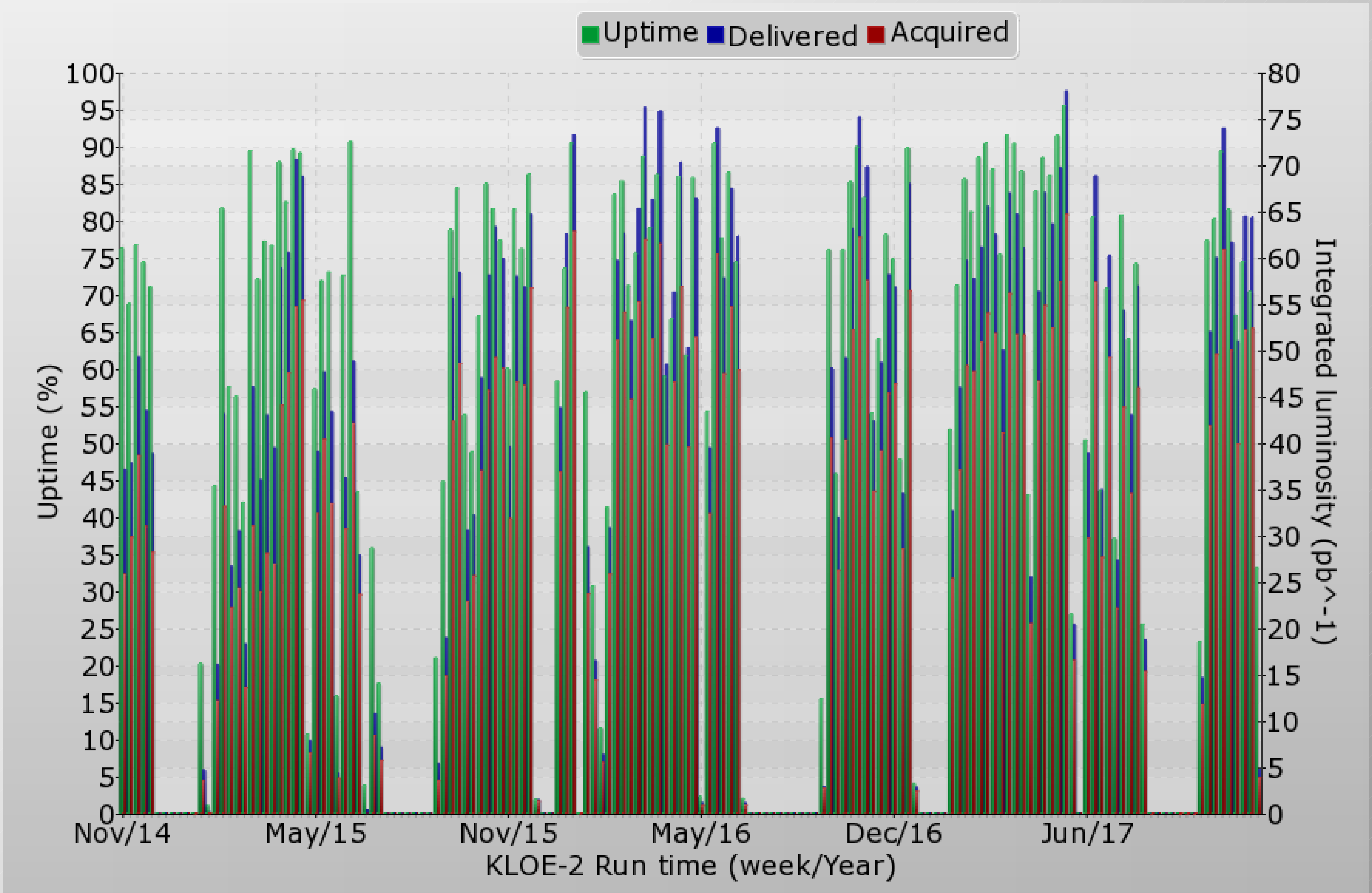
KLOE-2 Run Overview



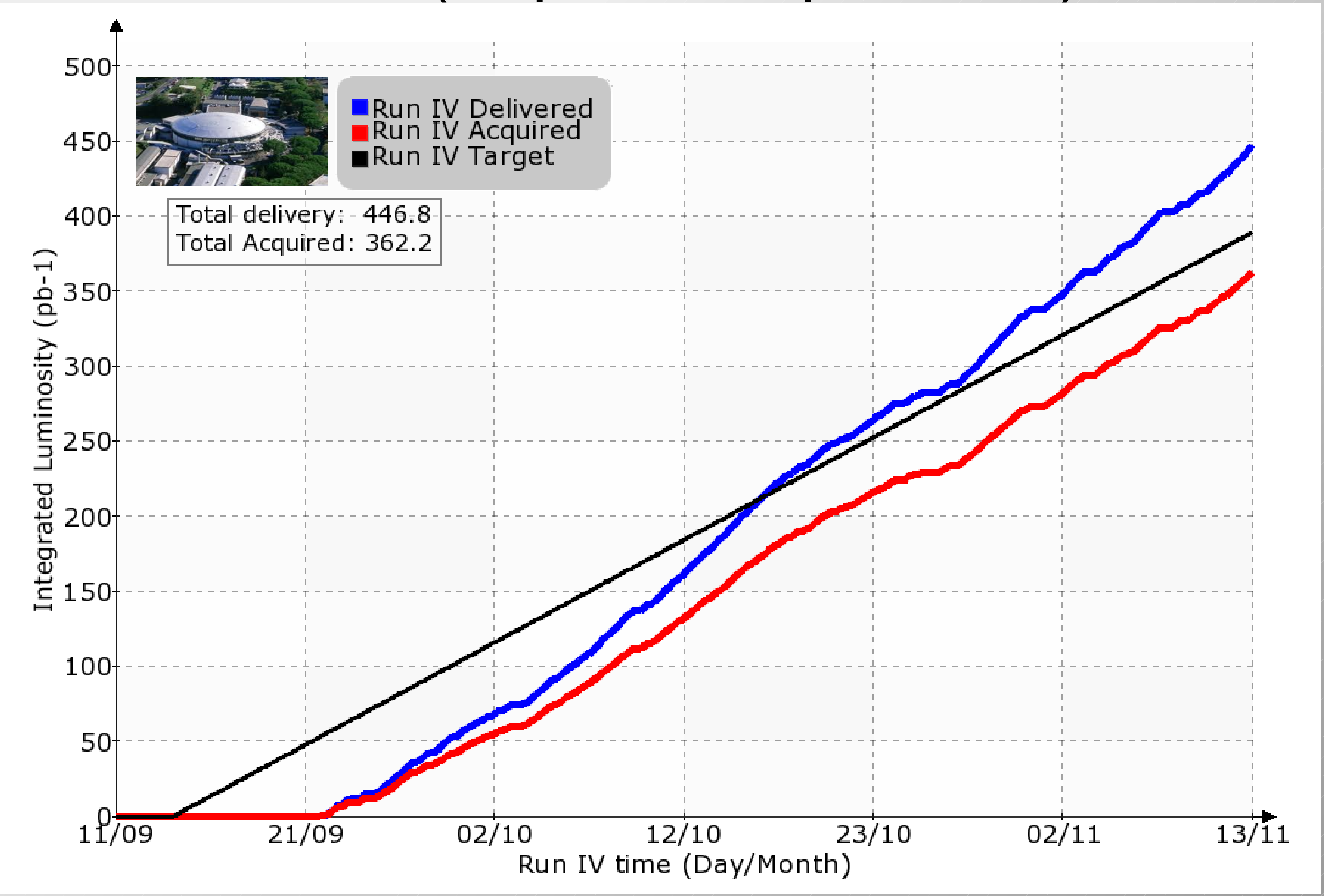
KLOE-2 Run Overview by Month



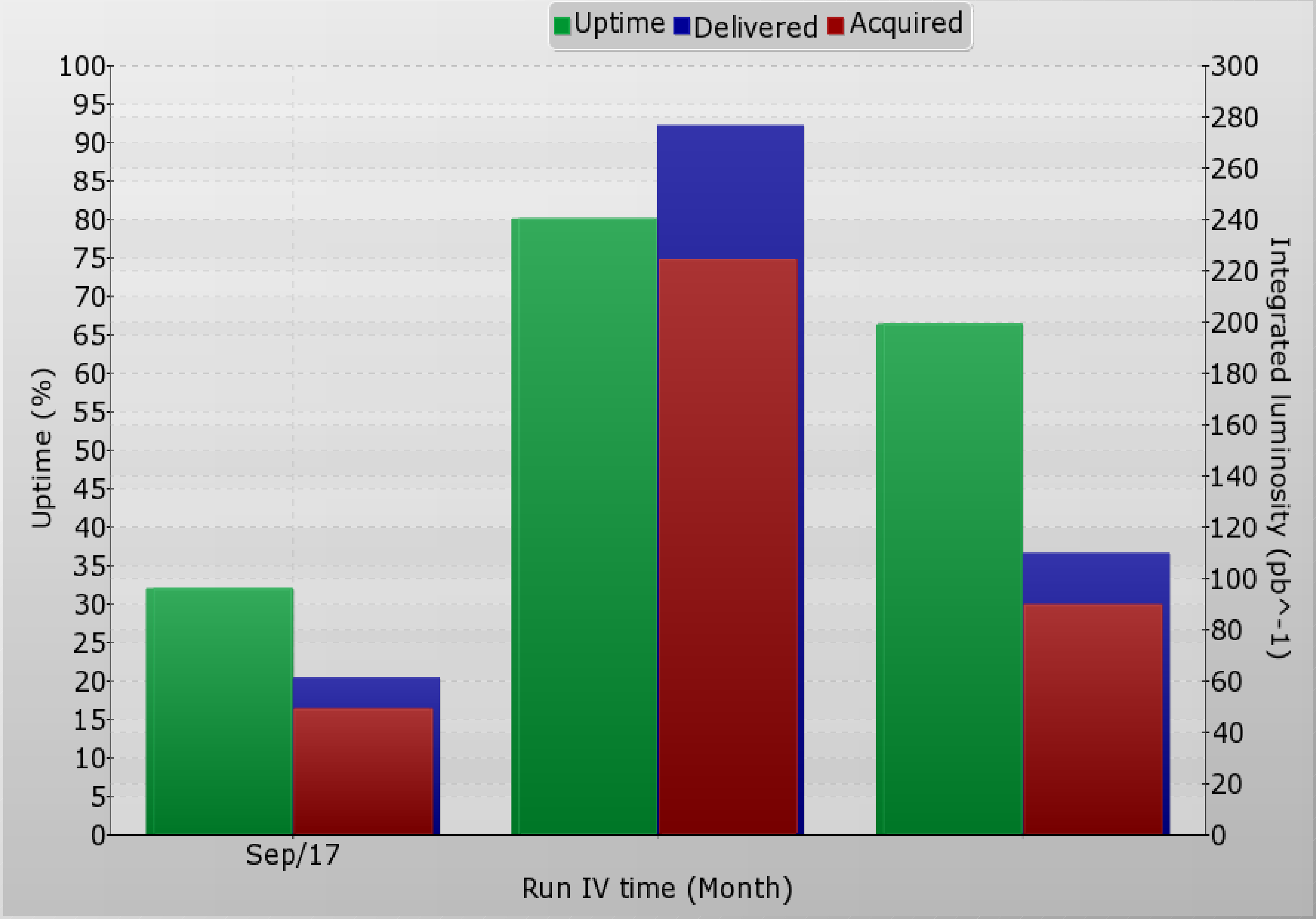
KLOE-2 Run Overview by Week



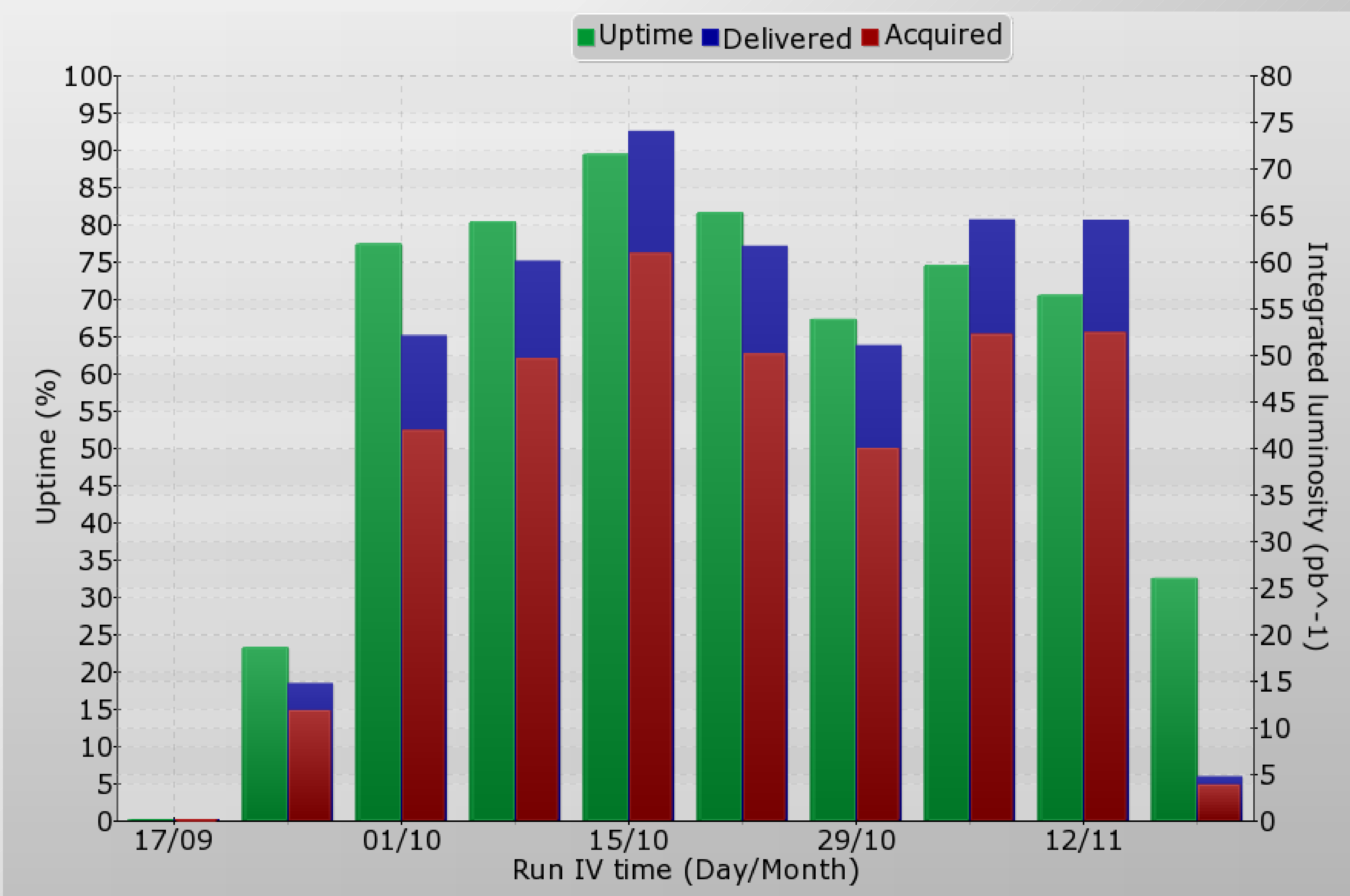
IV Run (Sep/2017-up to now)



IV Run Monthly Performances

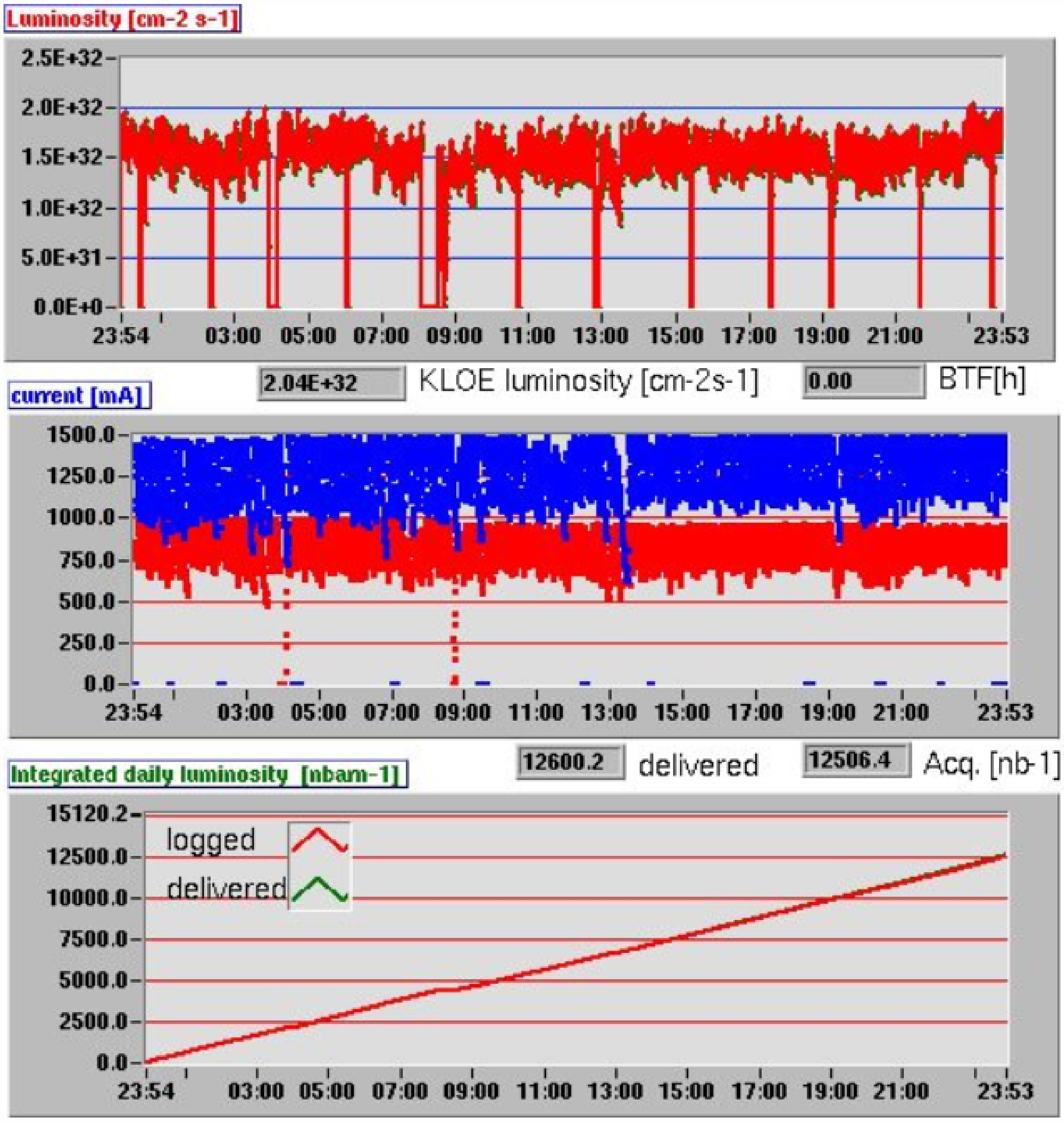


IV Run Weekly Performances



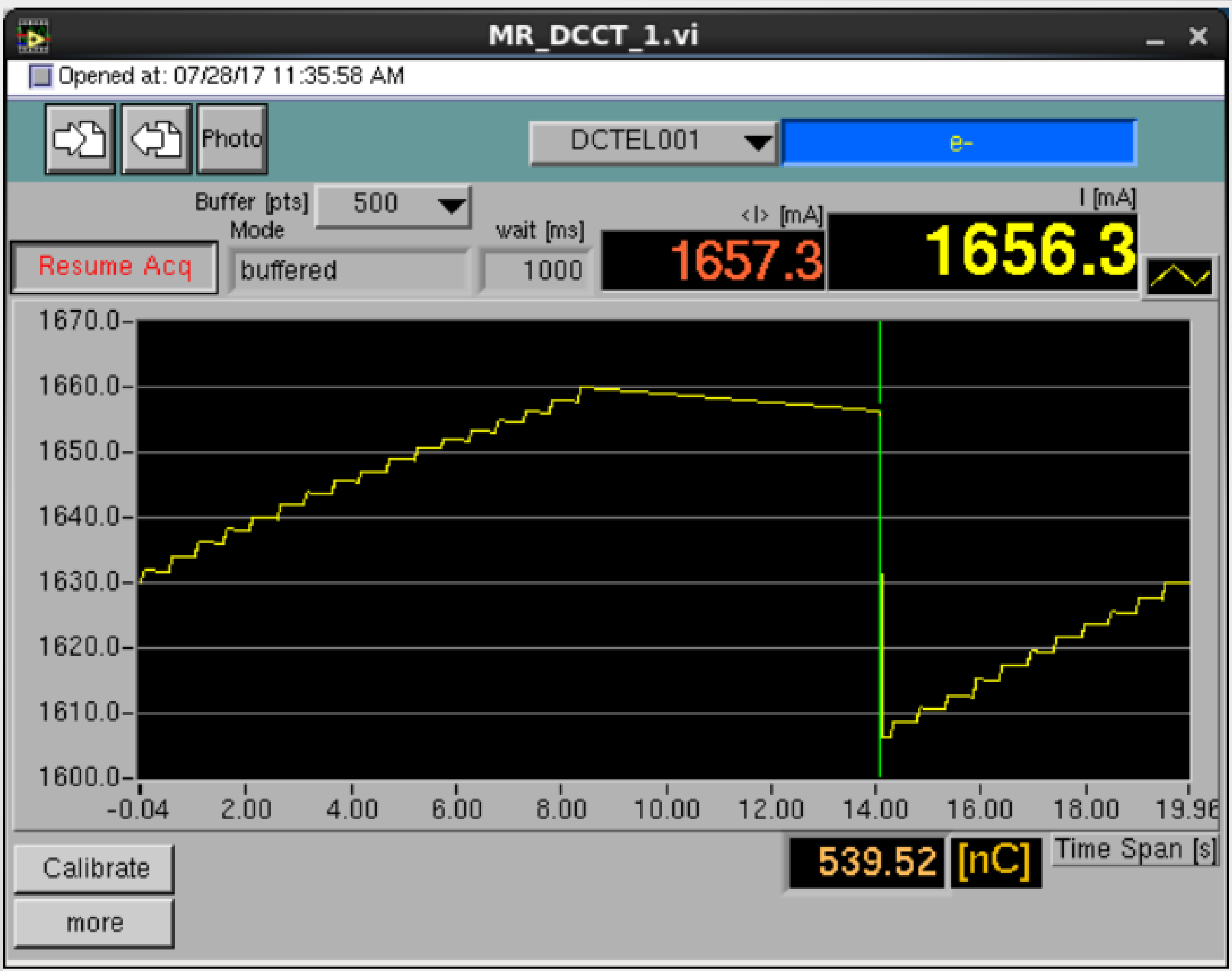
KLOE Luminosity History: 12/11/2017

Yesterday



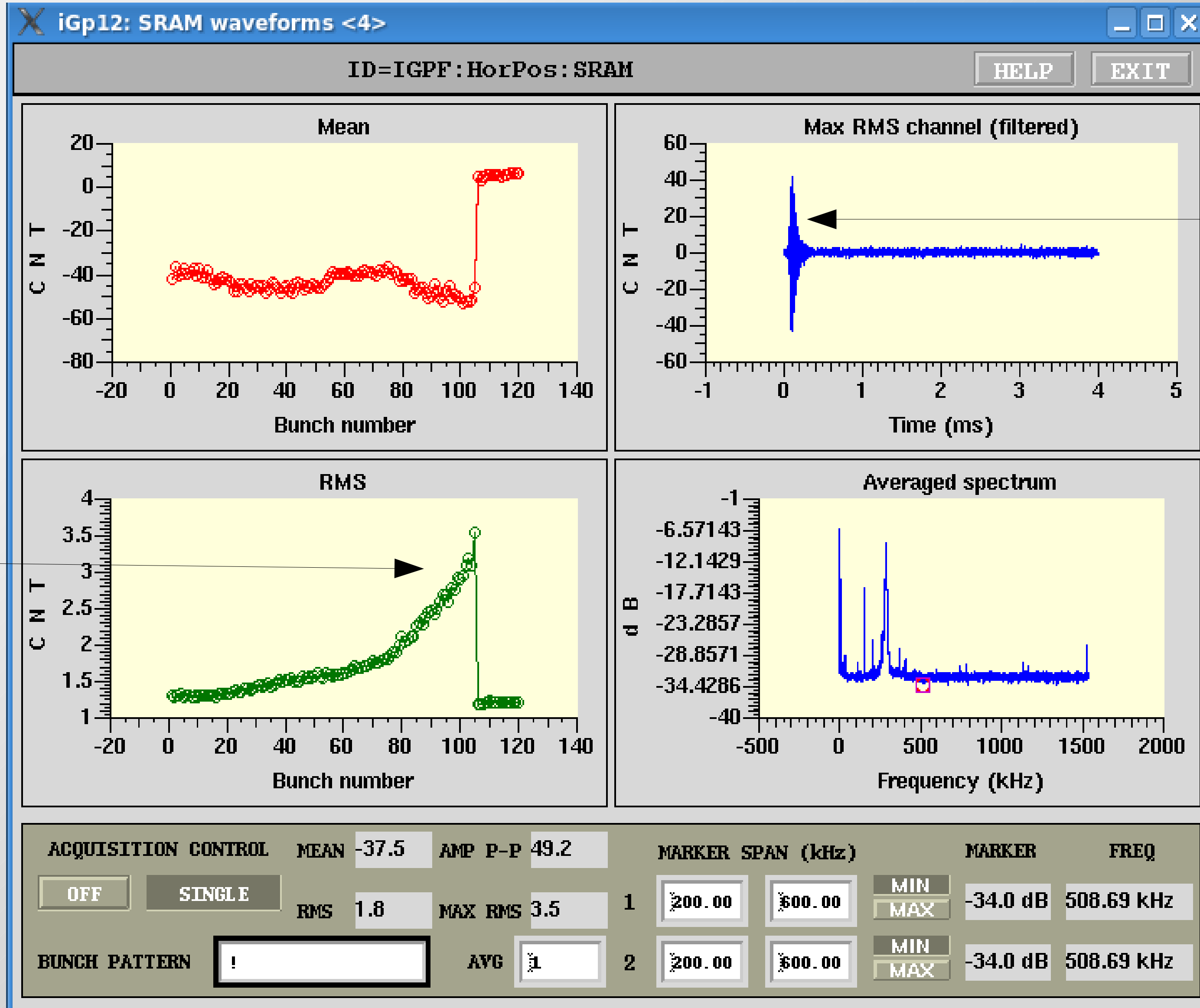
Beam current tests & achievements

July 28th: test of electron beam top current with stable beam



On October 25th tests on the positron current limit have been carried on.
As shown below a strong, destructive (even if expected) horizontal instability has been observed with beam current > 800mA

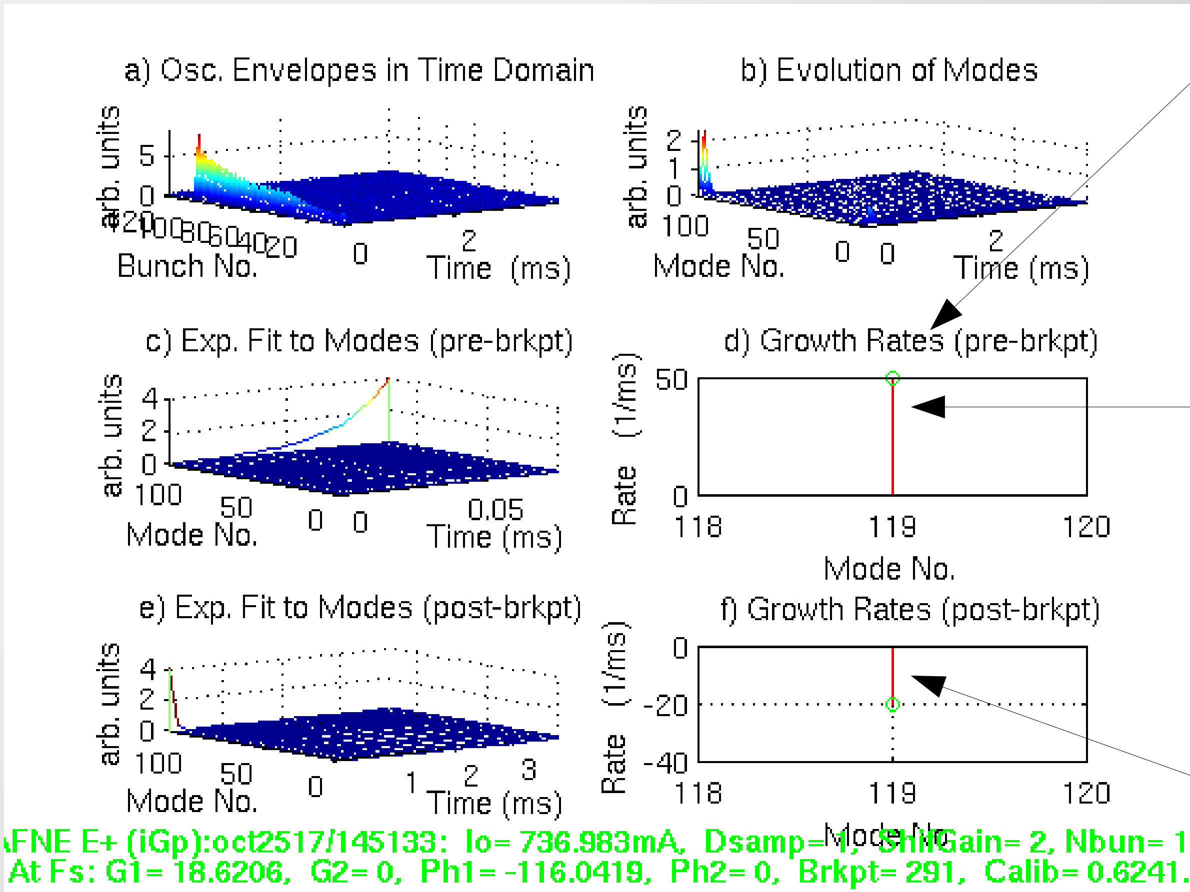
Instability hits stronger in the tail of the bunch train



Instability growth rate measured by turning off the hor feedback

After recording oscillation data during growth and damping period, a modal analysis has been made showing the instability growth rate and the damping feedback performance

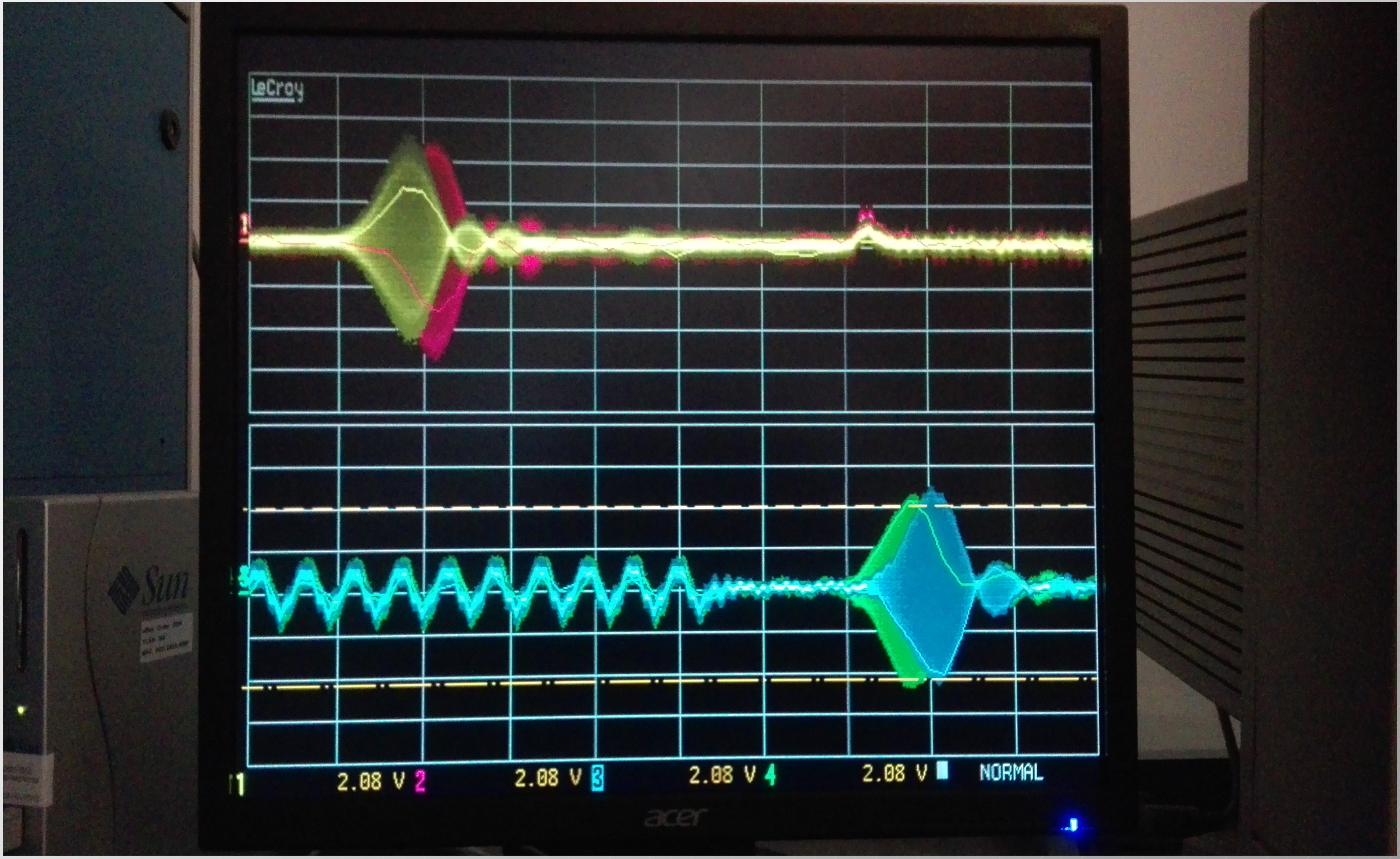
The mode is -1 (=120-119) as predicted by e-cloud model



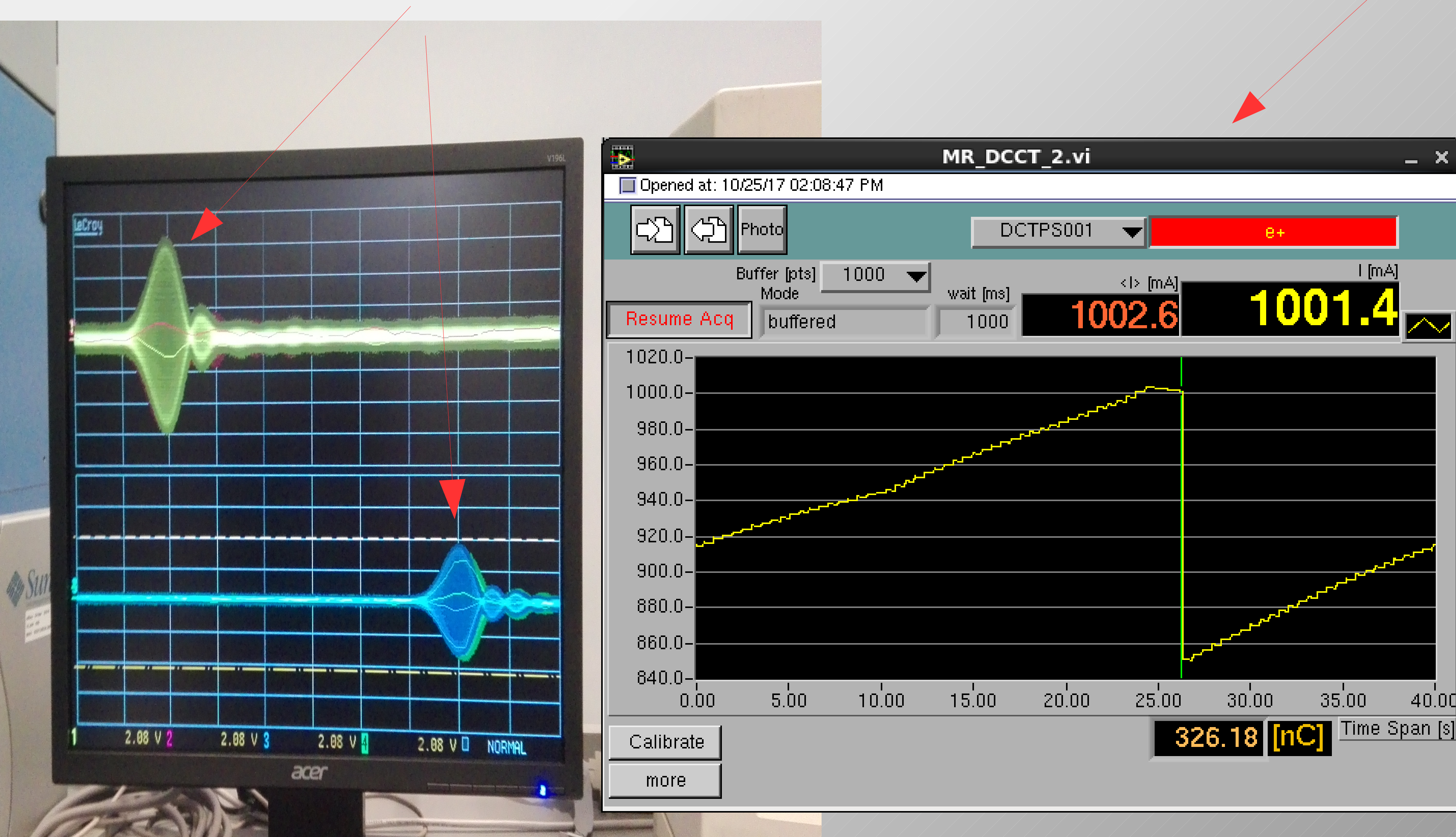
The growth rate is 50 ms-1 equivalent to 20 μs and corresponding to 60 revolution turns, a value that should be easily damped by the usual feedback performance

The feedback damping rate (-20 ms-1) is, on the contrary, below what is expected

The e+ beam current limit problem (evident only for I_beam>800 mA) has been identified, after many tests, in a bad equalization (in time and amplitude) of the power amplifier sections for both horizontal (upper traces) and vertical (lower traces) feedback systems



After fixing the feedback backend …..the positron beam current has been restored up to 1 A



Maintenance and consolidation program

DONE as scheduled

DAFNE Shutdown on May 2017

- May 15th–17th - Safety Controls: MR, Acc, Linac & BTF

- May 18th-26th - Maintenance
  - Control system: to complete cabling and tests
  - Longitudinal feedback: tests on power amplifiers
  - Hydraulics system: sw and hw upgrade to manage the towers, PLC, check regulation levels, and other maintenance operations
  - LINAC: C modulator Thyratron to be changed after the foreseen amount of working hours
  - BTF: gun test (on the Open Day) for long pulse for PADME experiment
  - Diagnostics: Thyratron of the accumulator ring kicker to be changed for end of life; frame grabber test;
  - Chiller unit checked

Maintenance and consolidation program during summer shutdown

Cooling System

- Restoring air conditioners in DAFNE hall (2 weeks)
- Restoring air conditioners in Accumulator and other halls (2 weeks)
- Linac water cooling tower maintenance and repairing small parts
- Wiggler water hoses changed in main rings
- Inverter installation after the accumulator tower water pump
- Compressed air circuits checked and replaced if necessary
- O-ring compressed air replacement in Linac and transfer lines

LINAC

- Ordinary checking and maintenance
- Gun cathode has been replaced with a component having the nominal specification

Low Level Control System

- Survey of PLC in the Interaction Region to recover ~ 10 remote I/O boards
- PLC replacement for temperature control at the end of Linac
- Diagnostics for temperature control in accumulator hall
- SUPERVISOR program upgrade

Magnets & Power Supplies

- New bar spares for the transistors of DANFISYK power supplies acquired
- 5 new control panels for DANFISIK power supplies acquired
- 5 power boards repaired
- Fan checked and repaired

Radio-frequency systems

- Ordinary maintenance
- RF amplifier in the accumulator ring:
  - Extraordinary maintenance
  - Boards checking and repairing
  - Equalization of the components
- Low Level Radio-Frequency tests

Control System & Diagnostics

- Frame grabber software for transfer lines

Diagnostics

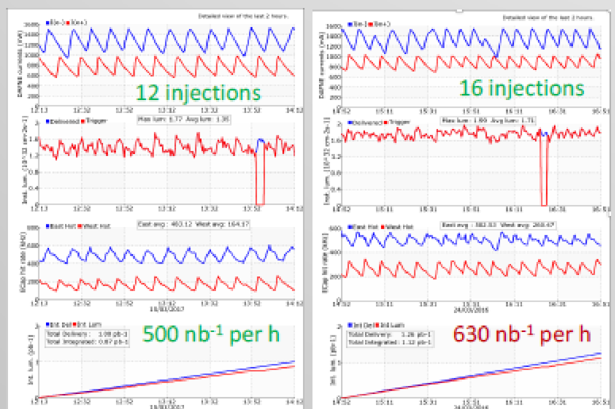
- Flag cameras check and replacements in transfer lines
- Check of accumulator kicker pulsers (expecially for KCKA3001)

DAΦNE control system: e ⇄ p switch speed-up

The DAΦNE switch time was dominated by the Power Supplies feeding the TL quadrupoles and dipoles (OCEM brand).

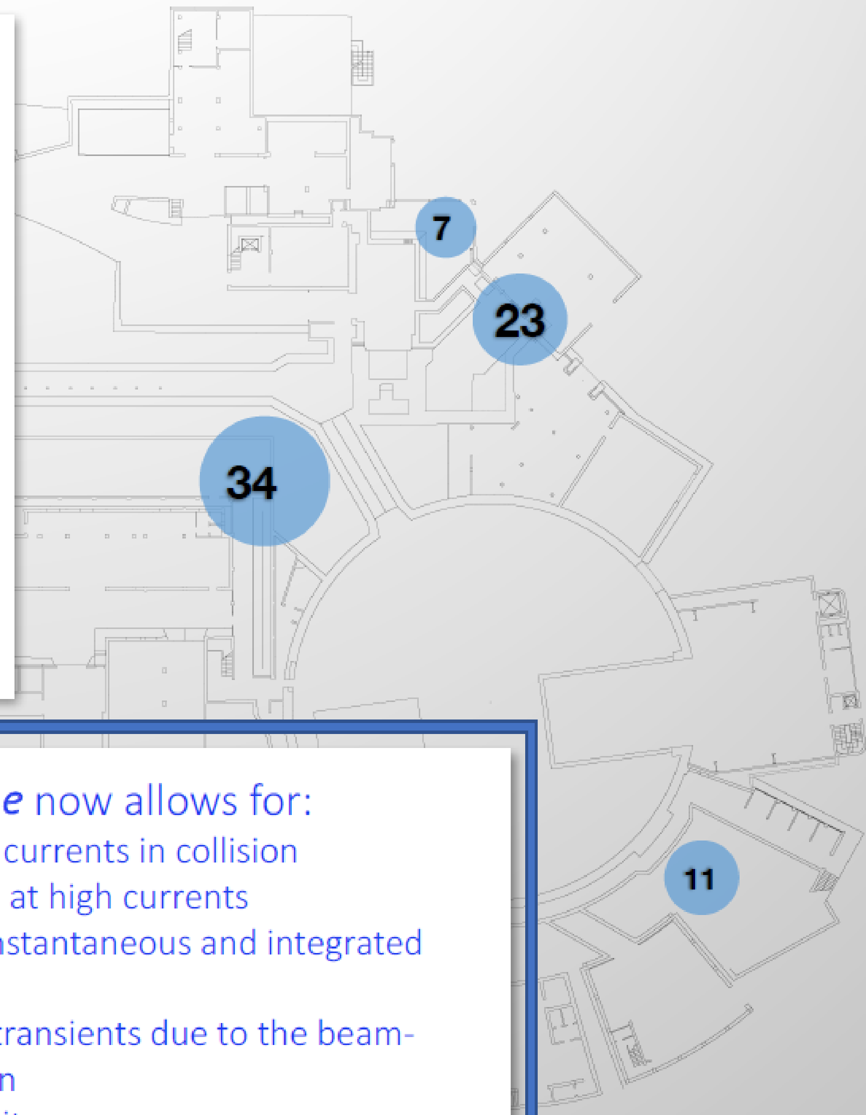
Due to their *non-efficient* communication protocol and multi-drop connections, it previously took more than 1.5 minutes to switch the whole TL from e to p and viceversa.

After having reduced the switch time, machine operations and data analisys indicates that the integrated luminosity increased up to 20%.

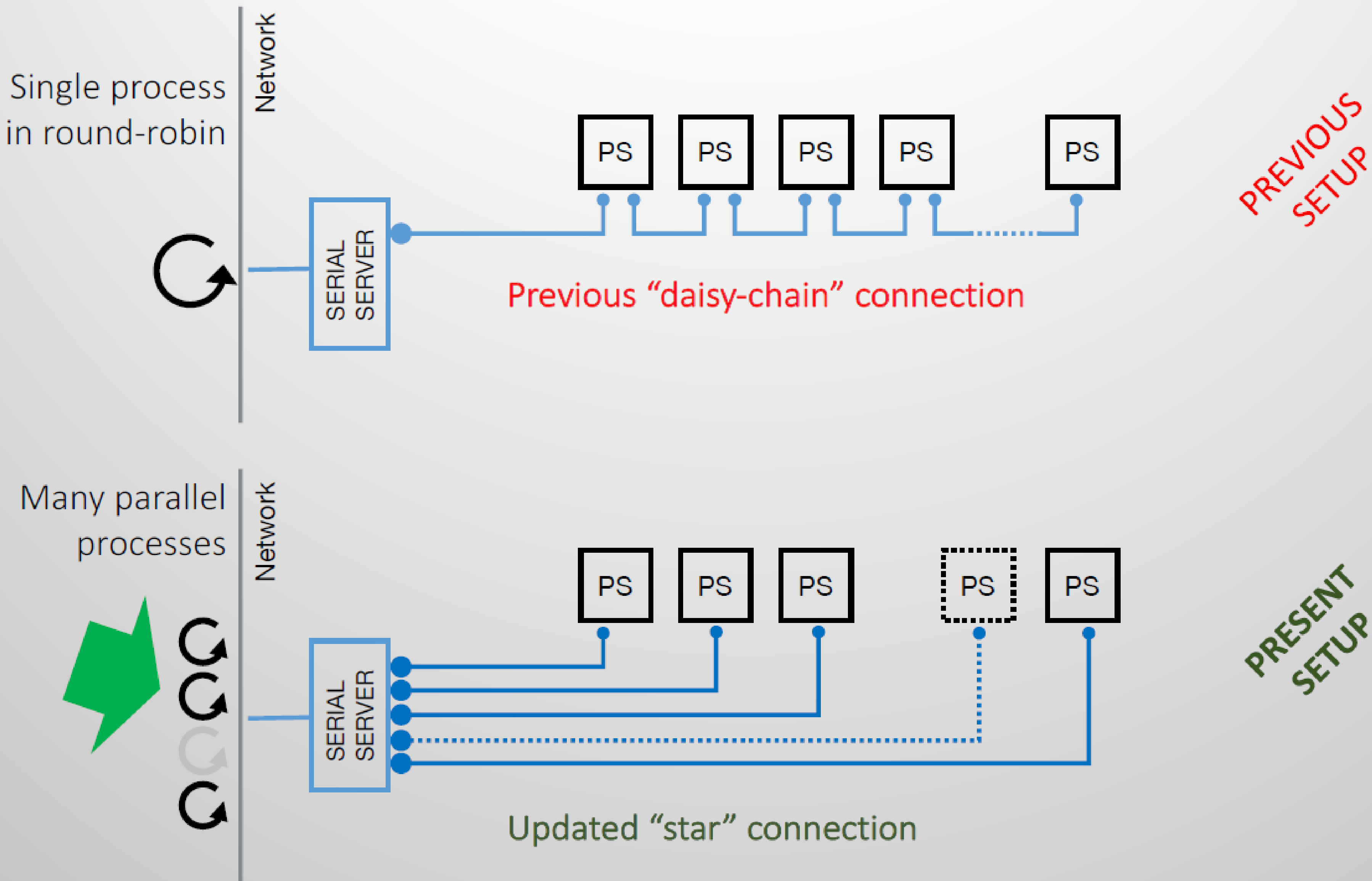


A shorter switch time now allows for:

- keeping highest currents in collision
- tuning collisions at high currents
- getting higher instantaneous and integrated luminosity
- minimizing the transients due to the beam-beam interaction
- leveling luminosity



DAΦNE control system: e ⟲ p switch speed-up



DAΦNE control system: !CHAOS introduction

!CHAOS

Control system based on **H**ighly **A**bstracted and **O**pen **S**trucure

!CHAOS is a new software framework developed at LNF for the control of plants and experimental setups. !CHAOS is also involved in many TT projects.

!CHAOS is being employed more and more besides the legacy DAFNE Control System

At the present time, the following systems have been redesigned from scratch in !CHAOS:

- new **accumulator orbit monitoring** system (*version beta1.0 operational*)
- new **luminometer** (*working prototype*)
- new **machine switch** procedure (*successfully tested on june 2017*)

The !CHAOS framework proved to be solid and suitable for the technical-scientific needs of an accelerator and is extremely promising as control environment for the incoming projects of LNF and INFN.

DAΦNE Run IV Schedule

Month	KLOE-2 operations (days)	Other DAΦNE activities	Description
Aug	0	Aug 21st – 31st Maintenance	
Spt	17	Spt 1st – 13th Maintenance	
Oct	31		
Nov	27	Nov 8th – 10th Safety Controls	
Dec	19		Winter shutdown
Jan 2018	29	Jan 2nd	Resuming KLOE-2 operations
Feb 2018	28		
Mar 2018	31		
Total Run IV	**182**		

DAΦNE after KLOE-2

DAΦNE Timeline

March 31st 2018

end of the KLOE-2 Run

April 1st ÷ July 31st

KLOE-2 roll-out and SIDDHARTA-2 installation

September ÷ December 2018

DAFNE commissioning and SIDDHARTA-2 setup

January 2019

start the SIDDHARTA-2 data taking

Collisions for SIDDHARTA-2

Several well founded considerations recommend to install SIDDHARTA-2 on the IR1

KLOE-2 detector must be removed together with the IR1 part of vacuum chamber and permanent magnets

To respect the DAFNE schedule it's necessary to rebuild the low-β section presently tightly packed among cables and detector layers deep inside KLOE-2

As a consequence a new low-β section has to be build with

- quadrupoles
- vacuum chambers
- diagnostics

SIDDHARTA-2 IR Infrastructures

KLOE pit wall
Main structure review: engineering work assigned

Main IR support structures
Structural design review: engineering work assigned
Steel structure maintanance: to be done
Concrete blocks procurement: no longer necessary
Tender for installation: to be done

SIDDHARTA-2 low-β QUADs

The **P**ermanent **M**agnet **QUAD**rupoles of the SIDDHARTA-2 low-β are realized in the framework of the collaboration agreement between LNF and ESRF (G. Le Bec, J. Chavanne and P. Raimondi).

Magnetic layout has been fixed

An extensive study of tolerances and sensitivity to errors has been done

The Al cases for the PMQDs and for the PMQF have been designed relying on a comprehensive analysis of the forces among the different PM blocks.

Still some design effort is required to complete specifications of:
tools necessary to manipulate the PMQUADs
support to be used during measurements and shimming

The procedure to acquire the PM blocks is being launched

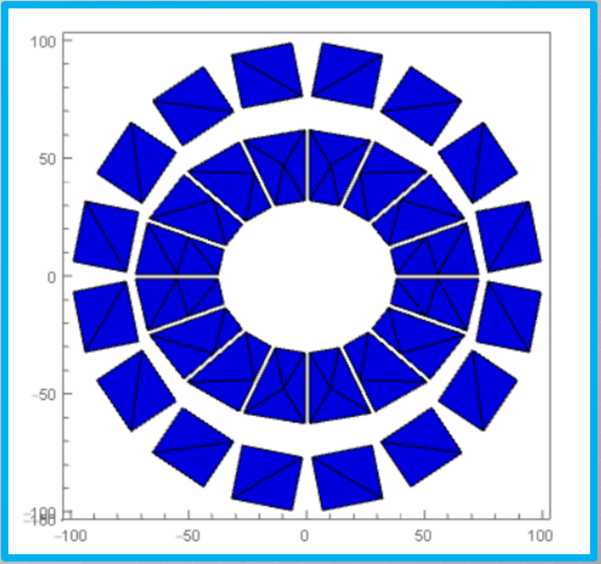
New PM QUADs Design

Several aspects will be improved:

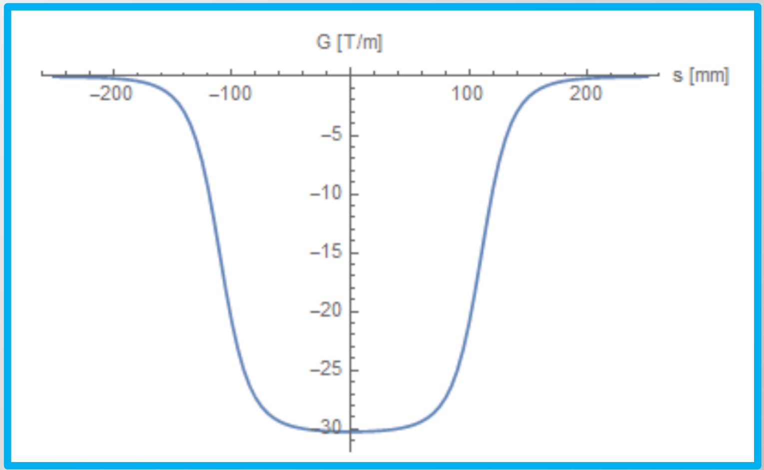
- good field region
- uniformity of the gradient
- QD aperture thinking to:
  - stay clear aperture
  - background
  - luminosity monitor efficiency
- mechanical assembly especially for QF

Permanent Magnet Defocusing QUADs **PMQDs**

Material: Sm2Co17 with *Br* = 1.1 T
Design: elliptical core + circular shimming
Aperture (H-V)**:** 76 mm - 65 mm
Length: 220 mm
Outer radius: 100 mm at nominal shim position

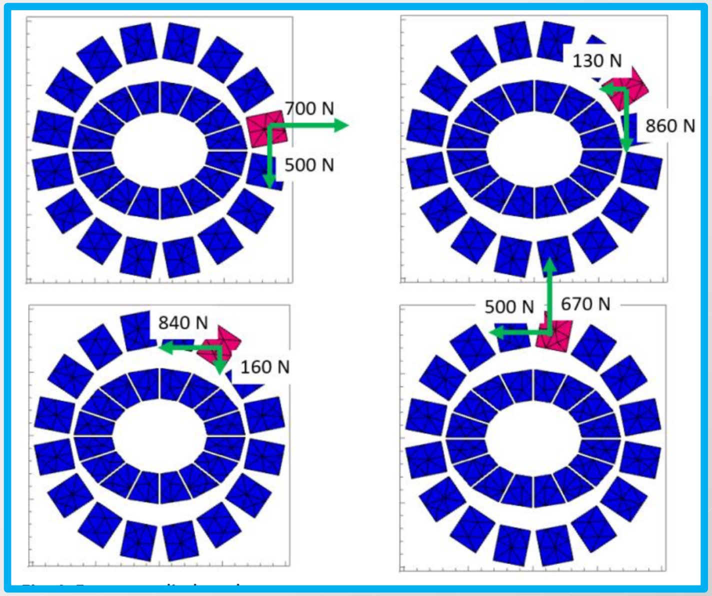


PMQD: magnetic layout (transverse section)

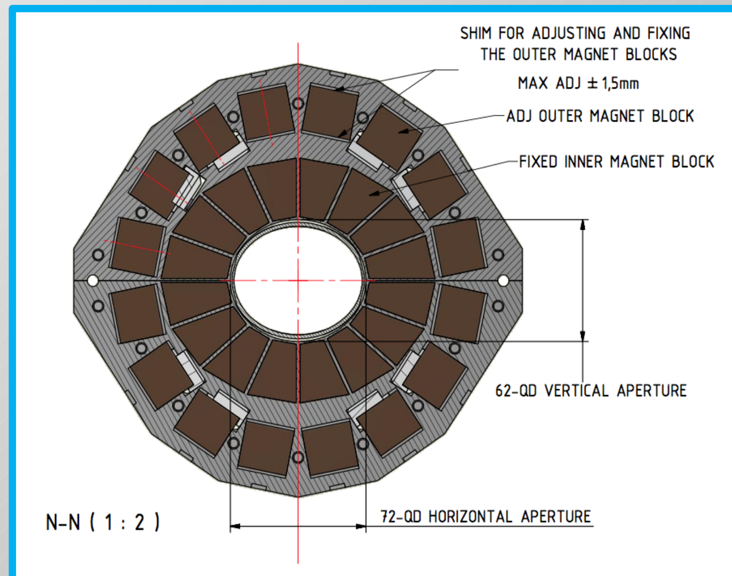


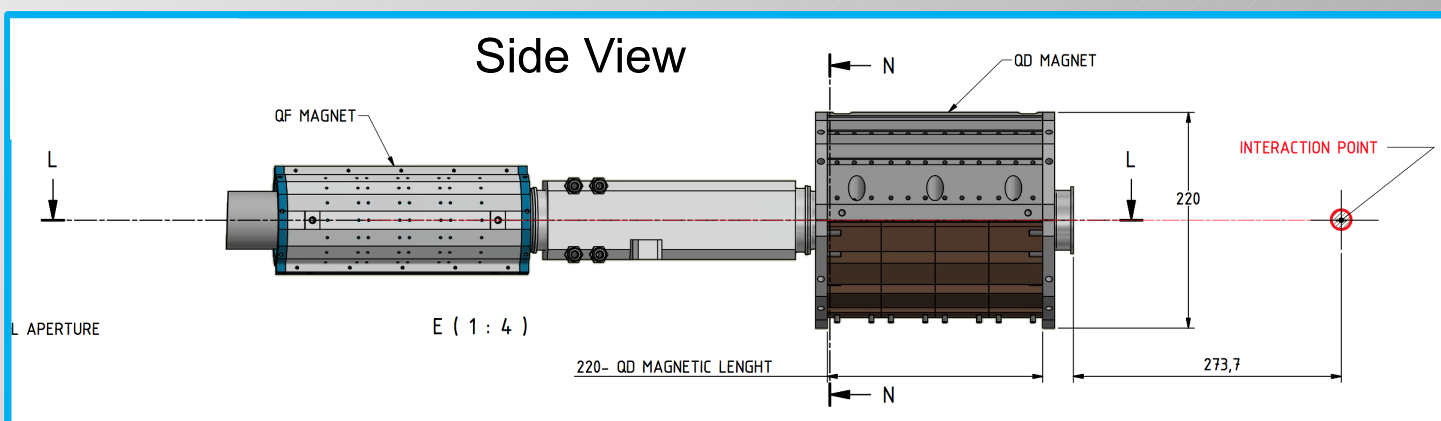
PMQD: longitudinal profile of the field gradient

PMQD Mechanical Assembly



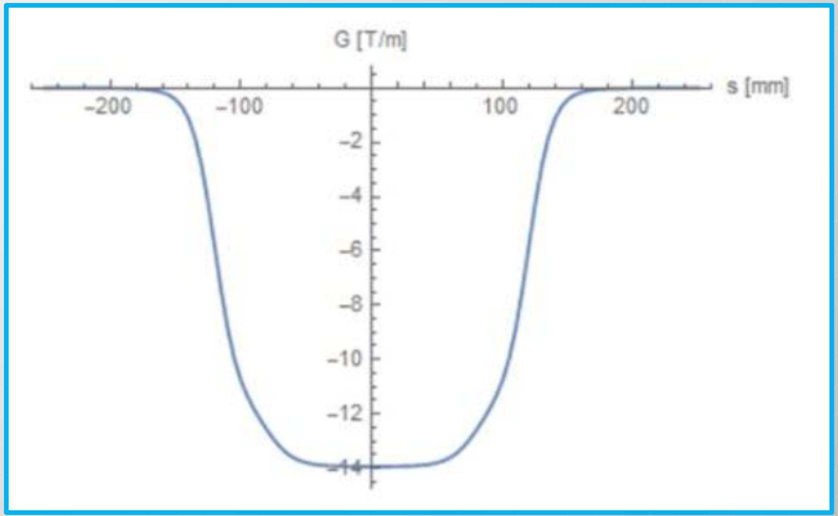
Forces acting on the outer PM blocks



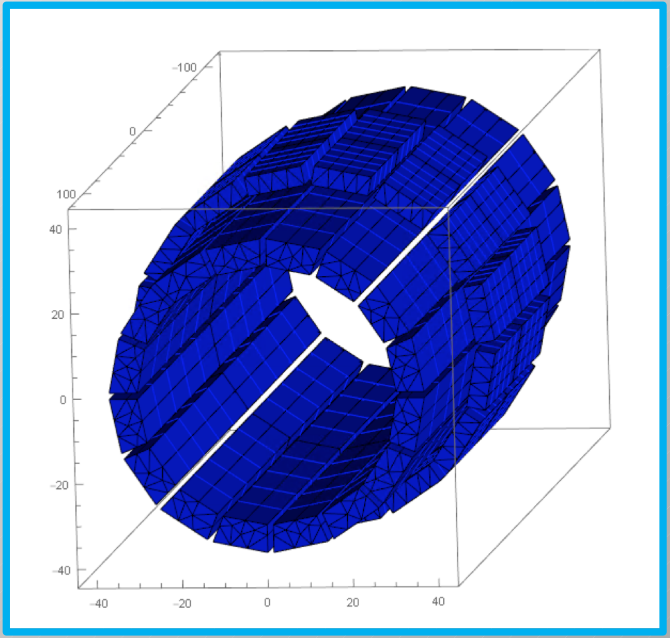


Permanent Magnet Focusing QUADs **PMQFs**

Material: Sm_2Co_{17} with B_r = 1.1 T
Design: circular core + circular shimming
Aperture : 61 mm
Inner Ring Length: 240 mm
Outer Ring Length: 160 mm
Outer radius: 43 mm

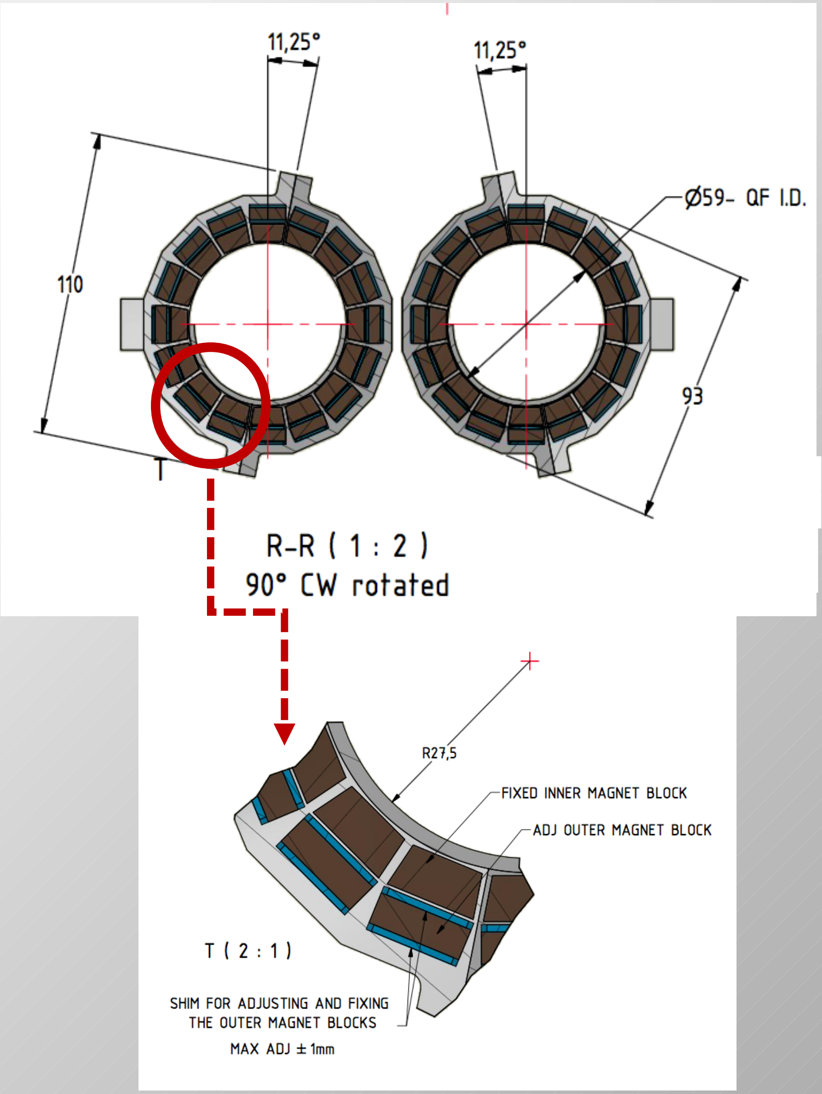


PMQF: longitudinal profile of the field gradient



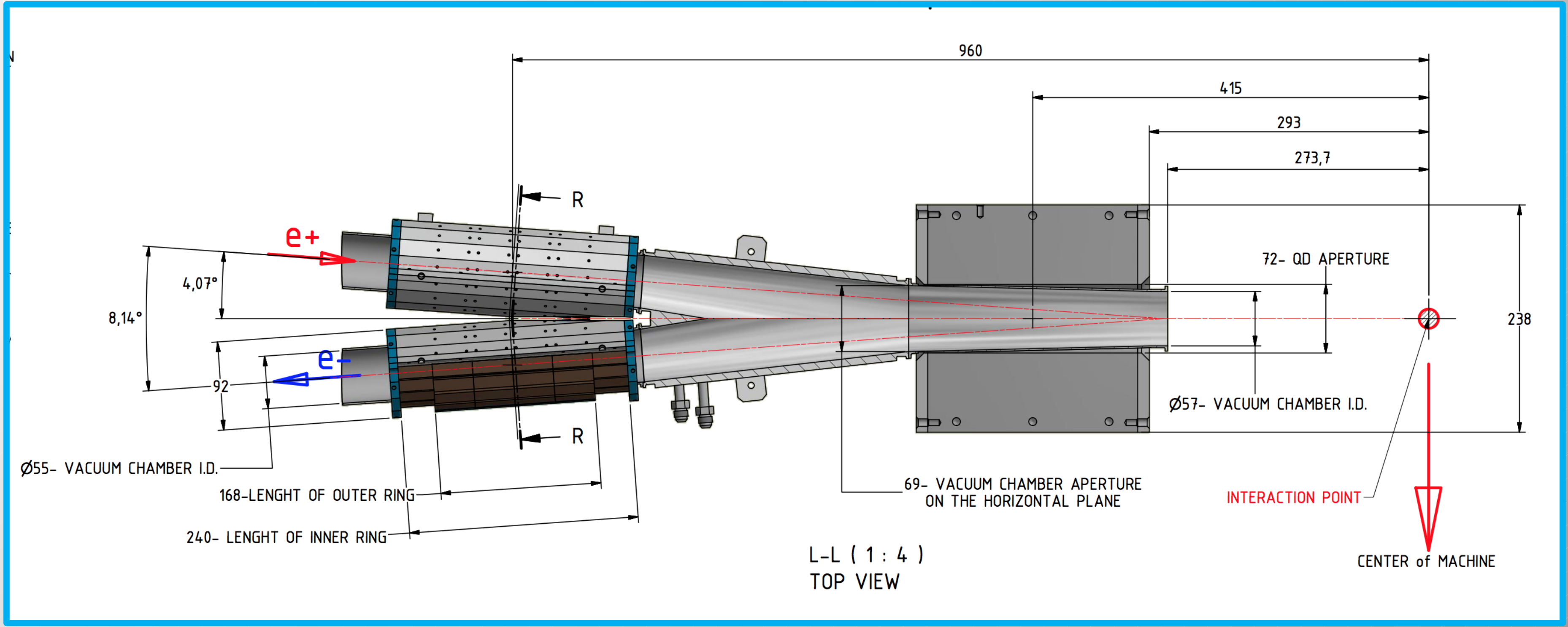
PMQF: magnetic layout (transverse section)

PMQF Mechanical Assembly



SIDDHARTA-2 IR Assembly

A vacuum chamber compatible with the new PMQUADs has been designed.
It provides a wider stay clear aperture for the beam
inside the PMQF (+1mm)
at the entrance of the PMQDs (+ 4mm)



Other R&D Activities for Siddartha-2 run

1) Vacuum components (bids for new pumps)
2) Clearing electrodes in the e+ ring to be checked
3) Laser treated vacuum chamber and diagnostics for e-cloud mitigation studies: two collaborations are under way, with Daresbury technological team and with a INFN-Pisa spin off company
4) Diagnostics for the new IR
5) Luminometer

Conclusions

DAΦNE operations are stable and reproducible and the background is compatible with an efficient data-taking.

The 3rd KLOE-2 run completed on past July achieved the foreseen goal Integrated Luminosity > 2 fb^{-1}

So far the I, II, III and IV runs have already delivered to KLOE-2

$$\int L \sim 5.5\ fb^{-1}$$

*Relying on this result, the final integrated luminosity goal (**~6.0 fb-1**) seems quite feasible within the schedule.*

Activities to secure the new DAFNE run for the SIDDHARTA-2 experiment in 2019 are going on according with our plans.

Thank you for your attention