DAΦNE Overview

Alessandro Drago
on behalf of the DAFNE Team

53rd LNF Scientific Committee, Frascati, 9-10 May 2017

The DAΦNE Team

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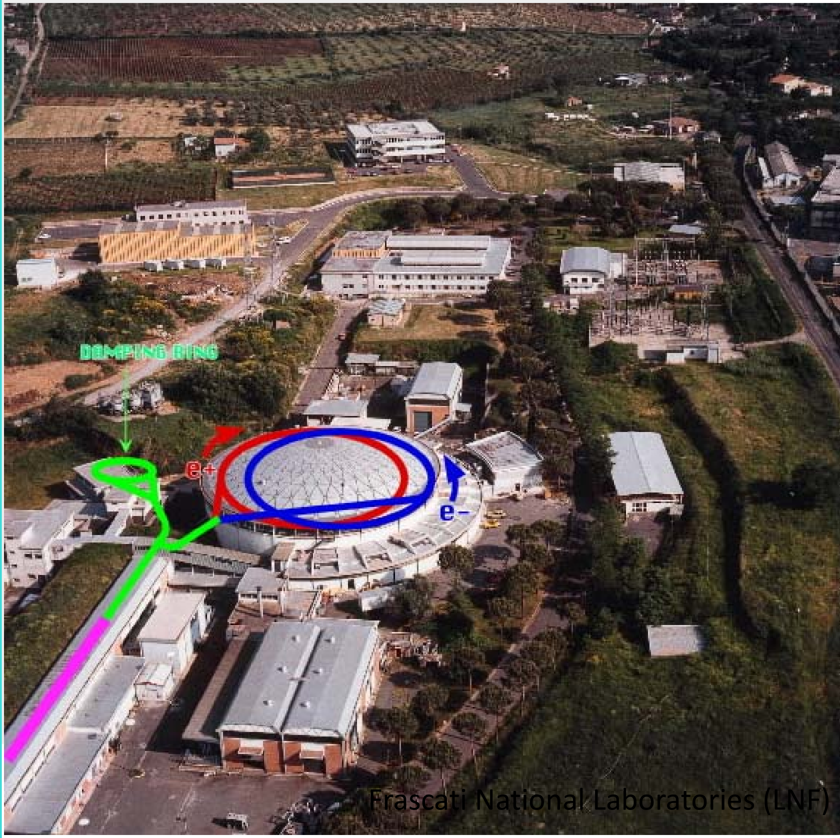
DAΦNE Operation Team

Baldini G., Battisti, Beatrici, Belli, Bolli, Ceccarelli G., Ceccarelli R., Cecchinelli, Clementi, Coiro, De Biase, Ermini, Fontana, Fusco, Gaspari, Giacinti, Iungo, Marini, Martelli, Mencarelli, Monteduro, Pellegrini, Piermarini, Quaglia, Rossi, Sardone, Scampati, Sensolini, Sorgi, Sperati, Sprecacenere, Strabioli, Tonus, Zarlenga, Zolla.

Outlines

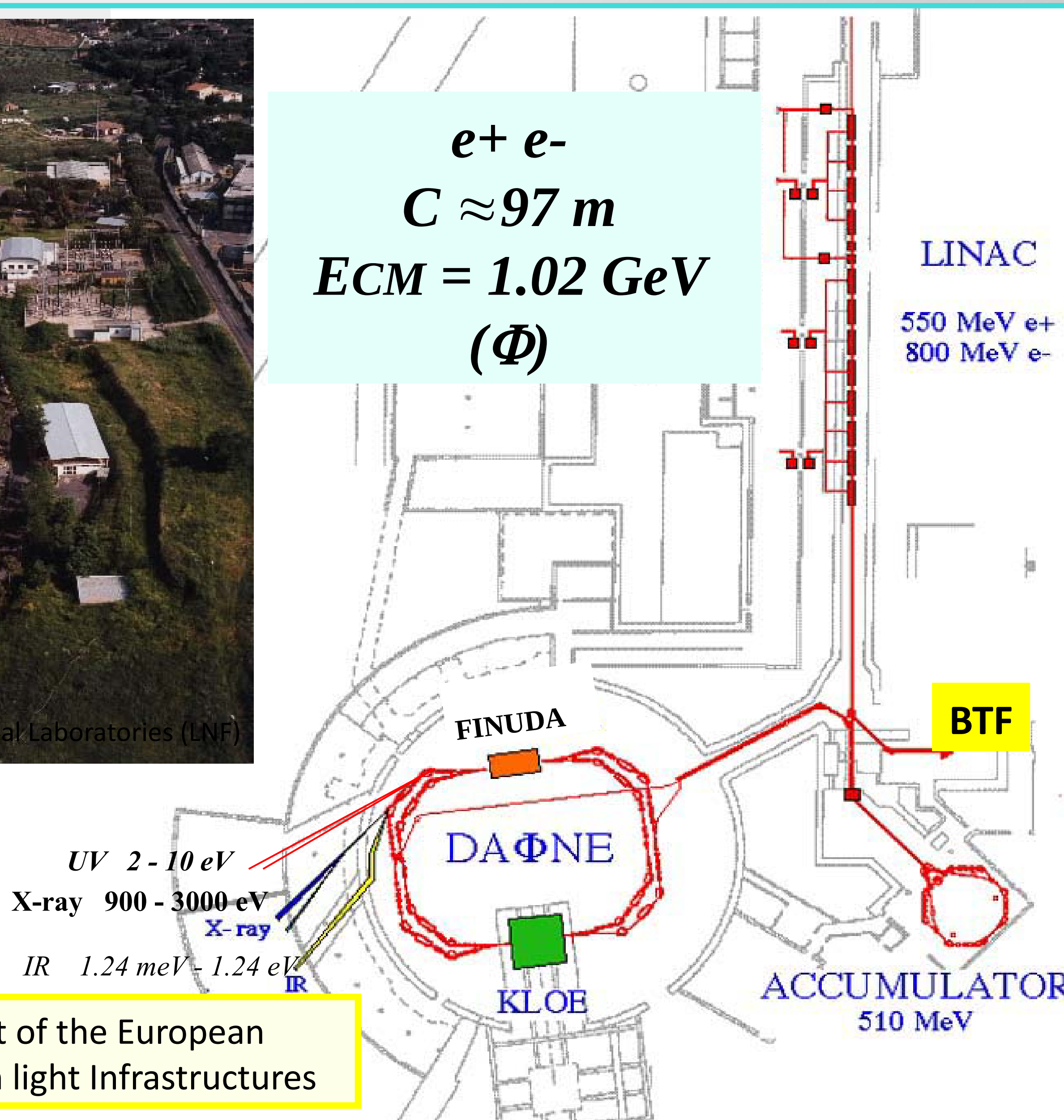
- DAΦNE overview
- KLOE-2 operations
- Maintenance and consolidation program
- SIDDHARTA-2 studies and plans
- Conclusions

The DAΦNE Accelerator Complex



Frascati National Laboratories (LNF)

_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
goal 1 fb-1

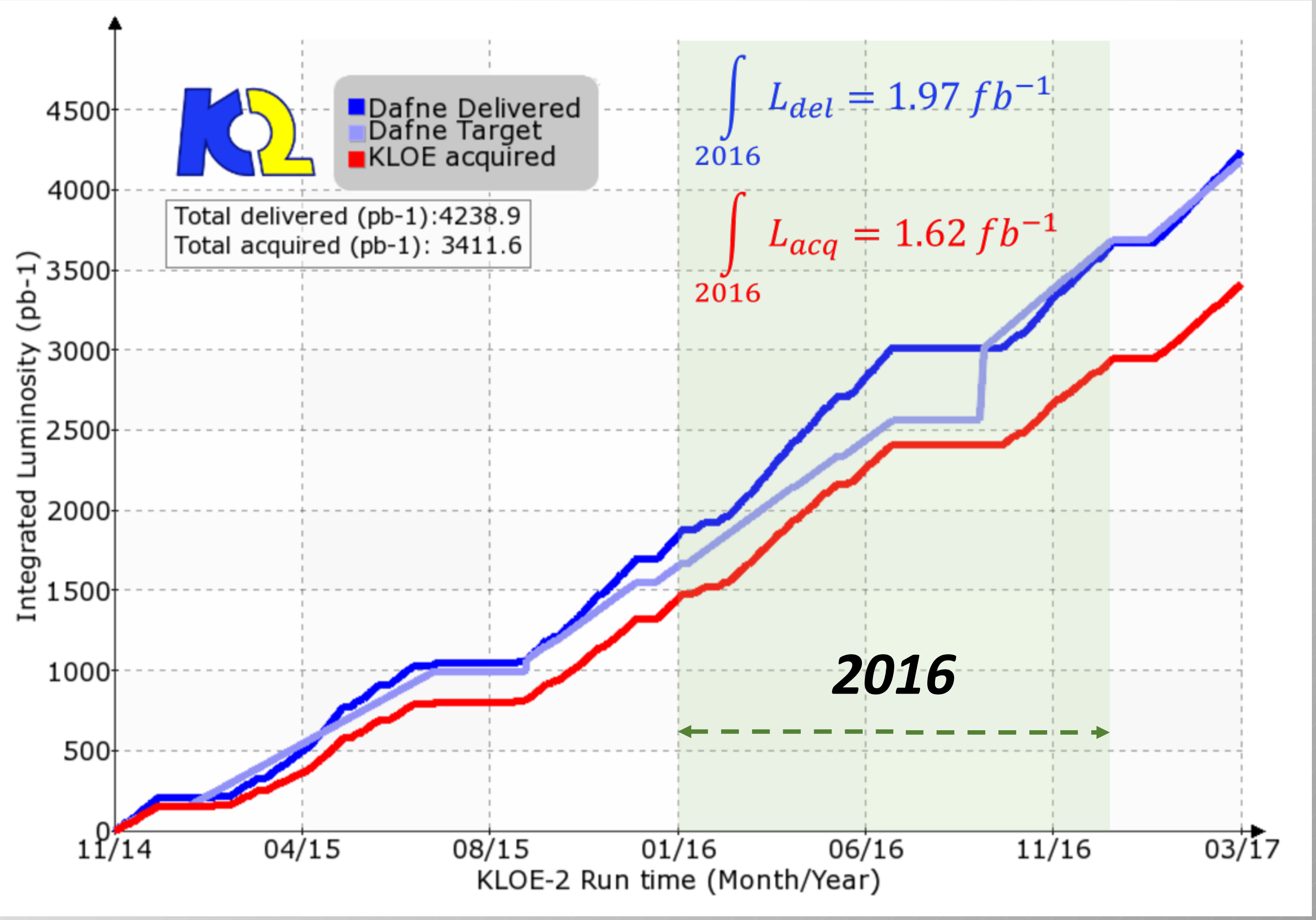
II Run Spt 28th 2015 ÷ Jun 29th 2016
goal 1.5 fb-1

III Run Spt 12nd 2016 ÷ Aug 1st 2017
goal 2 fb-1

IV Run Spt 6th 2017 ÷ Mar 31st 2018

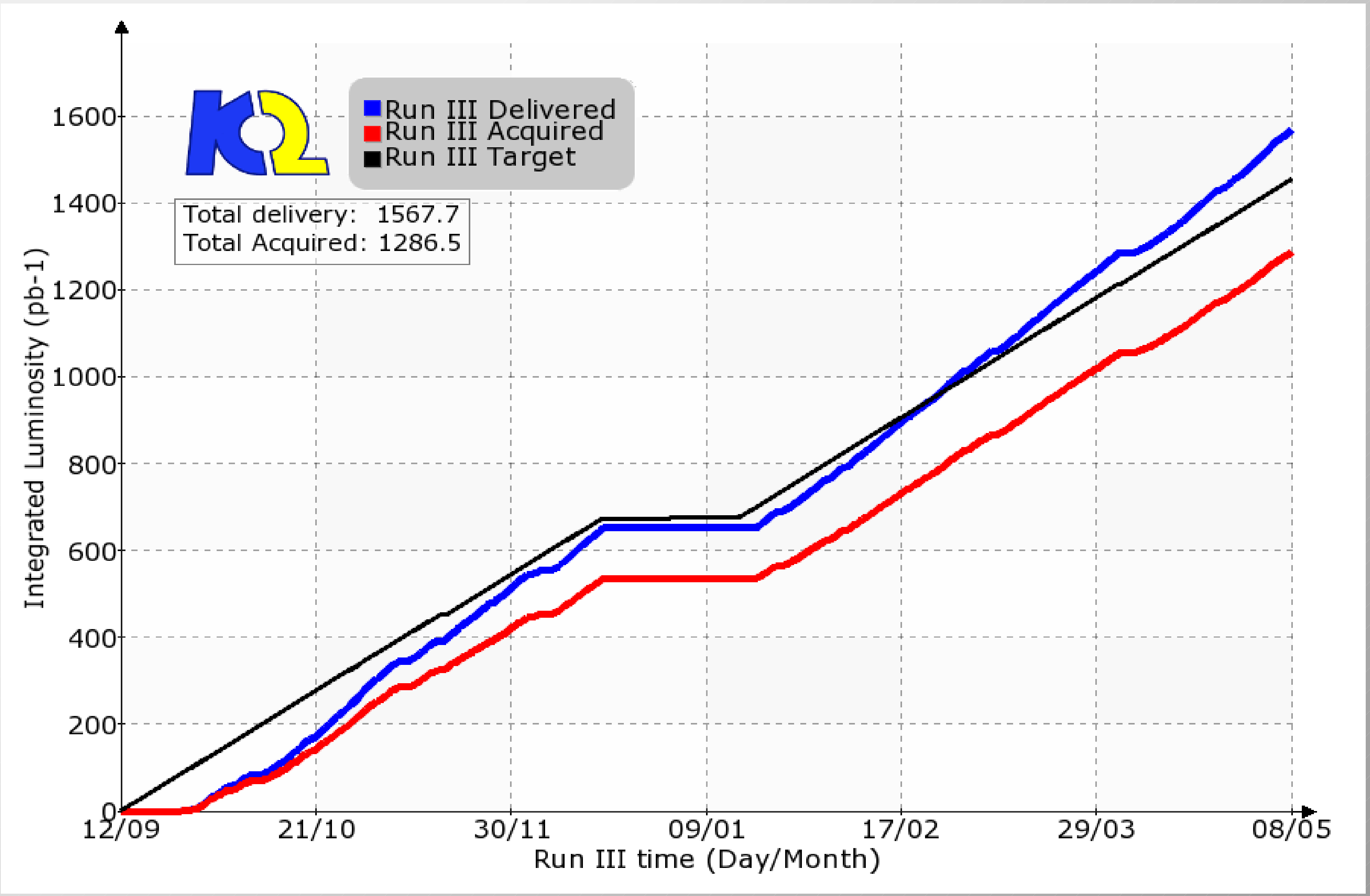
End of the DAΦNE activities for the KLOE-2 detector

KLOE-2 2016



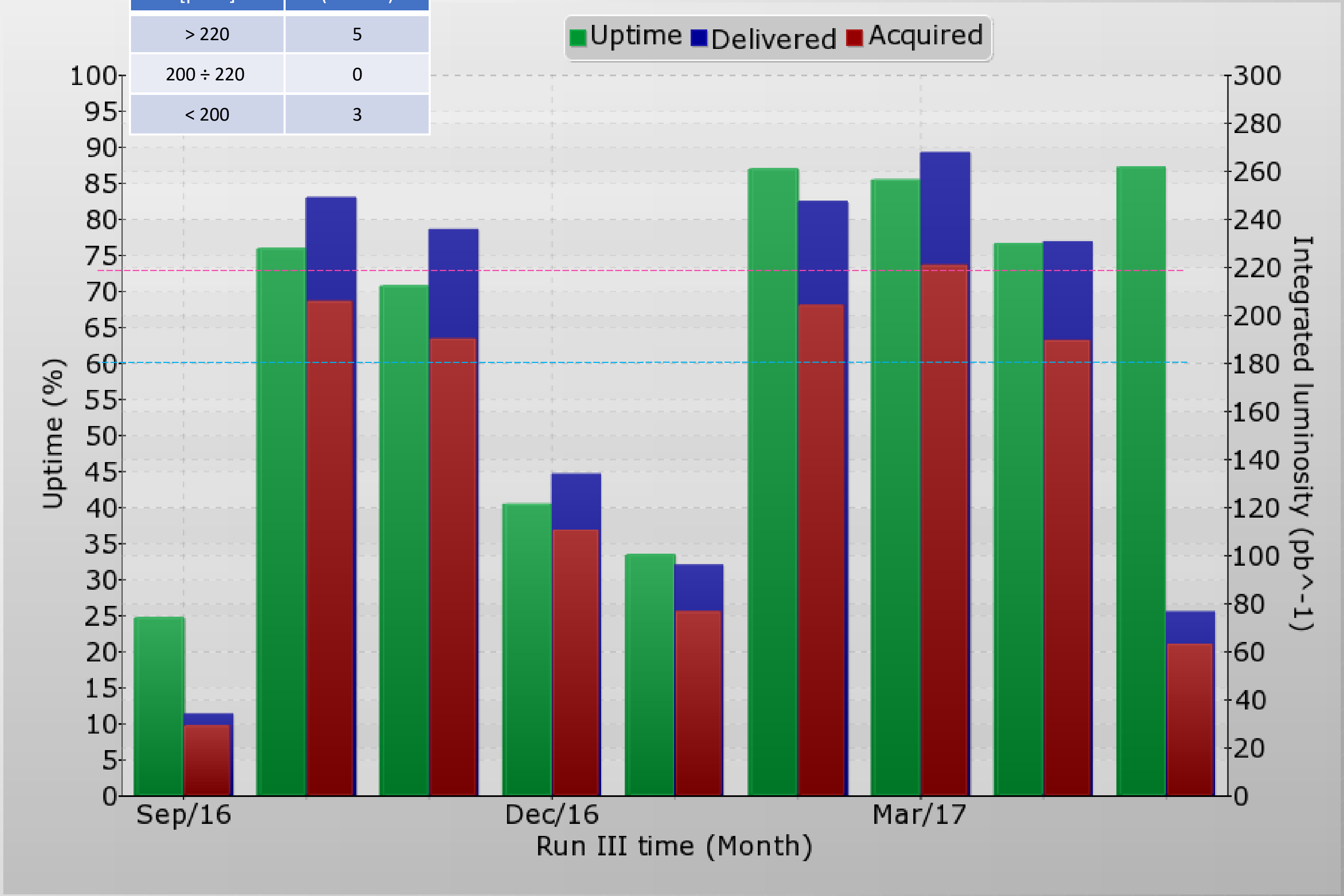
Dafne Delivered
Dafne Target
KLOE acquired
Total delivered (pb-1):4238.9
Total acquired (pb-1): 3411.6
$\int_{2016} L_{del} = 1.97\ fb^{-1}$
$\int_{2016} L_{acq} = 1.62\ fb^{-1}$
2016
Integrated Luminosity (pb-1)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
11/14
04/15
08/15
01/16
06/16
11/16
03/17
KLOE-2 Run time (Month/Year)

III Run so far (Sep/2016-May/2017)



III Run Monthly Performances

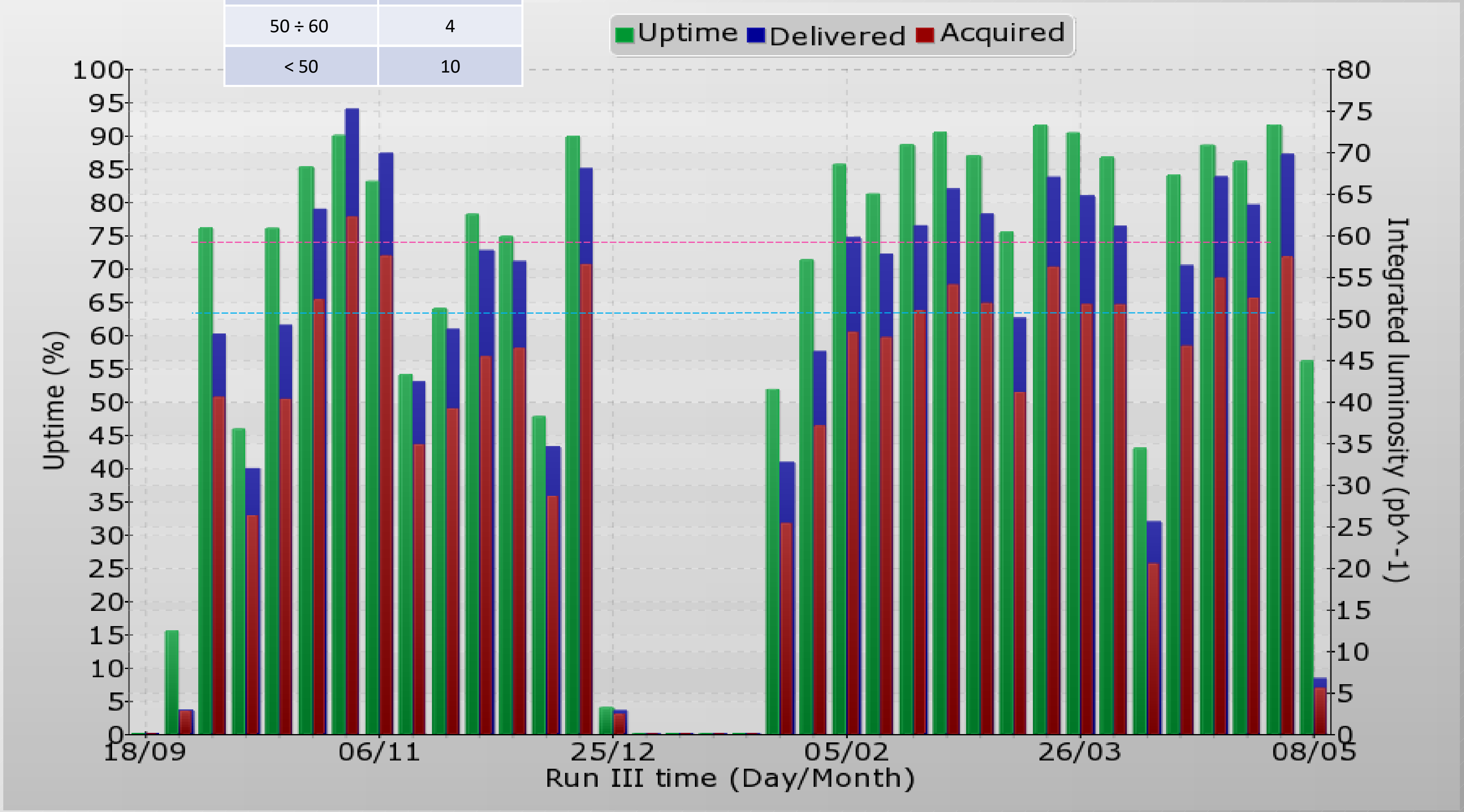
∫wL del [pb-1]	n months (8 total)
> 220	5
200 ÷ 220	0
< 200	3



Uptime is defined as the percentage fraction of the day in which the collider has been delivering luminosity, suitable for acquisition

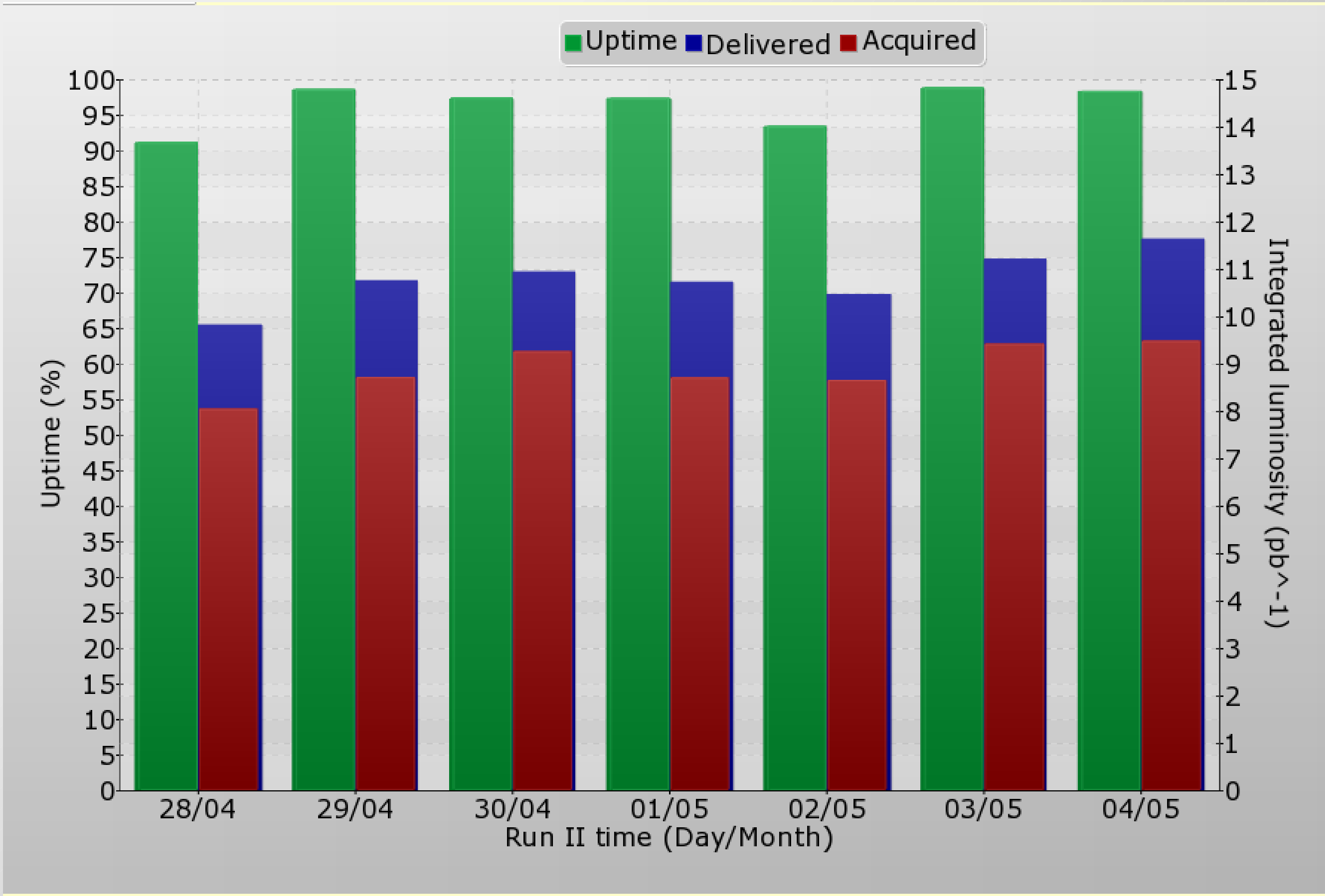
III Run Weekly Performances

∫wL del [pb-1]	n weeks (28 total)
> 60	14
50 ÷ 60	4
< 50	10

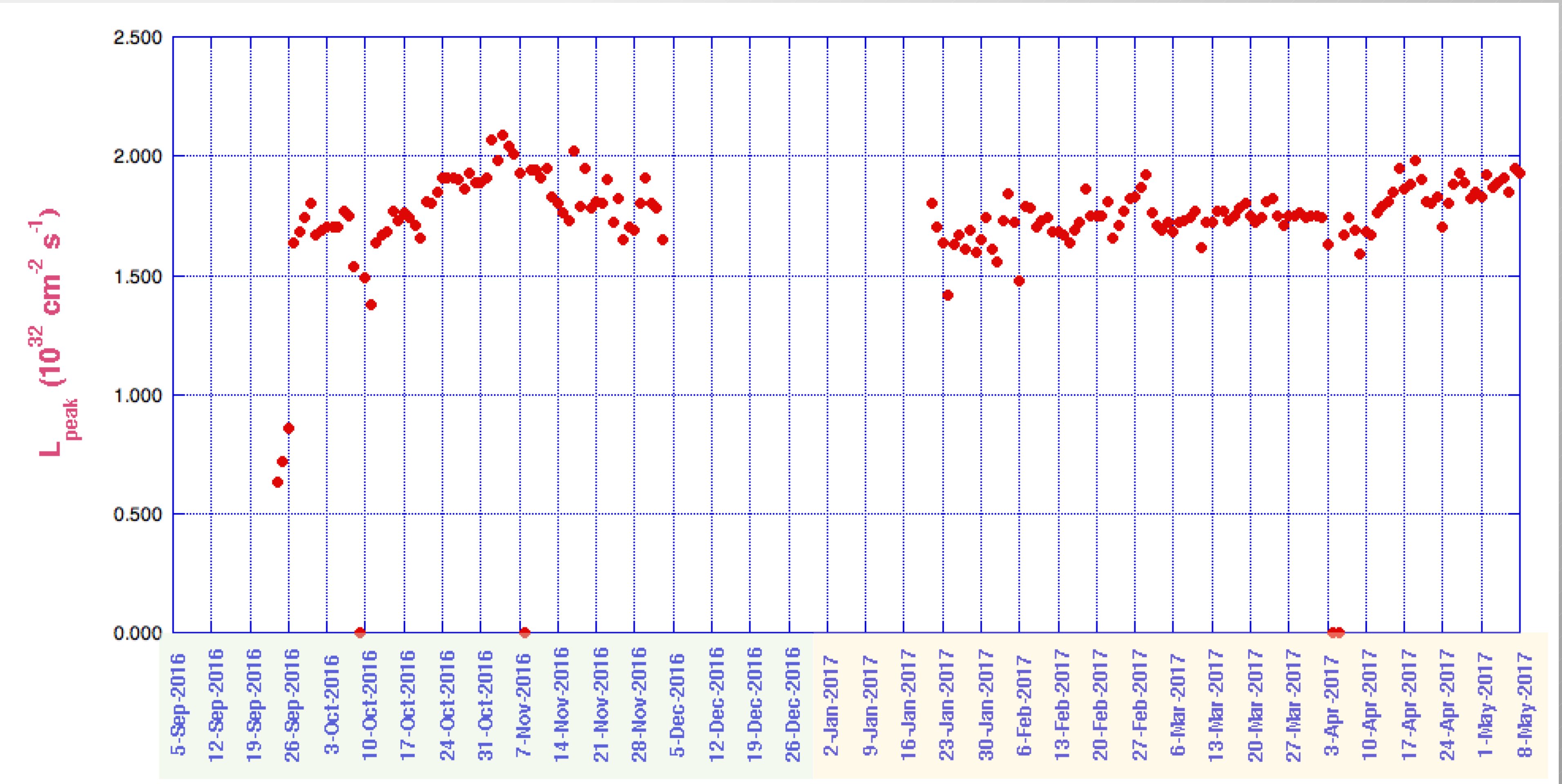


Uptime is defined as the percentage fraction of the day in which the collider has been delivering luminosity, suitable for acquisition

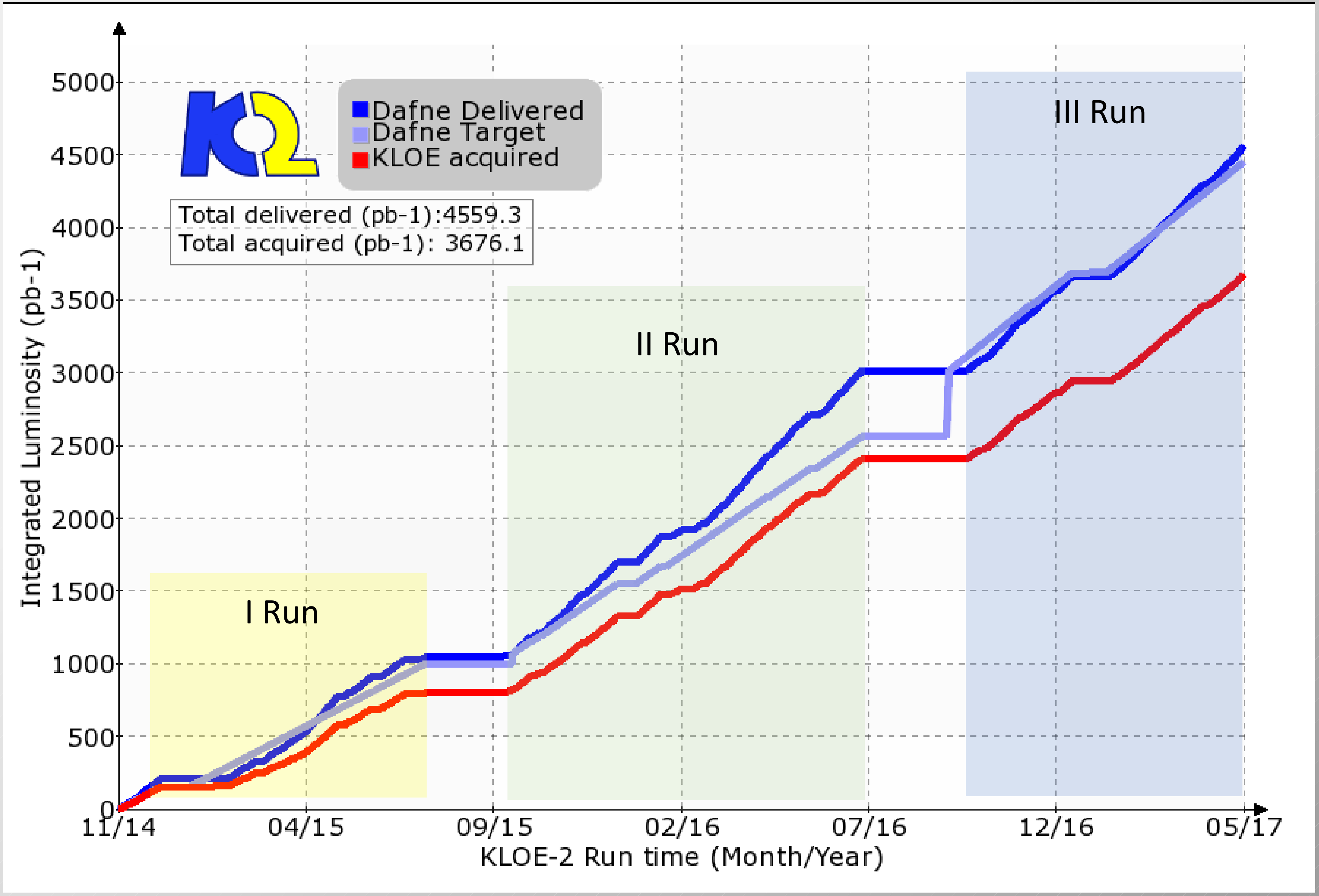
III Run: Day-by-Day Performance of last Week



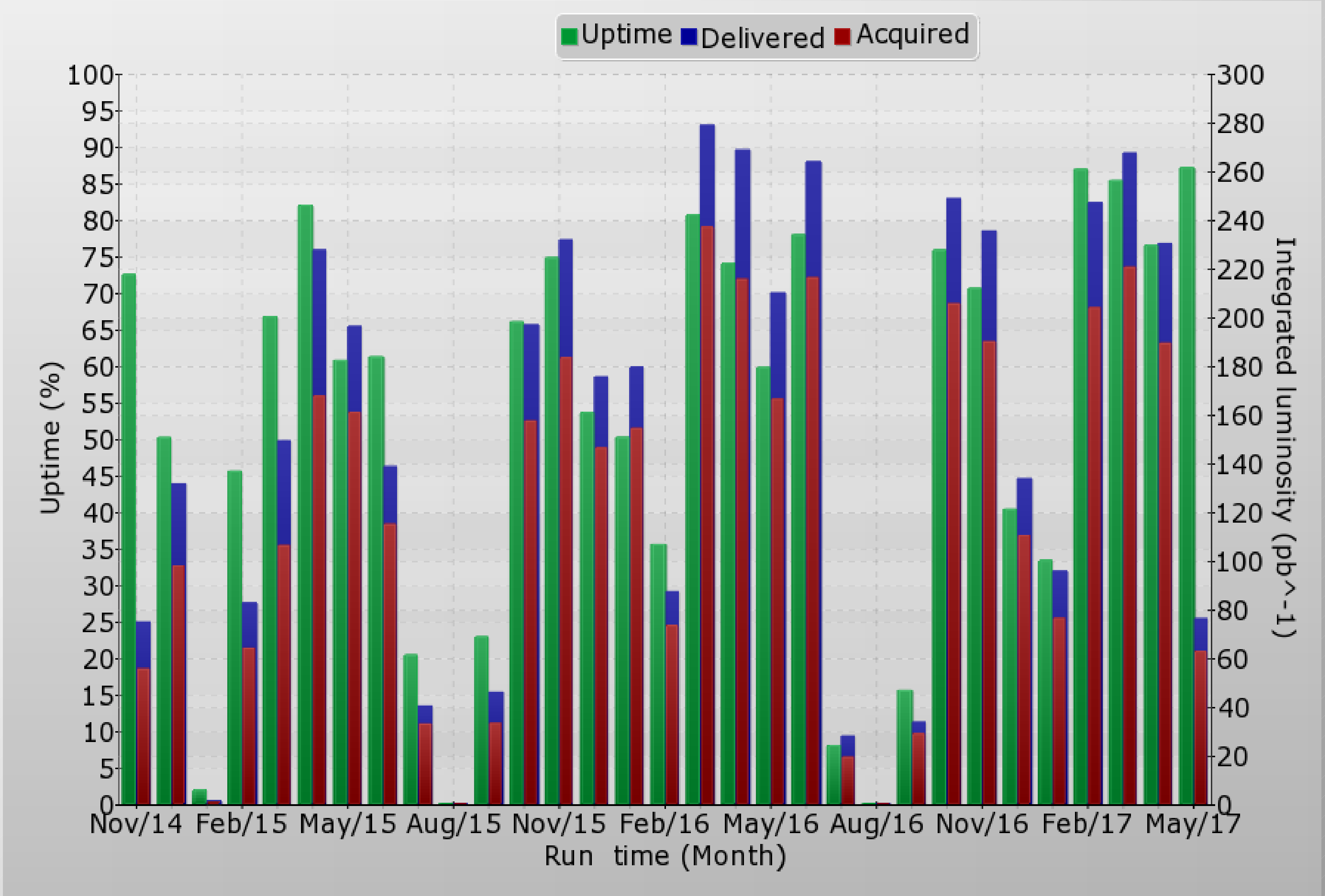
III Run Peak Luminosity Performances



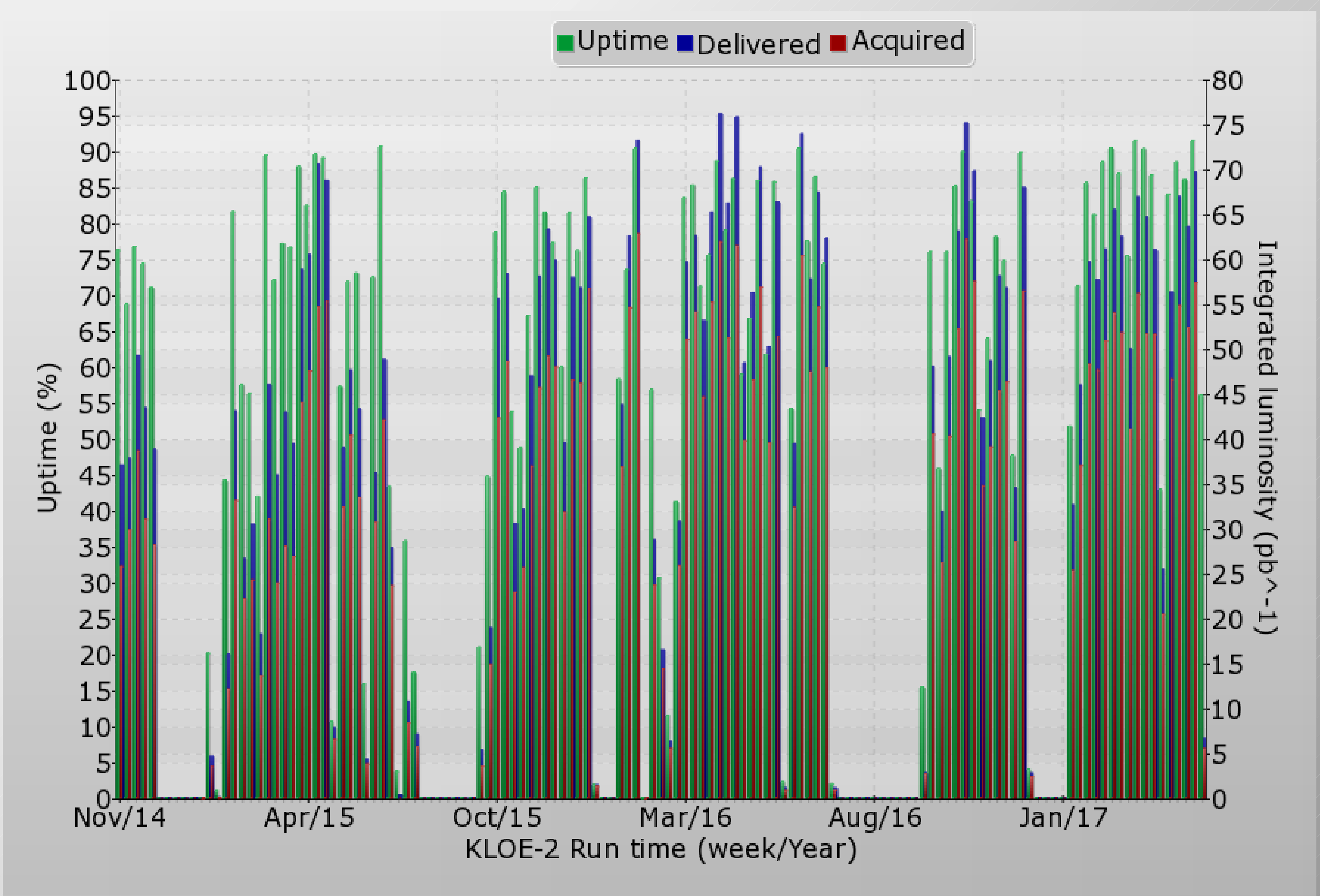
KLOE-2 Run Overview



KLOE-2 Run Overview by Month



KLOE-2 Run Overview by Week



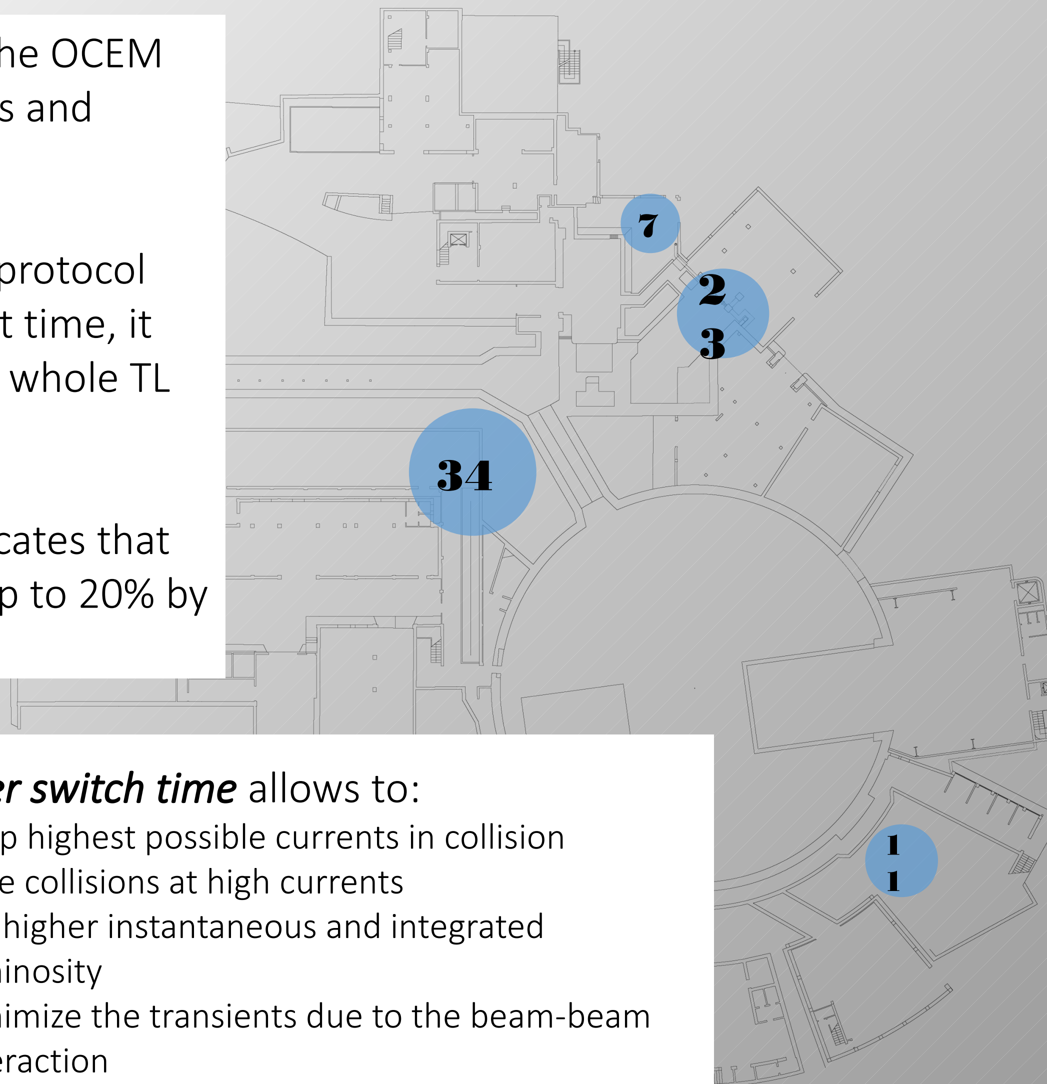
Maintenance and consolidation program

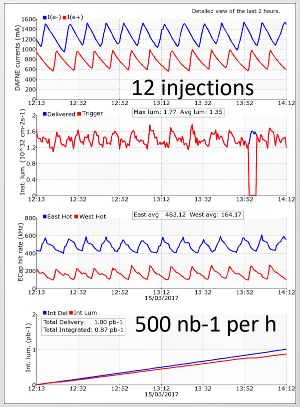
DAΦNE e+ <==> e- switch speed-up

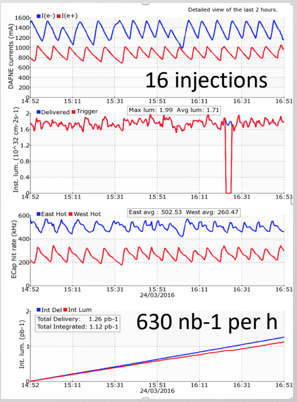
The DAΦNE switch time is dominated by the OCEM Power Supplies feeding the TL quadrupoles and dipoles.

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

Machine operations and data analysis indicates that the integrated luminosity could increase up to 20% by reducing the switch time.



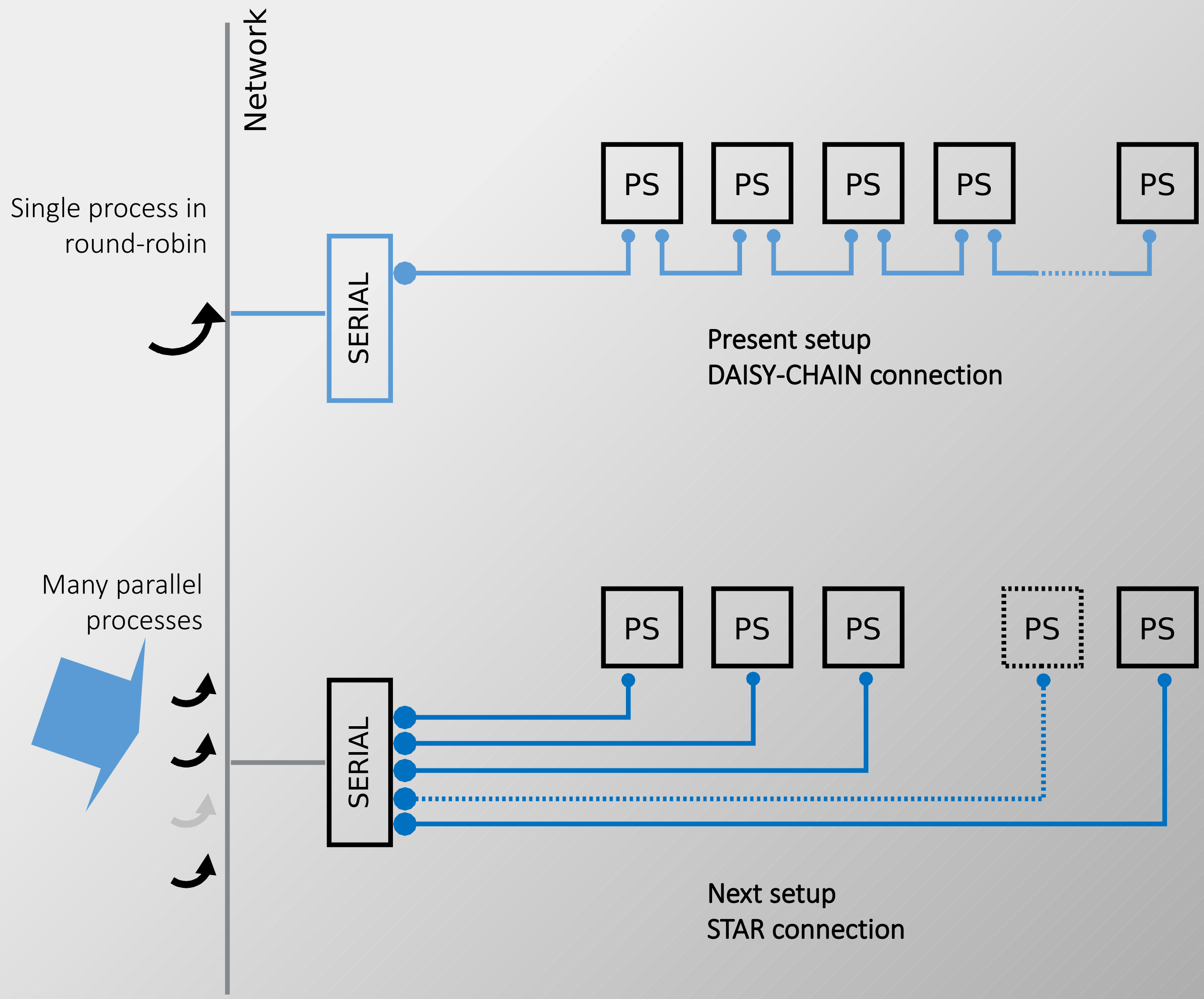




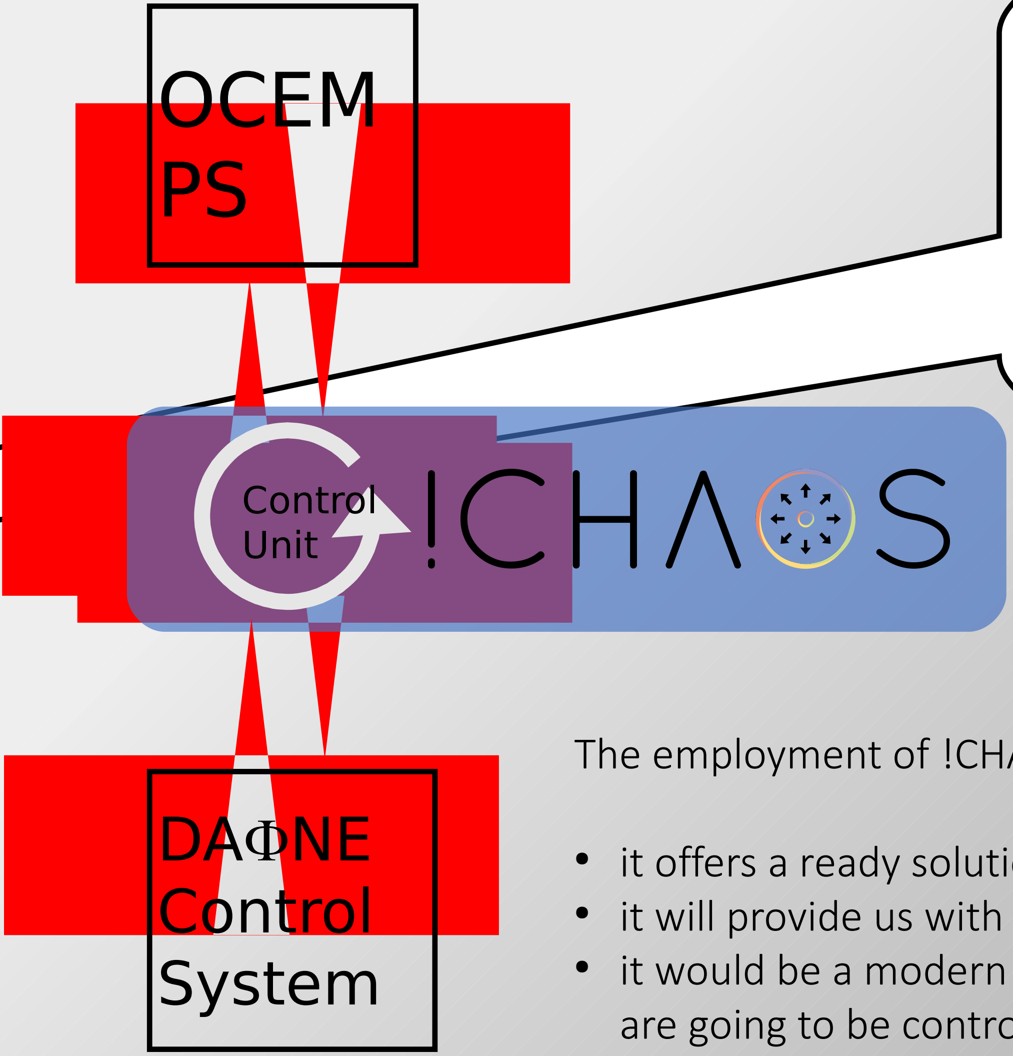
A shorter switch time allows to:

- keep highest possible currents in collision
- tune collisions at high currents
- get higher instantaneous and integrated luminosity
- minimize the transients due to the beam-beam interaction
- level luminosity

DAΦNE e+ <==> e- switch speed-up



DAΦNE e+ <==> e- switch speed-up



!CHAOS (*Control system based on Higly Abstracted and Open Strucure*) is a new software framework developed at LNF for the control of plants and experimental setups.
It has been tested on the DAFNE BTF and proposed for the SPARC upgrade.
!CHAOS is also involved in many TT projects.

The employment of !CHAOS is the logical choice because:

- it offers a ready solution to improve the OCEM commutation
- it will provide us with many other features such as *fast archiving*
- it would be a modern and uniform solution (BTF, PADME & SPARC are going to be controlled with !CHAOS)

DAΦNE e+ <==> e- switch speed-up

Roadmap

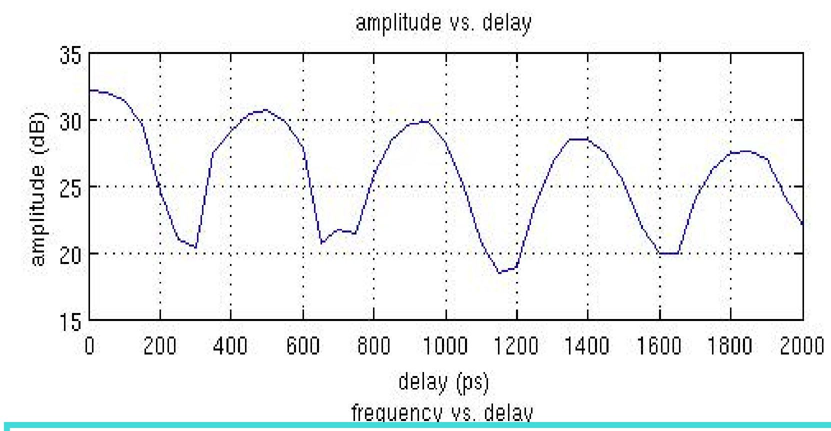
DONE

1. **pilot test on 9 Power Supplies**
   - dedicated serial lines
   - single control process (conventional DEVILs)
2. **final setup**
   - dedicated serial lines for the remaining 8 Power Supplies
   - employment of !CHAOS CUs as control processes

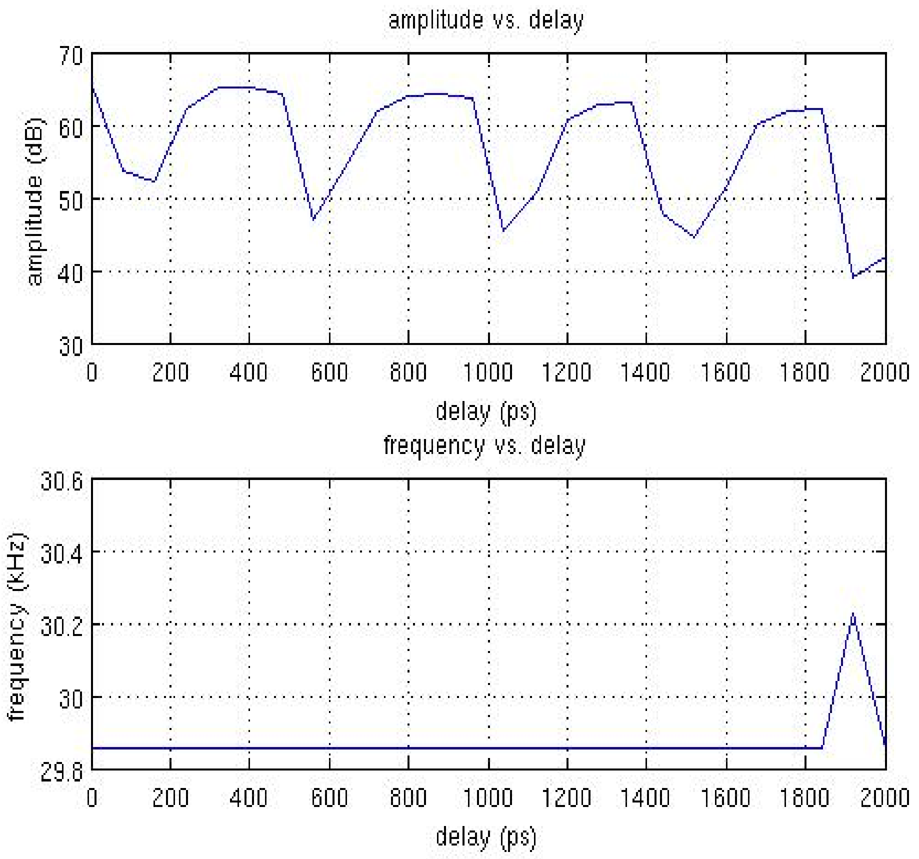
Longitudinal feedback upgrade

- *Both longitudinal feedback systems have been upgraded to achieve a more efficient correction signal during November'16 and January'17*
-
- *In the very past (years 1996-2007) the analog backend module was implemented by two modulation steps: AM and QPSK modulation*
- *After the transition (2007) from the old DSP project to new much more compact FPGA design, the backend module was simplified (only AM)*
- *With the Jan/2017 upgrade the double modulation scheme has been implemented again by developing the necessary hardware and software modules*

Longitudinal feedback timing plots after the upgrade: e- (left) and e+ (right)



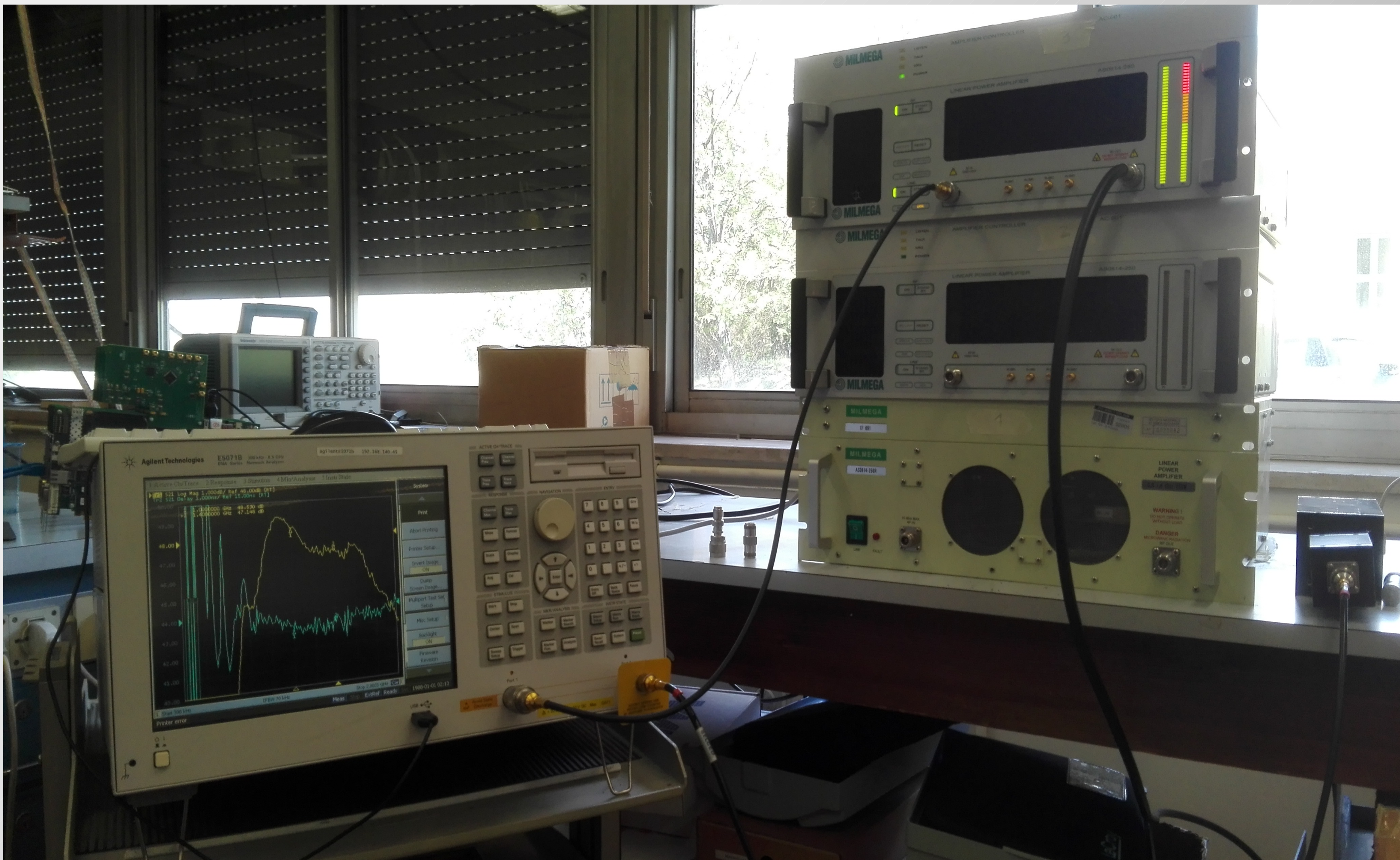
The double modulation scheme asks for a very accurate timing procedure to be executed with a single bunch that have to be excited at the synchrotron frequency



Longitudinal feedback power amplifiers

- *In the last years, T&L power amplifier faults have been rapidly found by internal or beam diagnostics*
- *In such cases amplifiers have been repaired mostly by SELCED (electronics service) technicians*
- *During last month a new kind of trouble has been found and fixed in one of the 6 power amplifiers*
- *The trouble is given by a too large ripple power supply*
- *Activities are in progress to manage promptly any next trouble of the same types in terms of both diagnose and repairing*

Longitudinal feedback power amplifiers: test in the laboratory



DAΦNE Schedule 2017

Month	KLOE-2 operations	Other DAΦNE activities	Extras
Jan	15	Jan 2nd – 13th Maintenance - restart on Jan 16th	
Feb	28		
Mar	31		
Apr	27		Apr 3rd visitors (10 hs) Apr 3rd ÷ 5th new SWITCH procedure test
May	18	May 15th – 17th Safety Controls + May 18th - 26th Maintenance	Open Day May 27th
Jun	30		
Jul	31		
Aug	0	Aug 21st – 31st Maintenance	
Spt	25	Spt 1st – 4th Maintenance	
Oct	30		Science Night 1 day
Nov	27	Nov 6th – 8th Safety Controls	
Dec	19		
Total	**281**		

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 to be checked

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
DAΦNE commissioning and SIDDHARTA setup

January 2019
start the SIDDHARTA-2 data taking

Collisions for SIDDHARTA

Several well founded considerations recommend to install SIDDHARTA on the IR1

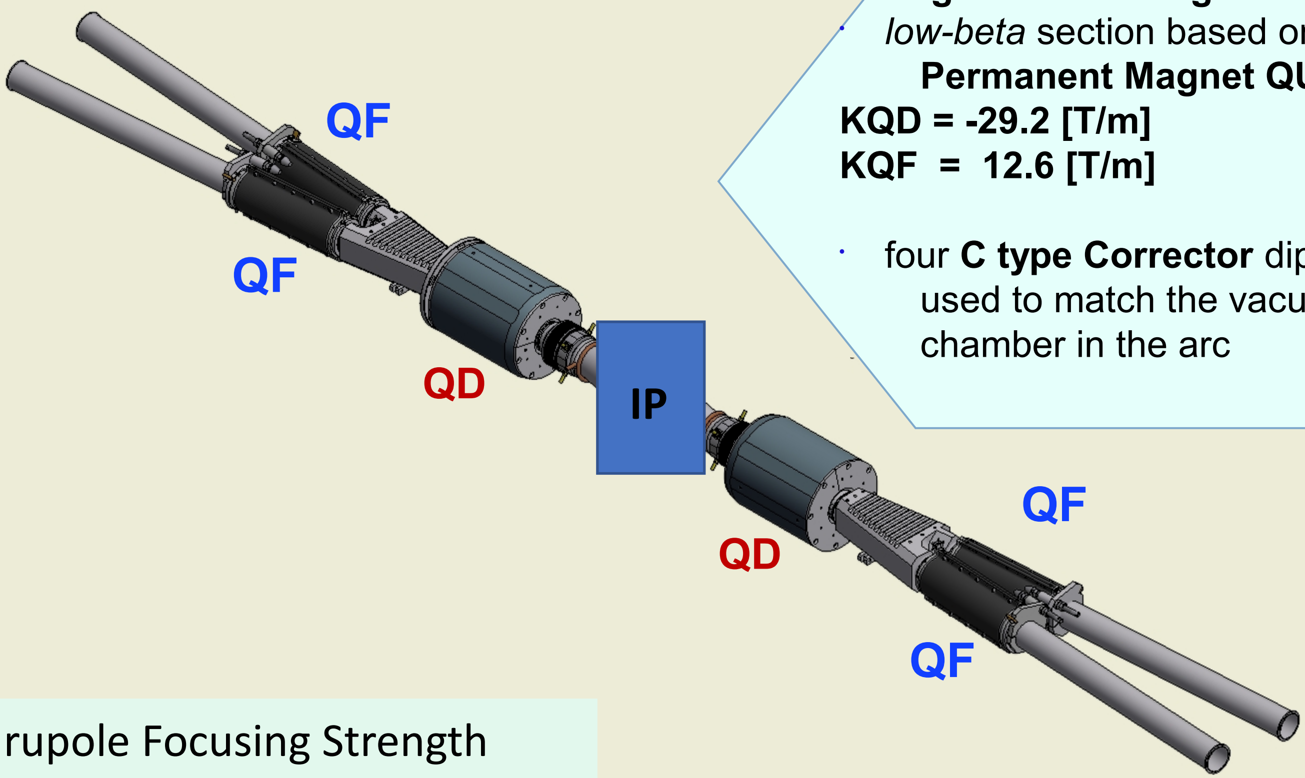
KLOE-2 detector must be removed together with the IR1 part of vacuum chamber and permanent magnets

To respect the DAΦNE 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

- quadrupoles
- vacuum chambers
- diagnostics

SIDDHARTA Low-β section



- **large collision angle ~ 50 mrd**
- *low-beta* section based on **Permanent Magnet QUADs**:

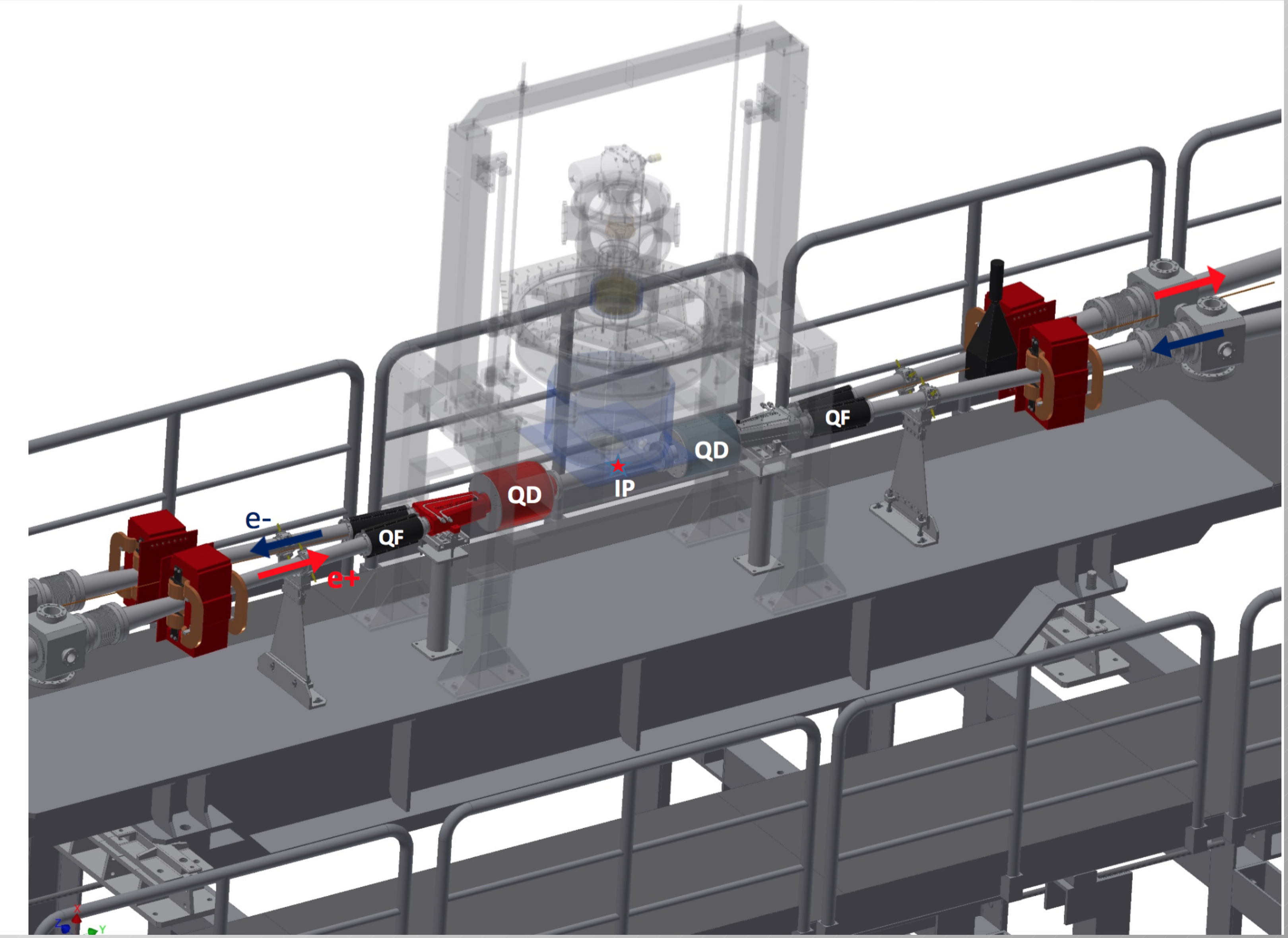
KQD = -29.2 [T/m]
KQF = 12.6 [T/m]

- four **C type Corrector** dipole are used to match the vacuum chamber in the arc

Quadrupole Focusing Strength

$$\boldsymbol{k}[m^{-2}] = \frac{e}{pc}\frac{\boldsymbol{dB_y}}{\boldsymbol{dx}} = \frac{0.299\boldsymbol{g}[T/m]}{\beta E[GeV]}$$

DAΦNE & SIDDHARTA-2



New PM QUADs Design

Several aspects could 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

Agreement for the realization of six permanent magnet quadrupoles based on SmCo2:17 technology DRAFT

(C. Milardi, L. Pellegrino – March 31st, 2017)

1. Scope of work

The work aims at designing six permanent magnets (two defocusing quadrupoles QD and four focusing QF) to be used in the new low-β section of the accelerator DAFNE for the Siddharta-2 experiment. The goal will be pursued trough the following steps:

1. Performing magnetic and mechanical simulations
2. Making the CAD models and all the drawings for the fabrication
3. writing the specifications for the fabrication
4. writing all the documents for the tenders
5. performing the mechanical and magnetic measurements.

The realization approach foresees to start from the specification, see table below, used for the construction of similar devices presently operating on the DAFNE collider, improving some aspects which have proved to be critical for the collider performances and the experiment data taking.

The final design shall include the electromagnetic as well as the mechanical design, and it shall be detailed at a level suitable for the construction.

The technical details, the division of work between LNF and ESRF and the responsibilities are listed in the present document.

PM QUADs Specifications

PM Quadrupole Specifications

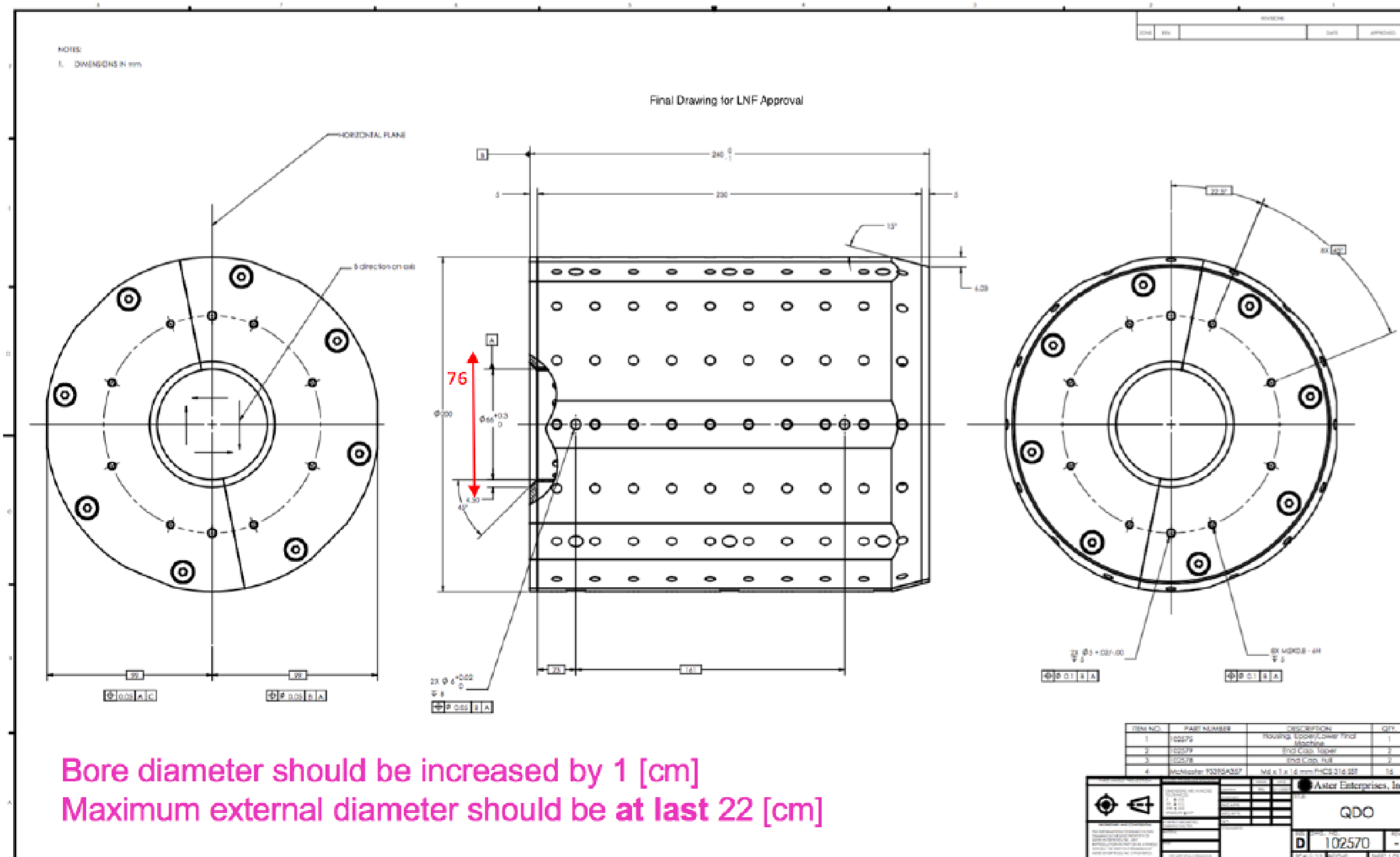
designation	QD0	QF1
Quantity	2	4
Minimum clear inside radius (mm)	33	30
PM inside radius (mm)	34	30,5
Maximum outside radius (mm)	100	45r/55ears/with cut
Magnetic length (mm)	230	240
REM physical length (mm)	230	240
Maximum mechanical length (mm)	240	250
Nominal gradient (T/m)	29,17	12,59
Integrated field strength (T)	6,71	3,02
Good field region radius (mm)	20	20
Integrated field quality |dB/B|	5,00E-04	5,00E-04
Maximum allowable mismatch of Integrated gradient between magnets	1,00E-03	1,00E-03
REM stabilization temperature (°C)	150	150
Magnet material type	SmCo2:17	SmCo2:17
Magnet construction	2 half – split	2 half - split

LNF and ESRF agree on SmCo2:17 as the material for the magnetic elements, and Aluminum alloy for the casing.

The QUADs are Halbach type permanent magnets

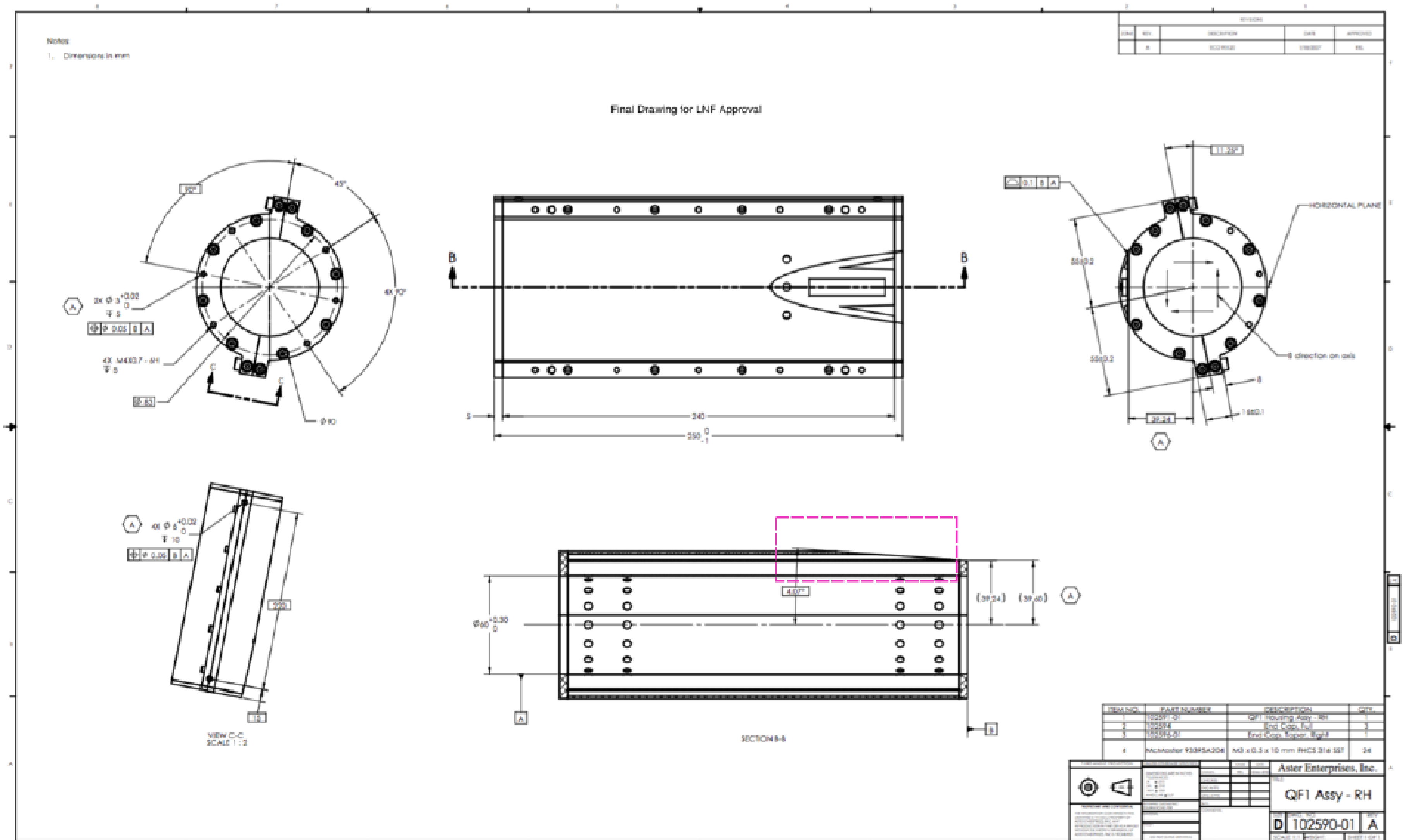
Appendix 1

PM QD



Mechanical drawing of the existing permanent magnet QD.

PM QF1w



Mechanical drawing of the existing permanent magnet QF (RH)

5. Time schedule

5.1. Milestones

The work aimed at realizing the six permanent magnet quadrupoles should be organized in order to fulfill the following main milestones:

Preliminary magnetic design delivered	end of June 2017
Final magnetic and mechanical design	mid Sep 2017
Mechanical supply ready	end Feb 2018
Magnets assembly	end March 2018
Magnetic and mechanical measurements	end Apr 2018

Activity	responsibility	Duration	start	End
Magnet performance specification	**CM**	**0 g**	**31/03/17**	**31/03/17**
Magnetic simulation and design optimization	ESRF	55 g	31/03/17	15/06/17
Preliminary magnetic design delivered		**0 g**	**15/06/17**	**15/06/17**
Mechanical design of casing and supports	GS	30 g	16/06/17	27/07/17
Thermal and mechanic simulation	LP	20 g	28/07/17	24/08/17
Mechanical design of tools for the assembly	GS	20 g	28/07/17	24/08/17
Validation of mech-mag design	LNF-ESRF	20 g	25/08/17	21/09/17
Mechanical design ready		**0 g**	**21/09/17**	**21/09/17**
REM Tender assignment	LNF	30 g	22/09/17	02/11/17
REM procurement	LNF	85 g	03/11/17	01/03/18
Casing, tools and supports procurement	LNF	85 g	22/09/17	18/01/18
Magnets assembly	ESRF-LNF	22 g	02/03/18	02/04/18
Magnetic and mechanical measurements and shimming	ESRF-LNF	15 g	03/04/18	23/04/18
END of Activity		**0 g**	**23/04/18**	**23/04/18**

Other R&D Activities

Vacuum components

Installation of laser treated vacuum chamber and diagnostics for e-cloud mitigation studies

Luminometer

SIDDHARTA-2 INSTALLATION
ACCELERATOR PRELIMINARY ECONOMIC PLAN (L. Pellegrino 17-11-2016)

ACTIVITY	duration (w)	internal resources	men-days (i.r. only)	Cost (contracts only)
KLOE2 setup roll out				
Beam pipe removing	0.6	3	9	
Cables arrangement	1	4	20	
Beam pipe securing to End Caps	1	4	20	
Services disconnection (power, water, cryo)	1	4	20	
Wall dismantling	1			€ 1,000.00
Plates removing	0.6	2	6	€ 500.00
Wheel mounting	0.4	2	4	€ 500.00
Roll-out	0.4	2	4	€ 500.00
Wall reassembling	1			€ 1,000.00
Final safe arrangement	1	2	10	€ 500.00
Main support structures				
Design structural review	8			€ 3,000.00
Steel structure maintenance	8			
Concrete blocks procurement	8			
Tender for installation	4	0.1	2	
Main structure installation	2			€ 15,000.00
Y vacuum chambers				
Design review	4	0.5	10	
Procurement	8			€ 30,000.00
Y chambers installation	1	3	15	
Permanent magnet quadrupoles				
Design	12	0.5	30	
Procurement	24			€ 200,000.00
Permanent quadrupole installation	1	3	15	
Supports for chambers, magnets and others				
Design of spider-like tools for KLOE	4			
Design of supports	6	0.5	15	
Supports procurement	12			€ 5,000.00
Supports installation	1	2	10	
External components re-installation	1	2	10	
Accelerator power supplies maintenance (tender incl.)	36			€ 90,000.00
Services				
Cables	1	2	10	
Cooling hoses	1	2	10	
Chiller procurement and installation	8			
Vacuum pumps replacement				€ 25,000.00
KLOE Wall structural review				€ 3,000.00
SIDDHARTA-2 setup installation				
Installation	2			€ 10,000.00
TOTAL			**220**	**€ 385,000.00**

Conclusions

DAΦNE performances:

- *operation are stable and reproducible*
- *background is compatible with an efficient data-taking*
- *the 3rd KLOE-2 run is ongoing as foreseen*

So far the I and II runs as well as part of III run have been already delivered for KLOE-2

∫L ~ 4.5 fb-1

In base at this result, the integrated luminosity goal is feasible within the schedule. Indeed in the III run, that will finish on July 31st 2017, in base at the agreements it will be necessary to deliver a total of 2 fb-1 (that means another 0.5 fb-1 to be collected up to the summer shutdown).

Maintenance and consolidation activities are in progress.

Well defined studies are under way to realize a new DAFNE run for the SIDDHARTA-2 detector

Thank you for your attention