

# DAFNE Status

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**Antonio De Santis**

*Laboratori Nazionali di Frascati – INFN*



- **DAFNE Layout**
- **KLOE-2 Physics Run achievement**
- **SIDDHARTA-2 Physics Run preparation**
- **DAFNE-TF: proposal for mid-term future**

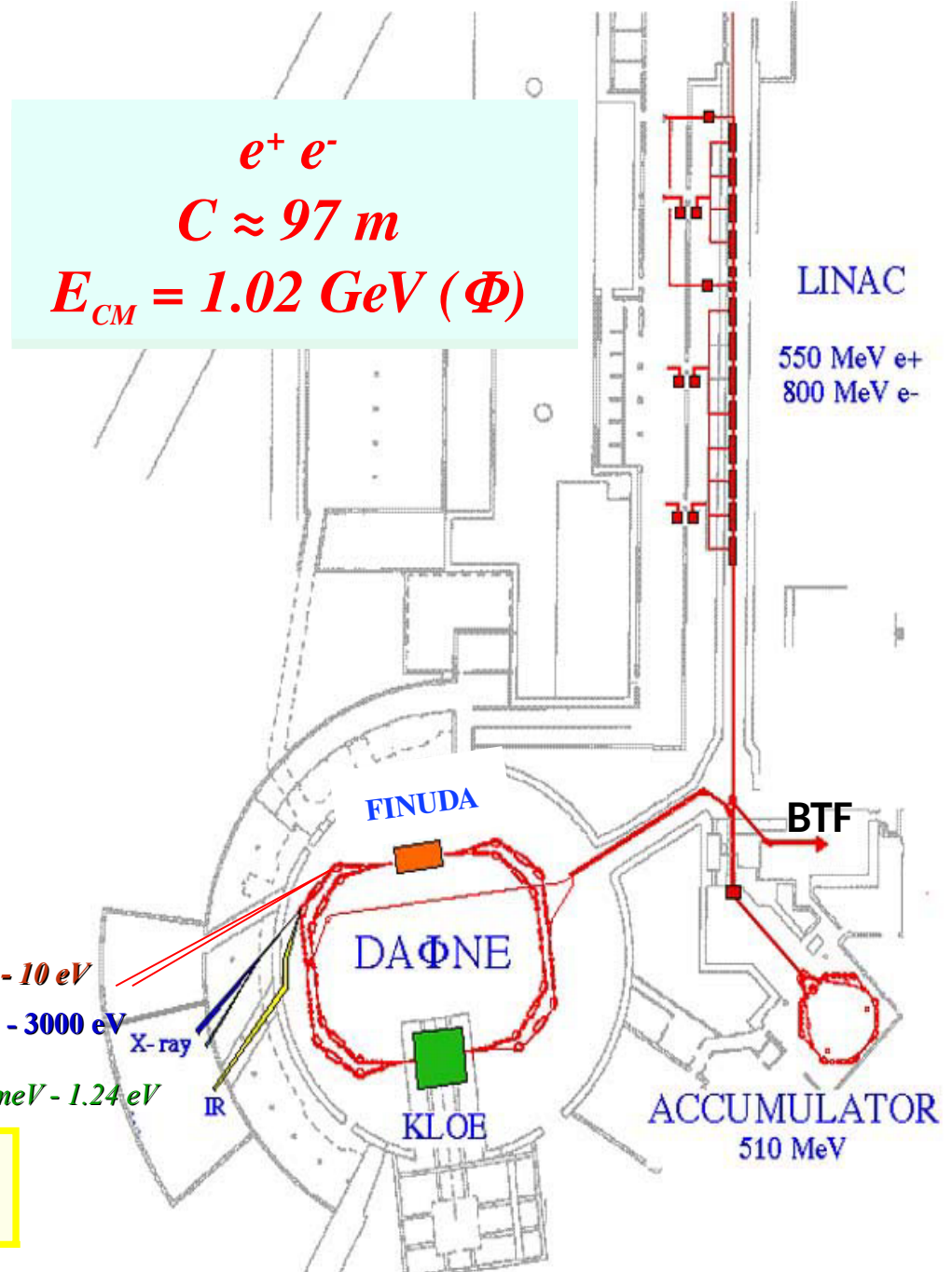
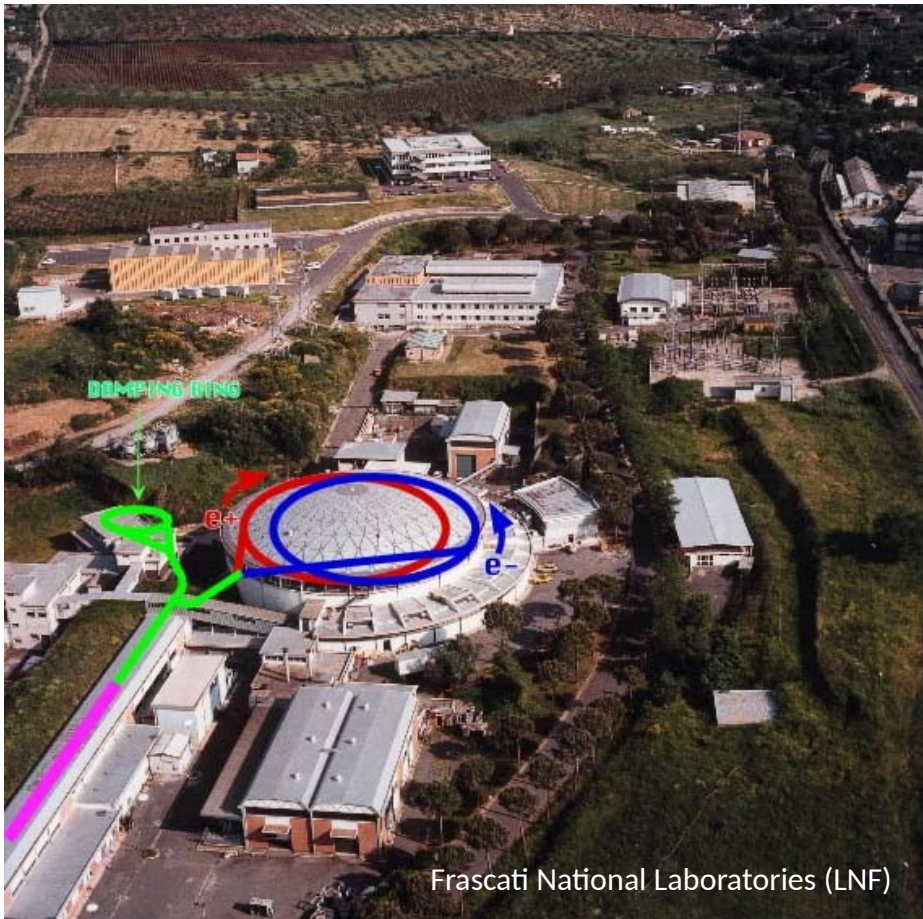
## **Laboratori Nazionali di Frascati:**

C. Milardi, D. Alesini, S. Bini, O. R. Blanco-Garcia, M. Boscolo, B. Buonomo, S. Cantarella, S. Caschera, A. De Santis, G. Delle Monache, C. Di Giulio, G. Di Pirro, A. Drago, A. D'Uffizzi, L. Foggetta, A. Gallo, R. Gargana, A. Ghigo, S. Guiducci, , S. Incremona, C. Ligi, M. Maestri, A. Michelotti, L. Pellegrino, R. Ricci, U. Rotundo, L. Sabatini, C. Sanelli, A. Stecchi, A. Stella, A. Vannozzi, M. Zobov.

## **International partners :**

J. Chavanne, G. Le-Bec, P. Raimondi (ESRF)  
D. Shatilov (BINP)

# The DAFNE Accelerator Complex

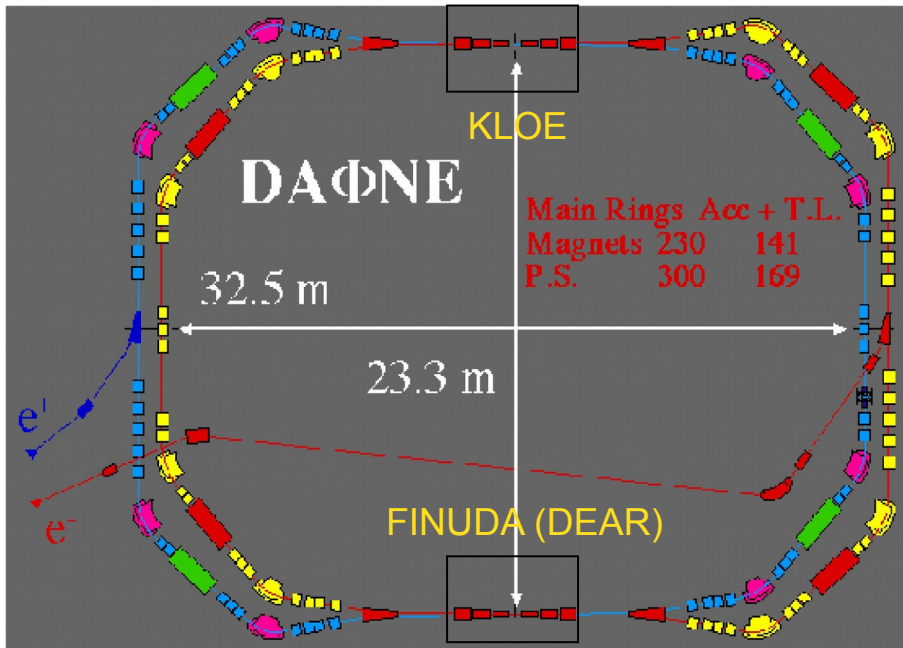


LNF are also part of the European synchrotron light Infrastructures

# DAΦNE Layout and Parameters



P. Raimondi , 2° SuperB Workshop, March 2006,  
 P.Raimondi, D.Shatilov, M.Zobov, physics/0702033,  
 C. Milardi et al., Int.J.Mod.Phys.A24, 2009.



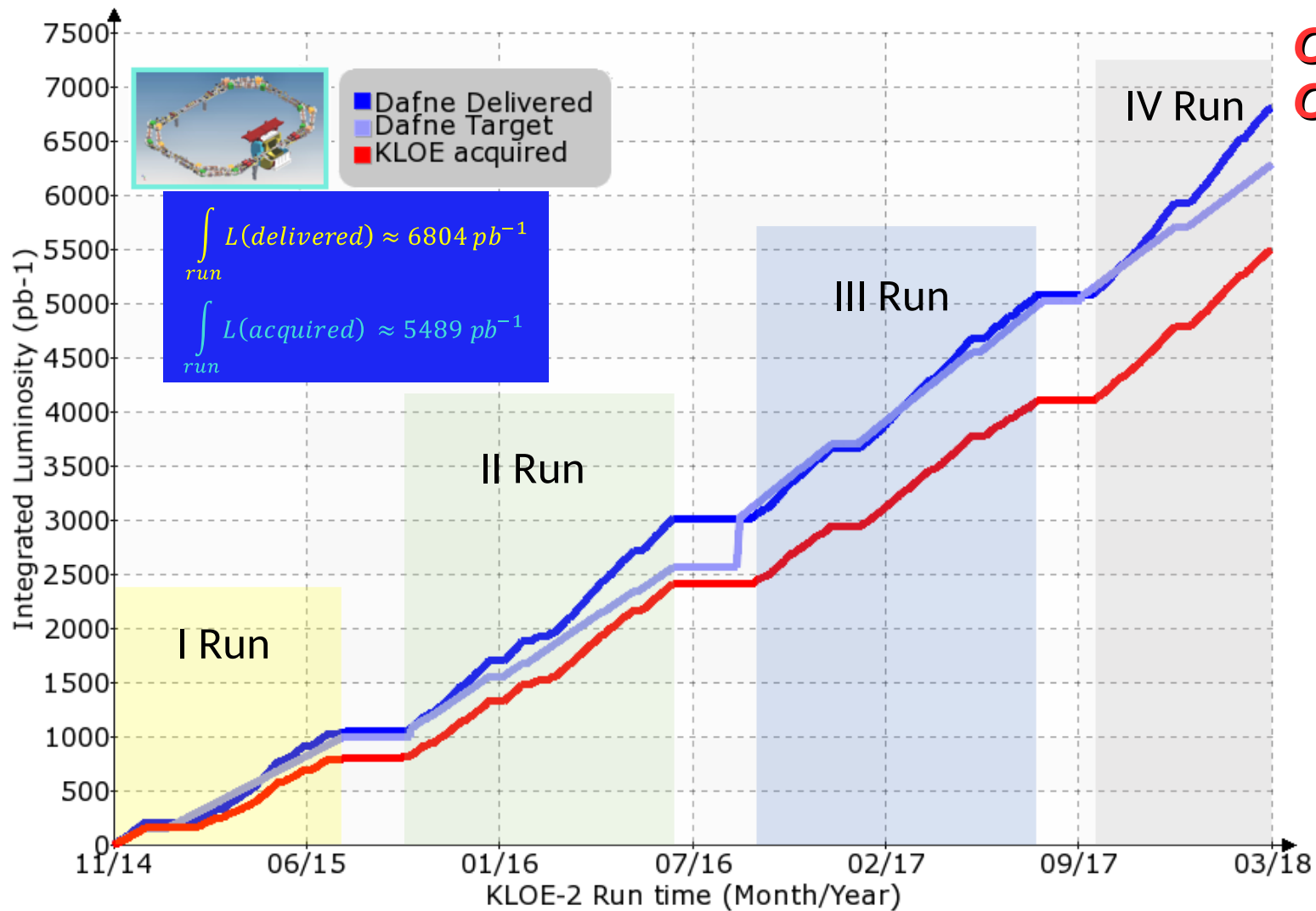
“Proposal for a  $\Phi$ -factory”, LNF-90/031 (IR),1990.

	DAΦNE native	DAΦNE Crab-Waist
Energy (MeV)	510	510
$\theta_{\text{cross}}/2$ (mrad)	12.5	25
$\epsilon_x$ (mm•mrad)	0.34	0.28
$\beta_x^*$ (cm)	160	23
$\sigma_x^*$ (mm)	0.70	0.25
$\Phi_{\text{Piwinski}}$	0.6	1.5
$\beta_y^*$ (cm)	1.80	0.85
$\sigma_y^*$ ( $\mu\text{m}$ ) low current	5.4	3.1
Coupling, %	0.5	0.5
Bunch spacing (ns)	2.7	2.7
$I_{\text{bunch}}$ (mA)	13	13
$\sigma_z$ (mm)	25	15
$N_h$	120	120

Colliding Beams have:  
 low E  
 high currents  
 short bunch spacing 2.7 nsec  
 long damping time

# KLOE-2 Physics Run: **achievements and outcomes**

# KLOE-2 Run Overview



Machine study often sacrificed to cope with anomalous fault rates in specific subsystems or to trace and identify unexpected behavior.

This approach and a considerable lack of manpower did not allow to exploit the DAFNE's full potential as a collider, but assured data taking.

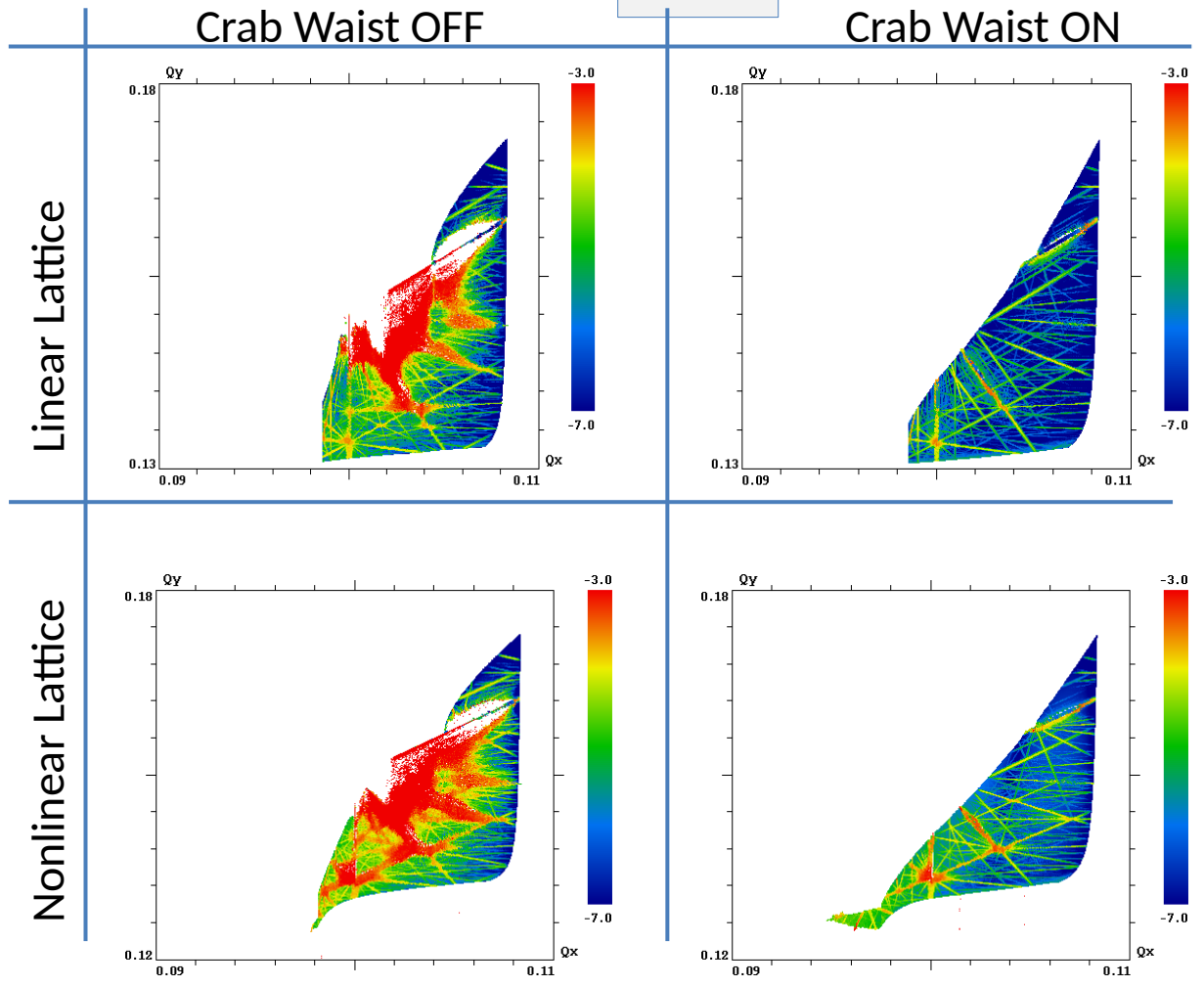
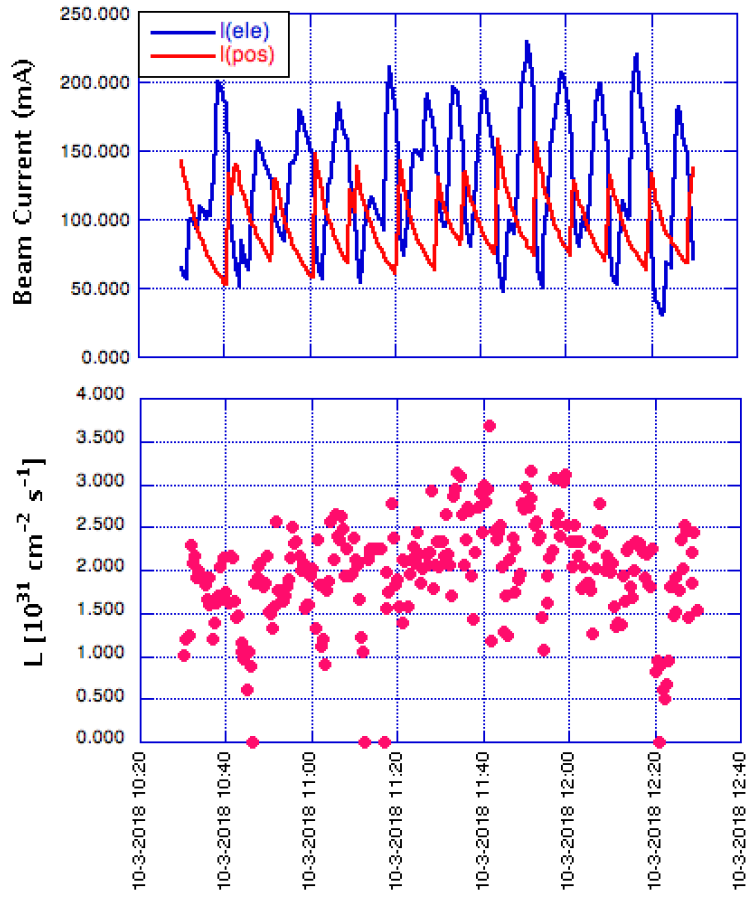
# Collisions study: 10 bunch luminosity

Aiming at minimizing the impact of multi-bunch effects and e-cloud instabilities on *Luminosity*

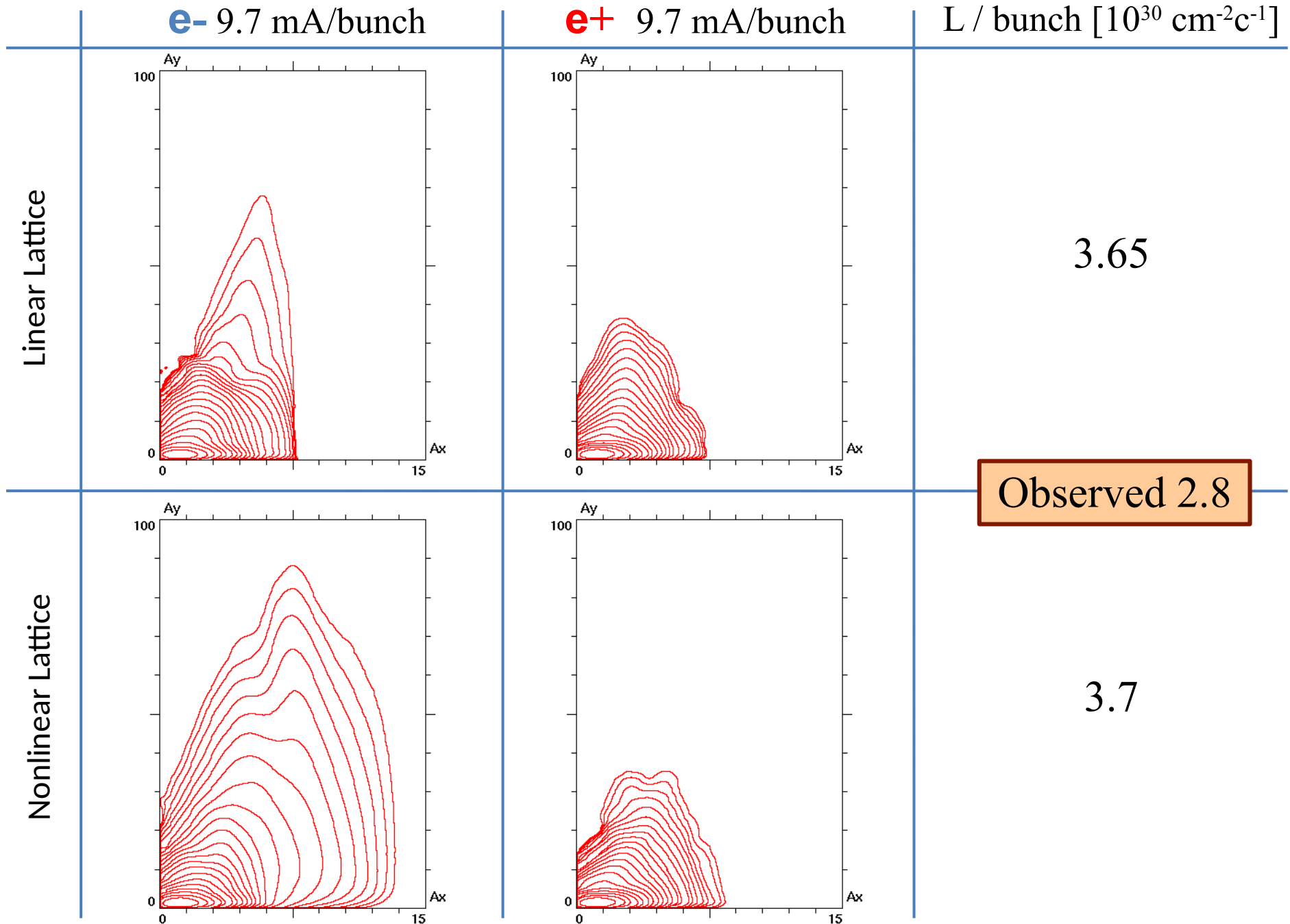
- $L_{peak} \sim 3 \times 10^{32} \text{ cm}^{-2} \text{ s}^{-1}$  might be achieved by colliding 100 bunches
- Beam-beam is not a limiting factor
- Crab-Waist Sextupoles work

Simulation with  
9.7 mA/bunch

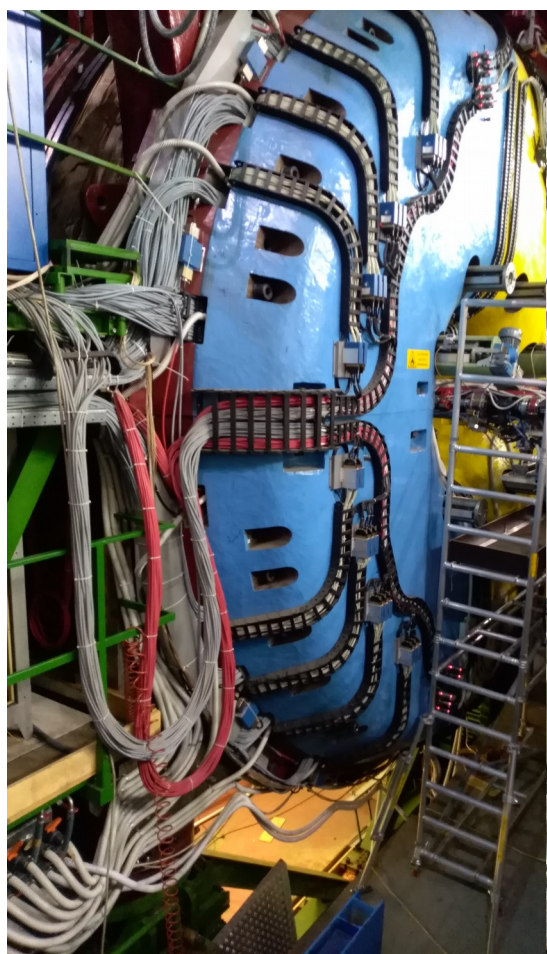
e+



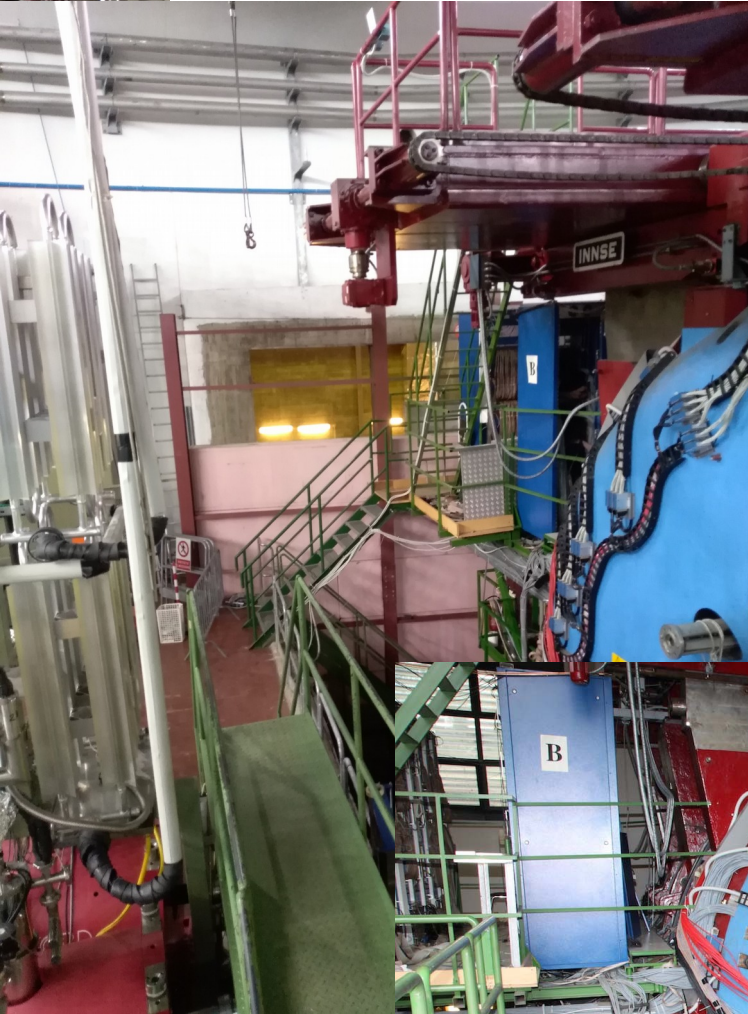




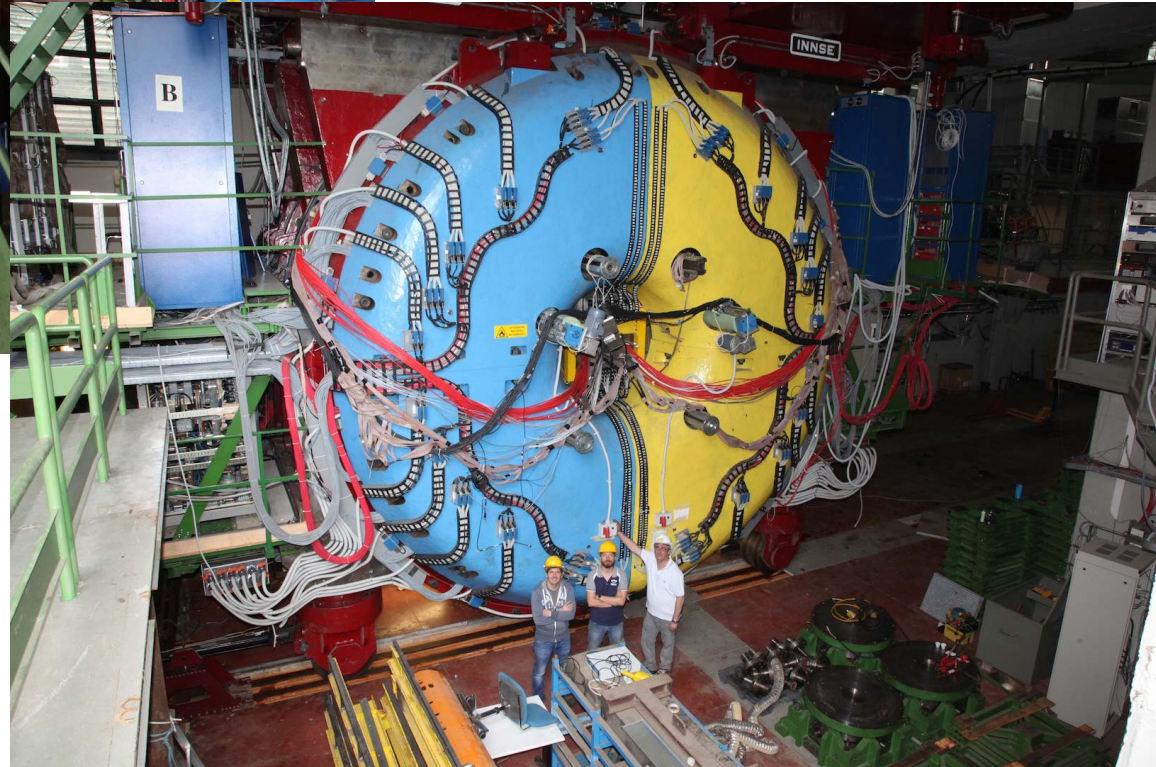
# SIDDHARTA-2 Physics Run: **collider preparatory phase**



**Apr18**



**May18**



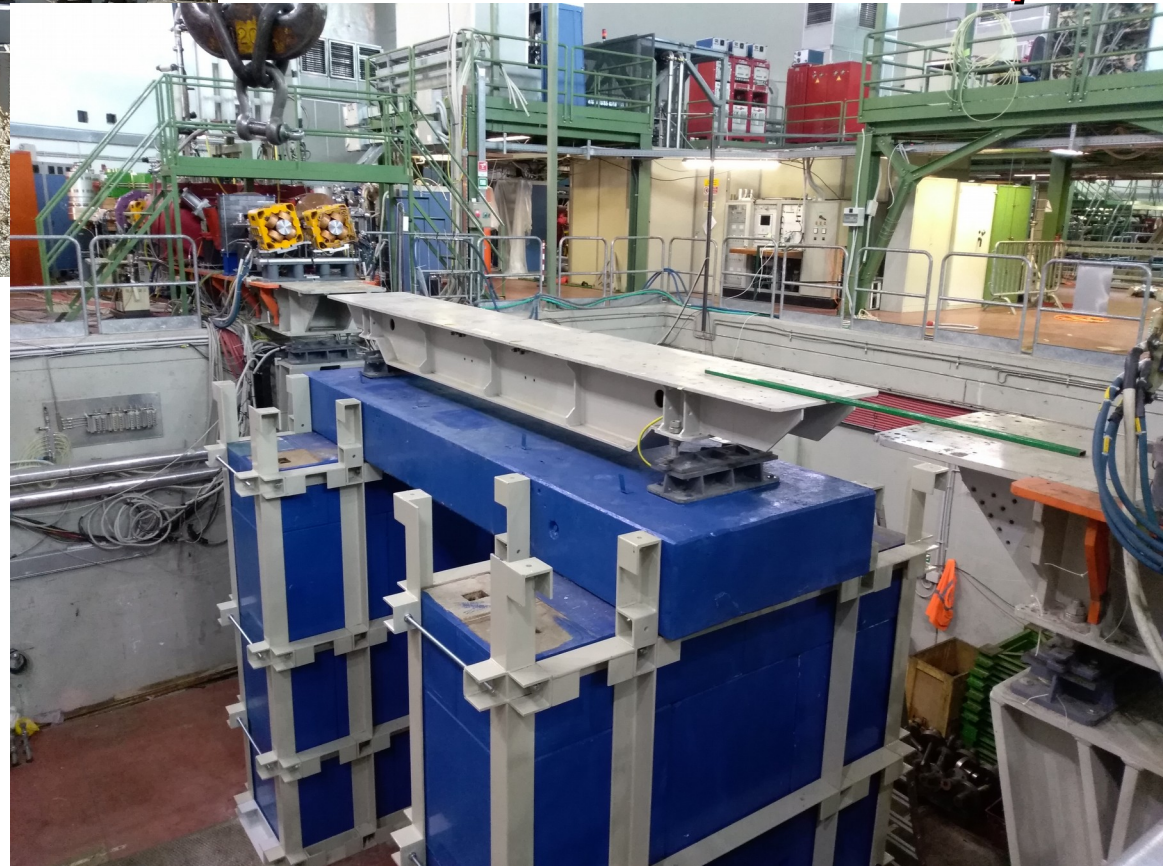
**Jun18**

# DAFNE IR for SIDDHARTA-2 preparation



**Apr18**

**Sep18**

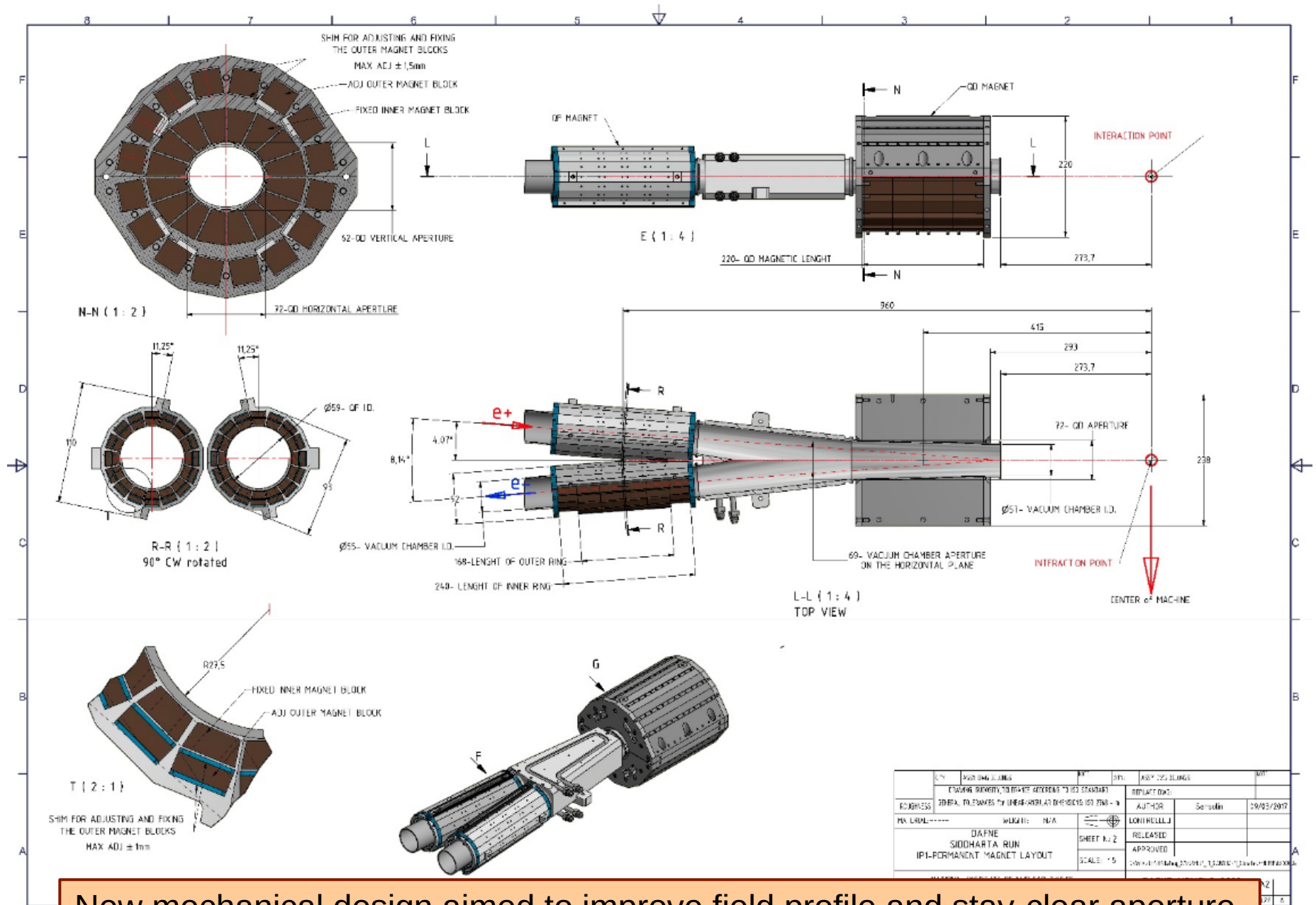


**Nov18**



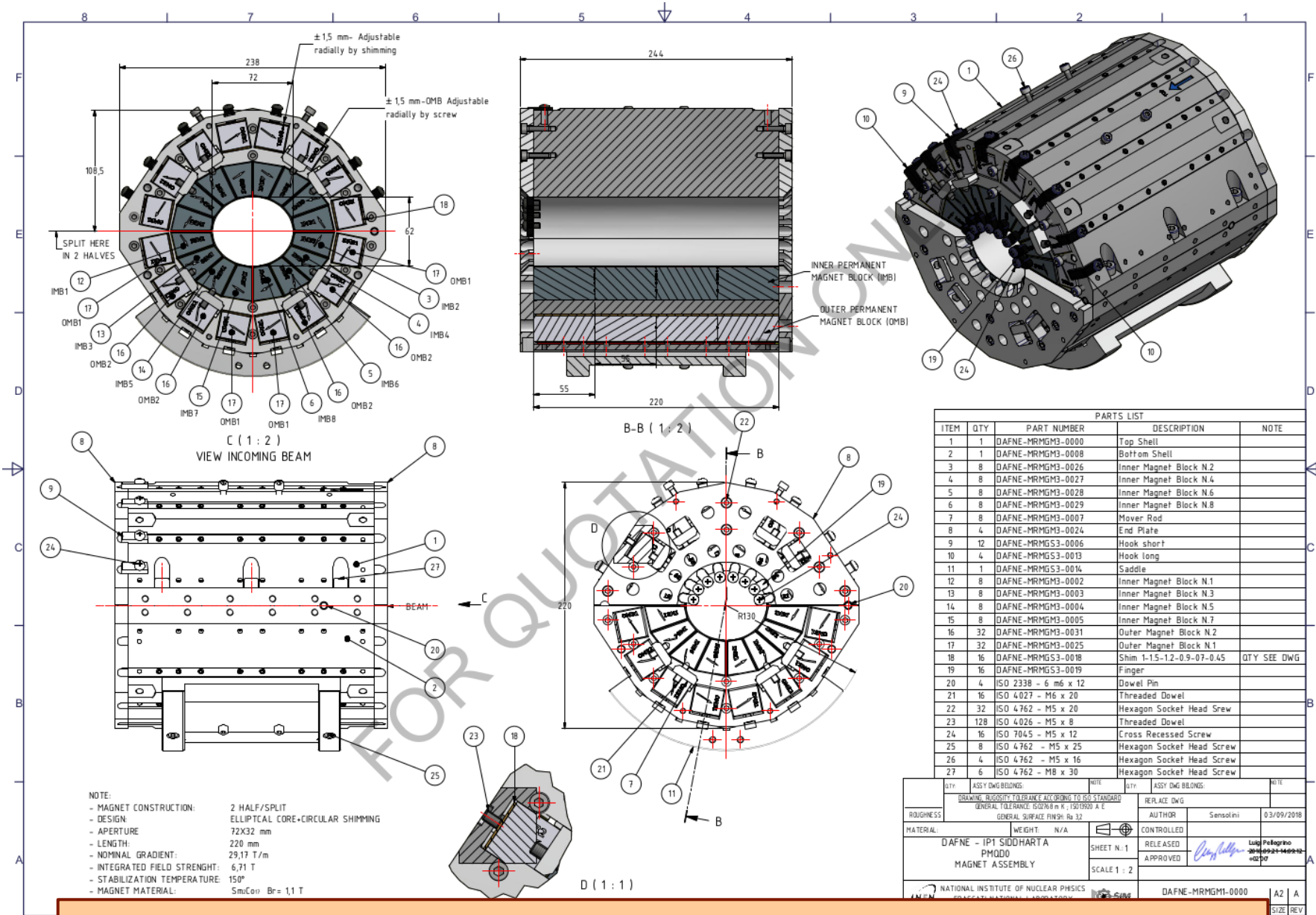
Area ready for IR & SIDDHARTA-2 installation  
Power supply, network and cooling services routed  
Magnets basements prealigned

# Magnet preliminary design @ May18



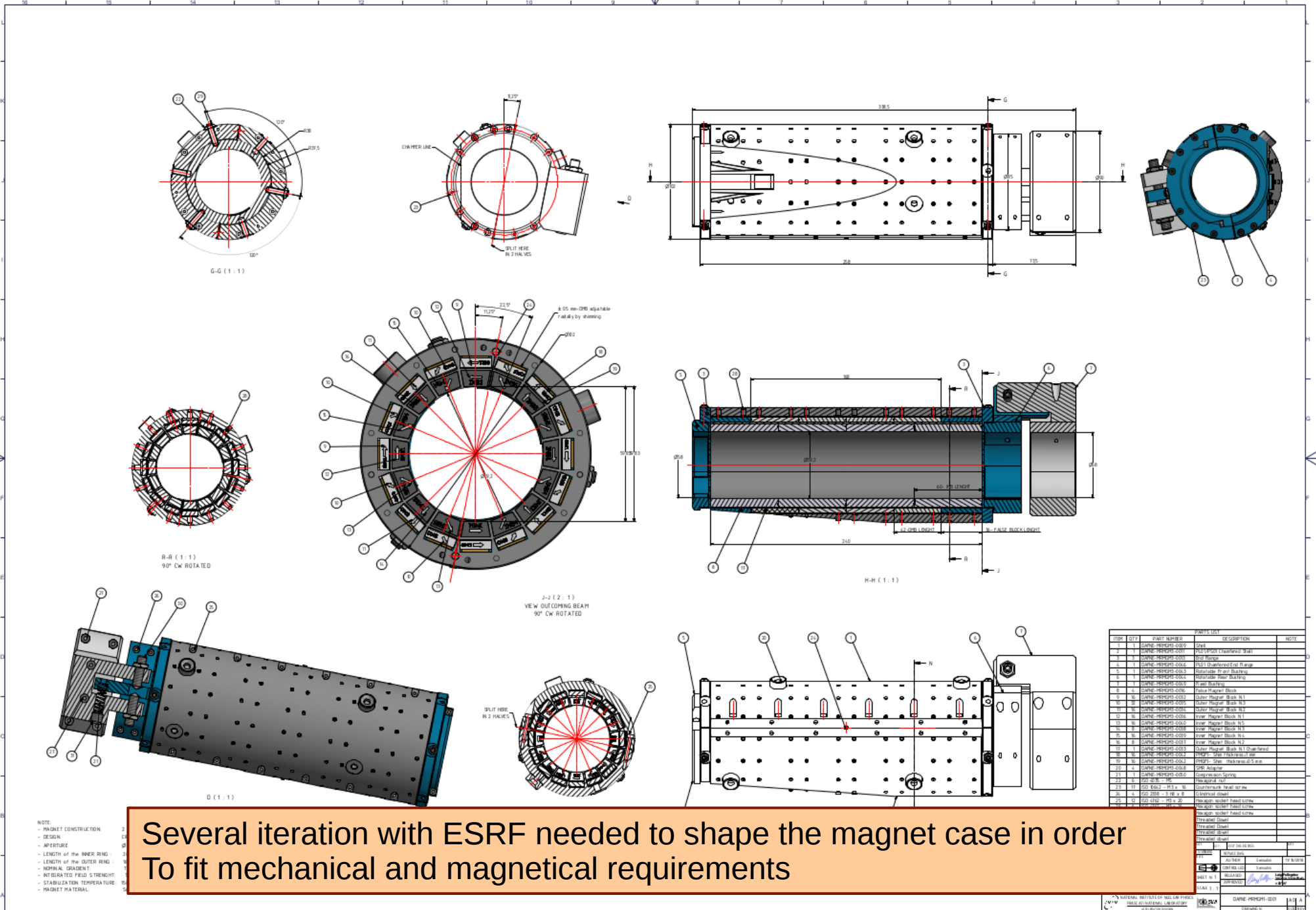
New mechanical design aimed to improve field profile and stay-clear aperture to reduce background on the detector

# PQD0 final drawing



Several iteration with ESRF needed to shape the magnet case in order To fit mechanical and magnetical requirements

# PQF Final drawing

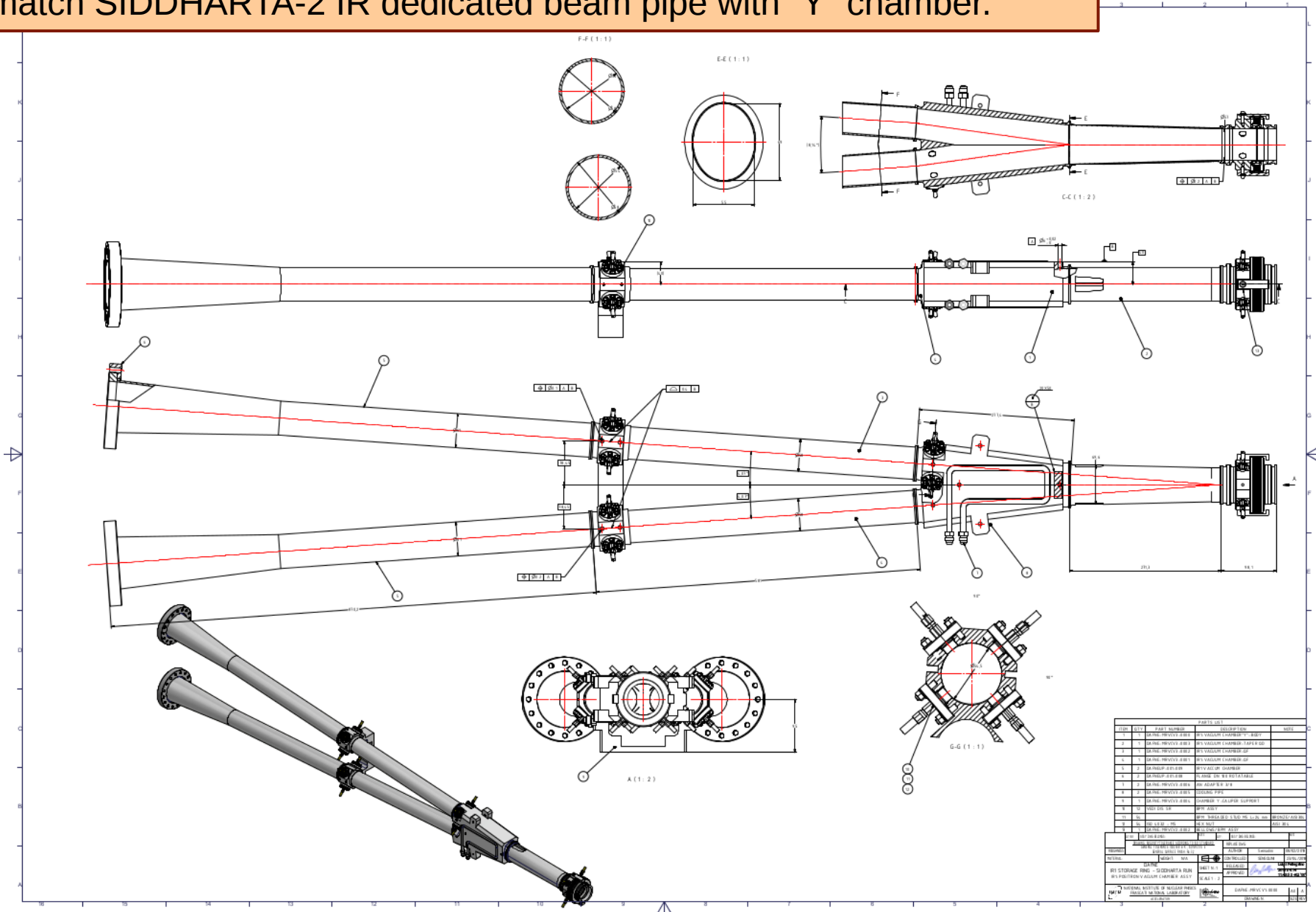


Several iteration with ESRF needed to shape the magnet case in order To fit mechanical and magnetical requirements

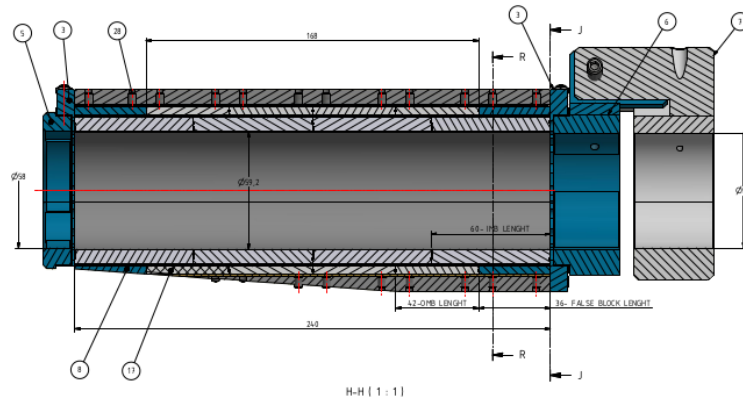
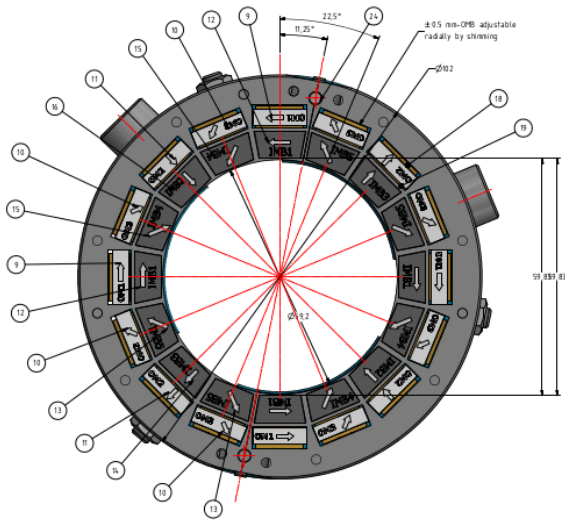


# DAFNE IR for SIDDHARTHA-2: Final drawing

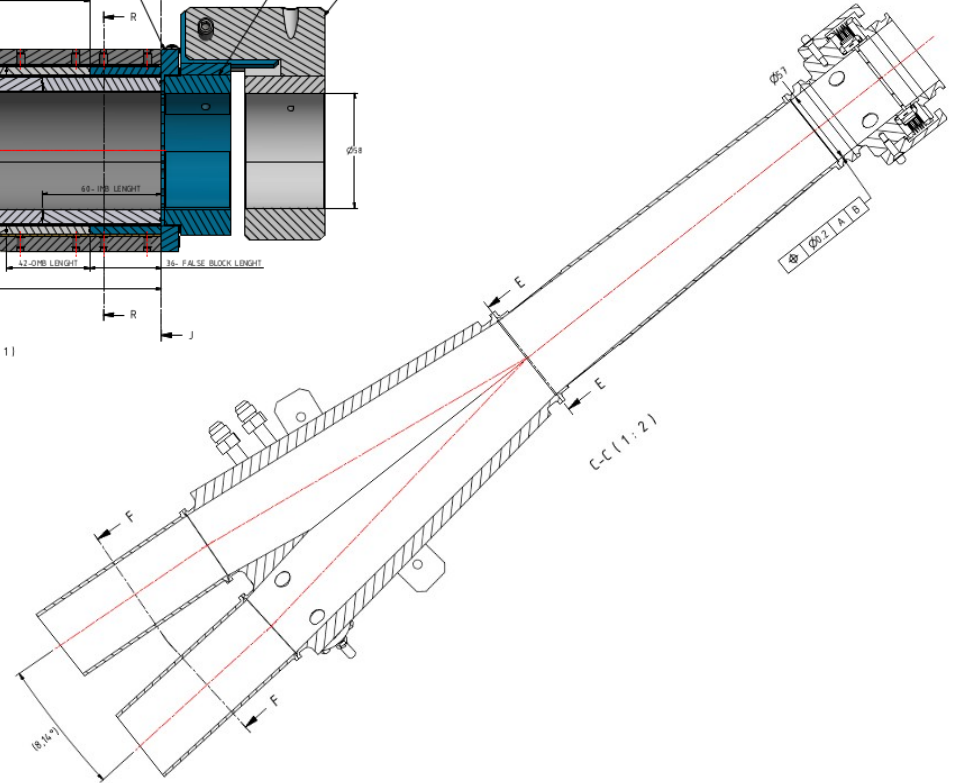
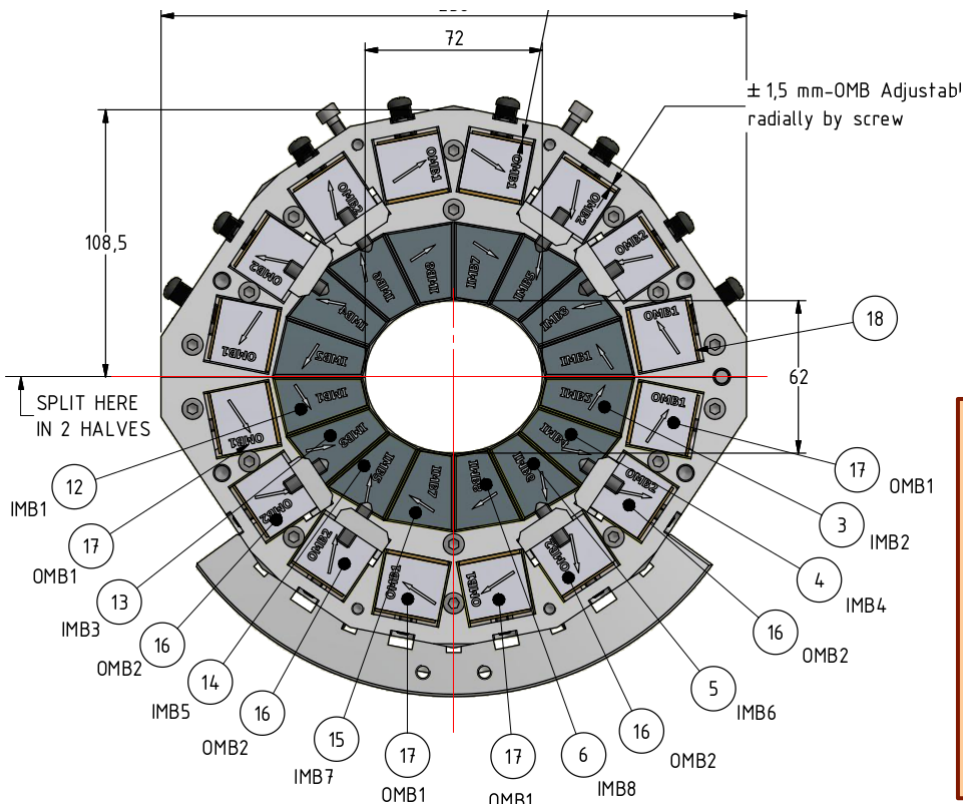
New beam pipe with tapered elliptical cross section have been designed to match SIDDHARTHA-2 IR dedicated beam pipe with "Y" chamber.



# DAFNE IR: Procurement status



J-J (2:1)  
VIEW OUTCOMING BEAM  
90° CW ROTATED



PQD0: Magnetic wedges @ ESRF  
Case Construction started

PQF: Magnetic wedges @ ESRF  
Order sent for (4x)PQF case

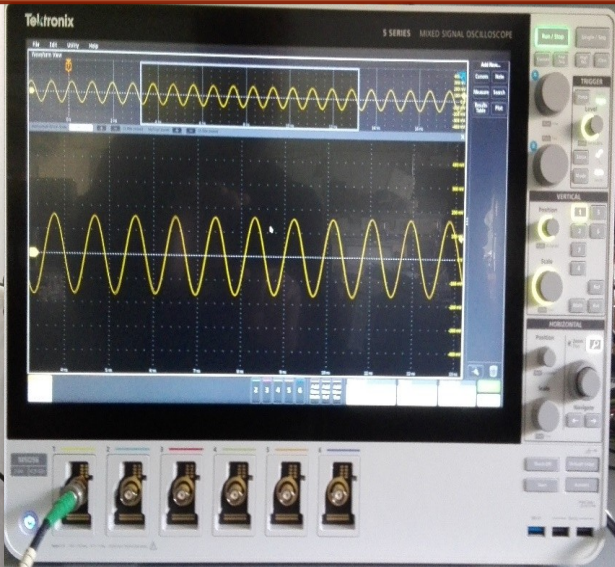
Beam-Pipe under construction

# Additional Horizontal FBK in e<sup>+</sup> Ring

The maximum current stored in the e<sup>+</sup> beam is limited by the *e-cloud* induced effects. Several considerations (Only two out of twelve *e-cloud electrodes* ECE work properly, new Al vacuum chamber in the IR) leads to *additional horizontal feedback system*.



New processing unit



New scope for beam and FBK monitor



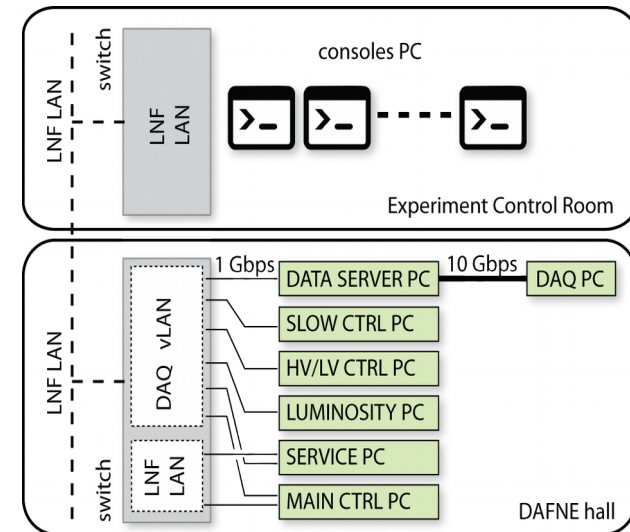
New attenuators (2x600W)

New amplifiers 2x500W



# Accelerator upgrades and maintenance

- **Main Ring Correctors Power Supply replaced**
  - 58 new PS to be installed
  - Control System interface to be revised
- **Control Room Consoles upgraded with new devices**
- **Machine – Experiment Data Exchange Program:**
  - Development of the network dedicated to:
    - DAQ and control of the experiment FEE;
    - DAFNE CS and SIDDHARTA data exchange ;
  - Data structure definition:
    - shared informations and related format;
    - data exchange protocols (!CHAOS oriented: JSON streaming through http REST and NFS).
- **LINAC modulator upgraded with solid state amplifier PS**
- **Beam Bremsstrahlung Monitor revision**
- **Bhabha absolute luminometer installation**

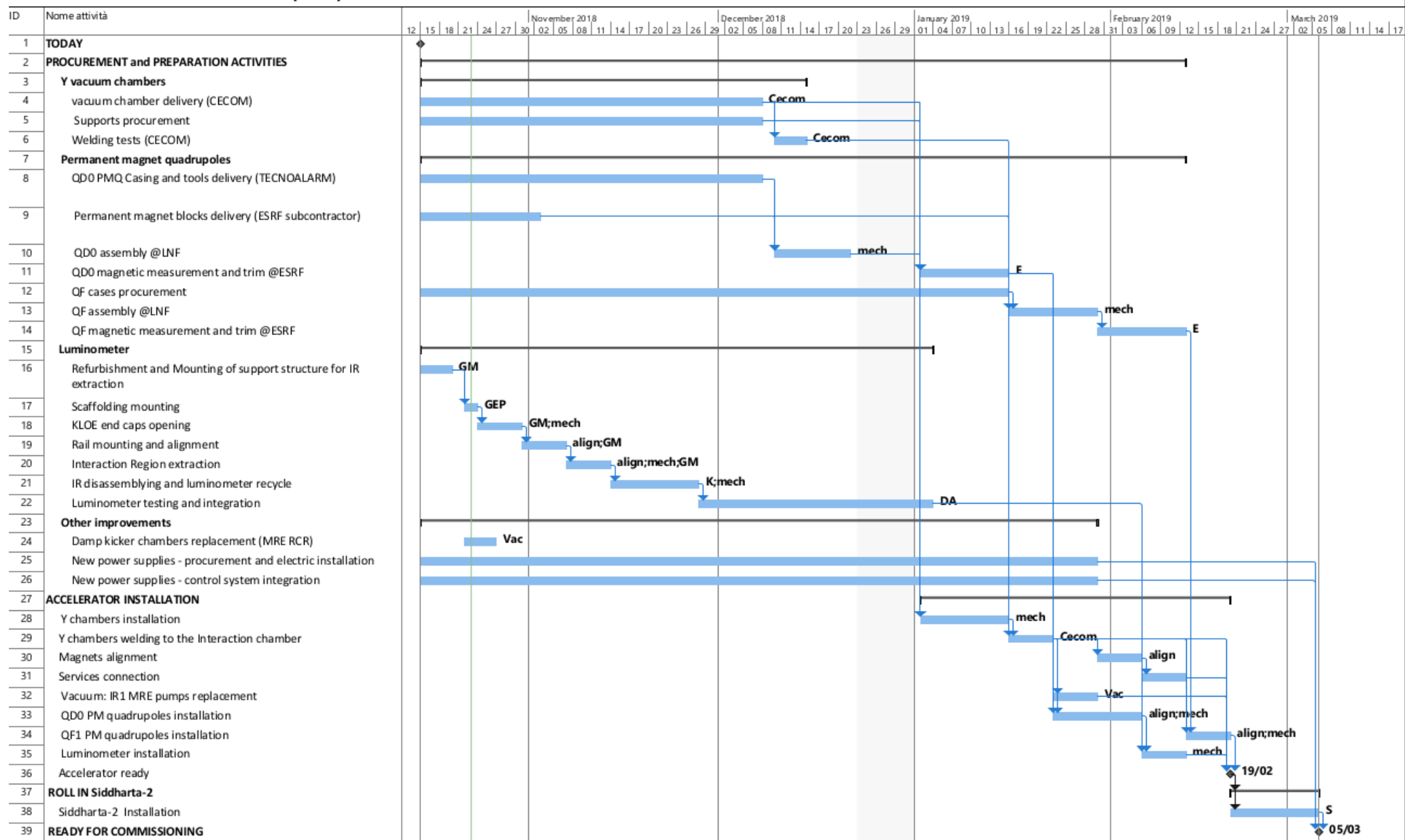


- WIGGLER rubber hoses systematic replacement:
  - Avoid water leakage from demineralized circuit;
  - Avoid downtime during SIDDHARTA-2 operations;
  - Avoid copper pipes damage and short circuits;
- Upgrade Services Supervisor:
  - More effective alarms
  - Temperature stabilization for TLs
- Variable speed drive to avoid pressure overshoot in the PS cooling pipes

# DAFNE Preparation masterPlan (Oct 2018)



## Siddharta2 run preparation - ONGOING INSTALLATION ACTIVITIES - L. PELLEGRINO 23-10-18



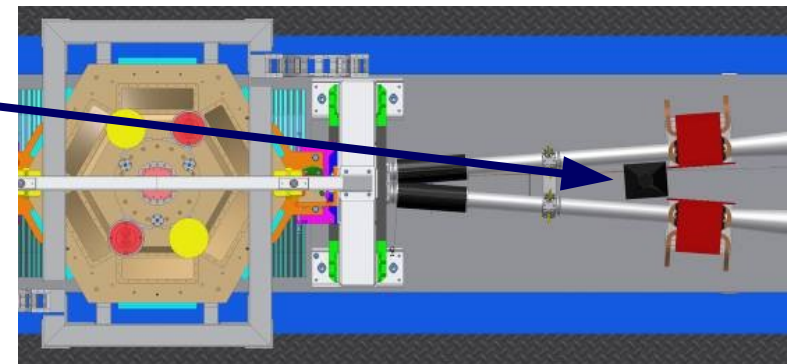
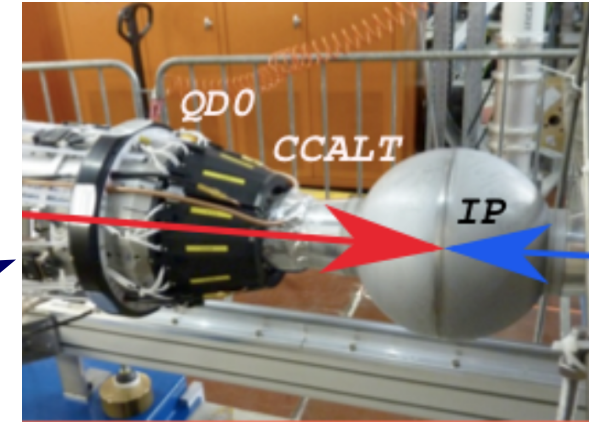
# DAFNE Luminosity measurement systems

During KLOE-2 run DAFNE luminosity has been measured by KLOE-2 calorimeter counting Bhabha scattering events with leptons emitted at large polar angle.

For SIDDHARTA-2 Physics Run the luminosity determination will rely on three different devices:

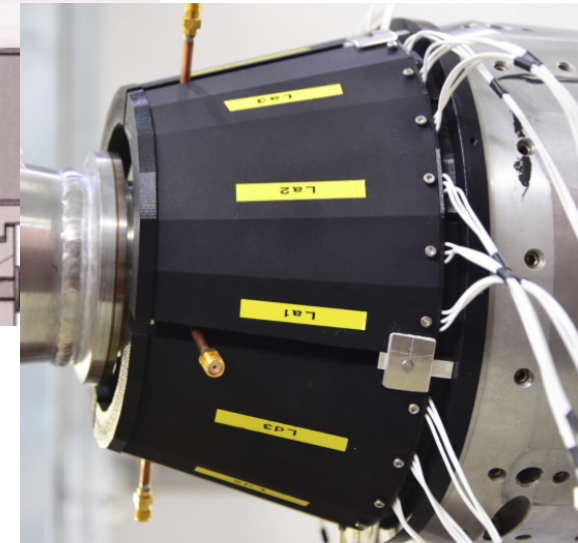
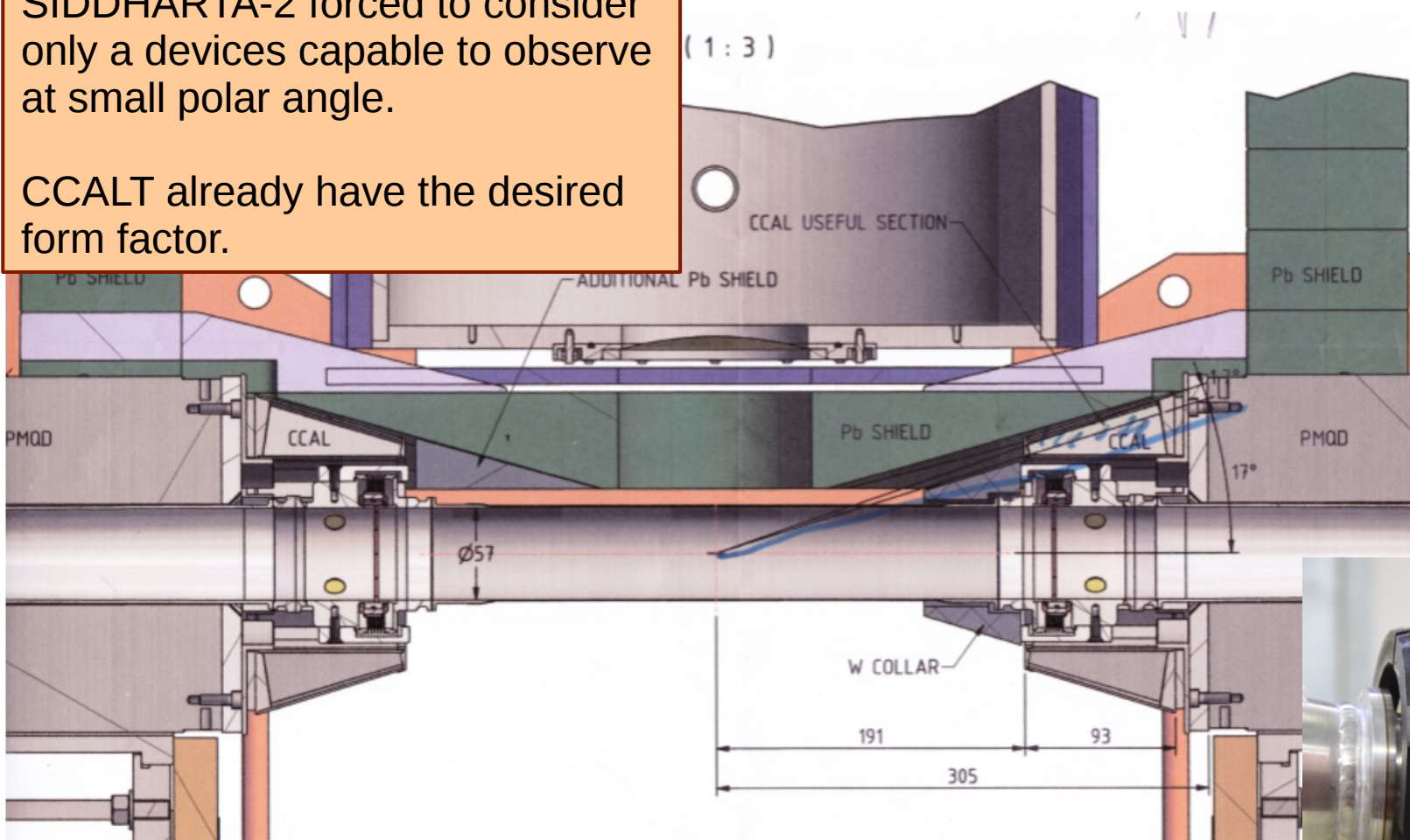
- **Crystal CALorimeters with Time (CCALT)**  
counting Bhabha scattering events with lepton emitted at small-angle (8-14 degree)
- **High Energy Taggers (HET)**  
counting radiative Bhabha scattering events with leptons emitted at very low angle
- **Kaon Monitor from SIDDHARTA-2**  
observing charged kaons emitted at large polar angle in the horizontal plane

For collisions tuning Gamma Bremsstrahlung counters will be used only observing relative variations.



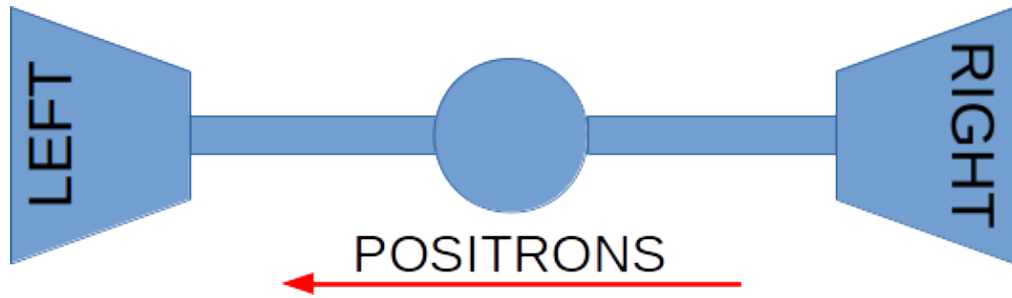
The increased shielding needs for SIDDHARTA-2 forced to consider only a devices capable to observe at small polar angle.

CCALT already have the desired form factor.





# CCAL-T Detector (KLOE-2 run)



## CCAL-T Specs:

- Crystal calorimeter
- Two sides
- 12 sectors per side
- 4 crystals per sector inside sector shell

## CCALuminometer DAQ:

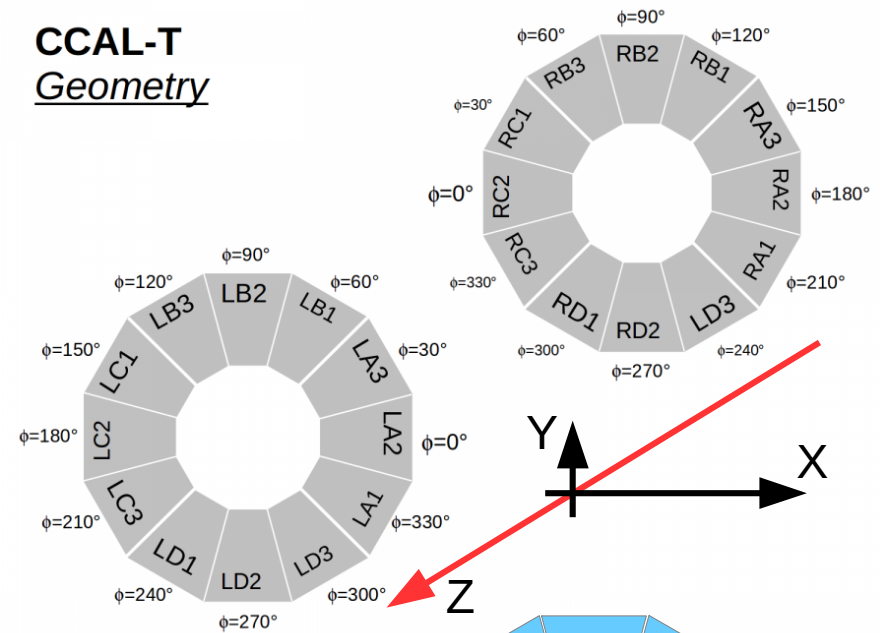
12 sectors total (6 per side) acquired measuring:

- Discriminated signals arrival time (TDC)
- Signal integrated charge (QDC)

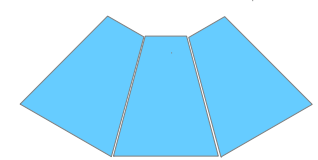
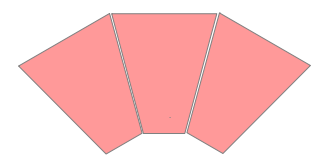
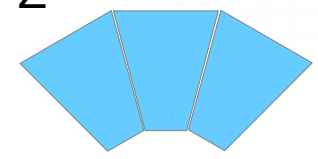
## Trigger Scheme:

Discriminated signals from each sector side are paired (logic OR). DAQ is started when a time coincidence (within 14 ns) between the two sides is observed

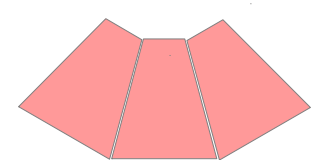
## CCAL-T Geometry



DAQ: Acquired sectors

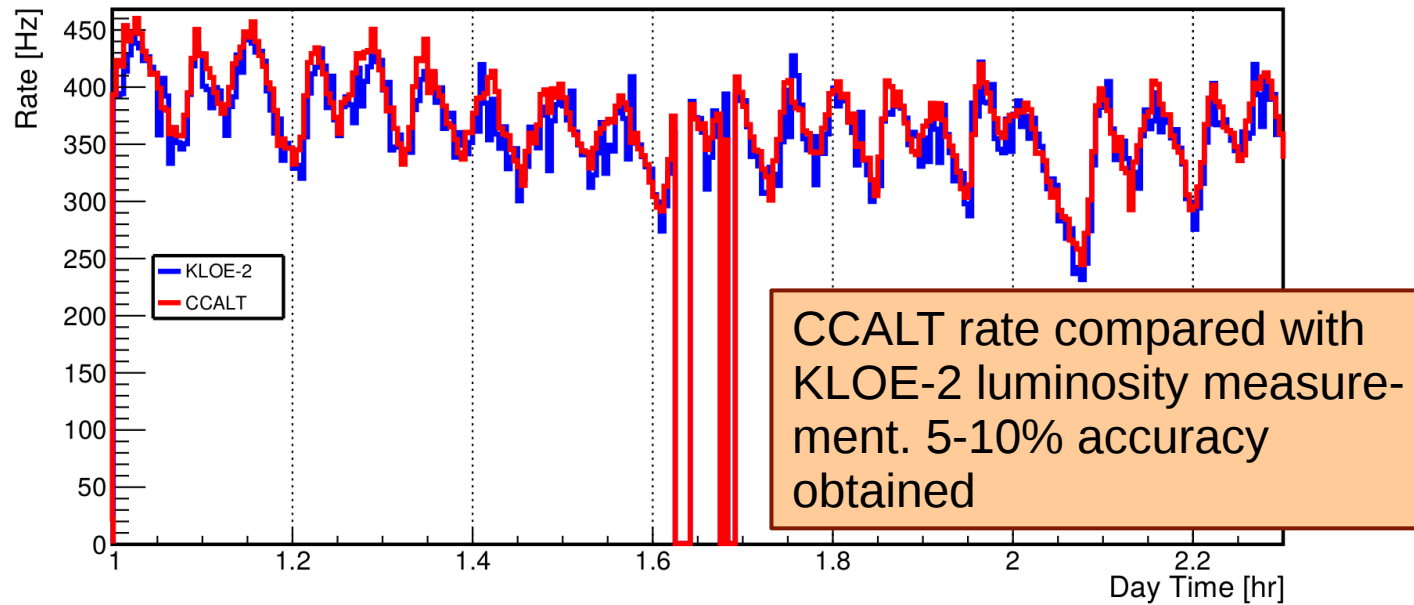


Electron

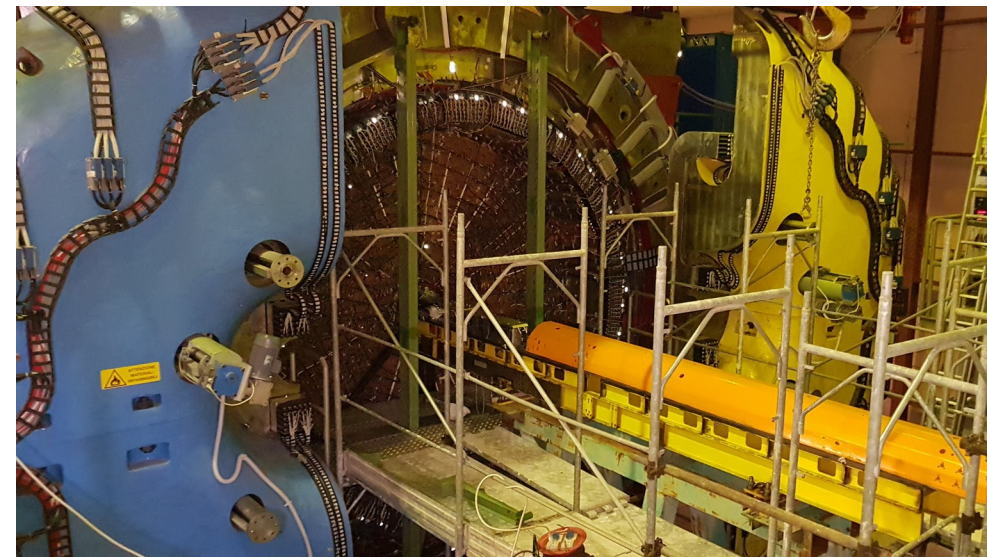
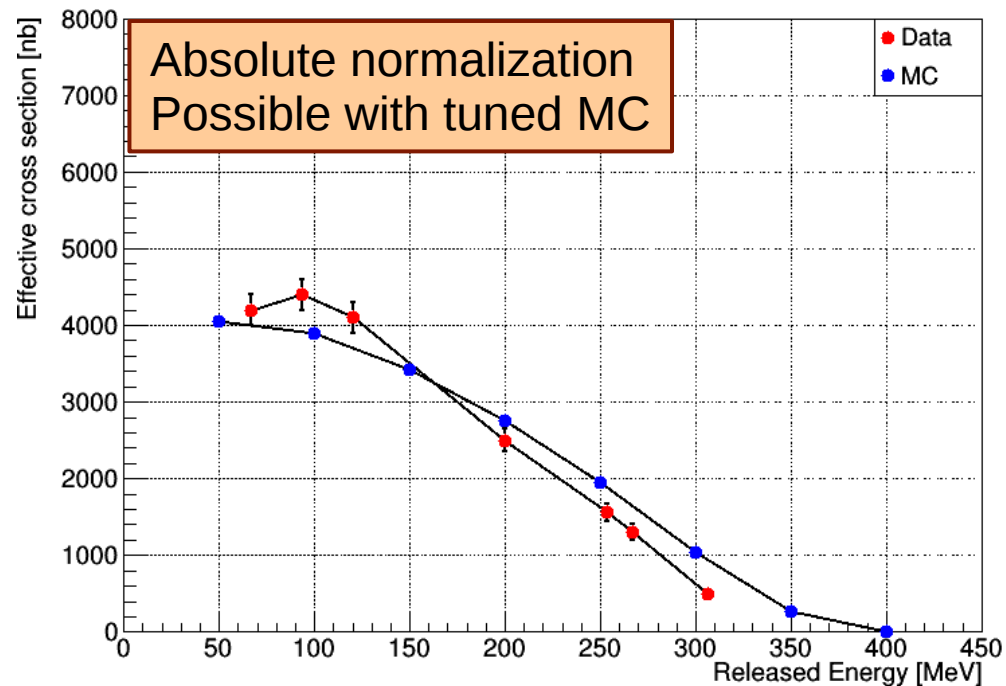


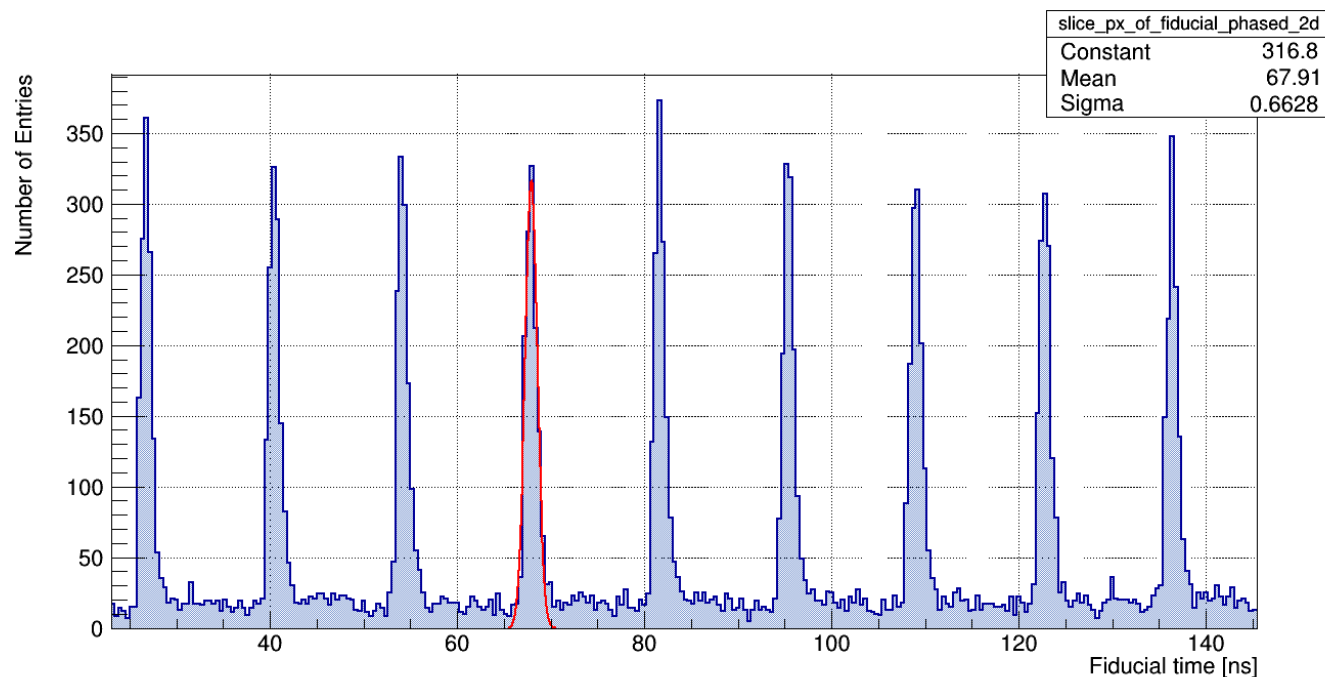
Positron

# CCALT Luminosity measurement (KLOE-2 Run)



Effective cross section Data/MC

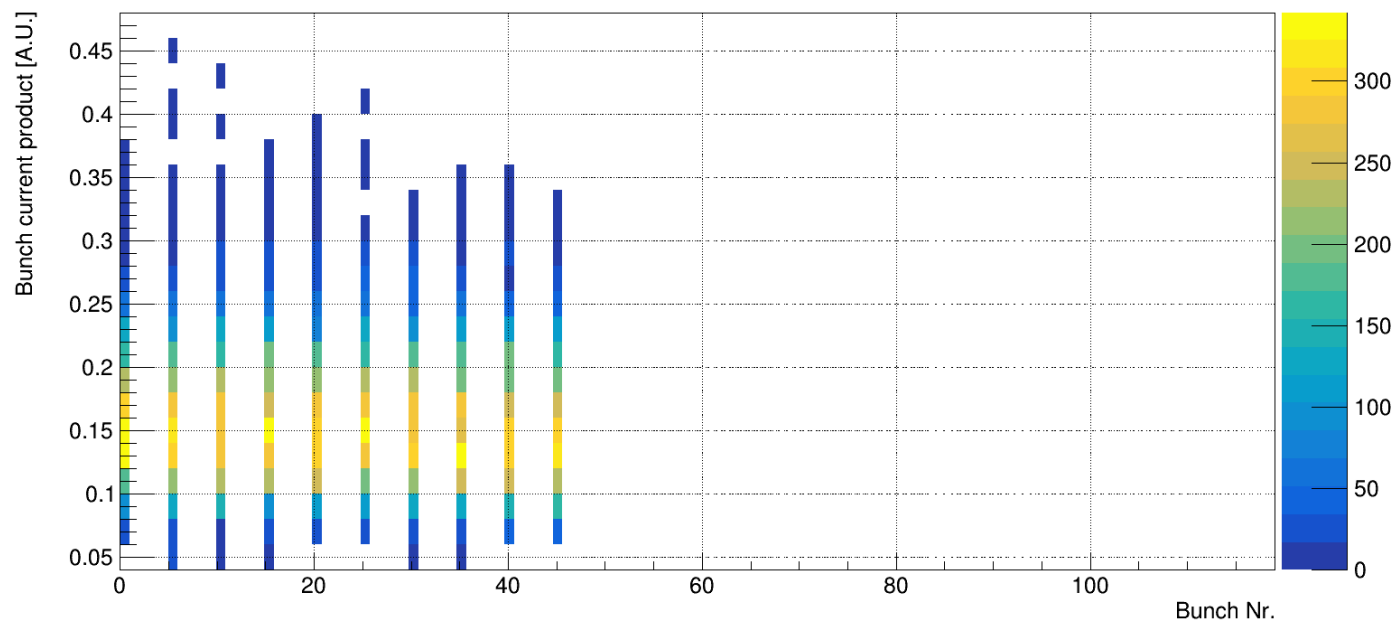




Small contamination from out-of-time hits

Time resolution in agreement with TDC specifications and trigger jitter

In this run 10 bunches only with 1/5 bunch structure.



- Combined shifts for PADME and SPARC
  - up to December, 20<sup>th</sup>
- LINAC maintenance:
  - From January, 2<sup>nd</sup> to January, 11<sup>th</sup>
- Combined shifts for PADME and SPARC
  - Resumed from January, 14<sup>th</sup>
- DAFNE Warm-Up:
  - February, 19<sup>th</sup> accelerator closed
  - SIDDHARTA-2 commissioning setup installation
- DAFNE Operation:
  - March, 4<sup>th</sup> collisions commissioning and Physics Run

DAFNE maintenance, installation and operation would have been impossible without the focused and strongly motivated work of technicians from Technical and Accelerator divisions to whom goes a strong acknowledgement from all DAFNE scientific staff.

DAFNE-TF:  
**proposal for the mid-term future**

- luminosity achieved at DAΦNE is almost an order of magnitude higher than the one obtained at other colliders operating in the same energy range
- Impedance budget is a factor 80 lower than in similar storage ring (EPA)
- Collisions with negative momentum compaction gave a 25% gain in terms of specific luminosity at low current without sextupoles
- Longitudinal feedback kicker designed for DAFNE has been adopted at: KEKB, BESSYII, PLS, SLS, HLS, ELETTRA, KEK Photon Factory, PEP II  
...
- Maximum current stored in the DAFNE electron ring, 2.45 A, is the higher ever stored in particle factories and modern synchrotron radiation sources.
- DAΦNE is the only collider operating routinely with, and thanks to the electrodes for e-Cloud mitigation
- *Crab-Waist collision scheme proved to be an effective approach to increase luminosity in circular colliders even in presence of an experimental apparatus strongly perturbing beam dynamics.*

Colliders	Location	Status
<b>DAΦNE</b>	<b>Φ-Factory</b> Frascati, Italy	In operation
<b>SuperKEKB</b>	<b>B-Factory</b> Tsukuba, Japan	Under commissioning
<b>SuperC-Tau</b>	<b>C-Tau-Factory</b> Novosibirsk, Russia	Russian mega-science project
<b>FCC-ee</b>	<b>Higgs-Factory</b> CERN, Switzerland	100 km, CW baseline design option
<b>CEPC</b>	<b>Higgs-Factory</b> China	54 km, local double ring option with CW
<b>LHC Upgrade</b>	<b>LHC CW Option</b> CERN, Switzerland	LHC with very flat beams (low priority)





# Laboratori Nazionali di Frascati

INFN-18-10-LNF  
September 18, 2018

**Proposal for a possible use of DAFNE  
as an open infrastructure (DAFNE-TF) for the study  
of physics and innovative technologies for accelerators**

C. Bloise (1), P. Campana (1), M. Giovannozzi (2),  
C. Milardi (1), N. Pastrone (3), A. Variola (1)

*(1) INFN - Laboratori Nazionali di Frascati - (2) CERN - (3) INFN - Sezione di Torino*

***The lines of scientific and technological research identified so far are compliant with the following items:***

- machine operating parameters
- impact that tests can have in terms of machine layout and components modification, invasive measurements and experimental activities hardly compatible with the actual machine configuration are unlikely to be considered
- maturity level of the experimental programmes proposed.

# Possible field of interest

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- *Study of low SEY (Secondary Electron Yield) elements and impedances; Graphitization of chambers and other technologies*
- *Accelerator components realized with 3D printers*
- *Wide-excursion adjustable permanent magnets*
- *High power solid state RF amplifiers*
- *High-power positron sources: peak Energy Deposition Density in the targets, wide aperture capture, accelerating sections in S Band*
- *Components for future SLED and pulse flatness compensation*
- *Components for accelerators (vacuum chambers, collimators, masks, kickers) and innovative beam diagnostic techniques*
- *Emittance manipulation*
- *Beams interacting with amorphous materials, crystals, lasers, plasma*
- *Nuclear or particle physics experiment with short baseline*
- *Outreach & High level (Master degree and PostDoc) educational programs*



## DAFNE-TF Workshop 2018

17 December 2018 INFN - Laboratori Nazionali di Frascati

[HOME](#) [PROGRAM](#) [REGISTRATION](#) [SUBMIT A CONTRIBUTION](#) [ACCOMMODATION](#) [HOW TO REACH US](#) [CONTACT](#)

### ICFA Mini-Workshop on DAFNE as Open Accelerator Test Facility in year 2020

The workshop will take place on **December 17<sup>th</sup>, 2018** at the Touschek Auditorium, [Frascati Laboratory of INFN](#), Italy.

The workshop is intended to discuss the interest from scientists to access the DAFNE  $e^+ e^-$  complex, which will conclude its physics program as collider in 2020. An infrastructure almost unique, that could open as Test Facility (DAFNE-TF) to the international community for studies of accelerator technologies and beam physics, for small experiments, and to be used as a test bed for enterprises active in the sector of components for accelerators.

[Invitation Letter of Prof. Lenny Rivkin](#), Chair of the International Scientific Committee

[INFN-18-10-LNF](#) - "Proposal for a possible use of DAFNE as an open infrastructure (DAFNE-TF) for the study of physics and innovative technologies for accelerators"

#### Call for Contributions:

Registrants are invited to submit ideas and contributions for scientific activities that could be carried out using DAFNE-TF characteristics at best, by filling the [online form](#) (📅 **Deadline: November 10, 2018**).

#### Scientific Committee

L. Rivkin (EPFL and PSI, chair), C. Bloise (INFN-LNF), Y. Cai (SLAC), A. Ghigo (INFN-LNF), M. Giovannozzi (CERN), C. Milardi (INFN-LNF), N. Pastrone (INFN-Torino), A. Variola (INFN-LNF)

#### Organizing Committee

O. R. Blanco Garcia (INFN-LNF), A. De Santis (INFN-LNF), A. Drago (INFN-LNF, chair)

#### Secretariat

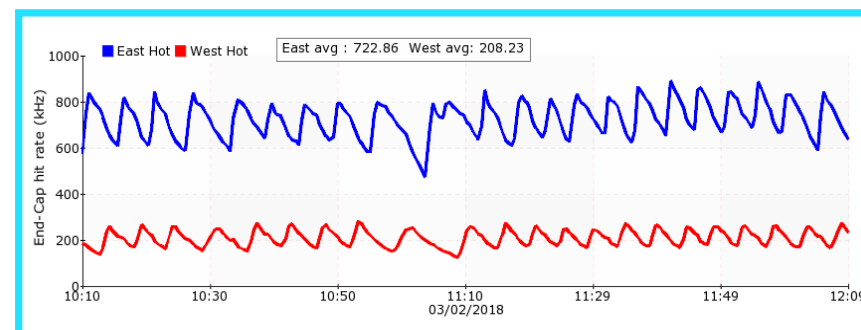
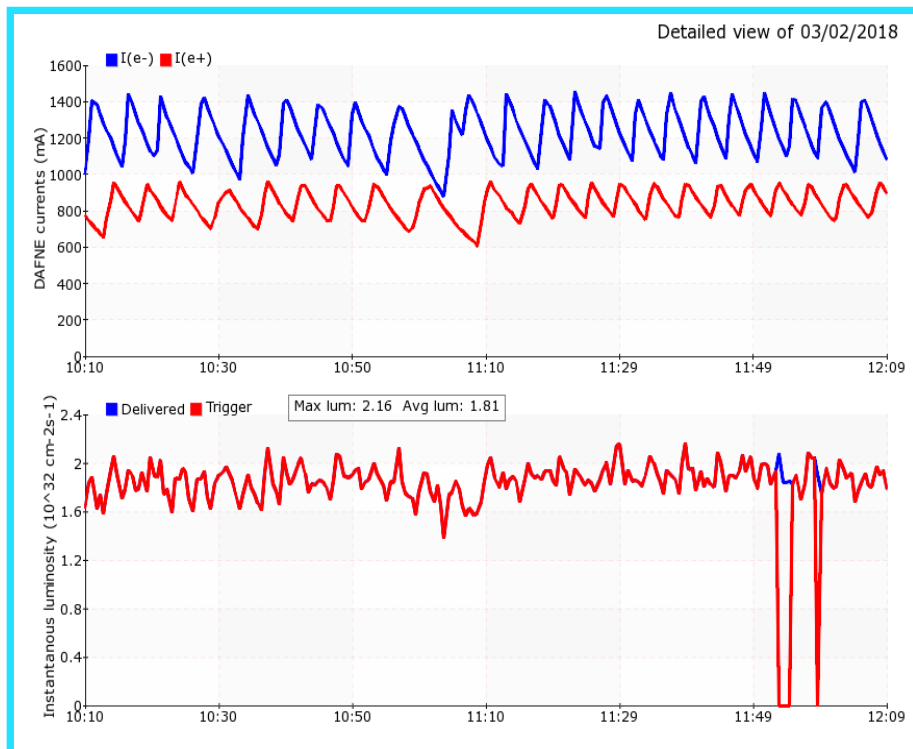
D. Ferrucci (INFN-LNF), M. Luciani (INFN-LNF)

✉ [dafne-tfw2018@lists.lnf.infn.it](mailto:dafne-tfw2018@lists.lnf.infn.it)

# *Questions?*

# SPARES

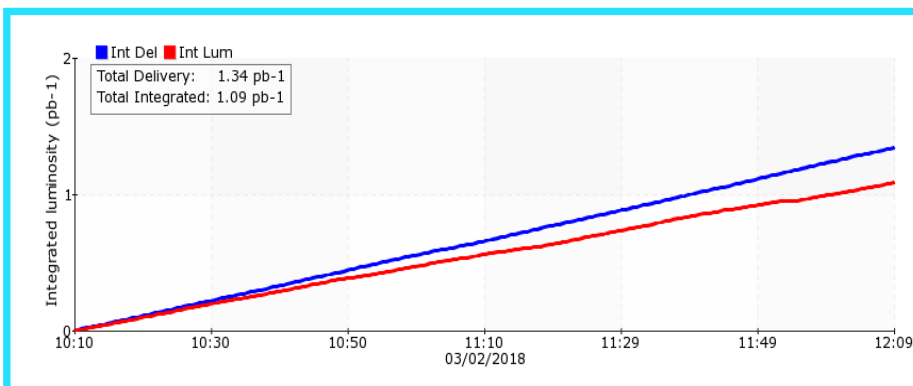
# Highest Hourly Integrated Luminosity



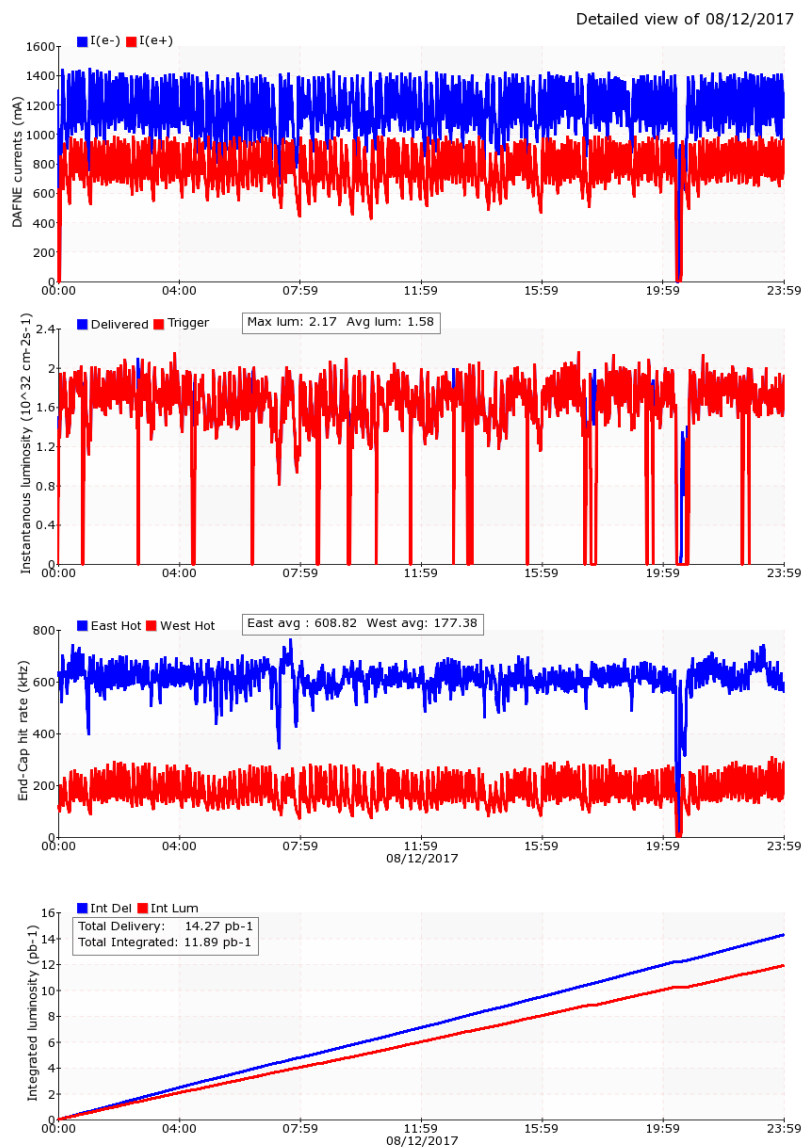
$$\int_{1h} L \sim 0.67 \text{ pb}^{-1}$$

$$N_b = 107$$

$$\int_{1 \text{ day}} L \sim 16 \text{ pb}^{-1}$$



# Highest Daily Integrated Luminosity

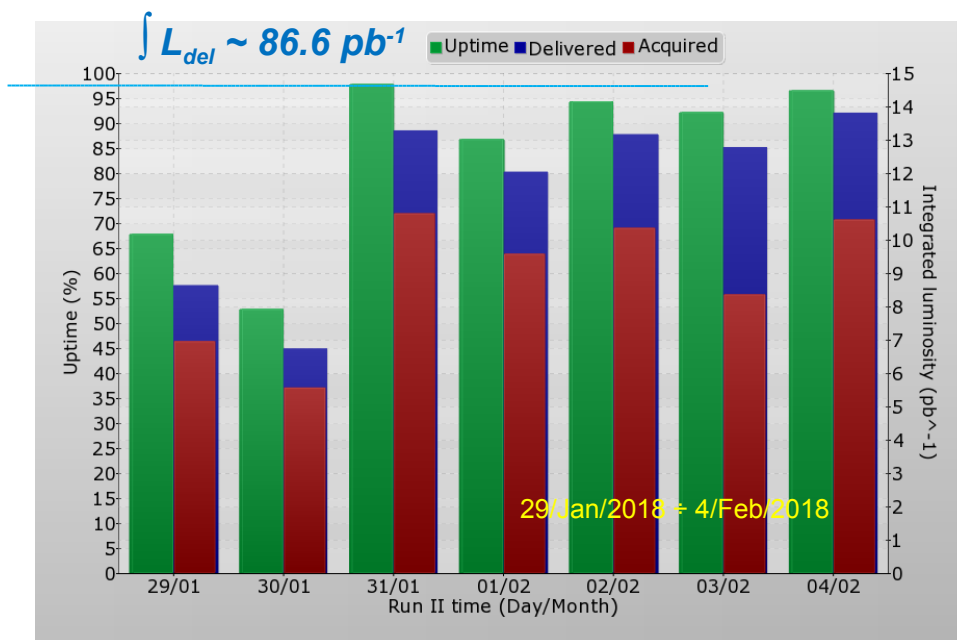


$$\int L_{del} \sim 14.3 \text{ pb}^{-1}$$

$$\int L_{acq} \sim 11.9 \text{ pb}^{-1}$$

Uptime  $\sim 98\%$

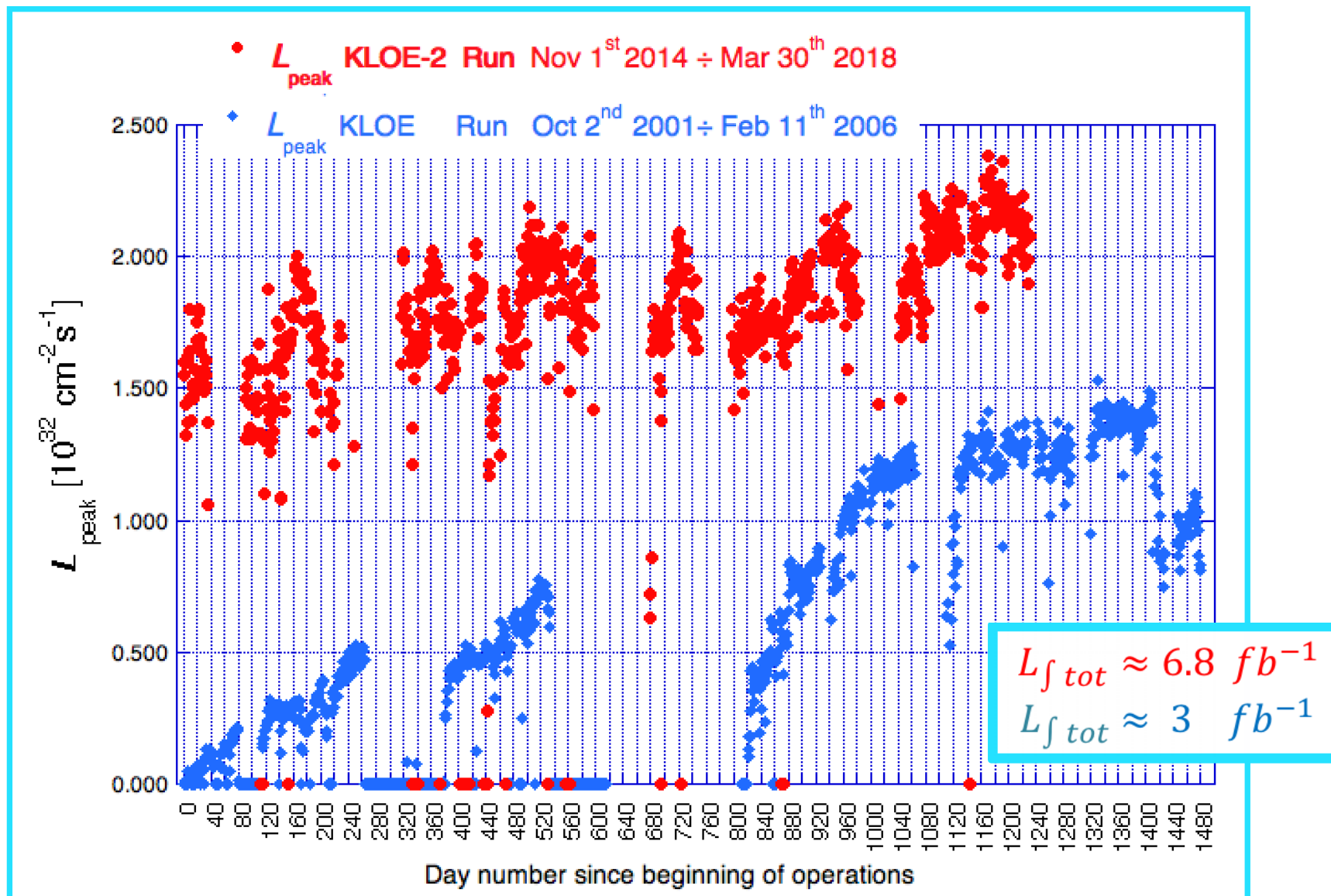
- 106 bunches
- Sustainable background



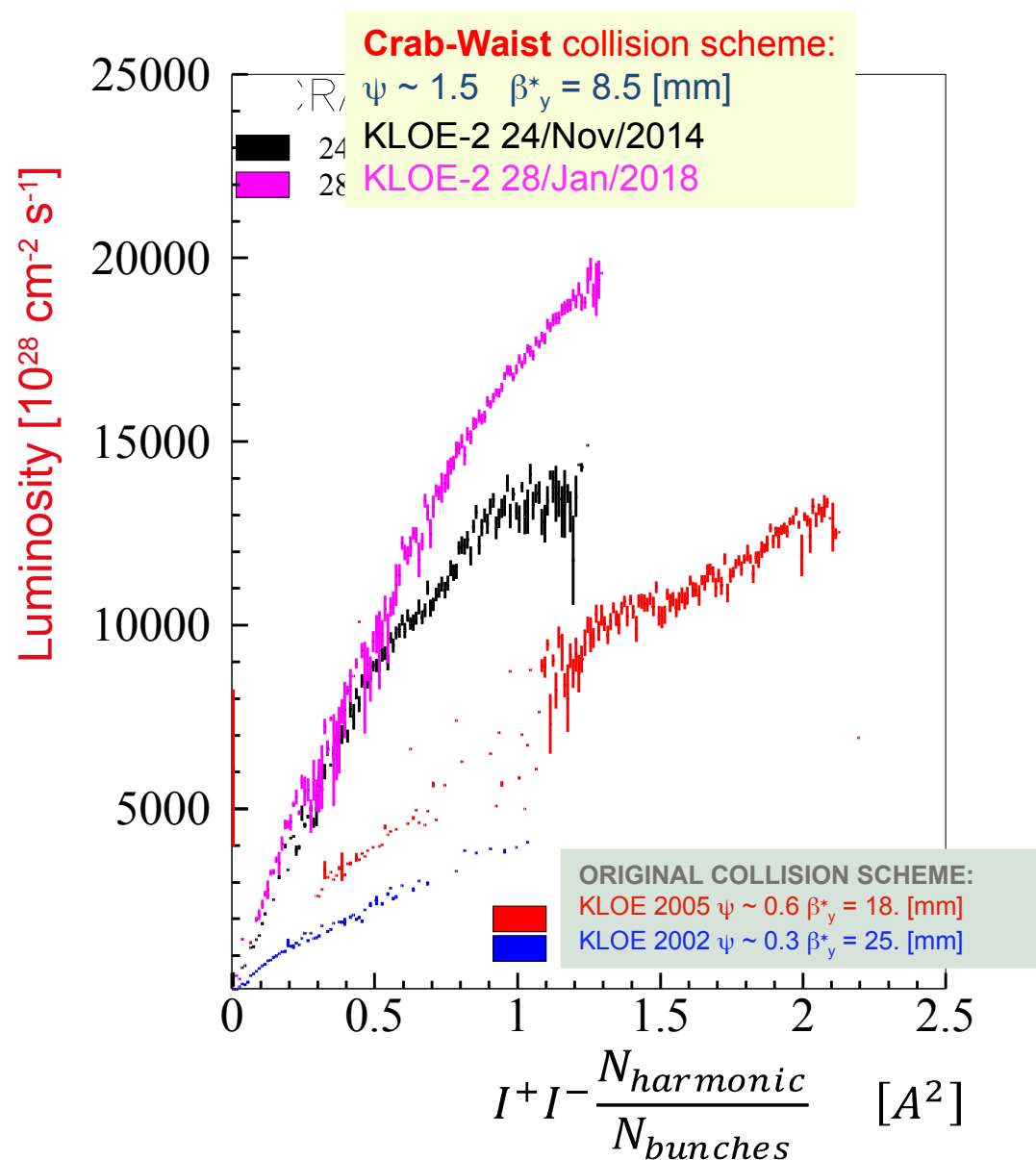


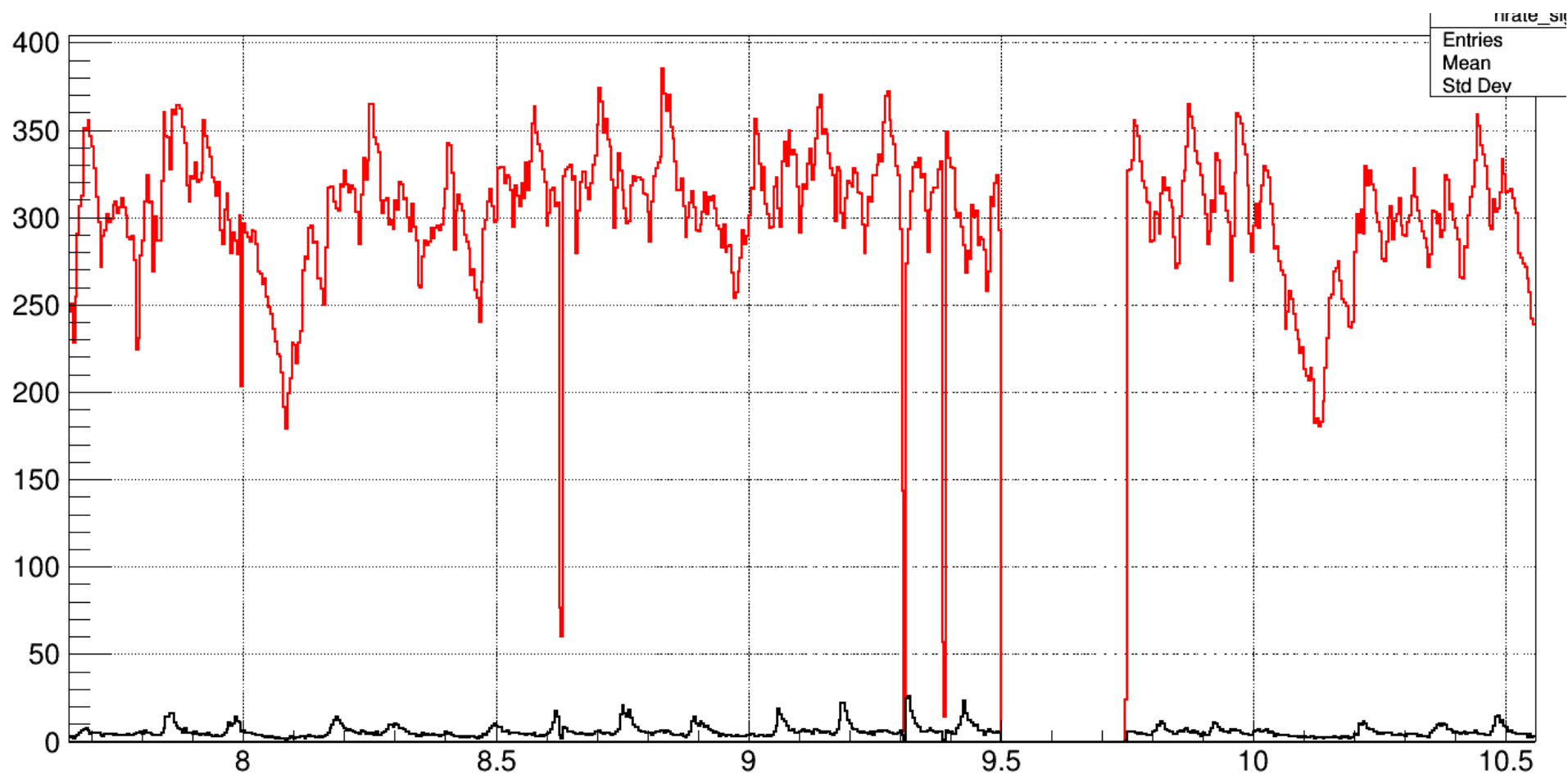
# Crab-Waist Luminosity Gain

Crab-Waist provides a 59% increase in terms of peak luminosity as evidenced by data taken by the same detector with the same accuracy



# Crab-Waist Luminosity Gain





Only 2 fired sectors in the CCAL-T within 30 ns and  $D\phi=30$  degree

$\text{Sigma\_effective} = (2700 \pm 200) \text{ nb } [(270 \pm 20)\text{Hz} @ 10^{32} \text{ cm}^{-2}\text{s}^{-1}(=0.1 \text{ nb}^{-1}/\text{s})]$

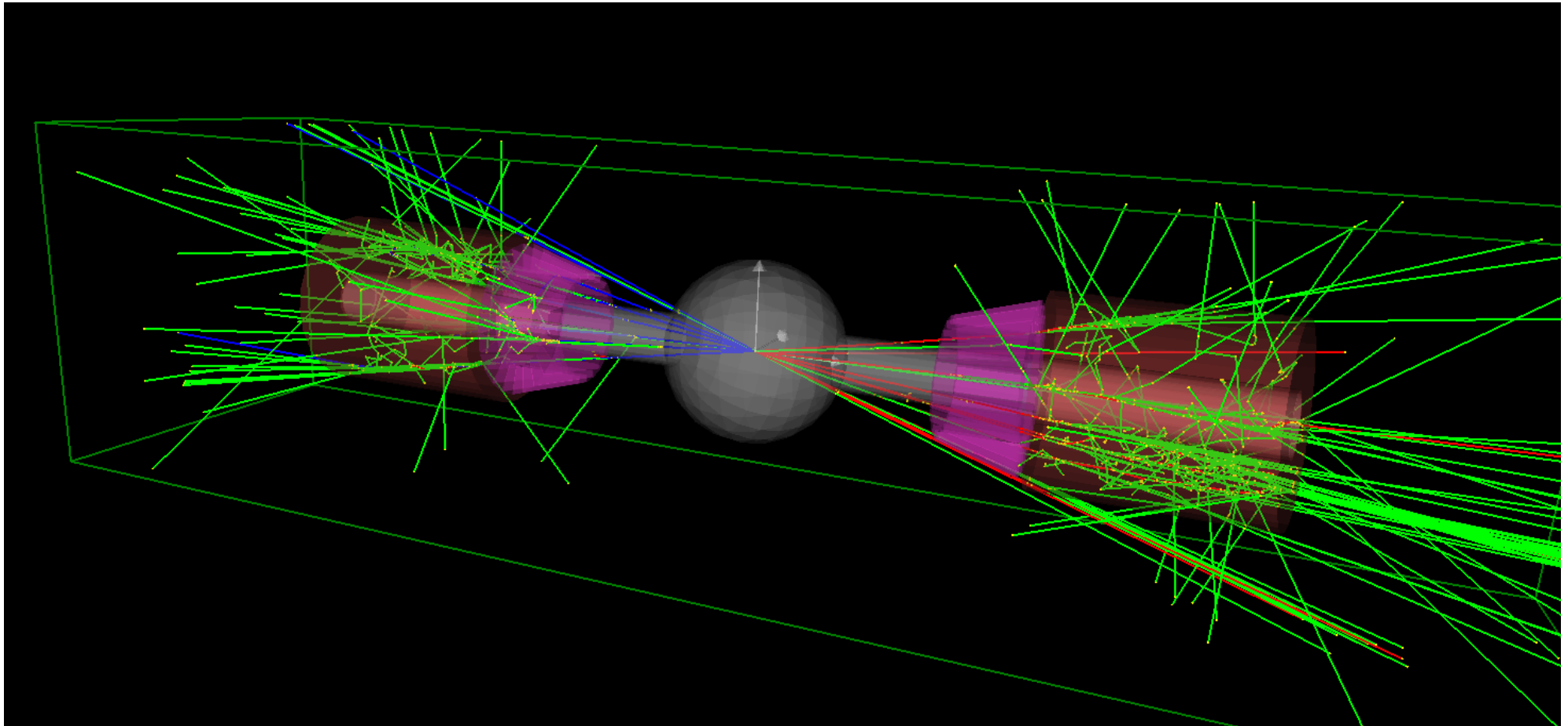
Residual background in the signal selection window  $\sim 2/4$  Hz

MC simulation includes:

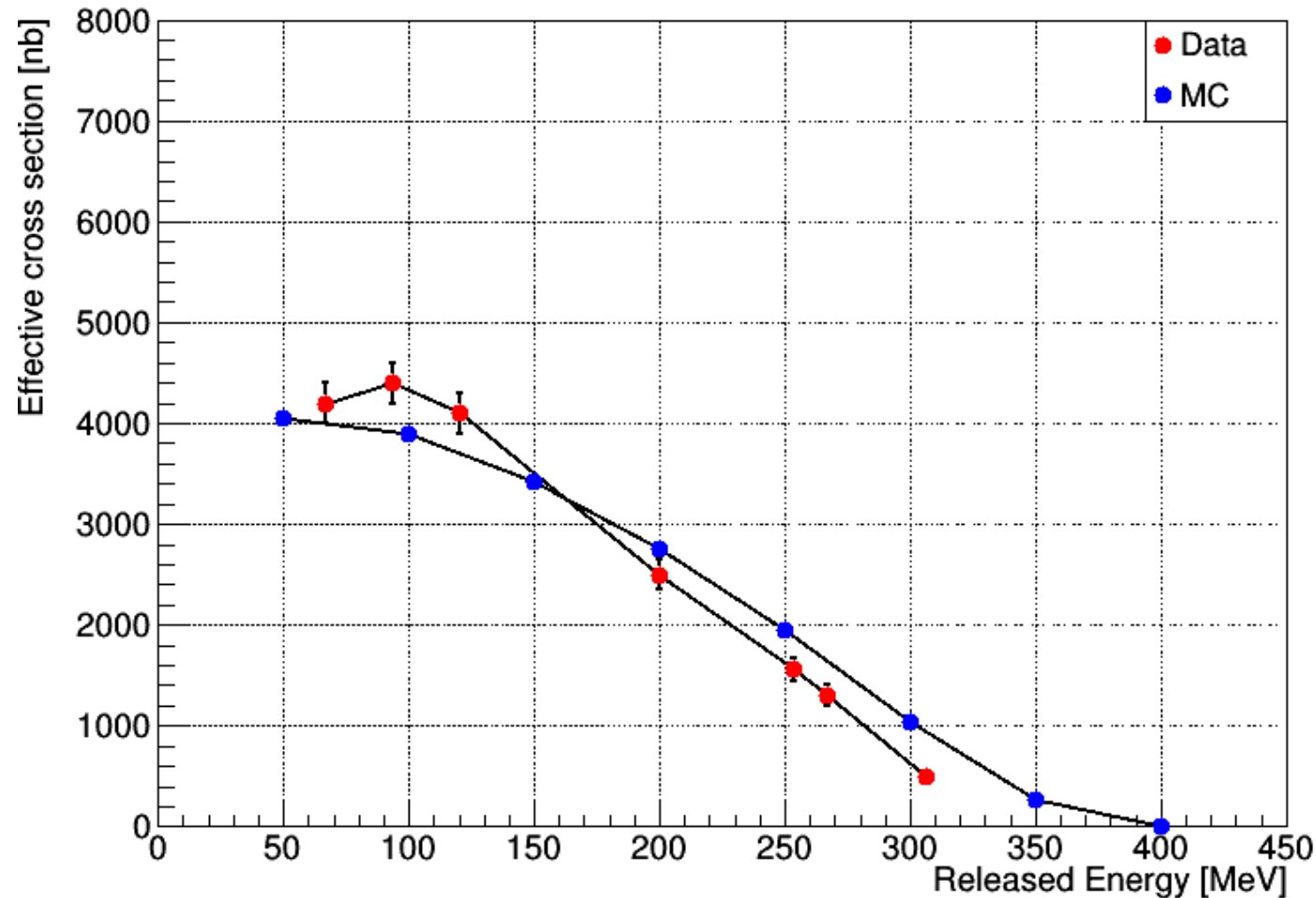
- + Full IR geometry
- + Beam crossing angle
- + KLOE-2 field map

Generator:

Babayaga-NLO (between 8 and 172 degree in polar angle)



Effective cross section Data/MC



Energy scale normalization still need to be checked.

Assumed correspondence around zero counts observed ( $V_{thr} = -150 \text{ mV} \leftrightarrow 400 \text{ MeV}$ )

MC Behavior has to be fully qualified with angular distributions (analysis ongoing).

Signal and Background time distributions could be checked with the KLOE-2 data (already started)

Total cross section:  $(48.6 \pm 0.2) \text{ ub}$

100Kevt simulated and fully tracked in the Detector

