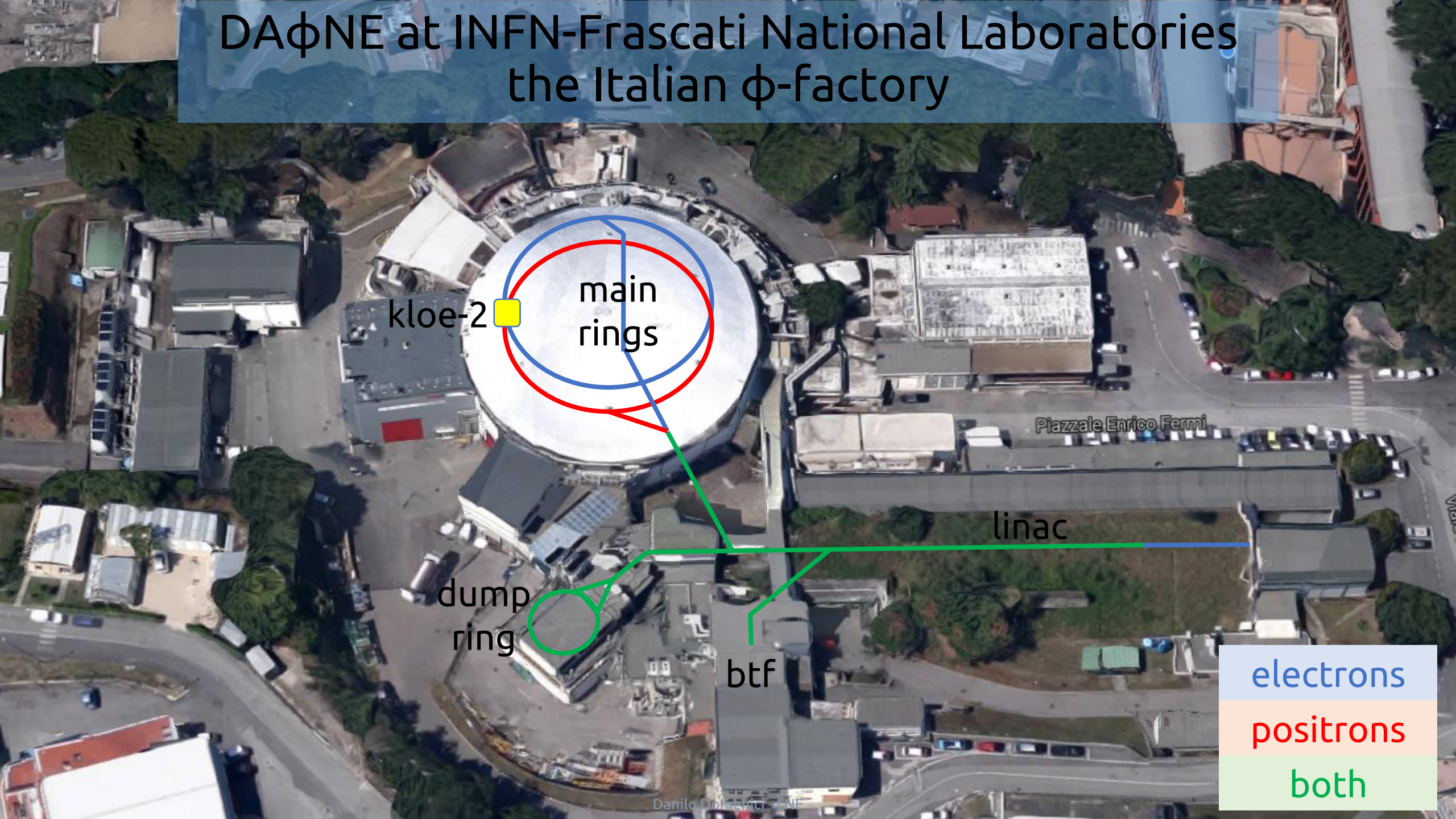
Status of the KLOE-2 experiment

KLOE-2 Workshop on e^+e^- collision physics at 1 GeV

Danilo Domenici - LNF
on behalf of the KLOE-2 collaboration

DAϕNE at INFN-Frascati National Laboratories
the Italian ϕ-factory



1 GeV Physics History at Frascati

KLOE experiment has already taken data in 2001-2006:

- 2.5 fb-1 at 1.02 GeV
- 250 pb-1 at 1.00 GeV

DAFNE upgraded in 2008 with Crab-waist interaction scheme:

- Large Piwinski angle
- Compensating Sextupoles

New experiment KLOE-2 started in 2014 to integrate > $5 fb^{-1}$ in 3÷4 years

- CKM unitarity
- CPT invariance
- CP violation
- ChPT model of QCD
- Hadronic cross-section for muon g-2
- γγ physics
- Hidden sector searches

Eur. Phys. J. C (2010) **68**: 619-681

KLOE-2 Detector

Tracking System

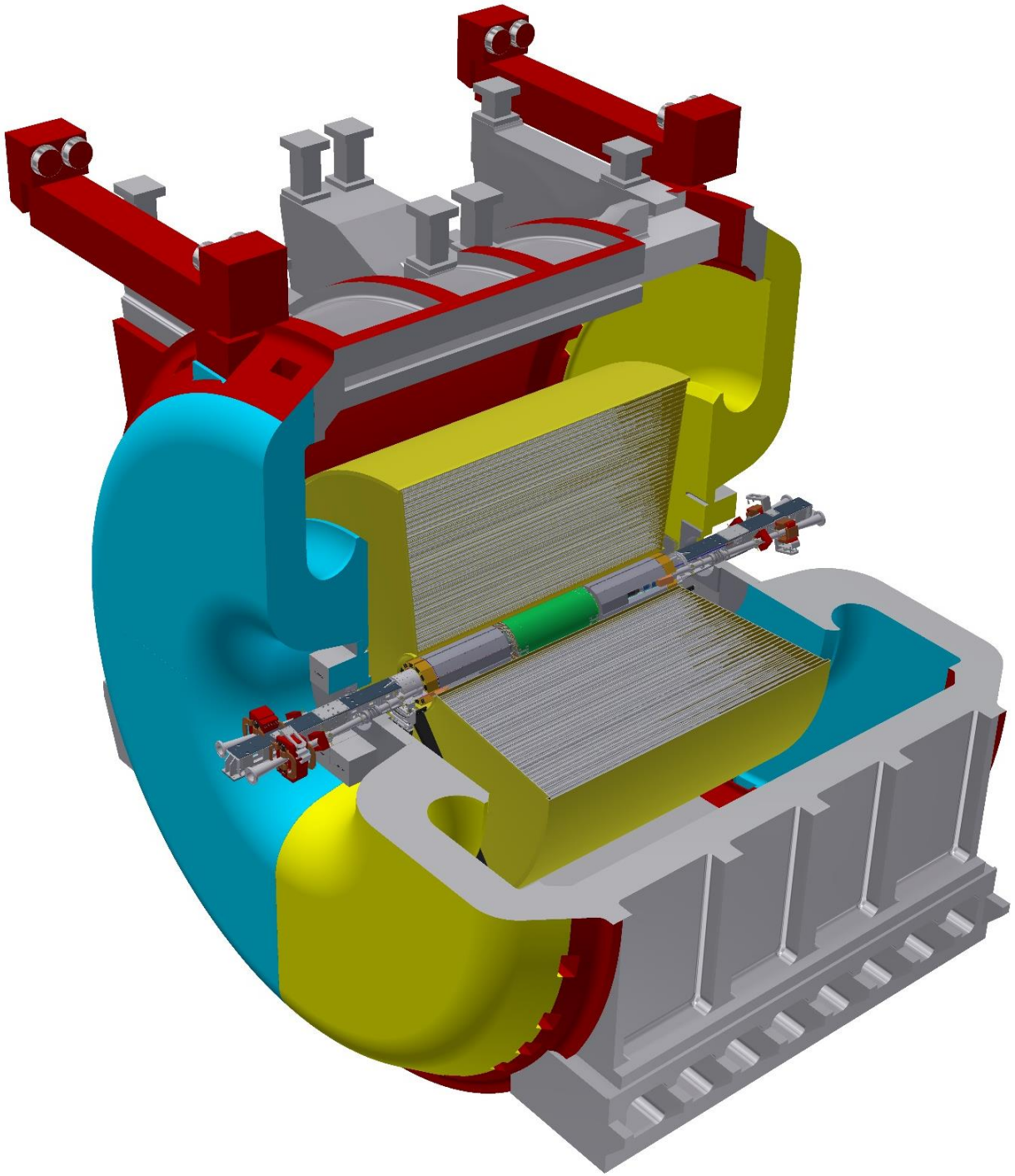
- DC - Drift Chamber
- IT - Inner Tracker
- Superconductive 0.5T Magnet

Calorimeter System

- EMC - Calorimeter
- QCALT - Quadrupole Calo
- CCALT - Crystal Calo

Tagging System

- LET - Low Energy Tagger
- HET - High Energy Tagger



Drift Chamber and Inner Tracker

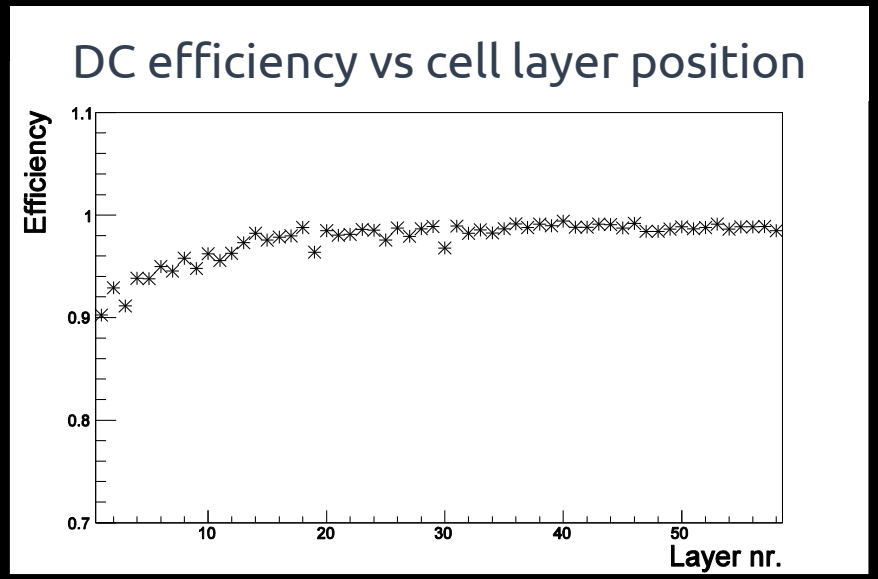
4m diameter - 3.7m length - 52k wires

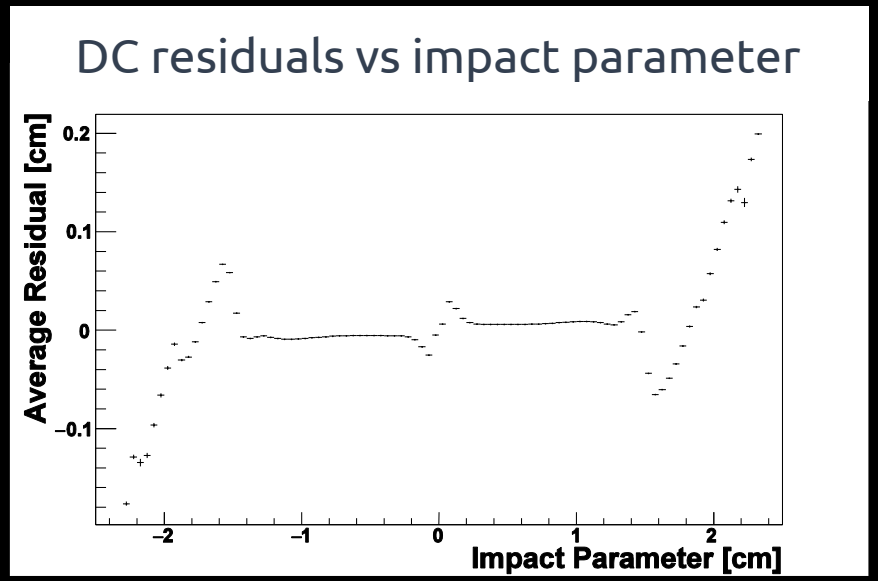
He:Iso=90:10 light gas mixture

σ_p/p = 0.4% (45° tracks)

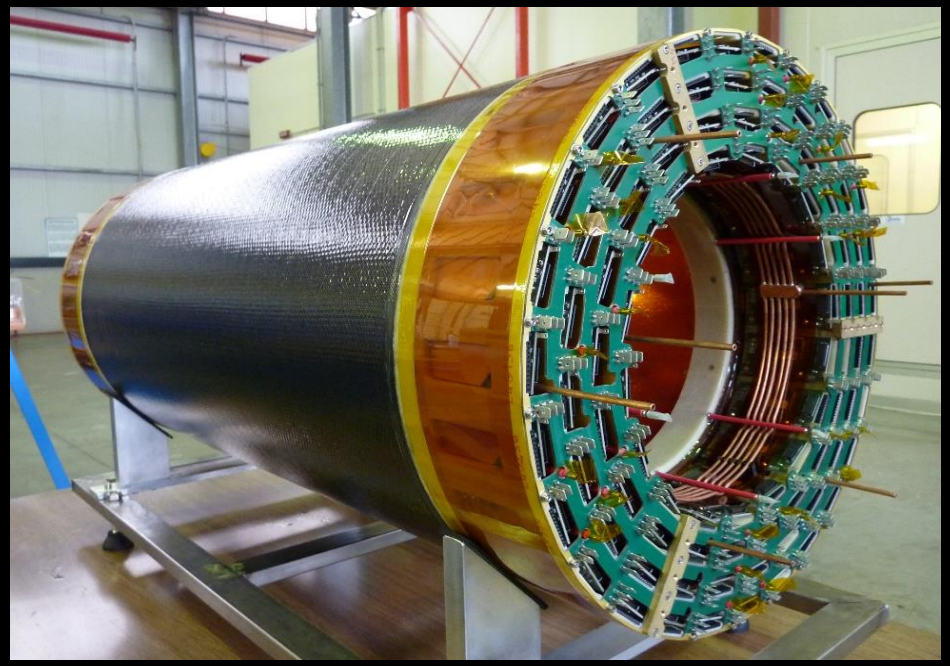
σ_{hit} = 150μm in XY and 2mm in Z

σ_{vertex} = 1mm

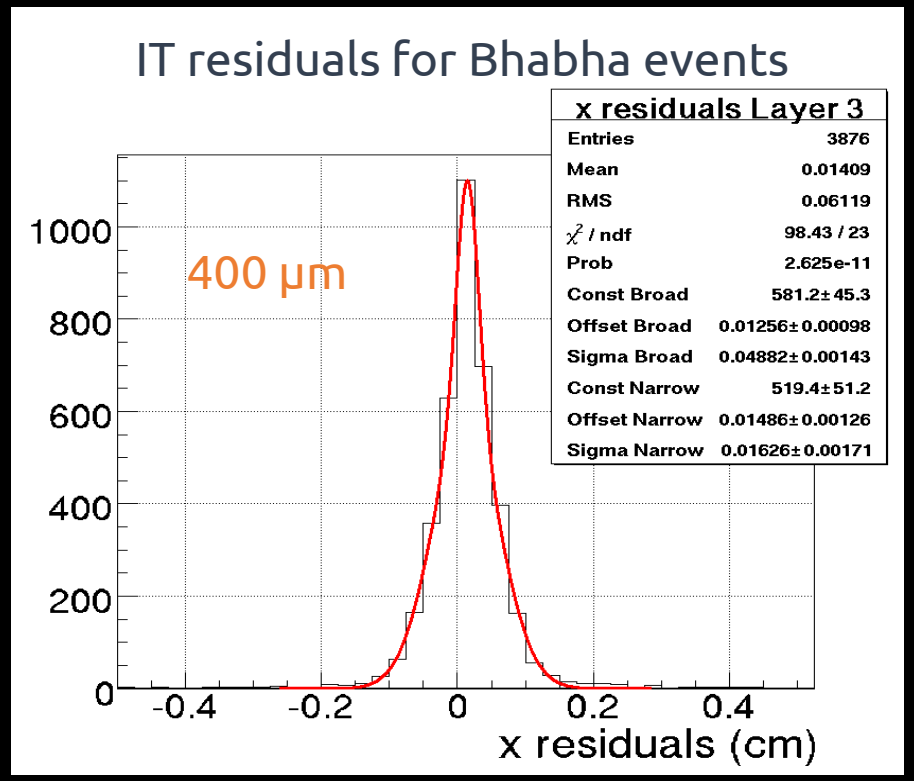




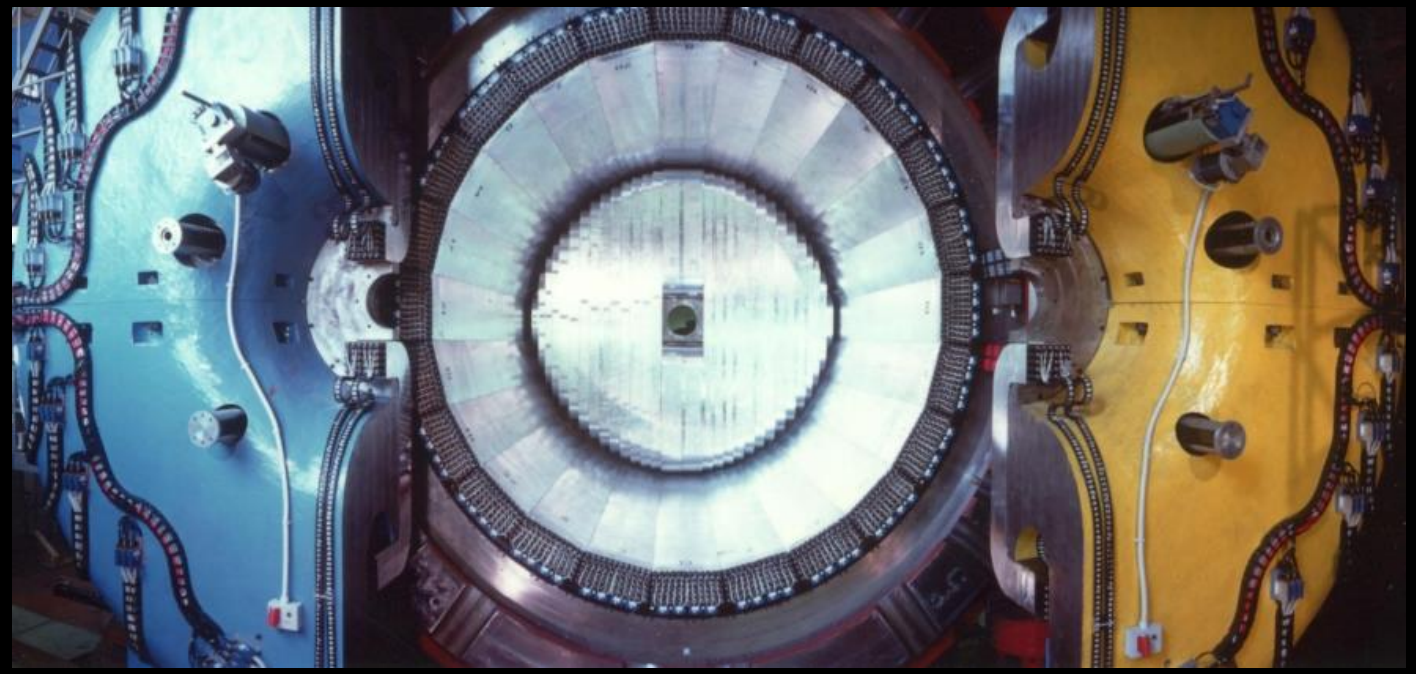
Drift Chamber and Inner Tracker

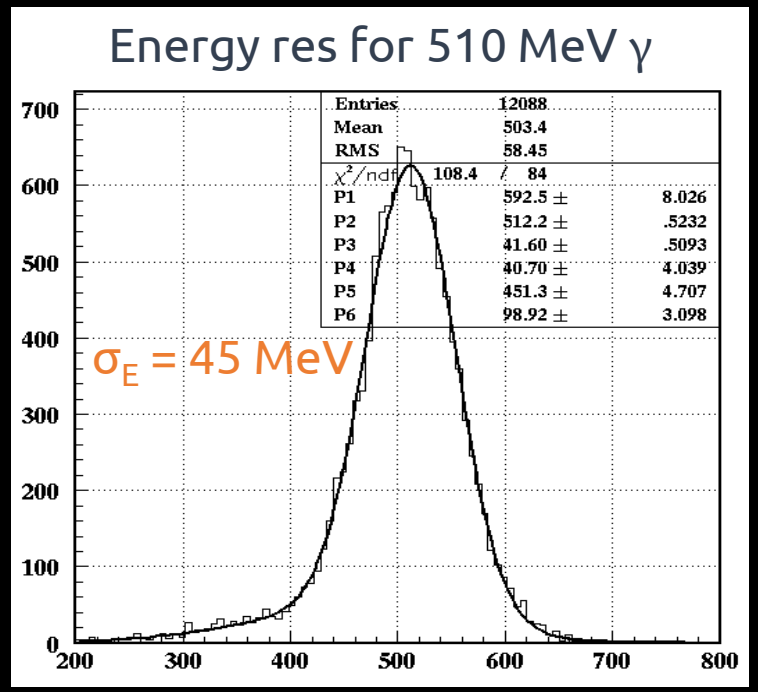


First cylidrical GEM detector ever built
4 tracking layers
13cm inner diameter - 70cm active length
Ar:Iso=90:10 gas mixture
650μm pitch X strips and V pads readout
1.6k HV channels and 30k FEE channels



Central Calorimeter





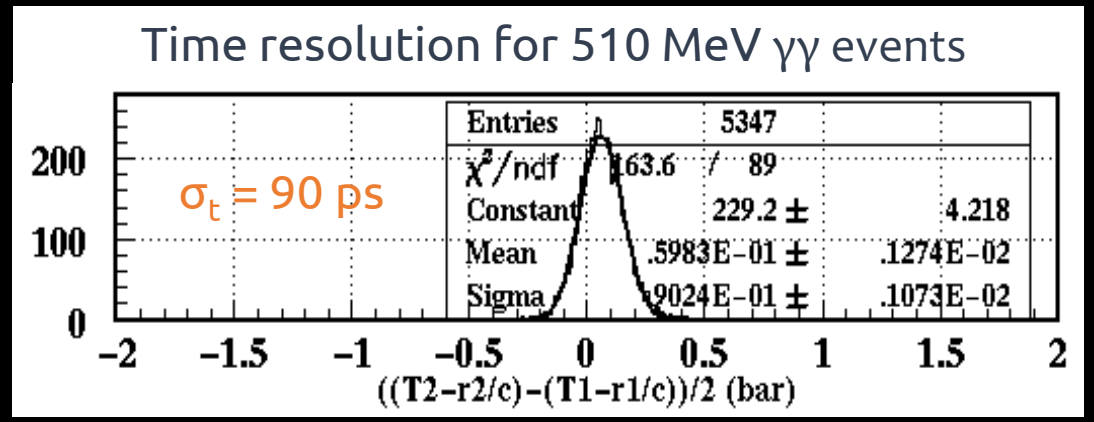
Barrel + 2 endcaps: 98% solid angle coverage

Pb+SciFi sampling – $15X_0$ thickness

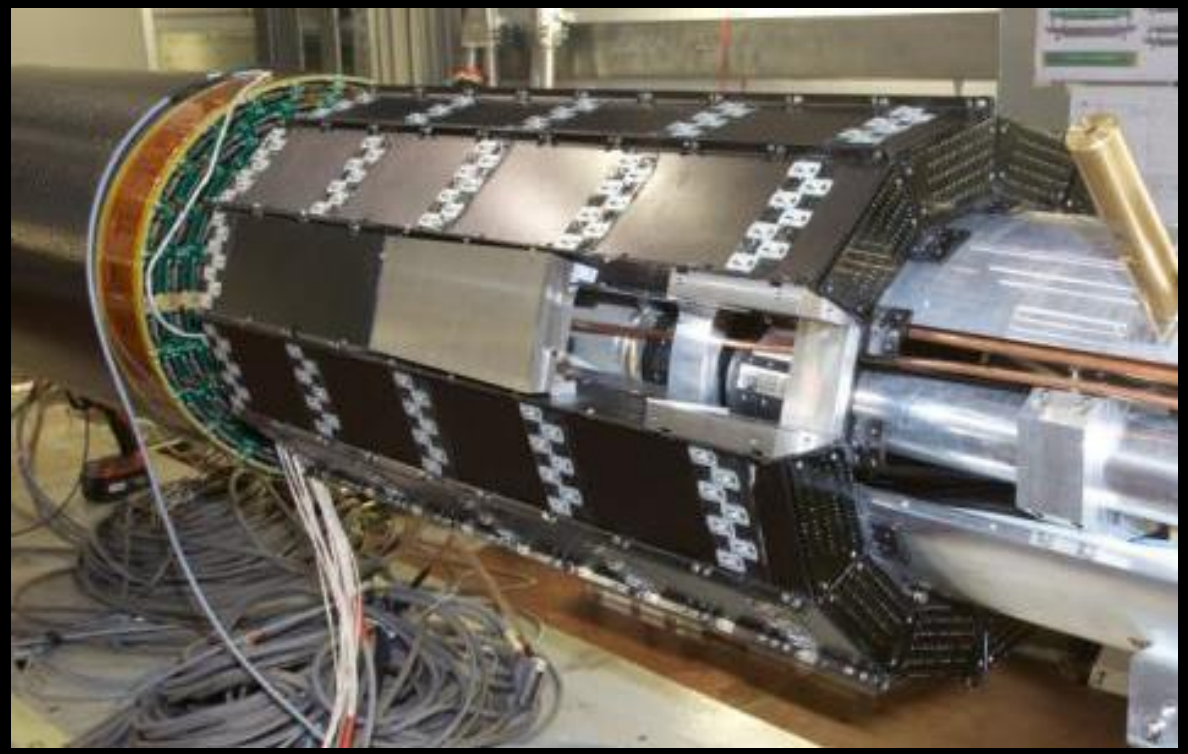
$\sigma_E/E = 5.7\% / \sqrt{E}$

$\sigma_T = 54ps / \sqrt{E} \oplus 50ps$

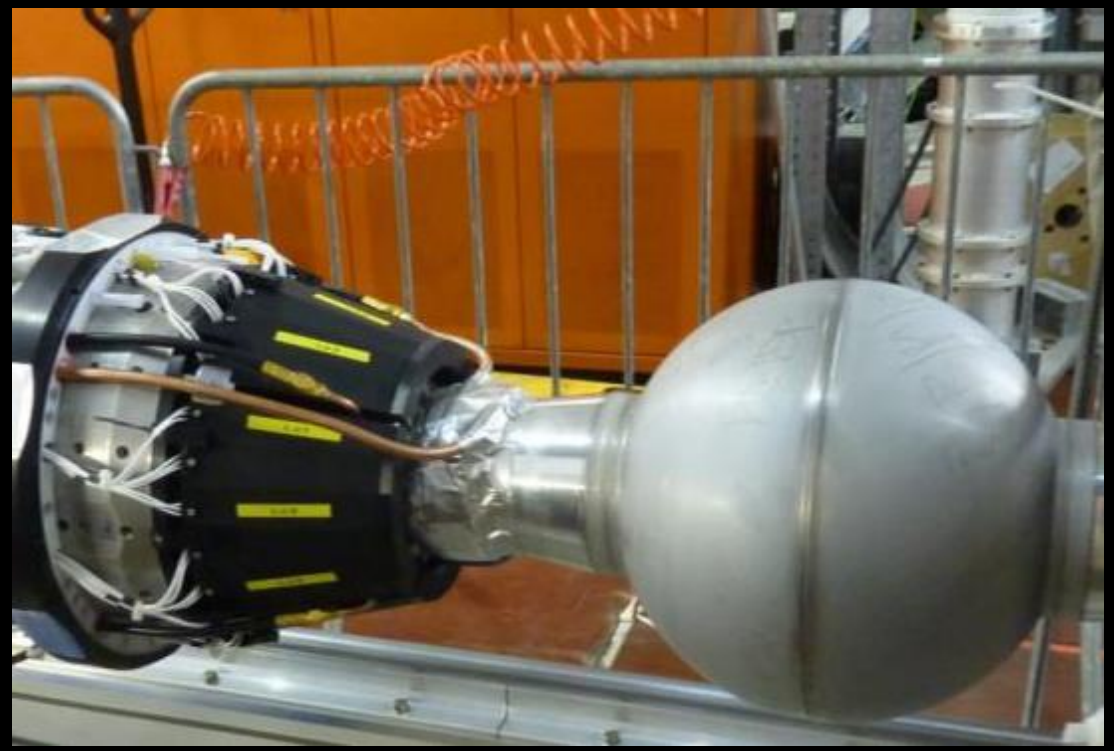
PID capabilities using TOF



QCALT – Quadrupole CALorimeter with Tiles
CCLAT – Crystal Calorimeter withTiming capabilities



2 structures aside of IT
12 towers surrounding beam-pipe
Tungsten+Scintillating tiles+WLS
SiPM readout
increase hermeticity for γ from K_L neutral decays

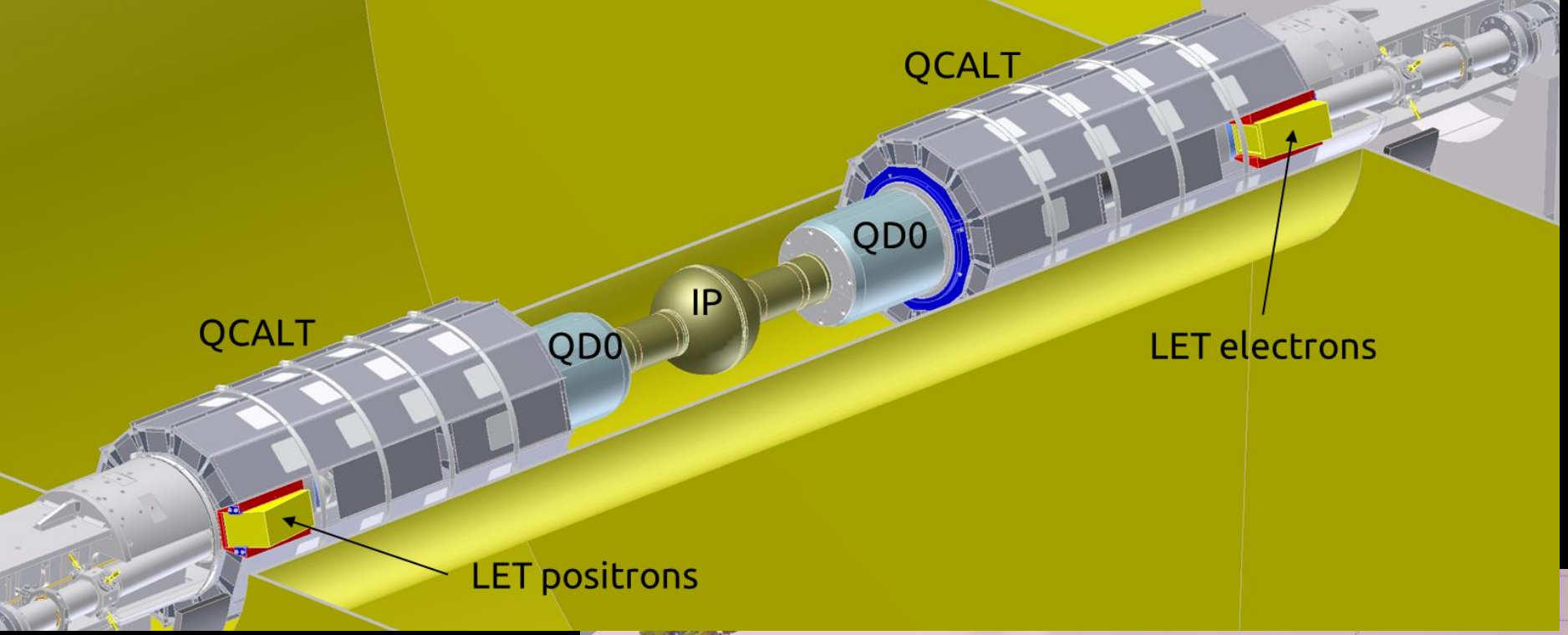


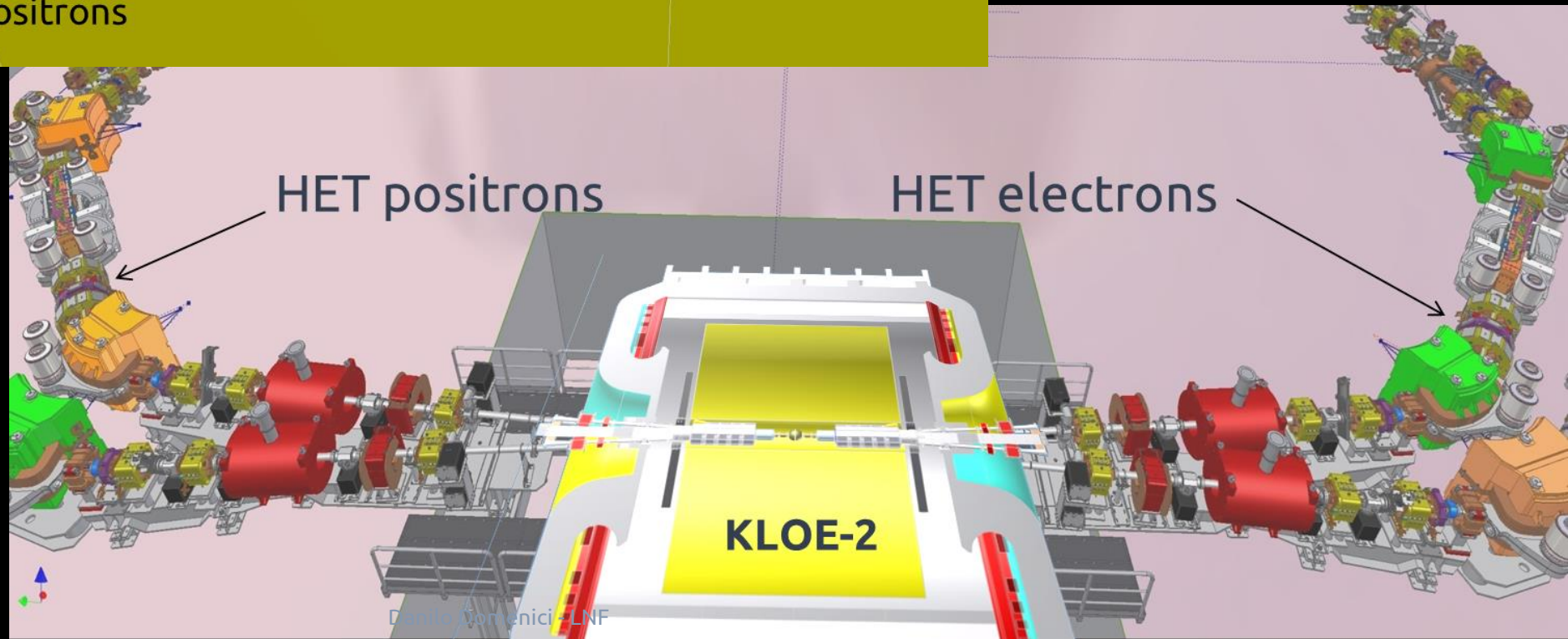
2 structures aside of IP
48 LYSO crystals per side
SiPM readout
extend photon acceptance down to 11°
used as luminosity monitor

Low and High Energy Taggers

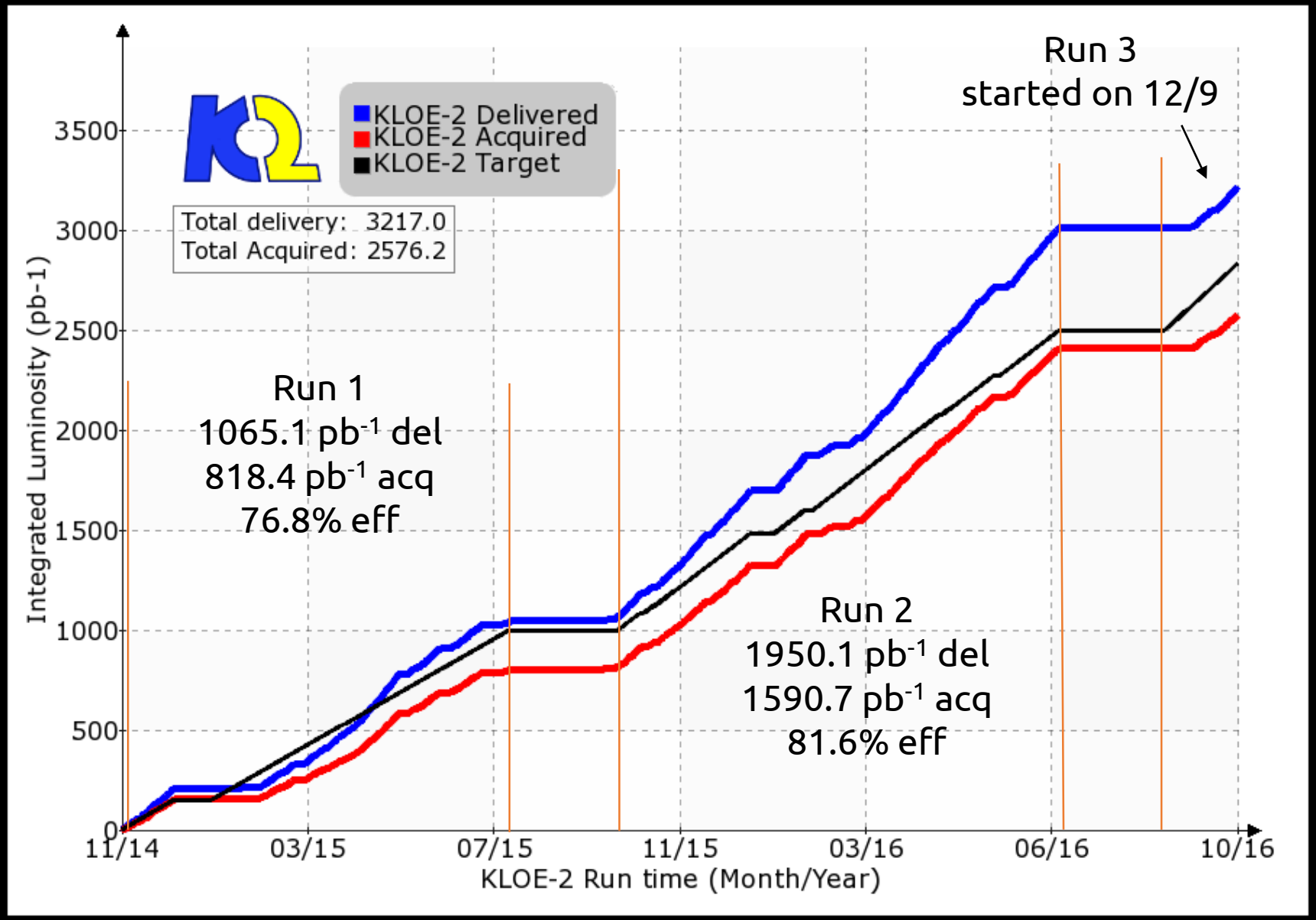
2 stations inserted in the QCALT
± 1m from IP
20 LYSO cristals + SiPM readout
σ_E/E = 10% for E > 150 MeV
150 ÷ 400 MeV energy range
essential for $2\pi^0$ resonance search

2 stations after the dipoles
± 11m from IP
Plastic scintillator hodoscope + PMT readout
400 MeV energy range
essential for π^0 resonance search

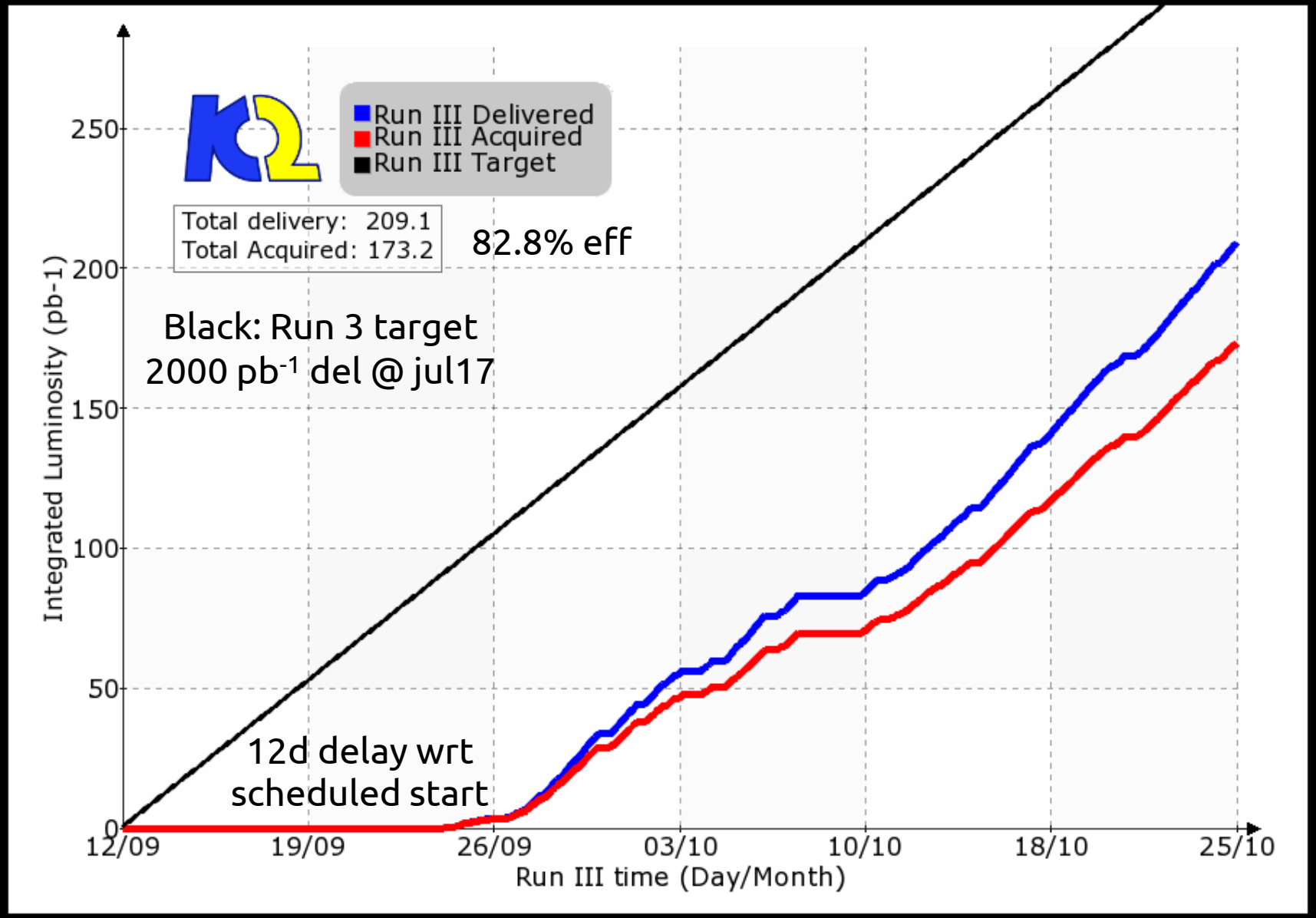

QCALT
QD0
IP
QD0
QCALT
LET electrons
LET positrons


HET positrons
HET electrons
KLOE-2

KLOE-2 data-taking



Welcome to Run 3

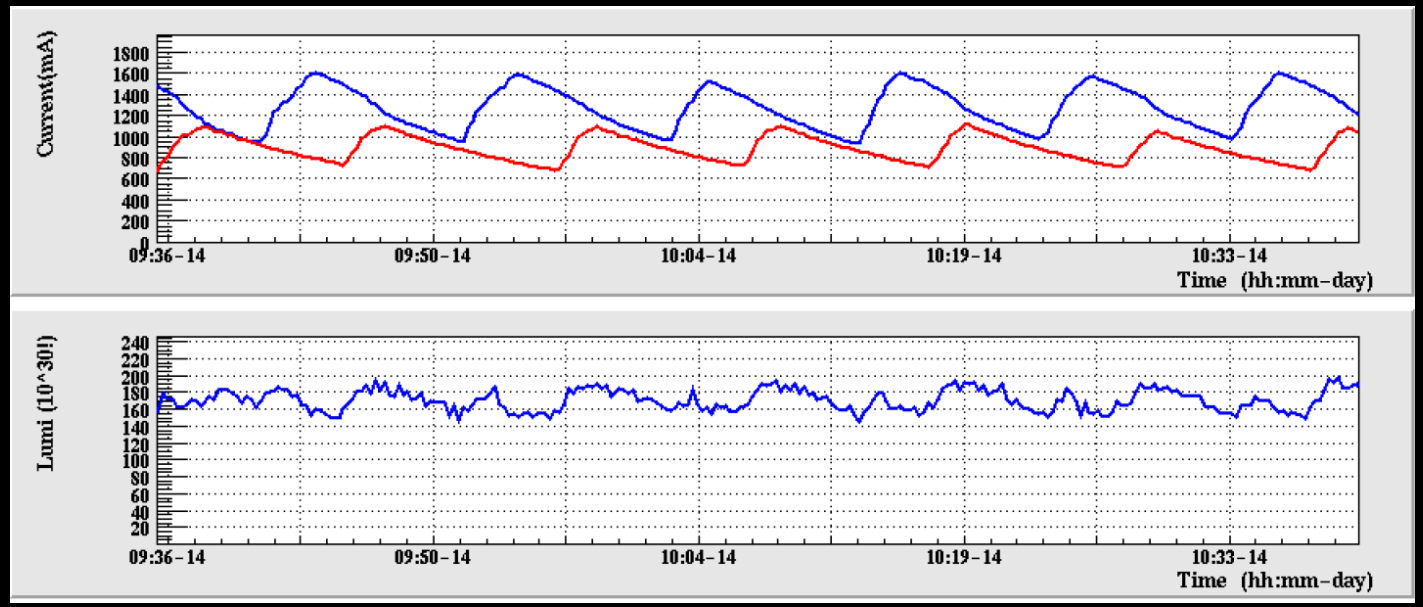


DAFNE performance

DAFNE complex consolidated in 2013 to improve up-time
Main characteristics:

- Typical beam currents 1.5A (e^-) and 1A (e^+)
- 105 bunches stored with 2.7 ns spacing
- Top-up injections of e^- and e^+ beams every 10 min
- Average up-time 80%

Typical hour of operation



Best Luminosity achievements in KLOE-2 Data-taking

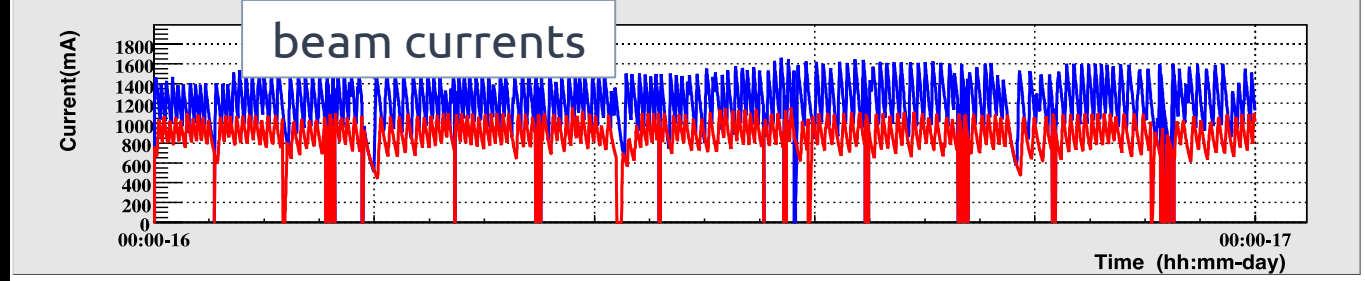
Max instantaneous: $2.21 \times 10^{32} cm^{-2} s^{-1}$
Max hourly: 651.0 nb^{-1}
Max daily delivery: 13.4 pb^{-1}
Max weekly delivered: 76.3 pb^{-1}

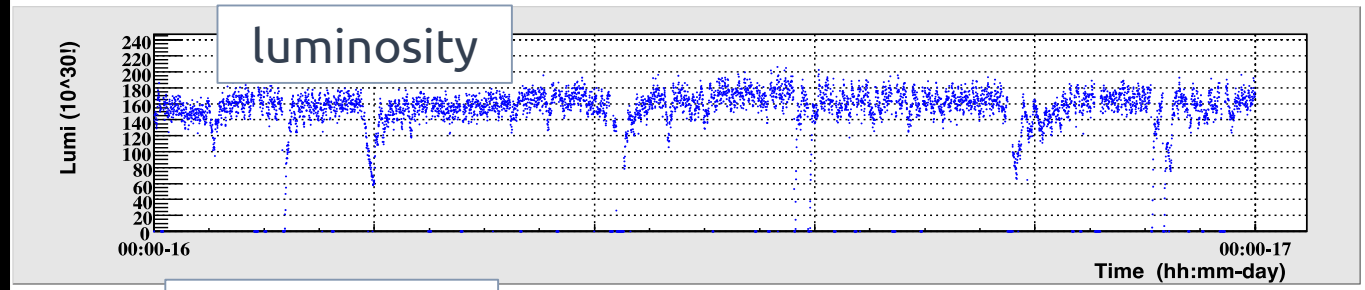
Typical Day

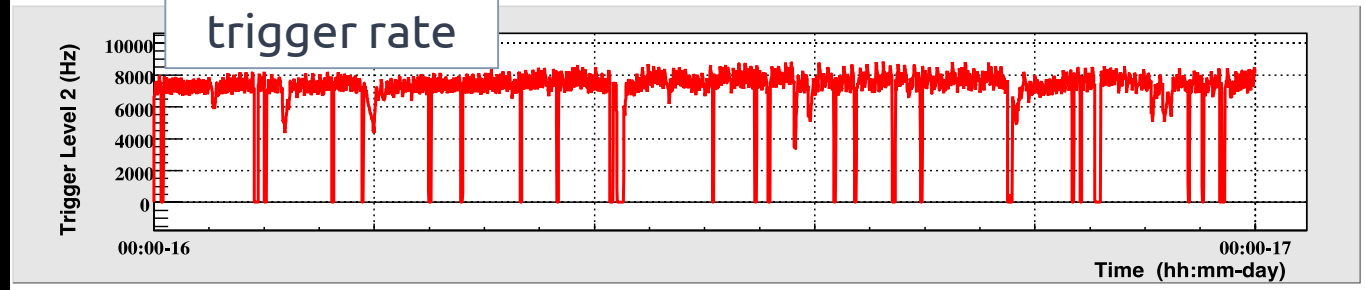
top-up injection results in a uniform instantaneous luminosity

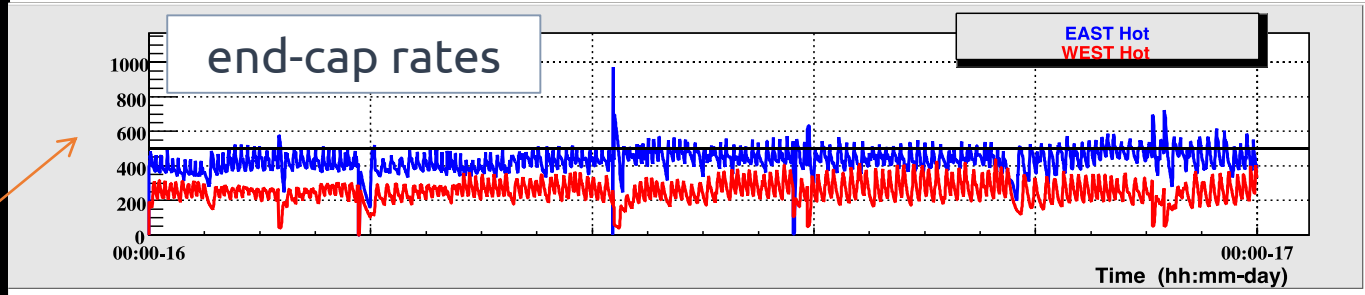
L2 trigger rate is about 7 kHz
500 Hz from Φ physics
3 kHz from cosmic muons
2.5 kHz from Bhabha events
the rest is background
(mostly Touschek scattered particles)

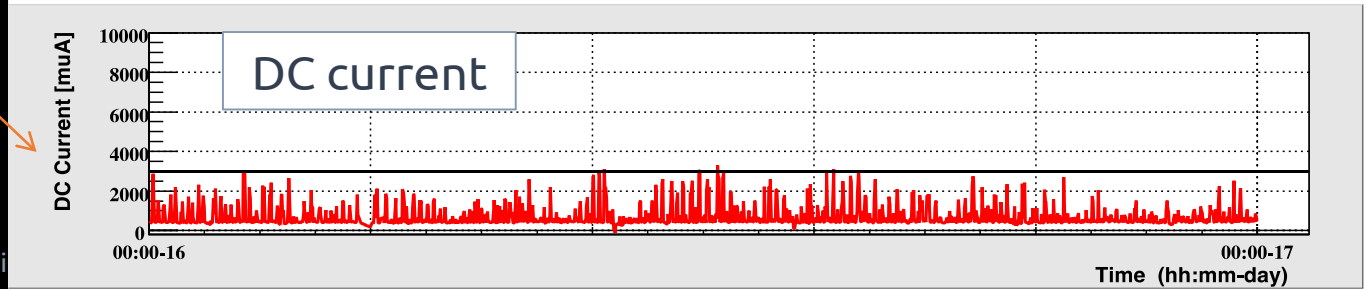
Calorimeter end-caps counters and total current in Drift Chamber are used as benchmarks for evaluating the machine induced background



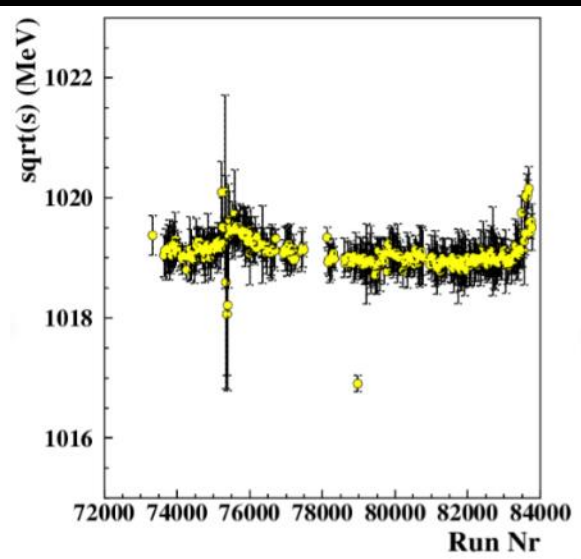




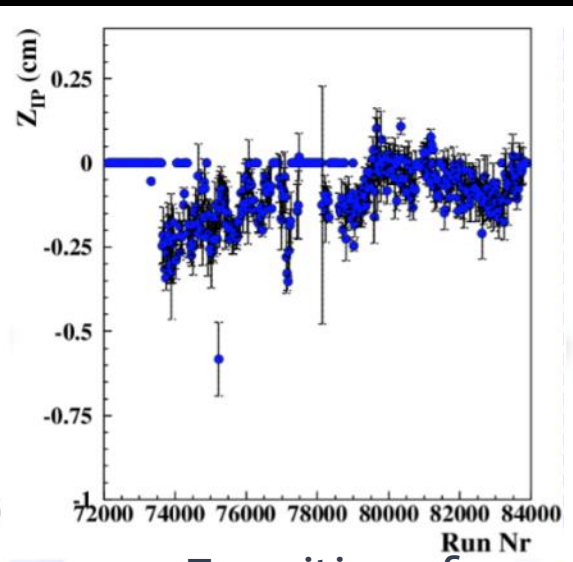




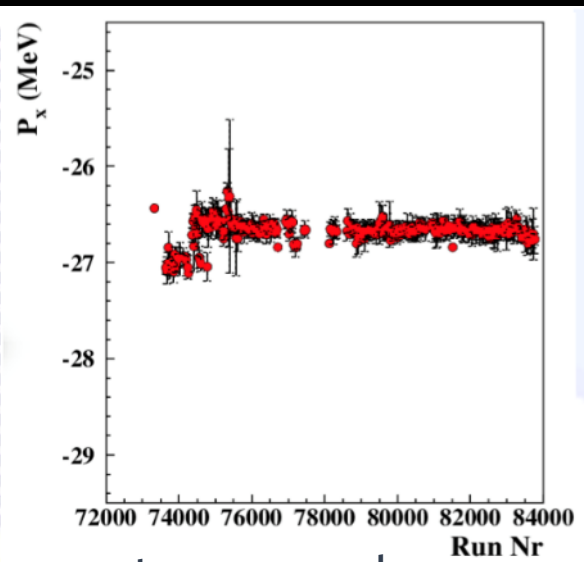
Beam parameters Monitor



center of mass energy

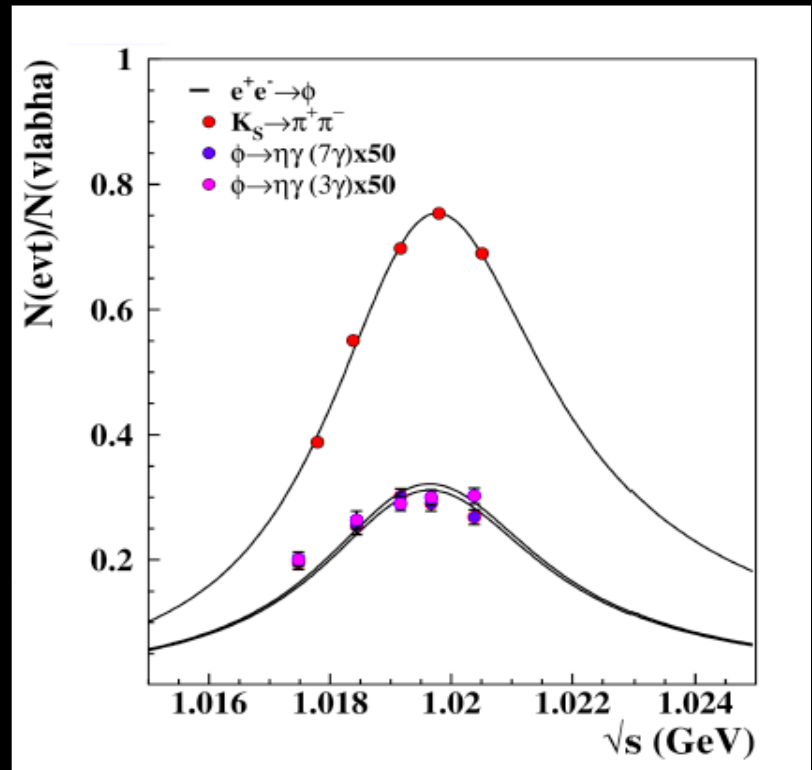


Z position of interaction point



transverse beams momentum

Beam parameters are precisely measured by KLOE and used also as feedback to DAFNE



DAFNE RF scan (550 keV steps) to precisely set the beam energy to Φ peak

√s = 1019.5

Data Quality Monitor Benchmark Analysis

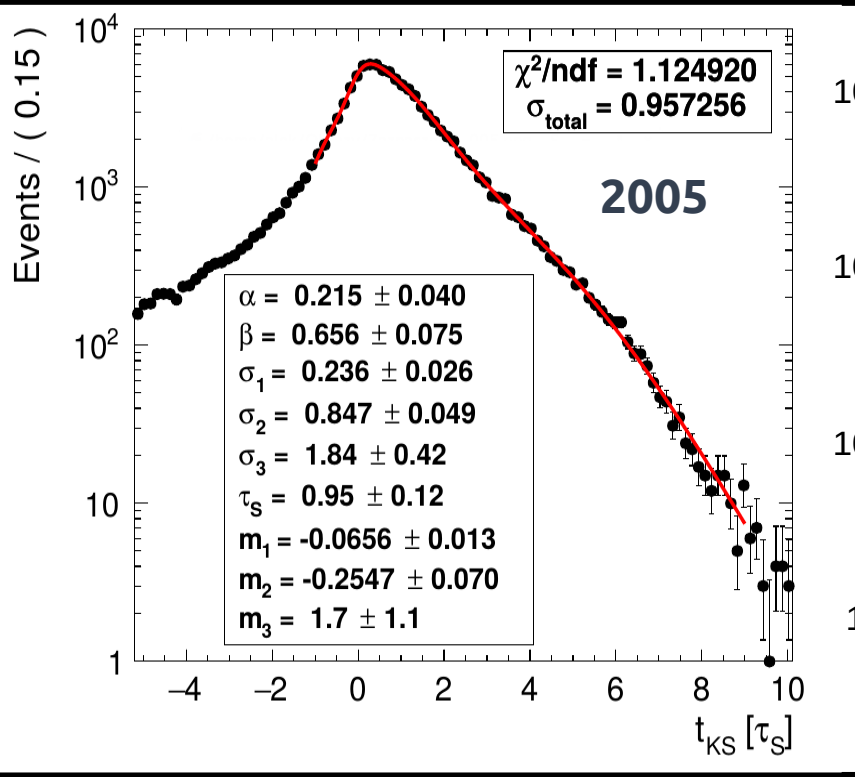
$\Phi \rightarrow \eta\gamma$ with $\eta \rightarrow 3\pi^0$ (fully neutral channel)

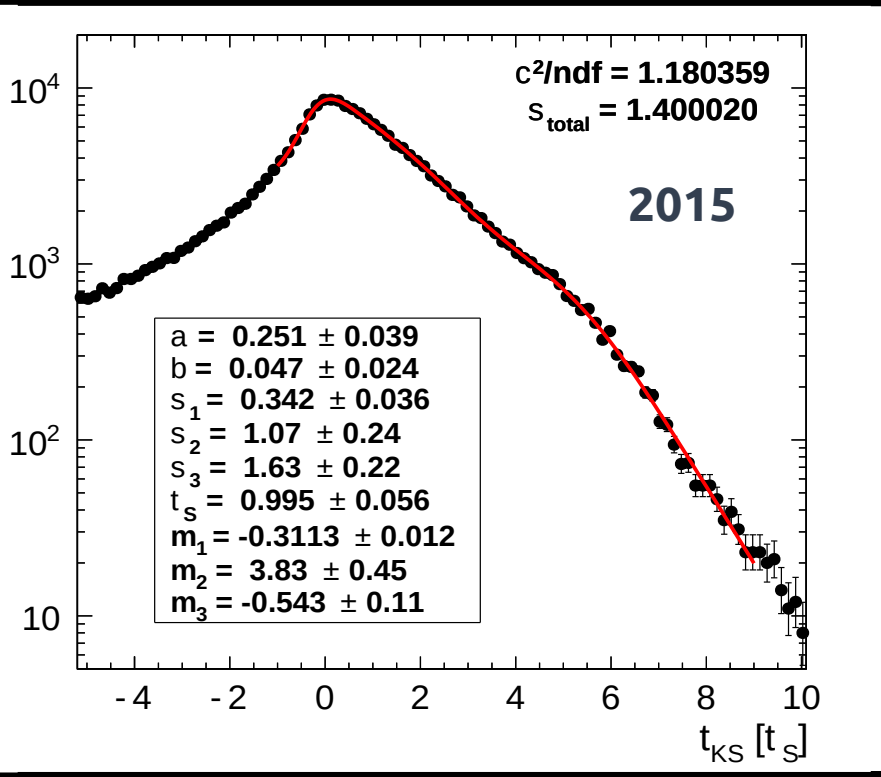
K_S lifetime with $K_S \rightarrow \pi^+\pi^-$ (fully charged channel)

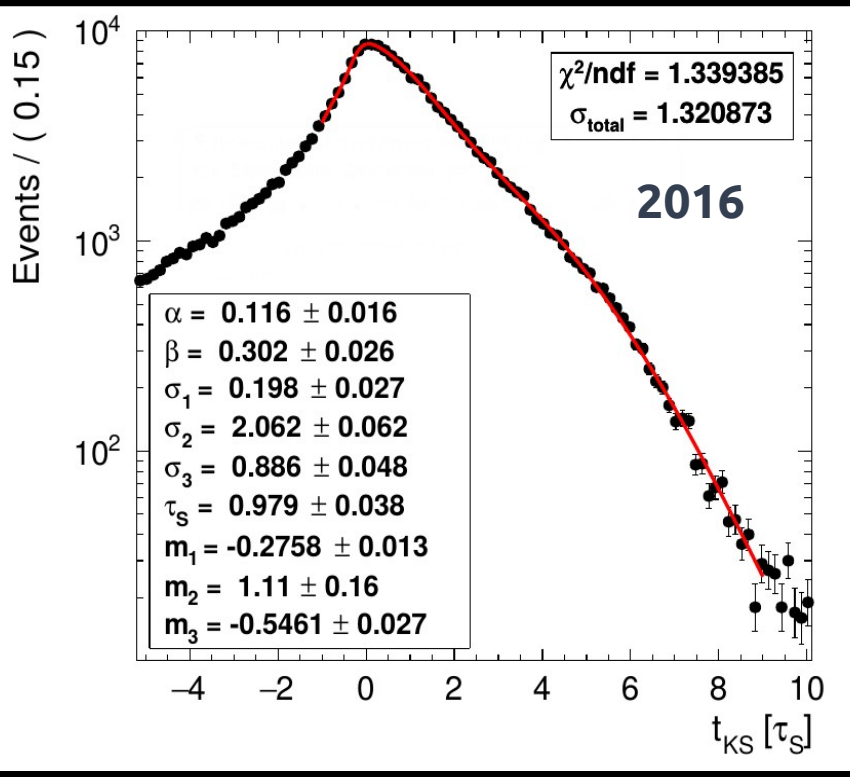
$\Phi \rightarrow \eta\gamma$ with $\eta \rightarrow \gamma\gamma$ (fully neutral channel)

$K_L \rightarrow \pi^+\pi^-$ (fully charged channel)

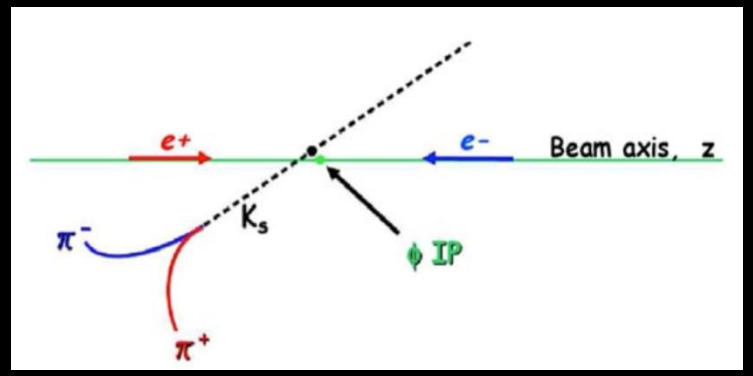
K_S lifetime with $K_S \rightarrow \pi^+\pi^-$



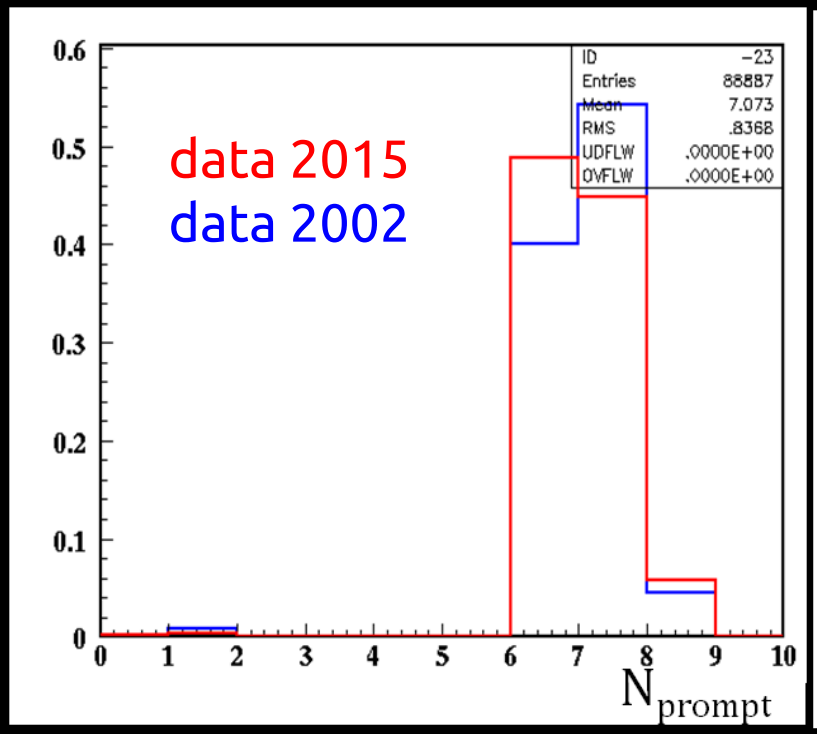


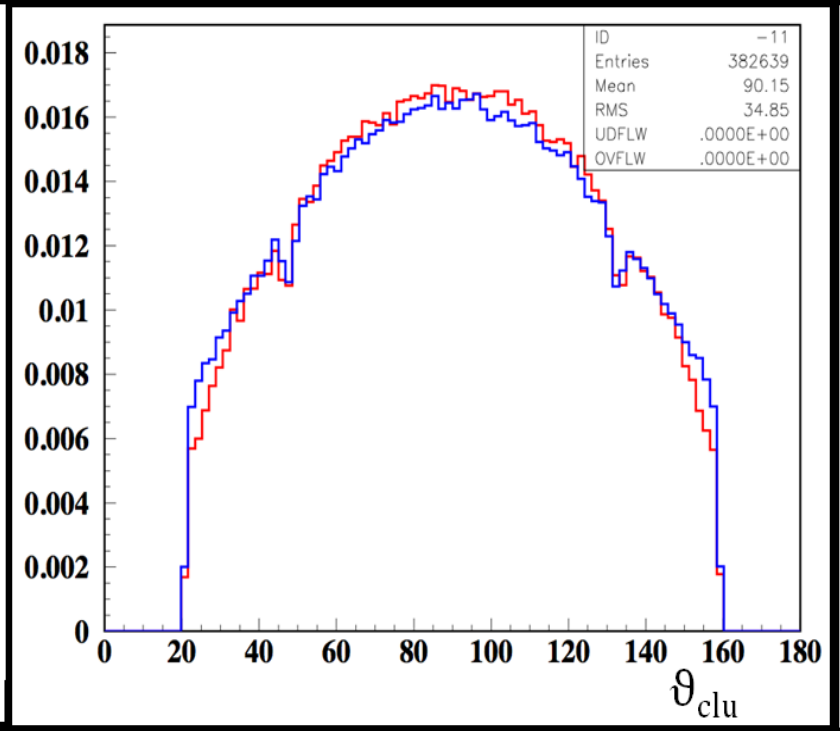


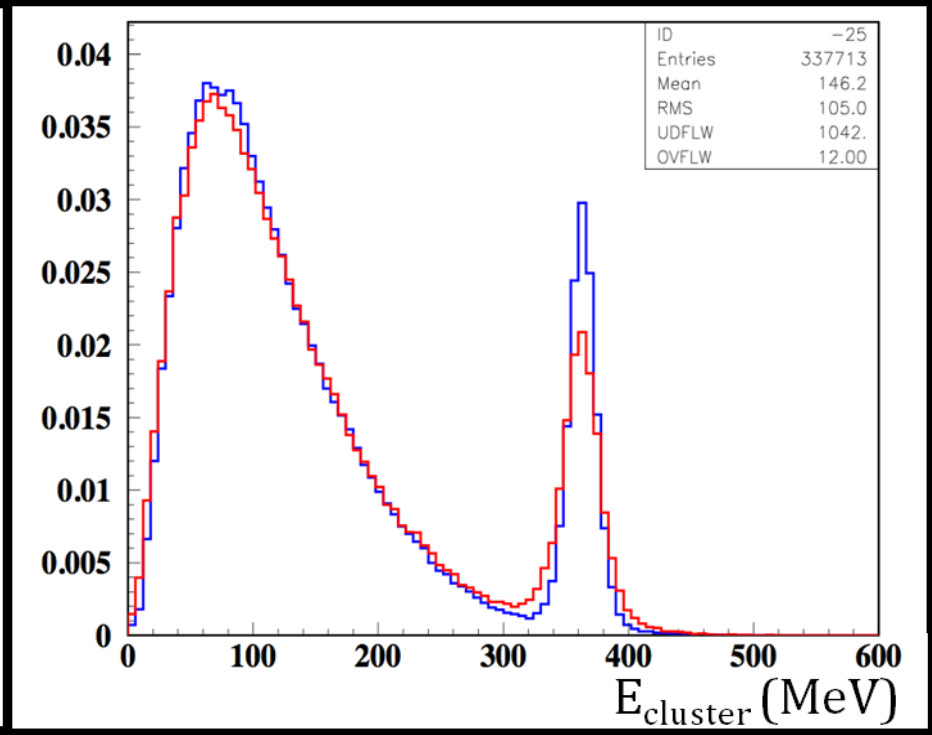
- Exponential function folded with a triple gaussian
- Time calculated from the projection of the decay length on the K_S momentum direction (negative tail due to resolution)
- Better resolution expected from IT tracking



$\Phi \rightarrow \eta\gamma$ with $\eta \rightarrow 3\pi^0$







- Search for neutral rad with $N_{prompt} > 5$ clusters
- Background contribution to cluster distribution wrt 2002
- Select $\Phi \rightarrow \eta\gamma$ with $\eta \rightarrow 3\pi^0$ (clean 363 MeV recoil γ)

Conclusions

DAFNE is steadily delivering luminosity
at 10 pb^{-1}/day

the same 2001-06 KLOE acquired data amount
(2.5 fb^{-1}) has been already taken in 2 years

KLOE-2 detectors are fully operational

data quality of first KLOE-2 data is being analyzed with benchmark channels
and found in good agreement with the past