The KLOE-2 Project

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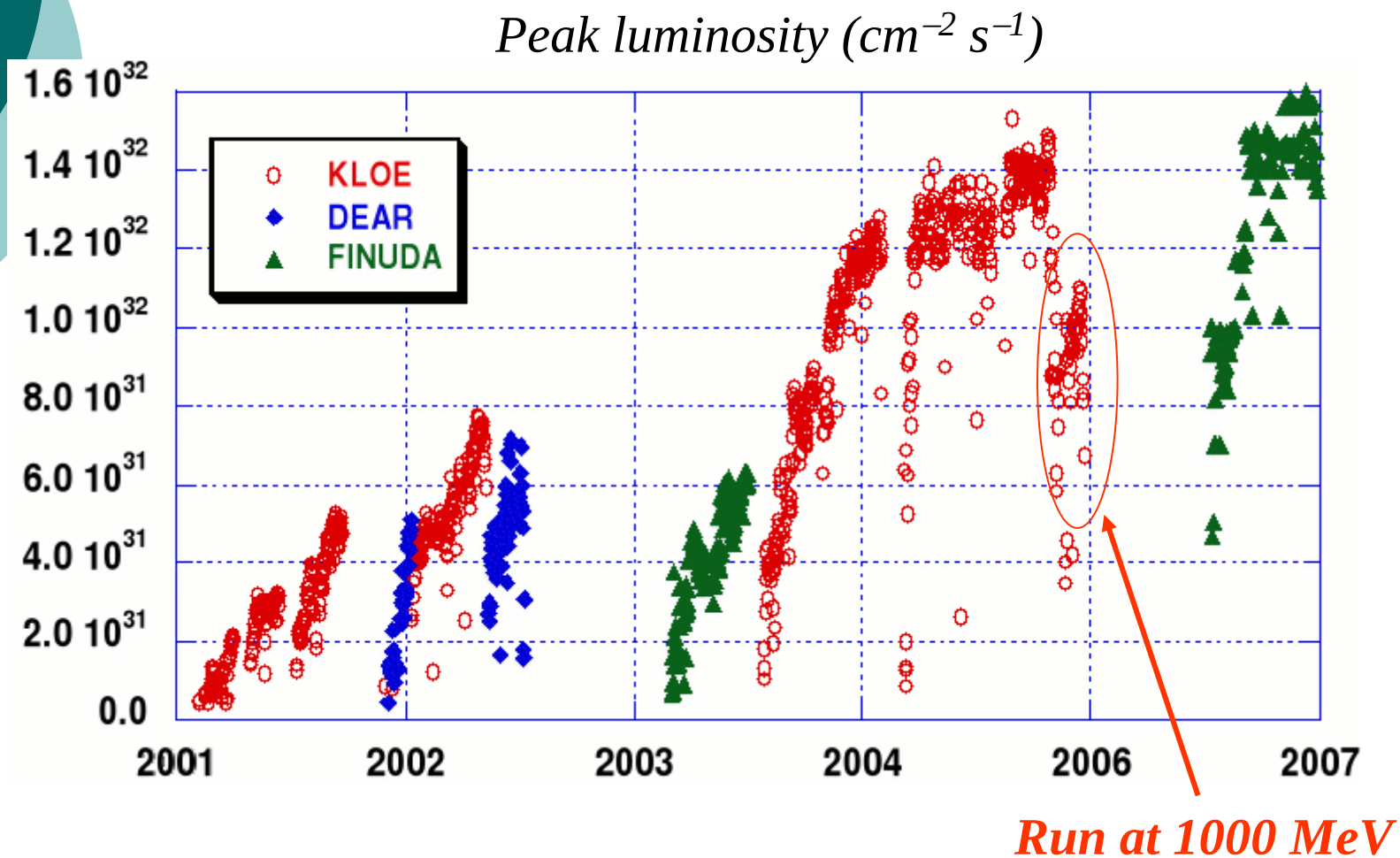
DAΦNE

Between years 2000-2007 the Accelerator Division of LNF has operated the DAΦNE collider with increasing performance

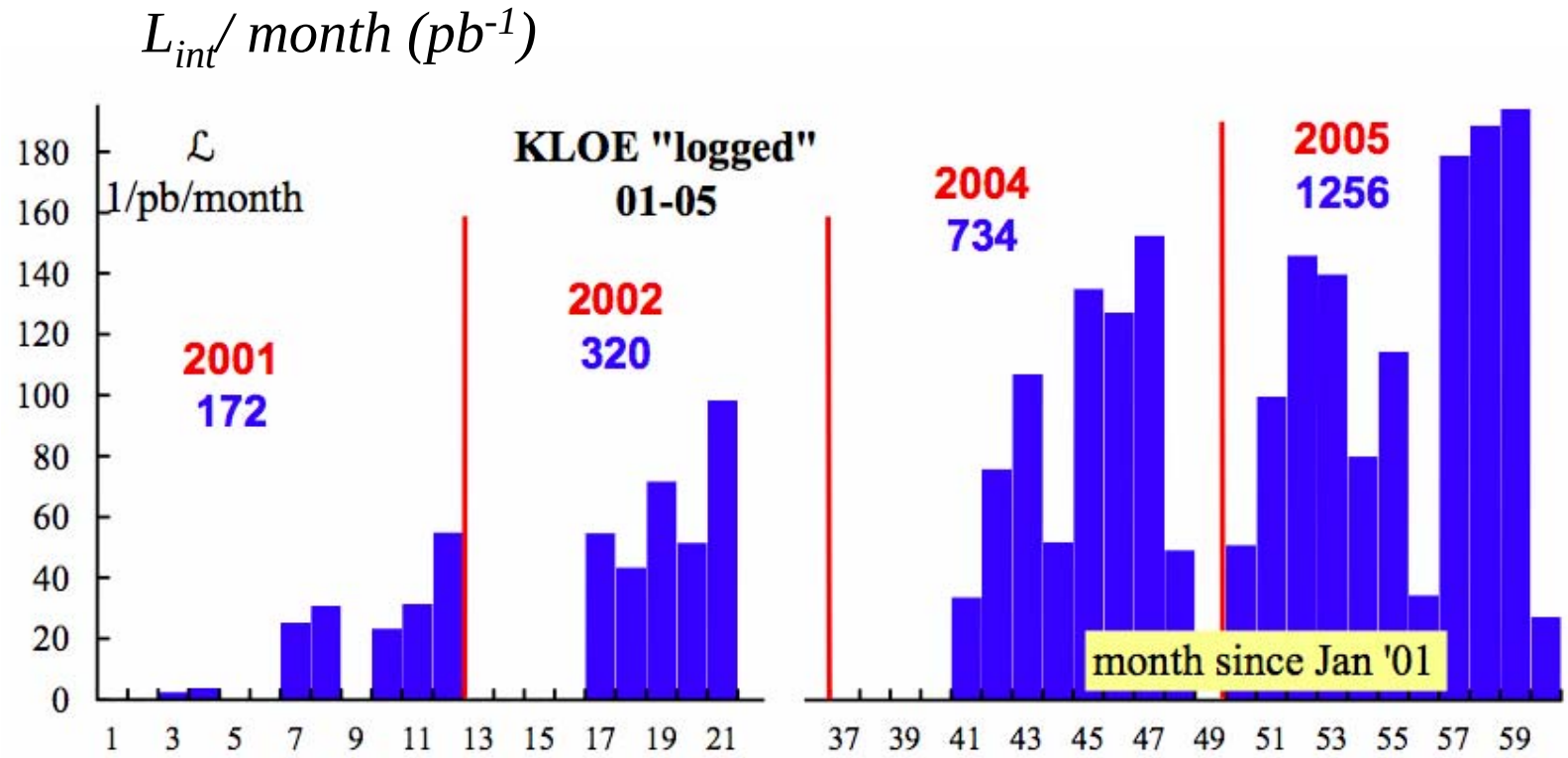
Three different experiments have shared the access to the beam during time, collecting in total ~ 4 fb^{-1} of data around the Φ resonance peak

- KLOE devoted mainly to the study of *K* meson decays, and fundamental symmetries conservation
- FINUDA devoted to hypernuclear physics
- DEAR devoted to the study of kaonic atoms

DAΦNE performance along years



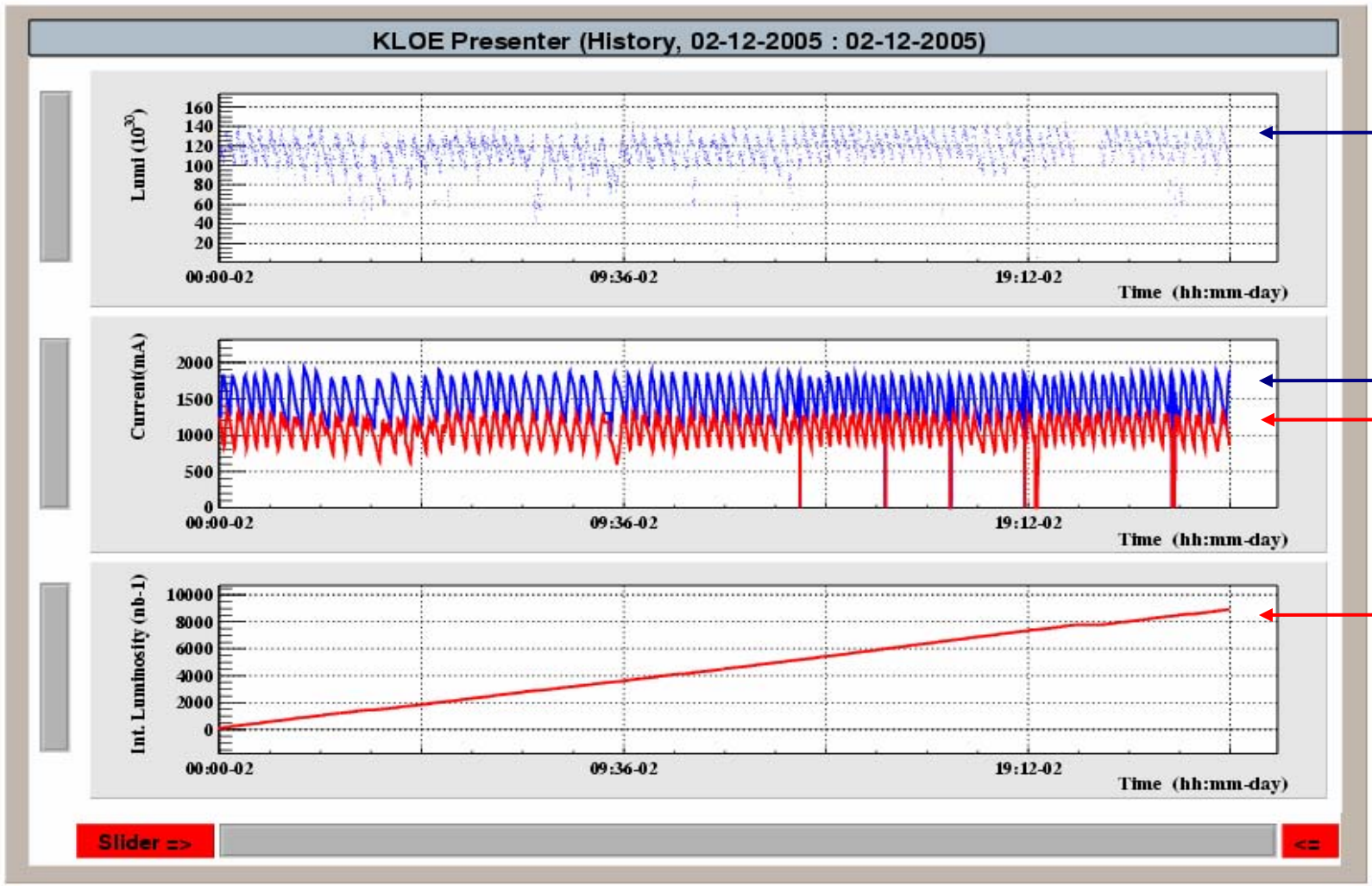
KLOE data taking



- **2001-2005** $L_{int} = 2482\ pb^{-1}$
- **2004-2005** $L_{int} = 1990\ pb^{-1}$
- **Best conditions: Sept/Oct/Nov 2005 ⇒ 179/189/194 pb^{-1}**

stable luminosity, beam energy and backgrounds

KLOE data taking



$\mathcal{L} = 1.4 \cdot 10^{32}$ cm^{-2}s^{-1}

$I_- = 1.6$ A

$I_+ = 1.1$ A

$\int \mathcal{L} dt = 8$ pb^{-1}

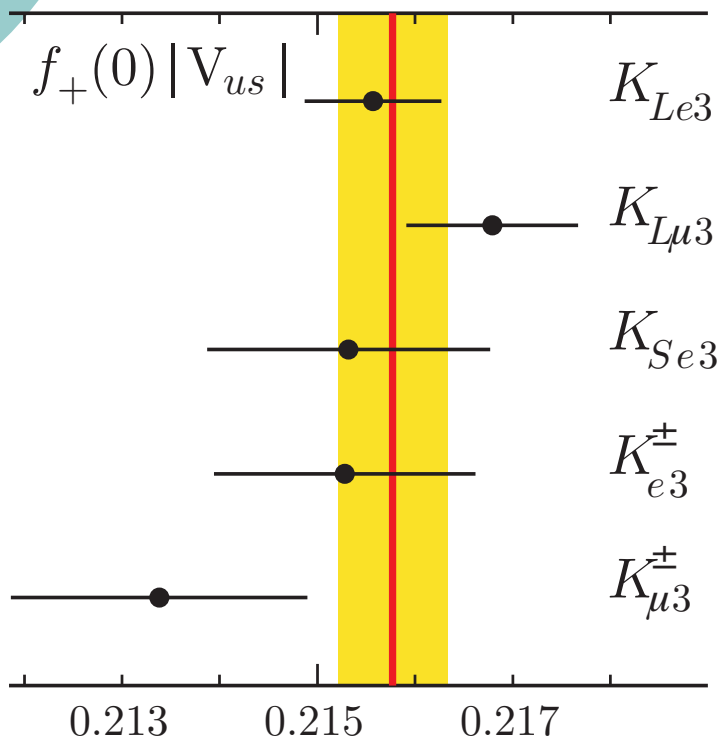
Physics from KLOE

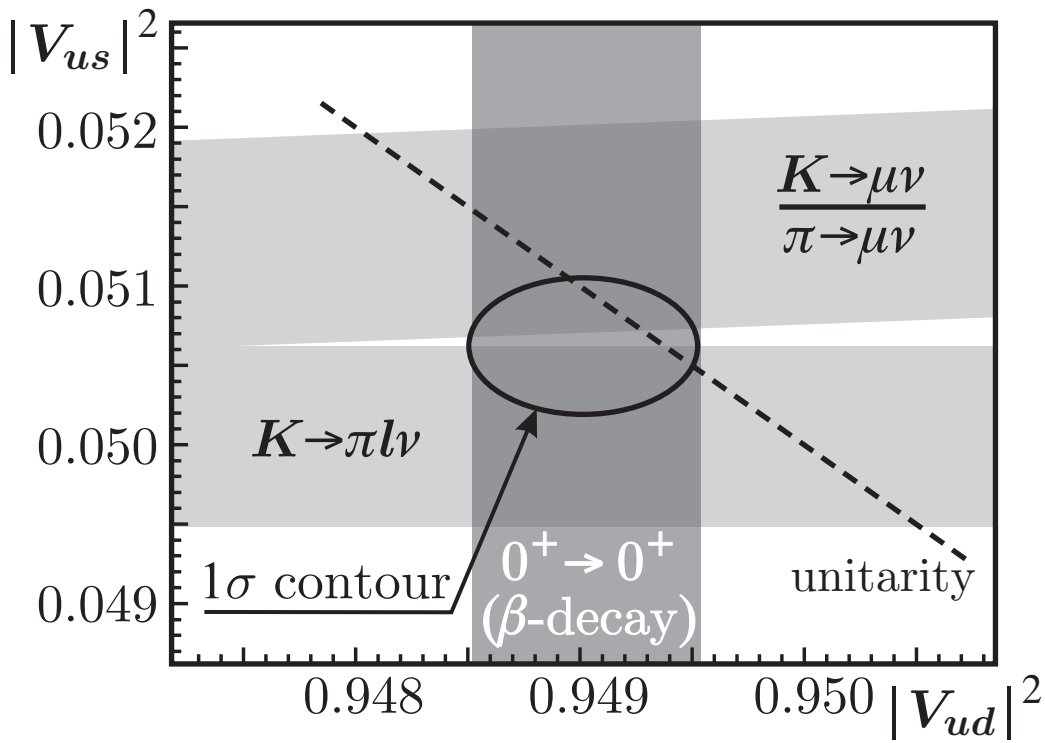
The intense analysis work pursued by the collaboration has produced so far about 40 physics papers, in the fields of flavour physics, hadronic physics, quantum interferometry

Many of these results are based on a limited part of the acquired data, so that we expect to publish many other papers in the near future

V_{us} from KLOE

KLOE has determined precisely the CKM element V_{us} by using several K_L, K_S and $K^{\pm}$ decay channels. Unitarity preserved at 6×10^{-4} level.

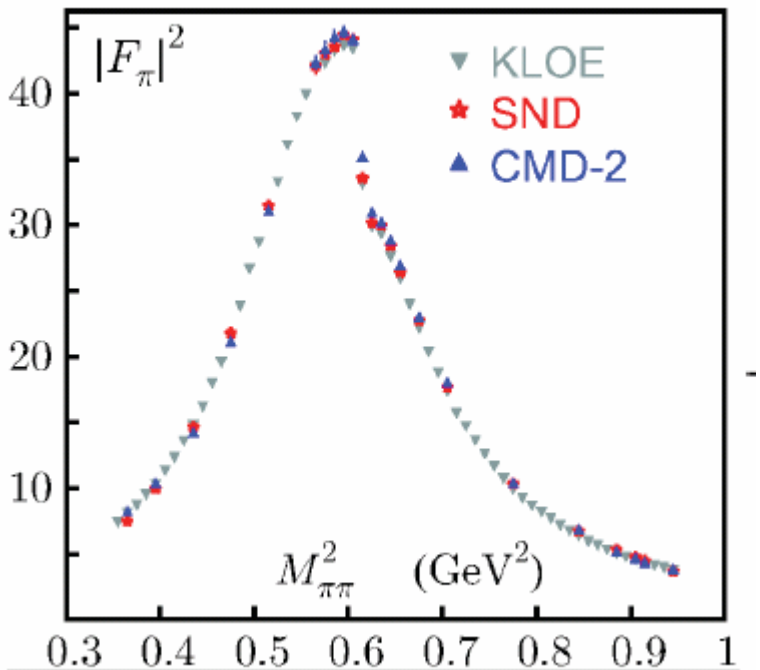




Hadronic cross section below 1 GeV

The hadronic cross section below 1 GeV is a fundamental ingredient for the theoretical determination of the muon *g-2*

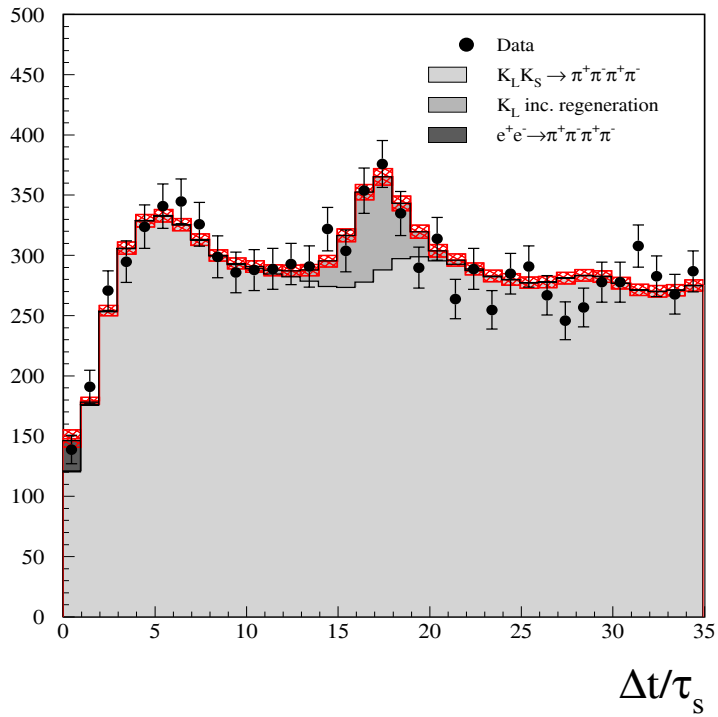
KLOE confirms the ~3σ discrepancy with the experiment, derived by e^+e^- data contrary to τ data



$$a_\mu^{\pi\pi}(0.35\text{-}0.95\text{GeV}^2) = (387.2 \pm 0.5_{stat} \pm 2.4_{sys} \pm 2.3_{theo}) \cdot 10^{-10}$$

CPT and QM tests

Tests of quantum coherence and CPT symmetry conservation have been performed using neutral kaons correlated pairs



KLOE published:

$$\zeta_{0\bar{0}} = \left(1.0 \pm 2.1_{\mathrm{STAT}} \pm 0.4_{\mathrm{SYST}}\right) \times 10^{-6}$$

CPLEAR:

$$\zeta_{0\bar{0}} = 0.4 \pm 0.7$$

BELLE (B system):

$$\zeta^{B}_{0\bar{0}} = 0.029 \pm 0.057$$

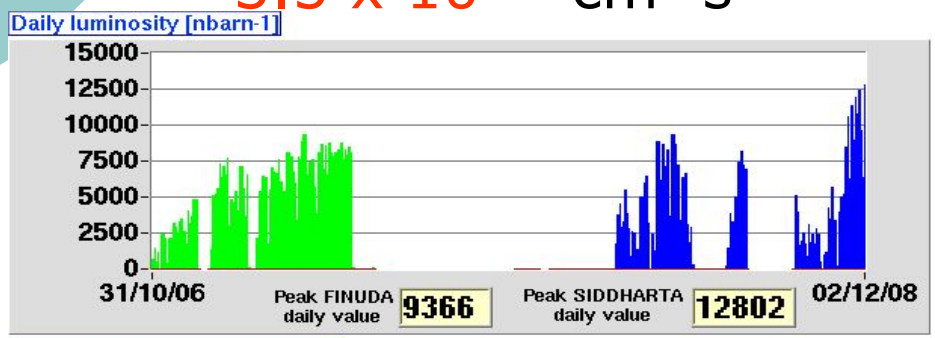
DAΦNE new interaction scheme

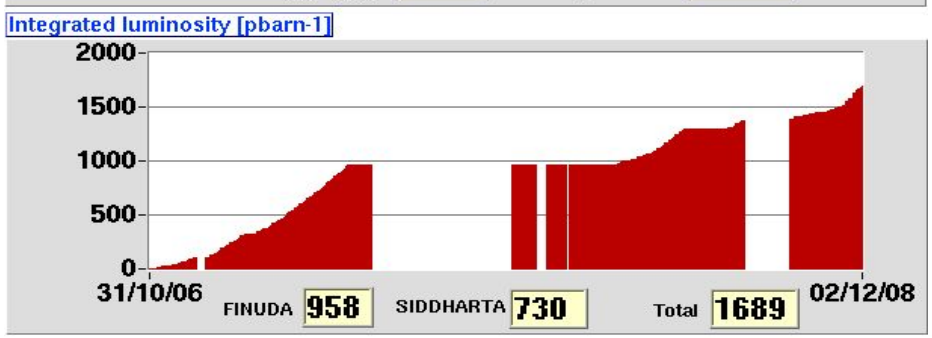
Since the beginning of 2008, DAΦNE has implemented a new interaction scheme based on the use of a large Piwinski angle in combination with a crabbed waist induced by properly designed sextupoles

The goal is to achieve an increase in luminosity by a factor ~3 with the same colliding currents. The scheme is being presently used during the course of the SIDDHARTA data taking

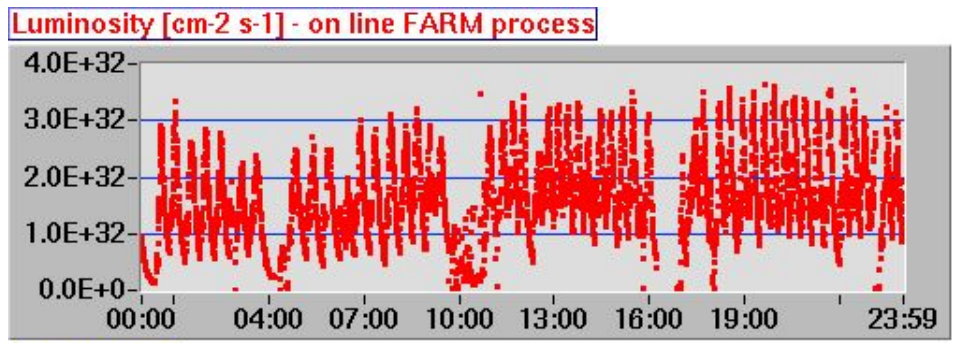
DAΦNE luminosity records

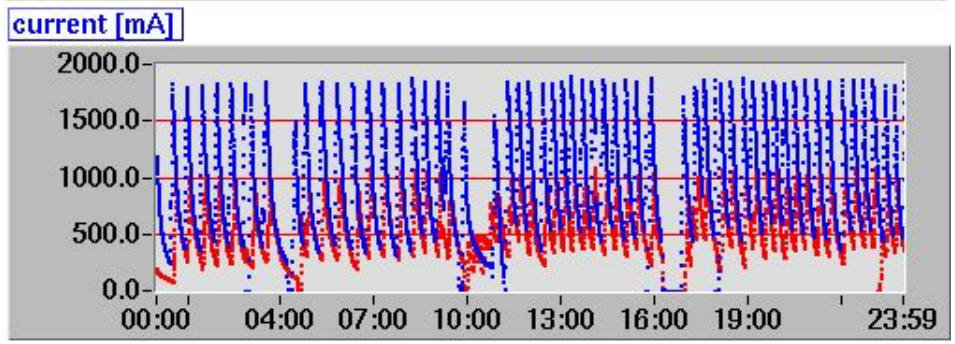
During the last month,
> 12 pb^{-1} /day were obtained several times.
Peak luminosity
~ 3.5 x 10^{32} $cm^{-2}s^{-1}$

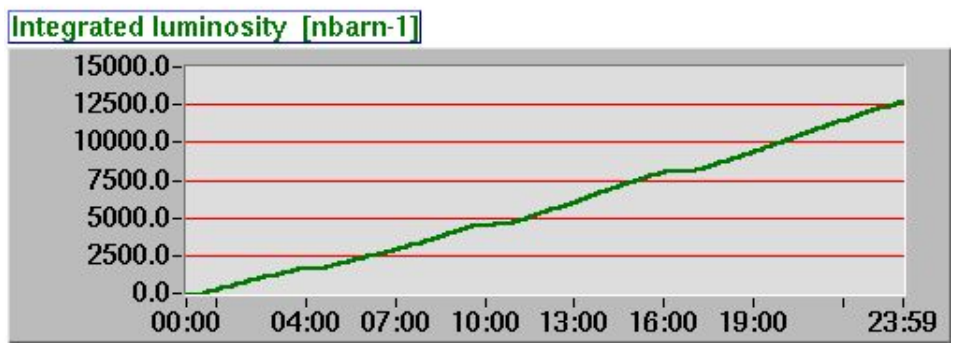




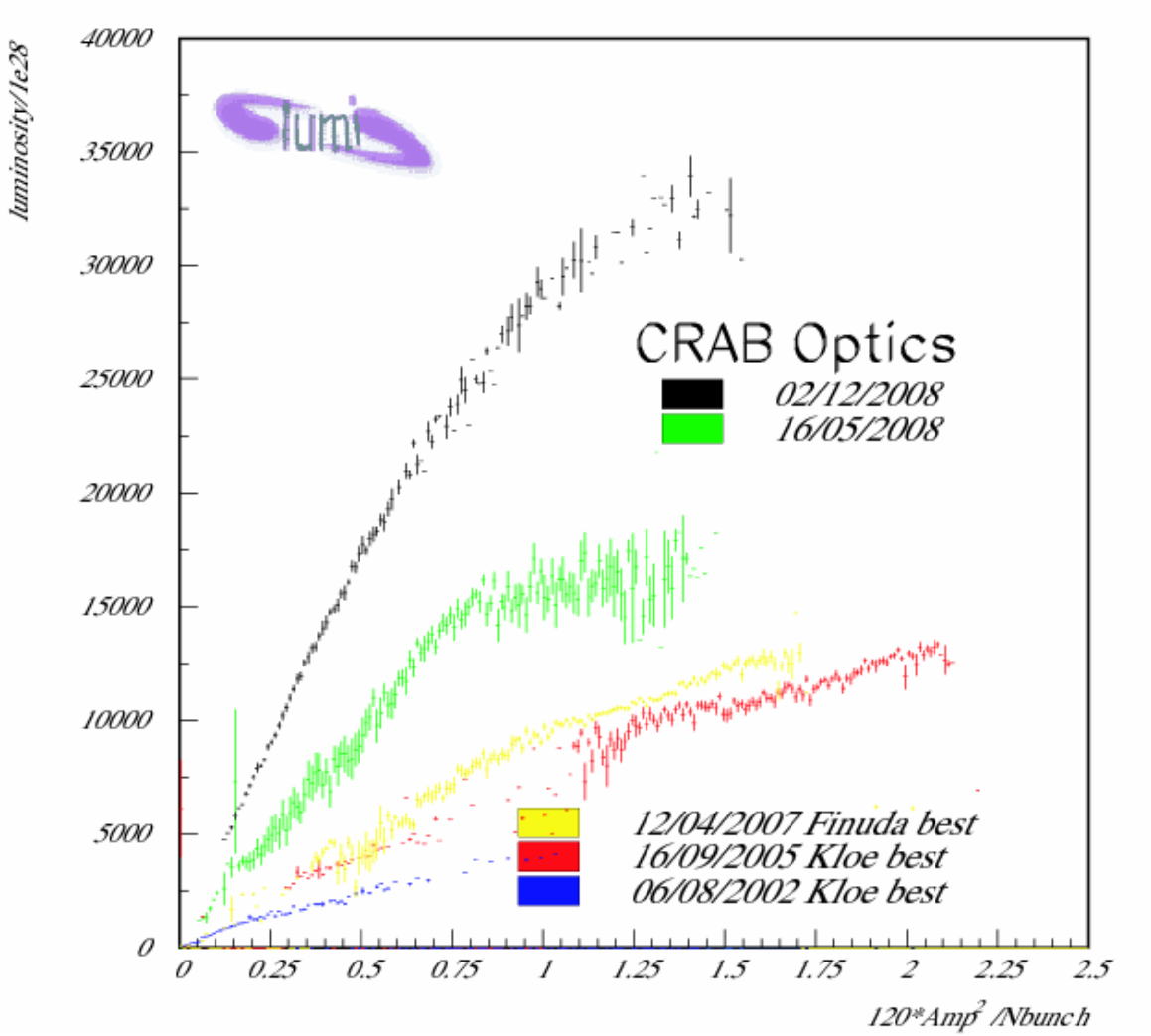
SIDDHARTA run luminosity estimeted by DAFNE luminosity Bhabha monitor, data logging starts 14/03/2008



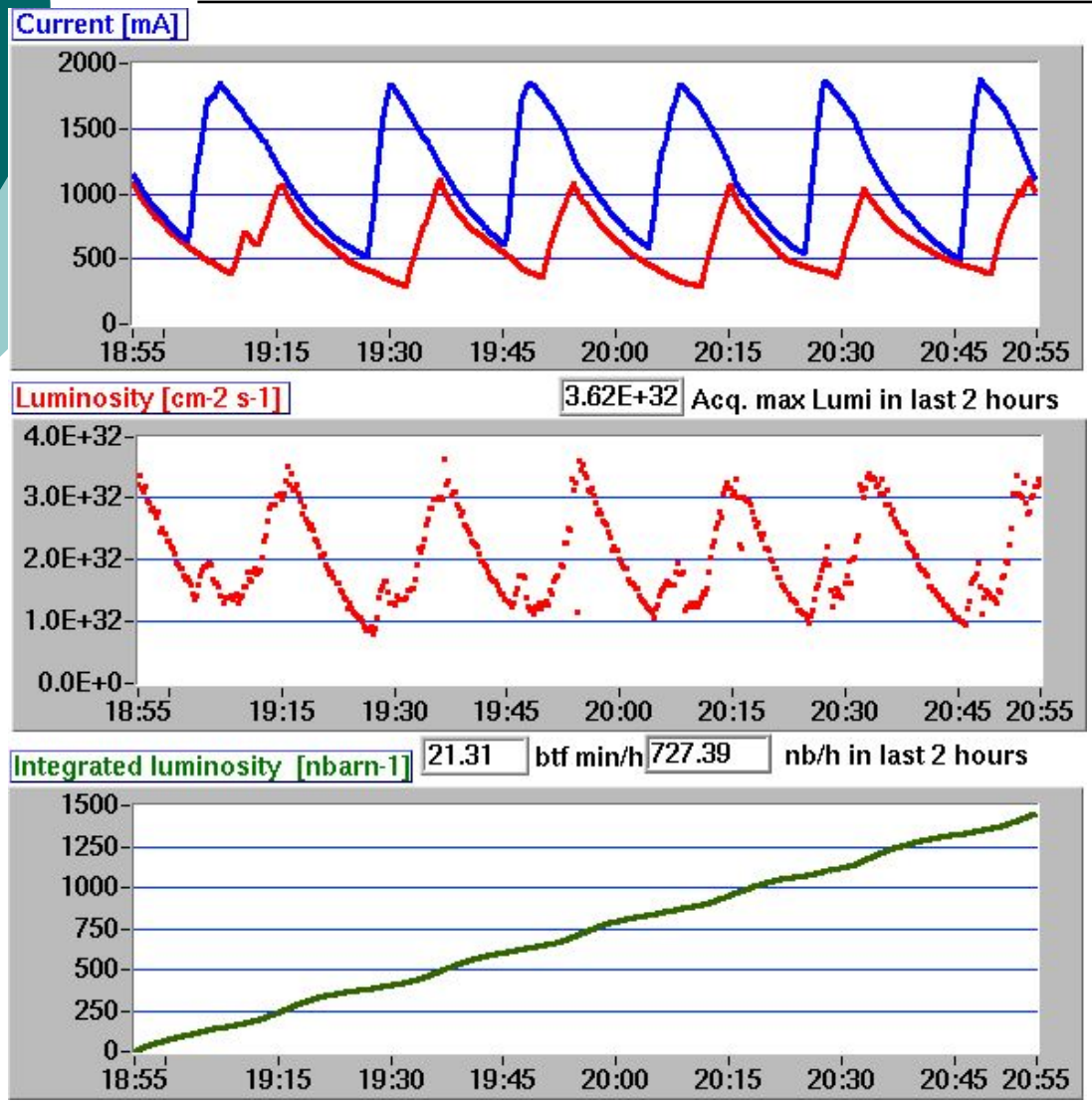




DAΦNE luminosity: new vs old



DAΦNE luminosity: new vs old



0.7 pb^{-1} / hour on a 2 hour basis obtained with moderate injection frequency required by SIDDHARTA

KLOE operates in a quasi continous injection regime

DAΦNE prospects for a future run

The above numbers mean that we have now a 'new' machine capable of delivering ~ 4 fb^{-1} / year, even accounting for a reasonable duty cycle

There is still space for improvements, both in terms of increasing the currents and in terms of operation efficiency

The goal of having the present KLOE statistics increased by ~ an order of magnitude within a few years is therefore perfectly realistic

The KLOE-2 project

A project for the continuation of the KLOE physics program on the upgraded machine, has been put forward since early 2006

It is proposed to improve the performance of the detector by the implementation of a few modifications to its design:

- The insertion of an inner tracker
- The modification of the quadrupole calorimeters (QCAL)
- The insertion of crystal calorimeters in the low θ region
- The insertion of a tagging system for $\gamma\gamma$ events

KLOE-2 roll-in plan

The newly born KLOE-2 Collaboration has submitted a proposal to the Laboratory for a two-steps roll-in of the detector (*LNF-07-19 (IR)*):

- *Step 0*: To be performed on end 2009. Roll-in of the present detector with the minimal upgrades required to run it safely and efficiently
- *Step 1*: To be performed most likely during 2011. Insertion of the more demanding upgrades with the goal of a longer data taking campaign

KLOE-2: physics motivations

There are several physics topics that can benefit of an acquired luminosity of ≥ 10 fb^{-1} with an upgraded detector

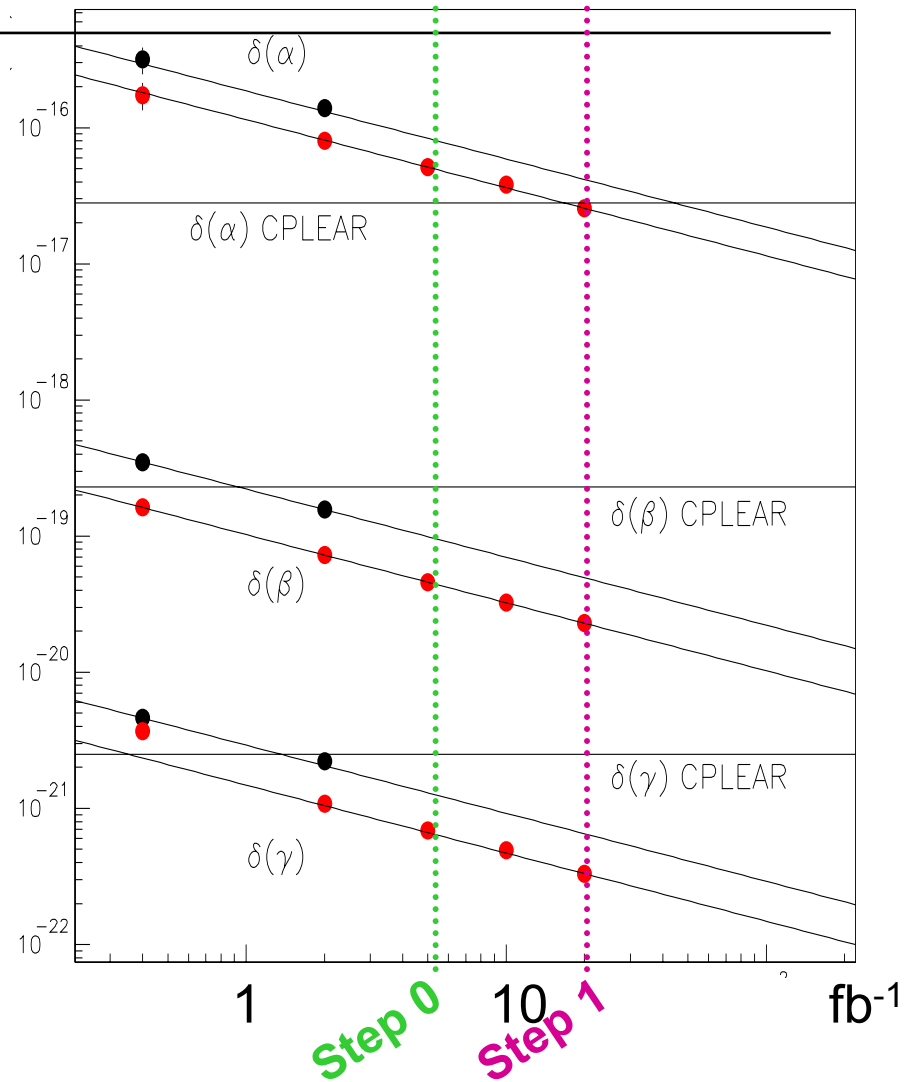
- Studies on CPT and QM violation with neutral kaons interferometry
- Tests of Lepton Flavor Violation with charged K_{e2} decays
- Studies on C, P, CP violation using rare η and K_S decays
- Tests of Chiral Perturbation Theory with η, η', and K_S decays
- Determination of the existence and nature of the scalar mesons a_0, f_0, σ

CPT

As an example we take the E.H.N.S. model which introduces three CPT violating parameters α, β, γ

KLOE-2 becomes competive on γ and β with a few fb^{-1}, and also on α with ≥ 20 fb^{-1}

The use of a inner tracker (blue points in figure) improves on the reachable limits by a factor ~ 3



Test of discrete symmetries with η decays

KLOE has already published the best limits on two decays not allowed by discrete symmetries conservation:

$\eta \to \gamma\gamma\gamma$ **(C)** $< 1.6 \times 10^{-5}$ **at 90% CL** ***(PLB 591, 49)***

$\eta \to \pi^+\pi^-$ **(P,CP)** $< 1.3 \times 10^{-5}$ **at 90% CL** ***(PLB 606, 276)***

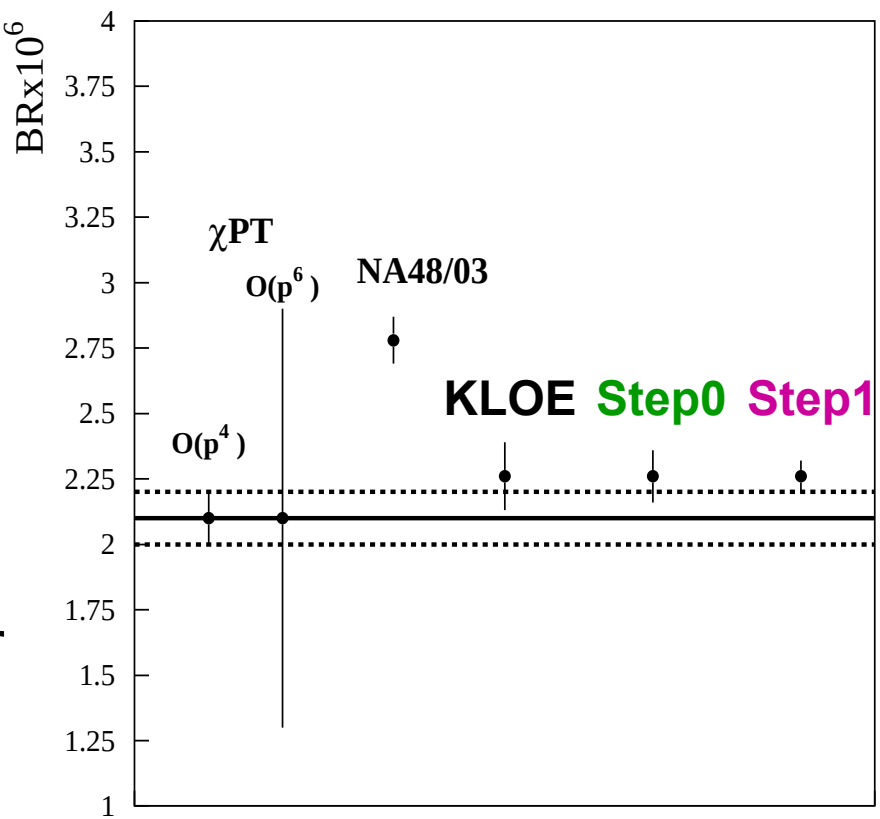
With KLOE-2 these limits can be improved by *~ 2 o.o.m*, thus becoming the most precise tests on C and P symmetries conservation in particle physics (see PDG08)

$K_S \to \gamma\gamma$: an experimental puzzle for ChPT

KLOE has already published a result which differs of ~ 3σ from a previous NA48 measurement

Theoretically, this result is very relevant since KLOE excludes large contributions $O(p^6)$ to the amplitude, which are instead implied by NA48

With KLOE-2 we can reach an accuracy comparable or better than the one of NA48



Studies on the nature of scalar mesons

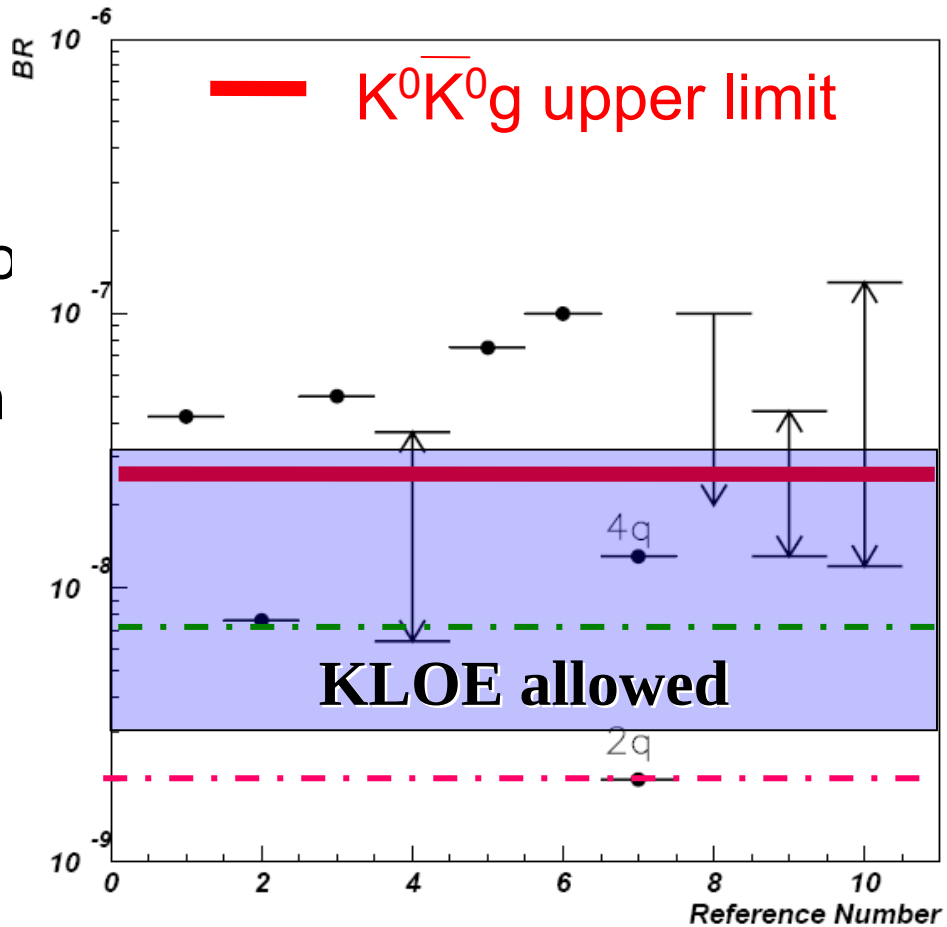
KLOE has published the best results on a_0/f_0 production in ϕ decays, relevant for the determination of their nature

We have also presented the best limit on their decays into kaon pairs, relevant to determine their coupling with the strange quark

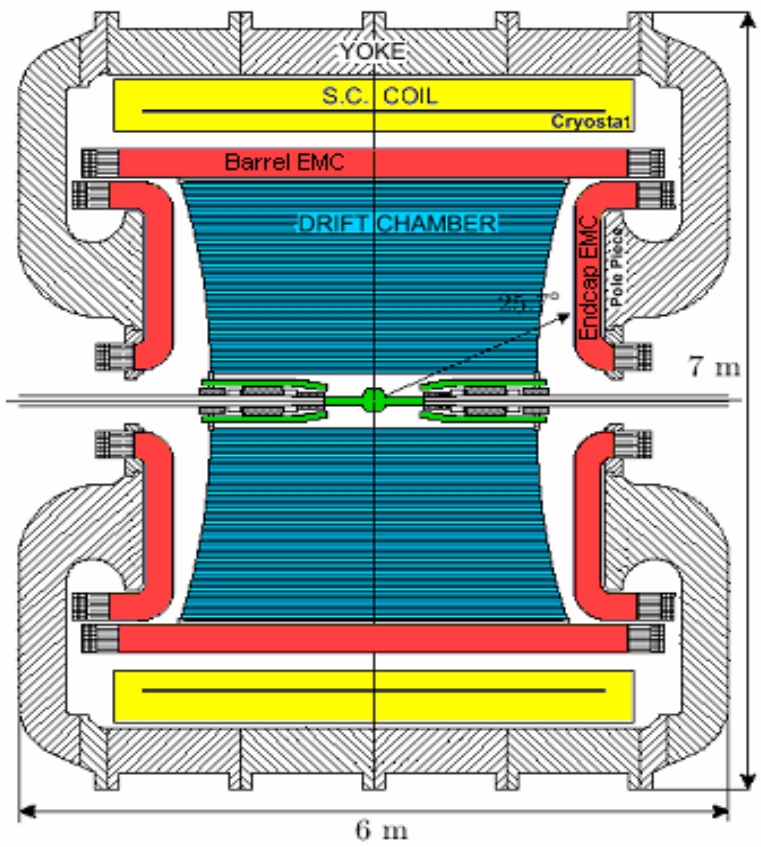
With KLOE-2 we can give the final answer to this long standing puzzle

Step 0

Step 1



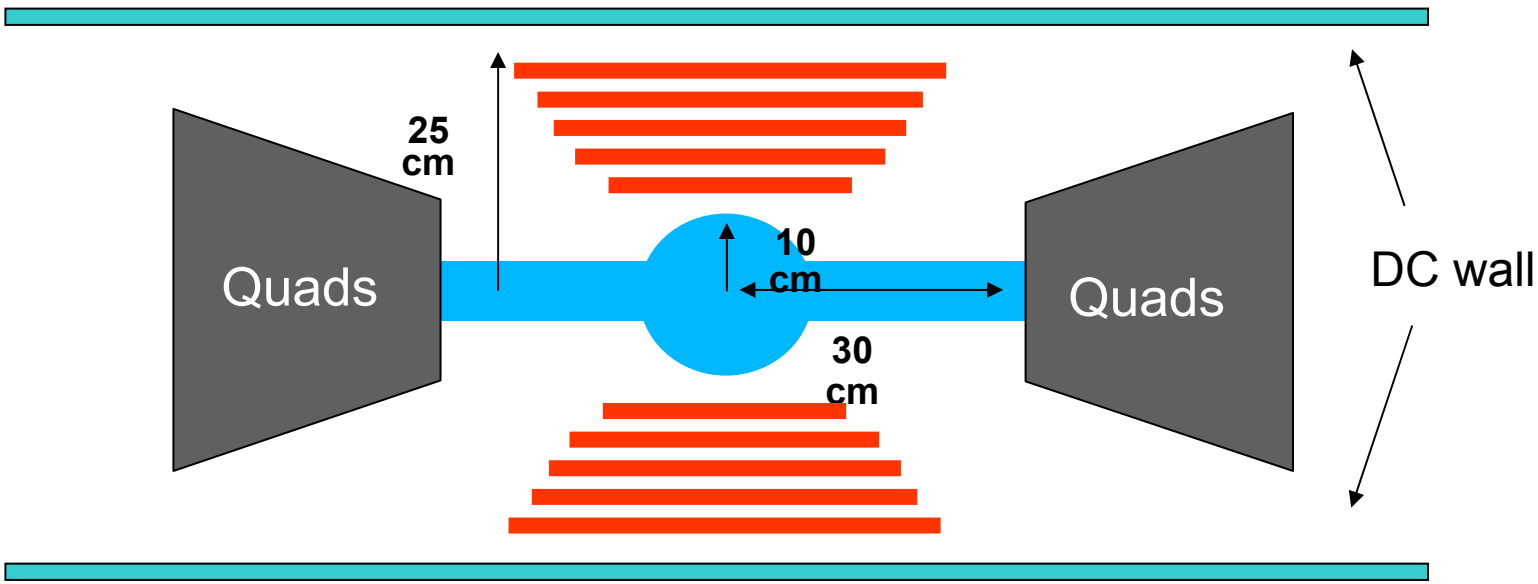
The KLOE detector



- **Superconducting coil** $B = 0.52$ T
- **Be beam pipe** (0.5 mm thick)
- **Electromagnetic calorimeter** Lead/scintillating fibers (1 mm ∅) 4880 PMT's, 15 X_0
- **Drift chamber** (4 m ∅ × 3.3 m) 90% He + 10% IsoB, CF frame, 12582 stereo, single sense wire, "almost squared" cells
- **Quadrupole calorimeter**

Inner Tracker: motivations

At present the first tracking layer of KLOE is at 30 cm from the IP. Many analyses would obviously benefit of an inner tracker , provided its material budget is kept at the 1-2% X_0 level

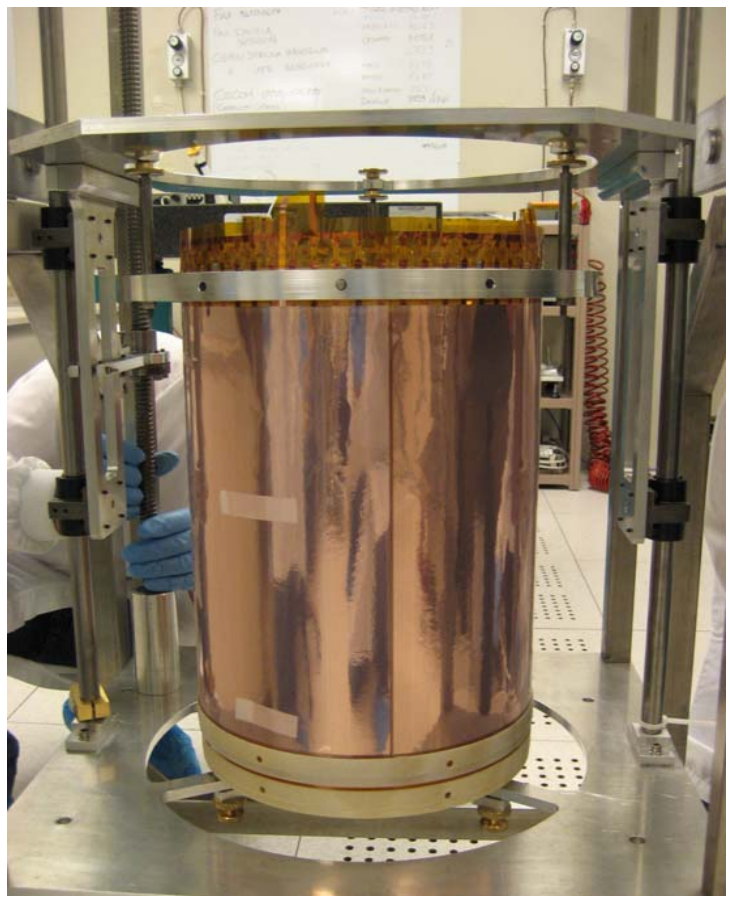


Inner Tracker: the C-GEM project

The proposed detector is based on a novel technology: the cylindrical-GEM, under development in Frascati

A prototype of the first layer has been built and has been tested with cosmic rays and at a test beam at CERN

Measured performance is very close to the design values. We are now preparing for the construction of the final detector



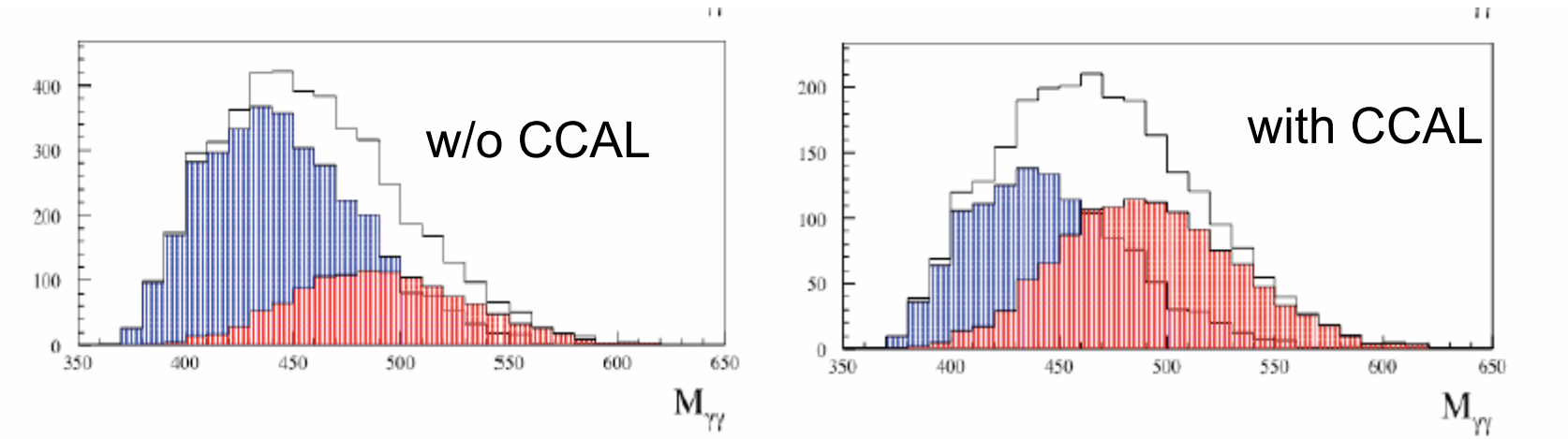
Low Angle Calorimetry

There are at least three analyses that can benefit of an extension at low angle of the KLOE calorimetry:

$K_S \rightarrow \gamma\gamma$ $K_S \rightarrow 3\pi^0$ $\eta \rightarrow \pi^0\gamma\gamma$

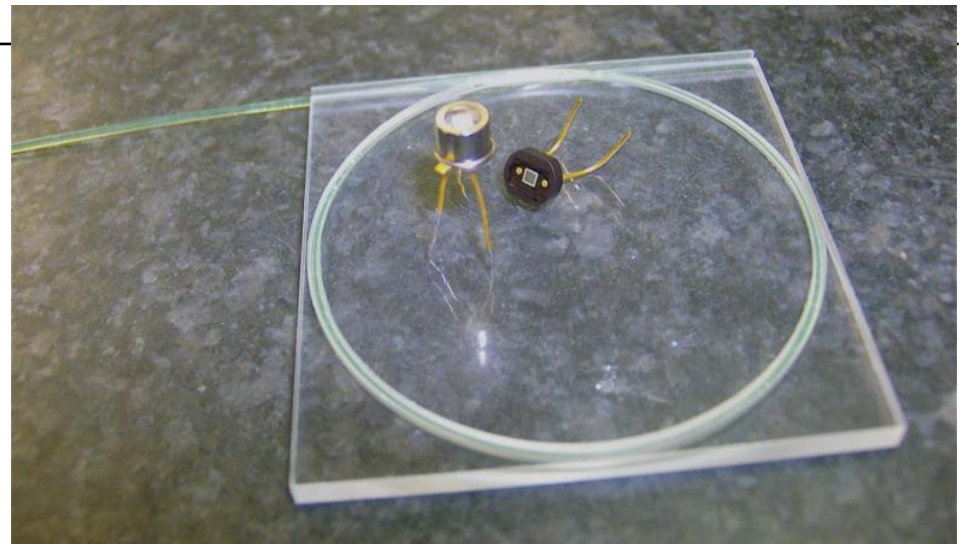
both for bckg reduction and for increasing acceptance

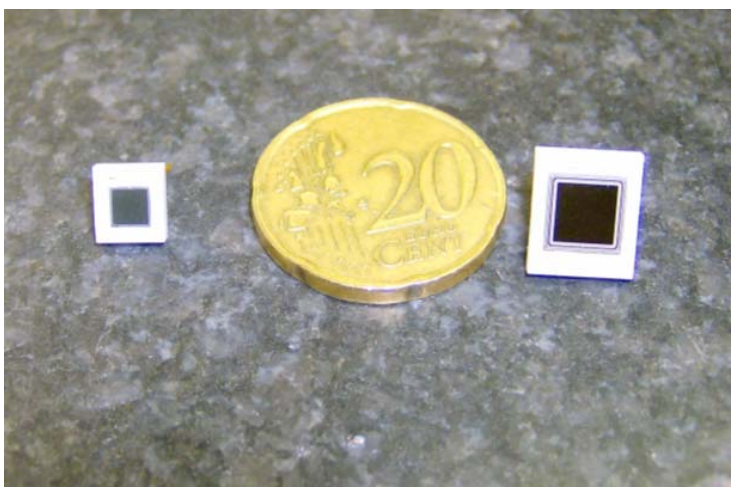
$K_S \rightarrow \gamma\gamma$: red = signal blue= background

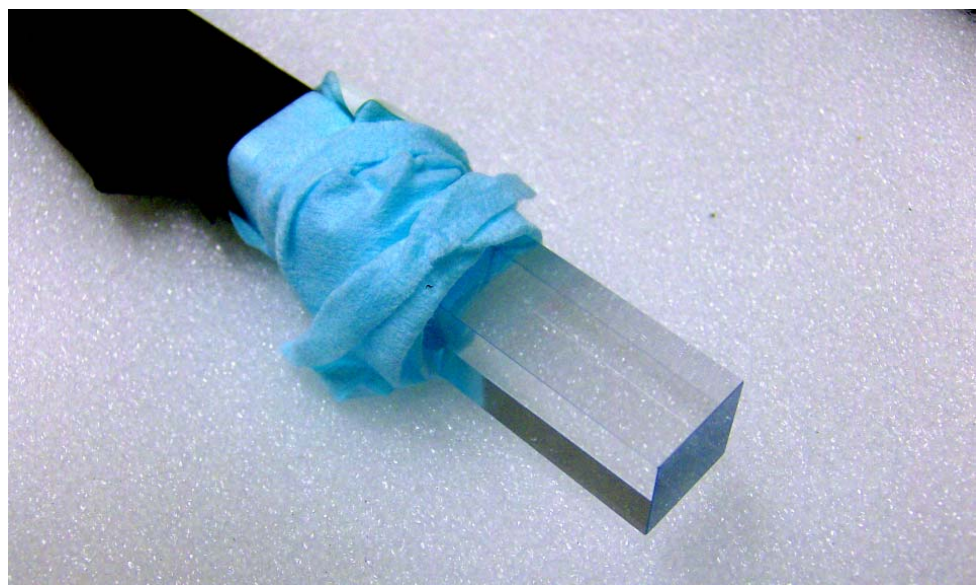


Low Angle Calorimetry

An intense R&D work is being pursued to define the type of crystal, its dimensions and its readout technology to be used among several possible solution







Conclusions (I)

The recent successful operation of the upgraded DAΦNE has put KLOE-2 on the launching pad

We are preparing for a first period of data taking, starting from the fall of 2009. Major detector upgrades will be implemented at a second stage, most likely during year 2011

There is a copious set of physics topics that can be studied with these new data, many of which in the field of discrete symmetries conservation

Conclusions (II)

KLOE-2 can be a wonderful place for doing physics at a ‘human’ level.

The dimensions of the project, in terms of both human and financial resources are such that it is perfectly suited for the present difficult economical situation

The collaboration is still growing. The laboratory is ready and very happy to host newcomers willing to join the enterprise