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Status of DAΦNE and its Physics Program

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Abstract

An e^+e^- collider optimized for operation at a total energy of 1019.4 MeV, the mass of the ϕ meson, christened DAΦNE, is now under construction at the Laboratori Nazionali di Frascati of the INFN. Here we report on DAΦNE's present status. We discuss its particle physics program, which include CP violation and other symmetry studies, tests of chiral pertubation calculations and light meson spectroscopy. The general purpose detector, KLOE, being built for performing these experiments, is described. DAΦNE has also a nuclear physics program for studying K-meson interactions and hyperon physics. A sketch of the detector dedicated to these studies, FI.NU.DA, is likewise included.

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1. Introduction

Quarks heavier than the "up" and "down" ones, form bound narrow quark-antiquark states ($q\bar{q}$) with, among other possibilities, quantum numbers $J^{PC}=1^{--}$ equal to those of the photon. These vector states are resonantly, copiously produced in e^+e^- annihilations at energies equal to the meson's mass. The physical process consists in the annihilation of the e^+e^- pair into a virtual photon of mass equal to the total available energy. The photon in turn creates a $q\bar{q}$ pair, which is bound by the color force resulting in the final state vector meson. These vector mesons are produced in e^+e^- annihilations with a large signal to noise ratio, as compared to production from hadronic collisions. The production cross-section σ, at the ϕ-meson, which is a $s\bar{s}$ pair, is $\sim$ 5μb, and the signal to noise ratio, S/N, is 30:1. The ϕ's in turn decay predominantly, into pairs of *stable* particles, formed from combining a light quark with the s or $\bar{s}$ quark of the initial pair.. The stable particles, $K\bar{K}$'s, decay only through the weak interaction, therefore have lifetimes of 1 ps or larger. Thus, an e^+e^- collider operating at the ϕ mass peak, of unprecedented luminosity, can thus produce very large numbers of K mesons.

A long outstanding problem in particle physics has been the origin of CP violation in the kaon system,[1] it has eluded clarification for about 30 years. A simple analysis of the requirements for performing a study of CP violation at a new level of accuracy and capable of measuring all the parameters defining the neutral kaon system, indicates the necessity of designing an e^+e^- collider capable of delivering a luminosity $\mathcal{L}$ of 1×10^{33} cm^{-2}s^{-1}, which is $\sim$100 times larger than achieved so far.

Two main lines of approach to obtain such luminosities have been proposed. The innovative way would be to try to invent a better collider, which will allow the increasing of the specific luminosity *i.e.* the single bunch luminosity $\mathcal{L}_0$. The more conservative approach is instead to accept the present empirical and theoretical limits for $\mathcal{L}_0$ and store in the collider a large number N of bunches, thus obtaining a luminosty $N\times\mathcal{L}_0$. Since the specific luminosity limit is essentially due to the effects of the beam-beam interaction, this second solution immediatialy imposes the first burden of two independent storage rings, with the associated complications of intersecting them and bringing the positron and electron bunches into collision with high accuracy and stability. In this way each bunch collides with another one only once per turn, in principle allowing the gain in luminosity above. In addition, attention must be given to vacuum, and accelerating RF cavities. Finally, dynamical control of instabilities by active feedback methods must be provided. Ornorous though these problems are, with modern technology they are relatively easier to solve than inventing new colliders.

2. DAΦNE

In June 1990 the first high luminosity e^+e^- colliders was approved and funded by the Istituto Nazionale di Fisica Nucleare, INFN, of Italy. It is an e^+e^- collider optimized for operation at a total energy of 1019.4 MeV, the mass of the ϕ meson. The machine, a so called ϕ-factory, has been christened DAΦNE, for Double Anular Φ-factory for Nice Experiments. Its design follows the second approach mentioned above.[2] DAΦNE consists of two coplanar rings, a linac and an accumulator for fast topping-off, all components to be installed in the buildings which housed the ADONE collider. The DAΦNE complex layout is shown in fig. 1.

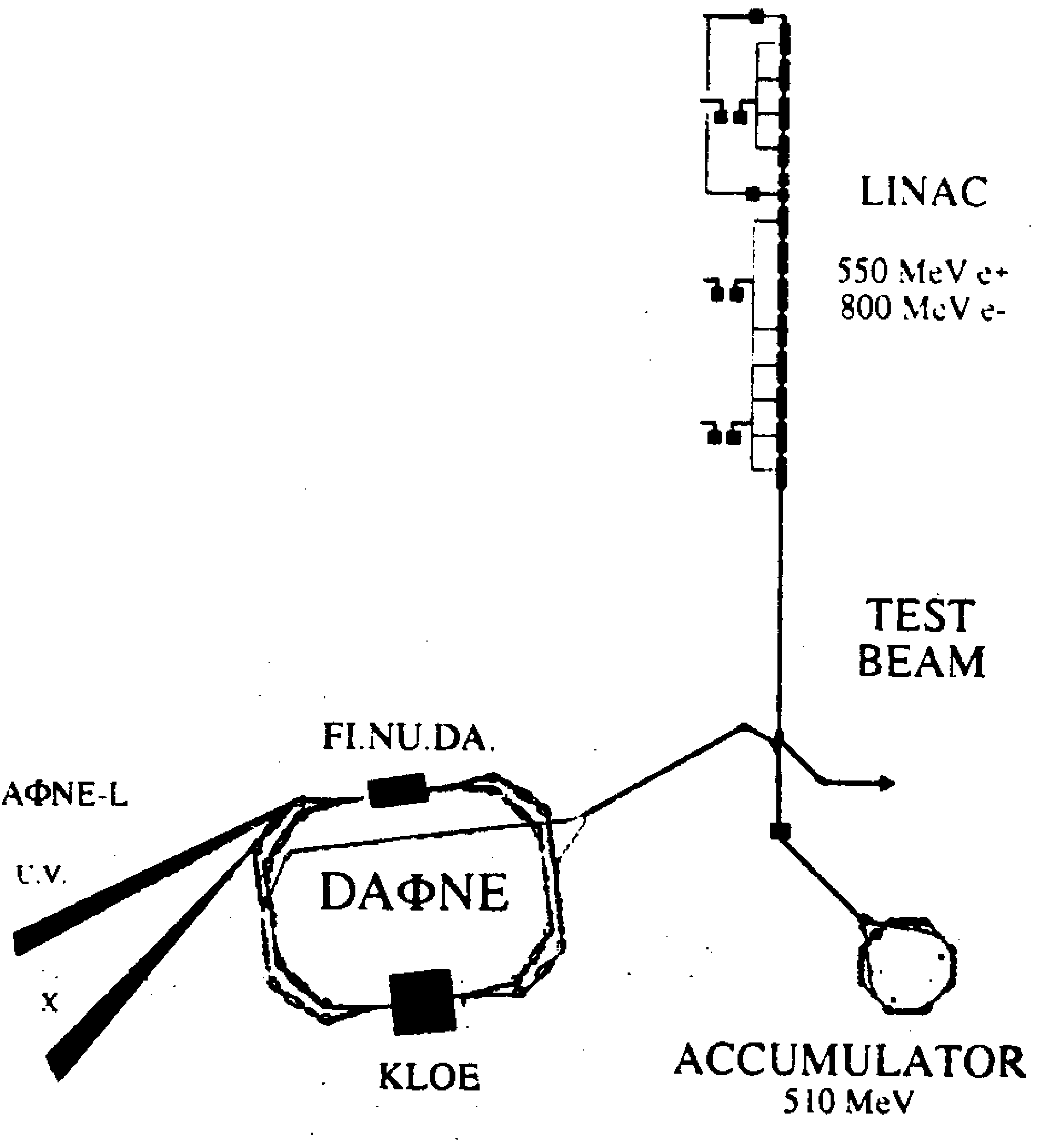

Fig. 1. DAΦNE

The operating energy range is 0.3 to 1.5 GeV. Two interaction regions will be available and the initial luminosity is expected to be $\sim 10^{32}$ cm^{-2} s^{-1}. The final target luminosity is $\mathcal{L} \sim 10^{33}$ cm^{-2} s^{-1}. Both values apply at the ϕ peak. The ring size allows for operation with up to 120 bunches in each ring, filling every RF bucket, at the operating frequency of 370 MHz. An estimate of the DAΦNE luminosity is obtained by scaling from the VEPP–2M collider, operating at Novosibirsk, with *flat* beams and two interactions per turn, at the ϕ peak. The single bunch luminosity for DAΦNE is $\mathcal{L}_0 = 7.2 \times 10^{30}$ cm^{-2} s^{-1} and for 120 bunches $\mathcal{L} \sim 9 \times 10^{32}$ cm^{-2} s^{-1}. The final expected luminosity can therefore be obtained with a conservative single bunch value, paying however in a very large value of the circulating currents, ~5 A.

The DAΦNE lattice is a four-period modified Chasman-Green type, with each achromat incorporating a two meter long wiggler to reduce the beam damping time. All paramaters of the machine are tunable through independent control of all elements, in order to maximize $\mathcal{L}_0$ and properly cure multibunch instabilities. The low–β insertion is a compromise between machine choices and experimental requirements. The free distance between the innermost quadrupoles is 80 cm and the insertion occults a cone of 9° half opening. Rare earths-cobalt permanent magnet quadrupoles are used. Table 1 lists the DAΦNE machine parameters.

Table 1. DAΦNE Parameters.

Beam Energy	0.510 Gev
Luminosity	$(1.35 \rightarrow 5.40) \times 10^{32}$
Time between collisions	$10.8 \rightarrow 2.7$ ns
Crossing half-angle	10 to 15 mrad
Energy spread	0.4×10^{-3}, rms
Bunch length	3.0 cm
Beam size at IR	2.1 mm horizontal 21 μm vertical
Free space at interaction point	± 0.46 m
Luminosity lifetime	3.0 hours
Topping up time	$< 2'$
Injection Energy	0.510 GeV
Transverse emittance	$1000 \times \pi \cdot 10^{-9}$ mrad, hor. $10 \times \pi \cdot 10^{-9}$ mrad, vert.
β^*	4.5 m, horizontal 4.5 cm, vertical
Beam-beam tune shift/crossing	0.04
RF Frequency	368.25 MHz
Particles/bunch	8.9×10^{10}
Bunches per ring e^+ and e^-	$30 \rightarrow 120$
Average beam current e^+ and e^-	$1313 \rightarrow 5250$ mA
Orbit length	97.7 m

DAΦNE will ultimately produce 5×10^{10} kaon pairs in one third of a year, the average on-time of an accelerator in a calendar year. This yield is quite adequate for the physics program described below. The milestones for DAΦNE are:

1. December 1994: LINAC operational. The LINAC is already fully assembled at TITAN-BETA in the U.S. and has delivered 4 amps to the target with 5.9 amps injected. It will be shipped to Frascati in November 1994.
2. September 1995: begin Accummulator commissioning.
3. June 1996: begin Main Rings commissioning. So far, all components are on schedule, including civil engineering work.
4. December 1996: installation of detectors in the interaction areas.

3. K's from DAΦNE

DAΦNE will produce neutral K's in a well prepared quantum state, and charged K pairs in copious quantities. Its high luminosity also will result in huge numbers of ρ's, η's, the rarer η''s and will allow measurements of rare ϕ radiative decays.[3] In addition, because the ϕ's decay at rest, kaons are produced in collinear pairs. The observation of one K guarantees the existence of the other, with determined direction and identity, *i.e.*, K's can be "tagged". Experiments at both interaction regions exploit this feature, as as well as the low momenta of the emerging kaons (110 MeV/c for neutral K's, and 127 MeV/c for charged ones). For typical 4π detectors, up to 10^{10} tagged K mesons can be collected per year. Finally, one has beams of K_S, with no background, and thus can dramatically improve knowledge of K_S branching ratios (most are not measured yet). Searches for $K_S \to \pi^0\nu\overline{\nu}$, $e^+e^-\gamma$, $\mu^+\mu^-\gamma$, $\pi^0e^+e^-$, $\pi^0\mu^+\mu^-$ etc., down to 10^{-8} or better are possible.

4. CP and CPT at DAΦNE by Quantum Interferometry

Consider the process $\phi \to KK \to f_1, t_1 + f_2, t_2$ where a K^0 meson decays into a state f_1 at time t_1 and the other into a state f_2 at time t_2, as illustrated below.

The decay intensity to f_1, f_2, as a function of $\Delta t = t_1 - t_2$ and for $\Delta t > 0$, is:

$$I(f_1,\ f_2;\ \Delta t) =$$

$$\frac{1}{2\Gamma}|\langle f_1|\,K_S\,\rangle\langle f_2|\,K_S\,\rangle|^2\Big(|\eta_1|^2 e^{-\Gamma_L\Delta t} + |\eta_2|^2 e^{-\Gamma_S\Delta t}$$

$$- 2|\eta_1||\eta_2|e^{-\Gamma\Delta t/2}\cos(\Delta m\Delta t + \phi_1 - \phi_2)\Big)$$

and a similar expression holds for $\Delta t < 0$. The interference term is sensitive to Δm, the magnitude of the amplitude ratios η's and their phase difference, while the complete distribution depends also on the K_S and K_L lifetimes. One can thus perform a whole spectrum of precision "kaon-interferometry" experiments at DAΦNE by measuring the above decay intensity distributions choosing appropriate pairs of the final states f_1, f_2, (provided the detector is sensitive to the named final modes). Four examples are listed below.

1. With $f_1=f_2$ one measures Γ_S, Γ_L and Δm, since all phases cancel.

2. With $f_1=\pi^+\pi^-$, $f_2=\pi^0\pi^0$, one measures $\Re(\epsilon'/\epsilon)$ at large time differences, and $\Im(\epsilon'/\epsilon)$ for $|\Delta t| \leq 5\tau_s$. Fig. 2 shows the interference pattern for this case.

3. With $f_1 = \pi^+\ell^-\nu$ and $f_2 = \pi^-\ell^+\nu$, one can measure the CPT–violation parameter δ_K;[4] its real part at large time differences; and the imaginary part for $|\Delta t| \leq 10\tau_s$. Fig. 3 shows the interference pattern.

4. For $f_1 = 2\pi$, $f_2 = K_{\ell 3}$, small time differences yield Δm, $|\eta_{\pi\pi}|$ and $\phi_{\pi\pi}$, while at large time differences, the asymmetry in K_L semileptonic decays provides tests of T and CPT. The *vacuum regeneration* interference is shown in fig. 4.

In all, by choosing appropriate f_1 and f_2 channels one can determine 16 independent parameters describing the neutral K system. If the validity of the $\Delta S = \Delta Q$ rule is assumed there are only 13 paramaters to determined. Experiments at DAΦNE can thus test CPT invariance, in addition to studying CP violation. Should however the $\Delta S = \Delta Q$ rule not hold (it is expected to be violated to only one part in 10^7 in the Standard Model), there are in fact 17 independent parameters.[5] A test of the $\Delta S = \Delta Q$ rule is not therefore possible with neutral K's at DAΦNE if $\not{C}\not{P}\not{T}$, but strangeness tagged K^0 can be obtained from charge exchange of K^+ mesons, in turn tagged by observation of a K^- meson from the copious decay $\phi \to K^\pm$.

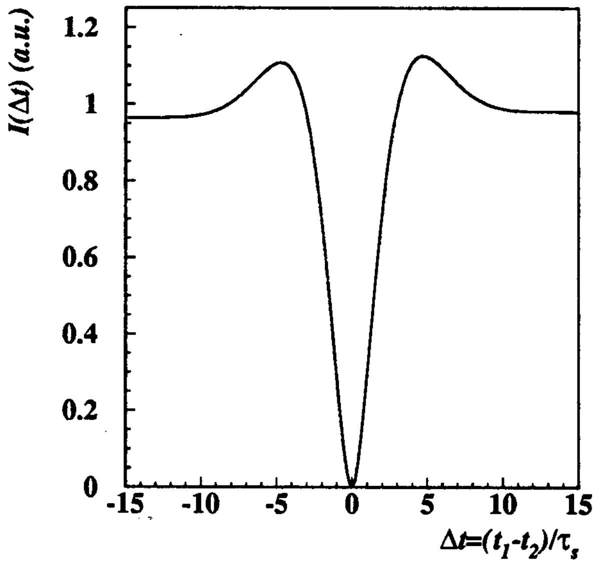

Fig. 2. Interference pattern for $f_1=\pi^+\pi^-$, $f_2=\pi^0\pi^0$

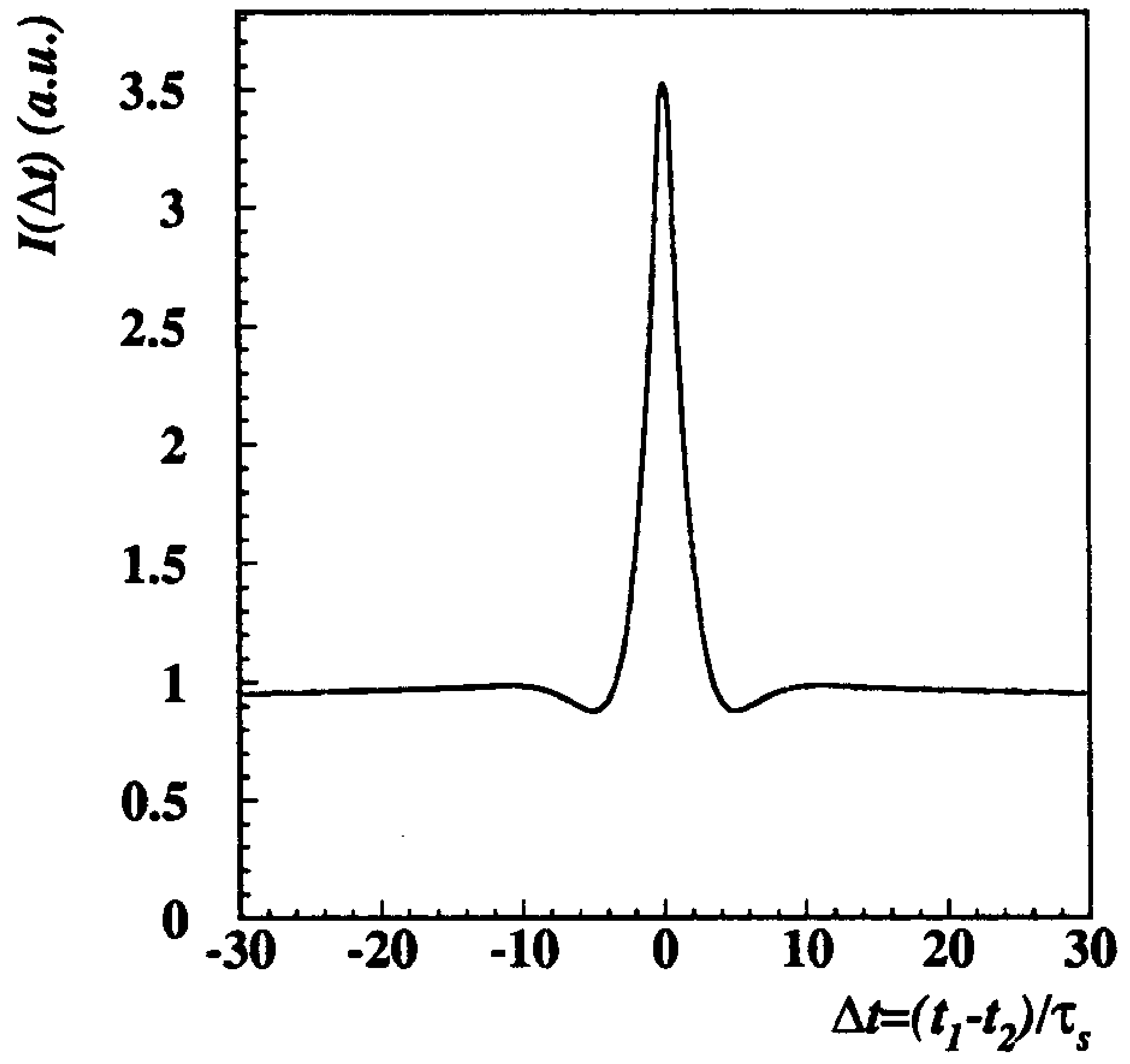

Fig. 3. Interference pattern for $f_1 = \ell^+$, $f_2 = \ell^-$

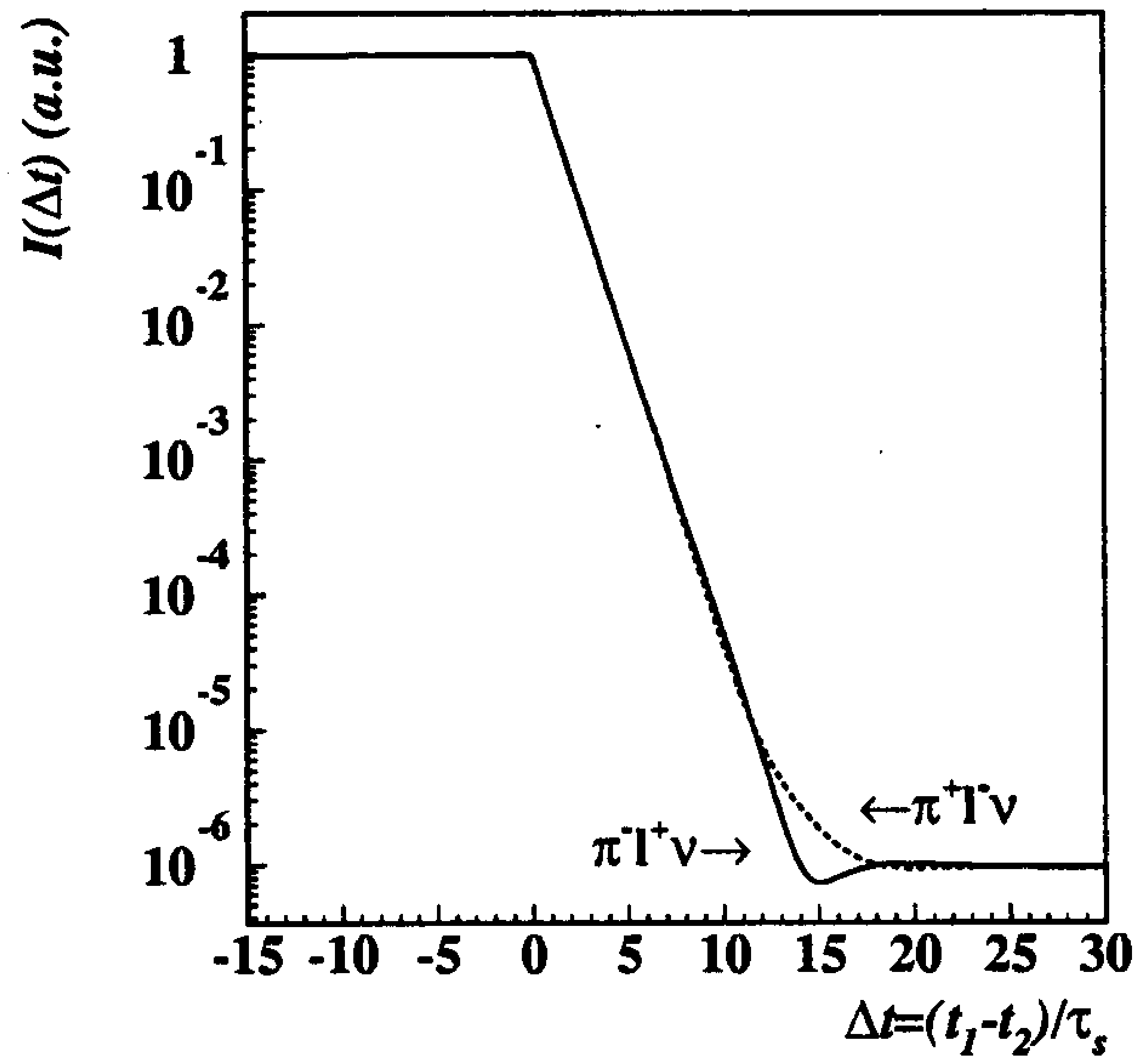

Fig. 4. Interference patten for $f_1 = \ell^\pm$, $f_2 = 2\pi$

5. Measuring $\mathcal{R}^\pm/\mathcal{R}^0$

In addition, we can also use the classical method of the double ratio $\mathcal{R}^\pm/\mathcal{R}^0 = 1 + 6 \times \Re(\epsilon'/\epsilon)$, and other ways of measuring $\Re(\epsilon'/\epsilon)$ from selected final states. Very different systematics are involved, thus allowing a self check of the results.

6. Other CP Violations at DAΦNE

So far CP violation has been observed only in the K_L system. Observation of $K_S \rightarrow 3\pi^0$ would constitute a new proof of CP violation. One can collect ~30 events in one year, with zero background. At DAΦNE one can also easily measure the difference in rates between $(K_S \rightarrow \pi^\pm \ell^\mp \nu)$ to 4×10^{-4}.

Evidence for direct CP violation can be also be obtained from the decays of charged kaons which are copiously produced at DAΦNE. CP requires equality of the partial rates for $K^\pm \rightarrow \pi^\pm\pi^+\pi^-(\tau^\pm)$ and for $K^\pm \rightarrow \pi^\pm\pi^0\pi^0$ $(\tau'^\pm)$. One can improve the present rate asymmetry by two orders of magnitude. One can also observe differences in the Dalitz plot distributions for K^+ and K^- decays in both the τ and τ' modes; at DAΦNE one could reach sensitivities of $\sim10^{-4}$. Finally, differences in rates in the radiative two pion decays of $K^\pm$, $K^\pm \rightarrow \pi^\pm\pi^0\gamma$, are also proof of direct CP violation. At DAΦNE the sensitivity reachable is $\sim1.4\times10^{-3}$.

7. Chiral Perturbation Theory

In the last decade chiral perturbation theory (CHPT) has been extended to the next order terms in the chiral expansion $(\mathcal{O}(m^4)$, $\mathcal{O}(p^4)$, $\mathcal{O}(m^2p^2))$. Many new amplitudes can then be predicted.[6] At lowest order the CHPT relation predicts the slope of the scalar form factor, λ_0. There is at present disagreement from experiment with the CHPT prediction, 0.017±0.004. one can measure λ_0 for K_L to an accuracy of 1.4×10^{-5}. Similar accuracy are obtained for $K^\pm$ and for λ_+. There is only one measurement of the relevant $K_{\ell4}$ form factors. These decays also provide another opportunity for the determination of the $\pi\pi$ phase shifts. The amplitudes for $K_{\ell2,\gamma}$, $K_{\ell2,e^+e^-}$ and $K_{\ell3,\gamma}$ depend on the K charge radius. The rate for $K^\pm \rightarrow \pi^\pm\gamma\gamma$ and the $\gamma\gamma$ distributions are uniquely predicted by the chiral lagrangian approach. Dalitz type decays of K mesons and two photon production of pions are also of great interest. At DAΦNE one can improve vastly on all these topics.

8. Radiative ϕ Decays

Many other physics topics can be studied, especially at the DAΦNE start up time, when the number of beam bunches will be approximately a quarter (30) that of the final design value. An example is the study of light meson spectroscopy. Another is the study of rare radiative decays. The unique, lightest scalar meson state $f_0(975)$ is poorly described by current models,[7] one can easily contribute to solving the puzzle.[3]

9. KLOE

The KLOE Collaboration[8] has proposed,[9] designed[10] and begun construction of the KLOE detector whose main mission is to study $\not{C}\not{P}$ with a sensitivity of $\mathcal{O}(10^{-4})$ and is fully capable of investigating a whole range of other physics described above. The scale of KLOE is driven by a fundamental parameter, the mean decay path length of the long lived K^0-meson $L(K_L)$. At DAΦNE, $\beta(K)$=0.216 and $L(K_L) = \gamma\beta c\tau =$ 3.44 m. Which is a large number indeed! Economical reasons and technical problems as well lead to a choice of a 2 m drift space for the K_L decays. Detector requirements are: 1) collect enough statistics, 2) measure the path length of the K_S, K_L decays to the required accuracy, 3) reject backgrounds at the desired level, and 4) be self-calibrating, using various K decay modes, in addition to Bhabha scattering events. In short, the experimental apparatus must be able to track charged particles of momenta between 50 and 250 MeV/c. It must also detect with very high efficiency γ's with energy as low as 20 MeV, measure their energies with a resolution $\delta E_\gamma / E_\gamma \sim 15\%$ at 100 MeV and provide the space coordinates of the photon conversion point. Thus while the general features of the KLOE detector are similar to those of a *typical* general purpose collider's apparatus: a cylindrical structure surrounding the beam pipe, consisting of a highly efficient, large tracking device for detecting the charged K^0 decay products, an electromagnetic calorimeter with exceptional timing ability, which also provides some particle identification, enclosed in a solenoidal field, each component has its own unusual features. A cross section view of KLOE is shown in fig. 5. We discuss the components, in order of increasing radius.

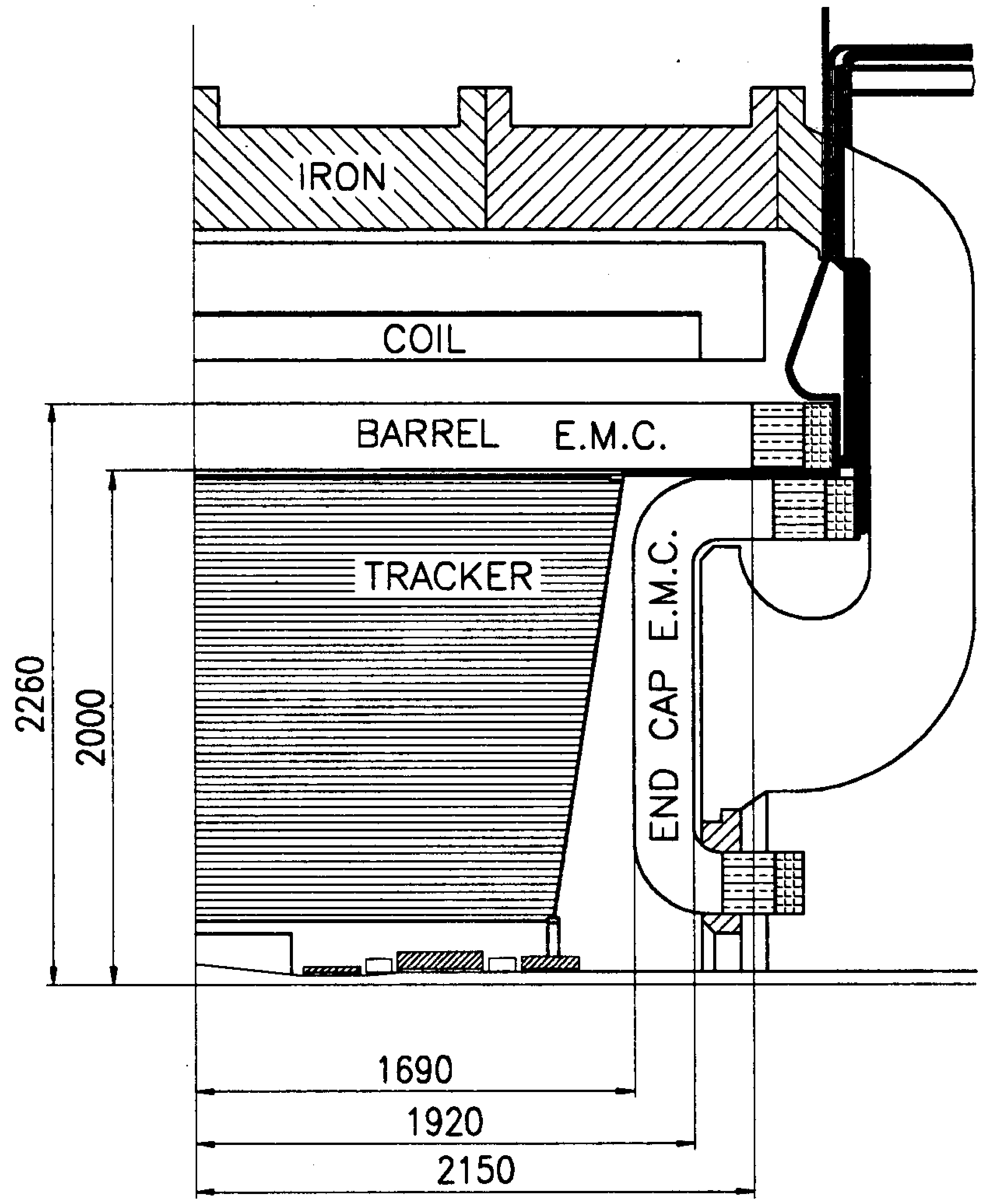

Fig. 5. KLOE cross section along the beam axis.

Beam Pipe. The radius of the beam pipe around the luminous point is 10 cm. This allows the definition of a fiducial region for K_S decays without complication from regeneration. The beam pipe is made of 0.5 mm thick beryllium to minimize multiple scattering, energy loss for charged kaons and regeneration. This enlargment of the beam pipe at the interaction point is in fact a technical challenge for DAΦNE because the structure act as a free wheeling RF cavity, with all the attending problems.

The Tracking Chamber. Identification of decays into charged particles requires tracking over the decay drift space. Tracking is performed in a large drift chamber, 3.5 m long and 4 m in diameter, employing helium (90%He+10%Isobutane) as gas to reduce regeneration and multiple scattering. The use of helium is well demonstrated. Unique to KLOE is the need of a uniform cell structure, because the K_L decay vertices are uniformly distributed in distance from the luminous point. Walls must very thin to provide good transparency for the photons from decays into π^0's to reach the electromagnetic calorimeter which surrounds the drift volume. The end plates have a spherical shape to provide rigidity under the tension from 50,000 some wires.[11]

Electromagnetic Calorimeter. Reconstruction of the $\pi^0\pi^0$ decay mode of a 110 MeV/c momentum K, the determination of its decay point and the efficient rejection of the three π^0 decays make the electromagnetic calorimeter, EmC, a most demanding element of the detector. Unique to the KLOE experiment, is the method of determining the flight path of K_L mesons by time measurements. The time of arrival of a photon gives the flight path of the K^0 to an accuracy $\delta l = \beta_K c \delta t \sim 6 \times 10^{-3}$ cm $\times$ δt(ps). For a 510 MeV K^0, that is for four photons with $\sum E_\gamma = 510$ MeV one expects a time resolution of ~100 ps and a path resolution of 0.6 cm. Flight time measurements for a single photon allow the determination of the flight path. Observation of only three out of four photons still allows an over constrained determination of both the K^0 mass and the flight path, using time, position and energy measurements.

We have developed and are building a lead-scintillating fiber sampling calorimeter with exceptional energy and time resolution. The EmC is divided in a central part, approximating a cylindrical shell, of 4 m diameter, 3.5 m length and 25 cm thickness. Two end caps, 4m in diameter and 25 cm thick close, as hermetically as possible, the calorimeter. Calorimeter modules are built by embedding 1 mm diameter scintillating fibers between thin grooved lead foils, obtained by rolling of ~0.5 mm thick lead. Fibers are glued to the foils, and run parallel to each other. In the bulk of the structure fibers are located at the vertices of equilateral triangles of 1.35 mm side. The sampling fraction is ~15% for a minimum ionizing particle.

Calorimeter prototypes have been tested extensively at the Paul Scherrer Institut, PSI, in Villigen, Switzerland and at Laboratori Nazionali di Frascati at the LADON facility with a photon beam. Measurements with γ's and e, μ, π's show that the KLOE EmC prototypes have the following performance:[12]

1. $\sigma_E/E \sim 4.5\%/\sqrt{E\ (\mathrm{GeV})}$, $\sigma_t = 50$ ps$/\sqrt{E\ (\mathrm{GeV})}$.
2. Full efficiency down to 20 MeV and excellent linearity.

3. Energy response and resolution are independent of the incidence angle, up to at least 60°.
4. They provide partial identification and pions and muons. In short, our design satisfies all the specifications required for the KLOE EmC.

Hermiticity and Background. The detector is quite hermetic. Background rejection is effectively achieved by kinematics closure, as in the case of $K_{\mu 3}$ decays or by photon count plus kinematic as in the case of $K \rightarrow \pi^0 \pi^0 \pi^0$.

Magnet and Yoke. The chamber and calorimeter are inside a superconducting coil which provides a field of 6 kG. The iron return yoke has deep cavities hollowed out so that the magnetic field therein is reduced and axial, to allow the proper funtioning of the mesh photomultipliers employed in the EmC readout.

Detector Performance. Some parameters of the detector are given in the table 2.

Table 2. DAΦNE Detector Performance.

Calorimeter	
δ(Shower Apex)	=1 cm
$\delta E/E$	$= 5\%/\sqrt{E}$
δt	$= 300$ ps$/\sqrt{E}/20$ MeV
Drift Chamber	
δpoint	$= 200\ \mu$m, r and ϕ
	$= 2$ mm, z
δp_t	$= 0.5\% \times p_t$
$\delta(\tan(\theta))$	$= (3.5 \oplus 2.5) \times 10^{-4}$

10. Nuclear physics at DAΦNE

DAΦNE is a unique copious source of tagged, low energy (16 MeV), monochromatic charged kaons, which can be stopped in a very thin target, offering the possibility of a unique nuclear physics program:

1. Spectroscopy of Λ-hypernuclei.
2. Decays of Hypernuclei, $\Delta I \neq ?1/2$
3. Do Σ-hypernuclei exist?
4. $K^{\pm}$-$\mathcal{N}$ at low energy.
5. Search for exotic states.

11. FI.NU.DA

The FI.NU.DA collaboration[13] is designing and building the FI.NU.DA detector[14] to address these issues. It is a non focusing magnetic spectrometer with cylindrical geometry. It consists of a central interaction/target region which is composed of 1.5 mm thick scintillators (TOFINO) surrounding a thin beam pipe, two

300 μm silicon microstrip arrays (ISIM and OSIM) sandwich a 1.5 mm carbon target; an external tracking system consisting of two arrays of eight planar drift chambers and an array of straw tubes; finally surrounded by an outer scintillator array (TOFONE). The full apparatus is immersed in a solenoidal field of 1.1 Tesla. Fig. 6 shows a cross section of the FI.NU.DA detector perpendicular to the beam axis.

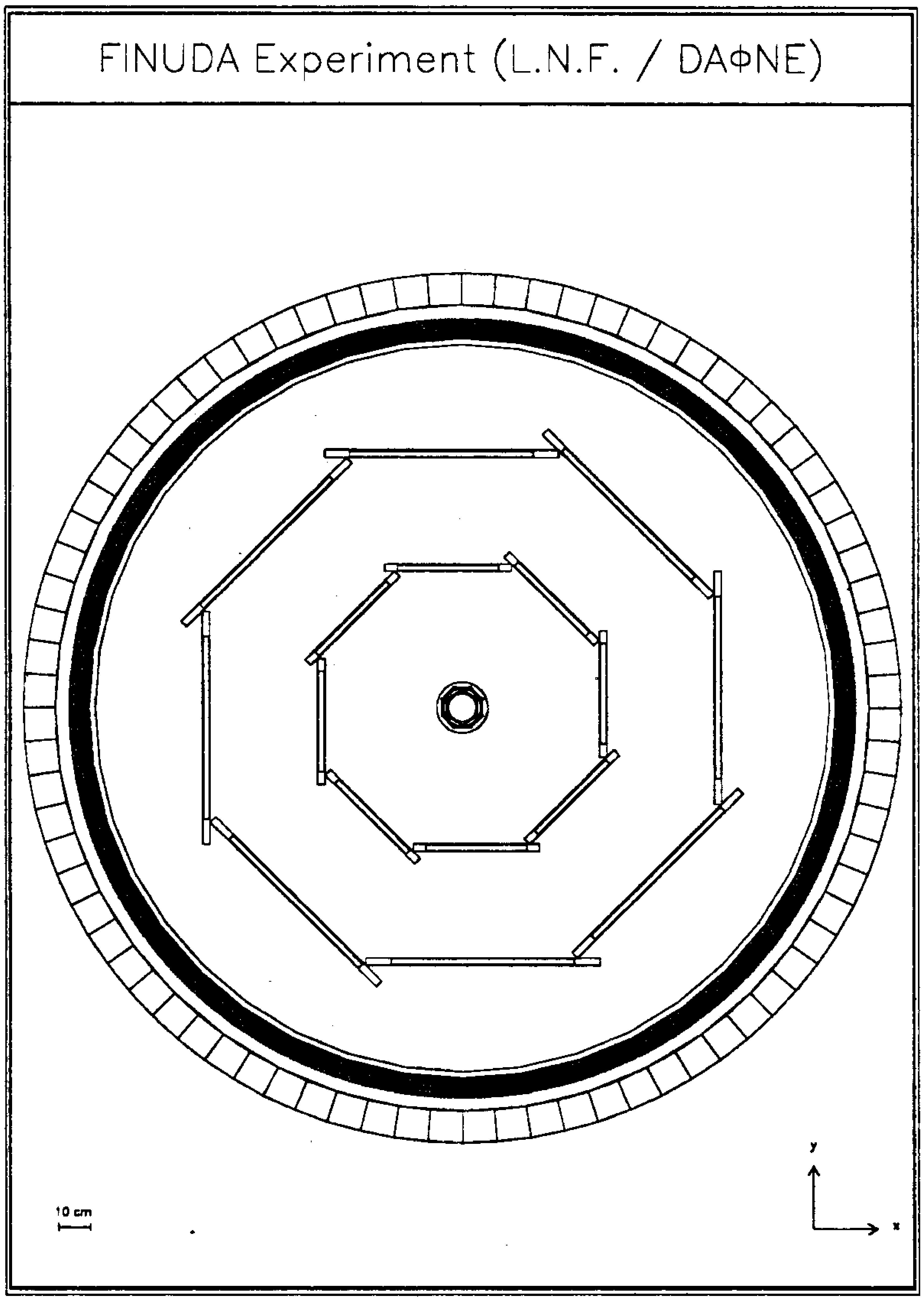

Fig. 6. Cross section of the FI.NU.DA detector.

The position information from the ISIM allow the reconstruction of the kaon tracks, which together with the hypernuclear formation pion's trajectory obtained from the outer tracking system, allows the determination of the K^- in the stopping target. The fast scintillators are used for a first level trigger, allowing a topology selection of back to back events (K^+ and K^- from ϕ decays). The TOFONE also serve as the neutron detectors for FI.NU.DA, which will be situated in the second interaction region of DAΦNE.

12. Conclusion

The new facility DAΦNE to begin operation in December 1996, promises an era of precision and varied CP and CPT violation studies, together with a complementary program in particle and nuclear physics.

13. Acknowledgements

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REFERENCES

1. J. H. Christenson *et al.*, Phys. Rev. Lett., **13**, 138 (1964).
2. G. Vignola, *Proc. of the Workshop on Physics and Detectors for DAΦNE*, G. Pancheri Ed., Frascati, 1991, p. 1.
3. J. Lee-Franzini, W. Kim, and P. J. Franzini, Phys. Lett. **B287**, 259 (1992).
4. C. D. Buchanan *et al.*, Phys. Rev. **D45**, 4088 (1992).
5. L. Maiani, *The DAΦNE Physics Handbook*, L. Maiani *et al.* Eds., Frascati, 1992, V. I, p. 21.
6. For all references on CHPT, see *DAΦNE Physics Handbook*, ed. L. Maiani *et al.*, LNF, Frascati.
7. N. Brown and F. Close, *The Daphne Handbook* p. 447.
8. Università and Sezione INFN, Bari; IHEP, Chinese Academy of Science, Beijing; Ben-Gurion University; Laboratori Nazionali di Frascati dell'INFN, Frascati; Institut für Experimentelle Kernphysik, Universität Karlsruhe; Università and Sezione INFN, Lecce; Università and Sezione INFN, Napoli; Columbia University, New York; Università and Sezione INFN, Pisa; Università and Sezione INFN, Roma I; Università and Sezione INFN, Roma II; ISS and Sezione INFN, ISS, Roma; SUNY at Stony Brook; Tel-Aviv University; Università and Sezione INFN, Trieste/Udine.
9. *KLOE, a General Purpose Detector for DAΦNE.*, the KLOE Collaboration, LNF Report LNF-92/019, 1992.
10. *The KLOE Detector Technical Proposal*, the KLOE Collaboration, LNF Report LNF–93/002, 1993.
11. *The KLOE Central Drift Chamber*, the KLOE Collaboration, LNF Report LNF–94/028, 1994.
12. "Results on Lead-Scintillating Fibers Calorimeter Prototypes for the KLOE Experiment", S, Miscetti with the KLOE Calorimeter Group, *Proc. of the IV Int. Conference on Calorimetry in High Energy Physics*, A. Baldini *et al.*, Eds. La Biodola, 1993.
13. Politecnico e Sezione INFN, Torino; Università di Brescia; Università e Sezione INFN, Pavia; Università, Torino Università, e Sezione INFN, Trieste; Università, e Sezione INFN, Bari; Laboratori Nazionali di Frascati dell'INFN, Frascati; TRIUMF, Vancouver; JINR, Dubna, Moscow.
14. *FI.NU.DA a Detector for Nuclear Physics at DAΦNE*, the FINUDA Collaboration, LNF Report LNF-93/021, 1993.