Physics Results from KLOE

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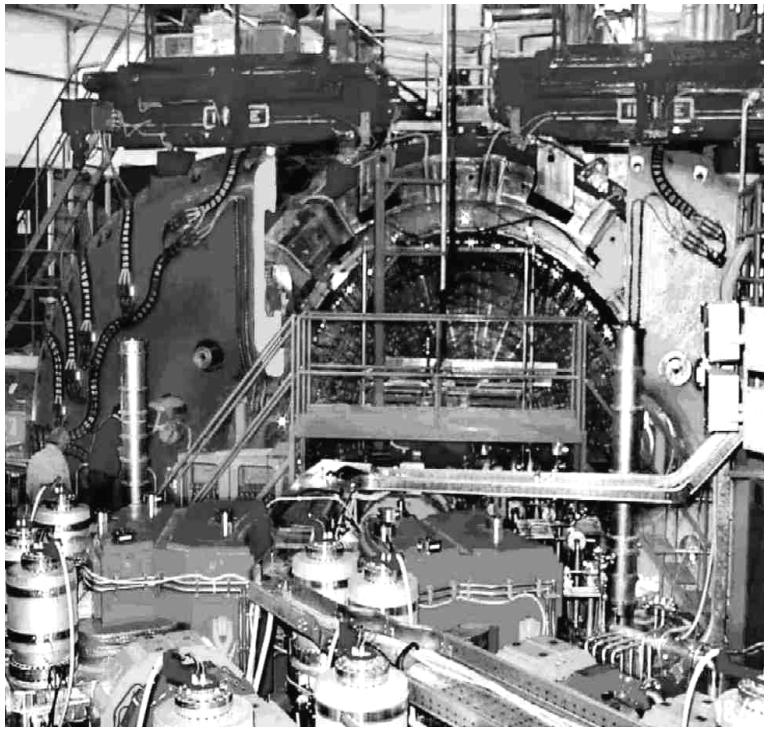
for the KLOE Collaboration

Outline:

- The KLOE detector at DAFNE
- Preliminary physics results from '99 data



- **Electron - Positron Collider on ϕ - mass $\sqrt{s}$ = 1.02 GeV**

- **Design Philosophy:**

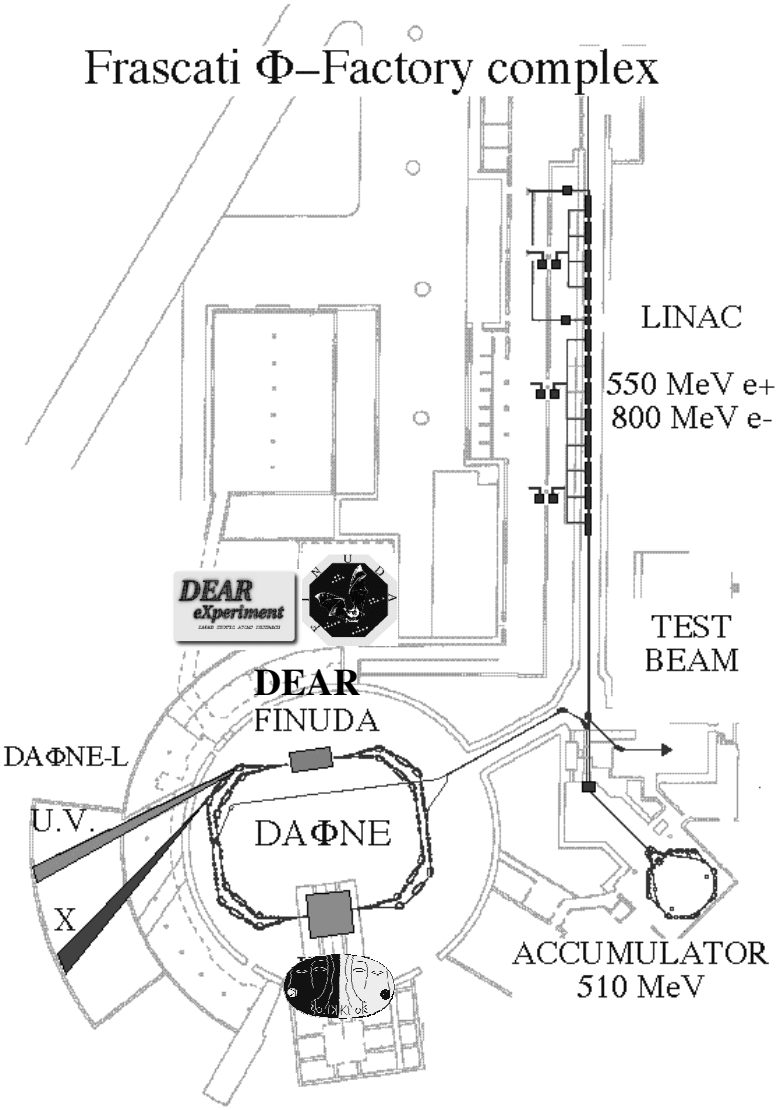
  Moderate Single Bunch Luminosity * **Large Number of Bunches**

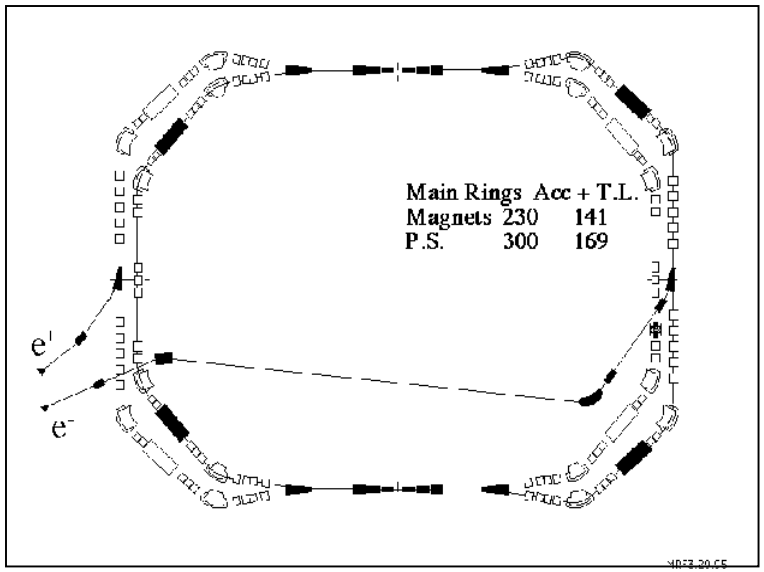
  $5 \cdot 10^{30}$ (VEPP-2M) * **120 Bunches**

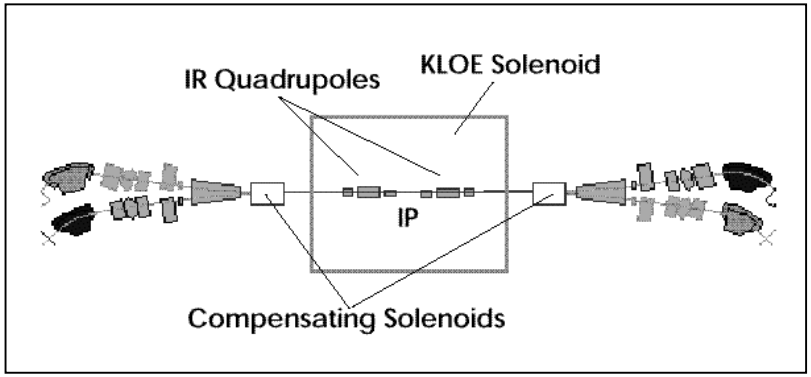
Design Luminosity $\approx 5 \cdot 10^{32}$

- **Beam - Beam - Scattering** 5A/beam **requires two independent beam lines for e^-, e^+**

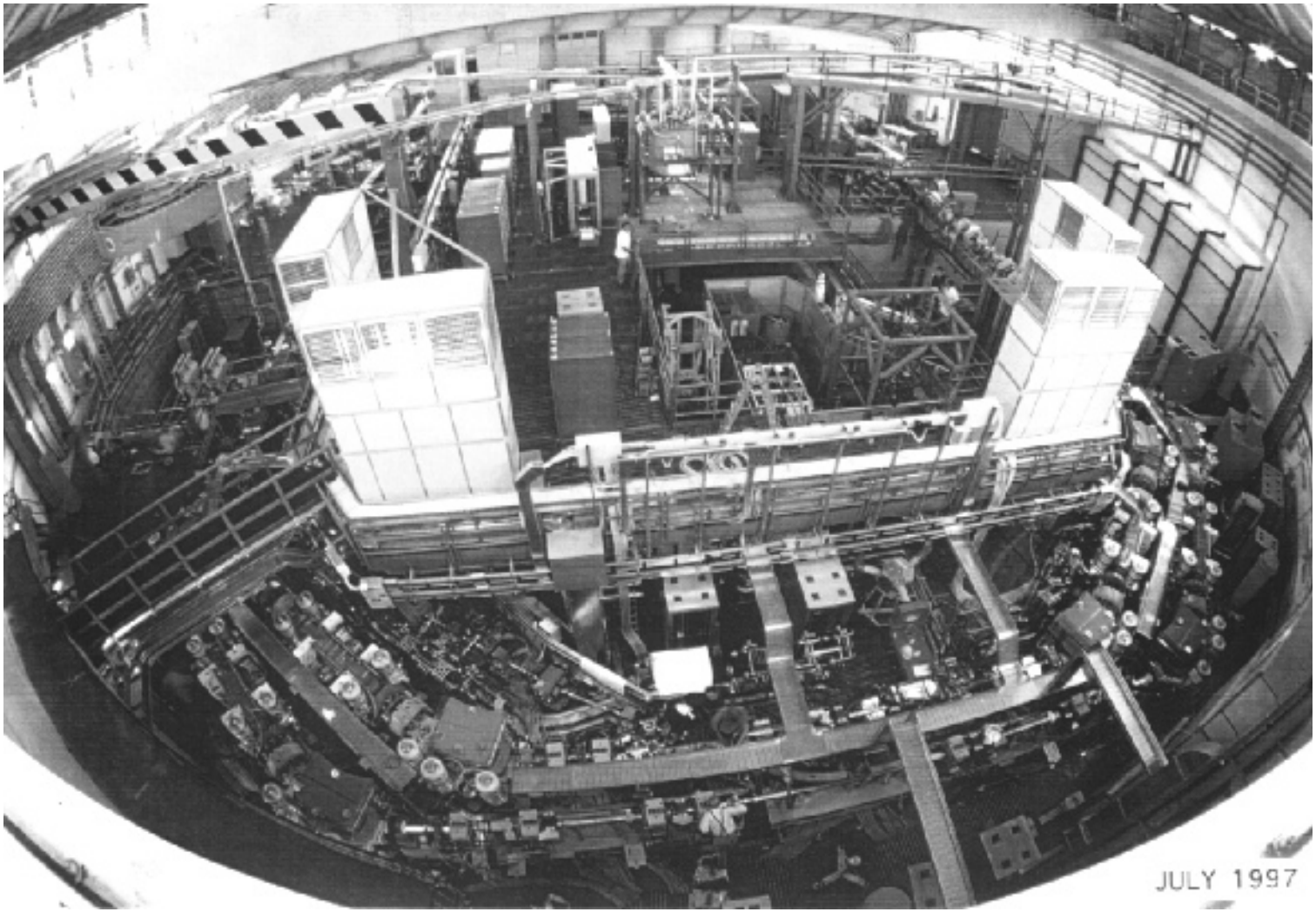
- **Two interaction points for detectors FINUDA / DEAR (Kaon-Nucleon-Interaction and Hypernuclear Physics) on one side and KLOE - detector on other side**







- Beam Energies = 0.51 GeV
  at 5A / beam
  High Current at Low Energy
- Beam Trajectory Length = 98 m
  maximum 120 Bunches
  Bunch Spacing = 2.7 nsec
- Bunch Length = 3.0 cm
  Transversal Sizes 20 / 2000 μm (y /x)
  flat beams
- beam crossing angle = 25 mrad
  giving rise to a phi boost p_x = -13 MeV
- KLOE Magnetic Field (6kG) requires
  superconducting compensators


JULY 1997

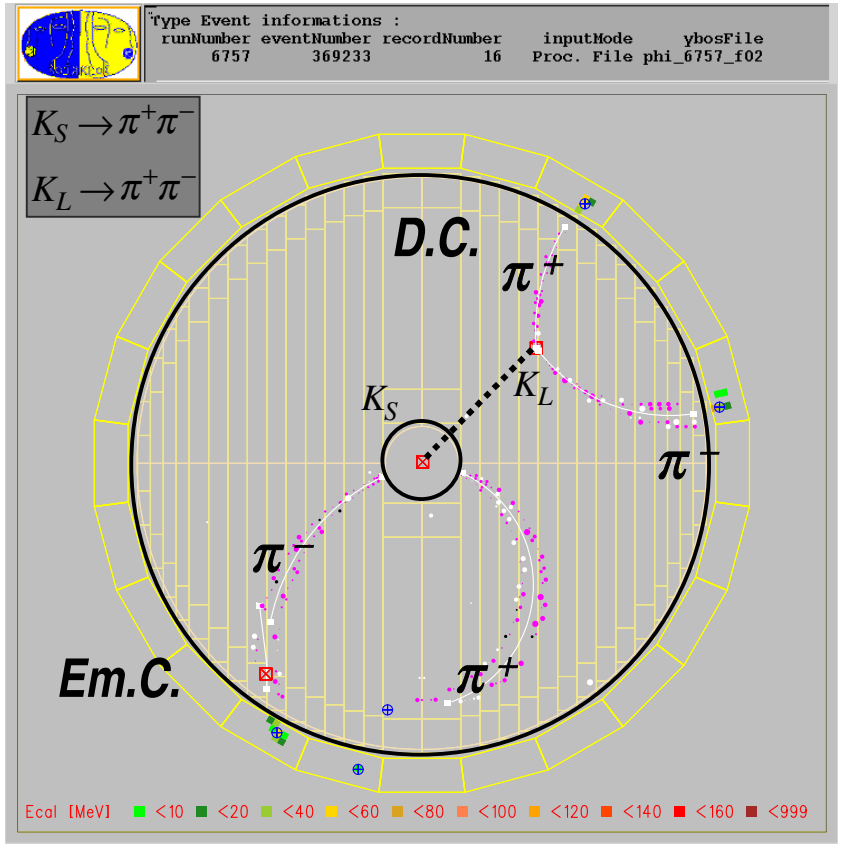
Decay $\phi(1020)$	BR	Events/y $2 \cdot 10^{10}$
K^+, K^-	49.5 %	$9.8 \cdot 10^9$
K_S, K_L	34.4 %	$6.9 \cdot 10^9$
$\rho\pi, \pi^+\pi^-\pi^0$	14.8 %	$3.0 \cdot 10^9$
$\eta\gamma$	1.3 %	$2.6 \cdot 10^8$
$f_0\gamma,\ a_0\gamma,\ \eta'\gamma$	$\approx 10^{-4}$	20 000

1 equiv. year @ 5 x 10^{32}

A Phi Factory provides pure and monochromatic KK beams back to back

$$e^+e^- \rightarrow \phi \rightarrow K_S\ K_L$$

Tagging of Kaon Pairs

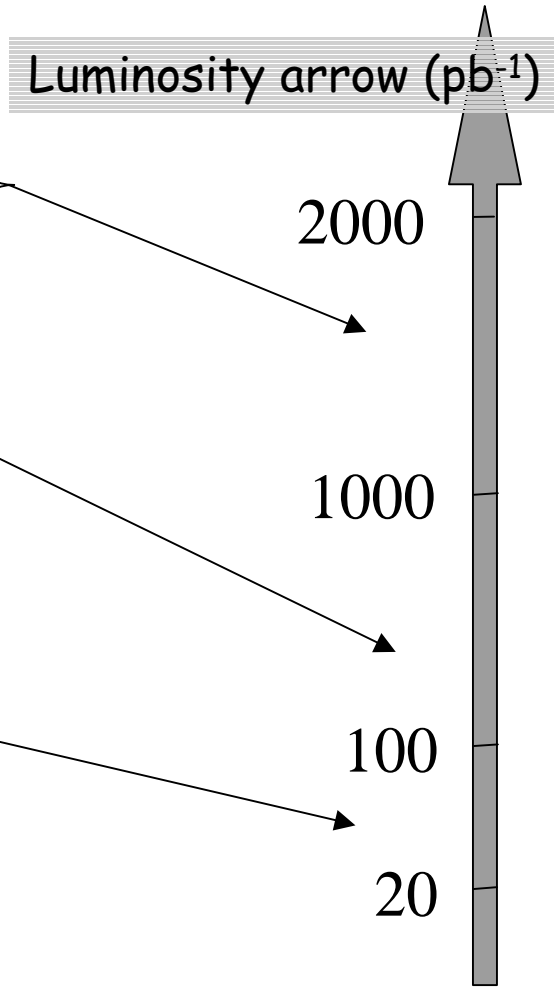


$p_S = -\ p_L$ $\quad p_K = 110$ MeV

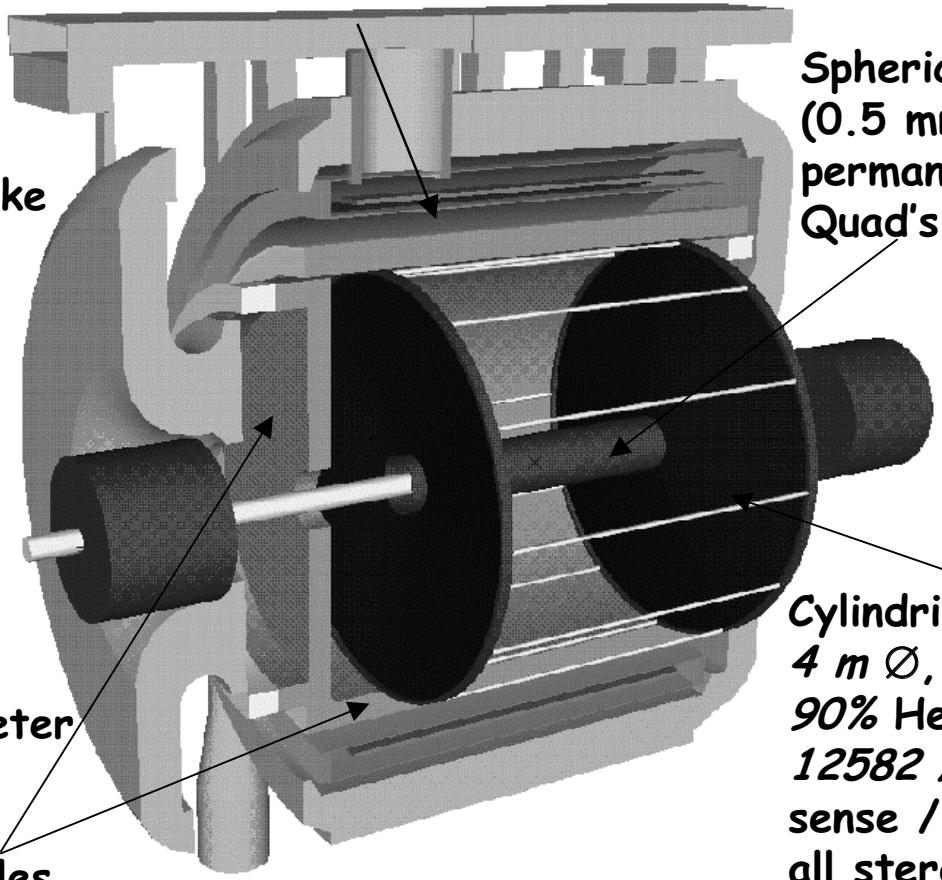
$\lambda_S = 0.6$ cm $\quad \lambda_L = 340$ cm

The KLOE physics program (red=non Kaon physics)

- ✓ CPT limits $K_S \to \pi^+e^-\nu$ / $\pi^-e^+\nu$ vs $K_L \to \pi^+e^-\nu$ / $\pi^-e^+\nu$
- ✓ CP violation studies (double ratio+interf.)
- ✓ rare and not so rare K_S decays ($\gamma\gamma$, πee, $\pi\mu\mu$, $\pi\nu\nu$)
- ✓ kaon form factors ($K_L \to \pi l\nu$, $K^\pm \to \pi^0 l^\pm\nu$)
- ✓ $K^\pm$ decays (in particular $\pi^0e^\pm\nu$, $\pi\pi\pi$)
- ✓ **σ_{HAD} for $(g-2)_\mu$ and $\alpha_{em}(m_Z^2)$**
- ✓ semileptonic K_S decays (**$K_S \to \pi l\nu$**)
- ✓ **regeneration measurements at low momenta**
- ✓ $\phi \to \pi^+\pi^-\pi^0$
- ✓ **radiative ϕ decays ($\phi \to \eta\gamma$, $\eta'\gamma$, $f_0\gamma$, $a_0\gamma$, ...)**



The KLOE Detector



Superconducting Coil *B=0.6 T*

Iron Yoke

Spherical Al-Be beam pipe
(0.5 mm thickness)
permanent +
Quad's instrumentation

Cylindrical Drift Chamber
4 m ∅, *3.3 m* Length
90% Helium, *10%* Isobutane
12582 / 52140
sense / total wires
all stereo wires

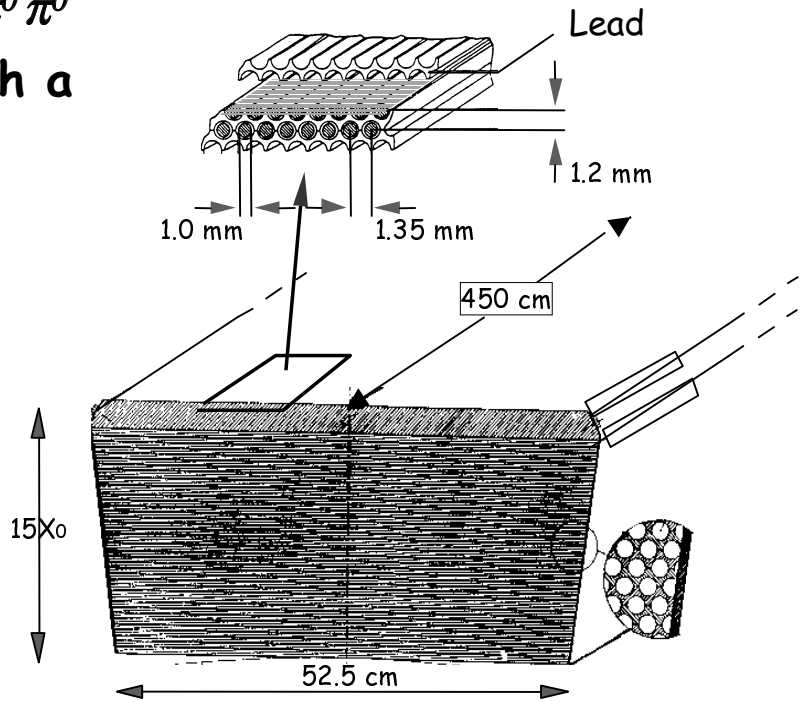
Electromagnetic Calorimeter
Pb / Scintillating Fibres
(4880 PMTs)
Endcap - Barrel - Modules

The Electromagnetic Calorimeter

Efficient Detection of Photons > *20 MeV*

- **Barrel + Endcap = *98%* Hermetic Coverage**
- **Discriminate $K_L \to \pi^0\pi^0$ against $K_L \to \pi^0\pi^0\pi^0$**
- **Reconstruct $K_L \to \pi^0\pi^0$ decay vertex with a precision < 1 cm**
- **Serve as a 1st level Trigger**

Pb - Sc.Fibres - Matrix
$\langle\rho\rangle$ = 5 g/cm^3
$\langle\lambda_0\rangle$ = 1.6 cm
sampl. frac.~15% (m.i.p.)



Design:

$\sigma_E/E = 5\%/\sqrt{E(GeV)}$

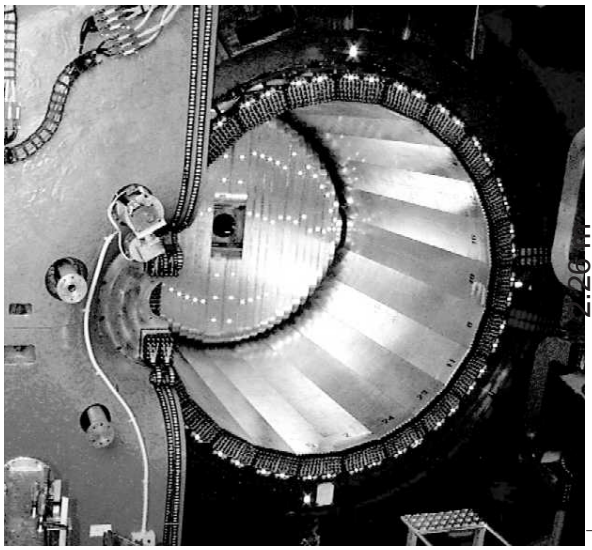
$\sigma_t = 70\ ps/\sqrt{E\ (GeV)}$

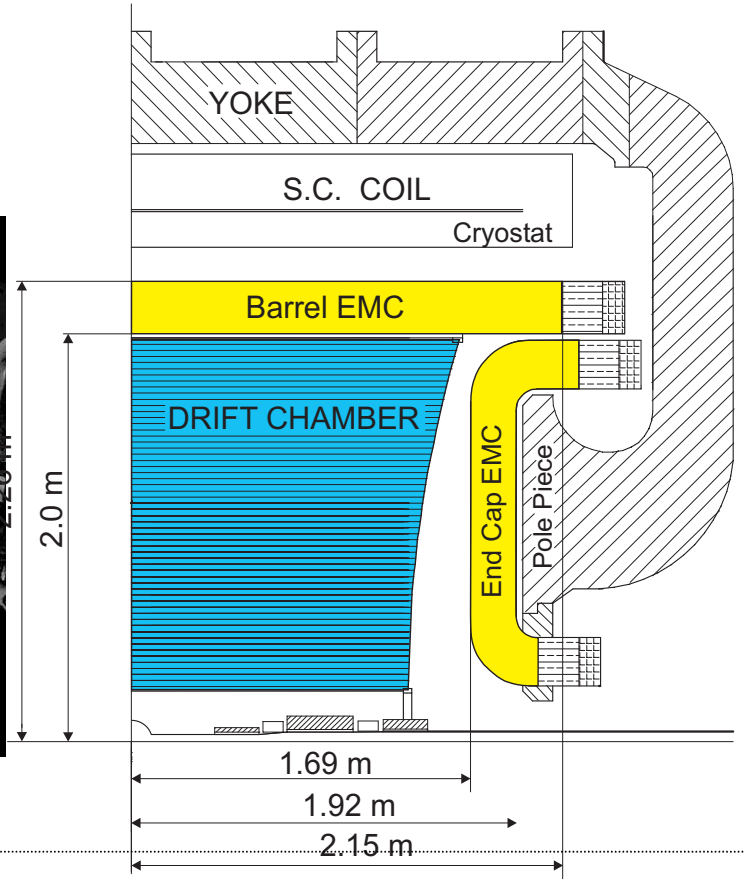
Measured :

$\sigma_E/E = 5.7\%/\sqrt{E(GeV)}$

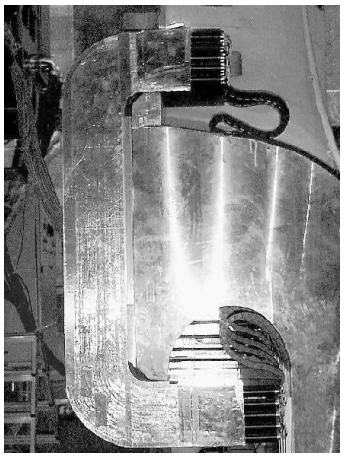
$\sigma_t = 57\ ps/\sqrt{E\ (GeV)} + 167ps$

24 barrel modules
60 cells (5 layers)
4.3m length





2 × 32 endcap modules
10/15/30 cells

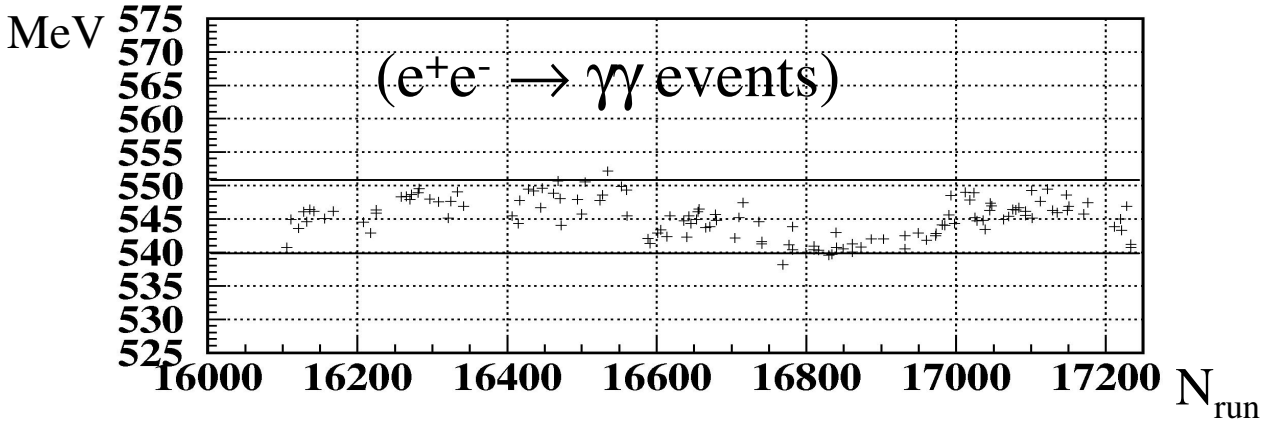


5000 ADC & TDC channels

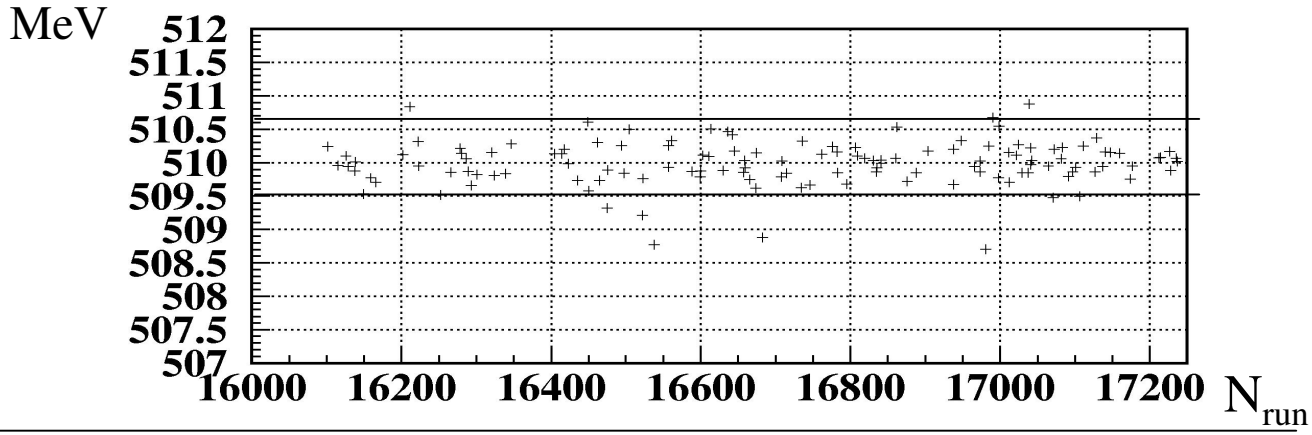
EmC: Energy calibration

- ✓ All cells are equalized to better then 1% with **MIPs**
- ✓ Absolute scale set using $\gamma\gamma$ and **Bhabha** events

Energy variations (~2%) measured and corrected every 100 nb^{-1}

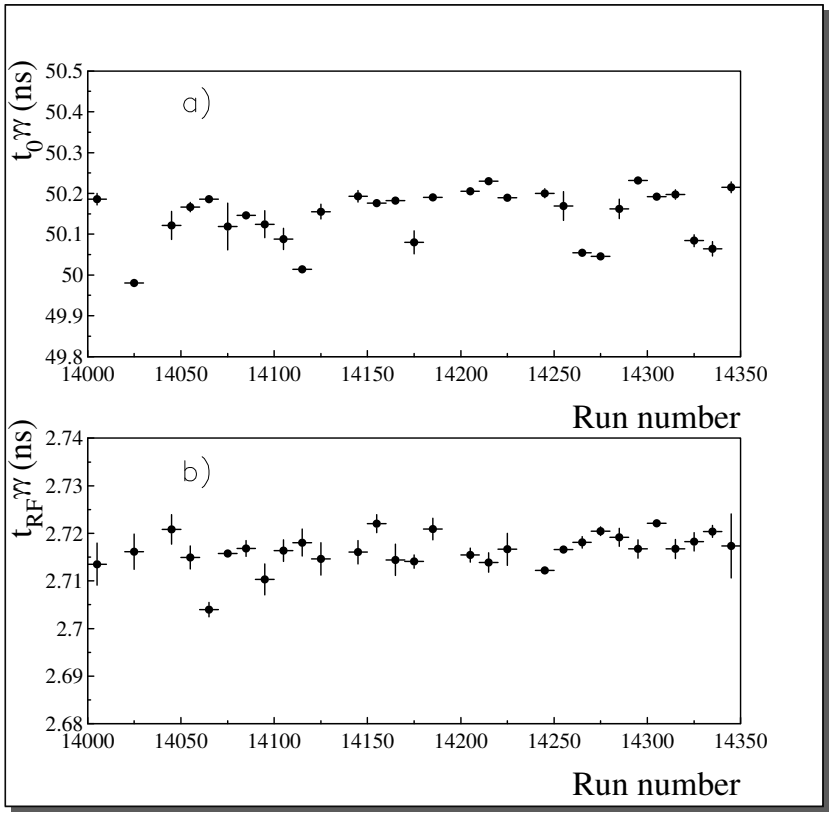


Energy absolute calibration ± 0.1%



EmC: Time calibration

Time calibration includes
Slewing correction is
Performed run by run

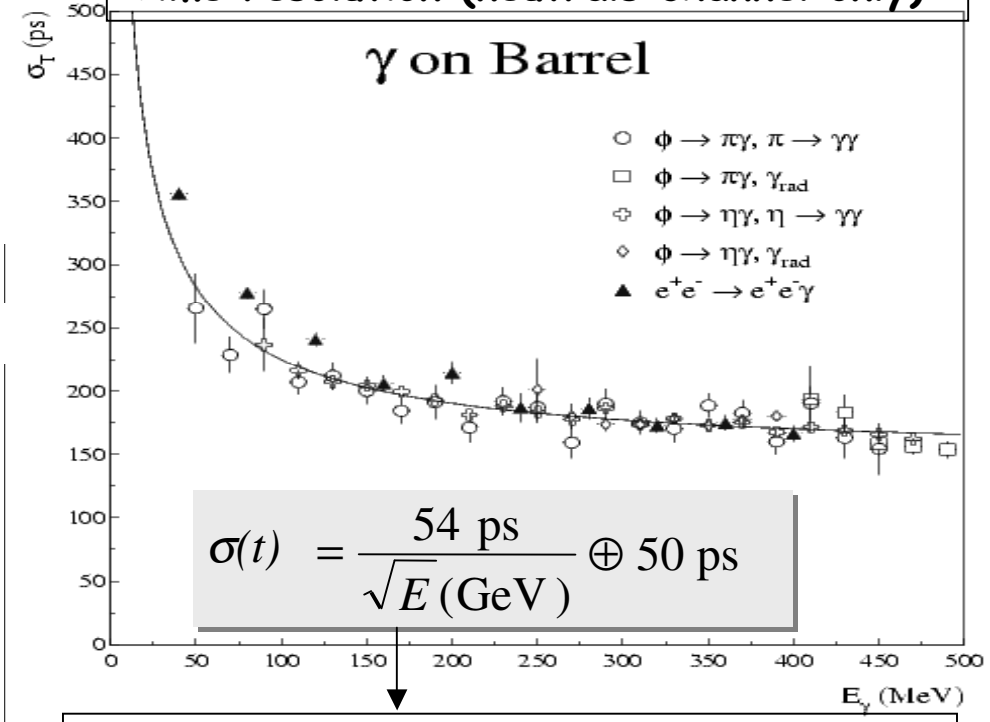


T0 global variations up to

100-200 ps corrected run by run.

EmC: Time & Energy performances

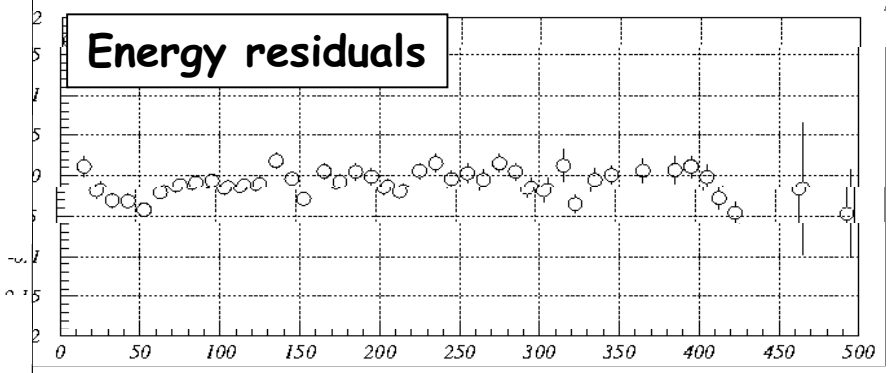
Time resolution (neutrals channel only)



$$\sigma(t) = \frac{54\ \text{ps}}{\sqrt{E\,(\text{GeV})}} \oplus 50\ \text{ps}$$

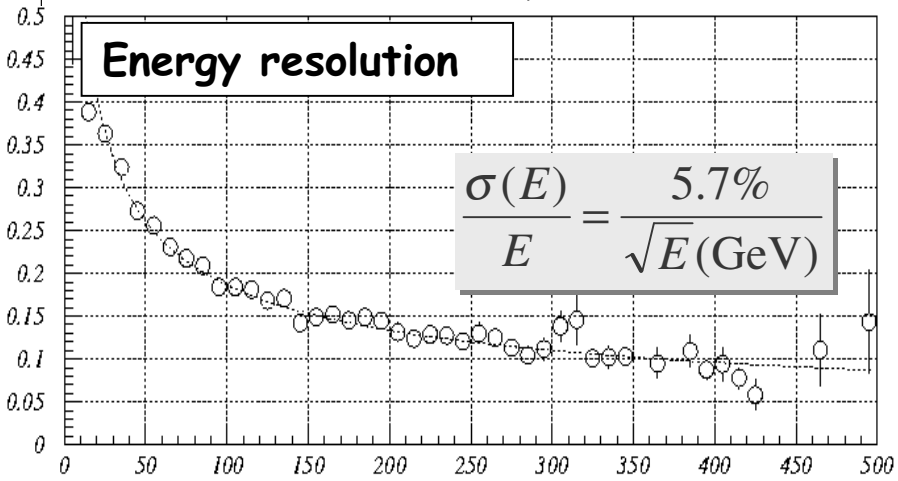
effects due to the beam (bunch length and bunch to bunch fluctuation) have been subctracted from the constant term

Energy residuals



$e^+e^- \to e^+e^-\gamma$ E_γ **from DC**

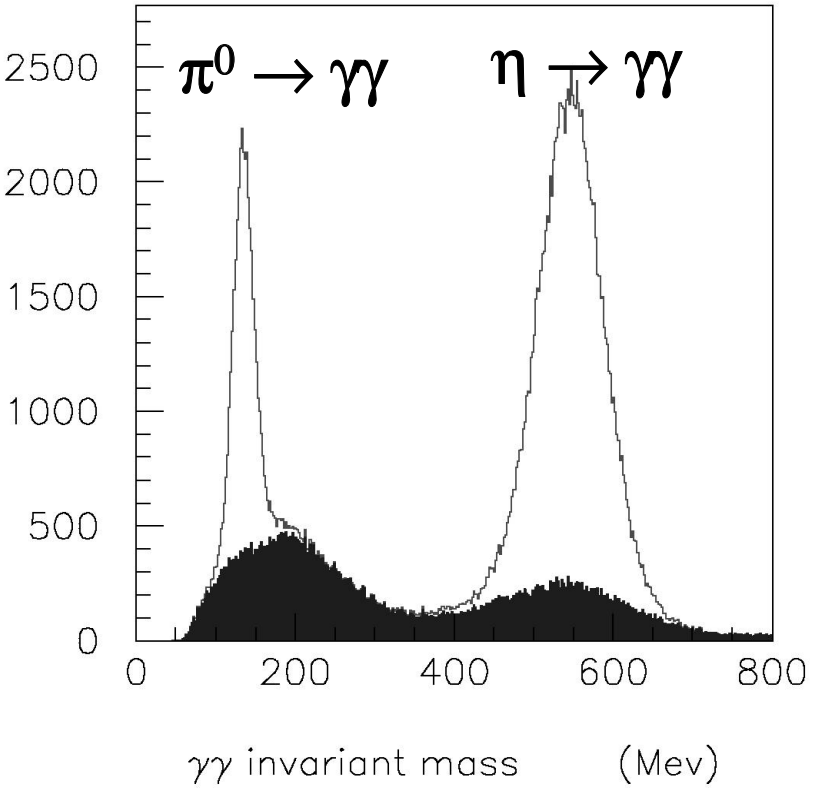
Energy resolution



$$\frac{\sigma(E)}{E} = \frac{5.7\%}{\sqrt{E\,(\text{GeV})}}$$

EmC: Mass resolution on fully neutral channels

$$\Phi \rightarrow \pi^0(\eta)\gamma \rightarrow \gamma\gamma\gamma$$



$$M_{\pi 0} = 135.0 \text{ MeV}$$
$$\sigma_M = 13.0 \text{ MeV}$$

$$M_{\eta} = 546.4 \text{ MeV}$$
$$\sigma_M = 40.3 \text{ MeV}$$

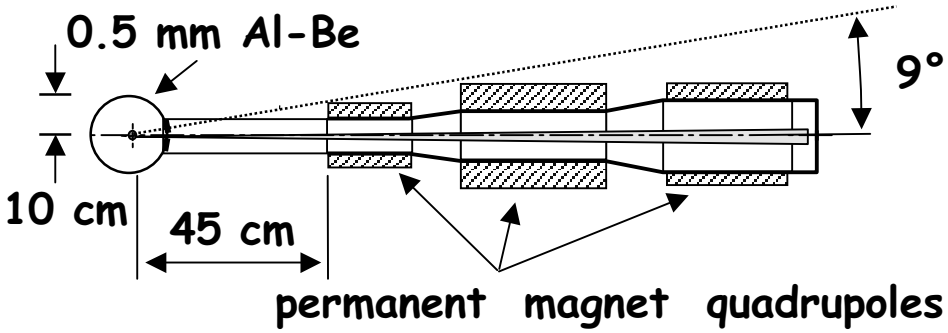
$$\frac{N(\phi \rightarrow \eta\gamma \rightarrow \gamma\gamma\gamma)}{N(\phi \rightarrow \pi^0\gamma \rightarrow \gamma\gamma\gamma)}\Big|_{PDG} = 4.05 \pm 0.35$$ PDG '00

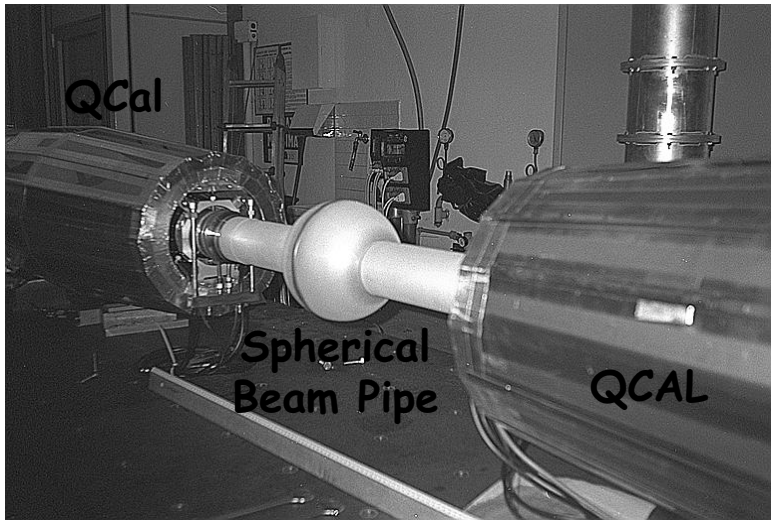
$$\frac{N(\phi \rightarrow \eta\gamma \rightarrow \gamma\gamma\gamma)}{N(\phi \rightarrow \pi^0\gamma \rightarrow \gamma\gamma\gamma)}\Big|_{KLOE} = 3.85 \pm 0.02 \pm 0.12$$

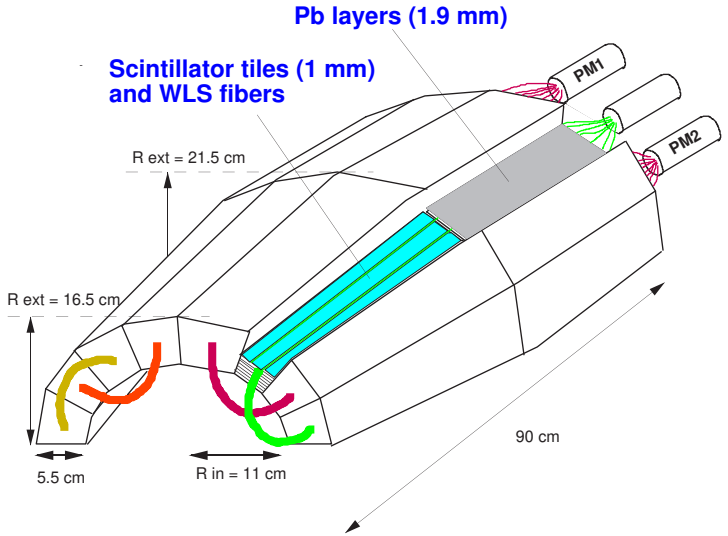
KLOE 10.7 pb^{-1}

Quadrupole Calorimeter (QCAL)

Acceptance increased thanks to Quadrupole Instrumentation : Lead-Scintillator-Tile Sampling Calorimeter







The Drift Chamber

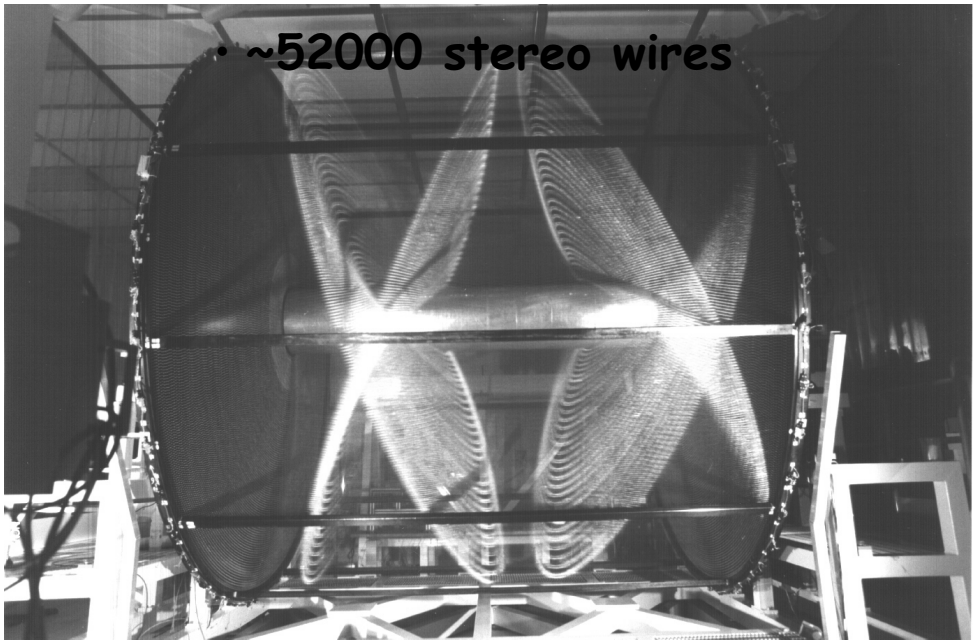
① **High and uniform track reconstruction efficiency**

② **Determine the $K_{L,S}$ vertex with an accuracy of > 1mm**

③ **Good momentum resolution ($\delta p/p \sim 0.3\%$) for Kl3 rej.**

④ **Transparent to low energy γ (down to 20 MeV) and $K_{L,S}$ regeneration ->**

[*90%* He, *10%* iC_4H_{10} (X_0=900m)
mec. str. in C-Fibre (<0.1 X_0)]

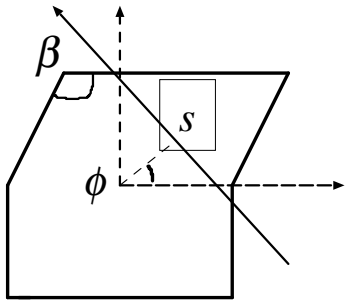


cell structure:

- **3:1 field:sense ratio**
- **3 × 3 cm^2 in the 46 outer layers**
- **2 × 2 cm^2 in the 12 inner layers**

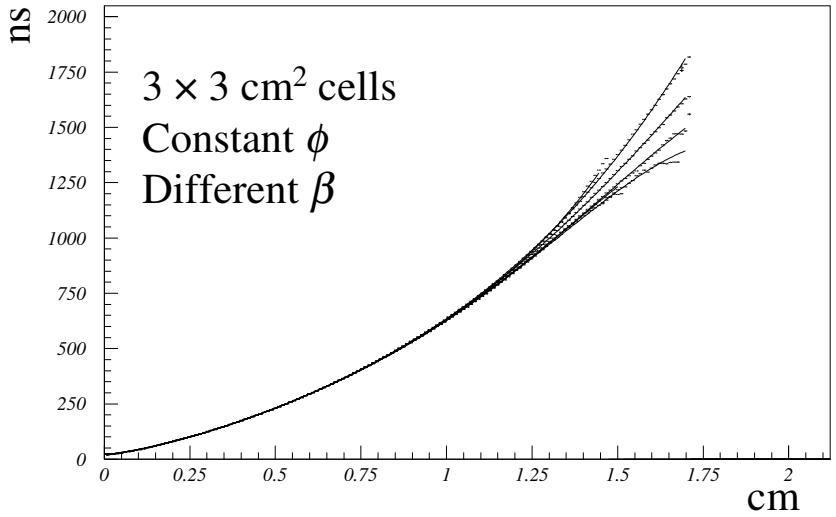
Drift velocity not saturated and depends on:

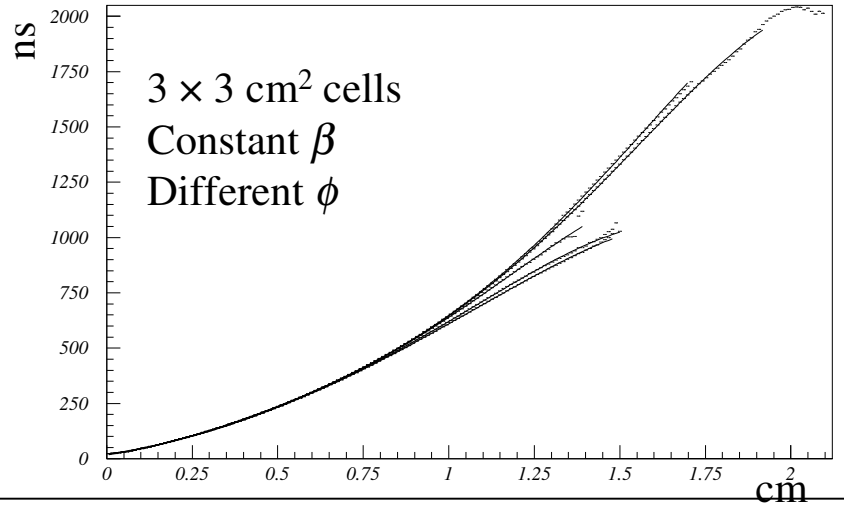
- drift distance (s)
- cell shape (β)
- crossing angle (ϕ)
- c(He), pressure



Compact parameterization of t-s relations:

- 6 reference cells (β)
- 36 bins in crossing angle (ϕ)
- 242 t-s relations total
- each described by 5th order Chebyshev polynomial

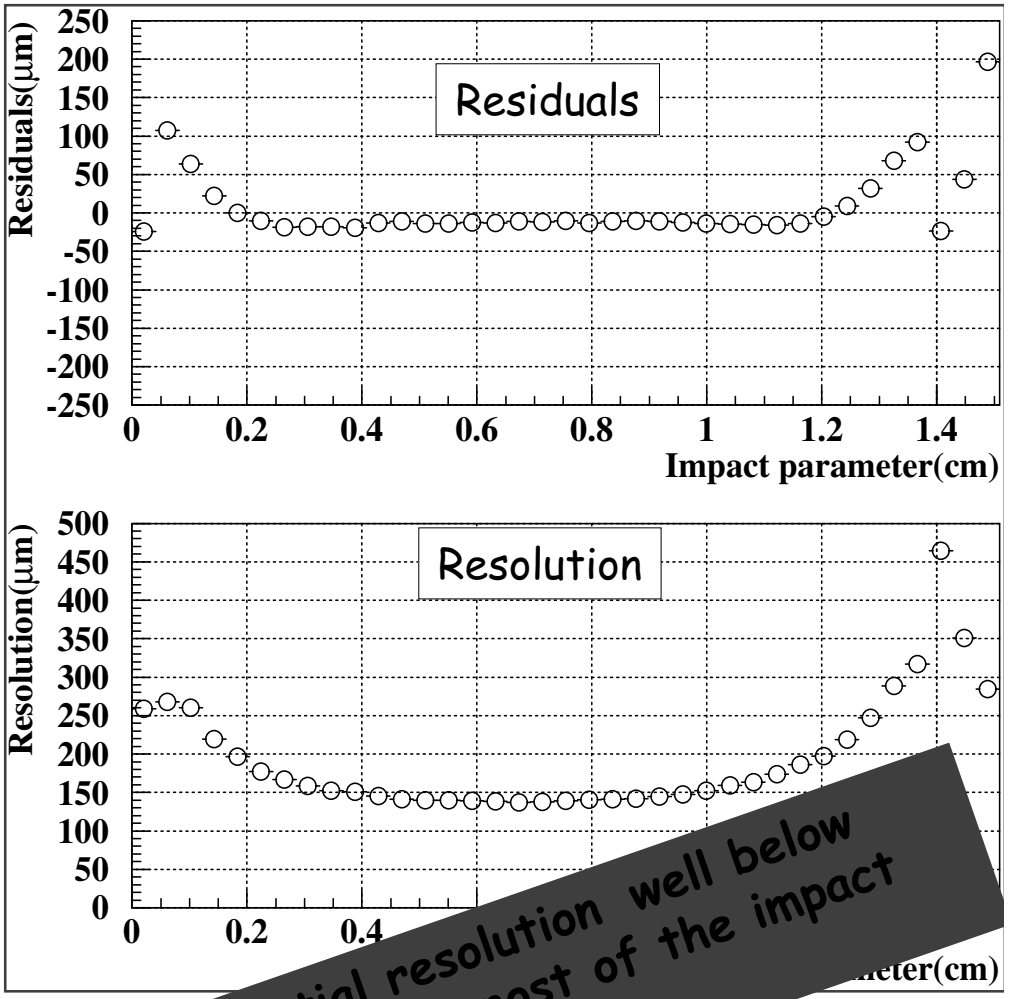




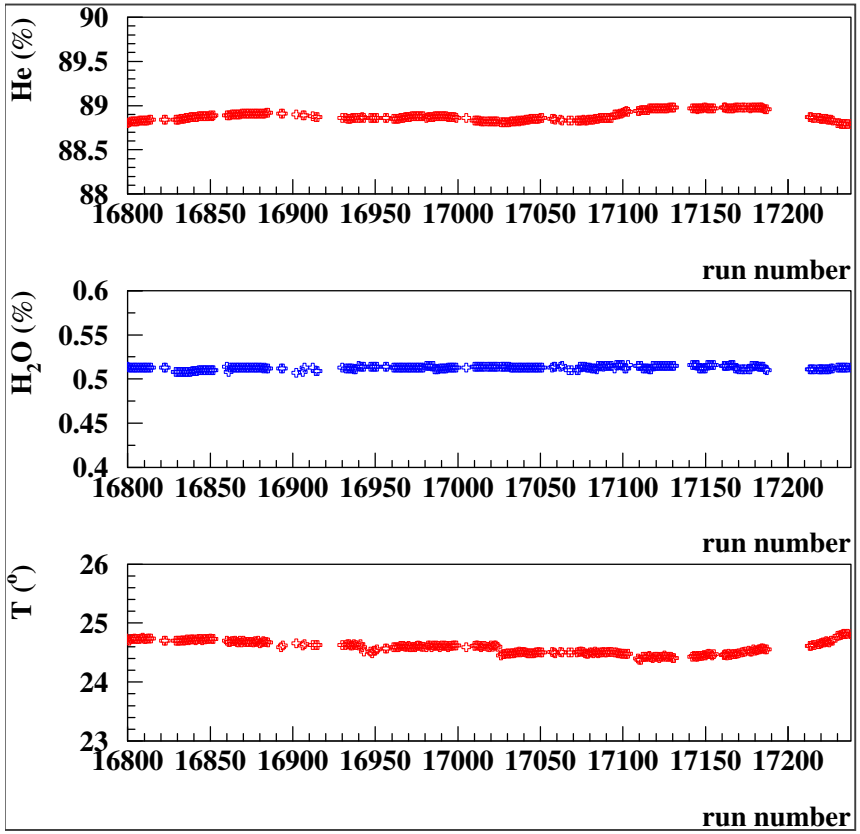
Bhabha

- the calibration is done online using cosmic data complete cell "covering" in terms of ϕ by and β
- the determination of the s-t coefficients is done using an iterative procedure:

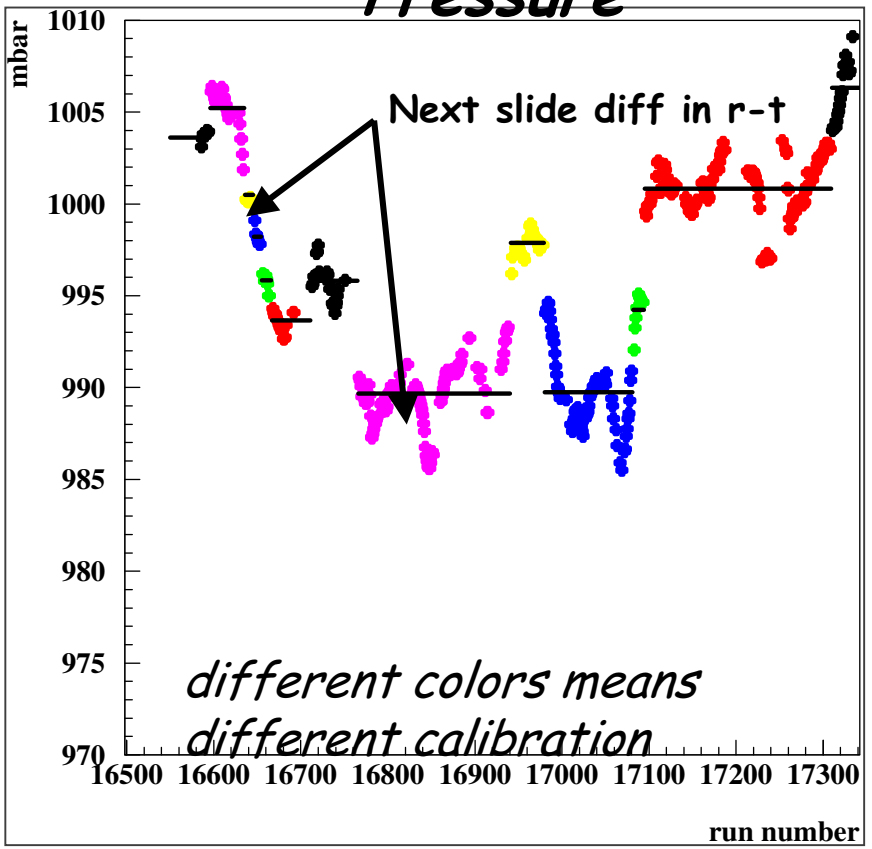
the iterations are stopped when average residuals are at the level of 40 μm checks are done with bhabha and $K_S \rightarrow \pi^+\pi^-$ events



Temperature and gas mixture are stable in time



The changing of the **atmospheric pressure** is the only ambient parameter that influences the calibration.



1 month

Resolution contributions:

- **Electron longitudinal diffusion:**

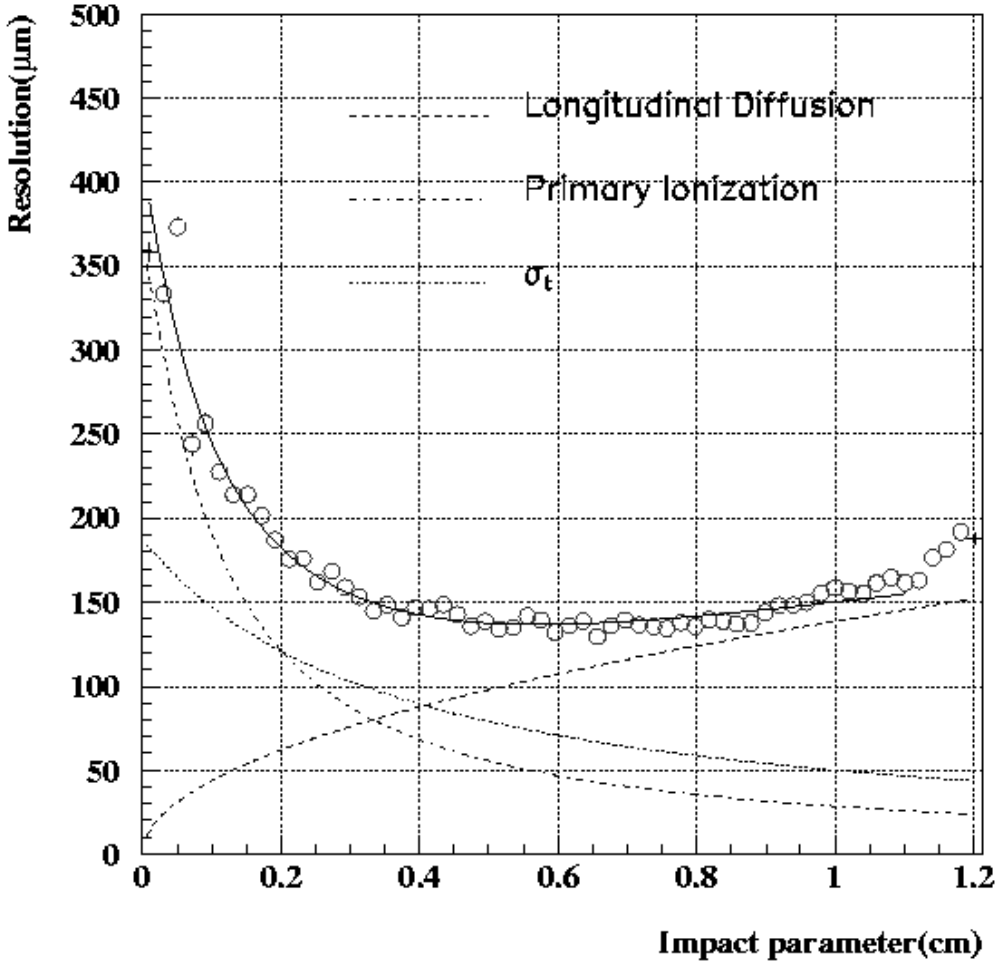
  140 mm for 1 cm of drift

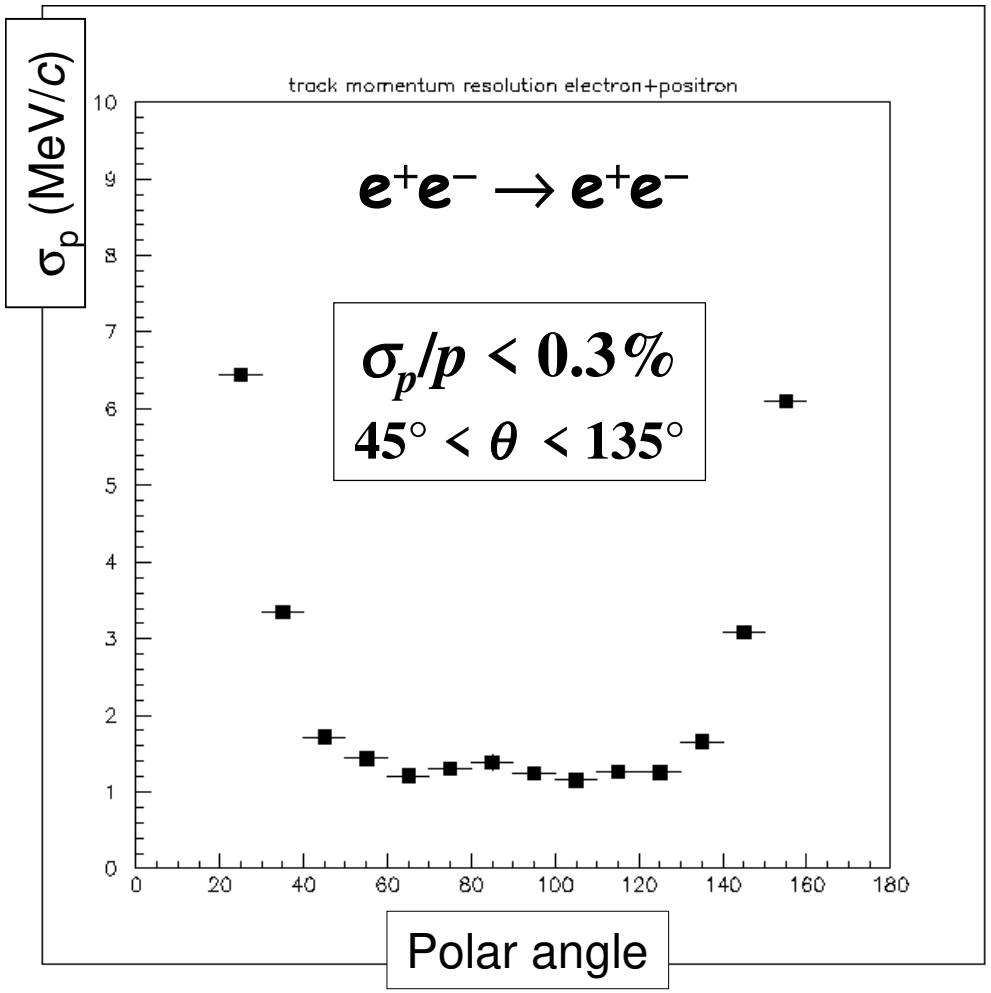
- **Primary ionisation statistics:**

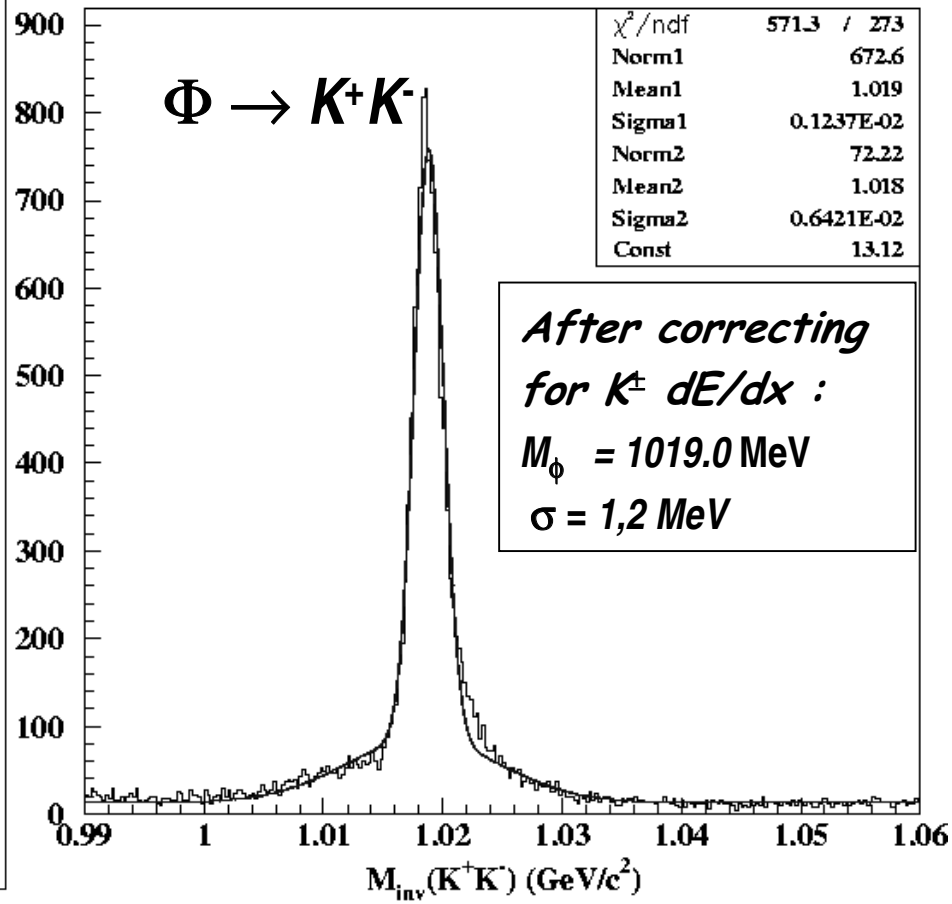
  718±14 mm mean free path between collisions corresponding to

  13.9±0.1 cm^{-1} clusters (2 GeV μ)

- **Time measurement resolution**

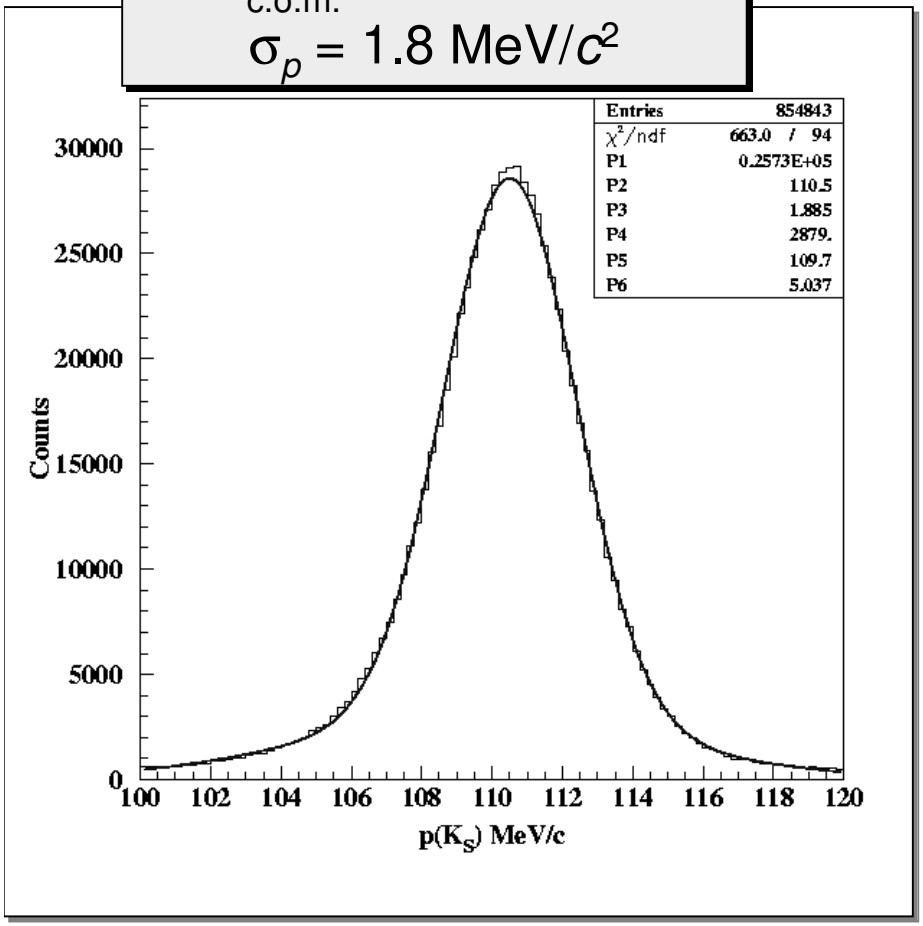



track momentum resolution electron+positron
σ_p (MeV/c)
$e^+e^- \rightarrow e^+e^-$
$\sigma_p/p < 0.3\%$
$45° < \theta < 135°$
Polar angle

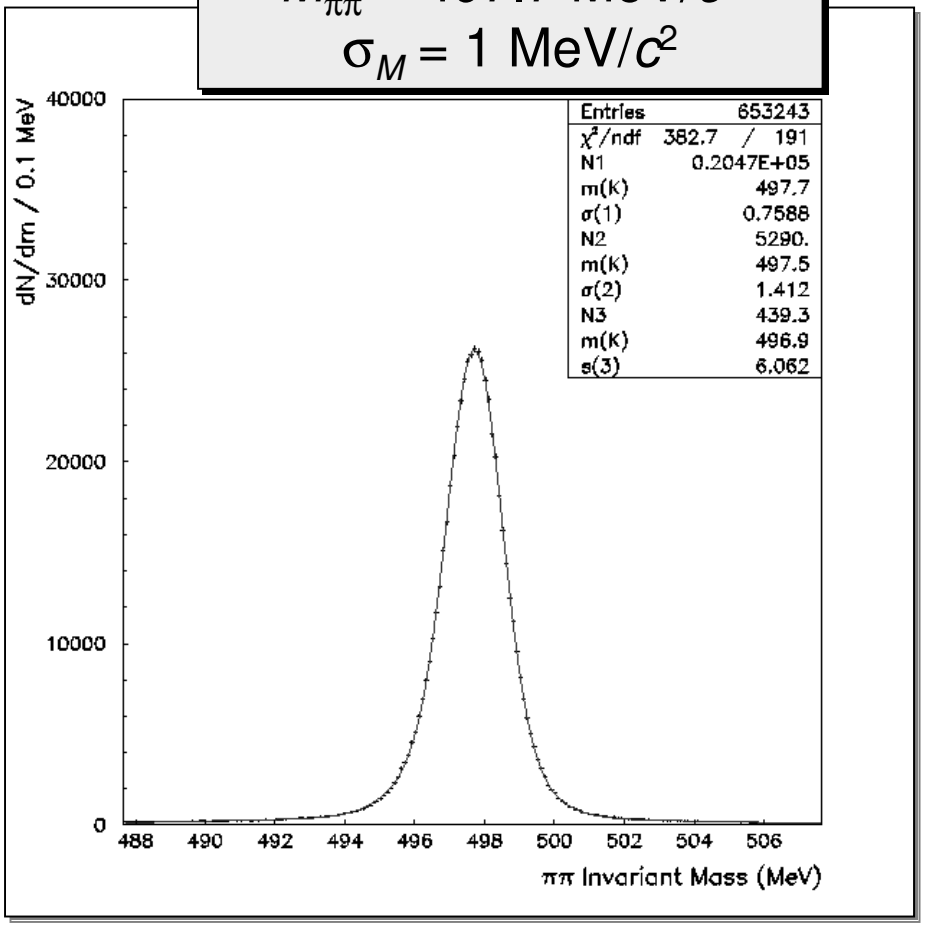

$\Phi \rightarrow K^+K^-$
χ^2/ndf 571.3 / 273
Norm1 672.6
Mean1 1.019
Sigma1 0.1237E-02
Norm2 72.22
Mean2 1.018
Sigma2 0.6421E-02
Const 13.12
After correcting for $K^\pm$ dE/dx :
M_ϕ = 1019.0 MeV
σ = 1,2 MeV
$M_{inv}(K^+K^-)$ (GeV/c^2)

$K_S \to \pi^+\pi^-$

$P_{c.o.m.}$ = 110 MeV/c
σ_p = 1.8 MeV/c^2



$M_{\pi\pi}$ = 497.7 MeV/c^2
σ_M = 1 MeV/c^2



Trigger

2 level Trigger based on EmC / DC

- **T1 (~ 200 ns after ϕ) fast trigger synchronized with DAΦNE clock**
  provides the start to EMC FEE
- **T2 (2 μs after T1) validation trigger provides stop to DC TDC's**
- **T1 and T2 decision based on:**

  Energy and Topology of 2 clusters in EMC (> 50 MeV each)
  Topology and number of DC hits

- **Designed for high ϕ decays efficiency**
- **MC: Trigger efficiency for $K_{L,S}\to\pi^+\pi^-$ and $K_{L,S}\to\pi^0\pi^0$ high and ca. equal**
- **Downscale Bhabha (2.6 KHz) and Cosmics (2.6 kHz) to acceptable level**

DAQ

DAQ handles 23000 FEE channels

- **Designed for 10 KHz event rate and sustained bandwidth of *50* MB/sec**

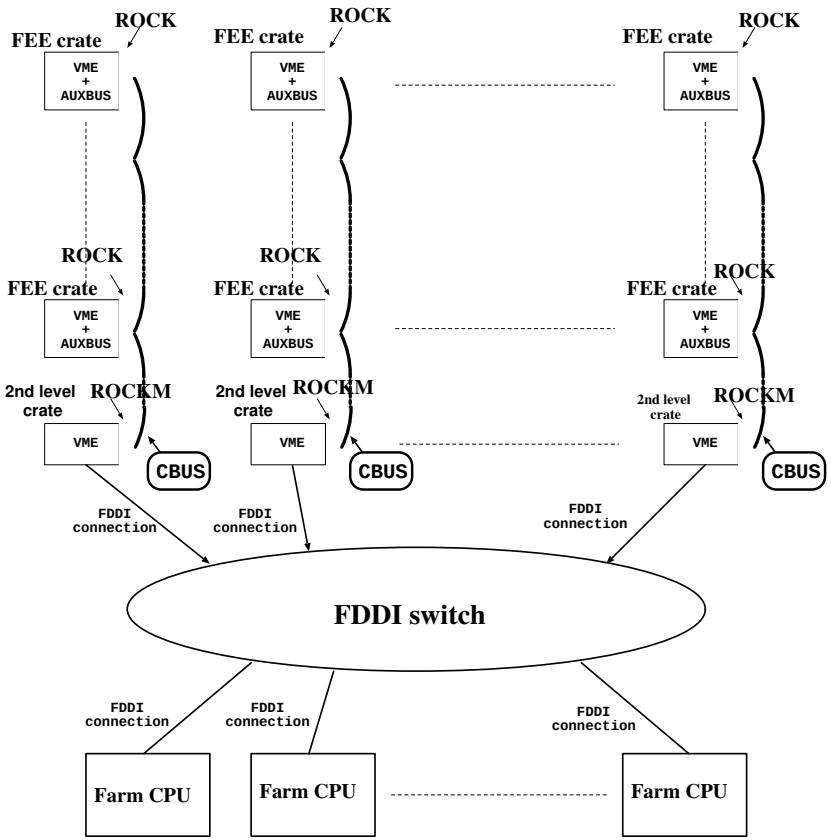
  ***5* kB average event size**

- **Low dead time (*~2%* at *10* kHz) independent of event configuration**

  ***2.2* μs dead time incurred at T1**

  All FEE channels digitized and buffered during this time

- **Fully tested at design rate**



Data quality

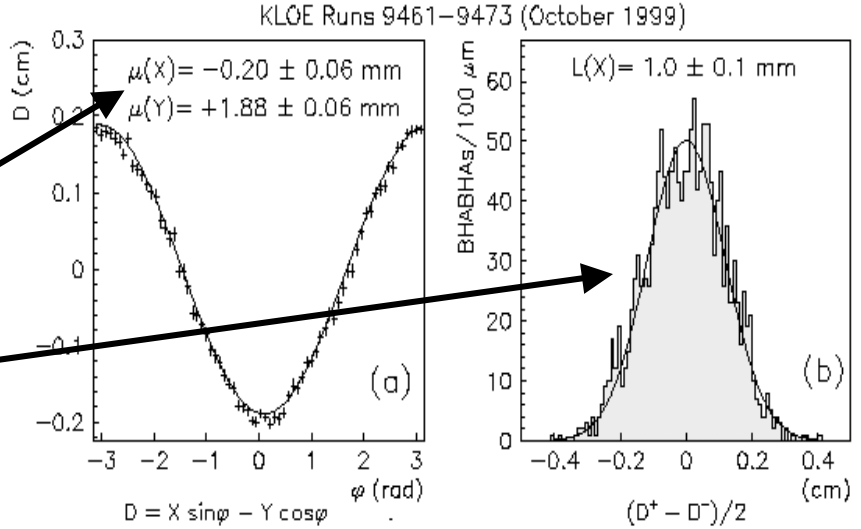
Luminosity (with LABs)

Crossing point position (±60μm in x,y ; ±1mm in z)

Dimensions of luminous point (±100μm in x ; ±1mm in z)

Center of mass energy (using Bhabha's and $K_S \rightarrow \pi^+\pi^-$)

Background

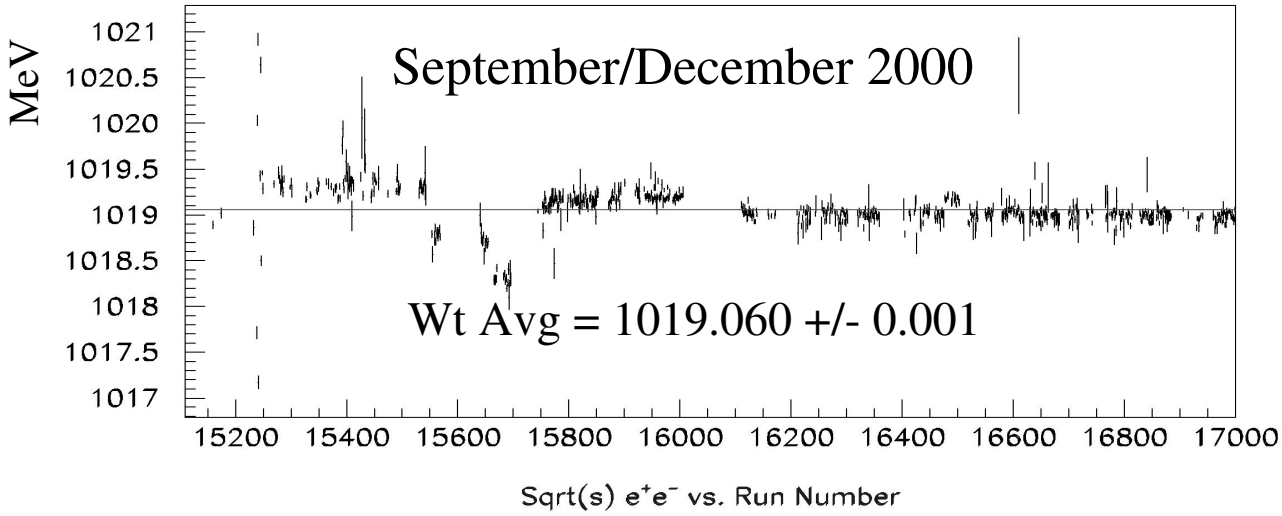


see next slide

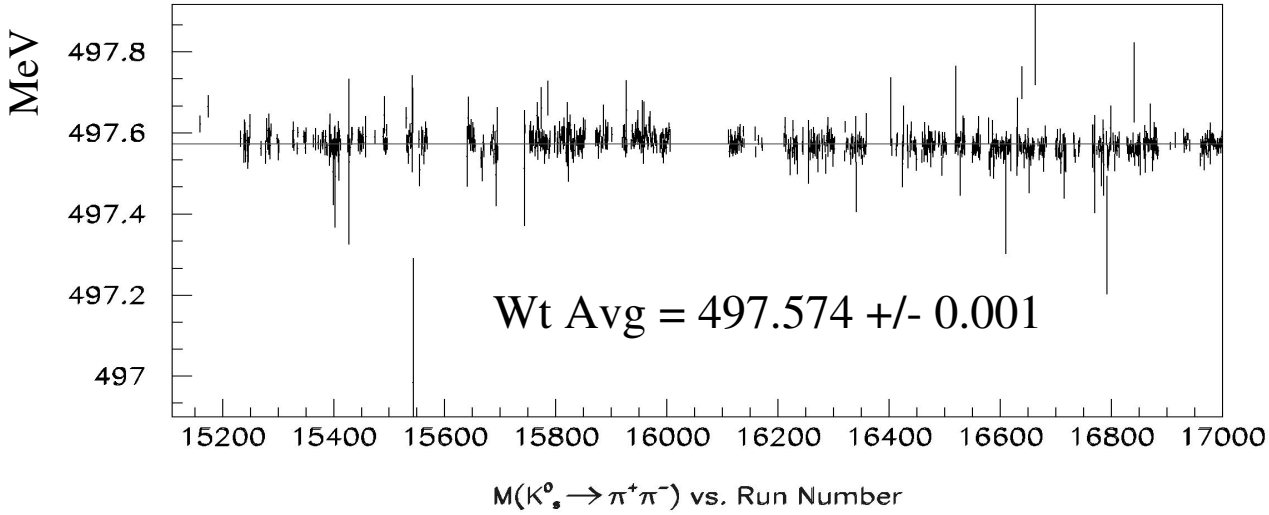
SCALER Status at 21:09:44 (5 '' ago !) on 21/03/2001											
QCal A	QCal B	QCal X	Bckg		T2	T1	T1 Free		Endcap EAST		Endcap WEST	
1 kHz	2 kHz	1 kHz	3.0		1.0 kHz	2.6 kHz	2.6 kHz		0.6 kHz	3 kHz	0.6 kHz	2 kHz

QCAL rate | Trigger rate | EndCap rate (beam off)

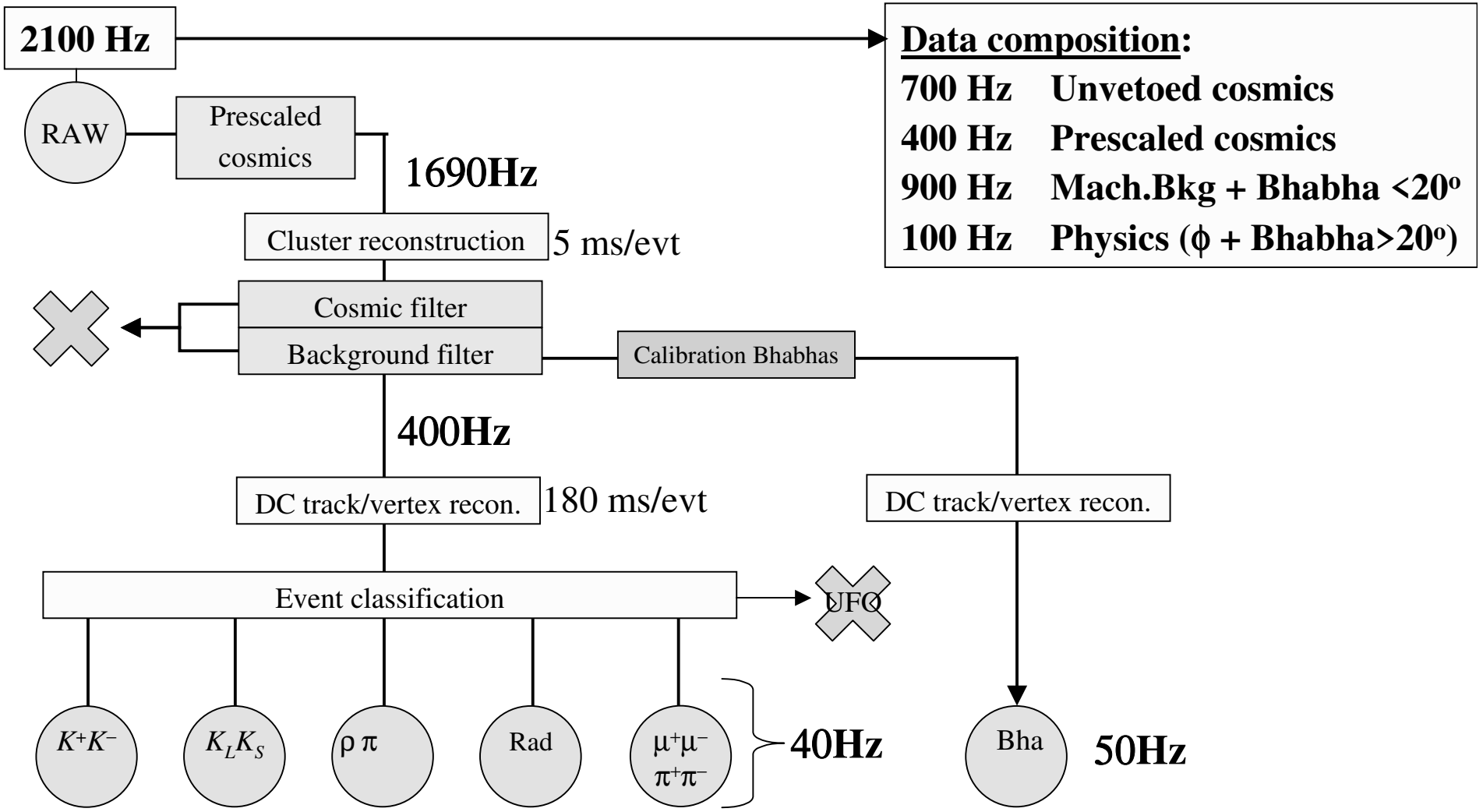
Center of mass energy monitored by the KLOE offline analysis: all the "jumps" are correlated with machine changes and ϕ scan.



Ks Mass reconstruction stable during the physics runs

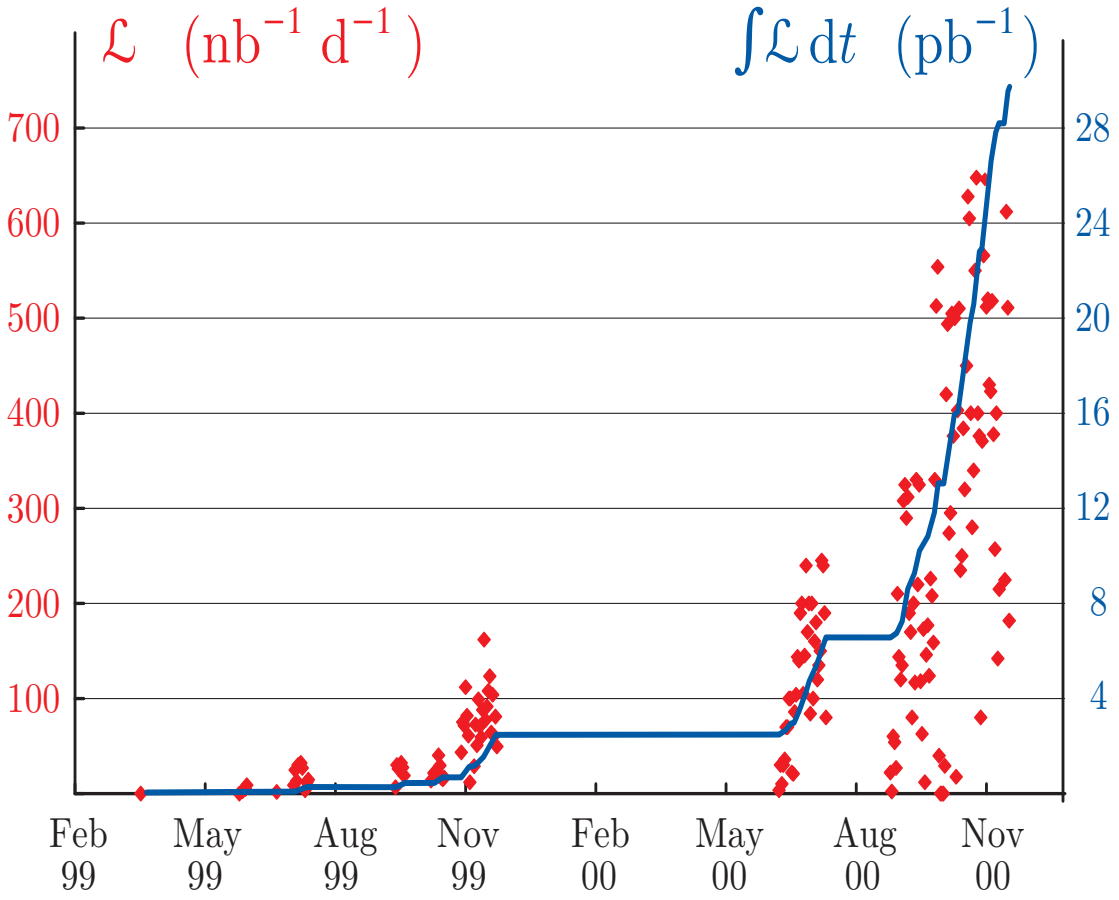


Event reconstruction



DAΦNE & KLOE recent History

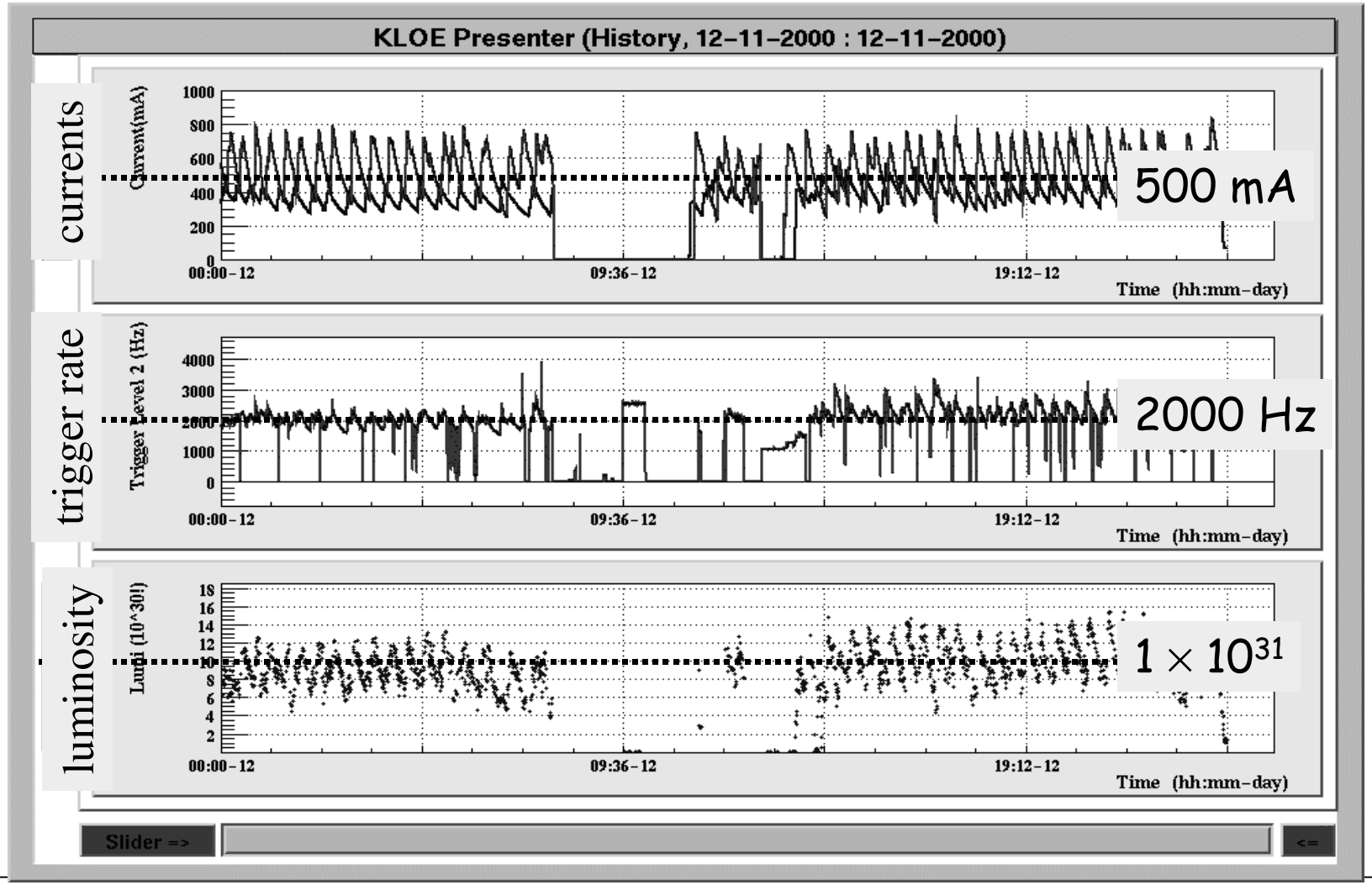
Fall 1998	KLOE roll - in
April 14, 1999	First collisions seen in KLOE
May 1999	First period of data taking → 20 nb^{-1}
June - November, 1999	M.D. + some data taking → 600 nb^{-1}
December 1999	Stable data taking → 1.8 pb^{-1} (max 100 nb^{-1}/day) (avg 65 nb^{-1}/day)
January - March, 2000	DAFNE hardware upgrades
April - June, 2000	M.D.
July 2000	Stable data taking → 4.4 pb^{-1} (max 250 nb^{-1}/day) (avg 130 nb^{-1}/day)
end Sept. - Dec.,10th, 2000	Stable data taking →22.7 pb^{-1} (max 650 nb^{-1} /day) (avg 400 nb^{-1} /day)



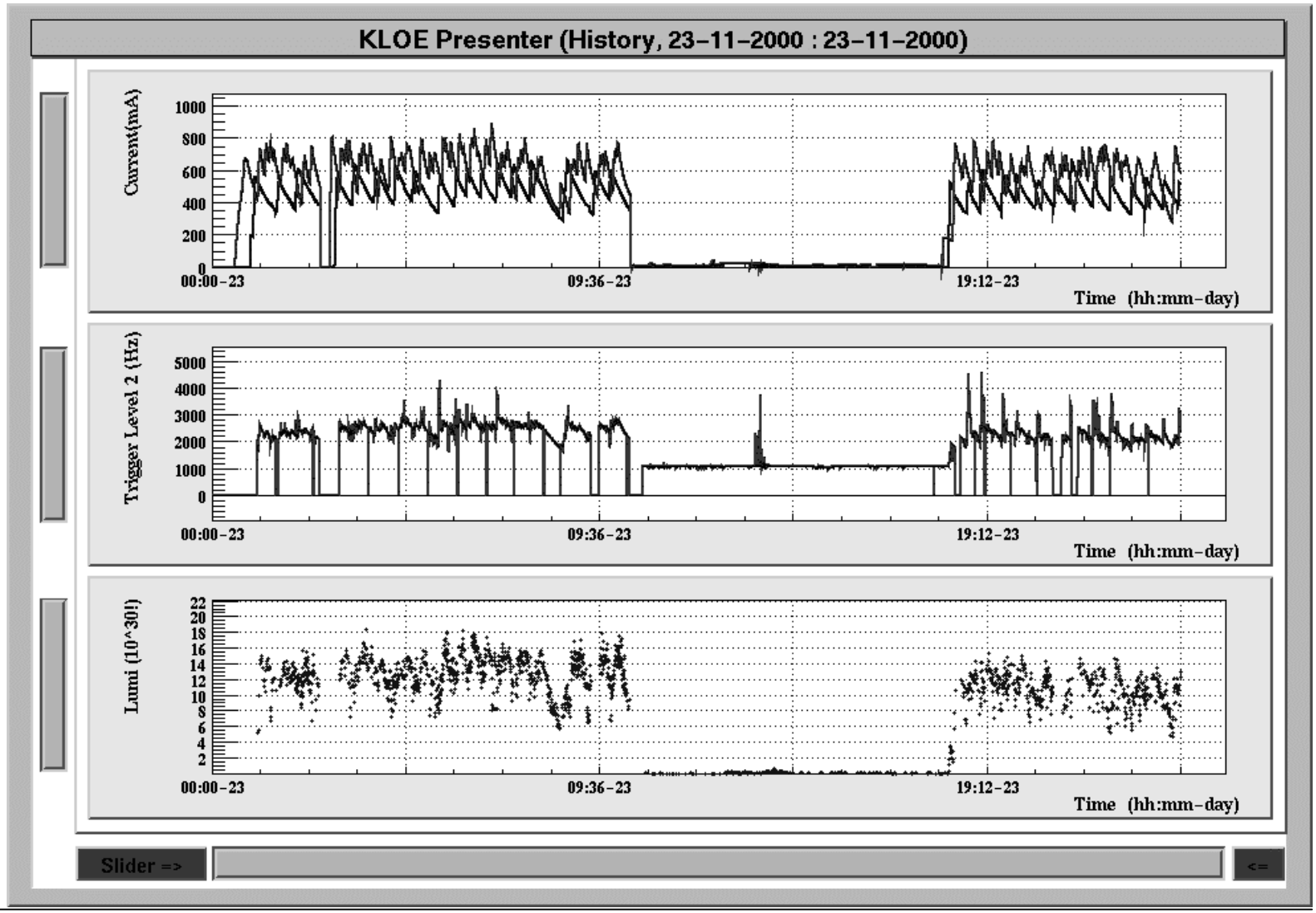
Data sample:

e^+e^-	153,190,100
K^+K^-	24,669,090
$K_s \to \pi^+\pi^-$	12,595,700
$\pi^+\pi^-\pi^o$	7,139,566
$K_s \to \pi^o\pi^o$	4,719,275
$\eta \to \gamma\gamma$	235,215

A good day in Y2K ($\int Ldt = 800 nb^{-1}$)



A "standard " day operation conditions



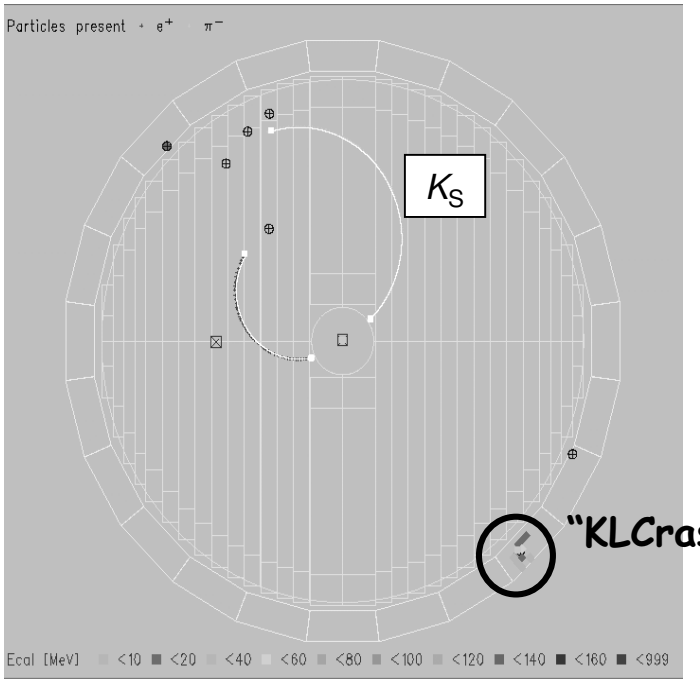
Preliminary analysis on Kaon physics

- ✓ $BR(K_S \to \pi^+\pi^-)/BR(K_S \to \pi^o\pi^o)$
- ✓ K_S semileptonic decays
- ✓ Regeneration cross section
- ✓ ~~CP~~ $K_L \to \pi^+\pi^-$ and $K_L \to \pi^o\pi^o$ decays

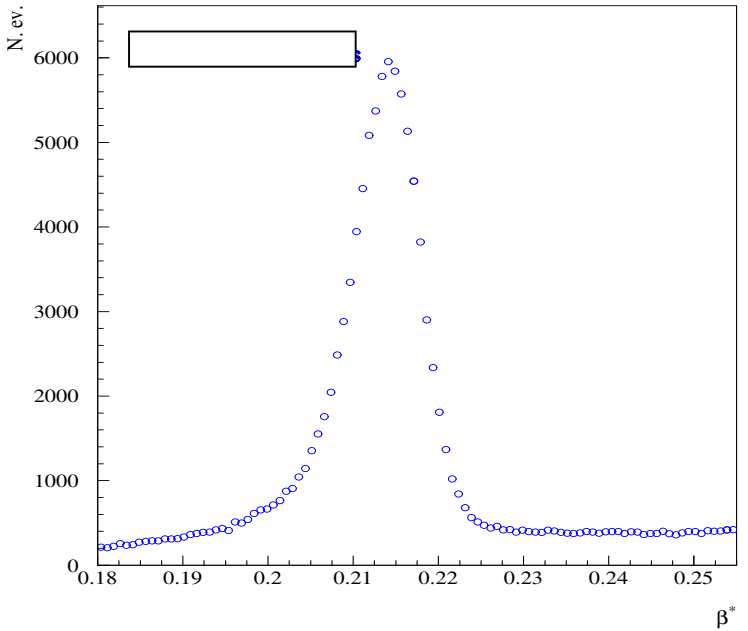
All the following results were obtained with ~5 pb^{-1} (out of 20 pb^{-1} collected)

Ks tagging by KLcrash

Clean Ks selection by time of flight of K_L interacting in calorimeter



$\delta\beta$ = *0.004 (compatible with machine energy spread)*



β^* distribution

$E_{cl} \geq 100$ MeV
$|\cos(\theta_{cl})| \leq 0.7$
$\beta^* = [0.195, 0.245]$

B(Ks->$\pi^+\pi^-$)/B(Ks->$\pi^0\pi^0$)

Important for ε'/ε measurement

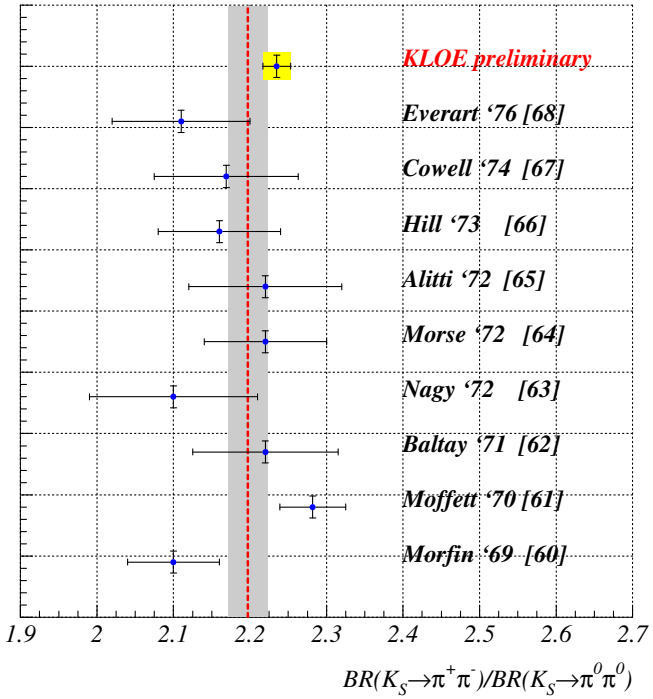
- Tag by Klcrash

- efficiencies from data

First result on:

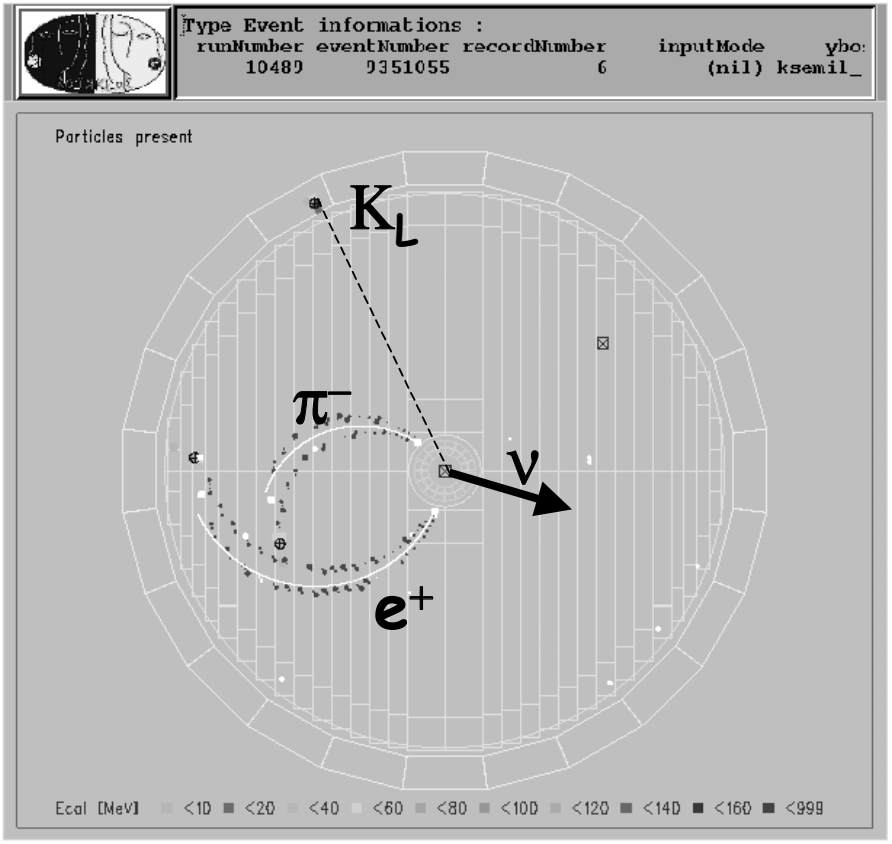
$$\frac{BR(K_S \to \pi^+\pi^-)}{BR(K_S \to \pi^0\pi^0)} = 2.237 \pm 0.009 \pm 0.016$$

(PDG mean value 2.197 ± 0.026)



Most of systematics from data
(dominated by reco. efficiency uncertainties)

K_s Semileptonic Decays



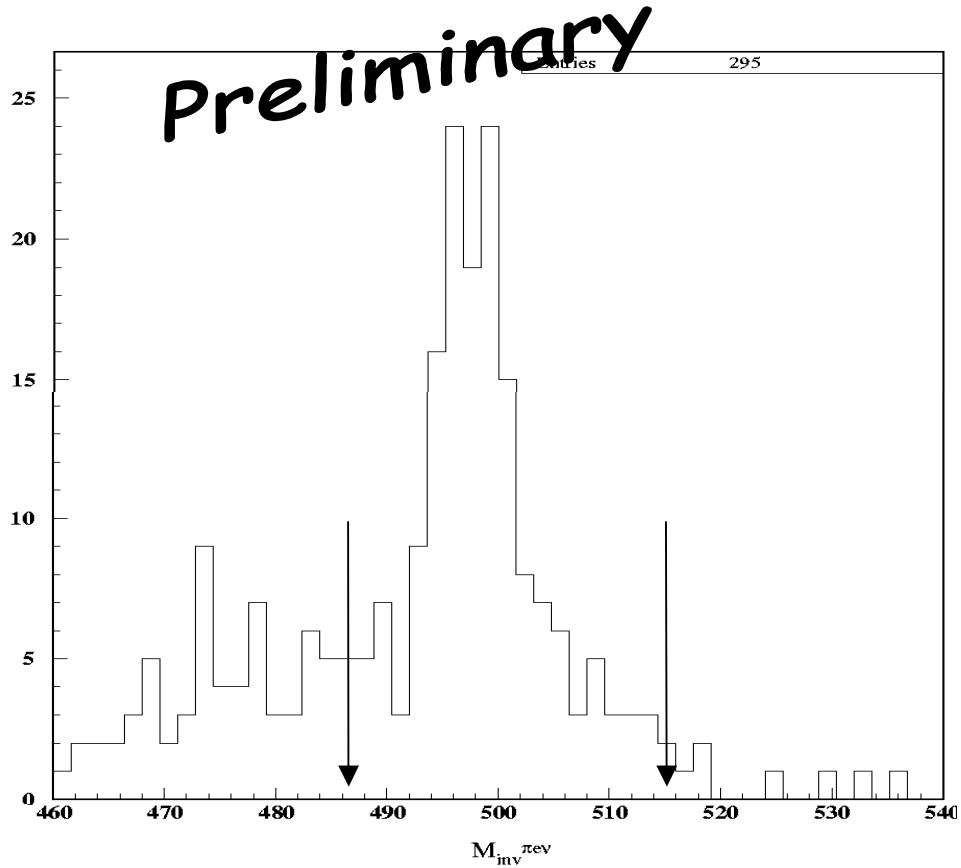
Only one existing measurement done at VePP-2M (75 events) :
BR ($K_S \rightarrow \pi e \nu$) = (7.2 ± 1.4)x$10^{-4}$

800 events are expected in 25 pb^{-1} (δBR_{stat} ~3.5%)

Ks tagged by KLcrash

In KLOE, with **5 pb^{-1}**, we expect 125 ev. semileptonic Ks decays and 33 ev. of background (global efficiency ~6% mainly due to KLCRASH and to geometrical acceptance)

-165 events found on data

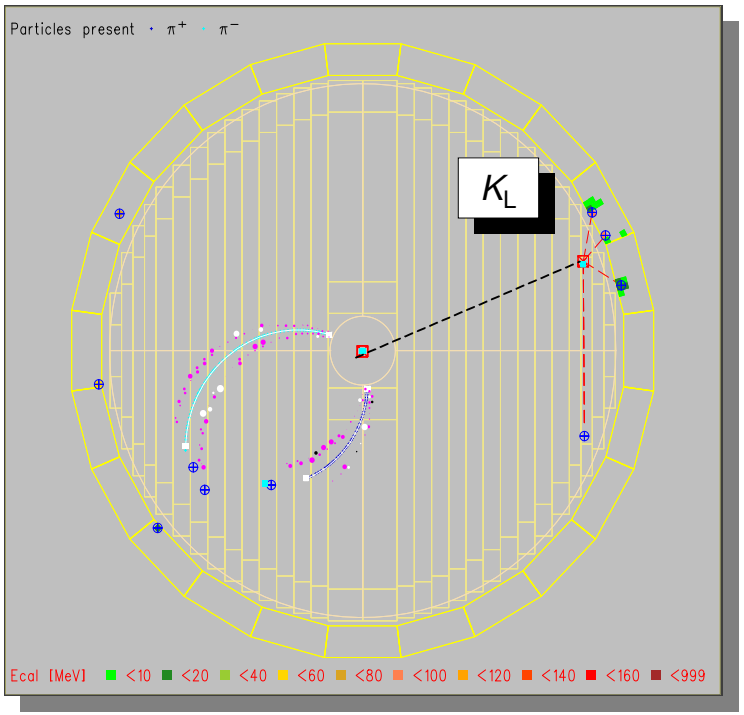


Invariant mass of πeν events (MeV/c^2)

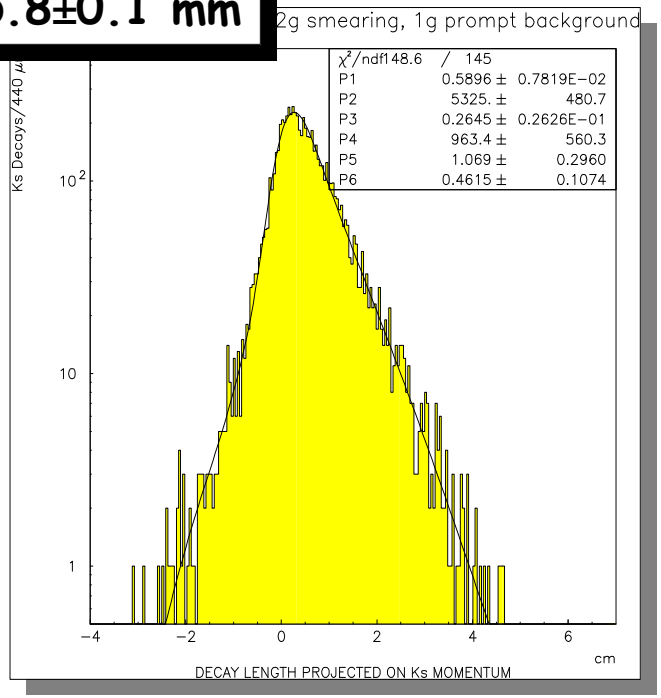
K_L - Tag by $K_S \to \pi^+\pi^-$

Selection K_S:

- charged vertex
- $r < 5$ cm from I.P.
- $50 < P < 170$ MeV/c
- $400 < M < 600$ MeV/c^2



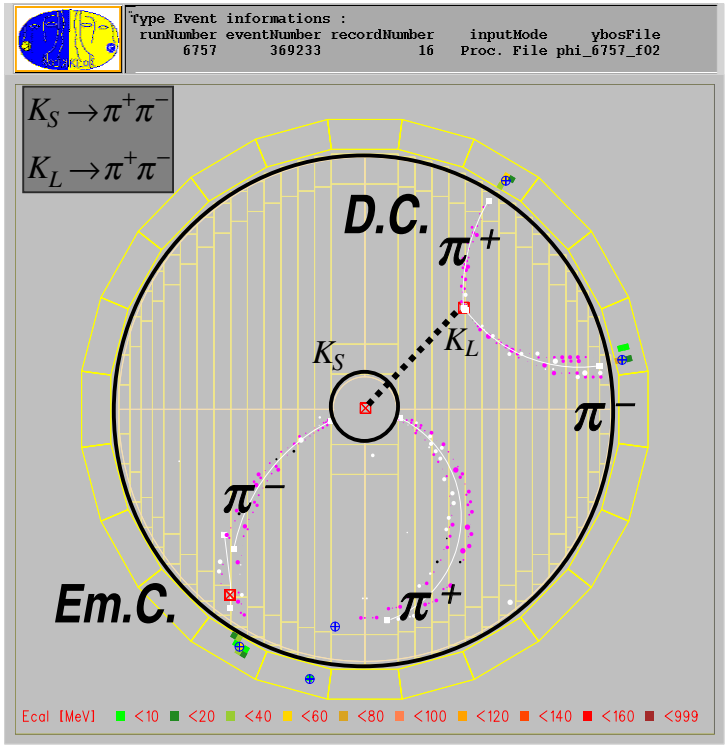
λ_S = 5.8±0.1 mm



$K_L \to \pi^+\pi^-$

CP violating events are there

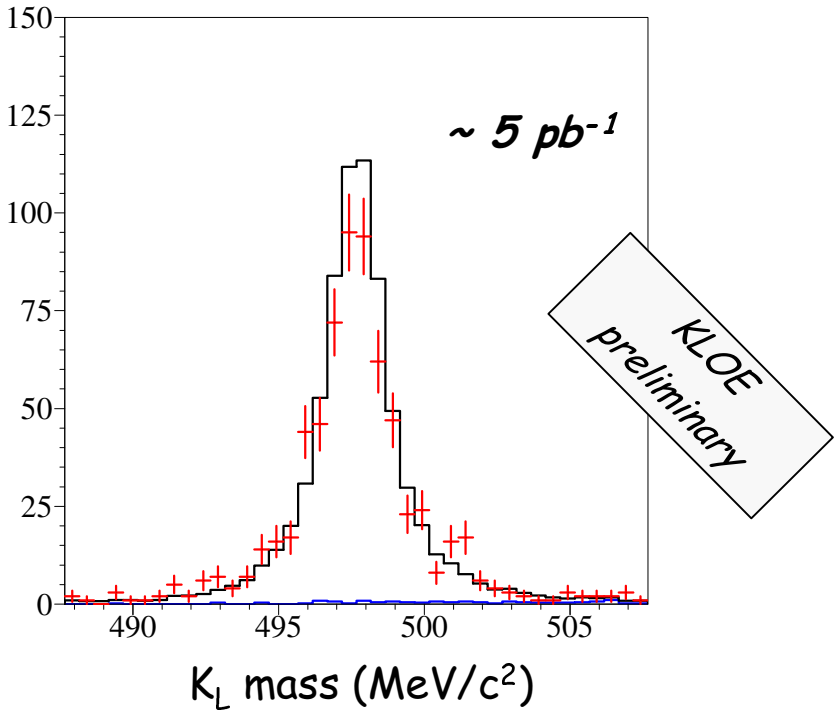
Use $K_S \to \pi^+\pi^-$ for K_L tagging



Simple kinematics fit to reject Kμ3 background

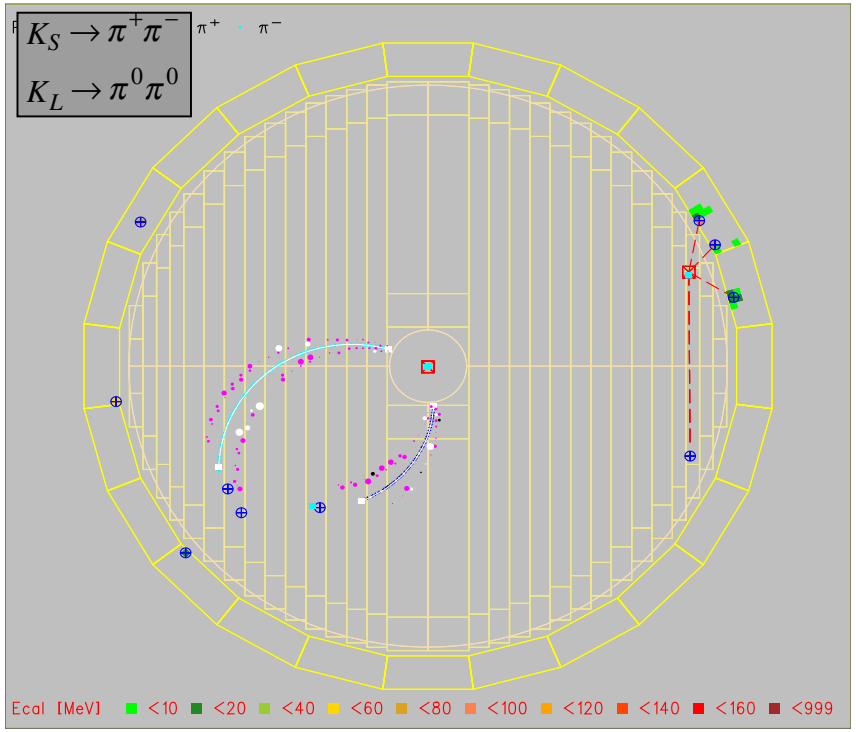
prelim. eff.: 56% purity = 98%

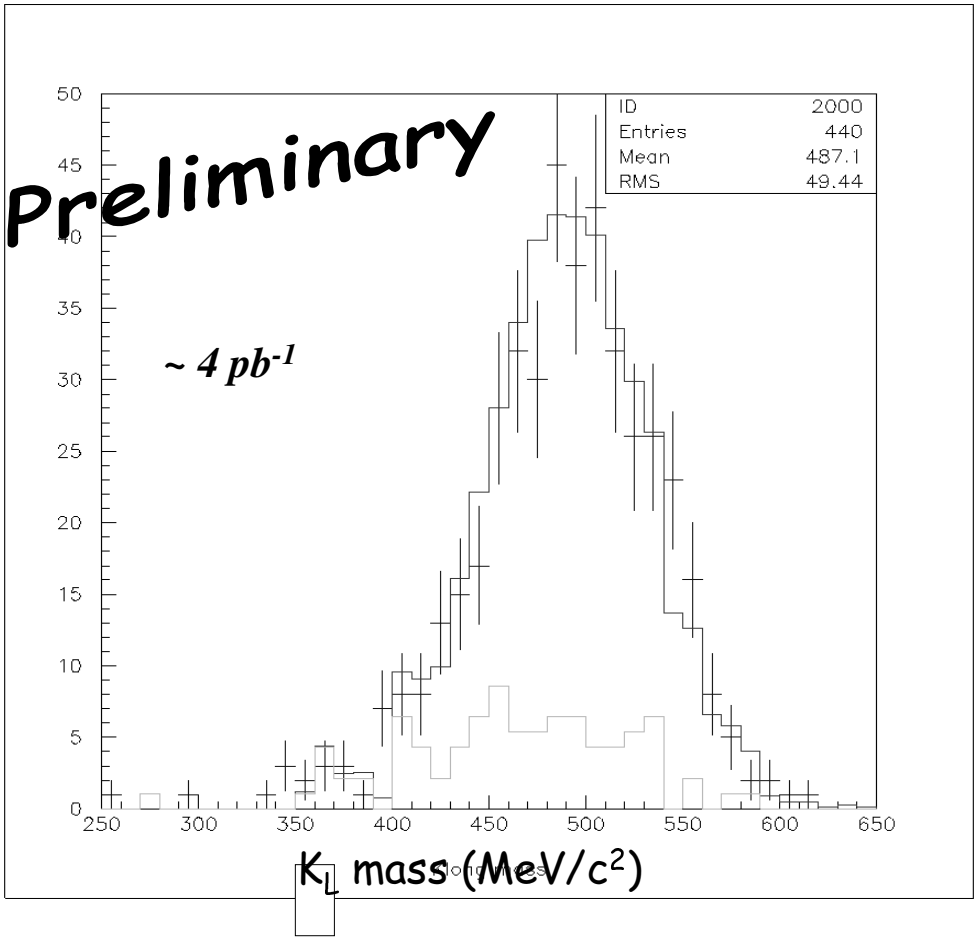
rejection factor 40,000



$K_L \to \pi^0\pi^0$

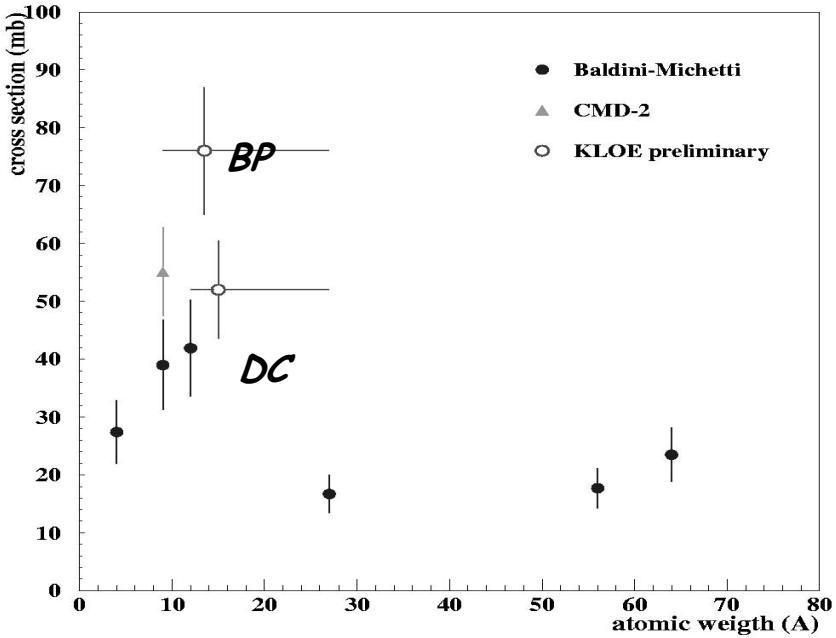
Kinematics + time informations
to suppress K_L-$3\pi^0$
prel. eff.: ~43 %
rejection power ~3500



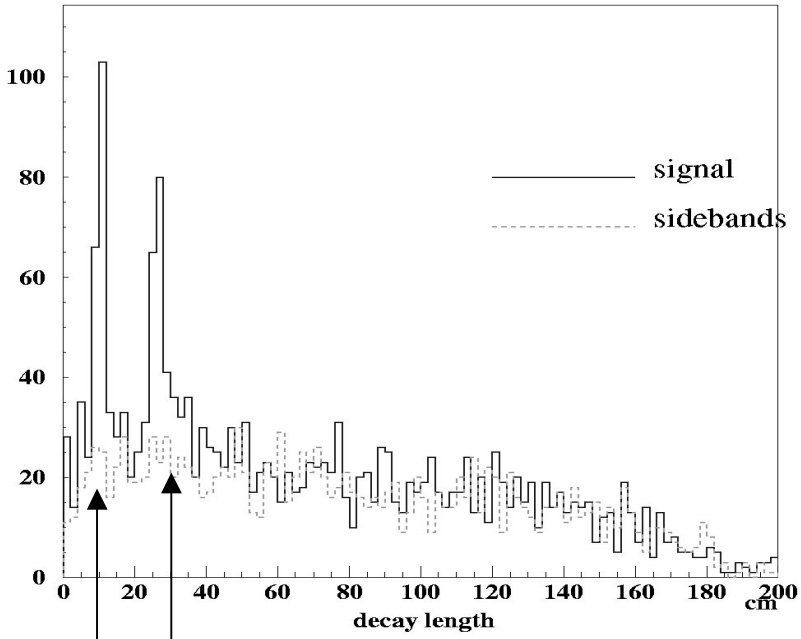


K_L Regeneration

➪ Incoherent regeneration expected (*elastic*) due to *K* momenta and small regeneration volume



Decay length for selected events



DC wall 750 μm *C + 250*μm Al

Beam pipe *500* μm *61%*Be + Al

$(\sigma_{reg})^{bp}$ = 75.7 ± 9.6 ± 10.6 mb

$(\sigma_{reg})^{dc}$ = 51.9 ± 6.2 ± 5.3 mb

ϕ Radiative Decays

Important test for CHPT

⇨ **Pseudoscalar Sector: Extract η - η' mixing angle**

$\eta(547)$, $\eta'(958)$

⇨ **Scalar Sector:**

$f_0(980)$, $a_0(980)$

Unclear nature of scalars ***(qq, qqqq, KK,..)***

BR $(\phi \to f_0 \gamma)$ **and** ***BR*** $(\phi \to a_0 \gamma)$ **are sensitive to the structure of the** f_0 **and** a_0

$\phi \to f_0 \gamma$ **with** $f_0 \to \pi^+\pi^-$

$f_0 \to \pi^0\pi^0$

$\phi \to a_0 \gamma$ **with** $a_0 \to \eta\pi^0 \Rightarrow \phi \to 5\gamma$

Novosibirsk **(CMD-2, SND) BR's** $\approx 10^{-4}$

Pseudoscalars: $\phi \to \eta\,\gamma\,,\ \eta'\gamma$

$$\begin{pmatrix}\eta\\ \eta'\end{pmatrix}=\begin{pmatrix}\cos\vartheta_p & -\sin\vartheta_p\\ \sin\vartheta_p & \cos\vartheta_p\end{pmatrix}\begin{pmatrix}\eta_8\\ \eta_0\end{pmatrix}$$

Extract mixing angle from

$$R_\phi = \frac{BR(\phi \to \eta'\gamma)}{BR(\phi \to \eta\,\gamma)}$$

Charged/neutral mode:

$\phi \to \eta\,\gamma \to\ \pi^+\pi^-\pi^0\gamma \to\ \pi^+\pi^-\,3\,\gamma$
$\approx 3 \cdot 10^{-3}$

$\phi \to \eta'\gamma \to\ \pi^+\pi^-\eta\,\gamma \to\ \pi^+\pi^-\,3\,\gamma$
$\approx 2 \cdot 10^{-5}$

Fully neutral mode:

$\phi \to \eta\,\gamma \to\ \pi^0\pi^0\pi^0\gamma \to\ 7\,\gamma$
$\approx 4 \cdot 10^{-3}$

$\phi \to \eta'\gamma \to\ \pi^0\pi^0\eta\,\gamma \to\ 7\,\gamma$
$\approx 1 \cdot 10^{-5}$

➪ **η' results ('99 data):**

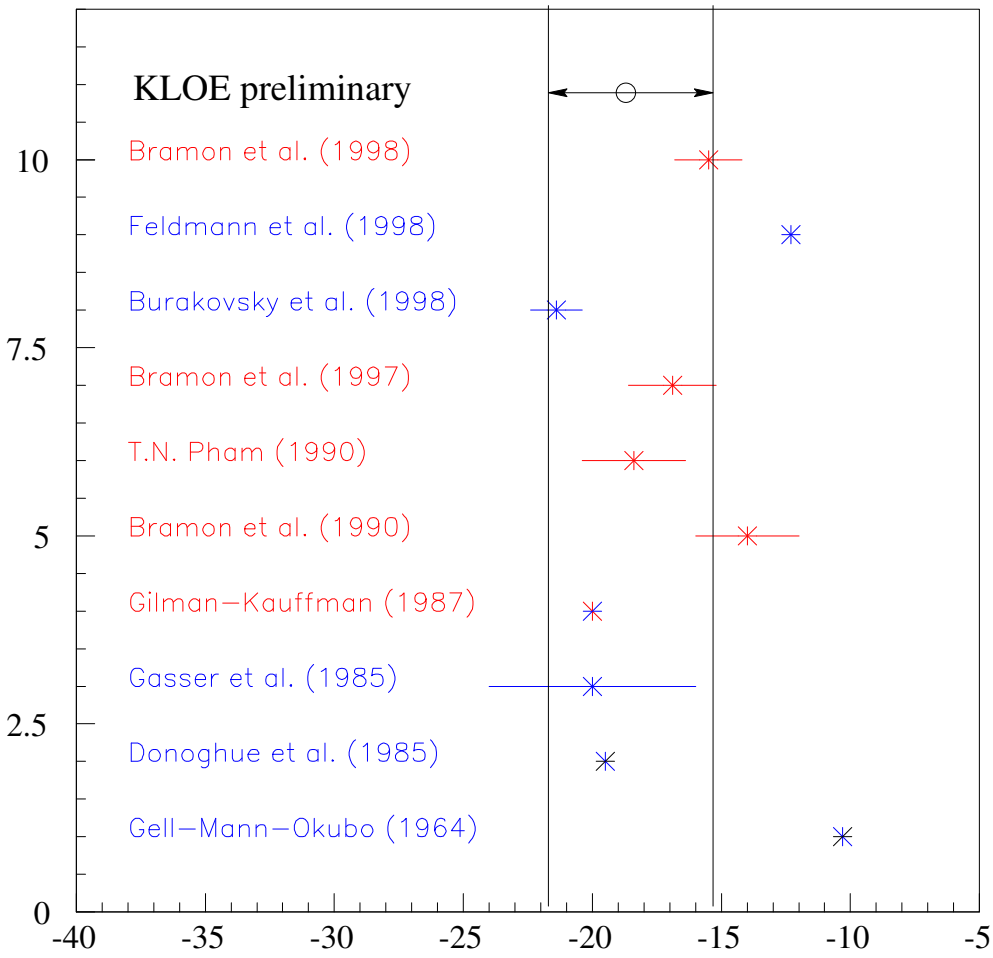
21 events selected by
ch./ne. analysis (b<0.4,eff~19%)

$$B(\Phi \to \eta'\gamma) = (8.9 \pm 2.0 \pm 0.6) \cdot 10^{-5}$$
$$(6.7 \pm 3.5) \cdot 10^{-5} \text{ (PDG)}$$

6 events selected by
ne. analysis (b<0.3,eff~10%)

➪ **combining the 2 channels:**

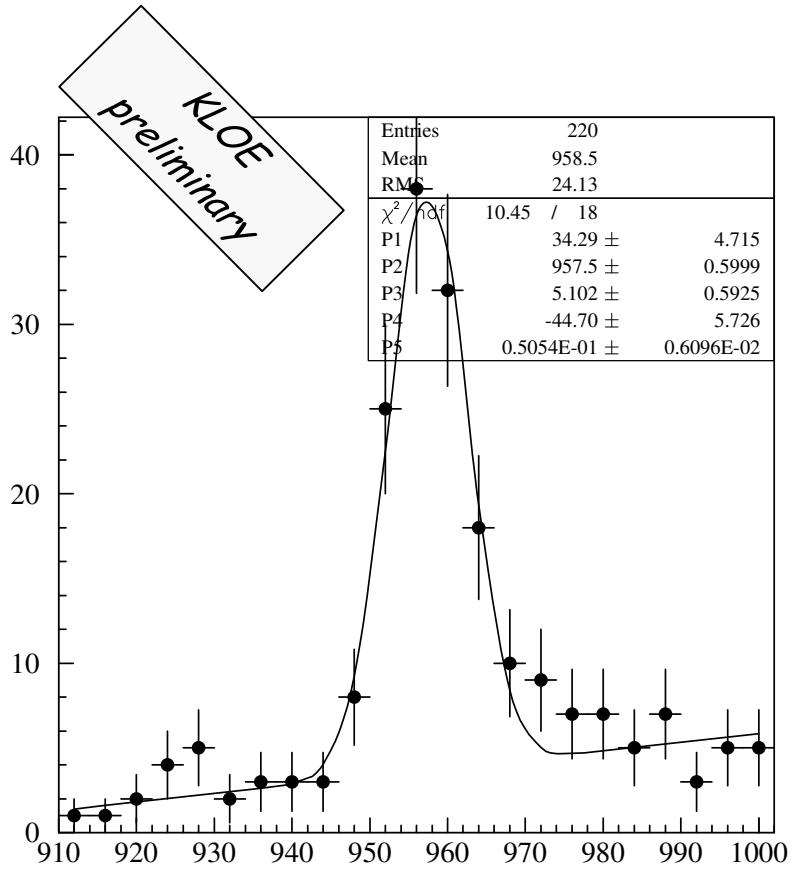
$$\vartheta_P = (-18.9^{+3.6}_{-2.8} \pm 0.6)^\circ$$



⇨ **10 times data in '00**

~16 pb-1 analysed for
ch./ne. channel
208 candidates
⇨
68 ± 10 background form sid.
150 ± 20 expected signal

new channel under study
$\gamma\eta' \to \pi^+\pi^- 7\gamma$
favourable S/B
223 events selected in '00
22 ± 7 background sidebands
196 ± 20 expected signal



Etaprime inv. mass (fit no m. c.)

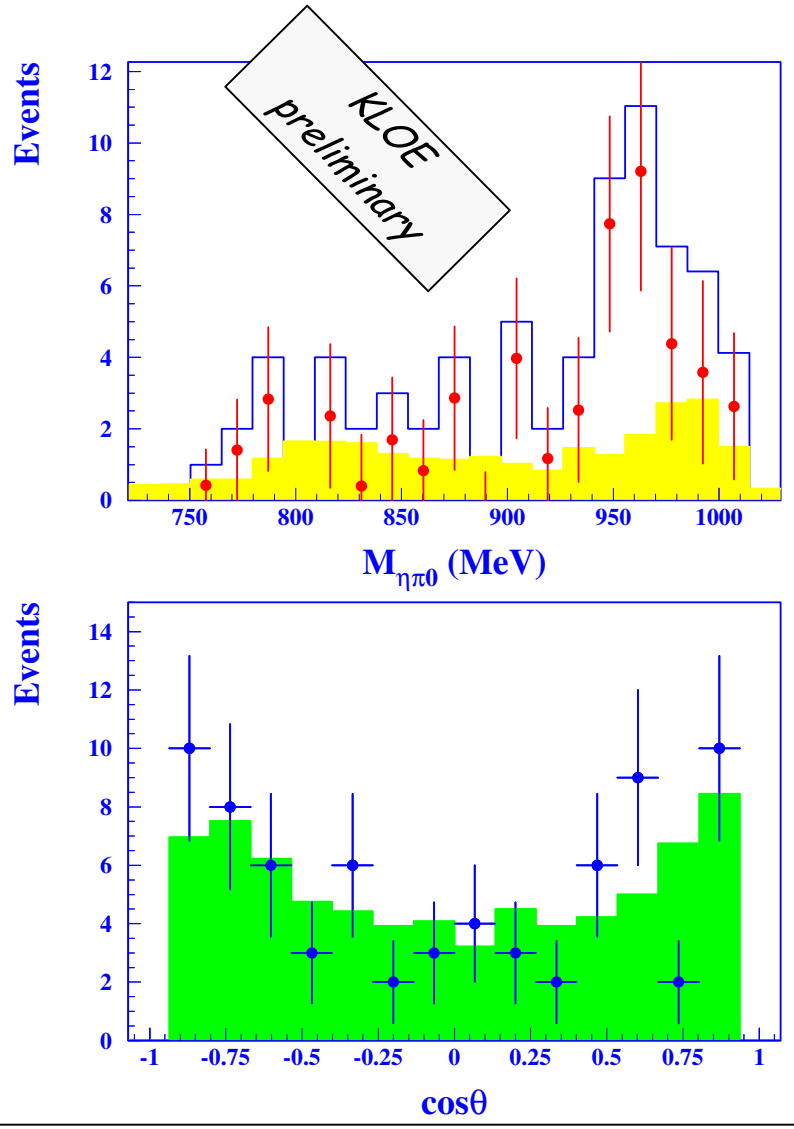
$$\phi \rightarrow a_0 \gamma \rightarrow \eta \pi^0 \gamma \rightarrow 5\gamma$$

Background:

$\phi \rightarrow \rho \pi^0 \rightarrow \eta \pi^0 \gamma$ (S/B = 7)
$e^+ e^- \rightarrow \omega \pi^0 \rightarrow \eta \pi^0 \gamma$ (S/B = 20)
$\phi \rightarrow \pi^0 \pi^0 \gamma$ (S/B = 0.1)
$\phi \rightarrow \eta \gamma \rightarrow \pi^0 \pi^0 \gamma$

Result: $N_{obs} = 74$
$N_{bkg} = 21 \pm 6$, eff~23%

$BR(\phi \rightarrow a_0\gamma \rightarrow \eta\pi^0\gamma) =$
$(0.77 \pm 0.15 \pm 0.10) \cdot 10^{-4}$



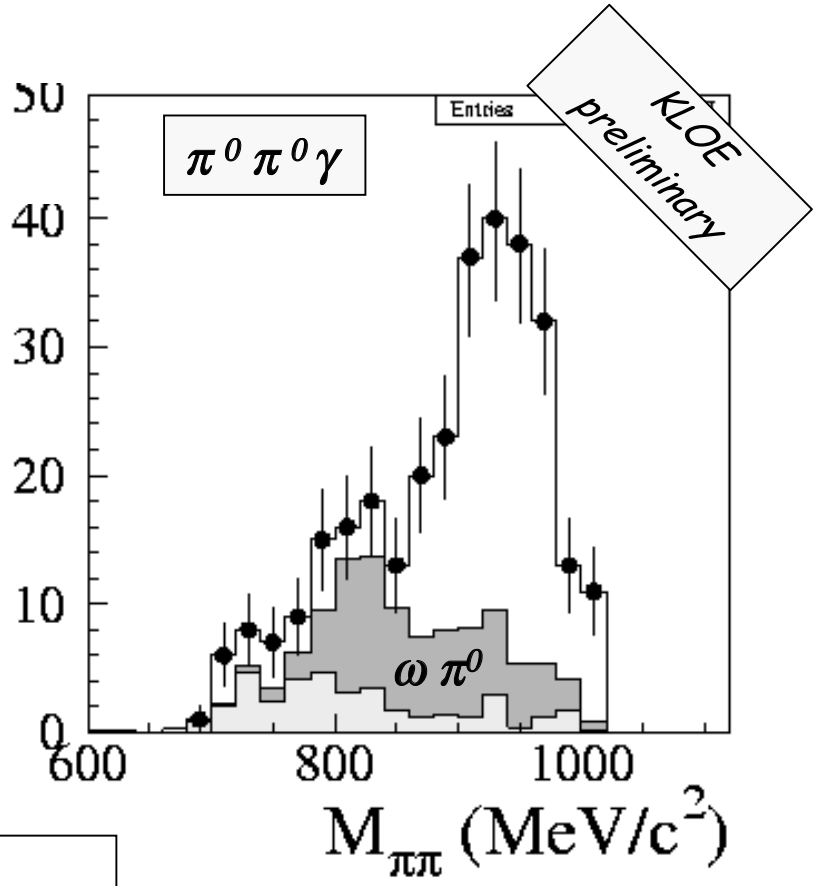
Radiative Decays : $\phi \rightarrow f_0 \gamma \rightarrow \pi^0 \pi^0 \gamma$

Main Background:

$\phi \rightarrow \rho \pi^0 \rightarrow \pi^0 \pi^0 \gamma$ (S/B = 3.0)
$e^+ e^- \rightarrow \omega \pi^0 \rightarrow \pi^0 \pi^0 \gamma$ (S/B = 0.5)
$\phi \rightarrow \eta \gamma \rightarrow \pi^0 \pi^0 \gamma$ (S/B =0.02)

Result: *307* **Events in data**
114 **± 9 exp. background**

$BR(\phi \rightarrow f_0 \gamma \rightarrow \pi^0 \pi^0 \gamma) =$
$(0.80 \pm 0.10 \pm 0.08) \cdot 10^{-4}$



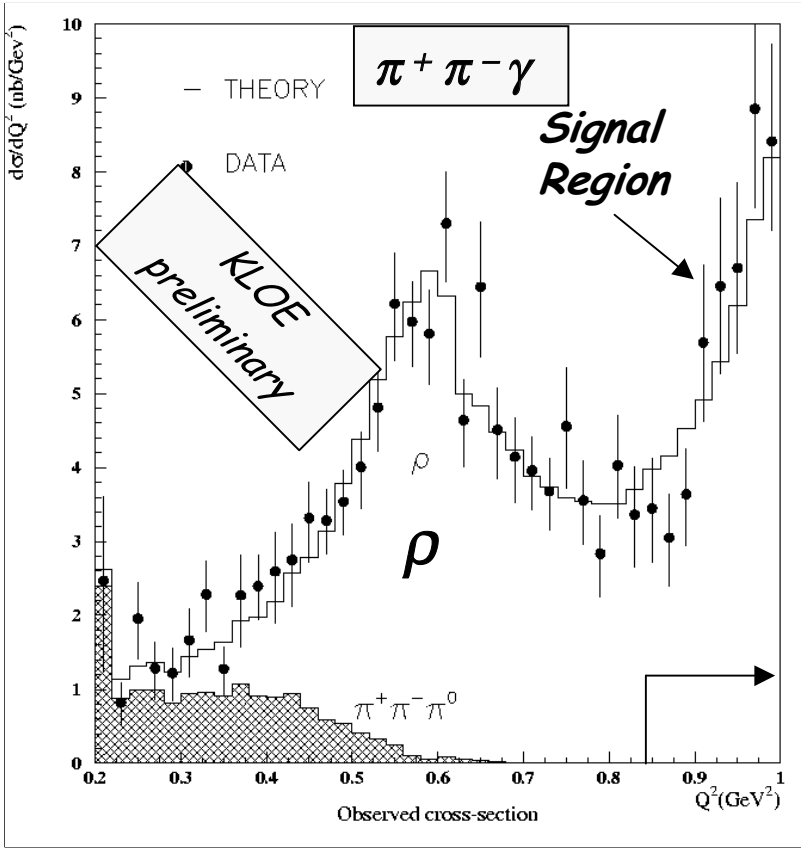
Important check for fo analysis
$\sigma(e+e- \rightarrow \phi \rightarrow \omega\pi^0 \rightarrow \pi^0 \pi^0 \gamma) =$
(0.65 ± 0.04 ± 0.06) nb

Radiative Decays : $\phi \rightarrow f_0 \gamma \rightarrow \pi^+\pi^-\gamma$

Irreducible background from non resonant production $e^+e^- \rightarrow \pi^+\pi^-\gamma$

low Q^2 ($\pi\pi$) region -> non resonant production

High Q^2 ($\pi\pi$) region sensitive to *fo* signal



Result: ***2003* Events**
***1968* expected from non r.p.**

BR($\phi \rightarrow f_0 \gamma \rightarrow \pi^+\pi^-\gamma$) < 1.6 $\cdot 10^{-4}$ @ 90% C.L.
assuming no interference with FSR

ϕ Radiative Decays result summary

$\sigma(e^+ e^- \to \phi)$ via $\phi \to \eta\gamma$

KLOE : $(3.19 \pm 0.02 \pm 0.26) \mu b$

CMD-2 : $(3.114 \pm 0.034 \pm 0.048) \mu b$

$\sigma(e^+ e^- \to \omega\pi^0 \to \pi^0 \pi^0 \gamma)$

KLOE : $(0.67 \pm 0.04 \pm 0.05)$ nb

SND : (0.64 ± 0.08) nb

BR $(\phi \to f_0 \gamma \to \pi^+\pi^-\gamma)$

KLOE : $< 1.6 \cdot 10^{-4}$ @ 90% C.L.

CMD-2 : $(1.93 \pm 0.68) \cdot 10^{-4}$

BR $(\phi \to f_0 \gamma \to \pi^0\pi^0\gamma)$

KLOE : $(0.81 \pm 0.09 \pm 0.06) \cdot 10^{-4}$

SND: $(1.14 \pm 0.10 \pm 0.12) \cdot 10^{-4}$

CMD-2 : $(1.06 \pm 0.09 \pm 0.06) \cdot 10^{-4}$

BR $(\phi \to a_0 \gamma \to \eta\pi^0\gamma \to 5\gamma)$

KLOE : $(0.77 \pm 0.15 \pm 0.10) \cdot 10^{-4}$

SND: $(0.89 \pm 0.14 \pm 0.06) \cdot 10^{-4}$

CMD-2 : $(0.83 \pm 0.23) \cdot 10^{-4}$

$$\phi \rightarrow \pi^+ \pi^- \pi^0$$

~0.3M events

KLOE preliminary

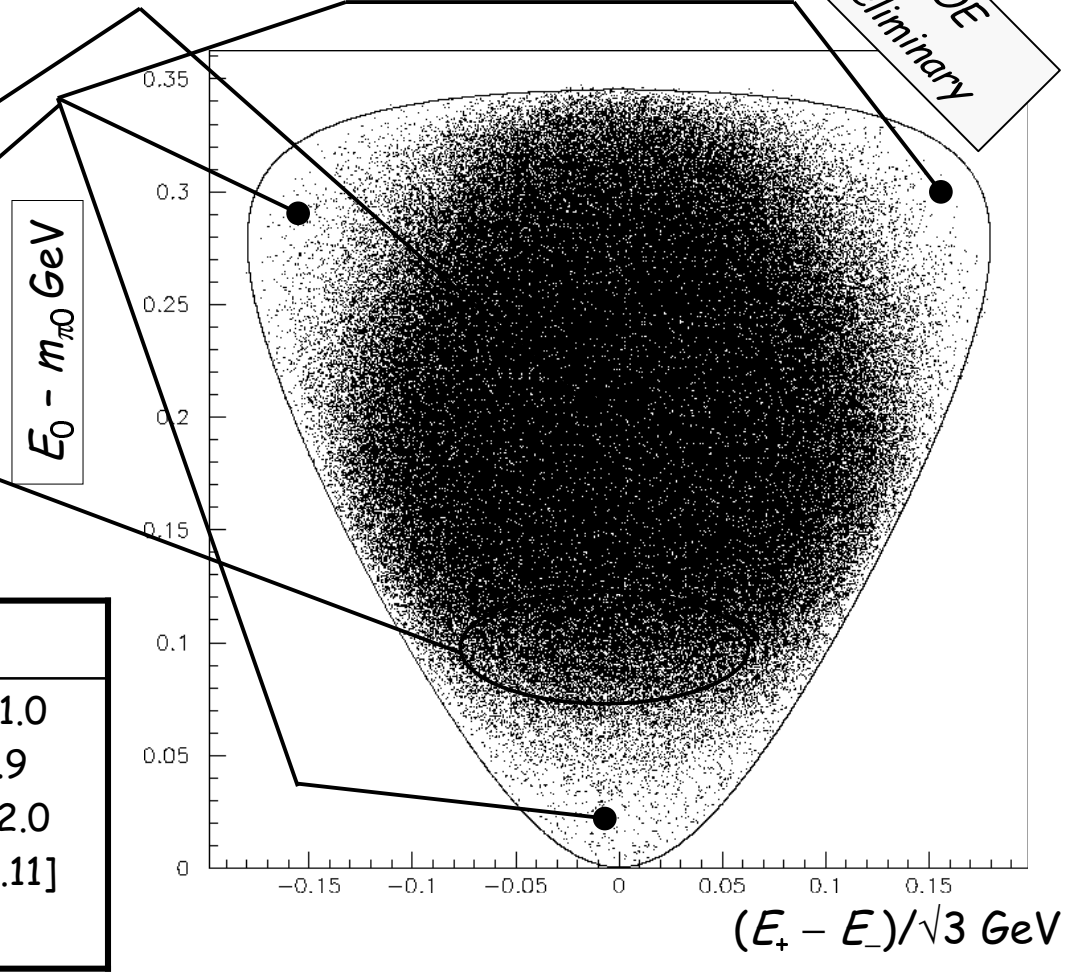
3 contributions to Dalitz plot

$\phi \rightarrow \rho^{\pm,0} \pi^{0,\pm}$

$\phi \rightarrow \pi^+\pi^-\pi^0$ (direct)

$e^+e^- \rightarrow \omega\pi^0$

Amplitudes of $\rho\pi$ and direct terms not well established



Parameter	Fit	PDG
$M\rho$ (MeV/c^2)	776.1 ± 1.0	776.1 ± 1.0
ΔM (MeV/c^2)	-0.5 ± 0.7	0.1 ± 0.9
$\Gamma\rho$(MeV/c^2)	-145.6 ± 2.2	150.9 ± 2.0
Adir./A ($\rho\pi$)	0.10 ± 0.01	[-0.15, 0.11]
Φdir.-$\Phi(\rho\pi)$	(114 ± 12)°	

Measurement of σ_{hadr}

⇨ Anomalous magnetic moment of the muon:

Prediction:

a_μ^{QED} = (11 658 470.6 ± 0.3) × 10^{-10}
a_μ^{hadr} = (673.9 ± 11/6.7*) × 10^{-10}
a_μ^{weak} = (15.1 ± 0.4) × 10^{-10}

hadronic vacuum polarization is not calculable using pQCD;
contribution determined from $\sigma(e^+e^- \to hadrons)$ for $\sqrt{s} < 5$ GeV by dispersion integral
low energy data enhanced $\sim 1/s^2$

Currently:

a_μ^{theor} = (11 659 159.6 ± 11/6.7*) × 10^{-10} * Including data from τ

a_μ^{exp} = (11 659 202.0 ± 14 ±6)∗10^{-10} **E821 (BNL) 2001**
Goal is 4 ∗10^{-10} total error

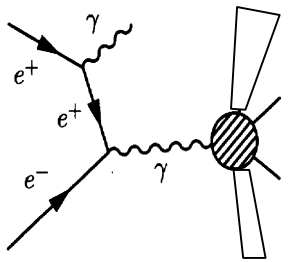
$a_\mu^{exp} - a_\mu^{theor}$ = (43± 16) ∗10^{-10}

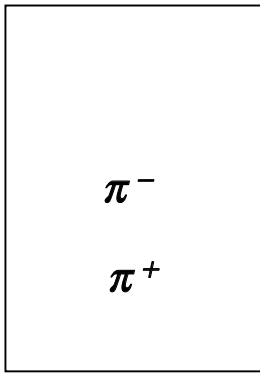
2-2.6* effect!

✓The standard way to measure $\sigma(e^+e^- \rightarrow hadrons, Q^2_{hadr})$ is to perform an energy scan (recently done at Novosibirsk):

✓At DAFNE an energy scan is not possible at short hand
but using ISR events KLOE can measure

$$ds\ (e^+e^- \rightarrow \pi^+\pi^-) \quad by \quad \frac{d\sigma}{dQ^2}\ (e^+e^- \rightarrow \pi^+\pi^-\gamma)$$



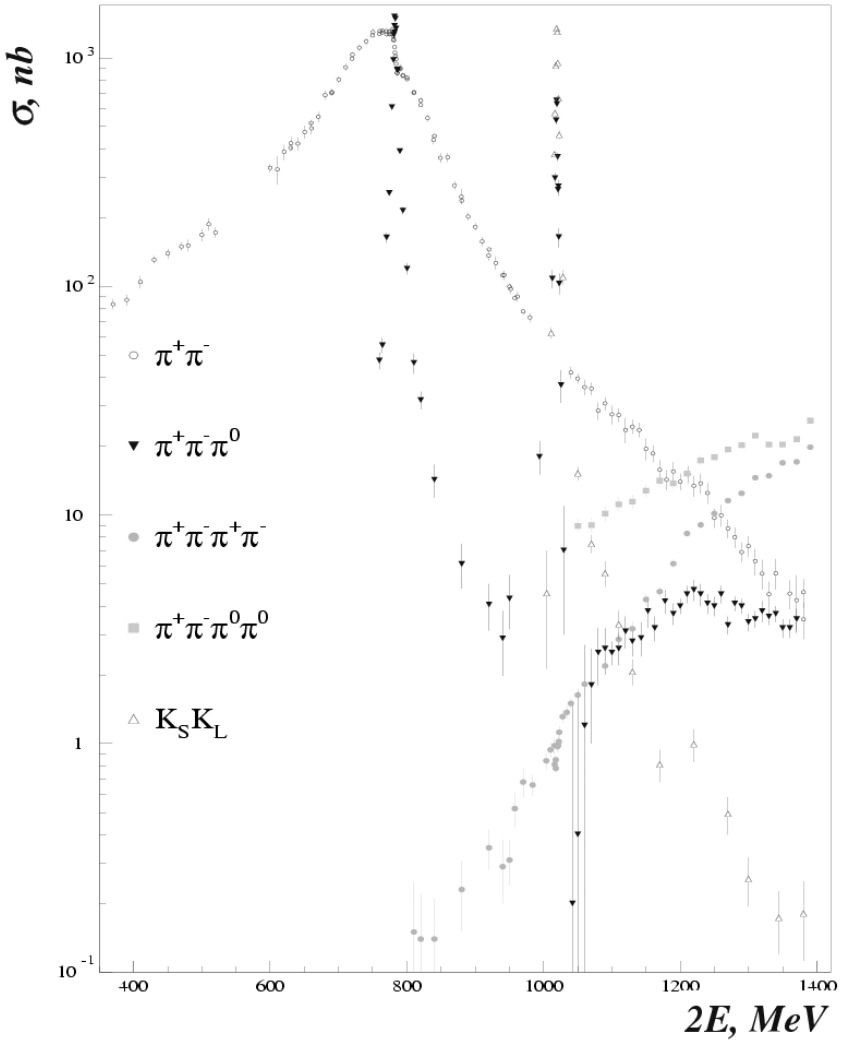


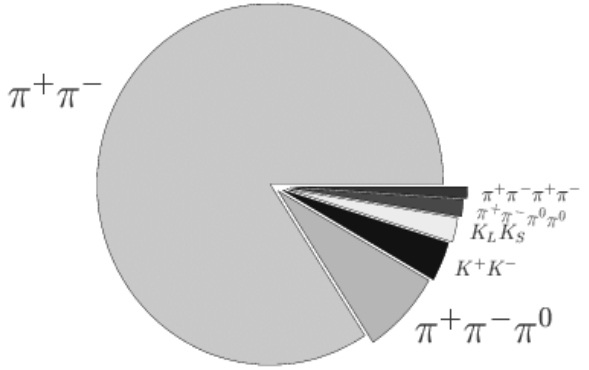
➢KLOE covers the region $4m^2_\pi < Q^2 < M_\phi{}^2$

Very important: about 70% of σ_μ^{had} is due to the ρ meson region ($\sqrt{s}$ < 1GeV)

✓***Statistical error on δa_μ^{rho} of 3×10^{-10} with 20pb^{-1}***

Recent measurement at Novosibirsk – CMD-2





channel	contribution to a_μ, ppm	measurements precision, %	conribution to error of a_μ, ppm
$\pi^+\pi^-$	43.19	0.6	0.26
$\pi^+\pi^-\pi^0$	3.88	1.5	0.06
K^+K^-	1.81	5.2	0.09
K_LK_S	1.12	1.9	0.02
$\pi^+\pi^-\pi^0\pi^0$	0.77	7	0.05
$\pi^+\pi^-\pi^+\pi^-$	0.53	7	0.04
$\omega \to \pi^0\gamma,\ \phi \to \eta\gamma$	0.31	6	0.02
Total	51.61		0.29

claim is that with this measurement: $\delta\sigma_\mu = 3.4 \times 10^{-10}$

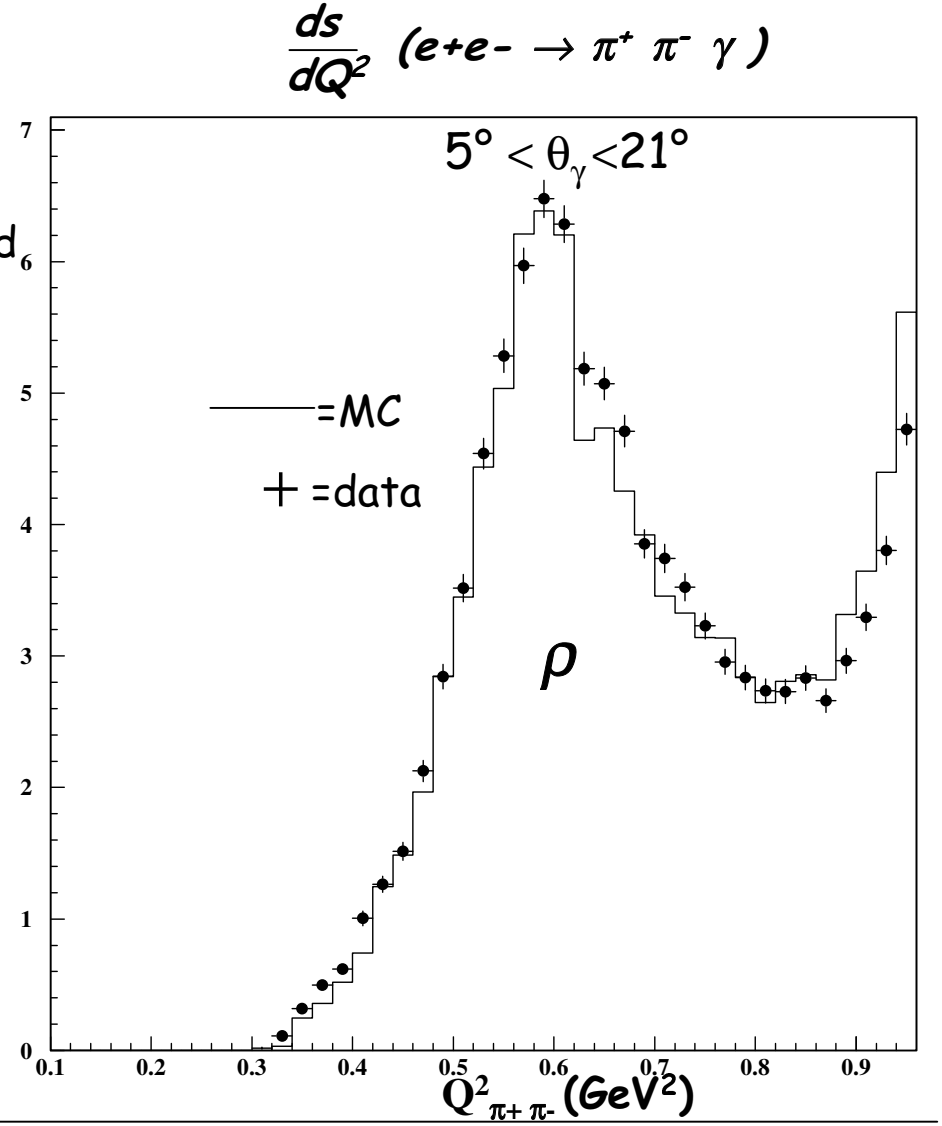
✓17 pb^{-1} has been analyzed

✓at small angles ISR contribution is enhanced with respect to FSR and resonant decay

✓FSR is a background process; can be suppressed < 1% by phase space cuts
Radiative Bhabha's by Likelihood Method

✓with 20pb^{-1} KLOE can statistically measure the hadronic cross section at the 2% level; this corresponds to $\delta a_\mu^{rho} \approx 3\times10^{-10}$

✓Complementary to energy scan since systematics (Lumin. ,Beam-Energy, …) enter only once



The DAFNE program for 2001

January – Feb.
- DAFNE maintenance (mainly cryogenics)
- Up-grade of the amplifiers for tra. feed-back
  → increase currents and N_{bunch}
- Up-grade of the beam scrapers

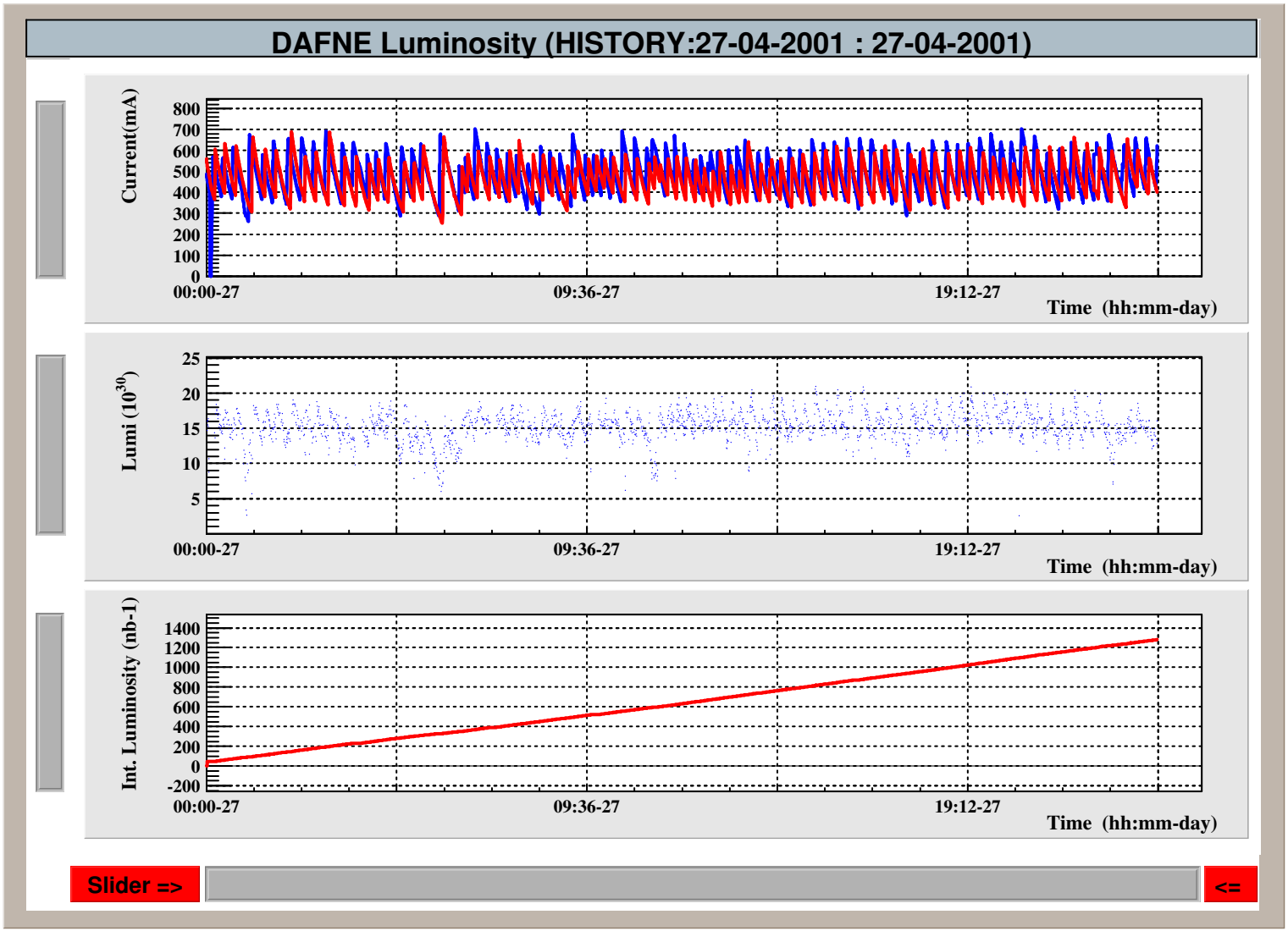
March — Machine development

April-July — Stable KLOE data taking **(April 1 pb^{-1}/day)**

August — FINUDA installation aside the I.P.

September – Dec. — Stable KLOE data taking

goal: deliver $L \sim 200\ pb^{-1}$ by the end of year 2001


DAFNE Luminosity (HISTORY:27-04-2001 : 27-04-2001)
Current(mA)
800
700
600
500
400
300
200
100
0
00:00-27
09:36-27
19:12-27
Time (hh:mm-day)
Lumi (10^{30})
25
20
15
10
5
00:00-27
09:36-27
19:12-27
Time (hh:mm-day)
Int. Luminosity (nb-1)
1400
1200
1000
800
600
400
200
0
-200
00:00-27
09:36-27
19:12-27
Time (hh:mm-day)
Slider =>
<=

Conclusions

- KLOE detector has almost reached its design values
- Analysis of 1999 Data (***2.4 pb^{-1}***) allowed first results in field of radiative ϕ - decays ; precision is comparable or better than world averages
- Analysis of 2000 Data is going on and will allow to further improve the results for hadronic physics; very preliminary results show consistency between '99 and '00 data.
- DAΦNE is increasing the Luminosity delivered
- during April 01: ***1 pb^{-1}*** */ day* from DAΦNE at acceptable background level has been achieved many times
  - to study the systematics for ε'/ε
  - to measure ε'/ε at the ***10^{-3}*** level (with > 100 pb^{-1})
  - to exploit the full physics program of KLOE