$R = K_L \to \gamma\gamma \ / \ K_L \to \pi^0 \pi^0 \pi^0$

(a brief report)

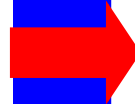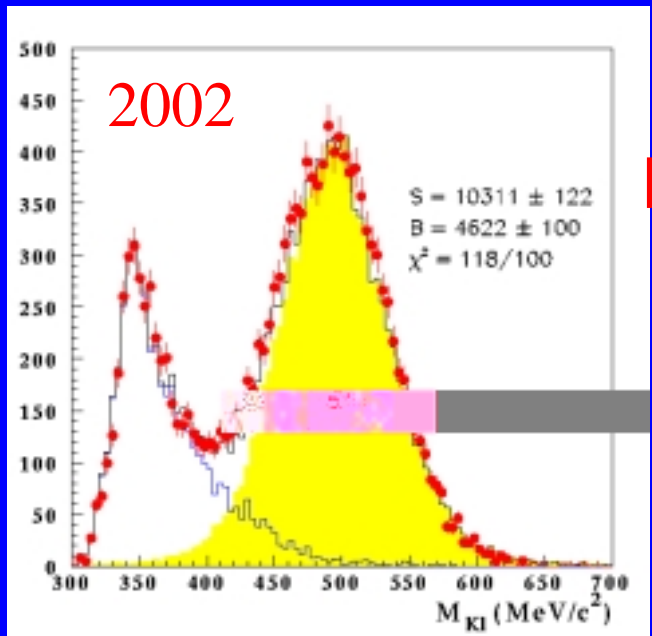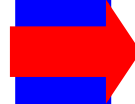G. Lanfranchi - KLOE General Meeting - Dec '02
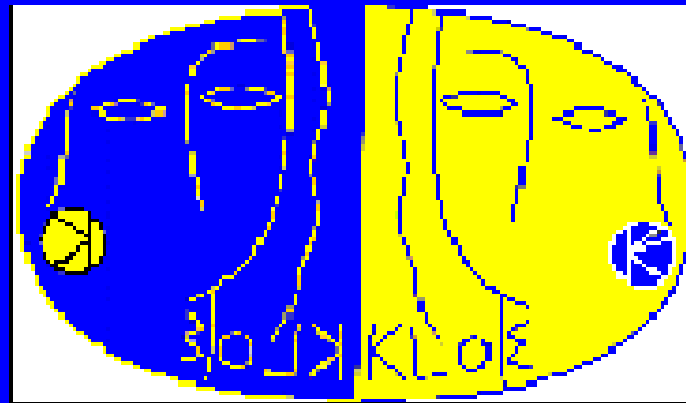
Major improvements:

- Analyzed statistics : 2001 : 142.6 pb-1
                        2002 : 169.4 pb-1
                        2001+2002: 312 pb-1   (3568 runs)

- Massive Monte Carlo production for $K_L \rightarrow \gamma\gamma$ background study:
                150 pb-1 of $Ks \rightarrow \pi+\pi-$, $K_L \rightarrow$ all

- Small refinements in the analysis cuts to improve systematic errors

The K $\to \gamma\gamma$ sample:

2001

S = 8826 ± 111
B = 3870 ± 89
χ^2 = 124/100

2002

S = 10311 ± 122
B = 4622 ± 100
χ^2 = 118/100

2001+2002

S = 19127 ± 184
B = 8503 ± 174
χ^2 = 141/100

1% stat.error

3
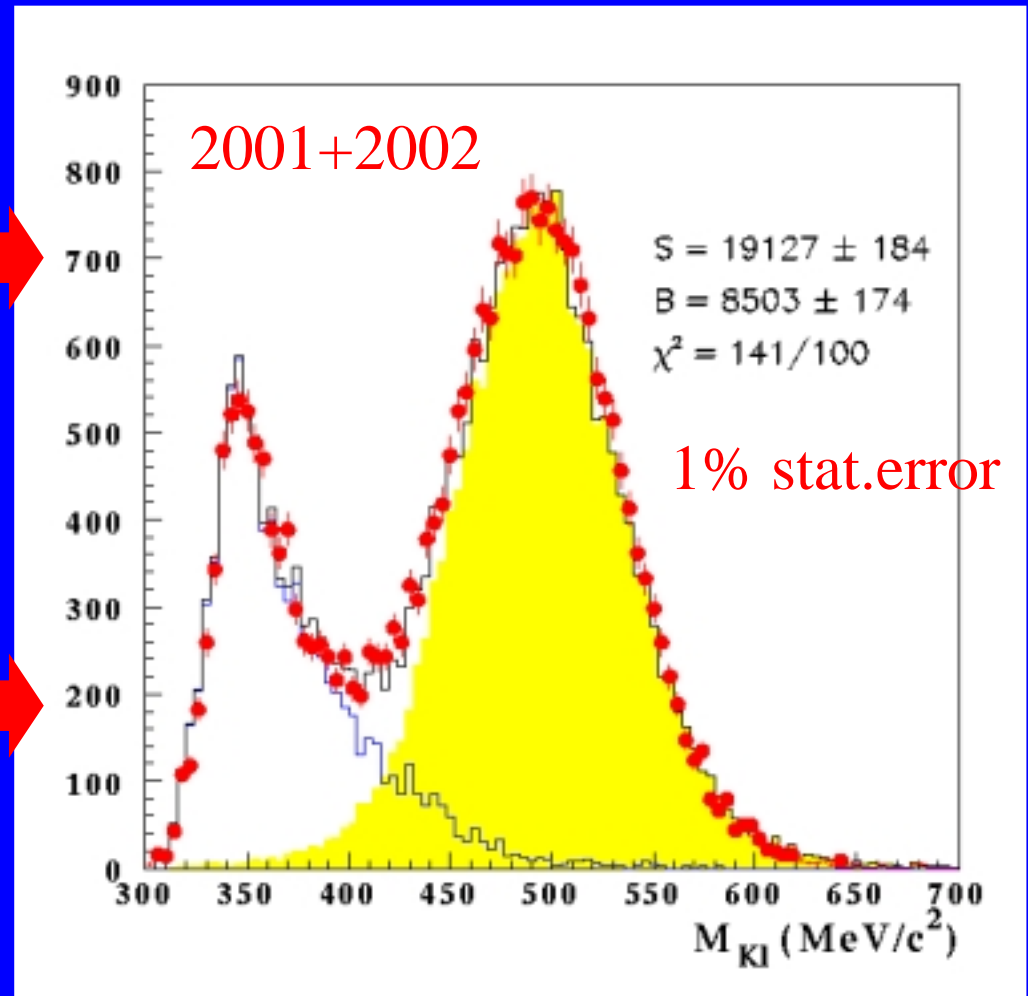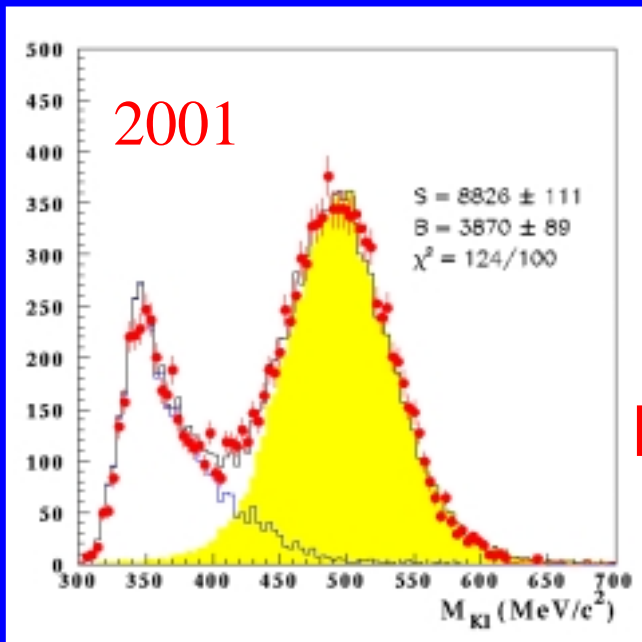
Efficiencies:

ε (trigger) = (99.6 $\pm$ 0.06 stat $\pm$ 0.1 syst)%

ε (filter) = (89.5 $\pm$ 0.1 stat $\pm$ 0.4 syst)% (93.6% acceptance)

ε (selection) = (91.1 $\pm$ 0.4 stat $\pm$ 0.5 syst)%

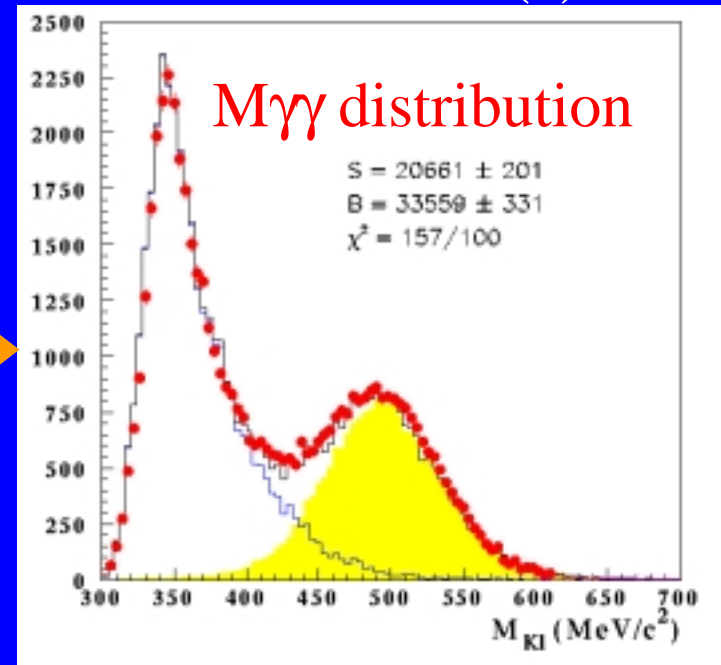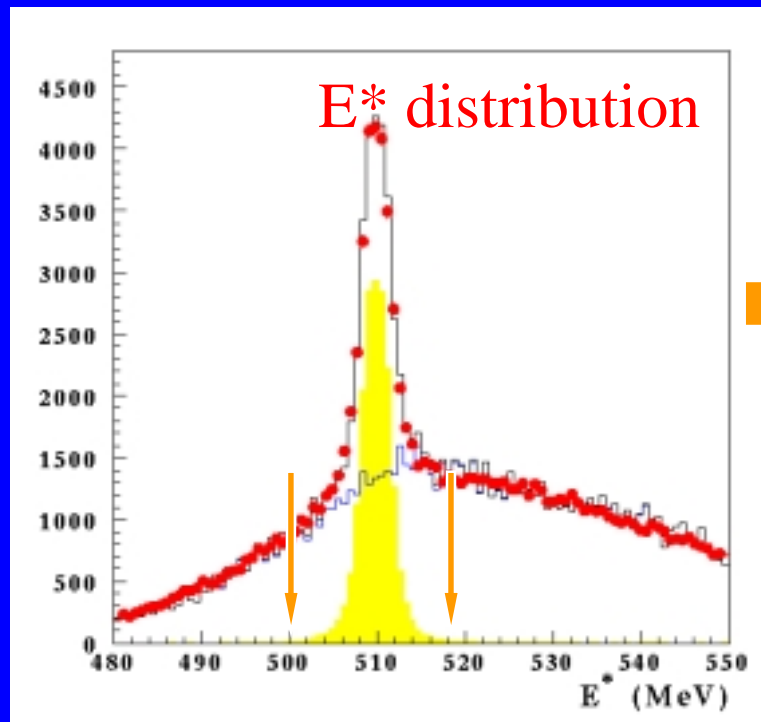ε (total) = (81.1 $\pm$ 0.4 stat $\pm$ 0.5 syst) %

Selection done with only two and very loose cuts:
 1) $|E^* - \mu| < 5\ \sigma$
 2) $\alpha < 15\ °$
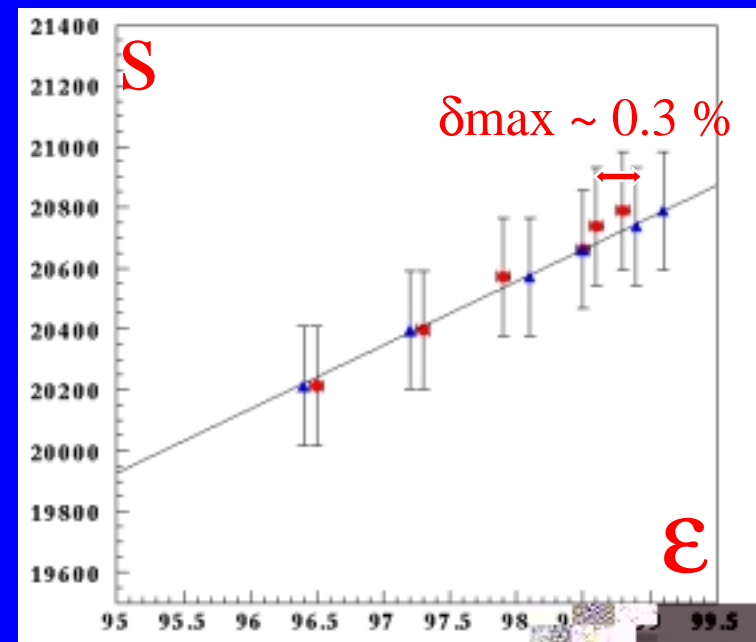Efficiencies estimated from data

Systematics on the selection cuts (I)

E* distribution

Mγγ distribution

S = 20661 ± 201
B = 33559 ± 331
$\chi^2 = 157/100$

S

δmax ~ 0.3 %

ε

1) Cut moved from $3\,\sigma \rightarrow 6\,\sigma$
2) Fit the Mγγ to get the signal content
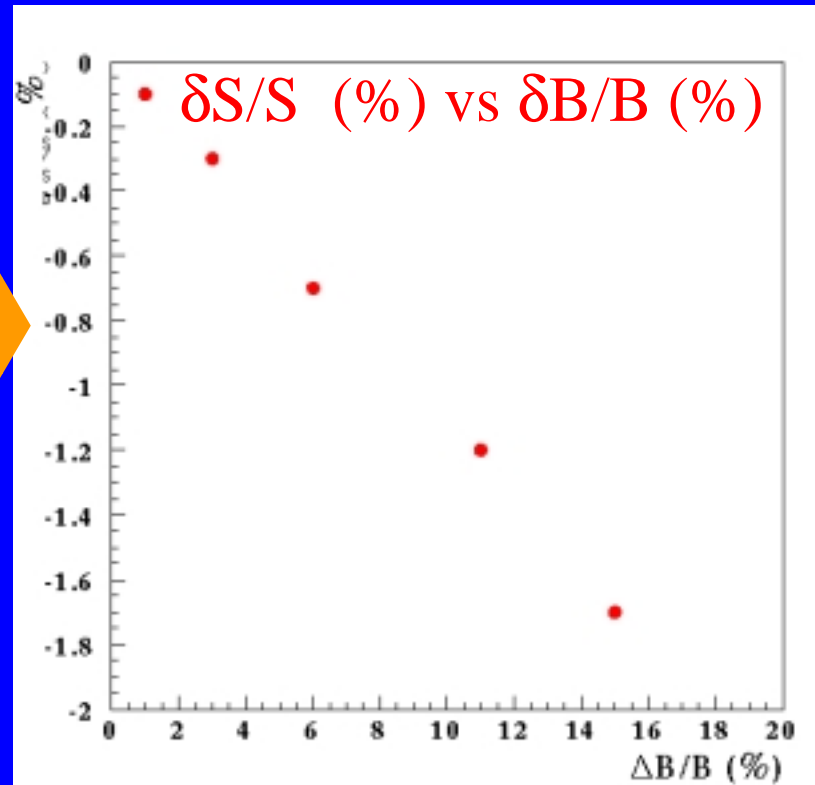3) Evaluate max displacement between the measured efficiencies and the nominal ones.

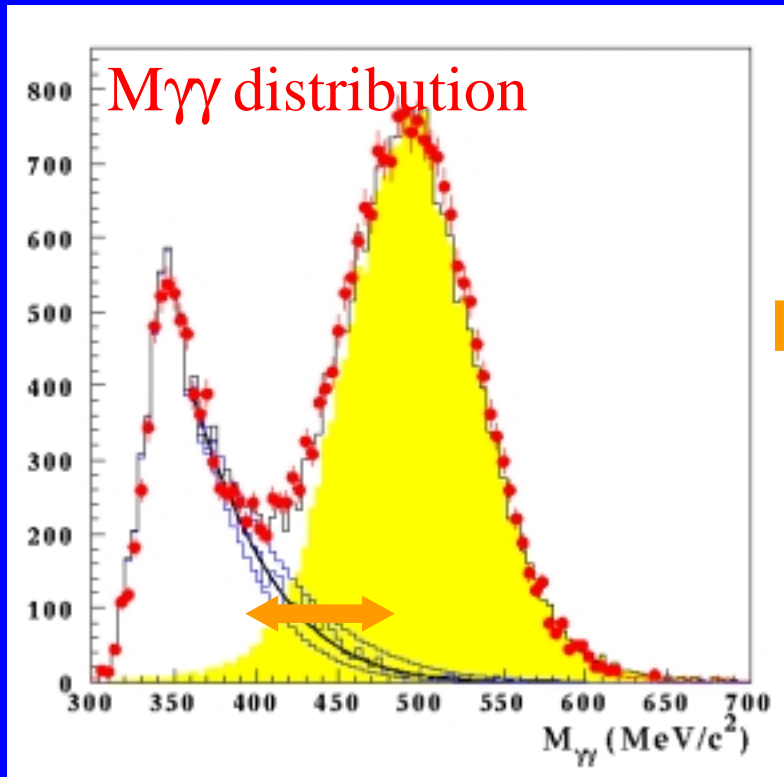# Systematics on the selection cuts (II)

1) Cut moved from 10º   22º
2) Fit the Mγγ to get the signal content
3) Evaluate max displacement between
   the measured efficiency and the
   nominal one.

Systematics on the background evaluation (I)

Mγγ distribution

$\delta S/S$ (%) vs $\delta B/B$ (%)

Background content in the signal window changed by an amount between ± 16 %. The effect on the signal content is 10 times smaller.

Systematics on the background evaluation (II)
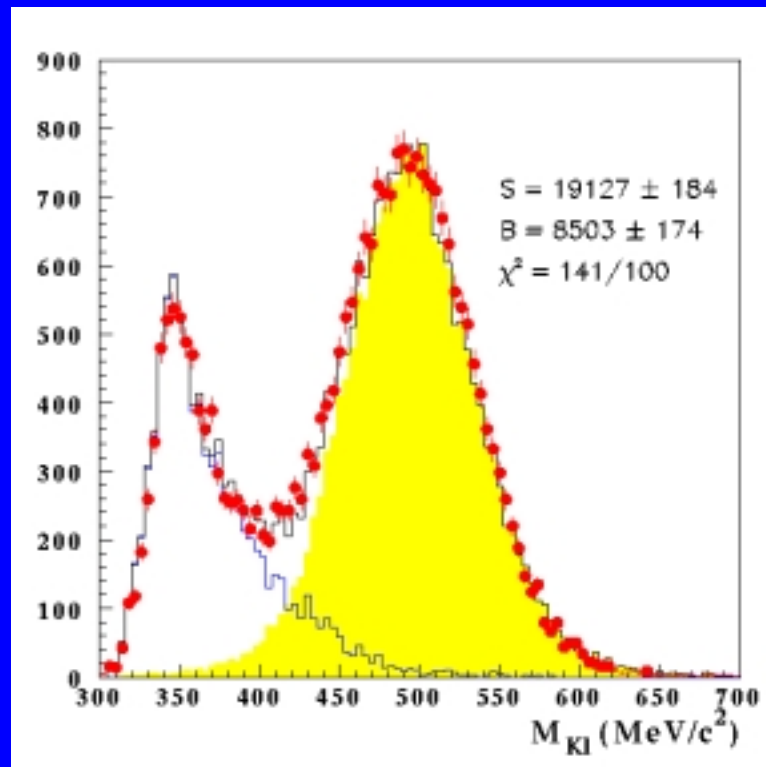

$$A(data)-A(mc)/A(data)$$

$$\pm\ 3\ \%$$
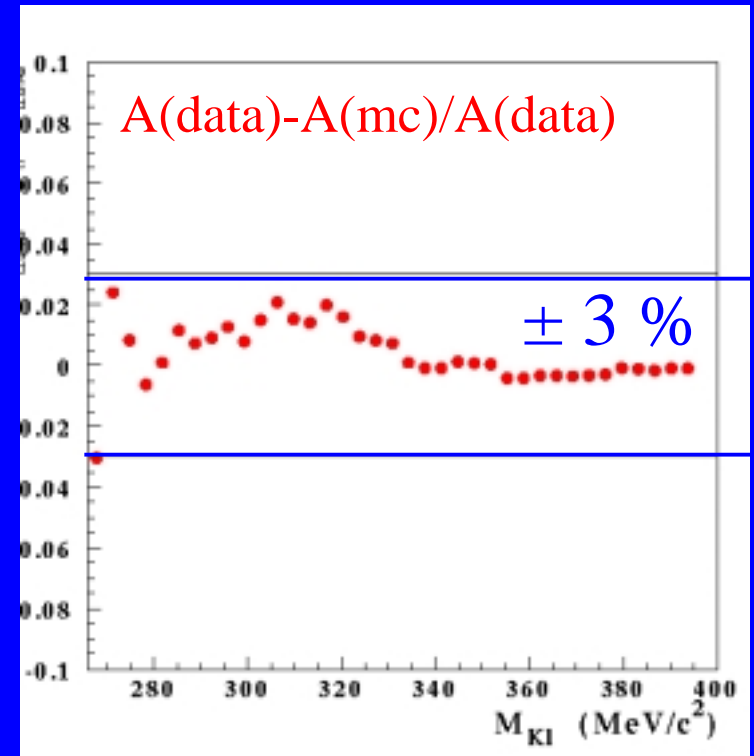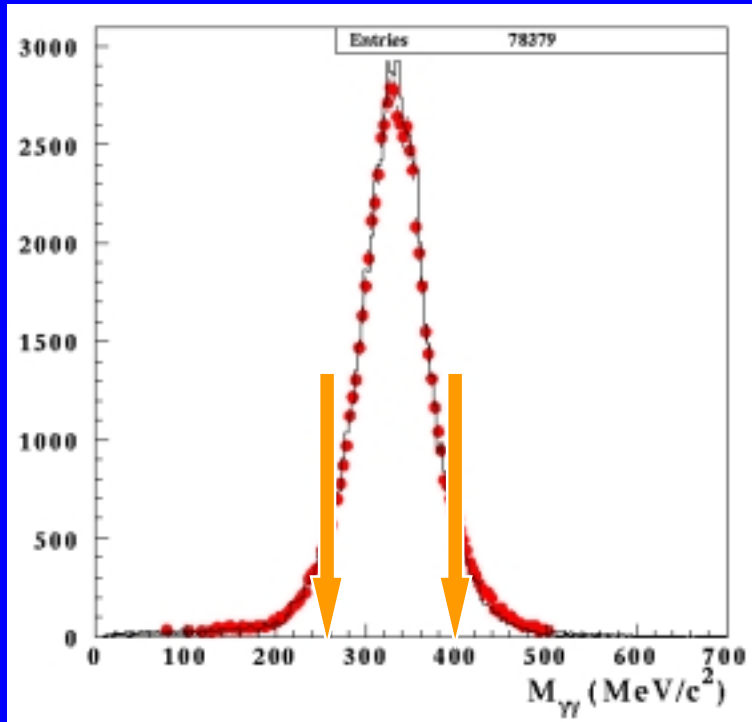
Shape of background studied in the range 280-400 MeV

Max difference in the cumulative distributions: 3 %

$\delta\ N\gamma\gamma\ /\ N\gamma\gamma\ (bkg) = 0.3\ \%$

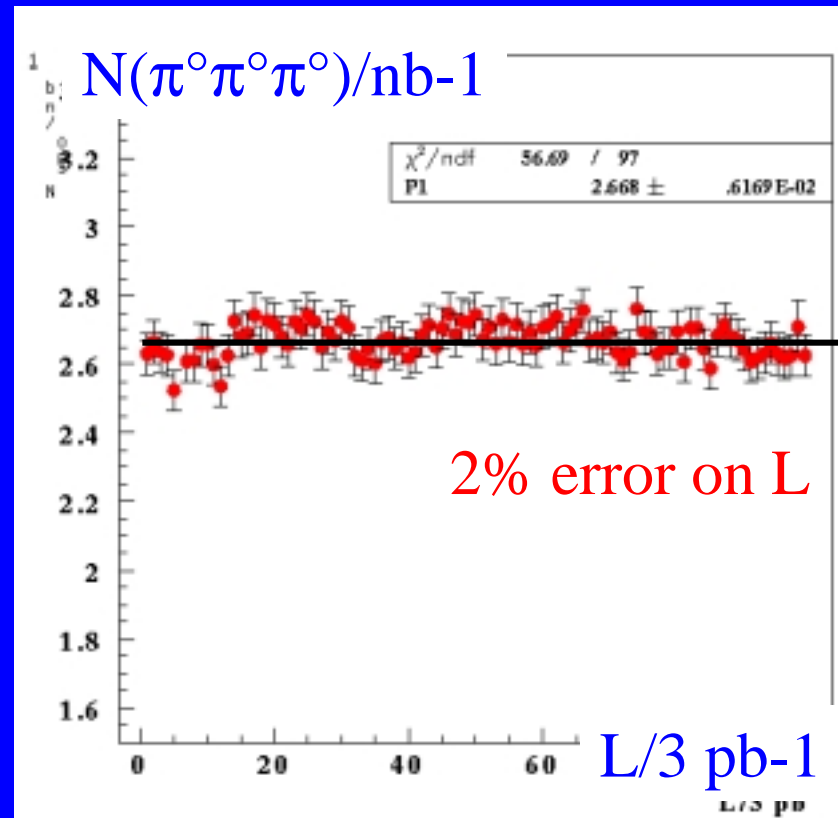# Nγγ final counting

S = 19127 ± 184
B = 8503 ± 174
χ^2 = 141/100

ε (total) = (81.1 ± 0.4 stat ± 0.5 syst) %

Nγγ = 23584 ± 236 (1%) stat ± 212 (0.9%) syst

K$_L \rightarrow \pi^o\pi^o\pi^o$ sample (I)

N($\pi^o\pi^o\pi^o$)/nb-1

2% error on L

L/3 pb-1
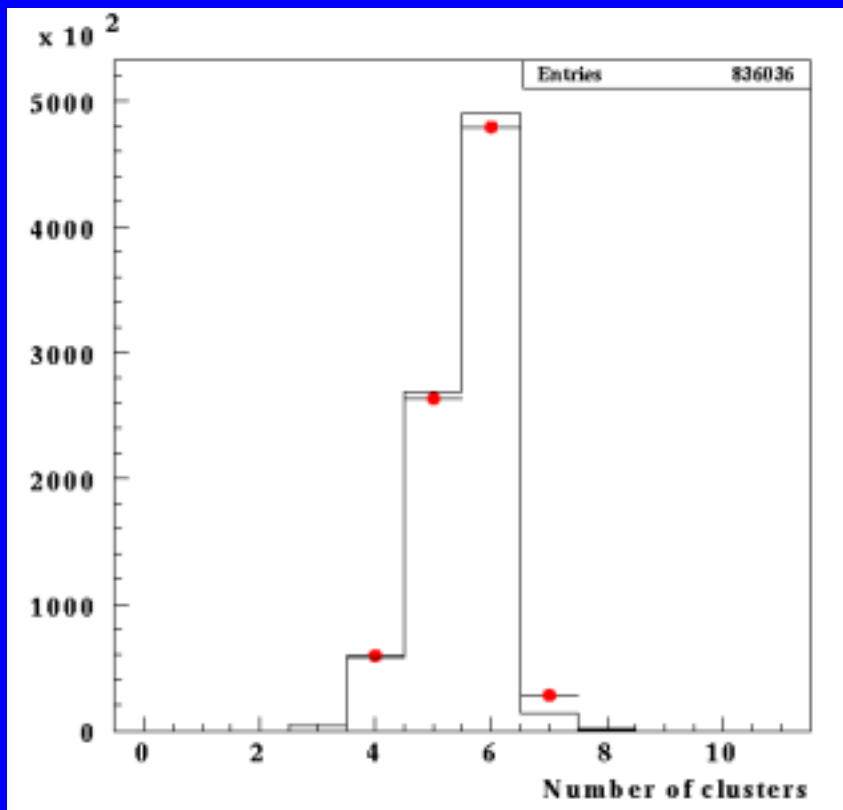
N $\pi^o\pi^o\pi^o$= 8429732 ± 920 (0.1%) stat ± 16800 (0.2%) syst

$K_L \to \pi^o \pi^o \pi^o$ sample (II)

Cluster Energy (MeV)

Small refinements:

1) cluster threshold moved
   from 7 MeV $\to$ 20 MeV
   (0.2% lost of events but helps
   in reducing contamination...)
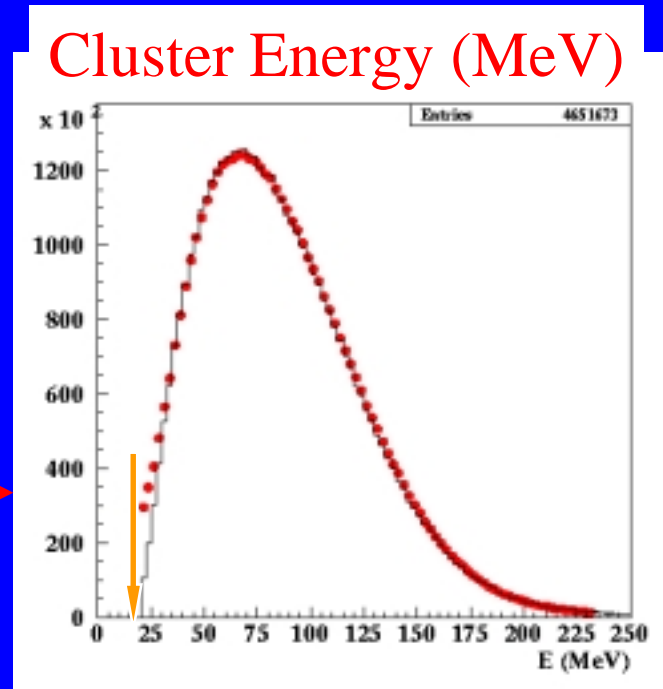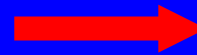
2) Looser track veto:
   distance (Kl vertex - first hit) < 50 cm

ϵ track veto

$K_L \rightarrow \pi^o\pi^o\pi^o$ sample : lifetime

τ (KLOE) = (51.5 $\pm$ 0.5) ns
τ (PDG02) = (51.7 $\pm$ 0.4) ns

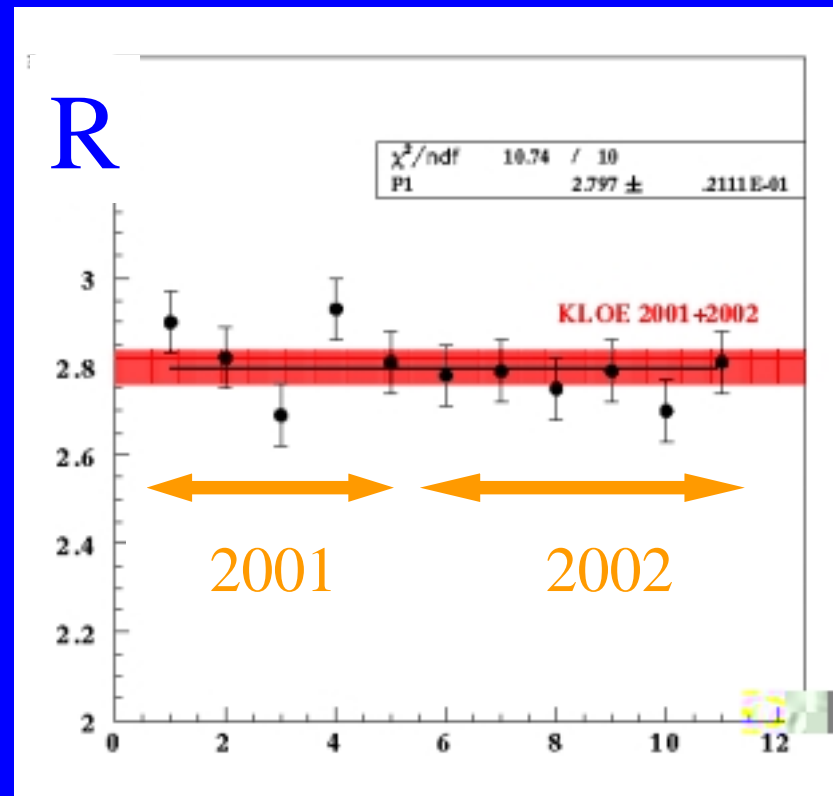| Entries	1094549	
χ^2/ndf	48.89 / 42	
P1	.2056E+05 $\pm$	59.80
P2	51.47 $\pm$	.4887

40 cm < r < 155 cm
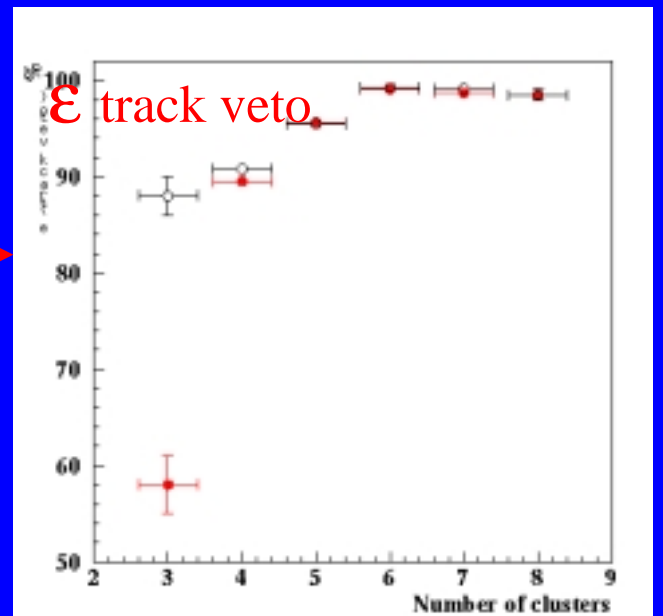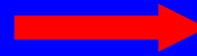
τ (ns)
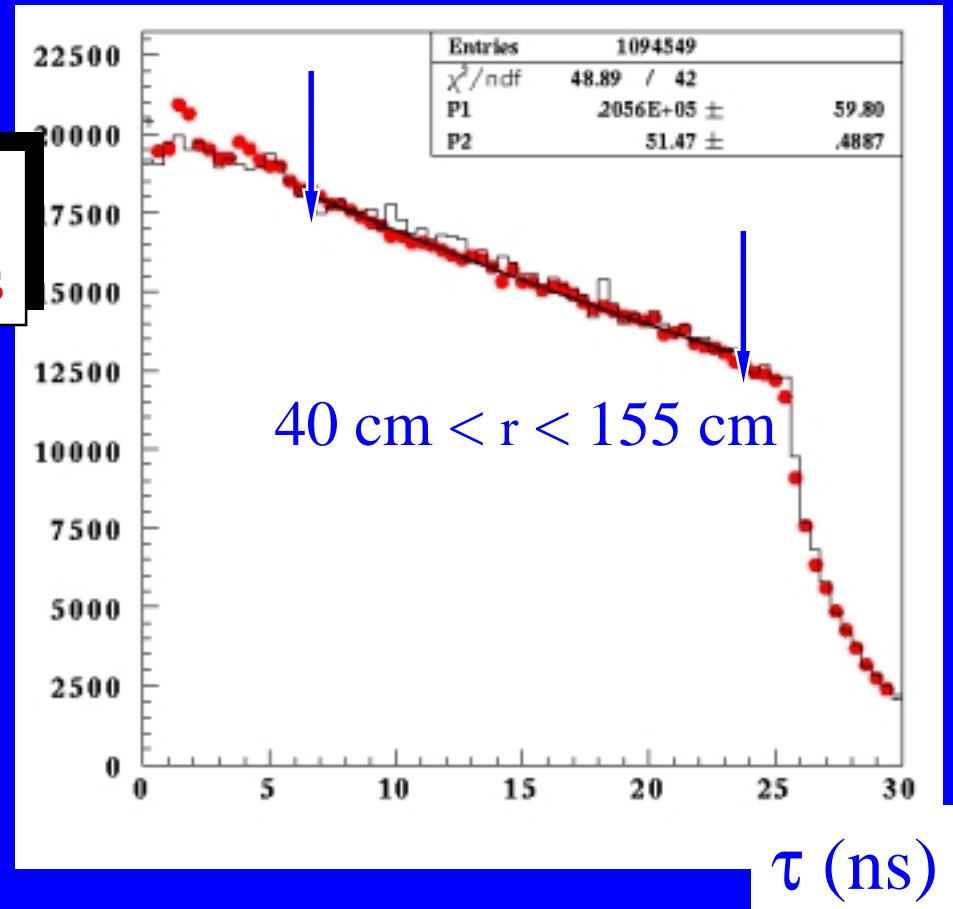
...Already at the PDG accuracy level using just 10% (30 pb-1) of data sample….

$$R = K_L \to \gamma\gamma / K_L \to \pi^o\pi^o\pi^o$$

KLOE (02) = $(2.797 \pm 0.028$ stat ± 0.025 syst$) 10^{-3}$
NA48 (02) = $(2.81 \pm 0.01$ stat ± 0.03 syst$) 10^{-3}$(hep-ex/0210053)
PDG(00) = $(2.77 \pm 0.08) 10^{-3}$ (from a fit)

Conclusions

R has been measured at 1% statistical error and 0.9 % systematic error using 312 pb-1 of 2001 and 2002 KLOE data sample .
•KLOE note in preparation followed by a paper draft.

• The result confirms the only other existing direct measurement (NA48, october 02) with a comparable accuracy.

• The error on BR(KL→γγ) is anyhow affected by the uncertainty on the BR(KL→π°π°π°) ~1.3%:

      PDG(02) = 2.5 %

      KLOE(0.2) = 1.8 %

      NA48(02) = 1.5 %

Future Plans

Measurement of KL lifetime using the KL $\rightarrow \pi^{\circ}\pi^{\circ}\pi^{\circ}$ decay seems a short term item:

- statistics is not a problem
- neutral vertex reconstruction efficiency wrt decay path length must be studied.

Direct measurement of BR(KL$\rightarrow\pi^{\circ}\pi^{\circ}\pi^{\circ}$) and of BR(KL$\rightarrow\gamma\gamma$) with an improved accuracy wrt PDG are possible if tag efficiency is known at $< 1\%$ level.