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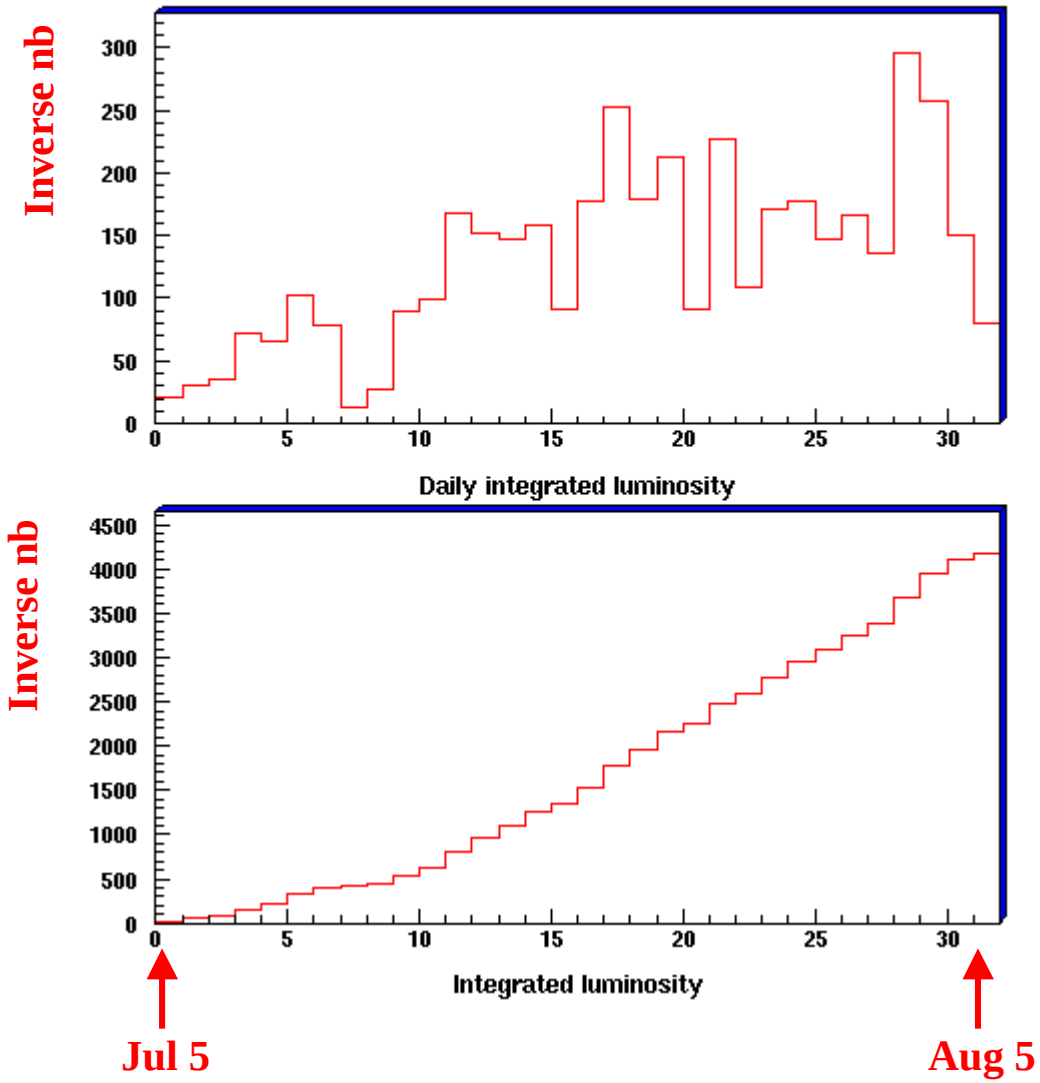
Oct 12, 2000

Offline status report

- Outline
  - ✔Machine background in reconstruction
  - ✔Check of data quality
  - ✔Preliminary results from July 2000 and comparison with 1999

Processing of 2000 data - Jul/Aug



- $\int_{\text{Jul/Aug 2000}} \mathcal{L}\, dt = 4.18\ \text{pb}^{-1}$

  corresponding to:

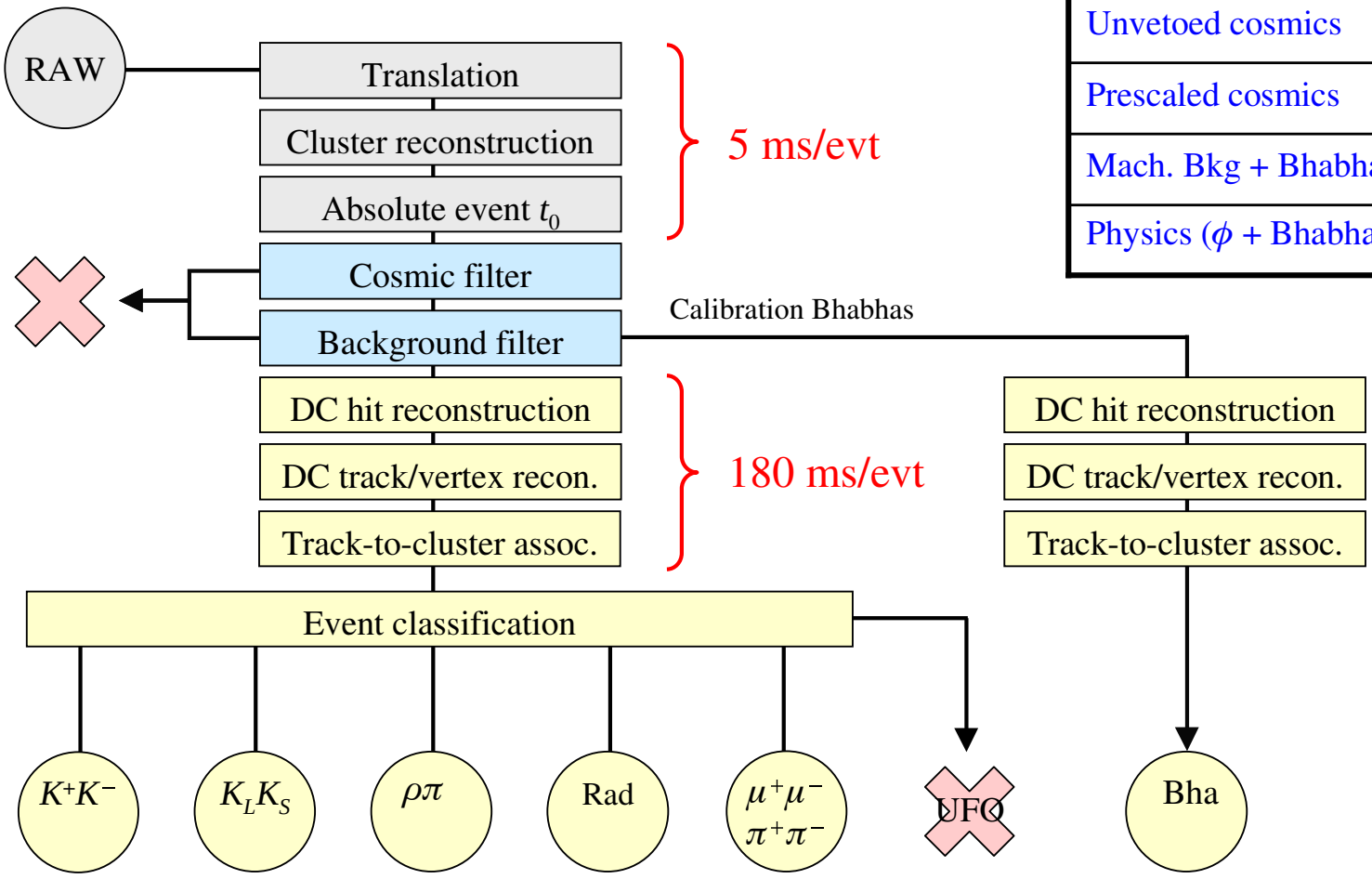
  - 1.2×10^7 ϕ's collected
  - 1.7×10^6 $K_S K_L$ tagged by $K_S \to \pi^+\pi^-$
  - 1.4×10^6 $K_S K_L$ tagged by KLCRASH (K_L interacting in EMC)
  - 5.1×10^6 K^+K^- tagged by vertex

- *All data reconstructed at acquisition*
- *Detectors calibrated continuously on-line by an automatic procedure providing*
  - *– calorimeter energy/time calibration*
  - *– s-t relations*

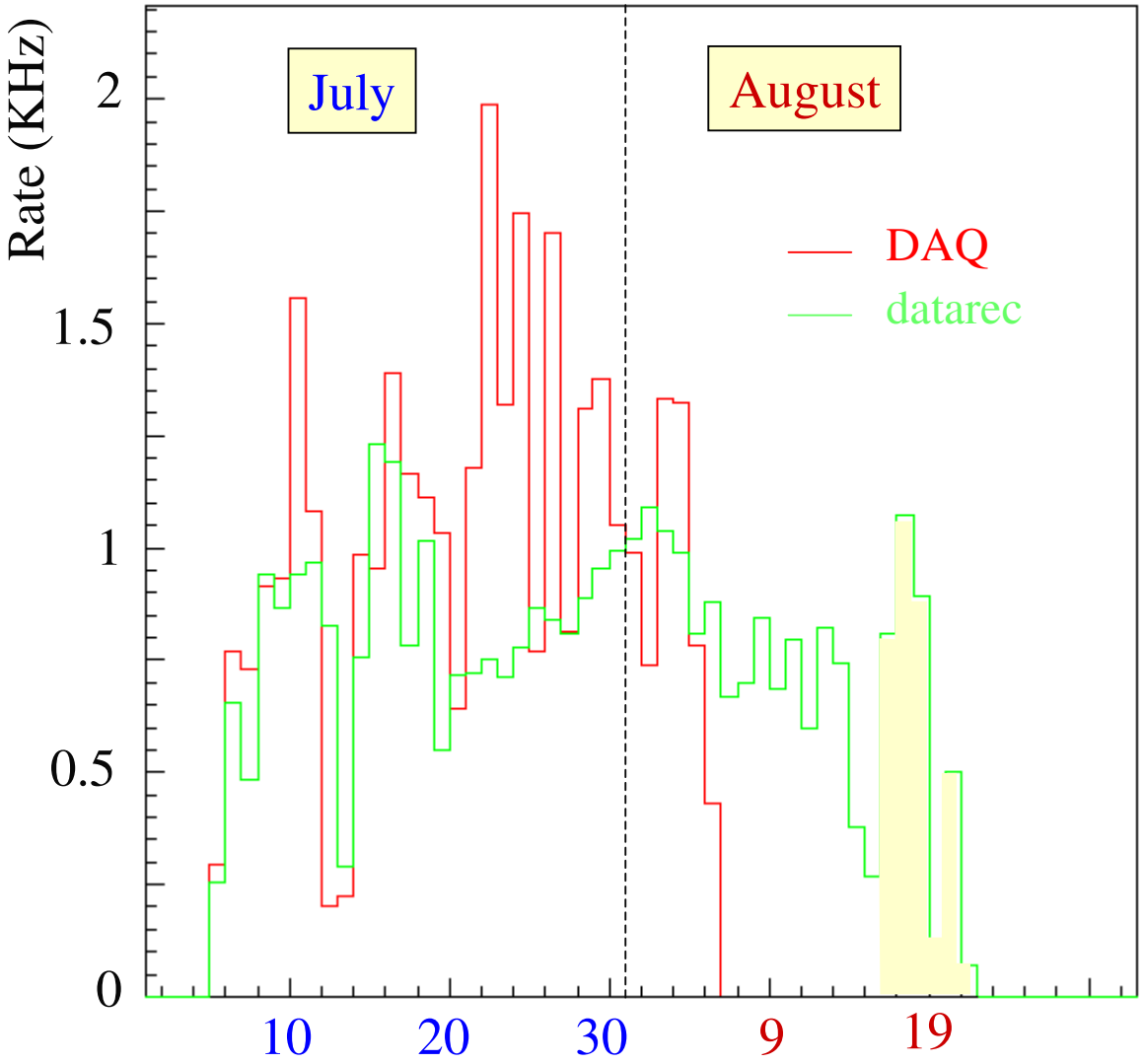
Overview of offline reconstruction

datarec "simplified" flow diagram

Typical data stream composition, Jul 2000 $\langle \mathcal{L} \rangle \sim 5 \times 10^{30}$ cm^{-2} s^{-1} → Trigger rate ~2 KHz	
Unvetoed cosmics	~700 Hz
Prescaled cosmics	~300 Hz
Mach. Bkg + Bhabha < 20°	~950 Hz
Physics (ϕ + Bhabha > 20°)	~50 Hz

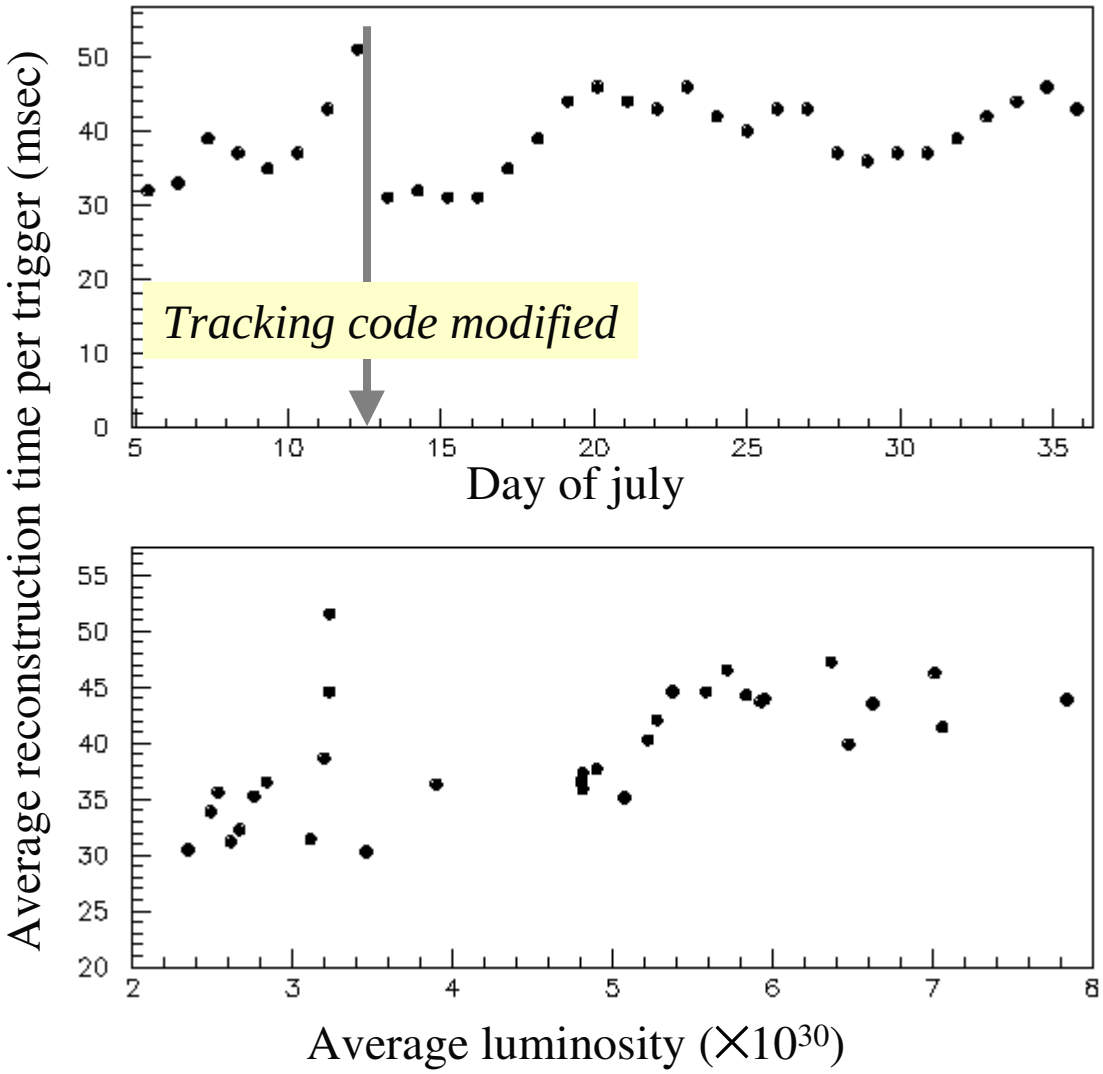


Acquisition and Reconstruction rate



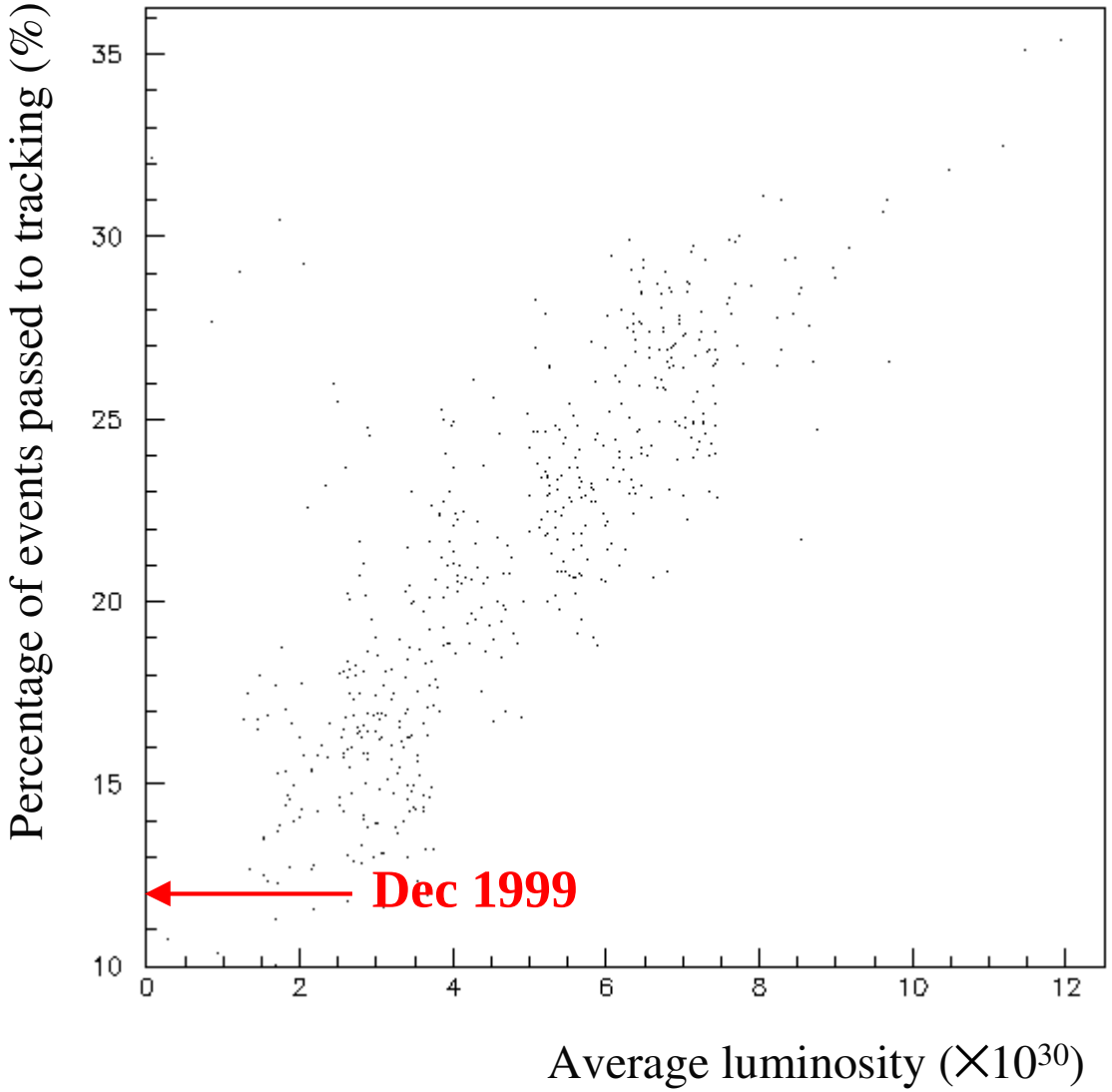
- Data have been taken with an *average daily rate (=including down time, inefficiency,... corresponding to ε~50%)* of ~1 kHz with peaks above 1.5 kHz
- The offline reconstruction (*datarec*) shows a saturation at ~ 0.8 - 1 kHz
- *Datarec* has a *tail* of ~25% after data taking is ended
- After august 16 part (~10%) of the collected data has been reprocessed due to a DC calibration problem

Event reconstruction time



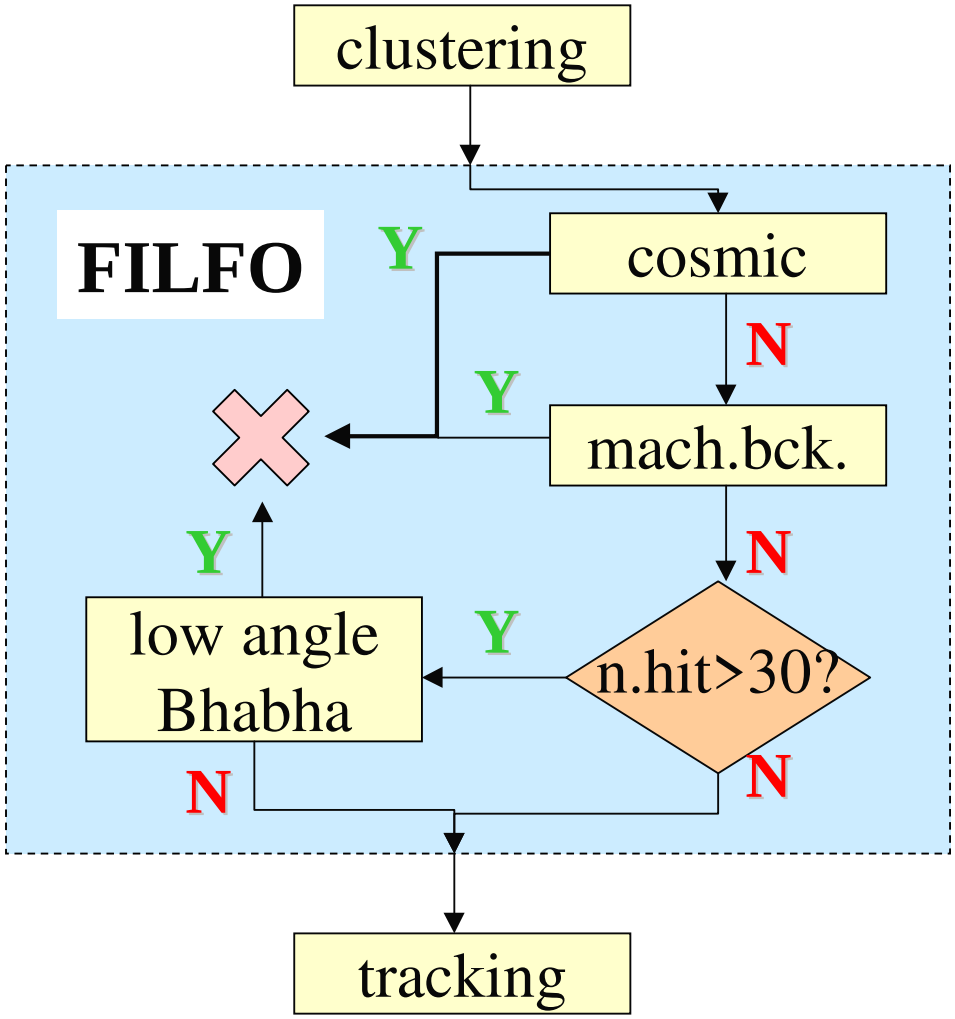
- The average reconstruction time varied along the run with beam conditions, with an average value of 40 msec corresponding to a reconstruction rate of 1 KHz using the whole offline farm (40 CPUs)
- The increase in reconstruction time is due to the increase in the number of machine background events passed to the tracking sector
- It is correlated with average luminosity because background scaled with <L>

Background rejection (FILFO)



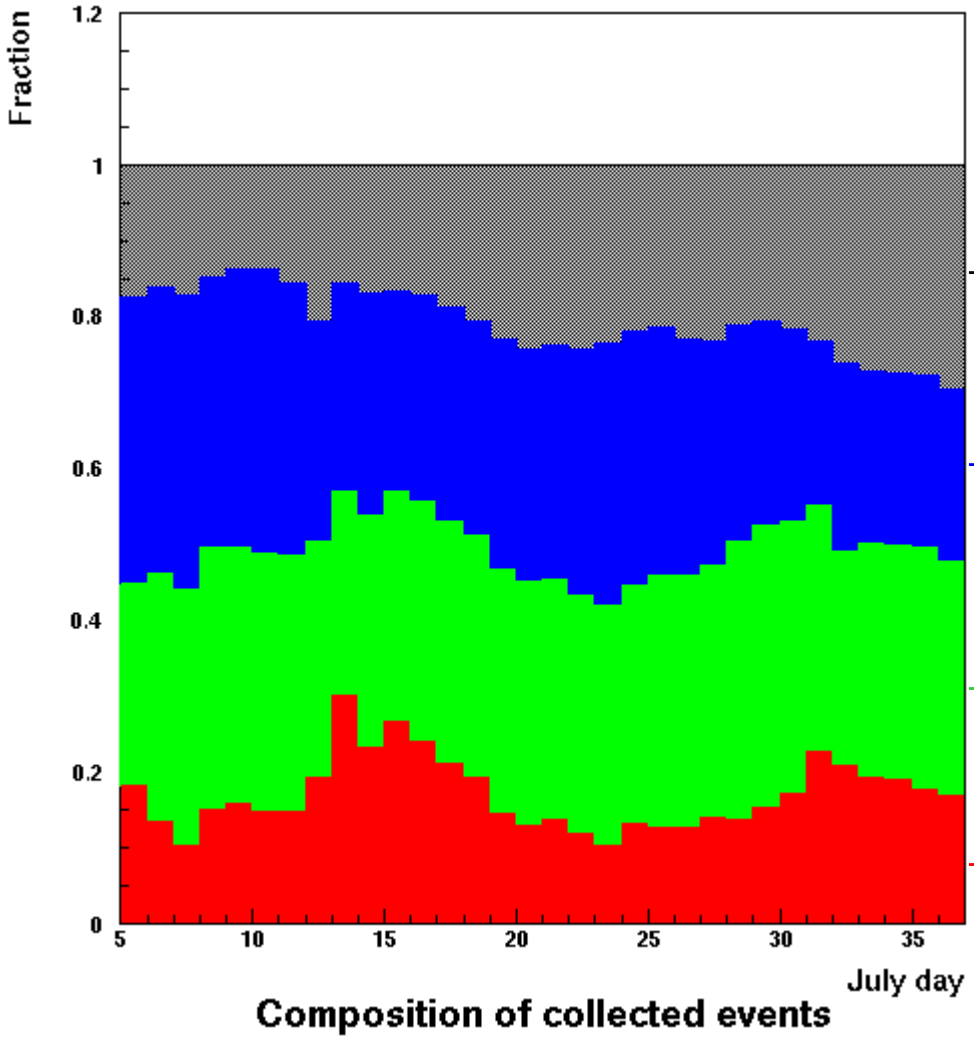
- The code has been optimized after december 1999 run, leading to a suppression of ~85% of background events
- during july run the M.B. conditions drifted away from december standard, and the absolute number of M.B. events
- a new tuning of the cuts will be done as soon as the machine conditions will be more stable

Background rejection - II



- Cosmic ray and machine background filters use complete EmC reconstruction + number of DC hits
- This filter is useful to clean the sample before passing events to the most time consuming module: the track fit
- **Cosmic efficiency** ~97%
- **Machine background** efficiency depends upon run conditions (~60% in Dec 1999)
- The **low angle Bhabha rejector** runs only on *charged events* because it rejects ~40% of $\phi \to \eta\gamma \to \gamma\gamma\gamma$

Background rejection - III



- The relative composition of background events varied along the run; in particular the efficiency of the **machine backgroun filter** decreased along the run

tracked events

machine background

cosmic rays

low angle Bhabhas

Background filters

Cosmic ray and machine background filters use complete EmC reconstruction + number of DC hits

Recent changes to filtering algorithms

- increase cosmic ray and MB suppression
- decrease inefficiency incurred for physics channels

Cosmic filter

suppression raised from 84% to 97% with decreasing physics losses

Machine background filter

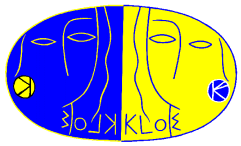
suppression highly variable depending on run conditions

- 40-90% over all KLOE runs
- 50-60% for Dec '99 data

Inefficiency incurred for physics channels

Final state	Cosmic filter $1-\varepsilon$	MB filter $1-\varepsilon$
$K_S K_L$	0.02%	0.2%
K^+K^-	2.4%	1.1%
$\pi^+\pi^-\gamma$	0.07%	0.07%
Neutral Radiative	0.3%	<0.01%
$\rho\pi$	0.2%	<0.04%

Conclusion 1

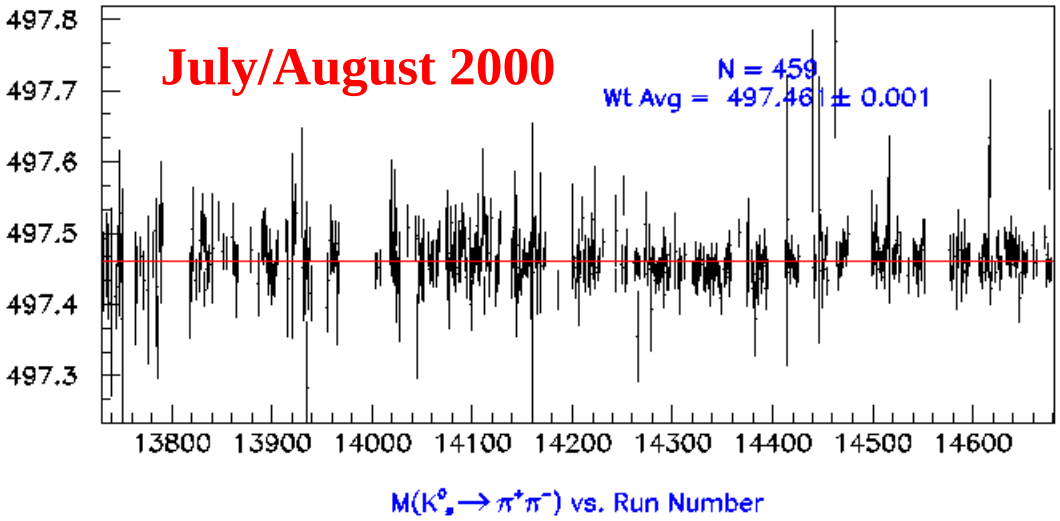


- At the moment we are tracking ~1/4 (500 Hz) of collected data with a *physics output rate* of ~50Hz
- Most of the reconstructed data are machine background events (which are not written in the reconstructed streams!)
- Convoluting with the clustering and tracking time, the *average reconstruction time* is *40msec/trigger*, corresponding to a *reconstruction rate* of *1kHz using 40 CPUs*
- This *saturation rate* is indirectely related to luminosity, since, up to now, the background rate scales with average luminosity

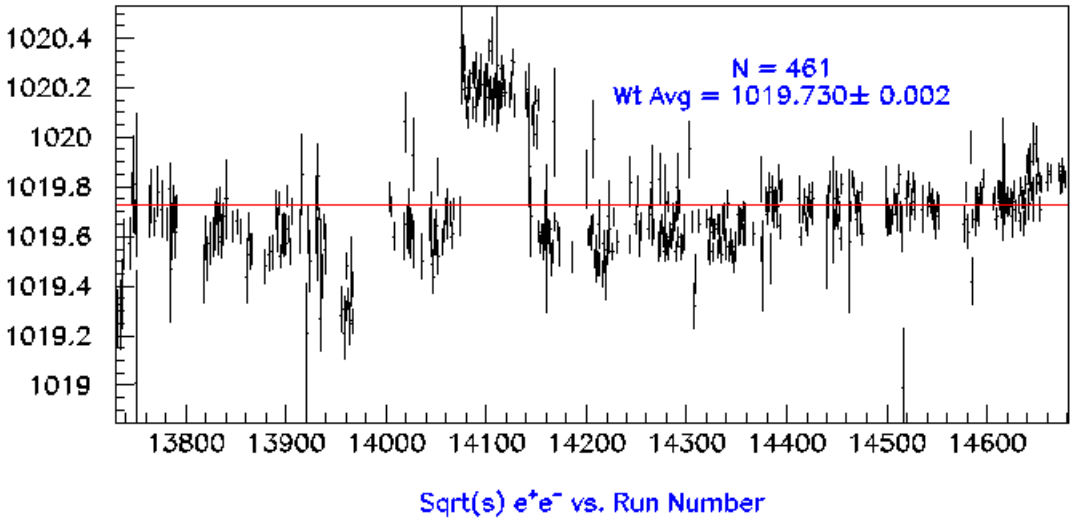
➡ Further increase in *average trigger rate* becomes costly in terms of available offline resources *(if all CPUs are used to reconstruct data after the end of DAQ, than it becomes problematic to make analysis, use tape drivers, ...)*

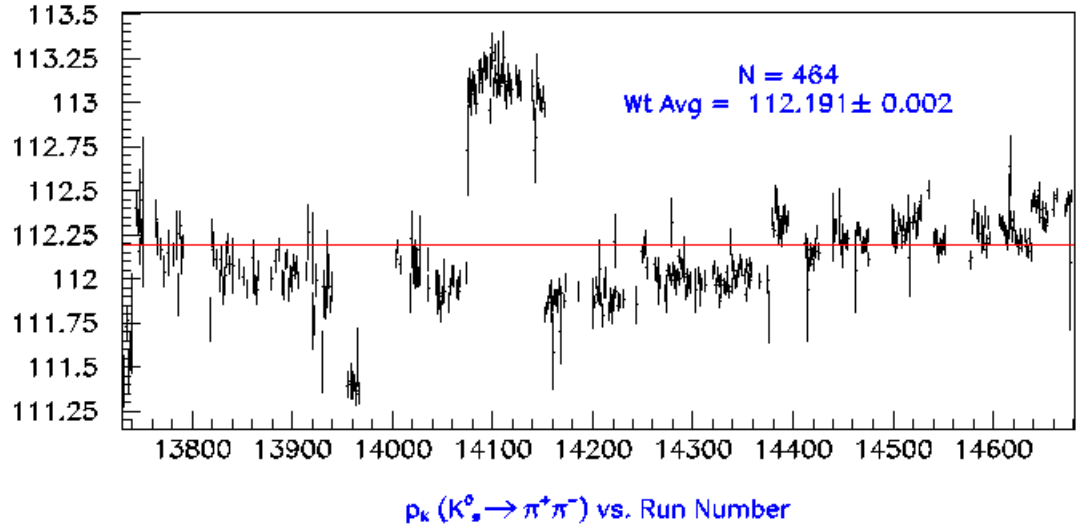
Data quality control

- Several physical quantities are monitored during reconstruction to control data quality
  - *global counters:* number of *LABs* (Large Angle Bhabhas), $K_S \to \pi^+\pi^-$, K^+K^-, …, per nb^{-1}; *ϕ cross section* from several decay channels; ...
  - *physical variables*: $\sqrt{s}$ from Bhabhas ; $M(K_S)$, $E(K_S)$, $p(K_S)$ from $K_S \to \pi^+\pi^-$; $p(K^\pm)$ from $K^\pm \to \pi^\pm\pi^0$; other exclusive decays .
- These quantities are sensible to *calibration problems*, effects induced by *machine background*, *bugs* in the selection codes (!), therefore they allow a prompt recovery from reconstruction problems



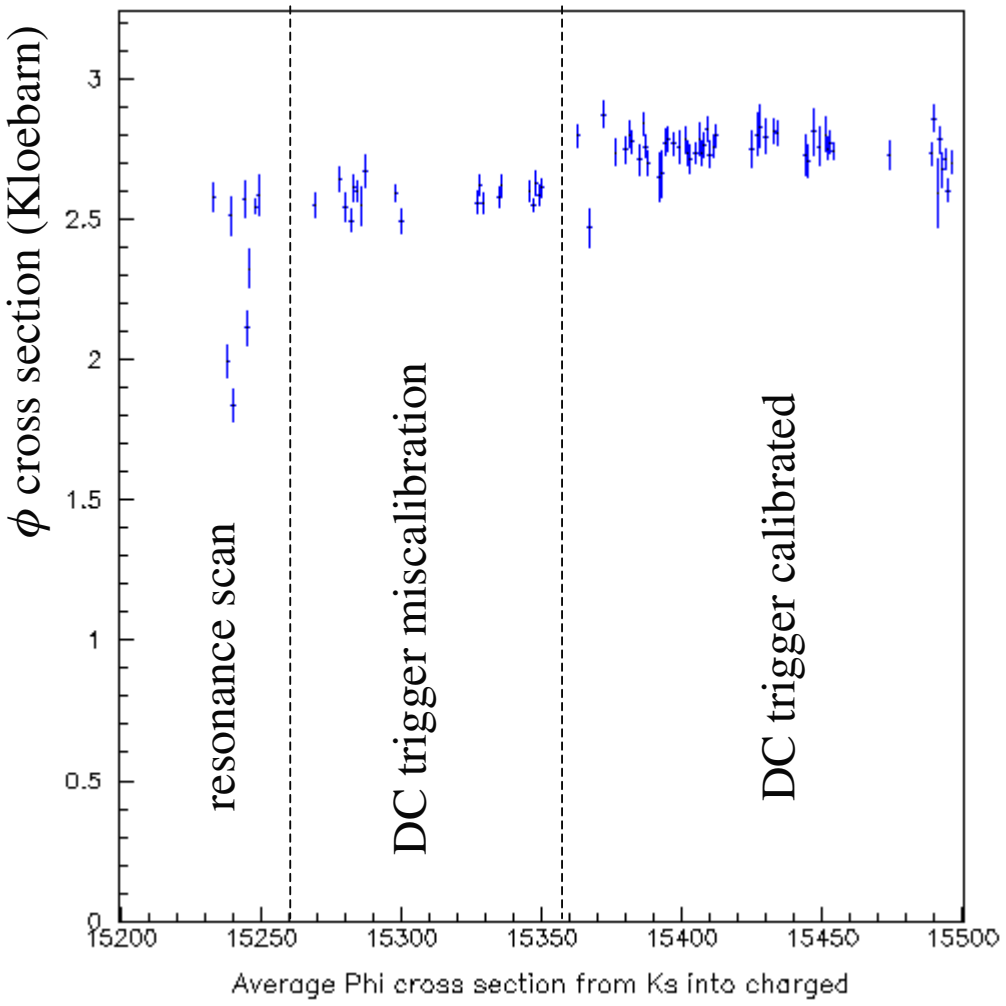
Monitoring of machine energy





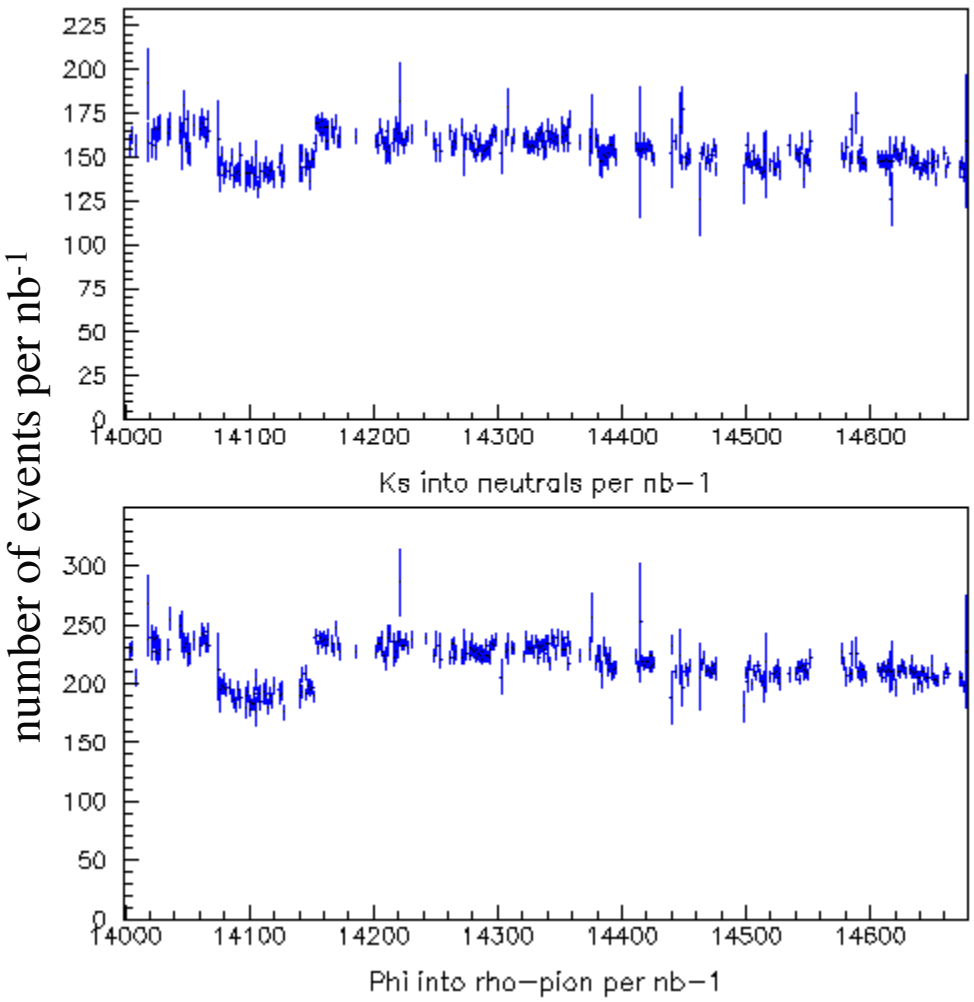
- The center of mass energy is measured both using Bhabha decays and using K_S momentum measured from the charged pions
- The plots show a sensitivity at the level of 100 keV in the machine energy
- However this response is not prompt, since it takes ~7 hours to process one raw file (≈1GB ≈ 700000 events ≈ 6 min @ 2kHz on 1 online farm)

Stability of KLTAG counter



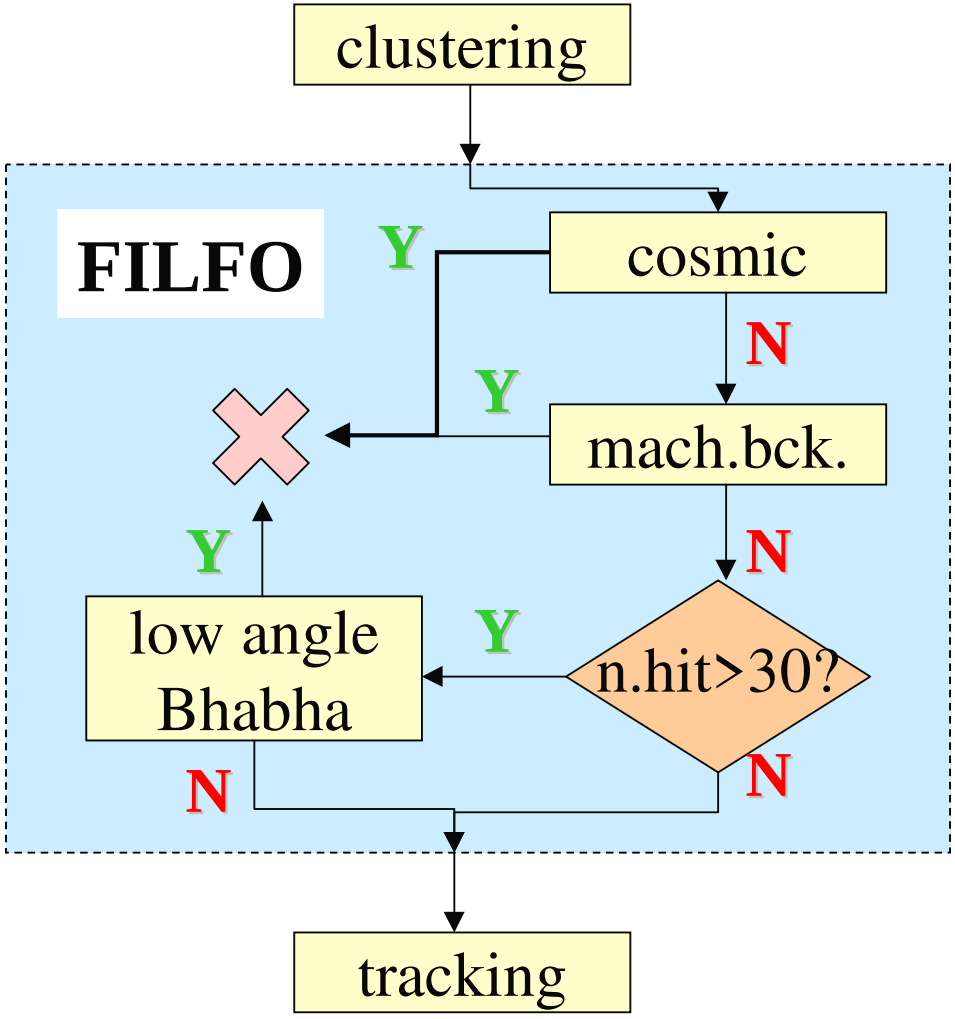
- The KLTAG counter counts the number of $K_S \to \pi^+\pi^-$ events with an efficiency of ~78%, dominated by the geometrical acceptance of the two charged tracks
- This counter, normalized to Bhabha events, is proportional to the ϕ cross section
- It is sensible to:
  - variations in machine energy
  - variations in trigger tresholds
- After corrections for machine energy fluctuations, the counter is stable at the level of $\pm 3\%$

Other counters



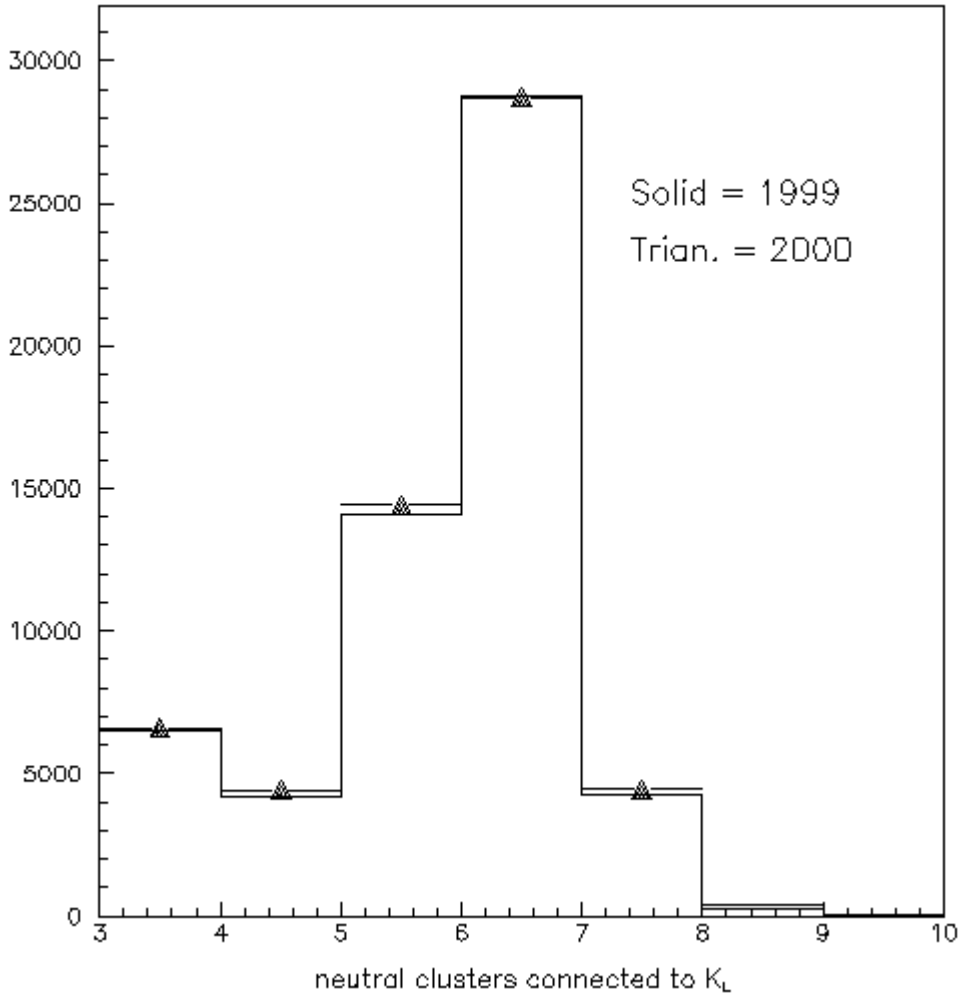
- Other counters used to control data stability:
  - $K_S \rightarrow \pi^0\pi^0$ = at least 4 prompt neutral clusters with $390 < M_K < 600$ MeV/c^2
    - ε=60% ; bck=1%
  - $\phi \rightarrow \rho\pi$ = 1 vertex close to the origin and at least two prompt clusters; a cut is applied on the kinematics of the two tracks to separate this category of events from $\phi \rightarrow \eta\gamma \rightarrow \pi^+\pi^-\pi^0\gamma$
    - ε=76% ; bck=1%
  - $\phi \rightarrow K^+K^-$ with a reconstructed vcrtex
    - ε=15% ; bck=35%
  - K_L interacting on calorimeter
    - ε=30% ; bck=50%

Pile up / chamber activity: $\phi \to \eta\gamma \to \gamma\gamma\gamma$



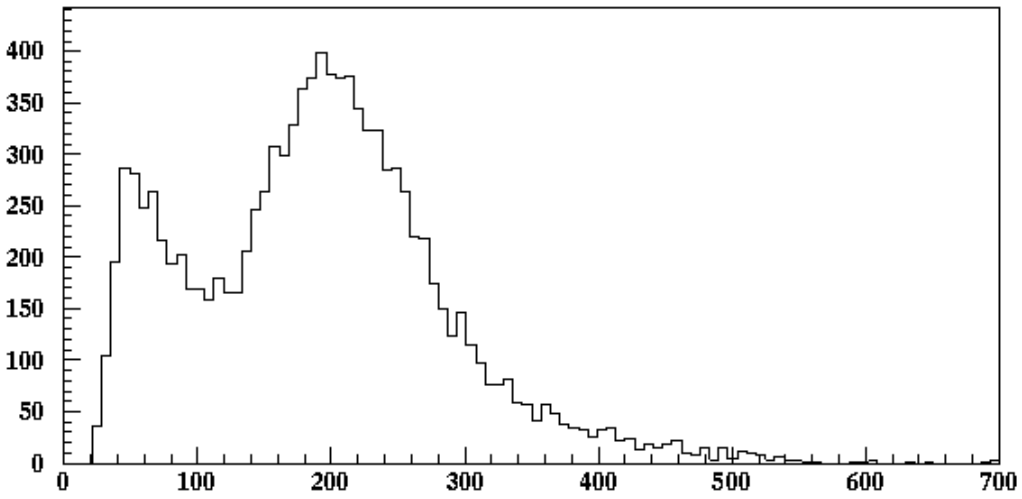
- The cut at **n.hit>30** to define *charged vs neutral events* was based on 1999 data
- 2000 data show an *increase in chamber activity* due both to *machine background* and to *hot channels*
- this resulted in a loss of ~40% of $\phi \to \eta\gamma \to \gamma\gamma\gamma$ events in the first processing of July 2000 data
- the loss can be recover with a reprocessing of the events
- *except for this loss, all the other variables show stability between 1999 and 2000*
- now hot channels are masked and a study of a new definition of "charged events" is in progress

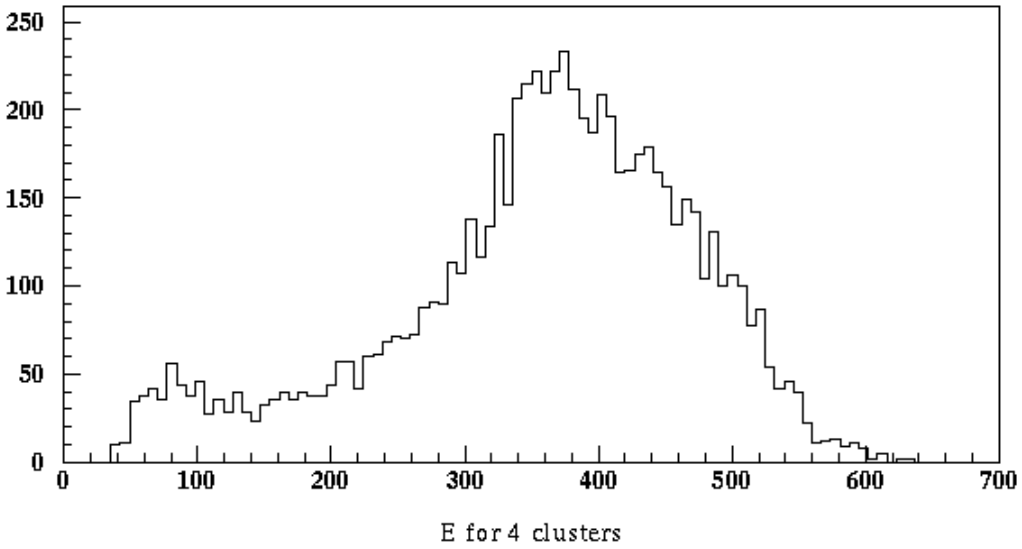
Pile up: neutral vertex



- The number of neutral clusters connected to the K_L vertex is very sensible to pile up clusters, since we must separate $K_L \to \pi^0\pi^0$ from $K_L \to \pi^0\pi^0\pi^0$ events
- A comparison between 1999 and 2000 data shows that, once tight cuts are applied on the timing of the pile up clusters, their effect on data is very small
- (in the plot also $K_L \to \pi^+\pi^-\pi^0$ decays are present, so the 3γ bin is enhanced)

Pile up: neutral vertex - II

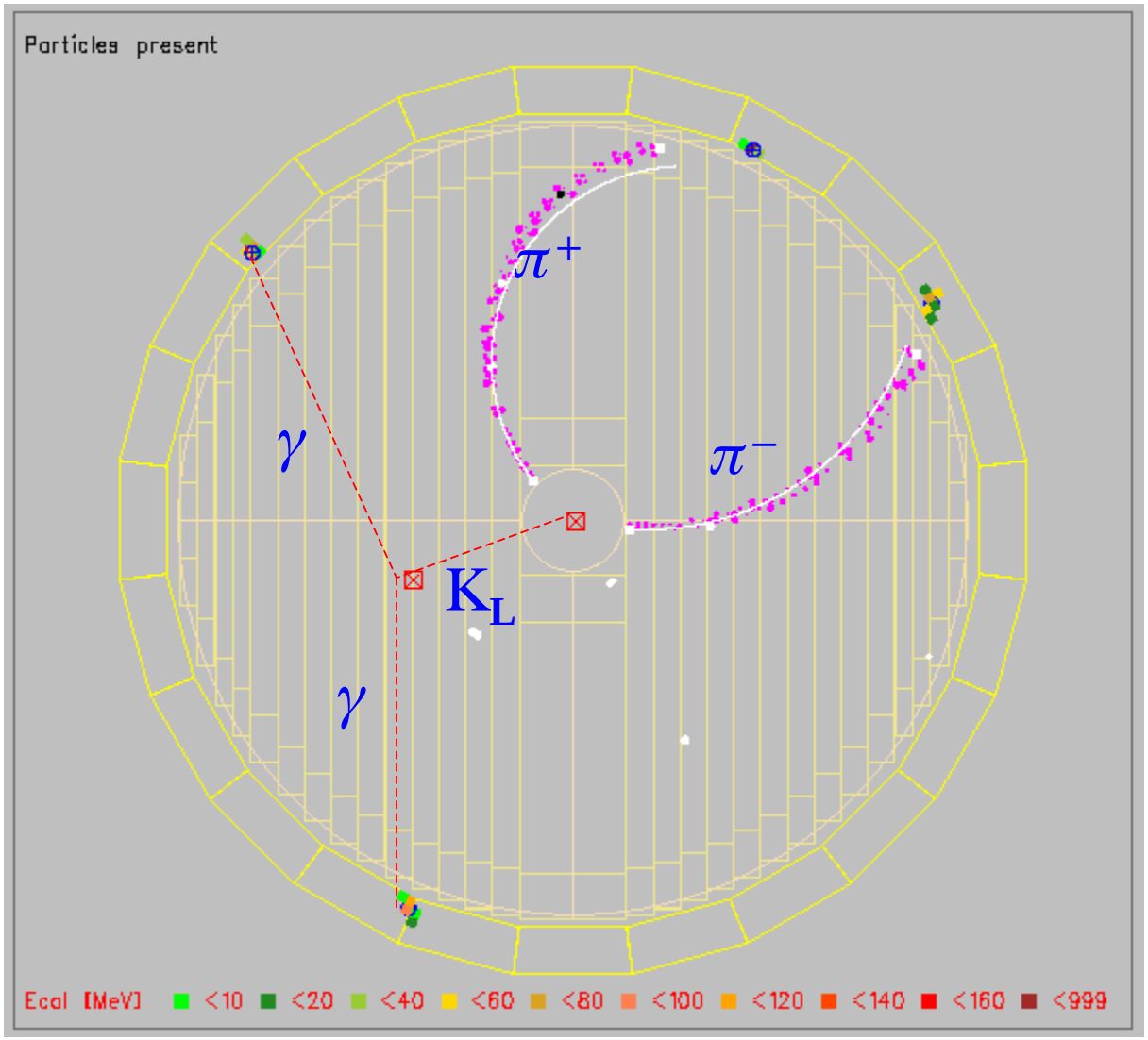




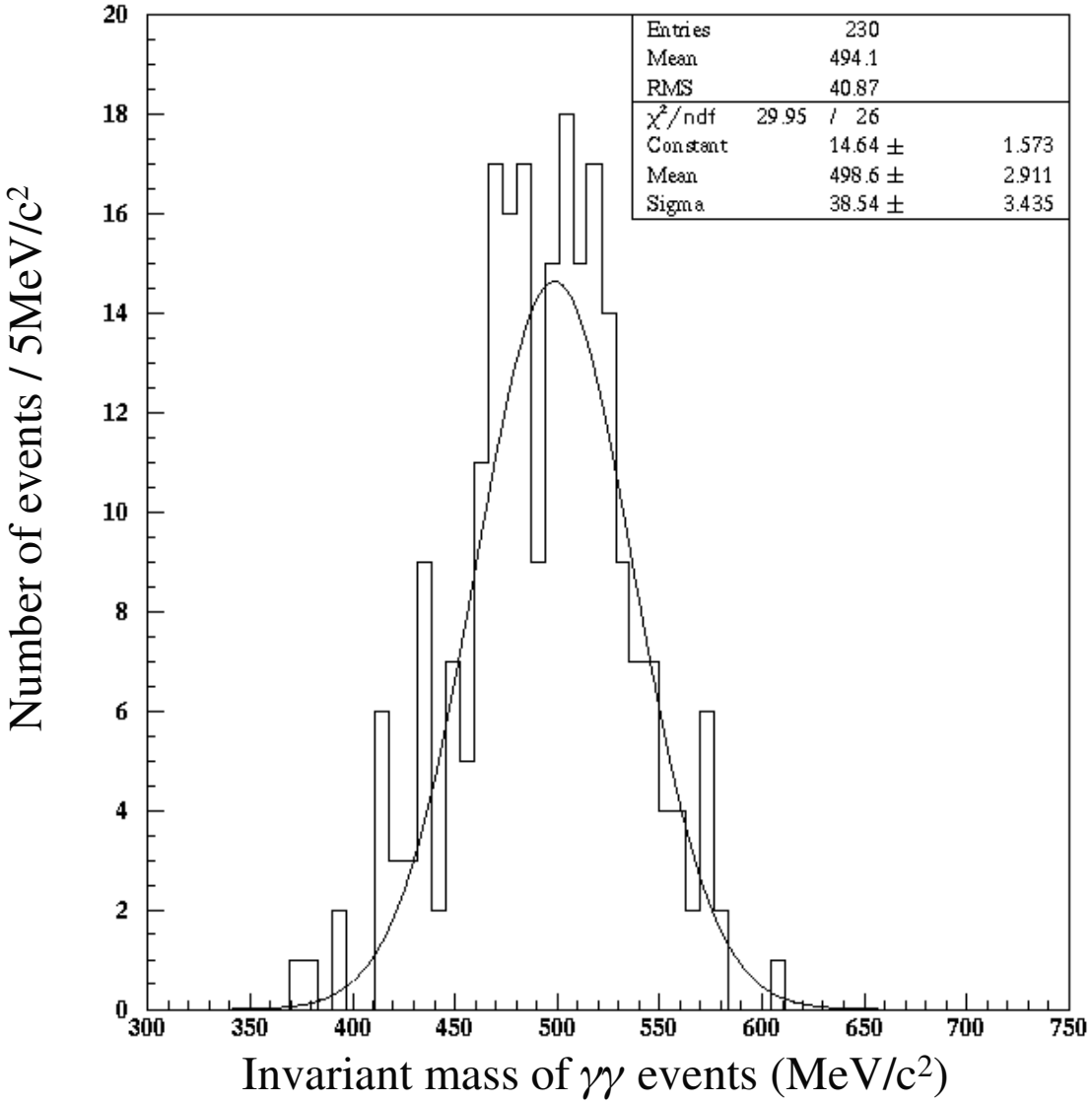
- Diostribution of the total energy of the neutral clusters connected to K_L vertex; no cuts are applied on charged tracks, so $K_L \rightarrow \pi^+\pi^-\pi^0$ events are present in the sample
- The eccess of events at low energy is due to *machine background splashes* overlapping a KLTAG event (needed to reconstruct the K_L flight direction)
- These pile up clusters are normally at low transverse radius and can be easily removed with kinematical cuts

Preliminary analysis: $K_L \to \gamma\gamma$

- the $K_L \to \gamma\gamma$ decay has a BR of $(5.86 \pm 0.15) \times 10^{-4}$ (NA31), dominated by systematics
- With 2.8×10^6 $K_S K_L$ tagged by $K_S \to \pi^+\pi^-$ in $5pb^{-1}$ and an efficiency of 17% (dominated by geometrical acceptance in fiducial volume) we expect ~250 events, corresponding to a statistical error of ~6%
- with 4 times this statistics the statical error becomes similar to the NA31 one

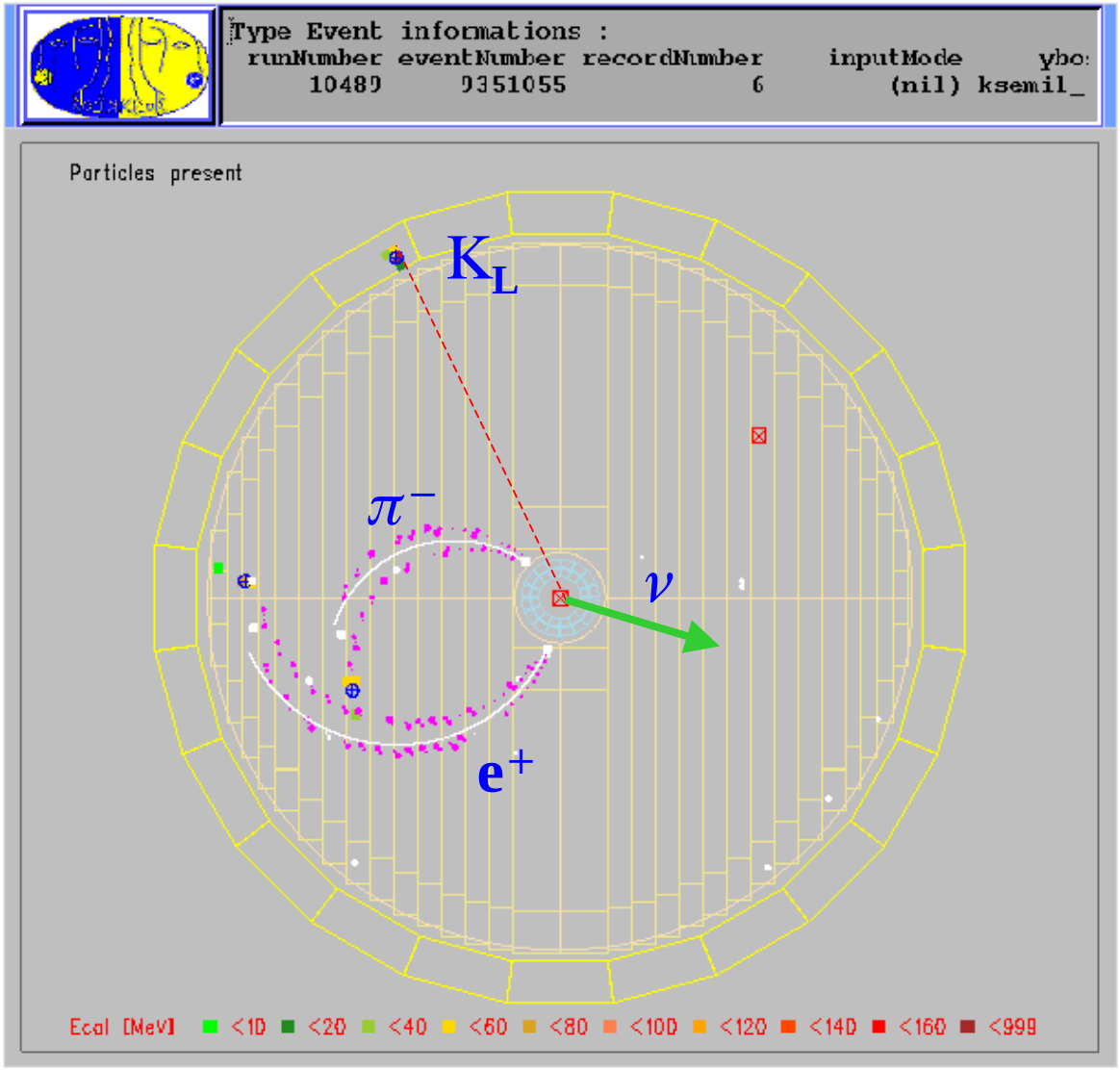


Preliminary analysis: $K_L \to \gamma\gamma$



Preliminary analysis: $K_S \to \pi e \nu$

- The $K_S \to \pi e \nu$ decay has a BR of $(7.2 \pm 1.4) \times 10^{-4}$ measured at VePP-2M with 75 events ($15 pb^{-1}$)
- Using KLCRASH tagged events (~1.04×10^6 events after background subtraction), and an efficiency of 20% we expect ~150 events in $5 pb^{-1}$, corresponding to a statistical error of 8%
- with $20 pb^{-1}$ KLOE can measure this BR with a statistical error of 0.3×10^{-4}



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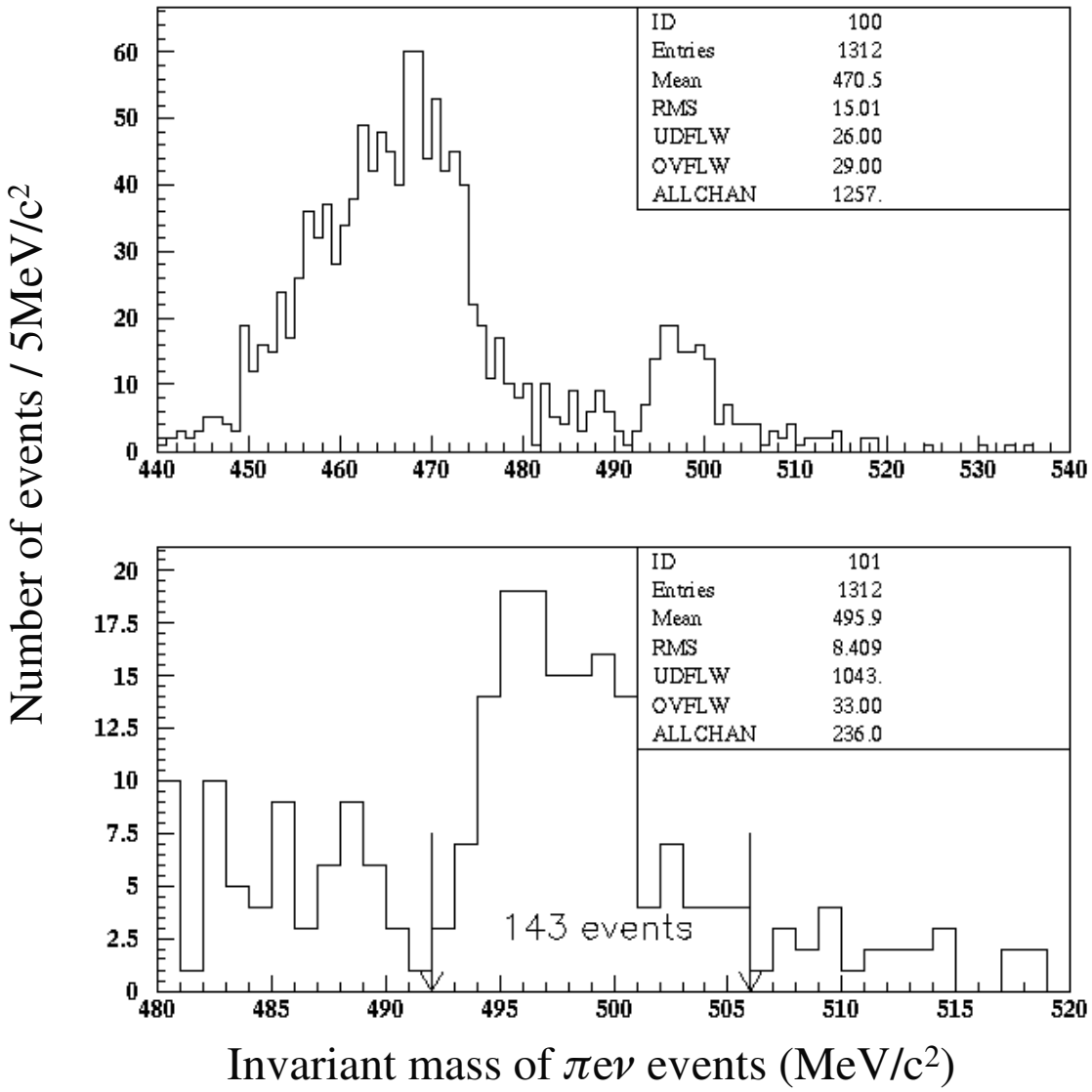


Conclusion 2

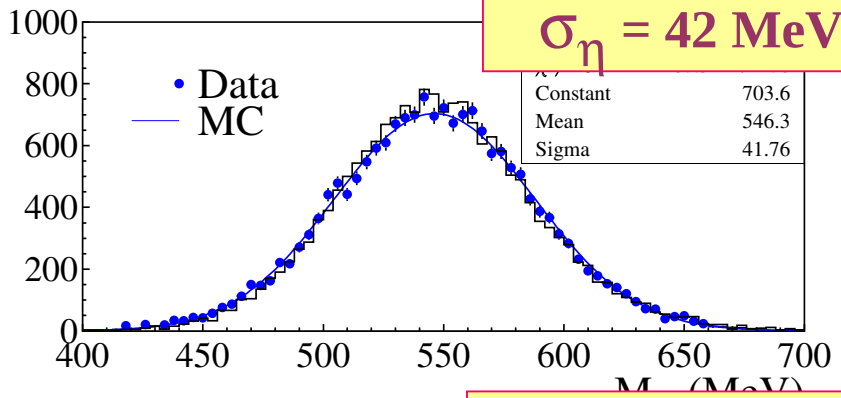
- July 2000 data have been useful to understand the effect that such a high machine background has on the physics channel
- KLOE has been able to perform some preliminary analysis obtaining results similar to the 1999 ones
- However a refined analysis is complicated by the fact that the trigger configuration and the background filters where changed along the data taking period to fight against the different M.B. conditions
- KLOE needs at least $20pb^{-1}$ of **good data** in order to obtain interesting physics results

Mass reconstruction in fully neutral final states

$\eta \rightarrow \gamma\gamma$

$M_\eta = 546$ MeV

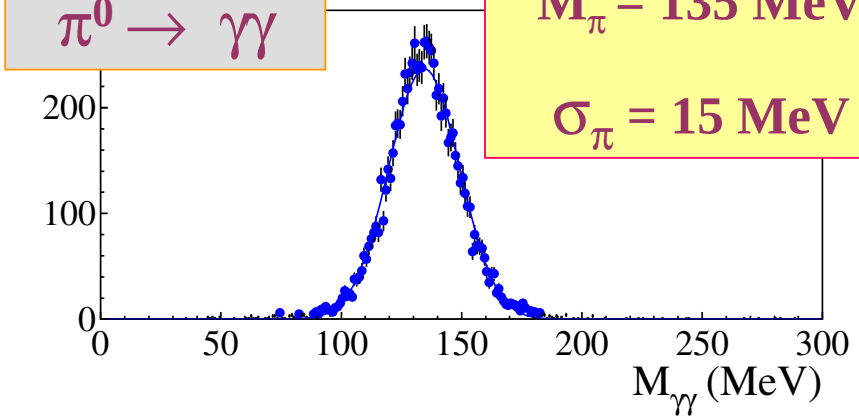
$\sigma_\eta = 42$ MeV



$\pi^0 \rightarrow \gamma\gamma$

$M_\pi = 135$ MeV

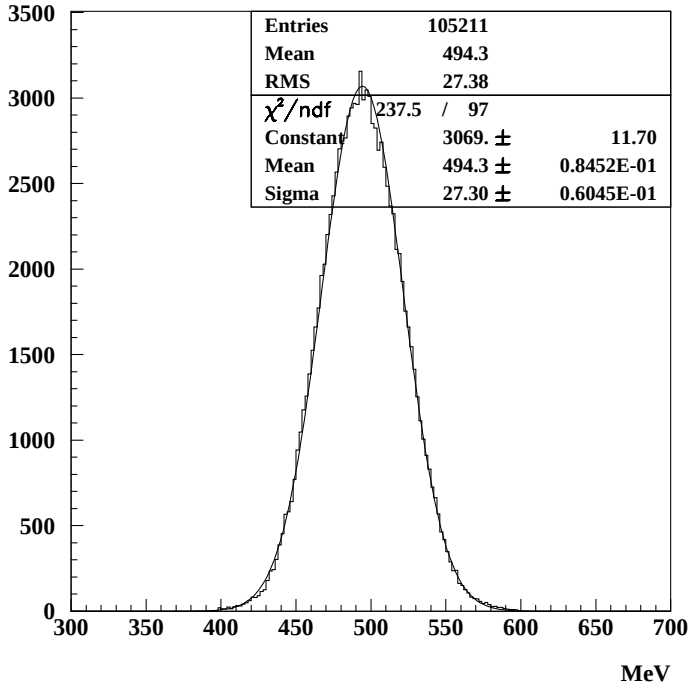
$\sigma_\pi = 15$ MeV



$K_s \rightarrow \pi^0 \pi^0$

$M_k = 494$ MeV

$\sigma_k = 27$ MeV



Event classification

Stream	Tagging algorithms/channels	Retained	Events/nb^{-1}	MB/nb^{-1}
raw		raw	762000	1260
kpm	**K^+K^- w/w/o vtx, single $K^\pm$**	recon	1000	33
ksl	**K_S: chg vtx in DC, $K_L \to$ EmC, $K_L \to \pi^+\pi^-\pi^0$, $K_L \to 3\pi^0$** **K_L: $K_S \to \pi^+\pi^-$, $K_S \to \pi^0\pi^0$** **$K_S \to \pi l \nu$**	recon	6700	190
rpi	$\rho\pi$, $\pi^+\pi^-\pi^0$ (prompt chg vtx w/ K_S veto)	recon	270	6
rad	**neutral radiative ϕ decays** (prompt neutral energy in EmC) **charged/neutral radiative ϕ decays**	recon	720	13
clb	$\pi^+\pi^-$, $\mu^+\mu^-$	recon	60	1
bha	**Golden Bhabhas (5.7 μb)** **Large-angle Bhabhas (0.75 μb)**	recon	5700	91
flt	**All events passing FILFO**	raw	112000	180
afl	**1/100 of events rejected by FILFO**	raw	4200	6
cos	**1/10 of prescaled trigger cosmics**	raw	23000	33