$\Gamma\left(\mathrm{K}_S \rightarrow \pi e \nu\right)$ preliminary results

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Summary

- **Motivations and strategy of the measurement**
- **Event selection**
- **Efficiencies estimations**
- **Conclusions and outlook**

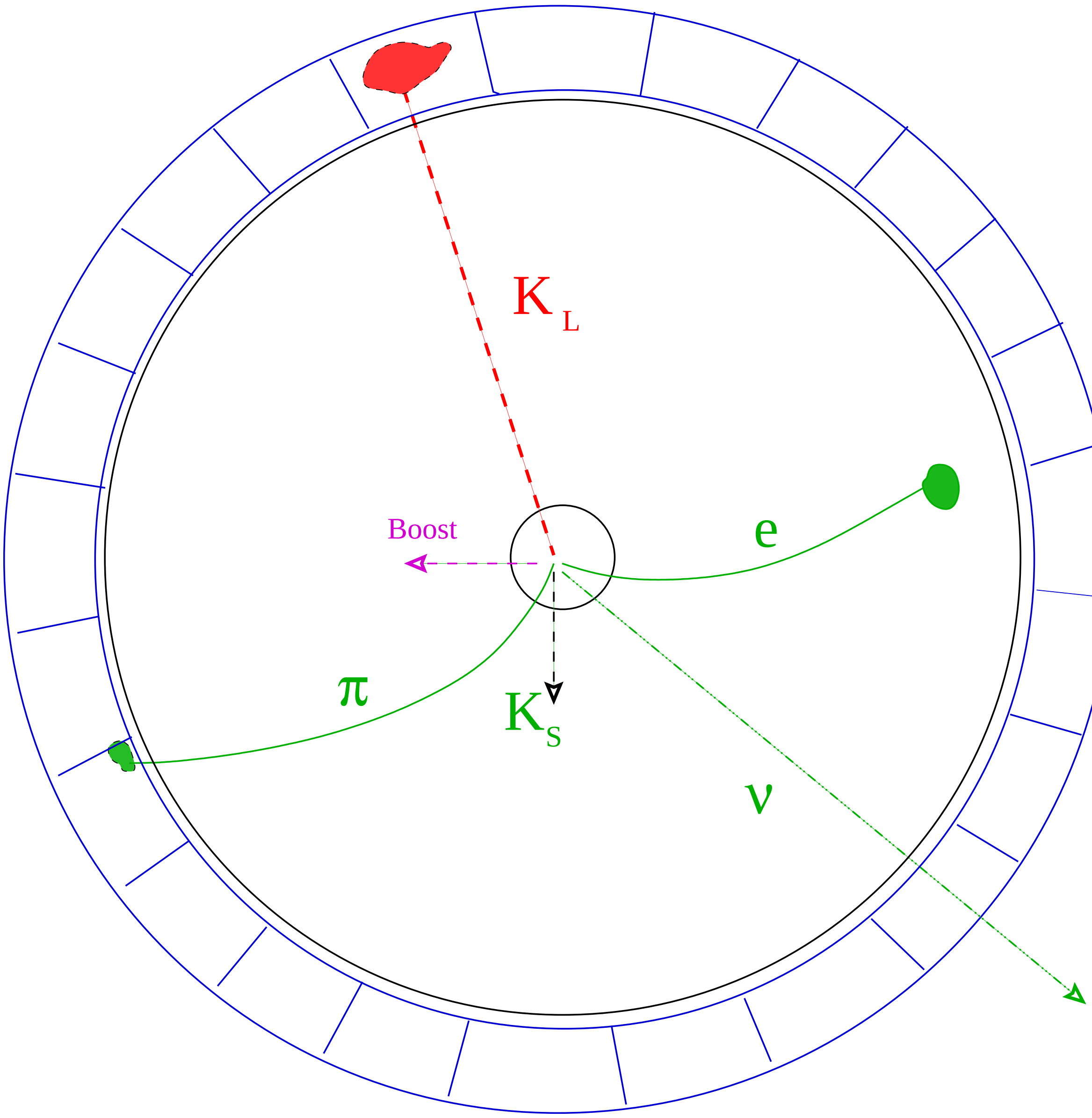
Motivations of the measurement

- Present knowledge on $BR\,(\mathrm{K}_S \to \pi e \nu)$ is based on the single measurement of the CMD experiment at VEPP-2M:
  $BR\,(\mathrm{K}_S \to \pi e \nu) = (7.2 \pm 1.4) \times 10^{-4}$.

- The K_S is tagged requiring a K_L interacting in the calorimeter (called K_{crash}) in the event: this is the most abundant tag and it is almost indipendent of the K_S decay channel.

- In the measure of $\frac{BR(\mathrm{K}_S \to \pi e \nu)}{BR(\mathrm{K}_S \to \pi^+ \pi^-)}$ the total number of tagged events cancels out.

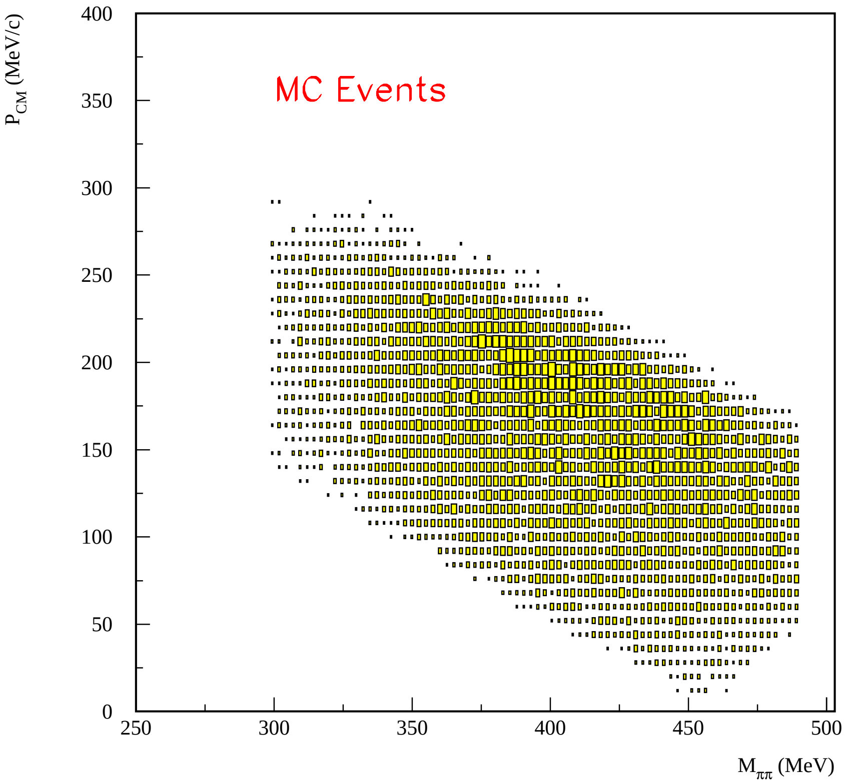
Strategy of the analysis



Analysis overviw: event selection

- Two tracks of opposite charge and a vertex in the K_S fiducial volume ($\rho < 4$ cm, $|z| < 8$ cm) are required

- A cut is applied on the invariant mass in the $\pi\pi$ hypothesis and the K_S momentum in the ϕ rest frame, rejecting the $\mathrm{K}_S \to \pi^+\pi^-$ peak



Analysis overview: klcrash

- The K_{crash} tagging algorithm is based on the identification of the K_L interacting in the calorimeter.
- The following cuts are applied to identify the K_L cluster:

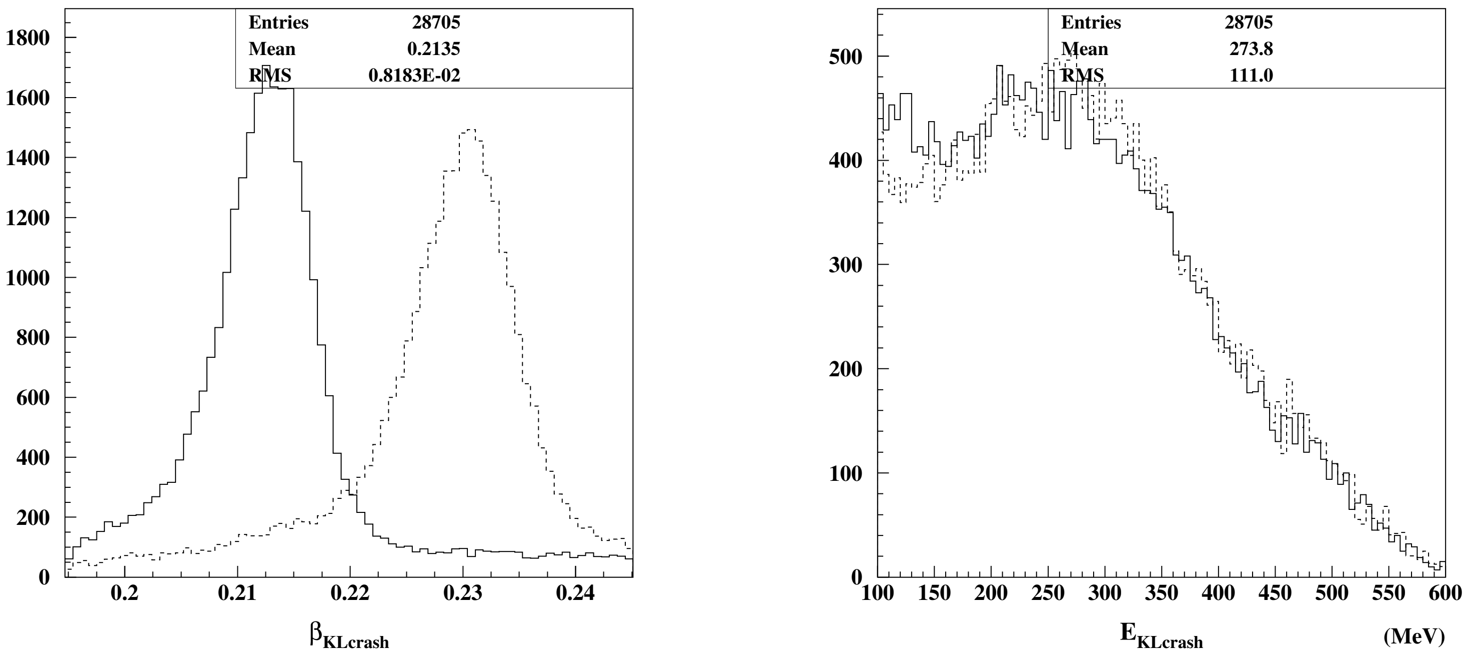
$$E_{cl} \geq 100 \text{ MeV}$$

$$0.195 \leq \beta^* \leq 0.245$$

where E_{cl} is the cluster energy and β^* is the speed of the kaon in the Φ C.M.S., obtained using calorimeter time measurement and the known Φ boost and energy.

- Due to the small time between bunch crossing in $DA\Phi NE$, event times are known modulo the bunch crossing period of 2.7 ns. This time correction is called the T_0 correction. As a first approximation the first cluster in time, with energy ≥ 50 Mev and distance from the beam axis ≥ 60 cm, is assumed to be a photon cluster and used to rephase each time in the event.
- Different K_S decay channels lead to different T_0 corrections, and so to different efficiencies in the K_{crash} tag.

Analysis overview: klcrash



Sample of $K_S \to \pi^0\pi^0$ (solid line), $K_S \to \pi^+\pi^-$ (dashed line) events.
Left: β^* distributions. Right: energy distributions.

Analysis overview: ToF identification

- Main background from $K_S \to \pi^+\pi^-$
  ($\pi \to \mu\nu$ within the DC wall)
- Particle Id. by ToF (a mass hypothesis needed)

$$\delta t(\text{mass}) = t_{cl} - \frac{l}{c\ \beta(\text{mass})}$$

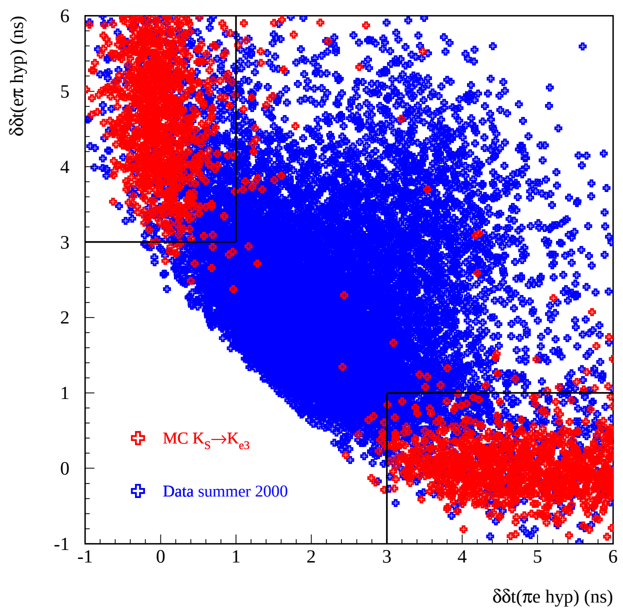
- Independence with respect to the global $T0$ estimation

$$D\delta t(\text{mass 1}, \text{mass 2}) = \delta t(\text{mass 1}) - \delta t(\text{mass 2})$$

- Two cuts are applied:

$$|D\delta t(m_\pi m_\pi)| > 1.5\text{ns}$$

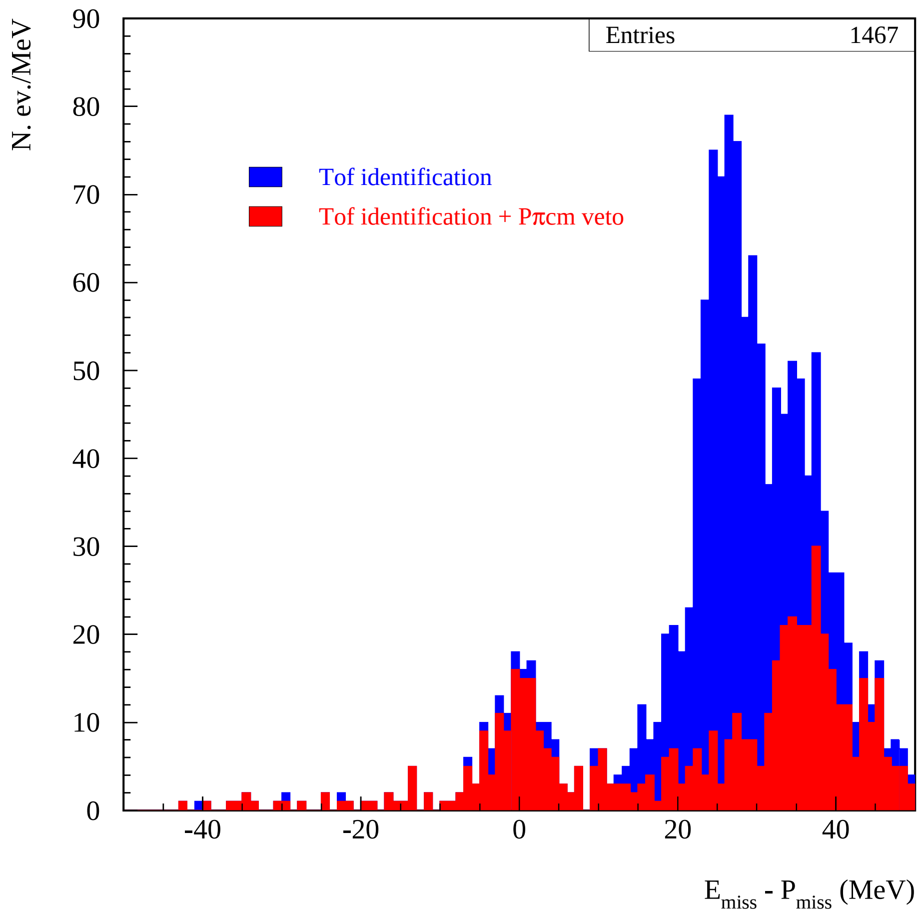
$$|D\delta t(m_\pi m_e)| < 1 \text{ ns and } |D\delta t(m_e m_\pi)| > 3 \text{ ns}$$



Analysis overview: final selection

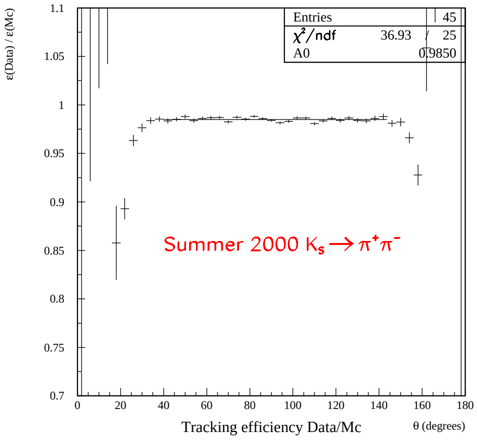
- The kinematics is closed with the K_S momentum estimated using: the direction of the K_{crash} cluster, the ϕ boost and $\sqrt{s}$.

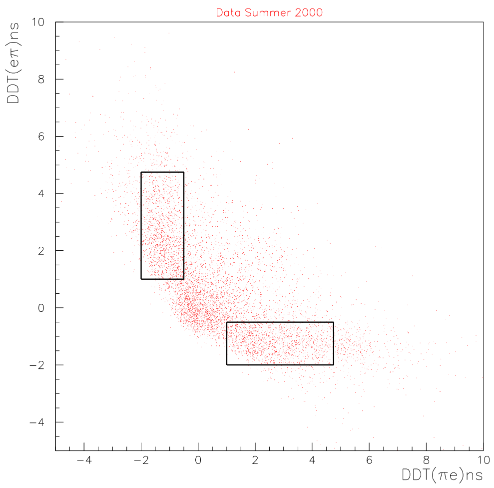
$$E\,(missing)_{\pi e} = E_S - E\,(\pi\ \text{hyp.})_1 - E\,(\text{e hyp.})_2$$



Event selection

- Tracking efficiencies have been preliminary studied on $\mathrm{K}_S \to \pi^+\pi^-$
- Vertex efficiency is under study on the $\mathrm{K}_S \to \pi^0\pi^0$ $\mathrm{K}_L \to \pi e \nu$ (before DC wall) control sample. Comparison with MC shows a difference of about 3%
- At present the efficiency is taken directly from Monte Carlo without any correction: $\epsilon = 62.4 \pm 0.3\%$

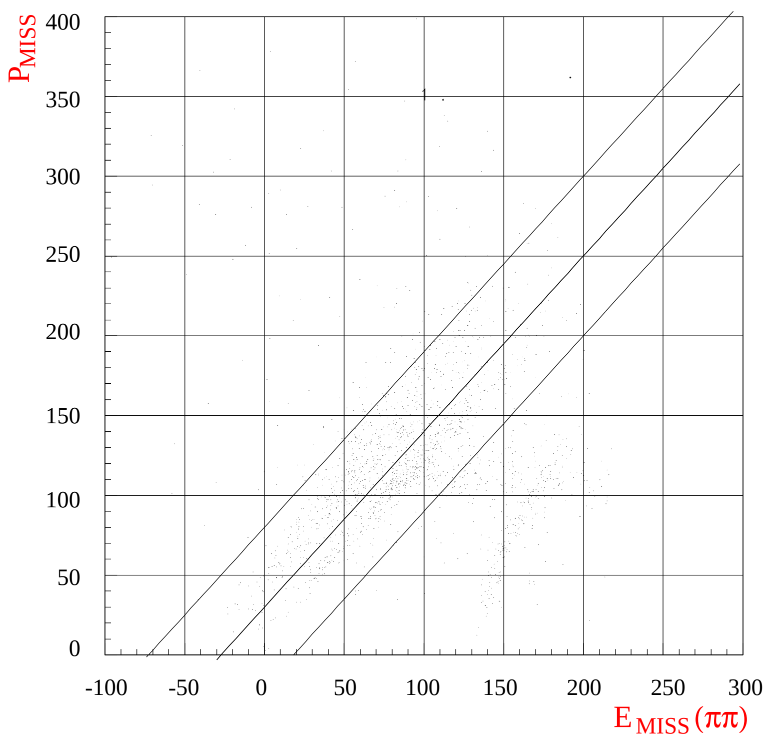


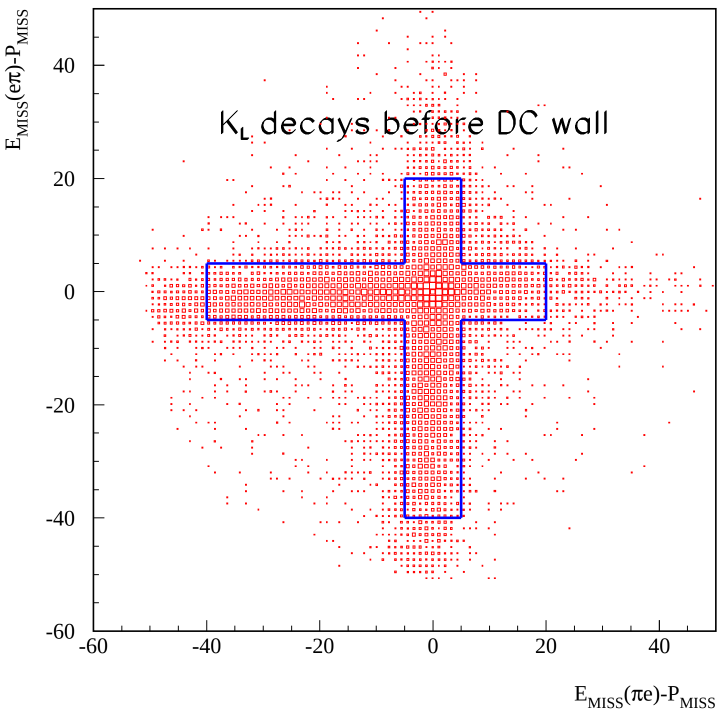


Left: Comparison between DATA and MC for single track efficiency.
Right: Selecting tracks coming from before the DC, associated to a cluster, the DDT cut is still a good variable to select $\mathrm{K}_L \to \pi e \nu$, even if the vertex position is not known.

Tca, T0 and calorimeter trigger efficiencies. Method 1

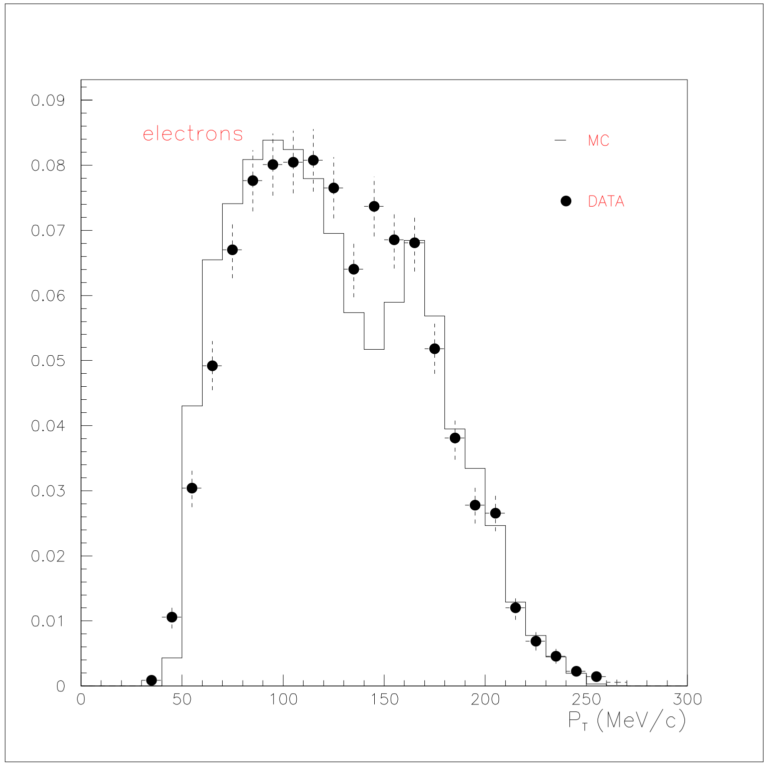
- $\mathrm{K}_S \to \pi^+\pi^-$ and $\mathrm{K}_L \to \pi e \nu$ before the DC wall. The events are selected cutting on kinematics at the K_L vertex.
- The trigger and $T0$ of the event is required using K_S pions clusters only.
- Events with superposition of K_S and K_L clusters have been rejected.

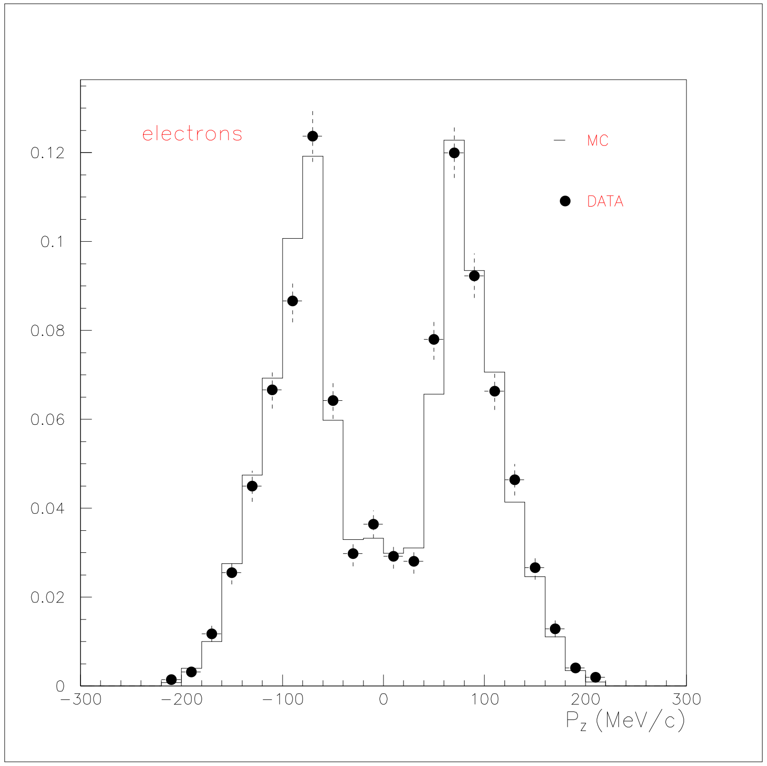




Tca, T0 and calorimeter trigger efficiencies. Method 1

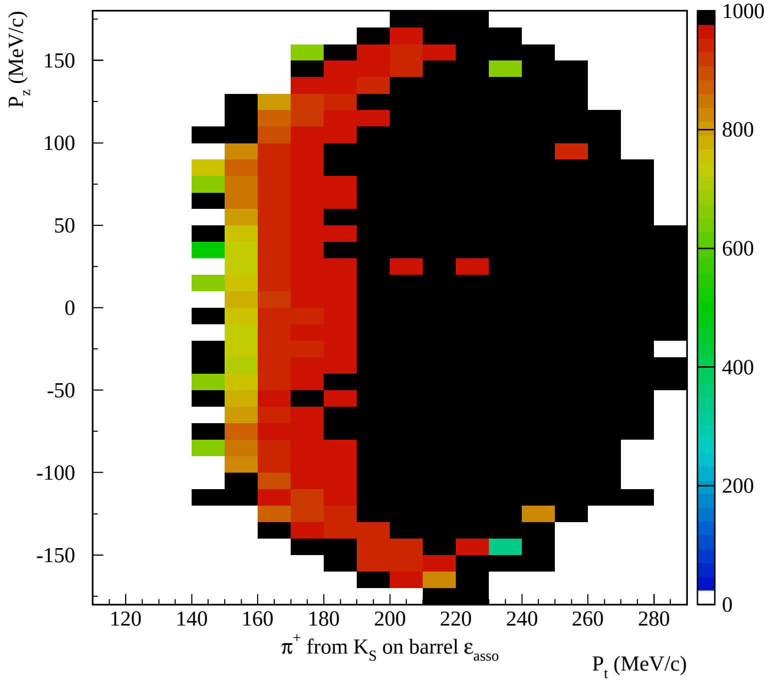
- The comparison of the kinematic population of this control sample, with respect to Monte Carlo simulation of $\mathrm{K}_S \to \pi e \nu$ has been performed **per single track** and shows a good agreement.
- TCA, T_0 and trigger efficiency is obtained directly from this sample.

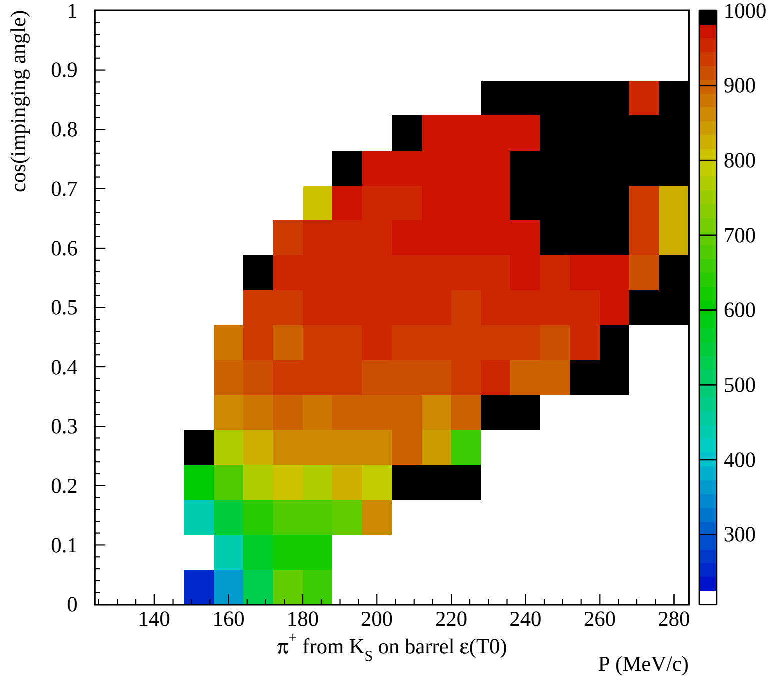




Tca, T0 and calorimeter trigger efficiencies. Method 2

- From $K_S \rightarrow \pi^+\pi^-$, K_{crash} and $K_S \rightarrow \pi^+\pi^-$, $K_L \rightarrow \pi e \nu$ events we estimate TCA, $T0$ and sector efficiencies **per single track** used to weight the Monte Carlo kinematics.
- The error on the mean efficiency estimations is calculated including the errors on the efficiencies and the Monte Carlo statistics





Tca T0 and Trig Efficiencies results

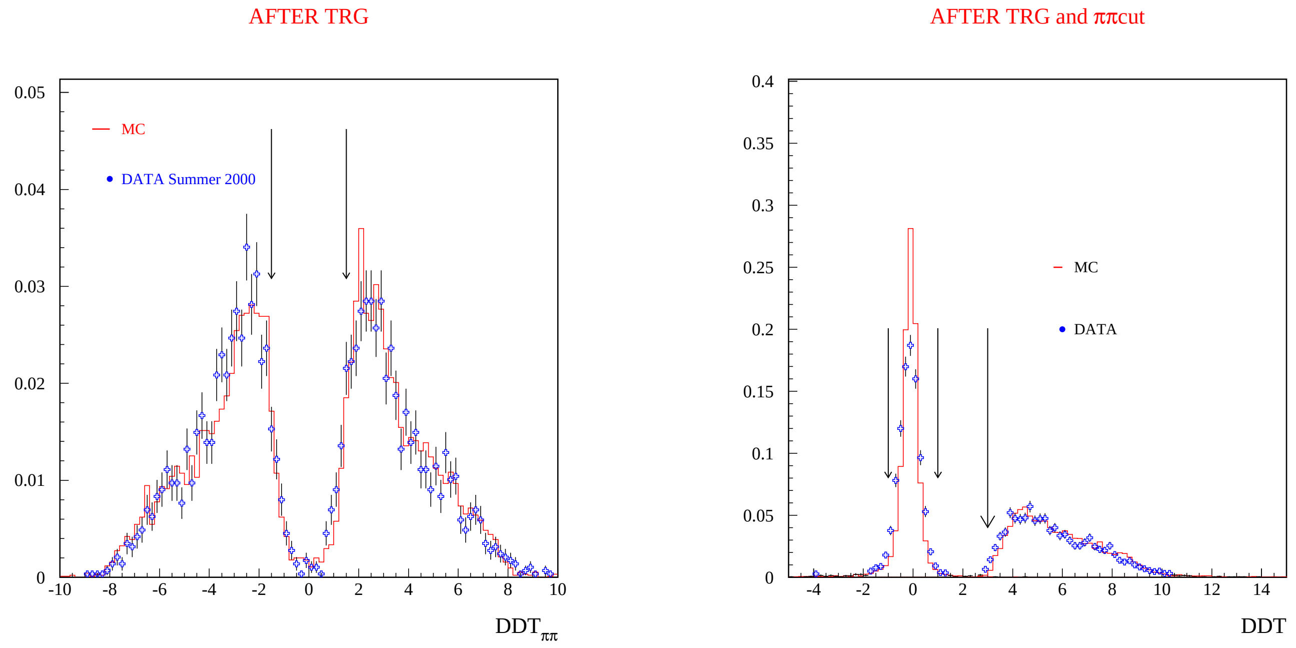
Period Method	Acceptance	Category	2TCA	$T0$	TRG sect≥ 1
1999 (1)	-	-	$91.8 \pm 0.5 \pm 0.6$	99.9 ± 0.1	-
1999 (2)	45.67 ± 0.03	97.5 ± 0.2	$92.1 \pm 0.1 \pm 0.6$	$99.8 \pm 0.3 \pm 0.4$	-
2000 (1)	-	95.6 ± 0.3	92.0 ± 0.4	99.83 ± 0.07	87.8 ± 0.5
2000 (2)	51.1 ± 0.02	95.9 ± 0.1	$93.1 \pm 0.2 \pm 0.3$	99.6 ± 0.1	89.4 ± 0.44

Period Method	2TCA+$T0 + TRG^*$
1999 (1)	-
1999 (2)	-
2000 (1)	85.1 ± 0.5
2000 (2)	85.6 ± 0.5

* Including K_{crash} trigger sector efficiency: one sector hit in 59.5% of the time, more than two sector hit in 40.5% of the time.

ToF efficiency

- $D\delta t$ distributions in $\mathrm{K}_L \rightarrow \pi e \nu$ decays before the DC wall, are compared with MC ones, passing semileptonic stream, K_{crash} and trigger.
- The efficiency for the cut $|D\delta t(\pi\pi)| > 1.5$ ns is 91.5±0.5% (92.9±0.3%)
- The efficiency for the cut $|D\delta t(\pi e)|$ is 91.8±0.5% (92.0±0.3%)



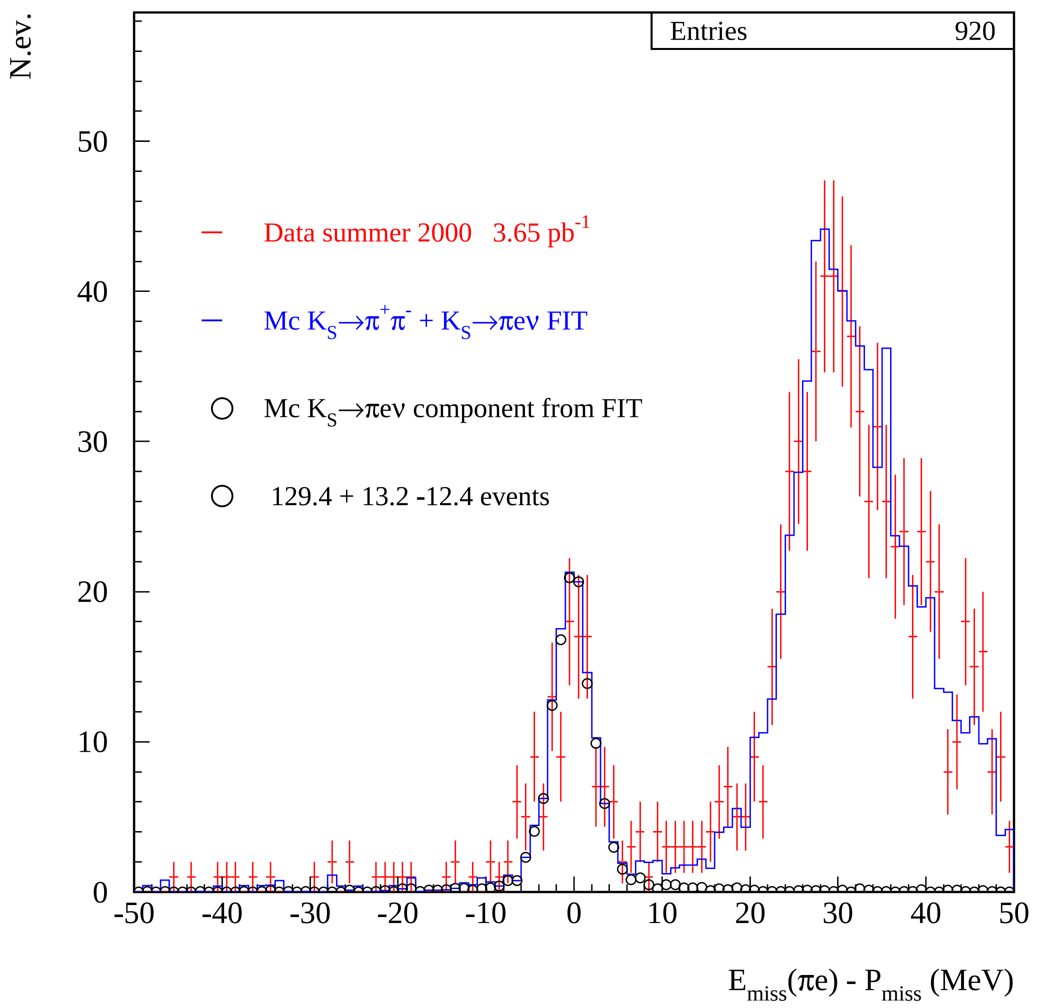
The total efficiency is 84.0±0.6% (85.4±0.4%)

Event counting (1)

- Monte Carlo simulation is used to obtain $\mathrm{K}_S \to \pi^+\pi^-$ background and $\mathrm{K}_S \to \pi e \nu$ spectra of $E_{miss} - P_{miss}$

- The data histogram is fitted with the linear combination of MC spectra

Event counting (2)



Conclusions and outlook

- Preliminary estimate of the total selection efficiency (K_{crash} excluded) gives $\epsilon = 0.218 \pm 0.003$.
- Our branching ratio estimate is $BR\,(\mathrm{K}_S \rightarrow \pi e \nu) = (8.9 \pm 0.9) \times 10^{-4}$ to be compared with the expected value $(6.70 \pm 0.07) \times 10^{-4}$.
- Systematics in valueting efficiency are still to be considered.