$\Gamma\left(\mathrm{K}_S \longrightarrow \pi e \nu\right)$ measurement update

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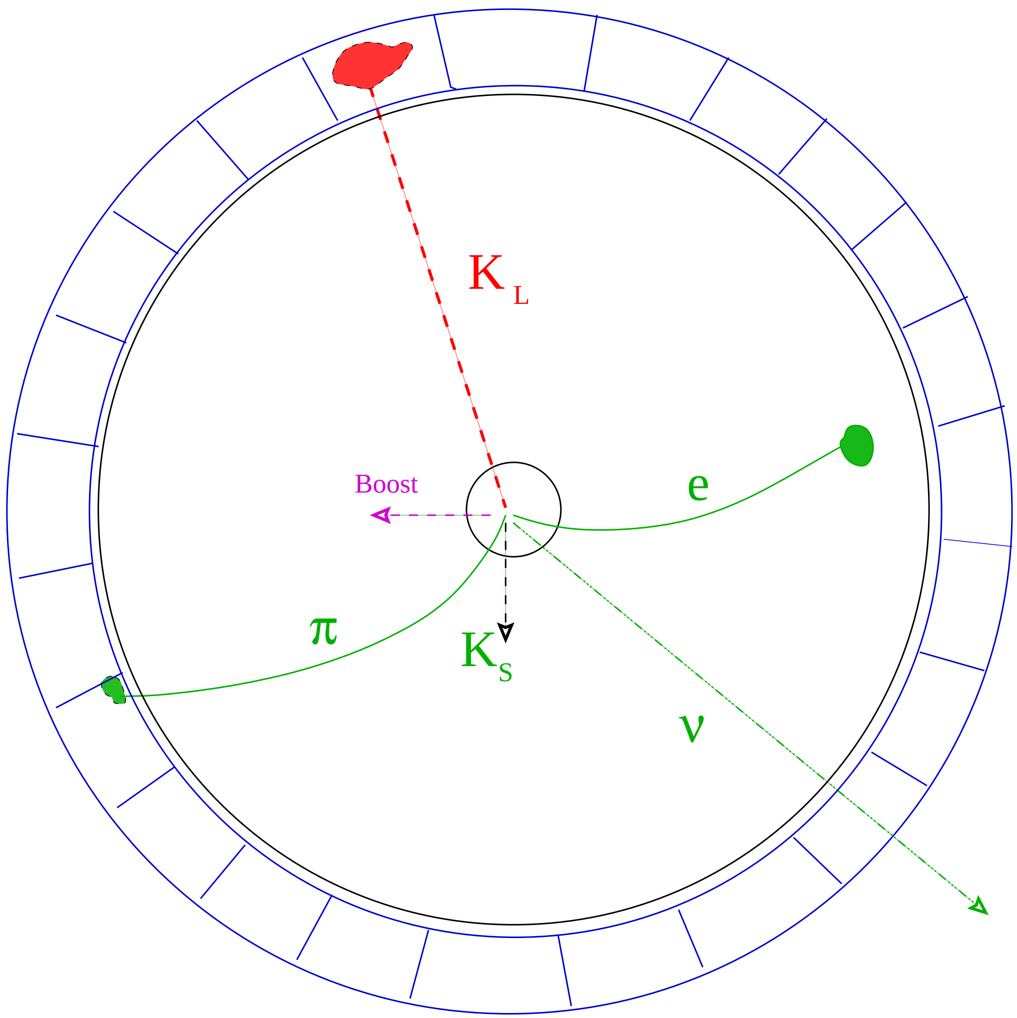
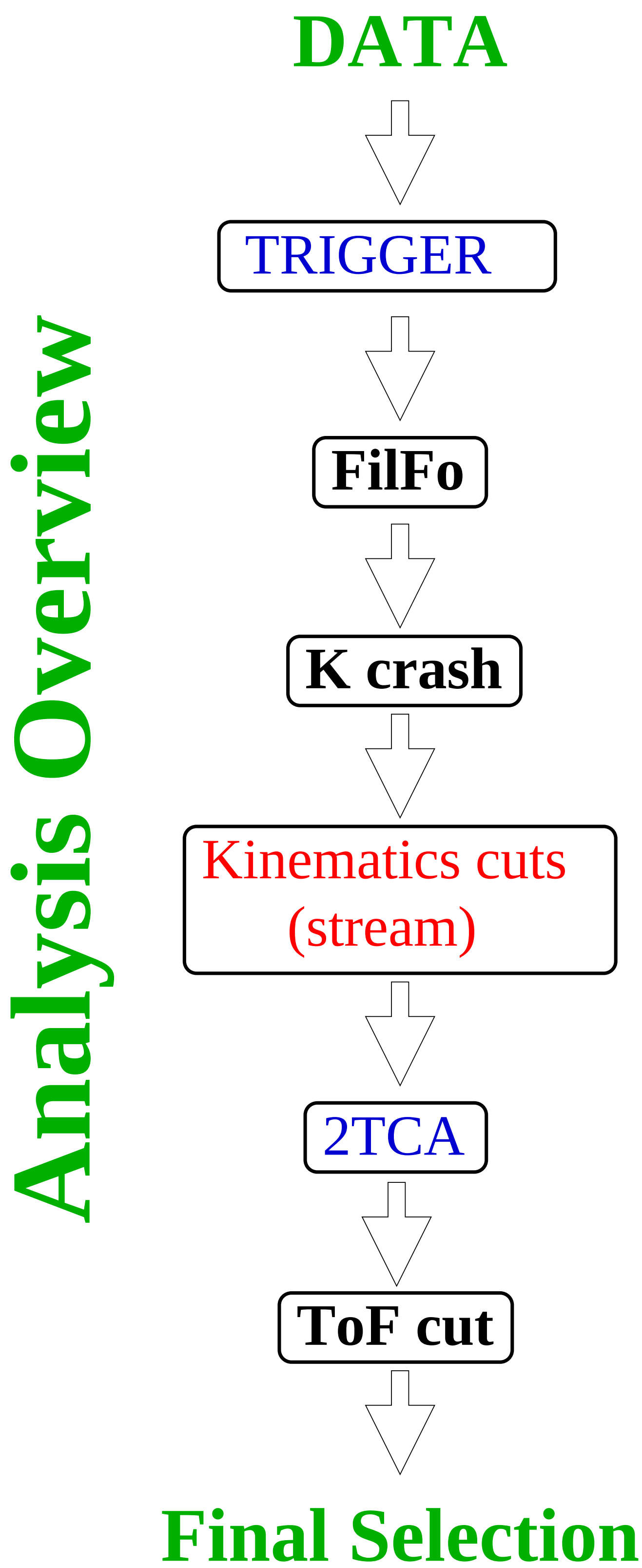
Summary

- **Event selection**
- **Efficiencies estimates**
  - **Kinematic preselection**
  - **Extrapolation, TCA, Trigger, T0**
  - **Tag bias due to the T0**
- **Conclusions and outlook**

Event selection



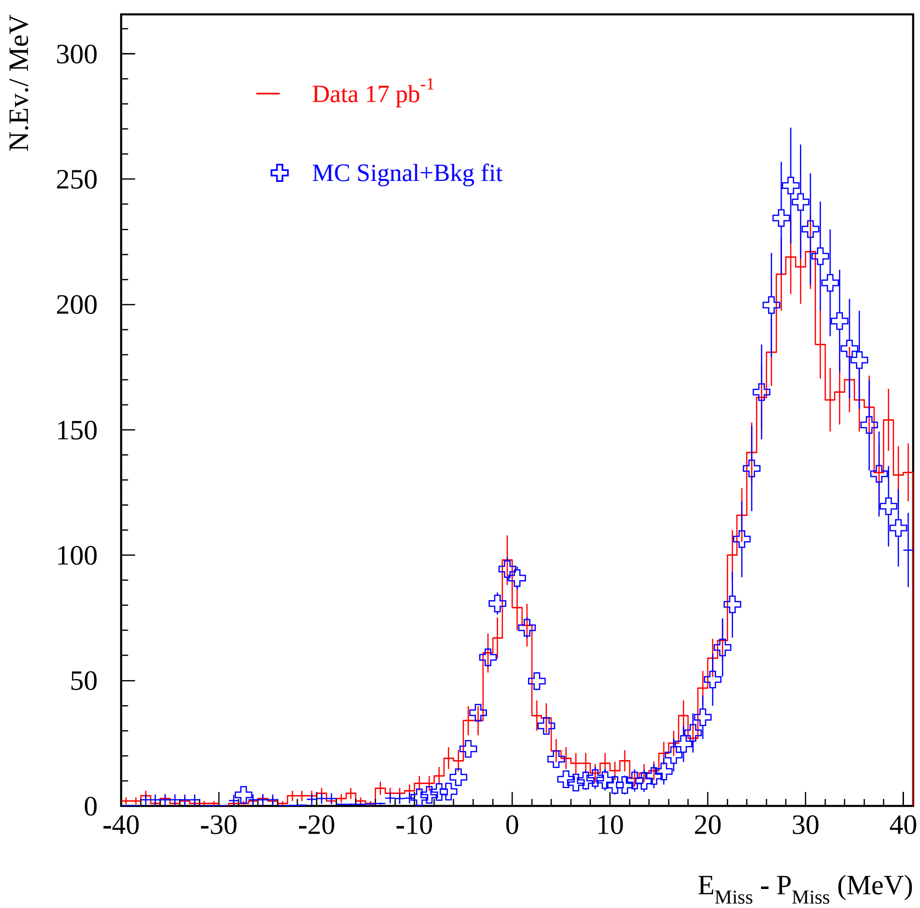
Event selection overview



Analysis overview: final selection

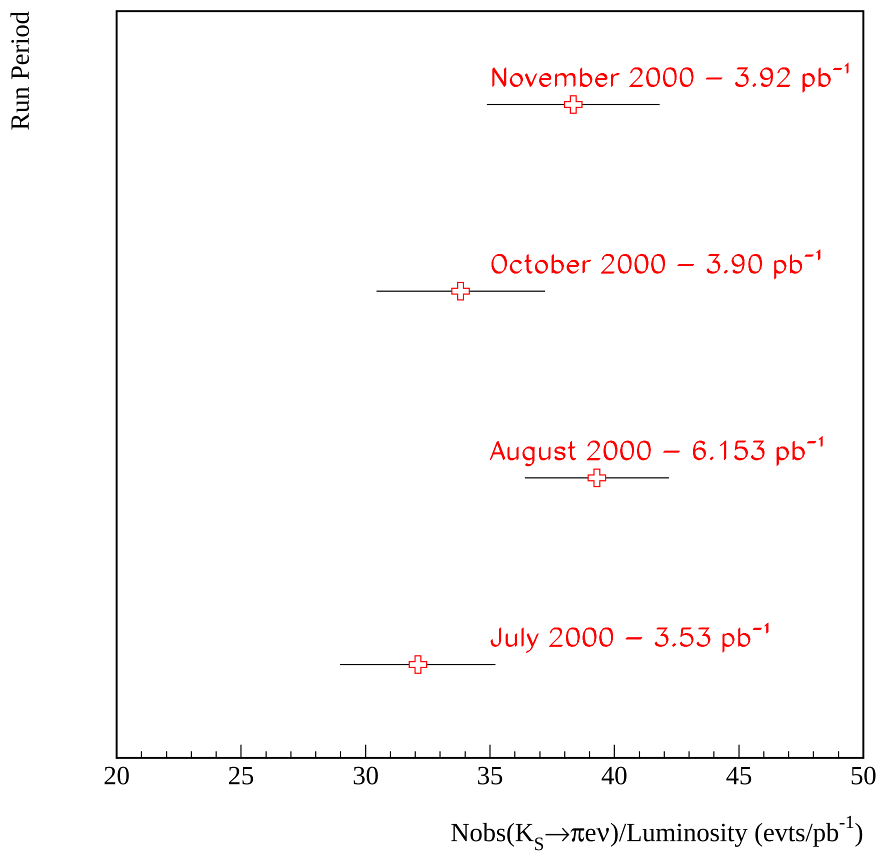
- The kinematics is closed with the K_S momentum estimated using: the direction of the K_{crash} cluster, the ϕ boost and $\sqrt{s}$.

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



Analysis overview: final selection

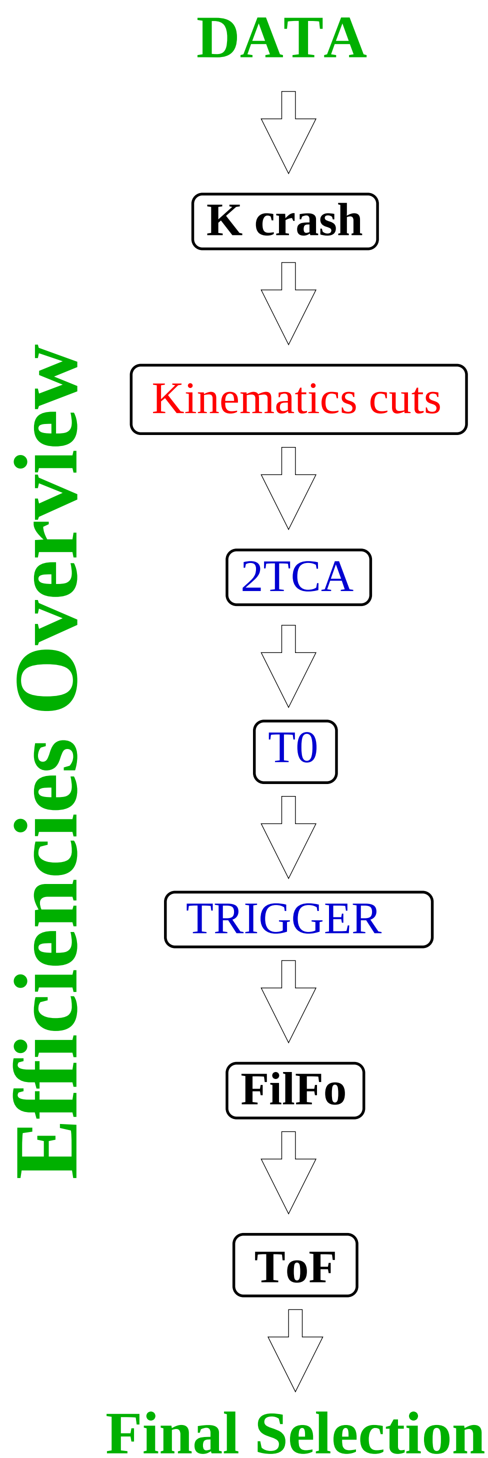
- Observed events per pb^{-1}



Analysis overview: final selection

Period	Luminosity	Nobs	Nobs/pb
July-August 15/7→5/8	3.53 pb^{-1}	113 ± 11	32.1 ± 3.1
October-November 30/10→15/11	6.15 pb^{-1}	242 ± 18	39.3 ± 2.9
November 15/11→24/11	3.90 pb^{-1}	132 ± 13	33.8 ± 3.4
November-December 24/11→6/12	3.92 pb^{-1}	150 ± 14	38.3 ± 3.5
Year 2000 Summary 15/7 → 6/12	17.5 pb^{-1}	627 ± 31	35.8 ± 1.7

Efficiencies estimates: overview



Efficiencies estimates: Outlook

- Efficiencies needed in order to measure the ratio of the branching ratios $\frac{B(\mathrm{K}_S \to K_{e3})}{B(\mathrm{K}_S \to \pi^+\pi^-)}$, (at the % level):

$$\frac{\langle \epsilon\,(\text{2 trks, 1 vtx IP, InvMass})\rangle \times \epsilon\,(\text{2 Extrap} \bullet \text{2 TCA} \bullet \text{T0} \bullet \text{TRG}) \times \epsilon\,(\text{Tof cut})}{\langle \epsilon\,(\text{2 trks from IP to the EmC})\rangle \times \epsilon\,(\text{T0} \bullet \text{TRG})} \times \frac{\epsilon\,(\text{tag}(\pi e \nu))}{\epsilon\,(\text{tag}(\pi^+\pi^-))}$$

Channel		Subject to be studied
$\mathrm{K}_S \to \pi^+\pi^-$	$\mathrm{K}_L \to K_{e3}$ near IP	TRG, T0 and TCA, VTX (?), tag-bias
$\mathrm{K}_S \to \pi^+\pi^-$	$\mathrm{K}_L \to K_{\mathrm{crash}}$	TRK and TCA efficiency for π, tag-bias
$\mathrm{K}_S \to \pi^0\pi^0$	$\mathrm{K}_L \to K_{e3}$ near IP	VTX
$\phi \to \pi^+\pi^-\pi^0$		TCA efficiency for π
$e^+e^-\gamma$	with low p_t electrons	TRK efficiency for $e^\pm$

Kinematic preselection: tracking efficiency

- Tracking efficiencies has been preliminary studied on $\mathrm{K}_S \to \pi^+\pi^-$
- The low-P_t-region is not entirely covered by $\mathrm{K}_S \to \pi^+\pi^-$
- Radiative-Bhabha events could be used to cover the low-P_t range.
- By now the efficiency is taken directly from Monte Carlo without any correction: $\epsilon = 62.4 \pm 0.3\%$

Kinematic preselection: vertex efficiency

- 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

- Selection is done using tof identification and PCA of the tracks to the origin

- The vertex efficiency data vs. Monte Carlo has also to be estimated in $K_S \to \pi^+\pi^-$ events, as function of the run period

- Both works are in progress

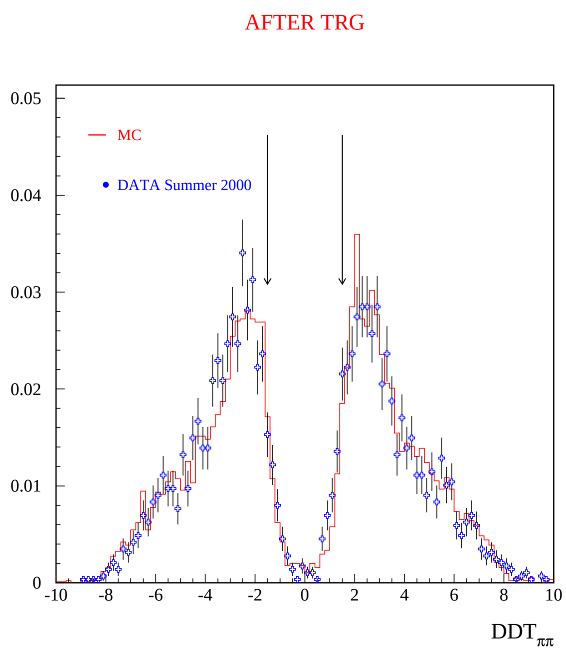
Extrapolation, Tca T0 and Trig Efficiencies results

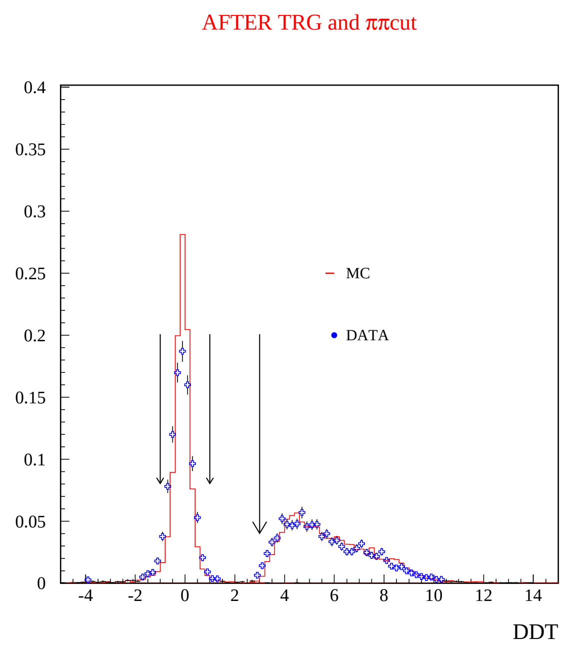
Method	Acceptance	Category	2TCA	T0	$S \geq 1$
1	-	95.6 ± 0.3	$92.0 \pm 0.4 \pm 0.37$	$99.83 \pm 0.07 \pm ??$	$87.8 \pm 0.5 \pm ??$
2	51.1 ± 0.02	95.9 ± 0.1	$93.1 \pm 0.2 \pm 0.3$	99.6 ± 0.1	87.1 ± 0.44

Method	trig	2TCA+T0+TRIG
1	92.65 ± 0.5	85.1 ± 0.5
2	92.3 ± 0.5	85.6 ± 0.5

ToF efficiency

- $D\delta t$ distributions in $\mathrm{K}_L \to \pi e \nu$ decays before the DC wall, are compared with MC ones, passing semileptonic stream, K_{crash} and trigger.



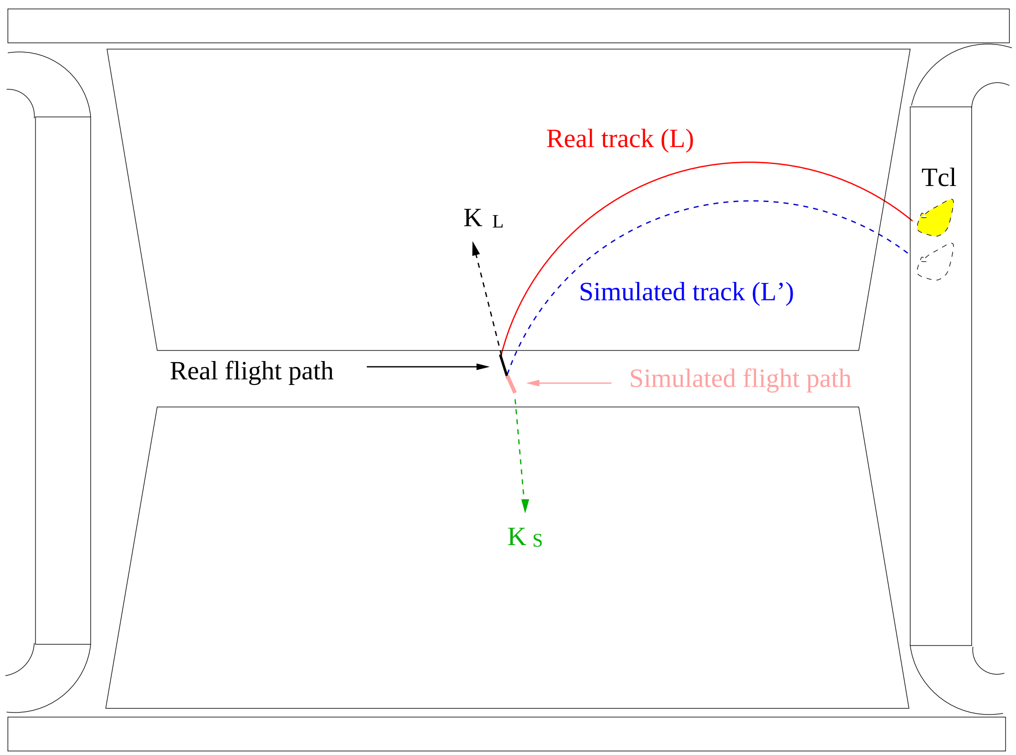


The final result for the TOF efficiency is:

$$\varepsilon_{TOF}(data) = (82.0 \pm 0.007)\,\% \; ; \; \varepsilon_{TOF}(MC) = (83.5 \pm 0.004)\,\%$$

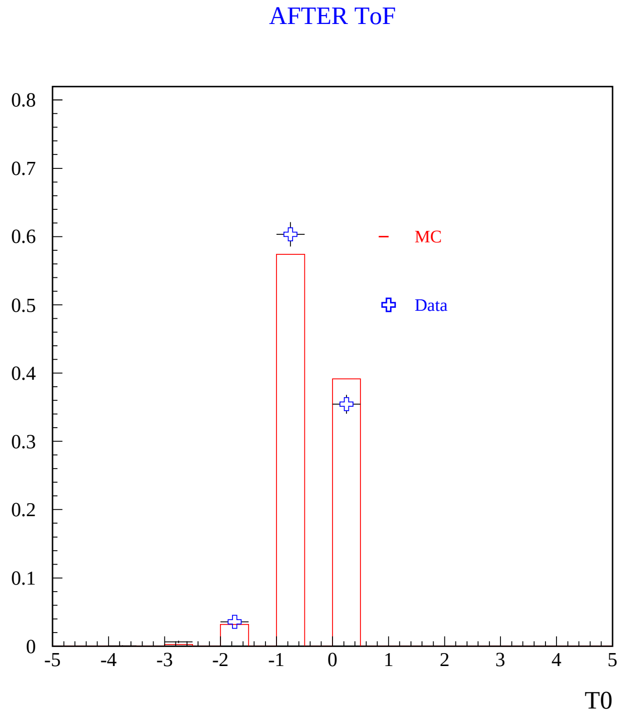
News - Tag bias

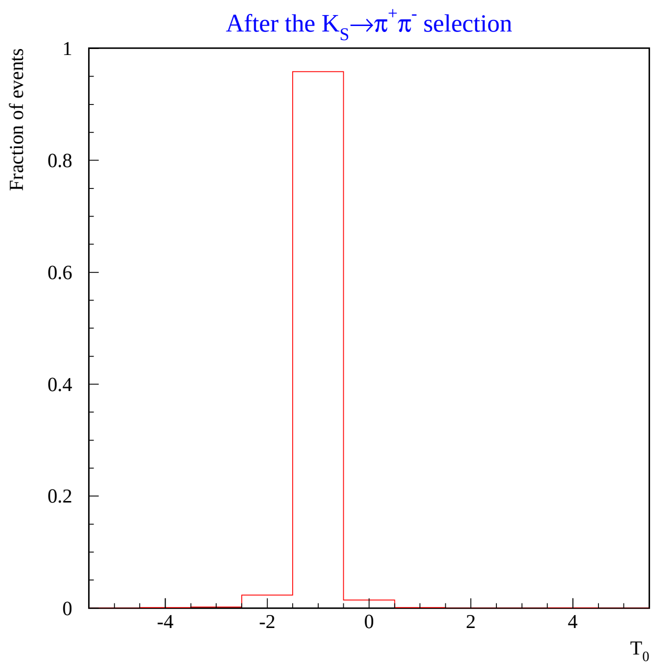
- Ratio of K_{crash} efficiencies has (almost) been estimated
- T_0 bunch populations (affecting β^*), have been estimated for semileptonic and $\pi^+\pi^-$ decays.
- T_0 distribution obtained for $\pi e \nu$ decays using the $K_S \to \pi^+\pi^-$, $K_L \to \pi e \nu$
- K_L time of flight and clusters topology is offline corrected to reproduce the signal



News - Tag bias

- $K_S \to \pi^+\pi^-$ T0 distribution obtained using K_S-tagging through $K_L \to \pi^+\pi^-\pi^0$ identification, T0-TRG unbiased
- Global T0 rephased using K_L photons and K_L vertex direction is always correct at the 3×10^{-3} level (checked using accompanying $K_S \to \pi^0\pi^0$)





News - Tag bias

- Final correction estimated using correct-T0 events ($\pi^+\pi^-$-rephased):

$$R_{\rm tag}^{\pm/{\rm ke3}} = \frac{\sum_m p_m^{\pm} \times N_m}{\sum_n p_n^{ke3} \times N_n}$$

- The final result for the tag bias is obtained:

$$\frac{\varepsilon_{tag}(K_S \to \pi^+\pi^-)}{\varepsilon_{tag}(K_S \to \pi e \nu)} = (97.7 \pm 0.4_{\rm stat} \pm 0.5_{\rm syst})\,\%$$

- Statistical error takes into account correlations between the N_n's and statistical error on the p_n's
- Systematic error takes into account the presence of pion fragments in $K_S \to \pi^+\pi^-$ events (Talk by P. Valente)

Efficiencies results

Preselection	$62.4 \pm 0.3_{\rm stat} \pm ??$
Acceptance	$51.1 \pm 0.2_{\rm stat}$
Category	$95.8 \pm 0.1_{\rm stat} \pm 0.3_{\rm syst}$
2TCA•T0•TRG	$85.3 \pm 0.4_{\rm stat} \pm 0.5_{\rm syst}$
TOF	$82.0 \pm 0.7_{\rm stat} \pm ??$

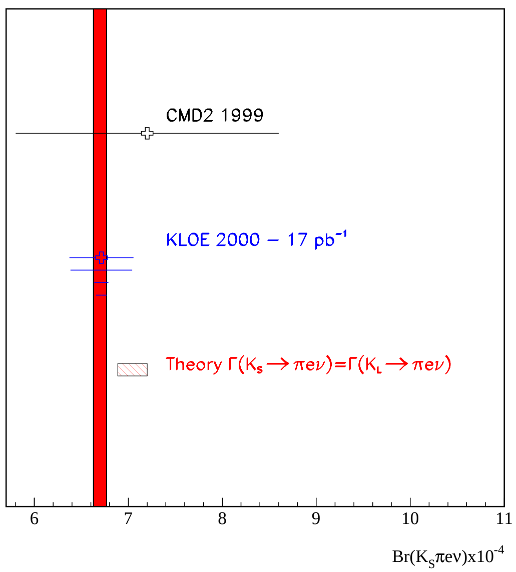
Efficiency	$21.4 \pm 0.2_{\rm stat} \pm 0.2_{\rm syst}$

Tag ratio	$97.7 \pm 0.4_{\rm stat} \pm 0.5_{\rm syst}$

Total Correction	$21.9 \pm 0.2_{\rm stat} \pm 0.2_{\rm syst}$

Conclusions and outlook

- Preliminary estimate of the total selection efficiency (K_{crash} excluded) gives $\epsilon = 0.219 \pm 0.003$.
- Normalizing to the $K_S \to \pi^+\pi^-$ events in the Summer period, one gets $BR = (6.7 \pm 0.3) \times 10^{-4}$ (5% relative error, dominated by the statistics)



Overlook

- Track-vertex efficiency still to be addressed: corrections are expected to be at the level of some percent
- In the forthcoming memo all *other* systematics estimated
- The perspectives on this measurement include the possibility to test the $\Delta S = \Delta Q$ rule, in a CPT-conserving framework
- The same level of statistical precision of CPLEAR ($\Re x = 6 \times 10^{-3}$) can be achieved with a measurement with a relative accuracy (better) of 2.3%
- This correspond to a sample of ~ 60 pb^{-1}, with present selection efficiency
- Work on the systematic side could be improved...
- Maybe, release the vertex cut in preselection phase?