Kaon TOF efficiencies in real data using $\phi \rightarrow KK$

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Event and track selection

- Event selection:
  - V0M centrality ($|cent_{V0M} - cent_{TRK}| < 5\%$)
  - Centrality bin width = 10%
- Global track (std cuts, FB=16)
  - $|N\sigma_{TPC}^{K}| < 3$
  - $|\eta^{K}| < 0.8$, $0.3 < p_T^{K} < 2.5$ GeV/*c*
  - $|\eta^{\phi}| < 0.8$, $0.0 < p_T^{\phi} < 5$ GeV/*c*
- tested: TOF
  - TOF matching efficiency for kaons
  - Bayesian PID efficiency for kaons: P > 0.2, 0.4, 0.5, 0.8

Run list and MC

DATA: LHC10H
7.8M events (0-90%)
Runs (AOD086):

137161	138190
137231	138192
137232	138201
137366	138225
137431	138275
137539	138364
137541	138396
137549	138442
137595	138534
137608	138653
137686	139038
137691	139107
137722	139437
137752	139465
137844	

MC: LHC11a10a_bis
PbPb, Hijing standalone, LHC10h anchors, 2760GeV (repeat of LHC11a10a), ID #254

Same run list as in data (AOD120)
750k events (0-90%)

With:
Å TuneOnData ON.
Å TPC η-dependance

TOF parameterization:
I-AliAODpidUtil::InitializeTOFResponse: TOF PID Params loaded from OADB
I-AliAODpidUtil::InitializeTOFResponse: TOF resolution 80.00 [ps]
I-AliAODpidUtil::InitializeTOFResponse: StartTime method 1
I-AliAODpidUtil::InitializeTOFResponse: TOF res. mom. params: 0.01 0.01 0.00 40.00

Why PbPb?
PbPb allows to look also at the effect of mismatch, while pp collisions allow to check the start time efficiency.

Definitions

1. TPC tracks	Filter bit 16 required
2. TOF tracks	kTOFout and kTIME
3. TOF good tracks	$\|n\sigma_{TOF}\|<3$
4. TOF 2σ	$\|n\sigma_{TOF}\|<2$
5. TOF PID	PID cut applied

TAB-A
Definition from track cuts

1. Matching efficiency	TAB-A (2) / TAB-A (1)
2. Good match efficiency	TAB-A (3) / TAB-A (2)
3. Gaussianity check	TAB-A (4) / TAB-A (3)
4. PID efficiency	TAB-A (5) / TAB-A (3)

TAB-B
Definition for efficiency

TAB-B (1): it reflect the TOF matching efficiency
TAB-B (2): = 1 – mismatch fraction
TAB-B (3): = 0.957 (Gaussian), = 0.932 (Gaussian+tail)
TAB-B (4): it reflect efficiency for Bayesian PID

MC analysis to tune the procedure

Fit function

Signal → Voigtian (Breit-Wigner ⊗ Gaussian)

Å Mass, Width and resolution parameters fixed.

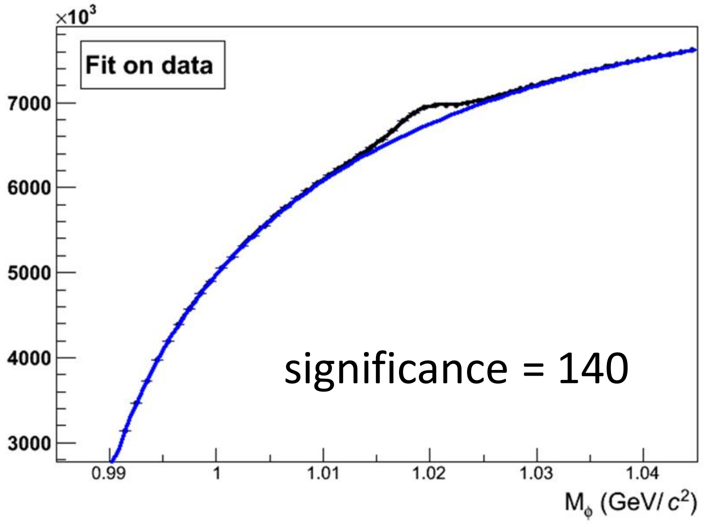
Background → Polinomial($\sqrt{M_{inv}}$)

- = $ax^{1/2} + bx + cx^{3/2} + dx^2 + ex^{5/2}$
- x = $M_{inv} - 0.987$

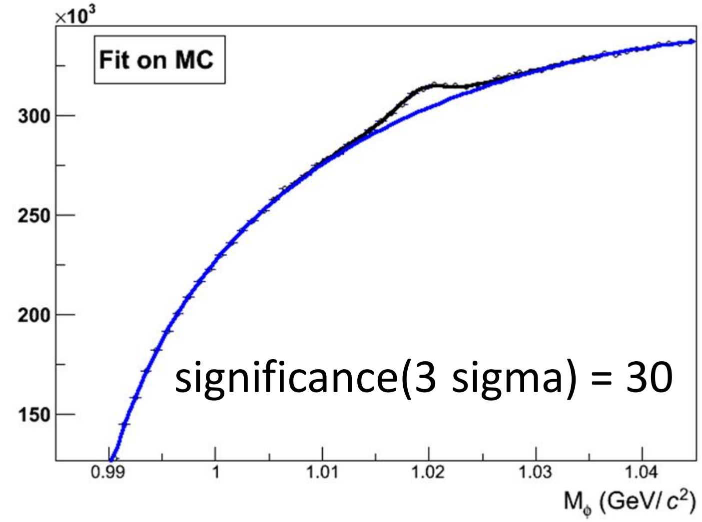
N.B. No background subtraction (only fitted)

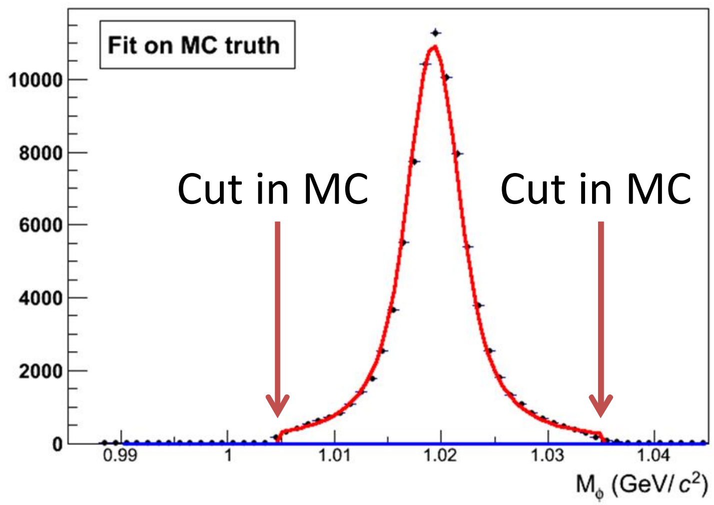
Fits

1.86M reconstructed ϕ (0.24 per event)



86k reconstructed ϕ (0.11 per event)





MC was fitted with a Breit-Wigner with a cut according to the MC generator.
Yields extracted by counting when truth was used.

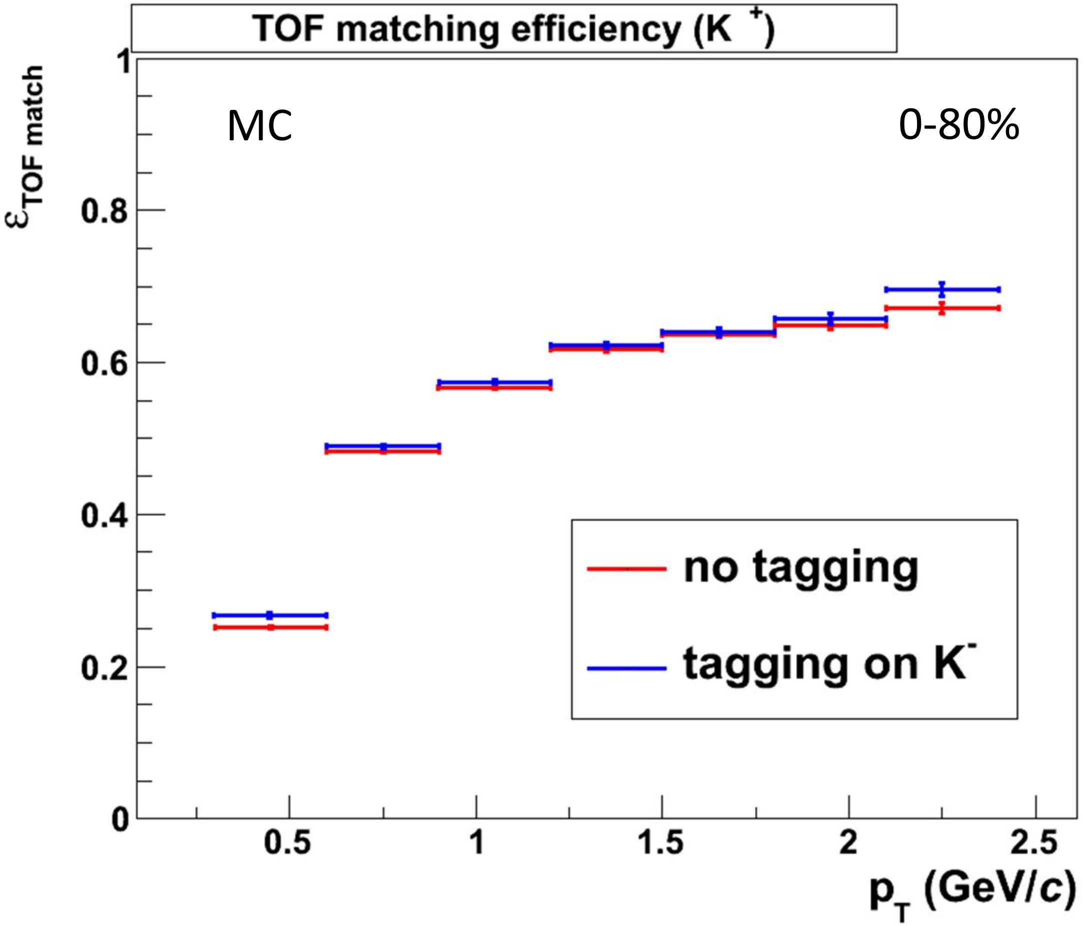
Tagging

In order to reduce background we studied separately positive and negative kaons.

When studying K^+ we applied a cut on K^- (and *viceversa*) and we estimated efficiency of K^+ (K^-) in its p_T bins (ϕ p_T not used at all).

Therefore we directly measured efficiency for single kaons using the yield extraction of the ϕ.

Negligible bias for tagging

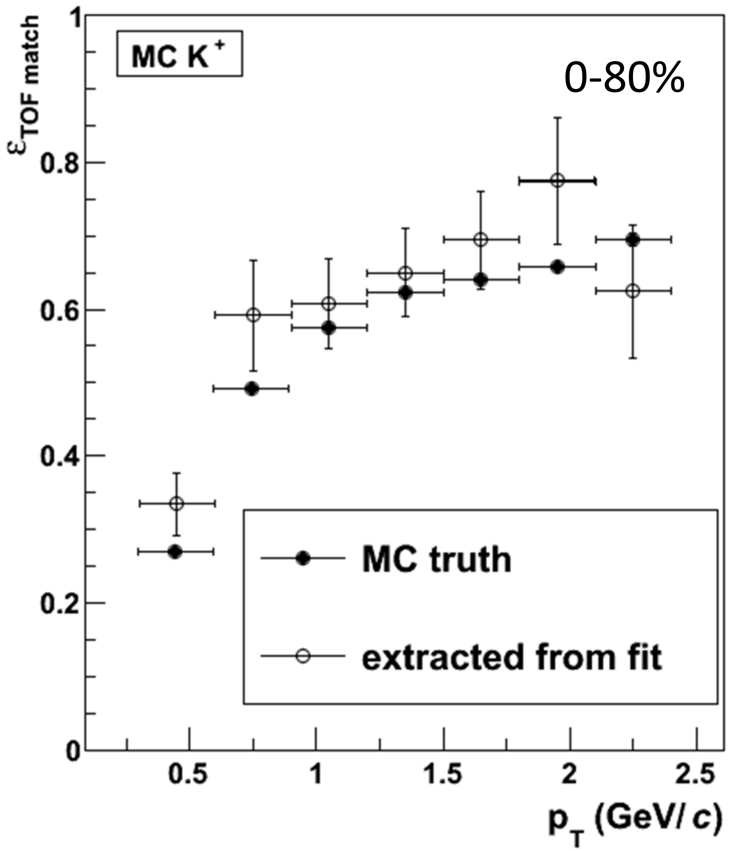


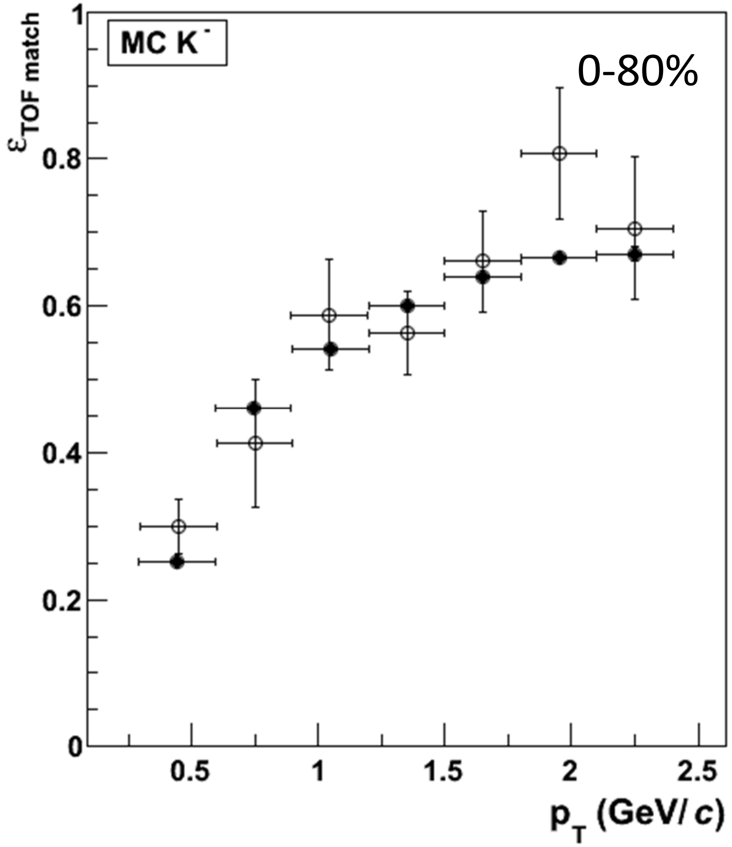
Tagging:
TOF probability > 0.8.
TOF not uniform acceptance can affect the measurement?

We check the effect on the efficiency due to the tagging on K^-.
The effect is negligible.

Tagging was always used in the next results!

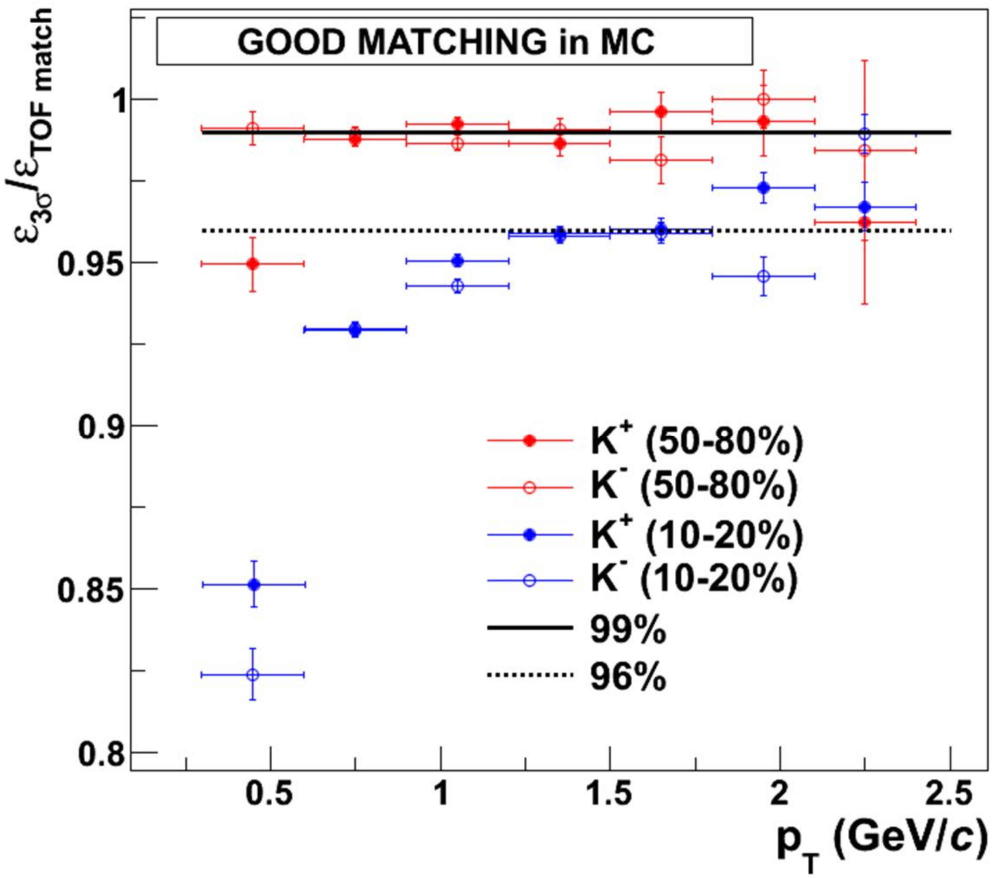
TOF matching efficiency



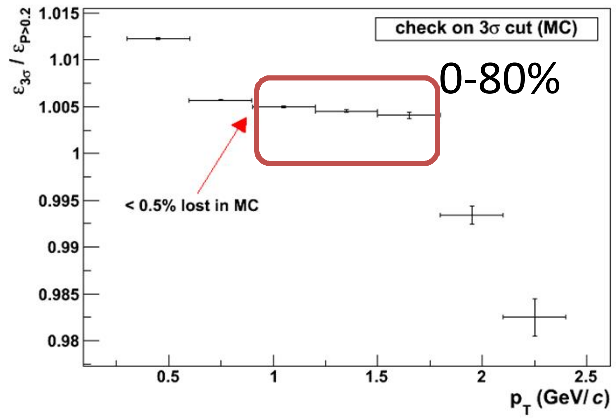


TOF matching efficiency was checked in MC e compared with the yield extraction procedure.

Good TOF matching

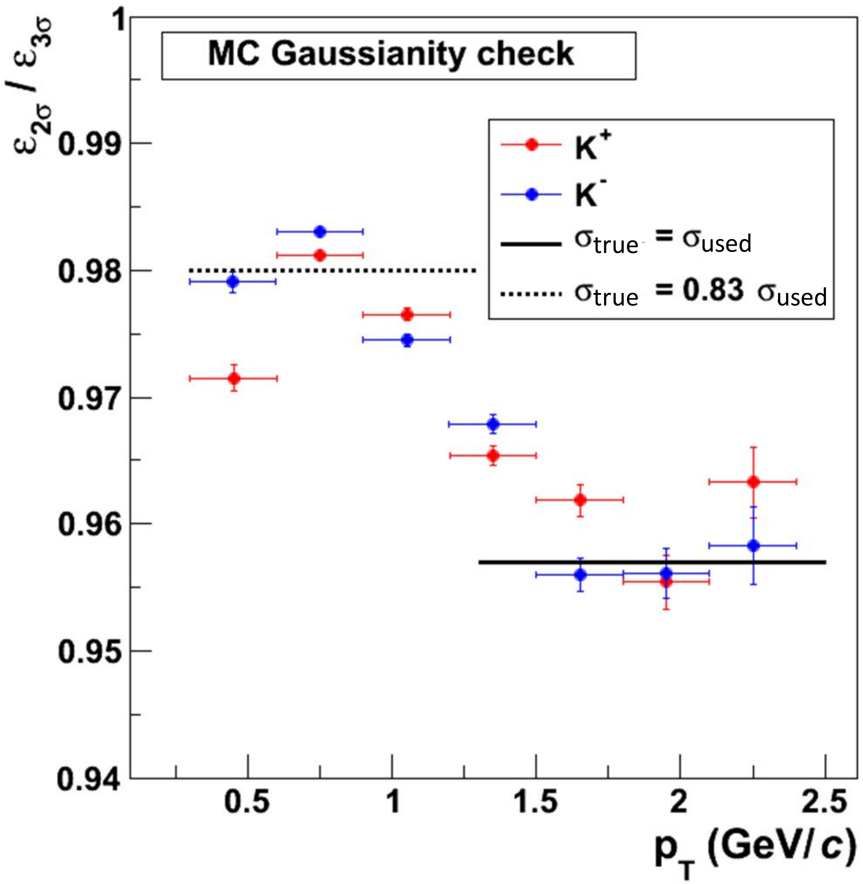


MC results for good TOF matching are consistent with a level of mismatch increasing with centrality.



PID cut with P > 0.2 expected to be 100% efficient at low momenta. Used to check the Nσ cut.

Test of Gaussianity

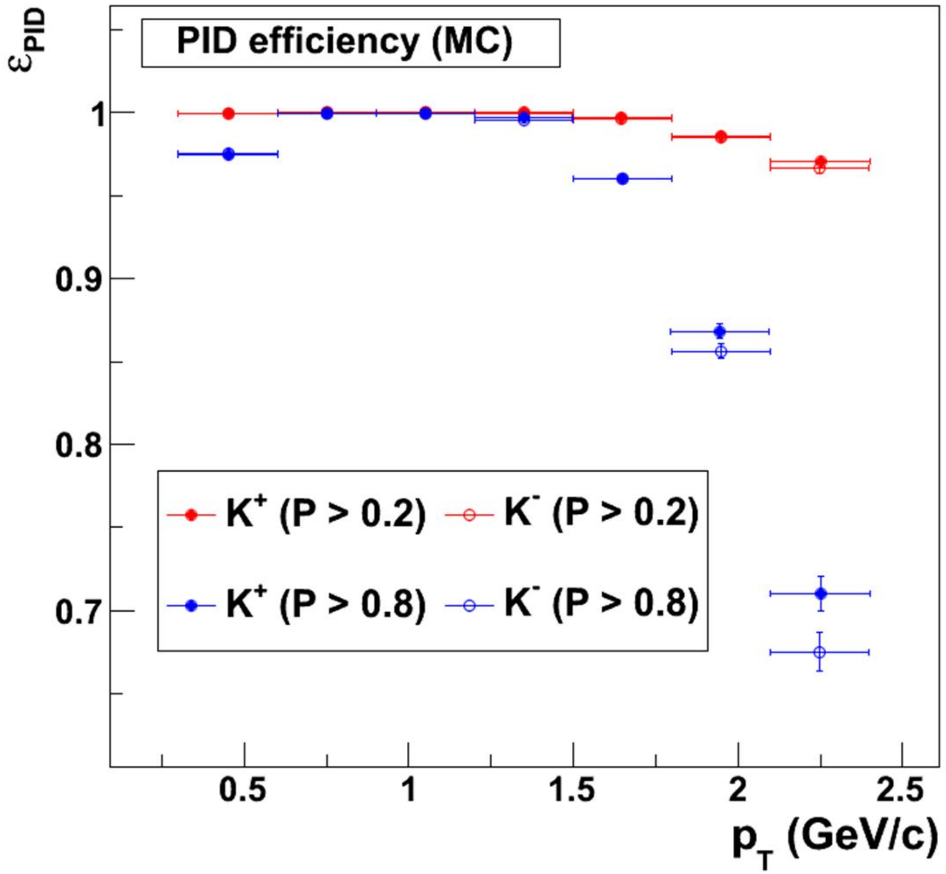


In MC the signal is generated perfectly Gaussian.
Therefore efficiency for 2σ cut should be scaled of 0.957 w.r.t 3σ cut.

Difference w.r.t. the standard value should be ascribed to uncertanties in the σ value.

The pools $\sigma_{true}(p_T)$ are consistent with 1 for $p_T > 1$ GeV/c and in between [0.83, 1] for lower momenta (not a dramatic effect).

Bayesian PID efficiency

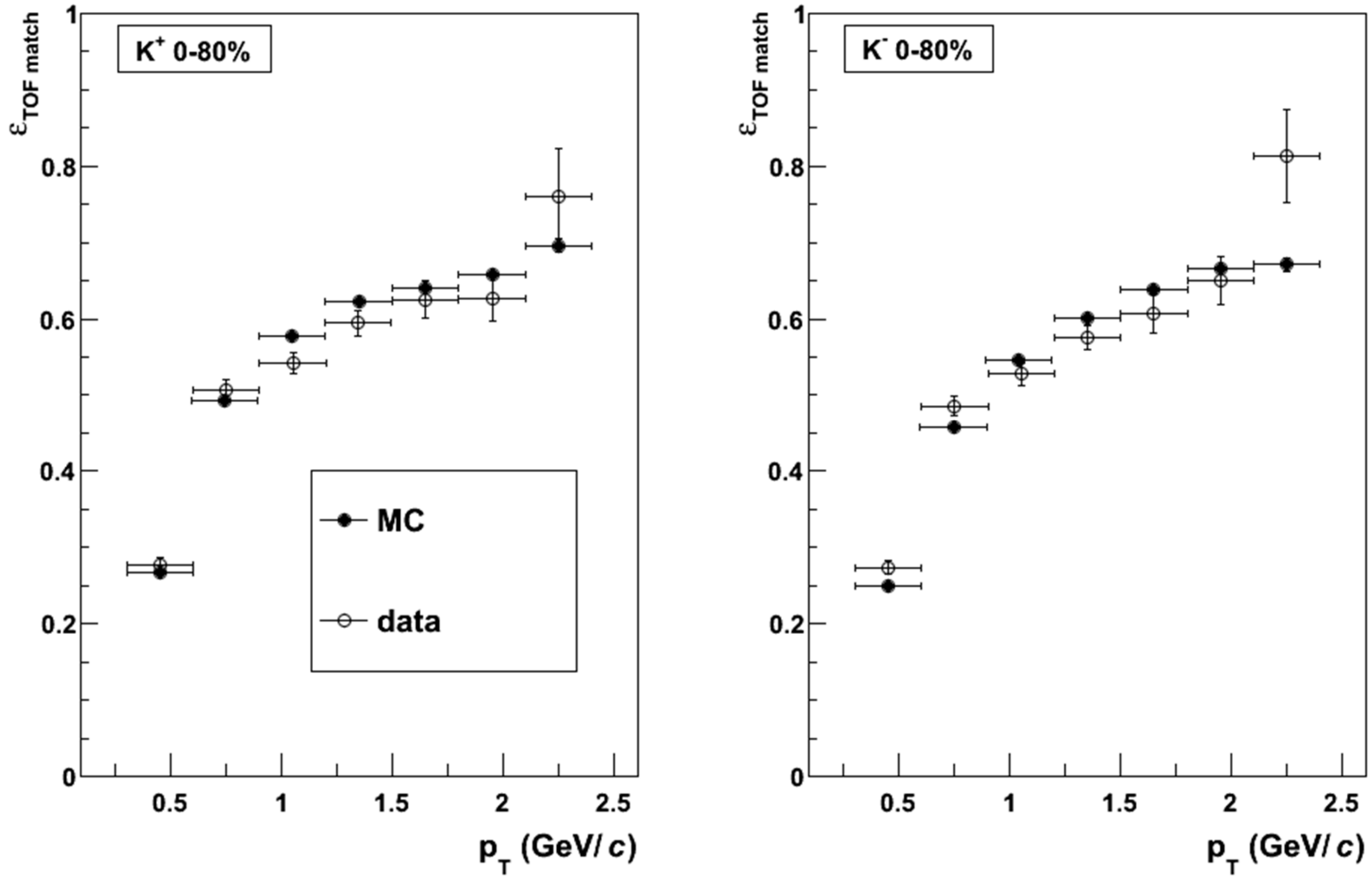


Using standard priors we tested Bayesian method applying a cut on the probability for several thresholds.

Notice that priors are slightly different for positive and negative tracks → efficiency are also slightly different.

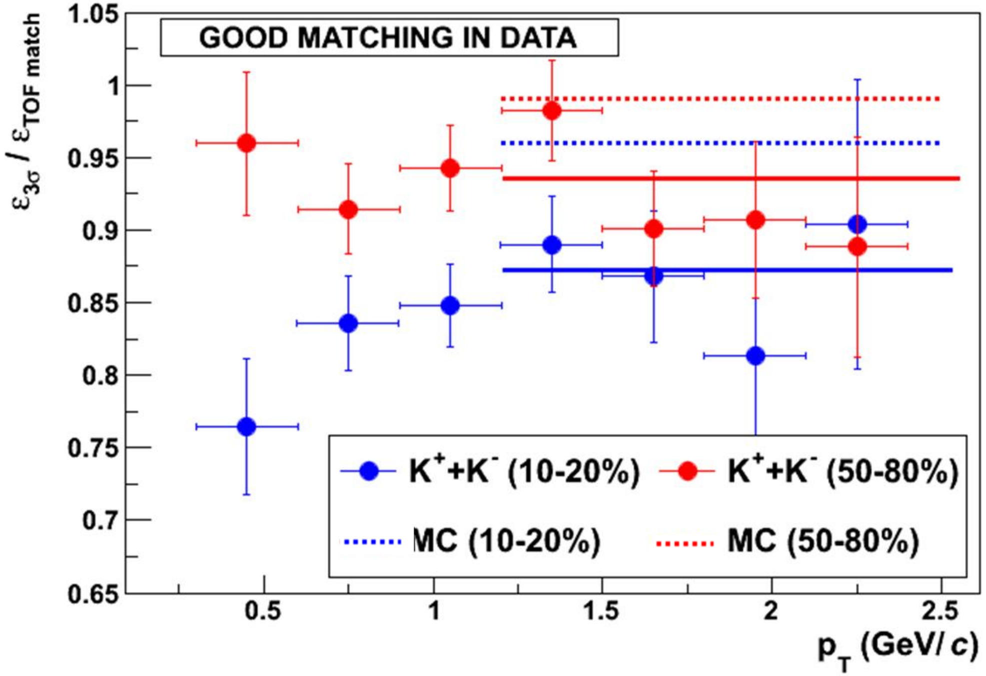
DATA analysis to validate PID

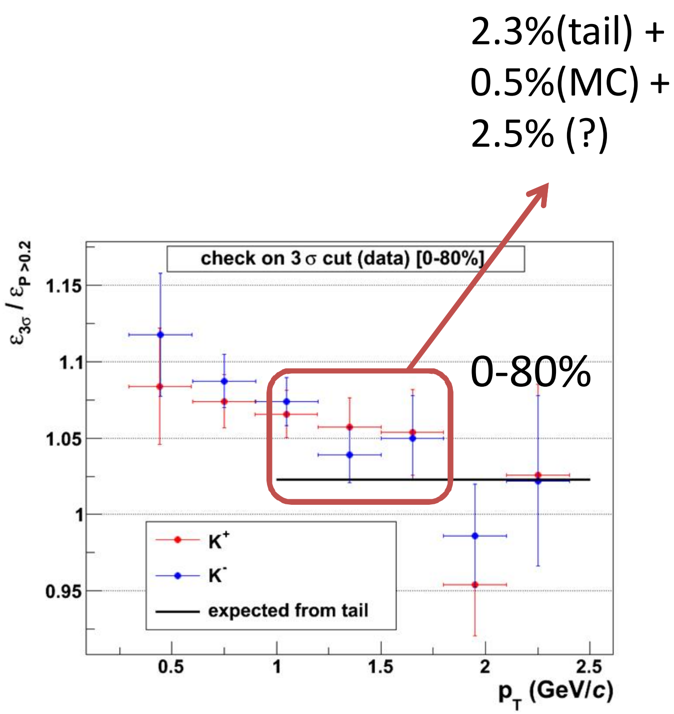
TOF matching efficiency



TOF matching efficiencies were checked for both charges.

Good TOF matching

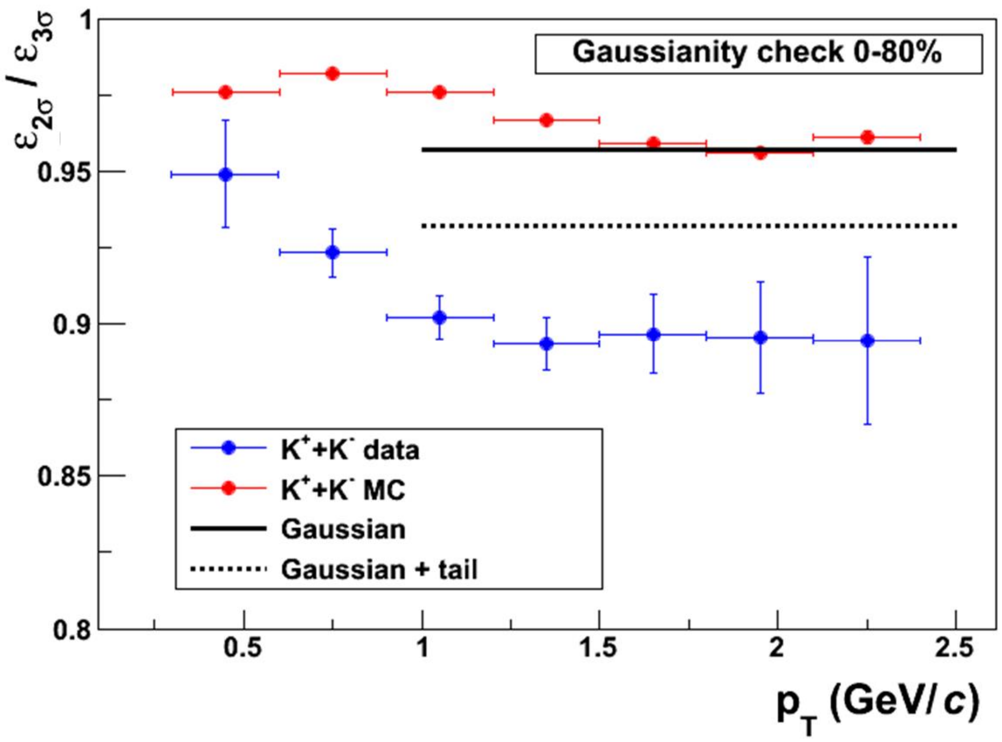




1. DATA good matching are 5% lower w.r.t. MC in pheripheral collisions (tail + …). Cuts on Bayesian probability are more flexibile.
2. In central collisions the difference is probably due to a 50% higher mismatch fraction in data w.r.t. MC.

PID cut with P > 0.2 expected to be 100% efficient at low momenta. Used to check the Nσ cut. Loose in 3σ cut expected from tail ~ 2.3%.

Test of Gaussianity

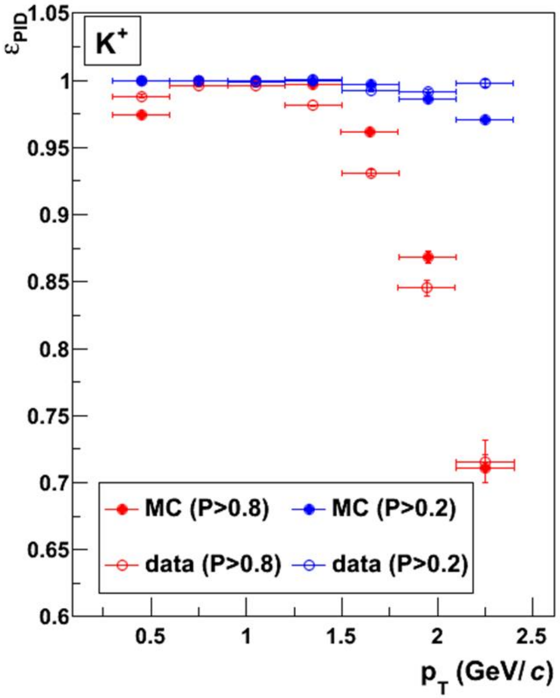


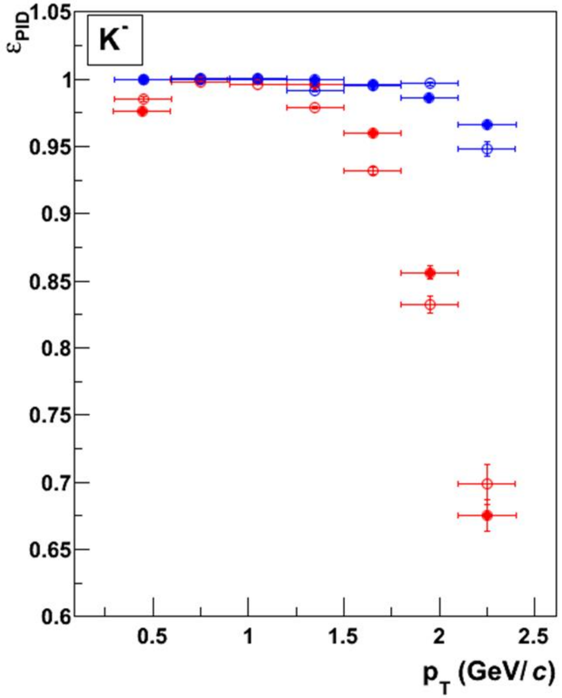
Efficiency changes when moving for 3σ cut to 2σ cut more drammatically in data w.r.t. MC.
The tail is responsible of a part of the difference.
Again a 2.5-3% residual difference is still present.

We can adjust a bit the TOF response:

1. resolution: 80 ps → 84 ps

TOF Bayesian PID efficiency





PID efficiency tested for several thresholds.
Good agreement observed.

Conclusion

- TOF response is in general well described in MC, a finest tuned can be reached:
  - Including the tail in MC
  - Adjusting the TOF resolution used (probably 84 ps is better than 80 ps)
- The biggest discrepancy which affects efficiency is probably related to the mismatch fraction in PbPb collisions. Data seems to be consistent with a higher mismatch fraction (at least 50% higher).

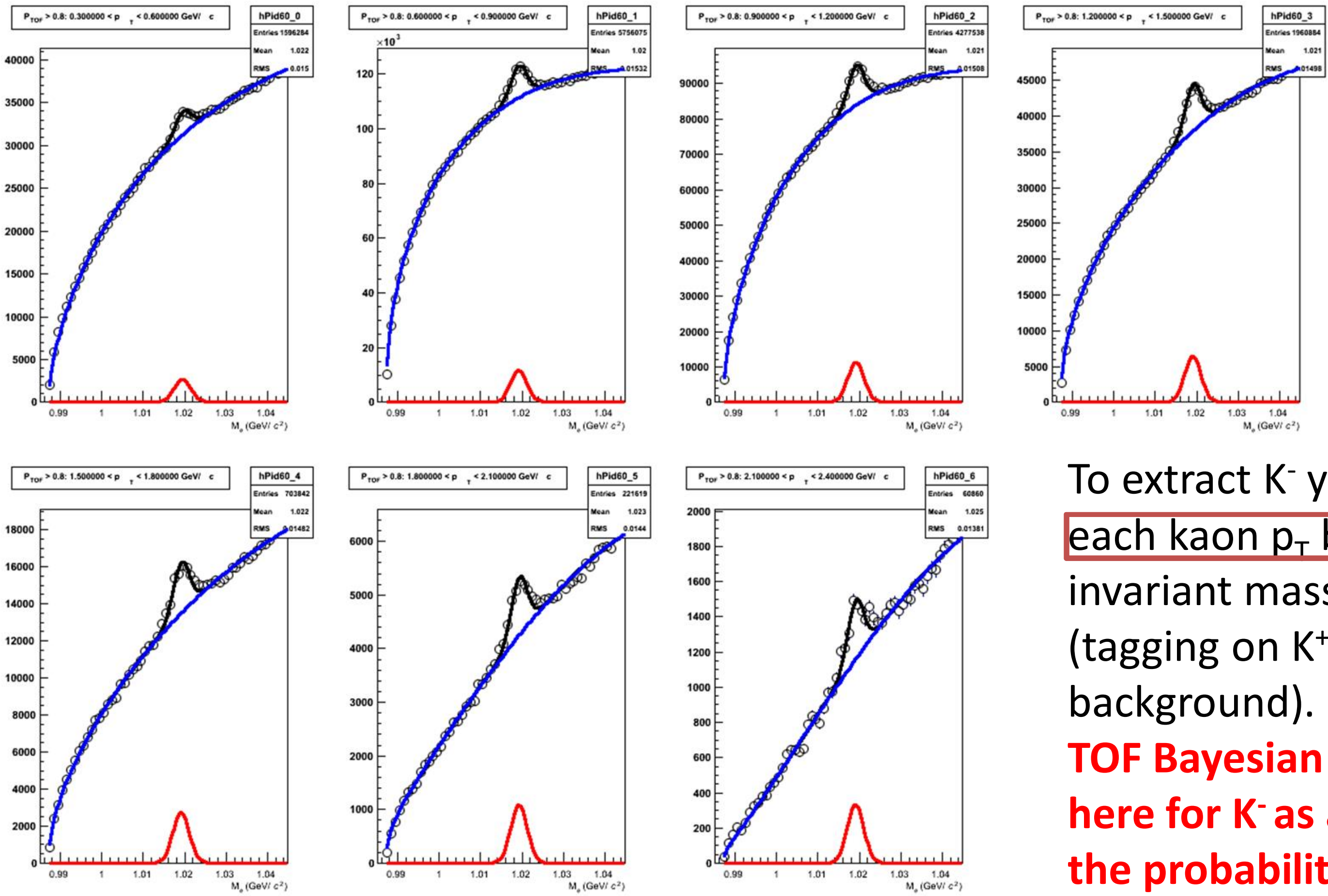
TO DO

Å to repeat the analysis for TPC+TOF combined Bayesian PID.

Å to repeat the analysis for TPC standalone Bayesian PID.

backup

Fit to ϕ invariant mass to extract yields



With PID

To extract K^- yields in each kaon p_T bin we fit the ϕ invariant mass distribution (tagging on K^+ to reduce background).

TOF Bayesian PID required here for K^- as a function of the probability threshold (here $P > 0.8$).