Kaon and Pion selectors in FastSim

Nicolas Arnaud, Leonid Burmistrov,
Alejandro Perez, Achille Stocchi

- PID selectors based on likelihood ratio cuts
  - PID systems in the SuperB detector
  - Likelihoods for PID selectors
  - Example of likelihood distributions
- Tuning Pion and Kaon selectors in FastSim
  - BaBar configuration
    - Barrel region
    - Forward region
    - **Forward region with TOF (SuperB configuration)**
- Outlook

Inputs for pion/kaon PID selectors

The SuperB detector uses different subdetectors to achieve charged particle identification

- SVT - (dE/dx) (just added to FastSim)
- DCH - (dE/dx)
- DRC - Cerenkov angle
  - number of photons
- Backward EMC - time (resolution ~100 – 150 ps) (currently not in FastSim)
- Forward PID system
  - or
    - RICH Cerenkov angle (currently not in FastSim)
    - Time Of Flight (TOF)
      resolution 20ps – 30 ps

Likelihood definition

→ Likelihood ratios are the variables to cut on to select tracks.

→ Example of Gaussian likelihood

$$LH = e^{(-chi2)}/norm$$

Norm is usually not constant → it really needs to be included in the computation

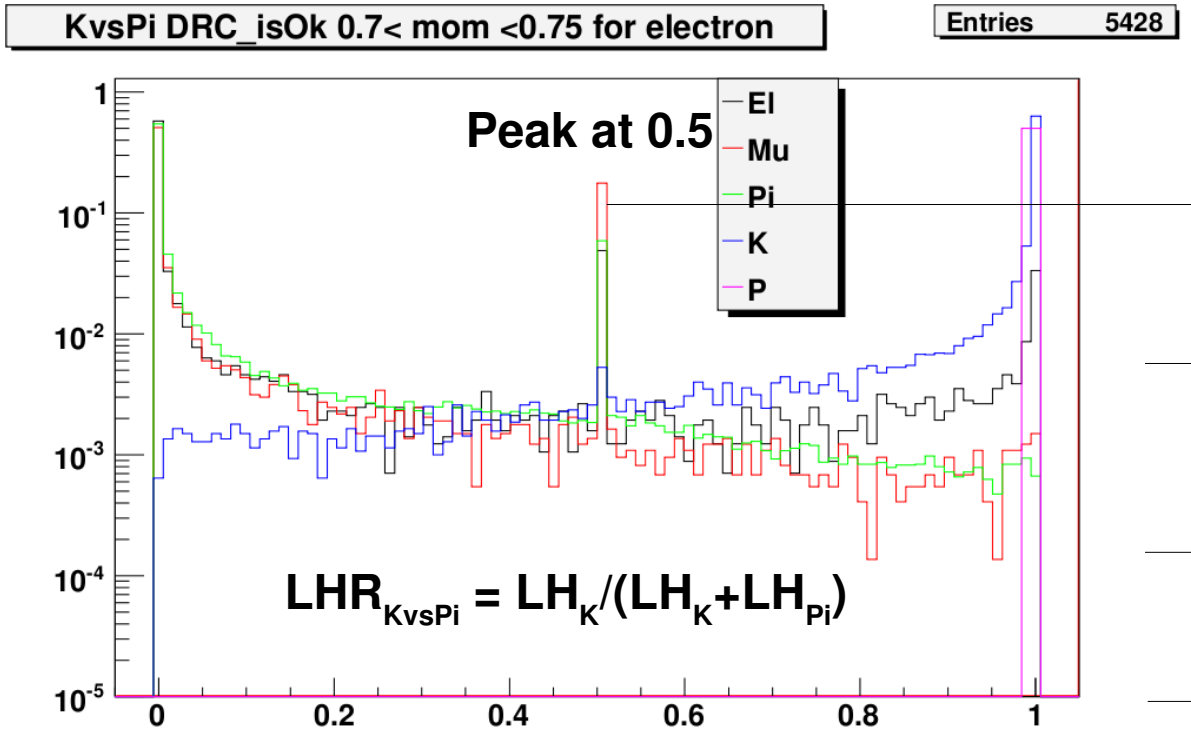
$$chi2 = (val_{meas}-val_{exp})^2/err^2$$

val_{meas} - measured quantity
val_{exp} - expected value = function(**reconstructed momentum, mass** , ...)
err - measurement error

→ Combine information form different detectors to better separate particles

$$LH_{tot} = LH_{DRC\_Cerenkov} \times LH_{DRC\_PhotNum} \times LH_{DCH} \times LH_{TOF} \times LH_{SVT} \times LH_{EMC\_bwd}$$

LH set to constant if corresponding subdetector not touched by track.
Currently $LH_{SVT} = LH_{EMC\_bwd} = 1$



Example of likelihood distributions
Truth-matched particles

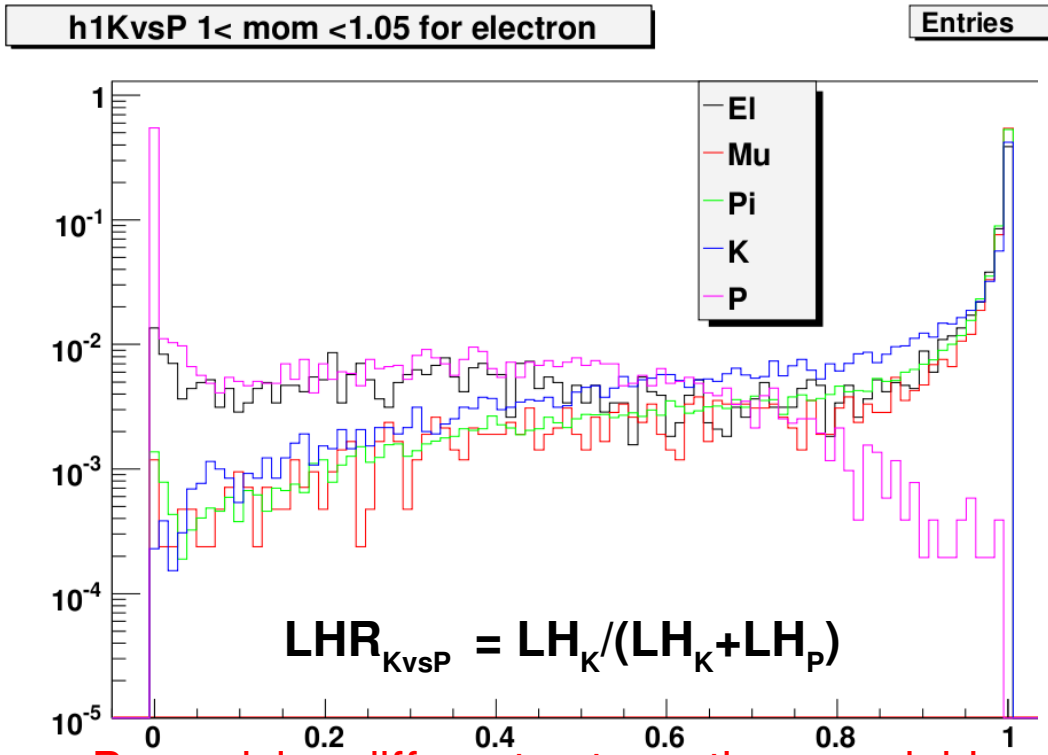
Tracks which have $LH_K=LH_{Pi}=0$ or $LH_K=LH_{Pi}=1$

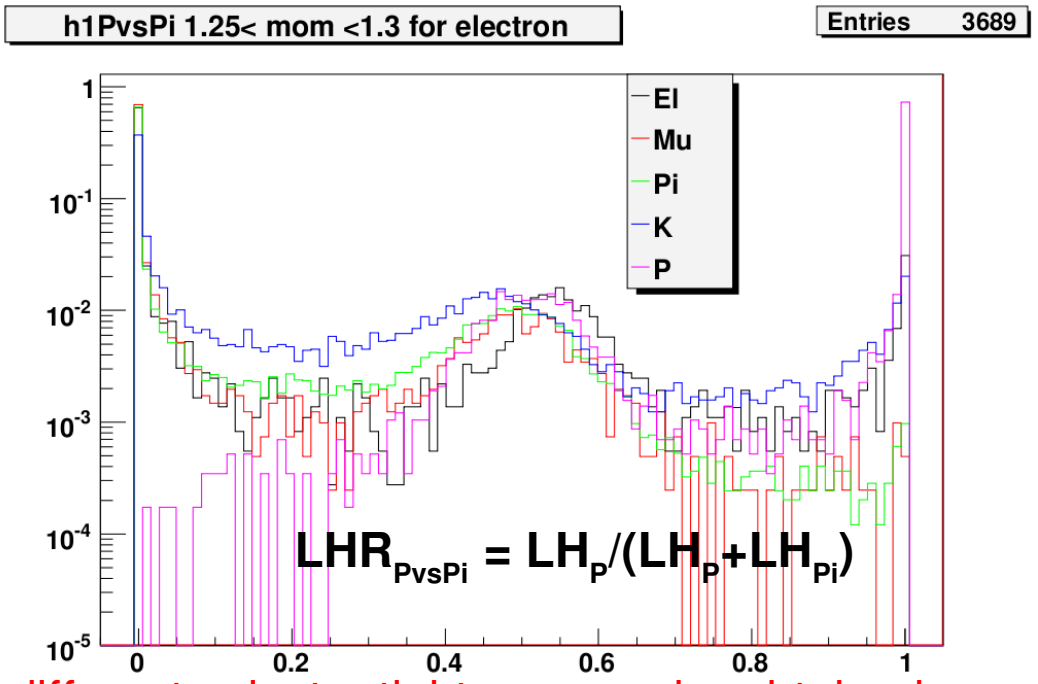
For more details look backup slides

→ With cut on $\mathbf{LHR_{KvsPi}}$ electrons, muons and pions can be removed, but not protons

→ With cut on $\mathbf{LHR_{KvsP}}$ and $\mathbf{LHR_{PvsPi}}$ protons can be removed

→ Adapt cuts used for BaBar selectors





By applying different cuts on these variables, different selector tightness can be obtained

Tuning selectors in FastSim

→ Cuts should depend on: momentum,
Detectors which have been hit by the track
quality of their response.

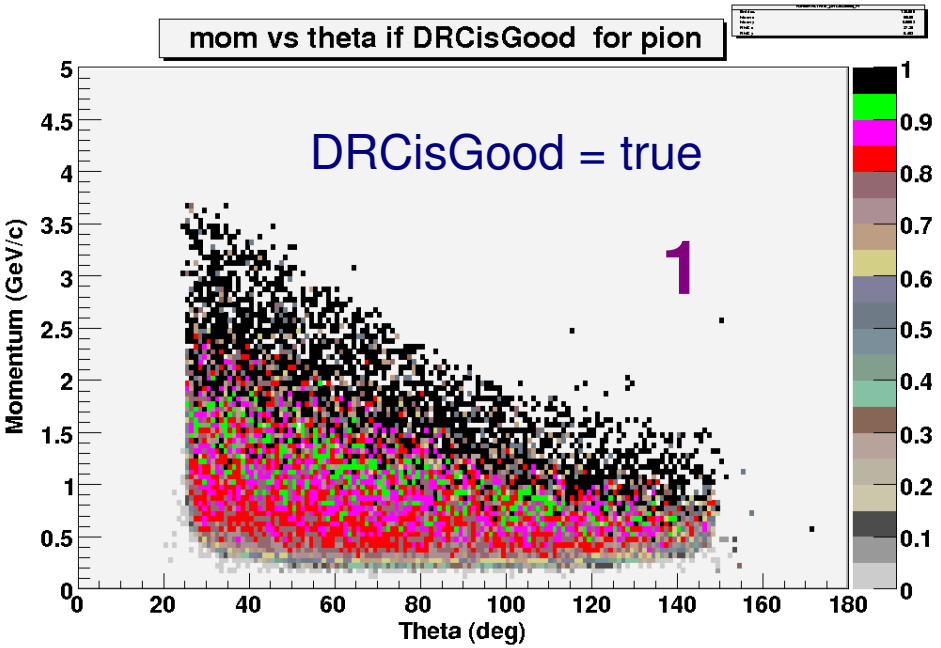
In BaBar regions are identified using the DRCisGood- bool variable

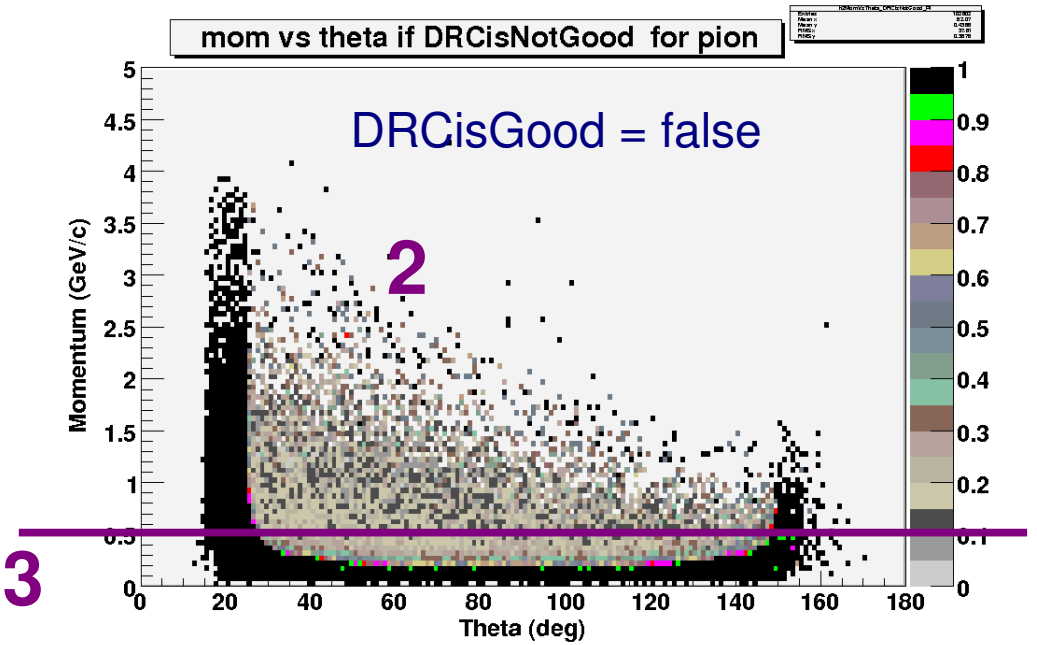
→ In general we have to defined 3 sets of cuts

1 Barrel region, DRC information is OK (Mom>0.5GeV) (80 - 85)%

2 Forward and backward region, with all momentum (~100%)
Barrel region (10 - 15)%

3 Low momentum, all theta region

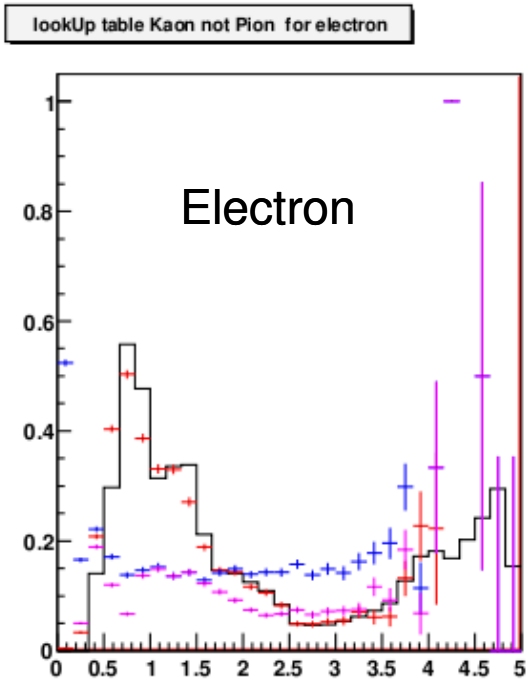


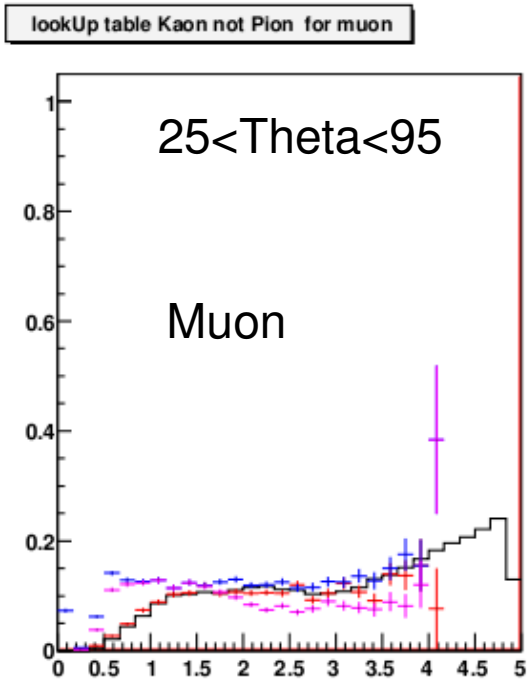


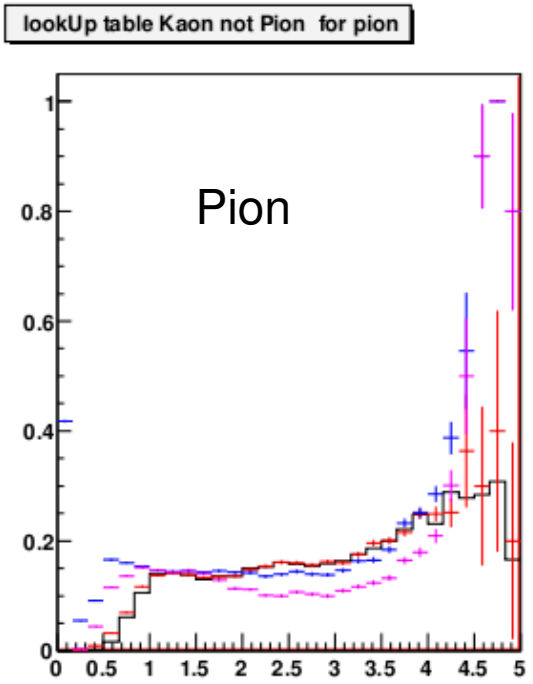
DRCisGood = If number of signal photons more than 7 and number of background photons less than number of signal photons.

Reproducing BaBar PID tables with FastSim LH selectors

KaonNotApion



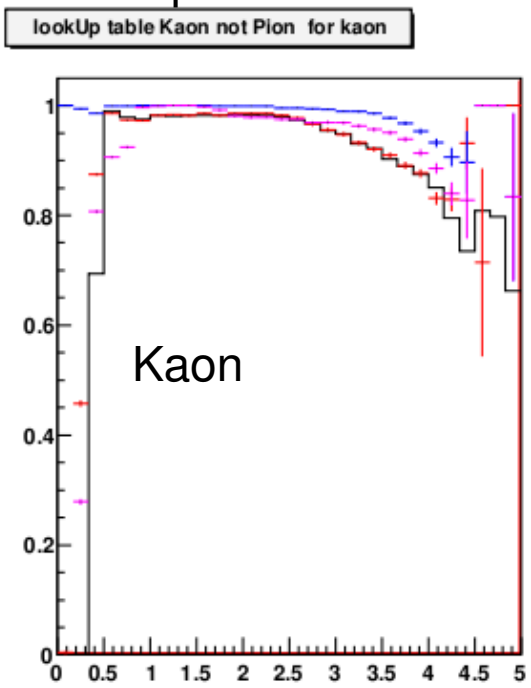


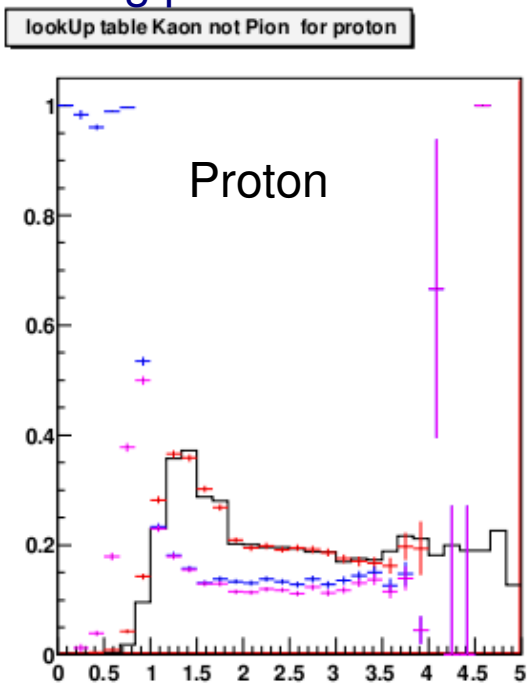


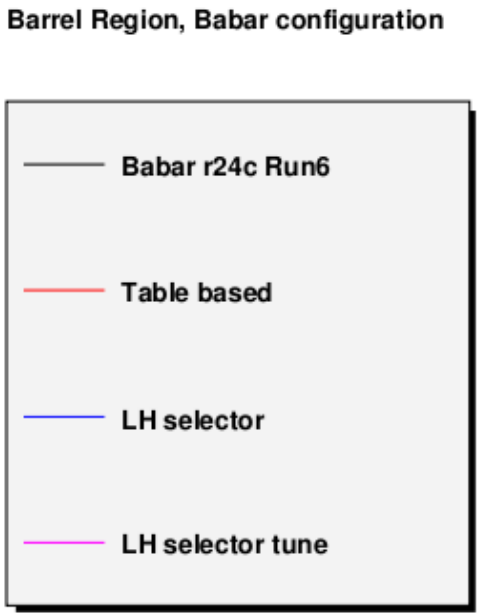
BaBar performances

Starting point: BaBar cuts

After tuning

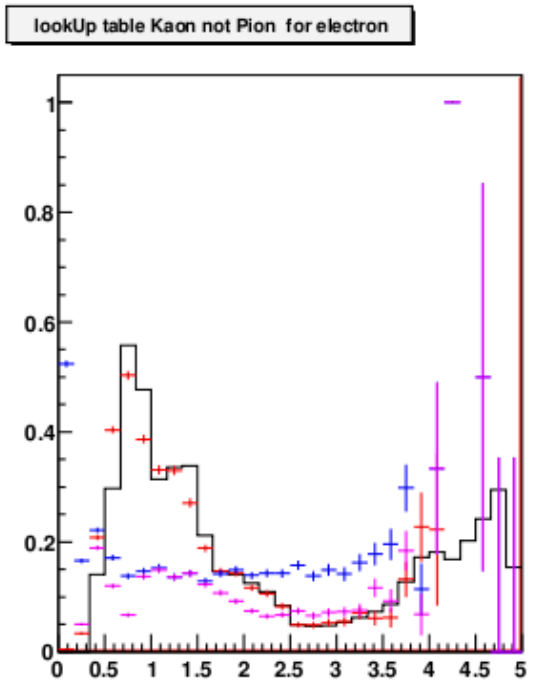


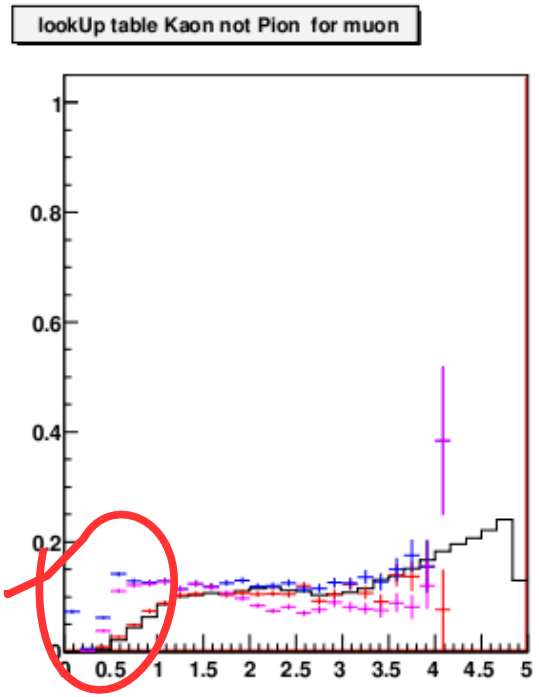


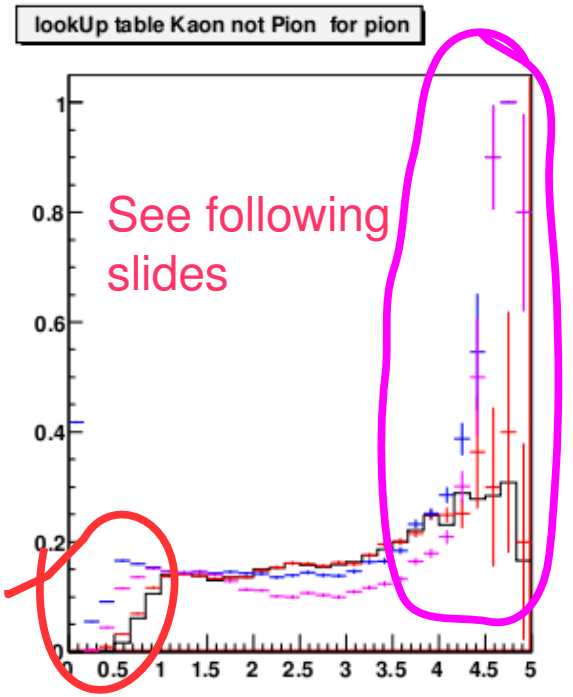


Reproducing BaBar PID tables with FastSim LH selectors

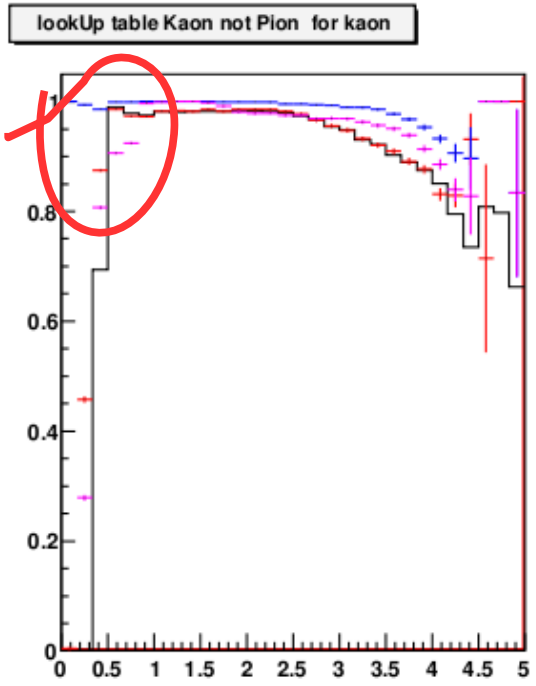
KaonNotApion

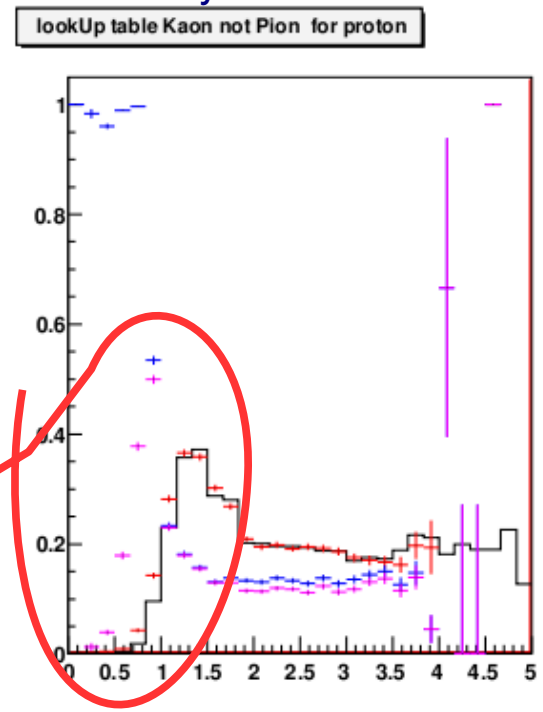


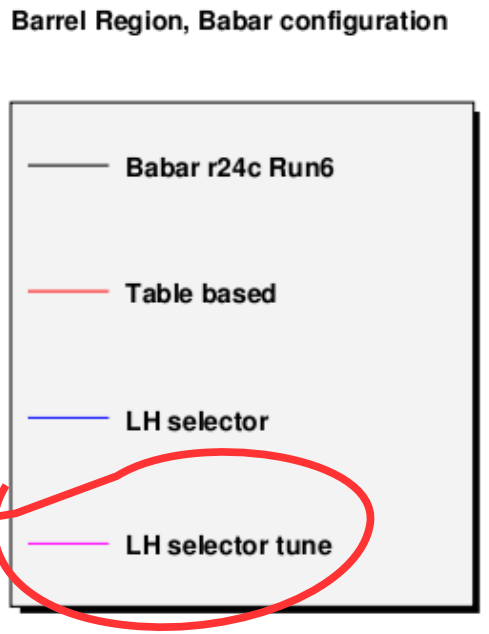




Still issues in the low momentum region. Possibly due to the lack of SVT dE/dx => to be checked

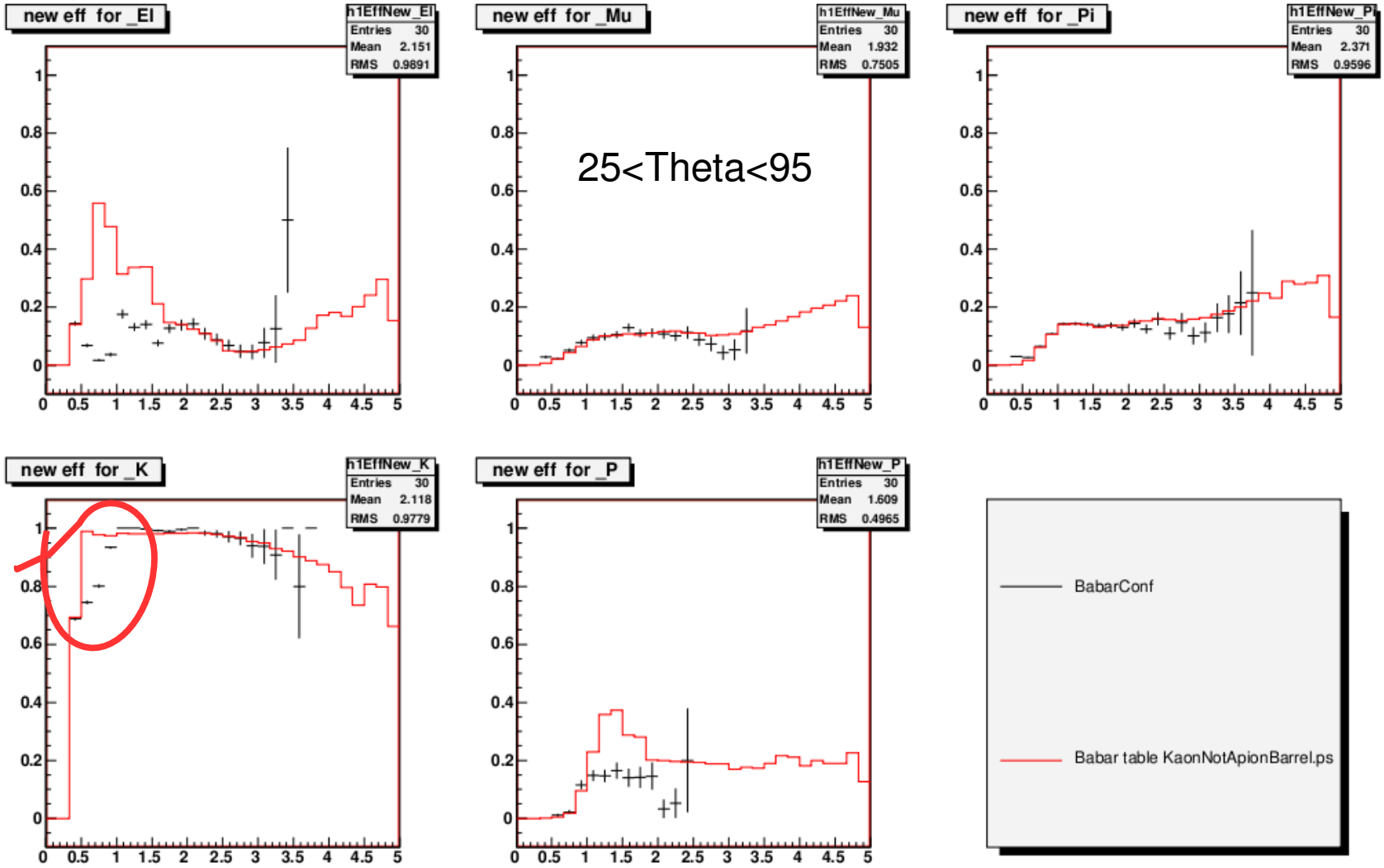






Another method to reproduce BaBar table as a crosscheck

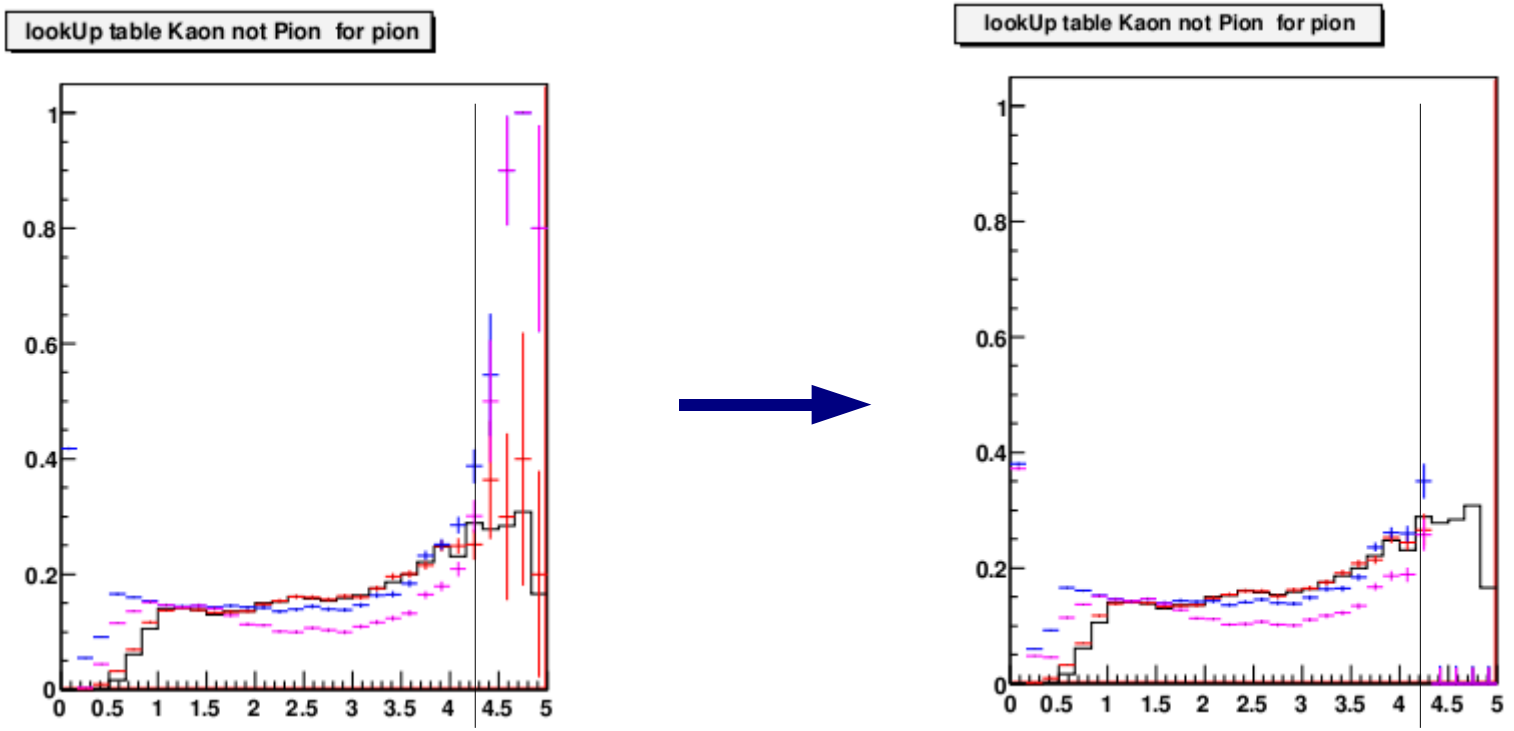
Divide the momentum range into several independent bins
Tune cuts bin-by-bin to 'minimize differences' with the BaBar tables



Results similar to main approach: we can reproduce Babar results, but not for low momentum region

07.10.09 ⟶ It seems we really need additional information @ low momentum

Influence of the momentum measurement precision

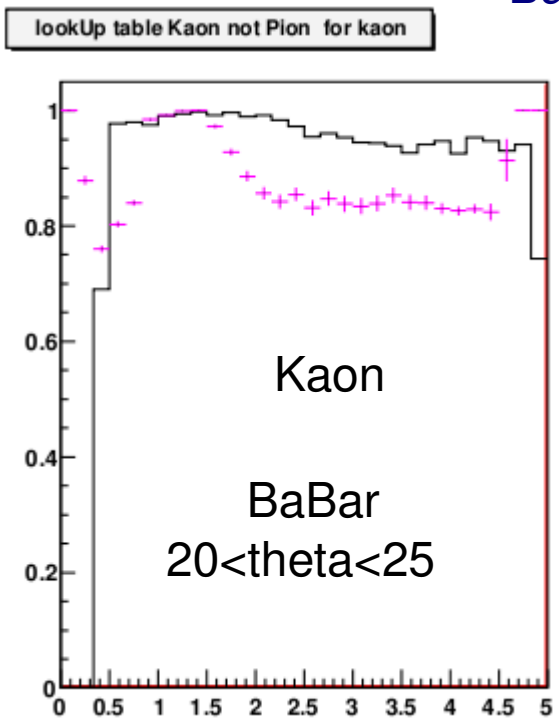


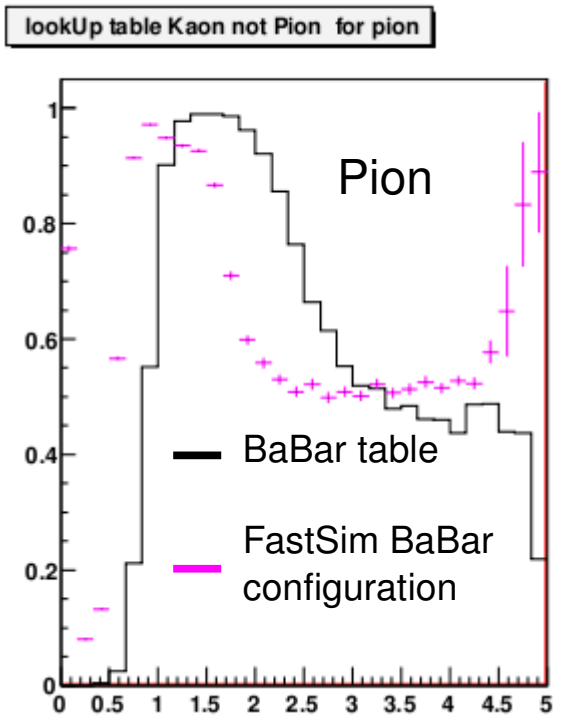
Reconstructed momentum

True momentum

For 0.56 boost maximum possible momentum of pions is around 4.2 GeV, so tracks with reconstructed momentum more than 4.2 GeV are not well-measured
=> Fluctuations in the last bins disappear when one uses true momentum on the x axis

BaBar

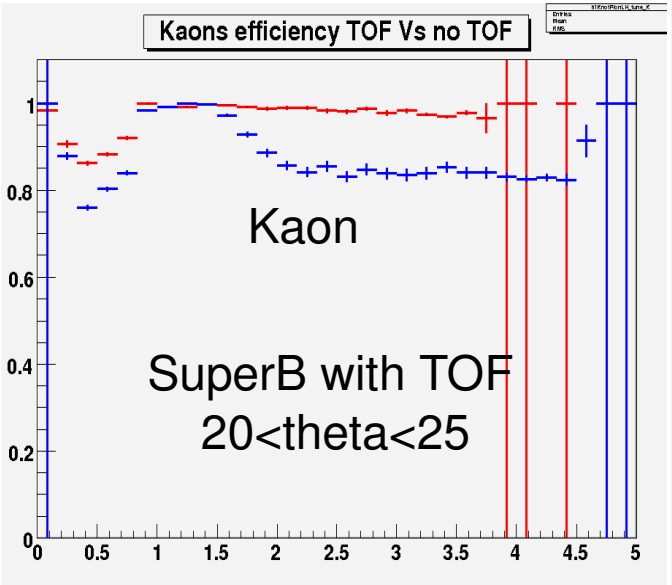


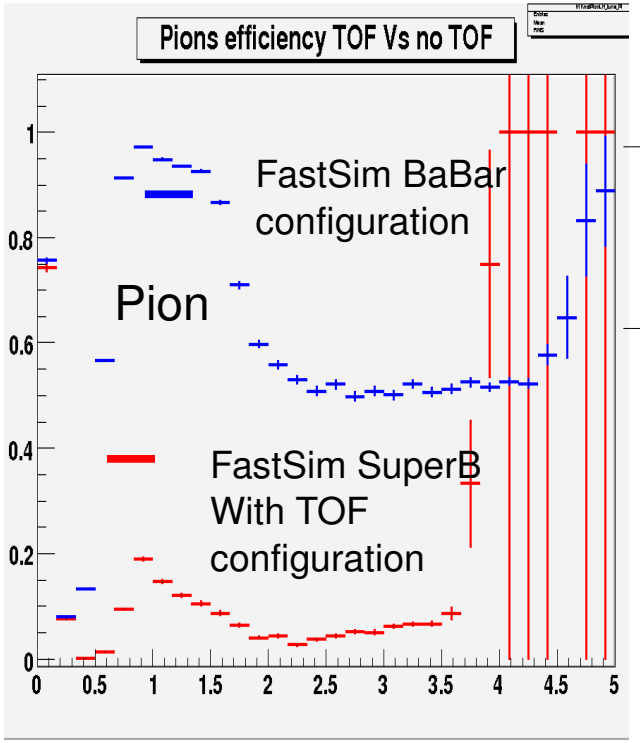


KaonNotApion selector

One possible reason of disagreement is that different sets of tracks may have been used in BaBar and FastSim

Comparison between forward region with TOF (SuperB configuration) and BaBar configuration





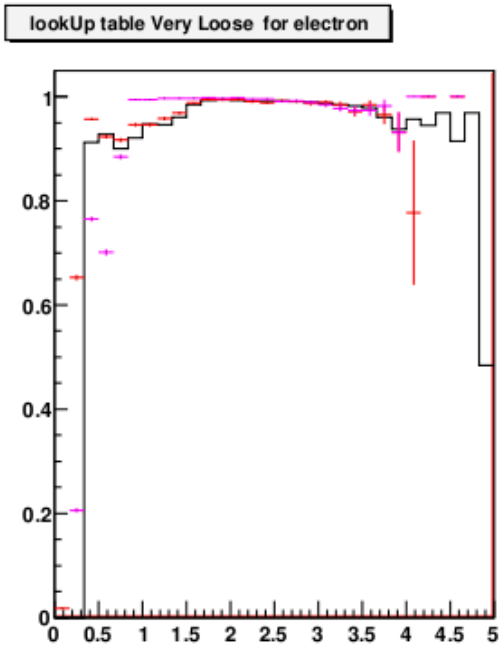
TOF simulation in FastSim is not 100% realistic yet => GEANT4 standalone simulation to be started soon

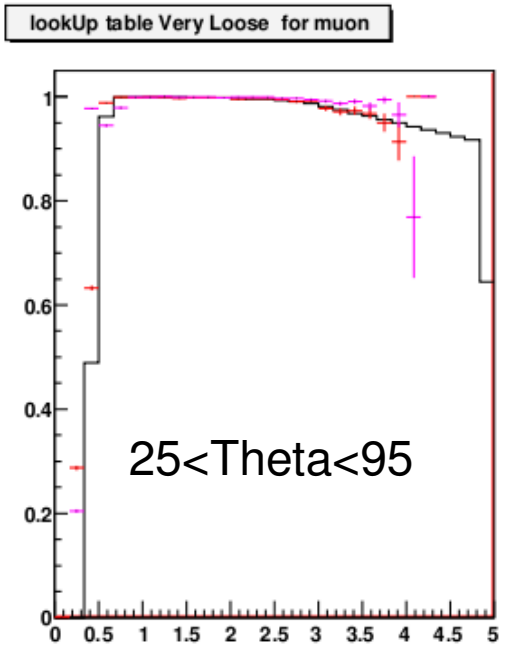
Conclusion

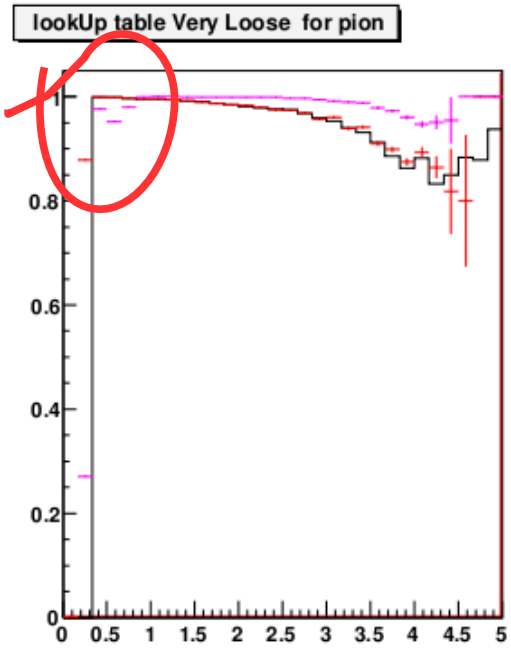
- Following selectors will be available soon in SVN:
  - Kaon: KaonNotApion
    - KaonVeryLoose
    - KaonLoose
    - KaonTight = KaonVeryTight (no Muon selector yet in FastSim)
  - Pion: PionVeryLoose
    - PionLoose
    - PionTight
    - PionVeryTight (to reject muons table-based selector was used)
- Wiki documentation to be updated accordingly.
- Agreement with BaBar tables in barrel region is OK
- Agreement in FWD region is not perfect (track sample selection!?)
- Forward region is improving a lot with TOF, as expected.
  Next step is to make the TOF more realistic using inputs from standalone G4 simulation.

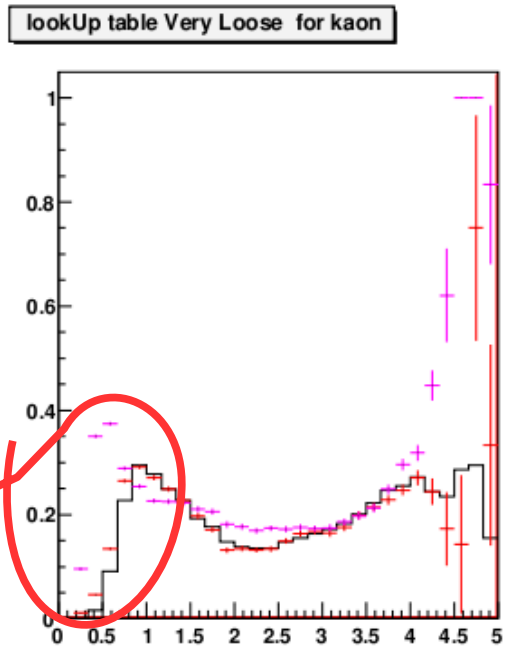
Backup slides

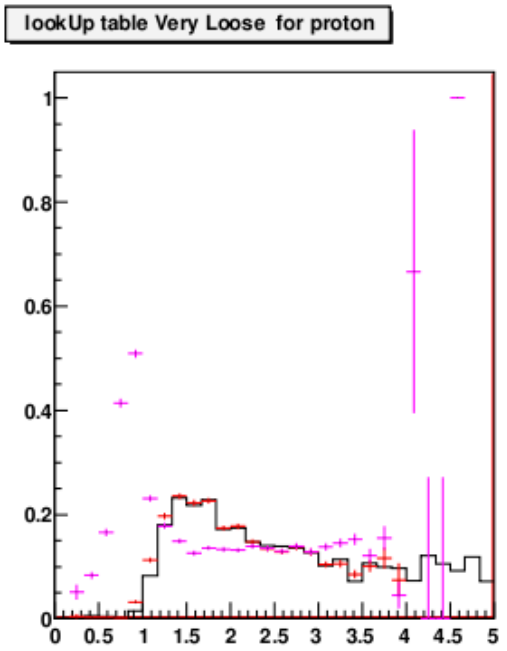
Pion Very loose selectors

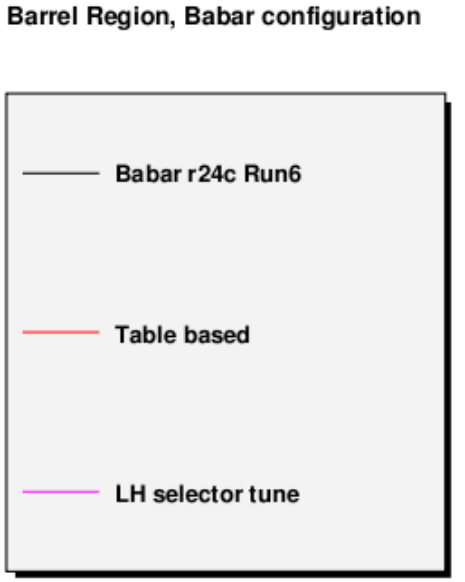




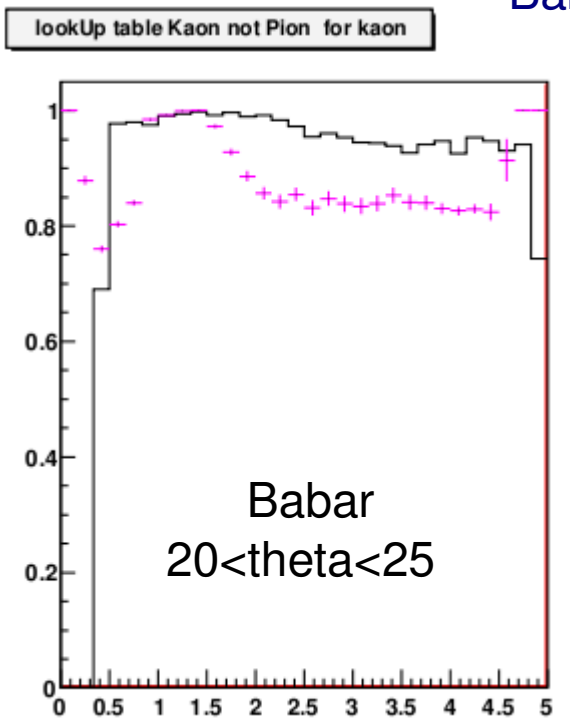


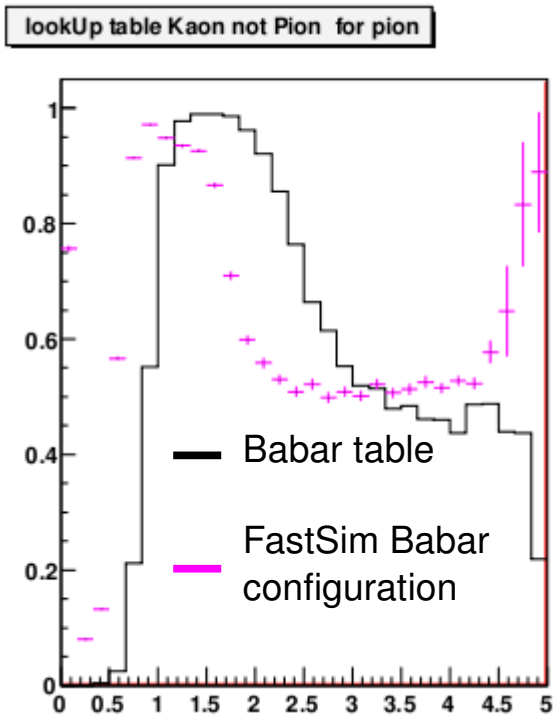




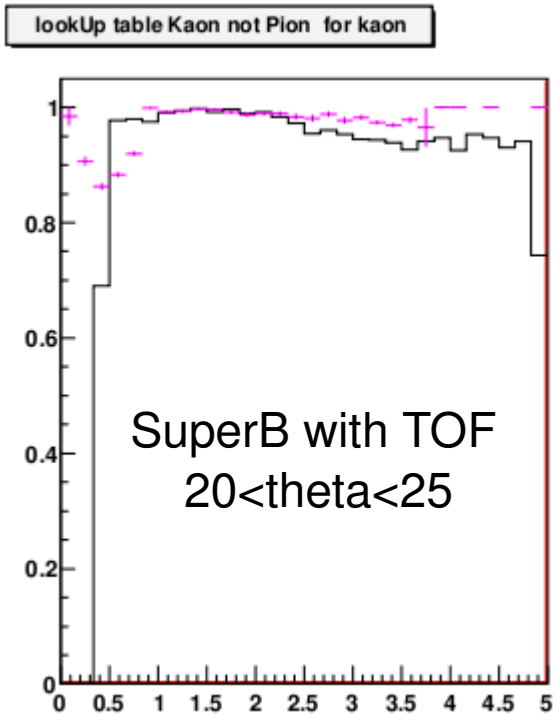


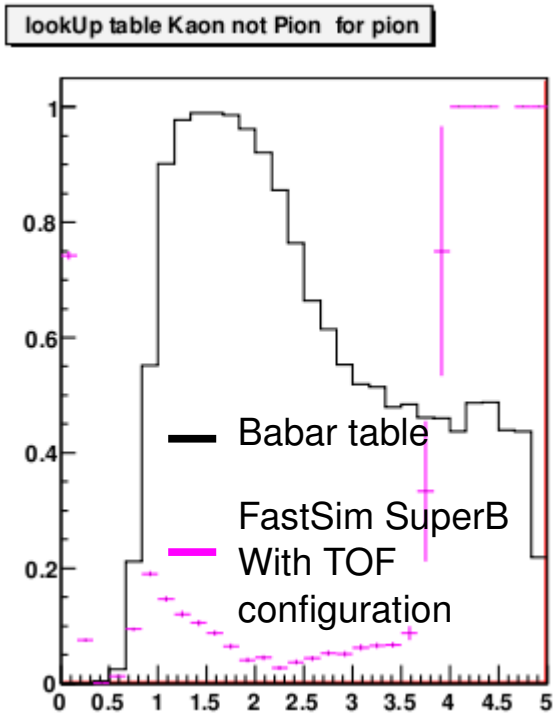
Babar





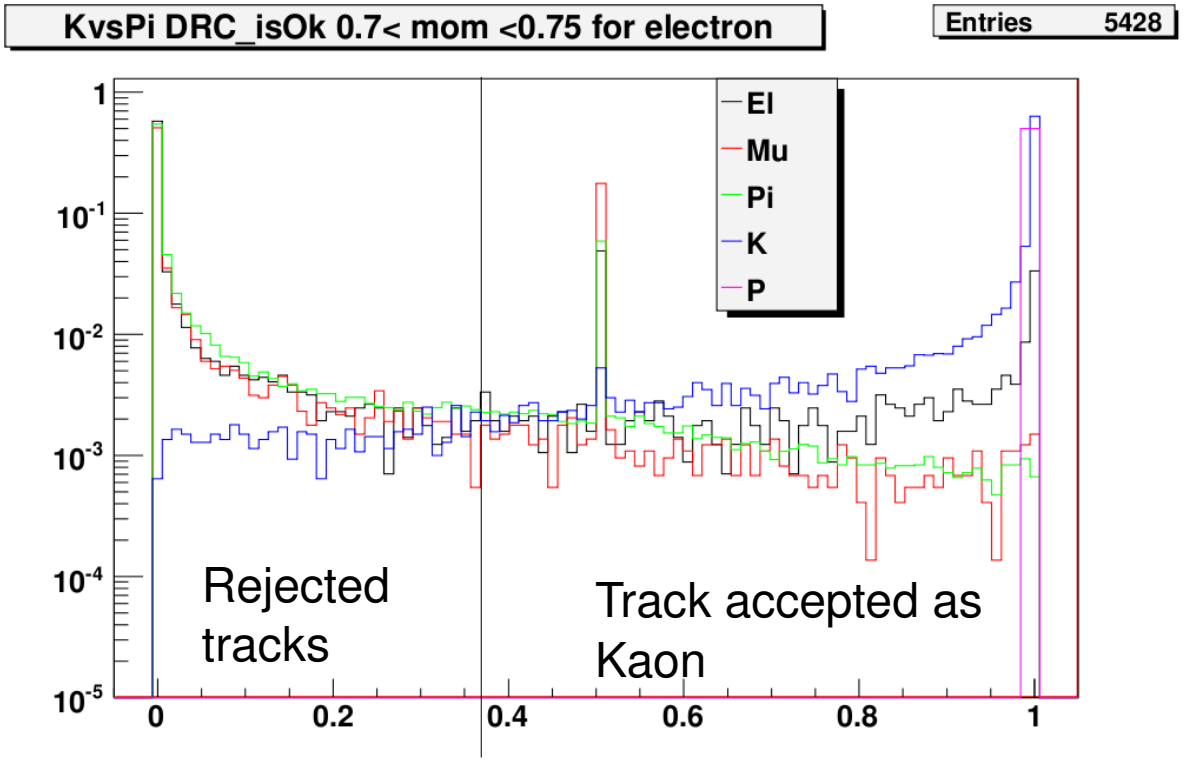
Comparison between forward region with TOF (SuperB configuration) and Babar configuration





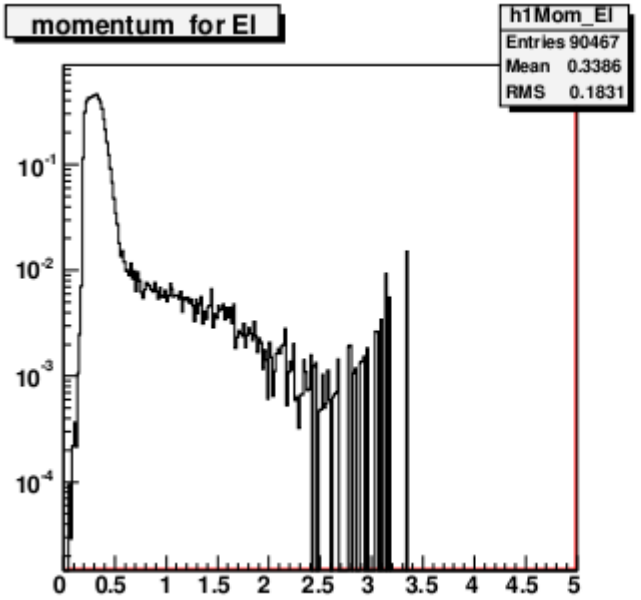
Reproducing BaBar PID tables with FastSim LH selectors

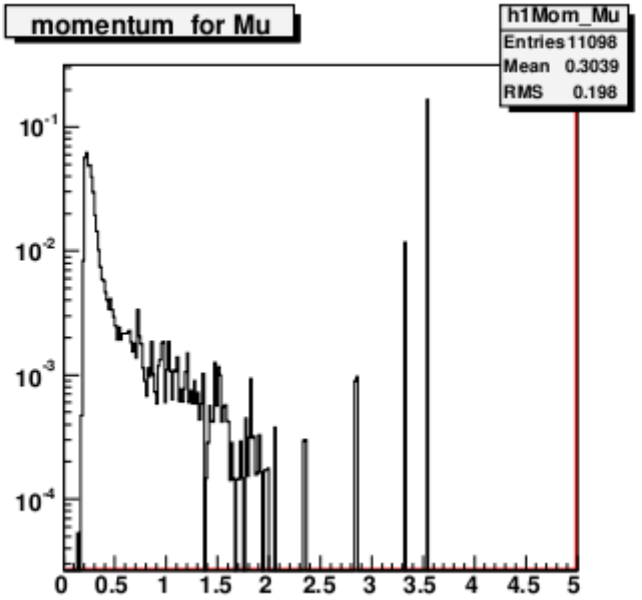
By applying cuts on different likelihood ratios, with different combinations and logical operation

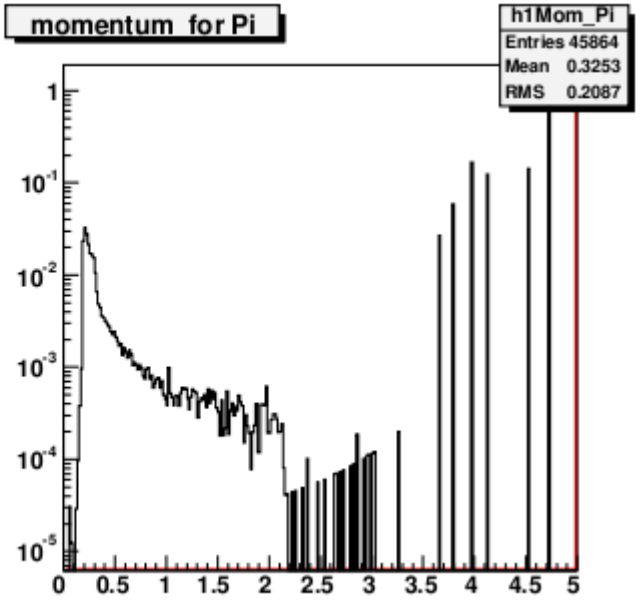


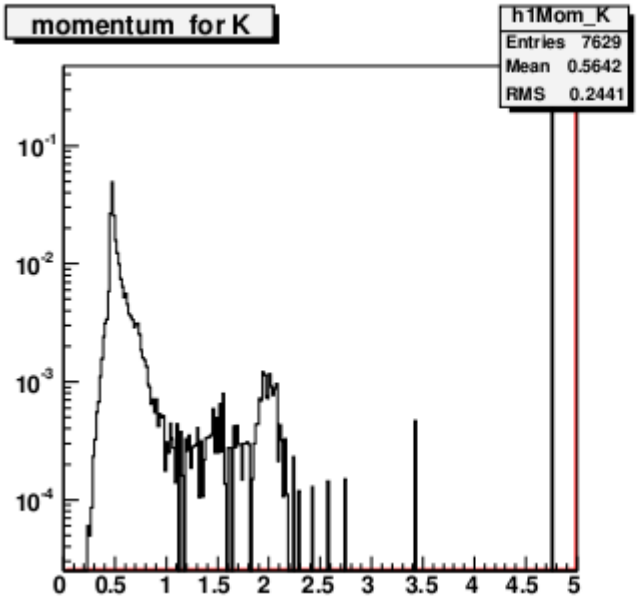
and taking into account different theta regions and quality of the measurements with DRCisGood variable

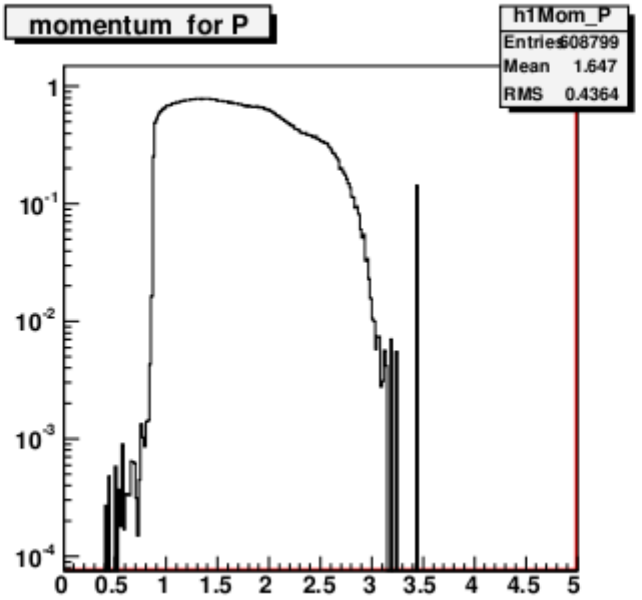
DRCGauss KvsPi = 0











DRCPoisson KvsPi = 1