Reconstruction of K0s using MinBias 7 TeV data

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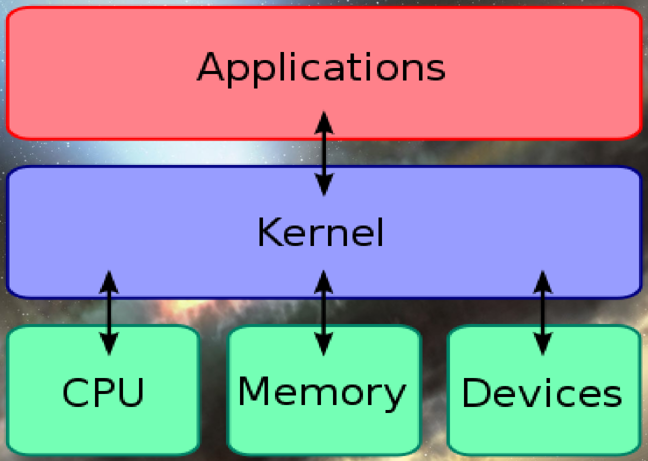
LHC

- LINAC2->PBS->PS->SPS->main ring (450Gev->7TeV)
- 1-2 times daily -> injection
- Accelerate 20 min, circulate 10-24 hr
- 4 intersection pts
- Superconducting niobium-titanium cables-> low-resistance B fields
- Liquid helium

ATLAS

- Magnetic field around the proton beam
- Straw Trackers
    - Charged particle->ionization->gradient->signal
- Transition radiation detector
    - Varying indexes of refraction->transition radiation->stronger signal in straws
- Electromagnetic calorimeter
    - Electron sees a charged nucleus->accelerates around it->emits photon->e-e+ pair->hits light emitting material->track light
    - Height of peak proportional to amt of energy
- Hadron calorimeter
    - Penetrate deeper->showers tend to start out later
    - Collide with nucleus->pions->pi neutral->2 photons->EM shower
        - Much messier
    - For a particular track, Eem/(Eem+Eh)
    - Test beams->energy distribution
    - Compensate for scale and distribution->put weight on energy
- Muon Spectrometer
    - Heavy leptons->don't accelerate much around the nuclei->doesn't radiate much->very penetrating
    - Can get tracked in calorimeter & ionize gas->some signal
        - BUT much less than a shower would give you
    - Much thicker straws->combine tracks->energy and momentum of muon

ROOT



- Bash (shell)
- Devices->CPU
- Linux
- Compilation of technical bit-level operations
- C++, ROOT
- Large amounts of same-class data->TTrees
- GUIs

Neutral kaons

Properties of kaons

Particle name	Particle symbol	Antiparticle symbol	Quark content	Rest mass (MeV/c^2)	I^G	J^{PC}	S	C	B'	Mean lifetime (s)	Commonly decays to (>5% of decays)
Kaon[1]	K^+	K^-	$u\bar{s}$	0,493.677 ±0.016	$1/2$	0^-	1	0	0	$1.2380 \pm 0.0021 \times 10^{-8}$	$\mu^+ + \nu_\mu$ or $\pi^+ + \pi^0$ $\pi^+ + \pi^+ + \pi^-$ or $\pi^0 + e^+ + \nu_e$
Kaon[2]	K^0	$\bar{K}^0$	$d\bar{s}$	0,497.614 ±0.024	$1/2$	0^-	1	0	0	[a]	[a]
K-Short[3]	K^0_S	Self	$\frac{d\bar{s}-s\bar{d}}{\sqrt{2}}$[b]	0,497.614 ±0.024[c]	$1/2$	0^-	(*)	0	0	$8.953 \pm 0.005 \times 10^{-11}$	$\pi^+ + \pi^-$ or $\pi^0 + \pi^0$
K-Long[4]	K^0_L	Self	$\frac{d\bar{s}+s\bar{d}}{\sqrt{2}}$[b]	0,497.614 ±0.024[c]	$1/2$	0^-	(*)	0	0	$5.116 \pm 0.020 \times 10^{-8}$	$\pi^\pm + e^\mp + \nu_e$ or $\pi^\pm + \mu^\mp + \nu_\mu$ or $\pi^0 + \pi^0 + \pi^0$ or $\pi^+ + \pi^0 + \pi^-$

- Superposition
- Mostly created by fragmentation
- Slow decay via weak interaction
- Primary vs secondary
- Requires secondary vertex reconstruction (flight distance =XXX)

Goals

- Reconstruct K0s mass peak
- Compare with MC predictions (PYTHIA MinBias) (width/peak)
- Optimize selection cuts to maximize S/B ratio
- Reconstruct pT/Eta spectrum and compare with MC
- Look at the Dalitz plot
- Reconstruct K0K0 mass spectrum (if 2 candidates are found in an event)
  - S/B ratio should be further increased
  - do we see K0K0 resonances (f(1520 etc..)
- Look at Lambda/Lambda(bar) (if time allows)

Main Programs

Using MinBias D3PD ntuples on the PC farm (7 Tev data), Intg. Lumi= 400 mb-1
D3PD contains V0 information
Using C++/ROOT program
Computer farm to process data

./A_RUN_MC, ./A_RUN_DATA
CutEvent.cxx
Tracks.cxx
analysis.h
Histo.cxx

Calculation of invariant mass

Declaring invMass with $E^2=(pc)^2+(mc^2)^2$

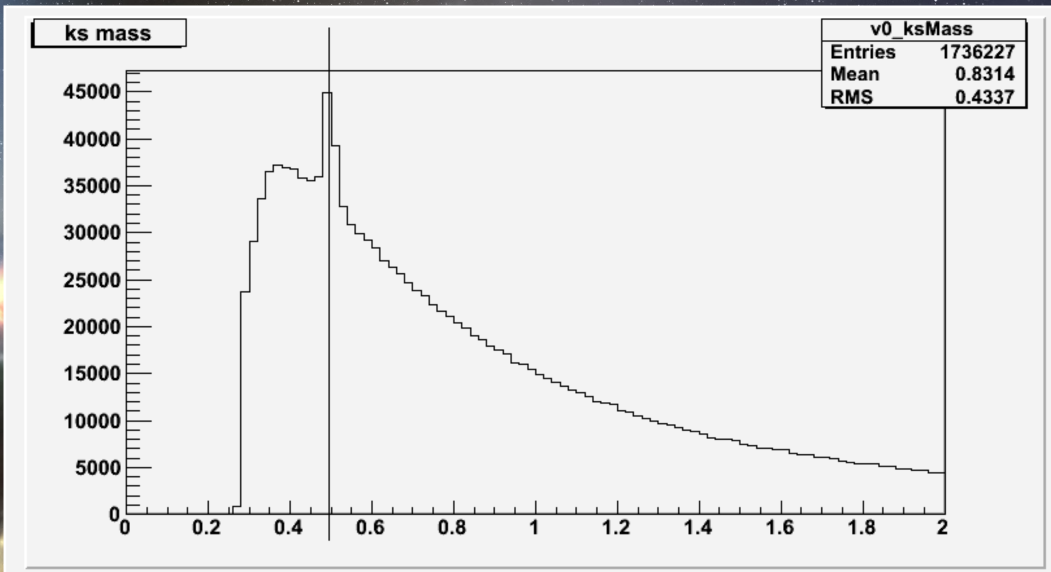
```
........
double px1=pt * cos(phi);
double py1=pt * sin(phi);
double pz1=pt * sinh(eta);
double e1 = sqrt(px1*px1+py1*py1+pz1*pz1+MPION2);
.........
 double pxt=px1+px2;
 double pyt=py1+py2;
 double pzt=pz1+pz2;
 double ee=e1+e2;
 double invMass = sqrt(ee*ee- pxt*pxt - pyt*pyt - pzt*pzt);
```

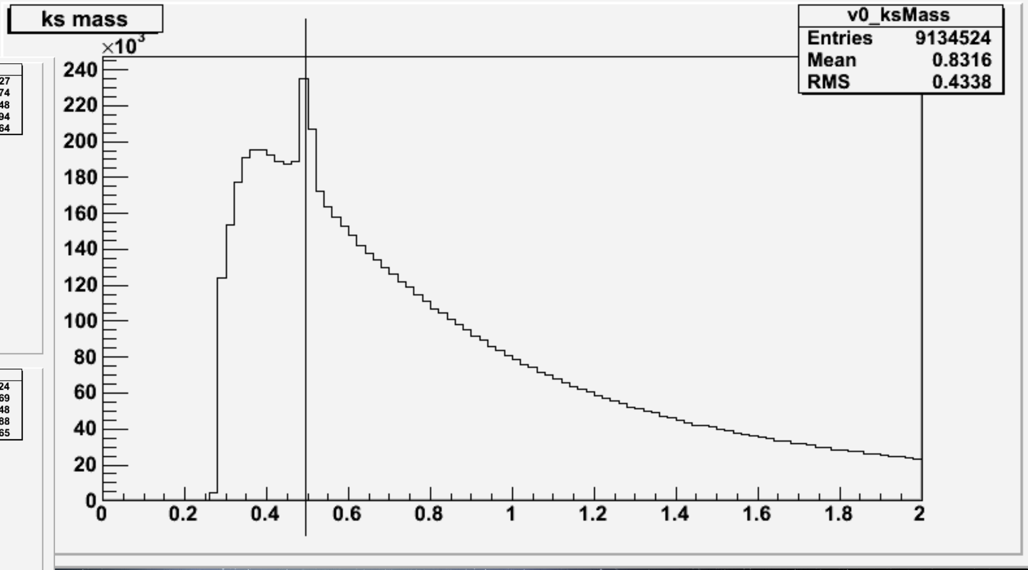
Declaring and filling histogram invMass

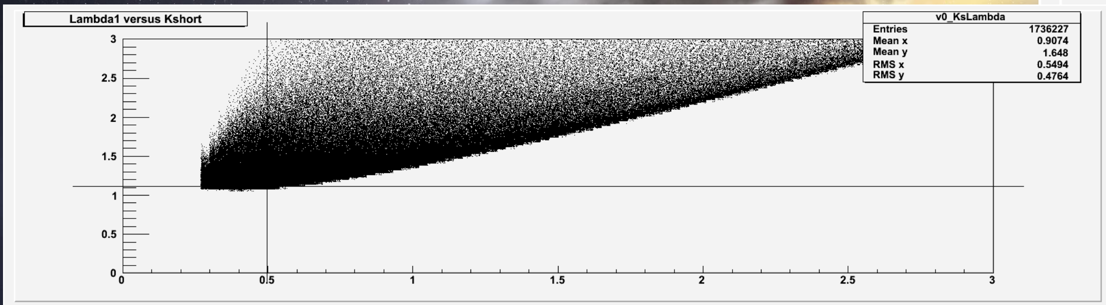
In the end, we switched to v0 variables->K0short.cxx

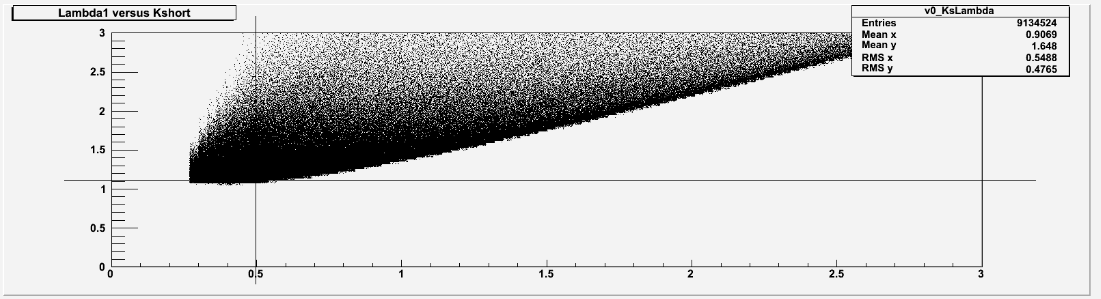
Early MC vs DATA

No cut optimization





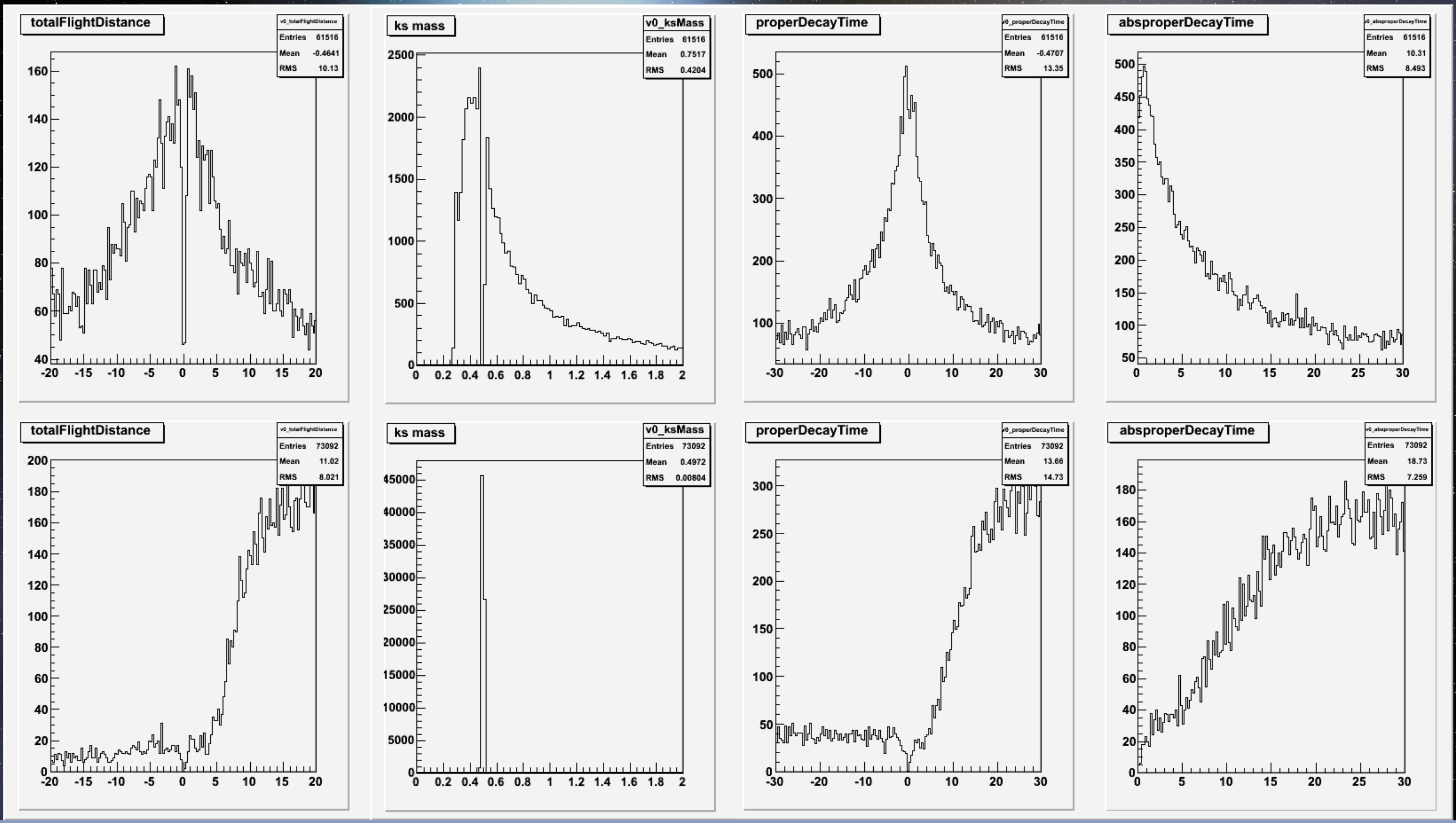




K0short mass reconstruction

- Methods:
- CutEvent.cxx: TakeEvent cut
  - Too many events had K0short
- K0short.cxx: ksMass cut
  - Signal=.497$\pm$ .018GeV

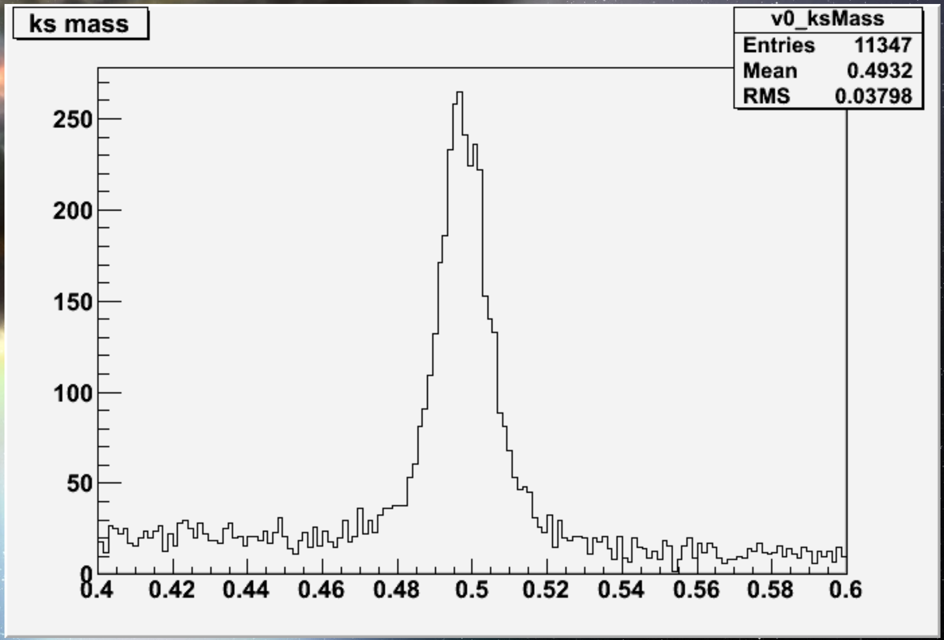
K0short mass reconstruction



Signal versus background (top) after setting fabs(cosThetaPointing)>.999

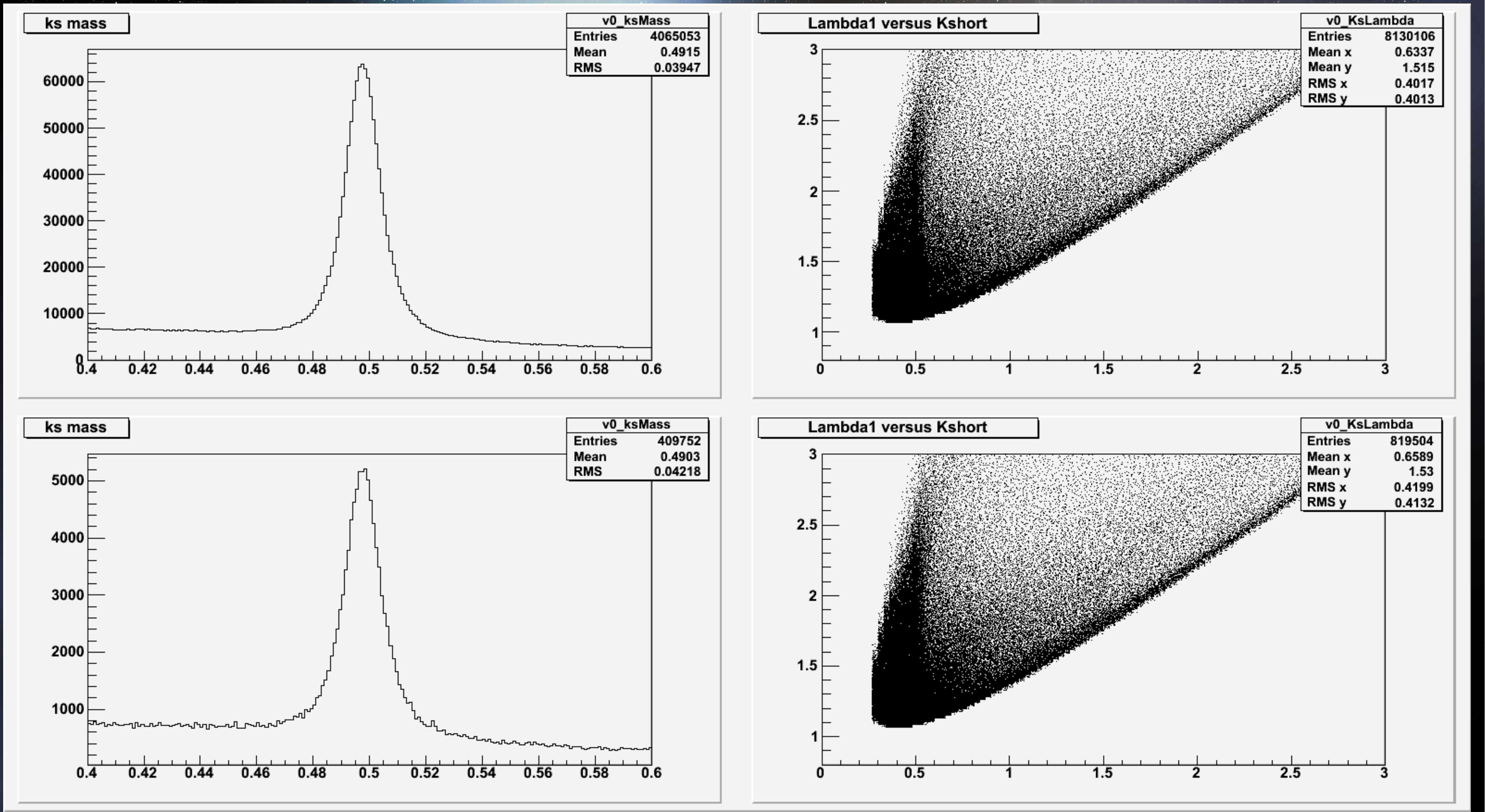
K0short cuts

- Event cuts
  - MinBias MBTS_1 trigger
  - PileUp cleaning cut
  - Vertex selection, cut for 2 tracks, etc
- Cuts on tracks:
  - |eta|<MaxEta
  - pt>MinPt
  - |d0|>5mm or |z0|>5mm
- Cuts on V0:
  - fabs(v0_costhetapointing)>.999
  - v0_totalFlightDistance>4
  - v0_properDecayTime>11



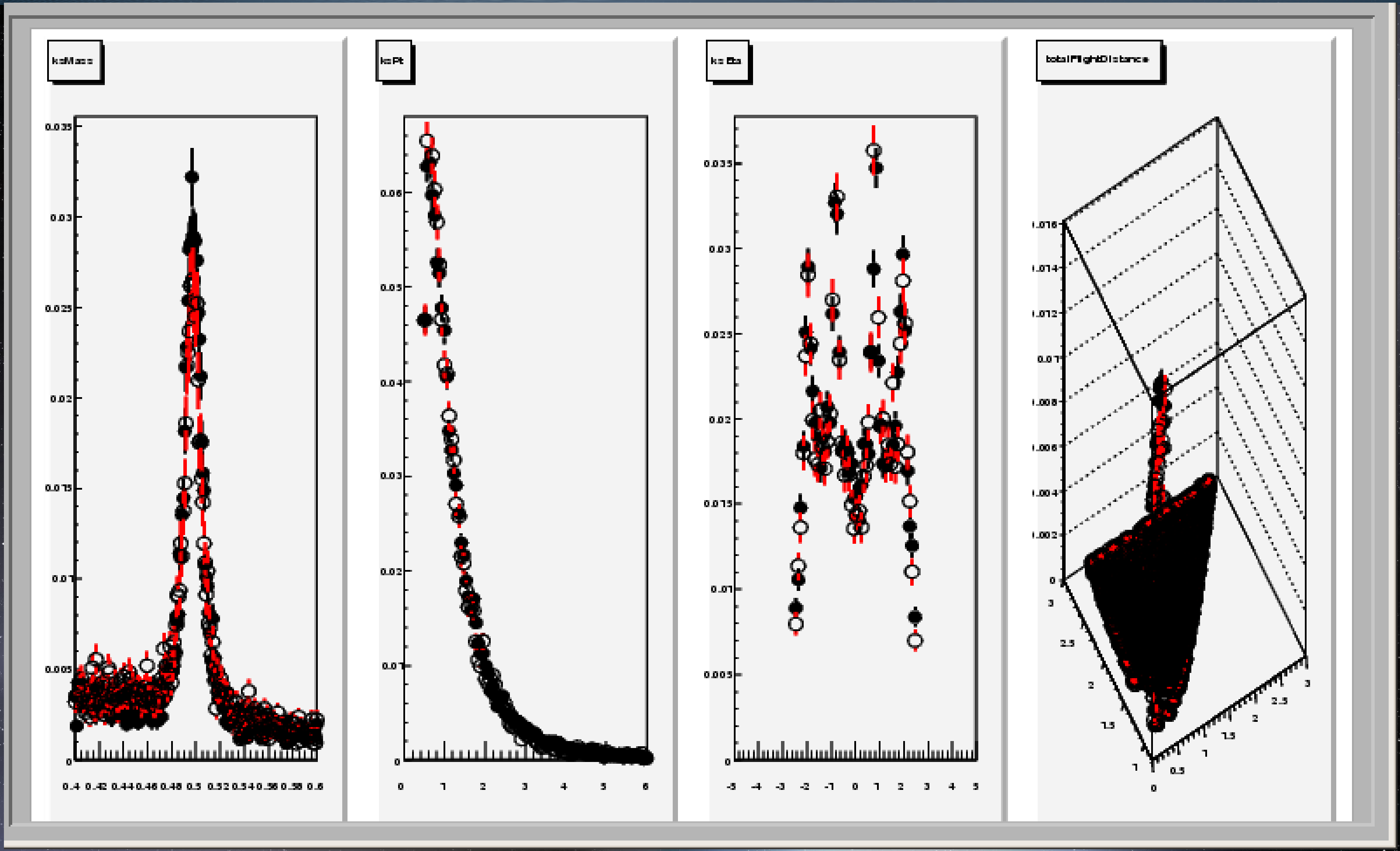
MC

Later MC vs Data



MC is on top here

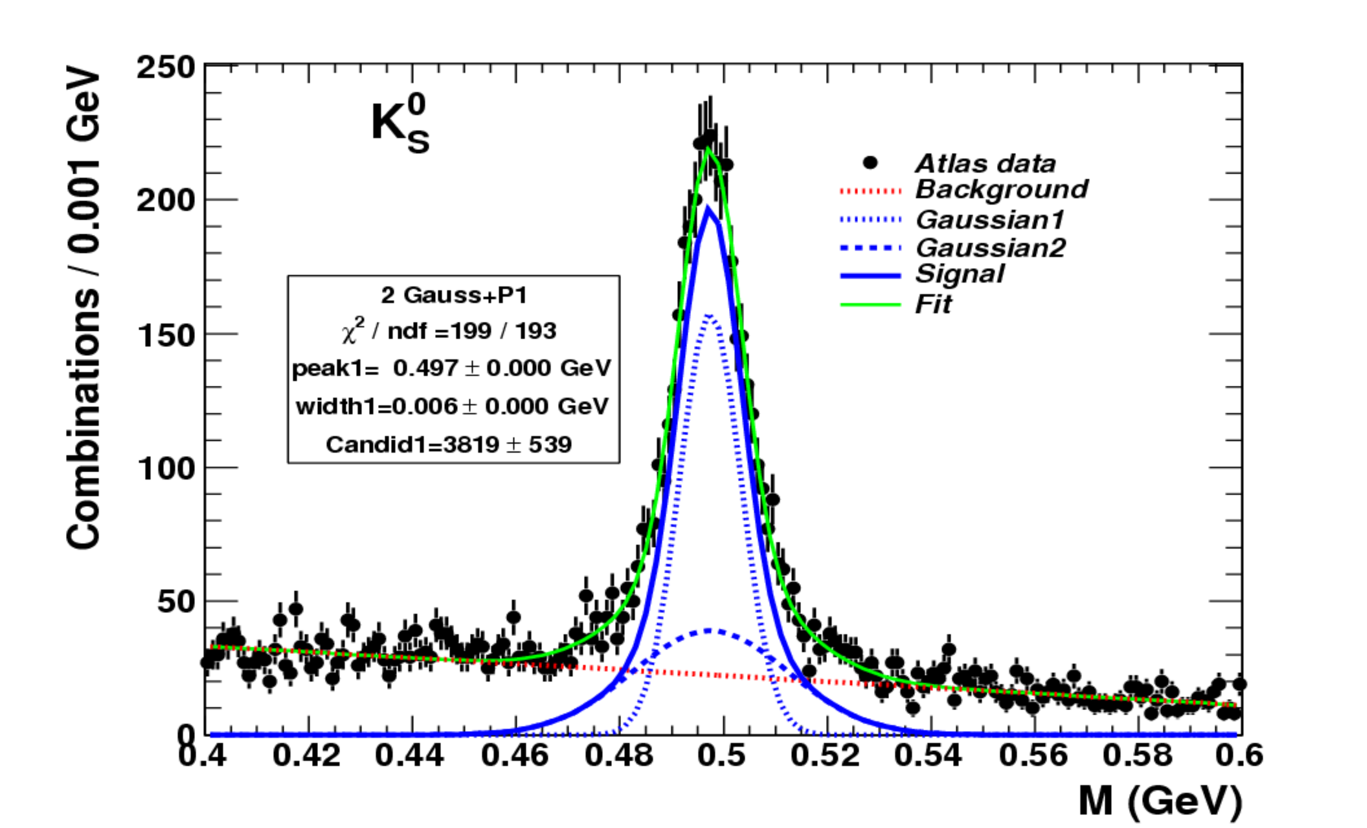
Comparison of MC vs Data



Red is Data here

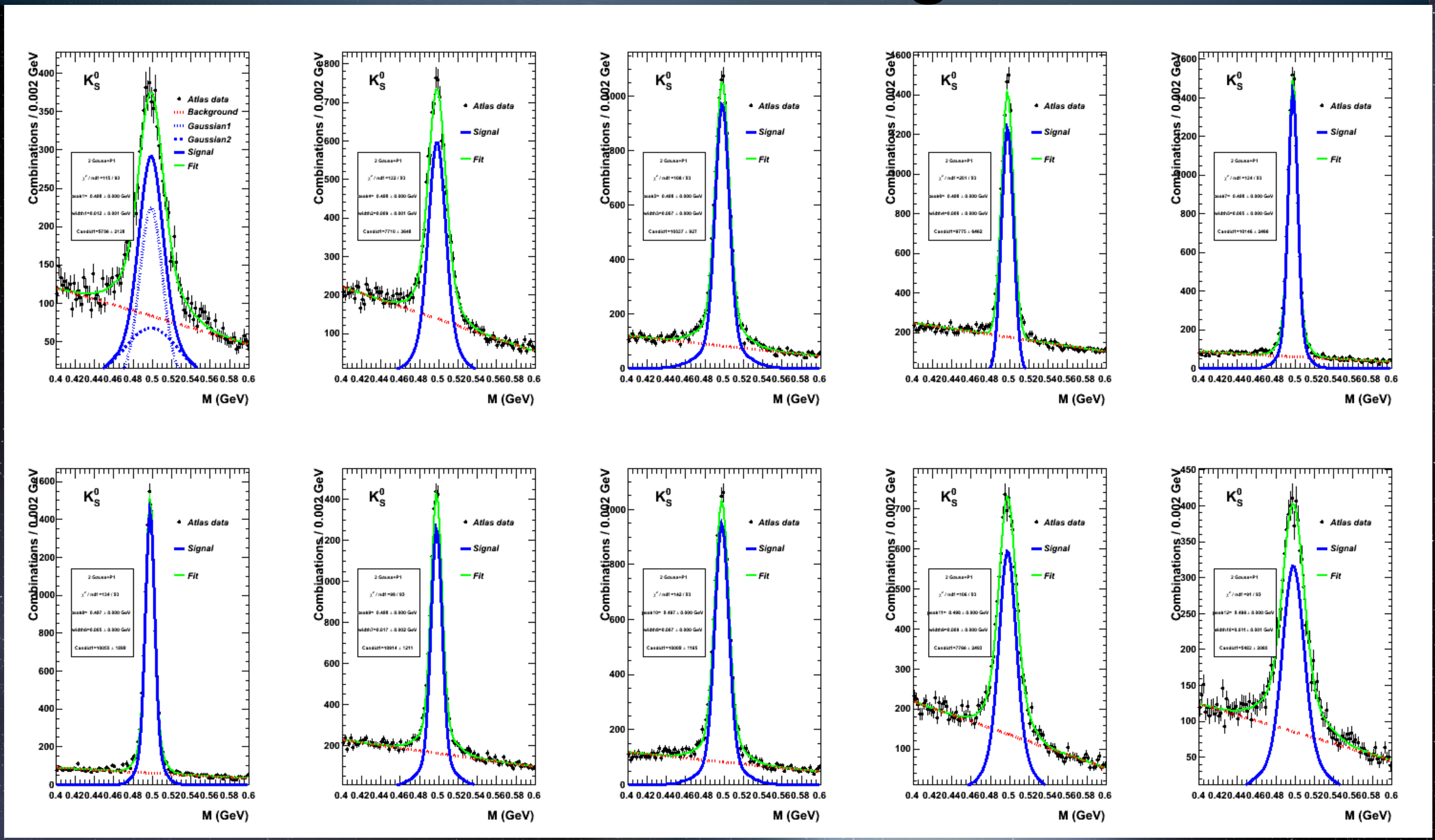
Test for accuracy of QCD prediction

Data Fitting



- Two Gaussians for signal
- Line for background
- Adding a Gaussian and manually defining the second Gaussian

Number of K0short candidates for Pt and Eta Range

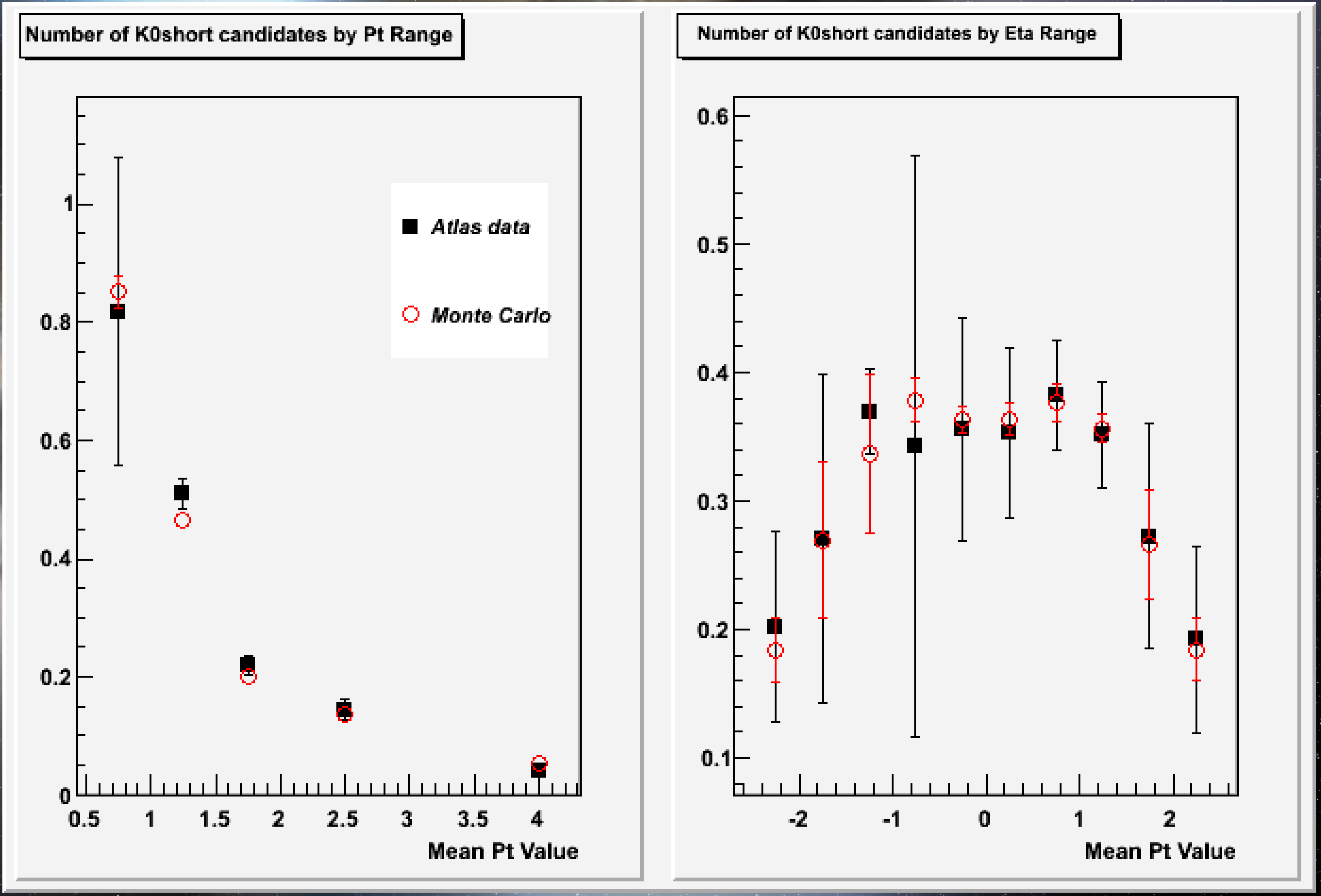


- Dividing integral by bin width
- if (v0_ksEta->at(j) >-2.5 && v0_ksEta->at(j) <=-2.0) {
  h.v0_Eta1Mass->Fill (v0_ksMass->at(j)/GeV); }

K0short candidates by Pt and Eta Range

Red is MC here

- Method
  - conjoin.cxx
- Consistent with QCD predictions?
- Conclusions



Future Goals

- Reduce background for K0short
- Reduce background for lambda
- K0K0
- K0short vs Lambda (#candidates)
- Lambda vs lambda bar (#candidates)-> remembering that it's matter?