Heavy Flavor Meeting

SSbar 250 GeV Analysis

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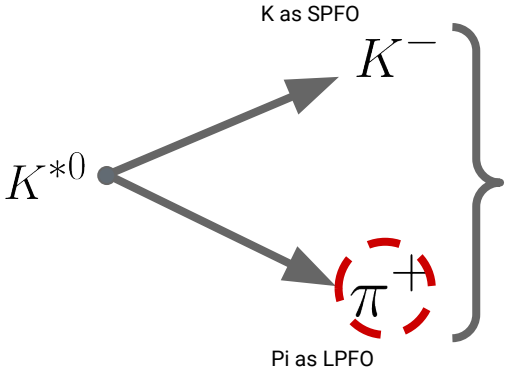
Sep 27th, 2022

Ko* Reconstruction

SSbar Analysis

K0* reconstruction

- SSbar can disintegrate into K0*, subsequently decaying into K± and π±.
- Pion can be the **Leading PFO (LPFO)** in such case.
- Kaon would be the **Secondary PFO (SPFO)**.

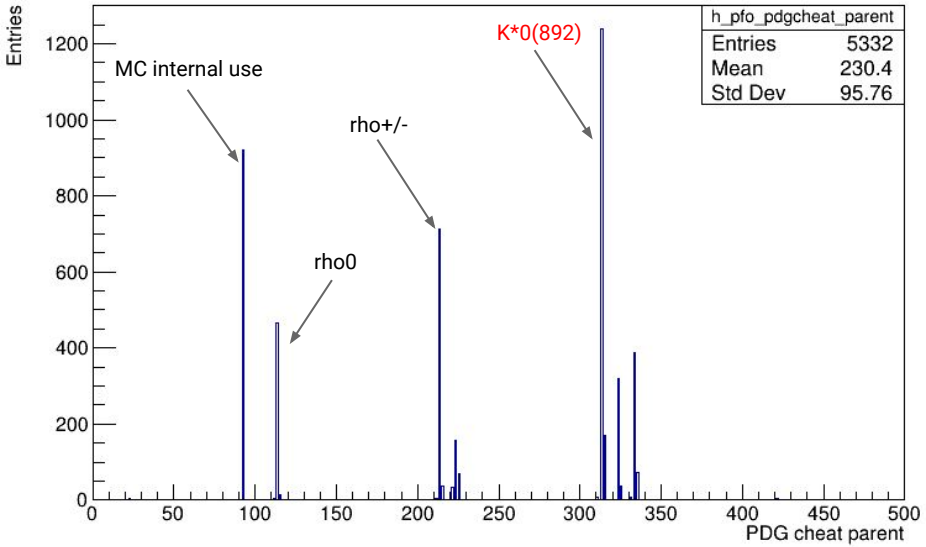


Conditions for K*0 identification:

1. Identify Particles
    a. Pion as LPFO
    b. Kaon as SPFO
2. Check charges of Pi-K and make sure they're opposite.
3. Reconstruct invariant masses for all possible combinations of Pion and Kaons.

SSbar Analysis

- **Compare MC Info**
  - Listed parents of **LPFO pions**
  - Aside from some ρ parents which disintegrates to a pair of π's, most of them are coming from K0*.
  - **Invariant mass** distribution should sufficiently distinguish between those parents, once combing Kπ mass to form one.



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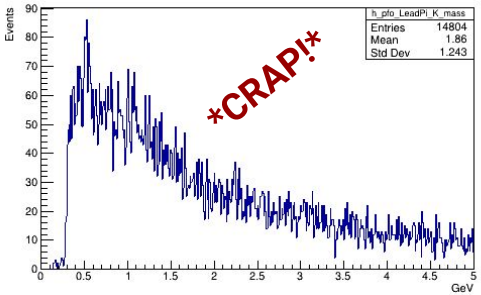
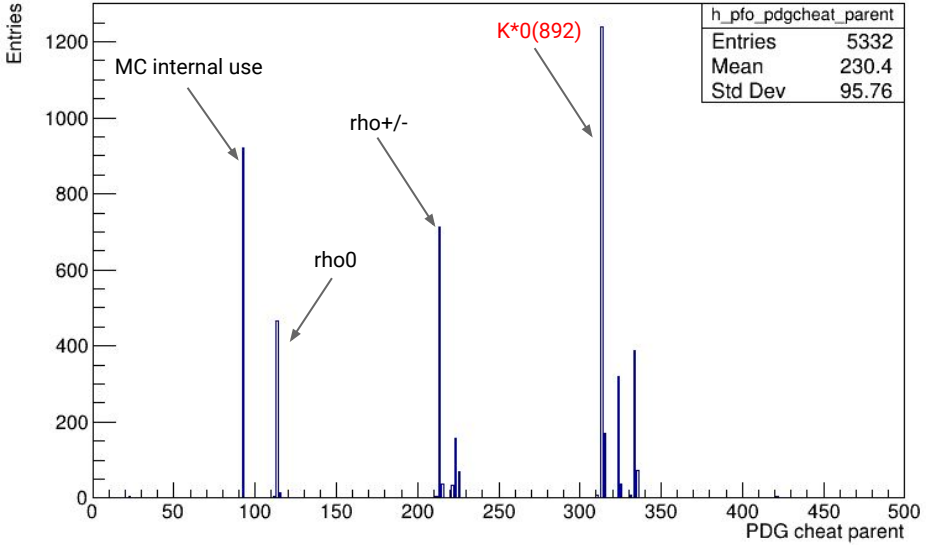
First attempt





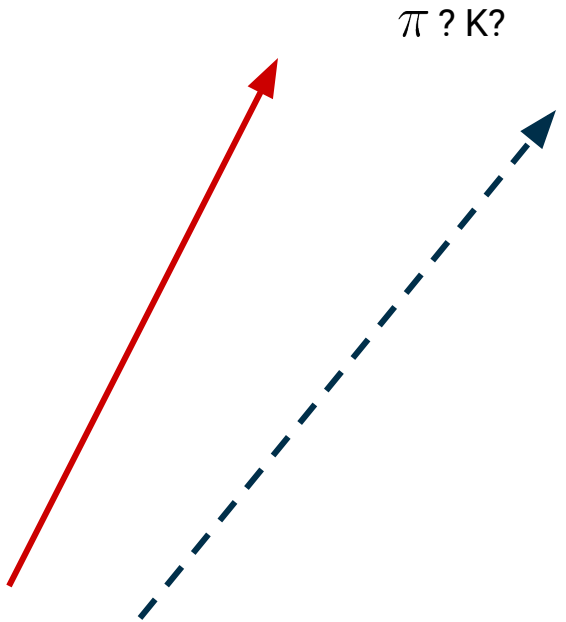
Mass Hypothesis

Usage of Correct Mass Hypothesis

- **Particle Reconstruction**
  - Upon reconstruction of particle, its energy is calculated using its **momentum** obtained from TPC and **pion mass**.

$$E^2 = m_{\pi^\pm}^2 + |p|^2$$

  - This is due to the fact that we simply do not have any basis of its PID upon energy calculation.
  - Thus after the PID of Kaon, we simply replace the mass of pion to those for Kaon.
    - Usage of track fit momentum
    - Refit processor?

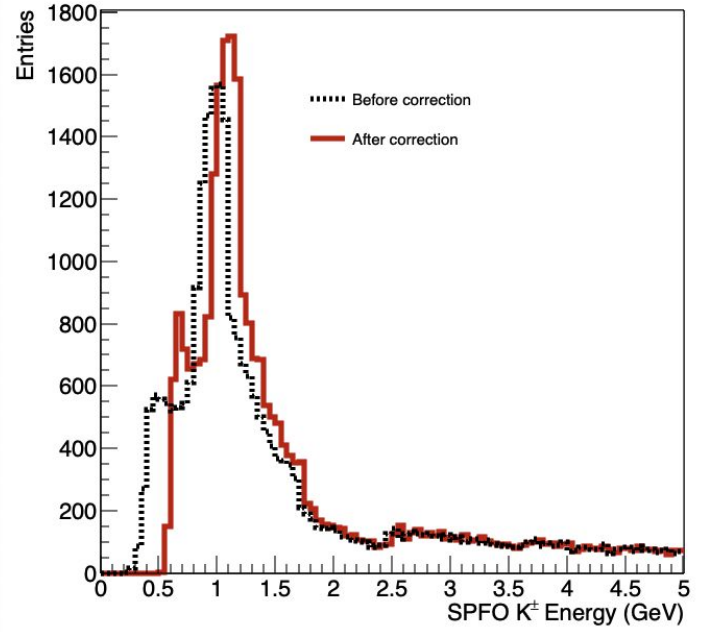


Energy Correction

- **Correction**
  - **Kaon Mass**

$$m_{K^{\pm}} = 0.493667 \text{ GeV}$$

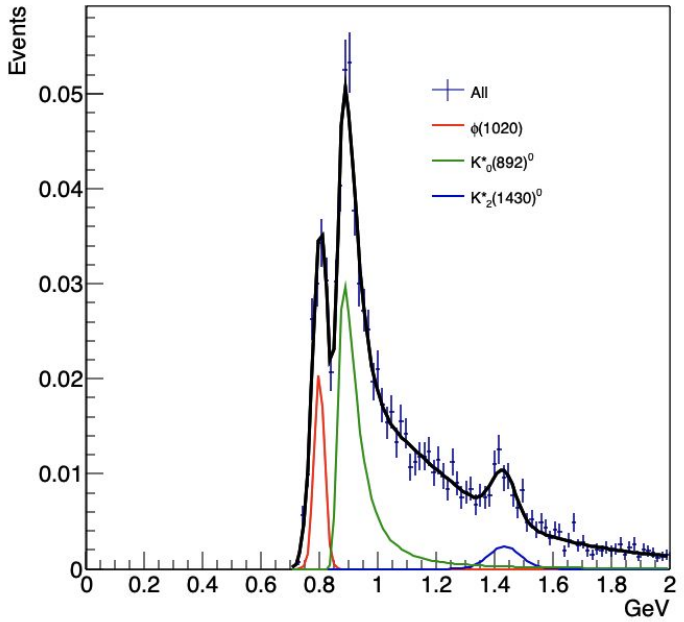
  - Slight shift in peak after the application of the correction, which become more apparent upon calculation of invariant mass.



Invariant Mass

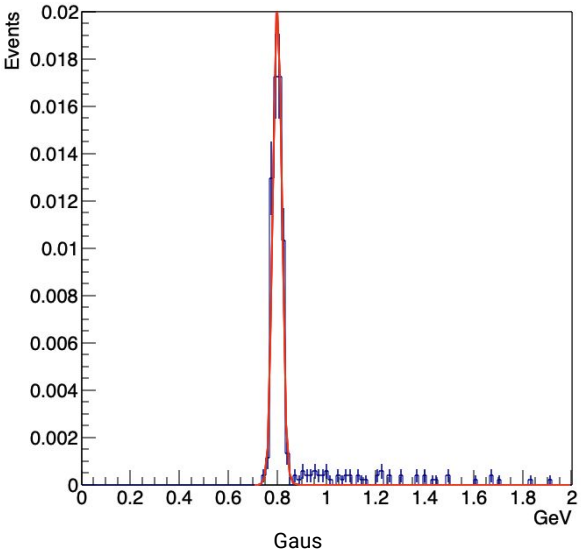
Invariant Mass Reconstruction

- Invariant mass plot on the right shows the combined mass of **Leading Pion** and **Secondary Kaons**.
- See clear peak at 0.8, 0.9 and 1.4 GeV
- MC parent information shows that those pions and kaons are coming from phi(1020), K*0(892) and K*0(1430)
- Phi mass distribution might be coming from the misidentification of pions from dE/dx information?
    - Phi decay into charged kaon pair.
    - Checking the leading pion MC PID.
      If it is misidentification of kaon as pion, those mass should be changed to kaon mass to obtain correct reconstructed phi mass at 1020 MeV

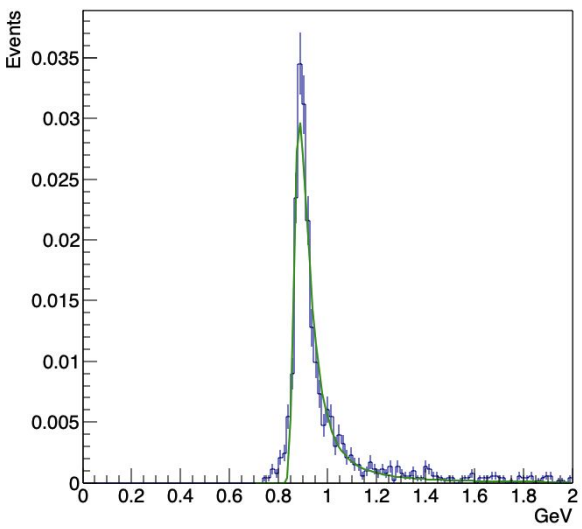


Invariant Mass

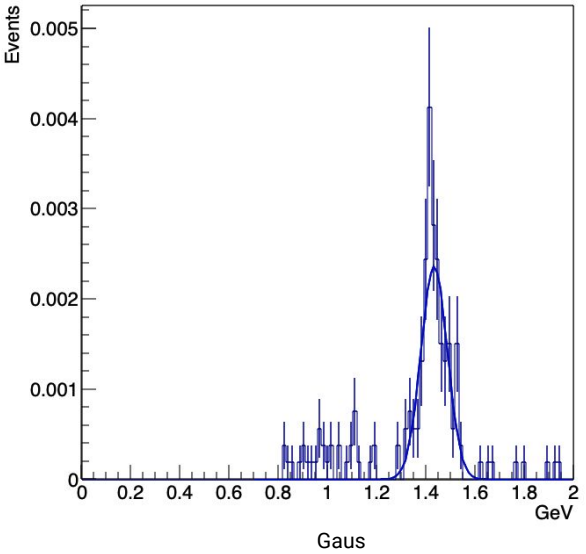
$\phi(1020)$



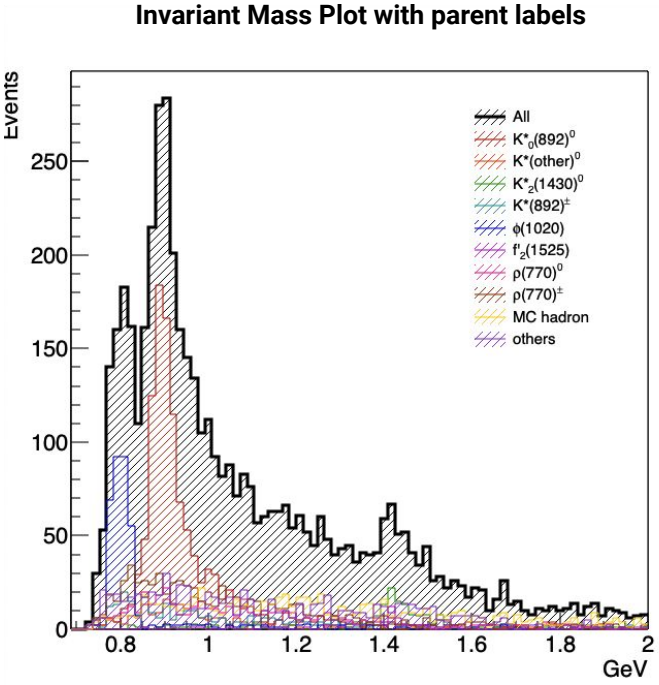
$K_0^*(892)^0$



$K^*(1430)^0$



Invariant Mass

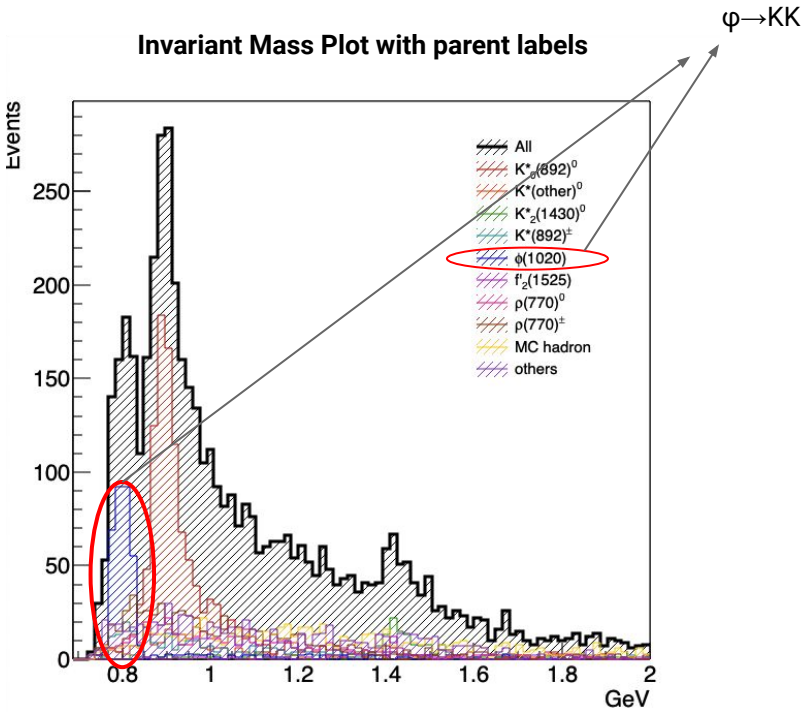


Invariant Mass

Replacing from Pion to Kaon mass hypothesis

- Cutting invariant mass at 850 MeV
- Replace leading pion mass hypothesis by the kaon mass
- Extreme peak at 1020 MeV

  Corresponds to φ mass.



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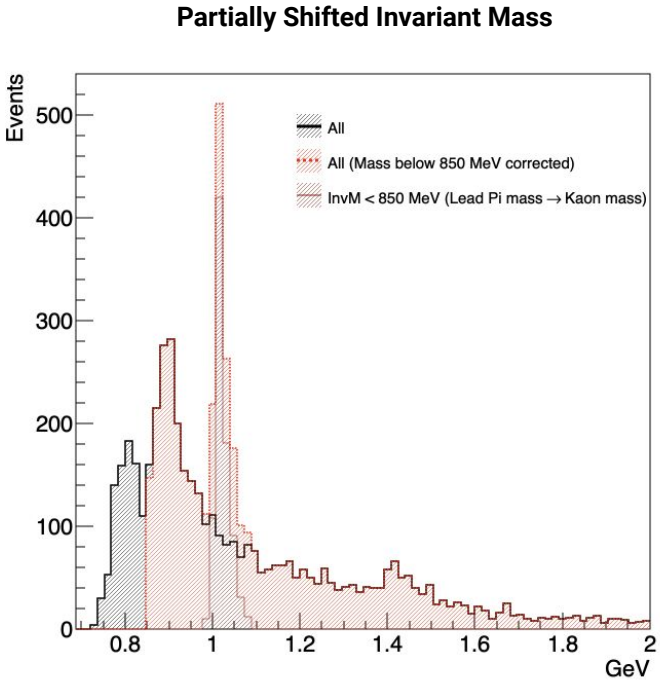

Full Statistics Sample

Events

Full Luminosity Simulation

- All data ee→qq processed
  - eLpR (full)
  - 26M events (ss: ISR removed)
  - Luminosity 4.6 ab-1
- Ran at KEKCC
  - 5.5 TB output at the end…

    Hopefully there will be no complaints from KEK..
- Migration to  is happening now.
  - Much faster here in France.

Processed Data Sets

283G	/group/ilc/users/yokugawa/QQbar250/l5/eLpR/15162
118G	/group/ilc/users/yokugawa/QQbar250/l5/eLpR/15271
116G	/group/ilc/users/yokugawa/QQbar250/l5/eLpR/15273
117G	/group/ilc/users/yokugawa/QQbar250/l5/eLpR/15315
115G	/group/ilc/users/yokugawa/QQbar250/l5/eLpR/15319
118G	/group/ilc/users/yokugawa/QQbar250/l5/eLpR/15351
116G	/group/ilc/users/yokugawa/QQbar250/l5/eLpR/15353
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118G	/group/ilc/users/yokugawa/QQbar250/l5/eLpR/15633

Events

Number of Events and Efficiencies

- All data ee→qq processed
  - **26M events** (ss: ISR removed)
  - **Luminosity 4.6 ab-1**
- SSbar reconstruction
  - Total valid events: 223k events
    - K-LPFO events: 168k events
    - K-Pi events: 55k events
  - **Efficiency: 0.86%**

Process	Events	Efficiency		
All	5.47E+08			
dd	1.10E+08			
uu	1.09E+08			
cc	1.09E+08			
bb	1.10E+08			
ss	1.10E+08			
ISR removal	2.61E+07	100.00%	**Luminosity (fb-1)**	4,635.03
k+/-	1.32E+07	50.48%		
20GeV<p_LPFO<60GeV	2.99E+06	11.45%		
TPC hit > 210	1.56E+06	5.98%		
off set < 0.1	1.50E+06	5.74%		
dEdx dist min	230966	0.89%		
SPFO opp (KLPFO)	168044	0.64%		
KPi	429071			
KPi(K*0(892))	55726	0.21%	↑	
Valid Events	223770		**Efficiency**	0.86%

High Lumi SSbar

Fit function:

$$S(1+\cos^2\theta)+A\cos\theta$$

Gen:

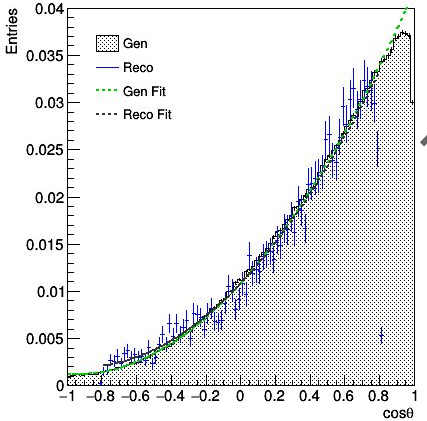
S = 1.07E-2 ± 1.7E-6

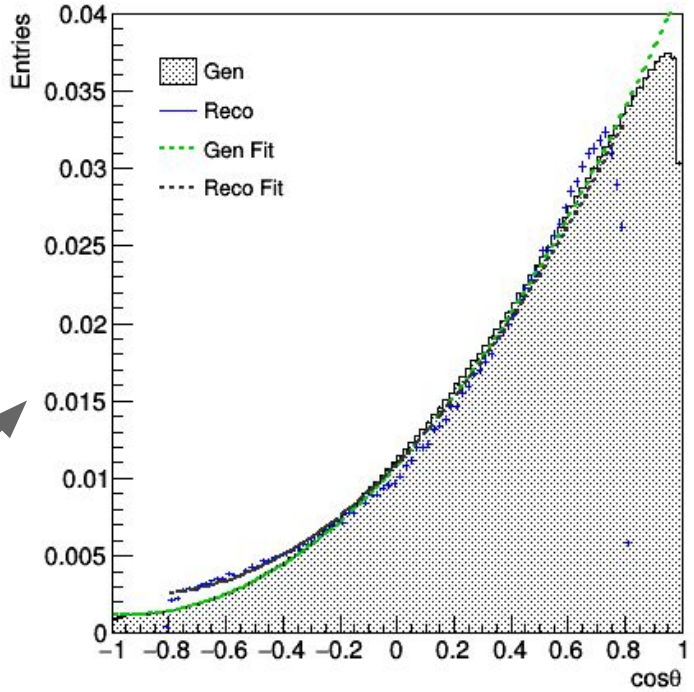
A = 2.01E-2 ± 3.7E-6

Reco:

S = 1.08E-2 ± 1.9E-5

A = 1.90E-2 ± 4.7E-5





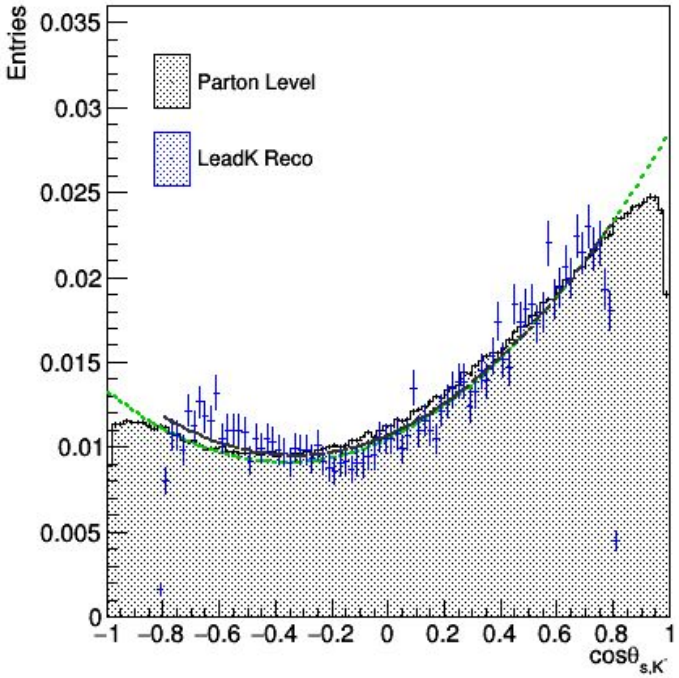
Normalization range (-0.76,0.76)

Right Handed Polarization

eRpL

- **Leading Kaons**
  - Leading Kaons were used to identify the Kaons coming from the original ssbar quarks.
  - The selection, cuts applied for this sample is same as what we applied for the left handed samples.
  - The asymmetry curve is gentle on the right handed polarization thus suppressing the **migration effects**.

Leading Kaon Polar Angle



Summary

Summary

- **K0* identification**
  - Leading π's were used to identify K0*.
  - Charged K were identified as the secondary PFOs.
  - Invariant mass formed from πK are crucial to distinguish them from other parents.
    - 💡: Can the invariant mass be the benchmark for the TPC particle identification?
    - The peak is narrow enough to distinguish one particle from another.
  - Polar angle plot on its way. (Need some cleaning for migration issues.)
- **High Statistics Sample**
  - 4.6 ab-1 achieved, using the entire 2f_Z_hadron samples that has been processed.
  - Raise in an efficiency is necessary.
- **Right Handed Sample**
  - First look on the eRpL sample.
  - Migration less affecting the polar angle distribution, compared to the eLpR, as expected.

Backup

High Lumi SSbar

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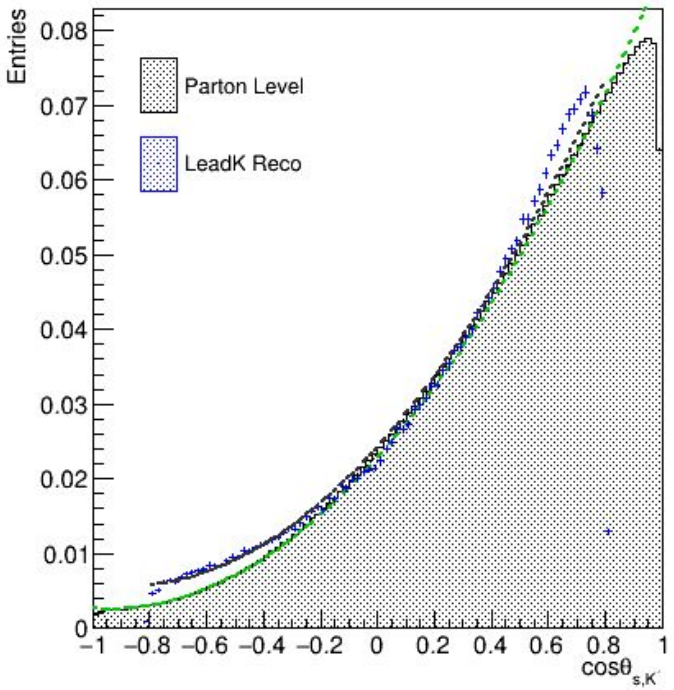

Normalization range (-0.4,0.4)