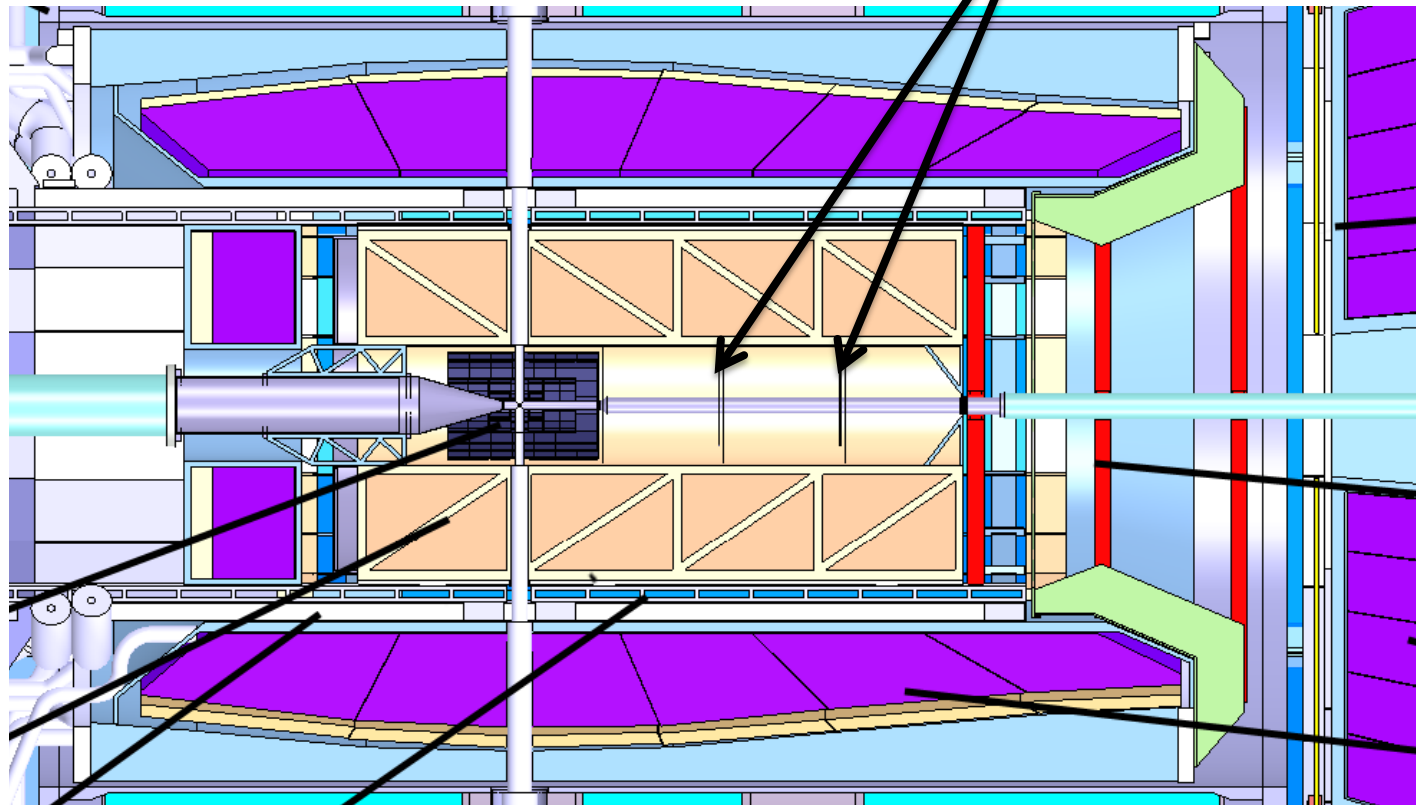


$\Lambda\bar{\Lambda}$ Analysis with $\bar{\text{P}}\text{ANDA}$

September 2013 – PANDA Collaboration Meeting | Simone Esch s.esch@fz-juelich.de

The PANDA Tracking System



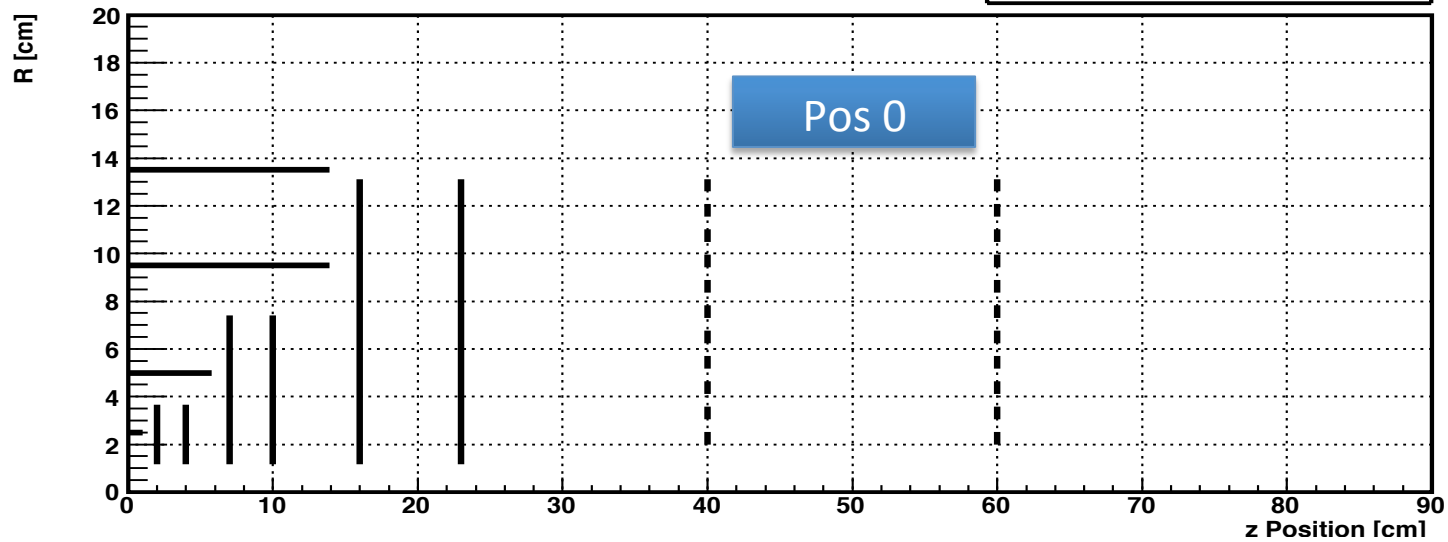
Question: How much can the Λ Disks contribute to the analysis of hyperon decay / $\Lambda\bar{\Lambda}$ decay?

Λ Disk Position

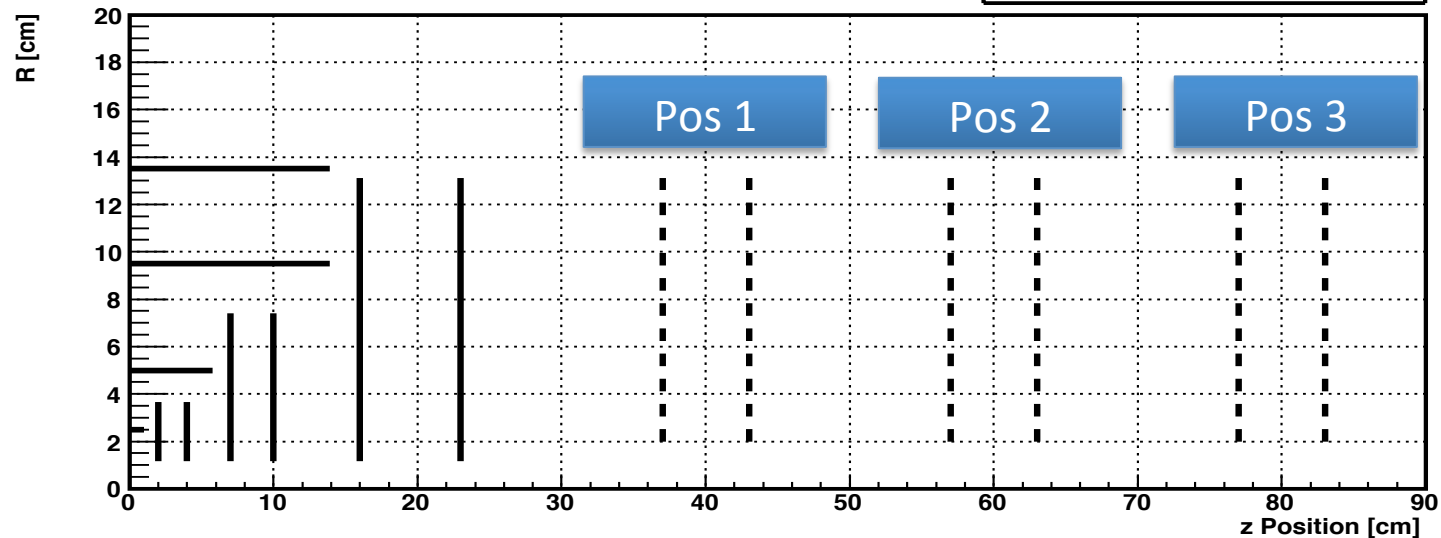
Pos -1

→ No Disks

Sketch of Λ Disk positions



Sketch of Λ Disk positions



Investigated Cases

- Five disk positions
- Just MVD, STT, GEM and FTS detectors
- Three beam momenta - 1.642 GeV/c
 1.918 GeV/c
 6.00 GeV/c
- 10,000 Events per momentum and disc position

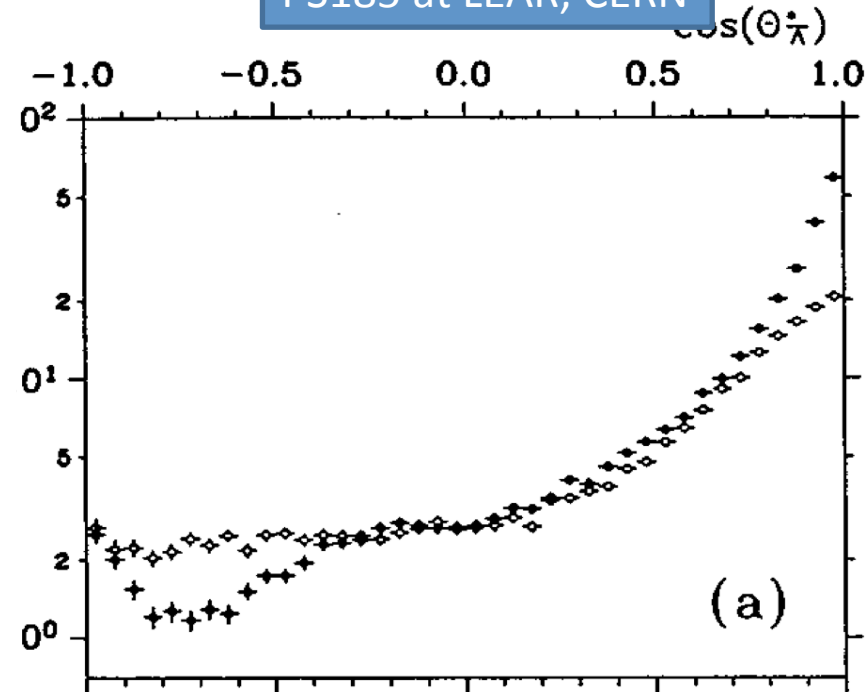
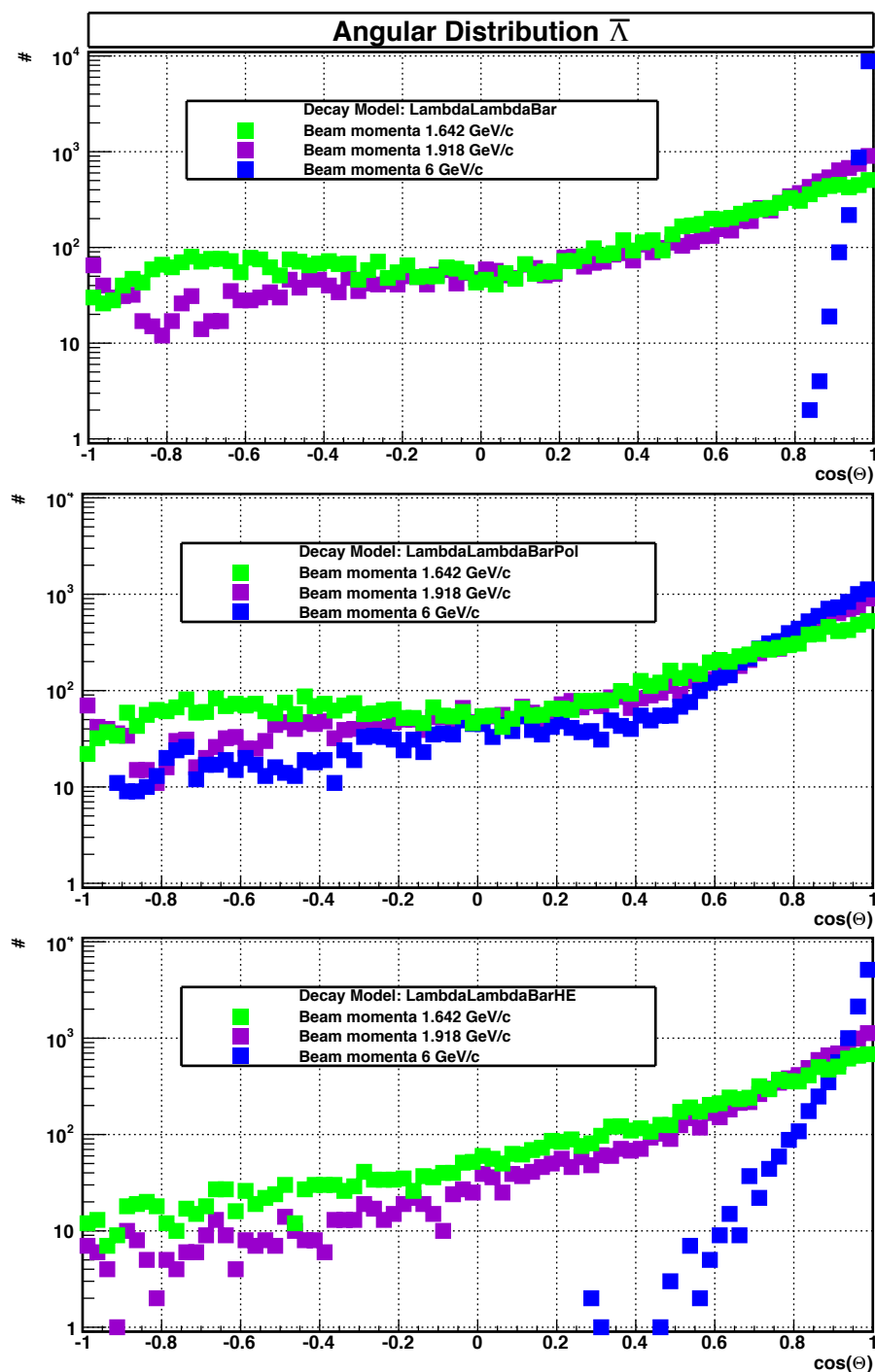
Used EventGenerator: EvtGenDirect

Decay Model available:

- LambdaLambdaBar → Generator base on experimental data
- LambdaLambdaBarPol → includes polarization of Λ particles
- LambdaLambdaBarHE → „just a example, dummy diff cross section should be replace by correct one “

Angular Distribution

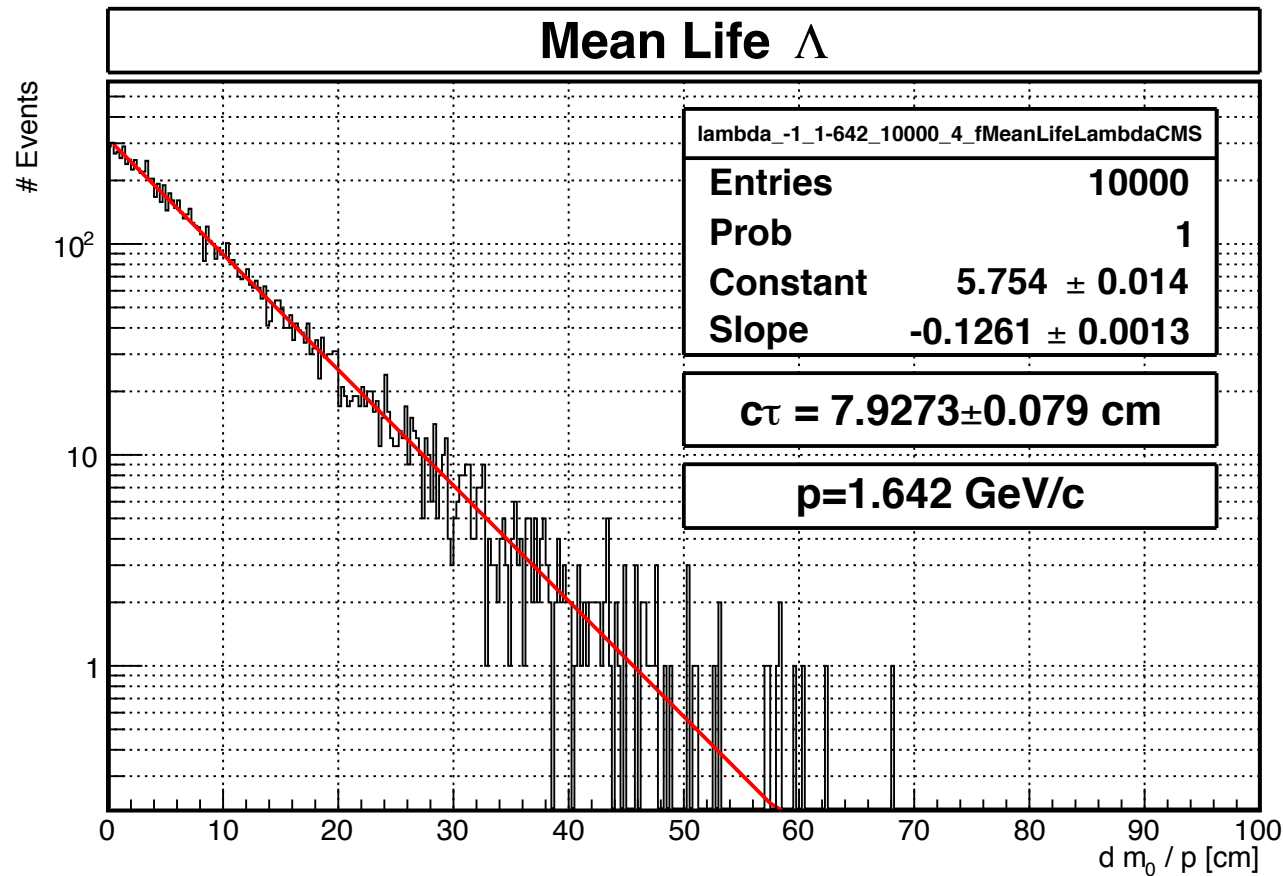
PS185 at LEAR, CERN



Ref.: P. D. Barnes et. al: Observables in high-statistics measurements of the reaction $p\bar{p} \rightarrow \bar{\Lambda}\lambda$. Phys. Rev. C, 54:1877–1886, Oct 1996.

Decay Length

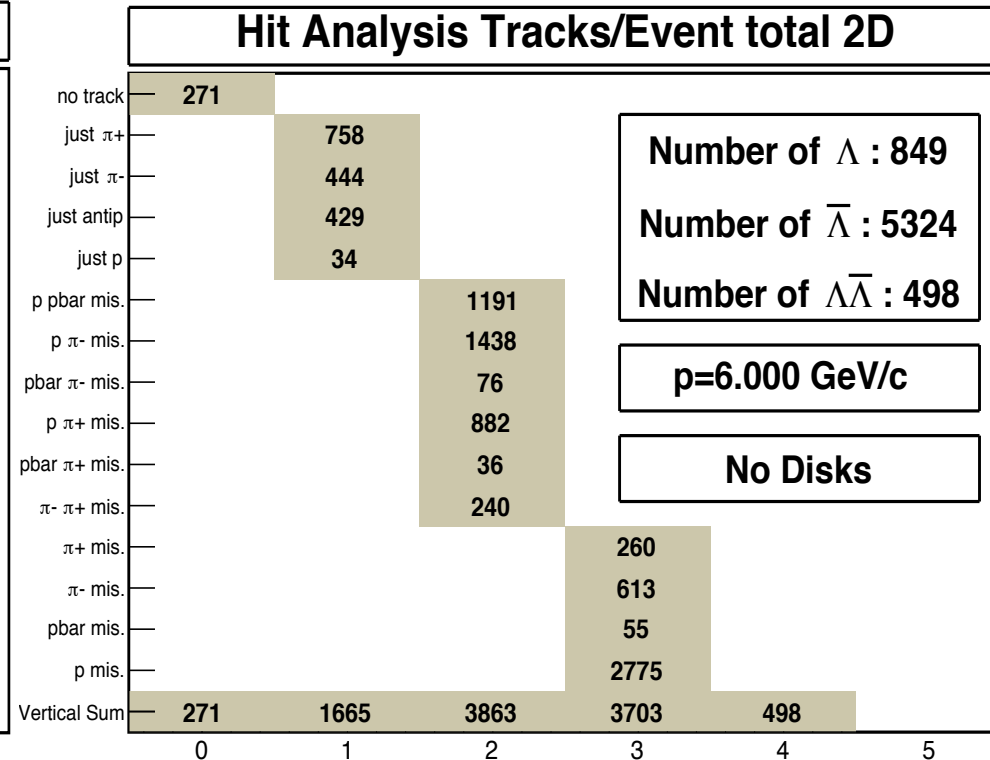
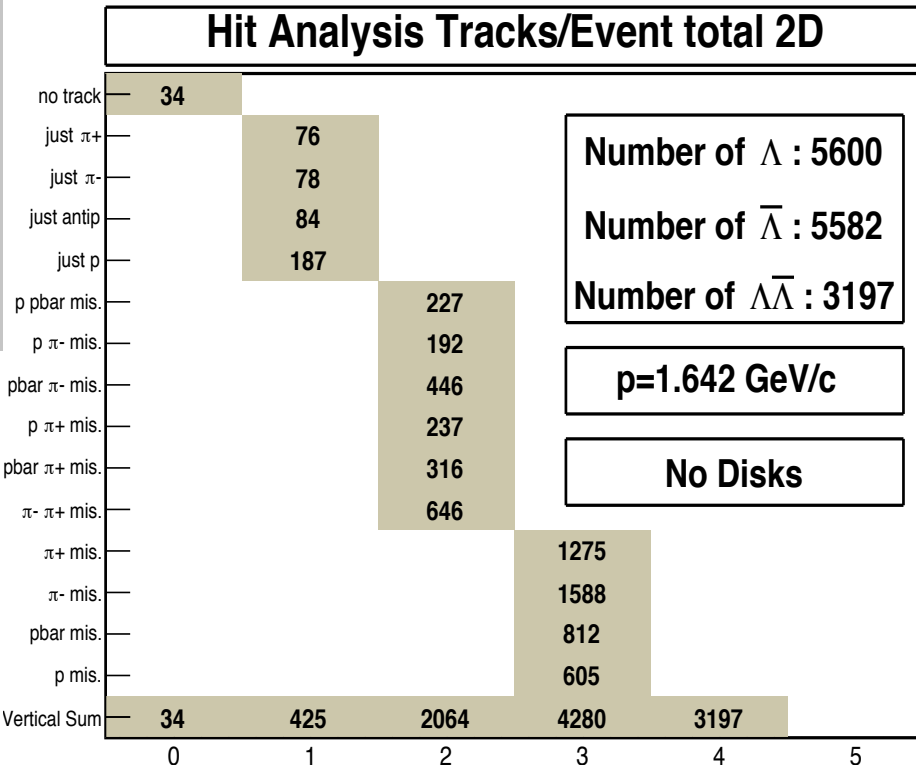
$$c\tau_{\text{PDG}} = 7,89 \text{ cm}$$



Track Selection / Cut Criteria

#MVDHits >3 and Sum(#STTHits, #GEMHits, #FTSHits)>1
or
SUM(#MVDHits, #STTHits, #GEMHits, #FTSHits) >9

At the moment no track finder available which finds secondary vertex >1cm
→ Using Ideal Track Finder with selection criteria to pretend real track finder.



After Selection Criteria

Momenta		Pos 0 40 cm & 60 cm		Pos 1 37 cm & 43 cm		Pos 2 57 cm & 63 cm		Pos 3 77 cm & 83 cm		Pos -1 no disk
1.642 GeV/c	# Λ	5709	+1.09%	5600	+0.0%	5758	+1.58%	5763	+1.63%	5600
	# Λ bar	6082	+5%	6093	+5.11%	6107	+5.25%	6130	+5.48%	5582
	# $\Lambda\Lambda$ bar	3463	+2.66%	3421	+2.24%	3530	+3.33%	3531	+3.34%	3197
1.918 GeV/c	# Λ	4857	+0.12%	4859	+0.14%	4958	+1.13%	4935	+0.9%	4845
	# Λ bar	6592	+7.17%	6541	+6.66%	6510	+6.35%	6495	+6.20%	5875
	# $\Lambda\Lambda$ bar	3266	+3.6%	3191	+2.85%	3246	+3.40%	3232	+3.26	2906
6 GeV/c	# Λ	822	-0.27%	838	-0.11%	849	+0.0%	862	+0.13%	849
	# Λ bar	5496	+1.72%	5473	+1.49%	5574	+2.5%	5489	+1.65%	5324
	# $\Lambda\Lambda$ bar	545	+0.47%	540	+0.42%	543	+0.45%	550	+0.52%	498

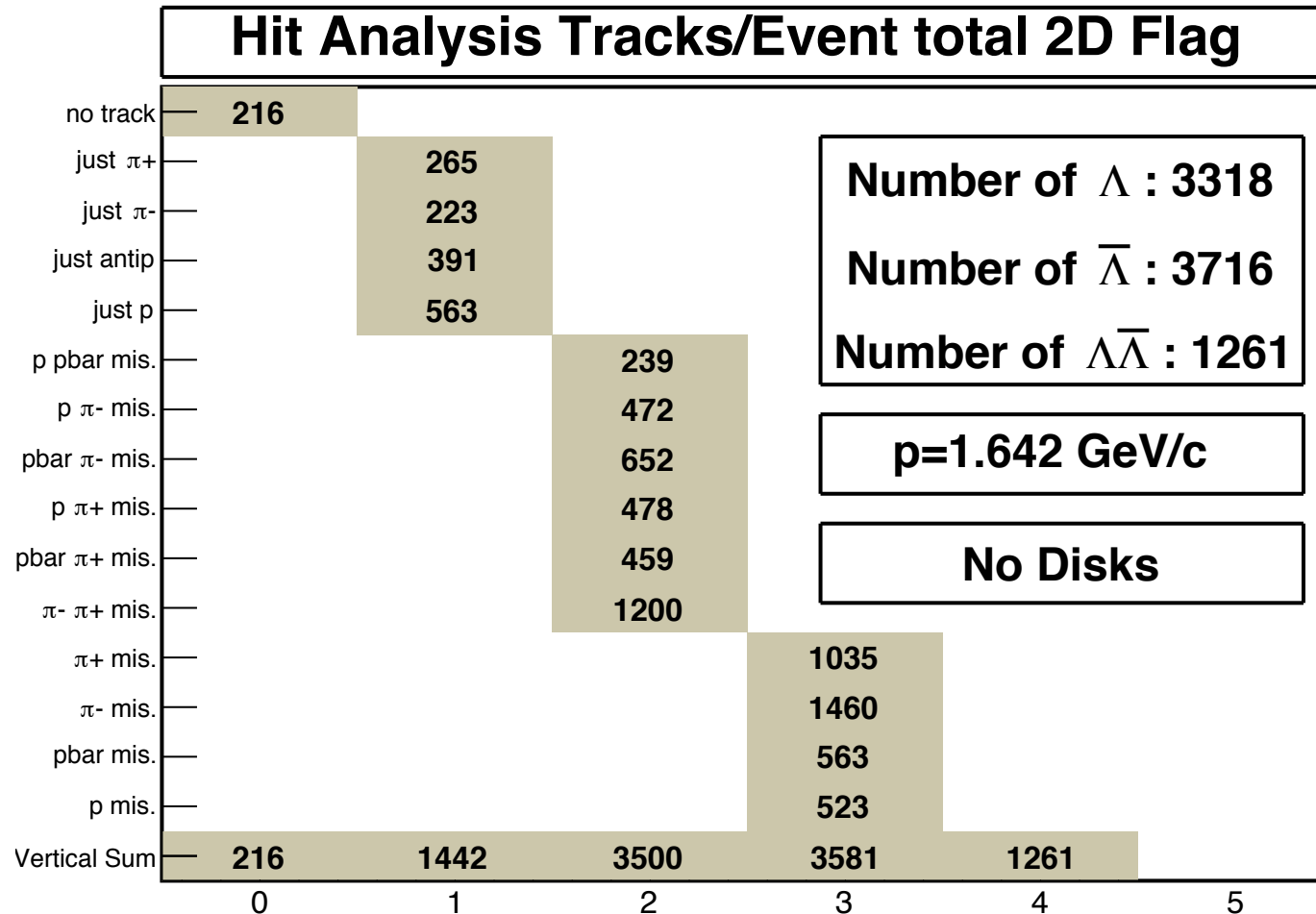
Percentage points relative to Pos-1

Abar efficiency gains from Lambda-Disks, Λ efficiency may suffer from it.

Number of Events after Fit

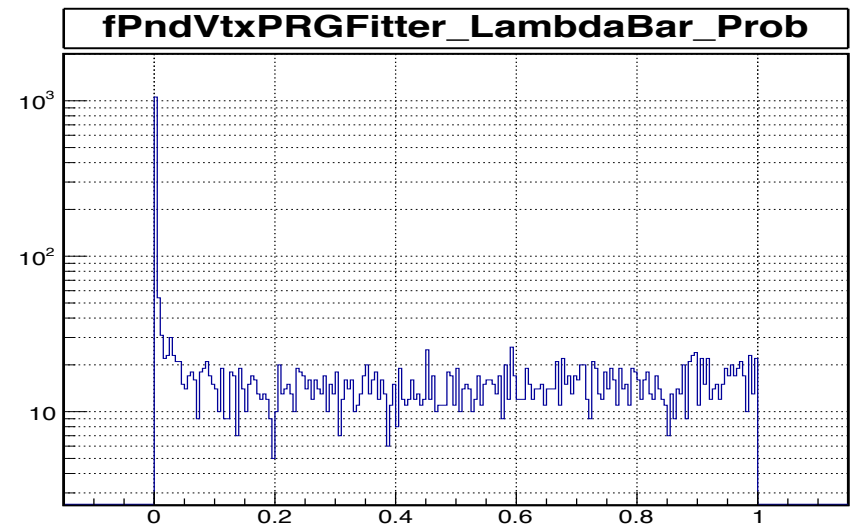
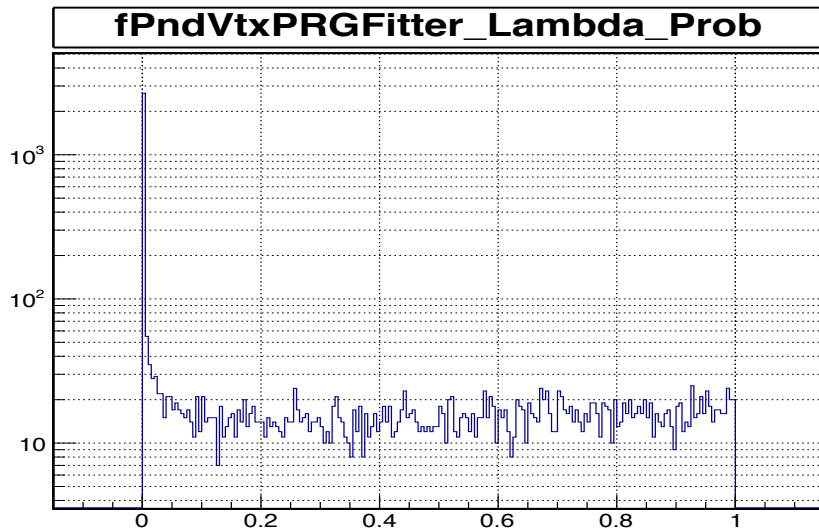
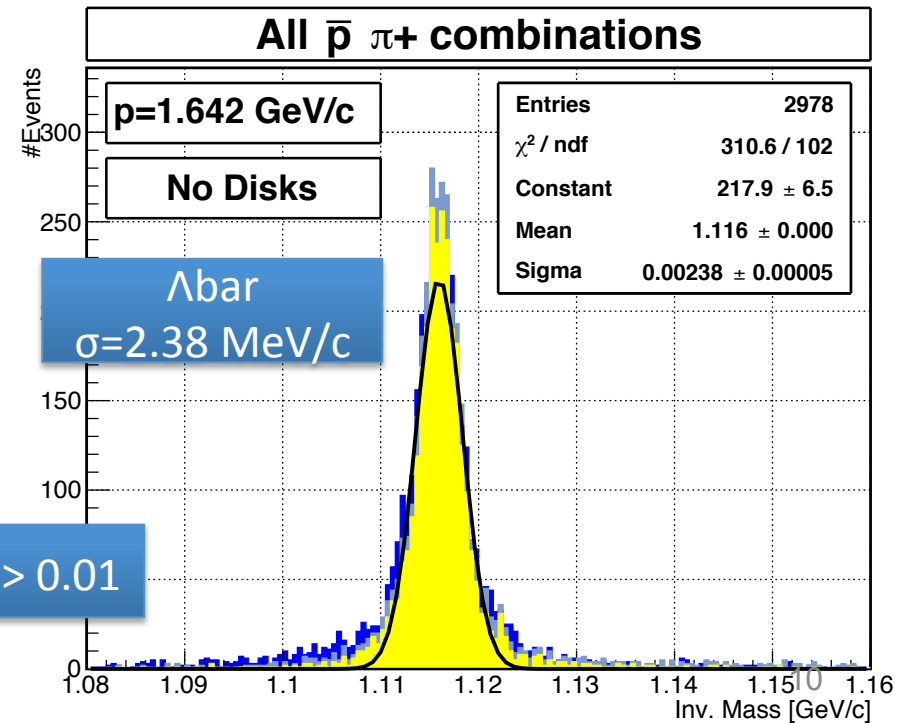
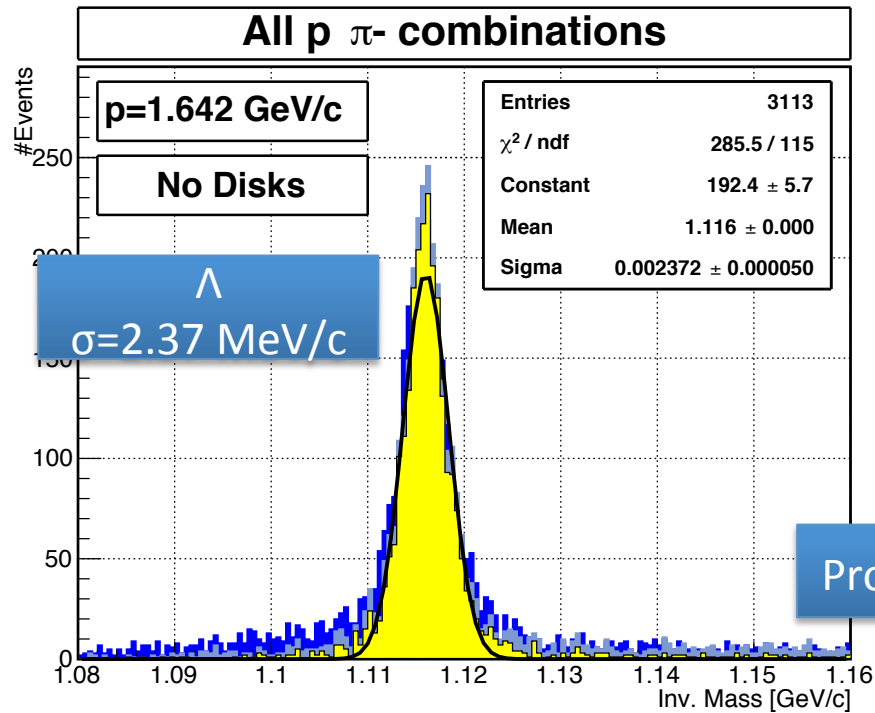
Cut away Tracks with FitFlag <0 (indication for a bad fit)

Only FitFlag=-1 appeared (NDF=0 or conversion from GenFitTrack to PndTrack failed)



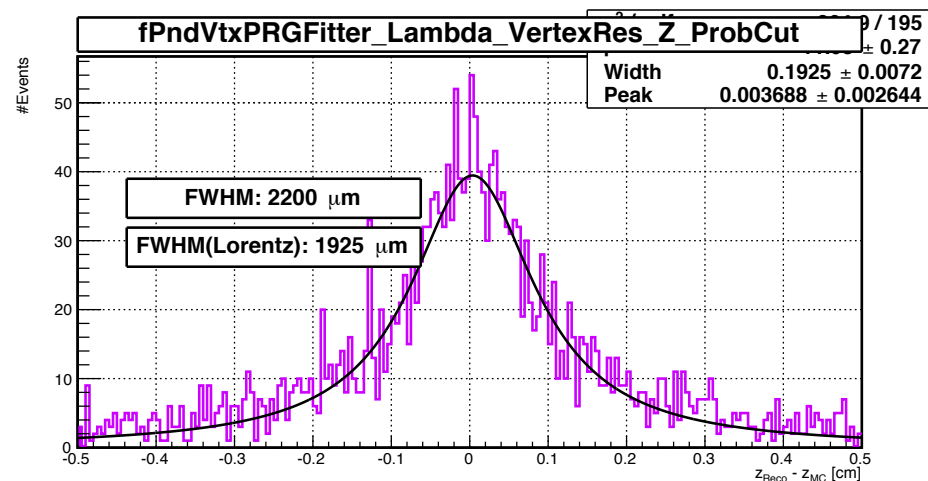
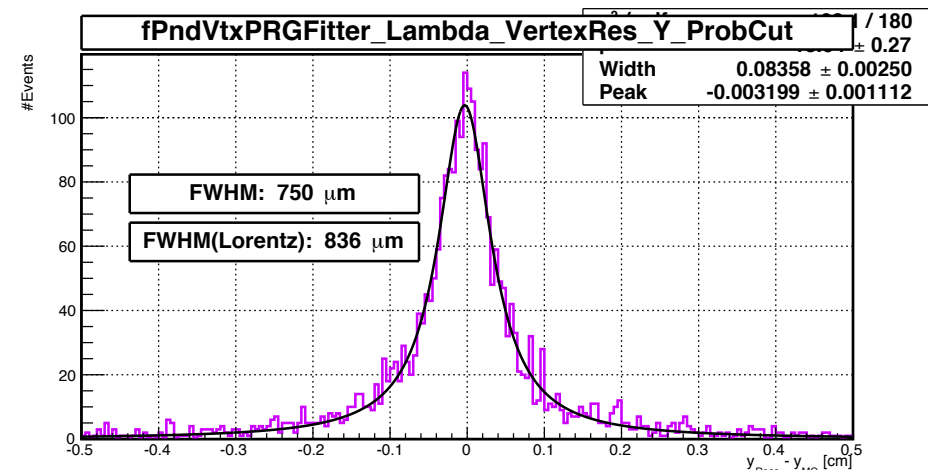
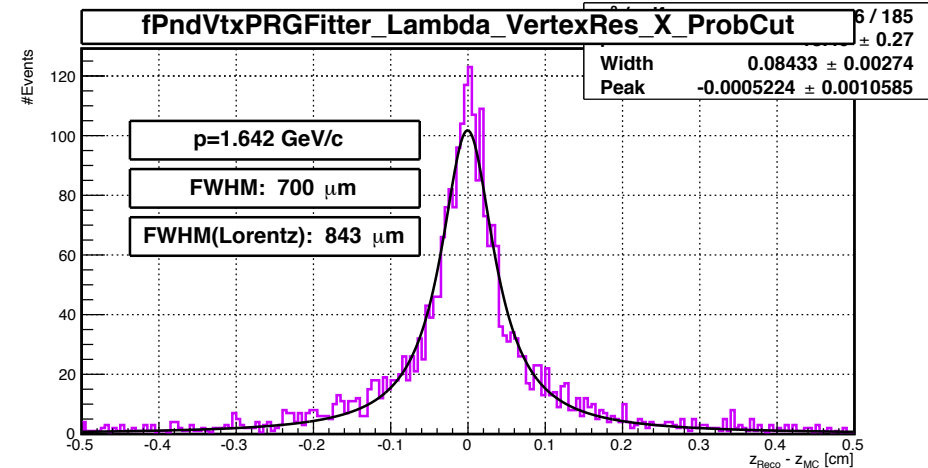
before:
 Λ 5600
 Λ bar 5582
 $\Lambda\Lambda$ bar 3197

Invariant Mass - PndVtxPRGFitter

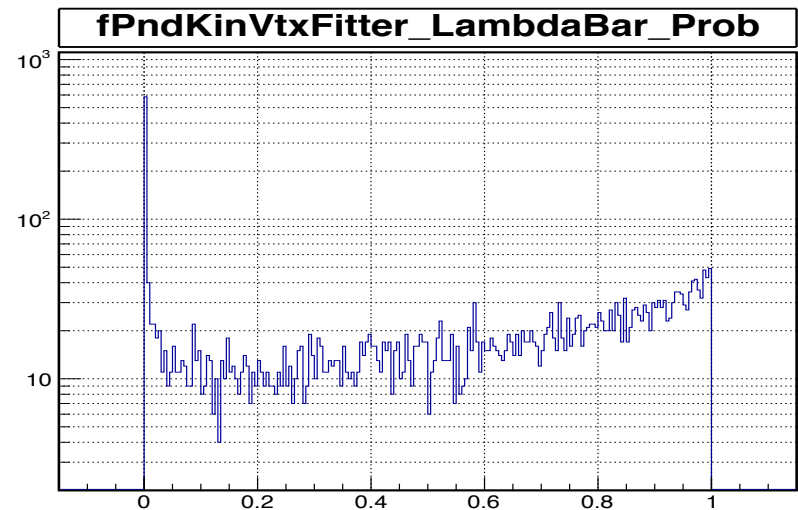
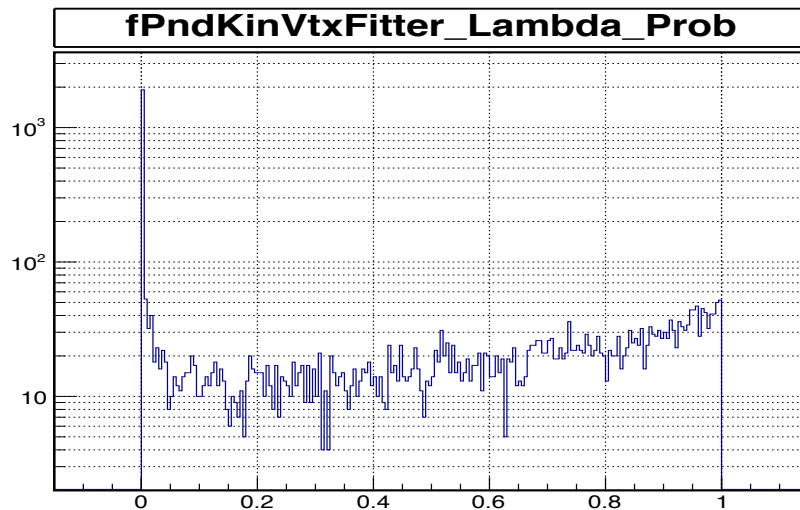
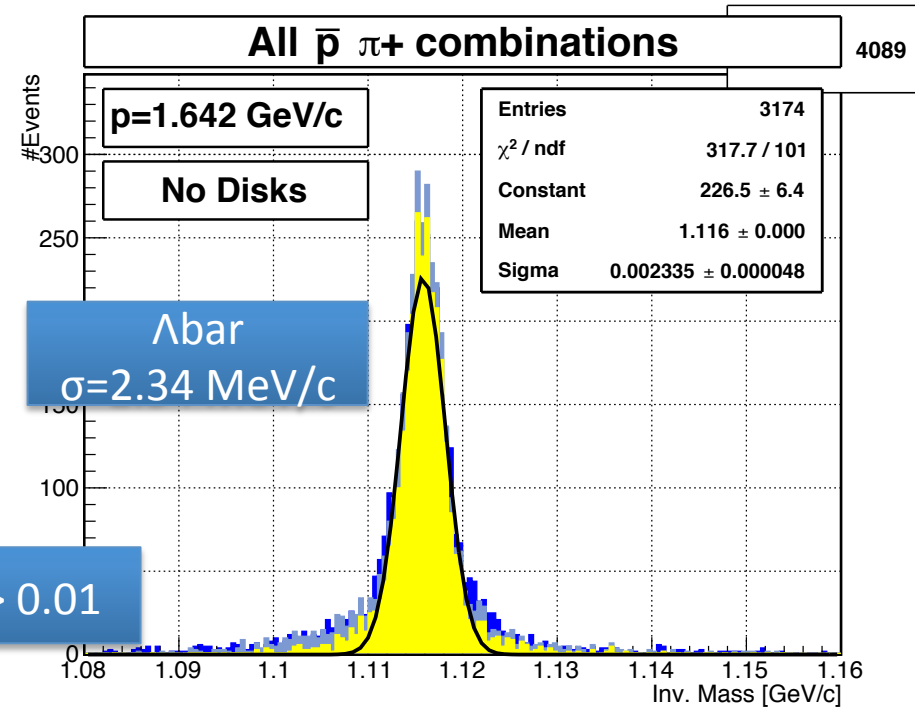
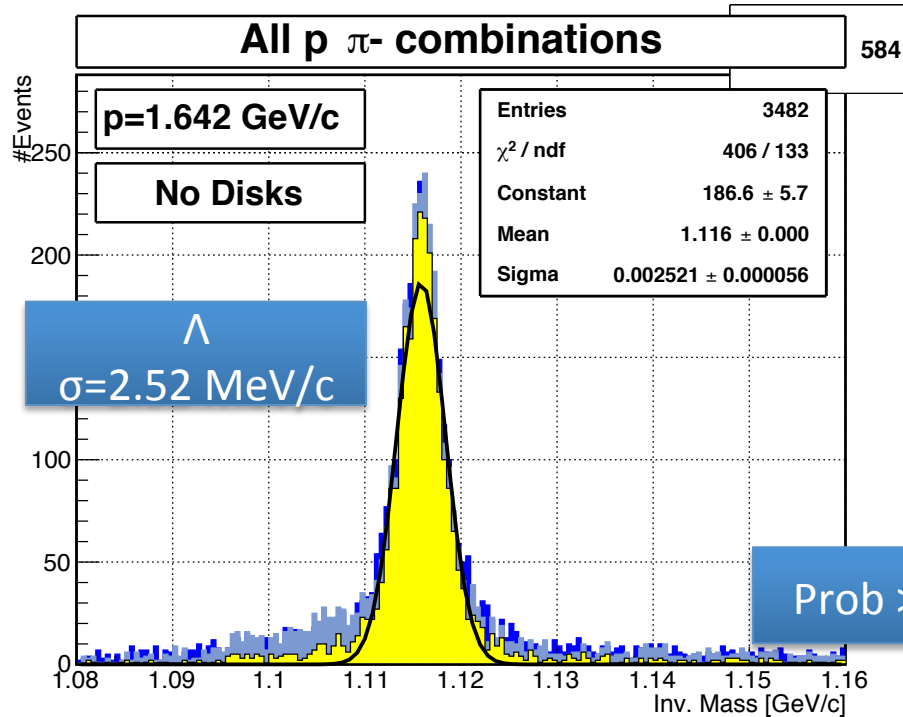


Vertex Resolution PndVtxPRGFitter

LambdaBar
1.642 GeV/c
Prob > 0.01
Fit: Lorentz Function

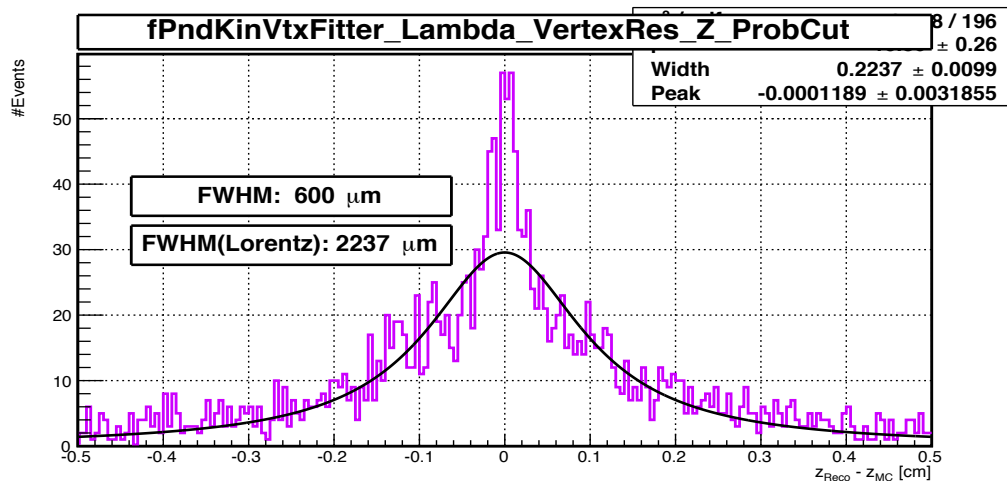
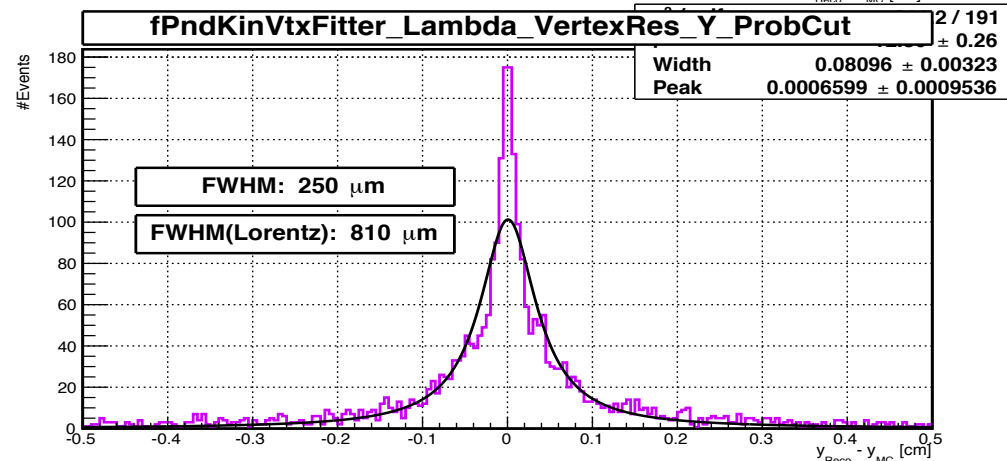
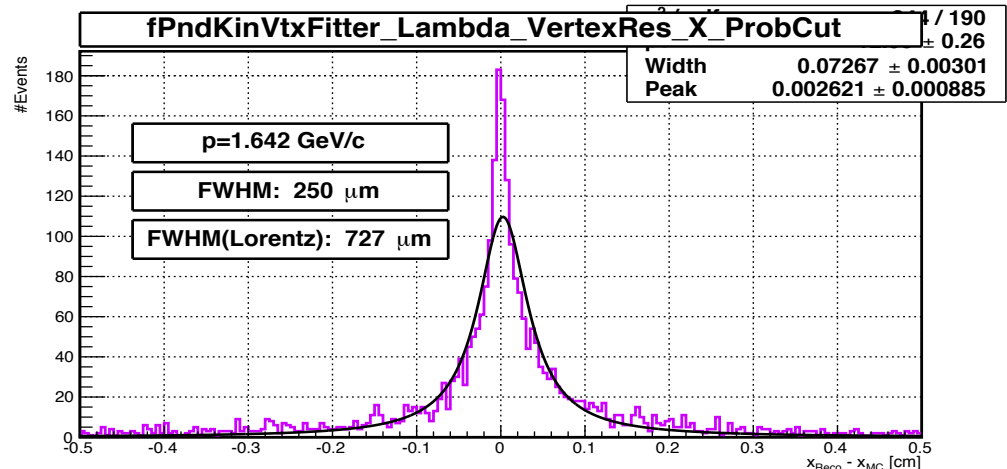


Invariant Mass - PndKinVtxFitter



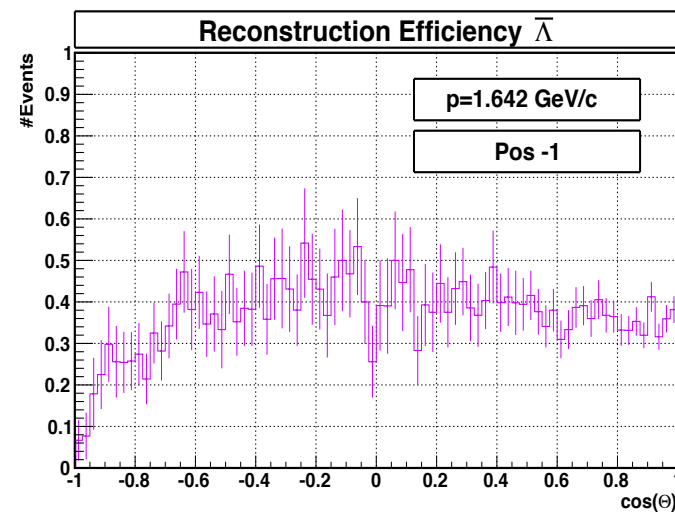
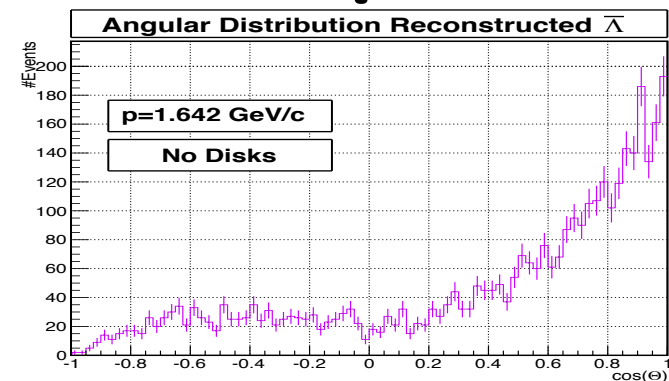
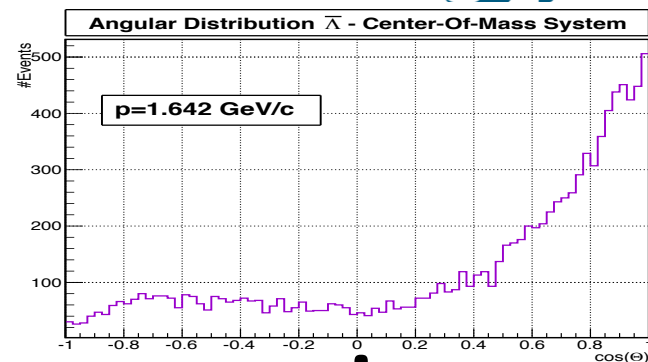
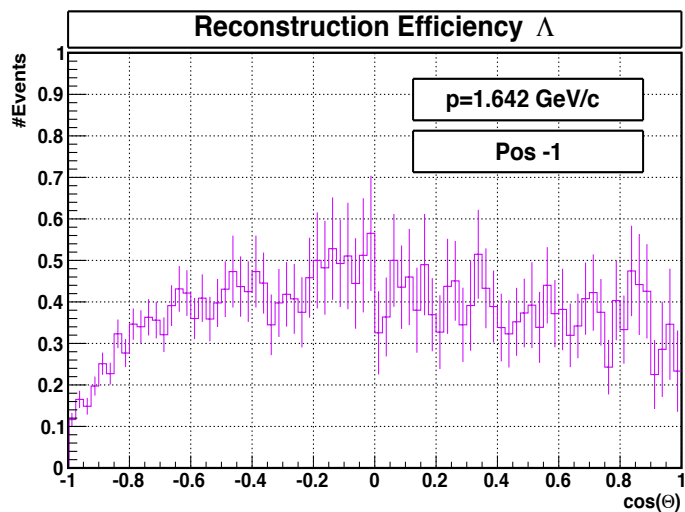
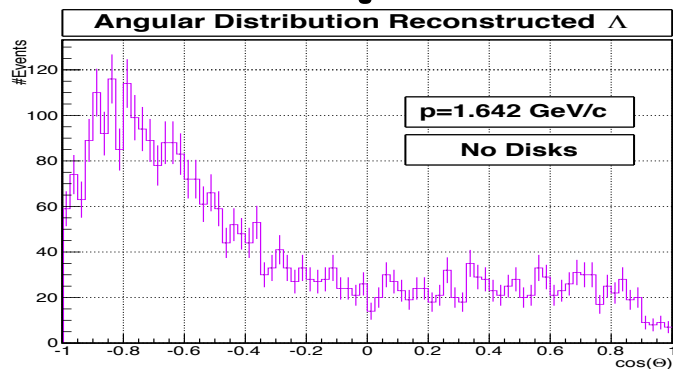
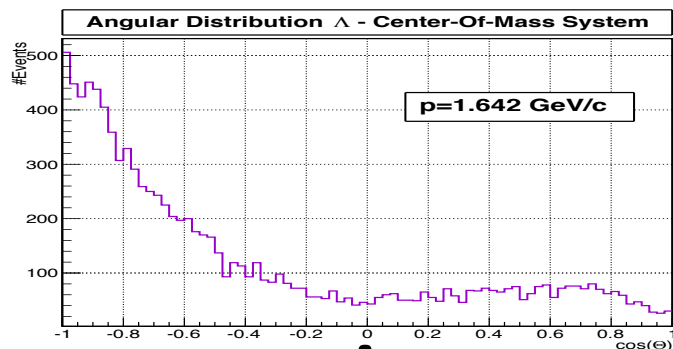
Vertex Resolution PndKinVtxFitter

LambdaBar
1.642 GeV/c
Prob > 0.01
Fit: Lorentz
Function



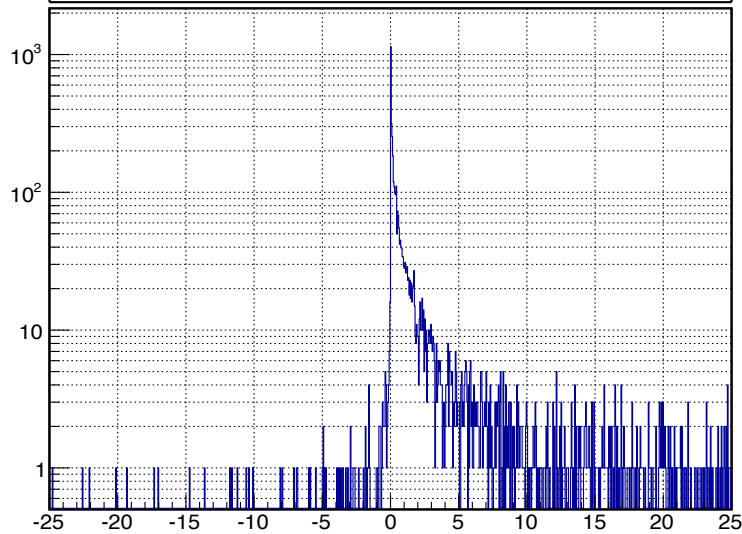
September 11, 2013

Reconstruction Efficiency

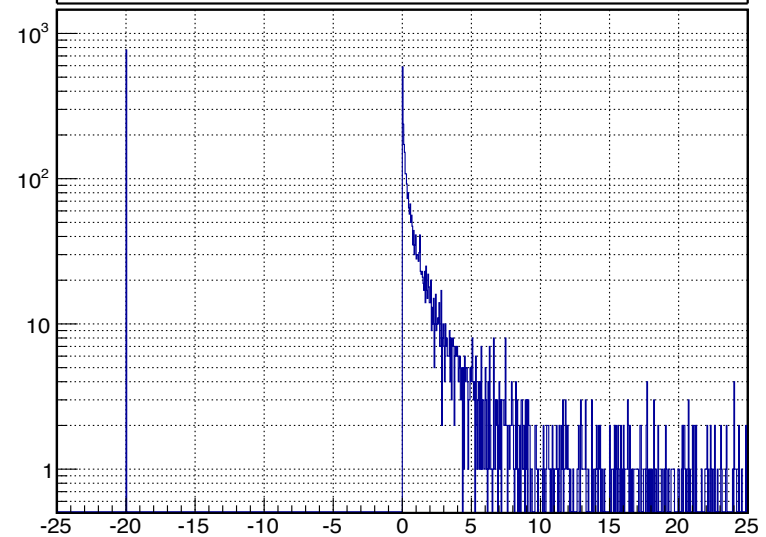


Chi2 Distributions

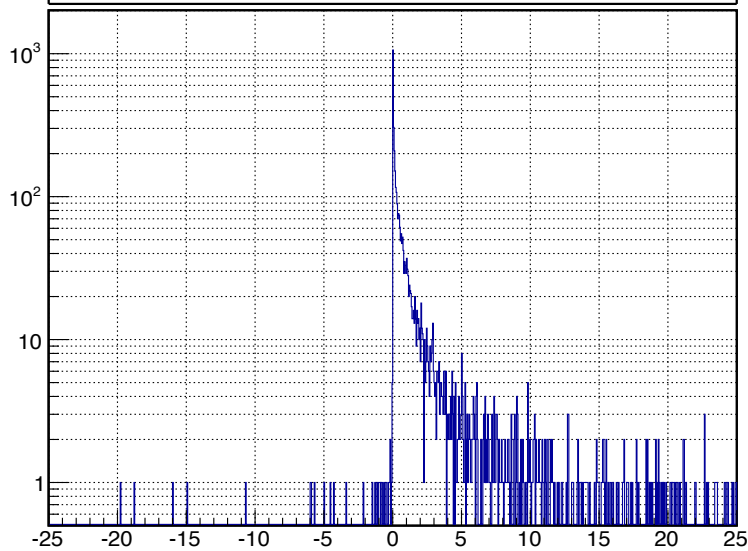
fPndKinVtxFitter_Lambda_Chi2



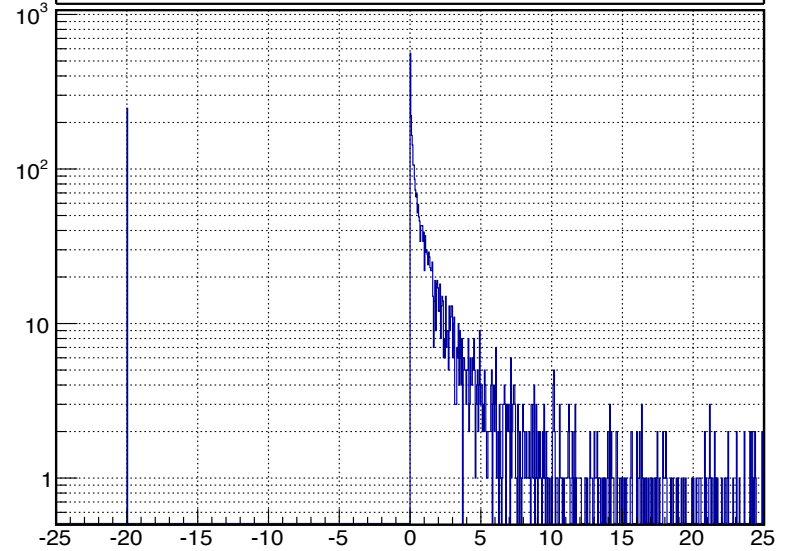
fPndVtxPRGFitter_Lambda_Chi2



fPndKinVtxFitter_LambdaBar_Chi2

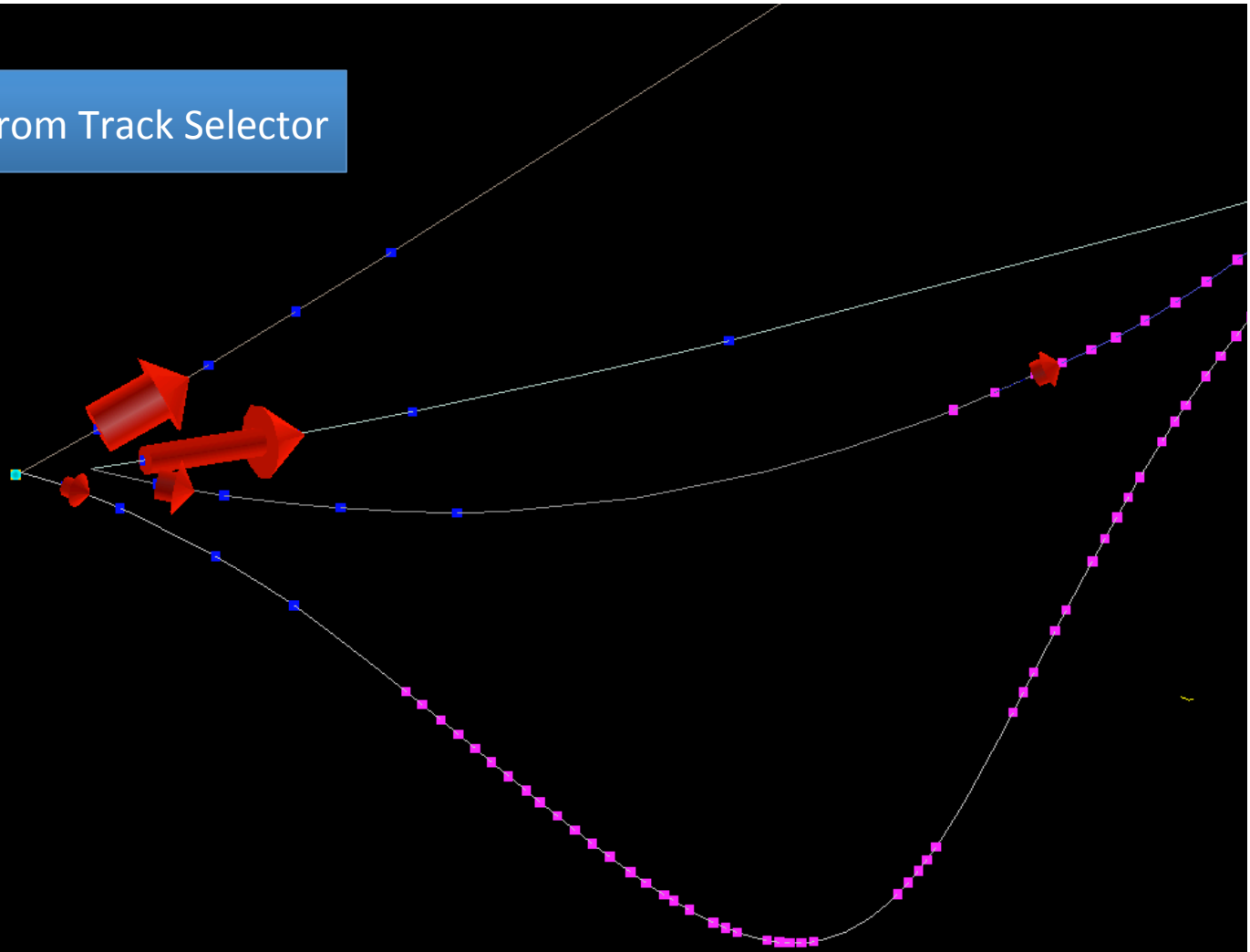


fPndVtxPRGFitter_LambdaBar_Chi2



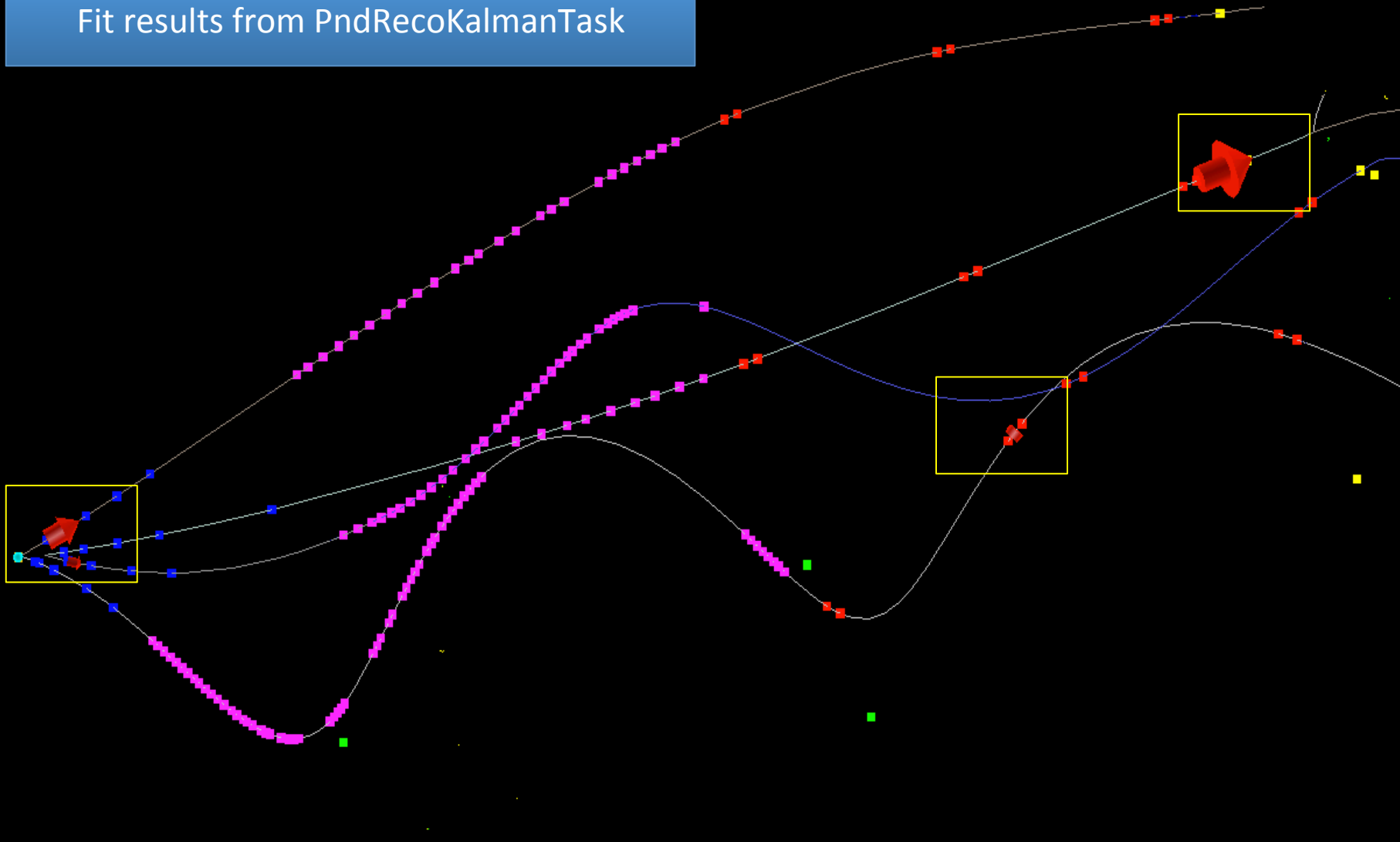
Problems: Kalman Track Fitter

Start values from Track Selector



Problems: Kalman Track Fitter

Fit results from PndRecoKalmanTask



- Decay of $p\bar{p} \rightarrow \Lambda \bar{\Lambda} \rightarrow \pi^+ \pi^- p^+ p^-$ has been investigated with the PANDA tracking detectors at three different momenta and five positions of the Λ -disks
- Counting studies have been done, $\bar{\Lambda}$ efficiency gains from the Λ -disks, Λ efficiency gains less or even suffers
- The invariant mass and the vertex resolution has been calculated with two different vertex fitters
- PandaRoot has still „issues“



Thank you for your attention

Dankeschön!



Thank you for your attention

Backup Slides



BACKUP SLIDES

After Fit Flag

Momenta		Pos 0 40 cm & 60 cm		Pos 1 37 cm & 43 cm		Pos 2 57 cm & 63 cm		Pos 3 77 cm & 83 cm		Pos -1 no disk
1.642 GeV/c	#Λ	3380	+0.62%	3313	-0.05%	3412	+0.94%	3422	+1.04%	3318
	#Λ bar	3996	+2,8%	3990	+2,74%	4022	+3.06%	4003	+2.87%	3716
	#ΛΛbar	1316	+0.55%	1309	+0.48%	1362	+1.01%	1329	+0.68%	1261
1.918 GeV/c	#Λ	3039	+0.76%	3041	+0.78%	3069	+1.06%	3083	+1.2%	2963
	#Λ bar	4656	+5,14%	4538	+3.96%	4557	+4.15%	4564	+4.22%	4142
	#ΛΛbar	1431	+1.95%	1382	+1.46%	1388	+1.52%	1355	+1.19%	1236
6 GeV/c	#Λ	489	-0.22%	516	+0.05%	495	-0.16%	520	+0.09%	511
	#Λ bar	4963	+1,77%	4963	+1.77%	5038	+2.52%	4969	+1.83%	4786
	#ΛΛbar	291	+0.35%	296	+0.4%	283	+0.27%	299	+0.43%	256

Hyperons

Hyperon	Quarks	Mass [MeV/c ²]	$c\tau$ [cm]	Main decay	$\mathcal{B}$ [%]	α_Y
Λ	uds	1116	8.0	$p\pi^-$	64	+0.64
Σ^+	uus	1189	2.4	$p\pi^0$	52	-0.98
Σ^0	uds	1193	$2.2 \cdot 10^{-9}$	$\Lambda\gamma$	100	-
Σ^-	dds	1197	2.4	$n\pi^-$	100	-0.07
Ξ^0	uss	1315	8.7	$\Lambda\pi^0$	99	-0.41
Ξ^-	dss	1321	4.9	$\Lambda\pi^-$	100	-0.46
Ω^-	sss	1672	2.5	ΛK^-	68	-0.03
Λ_c^+	udc	2286	$6.0 \cdot 10^{-3}$	$\Lambda\pi^+$	1	-0.91(15)
Σ_c^{++}	uuc	2454		$\Lambda_c^+\pi^+$	100	
Σ_c^+	udc	2453		$\Lambda_c^+\pi^0$	100	
Σ_c^0	ddc	2454		$\Lambda_c^+\pi^-$	100	
Ξ_c^+	usc	2468	$1.2 \cdot 10^{-2}$	$\Xi^-\pi^+\pi^+$	seen	
Ξ_c^0	dsc	2471	$2.9 \cdot 10^{-3}$	$\Xi^-\pi^+$	seen	-0.6(4)
Ω_c^0	ssc	2697	$1.9 \cdot 10^{-3}$	$\Omega^-\pi^+$	seen	

Ref: PANDA Physics Book

- Investigation of hyperon decays will bring new information on single and multiple strangeness production and its dependence on spin observables.
- It is usefull to reconstruct the Λ decay very well, since it most hyperons decay with an intermediate state of Λ .

Λ DECAY MODES

Mode	Fraction (Γ_i/Γ)
$\Gamma_1 \quad p\pi^-$	$(63.9 \pm 0.5) \%$
$\Gamma_2 \quad n\pi^0$	$(35.8 \pm 0.5) \%$
$\Gamma_3 \quad n\gamma$	$(1.75 \pm 0.15) \times 10^{-3}$
$\Gamma_4 \quad p\pi^-\gamma$	[a] $(8.4 \pm 1.4) \times 10^{-4}$
$\Gamma_5 \quad pe^-\bar{\nu}_e$	$(8.32 \pm 0.14) \times 10^{-4}$
$\Gamma_6 \quad p\mu^-\bar{\nu}_\mu$	$(1.57 \pm 0.35) \times 10^{-4}$

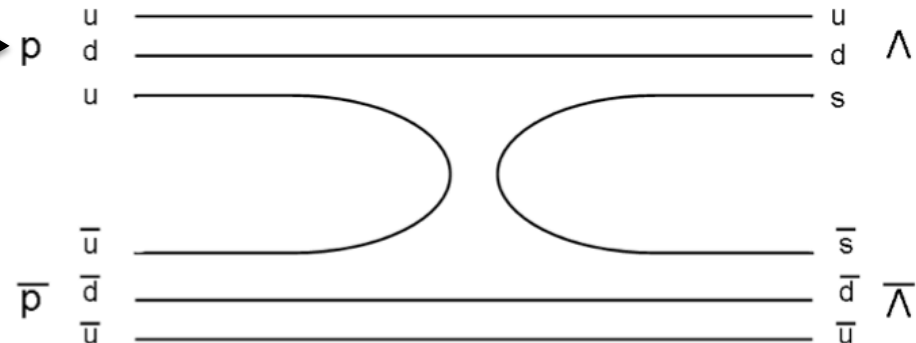
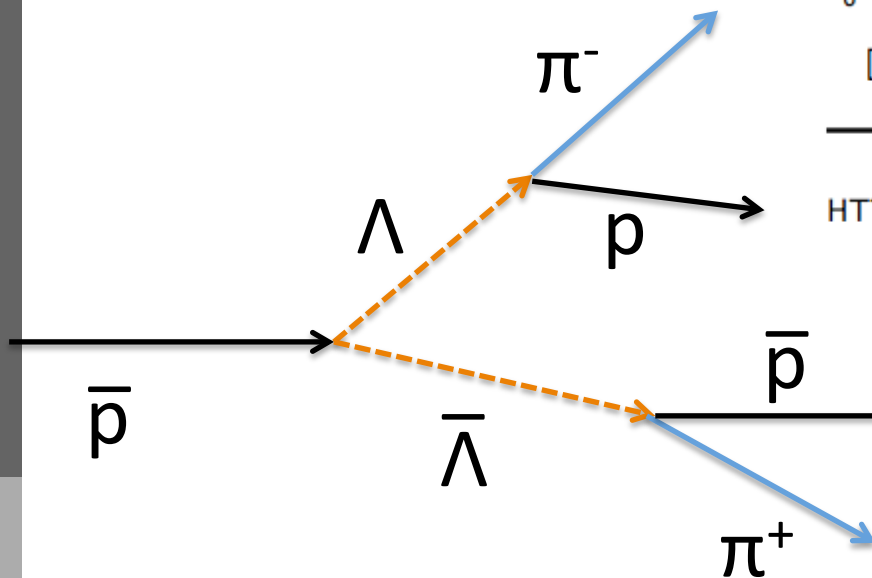
[a] See the Listings below for the pion momentum range used in this measurement.

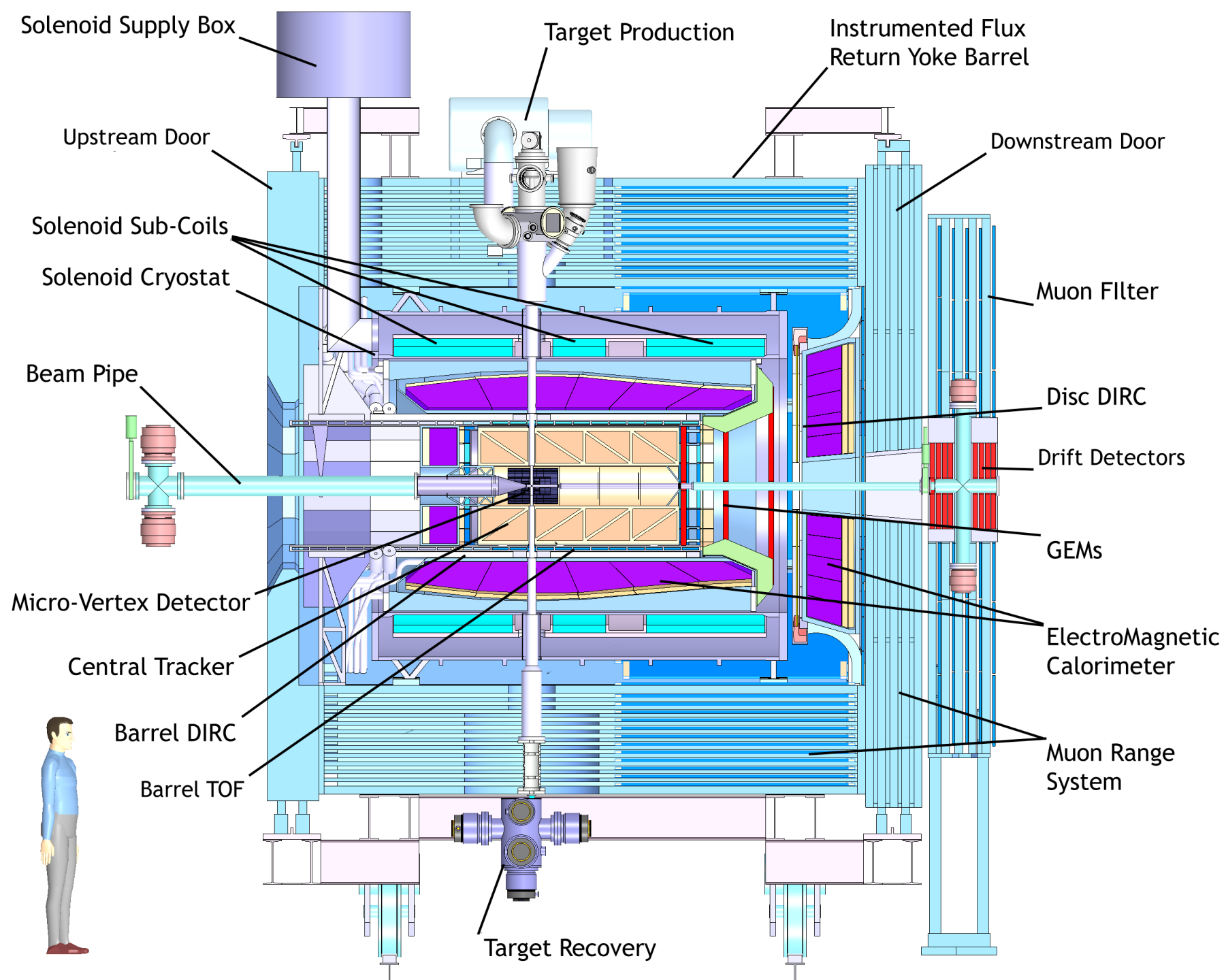
[HTTP://PDG.LBL.GOV](http://pdg.lbl.gov)

Page 3

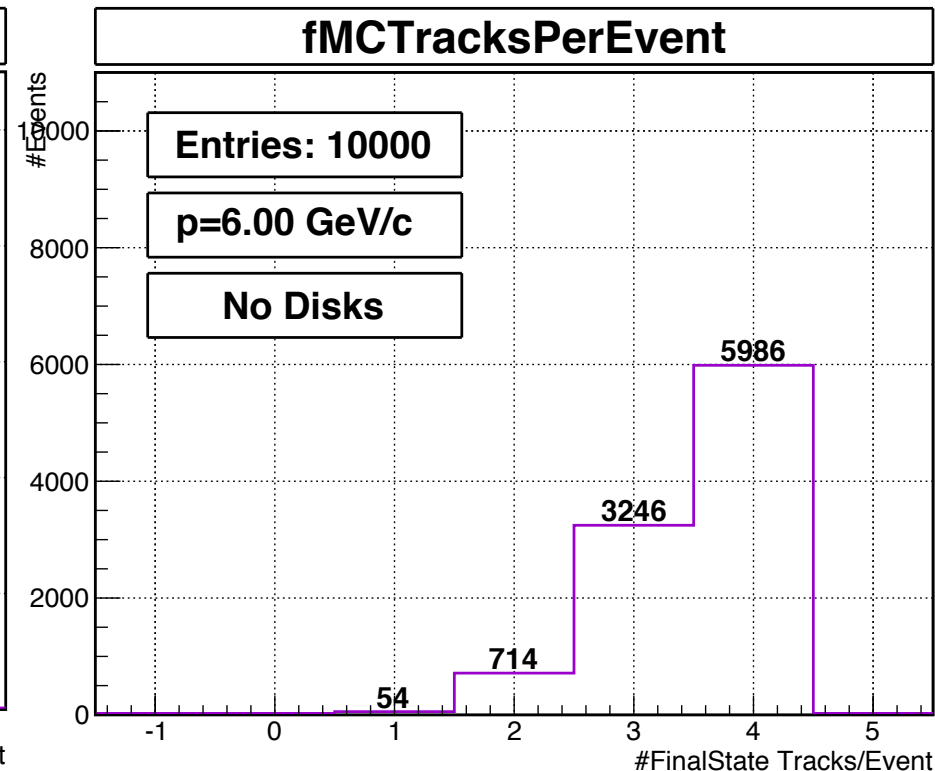
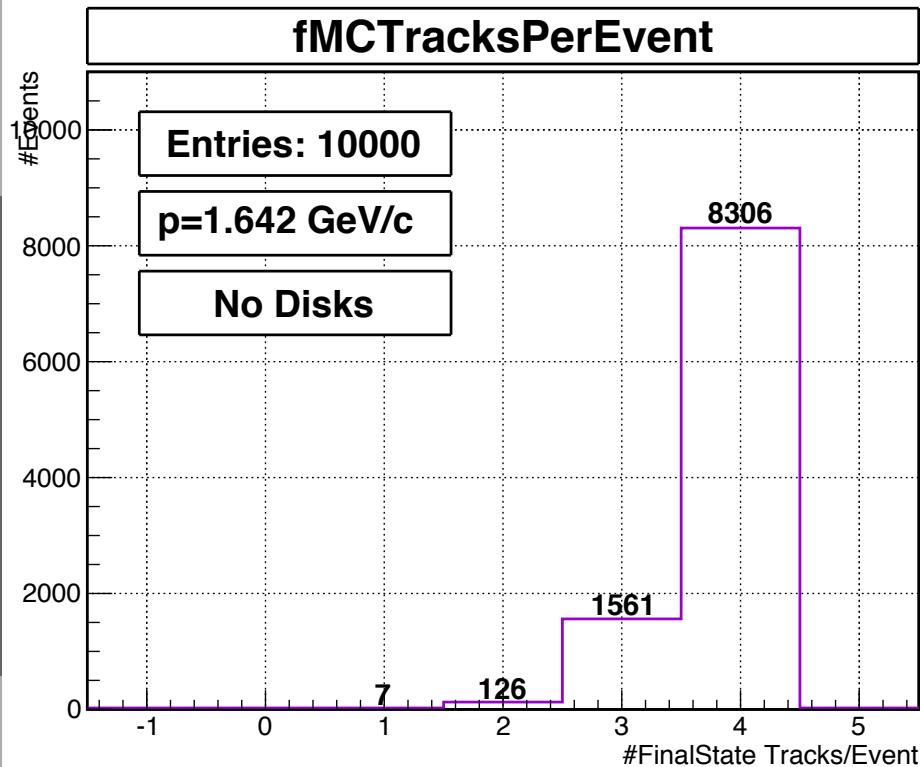
Created: 6/18/2012 15:09

The Λ Hyperon



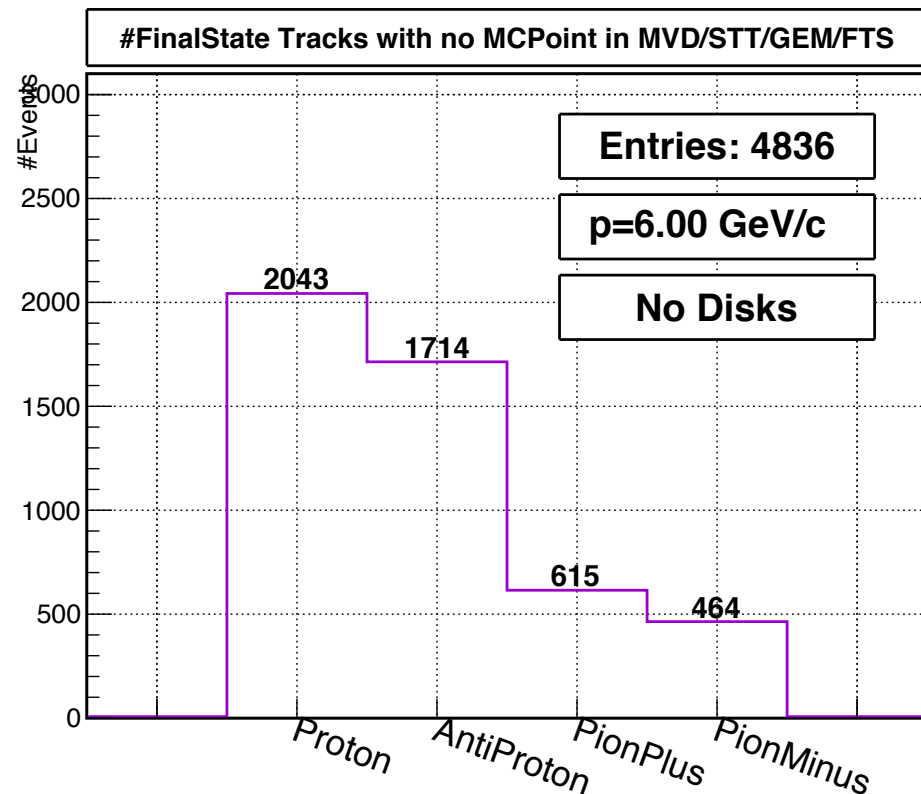
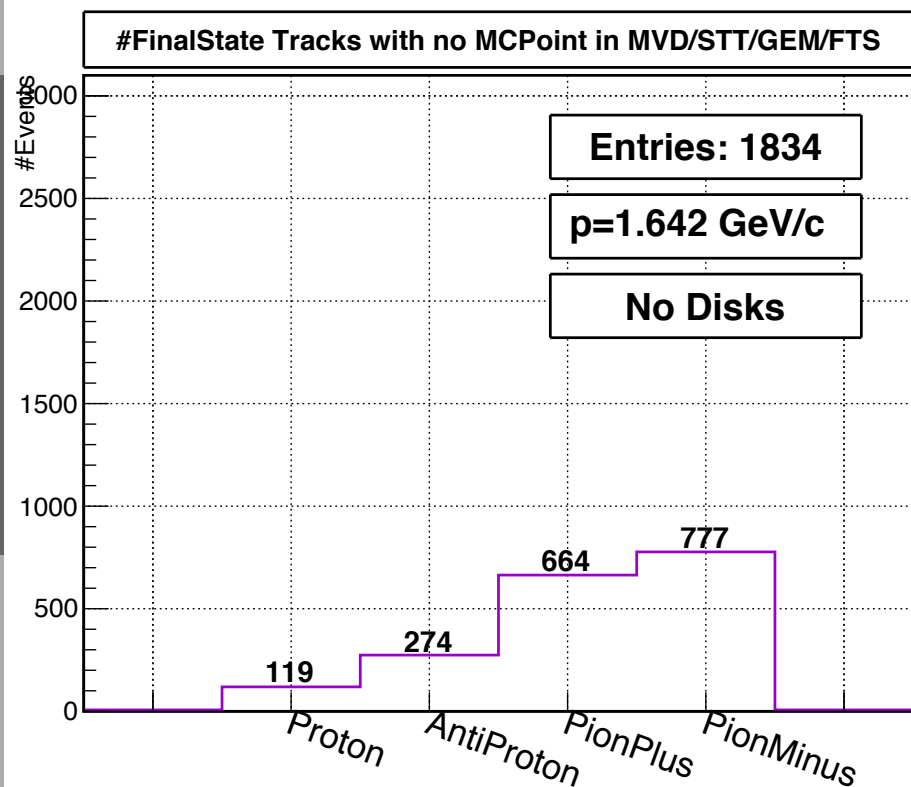


Tracks which leave >0 MCPoints in Detectors

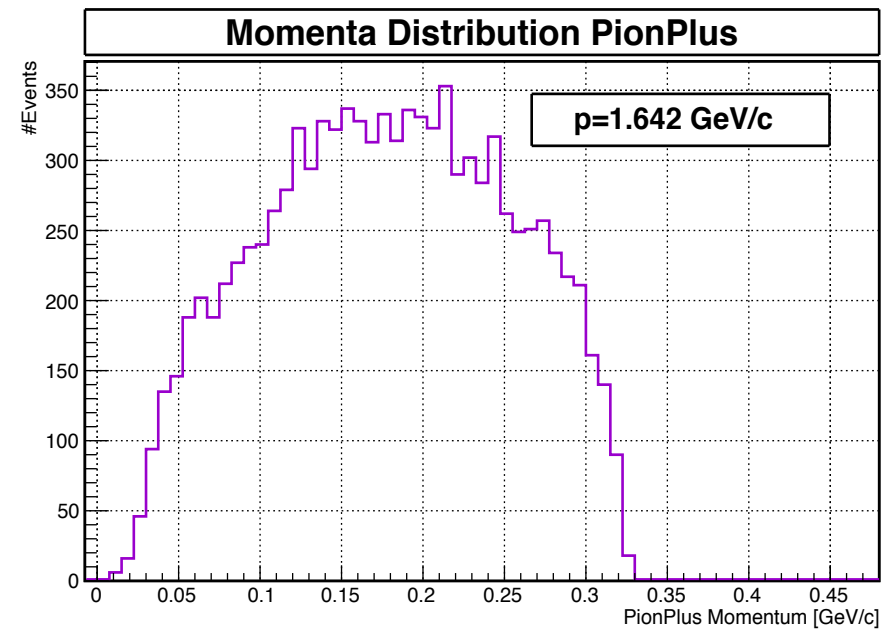
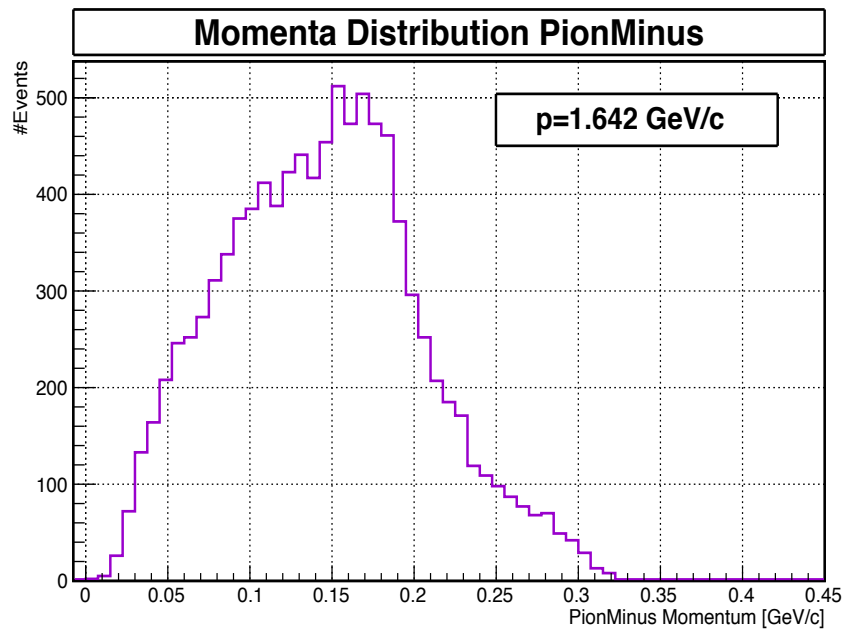


	Events w all Tracks	Events w 3 Tracks	Events w 2 Tracks
1.642 GeV/c	83.06 %	15.61 %	1.26 %
1.918 GeV/c	85.64 %	13.71 %	0.65 %
6.00 GeV/c	59.86 %	32.46 %	7,14 %

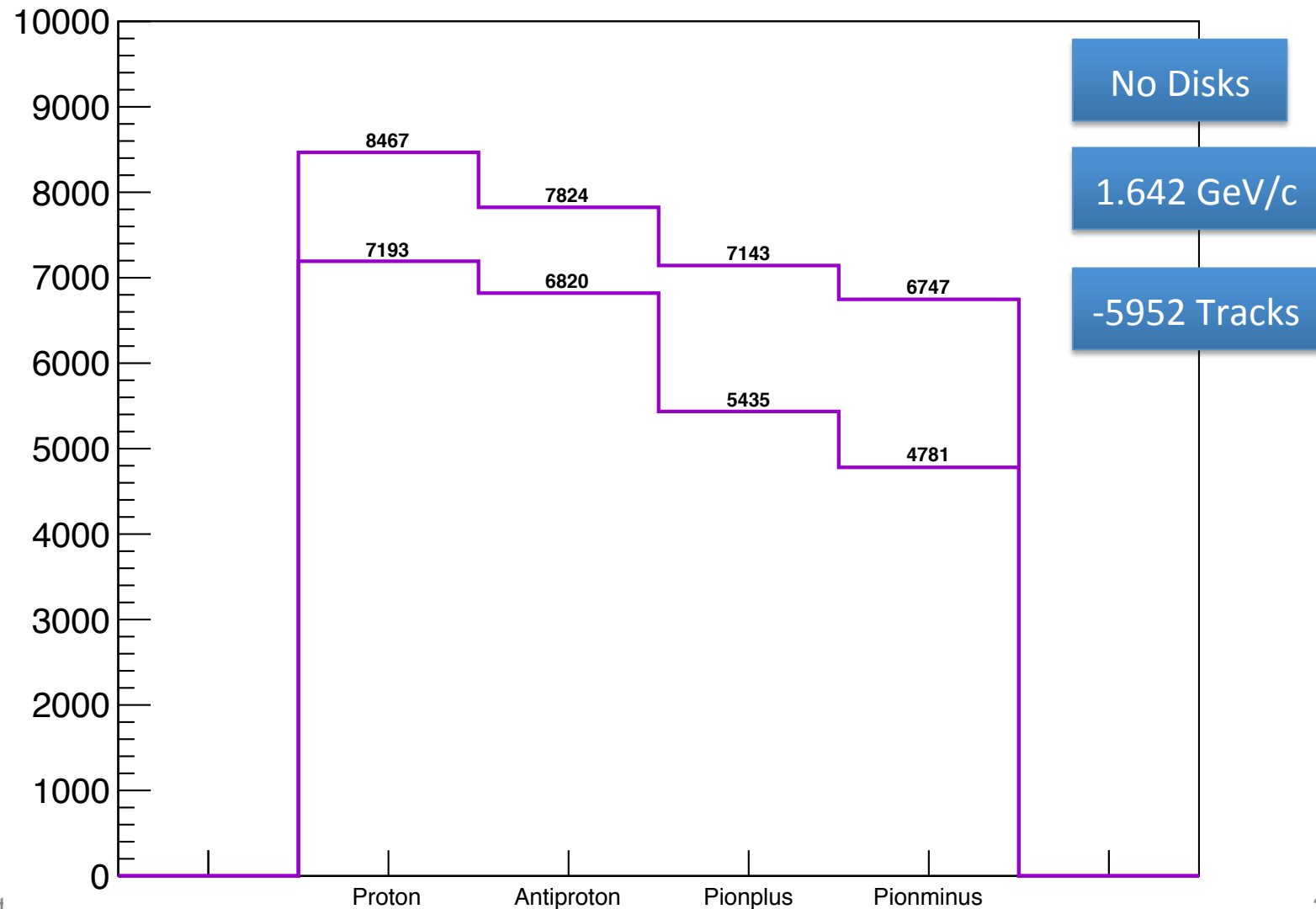
Particle Type of Missing Tracks



Momenta Distribution



Reduction per Particle due to FitFlag



Angular Distribution

