Lambda Production in SIDIS

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SIDIS Physics Interest in Λ production

- Self analyzing decay→Opportunities to study spin correlations in final state
  - Longitudinal/Transverse spin transfer
  - Polarizing fragmentation ($p_T/S_\perp$) correlations
  - …

Example:
polarizing Fragmentation:

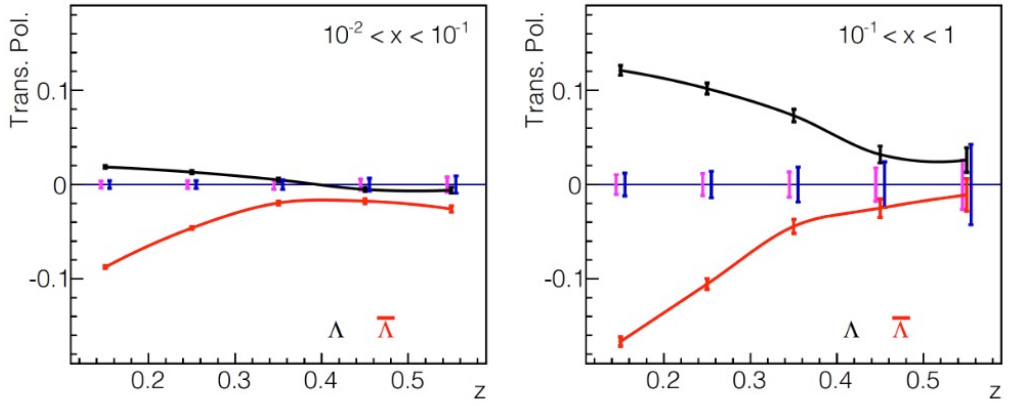
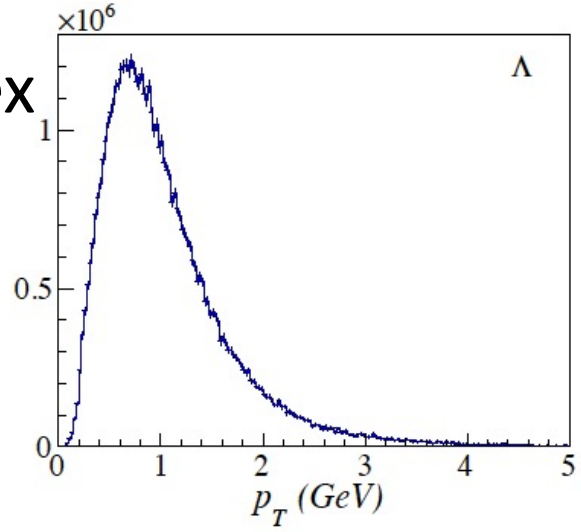


Figure 7.86: Projected transverse Λ polarization using the extraction in Ref. [961] for the highest energy configuration. The projected uncertainty on Σ^0 polarization is also shown which is important by itself and to estimate the polarization of the feed-down component. A 40% reconstruction efficiency is assumed but not the effect from feed-down which most likely reduces the magnitude of the asymmetries.

Issues with Λ reconstruction

- Displaced Vertex



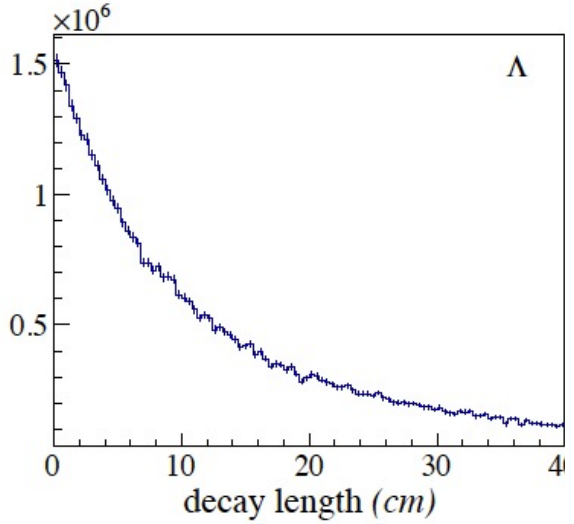


TABLE I. Barrel-layer radii and lengths.

Barrel layer	radius [cm]	length along z [cm]
1	3.30	30
2	5.70	30
3	21.00	54
4	22.68	60
5	39.30	105
6	43.23	114

FIG. 3. Transverse momentum (left) and decay length (right) distributions for reconstructed Λ and $\bar{\Lambda}$ at collision energy 18x275 GeV

- Slow pion

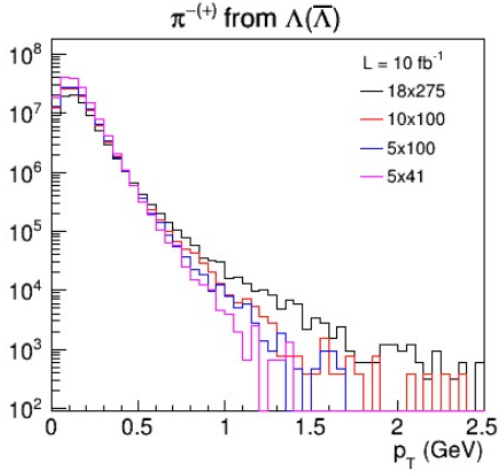
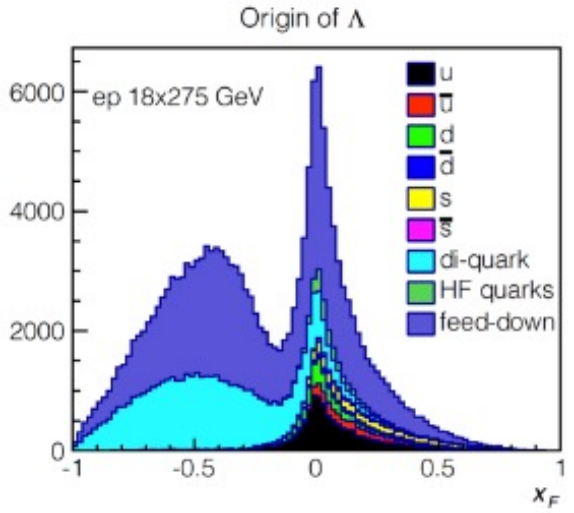
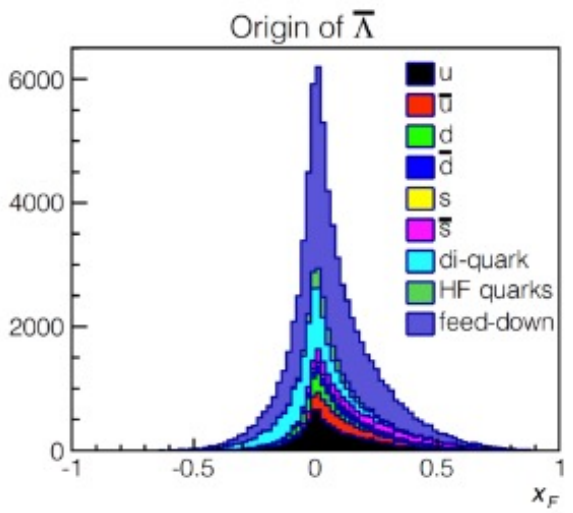


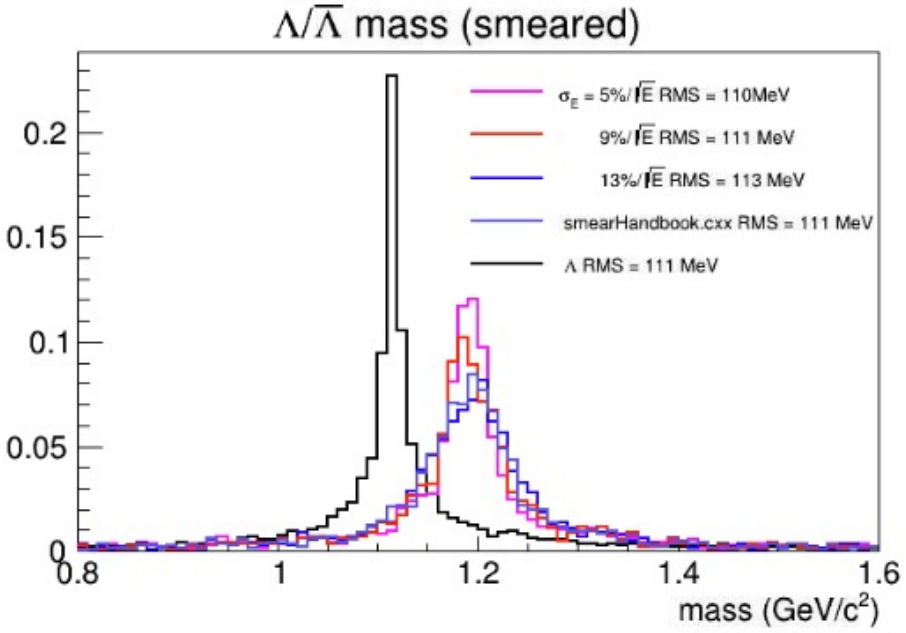
Figure 8.34: Transverse momentum and energy s
$\Lambda\gamma$ respectively.

Feed-down

- Almost half of Λ comes from feed-down
- We want to unfold contributions from Σ^0
- Need sufficient resolution of Λ and Σ^0 peaks







More detailed kinematics from YR

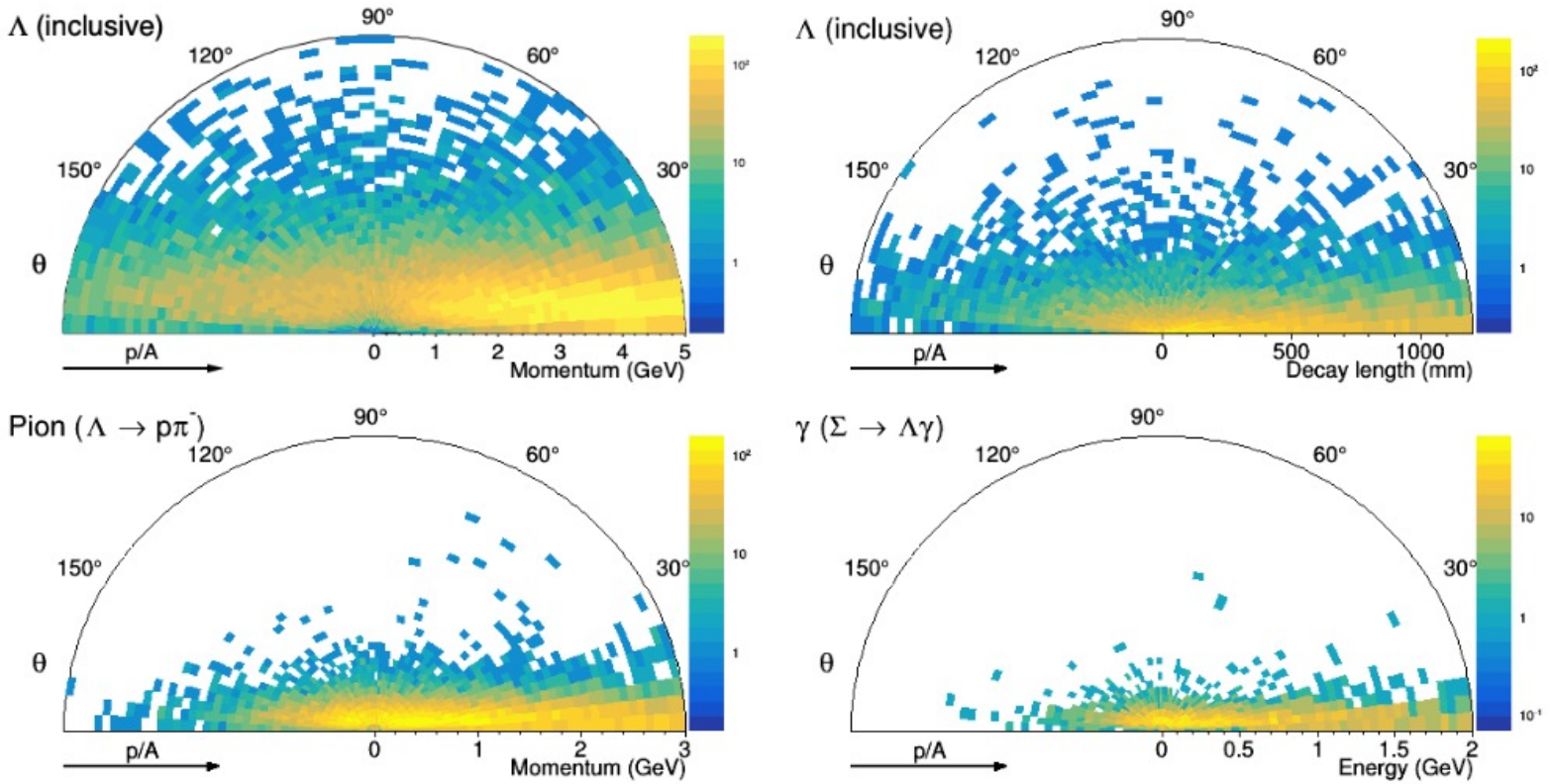


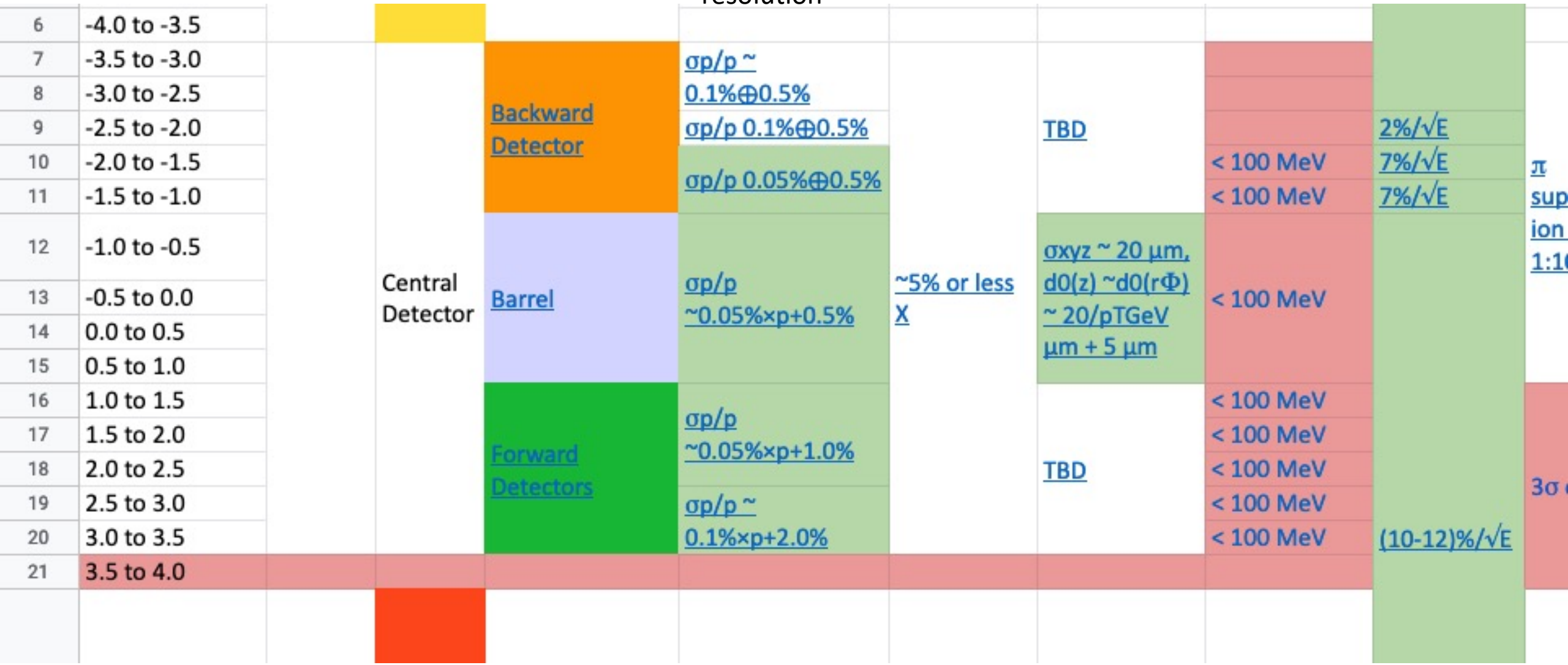
Figure 8.35: From top left to bottom right: kinematics of Λ, decay length of Λ, kinematics of decay π^- and kinematics of decay γ from the non-prompt Λ production chain $\Sigma^0 \rightarrow \Lambda + \gamma$. All plots from fast simulation of the 18×275 configuration.

Summary

- Lambda production is an important part for the SIDIS program
- Detection of lambdas pose challenges for tracking
  - Displaced vertex
  - Slow pion might curl up (for our studies we assume cutoff at 100 MeV)
  - Still need sufficient resolution to discriminate Λ, Σ^0
- Situation might be fine since most Λs go forward
  - Vertex resolution sufficient?

- Need to study performance of the compact tracker…

Assumed resolutions



				Tracking resolution				ECAL resolution	
6	-4.0 to -3.5								
7	-3.5 to -3.0		Backward Detector	σp/p ~ 0.1%⊕0.5%		TBD			
8	-3.0 to -2.5								
9	-2.5 to -2.0			σp/p 0.1%⊕0.5%				2%/√E	
10	-2.0 to -1.5			σp/p 0.05%⊕0.5%			< 100 MeV	7%/√E	π sup
11	-1.5 to -1.0						< 100 MeV	7%/√E	ion 1:1
12	-1.0 to -0.5	Central Detector	Barrel	σp/p ~0.05%×p+0.5%	~5% or less X	σxyz ~ 20 μm, d0(z) ~d0(rΦ) ~ 20/pTGeV μm + 5 μm	< 100 MeV		
13	-0.5 to 0.0								
14	0.0 to 0.5								
15	0.5 to 1.0								
16	1.0 to 1.5		Forward Detectors	σp/p ~0.05%×p+1.0%		TBD	< 100 MeV		3σ
17	1.5 to 2.0						< 100 MeV		
18	2.0 to 2.5						< 100 MeV		
19	2.5 to 3.0			σp/p ~ 0.1%×p+2.0%			< 100 MeV		
20	3.0 to 3.5						< 100 MeV	(10-12)%/√E	
21	3.5 to 4.0								

TABLE II. Disk z position and inner and outer radii.

Disk number	z position [cm]	outer radius [cm]	inner radius [cm]
-5	-121	43.23	4.41
-4	-97	43.23	3.70
-3	-73	43.23	3.18
-2	-49	36.26	3.18
-1	-25	18.50	3.18
1	25	18.50	3.18
2	49	36.26	3.18
3	73	43.23	3.50
4	97	43.23	4.70
5	121	43.23	5.91

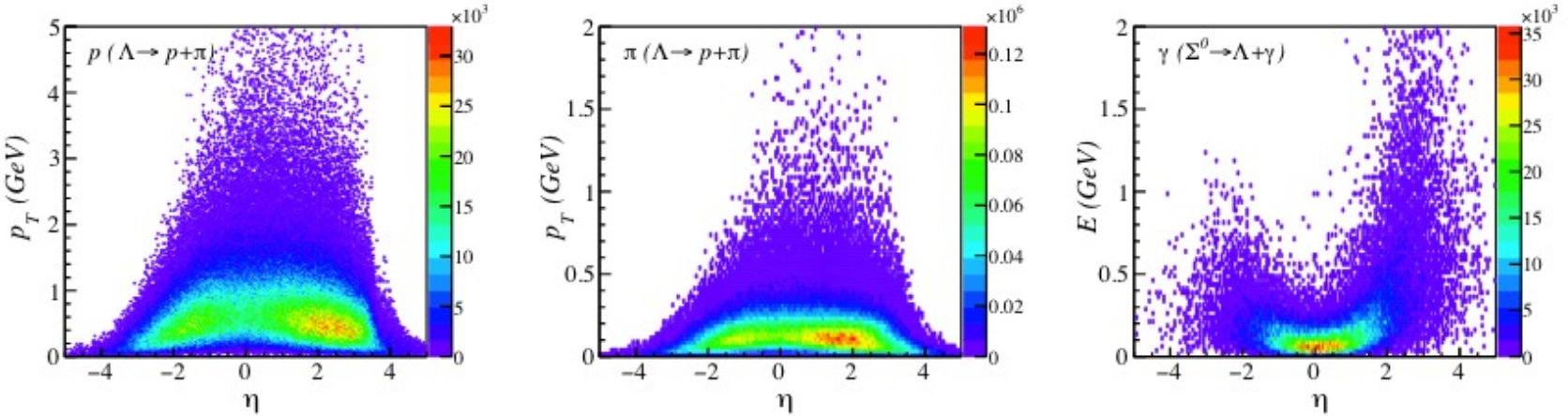


FIG. 2. Final state particle distributions in transverse momentum (energy) and pseudorapidity space for proton (left), pion (middle), and photon (right) from Σ^0 decay.

radii and lengths.

		length along z [cm]
		30
		30
		54
		60
5	39.30	105
6	43.23	114

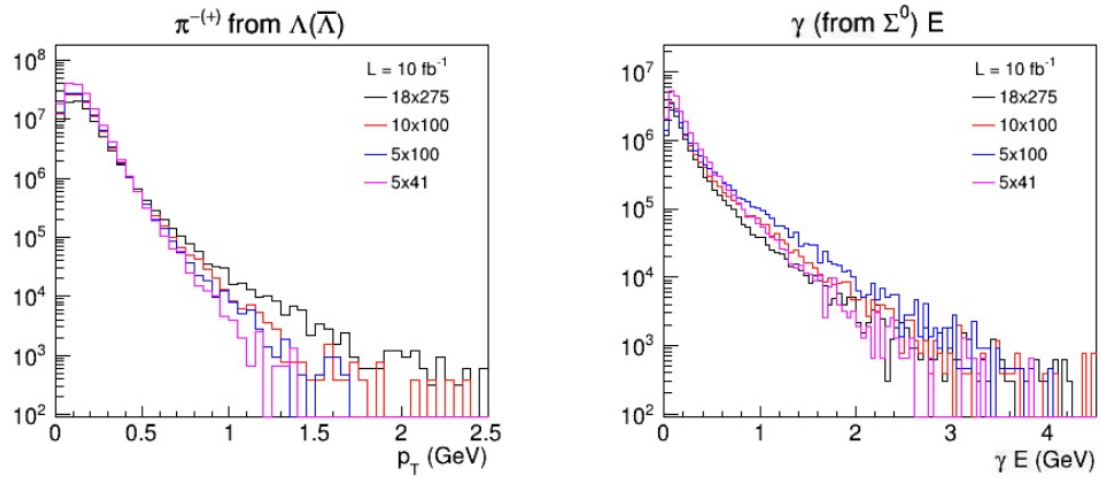
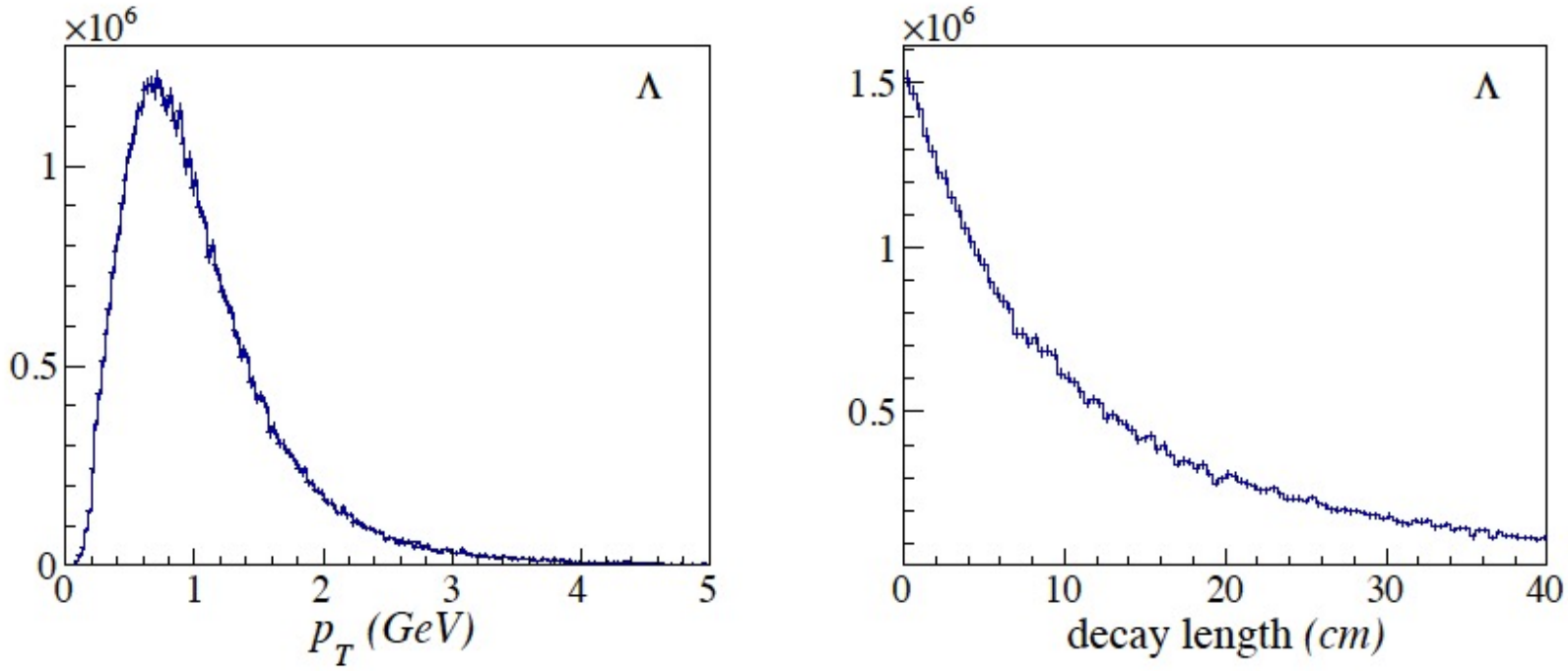


Figure 8.34: Transverse momentum and energy spectrum of pions from $\Lambda \to p\pi$ and $\Sigma^0 \to \Lambda\gamma$ respectively.



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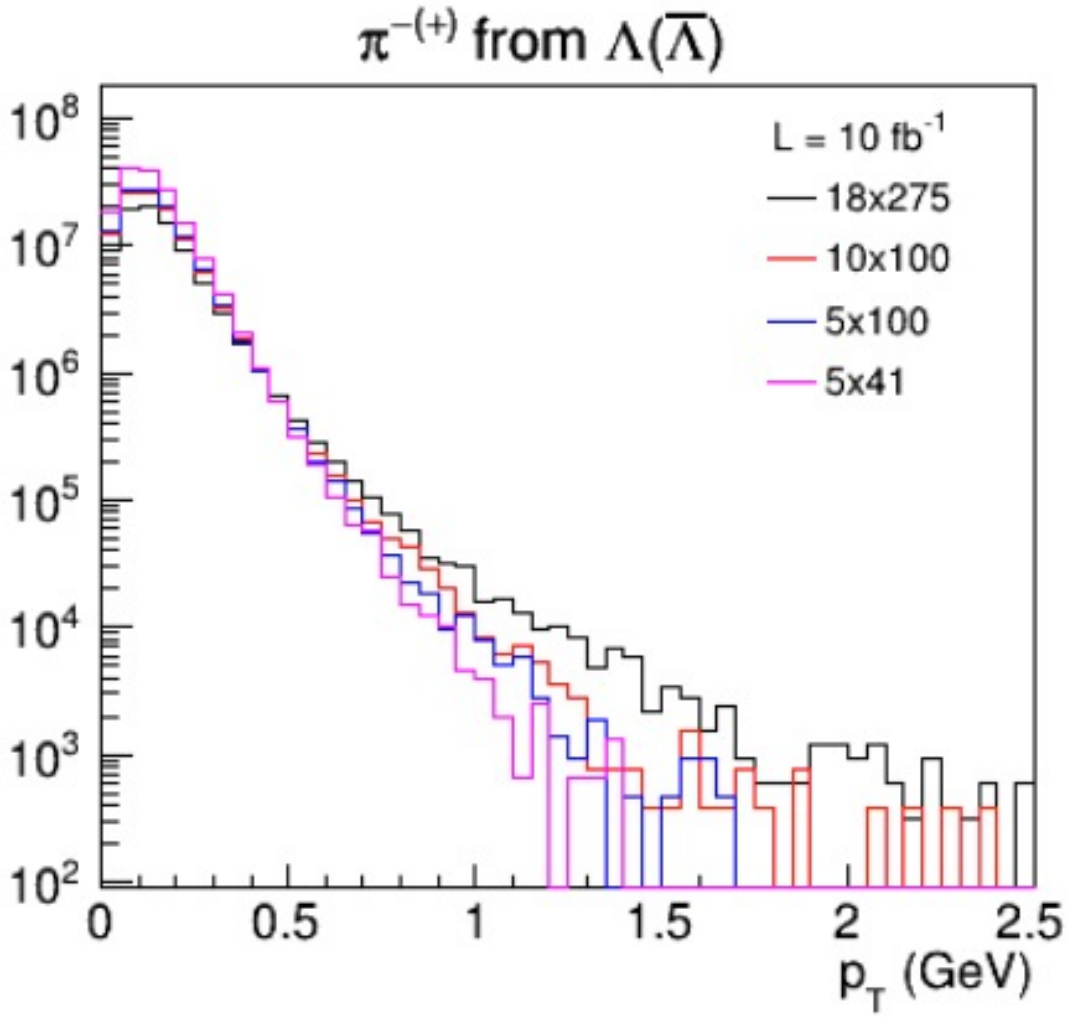

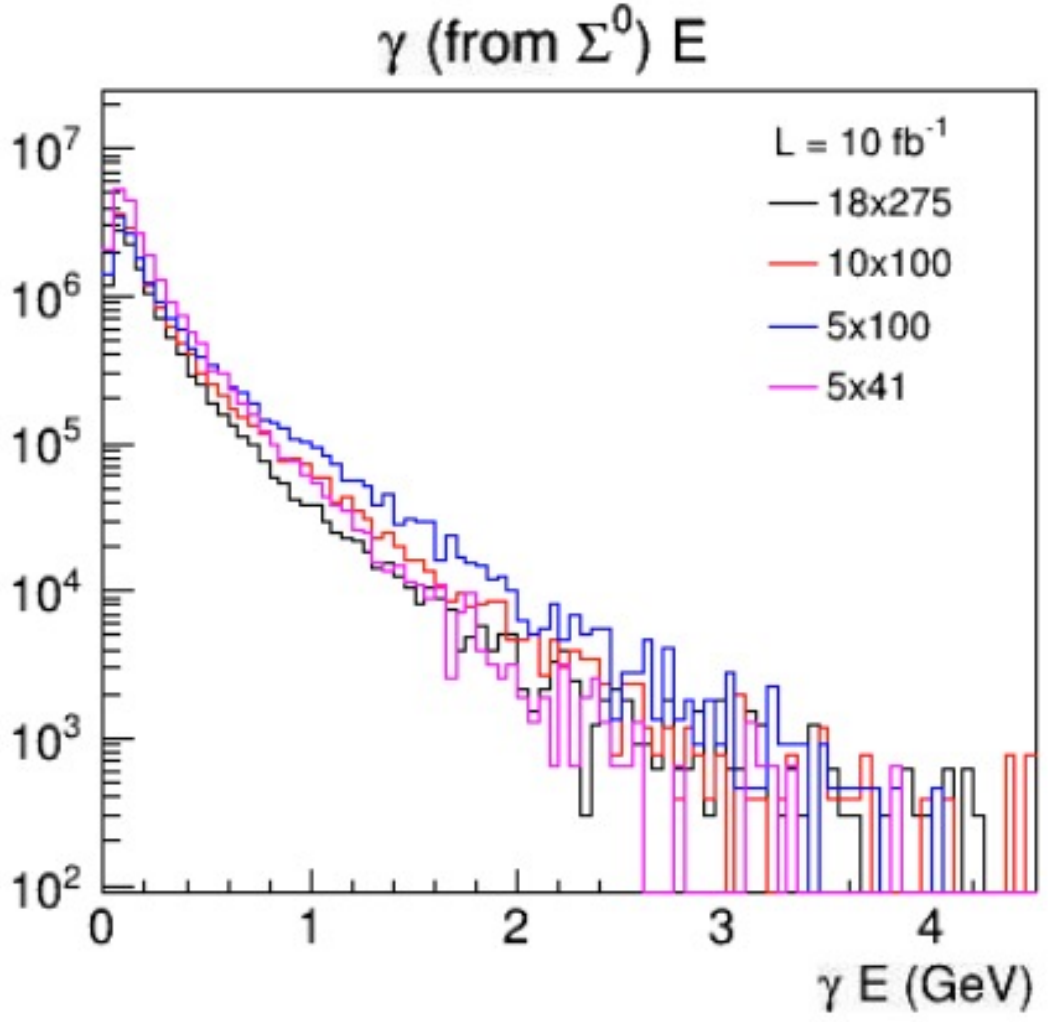

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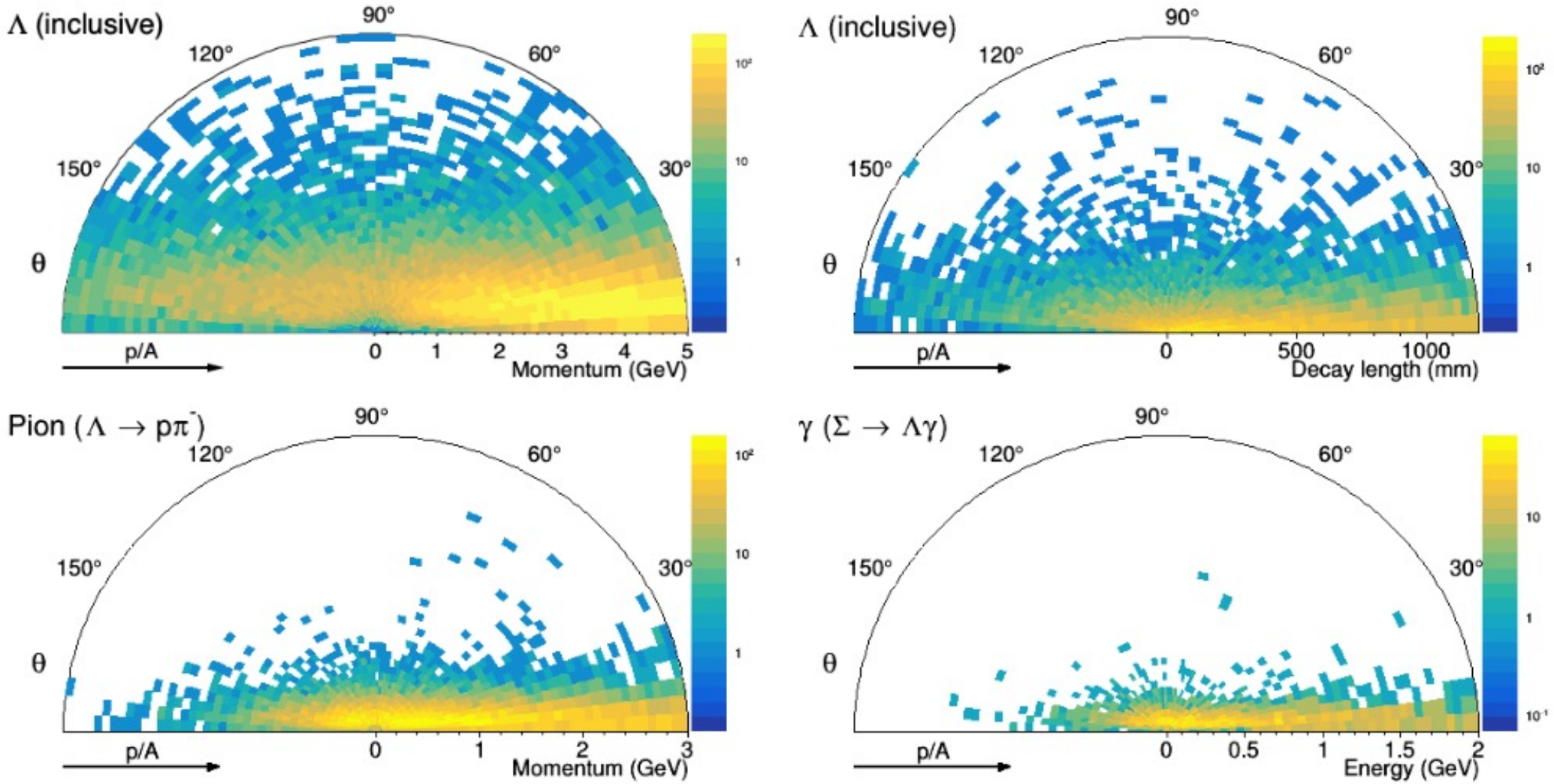

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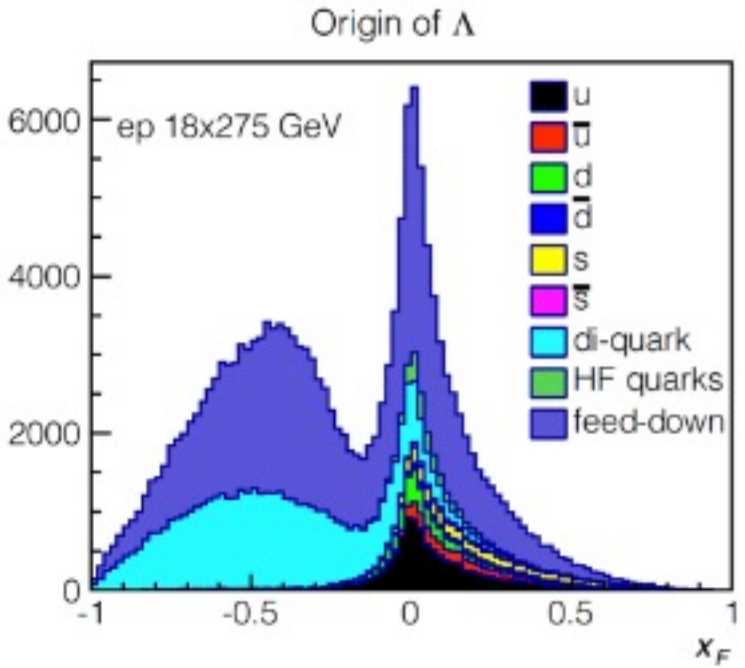
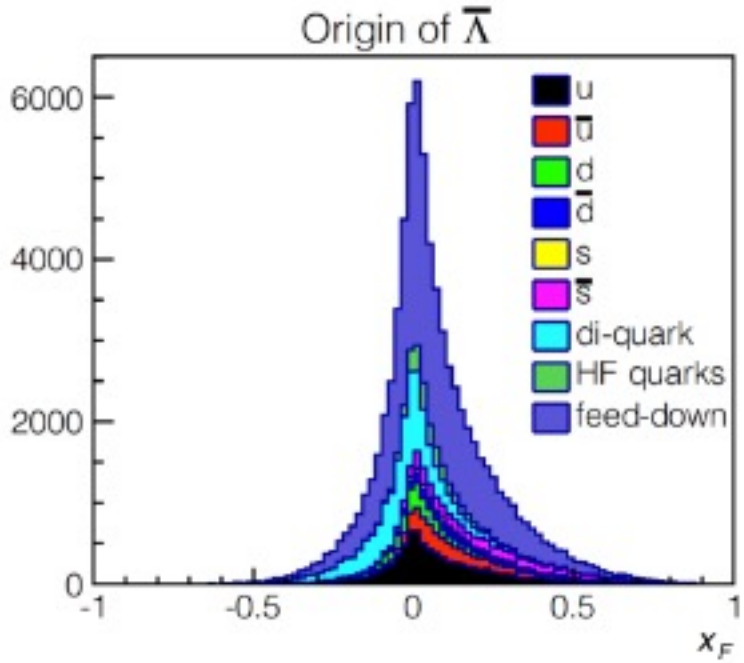

Origin of Λ
ep 18x275 GeV
u
ū
d
d̄
s
s̄
di-quark
HF quarks
feed-down
6000
4000
2000
0
-1
-0.5
0
0.5
1
x_F


Origin of $\overline{\Lambda}$
u
ū
d
d̄
s
s̄
di-quark
HF quarks
feed-down
6000
4000
2000
0
-1
-0.5
0
0.5
1
x_F