Feed-down Subtraction

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How to Subtract

- F.D. raw Lambda estimated with Xi^{-} embedding and spectra
  - F.D. raw Lambda ~ Xi^{-} -> Lambda + Xi^{0} -> Lambda ~ 2 * Xi^{-}->Lambda
  - Omega -> Xi + pi or Omega -> Lambda + K are not considered
- #(primary raw Lambda) = #(Inclusive raw Lambda) – #(F.D. raw Lambda)
- #(primary Lambda) = #(primary raw Lambda) / primary Lambda efficiency
- Similar estimation for F.D. raw Lambdabar

How to Subtract

- Omega^{-} -> Xi^{-} -> Lambda
  B.R. ~ 10%
- Omega^{-} -> Xi^{0} -> Lambda
  B.R. ~ 20%
- Omega^{-} -> Lambda
  B.R. ~ 70%
  - Estimate with 0-5%:

    Omega^{-} + Omega^{+} ~ 1.8% Lambda, Lambdabar

TABLE I. Integrated yields dN/dy and inverse slope parameters T (MeV) extracted from a Boltzmann fit to the p_T spectra of $\Lambda(\bar{\Lambda})$, $\Xi^-(\bar{\Xi})^+$, and $\Omega^- + \bar{\Omega}^+$ at midrapidity, with their statistical and systematic errors. $\langle N_{part} \rangle$ is shown for each centrality.

Centrality	0%–5%	10%–20%	20%–40%	40%–60%	60%–80%
$\langle N_{part} \rangle$	352 ± 3	235 ± 9	141 ± 8	62 ± 9	21 ± 6
Λ	16.7 ± 0.2 ± 1.1	10.0 ± 0.1 ± 0.7	5.53 ± 0.05 ± 0.39	2.07 ± 0.03 ± 0.14	0.58 ± 0.01 ± 0.04
	309 ± 1 ± 8	308 ± 1 ± 8	303 ± 1 ± 8	297 ± 2 ± 10	287 ± 3 ± 10
$\bar{\Lambda}$	12.7 ± 0.2 ± 0.9	7.7 ± 0.1 ± 0.5	4.30 ± 0.04 ± 0.30	1.64 ± 0.03 ± 0.11	0.48 ± 0.01 ± 0.03
	310 ± 1 ± 7	309 ± 1 ± 8	306 ± 1 ± 9	298 ± 2 ± 10	282 ± 3 ± 10
Ξ^-	2.17 ± 0.06 ± 0.19	1.41 ± 0.04 ± 0.08	0.72 ± 0.02 ± 0.02	0.26 ± 0.01 ± 0.02	0.063 ± 0.004 ± 0.003
	335 ± 4 ± 7	331 ± 4 ± 8	326 ± 3 ± 6	325 ± 4 ± 7	320 ± 8 ± 13
$\bar{\Xi}^+$	1.83 ± 0.05 ± 0.20	1.14 ± 0.04 ± 0.08	0.62 ± 0.02 ± 0.03	0.23 ± 0.01 ± 0.02	0.061 ± 0.004 ± 0.002
	335 ± 4 ± 9	334 ± 4 ± 9	327 ± 3 ± 6	327 ± 5 ± 7	302 ± 8 ± 16
$\Omega + \bar{\Omega}^+$	0.53 ± 0.04 ± 0.04	...	0.17 ± 0.02 ± 0.01	0.063 ± 0.008 ± 0.004	...
	353 ± 9 ± 10	...	348 ± 15 ± 12	336 ± 17 ± 13	...

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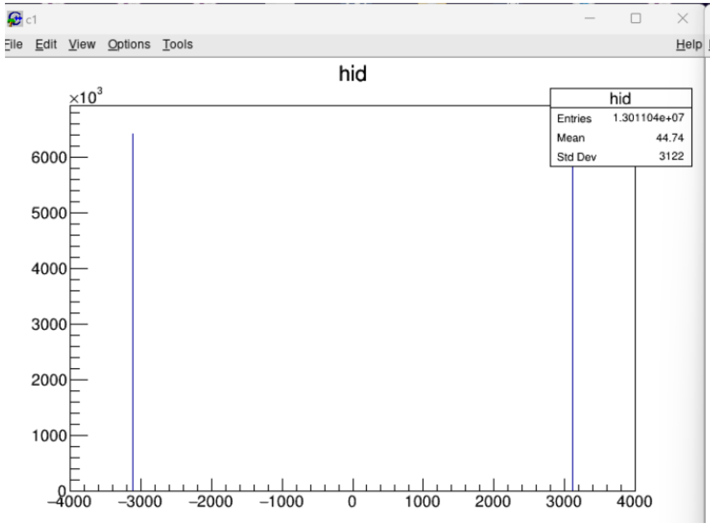
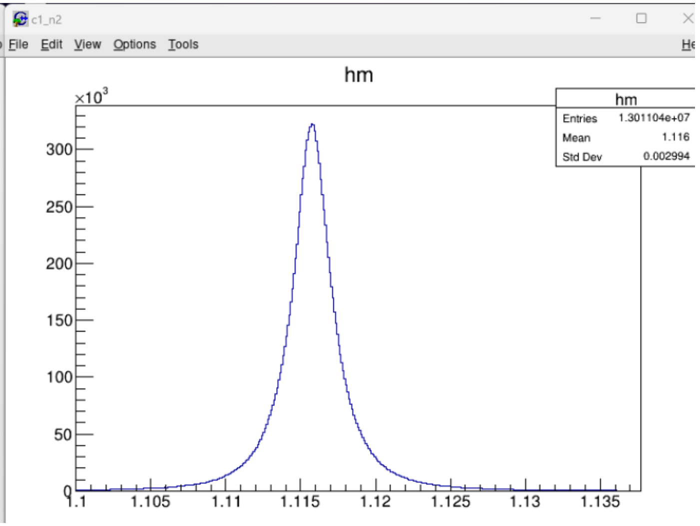
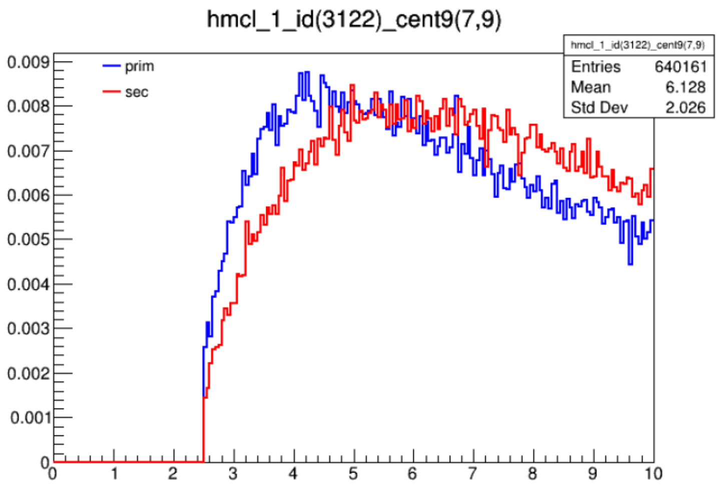
Reconstruct Lambda with Xi Embedding

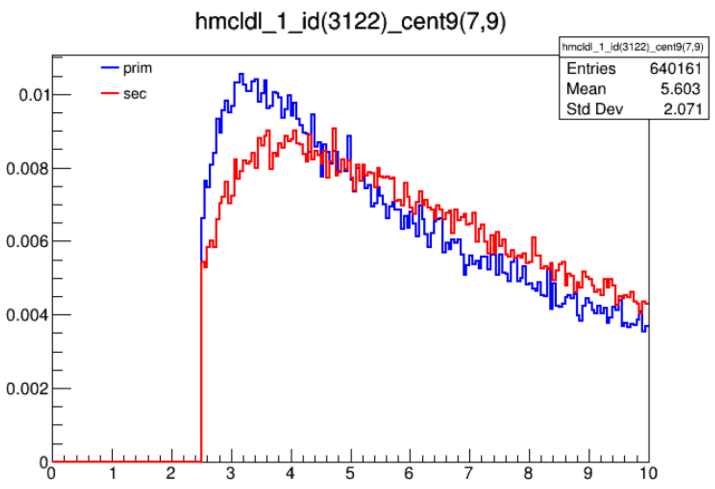


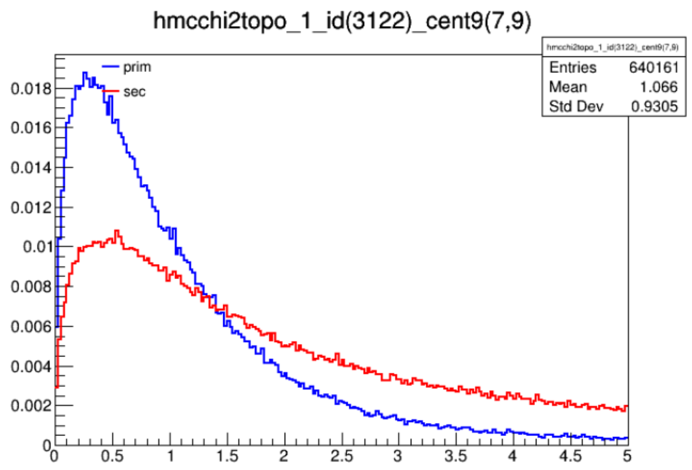


1.The entries are Lambda indeed

2.Secondary Lambda tend to have larger L/LdL/chi2topo compared to primary Lambda

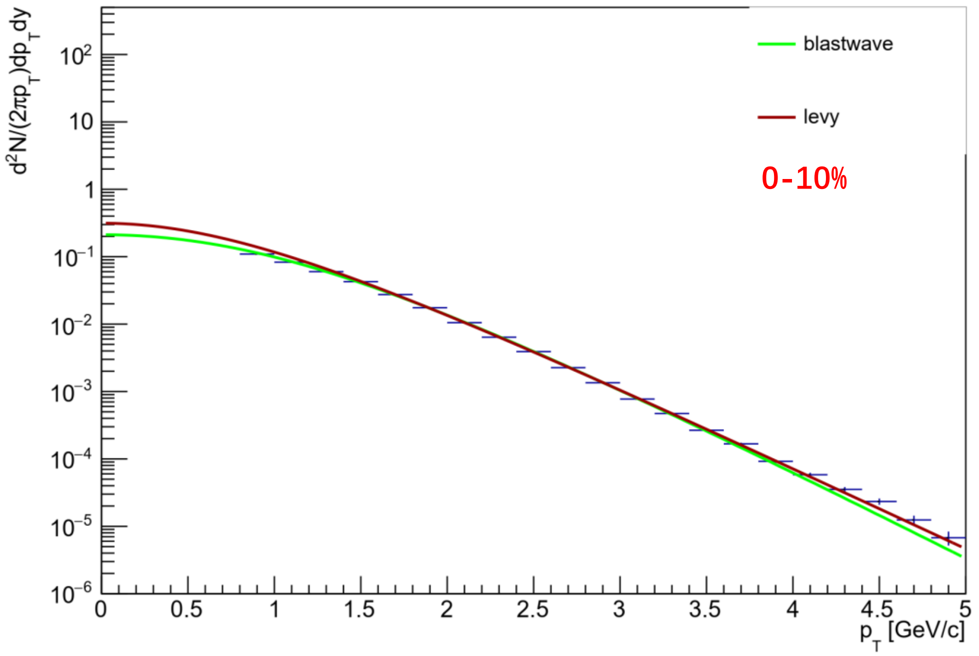


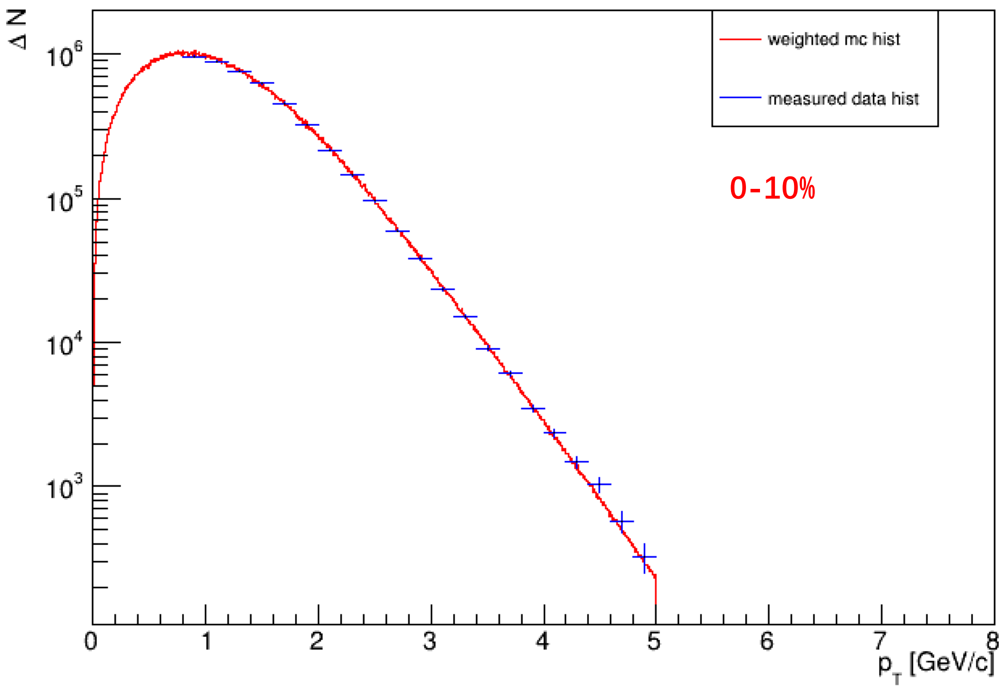




#(F.D. Raw Lambda)

1.Weight the total MC according to the Xi yield spectra
2.Apply exactly the same cuts on Xi->Lambda. This step is done automatically with a self-defined class which has been validated by the BG subtraction steps.





Xi^{-} spectra parameterization
pT < 2.5, Blast-wave
pT > 2.5, Levy

Normalization by counts within pT [1.2,4].

Here to compare the shape, we also add a factor of bin width.

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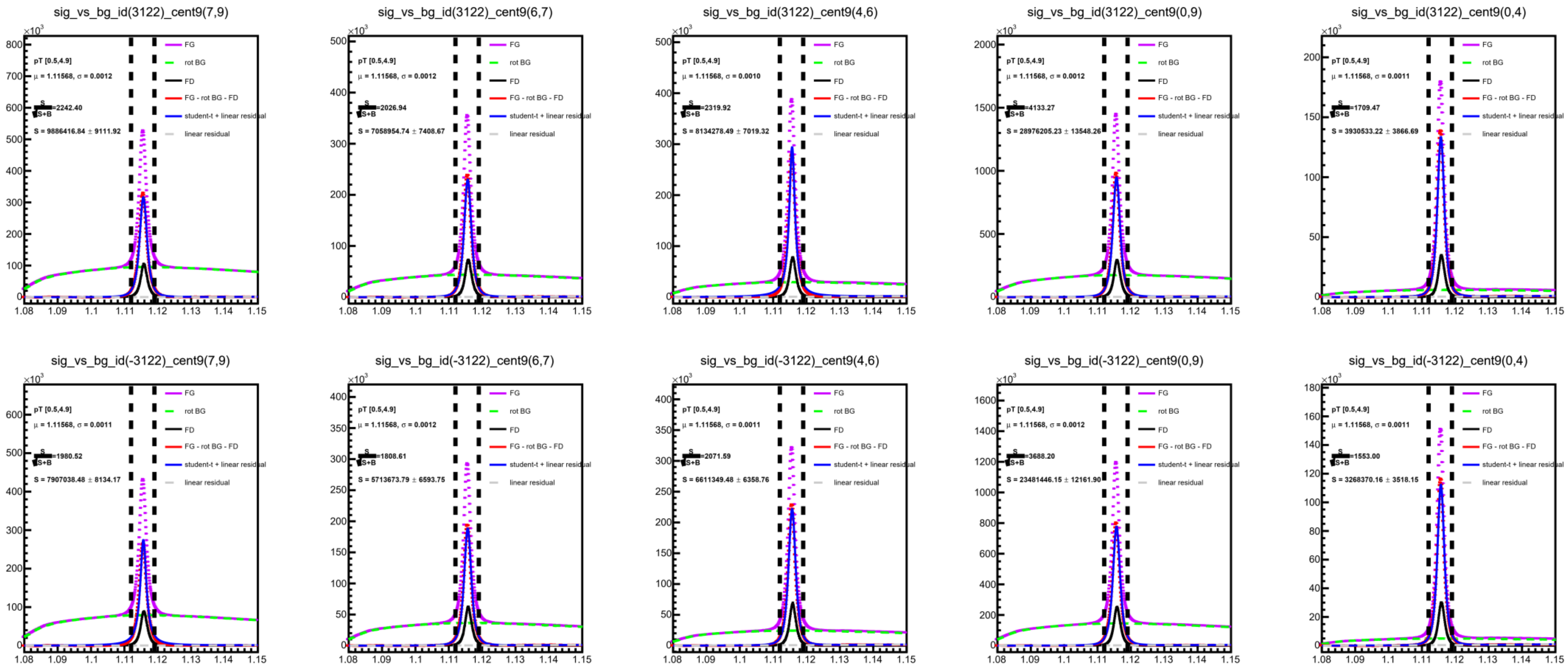
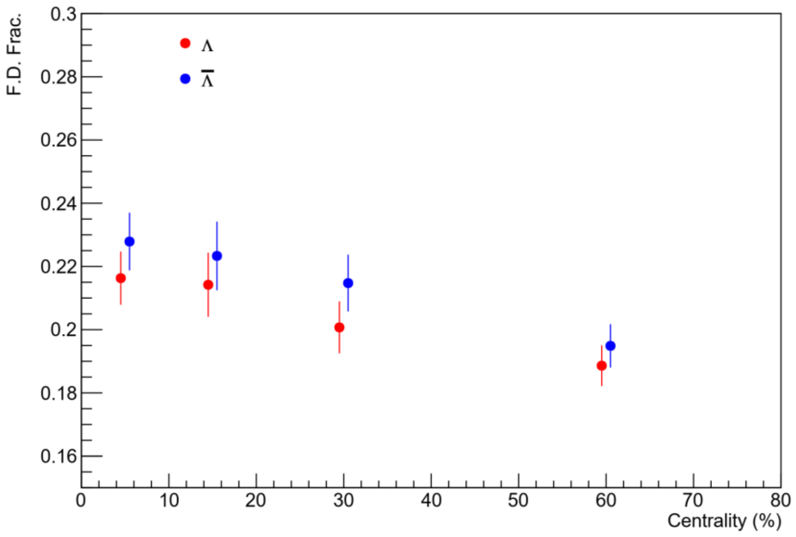
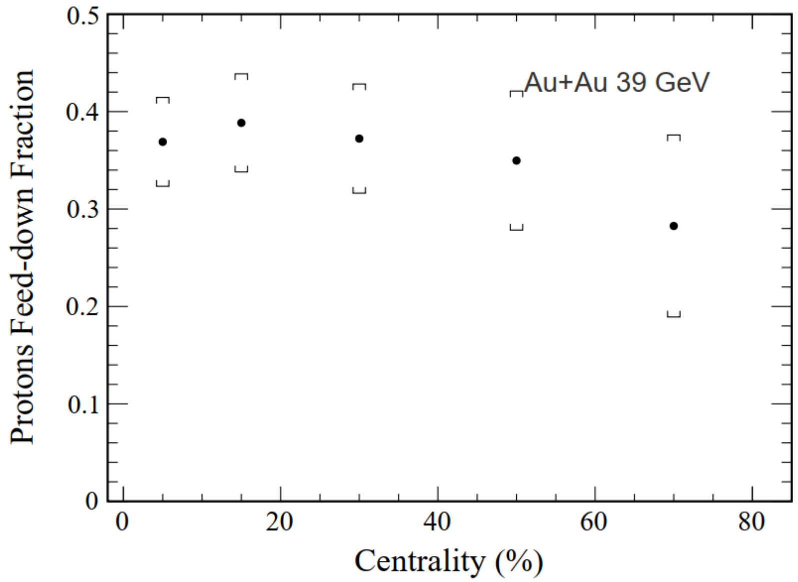


#(F.D. Raw Lambda)

- The pT-integrated feed-down fractions for Xi -> Lambda
  - Slightly varying with centrality
  - Comparable value with Au+Au 39 GeV result

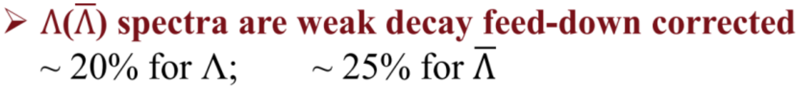


Proton feed-down at Au+Au 39 GeV:



https://drupal.star.bnl.gov/STAR/system/files/20201221_protonFD_Dingwei_0.pdf

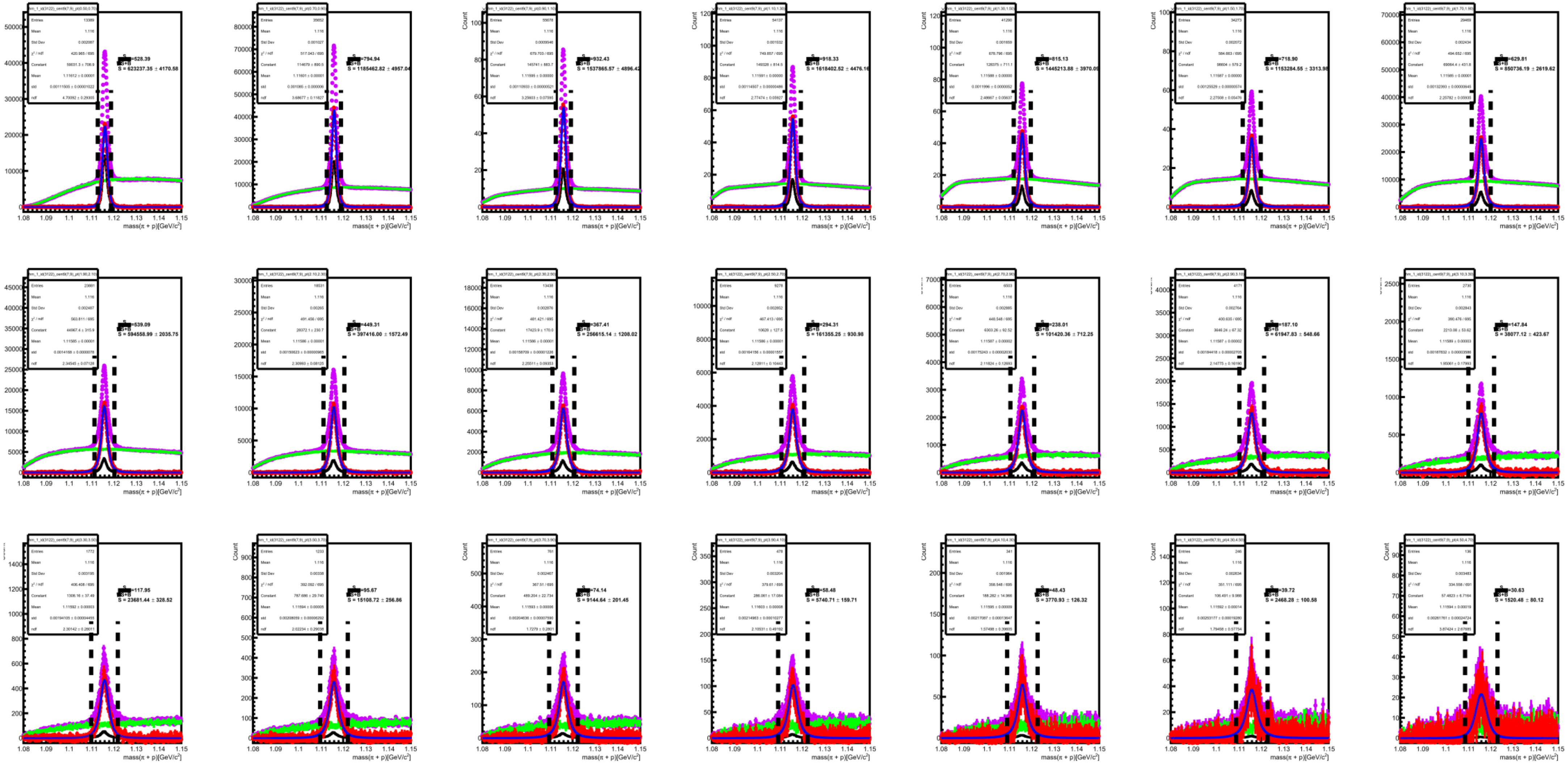
Lambda(bar) at Au+Au 39 GeV :



https://drupal.star.bnl.gov/STAR/system/files/zhang_SQM2015v3.pdf

#(F.D. Raw Lambda)

A larger feed-down fraction at low pT



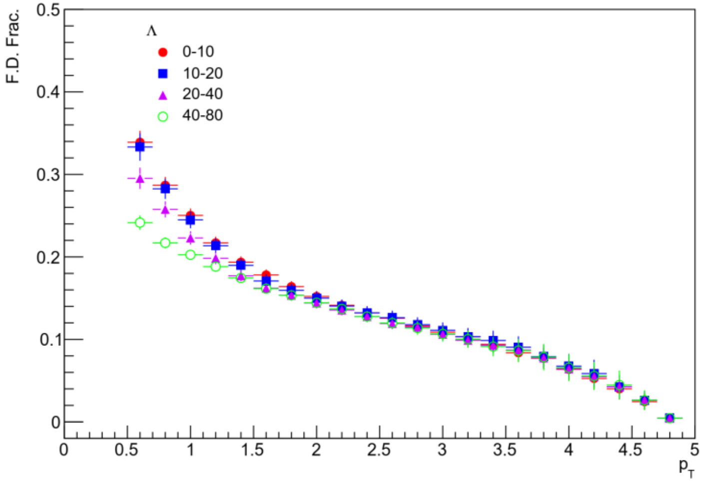
Lambda in 0-80%
pT 0.5~4.9

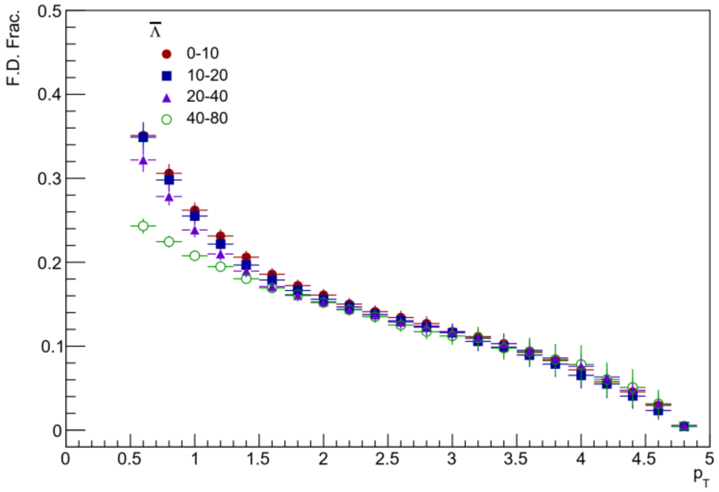
Violet: FG
Black: Rot_BG
Red: FG – Rot_BG - RES
Blue: student-t fit

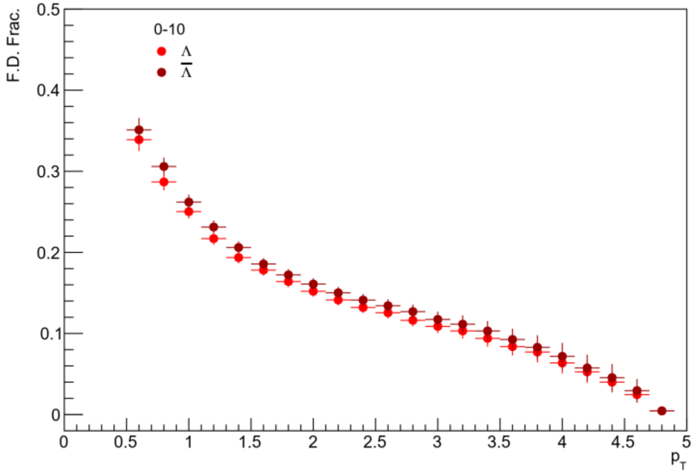
Higher pT with larger mass width

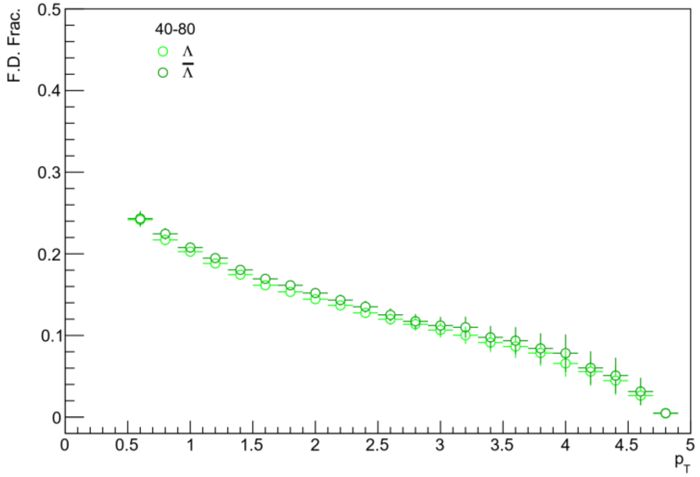
#(F.D. Raw Lambda)

- The pT-differential feed-down fractions show centrality dependence at pT < 1 GeV
- Quickly drop at low pT in all centralities

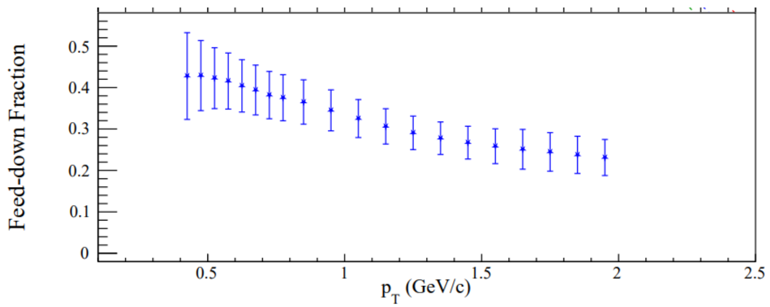








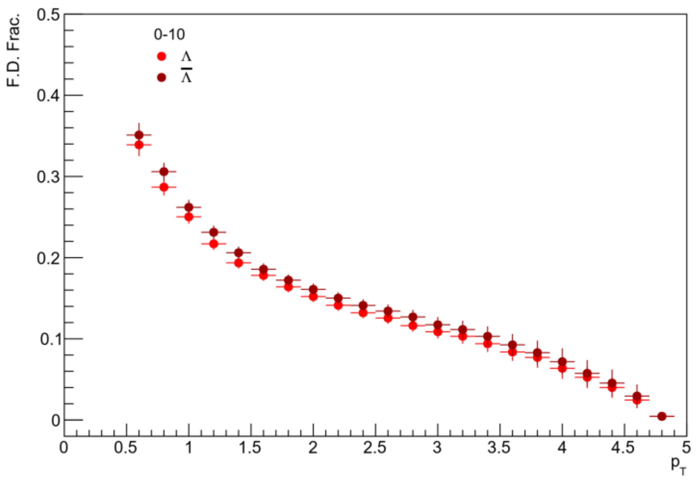
Proton feed-down at Au+Au 39 GeV, 0-10% :

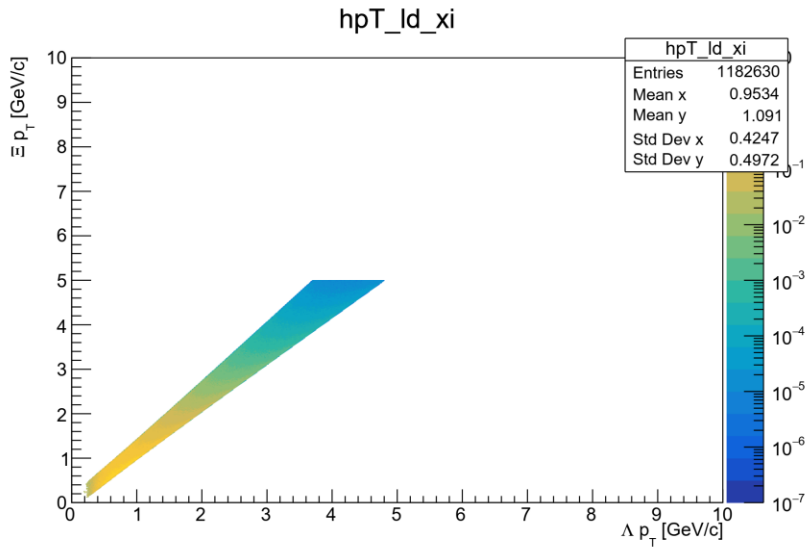


https://drupal.star.bnl.gov/STAR/system/files/20201221_protonFD_Dingwei_0.pdf

#(F.D. Raw Lambda)

We cannot trust the trend at Lambda pT > 3.5, with a small portion of Xi at pT > 5 are not considered

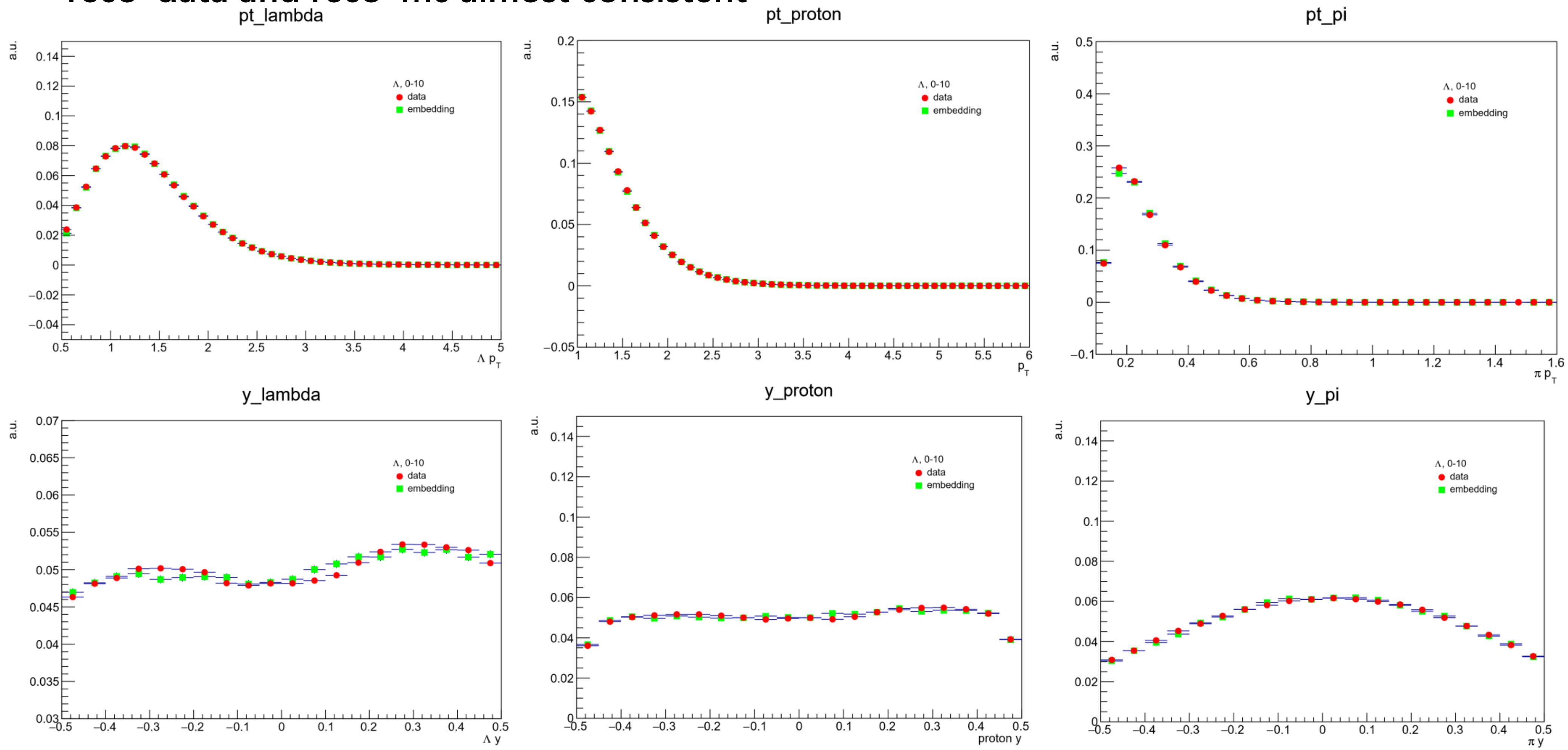




Data-MC Comparison

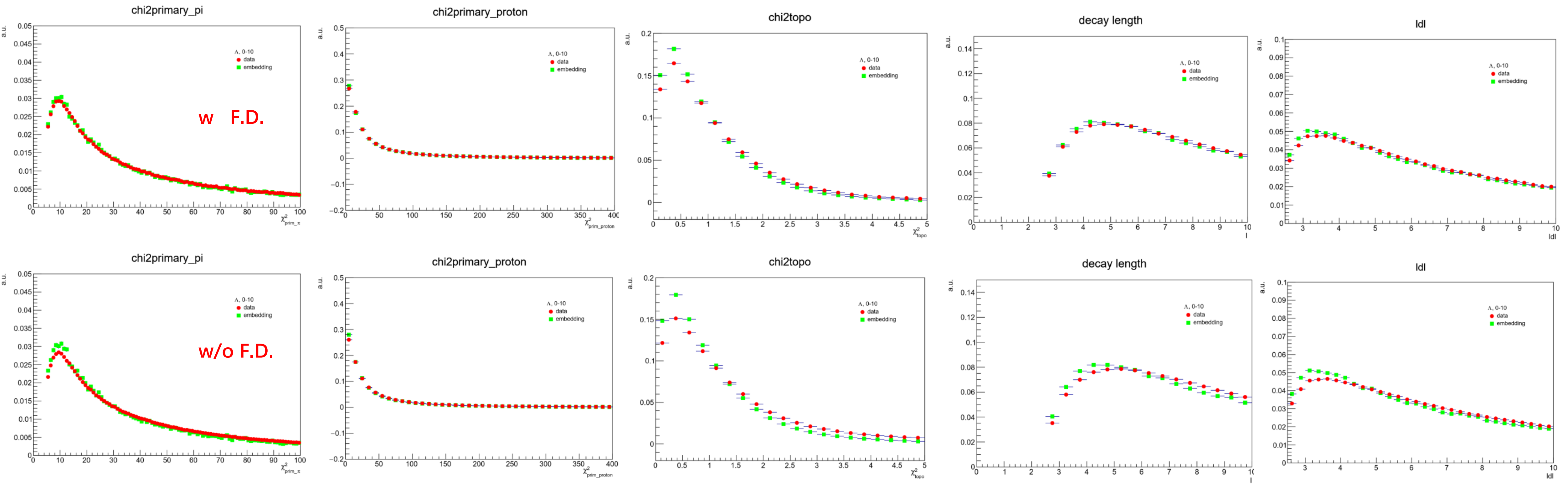
- pT&y weighted (Iteration)
  - pT: use corrected spectra with interpolation, y: pol-2
- reco-data and reco-mc almost consistent

Perfect consistence on pT/y distributions between data&mc
So the iteration is properly weighting MC

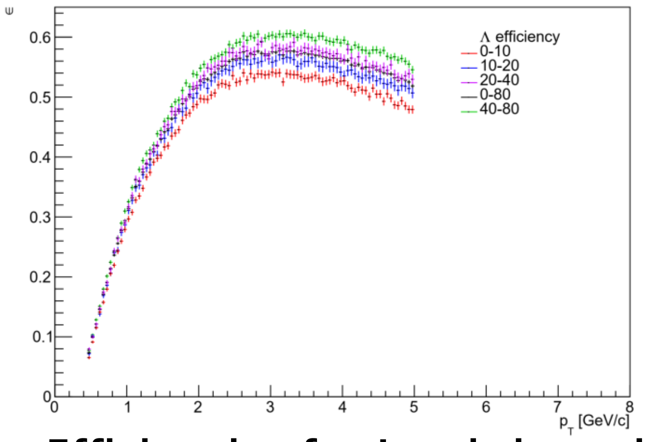


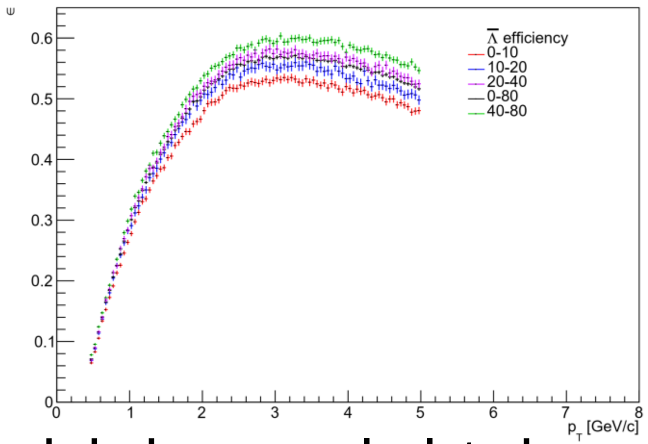
Data-MC Comparison

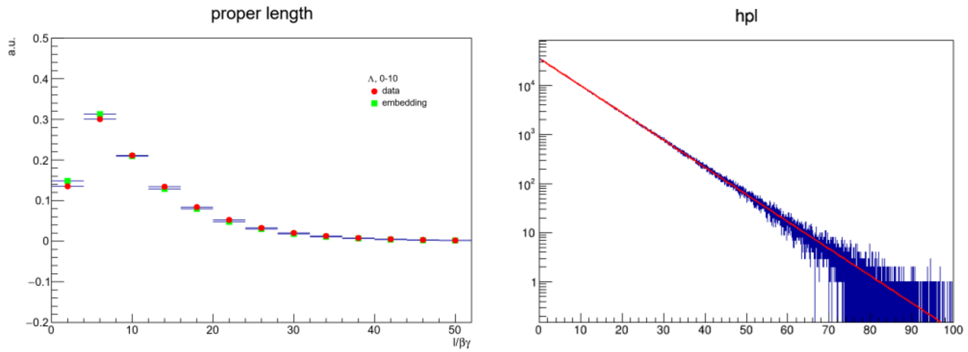
- We get slightly better consistence on chi2/decay length distributions
- The improvement comes from pT weight
- So with F.D. correction, the pT shape is more close to primary Lambda



Primary Lambda Efficiency





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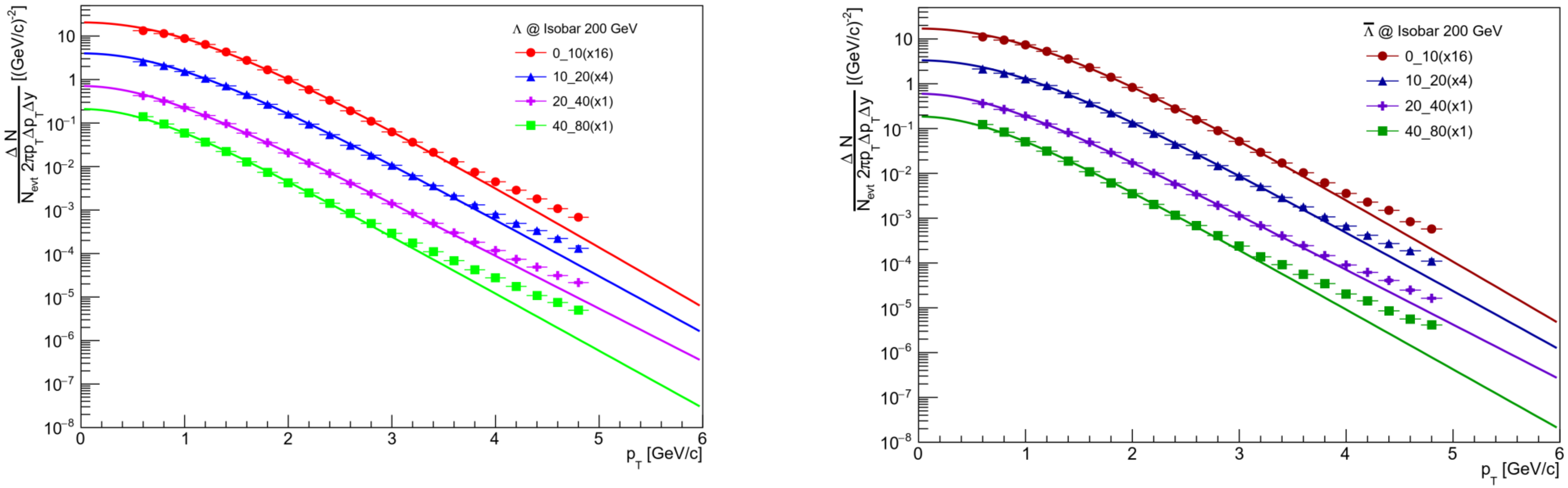
                     EDM=3.10746e-10    STRATEGY= 1      ERROR MATRIX ACCURATE
 EXT PARAMETER                                   STEP         FIRST
 NO.   NAME      VALUE            ERROR          SIZE      DERIVATIVE
  1  Norm         3.55264e+04   1.34441e+01   3.65207e-01  -2.15235e-06
  2  tau_         2.61730e-10   6.99873e-14   1.90119e-15  -8.89908e+07
```

MC Lambda lifetime: 2.6173e-10s
smaller than PDG value: 2.632e-10s   0.5% difference

- Efficiencies for Lambda and Lambda_bar are calculated, respectively
  - No tiny bit difference compared with previous results
    - This is expected
      - The only thing we have changed for MC is just the pT-weight
      - Since we use very fine pT-binning, the pT-differential efficiencies will not be affected
- There are still discrepancies between data&MC
  - Omega? (1.8%)
    - Total number small, but might be concentrated at low pT to change Lambda pT shape?
  - Wrong lifetime on MC Lambda? (0.5%, but might have more impact on MC shape)
    - Need reweight on lifetime
- How to assign systematics on F.D. correction?
  - From Xi and its parametrization, I need to get Xi systematic errors first. Function choice and fit error?
  - Will be part of signal extraction systematics of Lambda yields

Lambda Spectra with FD Correction



Primary Lambda(bar) fitted with blast-wave function

The high pT excess in 40-80% seems very different from other centralities?