Update on (Anti-)H3L Yield in Isobar Collisions at 200 GeV

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Outline

- Lambda Yield
    - Reconstruction
        - Variations for systematic error
        - Reconstruction methods
    - Efficiency
        - Checks
    - Spectra

Lambda Reconstruction

Event selection:

- Vz [-35,25], |Vz-VpdVz| < 3
- good run
- pile-up rejection
- Apply centrality weight (StRefMultCorr from Kaifeng and Yan)

Lambda_tree 5% stat; Lambdabar_tree 2.5% stat;
0-80% ~2e8 ~1e8

Track quality:

- Daughter pT > 0.1, eta [-1.5,1.5]
- Nhitsdedx>=5, nhits >=15 , nhitsfit/nhitsmax>0.52
- Dedxerror [0.01,0.25]

Analysis cuts	default	var1	var2
Chi2topo	<=4.5	<=4.5	<=4.5
Chi2ndf	<=5	<=5	<=5
Chi2primary_pi	>=11	>=10	>=12
Ldl	>=4.5	>=4.5	>=4.5
L	>=1.5	>=1.	>=2
Nhits	>= 17	>= 15	>= 20
lifetime	>0		

Signal Extraction	default	var1	var2
Mass window	3-sigma	4-sigma	5-sigma

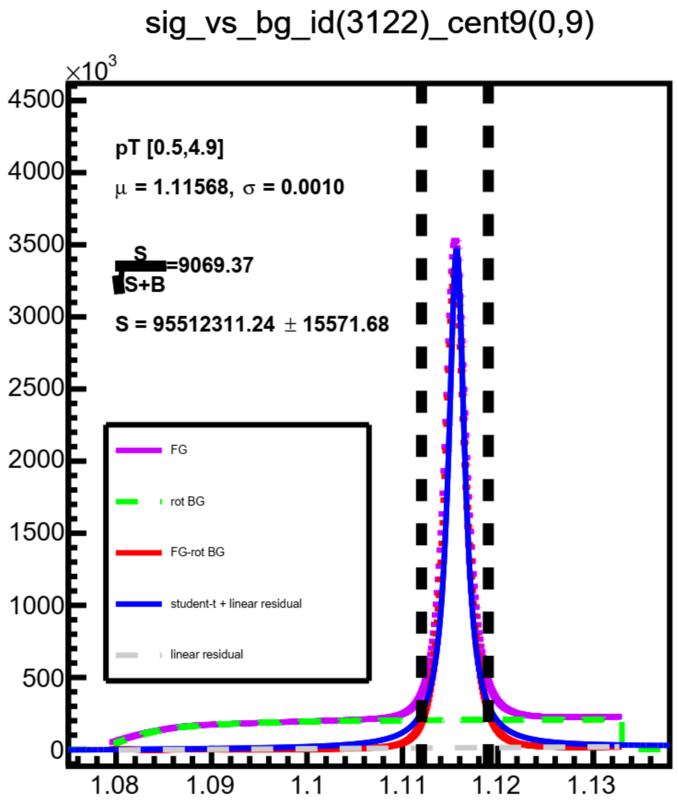
T0 from iteration:

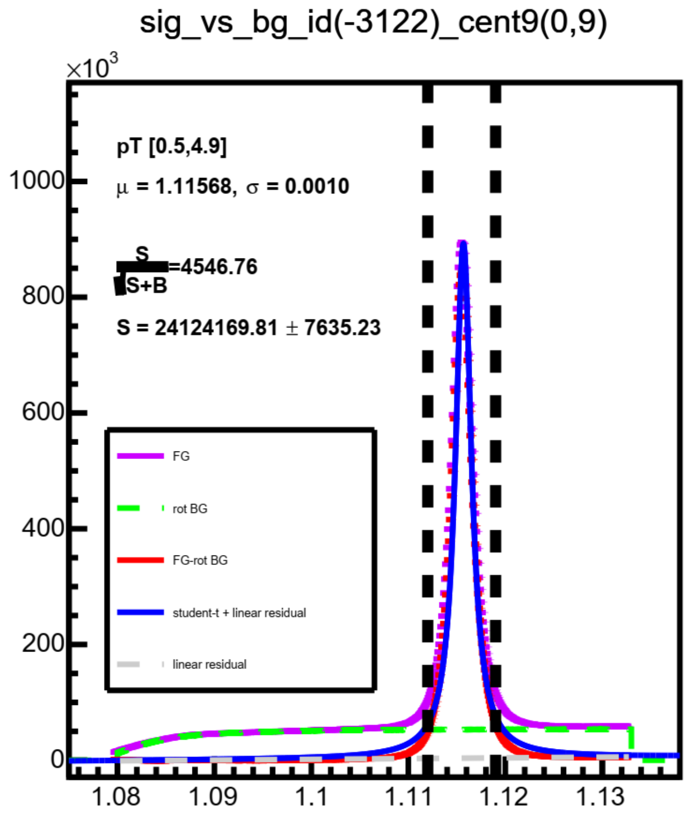
- Fit spectra with Boltzmann function
- Weight MC kinematics, calculate eff and do correction
- Fit the corrected spectra again
- …(loop a few times)
- Get T0 and its uncertainty eT
  (for lambda eT is ~1e-3 MeV; so we vary T0 with 20 MeV)

MC weight	default	var1	var2
Boltzmann T (MeV)	T0	T0-20	T0+20

Lambda Reconstruction

- Rotational background (pion, 180 degrees)
- For each centrality, get normalization factor of Rot_BG with sideband [1.08,1.09]
- For each centrality and pT bin, Fit the linear residual:
  - RES = FG-Rot_BG, remove its bin-contents within 7 sigma of the signal peak [1.108,1.123]
- Get spectra by counting bin-contents, SIG = FG-BG-RES in signal region (3/4/5 sigma)



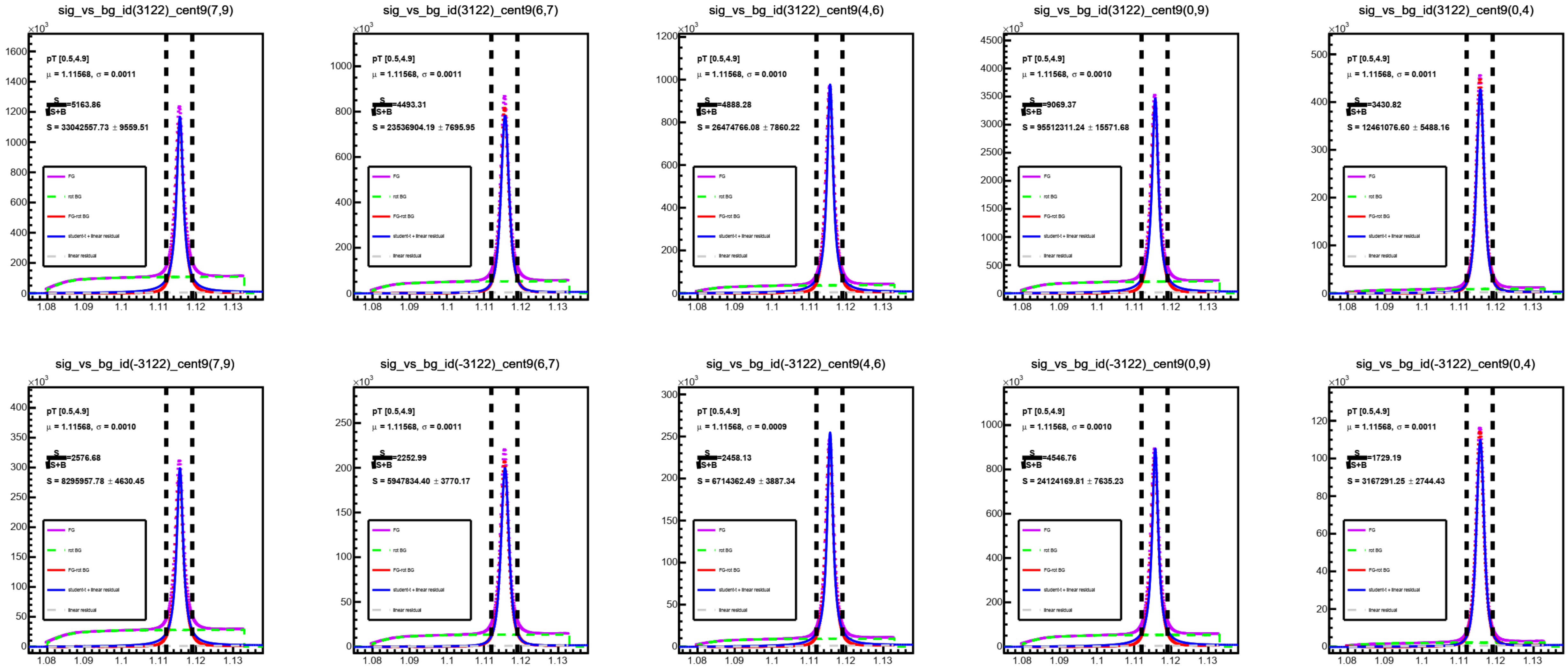


~4 times Lambda raw counts compared to Lambda_bar

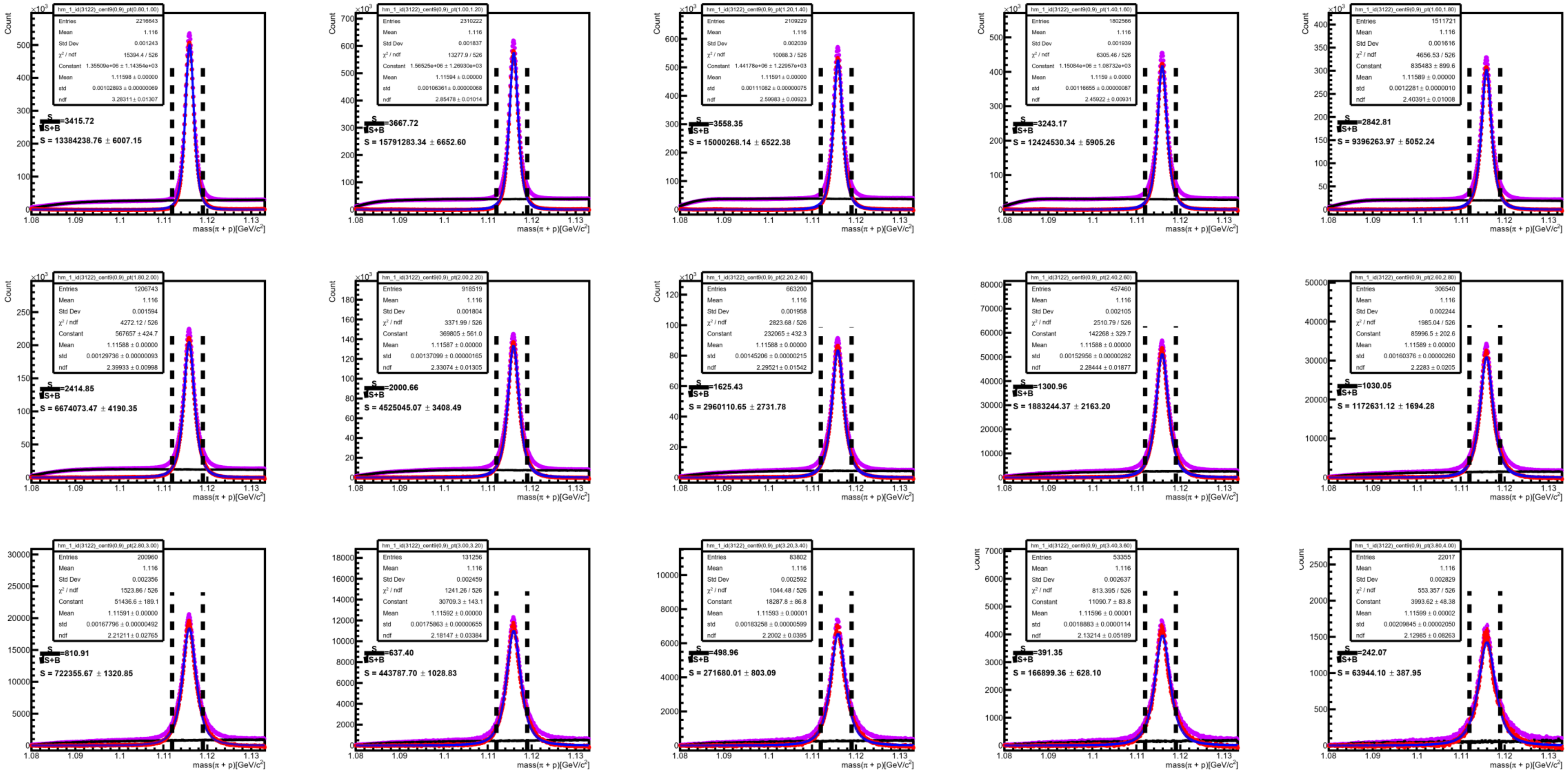
For invariant yield we expect Lambda twice larger than Lambda_bar, if we have similar efficencies

Lambda Reconstruction

Normalization in each centrality for lambda / lambda_bar



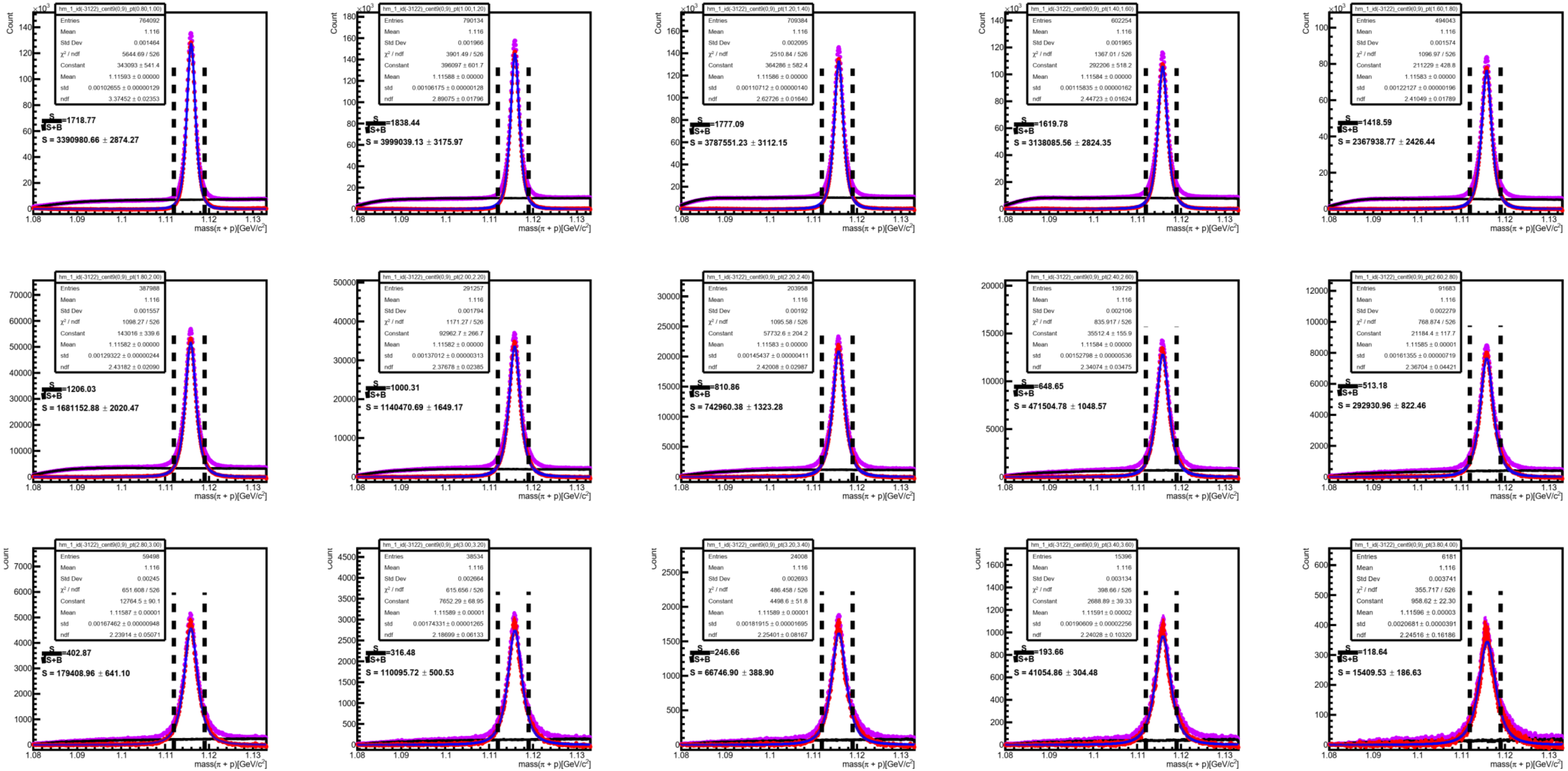
Lambda Reconstruction



Lambda in 0-80%

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

Lambda Reconstruction

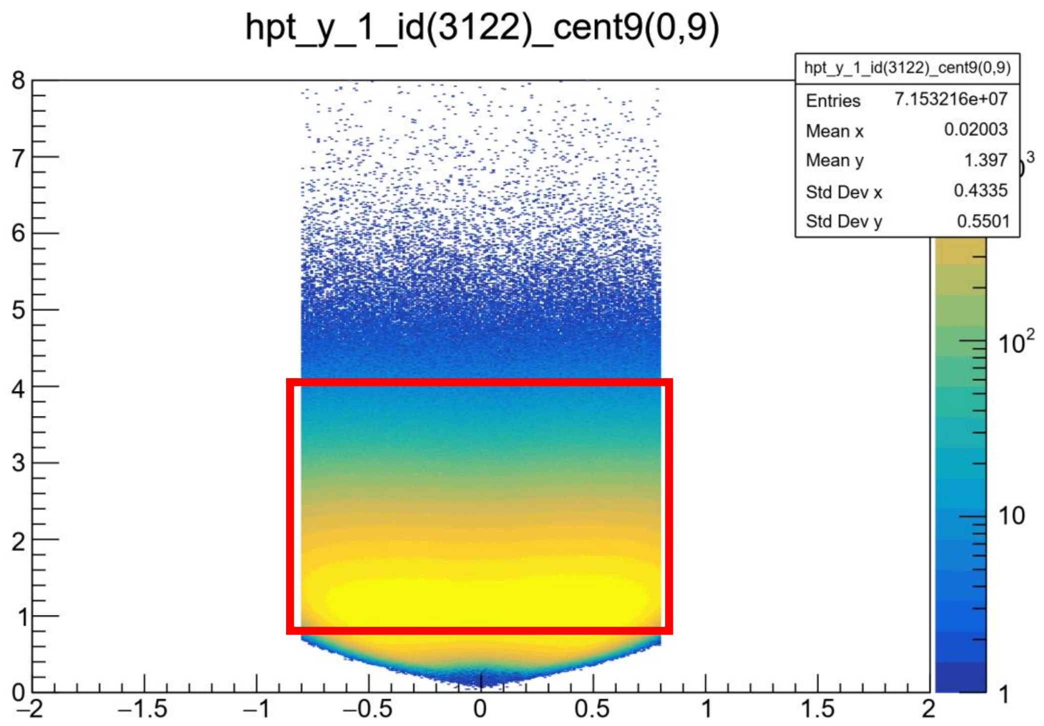


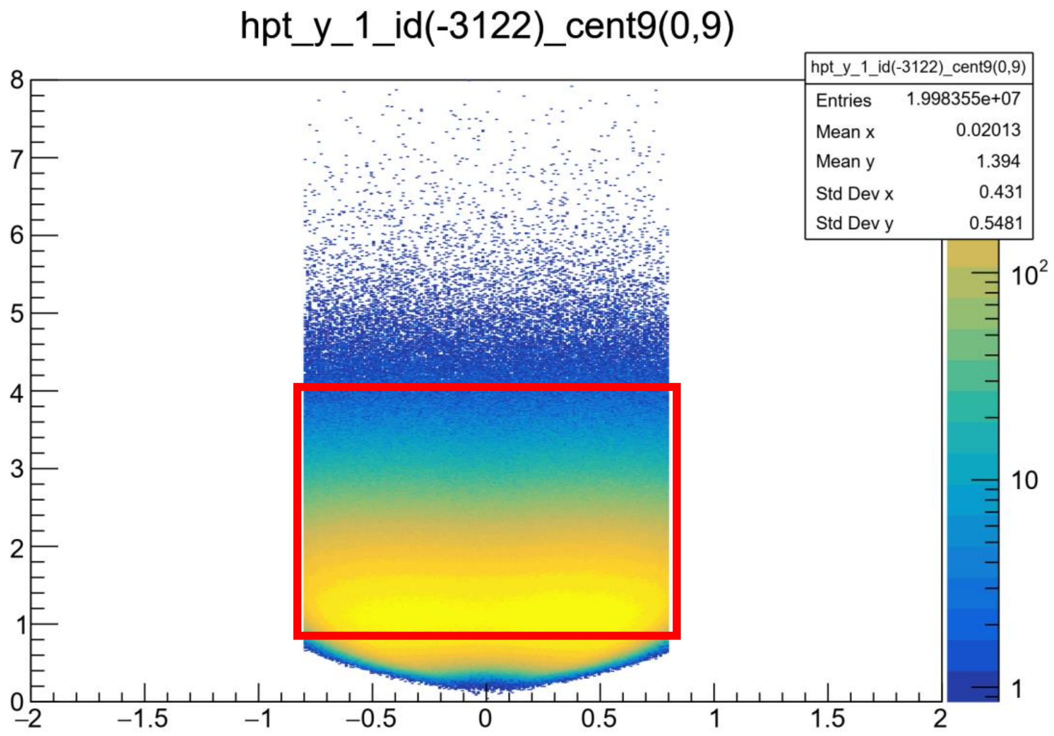
Lambda_bar in 0-80%

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

Lambda Reconstruction

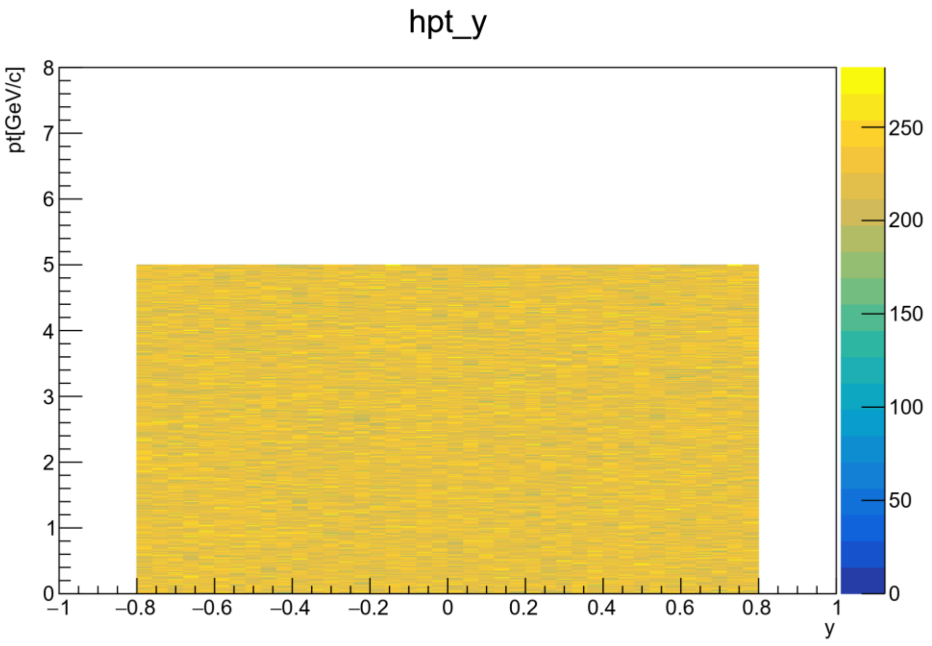
- **Acceptance**
  - **We will report yield within y[-0.8,0.8] x pT [0.8,4]**



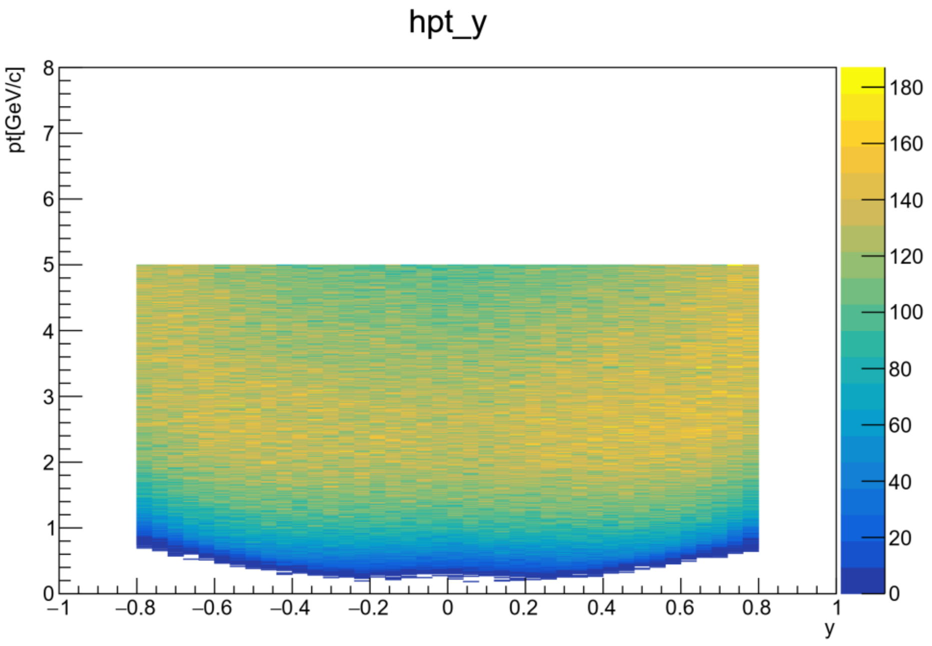


Lambda Efficiency

- MC before weighting
  - pT,y flat



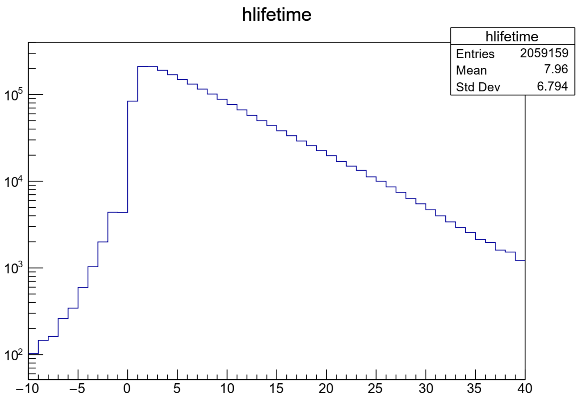
all-raw-mc

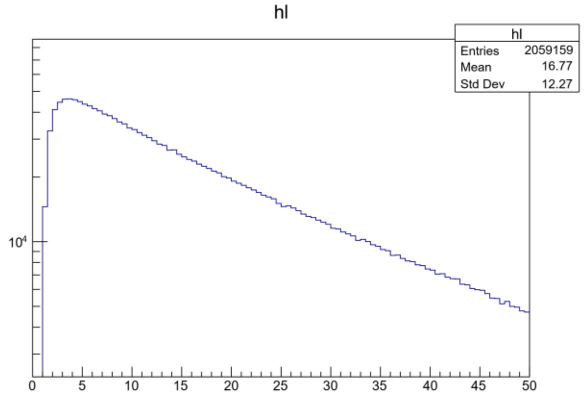


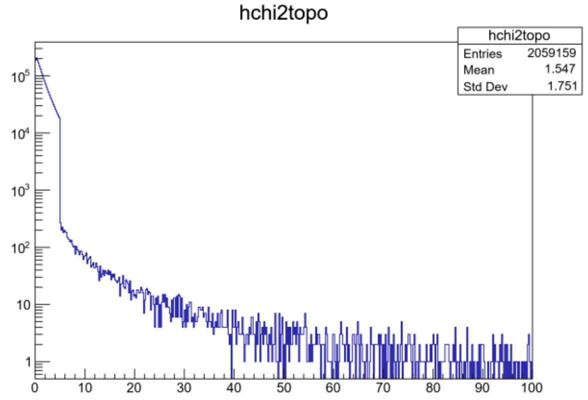
reco-mc with pre-cuts when producing the minitree

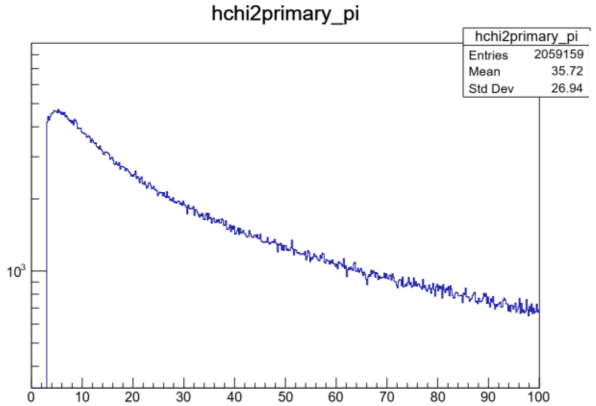
Lambda Efficiency

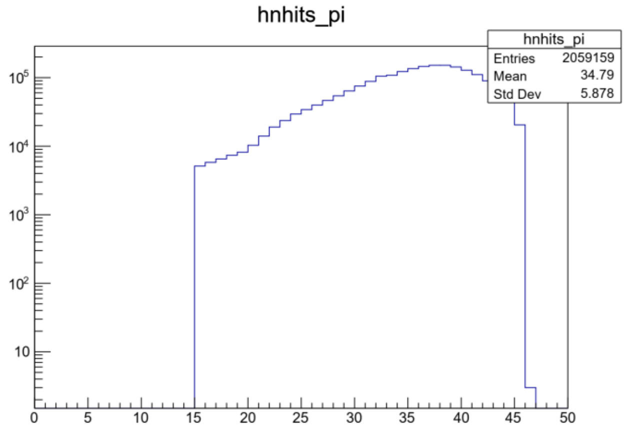
- MC before weighting
  - Reco-distribution with pre-cuts for mc mini-tree

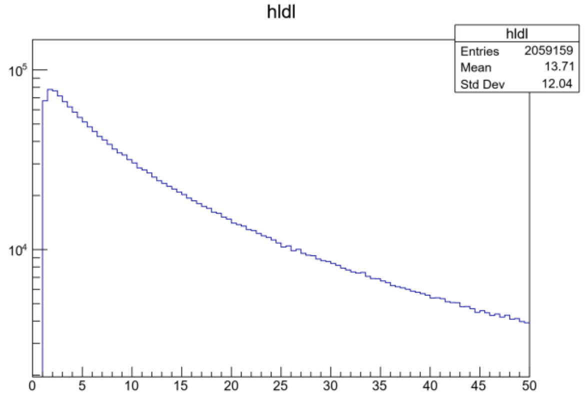


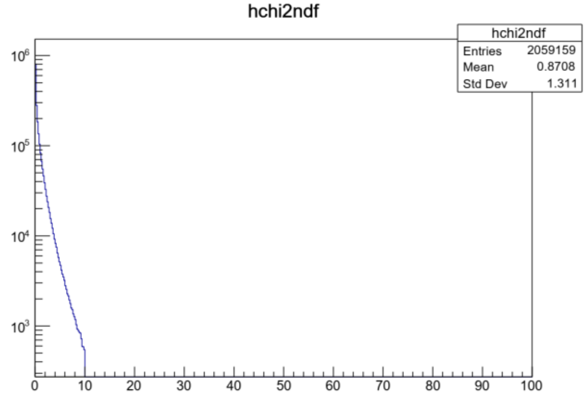


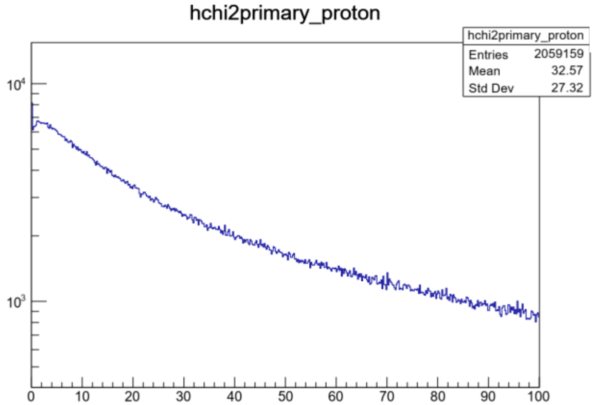


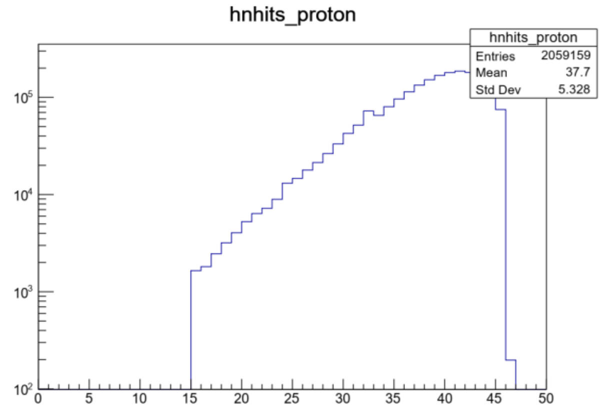








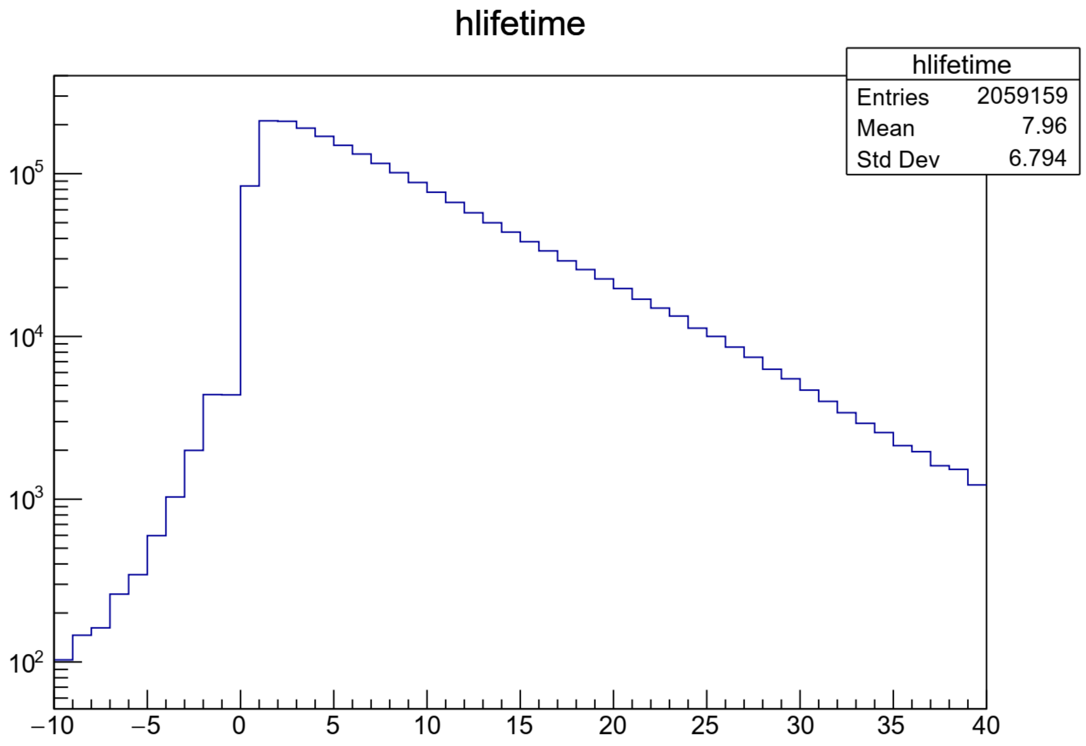




Lambda Efficiency

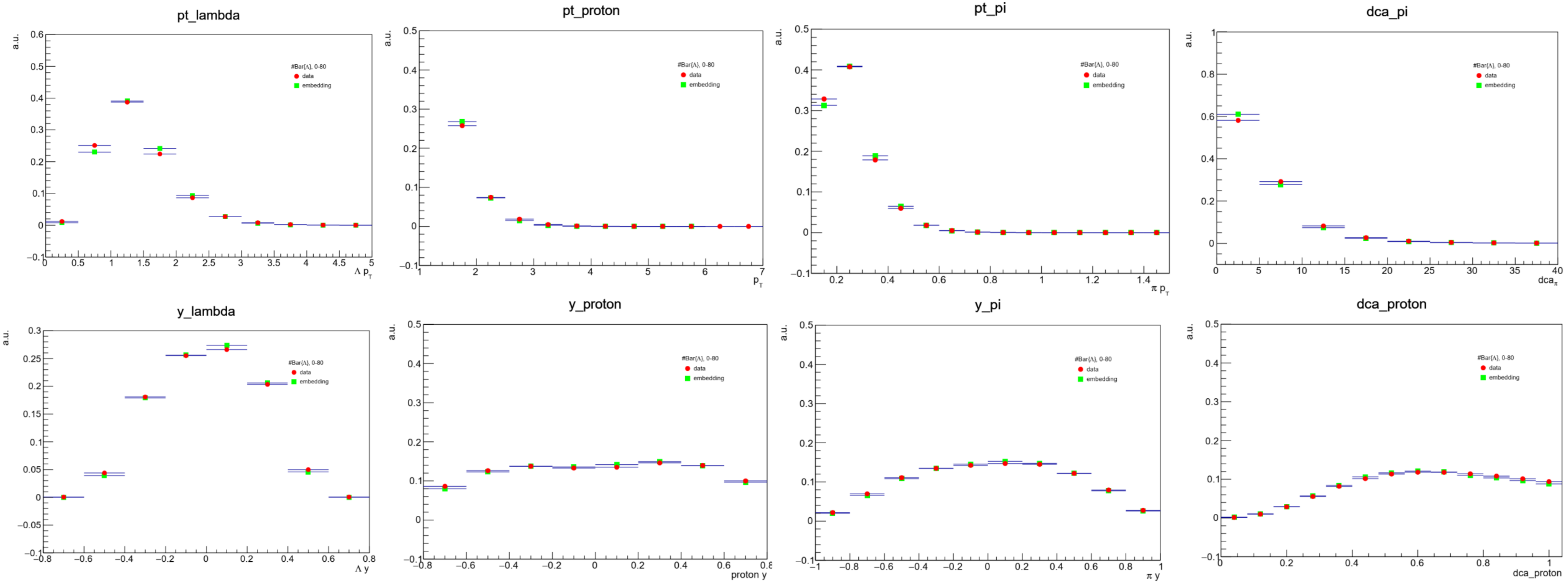
- MC before weighting
  - Reco-distribution
  - Pre-cuts for the mini-tree:
    - Decay length > 1 cm
    - LdL > 1 cm
    - Chi2ndf < 10
    - Chi2primary_pi > 3
    - Nhits > 15
  - A negative lifetime ?

```
ld_lifetime = tempSIMDParticle.GetLifeTime()[0];
```



Lambda Efficiency

- **pT&y weighted**
- **reco-data and reco-mc almost consistent**



Lambda Efficiency

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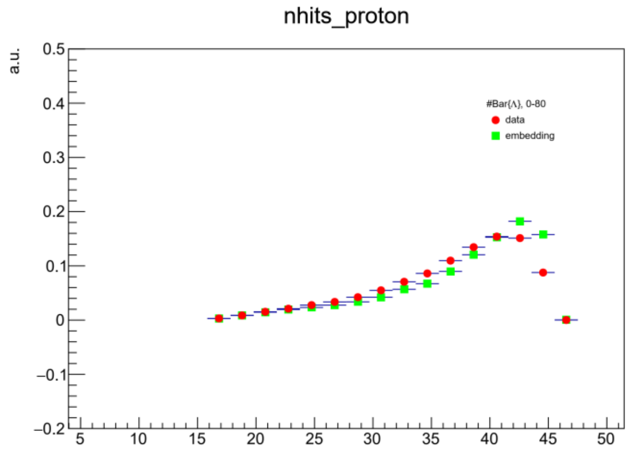
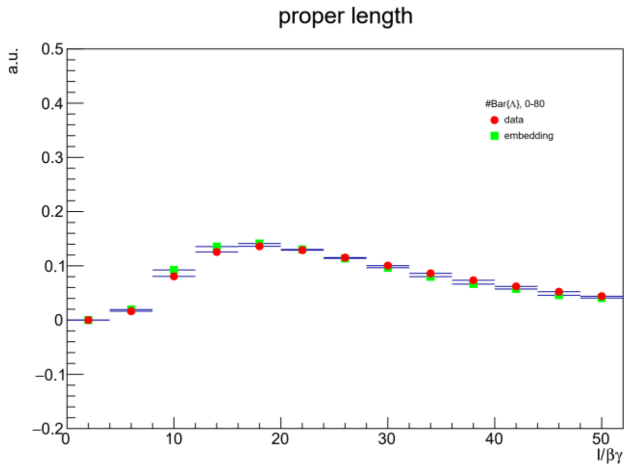
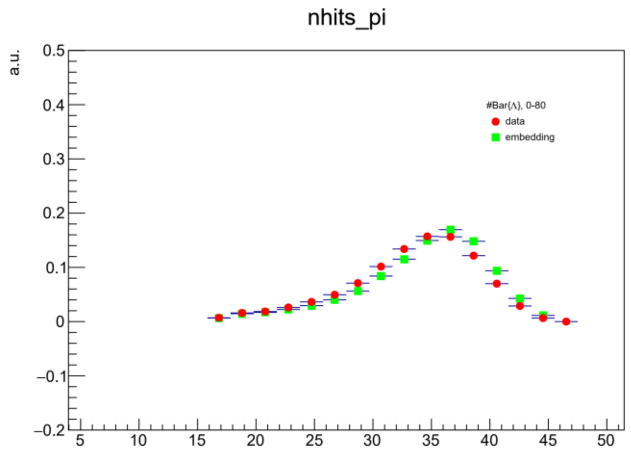
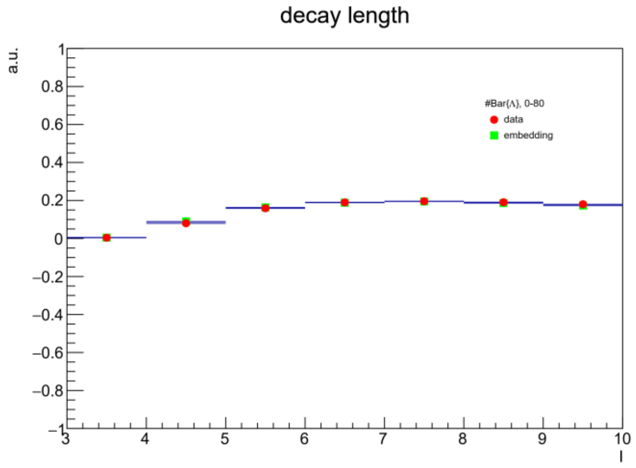


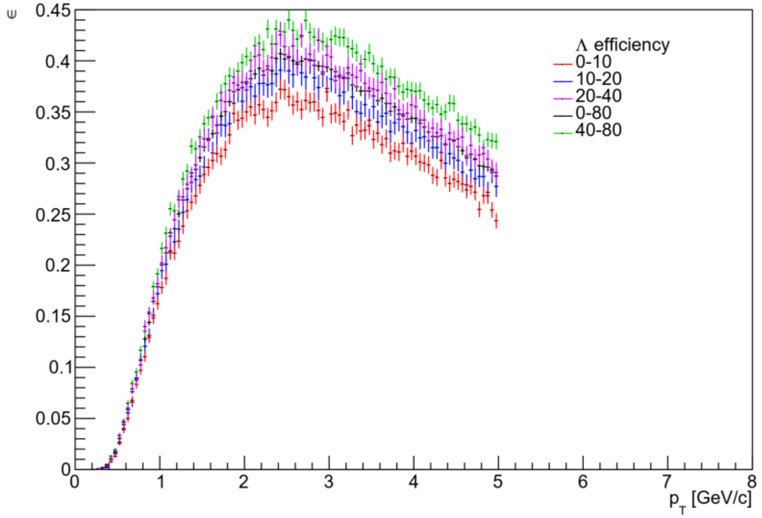


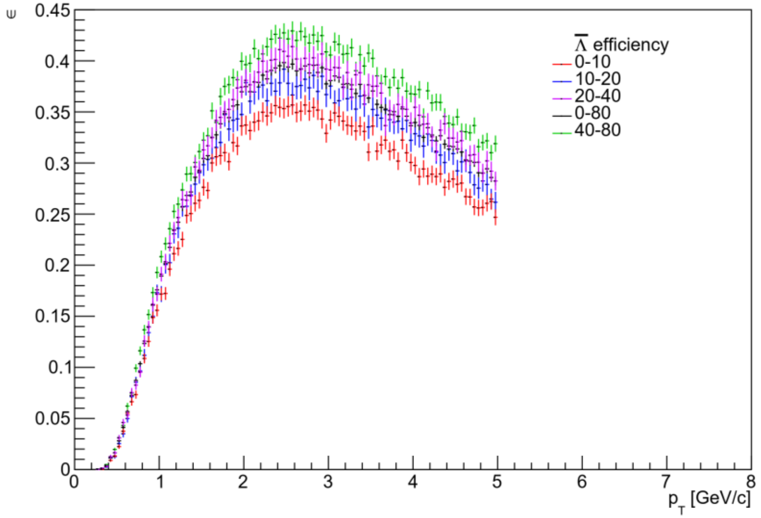


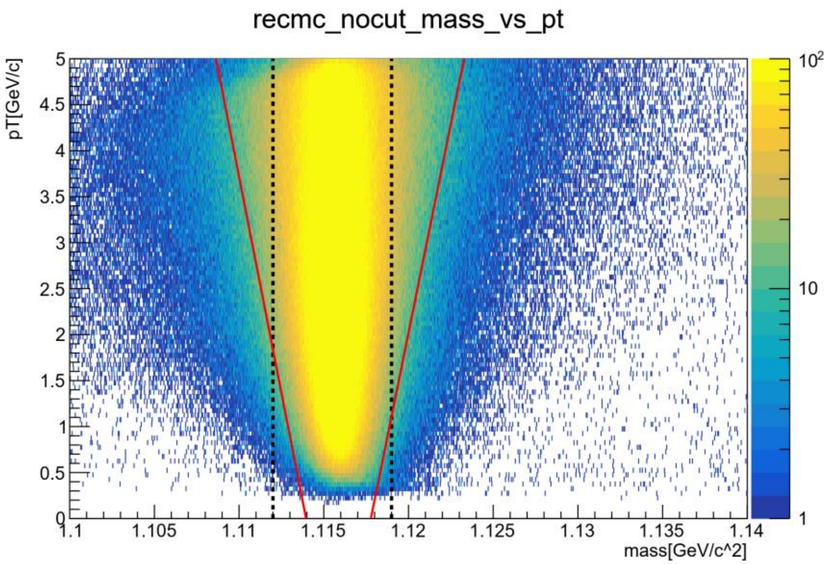


0-80% Lambda_bar are shown,
Lambda very similar to Lambda_bar

Lambda Efficiency

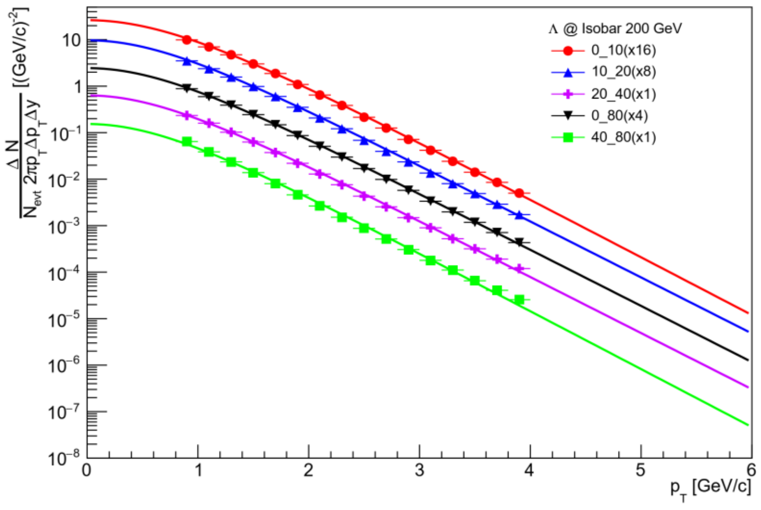


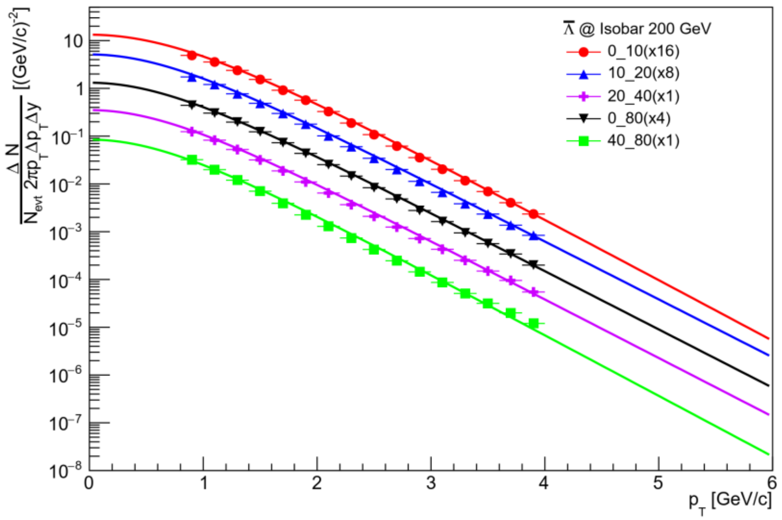




- Efficiencies for Lambda and Lambda_bar are calculated, respectively
  - Similar efficiency, so we will expect invariant yield --- Lambda ~ 2 * Lambda_bar
- At high pT, efficiency will drop because the mass width depends on pT
  - If remove mass cut, will be much more flat
  - Black line(3-sigma mass cut from pT integrated 0-80 spectra) will cut off more Lambda at higher pT
  - Red line, a possible substitute (3-sigma mass cut if we look at each pT slice from 0-80%) , not tried yet
- A larger embedding sample produced
  - Can read it to produce another mini-tree

Lambda Spectra





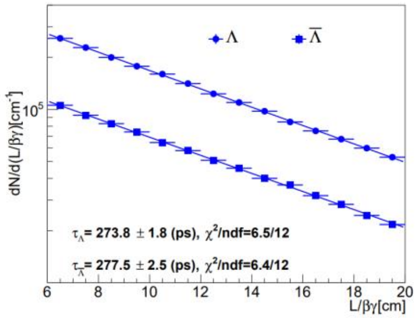
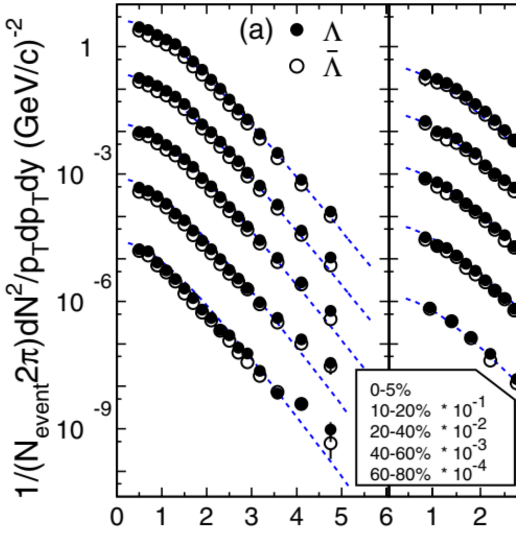


Figure 3: $dN/d(\frac{L}{\beta\gamma})$ as a function of $\frac{L}{\beta\gamma}$ for Λ and $\bar{\Lambda}$, and exponential fits to obtain their lifetimes.



- We fill all histograms again. Weight = the pT-dependent efficiency inverse x centrality reweight
- Lambda_bar spectra now corrected with Lambda_bar embedding
- Fitted with blast-wave function
- Junlin also sees Lambda ~ 2 * Lambda_bar in Au+Au 200 GeV (3.2 million)

Lambda Spectra

- Systematic error components (how to illustrate? Too many bins)
  - Barlow test (MC weighting never passed barlow test, so not used for this source)
  - Estimated with 0-80%, Lambda & Lambda_bar
    - Topo cuts/tracking/signal extraction
  - Centrality by centrality
    - Boltzmann weight on MC kinematics

Eliminate errors due to statistical fluctuations:

Difference between default value and variation cut value:

$\Delta = |\tau_{default} - \tau_{variation}|$

Statistic error on the difference:

$\sigma_{\Delta} = \sqrt{|\sigma^2_{default} - \sigma^2_{variation}|}$

If($\Delta > \sigma_{\Delta}$),systematic err: $\sigma_{sys} = \sqrt{\Delta^2 - \sigma^2_{\Delta}}$

pm	0_80	No.1 Bin	sys_ana_cuts:	0.02343	tracking	0.009764	sys_mass_window	0.004407
pm	0_80	No.2 Bin	sys_ana_cuts:	0.0186	tracking	0.006764	sys_mass_window	0.006264
pm	0_80	No.3 Bin	sys_ana_cuts:	0.01903	tracking	0.007303	sys_mass_window	0.008851
pm	0_80	No.4 Bin	sys_ana_cuts:	0.02022	tracking	0.00687	sys_mass_window	0.009858
pm	0_80	No.5 Bin	sys_ana_cuts:	0.01942	tracking	0.007102	sys_mass_window	0.01122
pm	0_80	No.6 Bin	sys_ana_cuts:	0.02183	tracking	0.007252	sys_mass_window	0.01335
pm	0_80	No.7 Bin	sys_ana_cuts:	0.02161	tracking	0.006487	sys_mass_window	0.0155
pm	0_80	No.8 Bin	sys_ana_cuts:	0.02298	tracking	0.006242	sys_mass_window	0.01719
pm	0_80	No.9 Bin	sys_ana_cuts:	0.02357	tracking	0.006175	sys_mass_window	0.02097
pm	0_80	No.10 Bin	sys_ana_cuts:	0.02583	tracking	0.005694	sys_mass_window	0.02225
pm	0_80	No.11 Bin	sys_ana_cuts:	0.02608	tracking	0.005278	sys_mass_window	0.02517
pm	0_80	No.12 Bin	sys_ana_cuts:	0.02582	tracking	0.004077	sys_mass_window	0.02775
pm	0_80	No.13 Bin	sys_ana_cuts:	0.02561	tracking	0.004681	sys_mass_window	0.02977
pm	0_80	No.14 Bin	sys_ana_cuts:	0.02547	tracking	0.003935	sys_mass_window	0.03011
pm	0_80	No.15 Bin	sys_ana_cuts:	0.0262	tracking	0.004651	sys_mass_window	0.03265
pm	0_80	No.16 Bin	sys_ana_cuts:	0.02449	tracking	0.003914	sys_mass_window	0.03299

p	0_80	input MC	0.001089	total	0.02578
p	0_80	input MC	0.0006222	total	0.02077
p	0_80	input MC	0.0004114	total	0.02222
p	0_80	input MC	0.0002996	total	0.02352
p	0_80	input MC	0.0002388	total	0.02353
p	0_80	input MC	0.0001687	total	0.02659
p	0_80	input MC	0.0001101	total	0.02738
p	0_80	input MC	0.0001077	total	0.02937
p	0_80	input MC	2.318e-05	total	0.03214
p	0_80	input MC	8.301e-06	total	0.03456
p	0_80	input MC	6.377e-05	total	0.03663
p	0_80	input MC	7.319e-05	total	0.03812
p	0_80	input MC	6.94e-05	total	0.03955
p	0_80	input MC	0.0001435	total	0.03964
p	0_80	input MC	0.000198	total	0.04212
p	0_80	input MC	0.0001559	total	0.04127