

Recent progress of χ_c analysis

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Overview

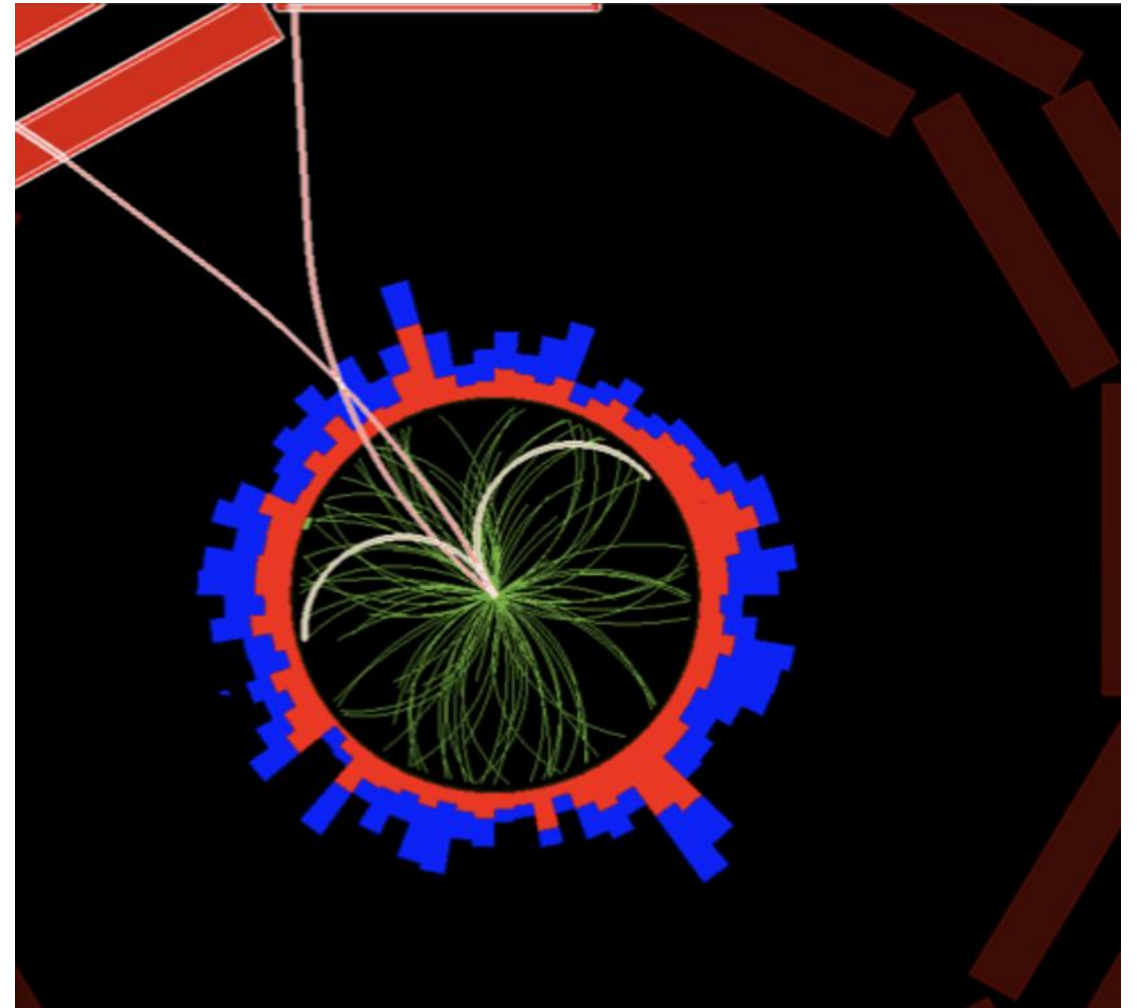
Status : Pre-approval

$\chi_c \rightarrow J/\psi + \gamma \rightarrow \mu^+ \mu^- + e^+ e^-$ (conversion)

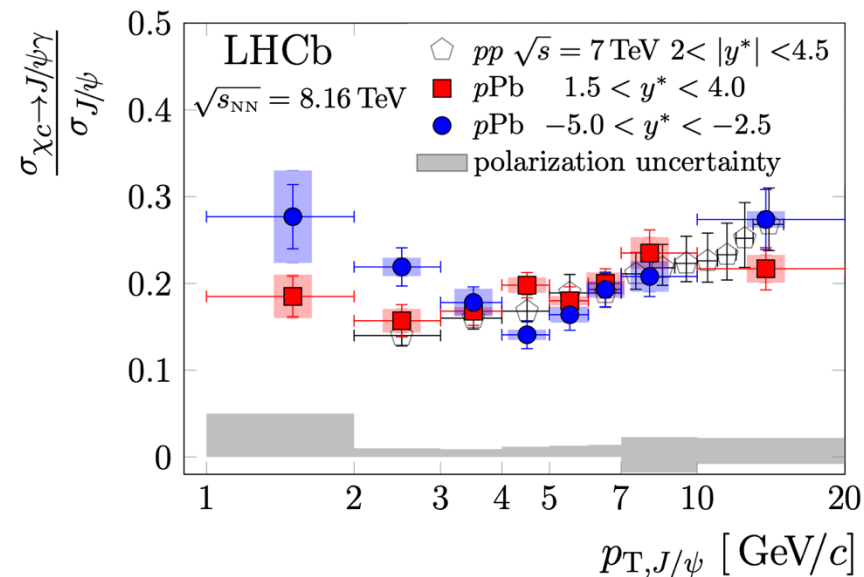
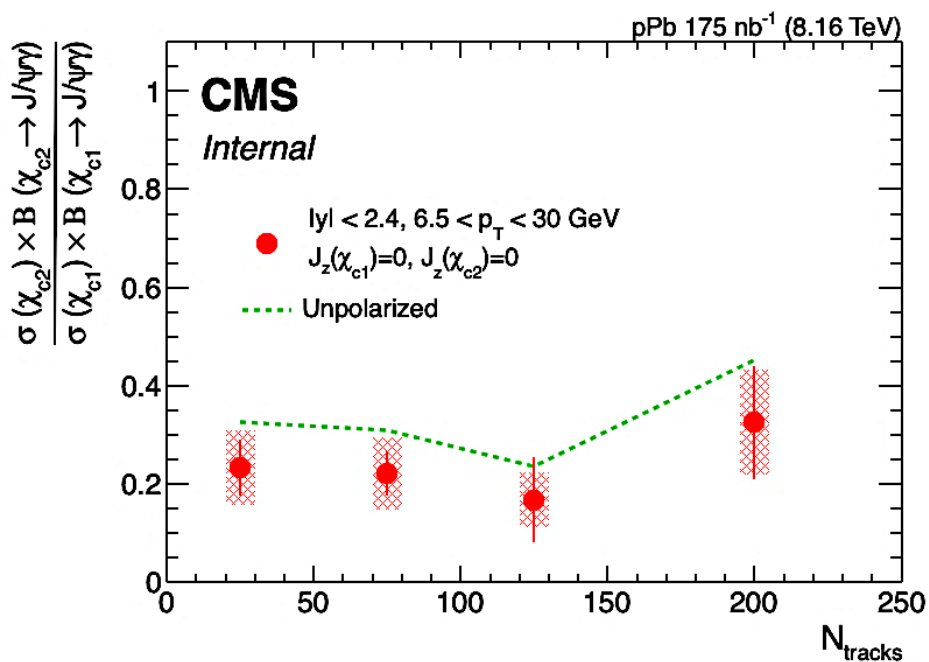
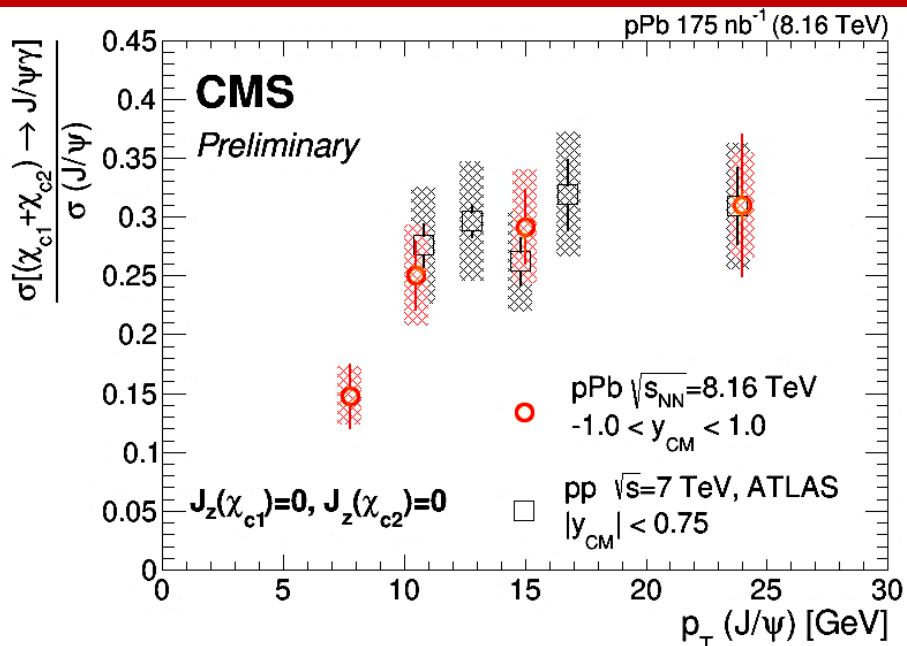
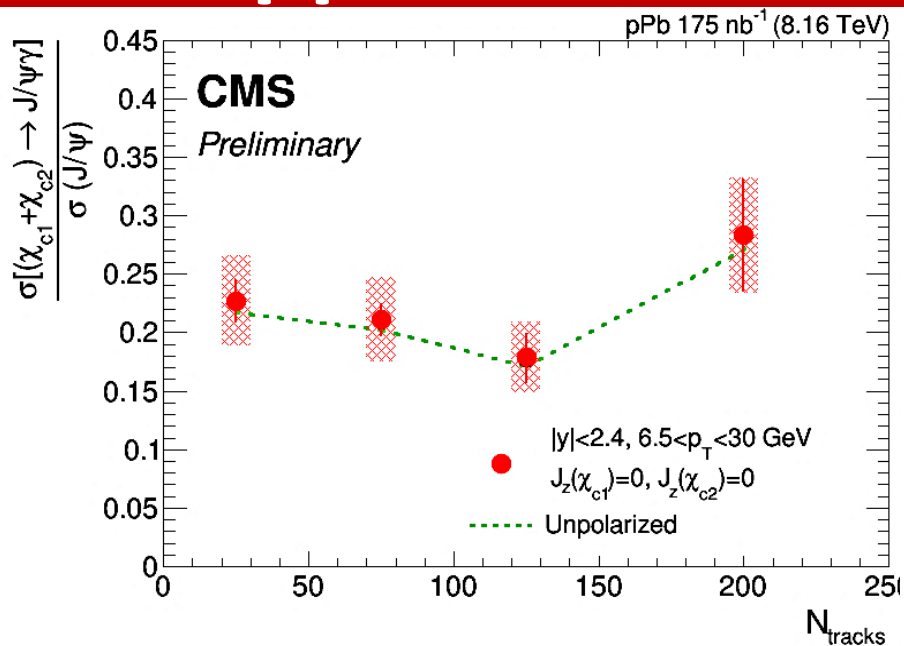
pPb 8.16 TeV

$|\eta| < 2.4$

$\chi_c / J/\psi$ and χ_{c2} / χ_{c1}



Pre-approval results

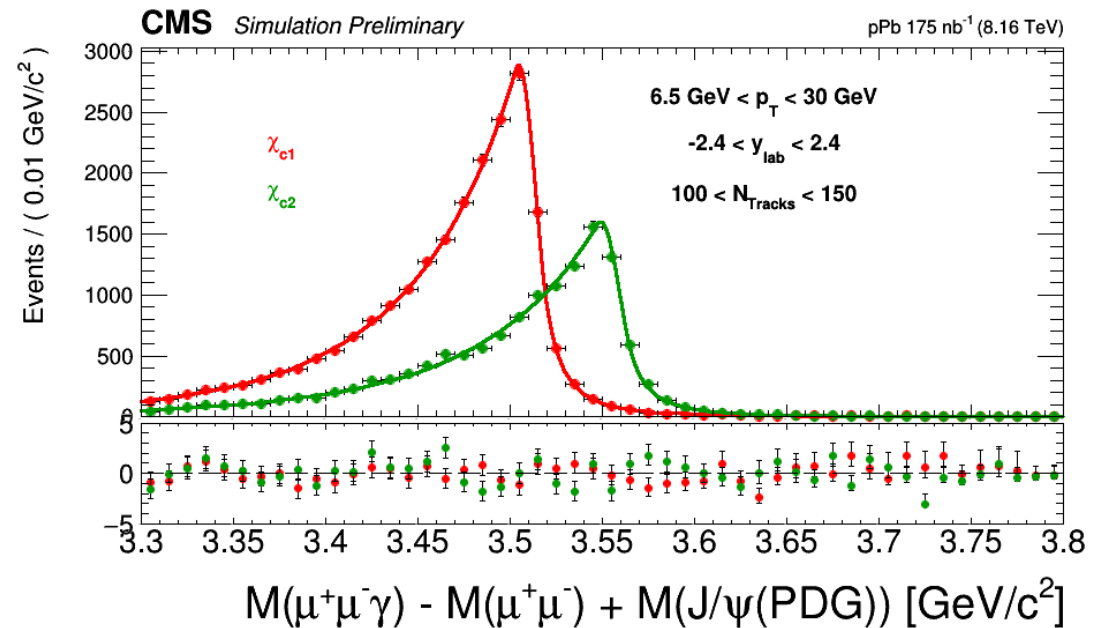
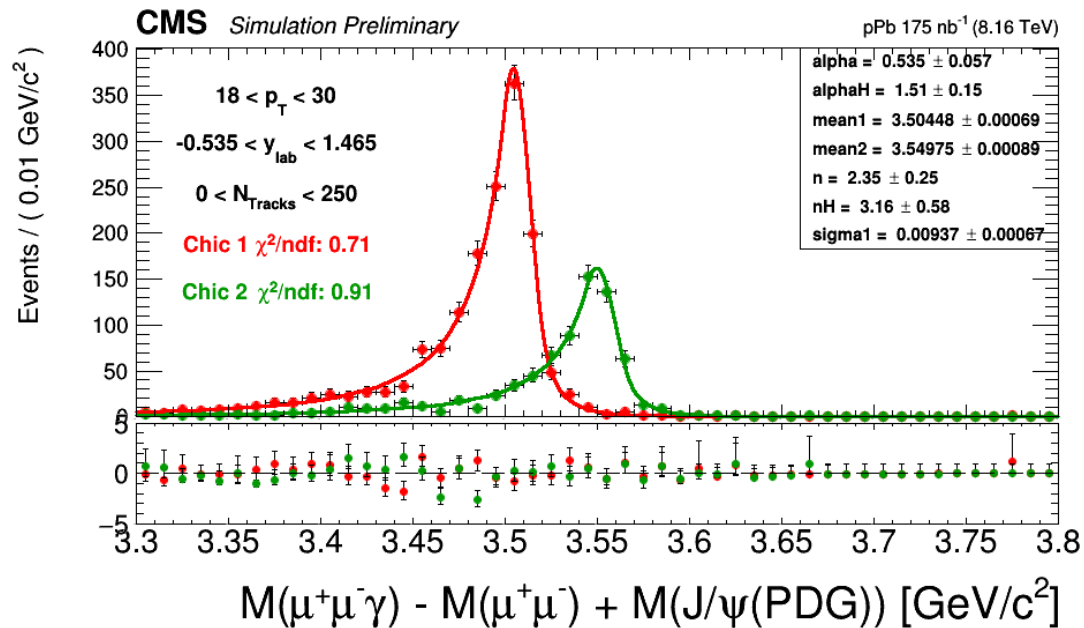
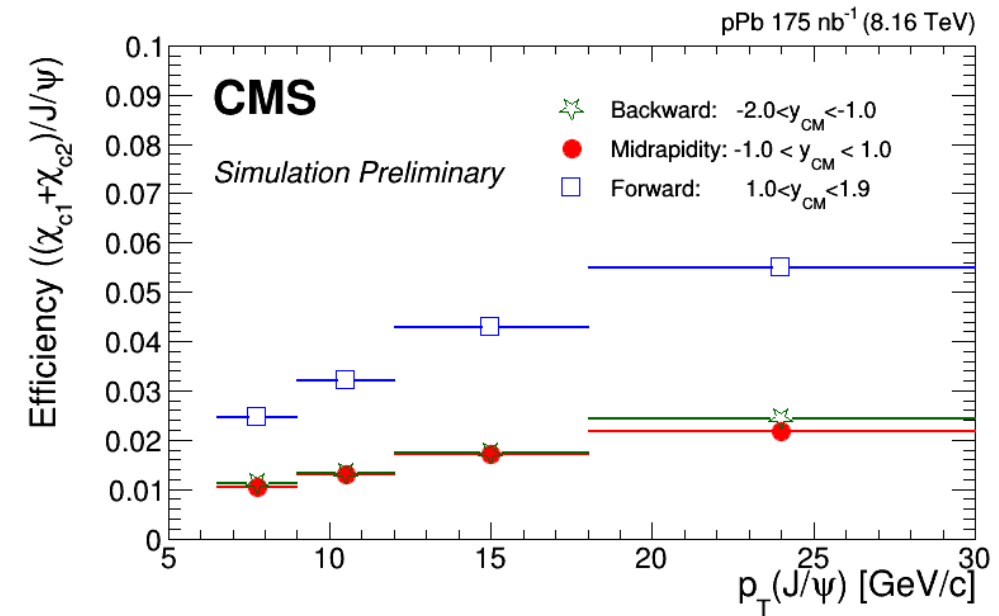


Pre-approval results

- Consist with pp results
- Consist with no dissociation of χ_c states
- Consist with LHCb results.

Reported Simulation performance plot

- Invariant mass fit plot for showing the detector performance
- Efficiency plot for showing the conversion efficiency in pPb collisions

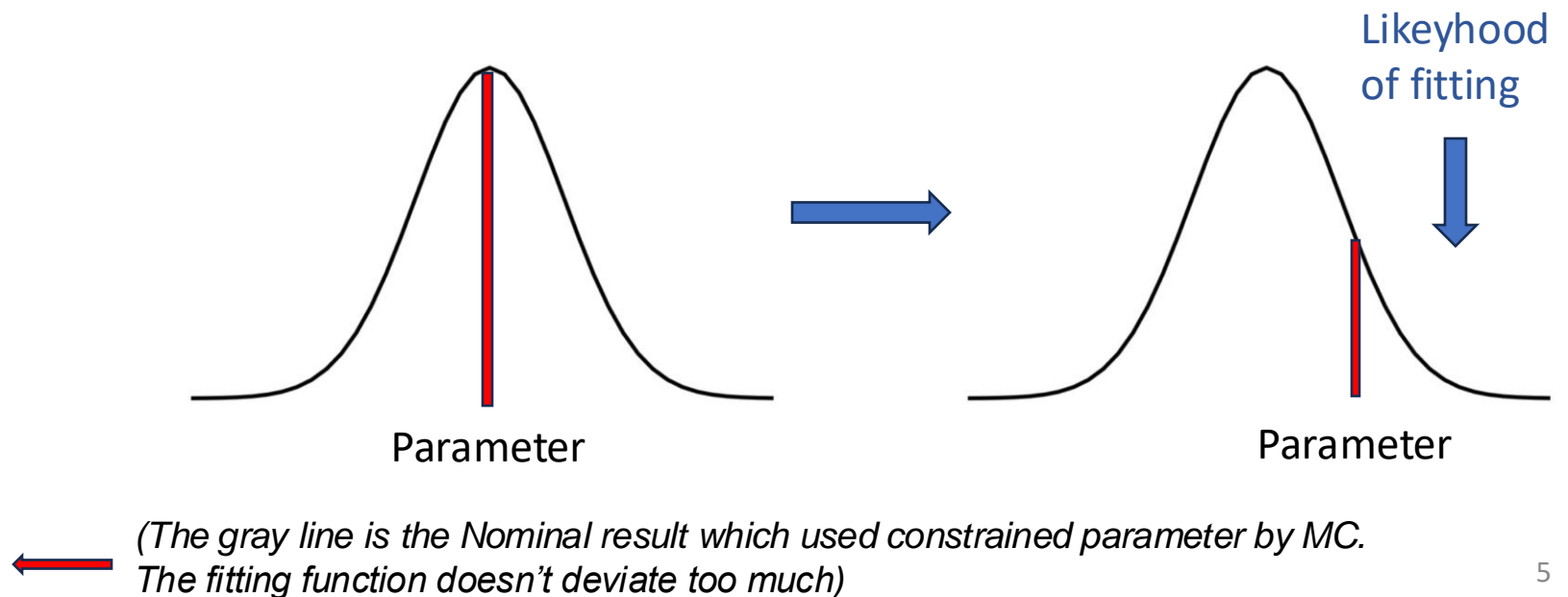
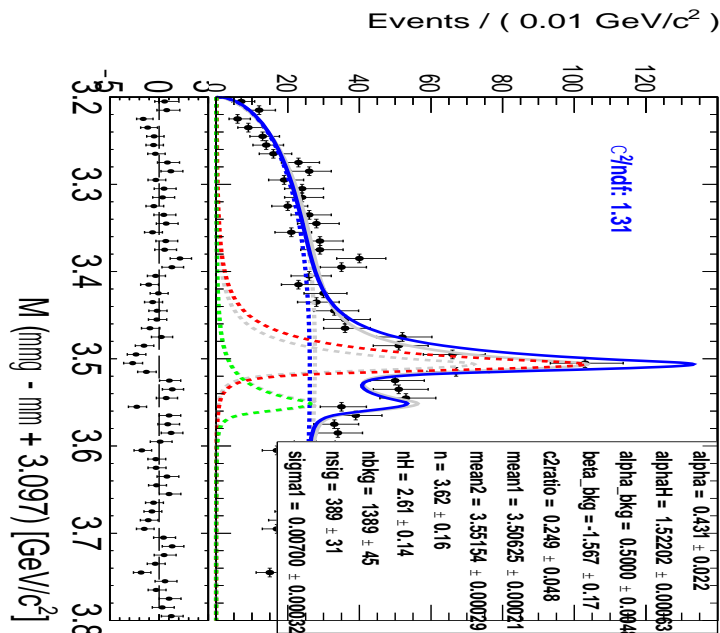


Pre-approval homework

- **Applied Gaussian constraint for χ_c fitting uncertainty
(Replaced previous alternative fitting function method)**
- **Using the π_0 TnP data-driven method for calculate the conversion efficiency.**
- **Added the uncertainty from non-prompt contamination**
- **The fitting algorithm test with pseudo-experiments**

Gaussian constraint- χ_c Fitting

- Applied Gaussian constraint to all parameters which is constrained before.
- By applying Gaussian weights to each parameter, if the parameter deviates too much from the mean value, the likelihood of fitting is reduced.
-> The parameter does not deviate significantly from the range and is adjusted while being corrected by the given Gaussian function.
- The mean and sigma value of the Gaussian function for the parameter is based on a MC constrained value and its uncertainty.

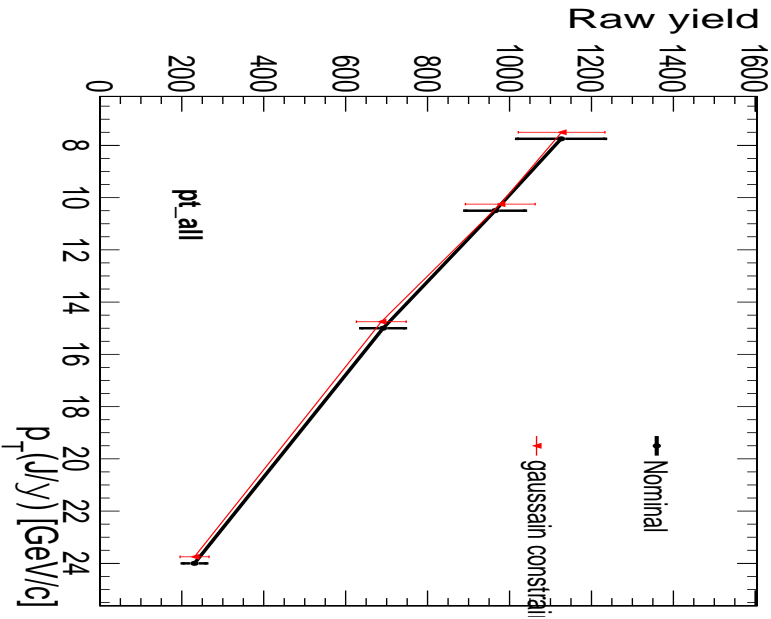
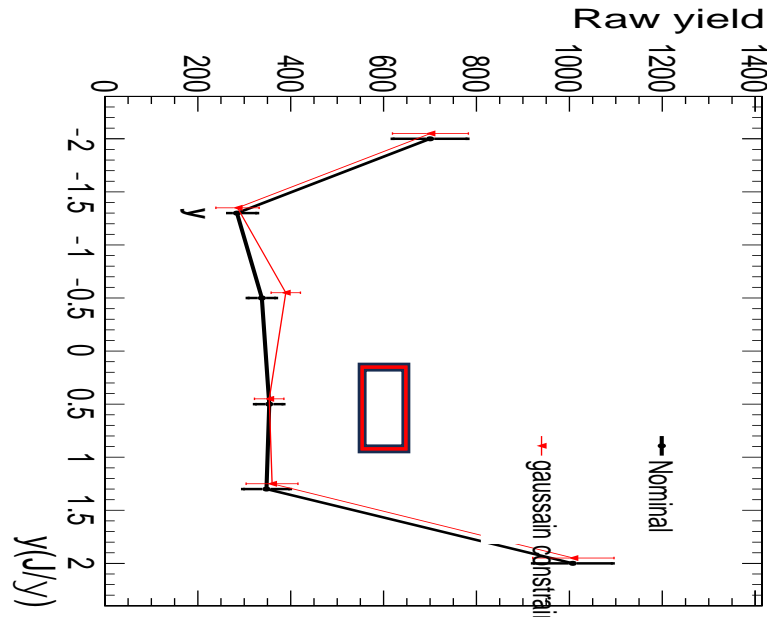
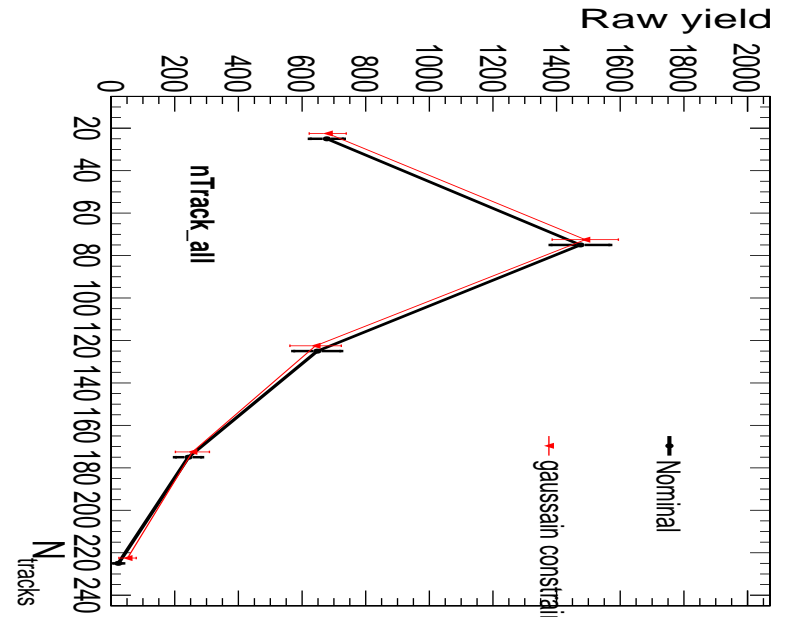
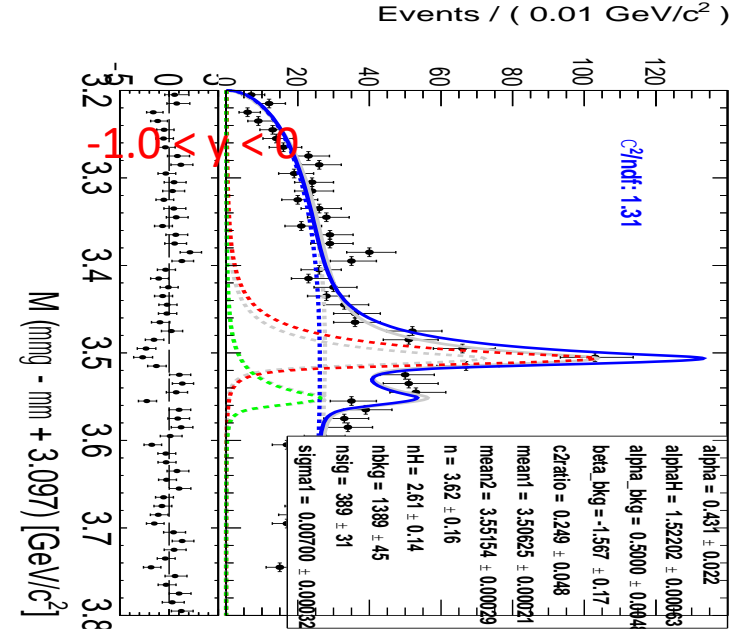


Gaussian constraint- χ_c Fitting

Overall there's not much deviation for each bin

- Some bin shows relatively large deviation compared to others but the fitting seems reasonable

- Calculate Uncertainties with $\epsilon = \frac{N_{Gaussian} - N_{Nominal}}{N_{Nominal}}$



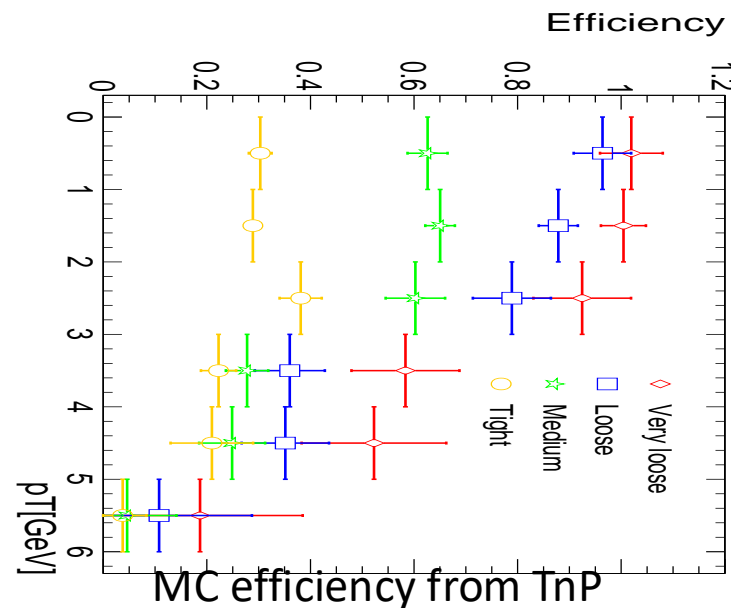
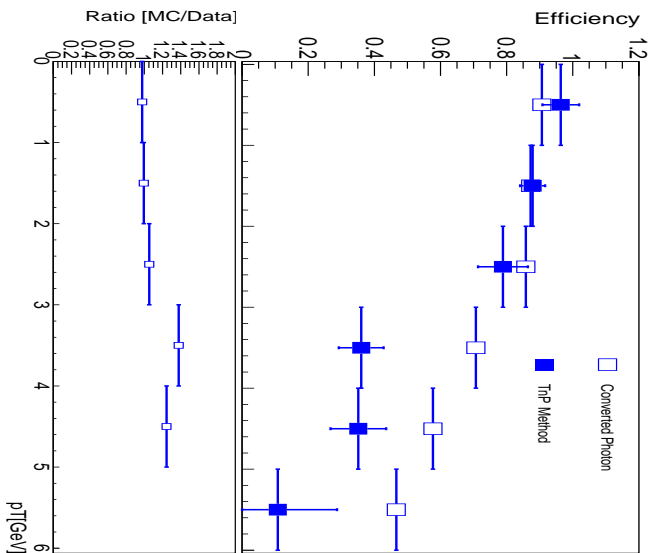
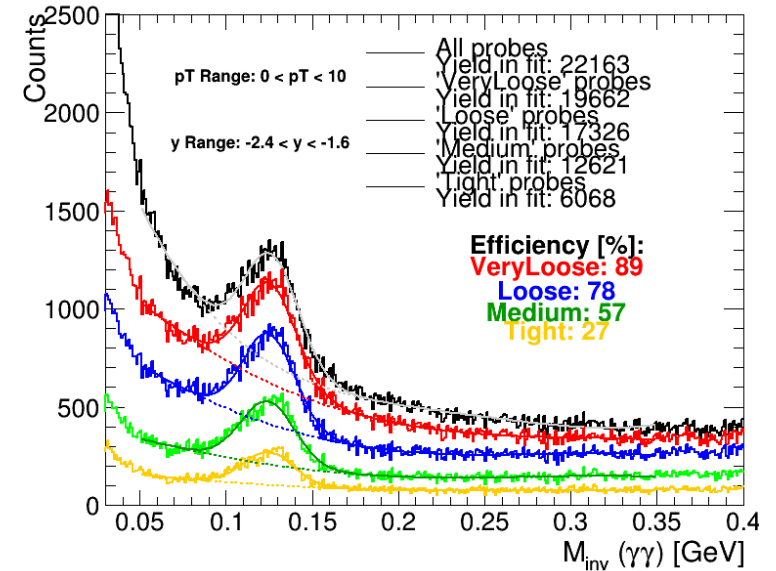
π_0 TnP data-driven method

Using the TnP data-driven method, we can assess the conversion efficiency directly from π_0 candidates. ($\pi_0 \rightarrow \gamma\gamma$)

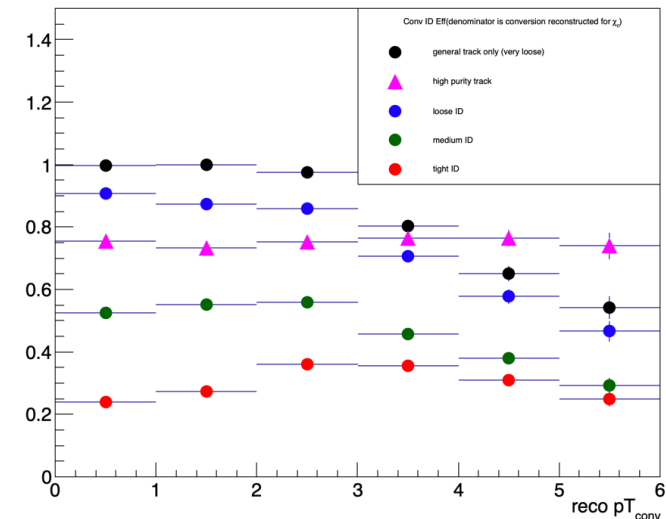
Calculate the π_0 conversion efficiency for both MC and Data

Verify MC conversions directly from χ_c to crosscheck the results.

->The trends are quite similar at low pT. Since there are not much candidates at high pT, we consider this discrepancy to be negligible.



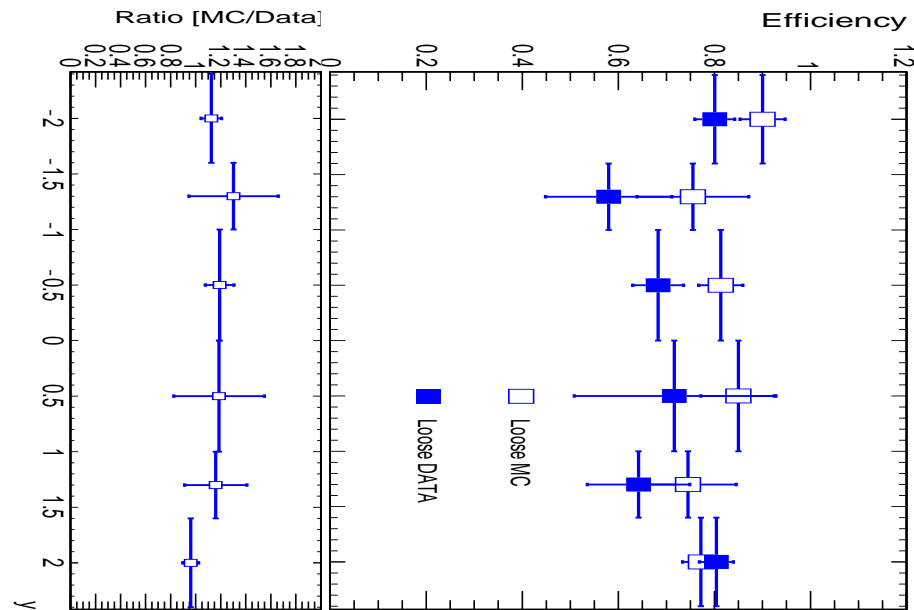
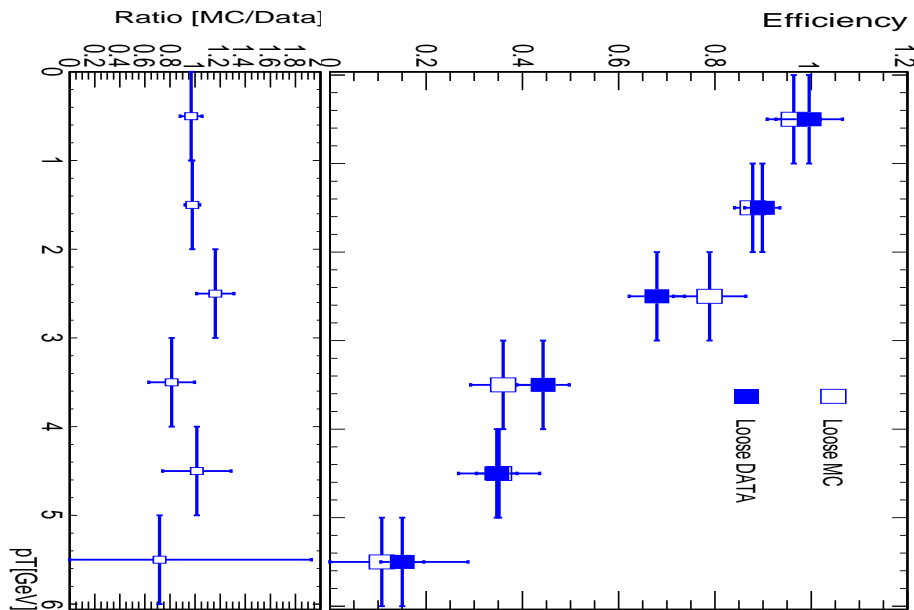
Converted photon ID efficiency



Comparison of data vs MC

Given the strong correlation at low pT (low candidate), and the relatively minor ratio deviations across each rapidity bin

we conclude that deriving uncertainty through integrated bins (as the difference between MC and data)
-> 5 % uncertainty will be added as the difference between MC and data.



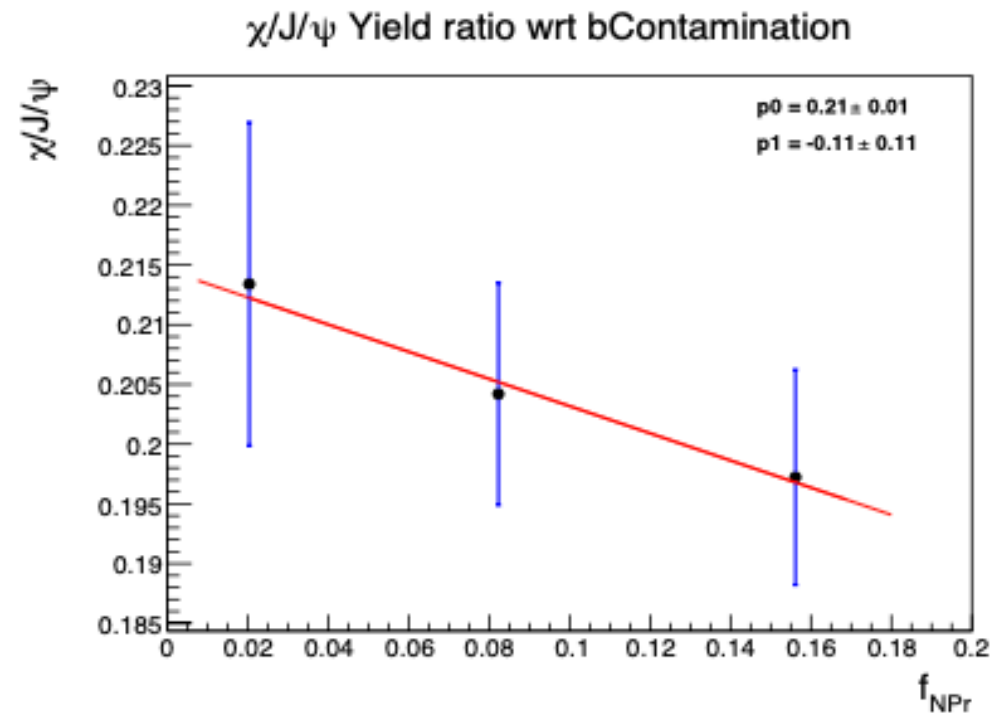
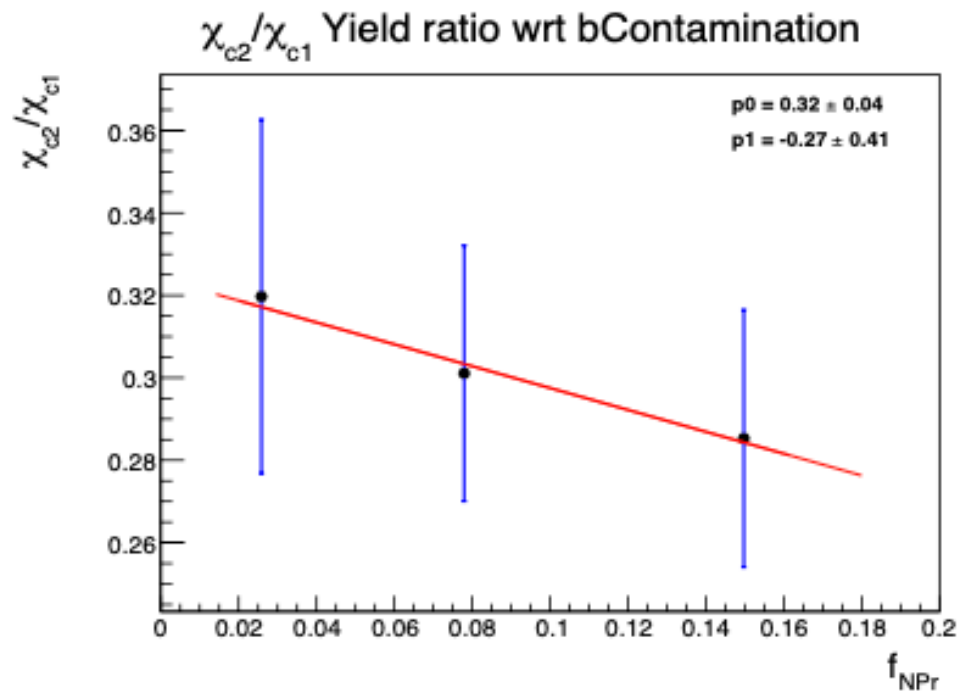
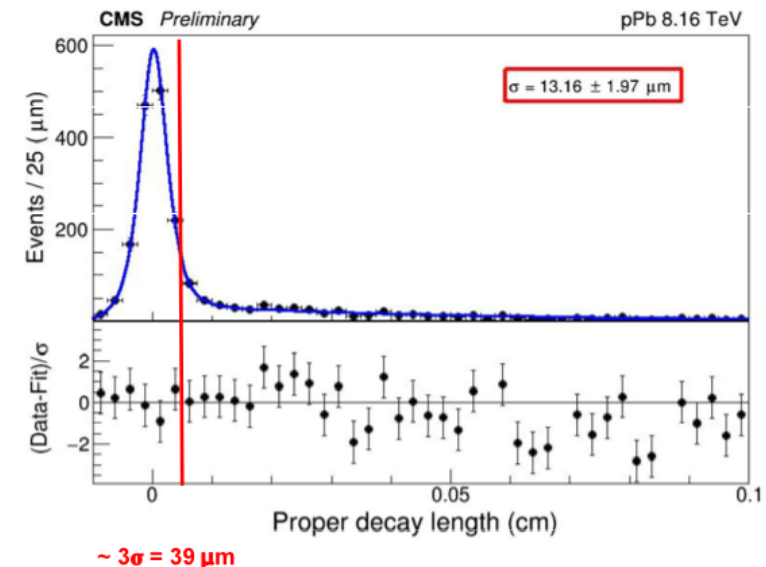
Non-prompt contamination

Previously, non-prompt rejection was based on a decay length cut determined from MC

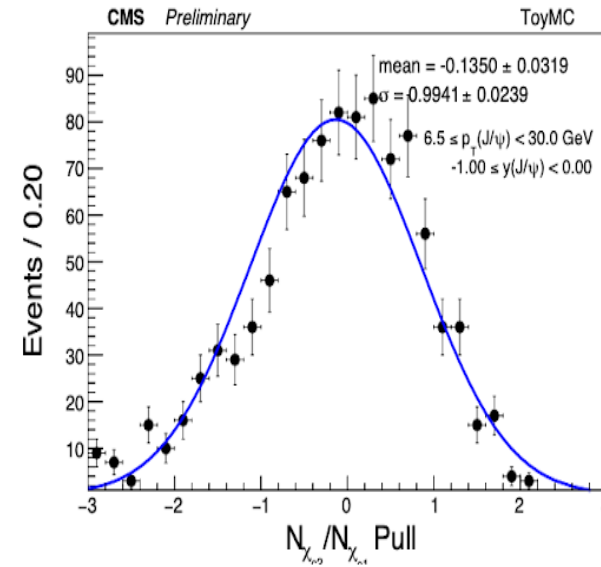
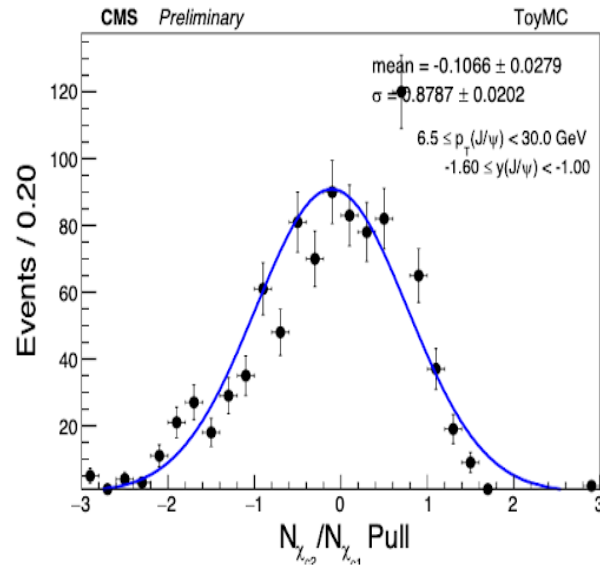
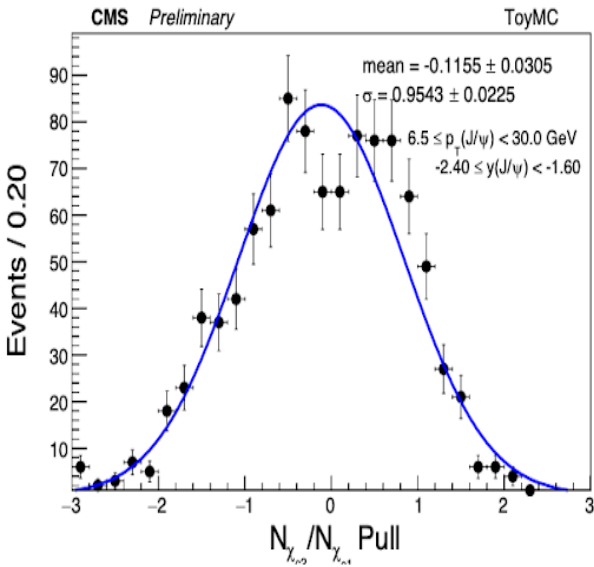
To more accurately assess the impact of non-prompt contamination,

we varied the decay length cut and find the point where contamination is 0

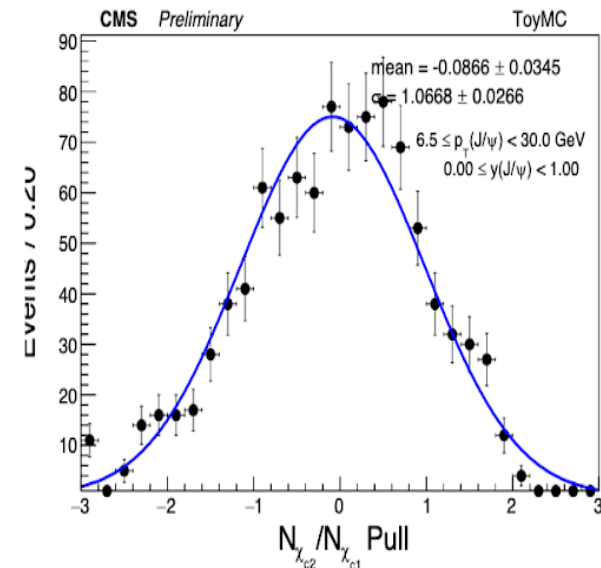
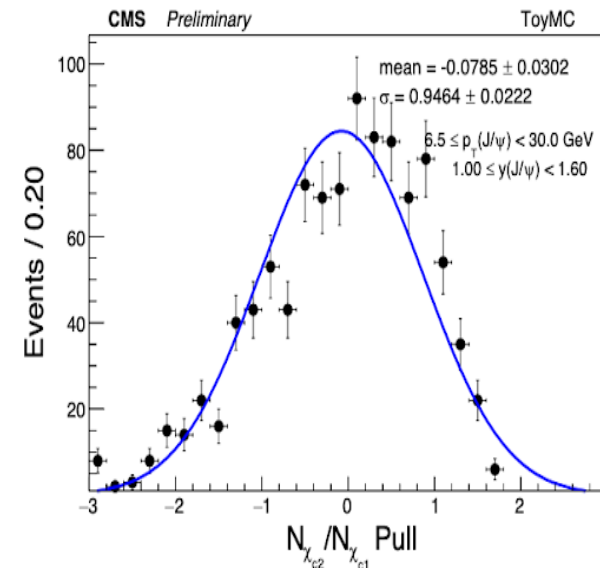
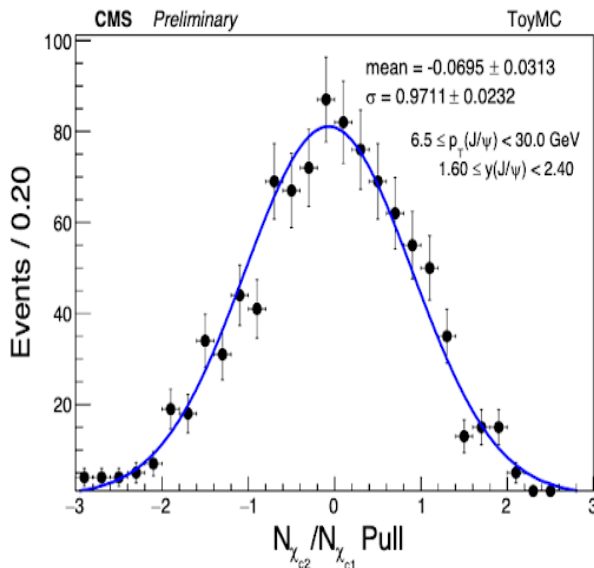
$\chi_c / J/\psi : 5\%$ $\chi_{c2} / \chi_{c1} : 8\%$



Fitting algorithm test with pseudo-experiments



Tested fitting algorithm by generating pseudo-data randomly according to the likelihood



This study allows to calculate a possible statistic bias due to the fitting algorithm.

Summary and To-Do list

- **Most questions from the pre-approval and first ARC meeting comments have been addressed**
- **The pre-approval homework is largely complete, though the ARC has provided some feedback**
- **Most of the remaining comments pertain to the polarization components**
- **The goal is to get approval before the HI run in October**