Photon Conversion Method for ALICE 3. χ_C reconstruction.

A. Marin [1], A. Uras [2]

[1]GSI, Darmstadt, Germany , [2]Centre National de la Recherche Scientifique, Lyon, France

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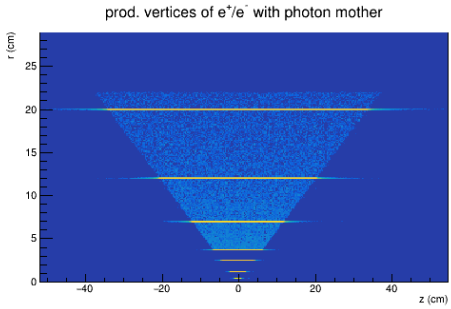
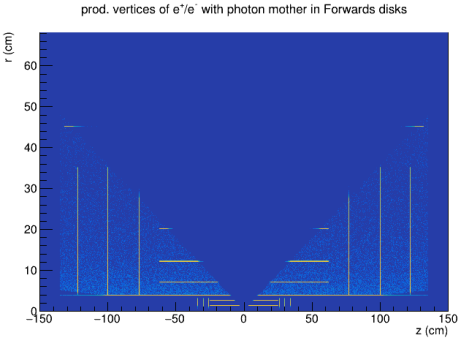
Simulation and reconstruction settings

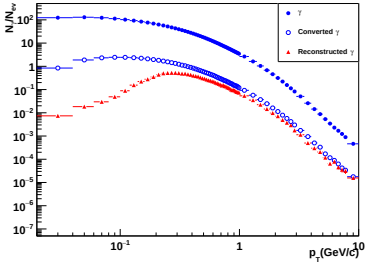
- Full simulations of pp $\sqrt{s} = 14$ TeV using PYTHIA 8.2 in local HD cluster (2.2×10^6events generated)
- Analysis using MC information:
  Central: $|\eta|$ <1.3 ($p_{\mathrm{T}} > 0.1$ GeV/c)
  Forward: 1.75< $|\eta| < 4$ (p > 0.1 GeV/c)
- Conversion vertices: (5 layers for reconstruction)
  Central: maxR = 22 cm
  Forward: -135 < Z < 135 cm

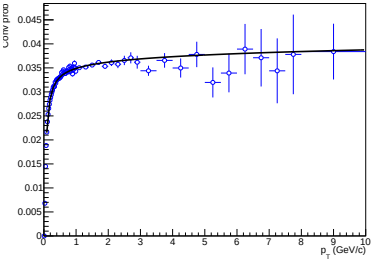
Photon Conversion vertices

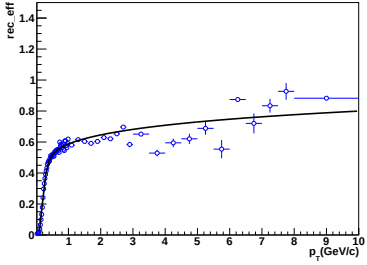


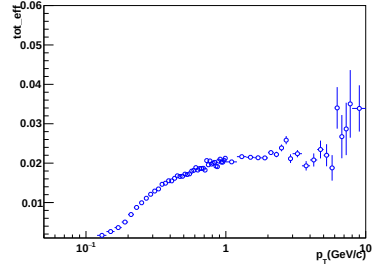


Central Barrel: γ reconstruction

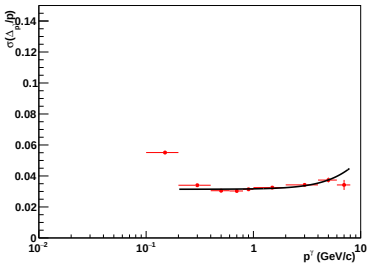




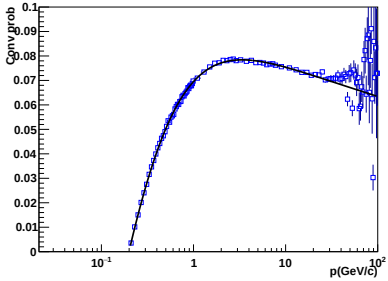




Central Barrel: γ resolution

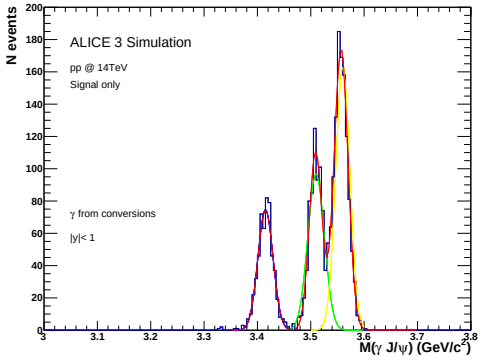


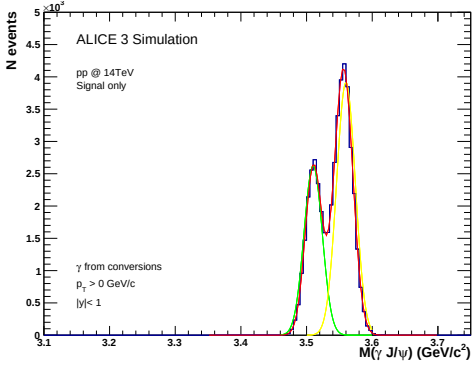
Forward Barrel: γ reconstruction



Central Barrel: $\chi_C \rightarrow J/\psi + \gamma$

Delphes Simulation





Delphes simulations used

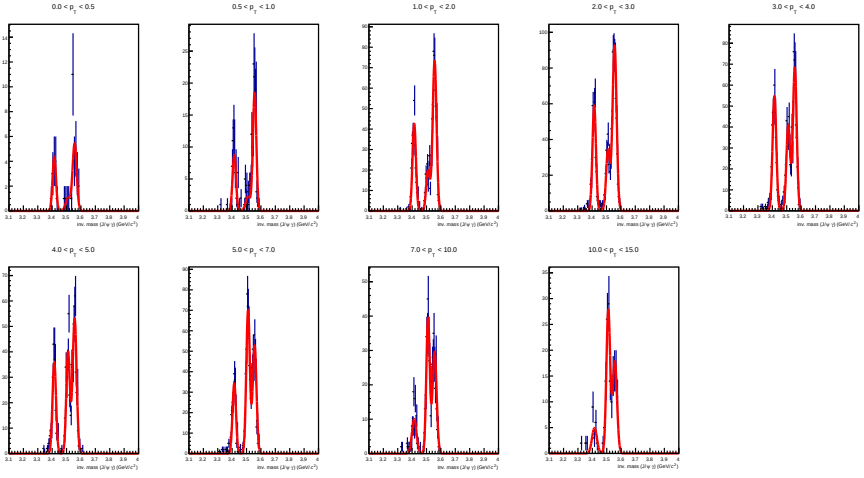
For signal :

- $/data2/amarin/productions/ECAL+PCM/delphes/pp\_onia\_X\_2022\_01\_18\_full/$
  $/home/amarin/alice/Run3Analysisvalidation/codeHF/AnalysisResults\_O2\_PCM\_config21\_Chic1\_Chic2.root$
- $/data2/amarin/productions/ECAL+PCM/delphes/pp\_onia\_X\_2022\_01\_23\_full/$
  $/home/amarin/alice/Run3Analysisvalidation/codeHF/AnalysisResults\_O2\_PCM\_config22\_Chic1\_Chic2.root$

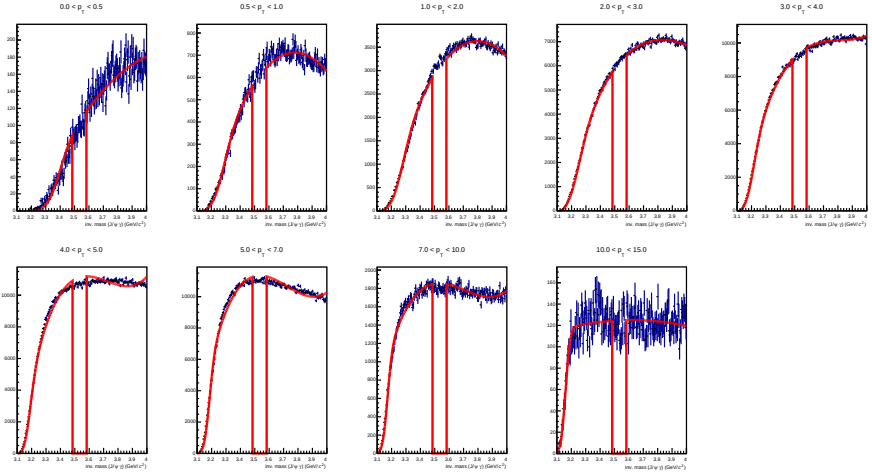
For background:

- PbPb
  $/home/mmazzill/PbPb\_100K\_inel\_2T\_rmin100\_11102021$
  $/home/amarin/alice/Run3Analysisvalidation/codeHF/AnalysisResults\_O2\_input\_config16.root$
- pp
  $/home/mmazzill/pp14TeV\_inel\_20M\_2T\_rmin100\_geometry\_v1\_11102021$
  $/home/amarin/alice/Run3Analysisvalidation/codeHF/AnalysisResults\_O2\_input\_config17.root$

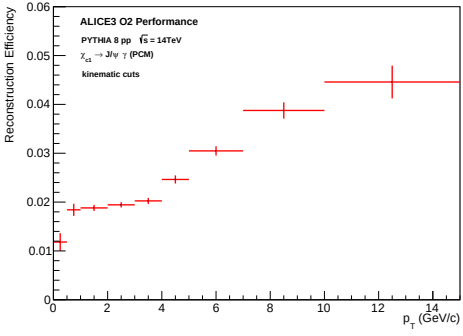
PCM: Signal estimation

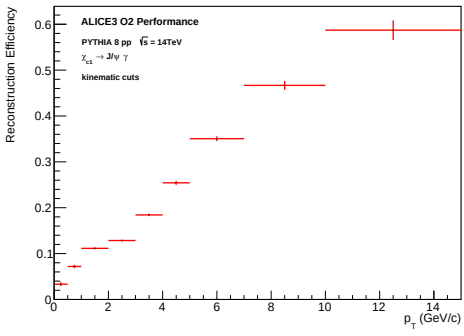


PCM: Background estimation

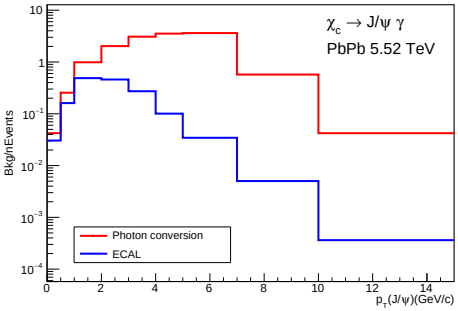


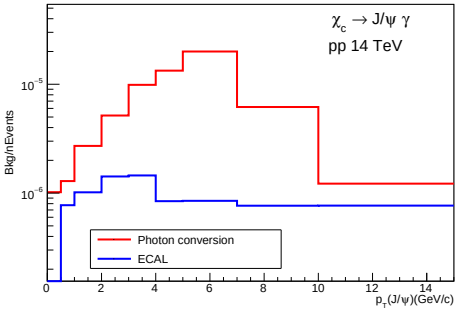
Reconstruction efficiency: PCM and ECAL



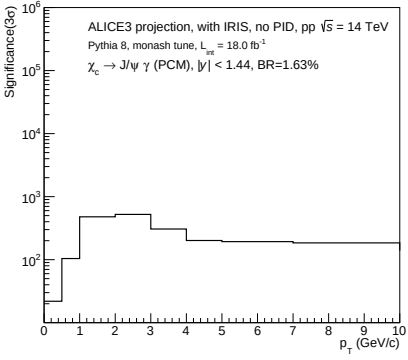


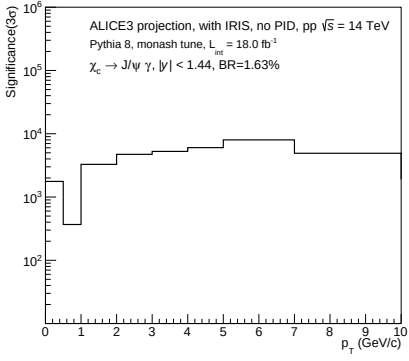
Background per event: PCM and ECAL





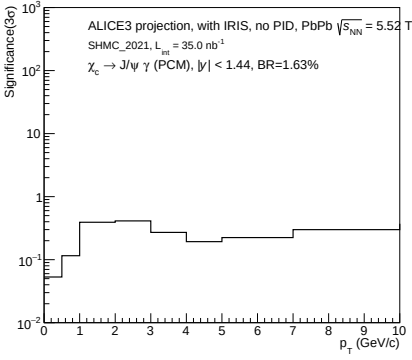
Significance in pp: PCM and ECAL

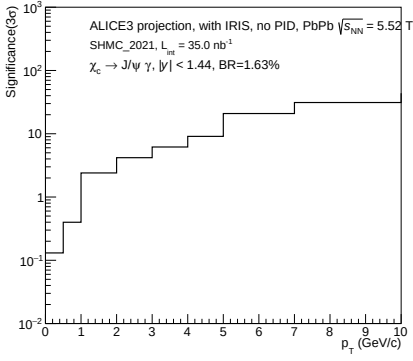




Significance calculated as sum of χ_{C1} and χ_{C2}
Combination of ECAL and PCM measurements will improve the significance

Significance in PbPb: PCM and ECAL

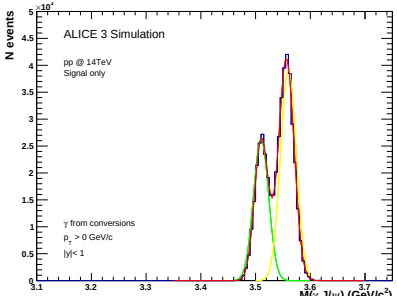




Significance calculated as sum of χ_{C1} and χ_{C2}

Proposed additions to the LOI

569 .... These states could also
570 be separated by reconstructing the photons through their conversion in the material, benefiting
571 from the good momentum resolution for charged particles.
Indeed, an initial simulation effort, described in Fig **??**... in section 'performance', demonstrates very good resolution in the measurement with the conversion method of the χ_c states as produced in pp collisions.



Place figure in section 3.2.2.2

Proposed additions to the LOI

Section 3.3.2.2 χ_c and χ_b states
2519 As discussed in Section 2.2.1, a comprehensive study of charmonium states in heavy-ion colli-
2520 sions should include a characterization of P-wave states such as χ_c and χ_b. With ALICE 3, this
2521 can be achieved by reconstructing decays in the χ_cJ $\rightarrow$J/ψ + γ decay channel using the muon
2522 identifier to reconstruct J/ψ and the electromagnetic calorimeter to detect decay photons (see
Section 4.5.1) or the photon conversion method (see Fig. **??**).
2524 The reconstruction of the χ_c candidates starts with the reconstruction of the J/ψ candidates fol
2525 lowing the strategy discussed in Section 3.3.2.1. Each selected J/ψ candidate is then combined
2526 with the available photons detected in the same event. In order to select a clean sample of χ_c
2527 candidates and to reduce the combinatorial background, the cuts reported for the J/ψ analysis
2528 are applied, combined with a 2σ cut on the invariant mass of the J/ψ candidate and a lower cut
2529 on the photon energy Eγ > 400 MeV in case of the ECAL. Figure 47 shows the significance of the χ_c measurement
2530 (sum of the χ_{c1} and χ_{c2} signals) corresponding to the currently implemented kinematic cuts, as a
2531 function of transverse momentum in pp collisions at $\sqrt{s}$ = 14 TeV (Lint = 18fb^{-1}) and in Pb-Pb
2532 collisions at $\sqrt{s_{NN}}$= 5:5 TeV (Lint = 35nb^{-1}) for the ECAL and PCM methods. A dedicated optimization of the cuts is currently
2533 undergoing, involving machine learning techniques based on boosted decision trees.
Special runs with a converter may be needed to increase the significance for the PCM measurements in HIC.

Create a Figure 47, where the significance of both methods (ECAL and PCM) is shown simultaneously