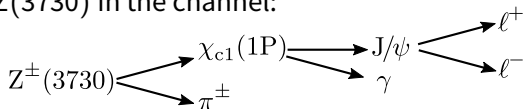


Simulation of $X(3872) \rightarrow Z^{\pm}(3730)\pi^{\mp}$ Transitions

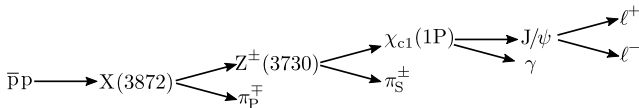
Status Update

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- Strong theoretical motivations for (still unobserved) transitions between X and Z exotic states
- PANDA's high production rate can enable searches for rare processes involving $X(3872)$
- Main idea: study $X(3872) \rightarrow Z$ transitions using data from the $X(3872)$ mass scan run
 - Synergetic analysis, without dedicated run
- Study discovery potential of $X(3872)$ decays to charged $Z(3730)$ in the channel:



- Channel with J/ψ : $\sim 10^4$ background suppression
- Complement search for neutral $Z(3730)$
- Test performance of $\chi_{c1}(1P)$ reconstruction



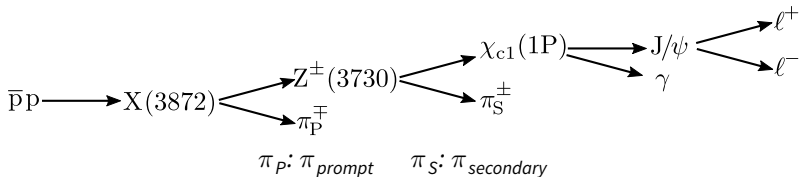
$$\mathcal{B} = \mathcal{B}(X \rightarrow Z\pi) \times \mathcal{B}(Z \rightarrow \chi_{c1}\pi) \times \mathcal{B}(\chi_{c1} \rightarrow J/\psi\gamma) \times \mathcal{B}(J/\psi \rightarrow l^+l^-)$$

- $\mathcal{B}(\chi_{c1} \rightarrow J/\psi\gamma) = (33.9 \pm 1.2)\%$ (PDG)
- $\mathcal{B}(J/\psi \rightarrow l^+l^-) = 11.52\%$ (PDG)
- $\mathcal{B}(X \rightarrow Z\pi) \times \mathcal{B}(Z \rightarrow \chi_{c1}\pi) = \mathcal{B}_{\text{unknown}}$

⇒ Perform analysis

⇒ Calculate minimum $\mathcal{B}_{\text{unknown}}$ for which we can get $\{3, 5\}\sigma$ during $X(3872)$ data-taking period

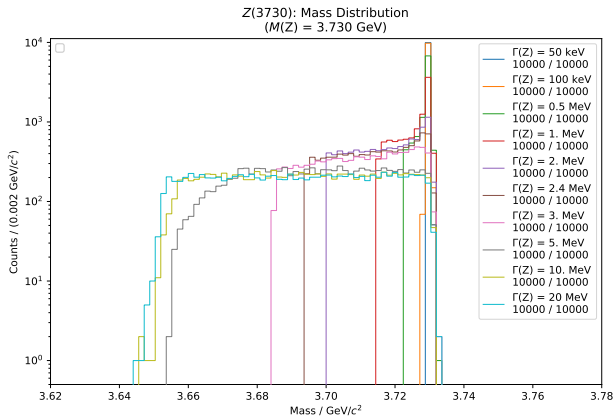
- Study the effect of varying $\Gamma_{Z(3730)}$
- First look at common DPM3872 background sample
- Updated PandaRoot version to release feb17
- Updated analysis macro \rightarrow analysis task
- Improved infrastructure for programmatic parametric studies



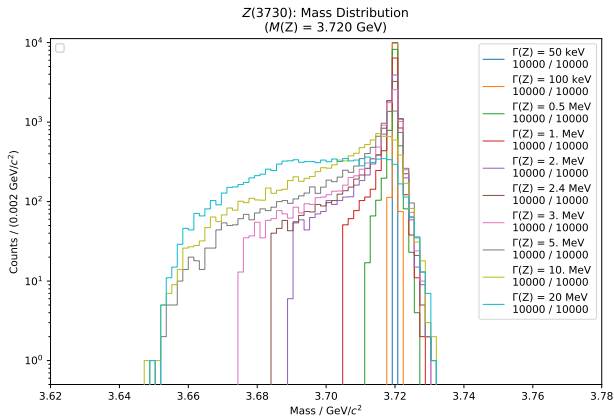
- $p_{\text{beam}} = 6.991 \text{ GeV}/c$ ($X(3872)$ threshold)
- All decays PHSP
- All BR 1.0 (scale result)
- Independent leptonic branches ($\ell = e, \mu$) studied in parallel
- Narrow $Z^\pm(3730)$ model in EvtGen ($\Gamma = 50 \text{ keV}$)
 - No strong indications from theory for a particular value of $\Gamma_{Z(3730)}$
 - \Rightarrow Perform analysis studying effects of varying Γ

- Generator-level analysis (EvtGen standalone)
 - Vary $\Gamma_{Z(3730)}$ in broad interval 50 keV–20 MeV
 - Repeat for $M_{Z(3730)} = 3.720$ GeV as a consistency check
- ⇒ Distributions of $\chi_{c1}(1P)$, J/ψ largely unaffected
- ⇒ Lower priority of repeating this study using full detector simulations

Variation of $Z(3730)$ width, $M_{Z(3730)} = 3.730$



Variation of $Z(3730)$ width, $M_{Z(3730)} = 3.720$



- Location: /lustre/nyx/panda/pbuehler/production/productions/day1/DPM3872 (Kronos/Nyx)
- Total size: 250M events (after filter), 25 TB
- Structure:
 - Sample: subdivided into 530 runs
 - Each run: subdivided in ~ 200 splits
 - Each split: 2000 events in single rootfile
 - `${SAMPLE}/output/run<runid>/<splitid>/<sampleid>_<filetype>_<runid>_<splitid>.root`
- Parameters:
 - Simulation engine: run 1-10: TGeant3, run 11-530: TGeant4
 - Versions: FairSoft may16_root5, FairRoot v-16.06b_fairsoft-may16_root5, PandaRoot feb17

(Info from `${SAMPLE}/README`)

- Individual files
 - Works as expected
- Start analyzing a few runs
 - Explore quality, features
 - Geant3/Geant4
 - Any specific studies to perform? Comparison with existing studies?
- If checks are OK, proceed on larger subsample
 - Prototyping for:
 - Signal/background optimization
 - Preliminary sensitivity estimates
- Use full sample for complete analysis

- Signal studies in progress
- Background studies in progress
 - Initial checks of DPM3872 sample

Next steps:

- Sensitivity estimation
- Optimization of basic cuts with background
- Study of observables for best sensitivity

BACKUP

- Motivation and physics case
 - Internal note [IN-PRP-2015-004](#)
 - Proceedings from HADRON2015: [Link](#)
 - Sören's talk at CM Uppsala: [Slides](#)
- Previous talks

- PandaRoot version: release feb17
- 4 particles in the final state
 - ℓ^+, ℓ^- from J/ψ
 - γ from $\chi_{c1}(1P)$
 - π_S from $Z(3730)$
 - Not included in reconstruction: π_P from $X(3872)$
- PID criteria
 - Best PID
 - `pidSel = "PidAlgoIdeal{Charged}"`