

$J/\psi \rightarrow \mu^+\mu^-$ for detector calibration

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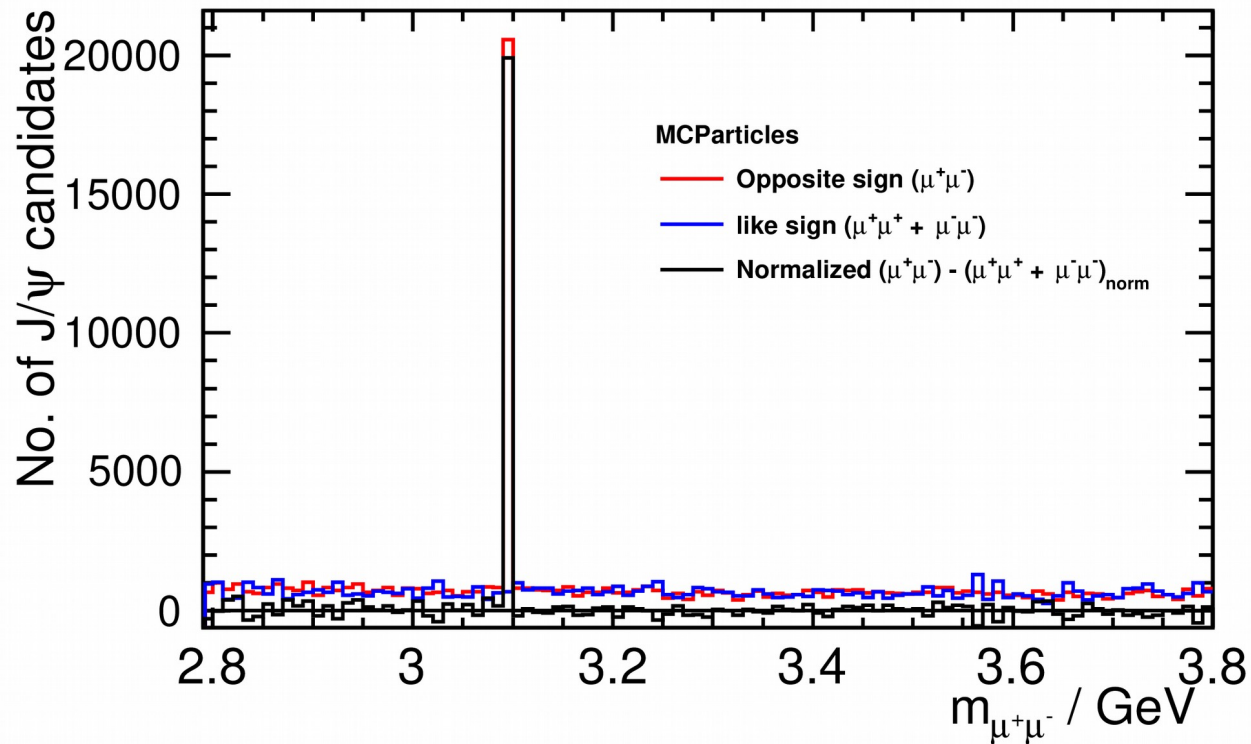
Introduction

- **$J/\psi \rightarrow \mu^+\mu^-$ can be used for Detector calibration**
- **Goals:**
 - **Show J/ψ peak for ILD_I5/s5 in IDR**
 - **Find the number of J/ψ 's**
- **Analysis:**
 - **Software version: ilcsoft-v02-00-02**
 - **Detector Models: ILD_I5_v2 / ILD_s5_v2**
 - **Full ILD Simulation at $E_{cm}=500$ GeV, $P(\pm 80\%, \pm 30\%), (++, +-, -+, --)$, $L_{int}=4ab^{-1}$**
 - **2f/4f-hadronic/semileptonic and 6f physics processes (totally 12m events)**
 - **MCParticles and PandoraPFOs collections**

J/ψ's in generator level

- Find $\mu^+\mu^-$ pairs in generator level (for each physics process):
 - Find first muon in the MCParticles collection (getPDG)
 - Look for the second muon
 - Check both muons to be different MCParticle (avoid double counting using id number)
 - Separate opposite-sign and like-sign pairs (according to PDGCode)
 - Form 4-momentum of muon pair combination in each class (opposite-sign / like-sign) and fill histograms by Inv. Mass.
 - Weight histograms for all 4 helicity configurations
 - Subtract opposite-sign by normalized like-sign to remove background
- Add up normalized histograms of all physics processes

Number of J/ψ 's in generator level



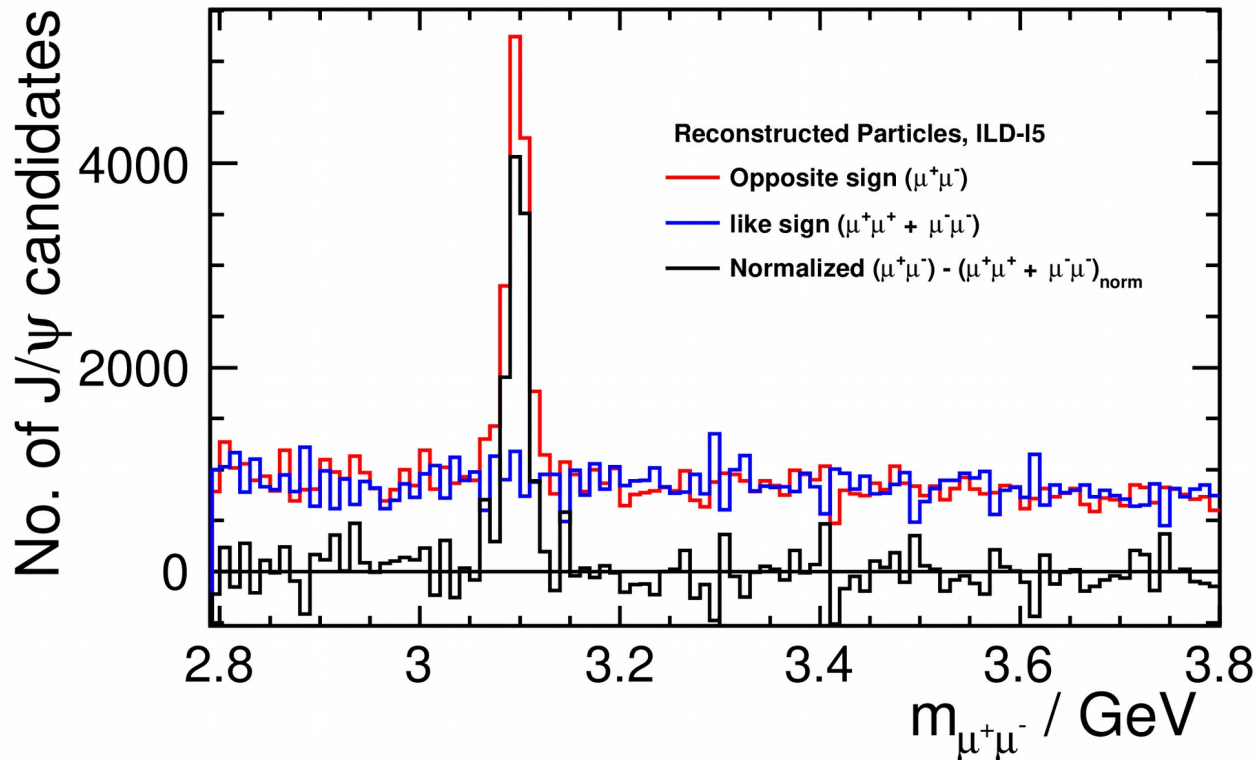
Number of events: 12m

Total number of 19909 J/ψ 's are in MCParticles

J/ψ's in PFO level

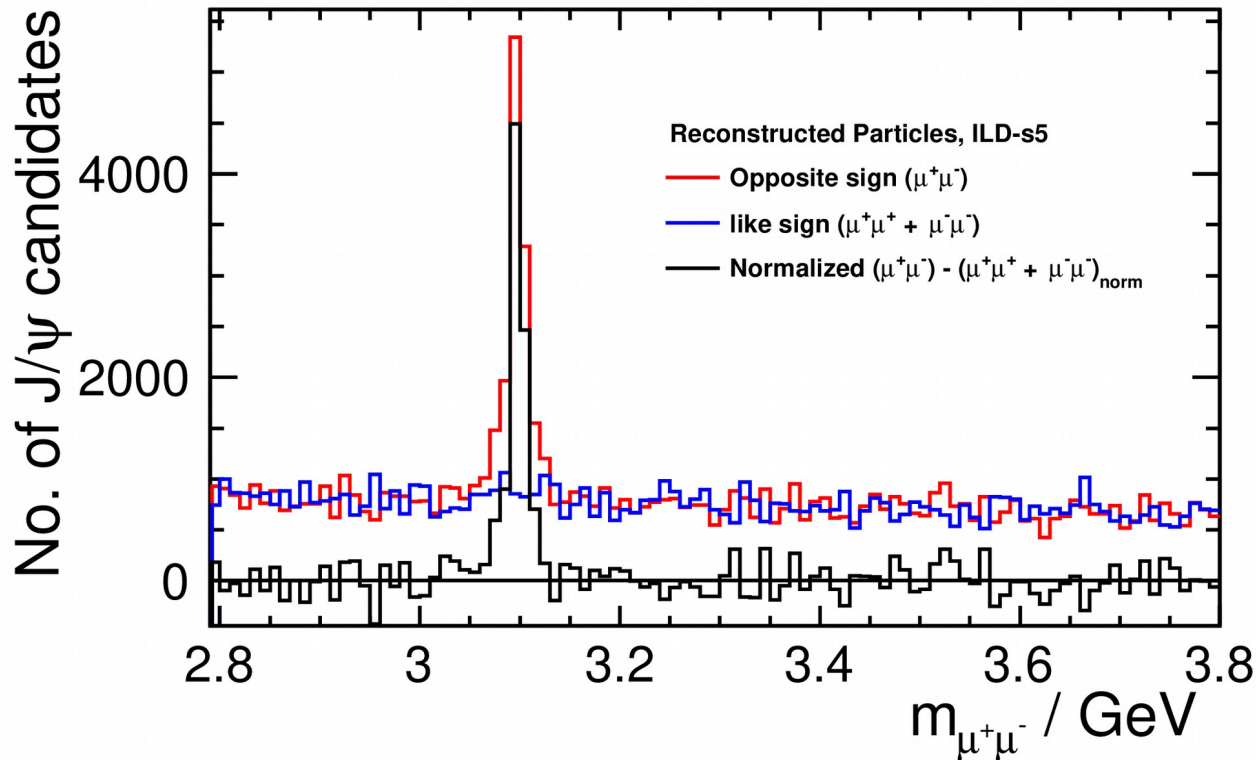
- Find $\mu^+\mu^-$ pairs in Reconstructed particles (for each physics process):
 - Find first muon in the PFOs collection (getType)
 - Look for the second muon
 - Check both muons to be different PFO (avoid double counting using id number)
 - Separate opposite-sign and like-sign pairs (according to Type)
 - Form 4-momentum of muon pair combination in each class (opposite-sign / like-sign) and fill histograms by Inv. Mass.
 - Weight histograms for all 4 helicity configurations
 - Subtract opposite-sign by normalized like-sign to remove background
- Add up normalized histograms of all physics processes

Number of reconstructed $J/\psi \rightarrow \mu^+ \mu^-$ in ILD-I5 detector



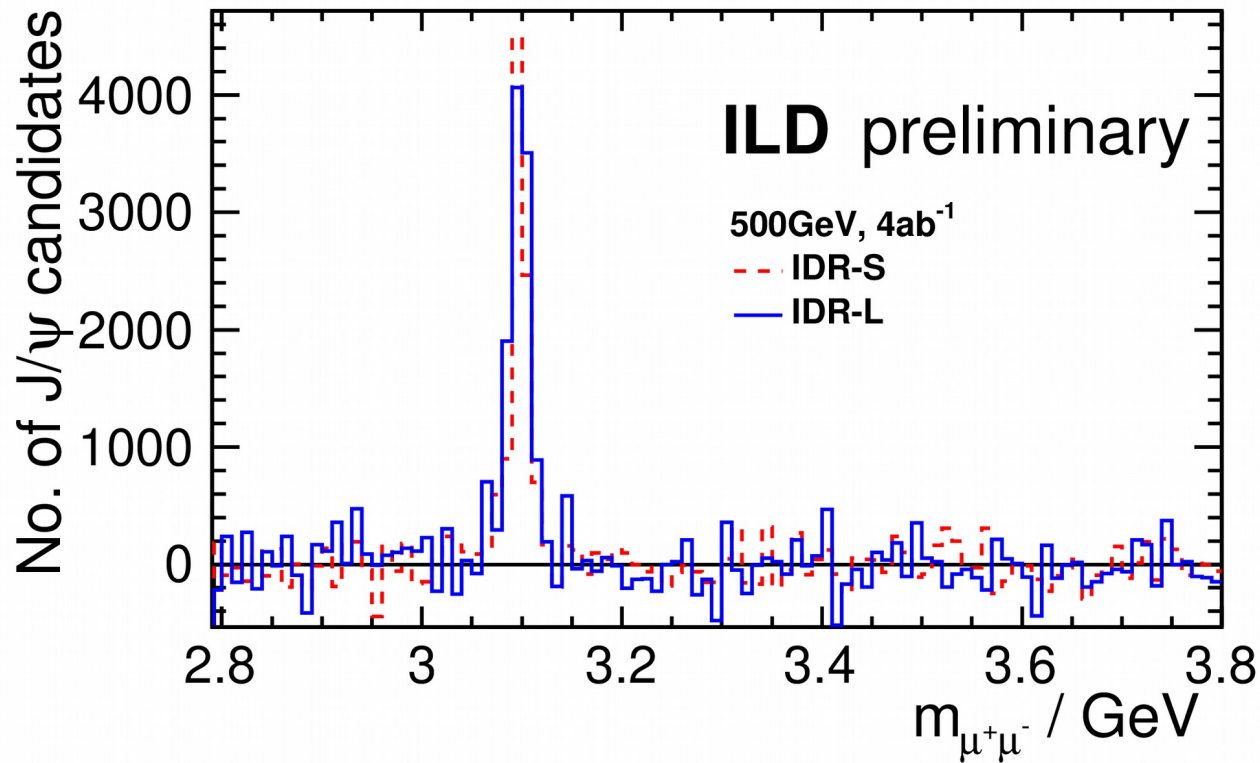
Number of events: 12m
11704 J/ψ 's reconstructed in large detector
(integration in peak region $3.05 < m < 3.15$)

Number of reconstructed $J/\psi \rightarrow \mu^+ \mu^-$ in ILD-s5 detector



Number of events: 12m
9679 J/ψ 's reconstructed in small detector
(integration in peak region $3.05 < m < 3.15$)

Candidate plot for IDR



- Small detector is more precise (stronger magnetic field and better momentum resolution; better mass resolution)
- Large detector finds more J/ ψ 's

Conclusion

- **J/ψ is candidate for calibrating the detector ($m_{J/\psi} = 3096.900 \pm 0.006$ MeV).**
- **Study number of J/ψ at generator and reconstruction level**
- **DiMuonMass processor developed for finding J/ψ's**
- **Found 19909 J/ψ in MCParticle ($E_{cm} = 500\text{GeV}$, $L_{int} = 4\text{ab}^{-1}$, $P(\pm 80\%, \pm 30\%)$)**
- **Almost half of J/ψ's are not reconstructed in both detectors**
 - **Found 11704 J/ψ in ReParticle in l5 (more number) and 9679 in s5 (better resolution)**
- **Next step: study $\cos(\theta)$ vs pt for J/ψ and muons**