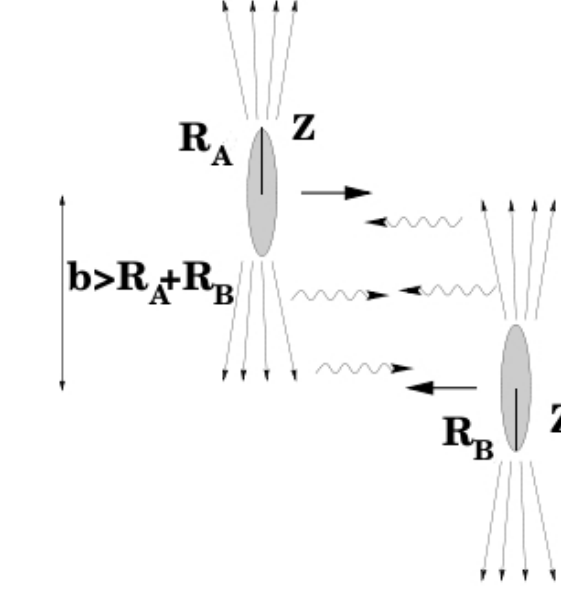


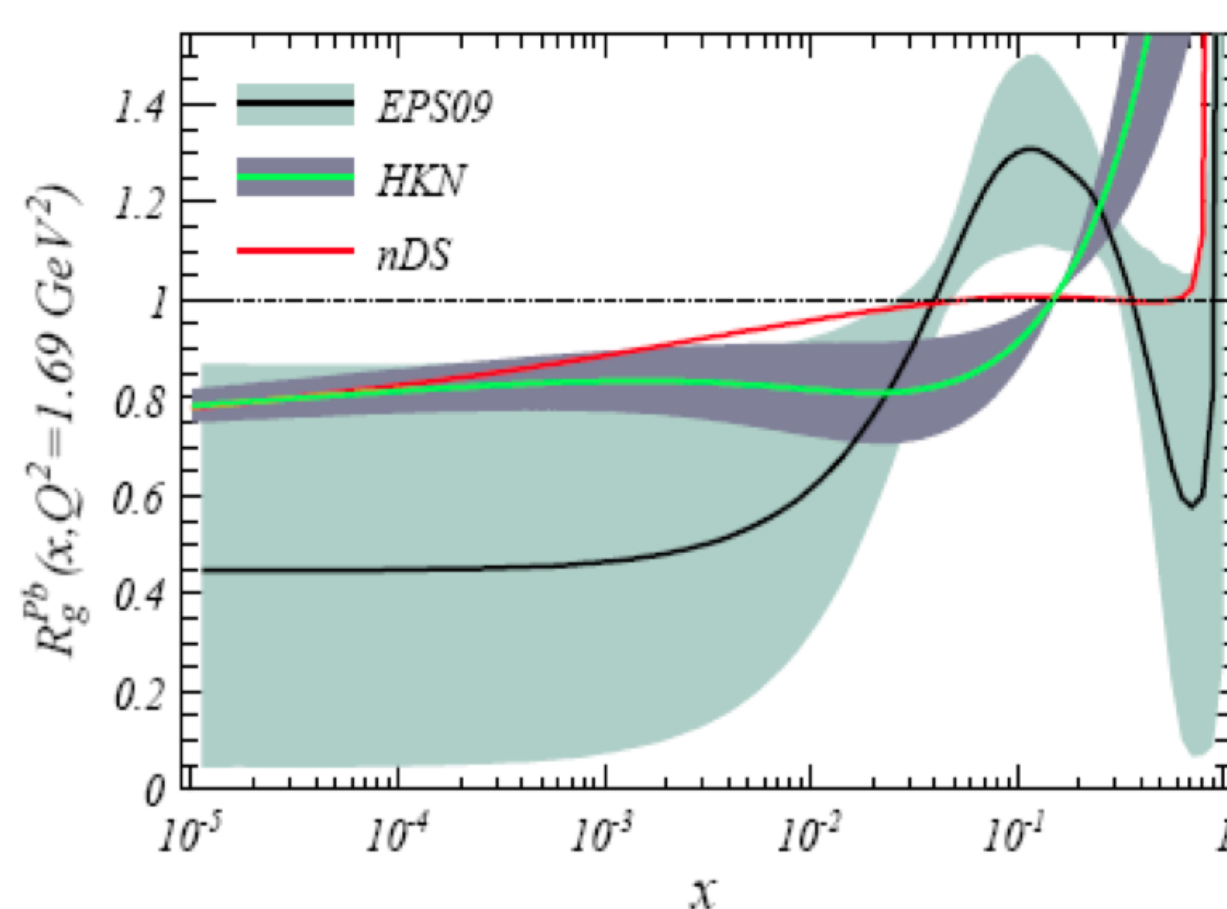
Physics motivation

- Ultra-peripheral heavy ion collisions (UPC)
 - experimental opportunity to create high energy photonuclear reactions ($\sqrt{s_{NN}} \sim 500$ GeV)
 - impact parameter b larger than sum of nuclear radii
 - hadronic interactions suppressed, but strong electromagnetic field
- Virtual photons by Weizsäcker-Williams method
 - field of quasi-real photons with low virtuality $\sim 1/R_{Pb} = 30$ MeV/c
 - photon spectrum



$$\frac{d^3 N_\gamma}{dk d^2 r} = \frac{Z^2 \alpha w^2}{\pi^2 k r^2} \left[K_1^2(w) + \frac{1}{\gamma_L^2} K_0^2(w) \right]$$

where K_0 and K_1 are modified Bessel functions, r the impact parameter of the two colliding ions boosted with a Lorentz factor γ_L and $w = kr/\gamma_L$



- Nuclear gluon distribution at low Bjorken- x
 - pQCD, two-gluon exchange with no net color transfer
 - for an exclusive J/ψ produced in $-3.6 < y < -2.6$, Bjorken- $x = \frac{M_{J/\psi}}{\sqrt{s_{NN}}} e^{-y}$ takes values $x \sim 10^{-2}$ or $x \sim 10^{-5}$, depending on the direction of the nucleus emitting the photon
 - exclusive vector meson production in heavy-ion interactions is expected to probe nuclear gluon distribution at low- x where gluon shadowing effect could be relevant

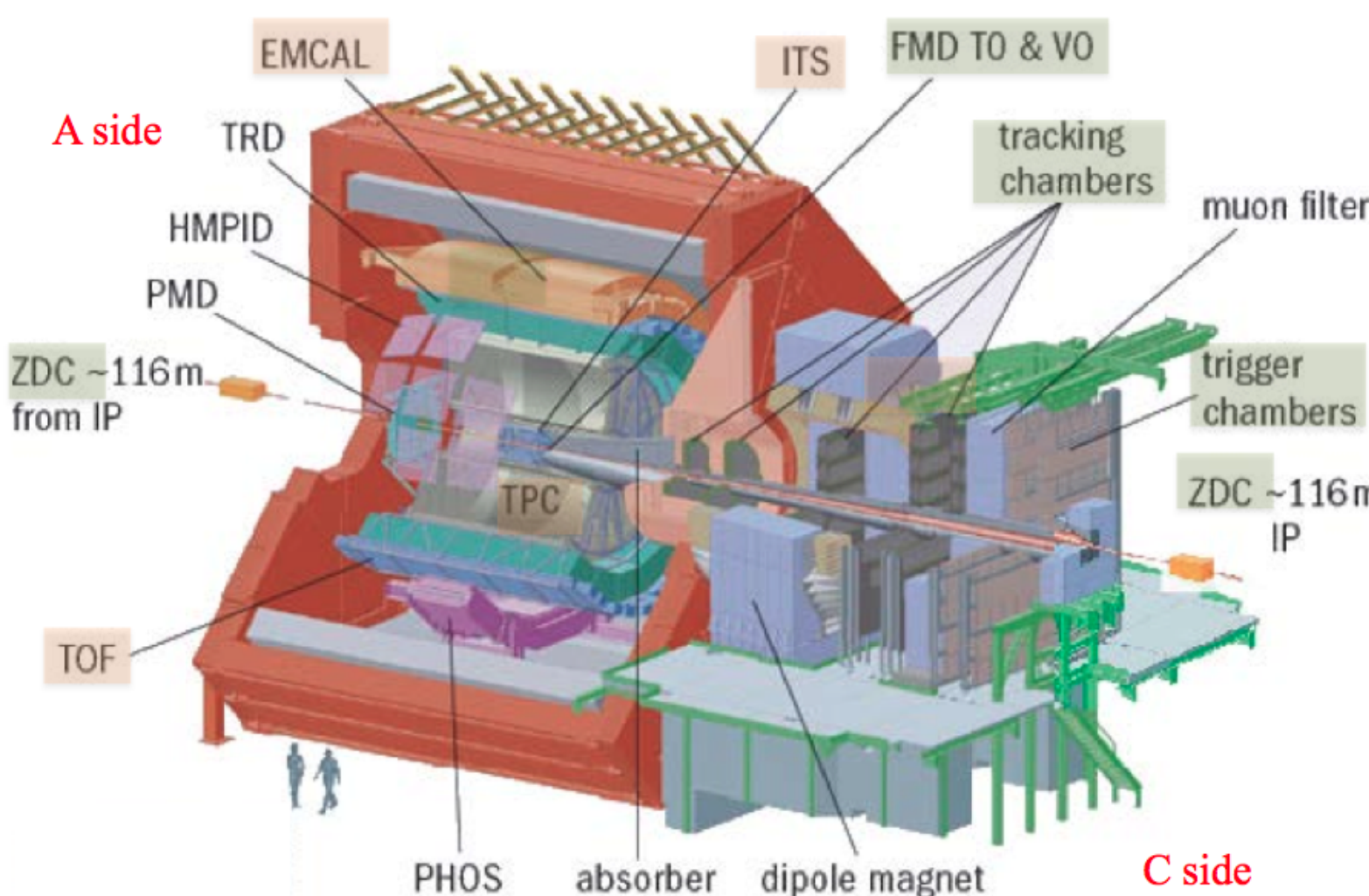
ALICE detectors involved in the analysis

Central detectors

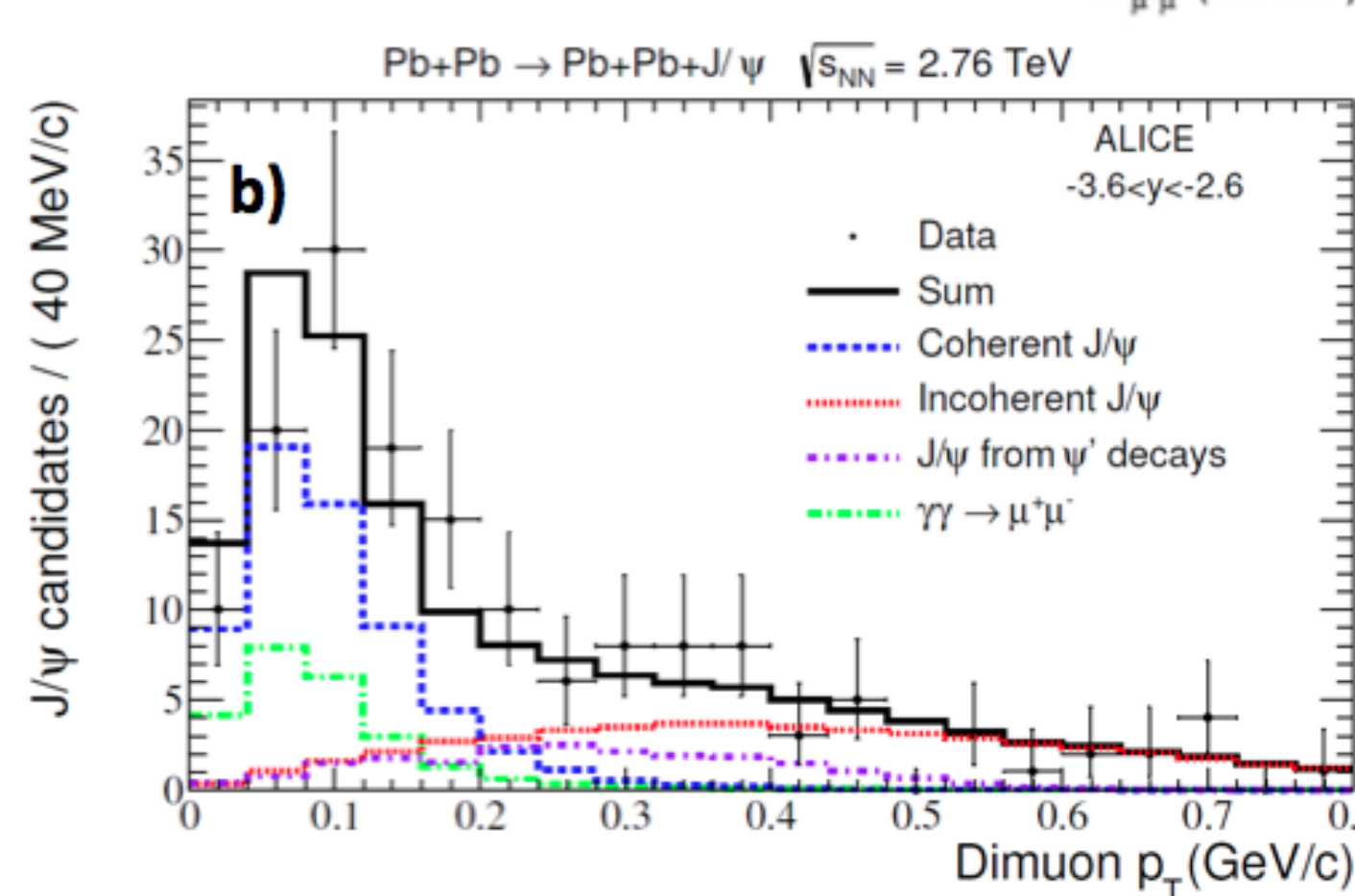
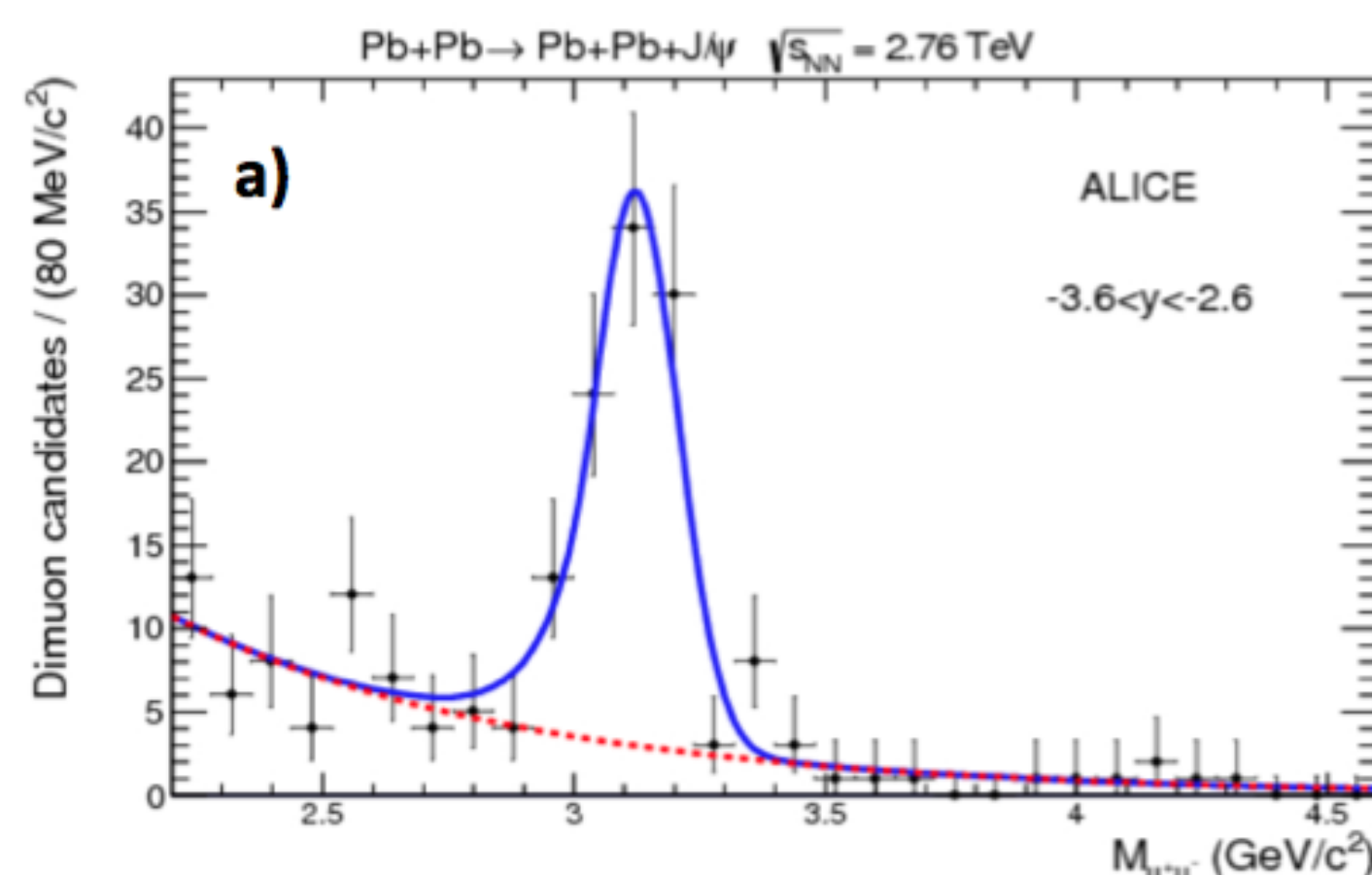
- ITS: Inner Tracking System (Si detector)
- TPC: Time Projection Chamber
- TOF: Time-Of-Flight
- EMCAL: electromagnetic calorimeter

Forward detectors

- V0: Large- η scintillators
- FMD: Forward Multiplicity Detector
- ZDC: Zero Degree Calorimeter
- Muon Arm: muon trigger and tracker



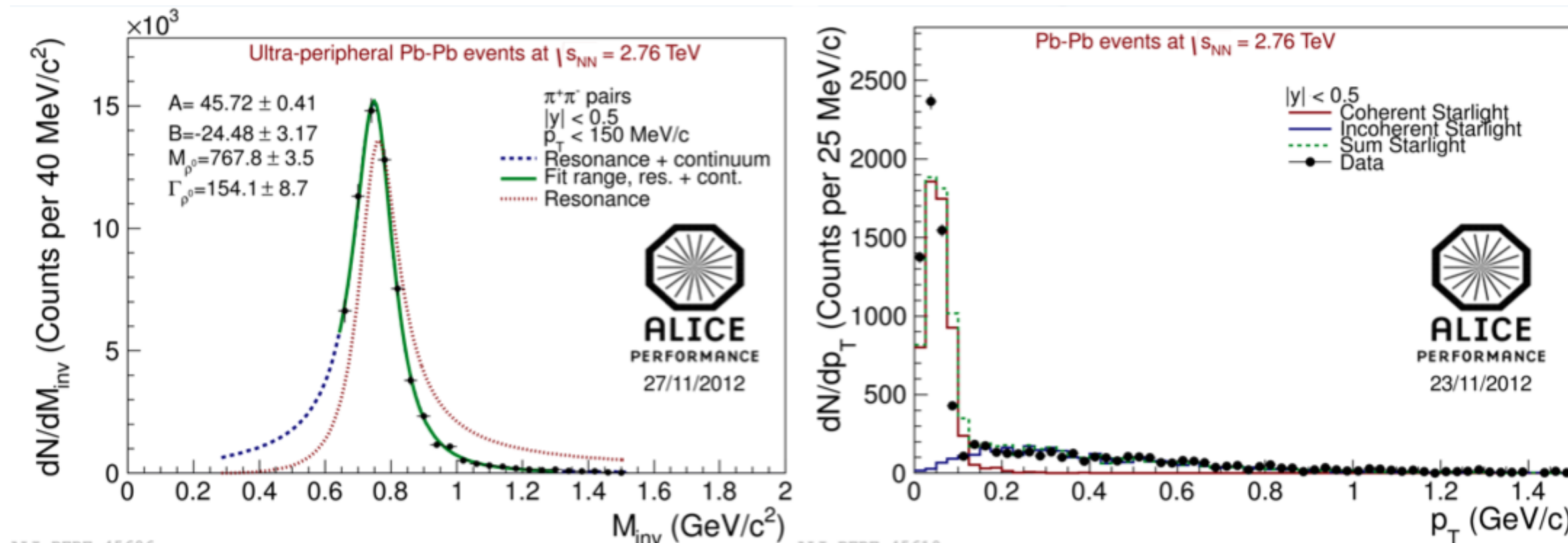
J/ψ at forward rapidity - Phys. Lett. B718 (2013) 1273



- Offline relevant analysis cuts
 - hadronic rejection with ZDC and SPD
 - less than 6 neutrons in both ZDC for coherent candidates
- Invariant mass spectrum fitted using CrystalBall (signal) and exponential (di-lepton background) functions
- p_T data distribution is reproduced summing four different MC templates
 - coherent and incoherent J/ψ production
 - J/ψ from ψ' decay
 - QED continuum pair production $\gamma\gamma \rightarrow \mu^+\mu^-$
- The measured coherent cross section is $d\sigma_{coh}/dy = 1.00 \pm 0.18(stat)_{-0.26}^{+0.24}(sys)$ mb

ρ^0 at central rapidity

The absolute cross section will be released soon



- coherent/incoherent template-pair- p_T distributions from STARLIGHT
- 7% contribution from incoherent events with pair- $p_T < 150$ MeV/c $^{-1}$
- p_T distribution in STARLIGHT broader than in data (similar trend in STAR, Annu. Rev. Nucl. Part. Sci. 55 (2005) 271)

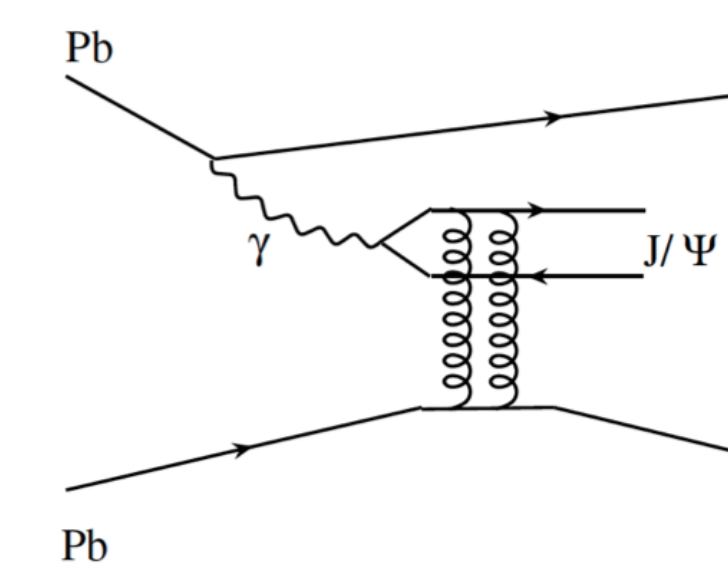
$$\frac{d\sigma}{dm_{\pi\pi}} = \left[A \frac{\sqrt{m_{\pi\pi}} M_{\rho^0} \Gamma(m_{\pi\pi})}{m_{\pi\pi}^2 - M_{\rho^0}^2 + i M_{\rho^0} \Gamma(m_{\pi\pi})} + B \right]$$

A, amplitude of the Breit-Wigner function
B, amplitude of the non resonant $\pi\pi$ production

$$\Gamma(m_{\pi\pi}) = \Gamma_{\rho^0} \frac{M_{\rho^0}}{m_{\pi\pi}} \left(\frac{m_{\pi\pi}^2 - 4m_{\pi}^2}{M_{\rho^0}^2 - 4m_{\pi}^2} \right)^{3/2}$$

Physics of ultra-peripheral collisions

Photoproduction cross section



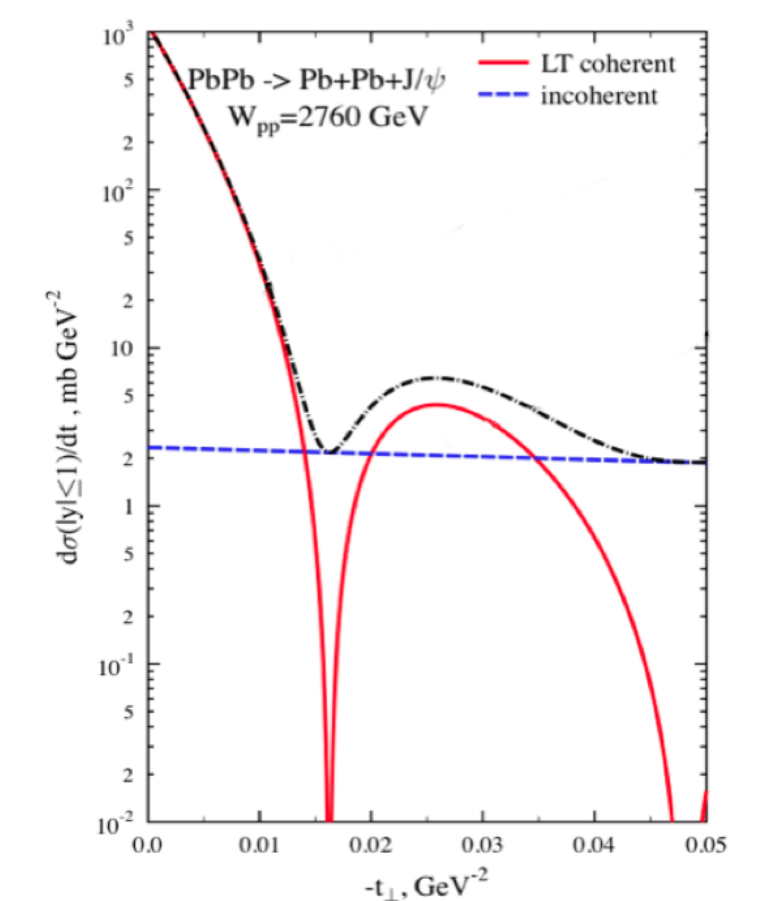
- photoproduction cross section $\sigma_X = \int dk (dN/dk) \sigma_X^2(k)$
- given the process $\gamma Pb \rightarrow J/\psi Pb$, the general cross section is $\frac{d\sigma(PbPb \rightarrow J/\psi Pb)}{dy} = N_\gamma(y) \sigma_{J/\psi}(y) + N_\gamma(-y) \sigma_{J/\psi}(-y)$ where N_γ is photon flux and y is J/ψ CM rapidity
- from pQCD, photoproduction cross section proportional to the squared gluon density

$$\sigma_{\gamma Pb \rightarrow J/\psi Pb}(s) = \frac{d\sigma_{N \rightarrow J/\psi N}(s, t_{min})}{dt} \cdot \left[\frac{G_A(M_{J/\psi}/s, Q_{eff}^2)}{A G_N(M_{J/\psi}/s, Q_{eff}^2)} \right]^2 \cdot F_A^2$$

where s is γ - N scattering invariant energy and F_A is nuclear form factor

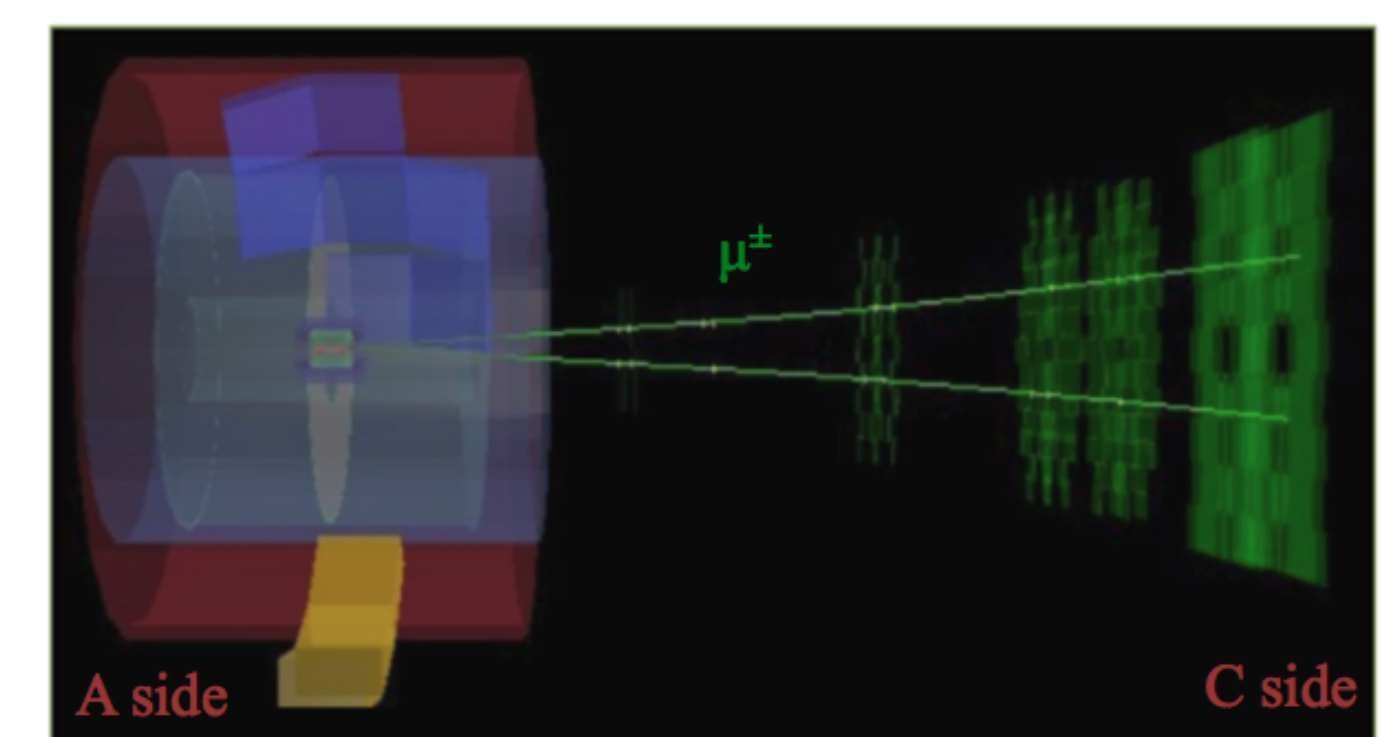
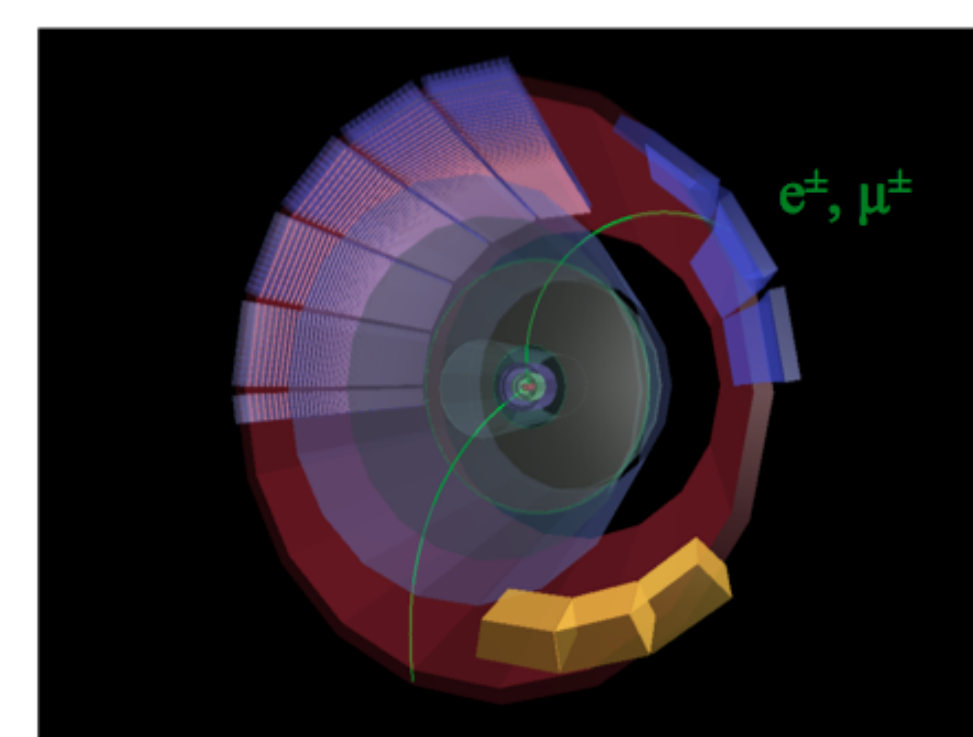
Coherent vector meson production

- photon couples coherently to all nucleons ($\lambda_\gamma > R_{Pb}$)
- $\langle p_T \rangle \sim 1/R_{Pb} \sim 60$ MeV/c $^{-1}$
- no neutron emission in $\sim 80\%$ of cases
- Incoherent vector meson production
 - photon couples to a single nucleon ($\lambda_\gamma \sim r_{proton}$)
 - $\langle p_T \rangle \sim 1/r_{proton} \sim 500$ MeV/c $^{-1}$
 - target nucleus normally breaks up



Collected data samples

- Vector mesons produced at low p_T , clear back-to-back track configuration in the transverse plane (only two tracks in an otherwise empty detector)



Overall acceptance in $|\eta| \leq 0.9$
TOPOLOGICAL TRIGGER:
V0A veto & V0C veto & SPD & TOF
Silicon Pix-Det triggers ≥ 2 hits
TOF triggers: $2 \leq N_{trig, pad} \leq 6$ in $150 < \Delta\phi < 180$
Observed rapidity: $|y| < 0.9$

Overall acceptance in $-4 < \eta < -2.5$
TRIGGER:
Muon_Trg & V0C & V0A veto
Single muon trigger above a 1 GeV/c p_T -threshold
V0c ≥ 1 hit
Observed rapidity: $-3.6 < y < -2.6$

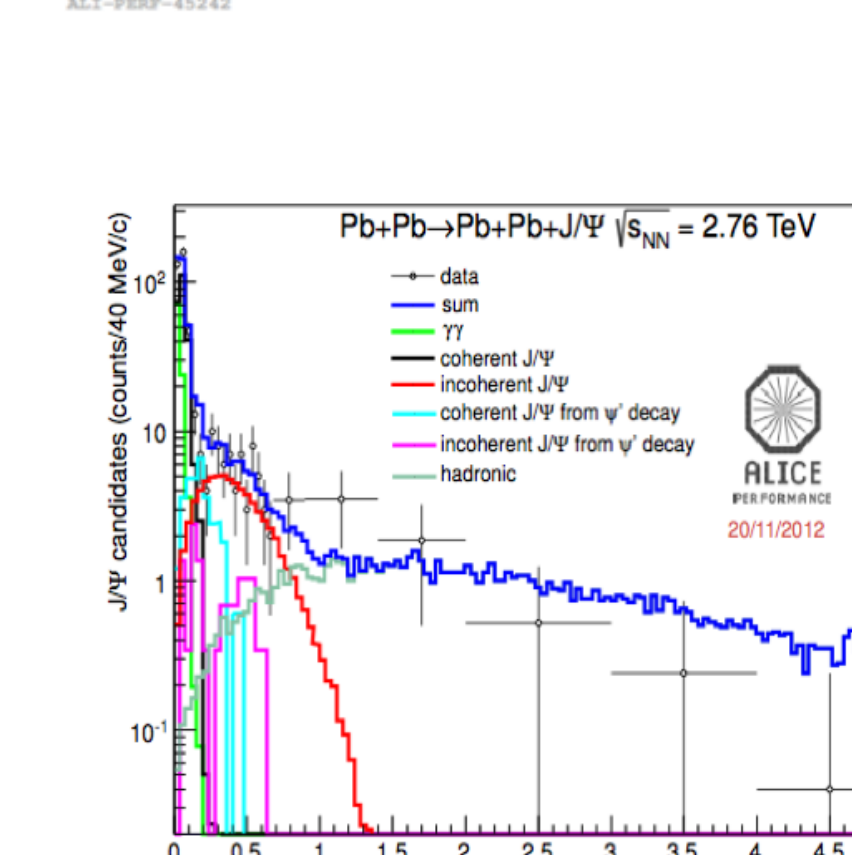
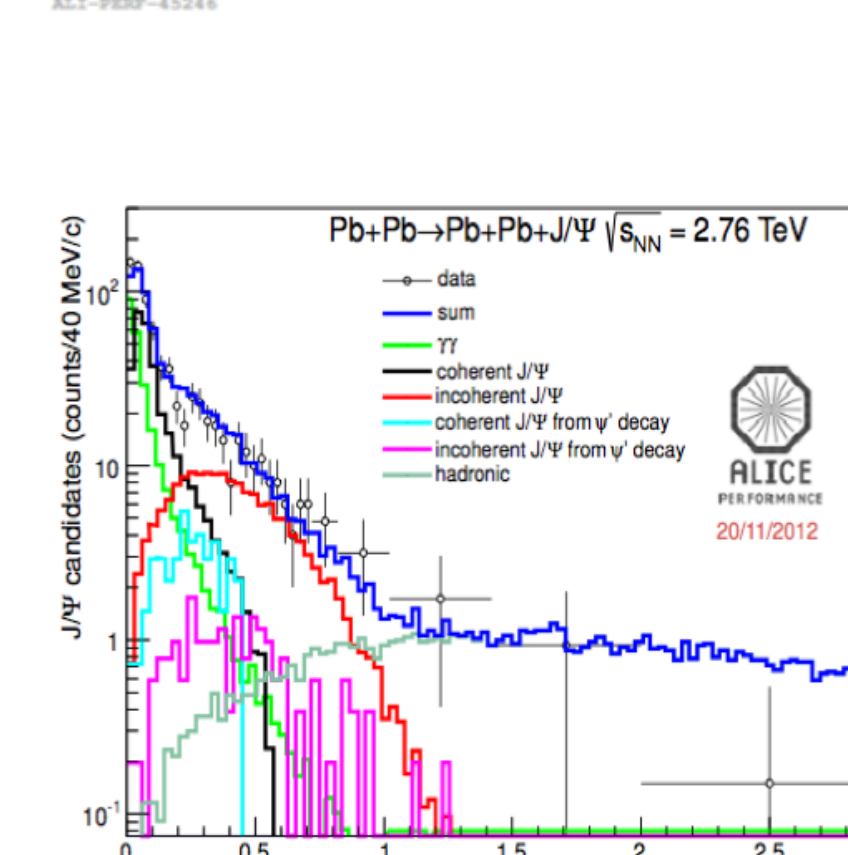
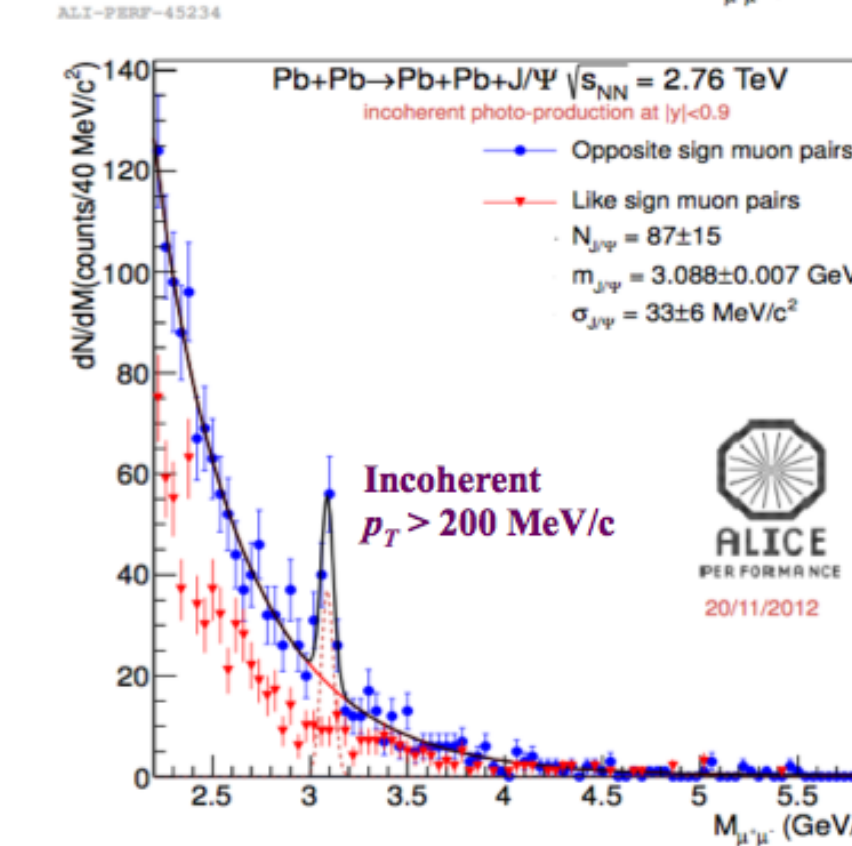
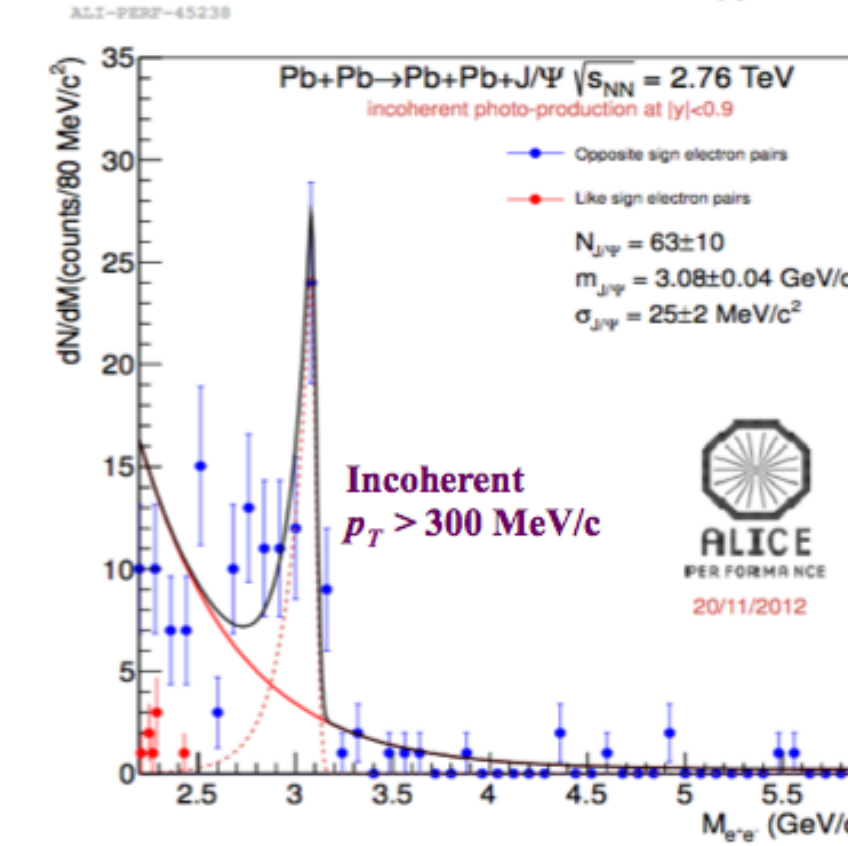
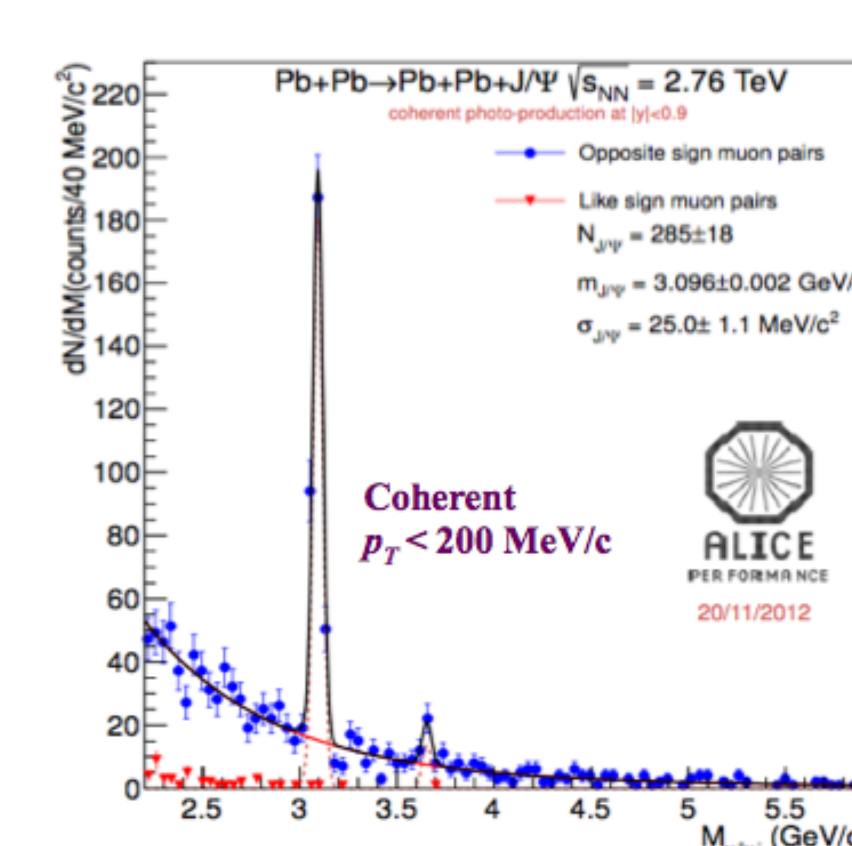
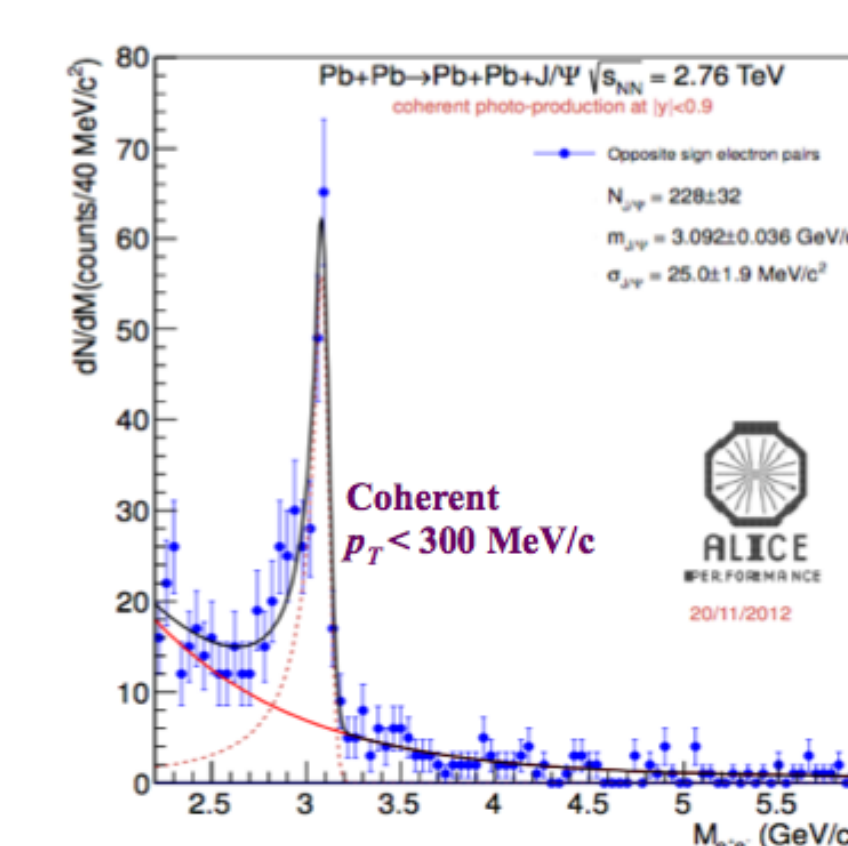
J/ψ photoproduction

- first LHC measurements in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV, both at forward and central rapidities
- $J/\psi \rightarrow \mu^+\mu^-$, muon spectrometer, forward rapidity $-3.6 < y < -2.6$
- $J/\psi \rightarrow l^+l^-$, barrel detectors, central rapidity $|y| < 0.9$
- 2011 Pb-Pb run integrated luminosity: $55 \mu b^{-1}$ (forward), $20 \mu b^{-1}$ (central)
- two low multiplicity triggers with topological request for the central barrel one

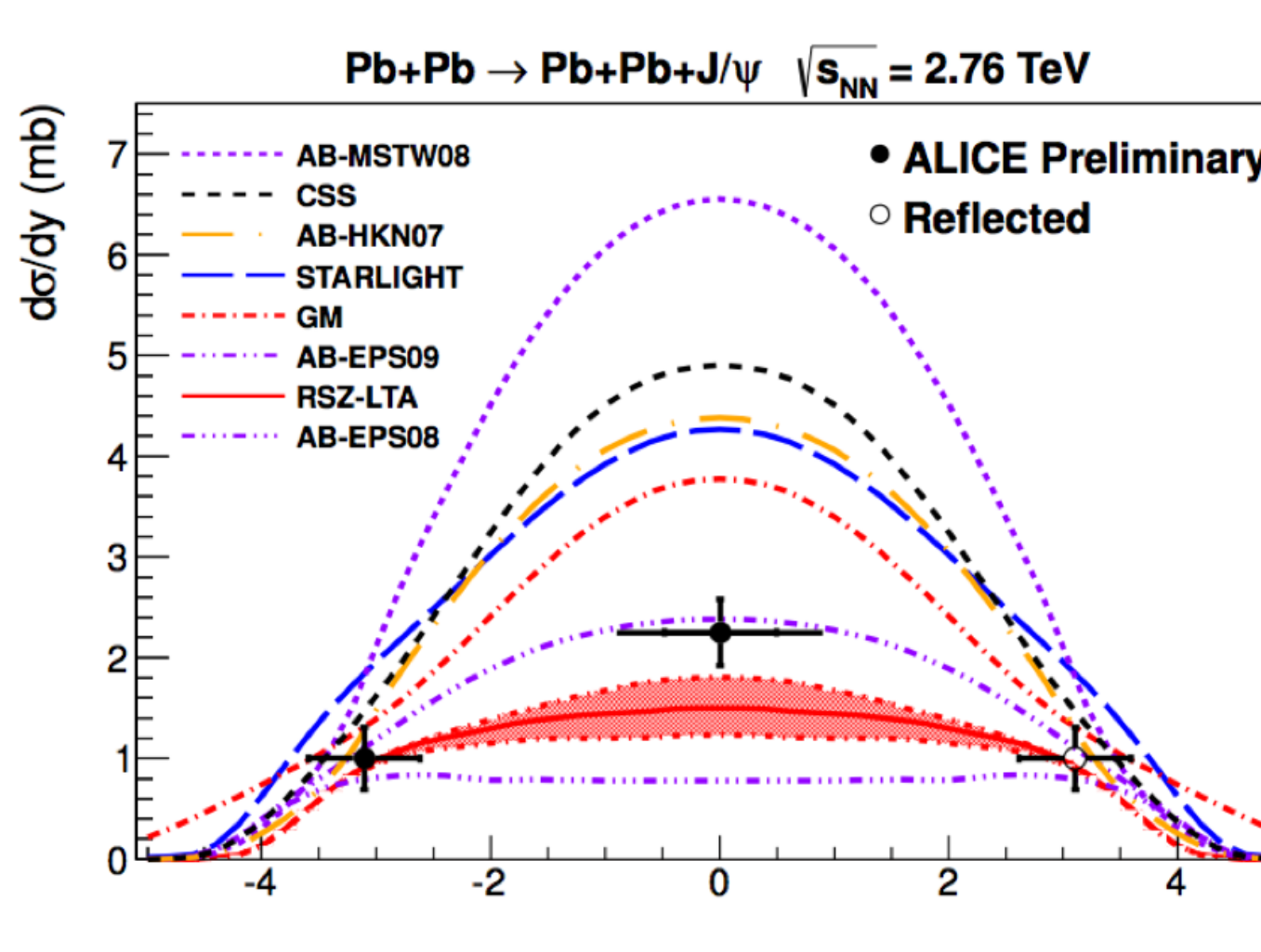
ρ^0 photoproduction

- $\rho^0 \rightarrow \pi^+\pi^-$, barrel detectors, rapidity $|y| < 0.9$
- 2010 Pb-Pb run integrated luminosity: $0.2 \mu b^{-1}$, same central barrel trigger but no topological requests

J/ψ at central rapidity and discussion on (preliminary) results



- Offline relevant analysis cuts
 - offline check on V0 timing
 - less than 6 neutrons in both ZDC for coherent candidates
 - e/μ identification via TPC energy loss
- Data points are reproduced summing six different Monte Carlo templates
 - VM photoproduction: coherent J/ψ , incoherent J/ψ
 - feed down contributions: coherent and incoherent J/ψ from ψ' decay
 - di-lepton photoproduction: $\gamma\gamma \rightarrow \mu^+\mu^-/e^+e^-$
 - peripheral events: hadronic J/ψ
- The measured coherent cross section is $d\sigma_{coh}/dy = 2.3 \pm 0.13(stat)_{-0.23}^{+0.25}(sys)$ mb



- Measurements vs model predictions
 - higher discrimination power in the central rapidity region
 - preliminary result in agreement with that one published for the forward region
 - The measured cross section is in good agreement with models which include nuclear gluon shadowing