Recent results from ALICE

LPCC forward physics meeting

3/19/17

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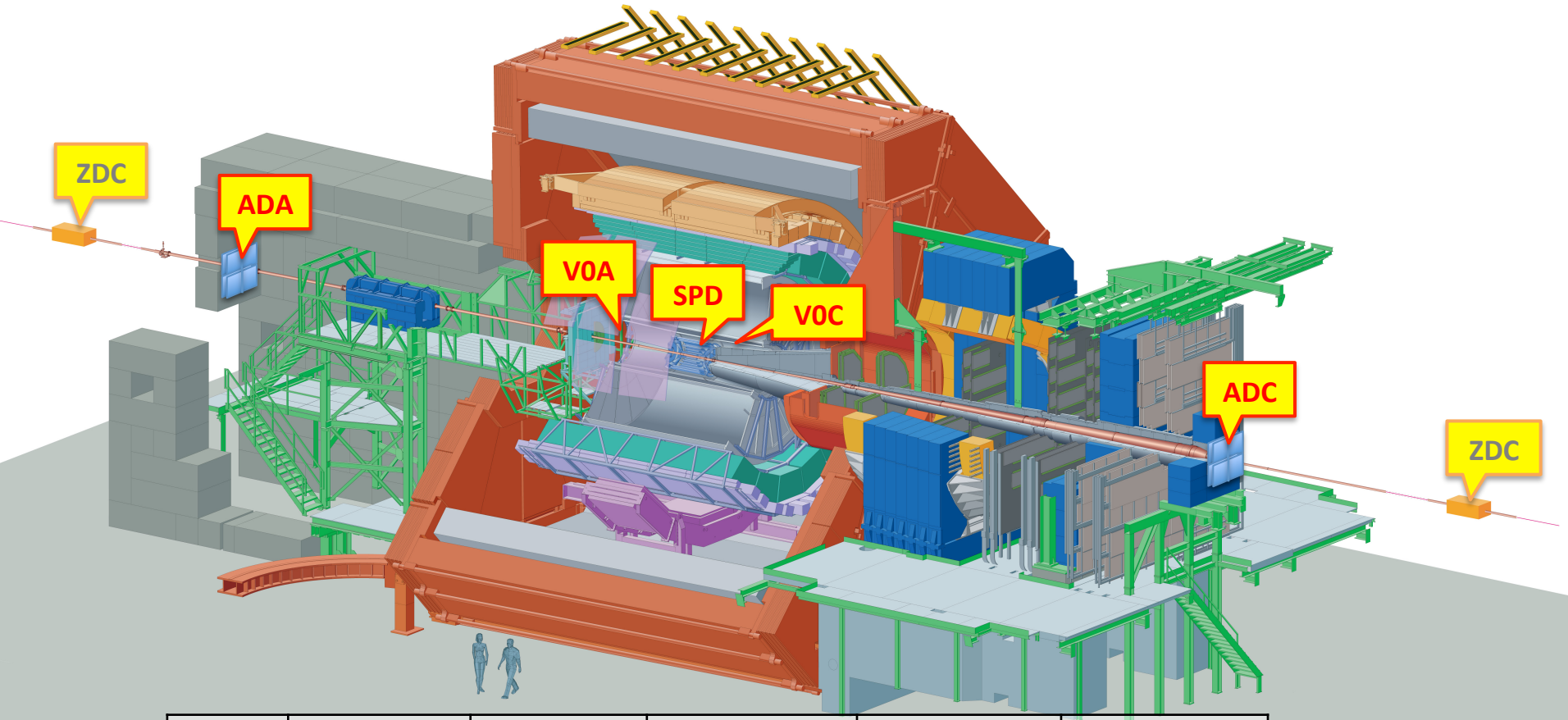
Overview

- Forward physics in ALICE in pp
- ALICE diffractive (AD) detector
- Forward physics in ALICE in p-Pp and in Pb-Pb

Main ALICE detectors used for MB data taking



ZDC	ADA	V0A	SPD	V0C	ADC
8<|η|	6.4>η>4.3	5.1>η>2.0	+2.0>η>-2.0 +1.4>η>-1.4	-1.7>η>-3.7	-4.9>η>-7.0

New in RUN2

Forward physics in ALICE (in pp)

- Measurement of diffractive and inelastic cross sections
  - √s = 2.76 and 7 TeV: Eur. Phys. J. C (2013 73:2456)
  - √s = 13 TeV: work in progress
- Central exclusive production
- Proton dissociation in p-p collisions using ZDCs

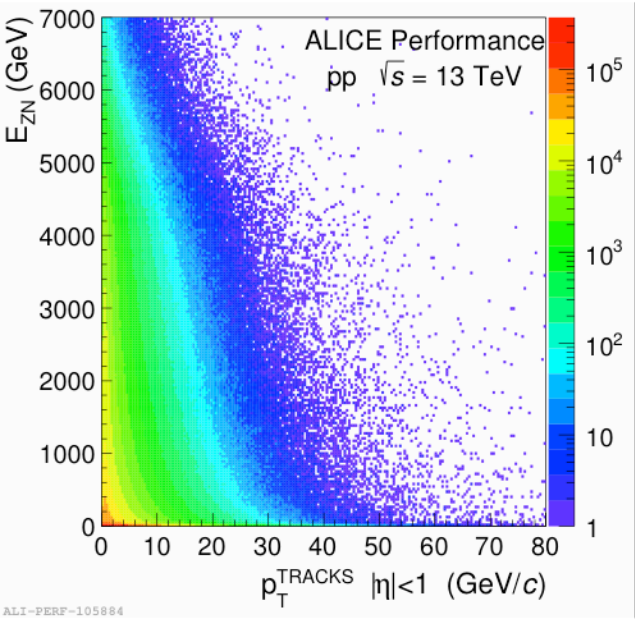
work in progress

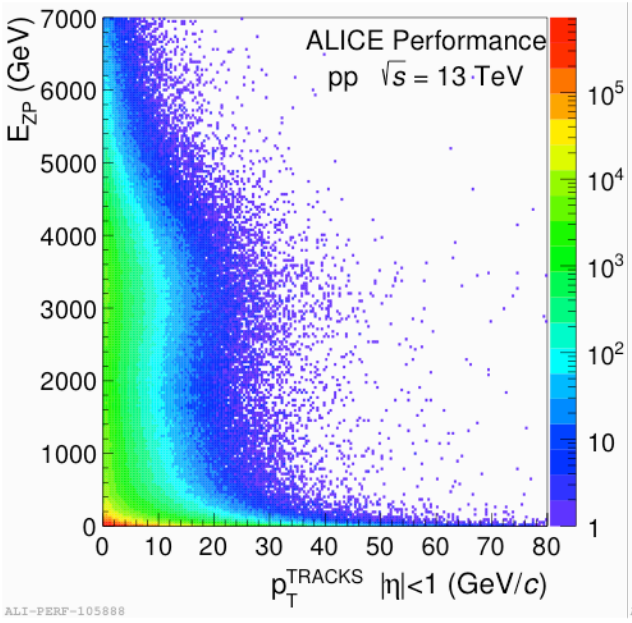
- In 2016 ALICE has collected ≈0.5/pb with a double-gap trigger
  - Challenging background (25ns bunch trains), however μ≈0.5% in ALICE
    → unique opportunity for ALICE to collect central production data
  - Central production can be measured up to high masses; one of the aims of on-going analyses: χ_c
  - At least the same amount of data expected for this year

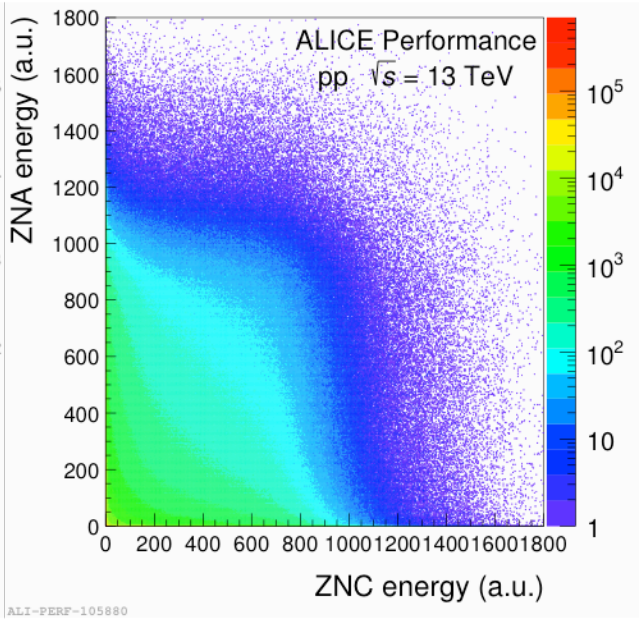
Proton dissociation in pp collisions

- Goal: study correlations between ZDC activity and track multiplicity
- Very low μ (<0.2%) is needed for this kind of analysis
- There is interest from several theorists in such measurements
- Special run required: half crossing angle (total=external+internal):
  <+85 μrad (<-32 μrad) for positive (negative) crossing

work in progress

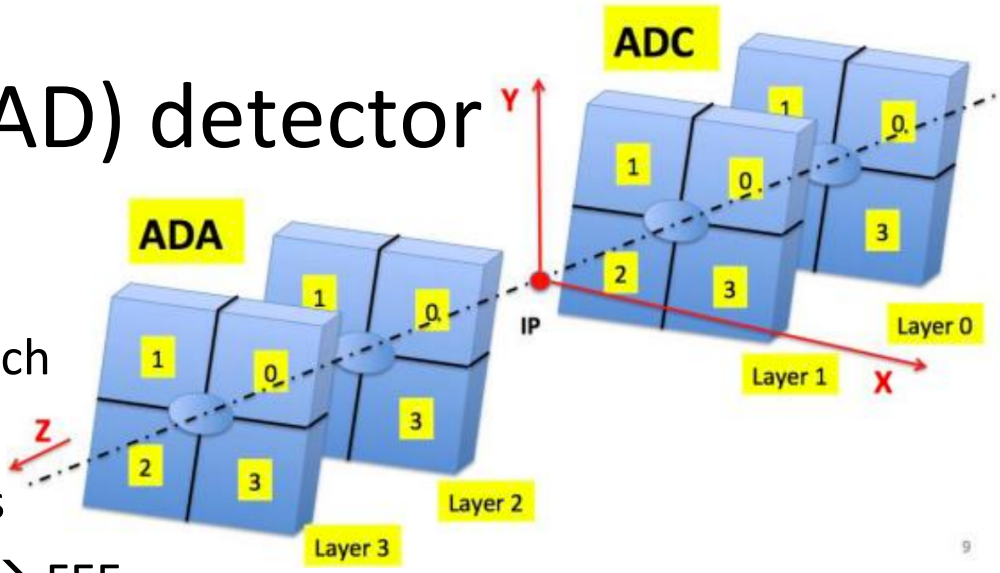


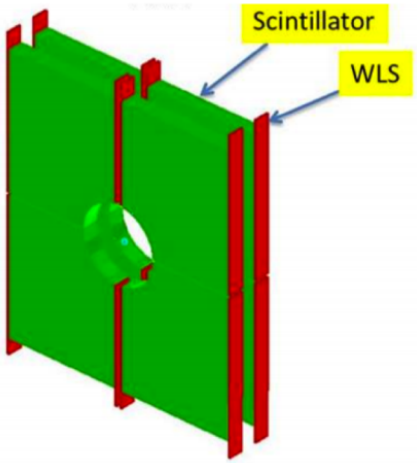


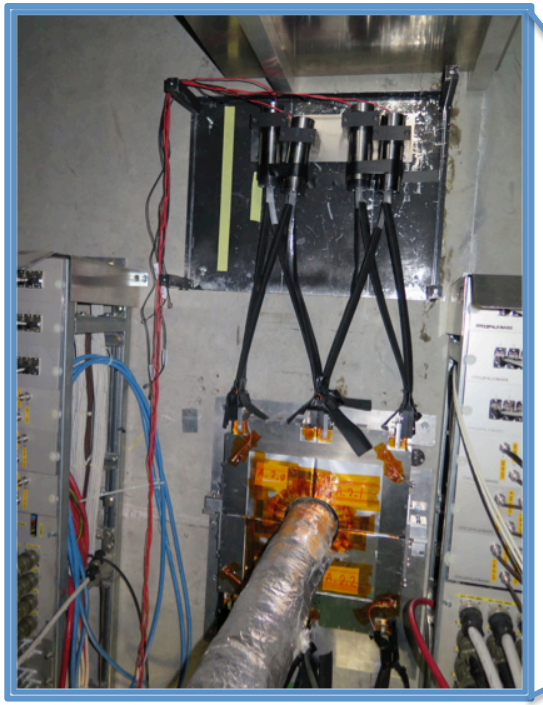


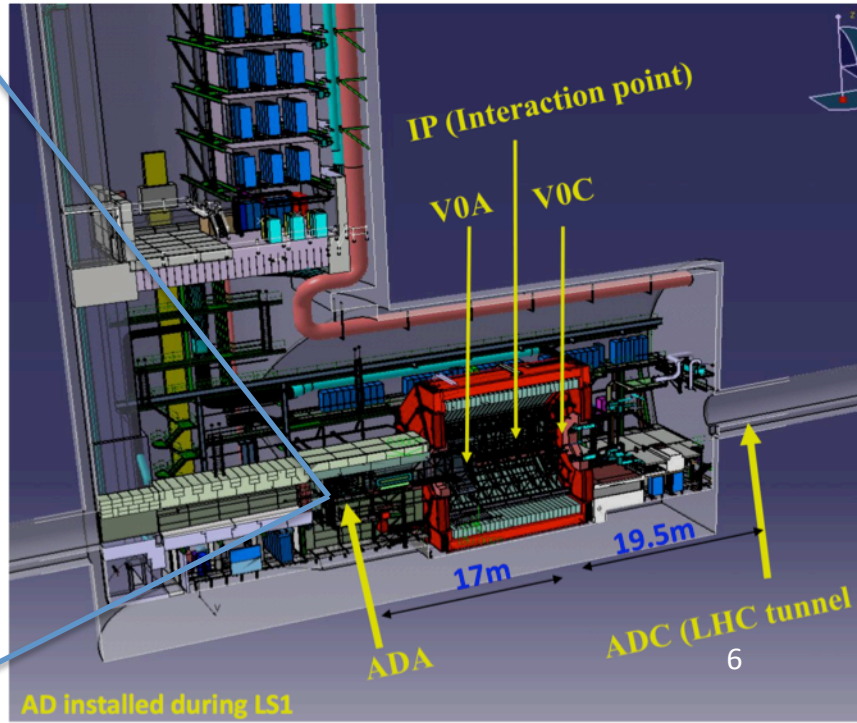
ALICE diffractive (AD) detector

- Installed during LS1
- Two layers of scintillator pads on each side of the IP
- Coincidence between adjacent pads
- Scintillator → clear fibers → PMTs → FEE

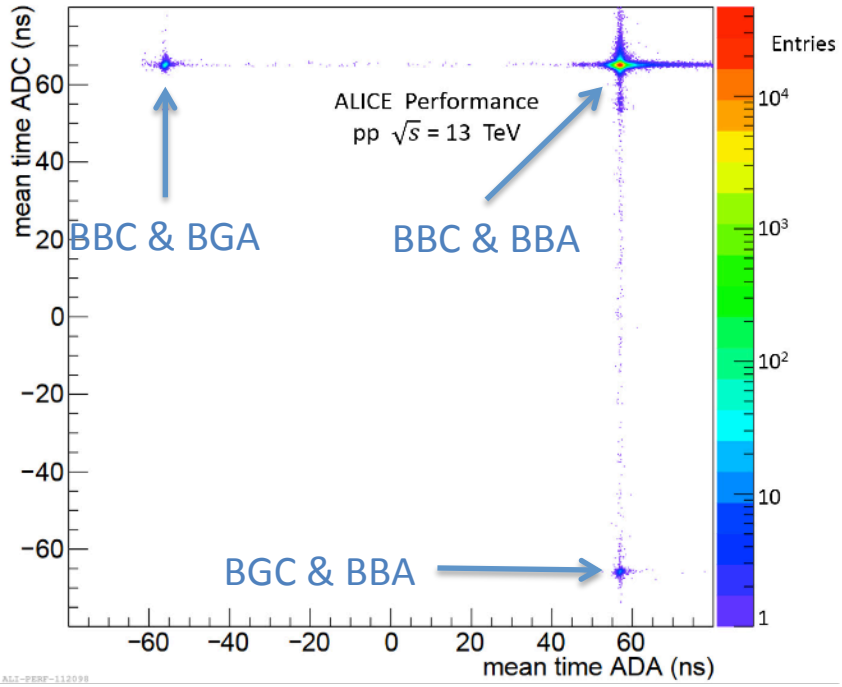








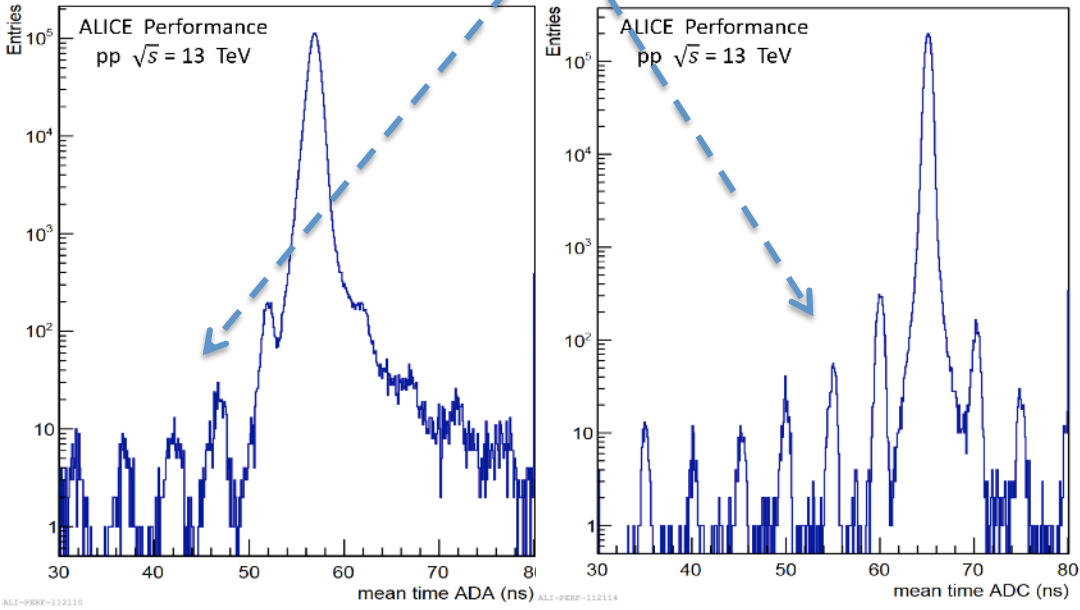
ALICE diffractive (AD) detector – time resolution



Excellent rejection of beam-gas

~120 ns separation between beam-beam and beam-gas for the same bunch

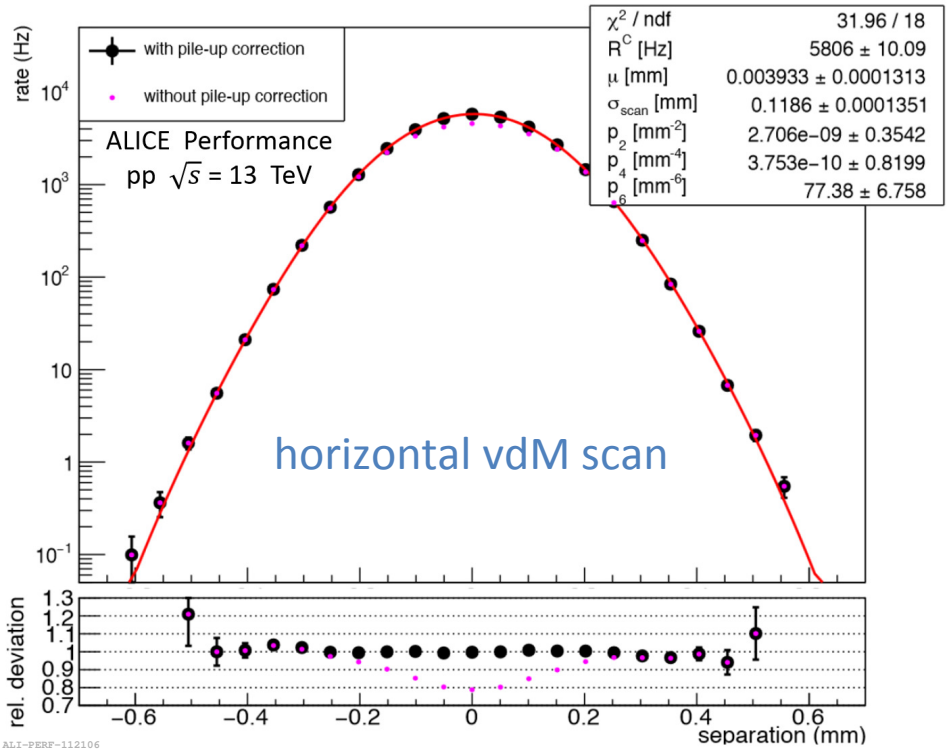
satellites

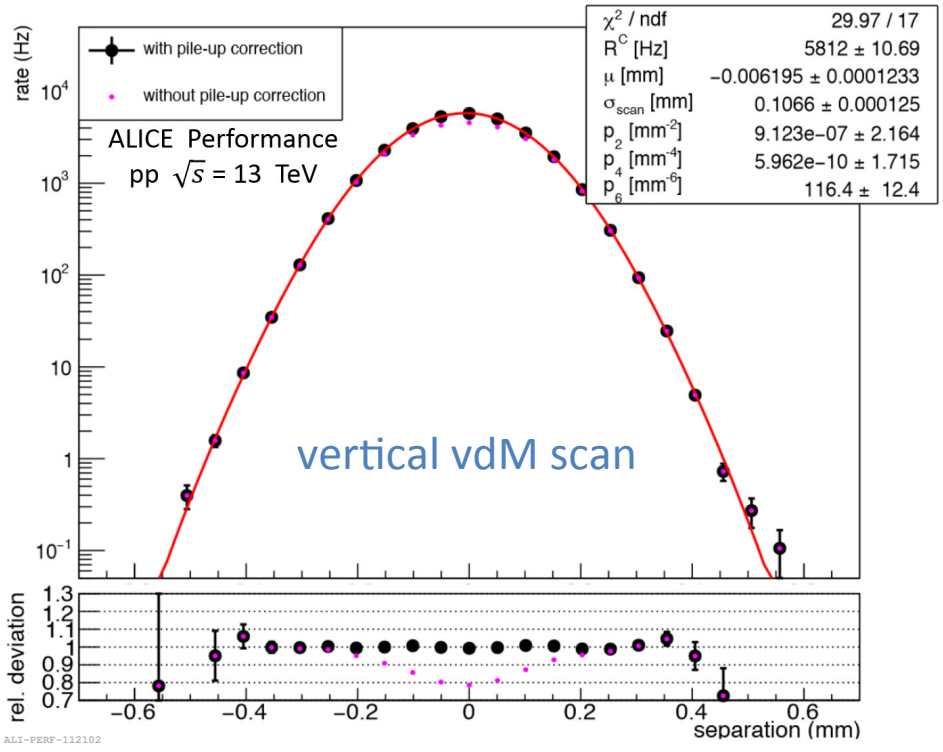


Time resolution: 0.3ns (0.5ns) on C(A)-side

satellite bunches can be nicely seen

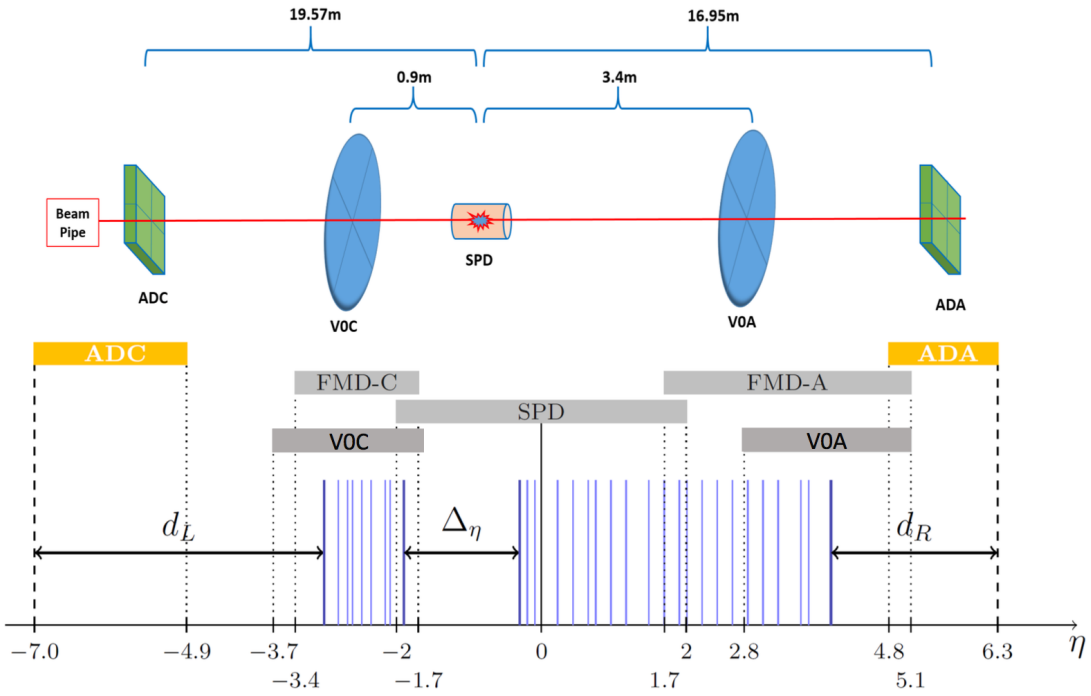
ALICE diffractive (AD) detector as a luminometer

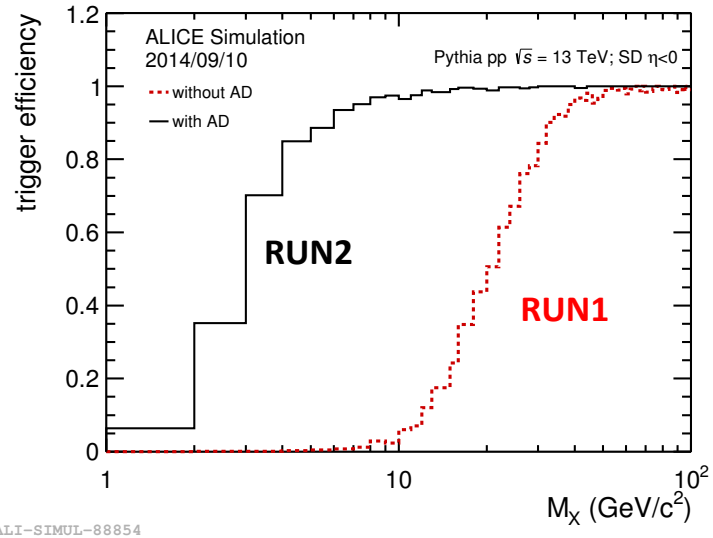


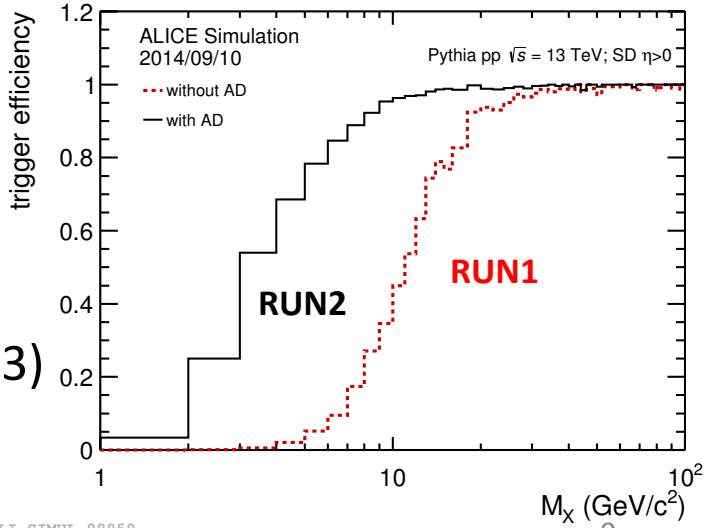


- 3rd luminometer in ALICE, complementing VZERO and T0
- AD_{AND} rate vs. separation: left (right) for horizontal (verical) scan
- Background is negligible (→ coincidence between adjacent modules)

ALICE diffractive (AD) detector



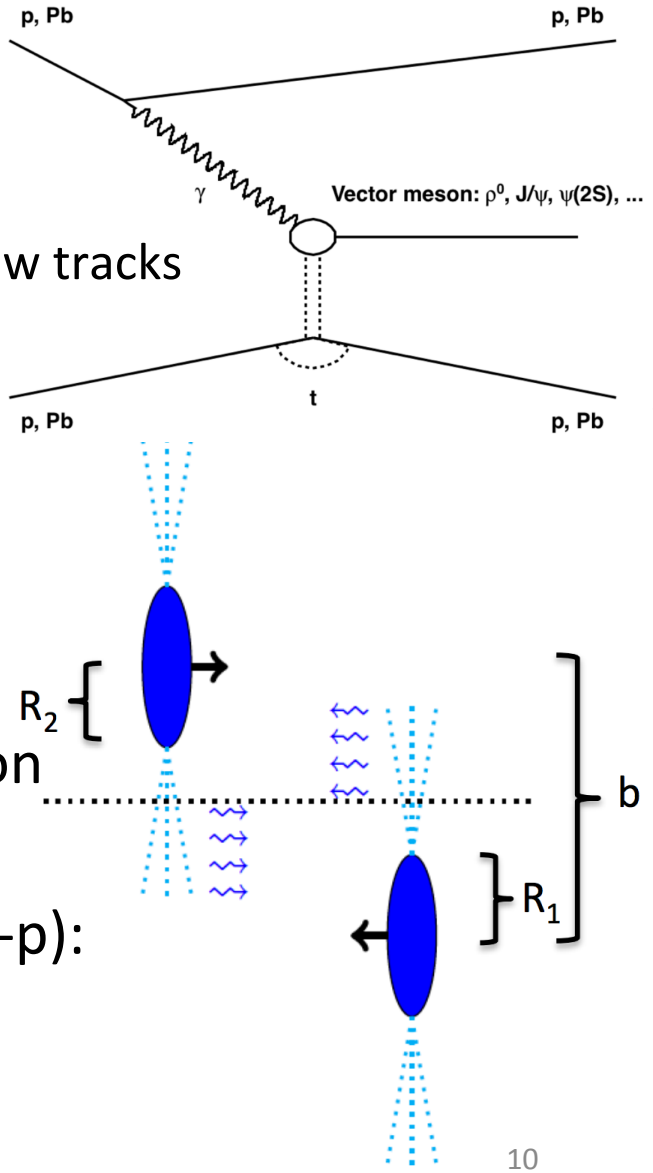




- Increased sensitivity for low diffractive masses M_X
- Increased efficiency of the global-OR MB trigger
- Increased pseudo-rapidity coverage (-7.0 < η < +6.3)

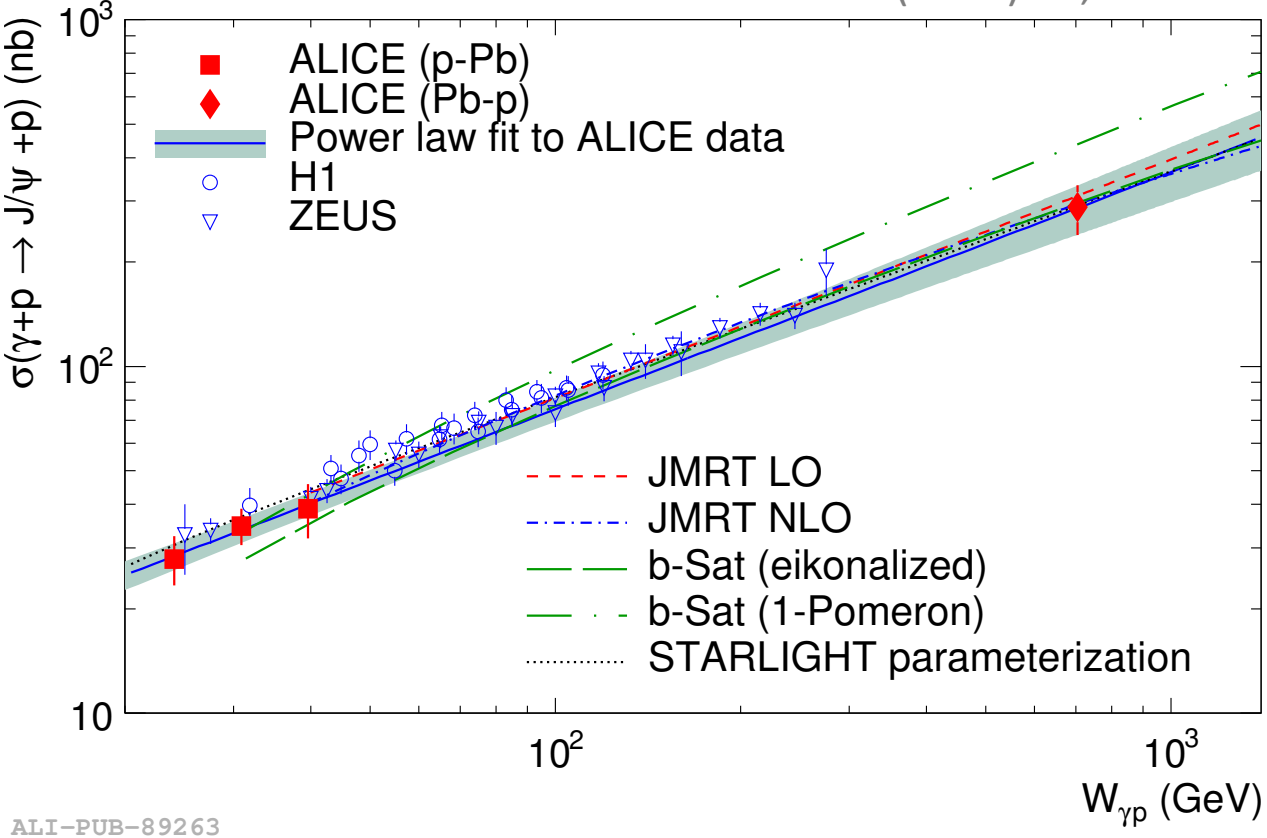
Photo-production in p-Pb

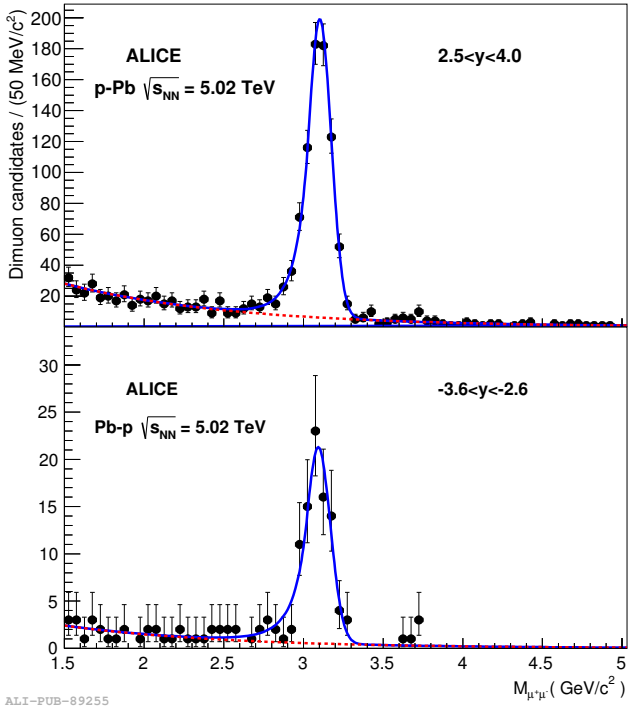
- Impact parameter b > R_1+R_2
  - hadronic interactions are suppressed
  - experimental signature: clean events with only few tracks
- There are two sources and two targets:
  - gamma-nucleus and gamma-proton interactions
- Cross section is the convolution of
  - photon flux ← QED
  - photon-target cross section ← QCD
- Relation between rapidity and gamma-proton energy: $W^2_{\gamma p} = 2\, E_p\, M_{J/\psi} \exp(-y)$
- Highest accessible $W_{\gamma p}$ energies in ALICE (Pb-p):
  - $580 < W_{\gamma p} < 950$ GeV (RUN1)
  - $700 < W_{\gamma p} < 1480$ GeV (RUN2)



J/ψ photo-production in p-Pb (2013)

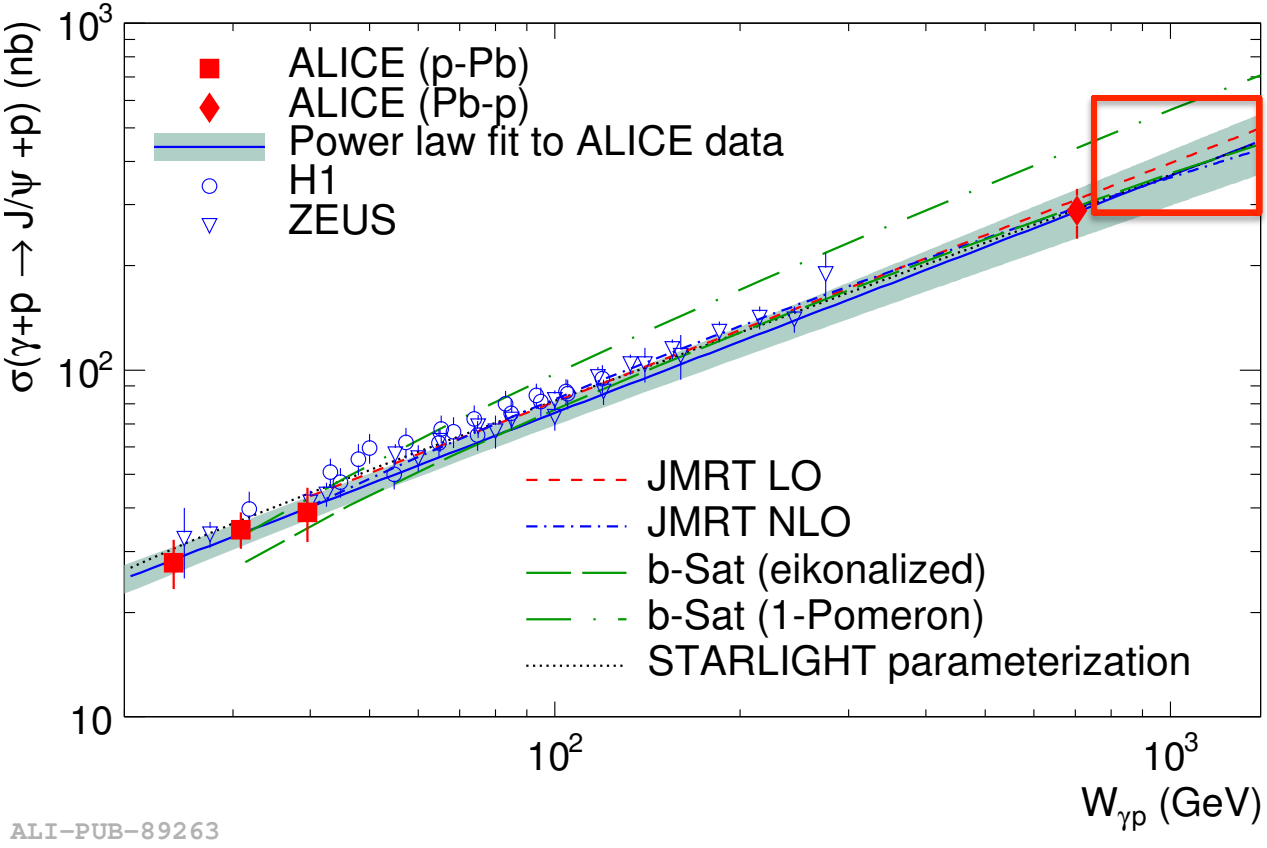
PRL 113 (2014) 23, 232504

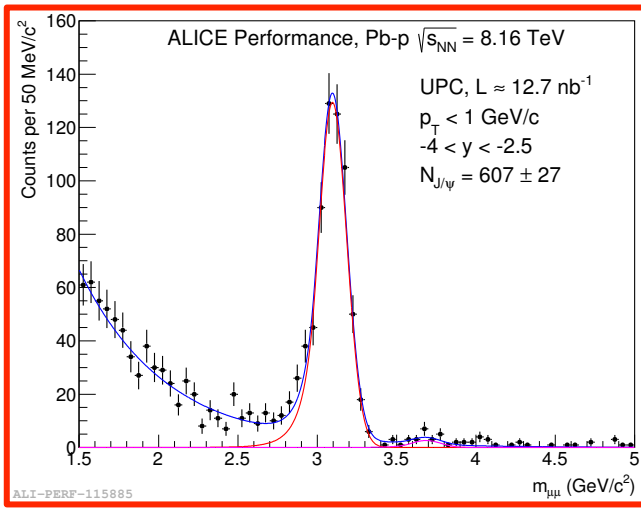




- Agreement with HERA data where there is overlap.
- Power law fit of ALICE data yields same parameters as found by H1 and ZEUS.
- No change in the behavior of the cross section seen from HERA energies to the highest ALICE measurement

J/ψ photo-production in p-Pb (2016)

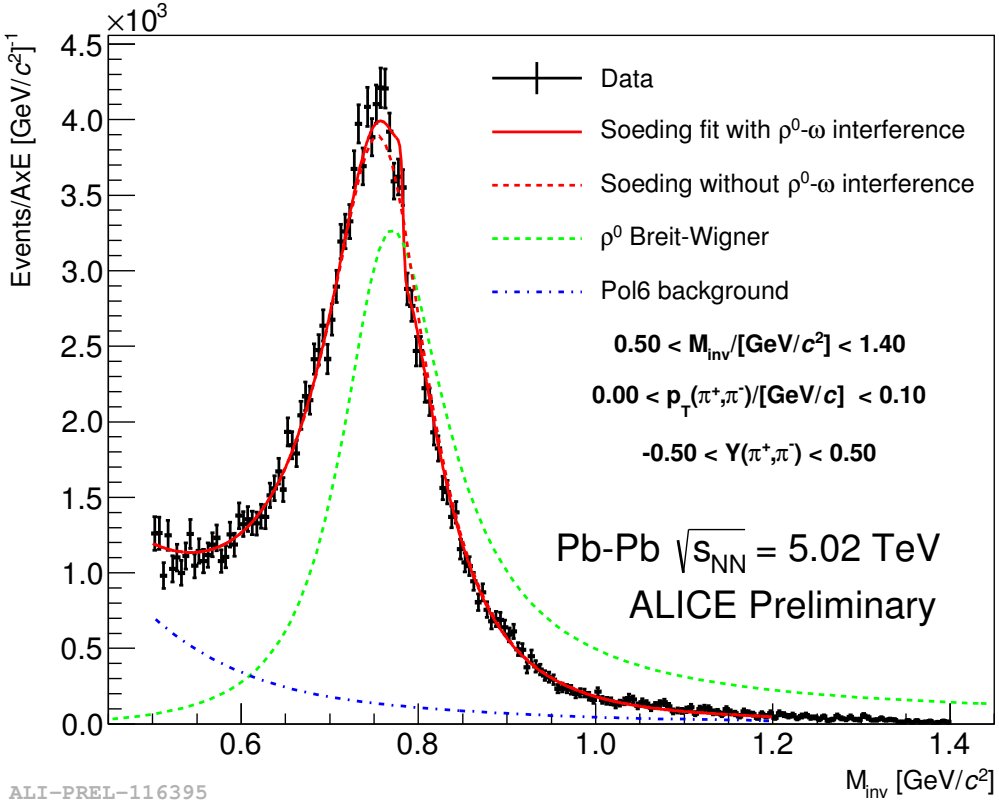




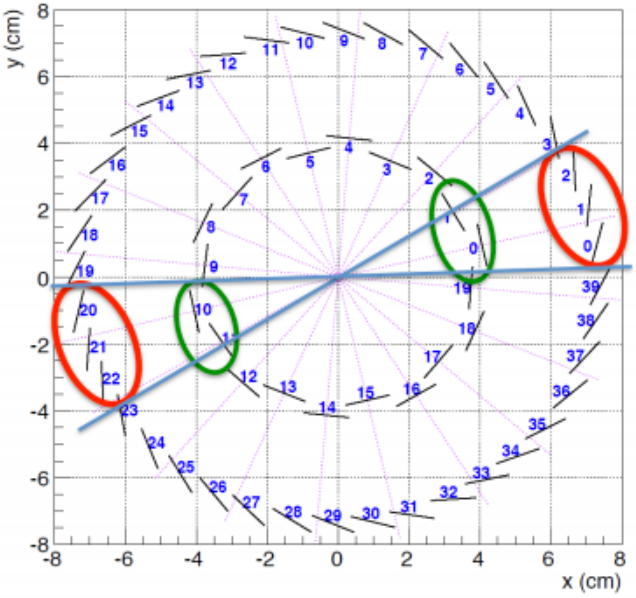
New measurement at $W_{\gamma p}$ > 1TeV

work in progress

ρ^0 photo-production in Pb-Pb (2015)



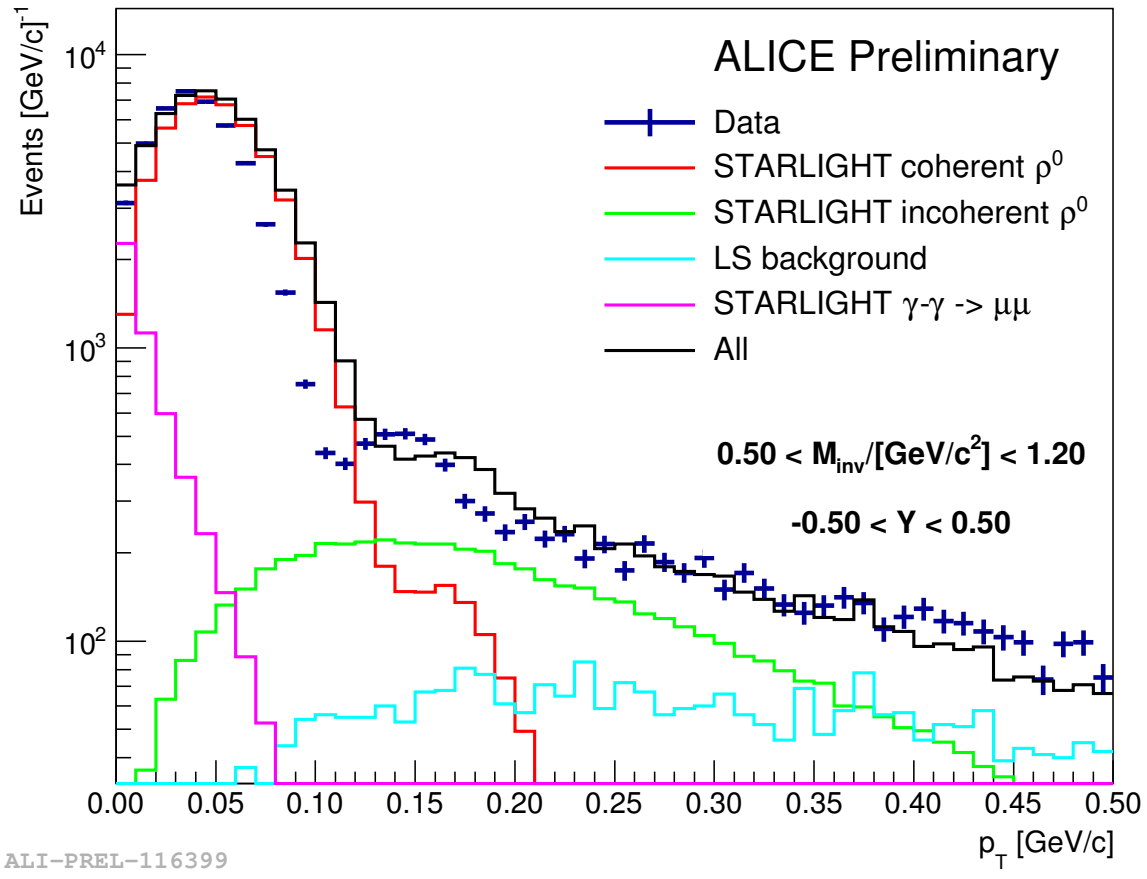
SPD topological trigger (L0)



- Trigger: vetoes on AD and on VZERO & SPD topological trigger
- Pion PID using TPC dE/dX
- Invariant-mass spectrum: ρ^0 with ω interference
- Acceptance × efficiency: STARLIGHT* MC and a flat (in M_{inv}, p_T) MC

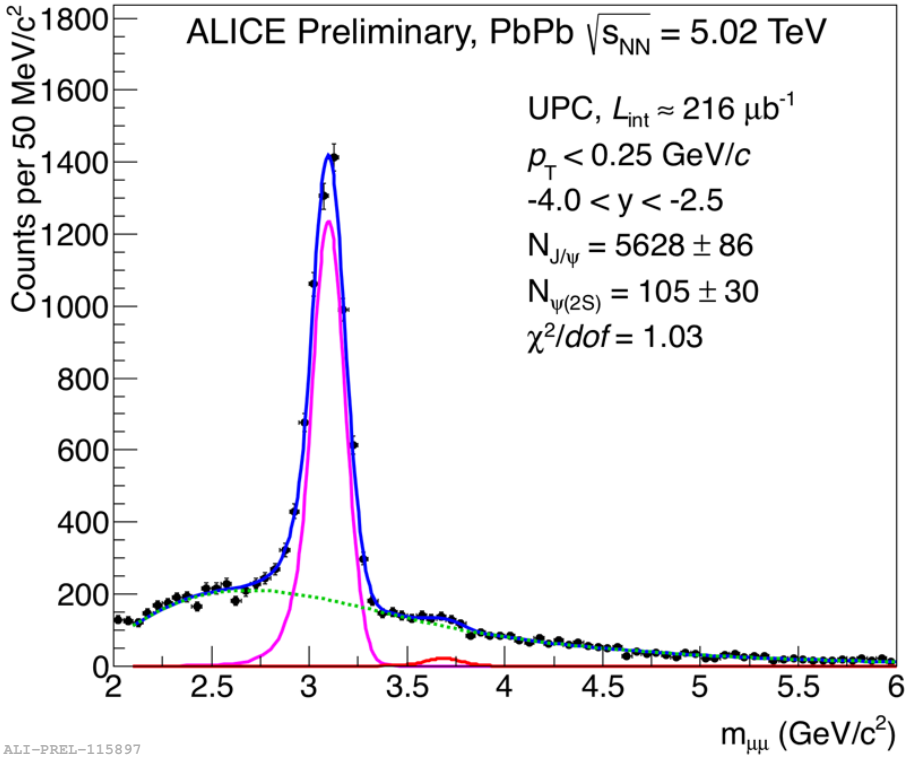
* Klein, Nystrand, et al., Comp. Phys. Comm. 212 (2017) 258-268.

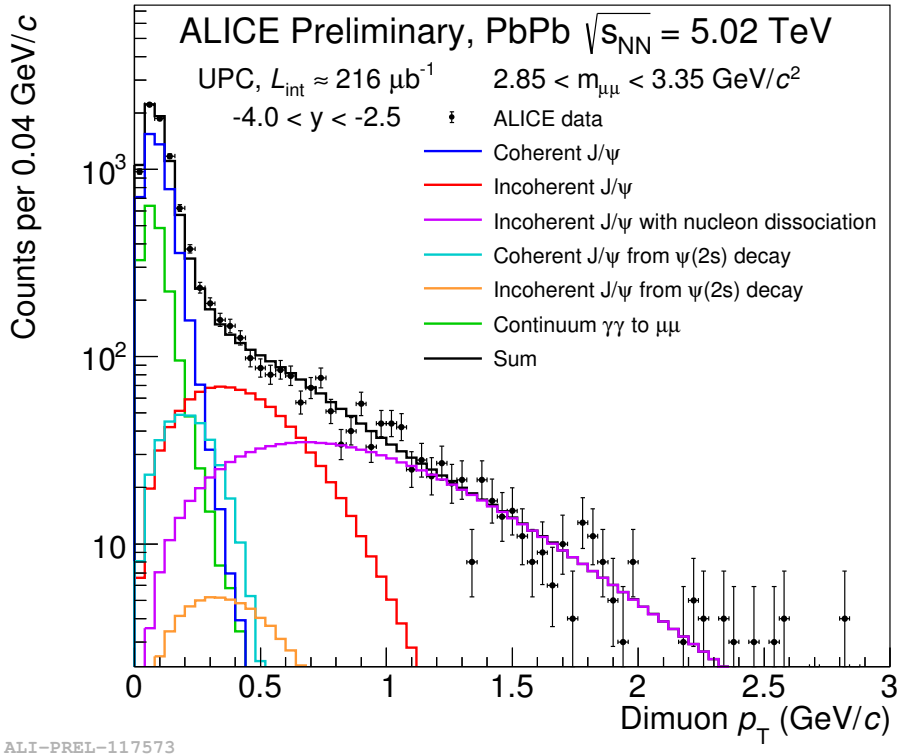
ρ^0 photo-production in Pb-Pb (2015)



- 1st and 2nd diffractive peaks can be clearly seen
- Very small like-sign bkgd.
- STARLIGHT description of the coherent peak in the p_T spectrum is too broad (as seen before in RUN1)

J/ψ photo-production in Pb-Pb (2015)

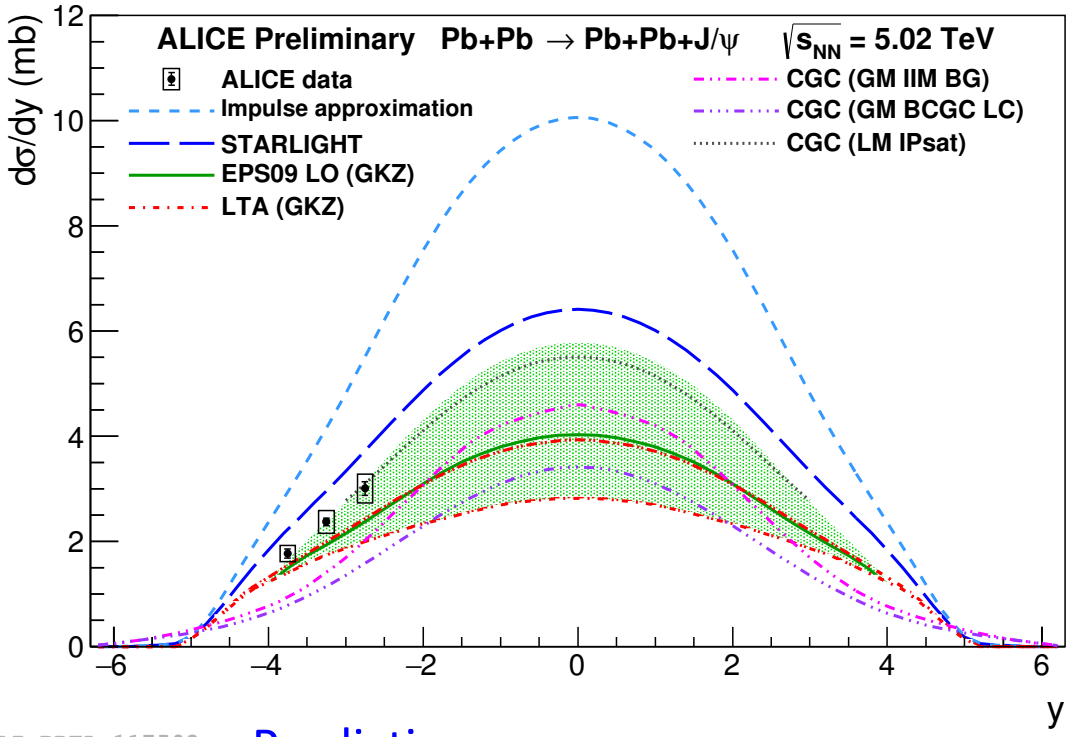




About 50 times more statistics than in RUN1

- Vetoes: ADA, ADC (offline), V0A offline. V0C empty or in beam timing, ≤2 hits in V0C, no SPD tracklets
- Shape of bkgd in the invariant-mass spectrum is described by MC
- Dimuon p_T templates for different processes come from STARLIGHT

J/ψ photo-production in Pb-Pb (2015)



Three rapidity ranges:

-4.0 < y < -3.5

-3.5 < y < -3.0

-3.0 < y < -2.5

References:

1) Comp. Phys. Comm. 212 (2017) 258
2) Phys. Rev. C93 (2016) 055206
3) Phys. Rev. C83 (2011) 065202, 87 (2013) 032201, and private communication,
4) arxiv:1612.06254; arxiv:1411.7918; arxiv:1407.4148

Predictions:

STARLIGHT (1) and an Impulse Approximation with no nuclear effects using STARLIGHT

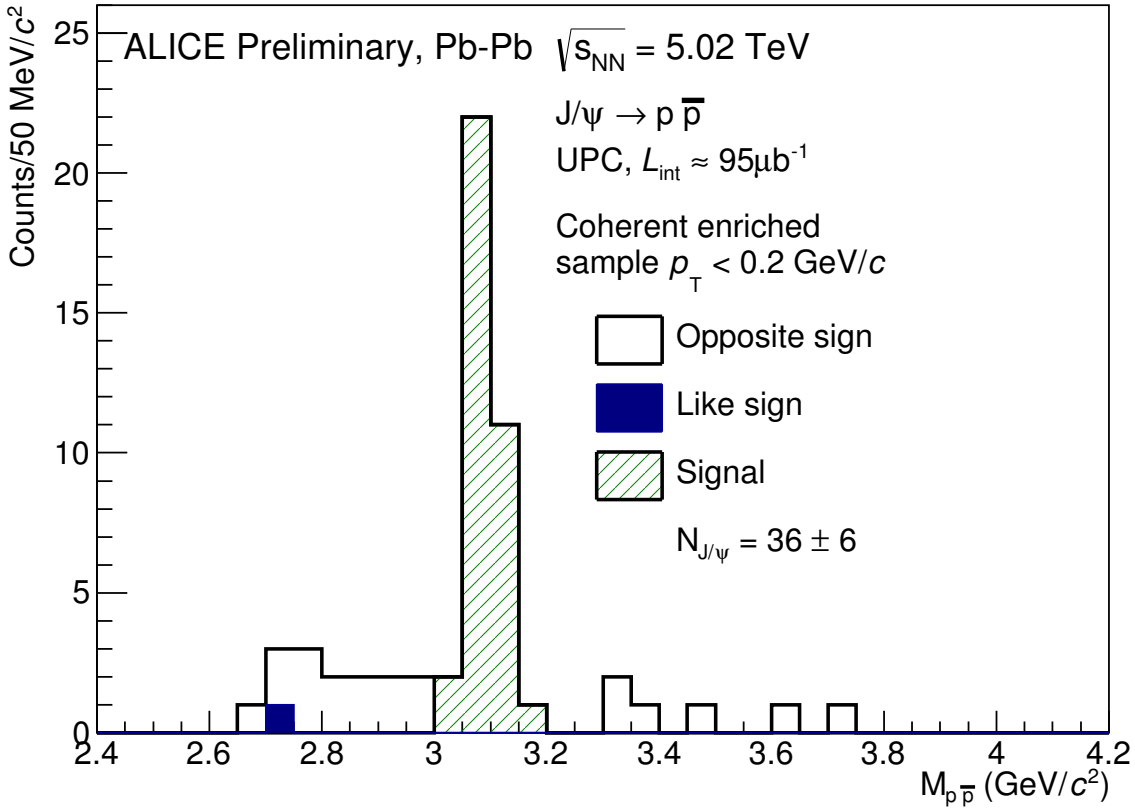
Leading-order EPS09 and using the Leading Twist Approximation (Guzey, Kryshen and Zhalov) (2)

CGC

IPSat12 (Lappi and Mäntysaari) (3)

Gonçalves, Machado (4) et al.: using two models for the dipole cross section (IIM/BCGC) and two different wave functions for the J/ψ (LC/BG)

J/ψ →ppbar photo-production in Pb-Pb (2015)



- First measurement of J/ψ →ppbar photo-production in Pb-Pb
- like-sign bkgd. is negligible
- continuum bkgd. might be γγ → ppbar

work in progress

the latest version of STARLIGHT includes this decay channel

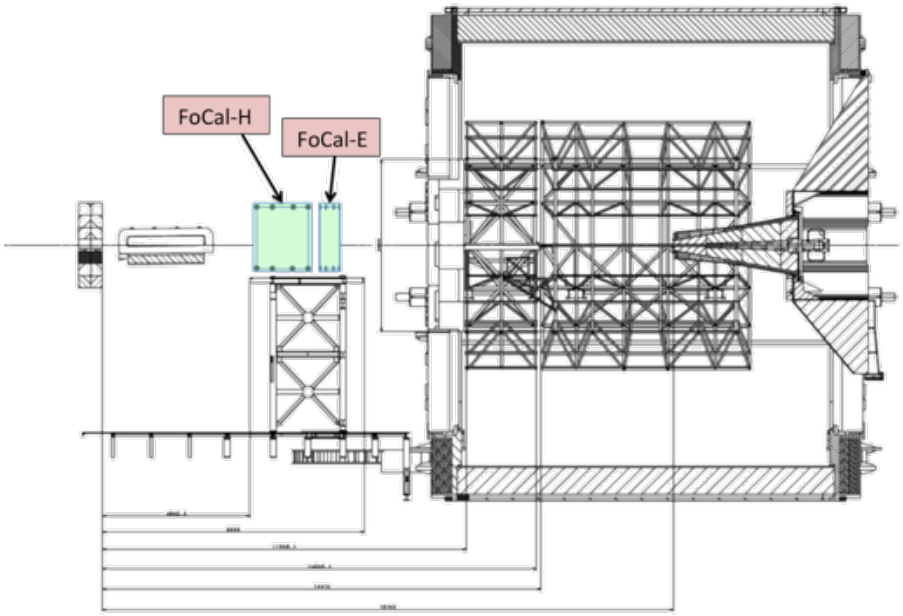
ALI-PREL-117138

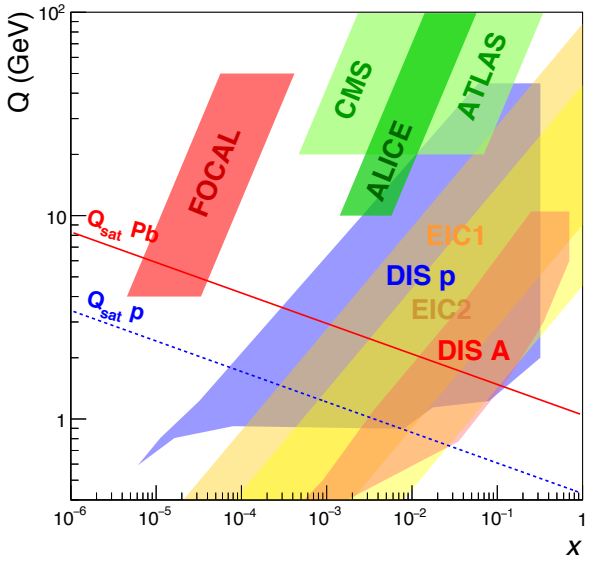
Summary

- Forward physics in ALICE in pp
  - measurement of INEL+diff. cross sections
  - central production (double-gap trigger)
  - proton dissociation measurements (ZDC)
- ALICE diffractive (AD) detector
  - improved exclusivity (veto)
  - coverage down to small diff. masses
  - 3rd luminometer in ALICE
- Forward physics in ALICE in p-Pp and Pb-Pb
  - photo-production of vector mesons
  - p-Pb allows to study gluon saturation
  - many new results from RUN2

Appendix

FoCal in ALICE





- main challenge: separate γ/π^0 at high energy
- need small Molière radius, high-granularity read-out
  - Si-W calorimeter, granularity ≈ 1mm^2

electromagnetic calorimeter for γ and π^0 measurement

preferred scenario:
- at z ≈ 7m (outside magnet)
  $3.3 < \eta < 5.3$
  (space to add hadr. calorimeter)

under internal discussion
possible installation in LS3

Thomas Peitzmann, "Performance and upgrade of ALICE"
LHC days in Split 19-24 September 2016 Split, Croatia