A quick look to the current potential for studying diffraction at the ALICE experiment at the LHC

WE-Heraeus Physics School

QCD - Old Challenges and New Opportunities

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Bad Honnef, Germany

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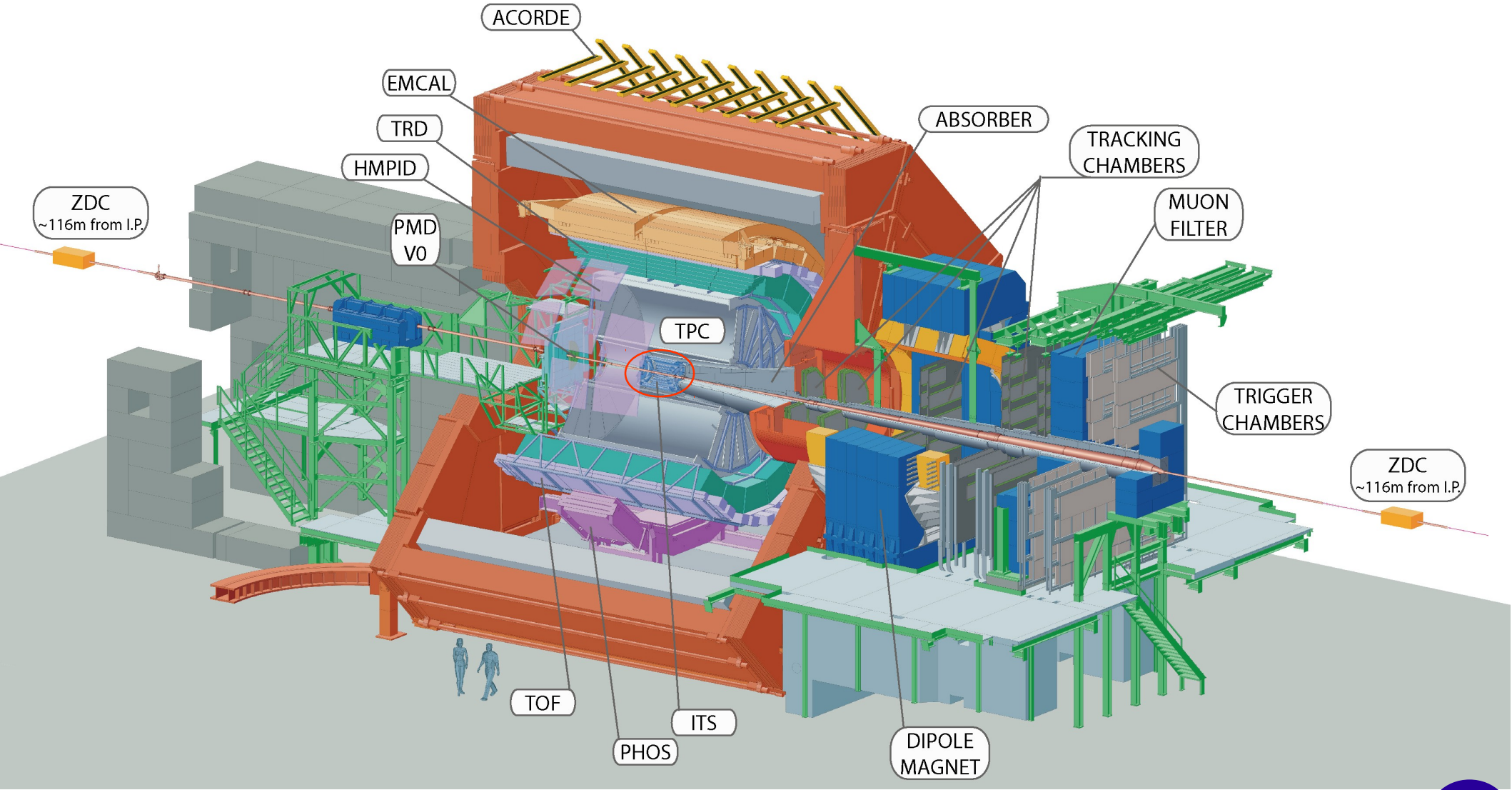
Potificia Universidad Católica del Perú

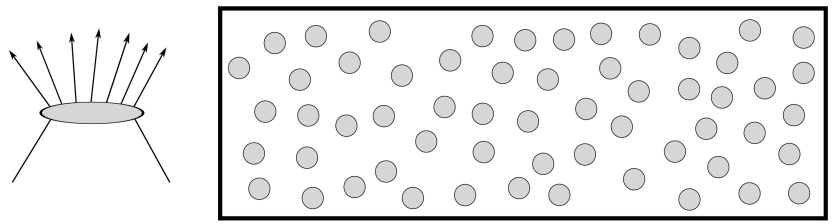
ALICE detectors



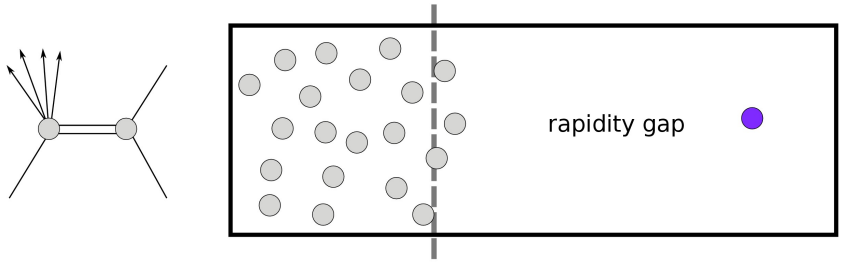
Diffraction in Run I

$$\sigma_{total} = \sigma_{elastic} + \sigma_{SD} + \sigma_{DD} + \sigma_{CD} + \sigma_{Non\text{-}Diff}$$

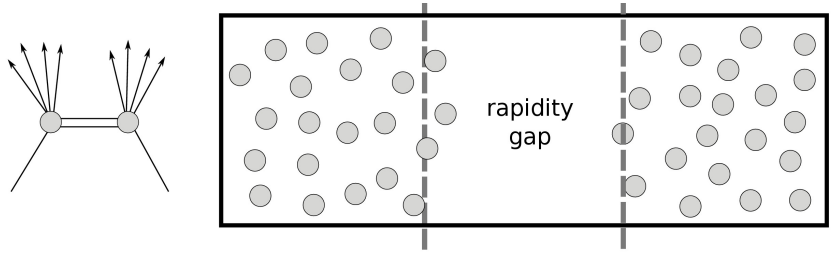
Non diffractive event (ND). No gap



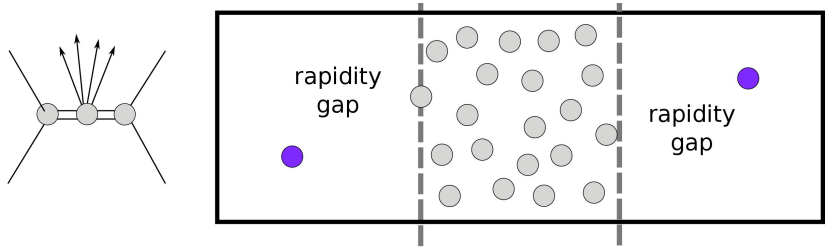
Single diffractive event (SD)



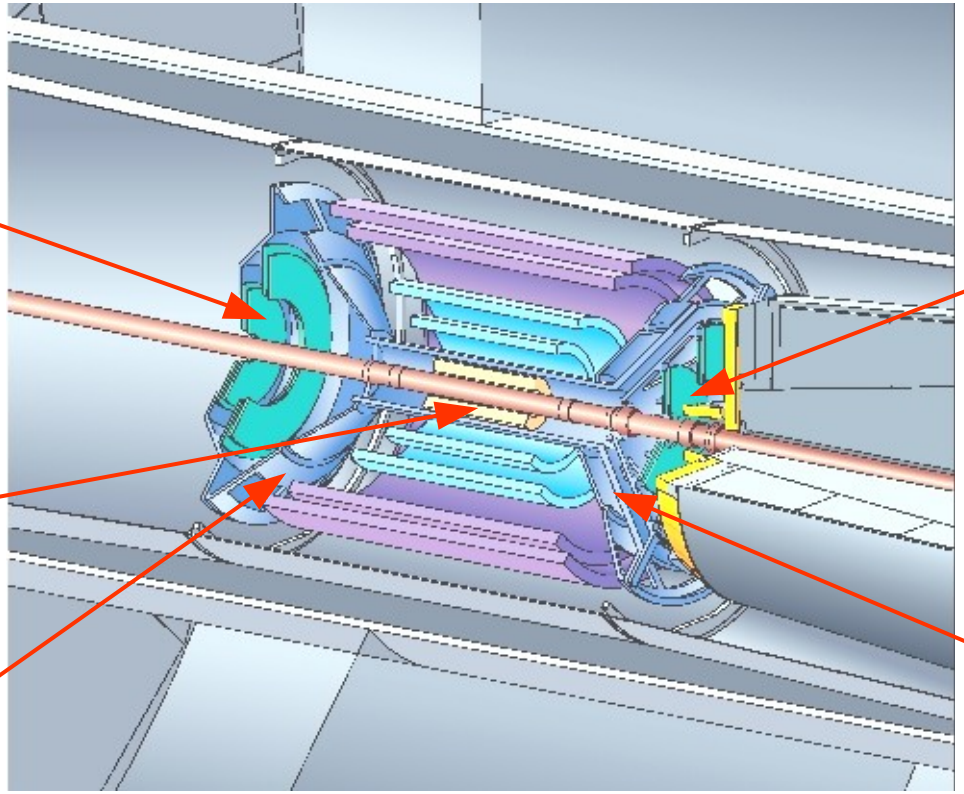
Double diffractive event (DD)

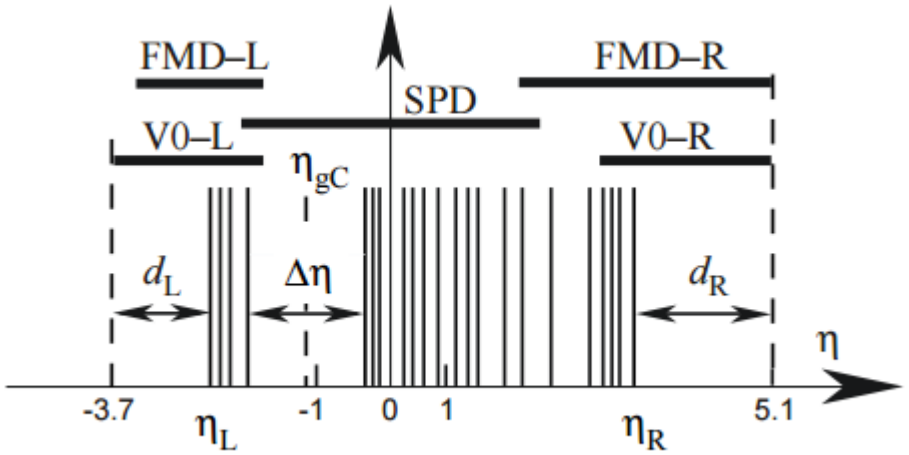


Central diffractive event (CD)



Diffraction in Run I



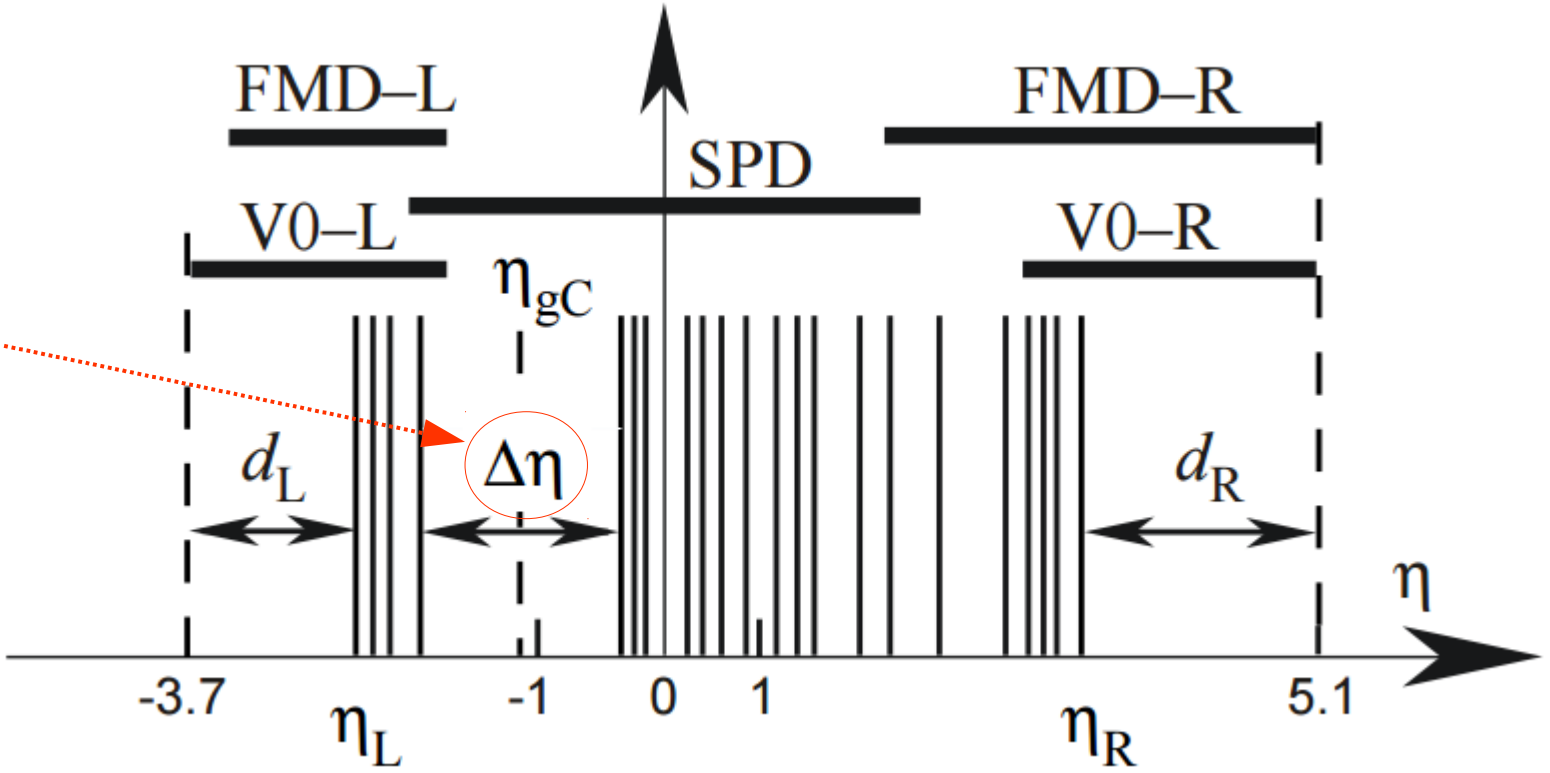


Diffraction in Run I

There are 3 event categories:

1-arm-L → **SD-L** (left or $\eta<0$)
1-arm-R → **SD-R** (right or $\eta>0$)
2-arm → **ND** and **DD** events

DD: 2-Arm and $\Delta\eta>3$



Diffraction in Run I: Classification procedure

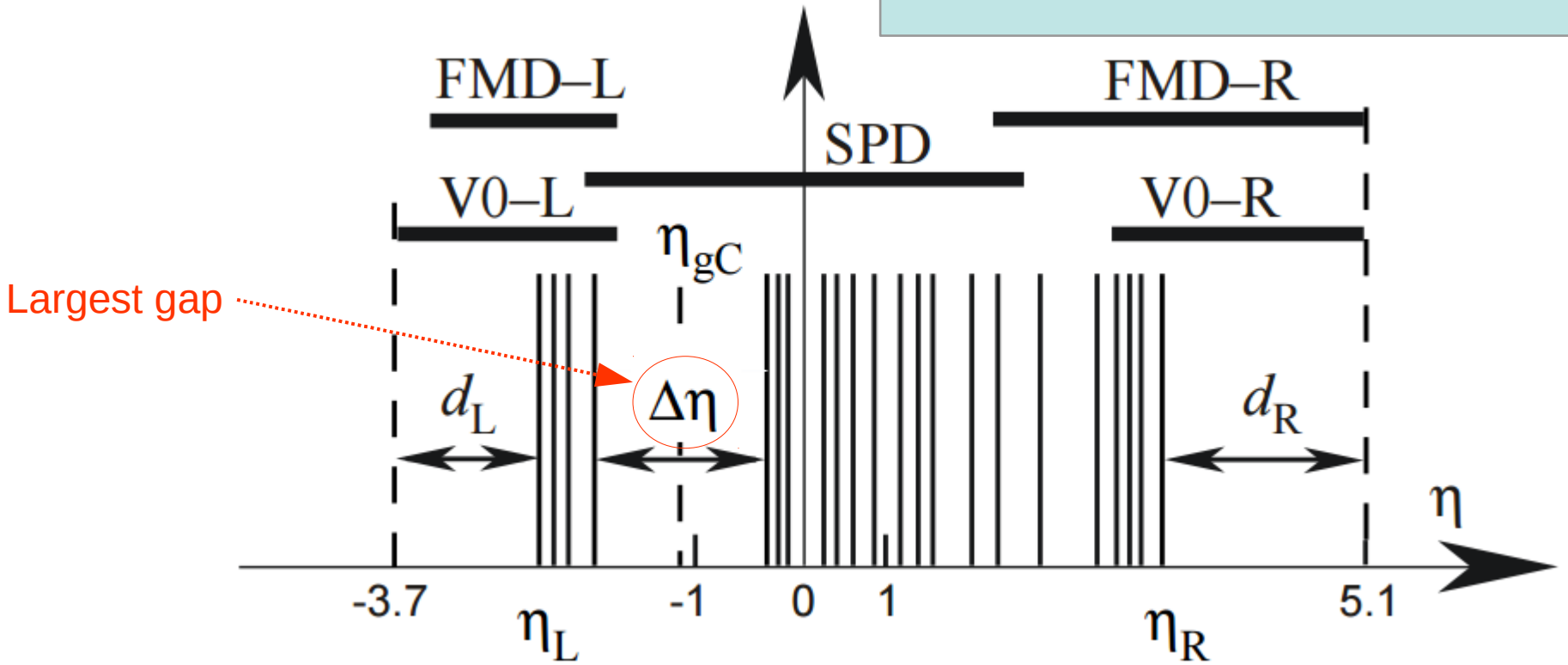
There are 3 event categories:
1-arm-L for **SD-L** (left or $\eta<0$)
1-arm-R for **SD-R** (right or $\eta>0$)
2-arm for ND and DD events

DD: 2-Arm and $\Delta\eta>3$

one-track event: all events satisfying the condition $(\eta_R-\eta_L) < 0.5$ and having all pseudo-tracks within 45◦ in ϕ,

For them we use:

$\eta_C = 1/2(\eta_L + \eta_R)$
If $\eta_C < 0$: → 1-arm-L
If $\eta_C > 0$: → 1-arm-R



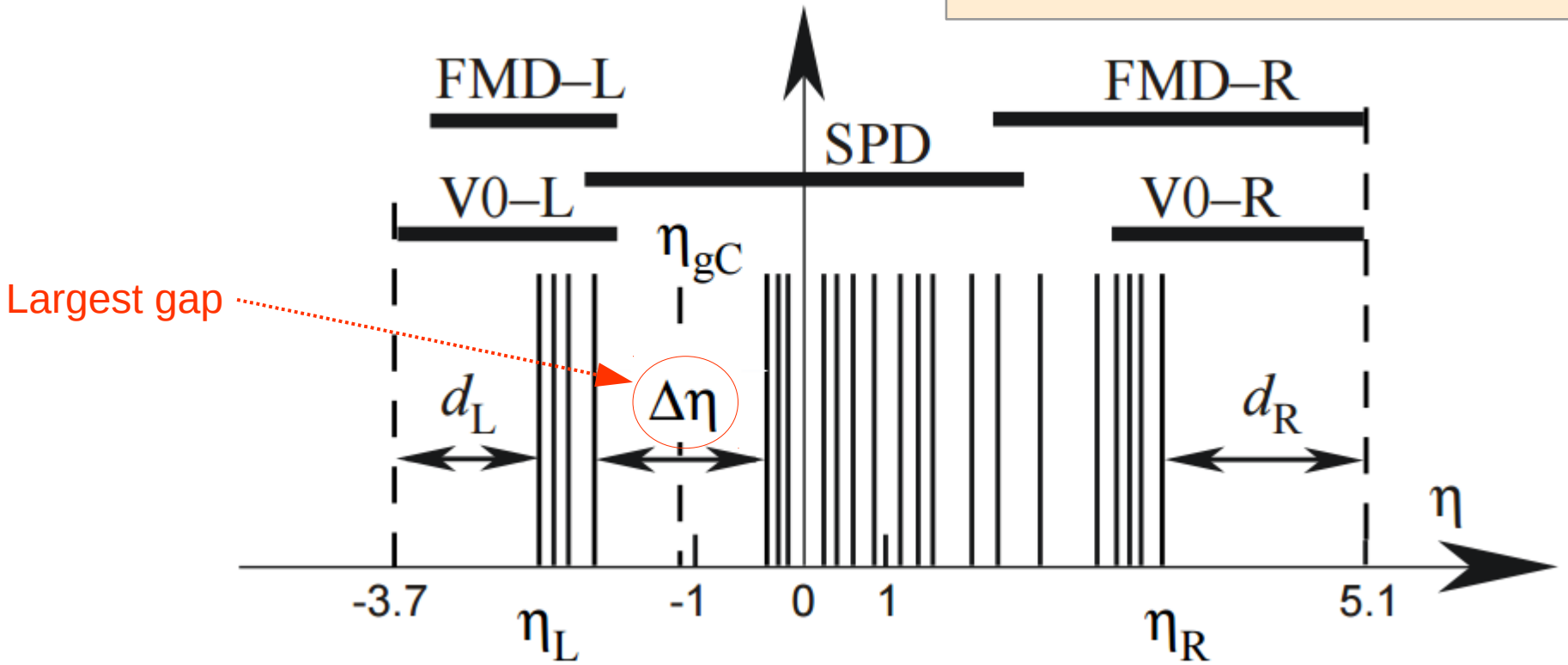
Diffraction in Run I: Classification procedure

There are 3 event categories:
1-arm-L for **SD-L** (left or η<0)
1-arm-R for **SD-R** (right or η>0)
2-arm for ND and DD events

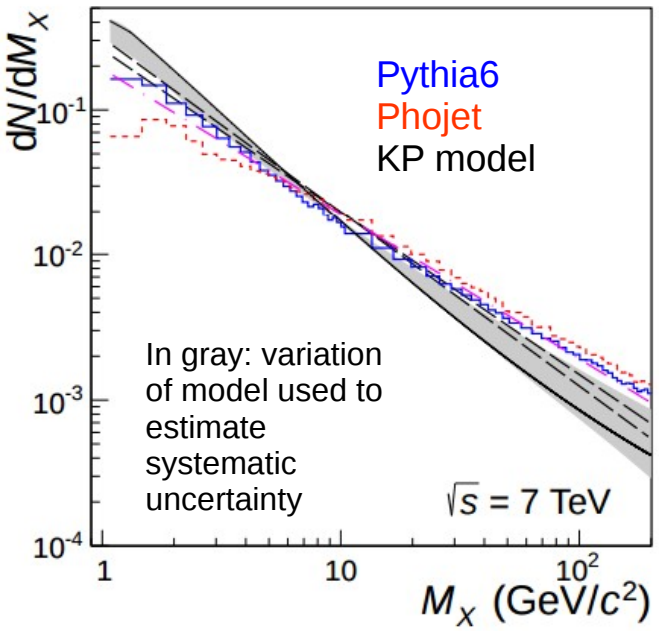
DD: 2-Arm and Δη>3

Otherwise, is a **multi**-track event,

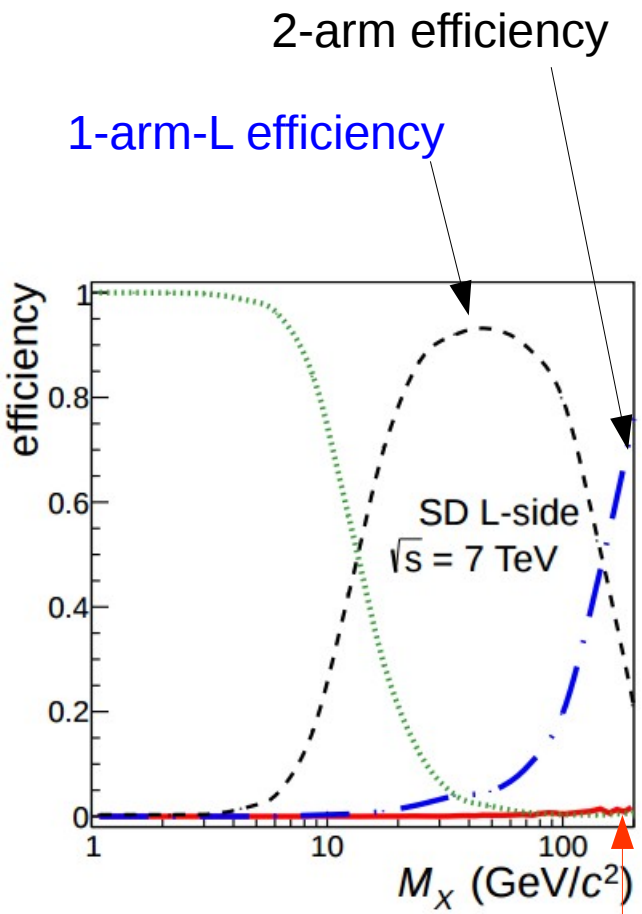
If Δη is larger than d_R and d_L → 2-arm
If -1<η<1 → 2-arm
else,
If η_R<1 → 1-arm-L
If η_L>-1 → 1-arm-R
Any remaining events → 2-arm

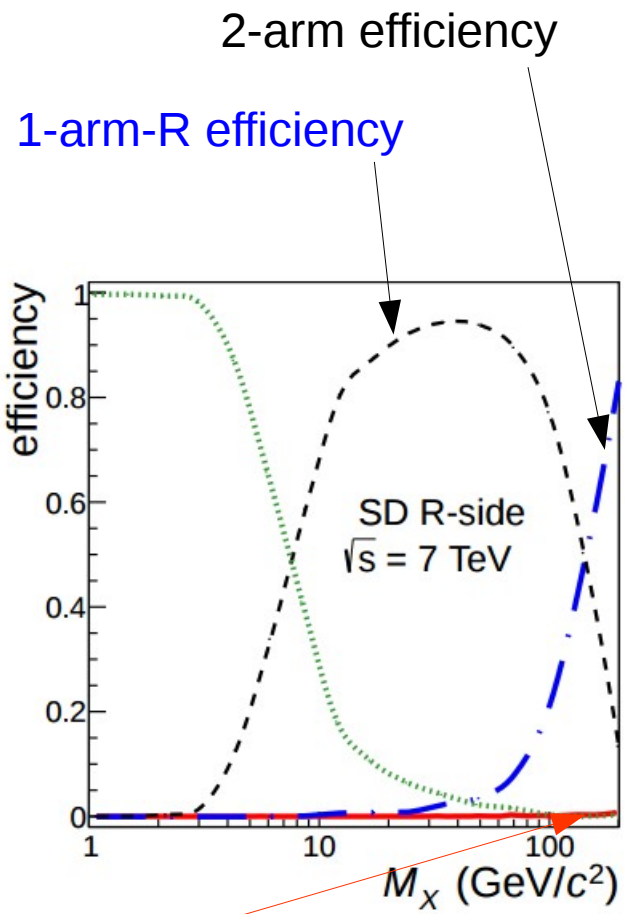


Diffraction in Run I: MC adjustment



Diffractive-mass distributions, normalized to unity, for the SD process in pp collisions (7 TeV)

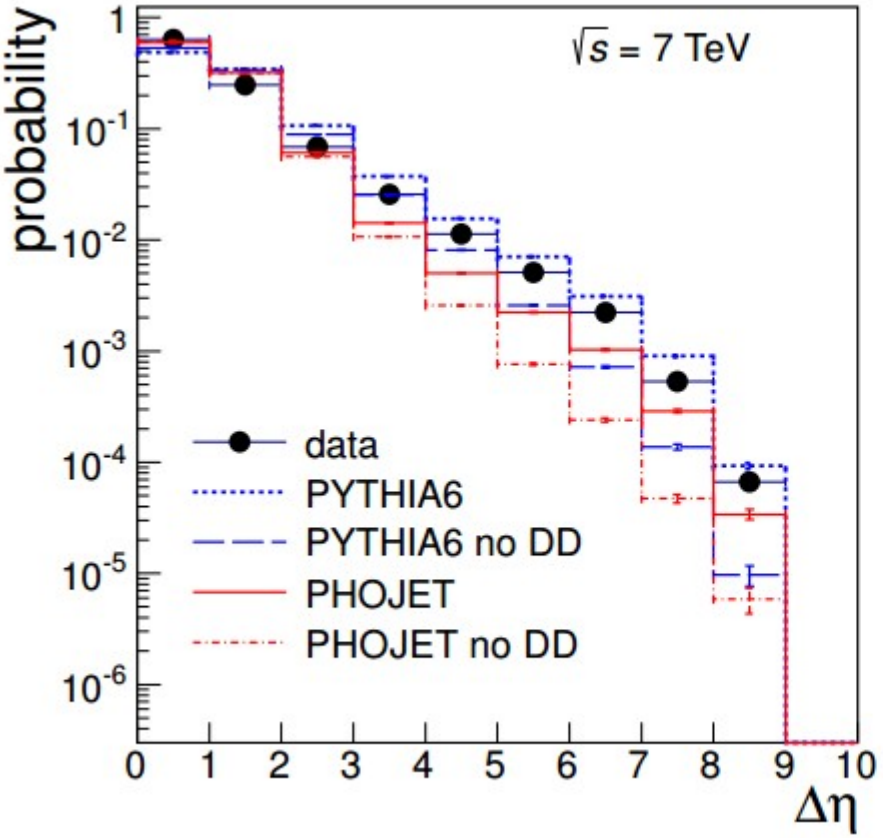




Opposite side efficiency

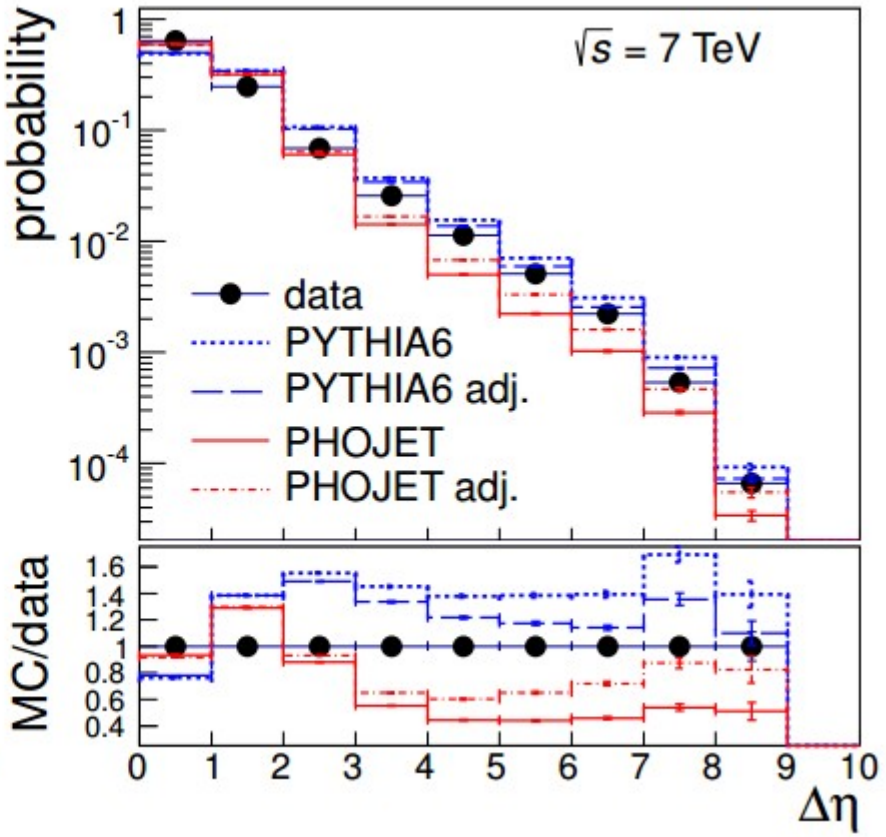
Diffraction in Run I: MC adjustment

Largest gap distribution:
Comparison between the data and MC with and without double-diffraction



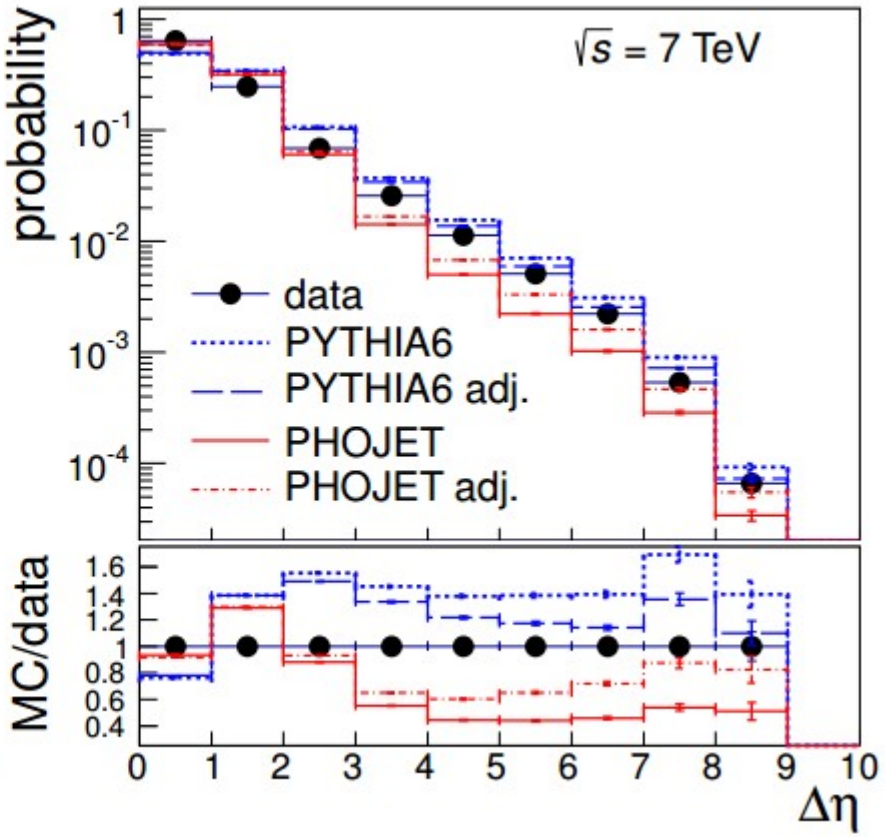
Diffraction in Run I: MC adjustment

DD fraction in MC is adjusted to data

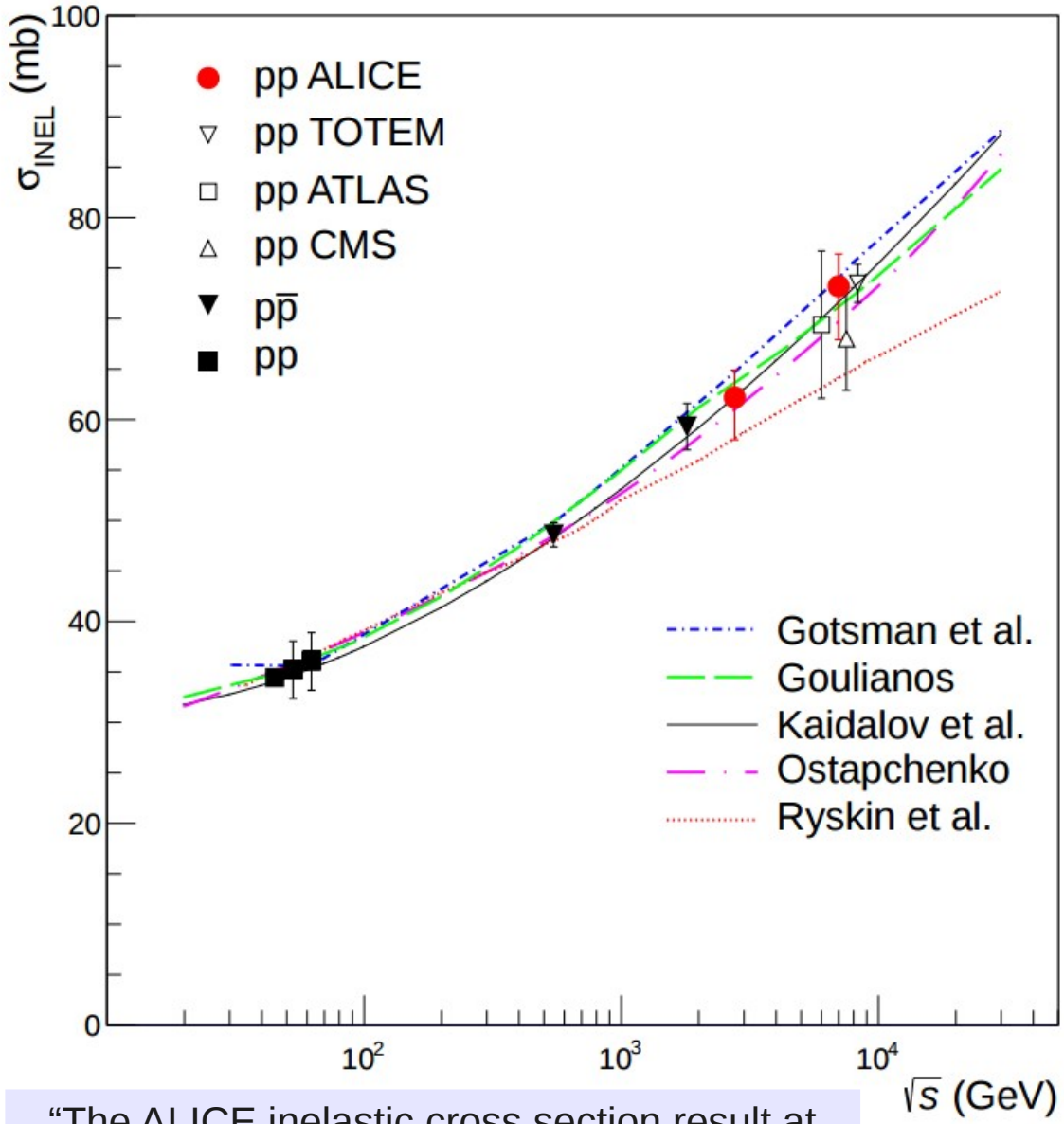


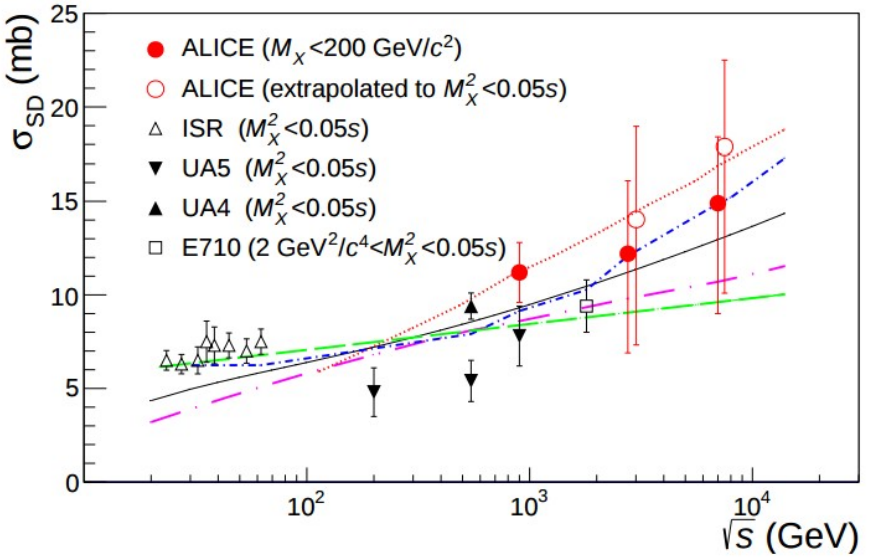
Diffraction in Run I: MC adjustment

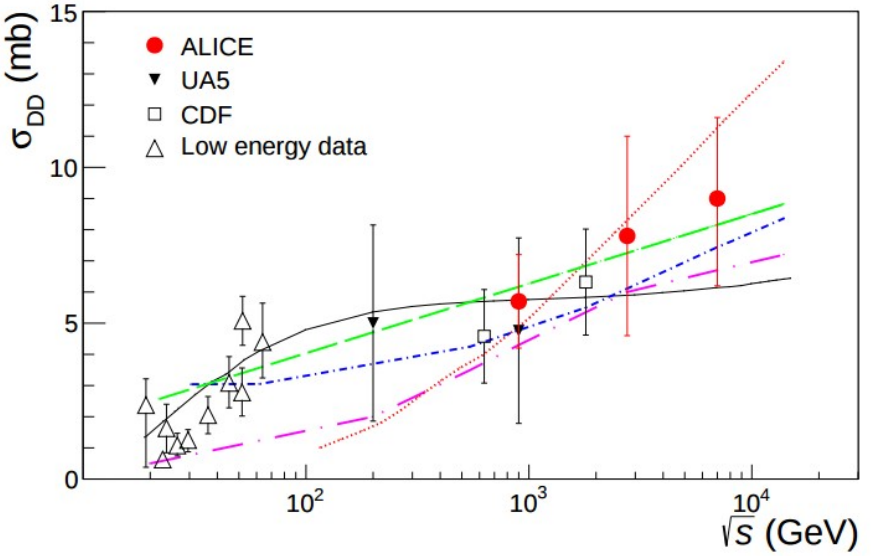
DD fraction in MC is adjusted to data



Diffraction in Run I: Results





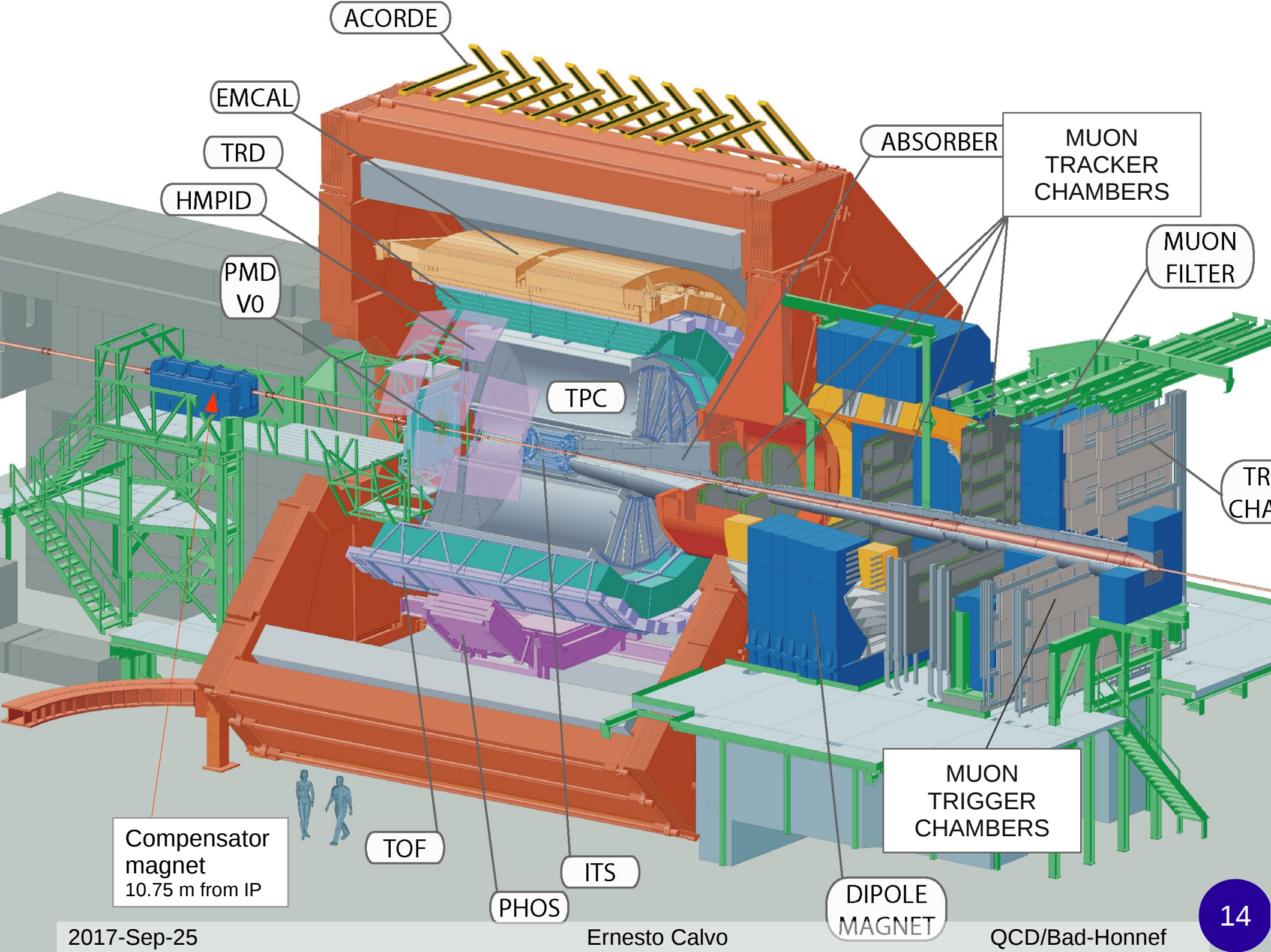


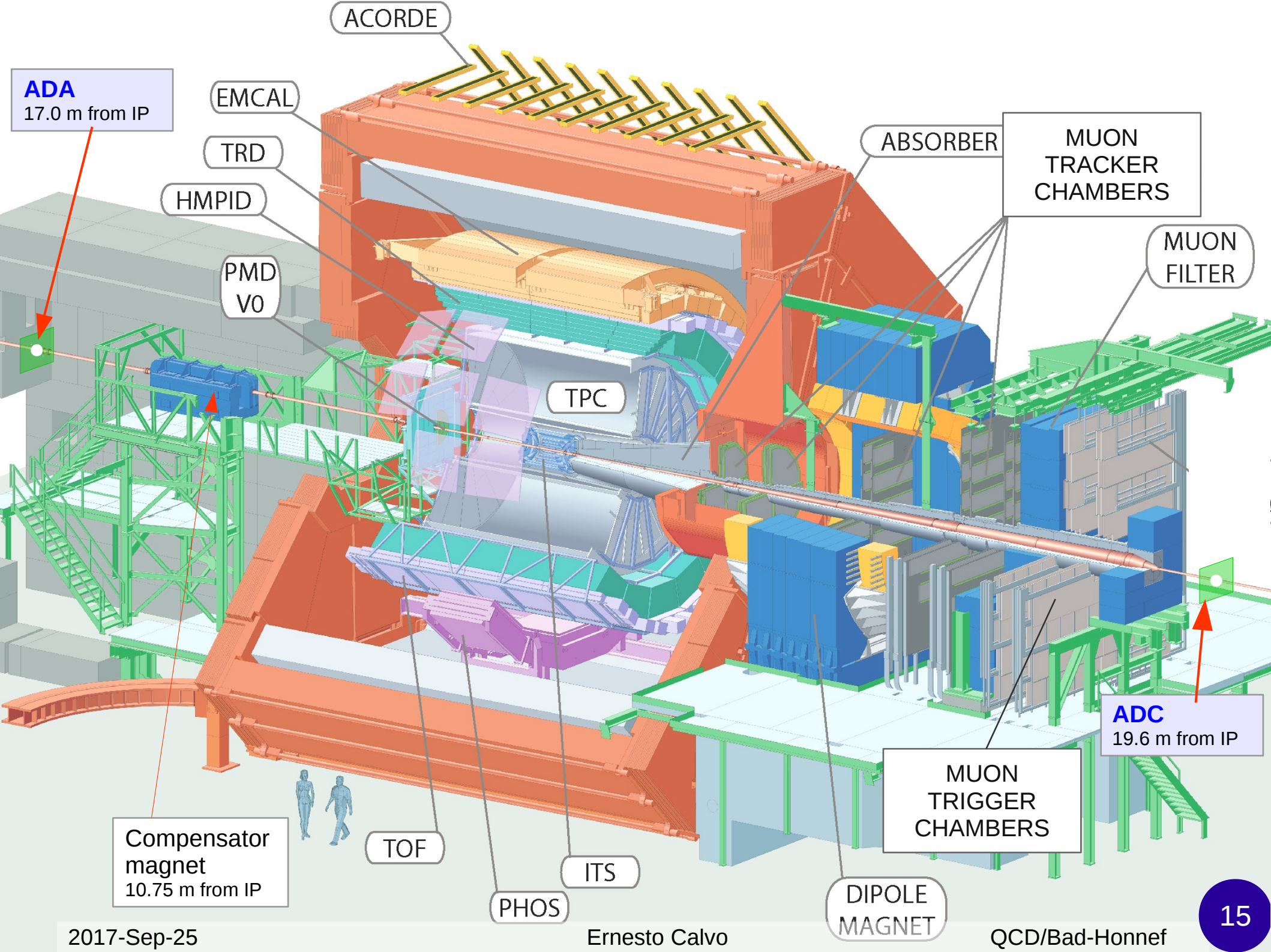
"The ALICE inelastic cross section result at √s = 7 TeV is consistent with those from ATLAS, CMS, and TOTEM"

ALICE: Eur.Phys.J. C73 (2013) no.6, 2456

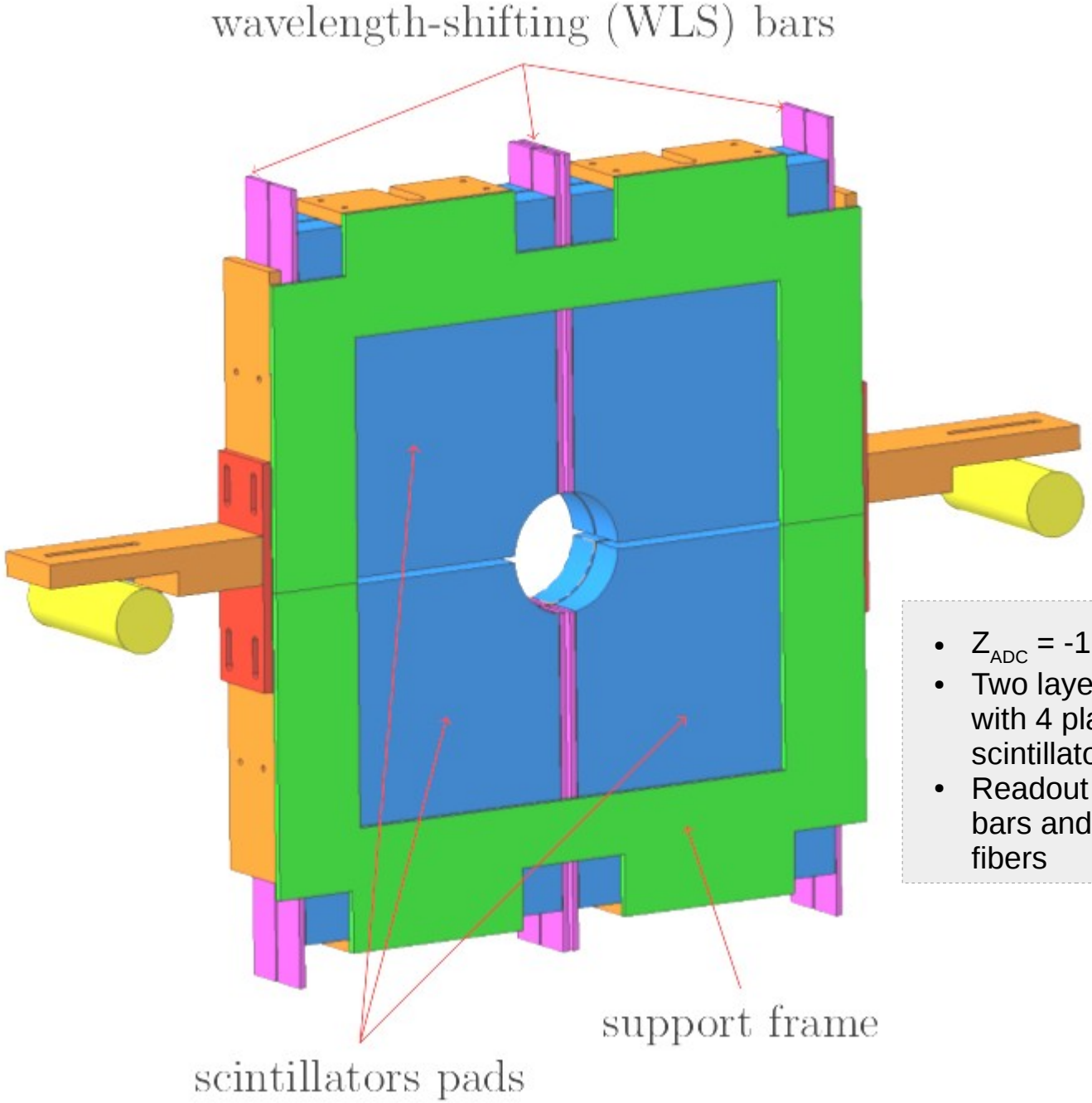
Diffraction in Run II

- At the end of run I the **ALICE Diffractive** detector (**AD**) was installed and commissioned, with the aim of increasing the pseudorapidity coverage and the sensitivity of ALICE to low mass diffractive systems.
- Two stations, ADA and ADC, located at z=-19.6 and z=17.0 meters respectively from the interaction point (IP).

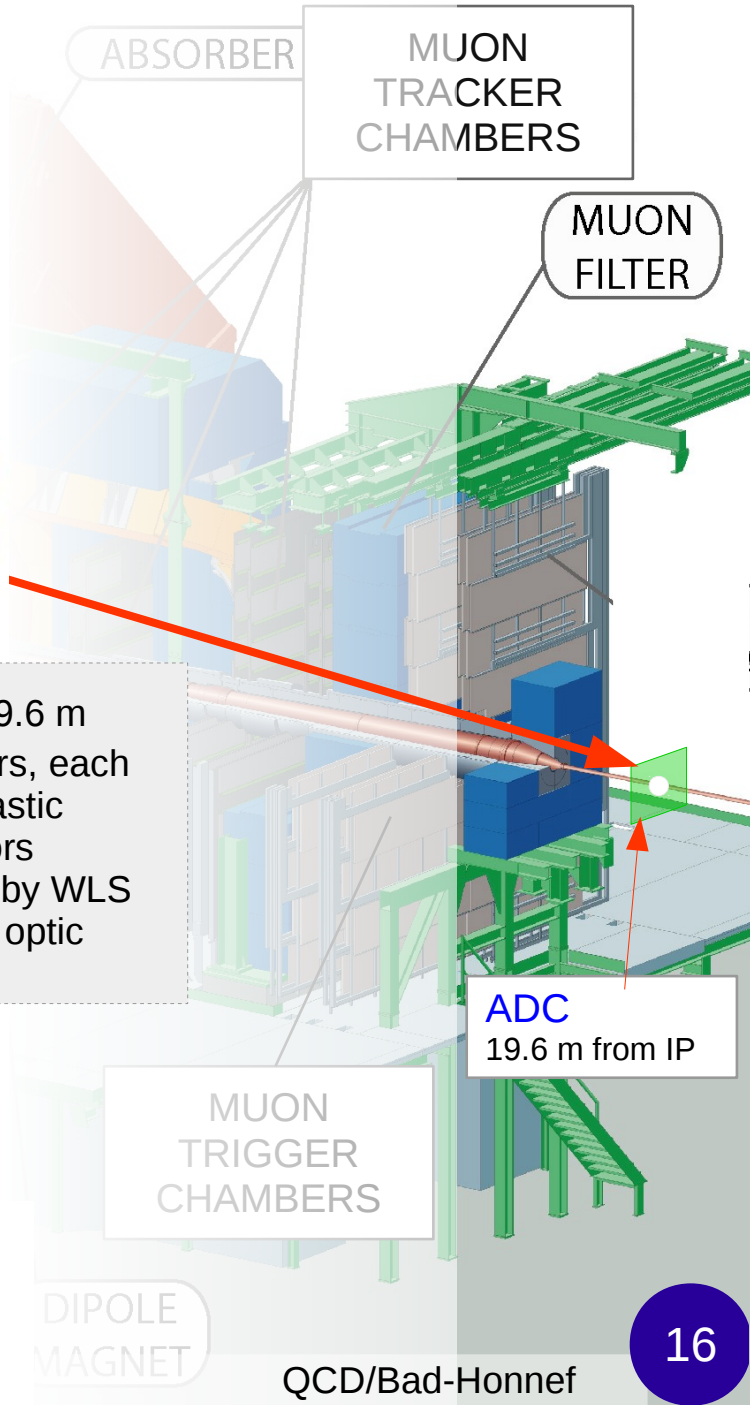

ACORDE
EMCAL
TRD
HMPID
PMD
V0
TPC
ABSORBER
MUON
TRACKER
CHAMBERS
MUON
FILTER
TR
CHA
MUON
TRIGGER
CHAMBERS
Compensator
magnet
10.75 m from IP
TOF
ITS
PHOS
DIPOLE
MAGNET


ACORDE
ADA
17.0 m from IP
EMCAL
TRD
HMPID
PMD
V0
ABSORBER
MUON
TRACKER
CHAMBERS
MUON
FILTER
TPC
ADC
19.6 m from IP
MUON
TRIGGER
CHAMBERS
Compensator
magnet
10.75 m from IP
TOF
ITS
PHOS
DIPOLE
MAGNET

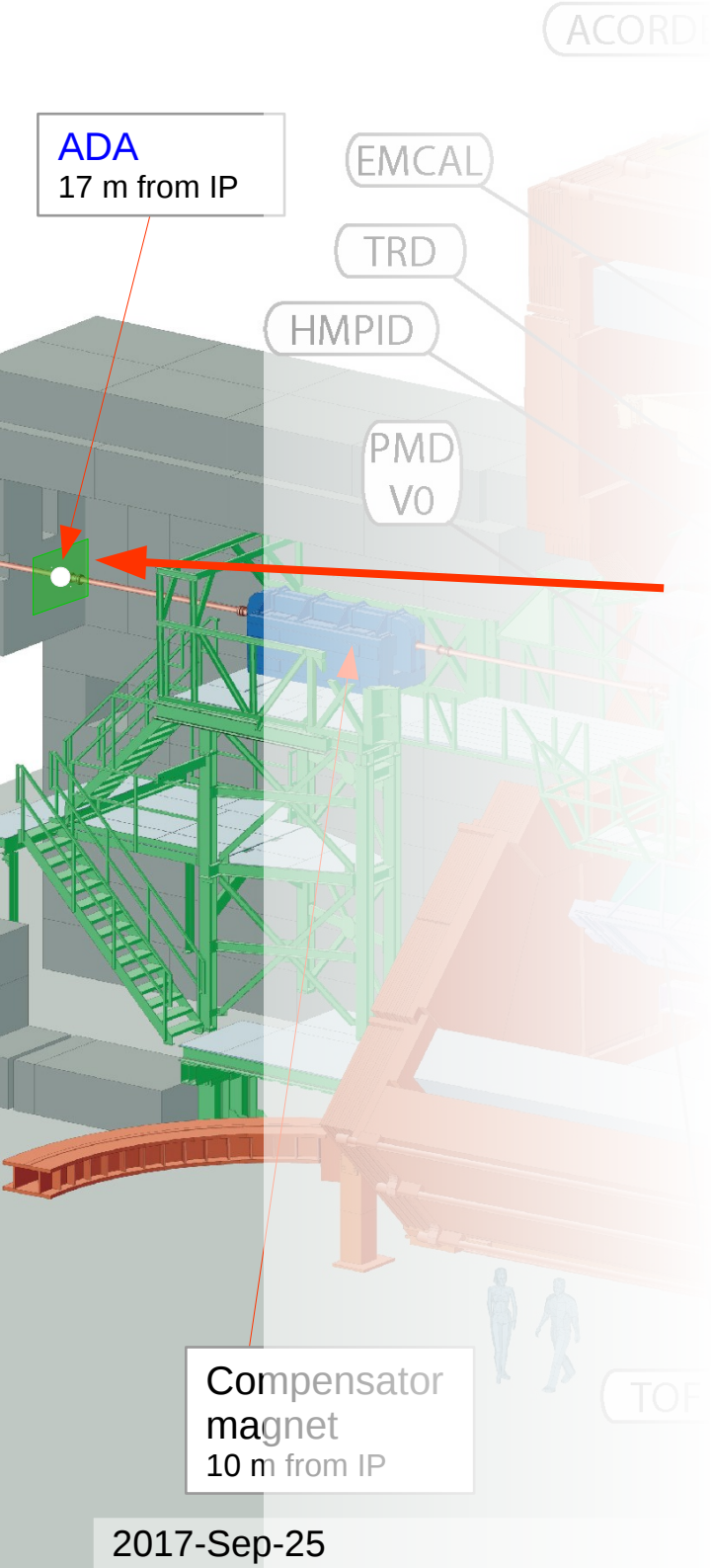
ADC Detector

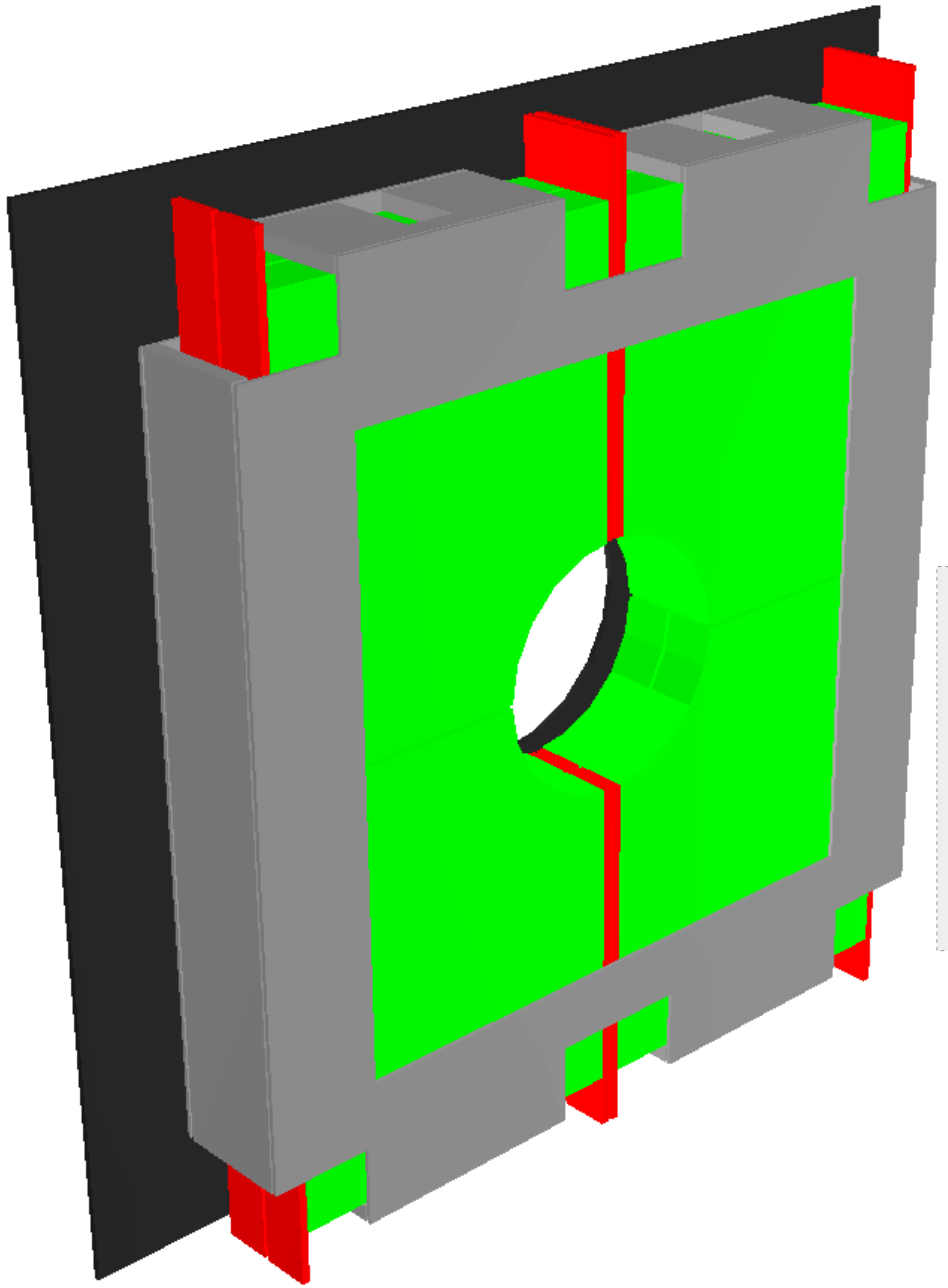


- Z_{ADC} = -19.6 m
- Two layers, each with 4 plastic scintillators
- Readout by WLS bars and optic fibers



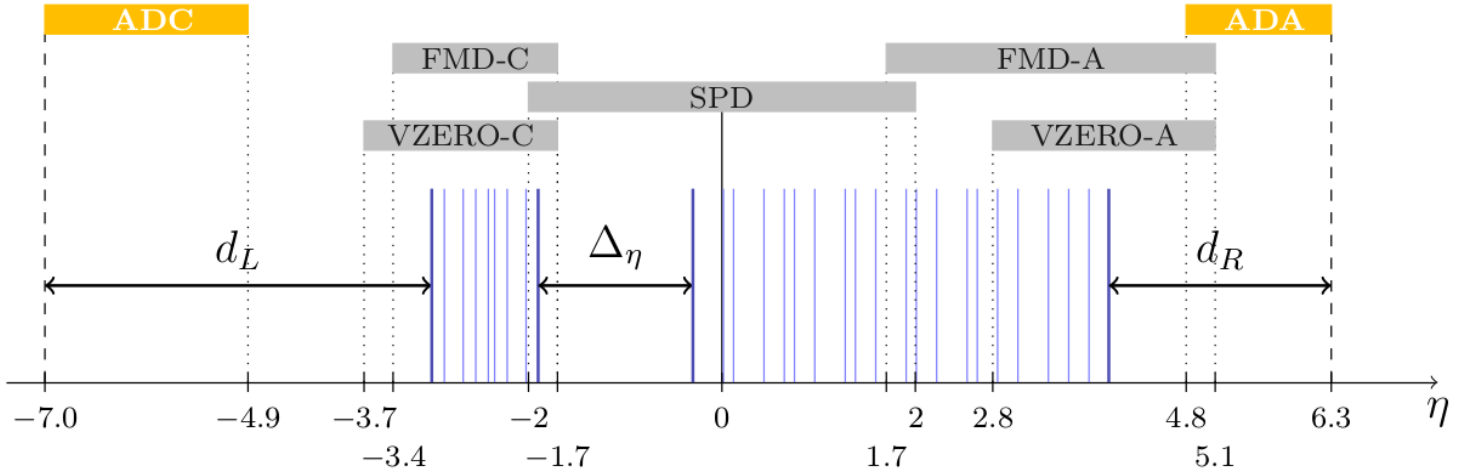
ADA Detector



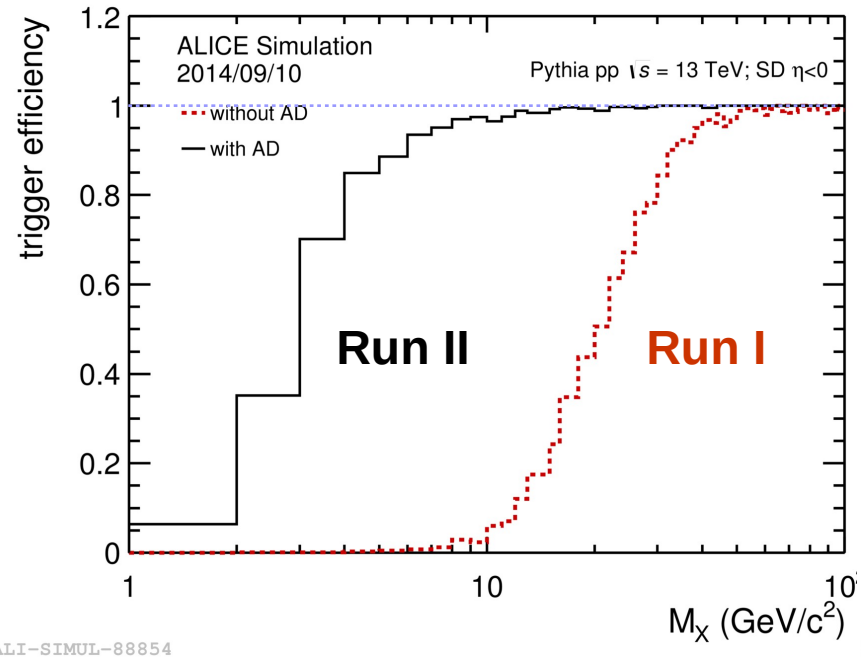


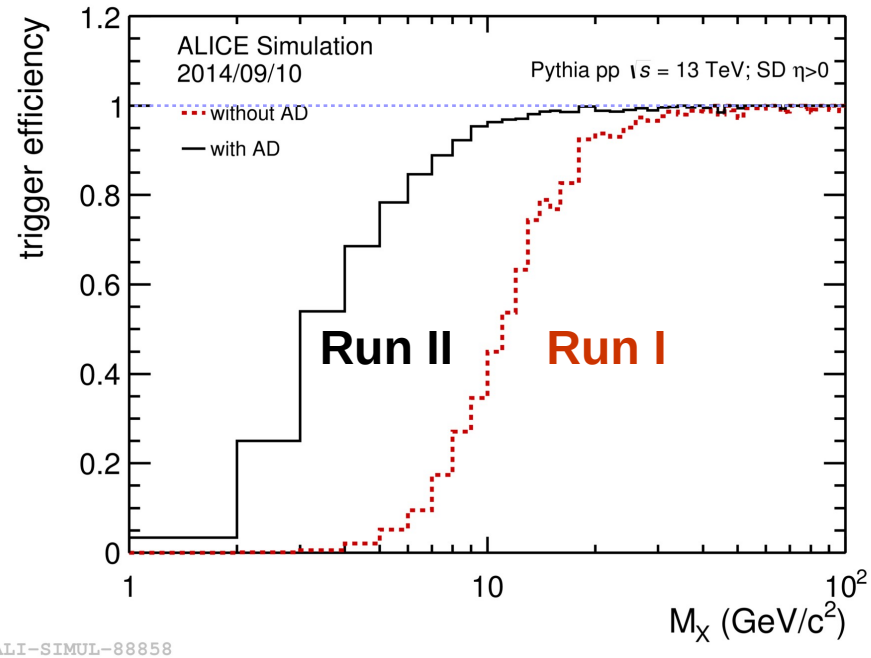
- Z_{ADA} = +17.0 m
- Two layers, each with 4 plastic scintillators
- Readout by WLS bars and optic fibers

AD Performance



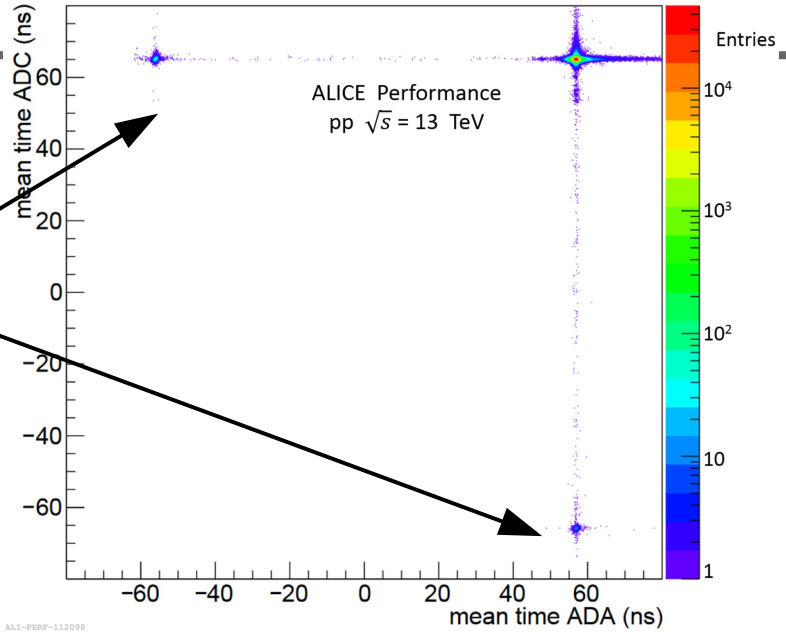
Improved trigger efficiency at low M_x: MB_{OR} = ADC || V0C || SPD || V0A || ADA





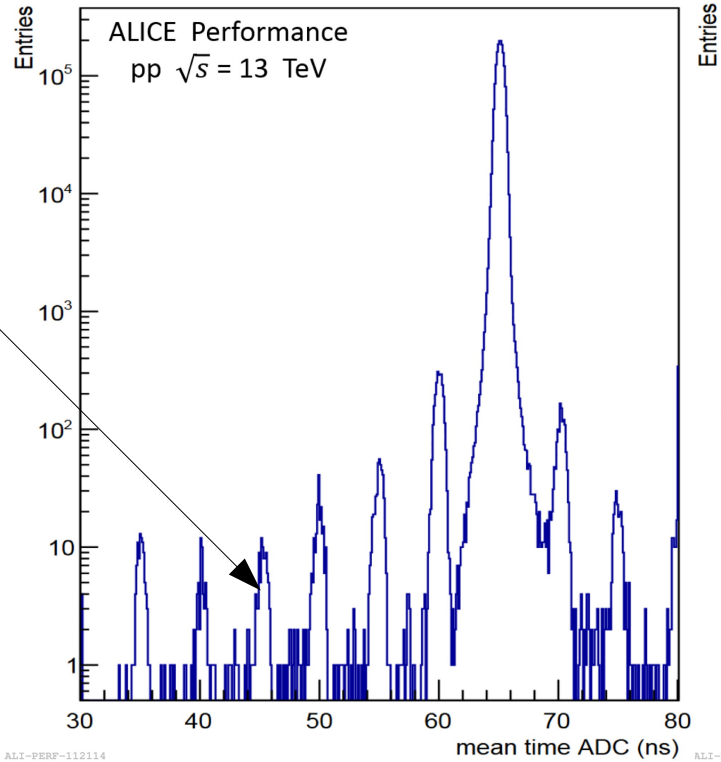
AD Performance

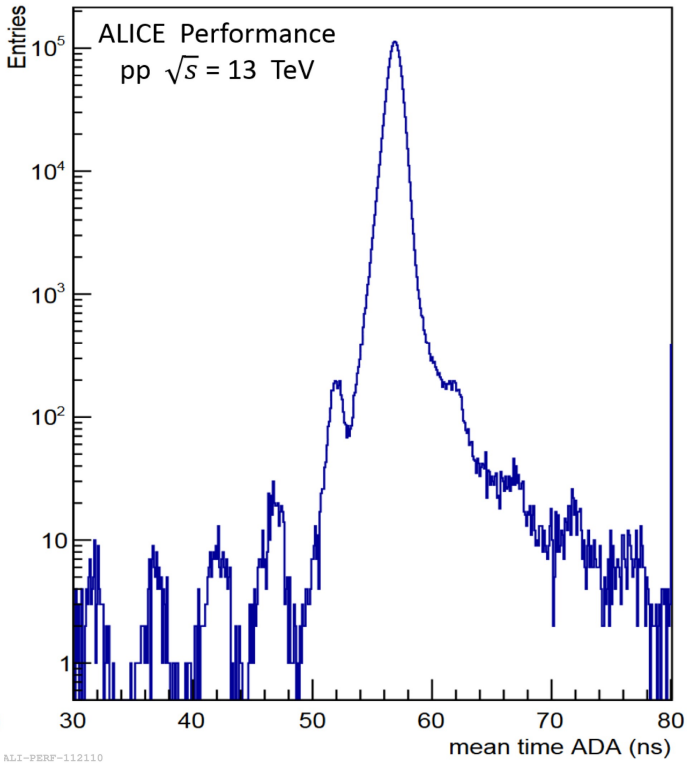
Excellent Beam-Gas separation



General characteristics of the AD detector

Highly sensitive: Satellites are clearly visible

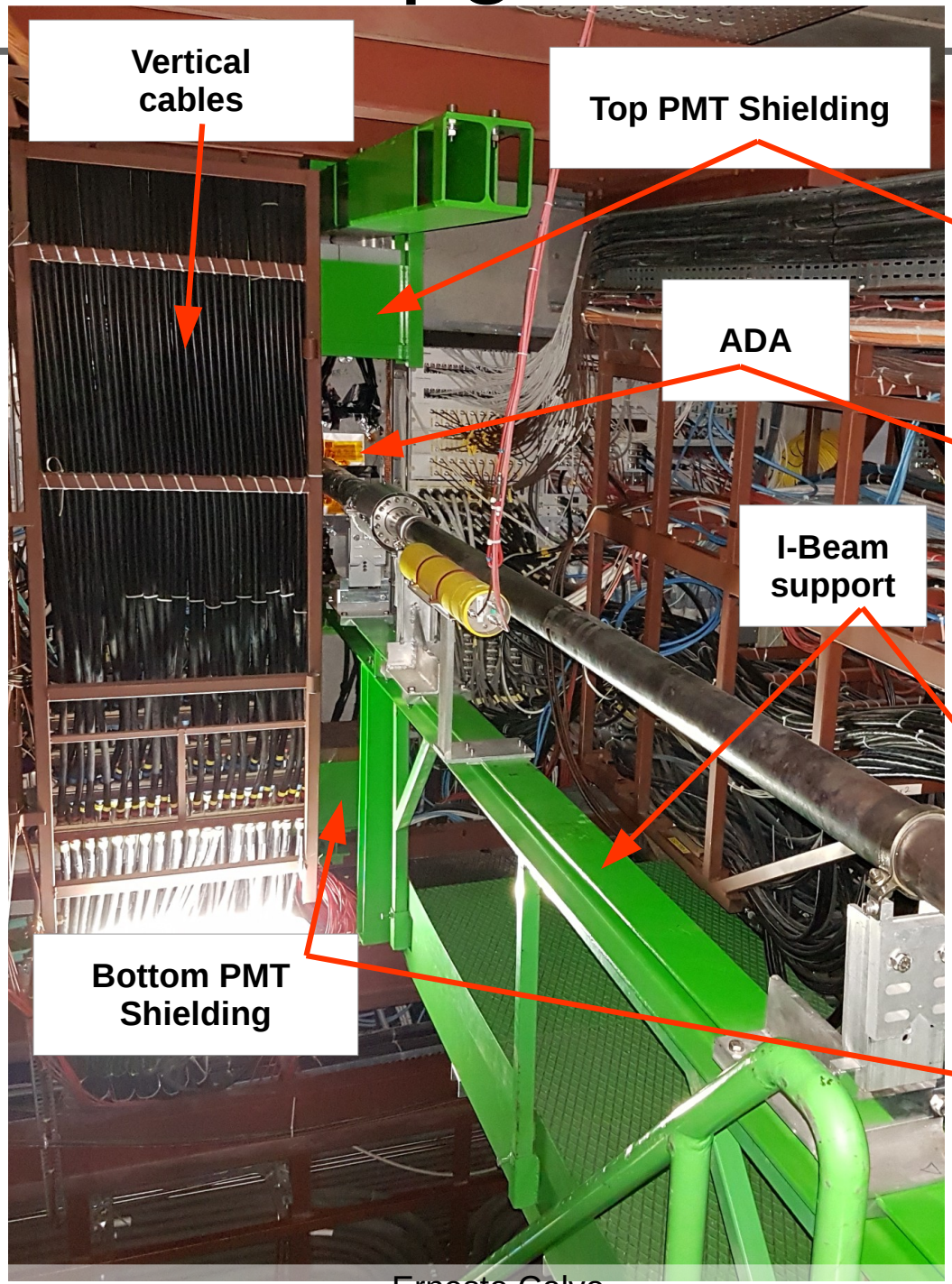


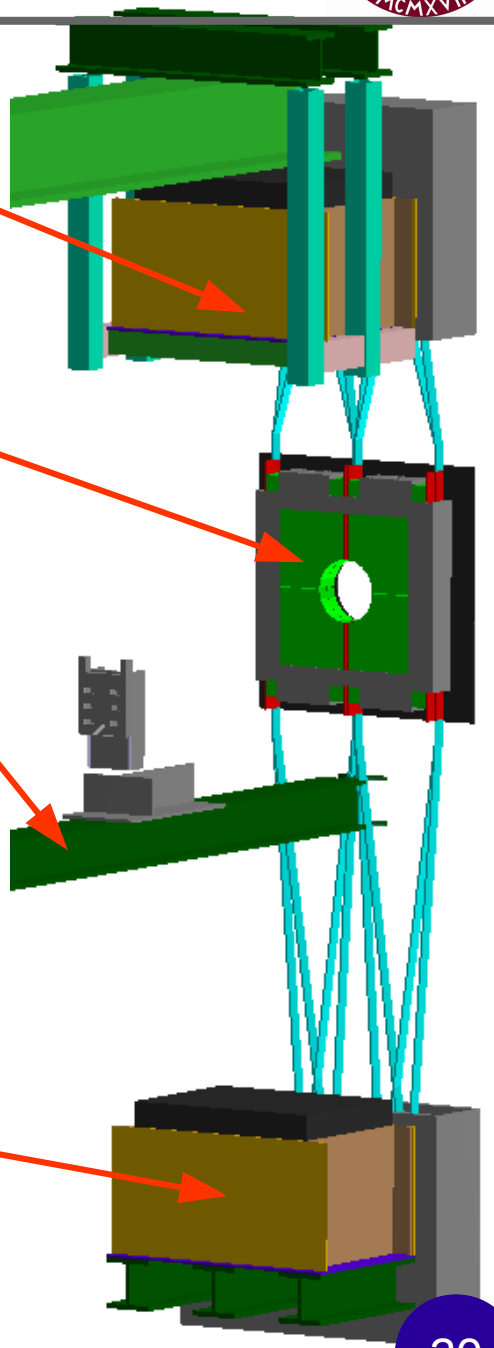


AD Upgrades

Left: Iron Shielding was added in front of the PMT boxes to protect the PMTs from direct particles hits, improving AD signal.

Right: AD Simulation correspondingly updated.

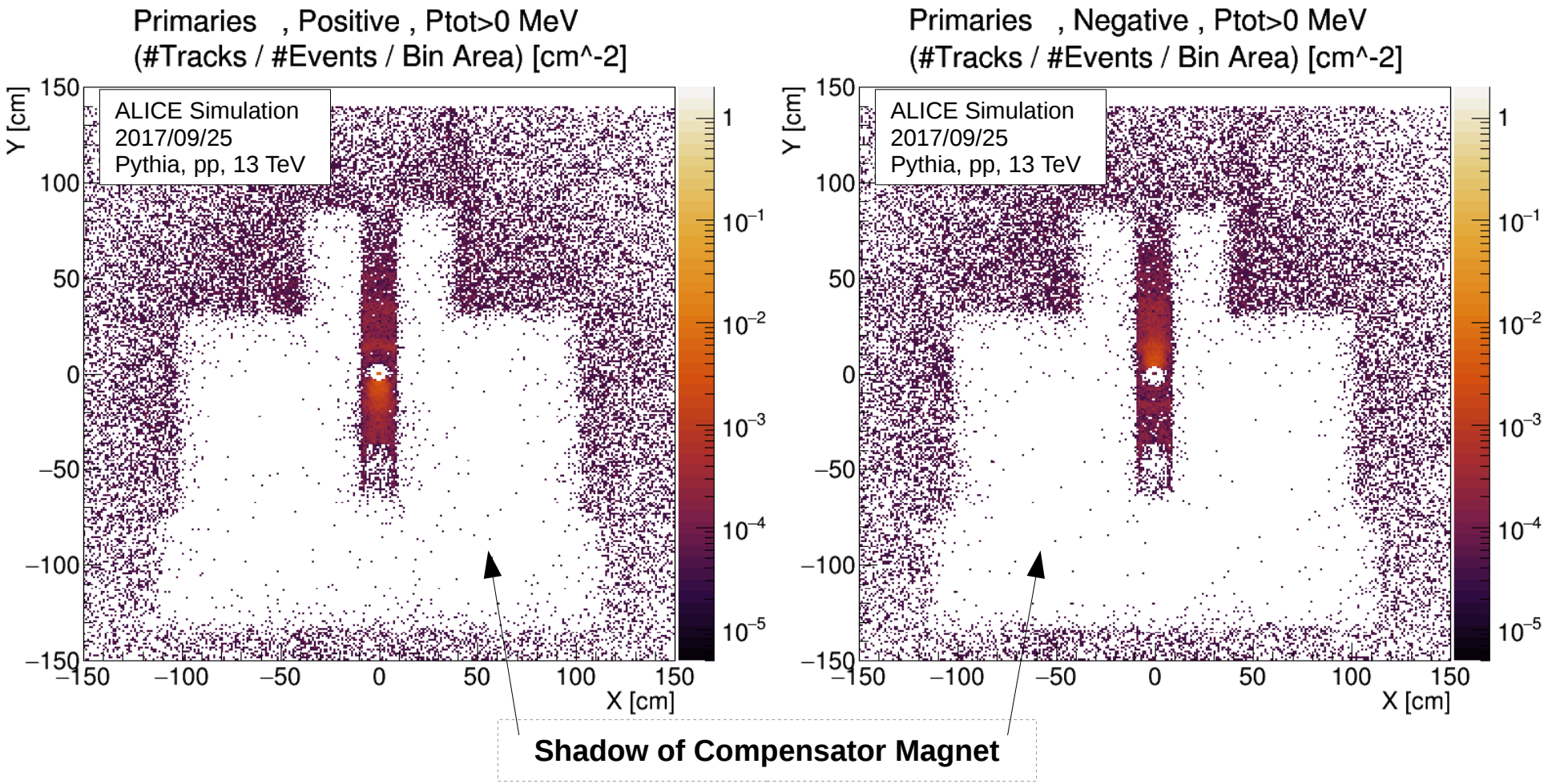




Particle flux at A-Side (Z=1685 cm)

You are looking towards the interaction point!

New Geometry (2017)



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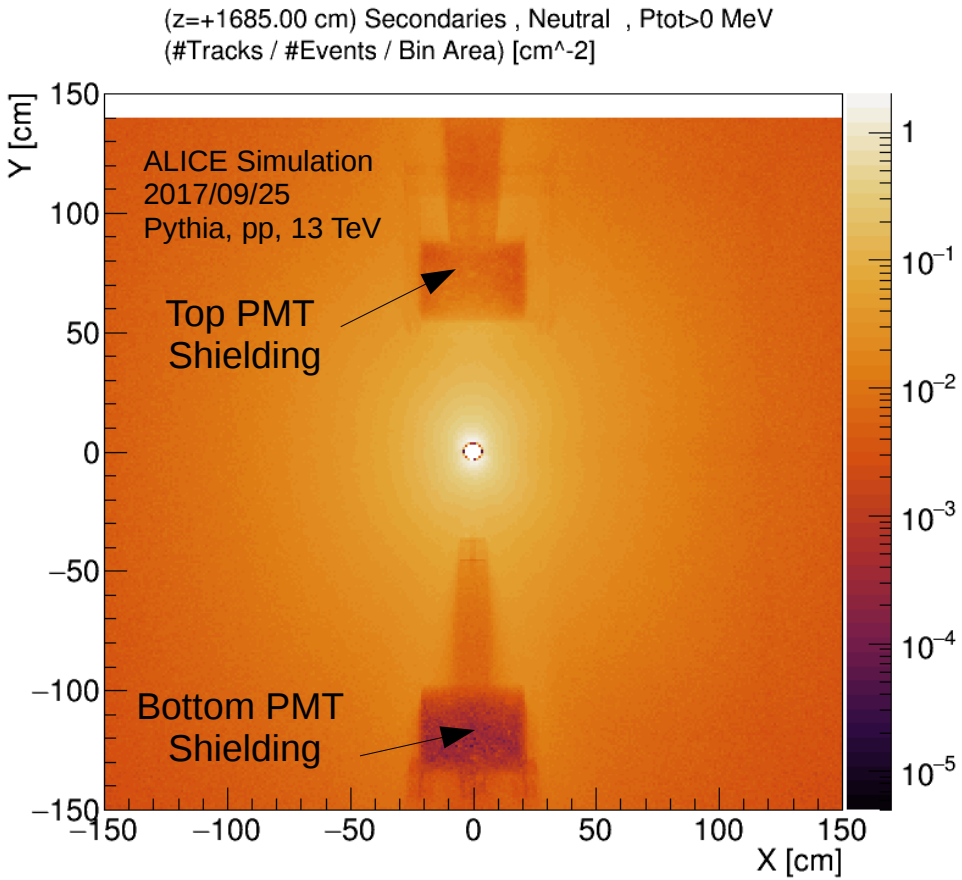

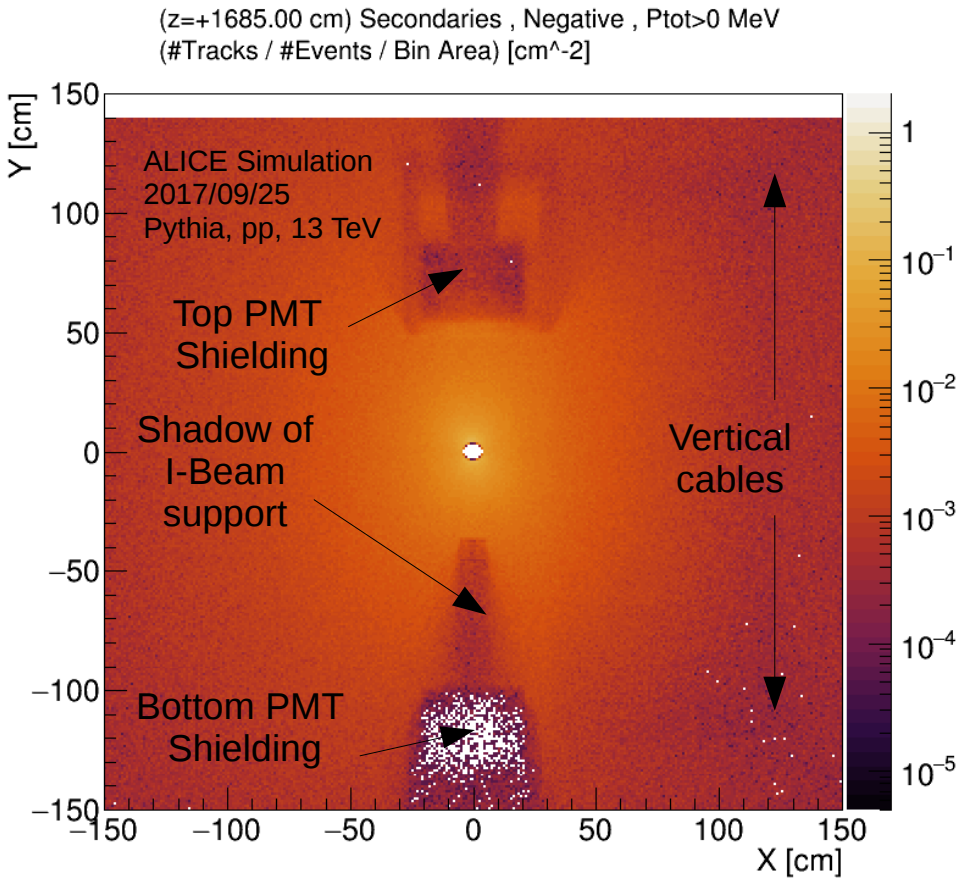

You are looking towards the interaction point!

Conclusions

- ALICE has measured inelastic, single and double diffractive cross sections in pp collisions at 7 TeV at the LHC (run I).
- The ALICE Diffractive detector (AD) increases the pseudorapidity coverage from 8.8 to 12.1 units in η.
- This translates into a higher sensitivity to lower mass diffractive systems.
- AD has a great performance (good time resolution, beam-gas rejection) and is participating in run II data taking, collecting a large sample of inclusive diffractive events and doble-gap triggers.
- Analysis and simulation work is ongoing. Expect news soon.

Thanks!