Activities of Yonsei group at ALICE, CERN

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Contents

- Multiplicity measurement in pp collisions
  - Motivation for multiplicity measurement
  - Previous results
  - New measurements
  - Summary
- Central diffraction at ALICE
  - Physics motivation
  - COMPASS result
  - Results
  - Summary

Multiplicity measurement

Motivations for multiplicity

- New results for 0.9TeV(more statistics), 2.76TeV, 7TeV(INEL, NSD) and 8 TeV

✓ Published papers for pseudo rapidity & multiplicity in p+p collisions

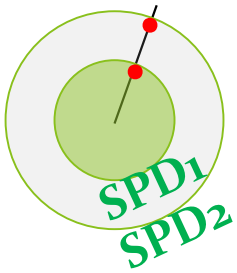
–	$\sqrt{s}$ = 0.9 TeV (INEL, NSD)	EJC: Vol. 65 (2010) 111
–	$\sqrt{s}$ = 2.36 TeV (INEL , NSD)	EPJC: Vol. 68 (2010) 89 **ALICE**
–	$\sqrt{s}$ = 0.9 TeV, 2.36TeV and 7TeV (INEL>0)	EPJC: Vol. 68 (2010) 345
–	$\sqrt{s}$ = 0.9 TeV, 2.36TeV and 7TeV (NSD)	arXiv:1005.3299v2(2010) **CMS**
–	$\sqrt{s}$ = 0.9 TeV (INEL, NSD)	Z,Phys.C, 33,1-6(1986) **UA5**

  - Data update : $dN/d\eta$ for all energies with INEL,NSD and INEL>0

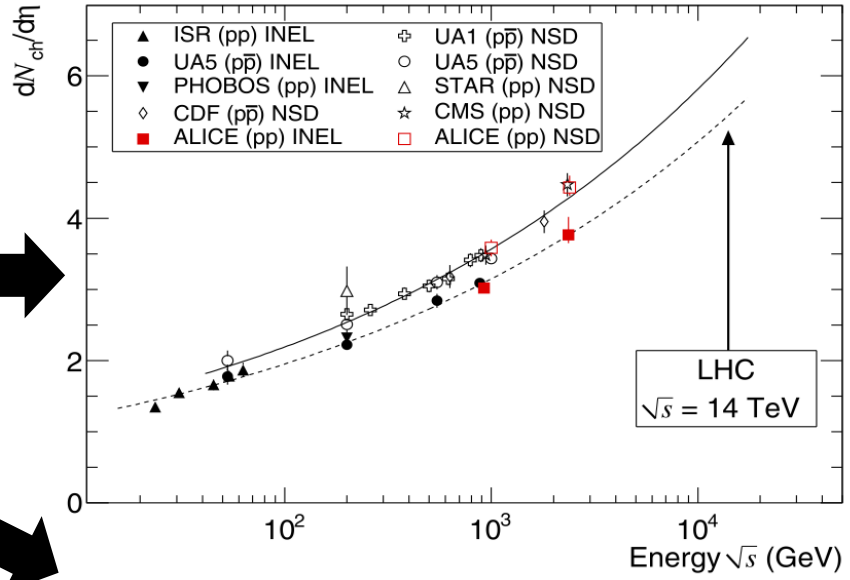
- Extending the pseudo-rapidity interval from $\eta = \pm 1.4$ to ± 2

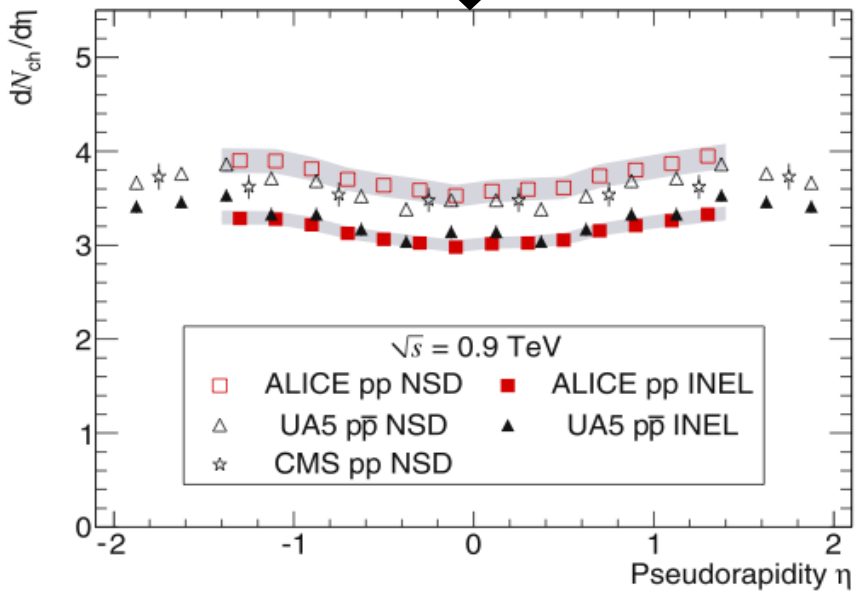
dN/dEta data in previous papers

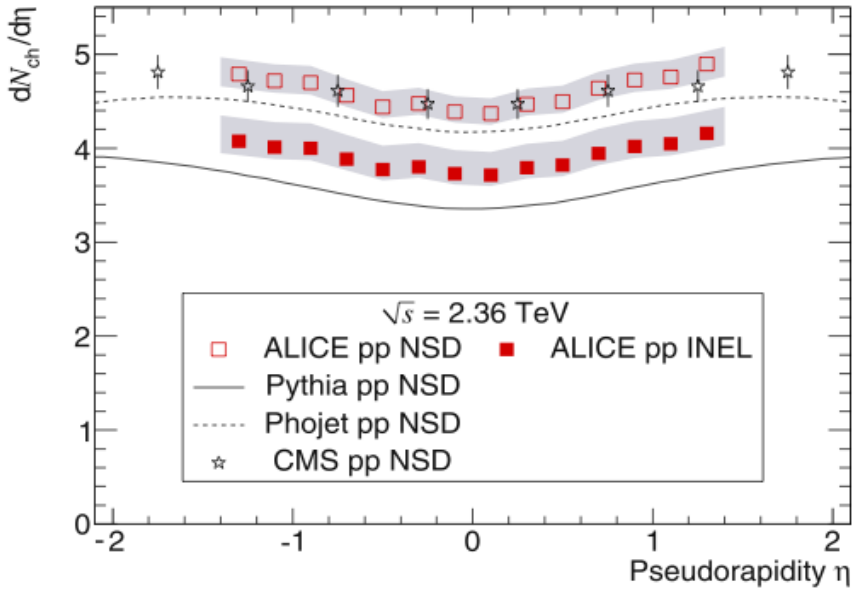
Used multiplicity estimator



SPD tracklet

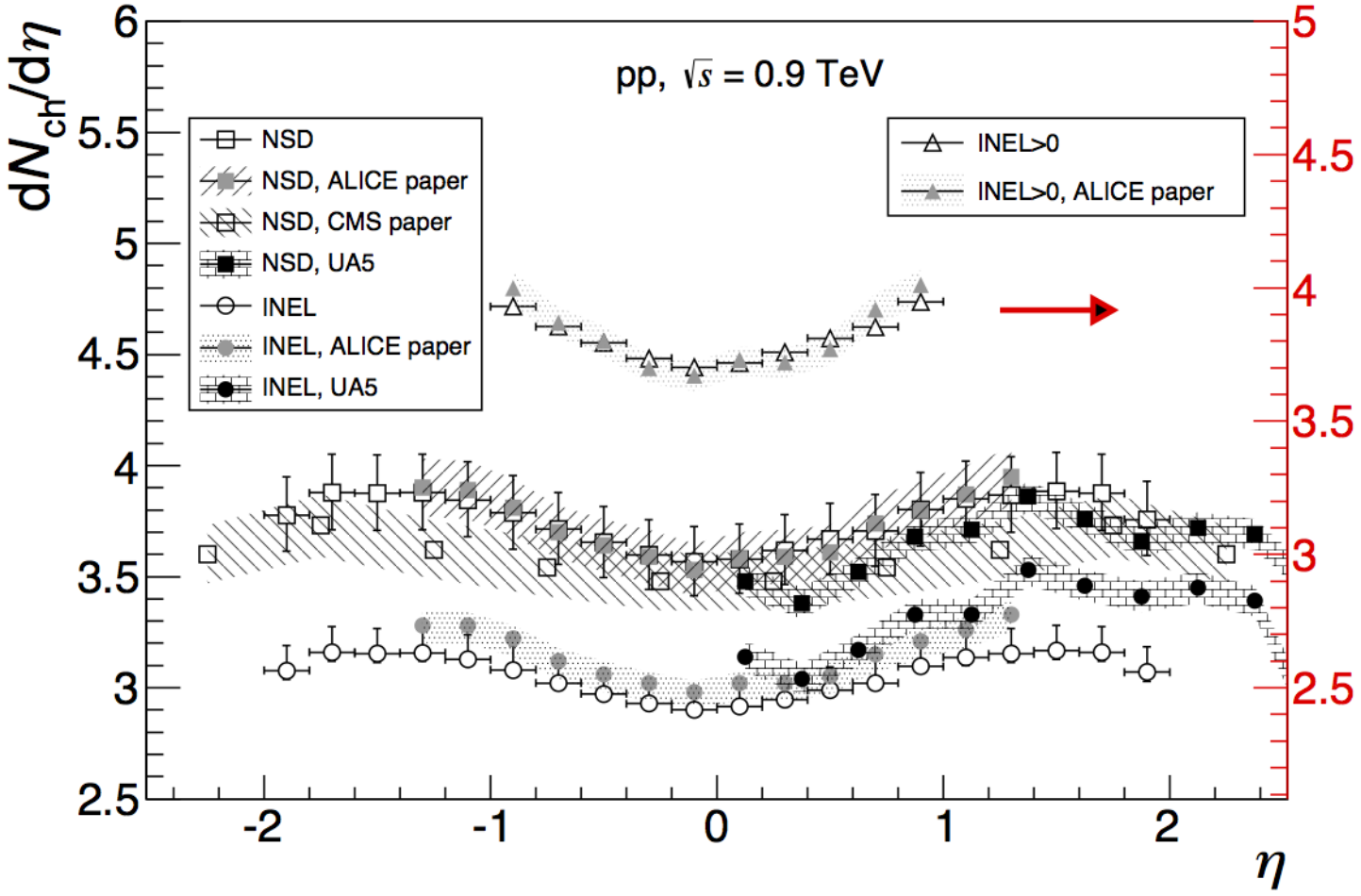






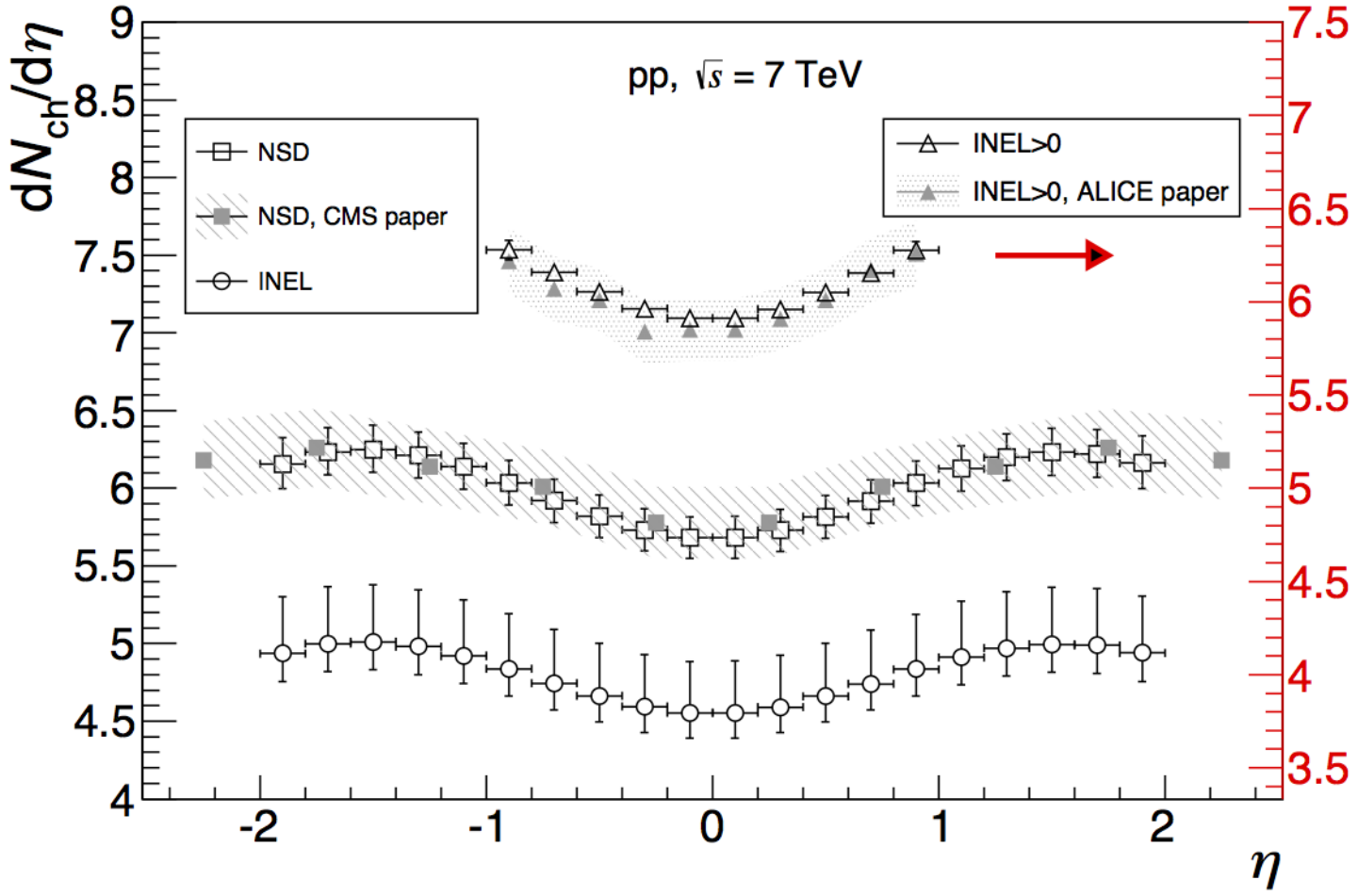
dN/dη results – 0.9 TeV

- ALICE previous paper, UA5, CMS results are shown to compare



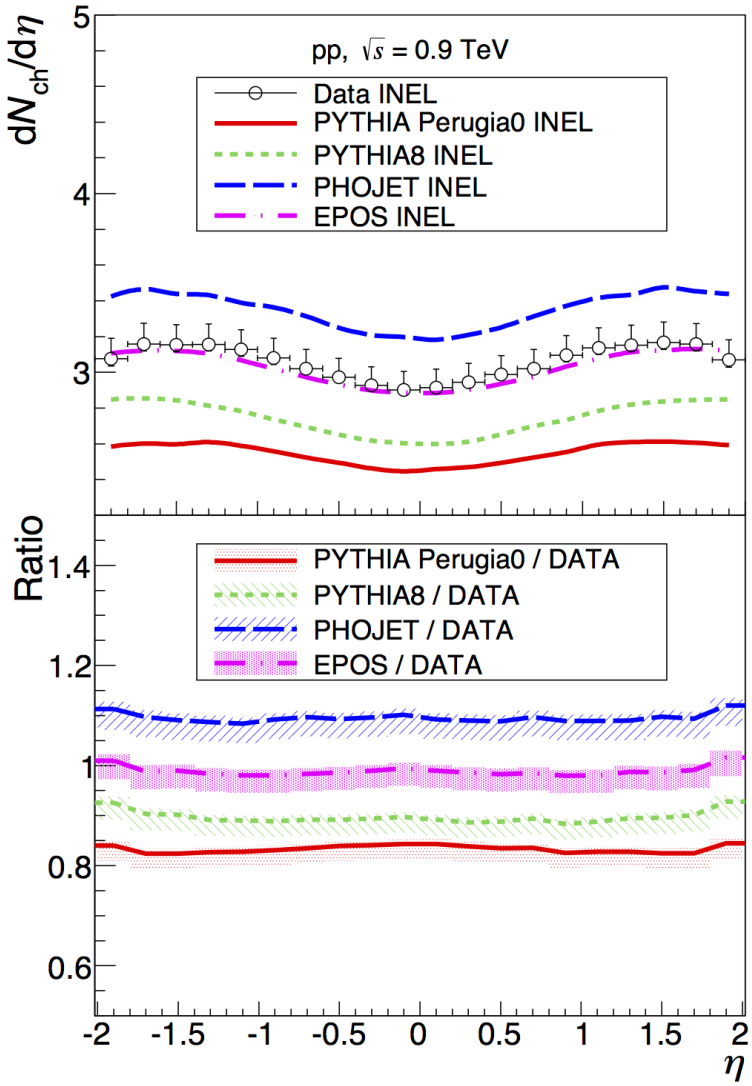
dN/dη results – 7 TeV

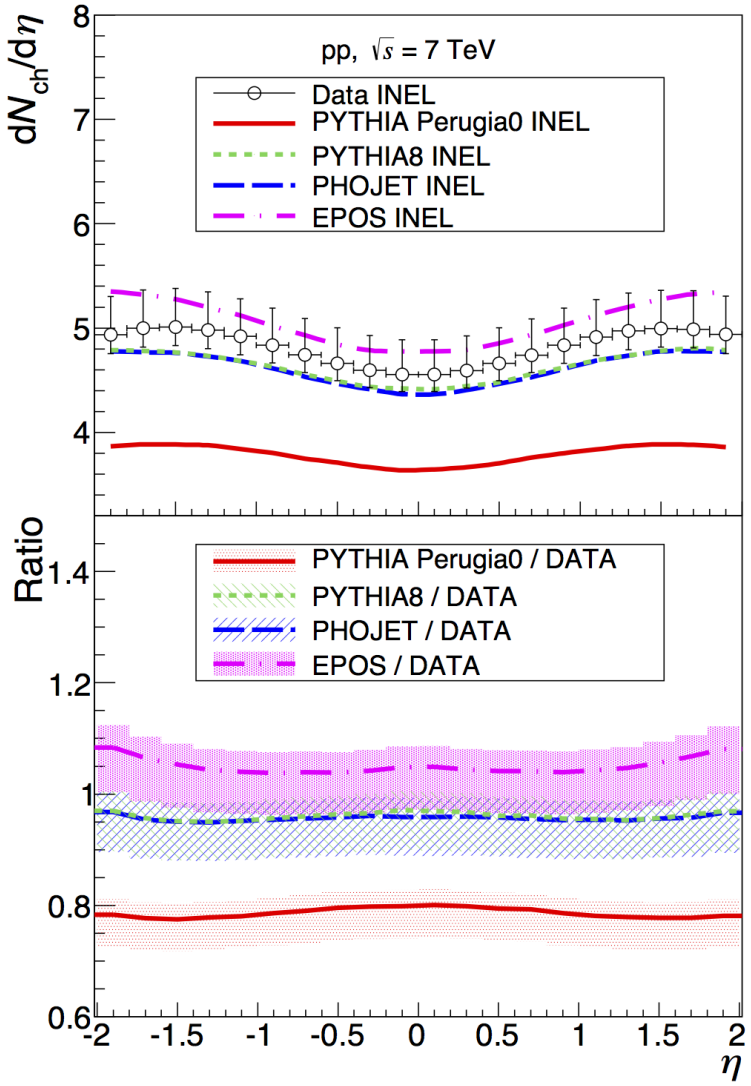
- ALICE previous paper, UA5, CMS results are shown to compare



Comparison with models

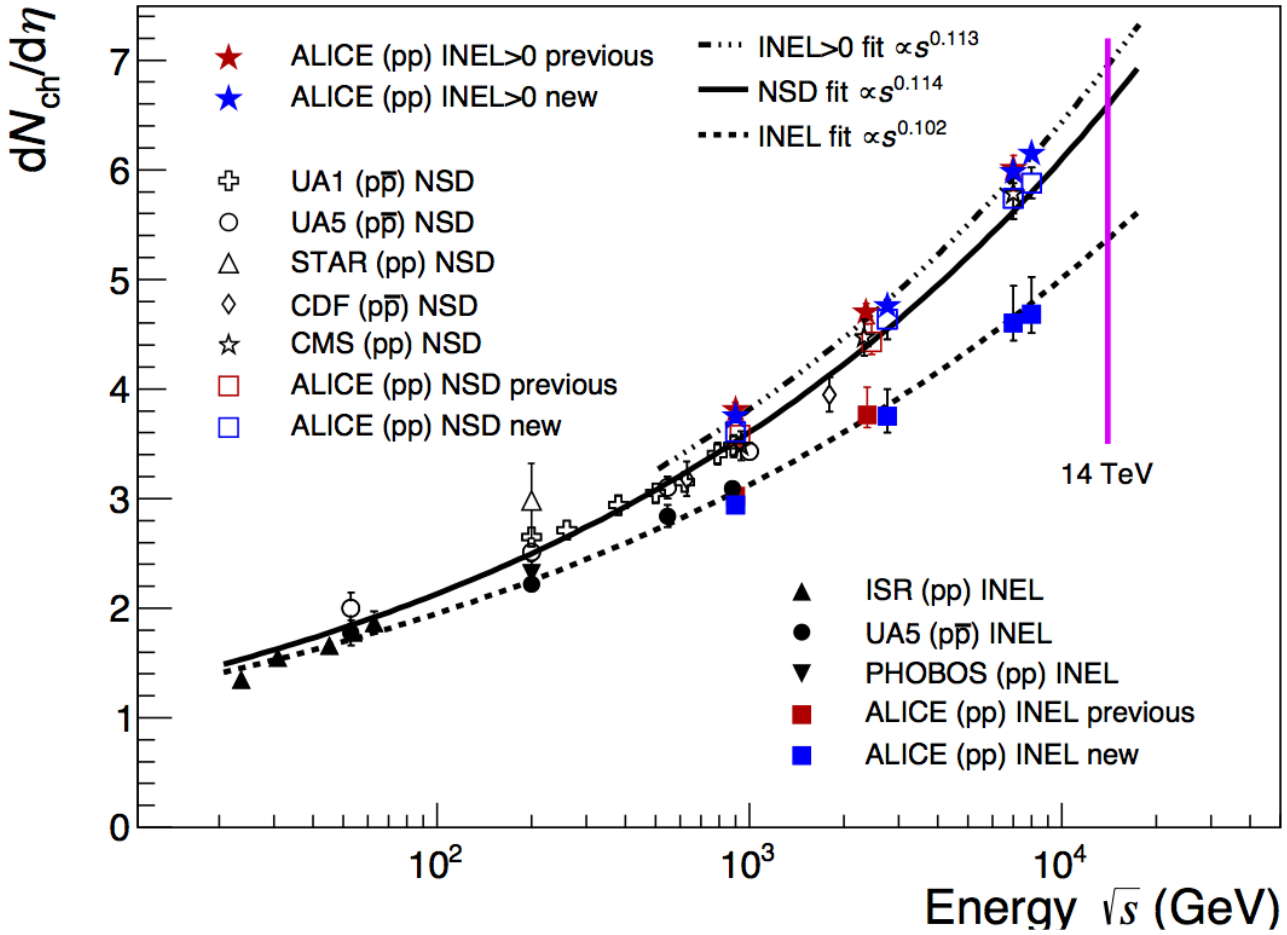
- EPOS, PYTHIA6, PYTHIA8, PHOJET for 0.9TeV, 7TeV INEL





dN/dη vs. $\sqrt{s}$

- In the RUN 2 period, CERN starts to run with $\sqrt{s}$ =13 ~ 14 TeV
- Expectation values at 14 TeV can be expected with the crossing points



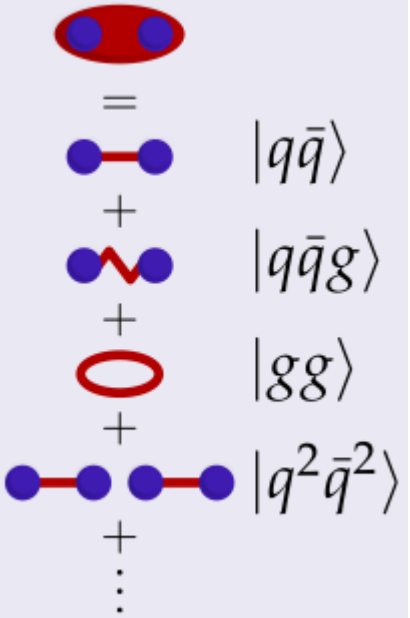
Summary and outlook

- Measured new points : 2.76, 7 TeV and 8 TeV
- Extended η region from ±1.3 to 2.0
- Measured expectation value at 14TeV for the RUN 2
- Paper draft of multiplicity summary will be submitted soon to EPJC
- Yonsei group is in charge of the first paper at ALICE with multiplicity mea surement at d-day of commissioning run of RUN 2(2015) (13 TeV)

Diffractive physics
Search for glueballs

Physics motivation

- Finding states beyond Constituent Quark Model (CQM)
  - Physics mesons = linear superposition of all allowed basis stat es: $|q\bar{q}\rangle, |q\bar{q}g\rangle, |gg\rangle, |q^2\bar{q}^2\rangle, \ldots$
  - Quarkonia
  - Hybrids
  - Glueballs : Purpose of this study
  - Tetra-quarks



- Central diffraction system (is a good system for glueball search)
  - **Central diffraction system is caused by two pomeron exchange**
  - **Gluon-rich environment**

  →Pomeron is also hypothetical particle composed by 2 or 3 gluons.

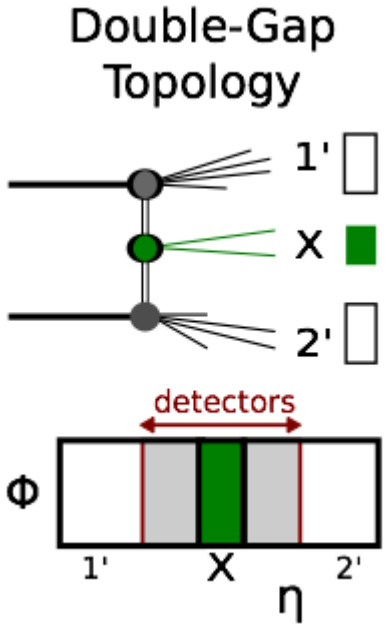
  → More possible to find a glueball
  - The best thing is we can exclude many quarkonia from the system

  → J^{PC} =even^{++} states are only possible with two pomerons exchange. Thus all quantum states not satisfying this cannot survive under the condition

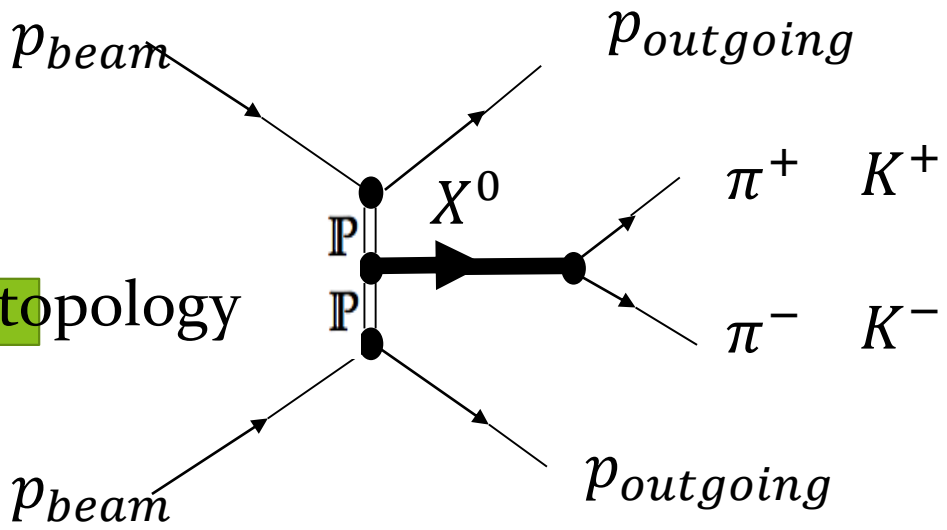
  → We can measure glueballs without many backgrounds

Double rapidity gaps and centrally diffracted system

- Centrally diffracted system is expected to show double rapidity gaps (no activities at forward rapidity regions with activity in the central barrel)
  - If we measure double rapidity gaps in an event, we can regard it as a central prod uction.



Detector topology

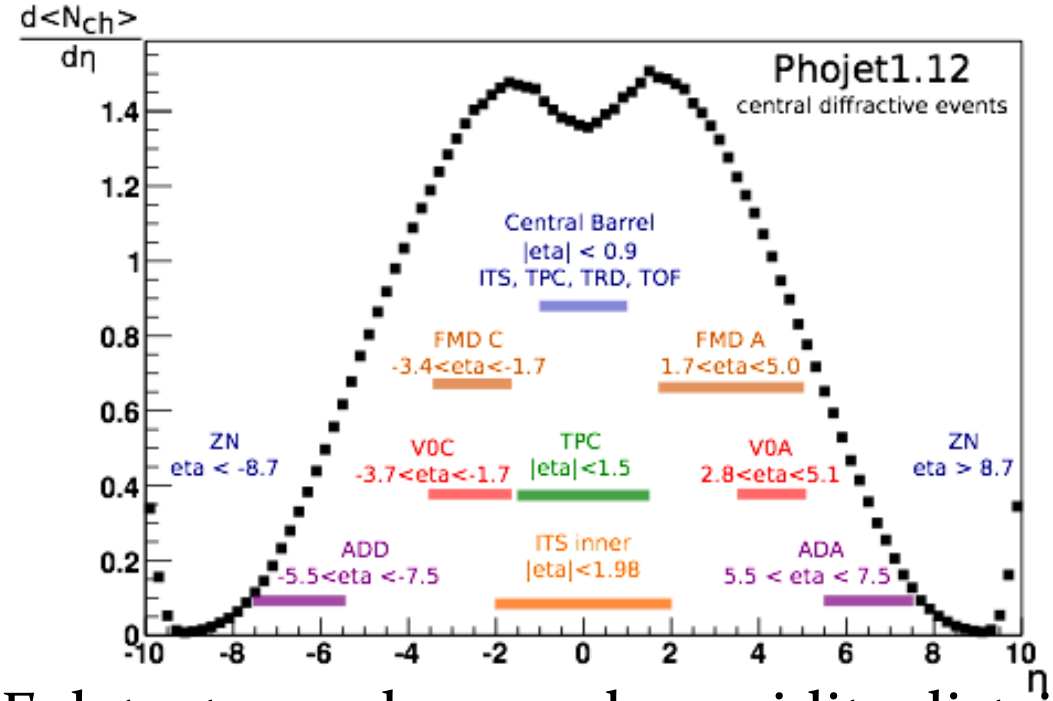


Experimental representation for the CD system

Two pomerons exchnage : Central diffractive system

Cut conditions for double rapidity gaps with ALICE

- By measuring no activities (no tracks) in $|\eta|>0.9$

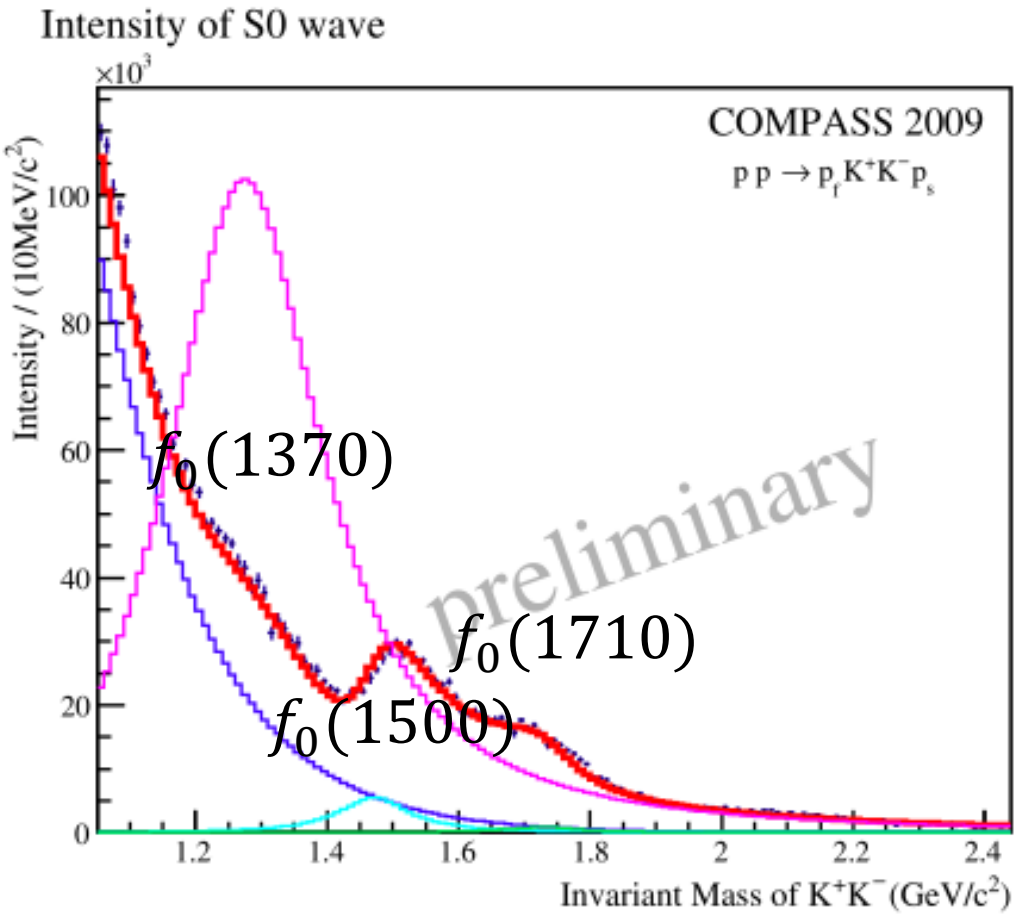


ALICE detector and a pseudo-rapidity distribution

- Hadronic activity(particles) in the central barrel($-0.9<\eta<0.9$)
  involved detectors : SPD, TPC and TOF
- Two gaps(no activity = no particles) outside of central barrel
  (A-side : $0.9<\eta<5.1$, C-side : $-3.7<\eta<-0.9$)
  involved detectors : Vo, FMD, SPD

COMPASS(SPS, CERN) results

- $K^+ K^-$ decay from X^o in central production

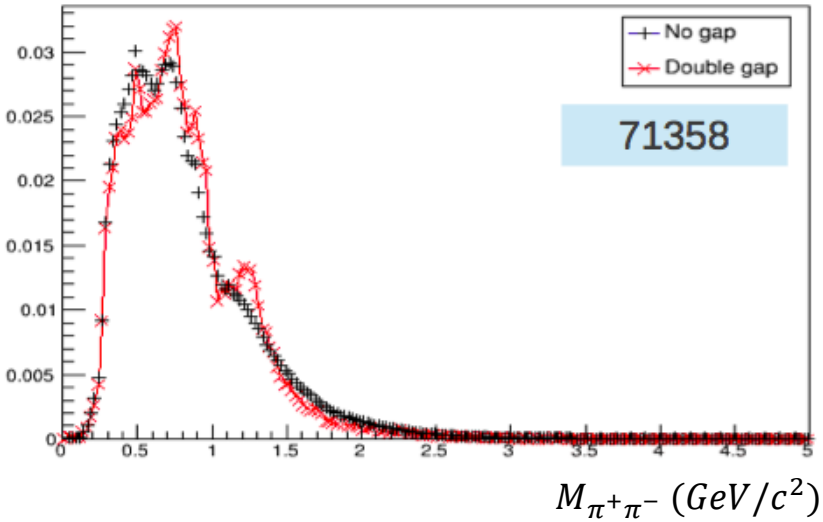


  - There is a dispute whether $f_0(1500)$ is a glueball

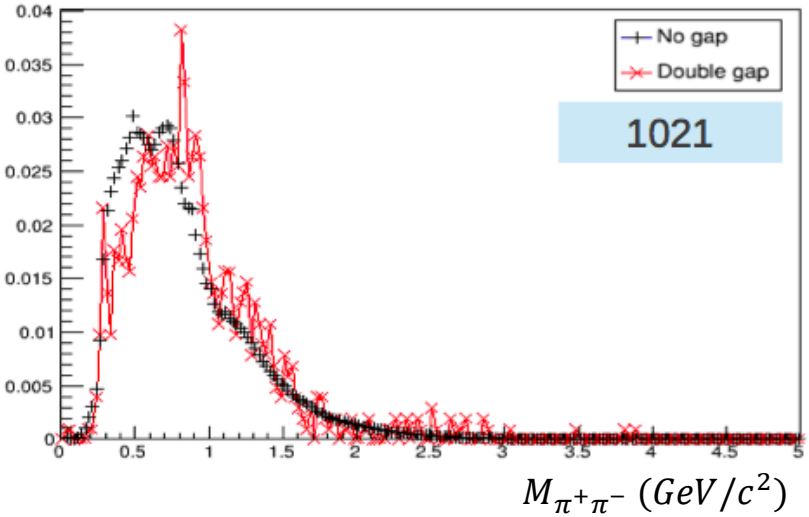
ALICE results for $(\pi^+\pi^-)^0$ decay from X^o

- With full statistics at 7TeV(about 300 million events)

Loose cut



Strong cut



  - With loose cut
    - $\rho_0(770)\ J^{PC} = 1^{--}, f_0(980)\ 0^{++}\ and\ f_2(1270)\ 2^{++}$ are shown with applying loose double gap condition. Because there is a peak from $\rho_0(770)$, we can think there is some background wit h the loose cut, since $J^{PC} = even^{++}$ only can be allowed for the centrally diffracted system.
  - With strong cut
    - We could reduce $\rho_0(770)$ peak, however, low statistics.
    - I am not sure that there is $f_0(1500)$ peak(one of glueball candidate)
    - We have been doing cut study to release a cut without loss of information

Summary and promising points for the physics

- We found that we can confine central production by control of the double rapidity gap condition. ($f_0(980)$, $f_2(1270)$ showed up with the condition as we expected)
- At RUN2(2015~) period, pp collisions with $\sqrt{s}$ =13 to 14 TeV are reserved. We expect that there would be more statistics with central production since cross-section of the double pomeron exchange goes up exponentially with energy.
- With the help of the forward new detectors, ADA & ADC, we can measure the system more efficiently with extended pseudo-rapidity coverage
- We have a plan(?) to implement Roman-pot detector to tag outgoing protons at RUN3(2019~). In that case, we can measure the central production perfectly.
- ALICE has the capability to measure low p_T particles compared to other LHC experiment(ATLAS, CMS) which is very important for this study

→Promising subject for RUN2, RUN3 with ALICE

Data table

Data	LHC10b,c,d,e pass2		LHC10f6(phojet)		LHC10f6a(pythia6)	
Double gap	Events	Fraction	Events	Fraction	Events	Fraction
None(Min bais)	$271X10^6$		$62X10^6$		$105X10^6$	
V0	$0.8X10^6$	0.3%	$5X10^4$	0.08%	$2.6X10^5$	0.24%
V0, FMD, SPD, TPC	$0.13X10^6$	0.05%	$7X10^3$	0.01%	$4.5X10^4$	0.04%

- All pp data
- Phojet contains central diffraction, pythia6 doesn't
- LHC10b,c,d,e are all 7TeV data