Central Diffraction in ALICE

- ALICE detector
- Selection of central diffractive single/double gap events
- Compare single/double gap events to non-diffractive events
- Analysis of multiplicity, P_T, η-distribution
- Analysis of $f_0(980)$ and $f_2(1270)$ production
- Prospects of dedicated double gap trigger
- Prospects of new detectors ADA, ADD
- Conclusions, outlook

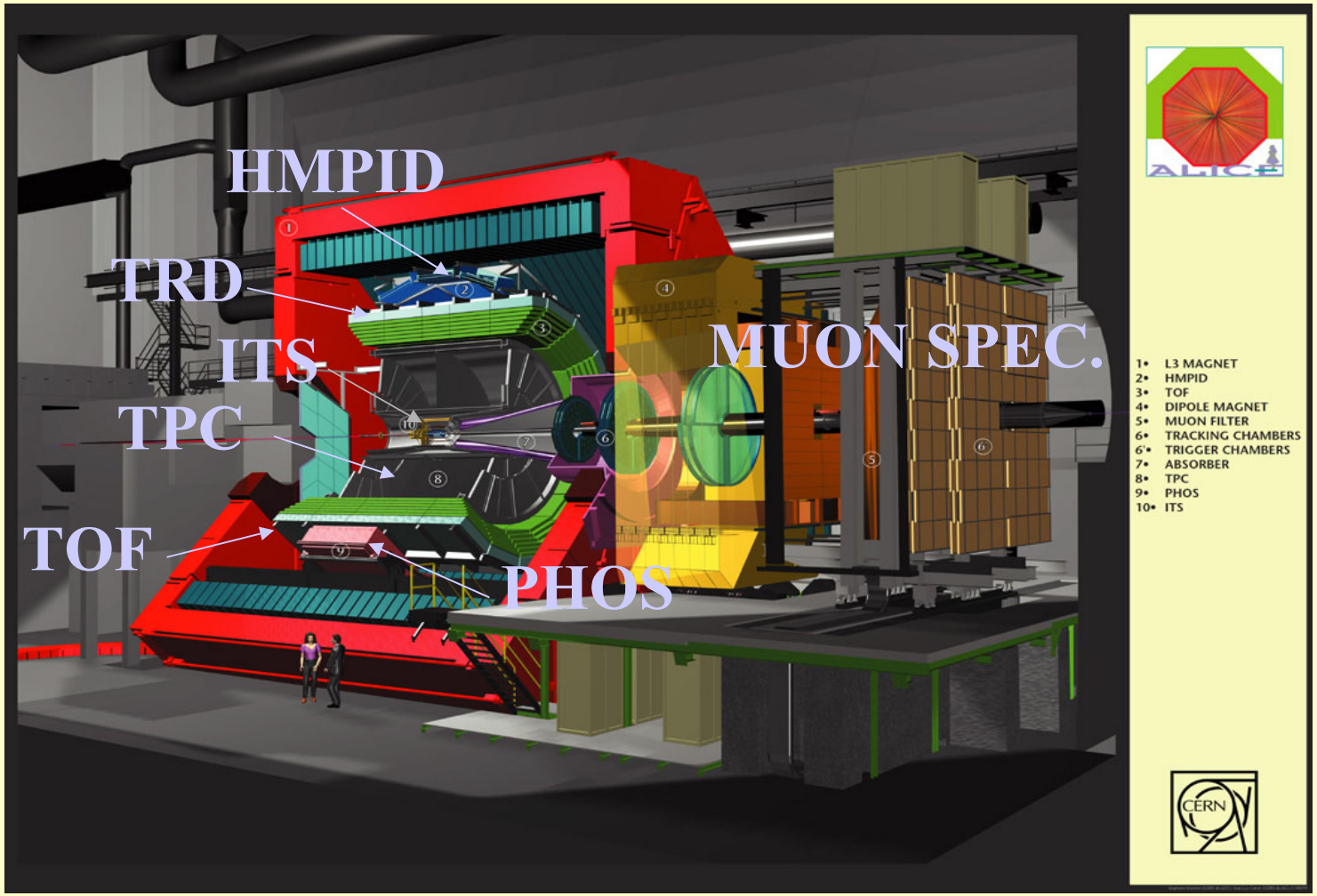
The ALICE experiment

Acceptance central barrel

$-0.9 < \eta < 0.9$

Acceptance muon spectr.

$-2.5 < \eta < -4.$



ALICE pseudorapidity acceptance

→ additional forward detectors

(no particle identification)

$1 < \eta < 5$

$-4 < \eta < -1$

→ definition of gaps η_+, η_-

p-p luminosity L = $5 \times 10^{30} cm^{-2} s^{-1}$:

→ reduced prob. overlapping events

diffractive L0 trigger (hardware):

Pixel or TOF mult (cetral barrel)

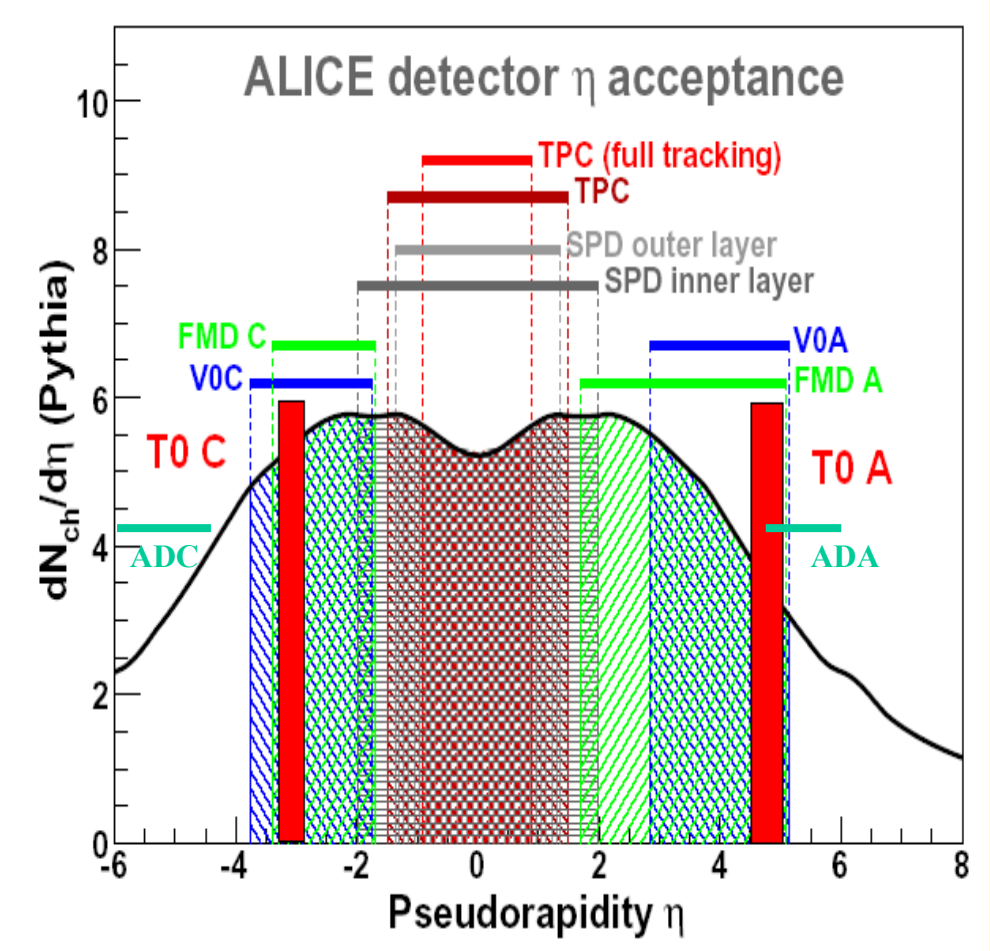
gap η_+: $3 < \eta < 5 \rightarrow \Delta\eta \sim 0.5$

gap η_-: $-2 < \eta < -4 \rightarrow \Delta\eta \sim 0.5$

high level trigger (software):

$-3.7 < \eta < 5$

→ improved including ADA, ADD

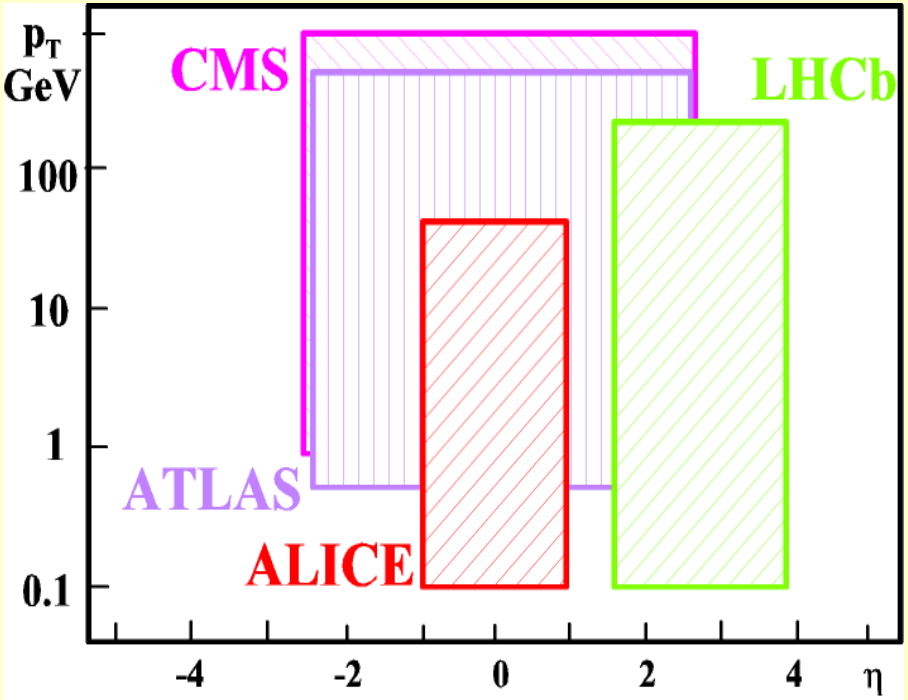


ALICE central barrel comparison to other LHC detectors

low magnetic field

	Magn. field (T)	P_T cutoff GeV/c	Material x/x0 (%)
ALICE	0.2-0.5	0.1-0.25	7
ATLAS	2.0	0.5 (0.08)	20
CMS	4.0	0.75 (0.2)	30
LHCb	4Tm	0.1	3.2

η–pt acceptance

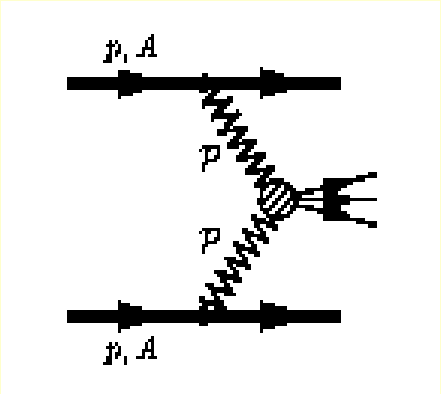


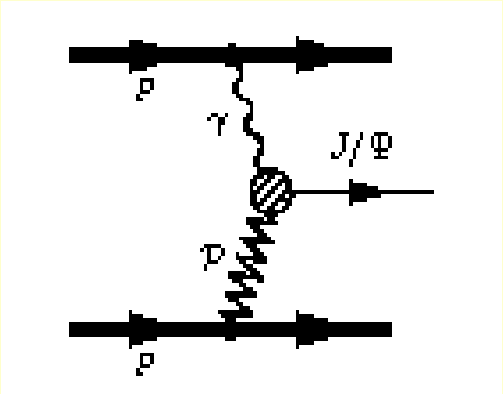
→ *low p_T trigger ?*

ALICE acceptance

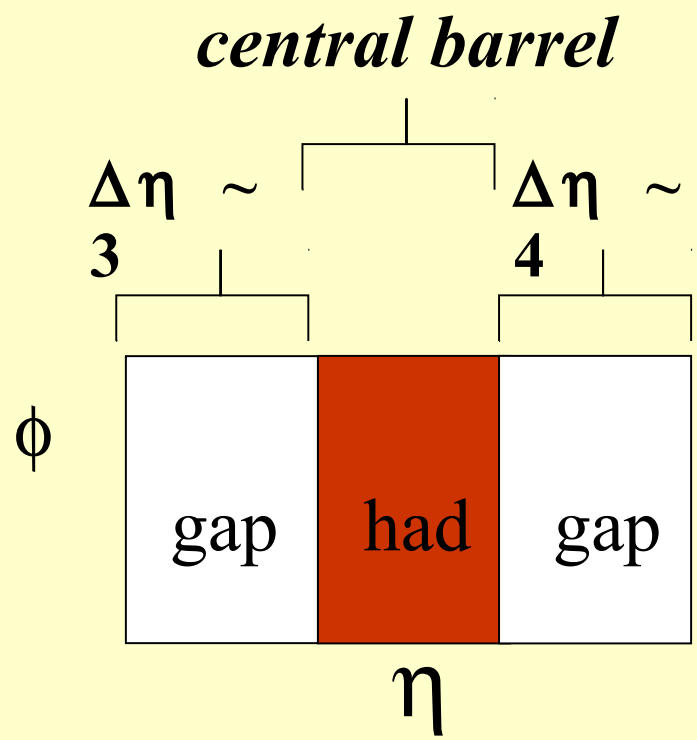
- ALICE acceptance matched to diffractive central production:

  double pomeron, (γ –pomeron, odderon-pomeron)



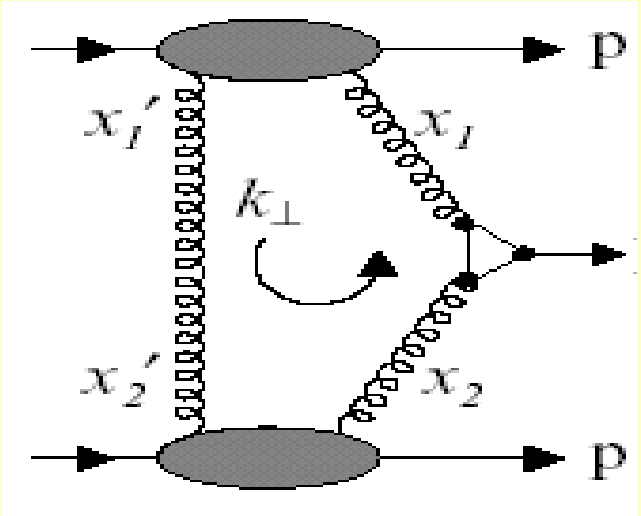


Data taking:
pp @ L = 5×10^{30} $cm^{-2}s^{-1}$ $\left(\rightarrow \frac{d\sigma}{dy}\Big|_{y=0} \sim nb\right)$
pPb @ L = 10^{29} $cm^{-2}s^{-1}$
PbPb @ L = 10^{27} $cm^{-2}s^{-1}$



Central exclusive diffraction in QCD

Formalism of central exclusive production predicts cross sections for $\gamma\,\gamma$, dijets, χc,χb



Ingredients

- *unintegrated gluon distribution*
- *cross section gg → X*
- *Sudakov factor, no additional hard gluon*
- *soft rescattering, suppression factor S^2*

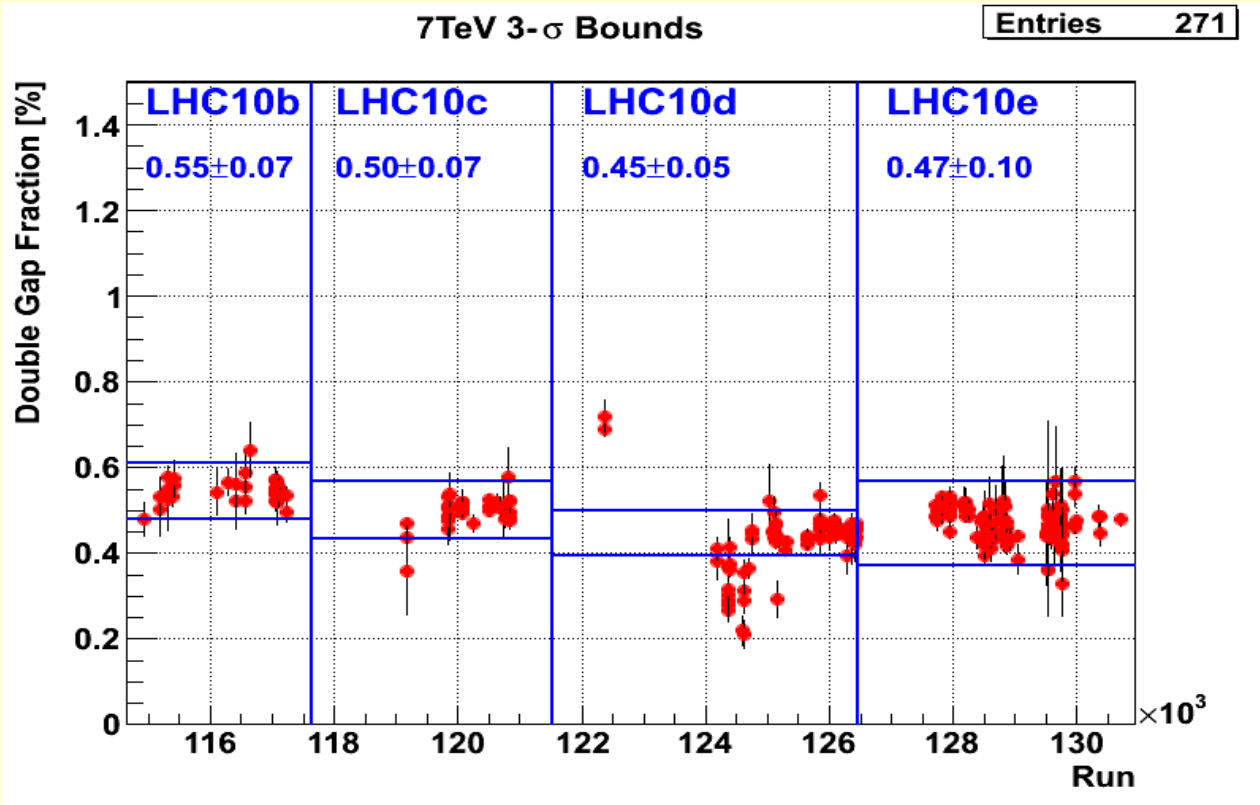
ALICE: measure central state with rapidity gap on either side

→ expect enhanced production of $J^{PC} = J^{++}$ states

→ $f_0(980)$: $J^{PC} = 0^{++}$, $f_2(1270)$: $J^{PC} = 2^{++}$

First analysis min bias data

3 σ cut on single gap, double gap fraction on a run basis

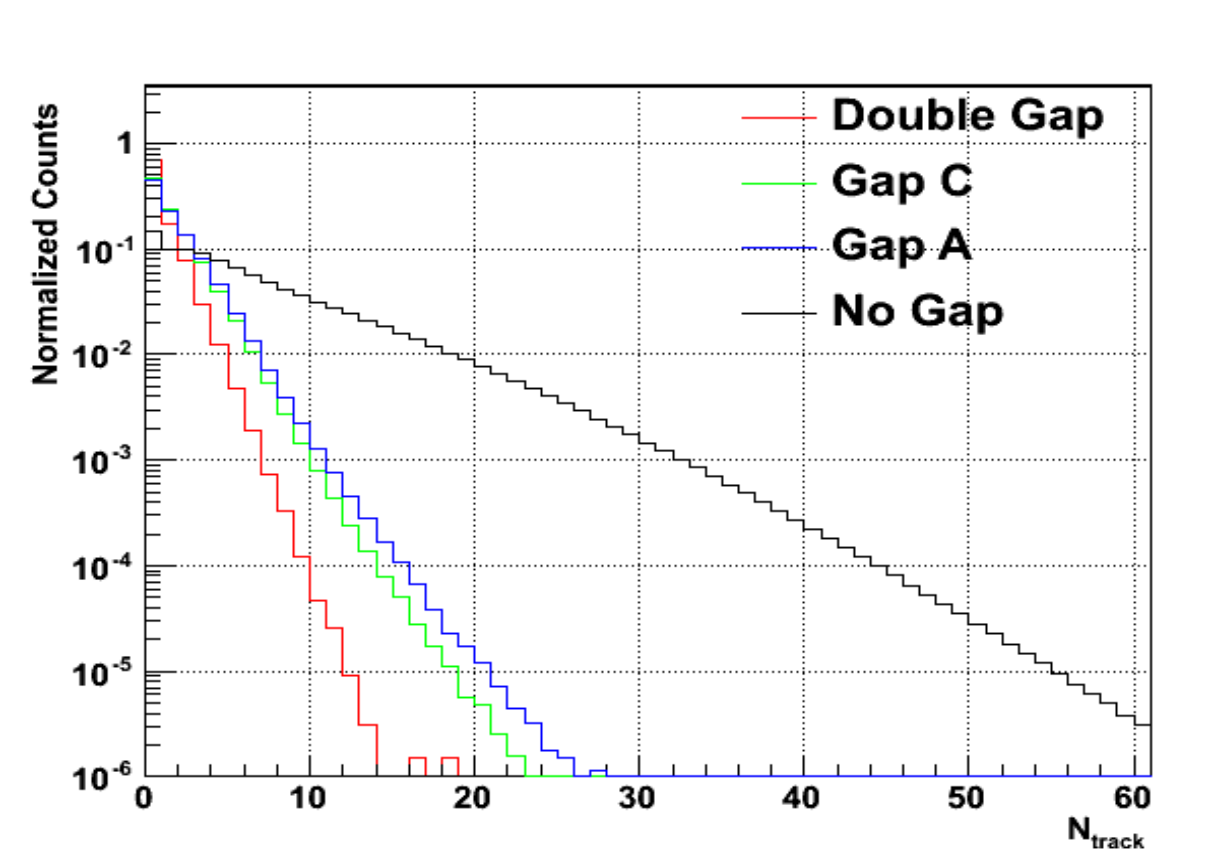


Data sample pp collisions at 7 TeV

- Total number of events 500×10^6
- Run selection 422×10^6
- Physics selection 392×10^6
- CINT1B trigger 361×10^6
- SPD fired 344×10^6
- Primary vertex 313×10^6
- 2-track events total $32{,}3 \times 10^6$
  good track:
  - # TPC cluster > 65, χ^2/cluster <4, reject kinks, ITS,TPC refit, $|\eta| < 0.9$,
  - SPD cluster in any SPD layer, P_T dep. DCA cut: 7σ transverse, 5σ longitudinal
- 2-track events:
  no gap = 29.2×10^6, gap A = 1.6×10^6, gap C = 1.4×10^6, double gap = 0.15×10^6

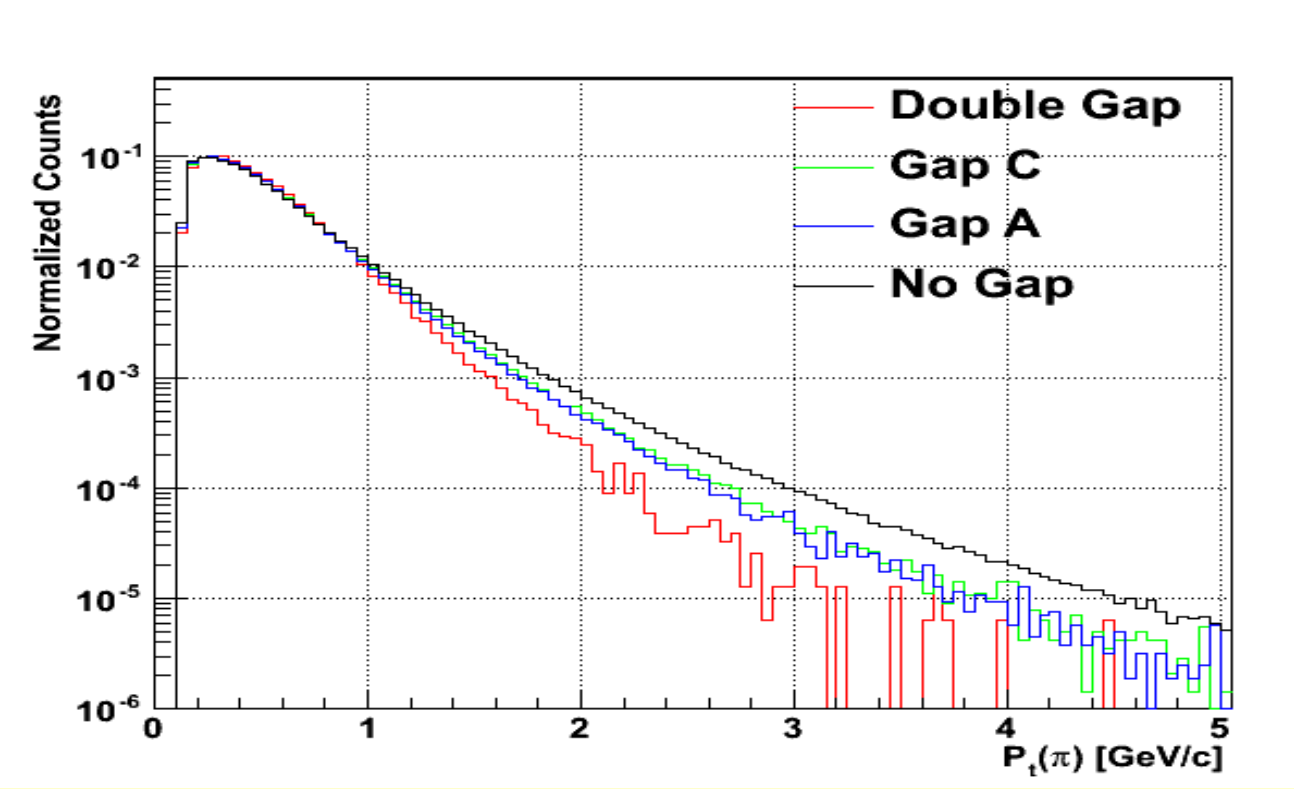
Multiplicity distribution

- Multiplicity distribution of gap and no gap events (good tracks)



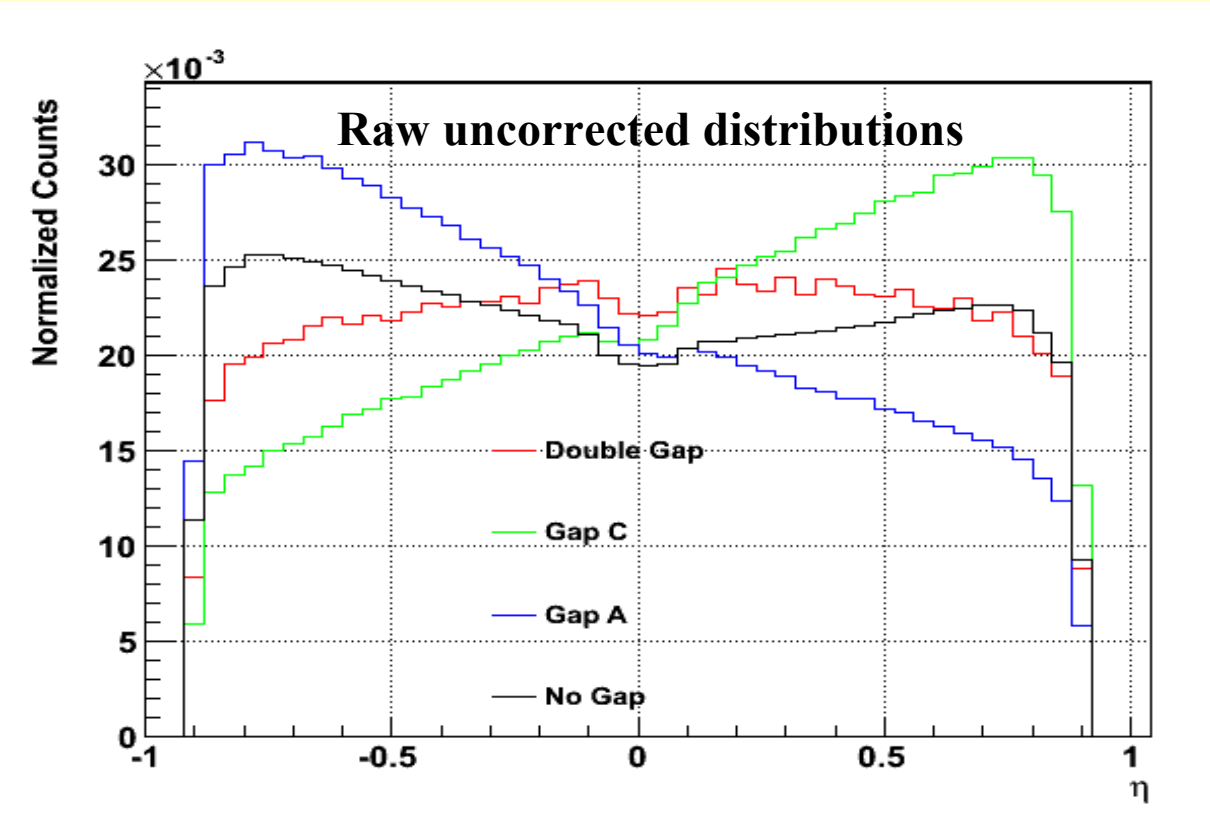
Transverse momentum distribution

- Single track transverse momentum distribution for gap and no gap two-track events



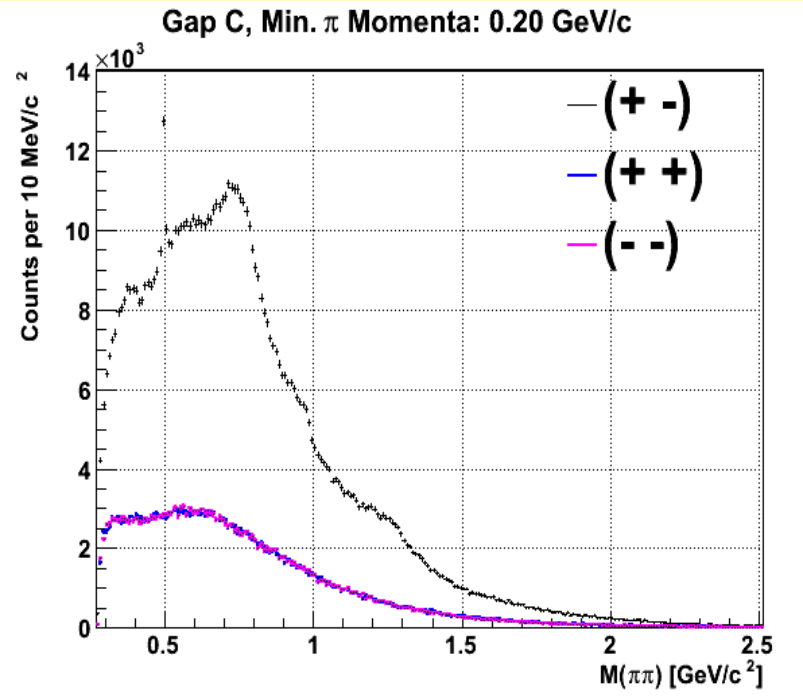
Pseudorapidity distribution

- Pseudo-rapidity distribution for gap and no gap two track events

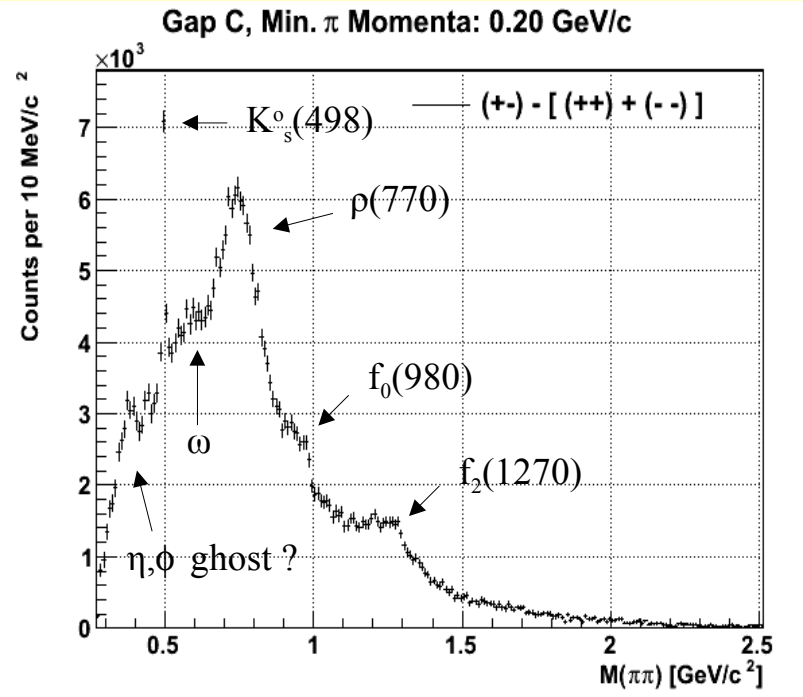


Invariant mass distribution single gap events

- Two track invariant mass distribution for gap C events



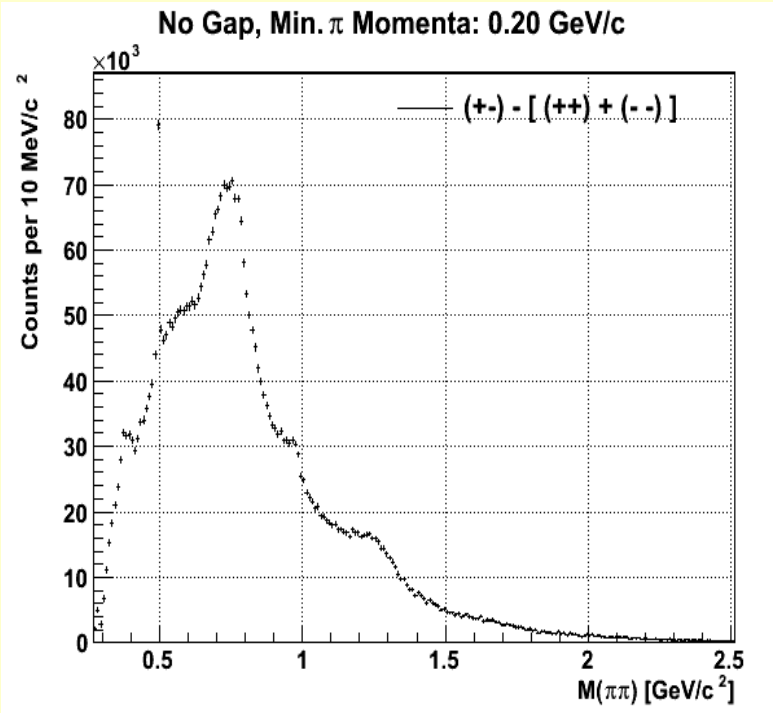
Invariant mass distribution for like and unlike sign pairs



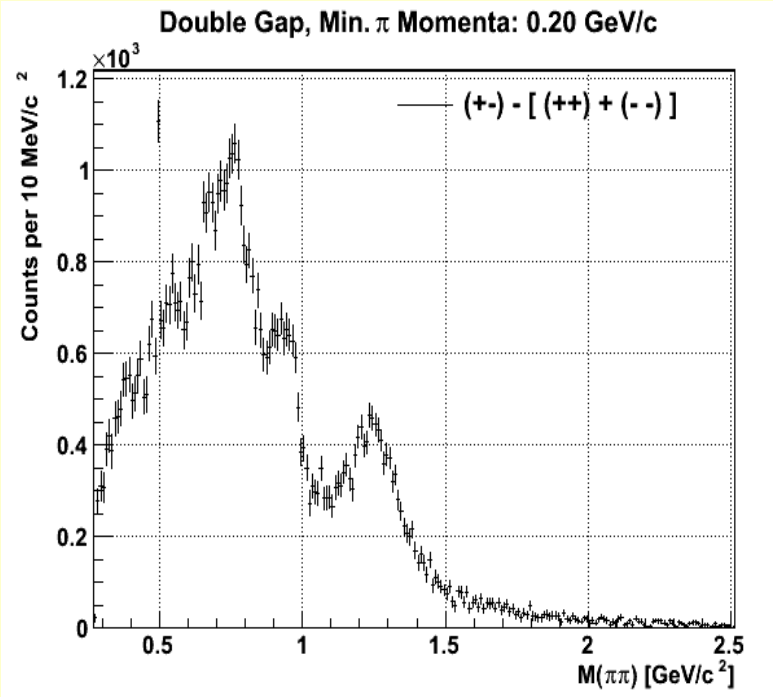
Invariant mass distribution corrected for like sign pairs

Invariant mass distribution for no gap and double gap events

- Two track invariant mass distribution for no gap and double gap events



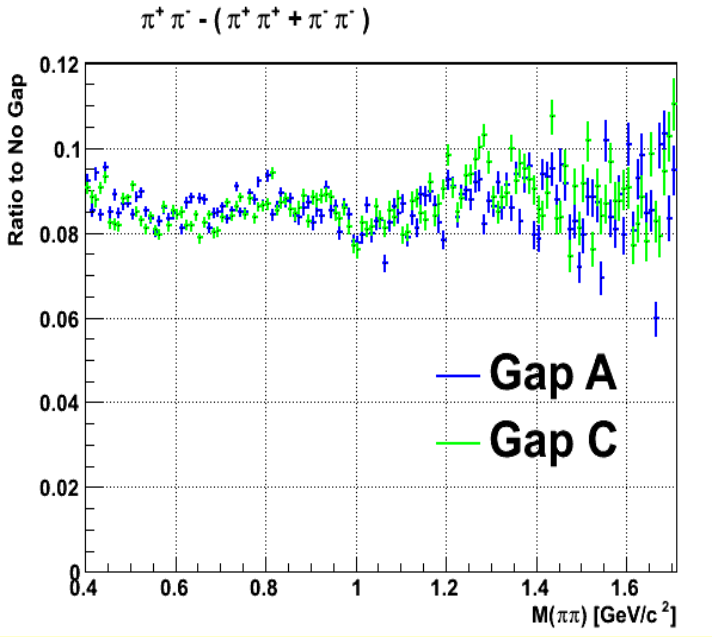
Invariant mass distribution no gap events, corrected for like sign pairs



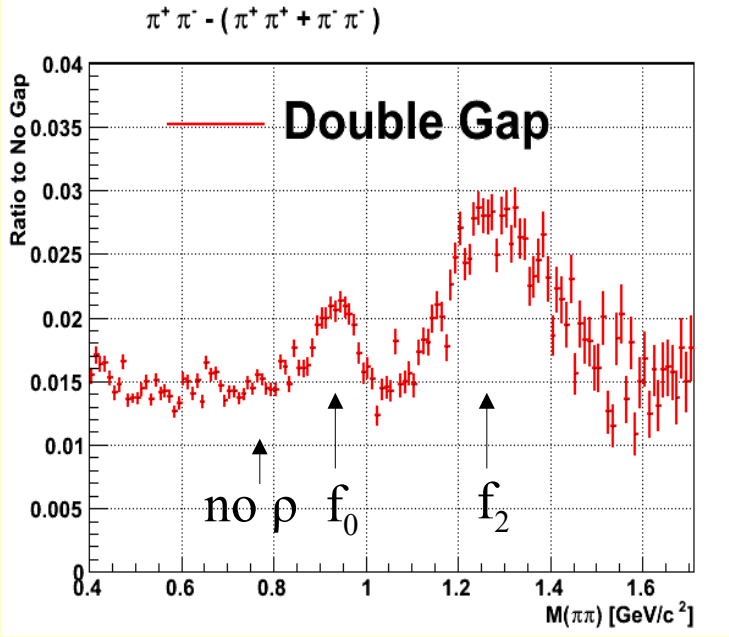
Invariant mass distribution double gap events, corrected for like sign pairs

Normalized mass distribution of gap events

- Two track invariant mass distribution of gap events normalized to mass distribution of no gap events



Normalized invariant mass distribution of single gap events



Normalized invariant mass distribution of double gap events shows enhancement of $f_0(980)$, $f_2(1270)$

→ where is the $f_0(1500)$?

Search for the $f_0(1500)$

- PDG: $f_2(1270)$: Br($\pi\pi$)=85%, Br($K\underline{K}$)= 5%
  $f_0(1500)$: Br($\pi\pi$)=35%, Br($K\underline{K}$)= 8%
- *Identify $f_2(1270)$, $f_0(1500)$ in $\pi\pi$ and $K\underline{K}$ decay channel:*
  - $K\underline{K}$ channel:
    - bad news: statistics of $f_2(1270)$ reduced by factor 17, $f_0(1500)$ reduced by factor 4
    - good news: strength of $f_0(1500)$ relative to $f_2(1270)$ grows by factor 4

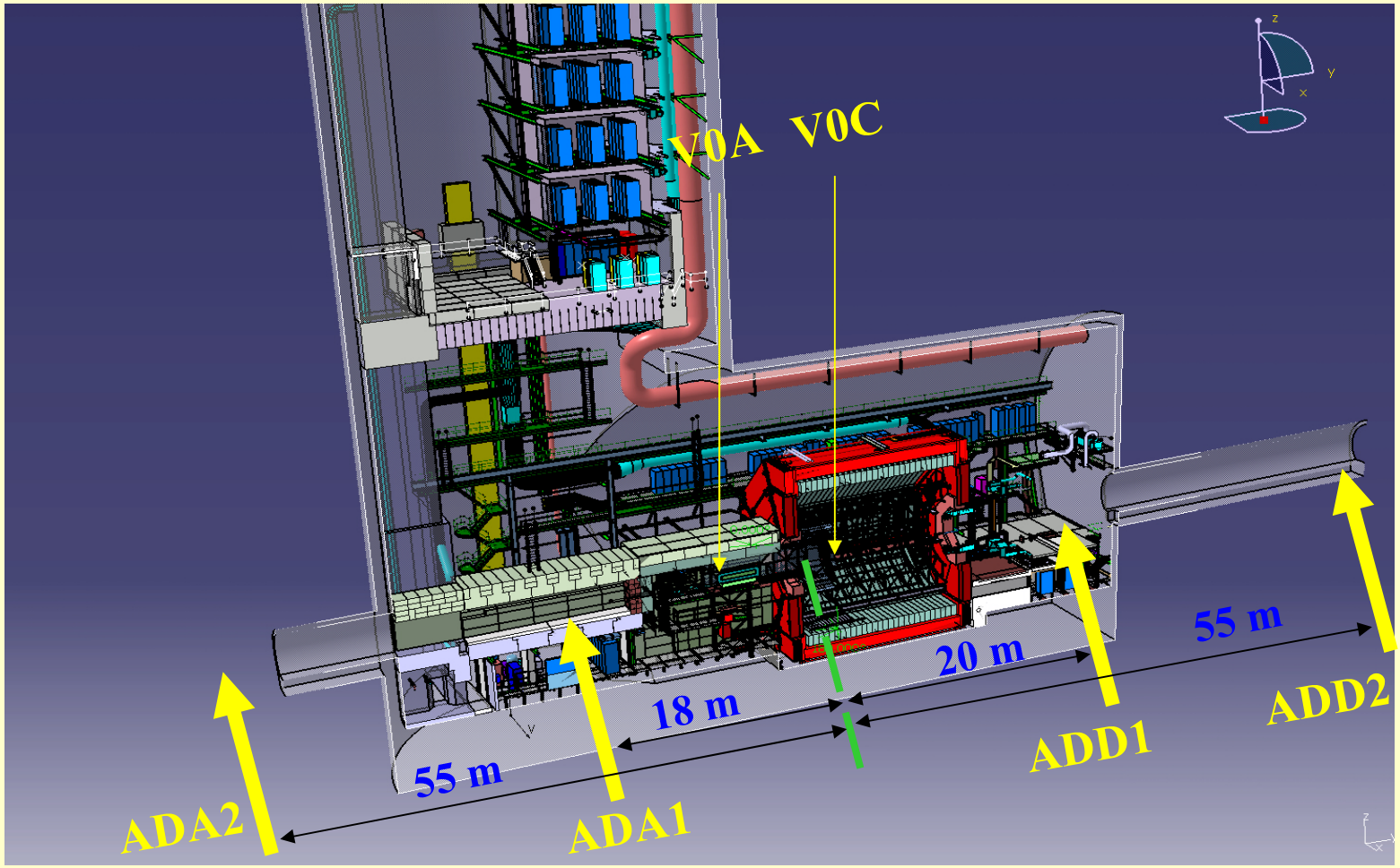
→ *$f_2(1270)$, $f_0(1500)$ analysis in $K\underline{K}$ needs a dedicated double gap trigger*

→ *proposal to physics board for implementing double gap trigger and data taking of 3 M double gap events (ALICE mini week oct 10)*

→ *if approved data taking expected in early 2011*

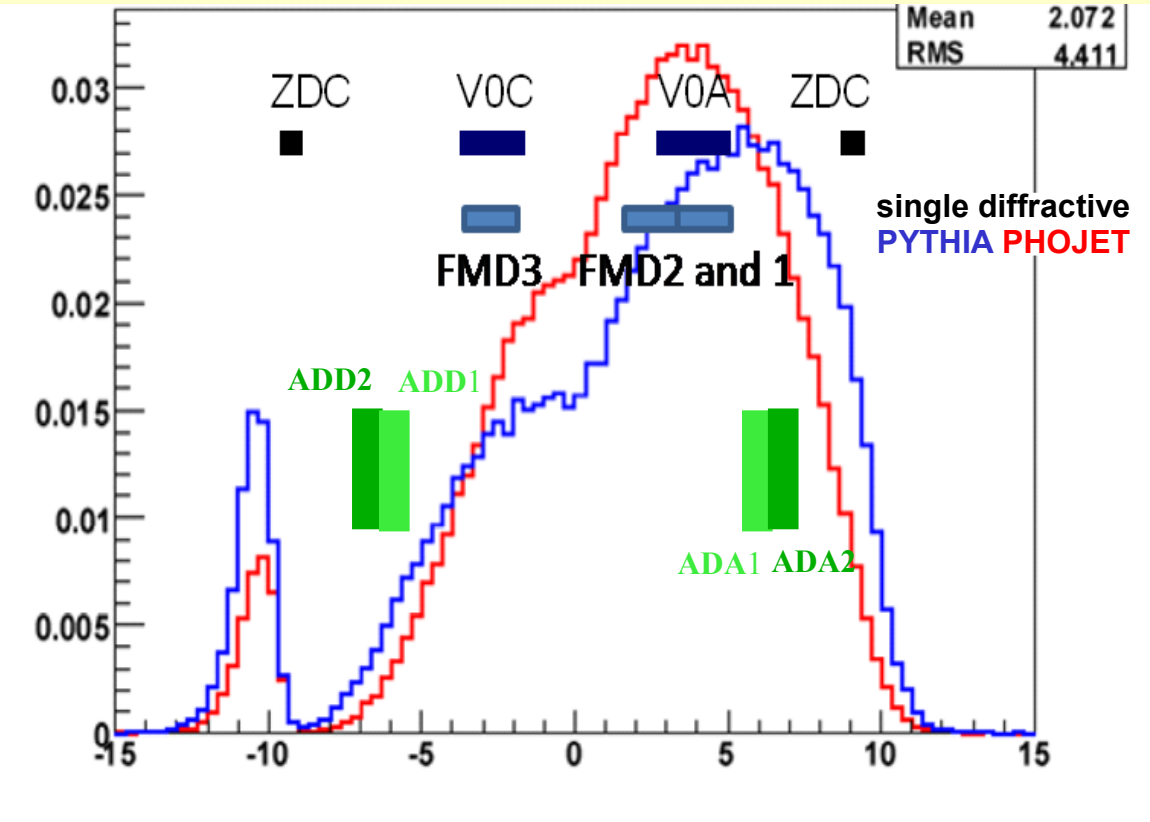
Prospects for data taking 2011

- Improve rapidity gap coverage by detector array AD (ALICE-INT-2010-014 v.1.)



Pseudo rapidity coverage of AD detector array

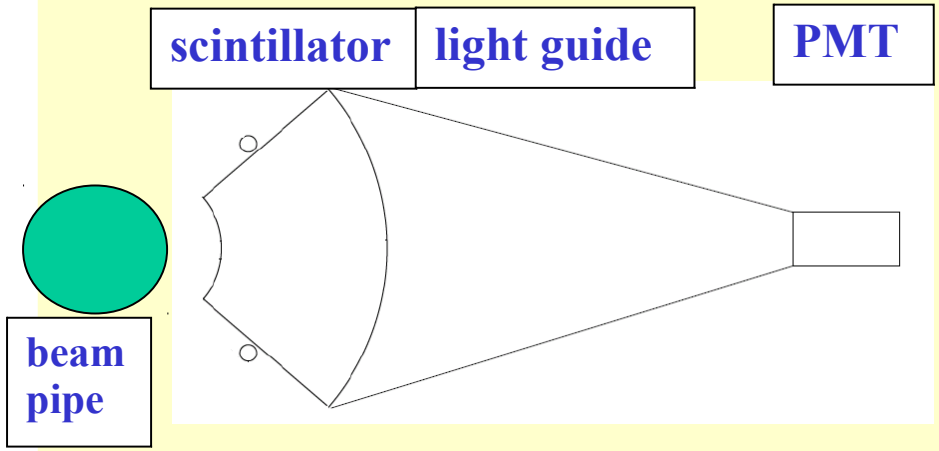
- Use data from AD detector array in offline analysis



PHOJET	Default fractions	PYTHIA
0.134	SD	0.187
0.063	DD	0.127

AD detector array

- geometry of AD detector array



pseudorapidity coverage

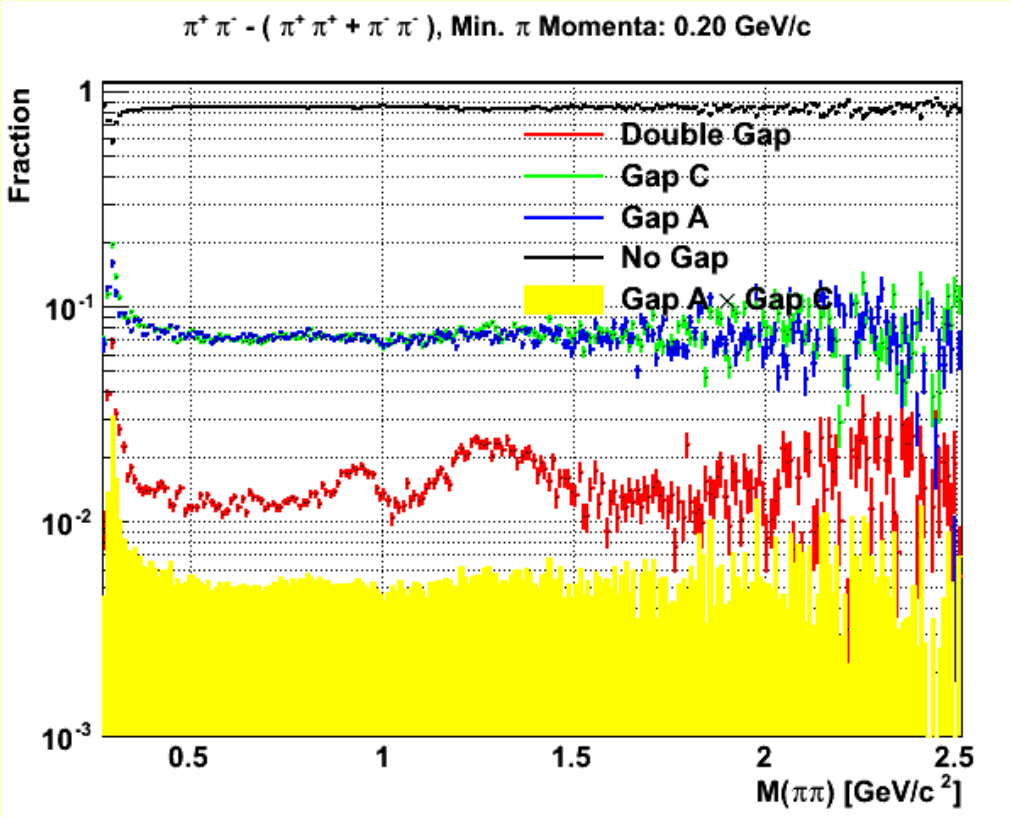
A side	distance from IP	outer radio	inner radio	η	C side	distance From IP	outer radio	inner radio	η
ADA1	17m	14 cm	5cm	5.5/6.5	ADD1	20m	16cm	6cm	- 5.5 /- 6.5
ADA2	55m	16 cm	6cm	6.5/7.5	ADD2	55m	16cm	6cm	- 6.5 /- 7.5

Conclusions, outlook

- ALICE has capability to identify single and double gap diffractive events
- Analysis of single and double gap events show different multiplicity and single track P_T and η-distribution
- Two track invariant mass distribution can be understood as continuum plus f_0, f_2 resonance contribution plus contribution from ρ-production of diffractive and non-diffractive events
- f_0, f_2 enhancement in double gap events established in normalized differential mass distribution
- Proposal for data taking of double gap events with dedicated trigger
- Purity of gap events will be improved by additional AD detector array

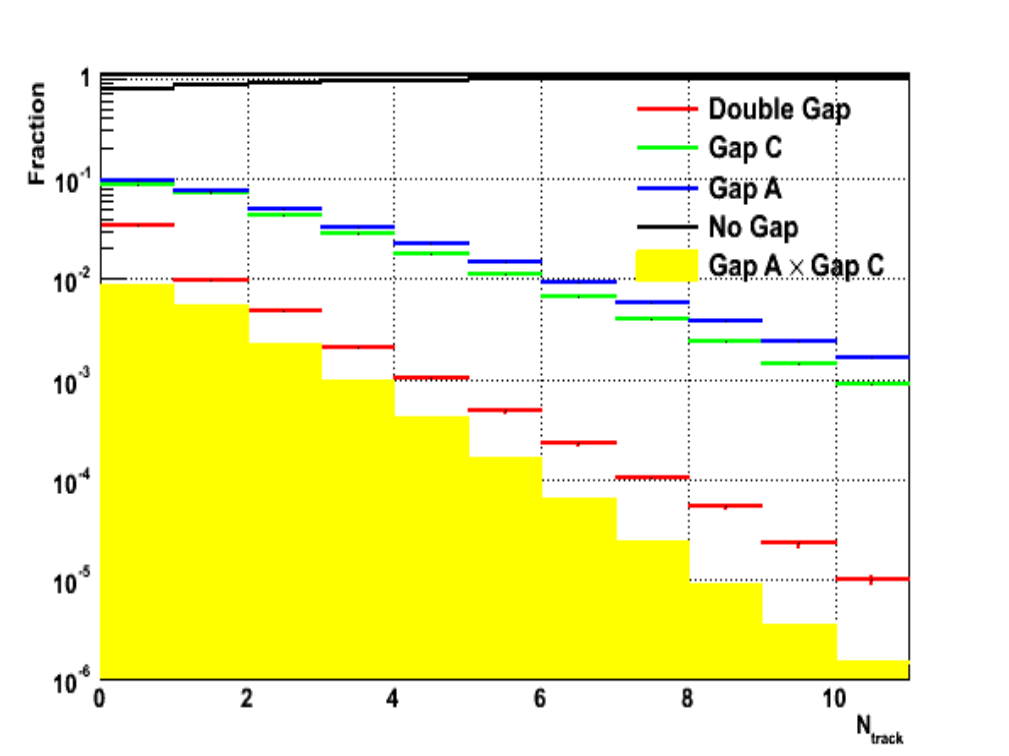
Backup: Two track mass distribution

Two track mass distribution normalized to unity per bin for gap and no gap events



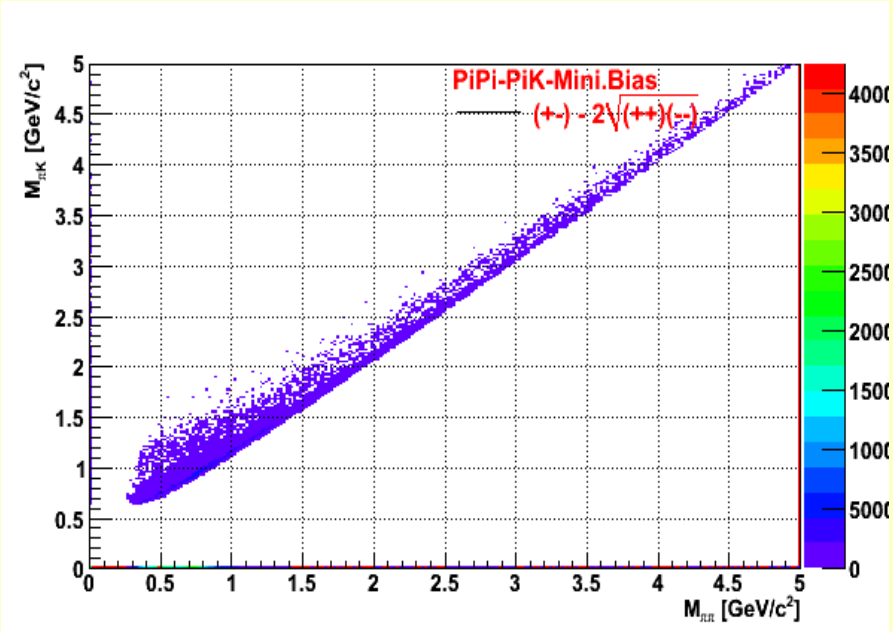
Backup: V0 efficiency

assumption: Single gap events only due to inefficiency of V0 detector

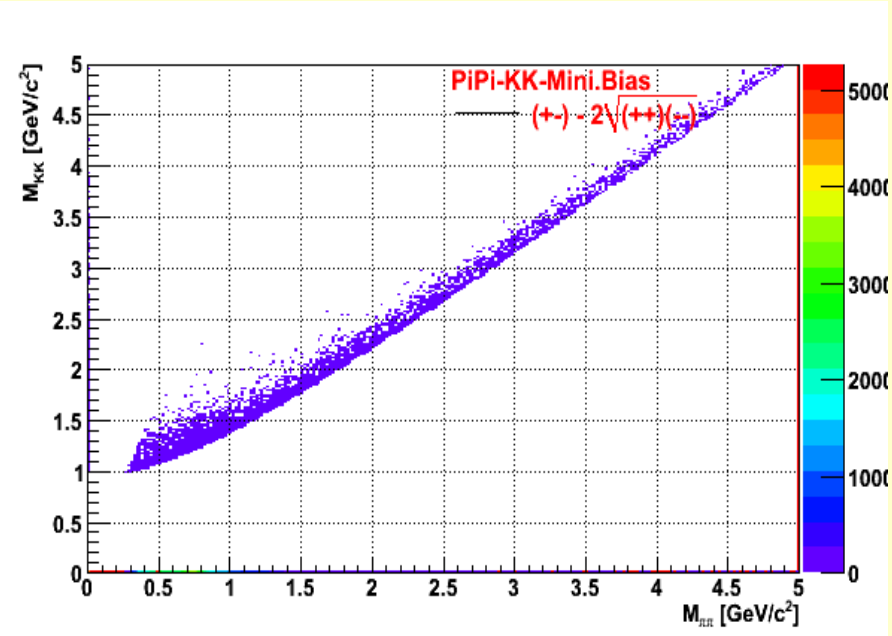


Backup: Two track mass ghosts

Resonance ghost due to π assumption



πK → ππ



KK → ππ