ALICE status report and first physics

for the ALICE collaboration

Karel Šafařík, CERN

- Data taking February – May 2010
- Detector status and performance
- Physics analyses

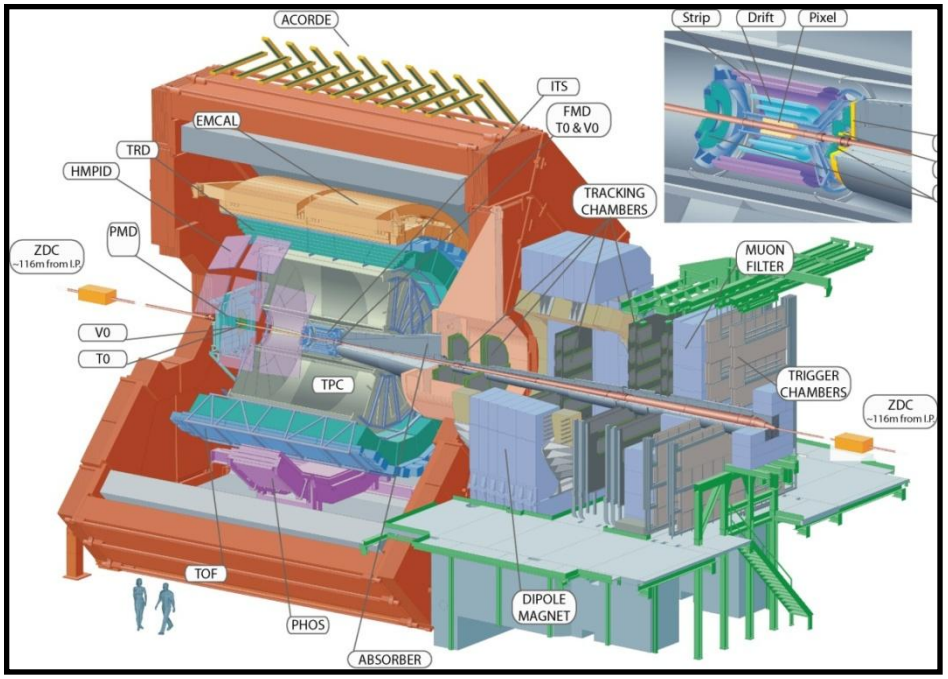
Detector configuration 2010

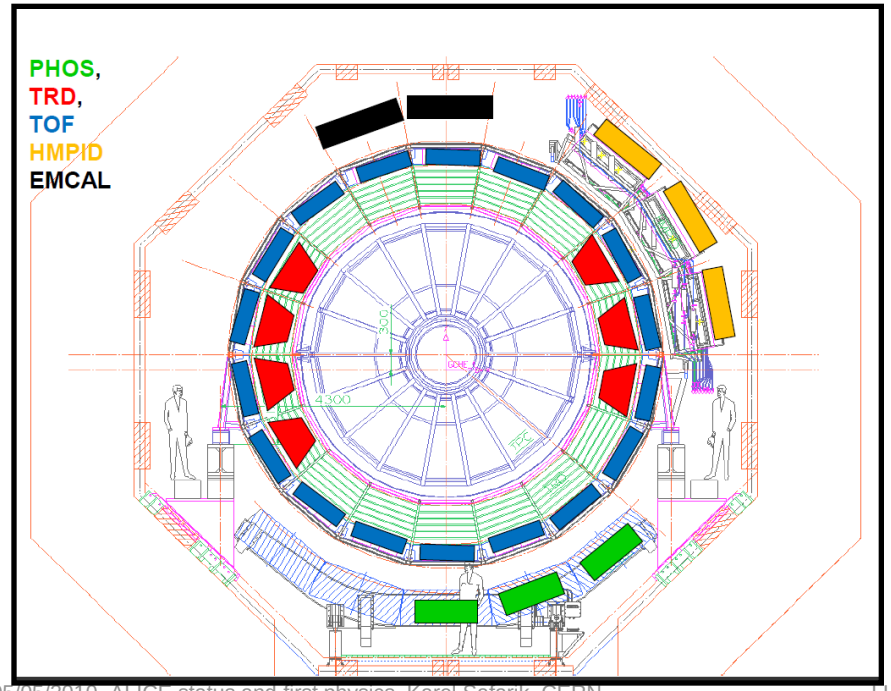
- ITS, TPC, TOF, HMPID, MUON, V0, T0, FMD, PMD, ZDC (100%)
- TRD (7/18)
- EMCAL (4/12)
- PHOS (3/5)
- HLT (60%)

full hadron and muon capabilities

partial electron and photon

no change with respect to 2009 run





Trigger configuration 2010

- based on *interaction* trigger reading *all detectors*:
  - SPD (min bias) *or* V0-A *or* V0-C
  - → at least one charged particle in 8 pseudorapidity units
- and *single-muon* trigger reading *MUON, SPD, V0, FMD, ZDC* :
  - single muon, low-p_T threshold, in the muon arm in coincidence with *interaction* trigger
- → activated in coincidence with the BPTX beam pickups:
  - 'bunch-crossing' with bunches from both sides
  - for control 'bunch-crossing' with bunch from side A or C only
  - for control 'bunch-crossing' with no bunches
- a fraction of 'bunch-crossing' trigger (no condition on trigger detectors)
  - for control
  - to measure relative fractions of single- and double-diffractive events
- HLT in Mode B (no event rejection)

Data taking since March 30th

since February till end of March cosmic-ray data taking

- ~10^5 events

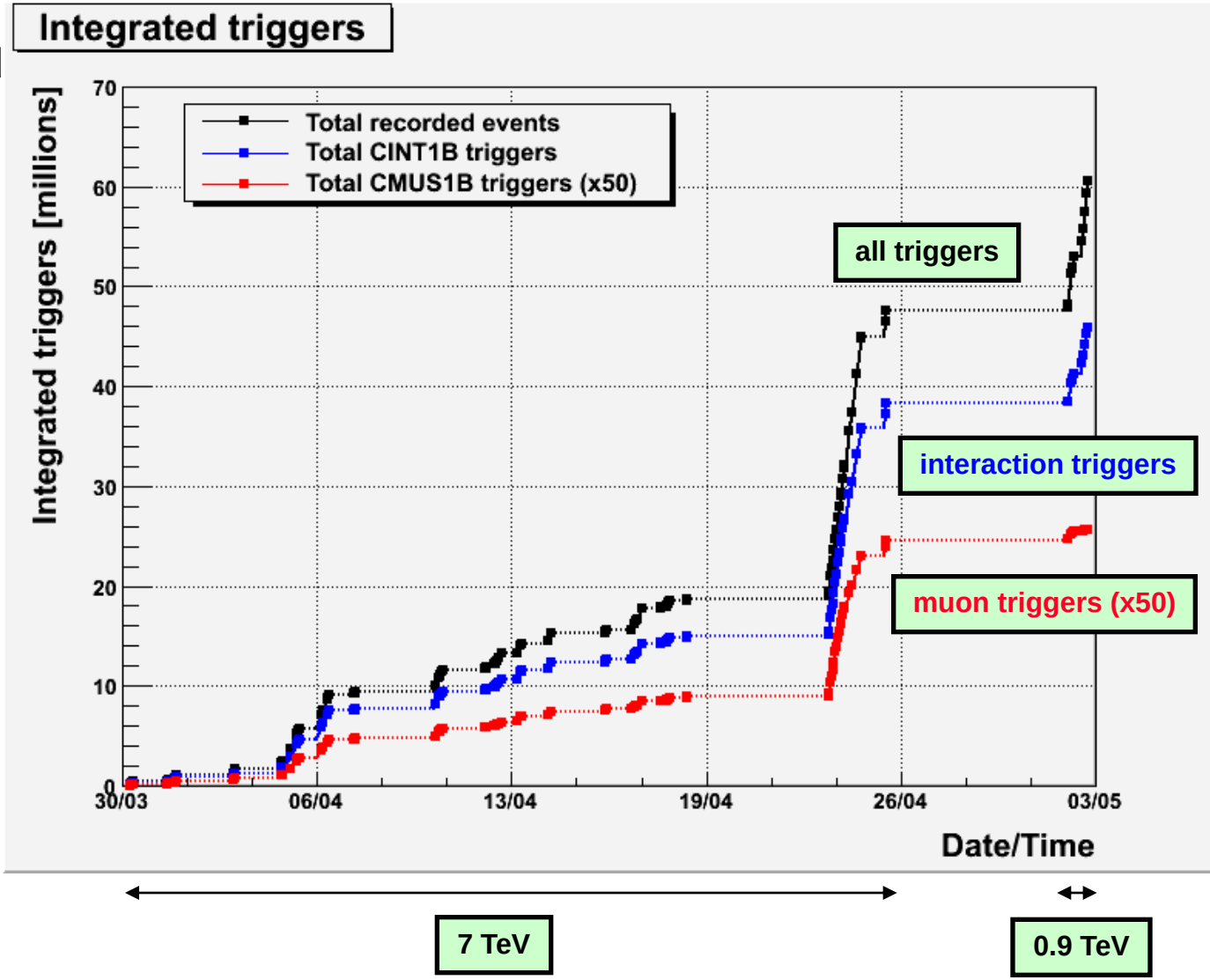
pp run since March 30th 2010

⇨ 7 TeV

- 40x10^6 events

⇨ 0.9 TeV

- 7x10^6 events

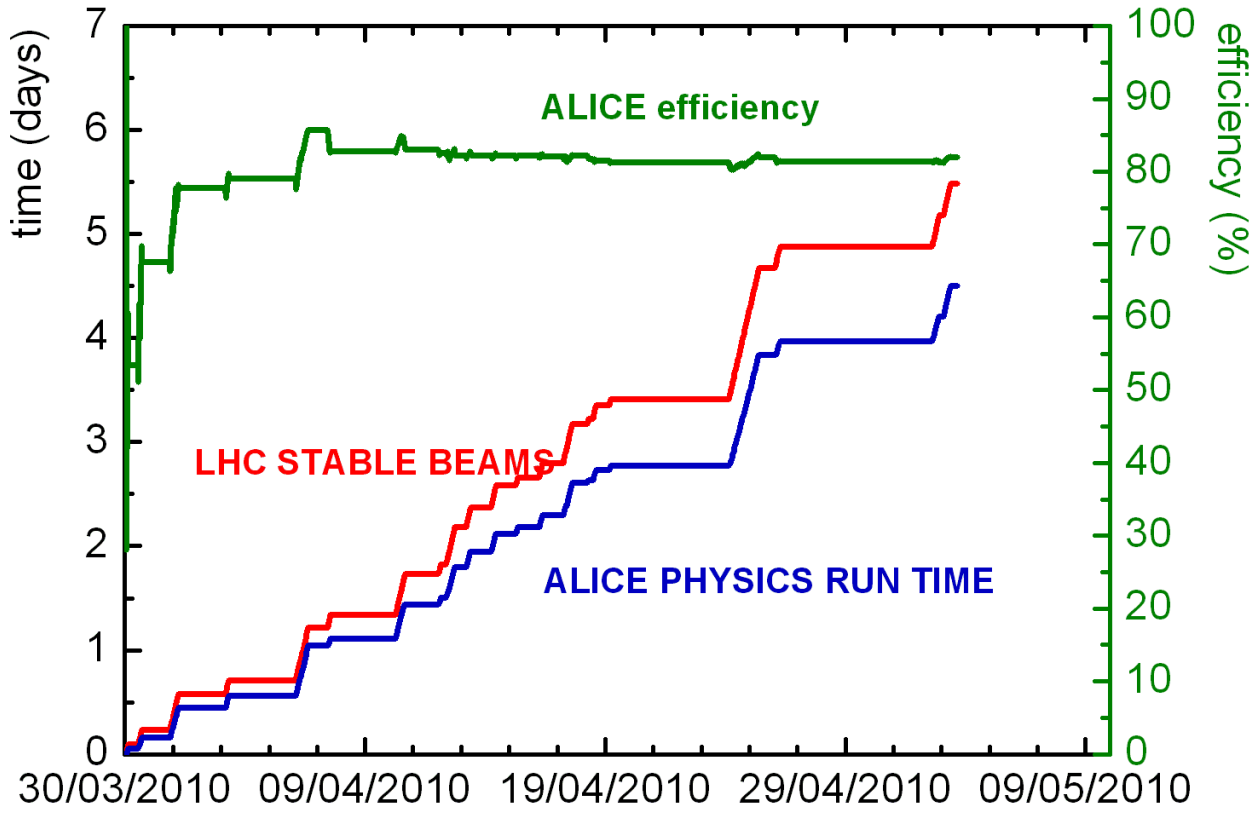


Data taking rates

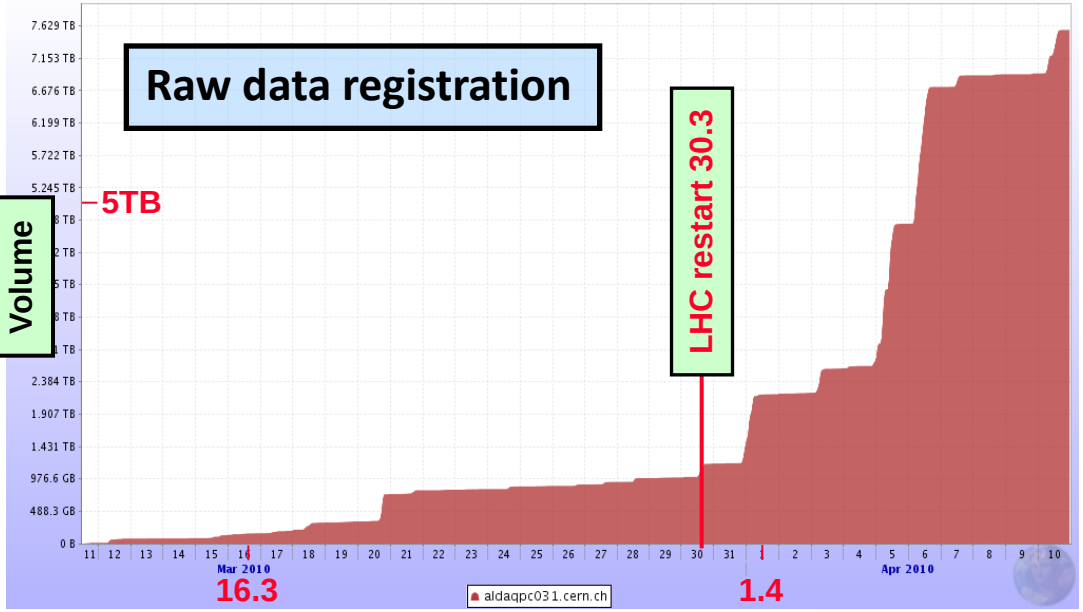
Online systems (CTP, DAQ, ECS, DCS, QA by HLT and prompt ONLINE)
running to specs

Data taking rates

- ⇨ **at 7 TeV**
  - ✪ **> 350 Hz**
- ⇨ **at 0.9 TeV**
  - ✪ **~ 270 Hz**
- ⇨ **dead time**
  - ✪ **~40 – 50%**



Offline data processing

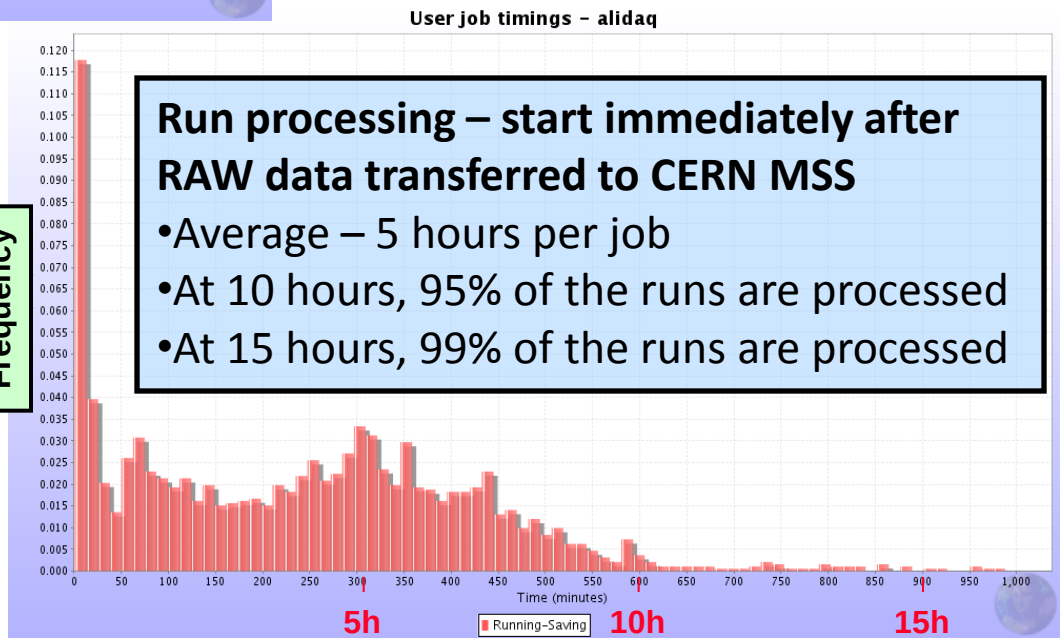


Raw data processing

- Pass 1-6 completed for 0.9 and 2.36 TeV data
- Pass 0 @T0 introduced for calibration
- Pass 1 @T0 for 7 TeV data follows the data taking
- Analysis train running weekly: QA, physics working groups organized analysis

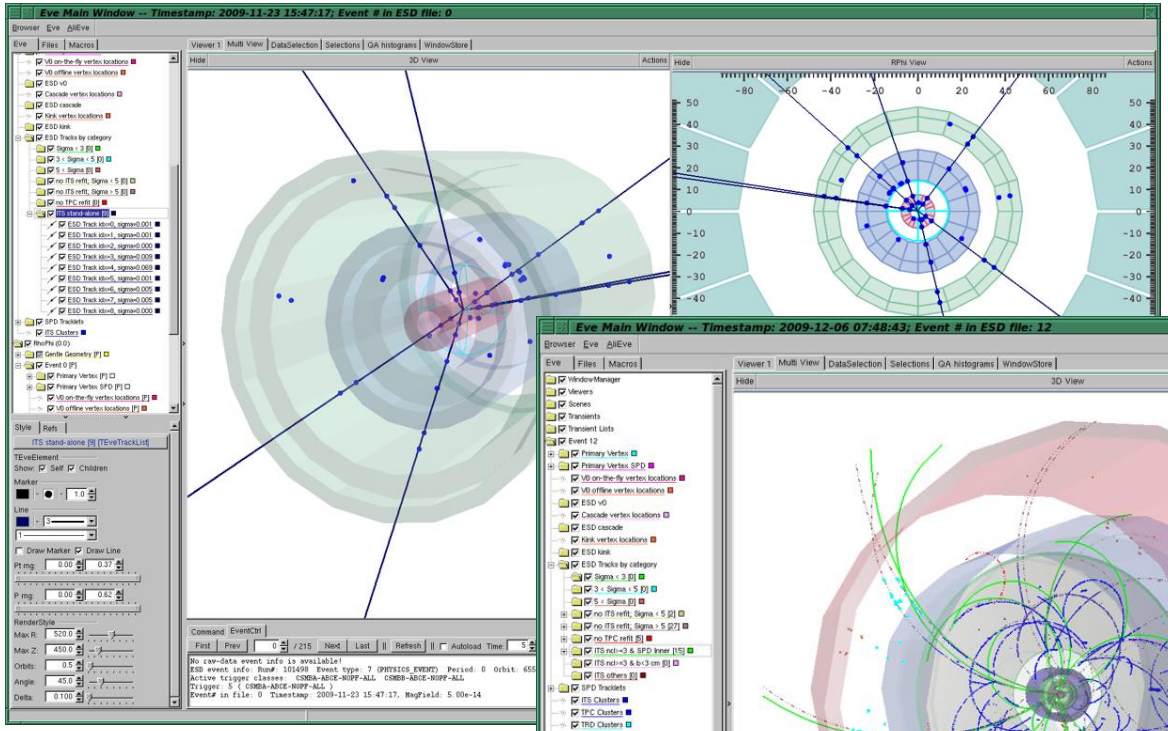
MC production

Several production cycles for 0.9, 2.36 and 7 TeV pp: 17×10^6 events with various generators (Phytia, PHOJET) and conditions from real data taking

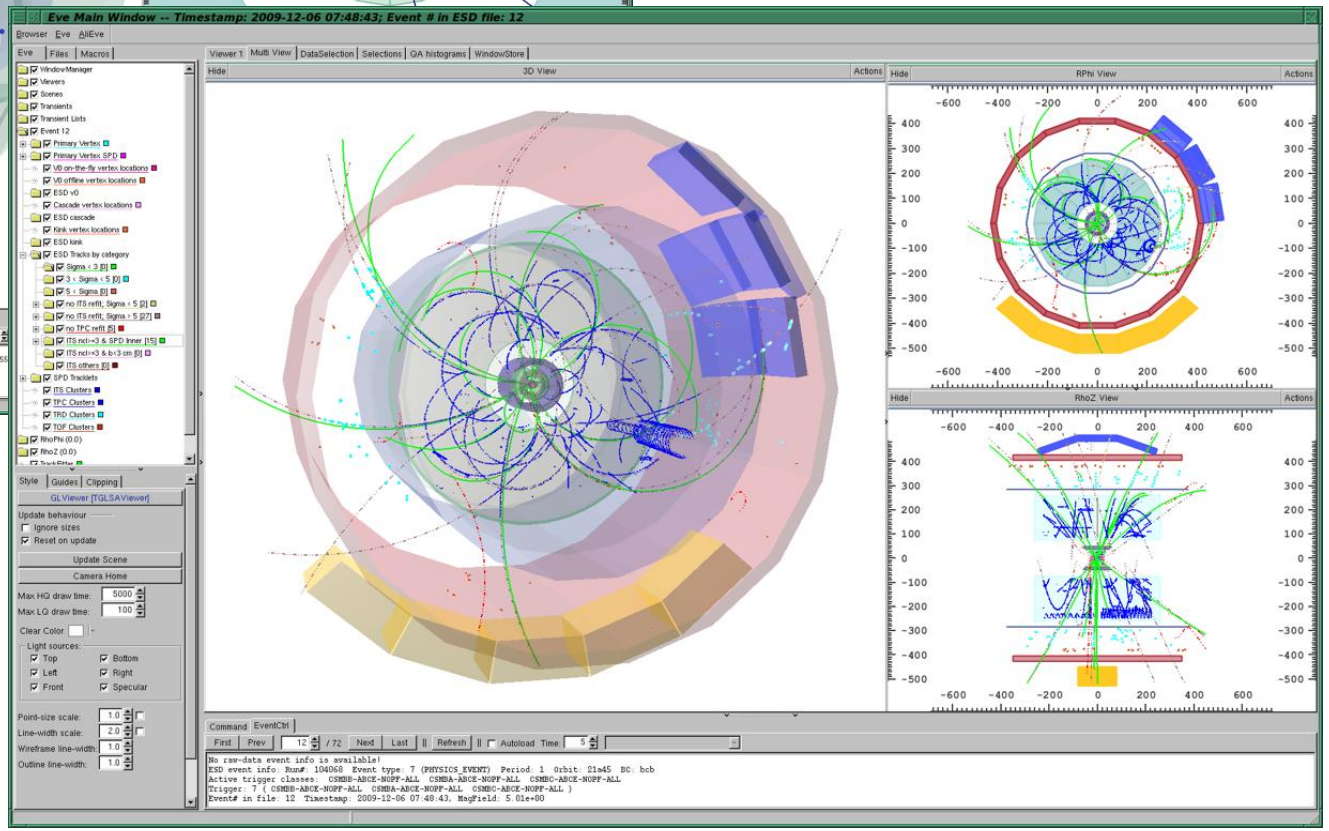


Events…

ALICE first event at 0.9 TeV …



… and at 7 TeV



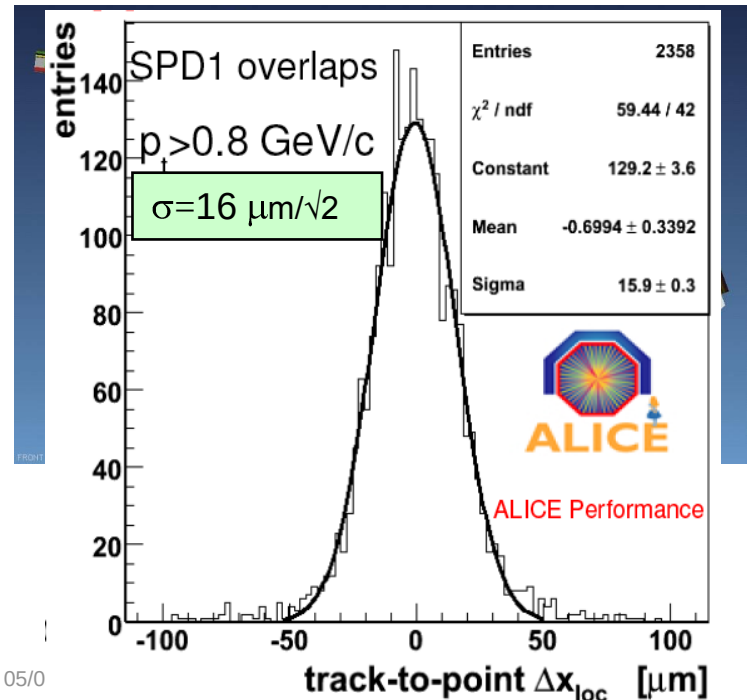
Inner Tracking System – SPD

Fully installed – still problem with cooling (insufficient flow of cooling fluid)
improvements: freon sub-cooling close to detector; flow-meters and pressure regulators on each line
typically ≥ 80% of half-staves operational
fraction of dead pixels (in active half-staves) ~1.2%

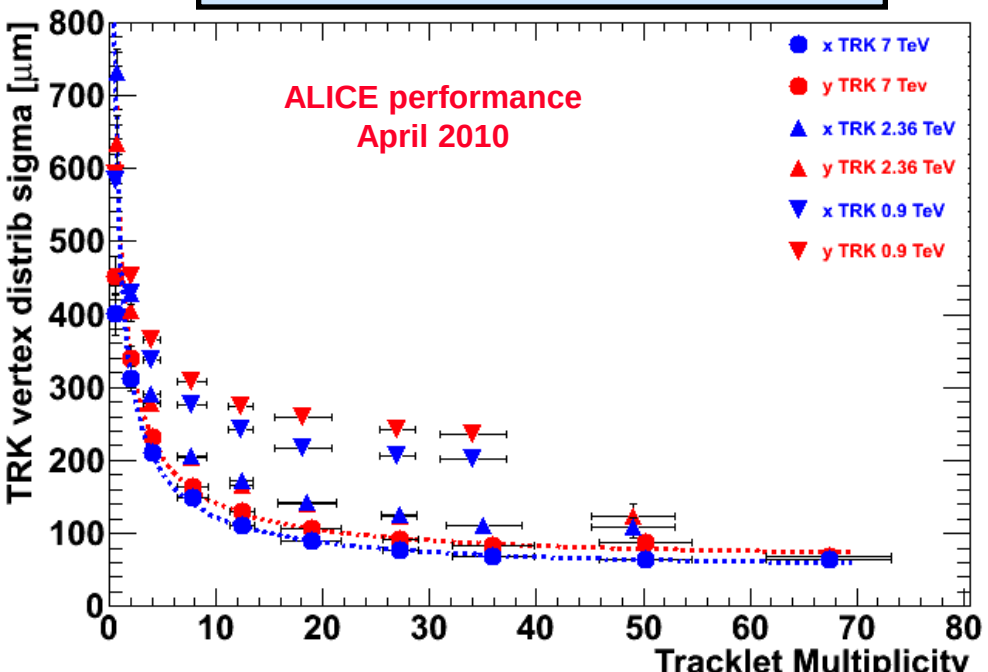
2010 run

	Full SPD	Inner layer	Outer layer
Active HS (out of)	103 (120)	32 (40)	71(80)
Dead pixels (in active HS)	1.18 %	0.6%	1.45%

Alignment precision



Vertex reconstruction precision

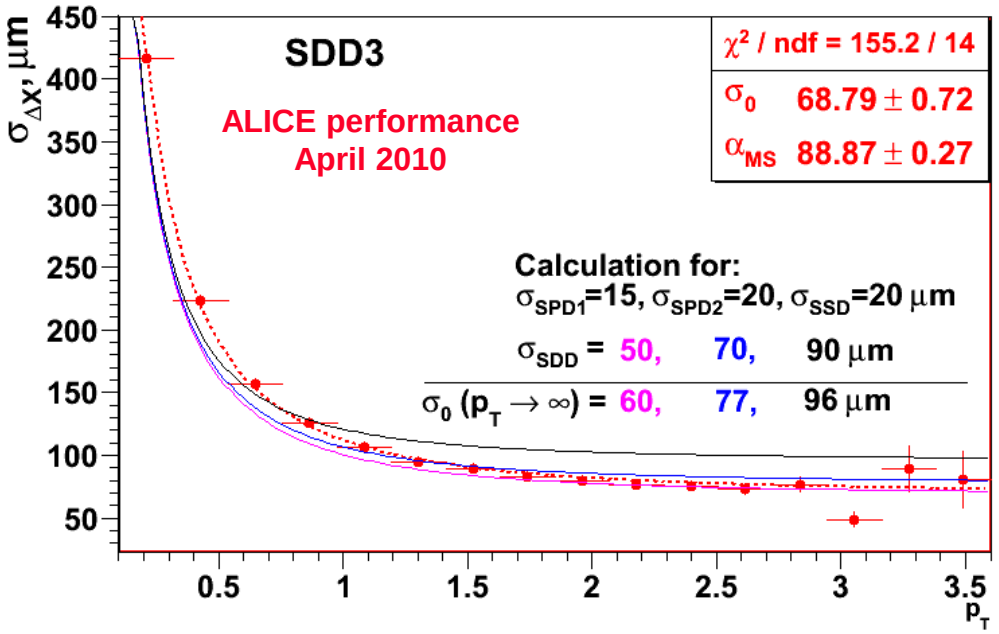


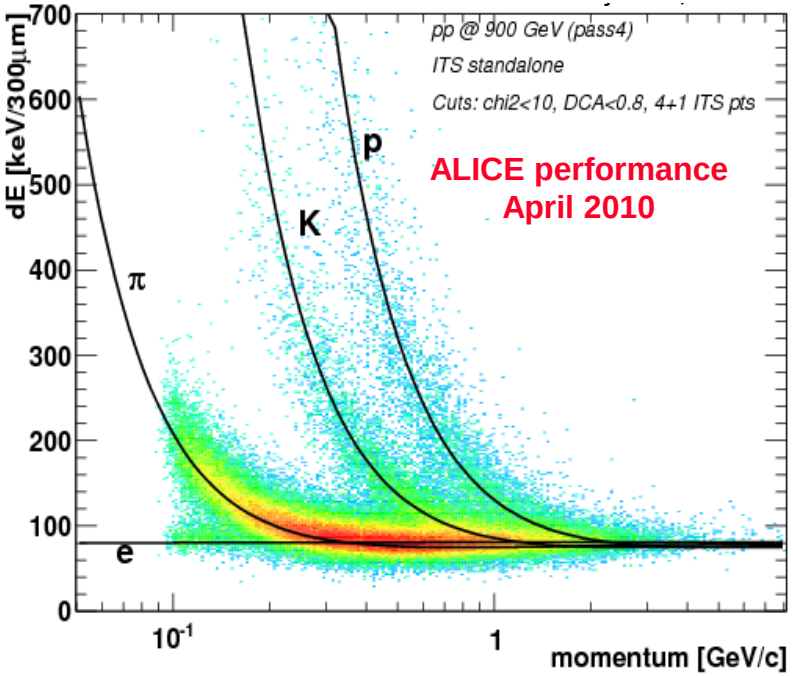
Inner Tracking System – SDD, SSD

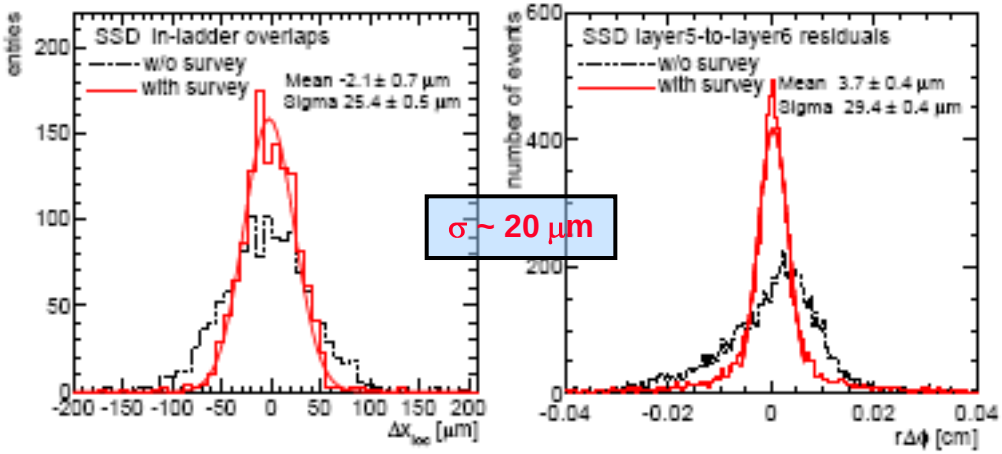
SDD – 94% (3) and 91.5% (4) operational
improved calibration of drift velocity
residuals ~ 60 μm (nominal 35 μm)

SSD – 138 half-ladders operational (96%)
alignment within ~ 20 μm

calibration of dE/dx for PID
ITS alignment: JINST 5 P03003 (2010)





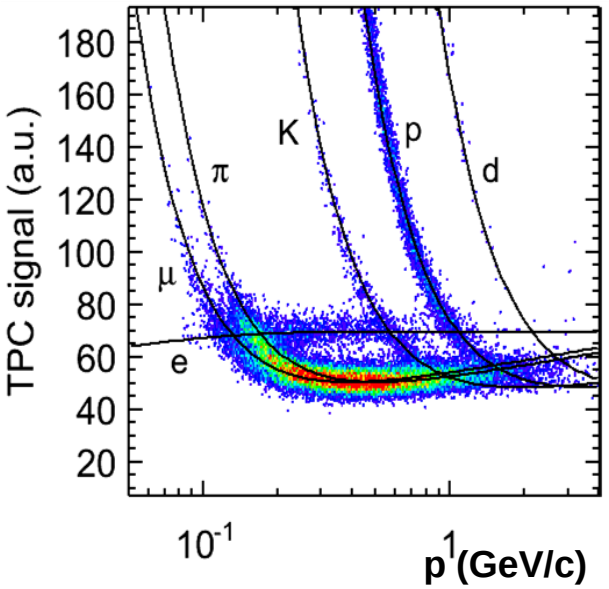


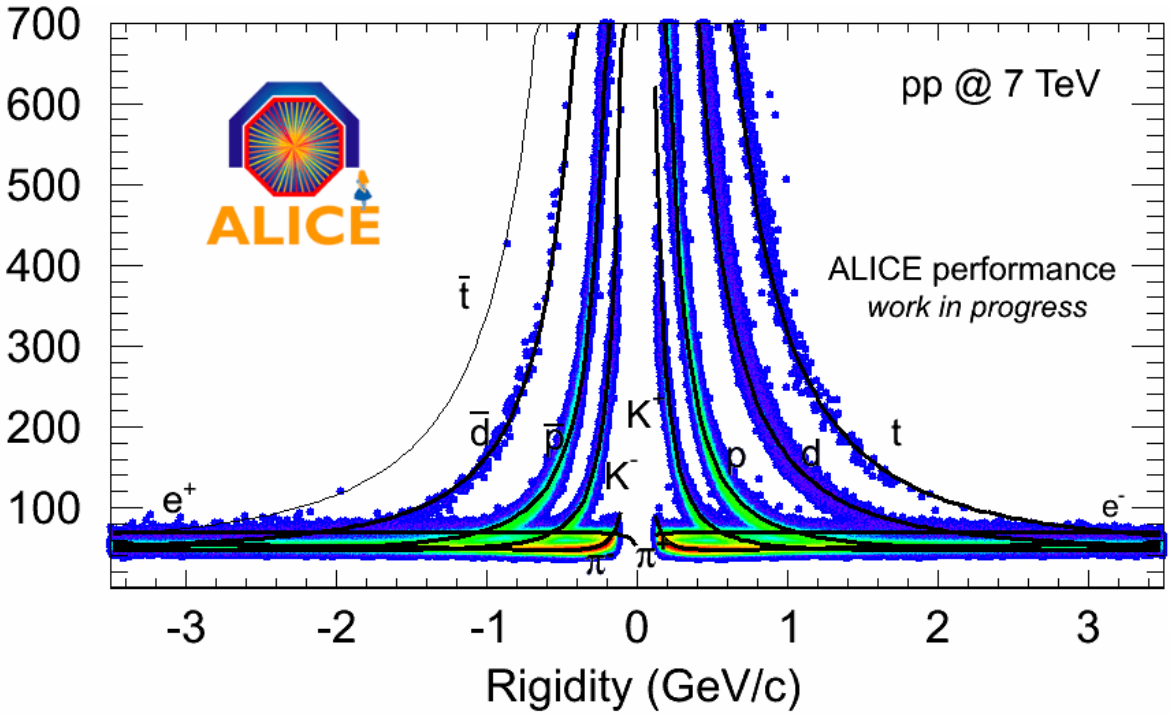
Time-Projection Chamber

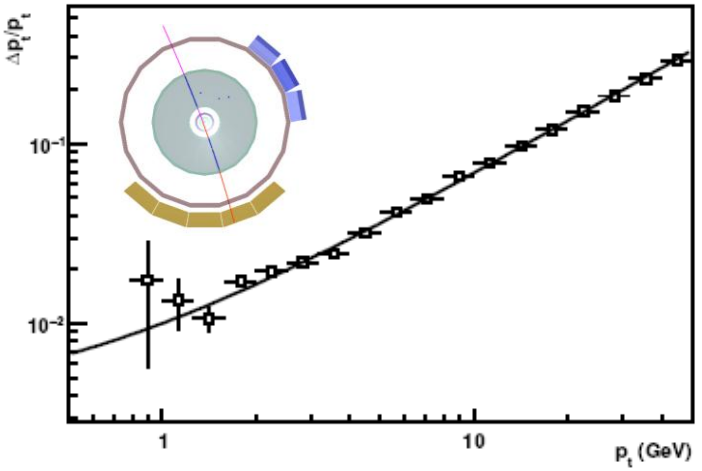
Detector fully operational: 99.9% of all channels
dE/dx resolution: < 5%
momentum resolution: < 7% at 10 GeV
working on distortion map: dp/p < 5% at 10 GeV

read-out rate up to 1kHz

J. Alme et al., ALICE TPC coll., Nucl. Instr. Meth. A (in print), arXiv:1001.1950





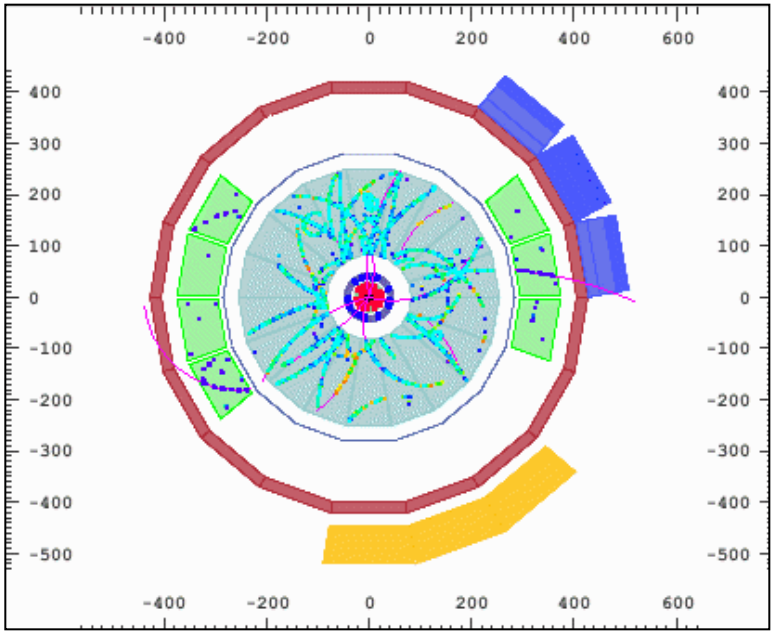


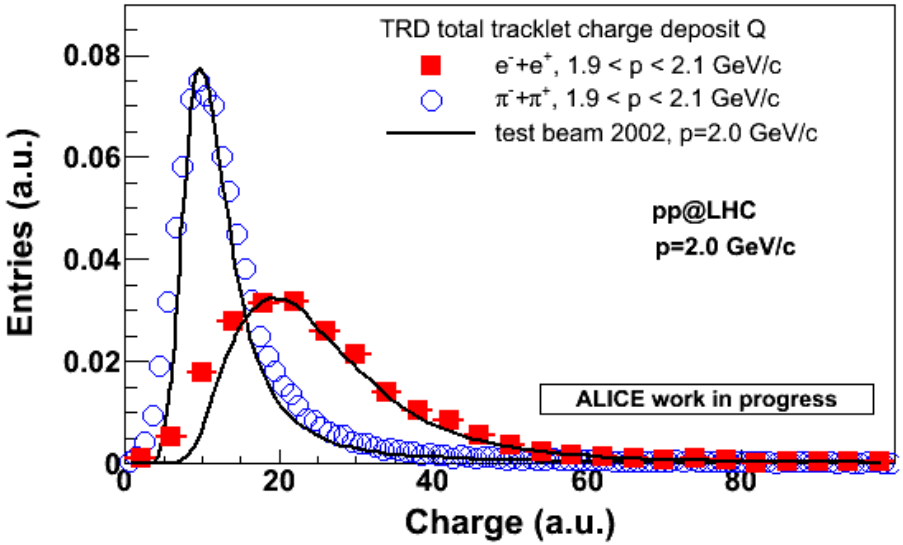
Transition-radiation detector

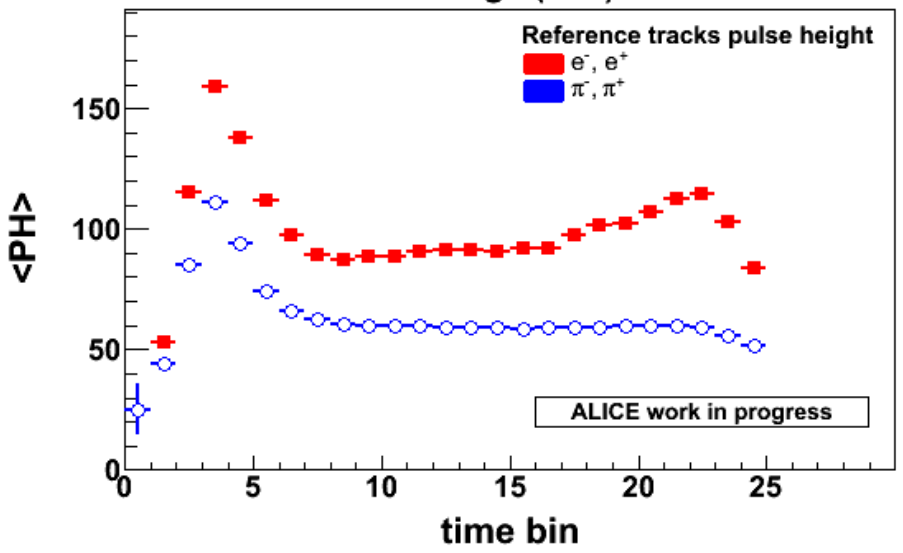
7 out of 18 supermodules installed
production on schedule –
will be adjusted according the length of winter shutdown

installed supermodules aligned with tracks

gain calibration with $\gamma \rightarrow e^+e^-$ $K^0_s \rightarrow \pi^+\pi^-$



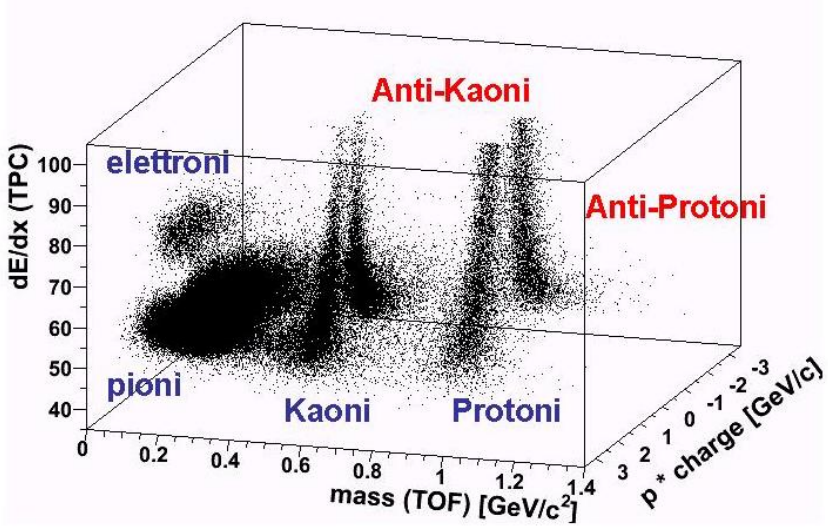


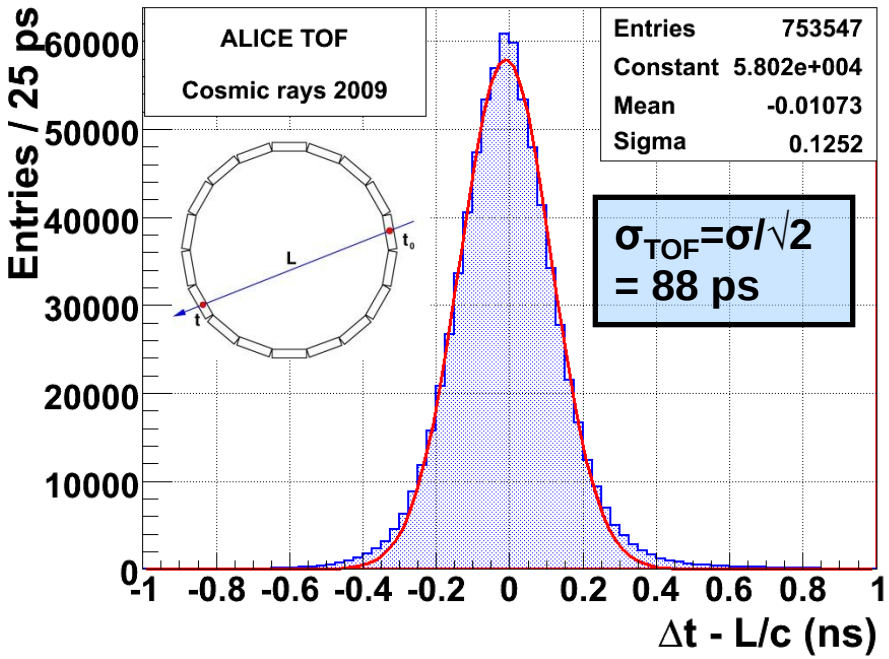


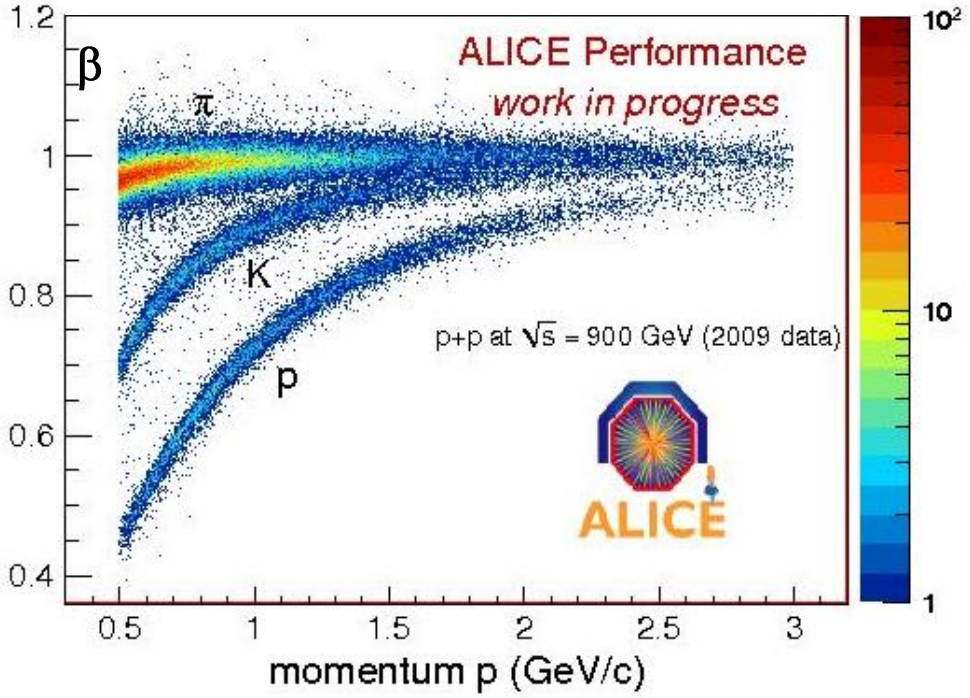
Time-of-flight detector

Fully installed –
95% channels operational

Time resolution –
close to nominal

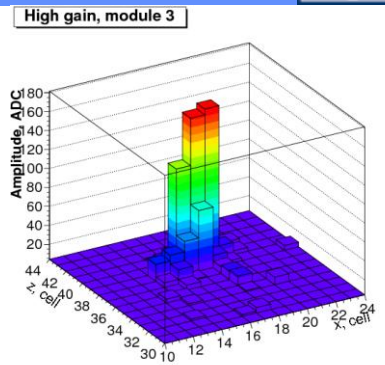






PHOS, EMCal, HMPID, PMD

PHOS – 3 out 5 modules installed and working at operational temperature – 25 C
calibration in progress



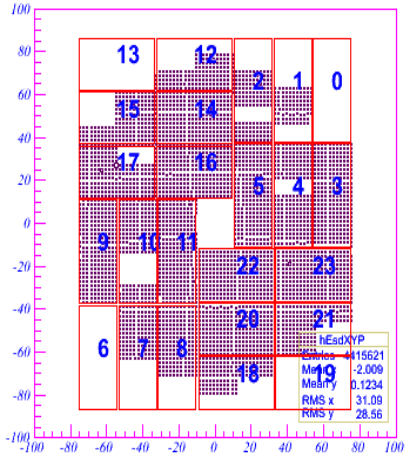
EMcal – 4 out 12 modules installed
calibration in progress
6 modules prepared for installation

HMPID – fully installed alignment and calibration in progress

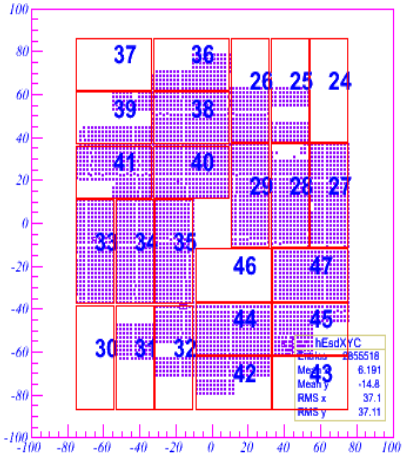
PMD – 90% of channels operational

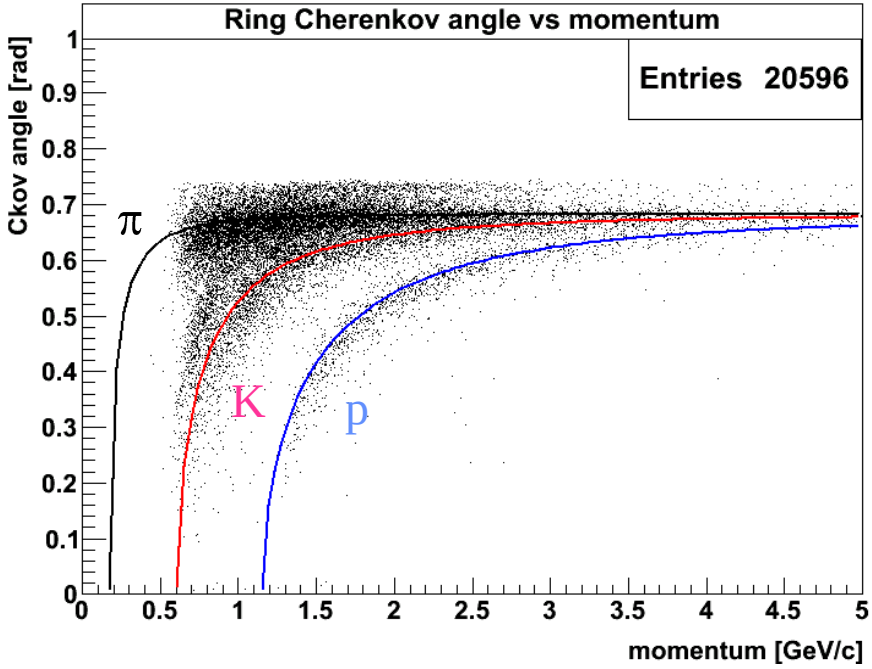
Hits Distribution

Preshower plane



CPV plane

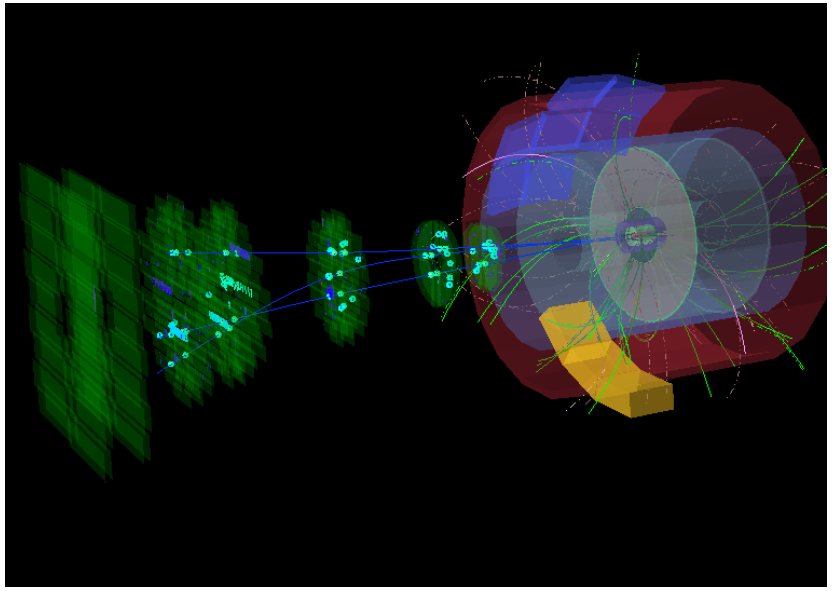


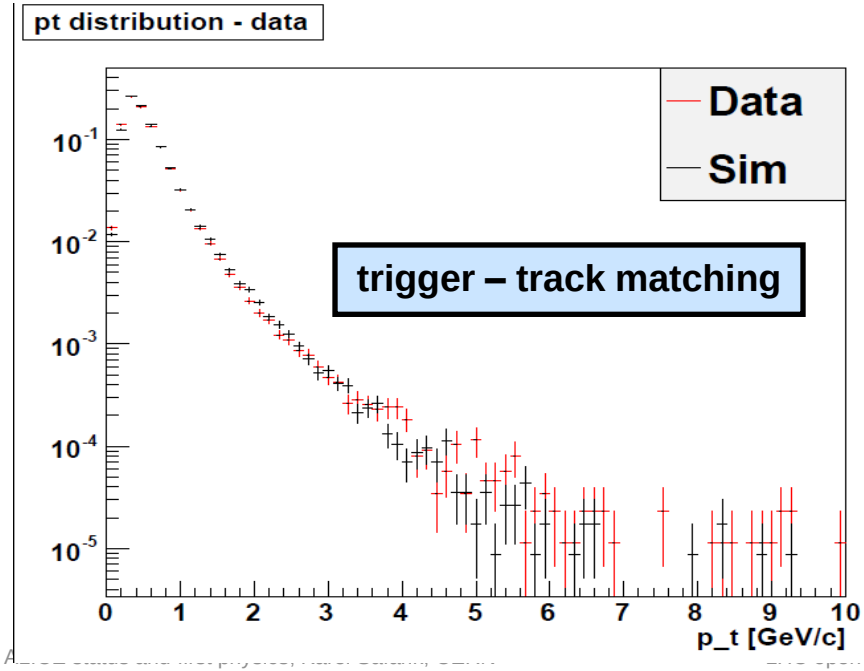


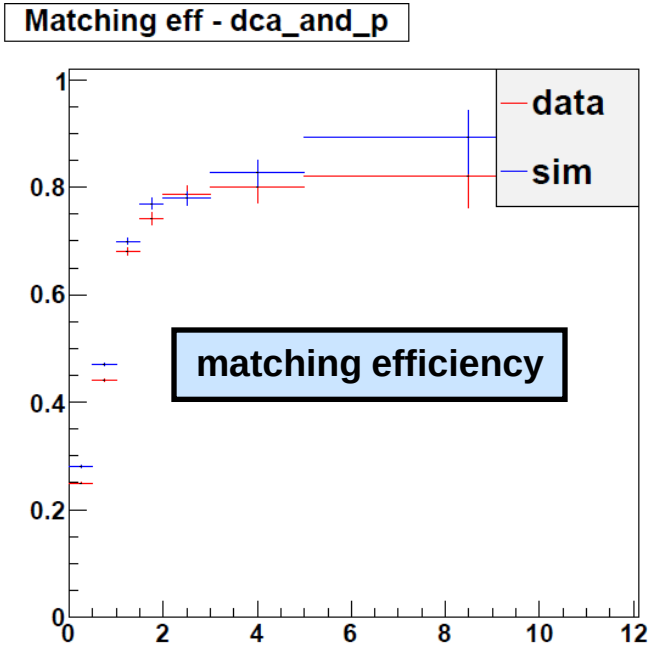
Muon detector

Fully installed – muon chambers 95% of channels operational
stable operation, alignment not finalized yet

Trigger – 99% channels operational
stable operation, at L0 trigger on p_t > 0.5 GeV







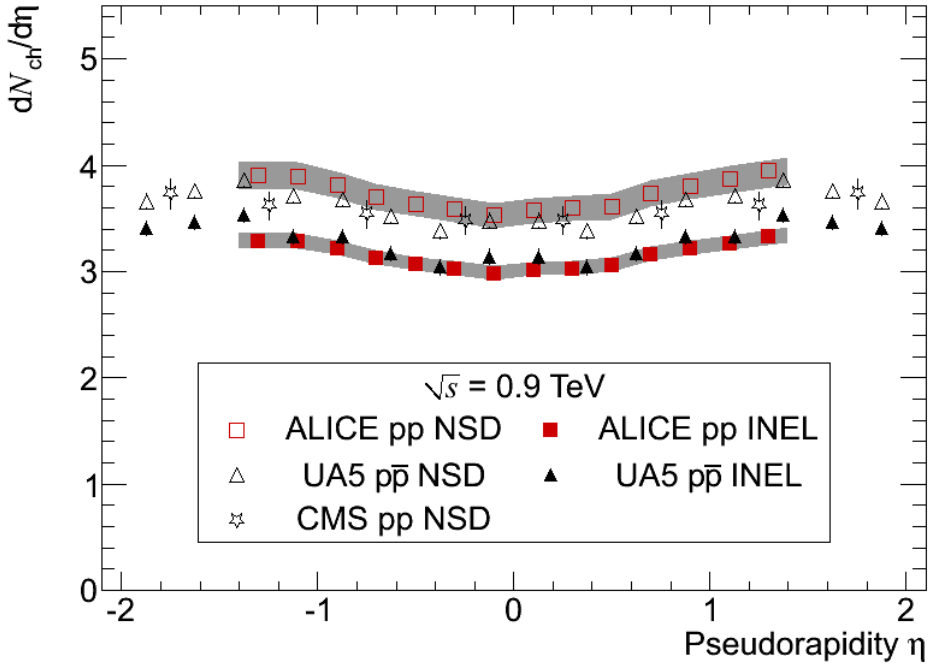
Physics analyses

- **3 papers published – submitted**
  - **Charged-particle density in 900 GeV pp collisions**
    K. Aamodt et al. (ALICE), Eur. Phys. J C 65 (2010) 111
  - **Charged-particle multiplicity in 0.9 and 2.36 pp collisions**
    arXiv:1004.3034[hep-ph] accepted in Eur. Phys. J C
  - **Charged-particle multiplicity in 7 TeV pp collision – letter**
    arXiv:1004.3514[hep-ph] to be published in Eur. Phys. J C
- **3 papers under internal review**
  - **Measurement of antiproton/proton ratio in pp at 0.9 and 7 TeV**
  - **Identical particle correlation in pp at 0.9 TeV**
  - **Charged-particle transverse momentum spectra at 0.9 TeV**
- **2 papers in draft**
  - **Identified charged hadron spectra and yields in pp at 0.9 TeV**
  - **Strange particle production in pp at 0.9 TeV**
- **Other analyses well underway**
  - **azimuthal correlations, event structure, π^0 spectra, charm production, …**

Charged-particle η-density

high statistics measurement at 0.9 TeV and 2.36 TeV
normalized to all inelastic events (INEL) and non-single-diffractive events (NSD)
very good agreement with our first publication and with CMS (NSD)
systematic errors 2–3 %
increase form 0.9 to 2.36 TeV ~ 24% (NSD)
well above model predictions

arXiv:1004.3034[hep-ph]



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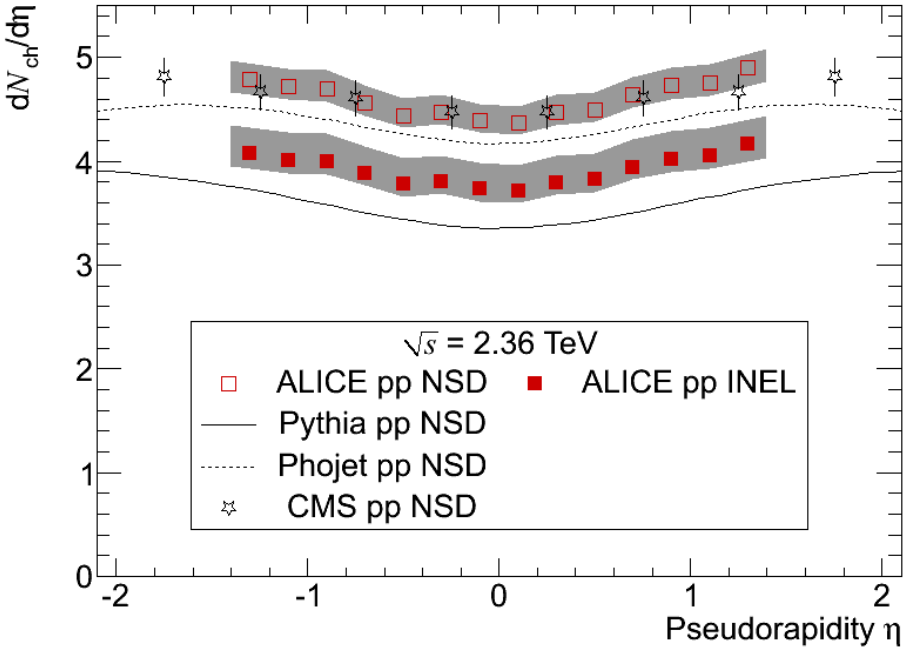
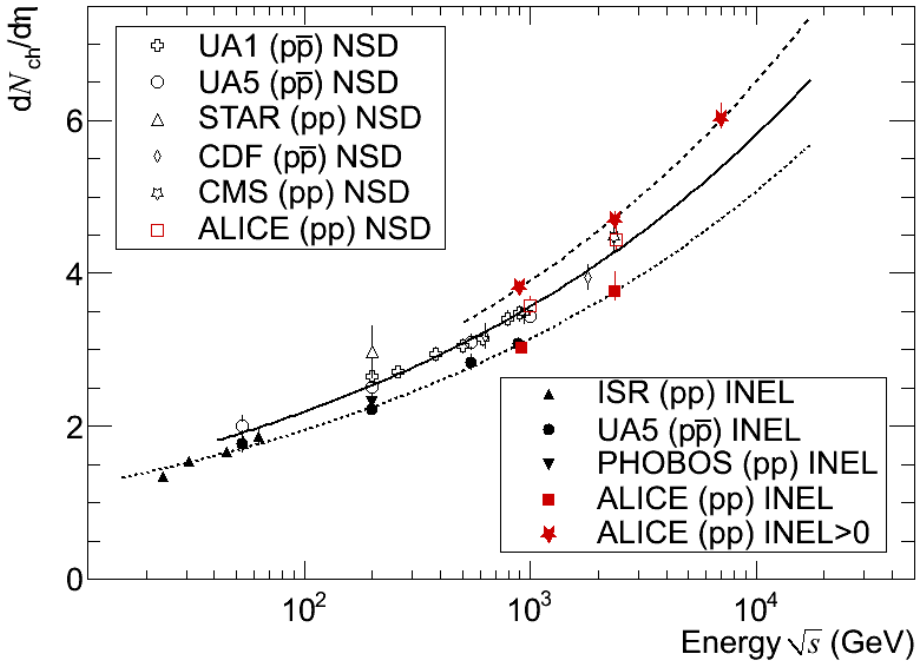


Charged-particle η-density

first measurement at 7 TeV
normalized to inelastic events (INEL>0) with at least 1 charged particle in $|\eta|<1$
minimizing model dependent corrections and systematic error
increase from 0.9 to 7 TeV ~ 57% (NSD)
even more above model predictions
energy dependence of charged-particle pseudorapidity density for different event classes: NSD, INEL, and INEL>0 (in $|\eta|<1$)
fit with power dependence on energy:

arXiv:1004.3514[hep-ph]



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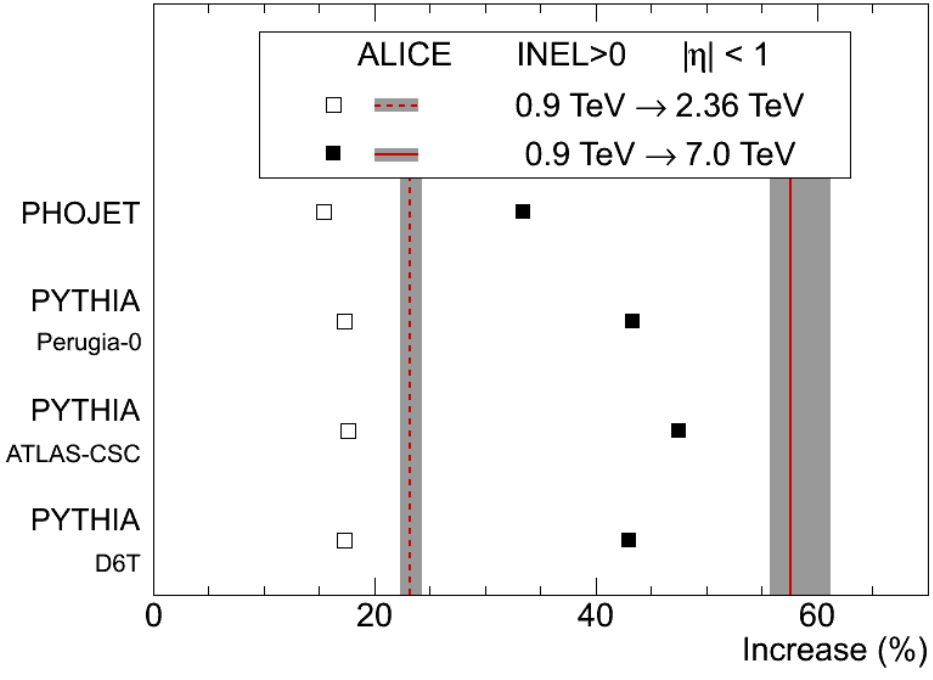
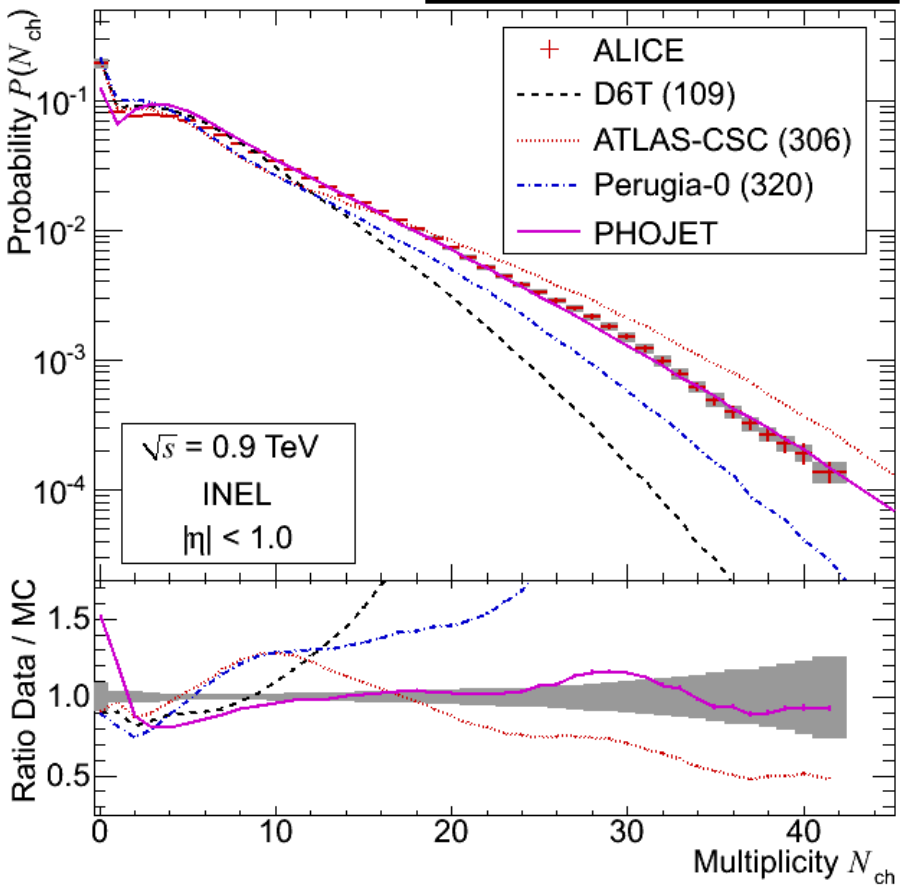


Multiplicity distribution 0.9 and 2.36 TeV

multiplicity distributions of charged particles in 3 η-intervals
wavy fluctuations due the unfolding
very good agreement with p anti-p measurement by UA5 in |η|<0.5
comparison with different models – tail increases faster

arXiv:1004.3034[hep-ph]



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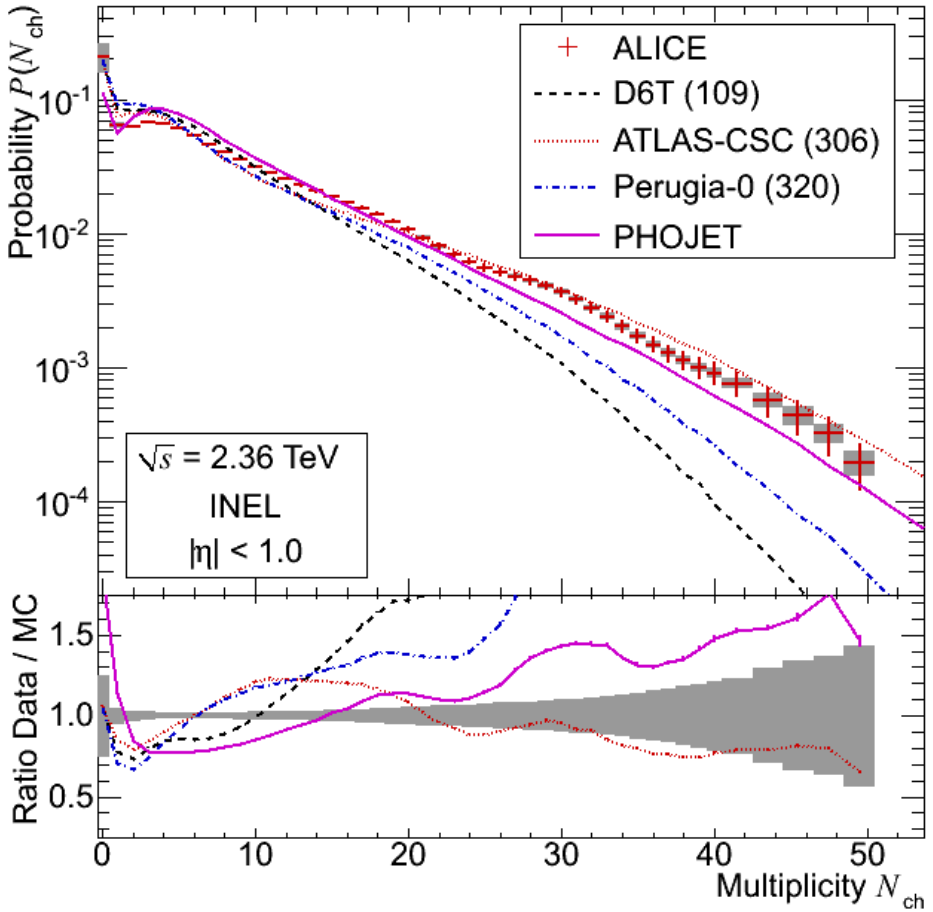
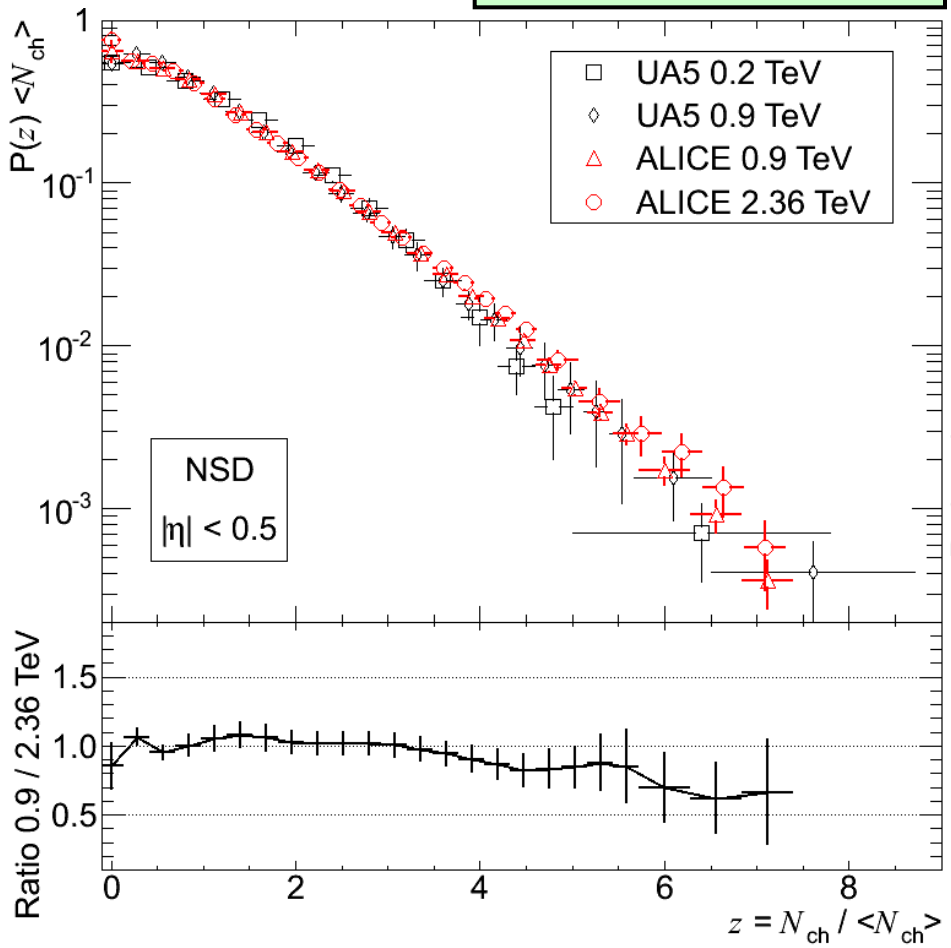


Multiplicity distribution 0.9 and 2.36 TeV

energy evolution of multiplicity distributions – KNO scaling
reduced moments: $C_q = \langle N^q \rangle / \langle N \rangle^q$

arXiv:1004.3034[hep-ph]



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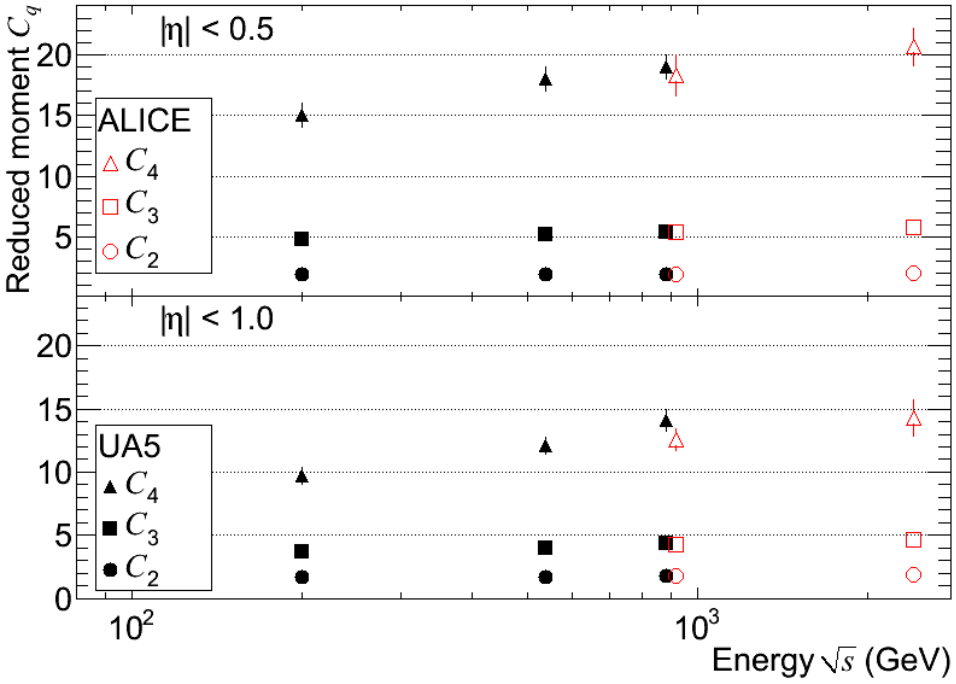
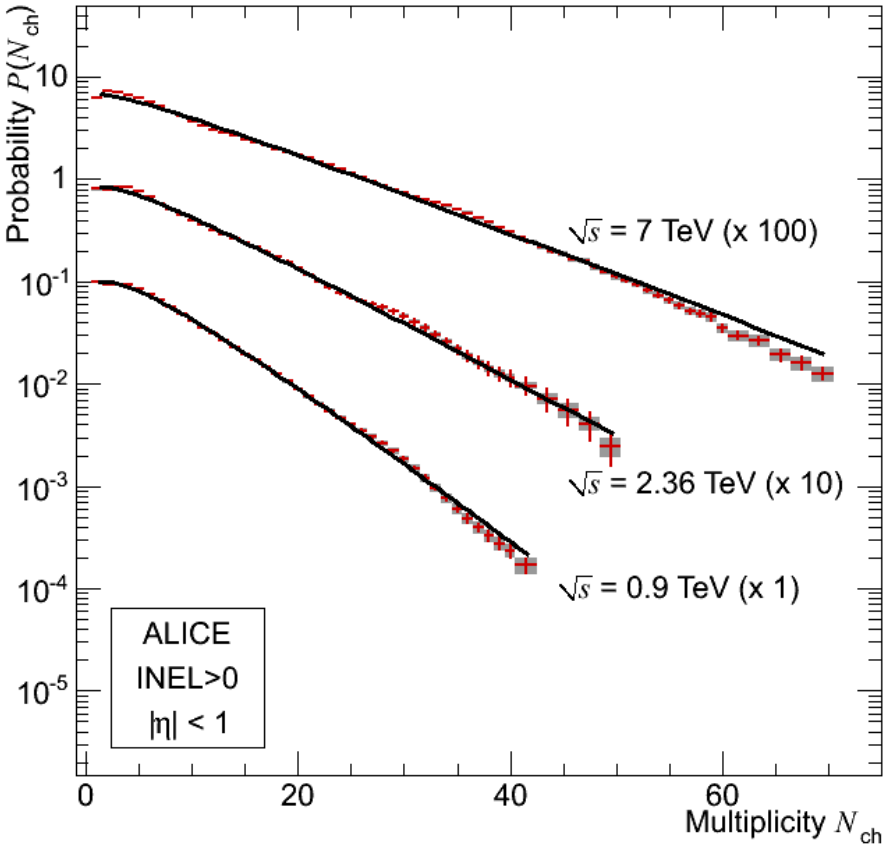


Multiplicity distribution 7 TeV

reasonably described by negative-binomial distributions
comparison with different models – not satisfactory

arXiv:1004.3514[hep-ph]



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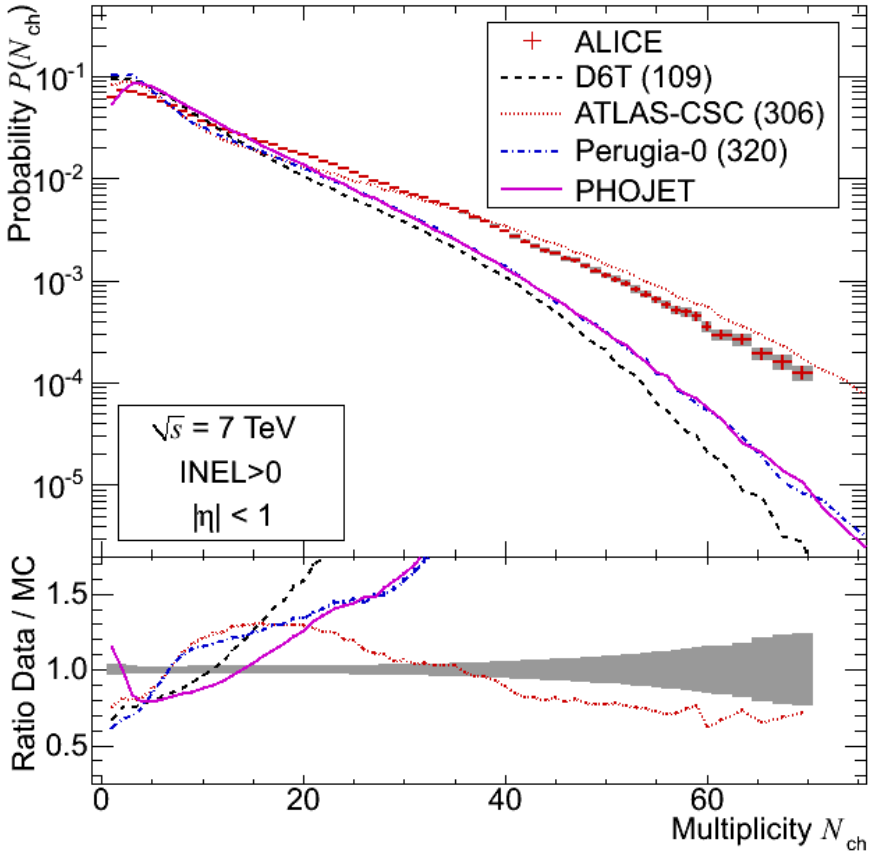
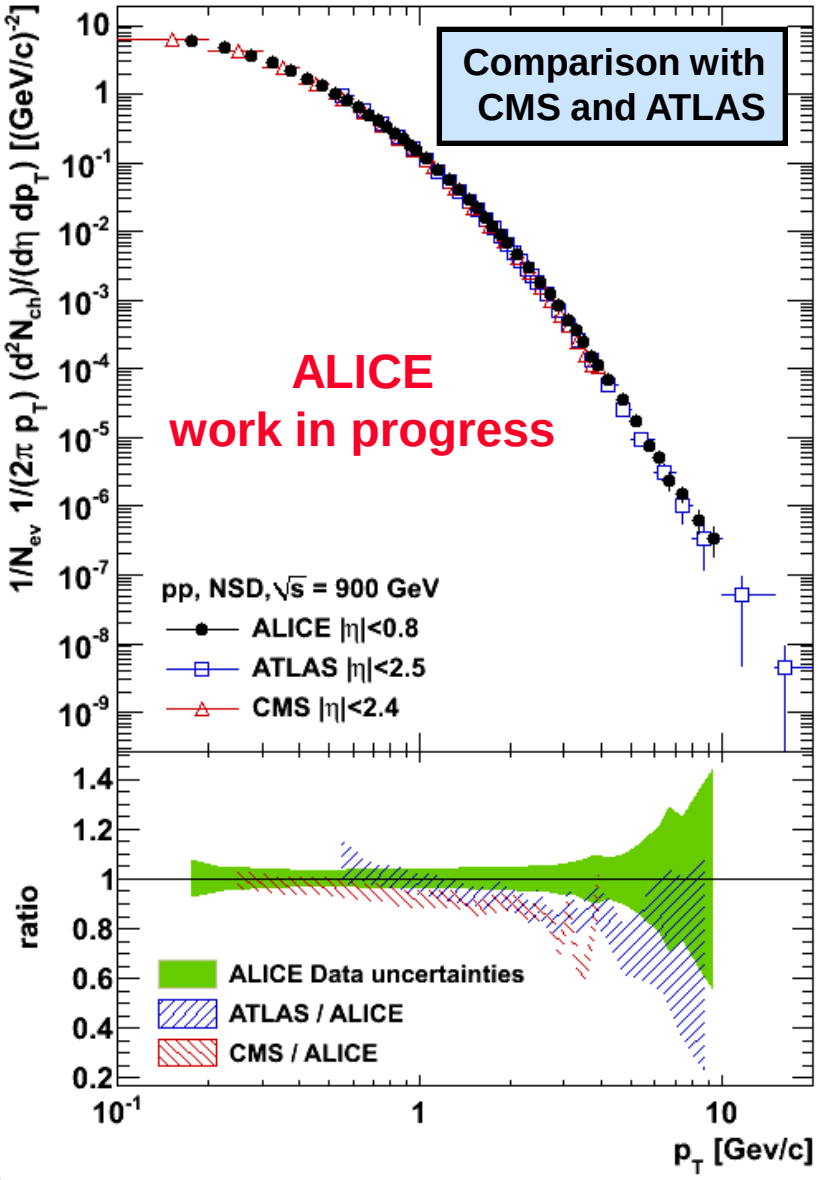
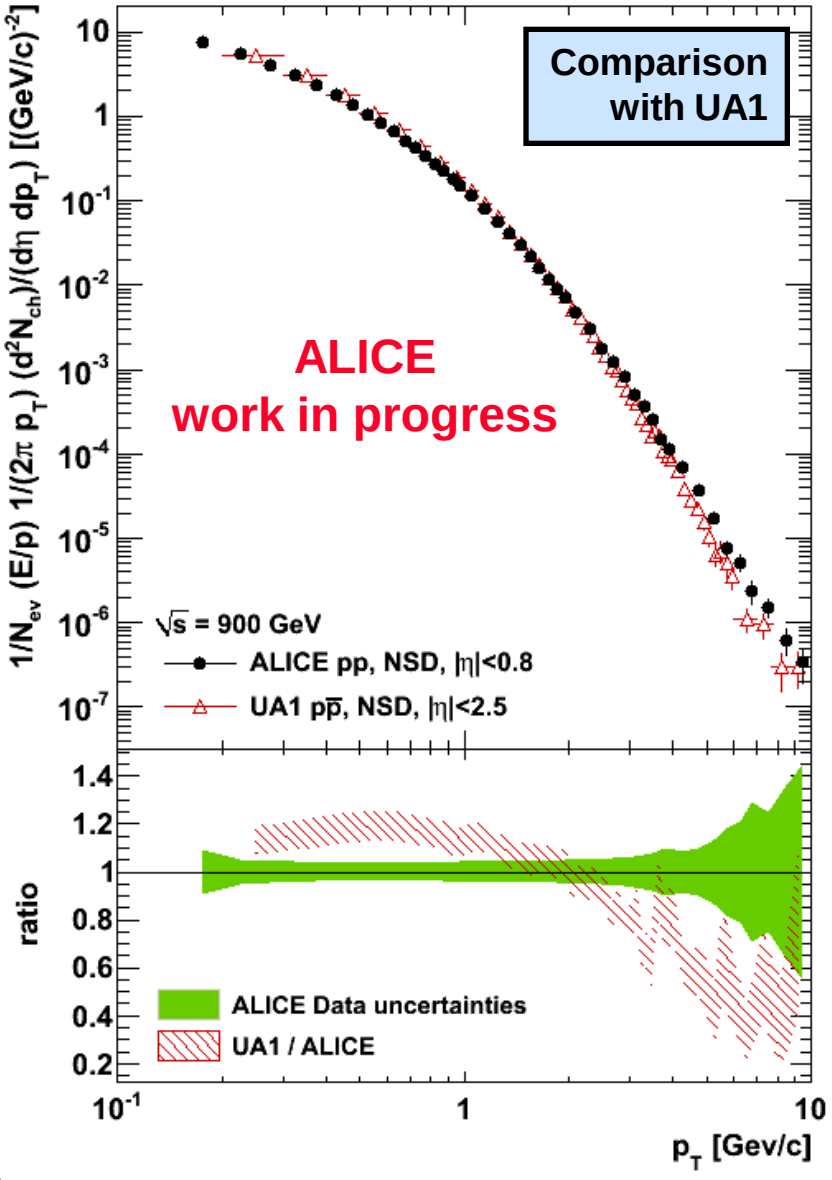


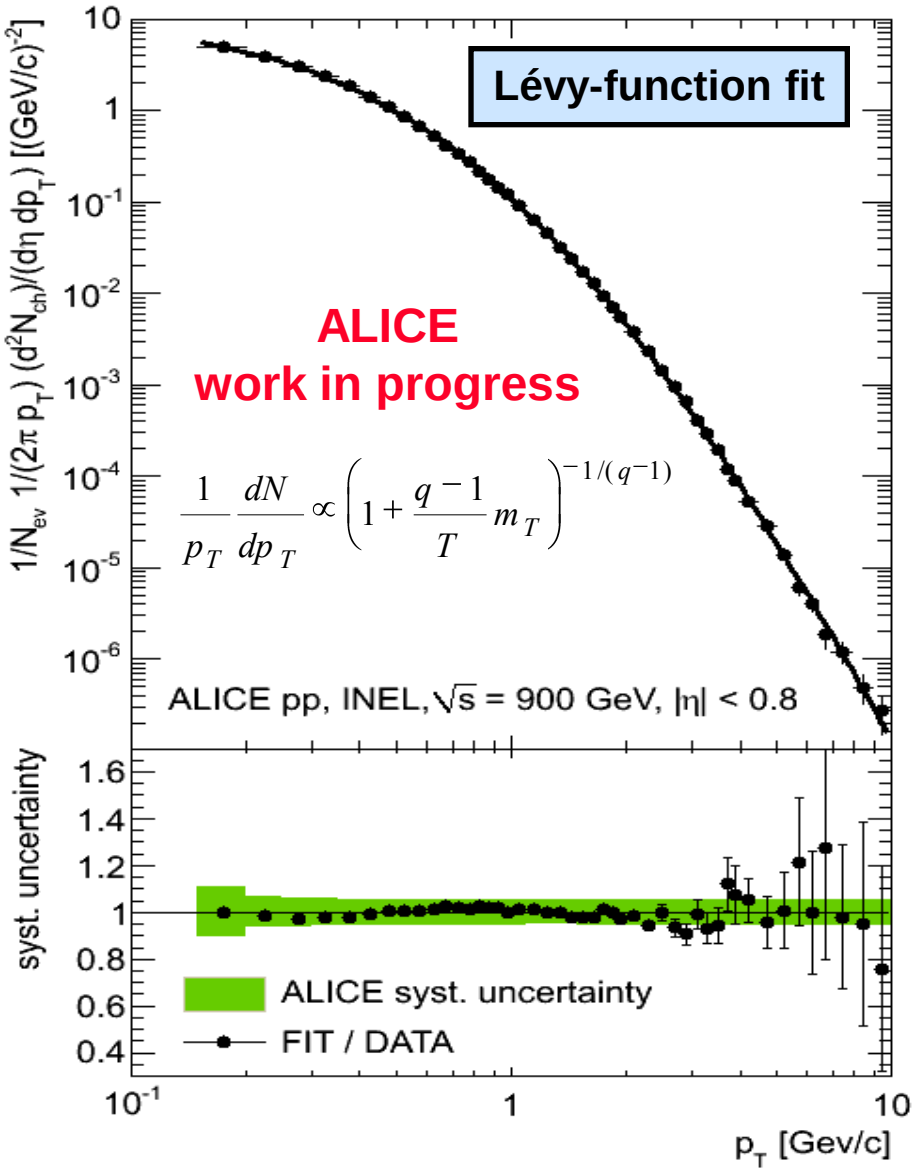
Transverse momentum distribution

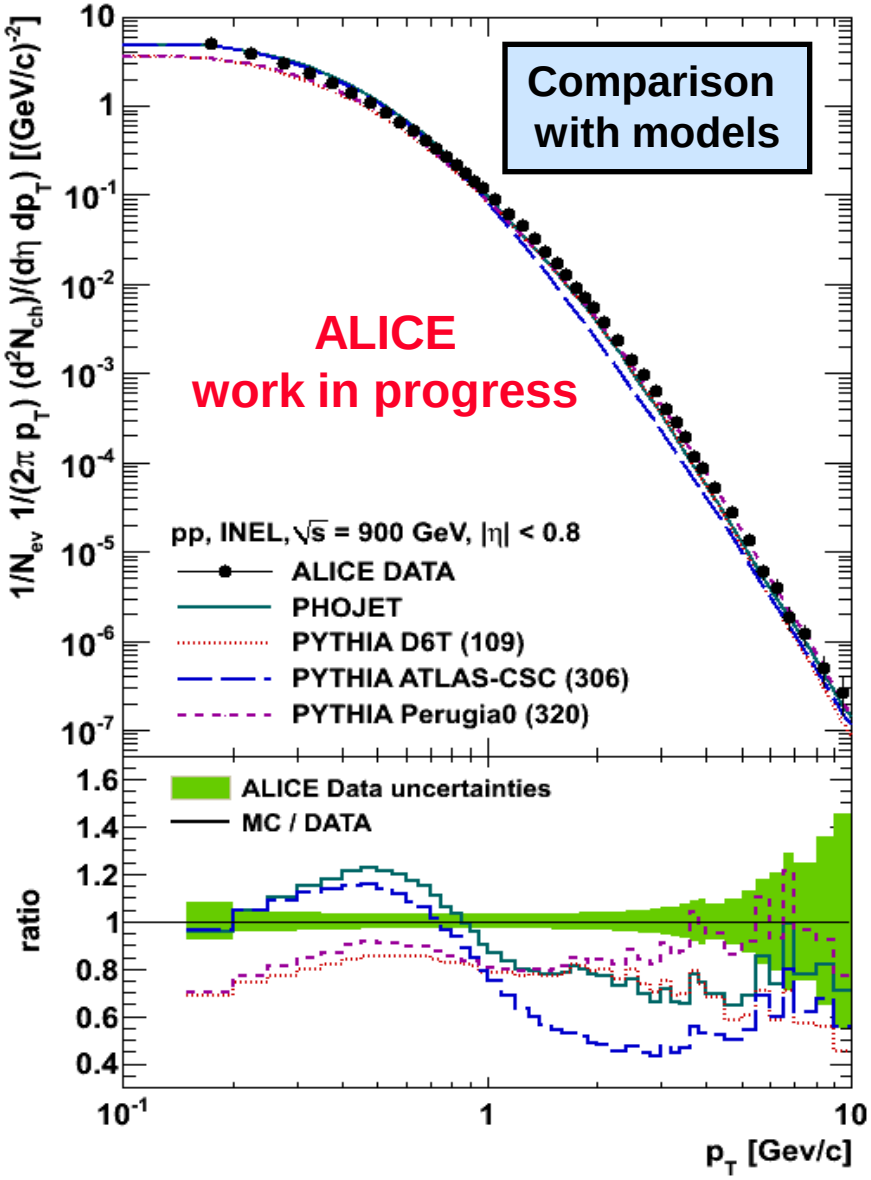




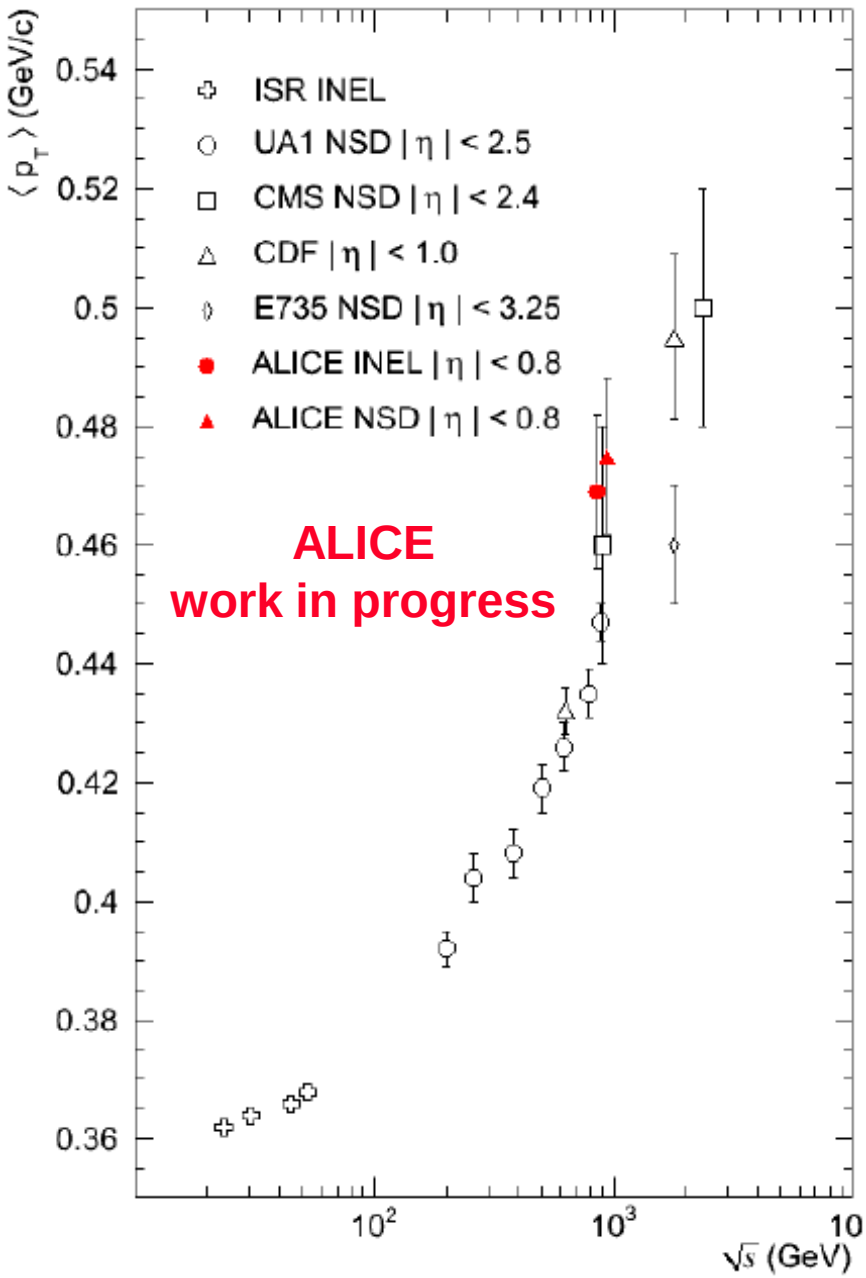
pen p

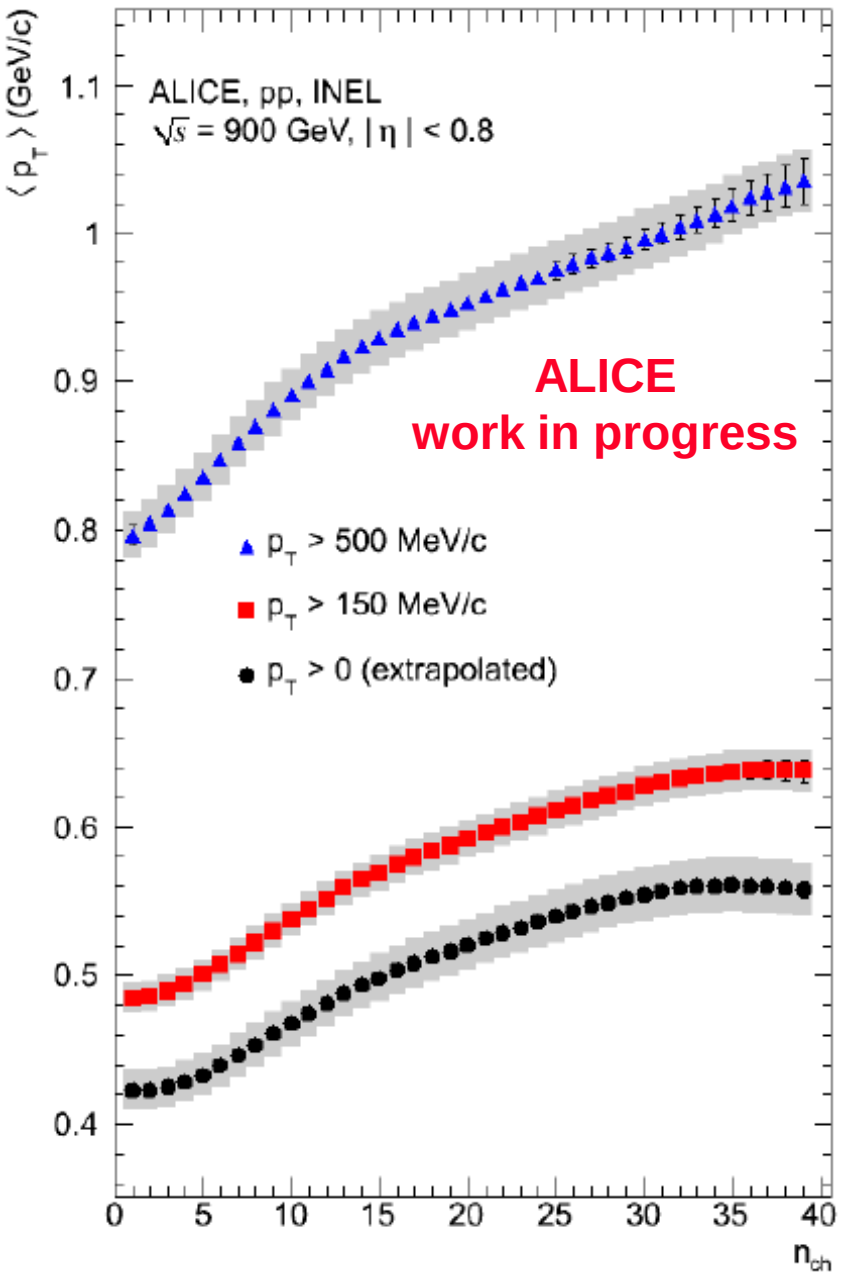
Transverse momentum distribution



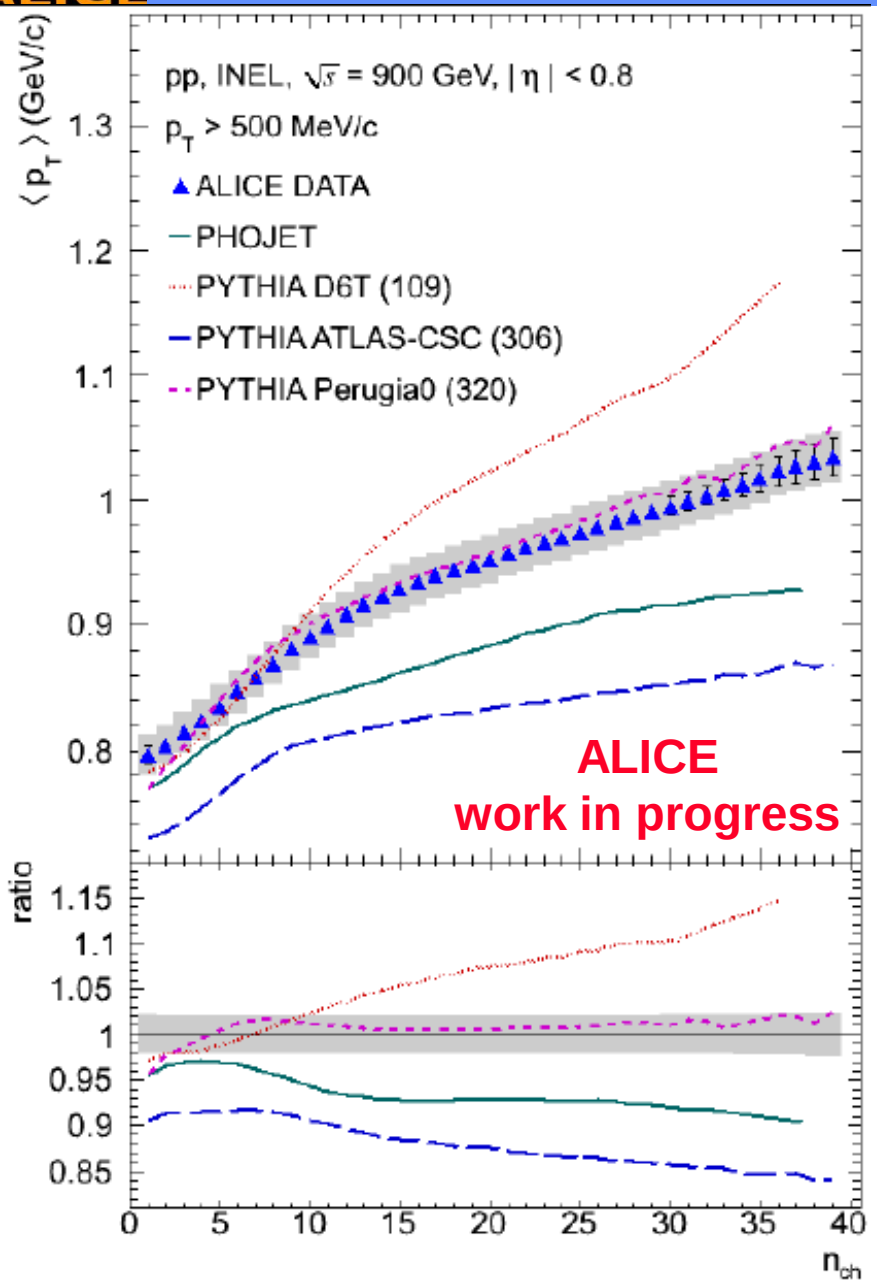


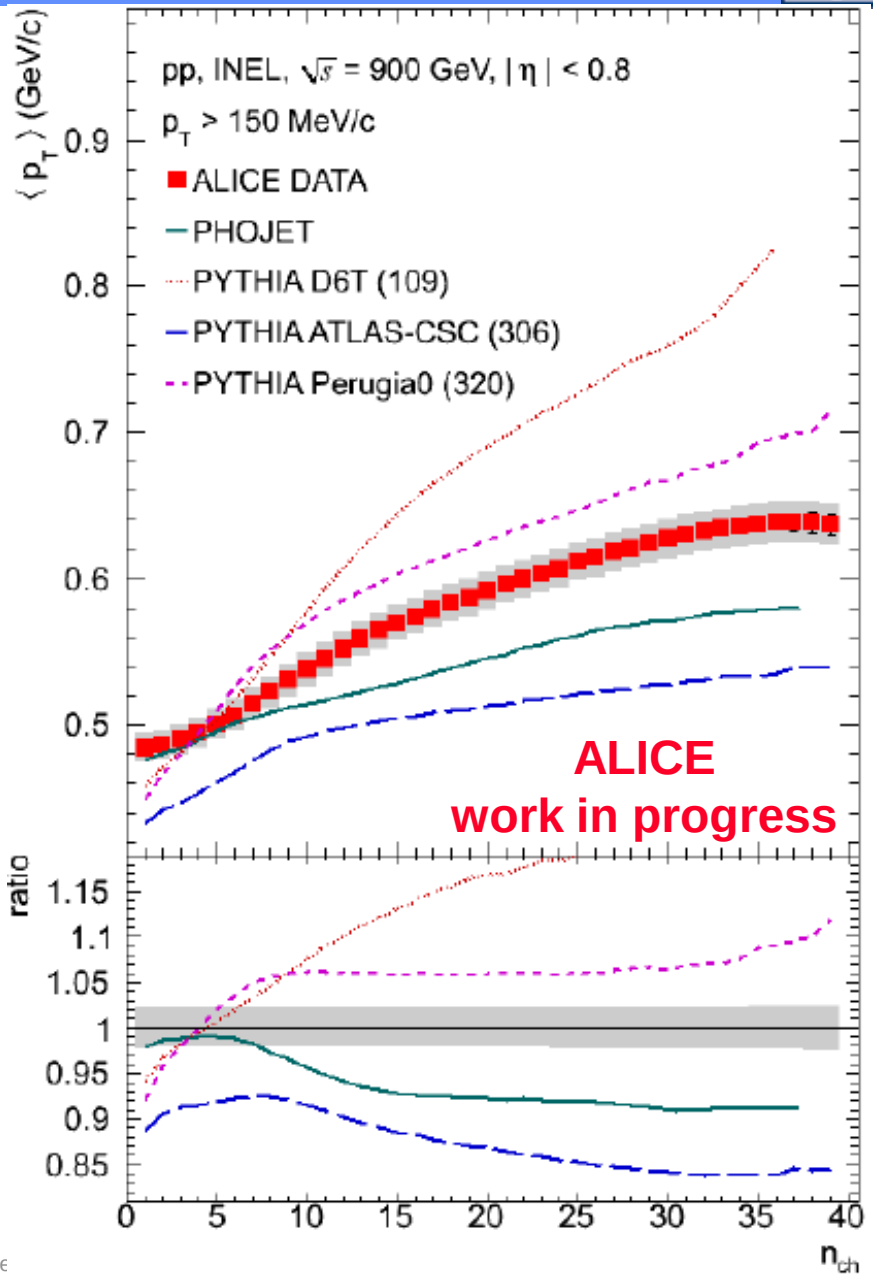
Mean p_t vs multiplicity



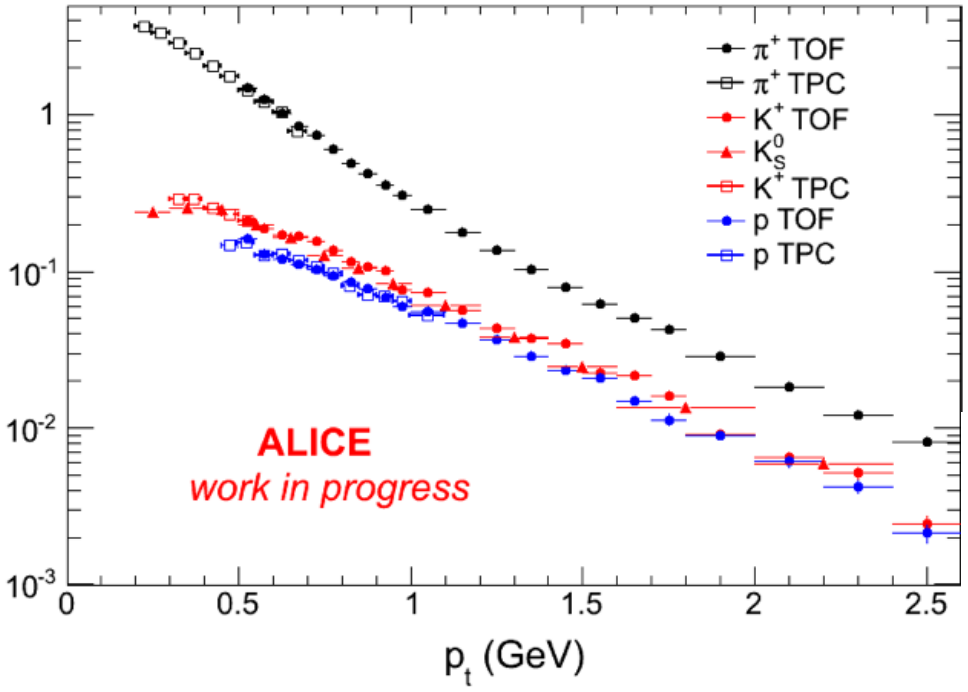


Mean p_t vs multiplicity





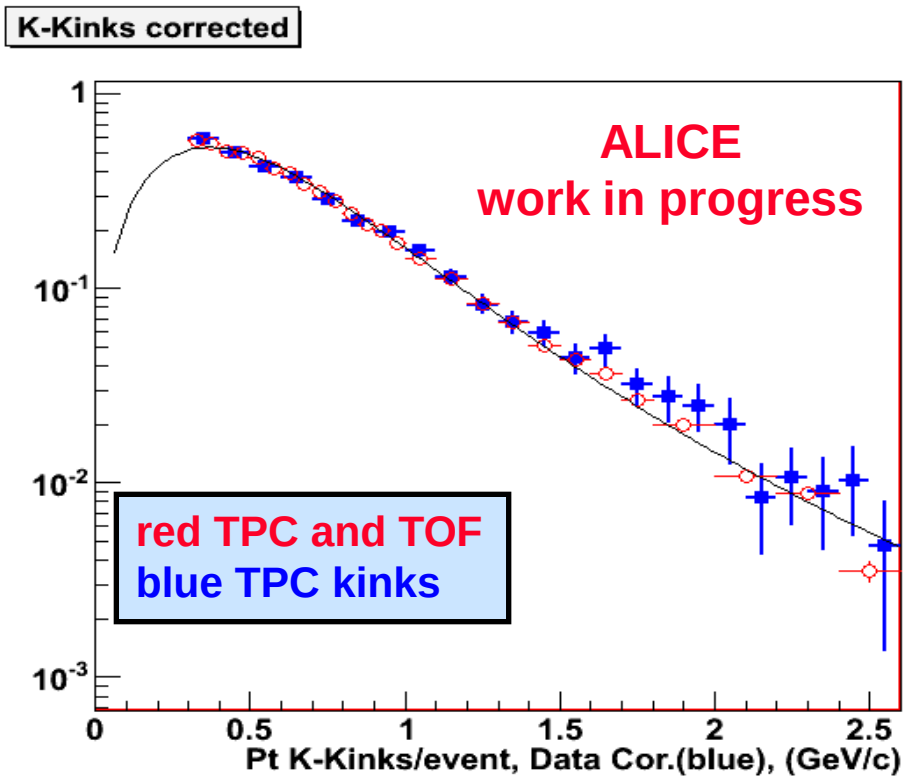
Identified charged hadrons



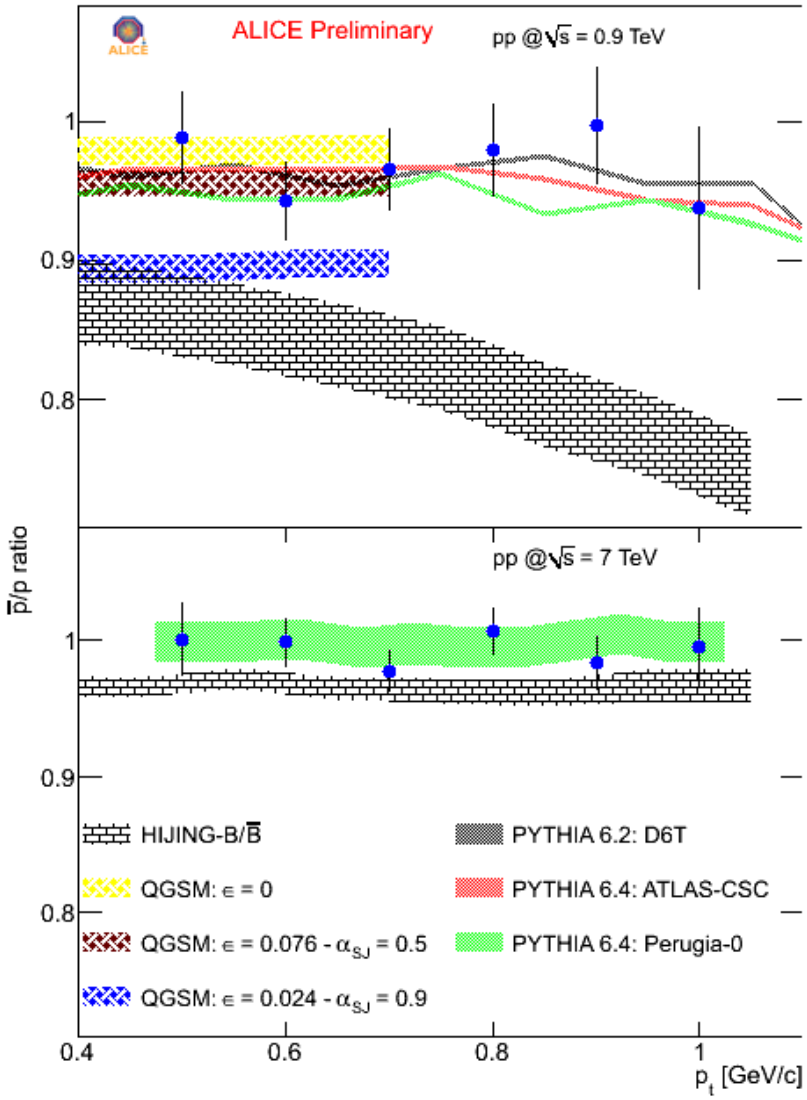
charged hadrons identified in different p_t ranges in different detectors:
TPC – TOF match within a few percent – no normalization factor
TPC – ITS not far

charged kaons identified in TPC in addition by their decays on flight

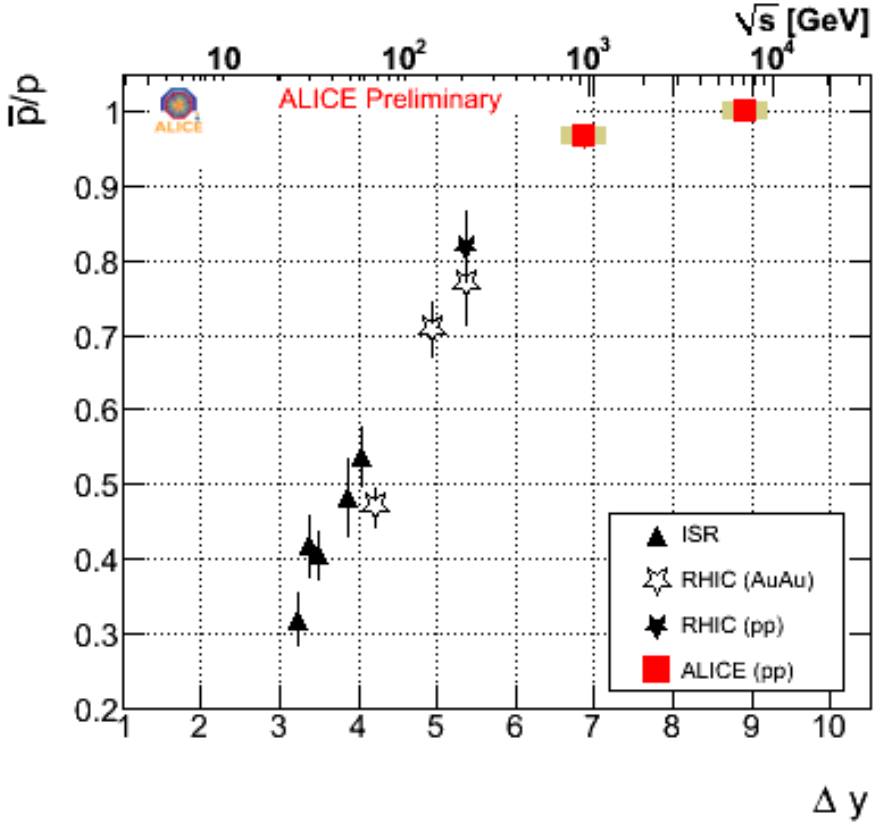
dE/dx, TOF, and kinks results agree very well



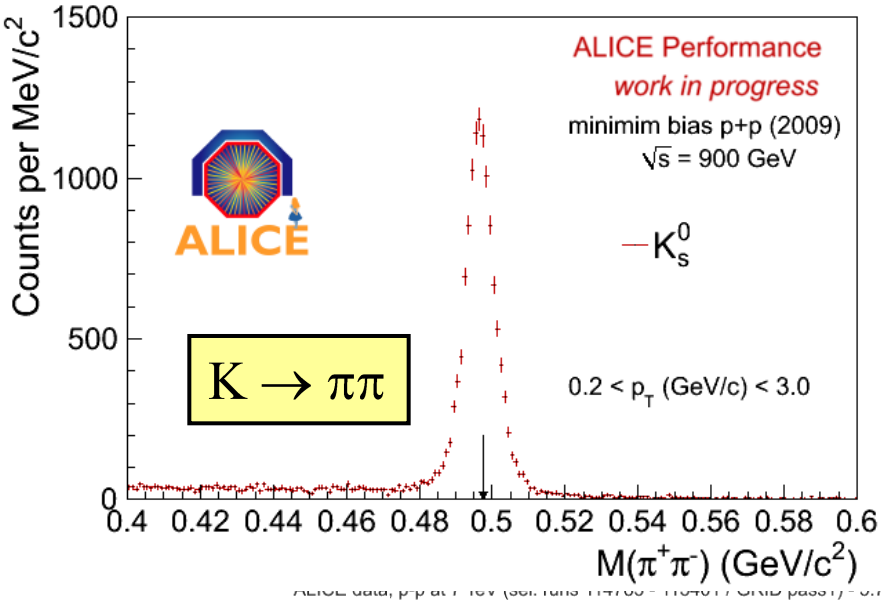
Baryon – antibaryon asymmetry in pp

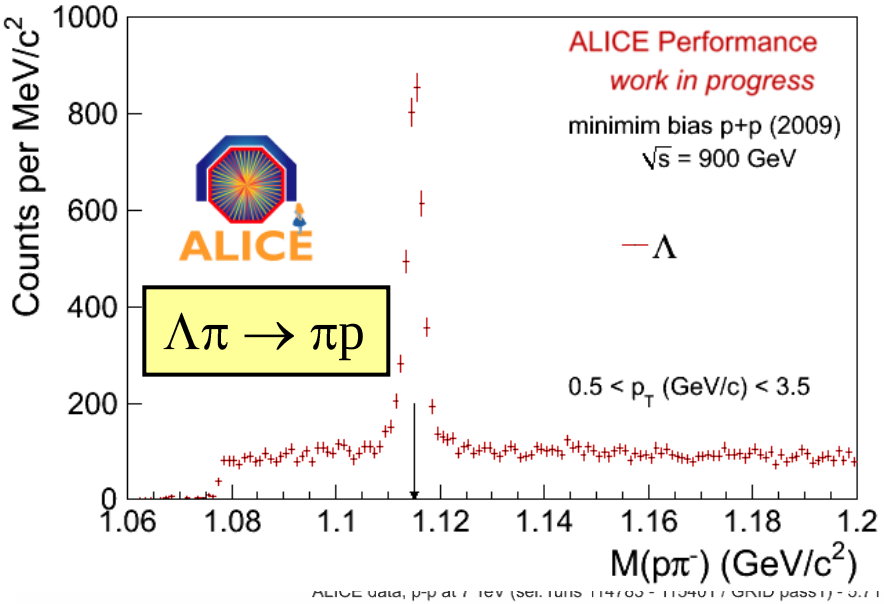


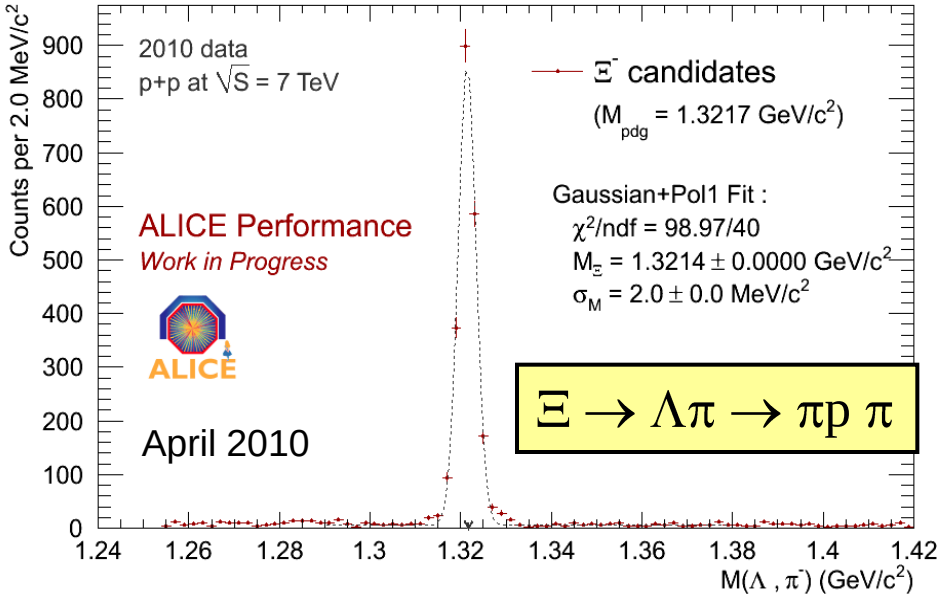
- pp collisions:
- baryon transfer through large Δy
- string-junction models different predictions
- value close to unity – little place for non-standard mechanism

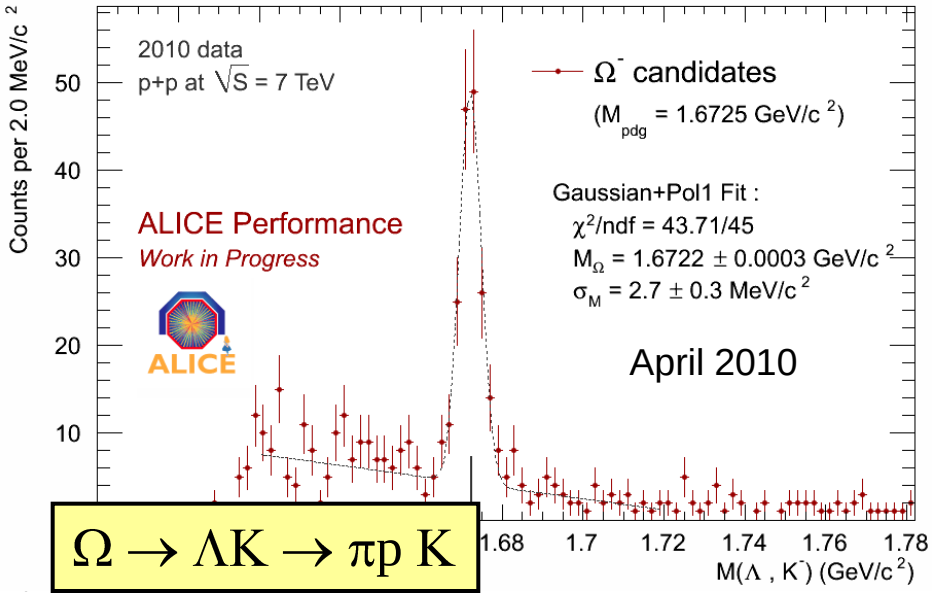


Strange particles

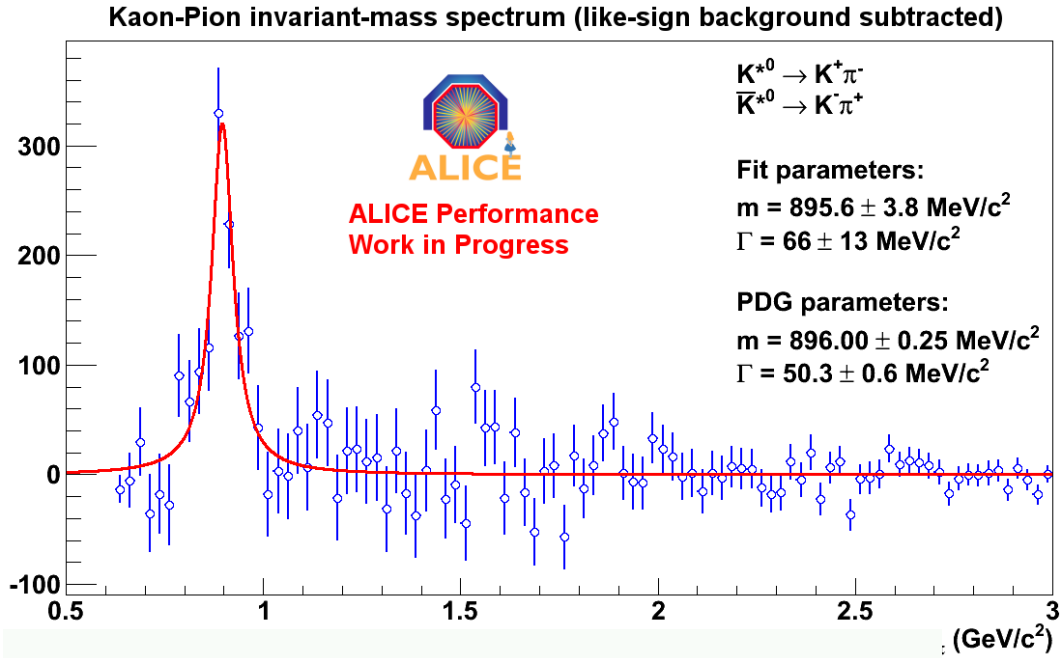


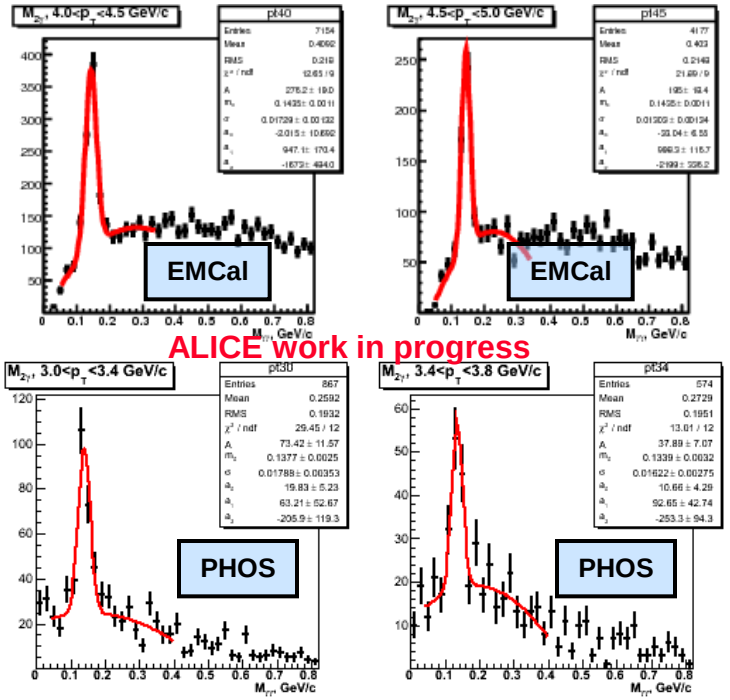


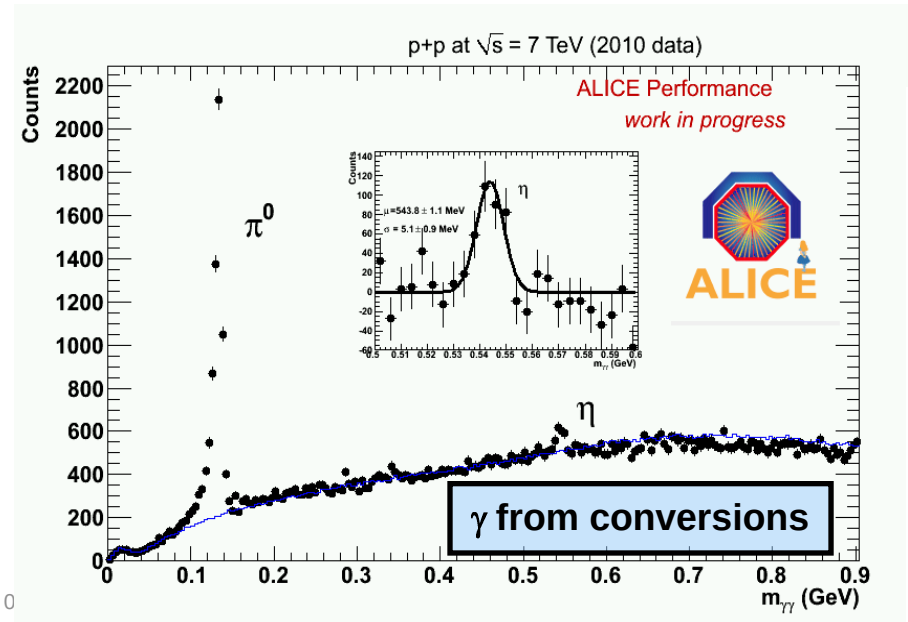


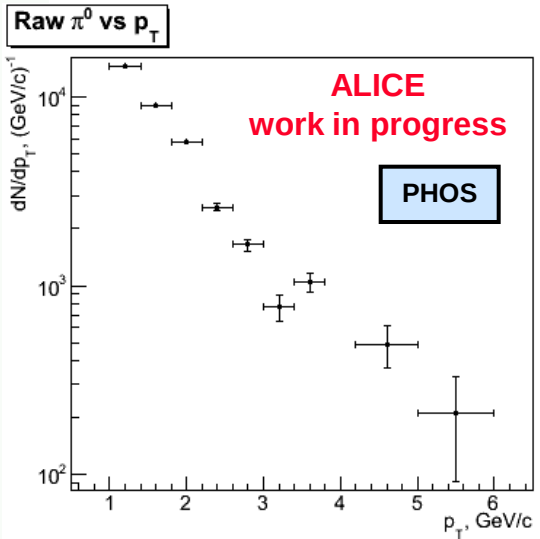


K^{*0}, π^0, η



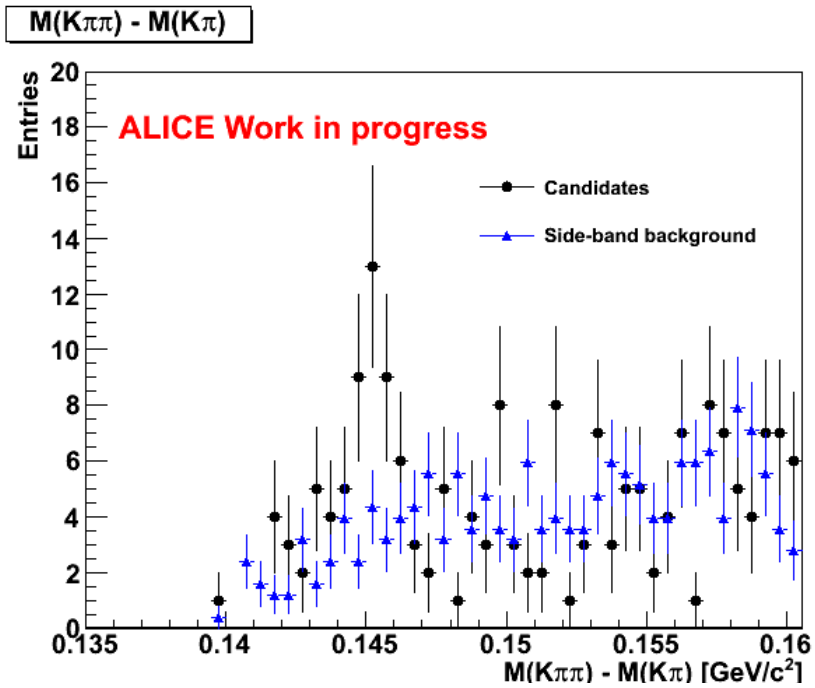


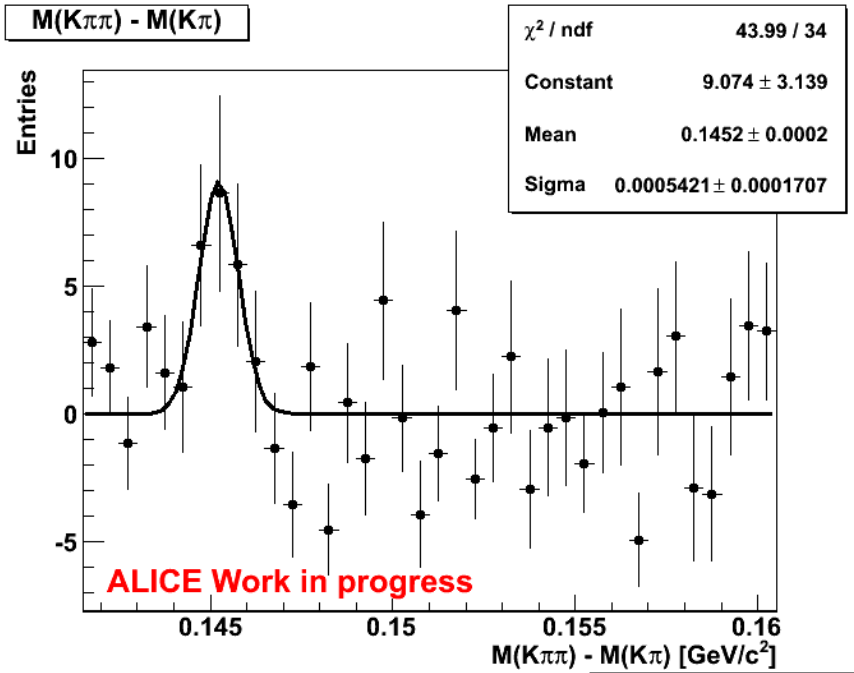


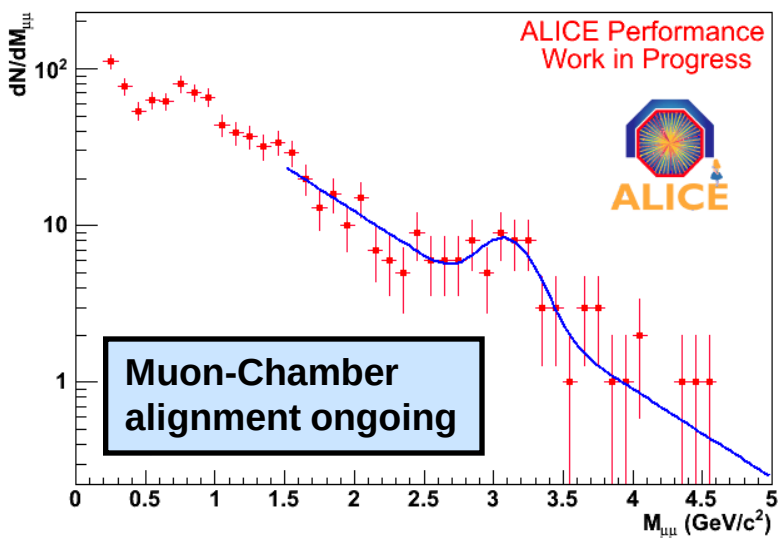


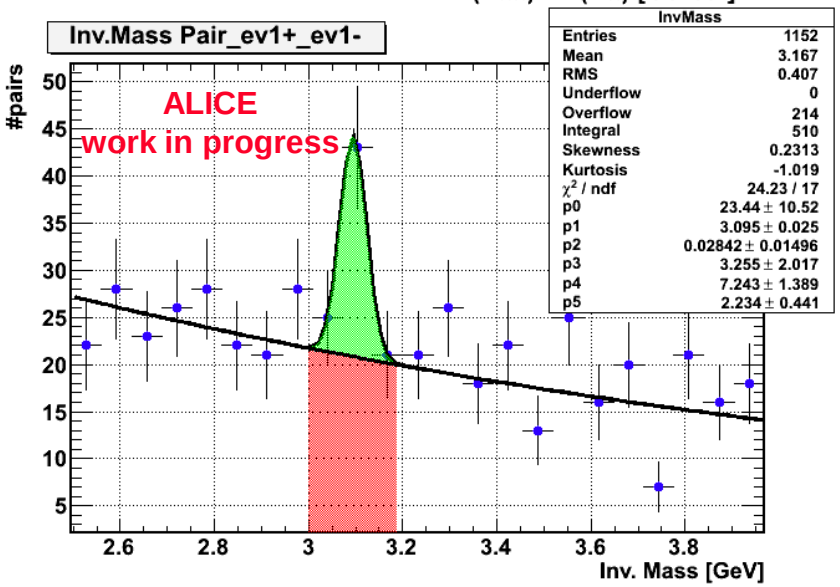
EMCal and PHOS were not energy-calibrated with test beams, ongoing with data

D* and J/ψ


M(Kππ) - M(Kπ)
ALICE Work in progress
Candidates
Side-band background
Entries
M(Kππ) - M(Kπ) [GeV/c²]


M(Kππ) - M(Kπ)
χ² / ndf 43.99 / 34
Constant 9.074 ± 3.139
Mean 0.1452 ± 0.0002
Sigma 0.0005421 ± 0.0001707
ALICE Work in progress
Entries
M(Kππ) - M(Kπ) [GeV/c²]

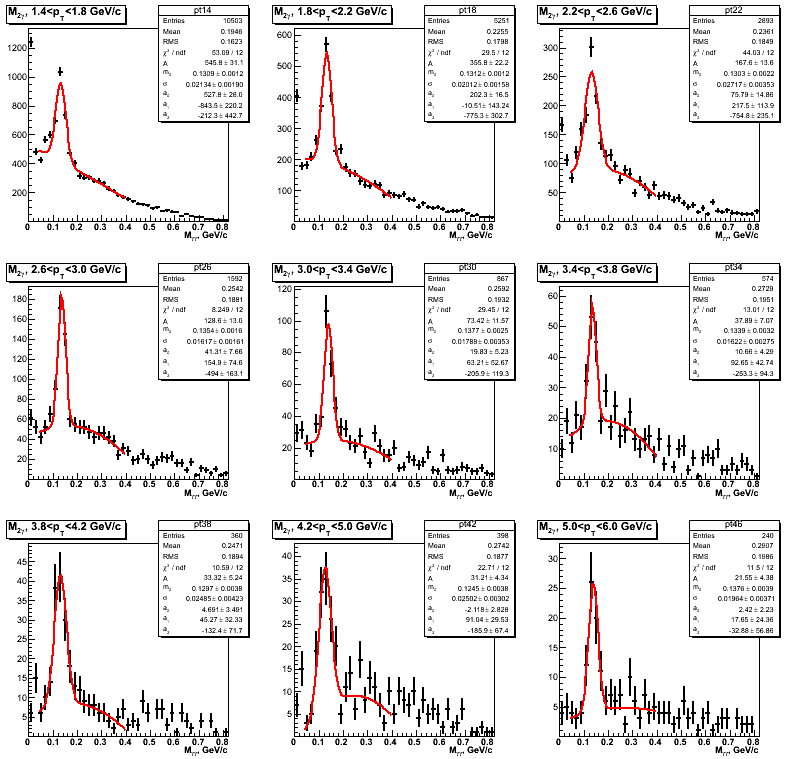

ALICE Performance
Work in Progress
ALICE
dN/dM_μμ
M_μμ (GeV/c²)
Muon-Chamber
alignment ongoing

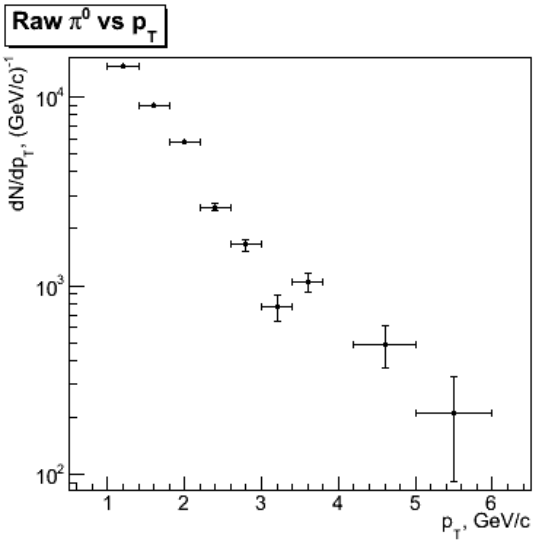

Inv.Mass Pair_ev1+_ev1-
ALICE
work in progress
InvMass
Entries 1152
Mean 3.167
RMS 0.407
Underflow 0
Overflow 214
Integral 510
Skewness 0.2313
Kurtosis -1.019
χ² / ndf 24.23 / 17
p0 23.44 ± 10.52
p1 3.095 ± 0.025
p2 0.02842 ± 0.01496
p3 3.255 ± 2.017
p4 7.243 ± 1.389
p5 2.234 ± 0.441
#pairs
Inv. Mass [GeV]

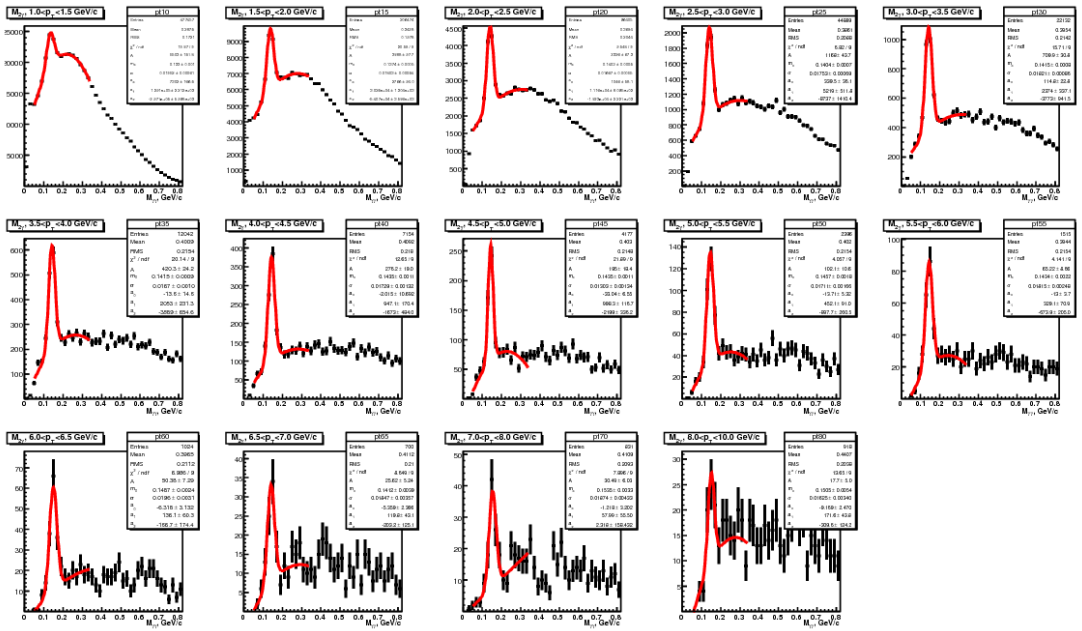
Conclusions

- 2010 running very successful
  - all detector, online, and offline systems ready
  - about 50 million events collected
- Alignment and calibration progressing well
  - performance of track and vertex reconstruction, particle identification close to design values
  - remaining: PHOS and EMCal energy calibration and Muon-Chamber alignment
  - tuning of simulation
- Physics analysis well underway
- Looking forward for more data to come and to PbPb collisions

Particle detected…

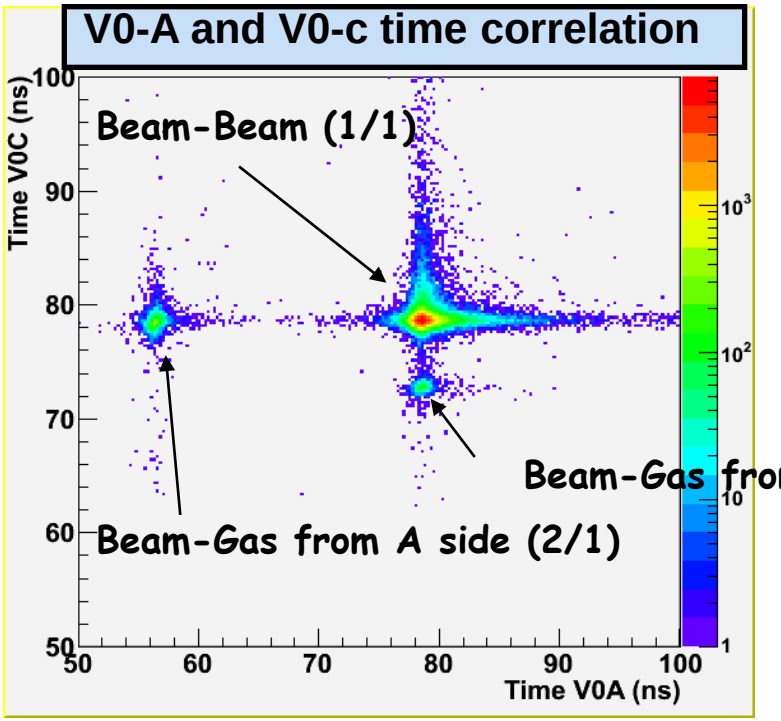




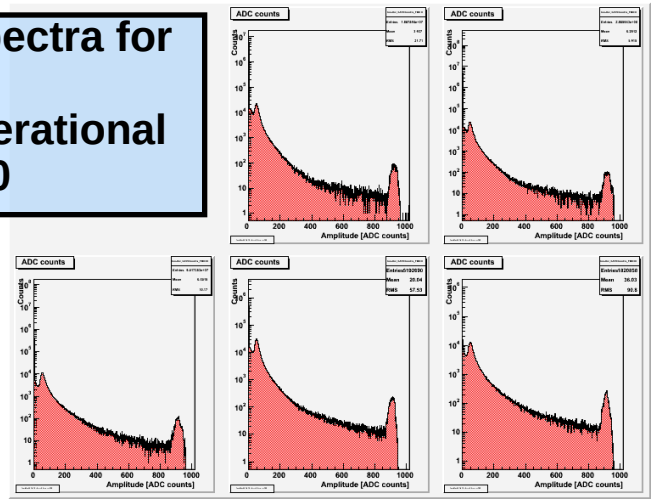


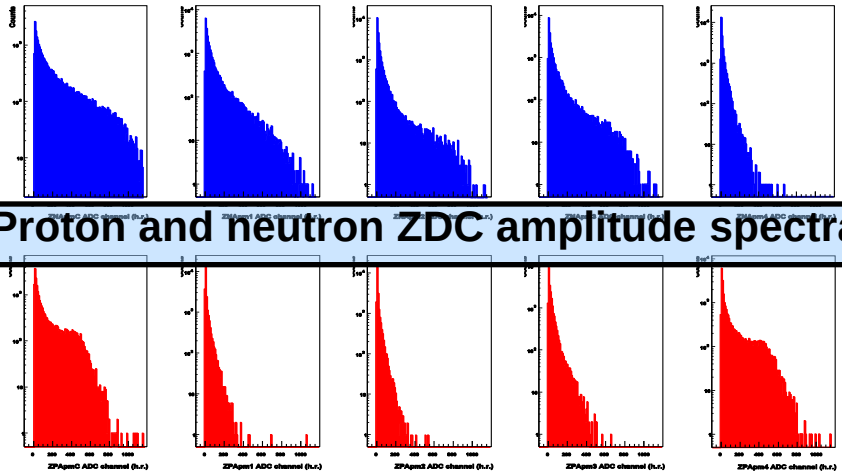
Forward detectors

V0-A and V0-c time correlation

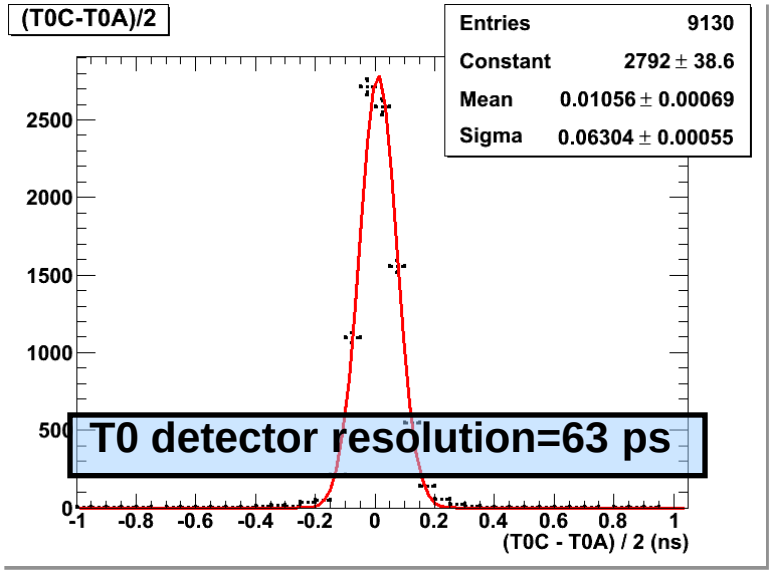


FMD amplitude spectra for 5 rings
99.9% cannels operational
signal/noise 20–40





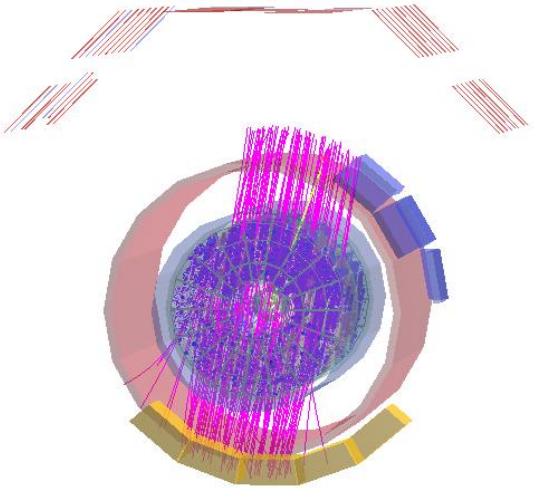
Proton and neutron ZDC amplitude spectra

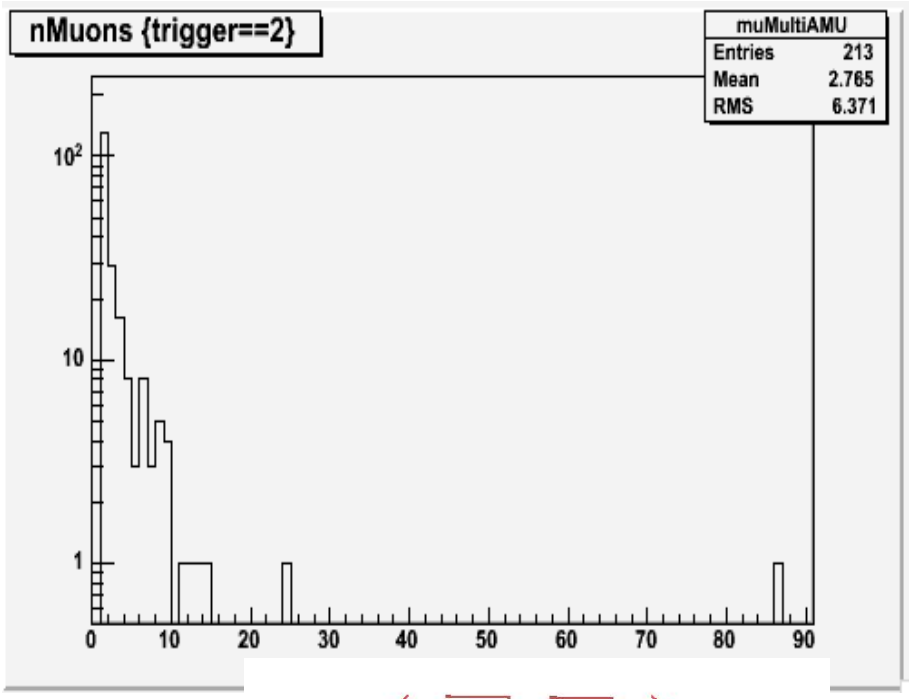


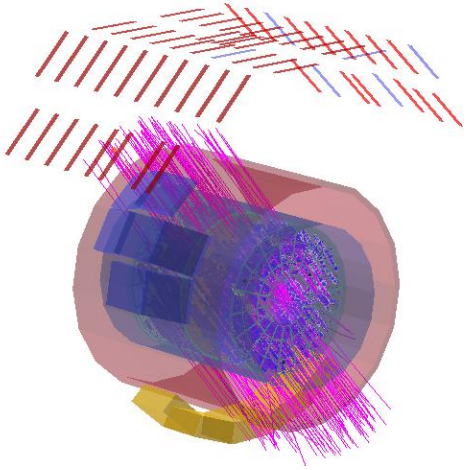
T0 detector resolution=63 ps

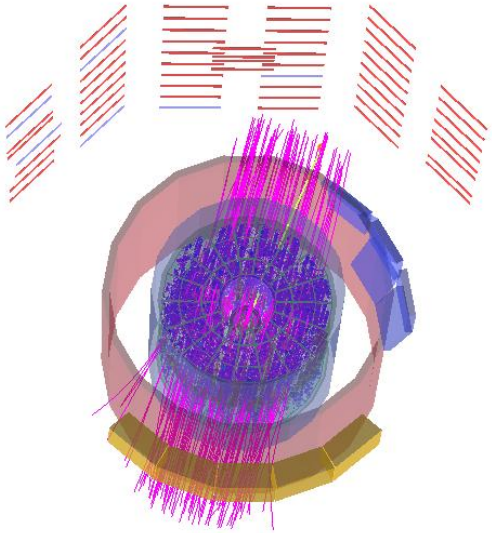
Acorde – cosmic-ray trigger

ACRDE – 60 modules 100% operational
single muon rate 130 Hz
4-module trigger 0.03 Hz

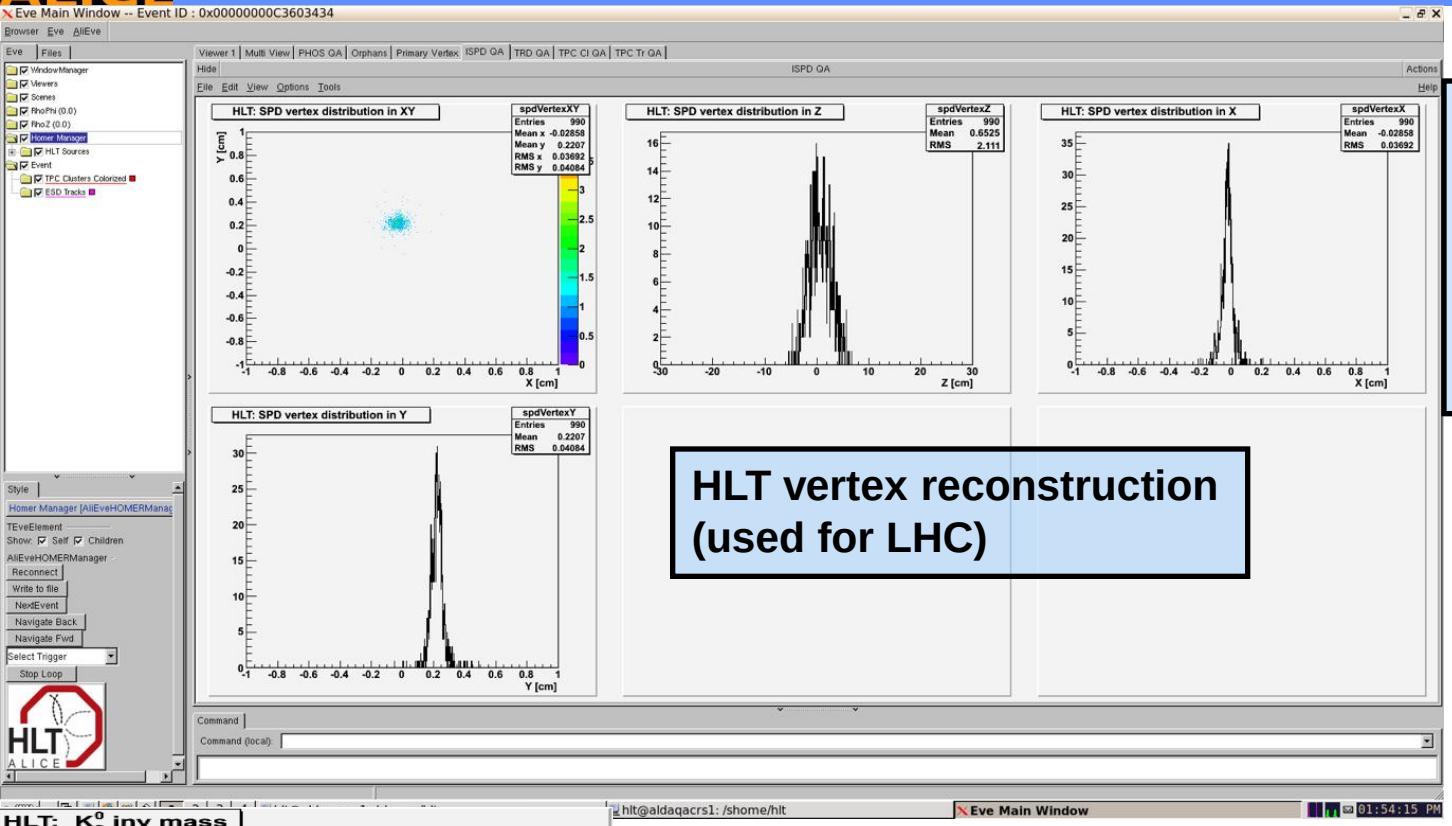








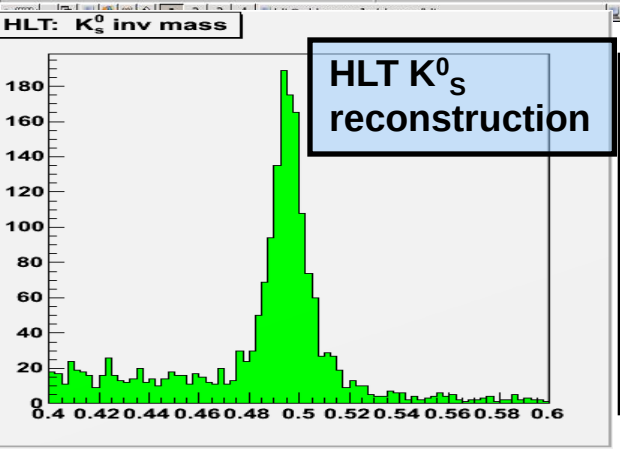
HLT, DAQ, DCS



HLT – infrastructure and front-end nodes completed for PbPb

computing nodes needs to upgrade

HLT vertex reconstruction (used for LHC)



HLT K^0_S reconstruction

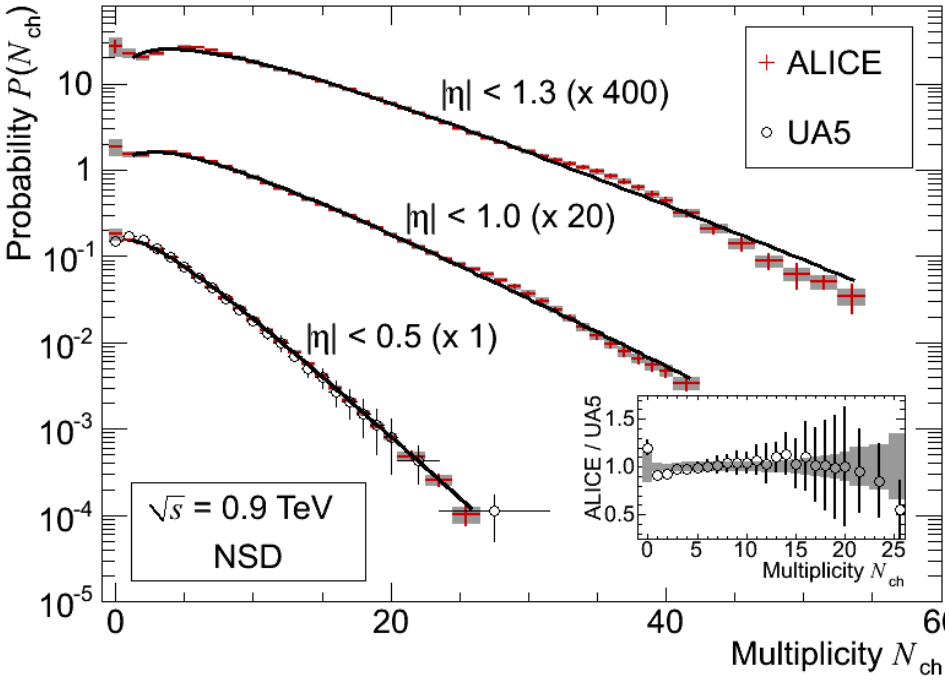
DAQ, DCS, ECS –
new Automatic Configuration Tool

Create and archive a set of known good configurations
Select from this set according to beam condition and physics program
Software wizard to configure all the detectors and online systems

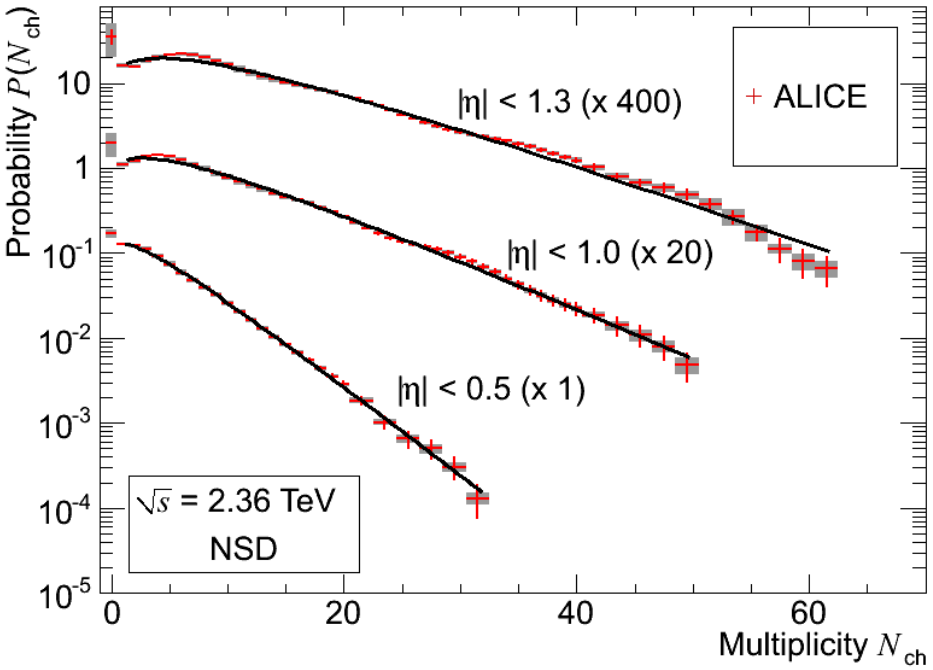
Multiplicity distribution 0.9 and 2.36 TeV

multiplicity distributions of charged particles in 3 η-intervals
wavy fluctuations due the unfolding
very good agreement with p anti-p measurement by UA5
reasonably described by negative-binomial distributions

arXiv:1004.3034[hep-ph]



arXiv:1004.3034[hep-ph]

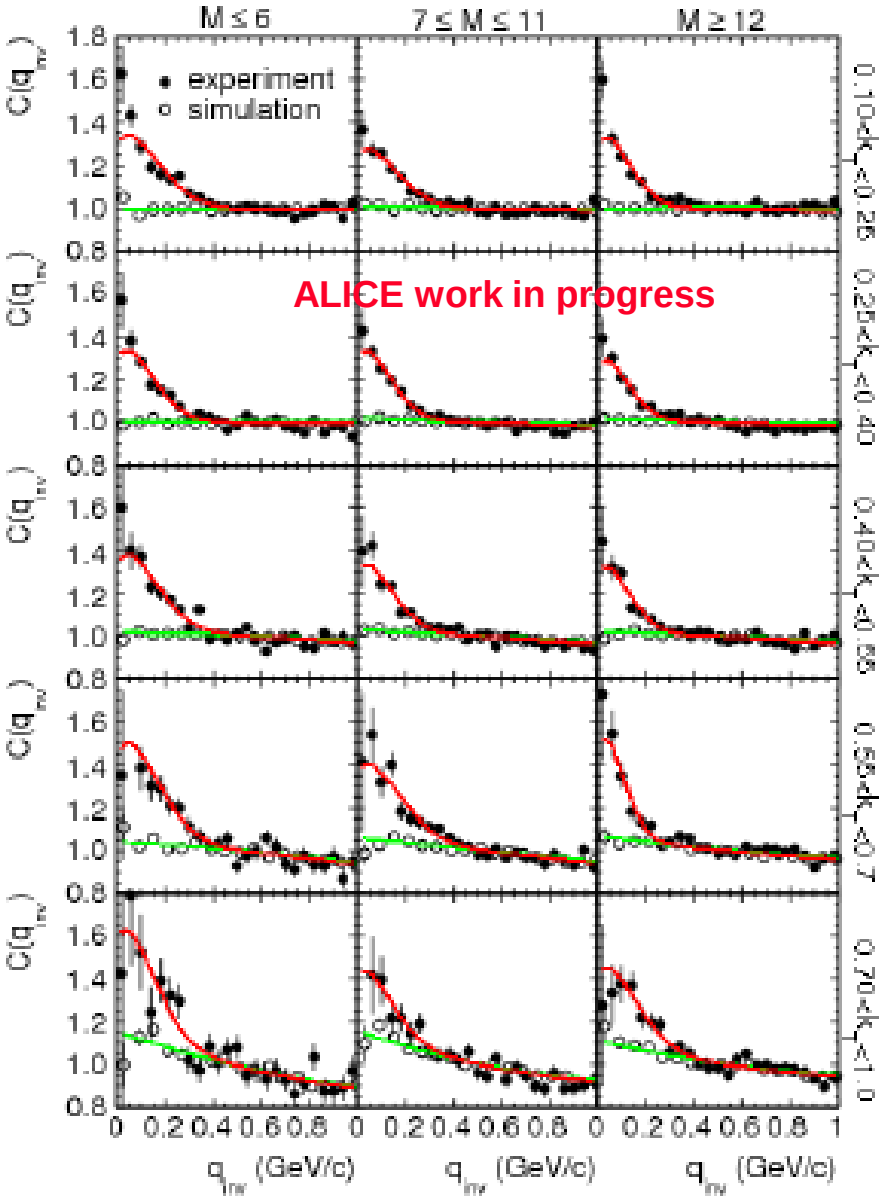


Identical particle correlation

result is very dependent of the assumptions on fitting function and the shape of baseline

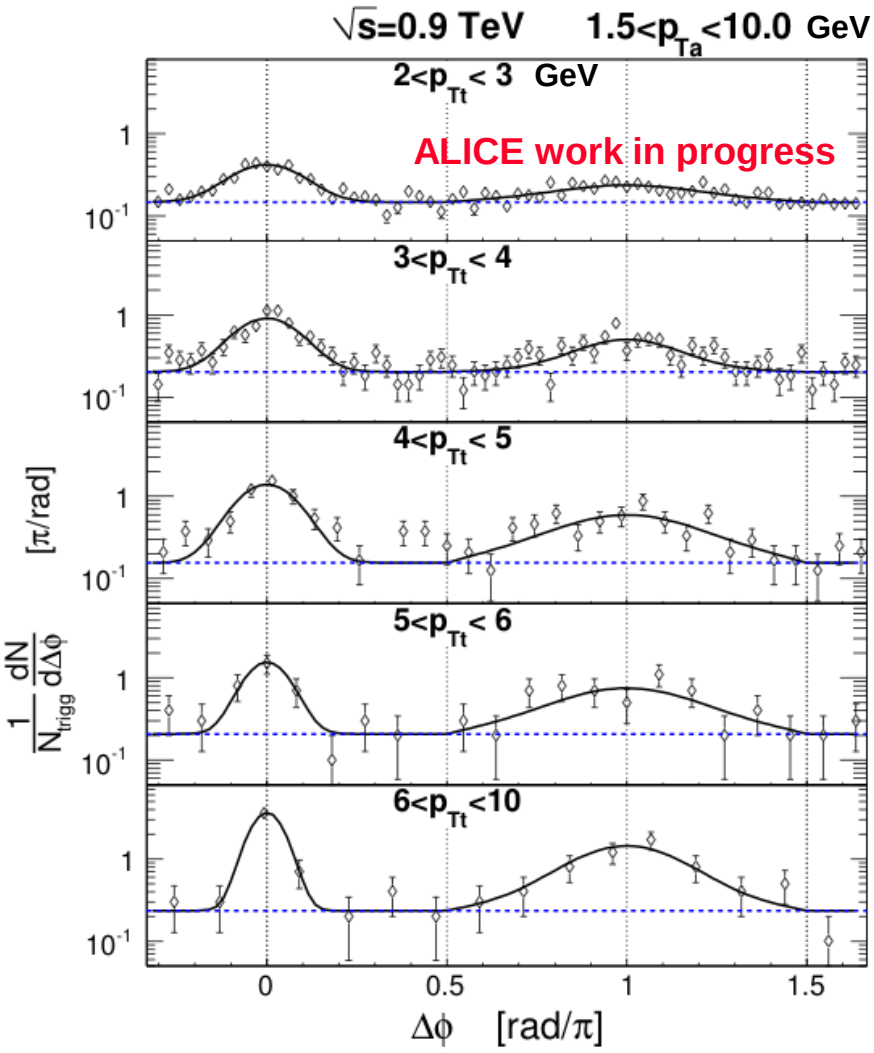
baseline is affected by correlation of non-identical particles – their are also present in MC models

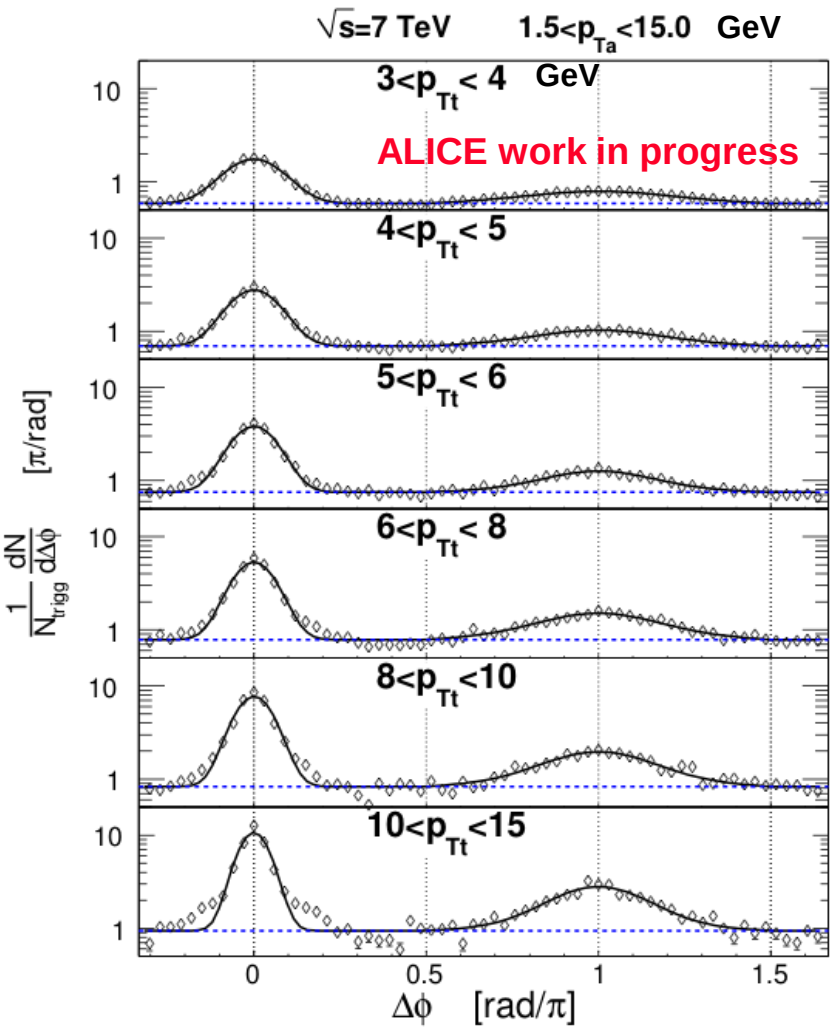
large systematic uncertainties !



Azimuthal correlation

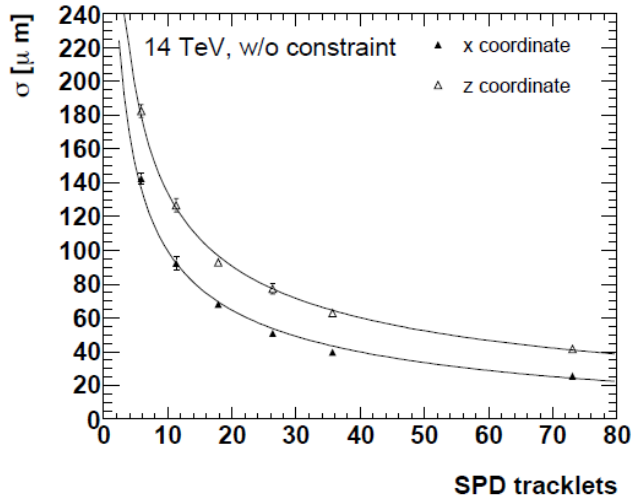
high-pt particle correlations show clear effect close to trigger and on the opposite side

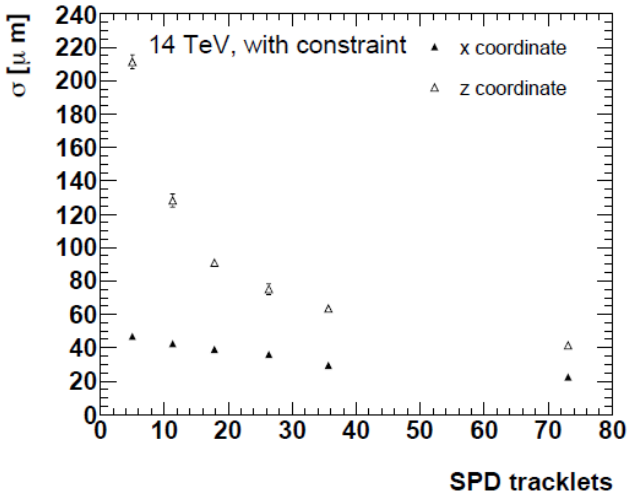




Squeezed beams in pp

- Important for Heavy Flavour physics
  - reduce transverse dimension of luminous region ($\sigma_{x/y\ lum}$)
- Effect of vertex diamond constraint on primary vertex resolution (σ)
  - e.g.: simulation for $\sigma_{x/y\ lum}$ = 50 μm:
    (E Bruna et al., ALICE-INT-2009-018)





- For 3.5+3.5 TeV, ε_N = 3.75 μm
  - β* = 10 m → $\sigma_{x/y\ lum}$ ~ 70 μm β* = 2 m → $\sigma_{x/y\ lum}$ ~ 30 μm
- Additional benefit: commission 2 m squeeze for Pb beams

Pile-up in ALICE

Outlook for 2010/2011:

- minimum bias physics (a few colliding bunches @ P2)
  - moderate pileup in TPC
  - e.g.: $\beta^* = 2$ m, 1 collision BX per orbit, 5 10^{10} ppb → ~ 35% pileup

after 2-3 months:

- high multiplicity physics (tens of colliding bunches @ P2)
  - moderate pileup in TPC, but low pileup in Silicon Pixel (high multiplicity trigger)
  - need $\mu < 0.05$ (corresponds to ~ 90% pileup contamination @ 7 x average multiplicity)

later still:

- high luminosity physics: rare signals
  - luminosity will depend on how much pileup we can take in the TPC
  - e.g.: 2.5 10^{30} $cm^{-2}s^{-1}$ → ~ 20 events in TPC
  - a test with high pileup at P2 has been requested

handles: β^*, bunch displacement, bunch intensities, $N_{bunches}$ for ALICE