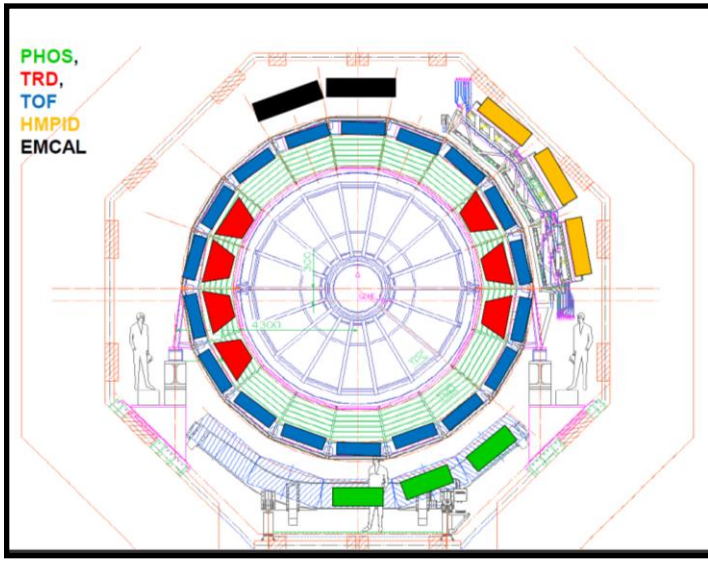
ALICE status

Paul Kuijer

- Data taking March – June 2010
- Detector status and performance highlights
- Physics analyses

Detector configuration 2010

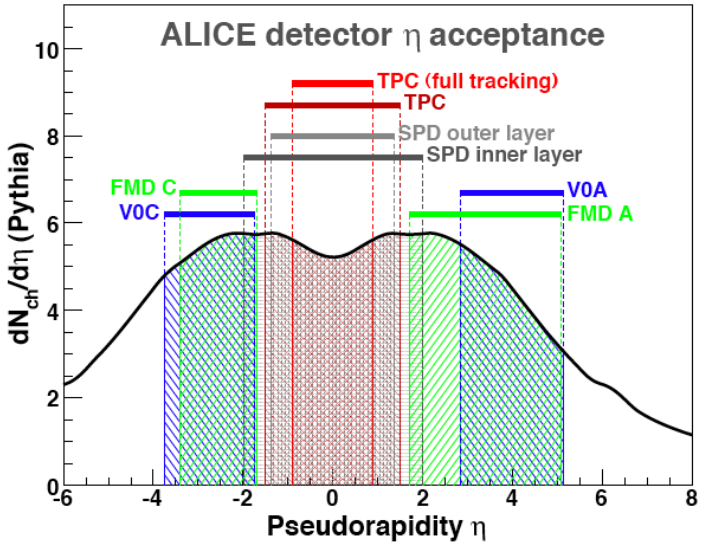


Partially installed:

- Transition Radiation Detector (TRD 7/18)
  - 2 supermodules ready at CERN
  - 1 arriving later this month
  - nominal supermodule construction time: 4 weeks
  - all chambers finished
  - read-out electronics production ongoing, yield > 97%
- EM Calorimeter (EMCAL 4/12)
  - Ready in August
- Photon Spectrometer (PHOS, 3/5)
- High Level Trigger (60%)

Need 10+ weeks to open the experiment

→ Installation continues in 2012



full hadron and muon capabilities
partial electron and photon

Goals for 2010

About 0.3 10^9 now

TPC pile up limit

Energy	Trigger	Conditions
7 TeV pp	10^9 Minimum bias	μ~0.05
	High multiplicity	μ~0.05
	Muon pairs	L ~10^{30}
	EMCAL	
2.76 TeV pp	50 *10^6 comparison PbPb (R_{AA})	μ~0.05
2.76 TeV PbPb	10^7 Minimum bias	L ~ 10^{25}

~1 day

Muon spectrometer limit

$$R_{AA}(p_T) = \frac{\left(\frac{dN}{dp_T}\right)_{AA}}{N_{COLL}\left(\frac{dN}{dp_T}\right)_{pp}}$$

Since 1/7: low μ running with displaced beams (high multiplicity physics)

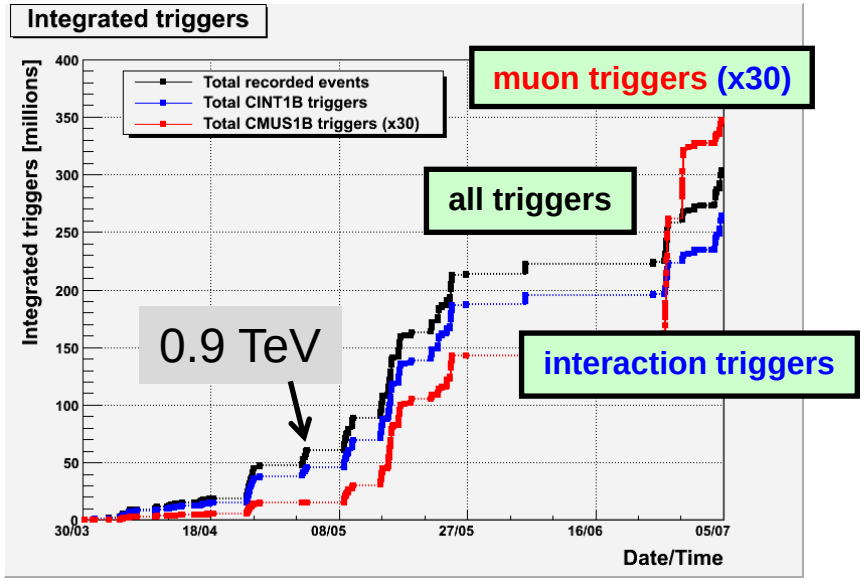
3.8 σ separation → ~ 1/30 bunch luminosity → μ: ~ 1.7 → 0.05

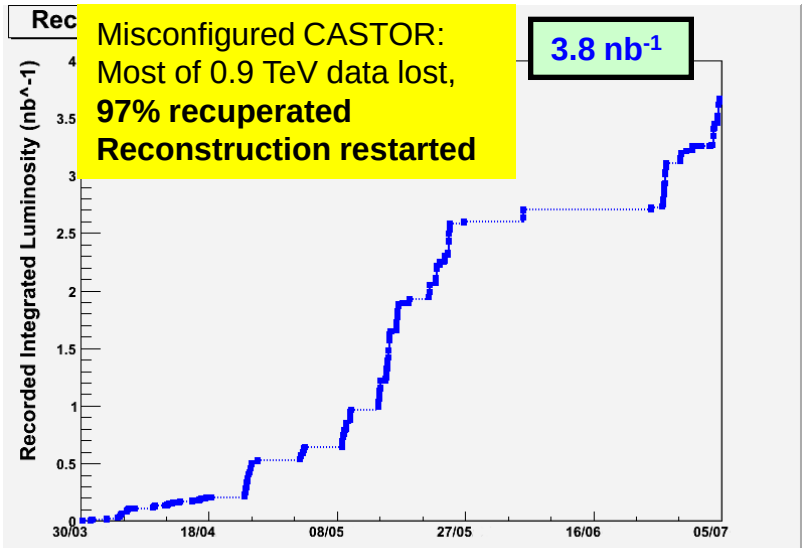
next: increase number of bunches (to L ~ 1-2 10^{29} cm^{-2} s^{-1})

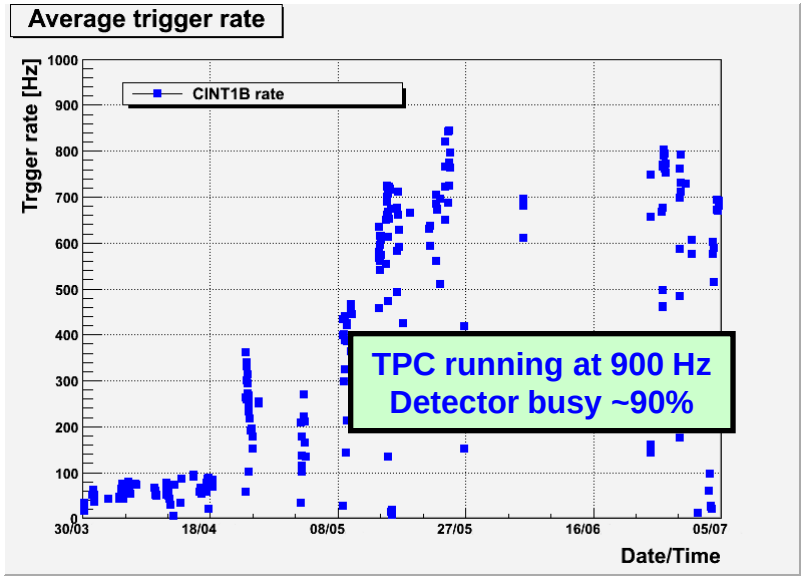
Other parameters: bunch configuration, β*, more studies needed

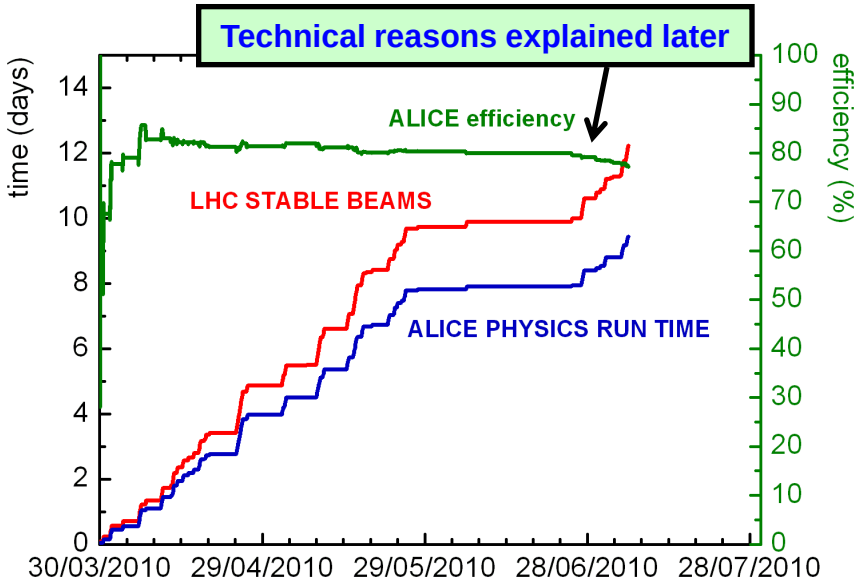
Data taking since March 30th

7 TeV: 300x10^6 events, 0.9 TeV: ~10x10^6 events

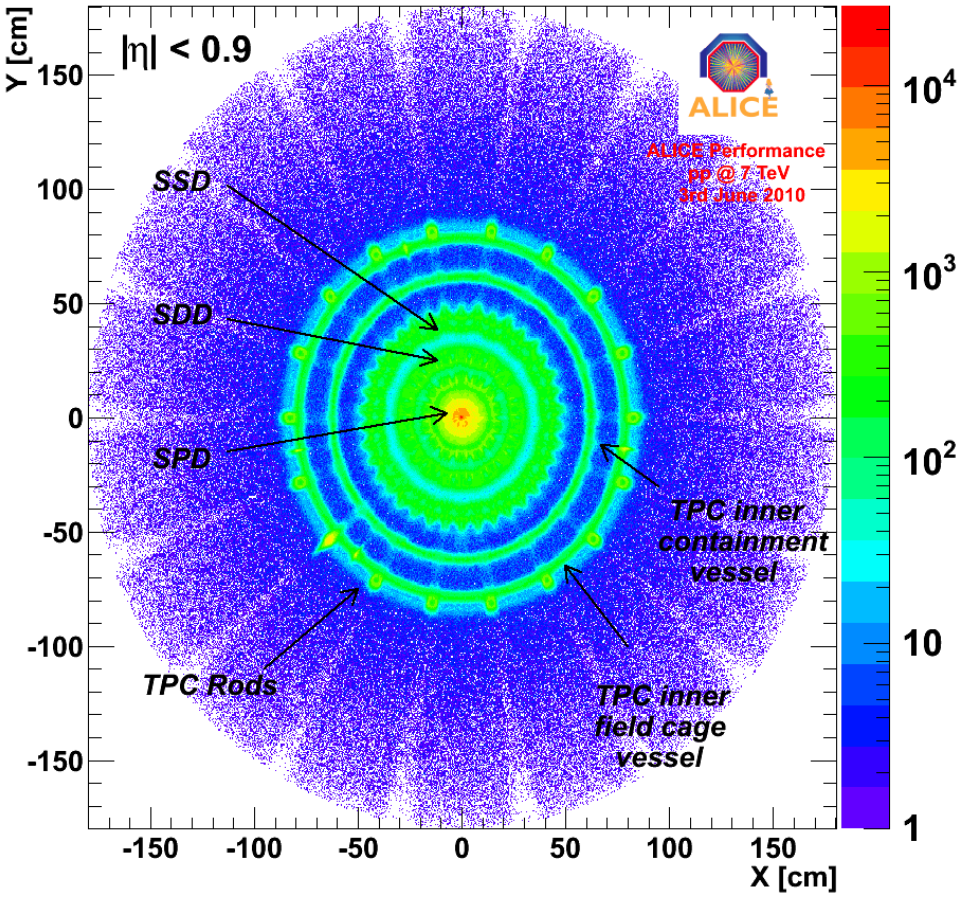




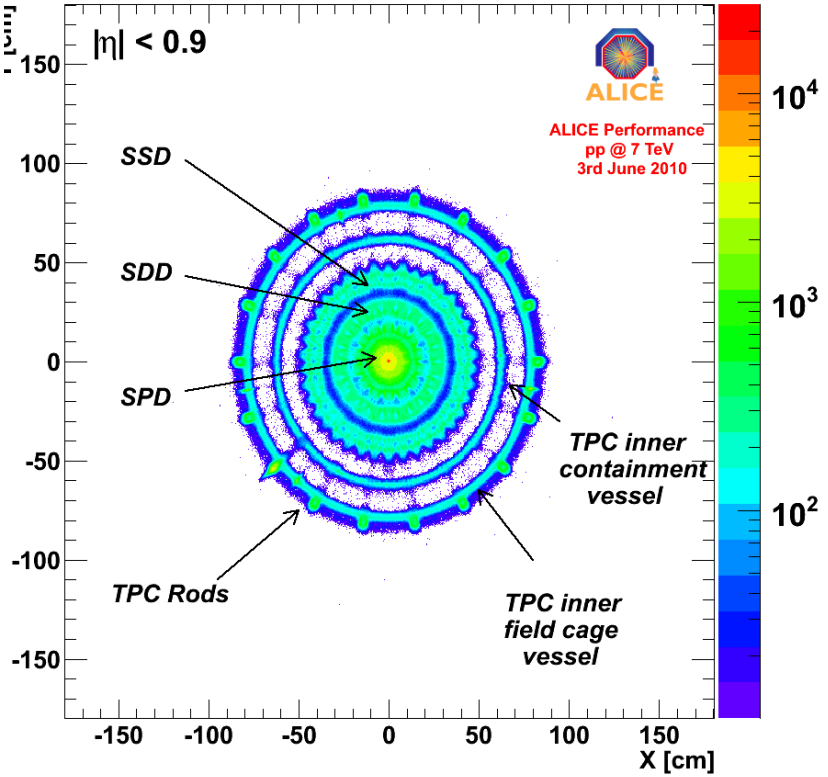




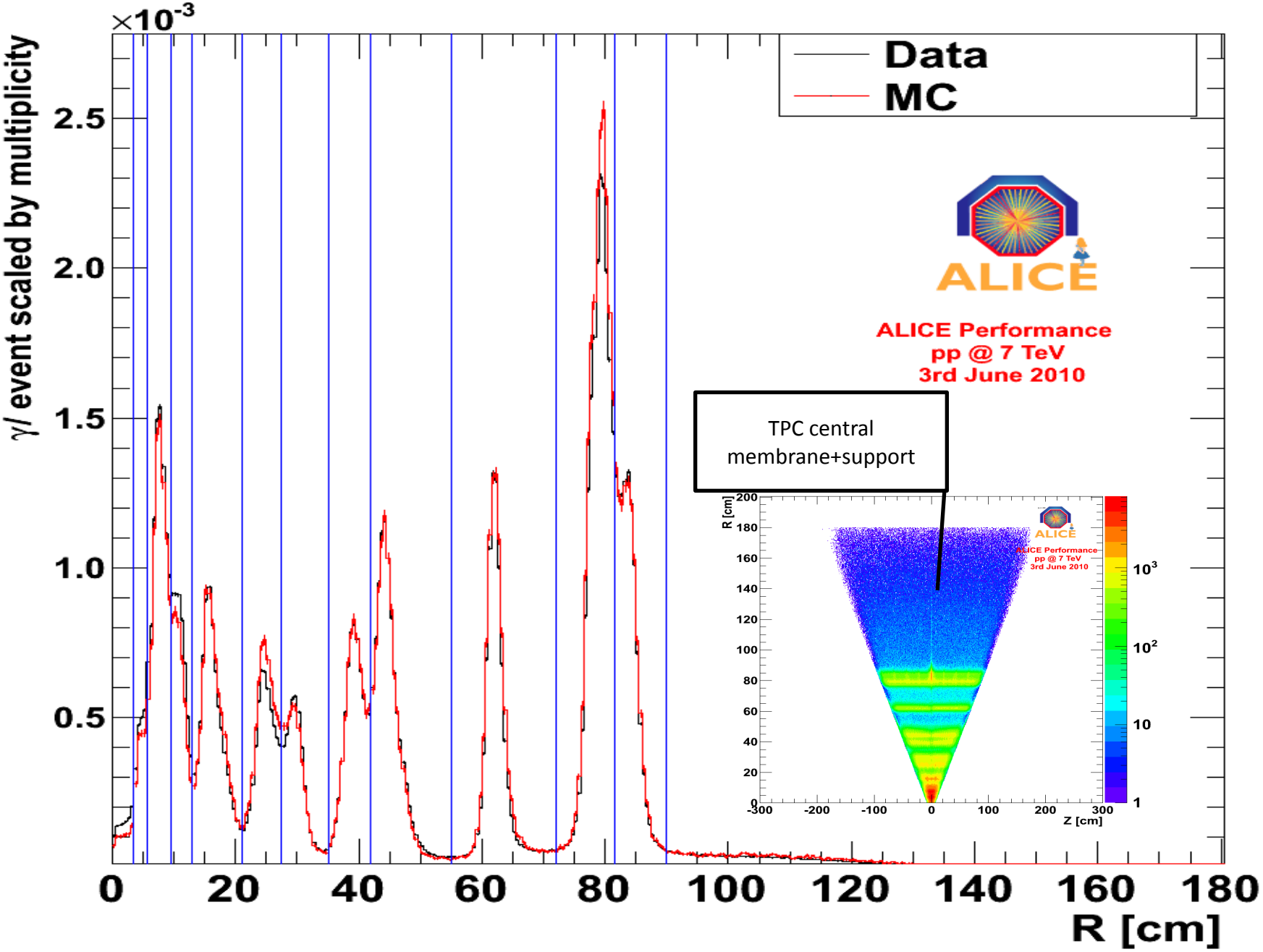
Amount of material measured with gamma conversions



Material tracking region close to design
Uncertainty ~5%
MC adapted accordingly



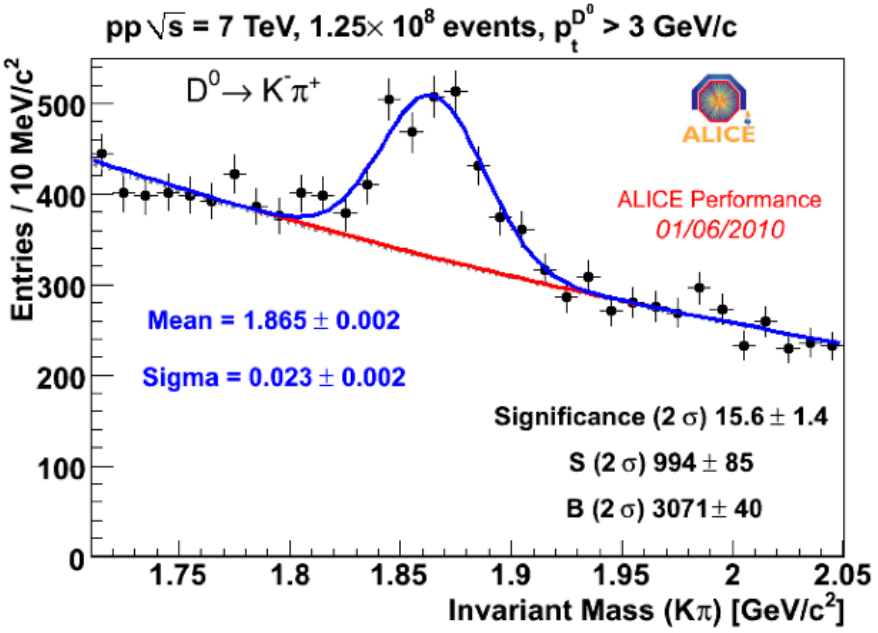
Amount of material gamma conversions data-MC



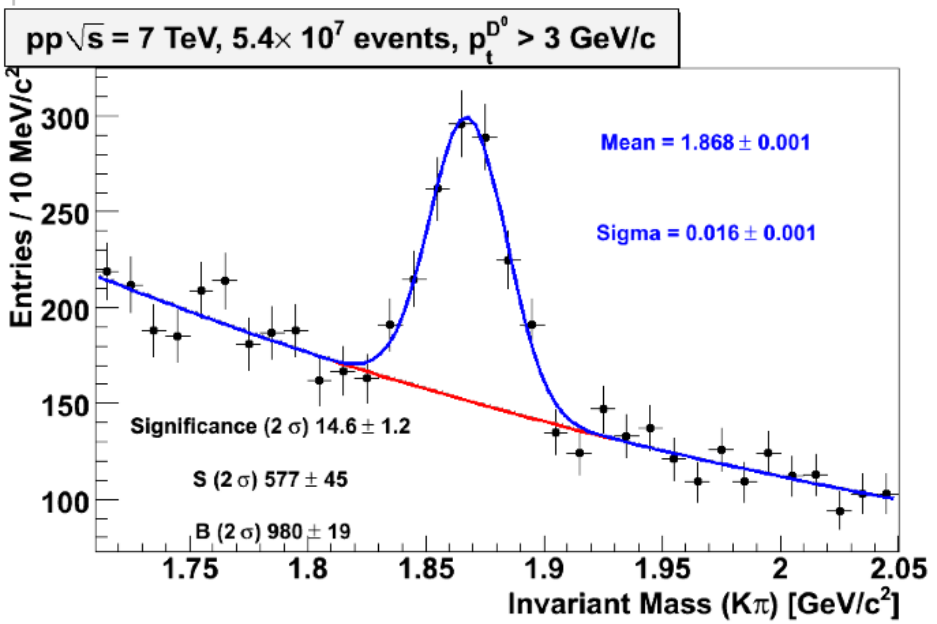
TPC calibration

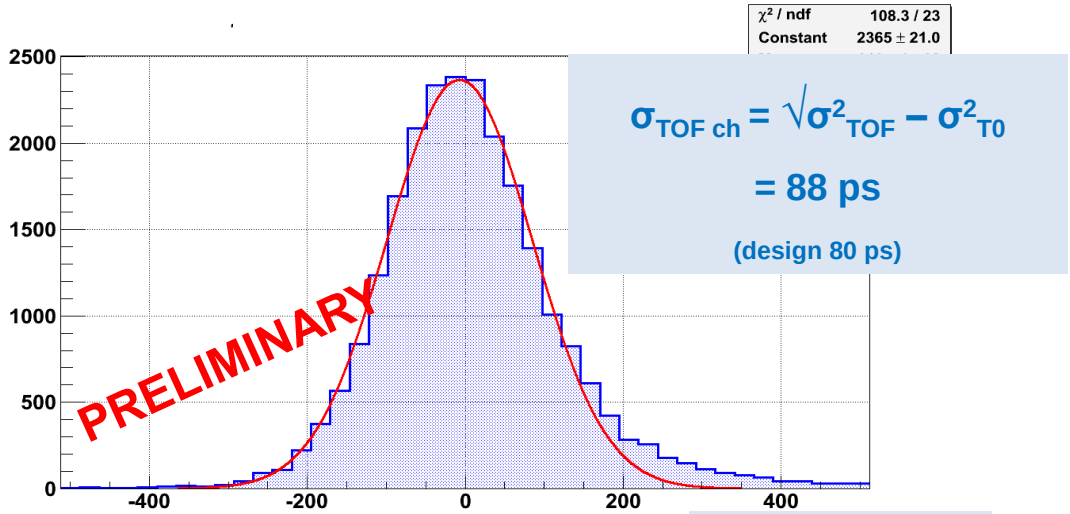
- Example: $D^0 \rightarrow K\pi$: pass1 vs pass2
  - better TPC calibration → better mom. resolution
  - **Mass resolution: 23 → 16 MeV/c²**
  - **S/B (p_t>3 GeV/c): 0.3 → 0.6**

125M, pass1



54M, pass2 (LHC10b & LHC10c)





$\sigma_{TOF\ ch} = \sqrt{\sigma^2_{TOF} - \sigma^2_{T0}}$

$= 88$ ps

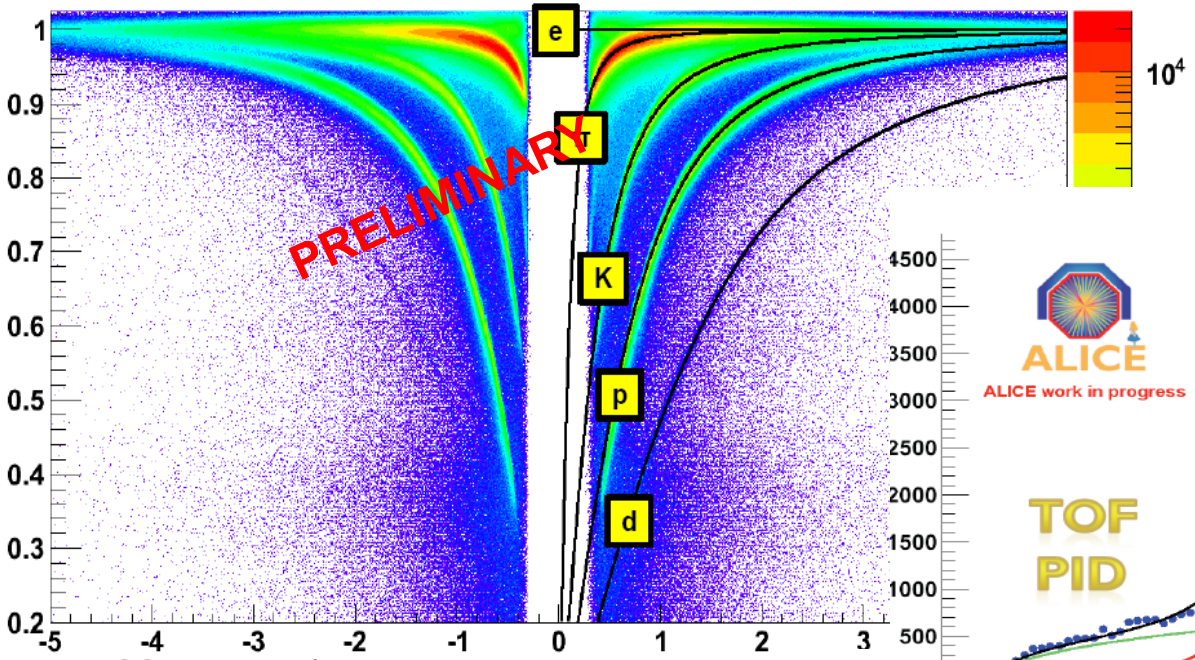
(design 80 ps)

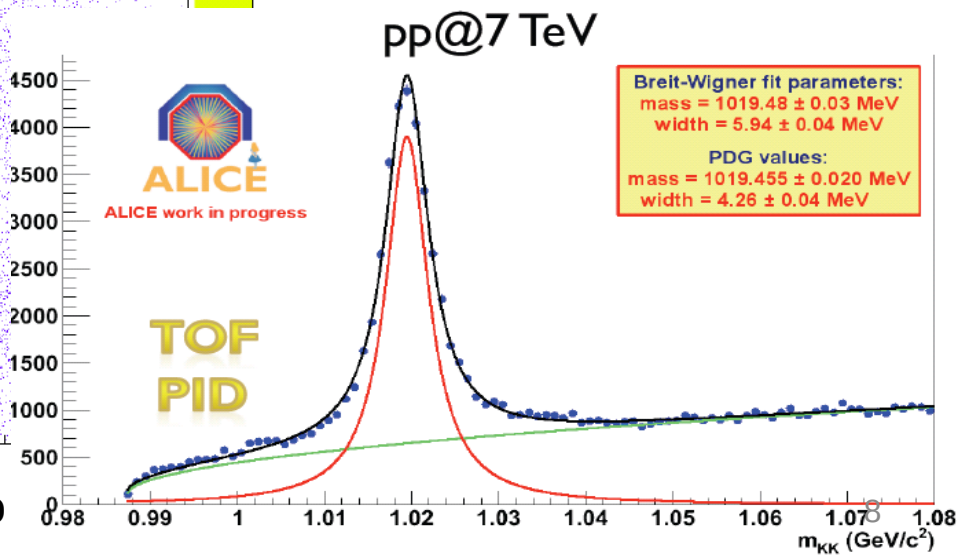
$\Delta t_{TOF} = t_{TOF} - t^{\pi}_{exp}$

ALICE TOF

100% installed
1593 MRPC
152938 readout ch.
~ 97% working

7 TeV
Improved
calibration





Muon Spectrometer – Tracking systsem

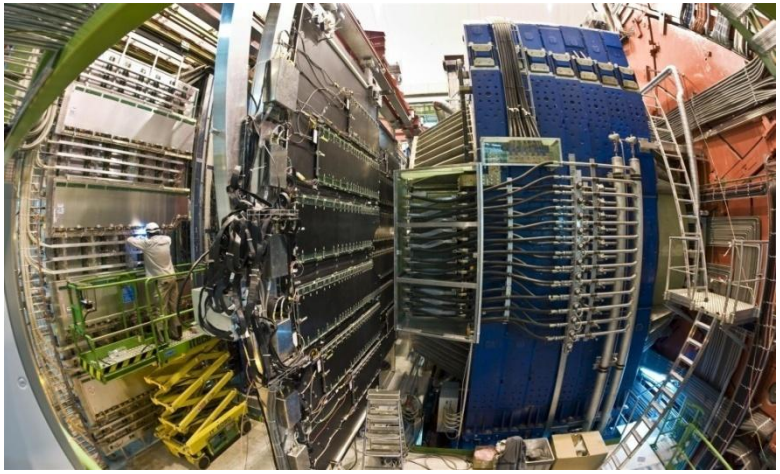
Fully installed, data taking at 7 TeV ongoing…

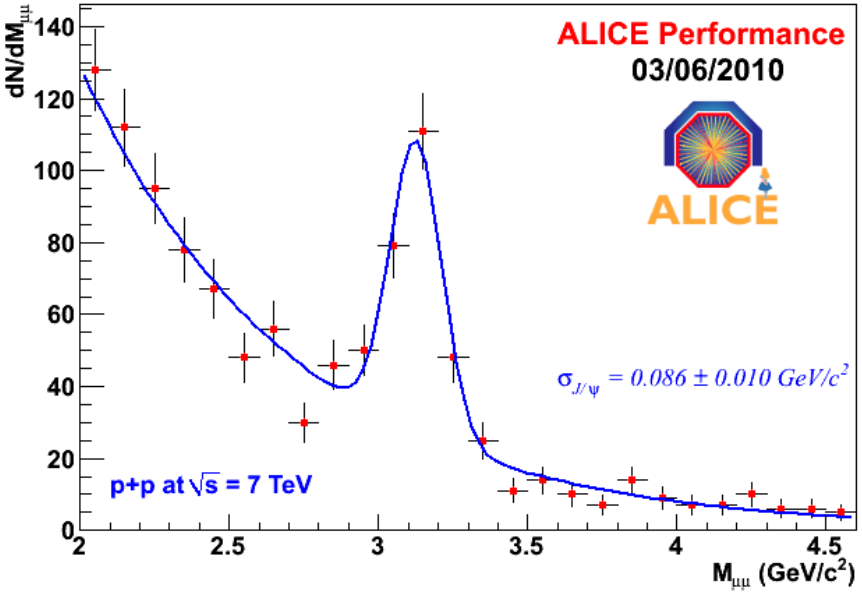
- Alignment:

•Significant improvement in the invariant mass resolution → $\sigma_{J/\psi}$ = 80-90 MeV/c^2 (design 80 MeV)

•Trigger:

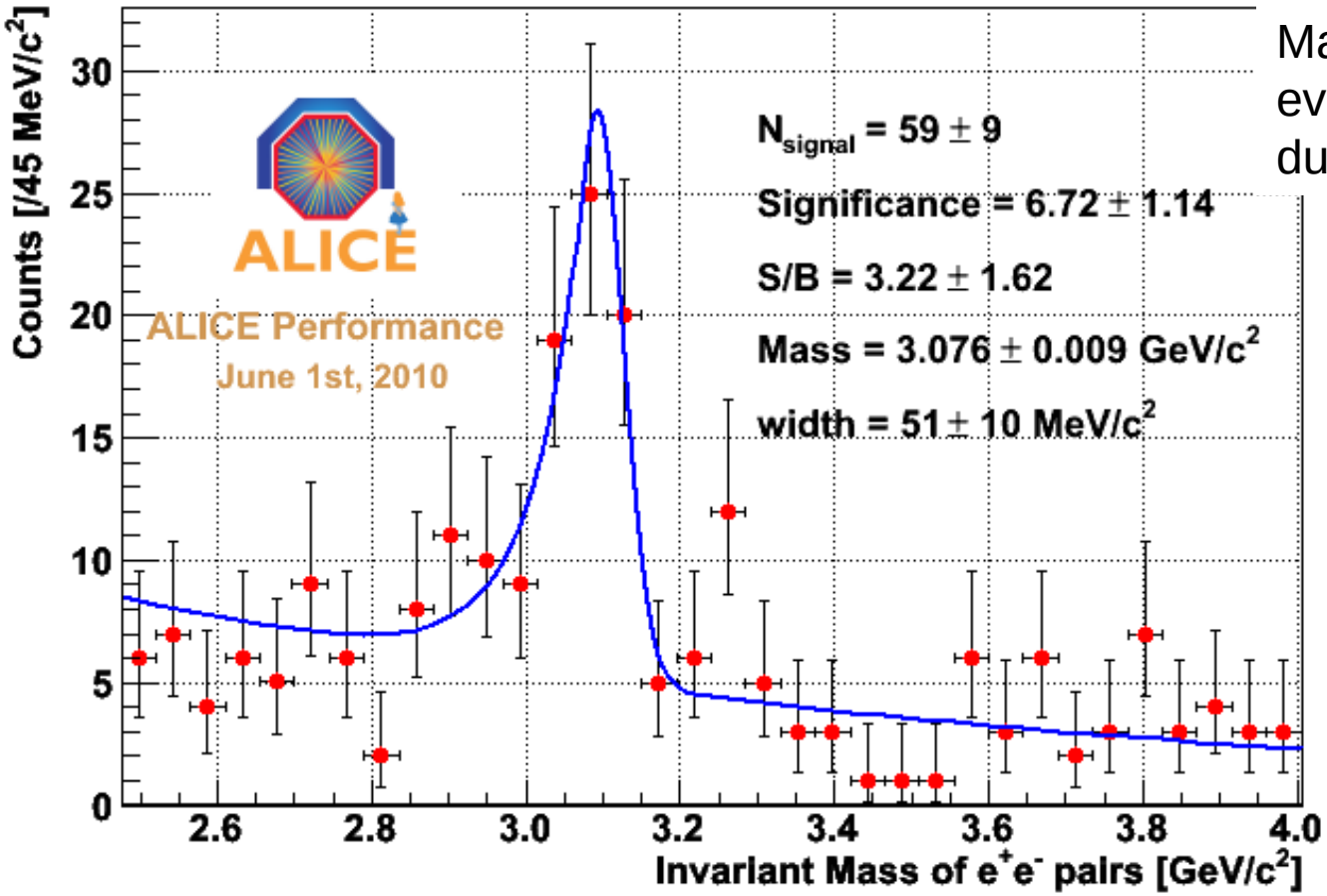
•Fine tuning of RPCs working conditions in avalanche mode





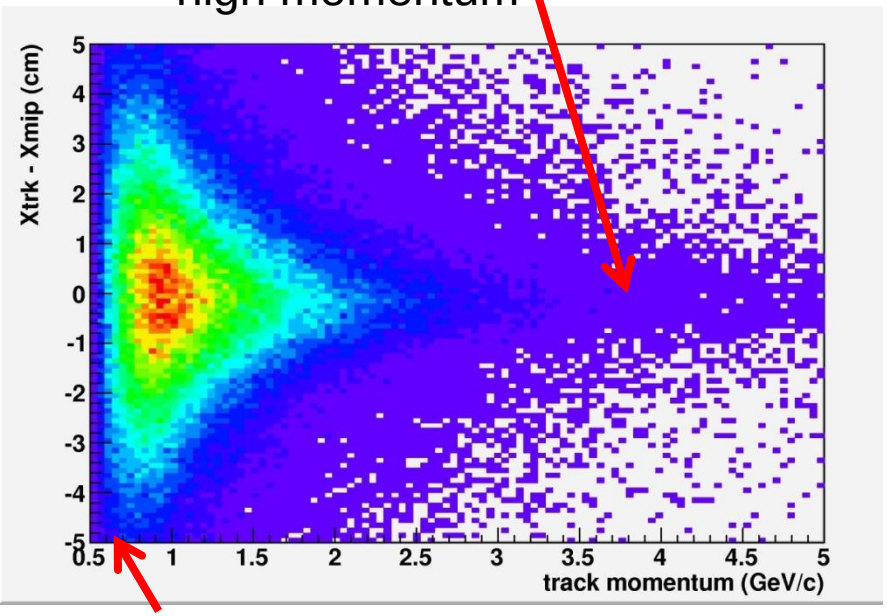
•- In the next technical stop fix LVPS problems on Ch. 5. (1/16 of detector)

J/Psi → ee

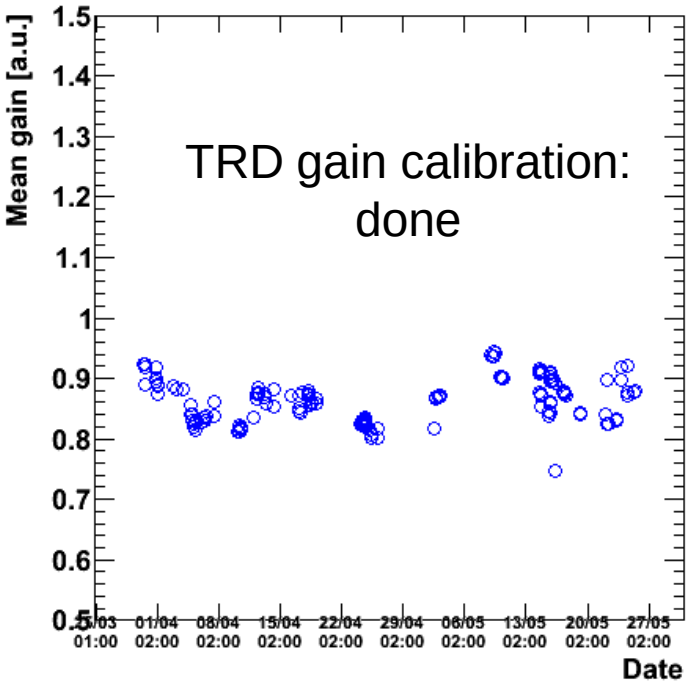


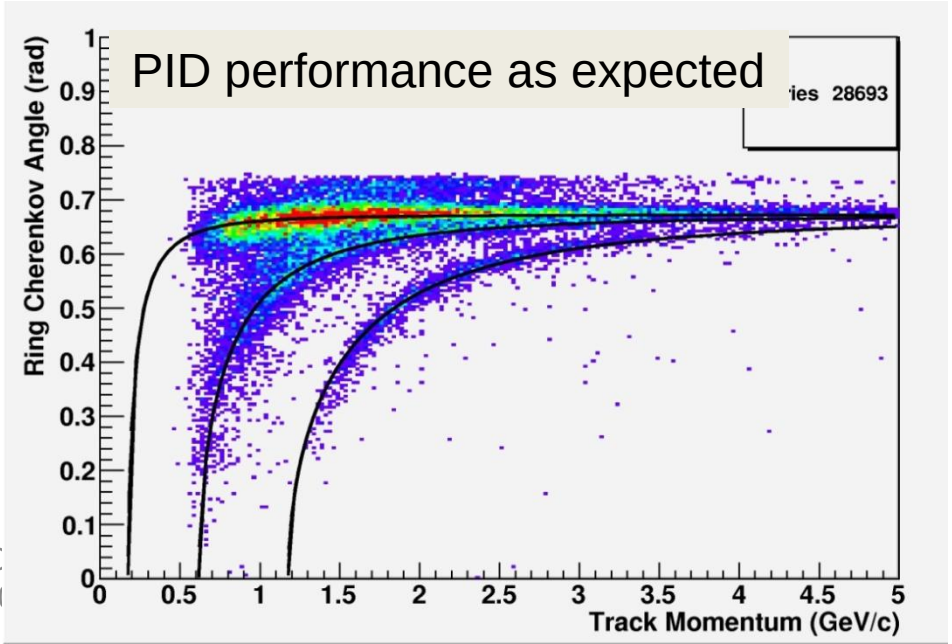
Mass resolution ~50 MeV
even with low field,
due to low material budget

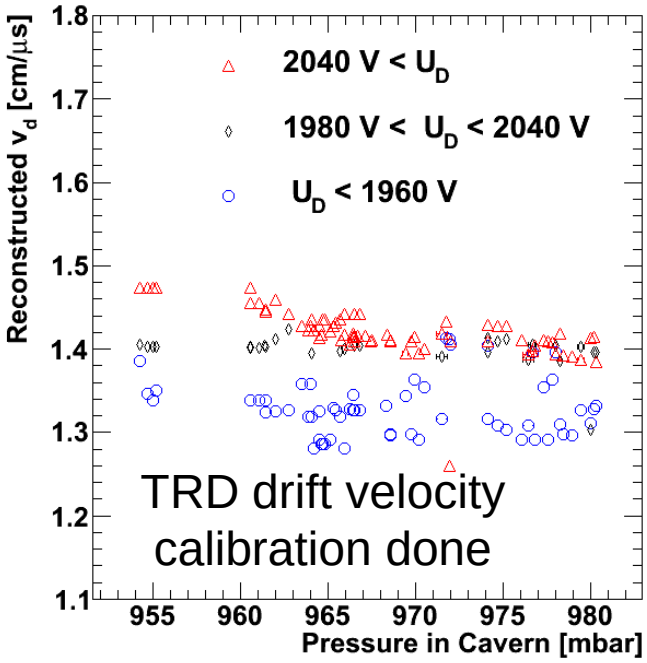
HMPID Alignment done for high momentum



Multiple scattering region to be optimized



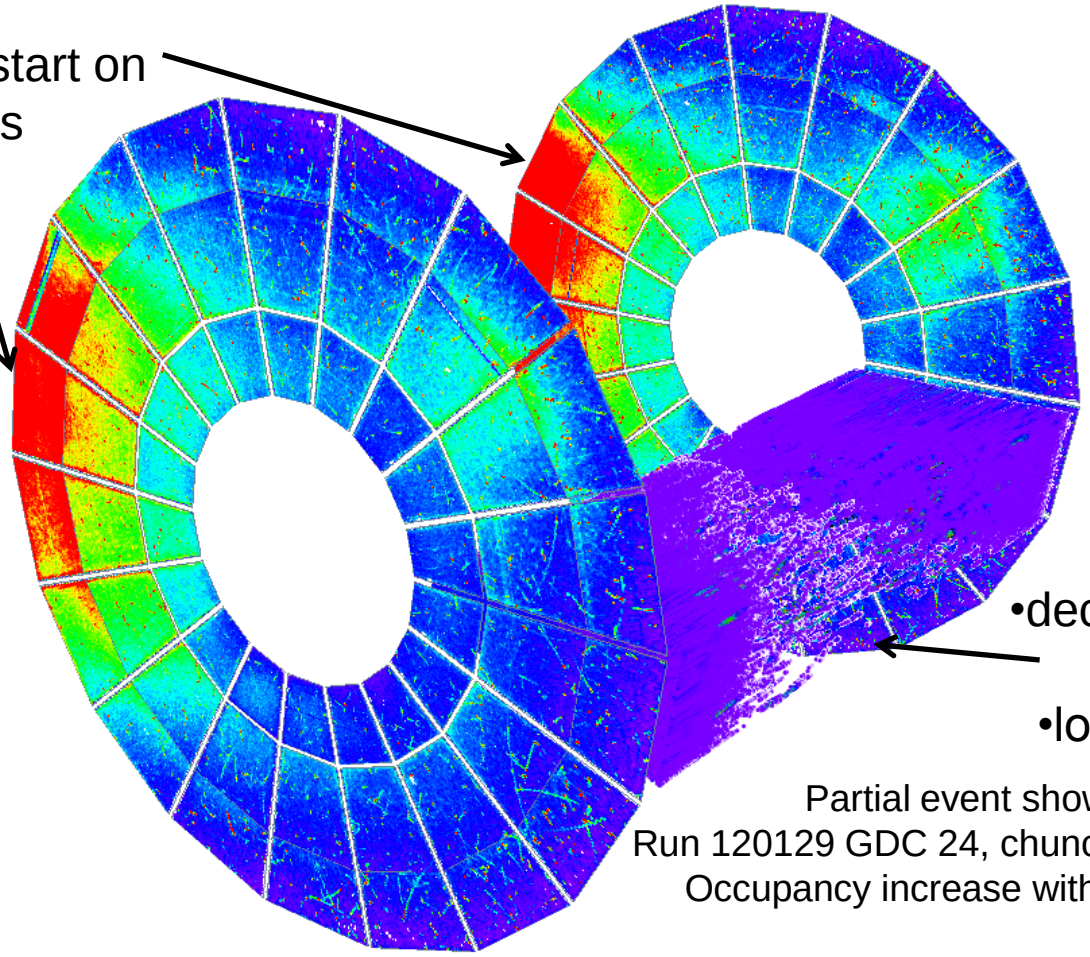




TPC

•Increasing beam current, increased number of TPC ROCs HV trips

High baseline start on both sides



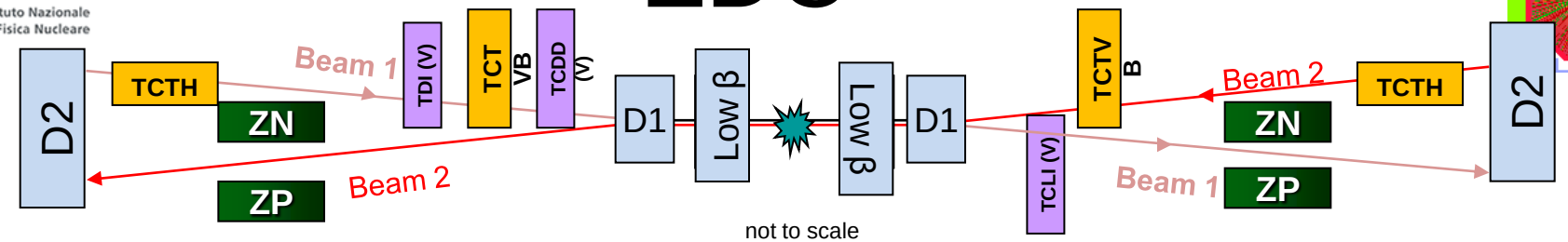
Occupancy increase in all sectors
Event size >500 MB
(25 kB is normal)

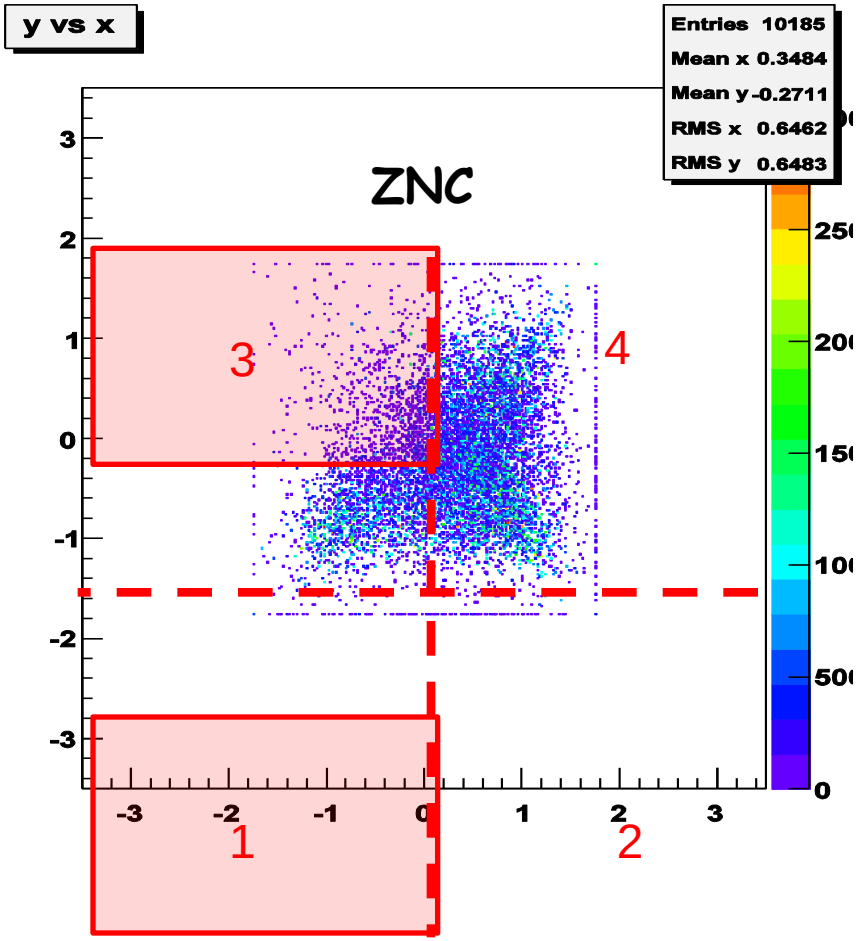
•decrease of the baseline
•long “pulses”

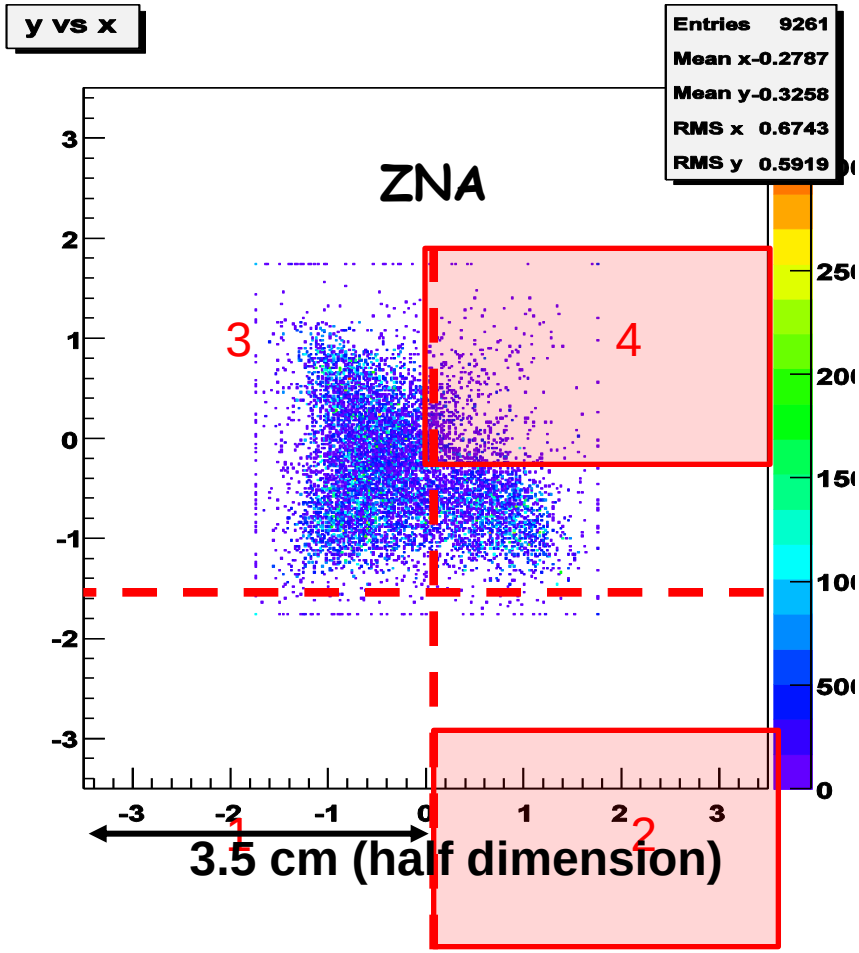
Partial event shown here
Run 120129 GDC 24, chunck 50, event 2746)
Occupancy increase within all the sectors

- Using TPC events to investigate, test runs with nominal or low gain, ...
- Since a few days less trips even during beam instabilities
- At present we do not exclude any hypothesis concerning the cause

ZDC





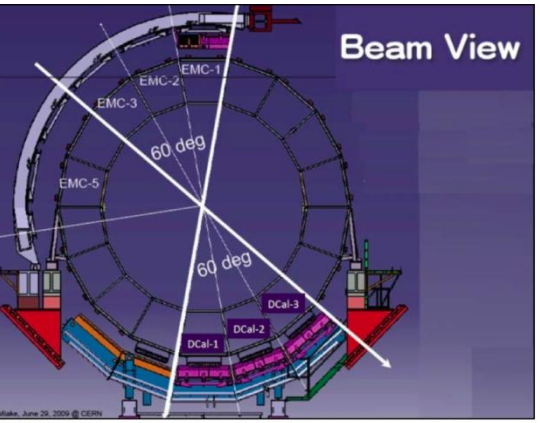


Run 122374 , Vert. Beam Crossing Angle 140 μrad

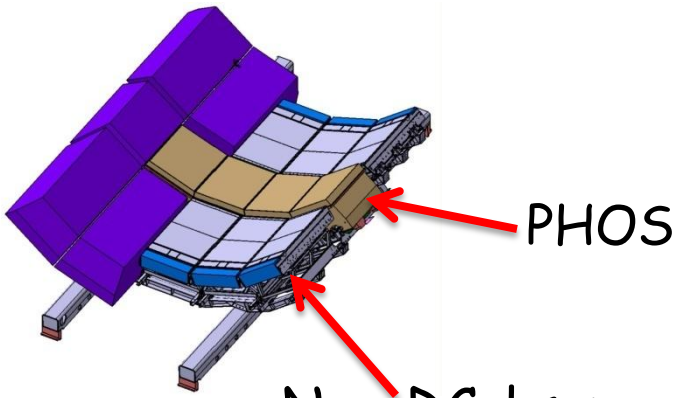
DCAL installation in 2012 (10+ weeks needed)

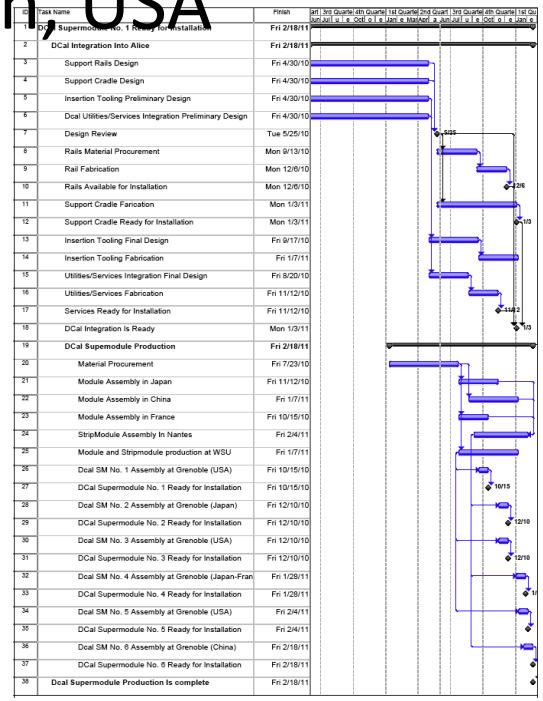
Proposed EMCAL extension: DCAL

- ALICE-TDR-014, 22 June 2010
- PHOS+extra EMCAL modules opposite to EMCAL
  - 60% extension of EMCAL acceptance
- Countries: China, France, Italy, Japan, USA
- Detailed project responsabilities
- Completion by February 2011



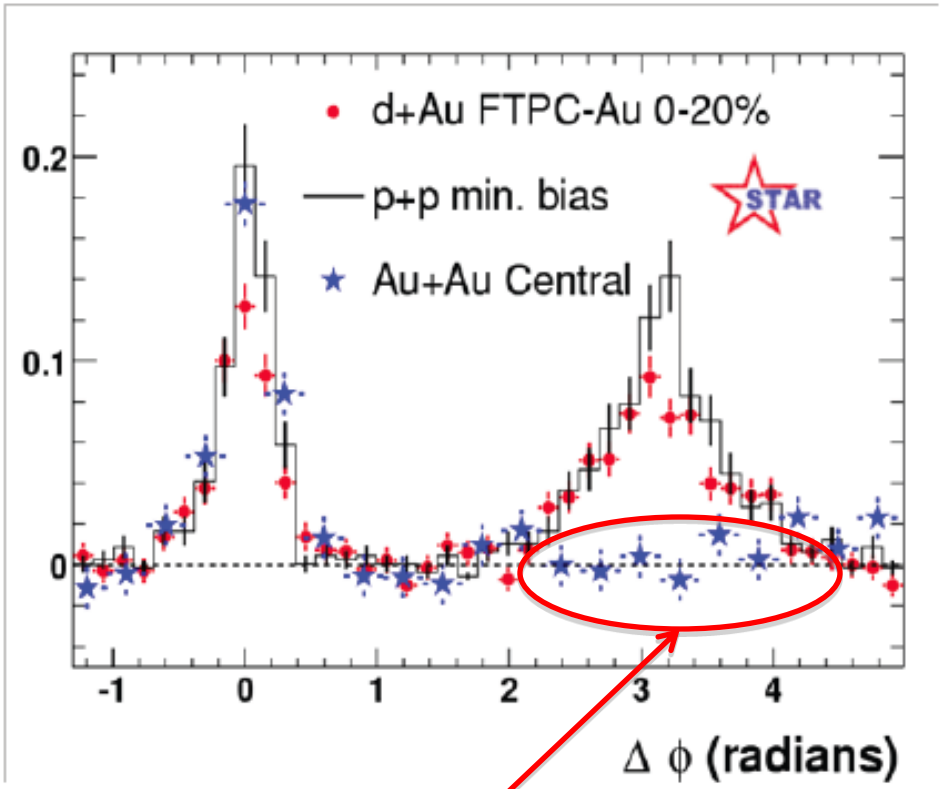
VI.1 Beam view of EMCal (above mid-plane) and DCal (below mid plane).





	Task Name	Finish
1	DCal Supermodule No. 1 Ready for Installation	Fri 2/18/11
2	DCal Integration Into Alice	Fri 2/18/11
3	Support Rails Design	Fri 4/30/10
4	Support Cradle Design	Fri 4/30/10
5	Insertion Tooling Preliminary Design	Fri 4/30/10
6	Dcal Utilities/Services Integration Preliminary Design	Fri 4/30/10
7	Design Review	Tue 5/25/10
8	Rails Material Procurement	Mon 9/13/10
9	Rail Fabrication	Mon 12/6/10
10	Rails Available for Installation	Mon 12/6/10
11	Support Cradle Farication	Mon 1/3/11
12	Support Cradle Ready for Installation	Mon 1/3/11
13	Insertion Tooling Final Design	Fri 9/17/10
14	Insertion Tooling Fabrication	Fri 1/7/11
15	Utilities/Services Integration Final Design	Fri 8/20/10
16	Utilities/Services Fabrication	Fri 11/12/10
17	Services Ready for Installation	Fri 11/12/10
18	DCal Integration Is Ready	Mon 1/3/11
19	DCal Supemodule Production	Fri 2/18/11
20	Material Procurement	Fri 7/23/10
21	Module Assembly in Japan	Fri 11/12/10
22	Module Assembly in China	Fri 1/7/11
23	Module Assembly in France	Fri 10/15/10
24	StripModule Assembly In Nantes	Fri 2/4/11
25	Module and Stripmodule production at WSU	Fri 1/7/11
26	Dcal SM No. 1 Assembly at Grenoble (USA)	Fri 10/15/10
27	DCal Supermodule No. 1 Ready for Installation	Fri 10/15/10
28	Dcal SM No. 2 Assembly at Grenoble (Japan)	Fri 12/10/10
29	DCal Supermodule No. 2 Ready for Installation	Fri 12/10/10
30	Dcal SM No. 3 Assembly at Grenoble (USA)	Fri 12/10/10
31	DCal Supermodule No. 3 Ready for Installation	Fri 12/10/10
32	Dcal SM No. 4 Assembly at Grenoble (Japan-Fran	Fri 1/28/11
33	DCal Supermodule No. 4 Ready for Installation	Fri 1/28/11
34	Dcal SM No. 5 Assembly at Grenoble (USA)	Fri 2/4/11
35	DCal Supermodule No. 5 Ready for Installation	Fri 2/4/11
36	Dcal SM No. 6 Assembly at Grenoble (China)	Fri 2/18/11
37	DCal Supermodule No. 6 Ready for Installation	Fri 2/18/11
38	Dcal Supermodule Production Is complete	Fri 2/18/11

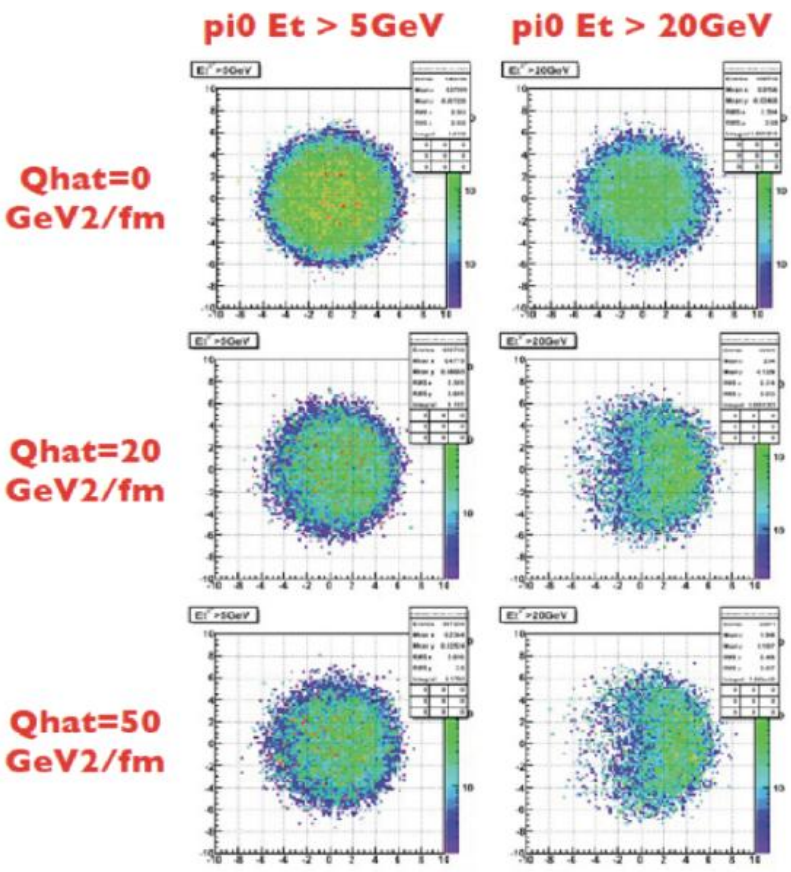
The Role of High P_T Correlation Measurements

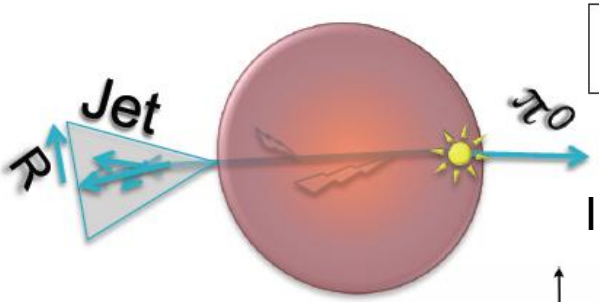


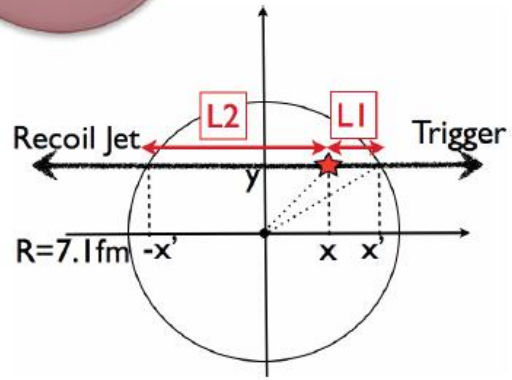
Now understood as a GEOMETRIC BIAS: The High P_T trigger favors minimum in-medium path length on the trigger side and thus maximum in-medium path length on the away side.

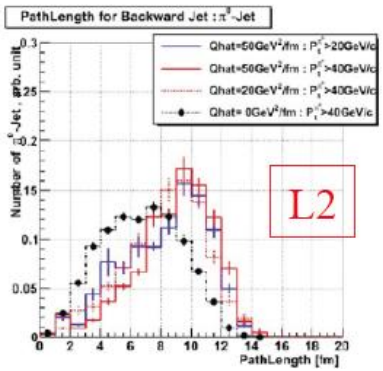
Next generation measurement: controlled variation of jet path length

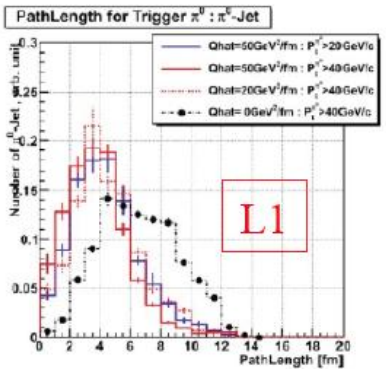
Calculation: qPYTHIA









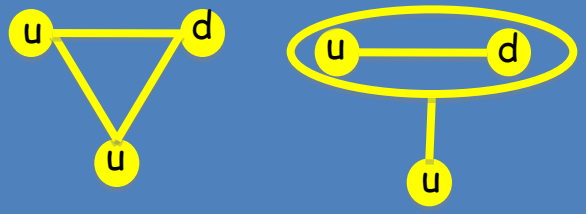


Physics analyses

- 6 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 by Eur. Phys. J C
  - Charged-particle multiplicity in 7 TeV pp collisions – letter
    - arXiv:1004.3514[hep-ph] accepted by Eur. Phys. J C
  - Mid-rapidity antiproton/proton ratio in 0.9 and 2.26 TeV collisions – letter
    - submitted to PRL
  - HBT correlations at 0.9 TeV
    - submitted to PRD
  - Transverse momentum spectra at 0.9 TeV
    - submitted to PLB
- Papers in draft
  - Identified charged hadron spectra and yields in pp at 0.9 TeV
  - Strange particle production in pp at 0.9 TeV

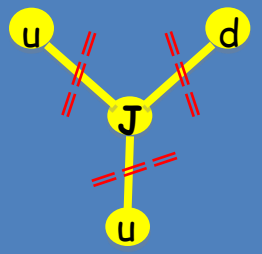
Ongoing analysis:
event shape, underlying event, azimuthal correlations, pi0, eta, open charm: D0 D+ D*, J/psi

Baryon transport in pp



Traditional

Baryon transport via the di-quark
Fragmentation function of di-quark exponentially suppressed at large rapitity gap



String Junction

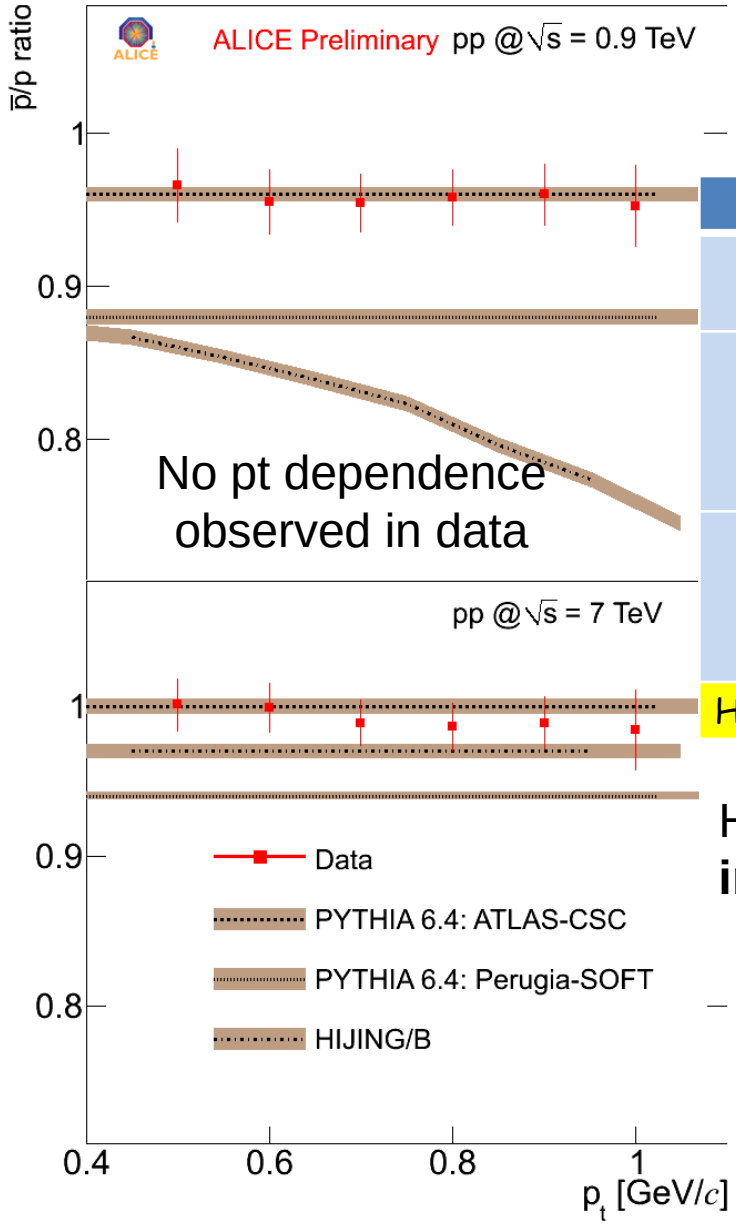
Baryon transport via di-quark, quark-J or Junction alone

→Different fragmentation functions

- Veneziano:
  - exponentially suppressed, intercept model dependent $P(\Delta y) \sim e^{(a_J - 1)\Delta y}$
- Kopeliovich:
  - Probability constant with rapidity $P(\Delta y) = const$

Large rapidity gap (9.6) at LHC → Difference in tails can be measured

Baryon – antibaryon asymmetry in pp

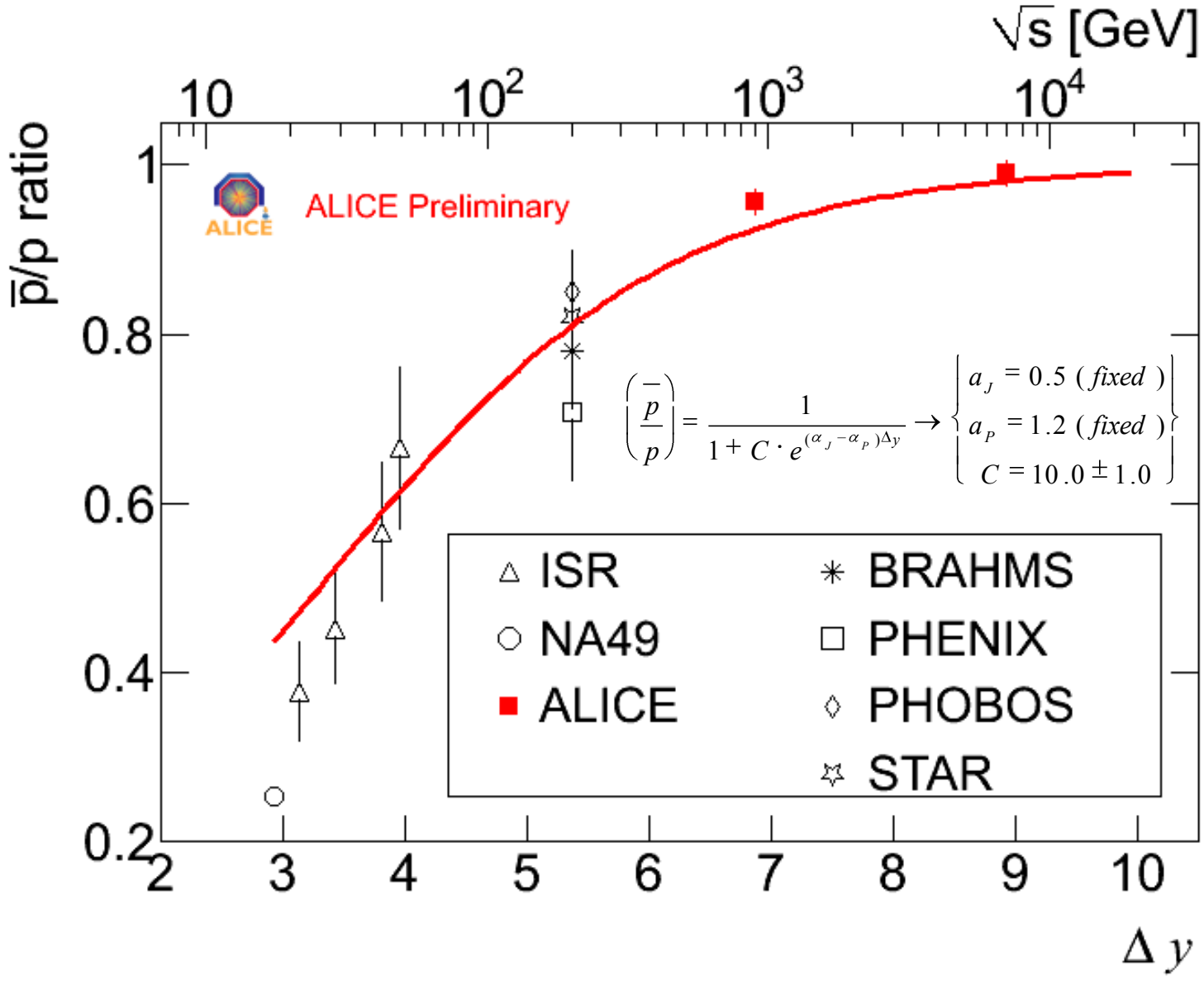


Energy [TeV]		0.9 TeV	7 TeV
ALICE		0.957 ± 0.015 *	0.991 ± 0.015 *
PYTHIA	ATLAS-CSC (306)	0.96	1.0
	Perugia-0 (320)	0.95	1.0
	Perugia-SOFT (322)	0.88	0.94
QGSM	ε=0	0.98	1.0
	ε = 0.076, α_J = 0.5	0.96	0.99
	ε = 0.024, α_J = 0.9	0.89	0.95
HIJING-B		0.83	0.97

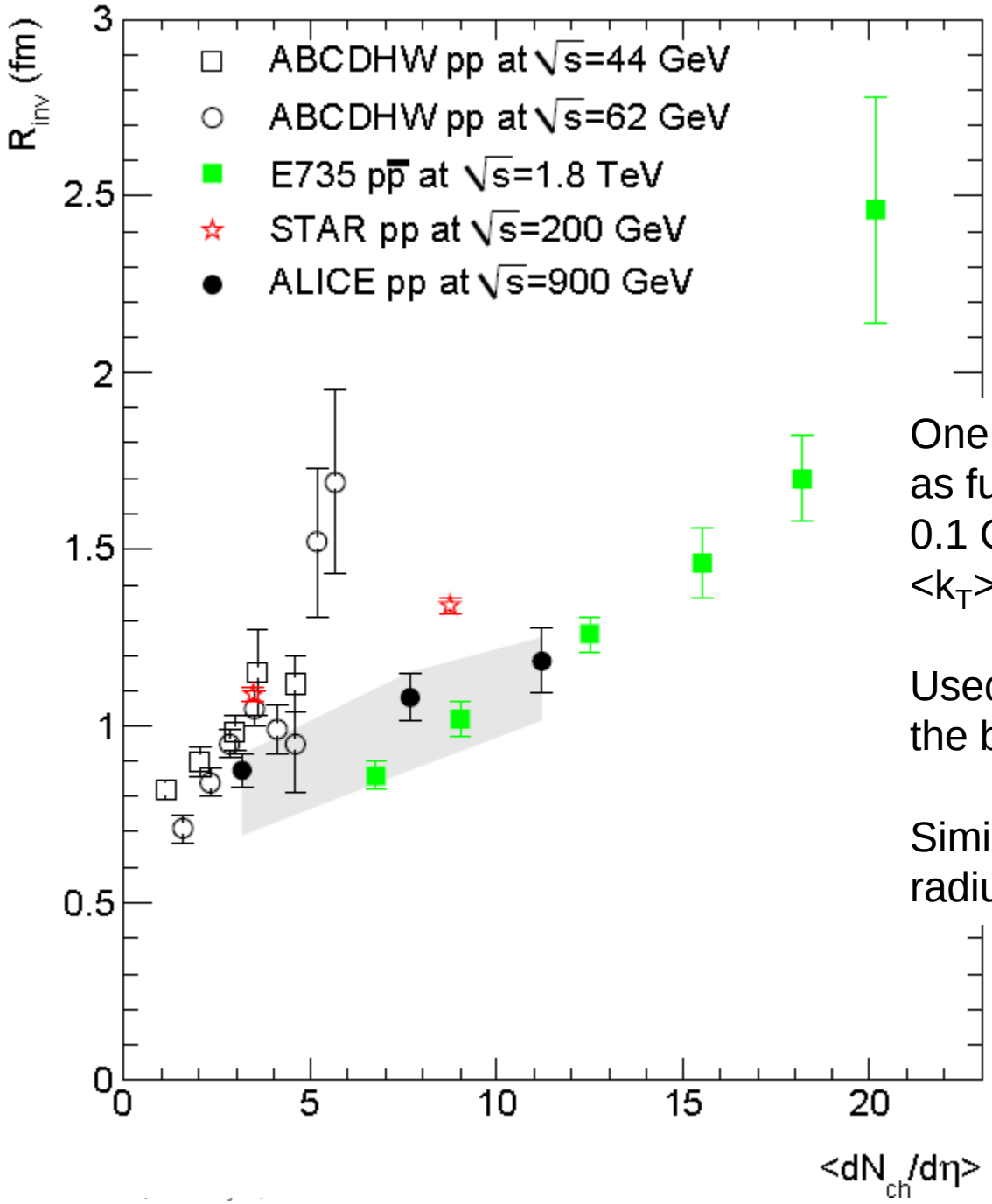
Hijing-B, Perugia-SOFT, QGSM(ε = 0.024, α_J = 0.9) **incompattible with the data**

* The error is the quadratic sum of the statistical and the systematic uncertainty

Pbar/p ratio


√s [GeV]
10
10²
10³
10⁴
p̄/p ratio
1
0.8
0.6
0.4
0.2
ALICE Preliminary
ALICE
$\left(\frac{\bar{p}}{p}\right) = \frac{1}{1 + C \cdot e^{(\alpha_J - \alpha_P)\Delta y}} \rightarrow \begin{cases} a_J = 0.5 \ (fixed) \\ a_P = 1.2 \ (fixed) \\ C = 10.0 \pm 1.0 \end{cases}$
ISR
NA49
ALICE
BRAHMS
PHENIX
PHOBOS
STAR
2
3
4
5
6
7
8
9
10
Δ y

HBT (submitted to PRD)

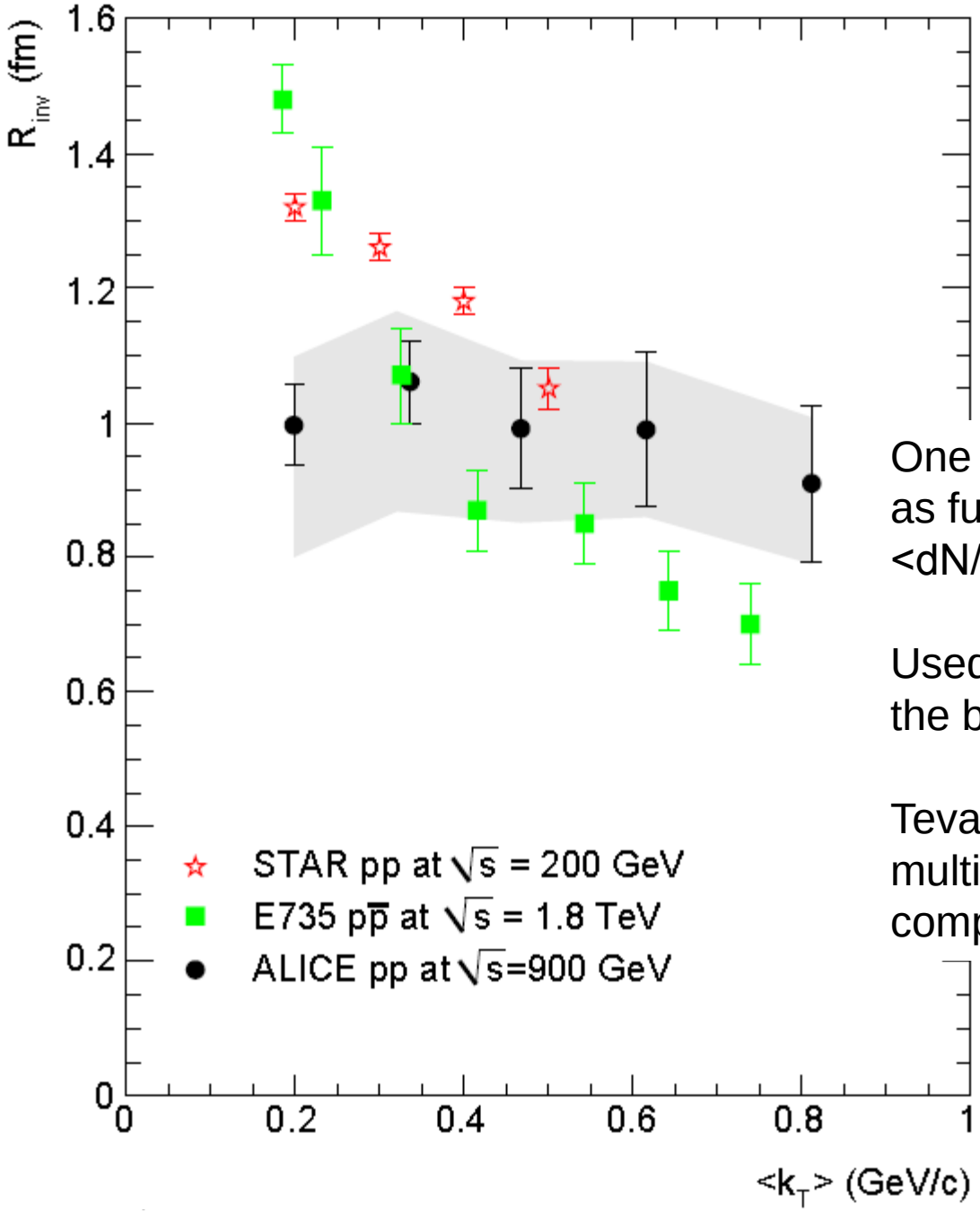


One dimensional Gaussian HBT radius as function of the multiplicity.
$0.1\ \text{GeV/c} < k_T < 0.55\ \text{GeV/c}$
$\langle k_T \rangle = 0.32\ \text{GeV/c}$

Used PHOJET and PYTHIA to subtract the baseline correlations

Similarly to heavy ion collisions the radius increases with multiplicity

HBT

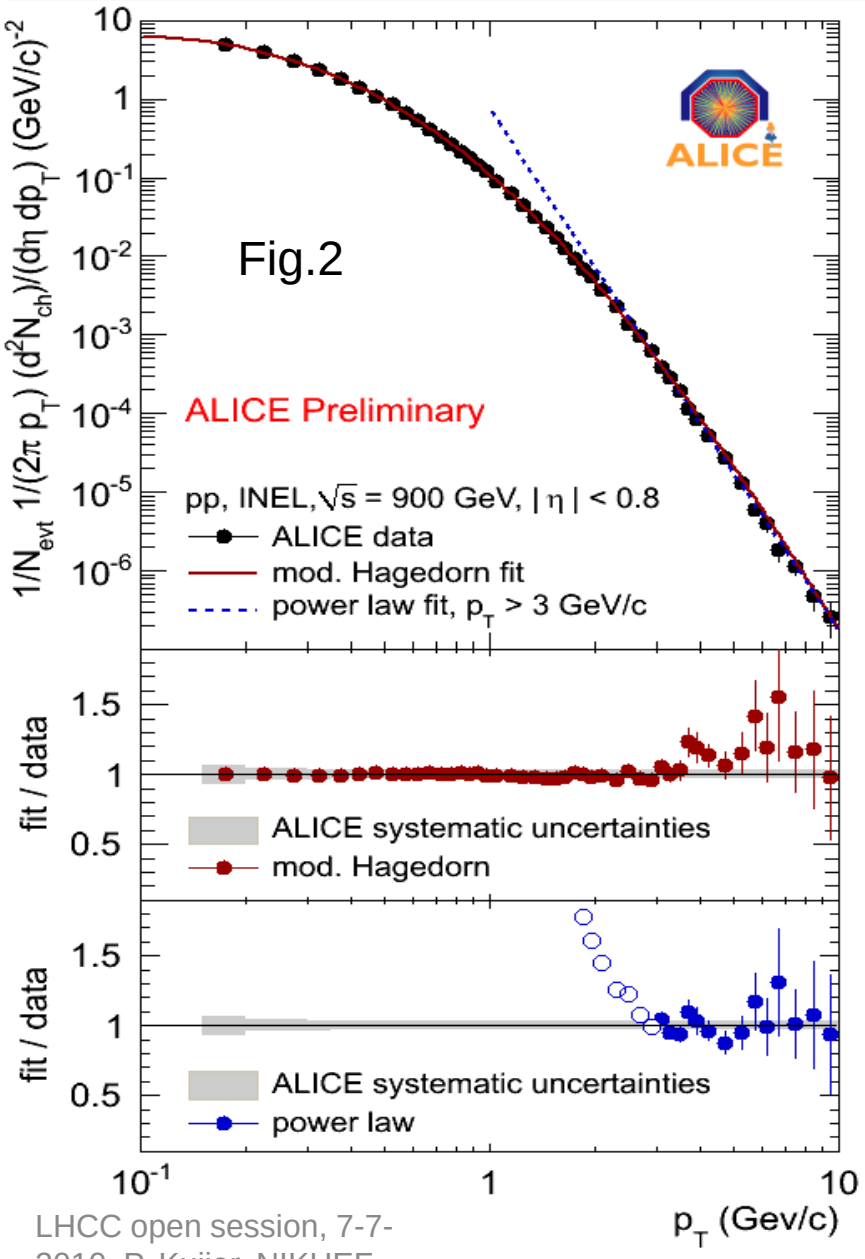


One dimensional Gaussian HBT radius as function of k_T.
<dN/dŋ>=3.6

Used PHOJET and PYTHIA to subtract the baseline correlations

Tevatron data at much higher multiplicity but STAR multiplicity is comparable

Charged particle pT spectrum (INEL)



Submitted to PLB

Mod. Hagedorn fit (0-10 GeV/c):

$$\frac{1}{2\pi p_T}\frac{d^2N_{ch}}{d\eta dp_T} \propto \frac{p_T}{m_T}\left(1+\frac{p_T}{p_{T,0}}\right)^{-b}$$

-> good description for small pT's
-> used for extrapolation to pT=0

$\langle pT \rangle_{INEL}$ =
0.483 +- 0.001 (stat) +- 0.007 (syst.) GeV/c
$\langle pT \rangle_{NSD}$ = 0.489 +- 0.001 +- 0.007 GeV/c

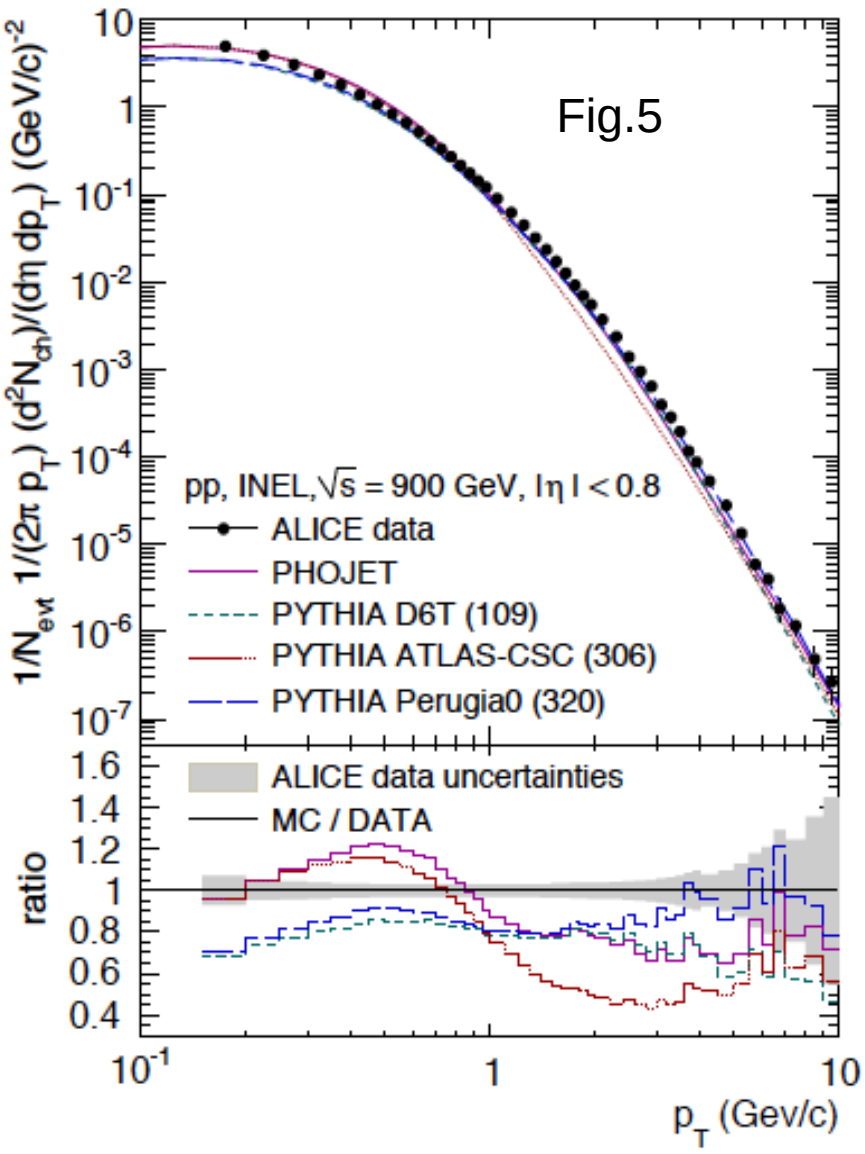
Power low fit (3-10 GeV/c):

$$\frac{1}{2\pi p_T}\frac{d^2N_{ch}}{d\eta dp_T} \propto p_T^{-n}$$

-> good description for pT > 3 GeV/c

pT points at the bin centers.

Comparison to models



- PYTHIA Perugia0 and D6T tunes describe the shape best, but yield ~20% too low

- PHOJET (at 900 GeV) and PYTHIA ATLAS-CSC tune (at 2.36 and 7 TeV) gave best description of the multiplicity distributions.

- ALICE sees larger $\langle p_T \rangle$ (and harder spectra)than other experiments with larger eta acceptance at 900 GeV

<pT> vs energy dependence

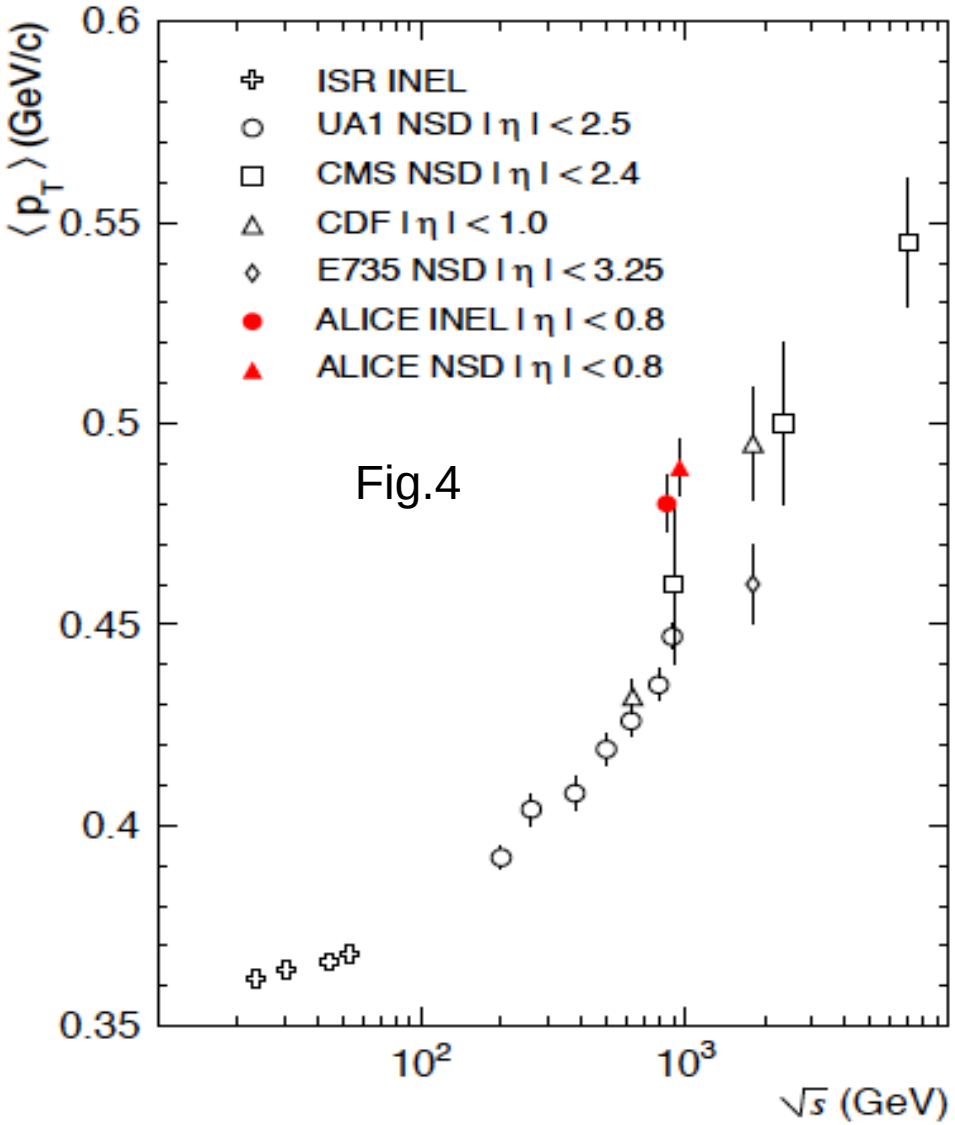


Fig.4

- ALICE sees larger $\langle p_T \rangle$ (and harder spectra)than other experiments with larger eta acceptance at 900 GeV

- Similar trend also at Tevatron

ALICE NSD:

$\langle p_T \rangle$ = 483 1 (stat.) 7 (syst.) MeV/c

ALICE NSD:

$\langle p_T \rangle$ = 489 1 (stat.) 7 (syst.) MeV/c

CMS NSD:

$\langle p_T \rangle$ = 460 10 (stat.) 10 (syst.) MeV/c

<pT> vs n_{acc} , <pT> vs n_{ch}

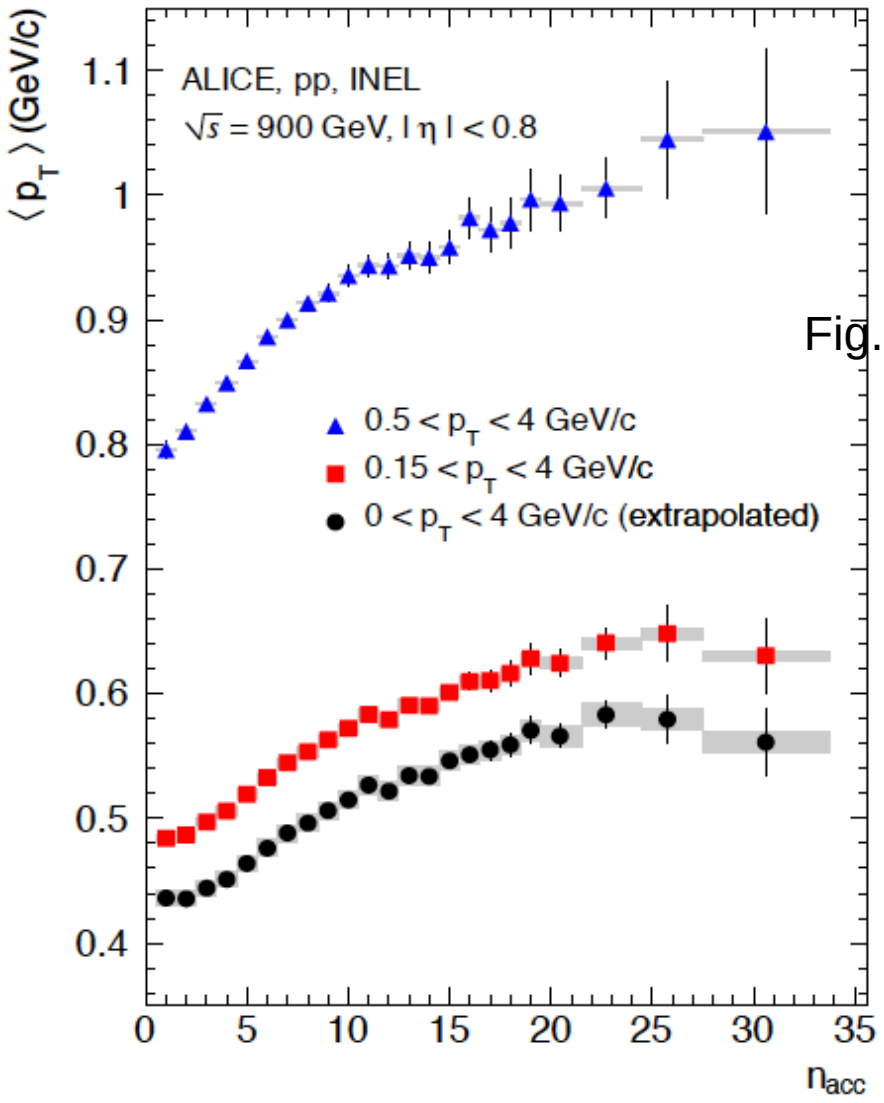
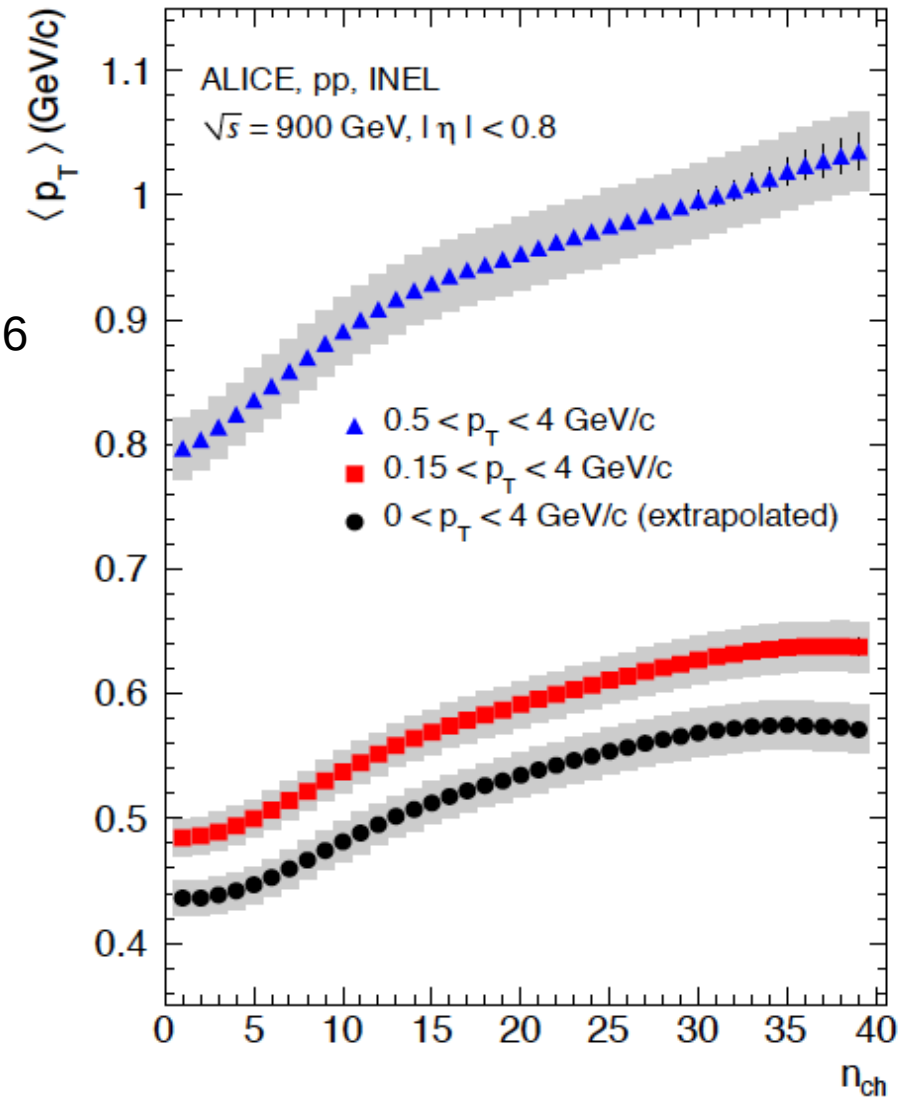


Fig.6



Comparison to models

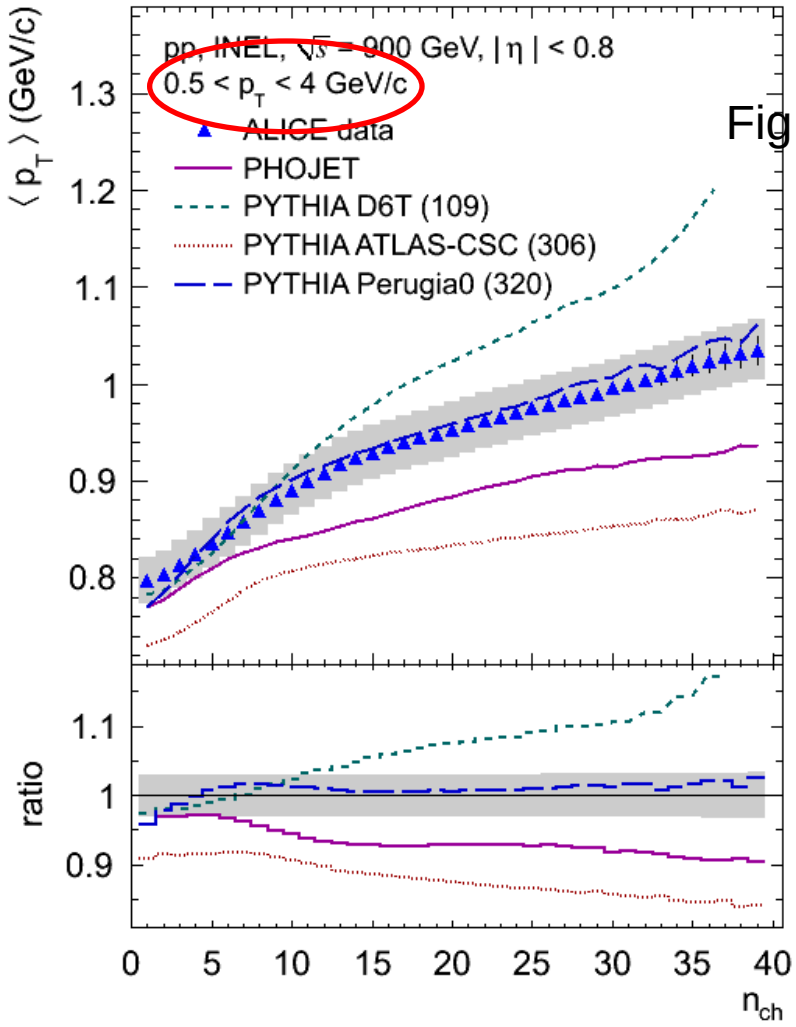
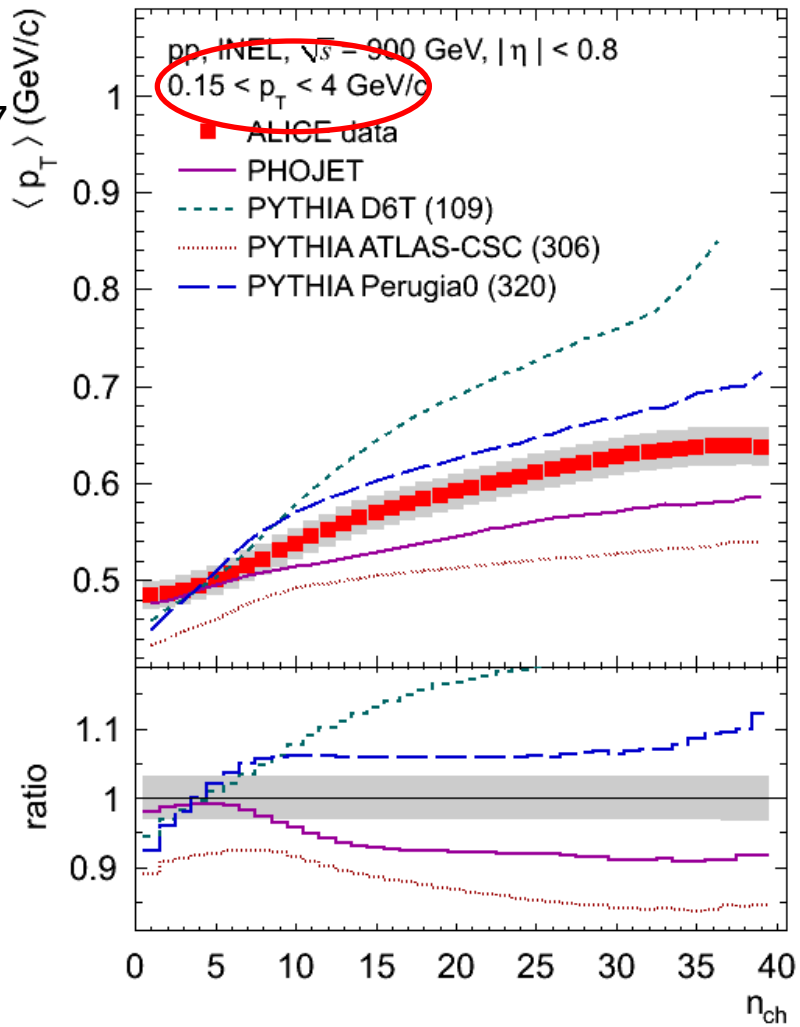


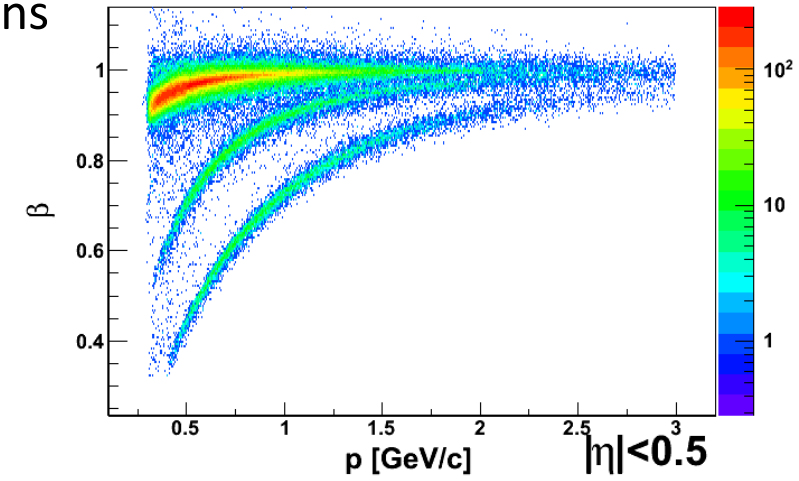
Fig.7

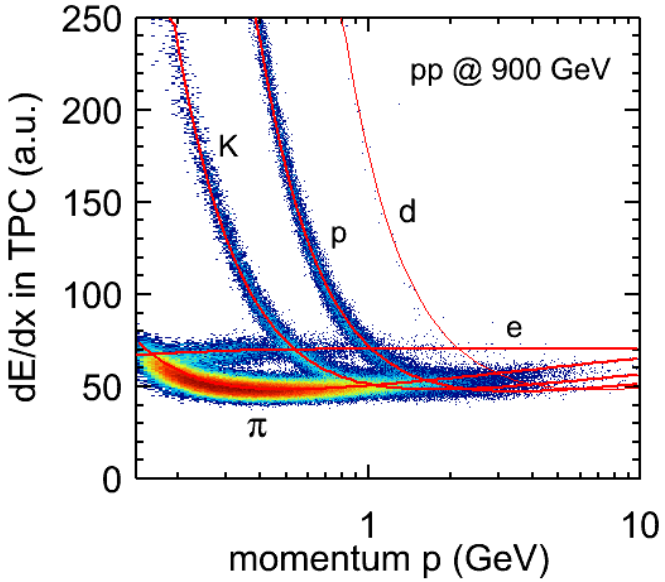


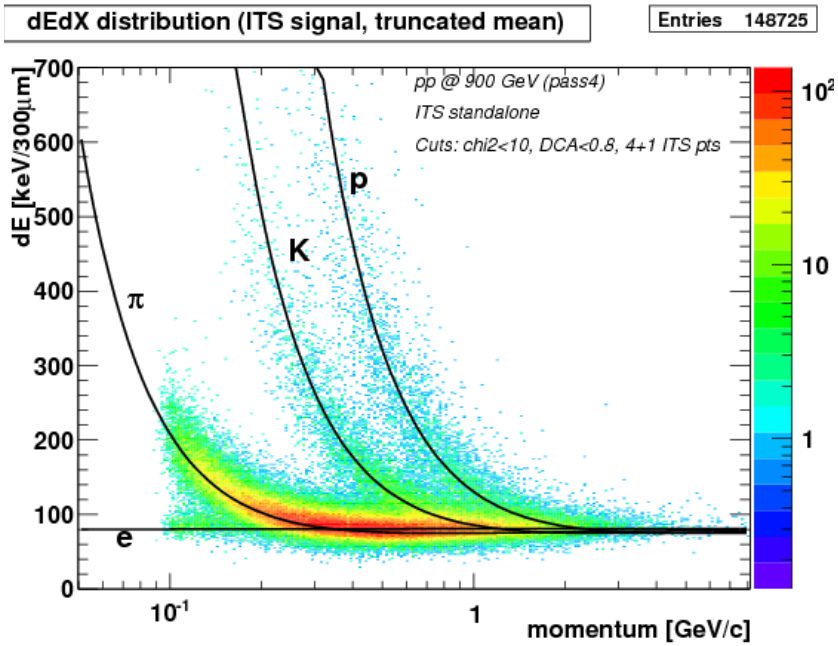
Identified particle spectra

(in progress)

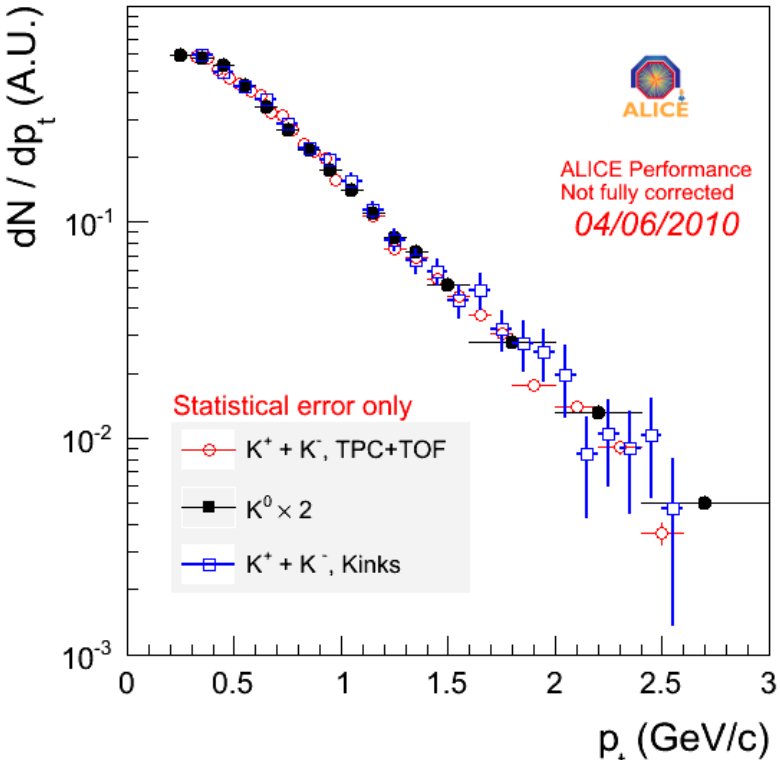
- pt spectra of indentified pions, kaons and protons
  - TPC dE/dx measurement
  - TOF at higher pt
  - ITS dE/dx measurement at lower pt

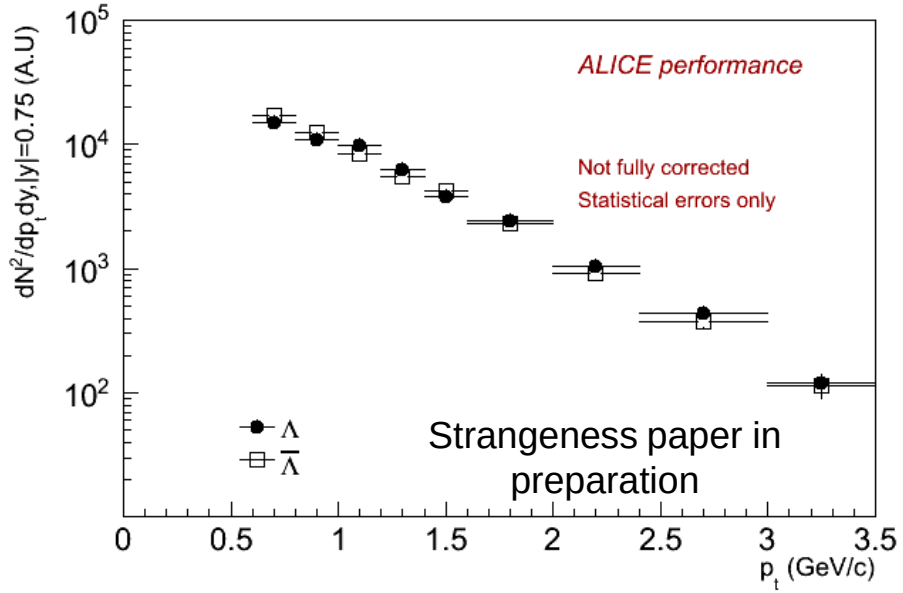




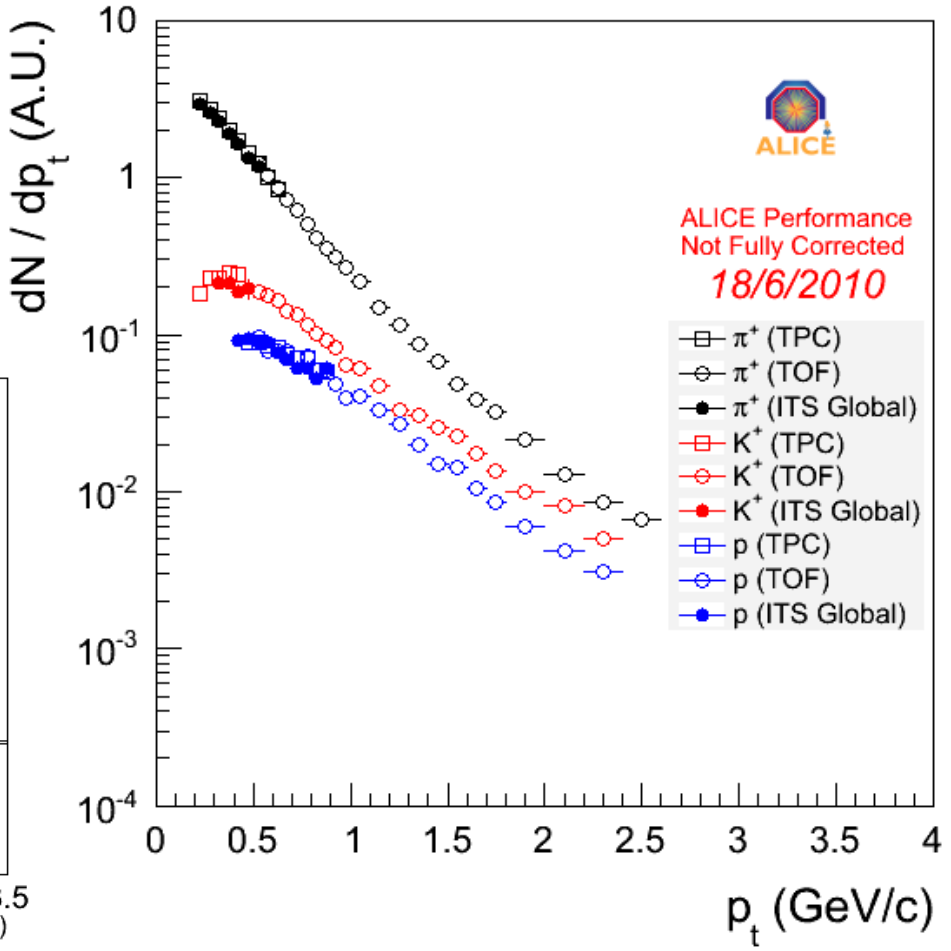


Papers in preparation



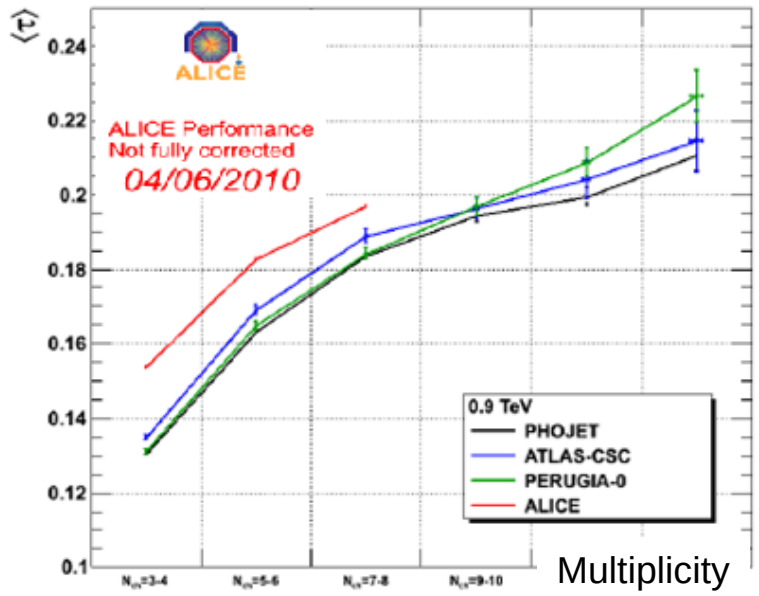


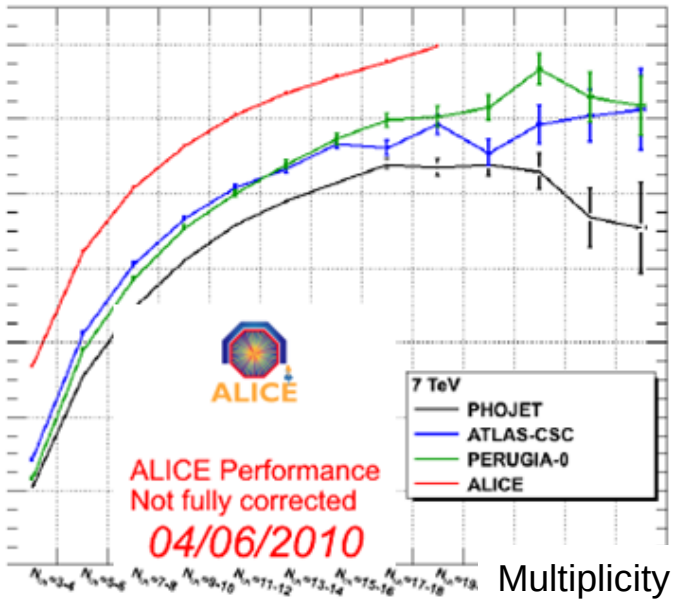
Identified particle spectra paper in preparation



Event shape analysis ongoing

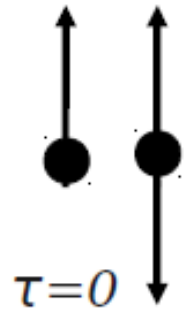
In the ALICE results only the statistical errors are shown.
The response matrix was obtained from PYTHIA.

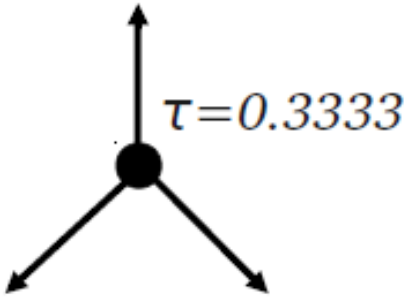


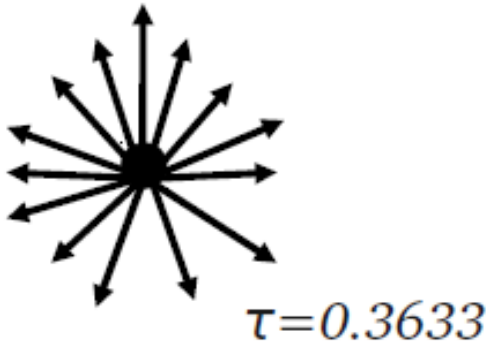


$$T \equiv \underbrace{max}_{\vec{n}_t} \frac{\sum_i |\vec{p}_{t,i} \cdot \vec{n}_t|}{\sum_i |\vec{p}_{t,i}|}$$

$\tau \equiv 1 - T$ → Related with the sphericity of the event.

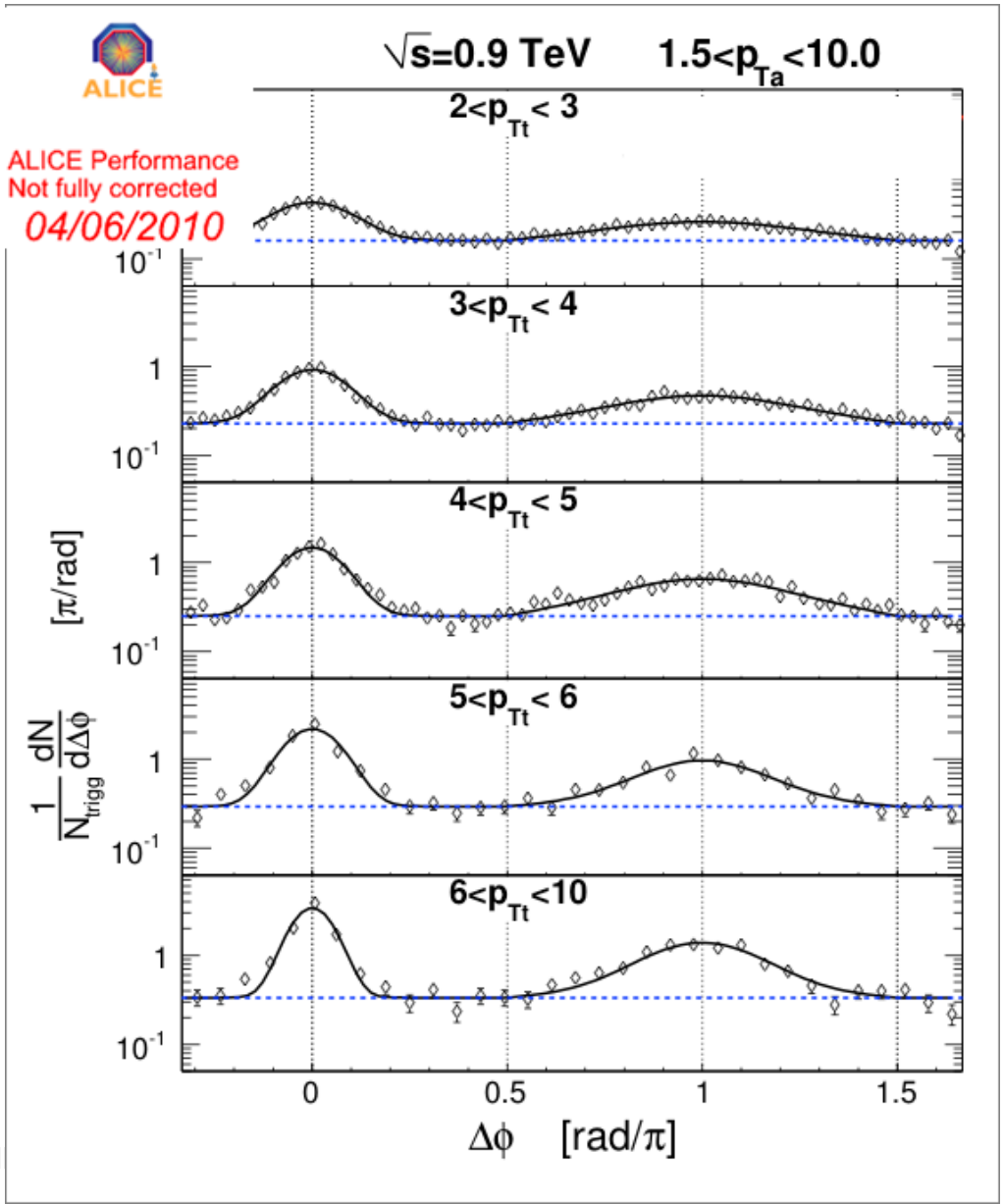






analysis ongoing

Azimuthal correlations



Conclusions

- **2010 running very successful**
  - **detector, online, and offline systems ready**
  - **about 300 million MB events collected at 7 TeV**
- **Phased installation of remaining detectors prepared**
- **Alignment and calibration progressing well**
  - **Material budget checked with photon conversions**
  - **performance of track and vertex reconstruction, particle identification close to design values**
  - **remaining: PHOS and EMCal energy calibration**
- **TPC trips to be investigated**
- **ZDC shadowing by collimator to be solved**
- **Physics analysis well underway**


Just started on pp, more to come
Eager for PbPb