

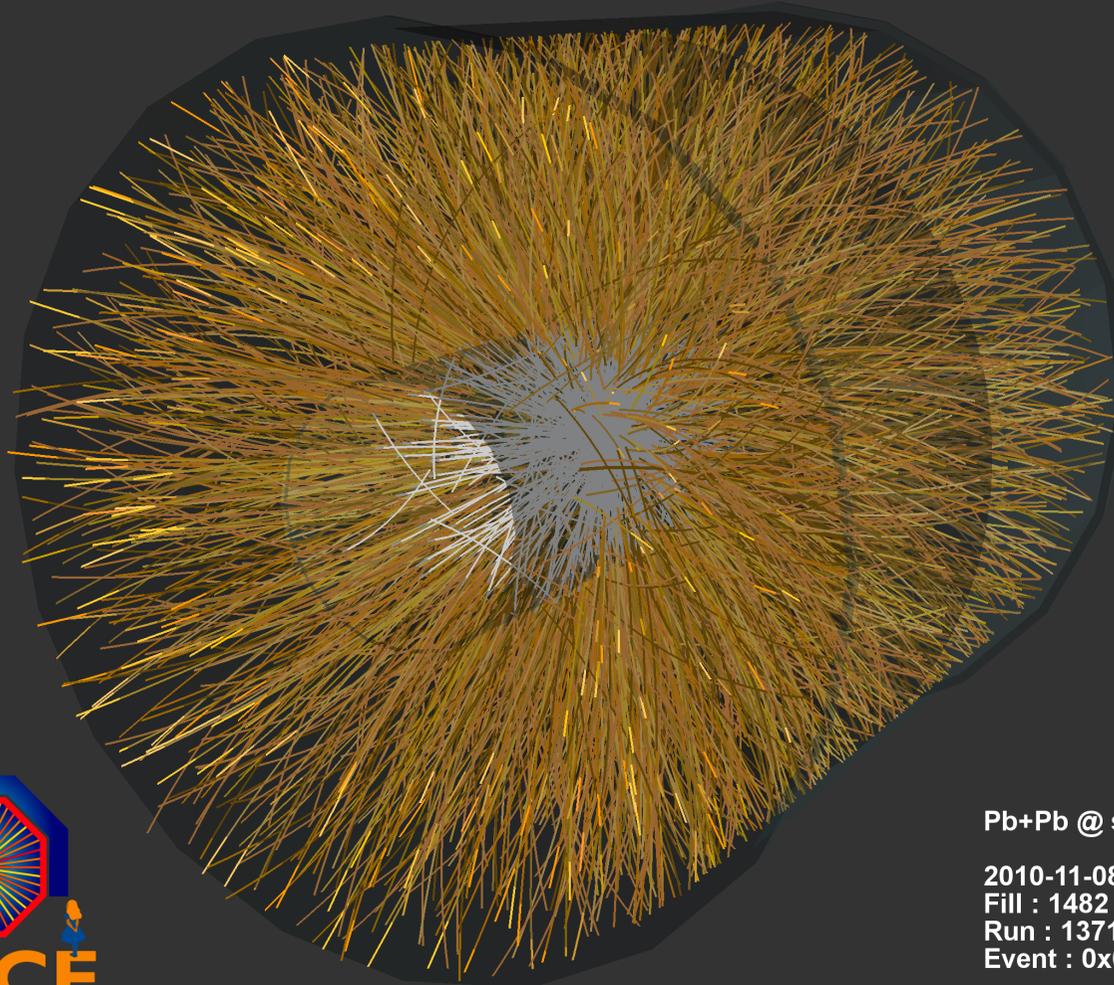


ALICE Status Report

104th meeting of the LHCC, 17.11.2010

Andrea Dainese
(INFN Padova, Italy)
on behalf of the ALICE Collaboration

→ largest energy jump ($\times 14$) in the history of heavy-ion physics!

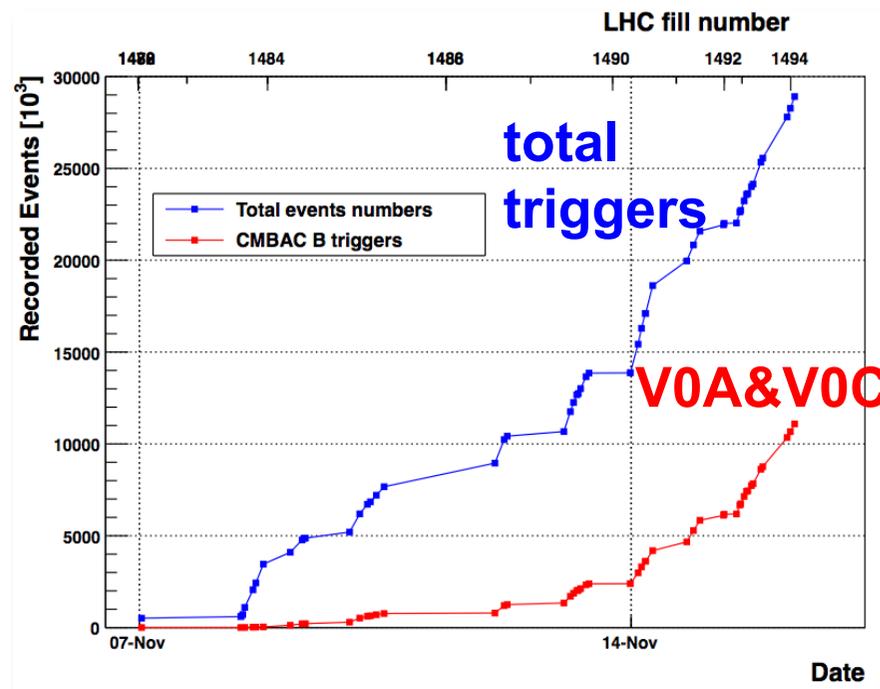


Congratulations to the LHC accelerator team for such an impressive start-up!

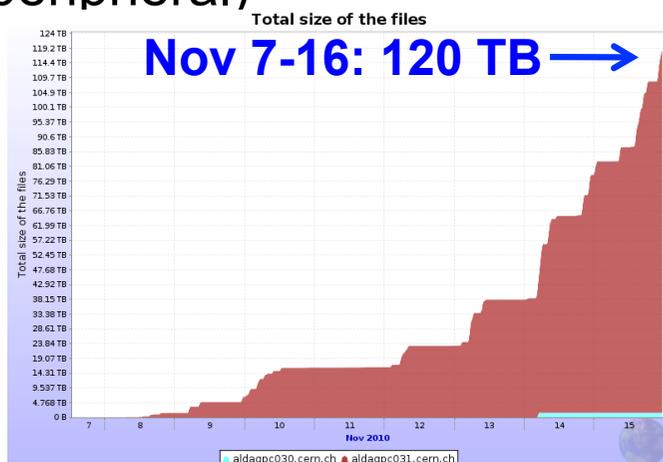


Heavy-ion trigger and data taking

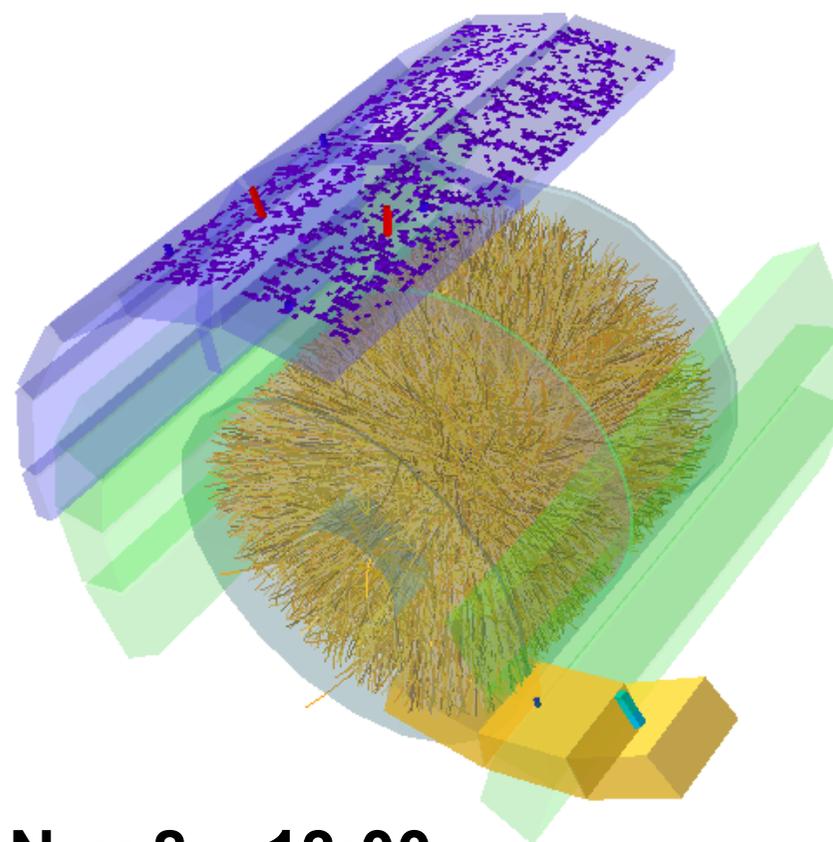
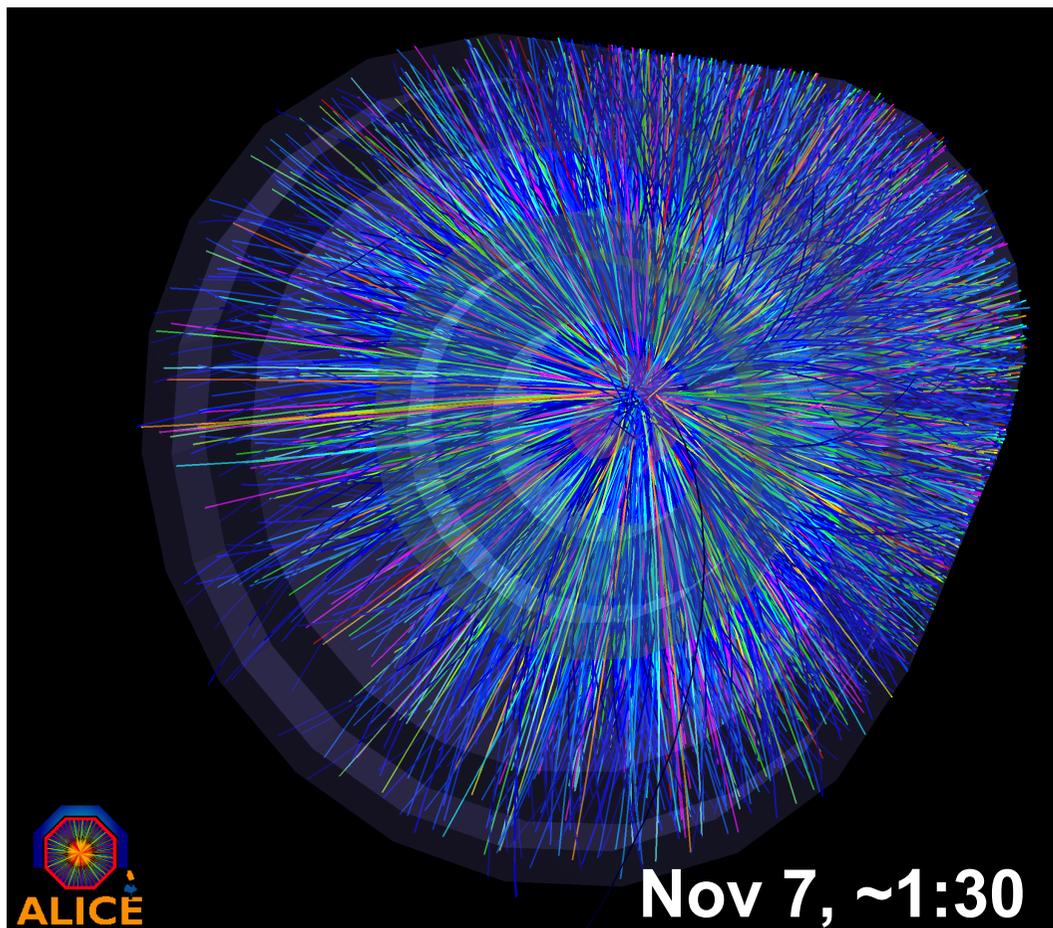
- ◆ Start with very open m.b. trigger
 - to get most of the inelastic cross section
- ◆ Main trigger: 2 out of 3 among:
 - ≥ 2 hits in outer pixel (SPD) layer
 - V0A scintillators
 - V0C scintillators
- ◆ Catches $\sim 98\%$ of hadronic cross section
- ◆ Commissioning trigger on ≥ 3 TOF “maxi-pads” at $R=3.7$ m (for ultra-peripheral)



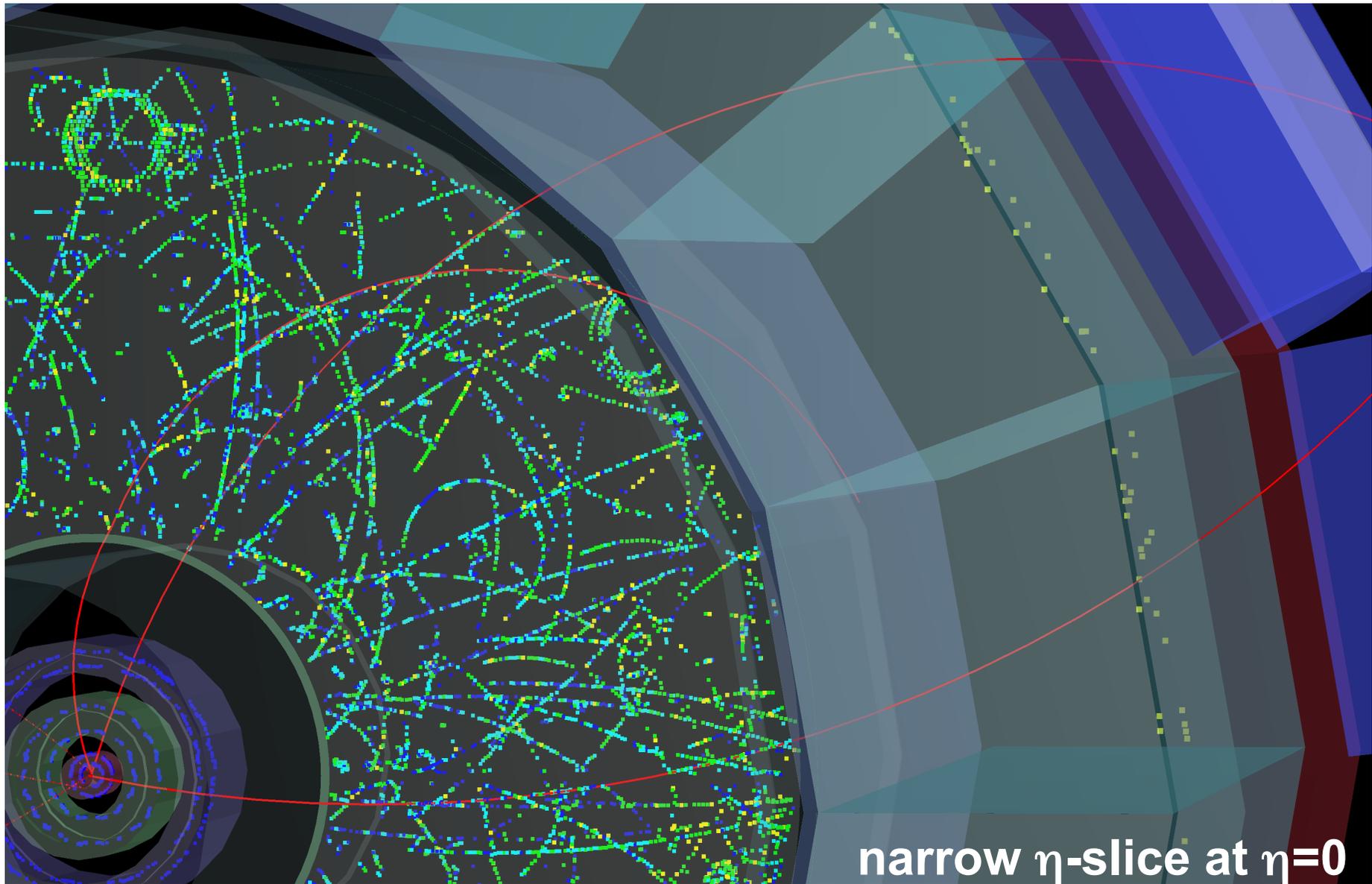
- ◆ Since Nov 7:
 - 55 hours of runs with 18 subdets
 - 88% efficiency
 - ~ 8 M Pb-Pb inelastic events on tape
 - 120 TB of data
 - DAQ throughput: max 1.9 GB/s, av: ~ 0.7 GB/s



Fireworks!

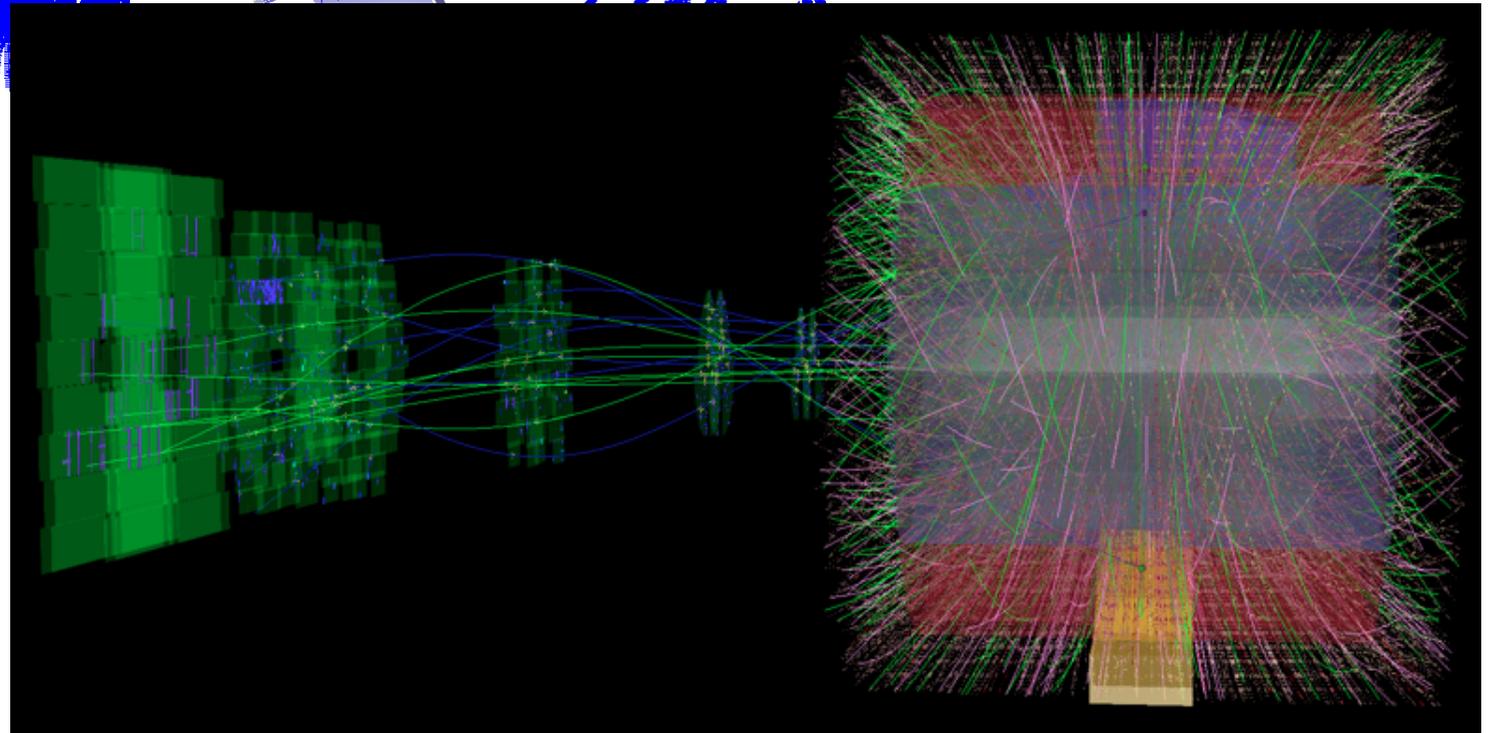
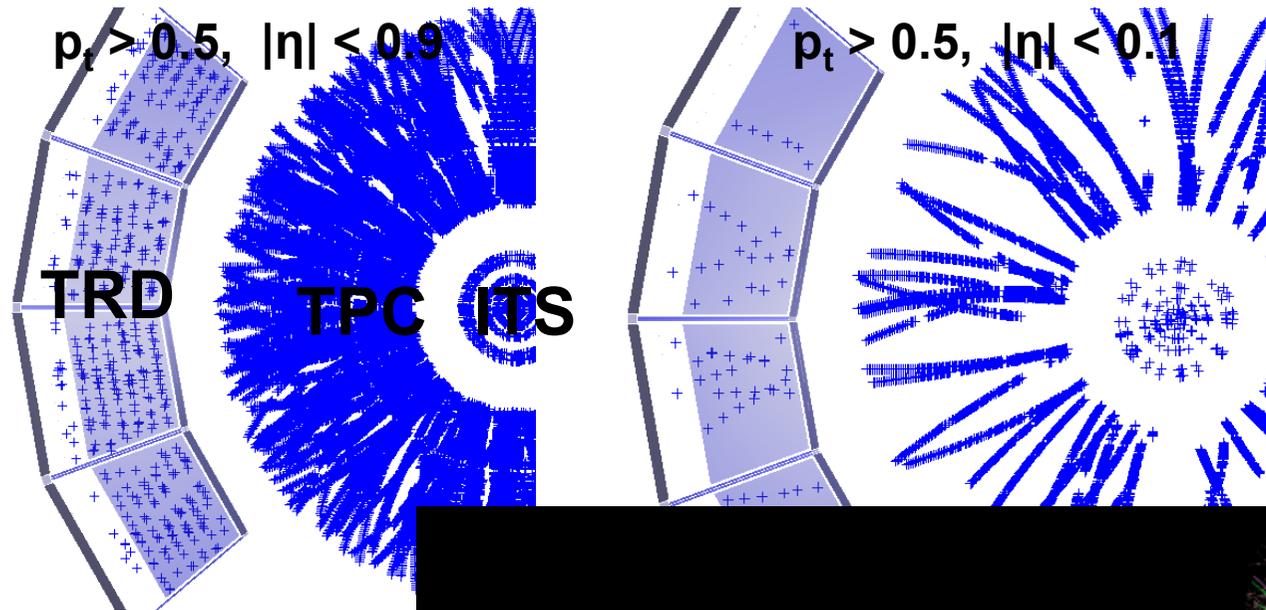


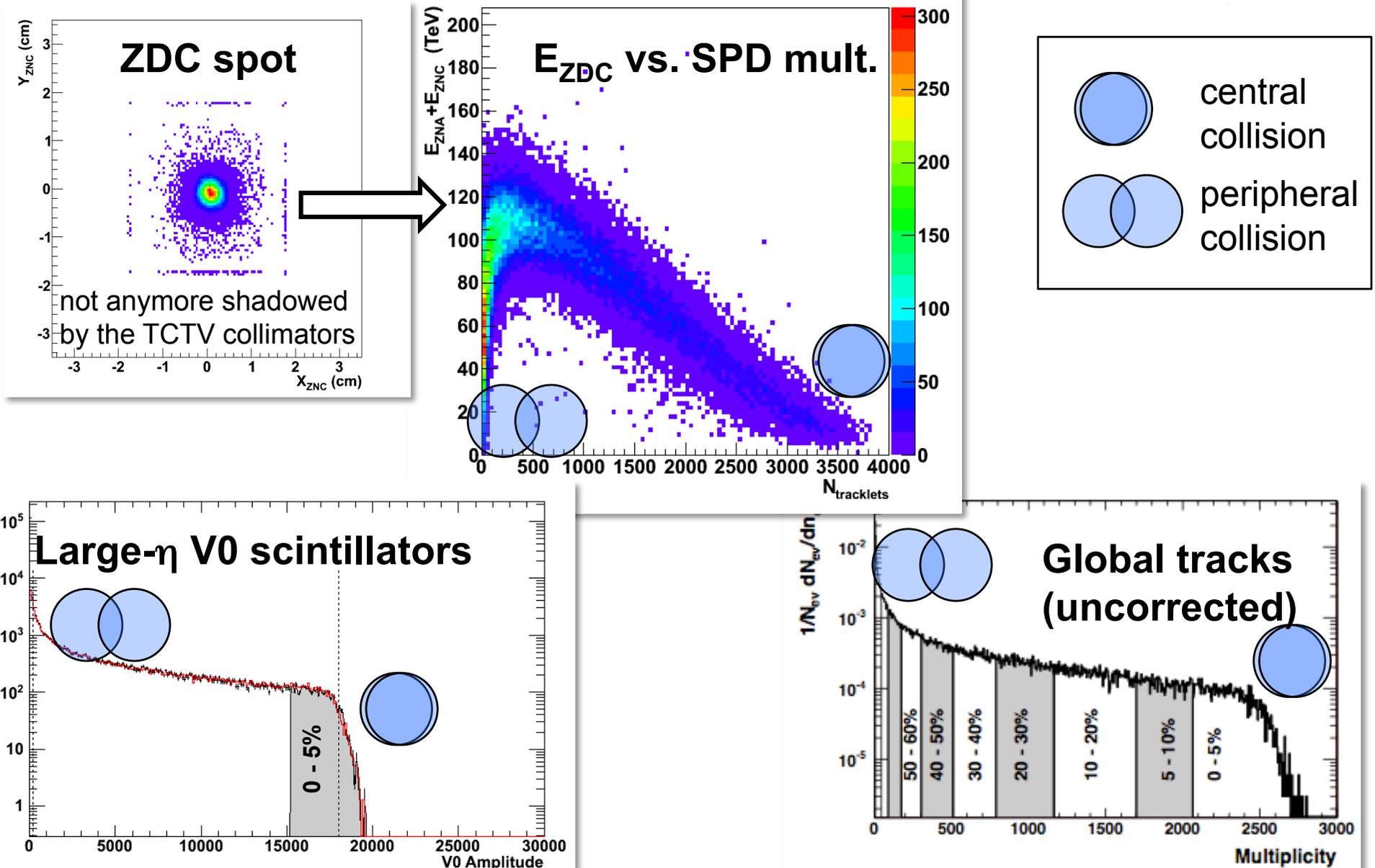
Fireworks!

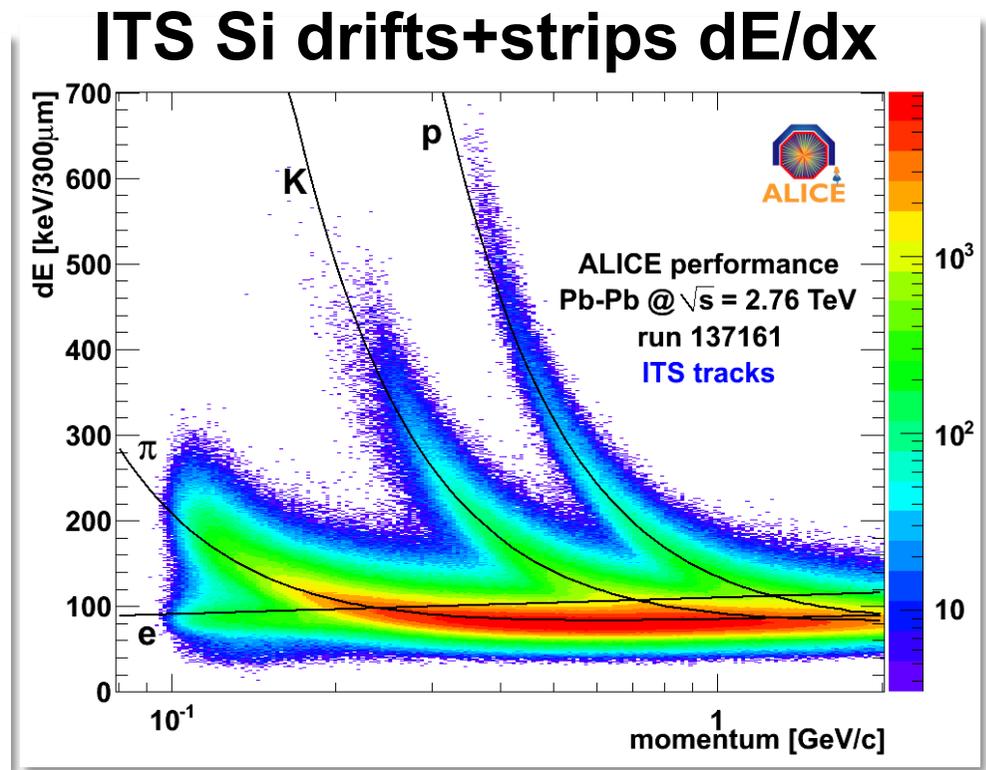
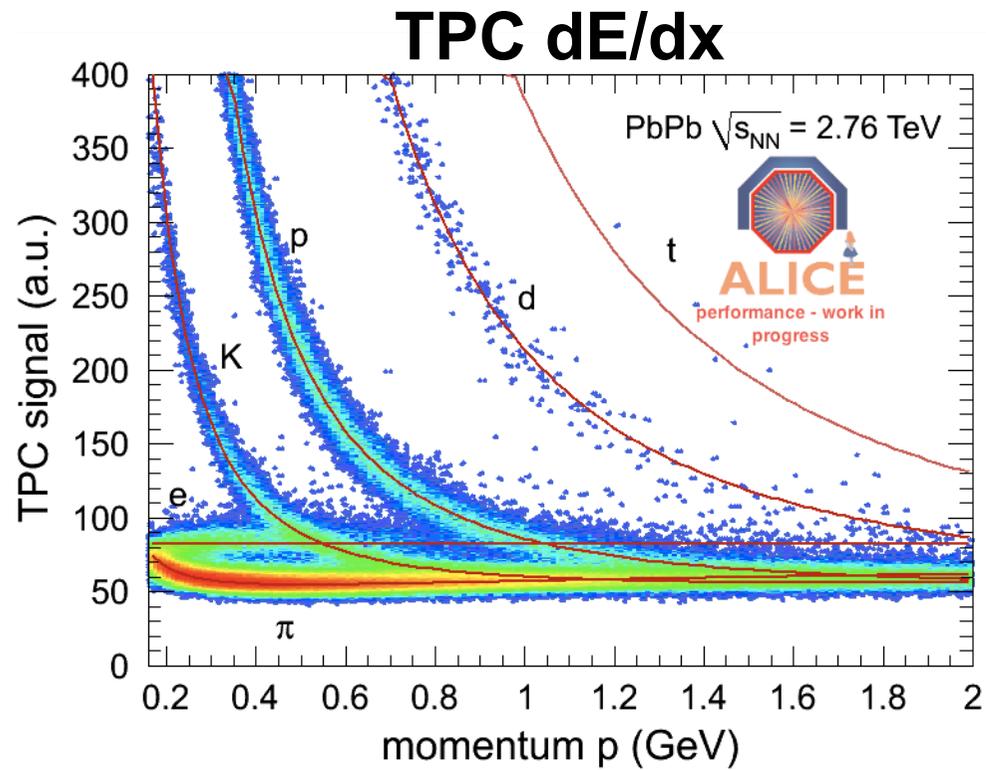


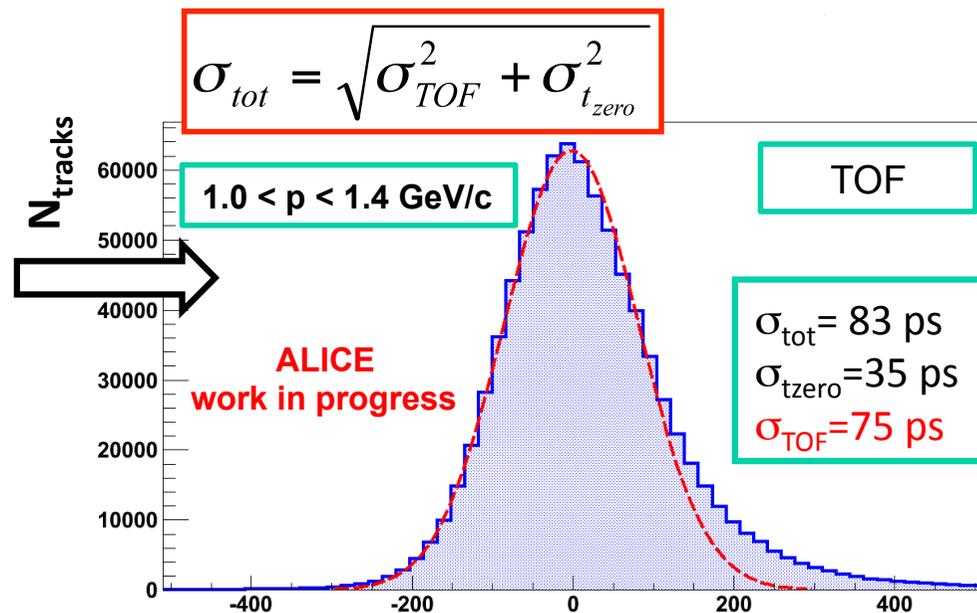
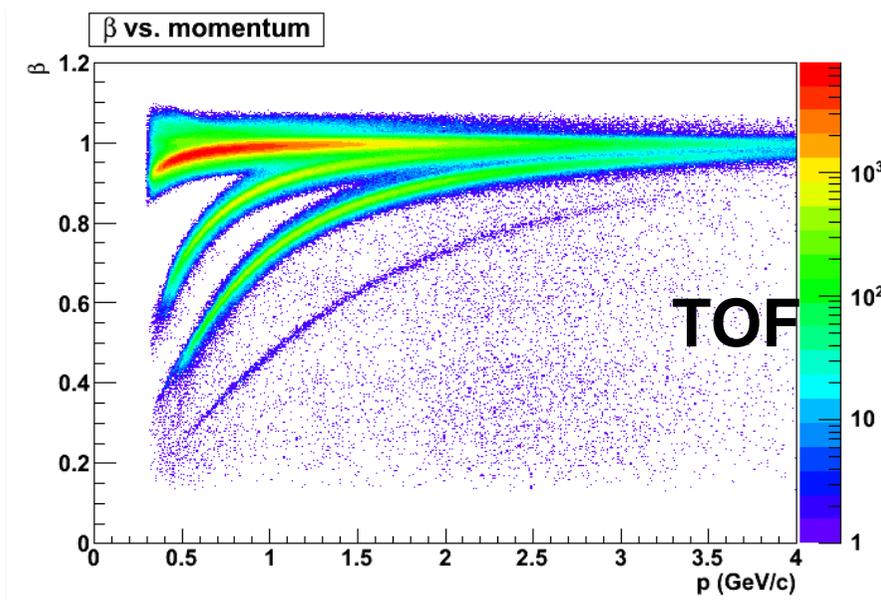
narrow η -slice at $\eta=0$

Fireworks!





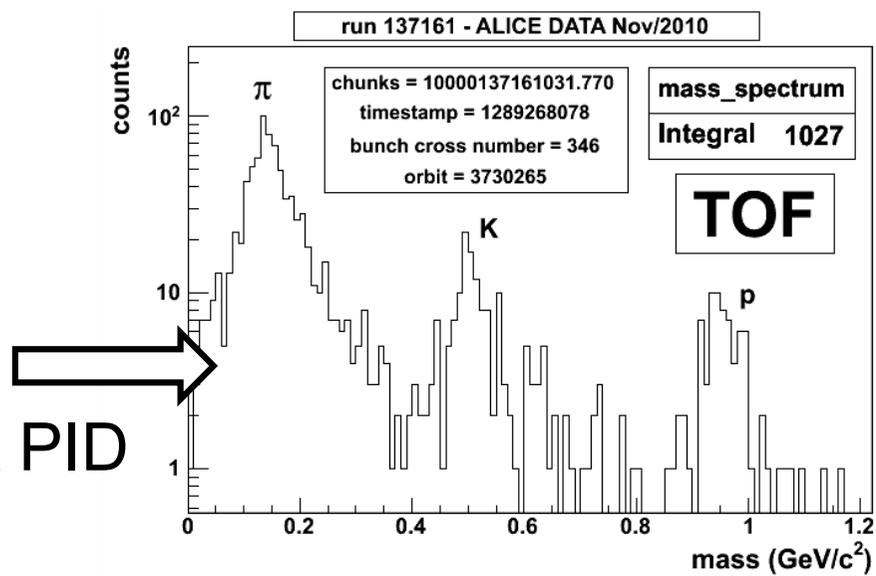




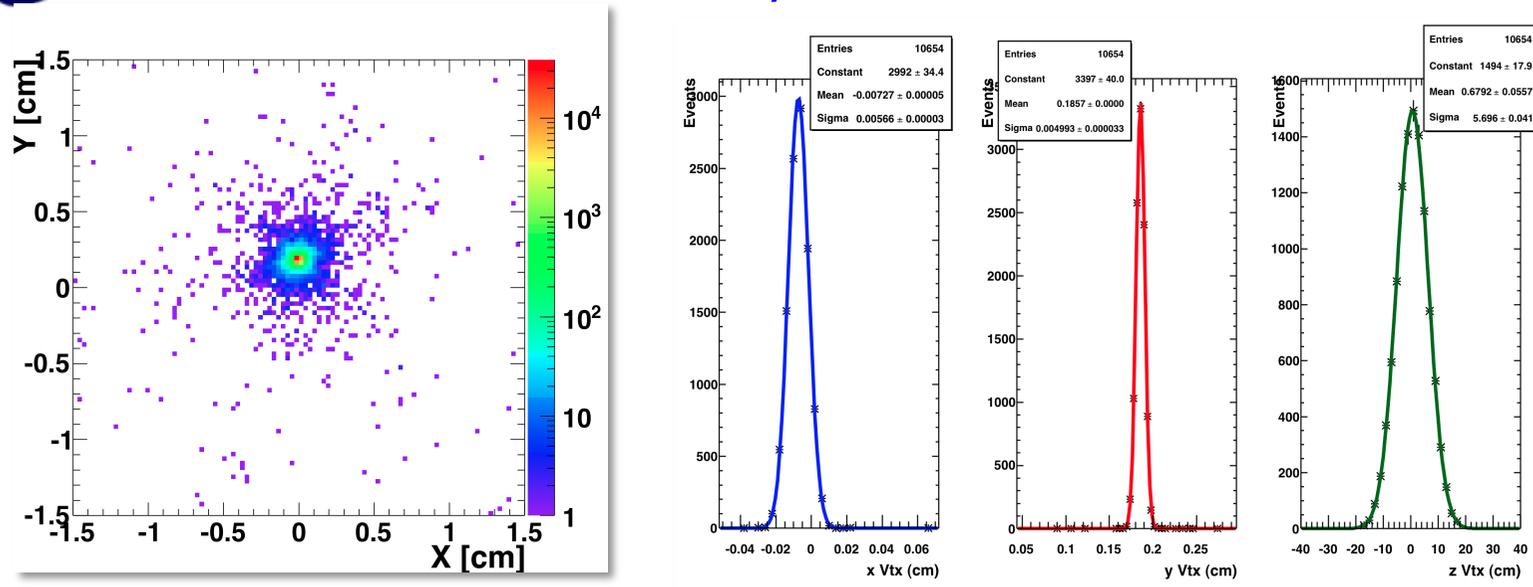
$t_{TOF} - t_{zero} - t_{exp}^{\pi}$ (ps)

<80 ps (design)
resolution seems
within reach!

A single Pb-Pb
collision!
Event-by-event PID



Primary Vertex in Pb-Pb

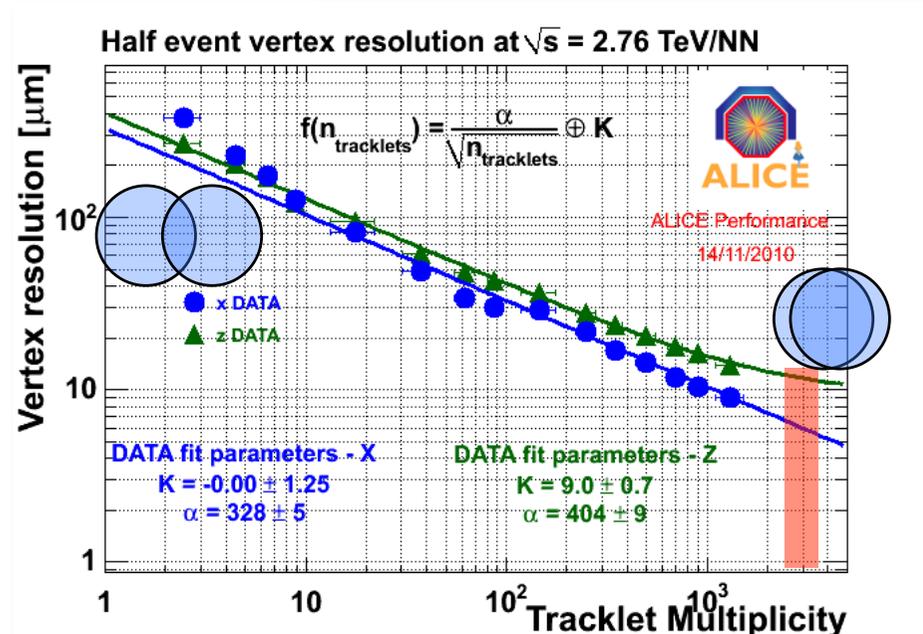


Lumi region:

$$\sigma_x \approx 55 \mu\text{m}$$

$$\sigma_y \approx 48 \mu\text{m}$$

$$\sigma_z \approx 5.7 \text{ cm}$$



Vertex with tracks.

Resolution

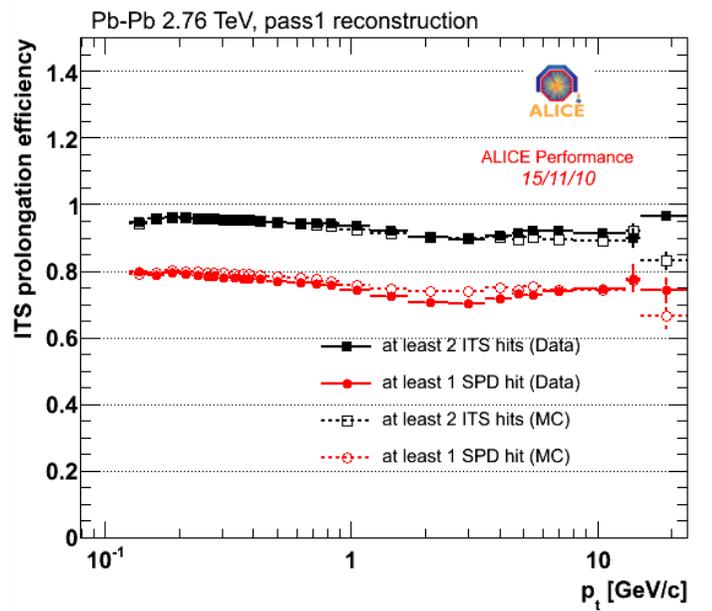
from half events:

$$x, y: \sim 6 \mu\text{m}$$

$$z: \sim 12 \mu\text{m}$$

in central events

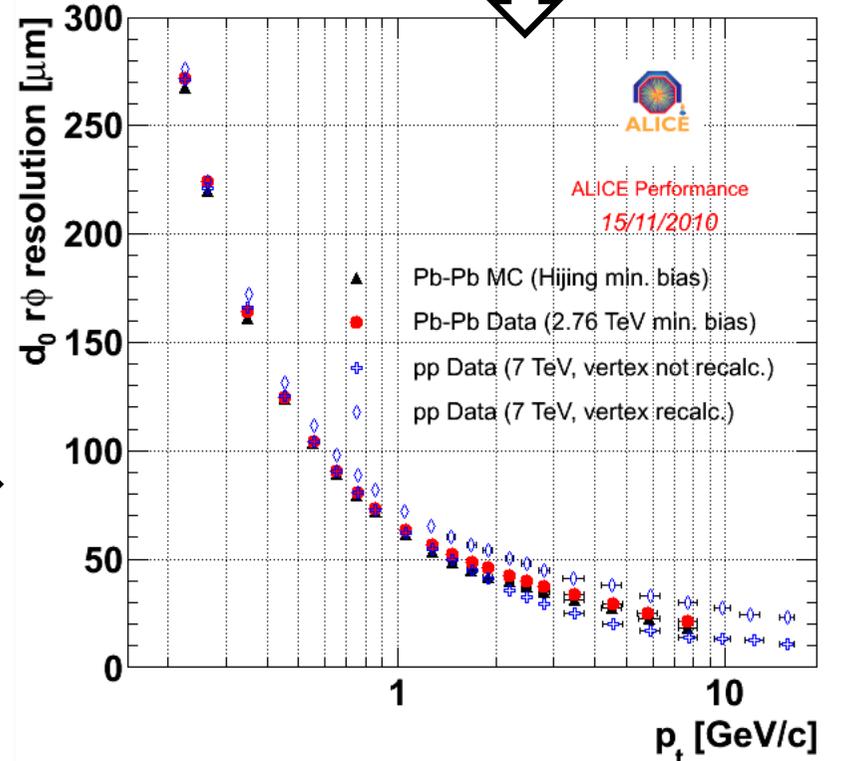
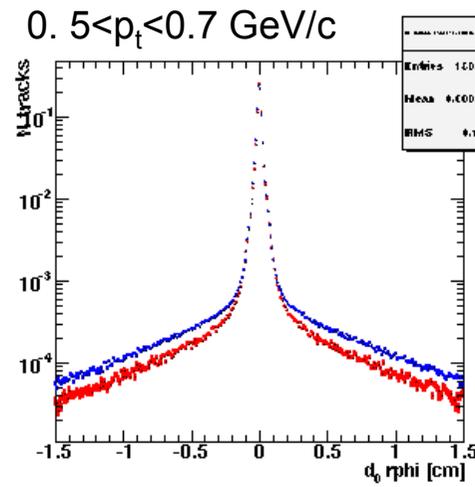
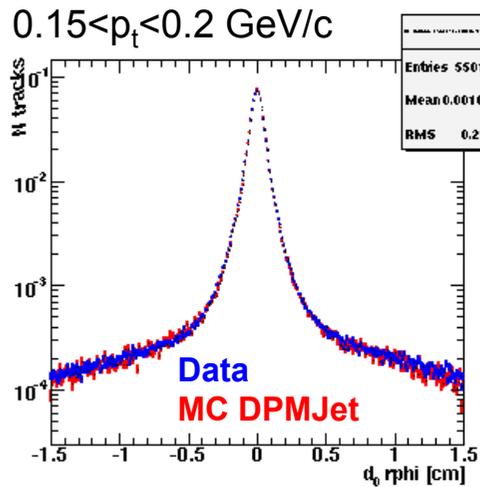
(Tracklet mult $\sim 3,500$)



Track prolongation efficiency from TPC to ITS already close to MC

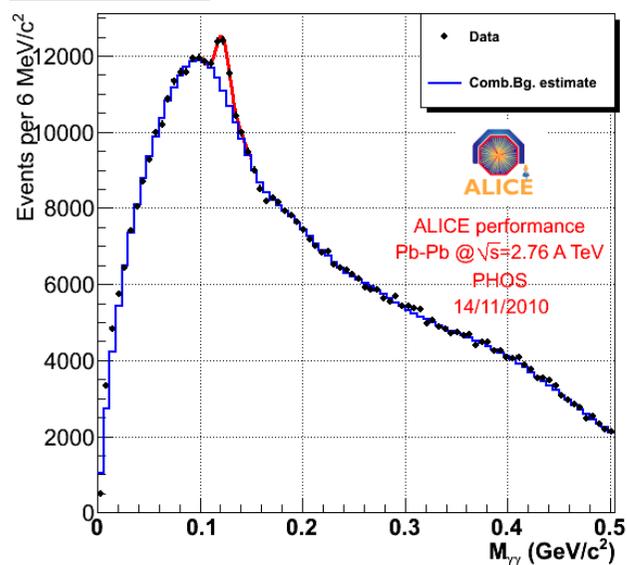
Track impact parameter resolution (TPC+ITS with 2 SPD hits) close to MC and “same” as in pp

Transverse d_0 distributions

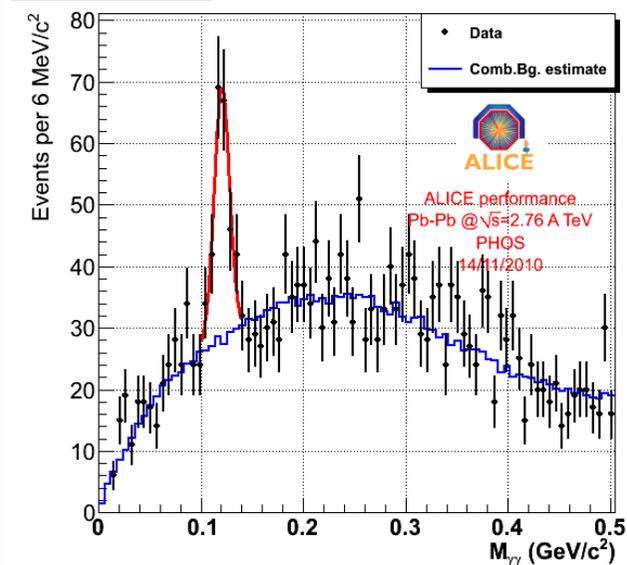


$\pi^0 \rightarrow \gamma\gamma$ in PHOS:

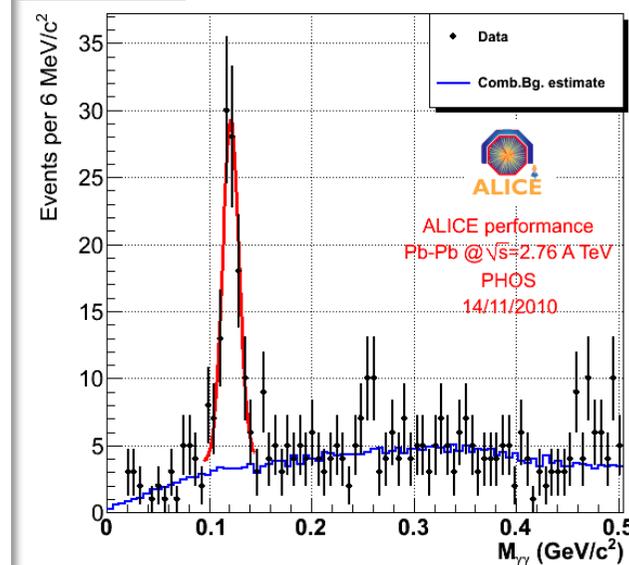
$1 < p_T < 2 \text{ GeV}/c$



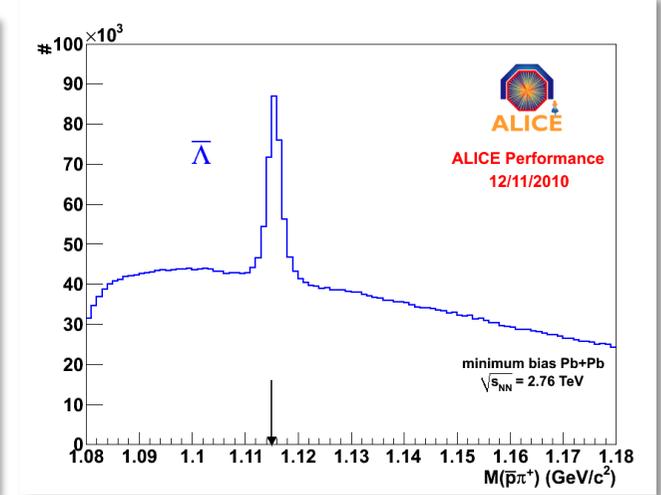
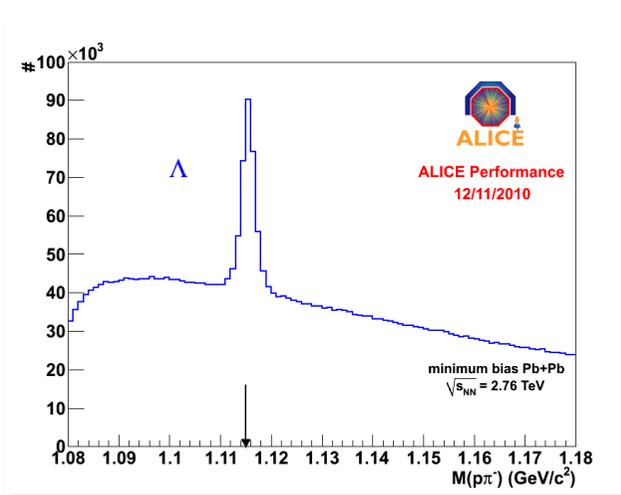
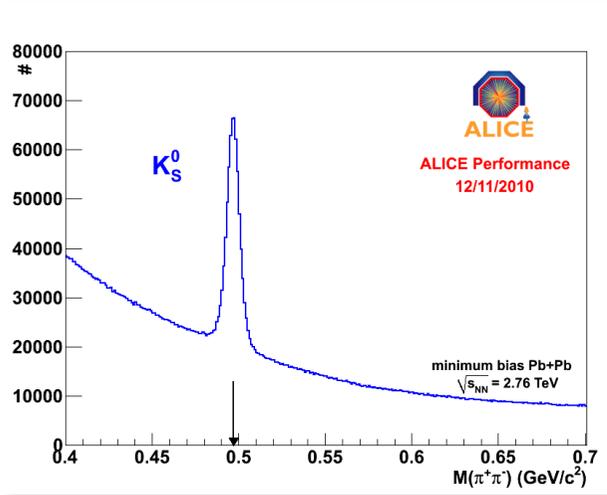
$3 < p_T < 4 \text{ GeV}/c$



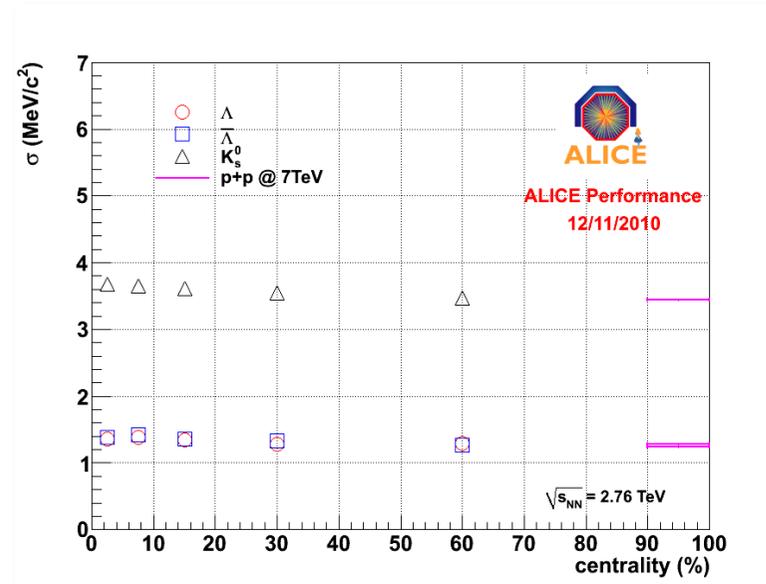
$4 < p_T \text{ GeV}/c$



K_S^0 , Λ in TPC+ITS:



Mass widths are indep. of centrality:



- ◆ Heavy Ion First Physics task force (lead by F. Antinori)
 - particle multiplicity ($dN_{ch}/d\eta$ in central collisions)
 - density of gluons in the QCD medium
 - elliptic flow (azimuthal anisotropy parameter v_2)
 - pressure gradients in the medium expansion
 - Bose-Einstein correlations
 - femtoscopic study of the medium size
 - p_t distribution compared to pp
 - energy loss induced high- p_t suppression
 - high- p_t azimuthal correlations
 - fate of the away-side jet

- ◆ All other analyses started within the Physics Working Groups

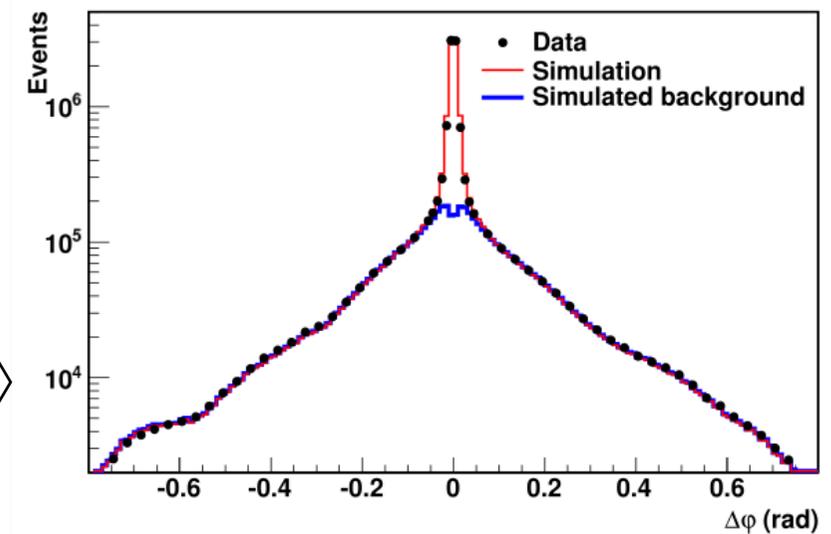
- ◆ Heavy Ion First Physics task force (lead by F. Antinori)
 - **particle multiplicity ($dN_{ch}/d\eta$ in central collisions) **READY****
 - density of gluons in the QCD medium
 - **elliptic flow (azimuthal anisotropy parameter v_2) (submitted today) **LAST NIGHT****
 - pressure gradients in the medium expansion
 - Bose-Einstein correlations
 - femtoscopic study of the medium size
 - p_t distribution compared to pp
 - energy loss induced high- p_t suppression
 - high- p_t azimuthal correlations
 - fate of the away-side jet

- ◆ All other analyses started within the Physics Working Groups

Measurement of $dN_{ch}/d\eta$ in central Pb-Pb at 2.76 TeV

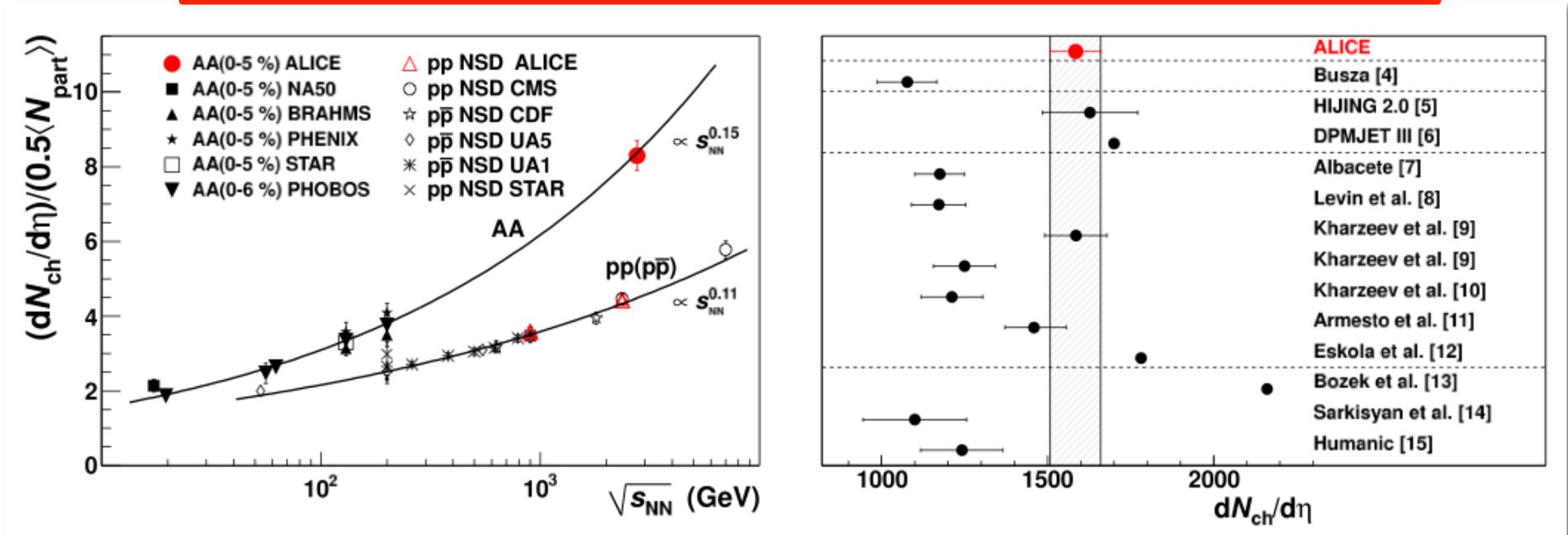
- ◆ First glimpse of the features of the high-density QCD state produced in these collisions
 - Related to the energy density and gluon density in the system
 - Strong test/constraint for theoretical models
- ◆ Data sample: ~50 000 Pb-Pb m.b. collisions collected on Nov 9
- ◆ Select the 5% most central using V0 amplitude (0-5% centrality class)
- ◆ Measurement based on pixel tracklets (as for our pp publications)
 - correlate hits on the two layers within a narrow $\Delta\phi \times \Delta\theta$ window from the primary vertex
 - cross-checked with global and with TPC-only tracks

Tracklets combinatorial background (14%)
Well described by MC (only 1%
scaling factor to match tails)



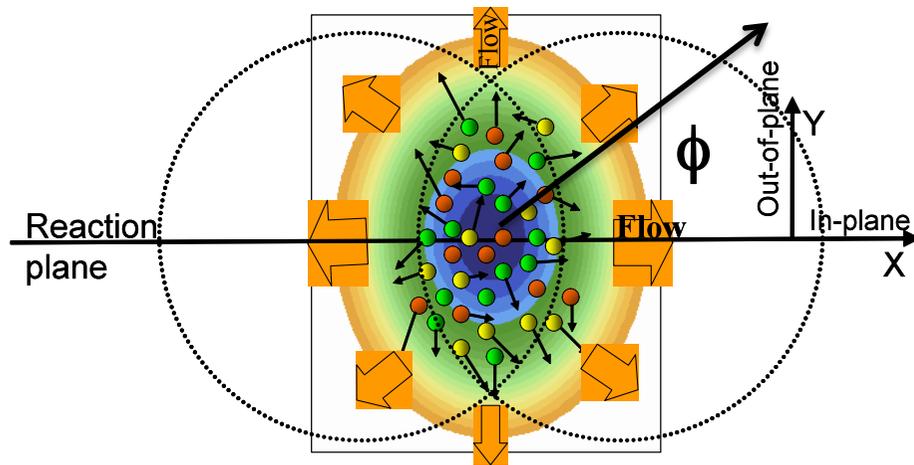
Measurement of $dN_{ch}/d\eta$ in central Pb-Pb at 2.76 TeV

$$dN_{ch}/d\eta = 1584 \pm 4 \text{ (stat.)} \pm 76 \text{ (syst.)}$$



- ◆ Increase by factor 1.9 wrt pp at same energy
- ◆ Increase by factor 2.2 wrt RHIC Au-Au 200 GeV
- ◆ Extrapolation based on RHIC data and limiting fragm. underpredicts
- ◆ pQCD-inspired MCs (Hijing, DPMJet) consistent with data
- ◆ Some of the models based on initial state saturation underpredict

Measurement of elliptic flow (v_2) of charged particles in Pb-Pb at 2.76 TeV

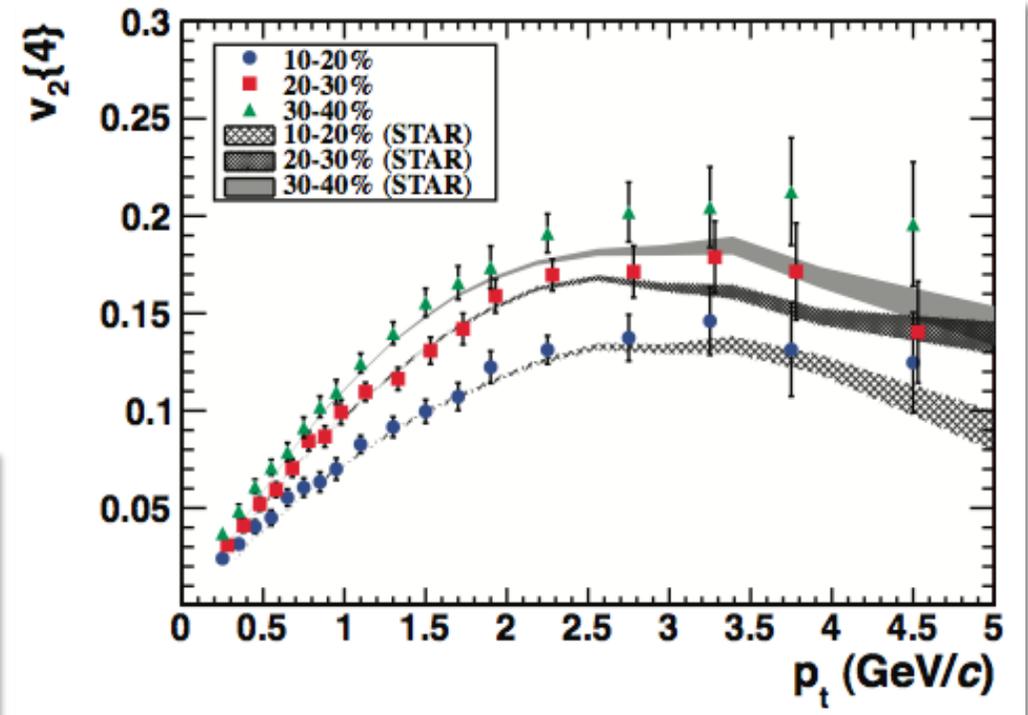
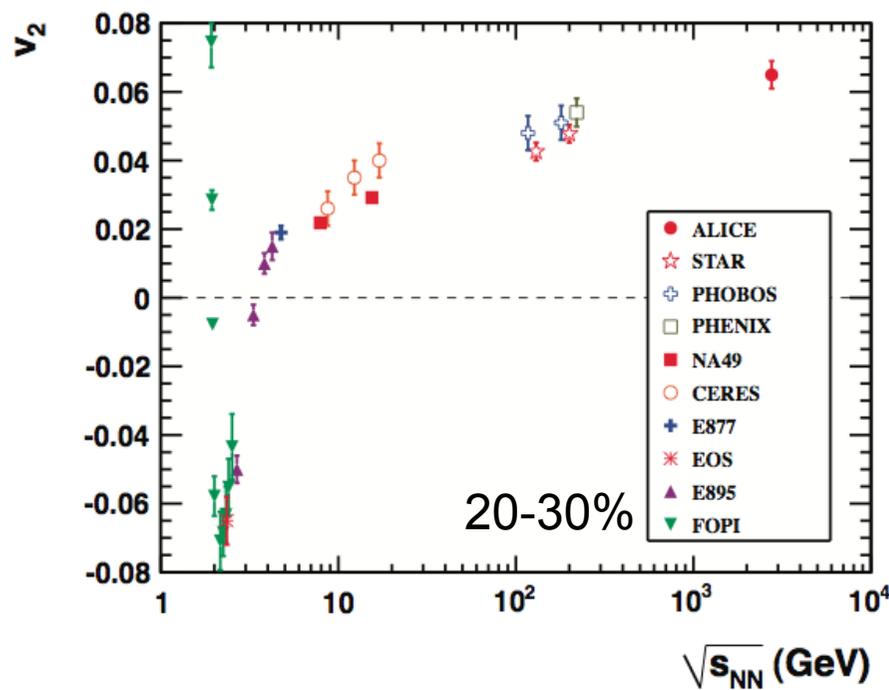


- ◆ Medium geometry asymmetric in non-central collisions
- ◆ Hydro-dynamic models:
 - expansion under azimuth-dep. pressure gradient
 - results in azimuth-dep. momentum distributions
- ◆ Measured by the elliptic flow parameter $v_2(p_t) = \langle \cos(2\phi) \rangle(p_t)$
- ◆ Data sample: ~50 000 m.b. events collected on Nov 9
- ◆ 9 centrality classes in 0-80%
- ◆ v_2 extracted based on 2 and 4 particle cumulants
 - methods well established based on RHIC experience
- ◆ Using TPC-only tracks (cross-check with global tracks)

Measurement of elliptic flow (v_2) of charged particles in Pb-Pb at 2.76 TeV

p_t dependence very close to RHIC measurements (in centrality classes)

→ expected based on hydrodynamic models



p_t -integrated v_2 in semi-central increases by 30% wrt RHIC
 → predicted by hydrodynamic models with viscous corrections



Back from Wonderland ...

Outline of the talk



- ◆ ALICE Collaboration News
- ◆ Detector Status and Plans for Christmas break
- ◆ Data Taking and Computing
- ◆ New pp Results



Outline



- ◆ **ALICE Collaboration News**
- ◆ Detector Status and Plans for Christmas break
- ◆ Data Taking and Computing
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ALICE Collaboration News



- ◆ New Spokesperson (as of January 1st, 2011)
 - **Paolo Giubellino** to take over from **Jürgen Schukraft**
- ◆ New Chair of the Collaboration Board (as of January 1st, 2011)
 - **Peter Braun-Munzinger** to take over from **Lodovico Riccati**
- ◆ Run Coordinator 2011:
 - **Paolo Martinengo** to take over from **Chilo Garabatos**
- ◆ 4 new Institutes in the Collaboration:
 - Bose Institute (Kolkata) and Gauhati University (Assam), India (full membership)
 - Korea Institute of Science and Technology Information (KISTI), Republic of Korea (Associate membership)
 - University of Tübingen



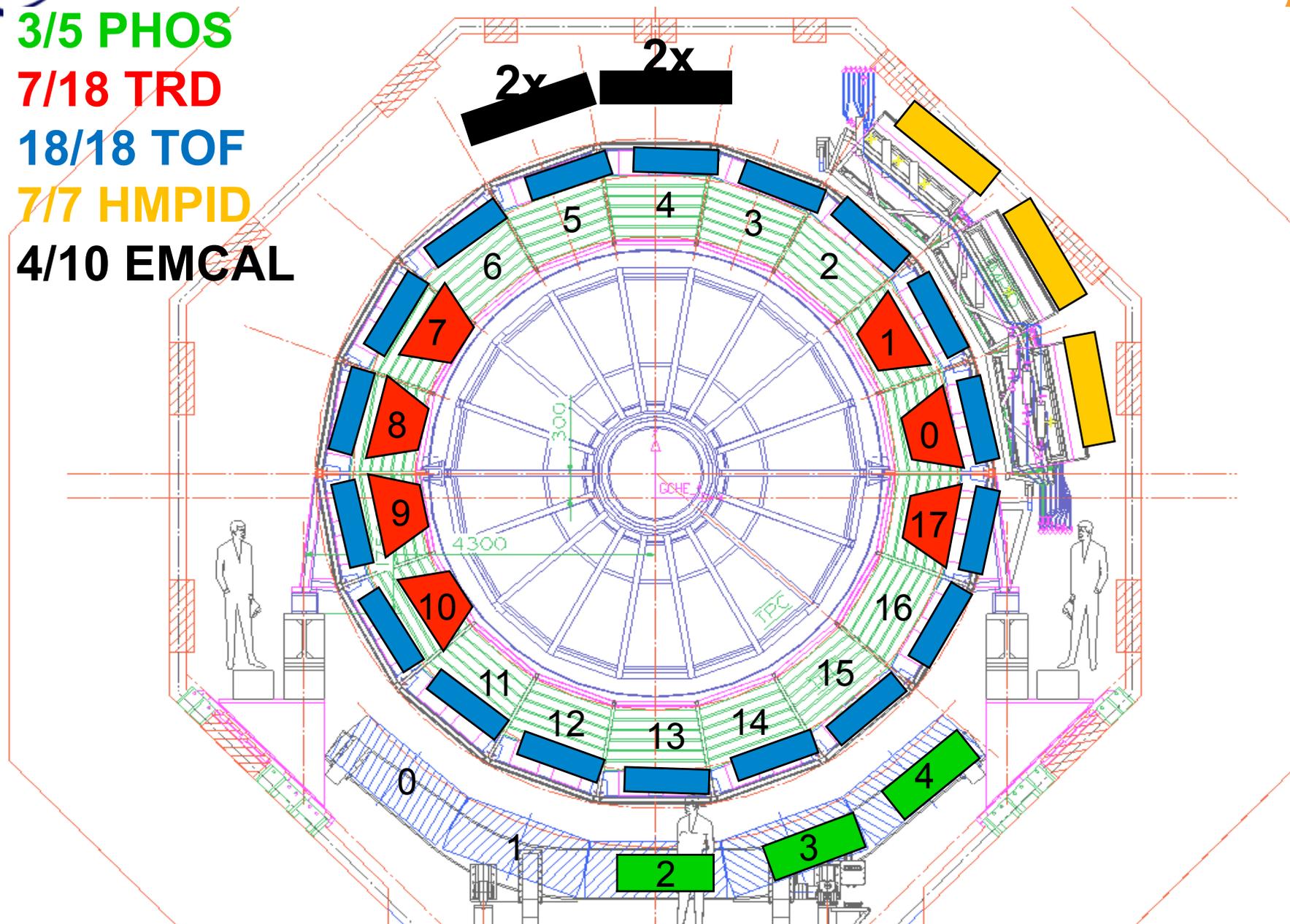
Outline



- ◆ ALICE Collaboration News
- ◆ **Detector Status and Plans for Christmas break**
- ◆ Data Taking and Computing
- ◆ New pp Results

ALICE Detector Status 2010

3/5 PHOS
7/18 TRD
18/18 TOF
7/7 HMPID
4/10 EMCAL



3/5 PHOS

10/18 TRD

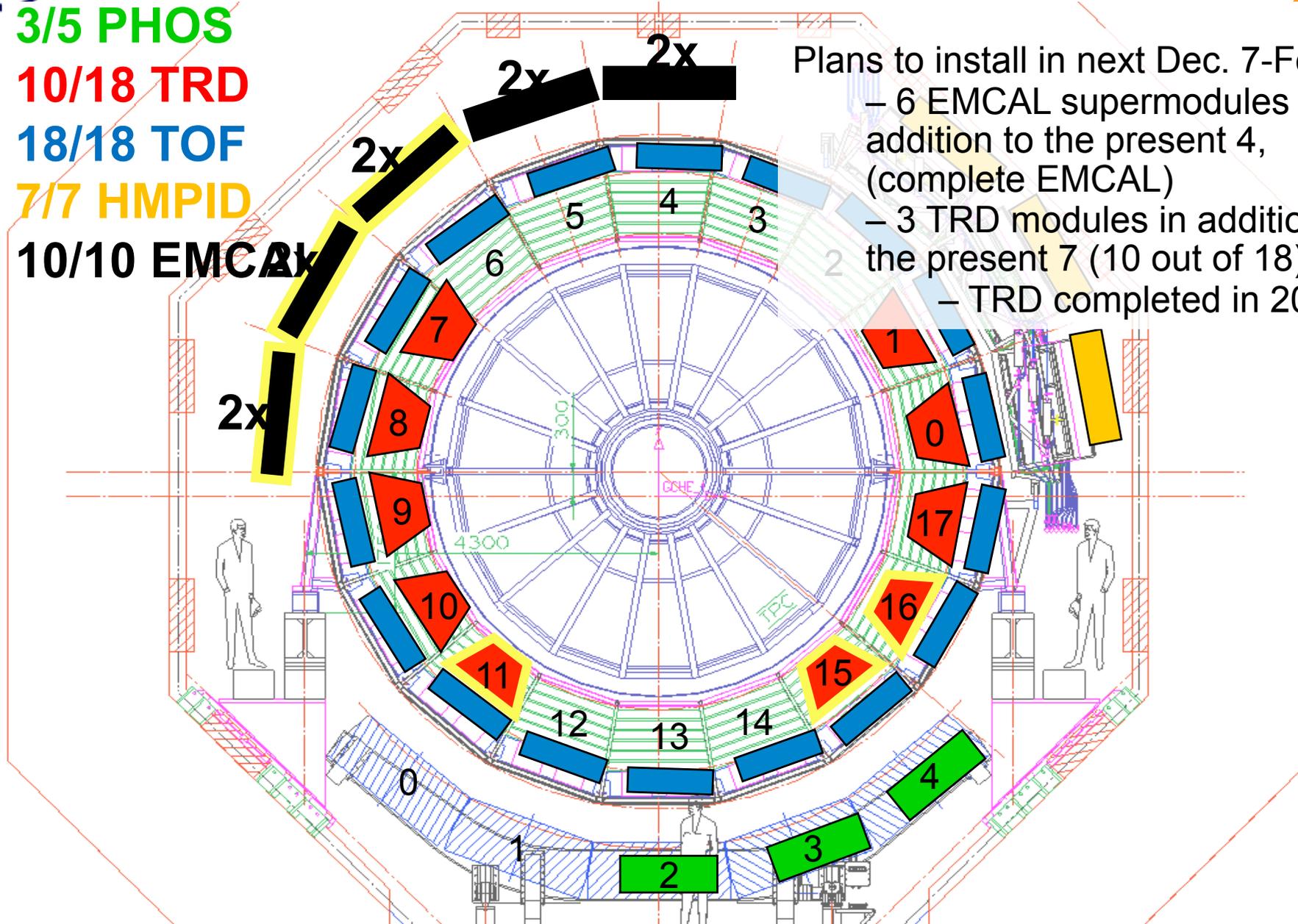
18/18 TOF

7/7 HMPID

10/10 EMCAL

Plans to install in next Dec. 7-Feb 4

- 6 EMCAL supermodules in addition to the present 4, (complete EMCAL)
- 3 TRD modules in addition to the present 7 (10 out of 18)
- TRD completed in 2012



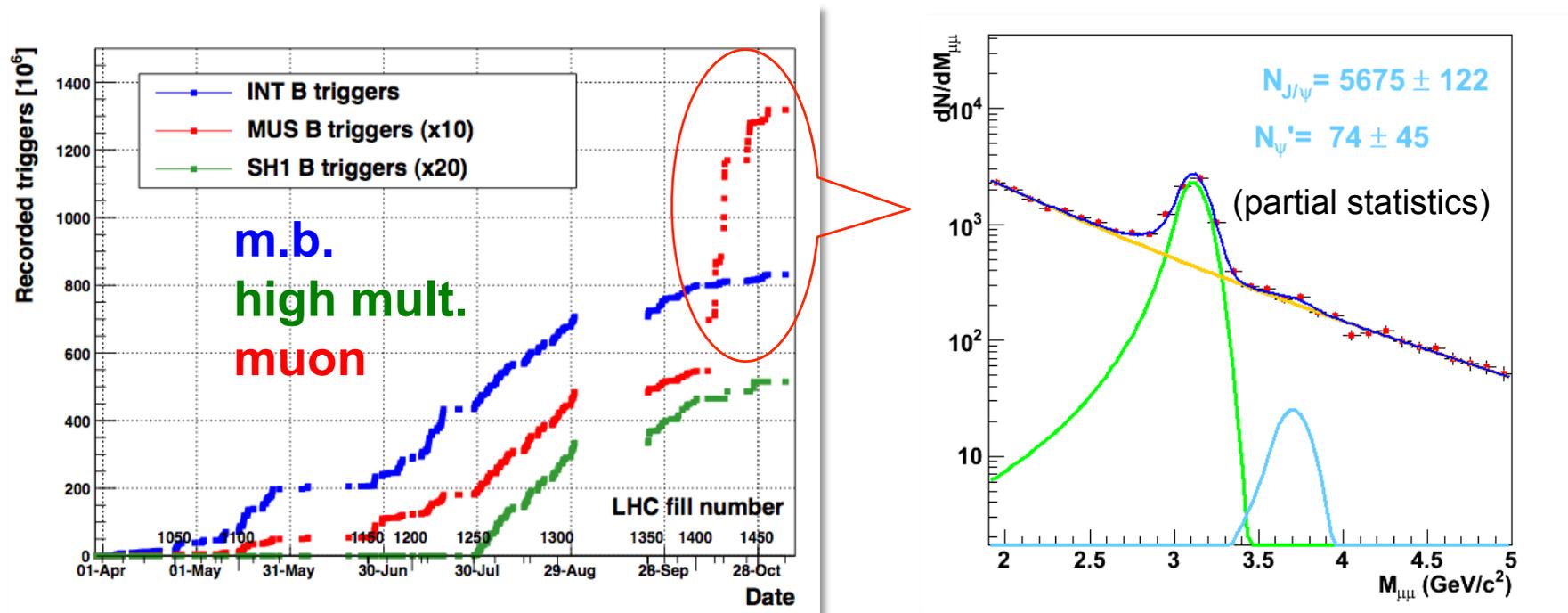


Outline

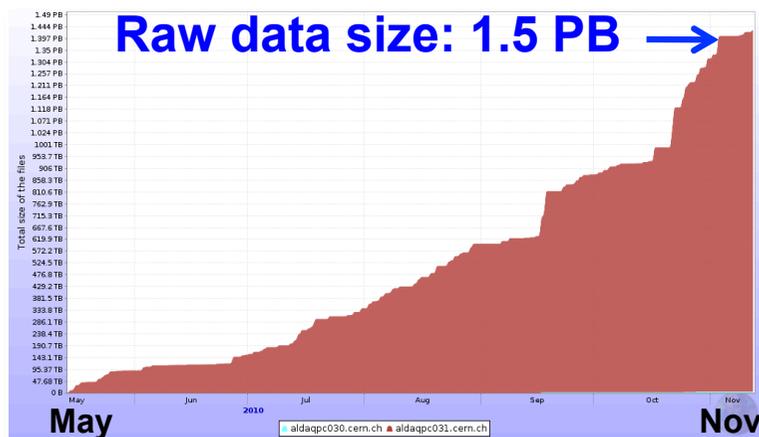


- ◆ ALICE Collaboration News
- ◆ Detector Status and Plans for Christmas break
- ◆ **Data Taking and Computing**
- ◆ New pp Results

- ◆ Reduced lumi since July
 - displaced beams (3.8σ) $\rightarrow \mu < 0.05$ (low pile-up)
- ◆ “High” lumi for muons in October (80 M triggers in a week @ 100 kHz)
- ◆ 850M min bias events + 130M muon triggers ($\sim 16,000 J/\psi$)



- ◆ The ALICE Grid: 70 Tiers
 - LBNL, LLNL, and KISTI (T1-prototype) joined recently
- ◆ Operated according to the Computing Model
 - Reconstruction, Analysis and Simulation: 6%, 13% and 81%
- ◆ Since 5 months, using all resources available for ALICE





Outline



- ◆ ALICE Collaboration News
- ◆ Detector Status and Plans for Christmas break
- ◆ Data Taking and Computing
- ◆ **New pp Results**

- ◆ Status of physics publications
- ◆ New preliminary 7 TeV results:
 - π^0 p_t -differential cross section
 - Underlying Event analysis
 - Heavy flavour production
 - Inclusive J/ψ p_t - and y -differential cross section
 - Charm mesons p_t distributions and ratios
 - Heavy flavour with single leptons
 - Cross section for single muons from c and b decay
 - Signal for single electrons from c and b decay

◆ Final Results (6 published + 3 ready to be submitted)

➤ N_{ch} **multiplicity** & distributions

- 900 GeV: EPJ C65 (2010) 111
- 900 GeV, 2.36 TeV: EPJ C68 (2010) 89
- 7 TeV: EPJ C68 (2010) 345

➤ **pbar/p** ratio (900 GeV & 7 TeV) PRL 105 (2010) 072002

➤ **momentum** distributions (900 GeV) PL B693 (2010) 53

➤ B-E **correlations** (900 GeV) PR D82 (2010) 052001

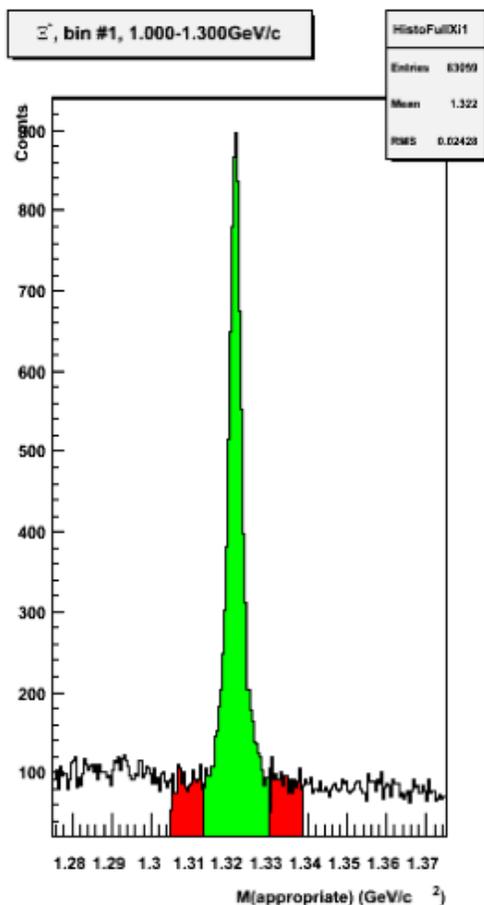
➤ **Identified charged particle** spectra (900 GeV)

➤ **Strangeness production** (900 GeV)

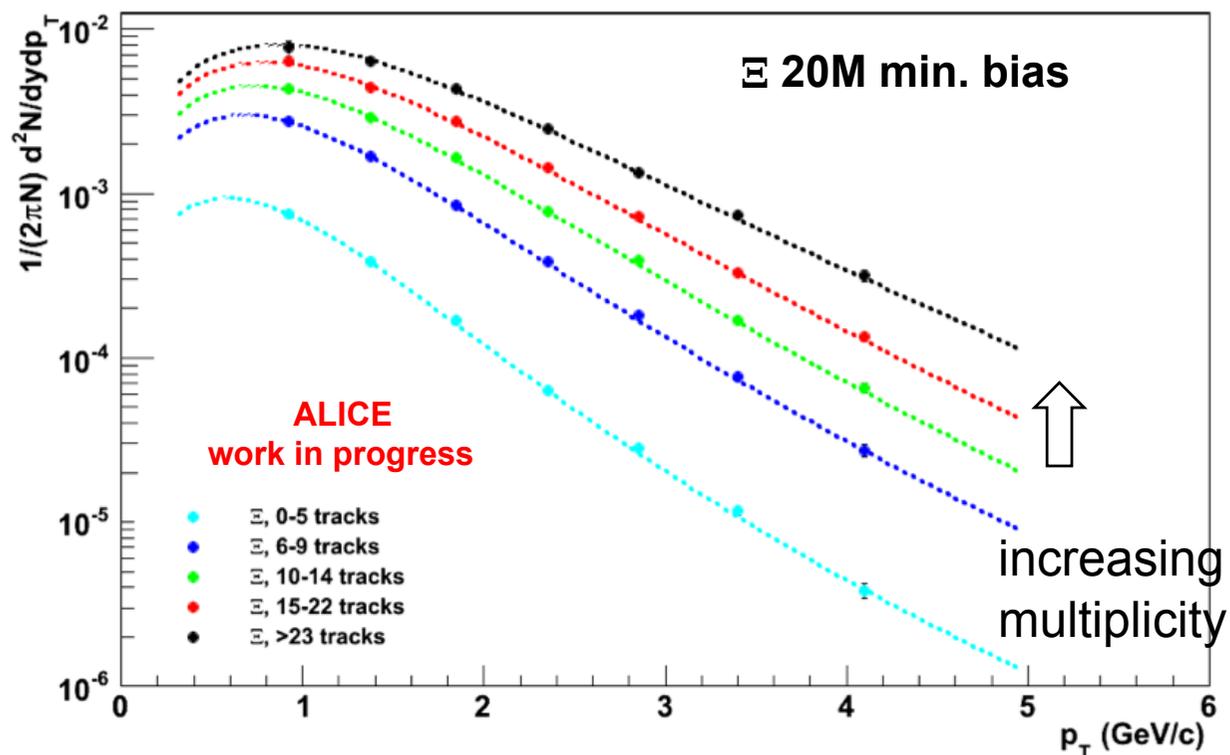
➤ B-E **correlations** (7 TeV)

} Preliminary
results shown
at Sept LHCC
meeting

- ◆ Same analyses as for 900 GeV (kaons, hyperons, ϕ), but in bins of multiplicity

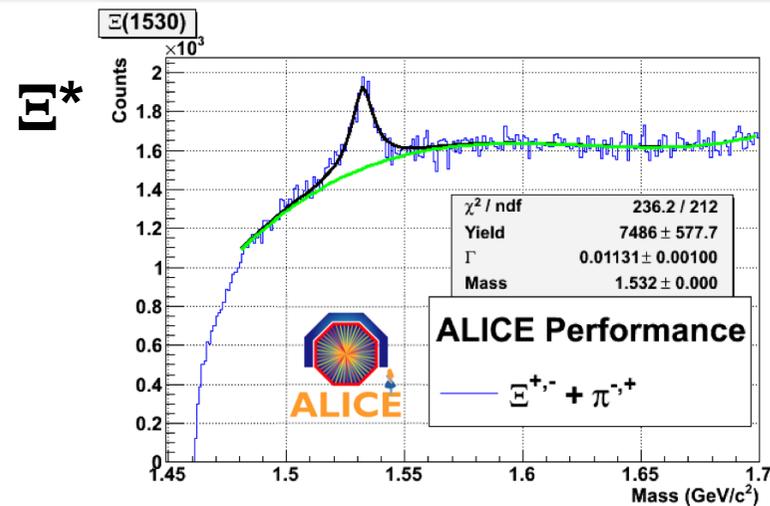
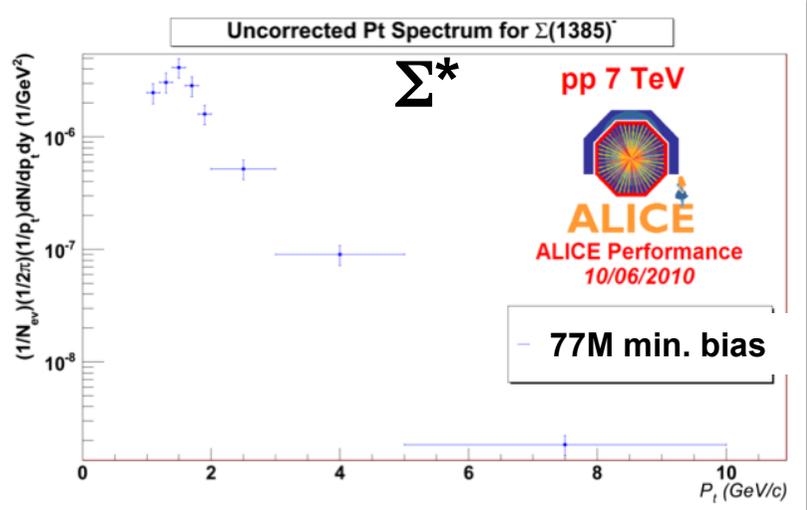
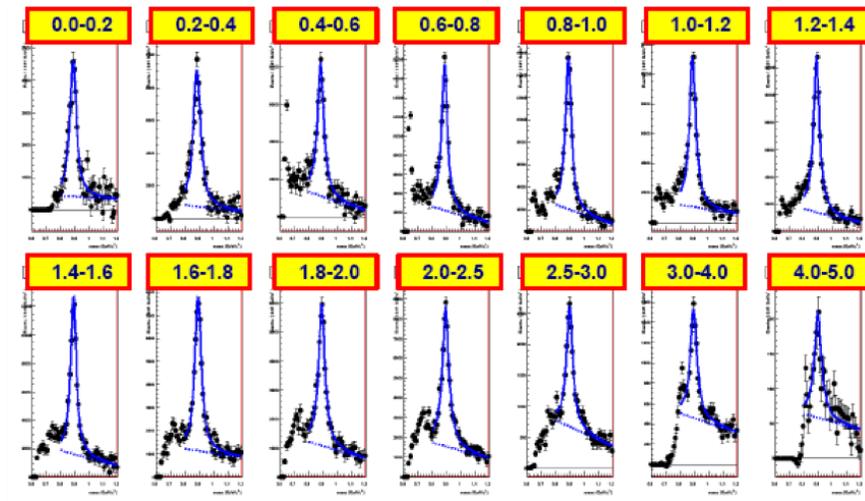
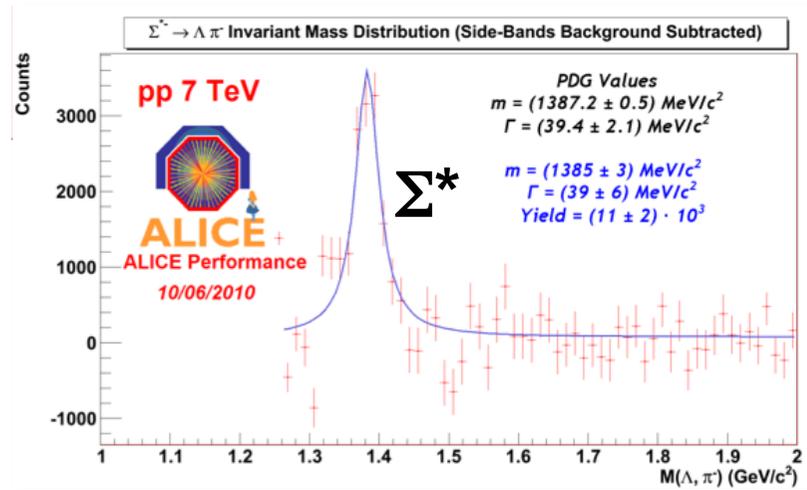


[Ξ^-] corrected spectra

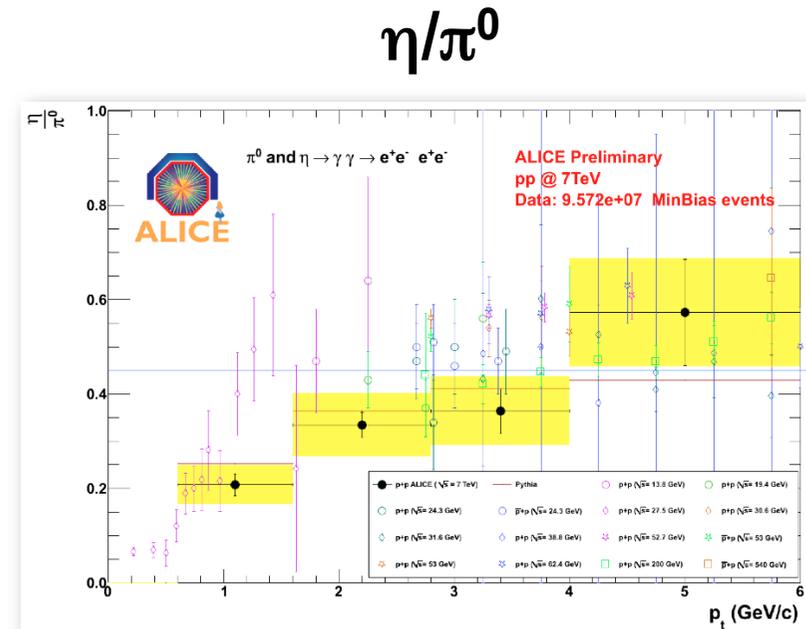
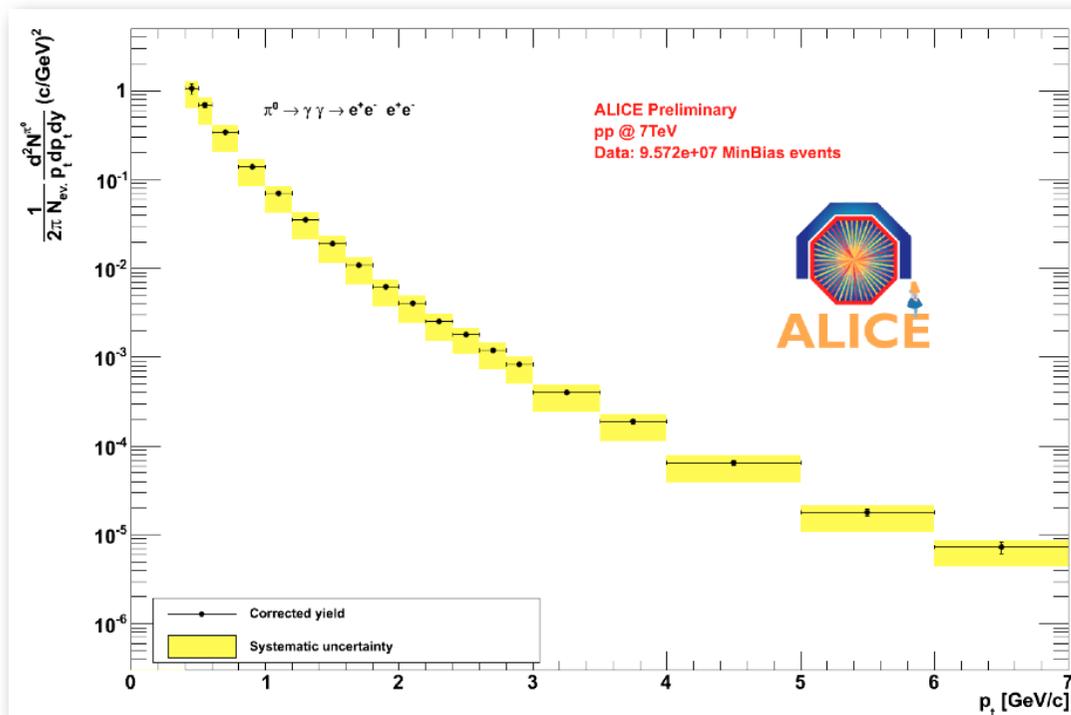


Strange particles at 7 TeV

- ◆ Same analyses as for 900 GeV (kaons, hyperons, ϕ) + other strange resonances



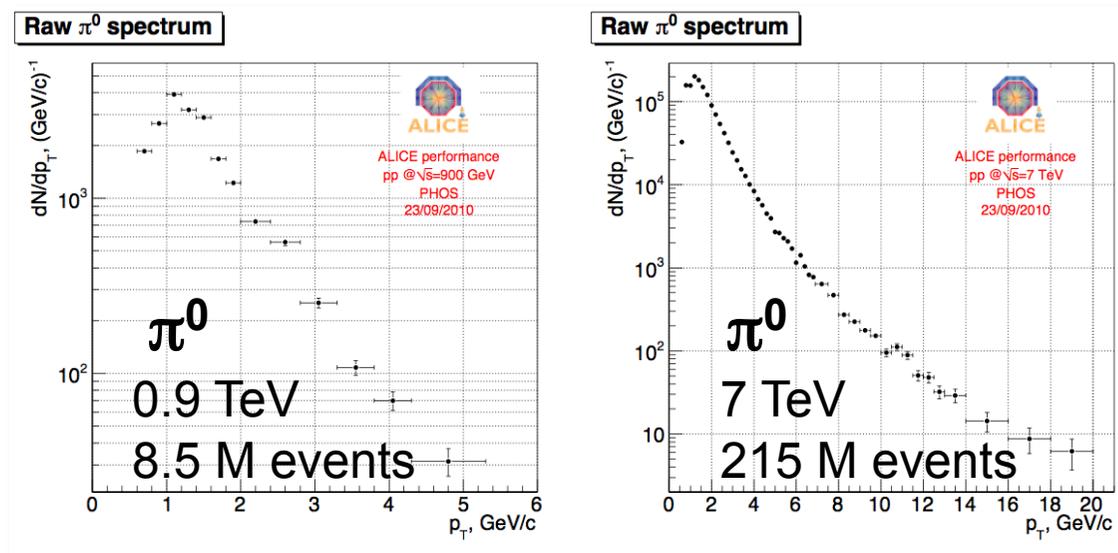
- ◆ First cross section measurement using double conversion reconstruction with tracking + e ID (TPC)
- ◆ Preparing final result, combined with measurement from PHOS and EMCAL electromagnetic calorimeters
 - important reference for suppression study in Pb-Pb



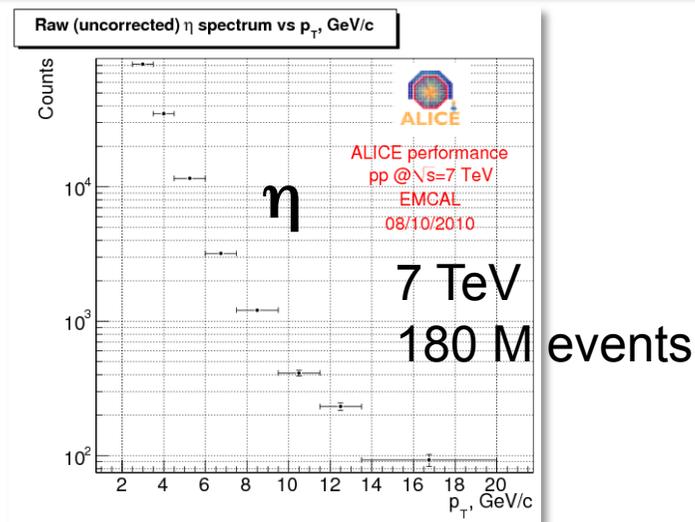
- ◆ Progress in calorimeters calibration (EMCAL, PHOS)

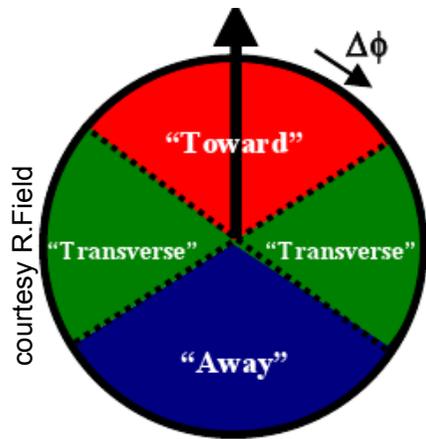
- ◆ Examples:

PHOS, π^0

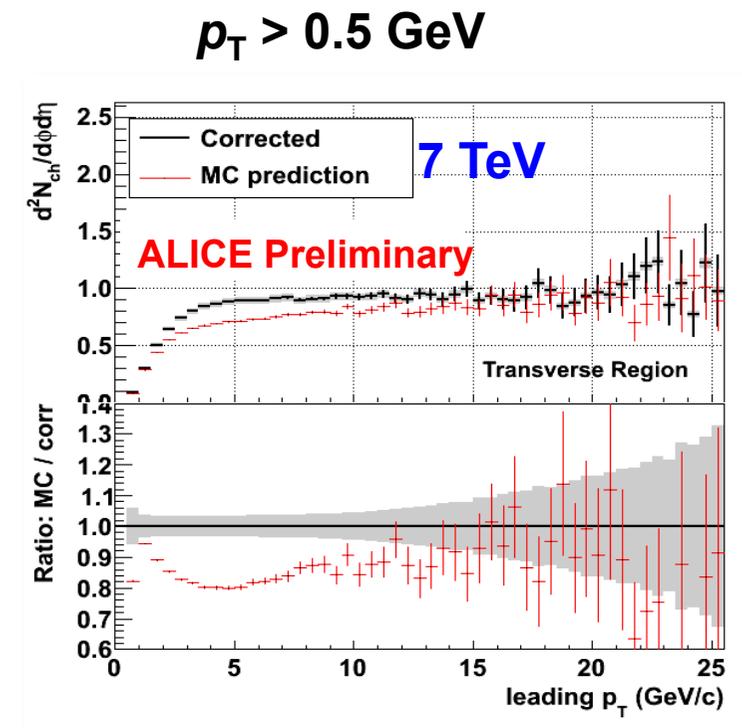
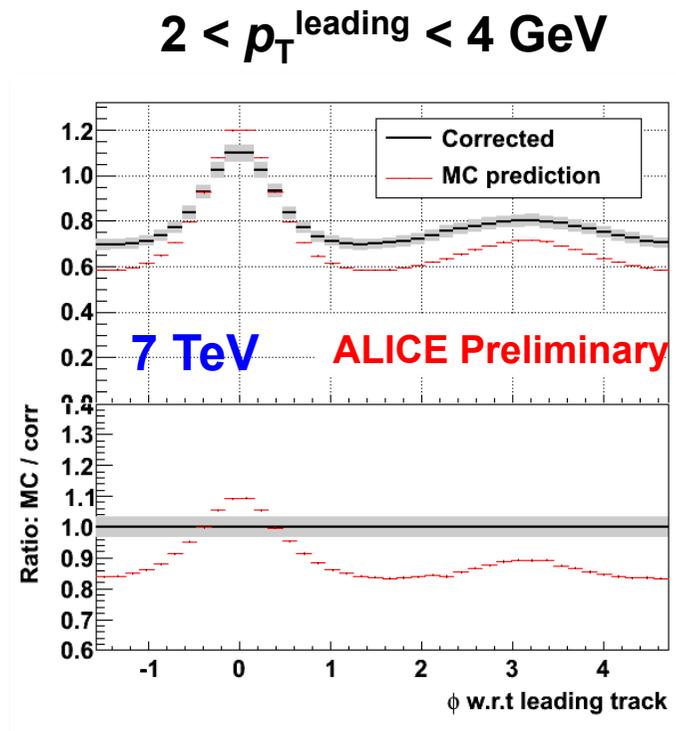


EMCAL, η





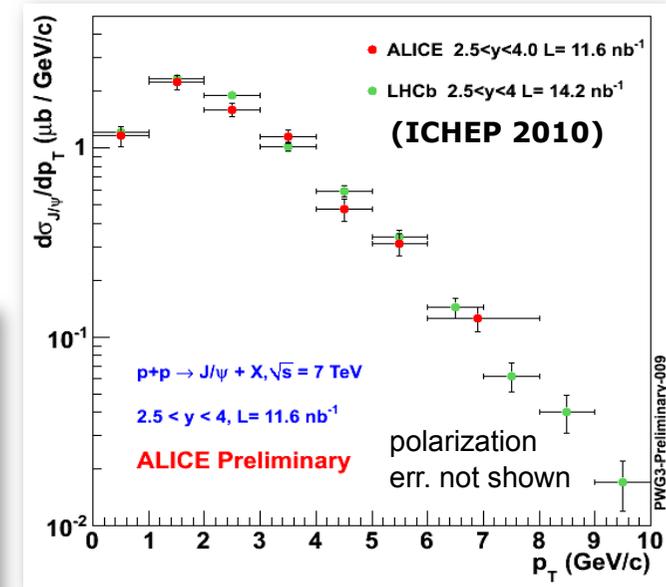
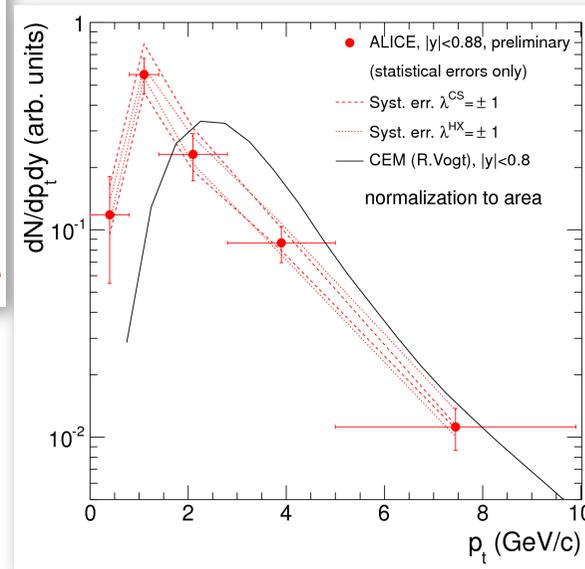
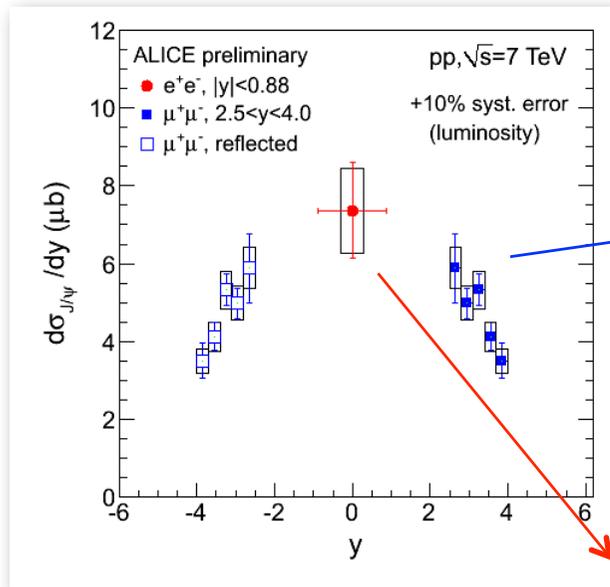
$$|\eta| < 0.8$$



→ More activity in transverse region than in MC (Perugia0)

Inclusive J/ψ cross section, 7 TeV

- ◆ Di-muon channel: $d\sigma/dp_t$ and $d\sigma/dy$ in $2.5 < y < 4$
- ◆ Di-electron channel: limited stat., σ in $|y| < 0.9$



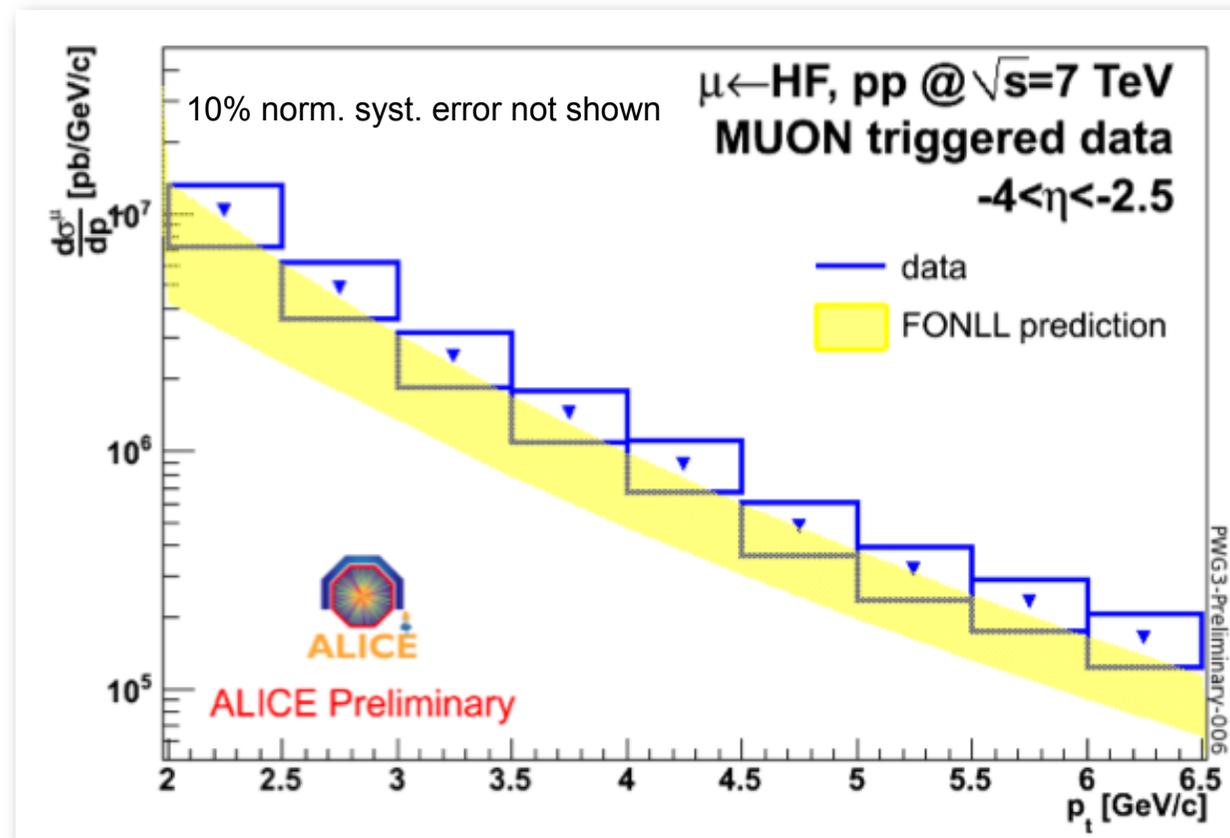
◆ Next:

- $d\sigma/dp_t$ at midrapidity
- use high-lumi muon run:
 - extend high p_t coverage
 - measure ψ' production in the forward region
 - measure polarization

$$d\sigma_{J/\psi}/dy(|y| < 0.88) = 7.36 \pm 1.22(\text{stat}) \pm 1.32(\text{syst})^{+0.88}_{-1.84} (\text{syst.pol.}) \mu\text{b}$$

$$\sigma_{J/\psi}(2.5 < y < 4) = 7.25 \pm 0.29(\text{stat}) \pm 0.98(\text{syst})^{+0.87}_{-1.50} (\text{syst.pol.}) \mu\text{b}$$

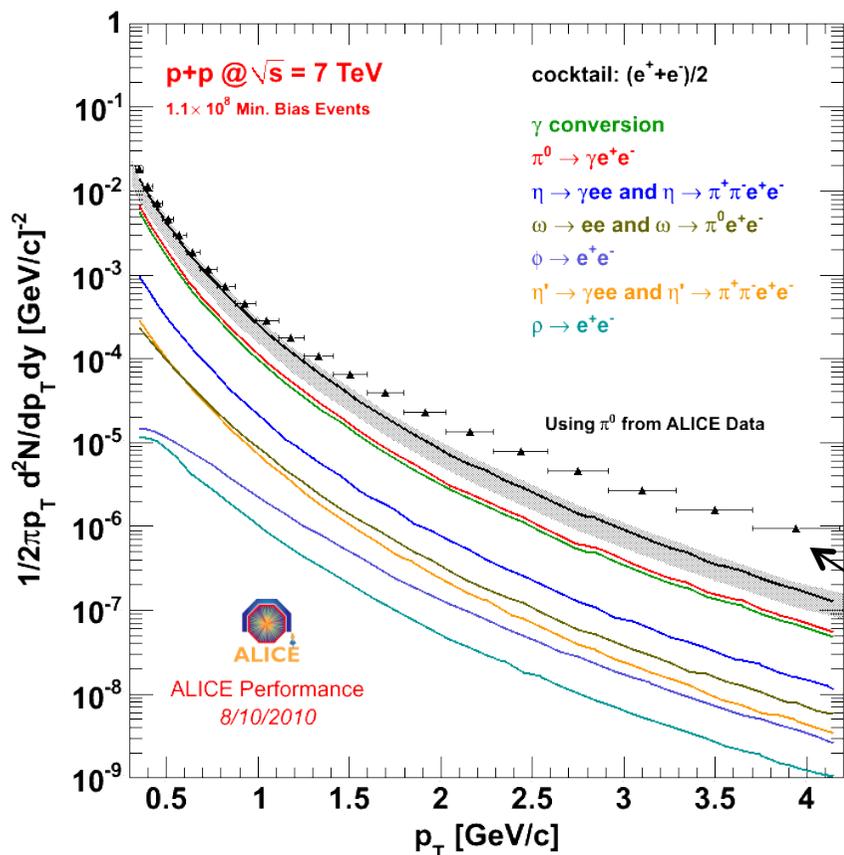
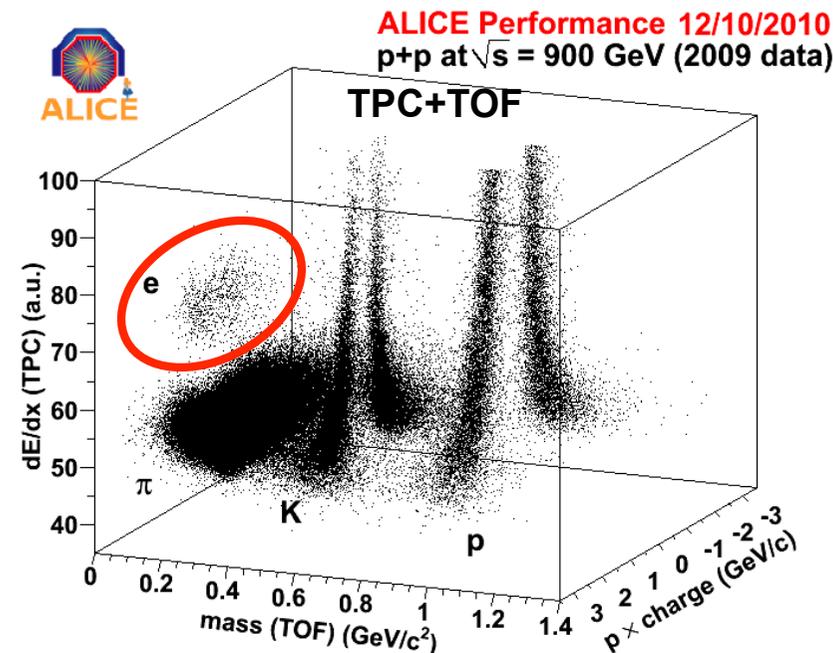
- ◆ Measured $d\sigma/dp_t$ for D and B decay muons in 2-6.5 GeV/c
- ◆ Compared to FONLL: agrees in shape and normalization



- ◆ Next steps:

- improved spectrometer alignment already deployed
 → extend to higher p_t
- D and B separation by fitting with pQCD shapes
- prepare reference for Pb-Pb beauty suppression studies

- ◆ Electron identification: TOF + TPC-dE/dx
 - TRD+EMCAL to join soon



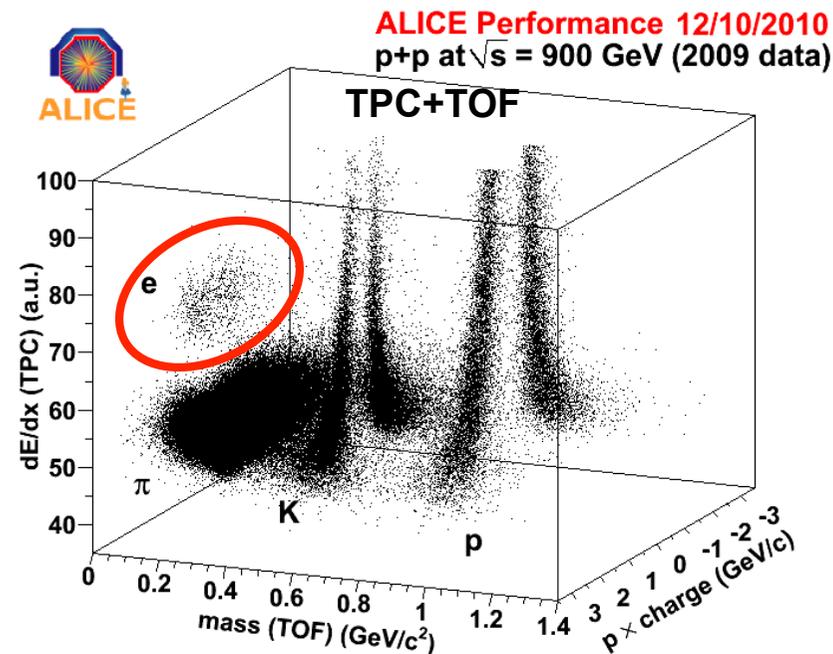
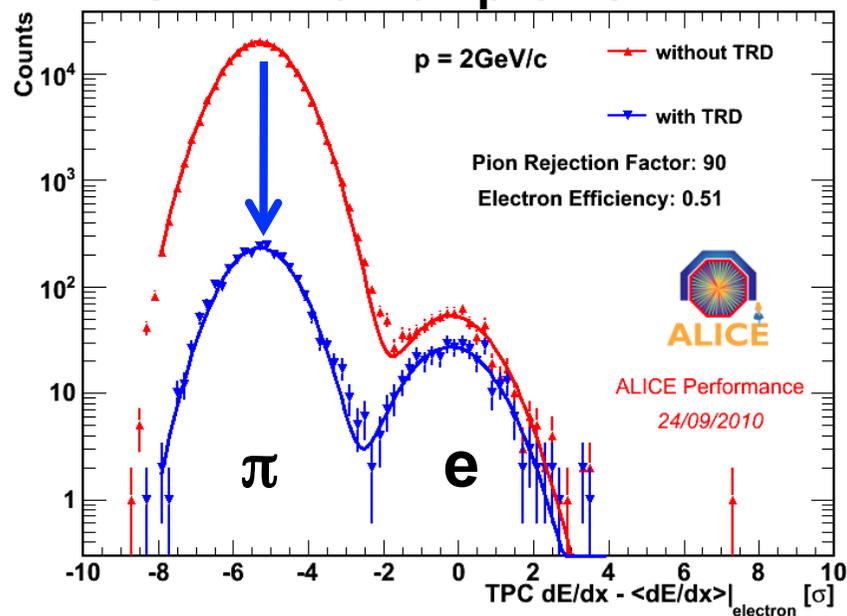
- ◆ Inclusive electron p_T spectrum
- ◆ Show large excess wrt a cocktail of “photonic electrons”
 - ◆ based on our π^0 data
- ◆ Signal of electrons from D and B decay
- ◆ Displaced electron studies ongoing

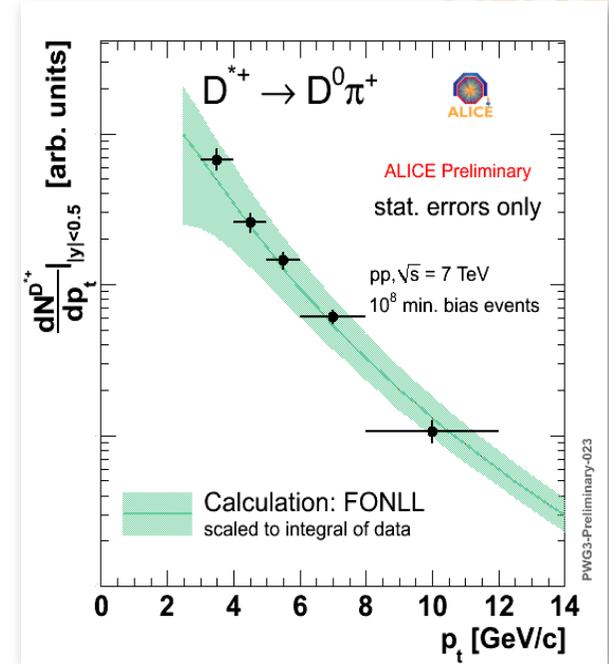
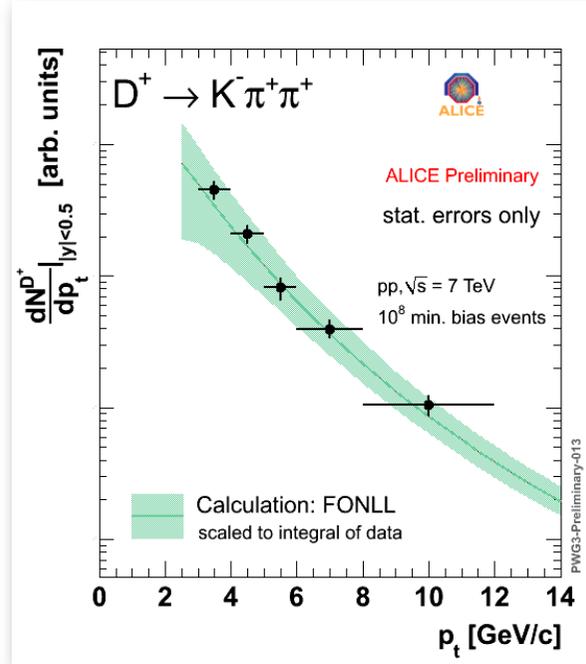
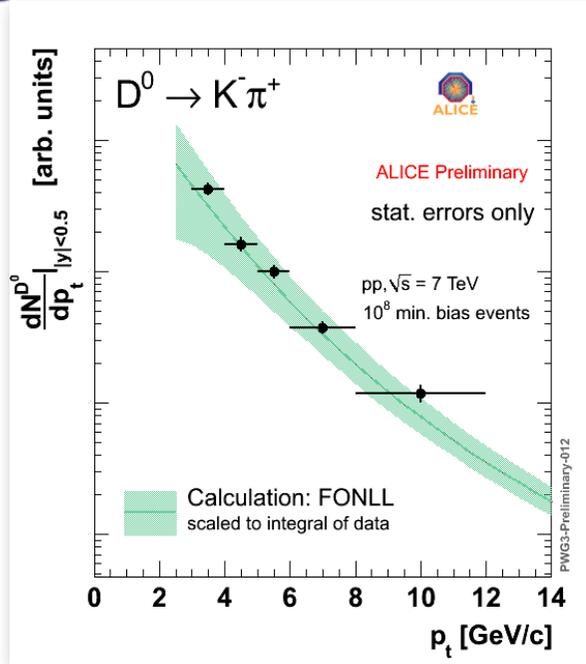
- ◆ Electron identification: TOF + TPC-dE/dx

- TRD+EMCAL to join soon

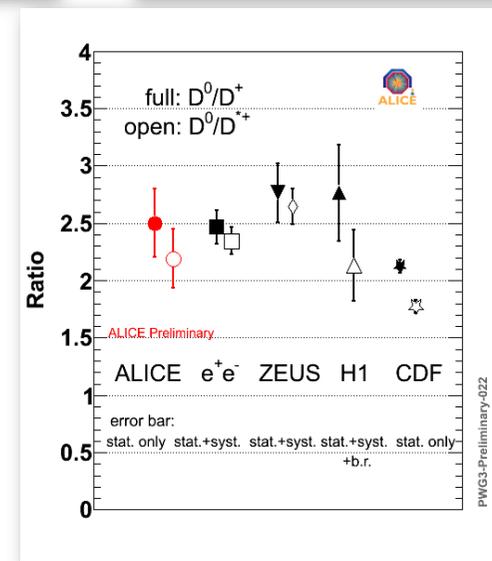


**Effect of TRD hadron rej.
on TPC dE/dx profile:**



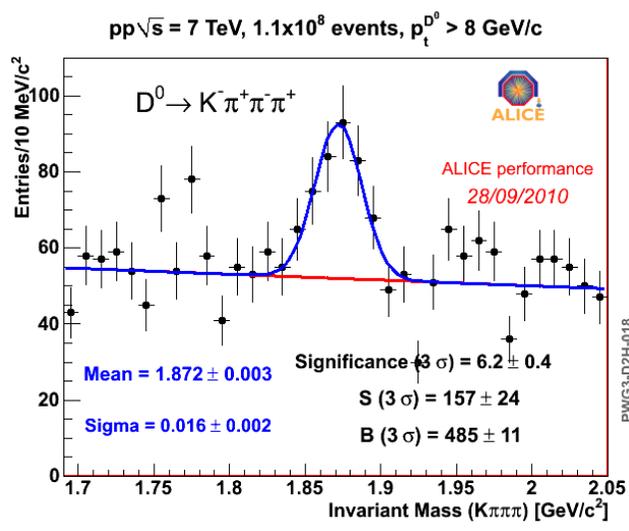


- ◆ Only statistical errors
- ◆ B feed-down from FONLL
- ◆ Shape compares well with pQCD (FONLL)
- ◆ Ongoing:
 - ◆ extension at low p_t
 - ◆ absolute normalization
 - ◆ systematic errors

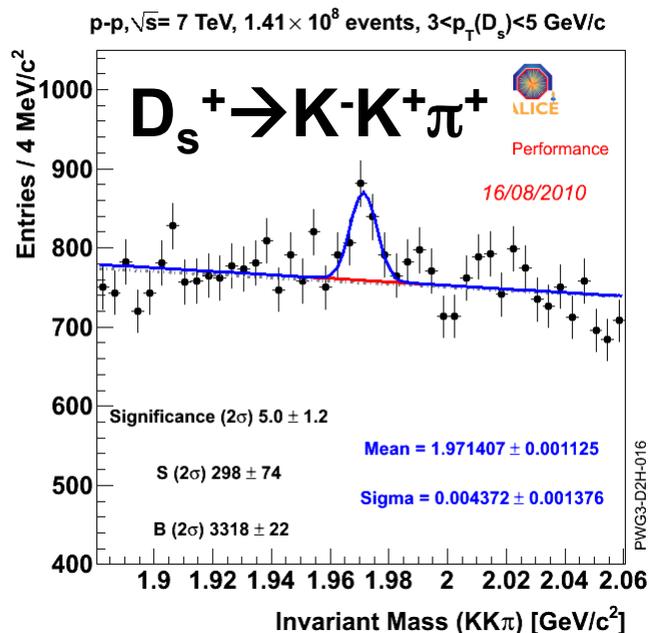
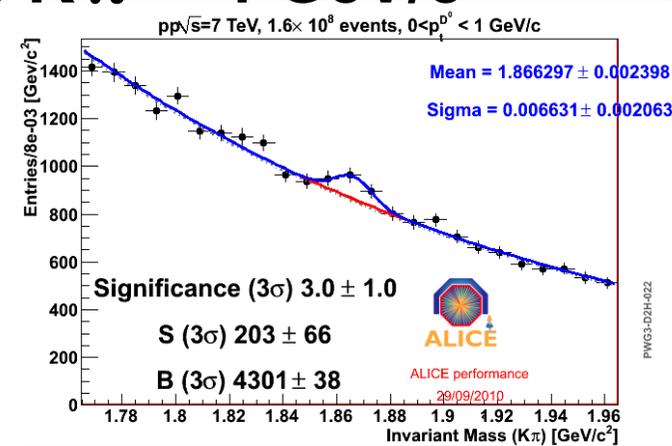


Charming Prospects!

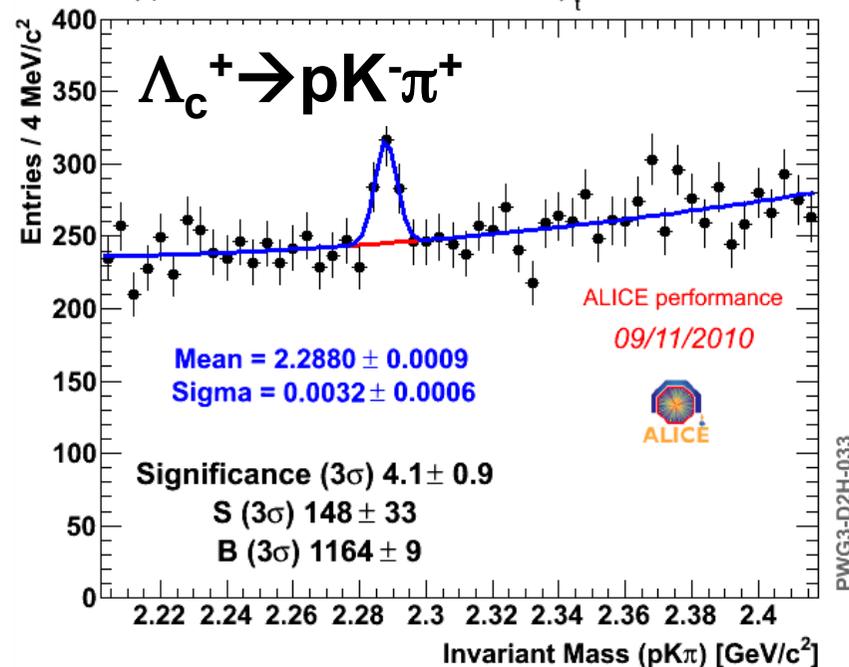
$D^0 \rightarrow K^- \pi^+ \pi^+ \pi^+$



$D^0 \rightarrow K^- \pi^+ < 1$ GeV/c



pp \sqrt{s} = 7 TeV, 1.01×10^8 events, $p_t^{\Lambda_c} > 4$ GeV/c



- ◆ Now, ALICE entered Wonderland
 - all subsystems perform very well with heavy ions!
 - first Physics is here!
 - looking forward to another two good weeks of data

- ◆ Analysis of pp 7 TeV progressing well
 - repeating the analyses done at 0.9 TeV
 - first results on QCD studies
 - first results on heavy flavour and quarkonia
 - preparing the references for heavy-ion studies

Congratulations to the LHC accelerator team for such an impressive start-up!



EXTRA SLIDES

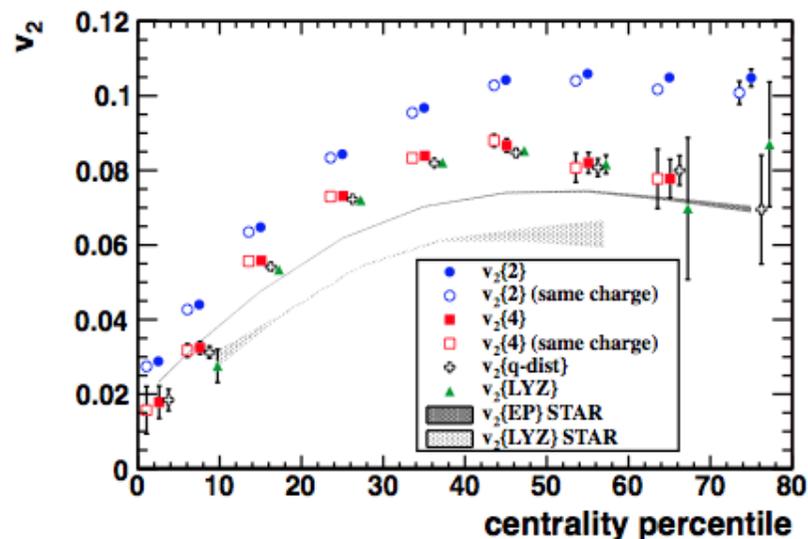
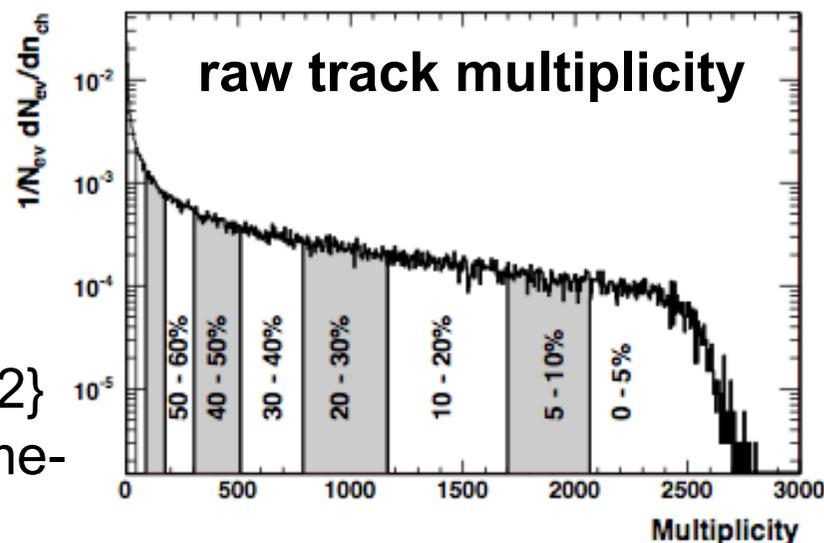
- ◆ 90% of QED processes in ultra-peripheral collisions give close to 0 mult.
- ◆ 1% background in the sample eliminated by
 - V0 timing selection
 - correlation between #TPC tracks and #hits in SPD inner layer
- ◆ Three methods for comb. background
 - from MC
 - from data: pixel inner layer rotation by 180deg
 - from data: injection of random hits
- ◆ Consistent results
- ◆ Measurement cross-checked with TPC-only tracks and with global (TPC +ITS) tracks
- ◆ Low p_t cutoff (50 MeV/c)
 - angular window
 - absorption in material
- ◆ Particle comp. varied by 50%
- ◆ Strangeness by factor 2
- ◆ Centrality done also with SPD and varying Glauber fit range

Source	
Background subtraction	2%
Particle composition	1%
Contamination by weak decays	1%
Low- p_t extrapolation	2%
Event generator	2%
Centrality definition	3%
Total (added in quadrature)	5%

$$E \frac{d^3 N}{d^3 p} = \frac{1}{2\pi} \frac{d^2 N}{p_t dp_t dy} \left(1 + \sum_{n=1}^{\infty} 2v_n \cos(n(\phi - \Psi_R)) \right).$$

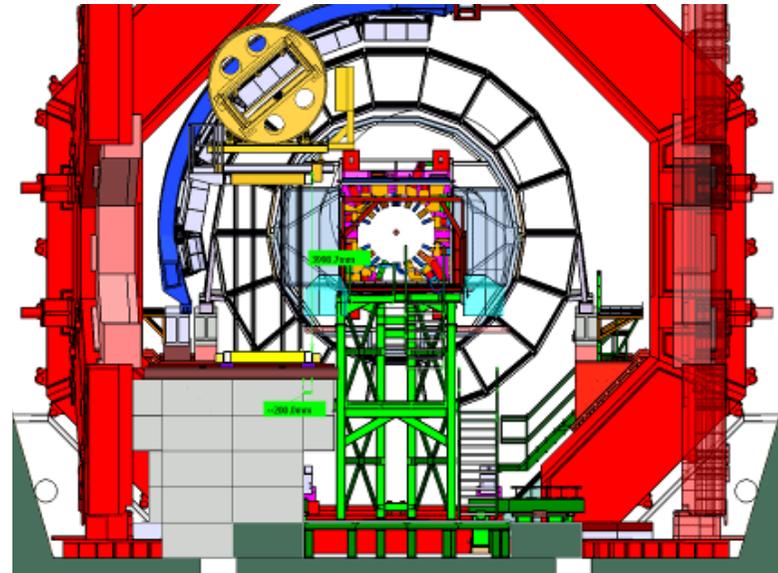
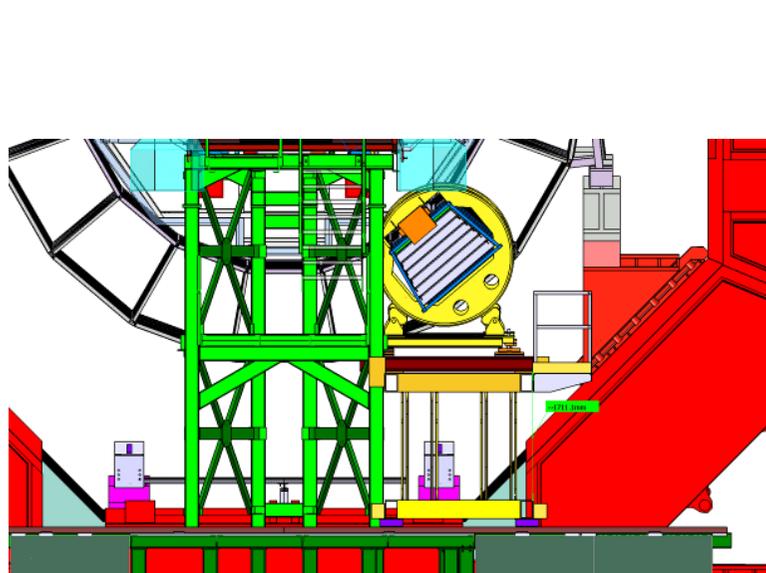
v₂{2} and v₂{4}:

- v₂{4} insensitive to nonflow contributions (BE, resonances, jets)
 - we estimate 5% nonflow contr. to v₂{2} by comparing with cumulants with same-charge tracks
- flow fluctuations have increase v₂{2} and decrease v₂{4}



ALICE Christmas break schedule

	Dec				Jan				Feb		
Wk	49	50	51	52	1	2	3	4	5	6	7
Mo	6	13	20	27	Close L3 I-side door ³	10	17	24	31	7	14
Tu											
We	Open Experiment		TRD		EMCal		Close L3 O-side door	Close Experiment			
Th	Open Experiment							Close Experiment			
Fr											
Sa		Open L3 doors	Xmas Day	NY Day							
Su											



Legend

Open/close Experiment
TRD
EMCal
Contingency

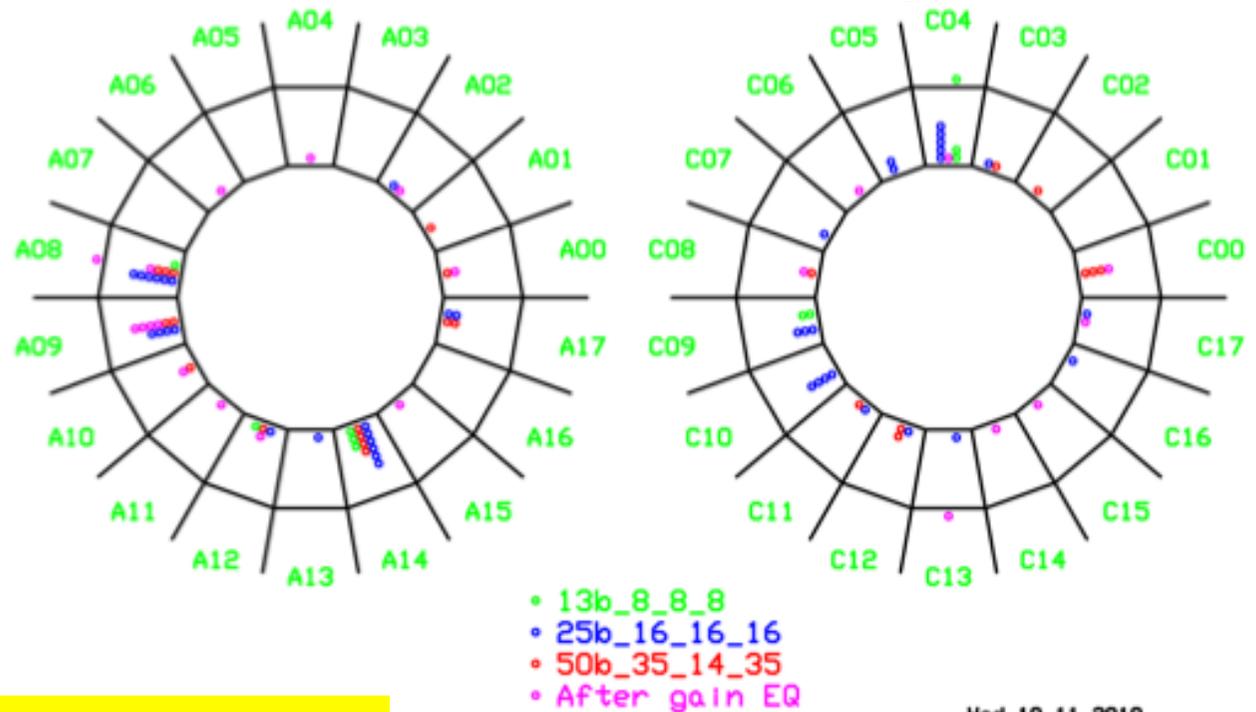


Other Christmas activities



- ◆ New PMD air cooling system – major installation work in January
- ◆ TRD: LV connections Wiener PS & netgear (wk 49 – evenings), LV connection BKF (wk 50 – evenings)
- ◆ Muon TRK: open ST3 (problem occupancies) + replacement quadrant ST2 (tbc)
- ◆ TOF:
 - HV hardware checks on SM13 (December)
 - TRM replacement (14 TRMs on the A side) (3/01 – 12/01)
 - Replacement DC-DC (with no LV spare channels):
 - No SM displacement foreseen up to now
- ◆ PHOS:
 - Investigate module 2 pedestal issues
 - Try to understand behavior of unstable branch in Module 3
 - Remake ISEG crate to connect to the hardware interlock
- ◆ SPD cooling:
 - cut pipes in order to open the doors
 - reconnect pipes once L3 I-side door is closed and test with dummy sector (MNF)
 - wash 4 lines
 - restart SPD cooling

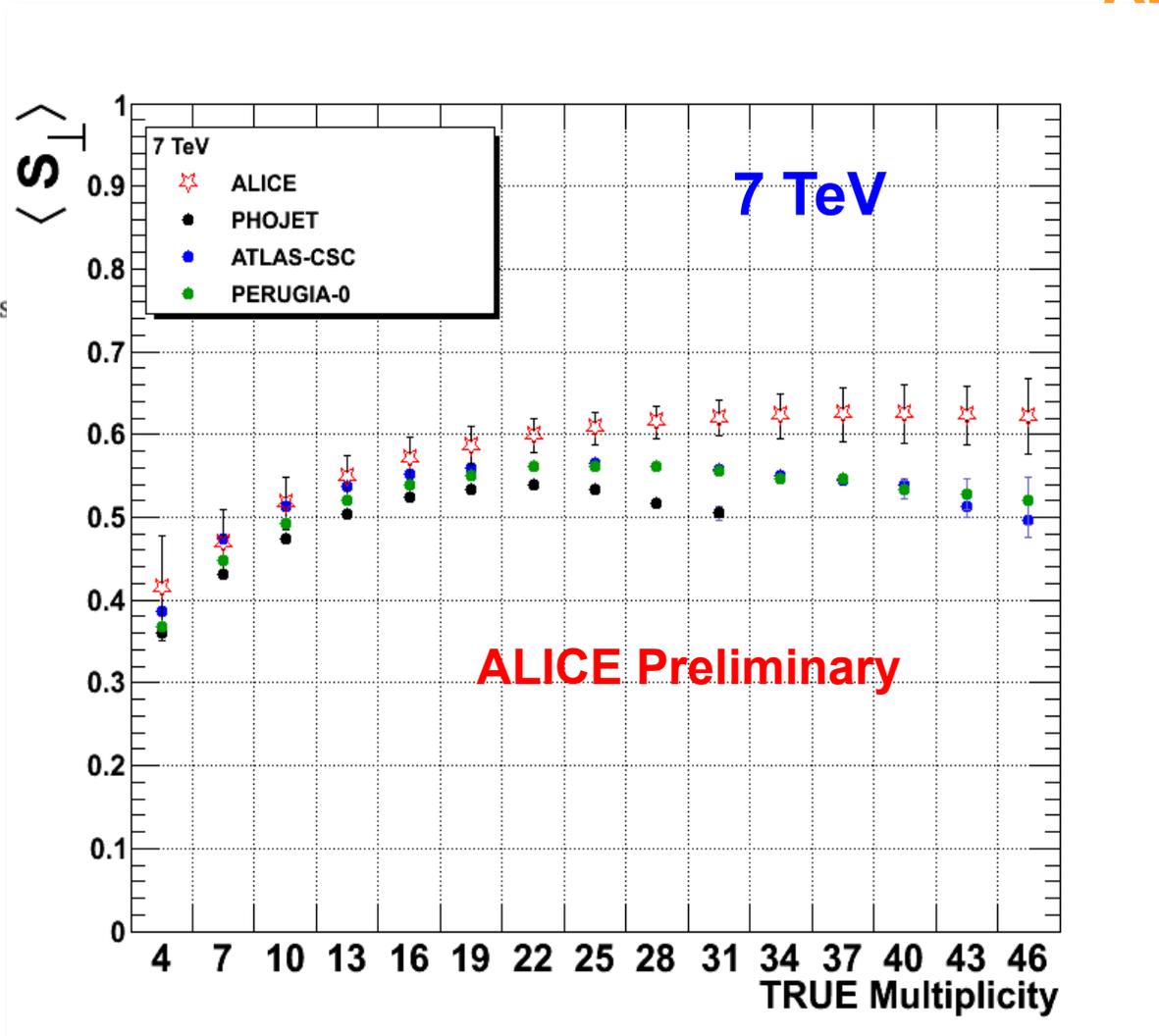
- ◆ Continues to perform extremely well, with one issue: chamber trips (≈ 100 trips since May 25) $\langle \text{time} \rangle \sim 4$ hours; one IROC at a time, not only when triggering; 16 FE cards (/4356) damaged
- ◆ Exceeding current limit in HV power supplies. Discharges 10nF capacitor potentially dangerous to FE cards (8 FE cards damaged/replaced during stops)
- ◆ Actions taken:
 - H₂O (50 to 200 ppm)
 - didn't help
 - HV filters
 - Decrease RC
 - Limit voltage swing



Trip statistics – detail of inner region of TPC endcaps

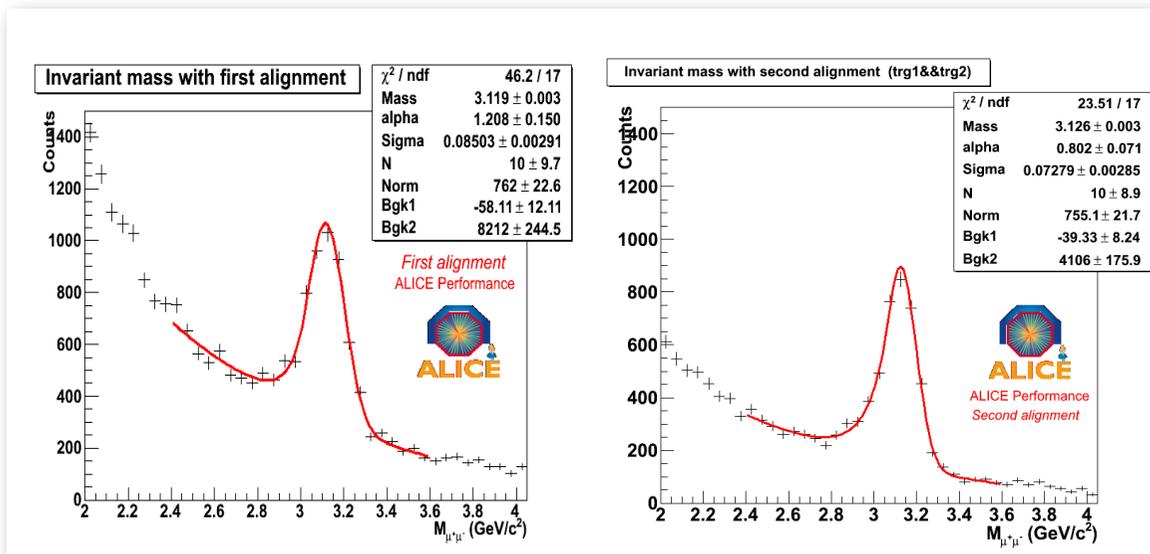
$$S_{xy} = \sum_i \begin{pmatrix} p_x^{(i)2} & p_x^{(i)} p_y^{(i)} \\ p_x^{(i)} p_y^{(i)} & p_y^{(i)2} \end{pmatrix}$$

$$S_{\perp} \equiv \frac{2\lambda_2}{\lambda_2 + \lambda_1} \begin{cases} =0, \text{ "pencil-like" events} \\ =1, \text{ isotropic events.} \end{cases}$$



→ Events more spherical than MC models

- ◆ Alignment with particles from the B OFF run (May, 200,000 tracks)
- ◆ Two alignment passes: first in May, second in October
- ◆ 2nd B OFF run scheduled at the end of the pp run could not be done



First alignment ~ 800 μm (BP)

$\rightarrow \sigma_{J/\psi} = (85 \pm 3) \text{ MeV}/c^2$

Second alignment ~ 200 - μm (BP)

$\rightarrow \sigma_{J/\psi} = (73 \pm 3) \text{ MeV}/c^2$

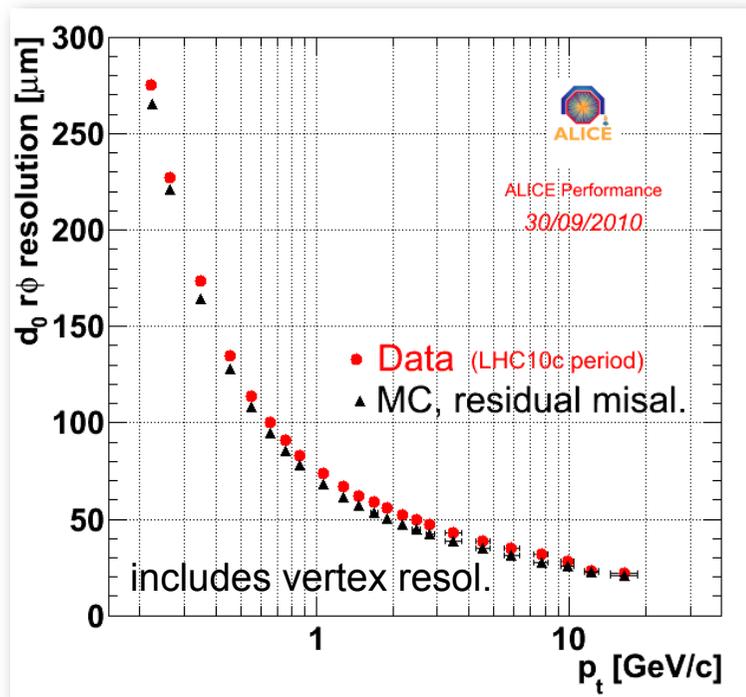
(nominal is 70 MeV/c^2)

Second alignment:

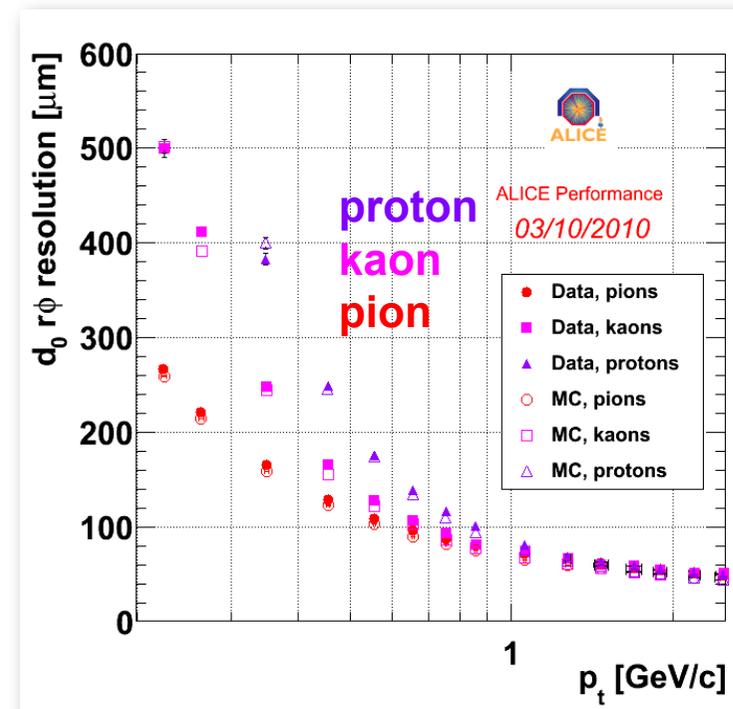
- Stat x 2 (corrupted files recov.)
- MuTrig used for track selection
- 1st align. used as a starting point

D mesons via secondary vertex

- ◆ Tracking and vertexing precision is crucial here
- ◆ Inner Tracking System alignment close to final
 - refine alignment after correction for Lorentz angle shift ($\sim 2 \mu\text{m}$ in pixels)
 - systematics / weak modes



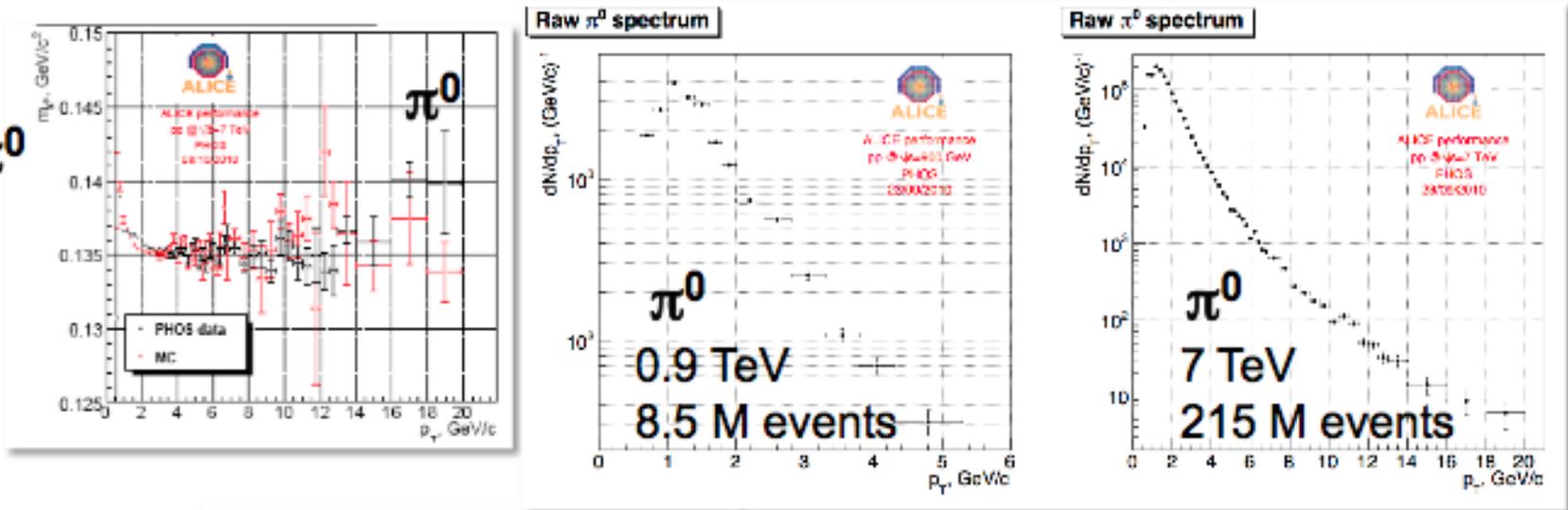
75 (20) μm at 1 (20) GeV/c
 Well described in MC



Mass dependence well described
 → material in MC under control

◆ Progress in calorimeters calibration (EMCAL, PHOS)

PHOS, π^0



EMCAL, π^0 , η

