



LHC

CMS

TOTEM

First results from ALICE

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LHCb

ATLAS

LHCf



ALICE



First collisions November 23, 2009!



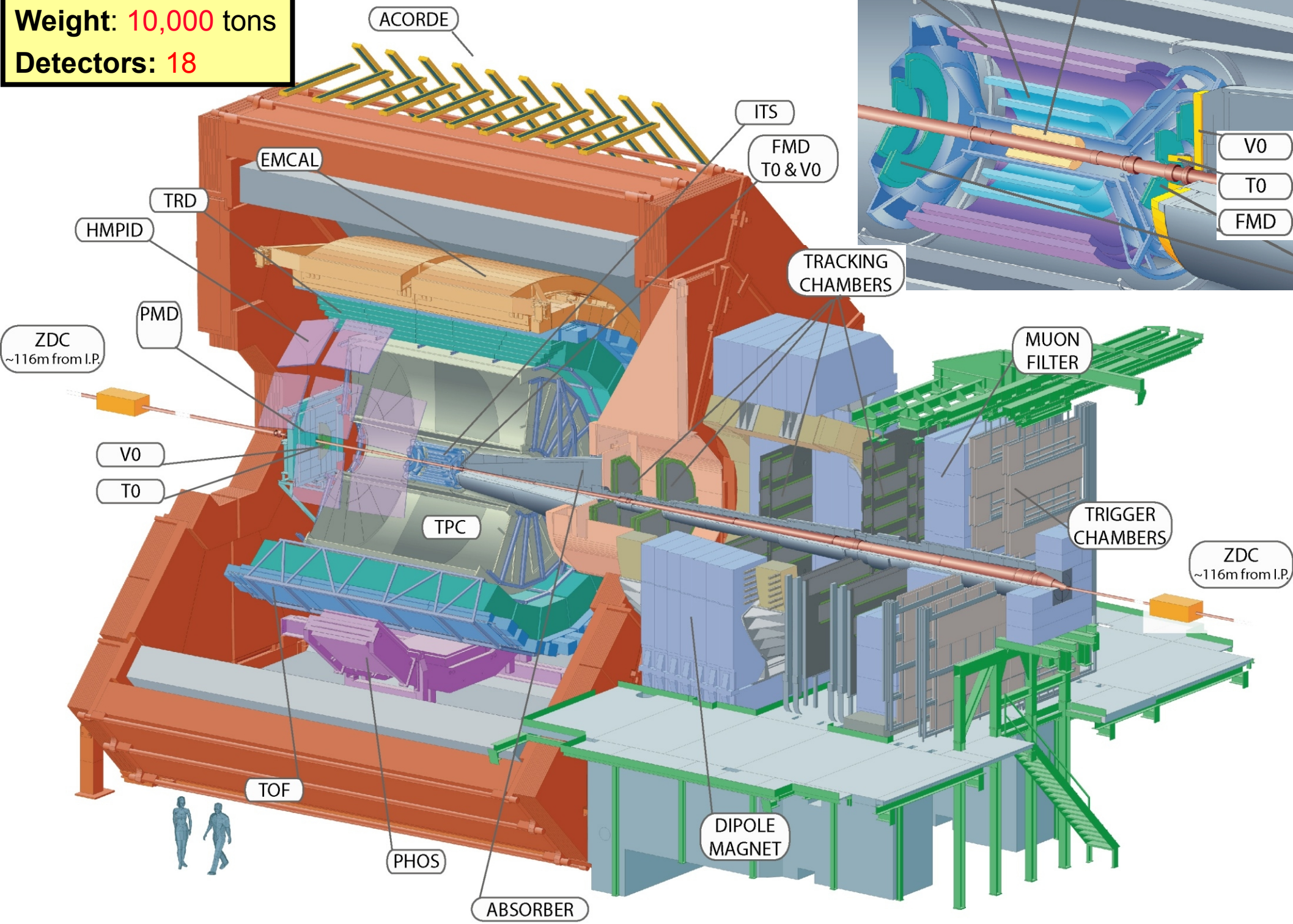
<http://www.youtube.com/watch?v=ZOJvgatf2VY>



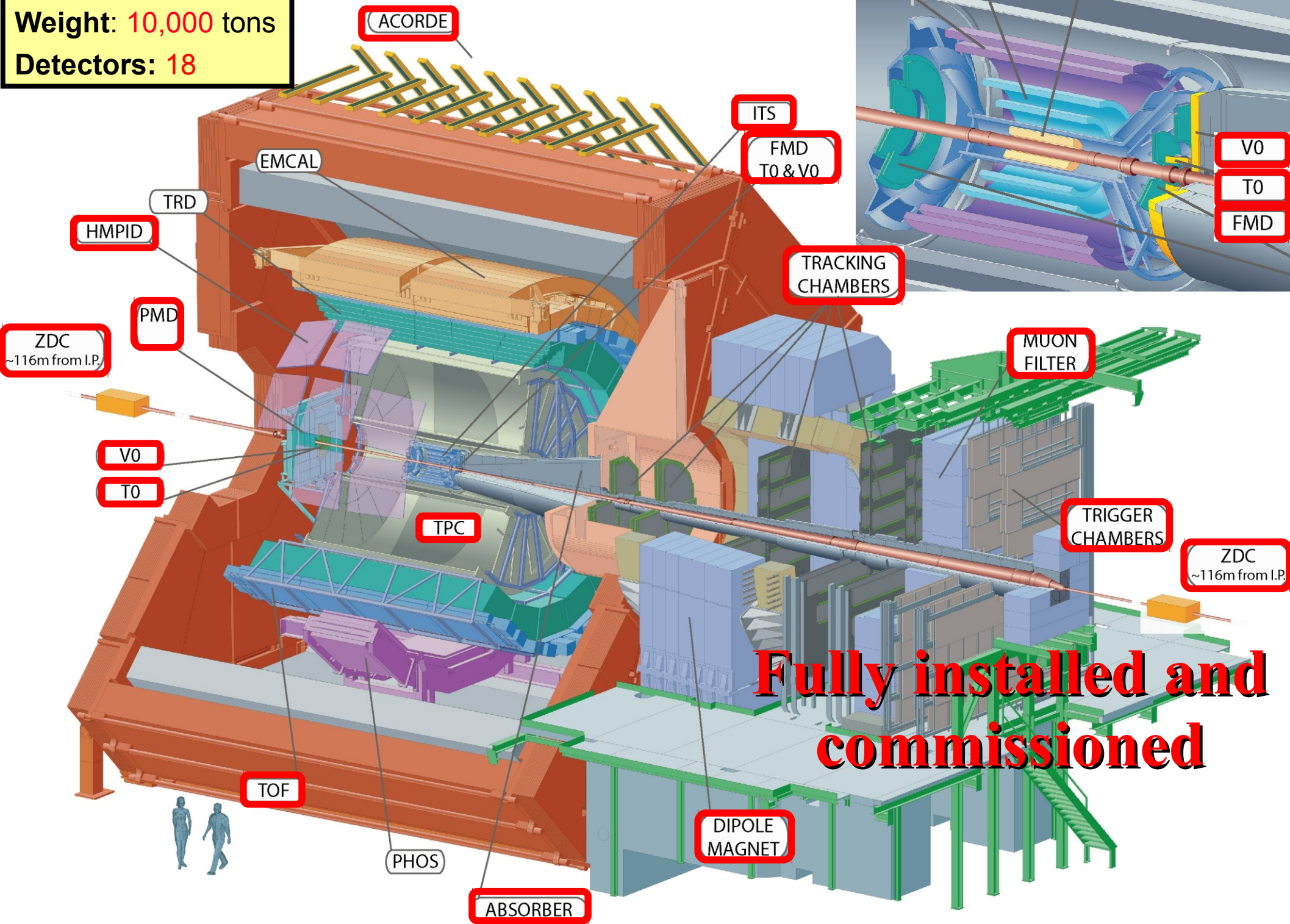
First results

- Published
 - Particle multiplicity: $dN_{\text{ch}}/d\eta$ measurements at 0.9, 2.36, and 7 TeV
- Preliminary (to be submitted soon)
 - Momentum spectra: Charged particle pt spectra at 0.9 TeV
 - Baryon production: \bar{p}/p at 0.9 and 7 TeV
 - Femtoscopy at 0.9 TeV
- In preparation
 - Momentum spectra
 - Identified charged spectra at 0.9 TeV
 - Strangeness at 0.9 and 7 TeV
 - π^0 spectra at 7 TeV
 - Charm and J/ψ production at 7 TeV

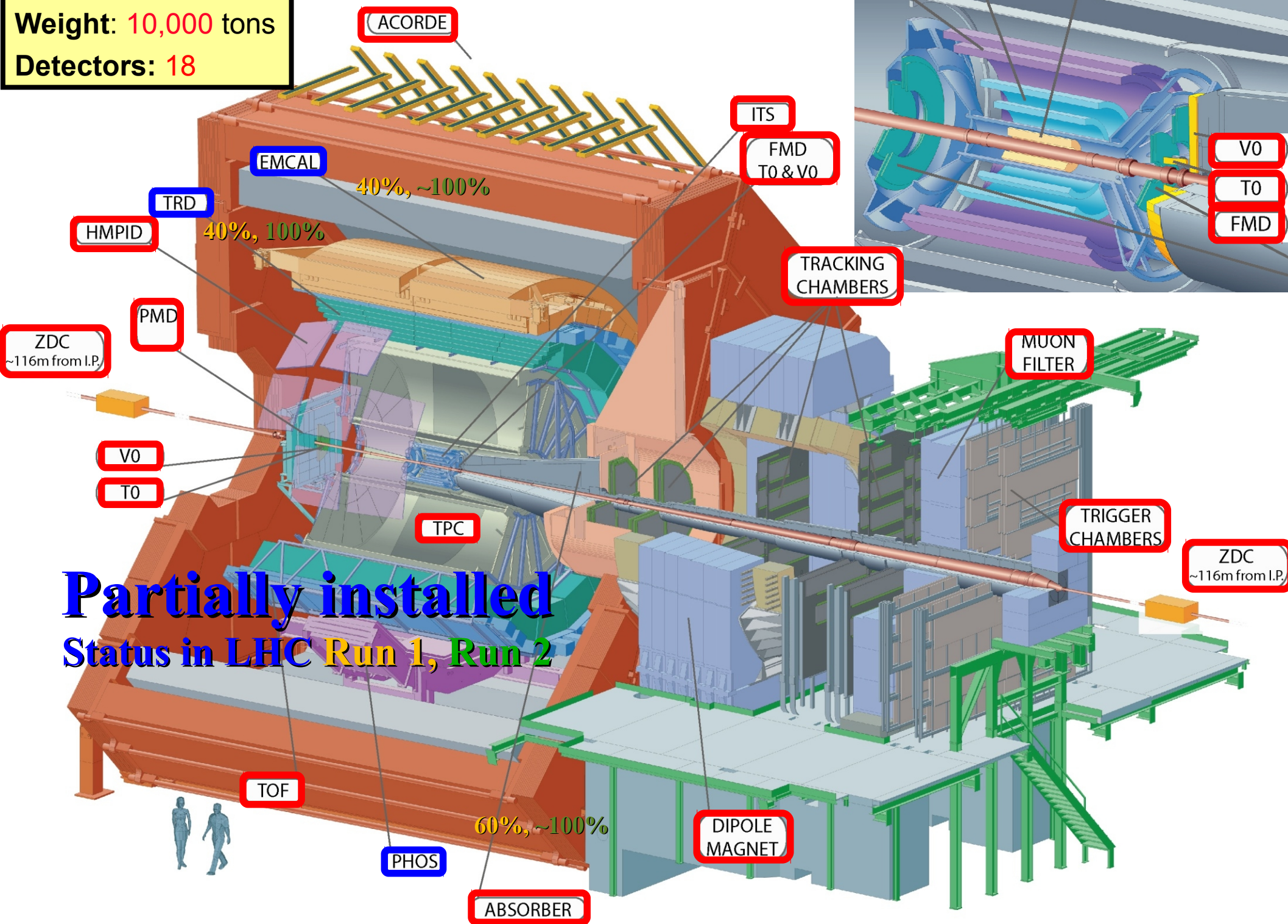
Size: 16 x 26 meters
Weight: 10,000 tons
Detectors: 18



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Partially installed
Status in LHC Run 1, Run 2



ALICE detectors and acceptance

Central barrel- $0.9 < \eta < 0.9$

- $\Delta\phi = 2\pi$ tracking, PID (TPC/ITS/TRD/ToF)
- single arm RICH (HMPID)
- single arm e.m. cal (PHOS)
- jet calorimeter (EMCal)

Forward muon arm- $2.4 < \eta < -4$

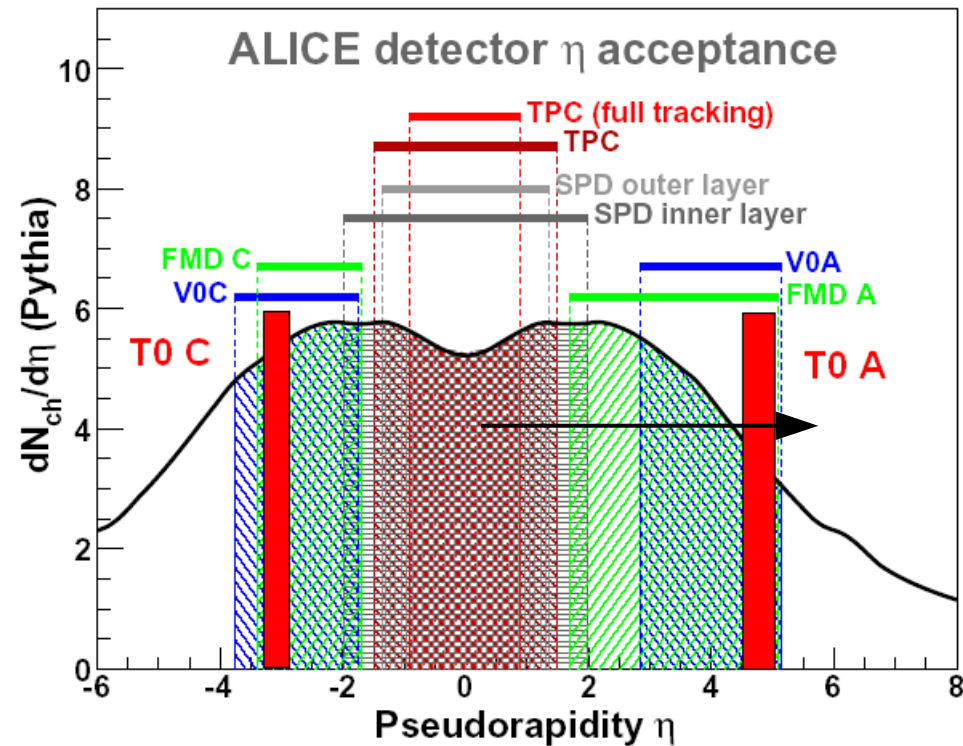
- absorber, 3 T-m dipole magnet
5 tracking + 2 trigger planes

Multiplicity detectors- $3.4 < \eta < 5$

- including photon counting in PMD

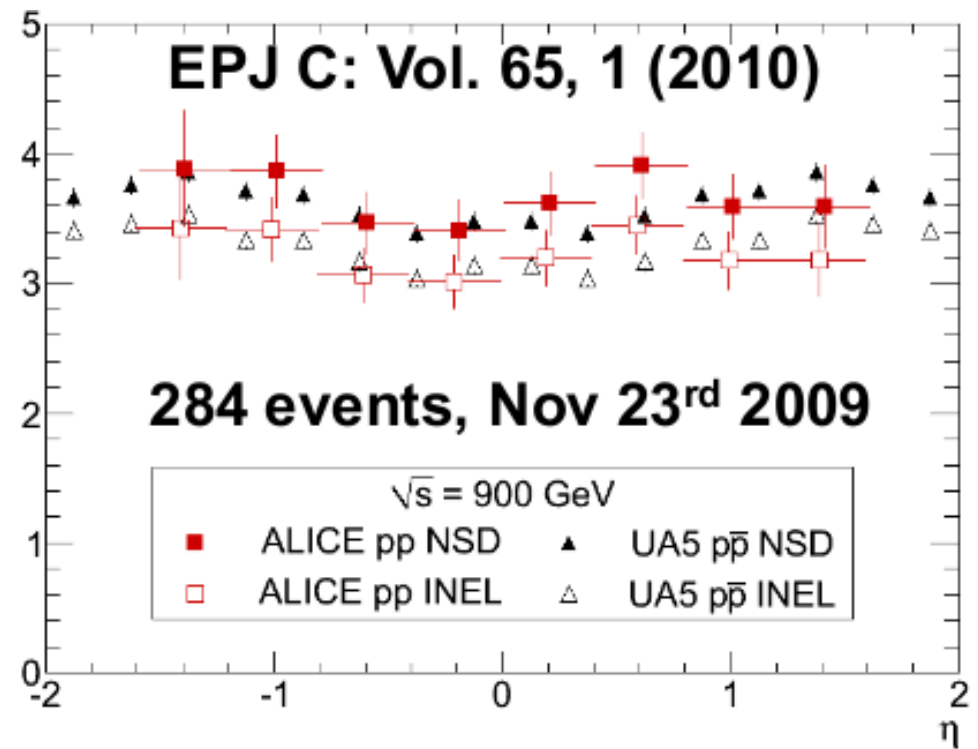
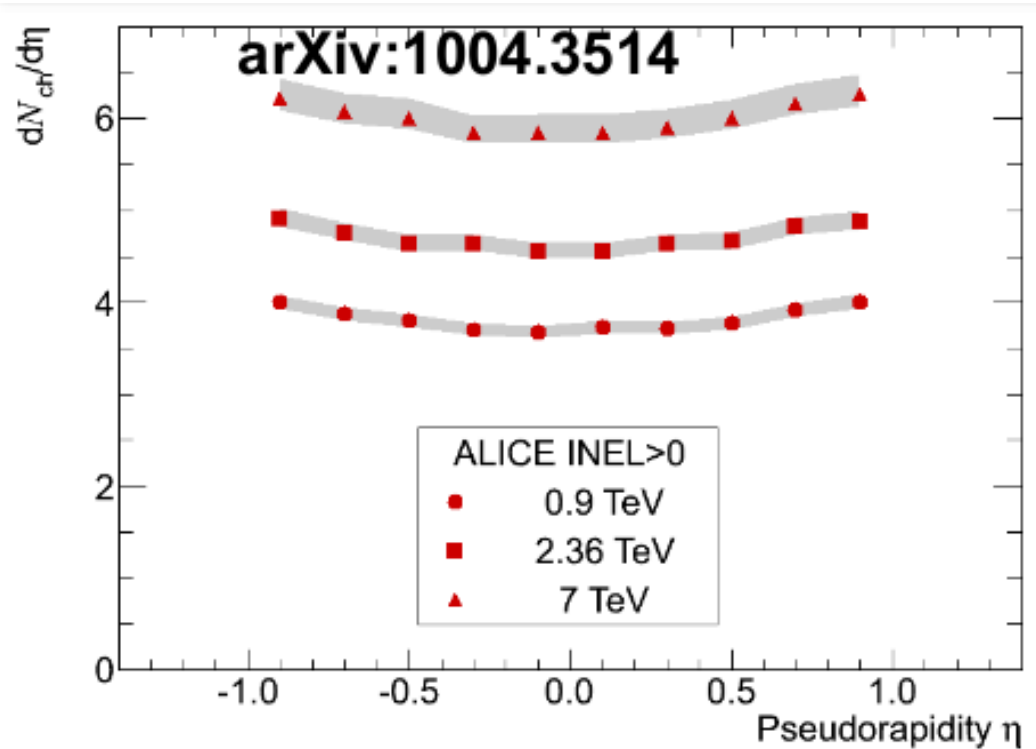
Trigger & timing detectors

- 6 Zero Degree Calorimeters
- T0: ring of quartz window PMT's
- V0: ring of scintillator Paddles





$$dN_{ch}/d\eta$$



- Multiplicity measured using tracklets in the two pixel layers ($R \sim 4$ and 7 cm)
- $dN_{ch}/d\eta$ at 0.9, 2.36, and 7 TeV
 - First paper from the LHC
 - First 7 TeV paper



Event classes

0.9 and 2.36 TeV

- Inelastic (INEL)
- Non-singly diffractive (NSD)
- Use measured diffractive cross sections

7 TeV

- Diffraction unknown
- Use events with at least one charged track (INEL>0)

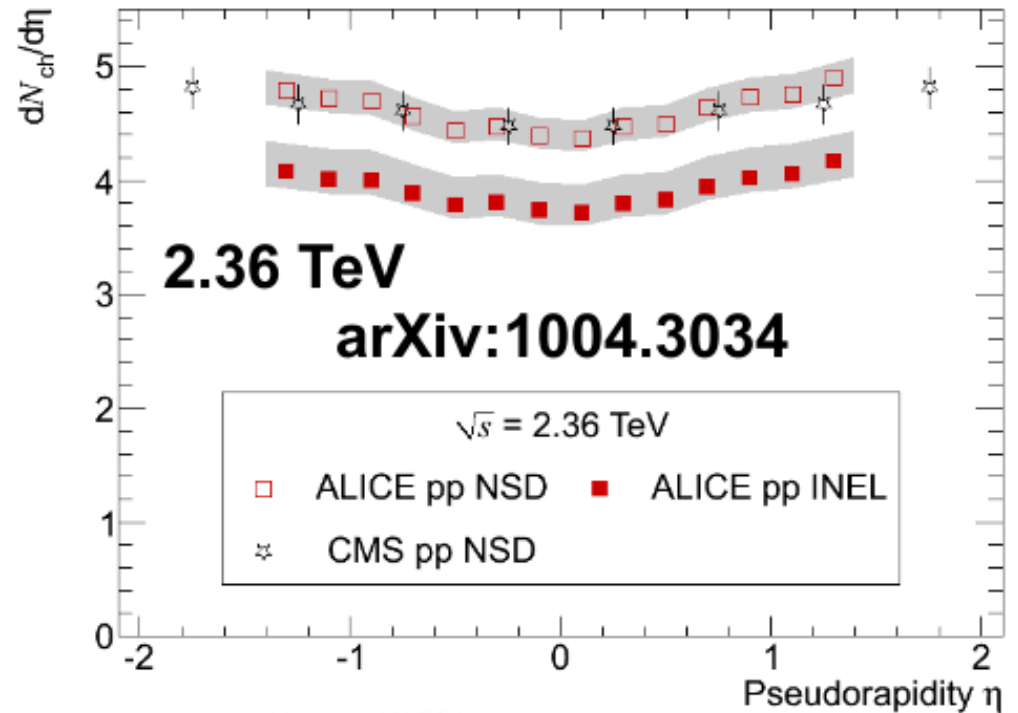
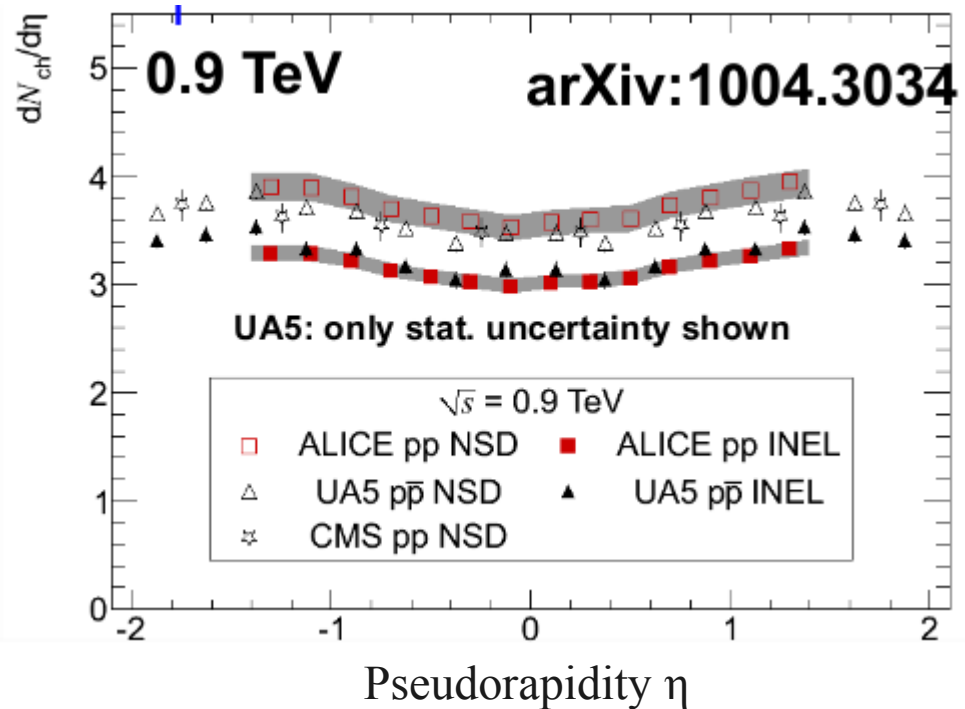
INEL: MBOR (SPD OR VZEROA OR VZEROC) AND offline background suppression

NSD: MBAND (VZEROA AND VZEROC) AND offline background suppression

INEL>0: INEL AND at least one charged primary particle in $|\eta| < 1$



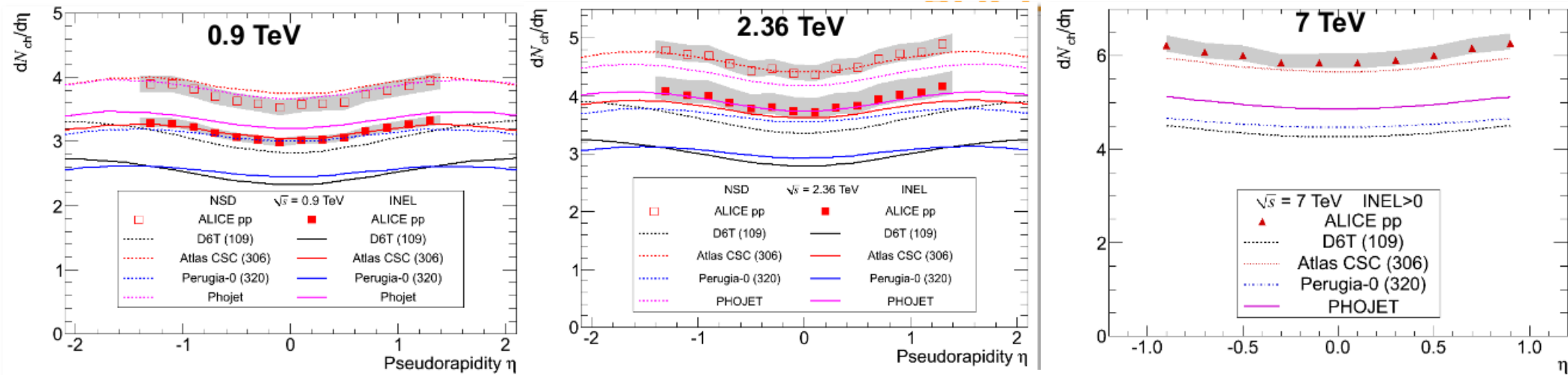
Comparisons to other measurements



- 900 GeV: consistent with both UA1 and CMS
- 2.36 TeV: Consistent with CMS (NSD)
 - CMS measurement excludes charged leptons ($\sim 1.5\%$)



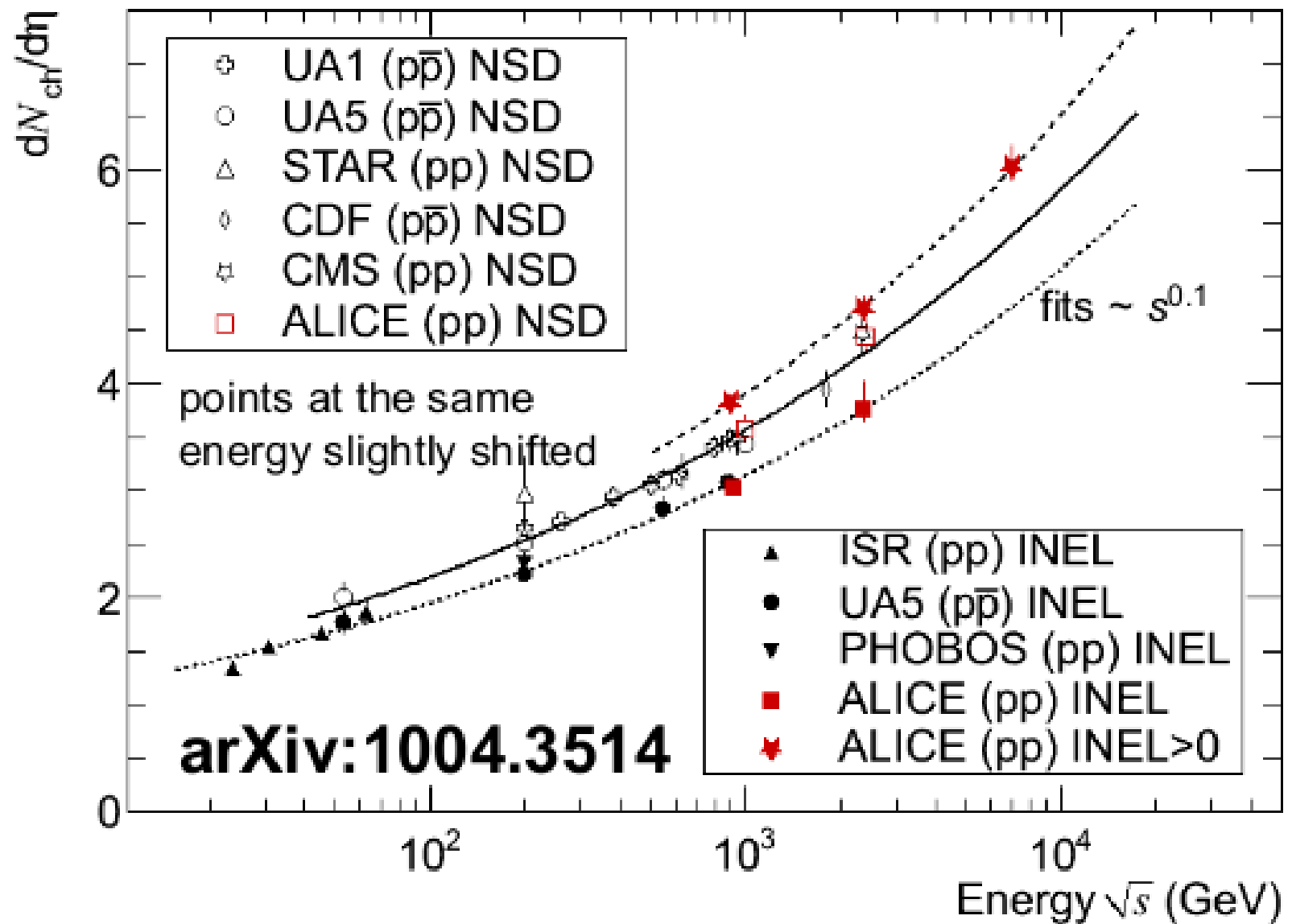
Comparisons to Monte Carlos



Most Monte Carlos underestimate data...
...but they are still within a few percent!

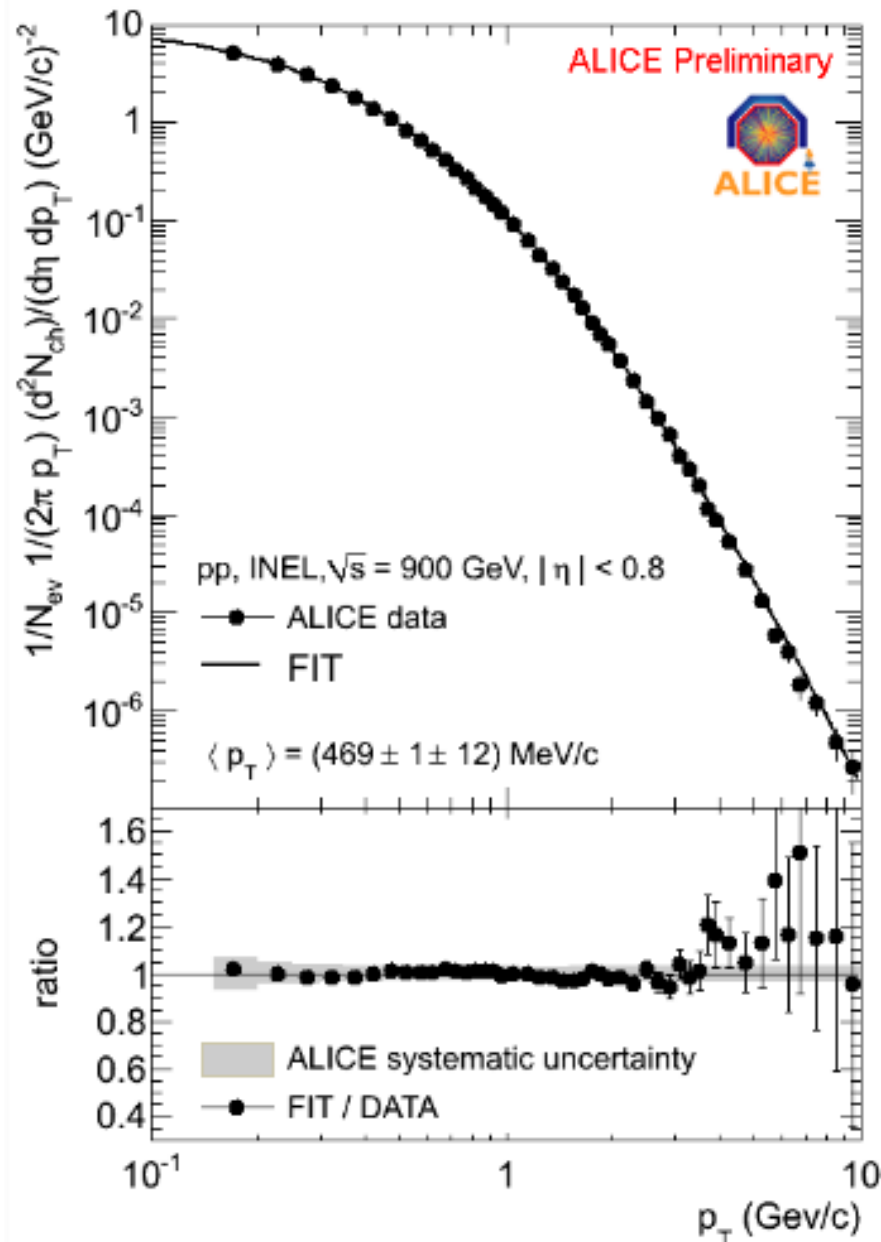


Energy dependence



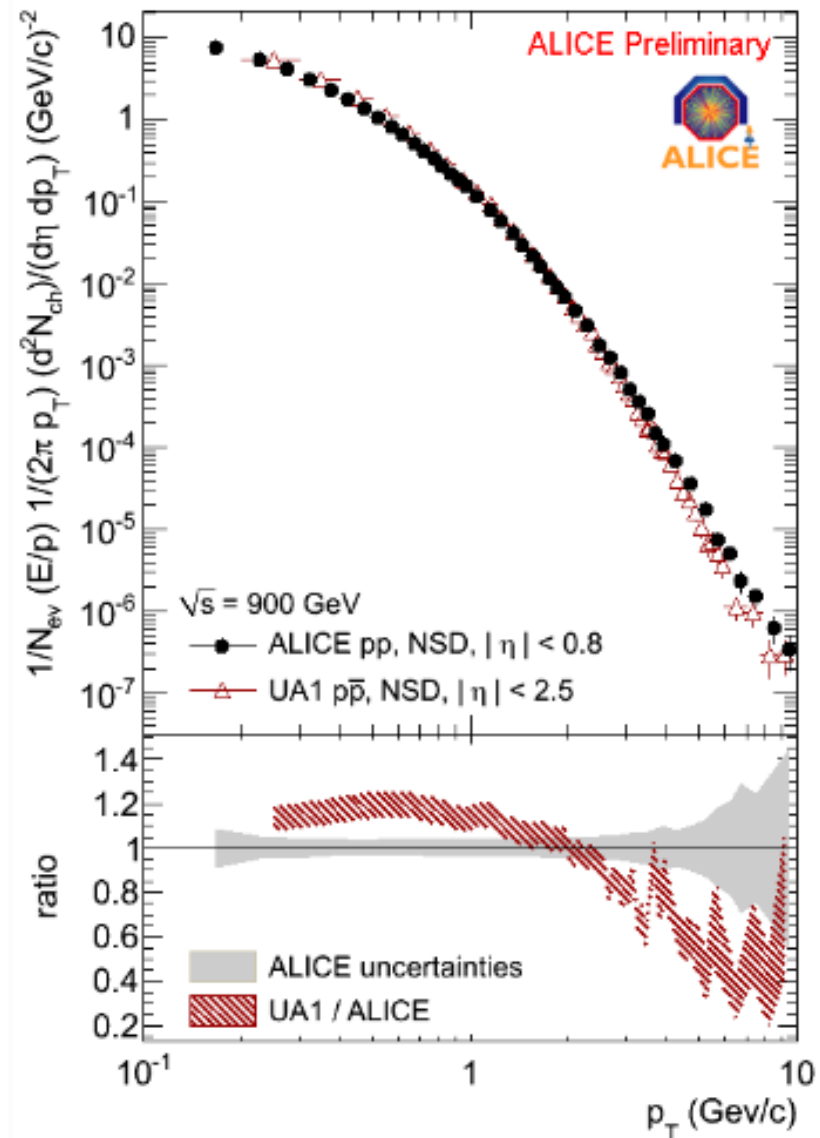
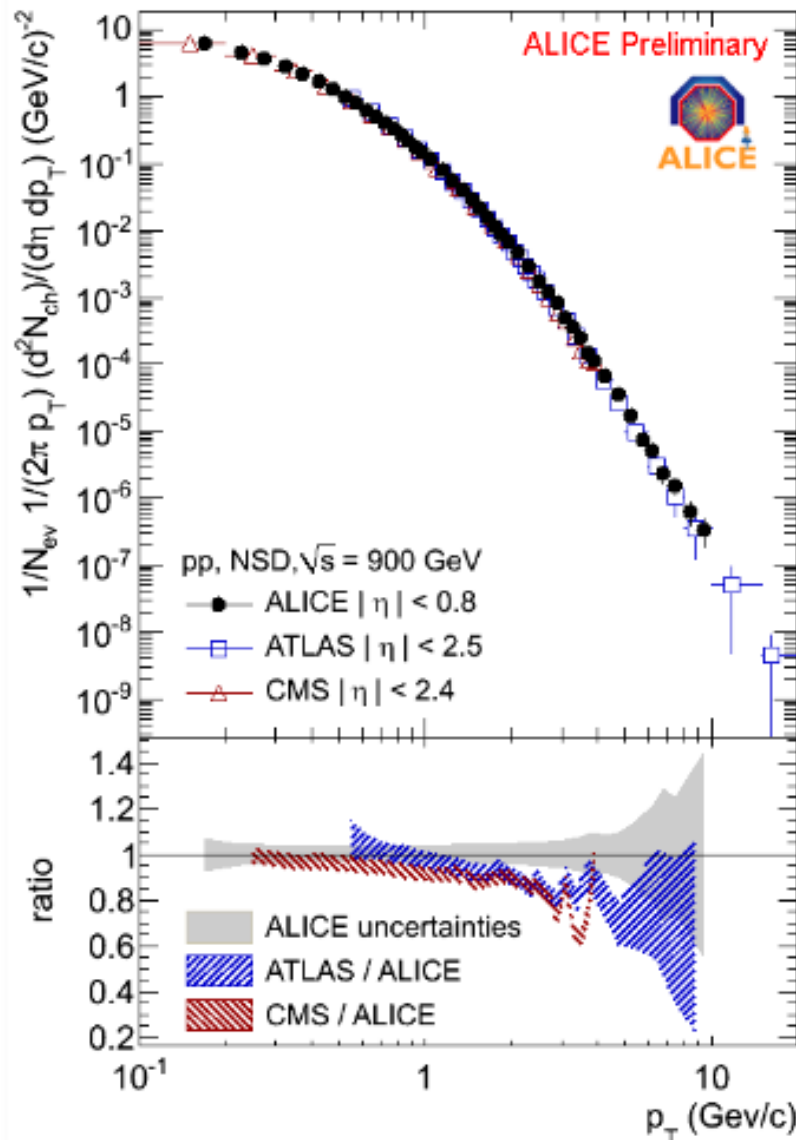


dN_{ch}/dp_T at 900 GeV





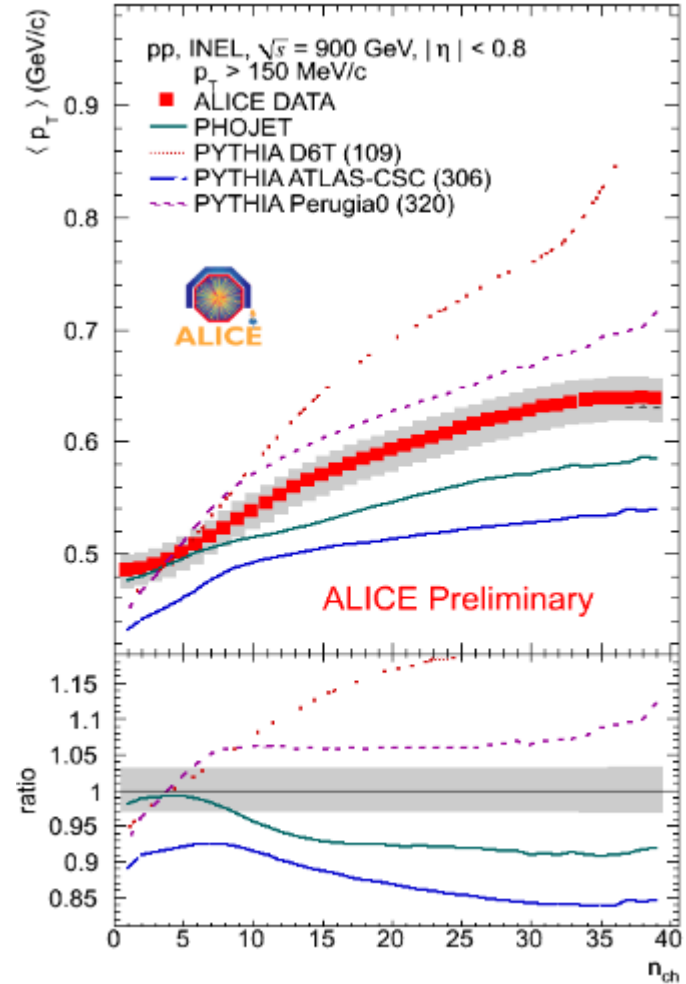
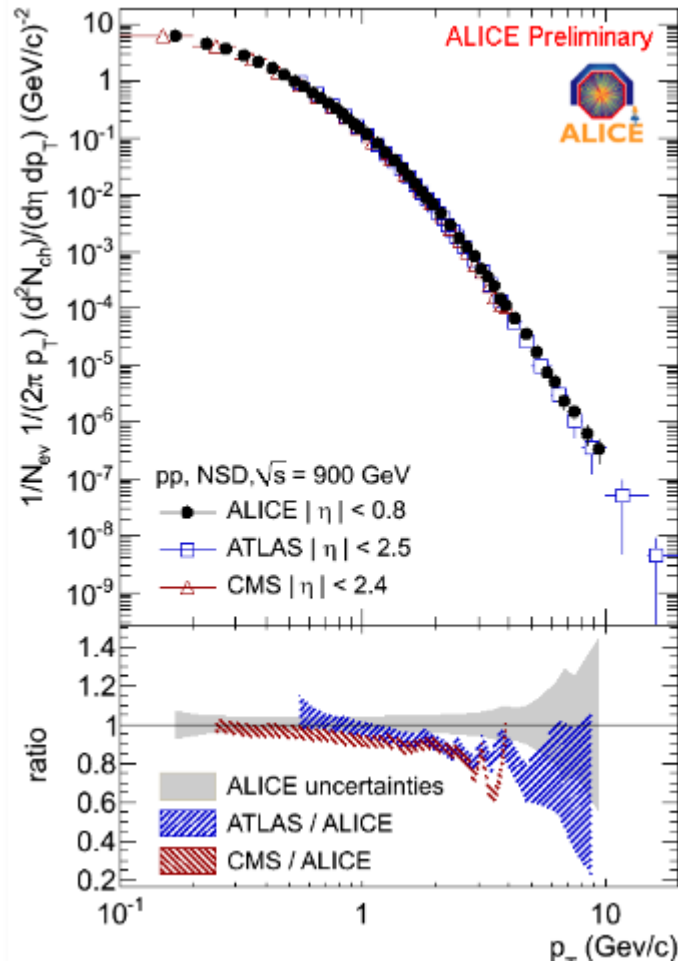
dN_{ch}/dp_T at 900 GeV



→ ALICE measures harder spectrum than CMS, ATLAS, UA1 (narrower window at central rapidity)

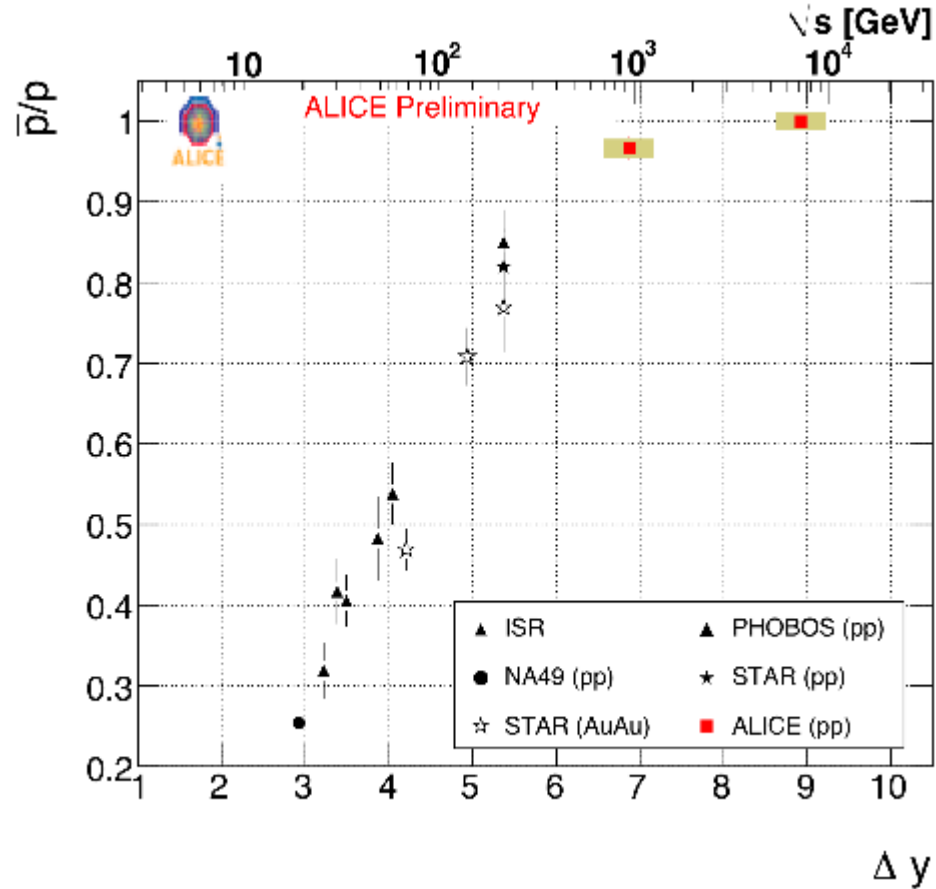


$\langle p_T \rangle$ vs N_{ch} at 900 GeV



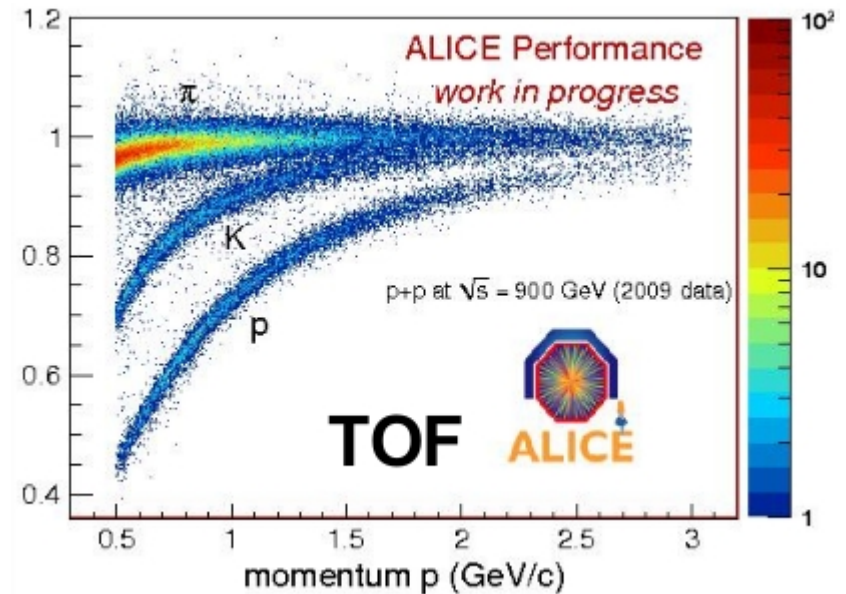
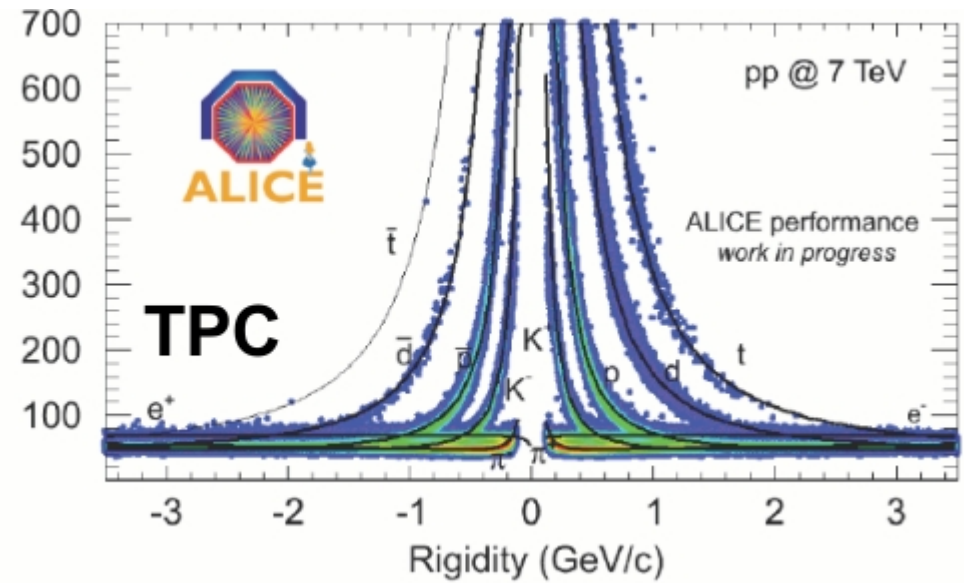
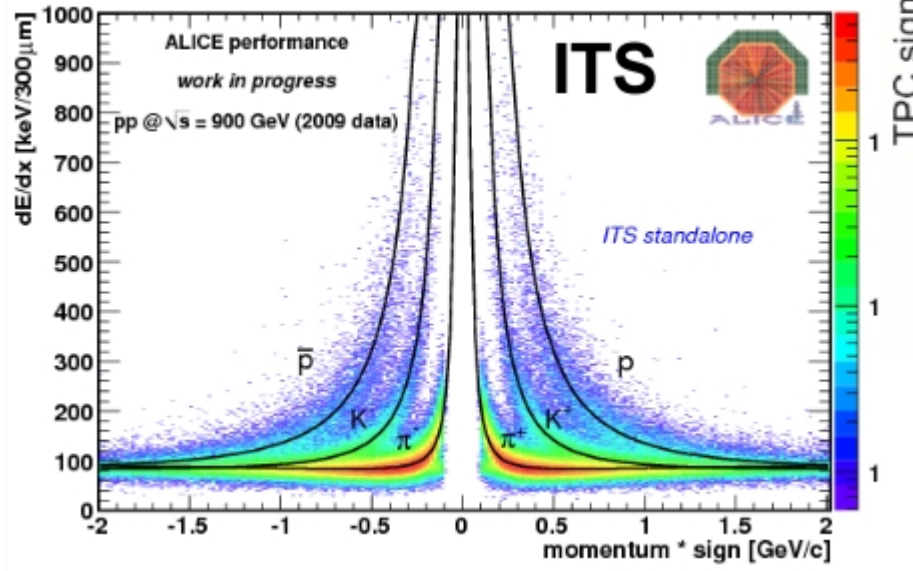


\bar{p}/p at 0.9 and 7 TeV



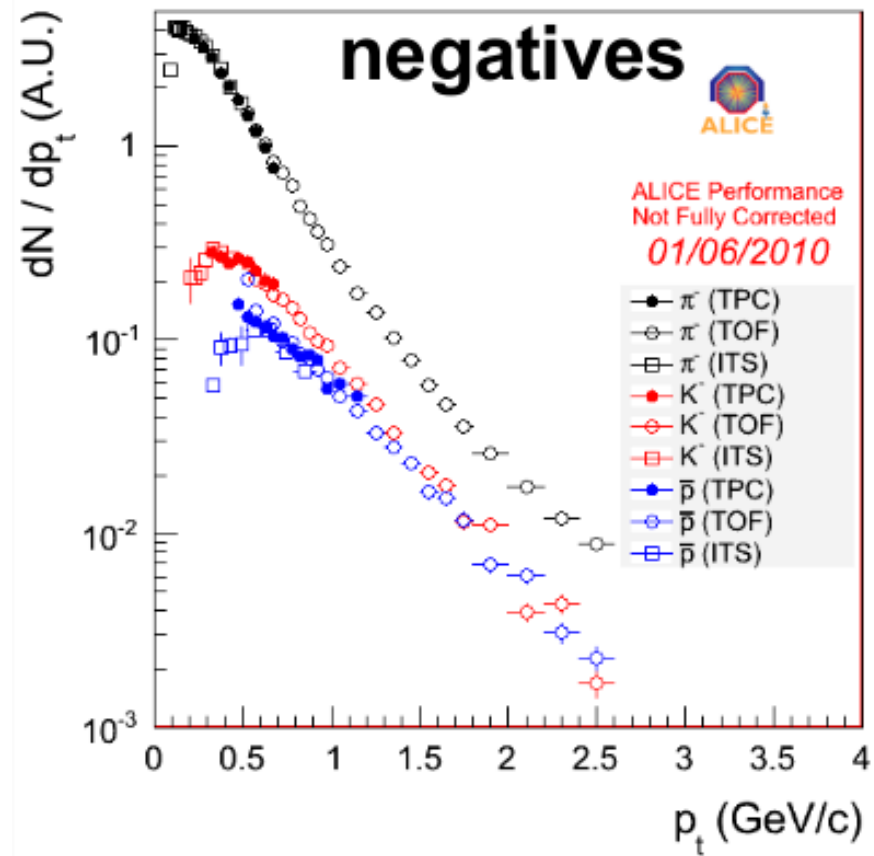
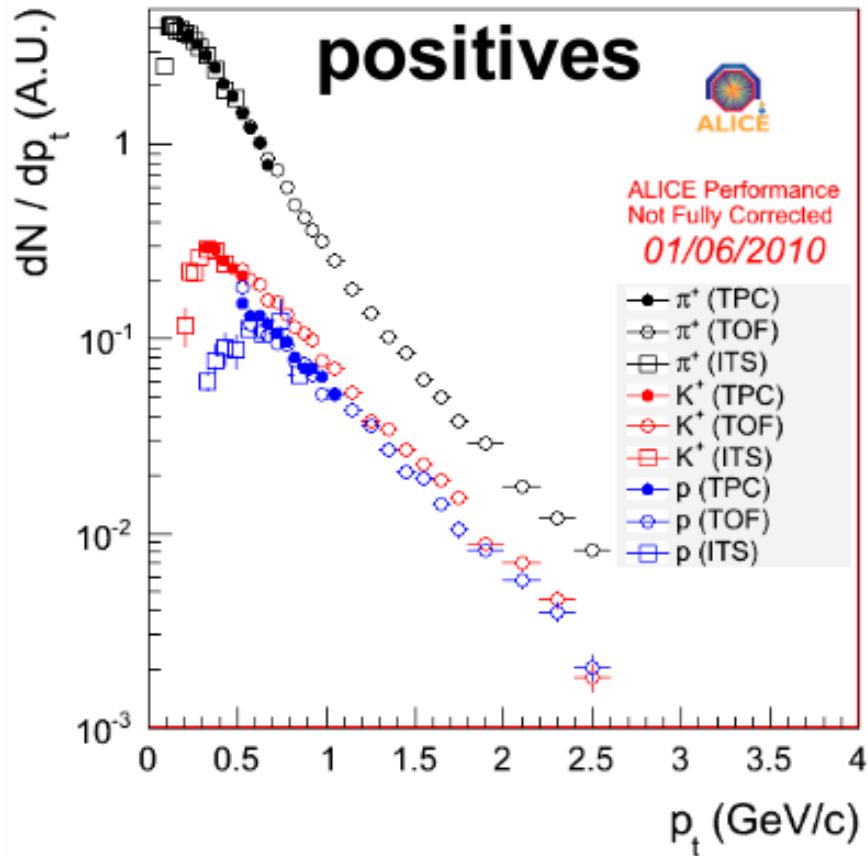


Particle identification





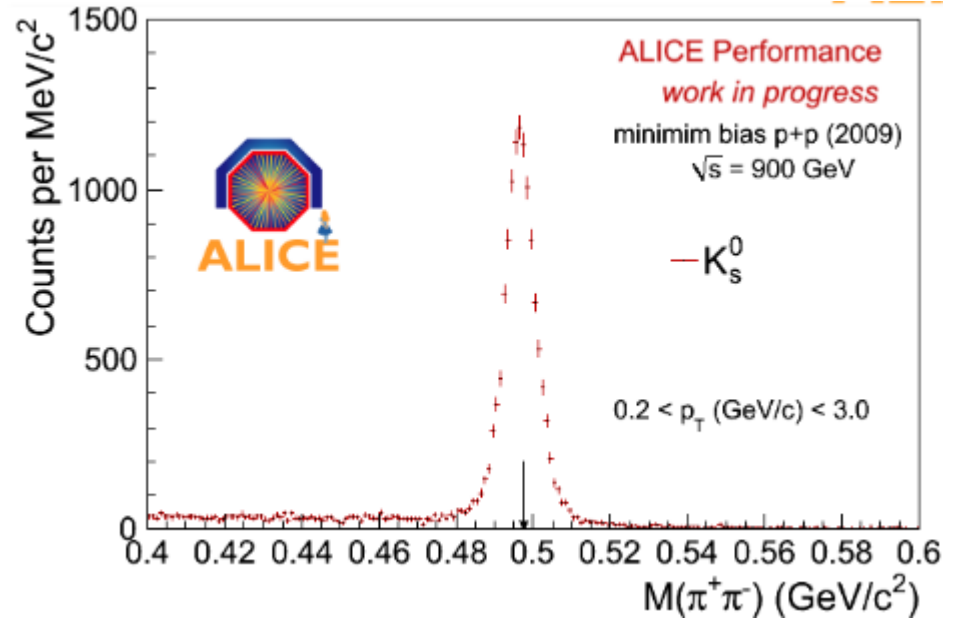
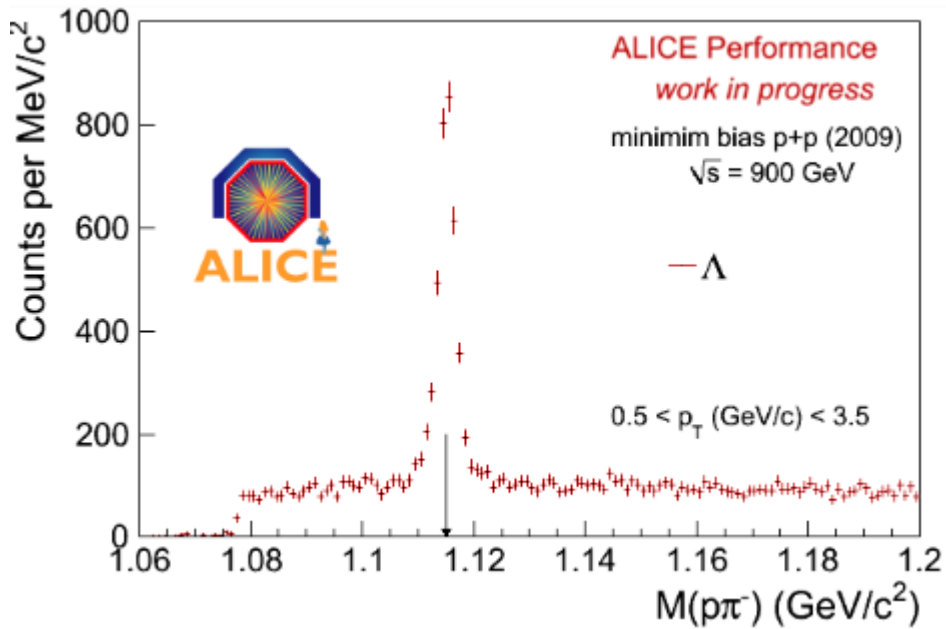
Identified particle spectra



- Analysis in progress (spectra not fully corrected yet)
- Good agreement between the 3 detectors (ITS, TPC, TOF)

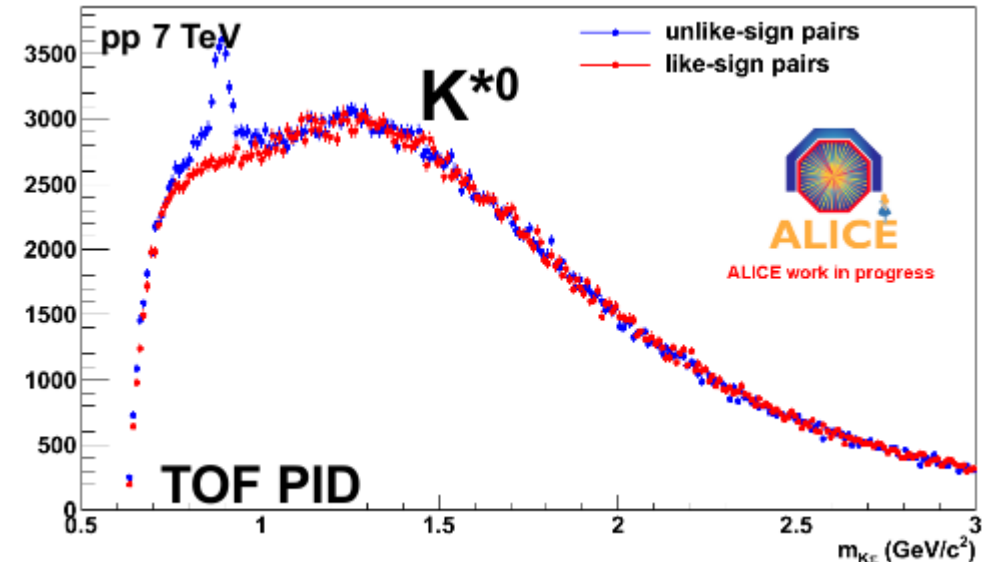
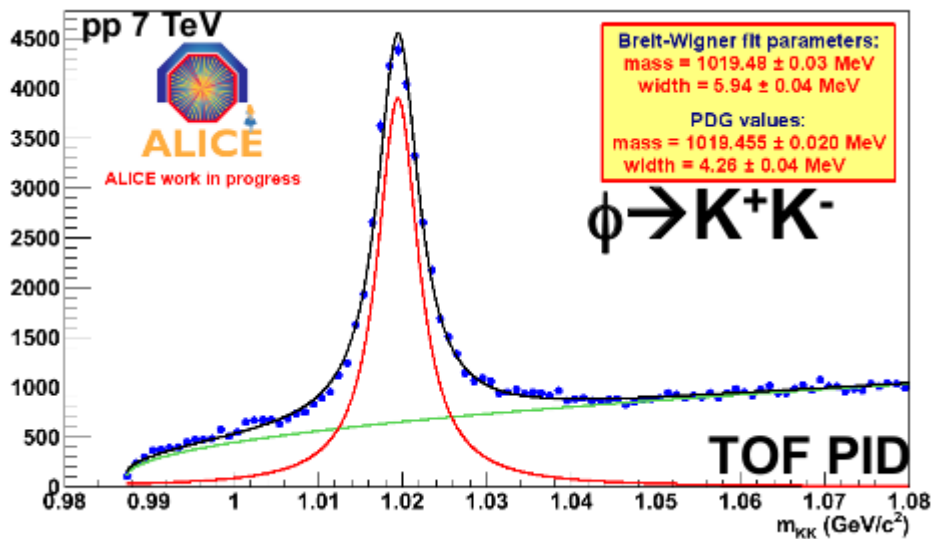
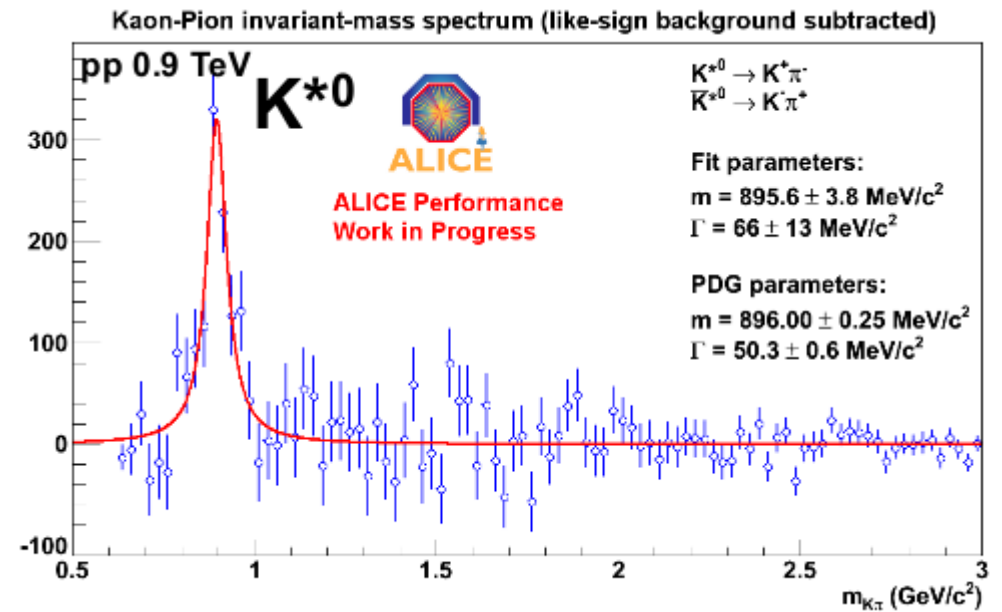
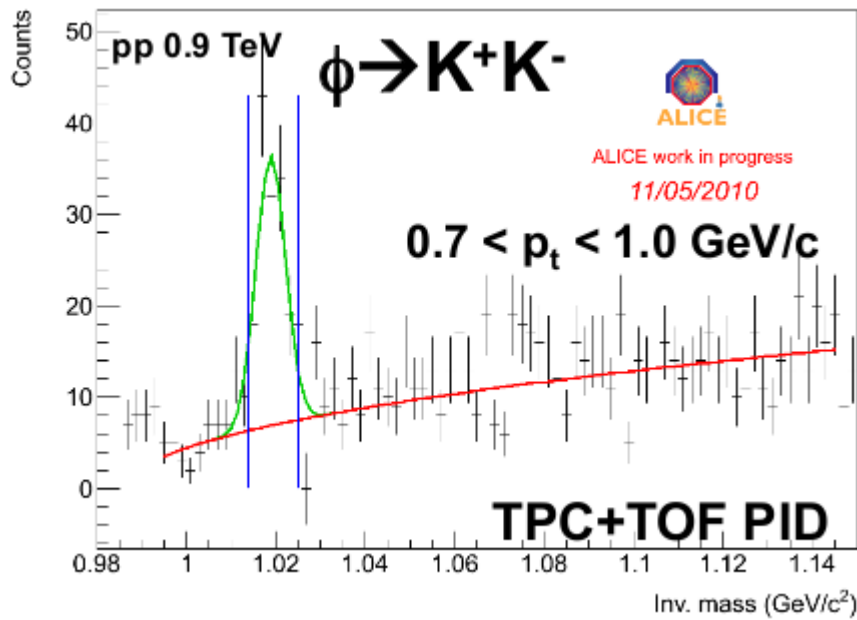


Strangeness in 900 GeV p+p



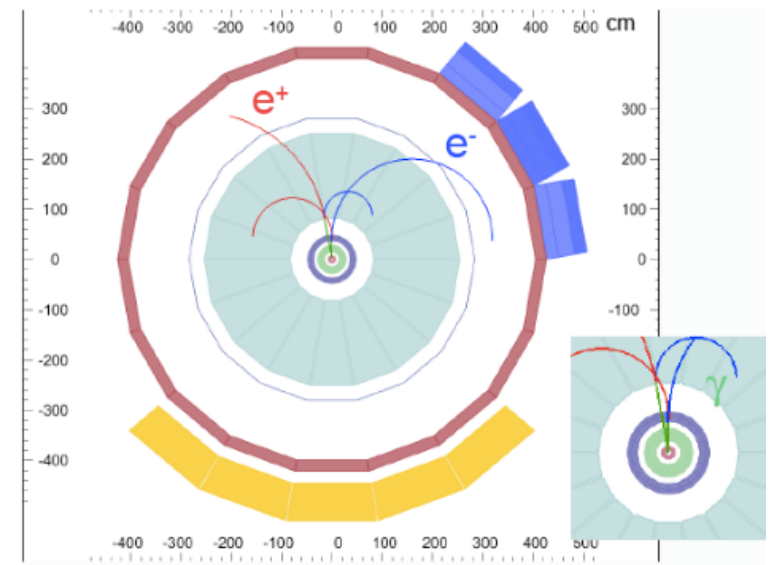
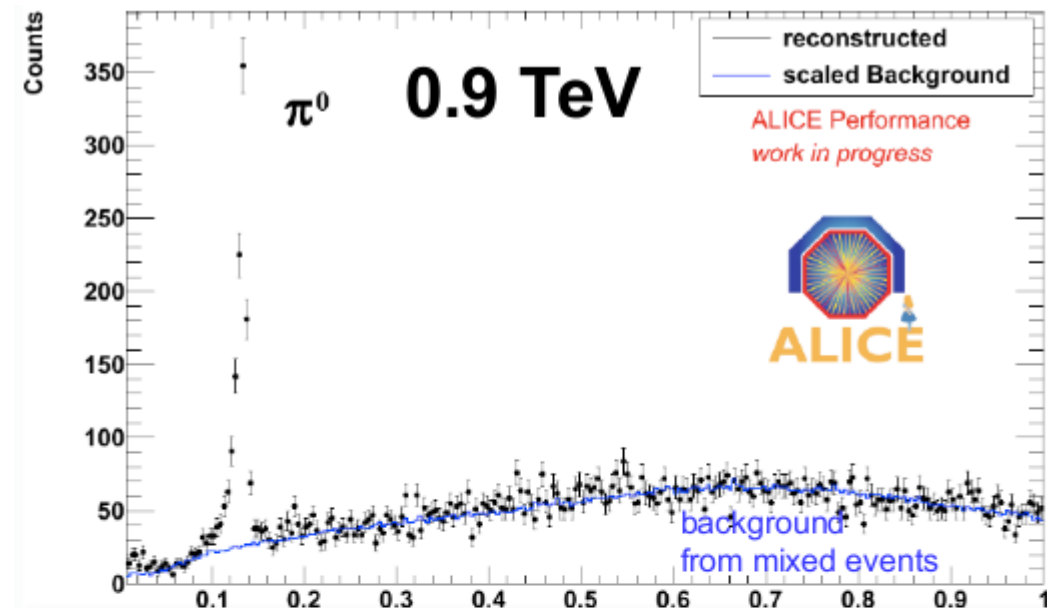


ϕ and K_0^* at 0.9 and 7 TeV

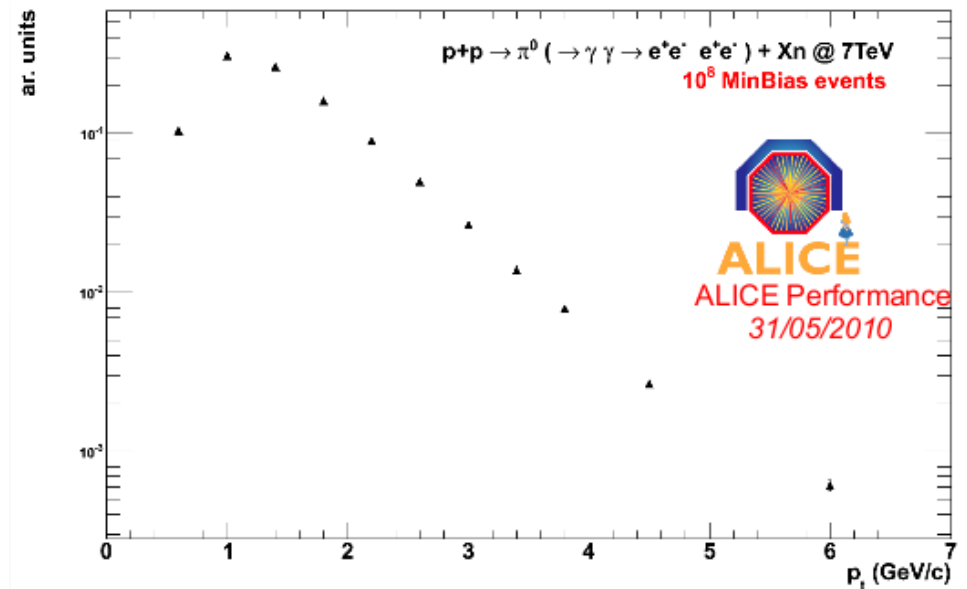
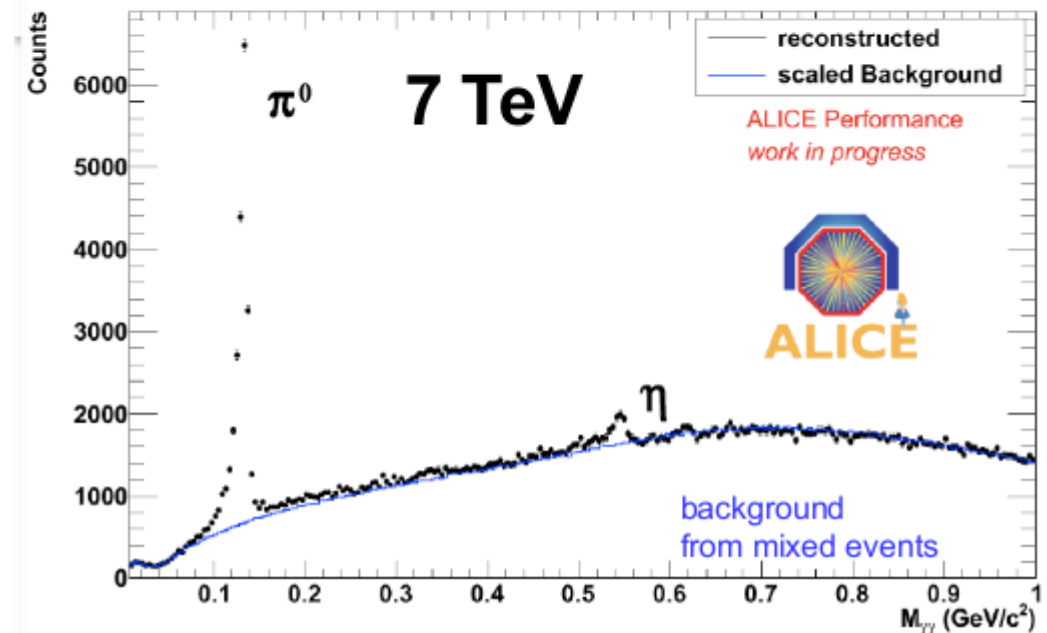




π^0 reconstruction through conversions



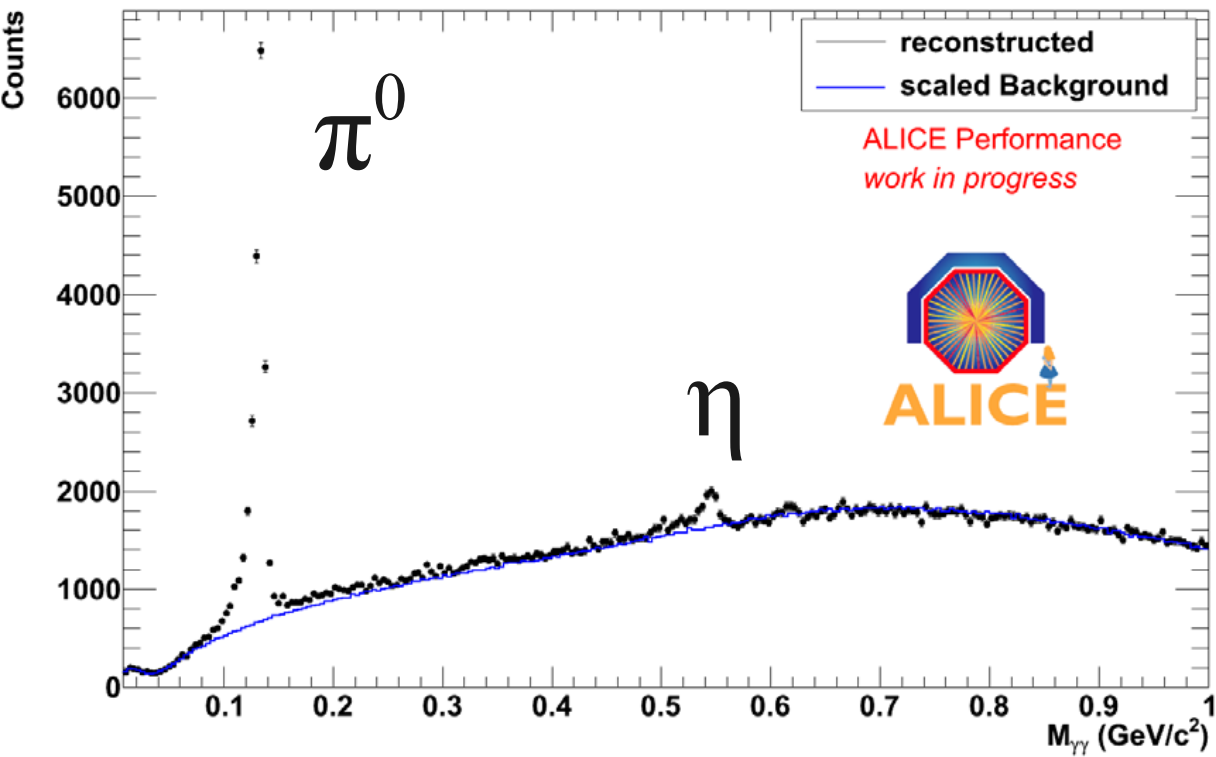
Raw π^0 dN/dp_t



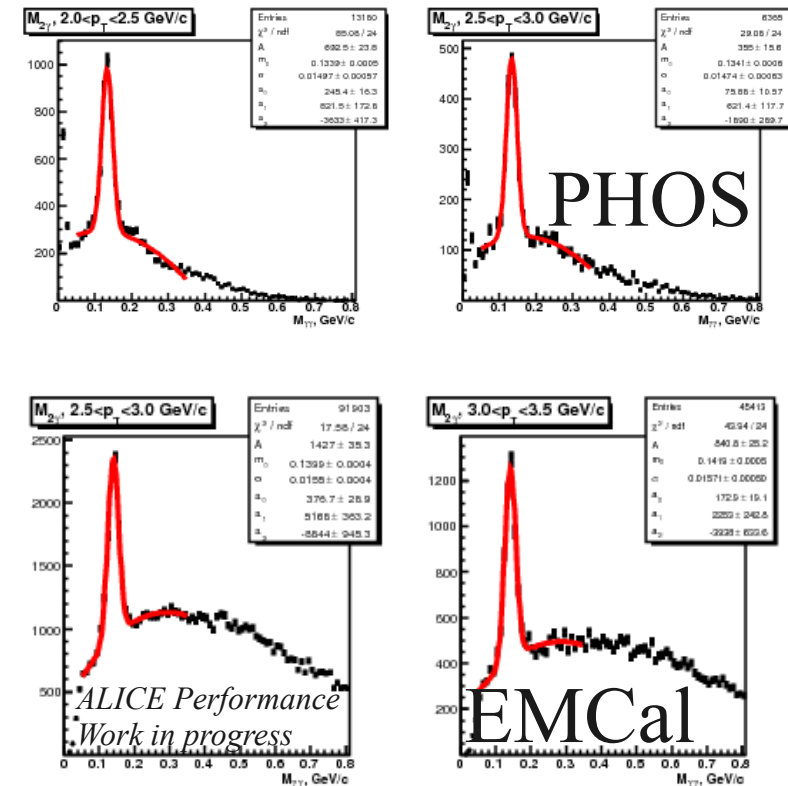


π^0 reconstruction in calorimeters

Conversion electrons in the TPC

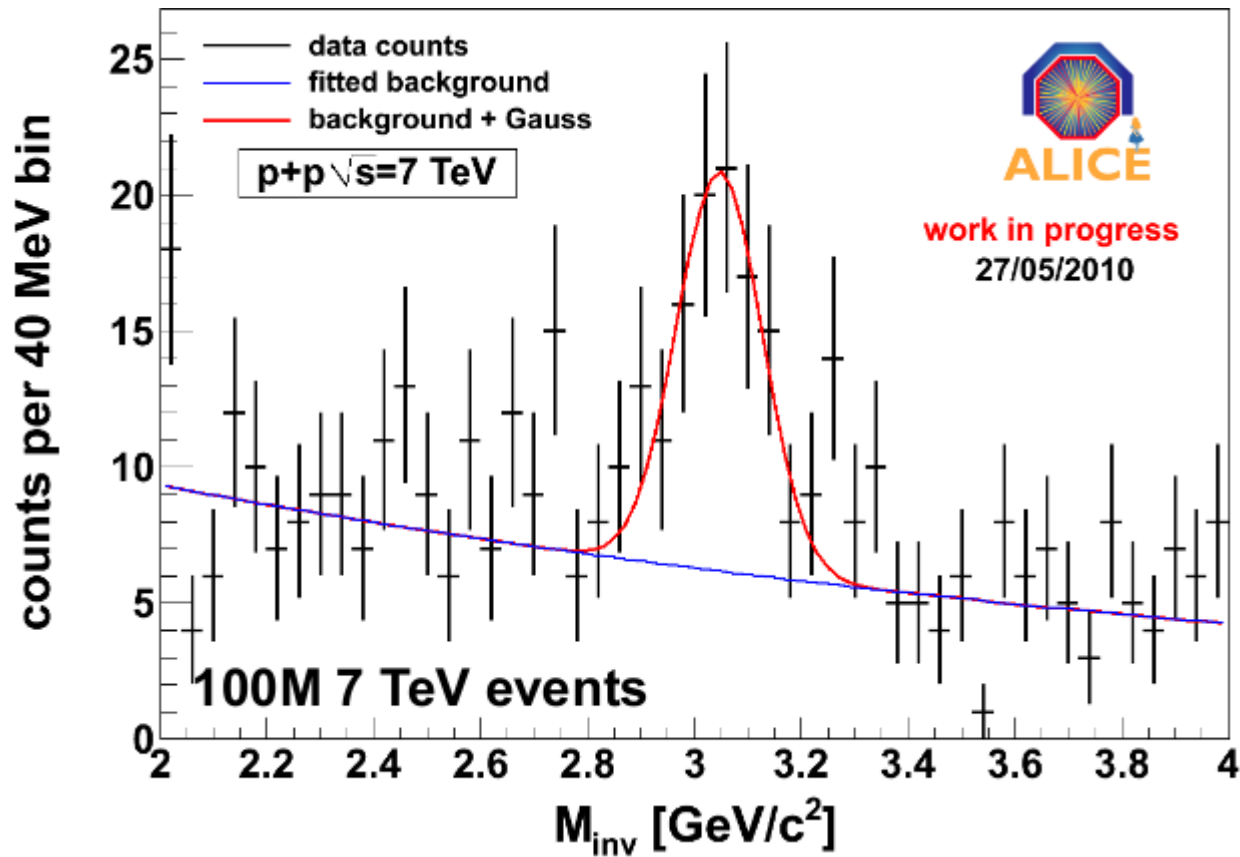


PHOS & EMCal



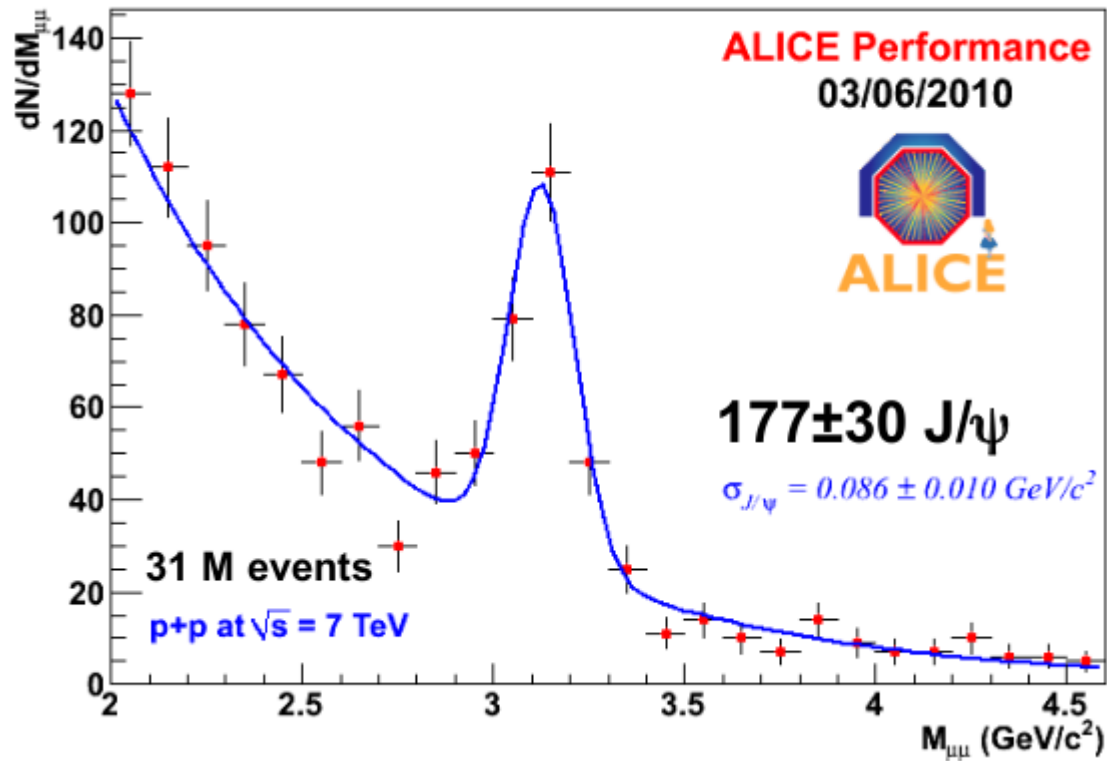


$J/\psi \rightarrow ee, |\eta| < 0.9$





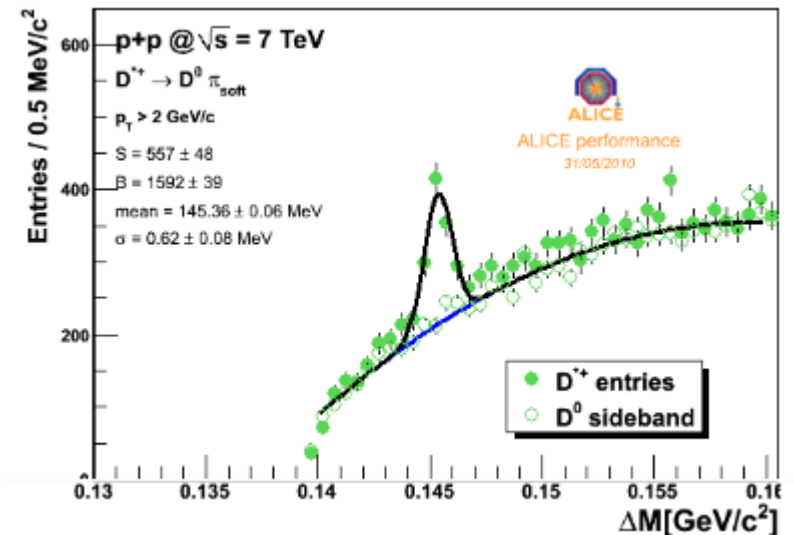
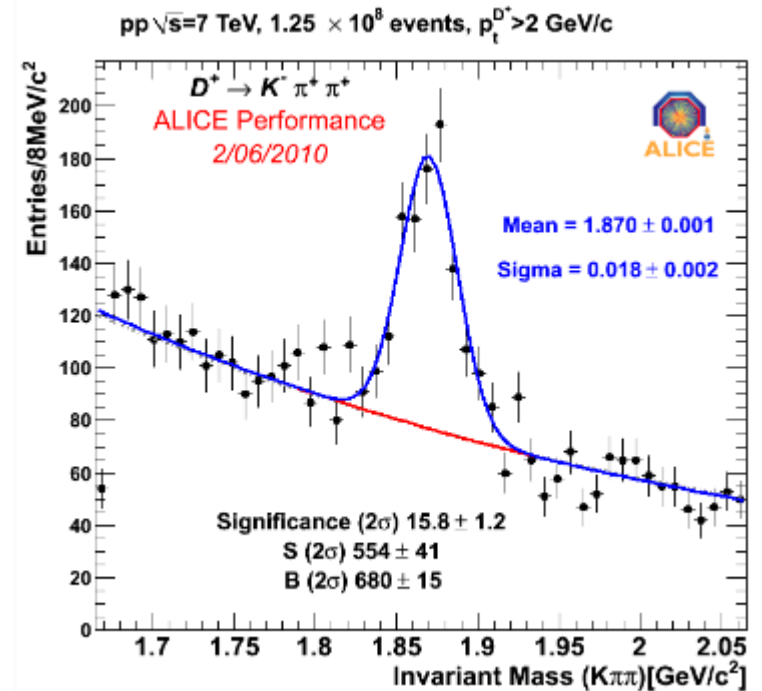
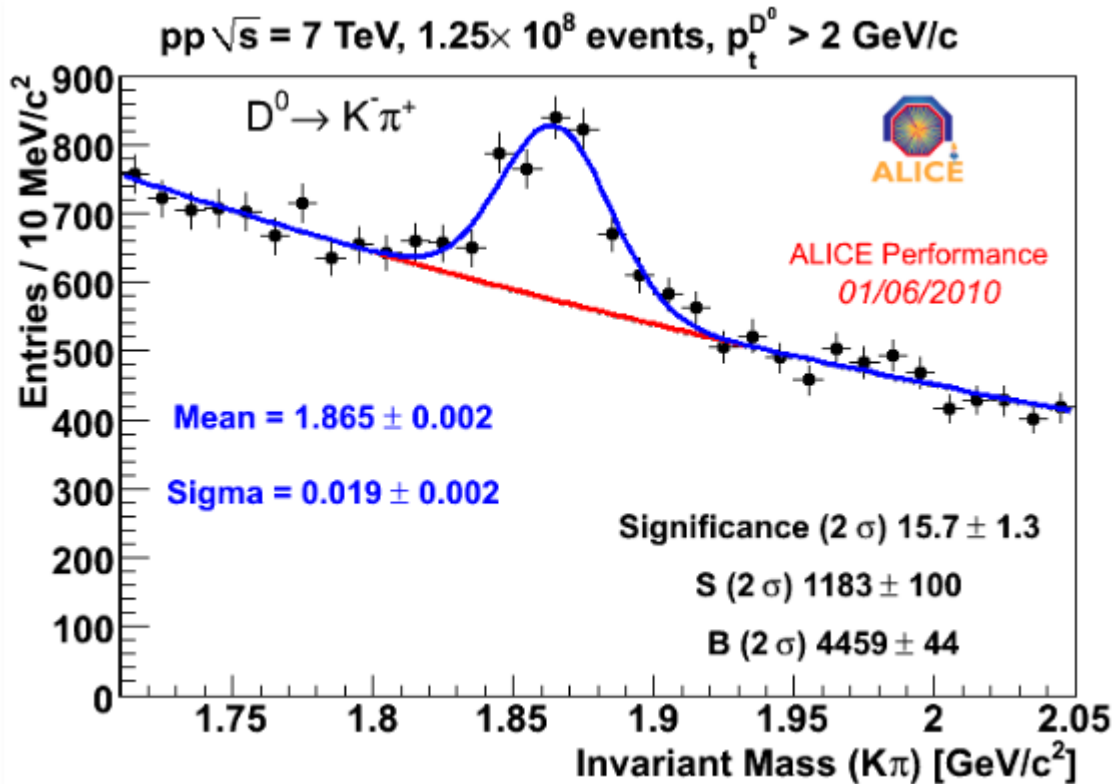
$J/\psi \rightarrow \mu\mu, -4 < \eta < -2.5$





Charm: D^0 , D^+ , D^{*+}

- 1.25×10^8 pp at 7 TeV
- Signals in 4 pt bins in 2-10 GeV/c
- expect to cover 0.5-15 GeV/c with 10^9





Conclusions

- Particle multiplicity
 - increase from 0.9 to 7 TeV significantly larger ($>20\%$) than predicted
- Momentum spectra
 - $\langle p_T \rangle$ vs N_{ch} not described by any of the MCs
- Anti-proton/proton ratio at midrapidity
- \bar{p}/p goes to 1 at 7 TeV
- Promising performance for ID spectra, strangeness, charm, charmonium

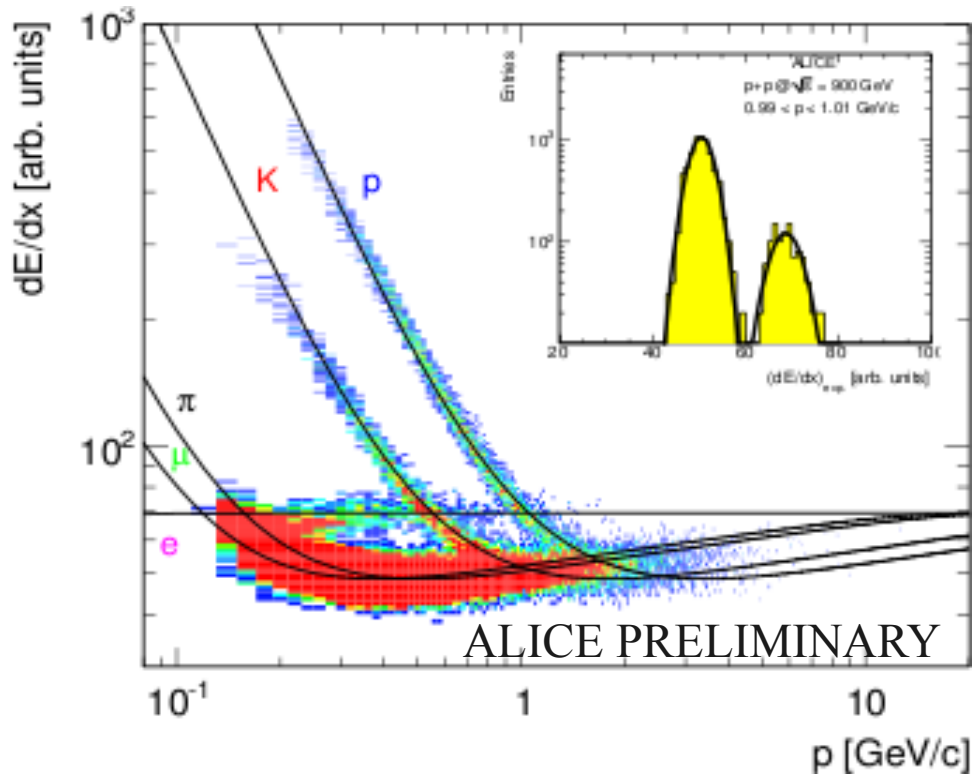


Backup slides

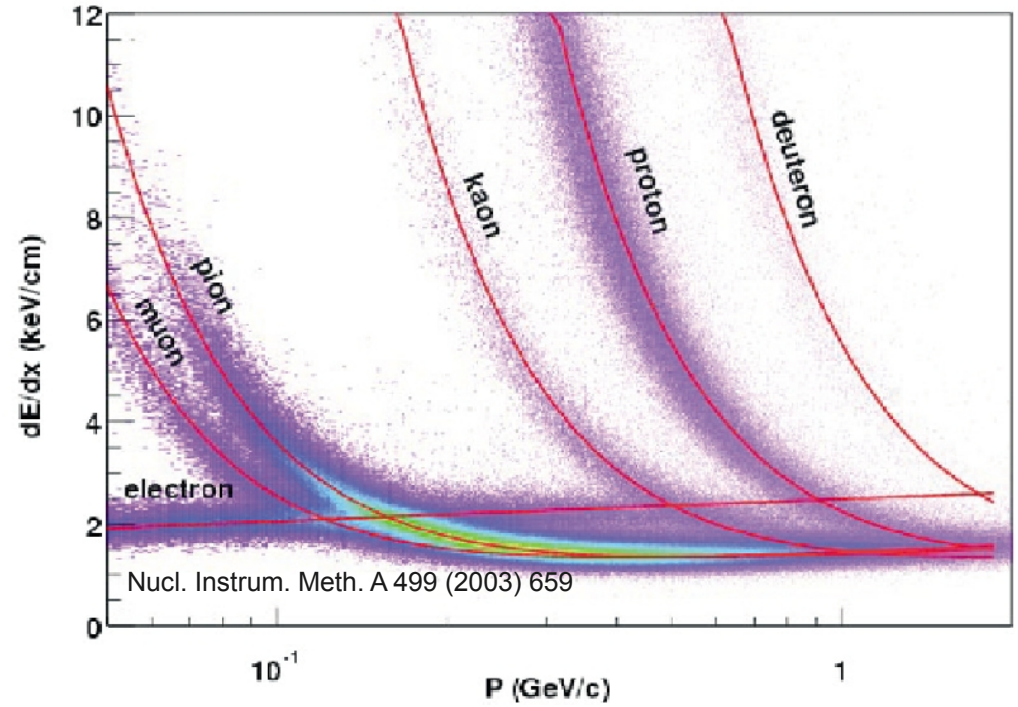


TPC Performance

ALICE



STAR





Simple Expectations for Heavy Ion Physics at LHC

	SPS	RHIC	LHC	
$\sqrt{s_{NN}}$ (GeV)	17	200	5500	28x
$dN_{ch}/d\eta$	~ 700	~ 1200	$\sim 2000-8000$	2-7x
T/T_c	1.1	1.9	3.0-4.2	Hotter
ε (GeV/fm ³)	3	5	15-60	Denser
τ_{QGP} (fm/c)	≤ 2	2-4	> 10	Longer lived

RHIC and LHC:

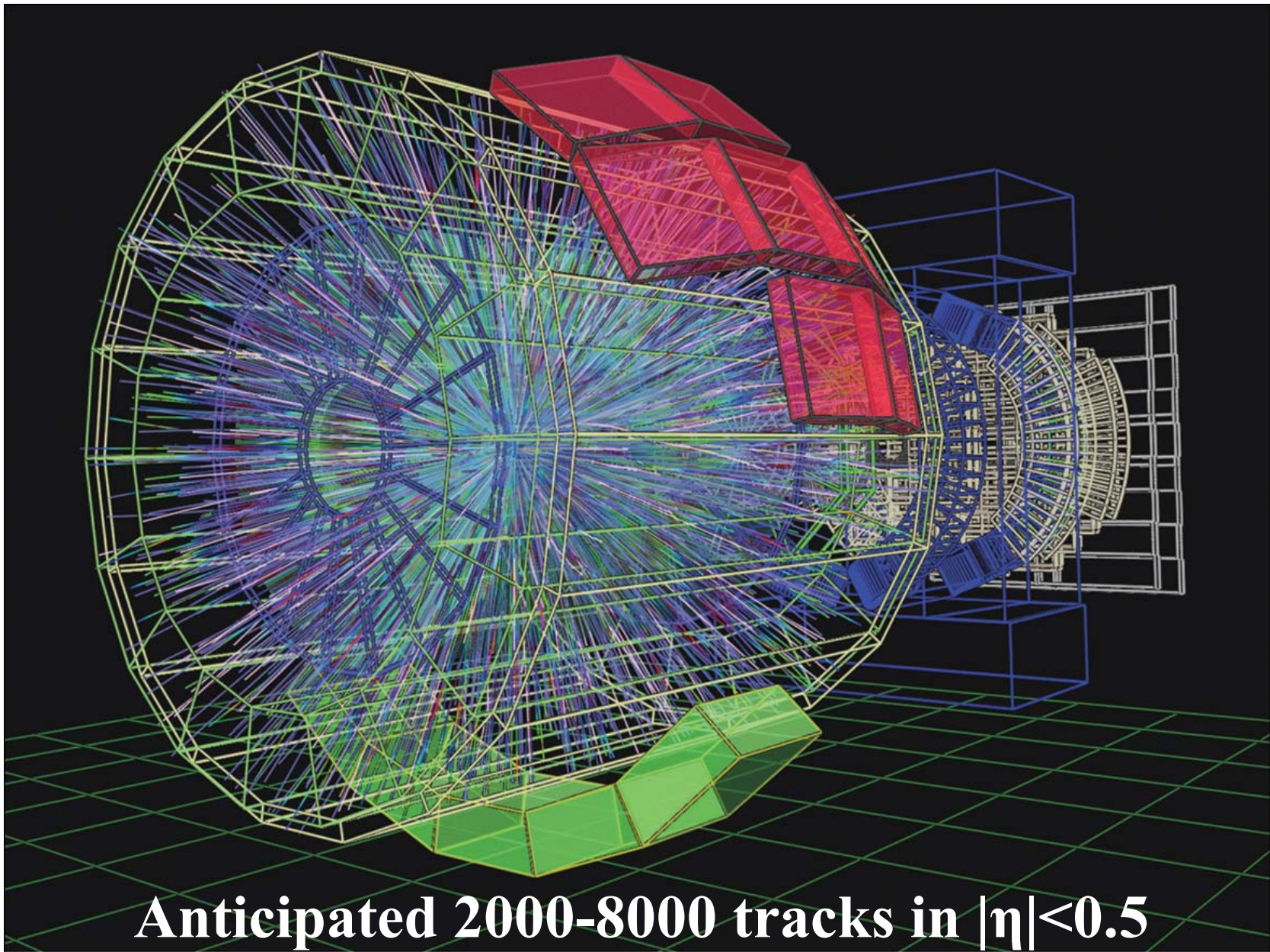
Cover 2 –3 decades of energy ($\sqrt{s_{NN}} \sim 20$ GeV –5.5 TeV)

To discover the properties of hot QCD at $T \sim 150$ –600 MeV





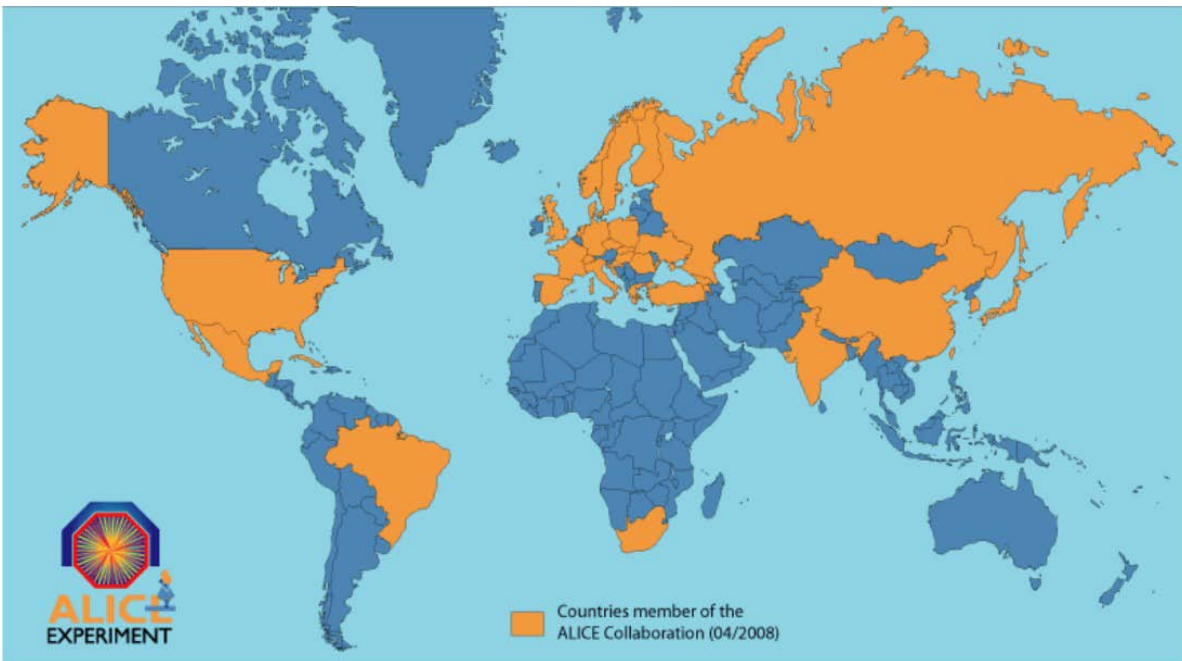
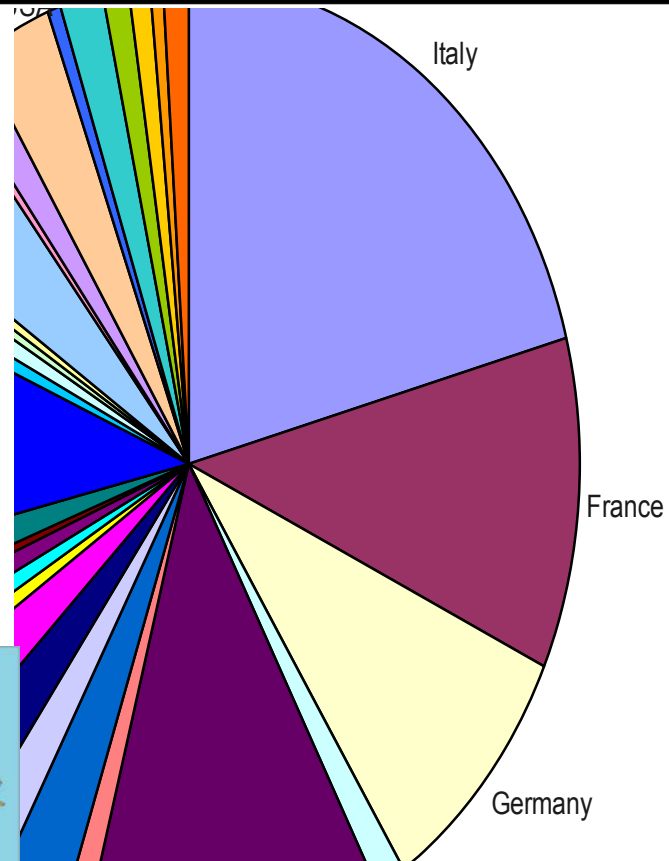
Simulated event





The ALICE Collaboration

- ~1000 Members
63% from CERN
member states
- ~30 Countries
- ~100 Institutes
- ~150 MCHF capital cost
(+magnet)



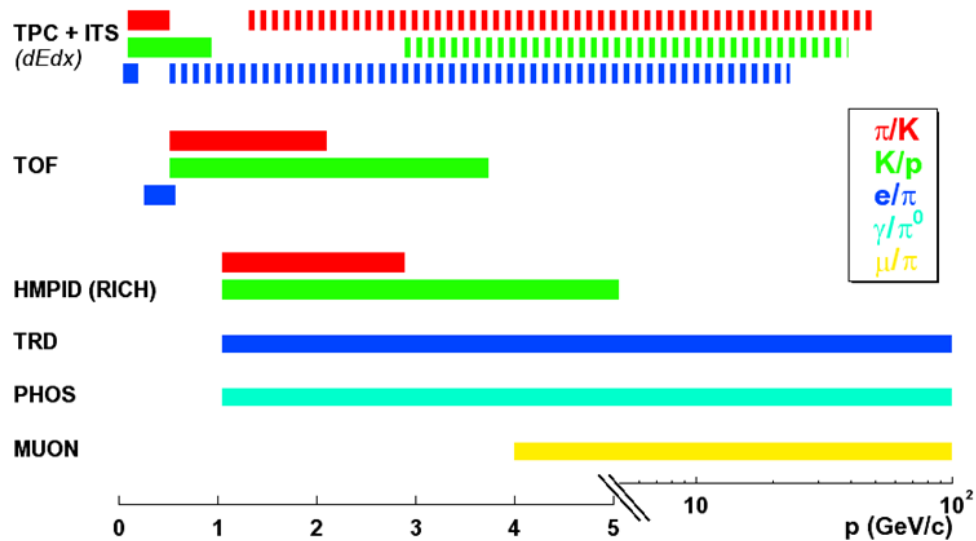
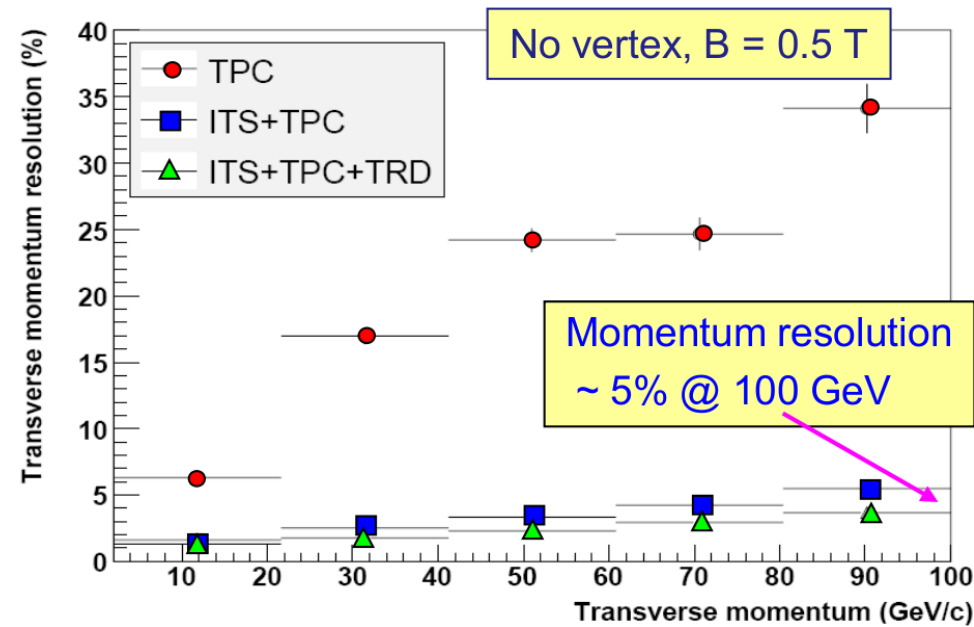
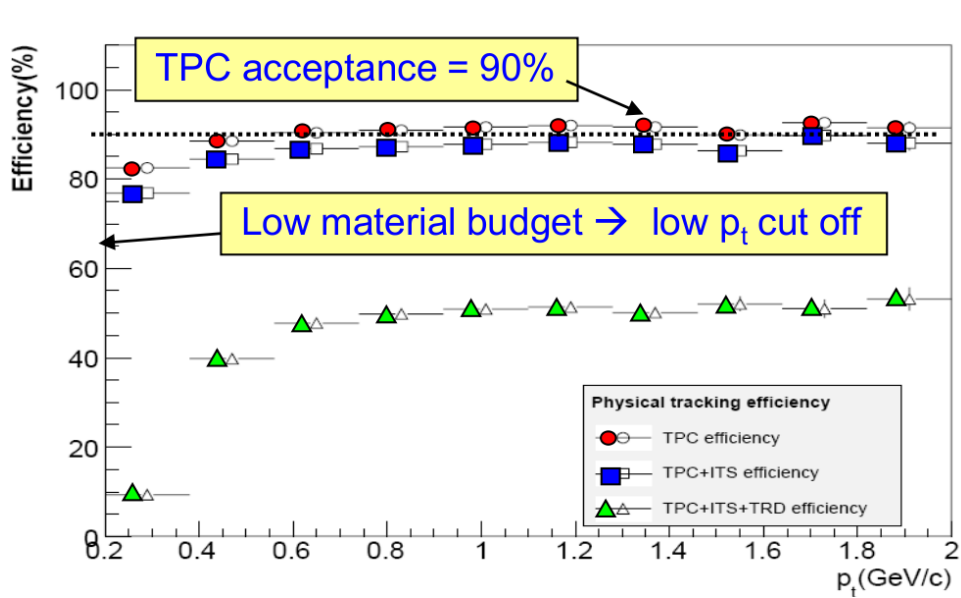
US ALICE

11 Institutions 53 members (inc. 12 grad. Students)
Cal. St. U. –San Luis Obispo, Creighton University, University of Houston, Lawrence Berkeley Nat. Lab, Lawrence Livermore Nat. Lab, Oak Ridge Nat. Lab, Ohio State University, Purdue University, University of Tennessee, Wayne State University, Yale University





ALICE Performance

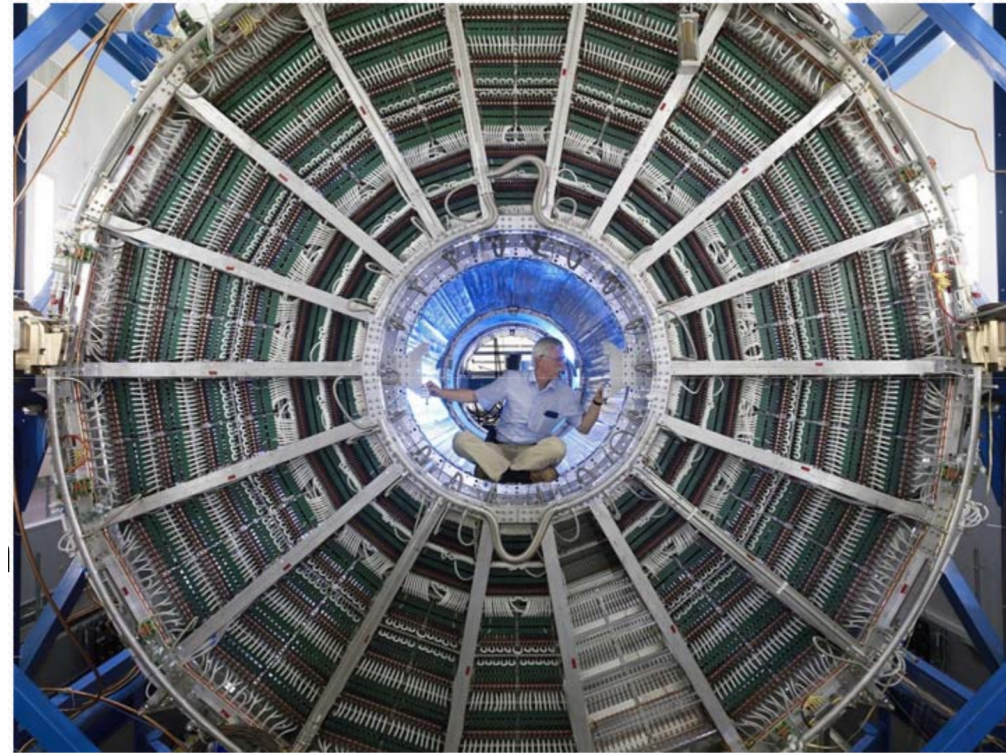
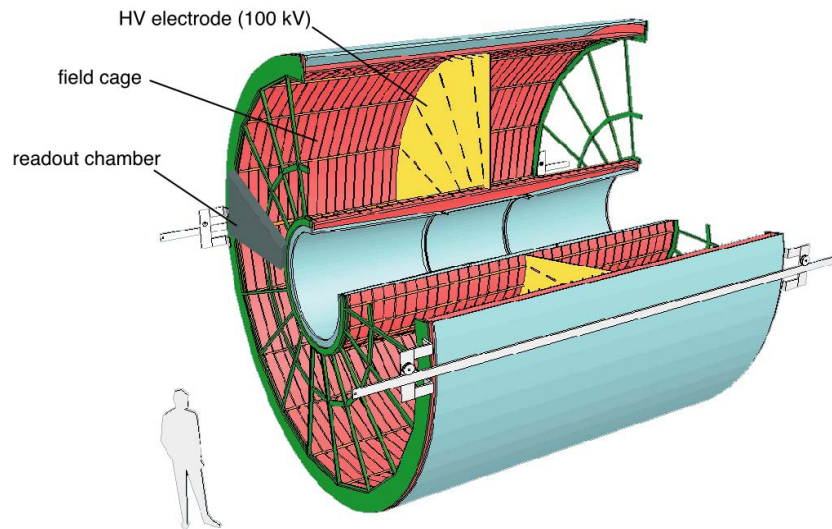




The Time Projection Chamber

Specifications

- Designed for $dN_{\text{ch}}/d\eta=8000$
- $|\eta|<0.9$, radius 0.9-2.5m
- In a 0.5 T Solenoidal Field
- 570k channels, 80MB/event
- 3% radiation length
- Outer diameter 5 m, Length 5 m
- Largest ever

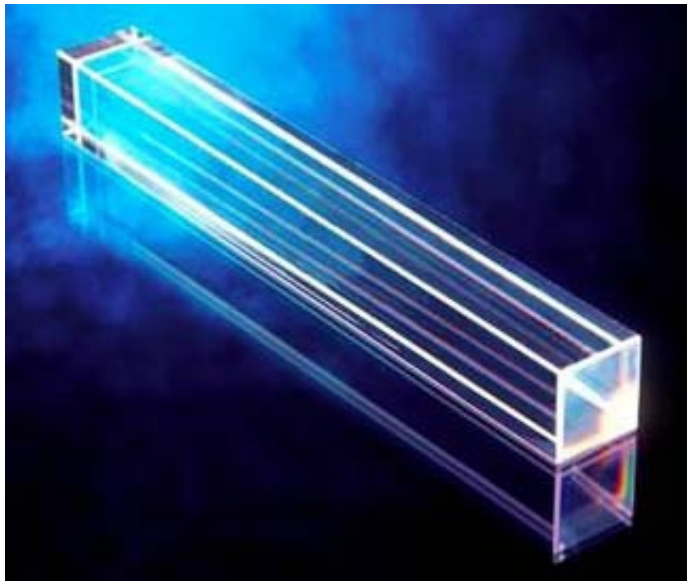




PHOS

PHOton Spectrometer

- PbO_4W crystal calorimeter
- γ, π^0, η for $1 < p < 100$ GeV
- $|\eta| < 0.12, \Delta\phi = 100^\circ$
- $\sigma(E)/E = 3\%, \sigma(x,y) = 4\text{mm}$





TRD, TOF, HMPID

Transition Radiation Detector

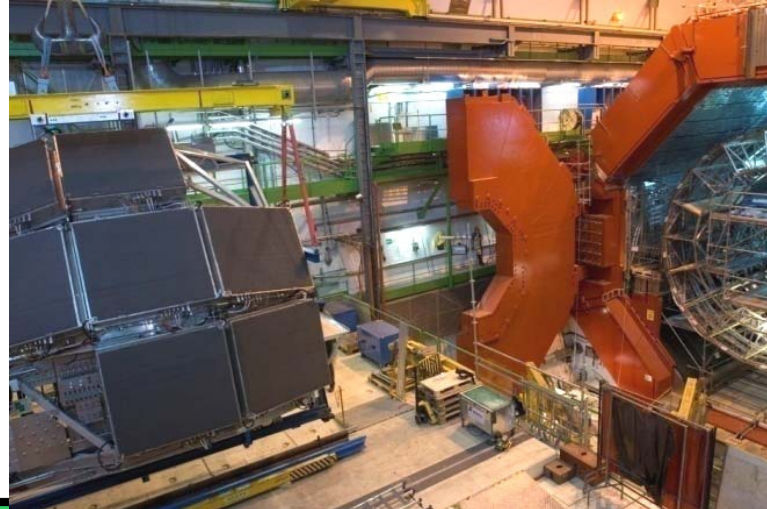
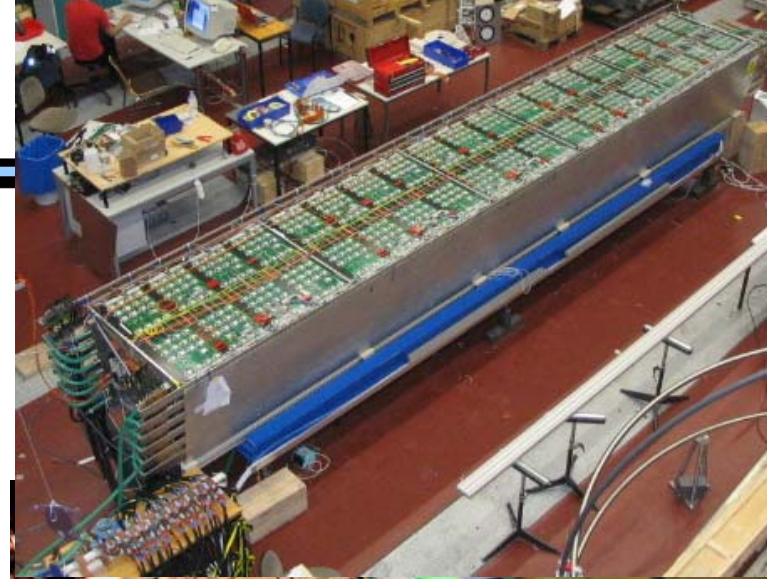
- $p_T > 1$ GeV electron id, $p_T > 3$ GeV trigger
- 540 modules, 4.8 cm radiator with 1.2M channels
- MWPC readout

Time Of Flight

- Multi-gap Resistive Plate Chambers (MRPC)
- 50 ps resolution at ~ 5 m
- $|\eta| < 0.85$, $\Delta\phi = 2\pi$

High Momentum PID

- Proximity focused, Ring Imaging Cherenkov RICH
- $|\eta| < 0.6$, $\Delta\phi = \pi/3$
- PID $1 < p < 6$ GeV



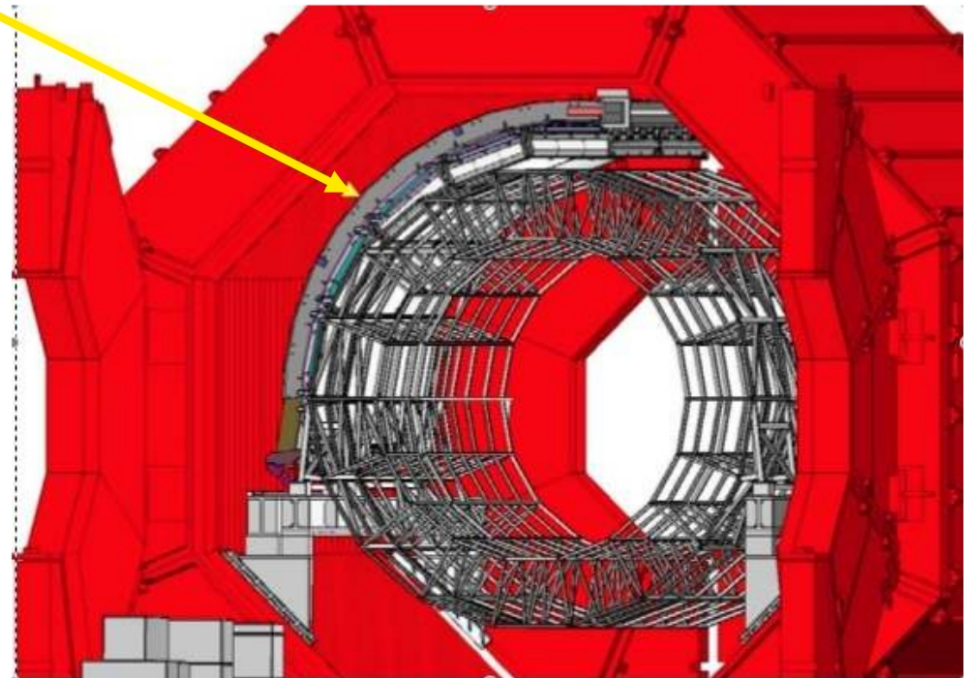
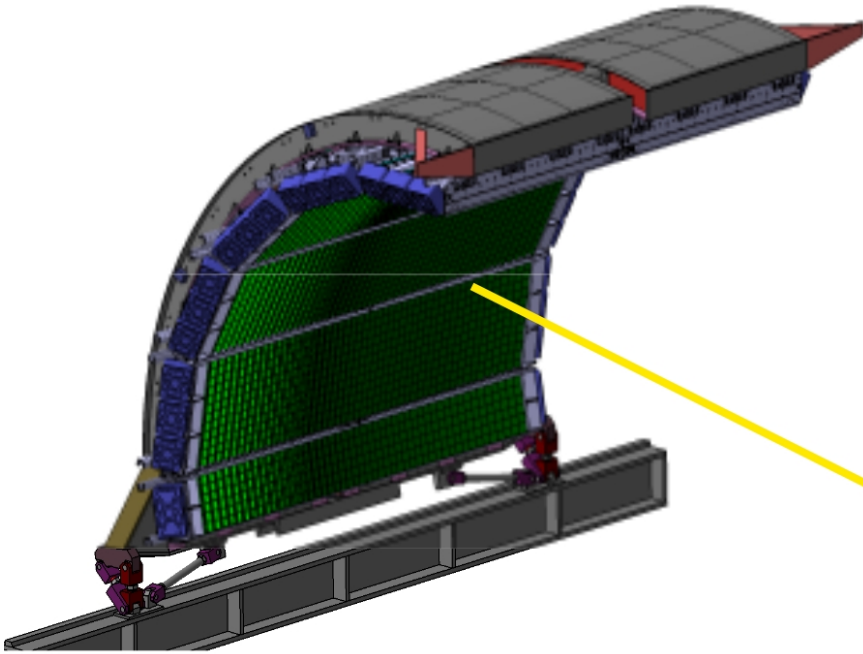


EMCal

Current coverage:

$\Delta\eta=1.4, \Delta\phi=39^\circ$ ($R \approx 0.3$ max)

Full calorimeter installation scheduled for 2012



- Lead-scintillator sampling calorimeter
- 13 k towers
- Each tower $\Delta\eta \times \Delta\phi = 0.014 \times 0.014$
- Shashlik geometry
- Avalanche photodiodes
- $\Delta\eta=1.4, \Delta\phi=107^\circ$
- $\sigma(E)/E = 0.12/\sqrt{E} + 0.02$