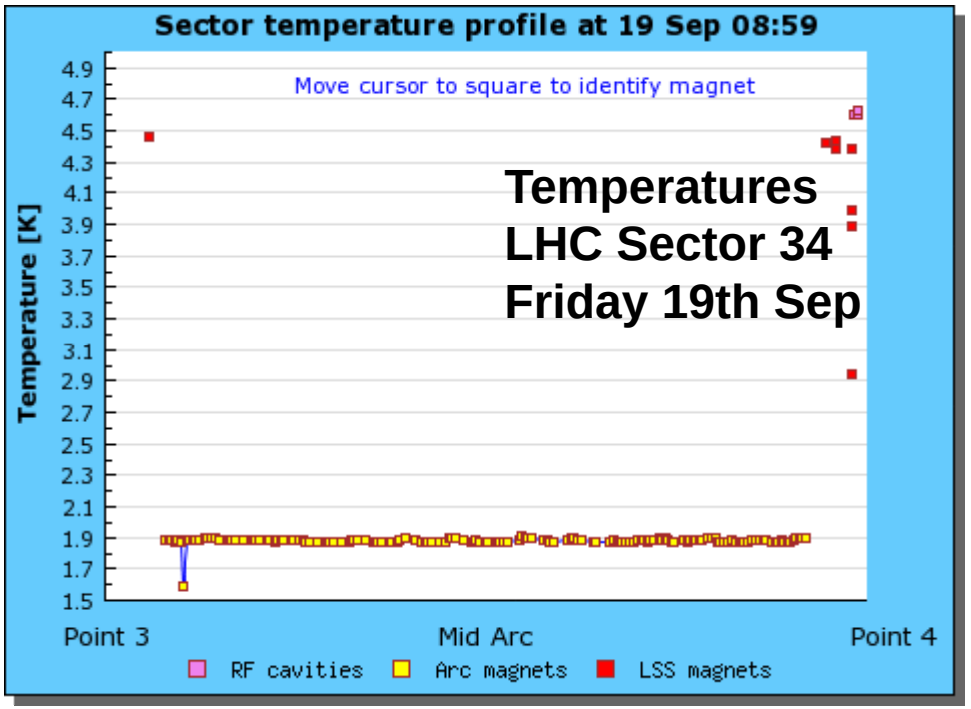


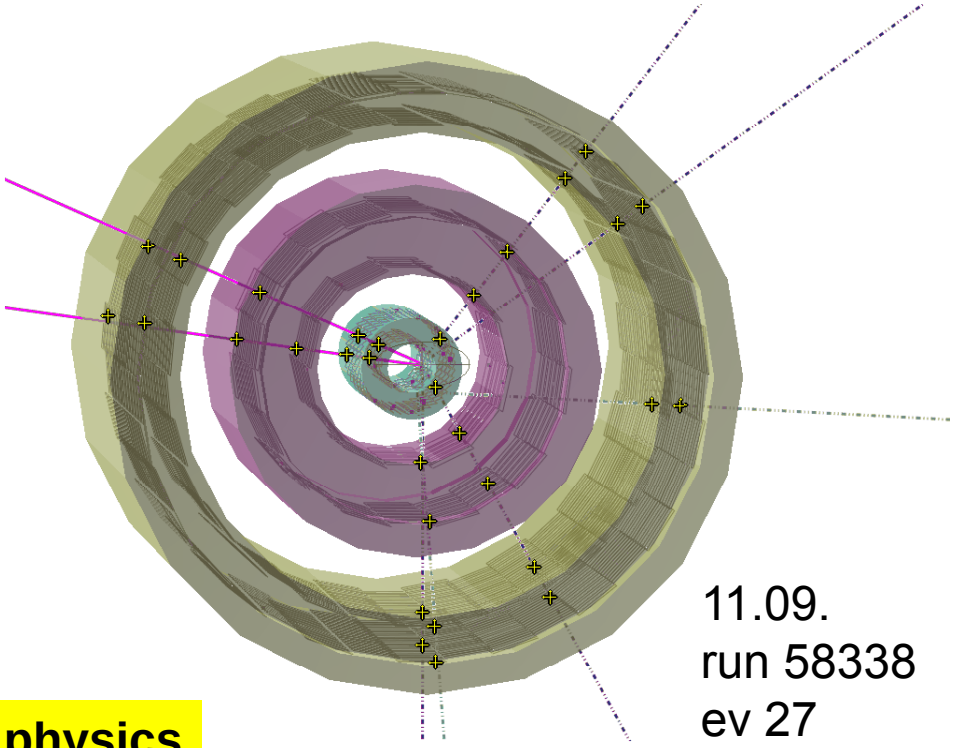
First Physics with ALICE

Physics at LHC
Split, 29.09. – 04.10.2008

Jan Fiete Grosse-Oetringhaus
(for the ALICE collaboration)

Content

- ALICE
- First Physics Plans
  - Pseudorapidity density $dN_{ch}/d\eta$
  - Multiplicity distribution
  - Particle Spectra



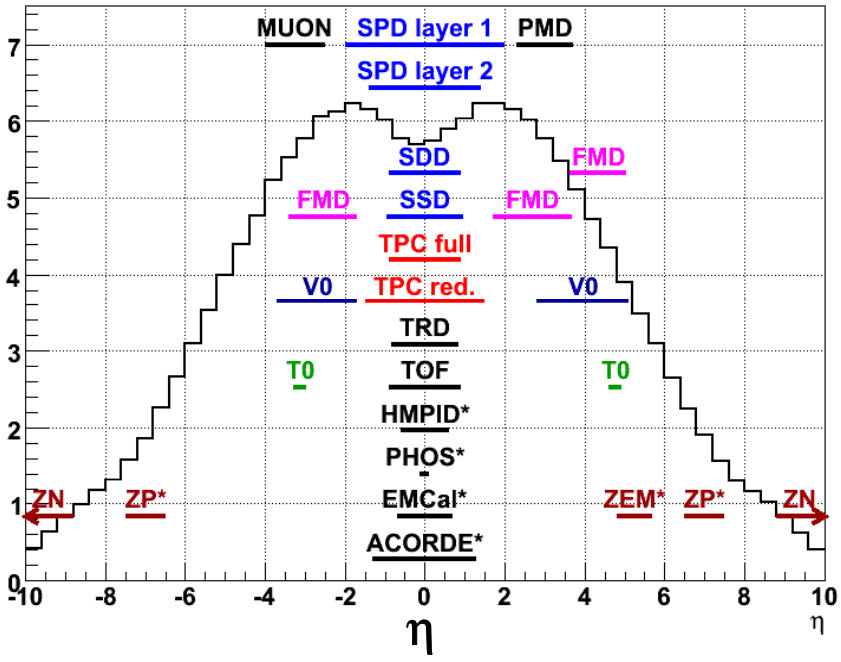
11.09.
run 58338
ev 27

Data needed for "first" physics
1-2 days to 1-2 weeks

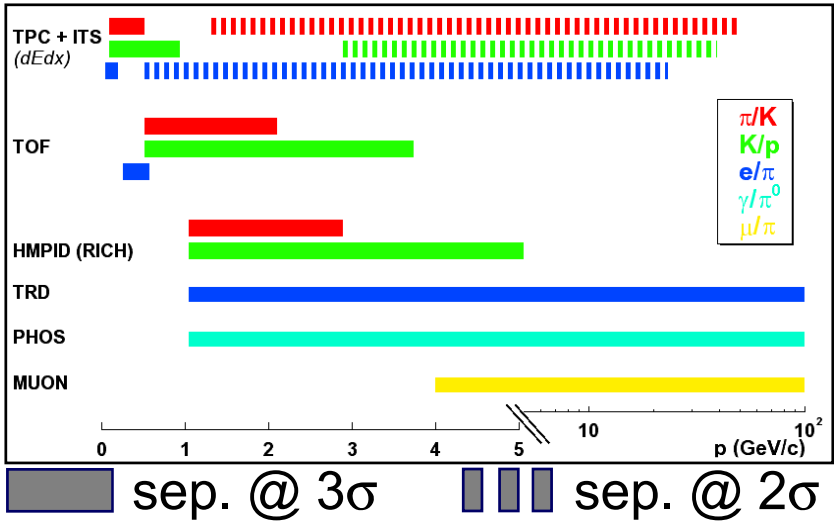
ALICE

- Heavy-ion experiment
  - p+p program integral part of the physics program
- Designed for $dN_{ch}/d\eta \mid_{\eta = 0}$ up to 6000
  - Low p_T cut off ~ 30 MeV/c
- Tracks and identifies particles over broad momentum range (~ 100 MeV/c – 100 GeV/c)
- Reconstruct short-lived particles (hyperons, B and D mesons) → decay vertices
  - Primary vertex resolution ~ 100 μm (p+p), 10 μm (Pb+Pb)

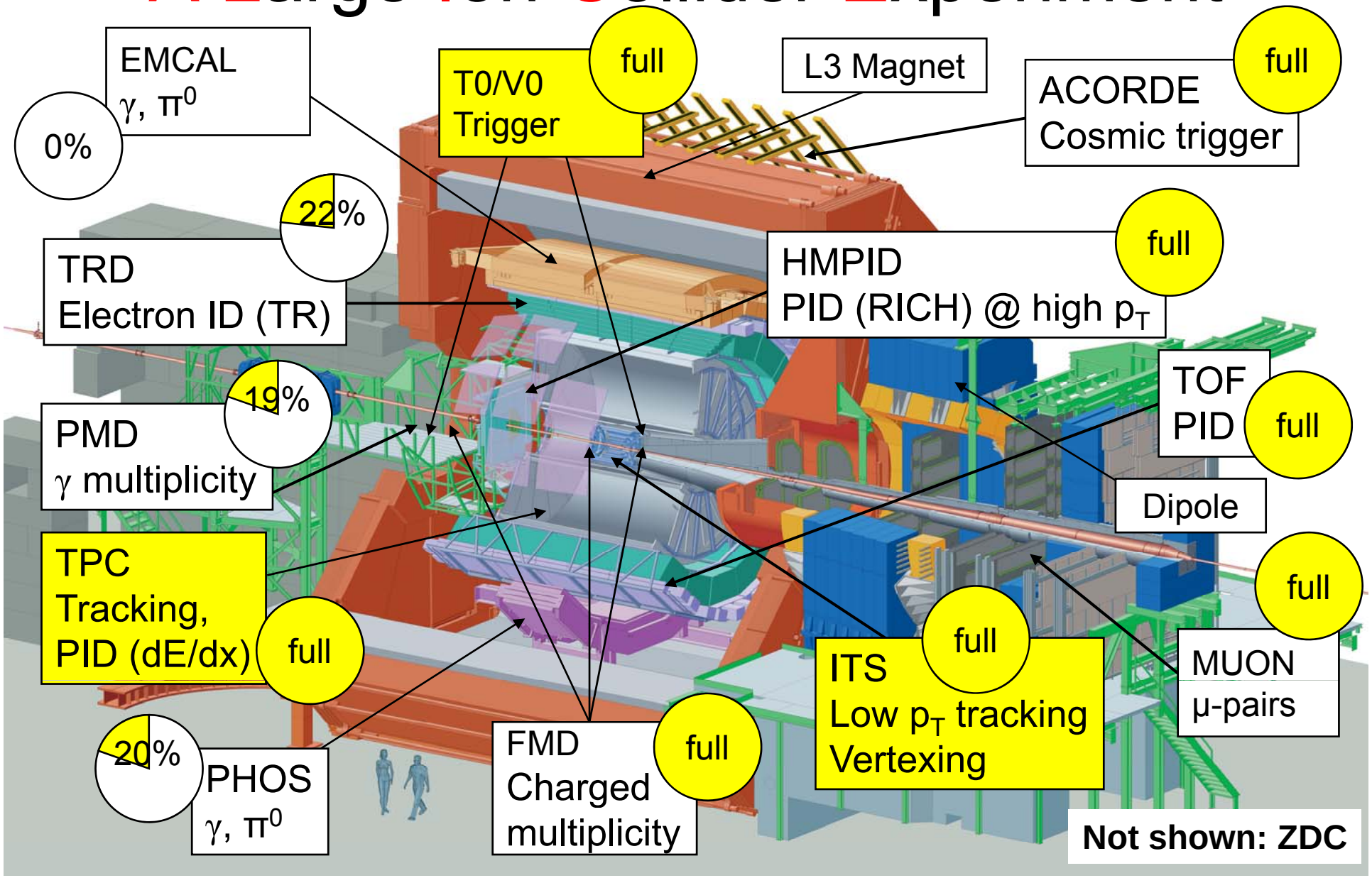
Detector Acceptance



Particle Identification

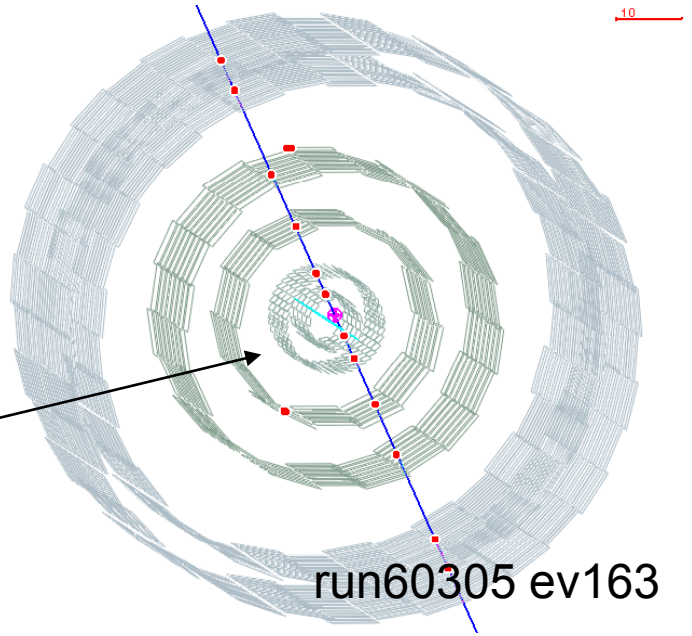


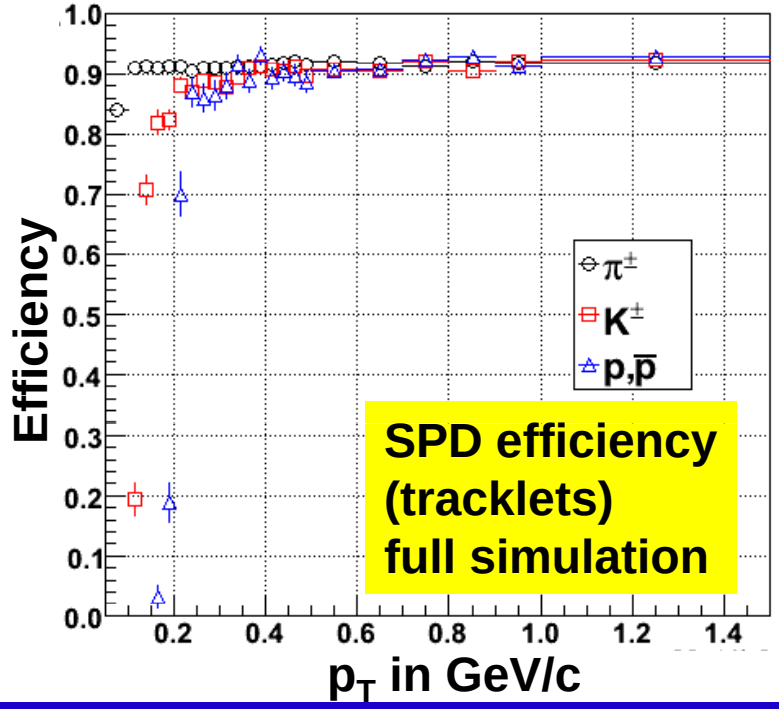
A Large Ion Collider Experiment



Silicon Pixel Detector

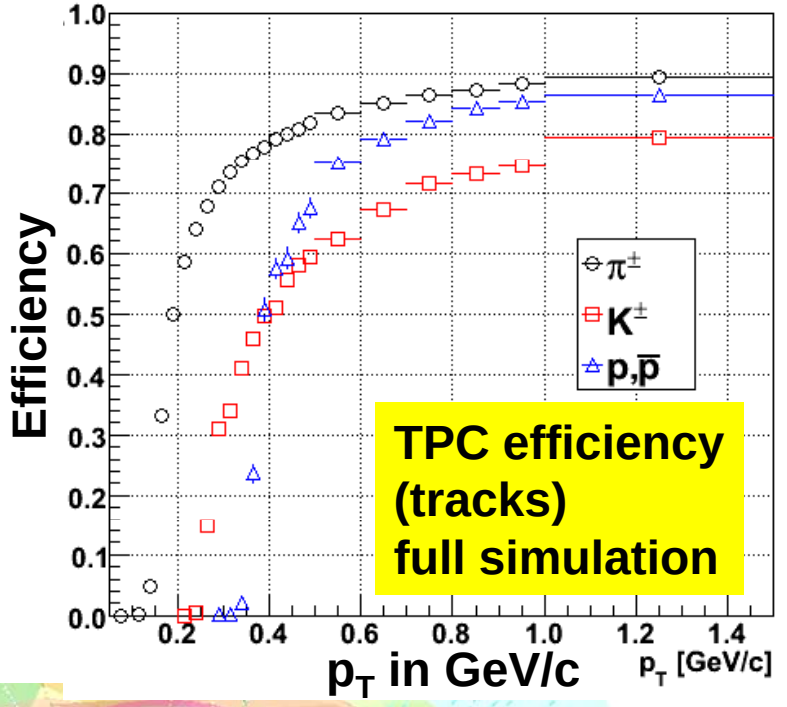
- Silicon Pixel Detector (SPD)
  - Two innermost layers of the ITS
  - Radii of 3.9/7.6 cm ($|\eta| < 1.4/2.0$)
  - 9.8 M channels
  - MB trigger (Fast OR)
  - Tracklet: 2 points + vertex
  - Very efficient down to $p_T \sim 30$ MeV/c
  - Nominal acceptance 99%
    - but ~ 10 % need hardware fixes
- The Inner Tracking System has been aligned with 50 K cosmic muons
  →residual misalignment < 10 μm

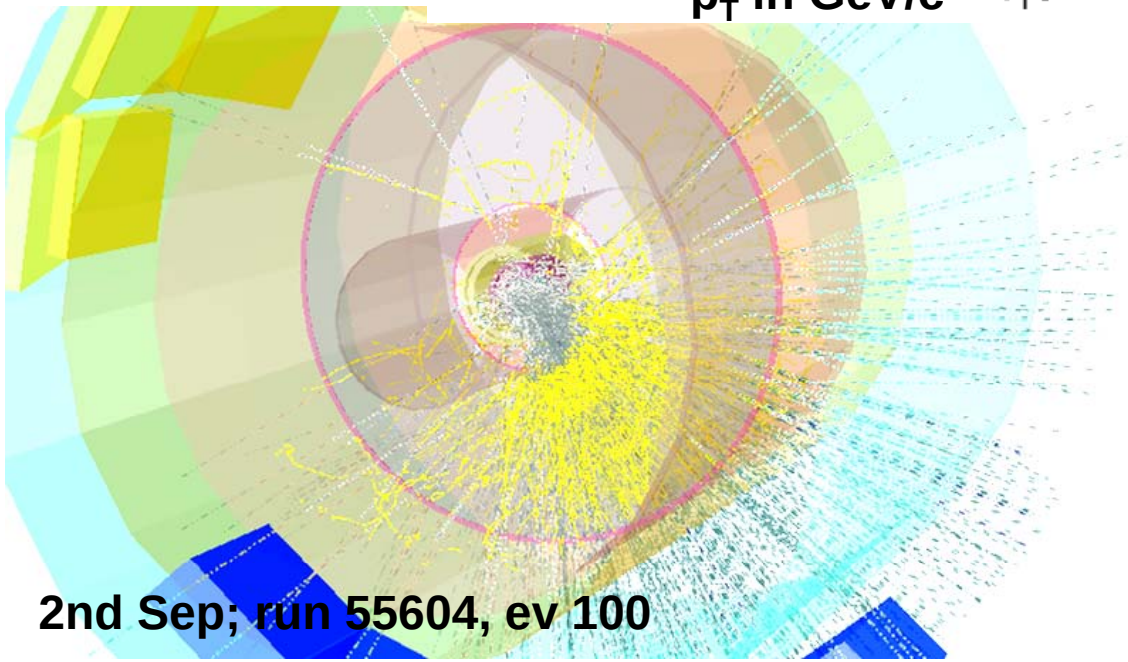




Time Projection Chamber

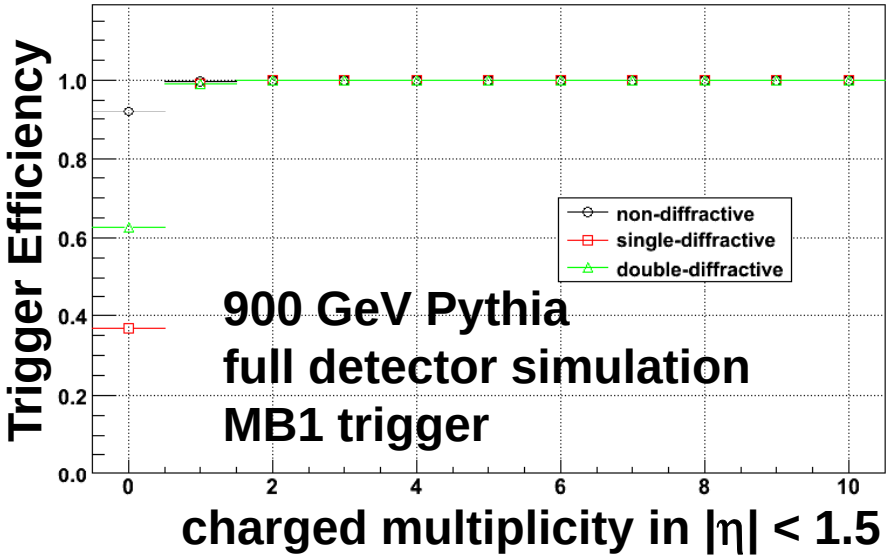
- Largest TPC in the world (90 m³)
- 0.85 m < r < 2.5 m
- |η| < 0.9 (1.5)
- 560 K channels, up to 160 clusters per track
- Tracking & PID
- Laser system for calibration and alignment

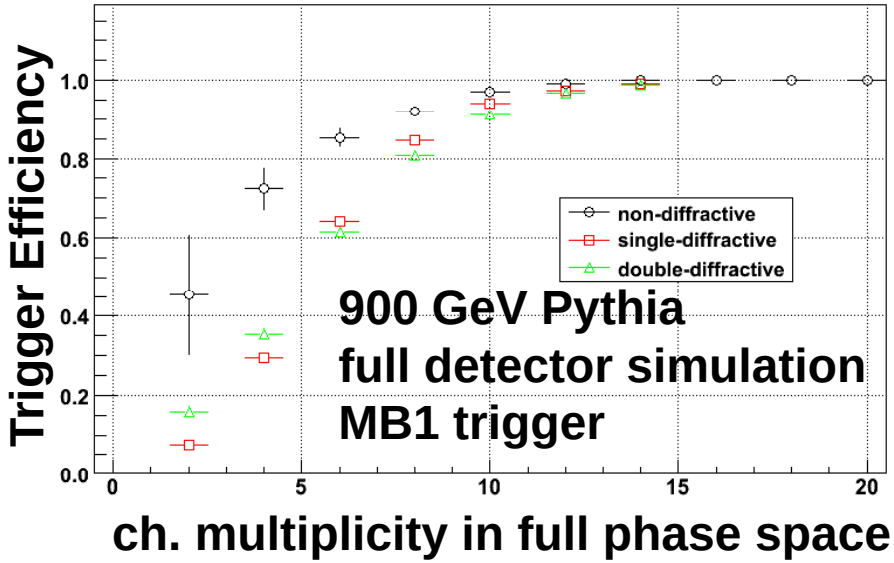




Minimum Bias Trigger

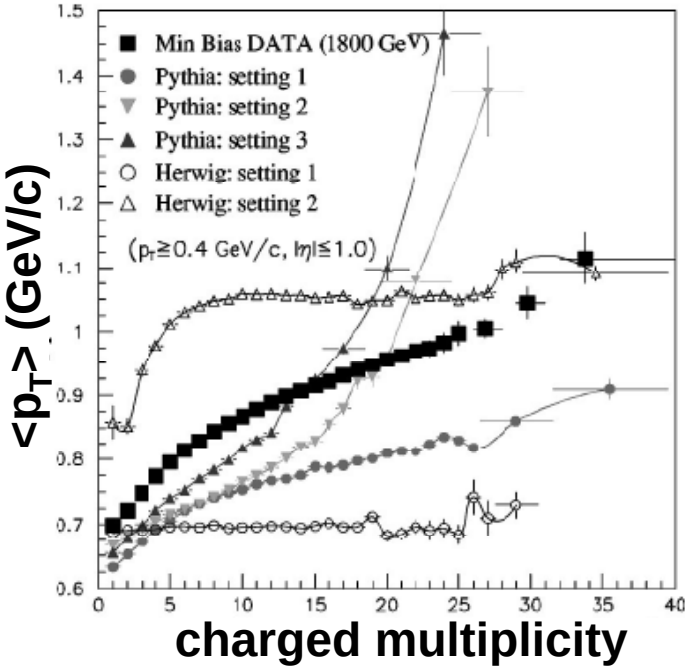
- Two arrays of segmented scintillator counters located in forward direction (VZERO)
  - Trigger bits: V0_A, V0_C
- MB1: SPD or V0_OR MB2: SPD and VO_OR
  MB3: SPD and V0_AND





First Measurements

- Pseudorapidity density $dN_{ch}/d\eta$
- Multiplicity distribution
- Momentum distribution dN_{ch}/dp_T
  - Unidentified & Identified
- Correlation $\langle p_T \rangle$ vs. N_{ch}, still unexplained
- Physics aims
  - Study of energy dependence
  - Describe collisions at a new energy, tune MC generators, understand underlying event (soft QCD)
  - Reference for Pb+Pb

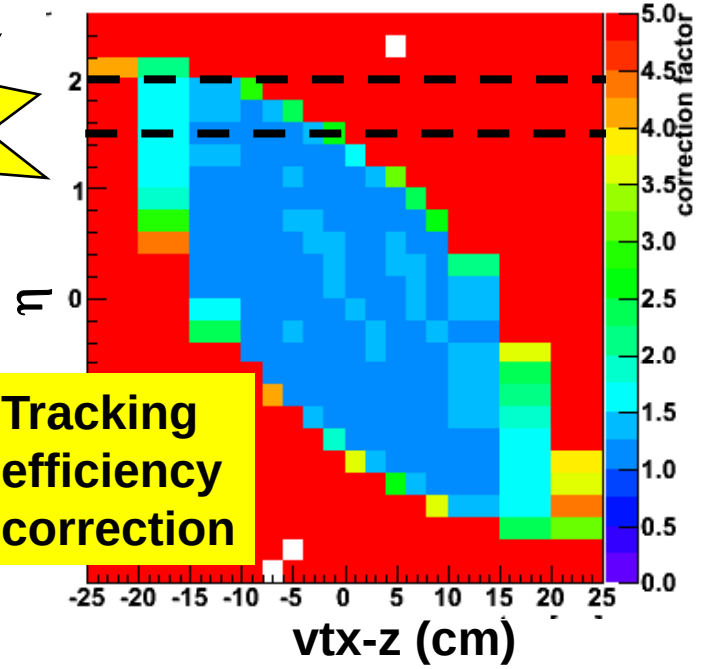


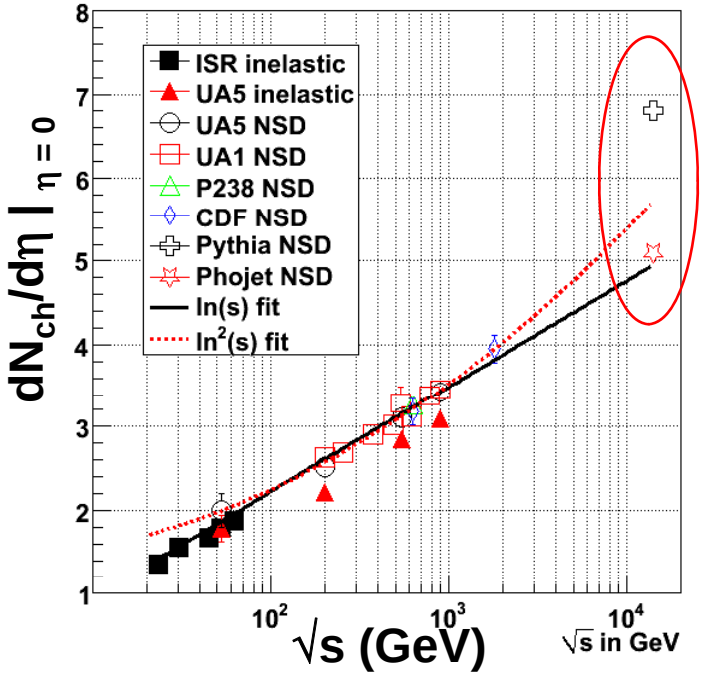
PRD65, 072005, 2002 (CDF)

$dN_{ch}/d\eta$ Measurement

SPD + TPC

- Calculate $\frac{dN_{ch}}{d\eta} = \frac{\text{Tracks in } \eta\text{ - bin}}{\text{Events}}$
- Correct for
  - Acceptance, tracking efficiency
  - Decay, energy loss, stopping
  - Vertex reconstruction efficiency/bias, trigger efficiency/bias
  - Low momentum cut-off
- $dN_{ch}/d\eta\,|_{\eta=0}$ of pp not measured yet at 900 GeV
  - Expected similar to ppbar at 900 GeV
  - QGSM/DPM (Pomeron exchange): very small difference of 0.1 - 0.2%
  - Models involving odderon exchange may give larger difference





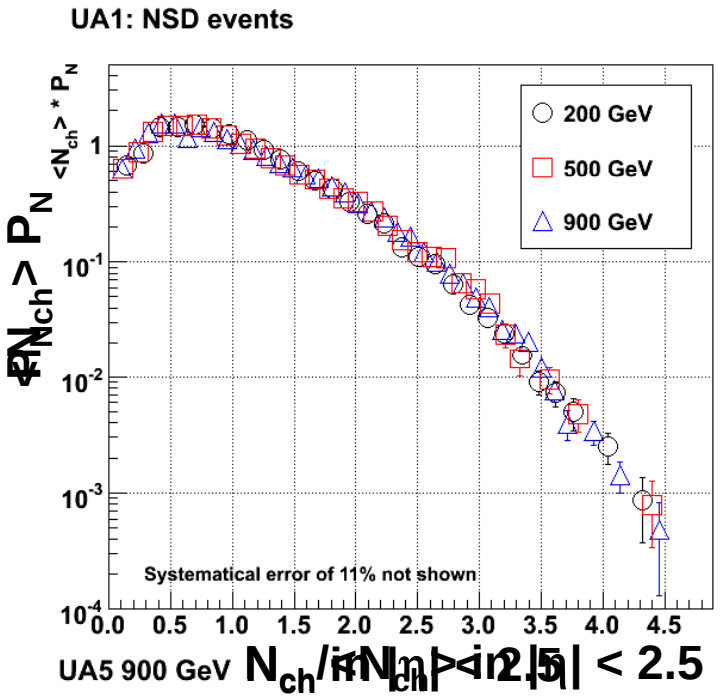
Systematic Uncertainties for $dN_{ch}/d\eta$ (SPD tracklets)

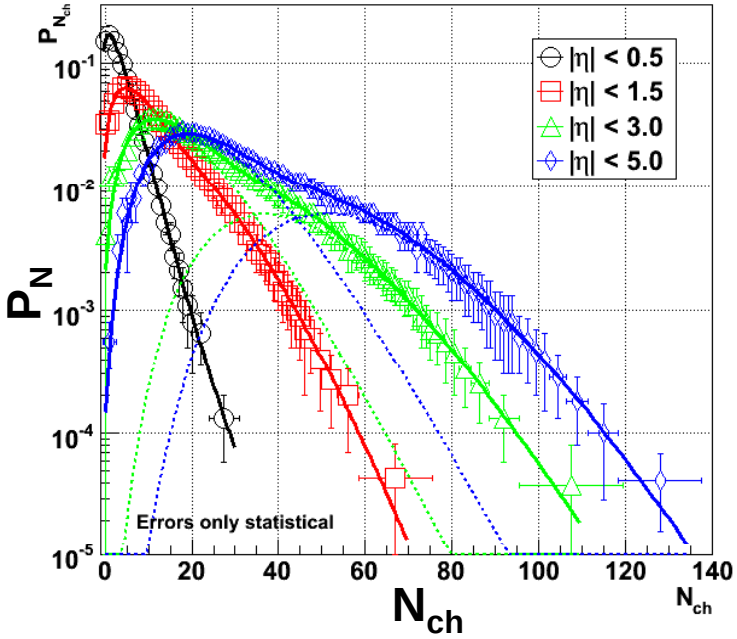
			day-1	ultimate
Track-to-particle correction	Material Budget (2 % radiation length)		negl.	
	Tracklet Selection ($\Delta\phi$ cut)		< 1%	
	p_T cut off		negl.	
	Particle Composition		negl.	
Vertex + Trigger	Cross sections of process types	correcting to INEL	2 %	< 1 %**
		correcting to NSD	8 %	< 1 %**
Global	Misalignment		negl.	
	Miscalibration		?	
	Beam-gas/Pile-up		?	

**** assuming rel. x-sections determined with 5% precision**

Multiplicity Measurement

- KNO scaling
  - Multiplicity distributions at all energies fall on one curve when expressed as z := n/<n>
  - Broken at 900 GeV (UA1, UA5) in full phase space, valid in limited η-intervals
  - Remains only valid in |η| < 1 for soft events at 1.8 TeV (CDF)
- Negative binomial distributions (NBD)
  - Up to 540 GeV in full phase space (ISR, UA5)
  - At 1.8 TeV only in |η| < 0.5 (CDF)
- Two-component model
  - Combination of 2 NBDs (representing soft and (semi-)hard part of the collision)
  - Works up to 1.8 TeV





Multiplicity Measurement

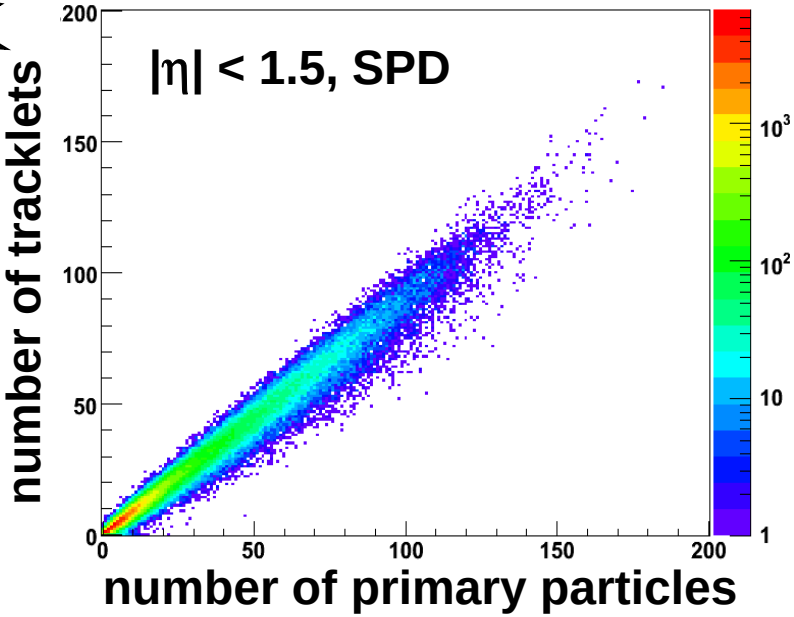
SPD

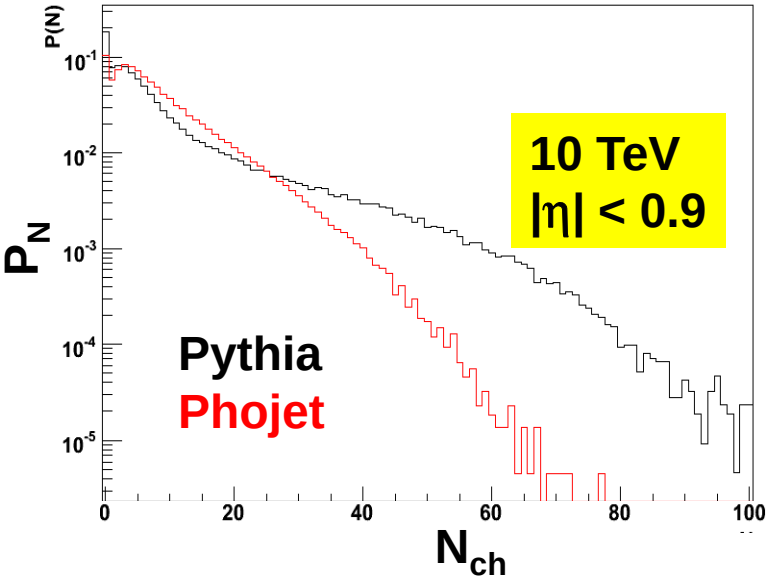
$$P(N) = \frac{\text{Events with multiplicity N}}{\text{All events}}$$

- Efficiency, acceptance: resolution wider than bin size → bin flow → Unfolding
- Unfolding Methods
  - X^2 minimization,

$$X^2(T) = \sum_m \left(\frac{M_m - \sum_t R_{tm} U_t}{e_m} \right)^2 + \alpha R(T)$$

  - Bayesian unfolding (based on Bayes' theorem)

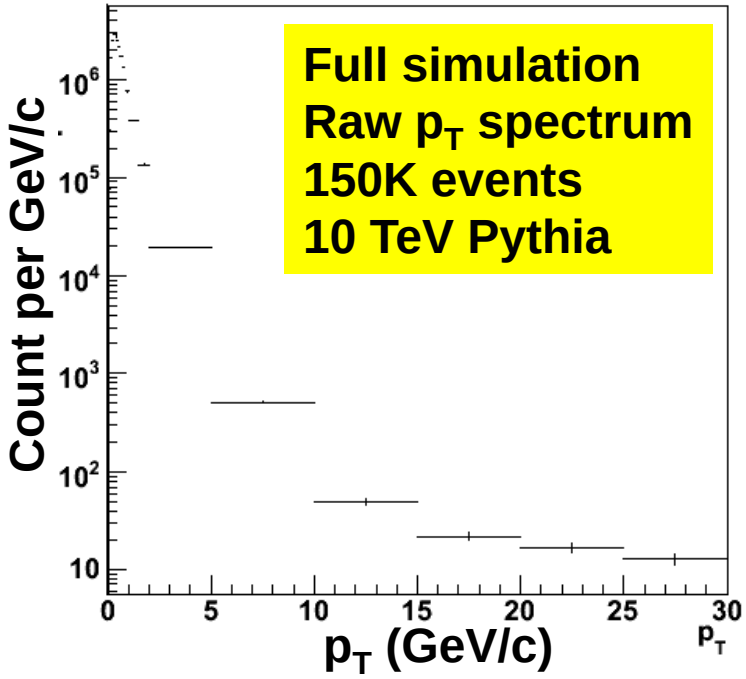


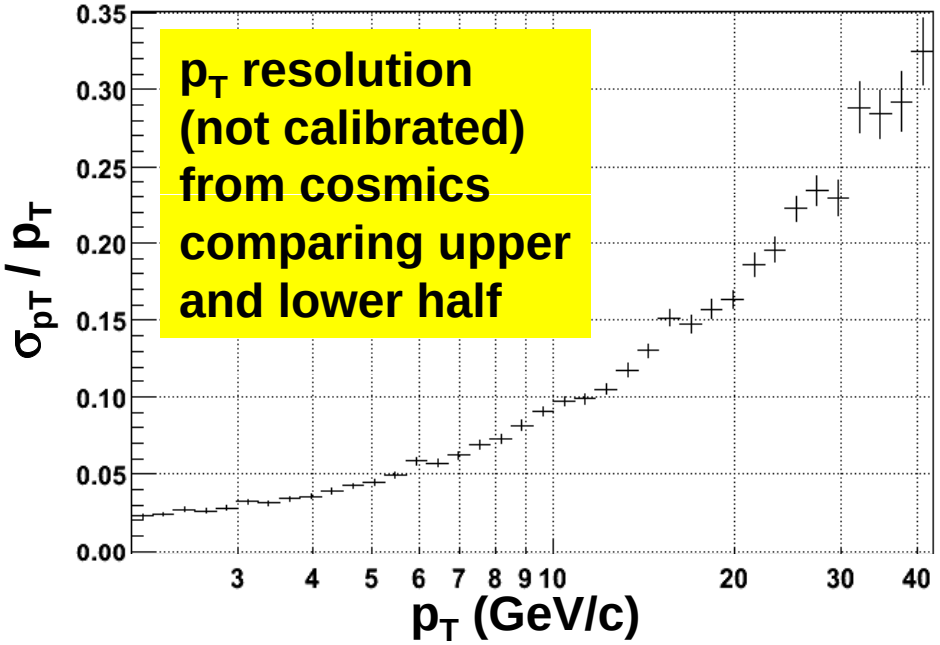


Unidentified p_T Spectrum

TPC

- TPC tracking
  - Calibration with laser tracks + cosmics
  - Alignment ongoing
  - p_T resolution ~ 10 % @ 10 GeV/c (without calibration)
- p_T up to ~ 20 GeV/c quickly accessible with ~ 150 k events

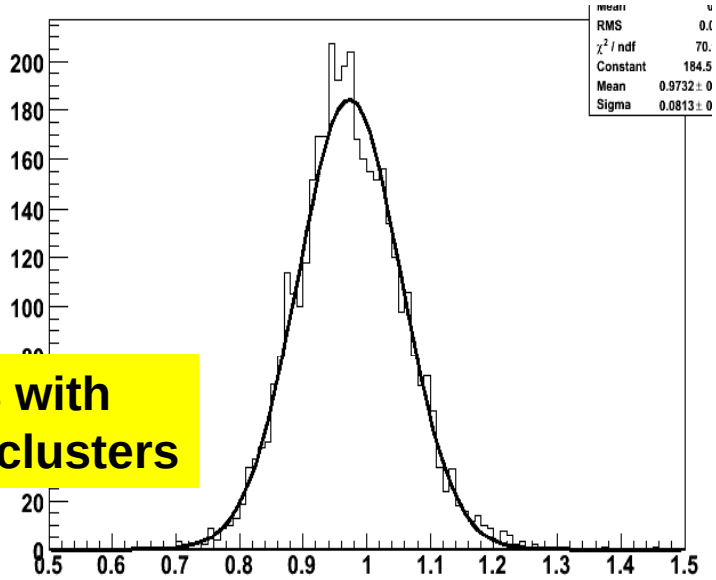




Identified p_T Spectrum

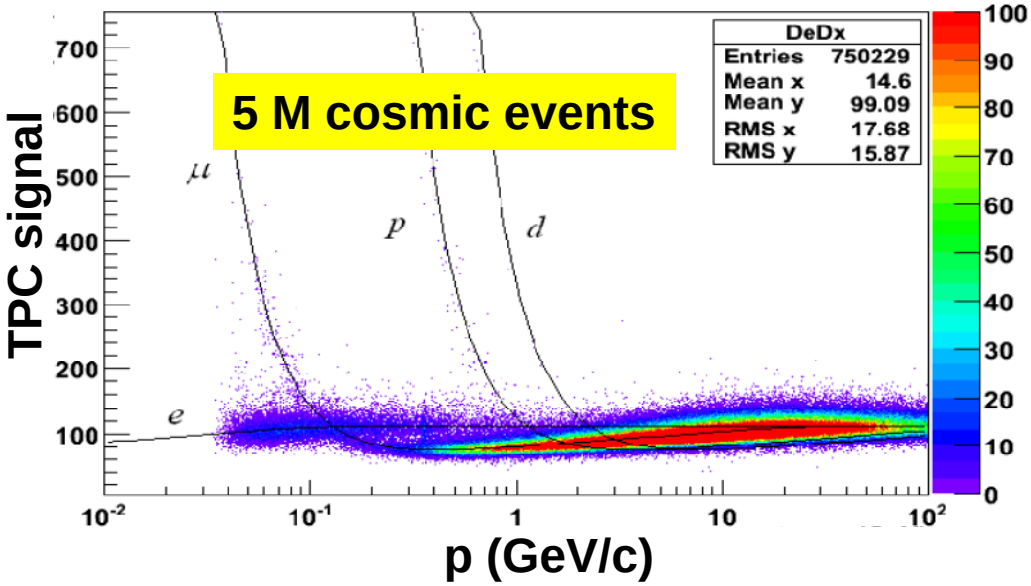
- TPC calibrated for PID with Krypton and laser
  - Applied on cosmics
- dE/dx resolution $\sigma \sim 5.7\%$
- Particle identification good at $p_T < 1$ GeV/c
  - 20.000 events sufficient for this region

TPC



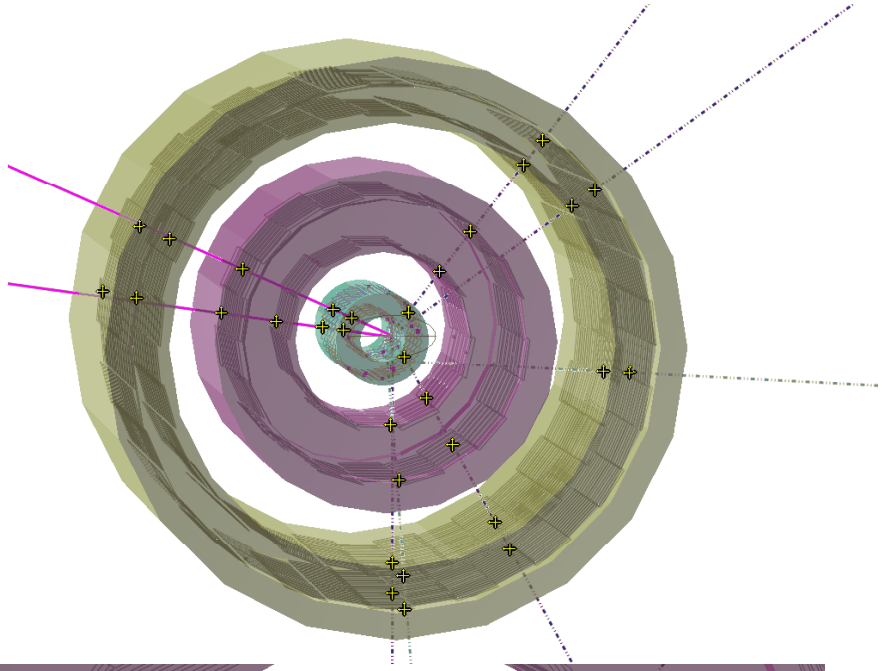
tracks with > 130 clusters

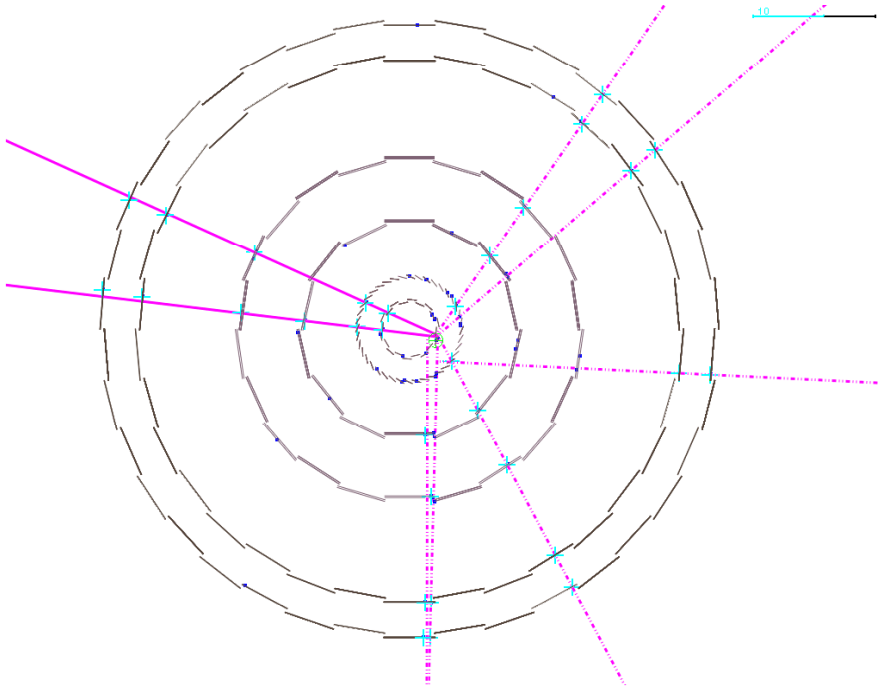
Ratio dE/dx upper/lower half of TPC

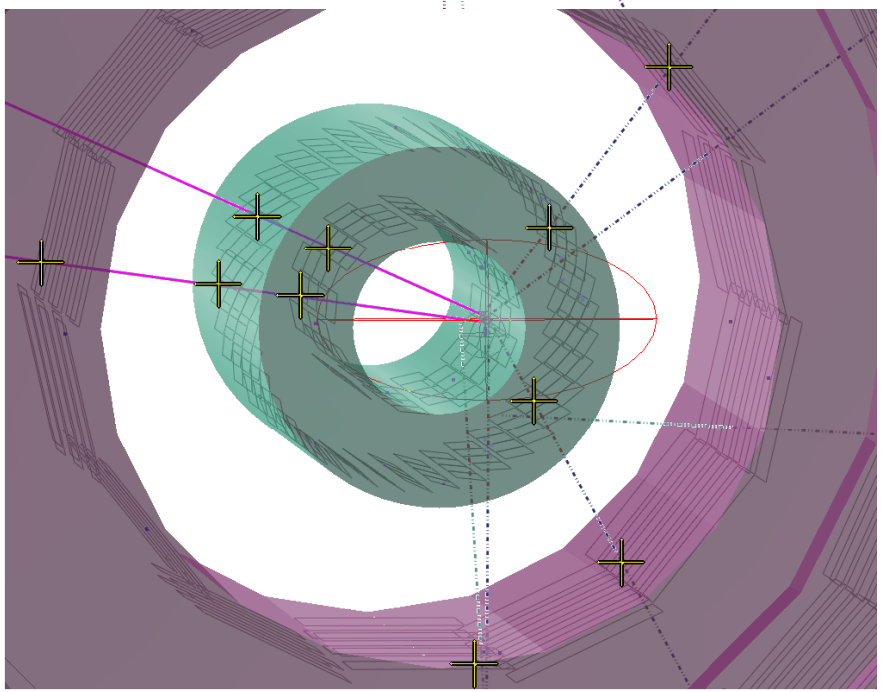


Collisions…

Proton + detector collision
11.09. run 58338 ev 27







Summary

- ALICE can measure with a few days of data basic properties of p+p collisions from 900 GeV to 14 TeV
  - Down to very low p_T (~ 30 MeV/c)
  - Particle identification is available over a large momentum range
- ALICE's measurements will describe p+p collisions at a new energy
  - Characterization of the underlying event
  - Tuning of MC generators (e.g. Pythia and Phojet differ significantly at 14 TeV)
- And much more to come…(in p+p)
  - Baryon transport, Strangeness, resonance production, femtoscopy, heavy flavor, jets, …

Friday morning:
ALICE Status and Potential (J. Schukraft)
ALICE Commissioning (S. Chapeland)

References

- Bayesian method
  - e.g. Nucl.Instrum.Meth.A362:487-498,1995
- $dN_{ch}/d\eta \mid_{\eta = 0}$ vs. $\sqrt{s}$, UA1/UA5 multiplicity
  - Phys. Rev. D 41 (1990) 2330
  - Nucl. Phys. B 129 (1977) 365
  - Nucl. Phys. B 335 (1990) 261
  - Phys. Lett. B 160 (1985) 193
  - Z. Phys. C 43 (1989) 357
- Two component model
  - Phys. Rev. D 59 (1999) 094020