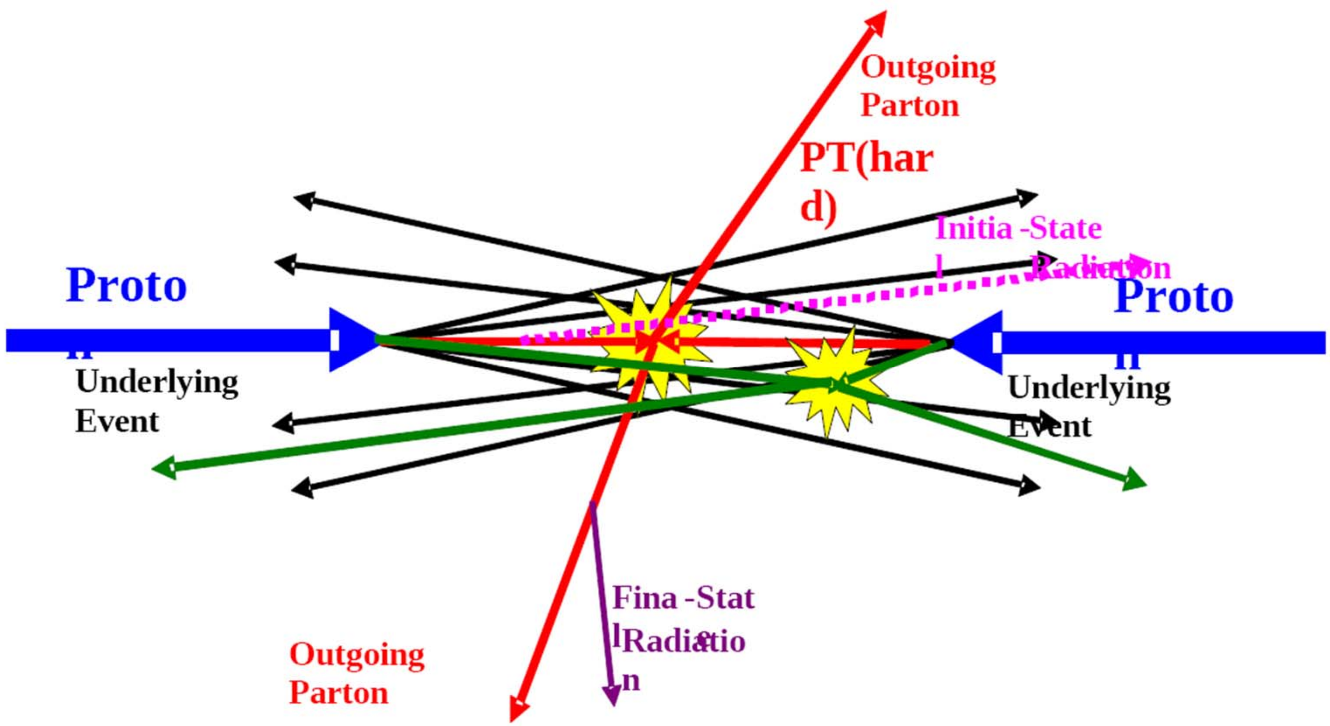
Study of Strangeness Production in Underlying Event at 7 TeV

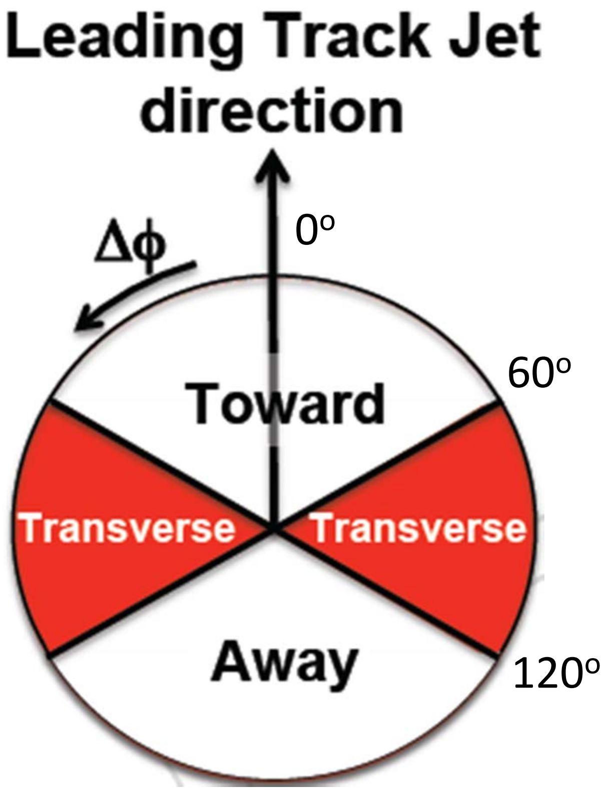
Tomas Hreus

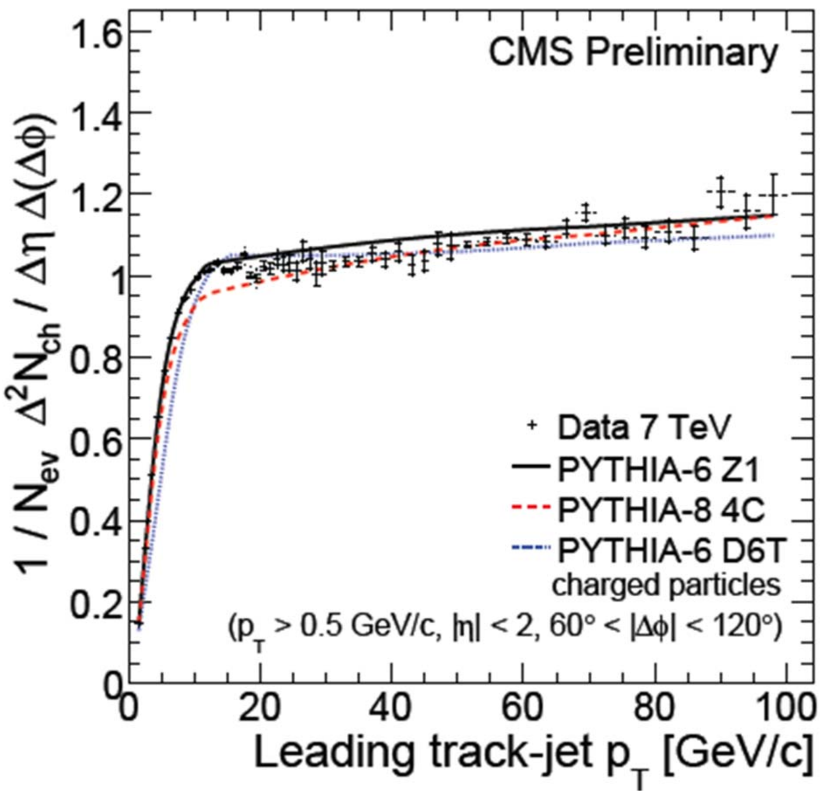
Introduction: Underlying Event (1)

Underlying event (UE) in the presence of hard parton-parton scattering:
- any hadronic activity in addition to what is attributed to hadronization of partons involved in the hard scatter
- attributed to multiple parton interactions (MPI) and beam-beam remnants



Introduction: Underlying Event (2)



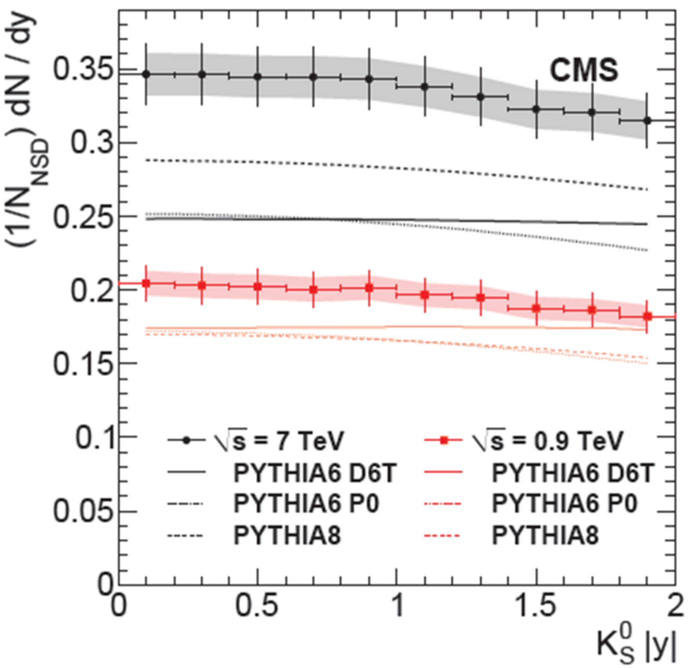


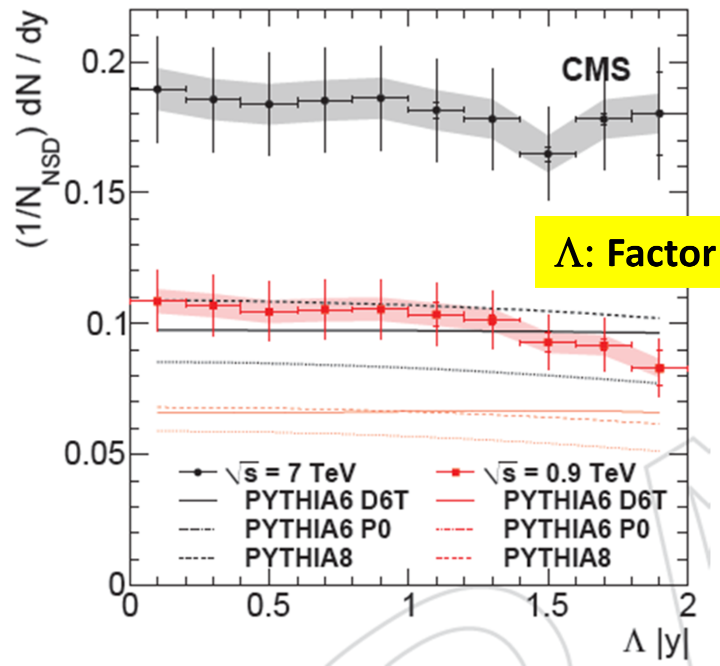
Topological structure of the hard scattering can be used to characterize the UE activity (transverse region)

Correlation between scale of hard process and UE activity

Strangeness Production

- an important ingredient in understanding the nature of the strong force
- production of *s* hadrons is relatively suppressed wrt hadrons made of u/d quarks
- amount of strangeness suppression is an important component in MC models





Λ: Factor 2 difference

Strangeness Production

K0s (m=0.497 GeV, ct=2.68cm) → π^+ π^- (69%)

Λ (m=1.115 GeV, ct=7.89cm) → p+ π^- (64%)

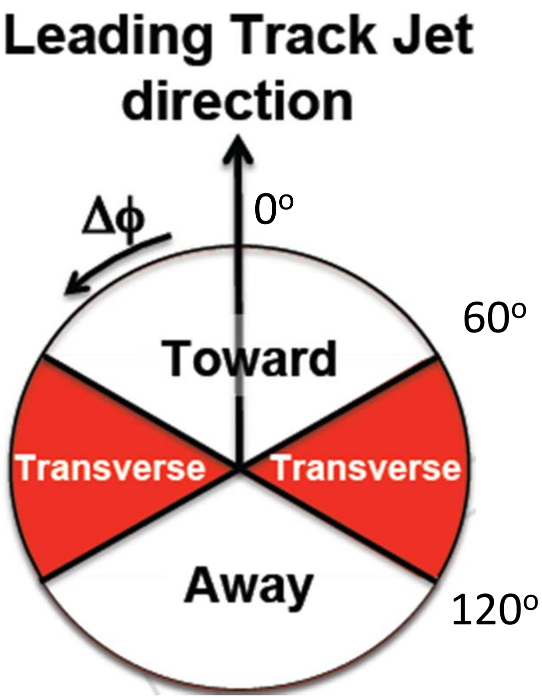
Λbar (m=1.115 GeV, ct=7.89cm) → p- π^+ (64%)

**Two tracks forming a secondary vertex,
that makes 3 particle hypotheses**

Event Selection

Using 7 TeV data from 2010

/MinimumBias/Commissioning10-Jun14thReReco_v1/RECO
/MinBias_TuneD6T_7TeV-pythia6/Summer10-START36_V10_SP10-v1/GEN-SIM-RECODEBUG



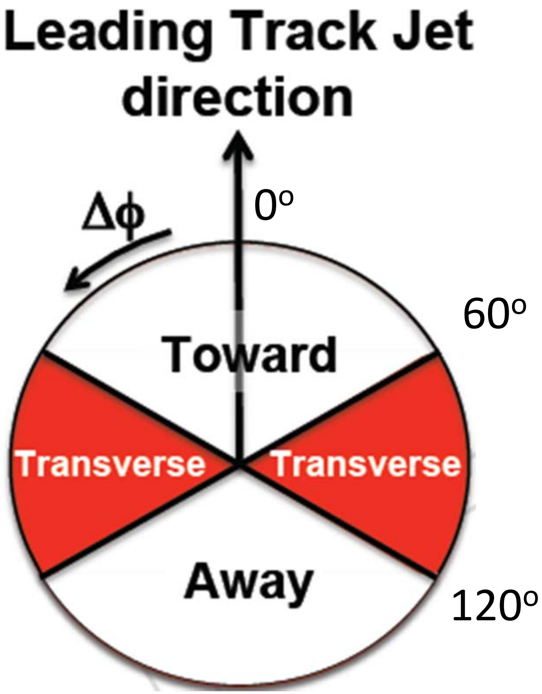
Primary vertex:

dZ(vtx, beamspot) < 10cm
Number of tracks > 4 (ndof > 4)

Leading Track-jet (anti-kt algr.):

tracks with pT > 0.5 GeV and |eta|<2.5

V0 Selection



Tracks:

$|\eta| < 2.5$
pT > 0.3 GeV
Nhits >= 3
χ^2 / ndf < 5

secondary vertex:

Distance of closest approach of both tracks < 1cm
χ^2 / ndf < 7
$d_T > 8\ \sigma(d_T)$; σ accounts for beam spot and sec. vertex errors

V0:

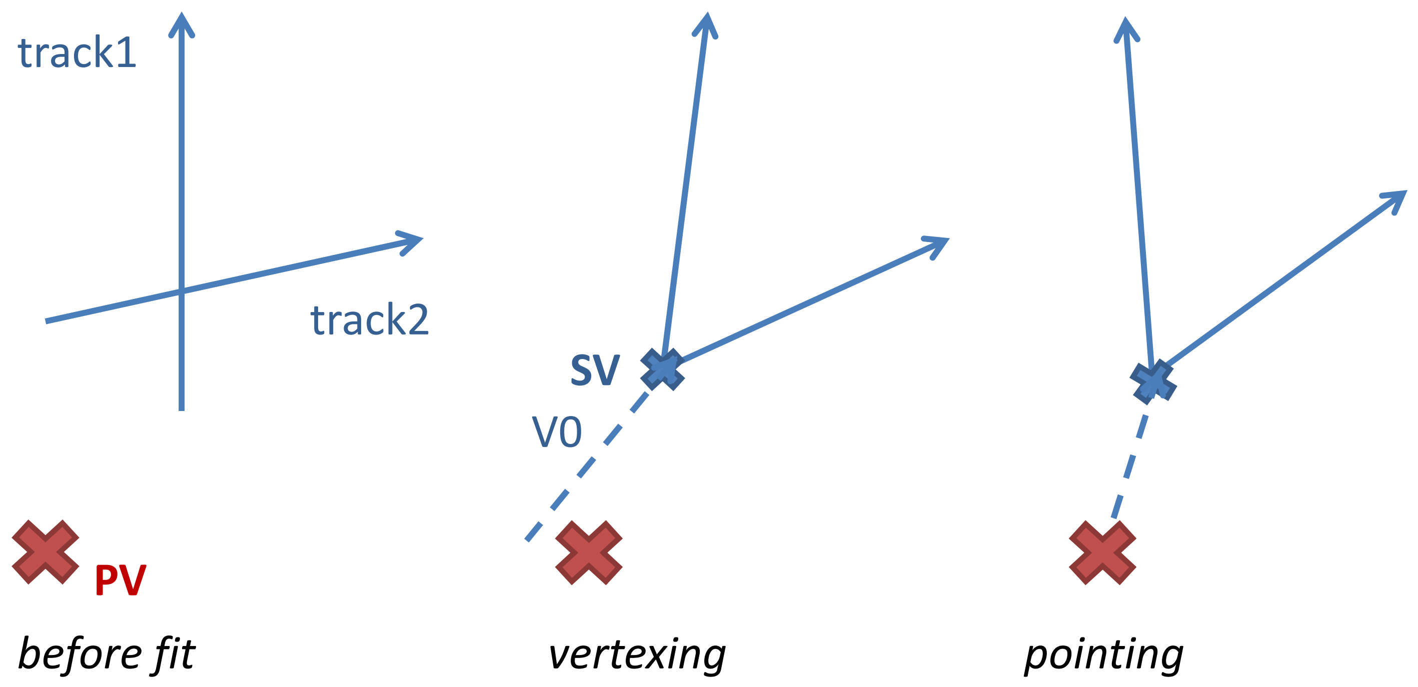
$|\eta| < 2.0$
0.5 < pT_K0s; 1.0 < pT_Λ, Λbar
Transverse flight distance > 1 cm

Kinematic Fit: Principle

Kinematic fit = iterative minimization of the χ^2 function with kinematic constraints, using covariance of track parameters

3 constraints applied:

- **vertexing** (daughter tracks come from the same point)
- **pointing** (V0 points to the primary vertex)
- **fixed V0 mass** to V0 PDG value



Kinematic Fit: V0 Identification

Result of the fit:

- fitted daughter track parameters (pt, θ, ϕ)
- χ^2 (probability)

Fit done separately for K0s, Lambda and Antilambda hypotheses:

χ^2 prob(K0s) vs χ^2 prob(Λ) vs χ^2 prob(Λbar)

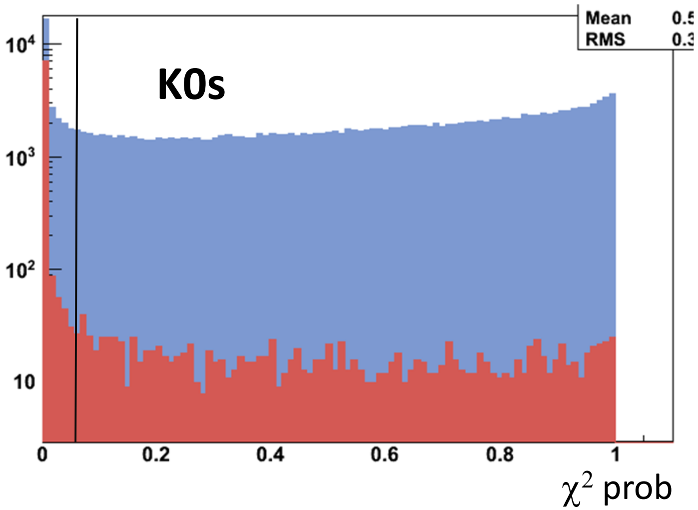
The mass hypothesis with the highest χ^2 probability dictates the V0 identification.

Fits with all probabilities < 5% are rejected.

Kinematic Fit: Remaining Background

matched to primary V0

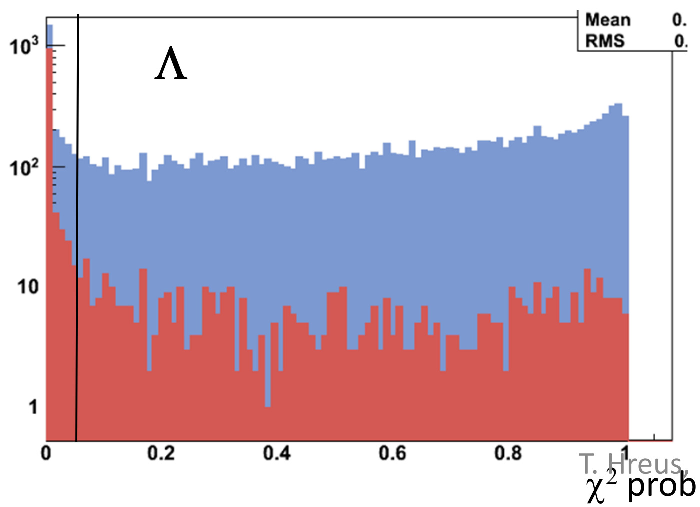
not matched to primary V0

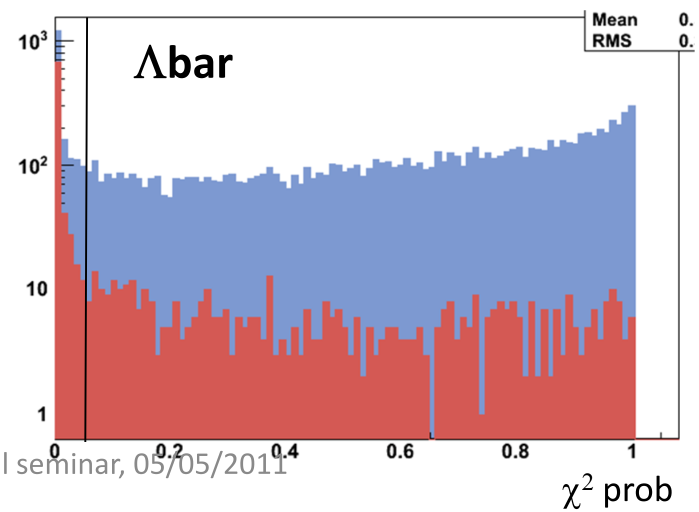


Primary-matched within $R(\Delta\eta\Delta\phi) < 0.1$ and $\delta pT < 0.1$

Background to V0 sample estimated from MC:

Background for K0s	~1%	*= ambiguous identification, photon conversions, nuclear interaction with material (some sources still to be understood)*
Background for Λ	~4%	
Background for Λbar	~6%	





V0 Correction

V0 Correction = 1 / (acceptance x efficiency)

acceptance is restricted to kinematic range of sufficient V0 selection efficiency

- small systematics expected

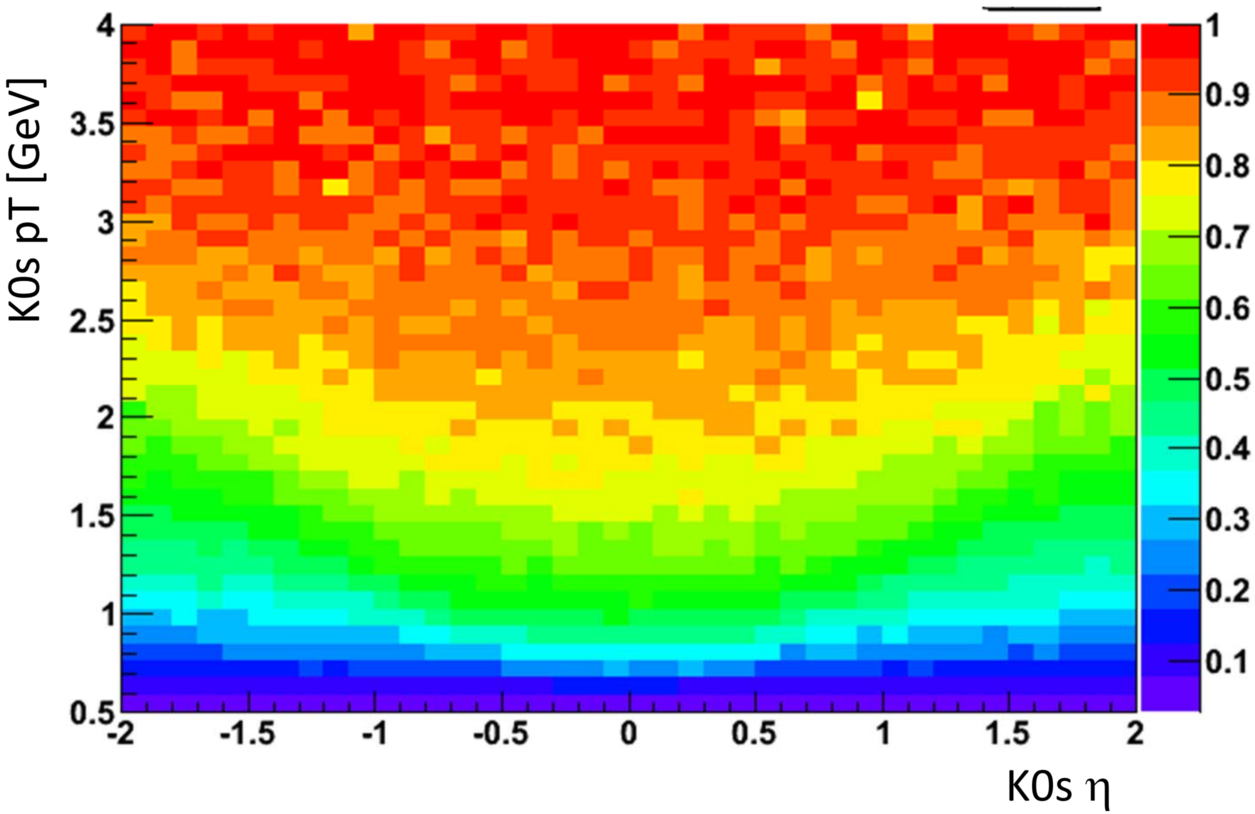
efficiency is estimated with detailed MC

K0s Correction: Acceptance

Acceptance definition: **N_acc / N_gen**

N_gen = K0s generated inside:
0.5 < pT < 4.0 GeV
|η| < 2.0

N_acc = fraction of N_gen which passed the acceptance cuts:
pT_daughters > 0.3 GeV
|η_daughters| < 2.5
gen transv. flight dist. > 1 cm
(simulated isotropic decay of gen K0s)

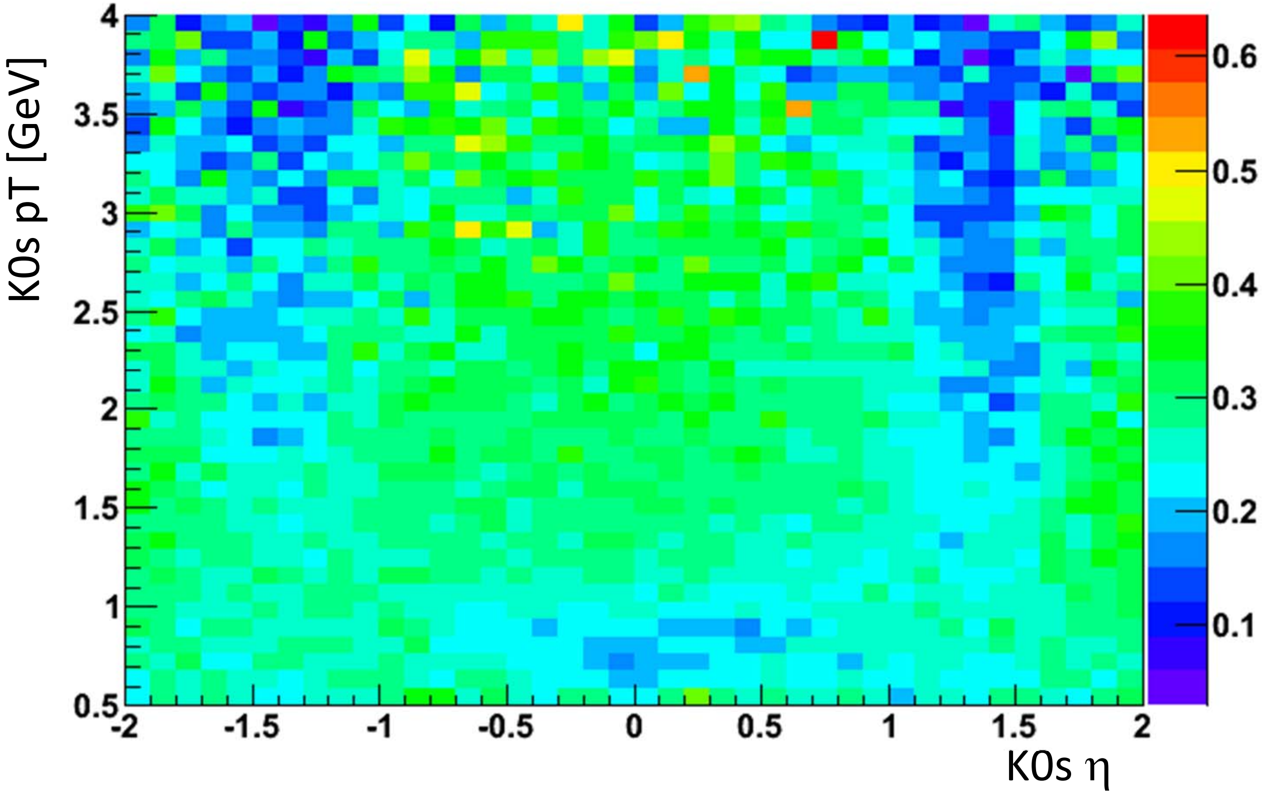


Lambda decay:
- *need angular distribution of decay proton*
- *Acc*eff depends on Lambda polarization*
- *never measured!*

K0s Correction: Efficiency

Efficiency definition: **N_rec / N_acc**

N_rec = K0s passed all reco cuts:
|η daughters| < 2.5
pT_daughters > 0.3 GeV
|η K0| < 2.0
pT_K0s > 0.5 GeV
Transverse flight distance > 1 cm, chi2prob > 0.05

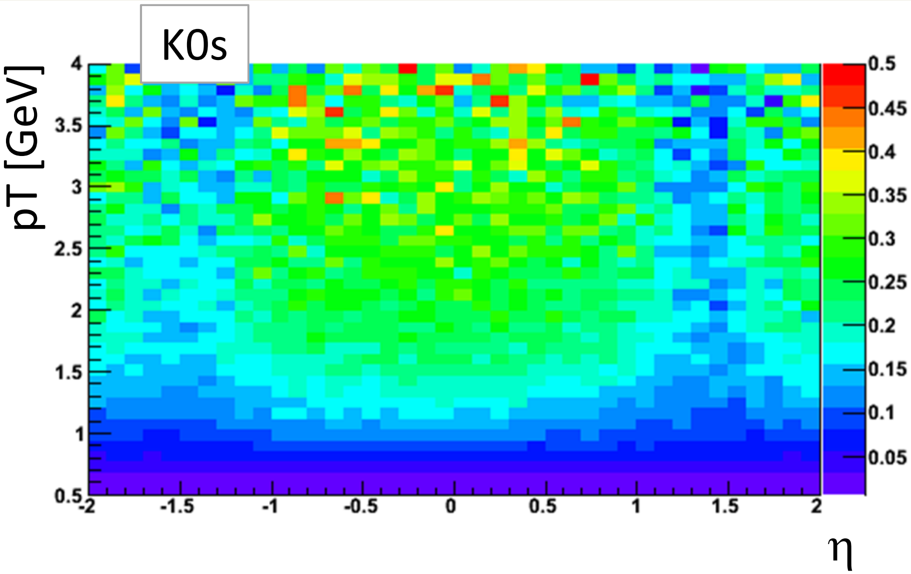


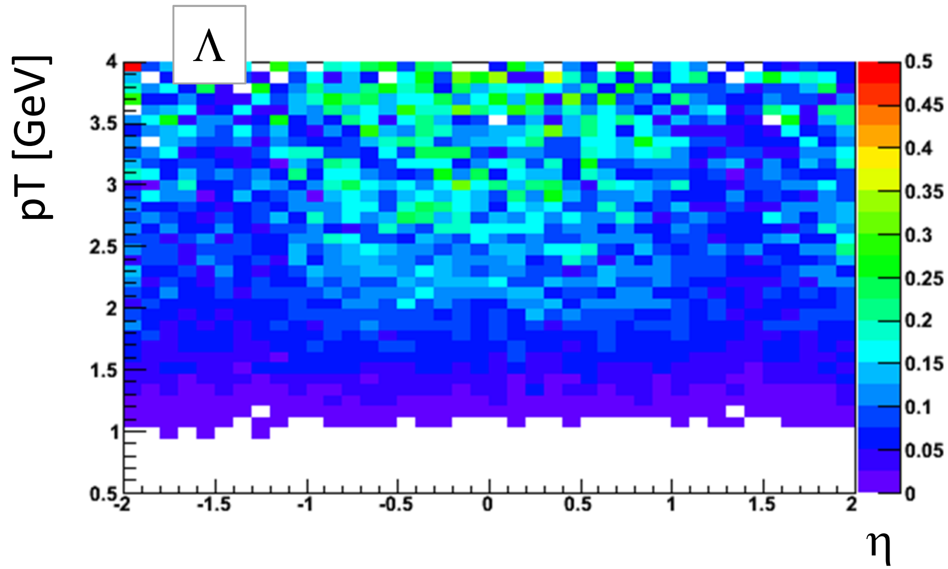
Efficiency is sufficient

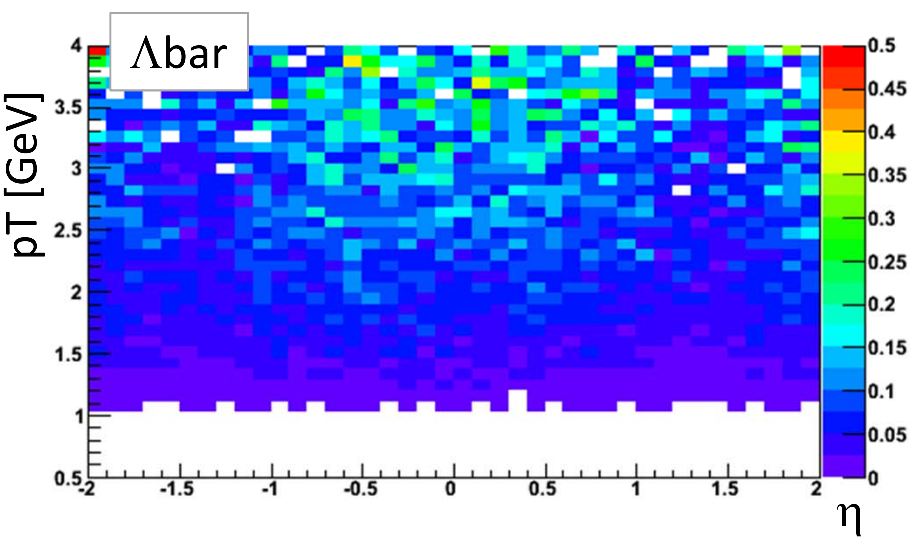
MC is describing efficiency correctly *(lifetime test by Pascal and QCD group)*

→ small systematic uncertainties expected on the rates.

V0 Correction: Acc x Eff

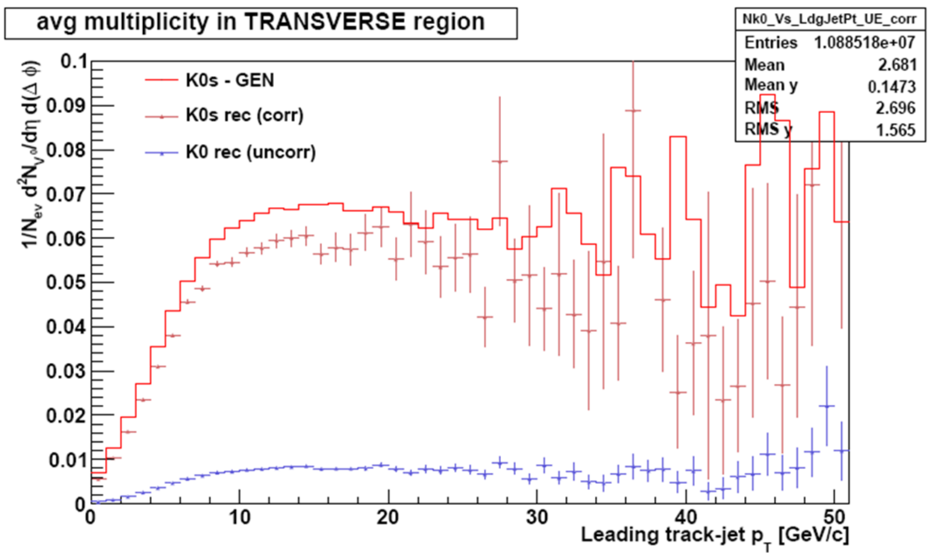


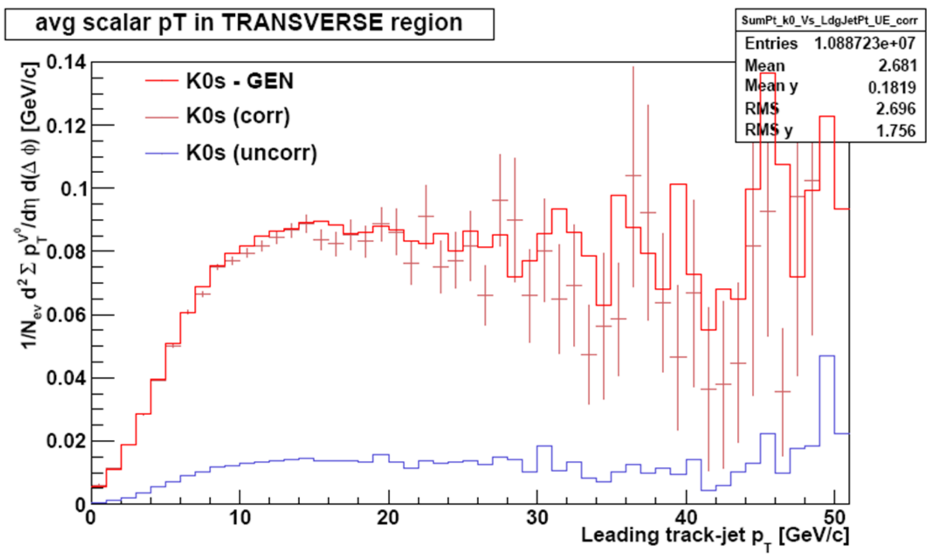




Acc x Eff = 1/weight

Closure Test (MC)



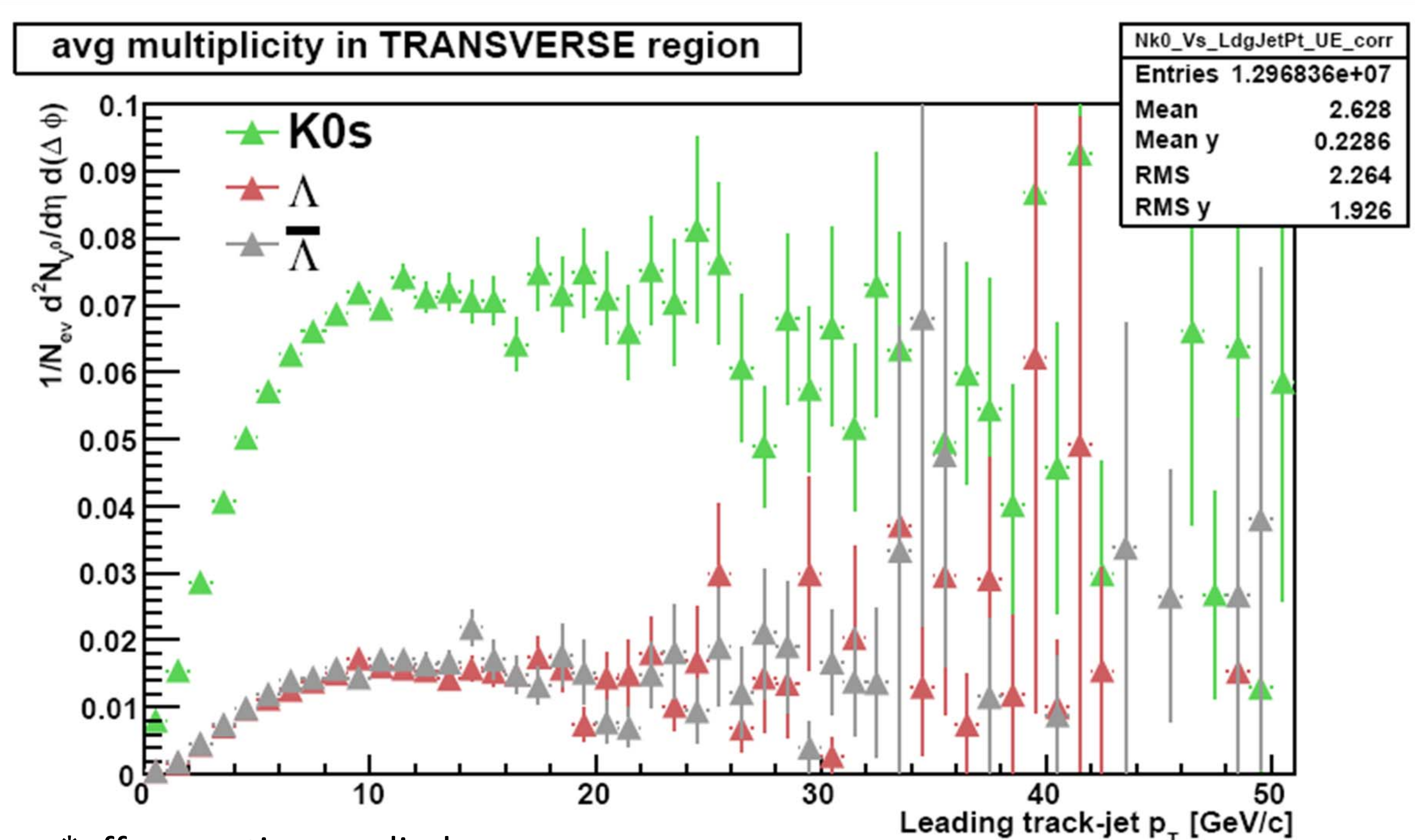


- compare TRUE MC distribution to corrected reconstructed level (acceptance, efficiency, background subtracted)

- corrections not perfect

- work in progress

Rates



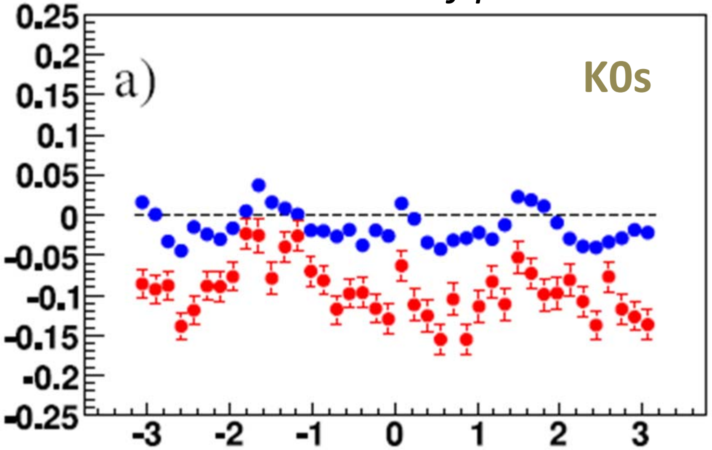
- acc*eff correction applied
- corrected for background (bin-by-bin basis)
- similar trend with track-jet pT as for primary charged particles: strong correlation with hard scale following by a plateau

Kinematic Fit: DQM

- Kinematic fit allows a detailed study of track parameter pulls:
- contribution to tracker DQM

$$rel.\ bias_{unc-fit} = \left\langle \frac{x_{unc} - x_{fit}}{\sigma(x_{unc} - x_{fit})} \right\rangle$$

Curvature of pi+



phi of π+ [rad]

Conclusion & Plans

- study of rates of the strange particles (K0s, Λ, Λbar) in the underlying event
- developed a kinematic fit to select relatively clean V0 sample
- efficiency and background seem under control
- ready for interesting measurements, i.e:

  Gosta Gustafson on Lambda polarization:

"Clearly you should measure the polarization if it is possible, also if theorists do not expect a noticeable effect. The most interesting results are the unexpected ones."

Plans

- correction of track-jet pT
- evaluate systematic uncertainties
  - V0 selection efficiency
  - V0 acceptance (different PYTHIA tunes)
  - trigger and event selection
- write PAS/paper

Scalar pT Sum