Anisotropic Flow of Strange Particles at SPS

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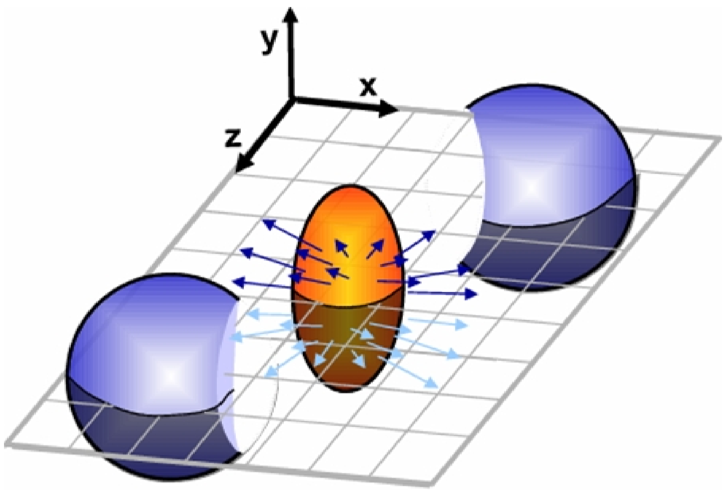
Outline

- Introduction
- Analysis
- Preliminary results on Λ elliptic flow
- Comparison with CERES and STAR data
- First preliminary results on K^0_s elliptic flow
- Summary and outlook

Introduction



Elliptic flow
- an effect of the pressure gradients in the interaction region
- sensitive to EOS and the degree of thermalization
- v_2 of heavy and strange particles
  → insight into very early stages

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

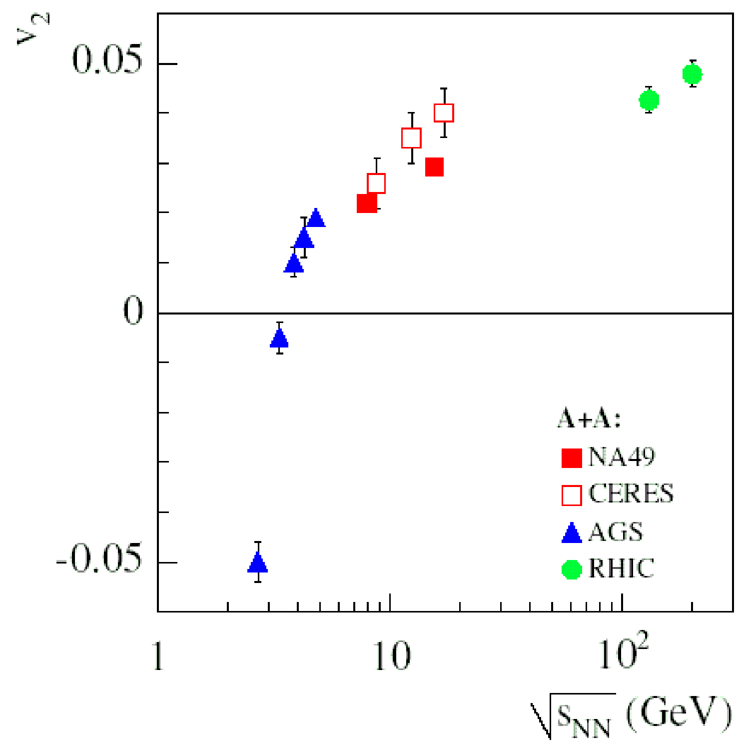
$$v_n=\left\langle\cos\left(n\left(\varphi-\Phi_r\right)\right)\right\rangle$$

Initial spatial anisotropy is transformed into momentum anisotropy characterized by

$$v_2=\langle\cos(2(\varphi-\Phi_r))\rangle$$

Elliptic flow for pions

increase with collision energy towards RHIC data and hydrodynamic model predictions ?

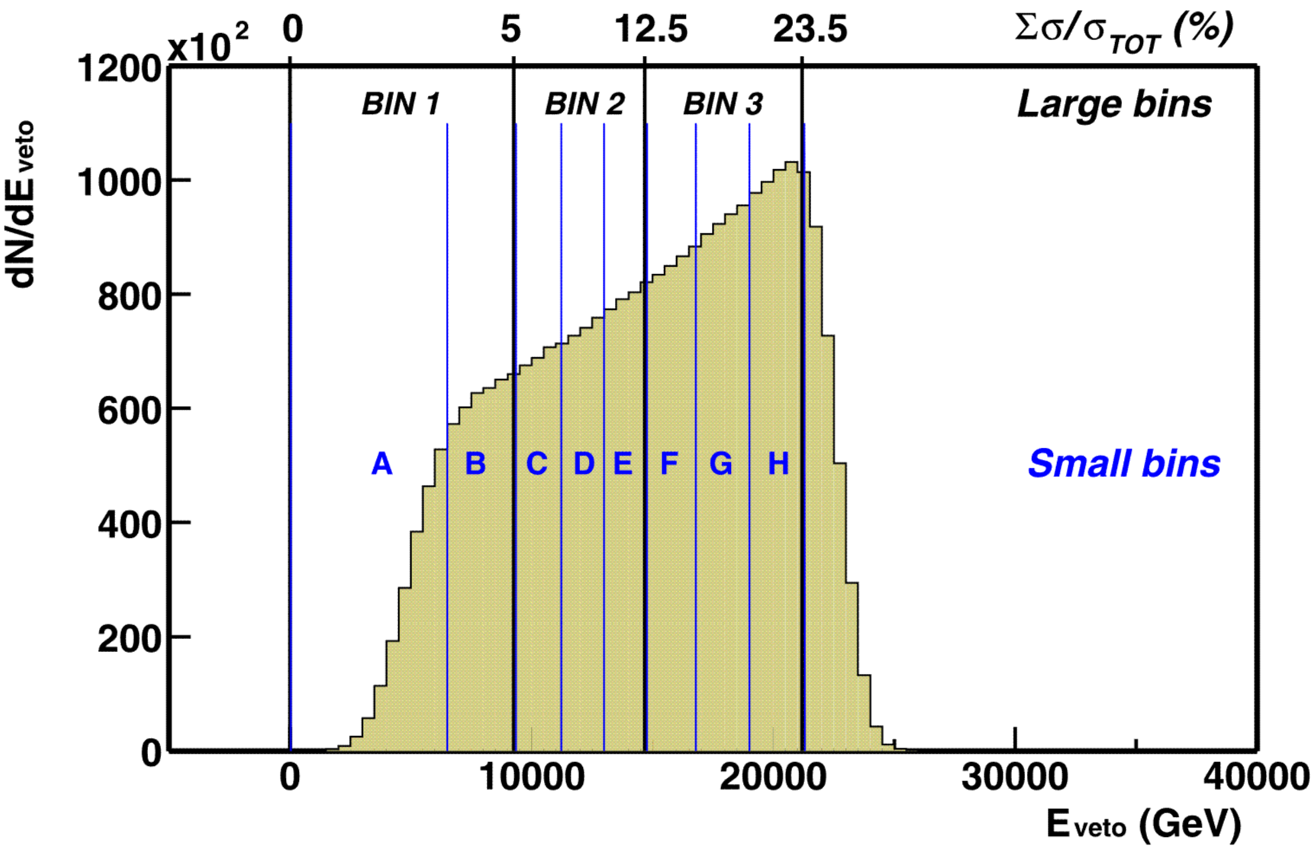


Mid-rapidity data, p_T integrated

What is the energy dependence of elliptic flow for heavier hadrons, in particular, strange hadrons?

Centrality Determination

- centrality selection made by the energy measurement in Veto Calorimeter



Pb+Pb 158A GeV

3M events

semi-central trigger
$\sigma/\sigma_{TOT} < 23.5$ %

Method of elliptic flow analysis

- estimate of the reaction plane by the second harmonic event plane ($\Phi_{2\,EP}$) of primary charged pions
- acceptance correction by recentering and mixed-events
- determination of the event plane resolution by correlation of sub-events ($\langle\cos(2(\Phi_{EP} - \Phi_{RP}))\rangle$)
- evaluation of the Fourier coefficient v_2' from the Λ azimuthal distribution with respect to the event plane

$$dN/d(\varphi_{lab}-\Phi_{2\,EP}) \sim 1 + 2\mathbf{v_2'}\cos[2(\varphi_{lab}-\Phi_{2\,EP})] + 2v_4'\cos[4(\varphi_{lab}-\Phi_{2\,EP})]$$

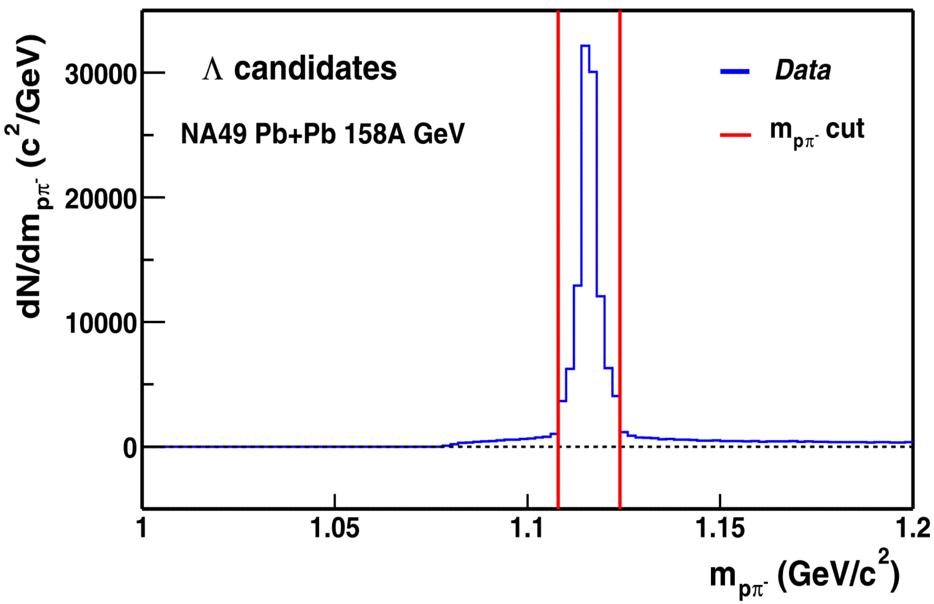
- correction for the event plane resolution

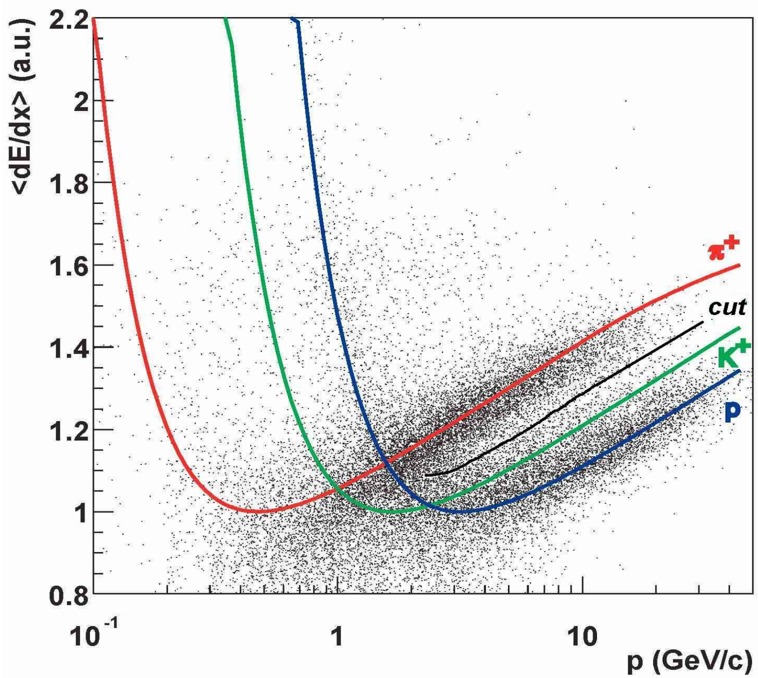
$$v_2 = v_2' / \langle\cos(2(\Phi_{EP} - \Phi_{RP}))\rangle$$

Selection of Λ candidates

$\Lambda \rightarrow p + \pi^-$ (BR = 63.9% , $c\tau$ = 7.89 cm)

1.108 GeV < $m_{p\pi^-}$ < 1.124 GeV



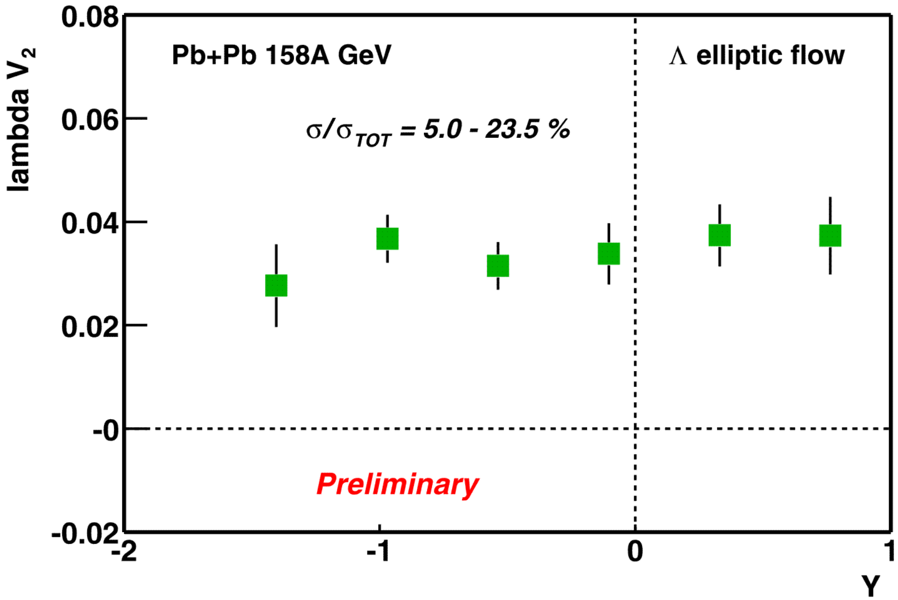


Use of the identified pions and protons significantly reduces the background

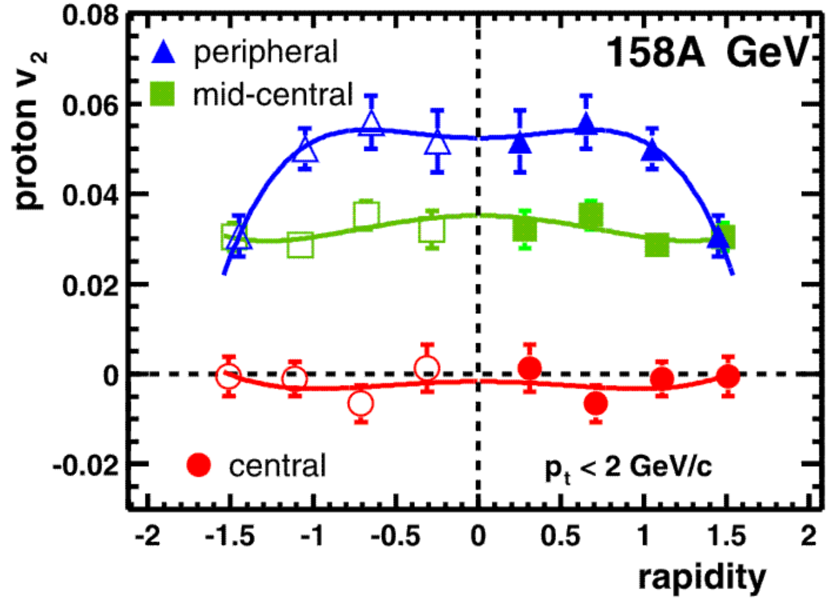
Identification of Λ decay daughter tracks

Rapidity dependence

Lambda flow



Proton flow

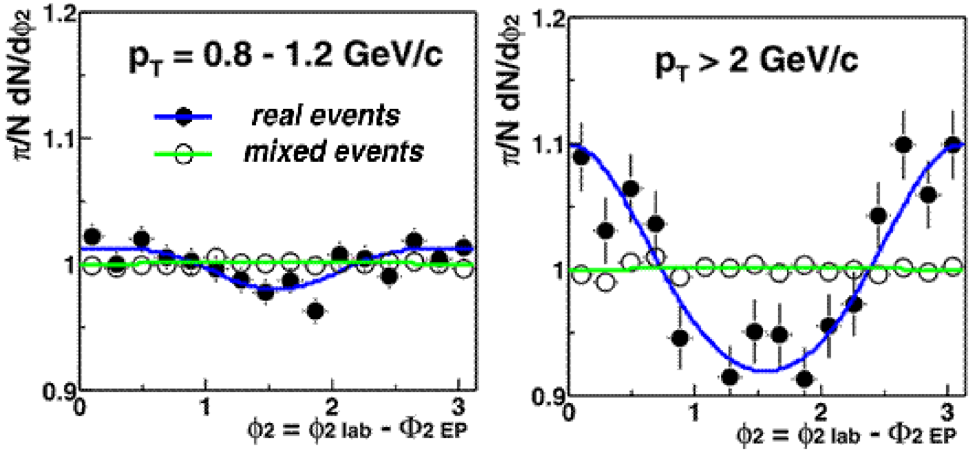


C.Alt et al., Phys. Rev. C 68 (2003) 034903

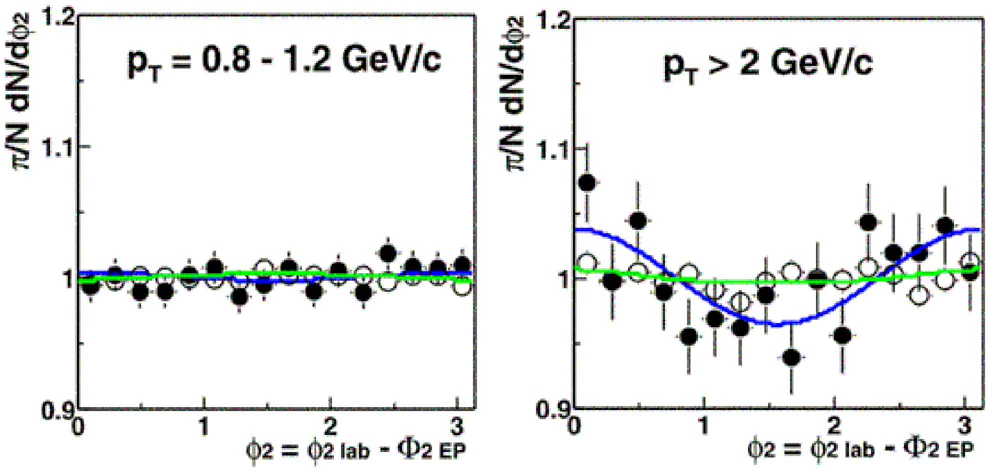
- no significant dependence of v_2 on rapidity for Λ and protons

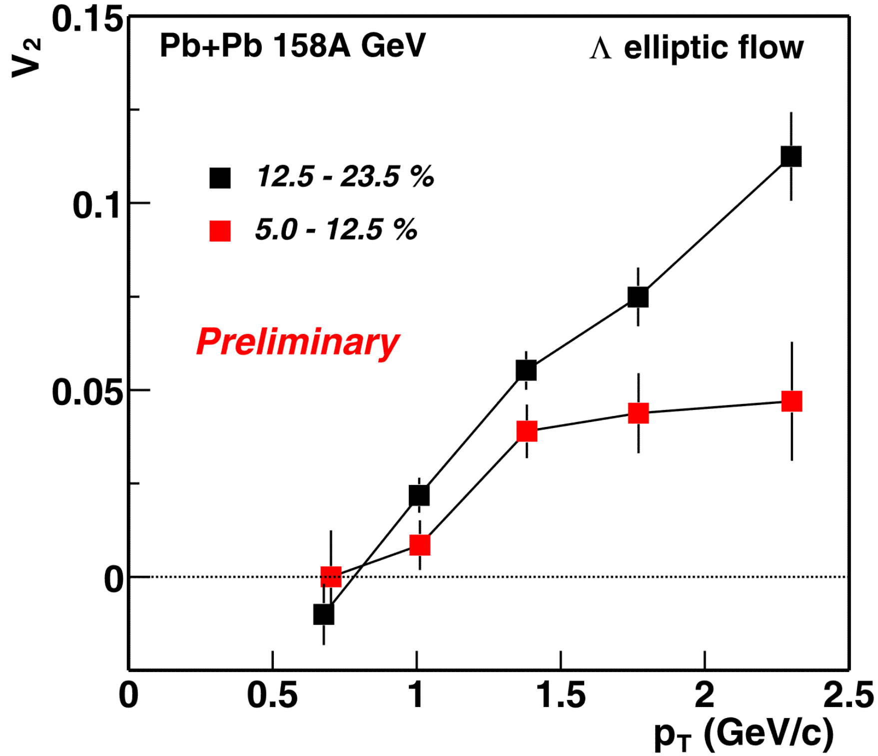
p_T and centrality dependence

σ/σ_{TOT} = 12.5 - 23.5 %



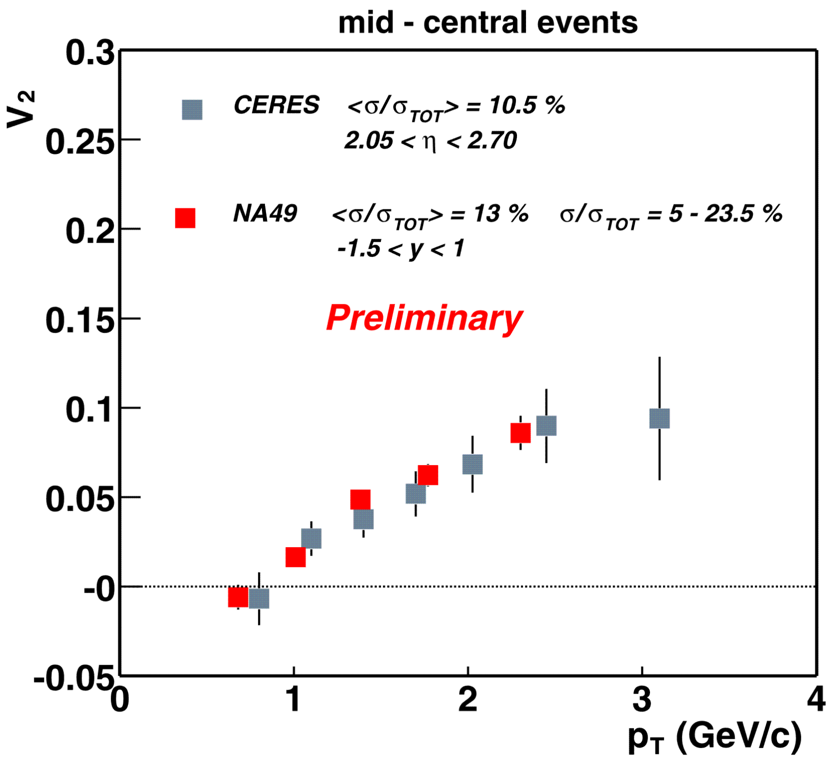
σ/σ_{TOT} = 5 - 12.5 %

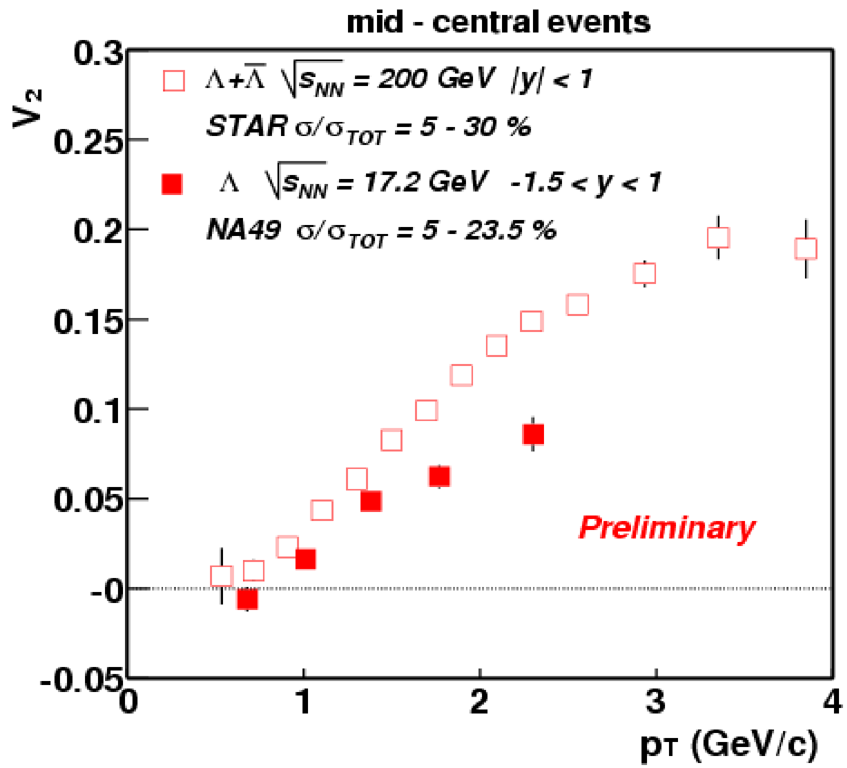




- significant increase of Λ v_2 with p_T
- stronger increase in more peripheral collisions

• Comparison with CERES and STAR data



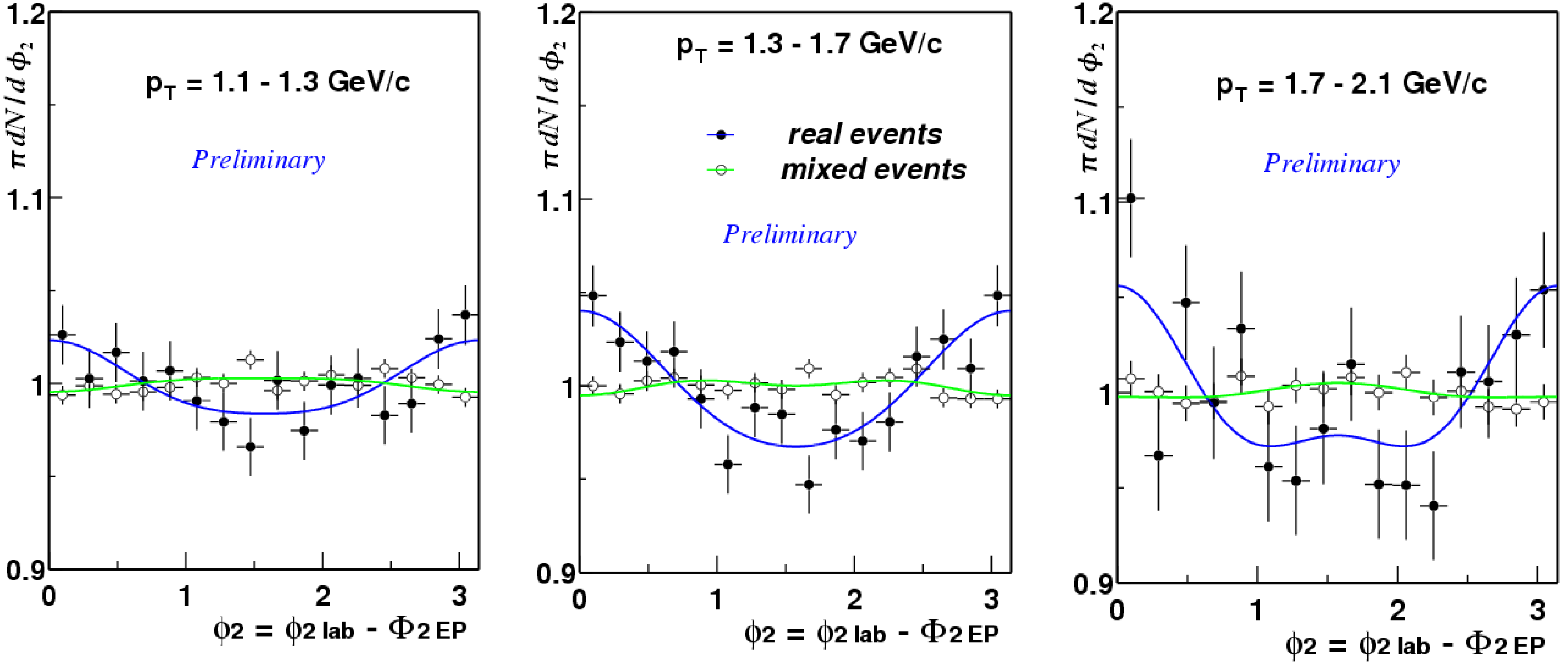


Good agreement between NA49 and CERES $v_2(p_T)$ of Λ hyperons

Linear rise of v_2 (p_T) up to 2 GeV/c
weaker increase at SPS than at RHIC
→ not explained by slightly different centrality

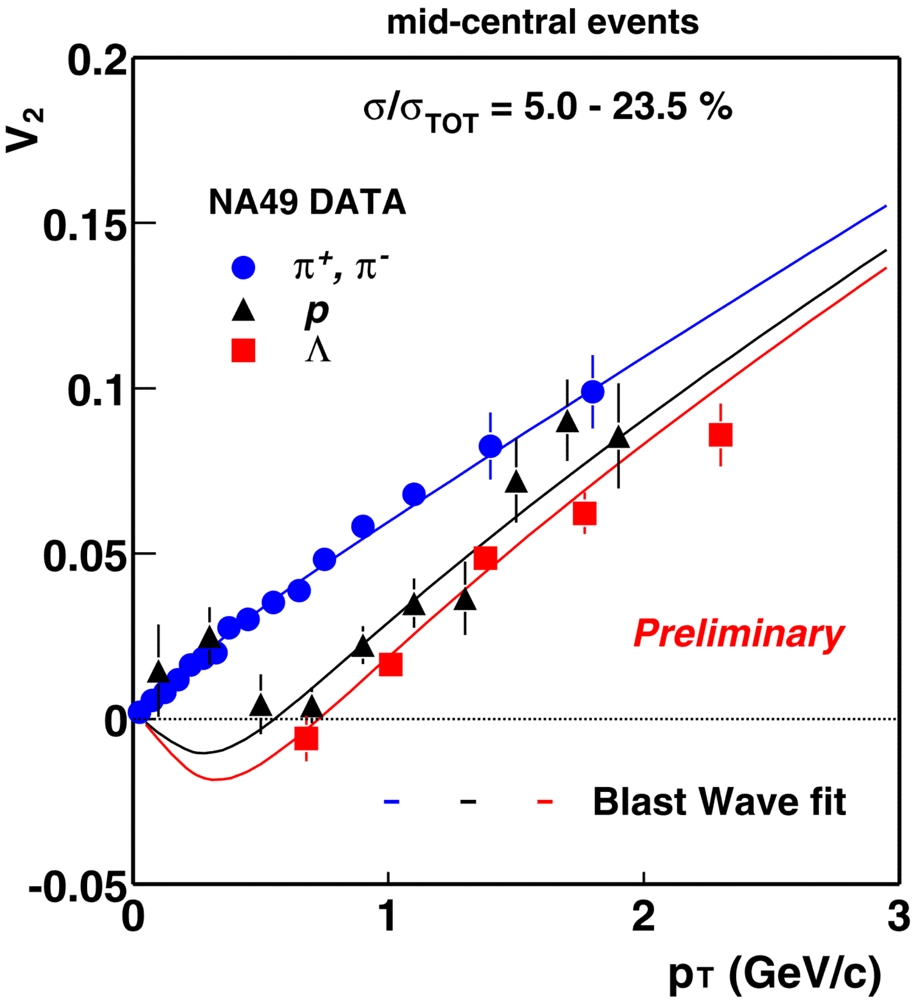
K^0_s Elliptic Flow - p_T dependence

σ/σ_{TOT} = 5 - 23.5 %



One can see elliptic flow effect, analysis on the way

Λ Elliptic flow - different species



- linear increase of v_2 with p_T for all species in mid-central events
- mass hierarchy $v_2(\pi)>v_2(p)>v_2(\Lambda)$ at $p_T < 2$ GeV/c)
- similar magnitude of v_2 for all particle species at p_T ~2 GeV/c
- blast vawe fit reproduce v_2 (and p_T spectra) quite well

Model:
F. Retiere, M. Lisa, Phys.Rev. C70 (2004) 044907

Data on pions and protons:
C.Alt et al. , Phys. Rev. C 68 (2003) 034903

Conclusions

- weak dependence of v_2 on rapidity
- v_2 increases with increasing centrality
- v_2 rises with transverse momentum up to 2.5 GeV/c
- slower rise with p_T at SPS than at RHIC
- good agreement with preliminary CERES results
- Blast Wave model reproduces $v_2(p_T)$ and p_T spectra for Λ, p and π

The NA49 Collaboration

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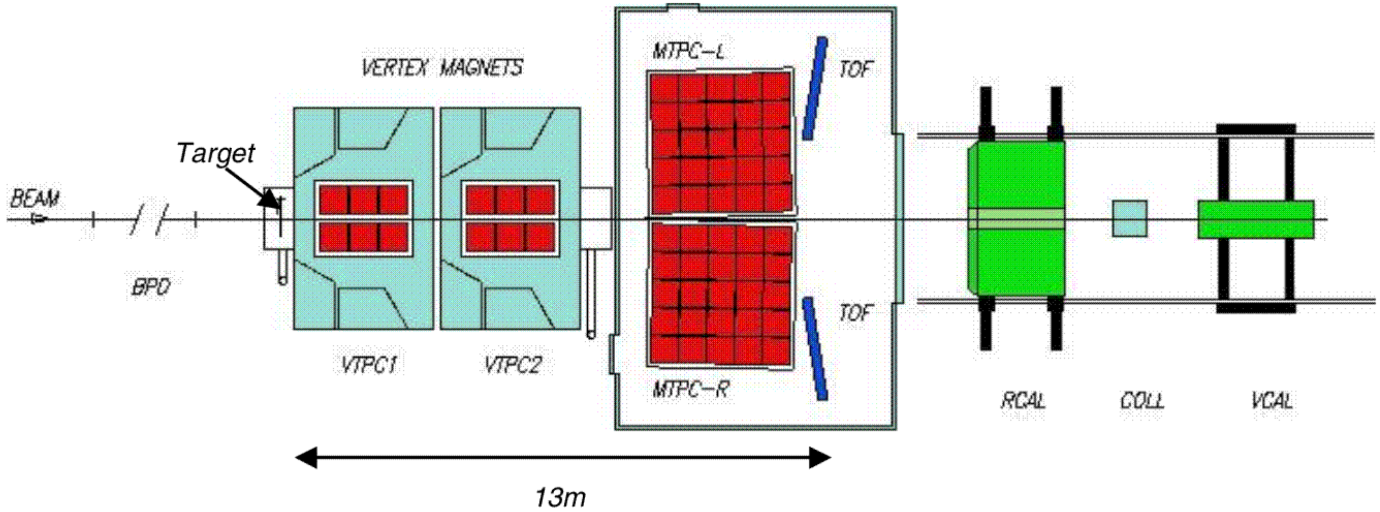
NA49 Experiment



- Two Vertex TPC (VTPC-1,VTPC-2)

  inside magnetic field
- Two Main TPC (MTPC-L, MTPC-R) outside magnetic field
- Veto Calorimeter (VCAL) detects projectile spectators

Target: Pb foil 224 mg/cm^2

$\Delta p/p^2 = 7\ (0.3)\ 10^{-4}\ (\mathrm{GeV}/c)^{-1}$

(VTPC-1, VTPC+MTPC)

dE/dx resolution 3-6 %

Identification of π^+, π^-, K^+, K^-, p, $\bar{p}$, d, $\bar{d}$

K^0_s, Λ, Ξ, Ω, φ