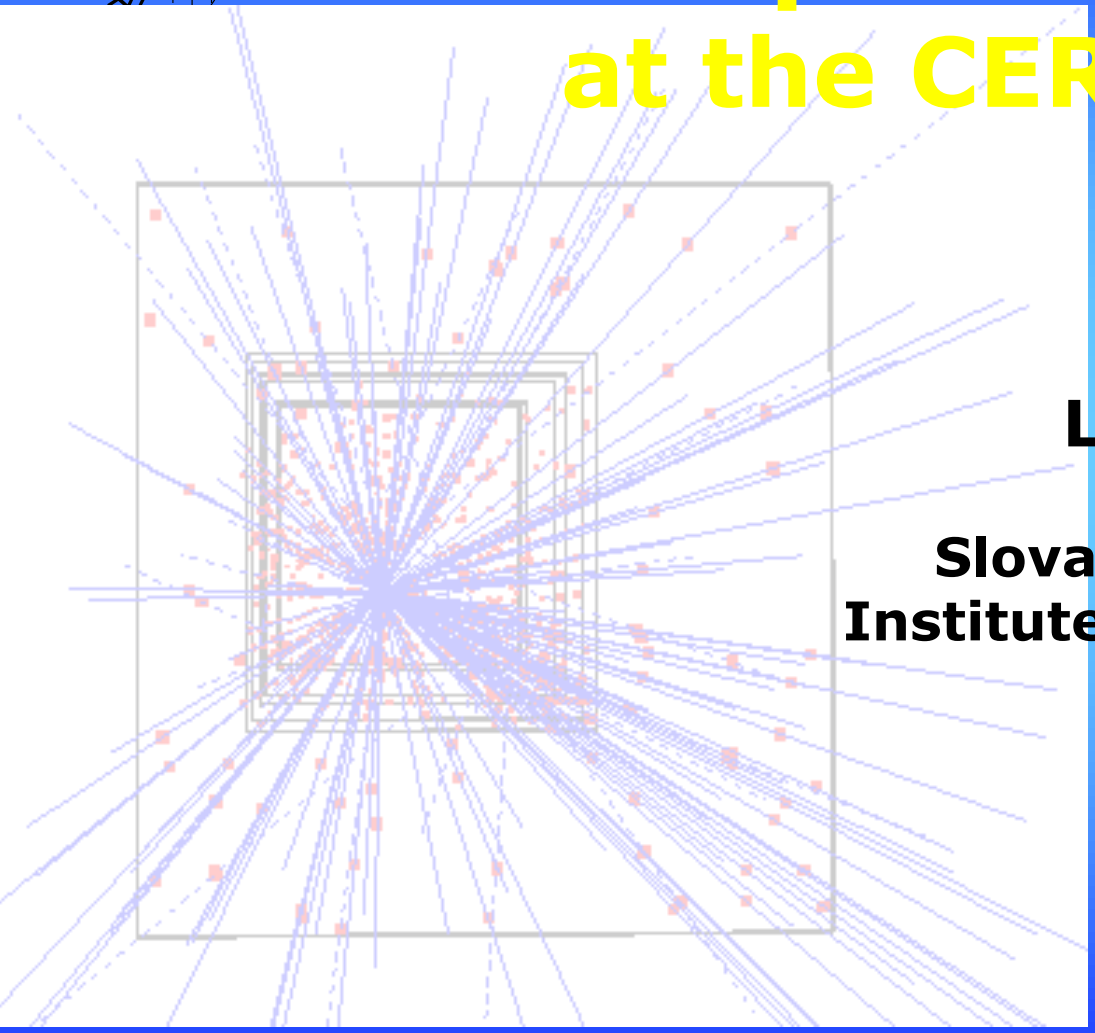
Experiments
at the CERN SPS



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Plan of talk

- **A bit of history**
- **Bratislava team in NA49**
  sincere thanks to V. Černý for details
- **Slovak participation in NA57**
- **Conclusions**

A bit of history

1984 – First informal contacts of Slovak experimenters with CERN, NA34

involvement both in particle and heavy-ion programme - M. Seman, L. Šándor, J. Antoš

1989 – Official participation of the first CS institute (IEP SAS Košice) in CERN experiment – NA34/3

First observation of anomaly in the dimuon spectrum (excess of continuum dimuon production) in heavy-ion collisions :

J. Antoš for the Helios/3 Collaboration: *Dimuon production in the 1-GeV/c**2 to 3-GeV/c**2 mass range in p W and S W reactions at 200-A-GeV/c*.
In *Les Arcs 1992, Perturbative QCD and hadronic interactions* 485-490.

Final HELIOS-3 data, confirming results of preliminary analysis, were elaborated in PhD thesis of I.Králik and published in Eur.Phys.J. C13 (2000) 433

1991 – WA97 experiment at the Omega facility starts, participation of Košice (IEP SAS) group

control electronics for cathode pad chambers
hyperon and anti-hyperon production in p-Be, p-Pb and Pb-Pb collisions at 158 *A* GeV
observation of strangeness enhancements at mid-rapidity

Key publications :

- **E. Andersen *et al.* Enhancement of central Lambda, Xi and Omega yields in Pb - Pb collisions at 158 A-GeV/c. Phys. Lett. B433 (1998) 209**
- **E. Andersen *et al.* Strangeness enhancement at mid-rapidity in Pb-Pb collisions at 158 *A* GeV/c. Phys. Lett. B449 (1999) 401**
- **F. Antinori *et al.* Production of strange and multistrange hadrons in nucleus-nucleus collisions at the SPS. Nucl. Phys. A661 (1999) 130.**

Important contribution of Slovak physicists to processing and analysis of data, as well as to the presentation of results

One of the main pieces of evidence for the formation of a new state of matter (CERN, February 2000);
award from the Slovak academy of sciences (2002)

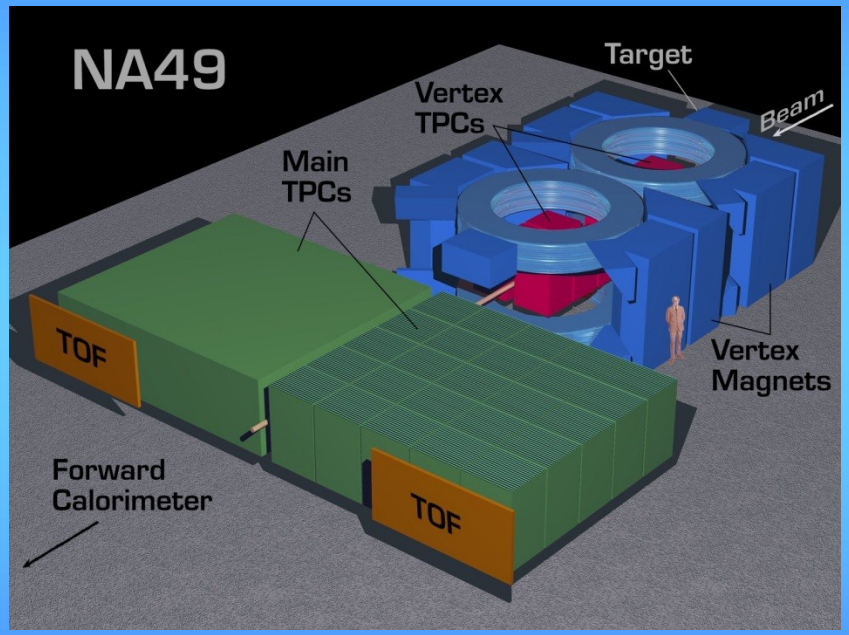
1997 - physicists from Comenius University in Bratislava joined the NA49 experiment

- in the same time groups from IEP SAS and P.J. Šafárik University (Košice) and from Comenius University (Bratislava) started their participation in the NA57 experiment, the successor of WA97

Many interesting physics results and a good preparation for participation in the LHC experiments

NA49

Large Acceptance Hadron Detector for an Investigation of Pb-induced Reactions at the CERN SPS

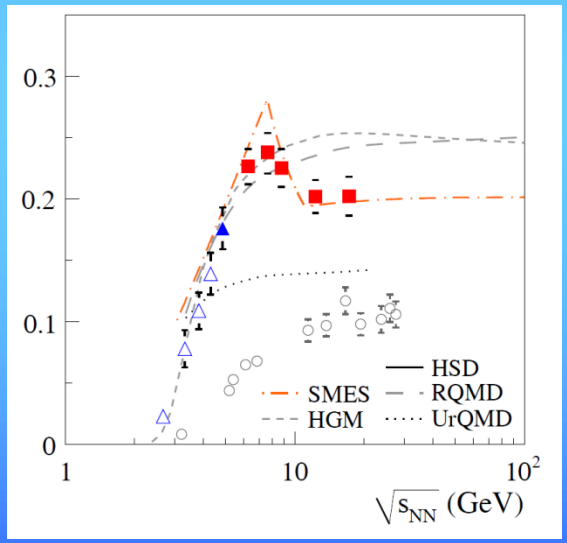


- **Bratislava joined NA49 collaboration in 1997**
- **At present the activity is terminating**

NA49

The NA49 detector is a large acceptance spectrometer employing a system of time projection chambers for efficient tracking and particle identification using the energy loss. Two time of flight walls augment particle identification

The NA49 experiment obtained evidence for the onset of deconfinement from a study of hadron production in central Pb+Pb collisions at the CERN SPS



Bratislava in NA49

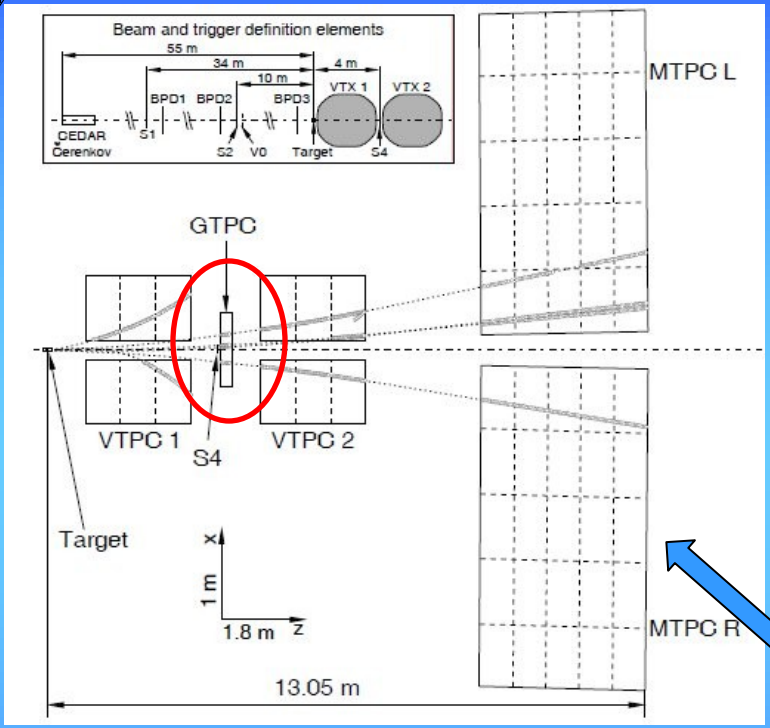
11 physicists took part with different level of involvement

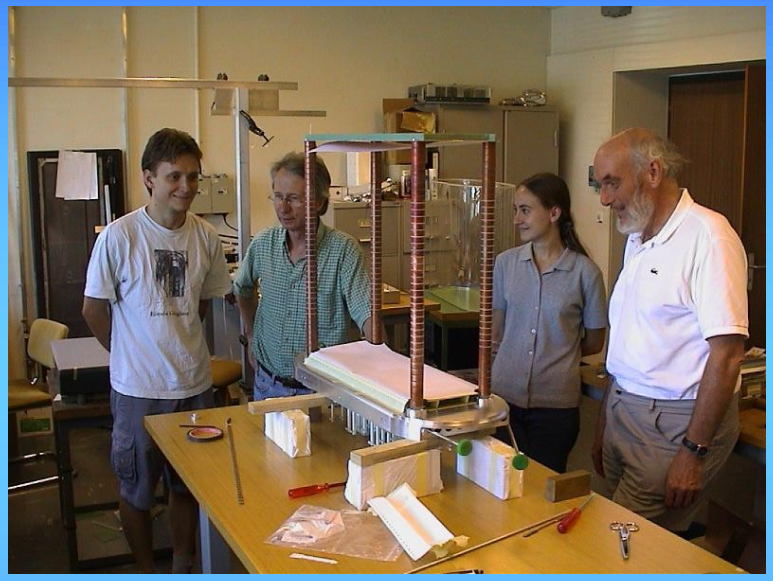
J.Braciník, V.Černý, J.Ftáčnik, V.Hlinka, M.Ivanov, R.Janik, M.Kreps, M.Pikna, B.Sitár, P.Strmeň, I.Szarka

- calculation of acceptance tables
- participating at the construction of the "Gap TPC"
- modules in the software production chain
- TPC simulations for better understanding of dE/dx
- feed-down-correction calculations
- development of the event-mixing method
- baryon spectroscopy in the pp interactions
- inclusive pion, proton, kaon production in pp

Bratislava participated mainly in the activities of the proton-proton (H.G.Fischer) group of NA49

Participation in gap TPC construction





GTPC added to improve acceptance

Worth to note:
Our students got excellent schooling and supervision at CERN

High quality data on inclusive particle production in p-p collisions

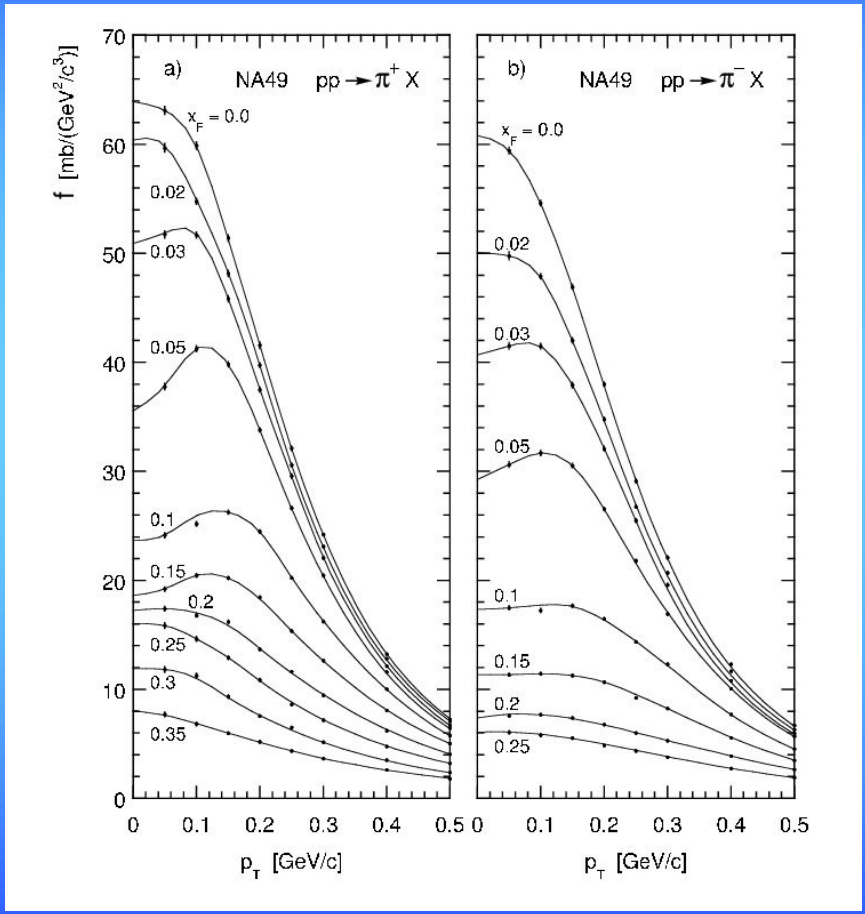
Inclusive production of charged pions in p+p collisions at 158-GeV/c beam momentum.Eur.Phys.J.C45:343-381,2006.

Inclusive production of charged kaons in p+p collisions at 158 GeV/c beam momentum and a new evaluation of the energy dependence of kaon production up to collider energies. Eur.Phys.J.C68:1-73,2010.

Inclusive production of protons, anti-protons and neutrons in p+p collisions at 158-GeV/c beam momentum. Eur.Phys.J.C65:9-63,2010.

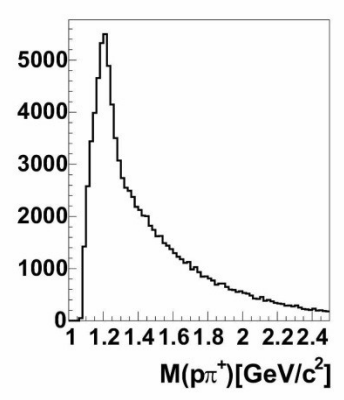
In the last years – 5 authors from Bratislava (J.Braciník, V.Černý, M.Kreps, M.Pikna, B.Sitár)

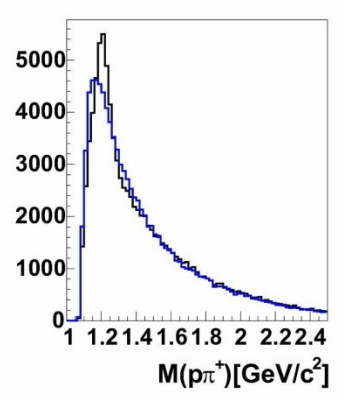
NA49 inclusive pion production

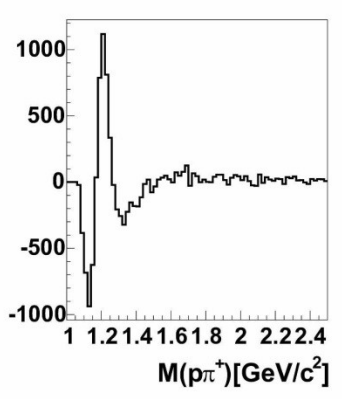


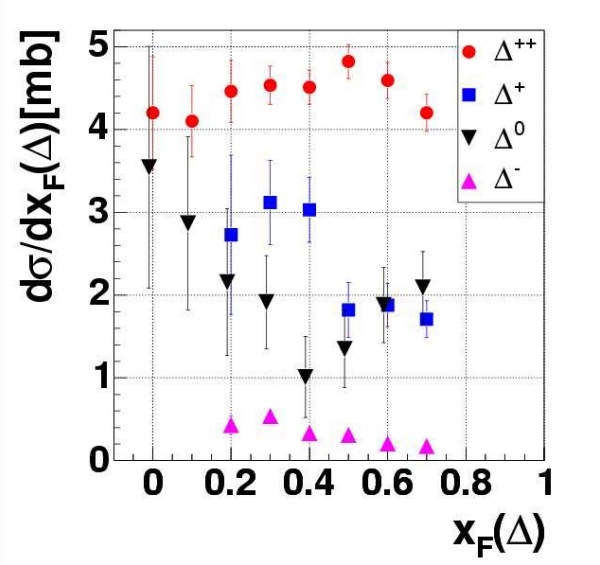
Resonance extraction by event mixing technique

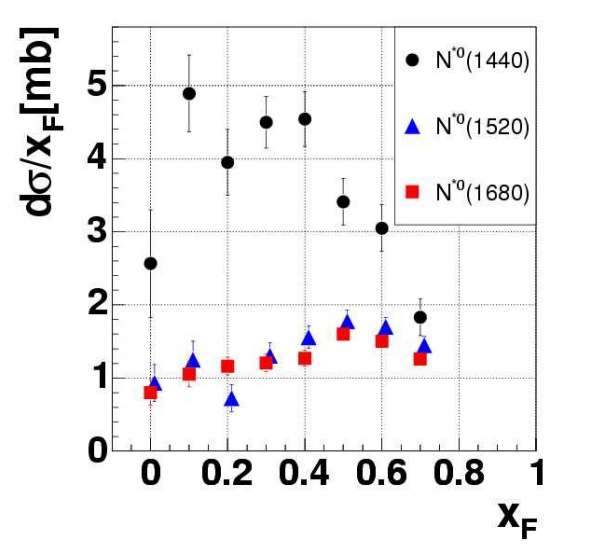
D. Drijard, H. G. Fischer, T. Nakada
Nucl. Instrum. Methods A225 (1984) 367





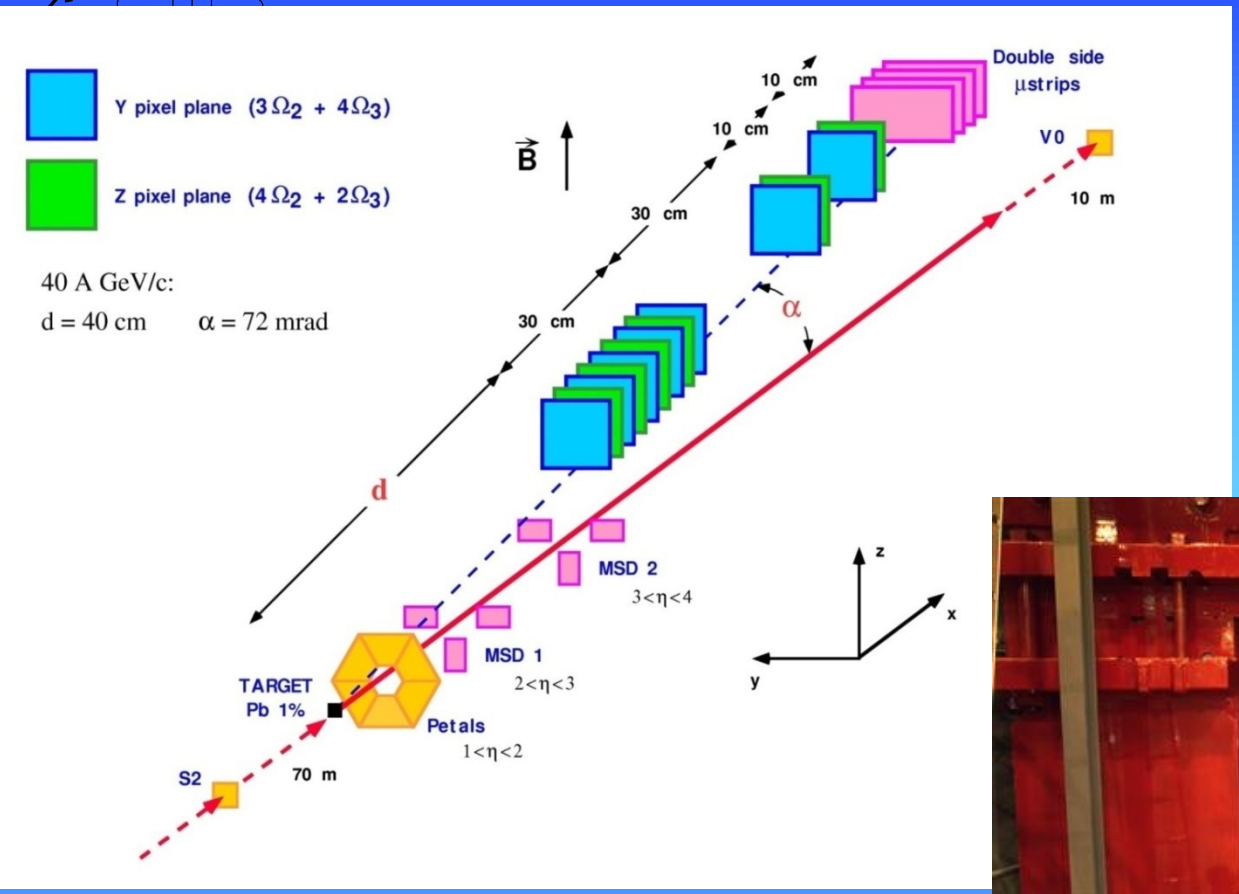






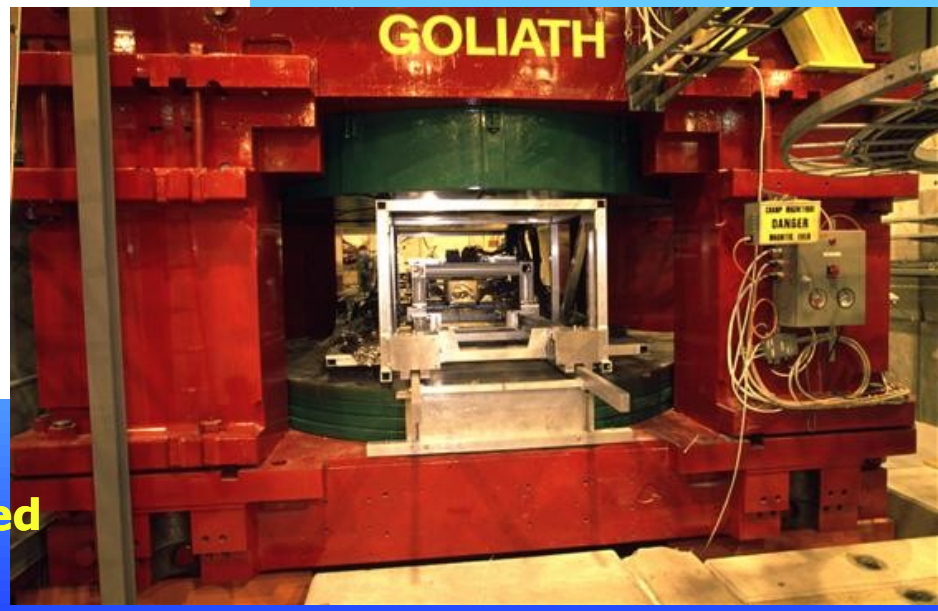
From M. Kreps PhD thesis

NA57 experiment



Main goal of experinent – study of the dependence of hyperon enhancements on the interaction volume (wide range of centrality) and on energy (data taking at two different energies – 40 and 158 *A* GeV)

Hyperons at mid-rapidity, Pb-Pb and p-Be collisions



Main tracking detector – the silicon pixel telescope, measurement of charged multiplicity, triggering on centrality

Slovakia in NA57

Since 1997 15 physicists and engineers took part in the experiment with different level of involvement (4 from Comenius Univ., 6 from Šafárik Univ., 5 from IEP)

Main Slovak contributions :

- **trigger and DAQ maintenance during data taking**
- **full p-Be data sample at 40 GeV processed in Košice**
- **simulations, study of systematics**
- **primary vertex determination, correction calculations,...**
- **physics analysis (Xi and anti-Xi production in Pb-Pb at 158 *A*GeV, K^0_S, Λ and anti-Λ in Pb-Pb and p-Be at 40 *A*GeV)**
- **analysis of strangeness enhancements**
- **publication and presentation of results**

Two PhD students successfully defended their theses in Košice

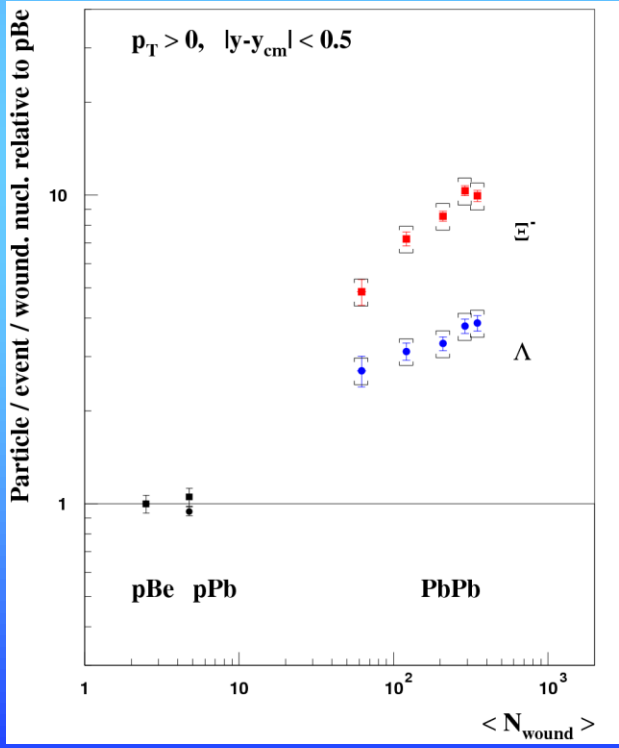
Summary of recent NA57 results

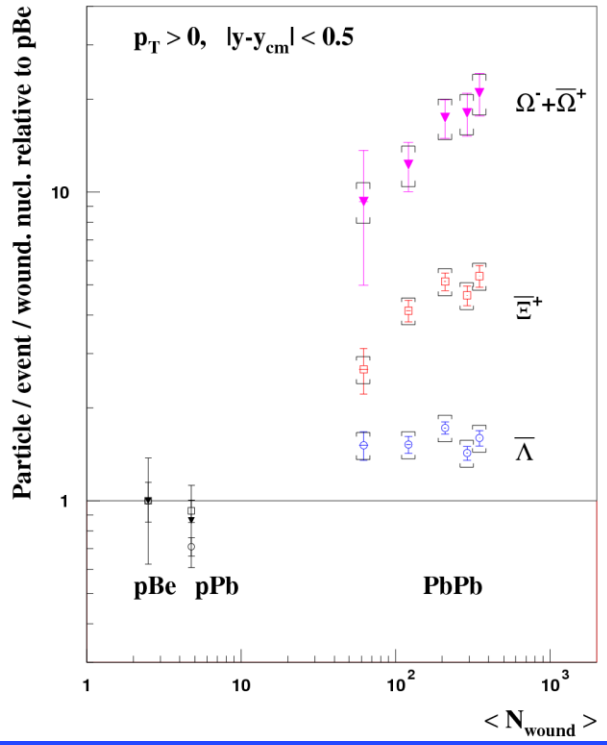
Strangeness enhancements

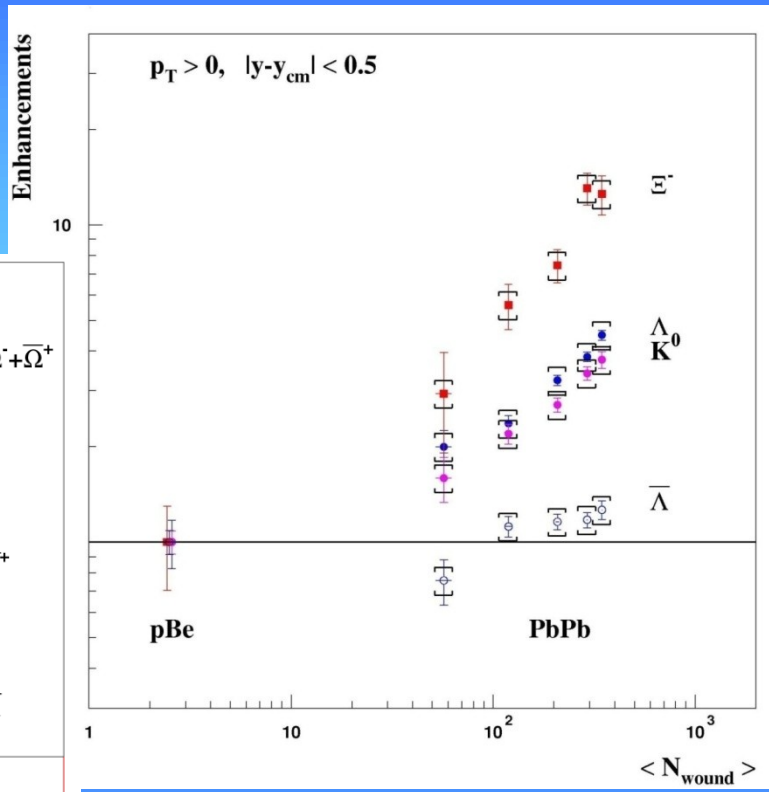
Strong centrality dependence observed at both energies

158 *A* GeV

F. Antinori *et al.*, J.Phys.G., 32 (2006) 427

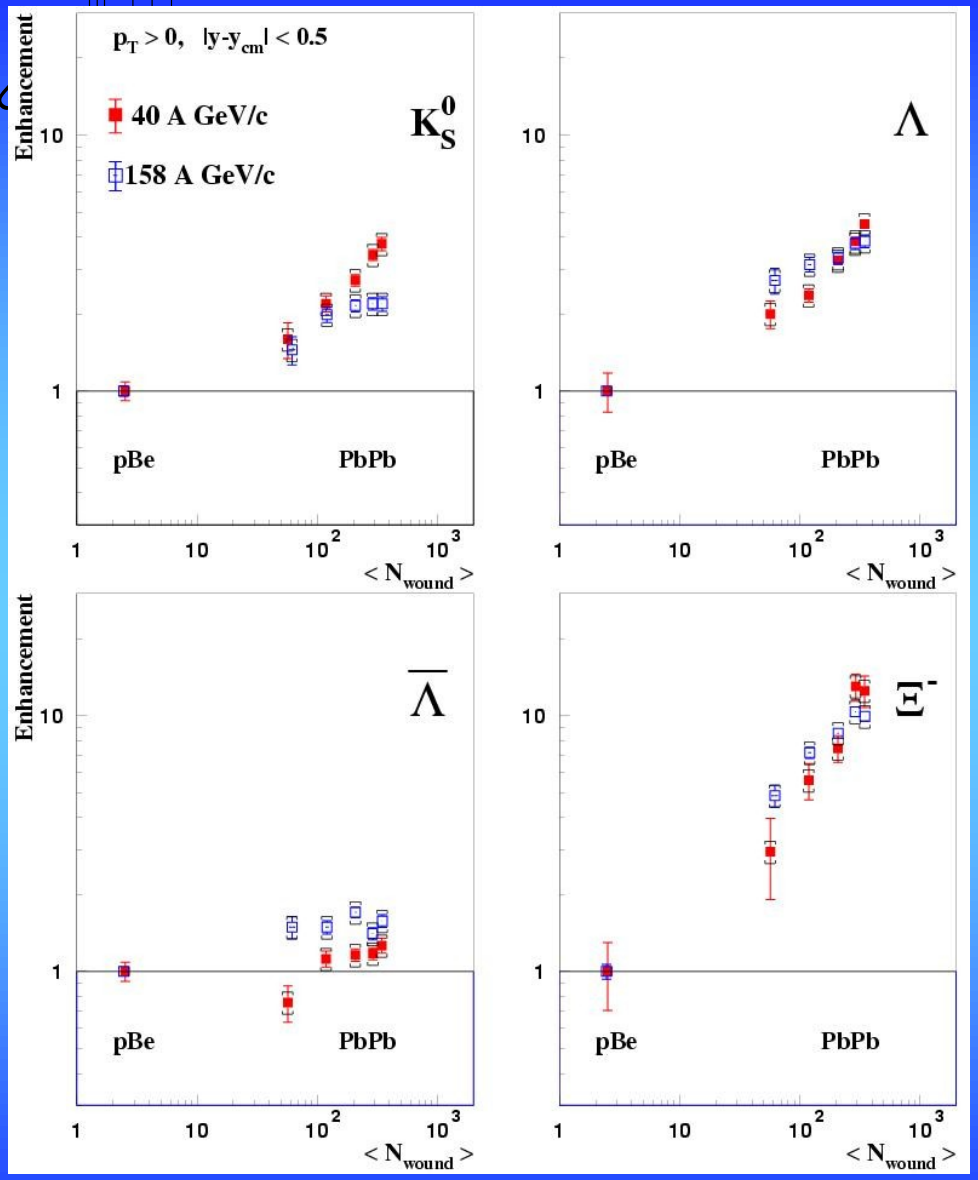






40 *A* GeV

F. Antinori *et al.*, J.Phys.G.,37 (2010) 045105

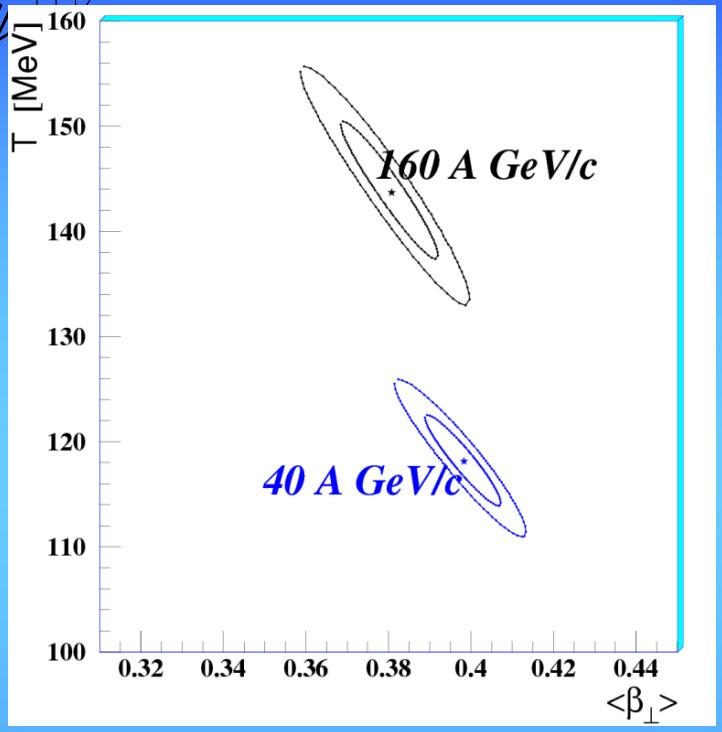


Energy dependence of enhancements

- in central bins 40 GeV enhancements higher
- steeper centrality dependence at lower energy
- anti-Λ data do not exhibit a significant enhancement nor centrality dependence

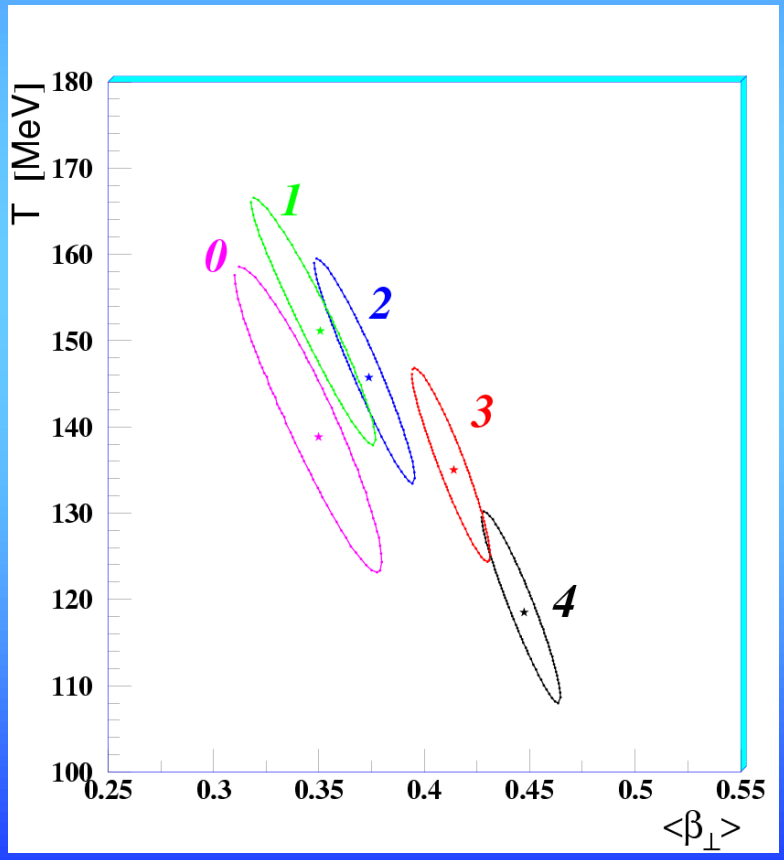
A centrality-dependent absorption effect of anti-Λ in a nucleon-rich environment at SPS ?

Thermal freeze-out parameters



Blast-wave analysis of mT spectra

F. Antinori et al., J.Phys.G., 30 (2004) 823
F. Antinori et al., J.Phys.G., 32 (2006) 2065



Important for calculation of hydro-dynamic limits for comparison with the v2 measurements at the SPS

Conclusions

- High quality new physics results obtained, both NA49 and WA97/NA57 experiments provided weighty arguments for identification of a new state of matter
- excellent school for our PhD students and researchers to be prepared for a new era of the LHC experiments
- learning of top experimental techniques (TPC, pixels,...) and prototyping of new methods (e.g. the NA57 trigger tested the approaches planned for ALICE) was highly profitable for contribution to the LHC detector building
- both experiments are coming now to the termination, last NA57 paper in 2010 prepared in Košice
- the majority of former NA49 and NA57 members joined efforts for a common long-term participation in ALICE, staying tuned for unexpected surprises...