Study of Nuclear Interactions in the *NA49* Experiment

G.L.Melkumov
(***JINR*** group of ***NA49***)

Experiments at *CERN*

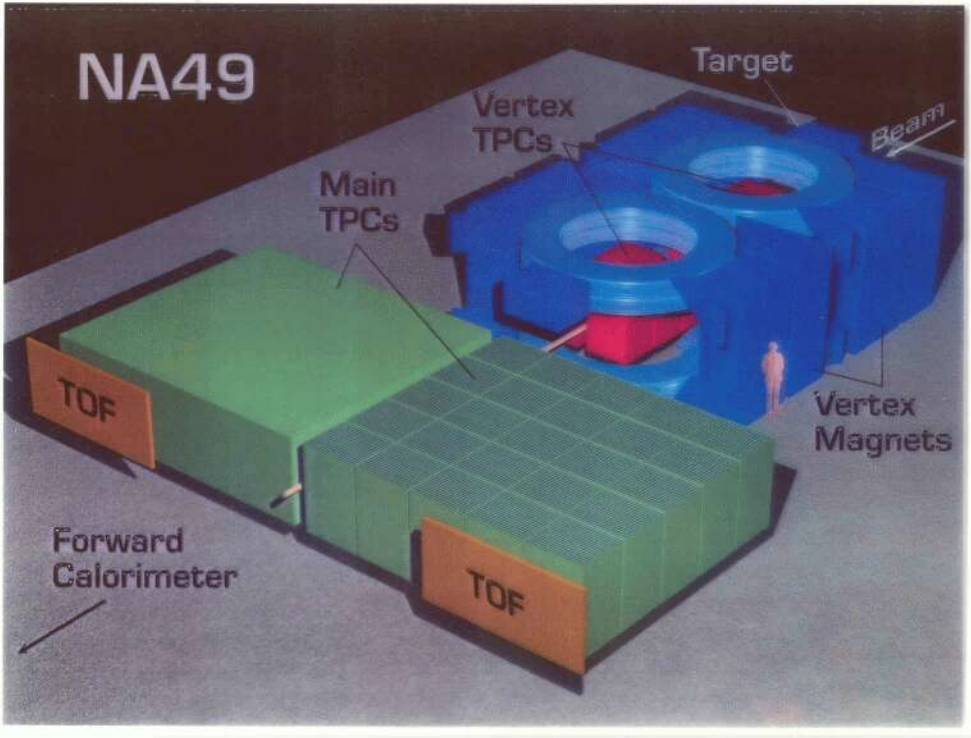
- → NA45/CERES
- WA97/NA57
- NA50(NA60)
- NA44
- → WA98
- → NA49

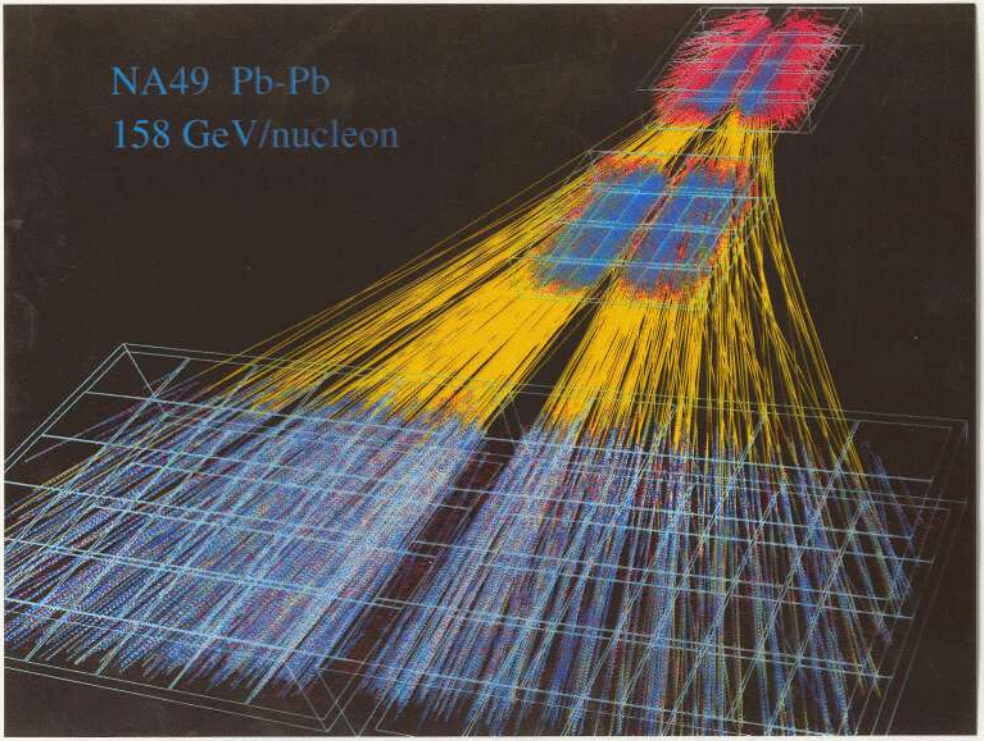
QGP Signatures :

Strangeness enhancement

J/ψ *suppression*

Thermal photons , dileptons


NA49
Target
Vertex
TPCs
Beam
Main
TPCs
TOF
Vertex
Magnets
Forward
Calorimeter
TOF


NA49 Pb-Pb
158 GeV/nucleon

Features NA49

$\pi^{\pm}, K^{\pm}, p, \bar{p}, d, \bar{d},$

$\phi, \Lambda, \bar{\Lambda}, K^{o}_{s}, \Xi, \Omega,$

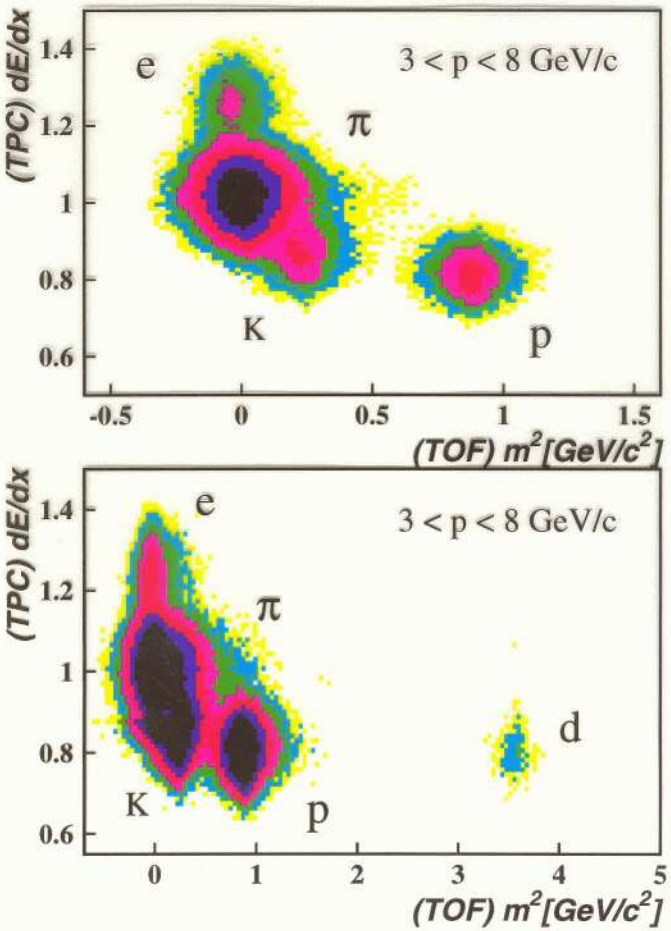
4% dE/dx

60-70 ps TOF

80% Acceptance

1200 charged particles

dE/dx vs TOF Identification



Conception NA49

- **Central Pb+Pb 160A GeV**

  - **High Stopping and Energy Density**

    $\varepsilon \approx 3$ GeV/fm^3

  - **Strangeness and Pion enhancement**
  - **Transverse Expansion and Flow**
  - **Small Event-by-Event fluctuations**

- **AA collisions at various centrality, size and energy**

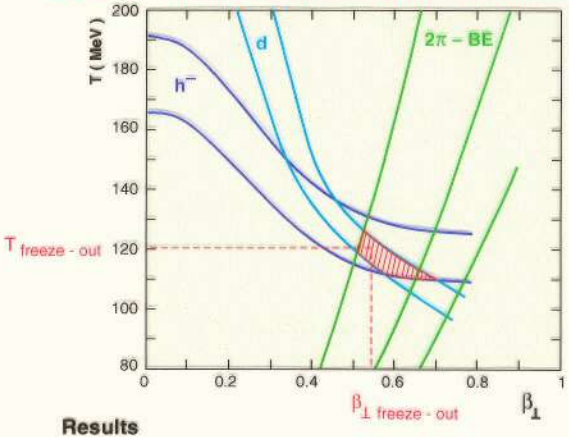
- **More elementary p+p and p+A interaction**

NA49 central Pb+Pb at 158 GeV/Nucleon

Hadronic Expansion Dynamics

- Bose Einstein correlation of **negative pions** (2π - **BE**)
- and transverse mass spectra of **negative hadrons** (h^-) and **deuterons** (d)

→ **determine the conditions at hadronic decoupling**



Results

From initial hadronization stage at T = 190 MeV to final hadronic decoupling (freeze - out)

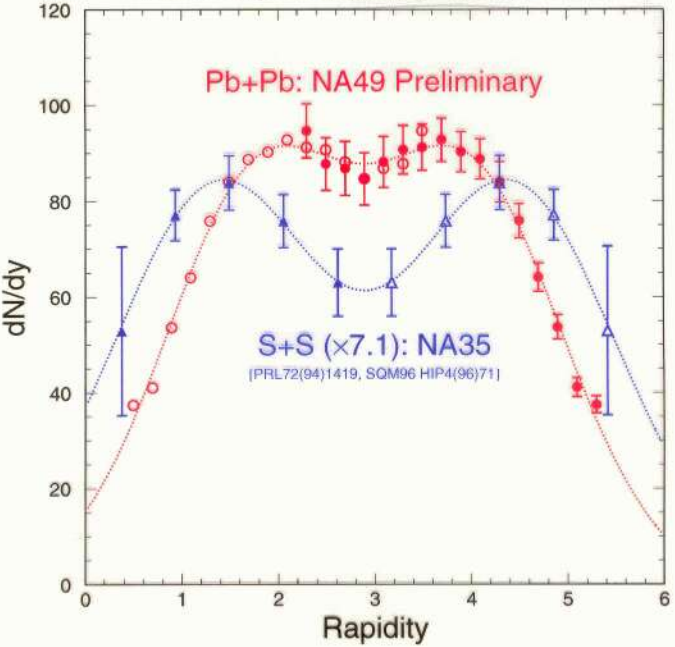
- **Source expanding radially and longitudinally**
- **Duration of expansion $< \tau > = 8$ fm / c**
- **Local thermal equilibrium**

$T_{freeze - out} = 120 \pm 10$ MeV

$\beta_{\perp\ freeze - out} = 0.55 \pm 0.12$

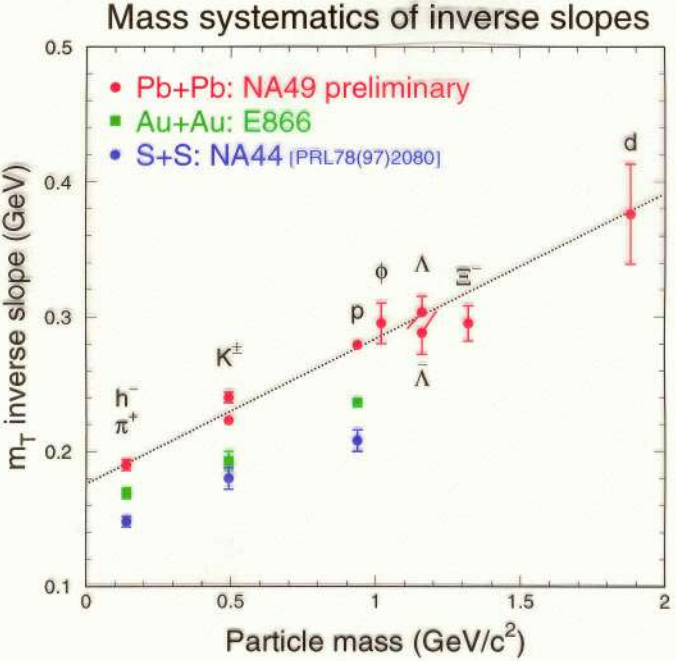
$\beta_{L\ freeze - out} = 0.90$

Net baryon rapidity distribution



Pb+Pb: 5% central, $\Delta y = 1.80 \pm 0.01$
S+S: 3% central, $\Delta y = 1.47 \pm 0.09$

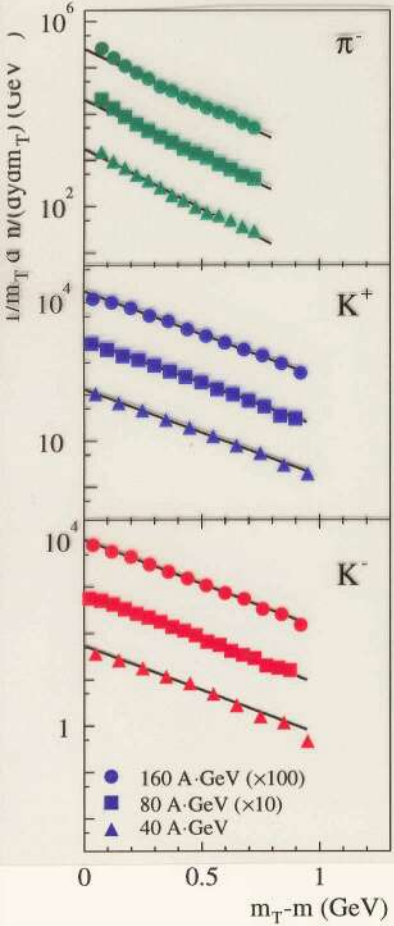
- Baryon stopping: Pb+Pb > S+S.
- More collisions → more stopping.



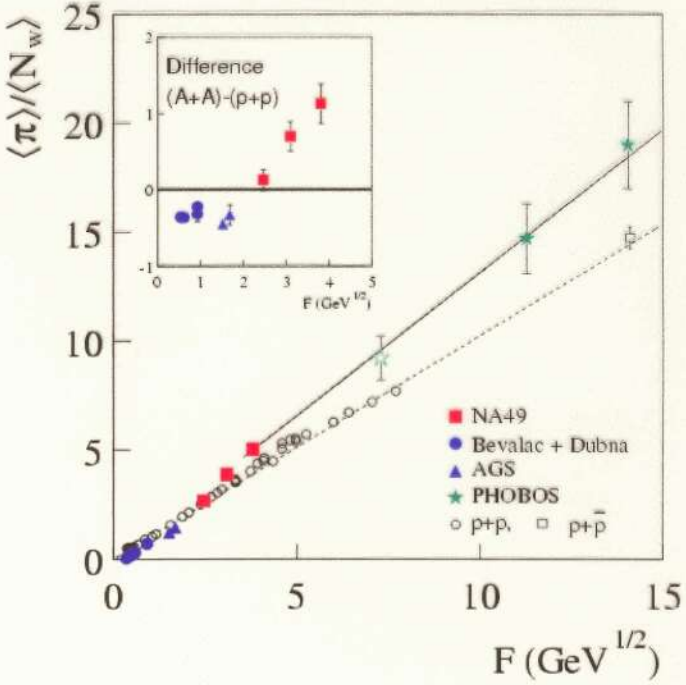
Two comparisons: Pb+Pb vs S+S, SPS vs AGS

Consistent with transverse radial flow.

m_T Spectra at Midrapidity



Pion Production



VAST DATA SET NA49

9.000.000 Events

Pb+Pb
Si+Si
C+C

at 160, 80 and 40 AGeV

13.000.000 Events

p+Pb
d+Pb
p+p
$\pi^{\pm}$+Pb
$\pi^{\pm}$+p

at 160 and 40 GeV

Summary

- Large acceptance measurements in pp, pPb, CC, SiSi and PbPb collisions at 40, 80 and 160 AGeV.
- 20 and 30 AGeV forthcoming.
- Energy, size and centrality dependence:
  - Particle yields
  - Spectra
  - Correlations
  - E-by-E fluctuation of the average event properties $\langle p_t \rangle$, $\langle K/\pi \rangle$, $\langle N_+/N_- \rangle$
- π yields and k^+/π^- ratio might be related to the phase transition to the QGP at lower SPS energy, as supported by statistical model

- **No unusual features of the produced hadron systems in:**
  - **$\pi\pi$ correlations**
  - **E-by-E fluctuations**
  - **Anisotropic flow**

- **Systematics of the evolution of particle production from pp via pPb to PbPb collisions:**
  - **Predictions for AA**
  - **Baryon number transfer**
  - **Isospin effect**
  - **Strangeness enhancement in pA**