

Energetic Scans of Marek Gazdzicki

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Interest in Nucleus-Nucleus Collisions since work on PhD thesis:

(Warsaw University, DUBNA 1980 – 1985)

Search for enhanced strangeness production
as indicator of hadron deconfinement

Thesis subject: Nucleus-nucleus interactions
at 4.5A GeV in the SKM200 streamer chamber
experiment at the DUBNA Synchrophasotron

Reactions C+C, C+Ne, C+Cu, C+Zr, C+Pb, O+Ne, O+Pb
 $\rightarrow \pi^- , K_s^0 , \Lambda$

Result: No statistically significant “unusual”
enhancement of Λ and K^0 production

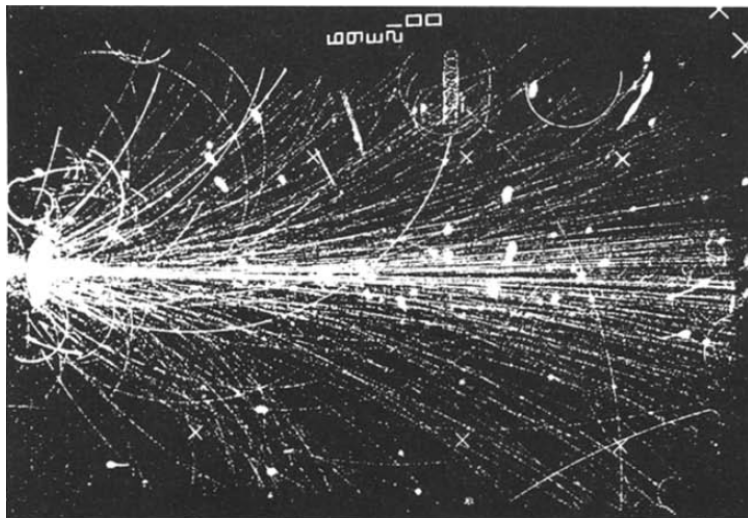


NA35 streamer chamber experiment at the CERN SPS

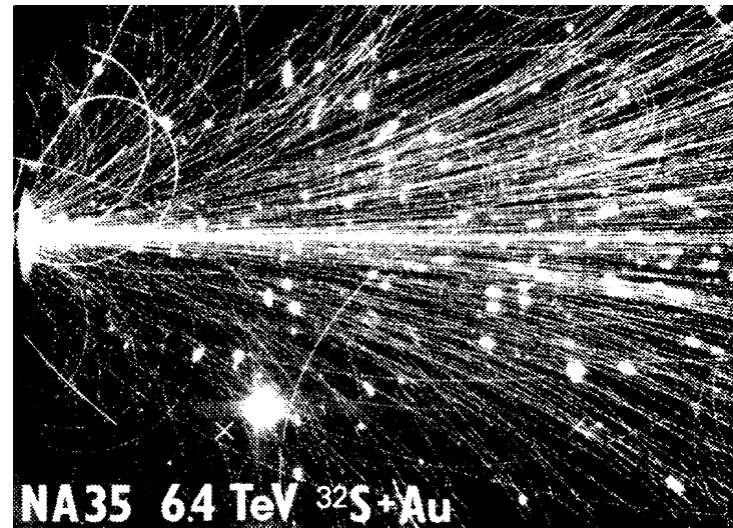


1986 – 1989 Heidelberg and Frankfurt University
1989 – 1992 Warsaw Institute of Experimental Physics
1992 – present Frankfurt and Kielce Universities

O+ (Au, Ag, Cu) reactions at 60A and 200A GeV (1986)
S + (Au, Ag, S) reactions at 200A GeV (1987, 1990)



O + Au



S + Au

First indication of enhancement of strangeness in final states of S+S, S+Ag reactions compared to p+A collisions

Strangeness suppression factor (Wroblewski):

$$\lambda_S = \frac{\langle s\bar{s} \rangle}{0.5 \cdot (\langle u\bar{u} \rangle + \langle d\bar{d} \rangle)}$$

Suppression decreases from N+N to S+A: **0.17 \rightarrow 0.35**

Measure of total strangeness production (at SPS energies)

$$E_S = \frac{\langle \Lambda \rangle + 4 \cdot \langle K_S^0 \rangle}{3 \cdot \langle \pi^- \rangle} \approx \frac{\langle \Lambda \rangle + \langle K + \bar{K} \rangle}{\langle \pi \rangle}$$

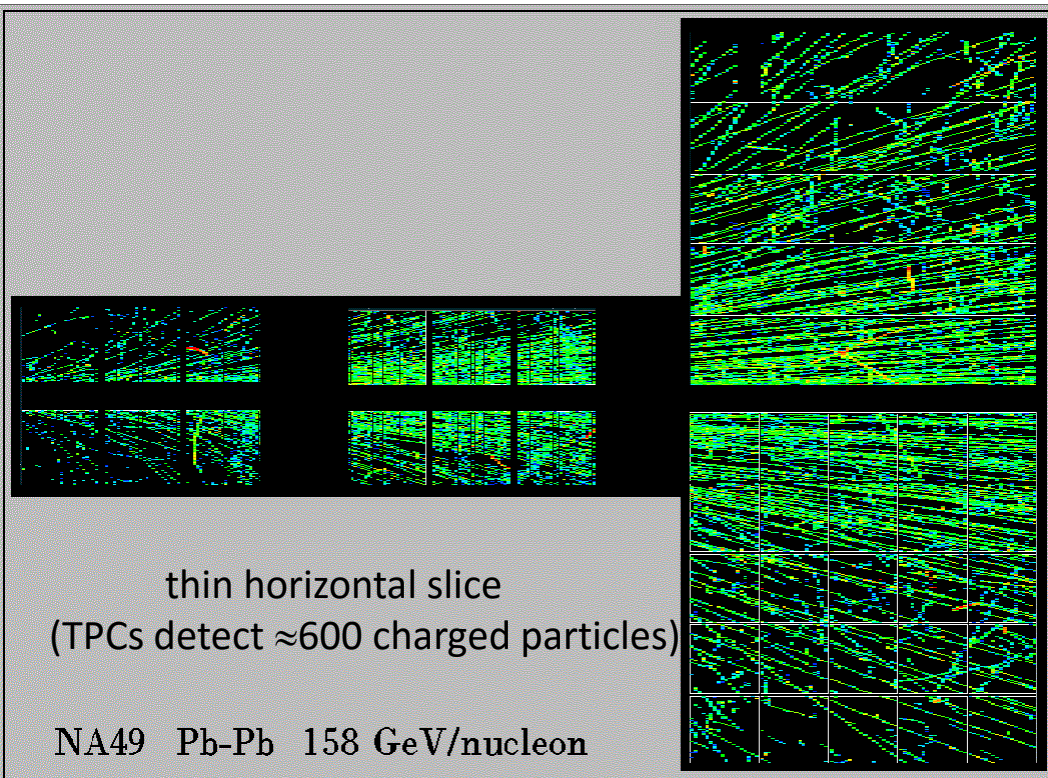
E_S increases from N+N to S+A: **0.1 \rightarrow 0.17**



SQM1994 Kolymbari

NA49 time projection chamber experiment at the CERN SPS

Pb beam from 1994 - 2002



- central Pb+Pb collisions at 158A GeV
- clear strangeness enhancement
- fluctuations compatible with mostly statistical origin
- no unique signal of deconfinement

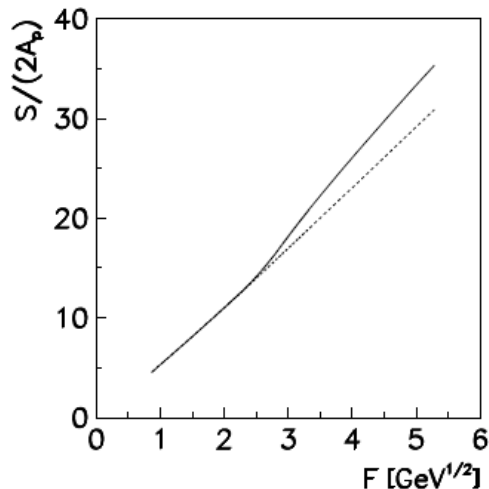
→ energy scan for onset of deconfinement signal

The statistical model of the early stage SMES

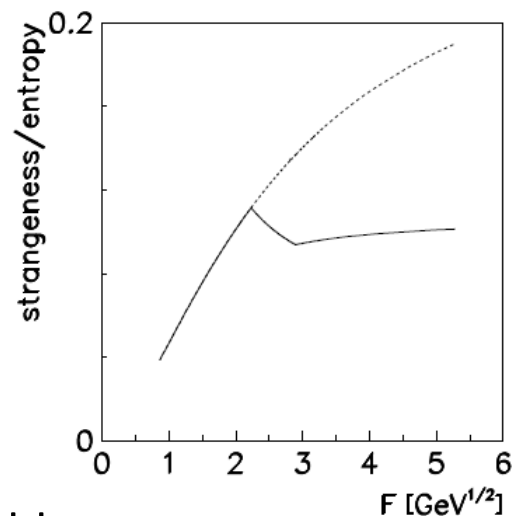
Extensive compilations of pion and strange particle production (with D.Roerich)
 Strong interest in the statistical model description of hadron production
 Led to the development of the SMES model with M.Gorenstein (1994 -1999)
 incorporating 1st order hadron \leftrightarrow quark, gluon phase transition

Characteristic experimentally observable signals of the onset of deconfinement were predicted in the energy dependence of hadron production properties

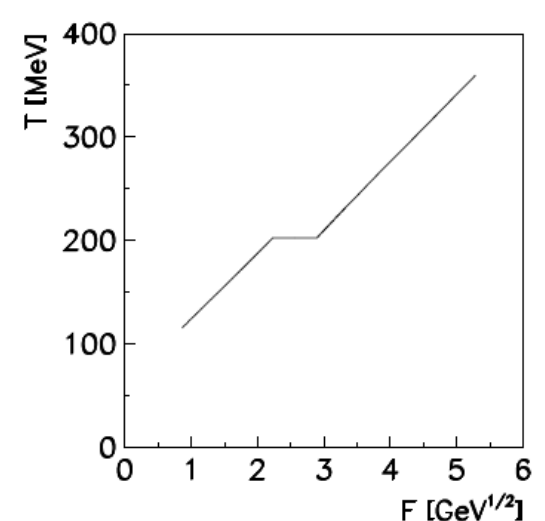
“kink”



“horn”



“step”



Proposed suitable observables:

$$\langle \pi \rangle / \langle N_W \rangle$$

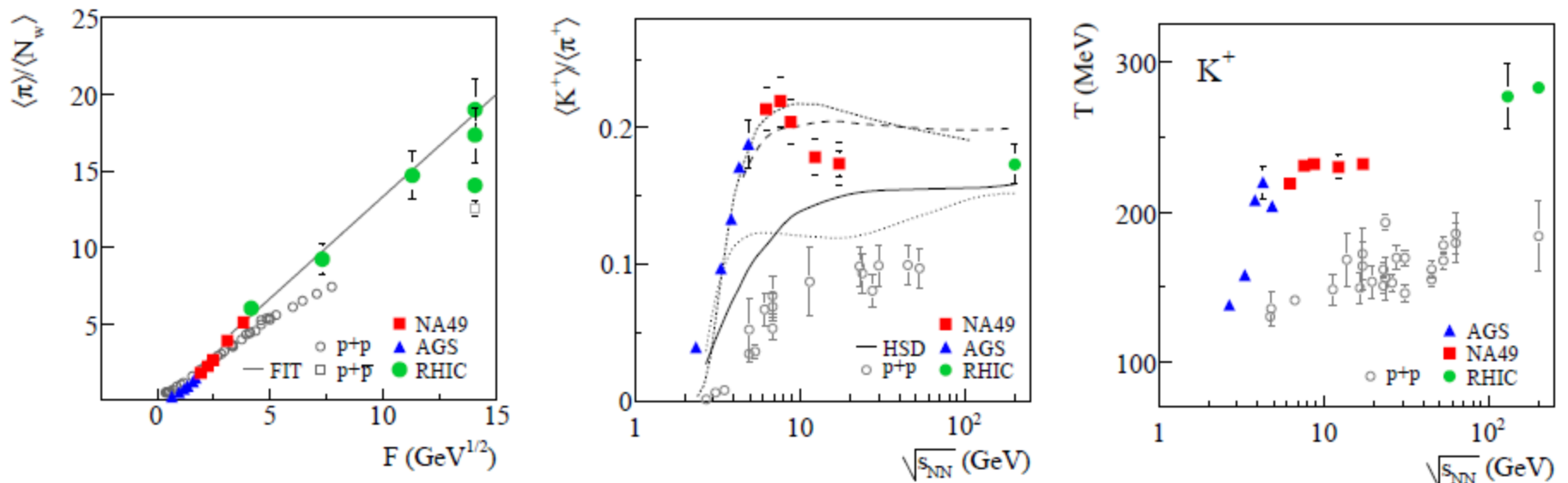
$$\langle K \rangle / \langle \pi \rangle$$

inverse slope T
 of Kaon p_T spectrum

Pb beam energy scan 20A – 158A GeV at CERN SPS (1998 – 2002)

Marek convinced the CERN program committee (SPSC) of the importance of an energy scan. This was carried out 1998-2002 and terminated NA49 data taking

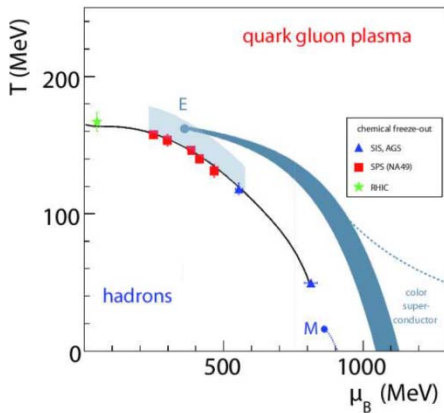
Final NA49 results confirmed the SMES predictions and located the onset of deconfinement in central heavy nucleus collisions in the region of 30A GeV



Interest now shifted to a systematic exploration of the phase diagram of strongly interacting matter and the search for the hypothesized critical point (CP)

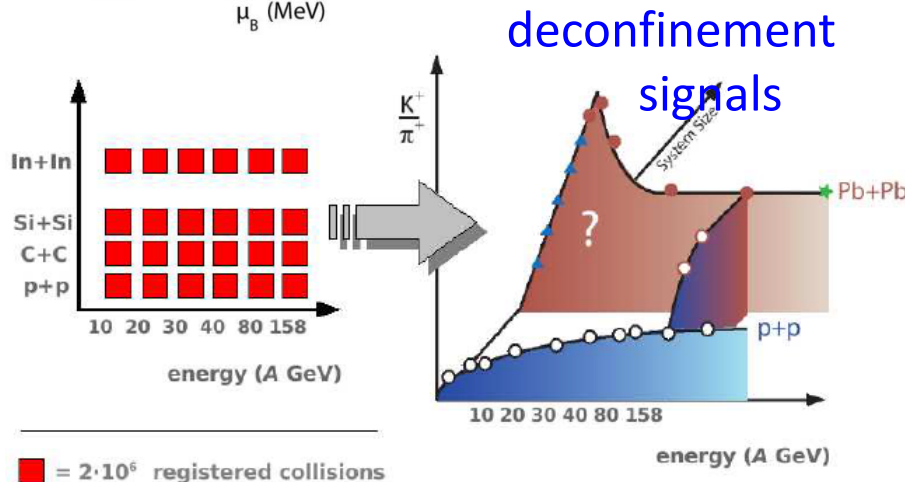
NA61/SHINE experiment at CERN SPS 2007 - 2018

Marek succeeded to reactivate the NA49 apparatus including upgrades in 2007 expanding physics program to particle production measurements for the T2K experiment

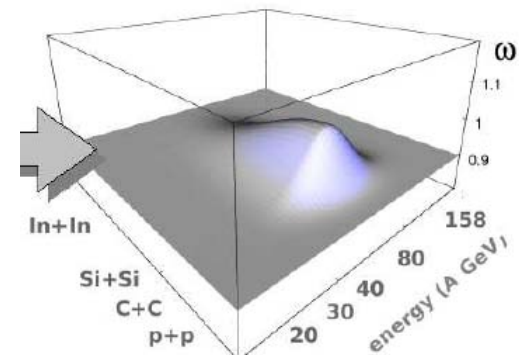


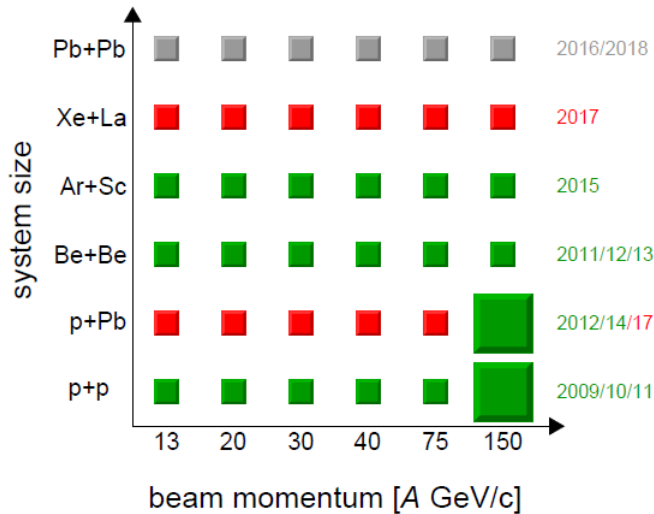
Marek's main interest:

study of the onset of deconfinement and search of the CP in a 2D scan in A, \sqrt{s}_N

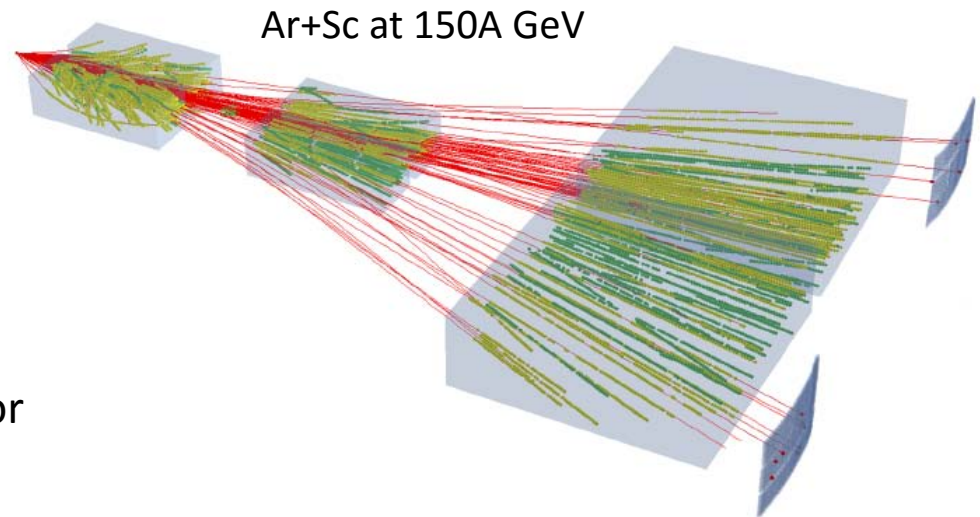


“hill” of fluctuations for CP





- reference measurements from p+p scan are being published
- preliminary results from Be+Be and Ar+Sc scans are becoming available



- Xe+La scan is scheduled for 2017
- Pb+Pb scan of NA49 will be repeated with the upgraded NA61/SHINE detector

Marek already plans a new generation large acceptance experiment using hadron and nuclear beams after LS2 (2020 +)

CPOD conference series

- Marek recognised the need for a discussion forum focused on the experimental and theoretical exploration of the phase diagram
- initiated in 2004 the ECT Trento workshop “Tracing the Onset of Deconfinement in Nucleus-Nucleus Collisions”
- leading to the conference series “Critical Point and Onset of Deconfinement” (CPOD) which started at Bergen in 2005



Followed by:

- 2006 Florence
- 2007 GSI
- 2009 BNL
- 2010 Dubna
- 2011 Wuhan
- 2013 Napa
- 2014 Bielefeld
- 2016 Wroclaw

Marek turns 60 on 9th of June



may he

- maintain his remarkable energy and enthusiasm to pursue his projects
- keep his ability to attract and motivate students and collaborators
- be rewarded by finding experimental evidence for the critical point
- and above all stay healthy and enjoy his family