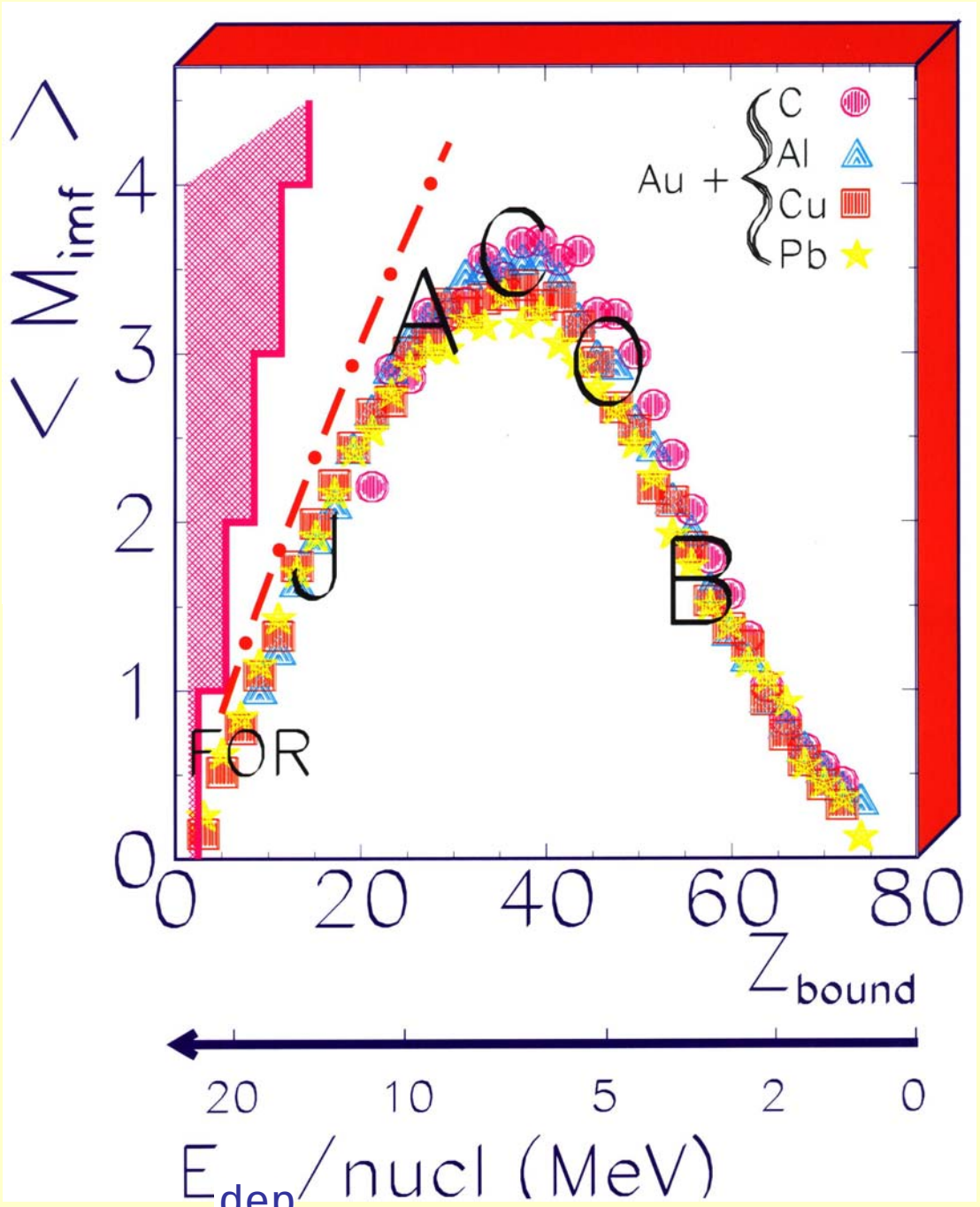
New results on multifragmentation and the SMM

Wolfgang Trautmann
GSI Darmstadt

09.10.2003

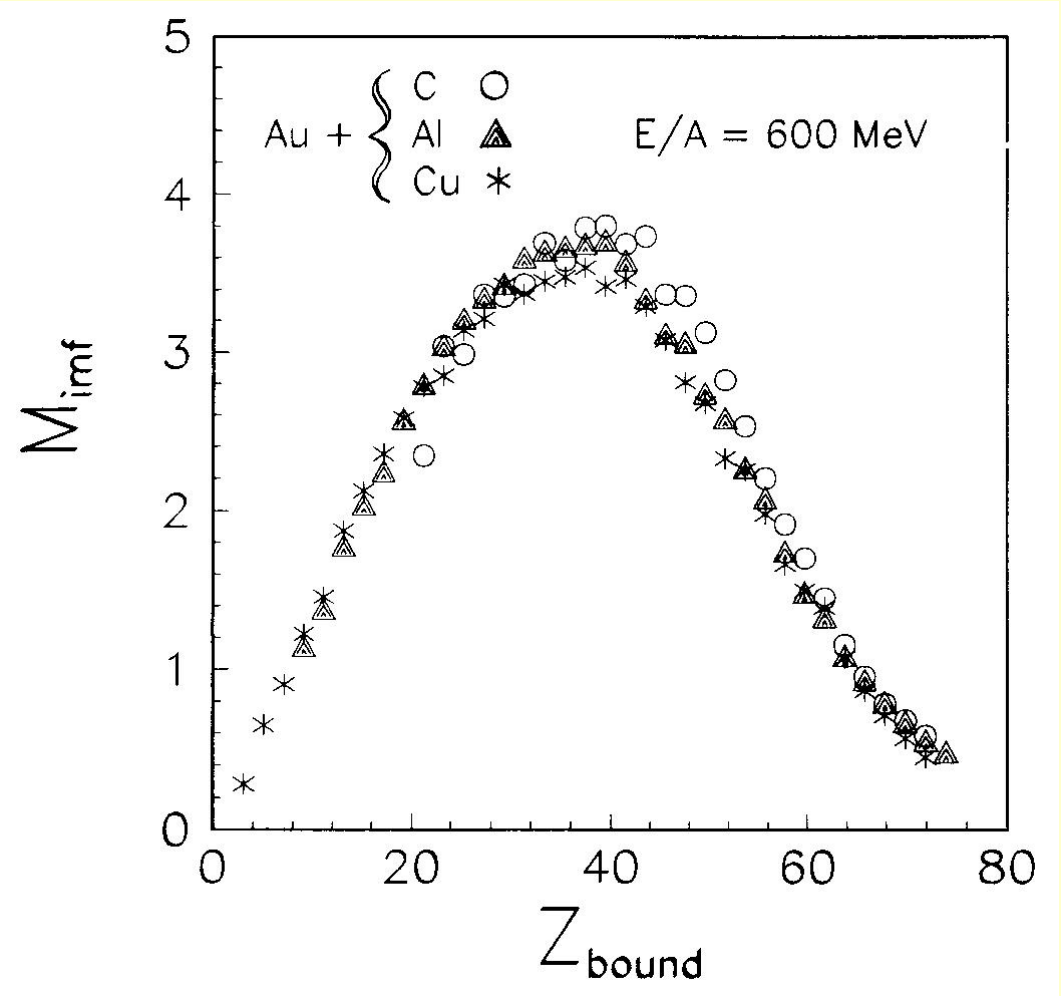
FOR JAKOB
1993



ALADIN data

J. Hubele et al.
PRC 46, 1577 (1992)

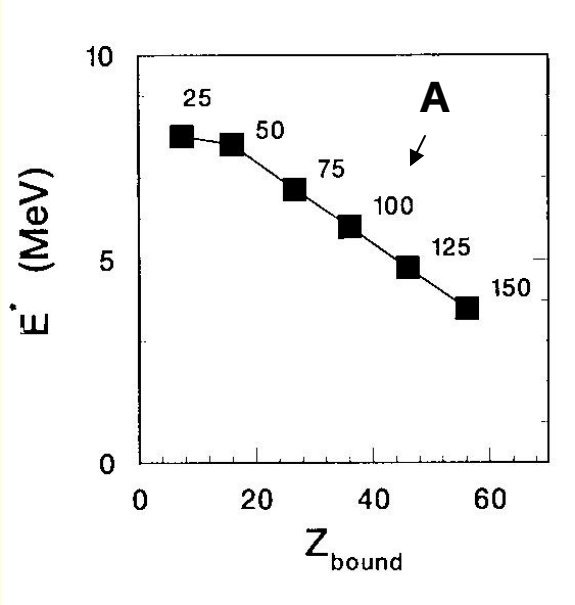
rise and fall
of
multifragment emission

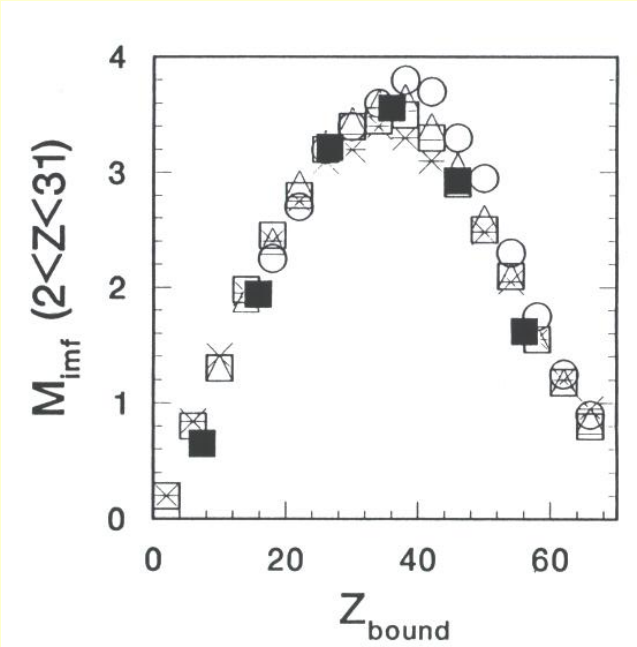


SMM interpretation

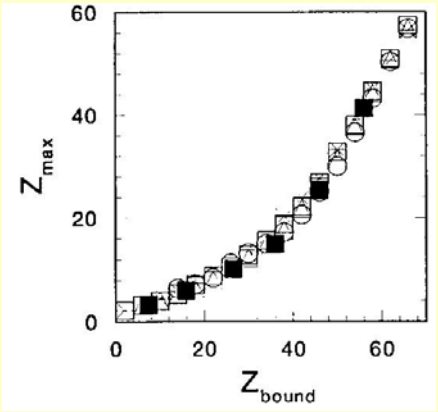
H.W. Barz, W. Bauer, J.P. Bondorf,
A.S. Botvina, R. Donangelo,
H. Schulz, K. Sneppen,
NPA 561 (1993) 466

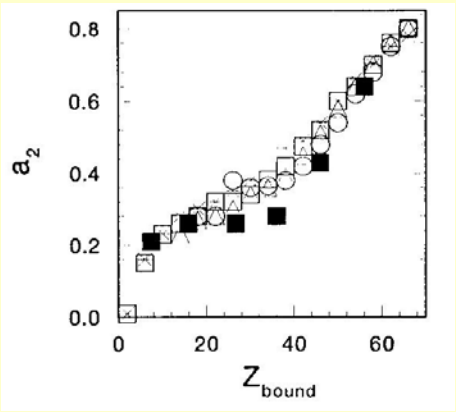
excitation energy adjusted !





universal partitioning !



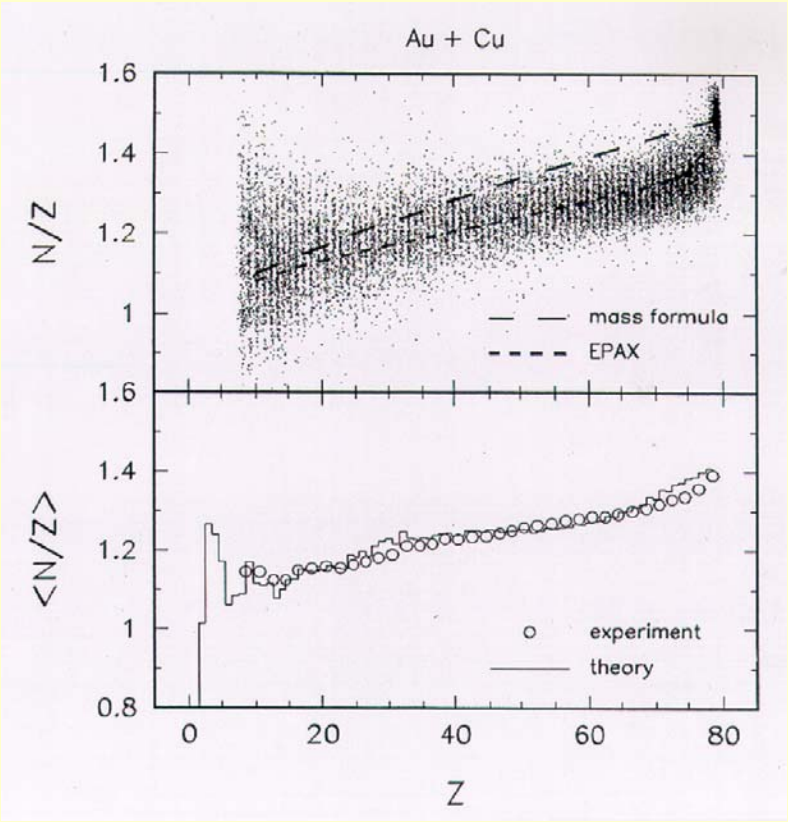


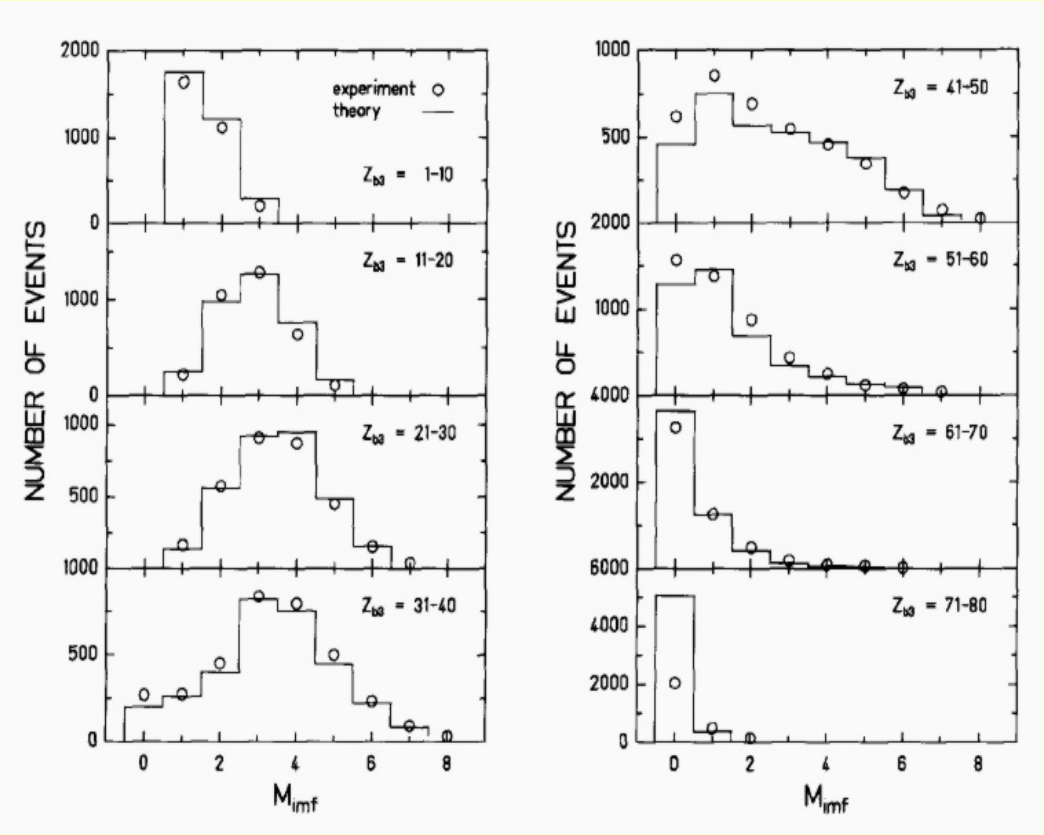
I. Was this the final word ?

1. Widths and N/Z
2. Backtracing
3. Temperatures

Widths and N/Z

A.S. Botvina et al.
NPA 584 (1995) 737





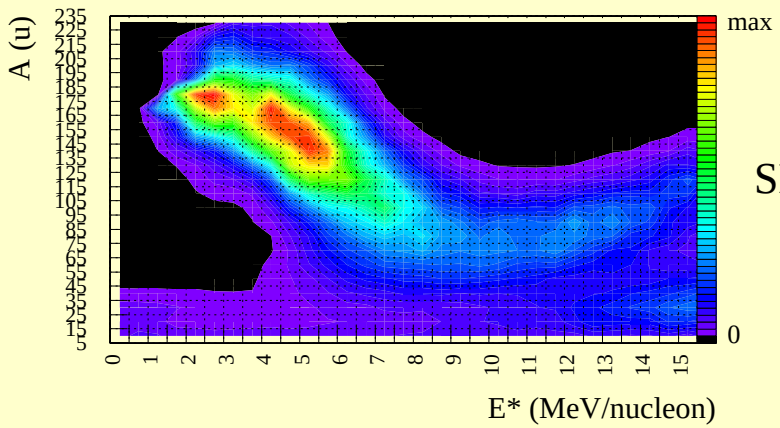
... by reconstructing the ensemble of thermalized nuclear systems

Backtracing

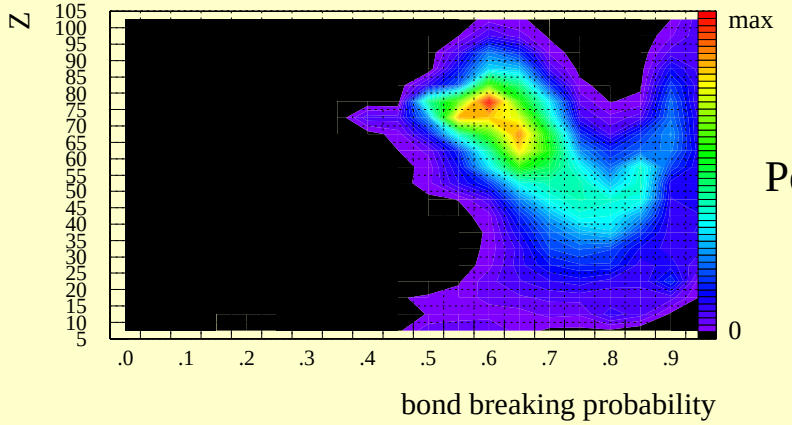
P. Désesquelles,
J.P. Bondorf,
I.N. Mishustin,
A.S. Botvina,
NPA 604 (1996) 183

... not with kinetic energies !

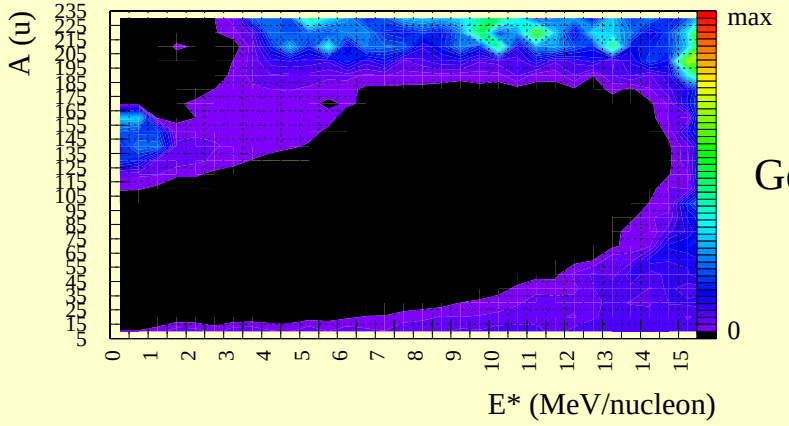
Source maps : P(s)



SMM



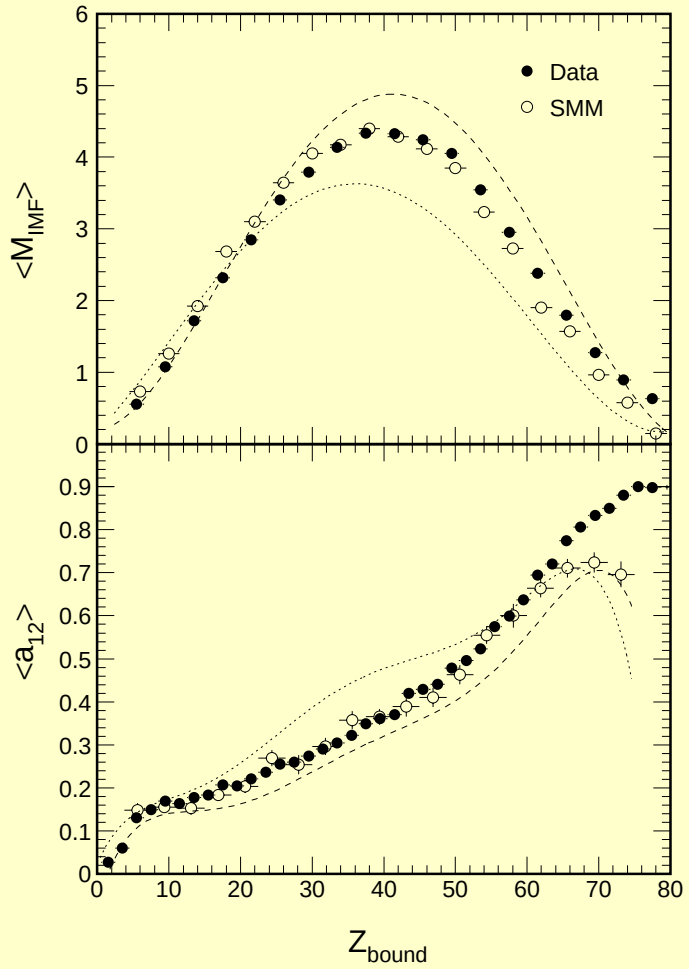
Perco.

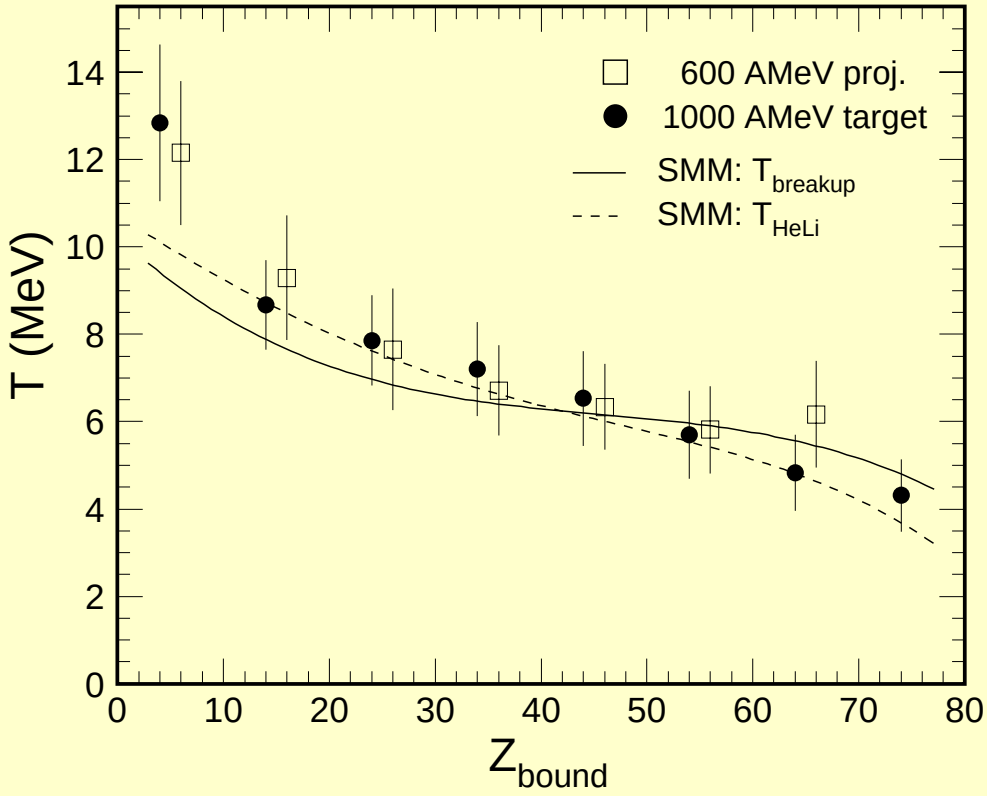


Gemini

He-Li Temperature

Hongfei Xi et al.
Z.Phys.A (1997) 397

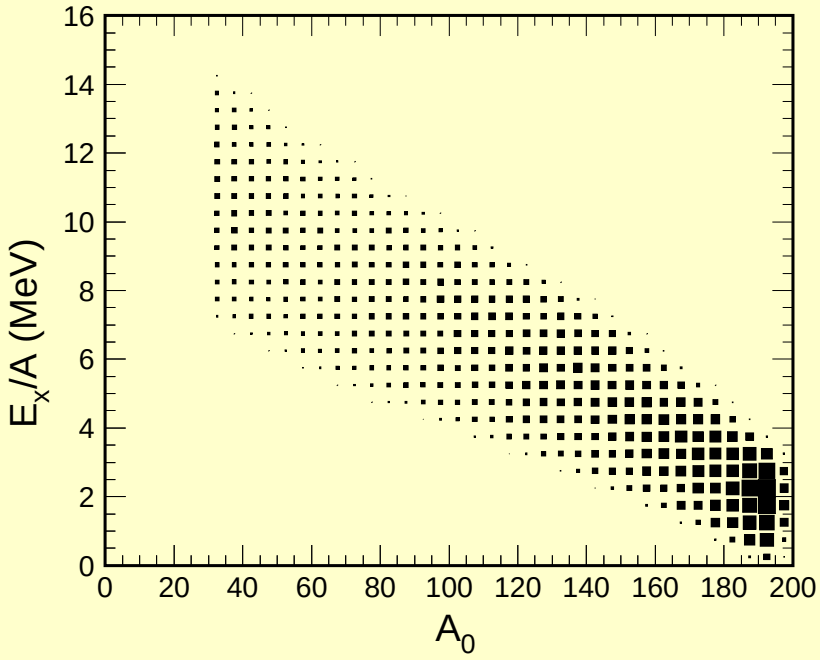


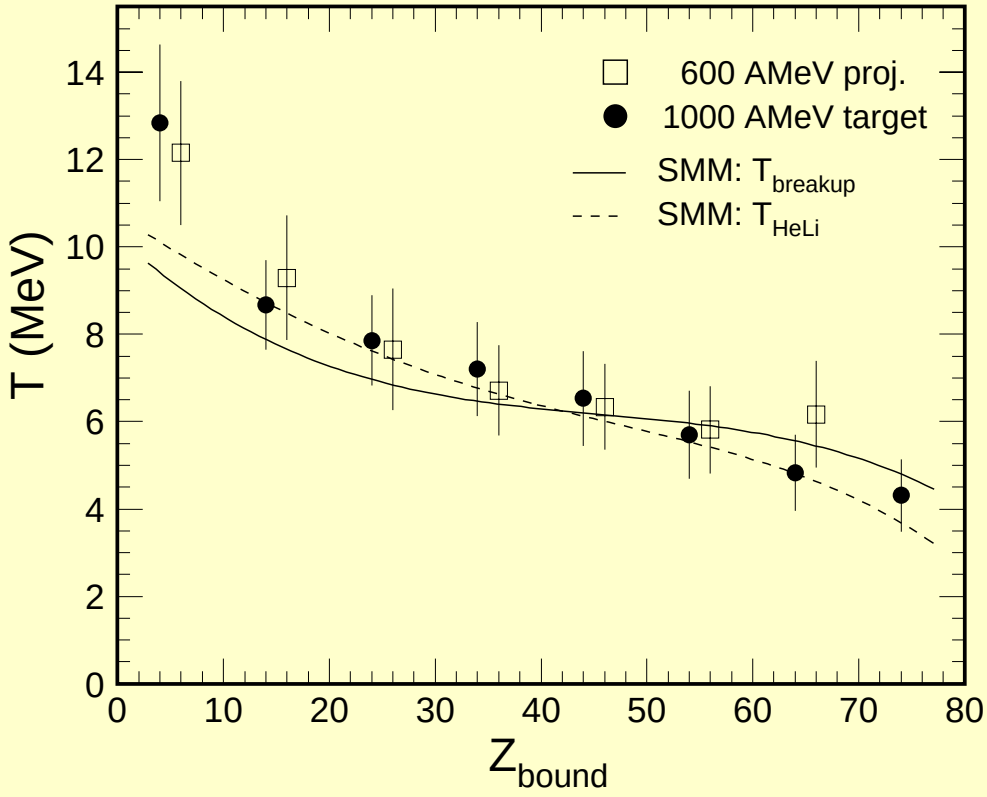


good reproduction
of the partitions

He-Li Temperature

Hongfei Xi et al.
Z.Phys.A (1997) 397



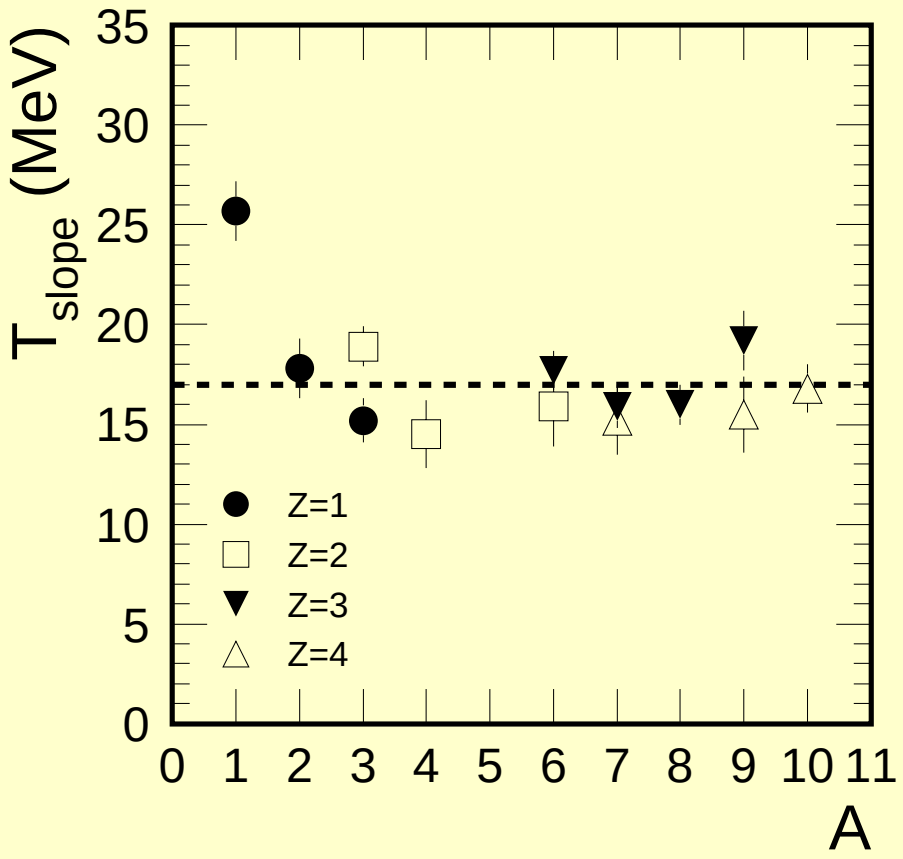


required ensemble

Kinetic energies and Fermi motion

T. Odeh et al.
PRL 84. 4557 (2000)

Au + Au at 1000 A MeV



T ≈ 17 MeV inconsistent with thermal equilibrium
can be explained with Fermi motion (Goldhaber)

II. More recent developments

1. Isotopic scaling and the symmetry term

2. Kinetic energies and Fermi motion

3. Flow and equilibrium

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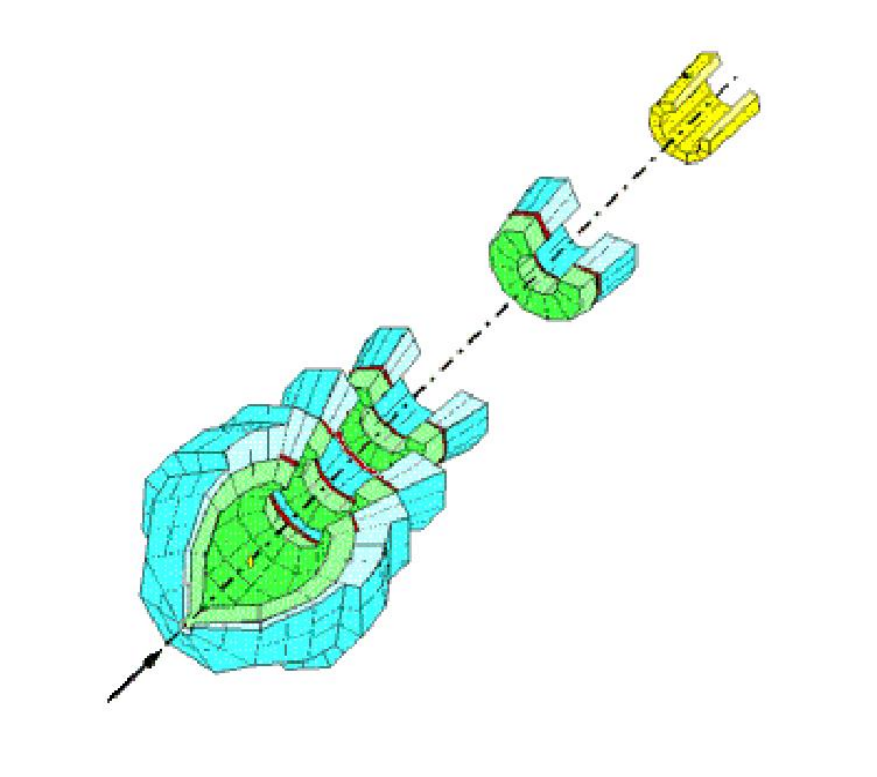
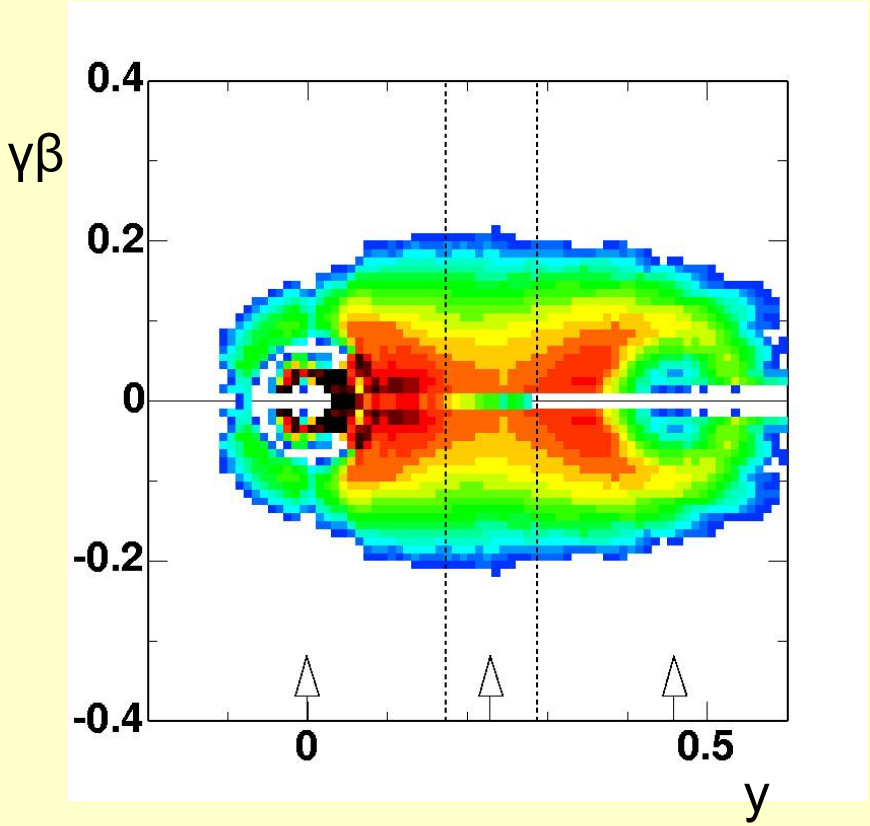
Peripheral Au + Au



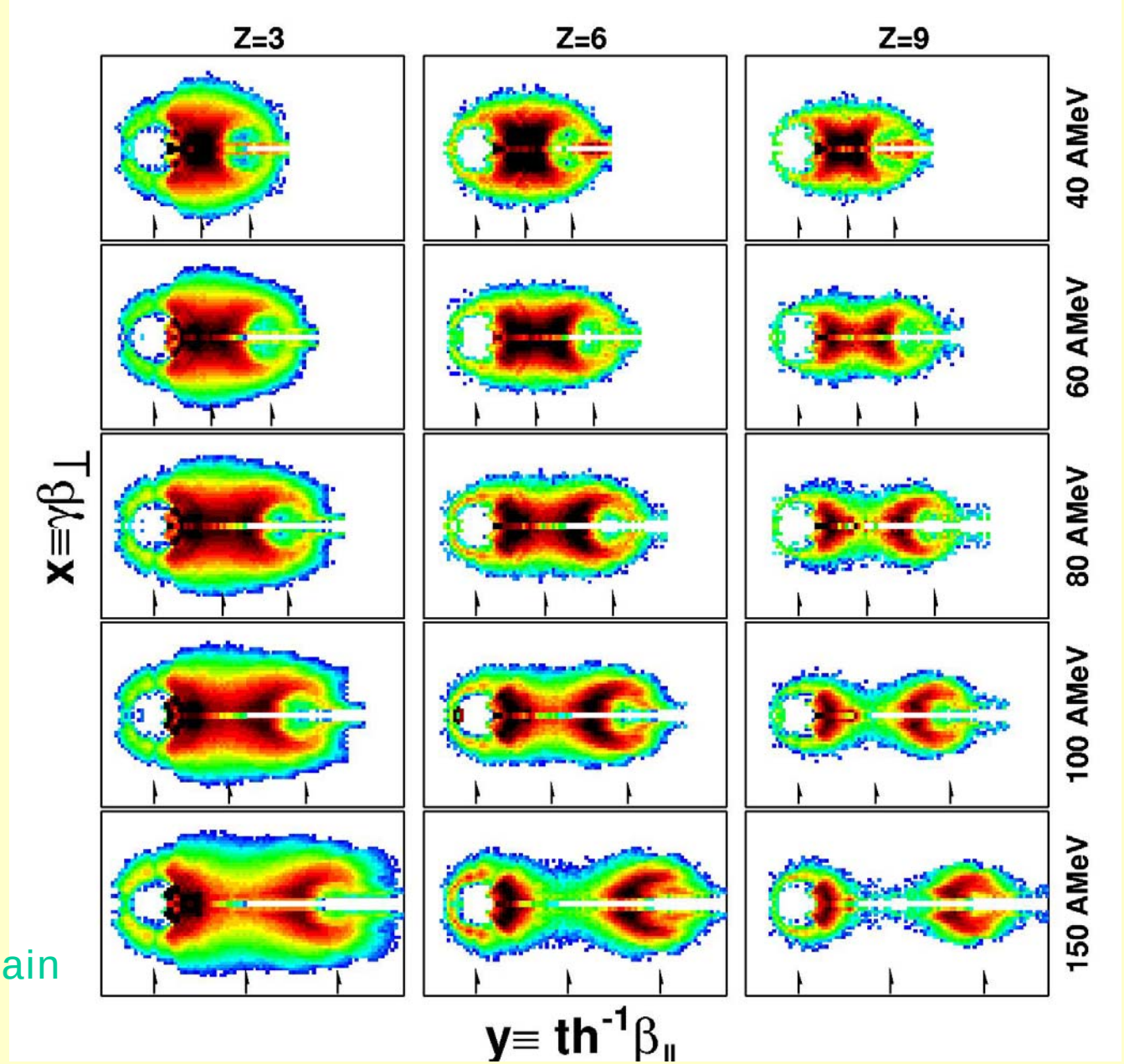


Z = 3 at 100 A MeV

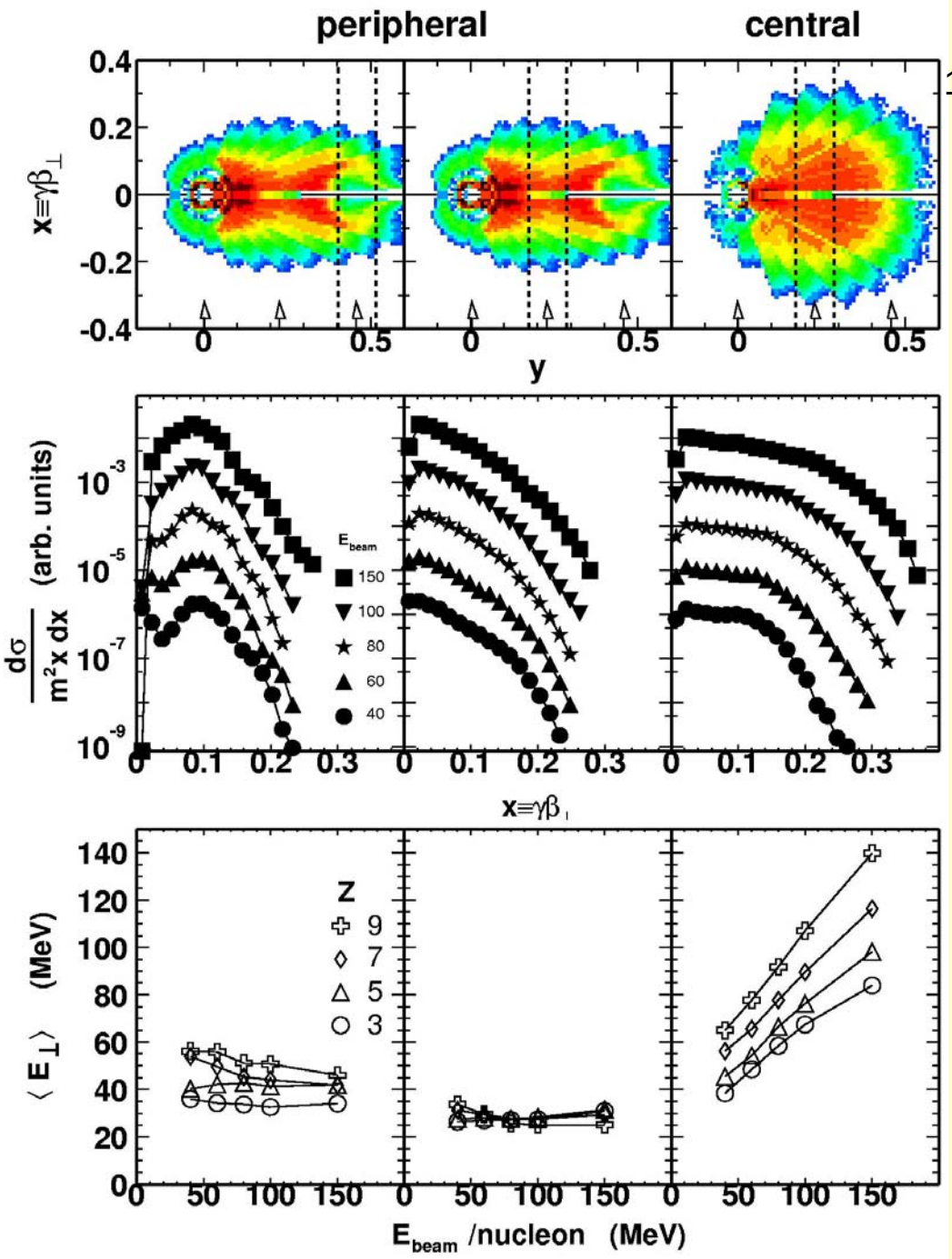
Au + Au

Invariant cross sections at peripheral impact parameters

From the Fermi to the relativistic domain



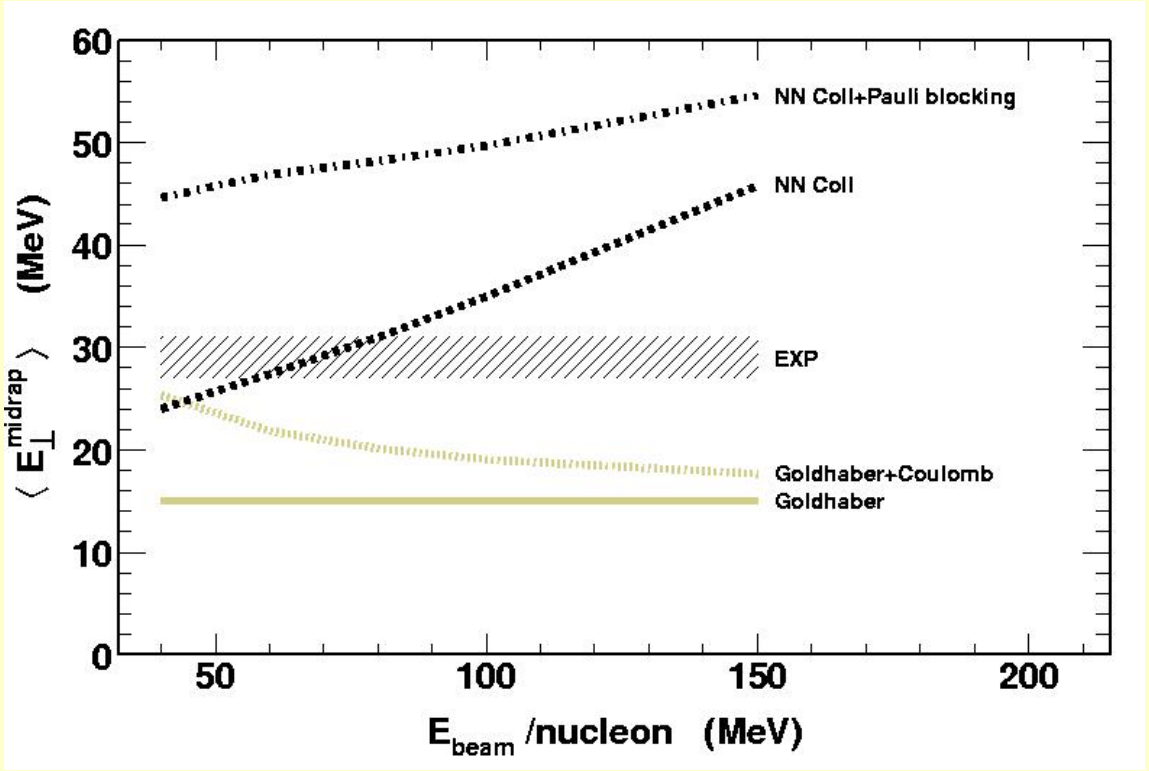
Transverse velocity spectra



J. Lukasik et al. Phys. Rev. C 66, 064606 (2002)

Contributions to transverse energies

at midrapidity



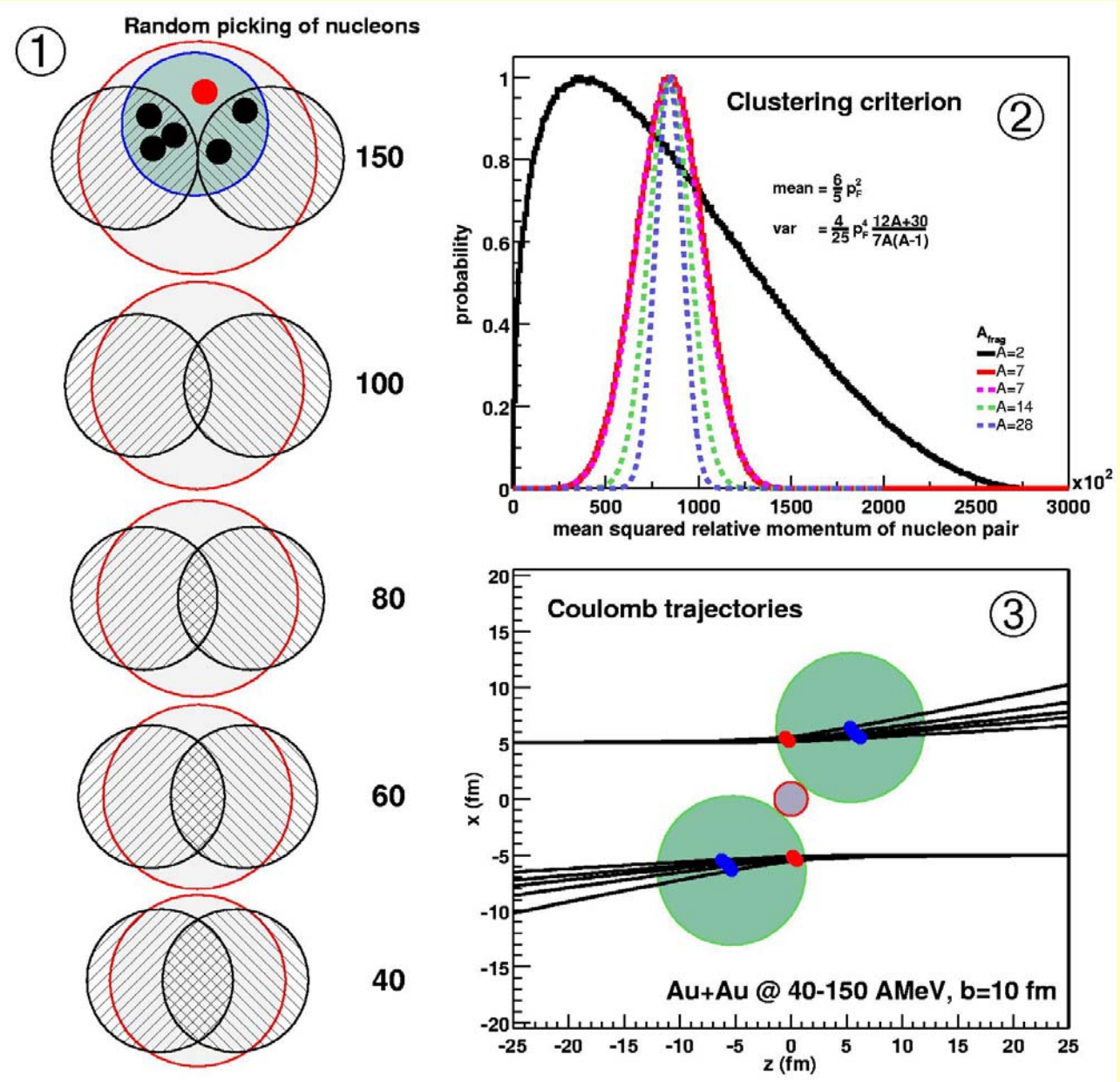
Fermi motion is not enough

N-N scattering is too much

Compensation due to Coulomb

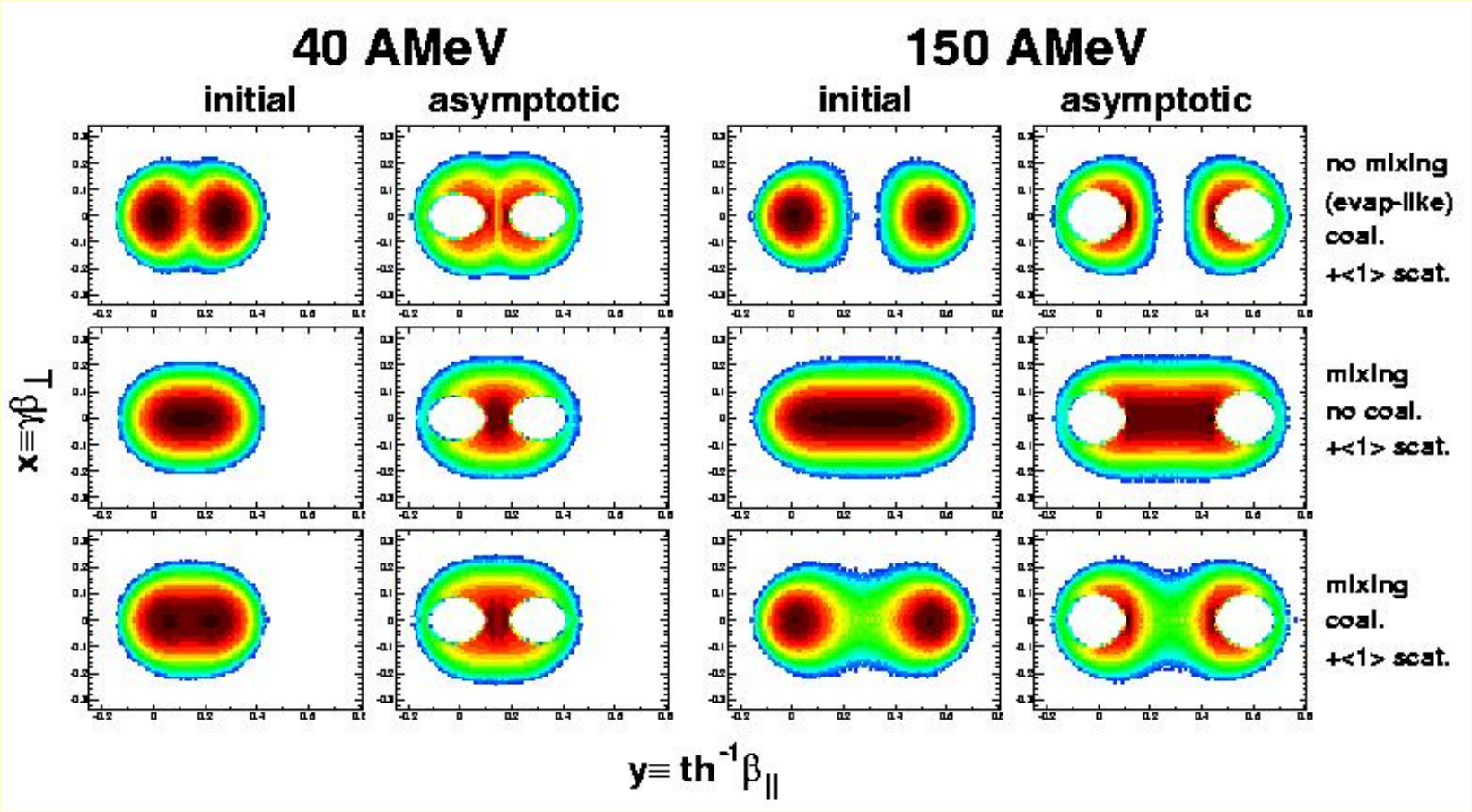
Extended Goldhaber model

in 3 steps

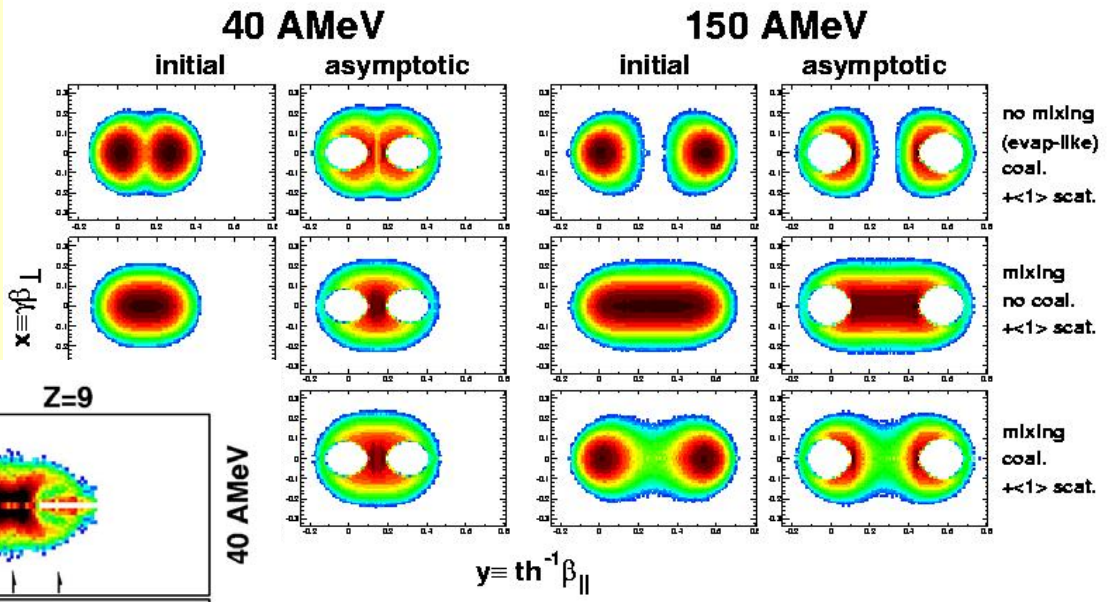


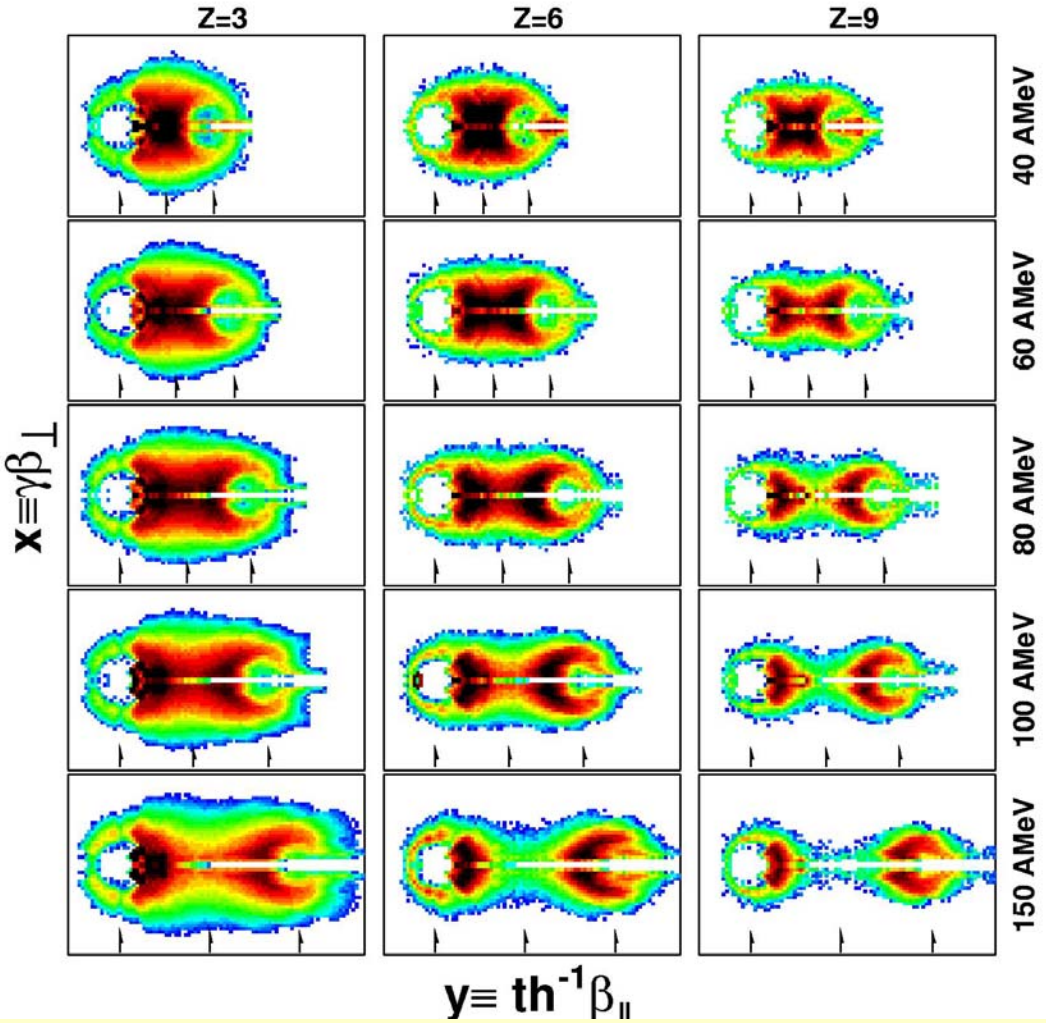
J. Lukasik et al.
PLB 566 (2003) 76

Model results



Comparison



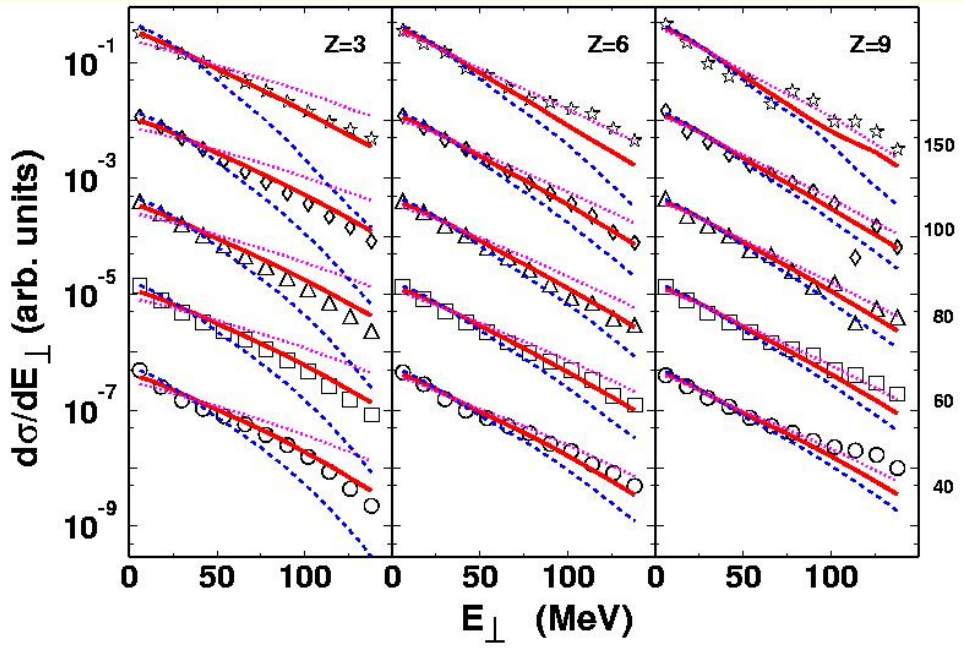


model

data

Quantitative description of data

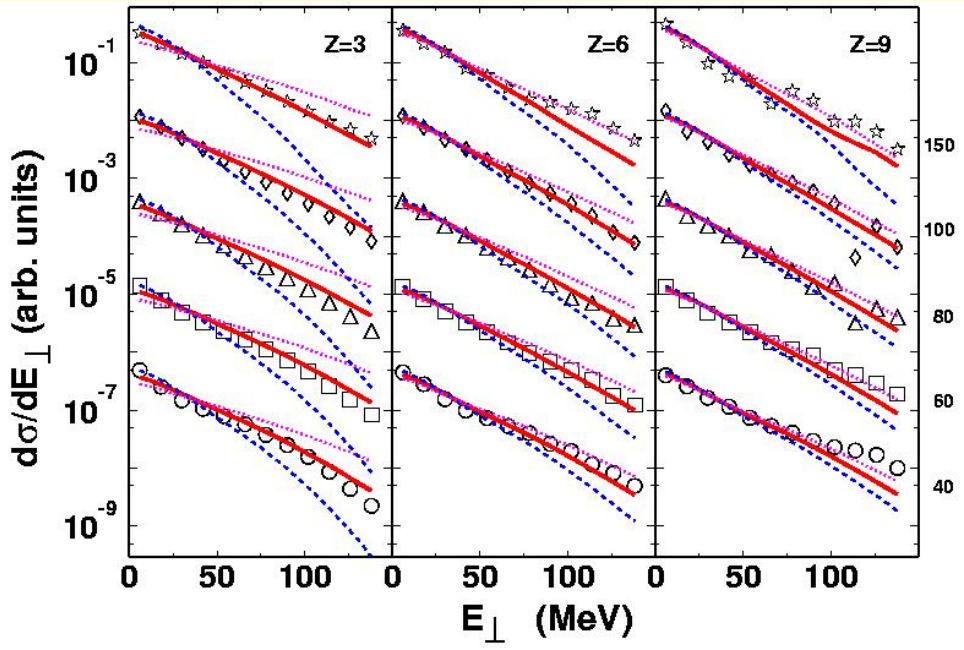
Transverse energy spectra



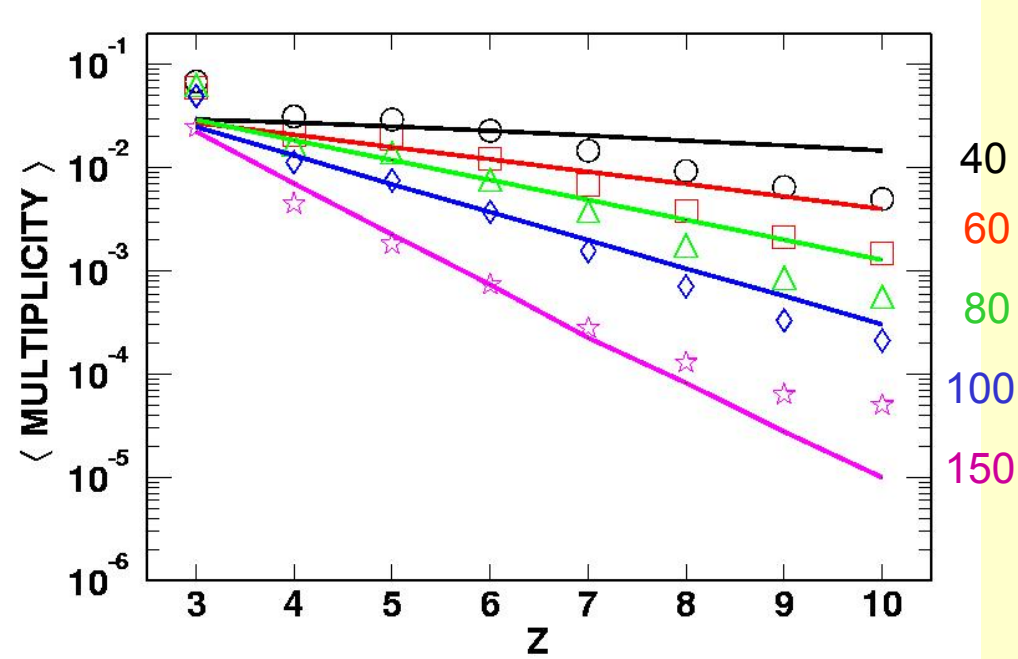
2 hard scattered
1 nucleons
0

Quantitative description of data

Transverse energy spectra



Atomic number Z spectra



Questions

1. Where is the equilibrated neck ?

2. Where is the equilibrated target/projectile residue ?

3. Clustering criterion on a nucleon distribution seems to be a general principle !

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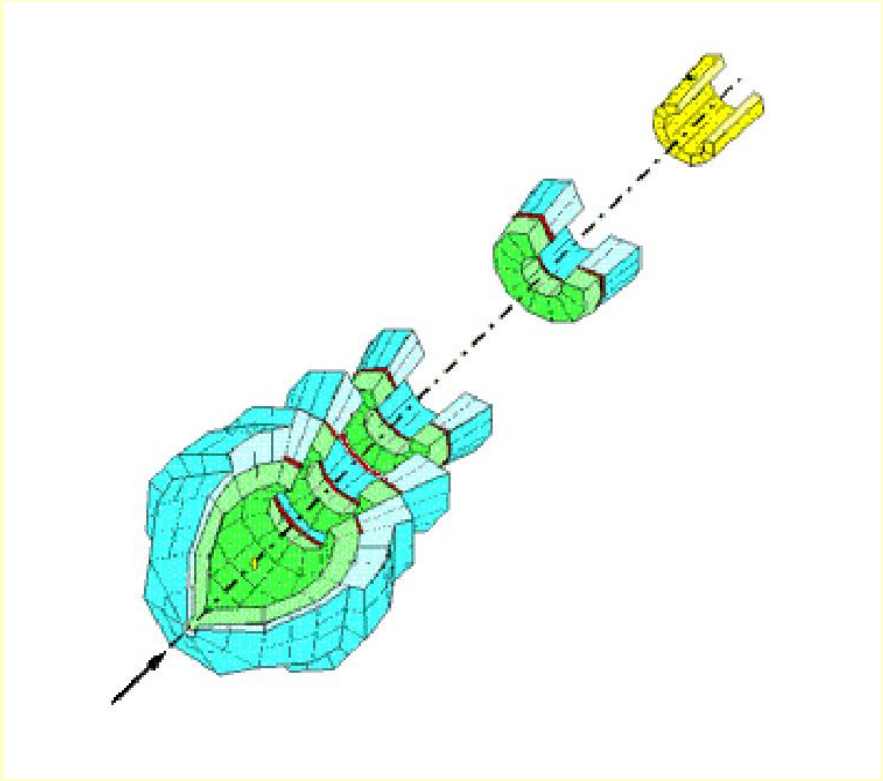
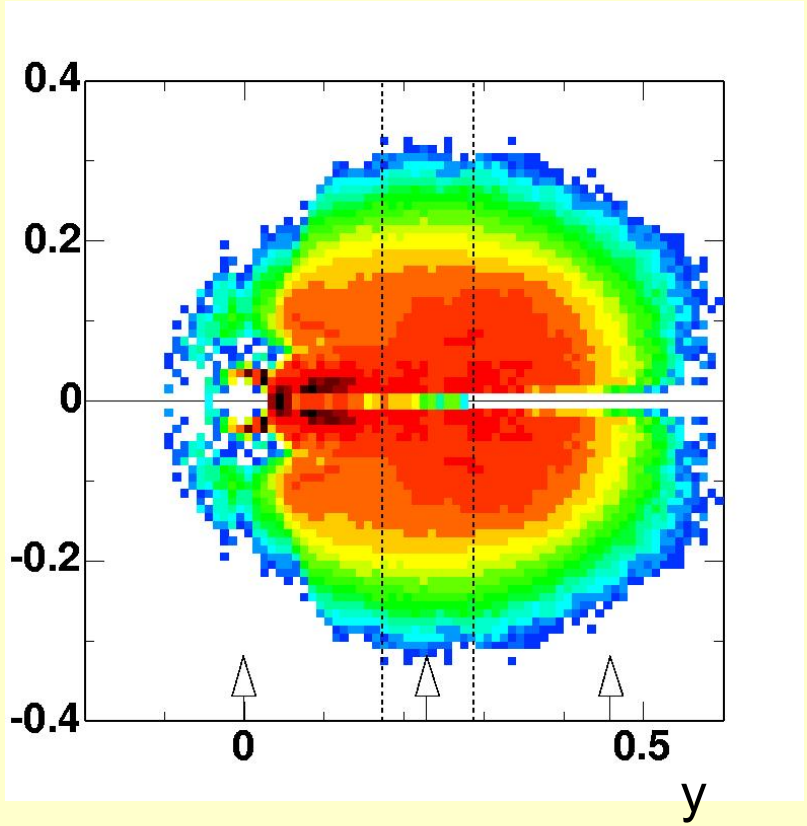
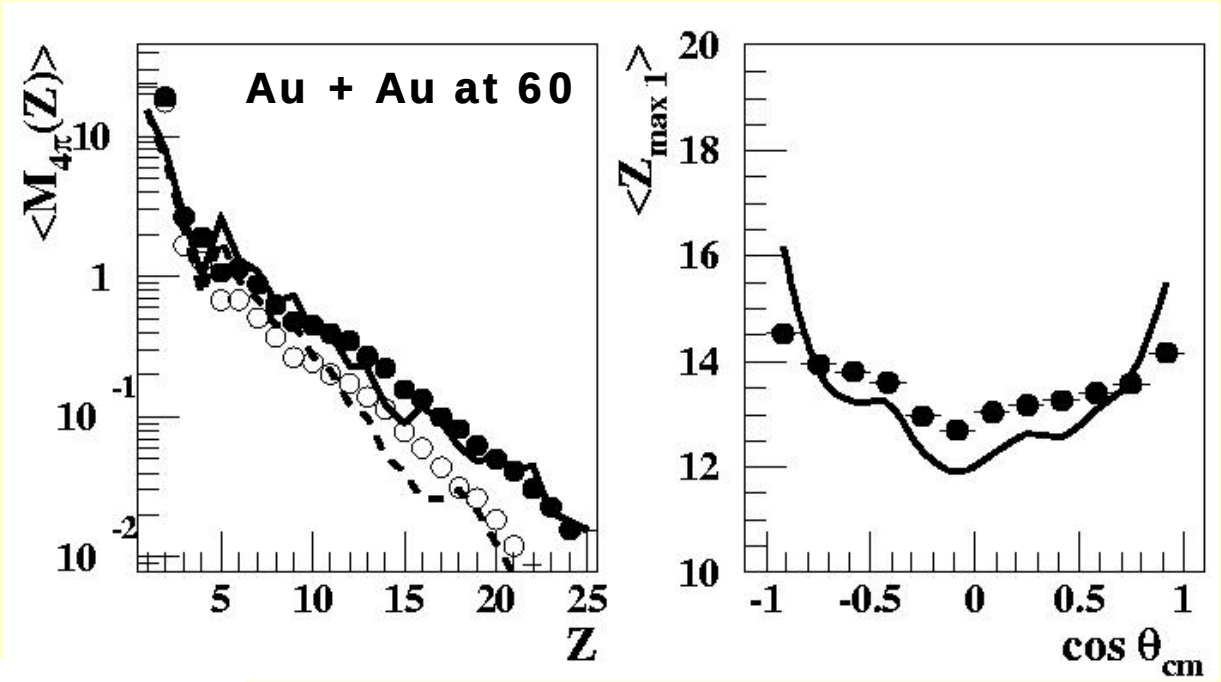
Central Au + Au

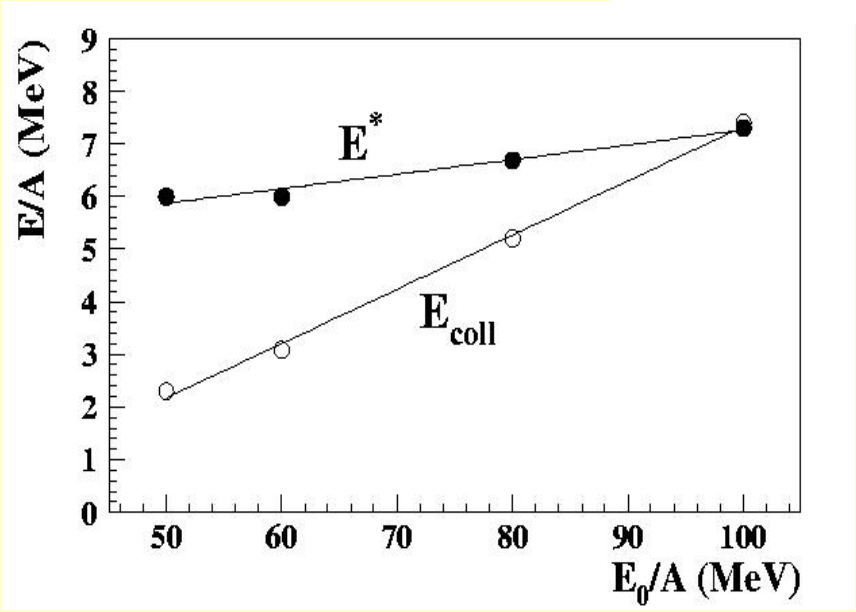




Z = 3 at 100 A MeV

Flow and fragmentation



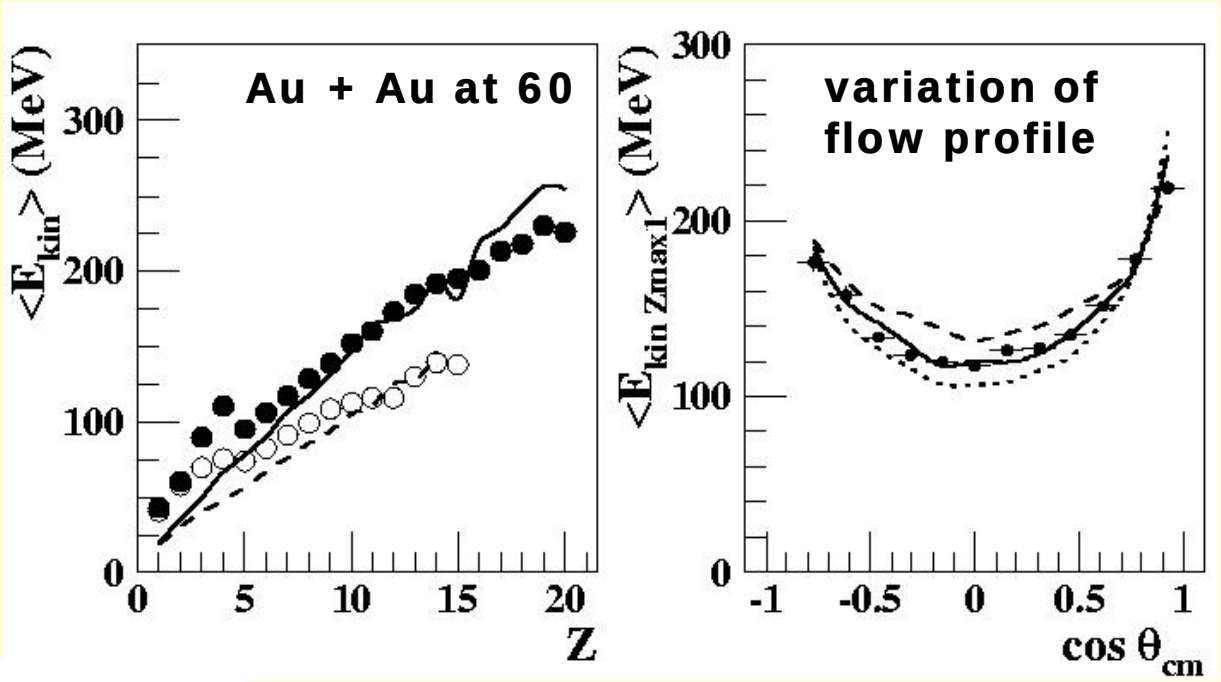


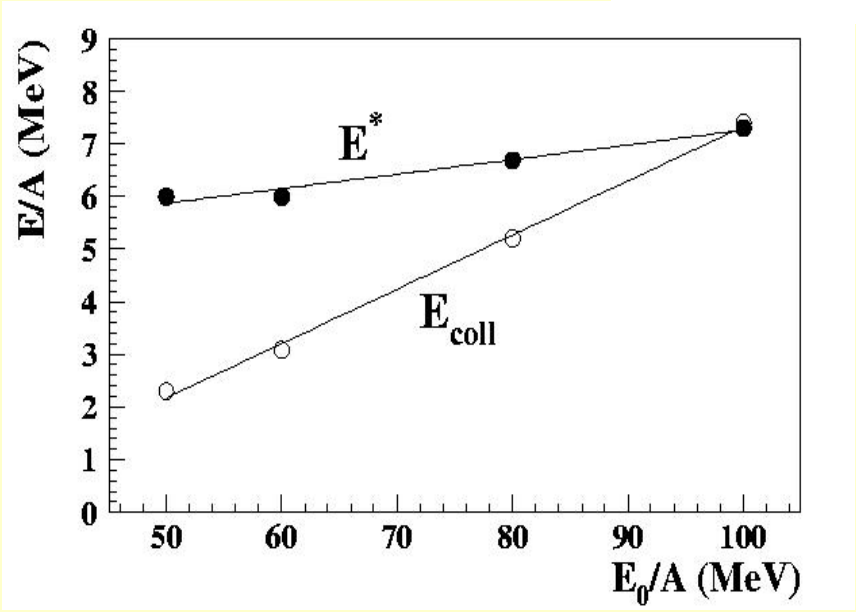
- ● longitudinal
- ○ transverse

from MMMC model description with deformed source (0.7:1) and with decoupled flow

A. Le Fèvre et al.
nucl-ex/0309016

Flow and fragmentation





- ● longitudinal
- ○ transverse

from MMMC model description with deformed source (0.7:1) and with decoupled flow

A. Le Fèvre et al.
nucl-ex/0309016

Questions

1. Why does the SMM or MMMC work so well in a dynamical situation ?

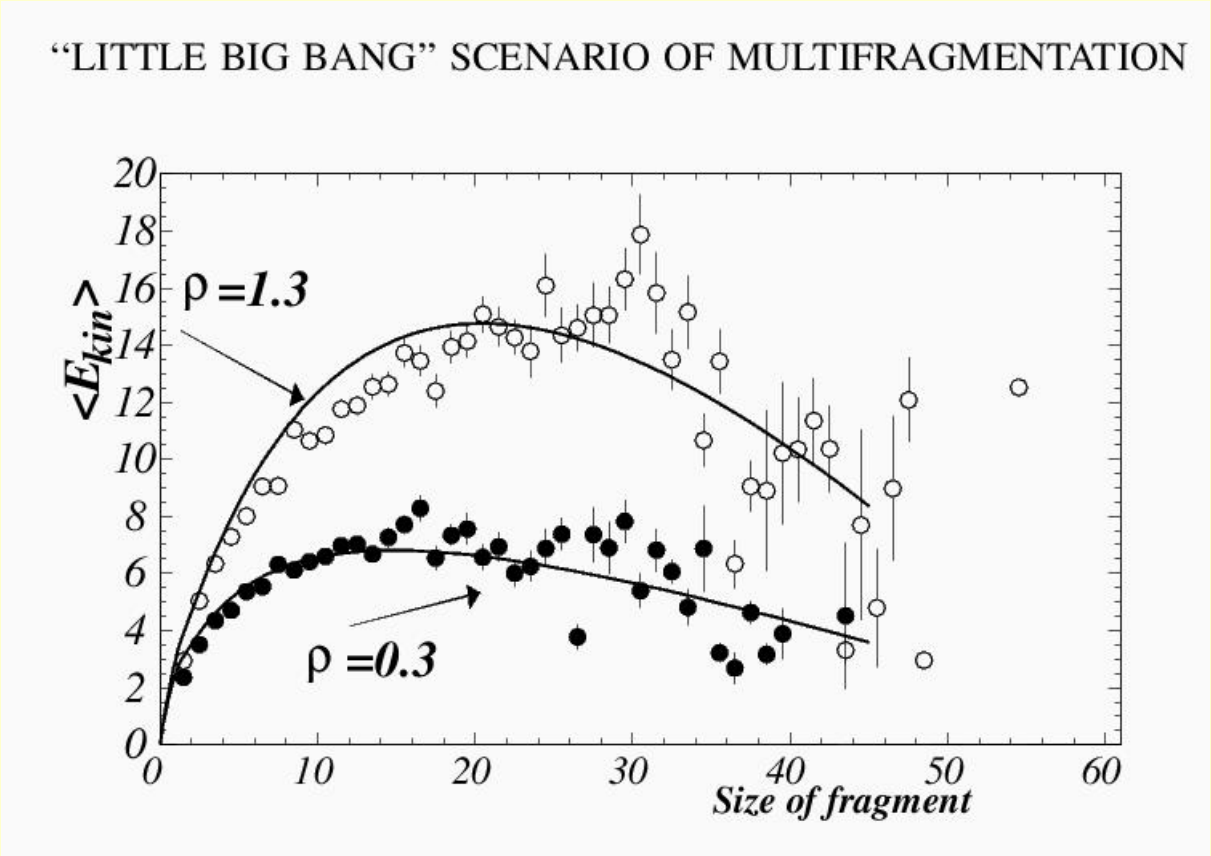
2. Deformation as a dynamical constraint !

3. Radial flow should be another constraint !
   Implicitly contained in parameters ?

Alternatively: early fragment formation, see
Danielewicz and Pan, Dorso and Aichelin, Barz et al.,
X. Campi et al., Phys. Rev. C 67, 044610 (2003)

Flow and fragmentation

X. Campi et al.,
Phys. Rev. C 67,
044610 (2003)



... shape of these distributions is characteristic of
the presence of Coulomb forces and close to what is observed ...

the end

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