Nuclear Stopping

from the Fermi Energy up to a few GeV/nucleon

*** a non-exhaustive review based on FOPI and INDRA data**

*** restricted to symmetric systems in central collisions**

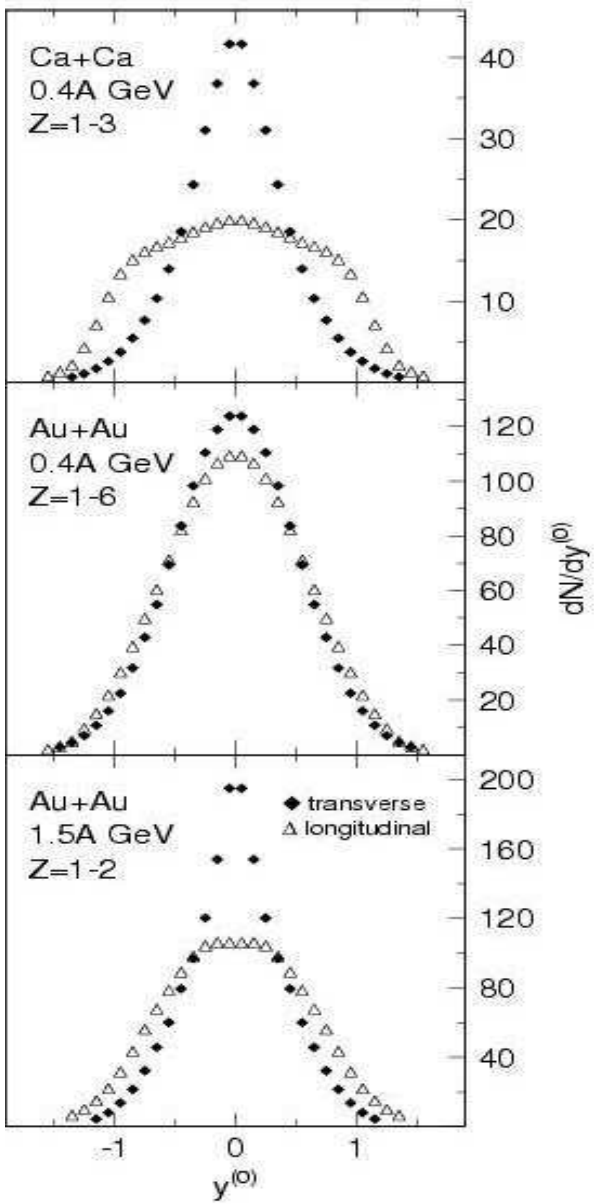
*** based on a study of the isotropy ratio R_{iso} and the velocity-dependent charge density: dZ/dV**

FOPI data: W. Reisdorf et al (accepted by PRL: nucl-ex/0404037)

INDRA data: C. Escano et al (submitted)

Variables used to study stopping power

FOPI



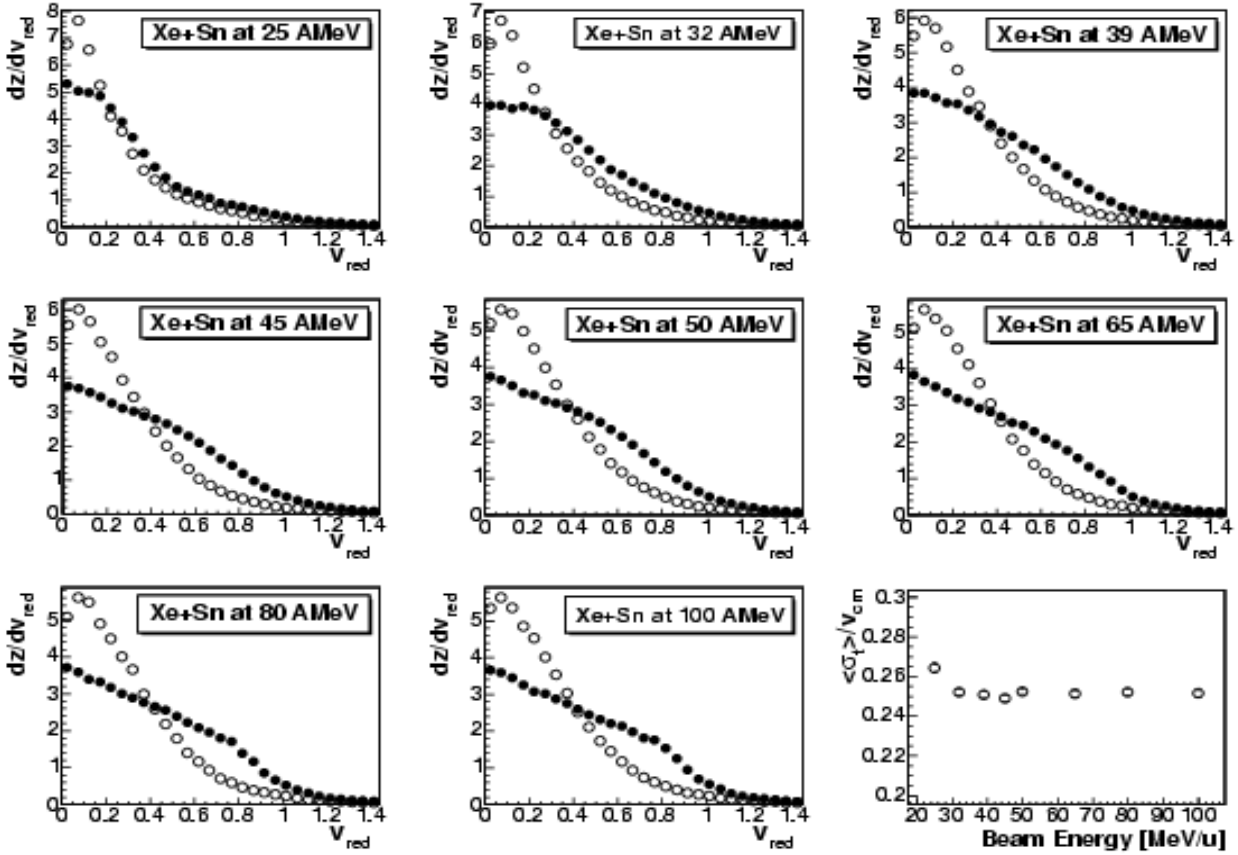
* velocity-dependent charge density

$dV/dV_{//}$ and dV/dV_{perp}

--> add each detected particle weighted by its charge in the corresponding velocity bin

* $Vartl = \sigma(dV/dV_{perp}) / \sigma(dV/dV_{//}) = 1$ thermalisation

INDRA



FOPI data

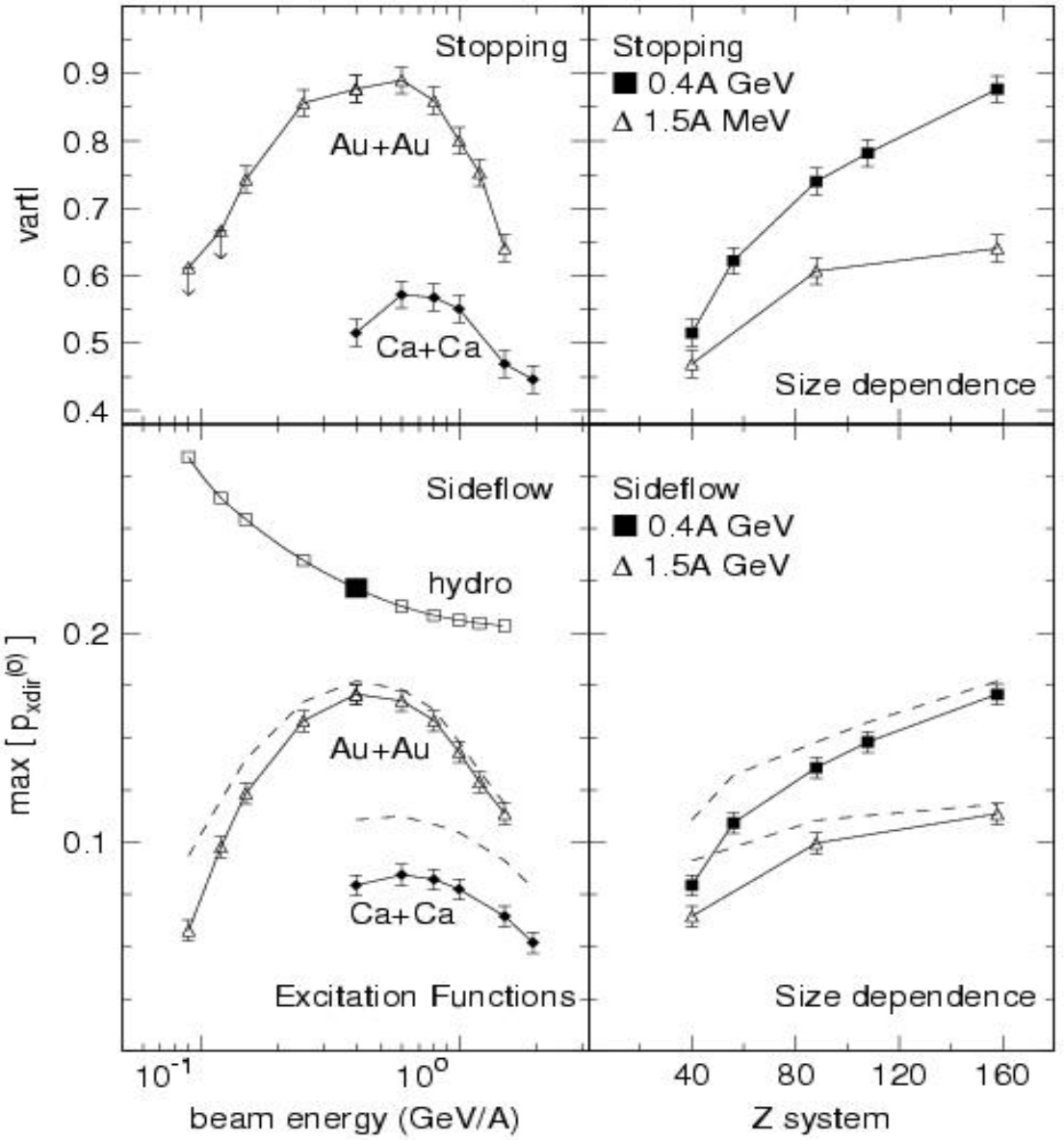
* stopping goes through a
maximum around 400 MeV/u

* approximate scaling law $A^{1/3}$

* strong correlation between flow
and stopping (not discussed here)

* decrease of stopping above 400 MeV/u -->
softening of the EOS

* decrease below 400 MeV/u ---> influence
of
'' Pauli blocked'' in-medium nucleon
nucleon
collisions

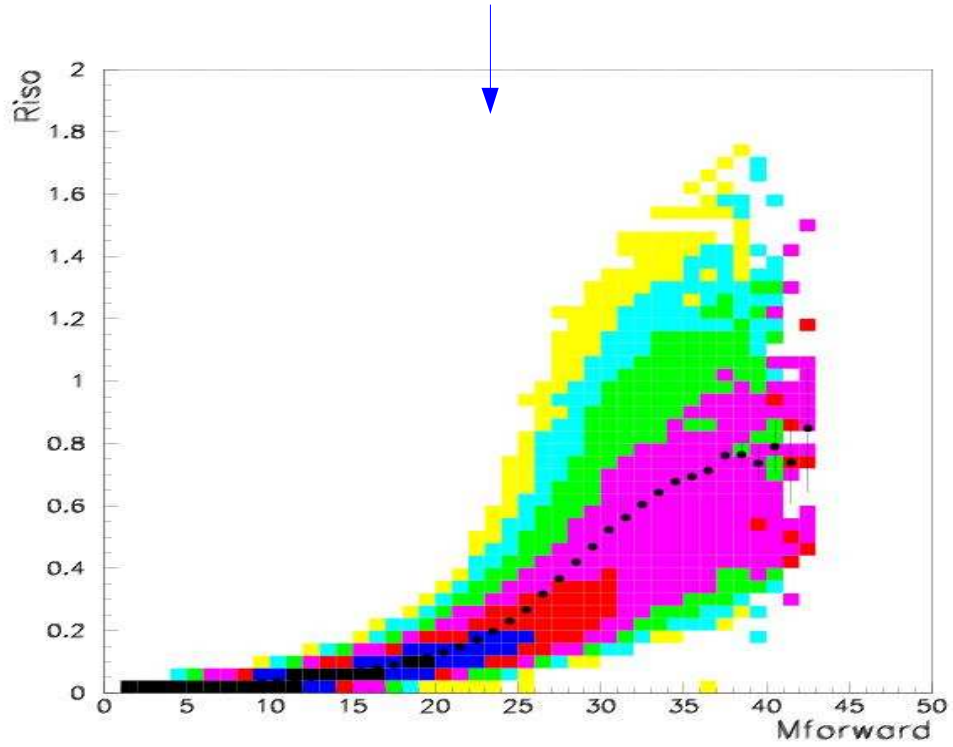


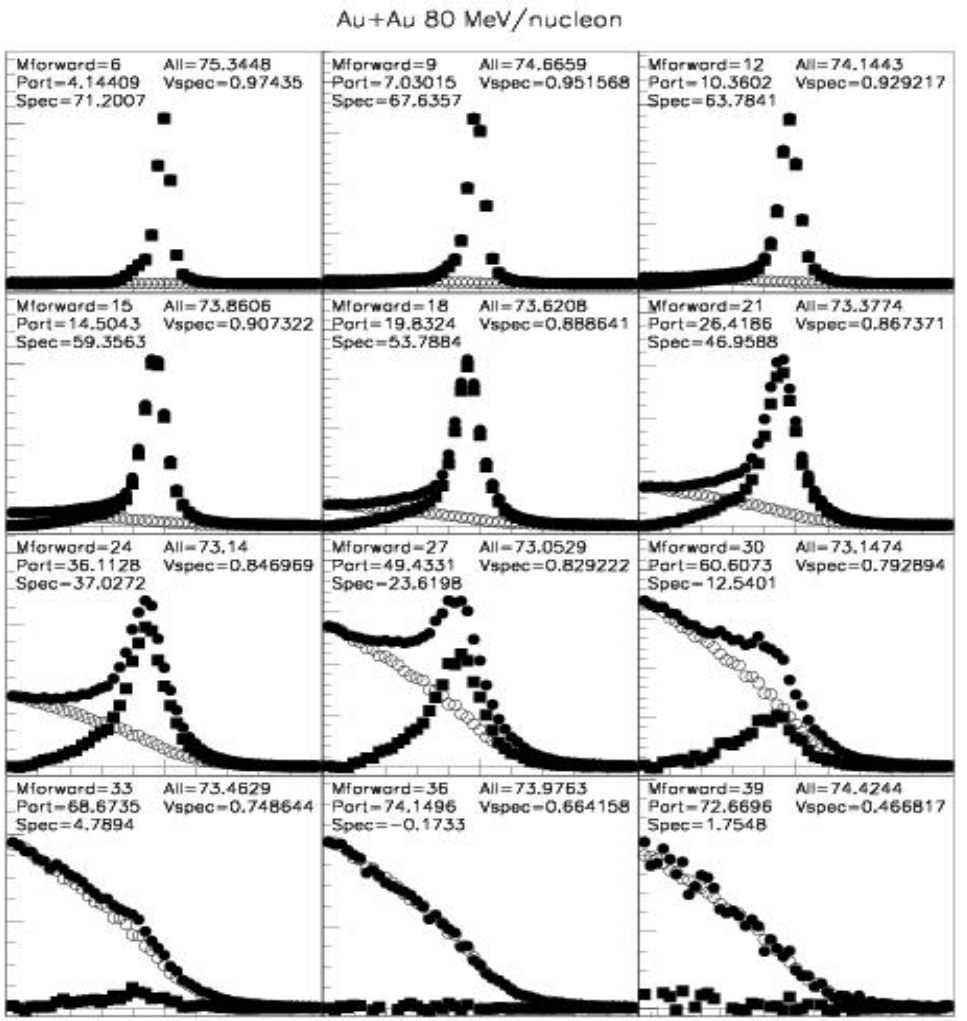
INDRA data: selection of central collisions based on $dZ/dV_{//}$

* select charged particles with positive cm velocities to avoid problems with detection thresholds
* select events for which the total charge is larger than 90 percent of Z_{proj}
* select central events on the basis of a multipicity cut (''scalar '' cut)

--> minimum bias selector because R_{iso} and $dZ/dV_{//}$ are ''vector'' quantities

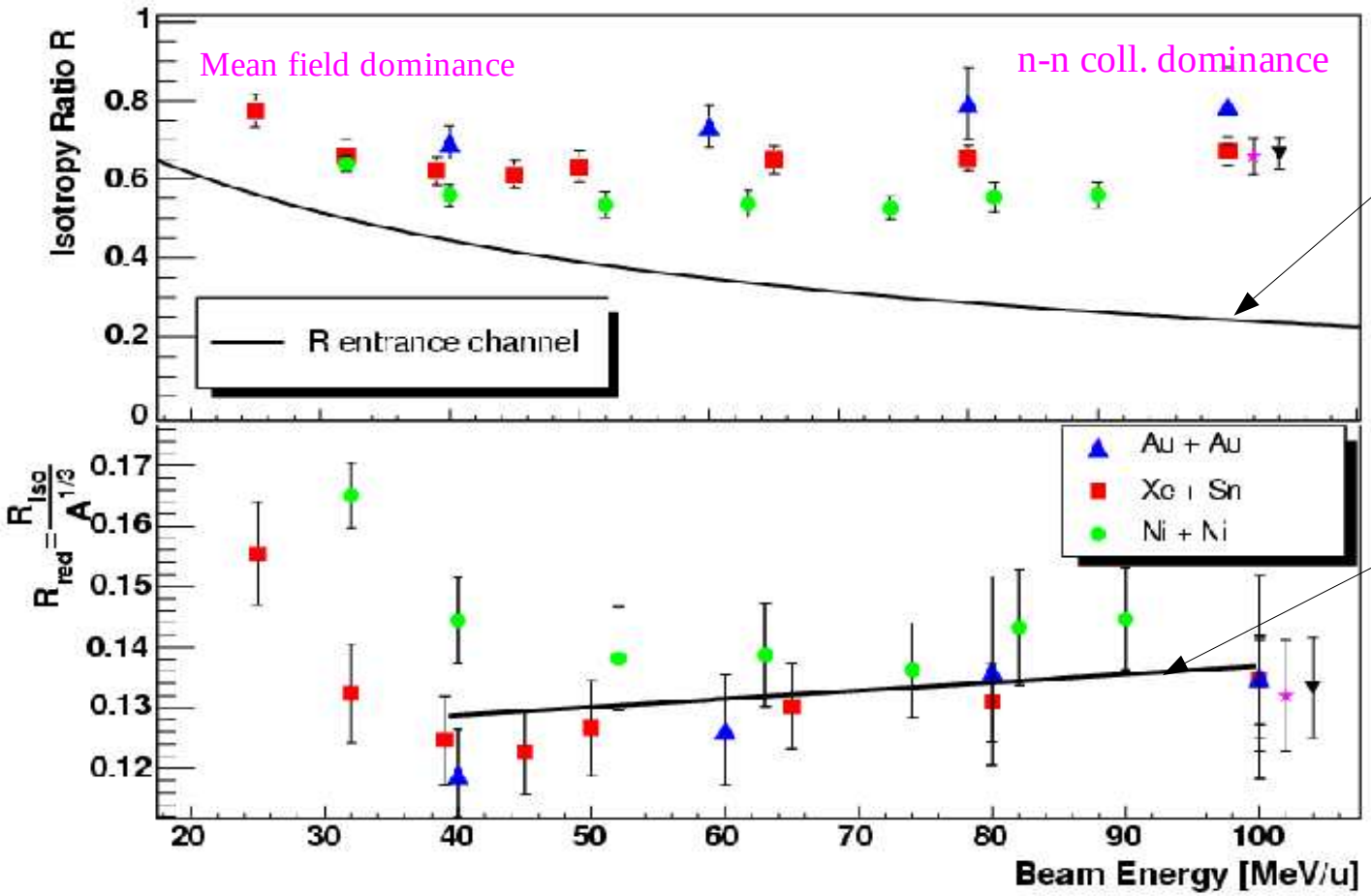
* beyond M_{cen} (here 37) , dZ/dV_{red} do not change anymore --> central collisions
* geometrical aspects of the reaction mechanism
* R_{iso} reaches an asymptotic value as a function of M_{tot}
* fluctuations of R_{iso} are (partly) due to finite number effect





Systematics of INDRA

$R_{iso} = \Sigma E_{perp} / 2\ \Sigma E_{//} = 1$ **thermalisation**



Entrance channel:
two sharp Fermi spheres

Approximate scaling law: $A^{1/3}$

Comparaison with FOPI: Vartl similar to R_{iso} but not rigourously equal

* Vartl= .75 for Xe+Sn at 400 MeV/u
* problem with Au+Au: Vartl=.6 at 100 MeV/u ---> work in progress to understand

Summary

*** transparency is a general trend in central symmetric nuclear collisions**

- observed by INDRA and FOPI with similar observables
- 'stopping' minimum close to E_{fermi} , maximum around 400 Mev/nucleon and then decreases
- 'stopping' scales roughly with $A^{1/3}$ ---> rôle of in-medium nucleon-nucleon collisions
  - reasonnable agreement between INDRA and FOPI data
  - detailed comparison (Vartl vs R_{iso}) in progress

*** tranparency is the key process to understand nuclear fragmentation in central collisions as a fast 'transient' mechanism**

*** these results constitute strong tests of the microscopic transport models**

- mean field vs nucleon-nucleon collisions, medium effects, MDI's, softening of the EOS ....