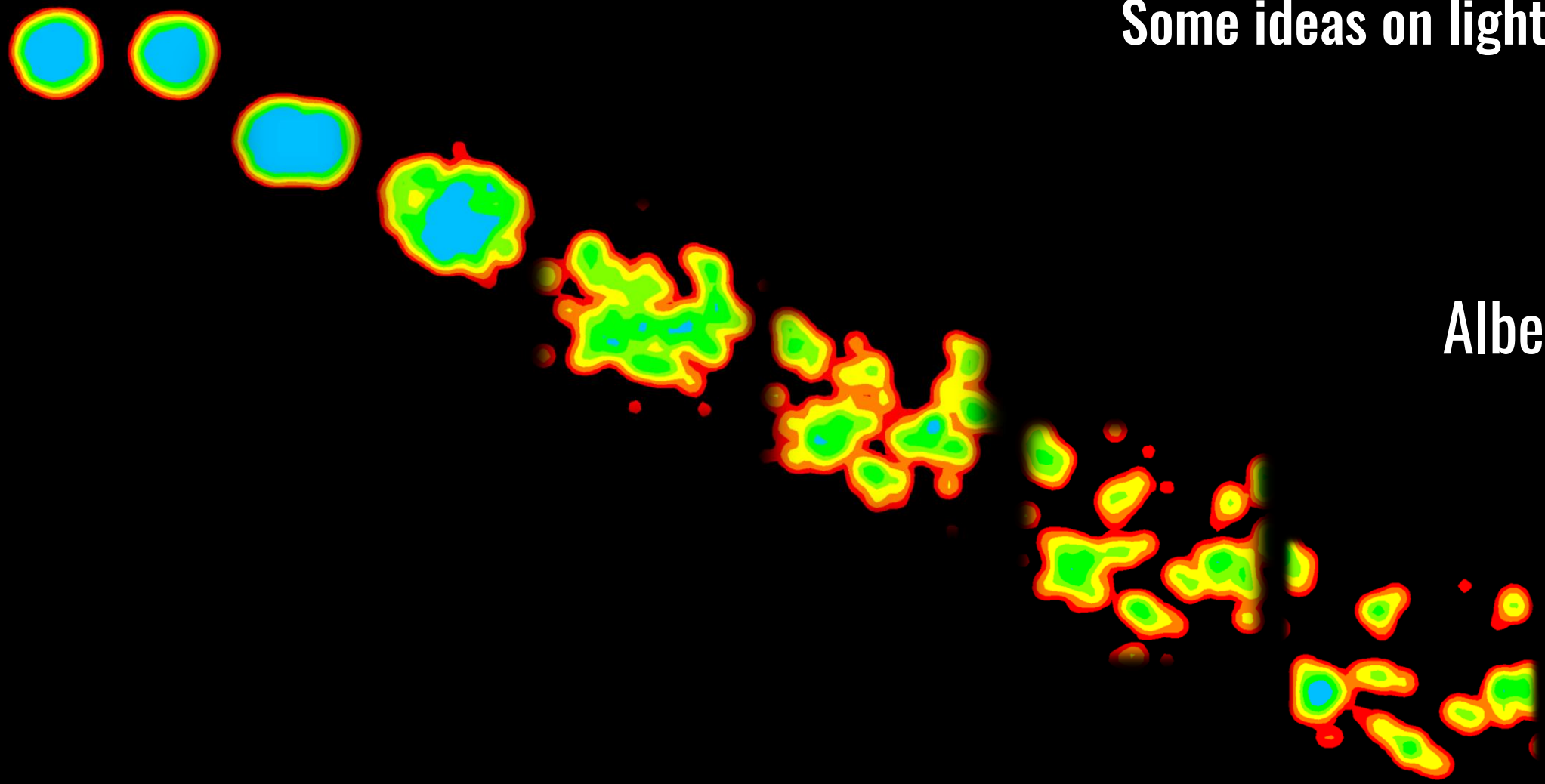
Some ideas on light ion collisions



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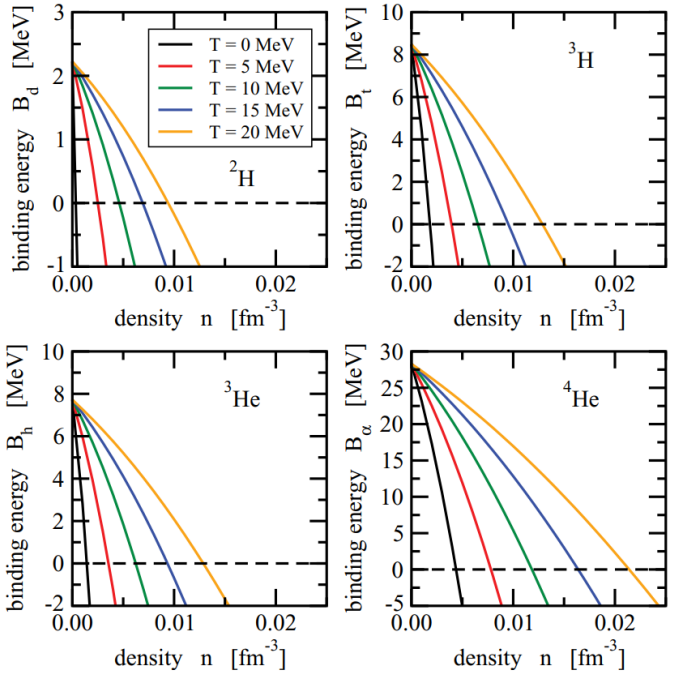
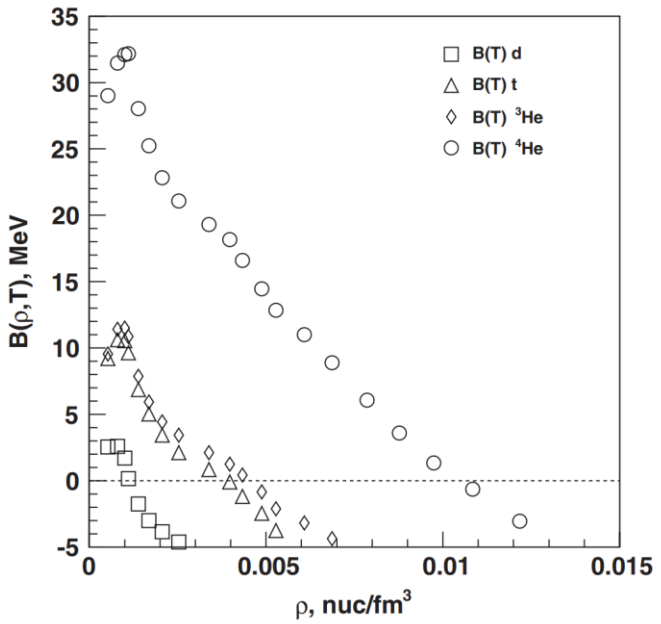
Mott transition

As the density of the nuclear medium in which such clusters are formed increases, they dissolve as a result of the Pauli principle. The Mott point is defined as the (T, ρ, p) where the binding energy of each cluster vanishes.

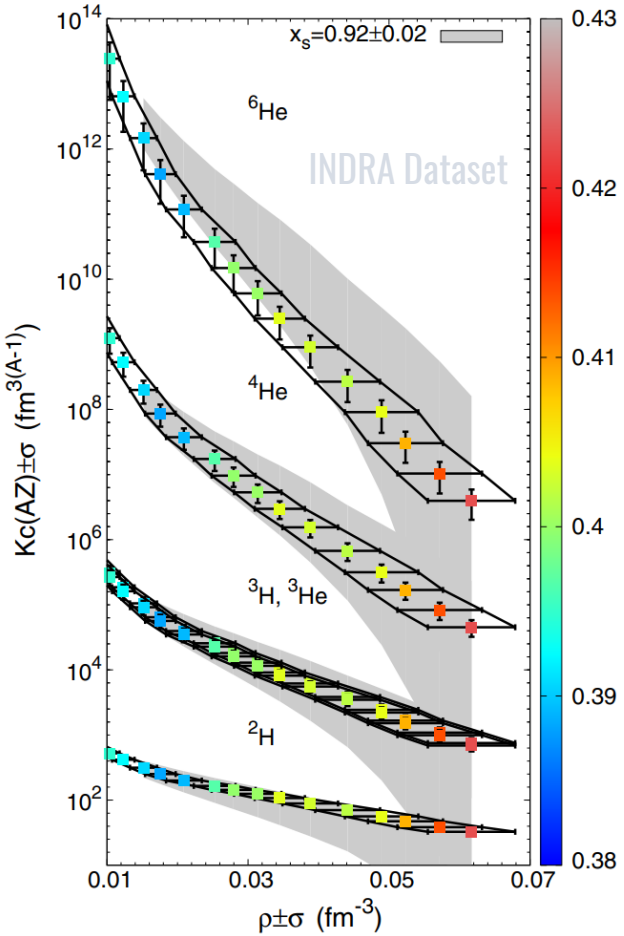
S. Typel et al., PRC 81 (2010)



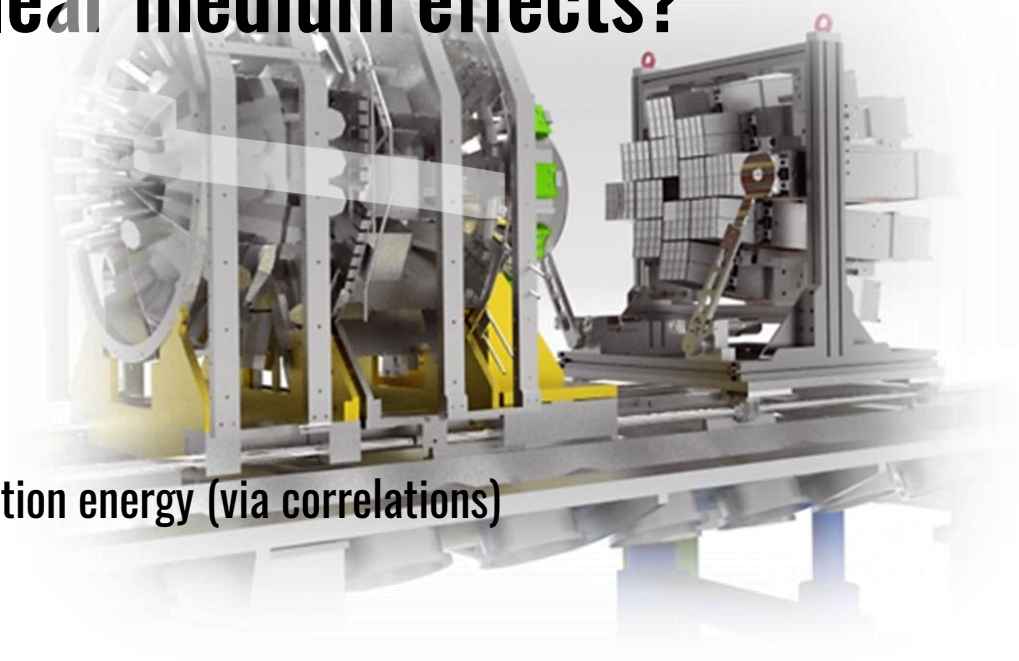
K. Hagel et al., PRL 108 (2012)



H. Pais et al., PRL 125 (2020)



How can we face cluster production and nuclear medium effects?



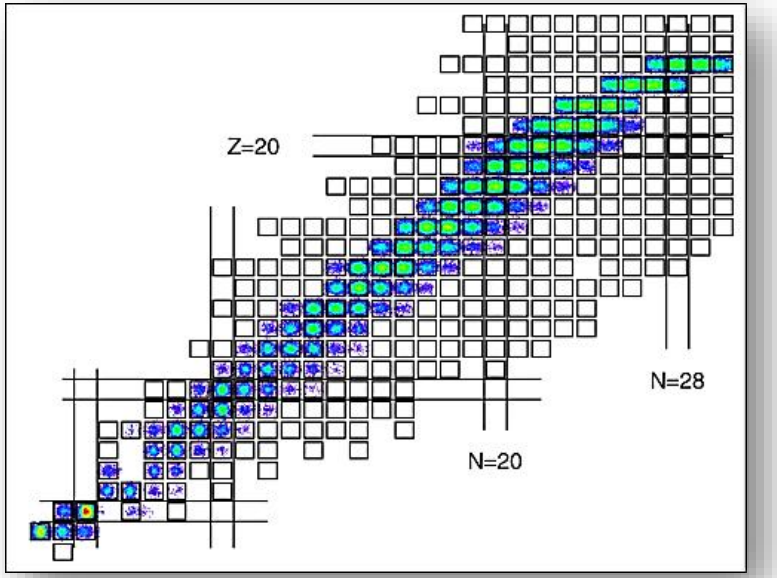
We propose to study $^{32}S+^{24}Mg$ at 50 and 75 MeV/u with the INDRA+FAZIA detector

Detection of event complete in charge: $Z_{det} = Z_{sys}$

1. Fully access the channel branching ratios and kinematics
2. Access main source (via calorimetry) and/or intermediate fragment excitation energy (via correlations)
3. (In)direct estimation of neutron multiplicity (through mass conservation)

The accessed observables

- Particle multiplicities
- Isotopic ratios
- Stopping



Mott effect

BUU simulation of ^{32}S + ^{24}Mg, testing

R Wang et al., PRC 108 (2023)

Two bombarding energies

50 and 75 MeV/u

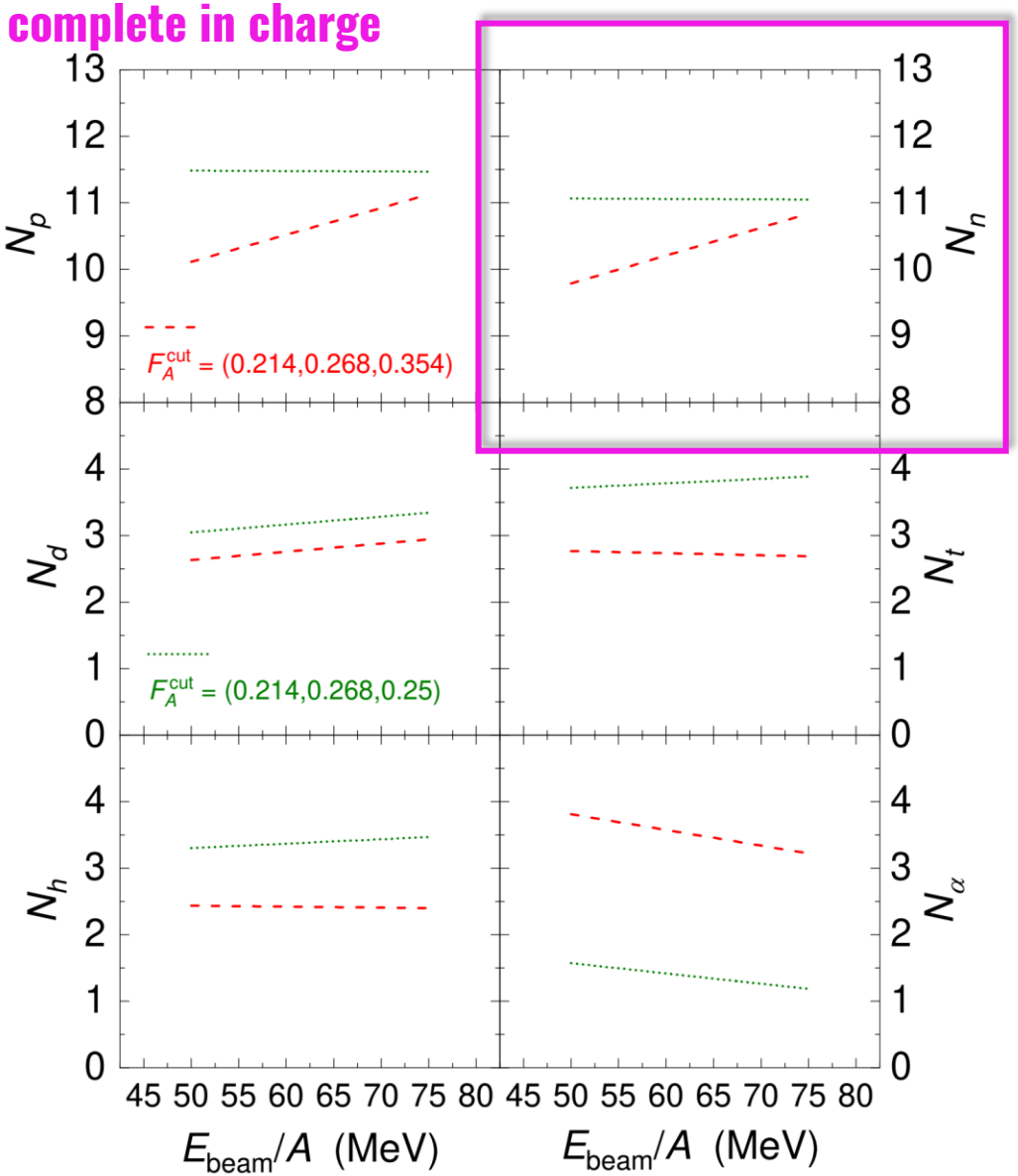
Two hypotheses on alpha Mott point

$$\rho_\alpha^{Mott}(T = 30\,\mathrm{MeV}, P = 0\,\mathrm{MeV/c}) = 0.03\,\mathrm{fm}^{-3}$$

$$\rho_\alpha^{Mott}(T = 30\,\mathrm{MeV}, P = 0\,\mathrm{MeV/c}) = 0.06\,\mathrm{fm}^{-3}$$

- ✓ Multiplicities show larger sensitivity than AMD
- ✓ Clear trend at GANIL energies (comparative analysis)
- ✓ Enhancement of n and p sesitivity as energy decreases

Only thanks to INDRA+FAZIA and events complete in charge



NN cross section and Mott effect

AMD simulation of ^{32}S + ^{24}Mg at 50 MeV/u, testing

https://journals.jps.jp/doi/pdf/10.7566/JPSCP.32.010076

Three hypotheses on Mott cut-off parameter

- Reduction of the clusterization phase-space ρ_c'

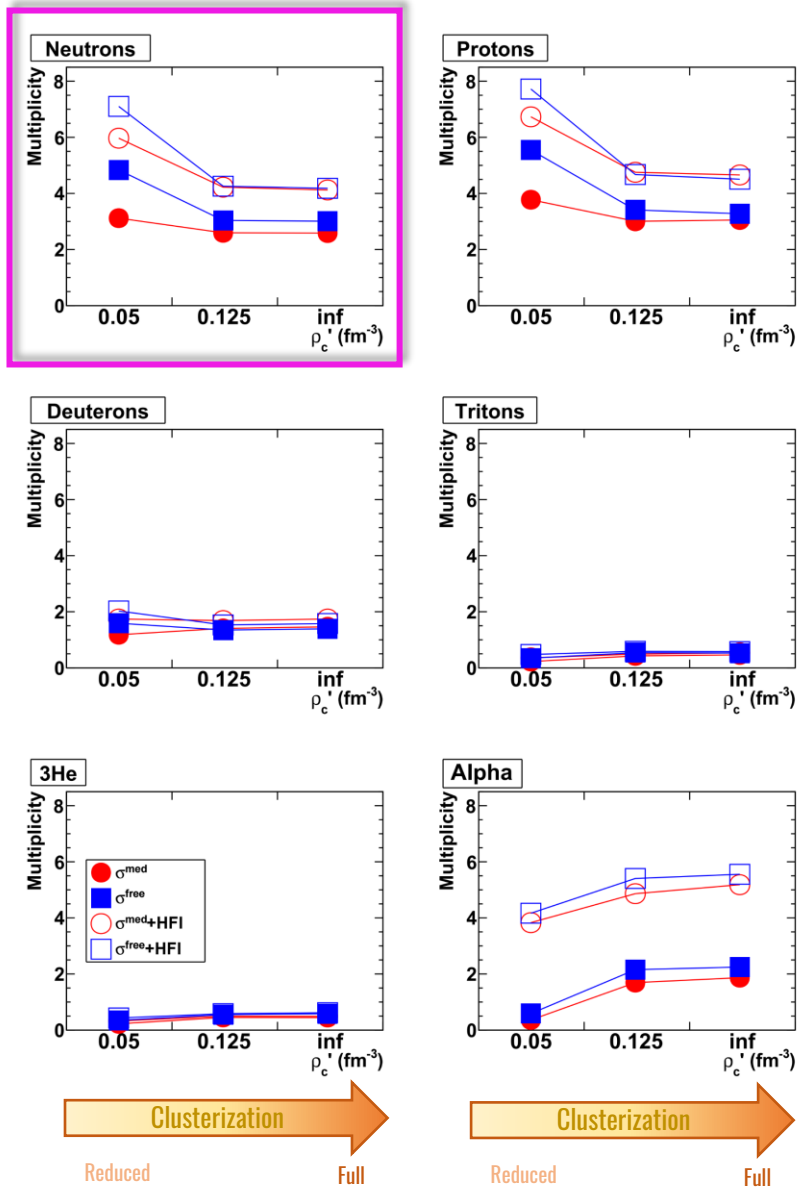
Two Nucleon-Nucleon cross section recipes + Afterburner (HFI)

C. Frosin et al., PRC 107 (2023)
L. Morelli et al. JOP G 41 (2014)

- In-mediun NN cross section → σ^{med}+HFI
  D. D. S. Coupland et al., PRC 84 (2011)
- Free NN cross section → σ^{free}+HFI
  J. Cugnon et al., NIM B 111 (1996)

- ✓ n, p, α multiplicities show sensitivity to Mott cut-off value
- ✓ n multiplicity best probe for Mott cut-off and NN cross section
- ✓ The afterburner does not wash out the sensitivity

Only thanks to INDRA+FAZIA and events complete in charge



NN cross section and Mott effect

AMD simulation of ^{32}S + ^{24}Mg at

https://journals.jps.jp/doi/pdf/10.7566/JPSCP.32.010076

Three hypotheses on Mott cut-off p

- Reduction of the clusteriz

Two Nucleon-Nucleon cross sectior

- In-mediun NN cross sectic

  D. D. S. Coupland et al., PRC 84 (2011)
- Free NN cross section

  J. Cugnon et al., NIM B 111 (1996)

- ✓ n, p, α multiplicit
- ✓ n multiplicity bes
- ✓ The afterburner d

PAC report about E880_23

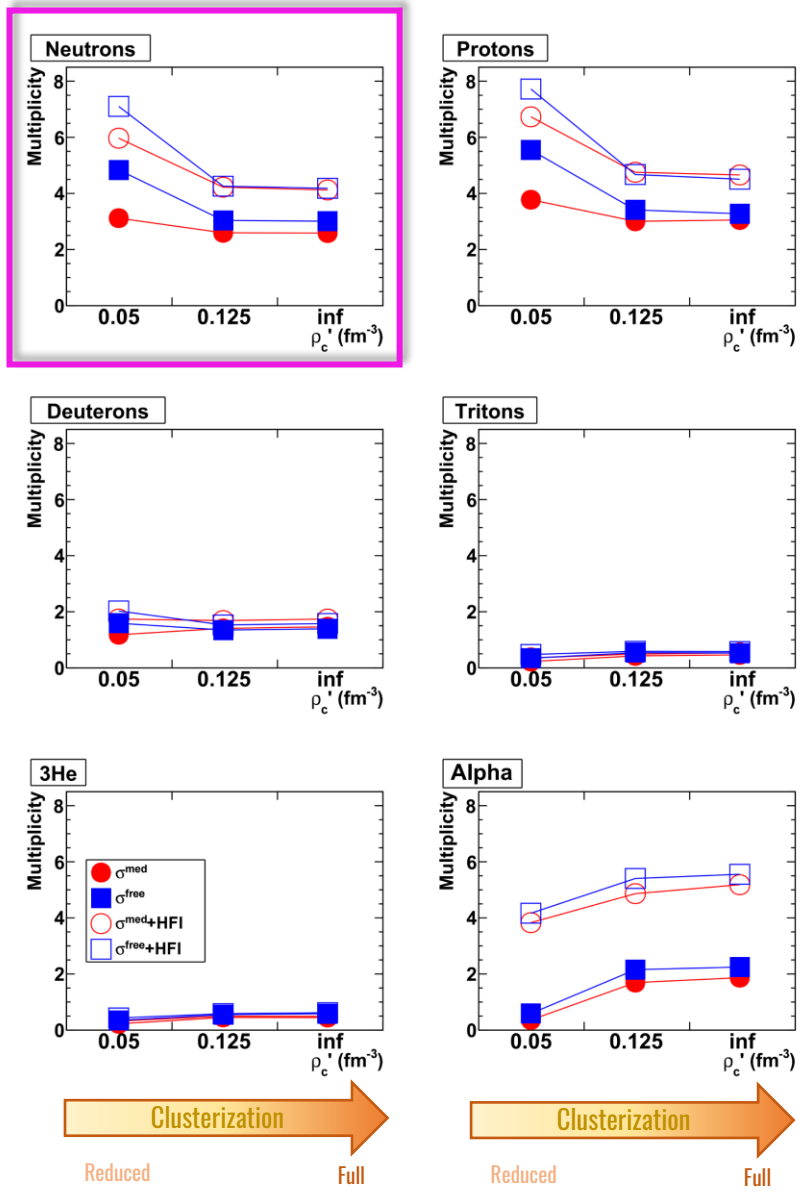
The proposal aims at further understanding cluster formation in heavy-ion collisions at Fermi energies and constrain the Mott point location within effective dynamical models. S-32 (projectile) + Mg-24 (target) collisions will be measured at 50 and 75 MeV/nucleon with the INDRA+FAZIA setup. The experiment focuses on events where all charged particles are detected. The multiplicity of neutrons, protons and light clusters will be analysed to address the question of The Mott point at which the clusters dissolve in the (temperature, momentum, density) phase space of nuclear matter.

The PAC acknowledges the importance of the physics case. The INDRA+FAZIA setup and complete identification of events of interest should provide a unique data set to benchmark and improve exiting transport models. Although the analysis methodology and interpretation frameworks are well identified, the PAC has doubts that the phenomenology of the interpretation can lead to a microscopic understanding of the clusterization beyond the parameterization of the considered models.

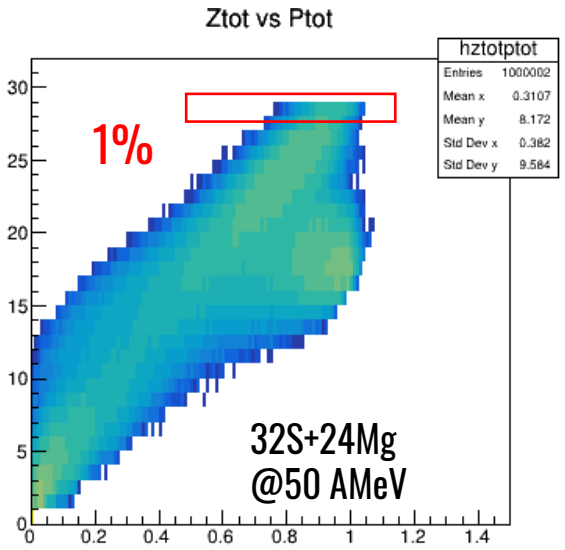
For the reason above and due to limited beam time availability, the PAC does not recommend beam time for this experiment.

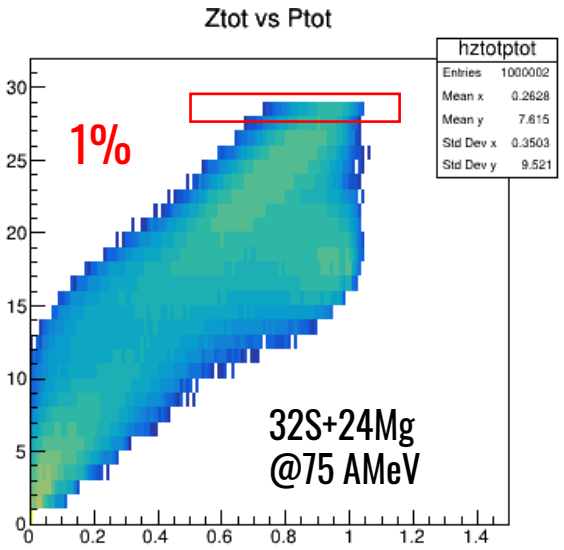
Close

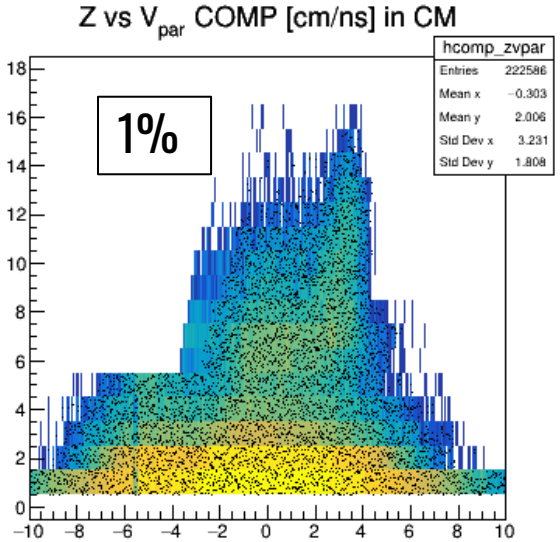
Only thanks to INDRA+FAZIA and events complete in charge

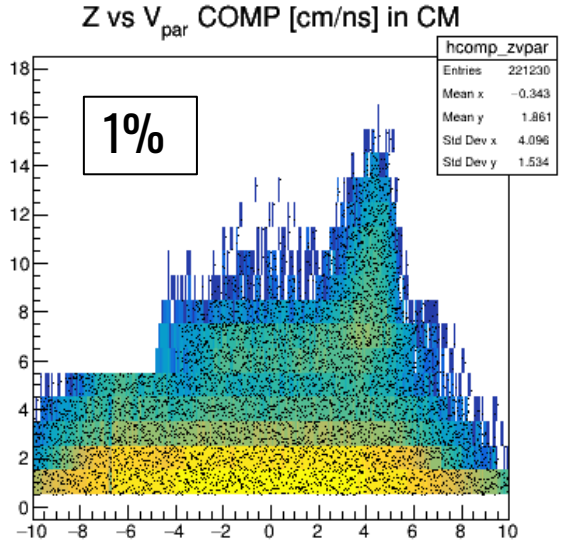


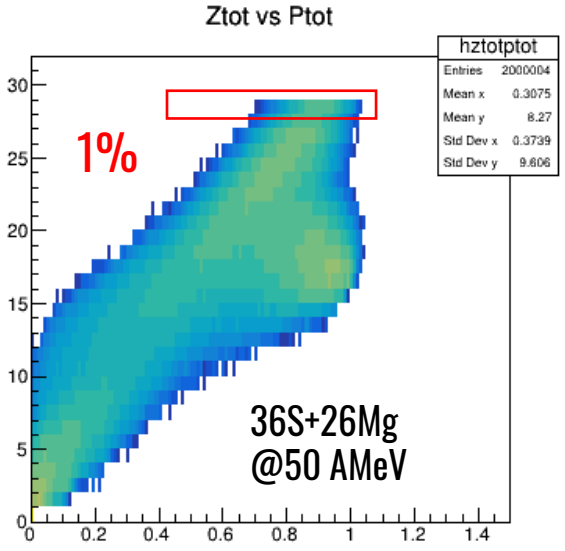
Can we say something on effective masses?

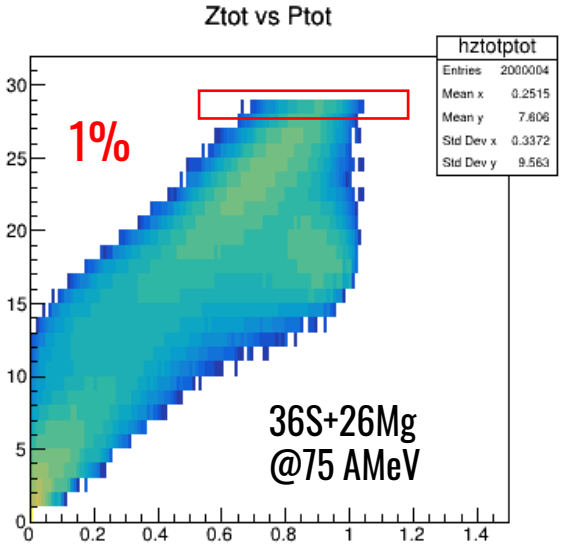


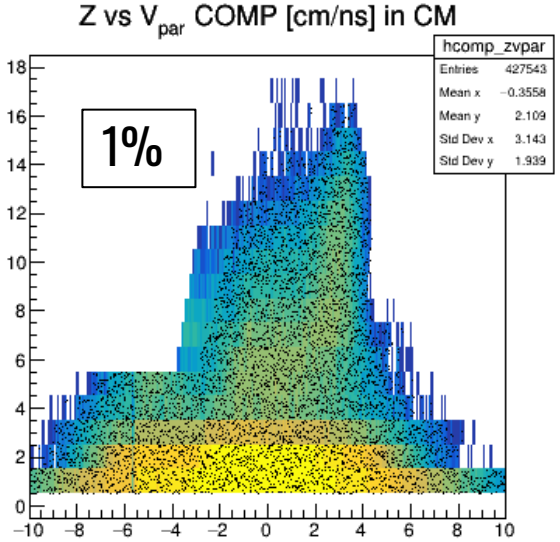


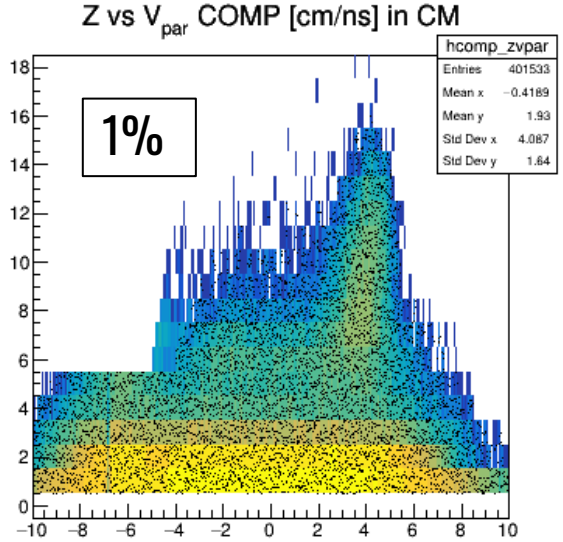












Can we say something on effective masses?

We can compare

1. n multiplicty vs p multiplicity
2. p kinetic energy
3. n missing energy
4. Clusters yields and energy spectr

Different effective pontential may be selected within AMD
(so far, tested Sly4 and SKM*), however only n vs p yield gave some hints

V. Baran et al. / Physics Reports 410 (2005) 335–466