A possible PAC proposal on QP breakup in Zn+X reaction

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Fazia Days

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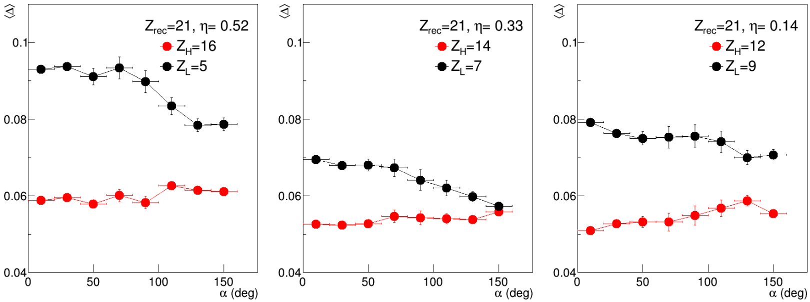
Ni+Ni data

HF-LF equilibration in E789



We observe an evolution of the neutron content of HF and LF with α.
We are somewhat limited around $\alpha \sim 90°$ due to the fact that we are only using FAZIA.

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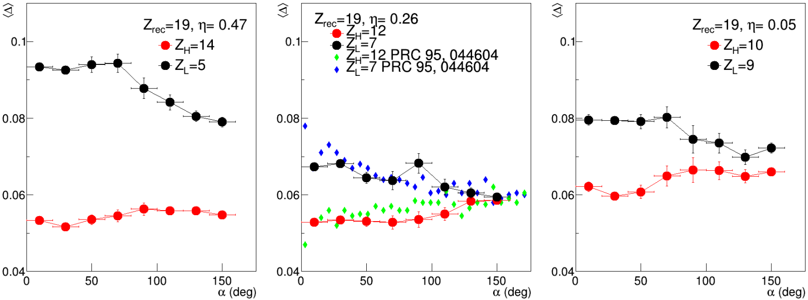

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We can compare the configuration $Z_L = 7$, $Z_H = 12$ for ^{64}Ni+^{64}Ni with
A. Rodriguez-Manso et al., PRC95, 044604 (2017)

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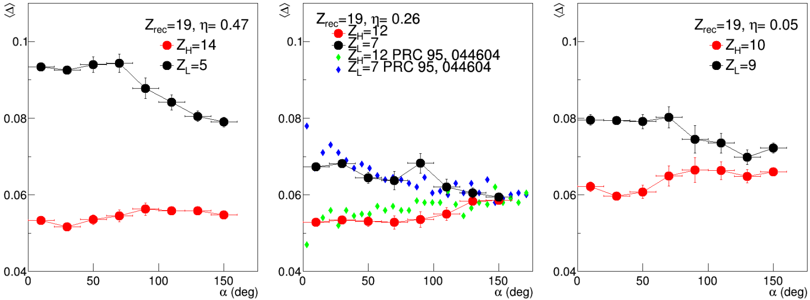

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Within the small charge asymmetries that we can probe the evolution of $\langle\Delta\rangle_L$ depends mostly on the identity of the LF, and less on the partner HF.

→ consider $\langle\Delta\rangle_L$ for a larger interval of Z_H

Ni+Ni data

$\langle\Delta\rangle_L$ vs α for different systems and beam energies

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Different energies:

- The LF is more neutron rich at $\alpha \sim 0$ at the lower beam energy
  $\rightarrow$ more effective isospin drift?
- The following evolution towards equilibration is not easy to compare

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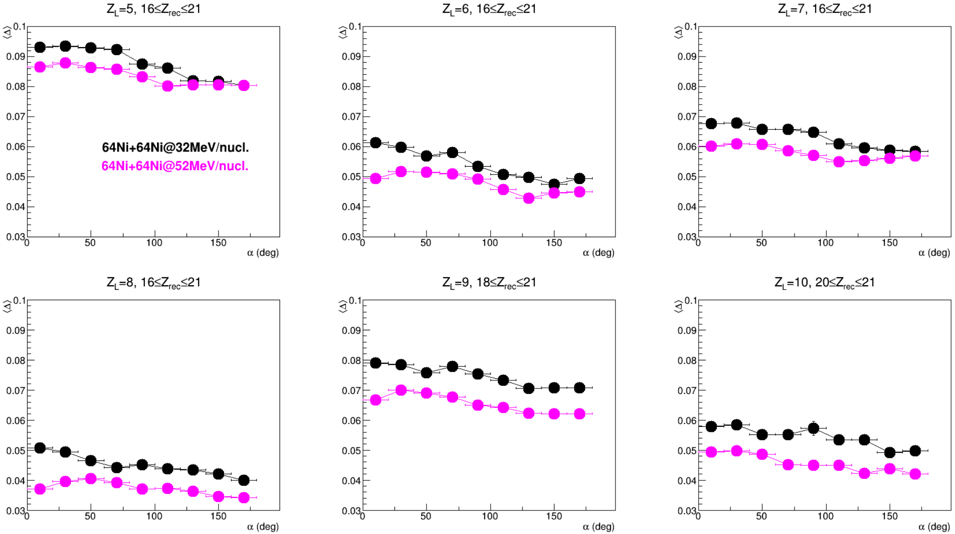

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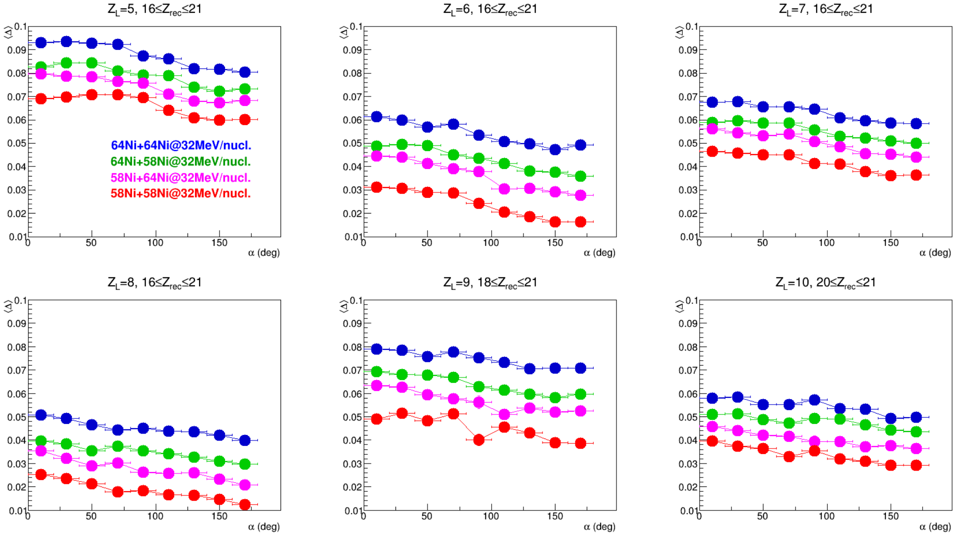
Different systems:

- The $\langle\Delta\rangle_L$ depends on the neutron content of both the projectile and the target
  The $\langle\Delta\rangle_H$ vs α plots maintain the same hierarchy
- The evolution towards isospin equilibration seems to proceed in a similar way, independently of the system

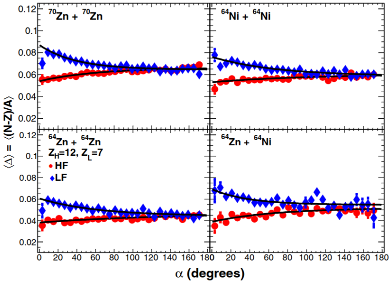
Ni+Ni data

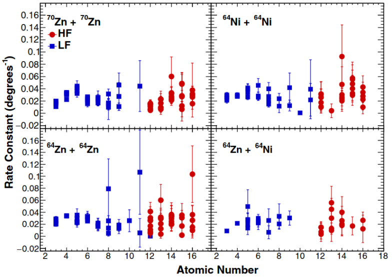
$\langle\Delta\rangle_L$ vs α for different systems and beam energies



Some literature

Previous studies with the same projectile on different targets





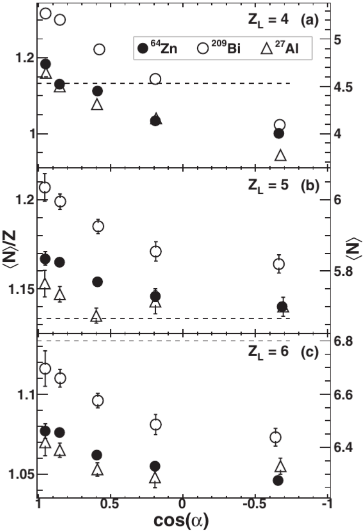
A. Rodriguez-Manso et al., PRC95, 044604 (2017):

two reactions with same projectile, i.e. ^{64}Zn+^{64}Zn,^{64}Ni at 35MeV/nucl.

- initial $\langle\Delta\rangle_L$ depends on the system, $\langle\Delta\rangle_H$ is the same
- the equilibrium composition depends on the system, the average rate constant does not seem to depend on it
  → *"the rate constants ought to depend on the details of the NEoS, but not on the composition of the system or the chemical potentials involved"*

Some literature

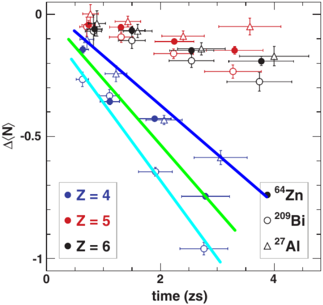
Previous studies with the same projectile on different targets



K. Brown et al., PRC87, 061601 (2013):

study of HF-LF equilibration for the three reactions ^{64}Zn + ^{27}Al,^{64}Zn,^{209}Bi at 45MeV/nucl

- strong similarities in the emission angles
- the composition of the Z_L depends on the target, but also the LF equilibration rate

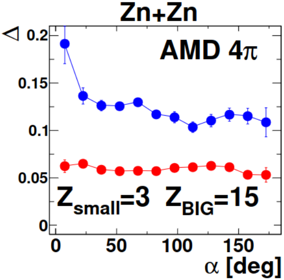


QP breakup in Zn+X reactions

A possible experiment: the systems

Study the evolution towards equilibration in three systems, using the same projectile on three targets with strongly different size and composition, e.g.:

- ^{70}Zn + ^{27}Al or ^{40}Ca
- ^{70}Zn + ^{70}Zn (as "reference" system)
- ^{70}Zn + ^{209}Bi or ^{208}Pb



These systems feature a stronger projectile-target asymmetry with respect to those of E789 and those of A. Rodriguez-Manso et al., PRC95, 044604 (2017), more similar to K. Brown et al., PRC87, 061601 (2013)

The different neutron reservoir provided by the targets will introduce a different initial isospin imbalance between the two sides of the deformed QP*
→ i.e. different $\langle\Delta\rangle_{L,H}$ at low α values

The aim is to probe the evolution of isospin equilibration inside the deformed QP* before its breakup in the three cases, to see to what extent it depends on the preceding step of the reaction.

QP breakup in Zn+X reactions

A possible experiment: the beam energy

- The beam energy could be 35 MeV/nucl., which allows to compare the results for the reference system ^{70}Zn+^{70}Zn with A. Rodriguez-Manso et al., PRC95, 044604 (2017).
- It could be interesting to have more than one beam energy for, e.g., the symmetric system.
  - In E789, we observe a different initial isospin content for the LF, but the comparison of the following evolutions is not clear.
  - In principle, the initial density on the LF side could be different.
- However, we need to collect a high statistics to study the breakup channel e.g. considering specific (Z_L, Z_H) pairs, and thus it may be better to focus on only three reactions, asking for an adequate amount of BTUs.
  - ^{70}Zn beam: ∼8 BTUs ×3 =∼24 BTUs
  - ^{12}C beams for calibration, as in E818: 6 BTUs

QP breakup in Zn+X reactions

Exploiting the actual capabilities of the setup

- Thanks to the INDRA upgrade we can access the mass information up to $Z = 10$ for a larger forward angle (up to 45°) with respect to E789.
  - in E789 the breakup study was hindered by the fact that we could only use the events in which both fragments were collected by FAZIA
    → "transverse" breakups ($\alpha \sim 90$) could not be accessed easily

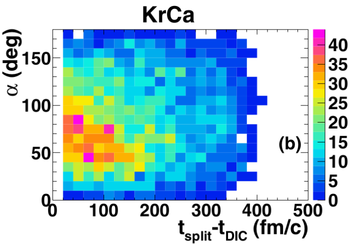
- Further evaluations that could be done on this dataset:
  - compare the distribution of the observables related to the dynamics of the breakup, e.g. α itself and the relative velocity between HF and LF
  - study how the probability to access the QP breakup channel evolves with the reaction centrality in the three systems
    → The new Rutherford monitor could provide an absolute reference

Backup slides

Correlation between time and angular alignment

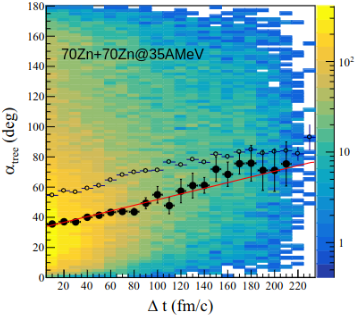
Contrasting results

AMD



In S. Piantelli et al., PRC101, 034613 (2020) the correlation between α and Δt_{BU} is ot supported by the AMD model (80Kr+48Ca@35MeV/nucleon)

CoMD

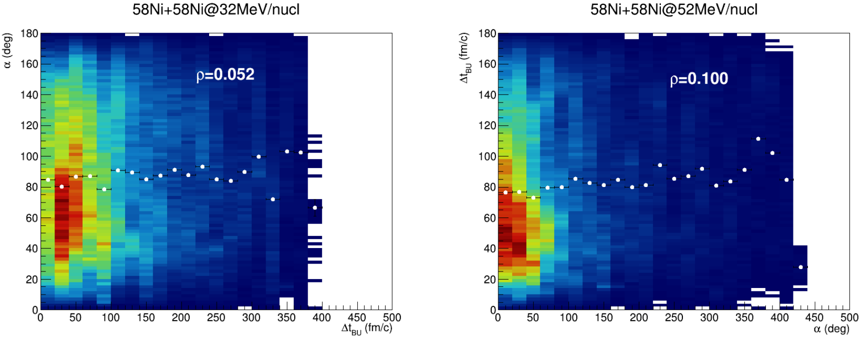


In B. Harvey et al., PRC102, 064625 (2020) they claim to find the $\alpha - \Delta t_{BU}$ correlation

Following the assumption, in A. Jedele et al., PRC107, 024601 (2023) the possible sensitivity of the extracted equilibration time scale to the asy-stiffness of the NEoS is investigated.

Simulated data

Correlation between time and angular alignment

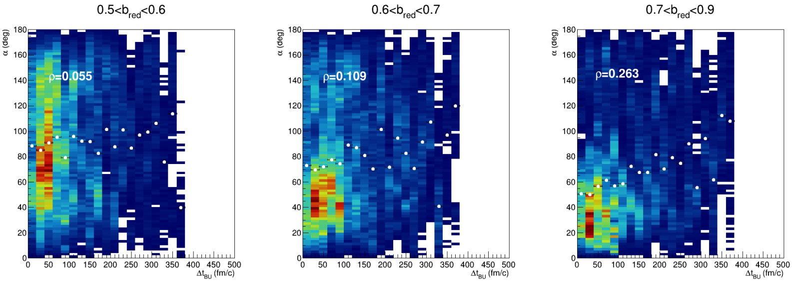


As expected, the same behavior as S. Piantelli et al., PRC101, 034613 (2020) is obtained also for Ni+Ni systems.

We can try to build the same correlations for different centrality intervals.

Simulated data

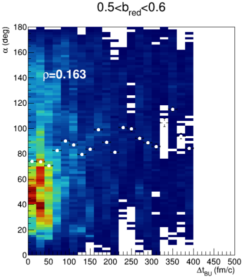
Correlation between time and angular alignment: centrality intervals

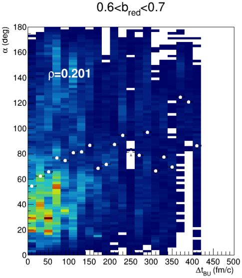


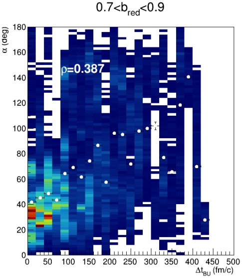
The correlation plot is slightly different in the three centrality intervals, both for 58Ni+58Ni @32MeV/nucl.

Simulated data

Correlation between time and angular alignment: centrality intervals







The correlation plot is slightly different in the three centrality intervals, both for 58Ni+58Ni @32MeV/nucl. and @52MeV/nucl.

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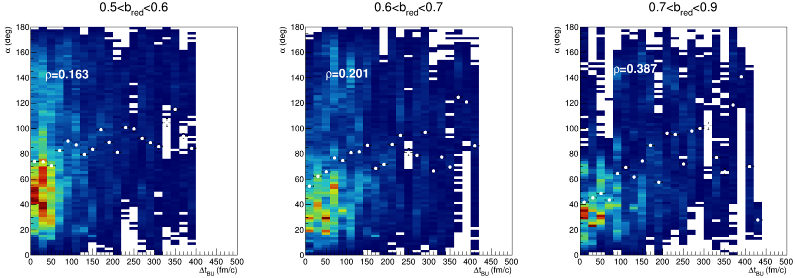

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A *weak* correlation is visible for the most peripheral reactions, particularly at 52MeV/nucl.
→ evolution of the Pearson corr. coeff. with b_{red}