Study the Neutron Shell Structure of ^{68}Ni via Missing Mass Spectroscopy

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and MUGAST@LISE Collaboration

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Introduction

The motivation is to investigate magicity at N=40, shell gap at N=50, and SO splittings of *pfg* shells in ^{68}Ni using neutron adding and removal reactions in inverse kinematics.

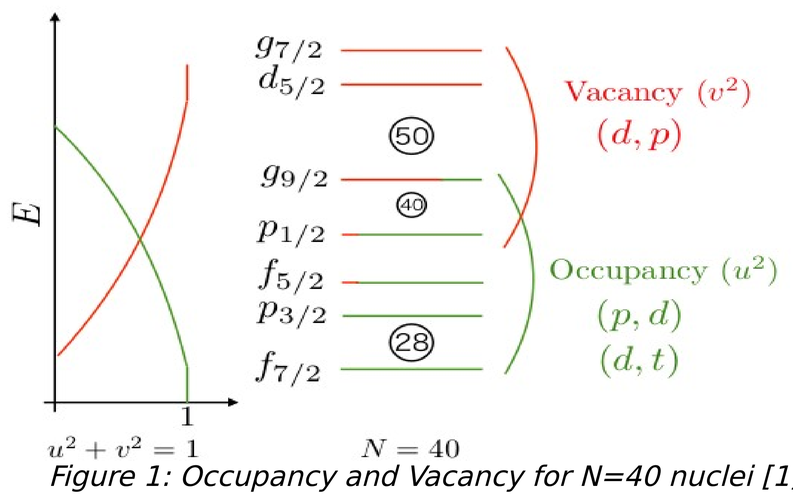
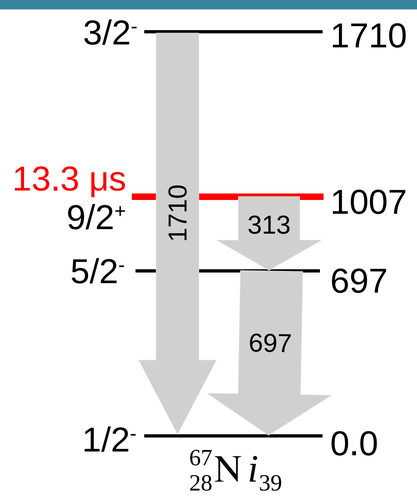
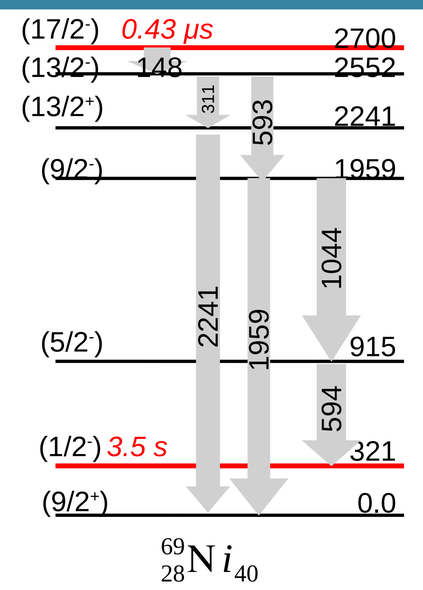


Figure 1: Occupancy and Vacancy for N=40 nuclei [1]

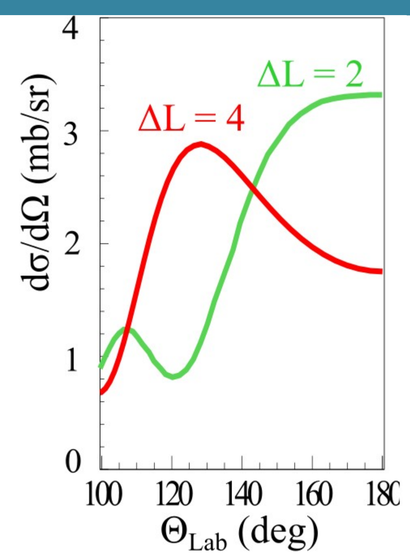


States of ^{67}Ni expected to populated by ^{68}Ni(d,t)^{67}Ni & ^{68}Ni(p,d)^{67}Ni reactions.
The observation of isomer is linked to N=40 shell closure.



Level scheme of ^{69}Ni

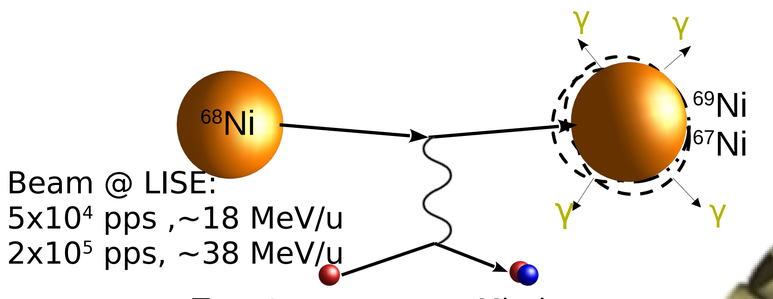
We hope to identify $5/2^+$ leading to N=50 shell gap, and $7/2^+$ leading to SO splitting



DWBA calculations for L=2 and L=4. [1]

Experimental Setup

^{70}Zn (62 MeV) + ^{9}Be (500 μm) → ^{68}Ni (@LISE)

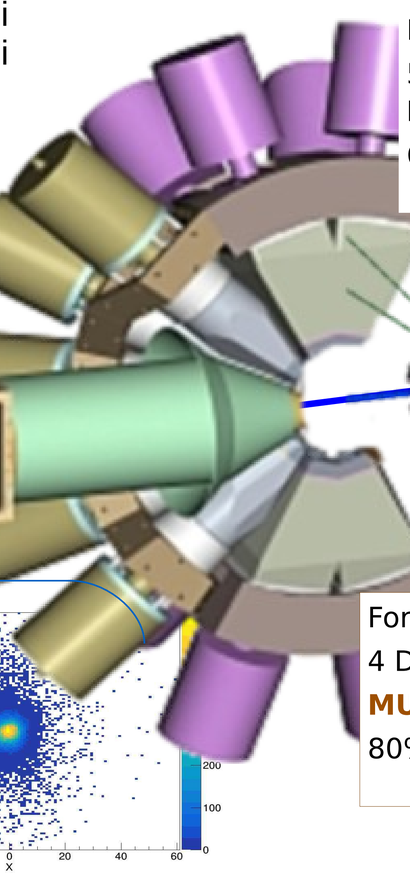


Beam @ LISE:
$5x10^4$ pps ,~18 MeV/u
$2x10^5$ pps, ~38 MeV/u

Targets:
CD_2 (0.5 mg / cm^2)
CH_2 (5 mg / cm^2)

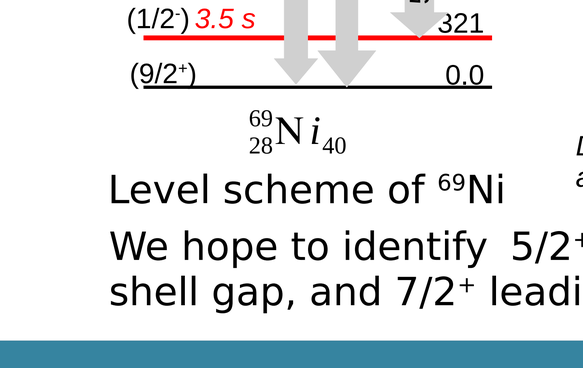
Missing mass:
Proton,
deuteron, triton

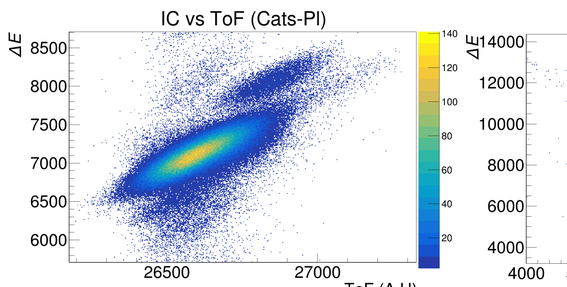
EXOGAM2:
12 HpGe Clovers
In beam γ measurement



For (d,p)
5 trapezoidal DSSSDs
MUGAST @ 110°-170°
60% acceptance

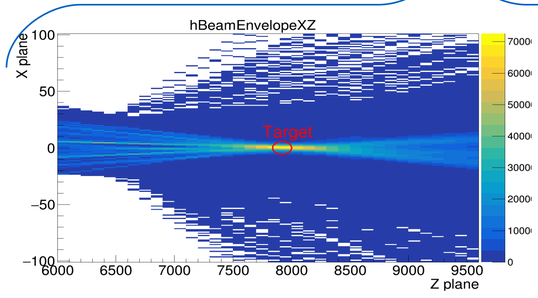
Target:
CD_2, CH_2



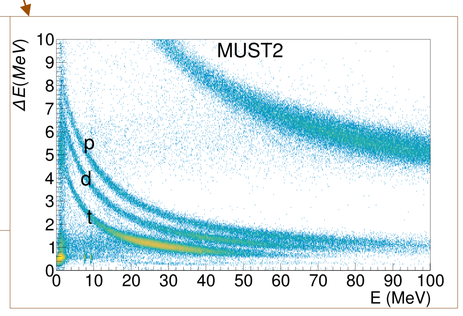


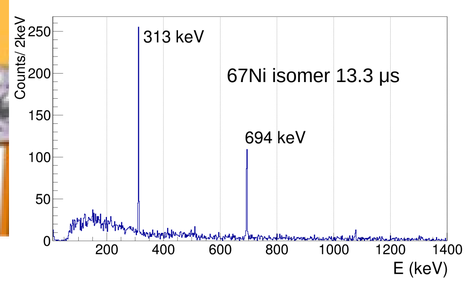
CATS1 &2
- Secondary beam E=10-50 MeV
- reconstructed position on target
- Time of flight

^{68}Ni



For (d,t) &(p,d)
4 DSSSDs & CsI
MUST2 @ 5° – 40°
80% acceptance



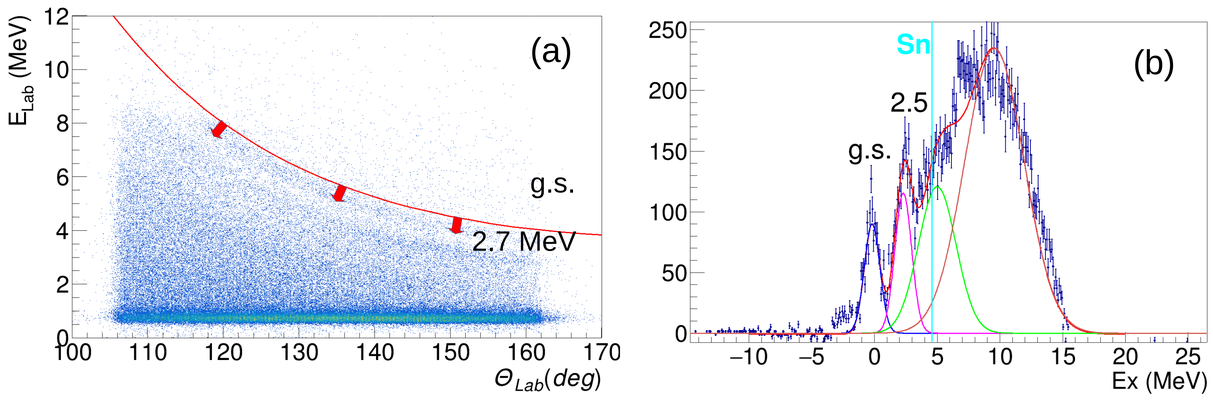


ZDD:
- Drift Chambers (**DC**) for XY measurement
- 5 tilted foils ionizing chambers (**IC**) for ΔE
- 5 Plastic Scintillators (**PL**) for Energy and clean up the reaction residue.
- 1 **Exogam** Clover (HpGe) for the isomers

Results & Conclusion

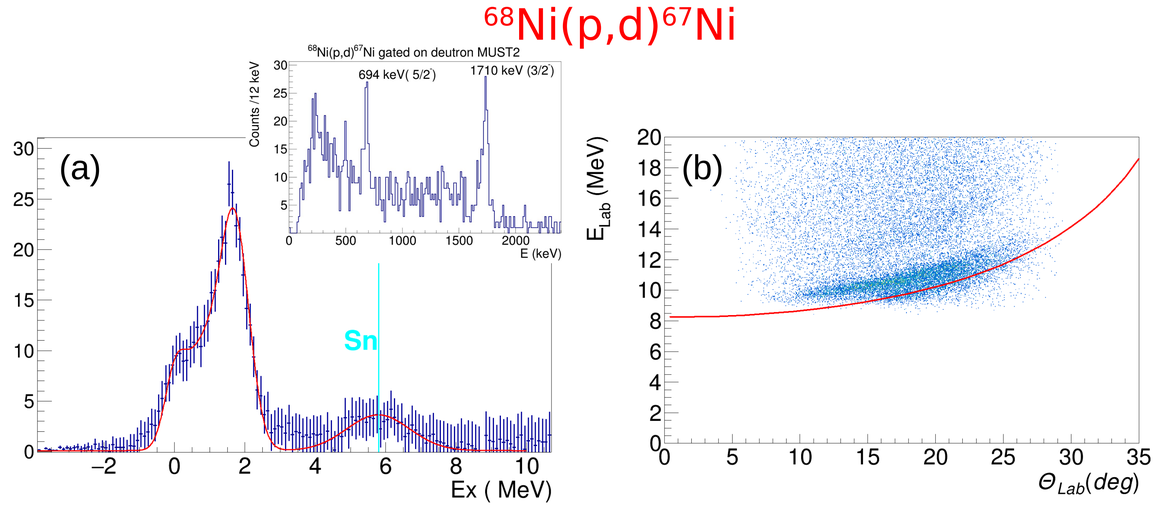
<u>The preliminary results</u> from May 2023 for Kinematics and excitation energies (Ex) are shown from missing mass.

^{68}Ni(d,p)^{69}Ni



(a) Kinematic curve for ^{68}Ni(d,p)^{69}Ni reaction.
(b) Ex spectrum displays some states on top of deuteron breakup above Sn, which will be subtracted later. Rough suppression of Carbon- induced reaction has been applied.

^{68}Ni(p,d)^{67}Ni



(a) Ex spectrum with the rough carbon component subtraction,insert deuteron gated g-ray spectrum shows that 2 excited states are populated. Further analysis will optimize Carbon subtraction.
(b) Kinematics of the ^{68}Ni(p,d)^{67}Ni reaction with calculated curve for the g.s. in red.

References

[1] S. Koyama, e843_21 exp proposal,2021

Fundings

RÉGION NORMANDIE
WINNING NORMANDY
GANIL spiral2 laboratoire commun CEA/DRF CNRS/IN2P3