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

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Introduction

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

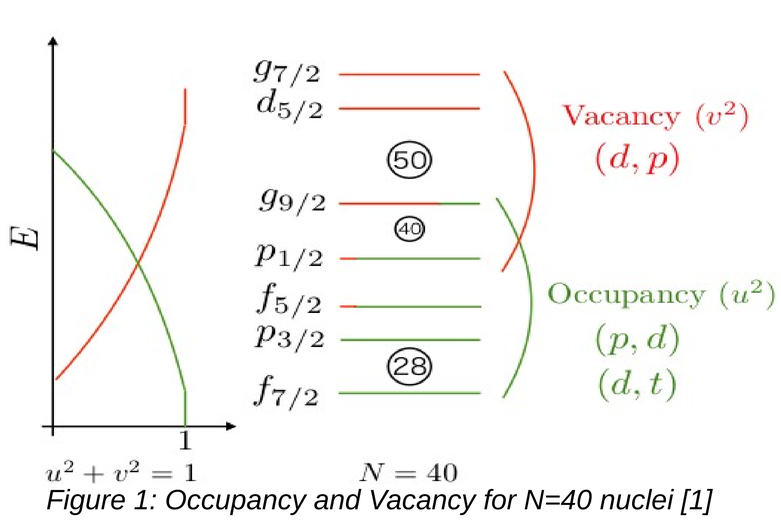
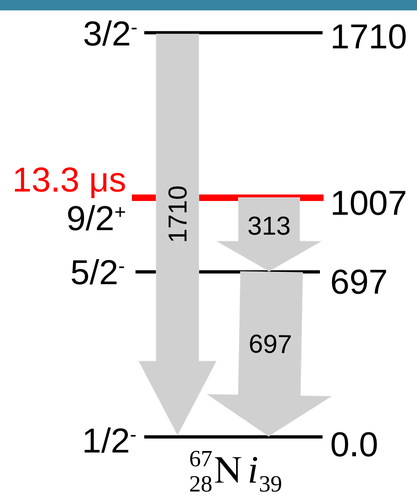
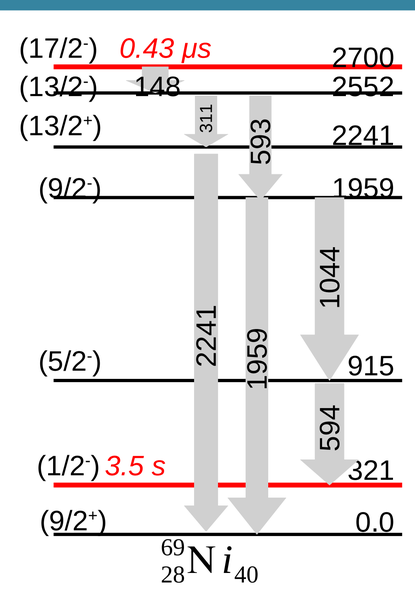


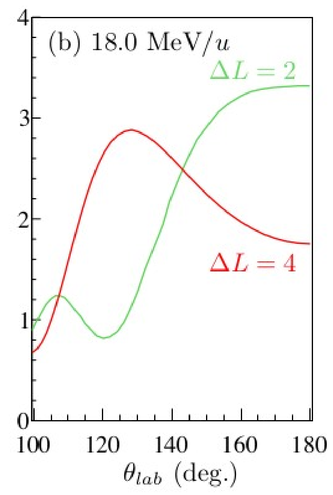
Figure 1: Occupancy and Vacancy for N=40 nuclei [1]



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 will be witness for N=40 shell closure.



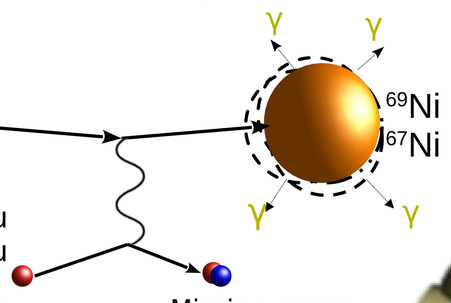
Level scheme of ^{69}Ni
We hope to identify 5/2+ and 7/2+ leading to N=50 shell gap.



DWBA calculations for L=2 and L=4

Experimental Setup

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

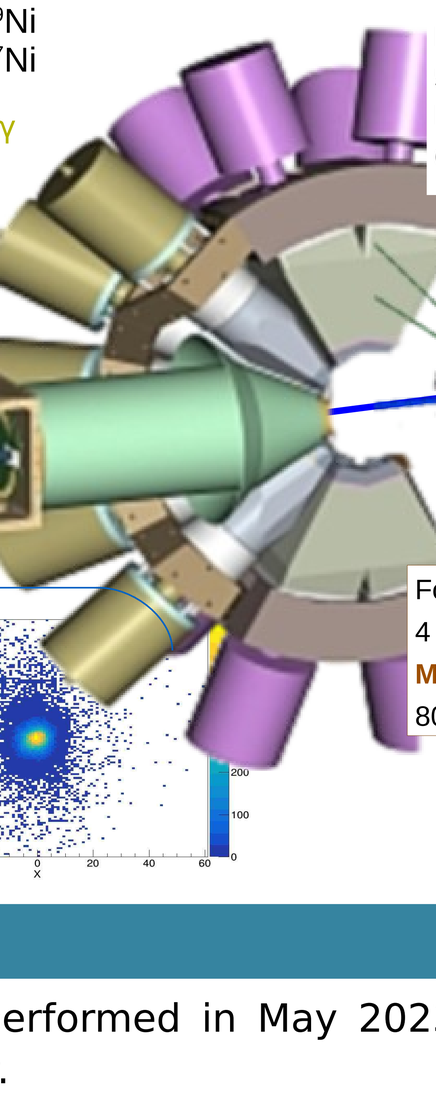


Beam @ LISE:
$5x10^4$ pps ,~18 MeV/u
$2x10^5$ pps, ~38 MeV/u

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

Missing mass:
Proton,
deuteron, triton

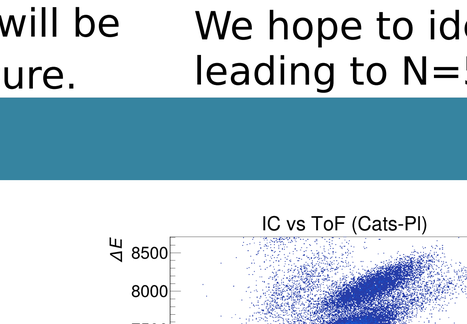
EXOGAM2:
12 HpGe Clovers
In beam γ measurement

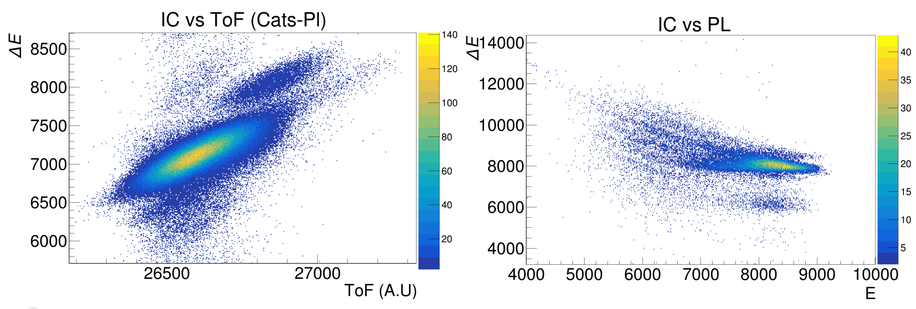


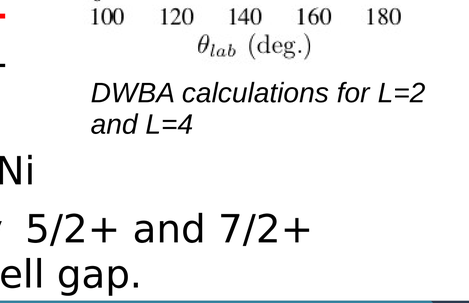
For (d,p)
5 trapezoidal DSSSDs
MUGAST @ 110°-170°,
60% acceptance

Target:
CD_2, CH_2

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

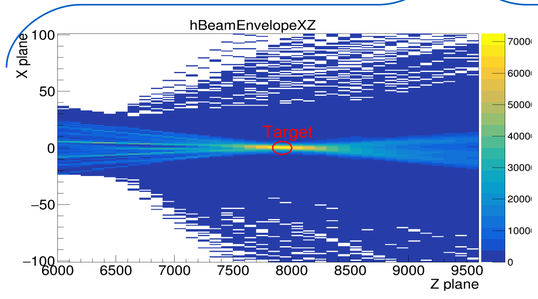






CATS1 &2
- Secondary beam E=10-50 MeV
- reconstructed position on target
- Time of flight

^{68}Ni

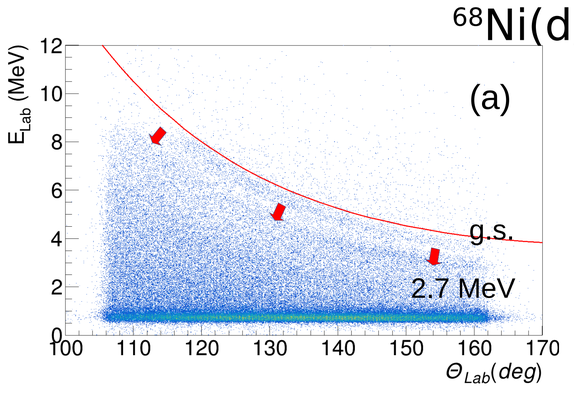


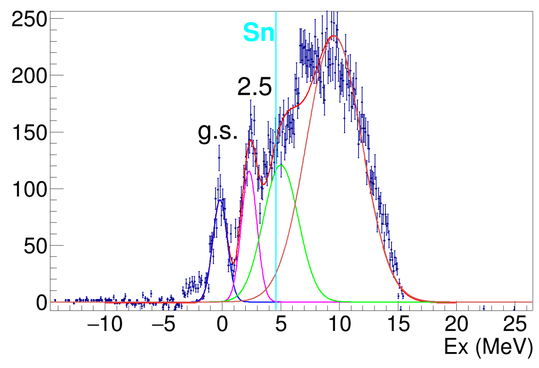
ZDD:
- Drift Chambers (**DC**) for XY measurement
- 5 tilted foils ionizing chambers (**IC**) for ΔE
- 5 Plastic Scintillators (**PL**) for Energy and clean up the reaction residue.
- 1 **Exogam** Clover (HpGe) for the isomers

Results & Conclusion

The experiment was successfully performed in May 2023. The preliminary results for Kinematics and Missing mass excitation energies are shown below.

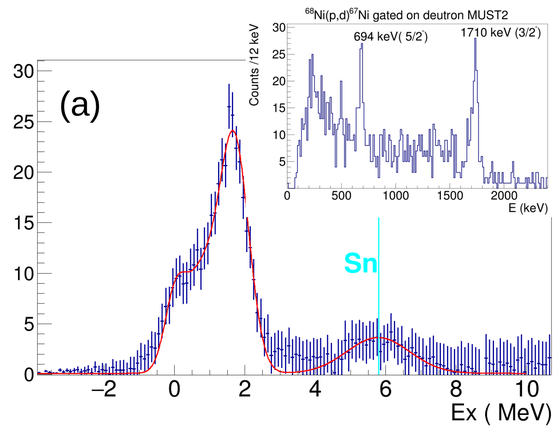
^{68}Ni(d,p)^{69}Ni

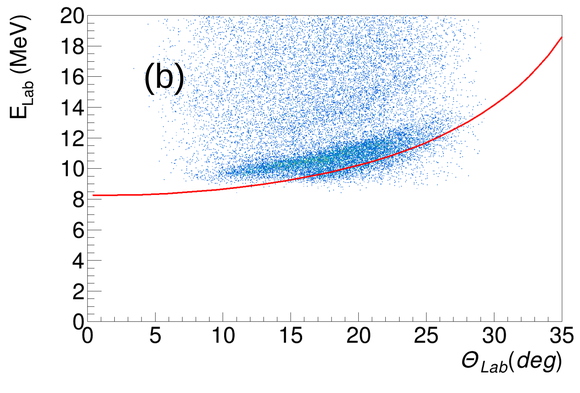




(a) Kinematic curve for ^{68}Ni(d,p)^{69}Ni reaction.
(b) In the missing mass spectrum we can identify the g.s. level and 2.5 MeV. The preliminary Carbon subtracted Ex results are contaminated by break up reactions of deuterium (*^{68}Ni(d → p+n) ^{68}Ni*) in further analysis we will optimize the subtraction and contamination.

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





(a) The Ex spectrum with the rough Carbon reaction subtraction, at least two component was added to g.s. Further analysis will optimize Carbon subtraction. Inside figure shows the corresponding γ-ray spectrum.
(b)The experimental data is well described by the kinematic curve of ^{68}Ni(p,d)^{67}Ni reaction in ground state.

References

[1] S. Koyama, e843_21 exp proposal,2021
[2] Diriken et al, PRC 91 054321

Fundings

RÉGION NORMANDIE
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