Transfer reactions at REX-ISOLDE: The ^{66}Ni(d,p)^{67}Ni experiment

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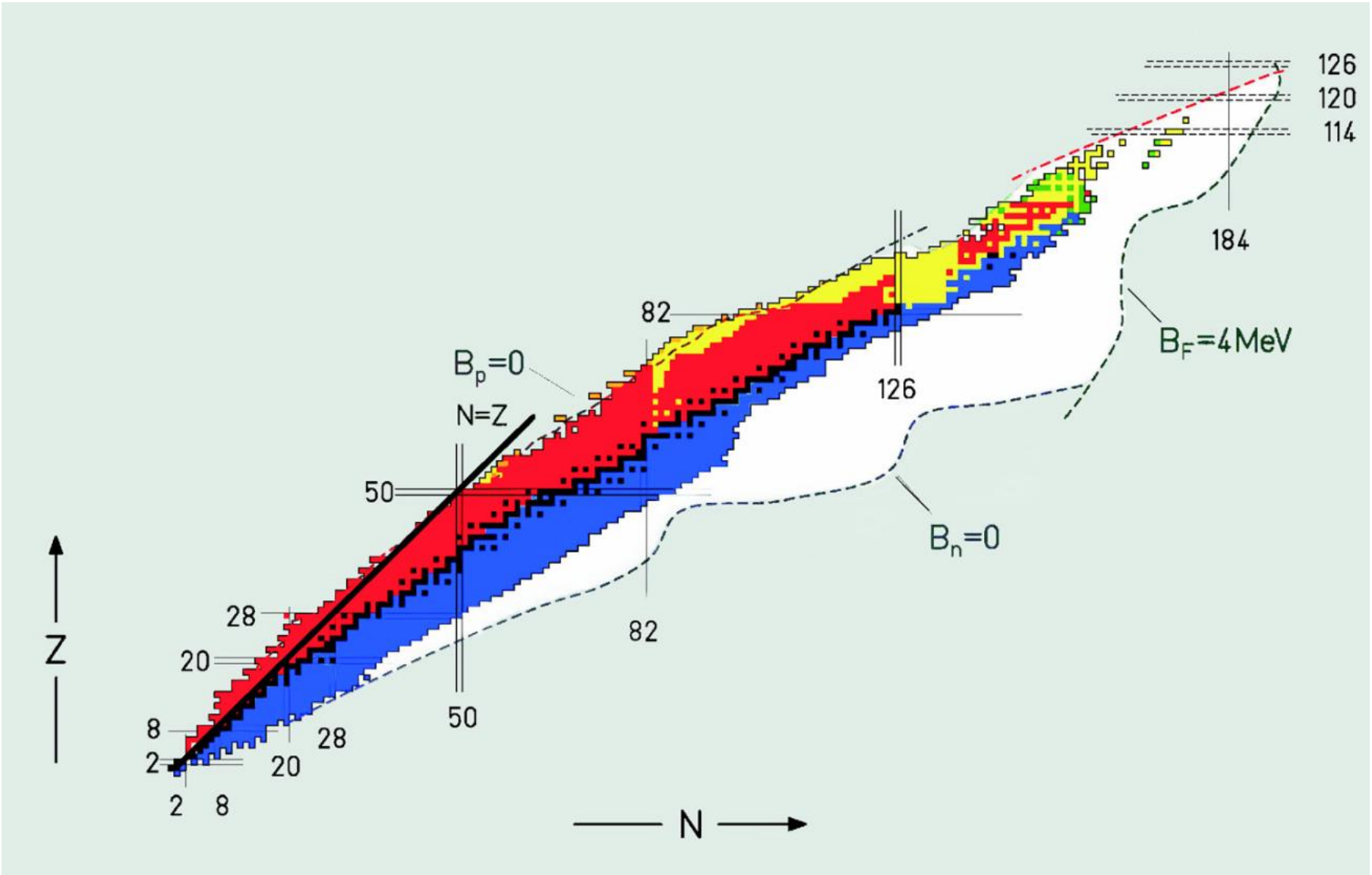
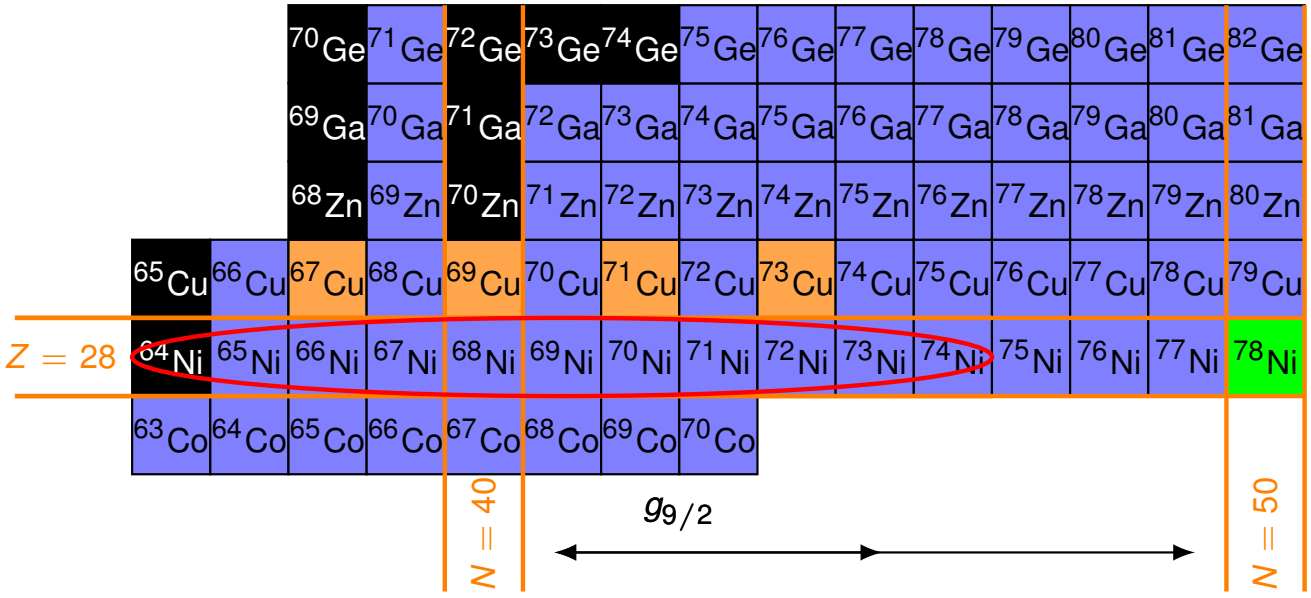
HINP Workshop, Ioannina 8 Sep 2012


126
120
114
184
82
126
B_p=0
N=Z
B_F=4MeV
50
B_n=0
28
20
82
8
2
28
20
50
2
8
Z
N

The N=40-Region



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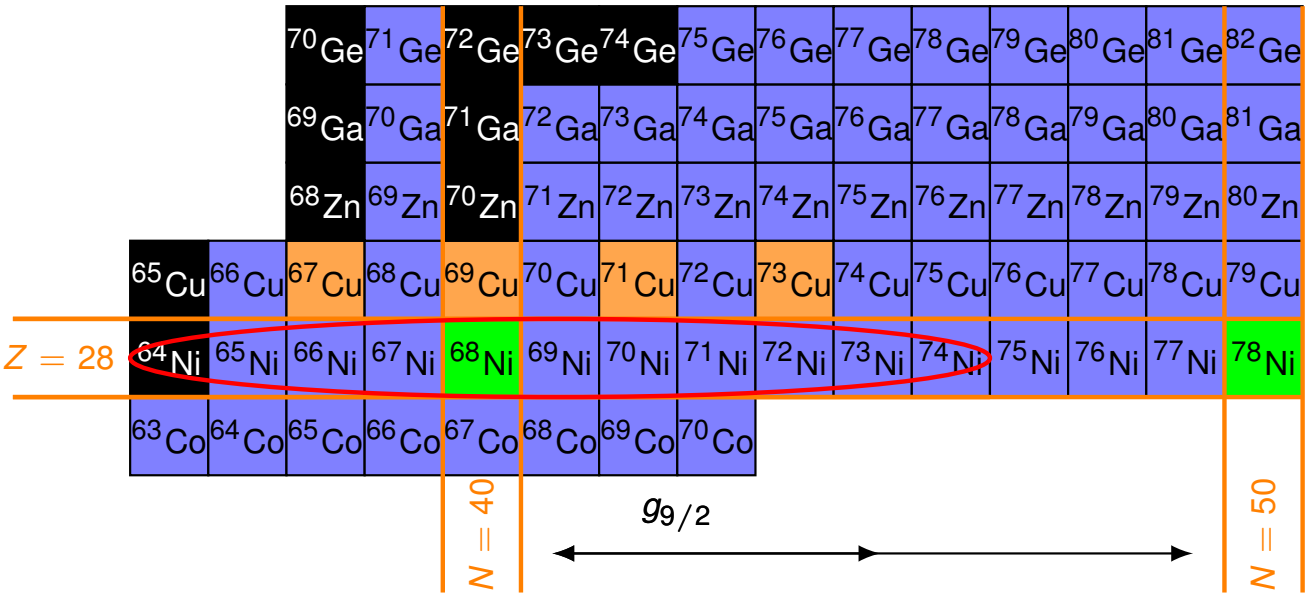
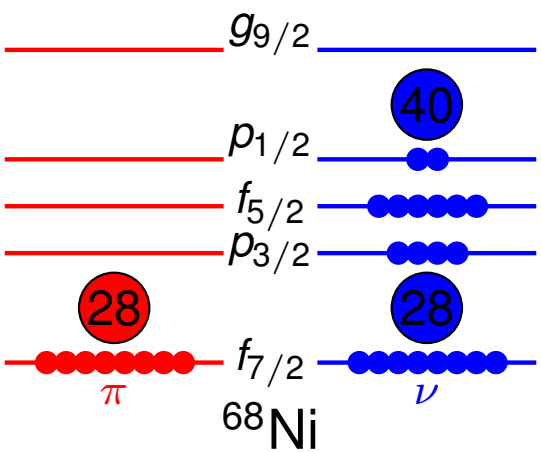
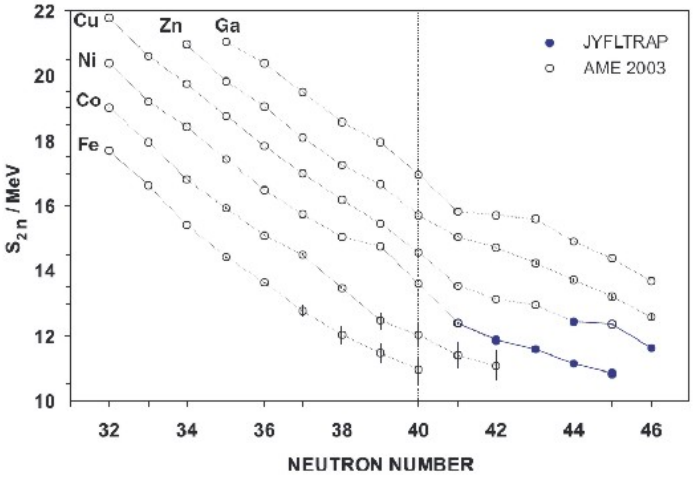
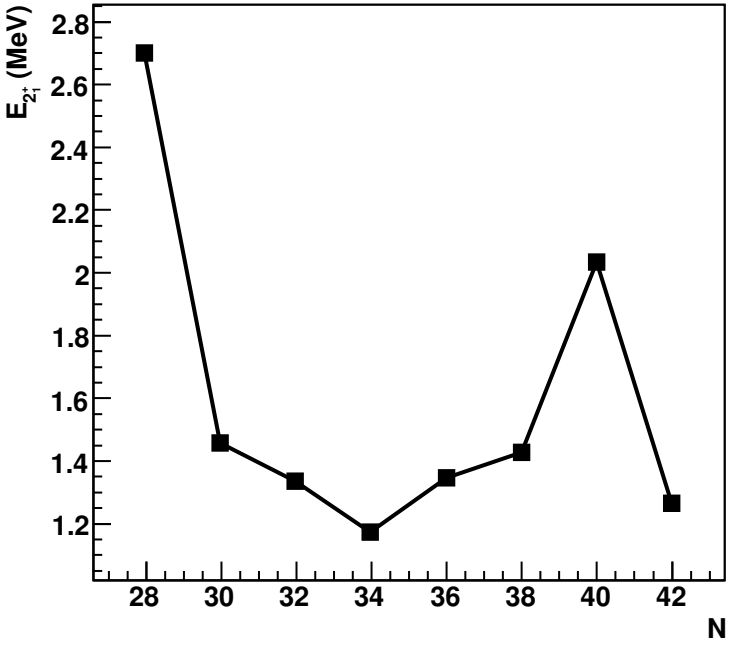


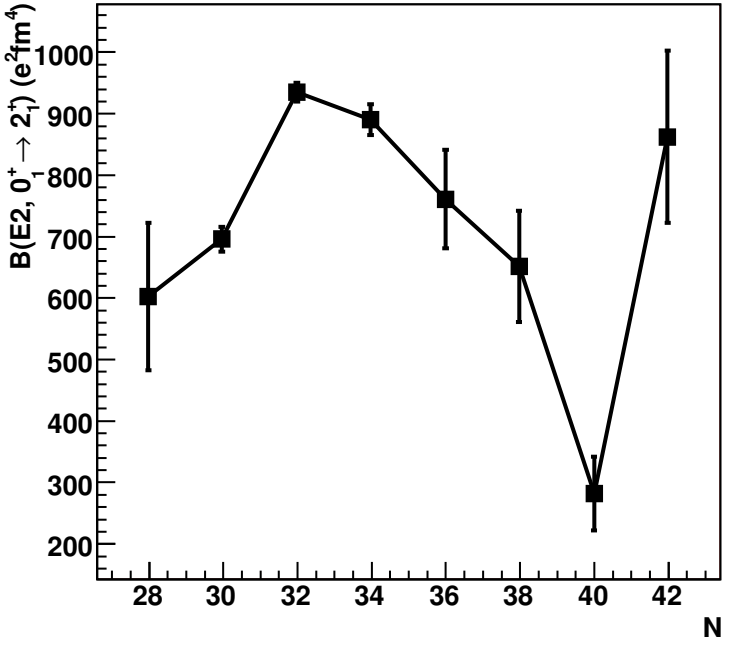


Results up to now

- The 2^+ state at higher excitation energy
- Small B(E2,$0^+ \rightarrow 2^+$)
- No irregularity around N=40 at S_{2n}
- Fragile nature of the N=40 subshell closure
- Other reasons $\neq$ magicity

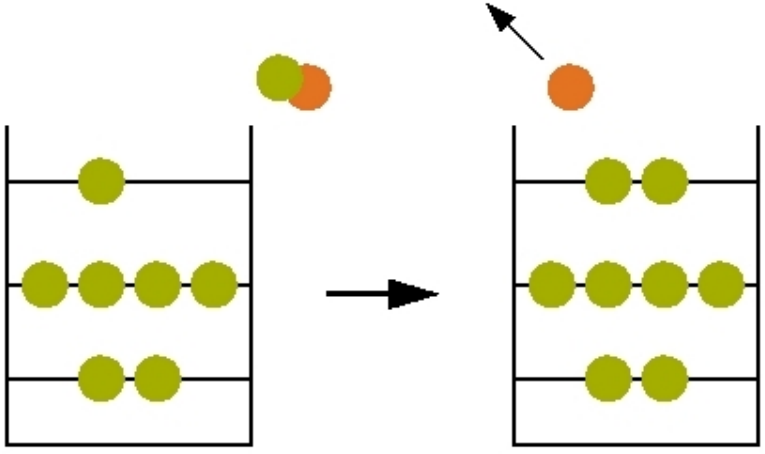




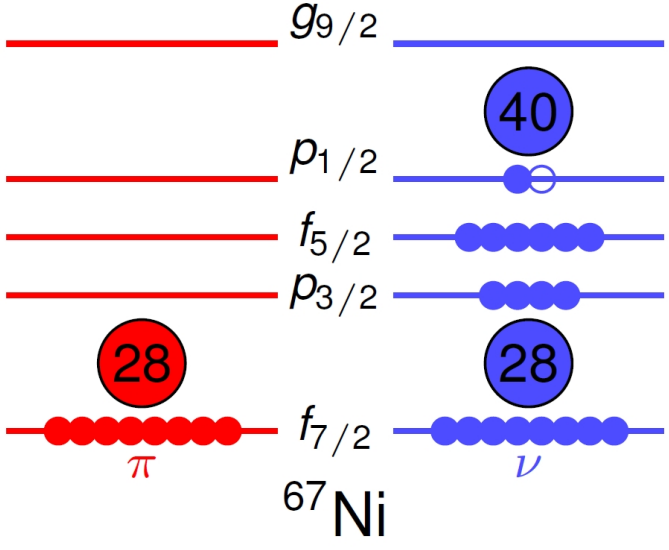


Spectroscopic information from transfer reactions.

- Excitation energies of populated states
- Angular distribution: momentum transfer
- Relative population: spectroscopic factors



Physics case: ^{66}Ni(d,p)^{67}Ni



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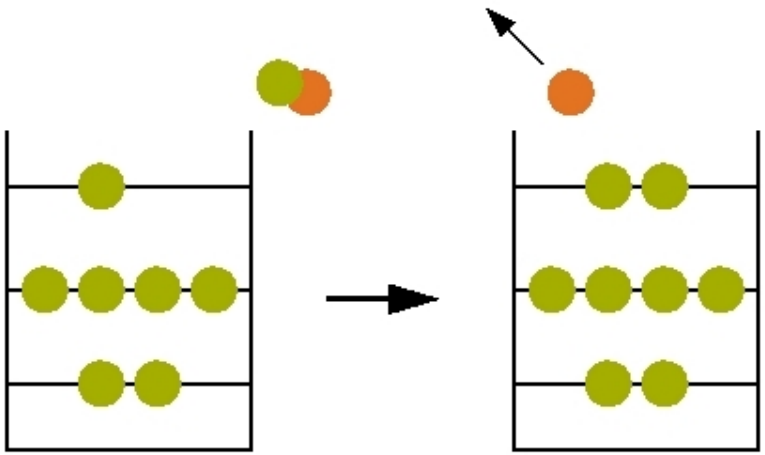

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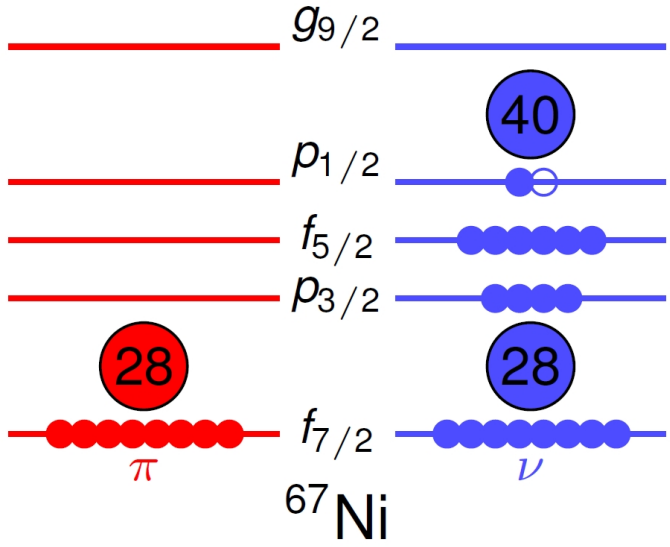

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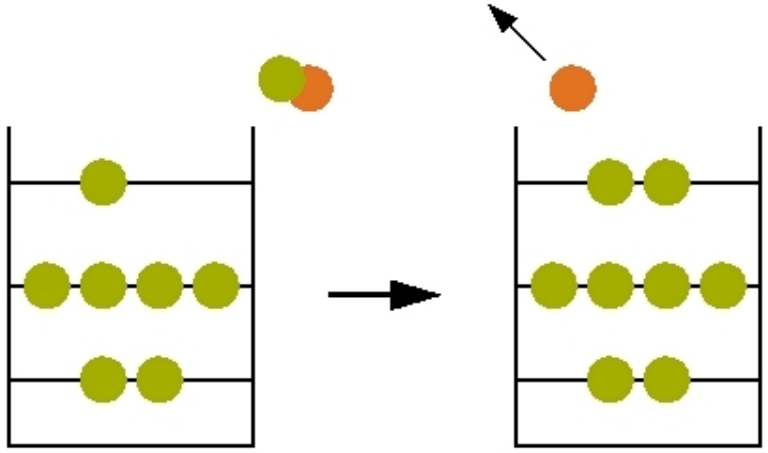

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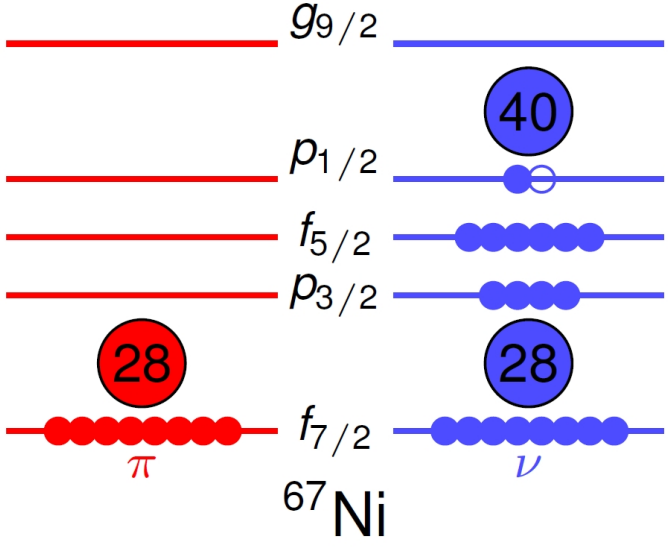
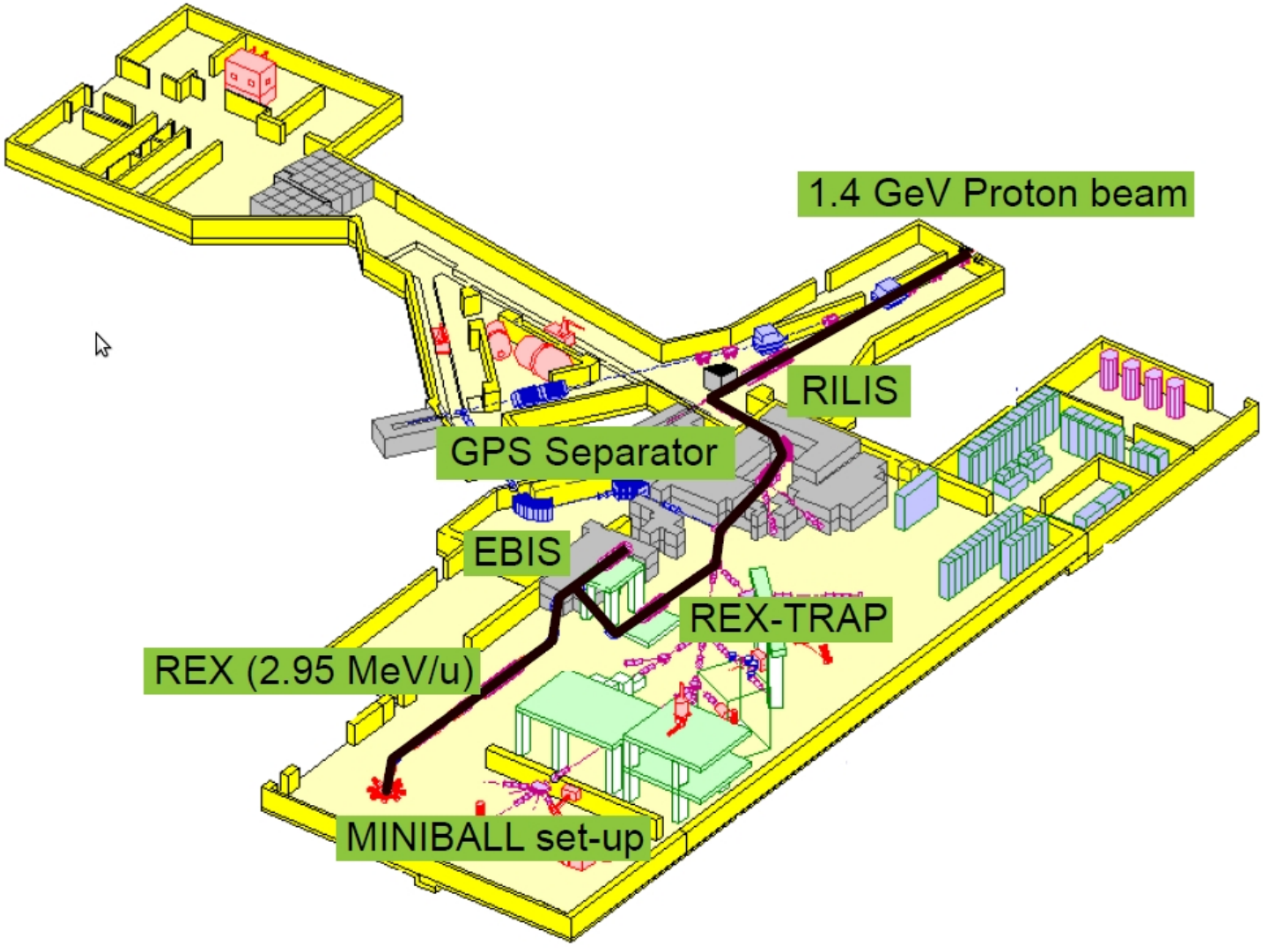
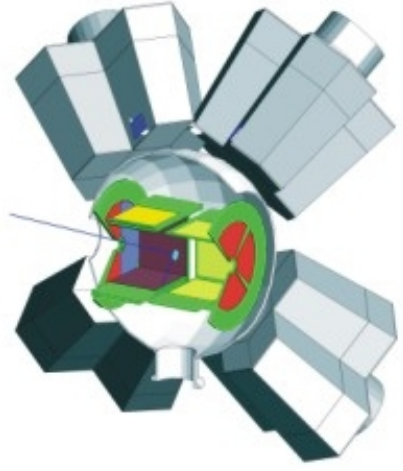


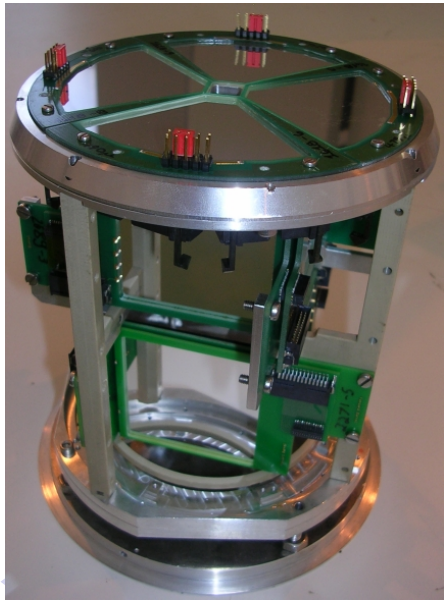


- Beam purity > 95 %
- Beam intensity > 10^6 pps

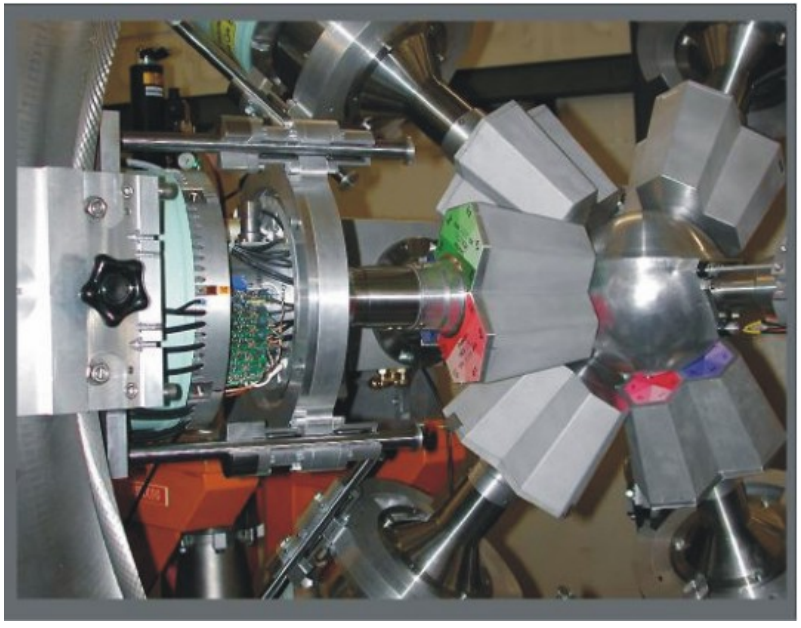
T-REX setup

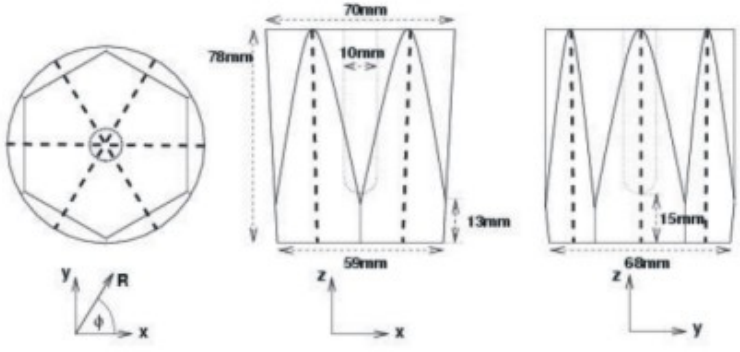
Detector	Thickness	Segmentation
Forw. ΔE barrel	140 μm	16 resistive stripes $\perp$ beam
Forw. E Barrel	1 mm	-
Backw. ΔE Barrel	140 μm	16 resistive stripes $\perp$ beam
Backw. E Barrel	1 mm	-
Backw. ΔE CD	500 μm	16 annular. $\times$ 24 radial
Backw. E CD	1.0 mm	-
(Forw. ΔE CD)	500 μm	16 annular. $\times$ 24 radial
(Forw. E CD)	1.5 mm	-





The MINIBALL setup

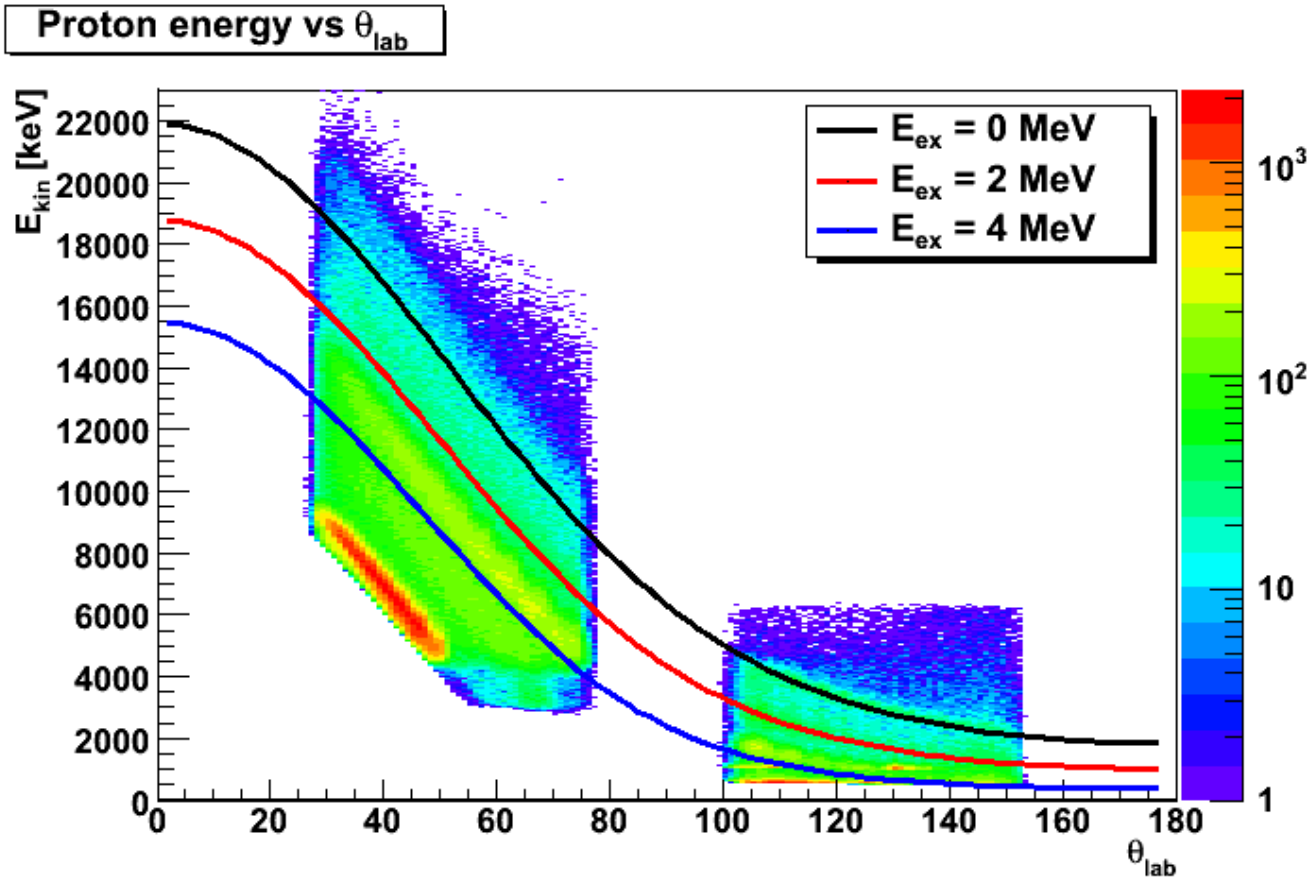




Main characteristics

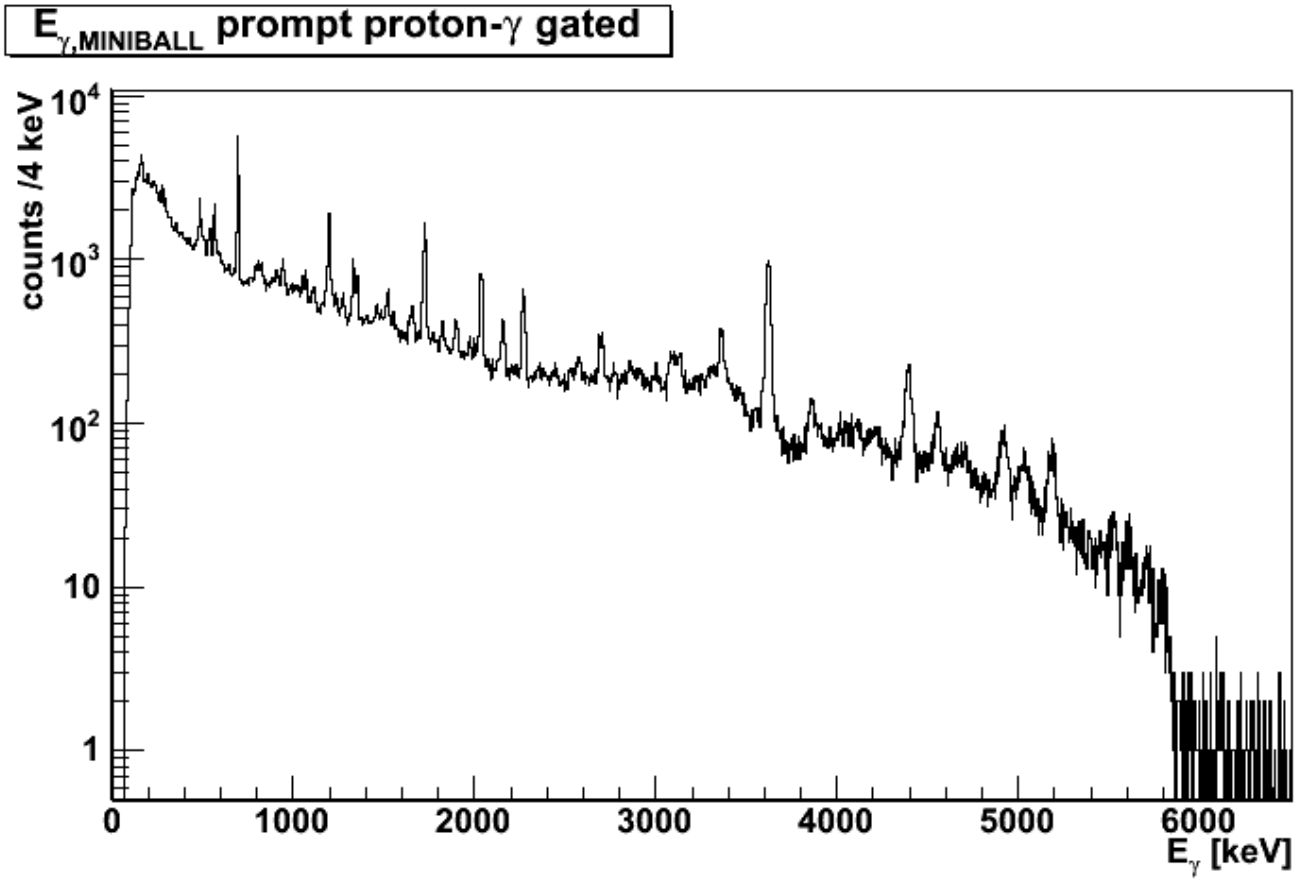
- 8 Miniball clusters
- Each cluster: 3 HPGe crystals
- Each crystal: 6-fold segmented
- 8% efficiency @ 1 MeV

protons detected from T-REX



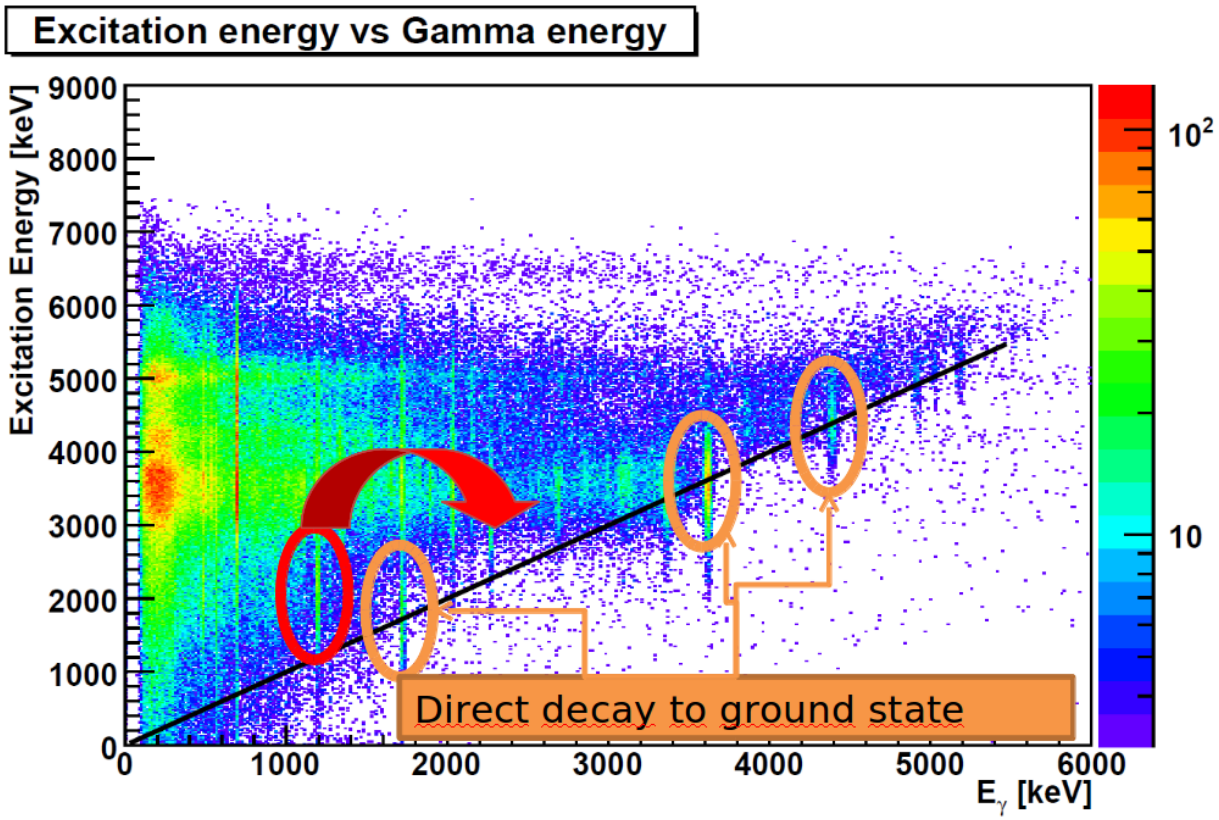
- Population of levels up to 6 MeV, strong feeding around 3.6 MeV
- ^{67}Ni excitation energy can be deduced from measured proton energy

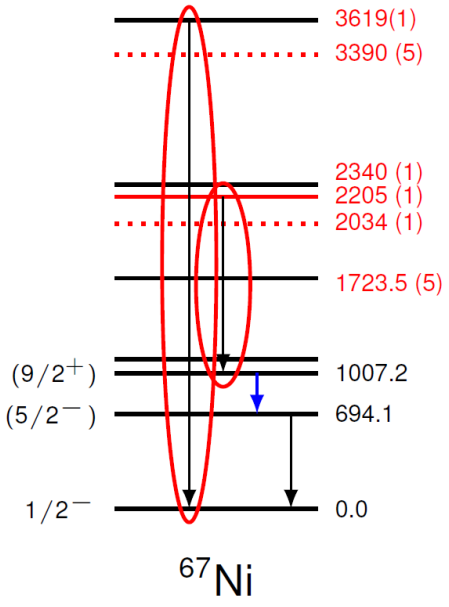
Doppler corrected γ-spectrum



- Very rich proton-gated γ-spectrum
- γ-transitions up to 5700 keV are observed
- p-γ-γ analysis was feasible

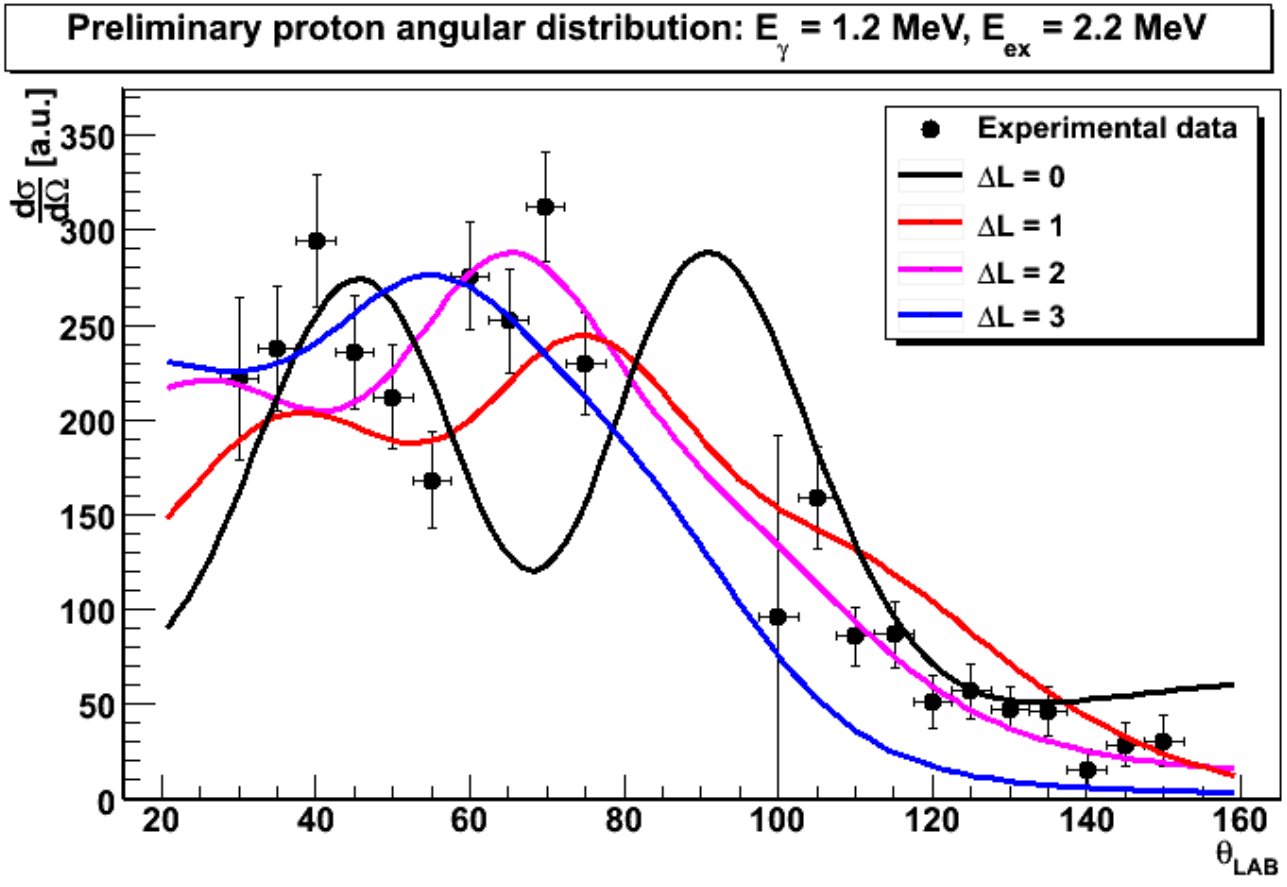
Excitation energy vs γ-energy





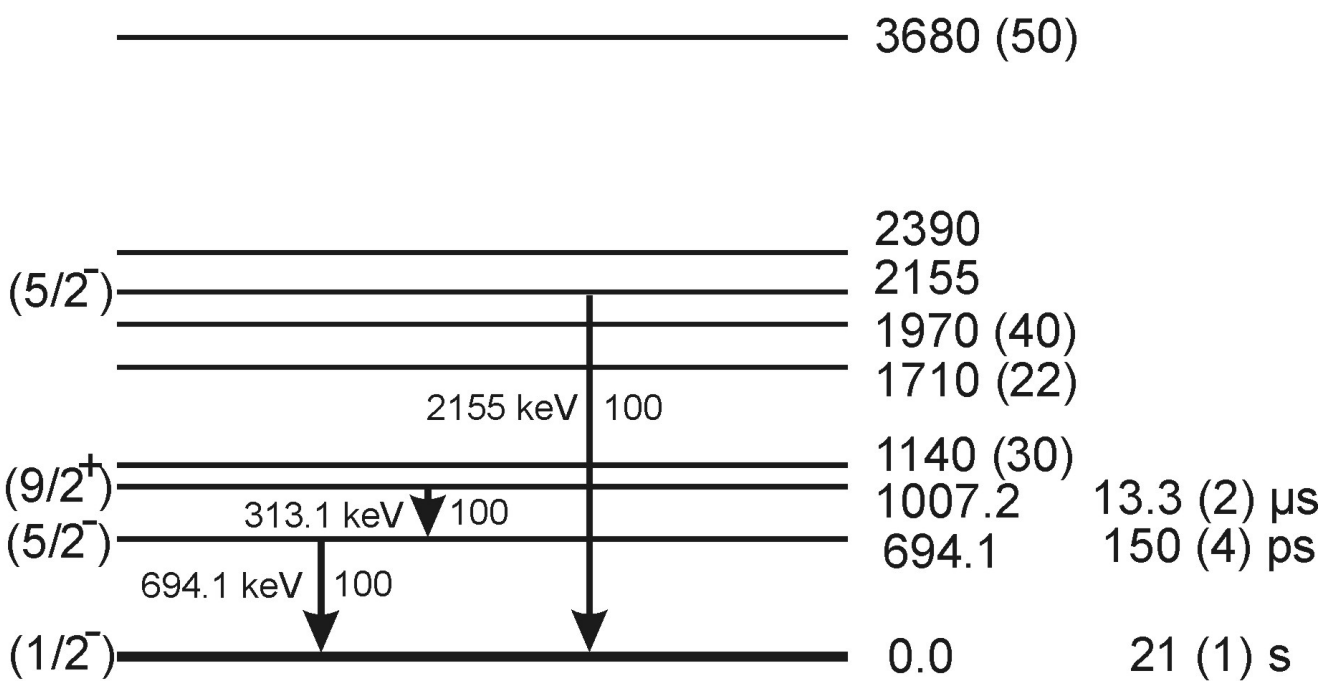
- Extensively new spectroscopic information of ^{67}Ni

Proton angular distributions

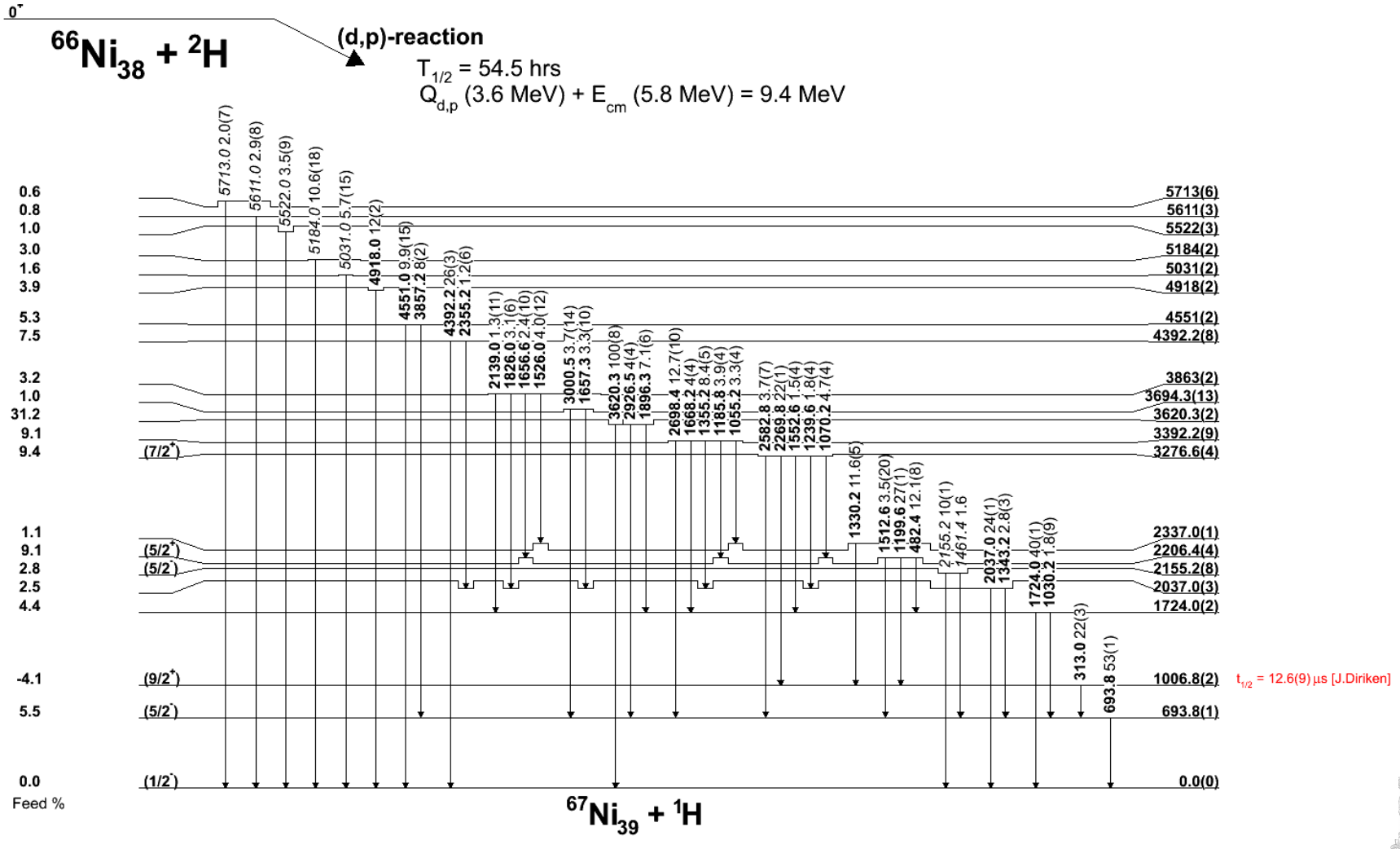


- Preliminary angular distribution for the 2.2 MeV state
- Slightly supporting L=2 transfer (hence d5/2 candidate)

Previously known levels for ^{67}Ni



Deduced Level scheme for ^{67}Ni



Conclusions and outlook

- **The first one-neutron transfer experiment around ^{68}Ni using T-REX and MINIBALL @ REX-ISOLDE was successful**
- **Population of excited states up to 6 MeV**
- **Extended new spectroscopic information is already deduced**
- **Analysis on spectroscopic factors has to be finalized**
- **Comparison with theoretical shell model calculations**

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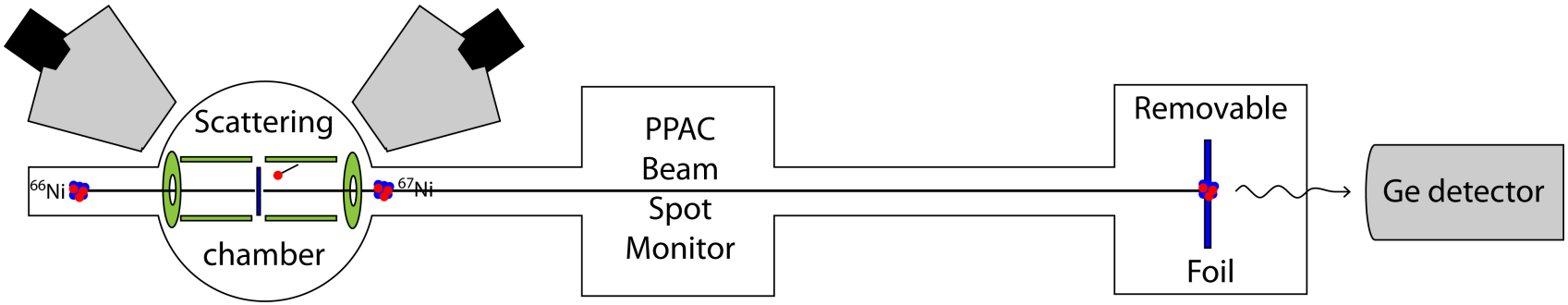
The IS-469 Collaboration

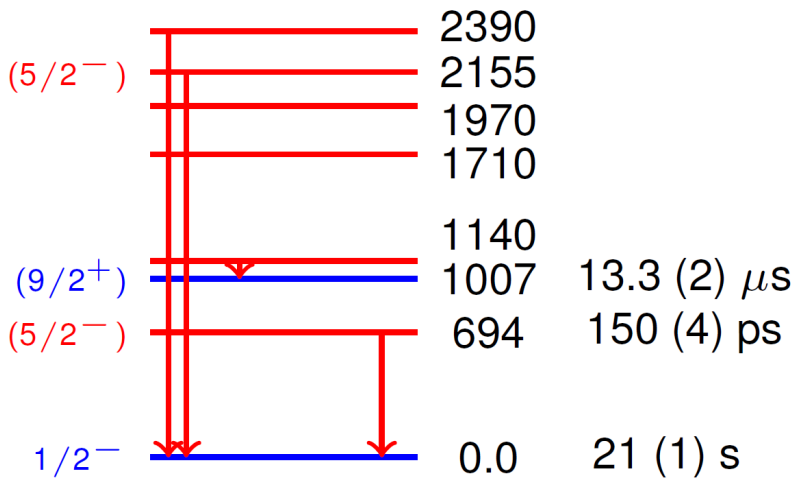
- **University of Ioannina**: N. Patronis, A. Pakou
- **IKS, K.U. Leuven**: J. Diriken, I.G. Darby, H. De Witte, J. Elseviers, M. Huyse, R. Raabe, T. Roger, P. Van Duppen
- **TUM, München**: K. Wimmer, V. Bildstein, R. Krücken
- **IKP, Darmstadt**: Th. Kröll
- **CERN, ISOLDE**:J. Pakarinen, J. Van de Walle, D. Voulot, F. Wenander
- **CNSM, Orsay**: G. Georgiev, C. Sotty, H. Tornqvist
- **IKP, Cologne**: A. Blazhev, Ch. Fransen, H. Hess, J. Jolie, P. Reiter, M. Seidlitz, N. Warr
- **Democritos, Athens**: T.J. Mertzimekis
- **UWS, Paisley**: A. Andreyev, R. Orlandi
- **Comenius University Bratislava**: A. Antalic

The slow coincidence setup

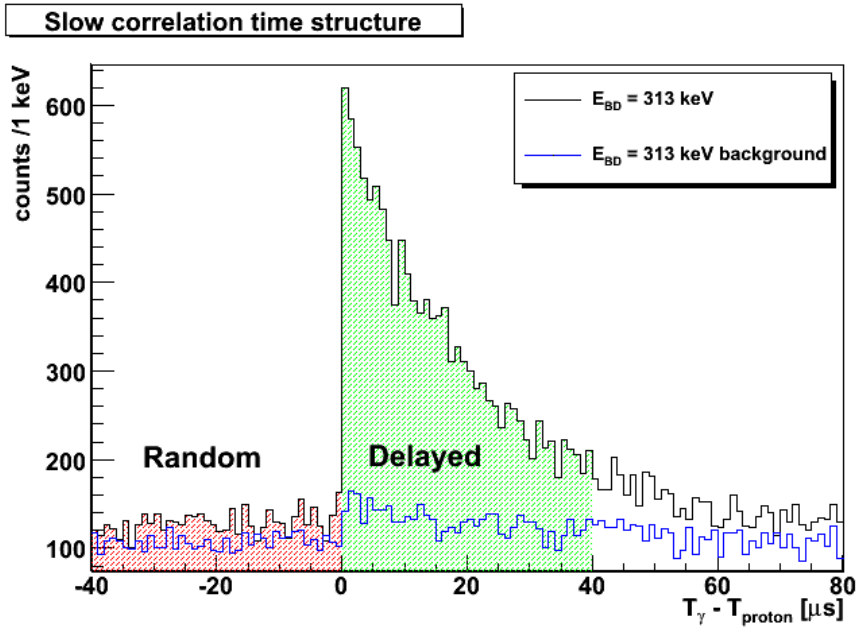


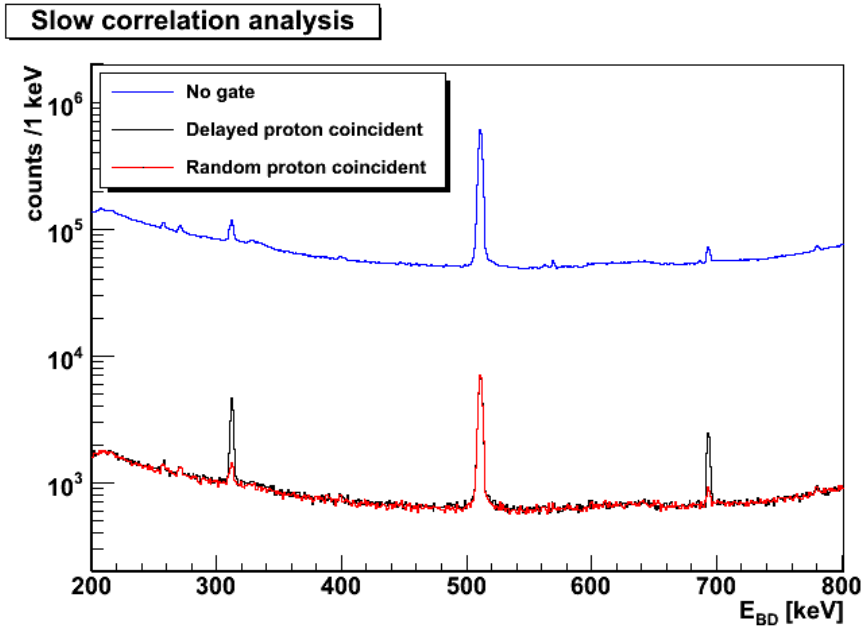
Why slow correlation?

- correlation of longer time-scale (40 μs) with protons
- identify population of (9/2$^+$) isomeric state

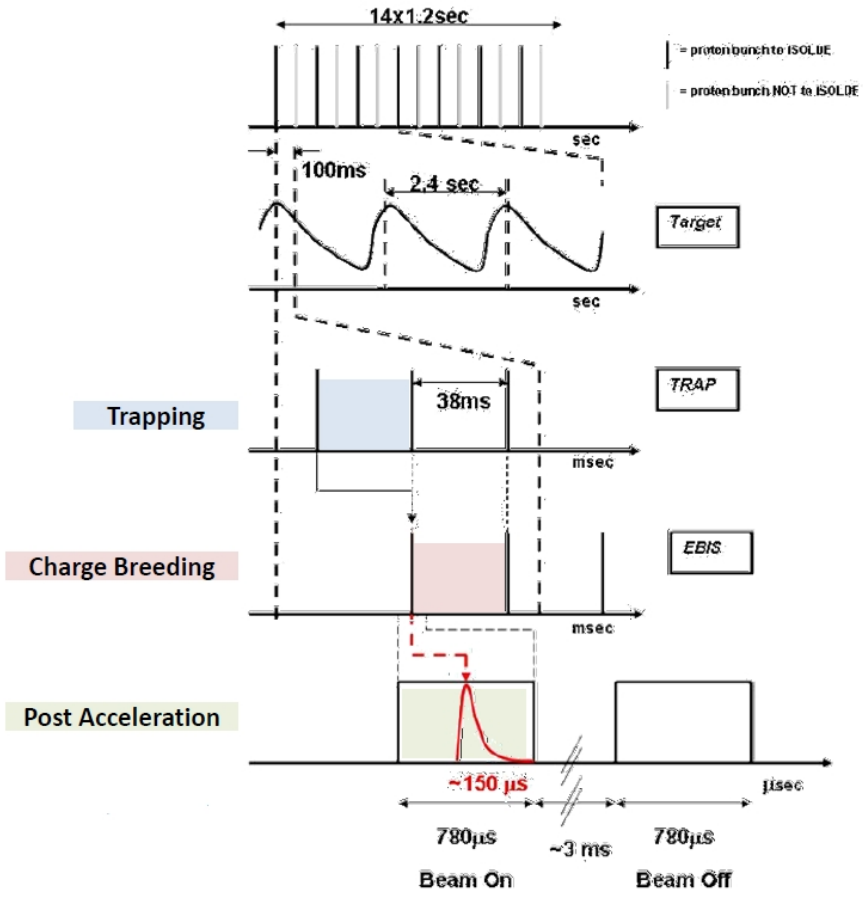


Slow correlation: Beam Dump γ-ray spectrum



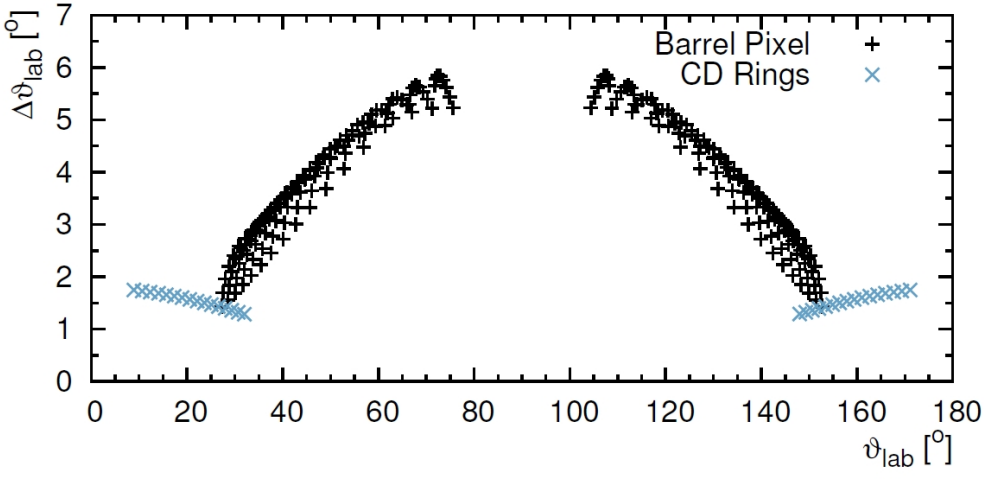


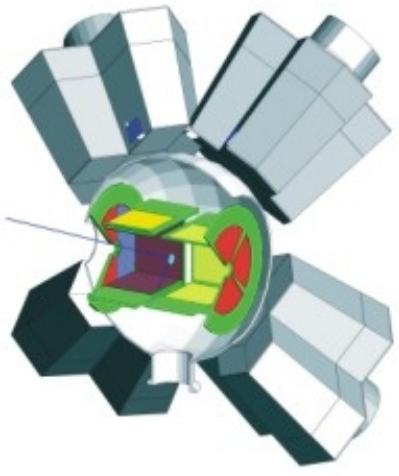
REX-ISOLDE beam time structure

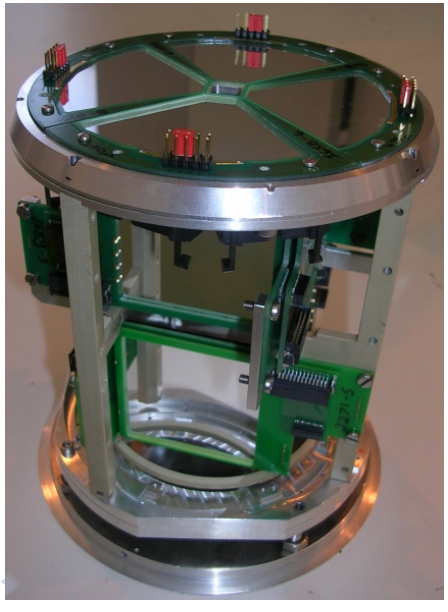


Running conditions

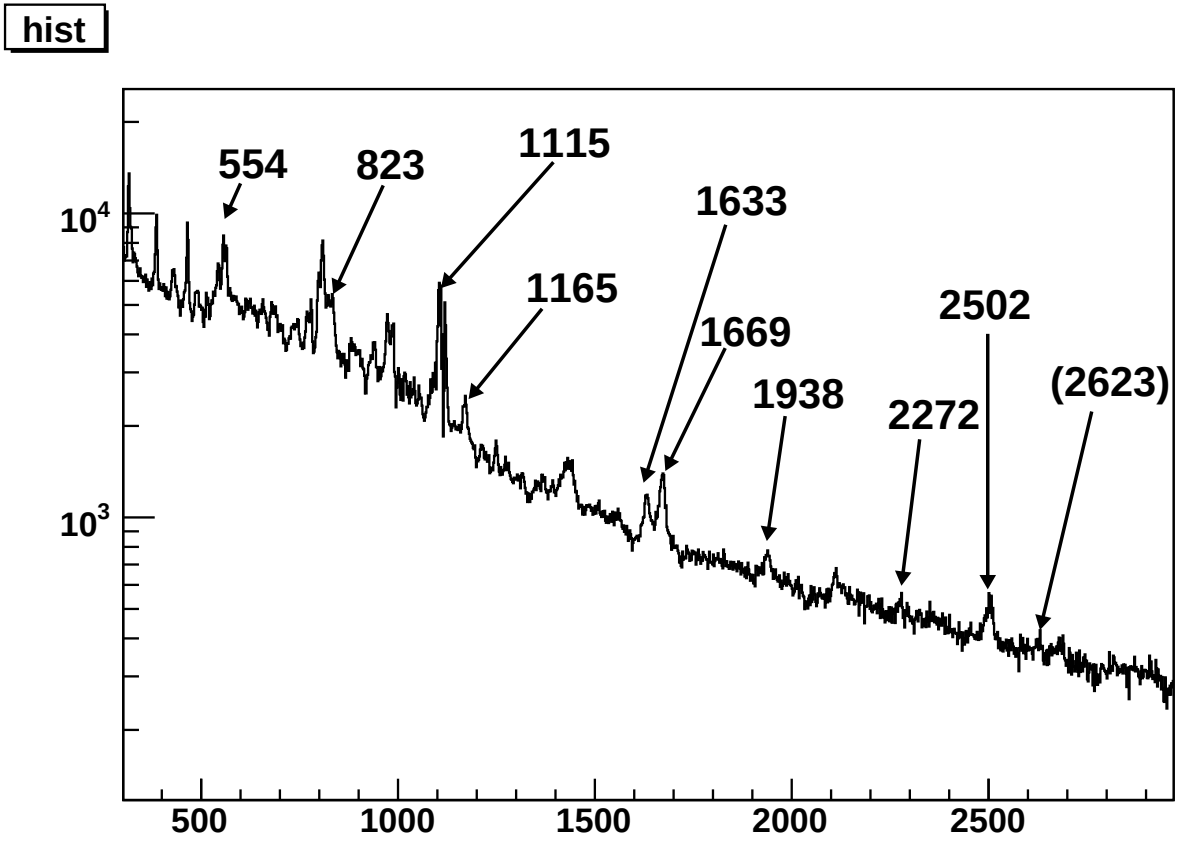
- CD_2 Target thickness: only 100 μgr/cm^2!
- Beam purity > 95 %
- Beam intensity > 10^6 pps %



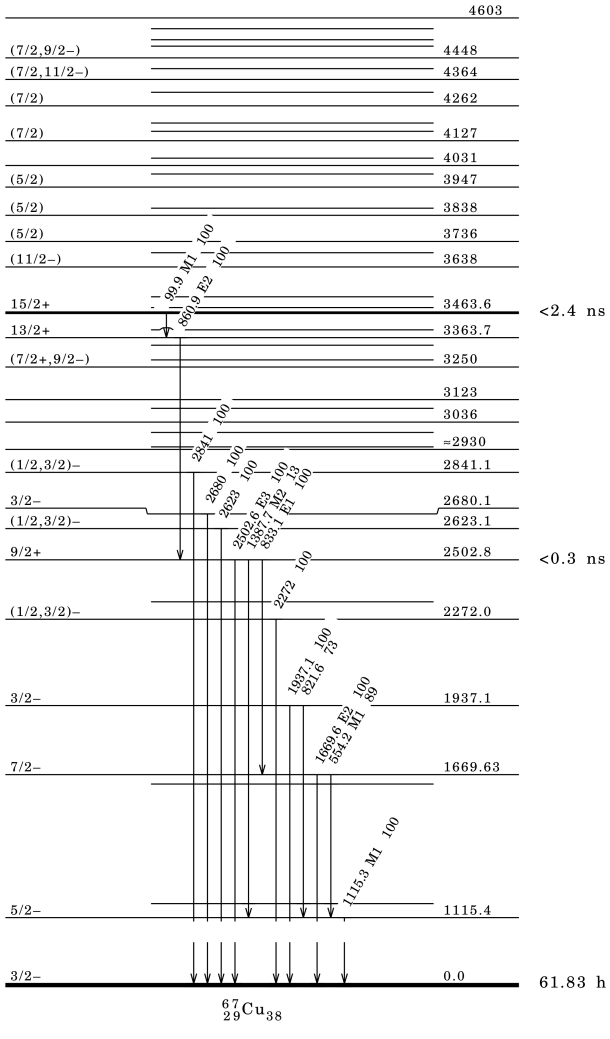


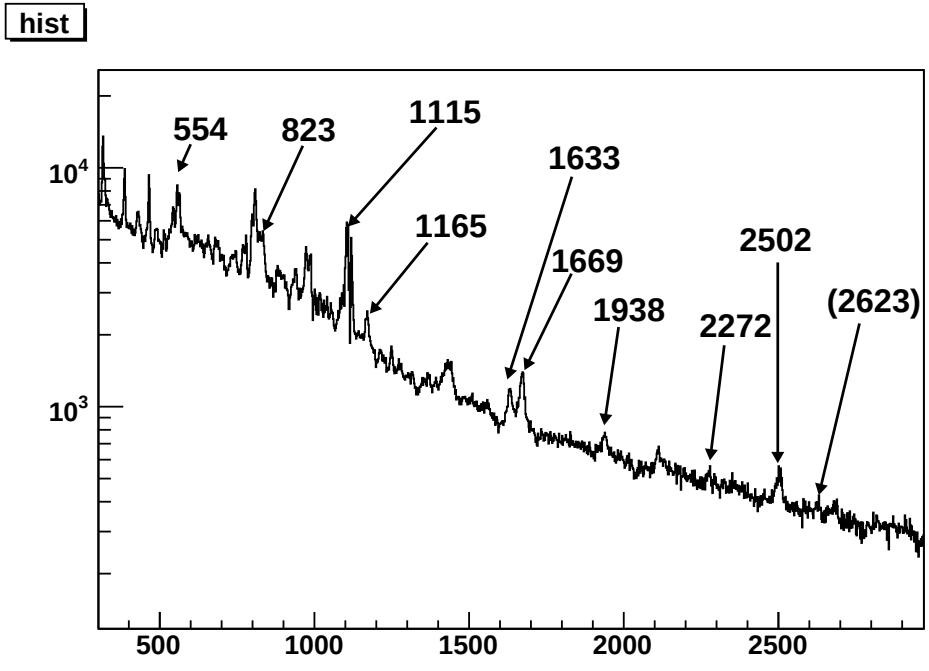


Study of other reaction channels

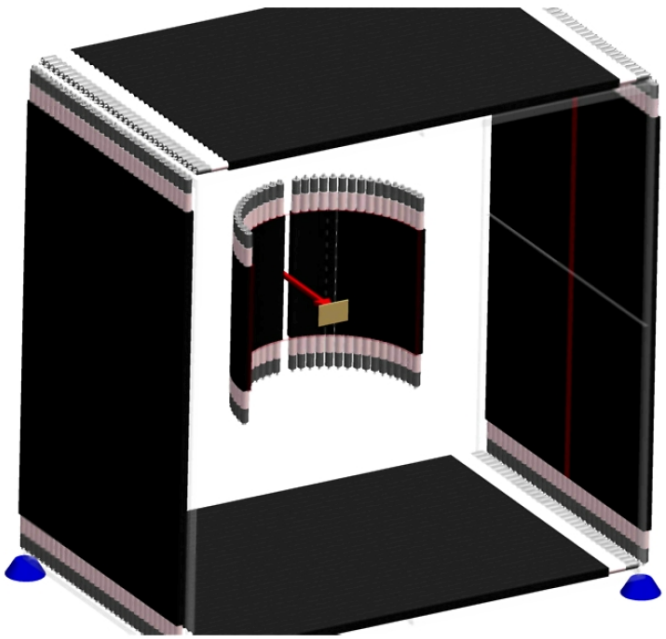


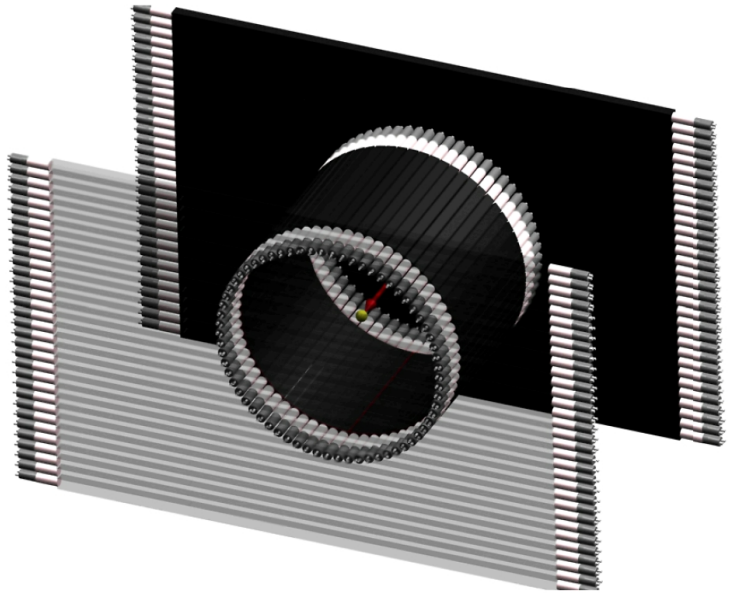
^{66}Ni(d,n)^{67}Cu


4603
(7/2,9/2−) 4448
(7/2,11/2−) 4364
(7/2) 4262
(7/2) 4127
4031
(5/2) 3947
(5/2) 3838
(5/2) 3736
(11/2−) 3638
15/2+ 3463.6 <2.4 ns
13/2+ 3363.7
(7/2+,9/2−) 3250
3123
3036
≈2930
(1/2,3/2)− 2841.1
3/2− 2680.1
(1/2,3/2)− 2623.1
9/2+ 2502.8 <0.3 ns
(1/2,3/2)− 2272.0
3/2− 1937.1
7/2− 1669.63
5/2− 1115.4
3/2− 0.0 61.83 h
99.9 M1
860.9 E2
2841
2680
2623
2502.6 E3
1357.7 M2
833.1 E1
2272
1937.1
821.6
1669.6 E2
554.2 M1
1115.3 M1
$^{67}_{29}Cu_{38}$


hist
10^4
10^3
554
823
1115
1165
1633
1669
1938
2272
2502
(2623)
500
1000
1500
2000
2500

Large Area Neutron Detection Setup





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