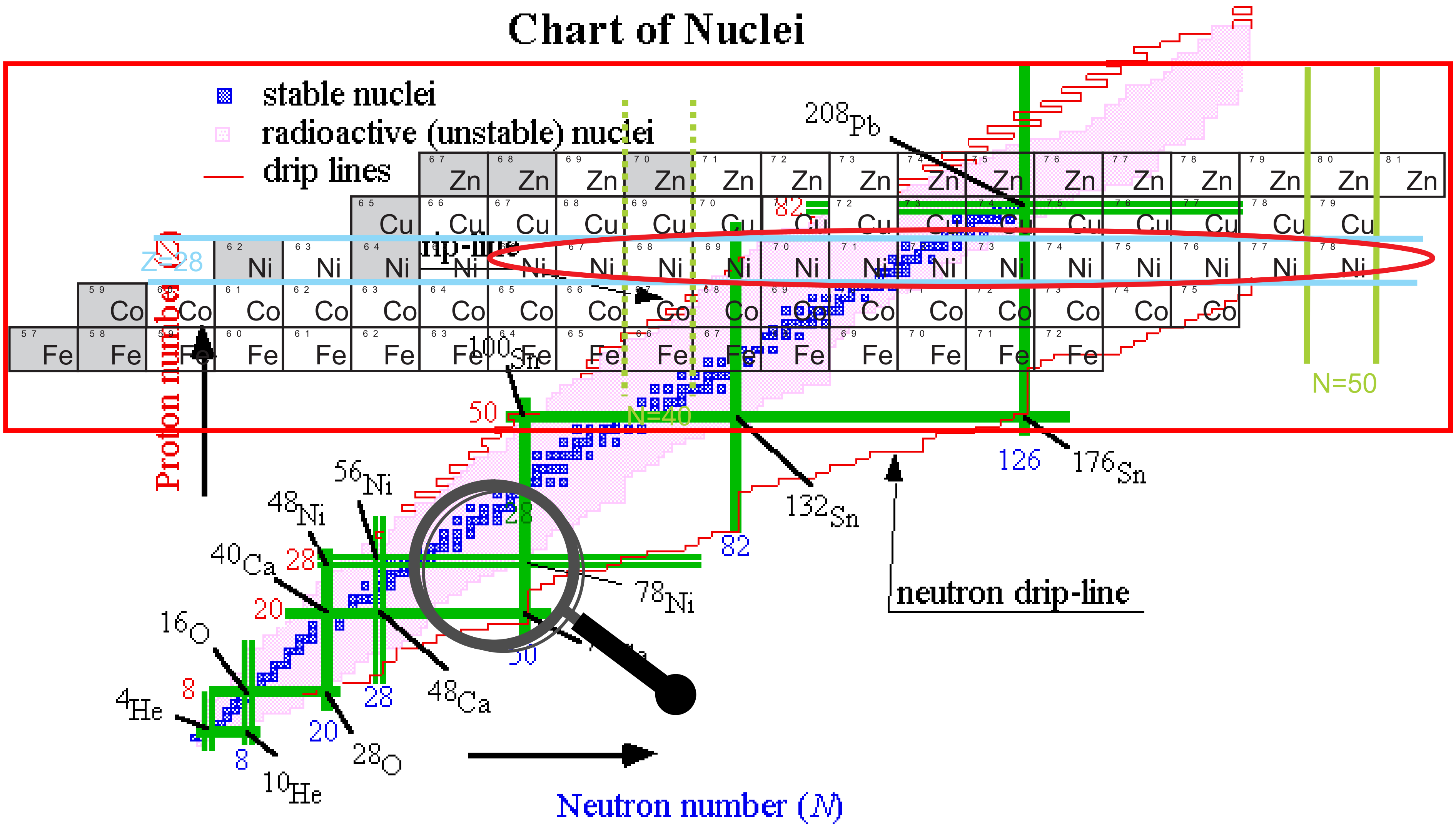
One Nucleon Transfer Reactions Around ^{68}Ni at REX-ISOLDE

Nikolas Patronis

1. Outline

- **Physics case:**
  - Region of interest
  - Why to study the $^{66}Ni(d,p)^{67}Ni$
- **Experimental method & set-up:**
  - Newly built Si detector barrel configuration
  - Technique
- **Beam time request:**
  - Considerations
  - Expected counting rate

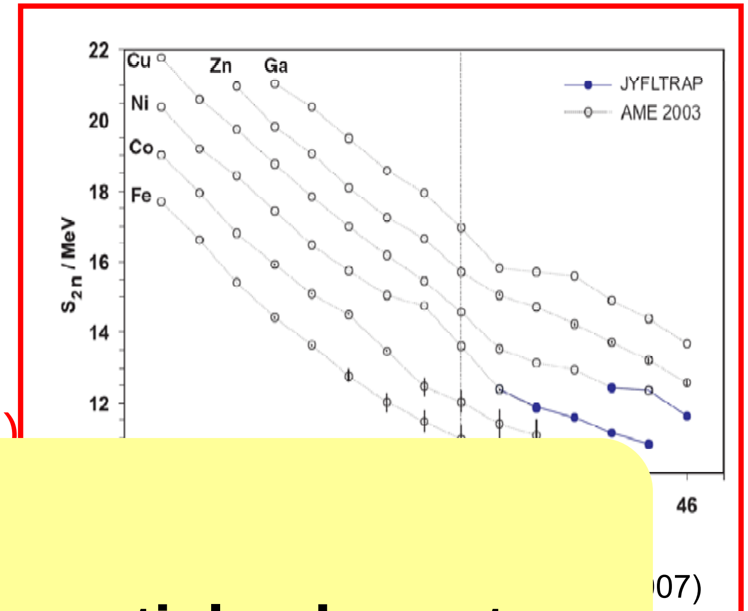
2. Physics case

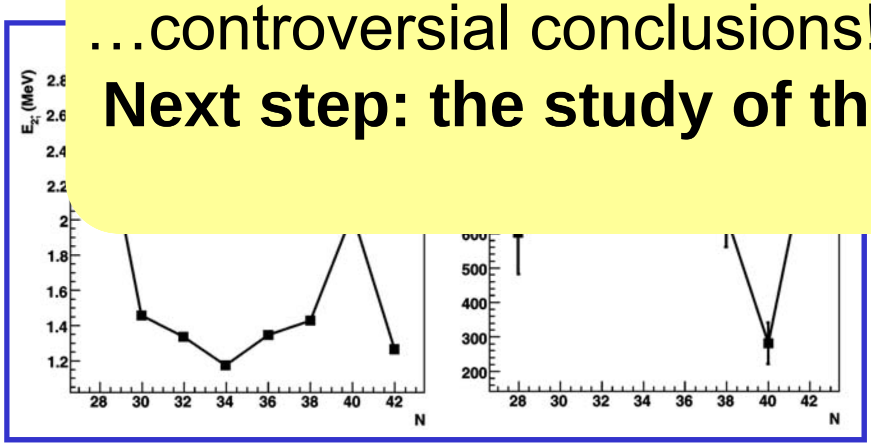


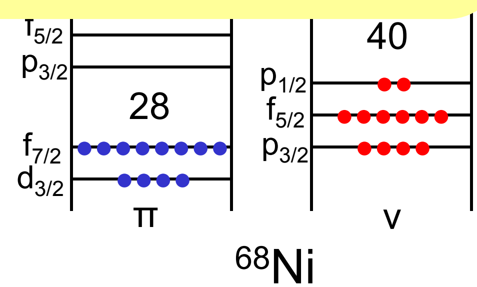
2. Physics case

Is the nature of the N=40 subshell closure understood?

- First excited state 0^+ at higher energies
- The 2^+ state at larger excitation energy
- Small $B(E2, 0^+ \rightarrow 2^+)$
- No irregularity at the S_{2n} or at the binding energies
- Fragile nature of the N=40 subshell closure
- Other reasons for the small observed $B(E2, 0^+ \rightarrow 2^+)$







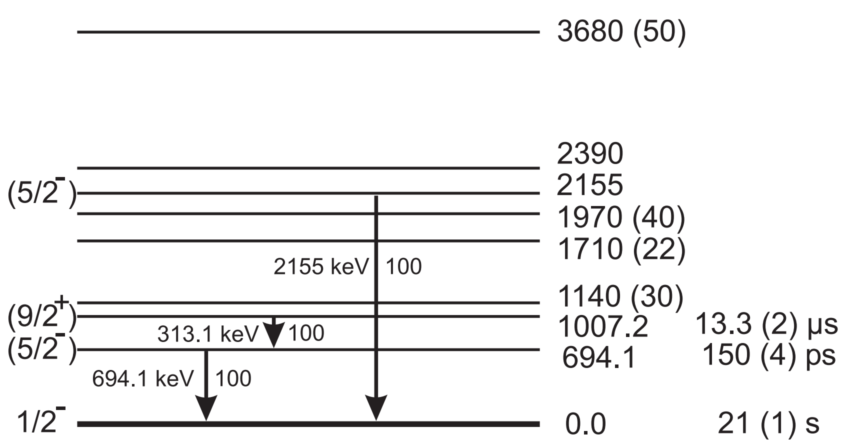
…controversial conclusions!

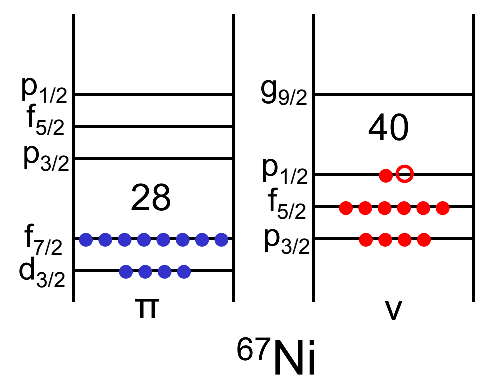
Next step: the study of the single particle character

2. Physics case

Study of the single particle character of the neutron rich Ni isotopes
Physics case: $^{2}H(^{66}NI,p)^{67}Ni$,Q = 3.583 MeV

- $^{67}Ni^{g}$ one hole state of the ^{68}Ni
- g factor exp. value smaller by a factor of 2 than the expected for $1g_{9/2}$
- Unambiguous determination of the spin and parities of the the first excited states - one more state $\nu_{3/2}$ not yet observed
- Single particle character of the states of ^{67}Ni (relative SF's)
- A good starting point as to determine the single particle character of the Ni isotopic chain – single particle systematics

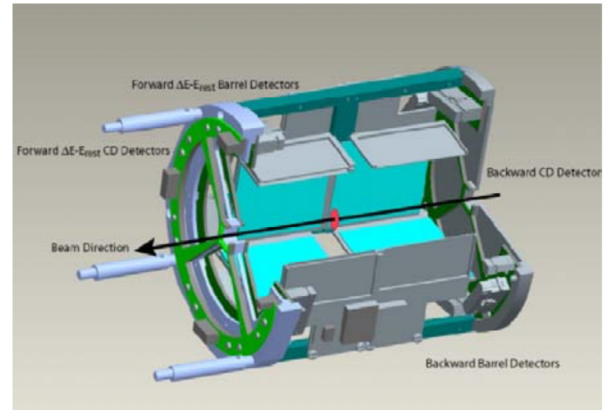




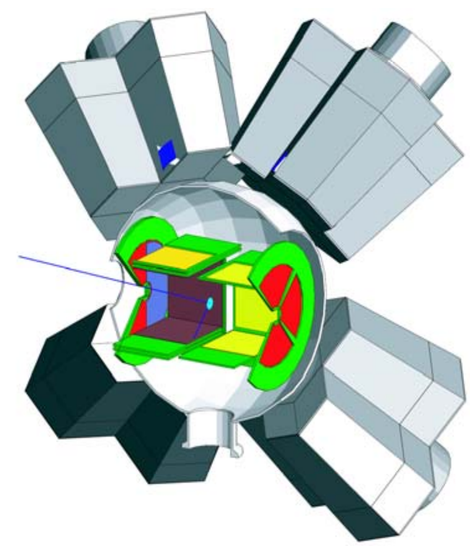
3. Experimental method & setup

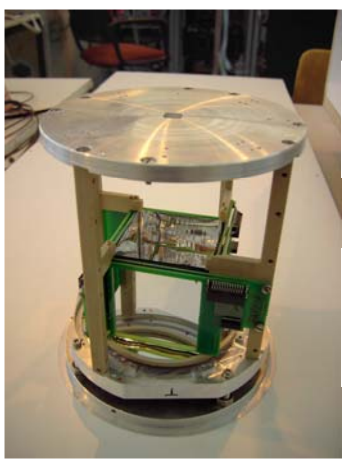
- Particle detection:

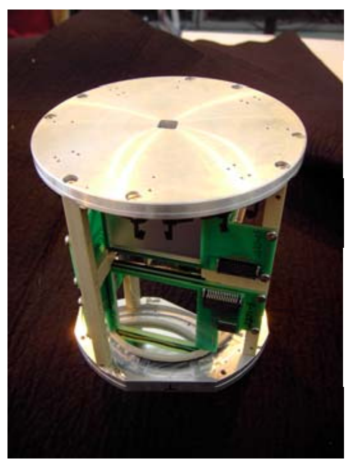
Detector	Angles	Thickness	Segmentation
Forw. CD (ΔE)	8-30	300 μm	16 annular x 24 radial
Forw. CD (E)	8-30	1.5 mm	no
Forw. Barrel (ΔE)	30-75	140 μm	16 stripes ⊥ beam + ch. Div resistive layer
Forw. Barrel (PAD)	30-75	1 mm	no
Back. Barrel	104-152	500 μm	16 stripes ⊥ beam + ch. Div resistive layer
Back. CD	152-172	500 μm	16 annular x 24 radial

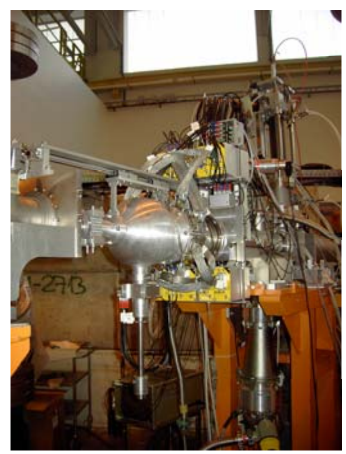


- γ-ray detection: 8 Miniball clusters (ε ~ 8 %)
- Beam composition: Bragg detector, HPGe detector, Laser on/off



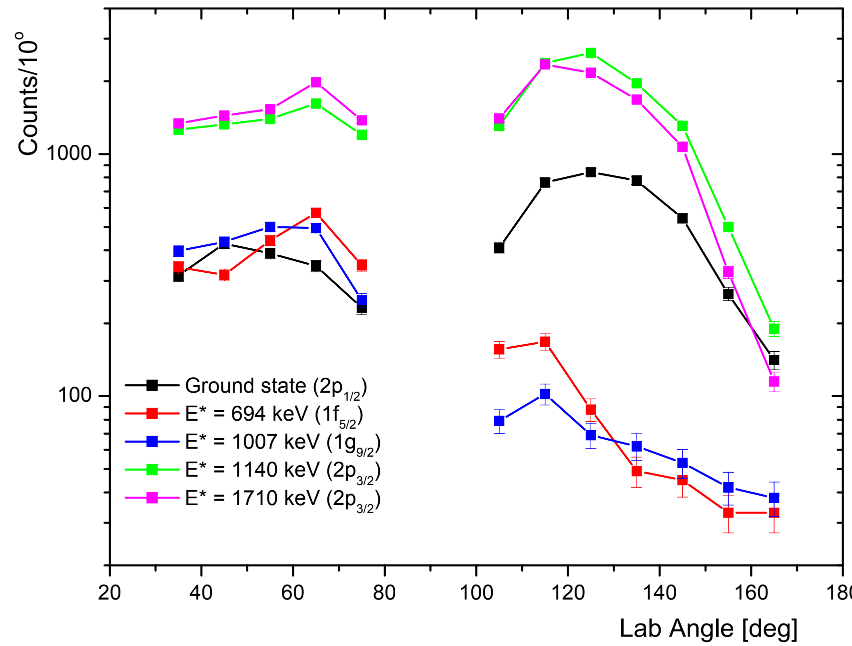


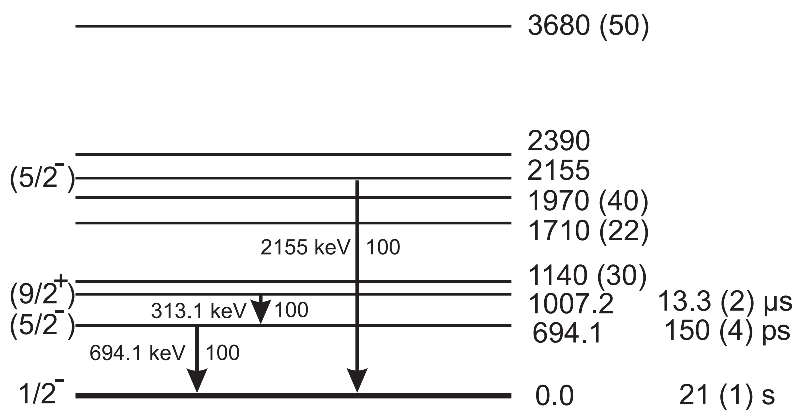


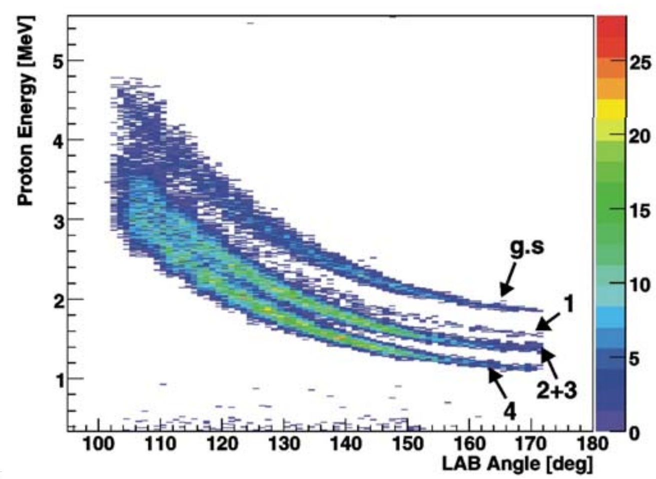


3. Experimental method & setup

- "Thick" CD_2 target measurement ($1 mgr/cm^2$)
  - Spectroscopic information for the excited states up to 3 MeV.
  - Coincidences with γ
- "Thin" CD_2 target measurement ($100 μgr/cm^2$)
  - Spectroscopic information for the ground and the second excited state.
  - Singles: only backward angles





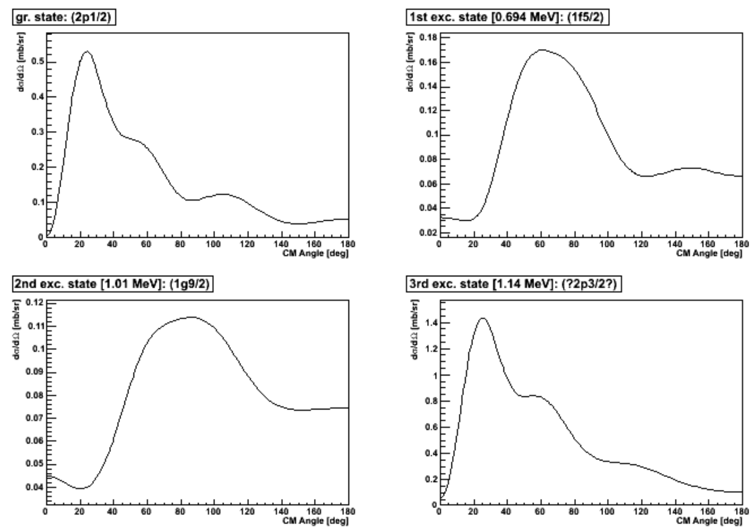


4. Beam time request

Counting rate:

Levels	Single particle state	Target ($\mu gr/cm^2$)	σ (mb)	events/h	Total number of events
ground	$2p_{1/2}$	1000	4.2	no p-γ coinc.	no p-γ coinc.
1	$1f_{5/2}$	1000	2.6	31	2700
2	$1g_{9/2}$	1000	2.2	no p-γ coinc.	no p-γ coinc.
3	$2p_{3/2}$	1000	13.4	160	14000
4	$2p_{3/2}$	1000	17	203	17800
ground	$2p_{1/2}$	100	4.2	62	5500
2	$1g_{9/2}$	100	2.2	32	2900
3	$2p_{3/2}$	100	13.4	200	17600

DWBA calculations



Considering:

- 10^6 pps at the MINIBALL target (ε_{REX} = 5%, Primary ISOLDE yield:1-3 10^7)
- ~ ε_{part} = 55 %, ε_{γ} = 8 %
- σ from DWBA assuming SF =0.2
- Requested beam time:

11 shifts for the “thick” target run
11 shifts for the “thin” target run
+3 shifts for beam preparation.

25 shifts in total

5. Summury

- **The properties of the nuclei in the mass region around ^{68}Ni have been extensively studied up to now with controversial results**
- **The fragile nature of the N=40 subshell closure is not yet understood**
- **We propose the study of the single particle properties starting with: d(^{66}Ni,p)^{67}Ni reaction**
- **Intense beam of ^{66}Ni is available at ISOLDE + Si barrel + MINIBALL**
  ⇒ REX-ISOLDE unique site to perform also transfer reaction studies
- **Spectroscopic information can be obtained for the ground and first excited states of ^{67}Ni. Also the relative SF will be directly compared with large scale shell model calculations**

Collaboration

Katholieke Univesiteit Leuven, Belgium

IPN Orsay, France

CSNSM, Orsay, France

Technische Universität München, Germany

Universität zu Köln, Germany

Technische Universität Darmstadt, Germany

Ludwig-Maximillians-Universität München, Germany

INP, NCSR “Demokritos”, Greece

Lund University, Sweden

CERN, Switzerland

University of Edinburgh, United Kingdom

University of Liverpool, United Kingdom

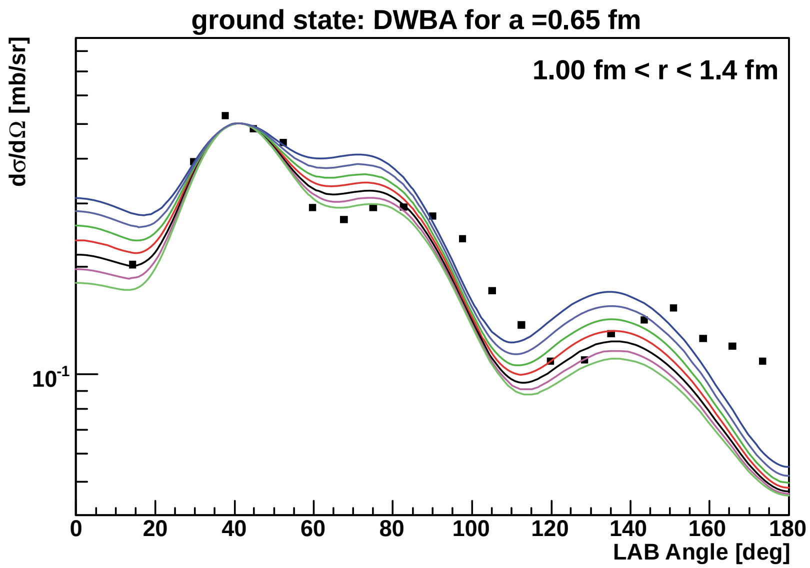
University of Manchester, United Kingdom

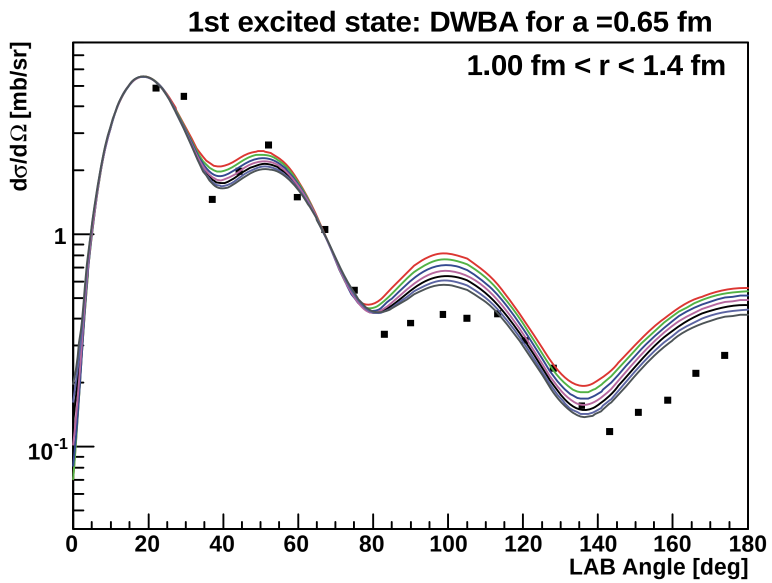
University of Paisley, United Kingdom

University of York, United Kingdom

THANK YOU

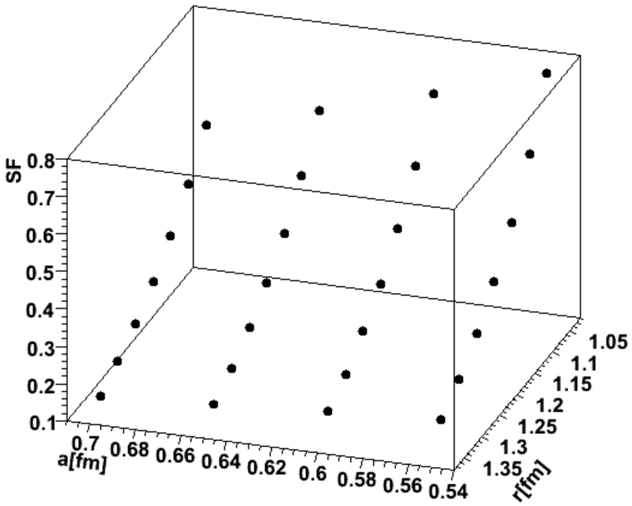
Sensitivity study of SF by changing the single particle potential parameters

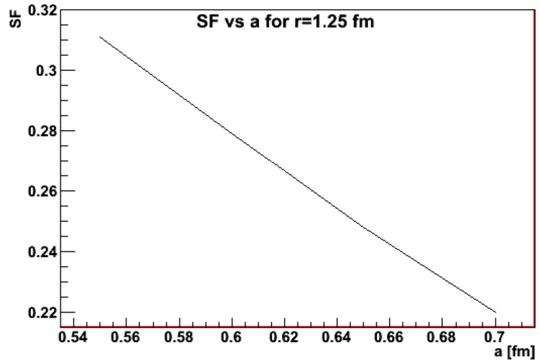


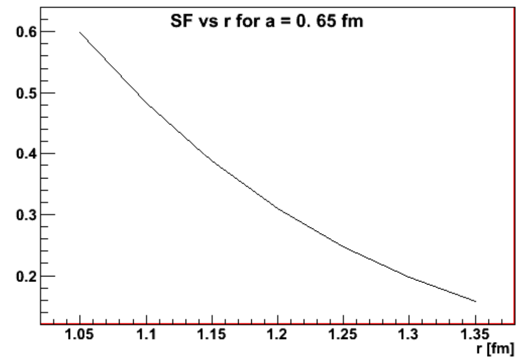


28 DWBA calculations $^{64}Ni(d,p)^{65}Ni^{g}$
1.00 fm < r < 1.40 fm
0.50 fm < a< 0.75 fm

14 DWBA calculations $^{64}Ni(d,p)^{65}Ni$
1.00 fm < r < 1.40 fm
0.50 fm < a < 0.75 fm

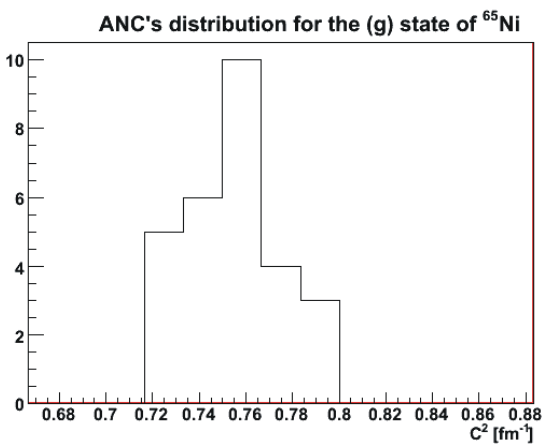


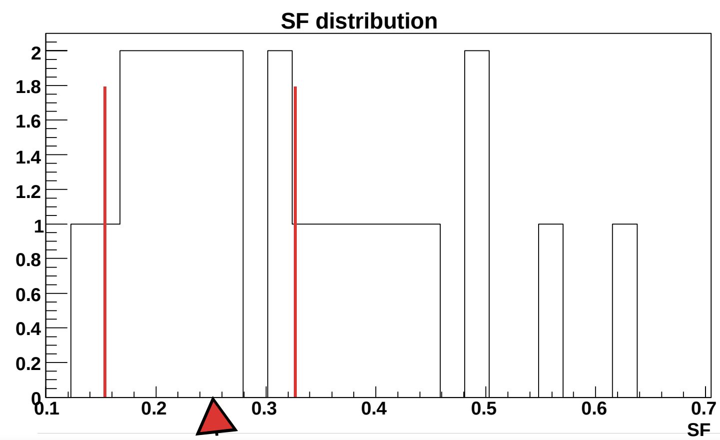


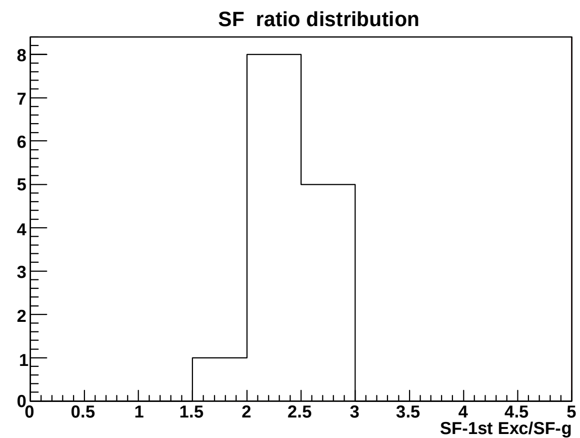


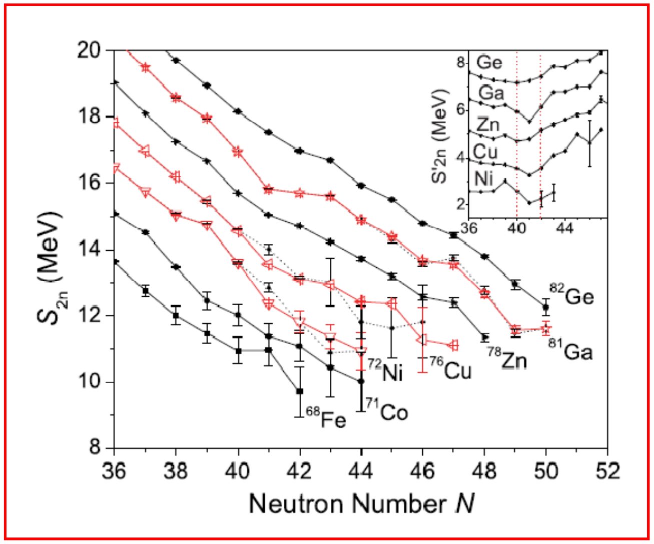
What we learn?

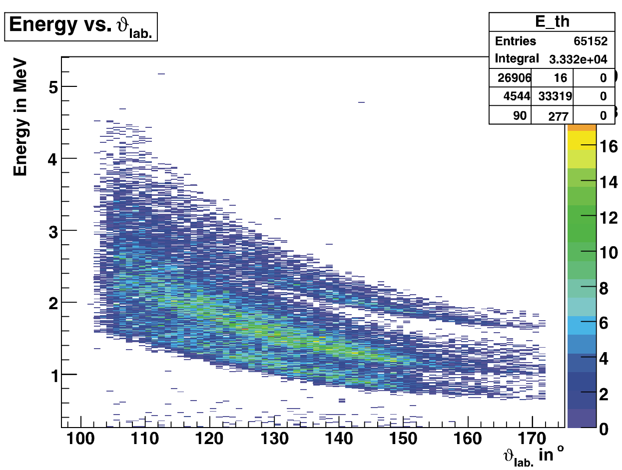
At the available beam energies we can't deduce absolute SF's <u>BUT relative SF's can be obtained quite accurately</u>

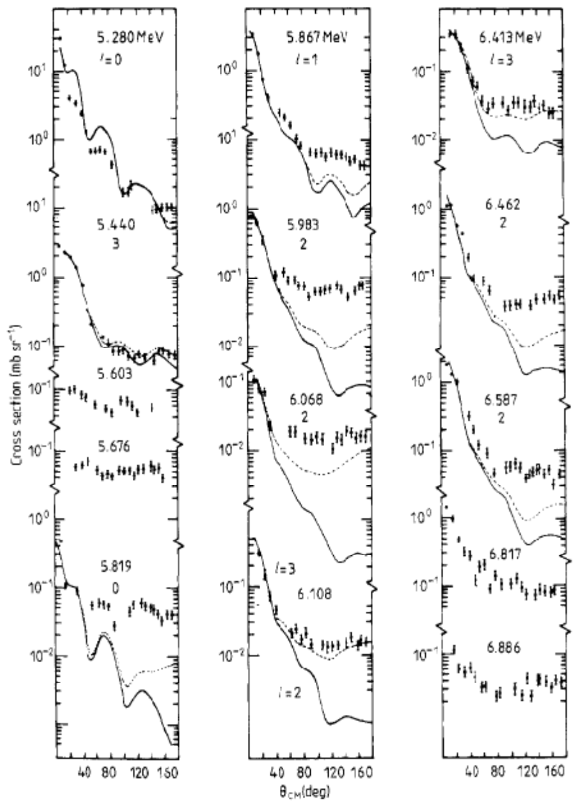






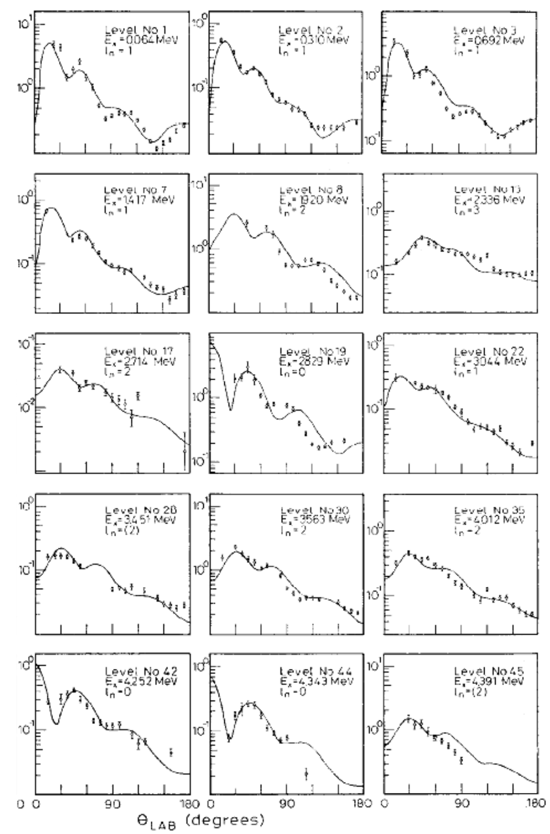






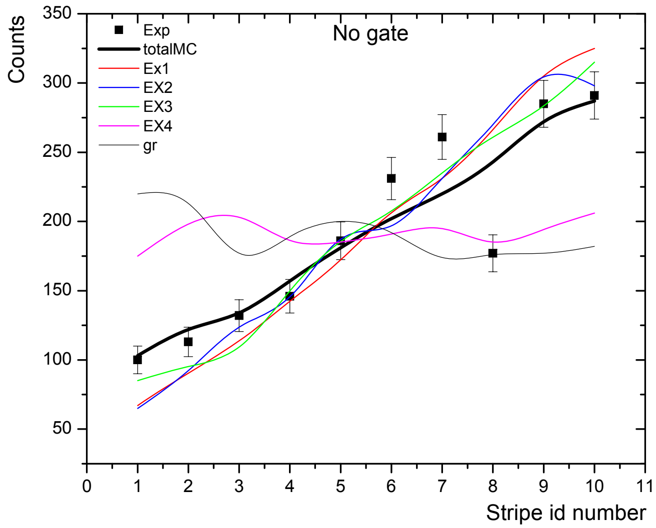
^{30}Si(d,p)^{31}Si: Ed=17 MeV

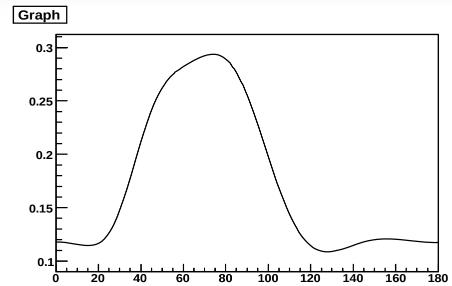
D.L. Watson and D.N. Slater JPG 9 1417 (1983)

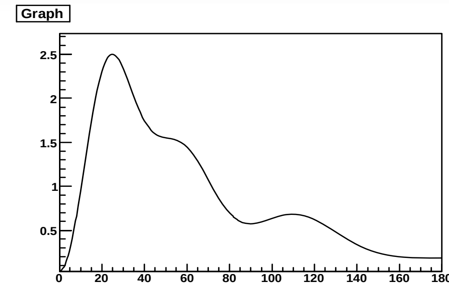


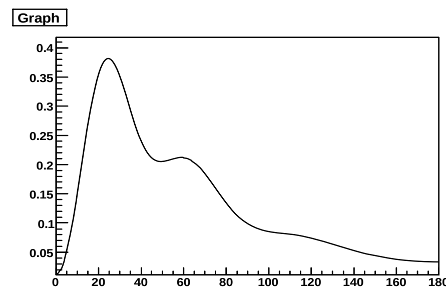
^{64}Ni(d,p)^{65}Ni Ed=7.5 MeV

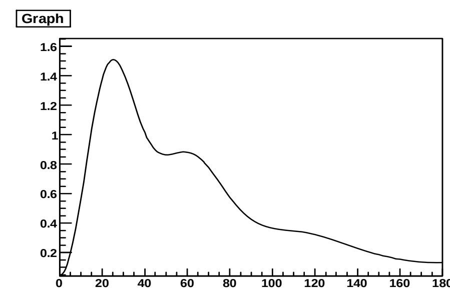
T.R. Anfinsen et al NPA 157 561 (1970)

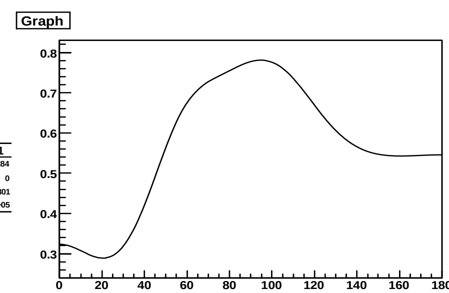


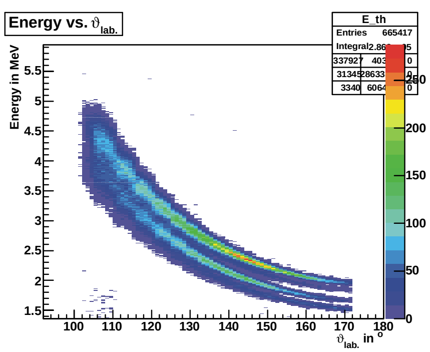


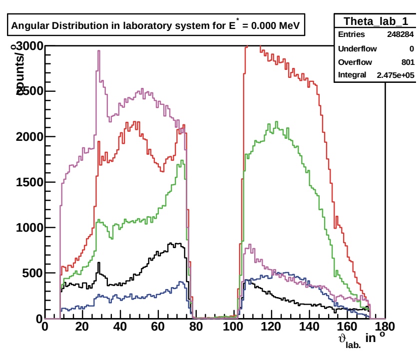




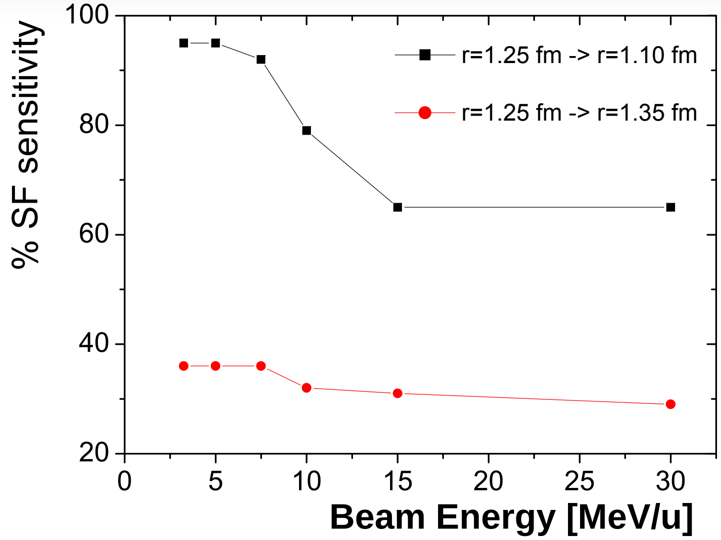




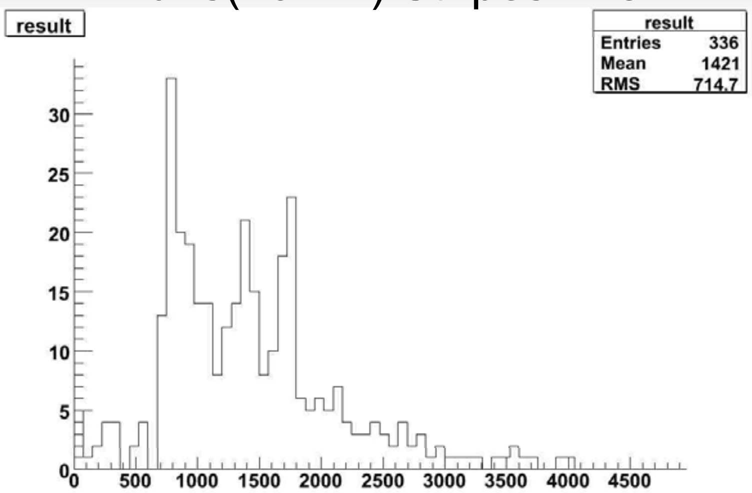




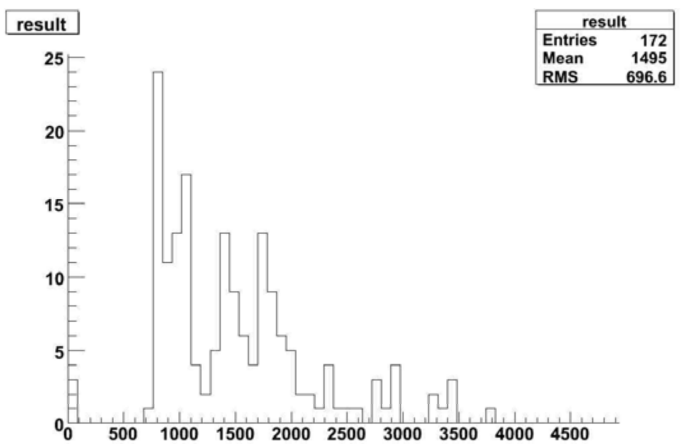
Ground
1-0.064 MeV
2-0.31 MeV
3-0.693 MeV
4-1.02 MeV



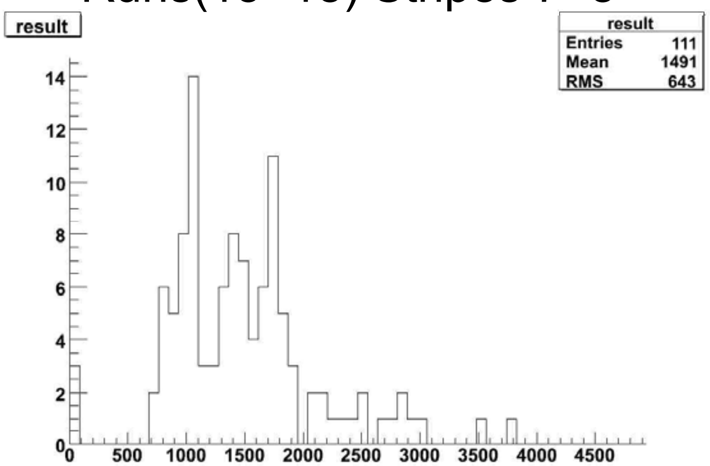
Runs(20+…) Stripes 7+8

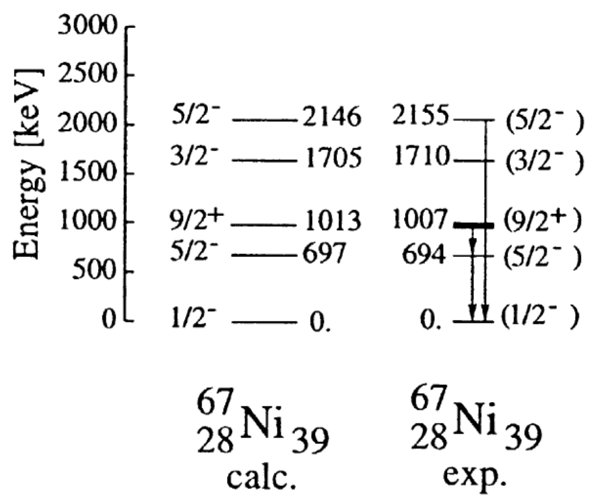


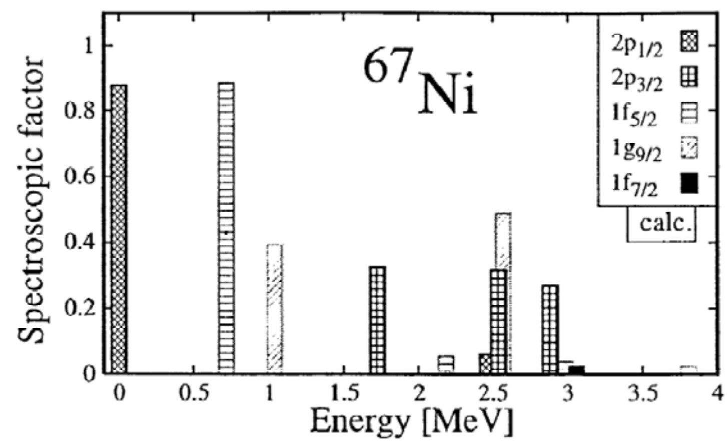
Runs(15+18) Stripes 9+10+11



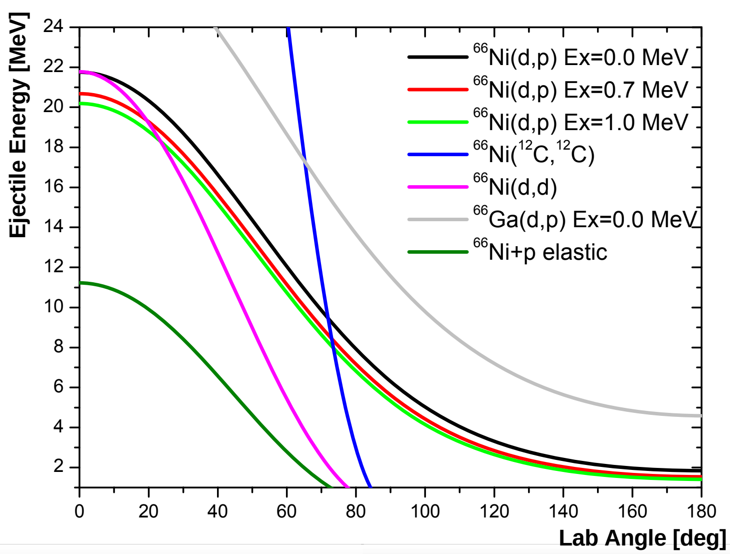
Runs(15+18) Stripes 7+8

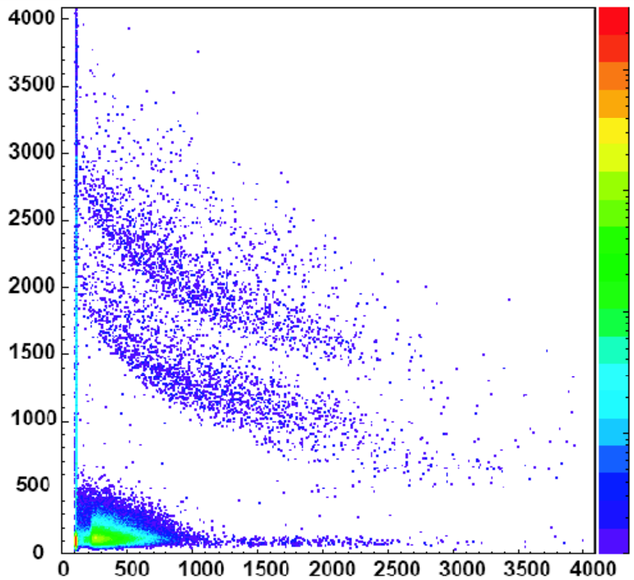






A.M. Oros-Peusquens and P.F. Mantica NPA 669 81 (2000)

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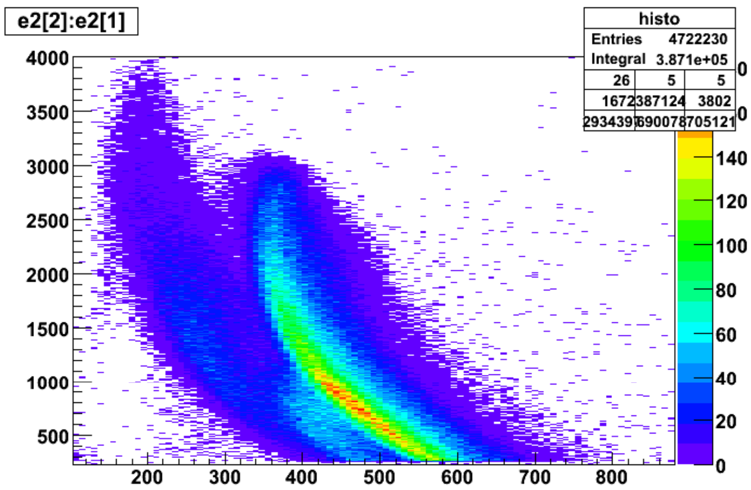
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