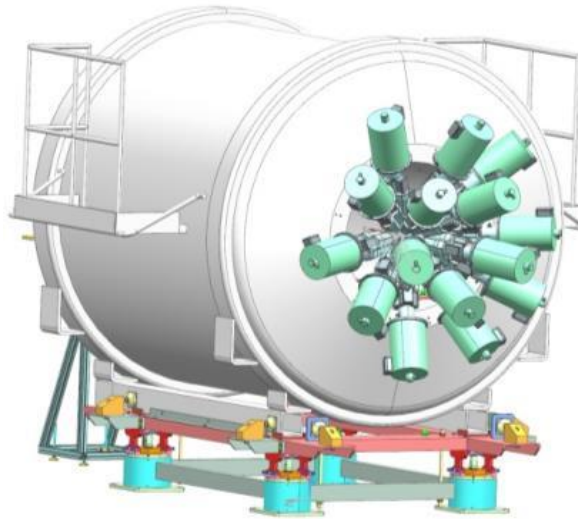




A new setup for direct reaction w/ RIBs

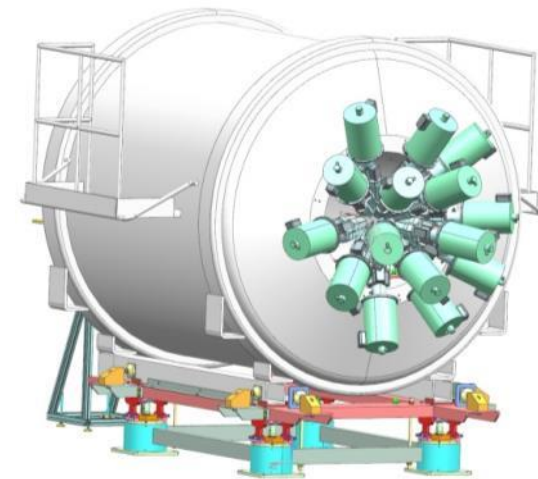
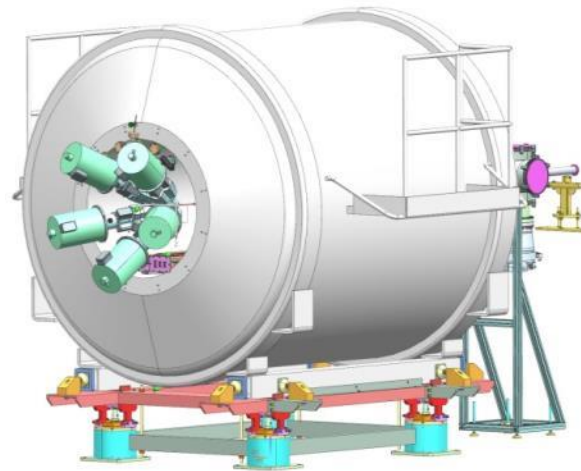
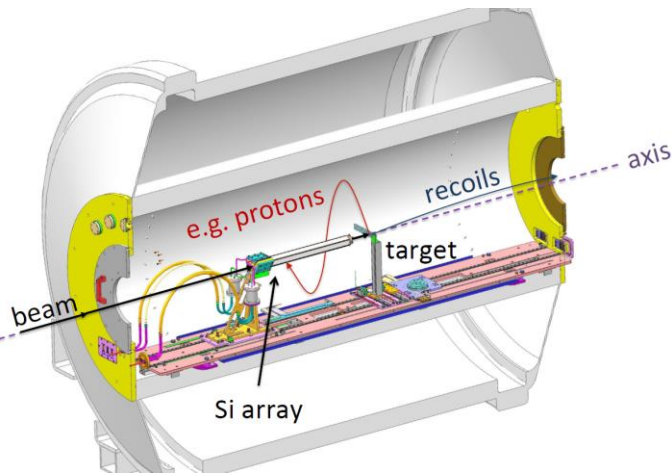
Francesco Recchia

Department of Physics and Astronomy
University of Padova



Nuclear Spectroscopy Instrumentation Network of ENSAR2,
NUSPIN 2017 - GSI Darmstadt - June 26th - 29th, 2017

Superconducting Solenoid + Germaniums



$$z \propto \cos \theta_{CM}$$

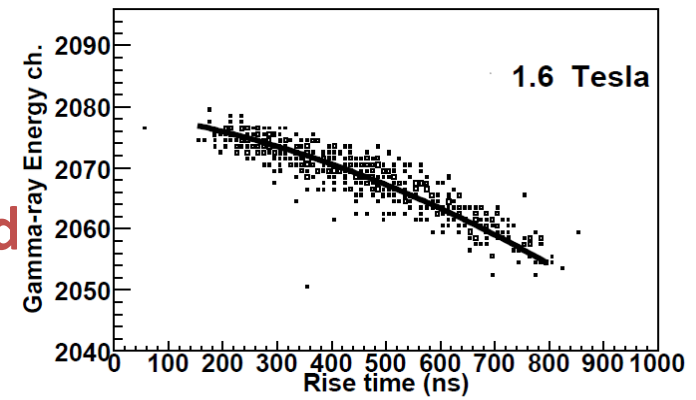
For a given state

$$E_{lab} = E_{CM} - A + Bz$$

For two states at fixed z

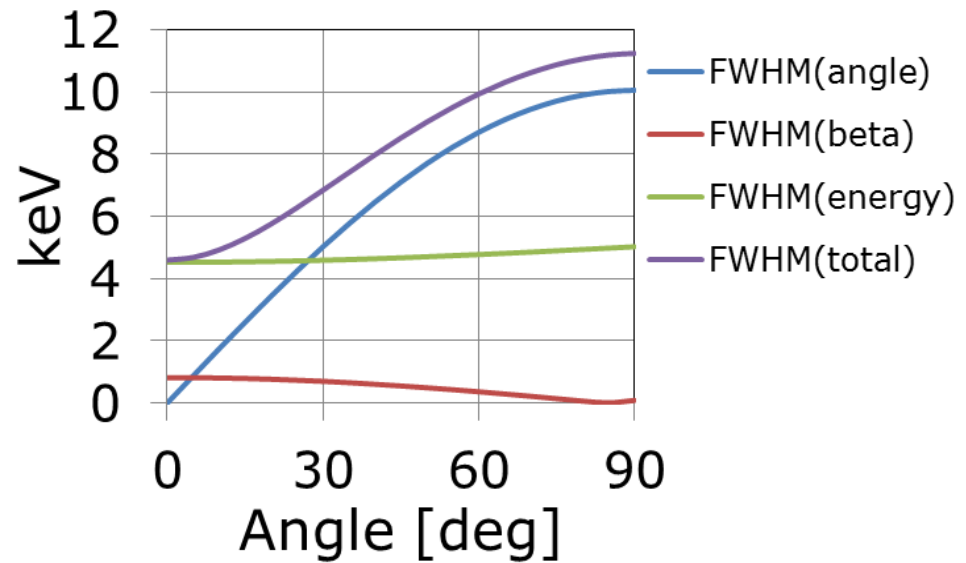
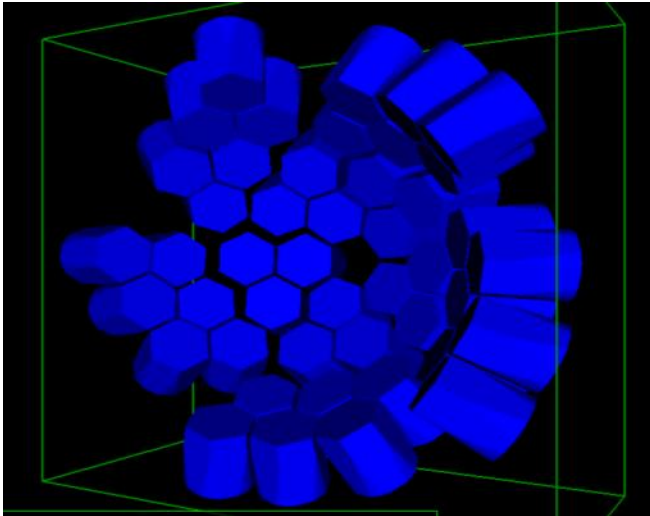
$$\Delta E_{lab} = \Delta E_{CM}$$

- Helios-like superconducting solenoid
- Add germanium detectors
- Proper signal treatment is needed



Superconducting Solenoid + Germaniums

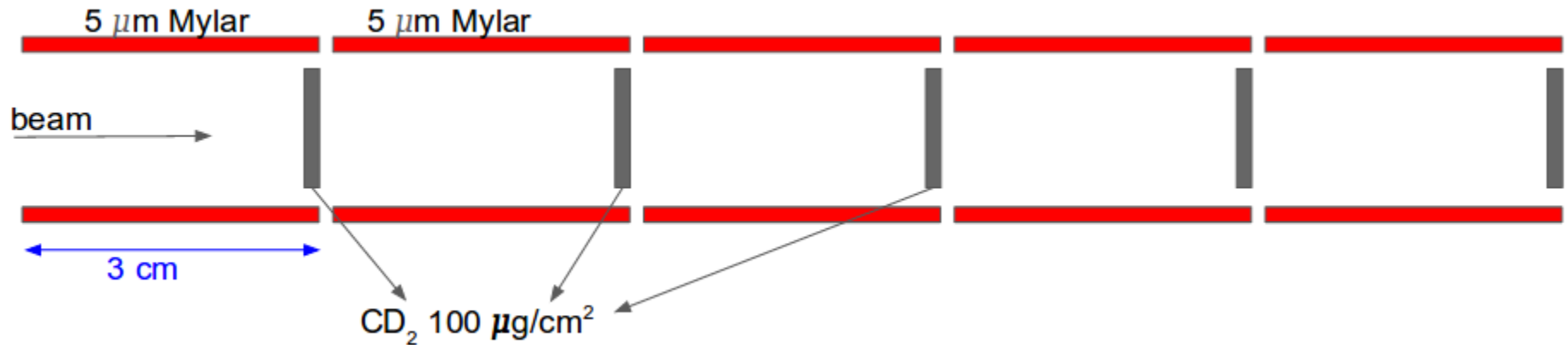
1. Response function



- Packing 15 triple clusters
- Expected efficiency $\sim 10\%$

Superconducting Solenoid + Germaniums

2. Target thickness

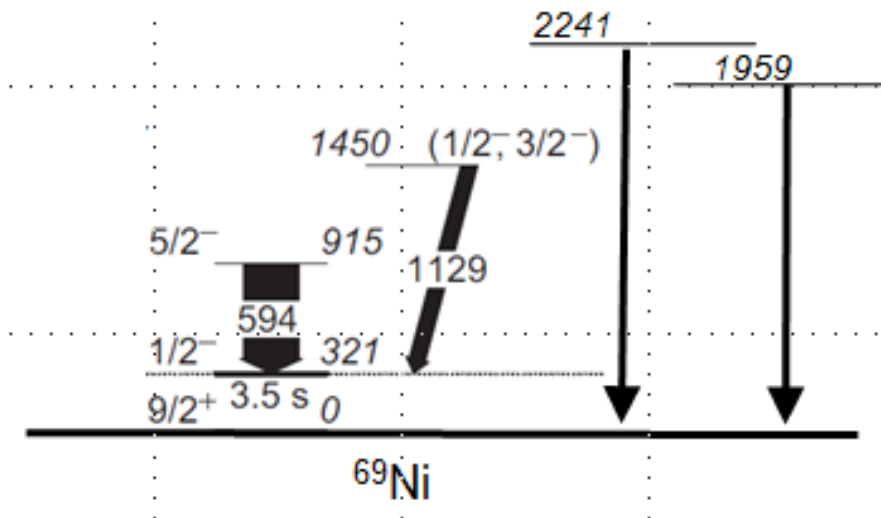


CATS:

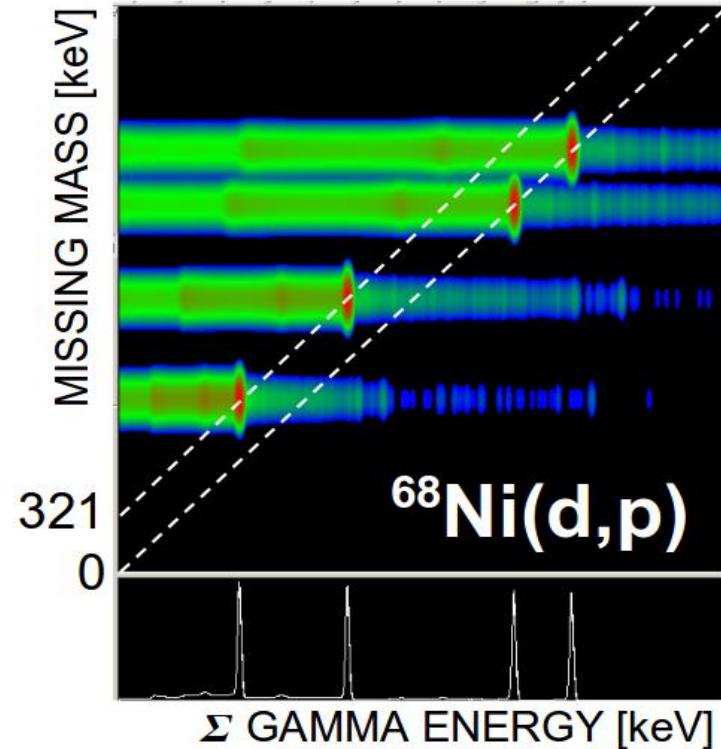
- windows: 1.5 μm + catodes = 5 μm of mylar total
- 5 μm of mylar → 150 keV energy loss for protons

Superconducting Solenoid + Germaniums

3. Excitation vs Deexcitation

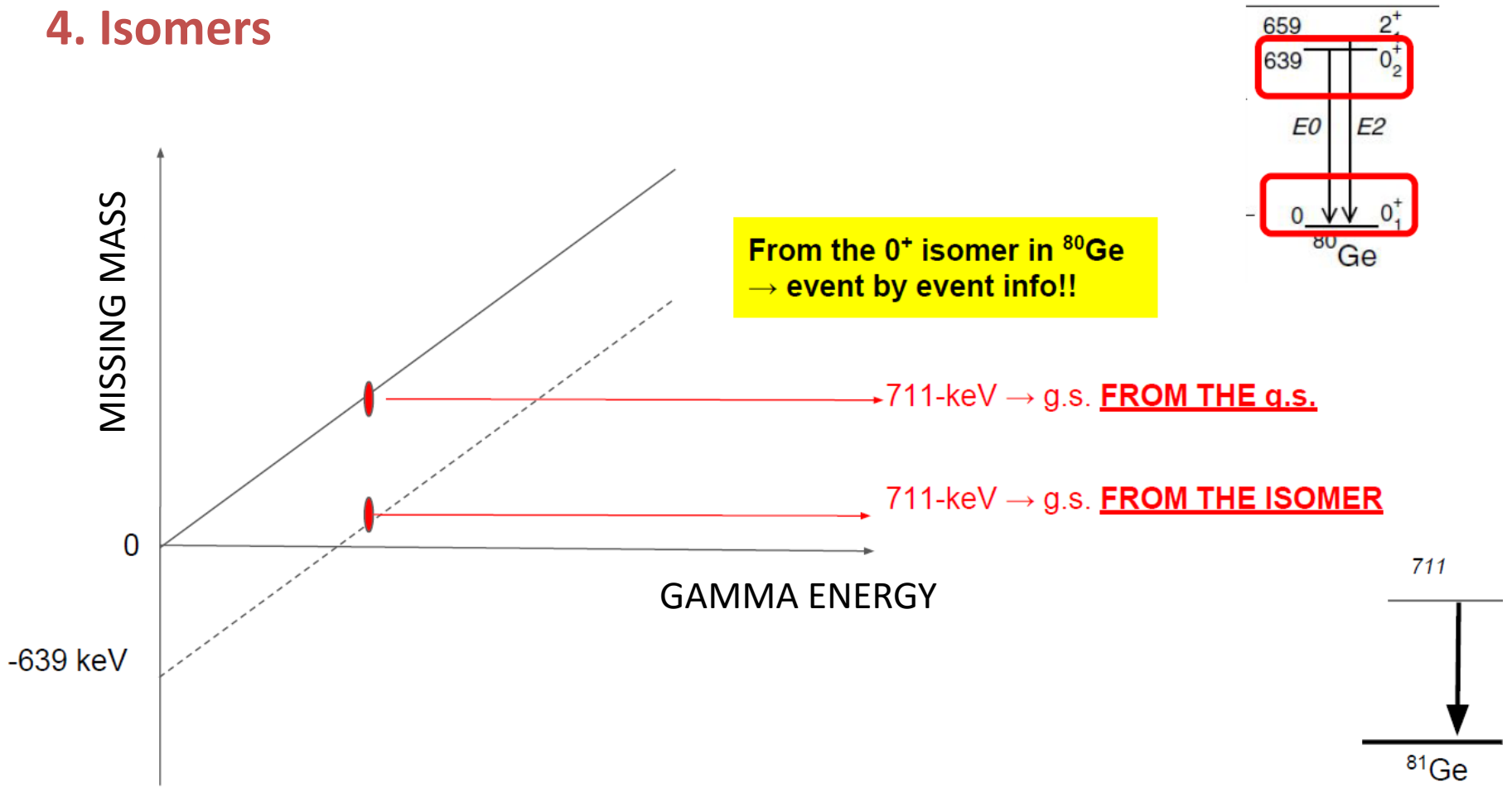


- Anti-Compton gate
- Feeding to isomers



Superconducting Solenoid + Germaniums

4. Isomers

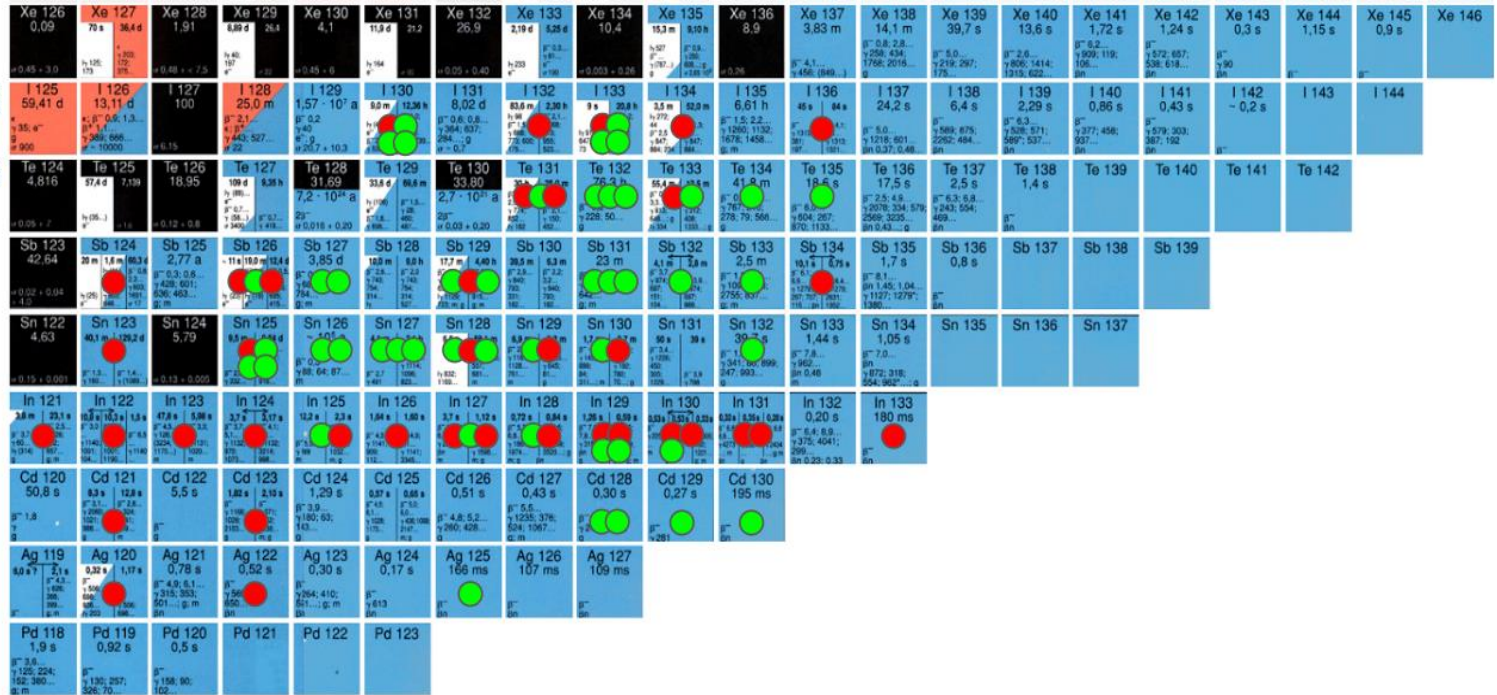


Superconducting Solenoid + Germaniums: nuclear structure

Isomers:

● > 100 ms

● < 100 ms



- Spectroscopic factors
- Lifetime measurements: feeding under control
- Neutron unbound states



Superconducting Solenoid + Germaniums: nuclear astrophysics

- $^{79}\text{Se}(d, p\gamma)^{80}\text{Se}$ used as a surrogate for the $^{79}\text{Se}(n, \gamma)$ reaction
- long lived isomer in ^{79}Se that will be present in the secondary beam
- together with the ^{79}Se sitting on the ground state.

Rb 79 23.0 m β^+ 1.8; 2.5... γ 688; 183; 143; 130; 508; 0. m	Rb 80 30 s β^+ 4.7... γ 616...	Rb 81 30.3 m 4.88 h β^+ 96; 6.1; β^+ 1.4; 9.1.1; γ 96.1; 9.46;	Rb 82 6.3 h 1.27 m β^+ 0.8; γ 776; 554; β^+ 3.3	Rb 83 86.2 d ϵ no β^+ γ 520; 530; 553...	Rb 84 20.5 m 32.8 d β^+ 248; 405; 79 β^+ 0.8 1.2; γ 7.0.9 1.982; γ 17	Rb 85 72.17 α 0.05 + 0.38
Kr 78 0.355 α 0.17 + 6	Kr 79 50 s 34.9 h β^+ 0.8; 1.81; 388; 596...	Kr 80 2.286 α 4.6 + 7	Kr 81 13.1 s 2.3 · 10 ³ a β^+ 180 4; γ 276	Kr 82 11.593 α 14 + 7	Kr 83 1.83 h 11.500 α 103	Kr 84 56.987 α 0.09 + 0.02
Br 77 4.3 m 57.0 h β^+ 239; 521; 587; 6	Br 78 6.46 m β^+ 2.6... γ 614...	Br 79 4.9 s 50.69 β^+ 23 · 8.3	Br 80 4.42 h 17.6 m β^+ 23; 8.3; β^+ 0.8; 1.64; 86.	Br 81 49.31 α 2.4 + 0.24	Br 82 6.1 m 35.34 h β^+ 3.4... γ 779; 3.1; 594; 619;	Br 83 2.40 h β^+ 0.9... γ 530; 520... m
Se 76 9.37 α 22 + 63	Se 77 17.5 s 7.63 α 42	Se 78 23.77 α 0.38 + 0.05	Se 79 3.9 m 4.8 · 10 ³ a β^+ 98 β^+ 2.2; m 1; 1	Se 80 49.61 α 0.05 + 0.54	Se 81 57.3 m 18 m β^+ 1.8; 290; 76; β^+ 1.8; γ 129; 290...	Se 82 8.73 1.08 · 10 ²⁰ a β^+ 3.8... γ 488; 491... 0
As 75 100 α 4.0	As 76 26.4 h β^+ 3.0... γ 559; 657; 1216	As 77 38.8 h β^+ 0.7... γ 239; 521; 250...	As 78 1.5 h β^+ 4.4... γ 614; 695; 1309...	As 79 8.2 m β^+ 2.1... γ 96; 365; 432; 879... m	As 80 15.2 s β^+ 5.4... γ 668; 1645; 1207.	As 81 34 s β^+ 3.8... γ 488; 491... 0

Superconducting Solenoid + Germaniums: fundamental symmetries

^{229}Pa : Previously studied
w/ $^{231}\text{Pa}(p,t)$
 $\rightarrow (p,p')$?

A.I. Levon et al./Nuclear Physics A 576 (1994) 267-307

Permanent electric dipole moments in atoms

Beyond the Standard Model

- Dominance of matter over antimatter (CP violation)
- ^{225}Ra , ^{223}Rn , ^{229}Pa are special (several thousand times more sensitive than ^{199}Hg)

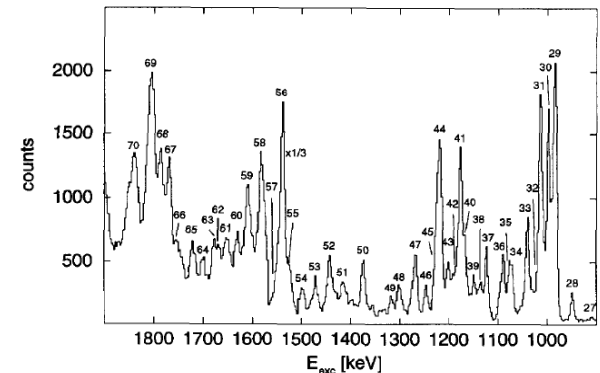
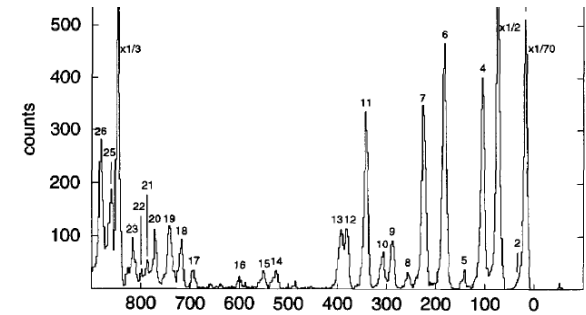
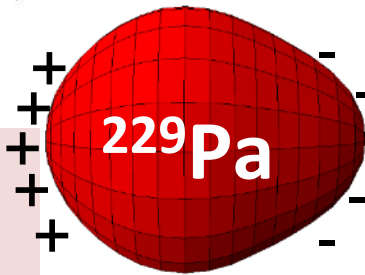
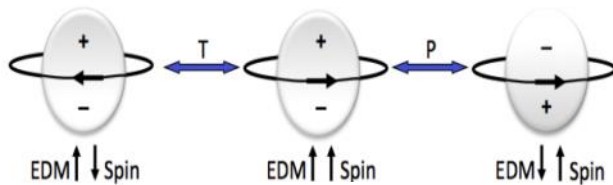


Fig. 1. Triton spectrum from the $^{231}\text{Pa}(p,t)^{229}\text{Pa}$ reaction at $E_p = 22$ MeV and $\theta = 45^\circ$. The peaks are numbered according to Table 1.

\rightarrow NUPRASEN-SPES workshop
"Probing fundamental symmetries and
interactions by low energy excitations with RIB"
Pisa, December 2017- January 2018



Conclusions

- Physics at future RIBs facilities:
 - SPES
 - ISOLDE
 - ...
- Physics opportunities
 - **New setups** will be the key to access new physics
 - Open to collaborations: **you are welcome!**

