Letter of Intent for SPES

NUCLEAR MOMENT STUDIES WITH GALILEO

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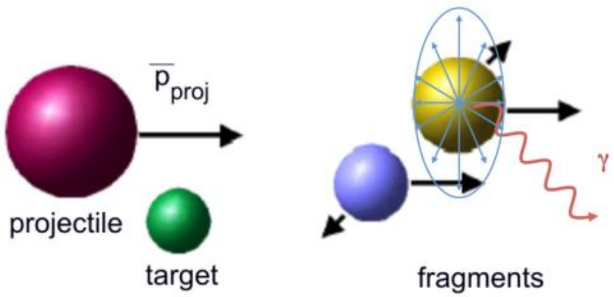
NUCLEAR MOMENT MEASUREMENTS

- magnetic moment $\mu = gI\mu_N$
  - nuclear s.p. structure
  - purity wave function
- quadrupole moment $Q = e\sum_{k=1}^{A}(3z_k^2 - r^2)$
  - collective properties
  - nuclear deformation



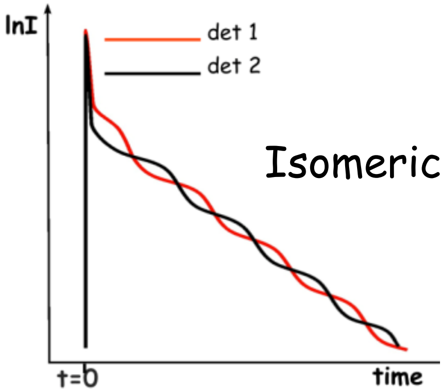
Spin-orientation (reaction-induced)

- fusion-evaporation ~50%
- fission (spontaneous/relativistic) ~40% / ~20%
- fragmentation ~15-30%
- multi-nucleon transfer and DI ? /(d,p) ~20-30%

THE TDPAD TECHNIQUE

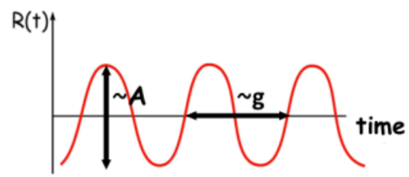
Time Differential Perturbed Angular Distribution

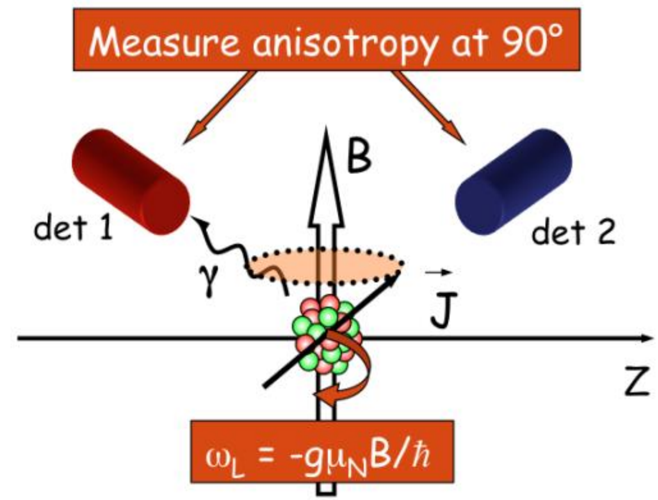
$$I(t,\theta,B) = I_0 \exp\left(-\frac{t}{\tau}\right) \sum_{k=even} A_k B_k P[\cos(\theta - \omega_L t)]$$



Isomeric decay

R(t) function





$$R(t,\theta,B) = \frac{I(t,\theta,B) - I\left(t, \frac{\pi}{2} + \theta, t\right)}{I(t,\theta,B) + I\left(t, \frac{\pi}{2} + \theta, t\right)} =$$

$$= \frac{3 A_2 B_2}{4 + A_2 B_2} \cos[2(\theta - \omega_L t)]$$

- g-factor: external $\vec{B}$ field

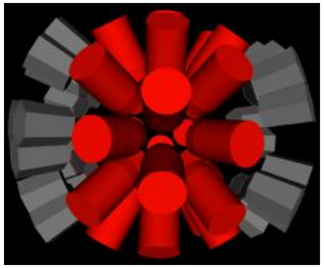
$$\omega_L = g \mu_N B / \hbar$$

- Q: host with $\vec{E}$ field gradient

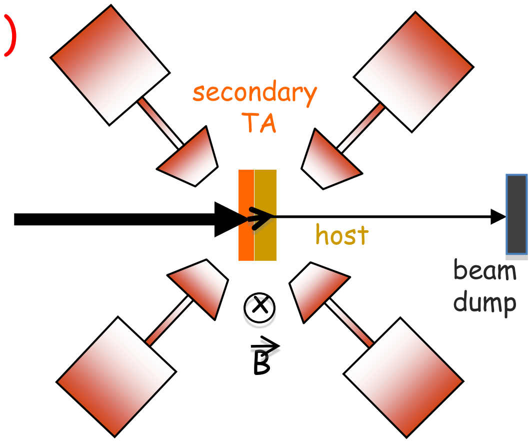
$$\omega_Q = Q V_{zz} / 4I(2I-1)\hbar$$

POSSIBLE CONFIGURATION @ SPES

- for g-factor measurements

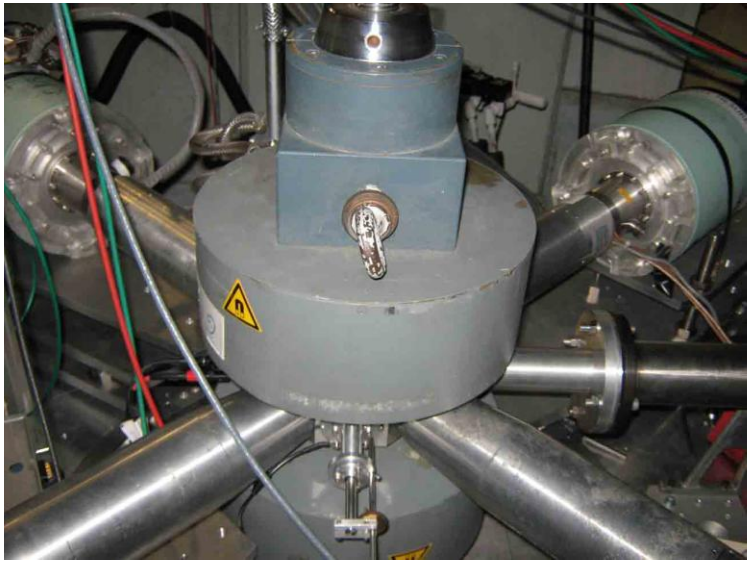


using G.GALILEO (4-8 3-cluster detectors) in a horizontal plane around electromagnet (e.g. g-RISING detector configuration)
-> 4 detectors @ 18 cm: ε: 2%
E_{beam}~5 MeV/u -> BG
-> TA/host sandwich (variable thickness to adjust stopping range)
-> coupling to particle detectors (DANTE, TRACE, LuSiA,…)

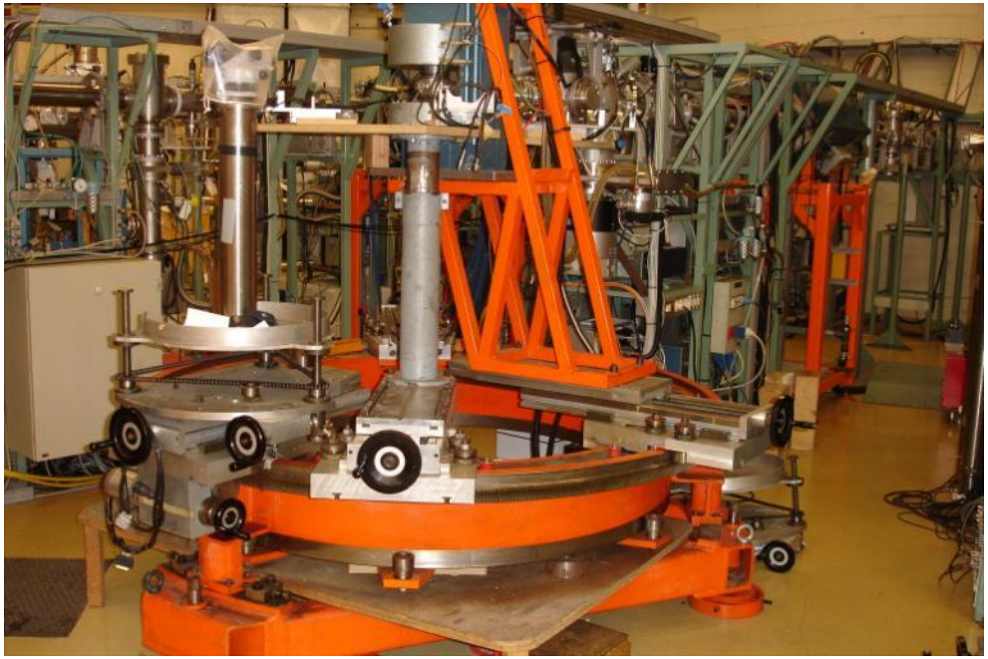


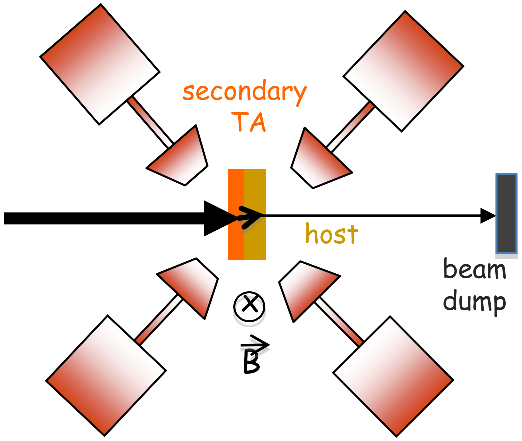
Tandem-ALTO/GANIL
4 Ge coax detectors (10cm -> ε: 3.5 %)

some info from g-RISING (43cm -> ε: 2.3%), 1T electro-magnet, ancilary detectors (validation+veto) to reject BG



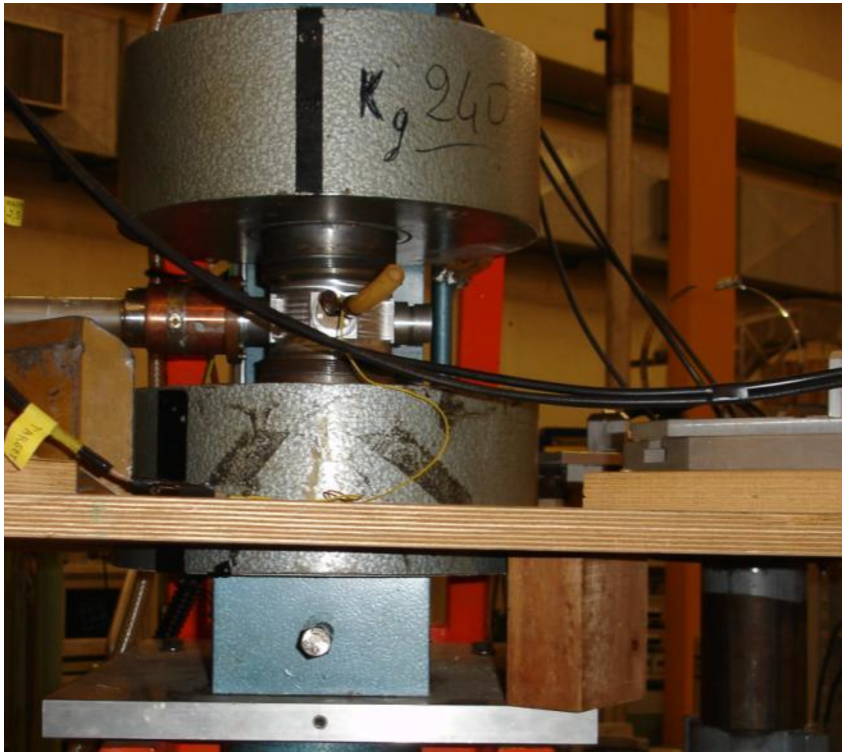
POSSIBLE CONFIGURATION @ SPES





The GAMIPE setup @ LNL (Hall I)

- planar Ge detectors
- GASP Ge detectors
- pulsed beam: res. 2 ns
  repetition 200 ns – 6.4 μs

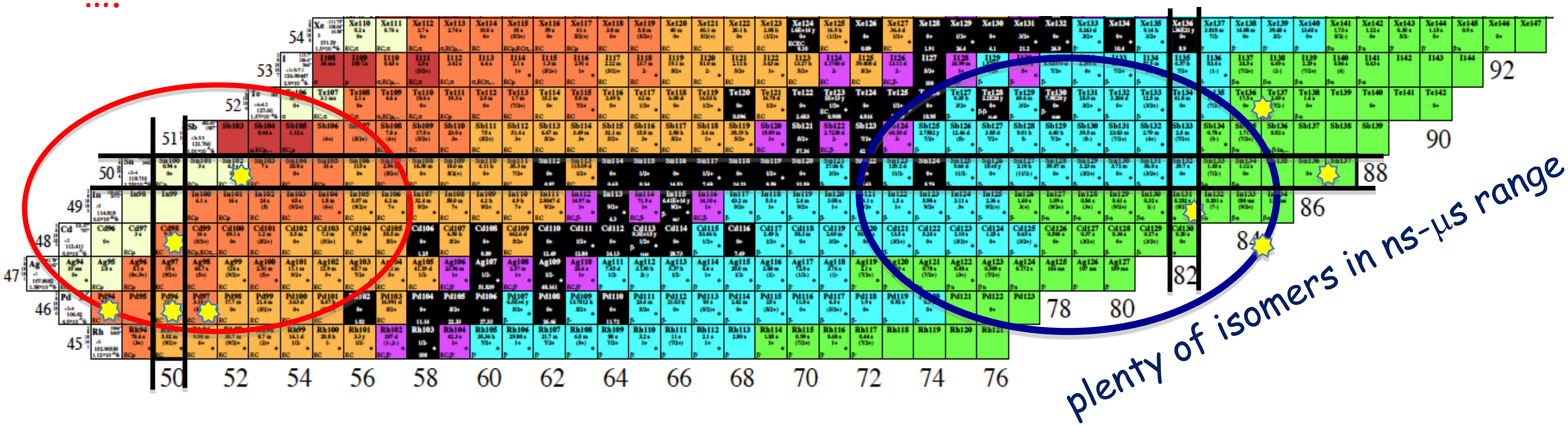


→ G.GALILEO

- Ge triple clusters

PHYSICS CASE

- neutron-deficient nuclei around ^{100}**Sn**: ^{94}Pd, ^{96,97}Pd, ^{98}Cd … ….
- **neutron-rich nuclei around ^{132}Sn: ^{129,131}In, ^{134}Sn, ^{134}Te…**



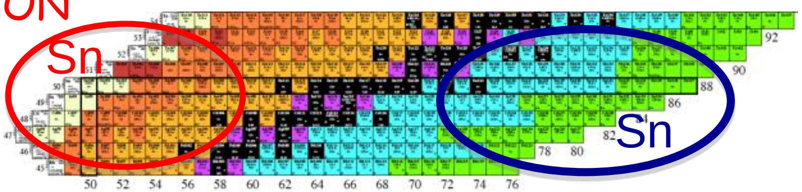
Challenges

- isomeric structure: p/h configurations on doubly-magic core states, p-n interaction
- fix/assign spins/parities
- properties M1 operator: ? quenching @ the two extremes of isospin (^{100}Sn <-> ^{132}Sn)
- seniority isomers & core excitations, competition between pairing & deformation
- single/particle <-> collective properties, …

FEASIBILITY @ SPES

FUSION-EVAPORATION

⇩



(d,p), (d,t)
MULTI-NUCLEON TRANSFER,
DEEP-INELASTIC

⇩

- neutron-deficient beams e.g. ^{56}Ni, ^{68}Ge
- high-intensity > 10^7/s
- combined with targets e.g. ^{50}Cr, ^{40}Ca
- energies 3-5 MeV/u from ALPI re-accelerator (batch mode)
- beam pulsing is ensured
- BG problems due to the more intense accompanying radioactive ions

- neutron-rich beams e.g. ^{125}In, ^{132}Sn, …
- high-intensity > 10^7/s
- combined with light-targets e.g. ^{2}H (d,p) (d,t)

(+) have spin-alignment / (-) can not go very far

- combined with ^{238}U: e.g. MNT, DI

(-) ? do no know much about the spin-alignment /
(+) can go more exotic

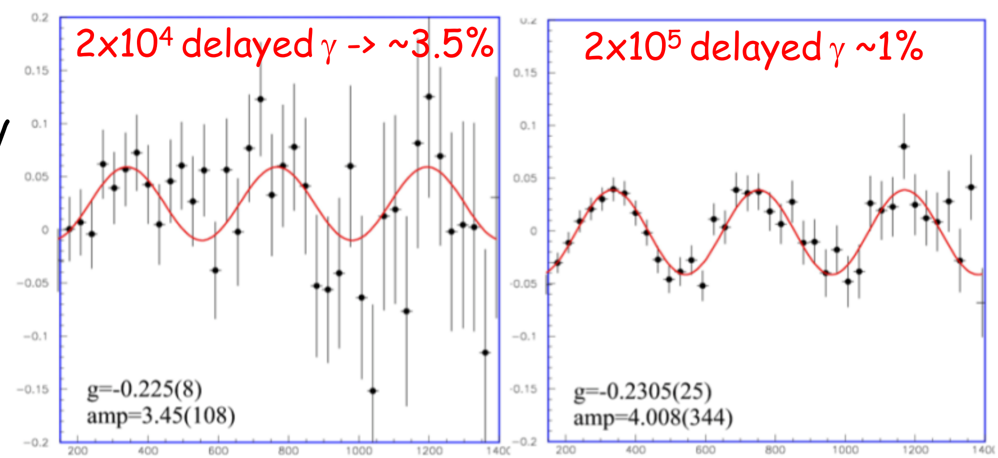
=> some pre-SPES investigations required !

(-) ? beam pulsing

<u>an example:</u>

^{40}Ca(^{56}Ni,2p2n)^{94}**Pd** σ~6-10 mb @ 190 MeV
target thickness: 1-2 mg/cm^2, int: 10^7/s
ε_γ: 2%, isomeric ratio: 10-15%
-> 3×10^6 ions/week -> 10^4 γ/det/week

=> g-factor can be measured with <5% uncertainty !



quality/uncertainty in g-factor mearements (*real data*)