The VAMOS gas-filled mode

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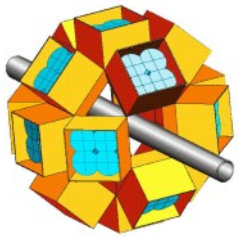
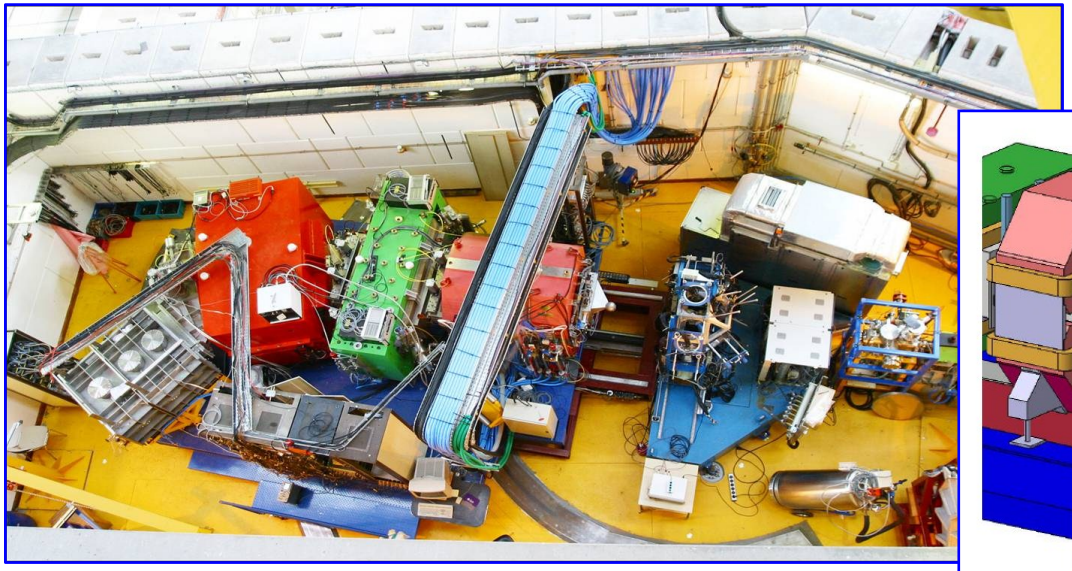
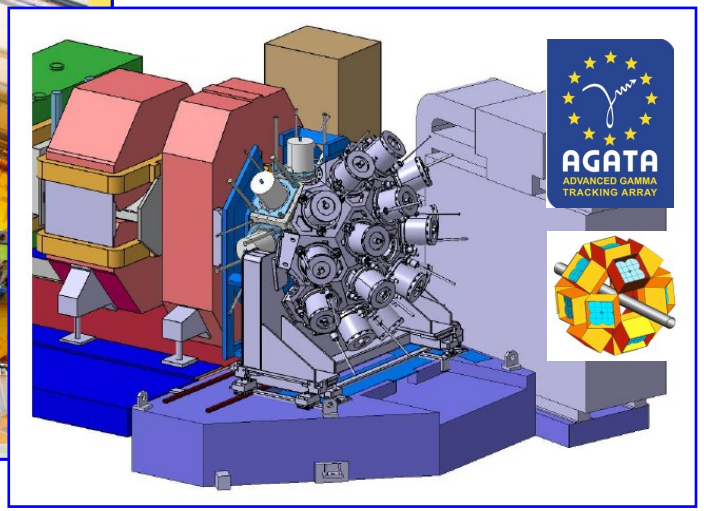


Fusion-evaporation with VAMOS : why ?

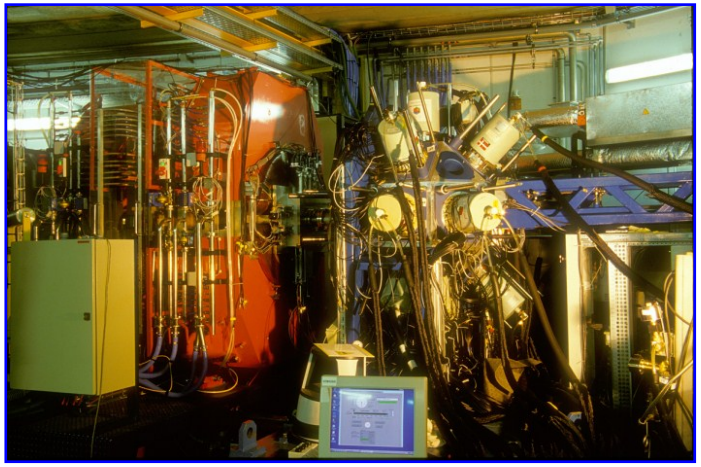




Large acceptance $\Omega \sim 60$ msr
→ Huge transmission

Exogam2, AGATA
→ Gamma spectroscopy, high efficiency

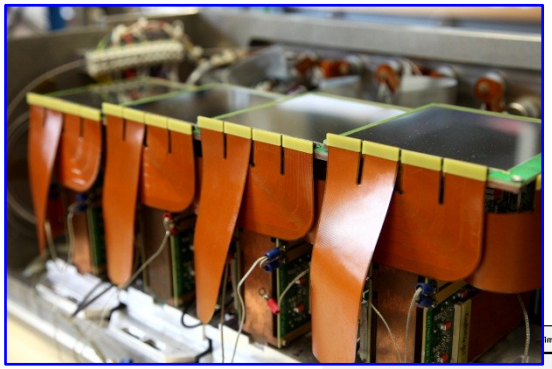
MUSETT
→ Focal plane detection, RDT

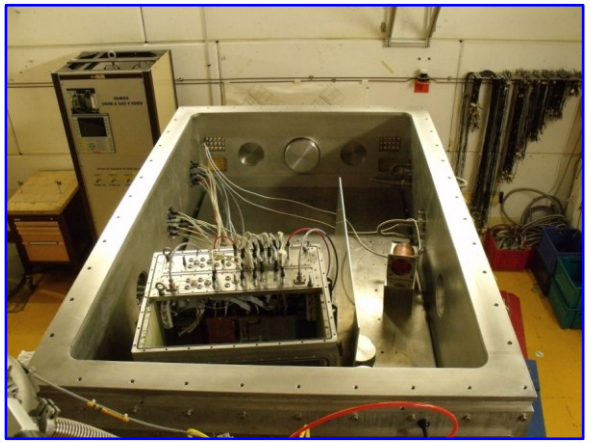


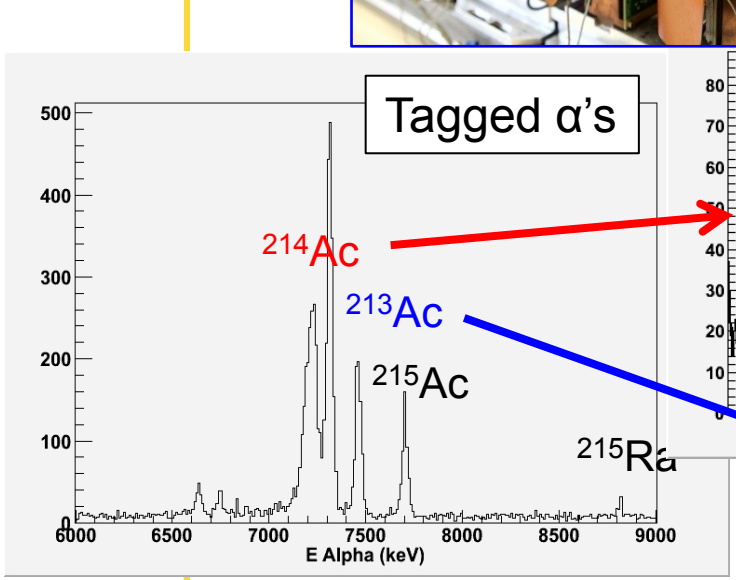
Questions : beam suppression at zero degree, transmission ?

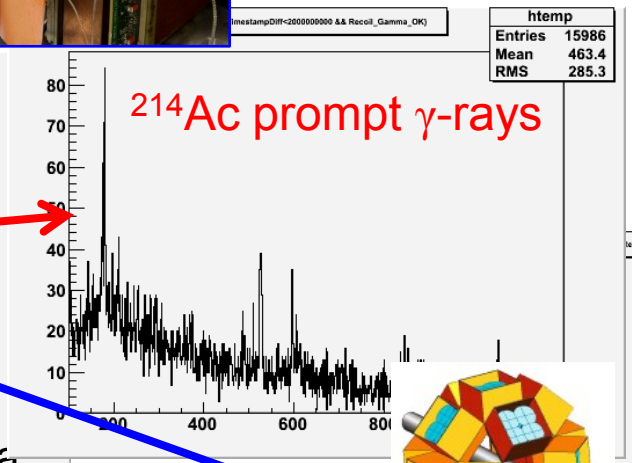
VAMOS in the vacuum mode (Wien Filter) ?

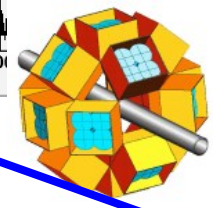
- 2010 : WF test + MUSETT commissioning + new DAQ (NARVAL) test
  - WF rejection disappointing ~ 10^7
  - Transmission for asymmetric Ne+Au ~ 40%
  - Successful MUSETT commissioning

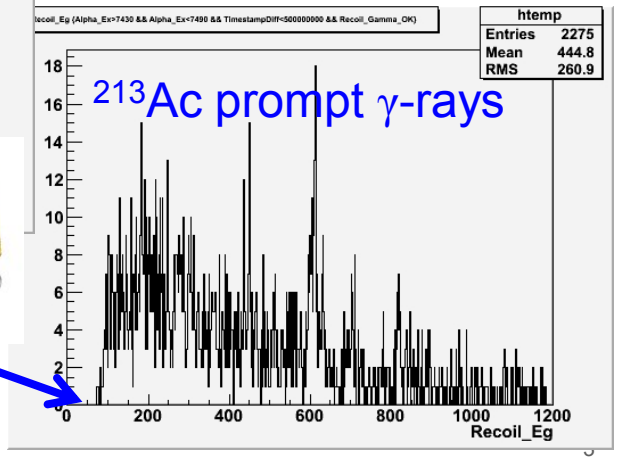








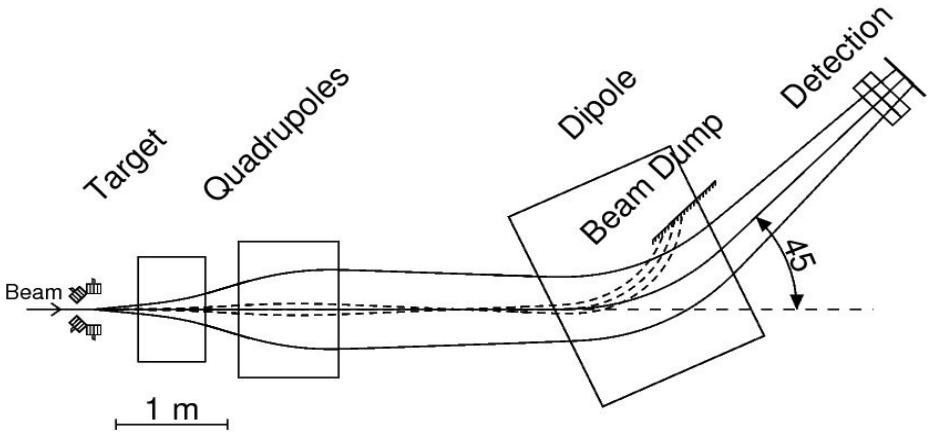




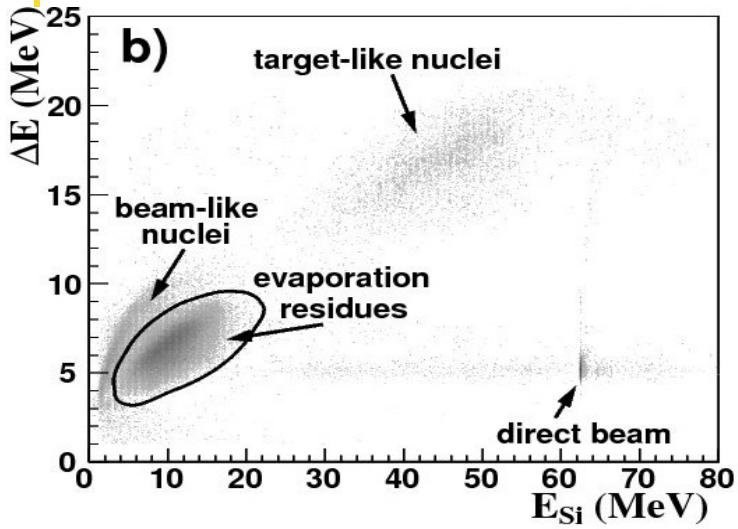
NIM paper soon
AIP Conf. Proc. 1377 (2011) 18

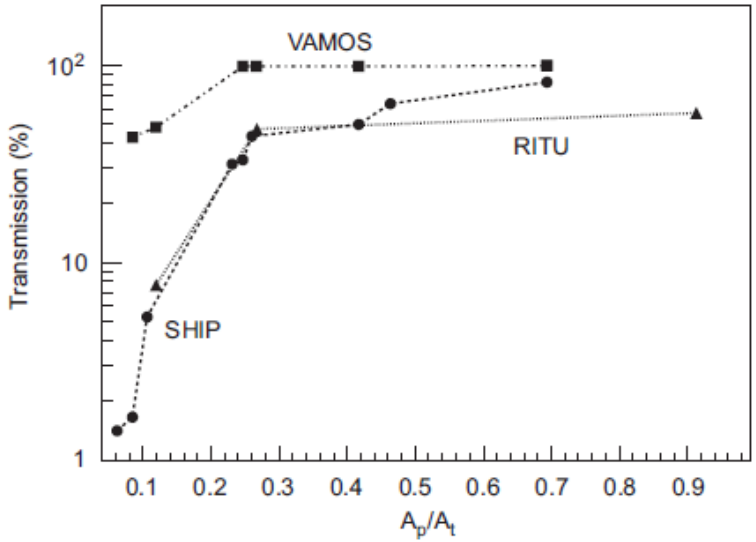
2009 Gas-filled mode test

^{40}Ca (196MeV) + $^{150}Sm \rightarrow {}^{190}Pb^*$ (σ_{ER} ~ 50mb)



- Beam rejection factor > 10^{10}
- Transmission =
  - 95 % for xn channels
  - 80% for αxn channels

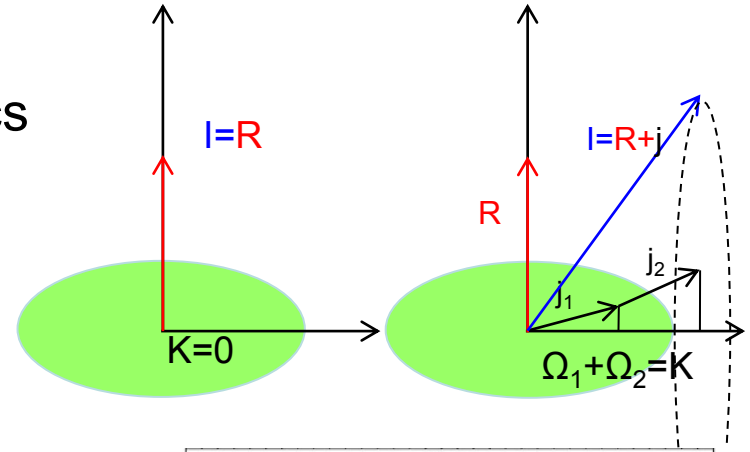


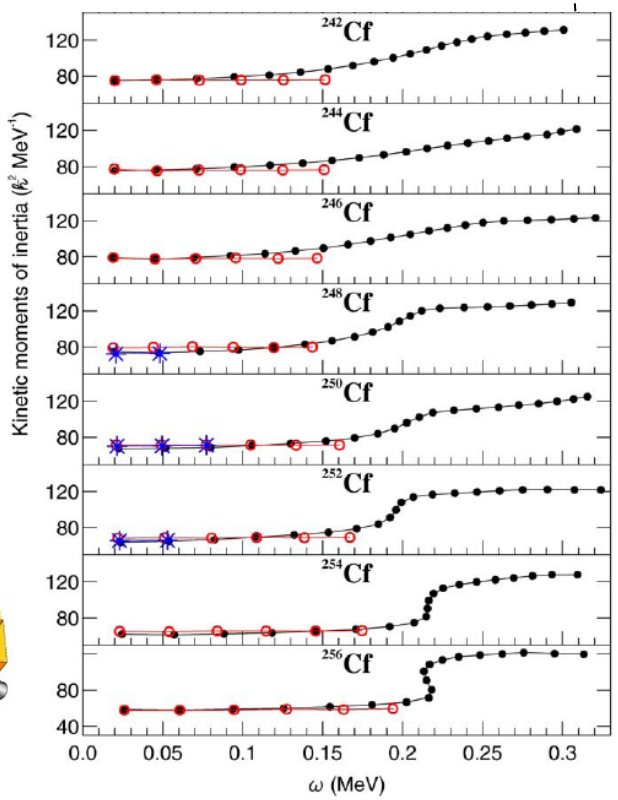


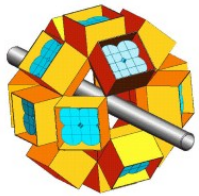
C. Schmitt *et al.*, NIM A 621 (2010) 558–565

Cf isotopes : a first physics case

- Spectroscopy of $^{240\text{-}244}$Cf : a not too difficult experiment with nice physics
  - 2 qp excitations : K isomers
  - Rotational band on top of K-isomer
  - Overview of 2qp K isomers around the magic deformed gap N=152, Z=100
  - Probe single-particle configurations
  - Yrast band : paring correlations
  - Cf isotopes still poorly known

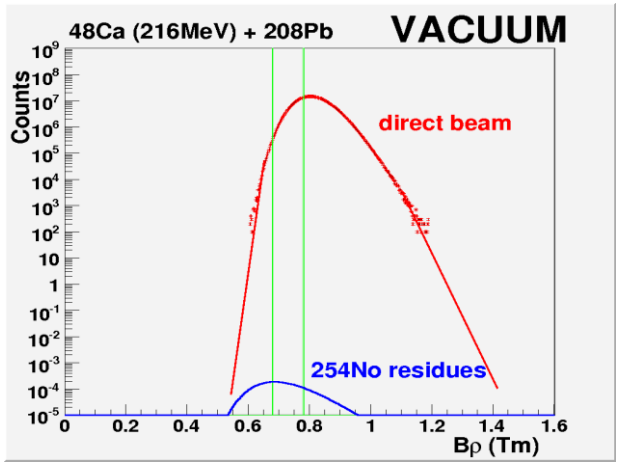


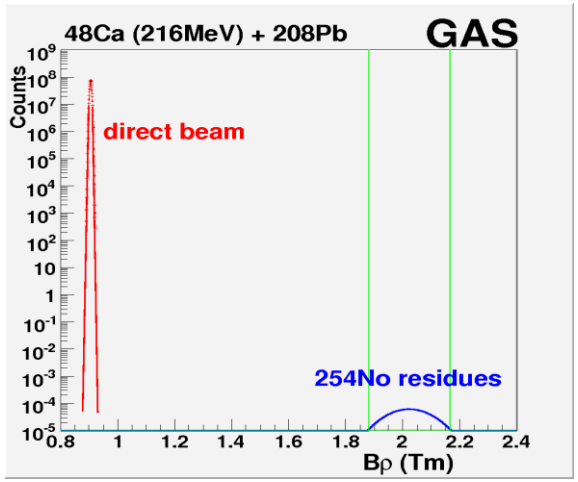




Sulignano / Greenlees / Theisen
Ganil PAC Dec. 2011

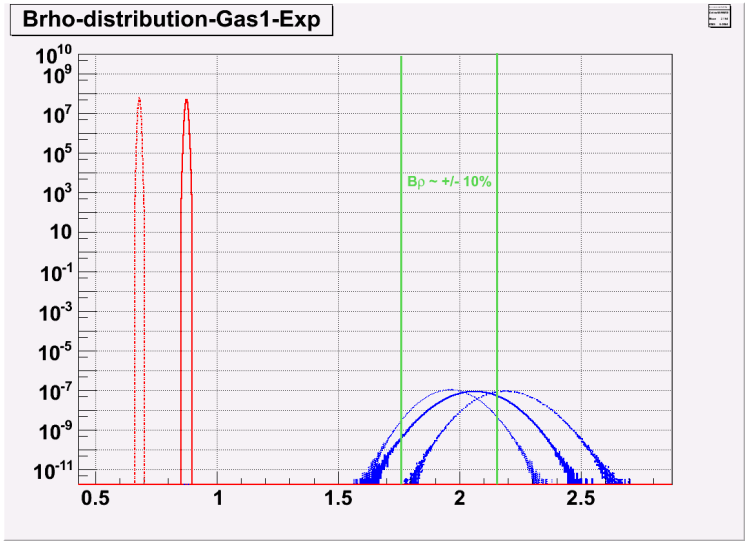
Bρ distributions ^{254}No, ^{244}Cf





^{48}Ca + ^{208}Pb → ^{254}No + 2n

^{48}Ca + ^{198}Pt → ^{244}Cf + 2n

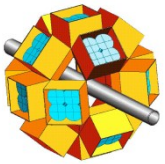


Physics cases with a 0 degree separator

- Actinides, transactinides but other nice cases using fusion-evaporation reactions and EXOGAM2, AGATA, PARIS … SPIRAL2 beams

- Nuclear structure@Spiral2
  - Evolution of shell structure, magic numbers
  - Exotic shapes (hyperdeformation)

- Spectroscopy close to the proton drip line
  - Alpha emitters north-east ^{100}Sn e.g. ^{106,108}Te, ^{109}I, ^{108,110}Xe, …

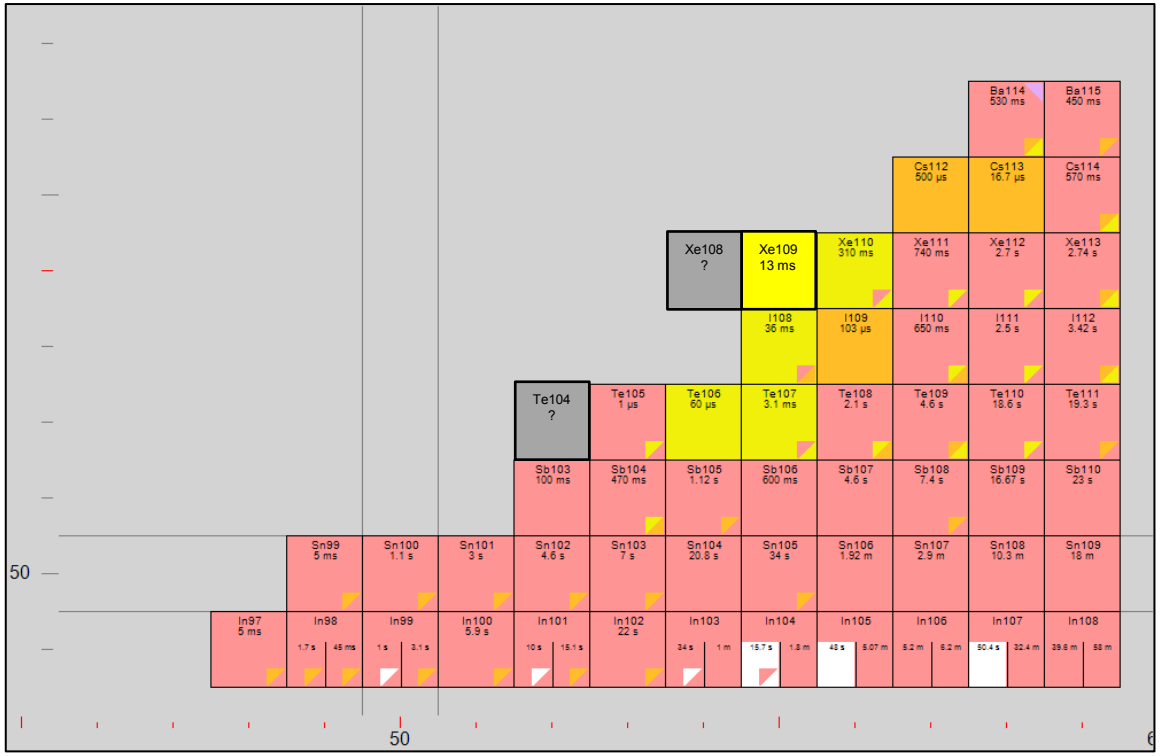


- Reaction dynamics with Spiral2 beams
  - Influence of nuclear structure on the competition between fusion and quasi-fission

- Lifetime measurement using a plunger (eg ^{254}No)

- Multi-nucleon transfer reaction ?
- **Large demand, many Spiral2 LoI's**

α-emitters north-east ^{100}Sn

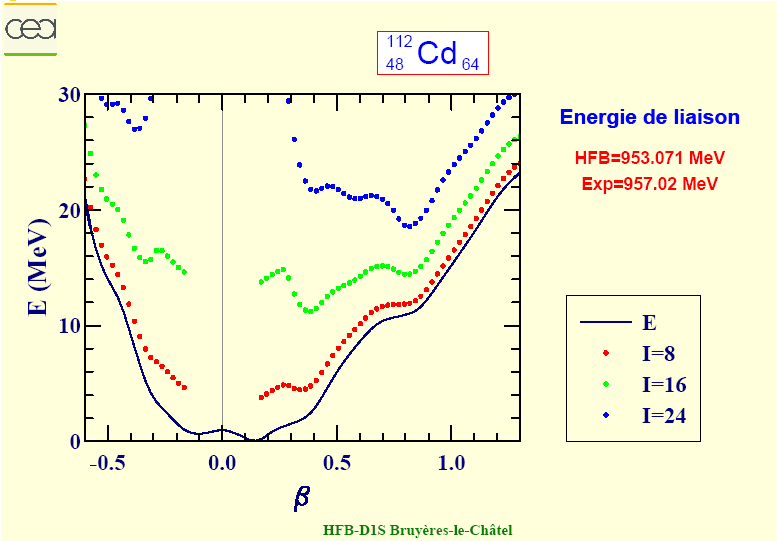


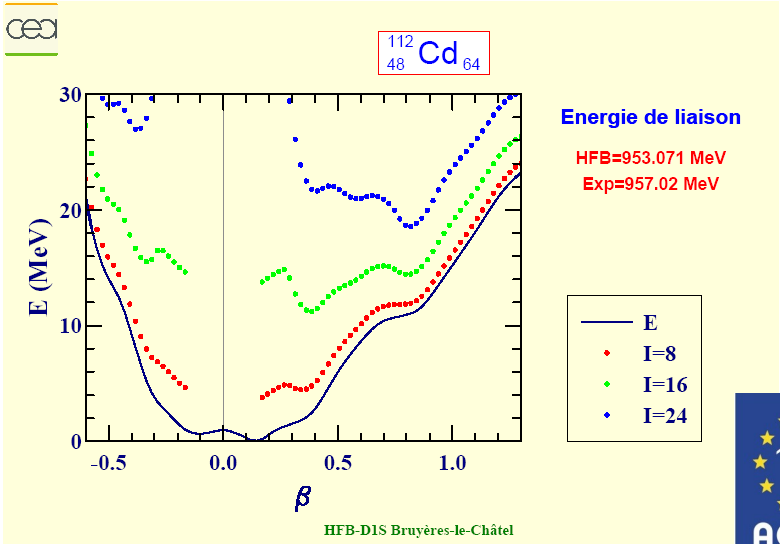
^{54}Fe(^{54}Fe,2n)^{106}Te (25 nb)
^{58}Ni(^{54}Fe, 2n)^{110}Xe(50 nb)
^{58}Ni(^{54}Fe,p2n)^{109}I (10 µb)
^{58}Ni(^{54}Fe, 4n)^{108}Xe (0,1-1 nb ?)
☢ ^{40}Ca(^{74}Kr,α 2n)^{108}Xe (40 nb ?)
☢ ^{58}Ni(^{56}Ni, α 2n)^{108}Xe (30 nb ?)

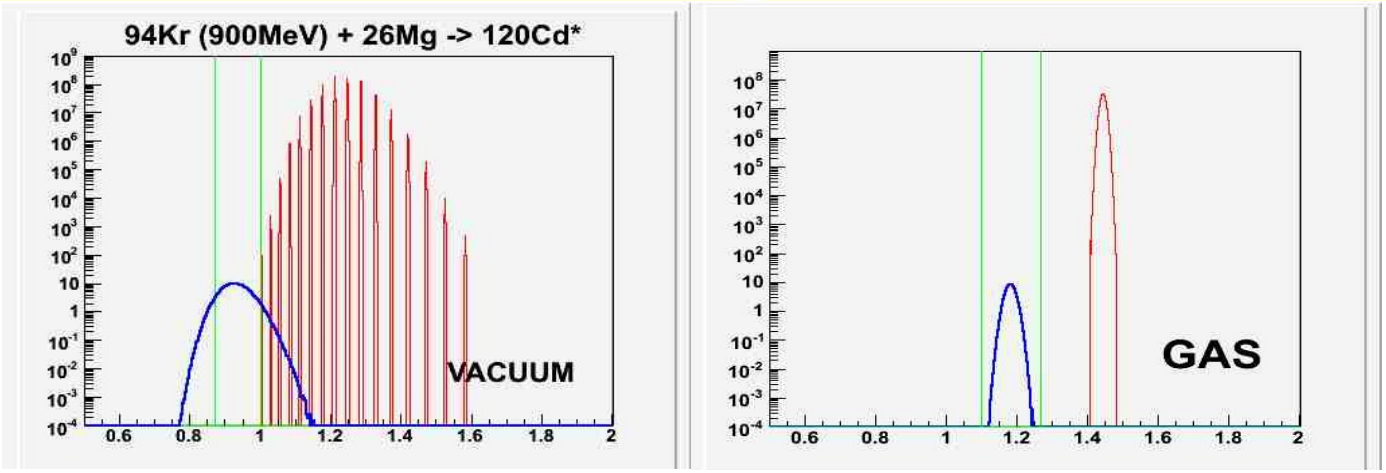
Fine for VAMOS-GFS only
☢ Total F-E cross-section is large → focal plane counting rate is ~ 2000 count / pnA for 1 barn.
Still manageable with MUSETT
☢ Lifetimes !

An example with Spiral2 : very elongated shapes

→ Hyperdeformation and Jacobi shape transition in neutron-rich Pd, Cd isotopes ?







PARIS @ VAMOS-GFS & SPIRAL 2

- Som examples of physics program based on fusion reactions

for PARIS @ GANIL / SPIRAL 2

- Jacobi shape transition

$$^{94}Kr\ (9\ AMeV) + {}^{24}Mg \rightarrow {}^{120}Cd^*$$

- Hot GDR studies in neutron-rich nuclei :

$$^{132}Sn\ (5\ AMeV) + {}^{12}C \rightarrow {}^{142}Ba^*$$

- Heavy ion radiative capture

$$^{12}C\ (2\ AMeV) + {}^{12}C \rightarrow {}^{24}Mg^*$$

Reaction mechanism with Spiral 2

- Influence of shell effects on reaction dynamics
- Competition between fusion and quasi-fission

- $^{134, 136, 138, 140, 142}$Ba (3-6 MeV/u) + ^{74}Ge
- $^{132, 134, 136, 140, 142}$Xe (3-6 MeV/u) + ^{82}Se
- $^{126, 128, 130, \mathbf{132}, 134}$Sn (3-5 MeV/u) + ^{88}Sr

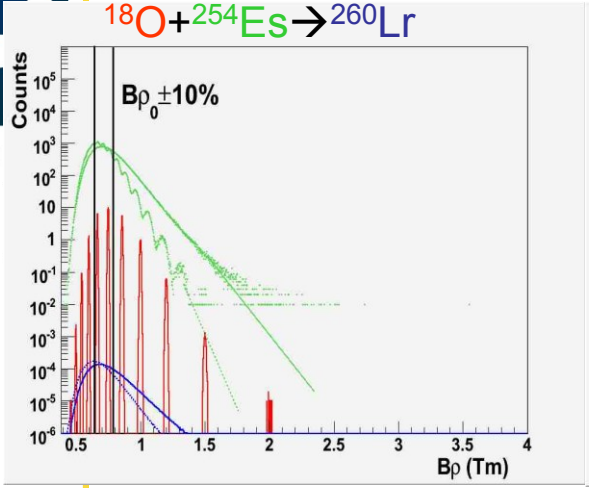
} $_{88}$Ra isotopes

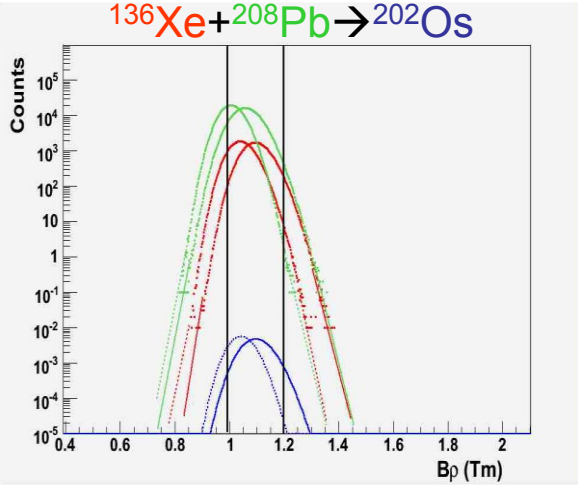
- F.E. residues are α emitter → RDT
- Additional identification using HiRes gamma-spectroscopy
- Reaction time → GDR

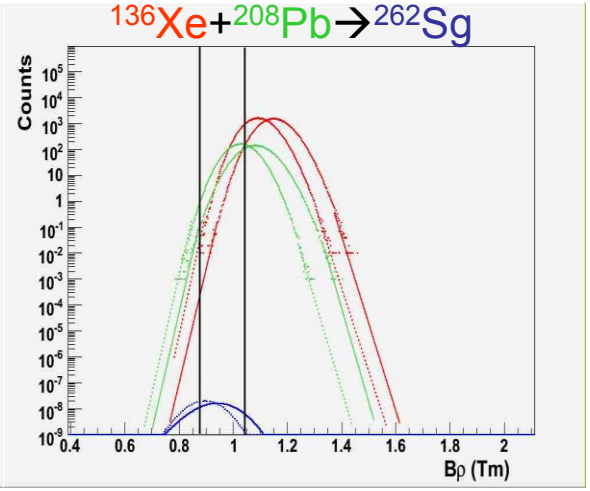
Consequences on SHE synthesis using RIB ?

Multinucléon transfer ?

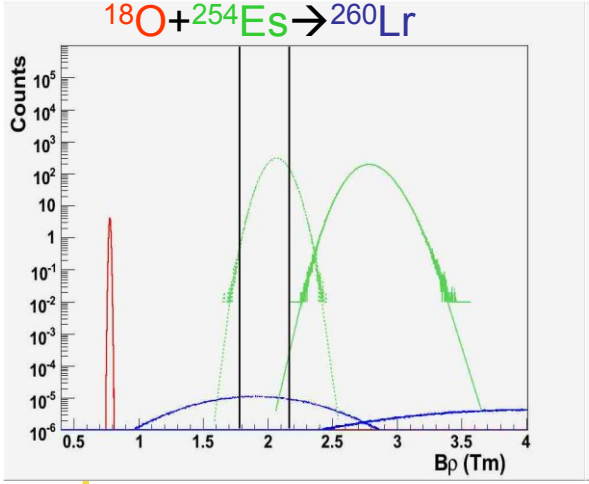
Vacuum mode (Q parameterisations from Shima and Sagaidak)

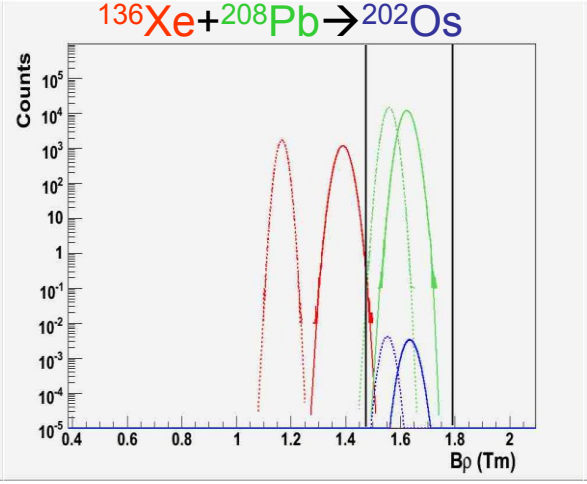


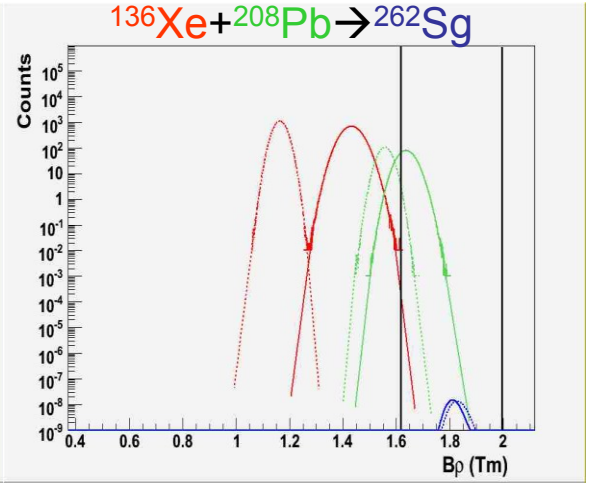




Gas-filled mode (Q parameterisations from Ghiorso and Oganessian)

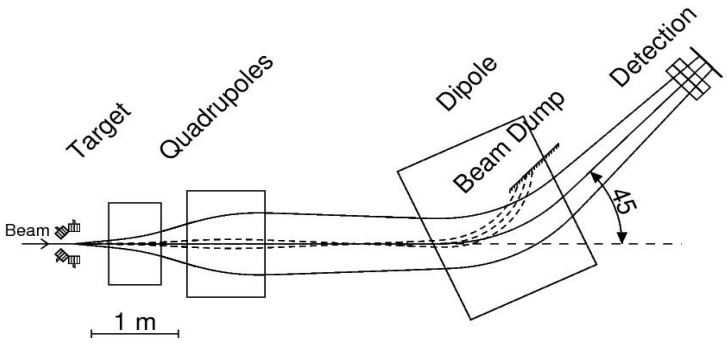




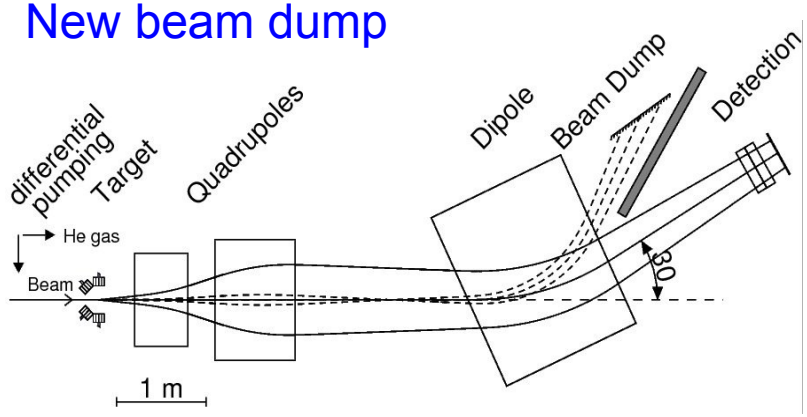


Technical requirements

2009 test



New beam dump



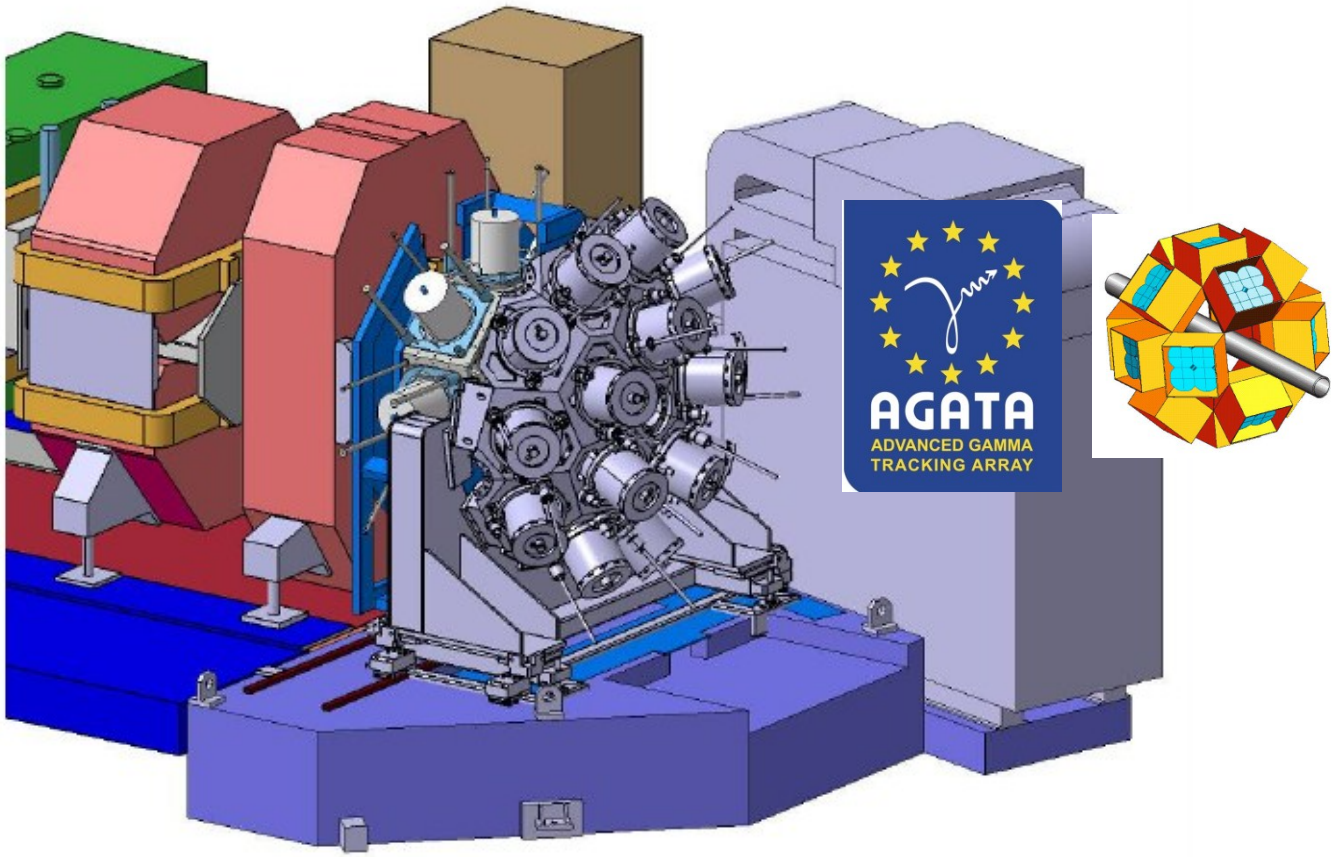
→ New focal plane chamber

Pressure differential He gas ↔ vacuum

- C Window : fine for first and “easy” cases
- Differential pumping system : mandatory to reduce background and straggling

- New target holder needed → mutualize with AGATA ?

A great opportunity : VAMOS GFS + AGATA



40 Agata crystals+ 8 Exo Clover ϵ > 20 %

We should be ready in 2014
It is time to start upgrading to VAMOS-GFS !