Vamos gas-filled mode: upgrade and future perspectives

Tasca 12, GSI, 14 Septembre 2012

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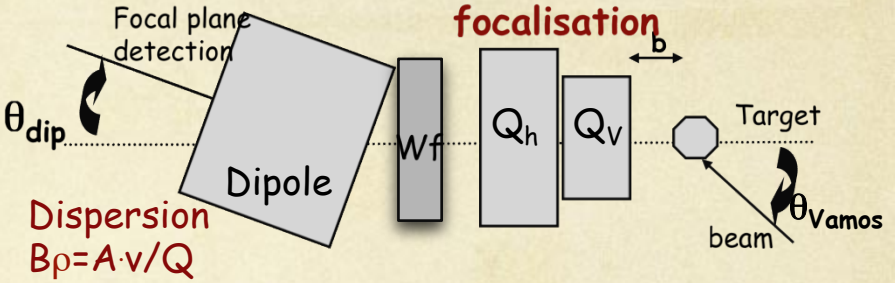
Cea Saclay, France

MOTIVATIONS for Heavy elements studies at VAMOS (Vacuum mode)

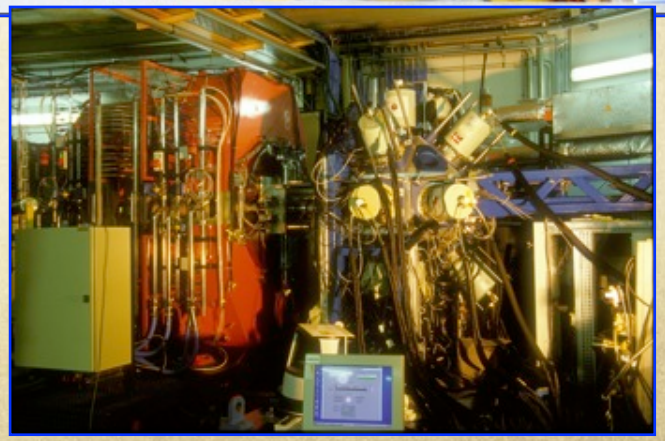
- High performances of VAMOS
  - Large angular acceptance Ω ~ 60 msr
  - High transmission
  - Unique for asymmetric reactions



- High performances of Exogam for low multiplicity cascades

Prompt γ spectroscopy with VAMOS + EXOGAM

- MUSETT: NEW Si window-less segmented detectors for RDT measurement



→ Performent set up for prompt spectroscopy of heavy element via decay tagging technique

Experimental results:

2010 : WF test + MUSETT commissioning + new DAQ (NARVAL) test +Exogam

$^{22}Ne(^{197}Au,xn)^{213,214,215}Ac$

Si Wall : 40x10 cm^2

Si detector:

- Window-less Si detectors; Number of strips : 128 x +128 y strips

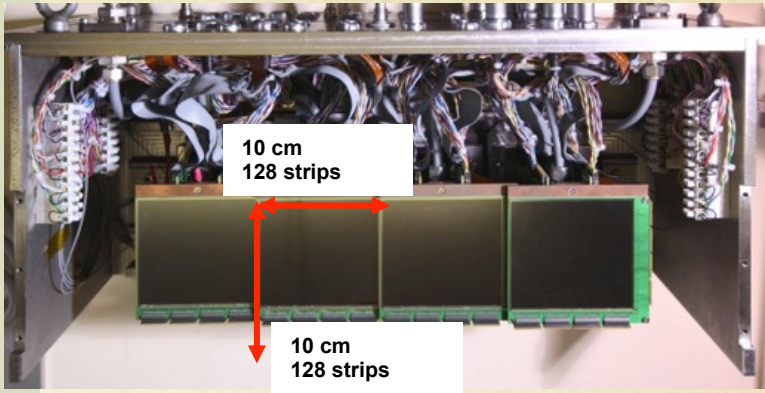
FRONT END ELECTRONICS:

- ASIC electronics : ATHED (based on MUST2)
- COFEE board on which 4 ASICs are installed →I2C slow control

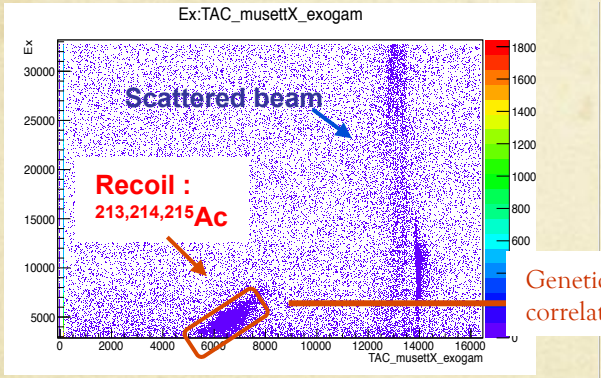
BACK END ELECTRONICS:

- MUVI VXI → readout & slow-control (GANIL)

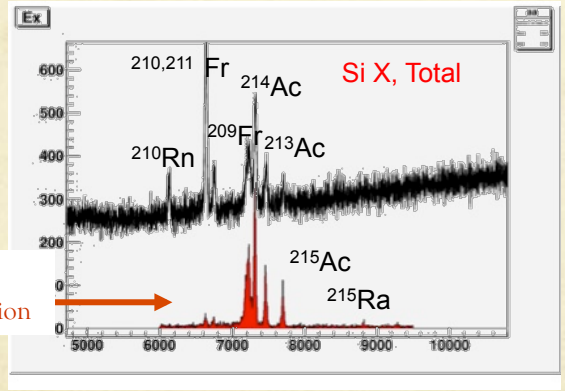
DAQ: 3 independent DAQs and data streams + NARVAL-based data flow



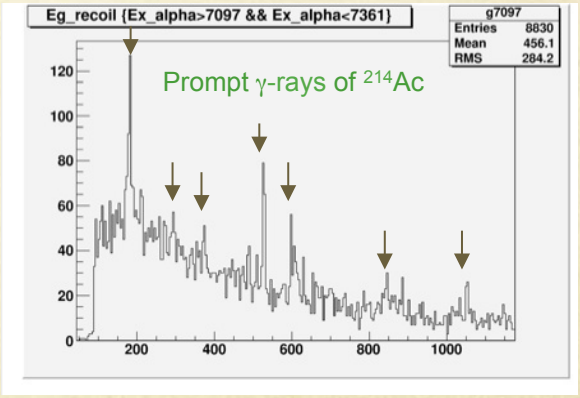
Recoil decay tagging



Genetic correlation



Prompt spectroscopy

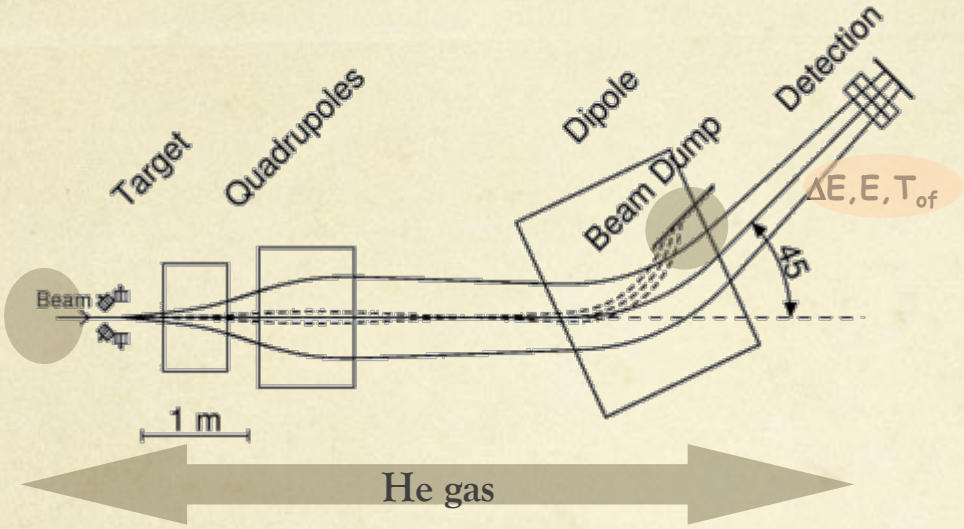


Conclusion : WF rejection disappointing ~ 10^7, Transmission for asymmetric ~ 40%

→ Successful MUSETT commissioning

VAMOS

From vacuum to gas



C.Schimtt et NIM (2010)

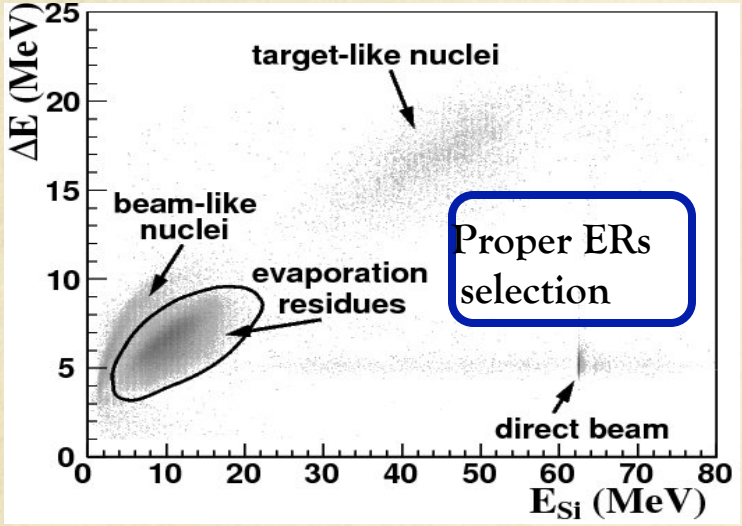
- C foil before the target for vacuum/gas separation
- He gas-filling ~1mbar
- beam stopper (Ta plate)

2009 VAMOS GFS test:

- ^{40}Ca (196MeV) + ^{150}Sm → ^{190}Pb* (σ_{ER} ~ 50mb)
- Ers identified via α-decay in Si wall and/or prompt γ- rays in EXOGAM

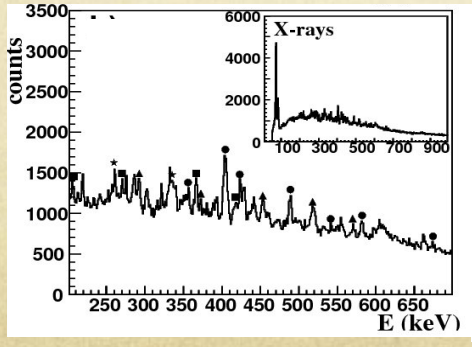
Results in the gas-filled mode

✓ Selection of the ERs

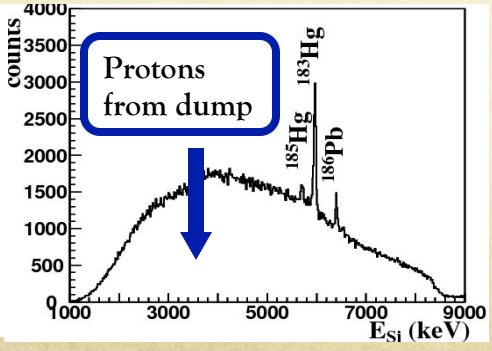


✓ Identification

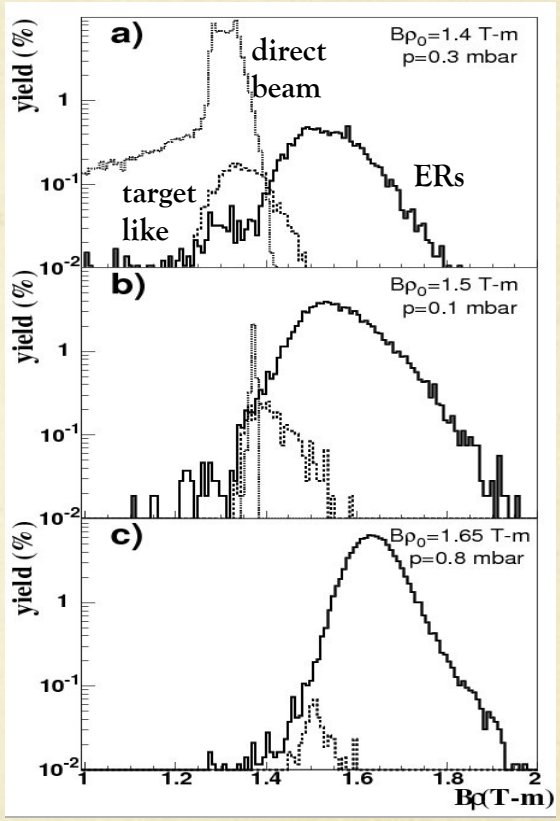
Prompt γ-radiation



Radioactive α-decay



✓ First measurement of Bρ @ a gas-filled magnet

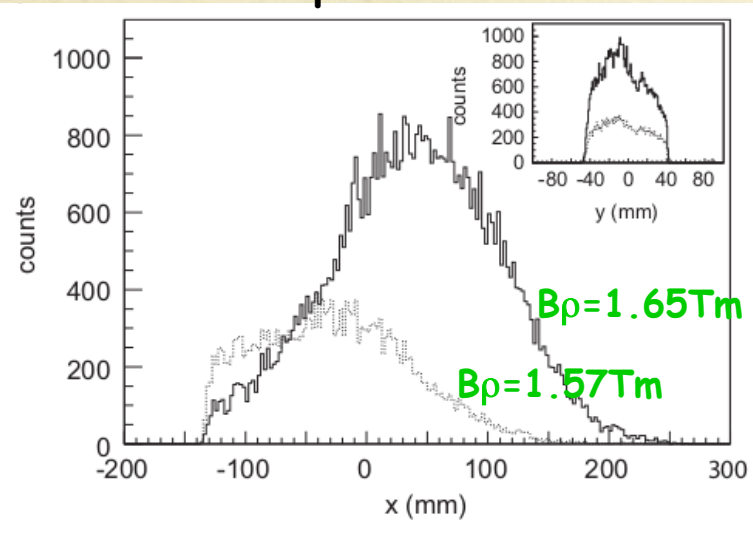


✓ Velocity at the target available
(crucial for high velocity and $\vartheta \neq 0°$)

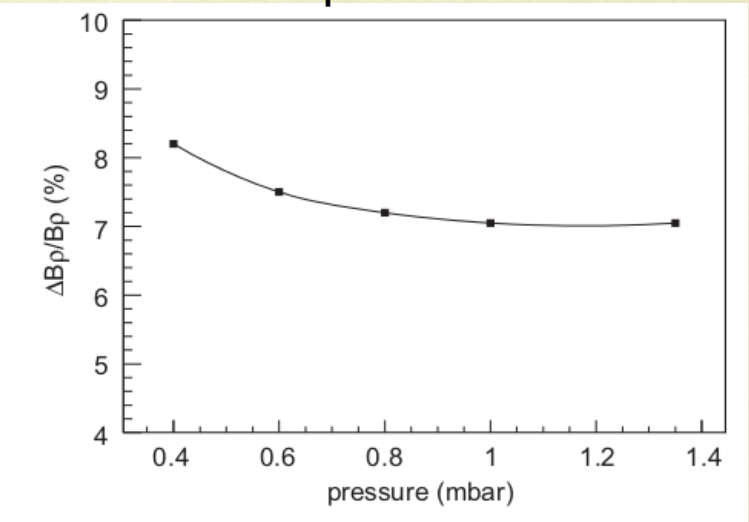
Performances (1)

✓ Beam Rejection

p = 0.8mbar



Bρ = 1.65Tm



Optimal conditions : **$B\rho_0$=1.65Tm and p ~ 1mbar** (with present simple set-up)

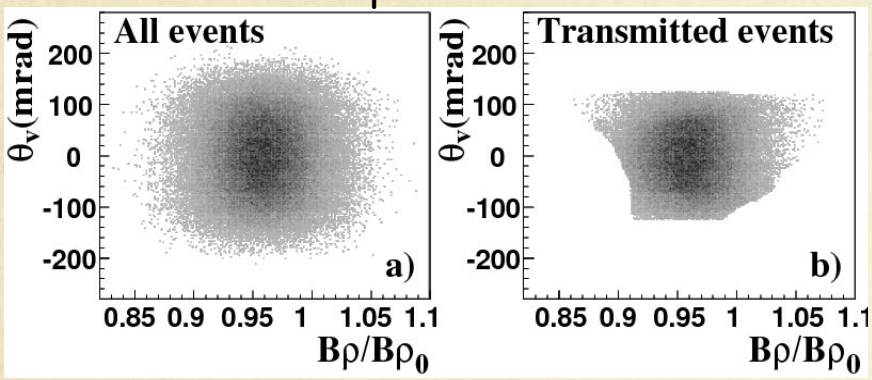
Beam rejection factor > 10^{10}

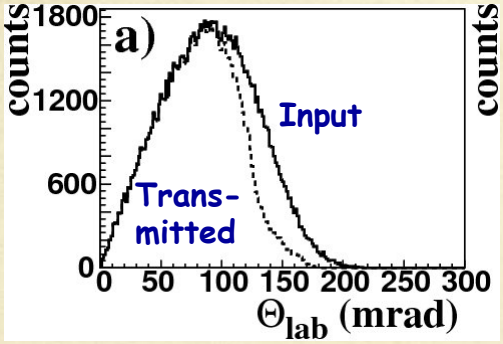
No direct beam on the detectors for $1{\cdot}2{\cdot}10^{10}$ ^{40}Ca per sec sent in VAMOS

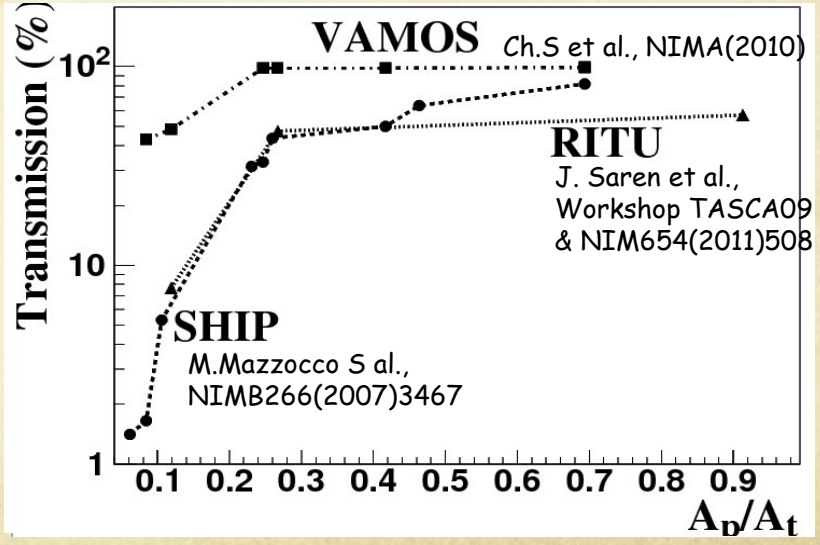
Performances (2)

✓ Transmission (from ion-optical calculations validated by the experiment)

α3n evaporation channel



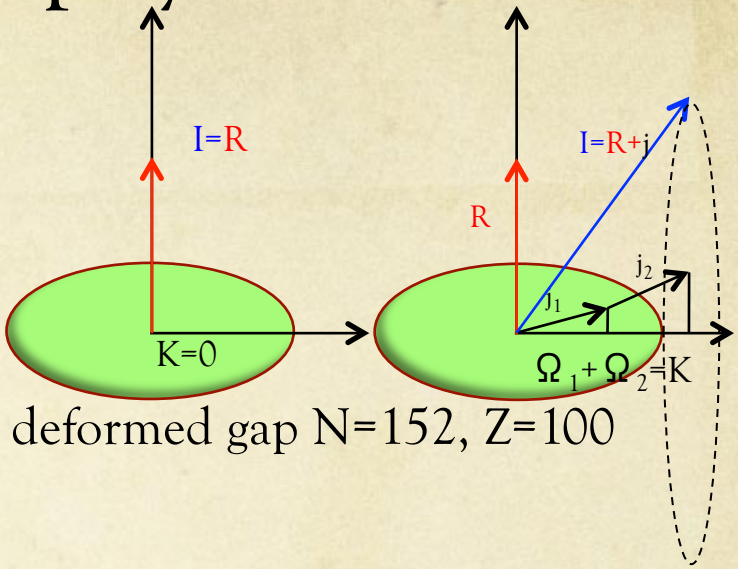




~ 80% for α evaporation channels
~ 95% for n/p evaporation channels

Cf isotopes : a first physics case

- Spectroscopy of $^{240\text{-}244}$Cf



- 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 configuration
- Yrast band : paring correlations

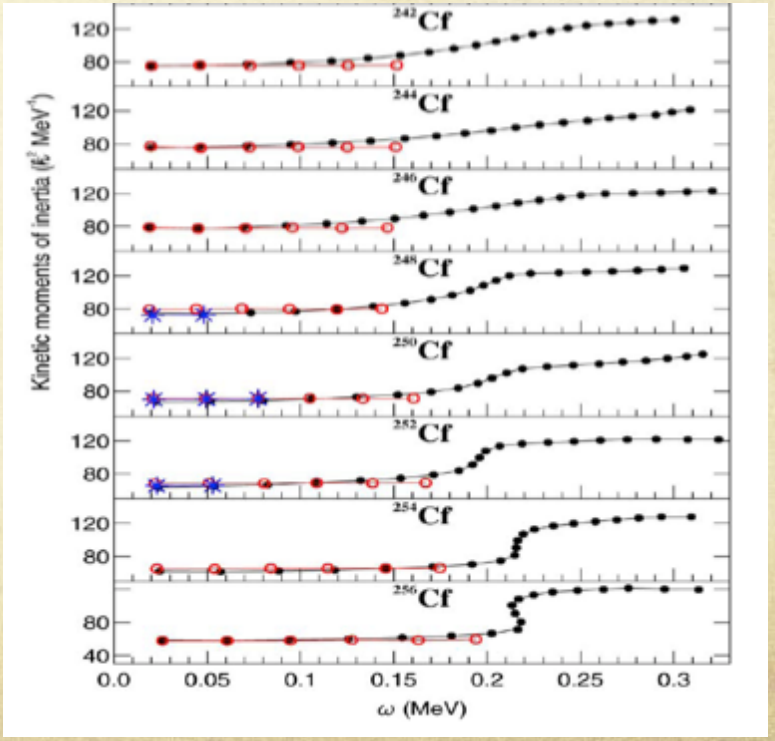
- Cf nuclei still poorly known

- Theoretical background :

HFB-Gogny with time-reversal breaking;
Bruyères-le-Châtel (J.-D. Delaroche, M. Girod).

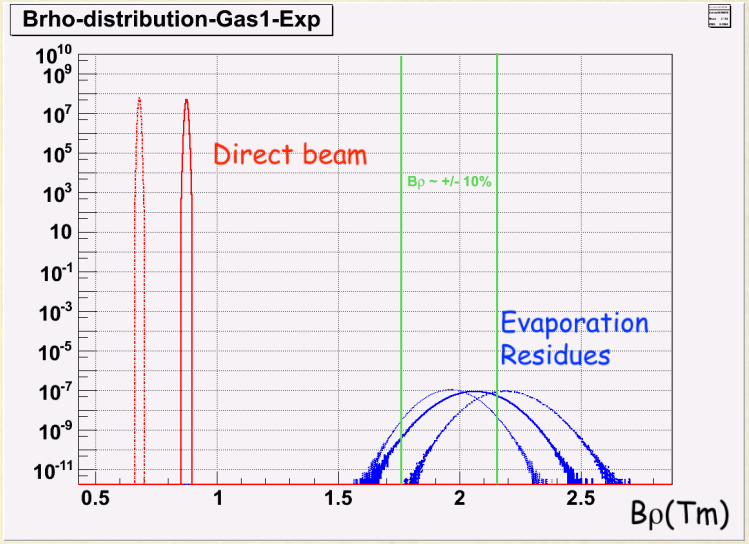
- Accepted 7 days experiement

Proposal B. Sulignano, P. Greenlees,
Ch. T, GANIL PAC november 7th 2011



Bρ distribution ^{244}Cf

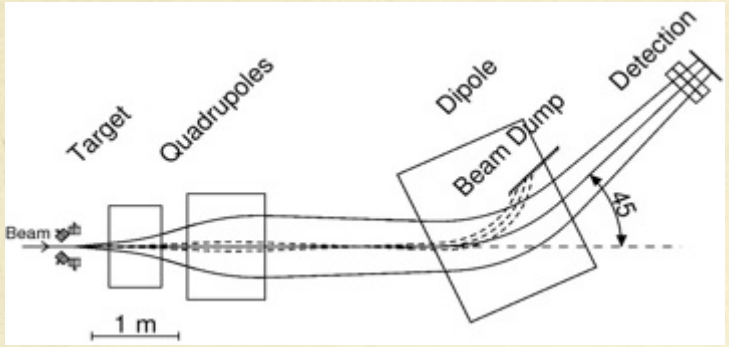
$^{48}Ca + {}^{198}Pt \rightarrow {}^{244}Cf + 2n$



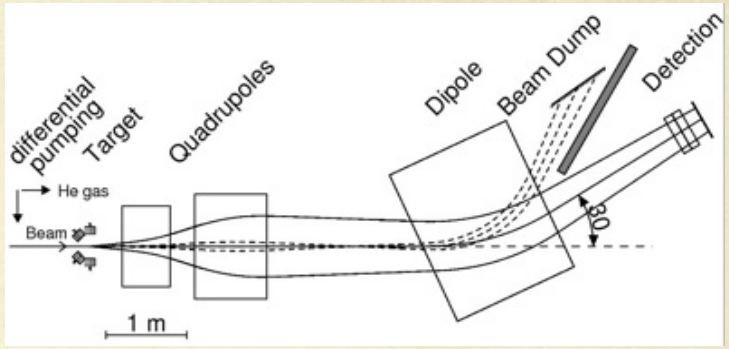
Improvements towards physics experiments

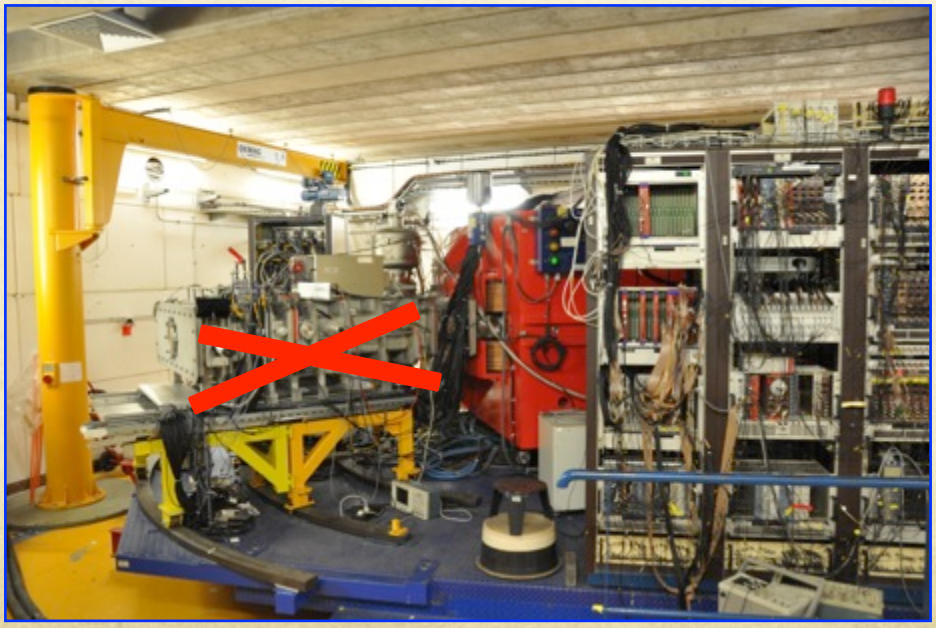
VAMOS-GFS : beam dump

2009 test



New beam dump





New focal plane chamber for

- Detection (MUSETT)
- Beam dump (movable)
- Shielding (movable)

Irfu Improvements towards physics experiments

VAMOS-GFS : pressure difference

- Solution 1 : C window.
  - 2009 test
  - Has been used at JYFL for years
  - Dubna-DGFRS uses a C window

Drawbacks :

- Parasitic reactions → gamma background
- Beam straggling → beam quality

But fine for first experiments and « easy cases »

- Improvements compared to the 2009 test
- Need a new target holder

Solution 2 : Differential pumping (windowless mode)

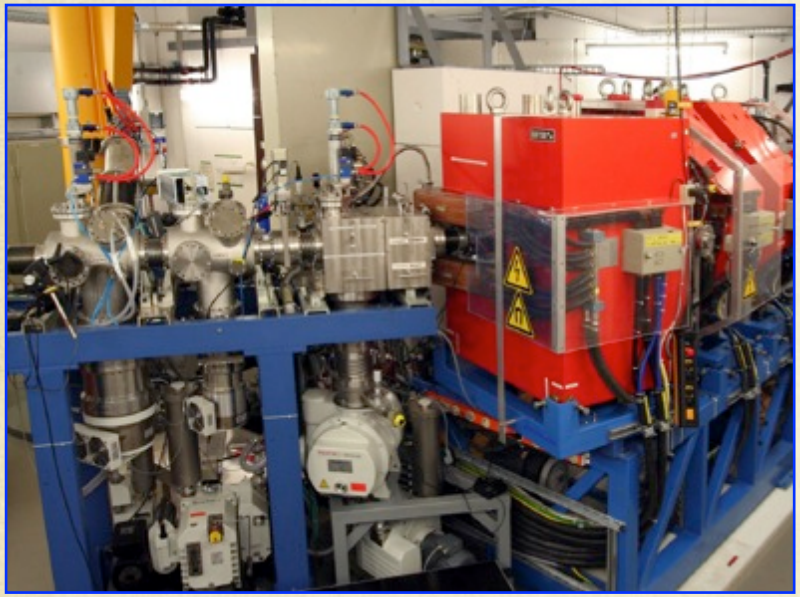
- RITU@JYFL, TASCA@GSI, GARIS@RIKEN, ...
- No parasitic reactions and gamma background
- No beam straggling
- Need a new target holder

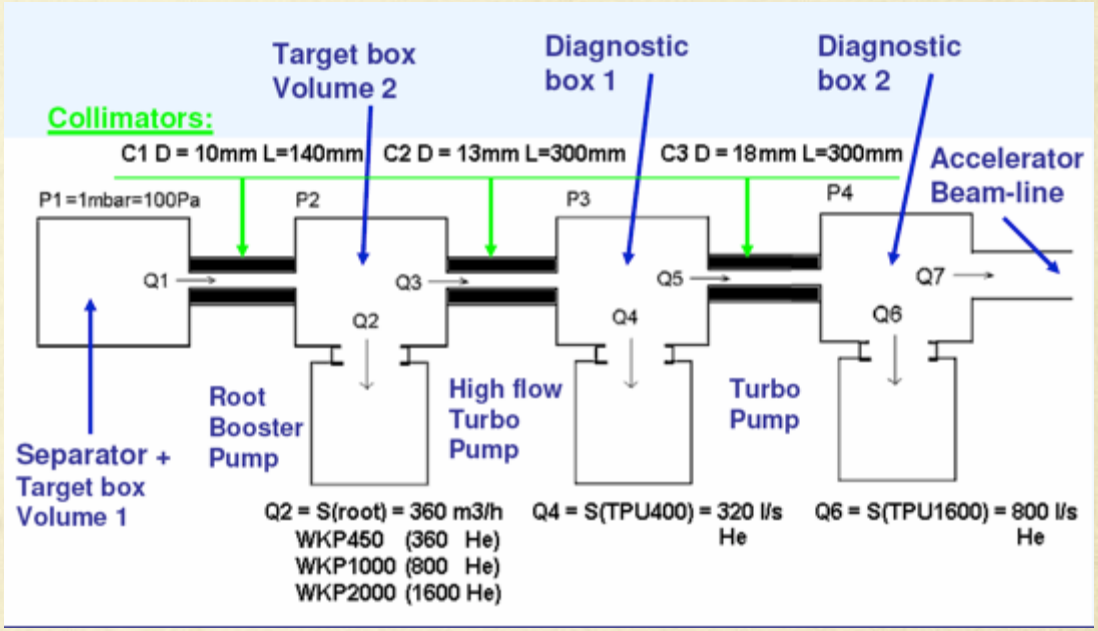
Improvements towards physics experiments

Differential pumping

- Series of collimators (reduce gas flow) + pumps

Example : differential pumping@TASCA (GSI):





- Collimators have to be compatible with the beam envelop
- New target holder needed
- Tight space (Ge detectors)

VAMOS-GFS : a 3 step project

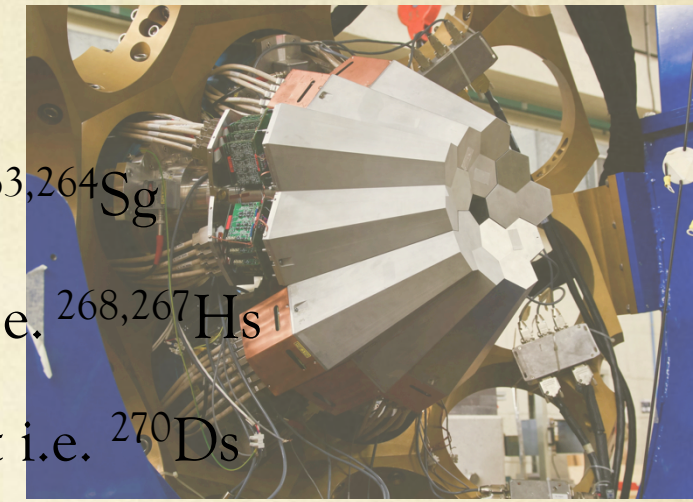
1. Beam dump + new C window + new target holder
   - ^{242}Cf and « easy experiments »

2. Differential pumping system
   - In time with AGATA (2014)

3. Spiral 2 (phase2) compatibility
   - What to do with the gas ?
   - Beam dump activation (not only a VAMOS-GFS problem, a general Spiral2 problem)
   - ≥ 2016

Future plans...Spectrosopy of heavy elements

AGATA @ Vamos Exogam2 @ Vamos



→ Reaction based on Si beam U target i.e. ^{263,264}Sg

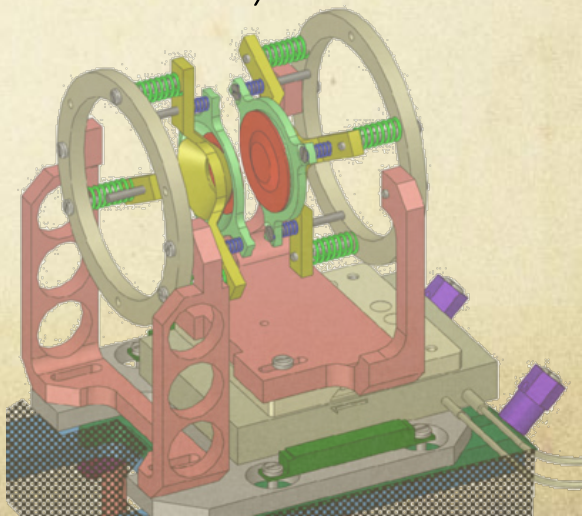
→ Reaction based on S beam and U target i.e. ^{268,267}Hs

→ Reaction based on Ni beam and Pb target i.e. ^{270}Ds

→ Reaction based on Ti beam and Pb or Bi target i.e. ^{256}Rf/Db

+ Oups (plunger) @ Vamos

→ Lifetimes Measurement (e.g. ^{254}No) (RDDS)



Conclusion

- First experiment accepted : $^{242,244}Cf$
- Large physics case : VHE/SHE, reaction dynamics, exotic nuclei and shapes, ...
- A 3 step project
  - Beam dump + C window + target holder
  - Differential pumping
  - Spiral2 high intensity

Task force

Irfu

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GRAZIE !