mercredi 31 août 2011

New Silicon arrays for new facilities

D. Beaumel, IPN Orsay

Unité mixte de recherche
CNRS-IN2P3
Université Paris-Sud 11

91406 Orsay cedex
Tél. : +33 1 69 15 73 40
Fax : +33 1 69 15 64 70
http://ipnweb.in2p3.fr

EGAN Workshop, Padova, June 27th – 30th, 2011

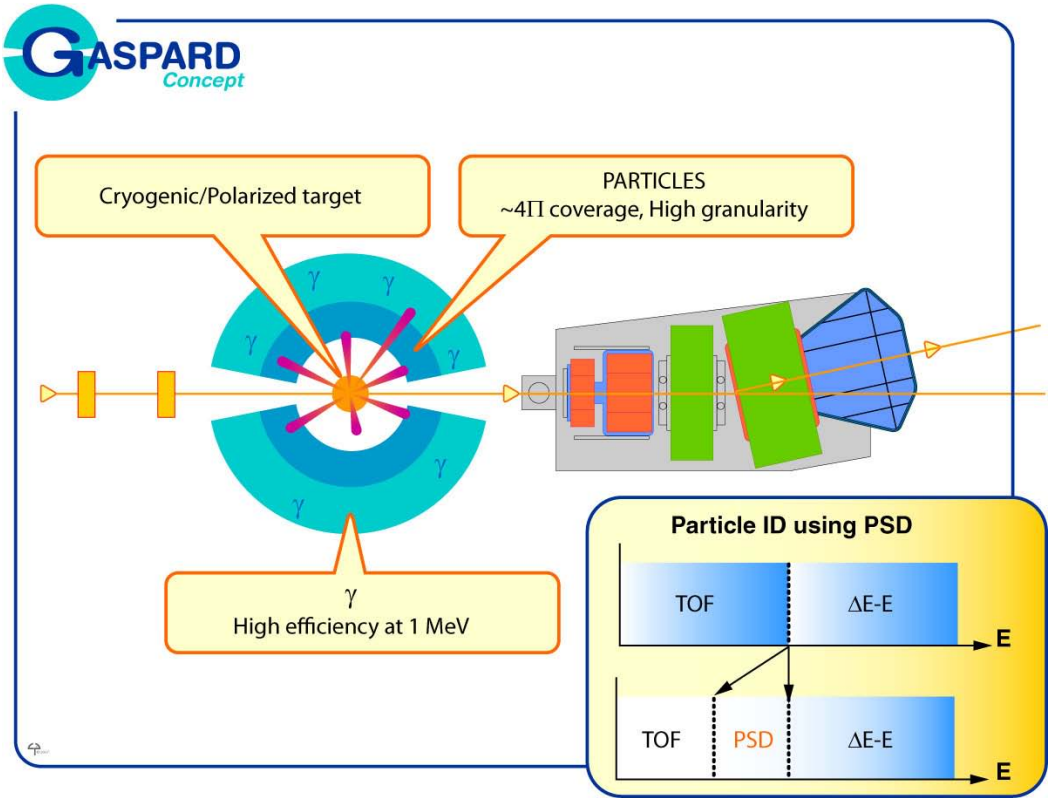
AIM : Optimal study of reactions with beams from SPIRAL2 , FAIR(LowE), SPES, HIE-Isolde, …

From SISSI/SPIRAL to Spiral2

Light ions (A≤40) ➔ Heavier ions (Fission fragments)

Optimized for PA –GA coincidences

- ***E* resolution gain>10 w/r particles only***
- ***High efficiency for γ w/r MUST2/TIARA/EXOGAM***
- ***Gamma spectroscopy of populated states***
- ***…***

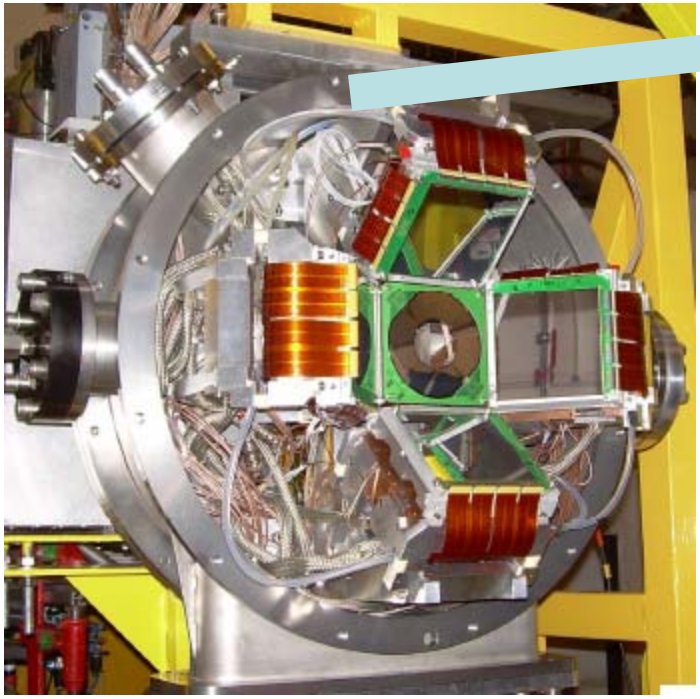


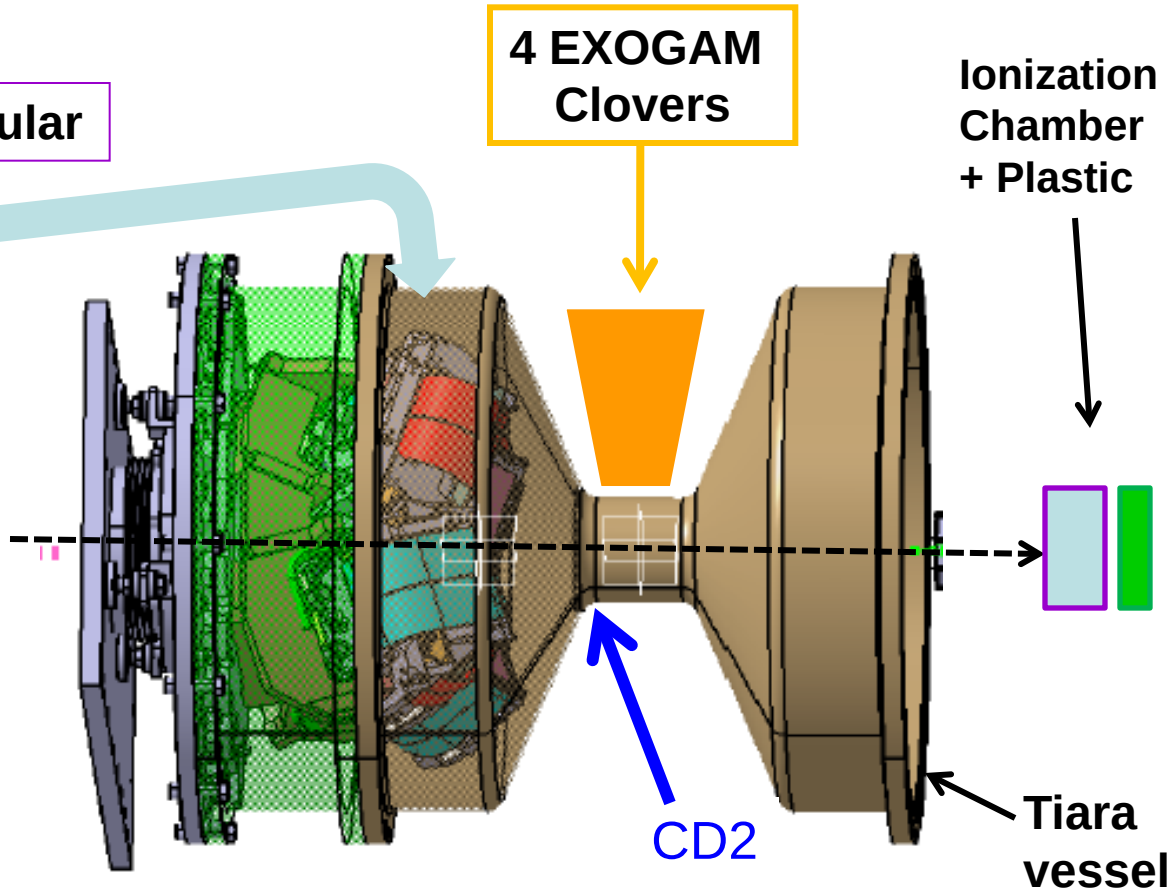
GASPARD : A 4π particle array fully integrable in major gamma arrays (PARIS, AGATA, EXOGAM2)

Recent MUST2 campaign using fragmentation beams at LISE
MUST2 + annular detectors combined with EXOGAM

- **Density dependence of the $p_{1/2}$-$p_{3/2}$ S.O. splitting** — **^{34}Si(d,p)**
  SP: O. Sorlin (GANIL)
- **Astrophysics – nucleosynthesis of ^{60}Fe** — **^{60}Fe(d,p)**
  SP: F.Hammache, N. De Séréville (IPNO)
- **Shell structure evolution near N=40, towards N=50** — **^{68}Ni(d,p)**
  SP : G. Duchêne (IPHC), D.Beaumel (IPNO)

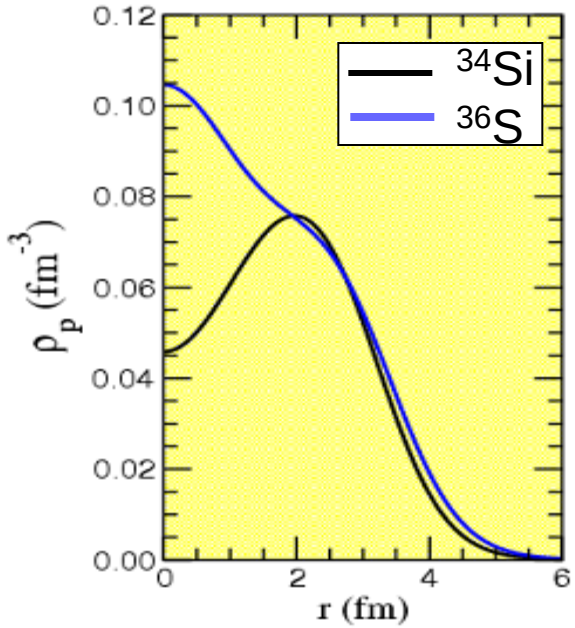
4 MUST2 telescopes + S1 annular

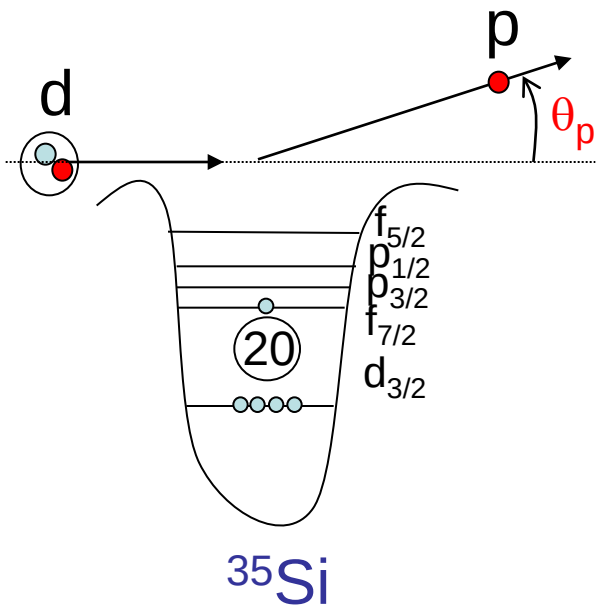




How to probe the central density of the SO interaction ?

Bubble nucleus: Grasso et al, PRC 79 (2009)





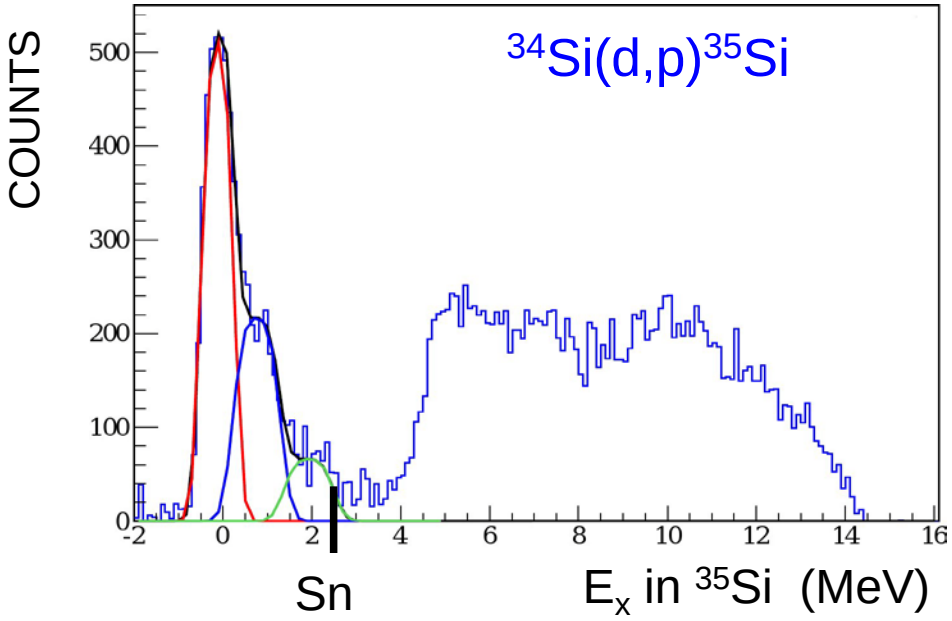
Predicted change of the $p_{3/2}$-$p_{1/2}$ SO splitting between ^{36}S and ^{34}Si

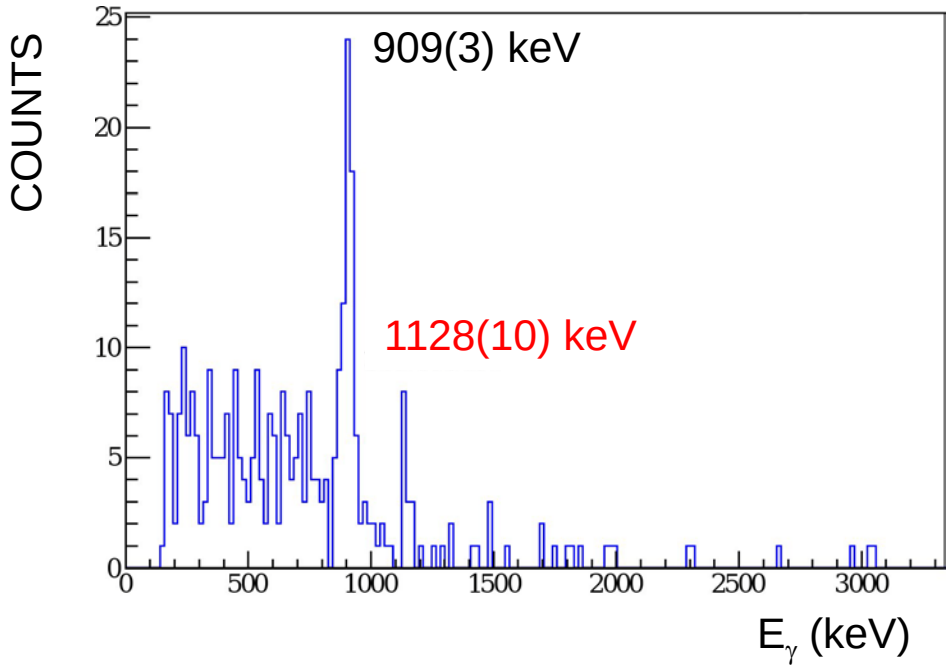
RMF/ NL3	70%
MF Skyrme/ Gogny	40%
SM spdf-u	30%
VlowK	< 10%

Compare $\nu(p_{1/2}$-$p_{3/2})$ splitting { **^{34}Si(d,p)^{35}Si** ; **^{36}S(d,p)^{37}S**

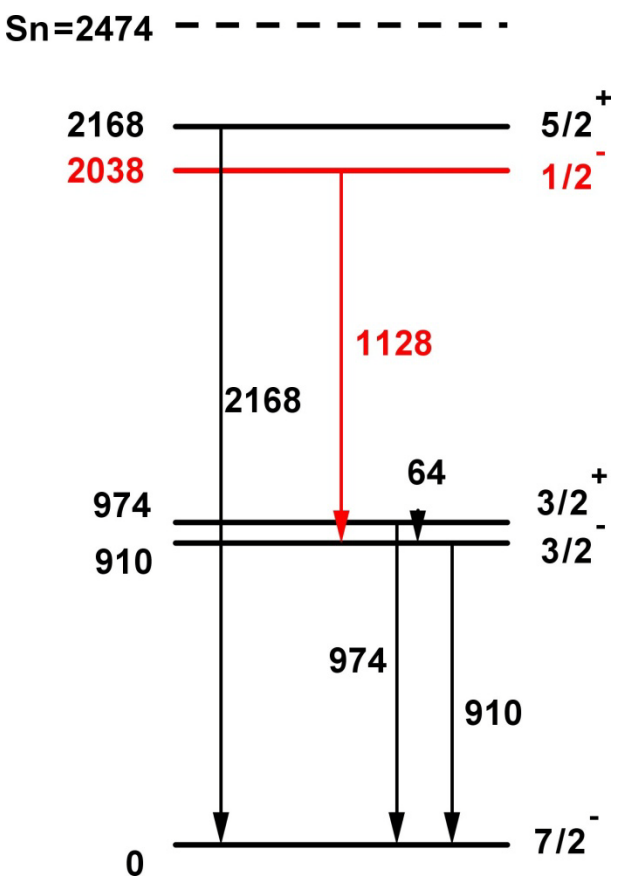
Courtesy O. Sorlin

Preliminary results for $^{34}Si(d,p)^{35}Si$



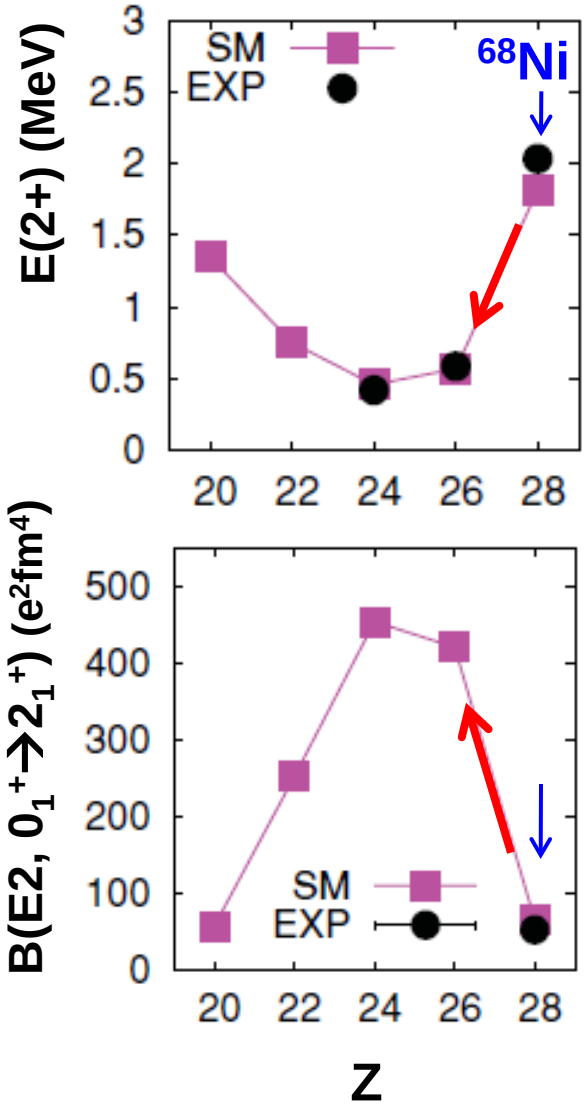


J.Burgunder, PhD thesis
GANIL



Southwest of Nickel's

N = 40



Large valence space SM calculations

S.M. Lenzi, F.Nowacki, A. Poves, and K. Sieja, PRC 82 (2010)

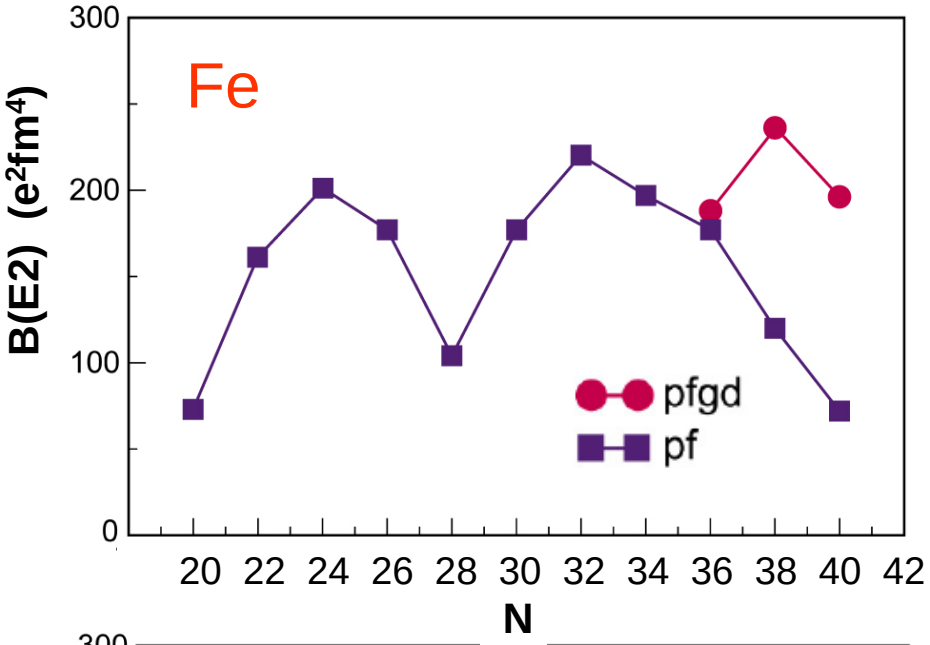
Nucleus	$\nu g_{9/2}$	$\nu d_{5/2}$	0p0h	2p2h	4p4h	6p6h	E_{corr}
^{68}Ni	0.98	0.10	55.5	35.5	8.5	0.5	−9.03
^{66}Fe	3.17	0.46	1	19	72	8	−23.96
^{64}Cr	3.41	0.76	0	9	73	18	−24.83
^{62}Ti	3.17	1.09	1	14	63	22	−19.62
^{60}Ca	2.55	1.52	1	18	59	22	−12.09

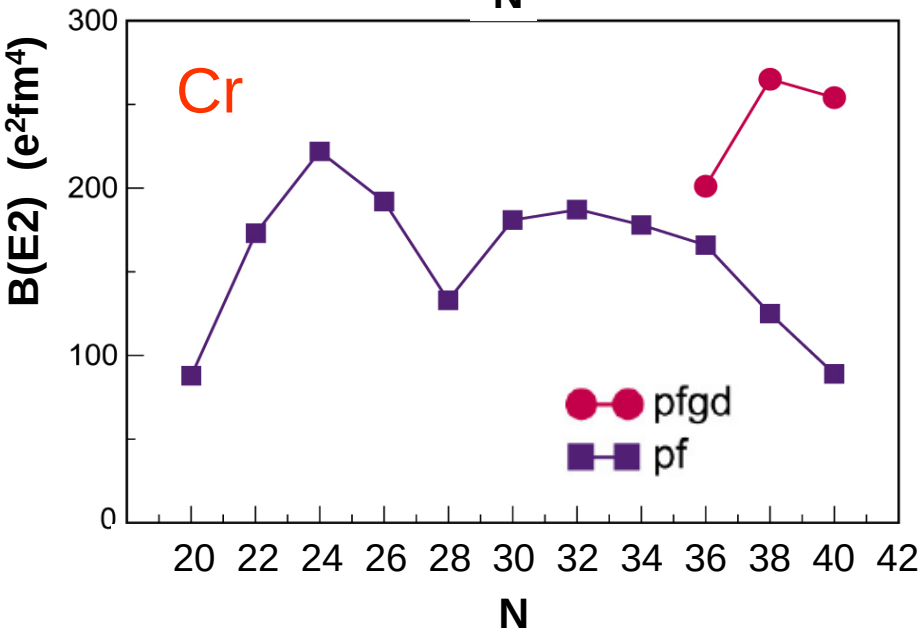
- **Drastic change with only 2 protons removed**
- **Strong gain in correlation energy**
  similar to ^{34}Si / ^{32}Mg
  New island of inversion

N= 40 region

- **Importance of the d5/2 orbital**
  - **First 2^+ state excitation energy experimental values in Fe and Cr N ~40 nuclei are reproduced only when d5/2 orbital included in the SM calculations**
  - **To reproduce ½- isomeric state in ^{67}Co**
  - **To predict the N=50 shell-gap**

measure ^{68}Ni(d,p)

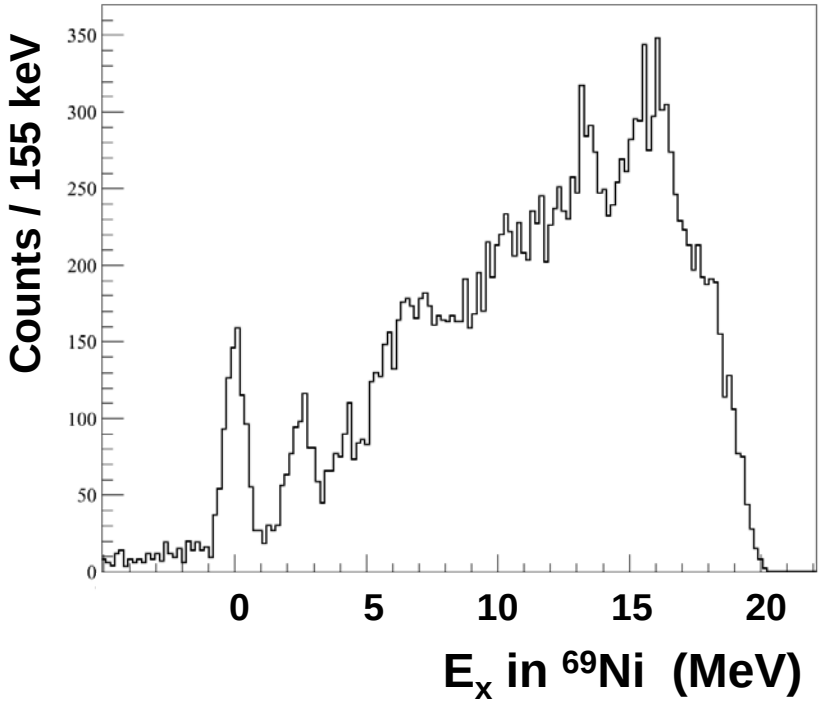


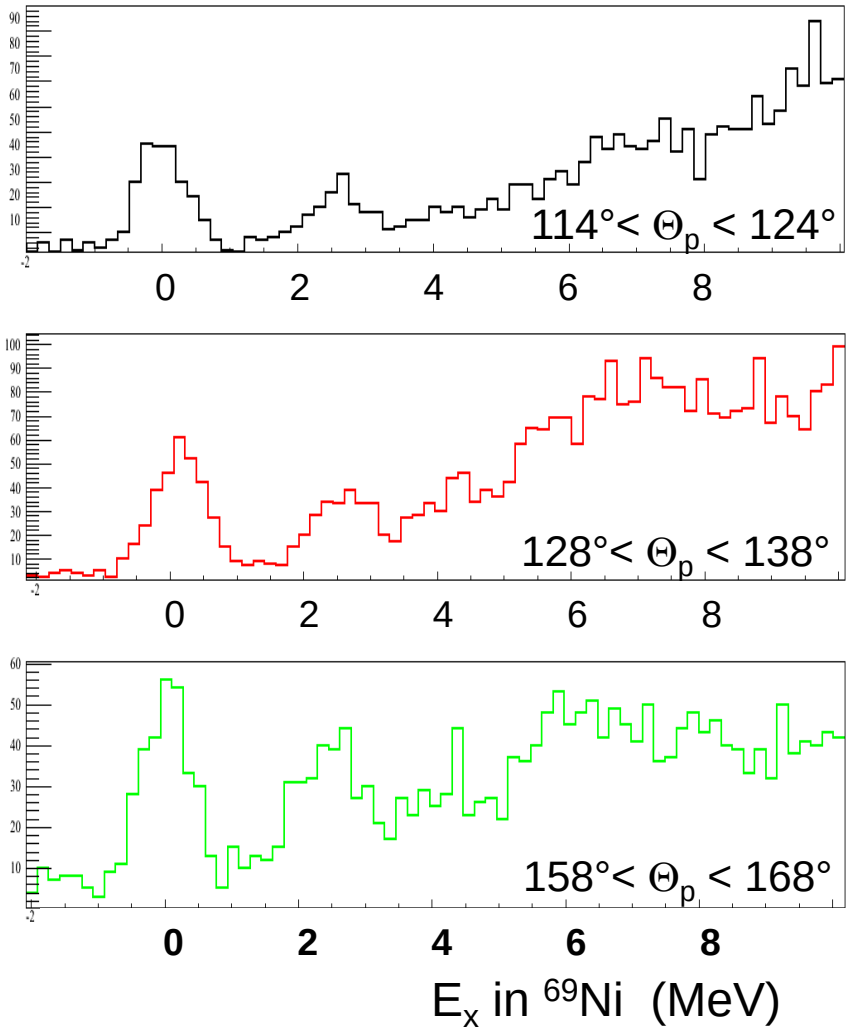


E. Caurier, F. Nowacki, A. Poves, EPJ A (2002)

Excitation energy spectra

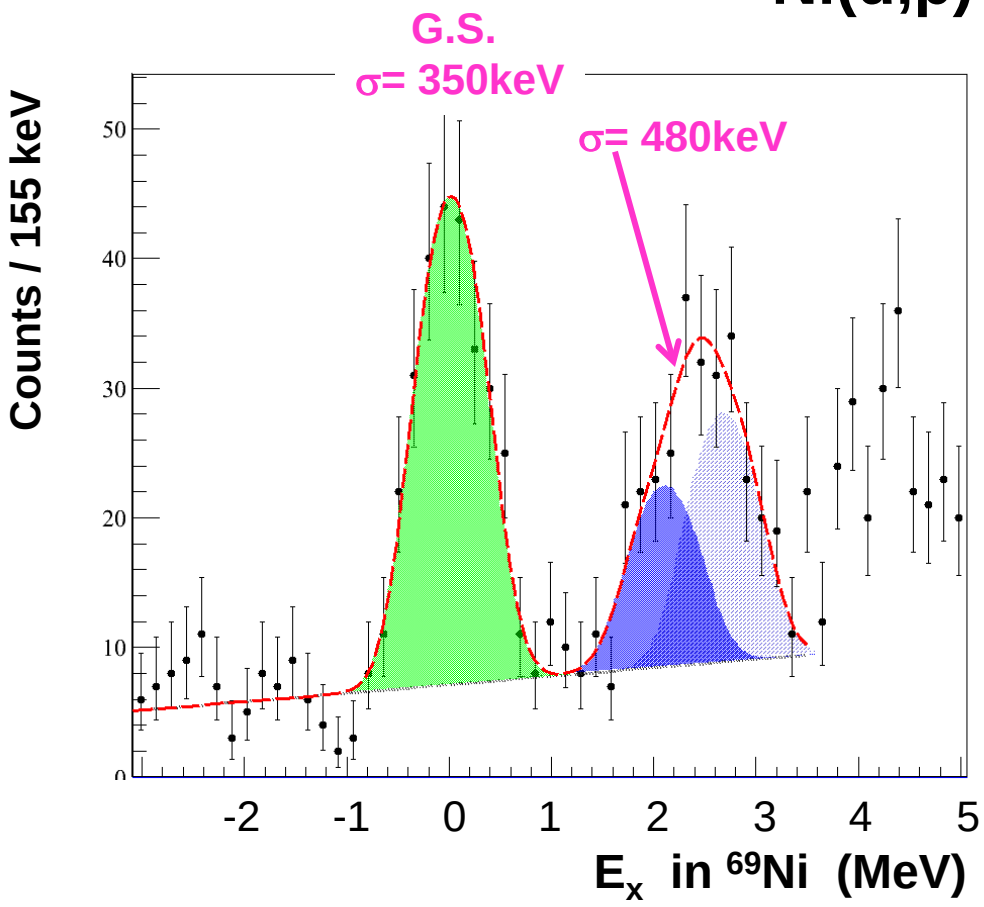
^{68}Ni(d,p) 25 MeV/u *(preliminary)*





E_x spectrum (backward angles)

^{68}Ni(d,p) 25 MeV/u *(preliminary)*



- **At backward angles:**
  E_x resolution mainly determined by resolution on E_{proton}
- **Simulations show that increase of σ due to target effect is ~10 %**

indication of a doublet of levels d5/2 - s1/2 ?

Should be confirmed by analysis of angular distributions gamma-ray spectra

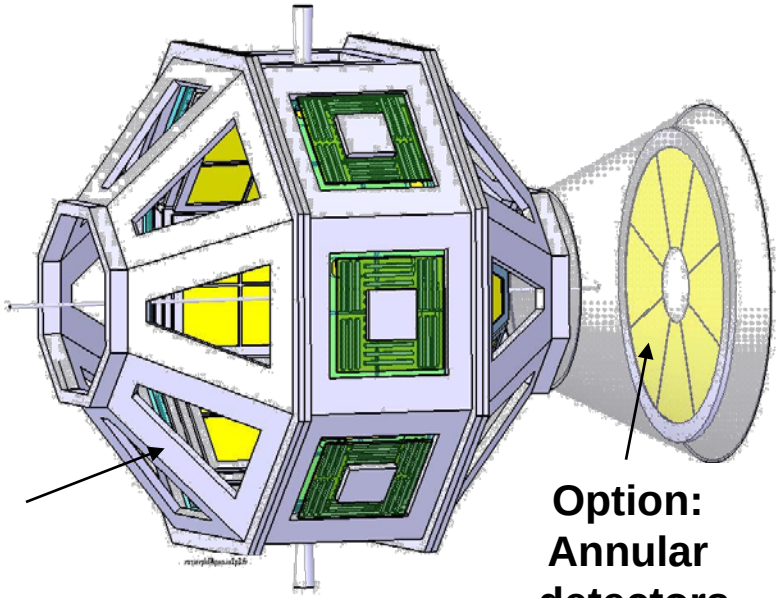
M.Moukaddam, PhD thesis
IPHC Strasbourg

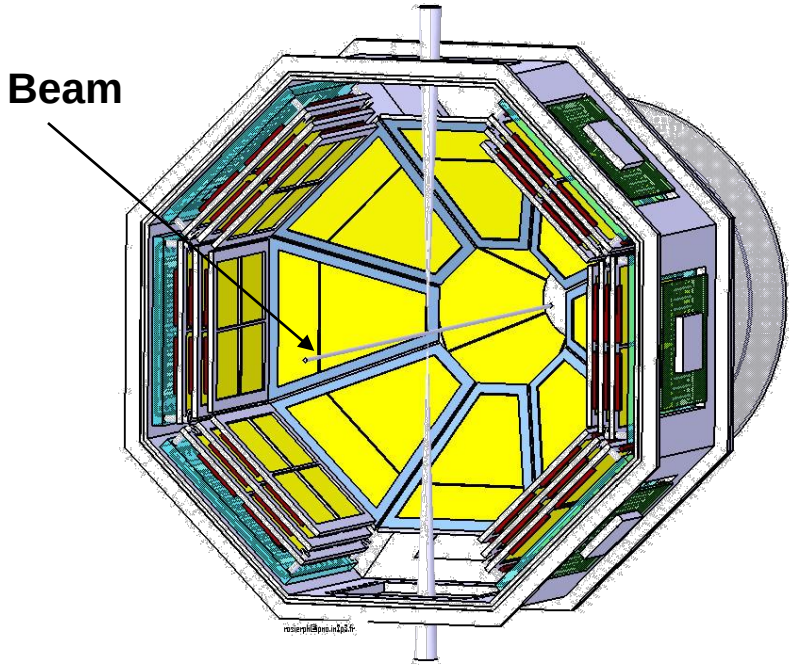
GASPARD design

GAmma SPectroscopy and PArticle Detection

"GASPHYDE" design - **fit inside AGATA**

Basis: DSSD's, 4" technology





Layers of Silicon :

- **300(500) μm DSSD pitch < 1mm**
- **1x [1.5 mm DSSD pitch~3mm] (FWD)**
- **2x [1.5 mm DSSD pitch~3mm] (BWD)**

➢**Integration of special targets(cryogenic,…)**

ELECTRONICS:
~ 15000 channels (Digital)
• Integration and effects on γ-ray under study
Preamps to be in vacuum

Management:

- **Project spokesperson: D. Beaumel (IPNO)**
- **Management Board :**
  - **D. Beaumel (Orsay)**
  - **W. Catford (Surrey)**
  - **I. Martel (Huelva)**
  - **E. Pollacco (Saclay)**
- **Liaison with GANIL: O.Sorlin (GANIL)**

Working Groups

- **Physics simulations** — **M. Labiche (Daresbury)**
- **Silicon detectors and PSD** — **J.Duenas (Huelva)**
- **FEE, C&C and DAQ** — **F.Druillole (Saclay)**
- **Targets and beam tracking** — **A. Gillibert (Saclay)**
- **Design / Integration - Coupling with other devices** — **W.Catford (Surrey)**

GASPARD Collaboration

GAmma SPectroscopy and PArticle Detection

M.Assié, D. Beaumel, N. De Séréville, S.Franchoo, F.Hammache, J.A. Scarpaci, I.Stefan **(IPN Orsay, France)**

W.N. Catford **(Univ. of Surrey, UK)**

M. Labiche **(STFC Daresbury, UK)**

A.Chatterjee, K. Mahata, A. Shrivastava, **(BARC Mumbai, India)**

L. Acosta, R.Berjillos, J.Duenas, I.Martel, V. Parkar, A.Sanchez-Benitez **(Univ. of Huelva, Spain)**

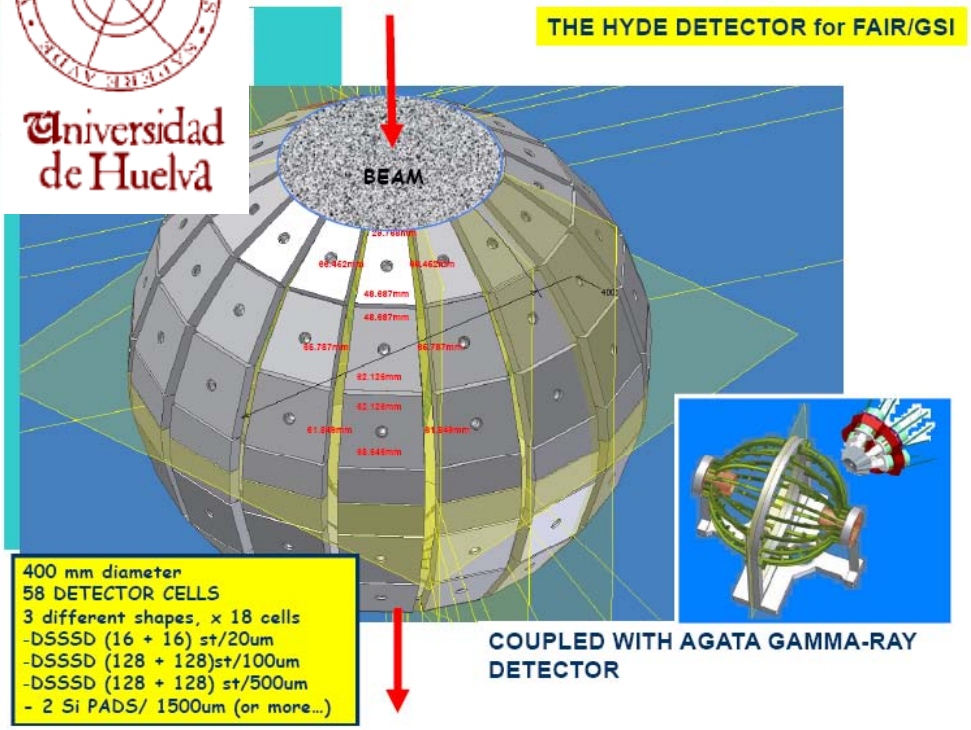
A.Corsi, F.Druillole, A.Gillibert, L.Nalpas, E. Pollacco **(SphN/IRFU, Saclay, France)**

A. Chbihi, F. De Oliveira, O.Sorlin **(GANIL, France)**

GASPARD Partners

- ***University of Huelva***
  HYDE project
- ***BARC Mumbai***

HYDE



Collaborations with other projects:

FAZIA (Silicon/PSA)

EXL (Silicon/PSA) under discussions

ACTAR (Physics, FEE/DAQ)

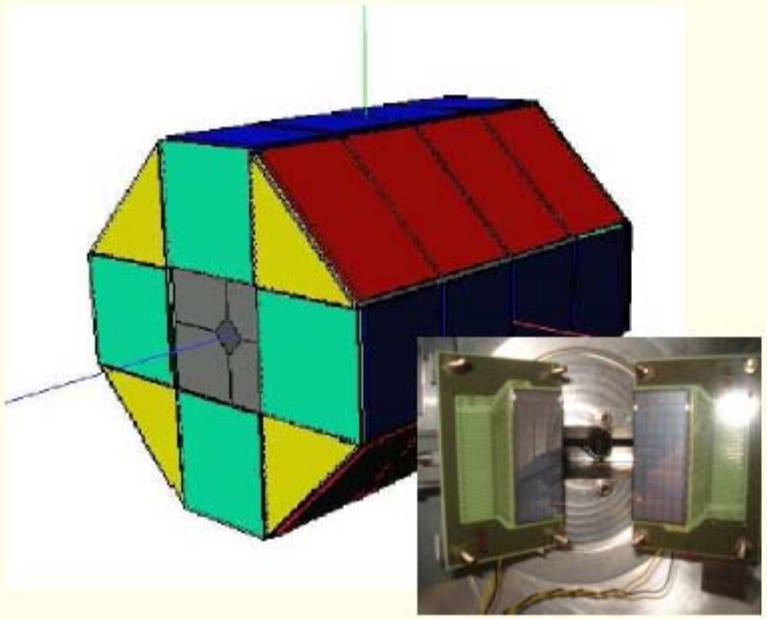
TRACE (FEE+detectors) under discussions

TRACE

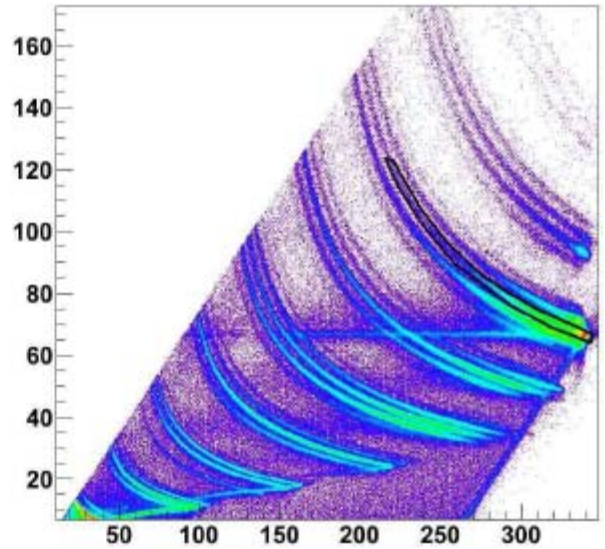
Highly-segmented silicon-pad detector for particles and light ions detection.

- Direct and Fusion evaporation reactions.
- Two-layer silicon-telescope array to be used mainly as an ancillary of large gamma-ray spectrometers.

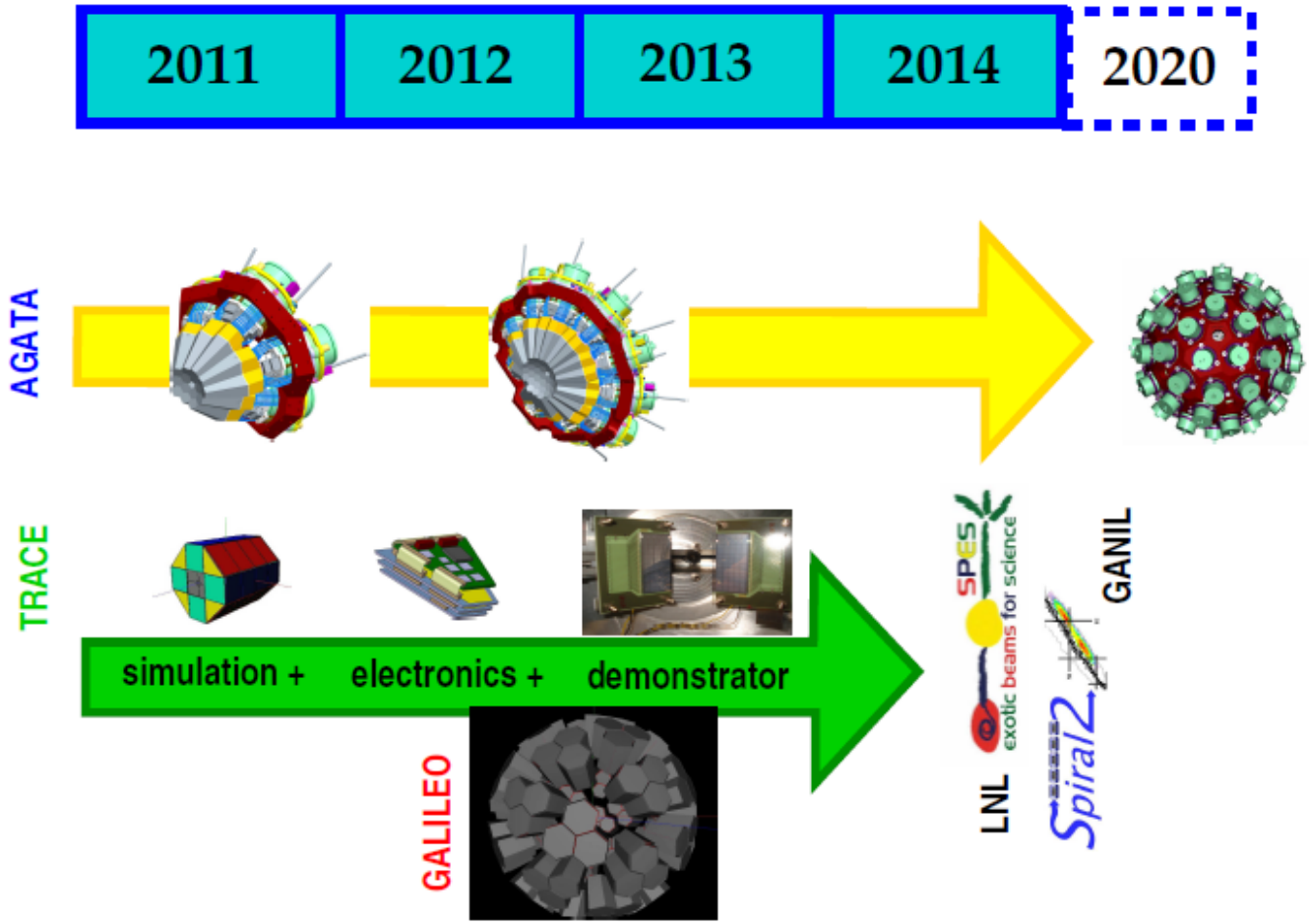
TRACE



$^{17}O+^{208}Pb$



Timeline



RECENTLY:

Detector: New batches (30 detectors each) from FBK-IRST: 200μm and 1.5 mm (I_{dark} <1μA)

Positions: 2 fully funded PhD positions open at Padova University (one devoted to FEE).

Preamp: New preamp with high gain 40mV/MeV, but covering only few hundres channels.

Simulations for GASPARD & HYDE

Marc Labiche, STFC Daresbury
Nicolas de Séréville, IPN Orsay
Angel Sanchez Benitez, University of Huelva

Main framework: GEANT4

- Monte-Carlo simulation code written in C++

Starting point: NPTool

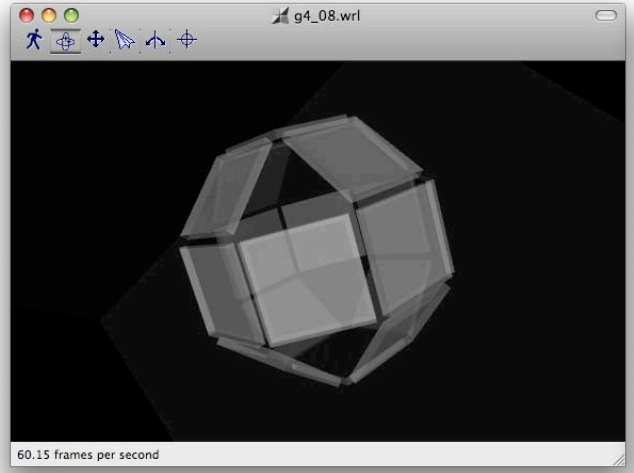
- Initially developped at IPNO for simulating the MUST2 array (Adrien Matta)
- First version: only charged particles detectors included
  Now includes gamma detectors from the PARIS array

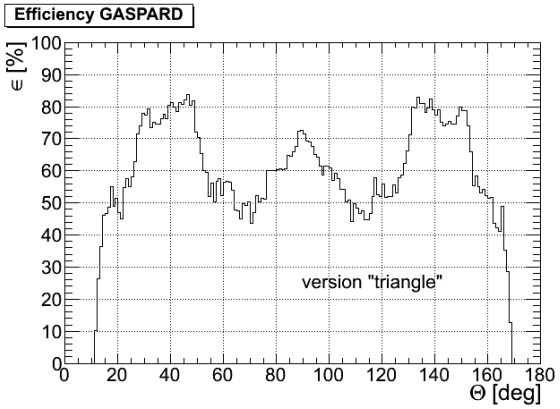
Two components:

- NPSimulation
  detector geometry & event generator (cross-section, kinematics, …)
  produces event file in root format
- NPAnalysis
  Set of tools (macros, programs) analysing the output file
  Calculate efficiency detection, excitation energy, …

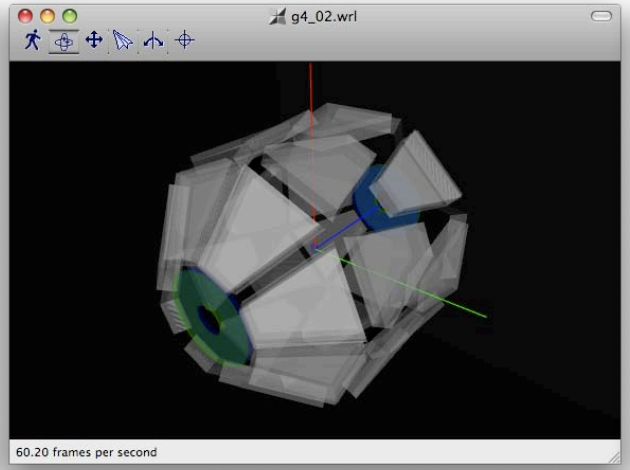
Realistic geometries

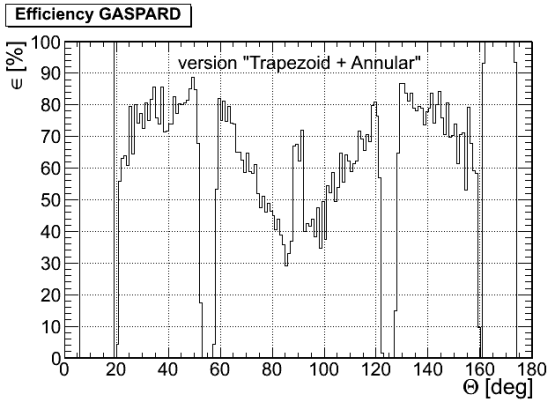
Square shape



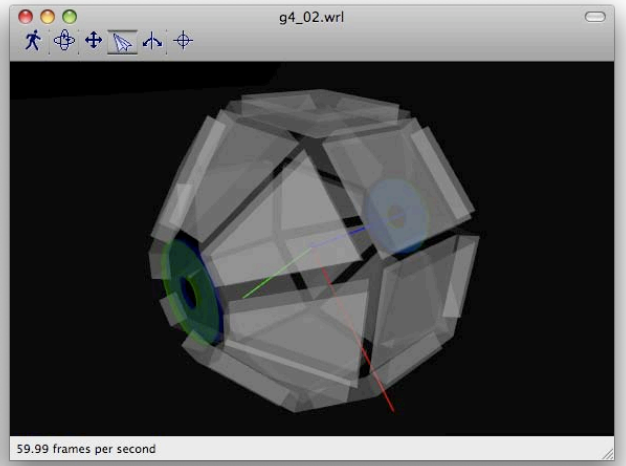


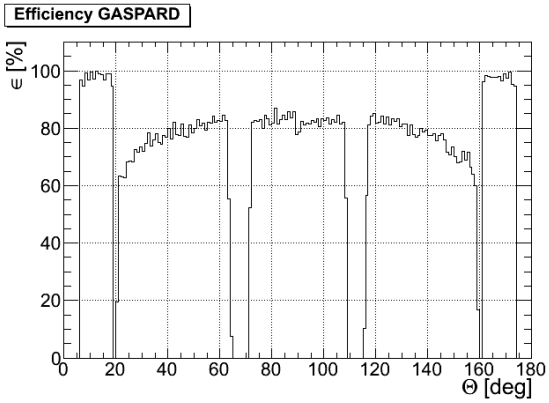
Trapezoid shape





GaspHyde shape

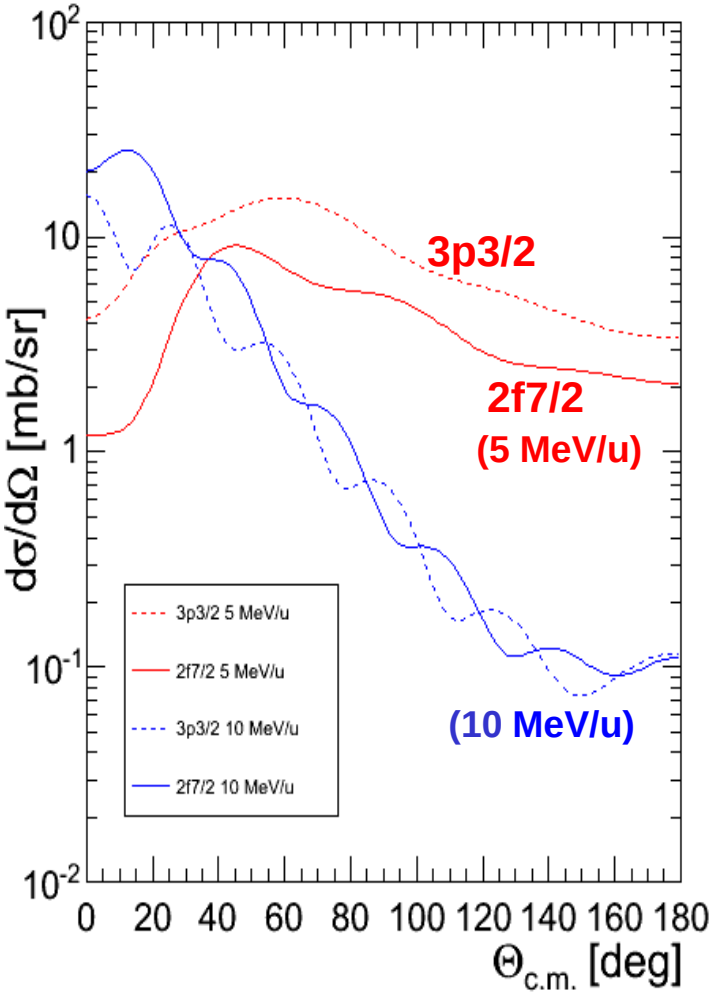




Simulations for $^{132}Sn(d,p)^{133}Sn$

CROSS-SECTIONS

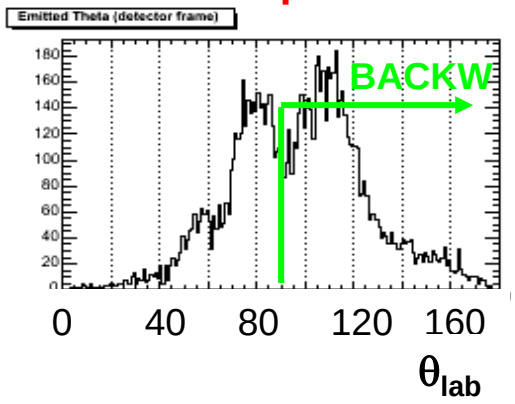
FRESCO (ZR-FRC)



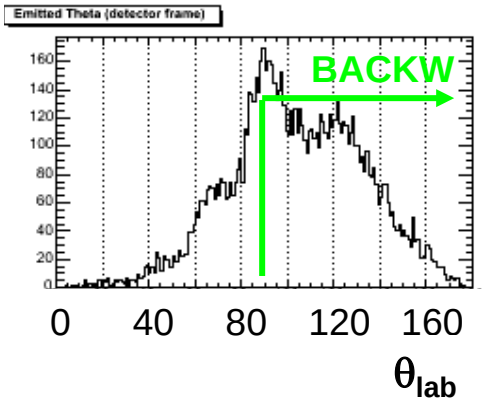
YIELDS

(10 MeV.A)

3 p3/2



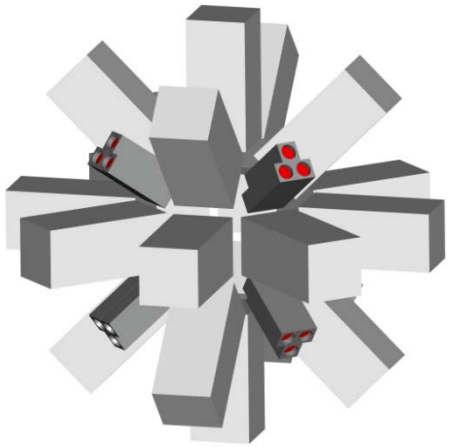
2 f7/2



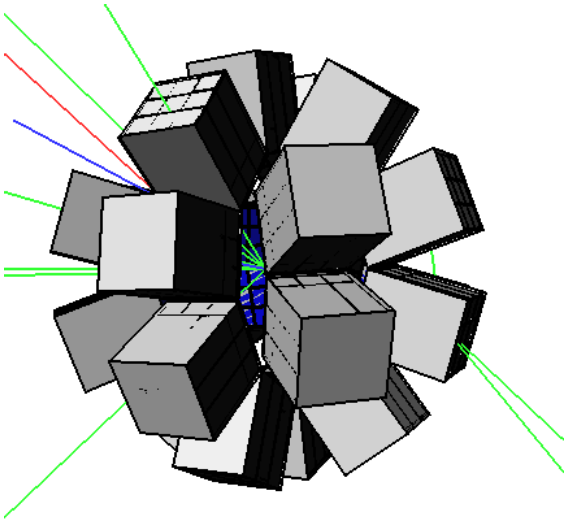
Other aspects studied:

- ***Effect on E* of***
  - ✓ ***Strip pitch***
  - ✓ ***Target thickness***
  - ✓ ***Beam tracking***
  - ✓ ***…***

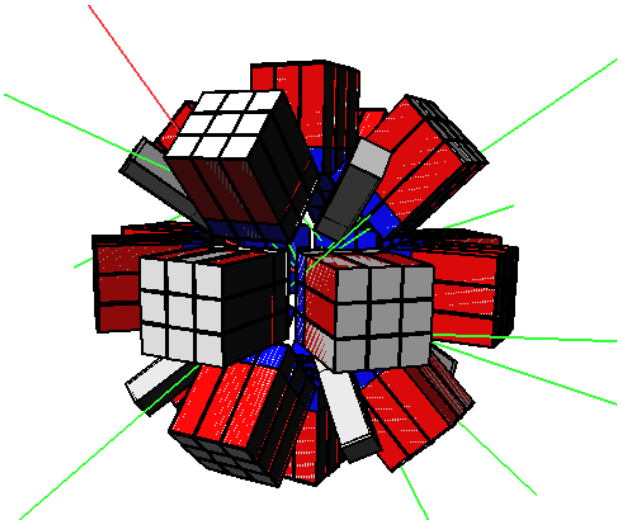
PARIS in NPTOOL
Spherical configurations



PARIS180
18 clusters + 18 phoswich
R = 235 mm
(8 clusters in main ring)



PARIS234
26 clusters
R = 235 mm
(10 clusters in main ring)



PARIS168
18 clusters + 6 phoswich
R = 208 mm
(8 clusters in main ring)

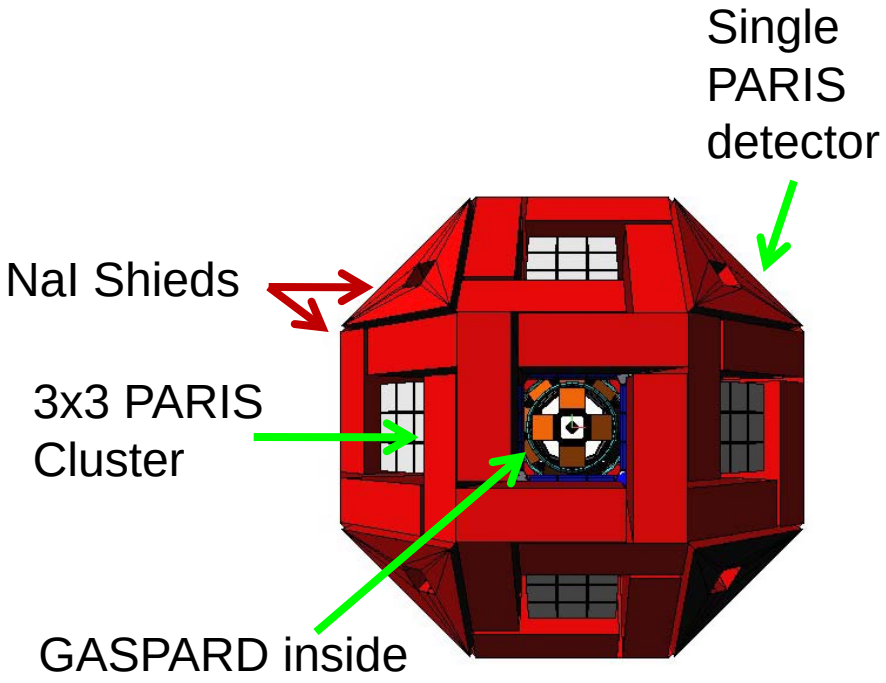
Under study :

- Efficiencies for spherical and cubic configurations
- Effect of FEE boards/connectics on low E gammas

Current simulation work

By: A.Corsi (Saclay), N. de Sereville (IPNO), M. Labiche (STFC), A. Sanchez (Huelva)

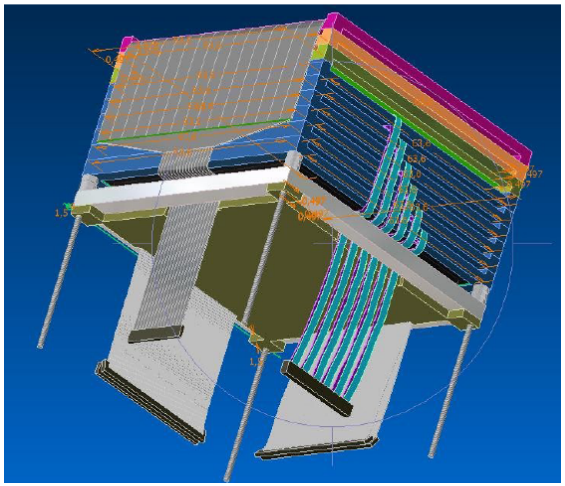
- ***Implementation of a realistic design of PARIS in NPTool***
- ***Gamma attenuation with GASPARD + chamber+ FEE+ cooling***
- ***New event generator to emit particle and gamma***
- ***Simulation with Hyde geometry (Agata-like)***
  Silicon layers:
  20μm + 100μm+ 500μm+ (2x1.5mm)
- ***Particle Id using TOF/E, E/ΔE, PSA***
- ***Simulation with CHYMENE (pure H/D target)***



Downloadable version of the simulation package at : **http://gaspard.in2p3.fr**

R&D on Silicon detectors and PSA

- **Prototype telescope under construction at Huelva using *:***
  - ✓ ***20,100, 500 μm thick NTD + 1500 μm thick DSSDs from MICRON SC***
  - ✓ ***500μm NTD DSSD CNM (Barcelona)***



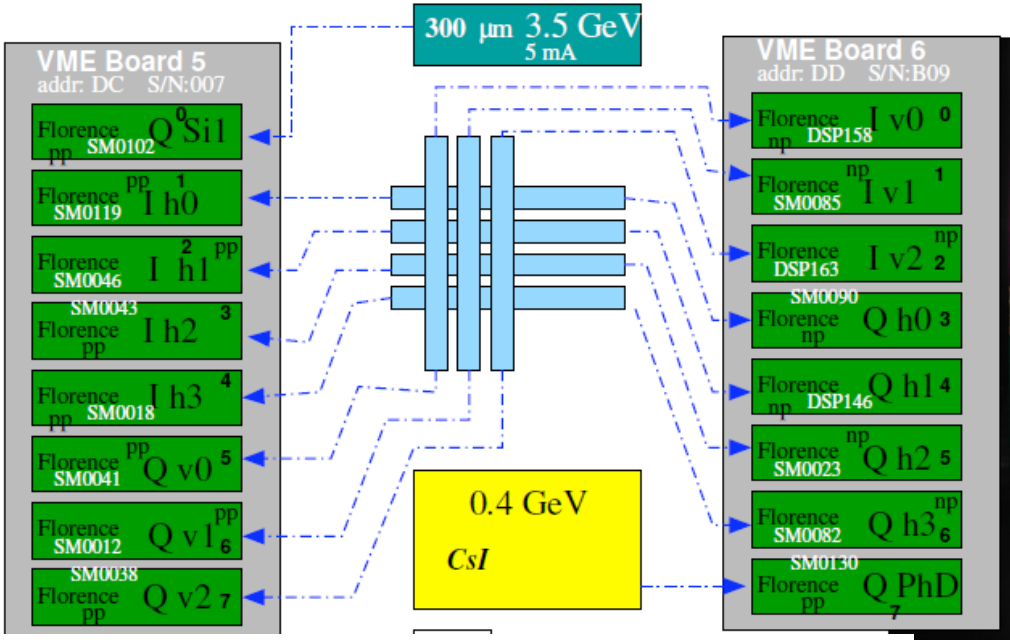
- **Test experiment @ IPNO tandem April(2011)**
  PID of light particles using PSA – det. resp. Simulations
  Strip and Pad detectors
  (GASPARD/TRACE/HYDE)

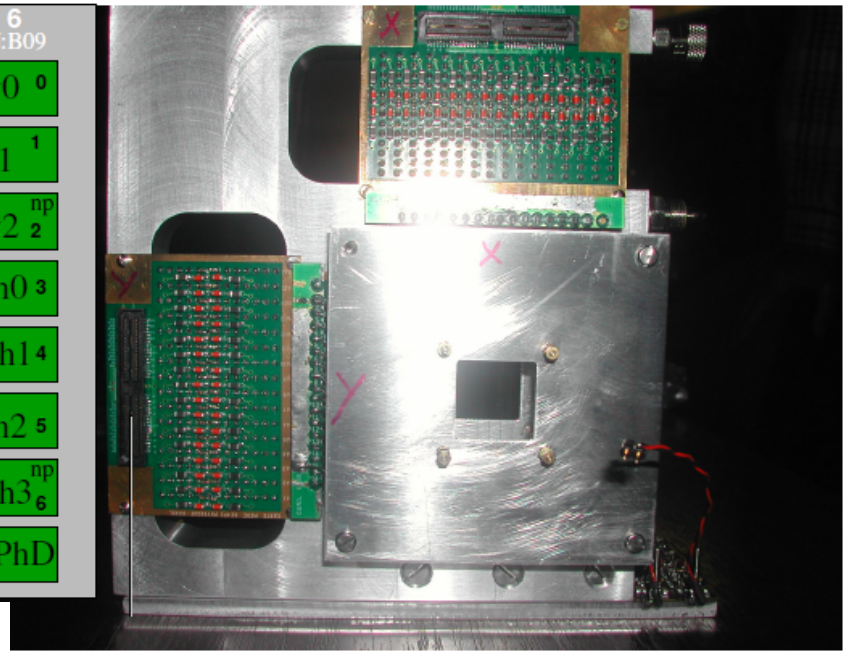
- **Prototype DSSD to be built by BHARAT Electronics (already funded)**
  Tests & PSA R&D at Mumbai

- **Development of thick (>1.5mm), large area Si detectors bid to NUPNET (Huelva, Barcelona, IPNO, INFN-Padova, Surrey)**

Test experiment at GANIL (may 2010)

(FAZIA & GASPARD/HYDE collab.)



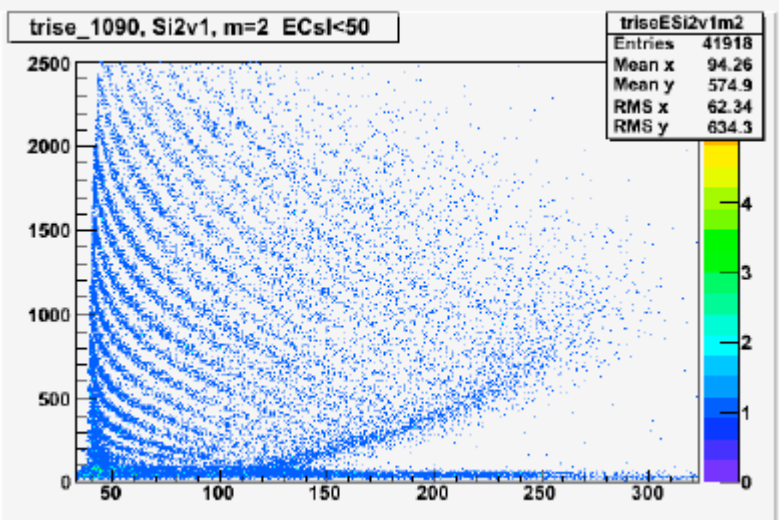


- 500 µm nTD, 16X+16Y, 4+4 unmasked (from MICRON SC, Topsil wafers
- rear mounted
- Placed between 300 µm Fazia as ΔE and CsI as E_R
- PACI Preamps, 3.6mV/MeV & 3000V/A

PSA with DSSD works

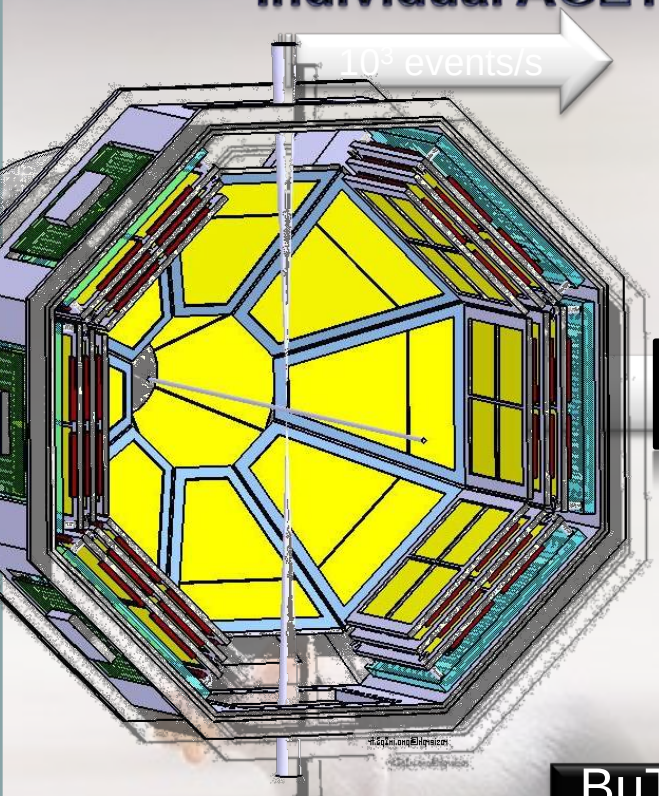
From A. Chbihi

Rise time vs Energy



Time-Slice, Trigger & Band Width

Common Dead Time
Or
Individual AGET Dead-Time



GASPARD

10^3 events/s

5 G. Bit

1G. Bit

10 Giga Bit

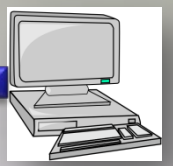
AsAdA
SIC
ADC
FPGA
PULSE
R
T/V/I

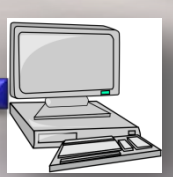
CoBo
FPGA

Mutant
Trigger
FPGA

μ-TCA

BuTiS/GTS





SUPPORTED BY ANR

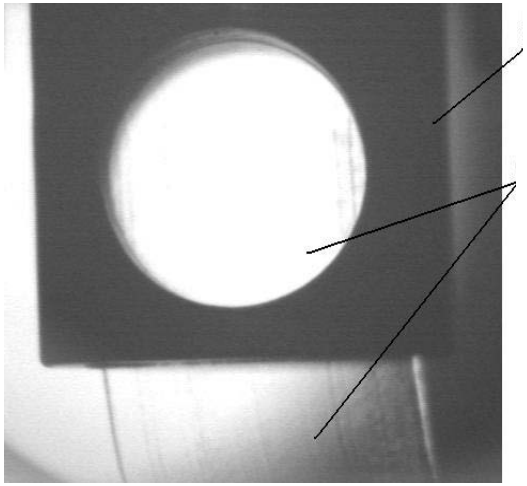
Emanuel Pollacco IRFU/SPhN

The CHyMENE H/D windowless target

Cible d'HYdrogène Mince pour l'Etude des Noyaux Exotiques

- Based on a (patented) system to produce Hydrogen or deuterium pellets
  PELIN (St Petersburg) produce pellet injectors for :
  LHD(Japan), TORE SUPRA tokamak (F), HT-6L (China),…

- Operation mode : continuous extrusion of ^{1}H or ^{2}H through a rectangular extruder nozzle (defining the film size)
  Thickness well adapted to DREB studies



Extruder nozzle

Hydrogen ribbon (0.2x11mm)

Ribbon of thickness ≈ 100 & 200 µm now produced with good reproducibility

Goal: 50 µm with good homogeneity

CHyMENE with GASPARD

CHyMENE collaboration :

- CEA/IRFU Saclay
  project coordinator: A. Gillibert
- CEA/DAM Bruyères
- IPN Orsay

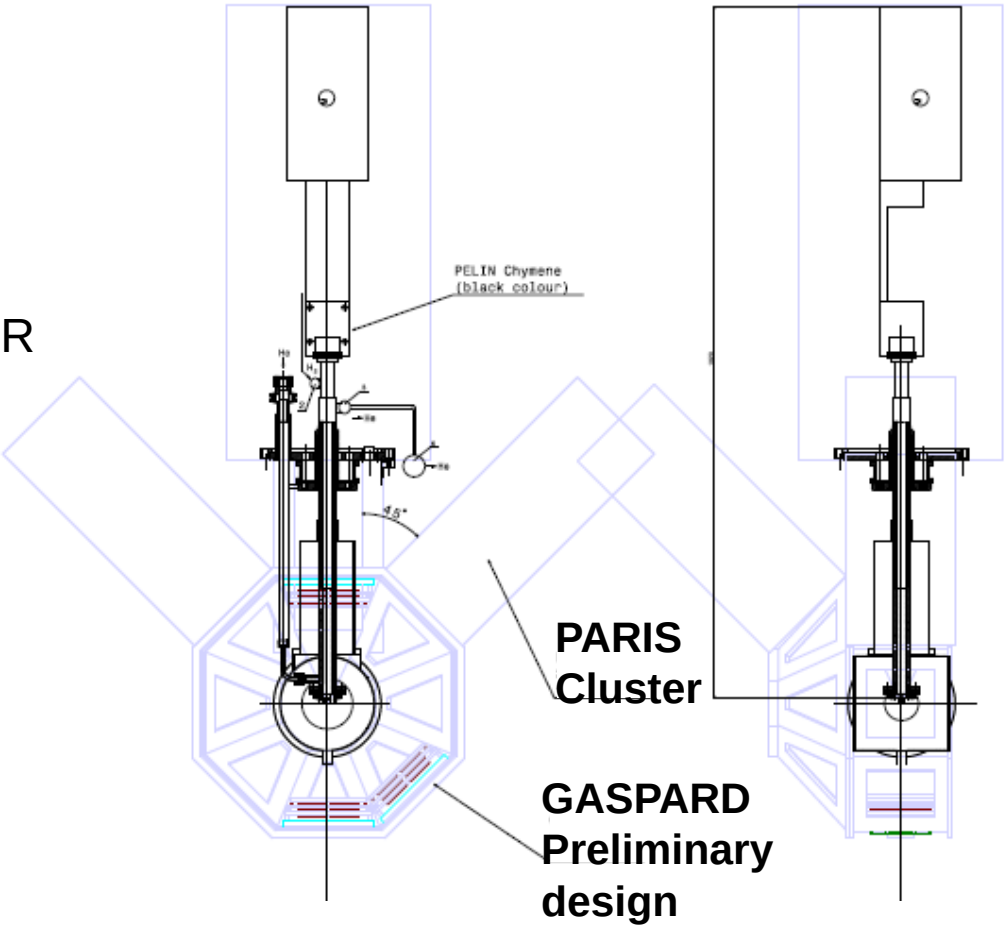
Now funded by the French agency ANR
~ 550 k€ over 4 years

Main purpose :

DIRECT REACTIONS studies
(Transfer, Resonant elastic, …)

+ laser induced reactions

PELIN prototype with GASPARD/PARIS :



CHyMENE to be designed for integration in GASPARD

LETTERS OF INTENT FOR SPIRAL2 PHASE2 - DAY1

mercredi 31 août 2011

13 LoI's related to GASPARD

SHELL EVOLUTION

- **How Magic is ^{78}Ni ?**
  W.Catford, O.Sorlin
- **Spectroscopic studies around ^{78}Ni and beyond N=50 via transfer and coulex**
  G.De France, A.Gadea, X.Valiente, R.Orlandi
- **Neutron shell evolution in weakly bound ^{134,135}Sn via (d,p) reactions**
  V.Lapoux, O.Sorlin

PAIRING

- **Probing the pairing interaction through two-neutron transfer reactions**
  D.Beaumel
- **Study of pair transfer in ^{134}Sn via ^{132}Sn(t,p)**
  O.Sorlin, K.Wimmer
- **2p capture on ^{15}O and proton correlation in 2p emission from excited states of ^{17}Ne**
  M.Assié, F. De Oliveira

CLUSTERS

- **Exploration of cluster breakup in light nuclei**
  J.A.Scarpaci, M.Assié

+ NEAR BARRIER REACTIONS, PDR, ASTROPHYSICS,…

FEE / DAQ : The GET System

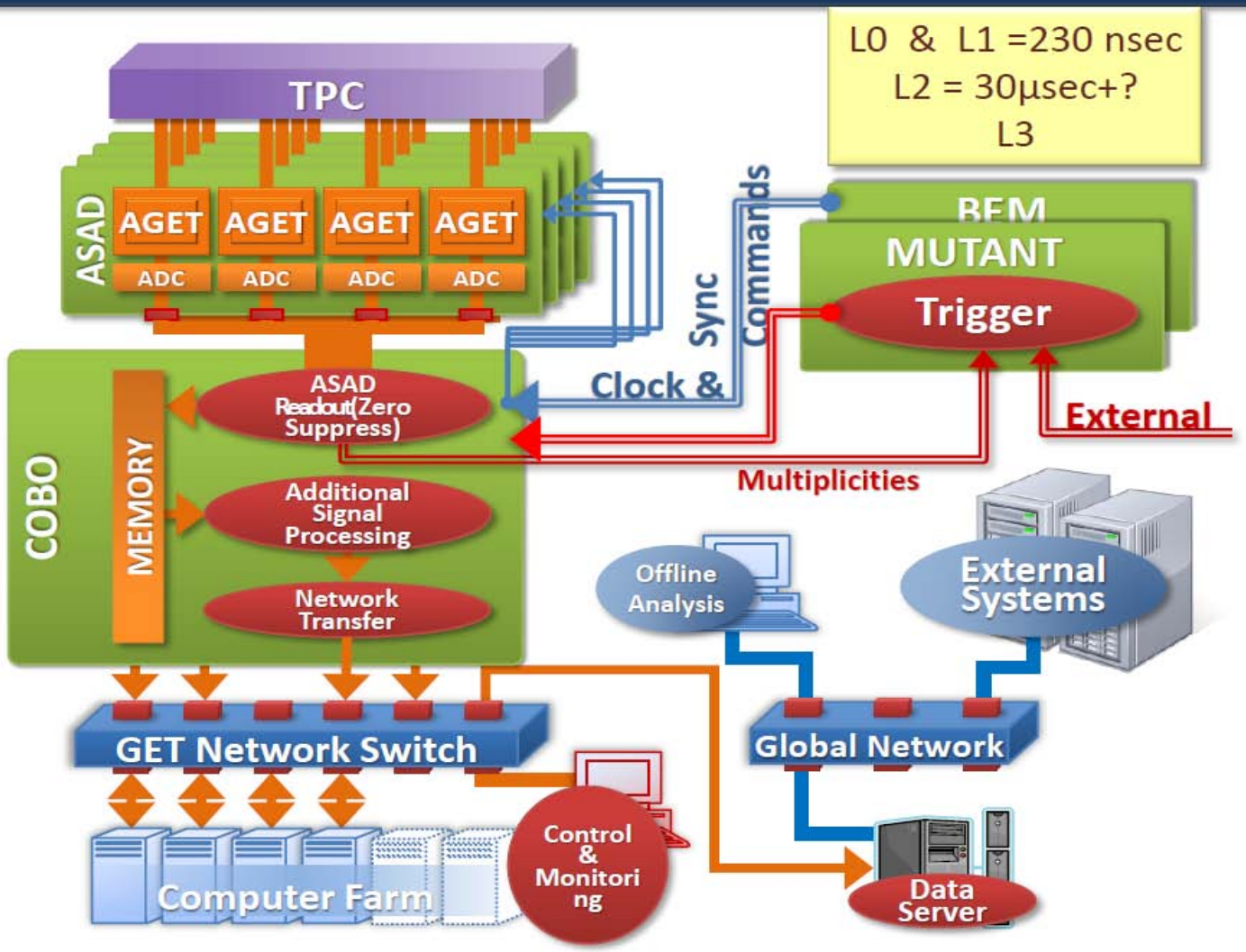
Hardware Architecture – 4 elements.

DET 10,000

AGET 64 → 1 ADC
AsAd 4X64

CoBo 16X64
→ 1 FPGA

µTCA 160X64
3µTCA 3X160X64



See talk of L. Pollacco

Other features of GASPARD

- ***Excellent PID for light particles***
  PSA technique for particle ID
- ***Integration of special targets***
  - ***Pure and windowless H or D***
  - ***Cooled ^{4}He or ^{3}He gas***
  - ***Triton targets for e.g. (t,p)***
    0^{+}_{2} states, pairing, etc…
  - ***Any solid target***
    e.g. ^{6}Li, ^{7}Li for p, a, … transfer
  - ***Polarized targets (require high intensities)***

- ***Capability to handle high intensity beams***
- ***Large dynamical range***
- ***Easy coupling with spectrometers***