

# Letter of Intent for at GANIL 2017-2018

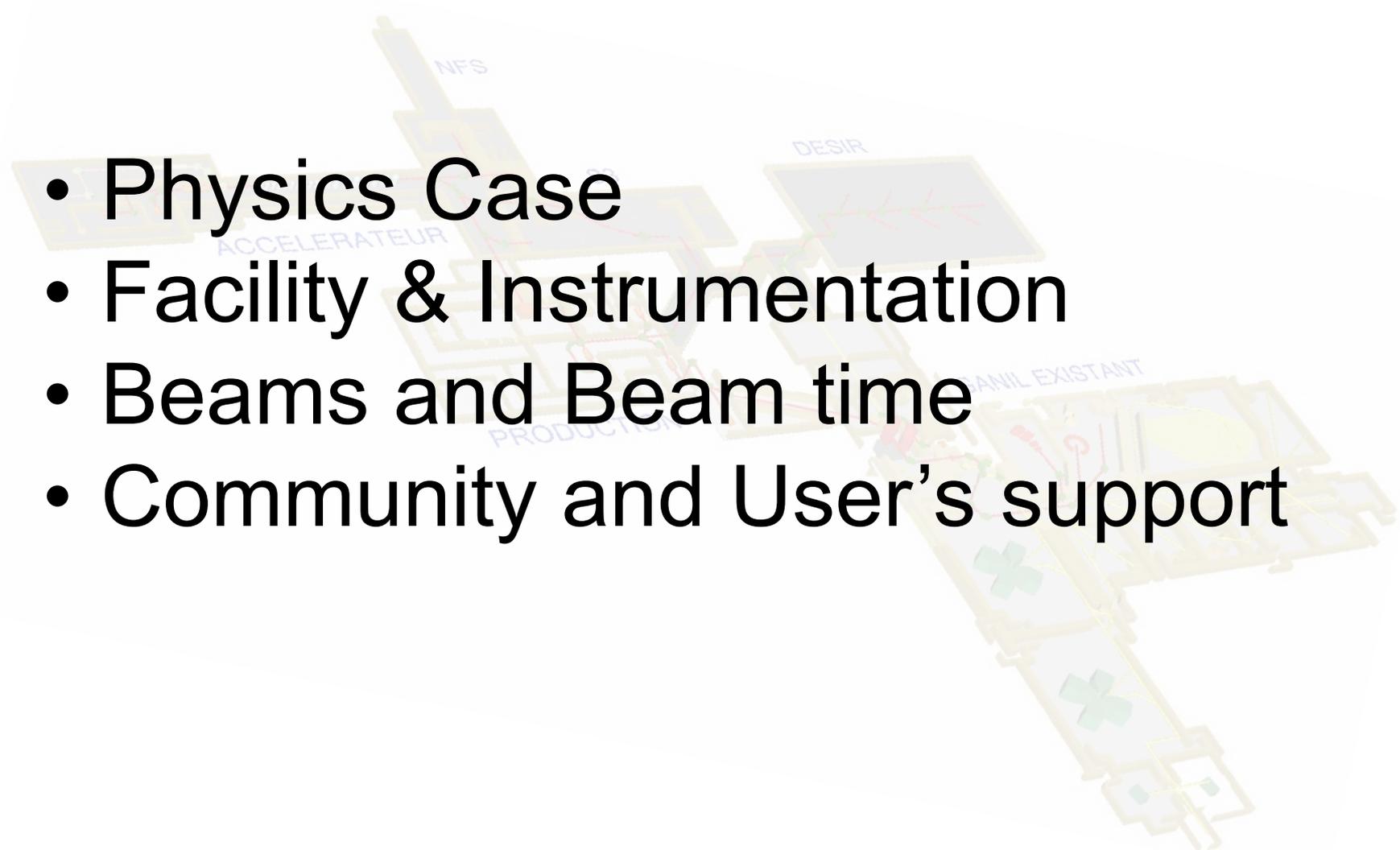


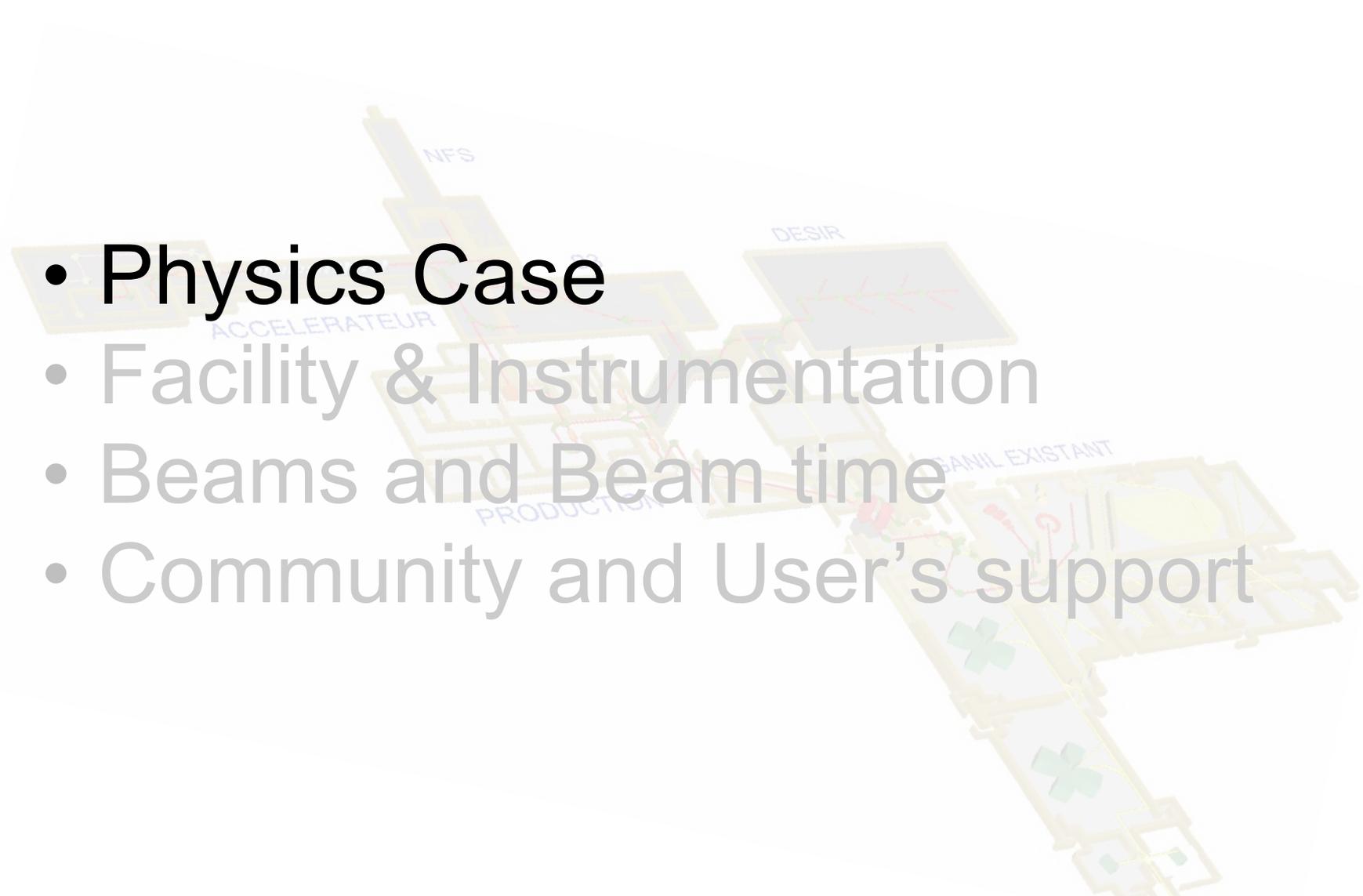
*Marek Lewitowicz*

**GANIL**

**CEA/DSM-CNRS/IN2P3, Caen, France**



- 
- Physics Case
  - Facility & Instrumentation
  - Beams and Beam time
  - Community and User's support

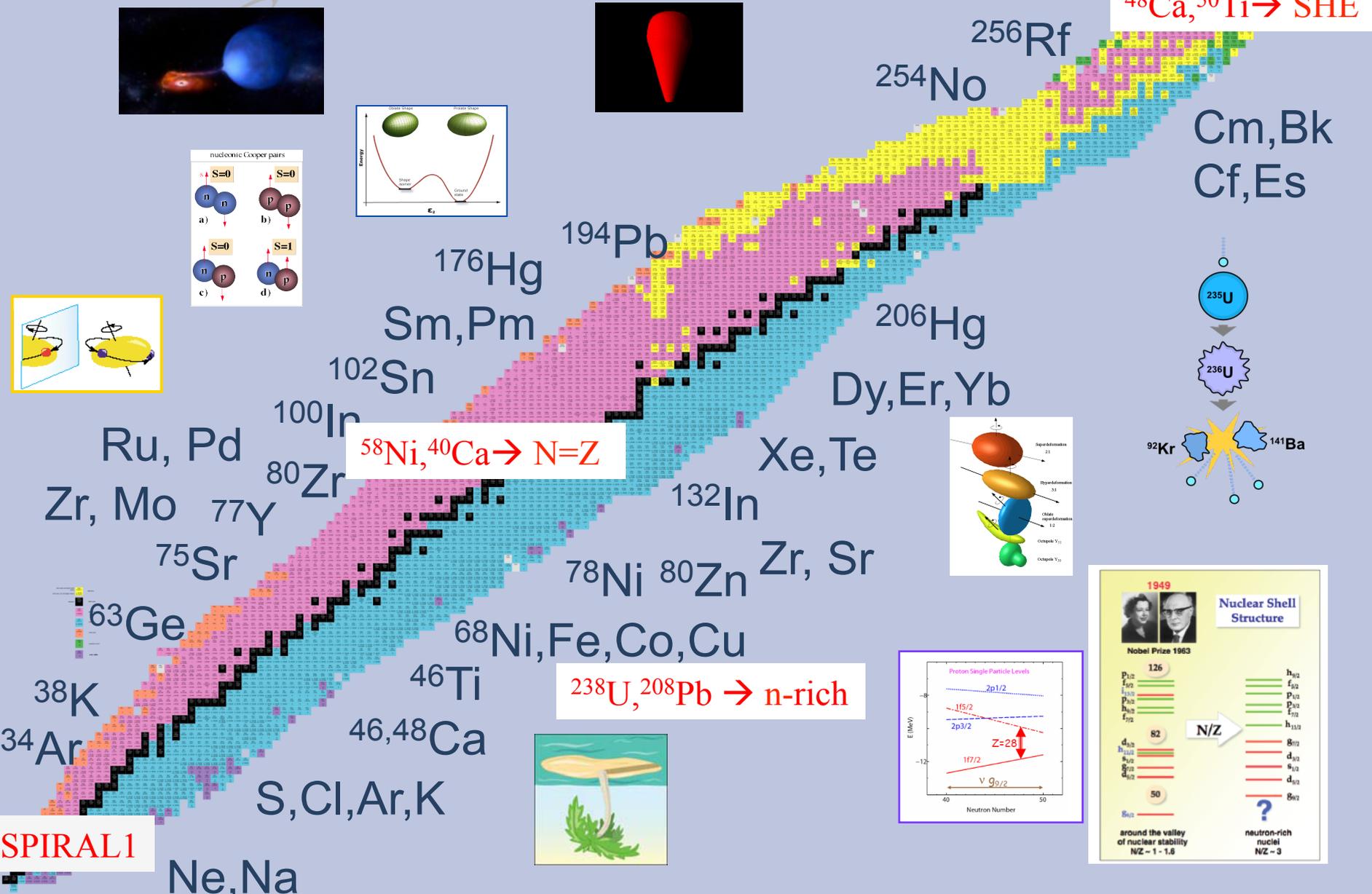
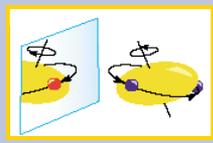
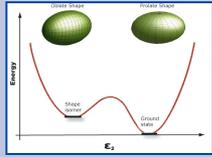
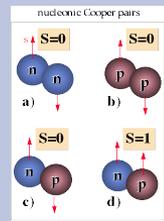
- 
- **Physics Case**
  - Facility & Instrumentation
  - Beams and Beam time
  - Community and User's support

# Physics cases for the AGATA campaign in GANIL

## 47 Letters of Intent



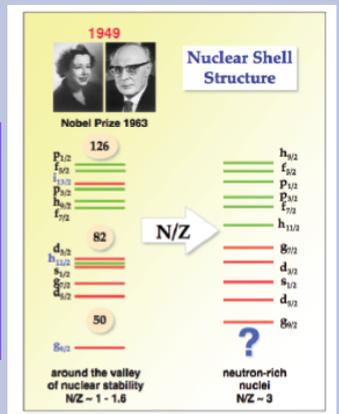
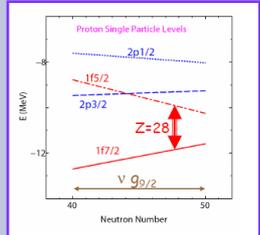
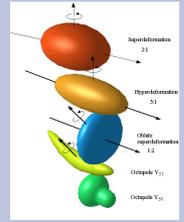
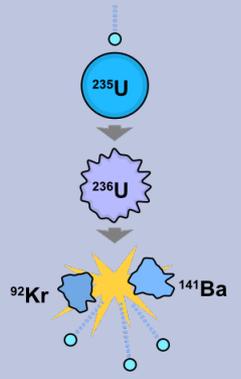
$^{48}\text{Ca}, ^{50}\text{Ti} \rightarrow \text{SHE}$



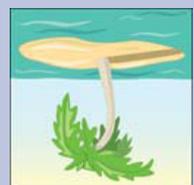
$^{58}\text{Ni}, ^{40}\text{Ca} \rightarrow N=Z$

$^{238}\text{U}, ^{208}\text{Pb} \rightarrow n\text{-rich}$

Cm, Bk  
Cf, Es



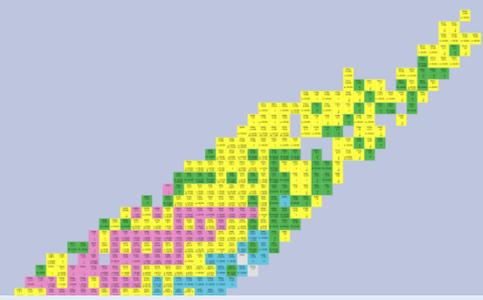
SPIRAL1



Ne, Na

# Physics case for the 1<sup>st</sup> AGATA Campaign at GANIL in 2015-2016

## Approved PAC March 2014



$^{238}\text{U}, ^{208}\text{Pb} \rightarrow$  n-rich

G. Georgiev et al;  $2^+$  lifetimes and g factor  $^{204,206,208}\text{Hg}$

C. Domingo-Pardo et al ;  $4^+, 2^+$  lifetime in  $^{94}\text{Ru}$  and  $^{96}\text{Pd}$

$^{208}\text{Pb}$

J. J. Valiente Dobon et al  $4^+, 2^+$  lifetime in  $^{106,108}\text{Sn}$

P. R. John et al ; Shape transition in W isotopes:  $^{190}\text{W}$  and  $^{192}\text{W}$  spectroscopy and fast timing

$^{100}\text{Sn}$

$^{132}\text{Sn}$

A. Navin et al ;  $i_{13/2}$  single particle state in  $^{133}\text{Sn}$  and high spin in  $^{108}\text{Zr}$

D. Verney et al; lifetime measurement in  $^{83}\text{Ge}$

$^{68}\text{Ni}$

$^{78}\text{Ni}$

G. Duchêne et al;  $^{80}\text{Zn}$  and  $^{82}\text{Ge}$  highest spin structures

J. Ljungvall et al ;  $2^+, 4^+ 6^+$  lifetime and g-factor in  $^{62,64,66}\text{Fe}$ ;

$^{48}\text{Ca}$

A. Lemasson et al : spectroscopy of  $^{39,41,43}\text{S}$

S. Leoni et al ; Lifetime in n-rich C and O isotopes: test of the three body forces

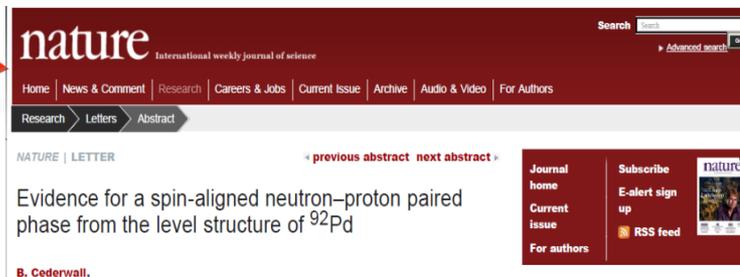
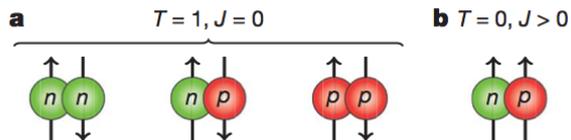
National Nuclear Data Center

National Nuclear Data Center, information extracted from the NuDat 2 database, <http://www.nndc.bnl.gov/nudat2/>

"Users should feel free to use the information from NuDat 2 (tables and plots) in their work, reports, presentations, articles and books."

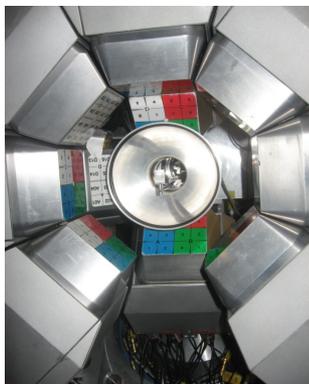
# <sup>92</sup>Pd: evidence for a new spin aligned np coupling scheme

\* B. Cederwall, et al.



## EXOGRAM-NWall-DIAMANT:

### The power of the coupling

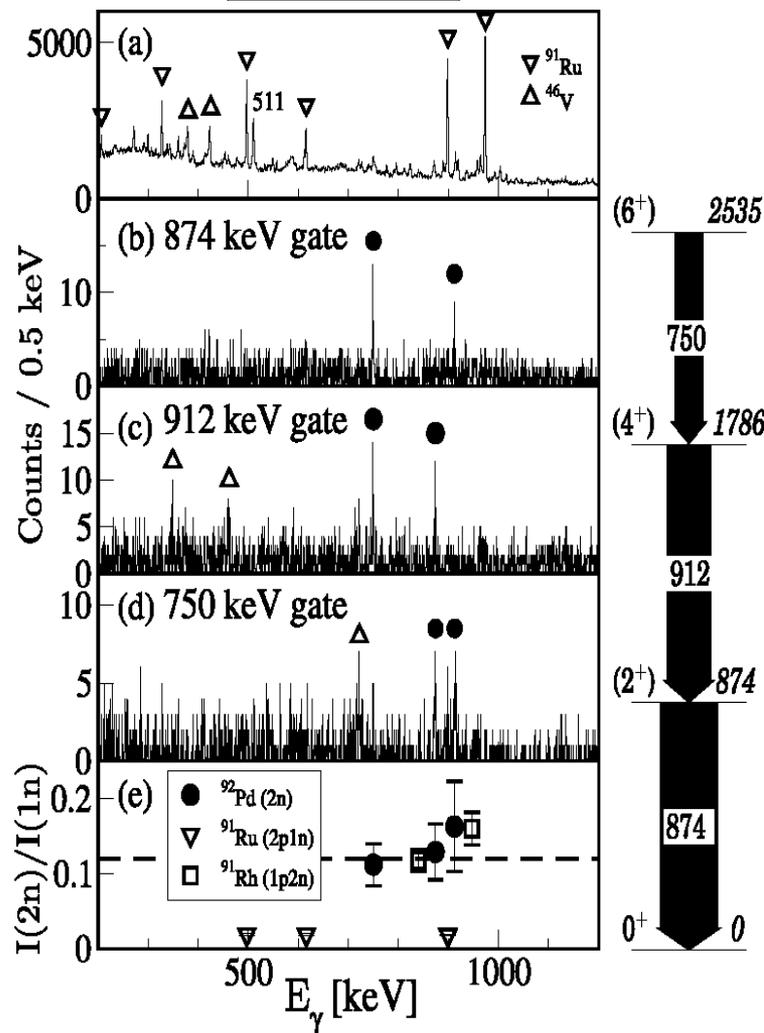
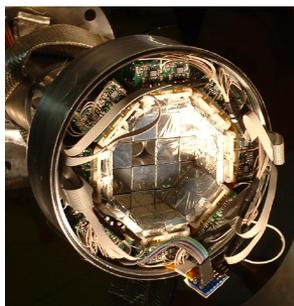


- EXOGRAM: 11 Clovers.  
 $\epsilon_p \omega \sim 10\%$  for  $E_\gamma = 1.3$  MeV

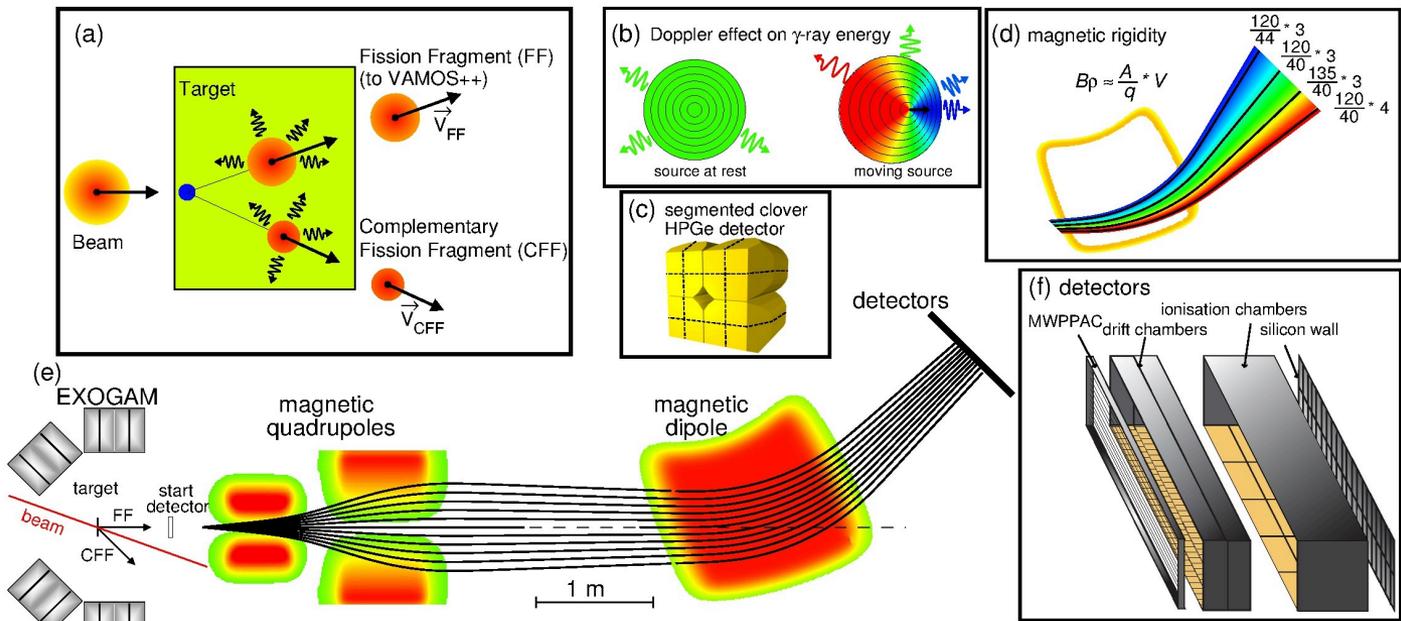


- The Neutron Wall:  
50 liquid scintillator detectors.  $\epsilon_{1n} \sim 23\%$

- DIAMANT  
80 CsI(Tl) dets.  $\epsilon_{p \text{ or } \alpha} \sim 66\%$

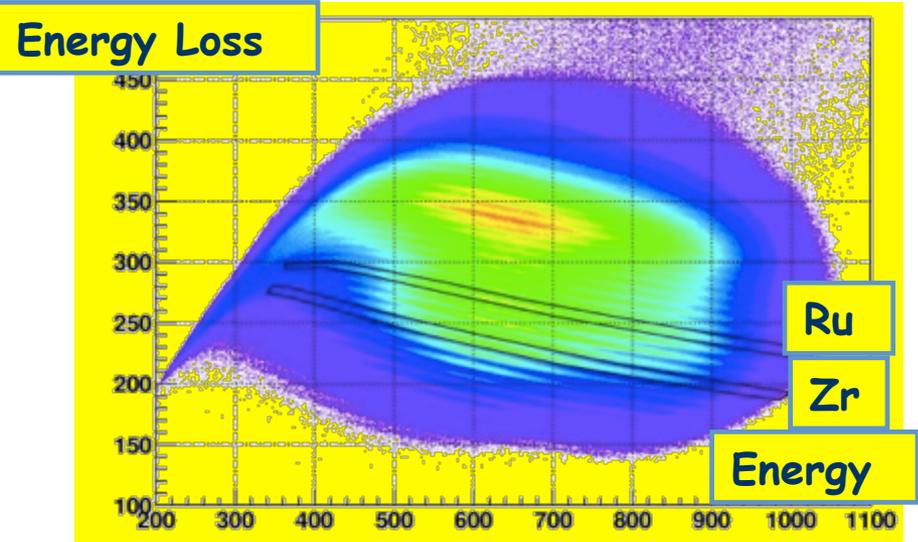
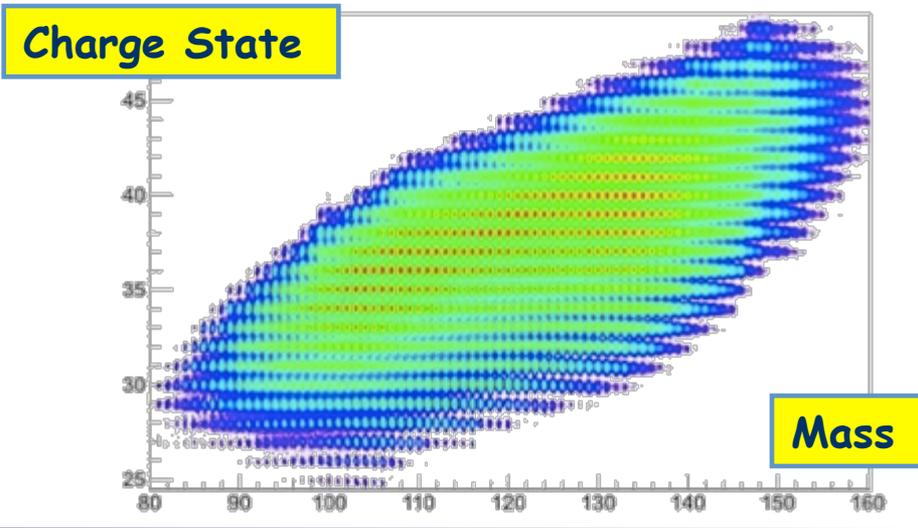


# Z, A & q identification at few MeV/nucleon



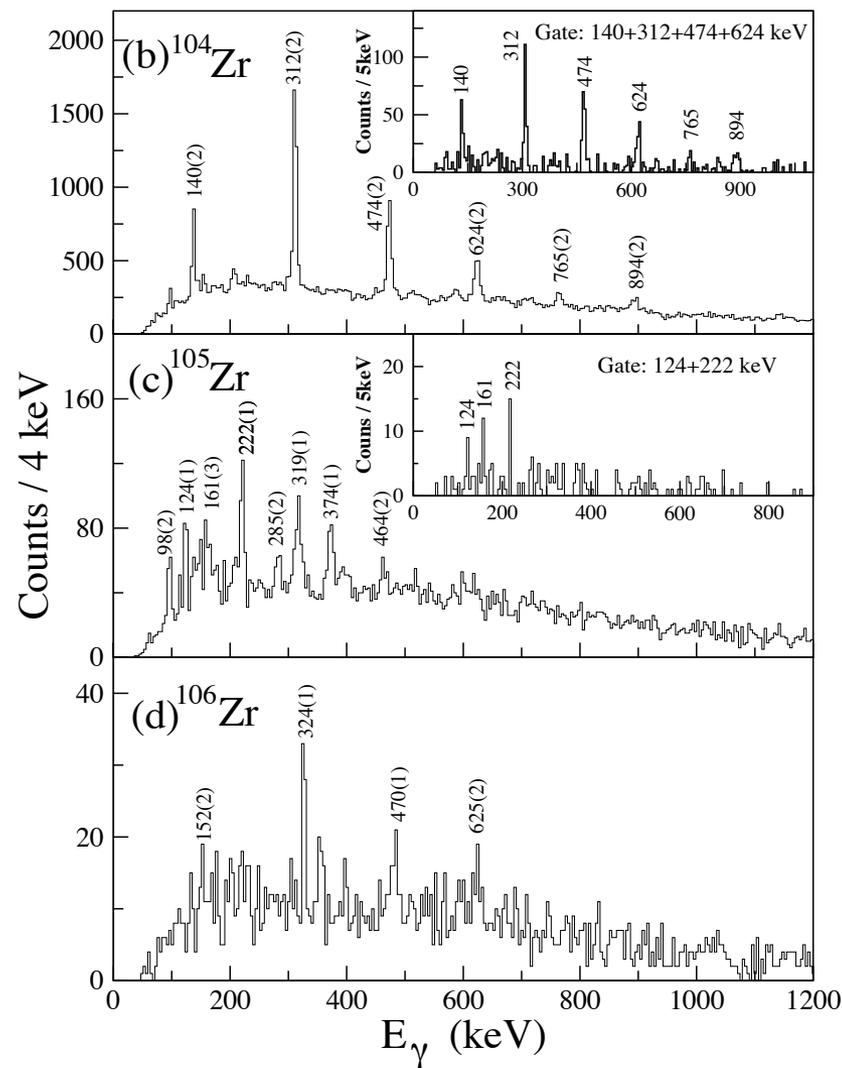
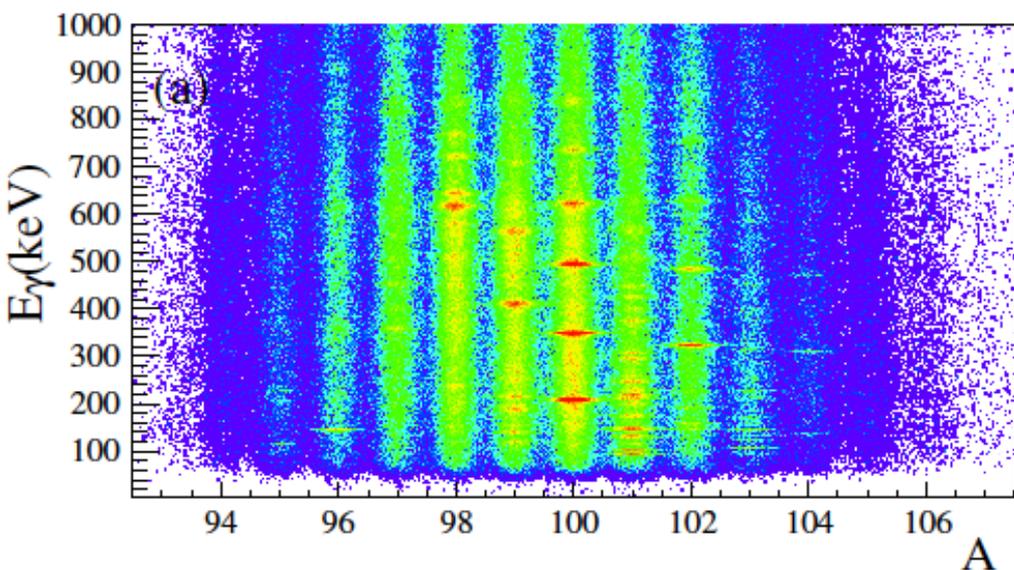
A. Navin and M. Rejmund  
McGraw-Hill Yearbook of  
Science & Technology (2014)  
(to be published)

Similar Z,A, & q  
resolution for  
multi-nucleon  
transfer reactions



# Study of Neutron Rich Zr isotopes

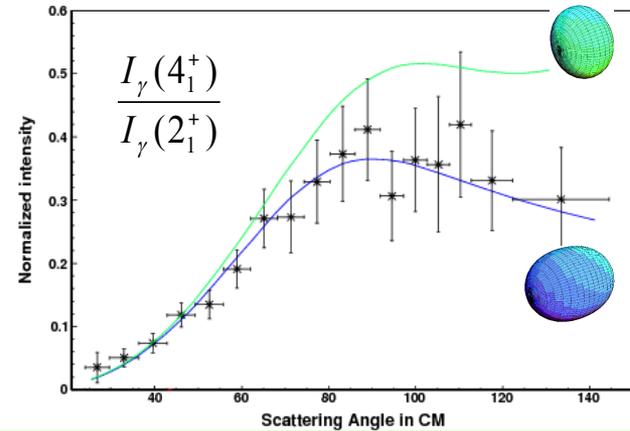
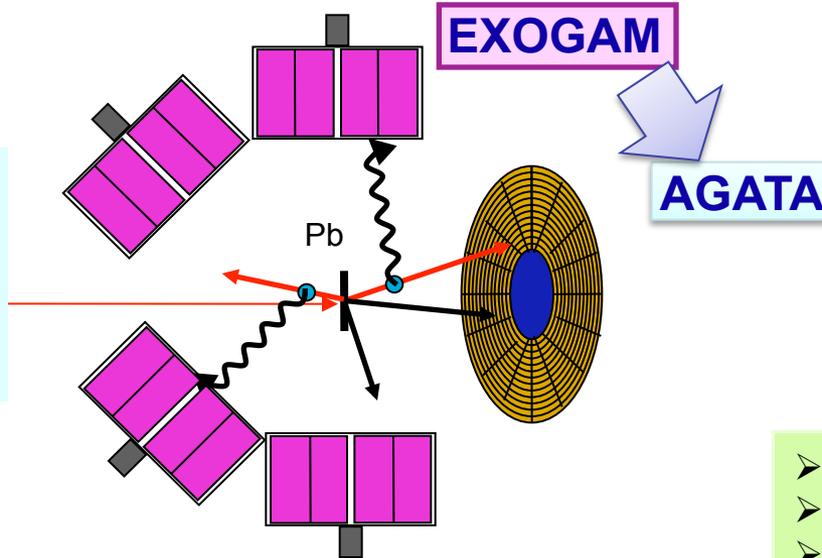
## Ion – gamma coincidences Zr isotopes



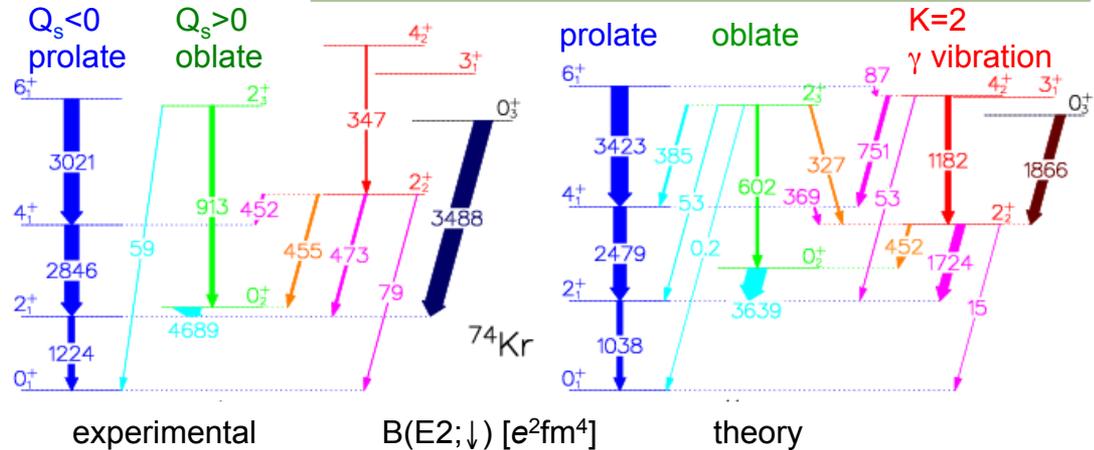
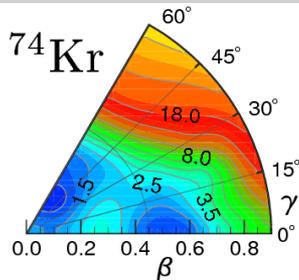
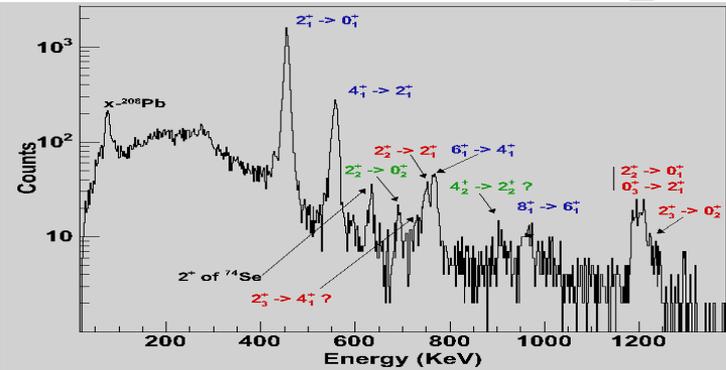
*N. Alahari, M. Rejmund et al.*  
**Phys. Lett. B728 (2014) 136-140**

# Coulomb Excitation of $^{74,76}\text{Kr}$ : Evidence for Shape Coexistence

SPIRAL beams  
 $^{76}\text{Kr}$   $5 \cdot 10^5$  pps  
 $^{74}\text{Kr}$   $10^4$  pps  
4.7 MeV/u



- up to  $8^+$  and non-yrast states
- 14 B(E2) and 5 quadrupole moments
- quantitative analysis of shape coexistence



- data for non-yrast states still quite limited
- evolution of shapes and configuration mixing with spin ?
- inversion of oblate and prolate shapes in  $^{72}\text{Kr}$  ?

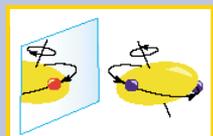
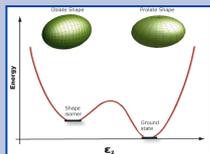
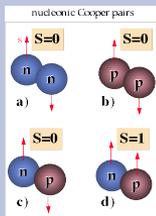
# Physics cases for the AGATA campaign in GANIL

2017-2018



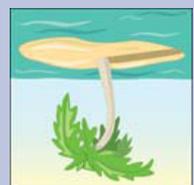
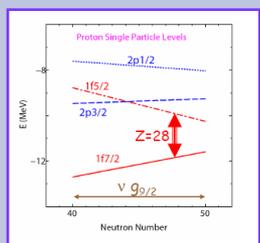
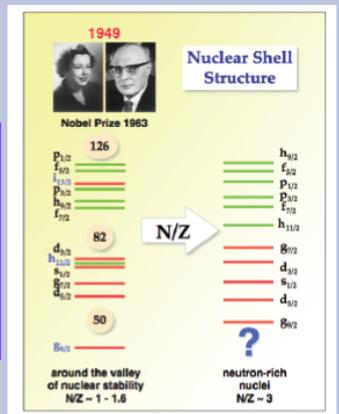
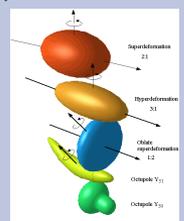
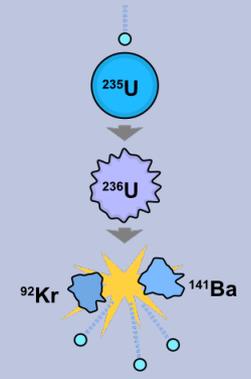
$^{48}\text{Ca}, ^{50}\text{Ti} \rightarrow \text{SHE}$

Cm, Bk  
Cf, Es

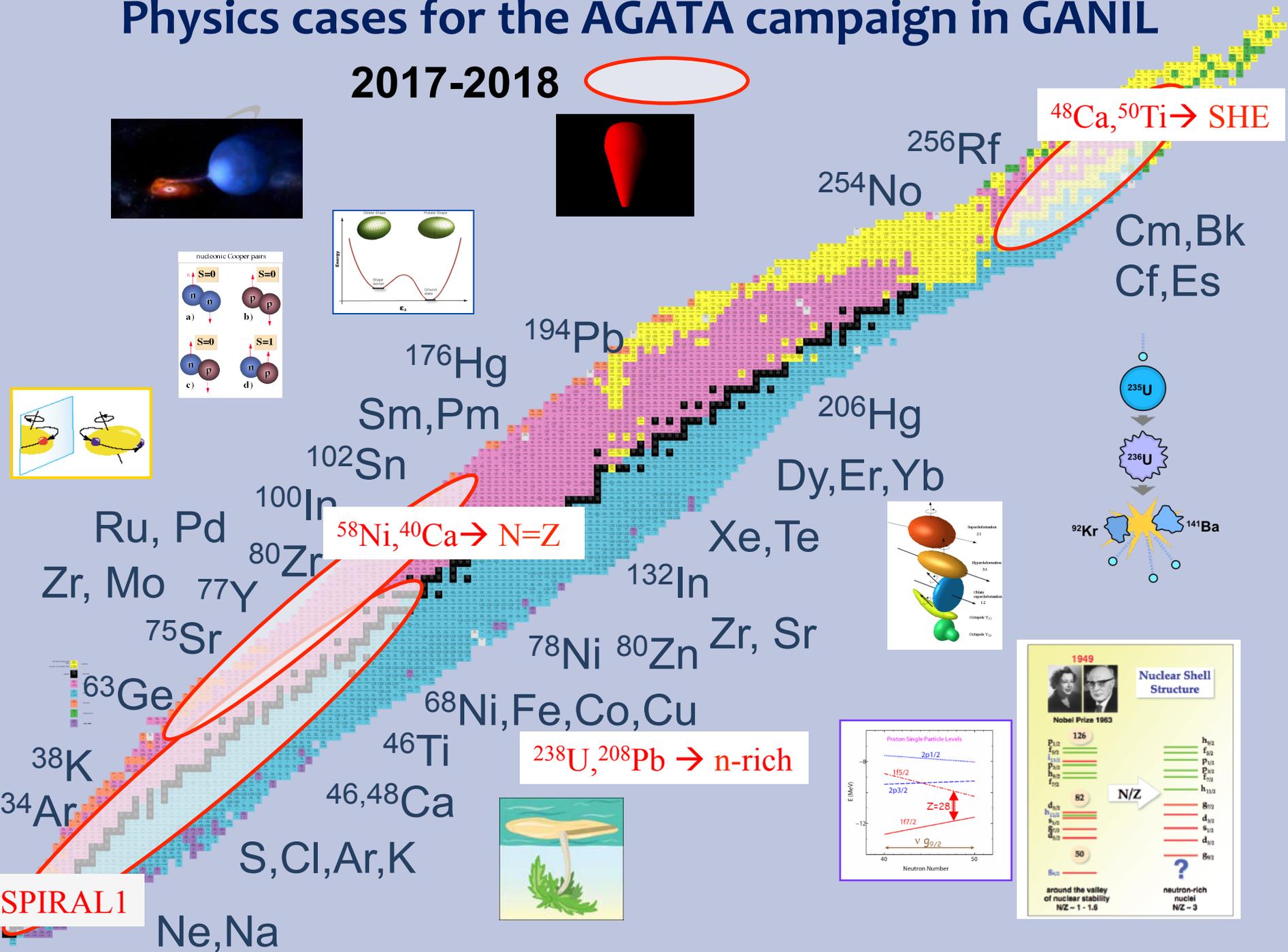


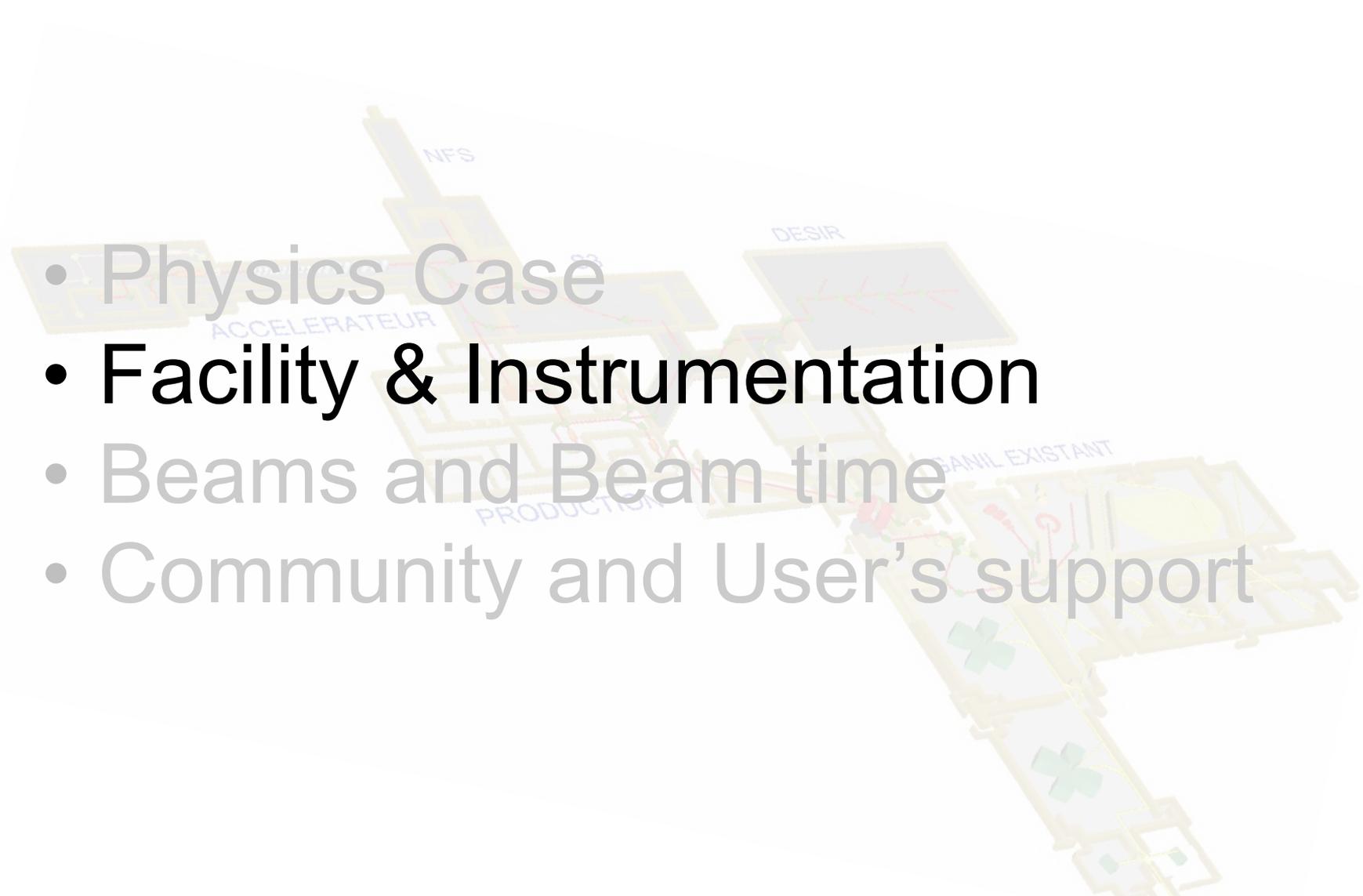
$^{58}\text{Ni}, ^{40}\text{Ca} \rightarrow N=Z$

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SPIRAL1



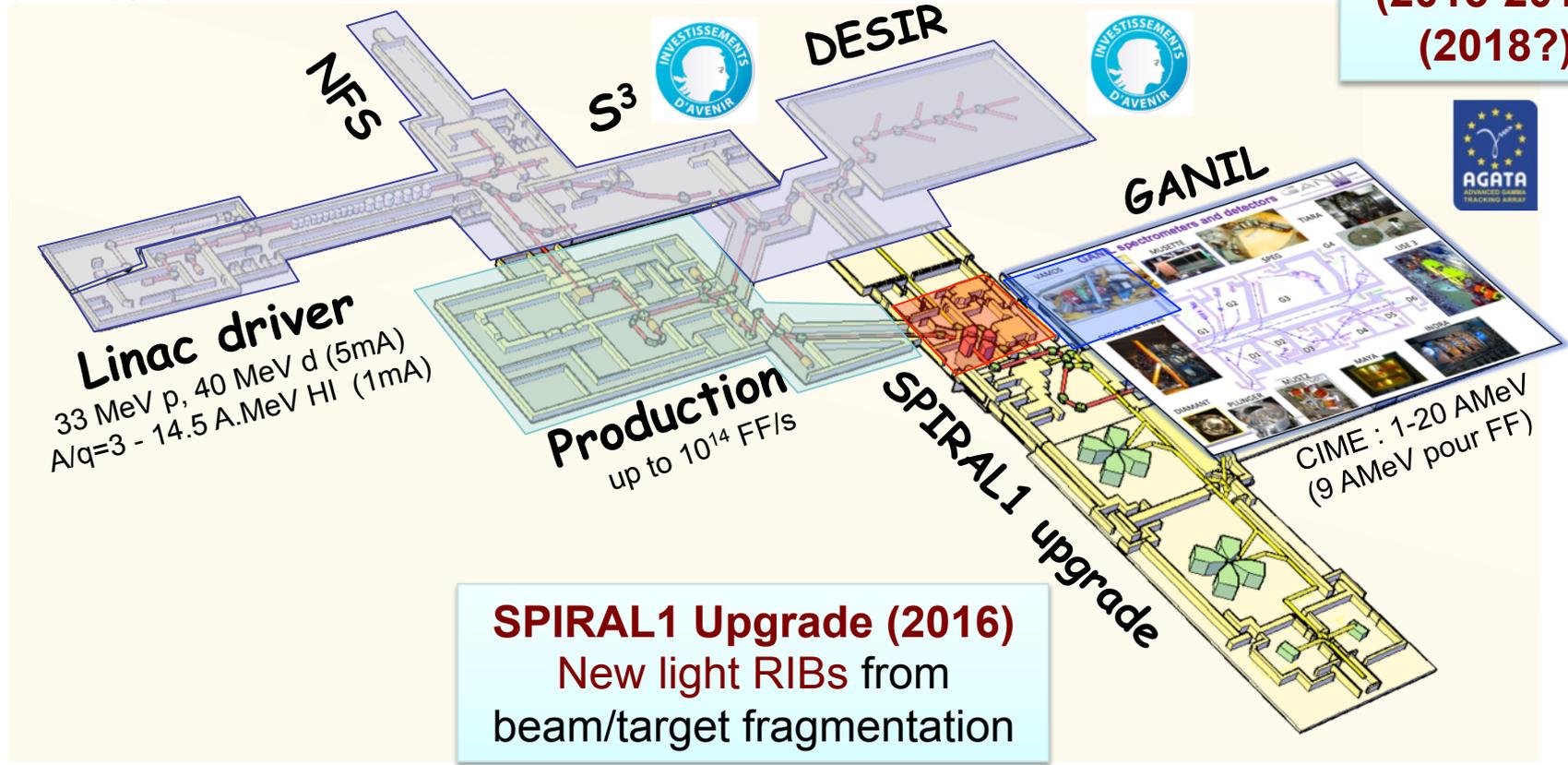
- 
- Physics Case
  - Facility & Instrumentation
  - Beams and Beam time
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## SPIRAL2 Phase1 (2015)

Increase the intensity of stable beams by a factor 10 to 100 – High intense neutron source

$10\mu\text{A}$  ( $6 \cdot 10^{13}\text{pps}$ )  $A < 50$

**AGATA**  
(2015-2016)  
(2018?)



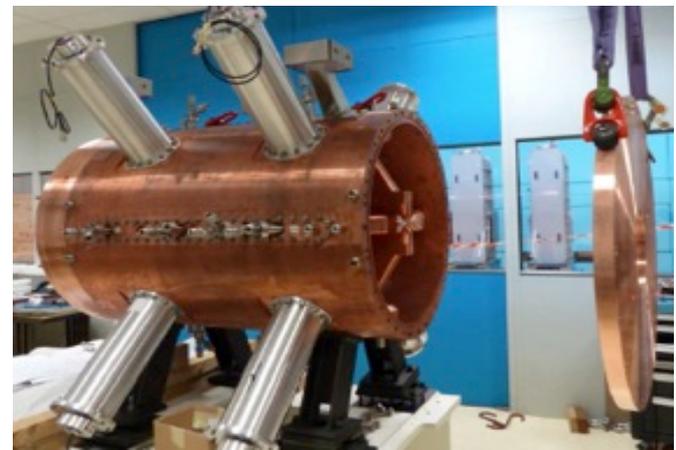
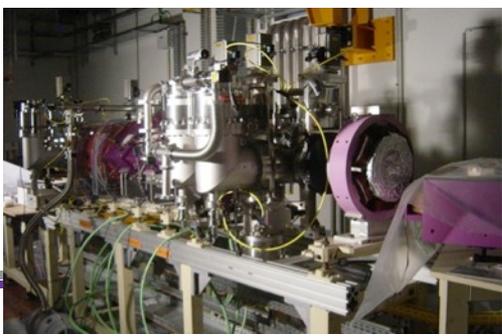
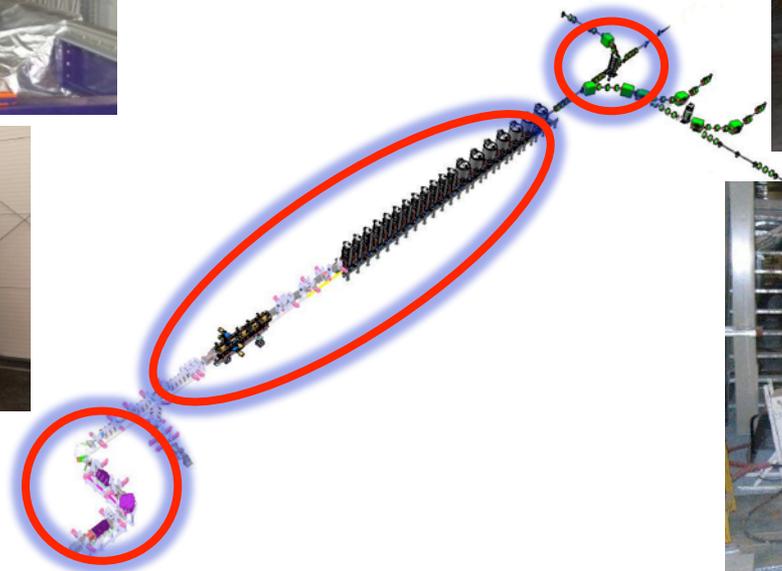
**SPIRAL1 Upgrade (2016)**  
New light RIBs from beam/target fragmentation

# SPIRAL2 Phase 1 Civil Construction

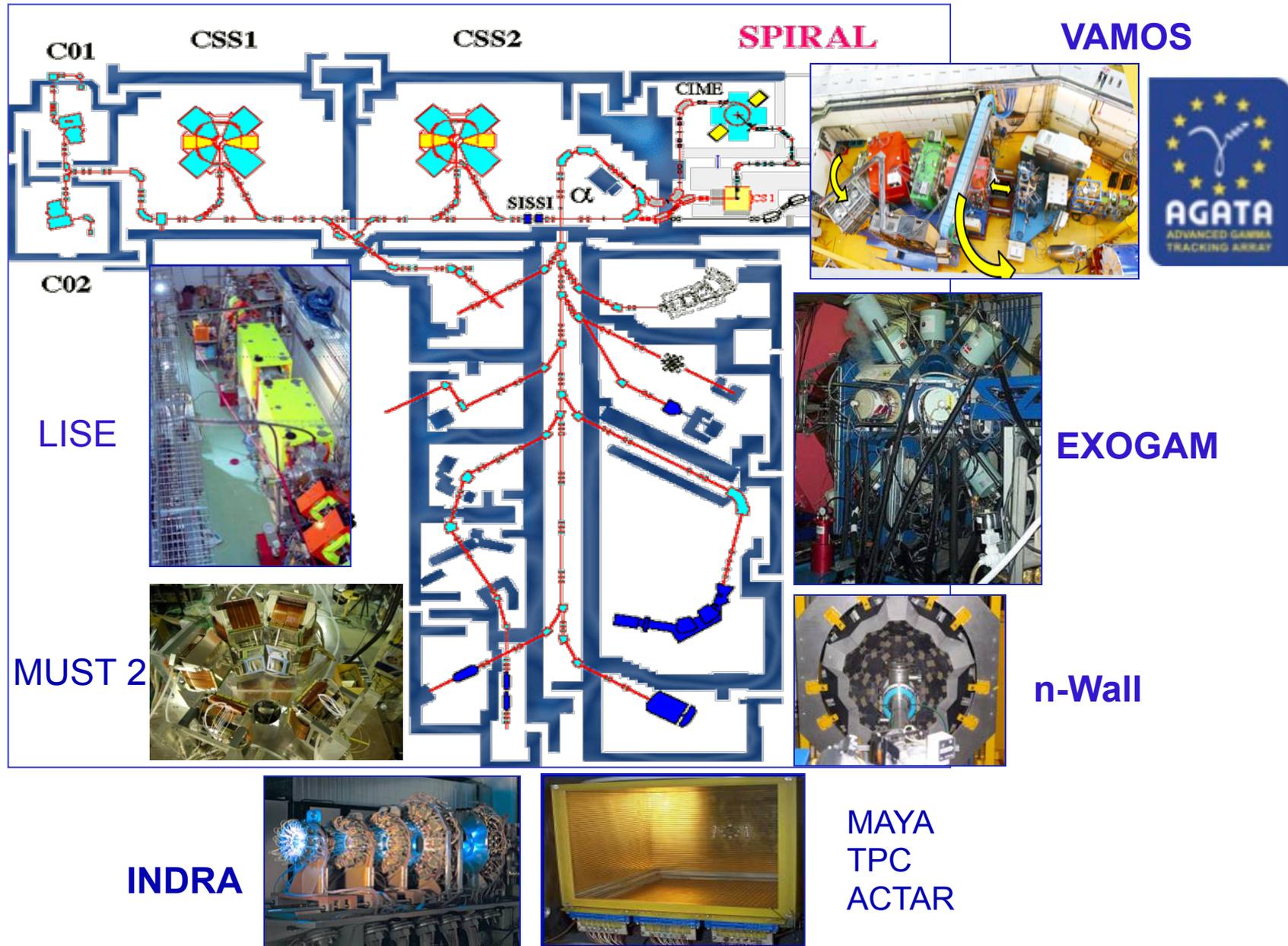
*100 % of the concrete done (14000m<sup>3</sup>)*

**June 25, 2014**

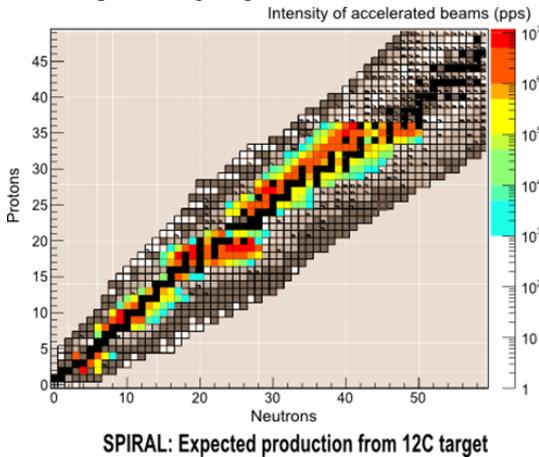
# Installation is going on



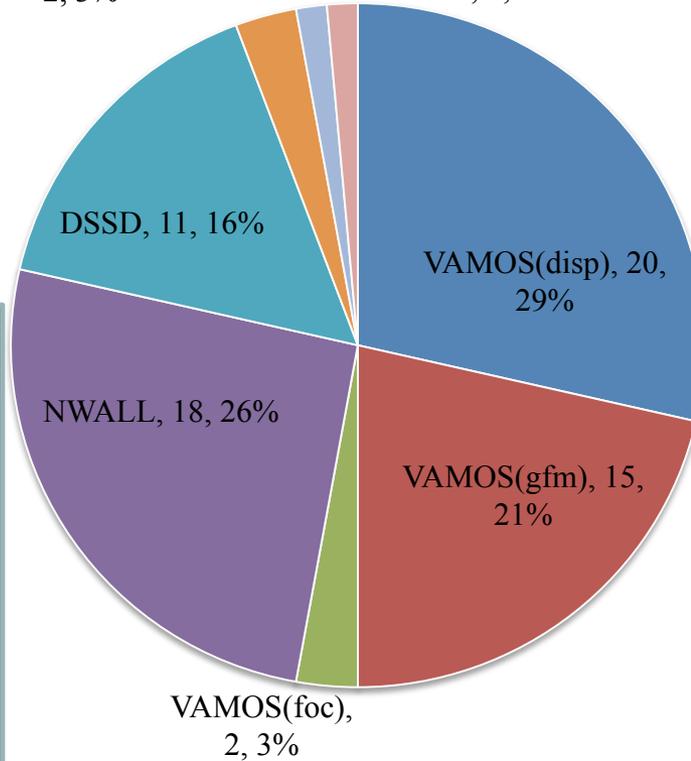
# Cyclotrons and Experimental Area



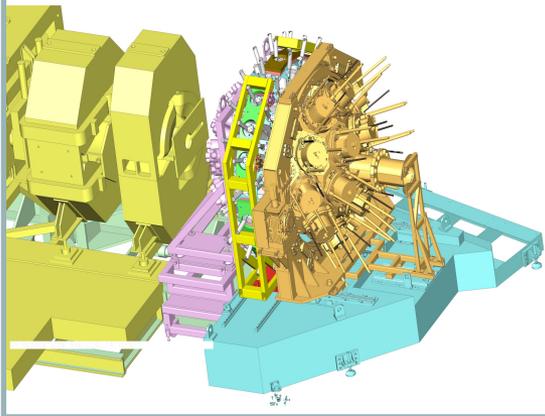
## ISOL RIB from SPIRAL 1 from 2016



DIAMANT Solo, 2, 3%    MUST2, 1, 1%    AGATA solo, 1, 1%



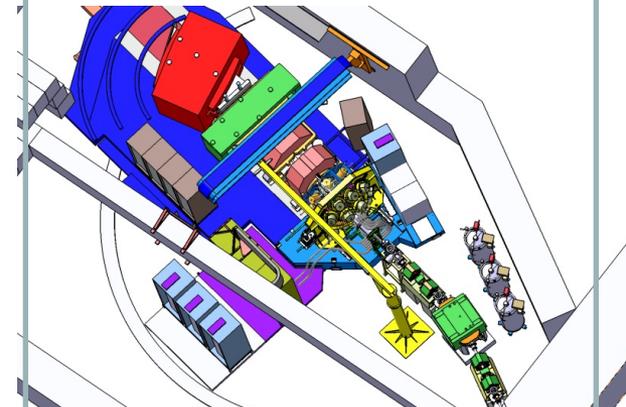
NEDA on-going (NEDA0@LNL)  
DIAMANT starting upgrade



## VAMOS vacuum mode



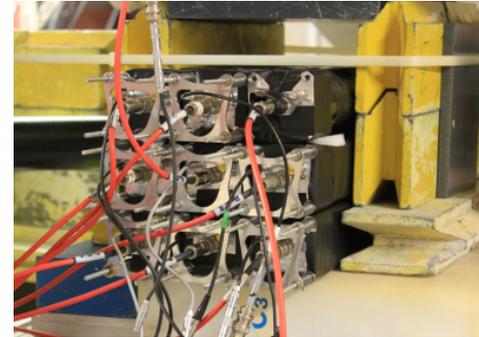
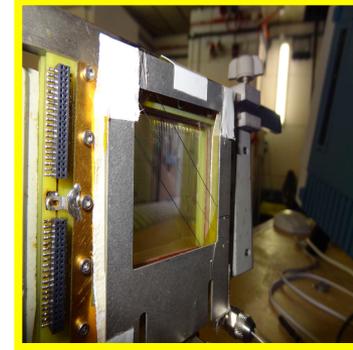
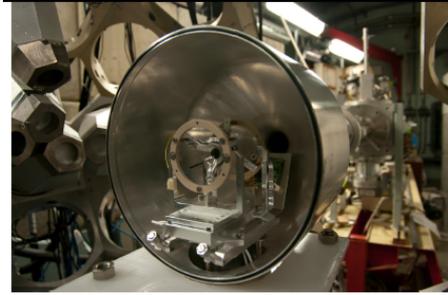
## VAMOS Gas-Filled From 2016



# Ancillary Detectors

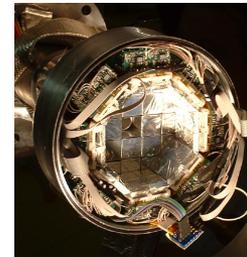
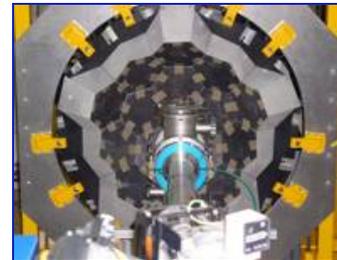
In 2015-2016

VAMOS vacuum mode  
EXOAM2  
Plungers (OUPS & Cologne)  
PARIS & FATIMA



From 2016

VAMOS Gas-filled  
NEDA/NWALL (after Galileo campaign)  
DIAMANT  
MUST2/GASPARD

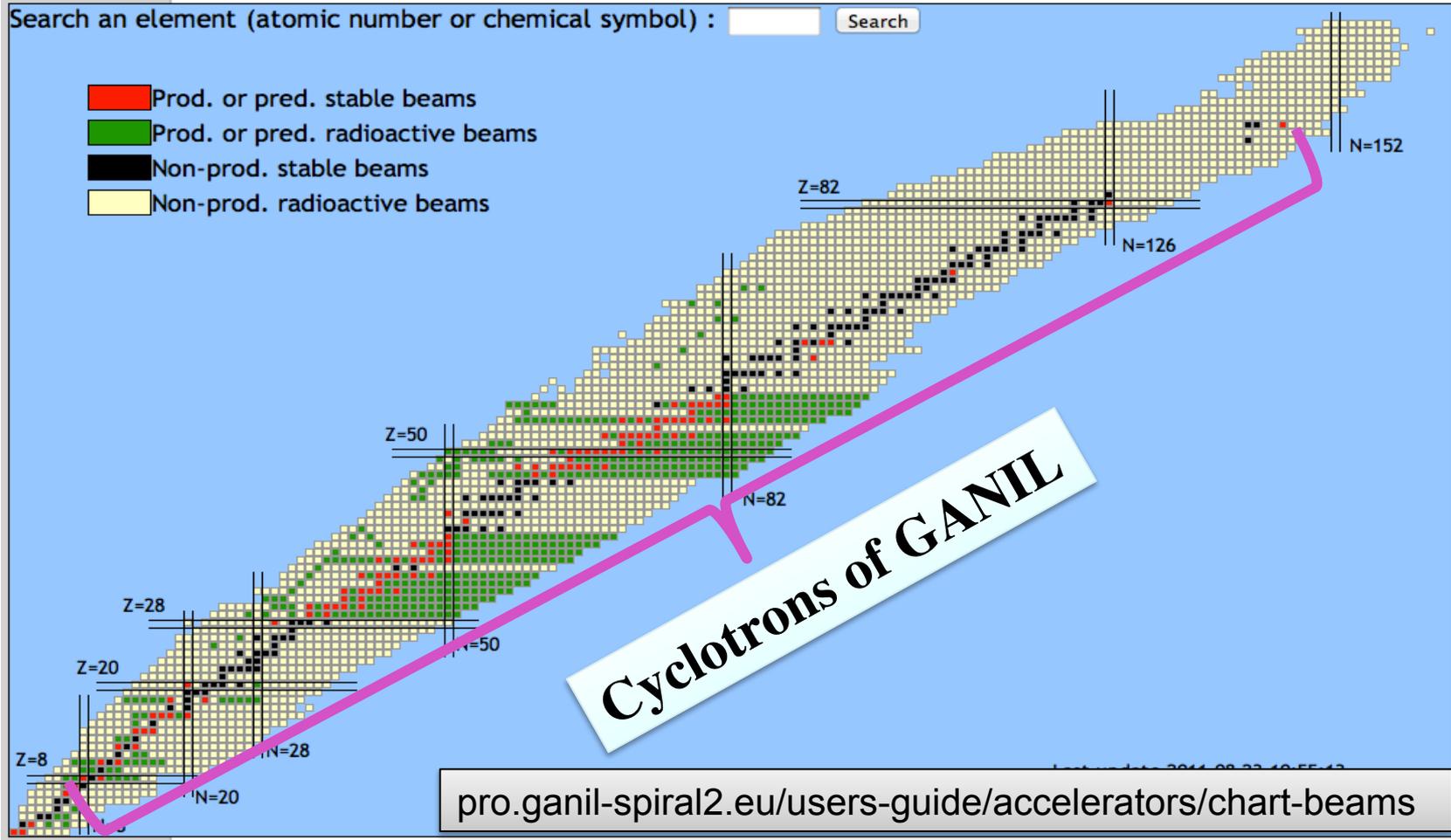


- 
- Physics Case
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  - **Beams and Beam time**
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# Stable ion-beams from cyclotrons of GANIL

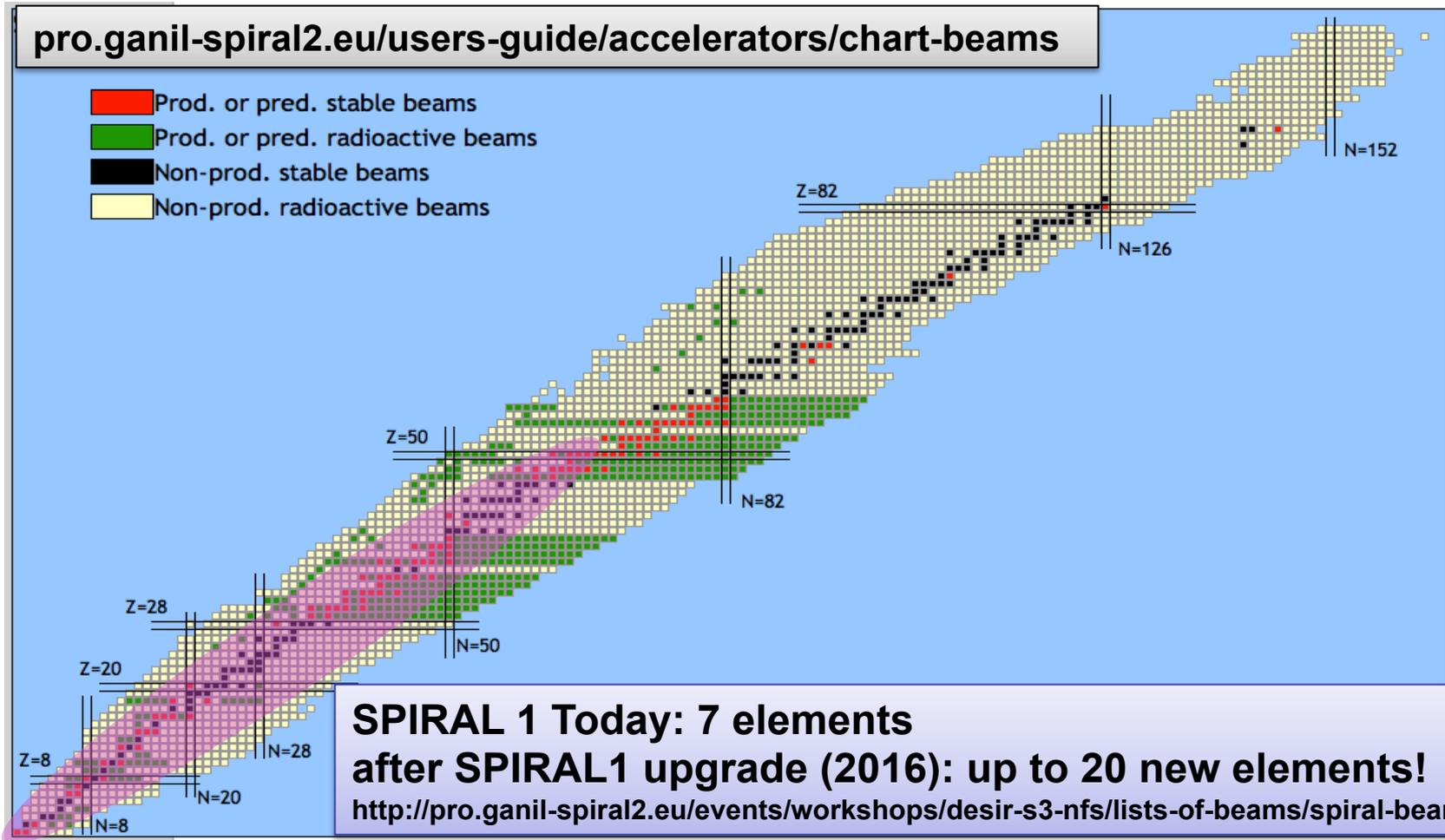
- Cyclotrons:  $\leq 10^{13}$  pps, from C to U, 1 MeV/n - 95 MeV/n

Rare stable-isotopes  $^{36}\text{S}$ ,  $^{40,48}\text{Ca}$ ,  $^{50}\text{Ti}$ ,  $^{58}\text{Ni}$ , & unique in Europe  $^{208}\text{Pb}$ ,  $^{238}\text{U}$



# Radioactive Ion Beams GANIL/SPIRAL1

- RIB by in-flight at LISE: few MeV/n to 50 MeV/nucl.
- ISOL RIB from SPIRAL 1 & SPIRAL 2:  $\leq 60\text{keV}$  et 1-15 MeV/nucl.

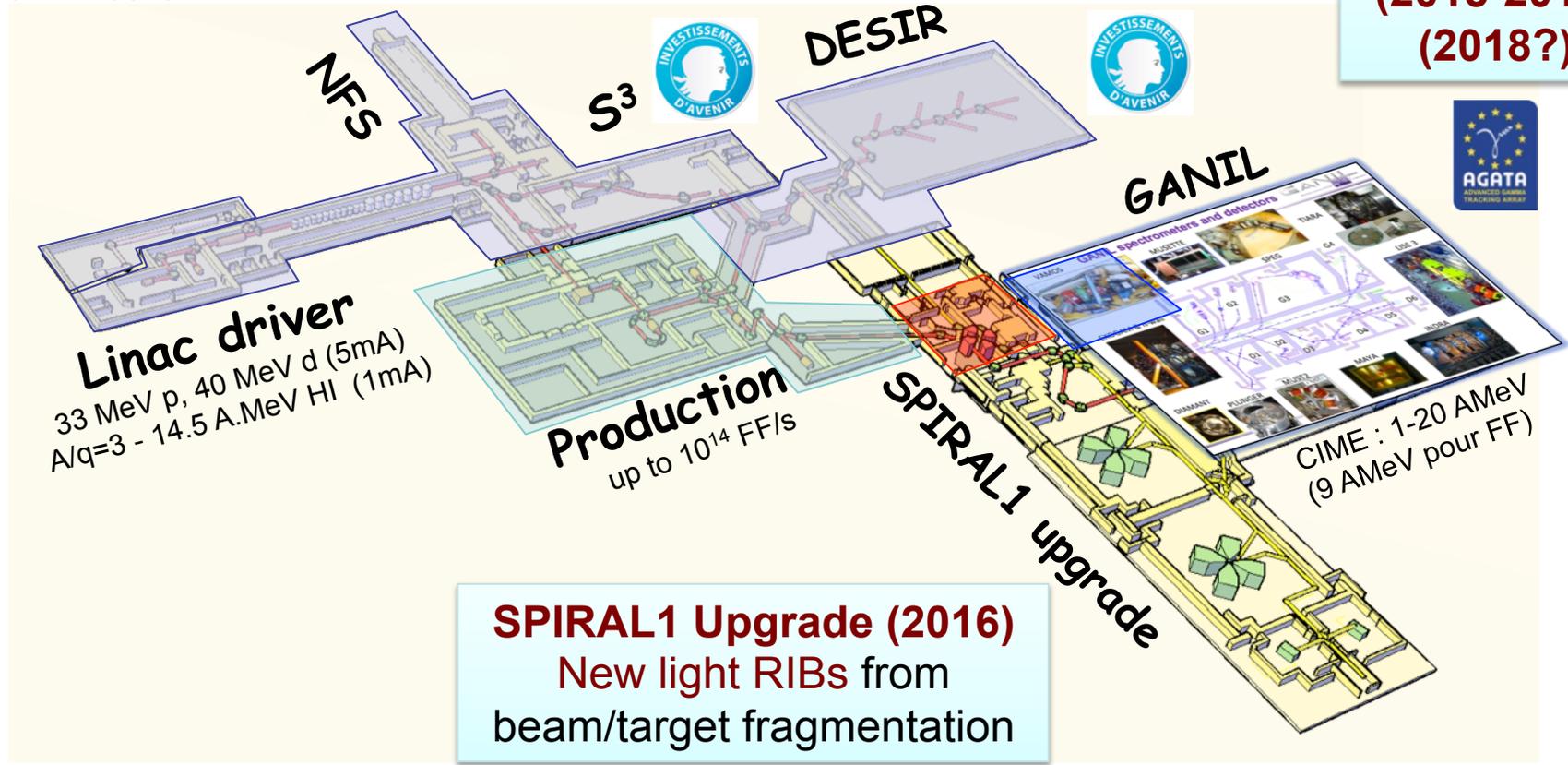


## SPIRAL2 Phase1 (2015)

Increase the intensity of stable beams by a factor 10 to 100 – High intense neutron source

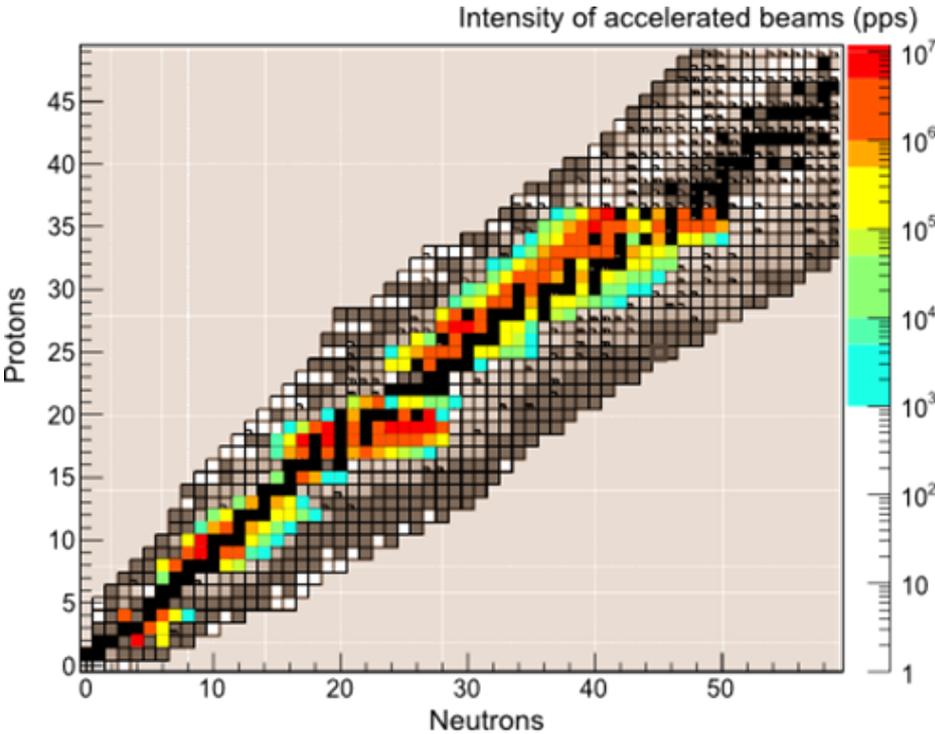
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**AGATA**  
(2015-2016)  
(2018?)

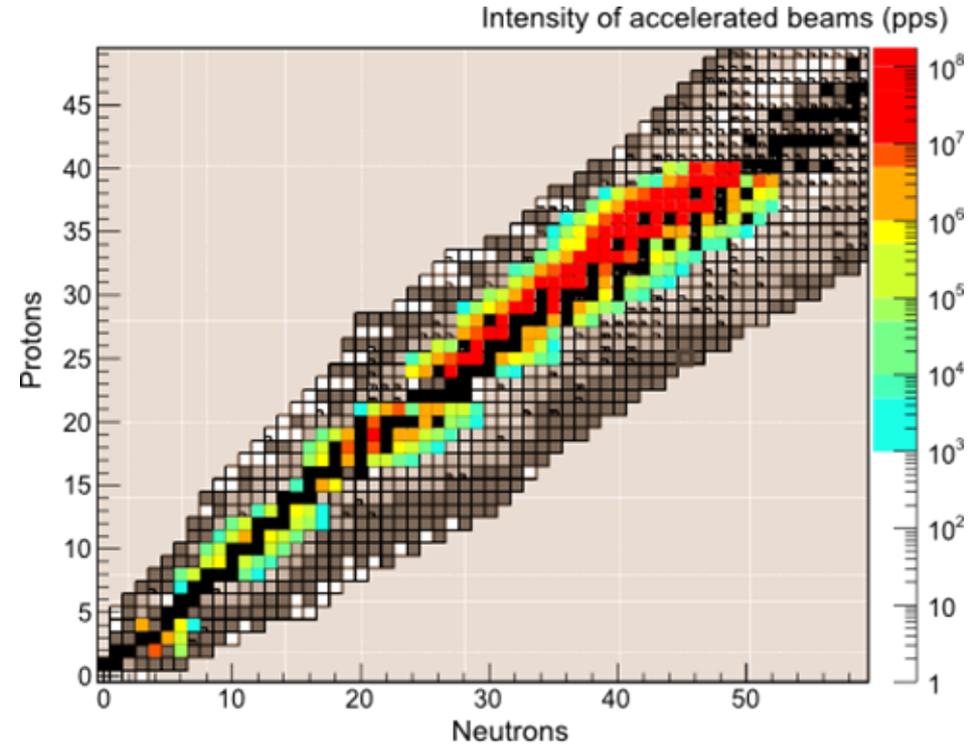


**SPIRAL1 Upgrade (2016)**  
New light RIBs from beam/target fragmentation

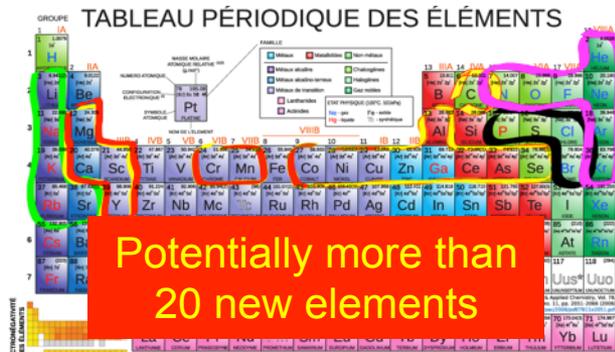
# SPIRAL 1 upgrade



SPIRAL: Expected production from  $^{12}\text{C}$  target



SPIRAL: Expected production from Nb target



New beams in the end of 2016 available for AGATA@GANIL campaign

- Nanogan - surface - Fe had - ecr HD

P. Delahaye

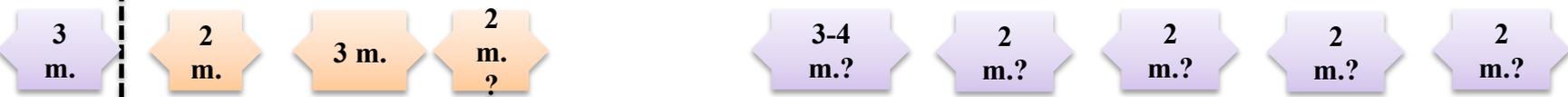
# Timeline GANIL & SPIRAL2

**Upgrade SPIRAL1**  
**VAMOS Gas-filled?**



**GANIL cyclotrons**

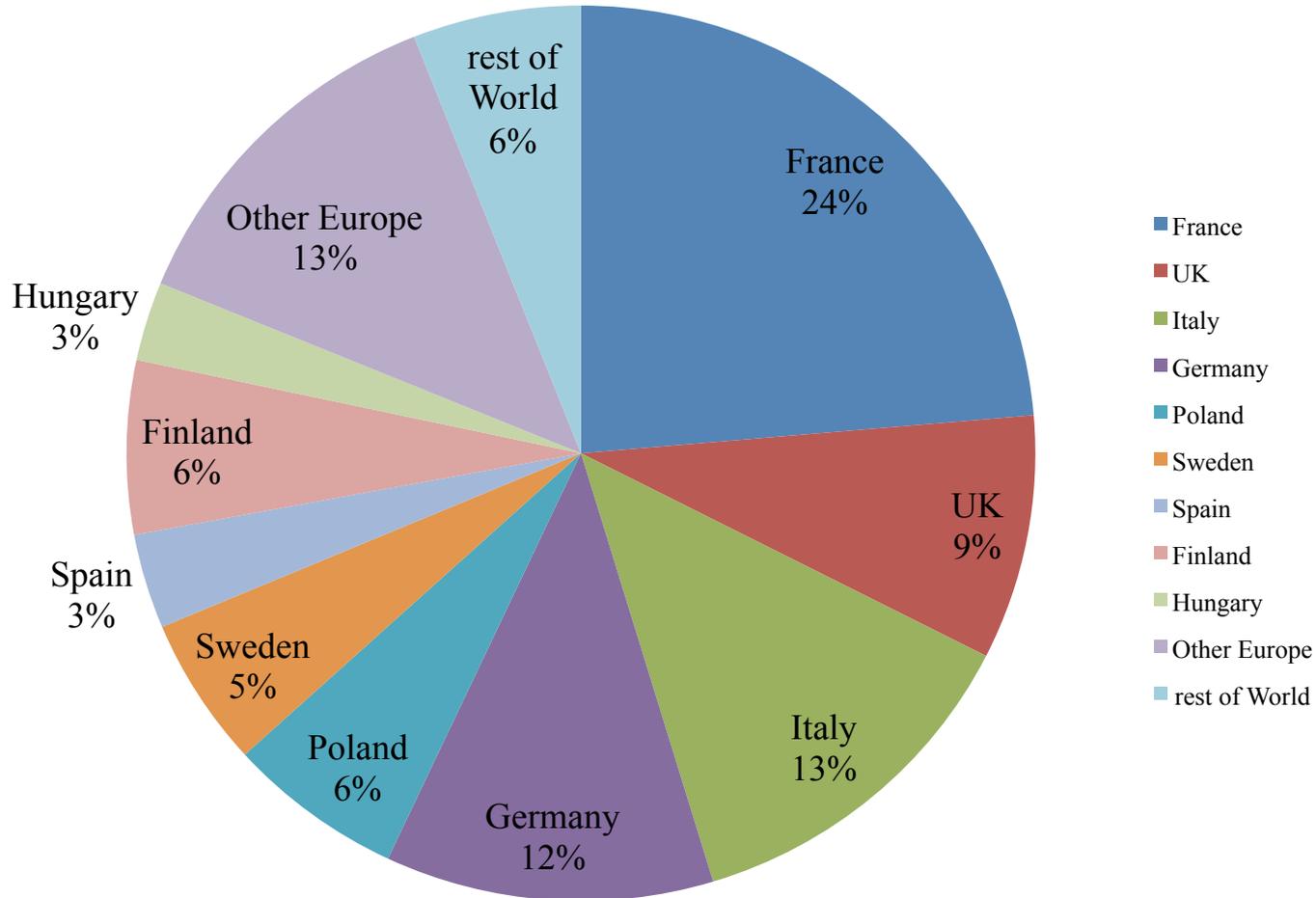
**SPIRAL2 Phase 1**



- 
- Physics Case
  - Facility & Instrumentation
  - Beams and Beam time
  - Community and User's support

669 days of continues beam

**351 authors have signed the LOIs**



## Support for installation & users of AGATA@GANIL

- Support for installation of AGATA: 390k€  
*350k€ from GANIL & 40k€ from IN2P3/CNRS*
- EU FP7 ENSAR (TNA GANIL, 2014 only): 70k€
- EU HORIZON 2020 Proposal ENSAR 2 (TNA GANIL, 2015-2018): 400k€ - at least 50% for AGATA exp.
- Support from GANIL & IN2P3/CNRS France (2 post-docs currently)
- GANIL financial support for longer stays

# Conclusion



## Exciting scientific program with AGATA@GANIL

### Summary of beamtime<sup>\*)</sup> 2014-2016 available for AGATA exp.:

- 27 weeks of CSS1 in 2015-2016 (10 experiments approved so far)
- 20 days for AGATA-VAMOS commissioning in 2014

*\*) beam preparation time including*

*Letter of intent*

### Extension of the AGATA@GANIL campaign to 2017 & 2018 with 20 additional weeks of beamtime, with focus on:

- *N=Z, Isospin symmetry, shape coexistence, nuclear astrophysics with NEDA*
- *Heavy and Very Heavy Nuclei with the VAMOS Gas-Filled Mode (the most efficient setup worldwide)*
- *Physics with light ( $A \leq 80$ ) ISOL Radioactive Ion Beams from SPIRAL1*

**Support for users via EU ENSAR (2014) and ENSAR 2 (2015-2018) and GANIL funds**

**Physics with AGATA is the priority for the current scientific program at GANIL**



# From proposal to Experiment

AGATA Pre-PAC workshop  
*Feb. 11-12, 2014*

Other GANIL/SPIRAL2  
proposals

Reception of Proposals by GANIL Beam Coordinator  
***Dead-line March 7, 2014***

Technical Advisory Committee (TAC) meeting  
*March 21, 2014*

PAC meeting with oral presentations of each proposal  
***April 3-4, 2014***

Yes!

Experiments scheduled by Beam Coordinators with the  
approval by GANIL Directorate  
*from March 2015*

*Next PAC  
In 2015*

# GANIL/SPIRAL2 Beam-time Schedule



## 2014

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Weeks	
<b>SPIRAL 2</b>														
LINAC														0
Maintenance LINAC														0
<b>AEL</b>														
NFS														0
S3														0
Tests LINAC (RFQ)									1	1	1	1	1	16
<b>Cyclotrons/SPIRAL 1</b>														
Cyclotrons														25
CSS1 solo	X	X	X	X	X	X	X	X						14
CSS2	X	X	X	X	X	X	X	X						11
Maintenance Cyclotrons														13
<b>GANIL Exp. Area</b>														
LISE	X	X	X	X	X	X	X	X						6
SPIRAL1	X	X	X	X	X	X	X	X						0
Aires GANIL	X	X	X	X	X	X	X	X						0
LIRAT	X	X	X	X	X	X	X	X						0



**PAC GANIL (AGATA)**  
**13 accepted exp.= 140 days (10 with AGATA= 108 days)**

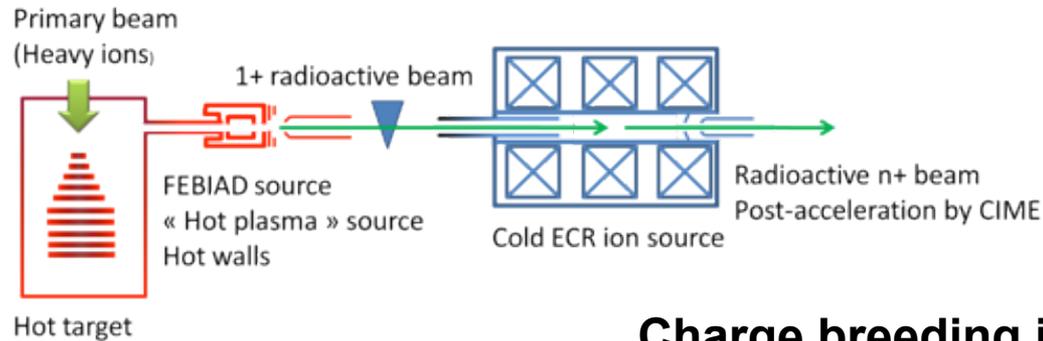
**AGATA**  
 tests and commissioning



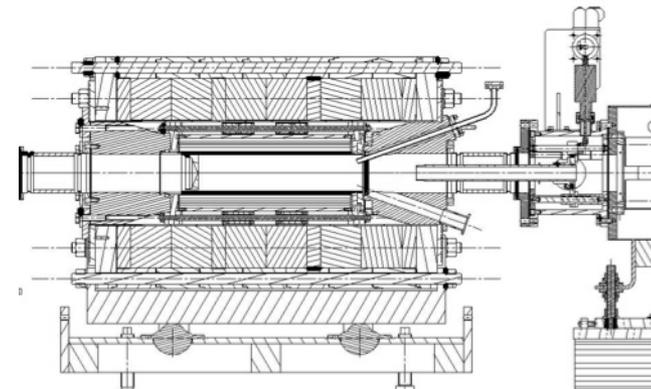


# SPIRAL 1 upgrade

## 1+/n+ ionisation scheme

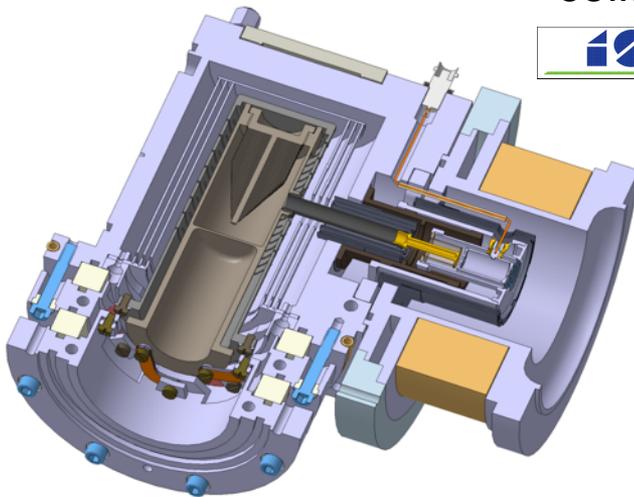


## Charge breeding in a Phoenix ECRIS



## FEBIAD 1+ ion-source beams

collaboration



collaboration



New beams in the end of 2016  
Available for AGATA campaign)

# Installation of AGATA at GANIL begun in May 2014

