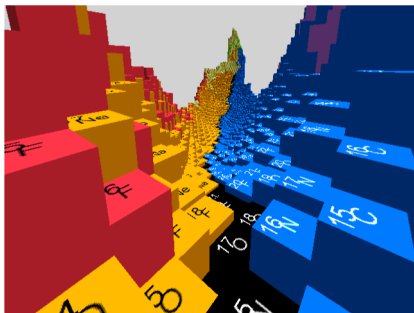


# Status of the GANIL/SPIRAL2 facility

Navin ALAHARI  
LIA France Brazil 2018

**GANIL (Grand Accélérateur National d'Ions Lourds)**  
**SPIRAL2 (Système de Production d'Ions Radioactifs Accélérés en Ligne)**



- **GANIL** : Nuclear microscope using **Cyclotrons** and detectors being used
- **SPIRAL2** : other newer microscope with its **LINAC** and its three arms

Try to answer the questions you wanted to ask about GANIL but did not ask

Many Challenges (?) but is our job to find the solutions and get cracking (we will and are)

Thanks to the all the labs National and international to make what GANIL is today

# GANIL/SPIRAL2

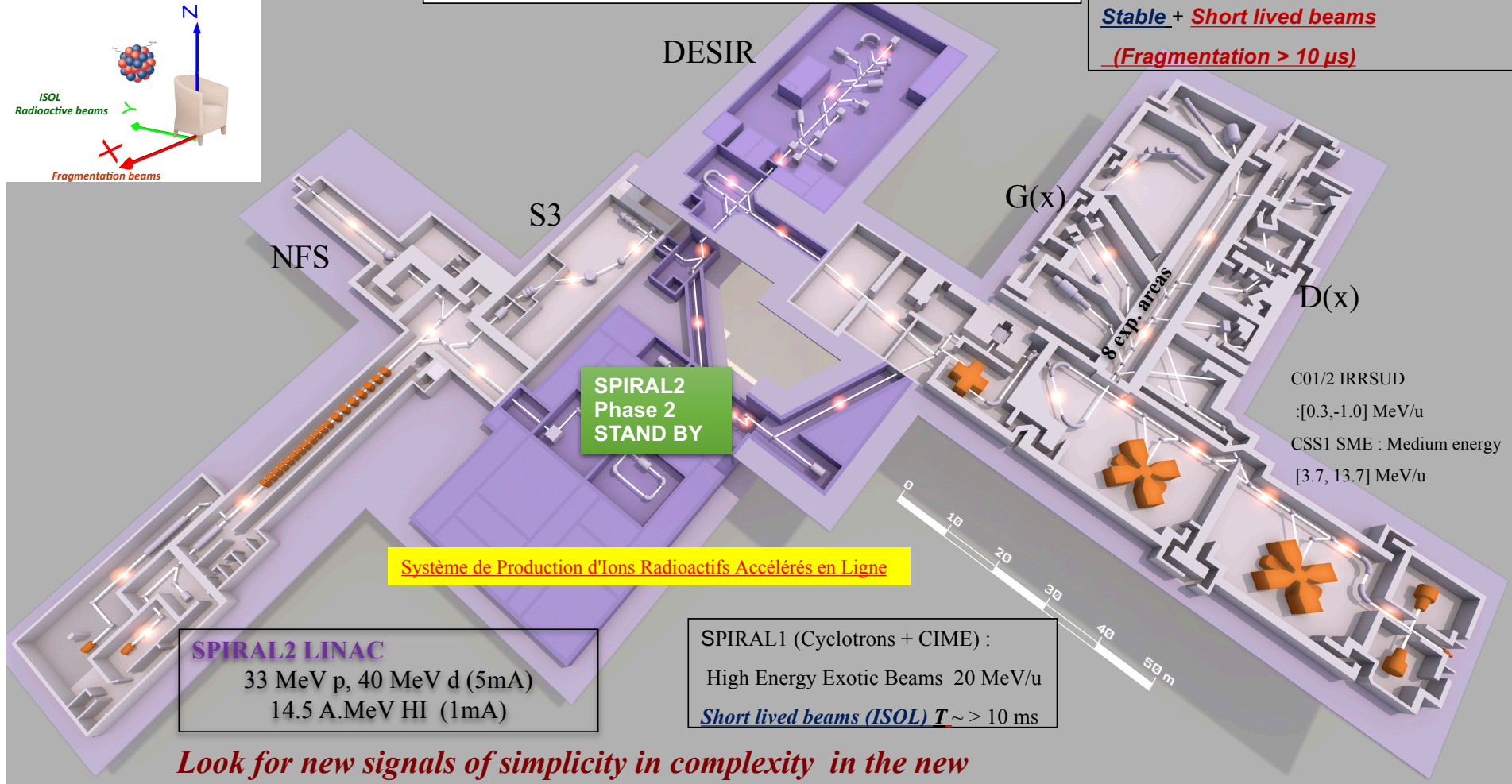
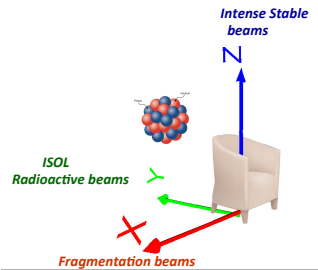
INB 113

Nuclear Physics / Material science / Atomic physics / Applications

High Energy Beams [24- 95] MeV/u

Stable + Short lived beams

(Fragmentation > 10  $\mu$ s)



**SPIRAL2 LINAC**  
 33 MeV p, 40 MeV d (5mA)  
 14.5 A.MeV HI (1mA)

SPIRAL1 (Cyclotrons + CIME) :  
 High Energy Exotic Beams 20 MeV/u  
Short lived beams (ISOL)  $T_{\sim} > 10$  ms

*Look for new signals of simplicity in complexity in the new phase space of  $E^* J T$  with stable, Fragmentation and ISOL beams*

# GANIL/SPIRAL2

INB 113

Nuclear Physics / Material science / Atomic physics / Applications

High Energy Beams [24- 95] MeV/u

Stable + Short lived beams

(Fragmentation > 10  $\mu$ s)

DESIR

Intense Stable beams  
ISOL Radioactive beams  
Fragmentation beams

Z/Elem. Symbol

A  
X  
Z

- All facilities
- Stable ions facilities
- Cyclotrons
- LINAC
- Radioactive ions facilities
- SPIRAL1
- S3
- SPIRAL2-Phase2-50kW

Stable Radioactive

Produced (Green) Produced (Blue)

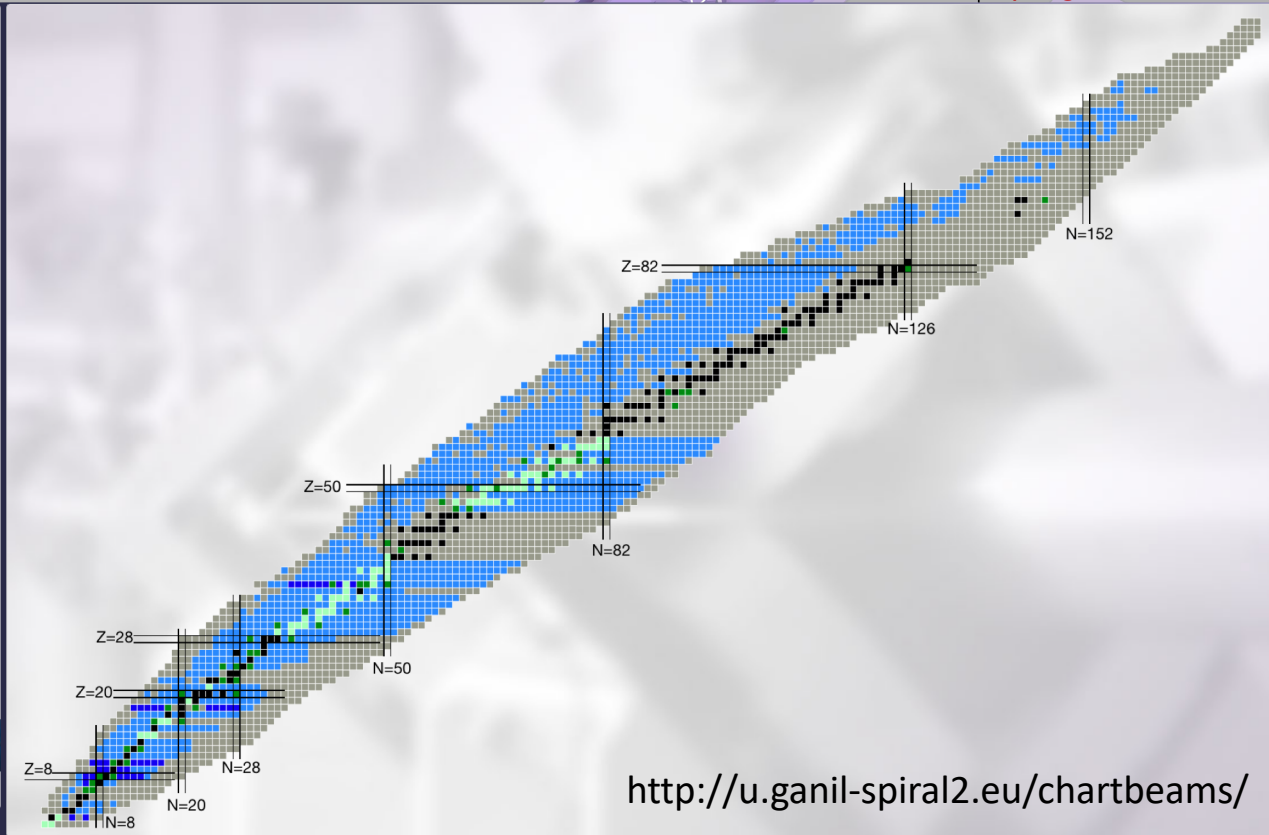
To Be Produced (Light Green) Produced (Light Blue)

Not Produced (yet) (Black) Produced (Grey)

Help Contact

©Chartbeams

Version 1.1 - 2016-05-23  
Data update : 2017-01-31



<http://u.ganil-spiral2.eu/chartbeams/>

*Look for new signals of simplicity in complexity in the new phase space of  $E^* J T$  with stable, Fragmentation and ISOL beams*

X)

IRRSUD

-1.0] MeV/u

SME : Medium energy

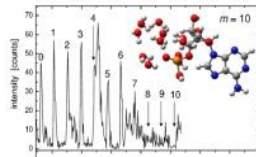
[3.7-13.7] MeV/u

# Interdisciplinary Research

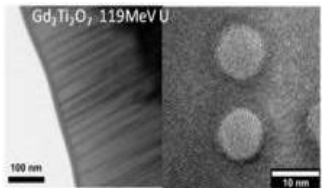
## eV to the GeV scale

CiMap

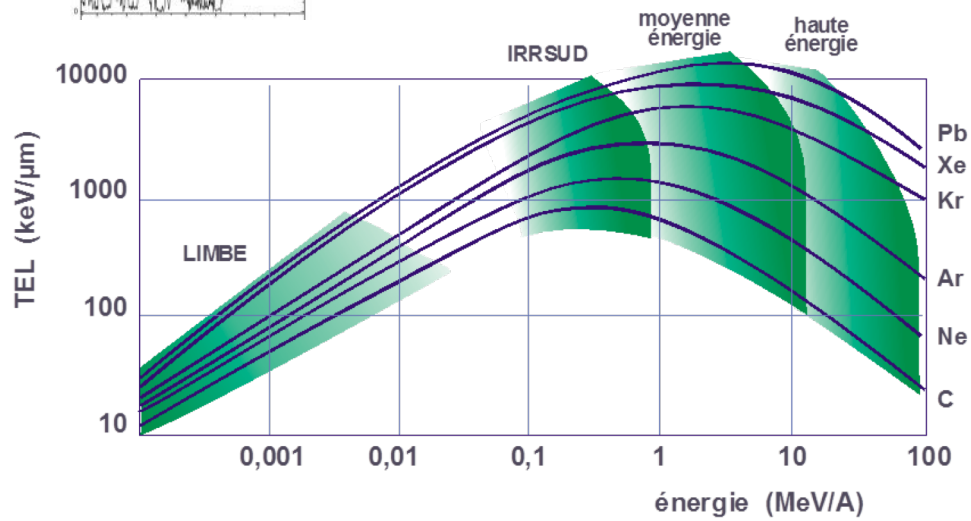
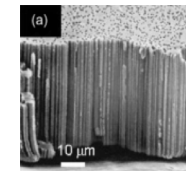
Diluted media, molecules, aggregates



Physis of solides  
Science of material

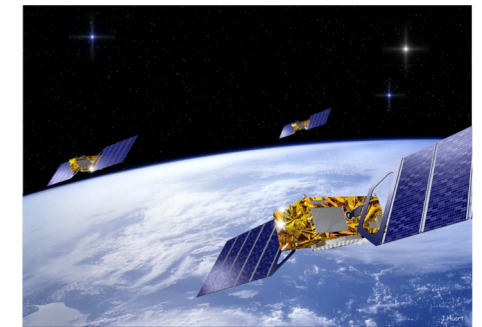


Structures,  
nano structures

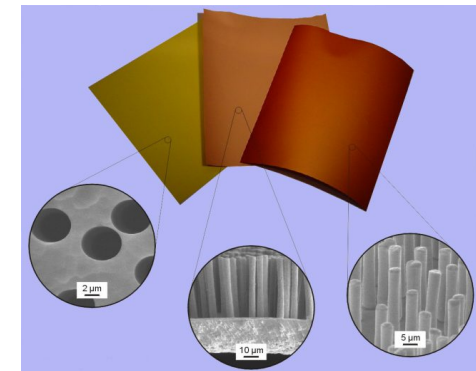


Radio chemistry  
Astrochemistry

## Industrial Applications



Radiobiology





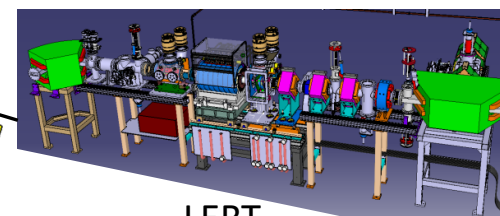
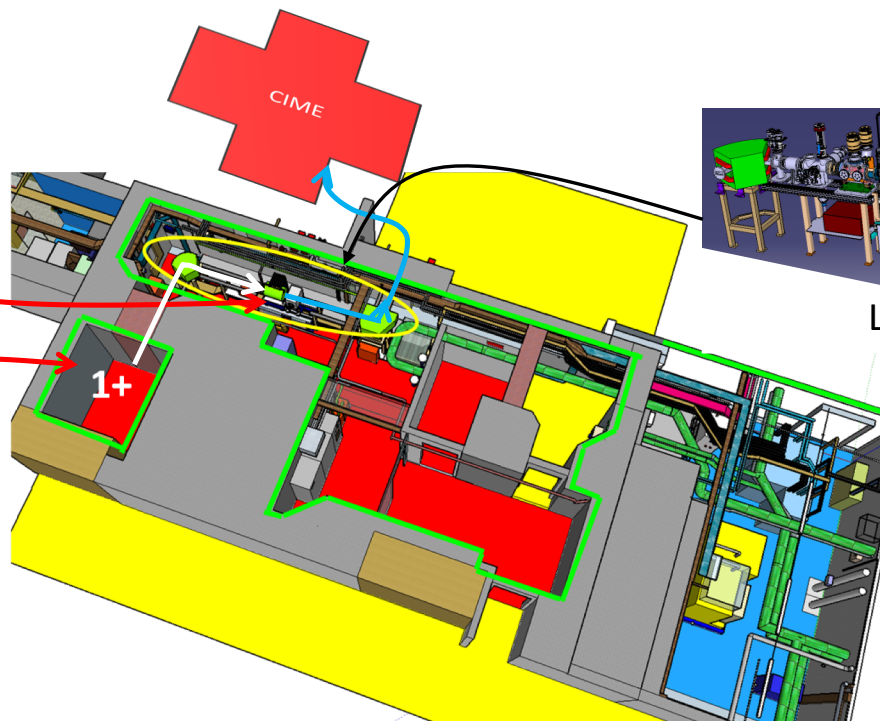
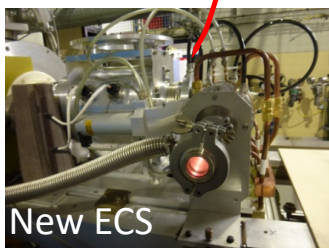
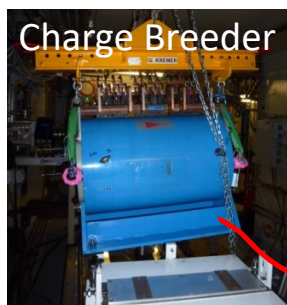


# SPIRAL1 UPGRADE



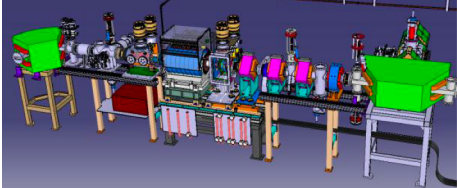
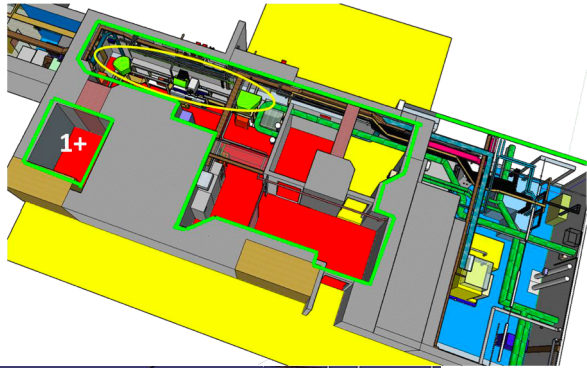
- Developing a new 1+ ion source : ECS FEBIAD + Graphite Target
- Install a Charge breeder to transform the 1+ beam into N+ beam
- Accelerate the N+ beam with CIME Cyclotron
- Infrastructure Works on the SPIRAL1 Facility (Nuclear Ventilation, ...)

New 1+ radioactive beams  
 Needed to accelerated the beam  
 New accelerated RIB  
 Safety improvement (RXS)



- Nuclear Ventilation -80Pa
- Nuclear ventilation -120Pa
- Booster services
- Fire zone improvement

# SPIRAL1 Return of the Jedi and Force awakens



17F exp using the new FIBAD source was unsuccessful due to failure of new FEBIAD source

But a next with a modified source (Thanks to collaborations with colleagues in other labs ...)

**EDF** within a week

The test show that the system works under real conditions

Test for beam for next year campaign

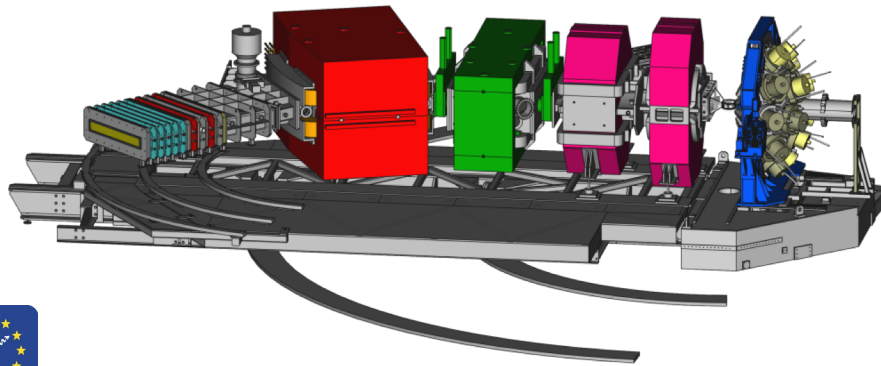
Isotopes	Worst case scenario (unlikely)	Nominal scenario (likely)	
	Rate (pps) (20% CIME)	Rate (pps)	Requested rate (pps)
37K		7,85E+04	1,57E+06 <i>Not requested</i>
38mK		1,85E+05	2,32E+06 5,00E+05
38K		3,78E+06	4,73E+07
45K		3,84E+05	4,80E+06 5,00E+06
28Mg		6,80E+04	1,70E+05 1,00E+05
25Al		8,16E+01	2,80E+03 1,00E+05
30P	?		4,40E+03 1,00E+05
15O		9,00E+06	1,50E+07 1,80E+07

## PRELIMINARY RESULT

Thanks to SPIRAL1 UPGRADE TEAM

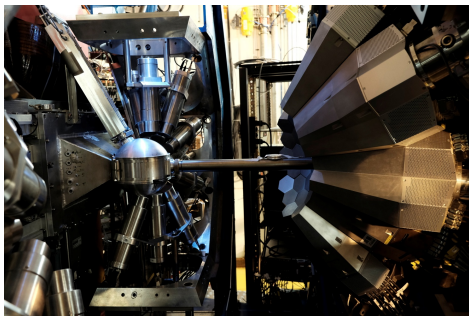
- $^{38m}\text{K}$ ,  $^{28}\text{Mg}$ ,  $^{15}\text{O}$  are ok
- $^{45}\text{K}$  is fine
- older beams ( $^{45}\text{Ar}$  and others) still available
- need some R&D for some beams

# VAMOS spectrometer + AGATA ...

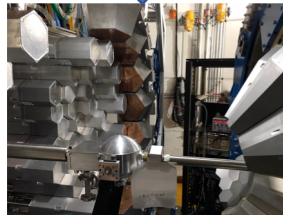


Variety of setup

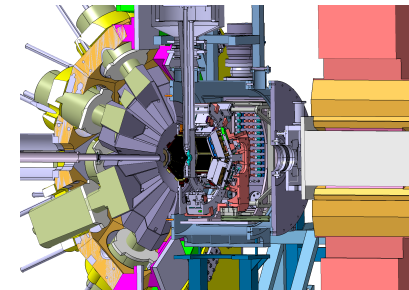
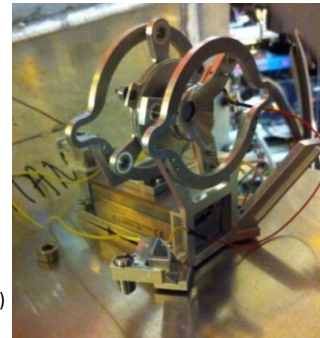
Prompt-Delayed Spectroscopy  
(fission Fragments...)



35 detectors



E. Clément et al., NIMA 855, 1-12 (2017)  
Y. H. Kim et al., Eur.Phys.J. A 53, 162 (2017)

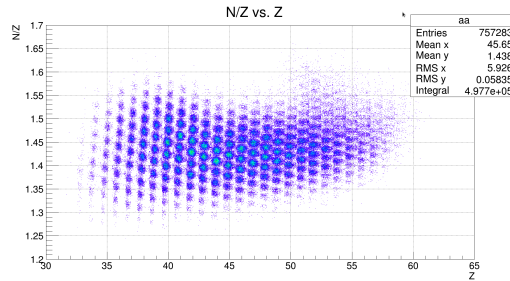
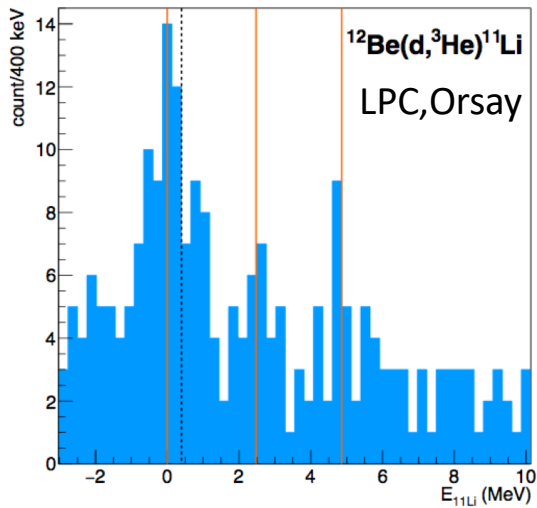


Prompt-Delayed Spectroscopy (fission Fragments...) + more using the unique facilities at GANIL

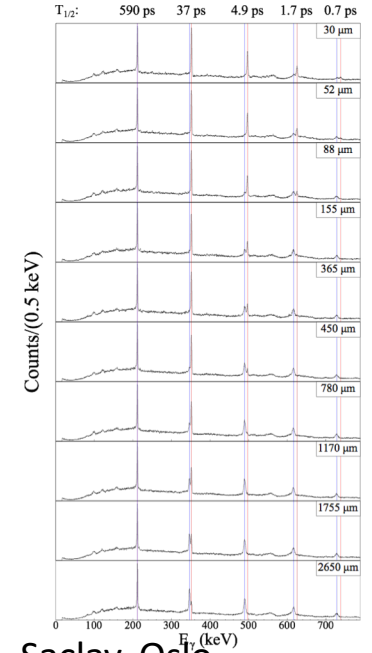
VAMOS Ganil contact person : A. Lemasson / AGATA Ganil contact person : E. Clément



# Online Images from our spectrometers LISE VAMOS

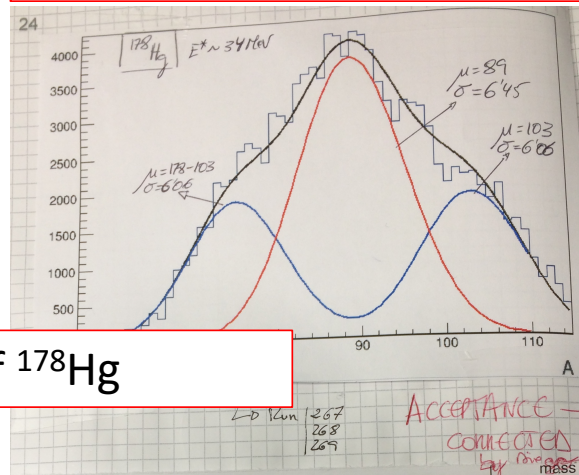


N/Z vs. Z from U+Mg



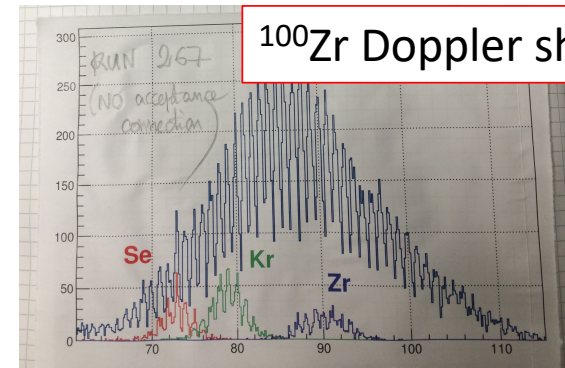
Saclay, Oslo

All Results are preliminary!

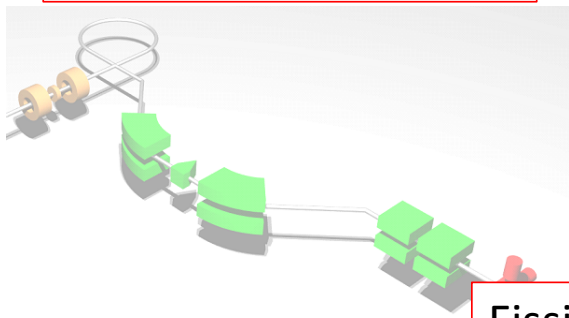


Fission of  $^{178}\text{Hg}$

USC Spain, GANIL



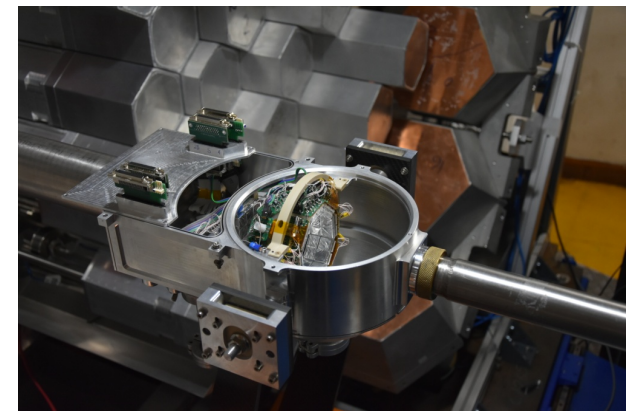
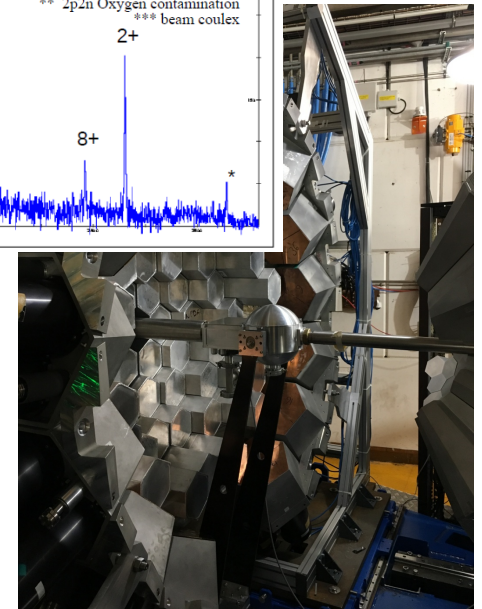
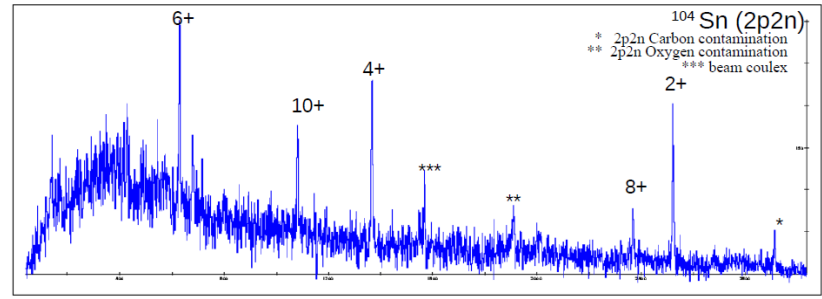
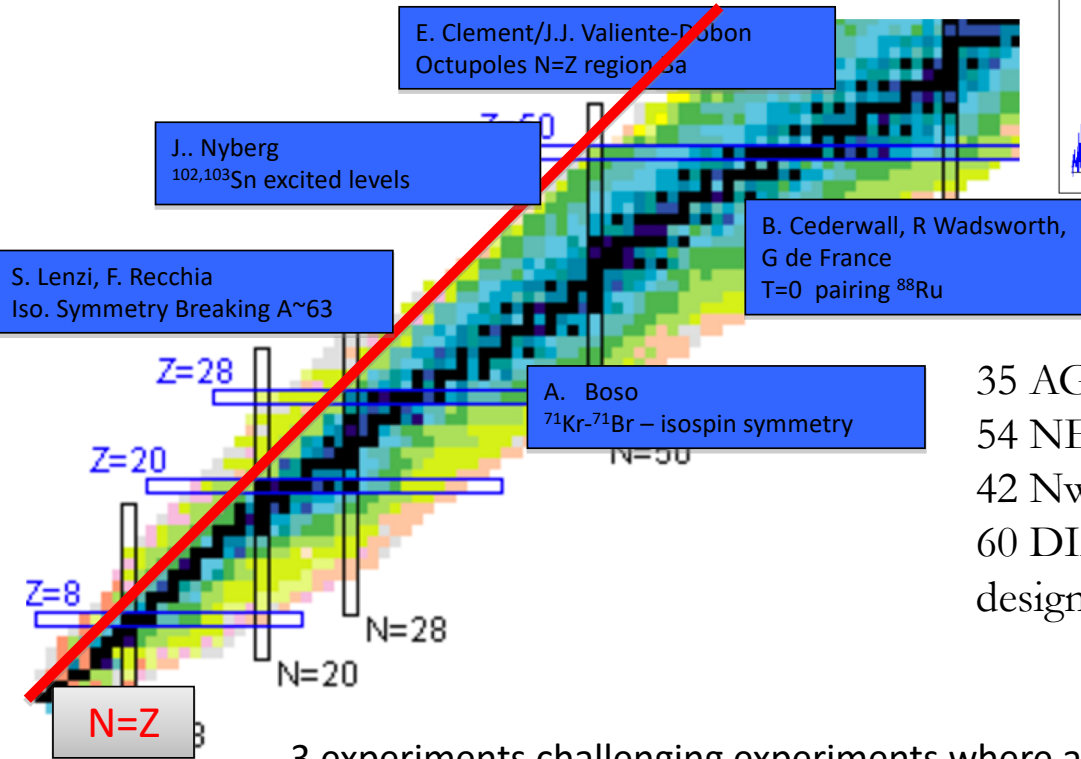
$^{100}\text{Zr}$  Doppler shifts from U+Be



(np transfer reaction)

# The AGATA-NEDA-DIAMANT Campaign at GANIL:

## Focus around $N=Z$



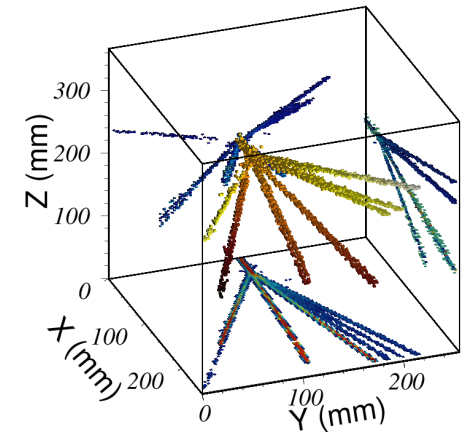
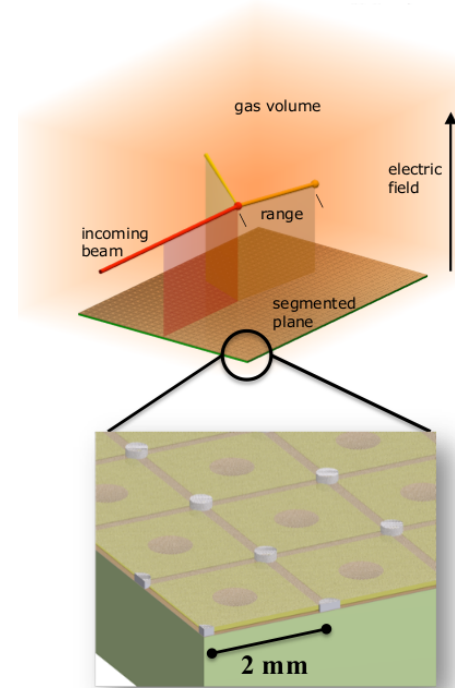
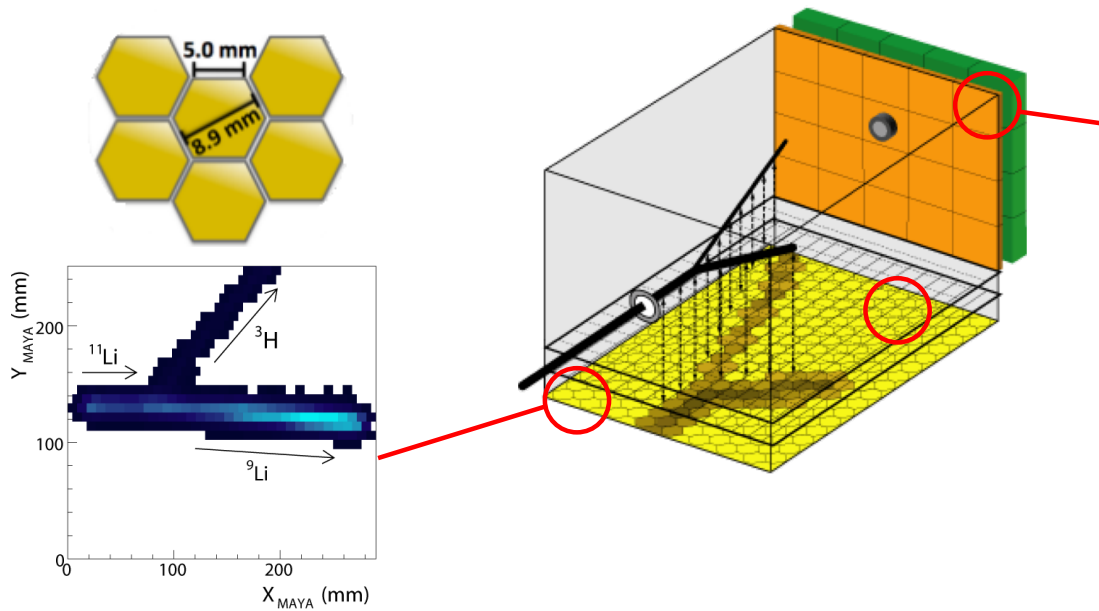
- 35 AGATA Capsules
- 54 NEDA detectors
- 42 Nwall detectors
- 60 DIAMANT CsI in a newly designet target chamber

3 experiments challenging experiments where all systems worked well

- Online event building and quasi online pre analysis
- Huge efforts of many people

Gilles de France et al

# Active targets MAYA -> Actar



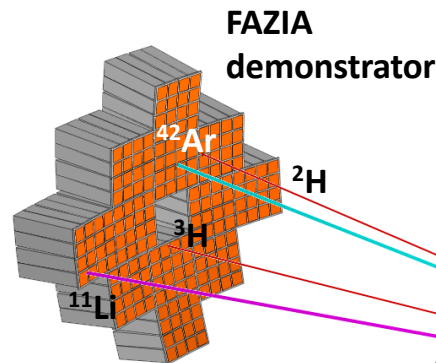
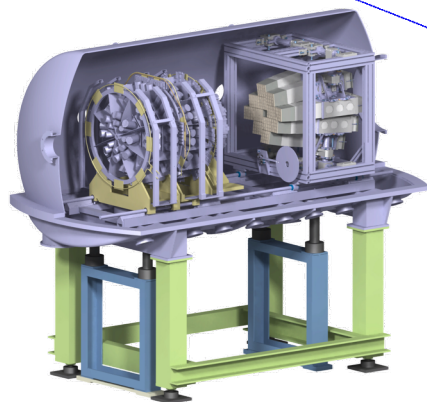
Successful commissioning of the ACTAR TPC

ACTAR Ganil contact person : T. Roger

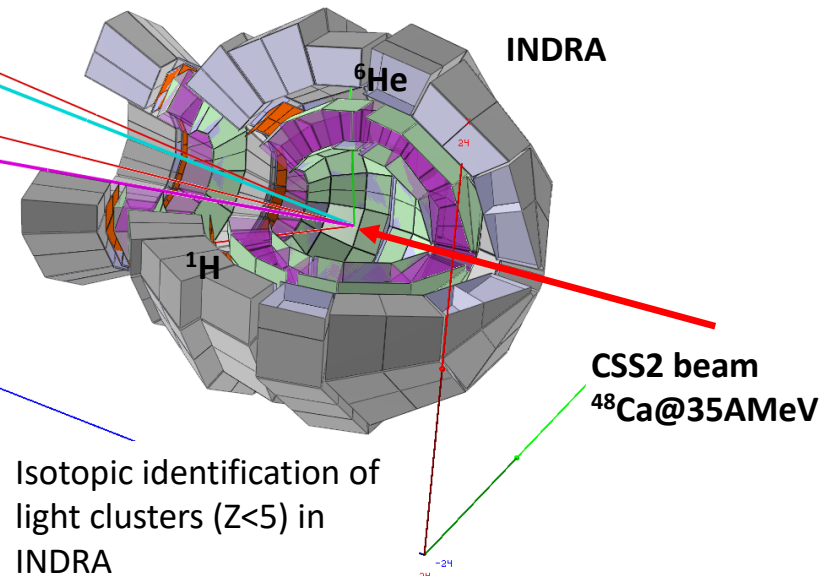
# FAZIA@GANIL Program

## Constraining asymmetric nuclear matter EOS

Full isotopic (Z,A) reconstruction of all decay products (incl. residue) in FAZIA



Typical (simulated) event  
Quasi-projectile decay  
 $^{48}\text{Ca}+^{48}\text{Ca}@35\text{A MeV}$

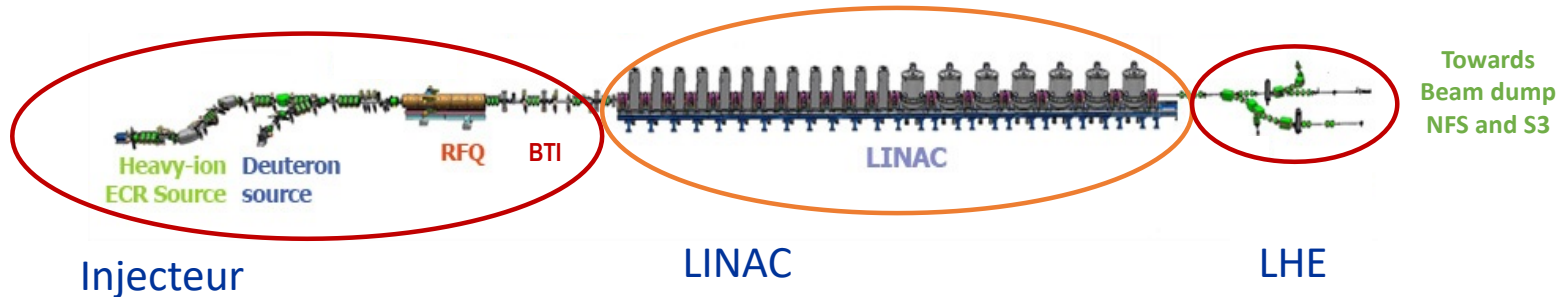


Isotopic identification of light clusters (Z<5) in INDRA

The whole system will be tested with beam on 25<sup>th</sup> of June 2018

FAZIA Ganil contact person : J. Franckland

# *SPIRAL2:Details LINAC*



## Sources

RFQ review suggestions for improvement

RFQ conditioning and full characterization with p and alpha to mimic deuterons

Test in progress

## LINAC

All LINAC modules cooled with the specifications for a max of 12hours Nov 2017

New improvements planned and will be in place in July and tested starting Aug 16

Tuning of the couplers

Waiting for RF authorization or Full authorization for putting RF

Internal Safety clearance and tests

Nuclear safety Authorities (ASN : Saga continues from Oct 2013. Improved relationship with ASN

After their last demand for 30 safety related question. All replied to in a phased manner Dec Feb April as per schedule

# *Status equipment SPIRAL2 phase 1*

---

S3 Work in progress for the spectrometer

*Use of the Hall for beyond 40 metres cleared for the next 5 years  
(related to the fire exit)*

Technical issues slowly being cleared

Detector systems progressing well

Project management Review Feb 2018

25 points to be looked into ( on the job)

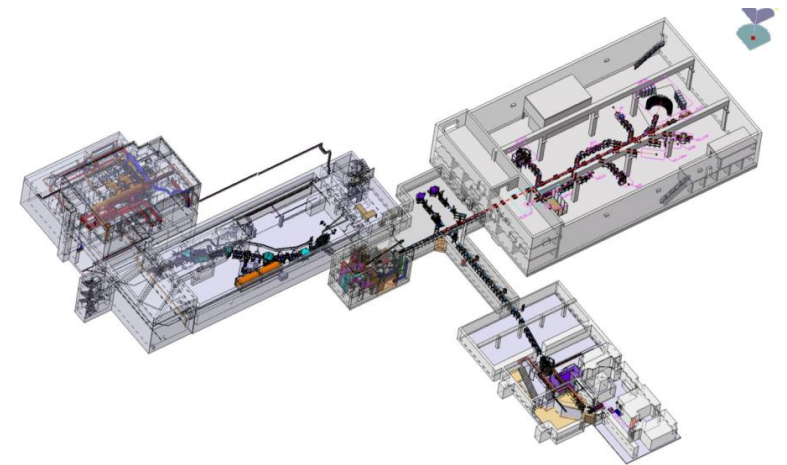
S<sup>3</sup> coordinator : H. Savajols

DESIR The contractor for construction to be chosen

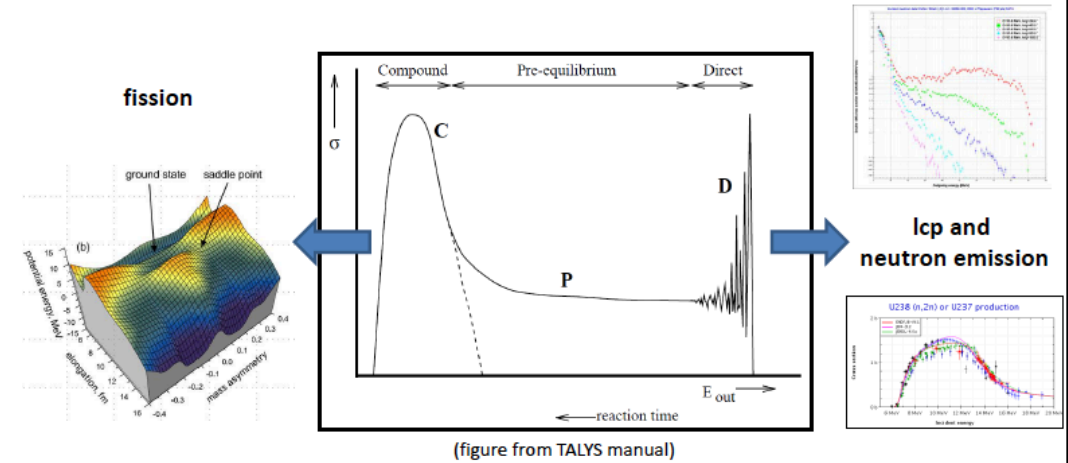
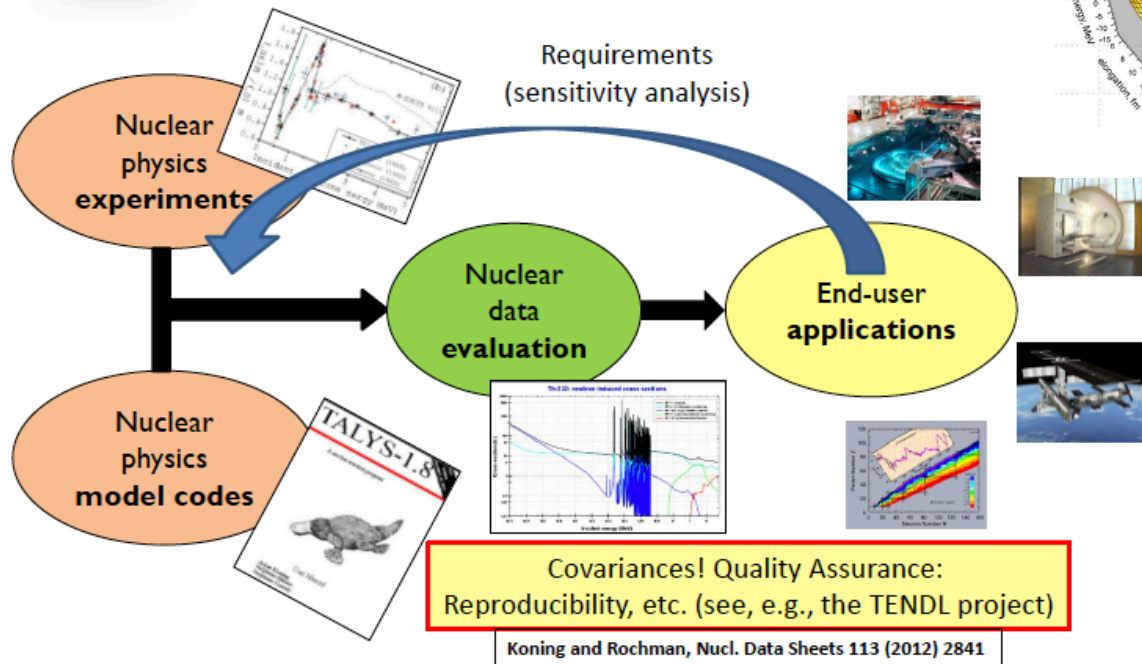
Final decision to made in June for a full completion in 2024

Will also construct the fire exit for S3

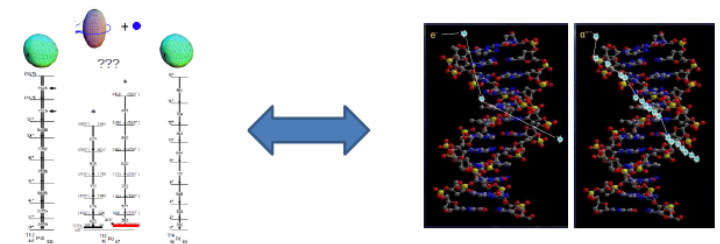
DESIR ganil coordinator : J.C. Thomas



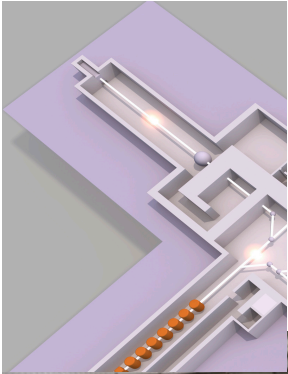
# A new variety of opportunities at NFS



- a unique facility offering several different beams,
- located in a fruitful research environment, with
- mutual benefits for different research disciplines.



## NFS – Status Beam line and the rotating convertor Avril 2018

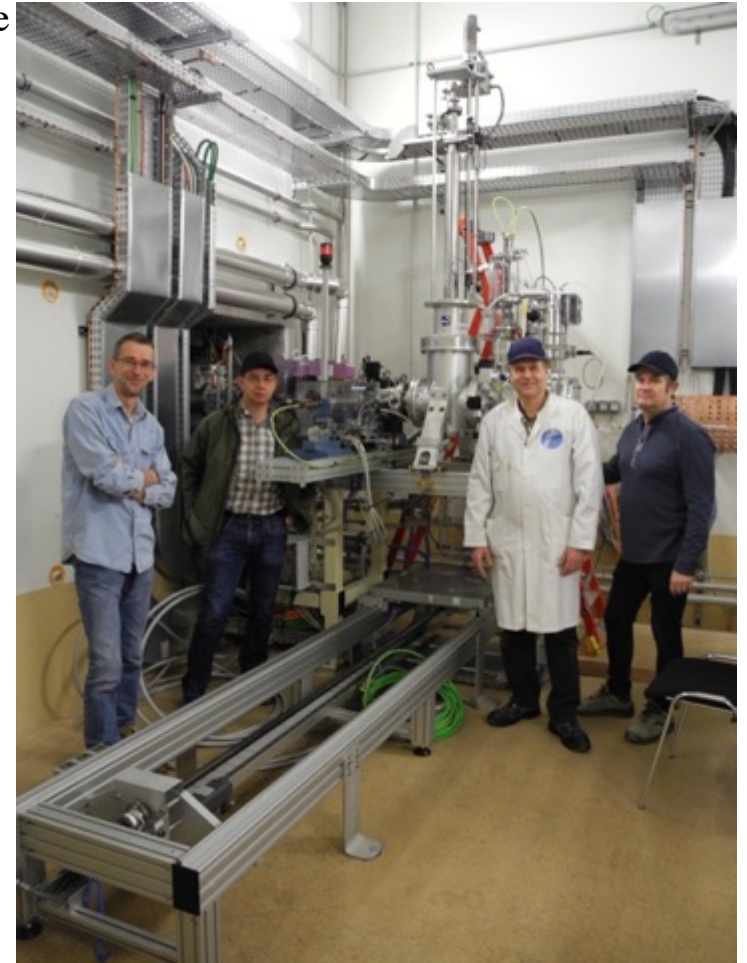


Neutrons For Science Very advanced stage  
Thin convertor  
Rotating convertor  
Beam line  
Fast Rabbit transfer  
Work in progress



-IPHC Strasbourg and GANIL

NFS coordinator : X. Ledoux



IRFU/DIS et GANIL to be finished by end of June



# Planning LINAC

**Planning SP2 construction - mise en service technique et tests sûreté**  
(23/05/2018)

contraintes accès LINAC (HF Linac)  
fonctionnement Ganil

## Accélérateur

**Hypothèse : obtention de l'autorisation partielle étendue à la HF linac en octobre**

Injecteur (conditionnement RFQ / tests faisceaux et équipements sur BTI)

démontage BTI / montage LME tests et mise en service

LINAC (reprises - mise au point- upgrade)

LINAC (mise en froid)

LINAC (qualification HF)

LHE

SPM-T (global) système de protection machine - thermique

## Systèmes EIS/EIP

Tests UGA / UGB (EIP 1)

Vannes rapides (EIP 5b-1)

Actionneur rapide (EIP5b-2)

STCR (5b2a) système de transmission de la coupure rapide

Tests globaux EIP 5b

Surveillance du vide (EIP 5a)

Entreposage des gaz (EIP 7)(y compris H2)

Circuit tertiaire (système de collecte et de rétention) (EIP 8)

Collecte et rétention de la cuve d'effluents douteux (partie tertiaire)

SPME + actionneurs (système de protection machine élargie)

TOF (mesure énergie faisceau)

ACCT/DCCT (mesure de courant faisceau)

BLM (beam loss monitor - mesure de perte faisceau)

Refroidissement AF LINAC

Tests sûreté SPME global (avec TOF, BLM, ACCT, refroidissement / élét de coupure)

SLAAF (système de limitation de l'activité de l'arrêt faisceau linac)

TCR-A (EIP 3) (tableau de contrôle du rayonnement)

SRA - EIP (système de remontée des alarmes pour EIP)

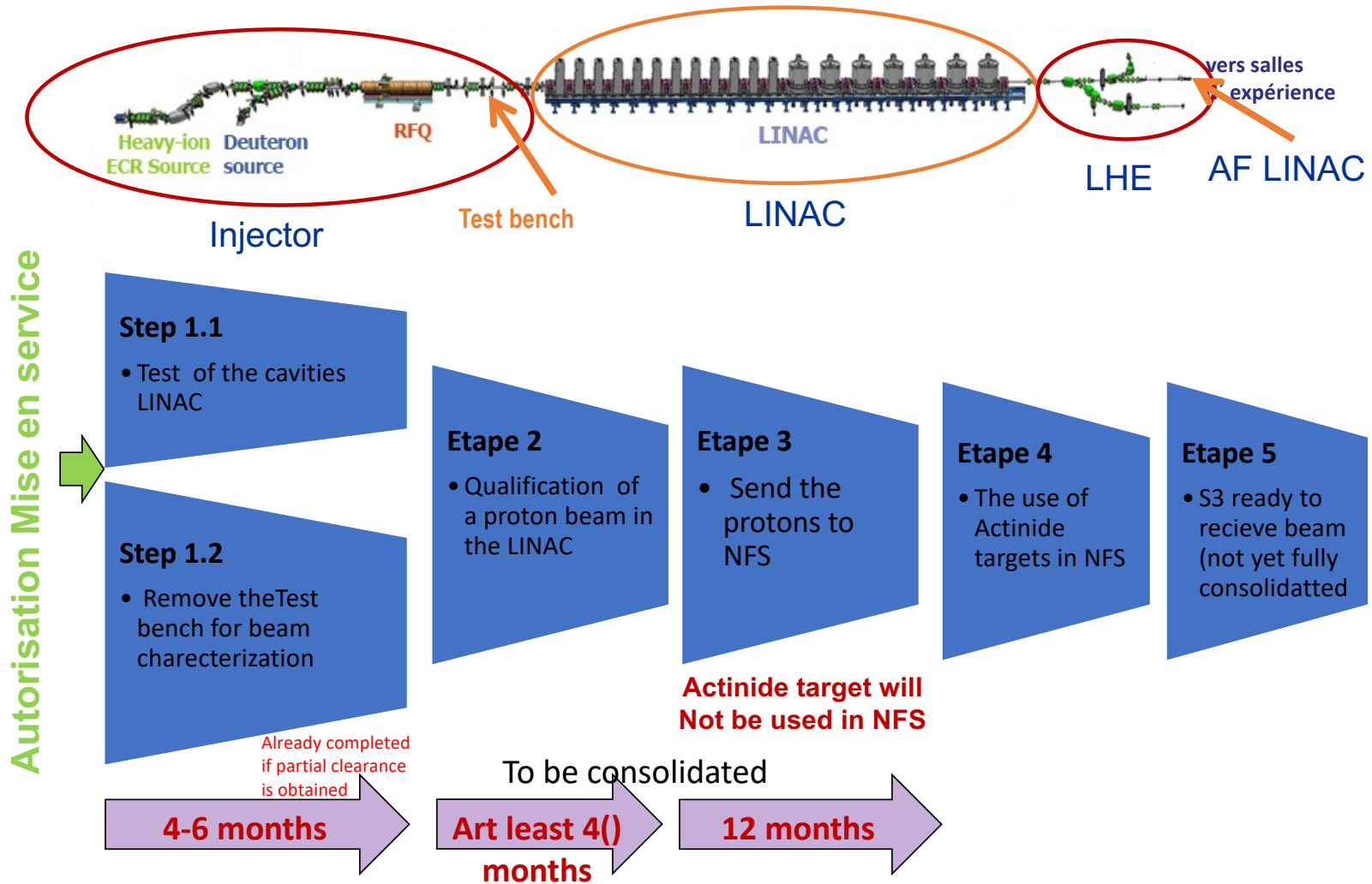
	2018												2019							
	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J
Injecteur (conditionnement RFQ / tests faisceaux et équipements sur BTI)																				
démontage BTI / montage LME tests et mise en service																				
LINAC (reprises - mise au point- upgrade)																				
LINAC (mise en froid)																				
LINAC (qualification HF)																				
LHE																				
SPM-T (global) système de protection machine - thermique																				
Tests UGA / UGB (EIP 1)																				
Vannes rapides (EIP 5b-1)																				
Actionneur rapide (EIP5b-2)																				
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Circuit tertiaire (système de collecte et de rétention) (EIP 8)																				
Collecte et rétention de la cuve d'effluents douteux (partie tertiaire)																				
SPME + actionneurs (système de protection machine élargie)																				
TOF (mesure énergie faisceau)																				
ACCT/DCCT (mesure de courant faisceau)																				
BLM (beam loss monitor - mesure de perte faisceau)																				
Refroidissement AF LINAC																				
Tests sûreté SPME global (avec TOF, BLM, ACCT, refroidissement / élét de coupure)																				
SLAAF (système de limitation de l'activité de l'arrêt faisceau linac)																				
TCR-A (EIP 3) (tableau de contrôle du rayonnement)																				
SRA - EIP (système de remontée des alarmes pour EIP)																				

exploitation Ganil

pas d'accès linac (présence RF)

tests intéressants la sûreté

# To get to the beam in an exp hall (Not yet consolidated)



# Next Steps

---

Continue to do its best to provide beam time with new opportunities to the community at GANIL

GANIL would offer its services/expertise for co coordinating “ENSAR3”

Internationalize GANIL

Be part of team to strengthen Nuclear Physics in Europe

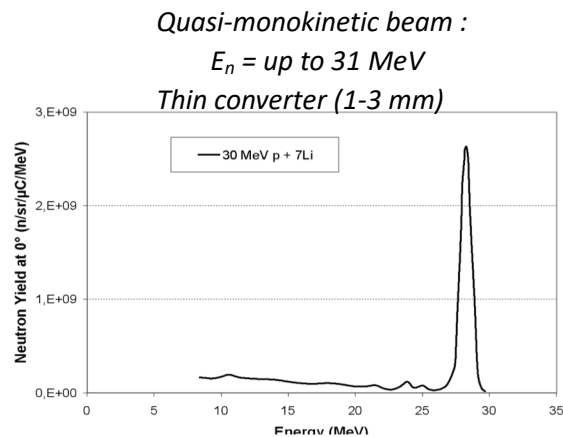




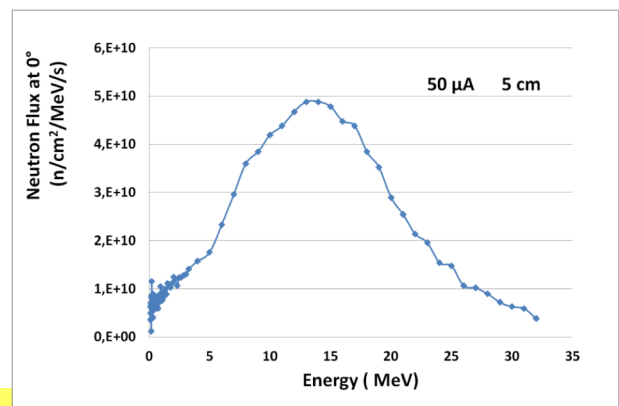
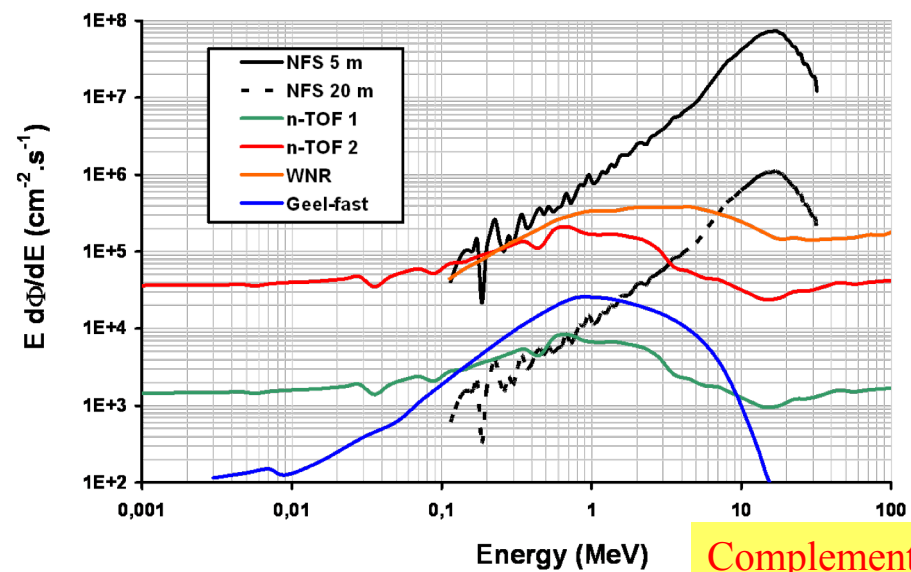
## NFS – Neutrons for Science (A Neutron time-of-flight facility.)

- Continuous and quasi-mono-energetic beam
- Flight path from 5 to 30 m
- High flux of fast neutrons

- $E_n$ : from 0,1 MeV to 40 MeV
- Good energy resolution
- Reduced  $\gamma$  flash
- Low instantaneous flux



C. J. Batty et al., NIM 68 (1969) p273-276



Complementary to  
the existing facilities