
GANIL
spiral2
laboratoire commun CEA/DSM
CNRS/IN2P3
cnrs
In2p3
cea
Campus Jules Horowitz
Epron – Caen – Hérouville Saint-Clair
ENSICAEN
ÉCOLE NATIONALE SUPÉRIEURE D'INGÉNIEURS DE CAEN
& CENTRE DE RECHERCHE
Physique Nucléaire
et Astrophysique
Radiobiologie
CIRIL
Physique atomique
Sciences des matériaux
BIP
CYCERON
Archade
ADVANCED RESOURCE CENTRE
FOR HADRONTHERAPY IN EUROPE
Cyceron
Sciences de la vie
Un grand instrument
pluridisciplinaire
pour la recherche française
et internationale

GIE commun CEA/CNRS

Creation GIE CEA-CNRS 1976; **extended in 2005 for 10 years**
First experiment: January1983

Permanent staff:
249,4 agents (31/12/2012): CEA(110,5), CNRS(137,9), Univ. (1):
Physicists (CEA 6, CNRS 19, Univ. 1), engineers, technicians, administration

Budget : **27,7 M€ (2012 hors SPIRAL2) including:**
2,4 M€ de other resources (Europe, Region, Valorisation)
10,4 M€ operation cost & investment

Users: **700 researchers (50% foreigners, EU, Japan, India, US..)**
de plus 130 Labs and institutes , 30 pays

Beams: **more than 10 000 hours/y (3-4 experiments in parallel)**

Scientific Production :
2500 publications, 200 PhD thesis, 30 Scientific Prizes
Organisation of 20 International Conferences
2000 visitors/y

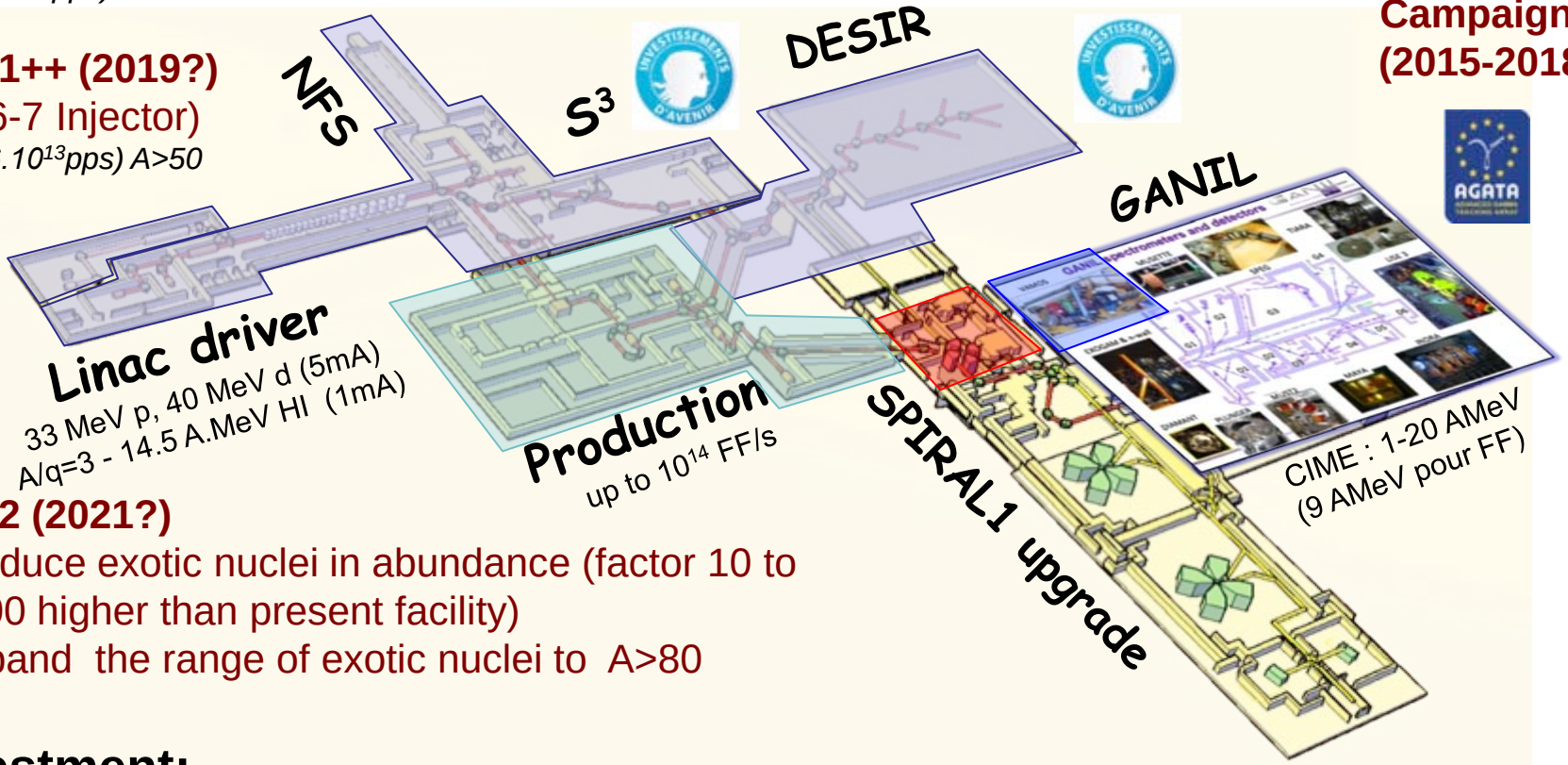
A National & EU priority

Phase1 (2015)
Increase the intensity of stable beams by a factor 10 to 100 – High intense neutron source
10pμA (6.10^{13}pps) A<50

Phase1++ (2019?)
(A/Q=6-7 Injector)
10pμA (6.10^{13}pps) A>50

DESIR Phase1+ (2019)
(low energy facility)

AGATA Campaigns (2015-2018)



Phase2 (2021?)
- Produce exotic nuclei in abundance (factor 10 to 1000 higher than present facility)
- Expand the range of exotic nuclei to A>80

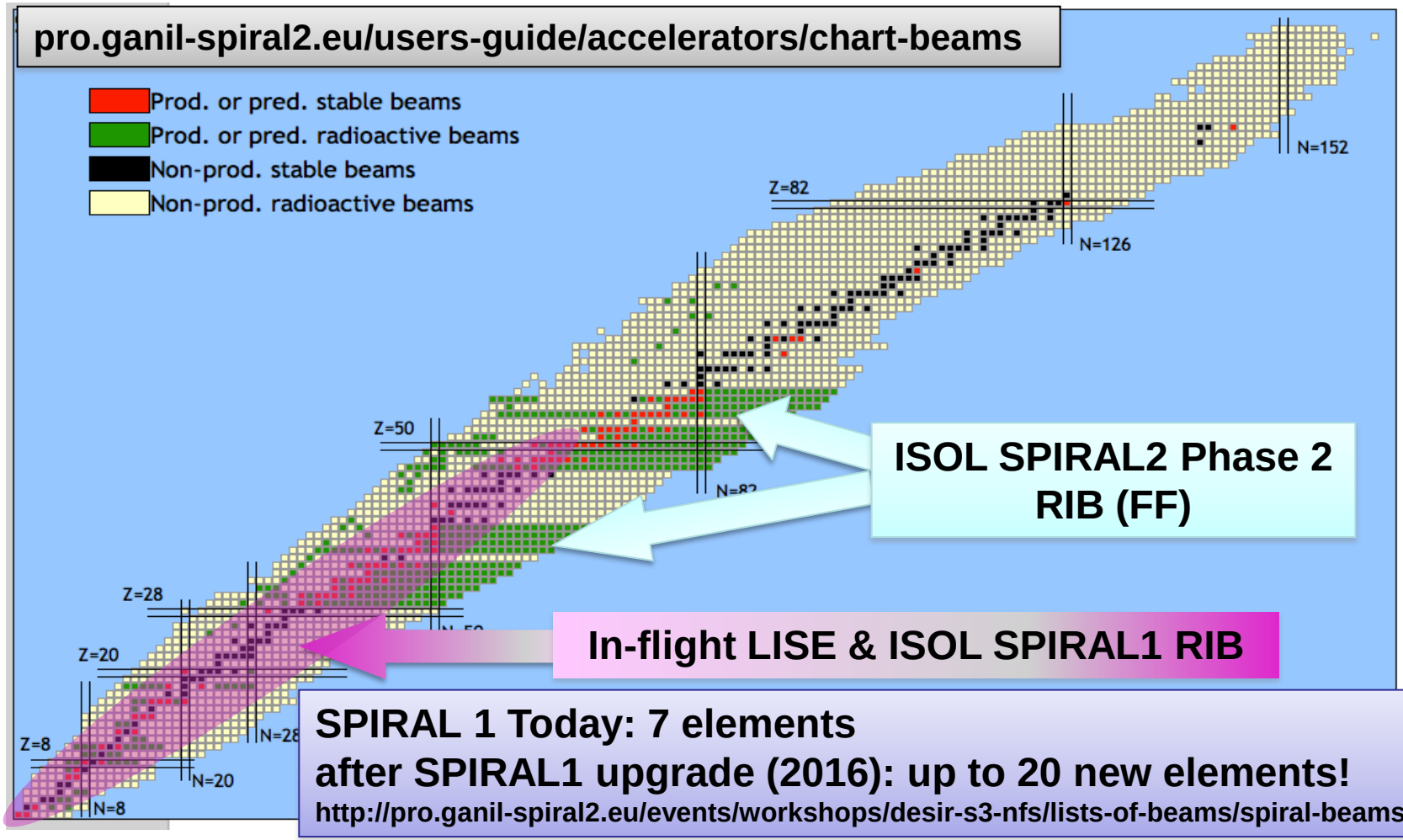
SPIRAL1 Upgrade (2016)
New light RIBs

Investment:
- **GANIL >500 M€ (estimation 2012)**
- **SPIRAL2 Phase 1&2 (2014): 210 M€**
- **New exp. halls and detectors ≥23 M€**

SPIRAL2 is on the list of the European Strategy Forum on Research Infrastructures (ESFRI)

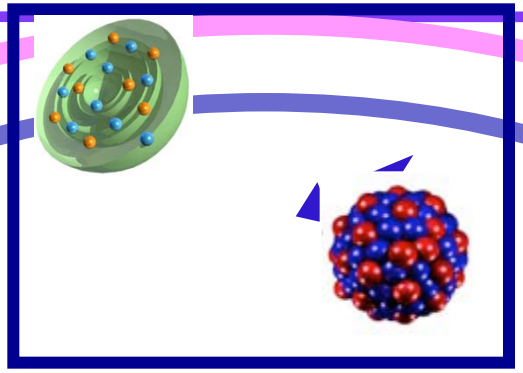
Radioactive Ion Beams GANIL/SPIRAL1&2

- **RIB by in-flight at LISE: few MeV/n to 50 MeV/nucl.**
- **ISOL RIB from SPIRAL 1 & SPIRAL 2: ≤ 60keV et 1-15 MeV/nucl.**

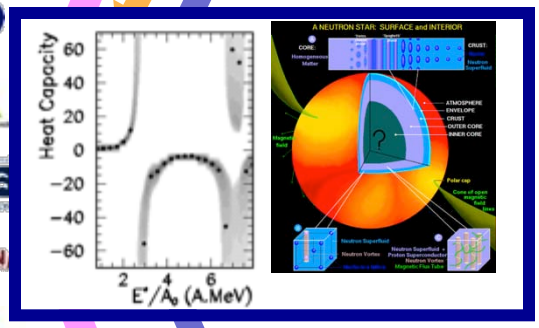


SPIRAL 1 Today: 7 elements
after SPIRAL1 upgrade (2016): up to 20 new elements!
http://pro.ganil-spiral2.eu/events/workshops/desir-s3-nfs/lists-of-beams/spiral-beams

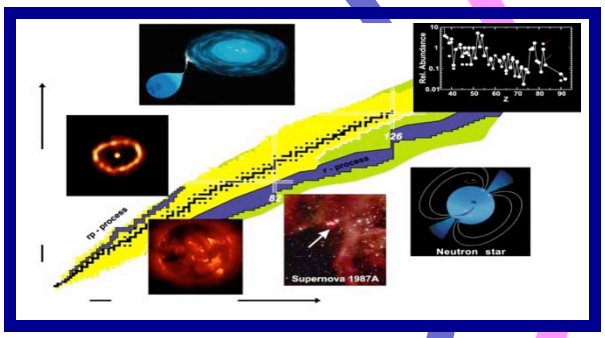
Nuclear structure



EOS
Liquid-gas phase
Isospin dependence

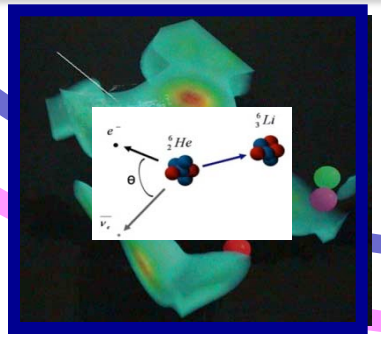


Nuclear Astrophysics

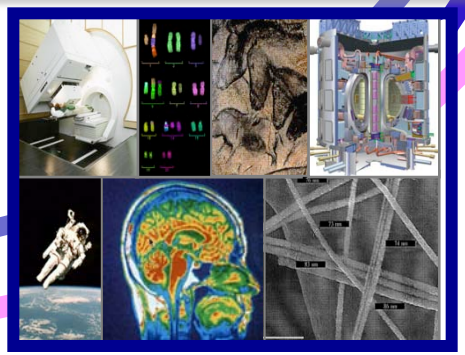


GANIL/SPIRAL2
Science

Fundamental Interactions



Multi-disciplinary research
& Applications



Recent results from GANIL/SPIRAL1 facility

Theory (example)
Gamow shell model description of proton scattering on 18Ne
Y. Jaganathen, N. Michel and M. Płoszajczak
PRC 89, 034624 (2014)

Y. Zheng et al PRC 87, 044328 (2013)
F. Ghazi Moradi et al PRC 89, 014301 (2014)
F. Ghazi Moradi et al PRC 89, 044310 (2014)

^{100}Sn region

In-flight fast-timing measurements in ^{152}Sm
C. Plaisir et al., PRC 89 (2014) 021302(R)

^{152}Sm

Transfer reactions in inverse kinematics: An experimental approach for fission investigations
C. Rodrıguez-Tajes et al., PRC 89, (2014) 024614

Observation of the β-Delayed γ-Proton Decay of ^{56}Zn …
S.E.A. Orrigo et al., PRL 112, 222501 (2014)

^{56}Zn

Fission fragments

Towards the high spin–isospin frontier using isotopically-identified fission fragments
A. Navin et al., PLB 728 (2014) 136

Experimental Study of the Two -Body Spin-Orbit Force in Nuclei
G. Burgunder et al., PRL112 (2014)

Investigation of collective radial expansion and stopping in heavy ion collisions at Fermi energies E. Bonnet et al., Phys. Rev. C 89, (2014) 034608

^{34}Si

Excited states in the neutron-rich nucleus 25F
Zs. Vajta et al., PRC 89 (2014) 054323

^{16}N

^{25}F

Probing Nuclear forces beyond the drip-line using the mirror nuclei ^{16}N and ^{16}F
I. Stefan et al., PRC 90, 014307 (2014)

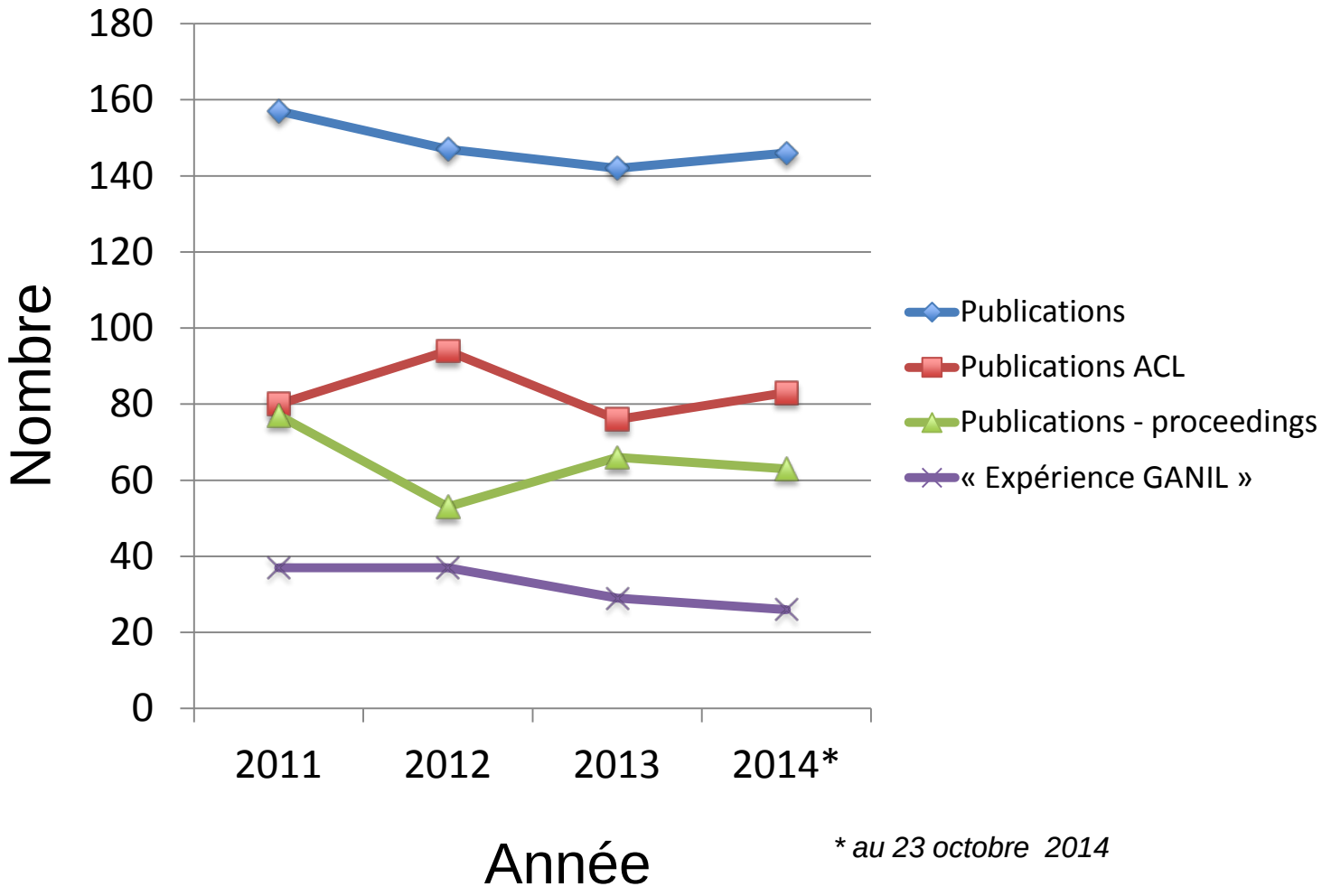
Zero-degree measurements of ^{12}C fragmentation at 95 MeV/nucleon on thin targets
J. Dudouet et al., PRC 89, 064615 (2014)

^{13}Be

Structure of 13Be …
G. Randisi et al., PRC 89 (2014) 034320

www.ganil-spiral2.eu

Publications GANIL 2011 - 2014



** au 23 octobre 2014*

FAZIA@INDRA Scientific Programme

Importance for nuclear physics & astrophysics

•structure & excitation of exotic nuclei; dynamics of HI collisions, clustering & phase transitions; SN collapse & nucleosynthesis; NS formation and structure

New experimental data from HI collisions around Fermi energies

unique laboratory to study hot, dilute ANM

•requires full mapping of (bound) neutron-proton phase space in reactions improve microscopic transport & Nuclear Statistical Equilibrium (NSE) models

FAZIA@INDRA@GANIL

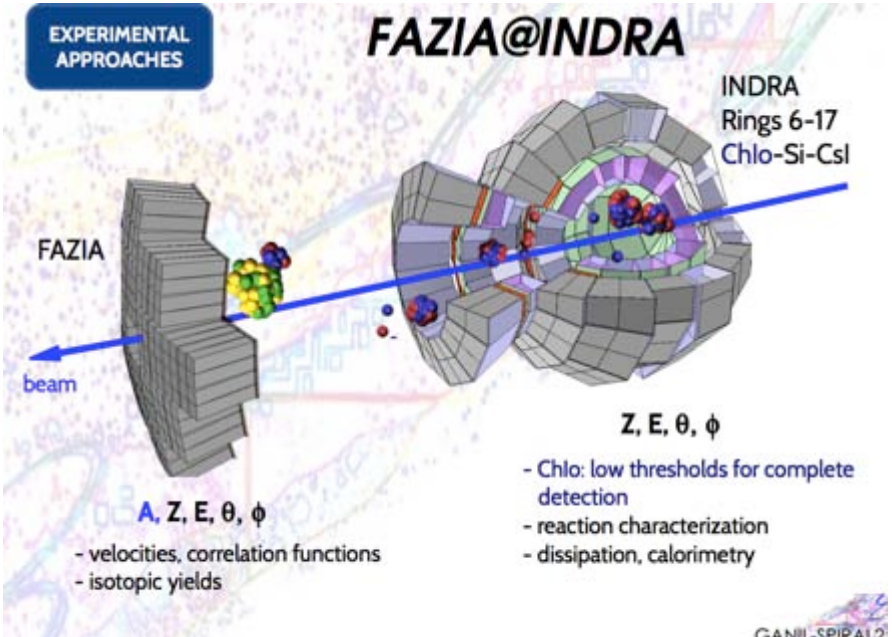
•CSS2: unique stable beams with wide range of energy & N/Z(^{40,48}Ca@≤60(80)AMeV; ^{58,64}Ni@≤64AMeV; ^{78,86}Kr@≤60AMeV; ^{124,136}Xe@≤50AMeV)

•FAZIA: A&Z id for fast ions with Z≤25 at forward angles (Z id all others)

•INDRA: full coverage for reaction mechanism control

Ongoing evaluation by the SC of GANIL

From 2016-2017?

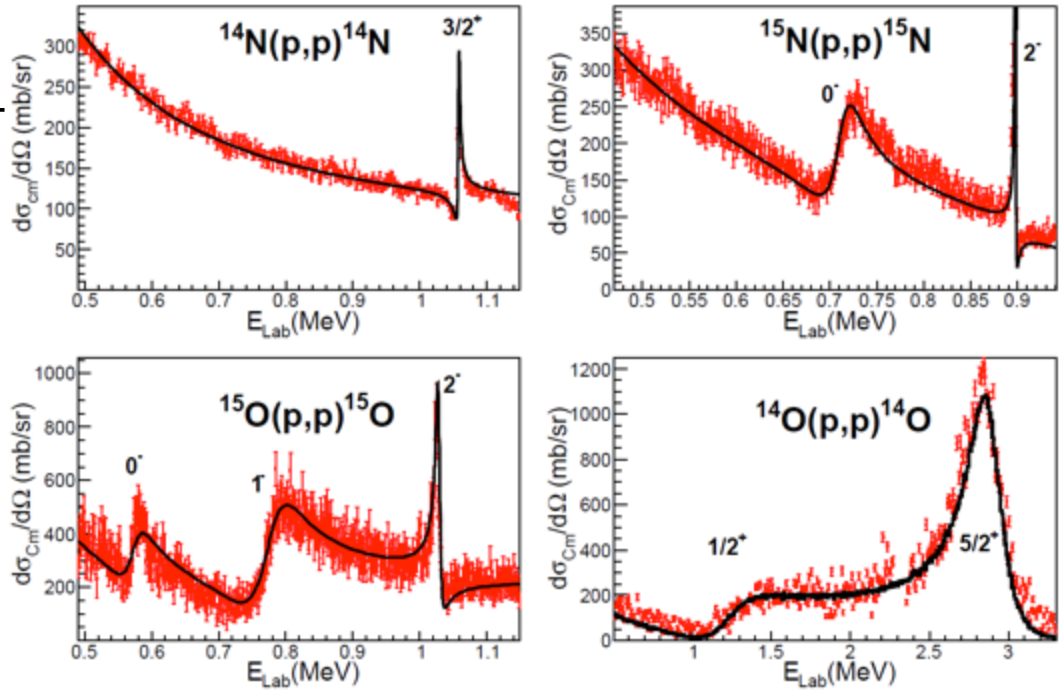


Probing Nuclear forces beyond the drip-line using the mirror nuclei ^{16}N and ^{16}F

I. Stefan et al. PRC 90, 014307 (2014)
IPNO, GANIL, Romania, CZ, Saclay, DAM, UK, LPC

Stable-ion beams

RIB



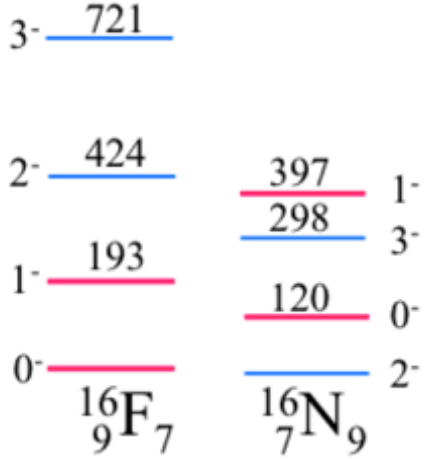
SPIRAL1 Beams :

^{15}O 10^6 pps, purity 97% ,

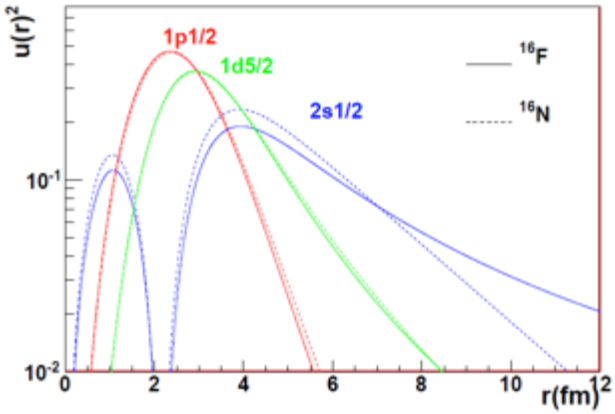
^{14}O 2×10^5 pps, purity ≥ 99%

Proton Energy Resolution :

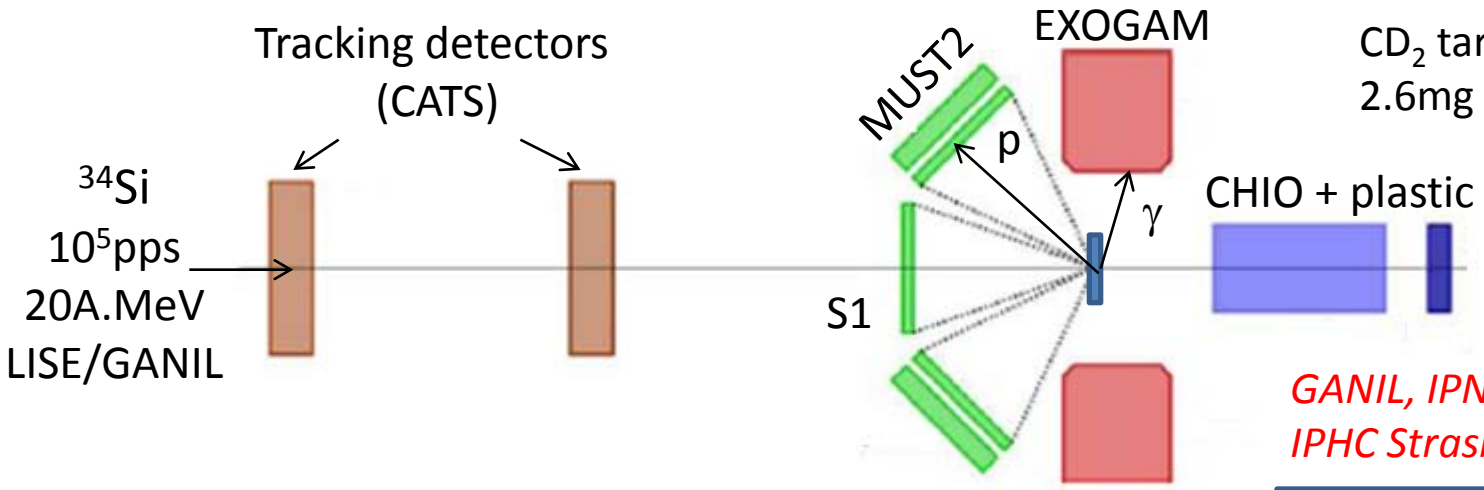
σ_{CM} = 3 keV



The observed difference between ^{16}N and ^{16}F comes from the spread of the 2s1/2 wave function

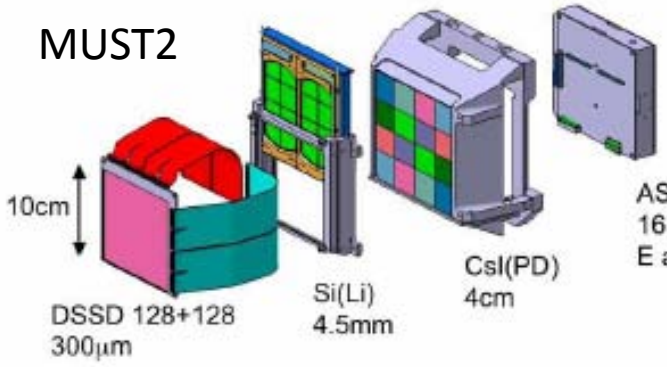


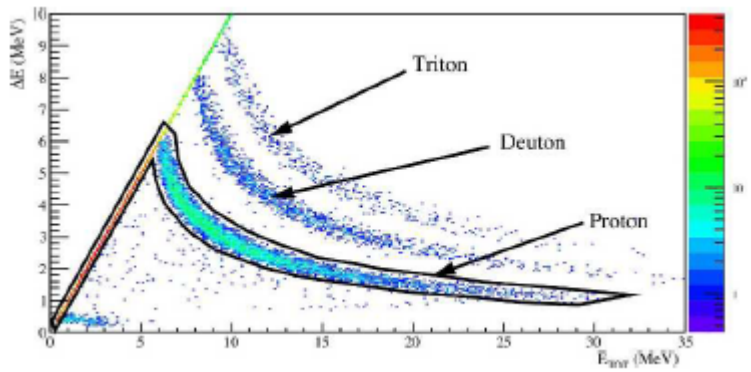
^{34}Si(d,p) reaction in inverse kinematics at GANIL



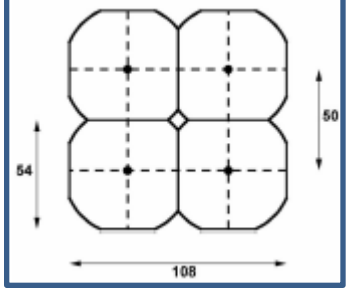
GANIL, IPN Orsay, CEA Saclay
IPHC Strasbourg

MUST2



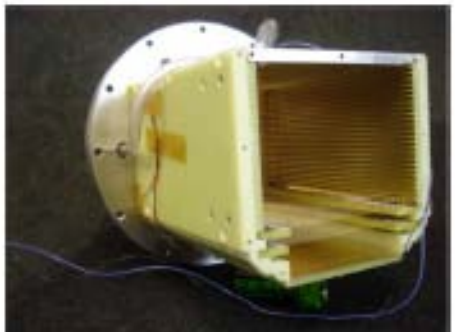


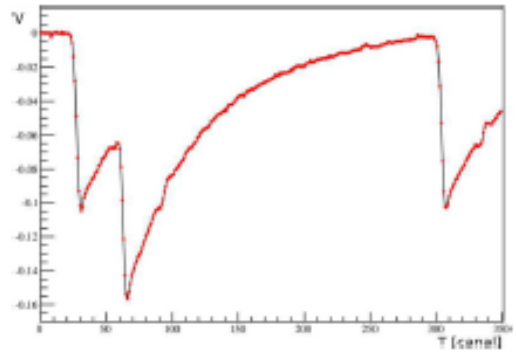
EXOGAM



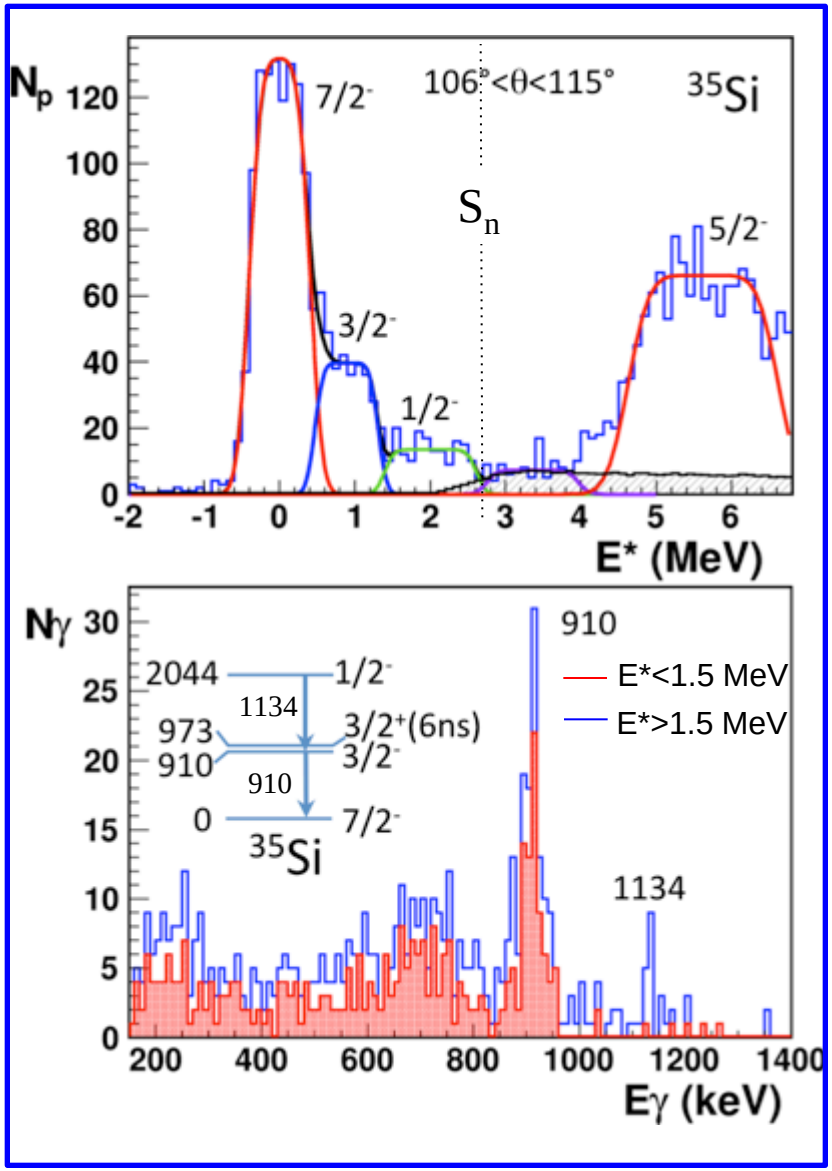
Annular detector (S1)

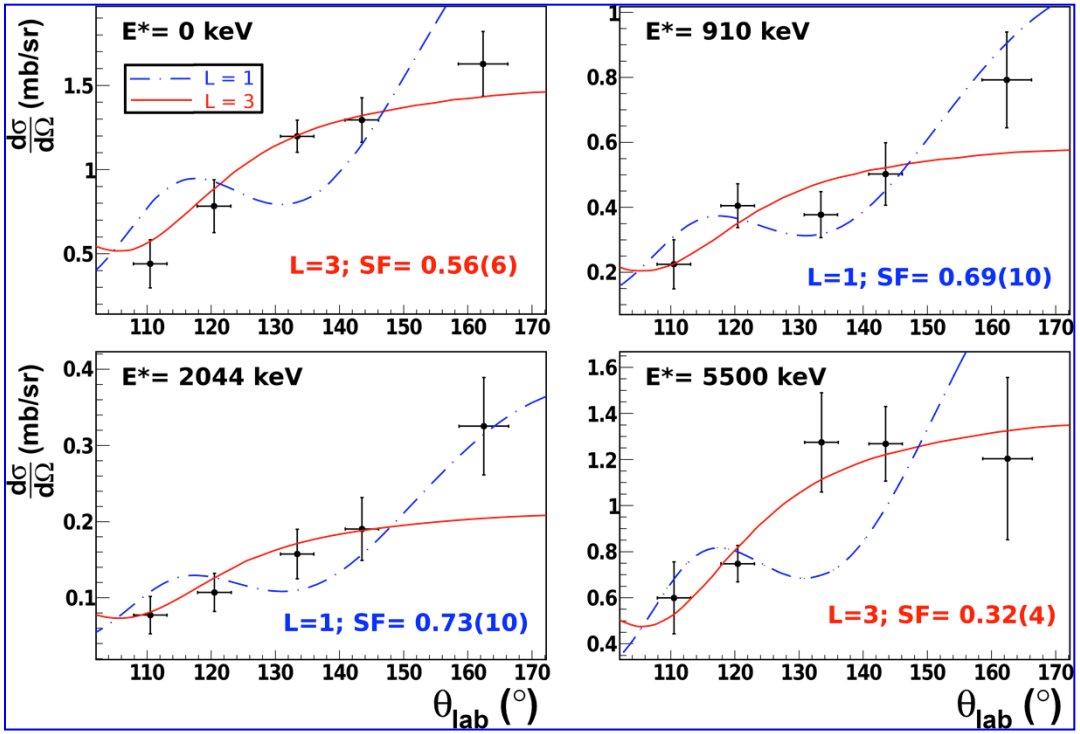
Ionization chamber (CHIO)





Spin-orbit splittings in ^{35}Si using ^{34}Si(d,p)^{35}Si

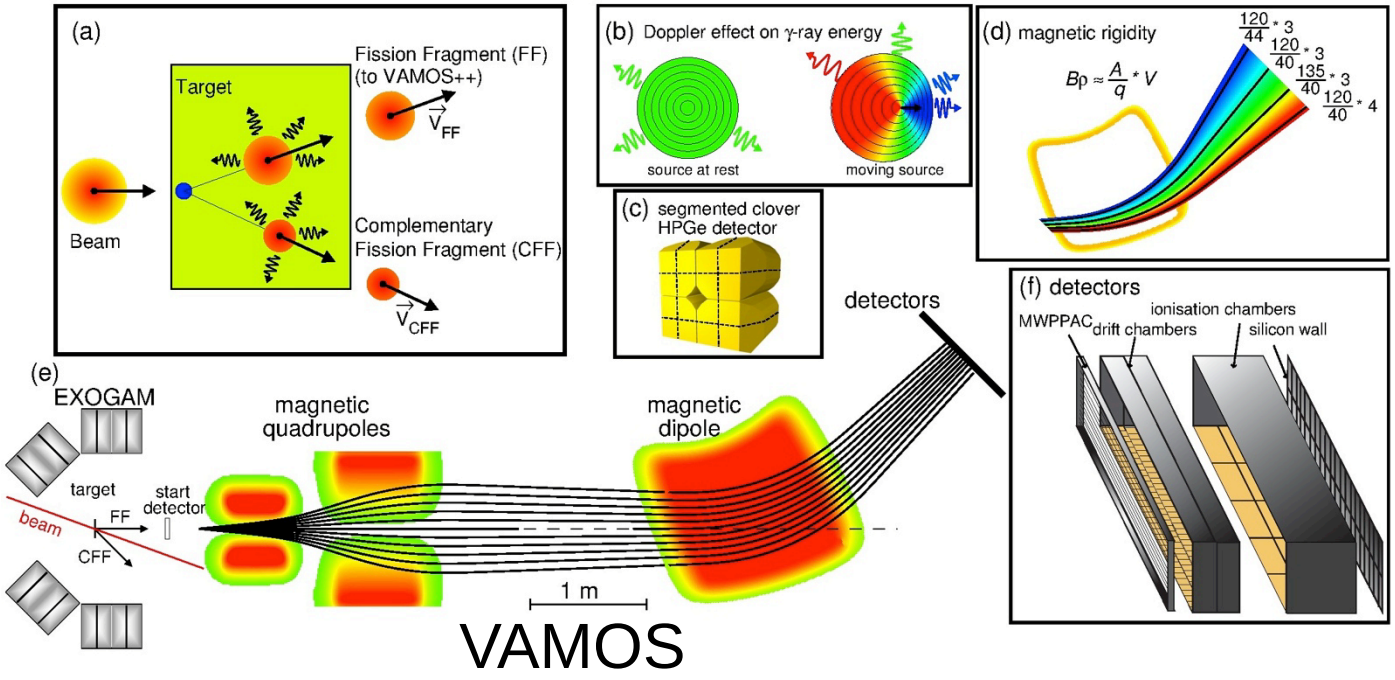




L assignments from proton angular distributions
Accurate energy of states with γ-ray detection

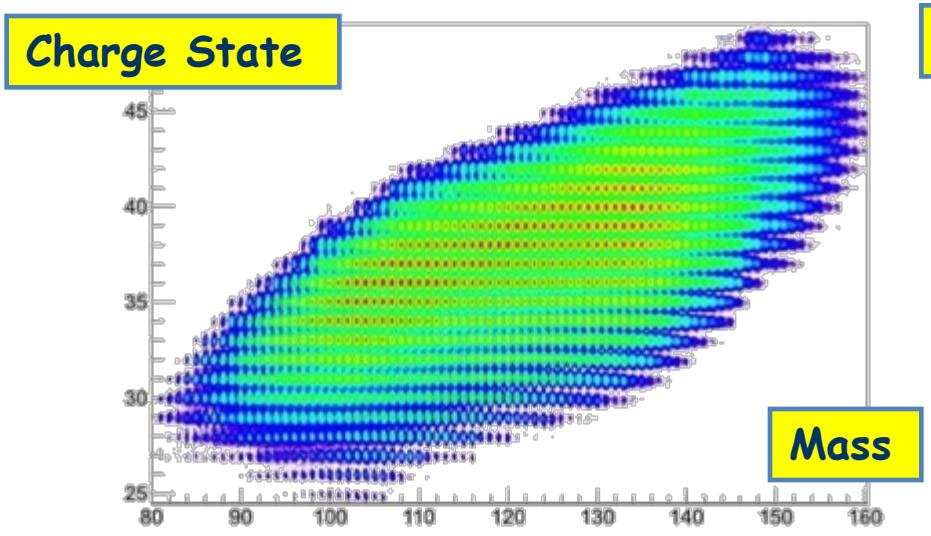
G. Burgunder et al., Phys. Rev. Letters 112 (2014)

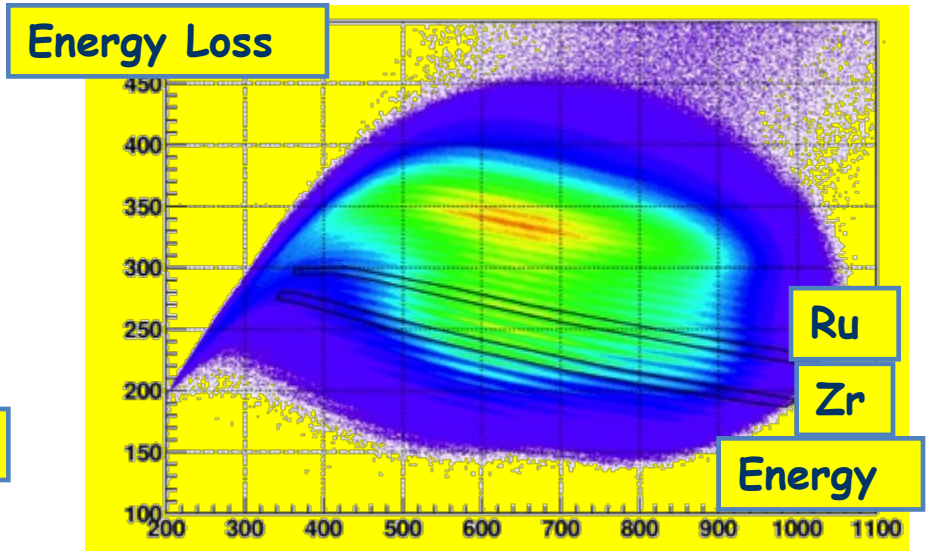
Z, A & q identification at few MeV/nucleon



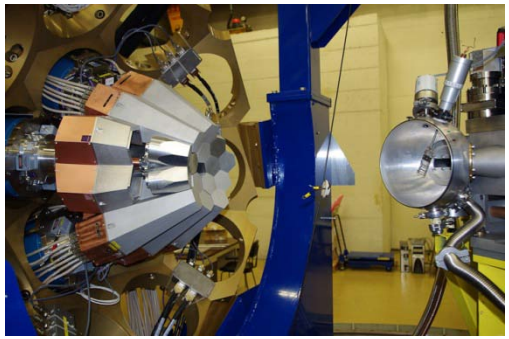
A. Navin and M. Rejmund
McGraw-Hill Yearbook of Science & Technology (2014)
(to be published)

ΔA /A~ 0.4%
Z resolved up to 63
Identified 450 nuclei
and their excited states





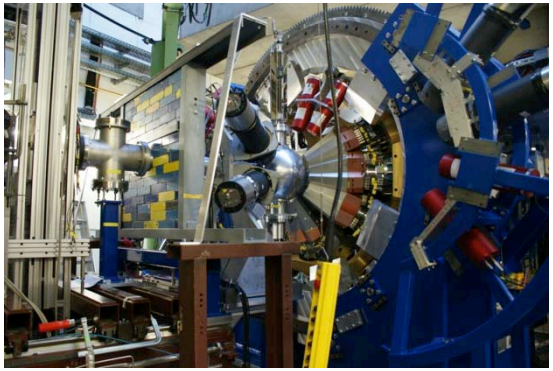
2010 → 2011
LNL : 5TC



AGATA D.+PRISMA

Total Eff $_{Nominal}$ ~2.6%

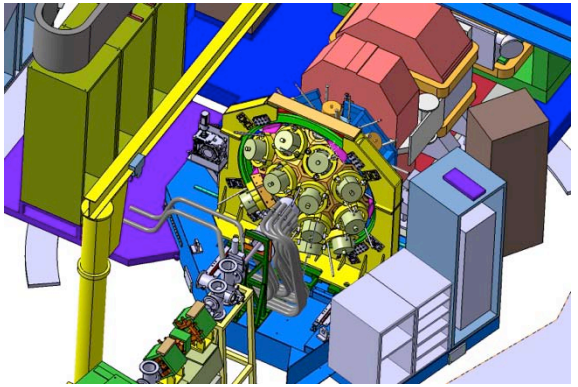
2012 → GSI/FRS
6TC+3 DC



AGATA @ FRS

Total Eff. (β=0.5) ~ 10%

2014 → 1018
GANIL/SPIRAL2
15TC

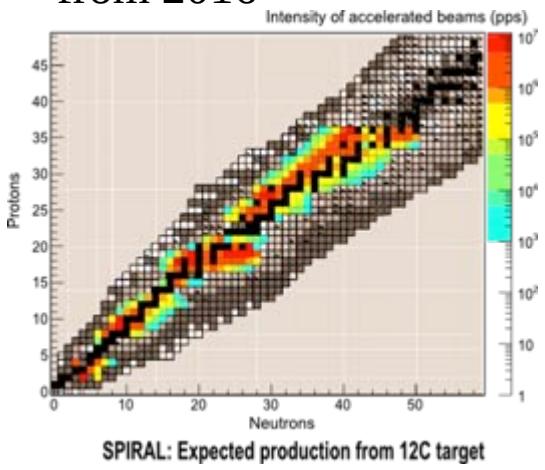


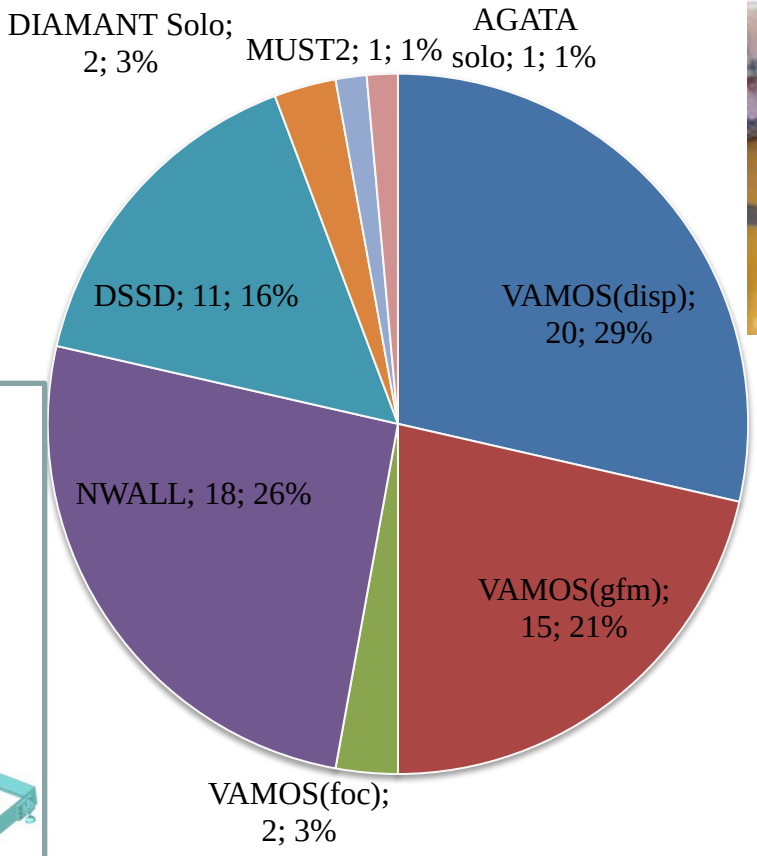
AGATA @G1

Total Eff ~ 8% to 14%

AGATA@GANIL Campaigns 2015-2018

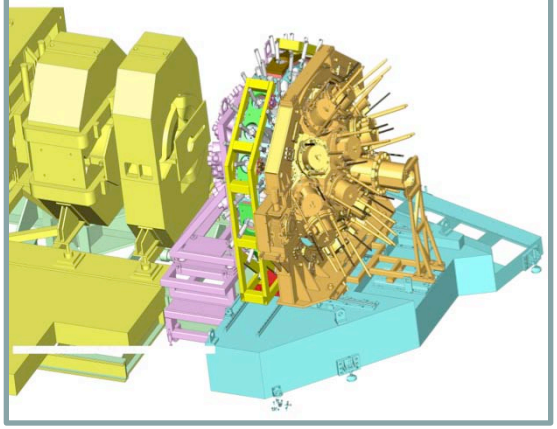
ISOL RIB from SPIRAL 1
from 2016



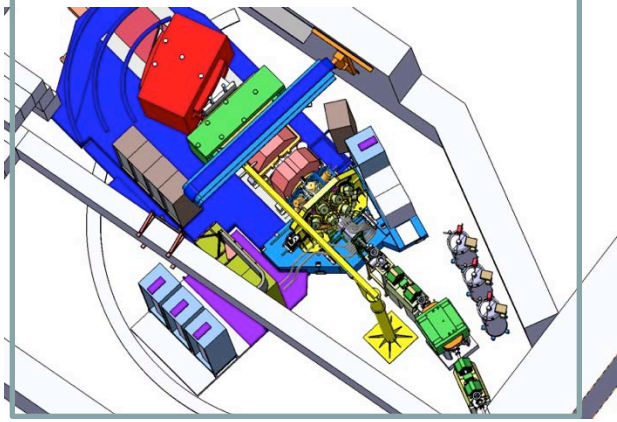


VAMOS vacuum mode

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



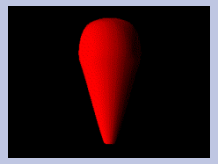
VAMOS Gas-Filled
From 2016

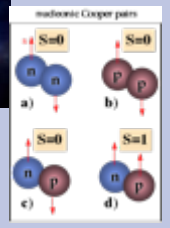


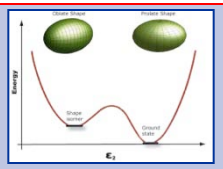
Physics cases for the AGATA campaign in GANIL

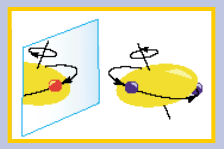
- 47 Letters of Intents
- The equivalent of ~2006 UT are proposed

→16048 hours of beam on target (669 days)









$^{48}Ca,^{50}Ti$→ SHE

^{256}Rf

^{254}No

Cm,Bk

Cf,Es

^{194}Pb

^{176}Hg

Sm,Pm

^{102}Sn

^{100}In

^{206}Hg

Dy,Er,Yb

Ru, Pd

Zr, Mo

^{80}Zr

^{77}Y

$^{58}Ni,^{40}Ca$→ N=Z

Xe,Te

^{132}In

^{75}Sr

Zr, Sr

^{78}Ni ^{80}Zn

^{63}Ge

$^{68}Ni,Fe,Co,Cu$

^{46}Ti

^{38}K

^{34}Ar

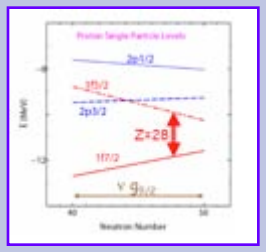
$^{238}U,^{208}Pb$ → n-rich

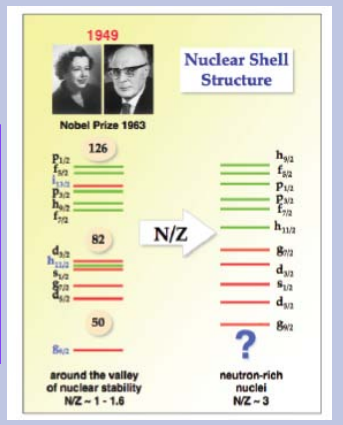
$^{46,48}Ca$

S,Cl,Ar,K

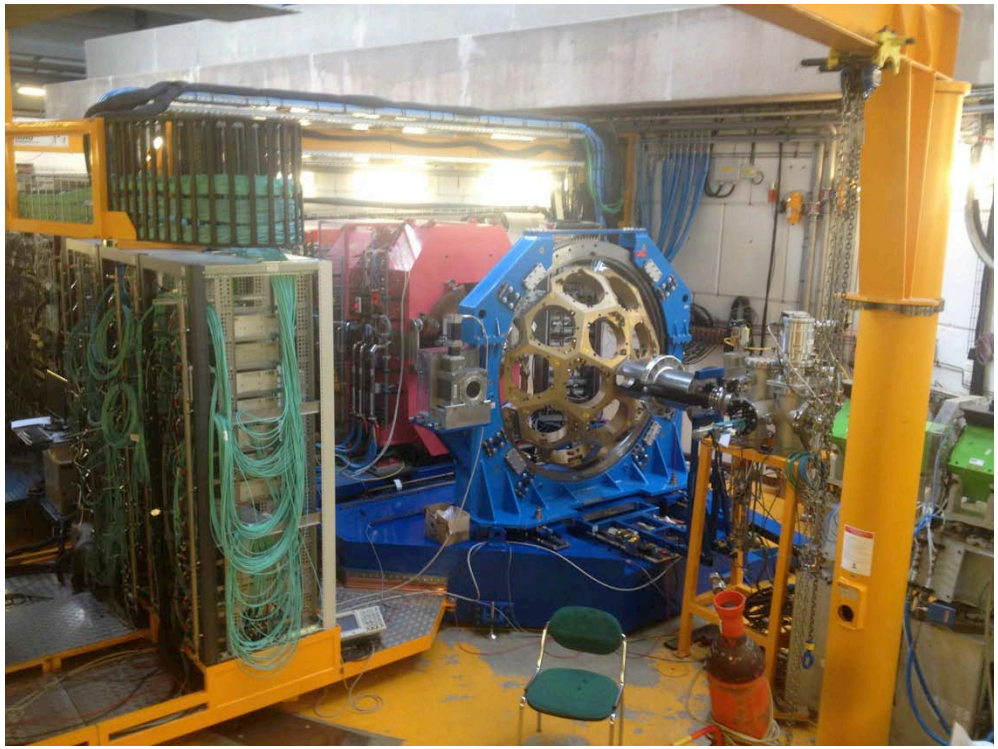
Ne,Na

SPIRAL1

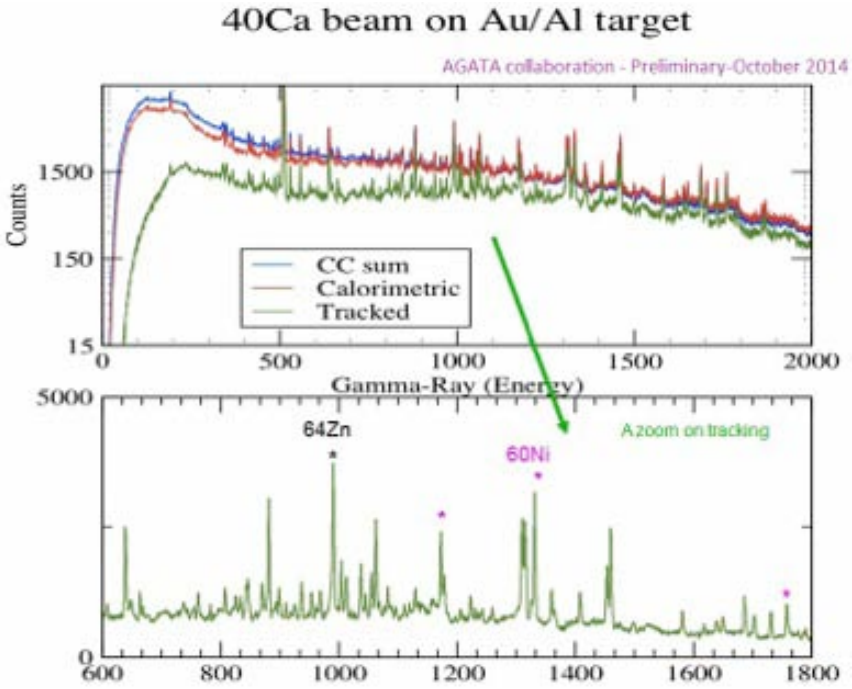




Installation & Commissioning



First “unofficial” in-beam spectra



9 or 10 clusters expected for first experiments in March 2015

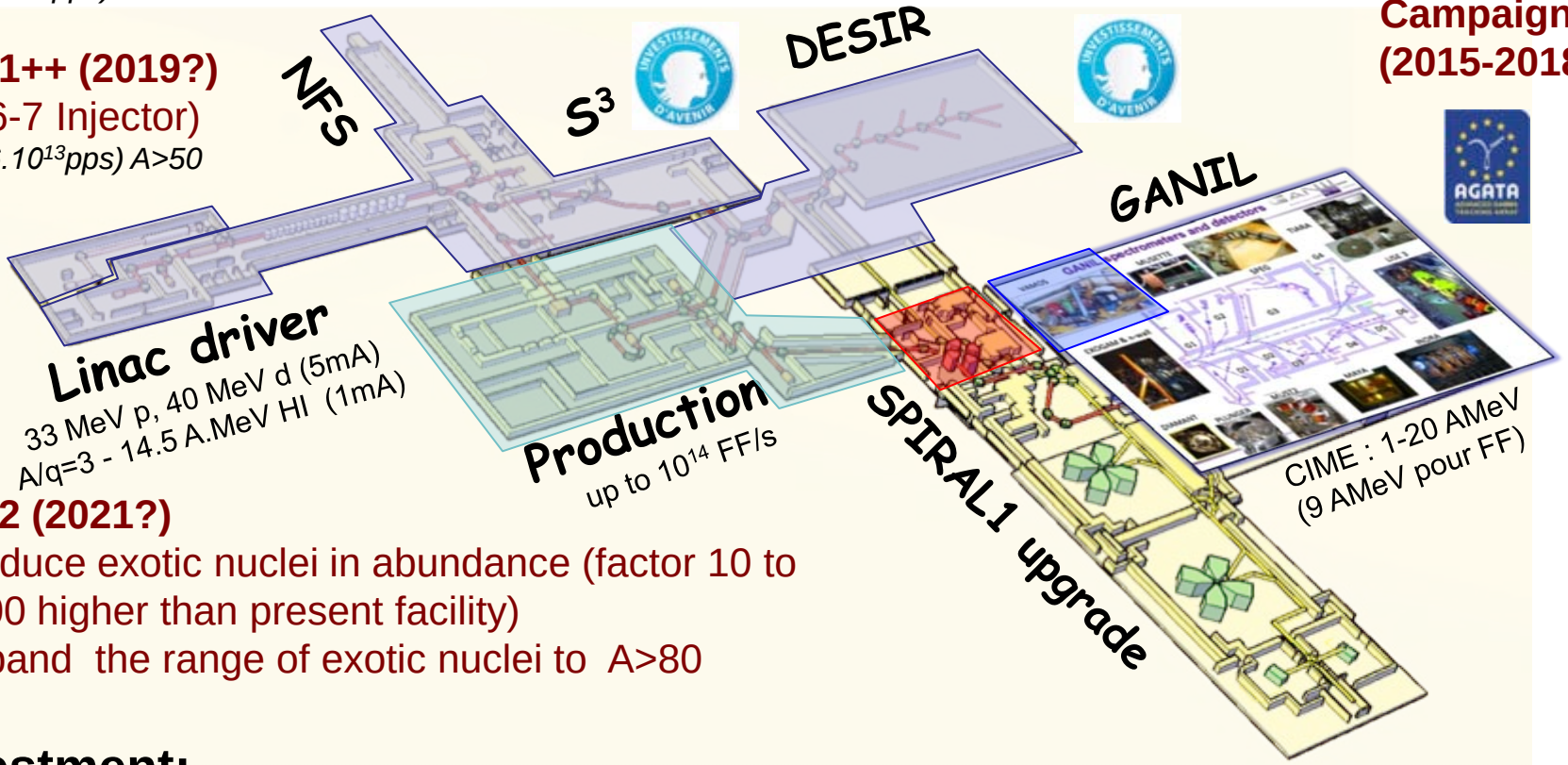
A National & EU priority

Phase1 (2015)
Increase the intensity of stable beams by a factor 10 to 100 – High intense neutron source
10pμA (6.10^{13}pps) A<50

Phase1++ (2019?)
(A/Q=6-7 Injector)
10pμA (6.10^{13}pps) A>50

DESIR Phase1+ (2019)
(low energy facility)

AGATA Campaigns (2015-2018)



Phase2 (2021?)
- Produce exotic nuclei in abundance (factor 10 to 1000 higher than present facility)
- Expand the range of exotic nuclei to A>80

SPIRAL1 Upgrade (2016)
New light RIBs

Investment:
- **GANIL >500 M€ (estimation 2012)**
- **SPIRAL2 Phase 1&2 (2014): 210 M€**
- **New exp. halls and detectors ≥23 M€**

SPIRAL2 is on the list of the European Strategy Forum on Research Infrastructures (ESFRI)

SPIRAL2 Phase 1 Civil Construction is finished

September, 2014

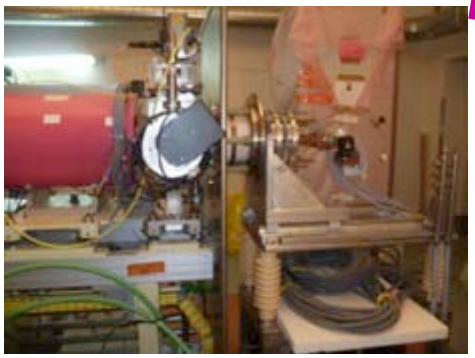
LINAC tunnel

Installation is going on

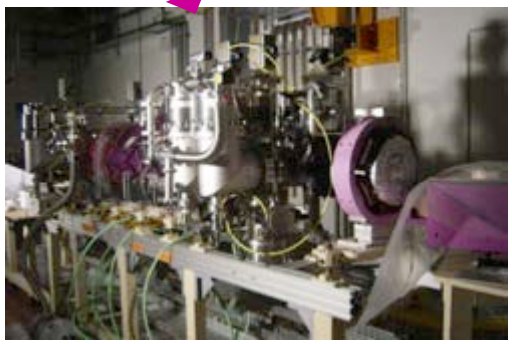
Beam lines & support

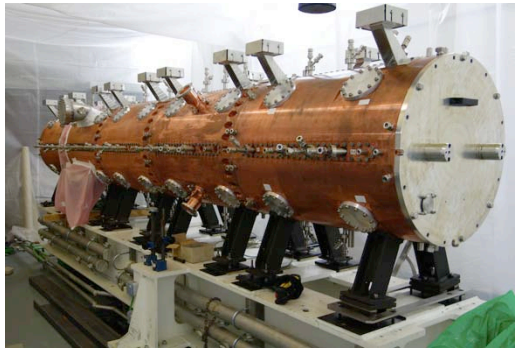
SC Cavities

HI ECR Source



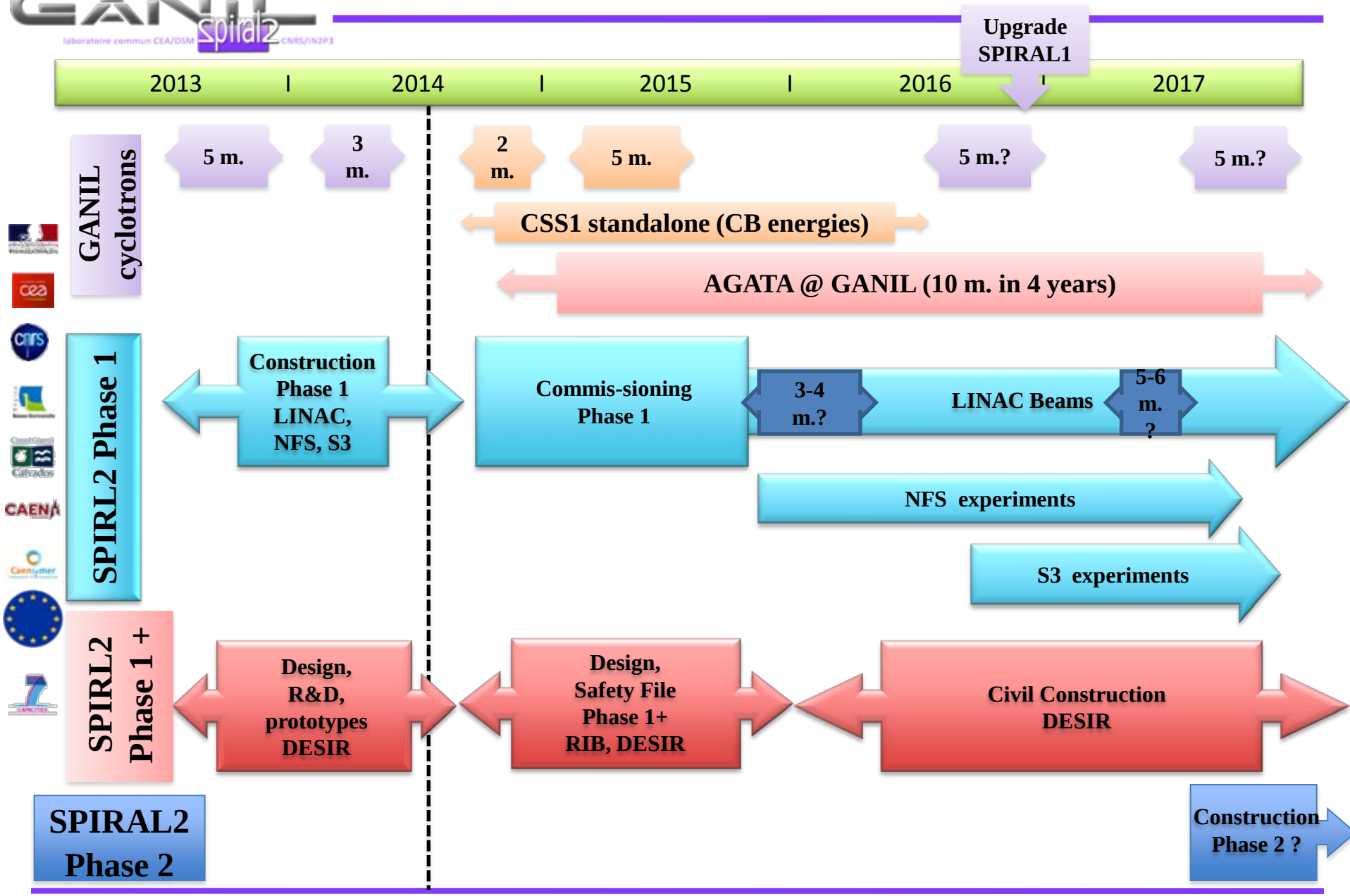
LI ECR Source





RFQ

Timeline GANIL & SPIRAL2

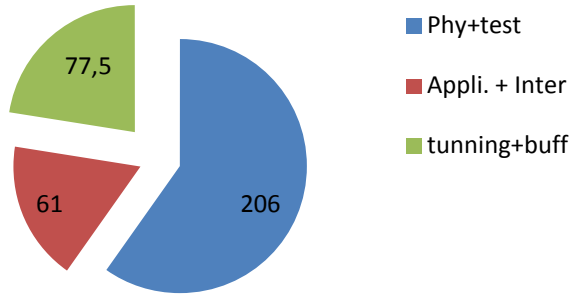


GANIL PAC Meeting
on April 2014

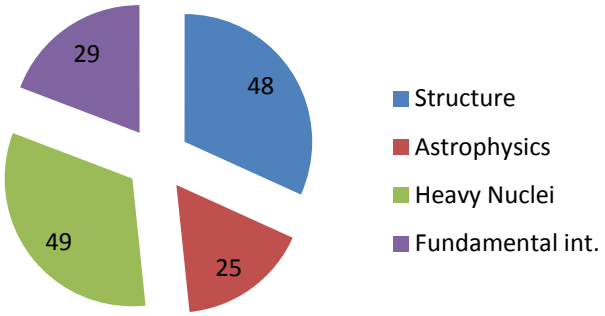
2013 Running Schedule

- **2013 Schedule (19 weeks)**
  - **Run 1: 23/06 – 26/07**
  - **Run 2: 02/09 – 05/11**
  - **Run3: 10/11 – 23/12**
  - **151 UT's for nuclear physics**
  - **7 experiments completed**
- **1 mini-campaign**
  - **76 UT's (2 exp.) LISE/FULIS/Wien Filter (Run 1-2)**
- **VAMOS**
  - **46 UT's (2 exp.) MUST**

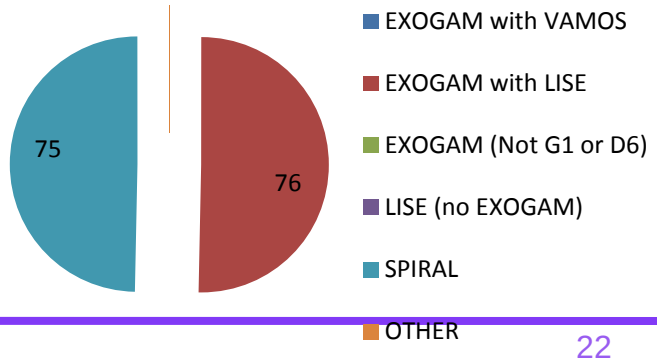
2013 Schedule (344,5 UT's)



Schedule 2013 (151 UT's)



Schedule 2013 (151 UT's)



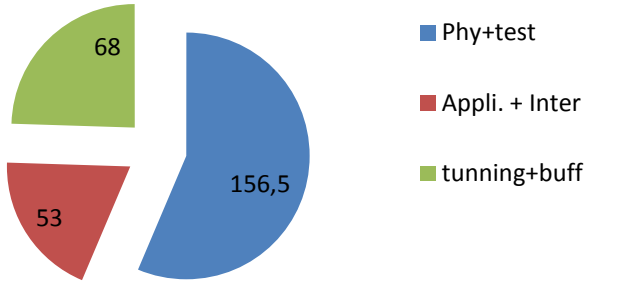
2014 Running Schedule RUN1

2014 Schedule (17 weeks)

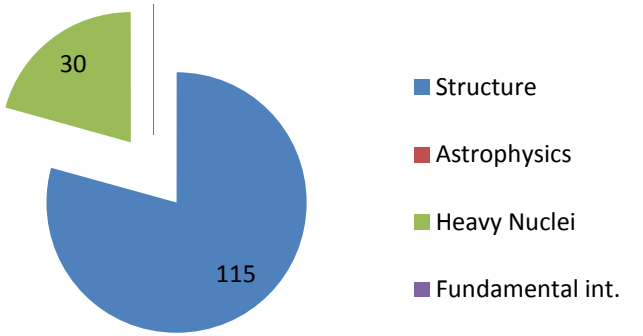
- Run 1: 03/03 – 06/06
- 145 UT's for nuclear physics
- 6 experiments completed

1 campaign

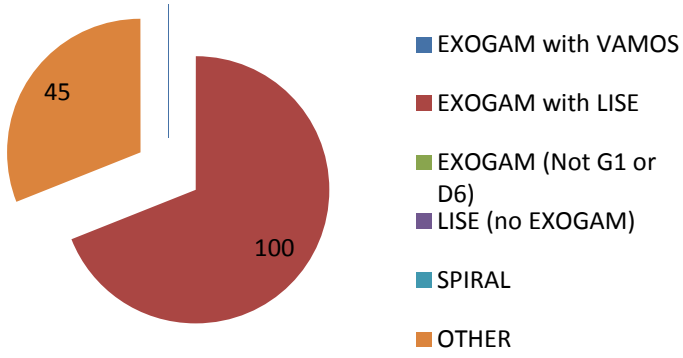
- 80 UT's (3 exp.) LISE/MUST2



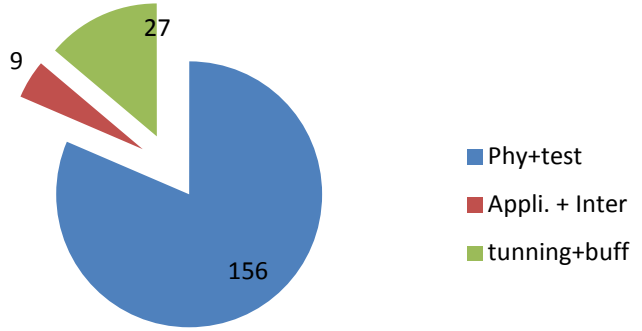
Schedule 2014 RUN1 (145 UT's)



Schedule 2014 RUN1 (145 UT's)

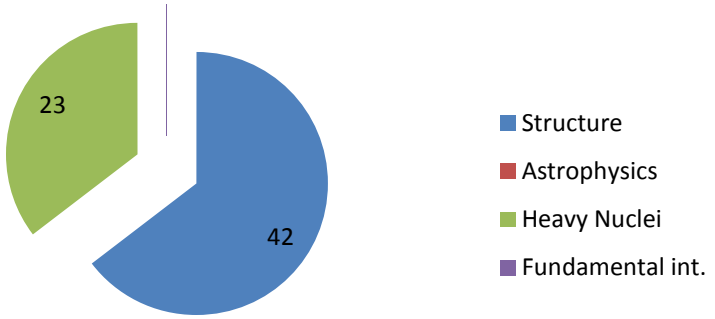


2014 Running Schedule RUN2



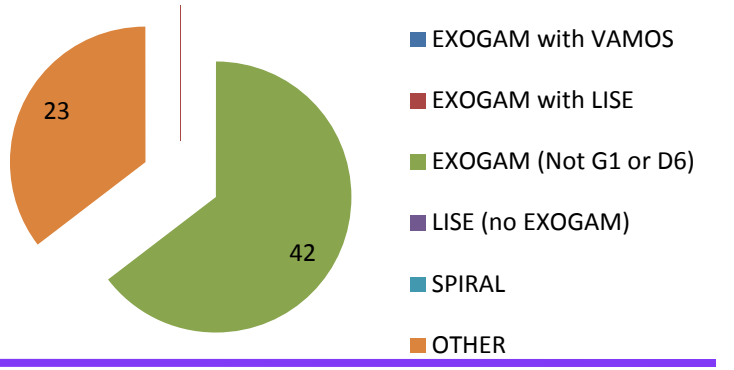
- **2014 Schedule (~10 weeks)**
  - **Run 2: 13/10 – 19/12**
  - **65 UT's for nuclear physics scheduled**
  - **2 experiments to be completed**
  - **~40 UT's to be scheduled…**

Schedule 2014 RUN2 (65 UT's)



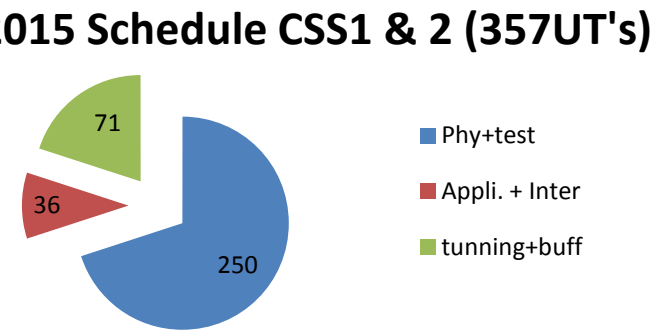
- **AGATA commissioning**
  - **54 UT's (2 exp.) VAMOS**

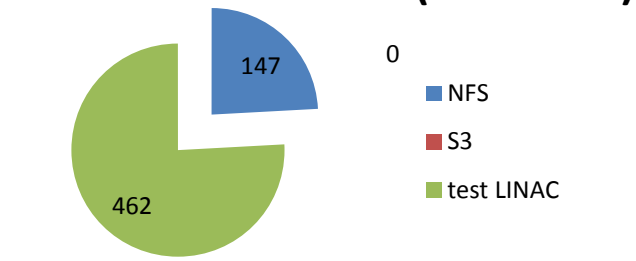
Schedule 2014 RUN2 (65 UT's)



2015
Running Schedule

- 2015 Schedule CSS1 & 2 (17 weeks)
  - 357 UT’s
  - 250 UTs for physics
  - ~9 experiments (28UTs/exp)
  - 40% increase from 2013





Approved Experiments GANIL PAC April 2014

N° EXP	Spokespersons	UT Allocated after TAC revision	
E661	A. Navin M. Rejmund	46	Exploring the coupling to the continuum and the Physics of high angular momentum AND high isospin using M,Z identified prompt fission Fragment γ- spectroscopy
E663	J. Ljungvall A. Görgen	25	Lifetime and gfactor measurements in the vicinity of 68Ni using AGATA, Oups and VAMOS
E664	J.J. Valiente Dobon	25	Study of quadrupole correlations in the 106,108Sn isotopes via lifetime measurements.
E666	B. Blank J-C. Thomas	23	Isospin mixing in pf-shell proton emitters
E667	C. Schmitt M. Rejmund	30	Insight into the origin of asymmetric low-energy fission of 180Hg
E669	D. Verney G. de Angelis	31	Neutron monopole drifts near the N=50 closed shell towards 78Ni
E672	G. Georgiev A.E.Stuchbery D.L.Balabanski	34	Lifetime and g-factor measurements of short-lived states in the vicinity of 208Pb
E673	P. R. John Pär-Anders Söderström	25	Shape transition in the neutron-rich W isotopes
E674	A. Lemasson S. Bhattacharyya	25	Collectivity in neutron-rich Sulfur isotopes
E676	S. Leoni B Fornal M. Ciemala	43	Lifetime measurements of excited states in neutron-rich C and O isotopes: a stringent test of the three body forces with the AGATA+PARIS+VAMOS setup
E680	G. Duchêne G. de Angelis	46	Test of the Z=28 proton- and N=50 neutron- gaps in 82Ge and 80Zn nuclei. Impact on the magicity of 78Ni
E682	C. Domingo-Pardo A. Gadea	25	Collectivity along the neutron-magic 94Ru and 96Pd
E686	J. Piot P. Greenlees	43	Decay spectroscopy of 257Db
	Total	421	
	Total AGATA	355	