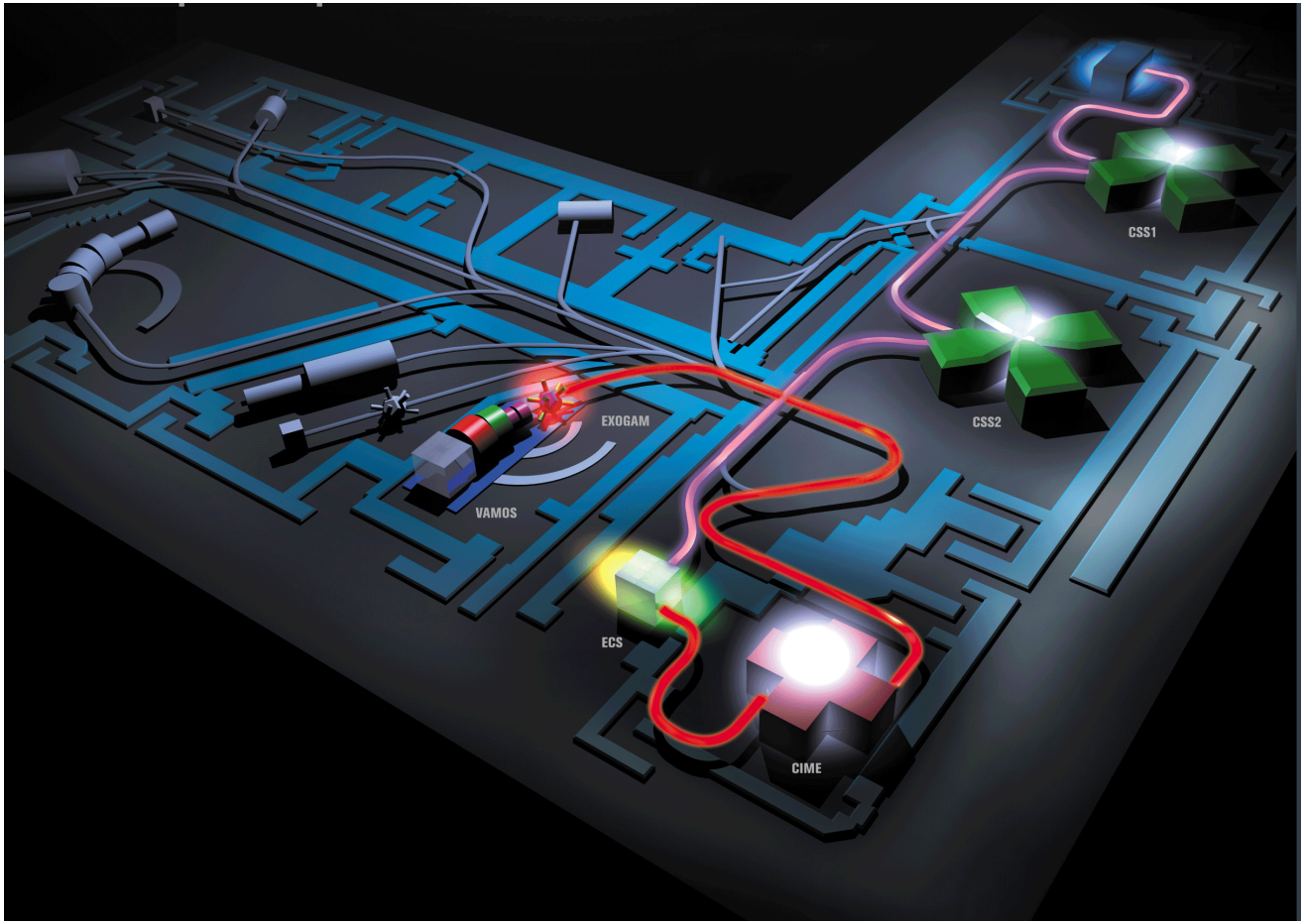
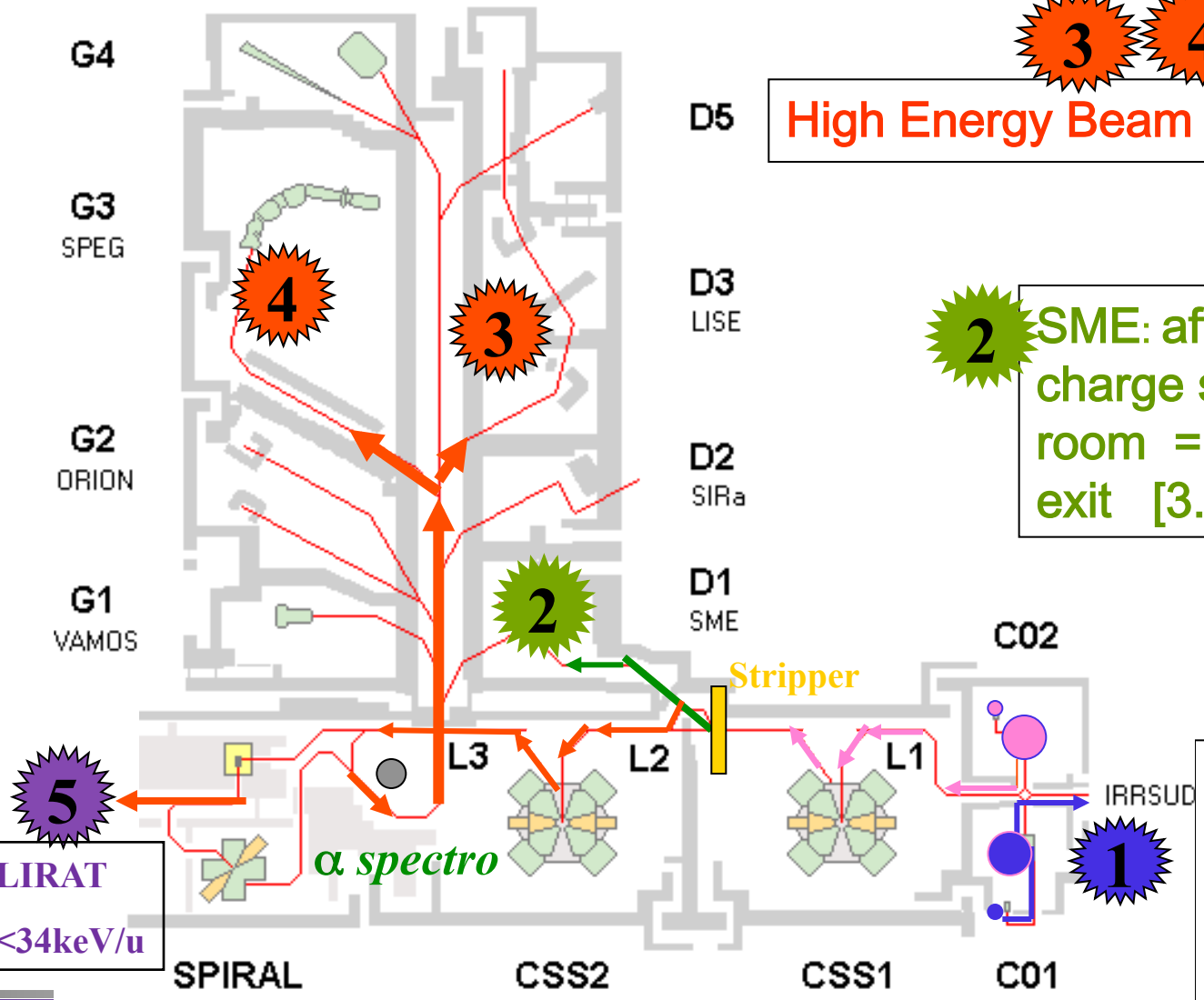
HIGH INTENSITY ION BEAMS AT GANIL



GANIL: HISTORY

- The first beam of GANIL was sent to an experimental room in 1983.
- Since then, the variety (116) and intensity of the ion beams available always increased.
- Progress in the source domain make possible to potentially transport of **kW beams**.
- The cyclotrons and the beamlines had to be **upgraded to handle** such a new constraint.

Multi-Beam Operating Mode:
5 experiments in parallel with stable beams



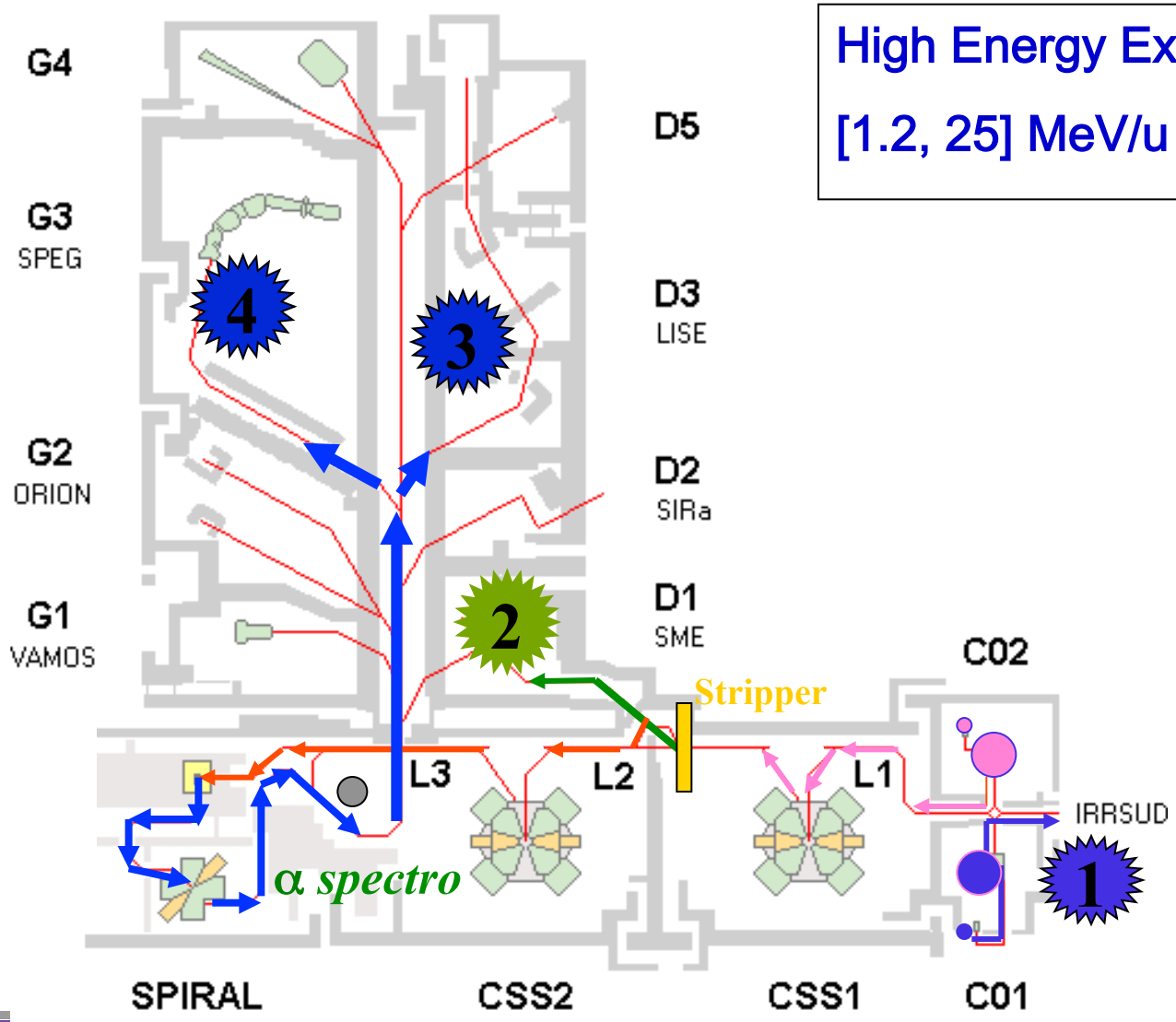
3 4 High Energy Beam GANIL [24, 95] MeV/u

2 SME: after a stripper, one charge state is sent to the D1 room => the medium energy exit [3.7, 13.7] MeV/u

IRRSUD: low energy beam irradiation line 1

[0.3, 1.0] MeV/u

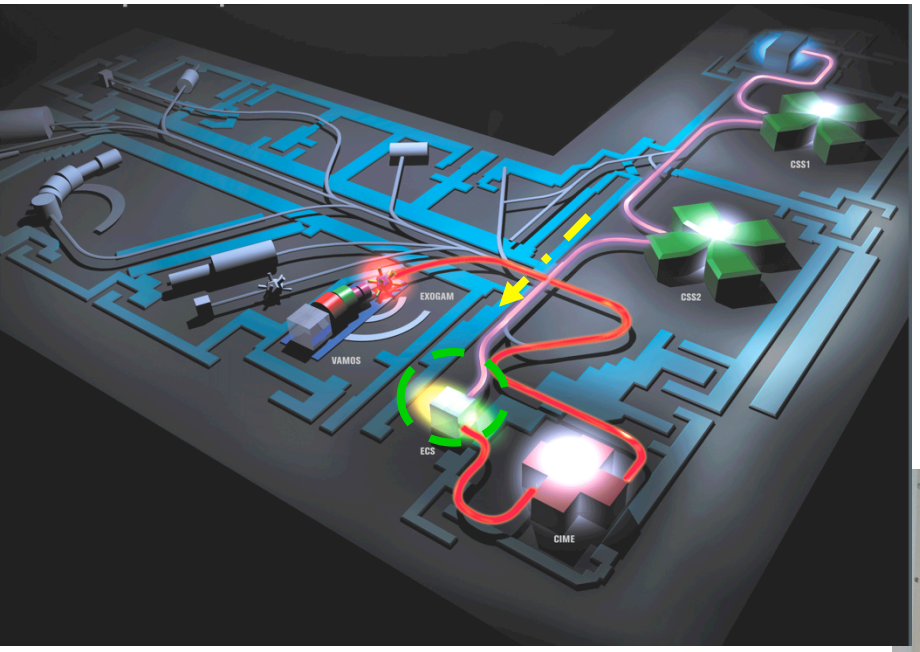
SPIRAL1 operating mode: 4 experiments in parallel



High Energy Exotic Beam

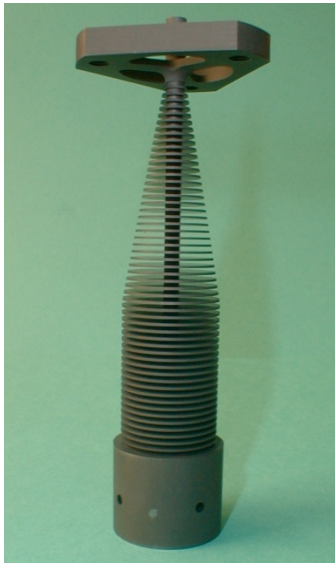
[1.2, 25] MeV/u 3 4

Radioactive ion beams with «ISOL» method since 2001 (W<25MeV/u)

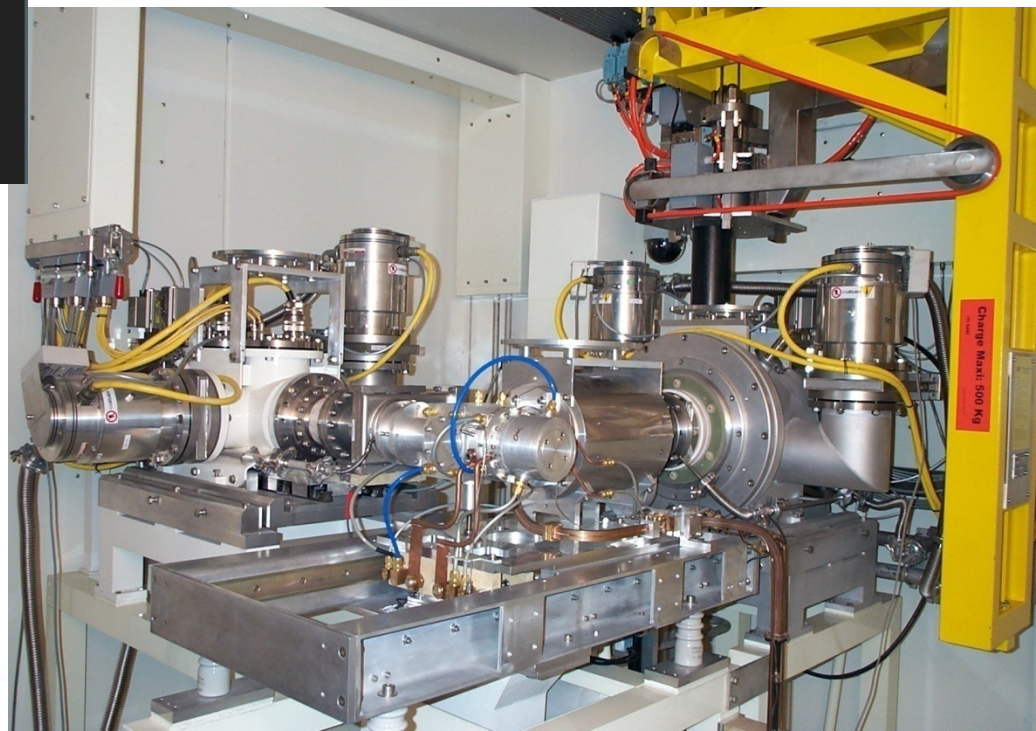


GANIL heavy ion beams up to 95 MeV/u onto a thick carbon target

→ radioactive atoms



Acceleration and Purification in the compact cyclotron CIME



SPIRAL: HISTORY

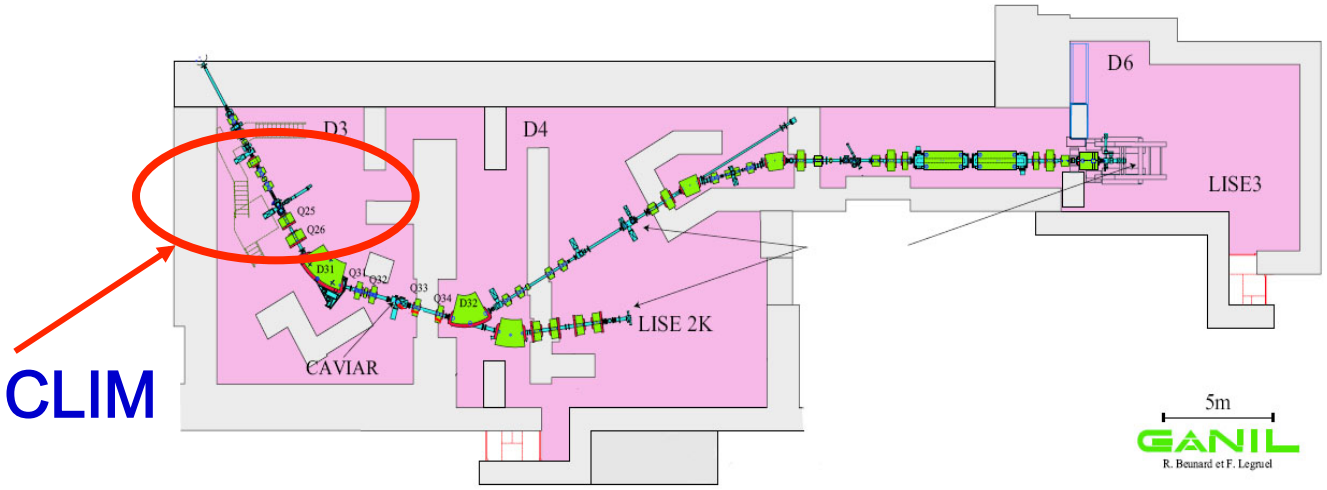
- In 2001, the first exotic beam of SPIRAL1 was produced with the existing cyclotron used as a driver.

- The exotic ion production was then depending on the target power resistance and **the increase of the primary beam power.**

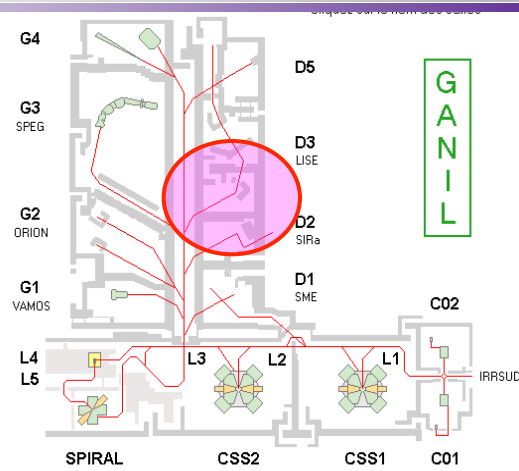
- This leading to the developments of 3 kW target of SPIRAL1 and meanwhile increase the primary beam power within the safety rules (shielding limit) :

  < 6kW or 2 10^{13} pps

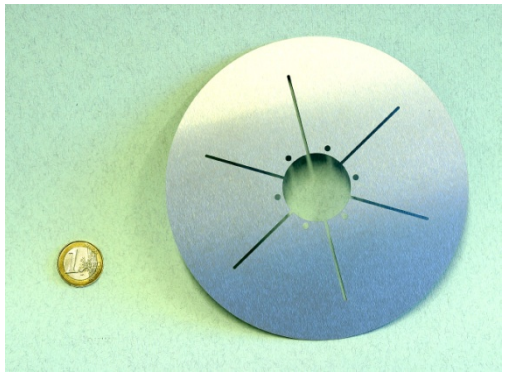
Radioactive ion beams with «In Flight» method (W<95 MeV/u)

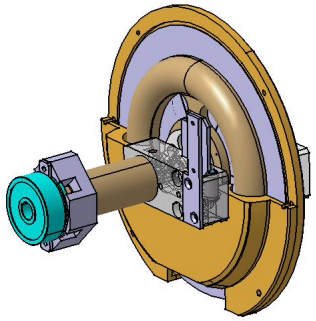


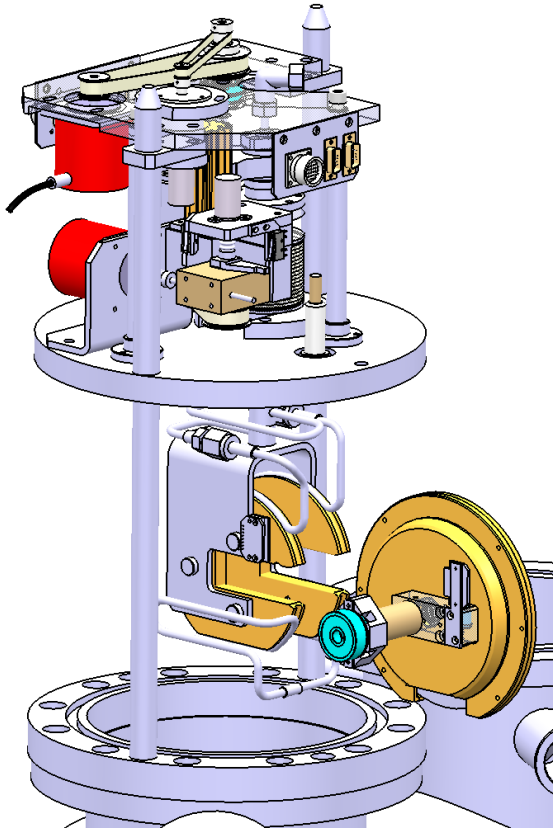
CLIM



- 2kW beam onto rotating target







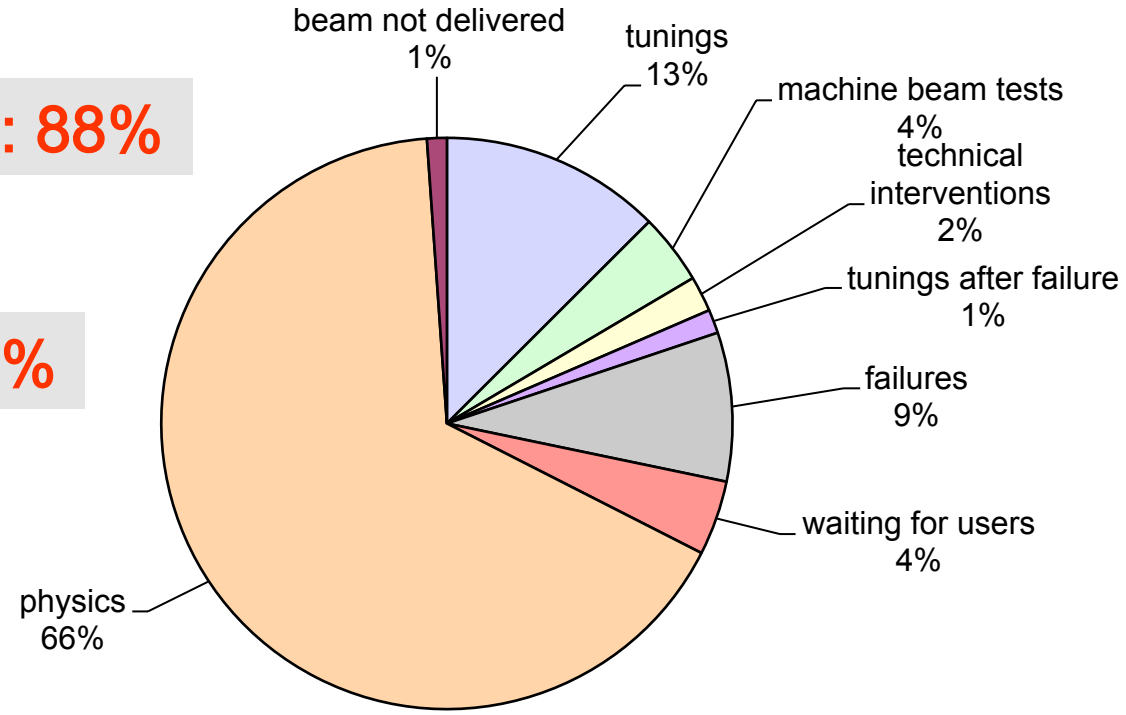
Multi-beam operating mode: Beam schedule

Date	hour	C01	C02	CSS1, CSS2	CIME	SME	Auxiliary beam
Saturday 25-Sep	6h00			36Ar18+ 95 MeV/A			
	10h00						
	14h00						
	18h00		36Ar 95 MeV/A	Test SPR D1			
	22h00			P832 (Testard) D1 2 UT			E587 S (I. Martel)
Sunday 26-Sep	2h00						
	6h00	Change of source chamber					
	10h00						
	14h00			P858 (Fourdrin) D1			
	18h00						
	22h00						
	2h00	Outgassing					
	6h00		36Ar 95 MeV/A	P858 (Fourdrin) D1			
Monday 27-Sep	10h00	Tuning ECR 13C3+					E587 S (I. Martel)
	14h00				16O2+ 2.02 MeV/A		
	18h00	Tuning C0 13C3+		BUFFER			
	22h00			Tuning Z	Tuning Z		
	2h00	13C 75 MeV/A			E587 S (I. Martel) G21		
	6h00			13C6+ 75 MeV/A			
Tuesday 28-Sep	10h00		Tuning ECR4 58Ni11+			SME	
	14h00						
	18h00				8He1+ 2 MeV/A 2e5 pps		
	22h00						
	2h00						
	6h00						
Wednesday 29-Sep	10h00		Tuning C0 58Ni11+ 0.8 MeV/A		IBE		
	14h00						
	18h00				E587 S (I. Martel) G21 9 UT		
	22h00						
	2h00						
	6h00		IRRSUD				
Thursday 30-Sep	10h00						
	14h00						
	18h00						
	22h00						
	2h00						
	6h00			BEAM ON SPIRAL TARGET			
Friday 1-Oct	10h00						
	14h00						
	18h00						
	22h00						

Running Statistics 2001-2012

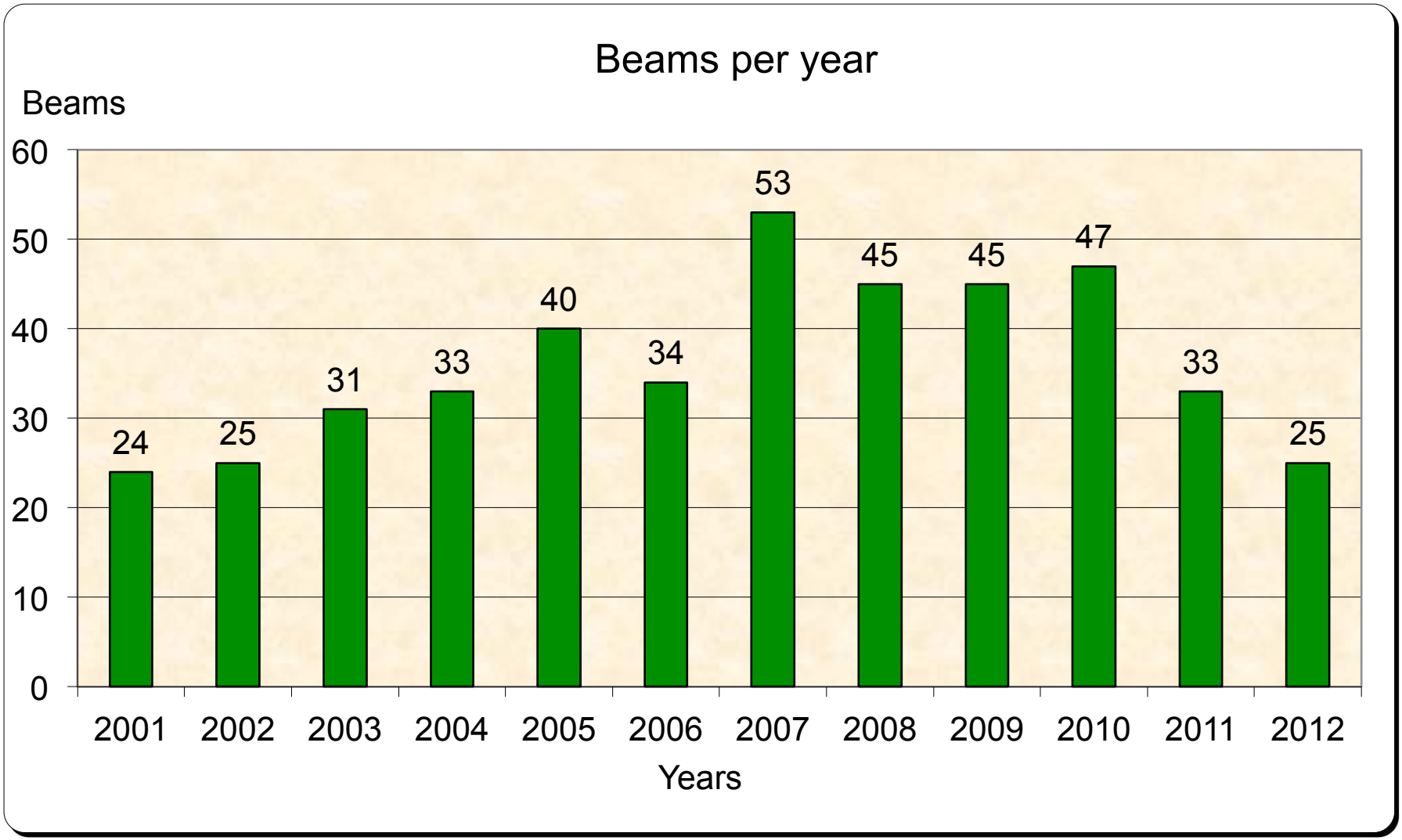
Availability over 12 years: 88%

Availability in 2012 : 89.7%

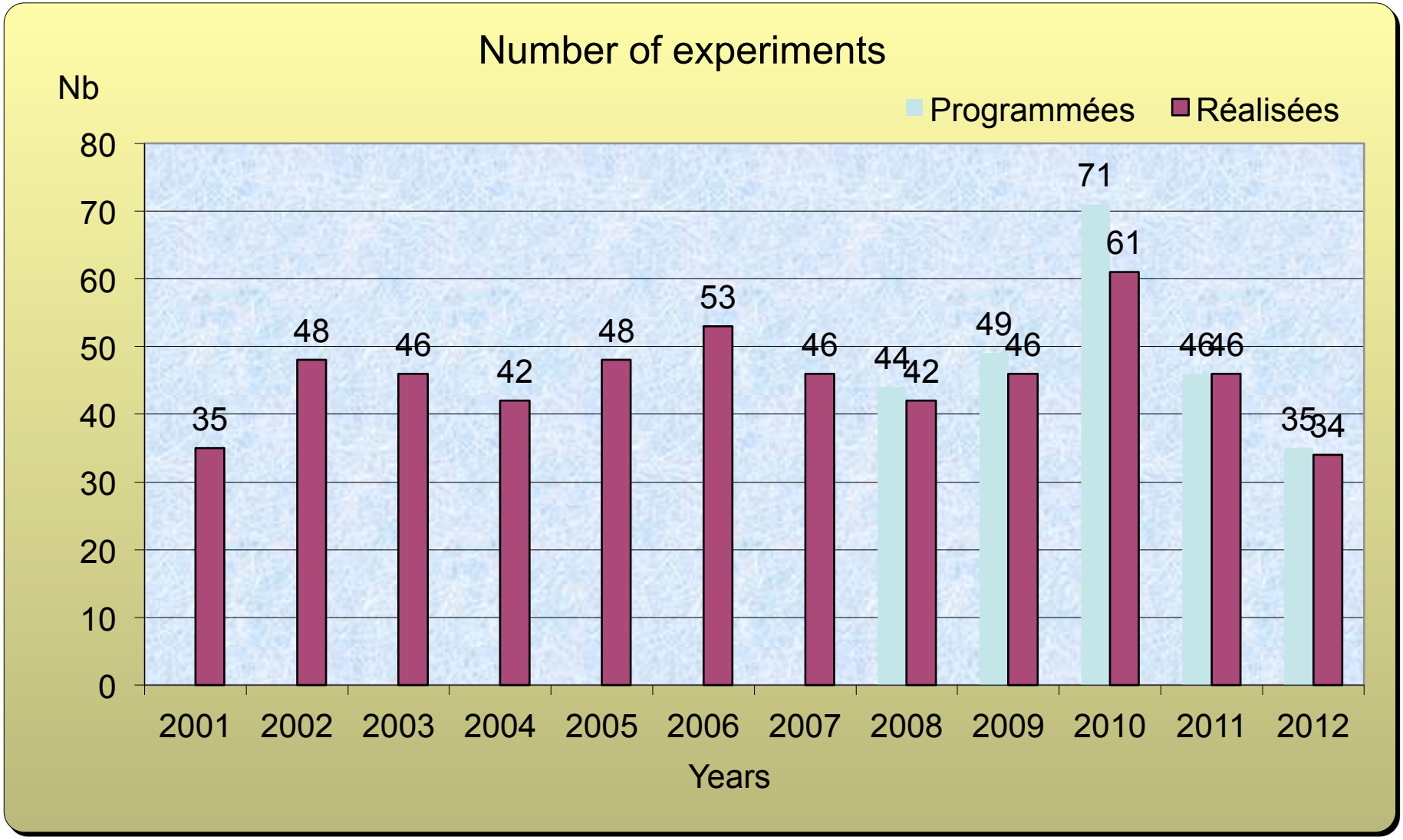


GANIL per year: 30 weeks / 4 periods: 5000h of operating time. Leading to 9000h of beam time for users (multi-beam effect)

From 2001 to 2012



From 2001 to 2012



Intense beams

2.10^{13}pps Safety limitation reached

Possible improvement

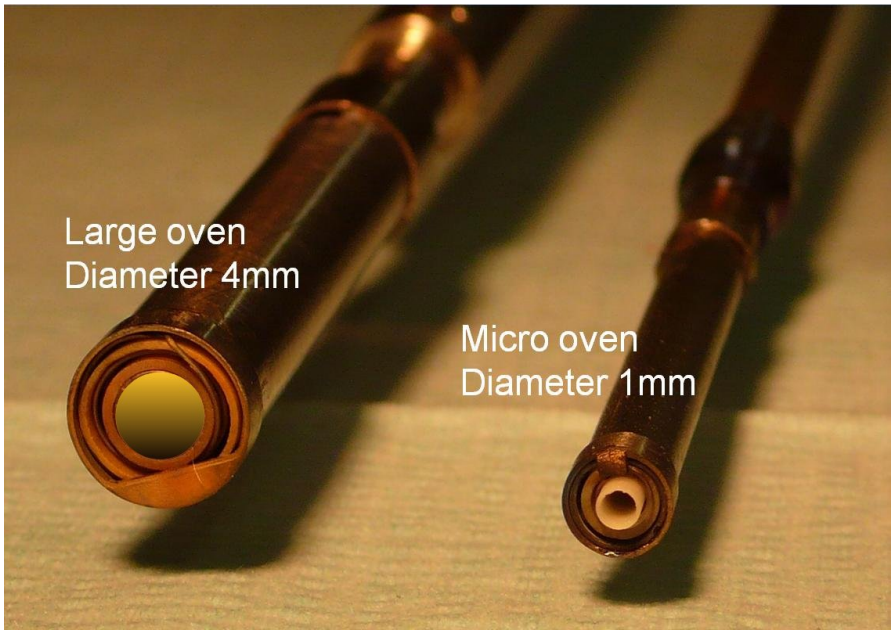
Beam	Imax [μAe]	[pps] <2 10^{13}	Emax [MeV/A]	Pmax [W] <6kW	Used with Spiral
$^{12}C^{6+}$	18	1.9 10^{13}	95	3 200	
$^{13}C^{6+}$	18	2. 10^{13}	80	3 000	X
$^{14}N^{7+}$	15	1.4 10^{13}	95	3 000	
$^{16}O^{8+}$	16	10^{13}	95	3 000	X
$^{18}O^{8+}$	17	10^{13}	76	3 000	X
$^{20}Ne^{10+}$	17	10^{13}	95	3 000	X
$^{22}Ne^{10+}$	17	10^{13}	79	3 000	
$^{36}S^{16+}$	11	4.3 10^{12}	77.5	1900	X
$^{36}Ar^{18+}$	24	8.3 10^{12}	95	4600	X
$^{48}Ca^{19+}$	4.5	1.5 10^{12}	60	700	X
$^{58}Ni^{26+}$	5	1.2 10^{12}	74.5	860	
$^{76}Ge^{30+}$	3.5	0.7 10^{12}	61	500	
$^{78\text{-}86}Kr^{34+}$	7	1.3 10^{12}	70	1200	X
$^{124}Xe^{46+}$	1.8	2.6 10^{12}	49.6	300	

http://pro.ganil-spiral2.eu/users-guide/accelerators/available-stable-ion-beams-at-ganil/view

R&D: Intense Primary beams

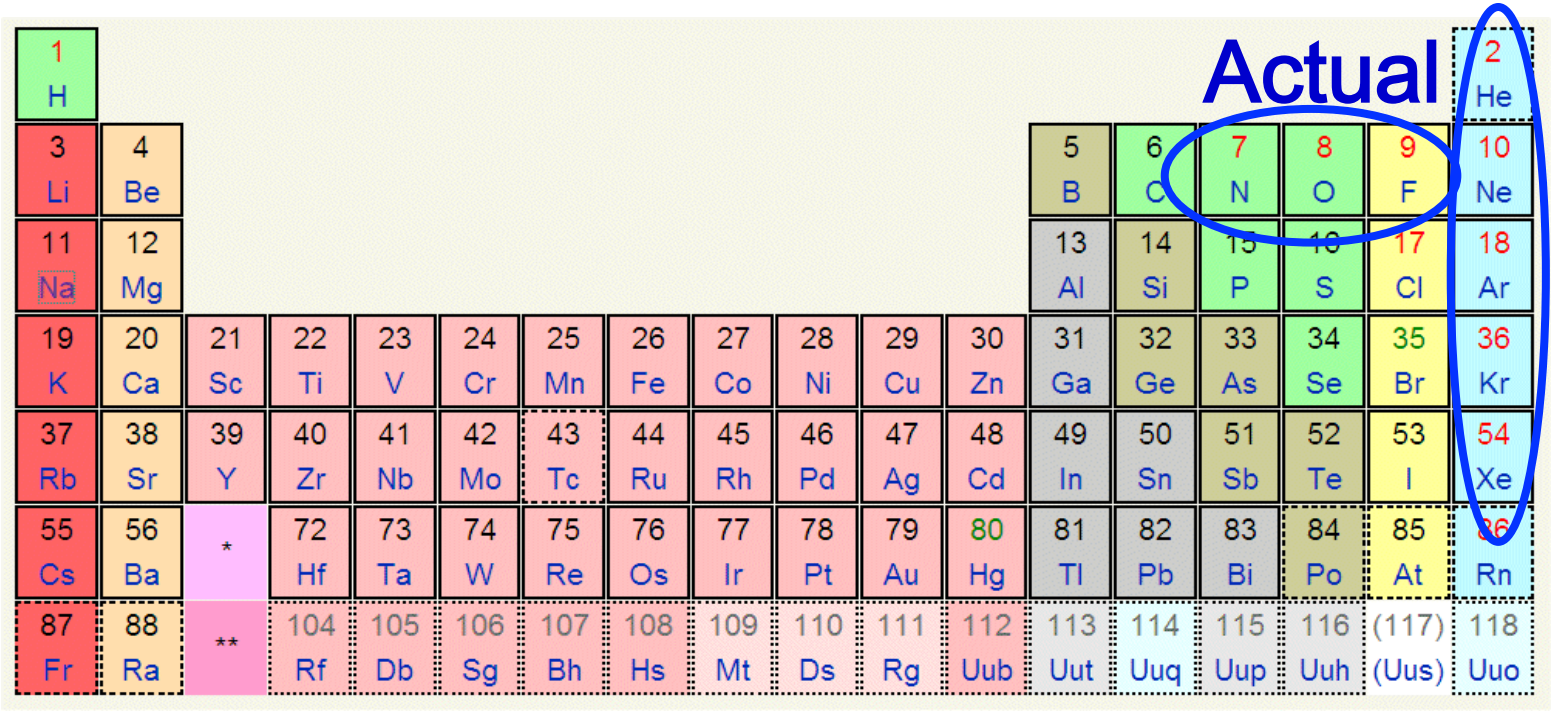
It goes with an **improvement of the source oven** for the metallic ion production.

- First, a modified version of the existing **micro-oven** at high temperature (1700°C max) to a **higher capacity oven** but at a lower average temperature (1100°C max).
- Second, build a large capacity and high temperature oven.
- Above the 1700°C temperature limit, development with induction oven is foreseen.



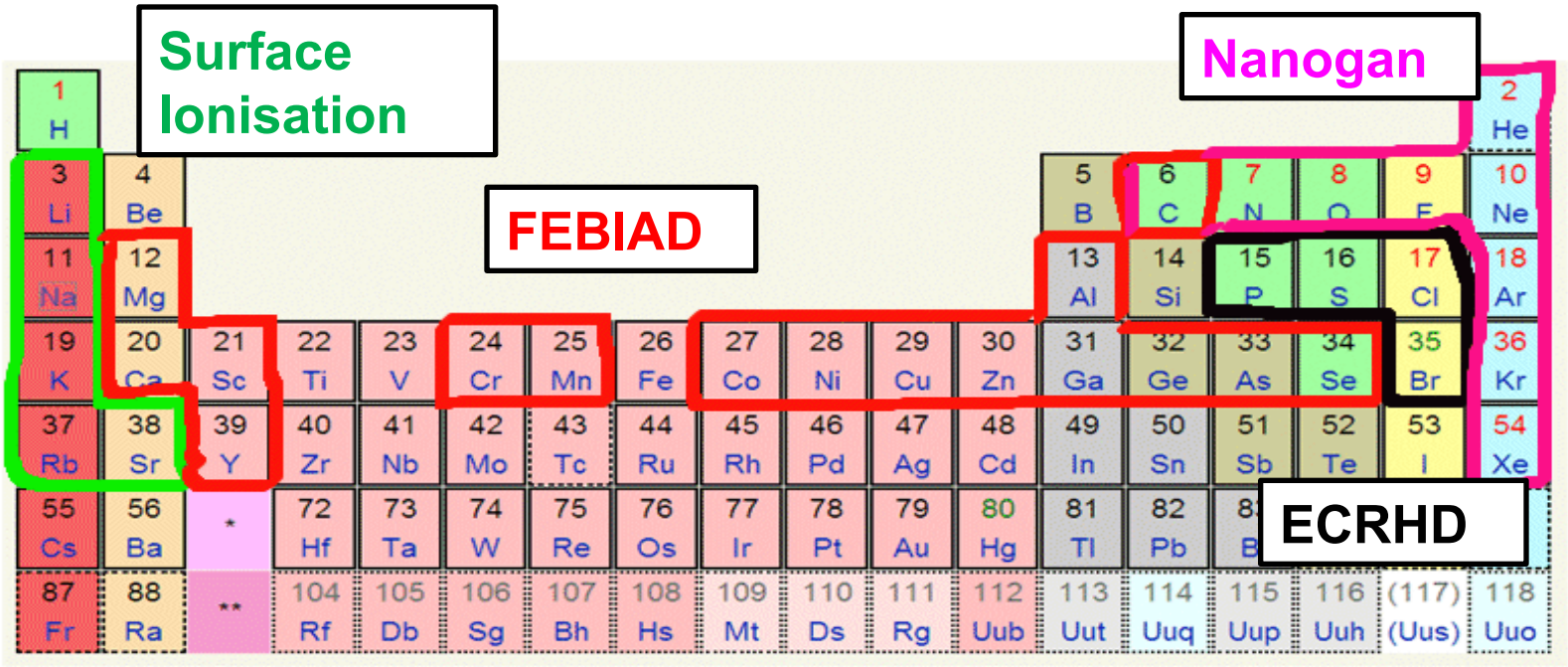
- Those developments are coherent with the beam needs expressed by the SPIRAL2 project for the production of $^{48}Ca^{16+}$ and $^{58}Ni^{19+}$.

R&D ISOL Production Limitation with the actual Nanogan 3 source



- GANIL group project constituted
- **Overview of source developments for SPIRAL1: done**

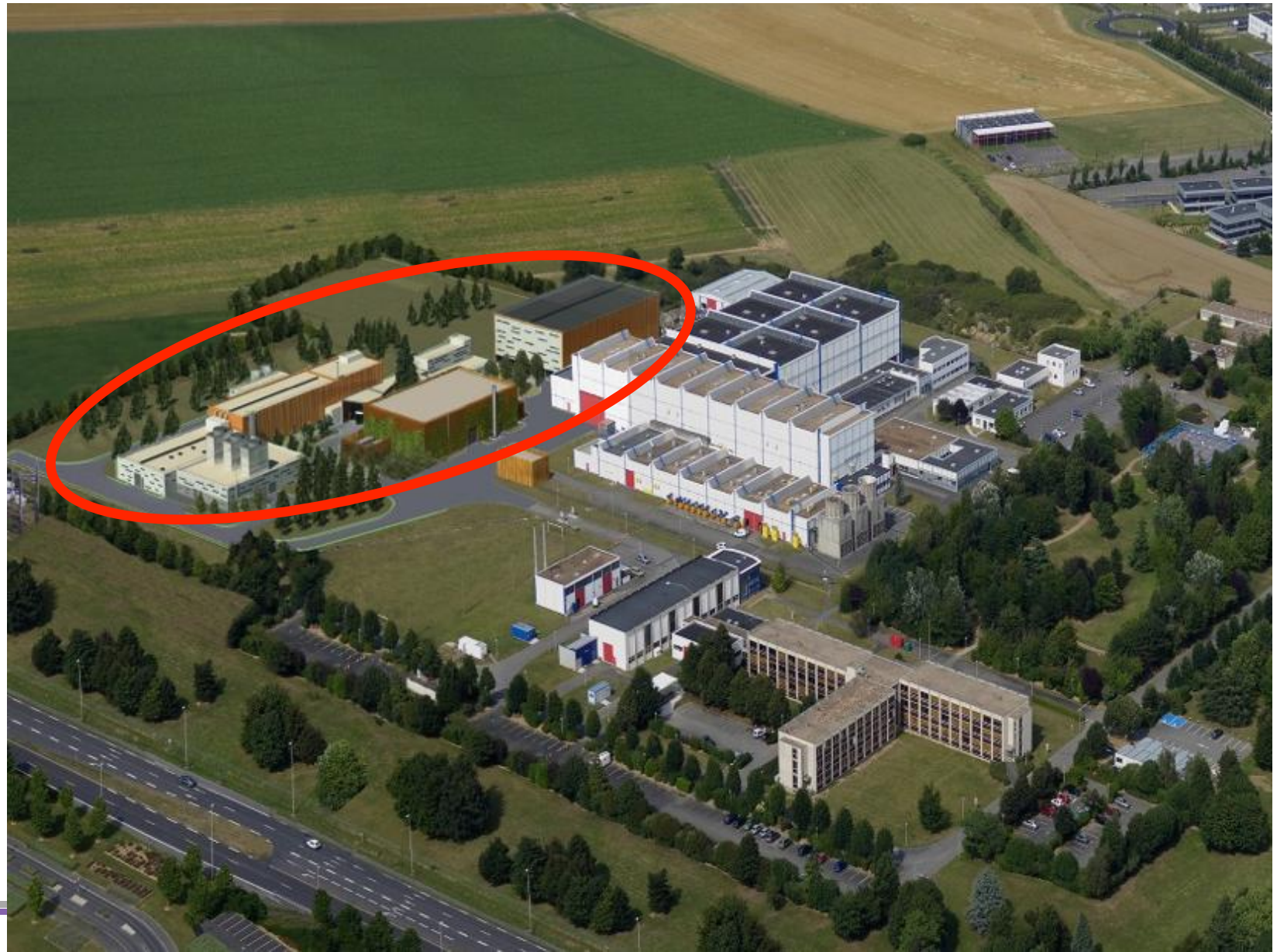
Possible New Beams from graphite targets with SPIRAL1 design compatible sources



Mass limited to <~90 for various technical reasons, can be extended in the future.

The developments should be driven by physics cases (LoI)

SPIRAL2

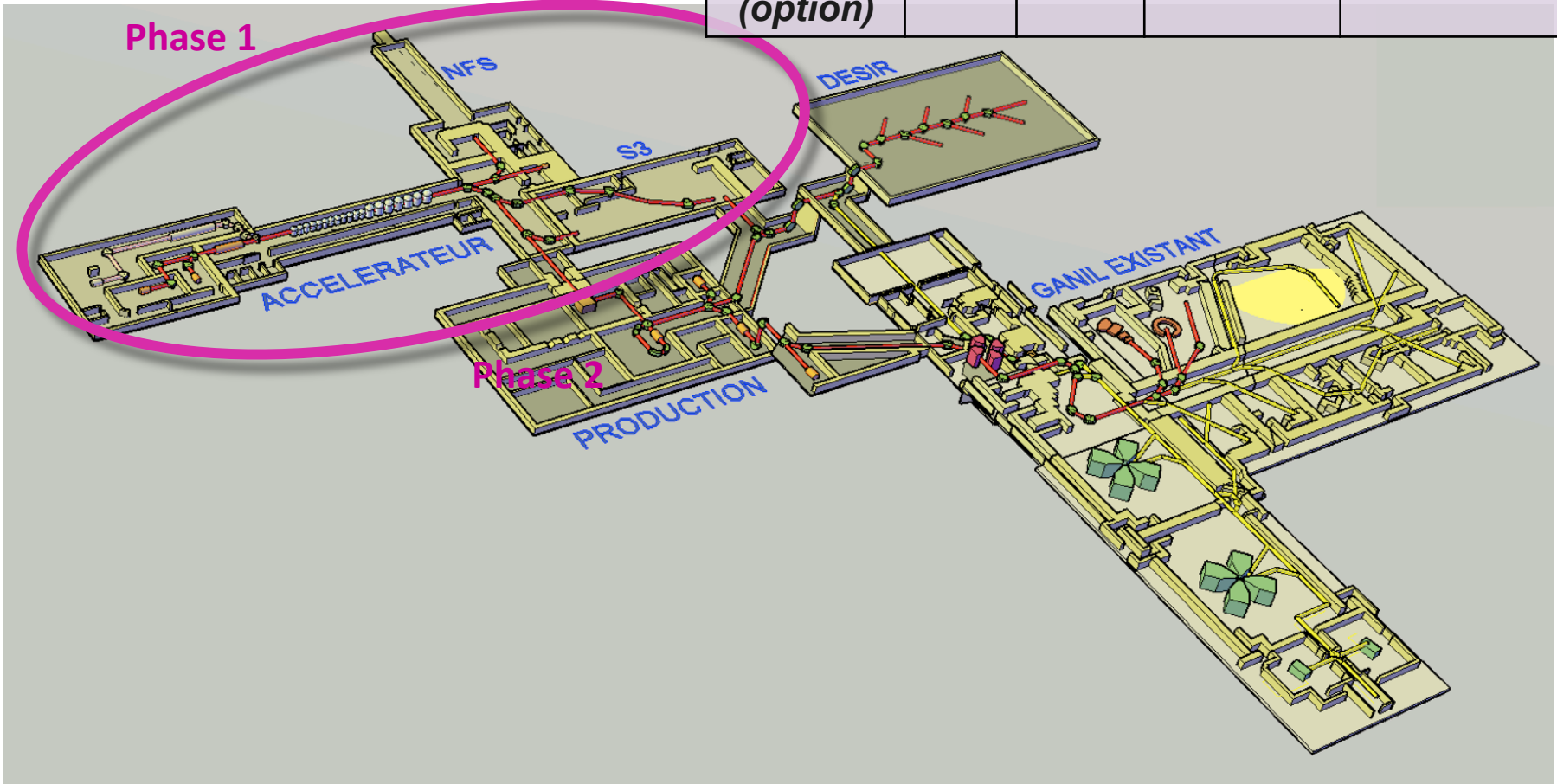


SPIRAL2 phase1 under construction:

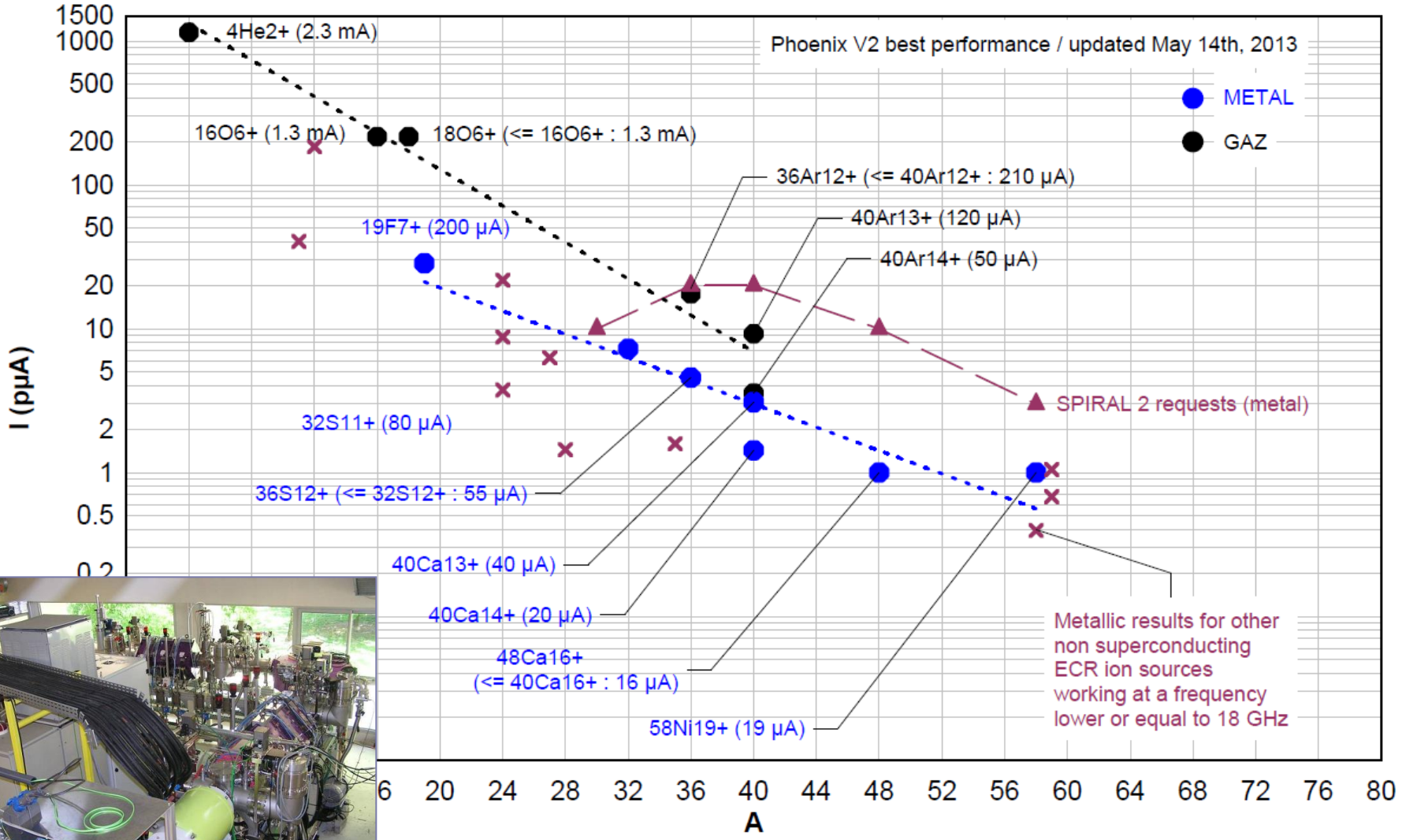
Phase 1: High intensity stable beams

Phase 2: Radioactive Ion Beams

	Q/A	I (mA)	Energy (MeV/u)	CW max beam Power (kW)
Protons	1/1	5	2 - 33	165
Deuterons	1/2	5	2 - 20	200
Ions	1/3	1	2 - 14.5	45
Ions (option)	*1/6*	*1*	*2 - 8*	*48*



Measured figures for the Phoenix V2 source

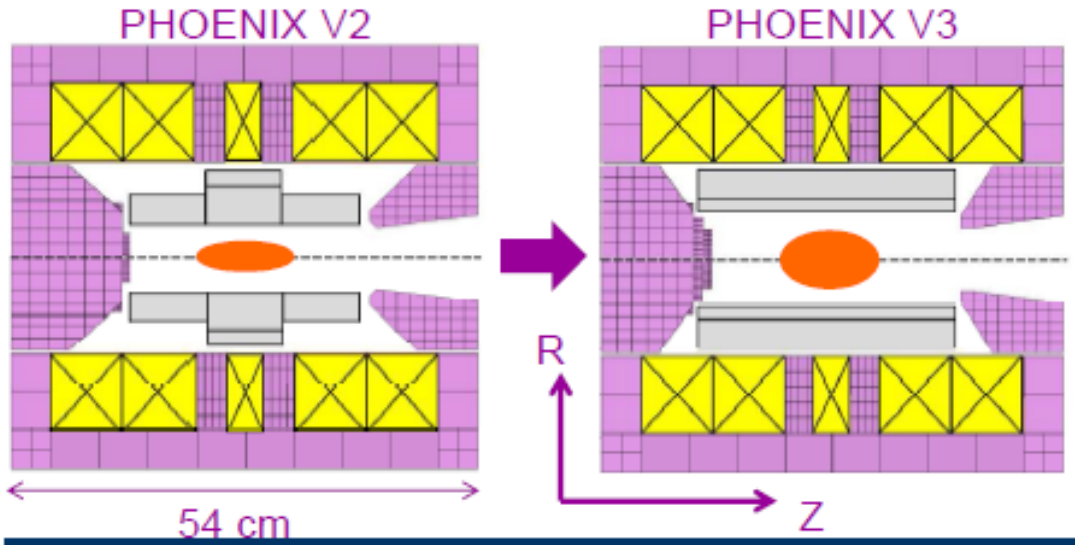


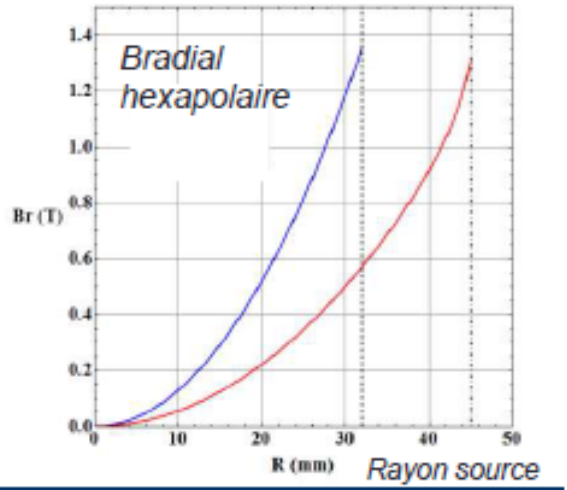
R&D: Intense Primary beams SPIRAL2

LPSC Grenoble — GANIL spiral2 laboratoire commun CEA/DSM CNRS/IN2P3 — IPNL

Q/A=1/3

Evolution Source PHOENIX V2 →PHOENIX V3



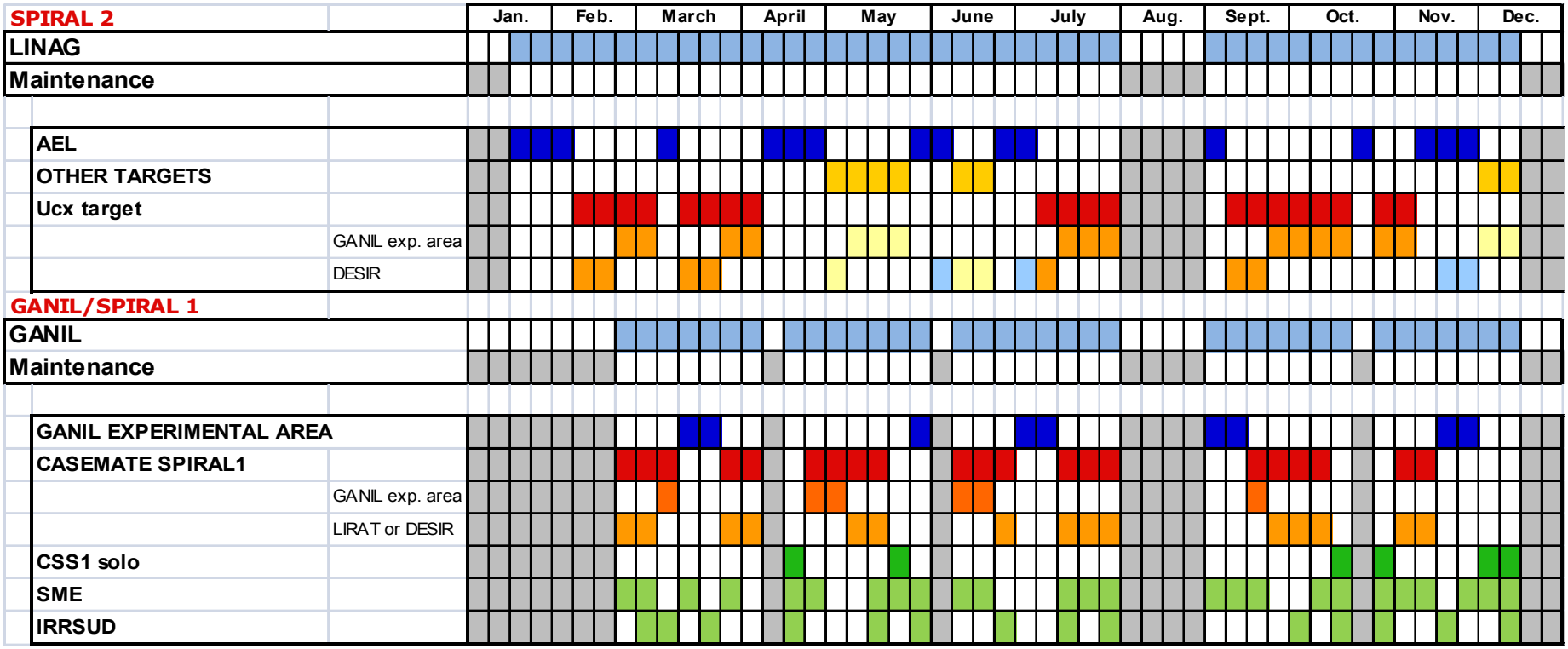


T. Thuillier, C. Peaucelle, L. Maunoury – 05.02.2012 1

✓**Beam tests fall 2013**

GANIL potentiality

44 weeks for SPIRAL2 and 36 weeks for GANIL a year are foreseen



Thank you for your attention