NEWGAIN Project – Status

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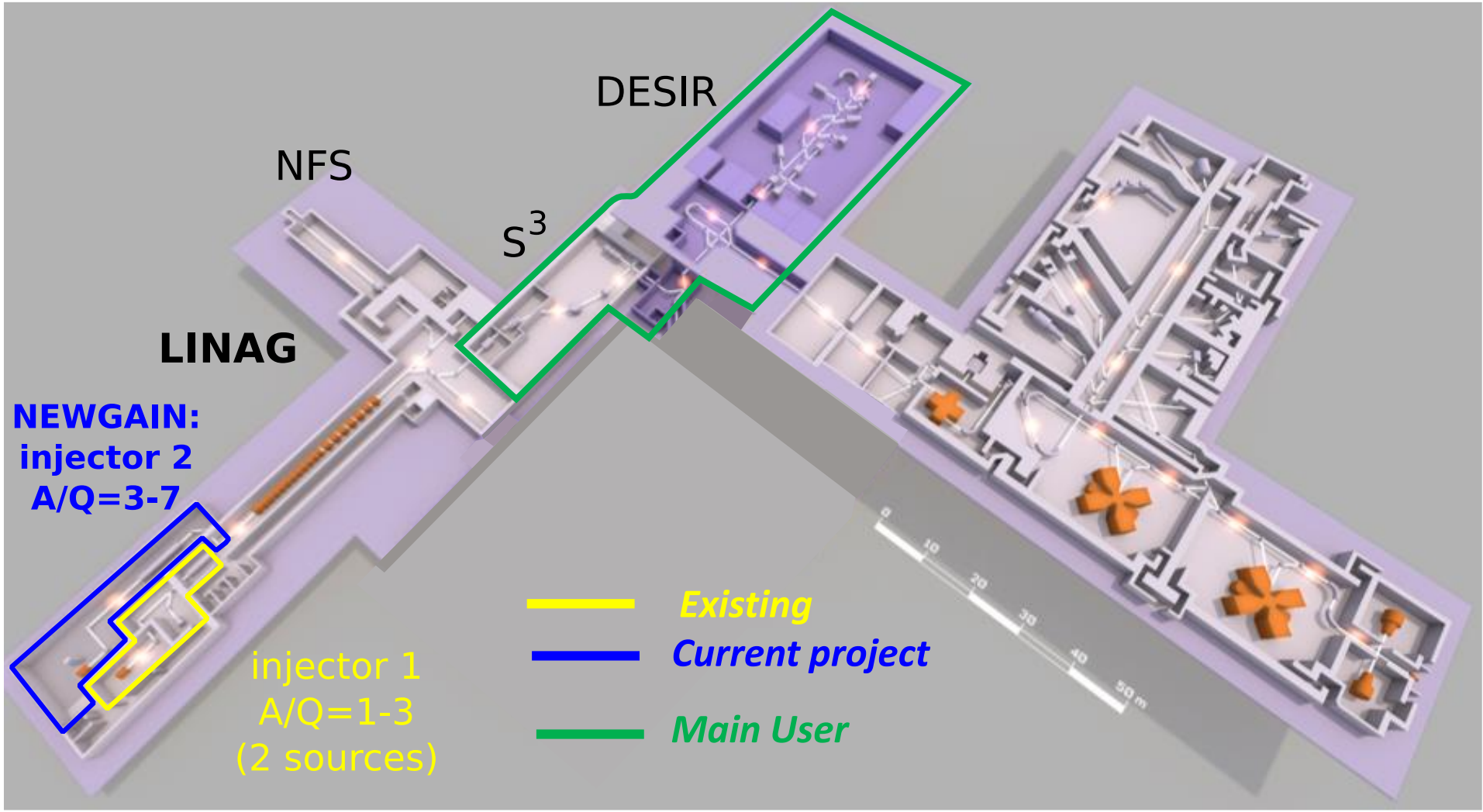
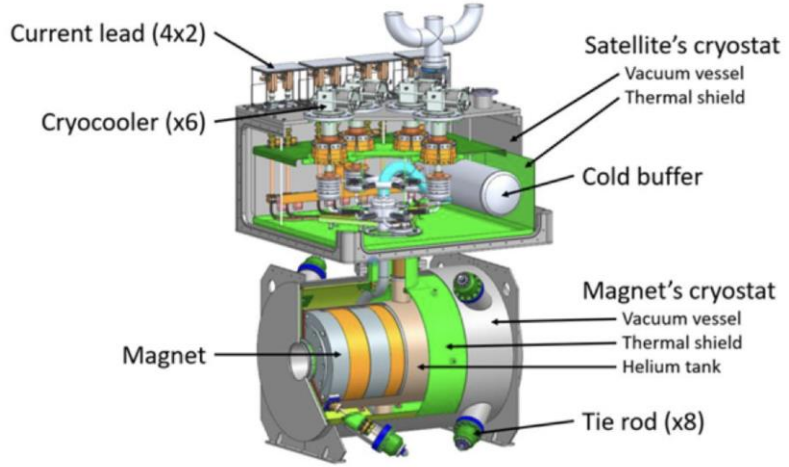
IJCLab
NEWGAIN scientific coordinator

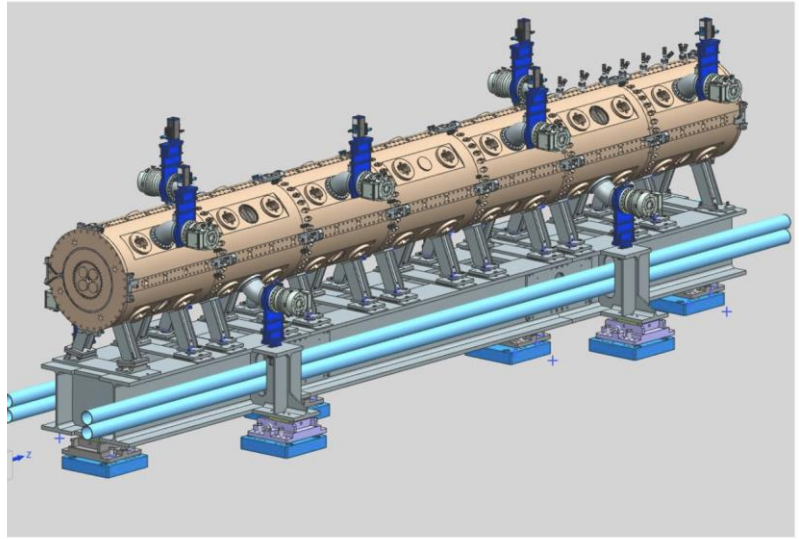
NEWGAIN project



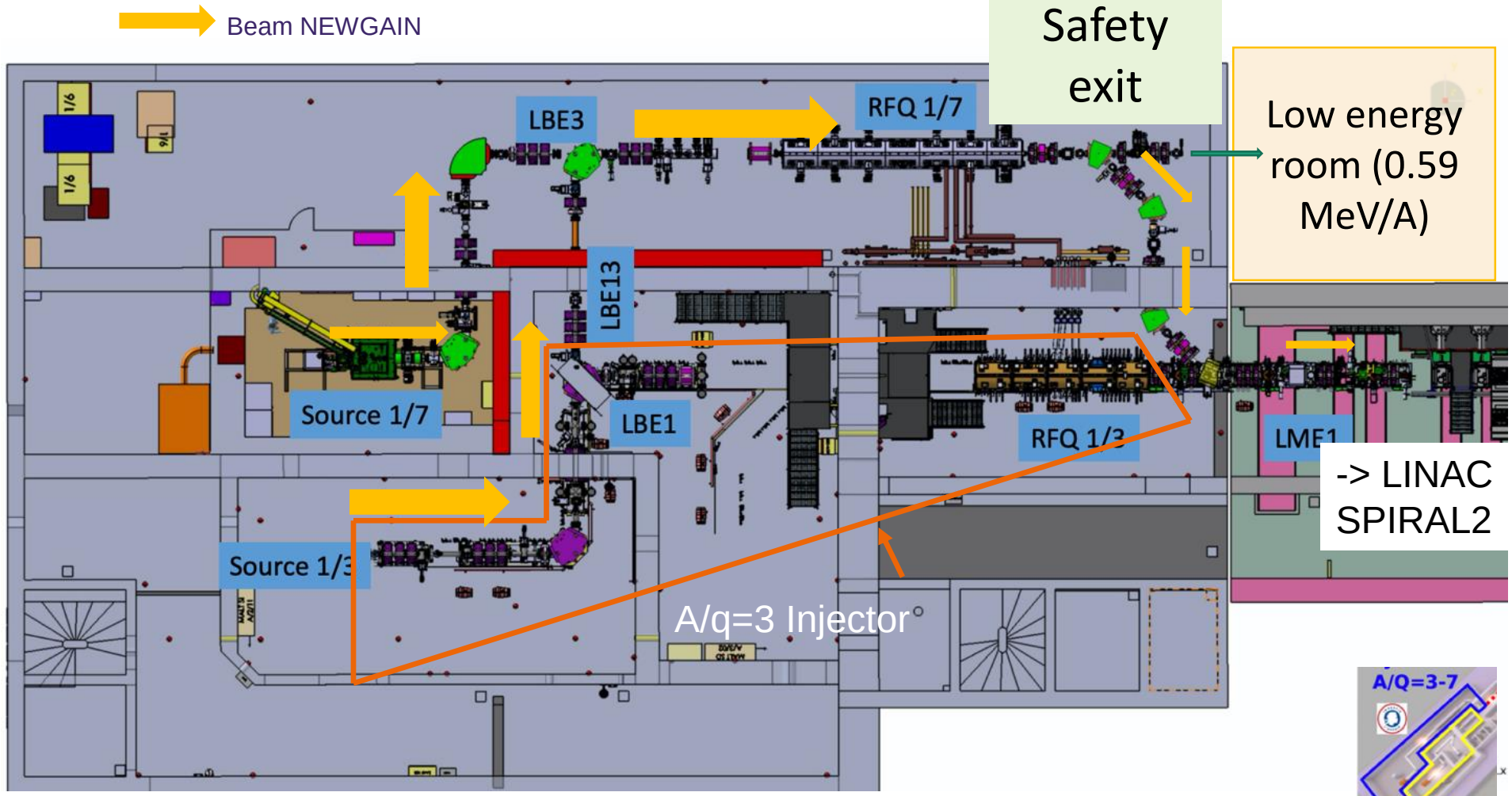
NEWGAIN project

- High-performance superconducting ion source and High-Voltage Platform
  ASTERICS design (evolution of VENIS – FRIB)
- Low energy beam transport line allowing the connection of both ion sources (superconducting one and existing Phoenix V3) to the RFQ
- RFQ that will accelerate heavy ions with minimal beam losses up to the injection energy for the superconducting LINAC
  Same technology as A/q=3 RFQ
- Medium energy beam line connecting the injector to the LINAC
- Ancillaries (*and emergency exit- not financed by Equipex*)





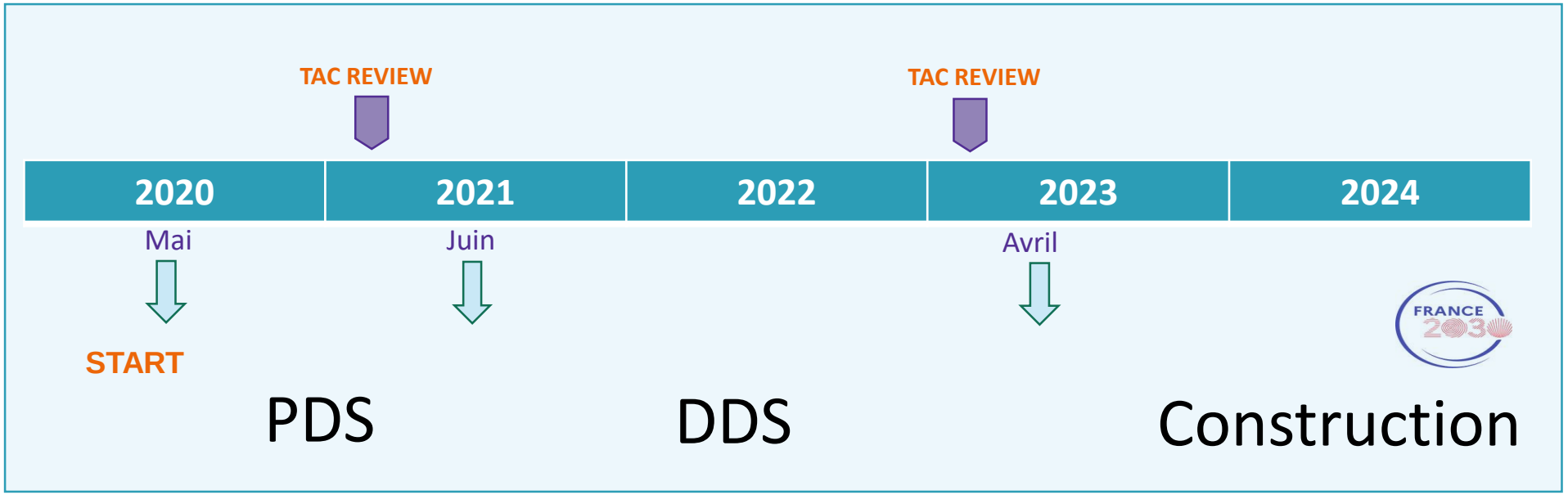
NEWGAIN project



NEWGAIN project

- 2007: first conceptual design of an A/q=6 injector, for the design of the SPIRAL2 building and integration of the future injector cave
- 2008: Evolution towards a A/q=7 injector (keeping the A/q=6 cave)
- 2016: decision from the GANIL authorities (CEA/CNRS) to integrate a second injector to SPIRAL2 facility
- 2018-2019: meetings with CEA/IRFU and CNRS/IN2P3 laboratories for the organization of the preliminary design study (PDS) phase
- January 2020: Scientific objectives of the project defended GSC
- 07 May 2020: Kick-off meeting of the design study phase in videoconference
- June 2020: EQUIPEX PIA3 founding request deposited
- February 2021: Project objectives defended GSC (A/Q 6 or 7)
- February 2021: First TAC for the Preliminary Design
- February 2021: Funding decision : 13,7 M€ funding by the National Research Agency – Complement to be funded by the GANIL budget (7,4 M€)
- June 2021: Start of the Detailed Design Study
- September 2022: Special TAC - SC magnet design
- October 2022: Special TAC - SC source design
- December 2022: "Physics with Spiral 2 Heavy Beams" workshop @ CAEN
- January 2023: Decision: ASTERICS design for SC Source
- Mars 2023: TAC for Detailed Design Study

NEWGAIN project



NEWGAIN project

	Design Study Phase		Construction Phase			Injector Installation, Tests and Commissionning		Operation Phase with Phoenix V3			With SC Source
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Beam Dynamics	Detailed study							SC Ion Source Tests and Commissionning (at LPSC then at GANIL)			
Superconducting Ion Source		preliminary study	Detailed study	Order and manufacturing (including SC magnet tests)			Installation in LPSC	Tests in LPSC		Transfer to GANIL	Tests in GANIL
Plate-Forme		Detailed Study		Order and manufacturing		Installation at GANIL					
RFQ		Detailed Study		Order and manufacturing			Installation and tests	Commissioning			
Beam Lines		Detailed Study		Orders and manufacturing		Installation	Commissionning				
Systèmes RF (amplifiers)		Detailed Study		Order and manufacturing	Installation	Acceptance Tests	Commissionning				
Vaccum Systems		Detailed Study		Order and manufacturing		Installation	Commissionning				
Power Supplies		Detailed Study		Order and Manufacturing	Installation	Tests with charges	Commissionning				
Diagnostics		Detailed study			Order and manufacturing	Installation et tests	Commissionning				
Control System		Detailed study		Development/Orders-Manufacturing		Tests	Commissionning				
First beams								With Phoenix V3			With SC source
Emergency exit without ASN Authorization		CdC and Call for tender	Study (APS APD) and safety document	PRO Studies and call for tenders	Construction and Reception						

- **Achievements**

  - **NEWGAIN "White Book – Scientific Requirements"**
    - **physics case**
    - **definition of basics beam properties (E, I, timing)**
    - **https://www.ganil-spiral2.eu/wp-content/uploads/2021/06/Whitebook_NEWGAIN-1.pdf**

2021

  - **detailed technical specifications**
    - **verified in "Spécifications Techniques Générales du Besoin de l'injecteur NEWGAIN"**
    - **detailed time structure and duty cycle including special mode(s) of operation (optional)**

2022

NEWGAIN Project - Scientific Goals: Existing Program

All this will be done using: S3, S3-LEB, DESIR

Fusion – evaporation: Neutron-deficient products

Discovery frontier

How many neutrons and protons can we put into a nucleus?

Precision frontier

High precision measurements for masses and similar properties

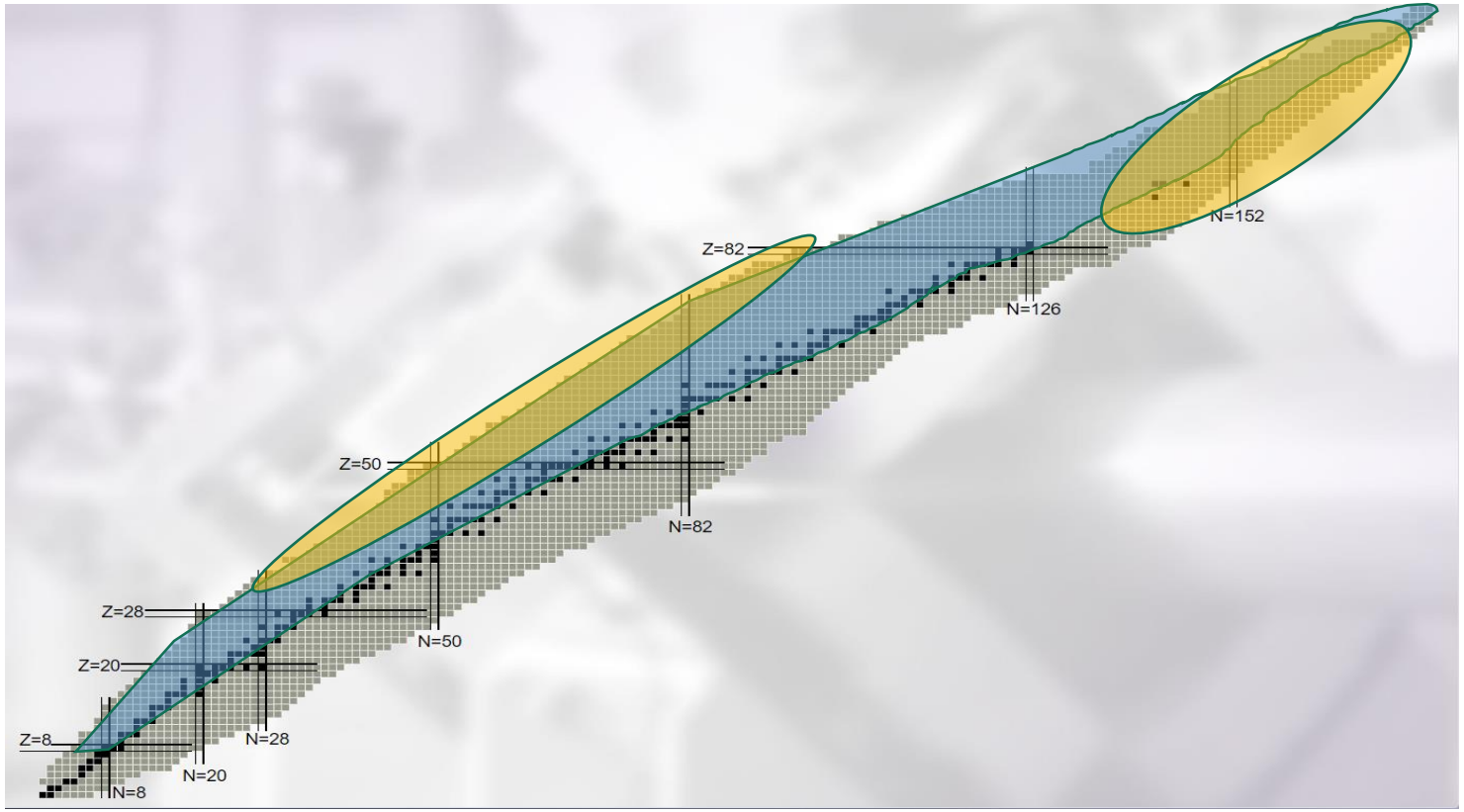
Interdisciplinary research - FISIC Project

study collisions fast ions vs slow ions

Solid state physics and medical applications

Material characterisation (beta-NMR, Mössbauer spectroscopy, and emission channelling techniques)

Astrophysics (needs beams from p to U)



NEWGAIN Project - Scientific Goals: Relevant Beams & Intensities

Estimated in 2021

Important: RFQ dimensioned for 15 puA ^{48}Ca and 10 puA for ^{238}U

Ions	Intensity (pμA) Phoenix V3 RFQ A/Q≤3	Intensity (pμA) Phoenix V3 RFQ A/Q≤7	Intensity (pμA) SC Ion Source RFQ A/Q≤7
^{18}O	80	*	375
^{19}F	>15	>40	>40
^{36}Ar	16	70	45
^{40}Ar	3.6	70	45
^{36}S	2.3	*	*
^{40}Ca	2.9	10	20
^{48}Ca	1.2	10	20
^{58}Ni	1.1	4	**8**
^{84}Kr	0.1	10	**20**
^{139}Xe	0.001	7	**>10**
^{238}U	<<0.001	0.1	**6**

Measured | Estimated

* -> no estimation

Collaboration S3-LEB-SIRIUS-DESIR

NEWGAIN Project - Scientific Goals: Relevant Beams & Intensities

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NEWGAIN

Consolidation and reinforcement of the S3, LEB & DESIR A/Q=3 physics program.

Relevant beams:

^{12,13,14}C, ^{16,17,18}O, ^{20,21,22}Ne, ^{23}Na, ^{24,25,26}Mg, ^{27}Al, ^{28,29,30}Si, ^{32,34}S, ^{35,37}Cl, ^{38,40}Ar, ^{38,39,40}K, ^{40,42,43,44,46,48}Ca, ^{46,47,48,49,50}Ti, ^{51}V, ^{50,52,53,54}Cr, ^{55}Mn, ^{54,56,57,58}Fe, ^{59}Co, ^{58,60,61,62,64}Ni, ^{63,65}Cu, ^{64,66,67,68,70}Zn, ^{74,76}Ge, ^{78,86}Kr, ^{84,86}Sr, ^{90}Zr, ^{92}Mo

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New opportunities . Now compatible with existing installation Beams:

^{136}Xe, ^{197}Au,^{208}Pb,Bi,Th,^{238}U

Incipient phase

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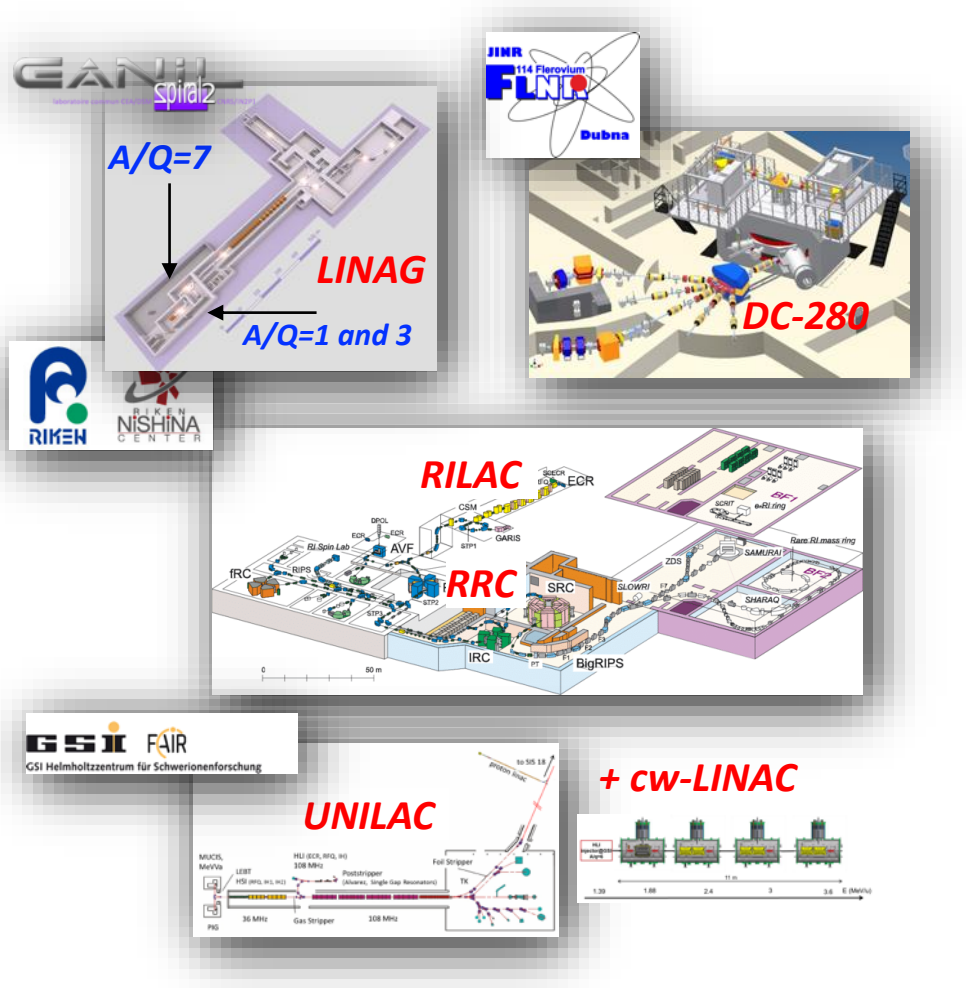
^{238}U	<<0.001	0.1	6

Measured | Estimated

* -> no estimation

A/Q=3 (existant): E<=14.5 MeV/A
A/Q=7 : E<=7 MeV/A

NEWGAIN Project - Scientific Goals



Comparison between different installations relevant to SHE studies

Beam intensities puA 100% enriched	SPIRAL2 GANIL, Caen		SHE factory FLNR, Dubna**	RIKEN Nishina Center Wako (Tokyo)		GSI Darmstadt
	LINAG A/q≤3 Phoenix v3	NEWGAIN* A/q≤7 SC source	DC-280	RILAC	RRC (RILAC(2) as injector)	UNILAC***
^{18}O	80	300	16	10	-	1
^{40}Ar	16	>38	10	10	1	8
^{36}S	23	>30	****	-	-	-
^{40}Ca	2.9	16	****	-	-	-
^{48}Ca	1.2	16	10	3	0.3	4
^{58}Ni	1.1	6.4	****	****	****	2.2
^{86}Kr	0.1	16	****	10	****	0.2
^{136}Xe	0.001	>10	16	10	0.3	1
^{238}U	<<0.001	4.8	0.008	0.2	0.5	0.06[i]

* 80% total transmission assumed
** http://flerovlab.jinr.ru/index.php/2017/03/23/she-factory/
*** for the cw-linac project with the assumption of a 50% total transmission, priv. comm. W. Barth et al., GSI
**** beams not delivered
i VARIS ion source, 80% Alvarez-transmission, mode: 2 Hz/0.1 ms, priv. com. W. Barth et al., GSI
\- intensities not provided

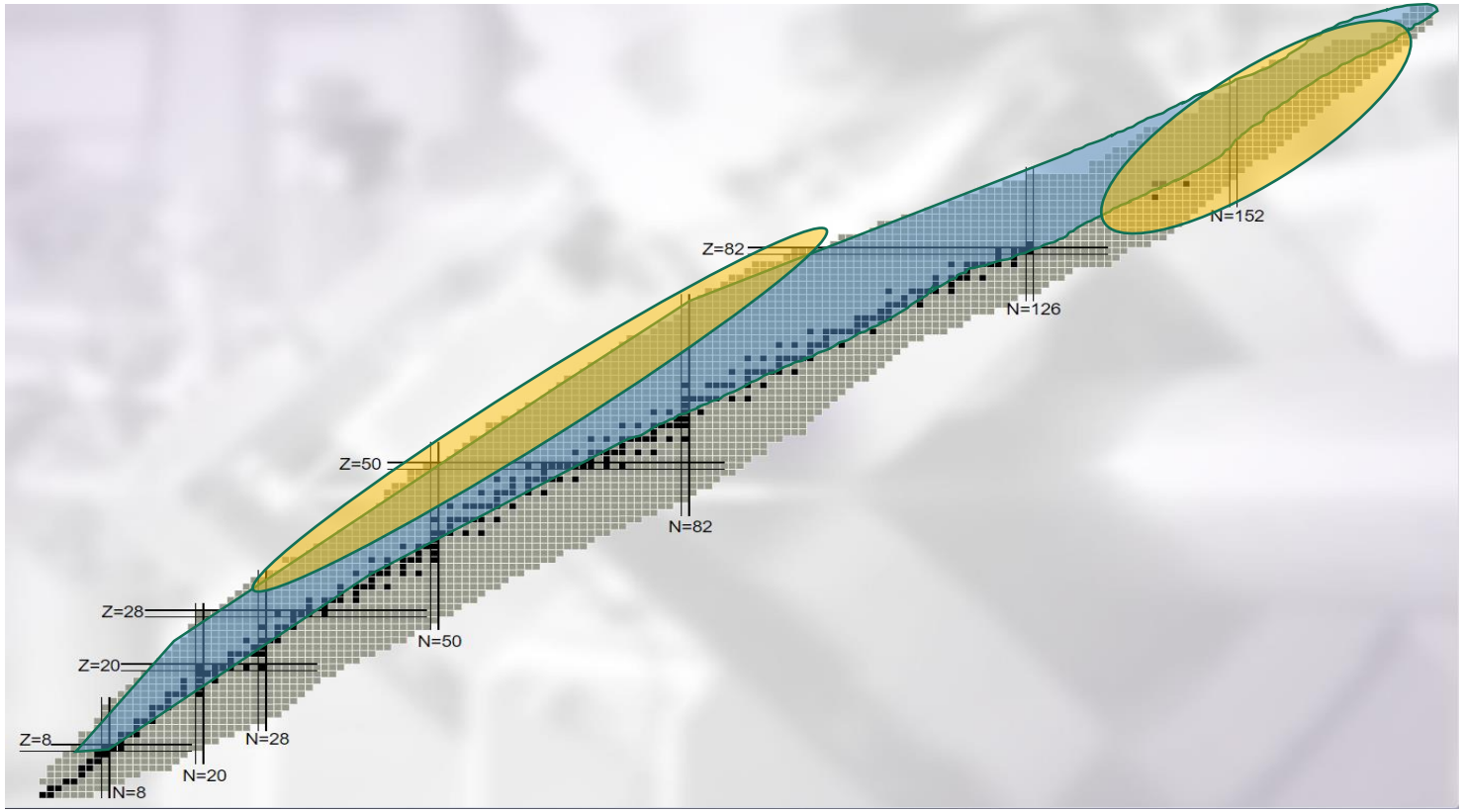
Highest intensity

Estimated in 2021

NEWGAIN Project - Scientific Goals: Opportunities

All this will be done using: S3, S3-LEB, DESIR

Fusion – evaporation: Neutron-deficient products



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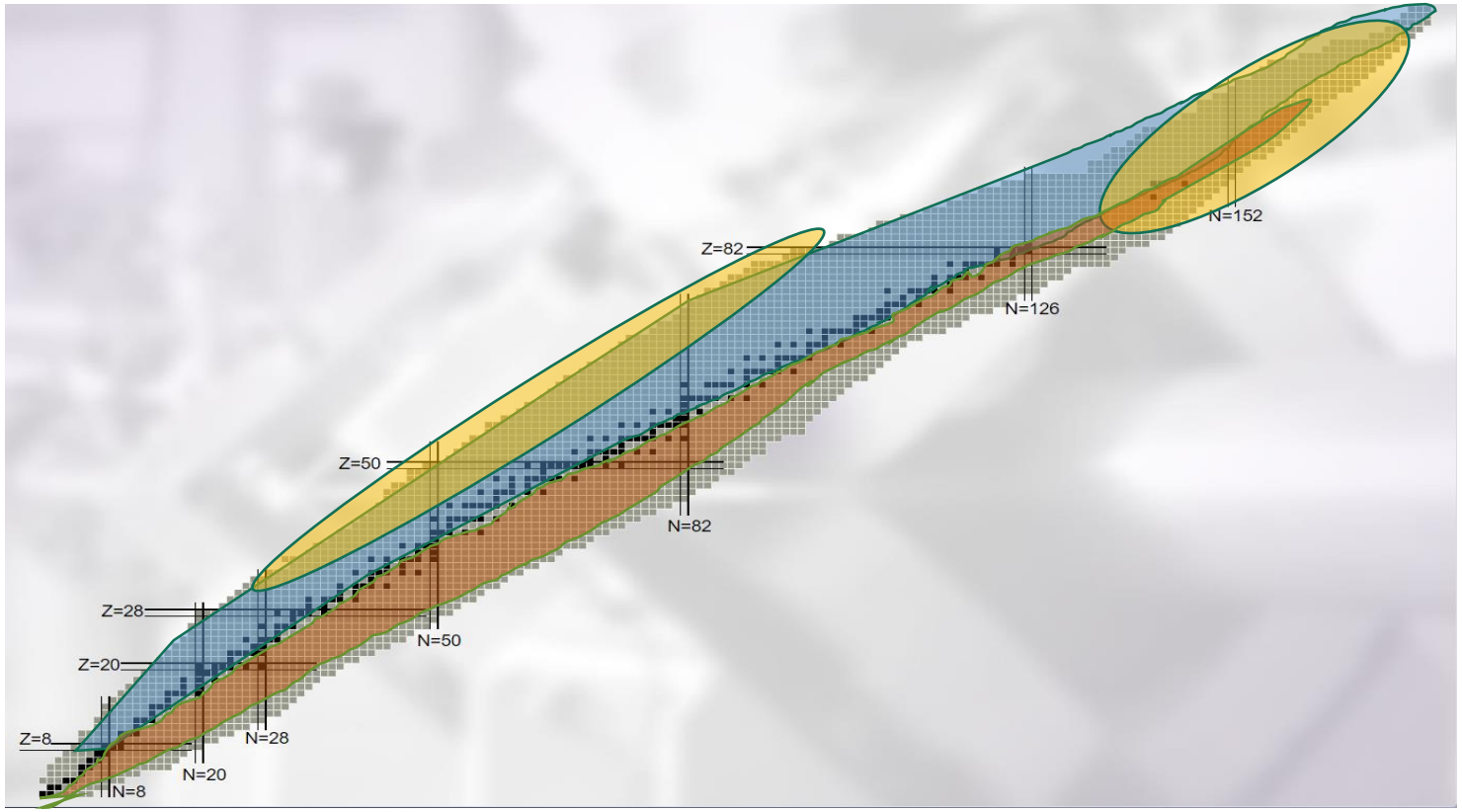

Opportunities

Multi-nucleon transfer + fusion-fission:

neutron-rich nuclei

- heavy beams (Pb, U)

-> incipient phase

-A new target-ion source based on multinucleon transfer reactions and fusion-fission reactions

-An electron-radioactive ion collider

-The reacceleration of radioactive ion beams, up to Fermi energies by a dedicated accelerator

Incipient phase!

Today in deep-inelastic -> max I aprox 50 pnA (JYFL, KEK)

KISS2 project (1 puA ^{238}U)

NEWGAIN Project - Scientific Goals: Summary

- **Opportunity to gain leadership position - S3, S3 LEB, DESIR**
  - **Neutron deficient nuclei (N=Z nuclei)**
  - **SHE studies**

  Constraints: S3 target -> 10 puA ^{70}Zn @5 MeV/A (18 puA ^{48}Ca)

- **Heavy beams: opportunity to develop a new physics program using: MNT, Fusion-fission & Fission-Evaporation in inverse kinematics** **(very) incipient phase**

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Not usable on existing installation (S3,NFS)

Crucial for S3, S3 LeB, DESIR (before 2030)

Will help define the future of GANIL/SPIRAL2

Gass cell
Solid target (Isoscele like)

END