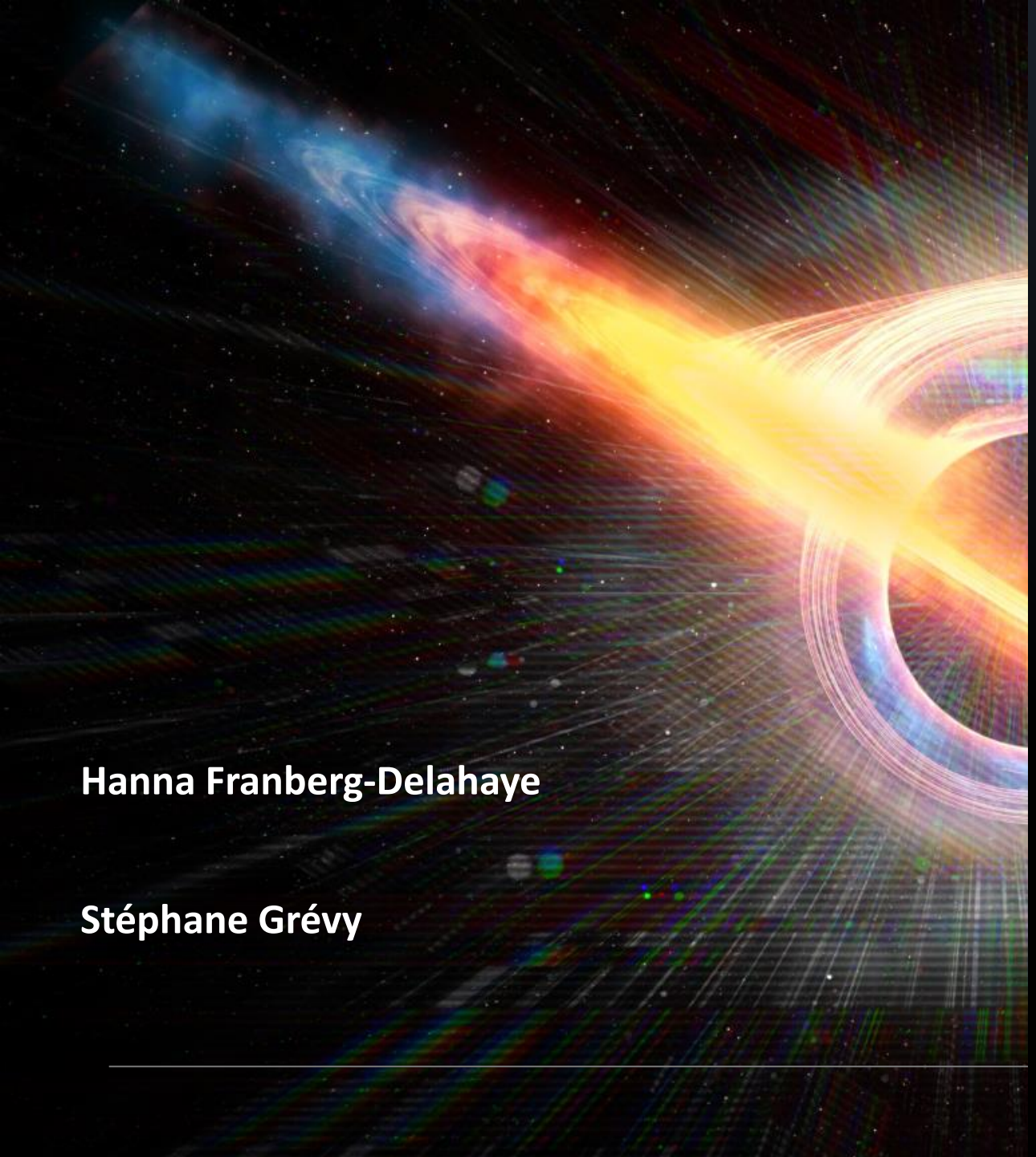


Ambition pour le futur du GANIL à long terme

Hanna Franberg-Delahaye

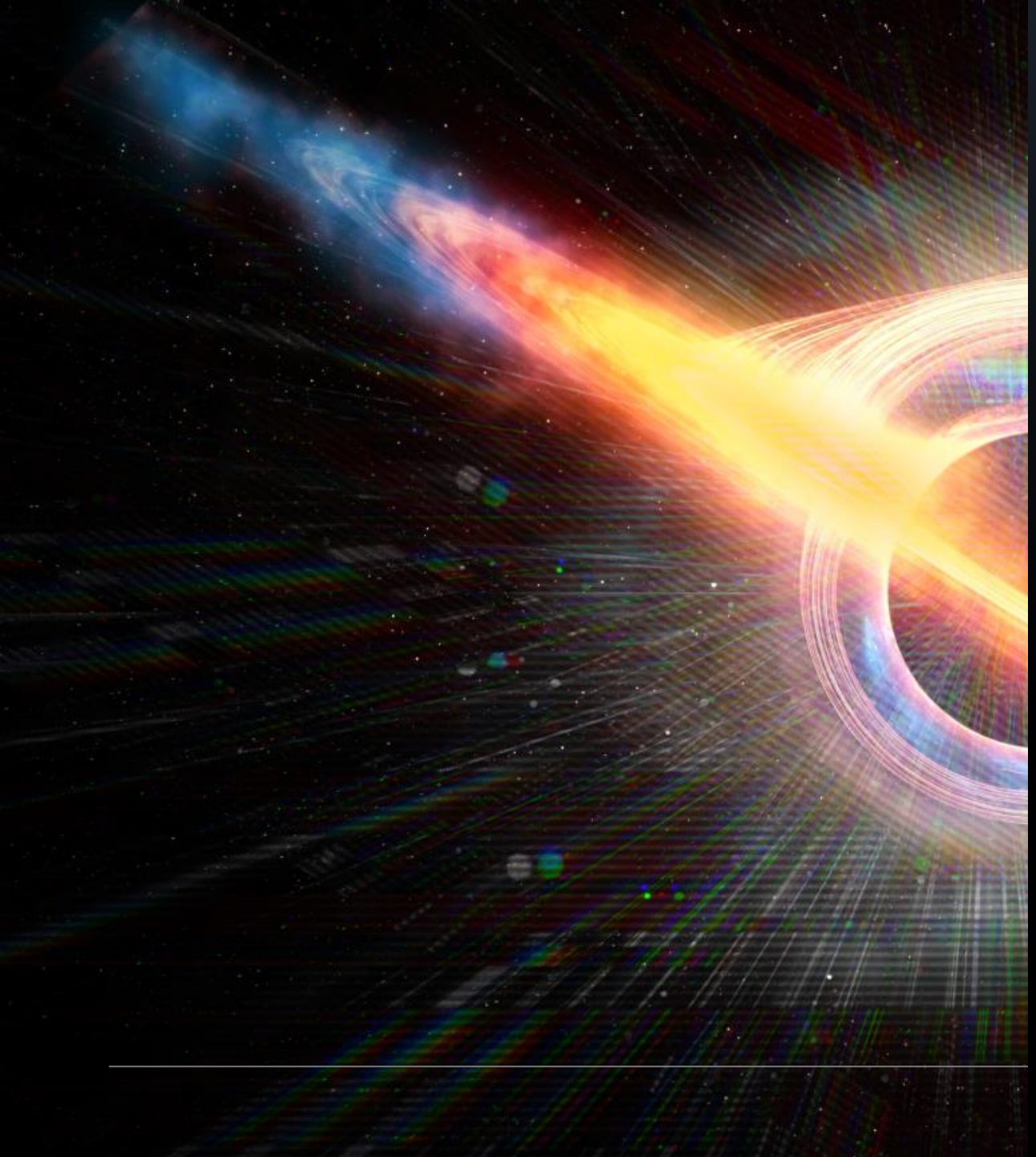
Stéphane Grévy

1- Evolutions of the GANIL infrastructure (and detectors) to allow a (r)evolution of the science

2- Which scientific prospective ?

3- From scientific prospective to new technical developments and infrastructures

4- “Avant Projet GANIL+” : towards new ambitions for GANIL

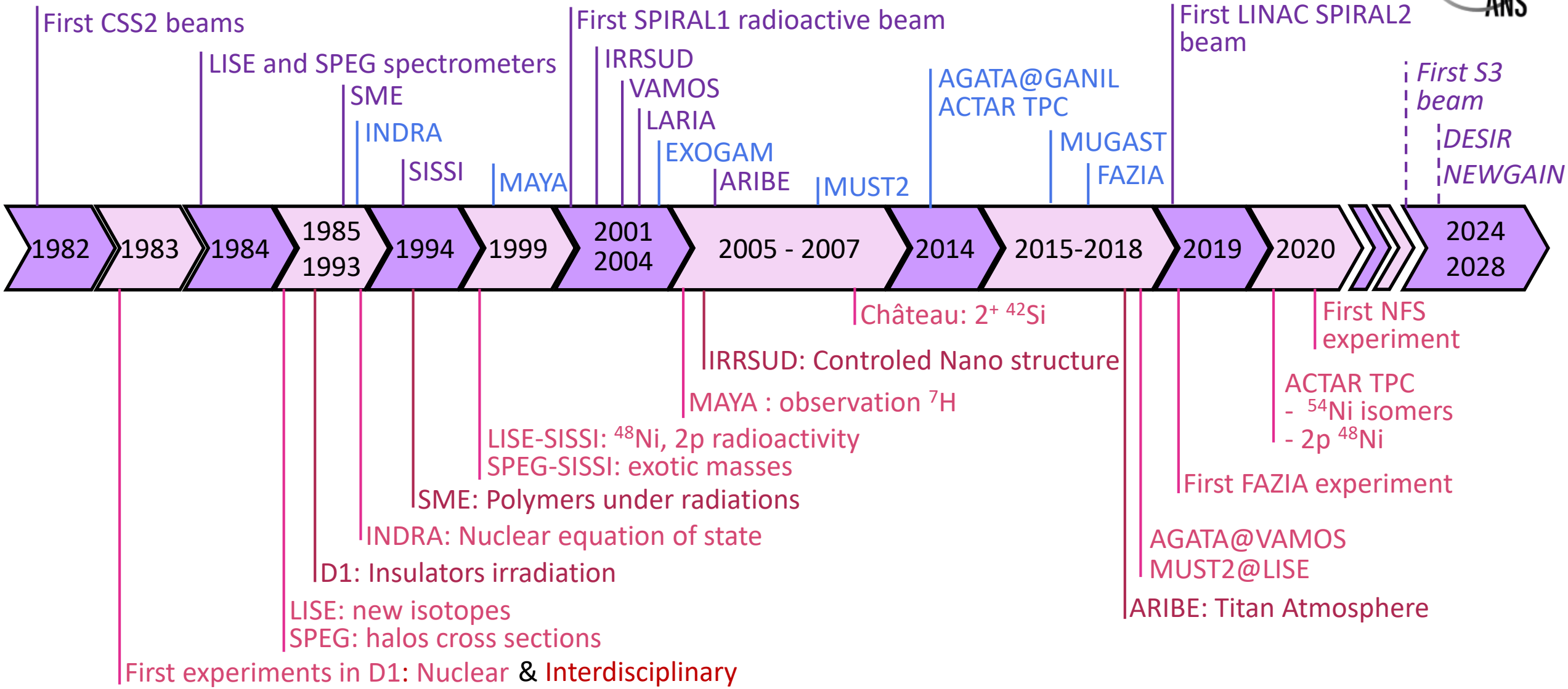


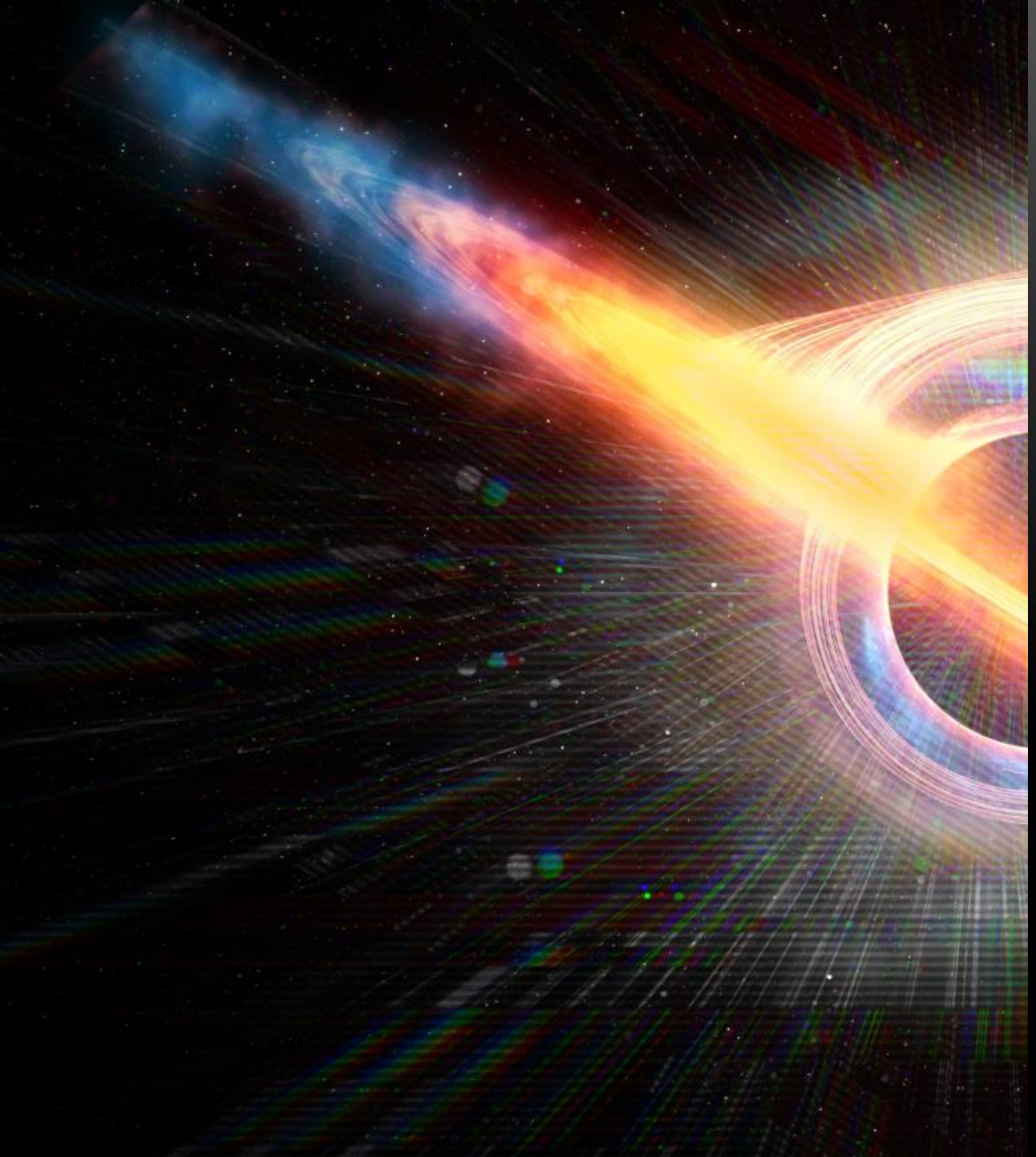
Ambition pour le futur du GANIL à long terme

1- Evolutions of the GANIL infrastructure (and detectors) to allow a (r)evolution of the science

GANIL

Evolutions of the GANIL infrastructure to allow a (r)evolution of the science





Ambition pour le futur du GANIL à long terme

2- Which scientific prospective ?

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Thinking about the future…

- The GANIL scientific community made several exercices to propose

  1995: SPIRAL1 white book → SPIRAL1

  2004: SPIRAL2 white book → Phase 1: LINAC, NFS, S3, DESIR…

  2009: « GANIL2015 » (Phase 2: production building for the fission fragments)

  2015: « GANIL2025 »

- The French scientific community also made several exercices of prospectives

  2012 : National scientific prospectives

  2019-2021 : National scientific prospectives

  - *call for contributions*
  - *organization of working groups to produce reports*
  - *town meeting in Caen to discuss the reports*
  - *definition of several Science Drivers for the nuclear physics*
  - *publication of recommendations to allow to tackle these SD*

- International Expert Committee on The Future of GANIL mandated by CEA and CNRS

  2020-2022 : « Mission SPIRO »

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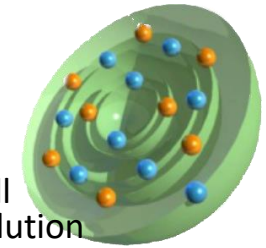
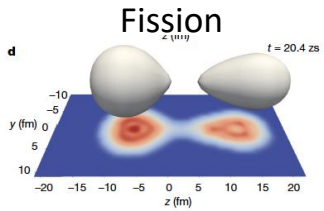
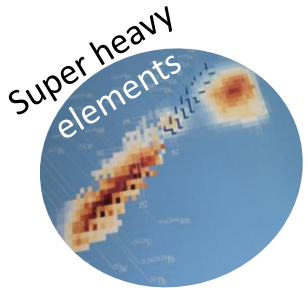
National scientific prospectives 2019-2021

→ Definition of 3 science drivers

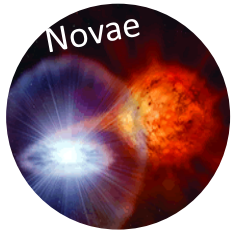
SD1 : How do nuclear systems evolve far from stability and in extreme conditions ?

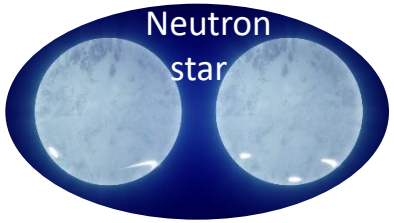




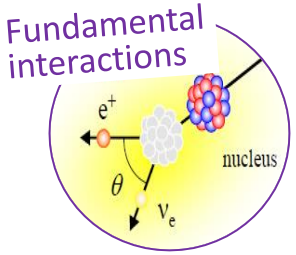


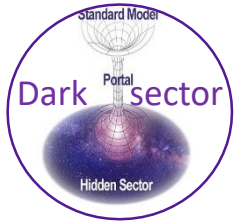
SD2 : How does nuclear physics allow a better understanding of the Universe?





SD3: How does nuclear physics contribute to the understanding of the Standard Model ?





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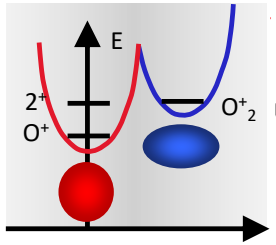
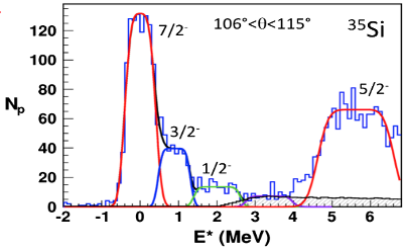
National scientific prospectives 2019-2021

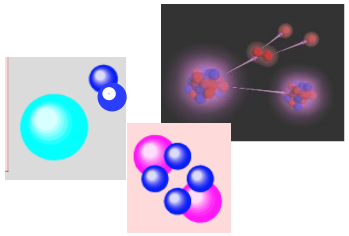
SD1: How do nuclear systems evolve far from stability and in extreme conditions ?

SD1.1: Understand and predict the evolution of shells, the competition between single-particle properties and collective behavior





SD1.2: Explore the properties of nuclear states near particle thresholds and drip-line phenomena



SD1.3: Understand the nuclear structure towards super-heavy elements

- FULIS campaigns… towards S3 physics

SD1.4: Enlarge systematics for the comprehension of fission process

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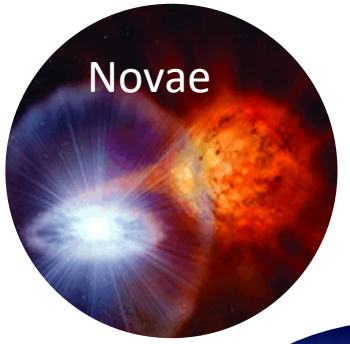
National scientific prospectives 2019-2021

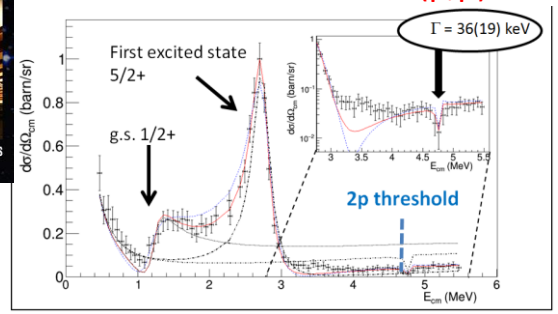
SD2 : How does nuclear physics allow a better understanding of the Universe?

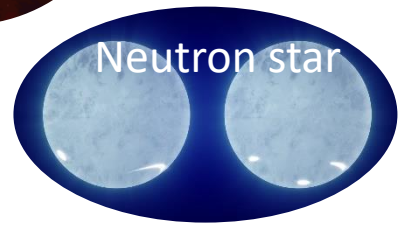


4 ANS

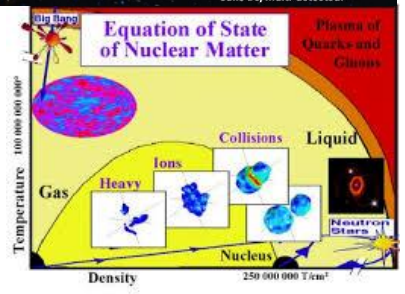
SD2.1 : Nuclear reactions for astrophysics

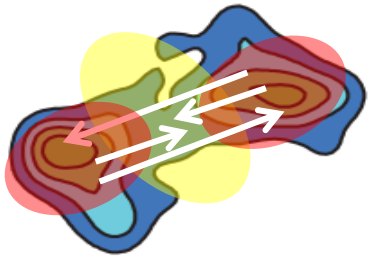
^{15}F studied with ^{14}O(p,p)^{14}O

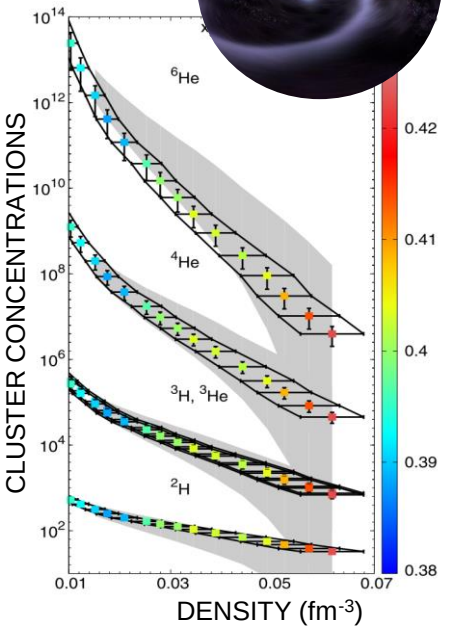




SD2.2 : Exploration of the phase diagram around saturation density through nuclear collisions







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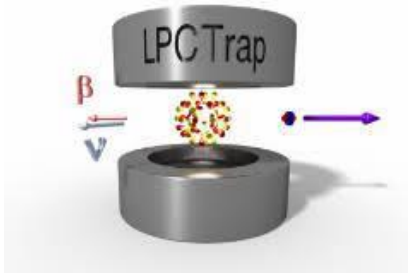
National scientific prospectives 2019-2021

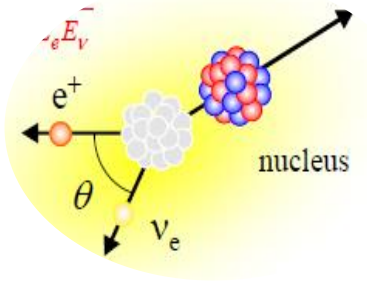
SD3: How does nuclear physics contribute to the understanding of the Standard Model?

Search for new physics beyond Standard Model through nuclear physics experiments

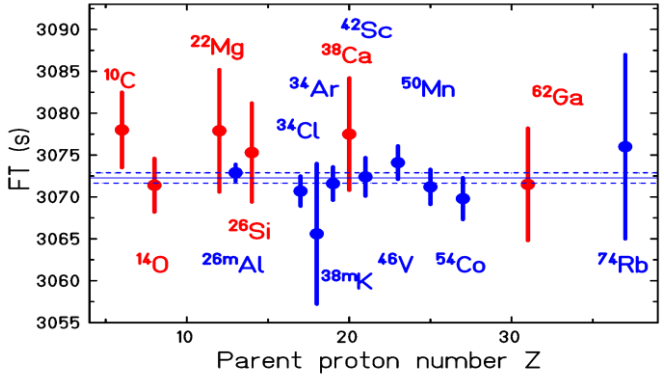
SD3.1 : At the high precision frontier

→ Exotic currents beyond *V-A* theory and CP-violation from beta decay measurements





→ CVC hypothesis, CKM unitarity from pure Fermi $0^+ \rightarrow 0^+$ transitions



SD3.2 : In rare nuclear transitions

Observation of Anomalous Internal Pair Creation in ^{8}Be

→ Creation and decay of X boson : mass ~ 17 MeV/c^2 ?

→ cross check measurement

→ other decays : ^{3}He, d …

→ Beta decays of ^{8}He with TETRA

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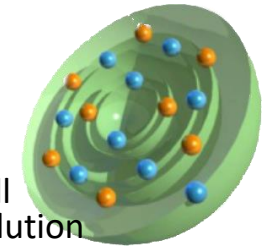
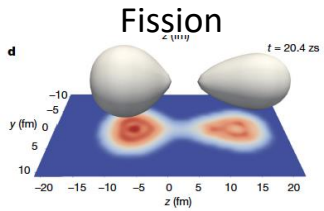
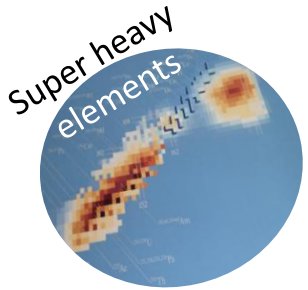
National scientific prospectives 2019-2021

→ Definition of 3 science drivers

SD1 : How do nuclear systems evolve far from stability and in extreme conditions ?







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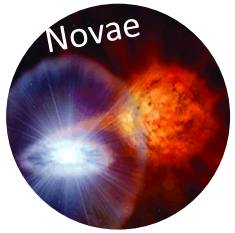

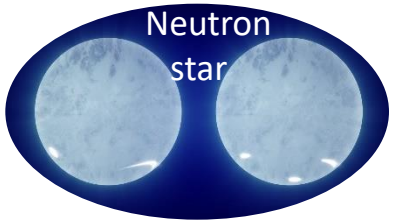

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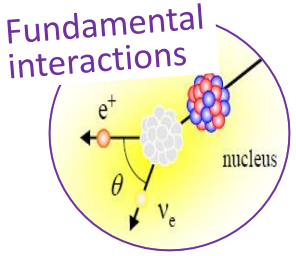

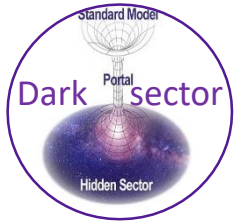

→ **The science drivers discussed during the prospectives strongly overlaps with the GANIL physics**

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National scientific prospectives 2019-2021

→ Definition of 3 science drivers

→ In order to tackle these sciences drivers, 3 main groups of recommendations have been expressed :

❑ *Develop the national facilities for nuclear physics* → ***"Mission SPIRO" for GANIL***

- ***complete the ongoing projects*** → ***recommendations 1-6***
- ***enlarge the GANIL capabilities*** → ***recommendation 7***
- ***engage the long term future*** → ***recommendation 8***

❑ *Develop high-resolution spectroscopic tools in international collaboration framework*

❑ *Re-inforce nuclear theory*

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National scientific prospectives 2019-2021

❑ *Develop the national facilities for nuclear physics*

1. Take advantage of the very high beam intensities delivered by SPIRAL2 LINAC to produce and select neutron-deficient reactions products (obtained from the fusion evaporation reactions).
   → S3 spectrometer

2. Perform advanced studies of exotic nuclei produced with S3 and deliver the products to DESIR.
   → S3-SIRIUS and S3-LEB

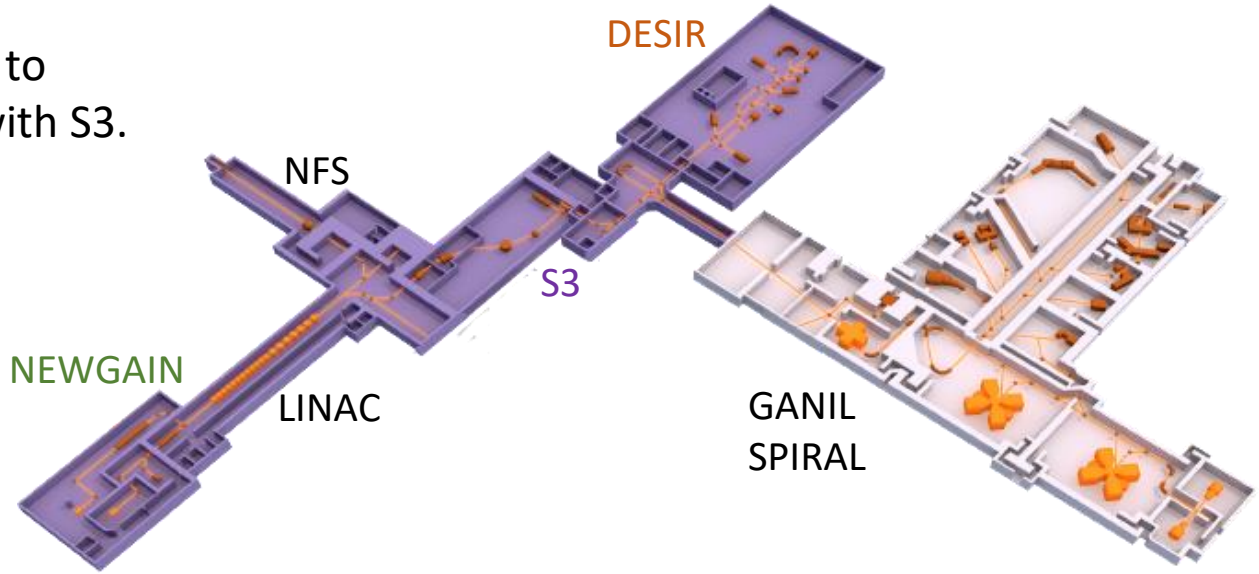
3. Study fundamental properties of exotic nuclei produced by SPIRAL1, S3 and the future fission fragment driver by means of precision experiments.
   → DESIR hall and equipments

4. Deliver some of the world best intensities for heavy ions up to Uranium to enhance the SPIRAL2 physics program related with S3.
   → NEWGAIN: New injector A/Q=7

5. Sustain the physics program of the community and enlarge it. → Increase the capabilities of the national facilities by
   a) increasing beam time at GANIL
   b) increasing variety of SPIRAL1 beams.

6. Develop the S3 physics program.
   → Increase the target developments capabilities

All these recommendations have been considered in the conclusions of the mission SPIRO



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National scientific prospectives 2019-2021

❑ *Develop the national facilities for nuclear physics*

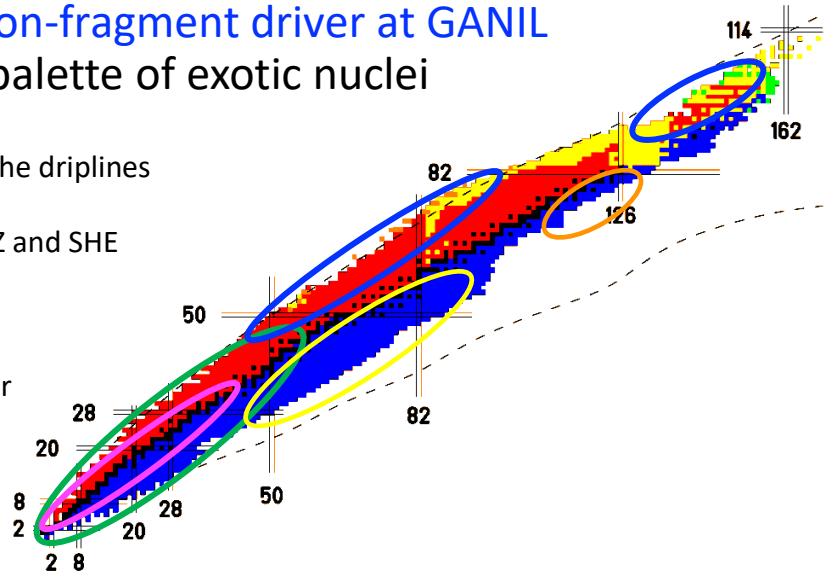
7. Deliver neutron-rich ions for SPIRAL2 physics program.

→ A dedicated fission-fragment driver at GANIL

- To enlarge the palette of exotic nuclei

LISE: light-medium at the driplines
SPIRAL1: light-medium
S3: medium-heavy N=Z and SHE

fission fragments
Multi Nucléons Transfer



8. Engage the long-term future of GANIL.

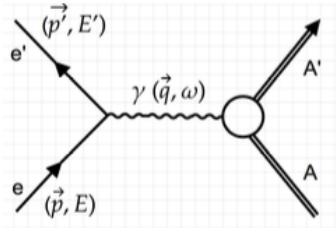
→ develop in-beam studies capabilities: post-acceleration to ~100 MeV/u

- Access to a large domain of reactions to study nuclear structure
  Coulex, transfer, pick up and stripping, giant resonances
- Study the equation of state of nuclear matter within the isospin

Great Num

→ studies towards an electron-Radioactive Ions collider

- Develop a new tool to perform tomography of exotic nuclei



4 ANS

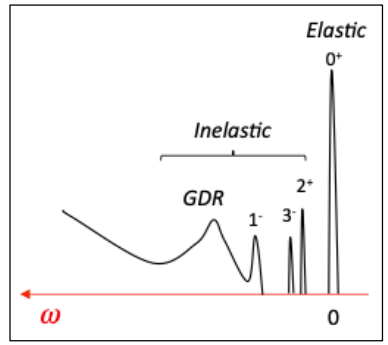
EM interaction is well known and weak
→ e- penetrate deeply without absorption
→ good theoretical description

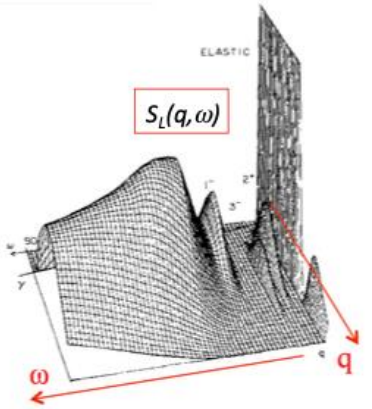
Integrated quantities

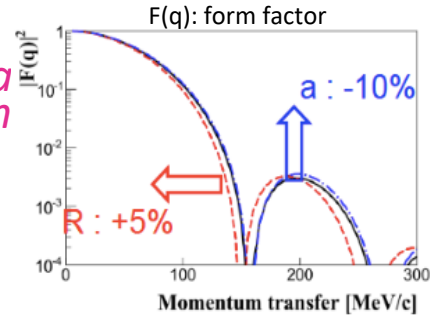
e⁻ scattering

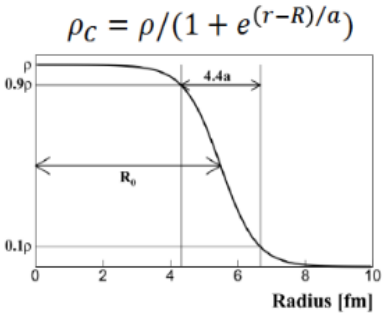
microscope

Spatially dependant quantities









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National scientific prospectives 2019-2021

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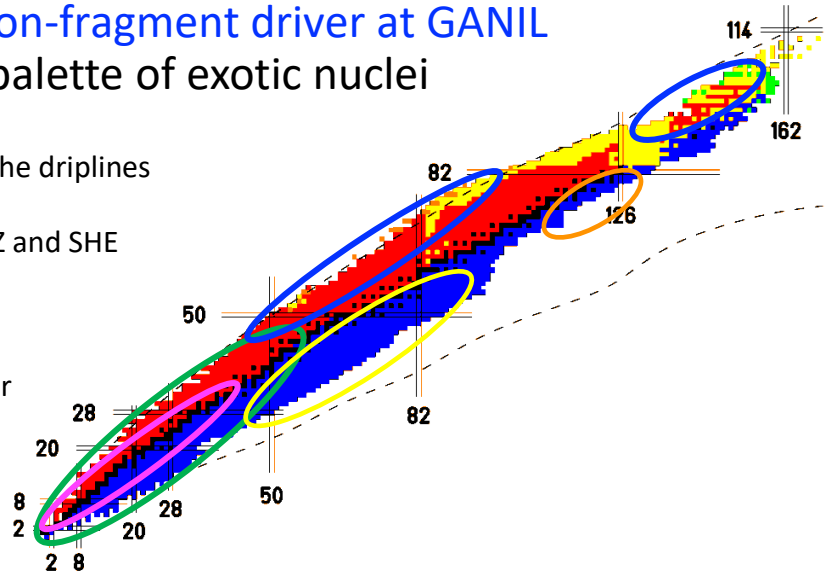

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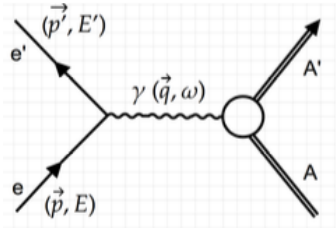

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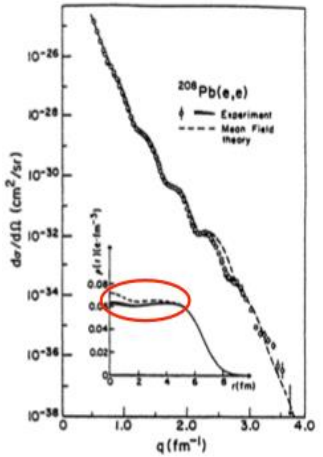
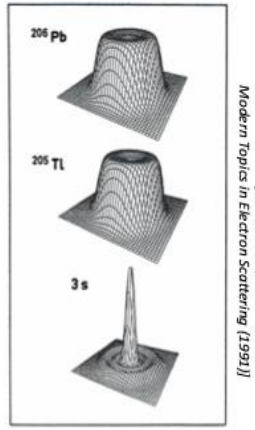


B. Frois and Papanicolas
Ann. Rev. Nucl. Part. Sci 37 (1987)

Dechargé and Gogny
PRC 81 (1980)

Cavedon, Frois, Goutte et al.
PRL 49 (1982)

etc...



[B. Frois et al., Modern Topics in Electron Scattering (1991)]

→ ground state density distributions

→ radii

→ transition densities to excited states

→ nuclear strength functions