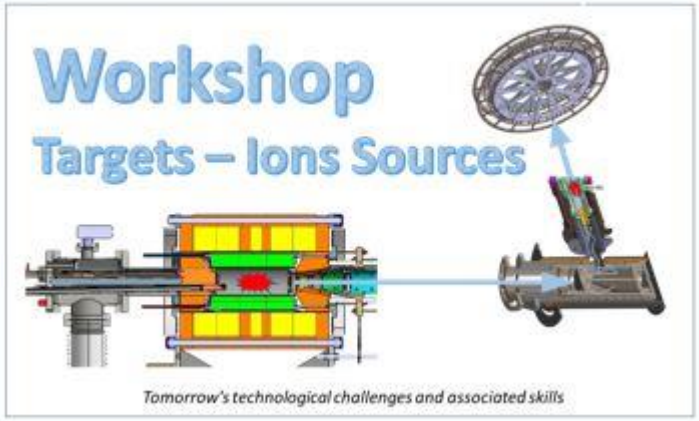

Target - ion source systems: introduction

P. Delahaye

Isotope Separation On Line technique

1951: Seminal experiment at Copenhagen

- Niels Bohr Institute: O. Kofoed – Hansen and K. Ove Nielsen
- d@11 MeV on a **Be converter** with **10 kg of UO2** (!)

The NBI isotope separator in 1951. The elements are the **high voltage terminal** and **ion source** (top), the **analyzing magnet** (behind), and the dispersion chamber with the collector slit used in the experiment (in front).

The NBI cyclotron around the time of the experiment. The person is the head of the cyclotron group, Prof. J. C. Jackobsen.

P. G. Hansen, Nuclear Physics News 11, n°4

Recoil energy spectrum to look for an evidence for the neutrino in neutron rich Kr nuclei

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Recoil energy spectrum to look for an evidence for the neutrino in neutron rich Kr nuclei

- A primary beam impinges on a thick target or a converter (light particle →n/γ)
- Reaction products diffuse from the bulk of the target material and effuse towards the ion source
- After ionization and electrostatic acceleration isotopes are separated by a magnetic dipole

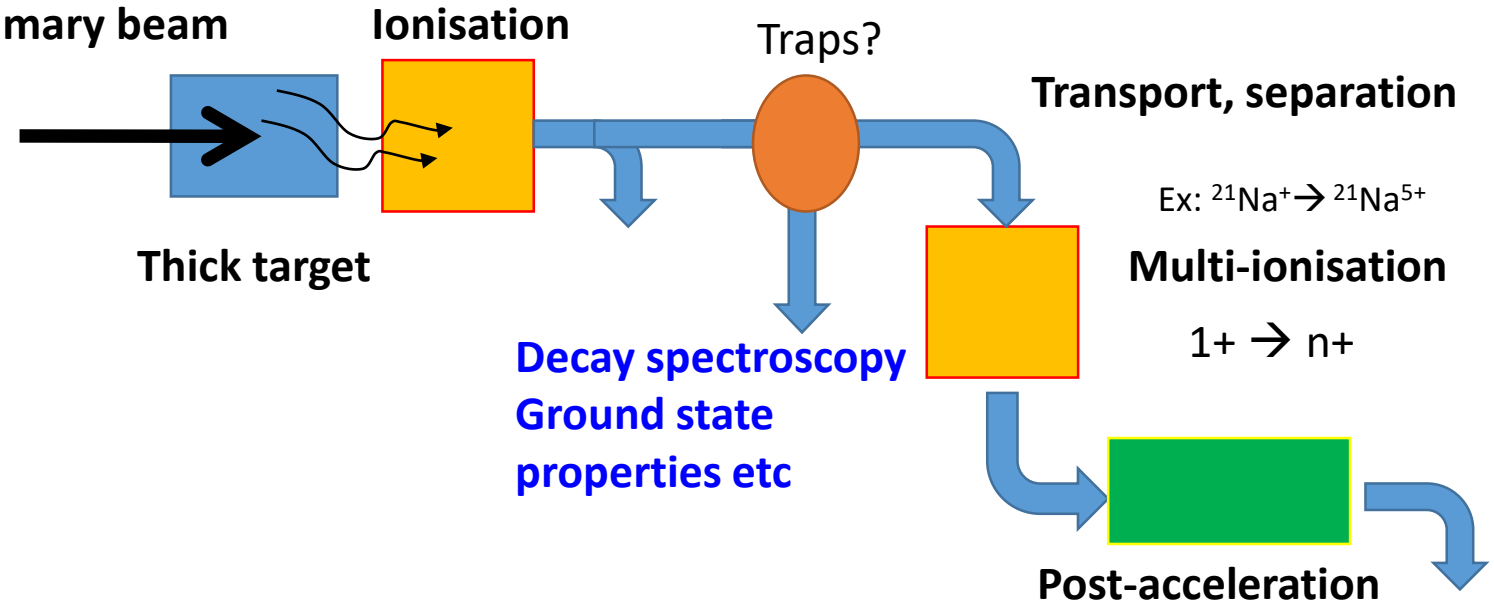
ISOL beam production

ISOLDE, TRIUMF, SPIRAL 1, ALTO…

Target – ion source system: the beating heart of the ISOL production technique

Ex: 1.5 kW ^{36}Ar @ 95AMeV (GANIL)
1.4-2GeV p (ISOLDE)

Ex: $^{21}Na \rightarrow {}^{21}Na^{+}$



At IN2P3:

Master projet « Ion Radioactifs »

- Targets
- Ionisation
- Transport
- Charge breeding

Optimizing processes

- Rapidity ($T_{1/2}$ down to a few ms)
- Efficiency
- Selectivity for beam purity

ISOL technique: what for?

When compared to in-flight (GSI, FRIB, RIKEN…) technique:

- Less exotic isotopes
  - Intensity strongly depend on chemistry and half-lifes ($T_{1/2}$>ms)
- **More intense** beams are possible (>pnA is possible)
- With higher beam **purity** and **optical quality**

Since the 1970s, a **rich universe of low-energy experiments** has developed

- See ISOLDE ecosystem,
- Tools: Ion coolers and traps with sub-eV beams, lasers, tape stations, associated detection
- Experiments: decay spectroscopy, mass measurements, laser spectroscopy, fundamental tests of the SM, solid state experiments, medical isotopes…

Since 2000's **reaccelerated beams** have opened new perspectives

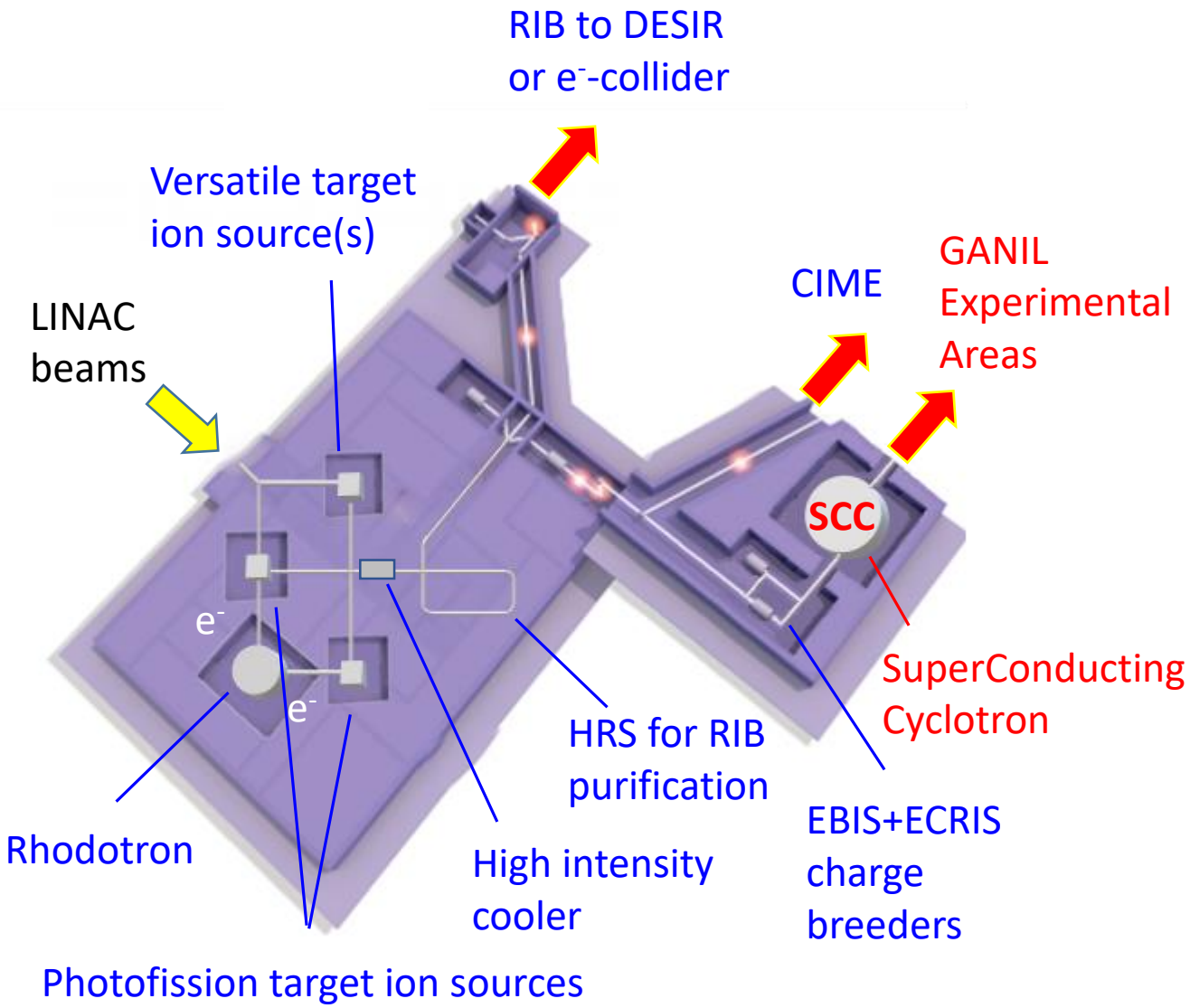
- Tools: charge breeders, post-accelerators, **GANIL spectrometers**, ad-hoc detection
- Experiments: Coulomb excitation, elastic/inelastic scattering, fusion, transfer & MNT, … for nuclear structure, reactions and nuclear astrophysics

ISOL physics overview at GANIL-SPIRAL2

Type of beams	Past 10 y	Present	<10 y	>10y
Target ion source	SPIRAL 1 TISS	**SPIRAL 1 upgrade** TISS Includes **FEBIAD** beams	SPIRAL 1 upgrade TISS Includes **FEBIAD** and **TULIP**	SPIRAL 1 upgrade TISS **TISS for photofission?** **Versatile TISS?** in new production building?
Low energy experiments	LIRAT: LPC Trap, $T_{1/2}$ for fundamental tests with light gaseous beams (He, Ne, Ar)	Sporadically some fundamental tests at LIRAT / IBE Mostly $^{6-8}$He	**DESIR** for fundamental tests + S3-LEB (gas cell, ie no TISS)	**Neutron – rich nuclei at DESIR**
Reaccelerated beams	Nuclear structure and reactions with light gaseous beams (mostly He, O, F, Ne, Ar) ^{38m}K for EXOGAM - 2019	**MUGAST + EXOGAM and ACTAR** Includes new beams from SPIRAL 1 upgrade inititated: ^{47}K in 2021 AGATA@VAMOS ^{8}Li, ^{48}Cr for 2024	Continued program with MUGAST(GRIT)/ EXOGAM, and ACTAR **More beams for AGATA to come back?**	New transfer and EOS studies with **100 MeV/n reaccelerator**?

Recall presentations of Marlène, Stéphane and Iulian

Future project at GANIL - after « comité SPIRO »



A new production building for 2 ambitious facilities complementing GANIL

- a reaccelerator to >50 AMeV
- an electron- RIB collider

See presentation of Stéphane

R&D overview in IN2P3

What's coming in the next presentations?

- 2 facilities: GANIL-SPIRAL2 and ALTO @IJCLab

ALTO:

- World-wide known as the pioneer facility for photo-fission
- Prepares the future of GANIL: DESIR and neutron rich nuclei

R&D overview in IN2P3… and beyond

What's coming in the next presentations?

As part of the Master projet « Ions Radioactifs »

- Targets:
  - UCx and STUC project @ ALTO – Julien Guillot
    - see presentation of Matthieu Lebois
  - Other targets @ SPIRAL 1 (part of TULIP project) – see presentation of Pascal Jardin
- Ion sources
  - Laser ion sources @ ALTO– François Leblanc
    - See presentation of Enrique
  - New beams from FEBIAD sources @ SPIRAL 1 – see presentation of Pierre Chauveau
  - Nier Bernas source for MNTs @ ALTO – Maher Cheikh Mhamed
    - Discussed as part of Iulian's presentation, emerging topic of research

In the most famous ISOL facility

- Target and ion source production and R&D at ISOLDE
  - See presentation of Sebastian Rothe

Thanks a lot for your attention

… Enjoy the presentations!