Production of radioactive ion beams and light exotic nuclei study at ACCULINNA-2 separator

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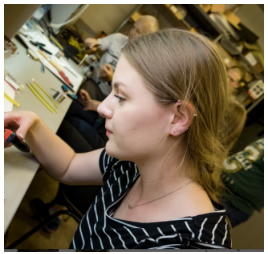
03.08.2018

Outline

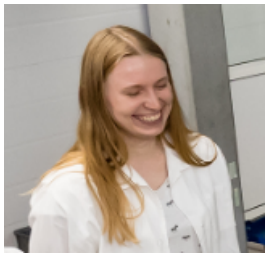
Our Team



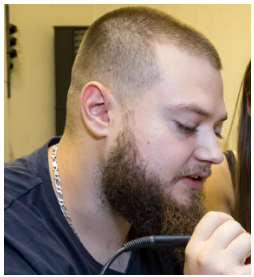
(a) Klepacka Marta PUT

(b) Górkiewicz Michał AGH

(c) Lisowska Marta PWr



(d) Abramuk Anna UW



(e) Karpowicz Paweł UW - Minor Advisor

(f) dr Kamiński Grzegorz - Supervisor

The purpose of the project

- Gaining knowledge about production of the radioactive ion beams, the structure of ACCULINNA and ACCULINNA-2 separators, drawing a comparison between the experimental data and the simulation in LISE++ software
- Practice at FLNR (Flerov Laboratory of Nuclear Reactions) JINR, Dubna
- Work under supervision of Grzegorz Kaminski

The area of ACCULINNA's research

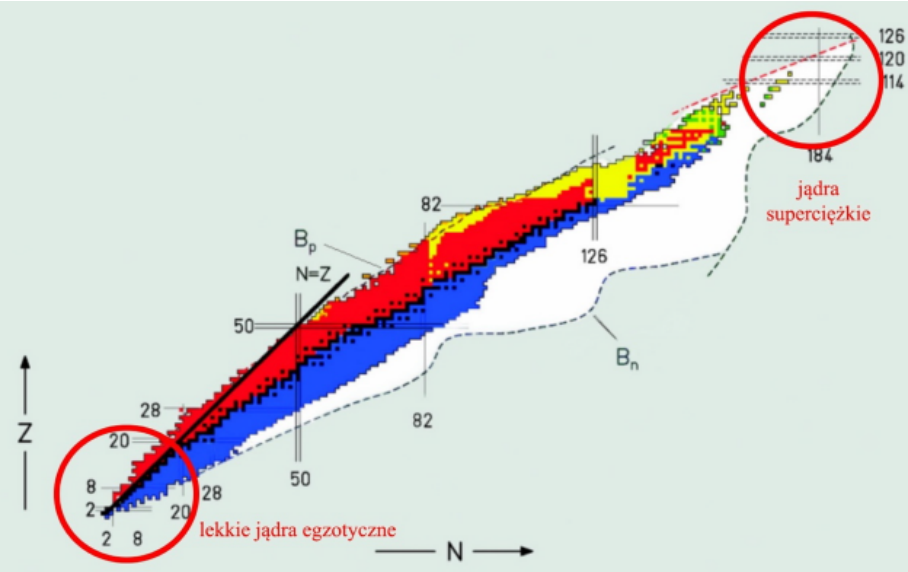
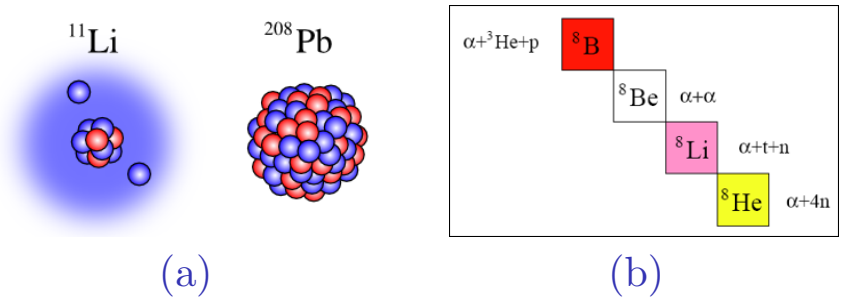


Figure 2: The area of research at FLNR. [3]

Exotic nuclei phenomenas

- Cluster structure of nuclei
- 2p decay
- Nuclear halo



(a) (b)

Figure 3: Example of exotic nuclei phenomenas [1]

How can we produce a radioactive ion beam?

In-Flight Separation

- Fragmentation of a beam of **heavy ions** projectiles collided with a **light target**.
- The biggest advantage is the possibility of undoubted identification of ions in flight, independence from a chemical form and a short time of separation, which enables the recording of a short-lived nucleus.

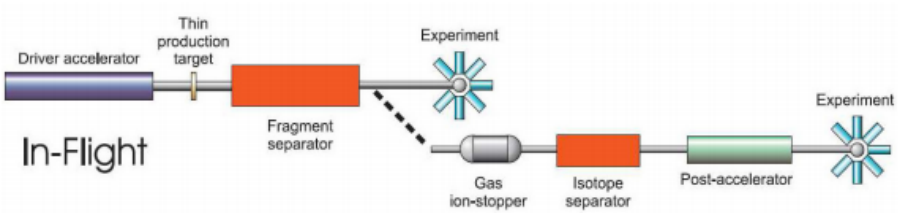


Figure 4: Main stages of In-Flight separation technique.[1]

ACCULINNA

The production of Radioactive Ion Beams and the separation of the produced isotopes (in-flight separator).

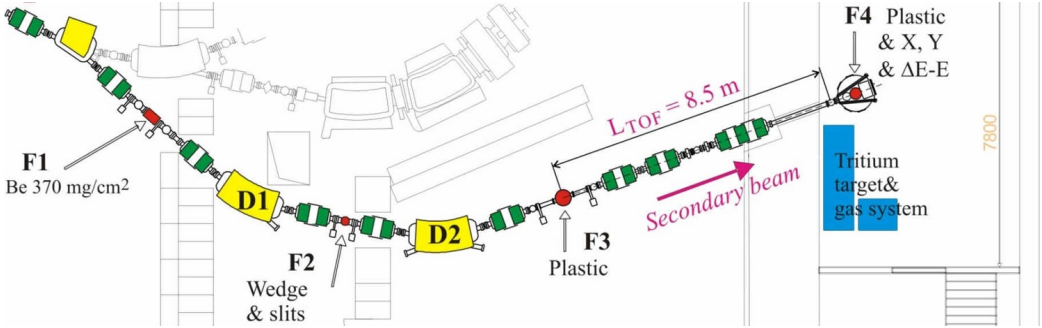


Figure 5: The scheme of ACCULINNA. [2]

- Stable beams transportation from cyclotron U - 400M (^{11}B, ^{15}N etc. with the energy of the beam in a range 32–50MeV/u) by nuclear reactions transforms to RIB beams up to ^{26}S

ACCULINNA-2 THE ENTRANCE TO 21th CENTURY AND NEW POSSIBILITIES

Why ACCULINNA-2 is better than ACCULINNA?

- The intensity of RIB is 15 times bigger (up to 10^{12-13} pps)
- Higher clarity of the RIB
- New separator widens the range of light detectable isotopes, which were inaccessible for ACCULINNA (around the proton drip line and beyond)
- The energy of the initial beam in a range 30 - 60 MeV/n, $3 \leq Z \leq 6$

ACCULINNA-2

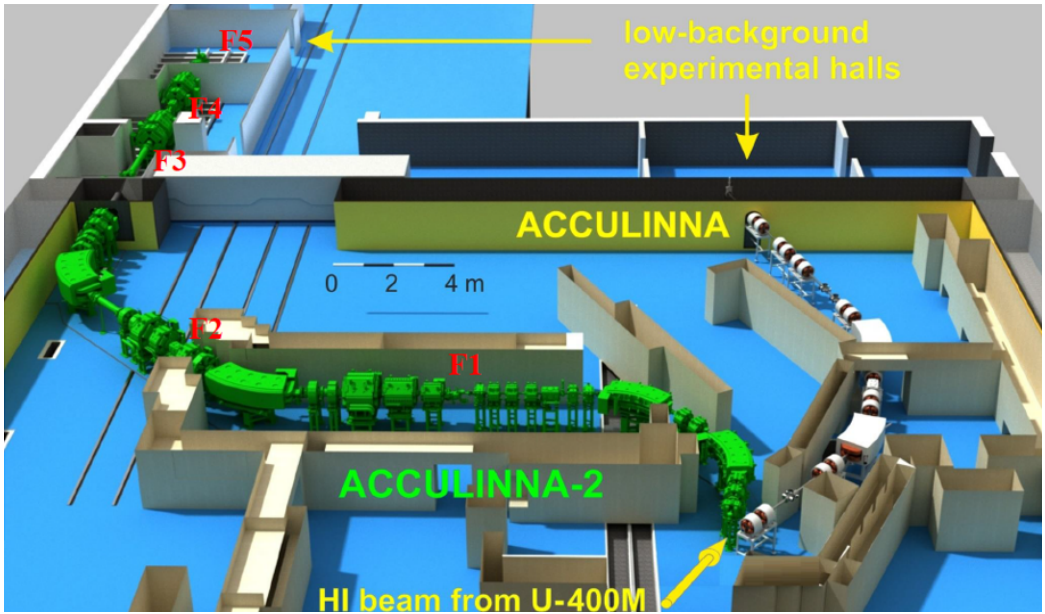


Figure 6: The 3-D scheme of ACCULINNA-2. [2]

The beam went through ACCULINNA or ACCULINNA-2 and what next?

Raw data

We have something, but we don't know exactly if the separation was successful?

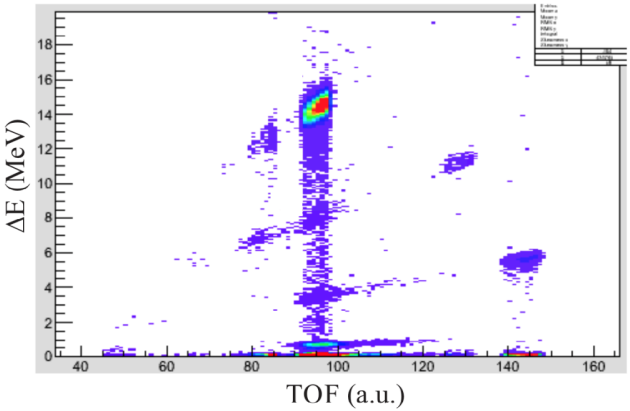


Figure 7: Example of a isotopes spectrum from experiment.

Raw data → LISE++

- The program for carrying out the simulations of experiments with ACCULINNA and other separators.

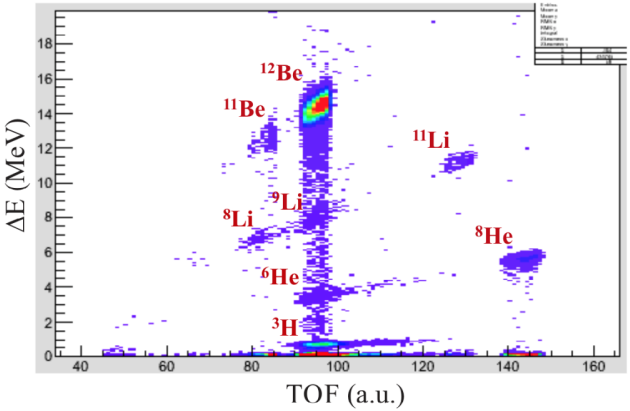


Figure 8: Identification of produced isotopes by Time Of Flight.

$$\mathrm{TOF} \sim \frac{A}{q}$$

Raw data → LISE++

- Identification isn't always so easy.

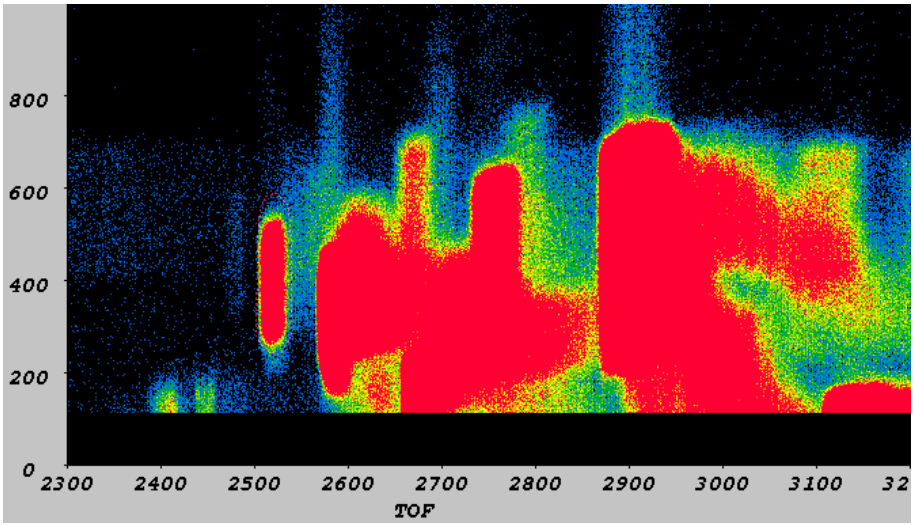
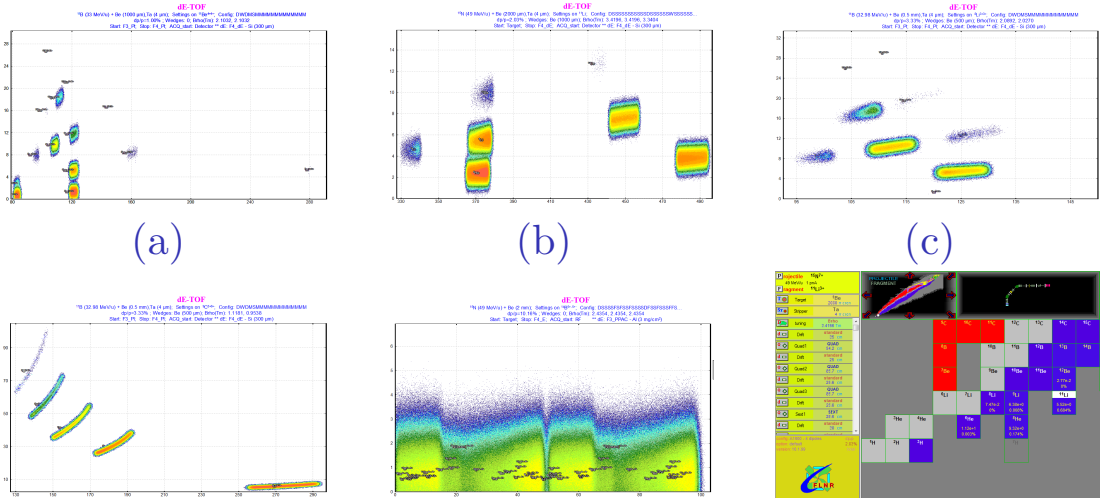


Figure 9: Example of a isotopes spectrum from experiment.

LISE++

LISE++ is a very useful software for experimental physicists.



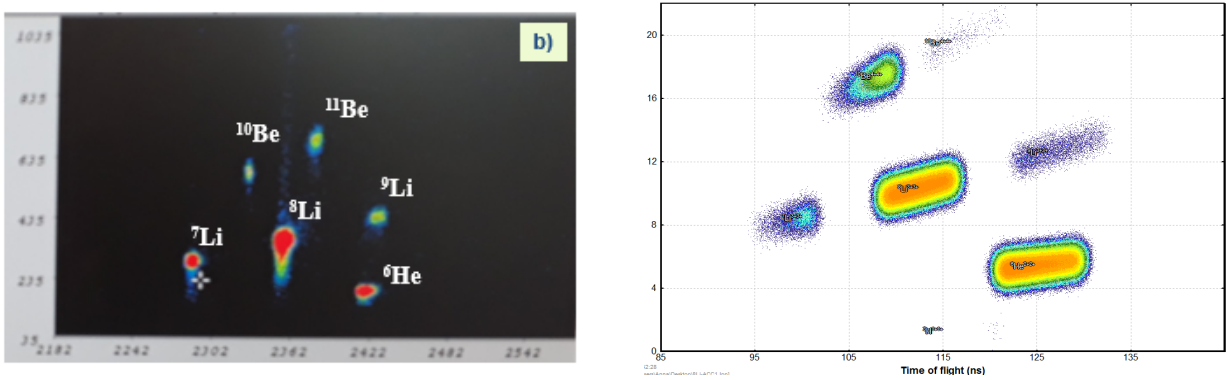
(a) (b) (c)

(d) (e) (f)

Figure 10: Examples of spectrums from LISE++ software.

The comparison

^{8}Li from ^{11}B(33 MeV/n) + Be (0.5 mm)



(a) Data from the experiment. (b) LISE++ simulation.

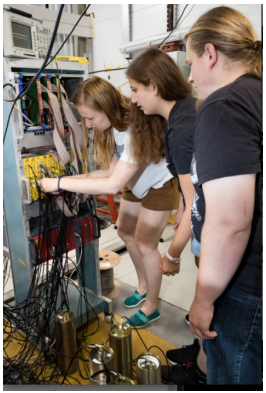
Figure 11: The spectrum the loss of energy versus the time of flight. [2]

Bibliography

[1] G. Kamiński, Analysis of production mechanisms of forward emitted fragments with 2 Z 12 in nucleus-nucleus collisions in the Fermi energy domain, IFJ PAN Kraków, 2012
[2] G. Kamiński, First beams at the new RIBs facility at Dubna, Presentation at LASNPA and WONP-NURT, 2017
[3] A.Świercz, Study of the structure of light nuclei using the ACCULINNA-2 separator

Additional activities during the practice

- plugging in cabels to see if a neutron detector works
- listening about the experiment, which was carried out last year in the laboratory
- familiarizing with a turbomolecular vacuum pump



(a)

(b)

(c)

- preparing and soldering of cabels
- sightseeing in the laboratory
- preparing a system of stabilization for the device, which includes vacuum pumps etc.

(d)

(e)

Backstage

Thank for your attention
And see you next year!