NEUTRON FLUX ESTIMATION IN THE SPALATION EXPERIMENT AT THE PNPI SYNCHROTRON

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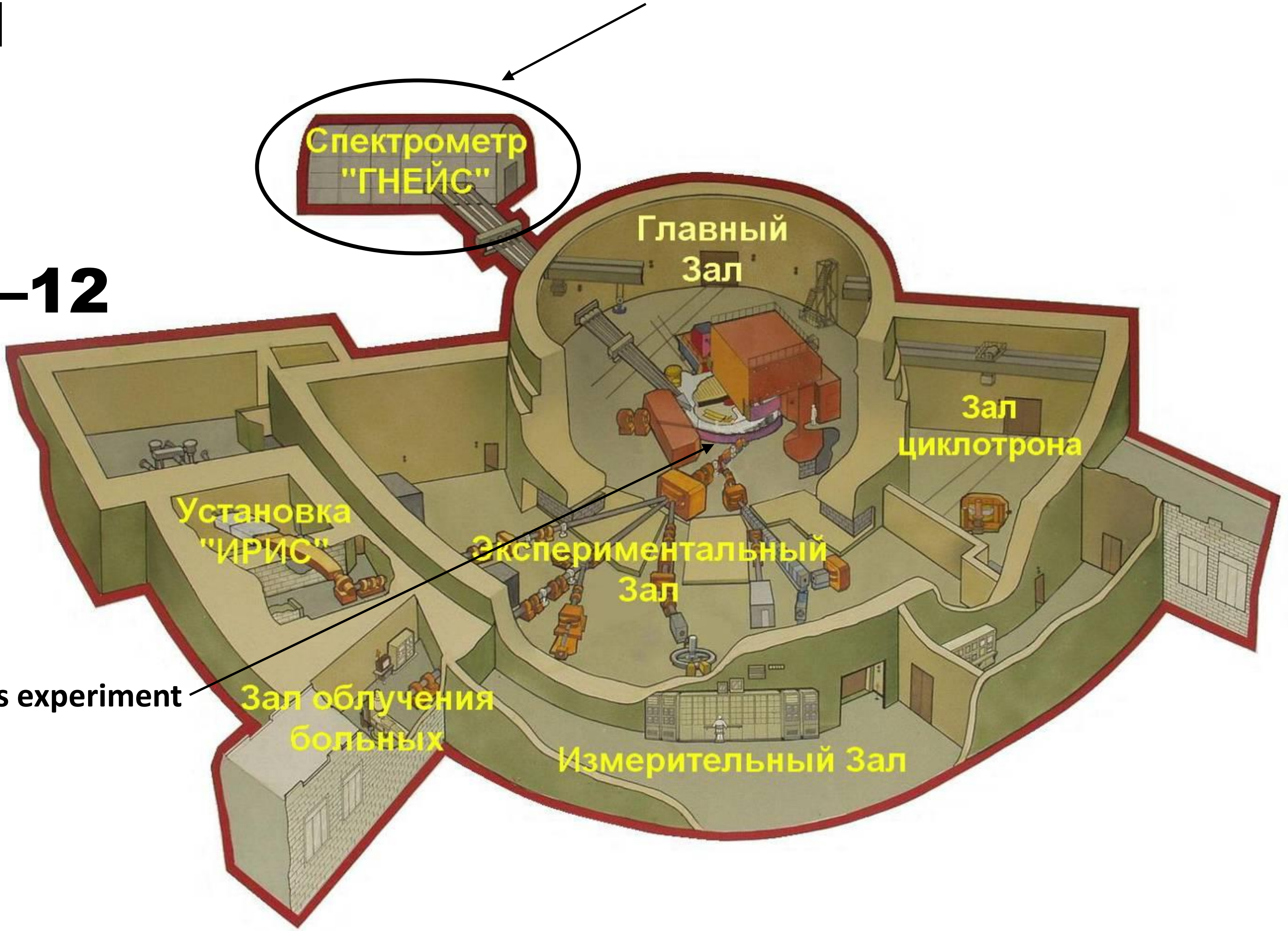
Michal Listengarten. 100 years since the birth.

Figure from Russian journal Devices and Technic of the Experiment A, 2010, № 4, p. 5–12

N.K. Abrosimov, O. A. Shcherbakov, A. S. Vorobyev, A. M. Gagarski, end etc.

NEUTRON TIME-OF-FLIGHT SPECTROMETER GNEIS



place of this experiment

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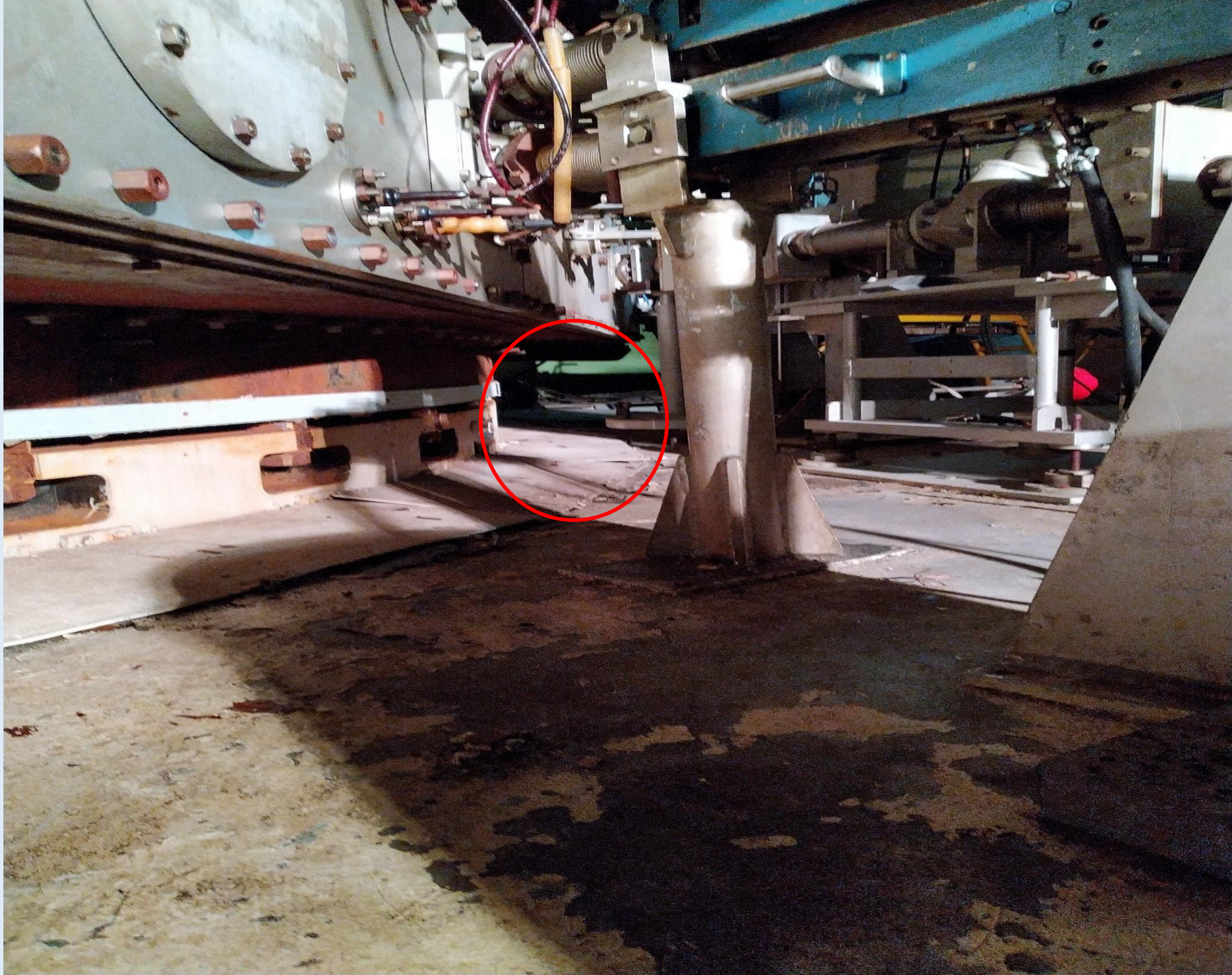
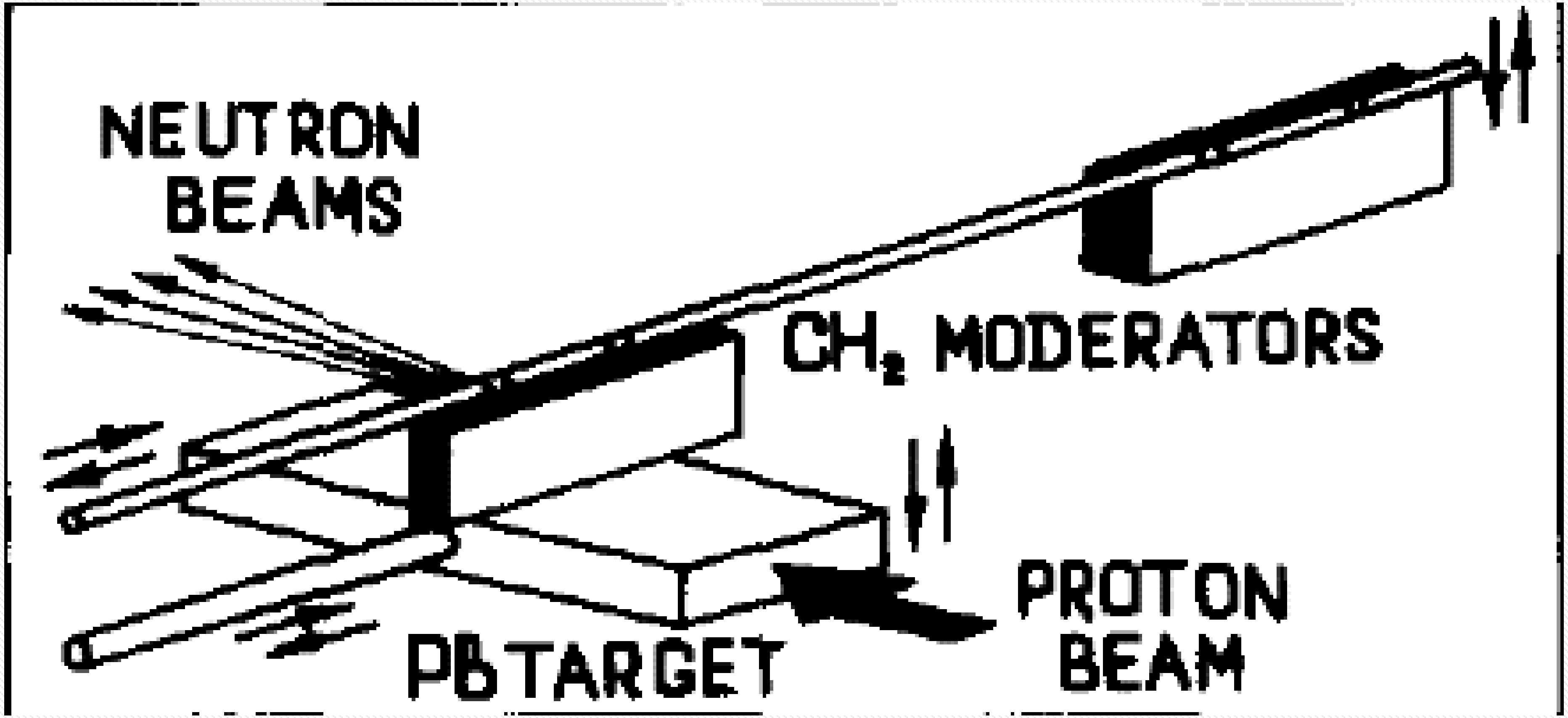


Spallation

Nuclear Instruments and Methods in Physics Research A242 (1985) 121-133
N.K. ABROSIMOV, etc.

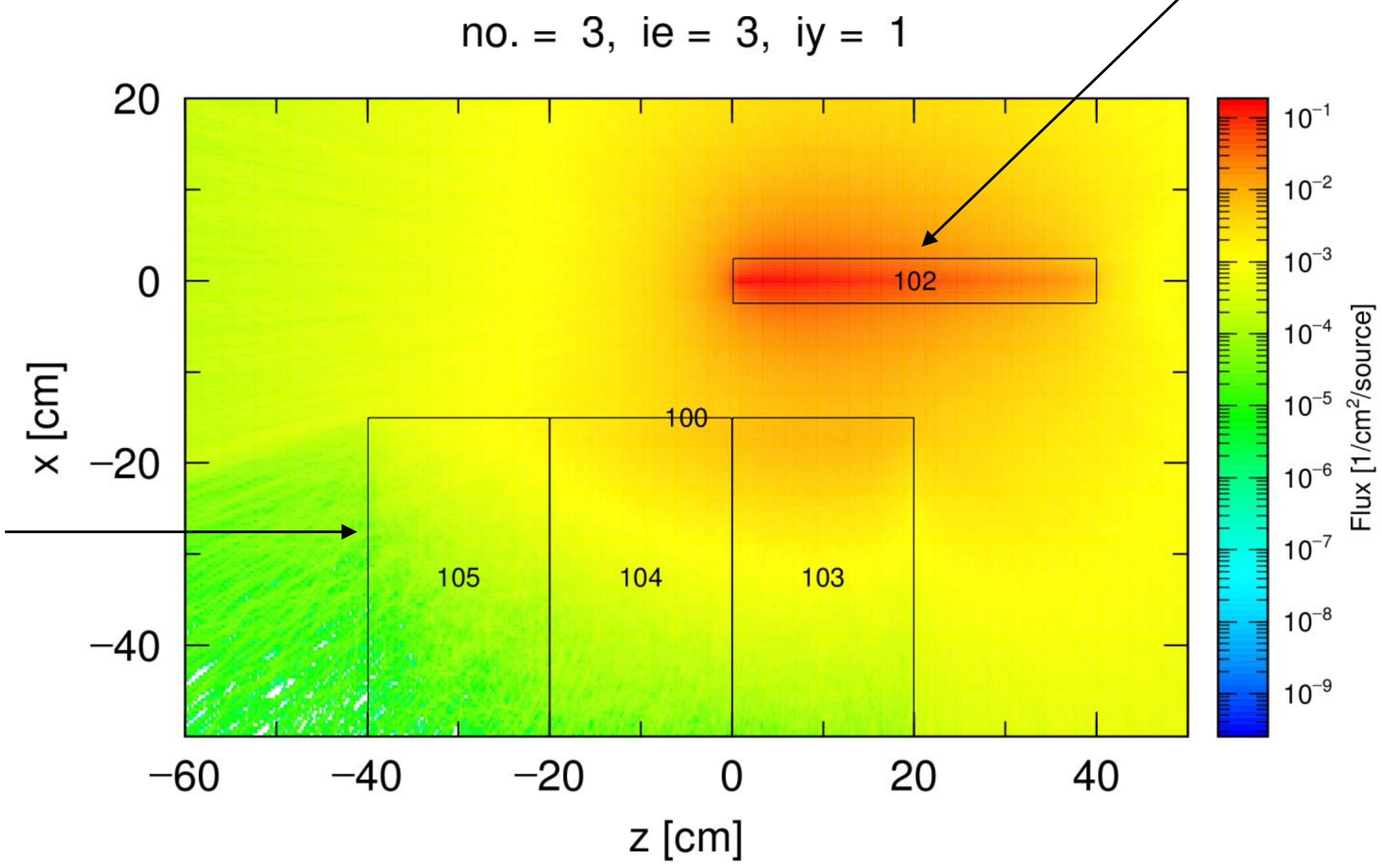


Proton beam parameters and neutron flux

- The duration of the entire deflected proton buch is – 10 ns at a repetition rate of ≤50 Hz.
- The internal current – 2.3 μA (a maximum value - 3 .3 pA has been reached) and the number of accelerated protons is – 3 x 10^{11} protons per pulse (1.5x10^{13} per second).
- Neutron multiplicity ~20. Neutron flux ~3x10^{14} in 4π.

Calculation

lead brick



20 l canisters with water

Goals of experiment

The main goal of experiment is to determine fluxes for different energies for each moderator thickness.

Why is it important and interesting?

- Time-dependent neutron experiment;
- Neutron experiment with high energy.

Potential application:

- Simulation of nuclear reactor;
- Transmutation;
- Exotic nuclear.

Methodology of experiment

- Directly under the target is a set of rectangular 24-l canisters with light water;
- Thin foils (monitors) are placed between them at the same height and on the same axis;
- After irradiation, the foils are examined using a gamma spectrometer with a HPGE detector.

Fluence calculation by experimental data

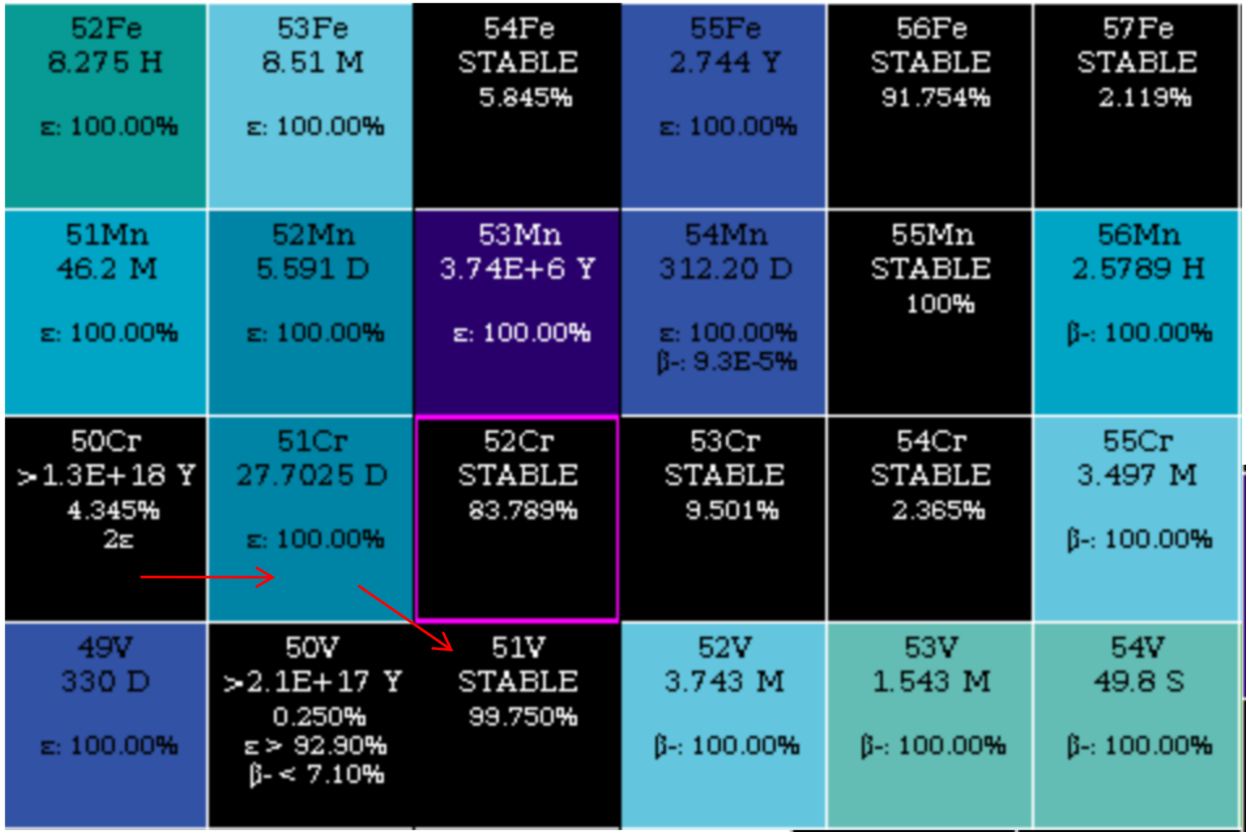
$$Fluence = \frac{IM_N e^{\frac{\ln 2}{T_{\frac{1}{2}}} t_{lag}}}{\text{mk}\sigma N_A \left(1 - e^{\frac{\ln 2}{T_{\frac{1}{2}}} t_{exp}}\right)}$$

I is the partial activity of the isotope in the monitor, M_N is the mass of the nucleus of the taget in atomic mass units, $T_{1/2}$ – the half-life of the product, t_{lag} – the measurement delay time after the synchrotron stops, t_{exp} – the time of irradiation of the sample in the neutron flux, m—the mass of the sample, k – the product of the content of the corresponding element and the percentage of the parent isotope in it, σ – the cross section of the reaction, N_A – the Avogadro number.

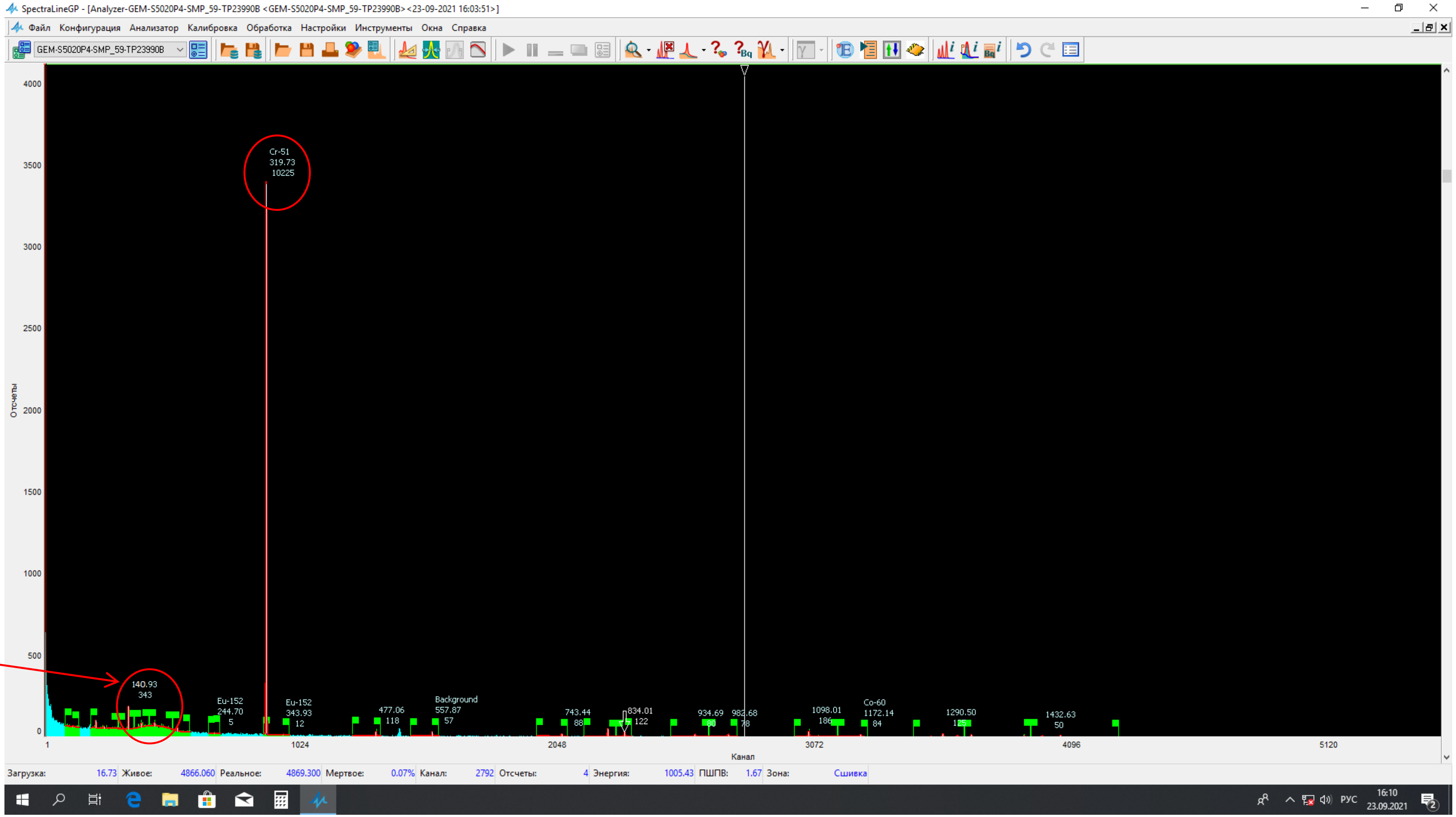
Foil content and reaction

Anealed Stainless steel 25μm

- Fe — 61%;
- Cr — 26%;
- Ni — 7%;
- Mo — 6%.



Example γ-spectrum of sample



Tc-99m

Results and conclusion

- Since both reactions have a resonant fashion with an energy of several keV, we can only estimate qualitatively the ratio between high-energy and thermal neutrons (in this particular case) ;
- For the last (fourth) sample, the value of the thermal neutron flux can be estimated ~10^8 n/sec/sm^2.

Further research

- The experiments with threshold nuclear reaction;
- Transmutation of fission products and transuranic elements;
- New reactions data search.

Thank you for attention