The cluster of the 9x CeBr3-NaI(Tl) phoswich detectors.

The cluster of 9 phoswich detectors was created within the framework of the PARIS international collaboration, which included participants from 10 countries, including JINR, Dubna, Russia. One of the general aims of the PARIS international cooperation is to study the processes of direct γ-decay of Giant Dipole Resonances (GDR) and Pygmy Dipole Resonances (PDR) formed in heavy-ion reactions.

Nuclear reactions with heavy ions are characterized by high multiplicity *M*γ of γ radiation, which is associated with the processes of dissipation of the input angular momentum that occurs during the fusion of colliding nuclei. The processes of nuclear cooling and dissipation of the angular momentum of the reaction products are passing through the particle emission, emission of statistical γ-quanta and γ-ray transitions of the yrast-line, respectively.

The direct γ-decay of GDR in heavy-ion reactions is accompanied by the γ-cascade with a large value of multiplicity *M*γ. It leads to a «pile-up» effect (the overlapping of detection pulses) in the γ-detectors. In can leads, due to «pile-up» effect, to the situation when the sum γ-energy of «pile-up» γ-quanta will be positioned in the energy scale close to the GDR region.

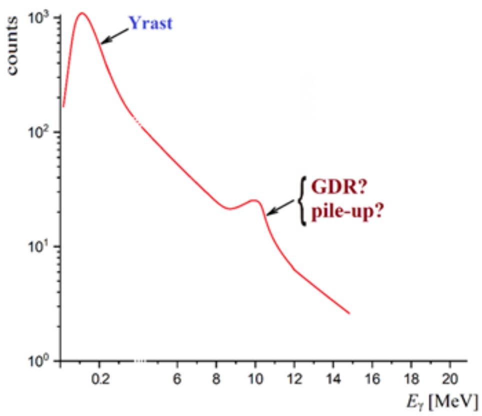

Fig.1. Illustration of the yrast-line spectrum, GDR and «pile-up» effect

The solution to the “pile-up” problem in high-energy γ-spectroscopy was carried out using the technique of phoswich detectors.

The phoswich detector is a pair of scintillation crystals optically connected to each other and to a PhotoMultiplier Tube (PMT). The thicknesses of the scintillation crystals are chosen in accordance with the condition of preferential absorption of low-energy γ-quanta in the first scintillator, while high-energy γ-quanta pass it without interaction with a high probability and are absorbed in the second scintillator of the detector. The most efficient combinations are $CeBr_3$:Ce-NaI(Tl) and $LaBr_3$:Ce-NaI(Tl) pairs because they have similar light yields, different emission times, and provide conditions for creating large volume detectors.

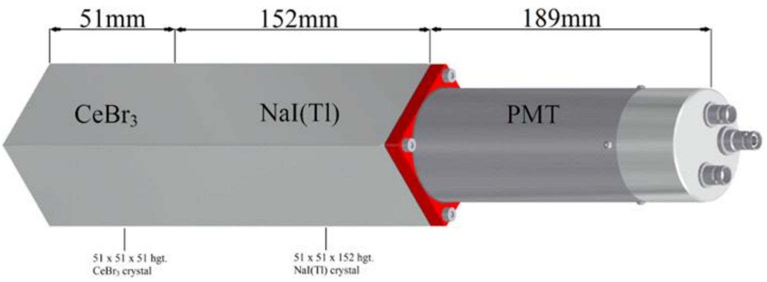

Fig.2. $CeBr_3$:Ce-NaI(Tl) phoswich detector

Different scintillator exposure times make it possible to sufficiently separate the scintillation components with a single photodetector. This made it possible to solve the problems associated with the effect of pulse superposition.

At the present time, to solve a number of problems related to the study of the properties of exotic radioactive nuclei in the Laboratory of Nuclear Reactions. G.N. Flerov, the MULTI setup is being created. This setup includes a 4π-β counter, a scintillation spectrometer of 12xCsI(Tl) detectors, assemblies of $9xCeBr_3$-NaI(Tl) phoswich detectors, and ^{3}He neutron counters.

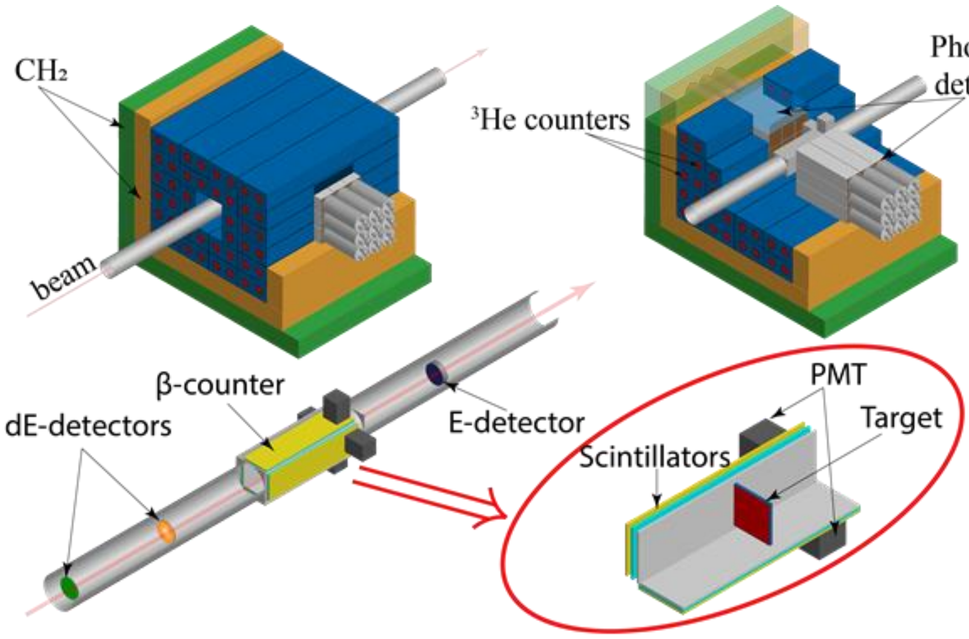

Fig. 3. The MULTI experimental setup

What is included in the practice?

Familiarization with the experimental setup, consisting of $CeBr_3$-NaI(Tl) phoswich detectors. Study of the properties of scintillation detectors.

What goals will be achieved?

The understanding the idea of phoswich detector method, acquiring practical skills in the experience with the ROOT software code, working with a VME Data Acquisition (DAQ) System, analyzing and processing experimental data obtained during laboratory work, mastering the operation of $CeBr_3$-NaI(Tl) detectors in Compton suppression mode.

References

[1] PARIS cooperation: http://paris.ifj.edu.pl/index.php?lng=en

[2] F. Camera, A. Maj, «PARIS White Book», H. Niewodniczanski Institute of Nuclear Physics Polish Academy of Sciences, Kraków 2021.

[3] Zh. Zeinulla, Yu.G. Sobolev, S.S. Stukalov, I. Sivacek, Yu. E. Penionzhkevich “GAMMA-RAY SPECTROMETER ASSEMBLED FROM 9×CeBr3-NaI(Tl) PHOSWICH DETECTORS” Acta Physica Polonica B

Number of students: 2