

# RAPORT ŞTIINŢIFIC FINAL

## PN-III-P4-PCE-2021-0595

### 2. Presentation of the results obtained

#### 2.1. Foreseen results

1. 7 scientific papers
2. 1 scientific paper of review type
3. 4 International experimental campaigns
4. 1 Webpage
5. 1 Master's thesis
6. 6 Conferences and workshops
7. 3 Phase report
8. 1 Final report

#### 2.1. Obtained results

##### Scientific papers:

1. A. Gavrilescu, J.A.C. Bekker, P.-A. Söderström, D.L. Balabanski, A. Tamii, L. Pellegrini, R. Neveling, A. Kuşoğlu, S. Adachi, Y. Fujikawa, et al., In-beam commissioning of the Grand Raiden spectrometer coupled with the silicon detector array SAKRA at RCNP, *Phys. Scr.*, submitted
2. P.-A. Söderström, M. Markova, N. Tsoneva, Y. Xu, A. Kuşoğlu, S. Aogaki, D. L. Balabanski, S. R. Ban, R. Borcea, M. Brezeanu, et al., Statistical properties and photon strength functions of the  $^{112,114}\text{Sn}$  isotopes below the neutron separation threshold, *Phys. Rev. C*, submitted
3. A. Kuşoğlu, et al. Direct observation of competing M1 and M3 transitions in  $^{10}\text{B}$ , *Phys. Rev. Lett.*, **133**:072502, 2024
4. A. Kuşoğlu, et al.,  $\gamma$ -ray spectroscopic study of self-conjugate  $^{10}\text{B}$  nucleus with inelastic proton scattering, *EPJ Web Conf.* **311**:00020, 2024
5. Y. Xu, D. L. Balabanski, V. Baran, C. Iorga, and C. Matei. Vortex photon induced nuclear reaction: Mechanism, model, and application to the studies of giant resonance and astrophysical reaction rate, *Phys. Lett. B*, **852**:138622, 2024
6. B. Wang, Y. Xu, and S. Goriely. Systematic study of the radiative proton capture including the compound, pre-equilibrium, and direct mechanisms, *Phys. Rev. C*, **109**:014611, 2024
7. S. Aogaki, D. L. Balabanski, R. Borcea, P. Constantin, C. Costache, M. Cuciuc, A. Kuşoğlu, C. Mihai, R. E. Mihai, L. Stan, et al., A setup for high-energy  $\gamma$ -ray spectroscopy with the ELI-NP large-volume  $\text{LaBr}_3:\text{Ce}$  and  $\text{CeBr}_3$  detectors at the 9 MV Tandem accelerator at IFIN-HH, *Nucl. Instrum. Methods Phys. Res. A*, **1056**:168628, 2023.
8. A. Kuşoğlu, and D. L. Balabanski. Renewed Interest in Spectroscopy of the Lightest Doubly-Odd  $N = Z$  Nuclei, *Quantum Beam Sci.* **7**:20, 2023

9. P.-A. Söderström, D. L. Balabanski, R. S. Ban, Gh. Ciocan, M. Cuciuc, A. Dhal, V. Fugaru, V. Iancu, A. Rotaru, A. B. Șerban, et al. Design and construction of a 9 MeV  $\gamma$ -ray source based on capture of moderated plutonium-beryllium neutrons in nickel *Appl. Radiat. Isot.*, **191**:110559, 2023.
10. D. L. Balabanski, Nuclear astrophysics studies with  $\gamma$ -ray beams: What do we expect to learn from them?, *EPJ Web Conf.* **275**:01002, 2023

**Scientific paper of review type:**

1. A. Tamii, L. Pellegri, P.-A. Söderström, D. Allard, S. Goriely, T. Inakura, E. Khan, E. Kido, M. Kimura, E. Litvinova, et al. PANDORA Project for the study of photonuclear reactions below  $A = 60$  *Eur. Phys. J. A*, **59**:208, 2023.
2. P.-A. Söderström, A. Kuşoğlu, and D. Testov, Prospect for measurements of  $(\gamma, n)$  reaction cross-sections of  $p$ -nuclei at ELI-NP, *Front. Astron. Space Sci.*, **10**:1248834, 2023.

**International experimental campaigns:**

1. Experimental Campaign IFIN-HH Bucharest 2022
2. Experimental Campaign IFIN-HH Bucharest 2023
3. Experimental Campaign IFIN-HH Bucharest 2024
4. Experimental Campaign RCNP Osaka 2023
5. Experimental Campaign CCB Krakow 2024
6. Experimental Campaign HI $\gamma$ S Durham 2024

**Webpage:**

1. <https://www.nipne.ro/proiecte/pn3/64-projects.html>

**Master's thesis:**

1. R. Niina, Measurement of branching ratios in photonuclear reactions of  $^{12,13}\text{C}$ , Masters Thesis, Osaka University, 2023. Supervisors: Prof. A. Tamii
2. R. A. Guțoiu, Possible Giant Dipole Resonance studies at ELI-NP, Bachelor Thesis, Universitatea din București, 2023. Supervisors: Dr. P.-A. Söderström and Dr. M. Pârvu

**Conferences and workshops:**

1. A. Gavrilăscu, Update on  $^{10,11}\text{B}$  analysis, 4th PANDORA Workshop, Wits Rural Facility, South Africa, November 10-22, 2024
2. P.-A. Söderström, Update on ELI-NP, 4th PANDORA Workshop, Wits Rural Facility, South Africa, November 10-22, 2024
3. A. Gavrilăscu, Photo-Absorption of light Nuclei and Decay Observation for Reactions in Astrophysics: The Pandora Project, International Symposium on Nuclear Science, Sofia, Bulgaria, September 9-13, 2024
4. P.-A. Söderström, A. Kuşoğlu, A. Gavrilăscu, M. Brezeanu, R.A. Guțoiu, and D.L. Balabanski, Gamma above the neutron threshold perspectives at ELI-NP, 57th Zakopane Conference on Nuclear Physics, Zakopane, Poland, August 25-31, 2024

5. J. Bekker, D. Allard, B. Baret, S. Binda, J. W. Brummer, J. Dahl, J. Finsrud, Y. Fujikawa, F. Furakawa, T. Furuno, A. Gavrilescu, A. Giaz, A. Gorgen, Y. Honda, V. W. Ingeberg, R. Iwasaki, P. Jones, I. Jurosevic, T. Kawabata, T. Khumalo, N. Kobayashi, A. Kusoglu, K.C.W. Li, E. Martinsen, R. Neveling, S. Okamoto, T. Okamura, S. Ota, L. Pellegri, K. Sakanashi, Y. Sasagawa, H. Shibakita, H. Shimojo, S. Siem, M. Spall, P.-A. Soderstrom, A. Tamii, J. Tanaka, C. Wang, O. Wieland, Z. Yang, K. Zhou, W. Paulsen, and P. von Neumann-Cosel, The PANDORA Project: Investigating Photonuclear Reactions in Light Nuclei, 9th Workshop on Nuclear Level Density and Gamma Strength, Universitetet i Oslo, Oslo, Norway, May 27-31, 2024
6. N. Tsoneva, Properties of the low-energy dipole strength of direct and cascade transitions in neutron-excess nuclei, 9th Workshop on Nuclear Level Density and Gamma Strength, Universitetet i Oslo, Oslo, Norway, May 27-31, 2024
7. P.-A. Soderstrom, On the path to gamma-beam experiments: Activities with the ELIGANT setups from ELI-NP, 9th Workshop on Nuclear Level Density and Gamma Strength, Universitetet i Oslo, Oslo, Norway, May 27-31, 2024
8. A. Gavrilescu, Analysis of High-Energy (p,p') data on  $^{12}\text{C}$  for the PANDORA Project, Young Researchers & Young Engineers Days - 2024, ELI-NP, Magurele, Romania, January 30-31, 2024
9. J.A.C. Bekker, L. Pellegri, A. Tamii, P.-A. Soderstrom, R. Neveling, and A. Gavrilescu, The PANDORA Project: Investigating Photonuclear Reactions in Light Nuclei, The African Nuclear Physics Conference 2023 (ANPC2023), Mpumalanga, South Africa, November 29 - December 3, 2023
10. Y. Sasagawa, A. Tamii, S. Ota, N. Kobayashi, A. Inoue, R. Iwasaki, T. Kawabata, T. Furuno, Y. Honda, H. Shibakita, Y. Fujikawa, S. Adachi, J. Bekker, L. Pellegri, R. Neveling, P.-A. Soderstrom, A. Gavrilescu, and M. Murata, Test measurement of the  $^{12,13}\text{C}(p, p\alpha)$  Reactions for the PANDORA Project, 2023 Fall Meeting of the Division of Nuclear Physics of the American Physical Society and Physical Society of Japan, Hawaii, USA, 26 November - 1 December, 2023
11. A. Gavrilescu, P.-A. Soderstrom, D.L. Balabanski, J.A.C. Bekker, R. Niina, A. Tamii, L. Pellegri, Photo-Absorbption of light Nuclei and Decay Observation for Reactions in Astrophysics: The Pandora Project, Euroschool On Exotic Beams, Sinaia, Romania, 27 August - 2 September 2023
12. P.-A. Soderstrom, Present and future activities with the ELIGANT setups at ELI-NP, 7th International Conference on Collective Motion in Nuclei under Extreme Conditions (COMEX7), Catania, Italy, 11-16 June 2023
13. P.-A. Soderstrom, Photonuclear reactions of low-mass nuclei and the PANDORA project, International Symposium on Physics of Unstable Nuclei 2023, Phu Quoc, Viet Nam, 4-8 May 2023
14. D.L. Balabanski, What more can we learn from experiments with high-brilliance  $\gamma$ -ray beams?, International Symposium on Physics of Unstable Nuclei 2023, Phu Quoc, Viet Nam, 4-8 May 2023
15. P.-A. Soderstrom, ELI-NP overview and updates, 3rd PANDORA Workshop, Okinawa, Japan, March 5-7, 2023
16. P.-A. Soderstrom, Photonuclear physics at ELI-NP, INTPART school 2023, Okinawa, Japan, February 20 - March 3, 2023
17. D. Balabanski Nuclear astrophysics studies with  $\gamma$ -ray beams: What do we expect to learn from them?. 11th European Summer School on Experimental Nuclear Astrophysics, INFN LNS, Catania, Italy, 12/06/2022 - 19/11/2022

**Phase reports:**

1. RAPORT ȘTIINȚIFIC 2022 PN-III-P4-PCE-2021-0595
2. RAPORT ȘTIINȚIFIC 2023 PN-III-P4-PCE-2021-0595
3. RAPORT ȘTIINȚIFIC FINAL PN-III-P4-PCE-2021-0595

**Final report:**

1. RAPORT ȘTIINȚIFIC FINAL PN-III-P4-PCE-2021-0595

**Other:**

1. P.-A. Söderström, D. Balabanski, M. Ciemala, M. Cuciuc, A. Gavrilesu, M. Kmiecik, I. Kuncser, A. Kuşoğlu, A. Maj, C. Matei, R. Neveling, H. Pai, L. Pellegrini, T. Petruse, A. Tamii, Charged particle and gamma decay in light nuclei and an in-beam test of the ELI-NP silicon endcap detectors, Proposal for the Krakow CCB Program Advisory Committee, 2023
2. L. Pellegrini, P.-A. Söderström, A. Tamii, D. Allard, A. Bahini, D. Balabanski, B. Baret, J.A.C. Bekker, S.D. Binda, E. Boicu, et al., Photo-nuclear reactions of light nuclei for propagation and disintegration of ultra-high energy cosmic-rays, contribution to the NuPECC Long Range Plan for Nuclear Physics 2024