Studies of proton-rich nuclei with EAGLE-NEDA-DIAMANT

Katarzyna Hadyńska-Klęk

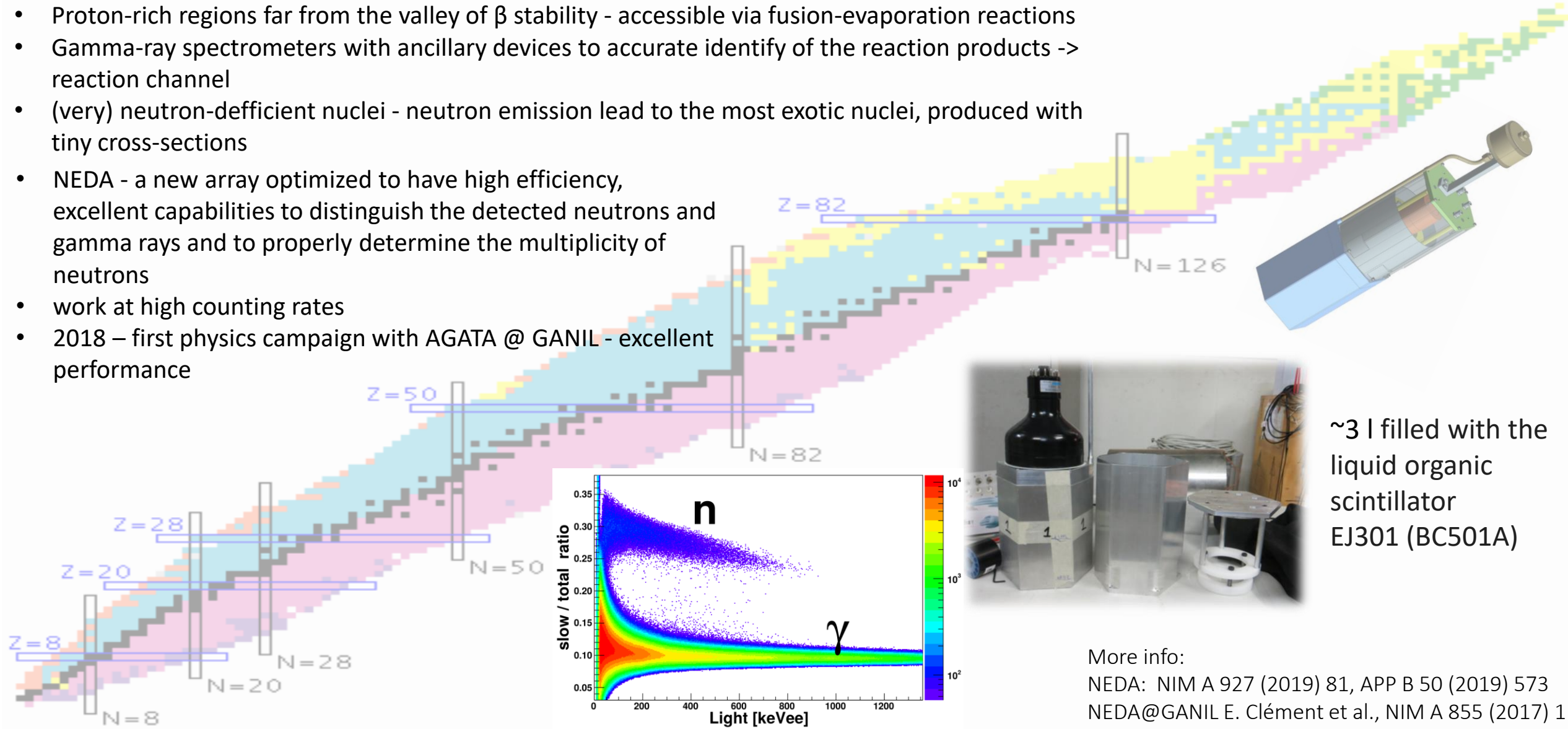
Heavy Ion Laboratory, University of Warsaw, Poland

on behalf of the NEEDLE / NEEDI collaborations @ HIL Warsaw

Third Annual Meeting (TAM) of the **EURO-LABS, CERN, 28-30 October 2024**

NEDA (NEutron Detector Array)

- Proton-rich regions far from the valley of β stability - accessible via fusion-evaporation reactions
- Gamma-ray spectrometers with ancillary devices to accurate identify of the reaction products -> reaction channel
- (very) neutron-defficient nuclei - neutron emission lead to the most exotic nuclei, produced with tiny cross-sections
- NEDA - a new array optimized to have high efficiency, excellent capabilities to distinguish the detected neutrons and gamma rays and to properly determine the multiplicity of neutrons
- work at high counting rates
- 2018 – first physics campaign with AGATA @ GANIL - excellent performance

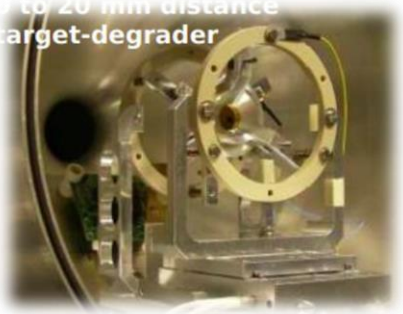


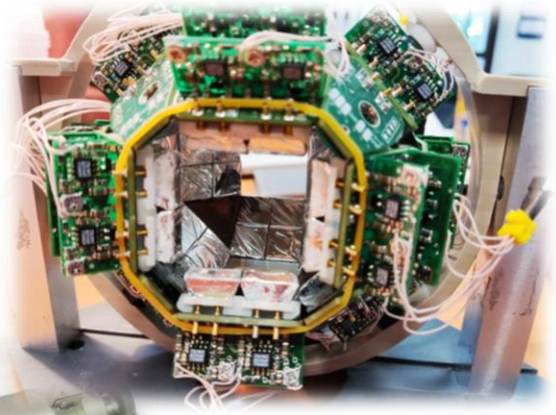
~3 l filled with the liquid organic scintillator EJ301 (BC501A)

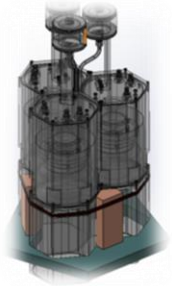
More info:
NEDA: NIM A 927 (2019) 81, APP B 50 (2019) 573
NEDA@GANIL E. Clément et al., NIM A 855 (2017) 1

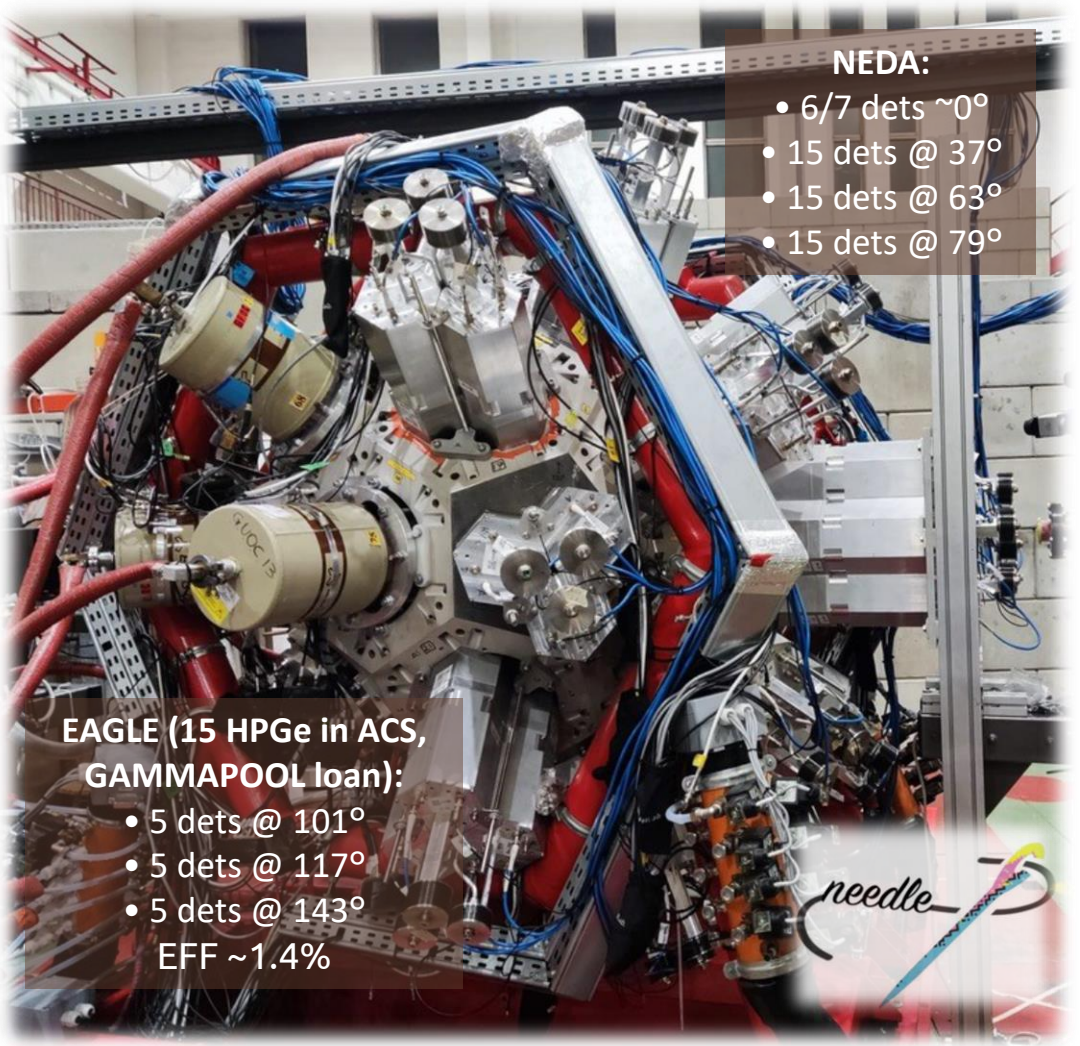
EAGLE + NEDA (NEEDLE) @ HIL Warsaw

- In December 2021 NEDA was shipped to HIL Warsaw and placed in the EAGLE frame
- The electronics - reconfigured to 6 CAEN V1725(S)(B) digitizers (6x16 channels, 14-bit, 250 MHz sampling):
  - 2 units with PHA firmware for HPGe and ACS
  - 4 units with PSD firmware for NEDA
- January 2023 - the first commissioning experiment (HIL-101, G. Jaworski et al.,)
- March 2023 - the first experiment with the EAGLE+NEDA in the configuration with Cologne plunger (HIL-099, B. Saygi, G. Jaworski et al.,) – after that 2 other successful lifetime runs (HIL-097, 106)
- November 2023 - the first experiment with NEDA+EAGLE+DIAMANT (HIL-105, M. Palacz et al.,) – followed by 4 other successful runs in this configuration (HIL-114, 115, 117, 126)
- Possible ancillaries:
  - Plunger
  - Electron conversion spectrometer
  - DIAMANT



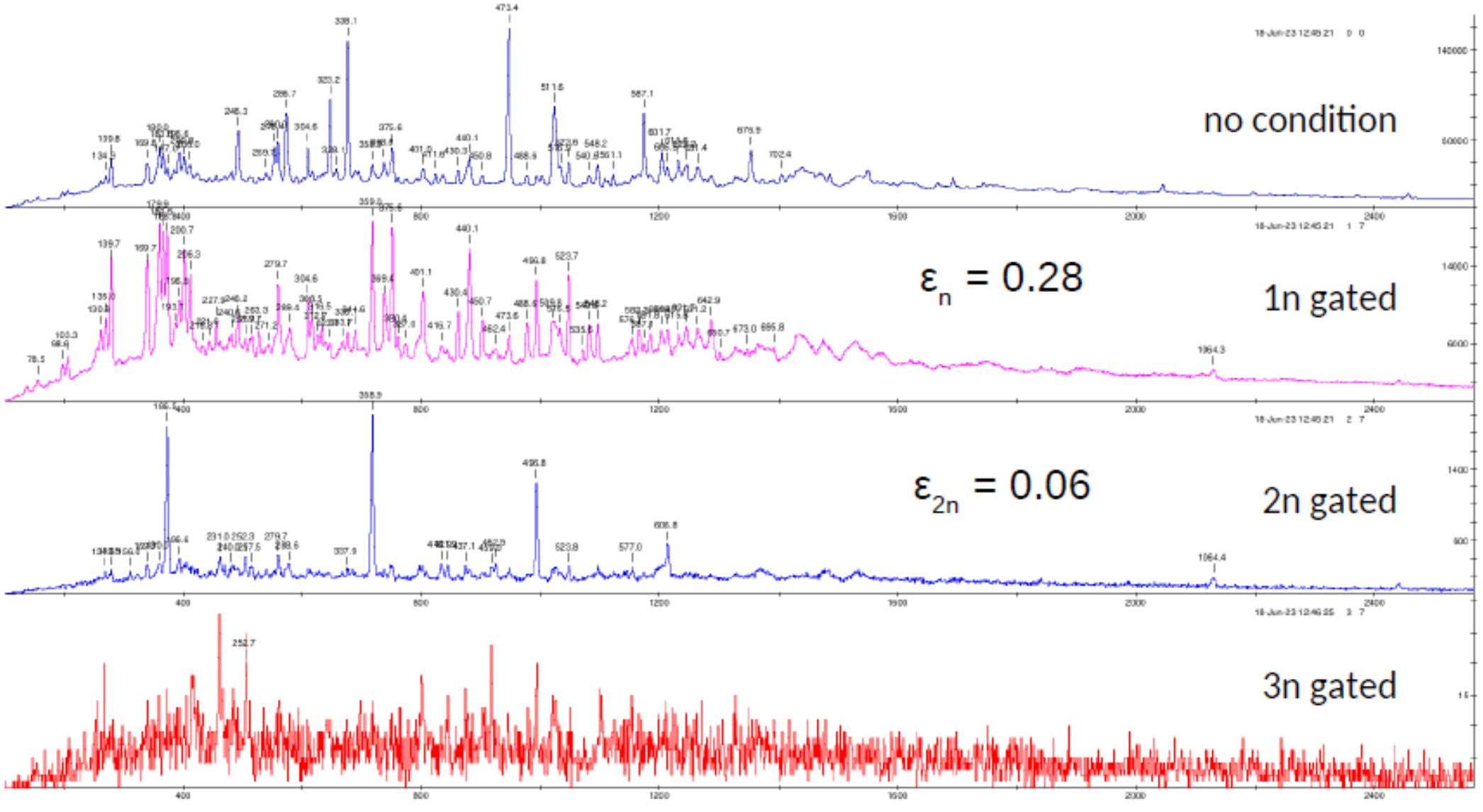






More info:
EAGLE: J. Mierzejewski et al., NIM. A 659, 84 (2011)
NEEDLE: G. Jaworski et al., Acta Phys. Pol. B Proc. Supp. 17, 3-A12 (2024)

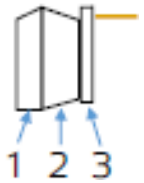
NEEDLE Performance



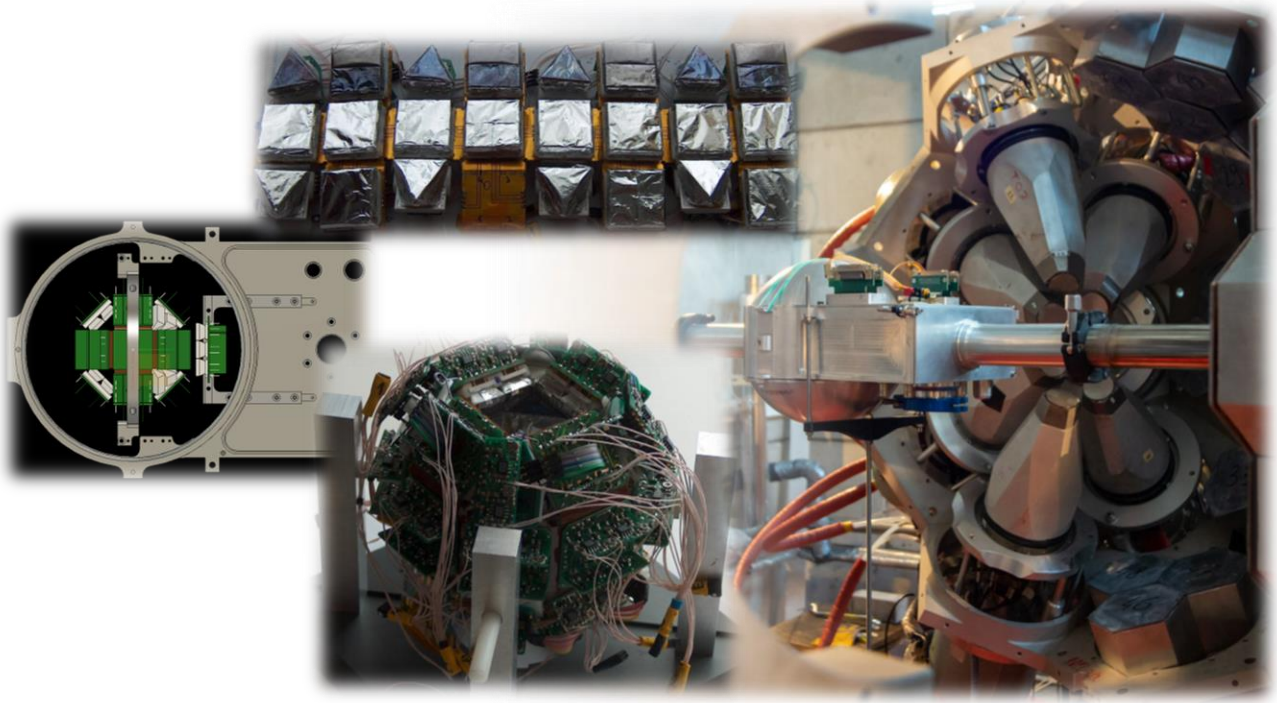
$^{32}S + {}^{92}Mo \rightarrow {}^{124}Ce\ (CN) \rightarrow {}^{120}Ba + 2p2n$ (HIL106)

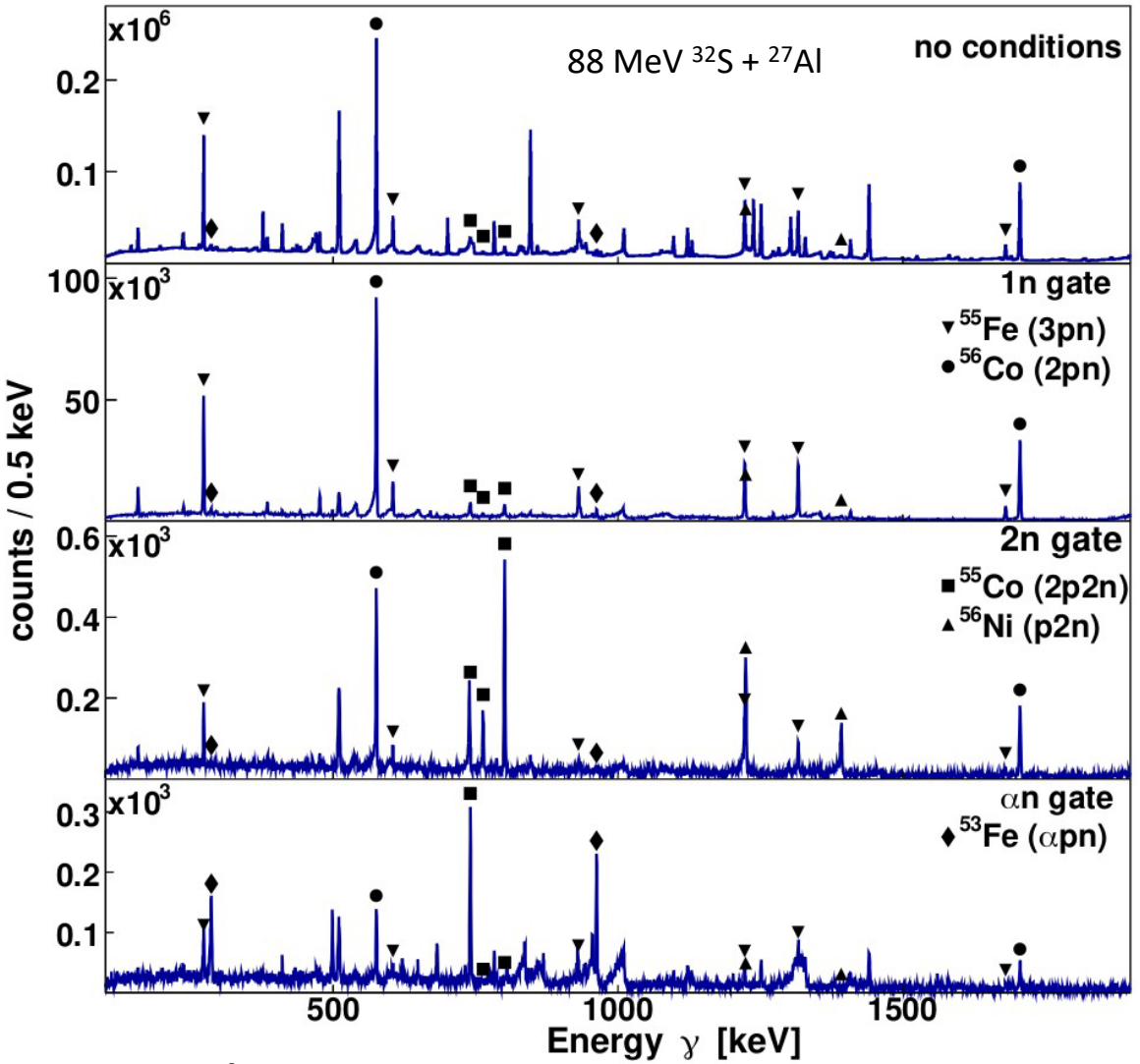
EAGLE + NEDA + DIAMANT (NEEDI): 2023 → …

- CsI(Tl) scintillators (1), optically coupled with light guides (2) to PIN photodiodes (3), with in-vacuum preamplifiers



- 72 scintillators, mounted on a flexible PCB –the FlexiBoard;
- 8 or 24 additional scintillators downstream
- Compact construction - can be easily placed around the target, inside the reaction chamber
- New target loader @HIL
- Electronics: DSP/DAQ: NUMEXO2 + CAEN V1725s





More info:
I. Kuti et al., Acta Phys. Pol. B Proc. Supp. 17, 3-A13 (2024)

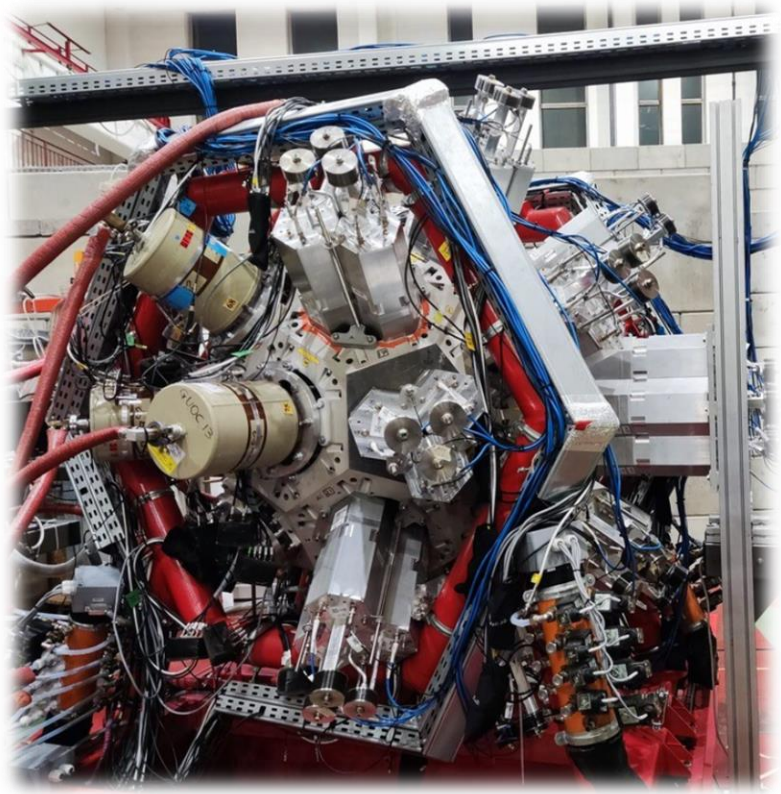
NEEDLE / NEEDI experiments supported with EURO-LABS

EXP ID	Spokesperson	Title	Cologne Plunger	DIAMANT	Days
HIL-101	G. Jaworski & I. Kuti	Commissionings of EAGLE-NEDA and EAGLE-NEDA-DIAMANT setups		✓	10
HIL-099	B. Saygi	Lifetime measurement of excited states in ^{134}Sm	✓		11
HIL-097	C. Petrache	Shape coexistence and octupole correlations in the light Xe, Cs and Ba nuclei	✓		14
HIL-106	C. Petrache	Shape coexistence and octupole correlations in the light Xe, Cs and Ba nuclei - continuation	✓		14
HIL-105	M. Palacz	Single-proton states and N=Z=28 core excitations in ^{57}Cu		✓	16
HIL-115	M. Matejska-Minda	Study of the anomalous behavior of the Coulomb energy difference in the A = 70, T = 1 izobaric multiplet		✓	15
HIL-114	B. Saygi	Gamma Ray Spectroscopy of ^{134}Sm		✓	14
HIL-126	I. Kuti	Search for candidate wobbling bands in ^{103}Pd and in ^{101}Ru		✓	16

EURO-LABS for EAGLE+NEDA+DIAMANT: 35 users from Hungary, Finland, Sweden, Turkey, France, Italy, China and the UK

EAGLE+NEDA+DIAMANT collaboration

- **G. Jaworski**, **M. Palacz** (setup, near-line, analysis, …)
- A. Goasduff, N.Toniollo (daq)
- **I. Kuti**, J. Molnar (DIAMANT, daq)
- M. Kowalczyk, P. Kulessa, M. Ciemała (daq, near-line)
- J. Grębosz (spy, GreWare – on-line spectra)
- M. Komorowska, M. Kisieliński, A. Špaček, T. Abraham, W. Okliński (HPGe, EAGLE front-end)
- C. Fransen, C. Lakenbrink, M. Beckers, F. v. Spee, C. Muller-Gatermann, A. Nałęcz-Jawecki (plunger)
- G. Colucci, A. Fijałkowska, K. Hadyńska-Klęk, A. Korgul, P.J. Napiorkowski, S. Panasenko, I.Piętka, J. Samorajczyk-Pyśk, P. Sekrecka, A. Tucholski, K. Wrzosek-Lipska (various support)
- B. Radomyski, M. Matuszewski (mechanics – projects, 3D printing)
- R. Kopik, P. Jasiński, M. Antczak (mechanical workshop)
- A. Stolarz, J. Kowalska (target preparation)
- students: A. Malinowski, A. Otręba, W. Poklepa, M. Regulska, K. Solak, K. Szlęzak, K. Zdunek
- spokepersons and participants of the experiments
- The HIL-UW stuff, including the cyclotrone operators



HIL Heavy Ion Laboratory

70 atomki DEBRECEN

INFN LNL

FUW

NCBJ

Universität zu Köln

Thank you for listening