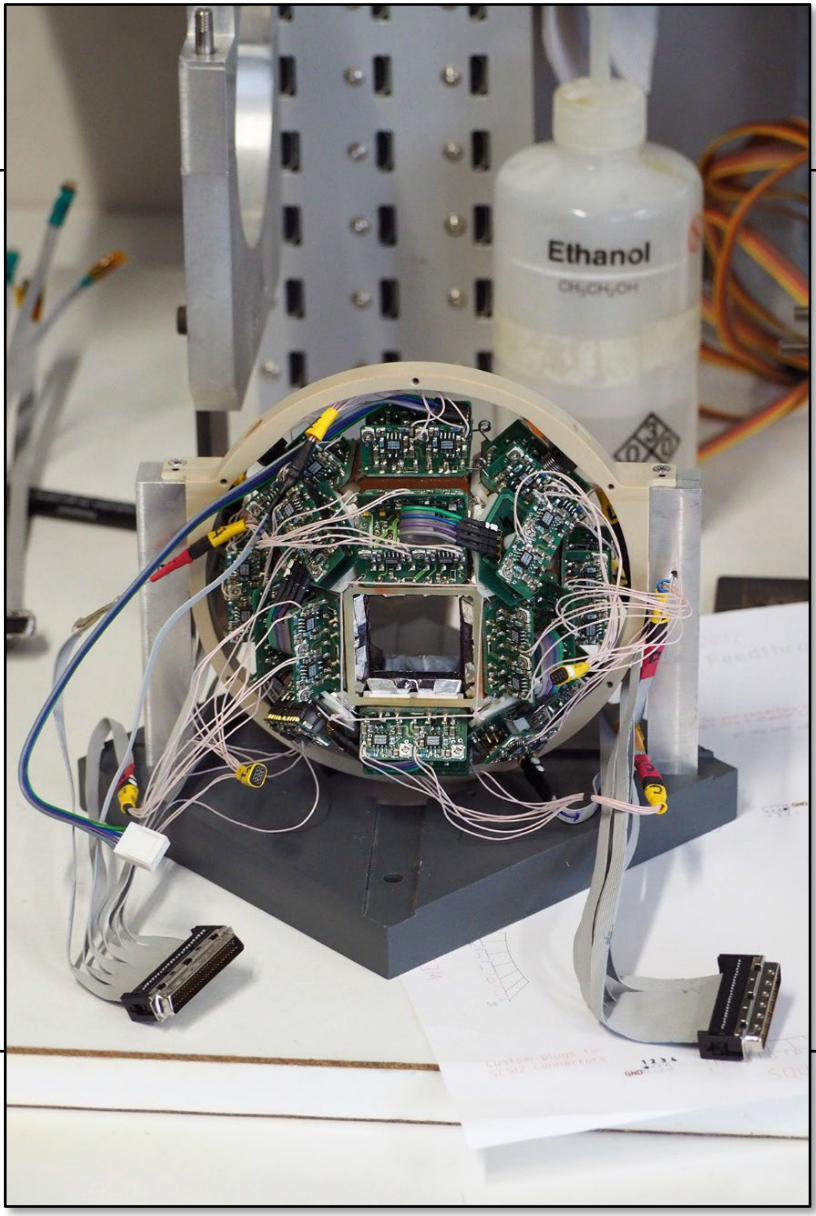
DIAMANT at HIL — the NEEDI setup

István Kuti
HUN-REN Institute of Nuclear Research (ATOMKI), Debrecen, Hungary

on behalf of DIAMANT *and* needle *collaborations*

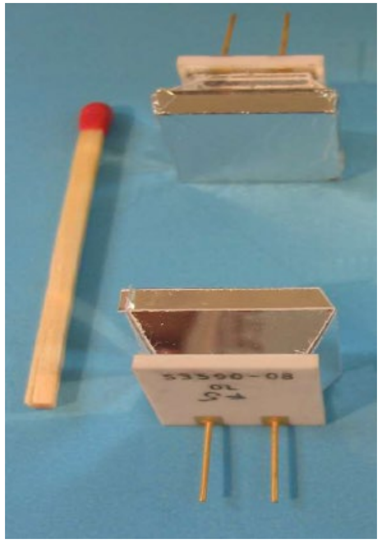
Zakopane Conference on Nuclear Physics, 28th August 2024

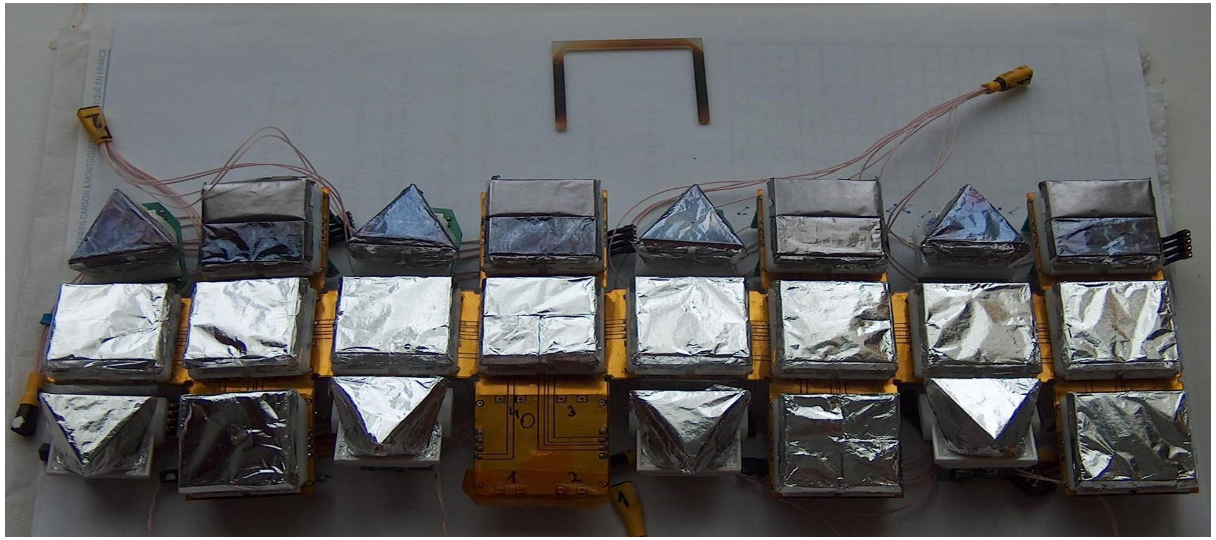


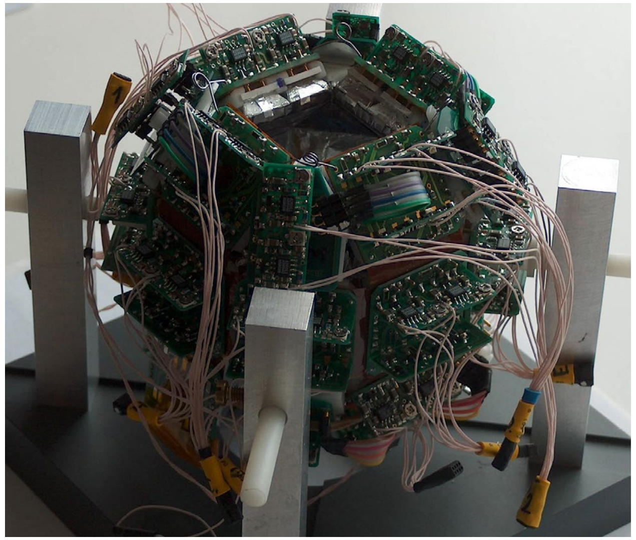
Compact CsI LCP detector system.

The operating principle of the CsI scintillators is based on the different light decay times for different particles.

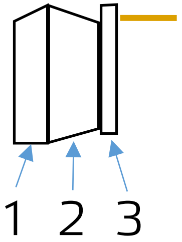
The main purpose is to select the reaction channels.





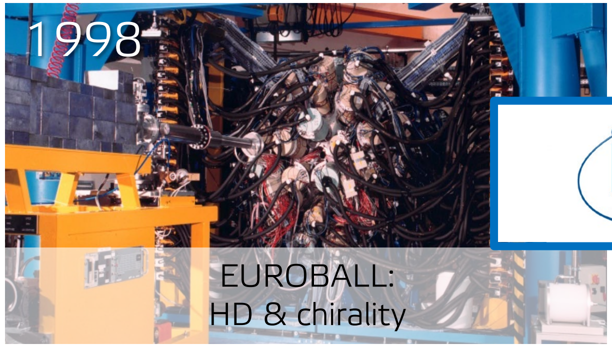


CsI(Tl) scintillators (1), optically coupled with light guides (2) to PIN photodiodes (3), with in-vacuum preamplifiers



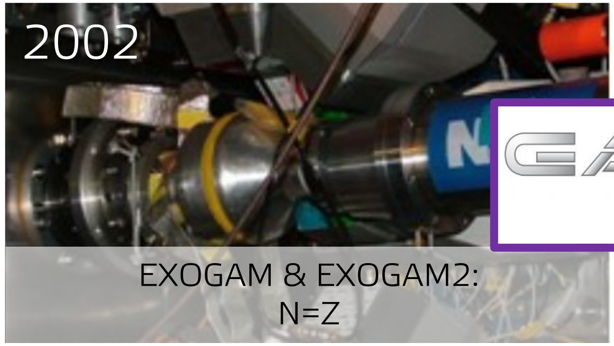
72 scintillators, mounted on a flexible PCB – the FlexiBoard; 8 or 24 additional scintillators downstream

Being very compact, DIAMANT can be easily placed around the target, inside the reaction chamber.



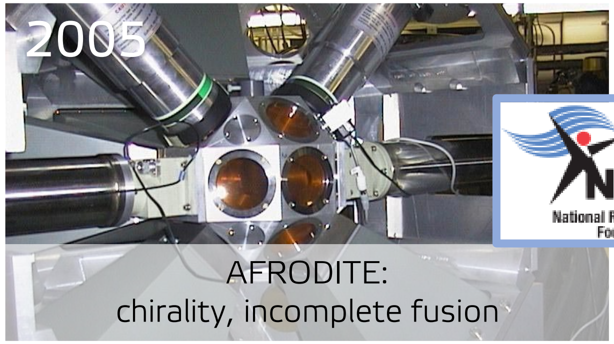
EUROBALL:
HD & chirality

iReS Institut de Recherches Subatomiques STRASBOURG



EXOGAM & EXOGAM2:
N=Z

GANIL spiral2



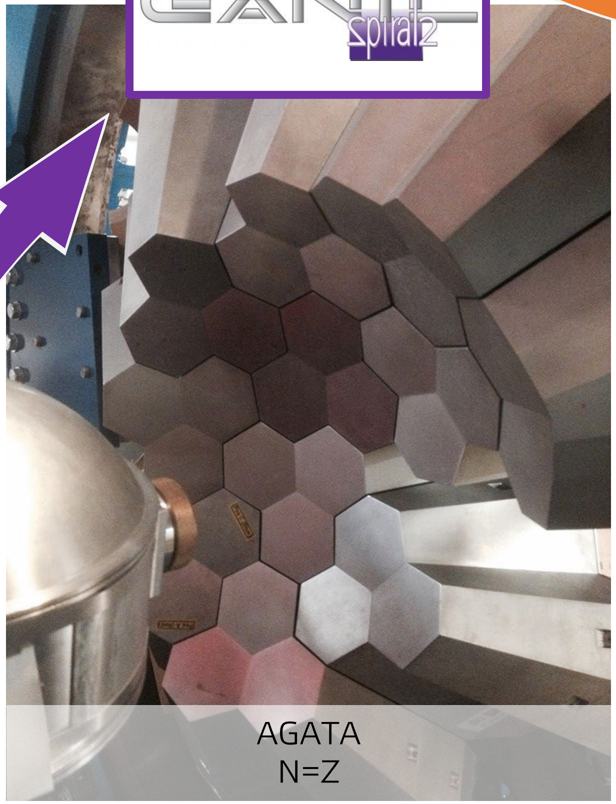
AFRODITE:
chirality, incomplete fusion

NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

One of the main ancillaries
of AGATA@GANIL (2018)

AGATA + NEDA + DIAMANT

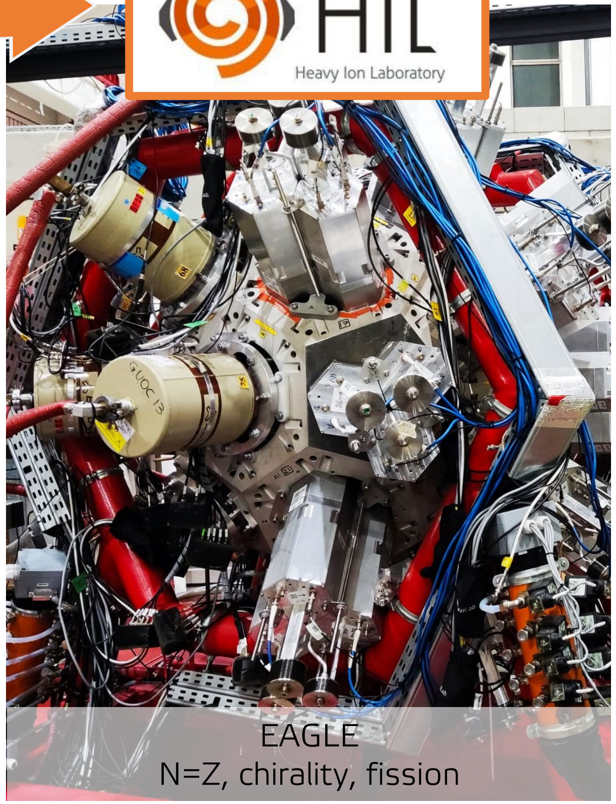
GANIL spiral2

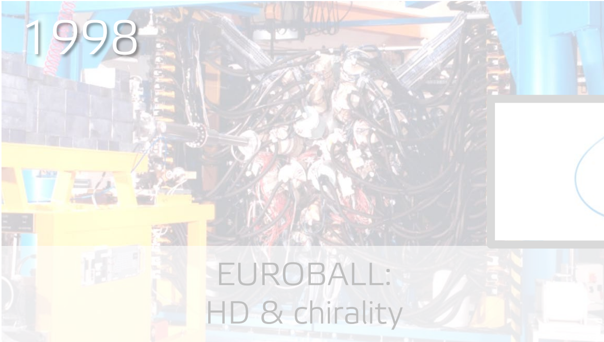

AGATA
N=Z

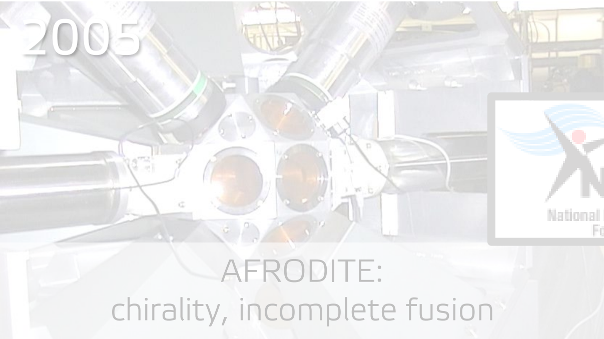
NEEDI campaign
(2023 –)

EAGLE + NEDA + DIAMANT

HIL Heavy Ion Laboratory

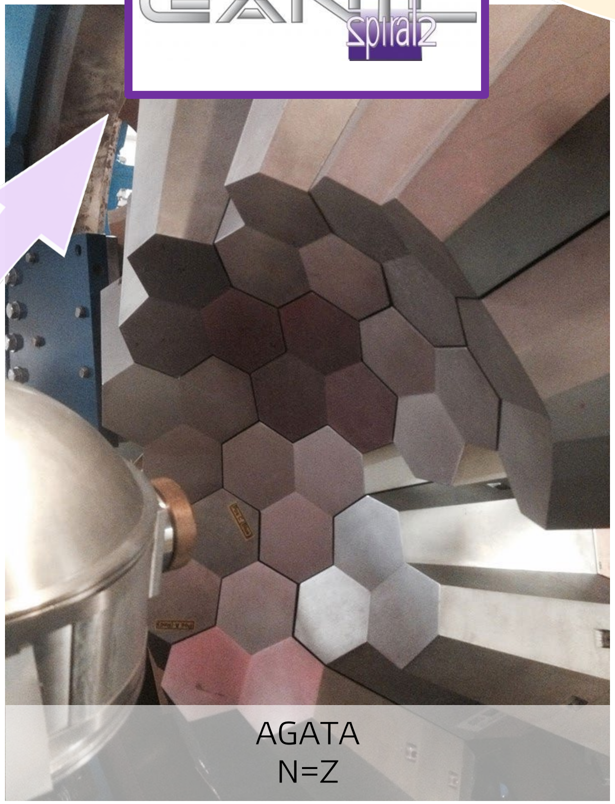

EAGLE
N=Z, chirality, fission





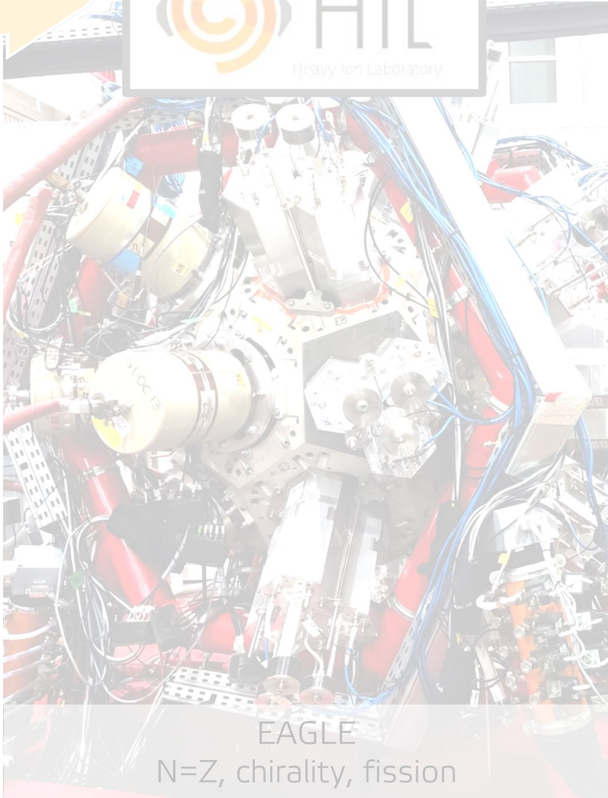
One of the main ancillaries
of AGATA@GANIL (2018)

AGATA + NEDA + DIAMANT



NEEDI campaign
(2023 –)

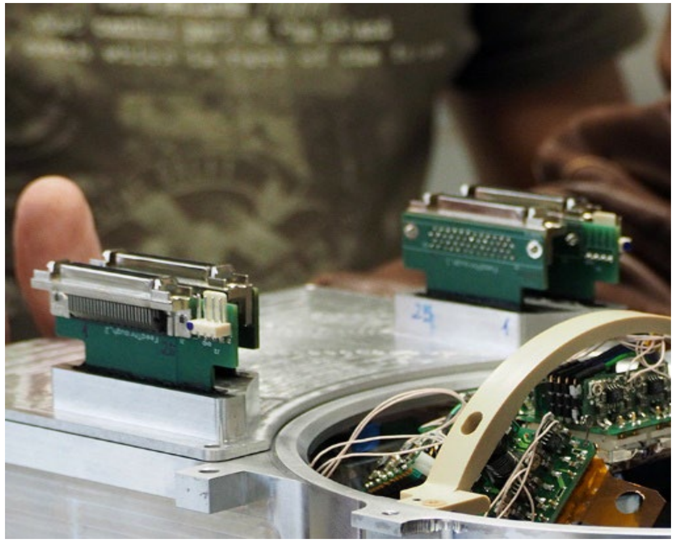
EAGLE + NEDA + DIAMANT

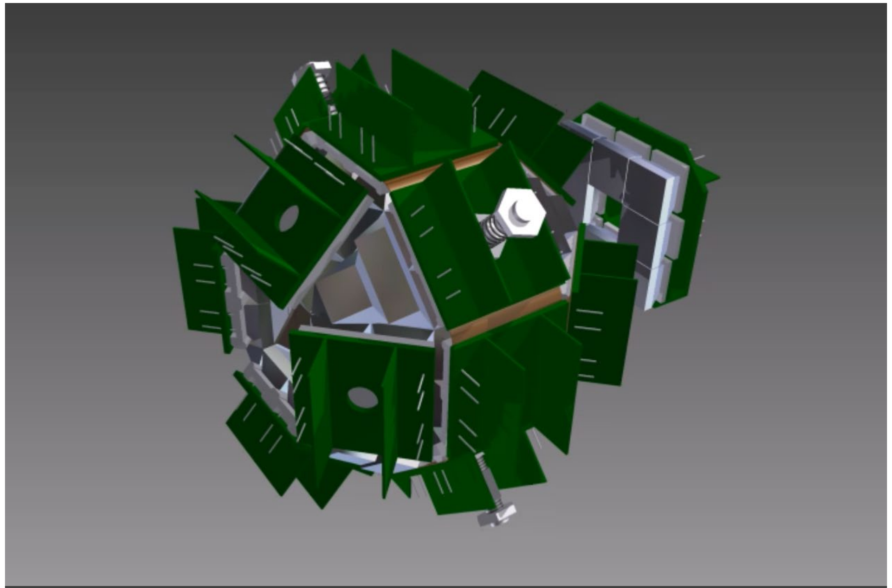
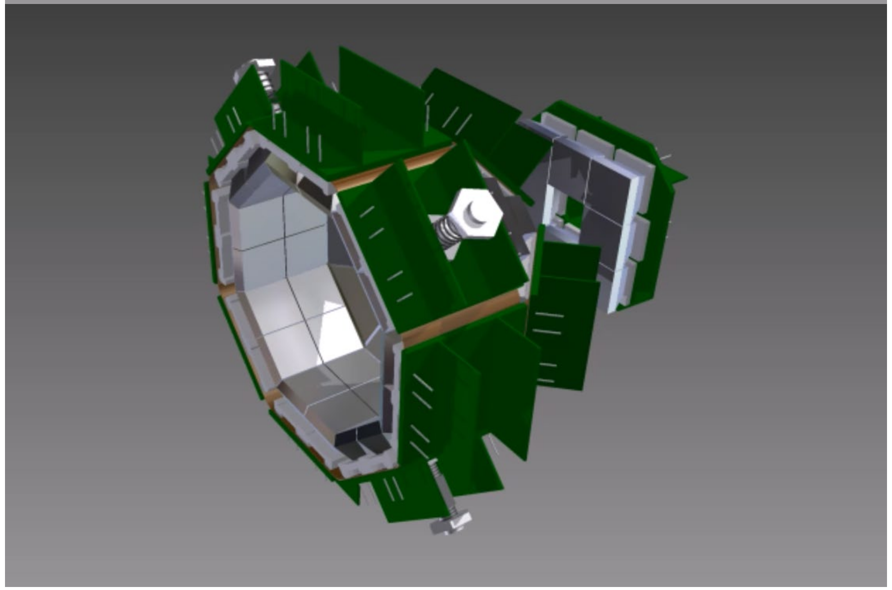


AGATA@GANIL (2018):

- new DSP, v1.0 firmware
- new 2nd stage amplifier (SeDiff)
- new vacuum feedthrough
- old flexiboard, „modified”

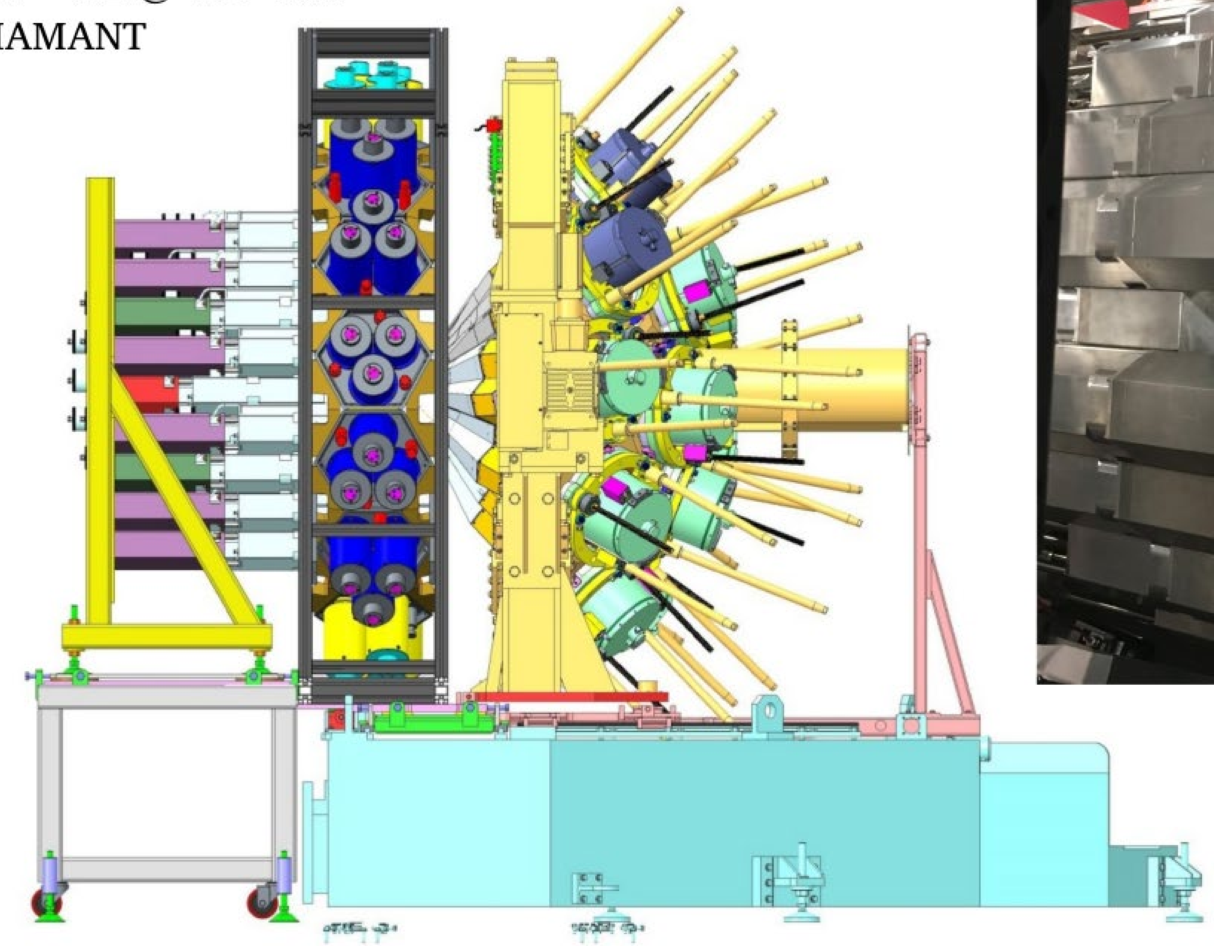
- only 60 detectors:
    - backward part removed
    - dual triangles replaced



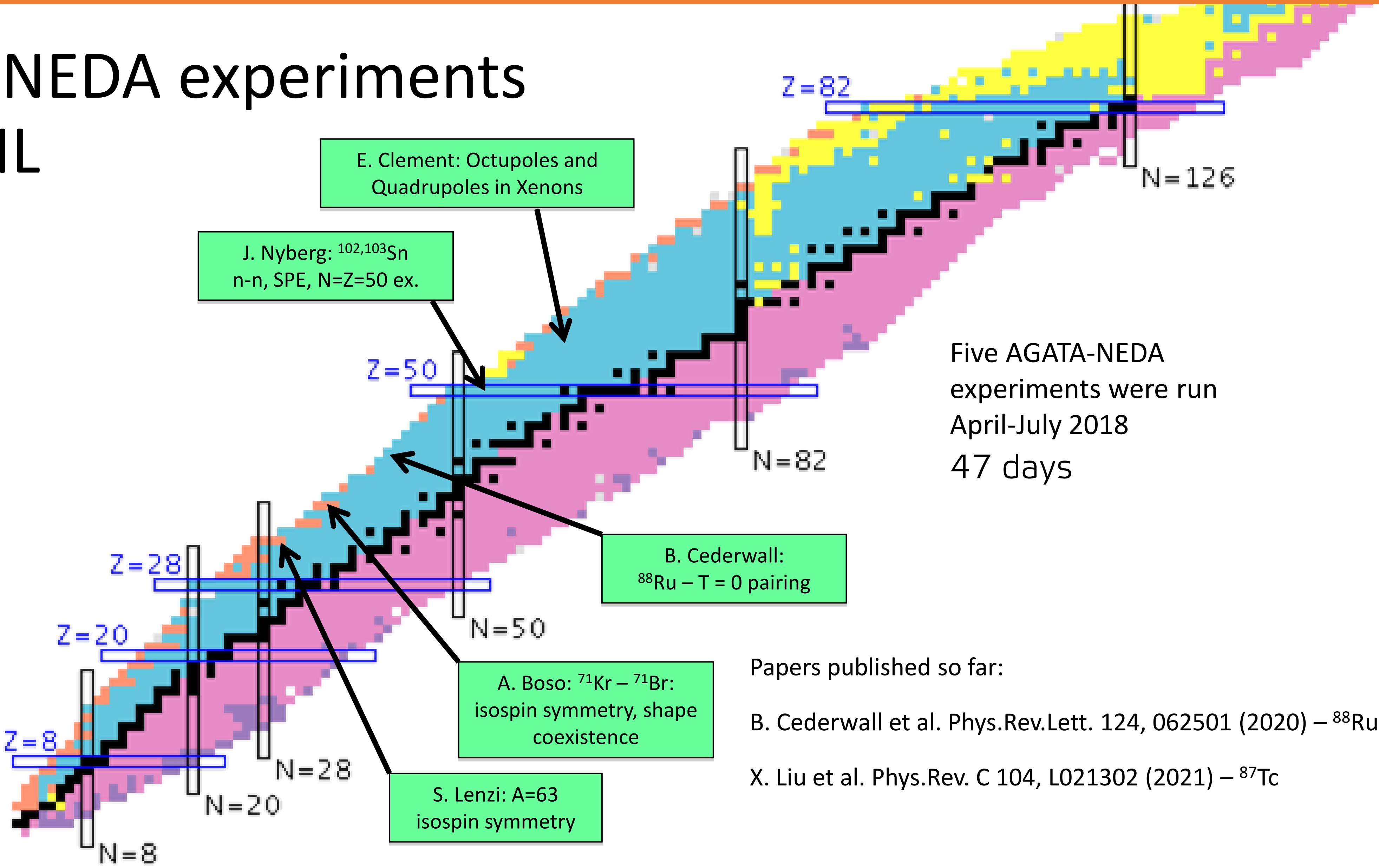




NEDA at GANIL (2018)

AGATA @ 145 mm
NEDA(54)@ 510 mm
NW (42)@ 650 mm
DIAMANT



AGATA-NEDA experiments at GANIL



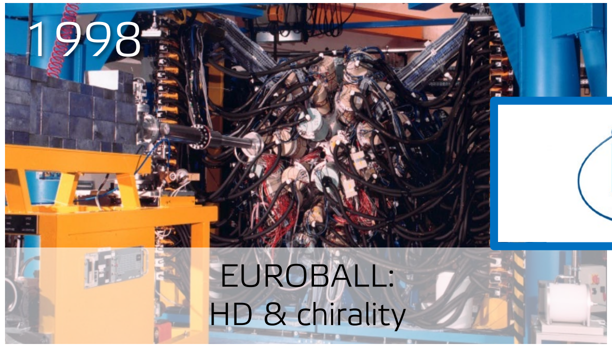
Five AGATA-NEDA experiments were run April-July 2018

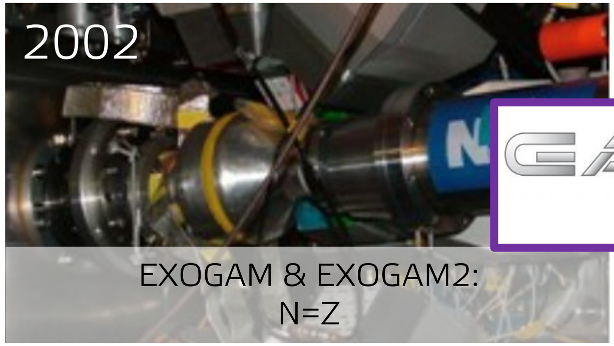
47 days

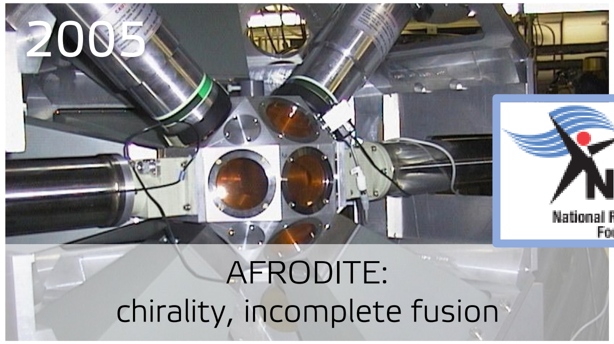
Papers published so far:

B. Cederwall et al. Phys.Rev.Lett. 124, 062501 (2020) – ^{88}Ru

X. Liu et al. Phys.Rev. C 104, L021302 (2021) – ^{87}Tc

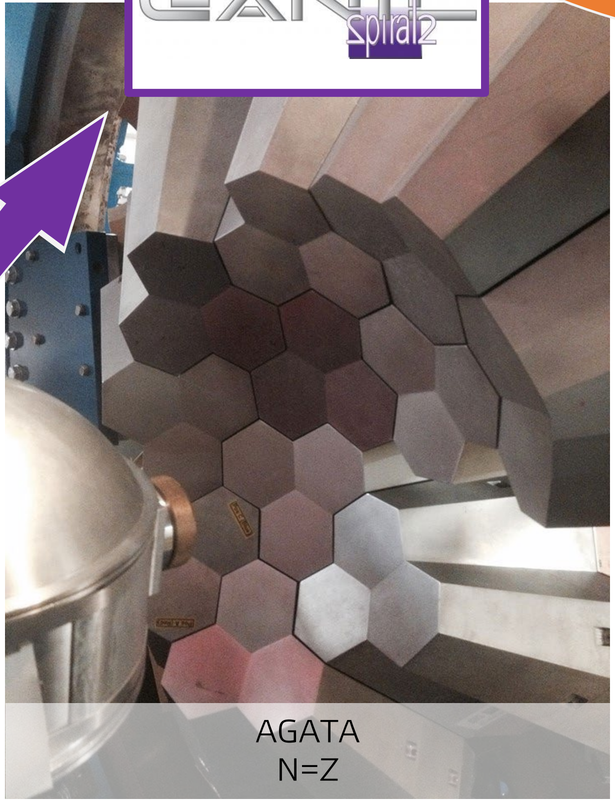






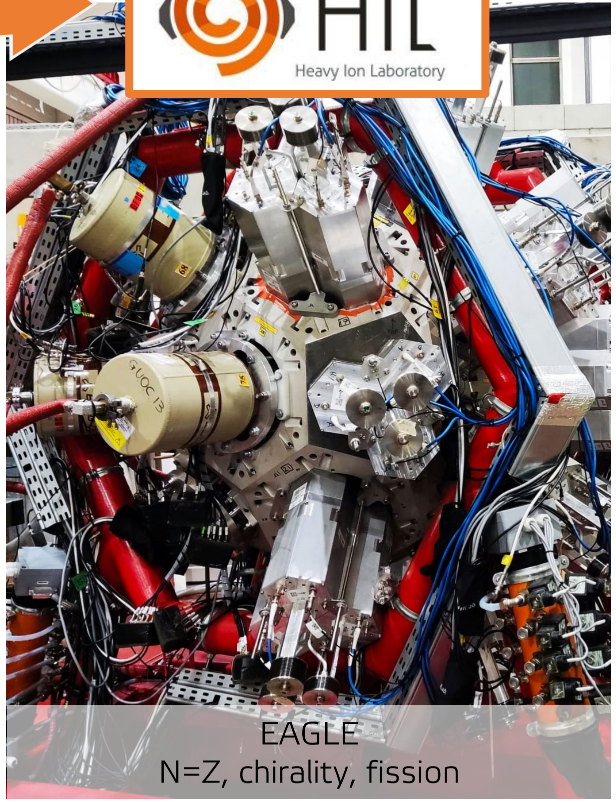
One of the main ancillaries
of AGATA@GANIL (2018)

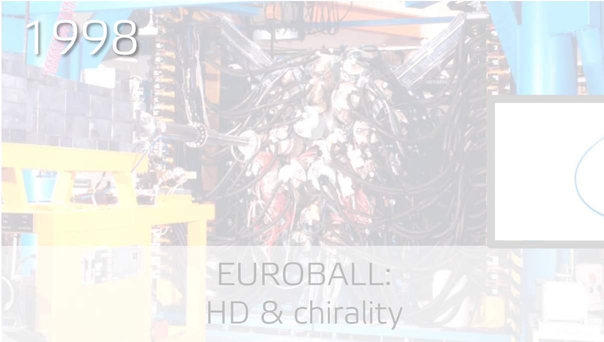
AGATA + NEDA + DIAMANT:
47 days of experiments
without any issues.

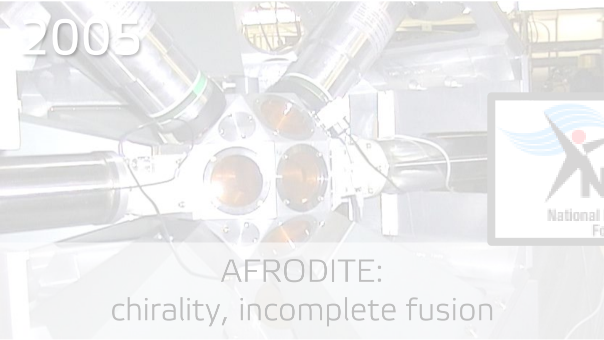


NEEDI campaign
(2023 –)

EAGLE + NEDA + DIAMANT:
5 experiments done,
2 in backlog.





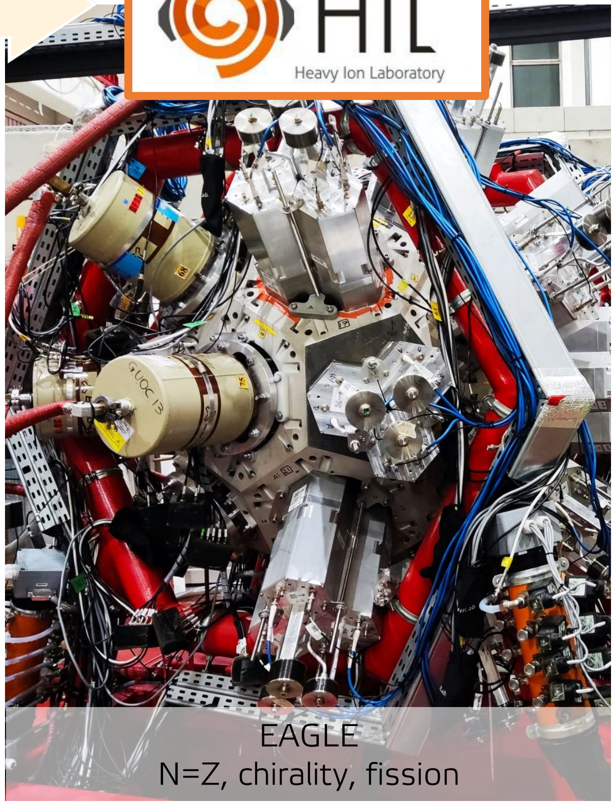


One of the main ancillaries
of AGATA@GANIL (2018)

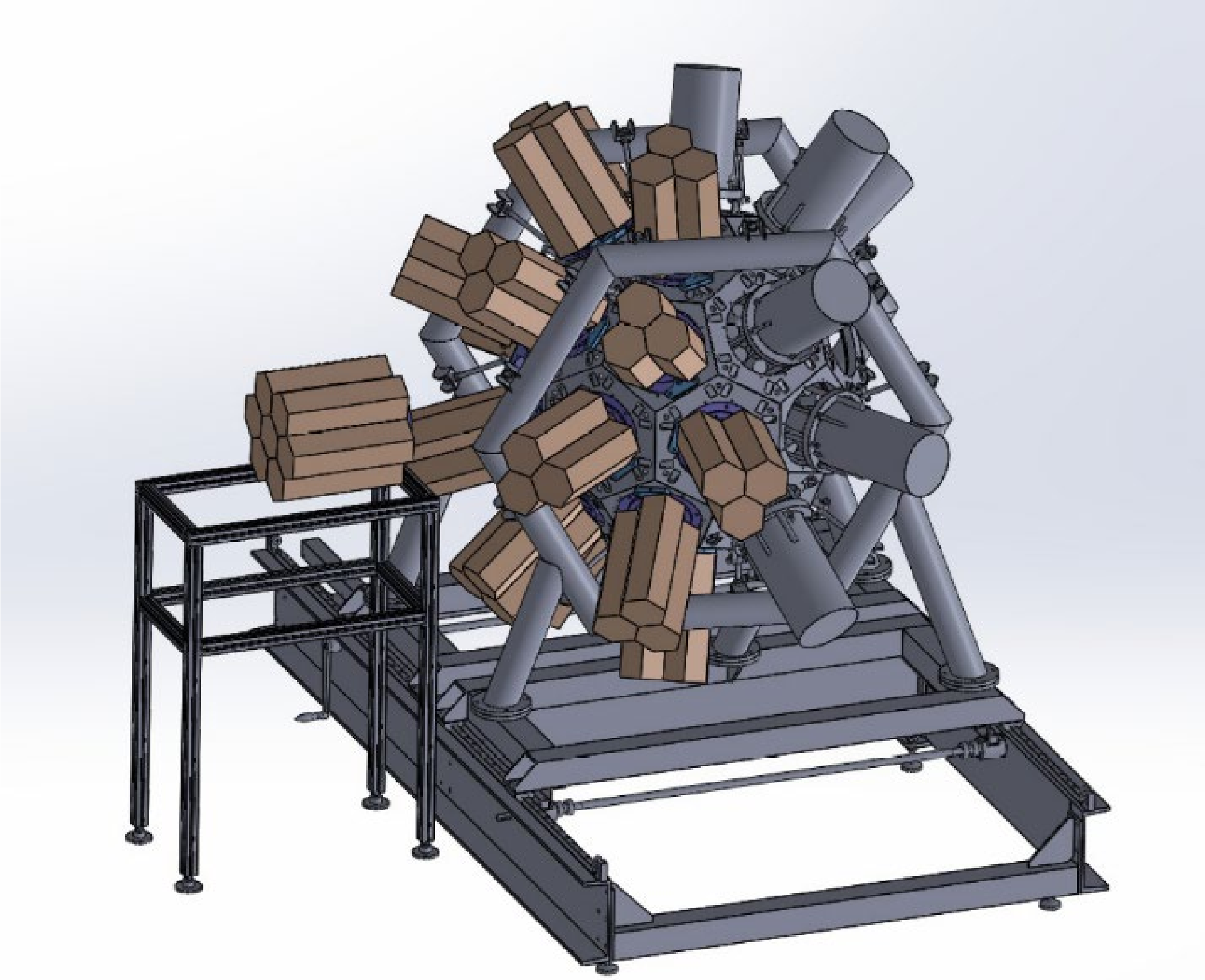
AGATA + NEDA + DIAMANT:
47 days of experiments
without any issues.

NEEDI campaign
(2023 –)

EAGLE + NEDA + DIAMANT:
5 experiments done,
2 in backlog.



NEEDLE 2022-2024

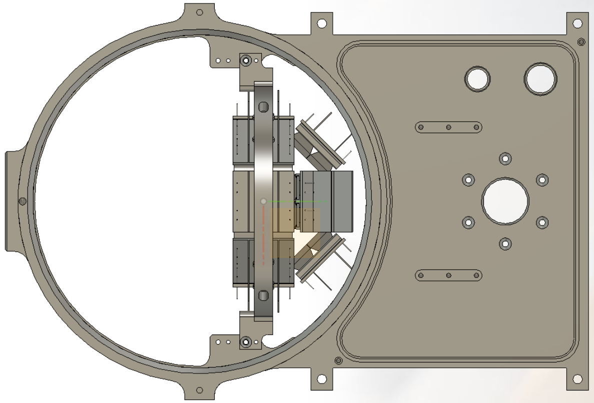


EAGLE (HPGe):
- 5 dets @ 101°
- 5 dets @ 117°
- 5 dets @ 143°

- **NEDA:**
- 6/7 dets ~0°
- 15 dets @ 37°
- 15 dets @ 63°
- 15 dets @ 79°

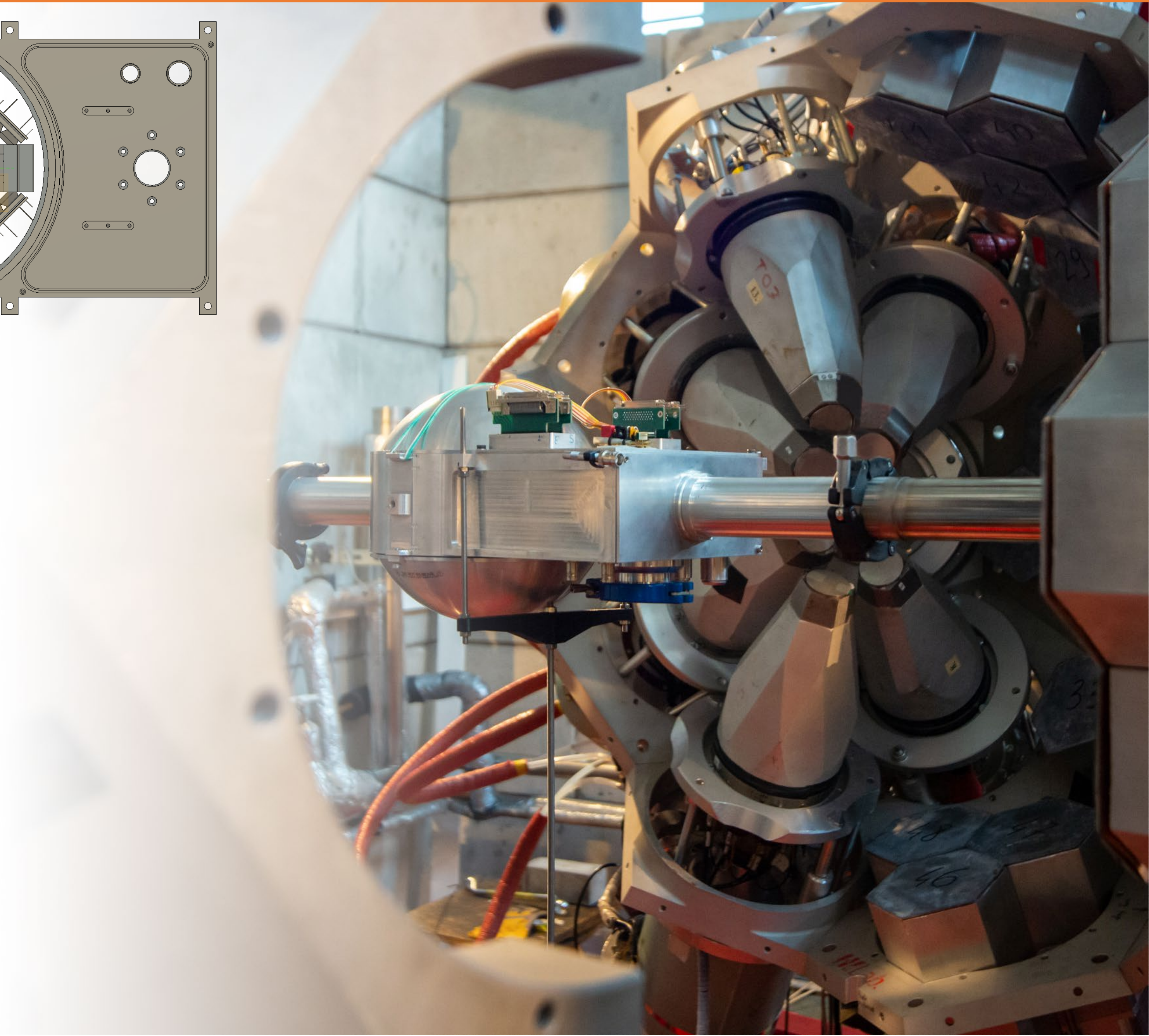
Mechanical adaptation:

- new geometry
- reposition FWW
- new flexiboard
- new targetloader



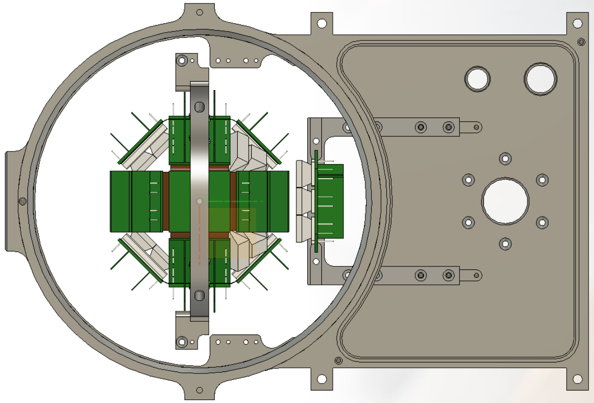
DSP/DAQ:

NUMEXO2 + CAEN V1725s



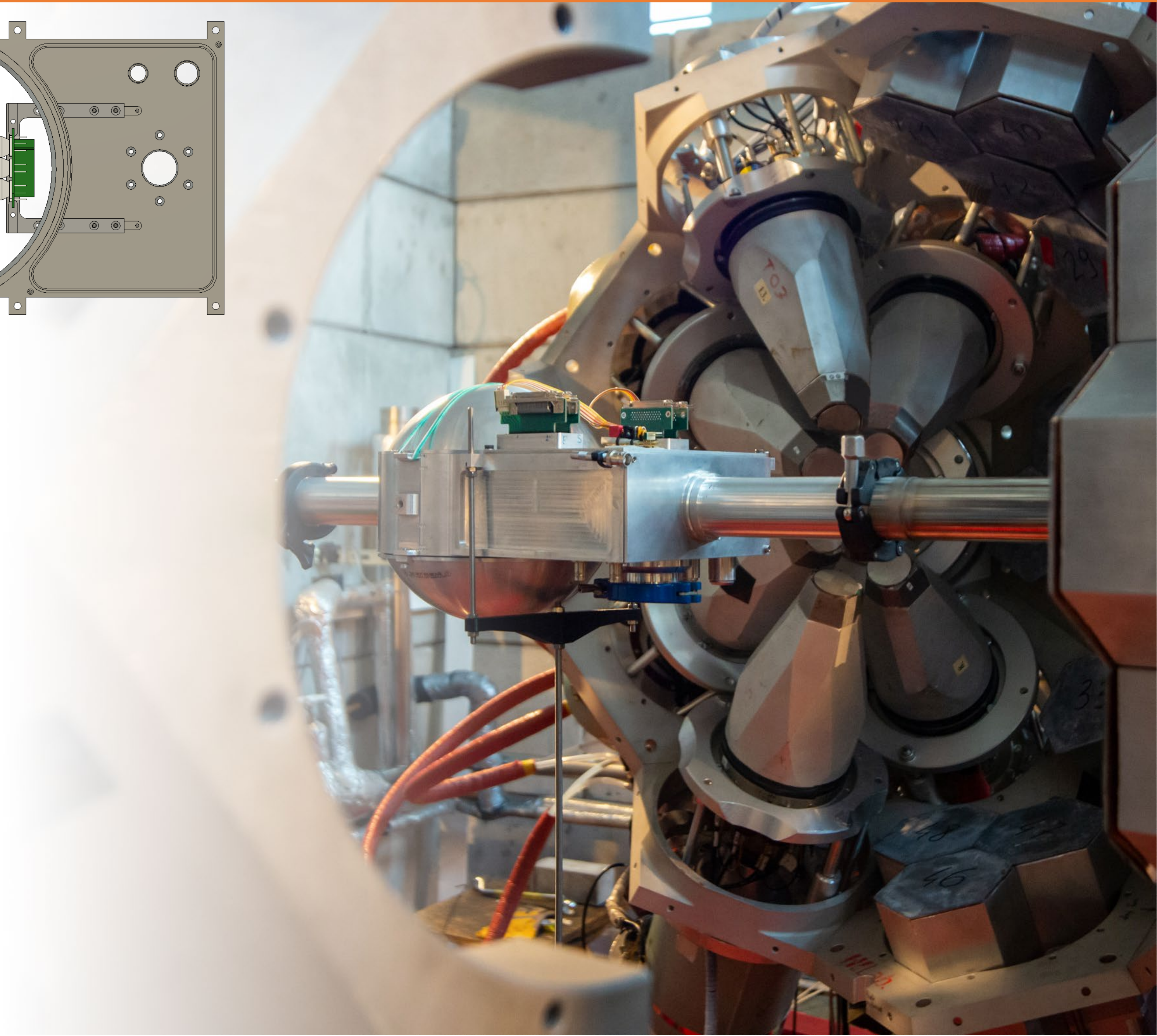
Mechanical adaptation:

- new geometry
- reposition FWW
- new flexiboard
- new targetloader



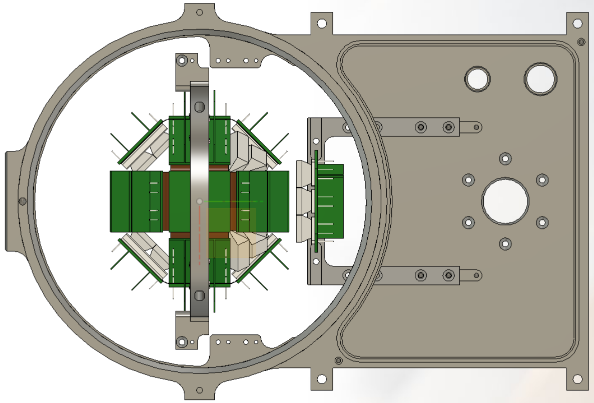
DSP/DAQ:

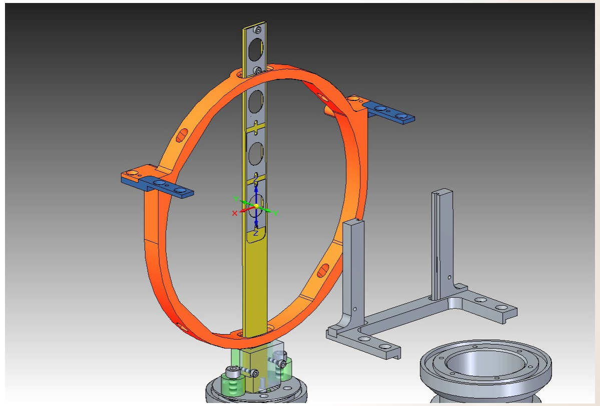
NUMEXO2 + CAEN V1725s



Mechanical adaptation:

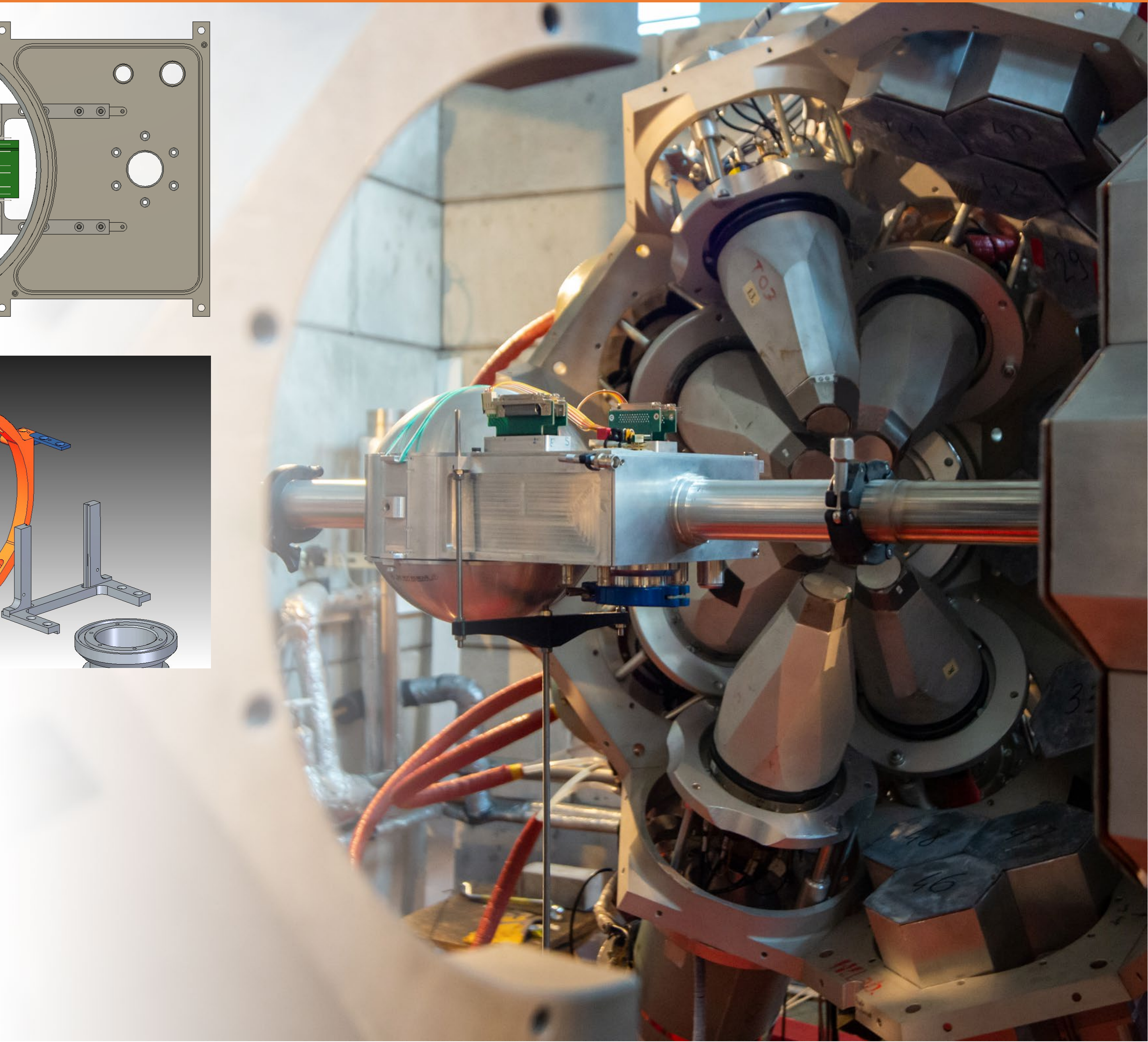
- new geometry
- reposition FWW
- new flexiboard
- new targetloader





DSP/DAQ:

NUMEXO2 + CAEN V1725s

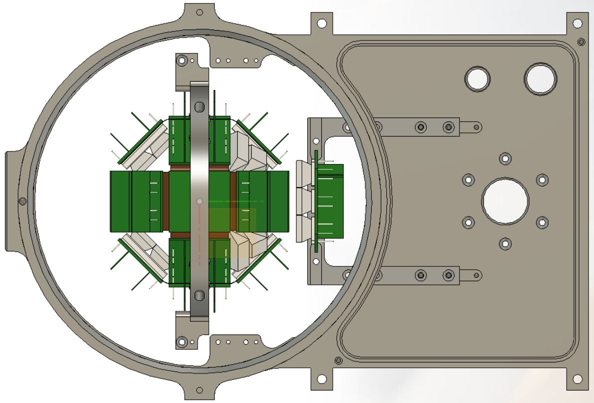


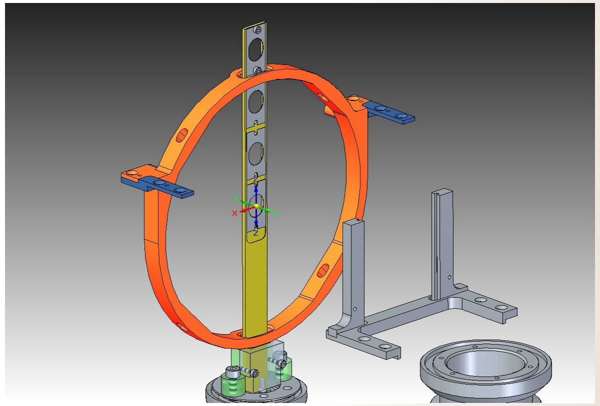
Mechanical adaptation:

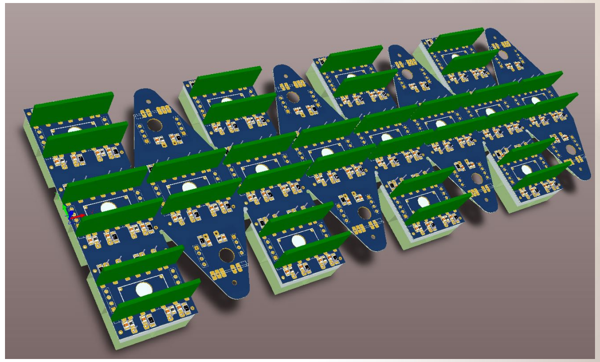
- new geometry
- reposition FWW
- new flexiboard
- new targetloader

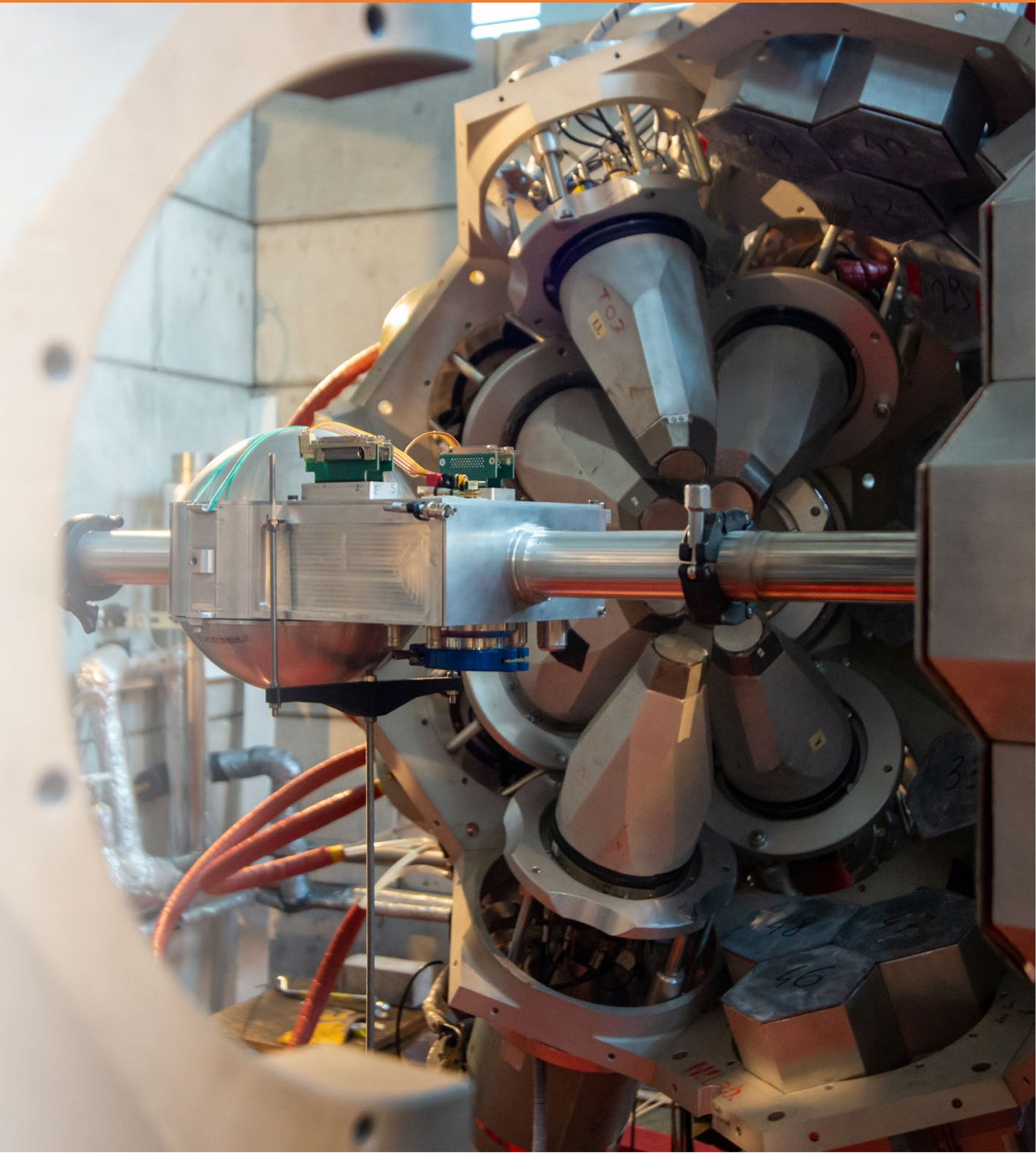
DSP/DAQ:

NUMEXO2 + CAEN V1725s



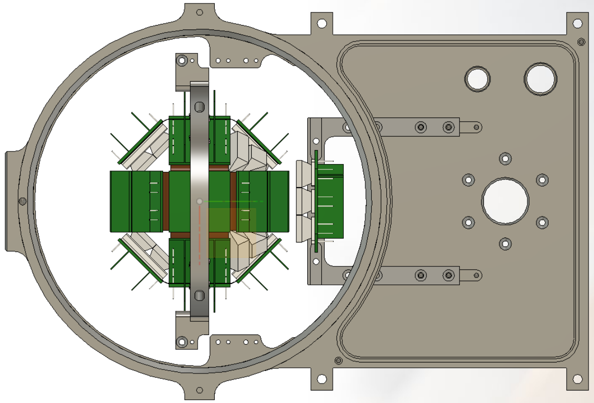


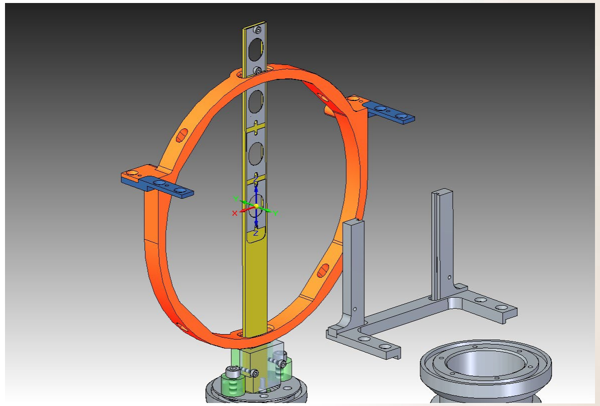


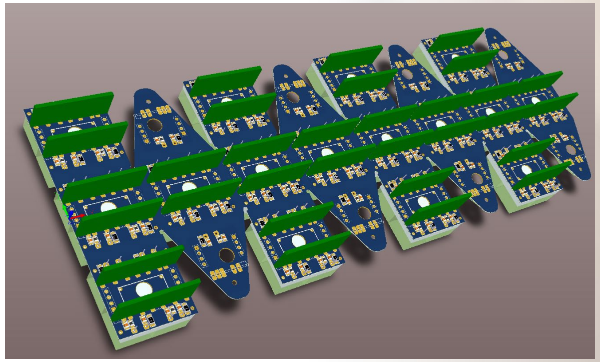


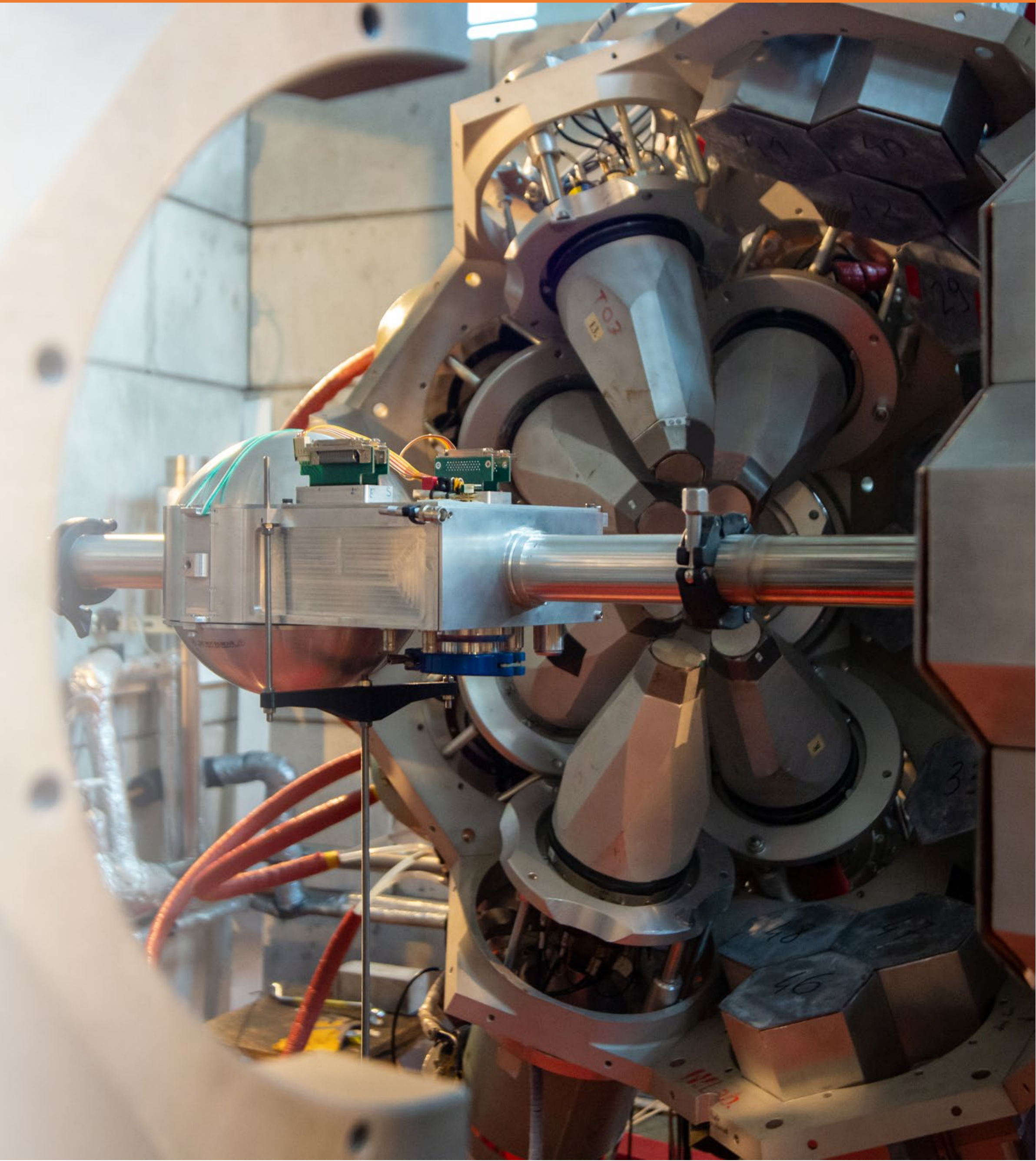
Mechanical adaptation:

- new geometry
- reposition FWW
- new flexiboard
- new targetloader









DSP/DAQ:

NUMEXO2 + CAEN V1725s

NEEDI = NEDA + EAGLE + DIAMANT

Physics cases in 2023:

Single proton-particle levels at N=Z=28 and core softness by studying excited states of ^{57}Cu

Study of the anomalous behavior of the Coulomb energy difference in the A=70, T=1 izobaric multiplet

Gamma-ray spectroscopy of ^{134}Sm

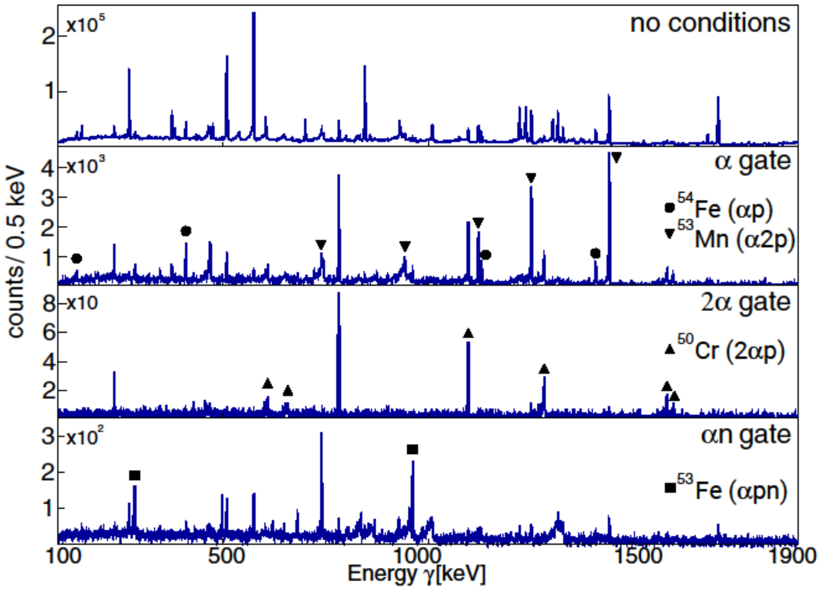
Physics cases in 2024:

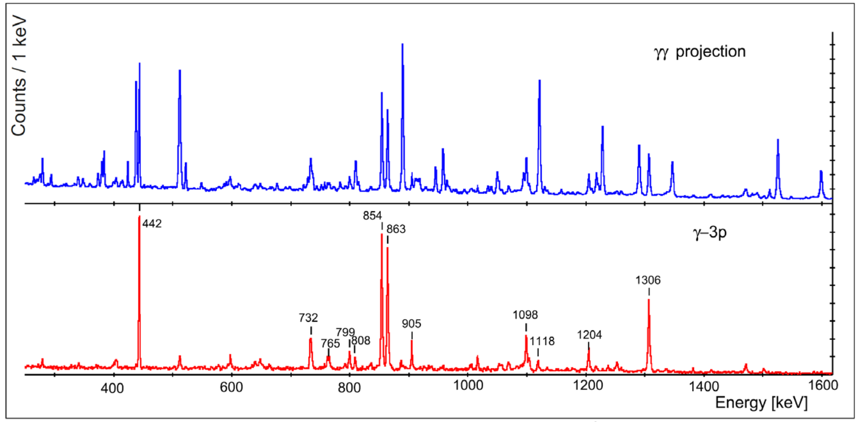
^{144}Dy fission studies

Search for candidate wobbling bands in ^{103}Pd and in ^{101}Ru

The discovery of excited states in very neutron deficient europium nuclei

The discovery of excited states in very neutron deficient ^{63}Ge nucleus





Courtesy of M. Matejska-Minda

HIL105

HIL126

NEEDI = NEDA + EAGLE + DIAMANT

- New setup to access proton-rich nuclei is available in Warsaw
- A handful of experiments have been run with success in 2023 – 2024
- NEDA + DIAMANT : full evaporation channel tagging is available
- Further experiments with NEDA in 2024
- NEDA might go to LNL for a while to visit AGATA
- DIAMANT will stay, DIAMANT will improve!

- Join us for the experiments in Nov-Dec 2024

- Get ready for the next PAC!

Thank you for your attention!

I. Kuti, J. Molnár, Gy. Hegyesi,
D. Sohler, J. Timár,
A. Krakó, B. Kruzsicz

G. Jaworski, M. Palacz,
M. Matuszewski, M. Komorowska,
A. Špaček, M. Kowalczyk,
A. Stolarz, J. Grębosz, P. Sekrecka,
… and many many colleagues from

Heavy Ion Laboratory

Acnowledgments: I.K. acknowledges the support of the International Visegrad Fund under project no. 62320200. The operation of DIAMANT is supported by the National Research, Development and Innovation Fund of Hungary (NKFIH), financed by the project with contract No. TKP2021-NKTA-42, as well as under the K18 funding scheme with projects No. K128947 and No. K147010. The installation and the use of NEDA at HIL is supported by NCN (SONATA) grant no. 2020/39/D/ST2/00466. Support from the GAMMAPOOL network is acknowledged.

Proposal0	Spokes-persons	Title and requested beam	8-hour shifts	
			requested	recommended
HIL117	K. Miernik	*^{144}Dy fission studies* beam: **^{32}S (200 MeV)**; setup: **EAGLE + DIAMANT**	21	21
HIL119	J. Heery / J. Henderson	*Coulomb excitation of ^{34}S* beam: ^{34}S (92 and 129 MeV); setup: EAGLE + DSSSD	21	21
HIL120	C. Liu / S. Y. Wang	*Search for the new chiral nucleus in the 80 mass region: ^{72}As* beam: **^{11}B (50 MeV)**; setup: **EAGLE**	36	36
HIL121	J. Perkowski	*Test of new magnetic selector and digital electronics system for ULESE spectrometer* beam: **^{14}N (90 MeV)**; setup: **EAGLE + ULESE**	7	7
HIL122	N. S. Martorana / E. Geraci	*T-INSIDE (Timing Investigation in SiC Detectors)* beam: **^{12}C (80 - 90 MeV)**; setup: ICARE	10	10
HIL123	B. Gnoffo	*MoReNA Test (Molecular states Resolution with NarCoS)* beam: **^{13}C (80 – 90 MeV)**; setup: **ICARE**	14	14
HIL124	A. Nałęcz-Jawecki	*Search for transition between chiral and non-chiral configuration in ^{128}Cs by lifetime measurement of $I=11^+$, 12^+ states with a plunger technique* beam: **^{22}Ne (85 – 90 MeV)**; setup: **EAGLE + LEPS + Plunger**	36	36
HIL126	I. Kuti	*Search for candidate wobbling bands in ^{103}Pd and in ^{101}Ru* beam: **^{12}C (69 MeV)**; setup: **EAGLE + NEDA + DIAMANT**	42	42
HIL127	A. Fijałkowska / G. Jaworski	*The discovery of excited states in very neutron deficient europium nuclei* beam: **^{40}Ca (180 - 190 MeV)**; setup: **EAGLE + NEDA + DIAMANT**	45	45
HIL129	G. Jaworski / A. Fijałkowska	*The discovery of excited states in very neutron deficient ^{63}Ge nucleus* beam: **^{40}Ca (100 - 110 MeV)**; setup: **EAGLE + NEDA + DIAMANT**	45	45

Cyklotron K= 90 – 160						
Jon	Energy min [MeV]	Energy max [MeV]	Energy max [MeV/nukl]	Intensity of the extracted beam [nA]	Intensity of the extracted beam [pnA]	Intensity of the extracted beam [p/s]
$^{10}B^{+2}$	51	55	5.5	45	9.0	$5.6\ 10^{+10}$
$^{11}B^{+2}$	40	50	4.5	50	10.0	$6.3\ 10^{+10}$
$^{12}C^{+2}$	38	50	4.2	100	16.7	$1.0\ 10^{+11}$
$^{12}C^{+3}$	53	92	7.7	220	36.7	$2.3\ 10^{+11}$
$^{13}C^{+3}$		90	6.9	90	16	
$^{14}N^{+2}$	32	50	3.6	240	34.3	$2.1\ 10^{+11}$
$^{14}N^{+3}$	57	91	6.5	1500	214.3	$1.3\ 10^{+12}$
$^{15}N^{+3}$		43	2.9	50	7.1	
$^{16}O^{+3}$	46	80	5.0	400	50.0	$3.1\ 10^{+11}$
$^{16}O^{+4}$	80	120	7.5	650	81.3	$5.1\ 10^{+11}$
$^{18}O^{+4}$	100	120	6.7	2000	250.0	$1.6\ 10^{+12}$
$^{19}F^{+3}$	50	66	3.5	10	1.1	$6.9\ 10^{+9}$
$^{20}Ne^{+3}$	45	68	3.4	300	30.0	$1.9\ 10^{+11}$
$^{20}Ne^{+4}$	68	115	5.8	1300	130.0	$8.1\ 10^{+11}$
$^{20}Ne^{+5}$	130	160	8.0	120	12.0	$7.5\ 10^{+11}$
$^{22}Ne^{+3}$	44	55	2.5	260	26.0	$1.6\ 10^{+11}$
$^{24}Mg^{+4}$		77	3.2	120	10	
$^{32}S^{+5}$	79	110	3.4	50	3.1	$2.0\ 10^{+10}$
$^{32}S^{+6}$	*120*(*)	150	4.7	70	4.4	$2.7\ 10^{+10}$
$^{32}S^{+7}$	*120*(*)	142	4.4	50	3.1	$2.0\ 10^{+10}$
$^{40}Ar^{+6}$	*90*(*)	132	3.7	100	5.6	$3.6\ 10^{+10}$
$^{40}Ar^{+7}$	*130*(*)	164	4.1	35	1.9	$1.2\ 10^{+10}$
$^{40}Ar^{+8}$	*180*(*)	200	5.0	40	2.2	$1.4\ 10^{+10}$

(*) estimation, no experimental data