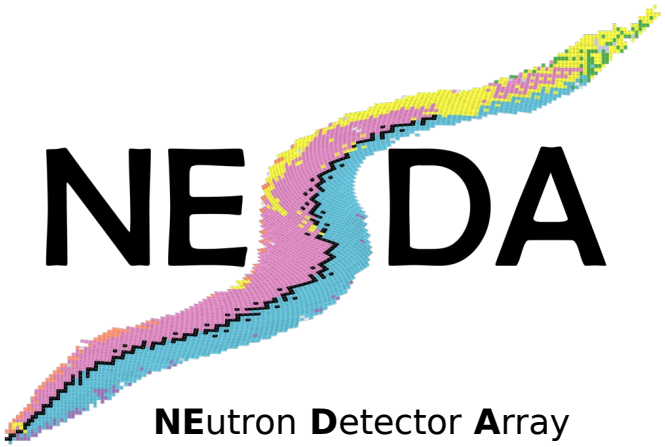


NE DA @

HIL

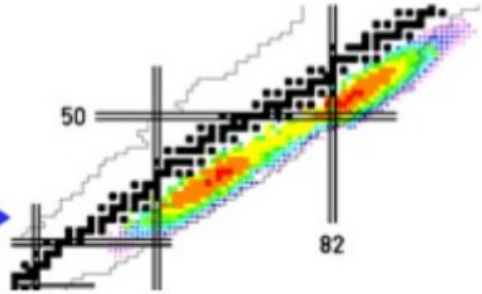
Heavy Ion Laboratory

Grzegorz Jaworski

HIL UW

NEDA kick-off meeting (2007)

Spiral2



NWall at GANIL and New Neutron Detectors for SPIRAL 2

Heavy Ion Laboratory, University of Warsaw
4-5 October 2007
lecture room B

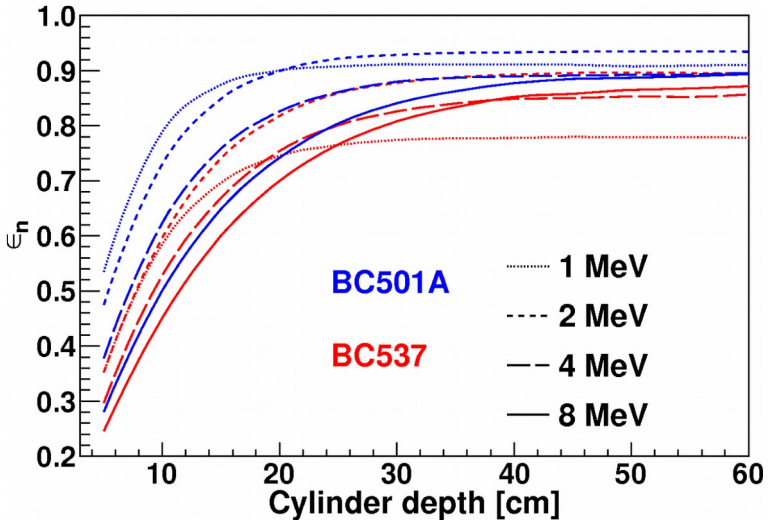
The aim of the first day of the meeting is to evaluate plans of future experiments with the Neutron Wall at GANIL, especially in connection to the current call for proposals, with the submission deadline on 6 November 2007.
The second day of the meeting will be devoted to the construction of the new neutron detector system for SPIRAL 2.

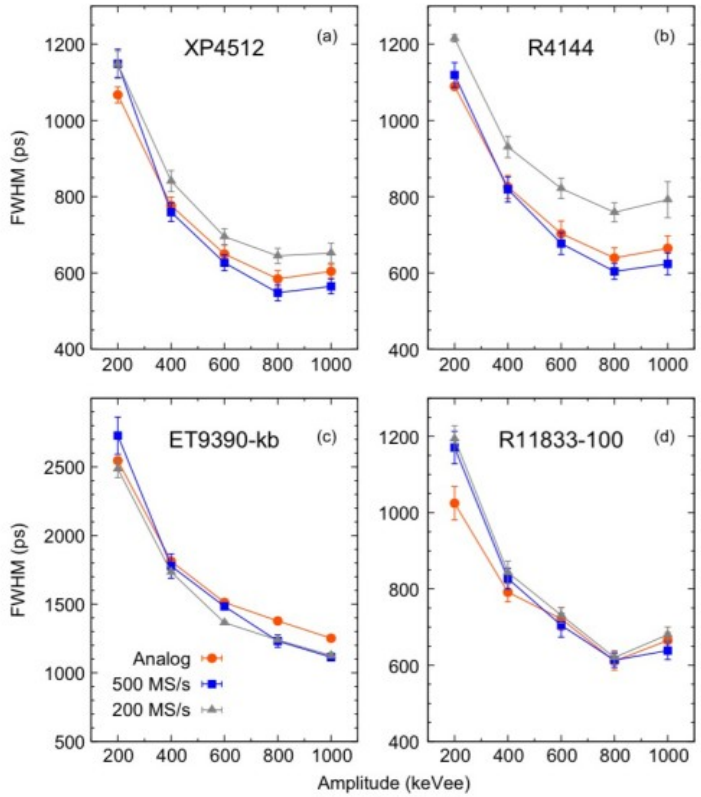
Organisers: Johan Nyberg, Marcin Palacz, Javier Valiente

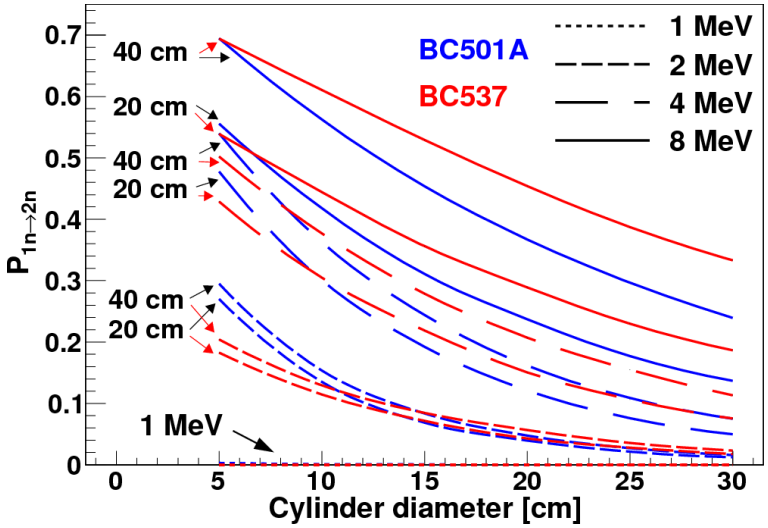
Timeline

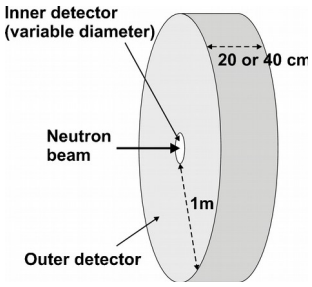
- NEDA (phase 1) was constructed in years 2007-2018
- NEDA in 2018 was used with AGATA@GANIL
- NEDA is now moved to HIL for experiments with EAGLE
- NEDA goes to LNL to be coupled to AGATA in the 2nd half of 2023
- In future NEDA can be used with EXOGAM2, GALILEO, PARIS, etc, for experiments with high intensity stable and radioactive ion beams

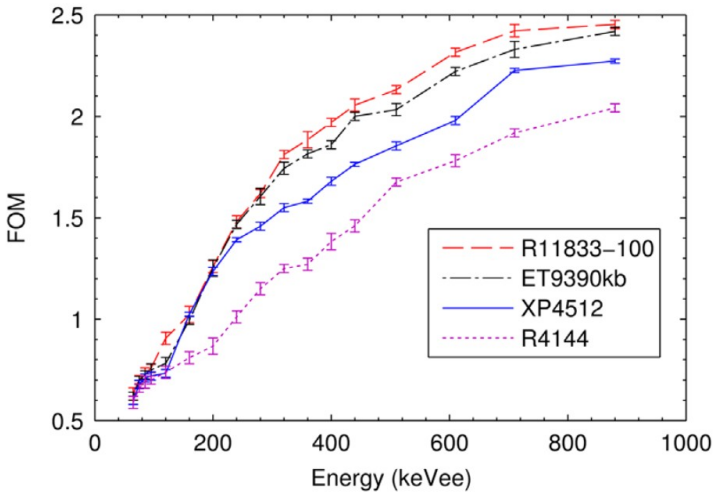
Sims and measurements for optimum det & PMT





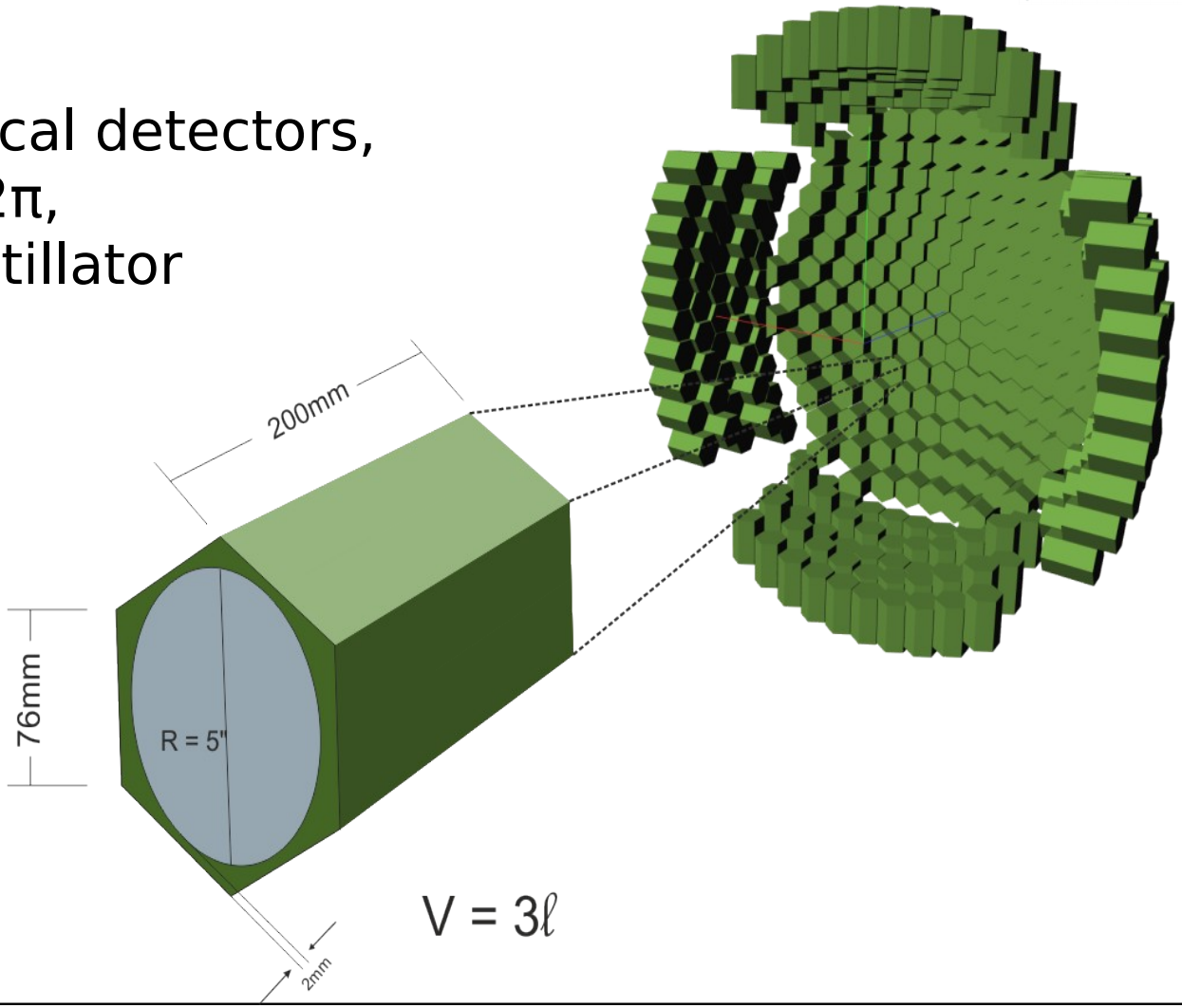






Ultimate goal

355 identical detectors,
covering 2π,
EJ301 scintillator



Production of detectors

59 detectors constructed

- → Detector vessels and PMT housings are made by welding flanges to hexagonal profiles
- → EJ520 TiO_2 paint; TorrSeal; 5” 5mm BK7 glass
- → Expansion bellow – ΔT = 40 K.
- → EJ301 (BC501) liquid scintillator

- → SBA R11833-100HA 5” PMT (32% Q.E.)
- → custom transistorized VD provided by Świerk
- → mu-metal shielding (1 mm)

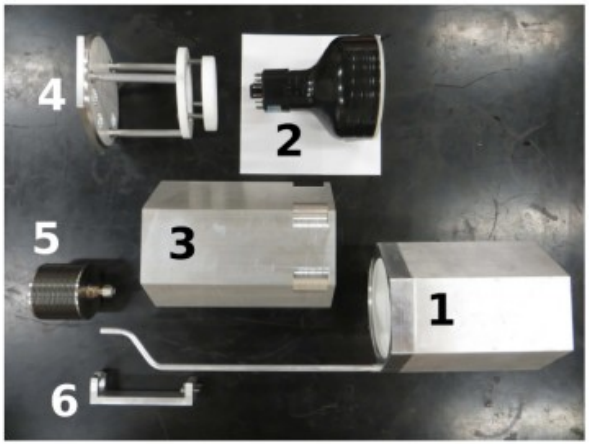
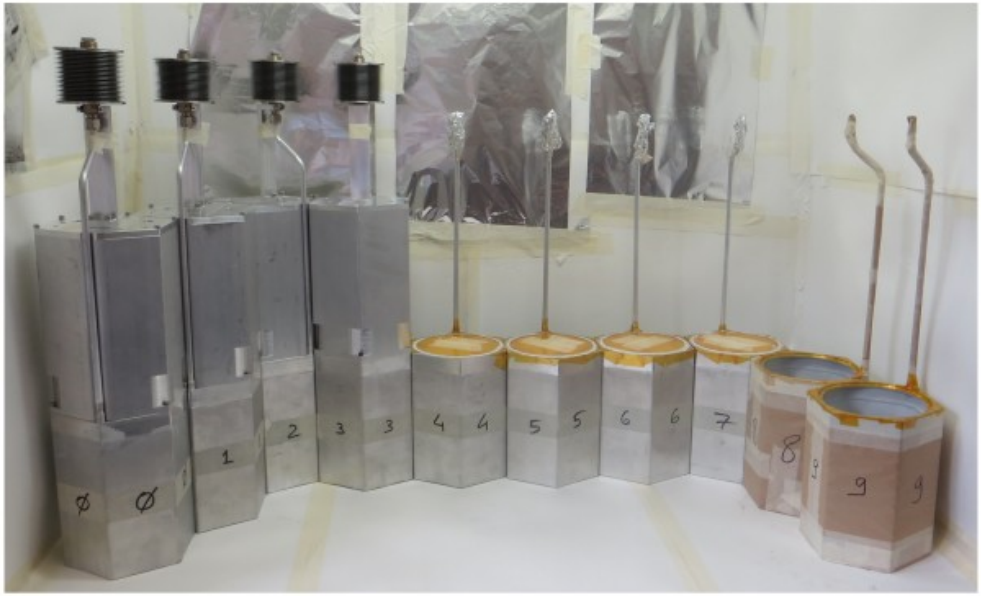
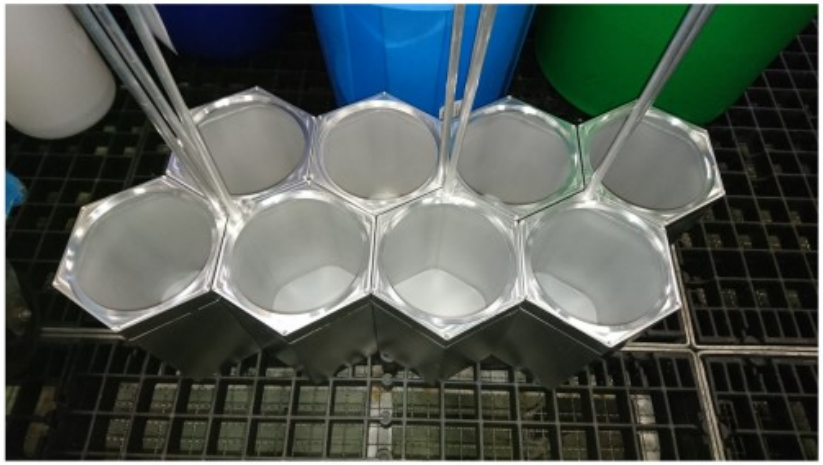
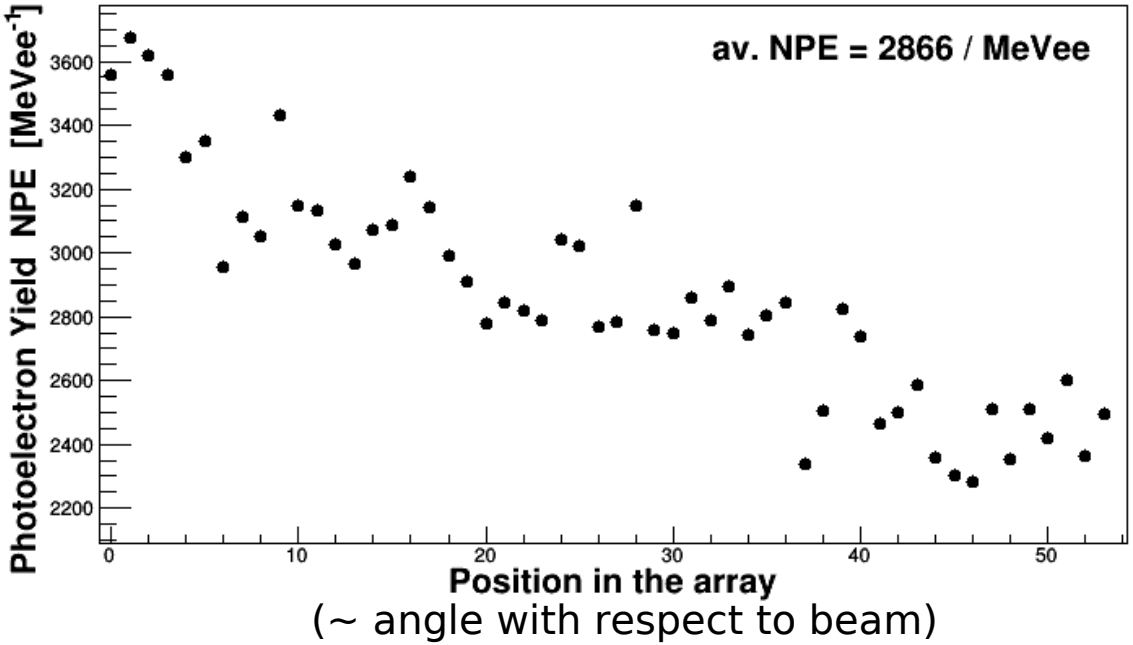


Fig. 1. Elements used for the construction of the NEDA detector: detector cell, with extension pipe (1); PMT (2); PMT housing (3); PMT pusher (4); the bellow (5) and the support for the bellow (6).





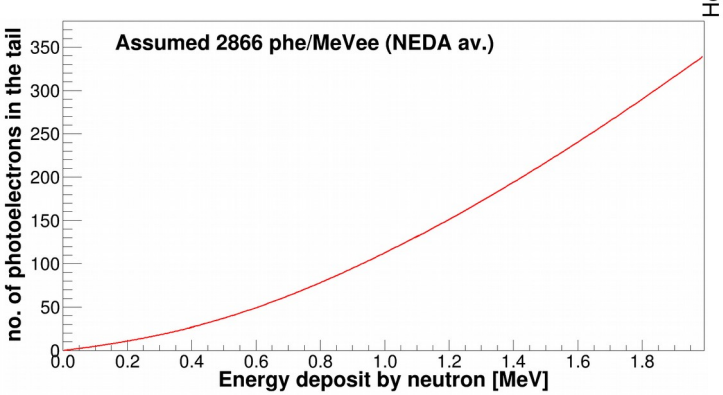
Light matters!

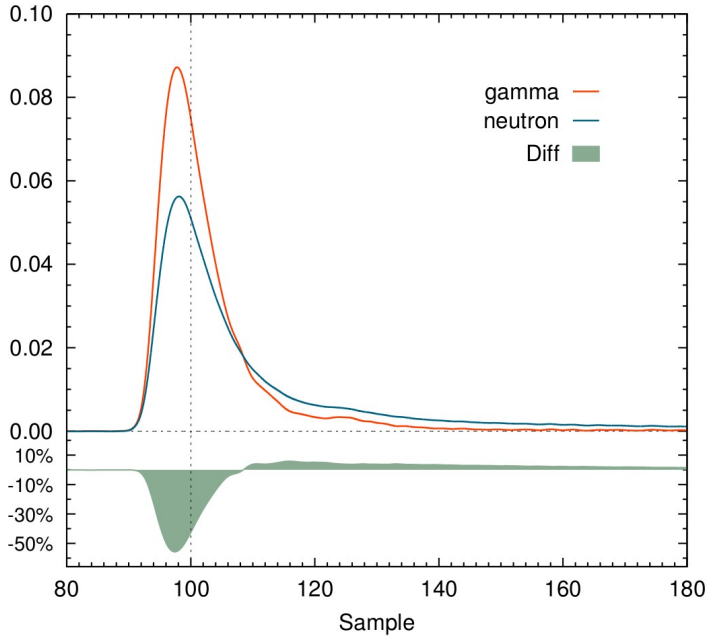


(~ angle with respect to beam)

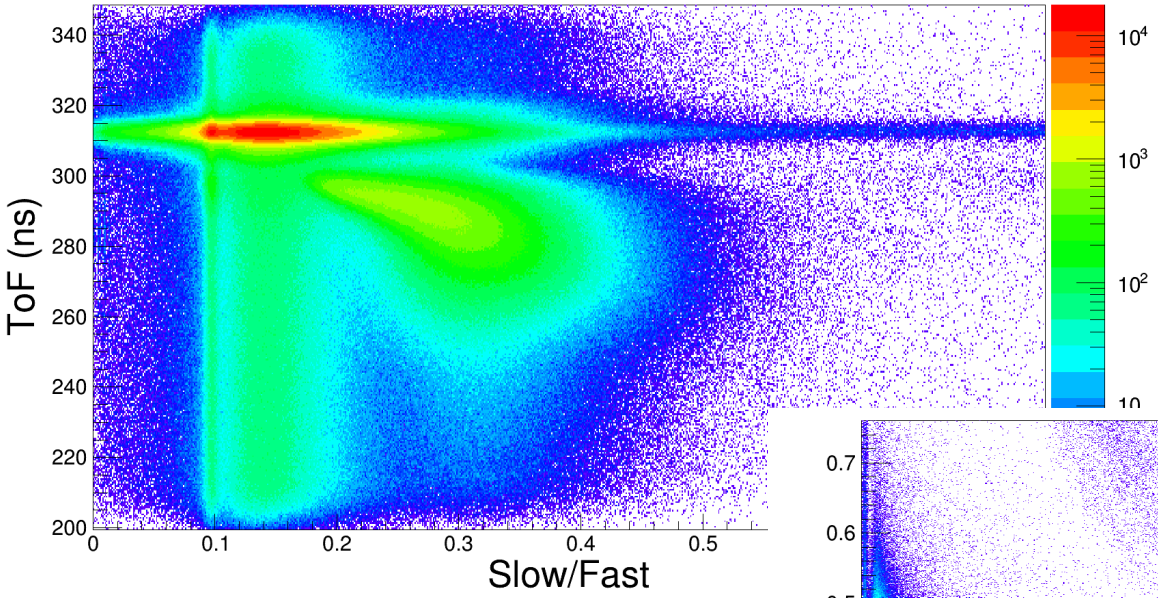
Neutron Wall:
~1300 new 1998
472 av. 01.2018

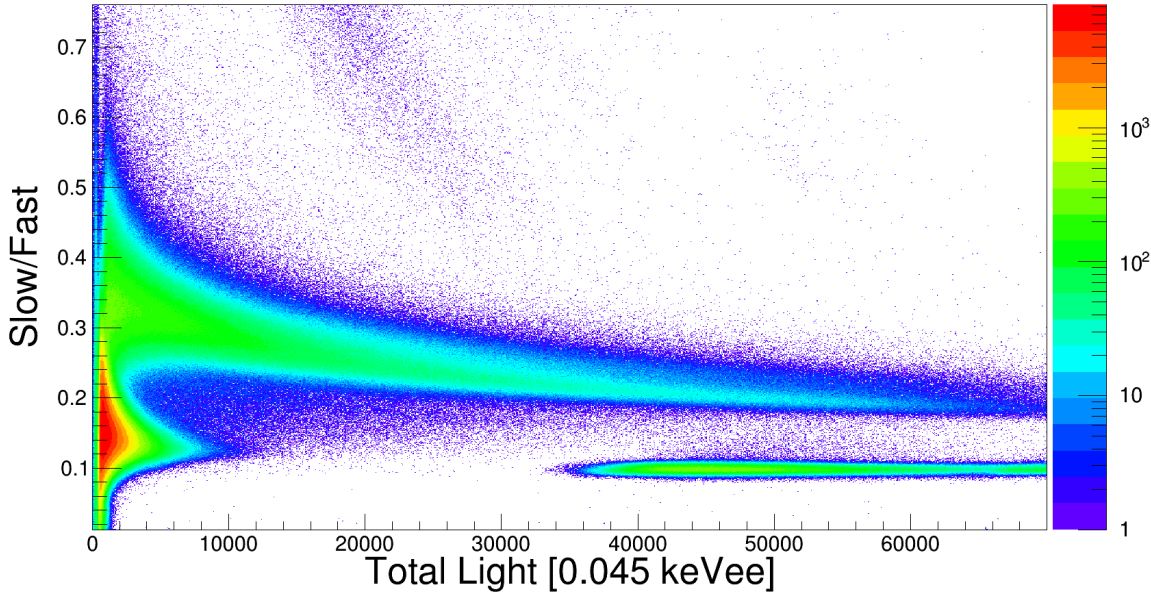
1800 – Bicron 5”x5”





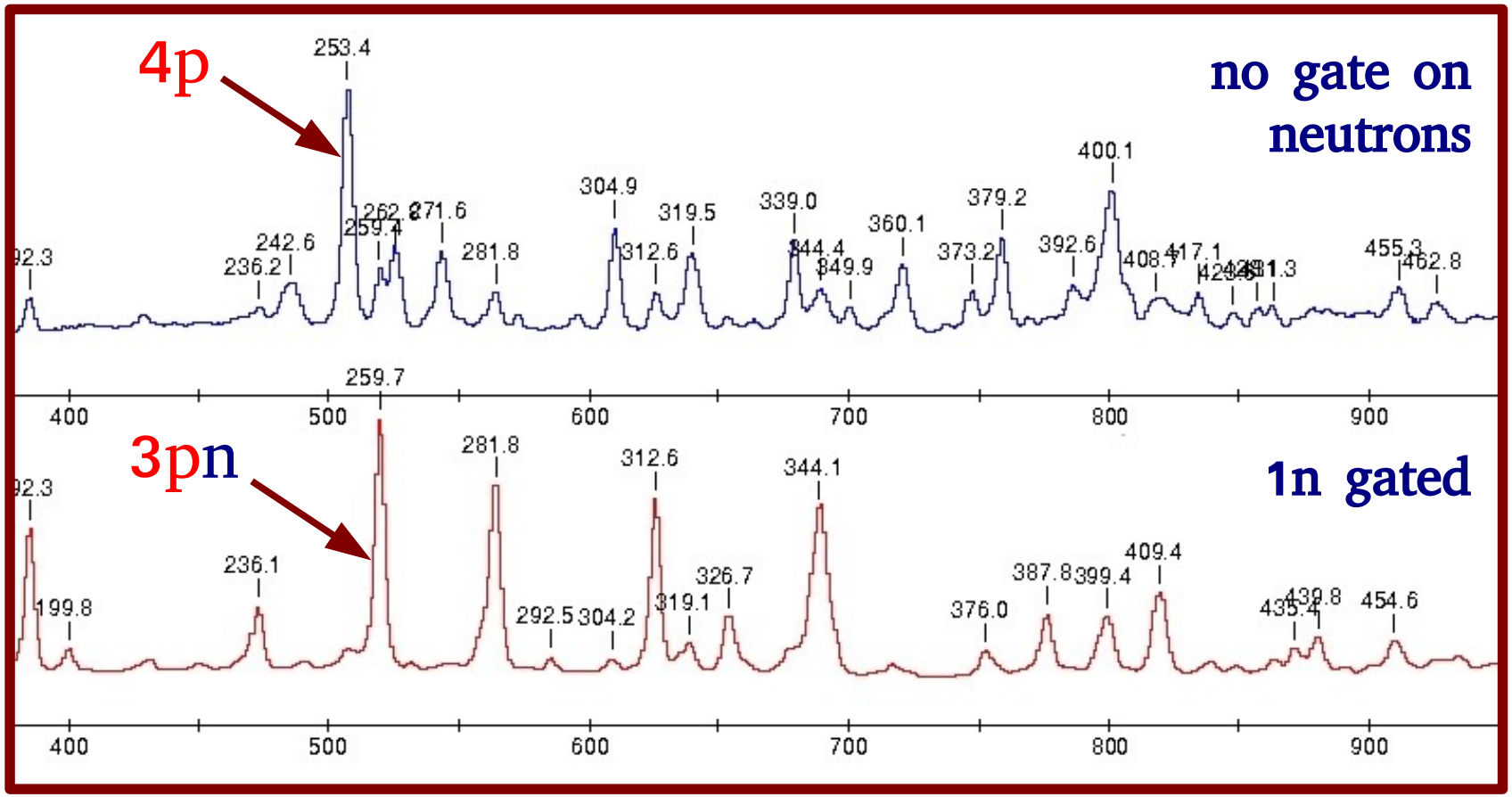
n/γ discrimination





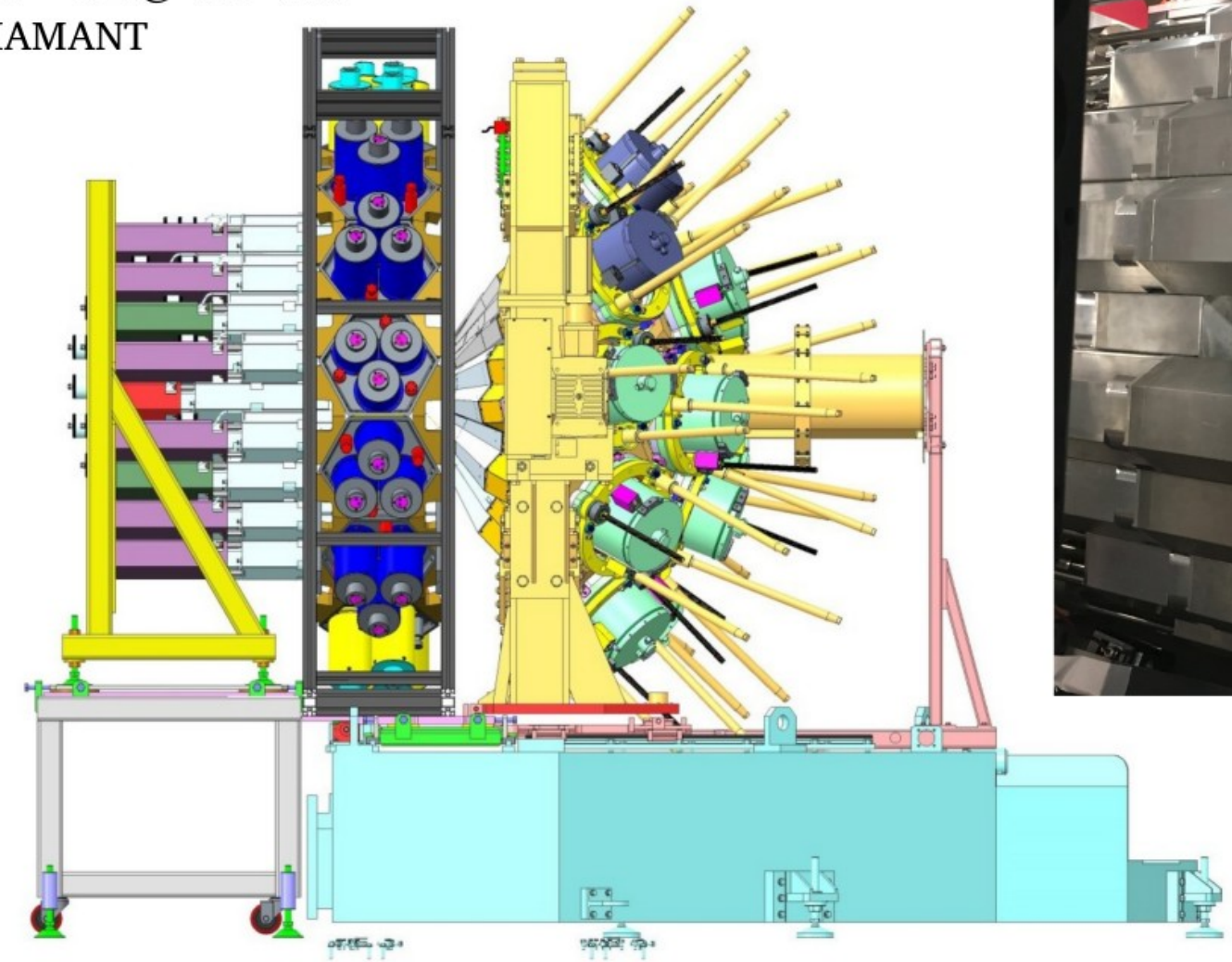
n selection

EXOGAM experiment: ^{58}Ni (240 MeV) + ^{54}Fe

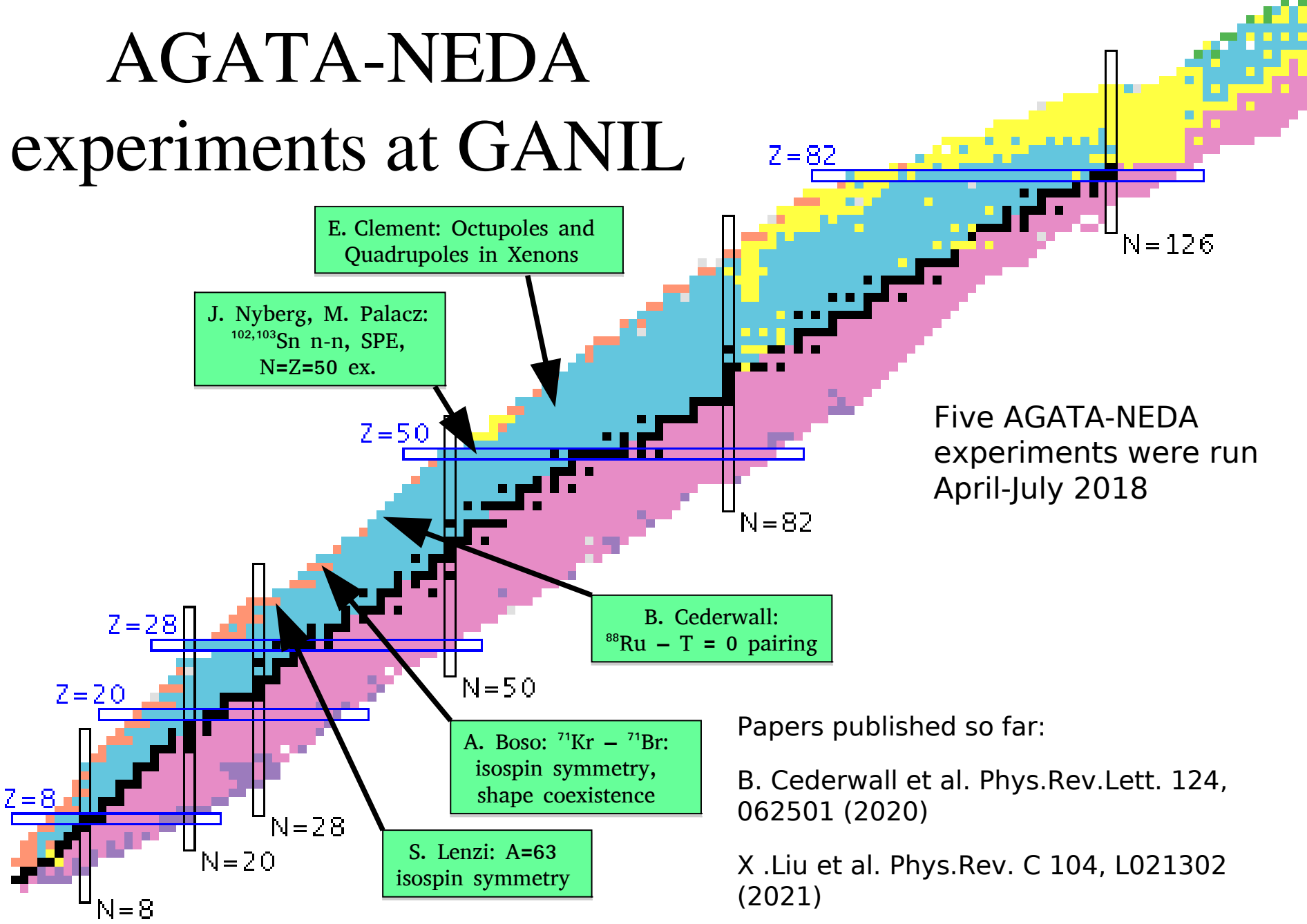


NEDA at GANIL (2018)

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

Papers published so far:

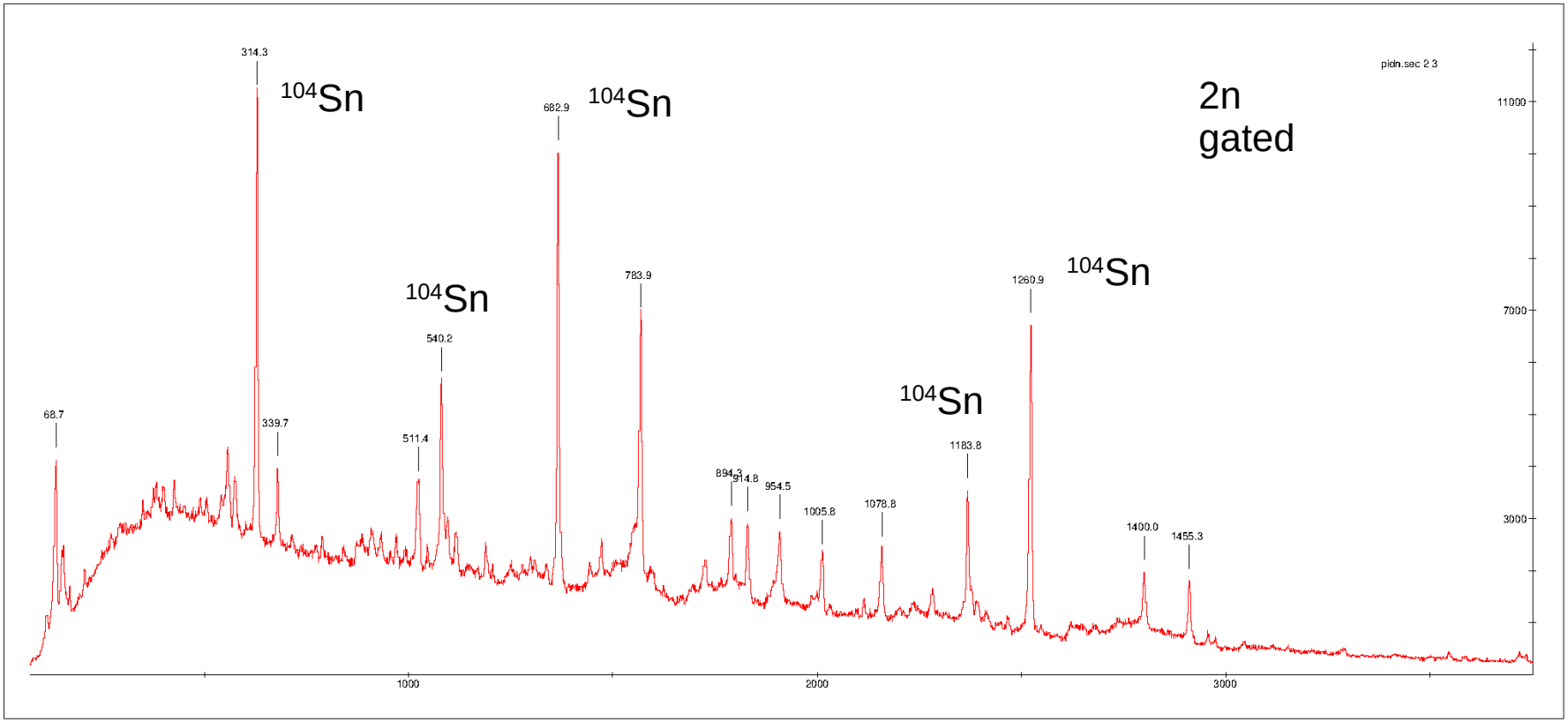
B. Cederwall et al. Phys.Rev.Lett. 124, 062501 (2020)

X .Liu et al. Phys.Rev. C 104, L021302 (2021)

Performance at GANIL (E703 experiment)

^{50}Cr (175 MeV) + $^{58}Ni \rightarrow {}^{108}Te$ (CN)

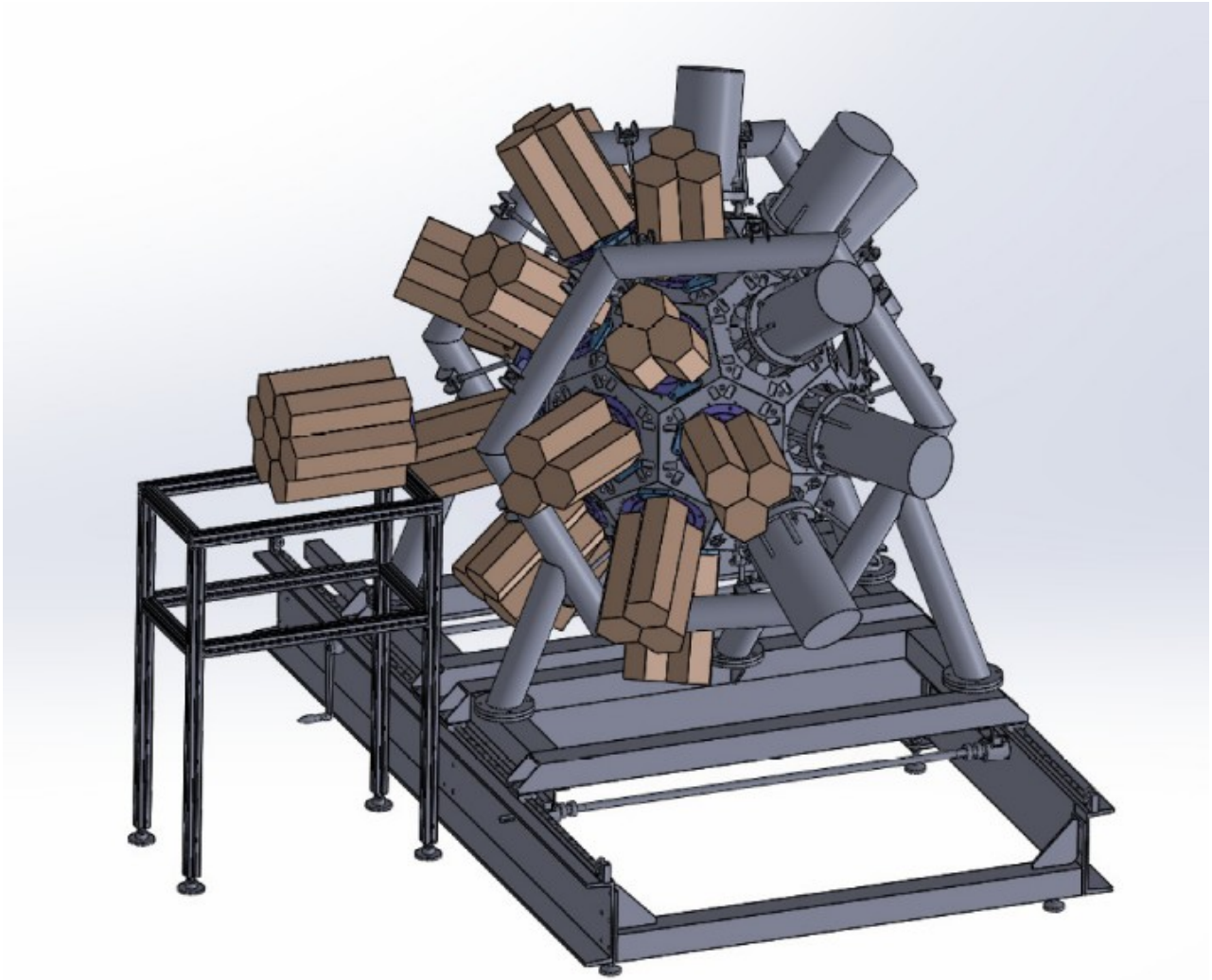
$\varepsilon_n = 0.3 \quad \varepsilon_{2n} \approx 0.06 \quad P(\gamma \rightarrow n) \approx 0.001 \quad P(1n \rightarrow 2n) \approx 5*10^{-4}$



Total fusion x-section ≈ 300 mb

^{104}Sn produced with the emission of 2p2n $\quad \sigma(^{104}Sn) \approx 0.5$ mb

NEEDLE 2022-2023



Drawing by B. Radomyski

EAGLE:

- 5 dets @ 101°
- 5 dets @ 117°
- 5 dets @ 143°

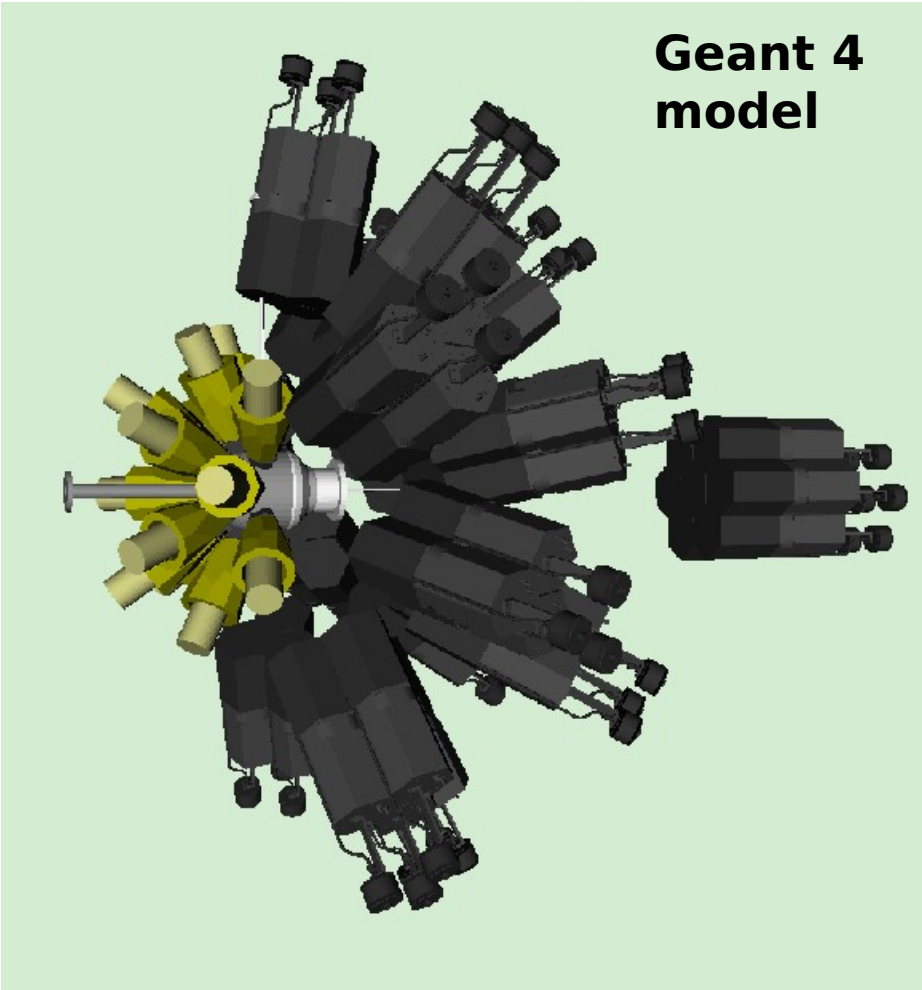
NEDA:

- 6 dets ~0°
- 15 dets @ 37°
- 15 dets @ 63°
- 15 dets @ 79°

Efficiencies

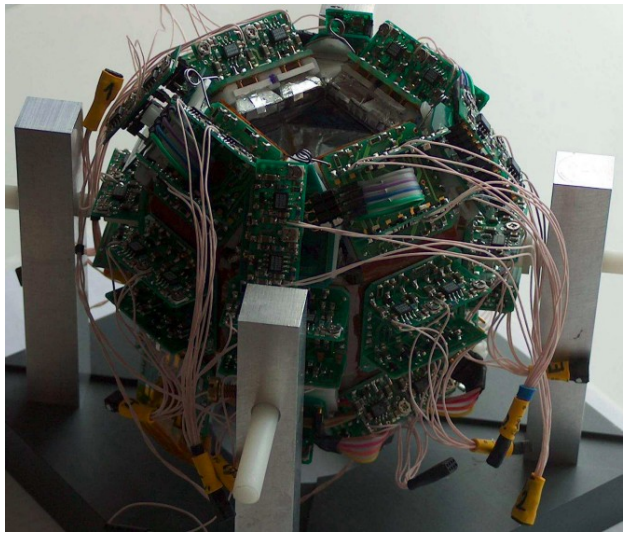
Basic parameters:

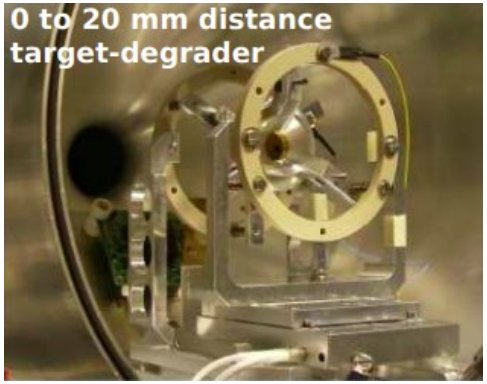
- EAGLE: 15 det. ACS HPGe
  eff(γ) = 1.5% @1.3 MeV
- NEDA: 51 det.
  eff(1n) = 20-25%, eff(2n) = 3%
- NEEDLE: eff(γγ2n) = 6.75e-6



Other ancillaries

- DIAMANT – charged particle detector
- Electron spectrometer
- plunger(s)





Beams

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

^{58}Ni in spe...

NEDA @ HIL prePAC Workshop, 20-21 October 2021

Wednesday, 20 October 2021				
12:00				Start of the registration
13:00	01:00	14:00		Lunch
Session 1. Chair: Katarzyna Wrzosek-Lipska				
14:00	00:30	14:30	Macin Palacz	Welcome. NEDA - the story and performance of
14:30	00:30	15:00	Grzegorz Jaworski	NEDA at HIL
15:00	00:20	15:20	Christoph Fransen	Köln plunger
15:20	00:15	15:35	Jarosław Perkowski	Electron Spectrometer
15:35	00:30	16:05		Coffee break
Session 2. Chair: Magda Górska-Ott				
16:05	00:25	16:30	Bahadir Saygı	Collectivity of 160Hf, 162W and 138Sm
16:30	00:25	16:55	Bahadir Saygı	Searching for X(5) symmetry in 132Nd
16:55	00:25	17:20	Dmitry Testov	np-correlations in rotational band alignments in light Cs isotopes
17:20	00:25	17:45	Costel Petrache	Lifetimes of bands in proton-rich Ba-Cs nuclei
19:30				Workshop dinner, restaurant "Stara Szafa", ul. Ludna 10

Thursday, 21 October 2021				
09:00	00:30	09:30		Coffee
Session 3. Chair: Katarzyna Hadyńska-Klęk				
09:30	00:10	09:40	Paweł Napiorkowski	Late welcome from the director of HIL
09:40	00:20	10:00	István Kuti	DIAMANT
10:00	00:25	10:25	Marcin Palacz	Single particle states and N=Z=28 core excitations in 57Cu
10:25	00:25	10:50	Bahadir Saygı	Lifetime Measurement of Isobaric Analog States in 45V and 49Mn
10:50	00:30	11:20		Coffee
11:20	00:25	11:45	Bahadir Saygı	Reduced transition probabilities of excited states in non-yrast bands of 166 Yb and 162Er
11:45	00:25	12:10	Rafael Escudeiro	Test of isospin symmetry in E1 transitions in the T=1/2 A=35 mirror pair
12:10	00:10	12:20	Marcin Palacz	Summary
12:20	00:40	13:00		Discussions (in the lecture hall and at the experimental site)
13:00	01:00	14:00		Lunch

The workshop is sponsored by the University of Warsaw within the “Excellence initiative” programme.

During the workshop: 8 LoI presented, ~11 measurements (beam-target combinations)

New LoIs are welcome any time.

Proposals are needed soon (PAC early 2022).

NEEDLE – Schedule

- NEDA detectors and associated equipment to be transported in mid Nov. 2021
- Mechanical adaptation – ongoing – to be finished in Dec. 2021
  Purchases of needed electronics etc – ongoing…
- Installation, configuration of the electronics, tests on the sources – asap – early 2022.
- 1st PAC – first half of 2022 (possible 2nd PAC fall 2022).
- Comissioning
- Experimental campaigns – 2nd half of 2022, 1st half of 2023
- 2nd half of 2023 – NEDA goes to LNL

Summary

- 59 high quality neutron detectors constructed
- Versetile, 70% int.efficiency, excellent NGD
- NEEDLE: 1st PAC – first half of 2022.
- NEEDLE: campaigns – 2nd half of 2022, 1st half of 2023

neda
It's good for you!

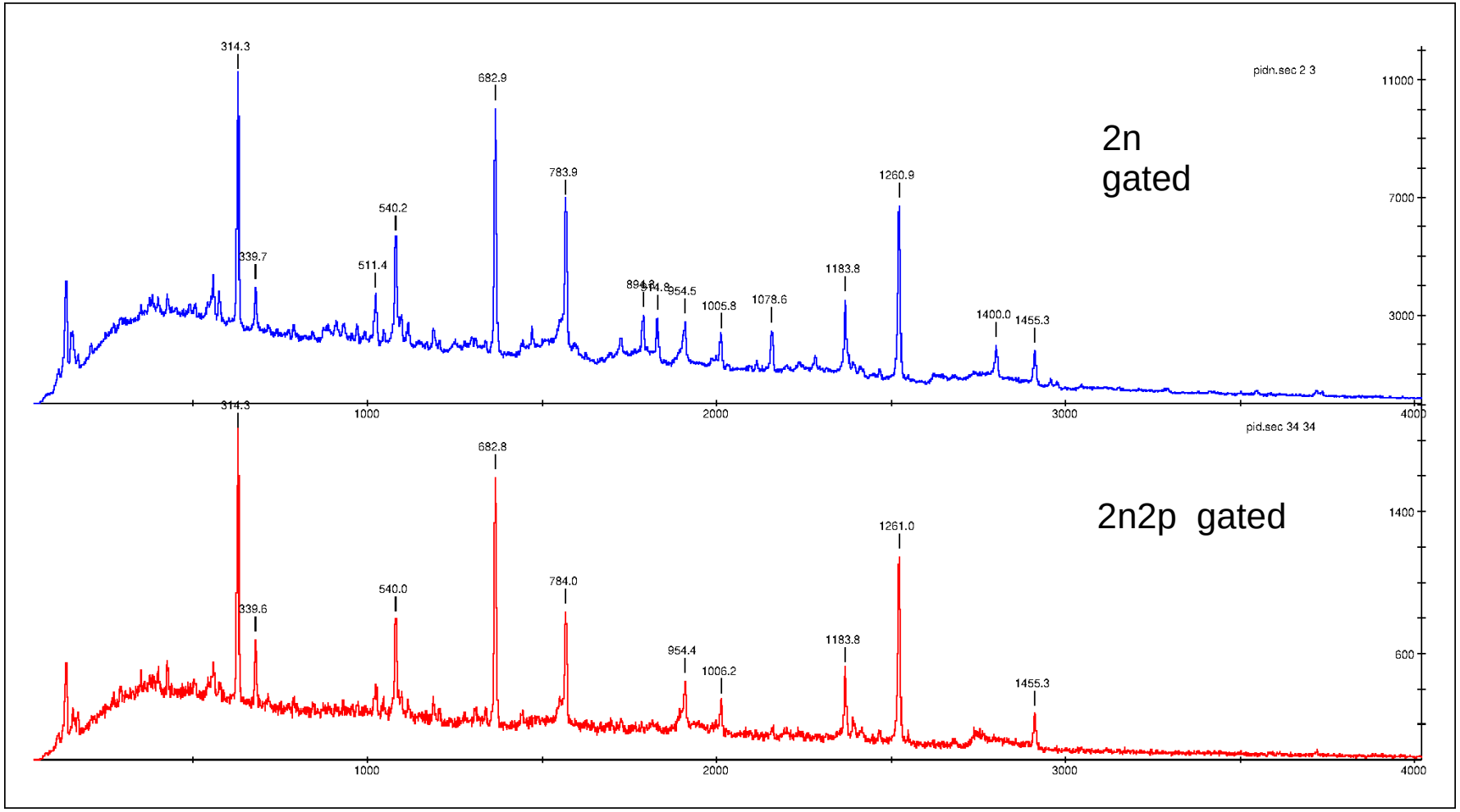
Acnowledgment: Polish contribution to NEDA, studies of proton-rich nuclei, and installation of NEDA at HIL is supported by NCN grants:
2017/25/B/ST2/01569 (OPUS)
2020/39/D/ST2/00466 (SONATA)


NEDA

NEEDLE Workshop


NEDA

NEDA and DIAMANT



Read-out – NEEDLE

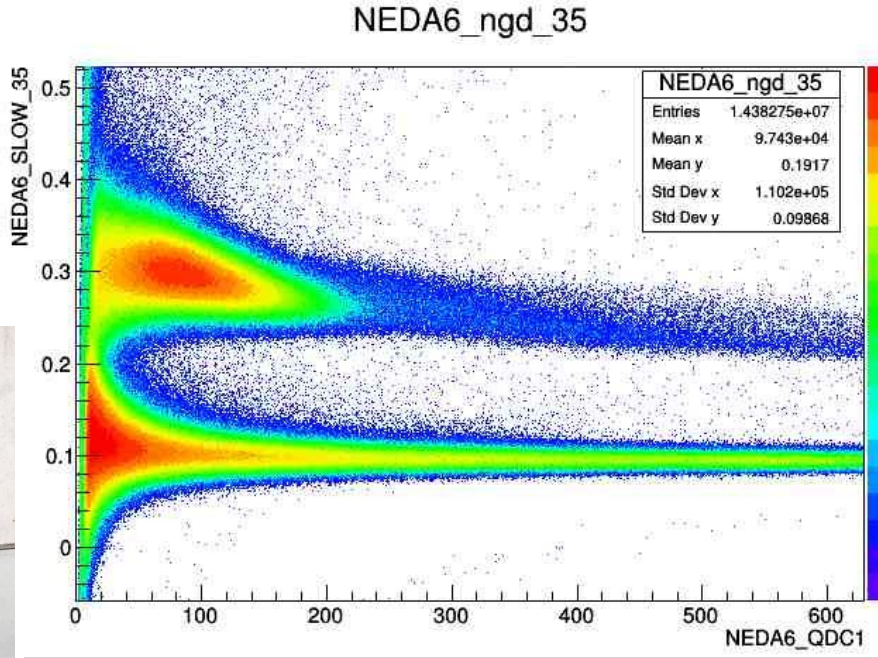
NEDA: Caen V1725 x4 with DPP-PSD
EAGLE: V1725 x2 with DPP-PHA

- 250 MHz, 14 bit
- 16-ch VME modules:
  - MCX connectors
- Dynamic range 0.5 and 2 Vpp
  + setable DC offset
- DPP algorithms implemented in FPGA:
  PHA, PSD
- Read-out – optical link (and VME64)
- 16 programmable LVDS I/Os
- Daisy chain possibility
- COMPASS, C & LabVIEW libraries

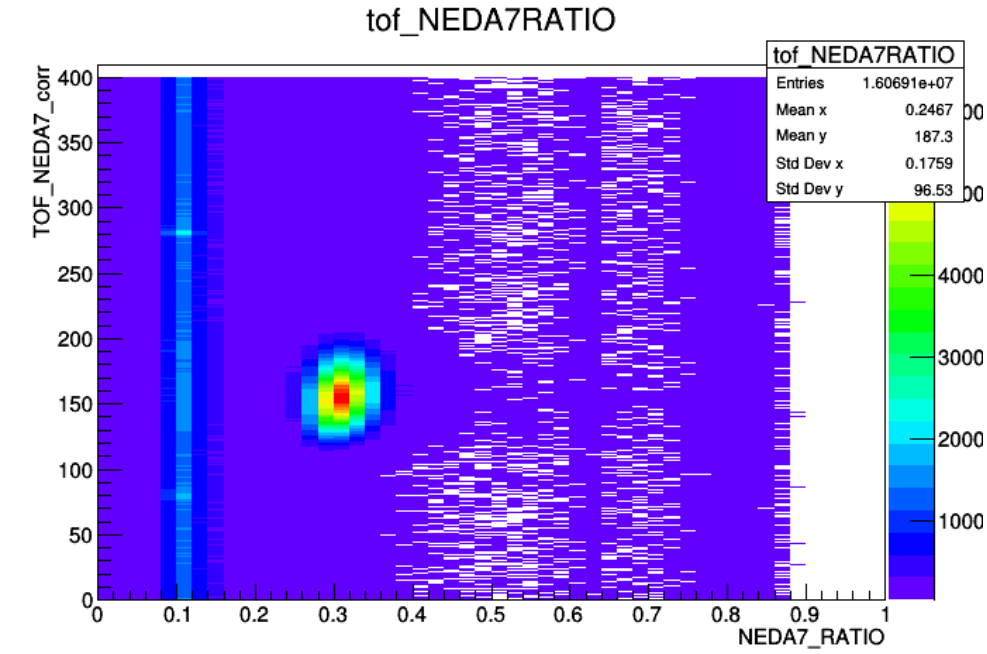
NEDA: Amplitude limiters needed

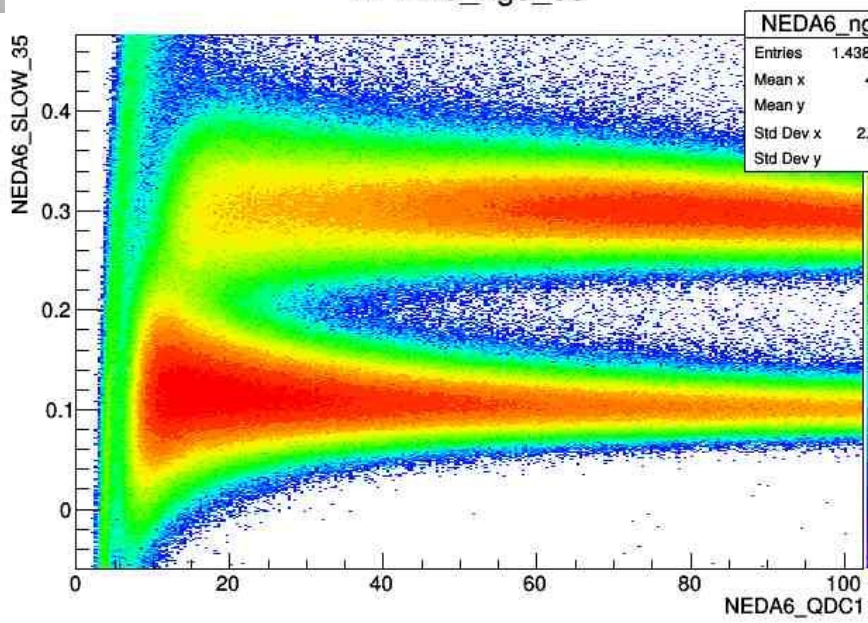
xdaq based DAQ

$p(^7Li,n)^7Be$ LICORNE @ ALTO



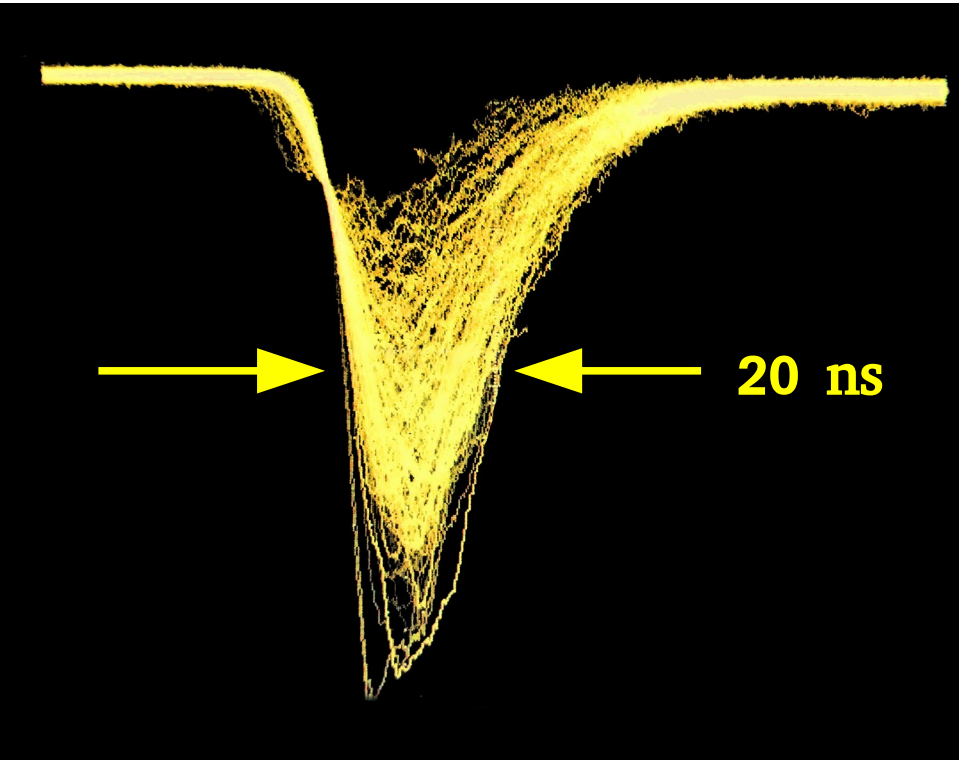
FOM = 1.88 for (50-200) keVee



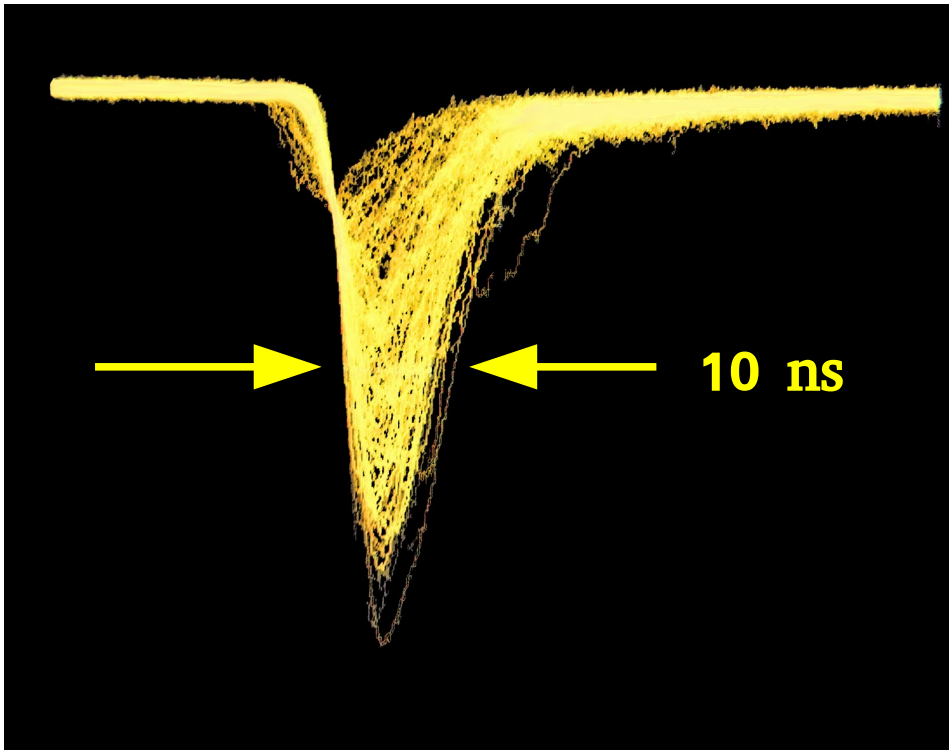


Construction

NEDA



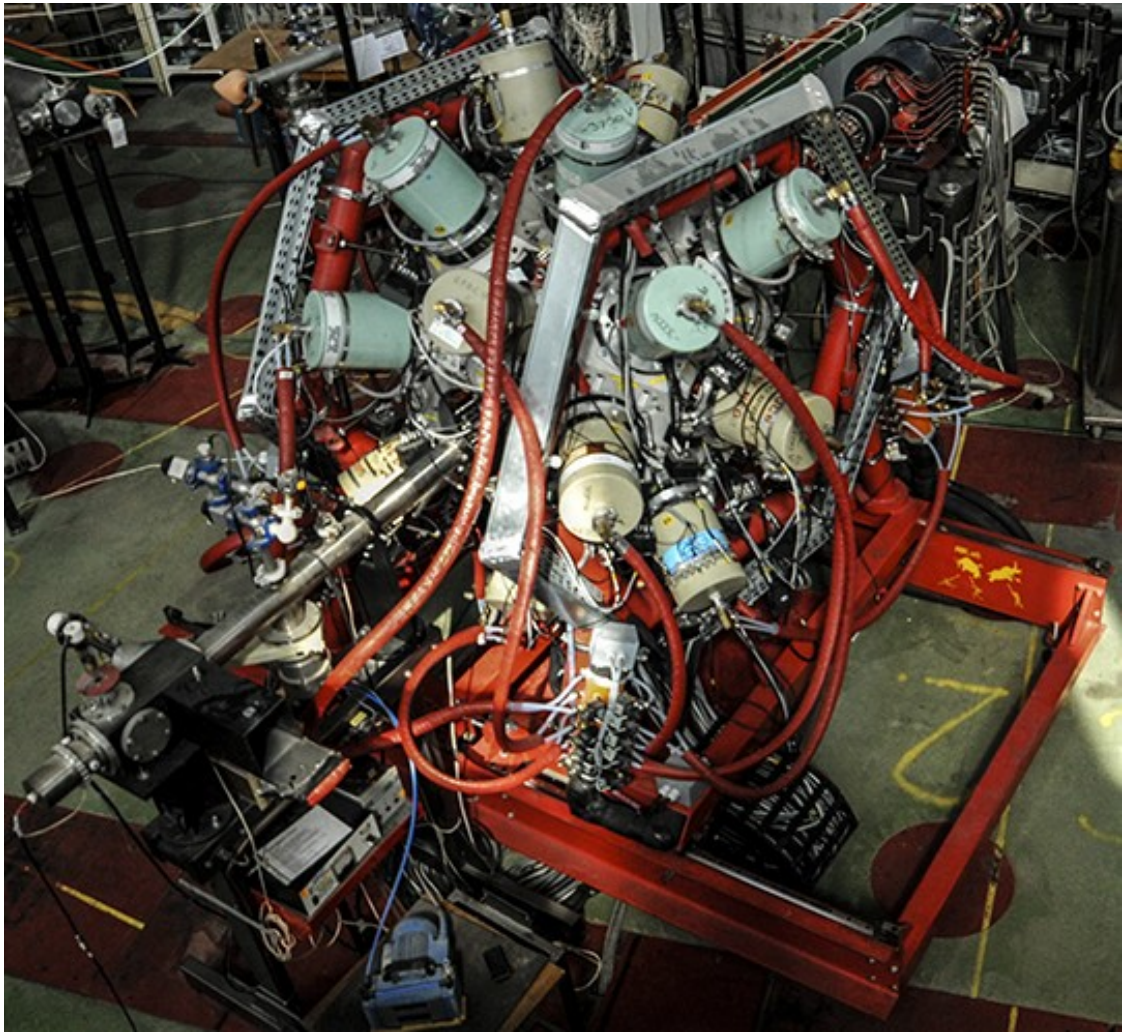
NWall



Quality starts from the initial signal.

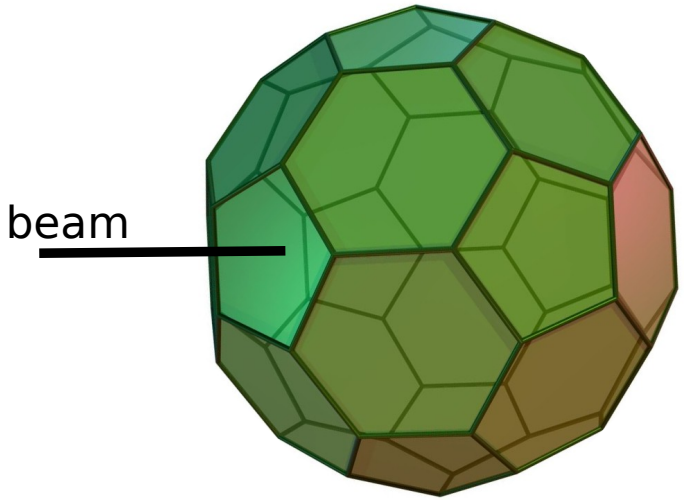
EAGLE

A flexible array able to accomodate up to 30 HPGe detectors with ACS shields, anc ancillary devices



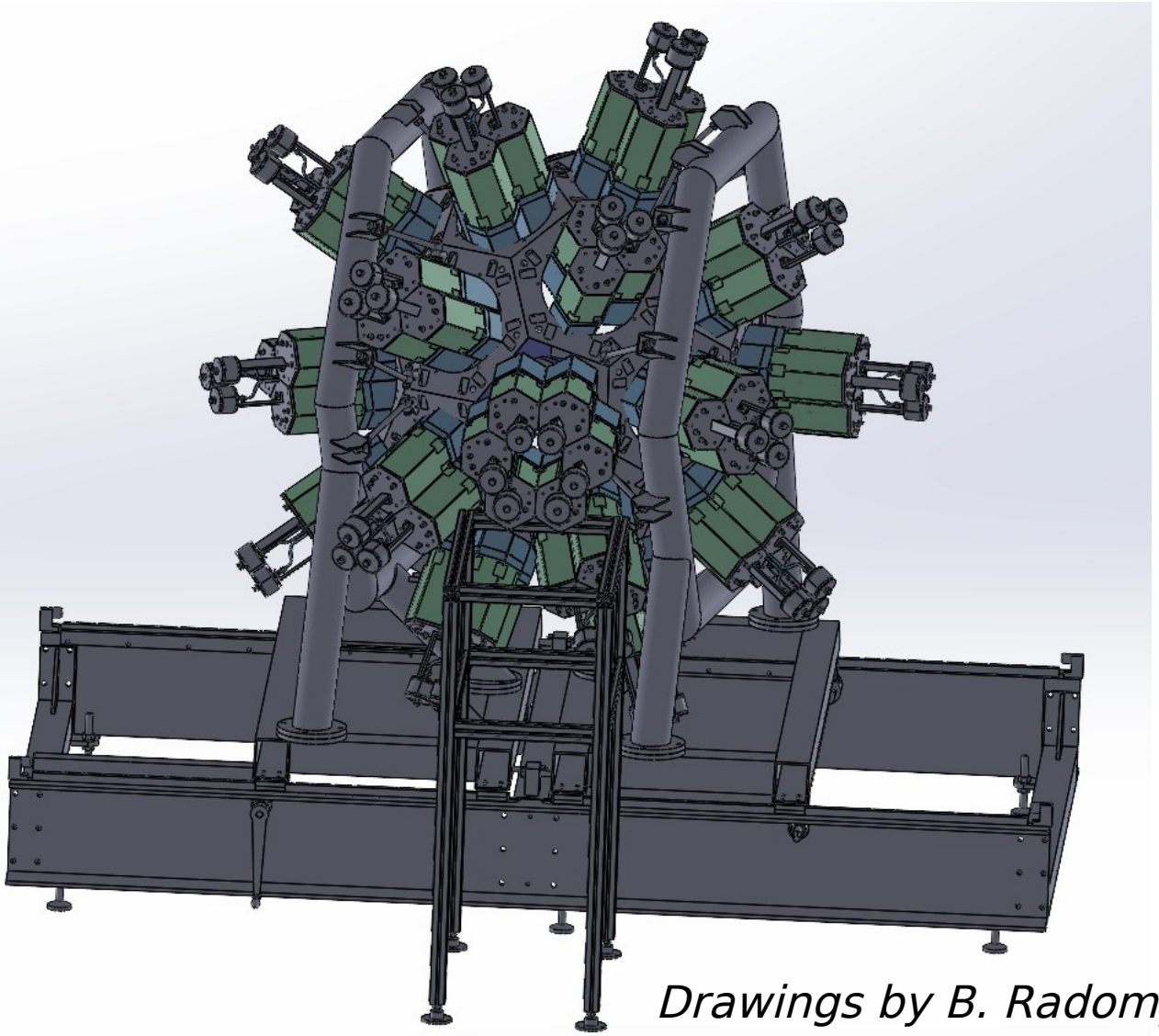
/

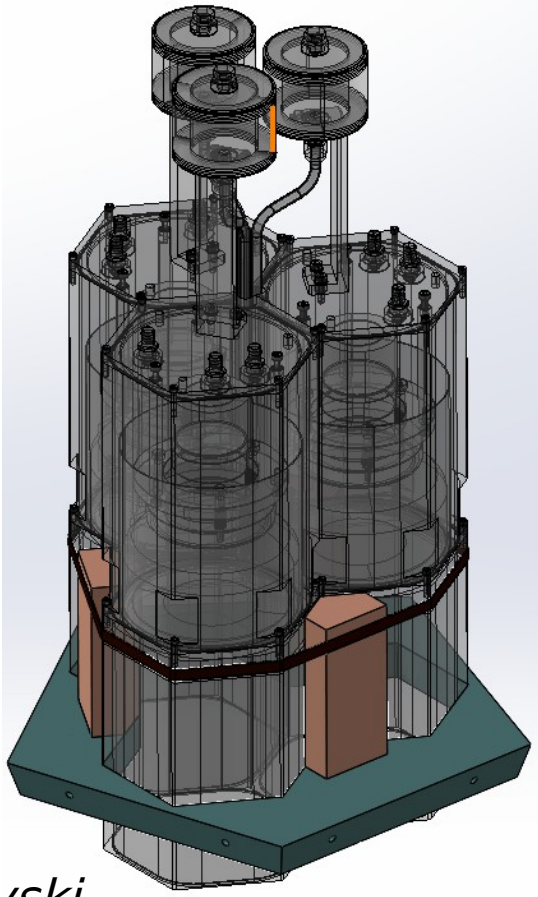
The EAGLE array



- Truncated icosahedron:
  - 20 hexagonal faces,
    4x5 theta angle rings:
    37°, 79°, 101°, 143°
  - 10 pentagonal faces 2x5 rings: 63°, 117°
- Minimum distance target-detector (collimator):
  hexagon: ~ 11cm eff=0.001 at 1.3 MeV per det.
  pentagon: ~ 15 cm eff=0.0008
- Solid angle covered by one detector at minimum distance: 0.0075
- Detectors at HIL:
  loan from GAMMAPOOL of 17 HPGe EUROBALL phase 1 detectors with 15 ACS (80%)
  19 smaller HPGe's (20 to 40%)

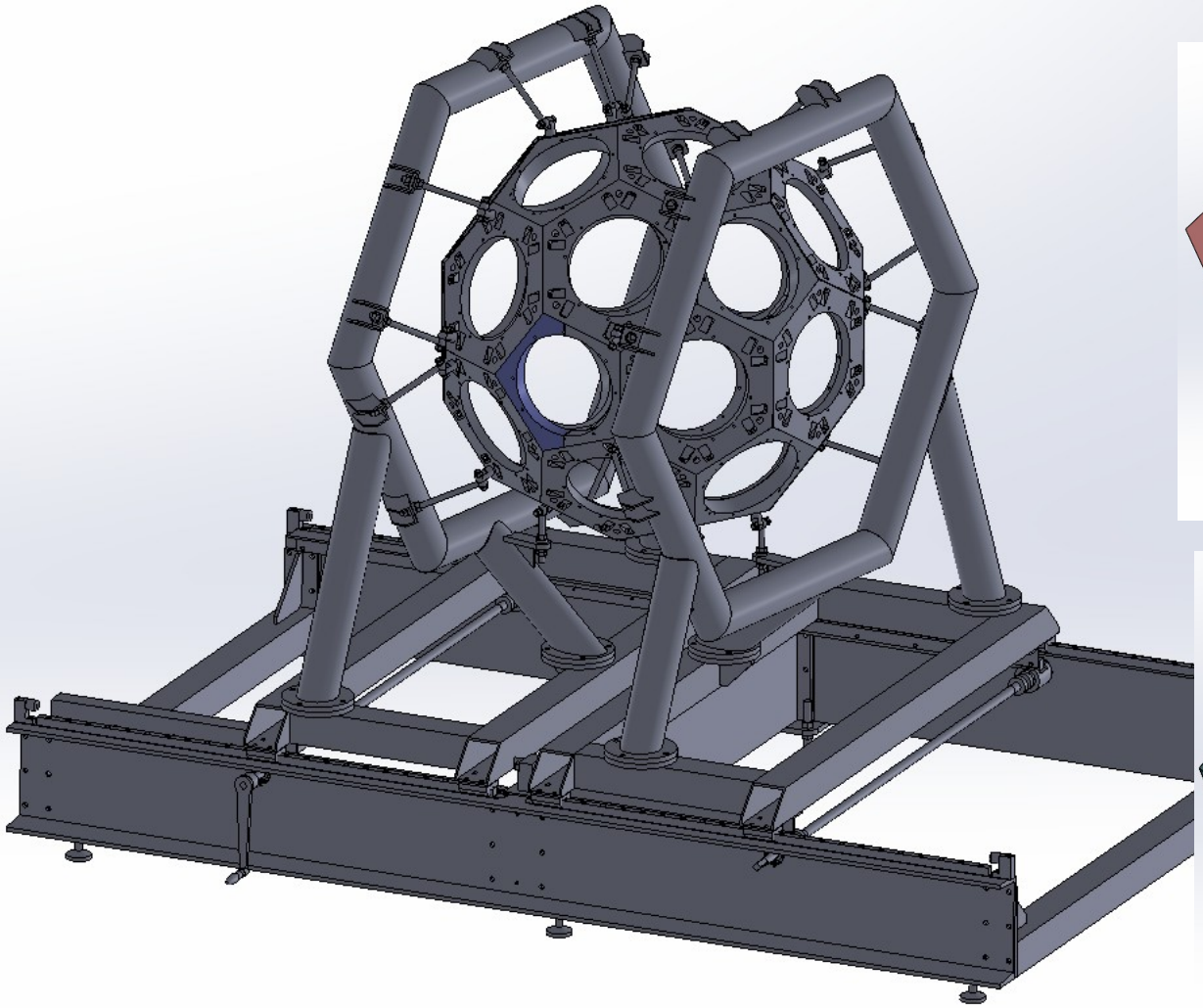
Mechanics

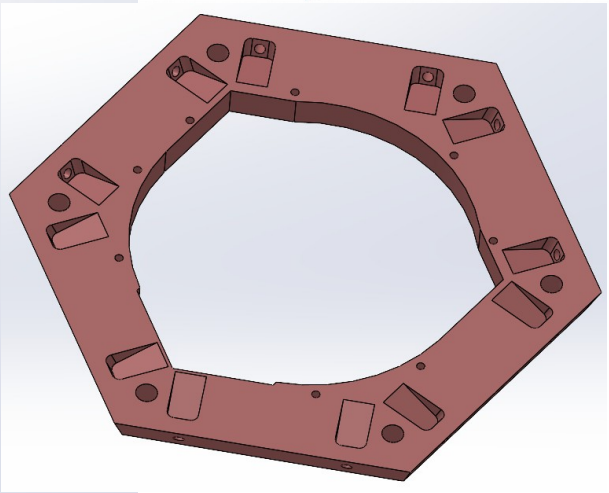


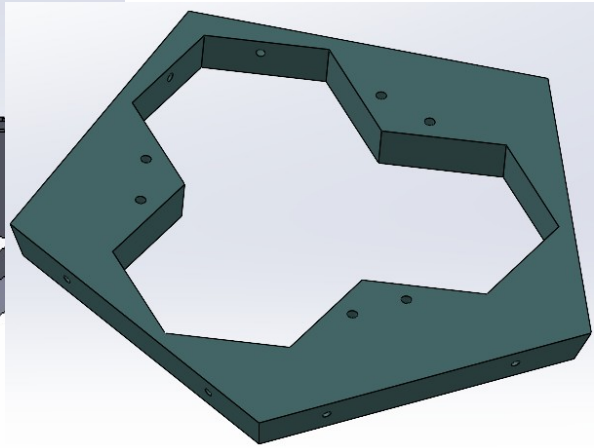


Drawings by B. Radomyski

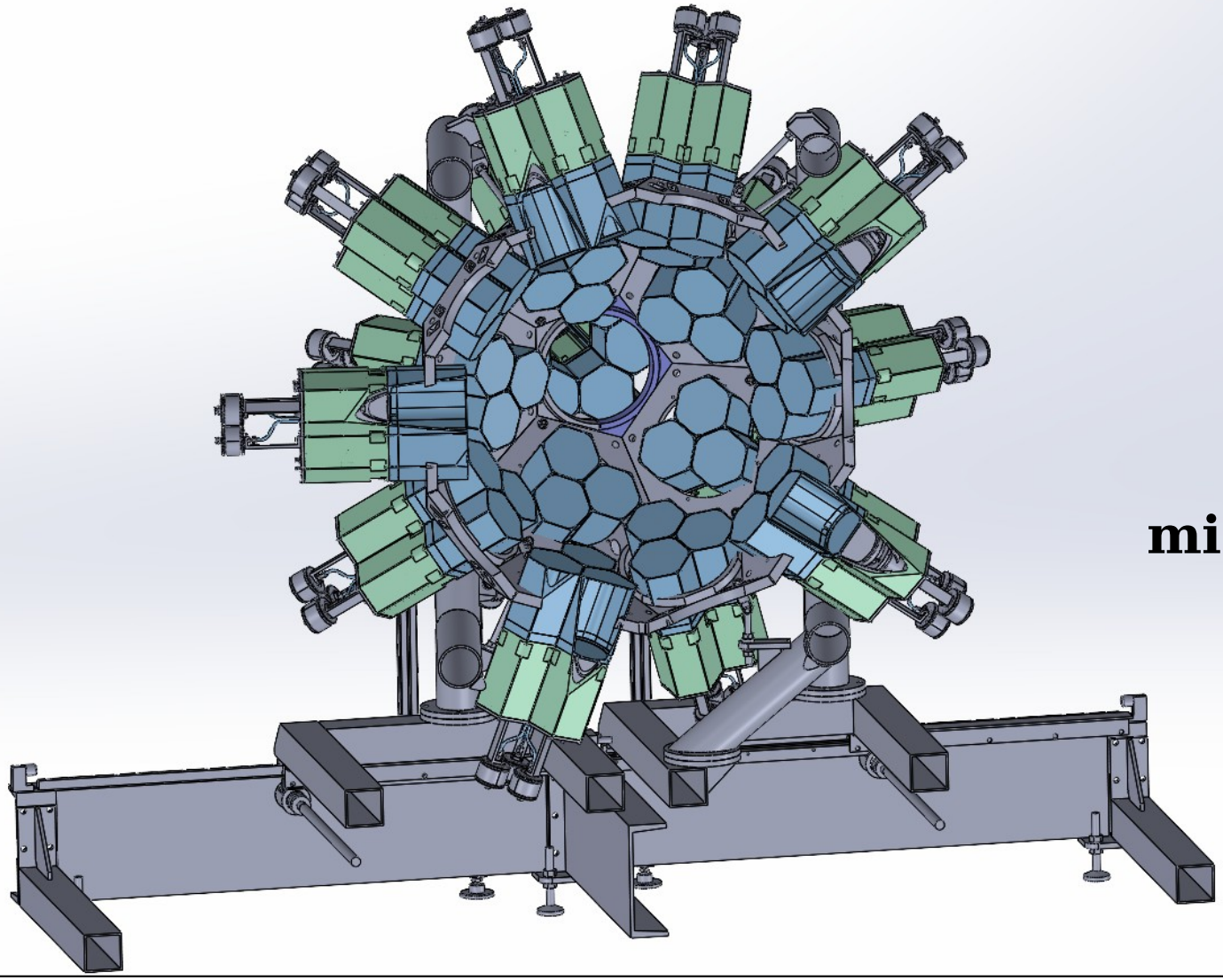
Mechanics







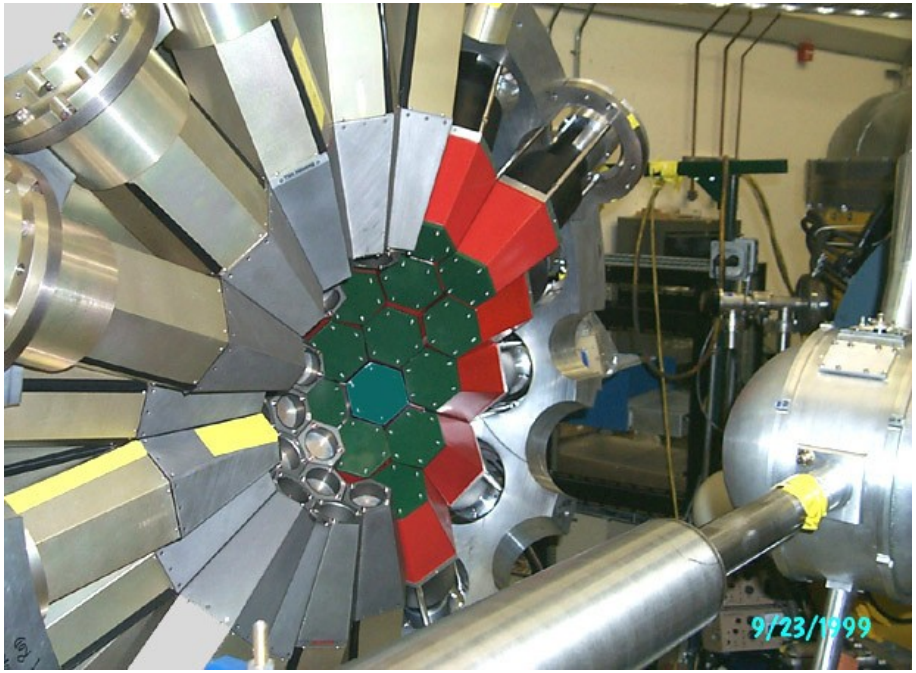
Mechanics



min r ≈ 450 mm

n selection

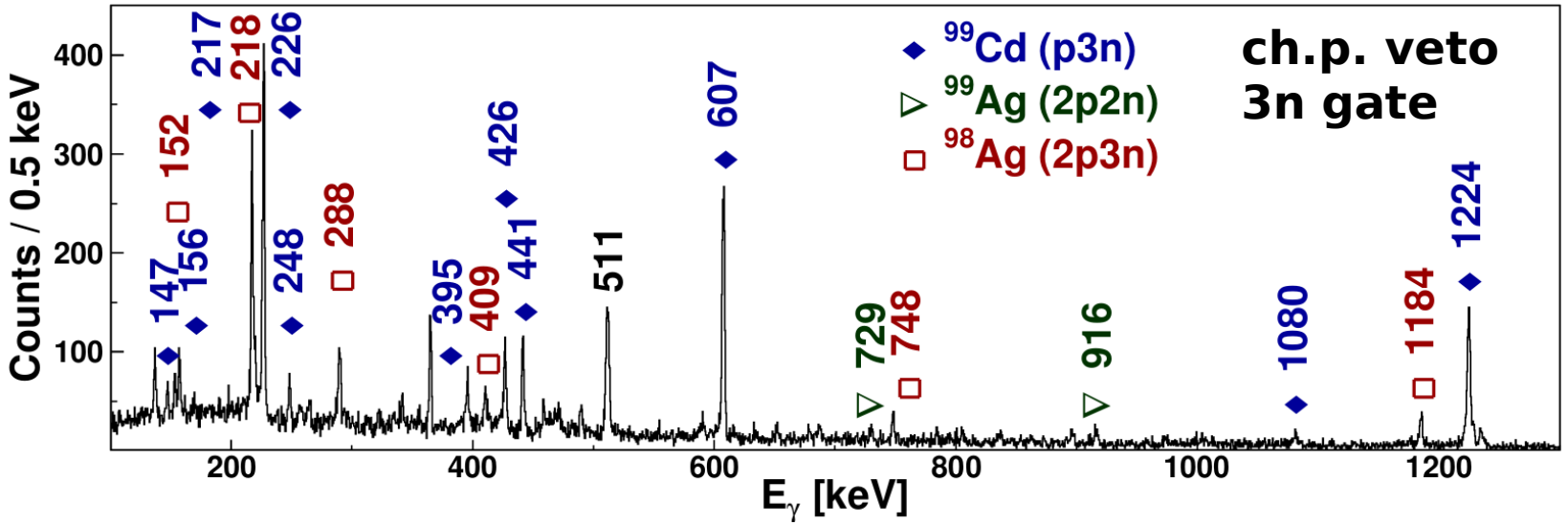
Neutron Wall



Neutron Shell

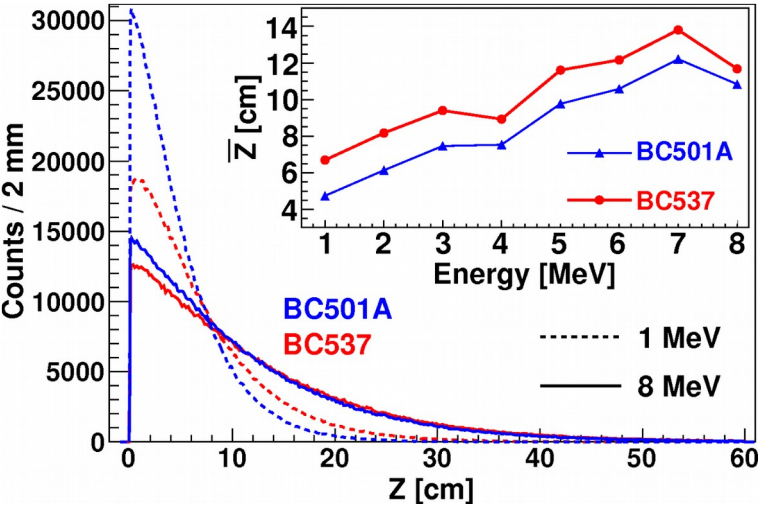
Why a new array?

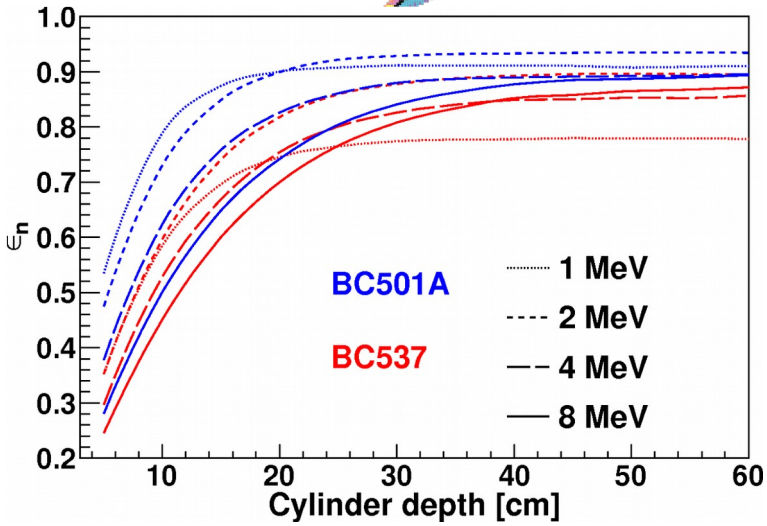
An example:
Attempt to study ^{100}In – 1ν $1\pi^{-1}$ outside ^{100}Sn
3n evaporation channel – the only 3n case with NWall (+ EUROBALL)

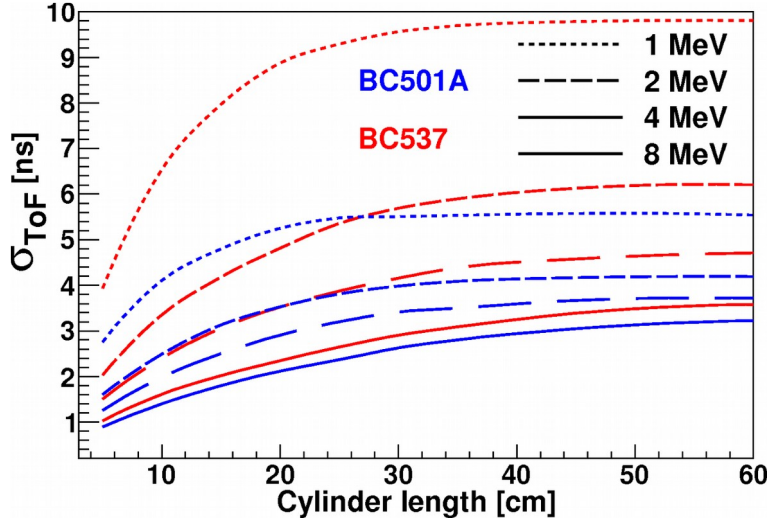


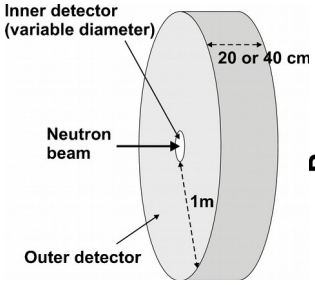
^{100}In not observed, but observation only a matter of statistics.
20x statistics: → a year with EXOGAM + NWall,

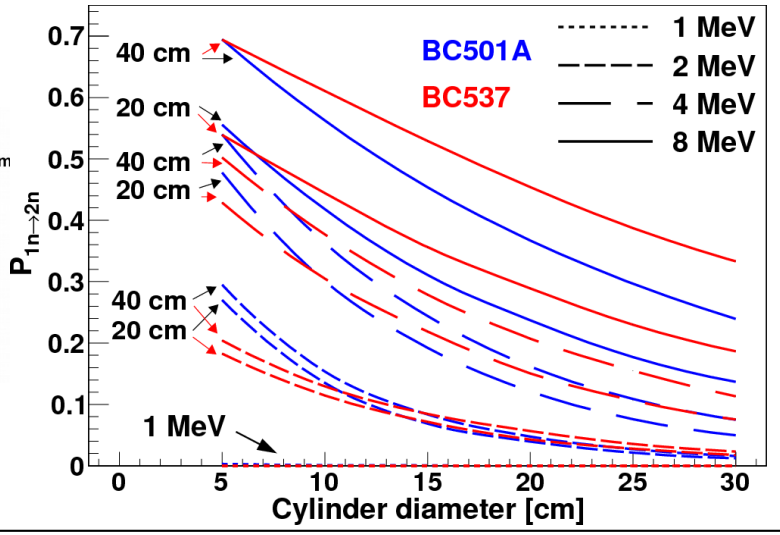
Single cell


Counts / 2 mm
Z [cm]
$\overline{Z}$ [cm]
Energy [MeV]
BC501A
BC537
1 MeV
8 MeV


ϵ_n
Cylinder depth [cm]
BC501A
BC537
1 MeV
2 MeV
4 MeV
8 MeV

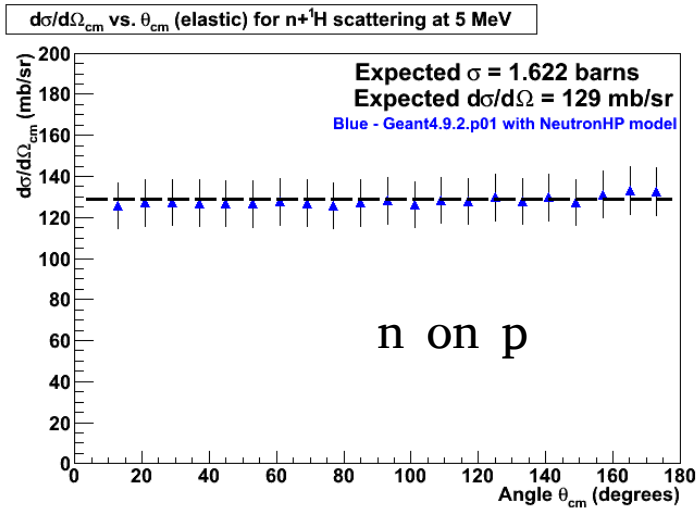

σ_{ToF} [ns]
Cylinder length [cm]
BC501A
BC537
1 MeV
2 MeV
4 MeV
8 MeV

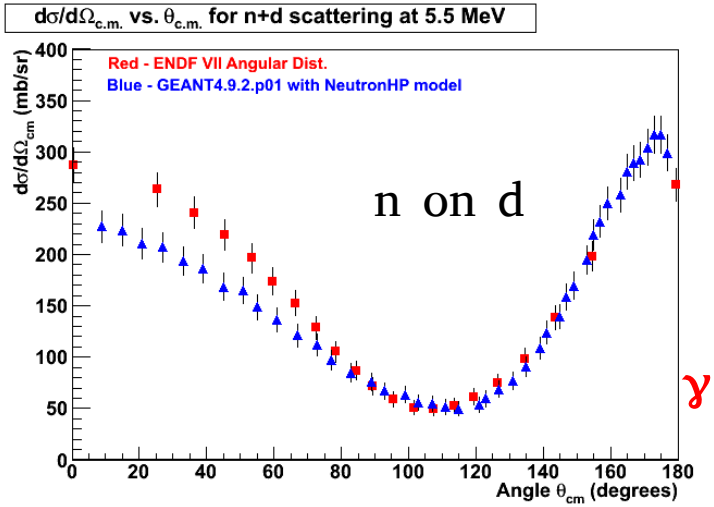

Inner detector
(variable diameter)
20 or 40 cm
Neutron
beam
1m
Outer detector


$P_{1n\to 2n}$
Cylinder diameter [cm]
BC501A
BC537
1 MeV
2 MeV
4 MeV
8 MeV
40 cm
20 cm
40 cm
20 cm
40 cm
20 cm
1 MeV

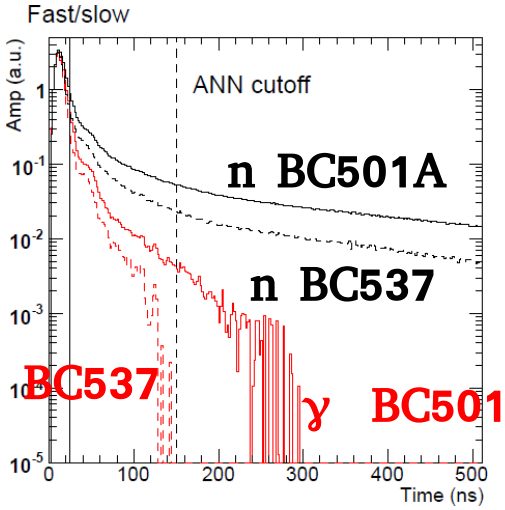
Scintillator

? BC501A / BC537 / EJ299 / … ?

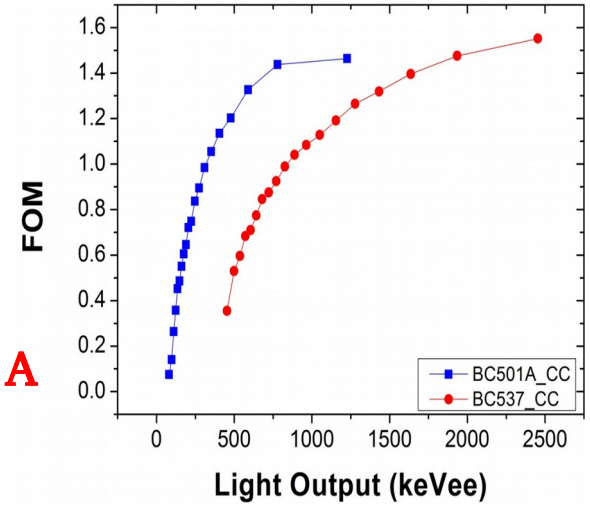




γ BC537

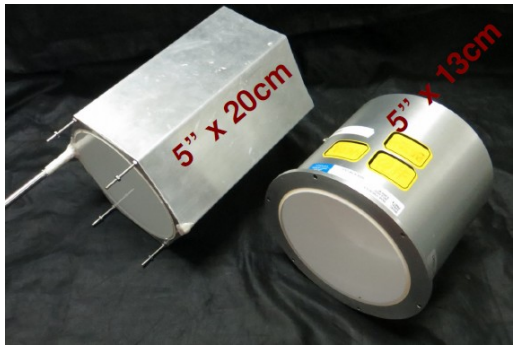


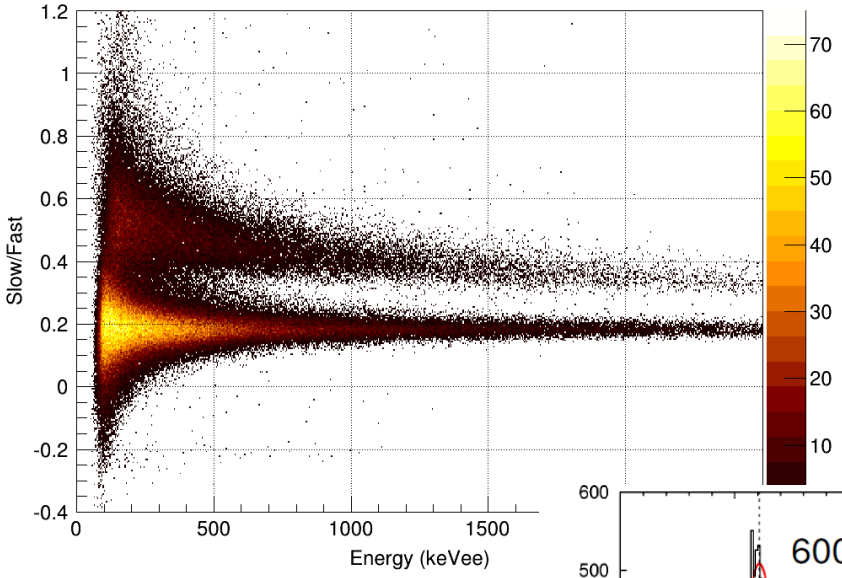
γ BC501A

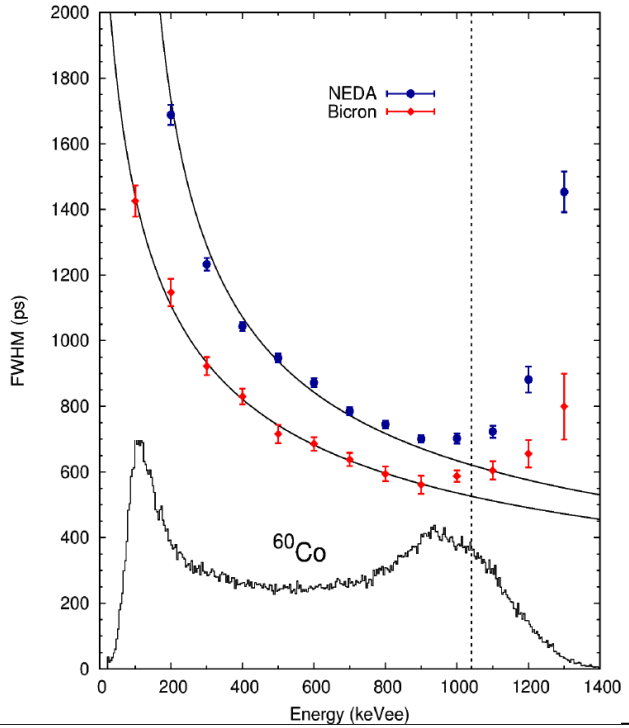


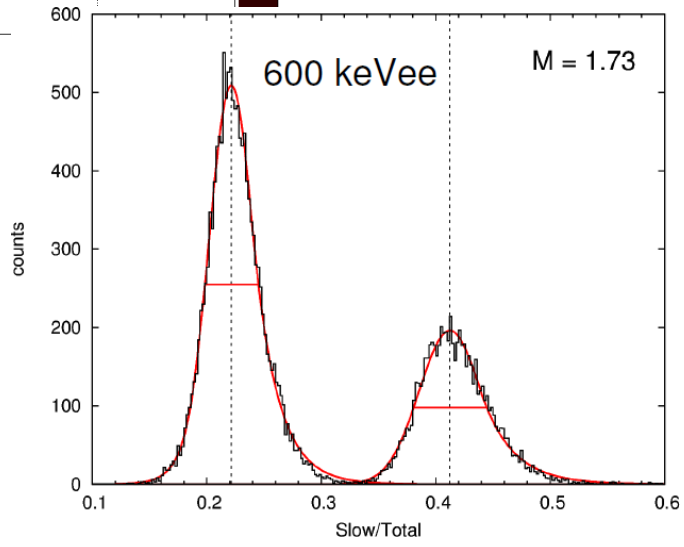
preliminary

Prototype

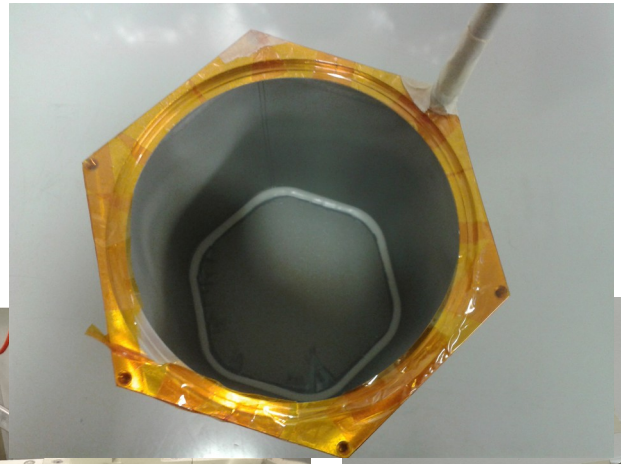

5" x 20cm
5" x 13cm

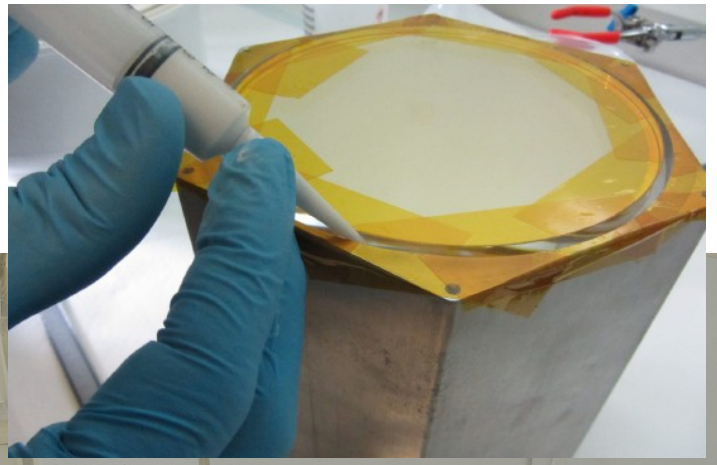

Slow/Fast
Energy (keVee)
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
0
500
1000
1500
70
60
50
40
30
20
10


FWHM (ps)
Energy (keVee)
NEDA
Bicron
^{60}Co
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
200
400
600
800
1000
1200
1400


600 keVee
M = 1.73
counts
Slow/Total
600
500
400
300
200
100
0
0.1
0.2
0.3
0.4
0.5
0.6

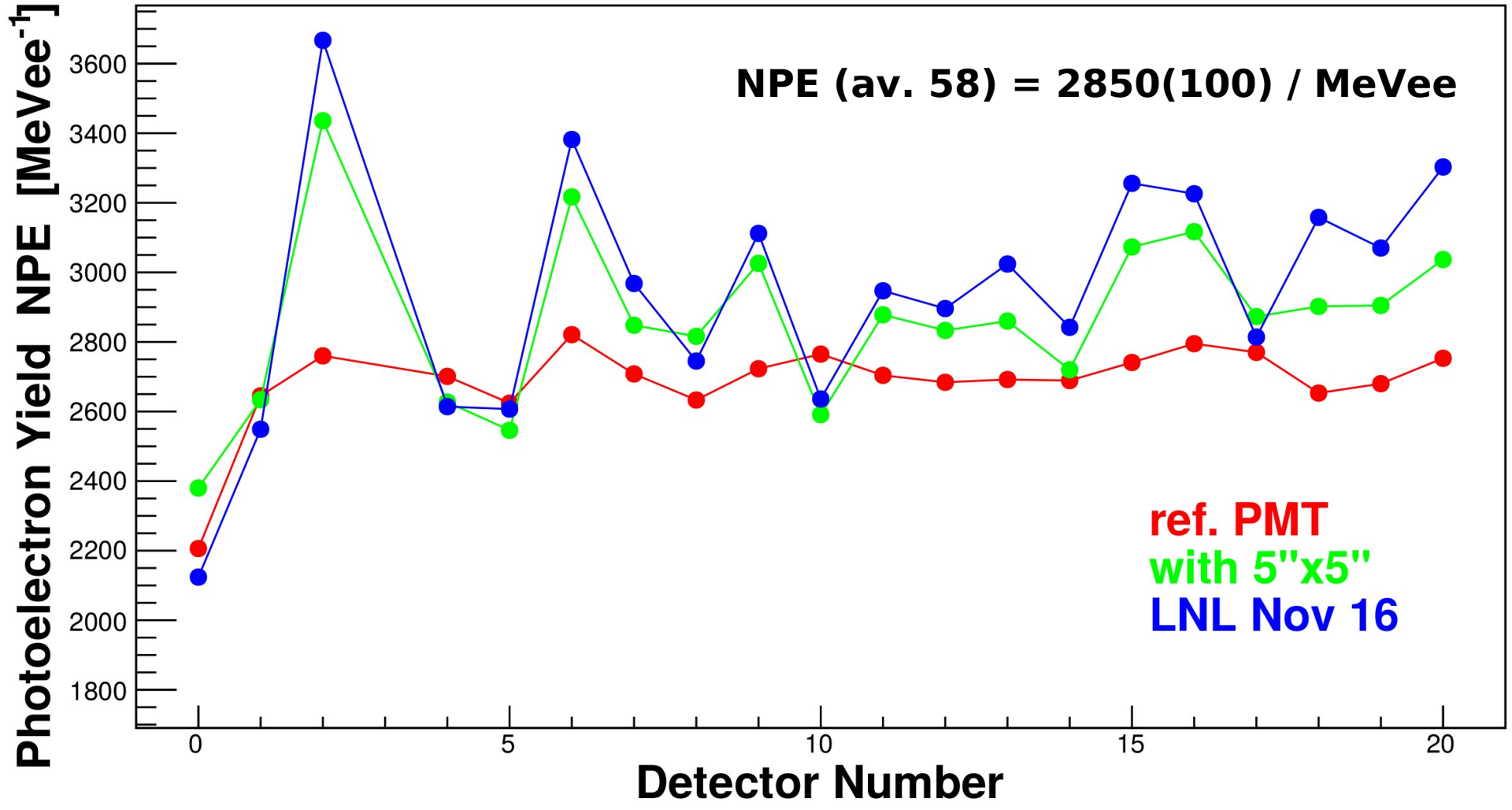
Detector production



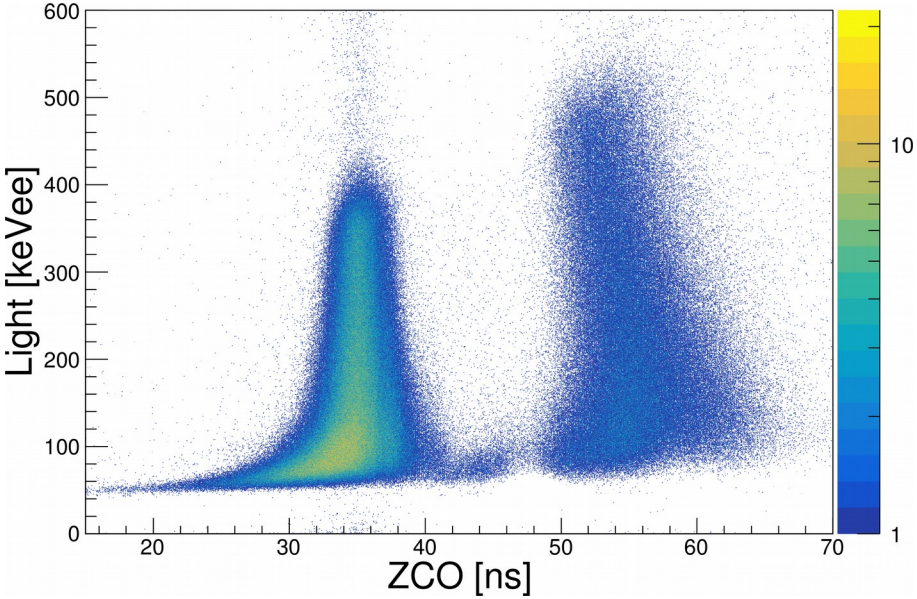


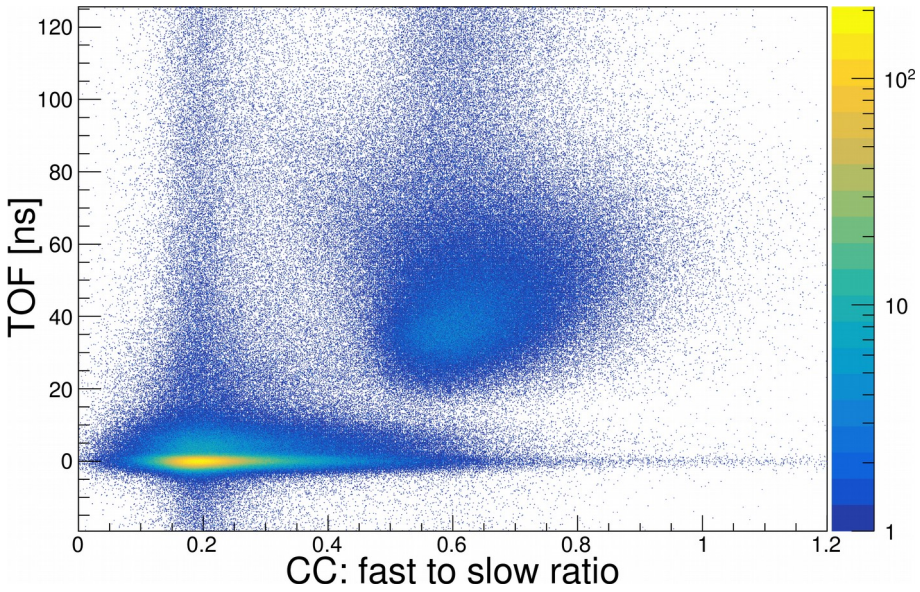
Detector production

Characterisation



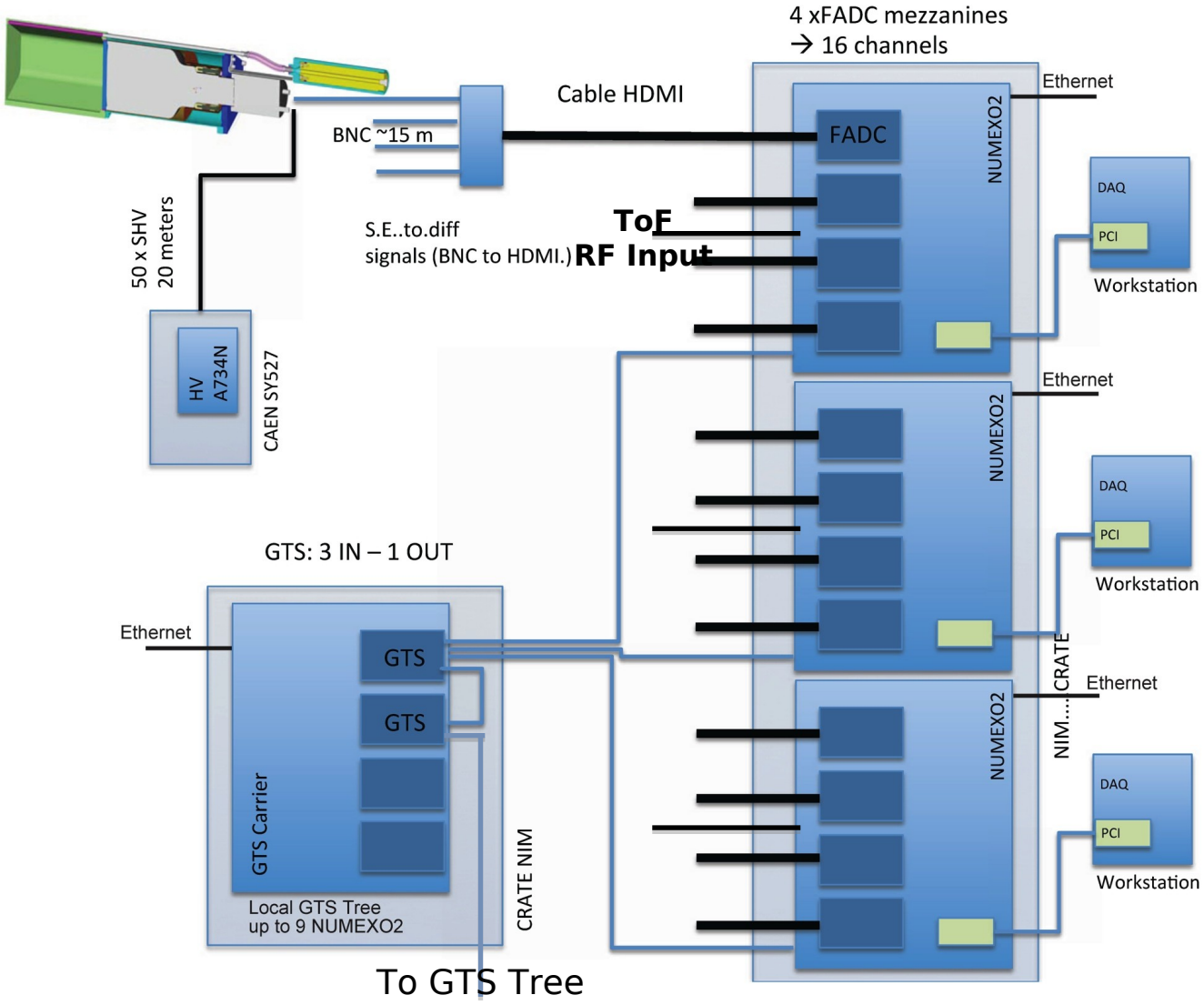
Characterisation



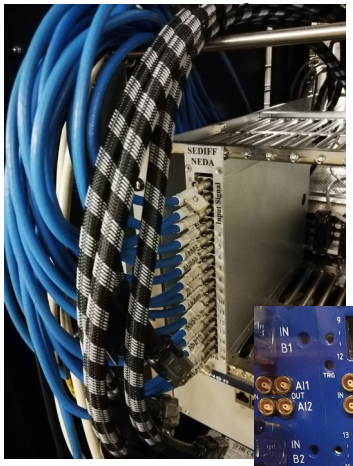


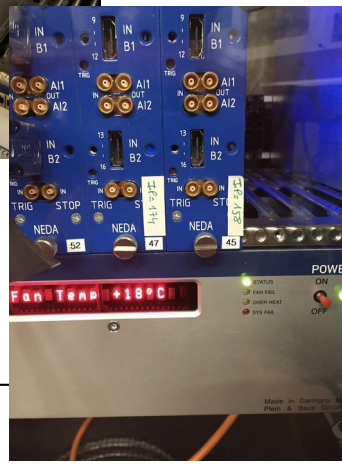
NEDA #21

Electronics

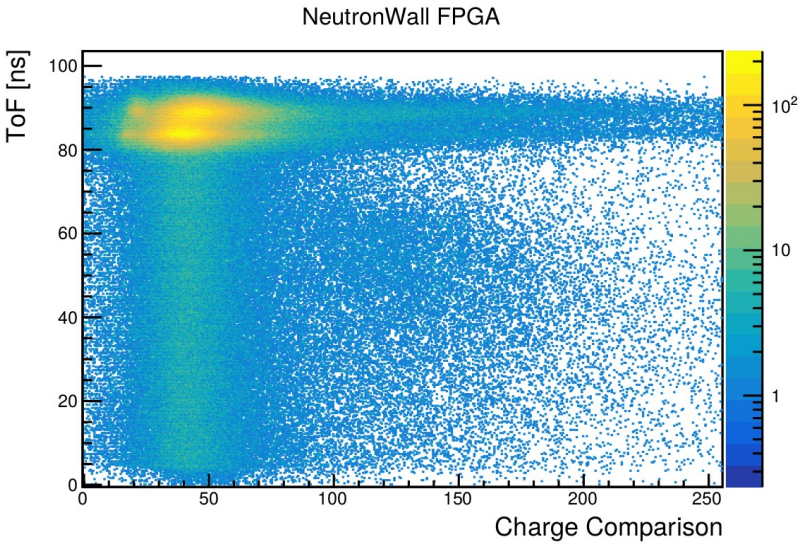


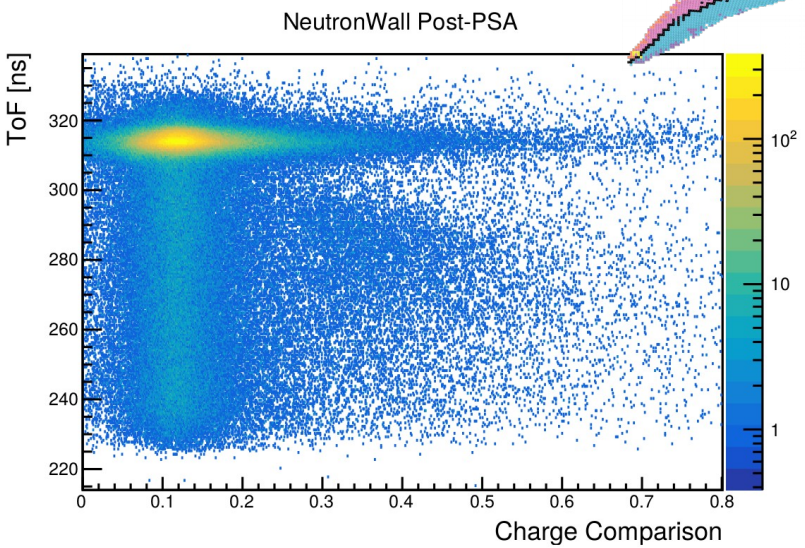
→ NUMEXO2 board
→ GTS on board
→ GTS logic trigger tree
→ 200 MHz, 14 b
(11.3 enob)
FADC

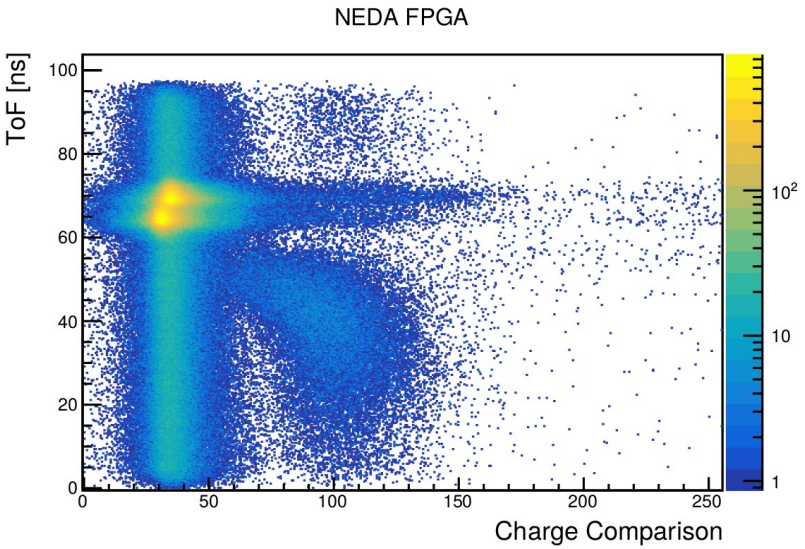


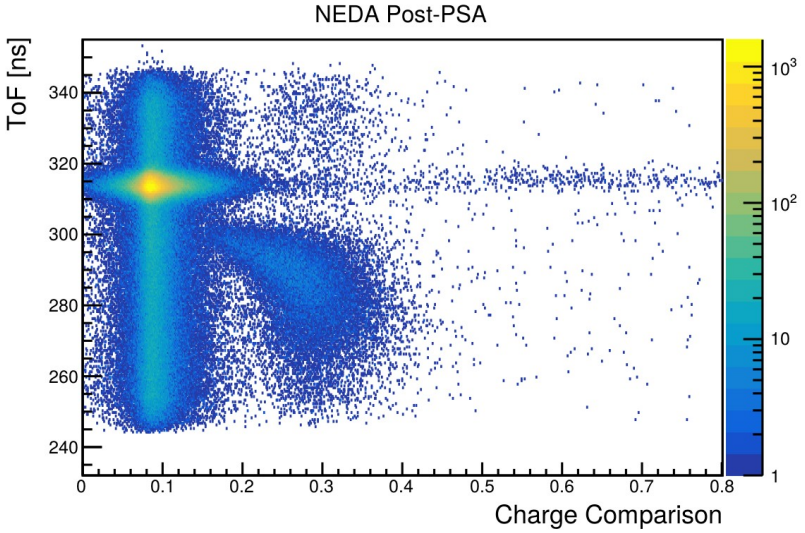


Digital NGD online

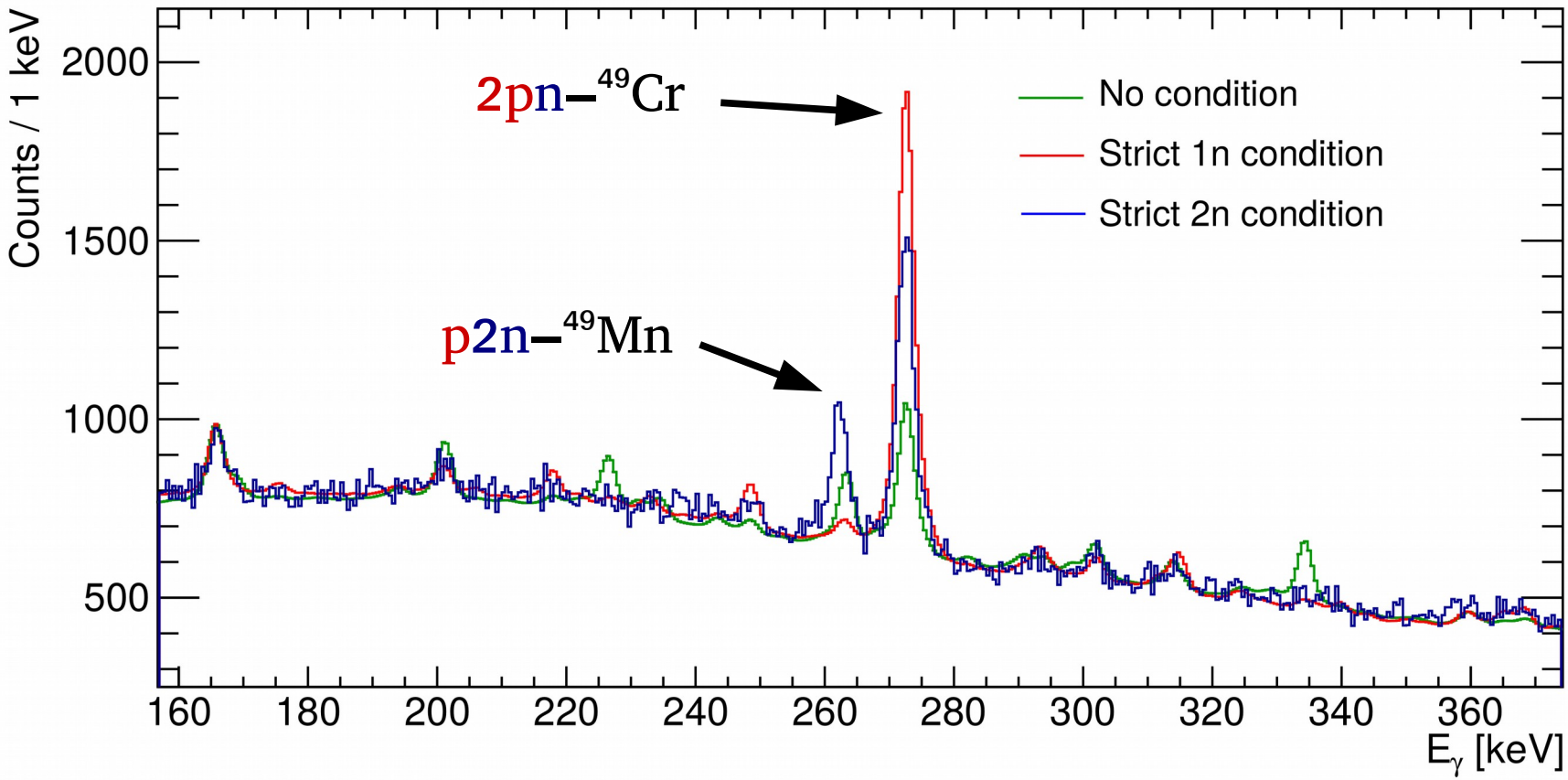








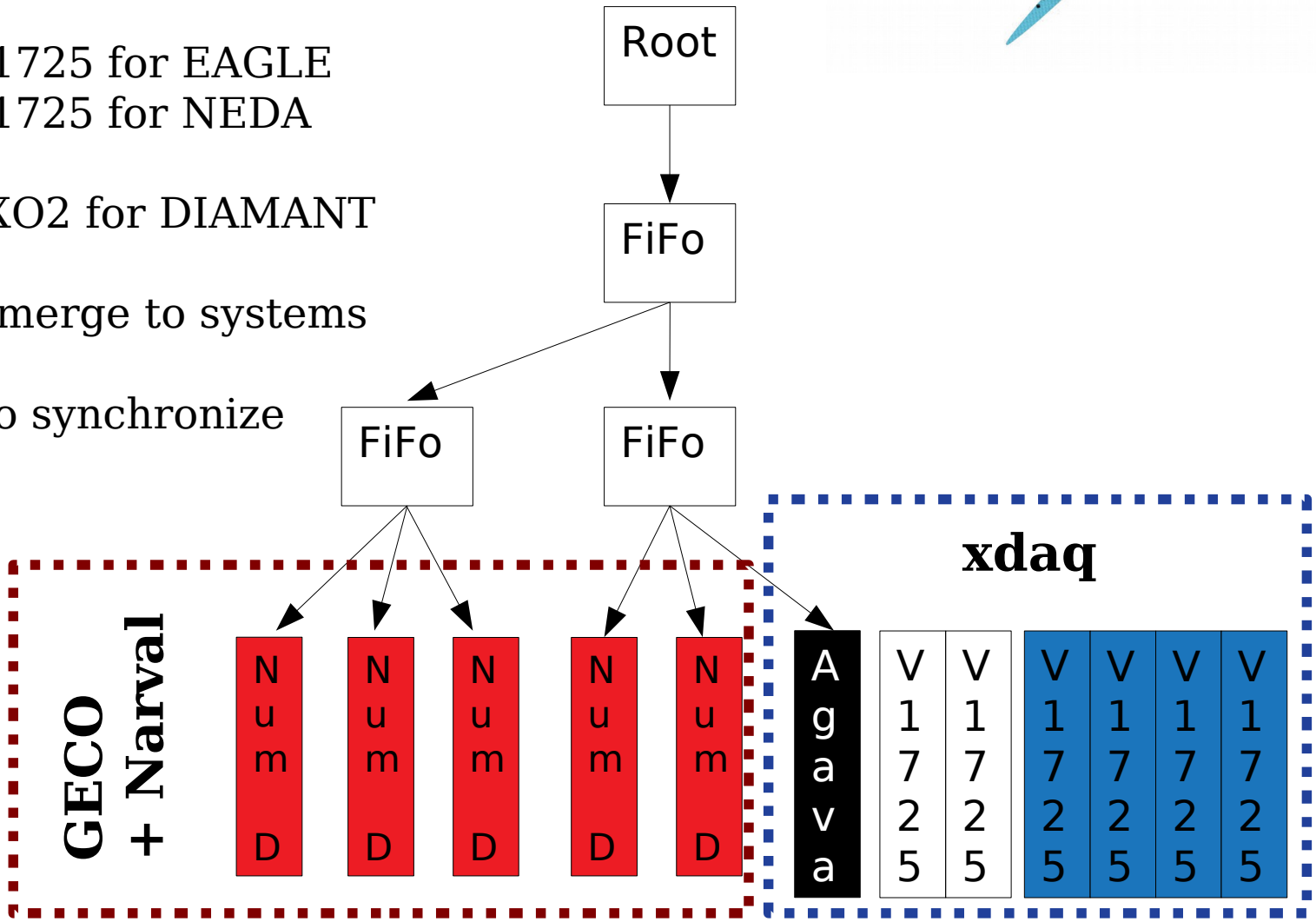
n multiplicity selection



^{36}Ar + ^{16}O → ^{52}Fe*

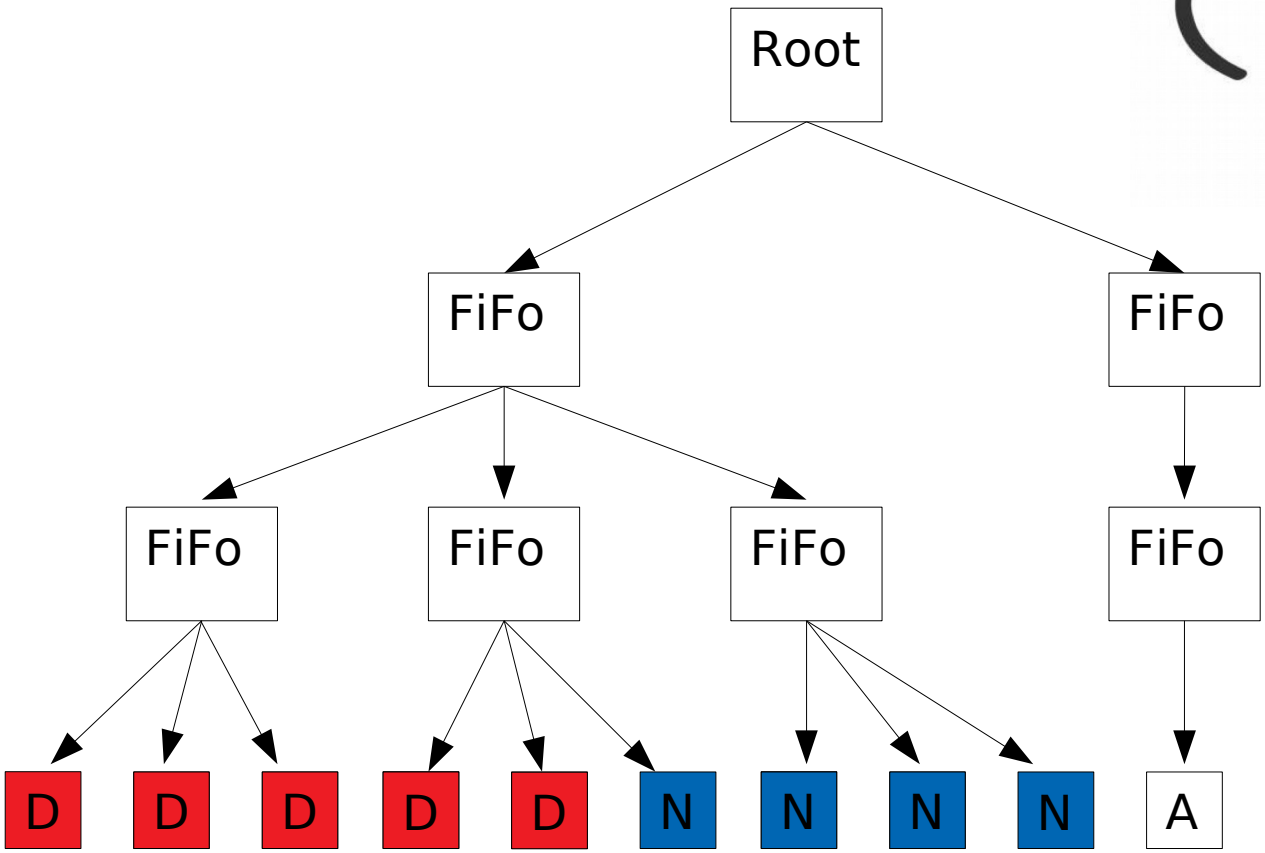
Read-out – with DIA

- 2x Caen V1725 for EAGLE
  4x Caen V1725 for NEDA
- 5x NUMEXO2 for DIAMANT
- AGAVA to merge to systems
- GTS tree to synchronize



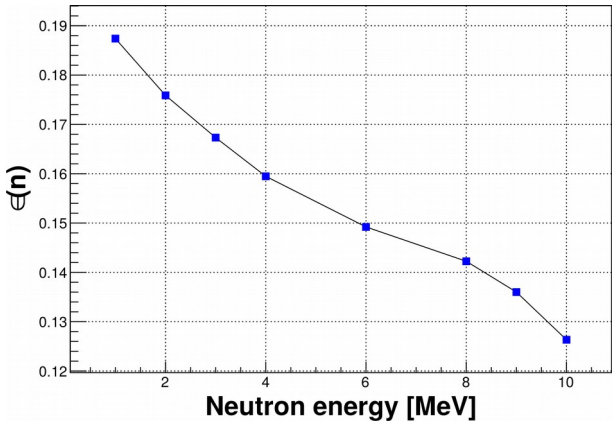
NEEDLE – Schedule

- NEDA detectors and associated equipment to be transported in mid Nov. 2021


Root
FiFo
FiFo
FiFo
FiFo
FiFo
FiFo
D
D
D
D
D
N
N
N
N
A

Flexible distance

50 cm – Ω= **0.264***4π str.



60 cm – Ω= **0.197***4π str.