Istituto Nazionale di Fisica Nucleare
LABORATORI NAZIONALI DI LEGNARO

Asiago 2024

Ancillaries of AGATA

M. Balogh *on behalf of local AGATA group*

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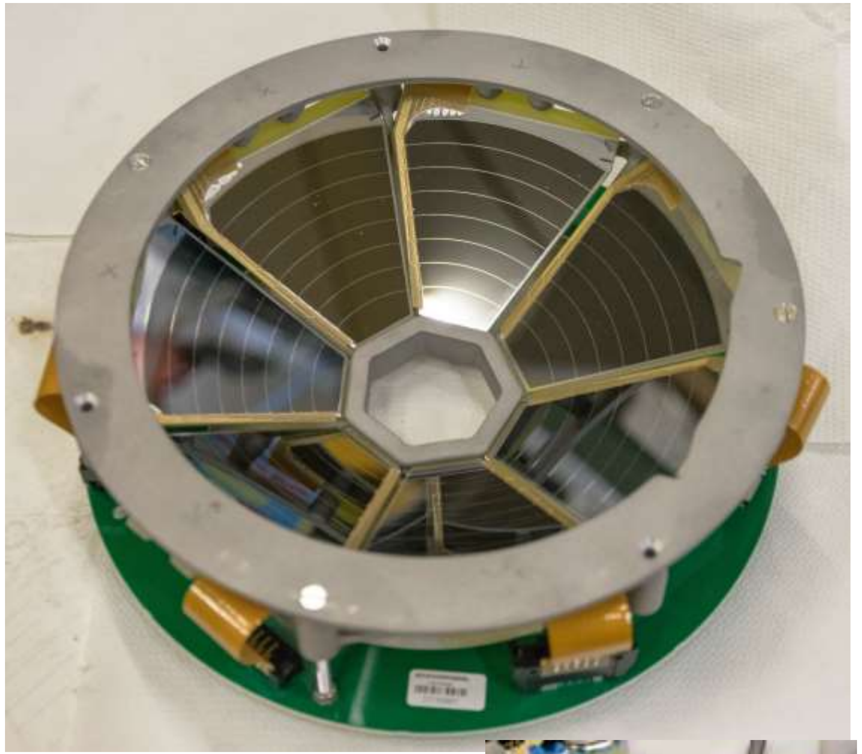
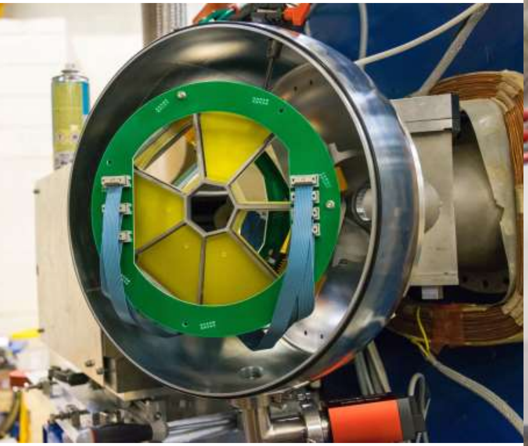
Detectors

SPIDER



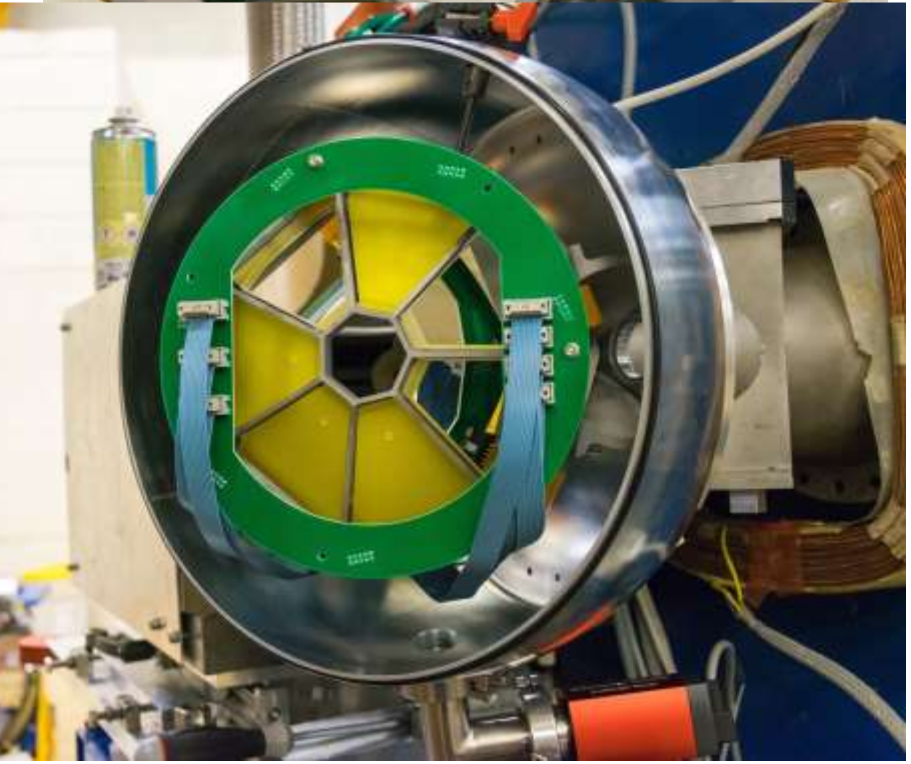


Silicon PIe DEtectoR

- 7 trapezoidal detectors, each segmented to 8 strips
- coverage 124-161°
- 300µm thick

Reference paper 10.1016/j.nima.2020.164030

SPIDER



Silicon PIe DEtectoR

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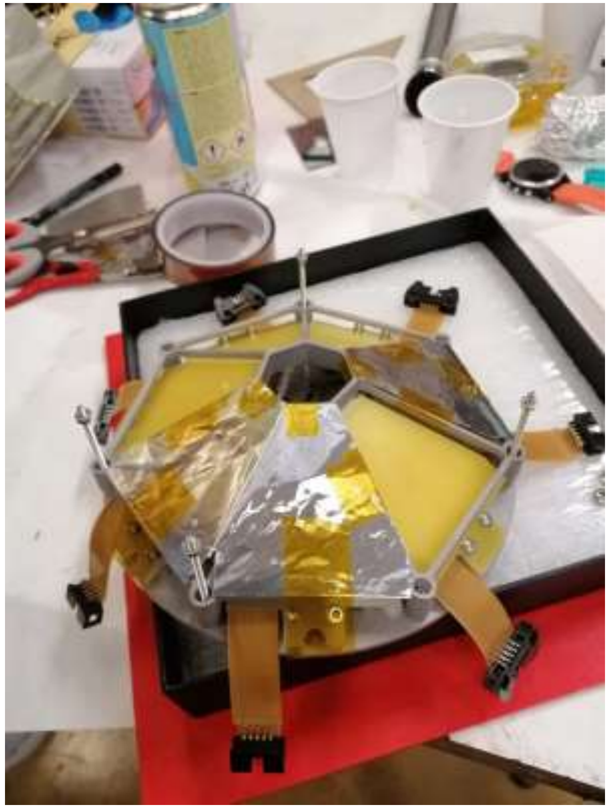
- 300µm thick

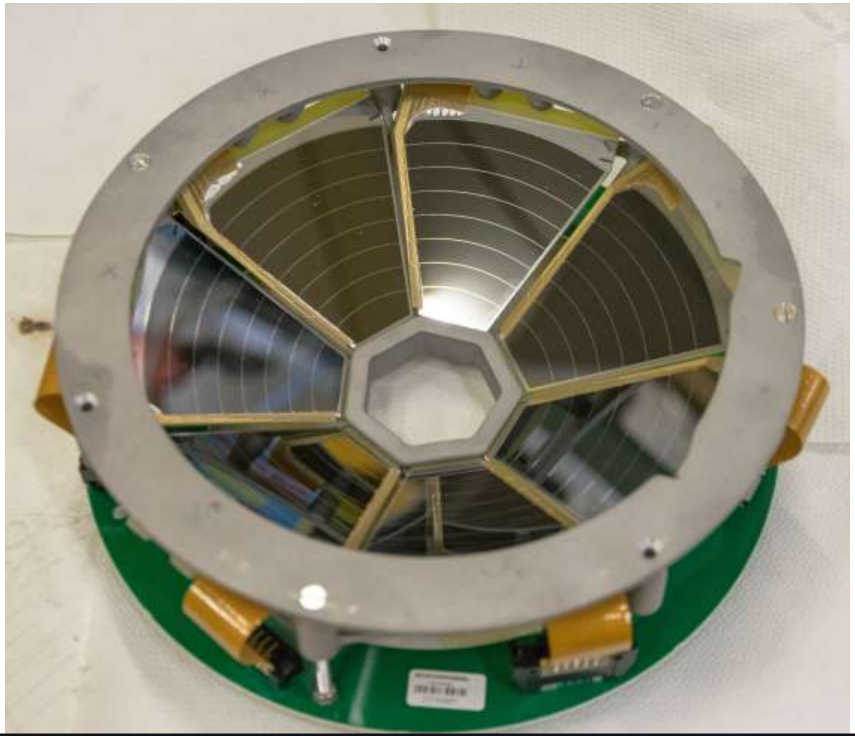
Hardware issues

No backing on several detectors

- getting hit with scattered beam/electrons
- now fixed



SPIDER



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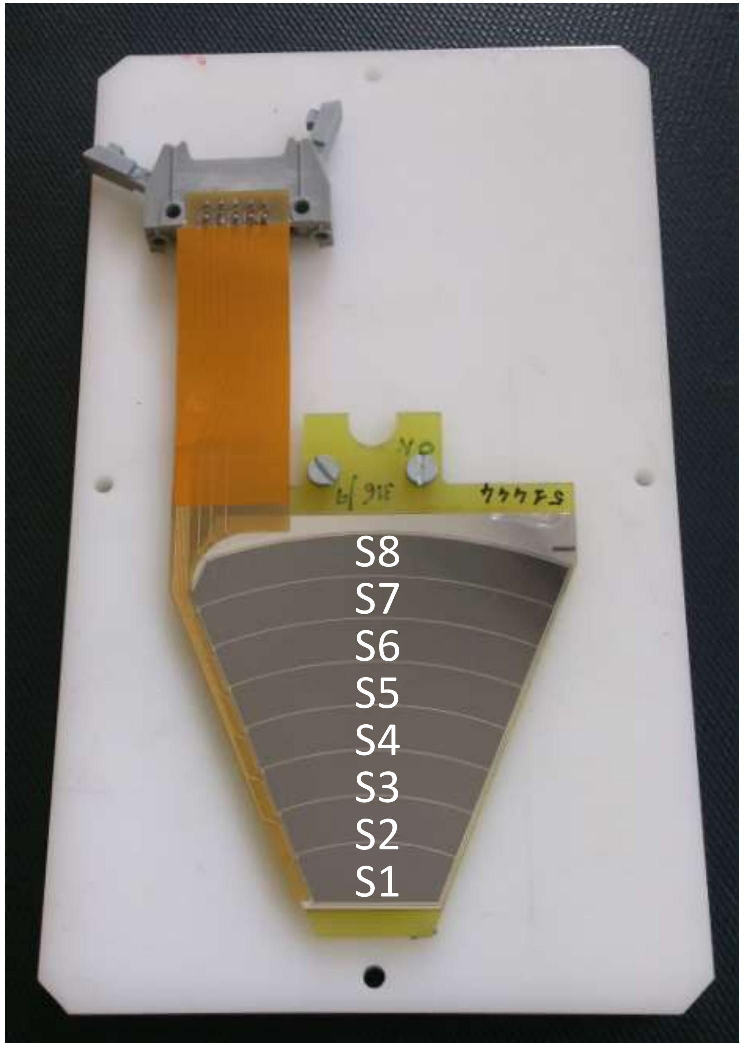
Keep in mind

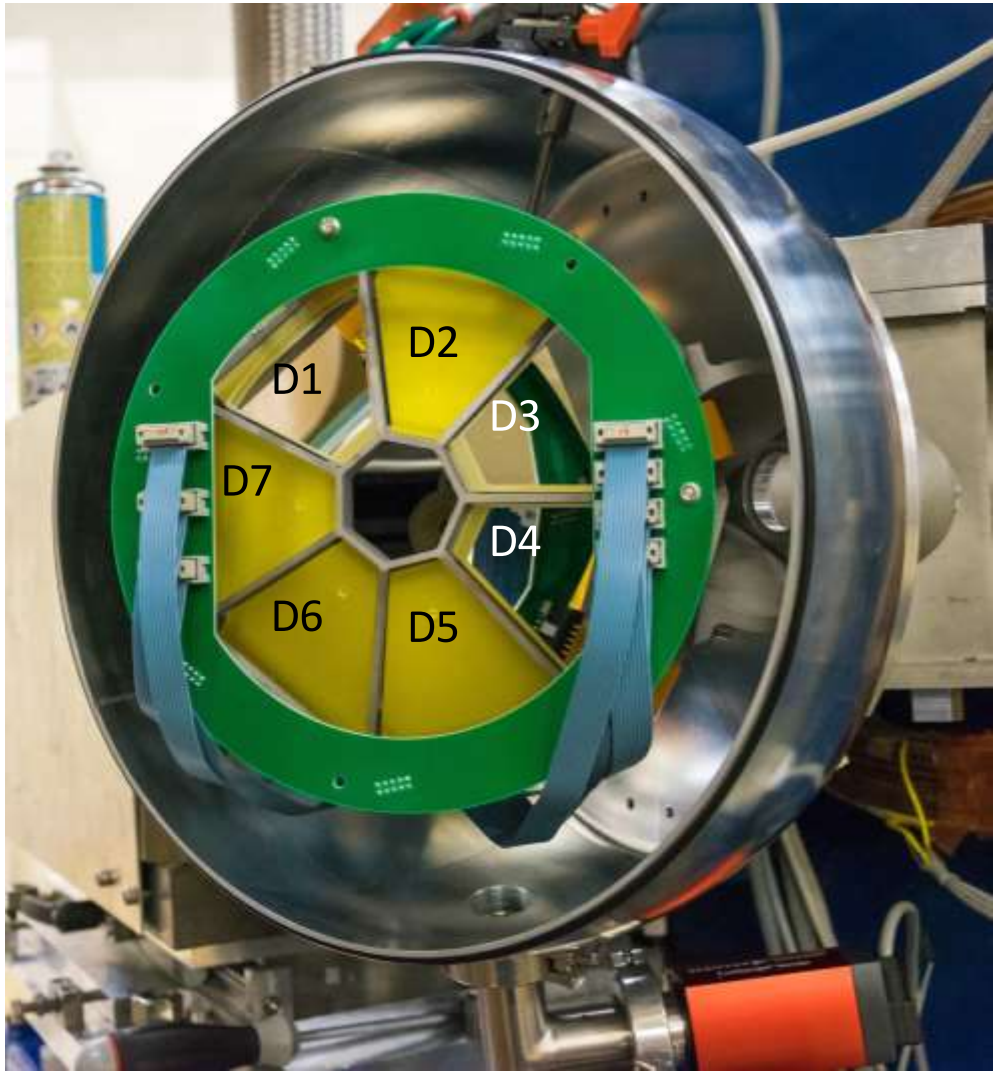
Leakage current

- damage induced leakage current decreases effective HV applied thus reduces the depleted region
- **check your energy calibration as a function of time!**

SPIDER



Front (beam entering) view

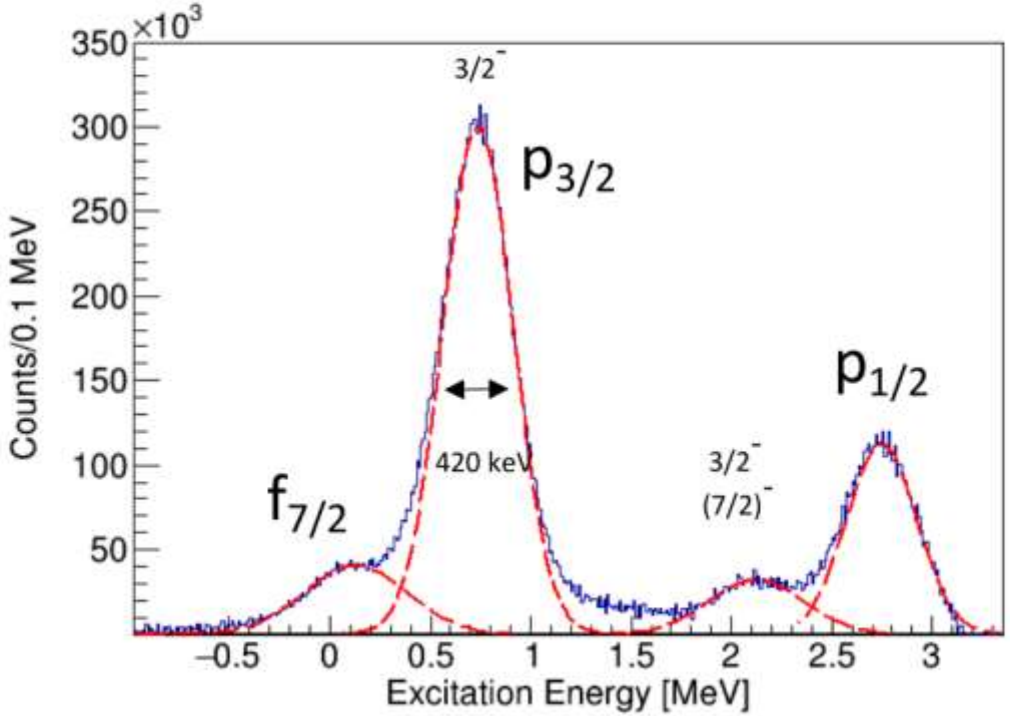


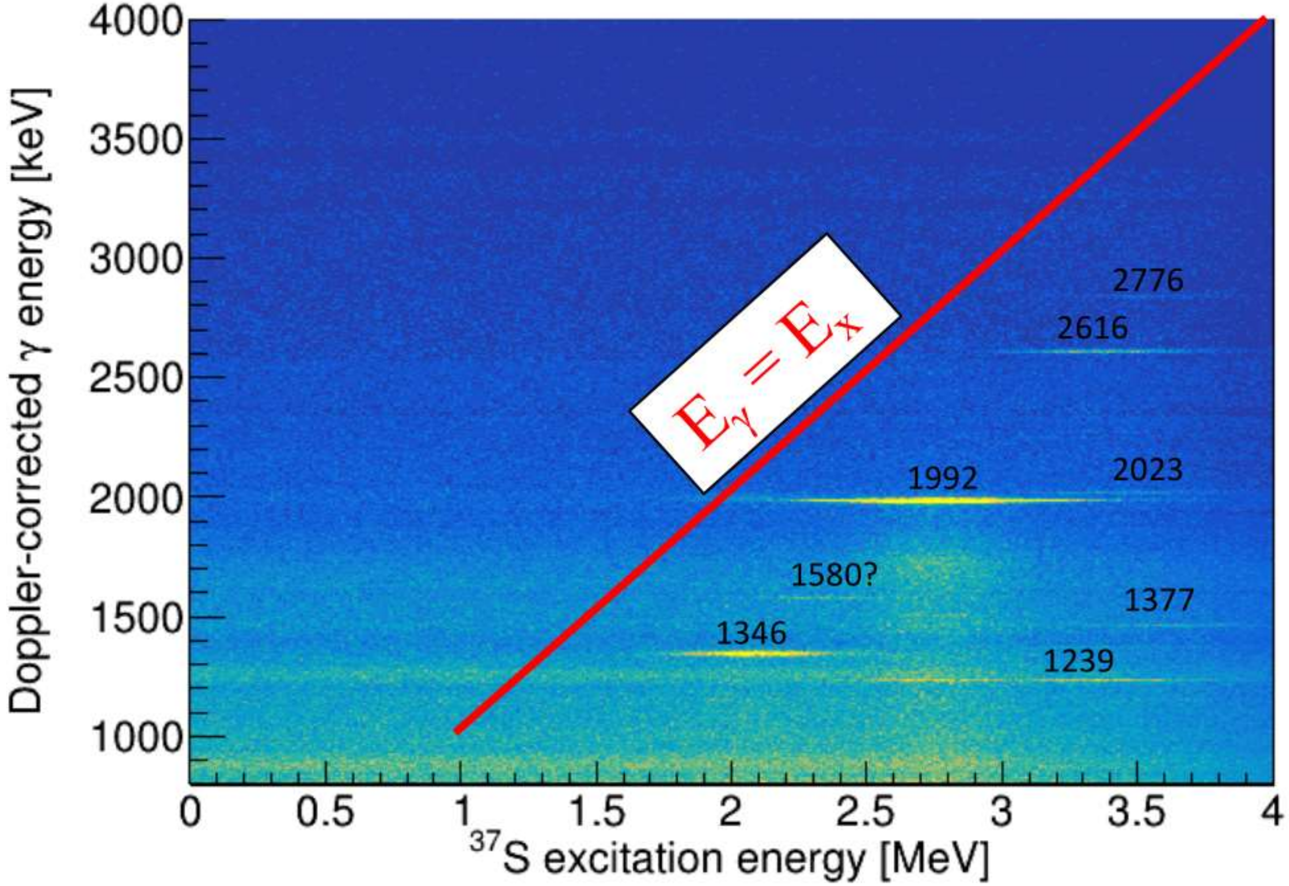
SPIDER

Excitation energy

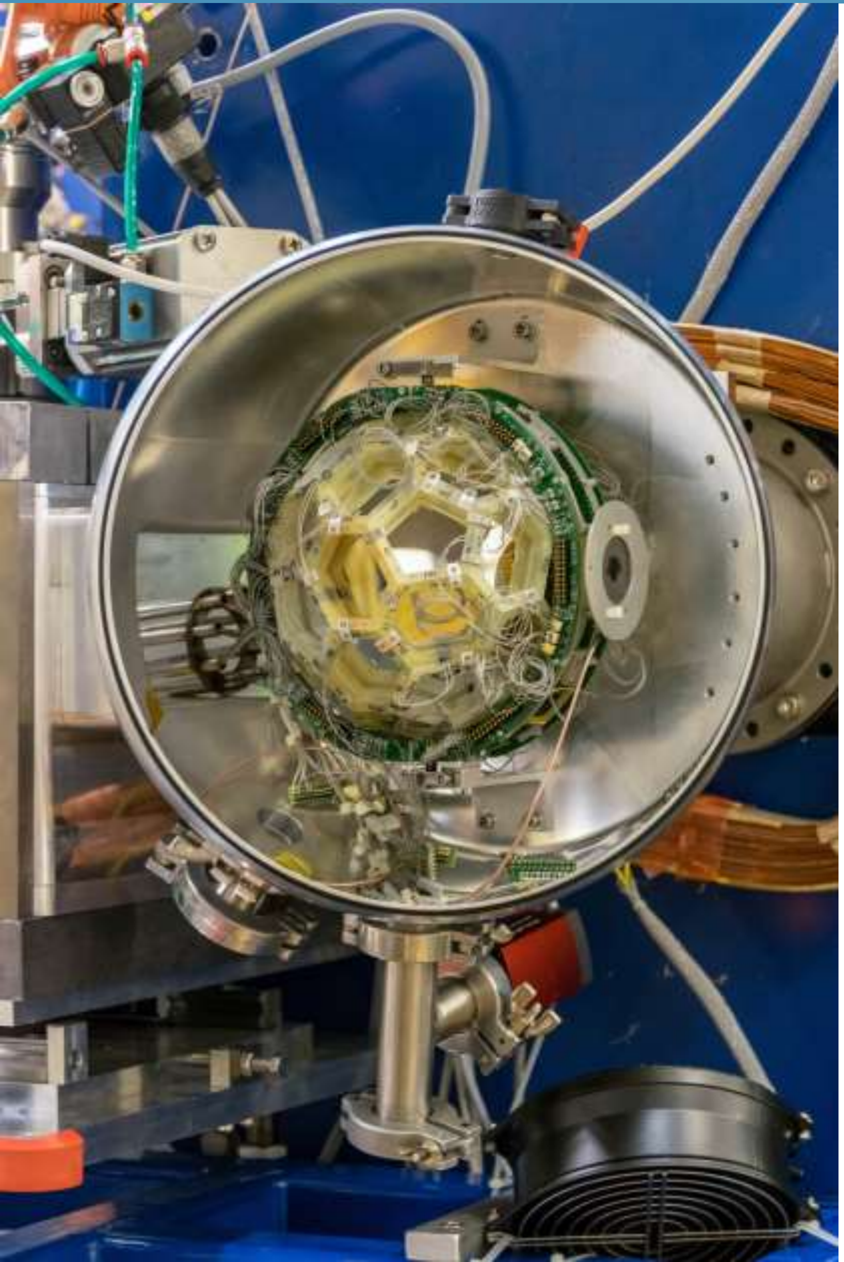
^{37}S

PhD thesis of L. Zago





EUCLIDES

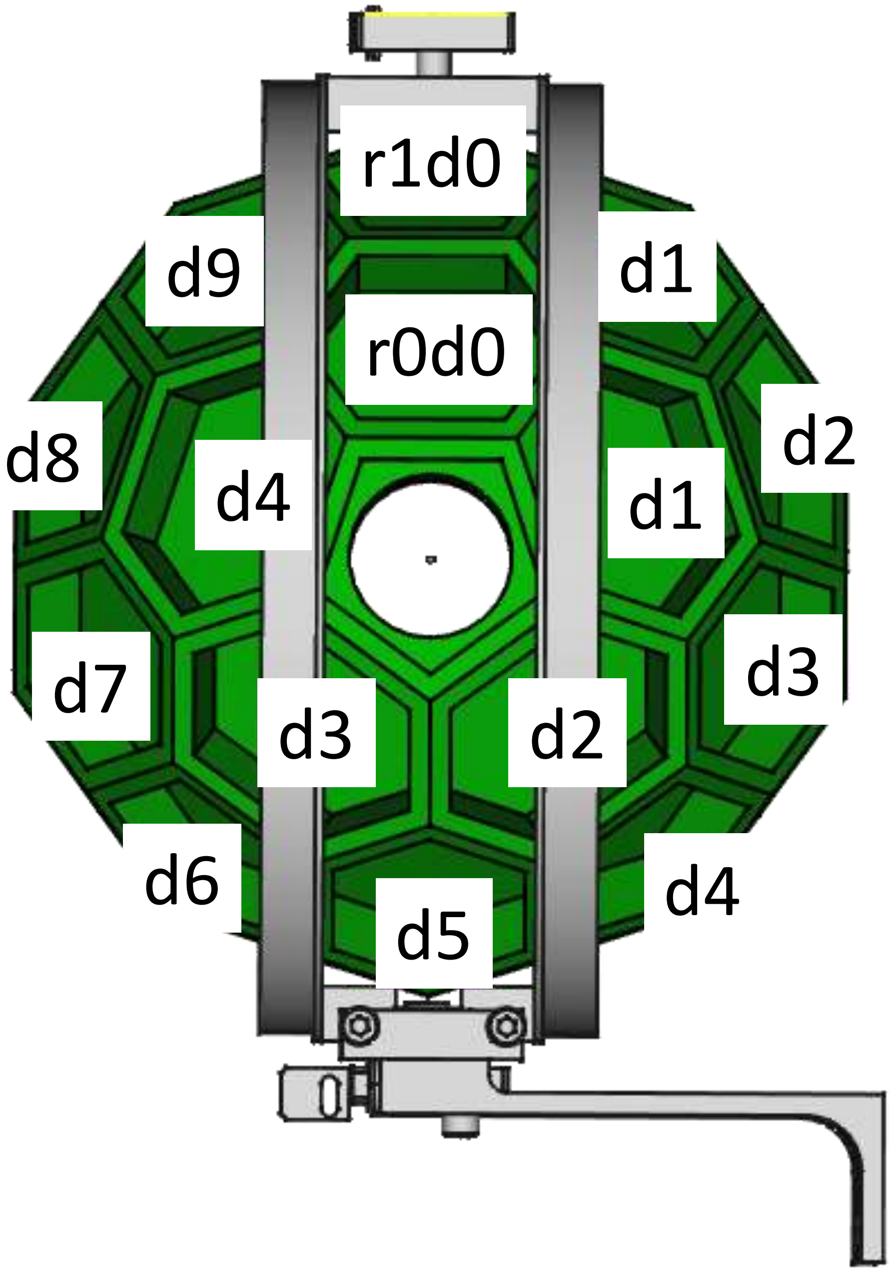


EUCLIDES

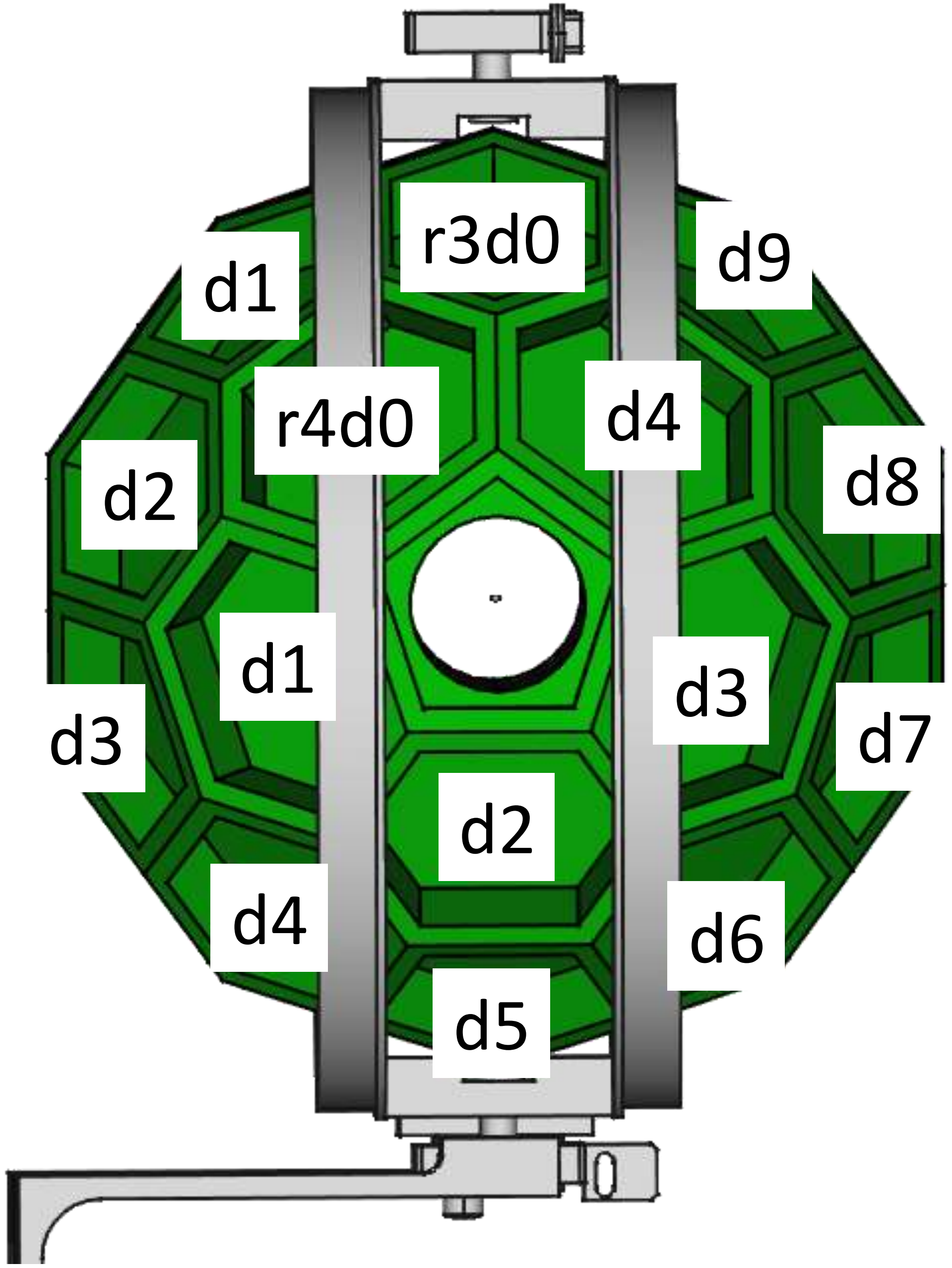
- array of dE-E telescopes, 130µm and 1000µm thick
- 4π coverage
- 5 rings composed of pentagonal or hexagonal detectors
    - forward most ring has segmented hexagons
- thin aluminum tube inside to stop elastics

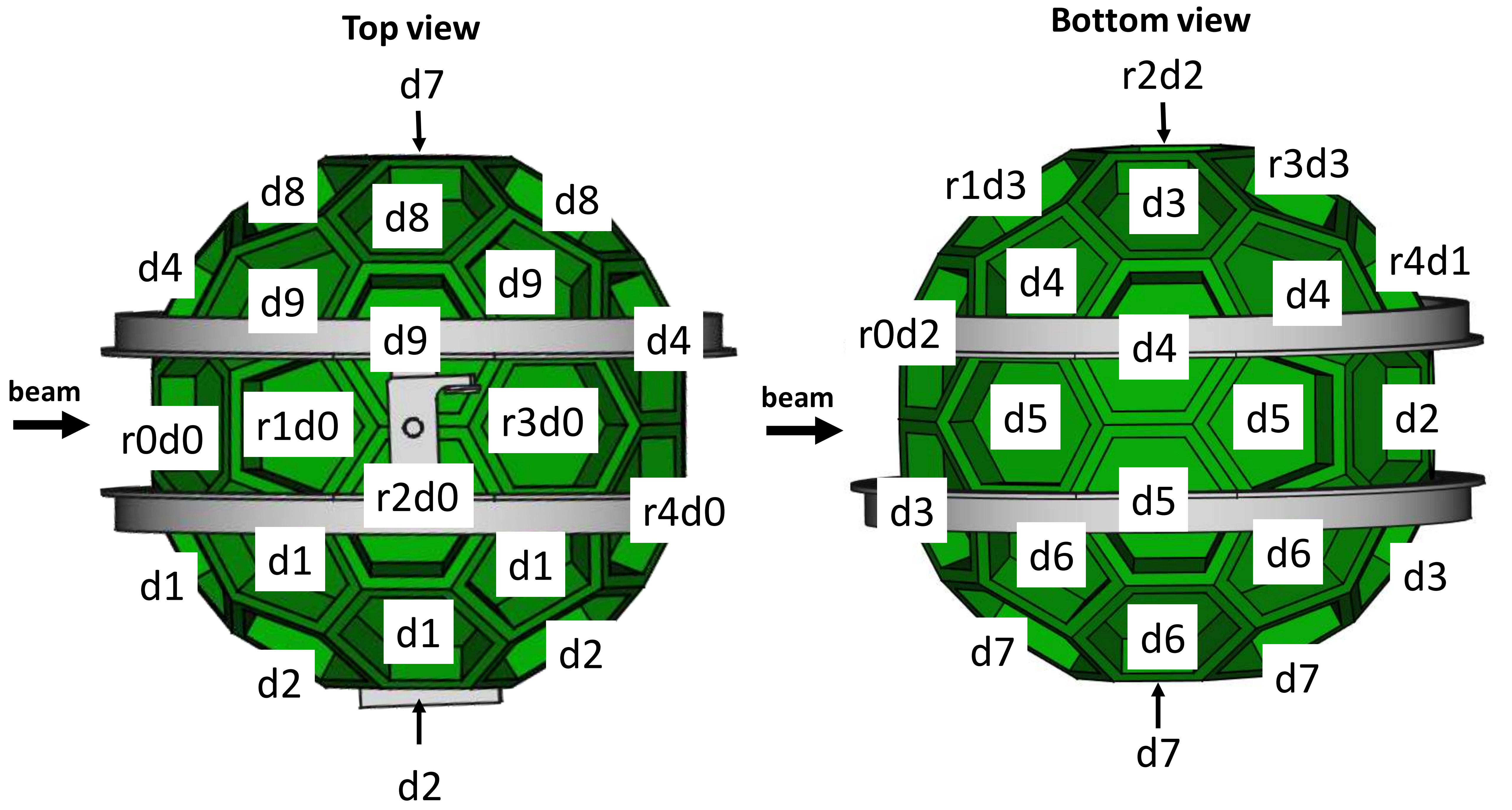
Reference paper 10.1140/epja/i2019-12714-6

Front (beam entering) view



Front (beam exiting) view




Top view
d7
d8
d8
d8
d4
d9
d9
d9
d4
beam
r0d0
r1d0
r3d0
r2d0
r4d0
d1
d1
d1
d1
d2
d2
d2
Bottom view
r2d2
r1d3
d3
r3d3
d4
d4
r4d1
r0d2
d4
beam
d5
d5
d2
d3
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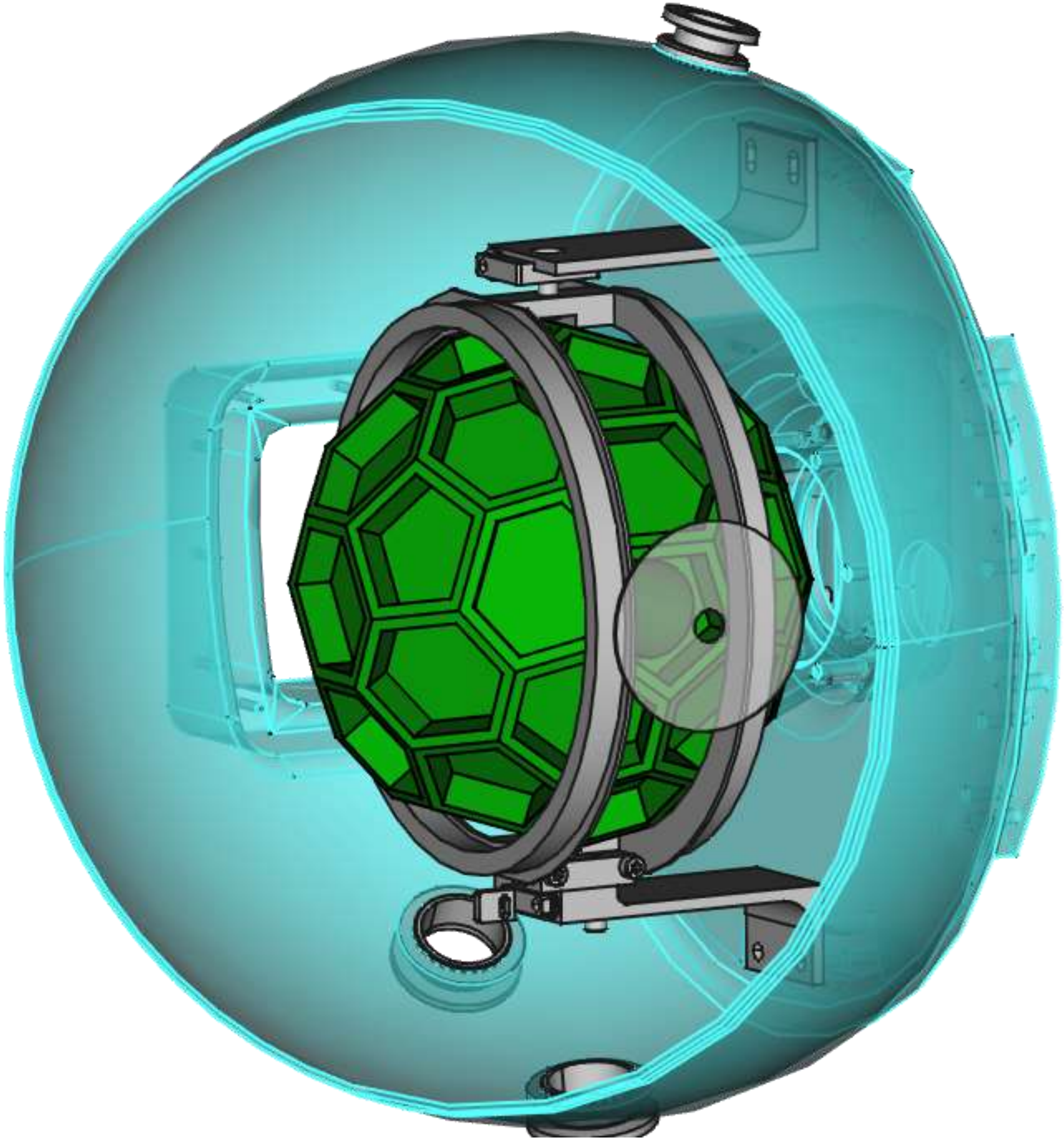
d7
d6
d7
d7



Using “map” value to identify detector:

layer, E=1 dE = 2 ← ABCD → **segment no.**

A = **layer**, B = **ring no.**, C = **detector no**, D = **segment no.**

<u>Rings</u> are numbered from back (0) to front (4)

<u>Detector number</u>: from 0 clockwise, starting from the top. If the top has 2 detectors, count from the right one

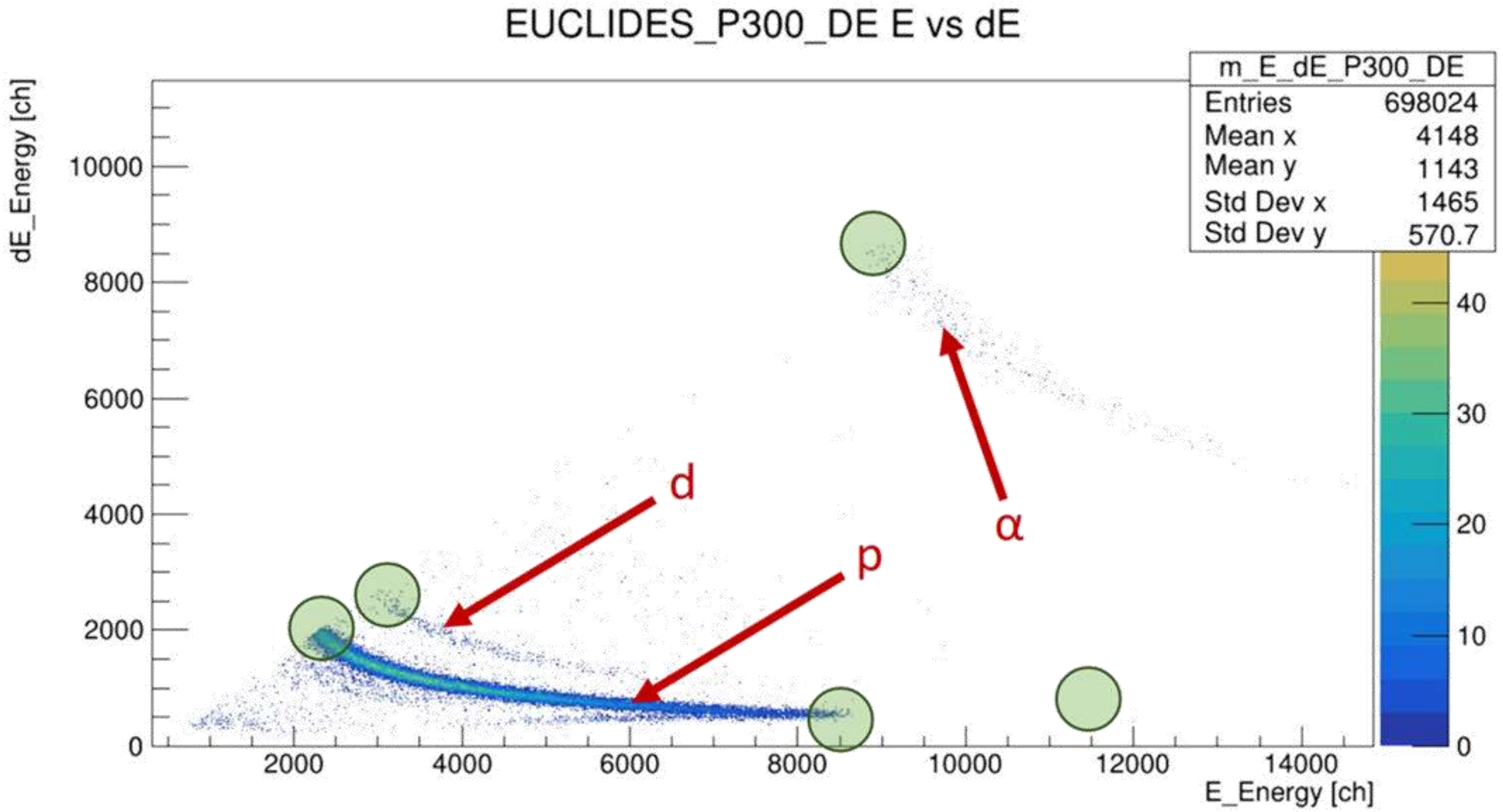
<u>Segment</u> 0 = not segmented, 1-4 segments A-D

EUCLIDES

Energy calibration

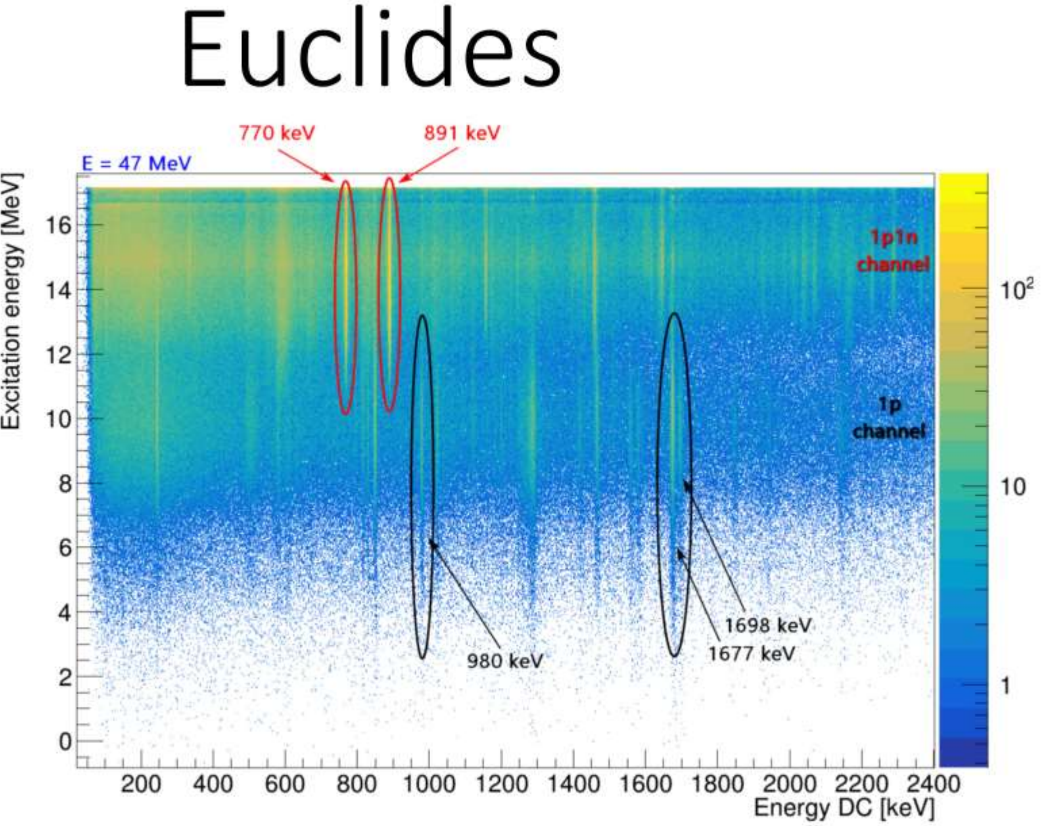
- alpha source
- elastic channel
- punch-through

PhD thesis of M. del Fabbro

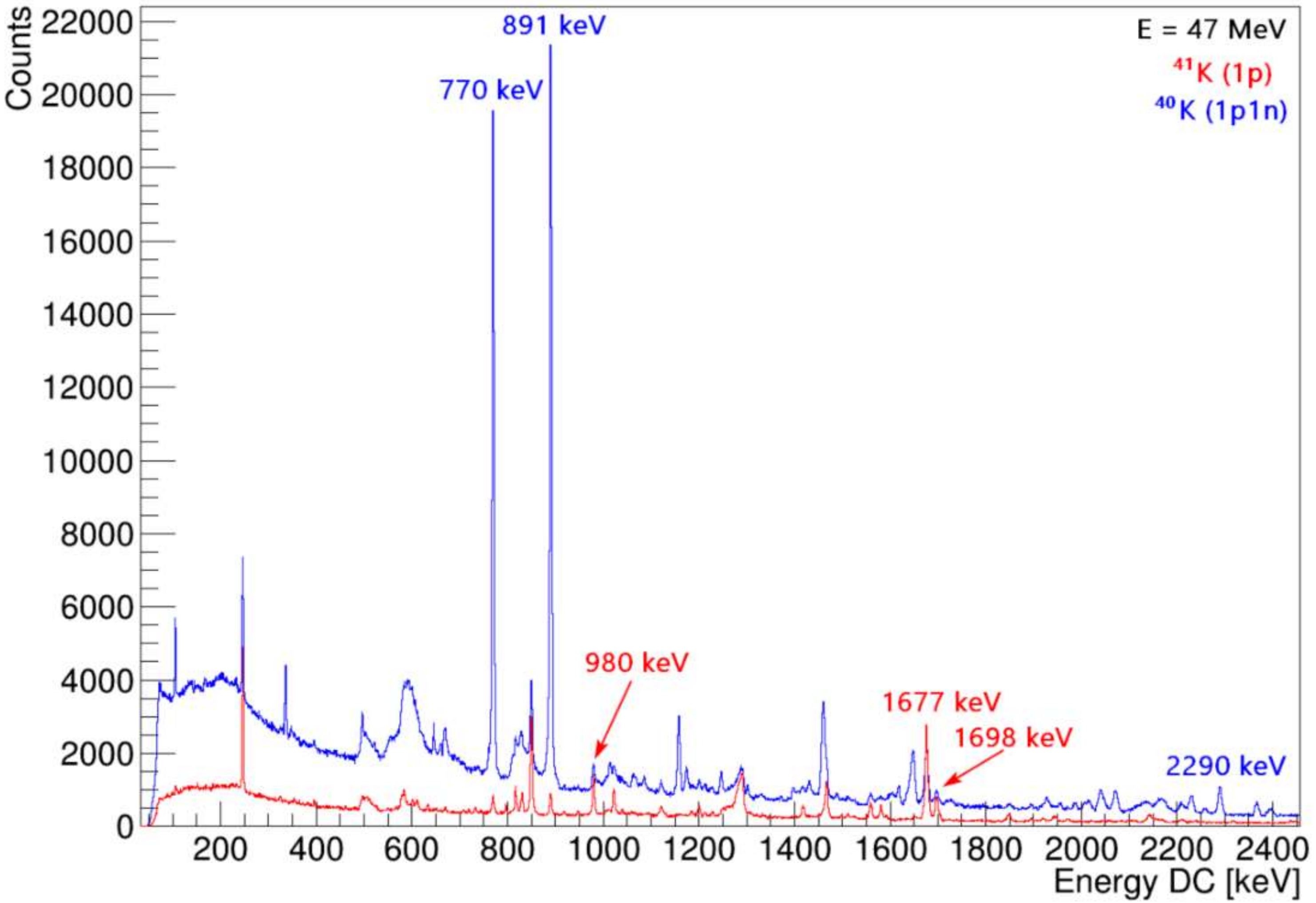


EUCLIDES

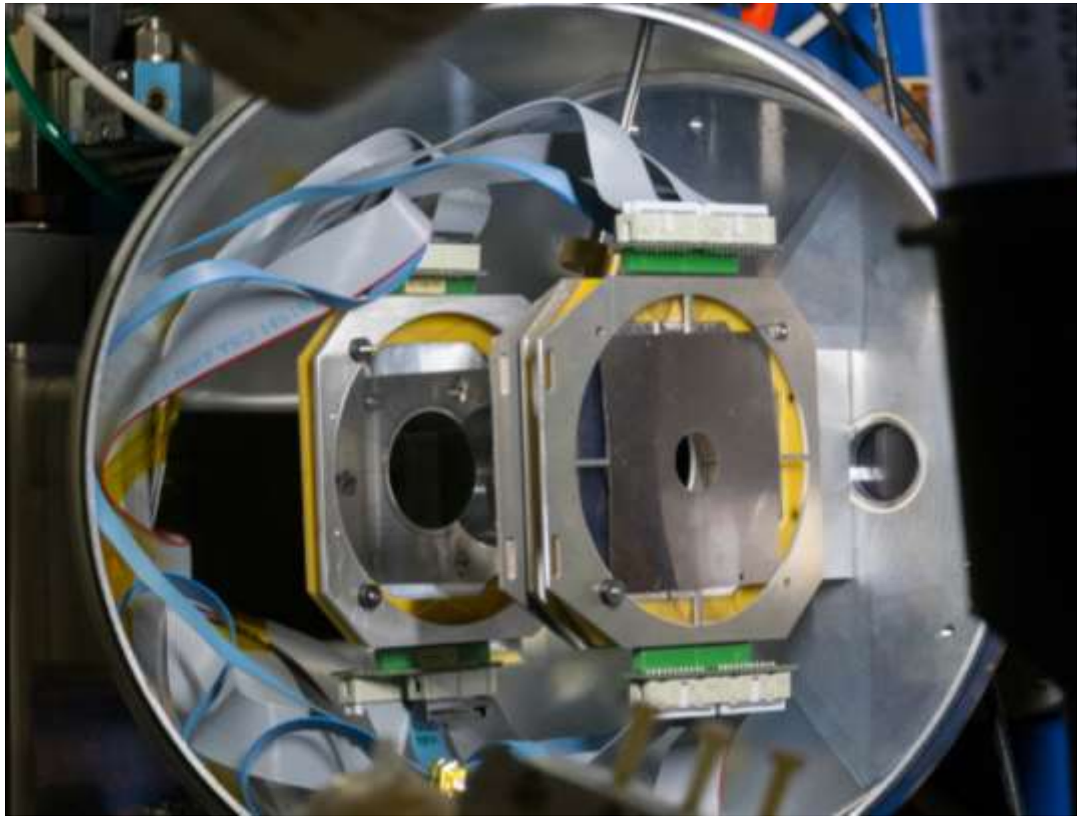
Separation of 1p and 1p1n channels with rough compound system excitation energy.

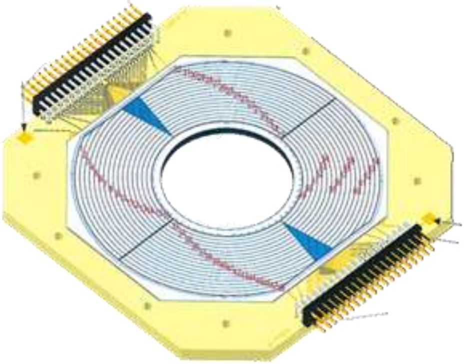


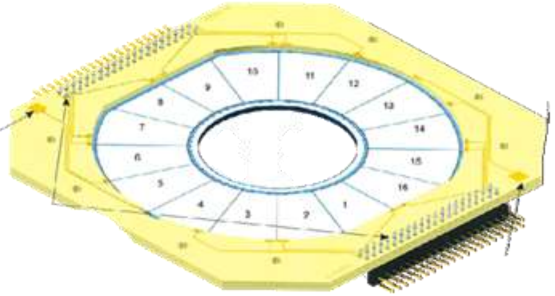
PhD thesis of M. del Fabbro



SAURON







SAURON (Silicon AnnUlar stRipped iON detector)

- annular DSSSD:
  - junction (P) side: 4 quadrants, each with 16 radial strips
  - ohmic (N) side: 16 polar pads
  - total of 256 sub-strips/pixels
- available thickness 300, 500, 1000, 1500µm
- strip resolution 1% @5.5MeV for **NEW** detector

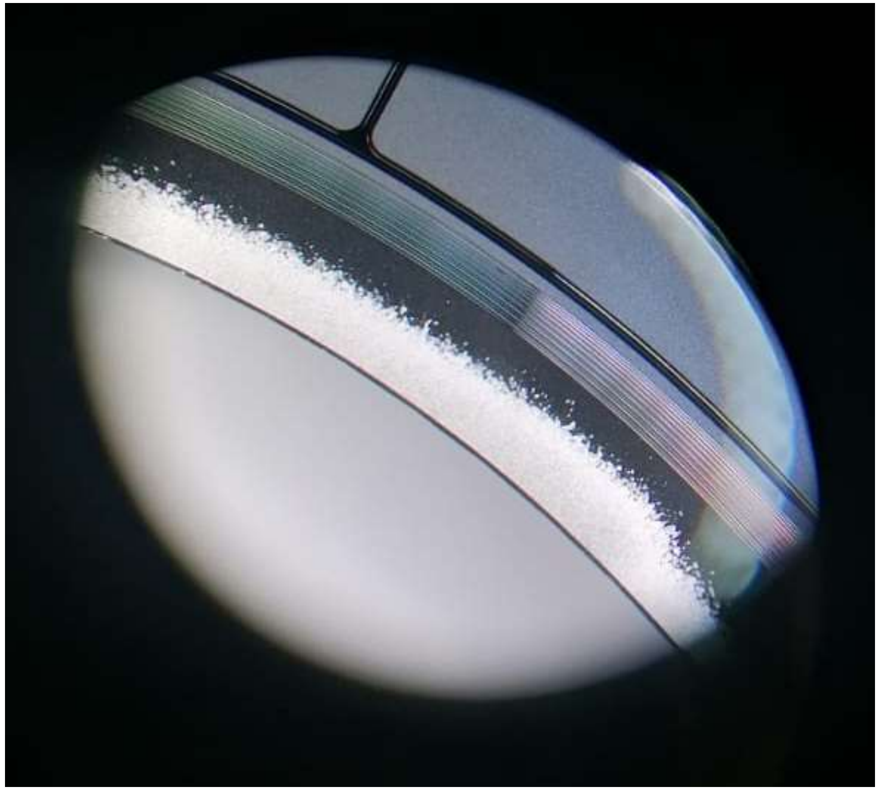
- nominal position 5cm from target
  - 25-45°
  - 135-155°

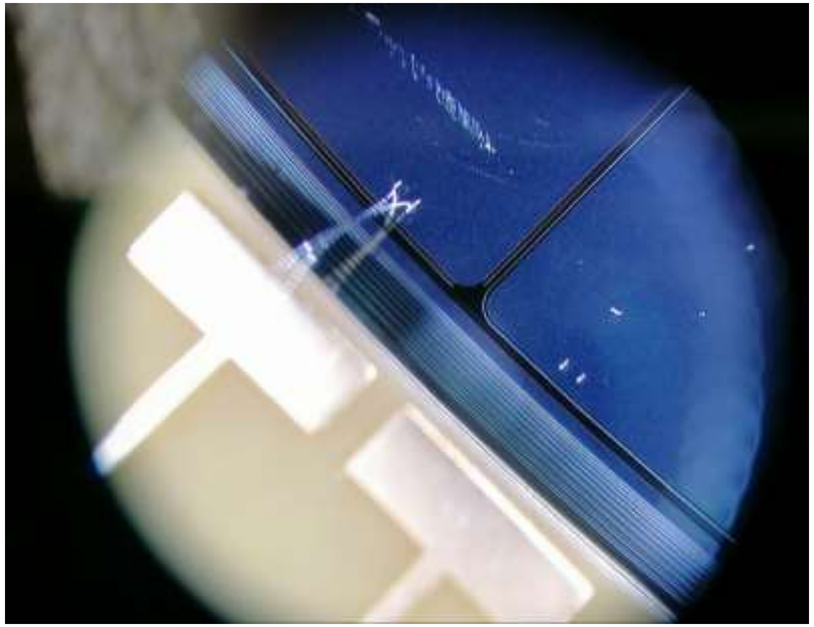
- max 2 detectors active
  - front + back configuration
  - dE+E configuration (not tested)

SAURON

Known problems

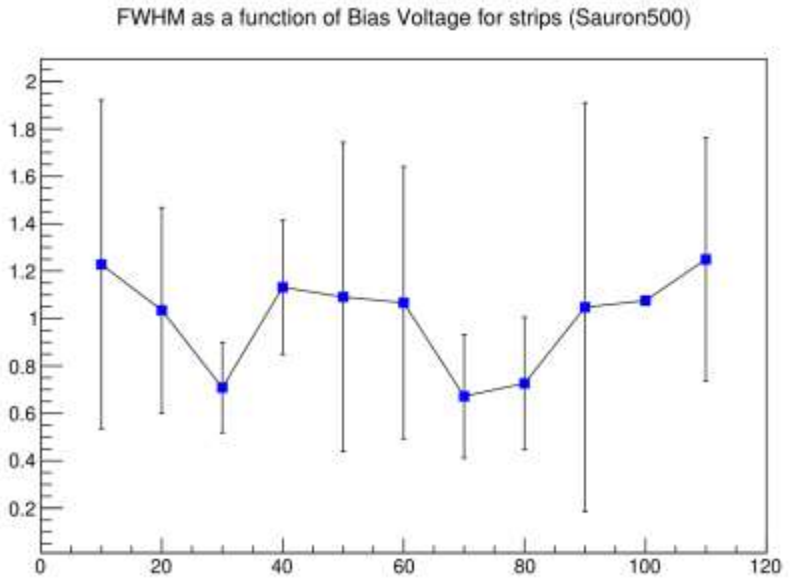
- fragile
- correct absorbers!
- leakage current runoff
  - presumably due to charge trapping by floating field plate and guard ring

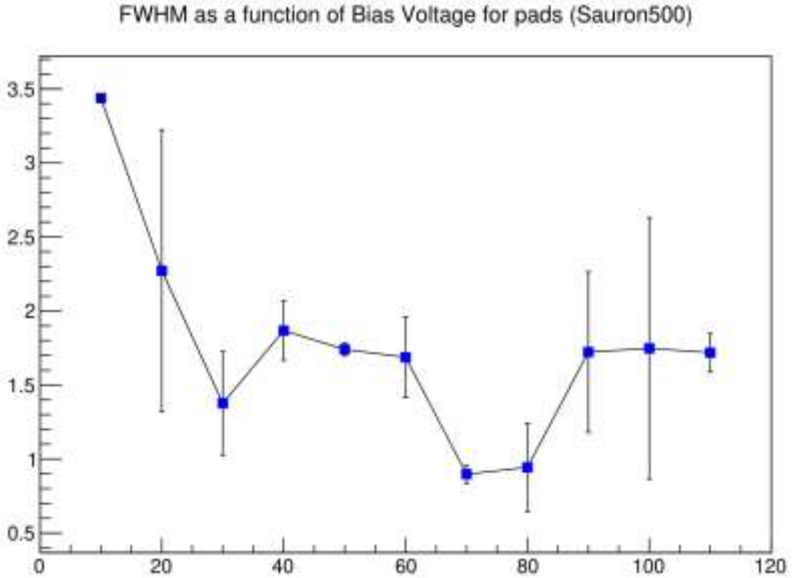


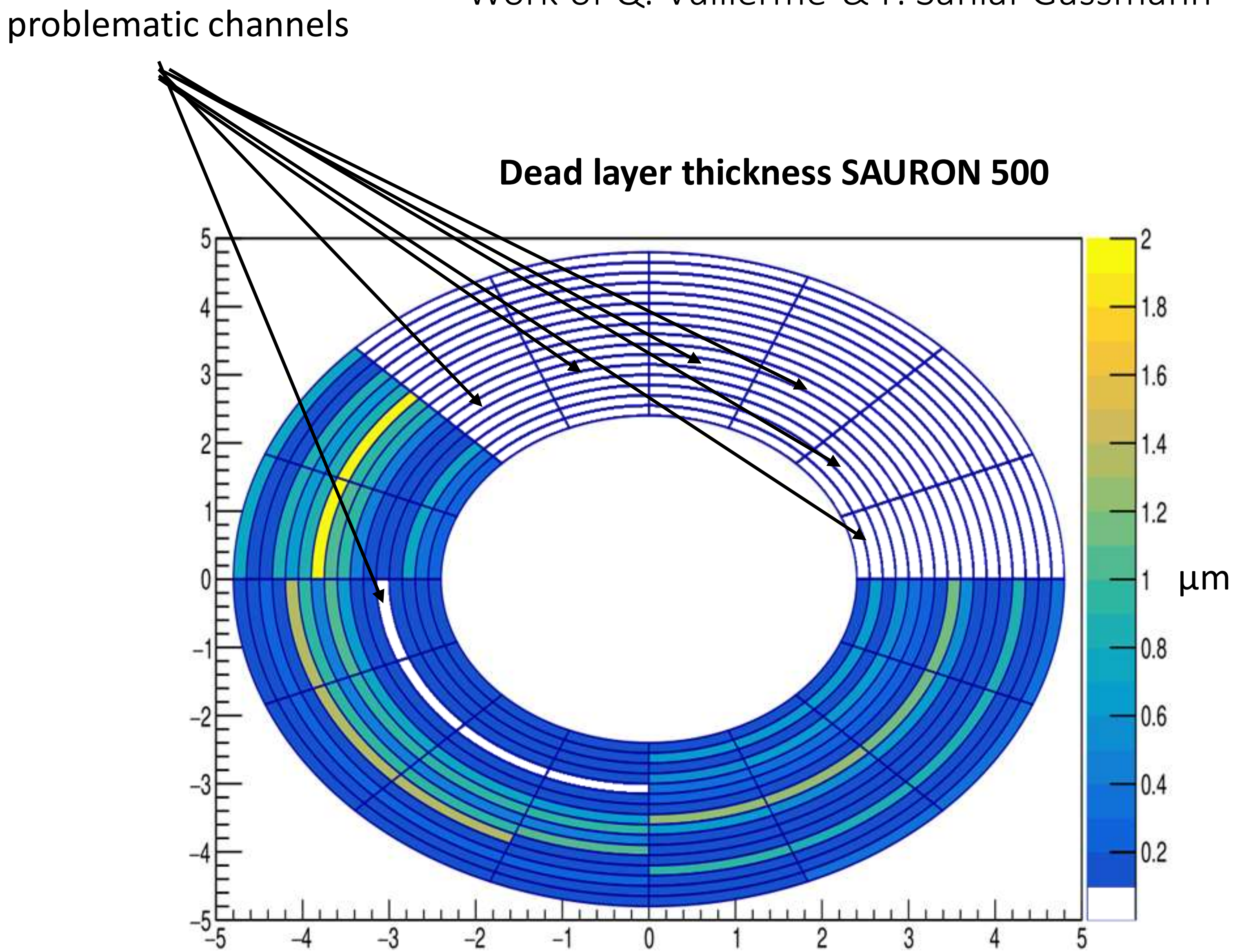


SAURON

Work of Q. Vullierme & F. Sanial-Gassmann



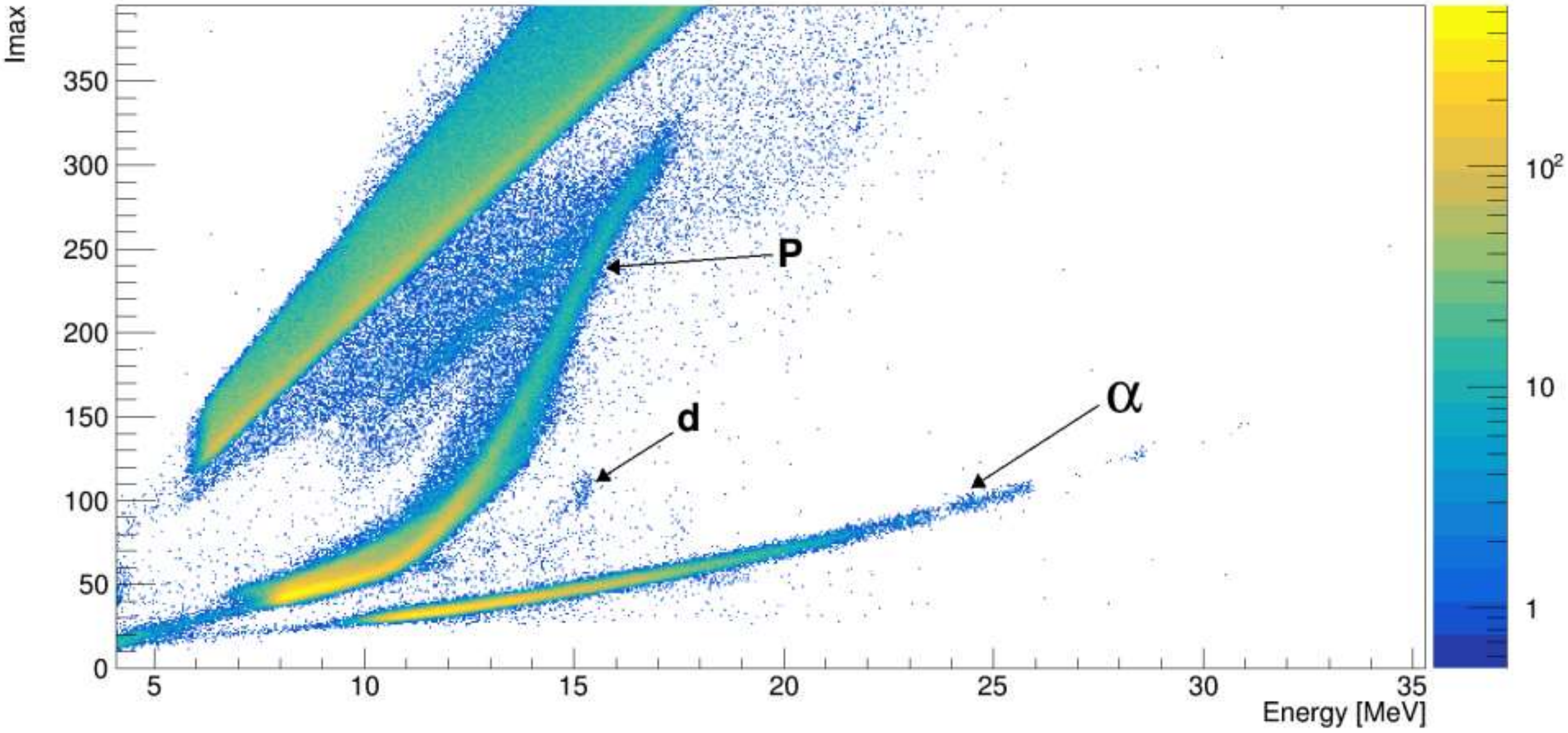




SAURON

PSA/PID
- I_{max} integrated
- NN…….. work in progress!

M. del Fabbro

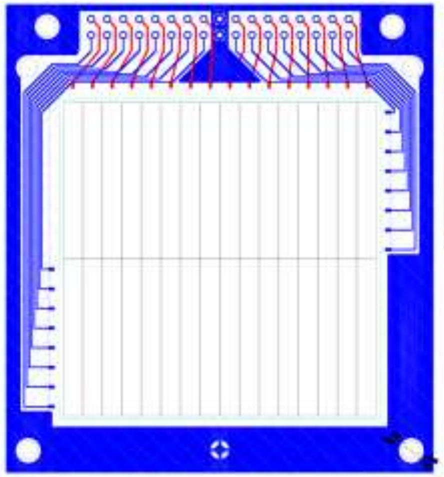


OSCAR

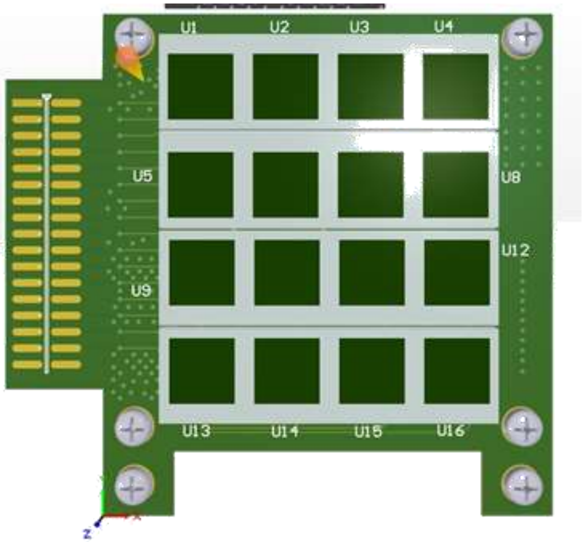
- borrowed from LNS
- dE-E telescope
  - dE: 20 µm
  - E: 300 µm

Reference paper 10.1016/j.nima.2017.09.046

dE



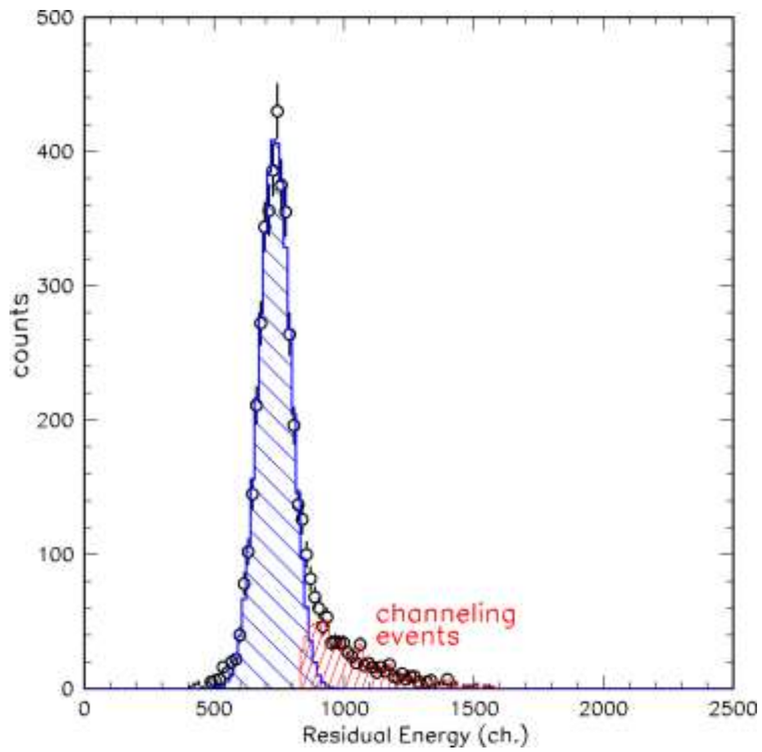
E

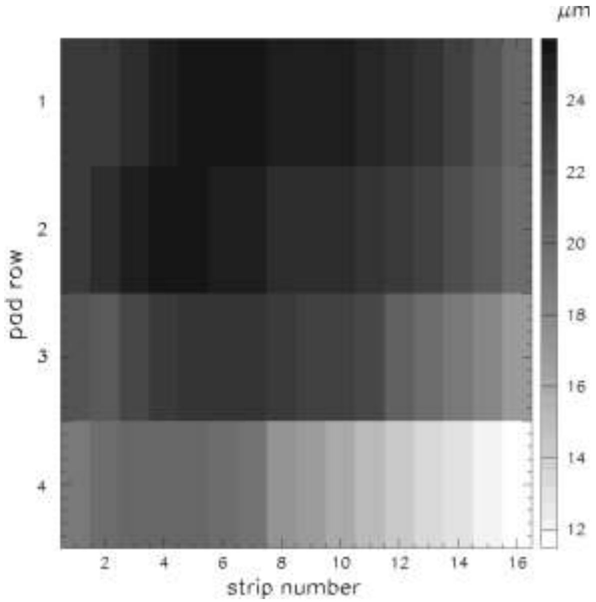


OSCAR

Known problems

- super fragile
- non-uniform dE thickness (50%)
- channeling effects

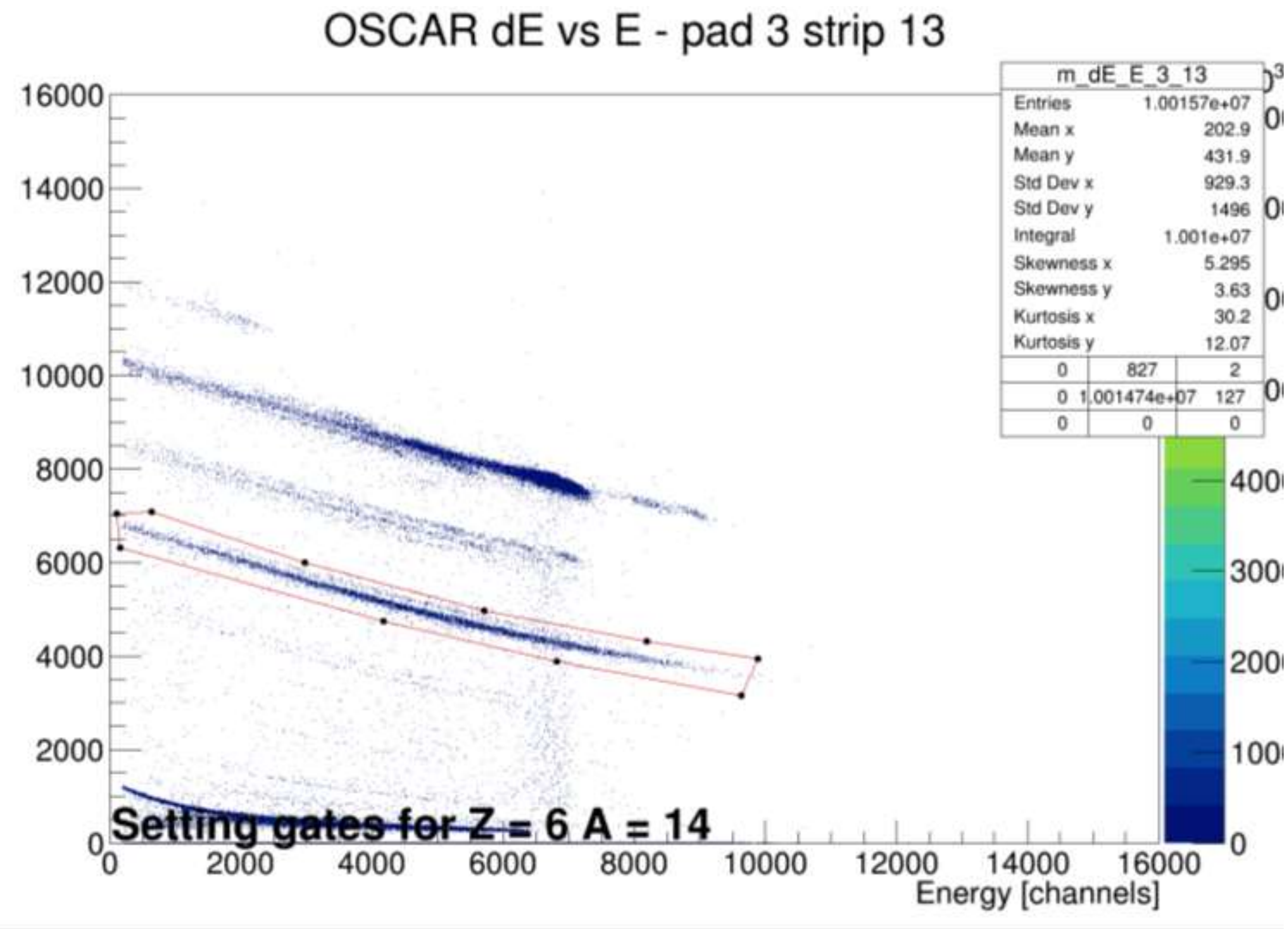




OSCAR

Exp 026

$^{54}Fe(^{16}O, ^{14}C)\ ^{56}Ni$

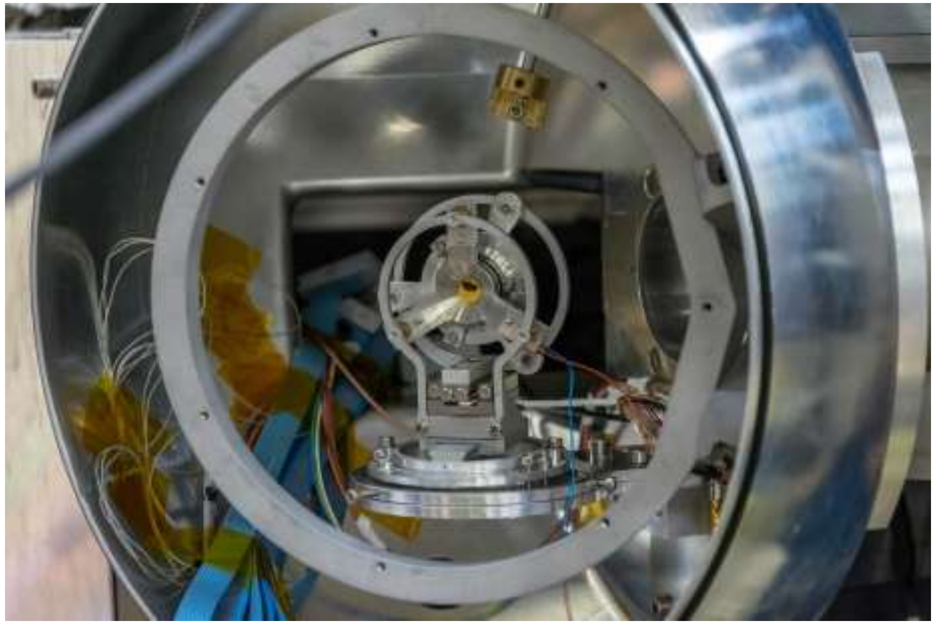


Plunger device(s)

- 2 devices: **GALILEO** and **AGATA** plunger
- similar properties
  - max distance 1.2 cm
  - same movement precision
  - can be coupled with other particle detectors***

GALILEO plunger

- can move target OR degrader foils



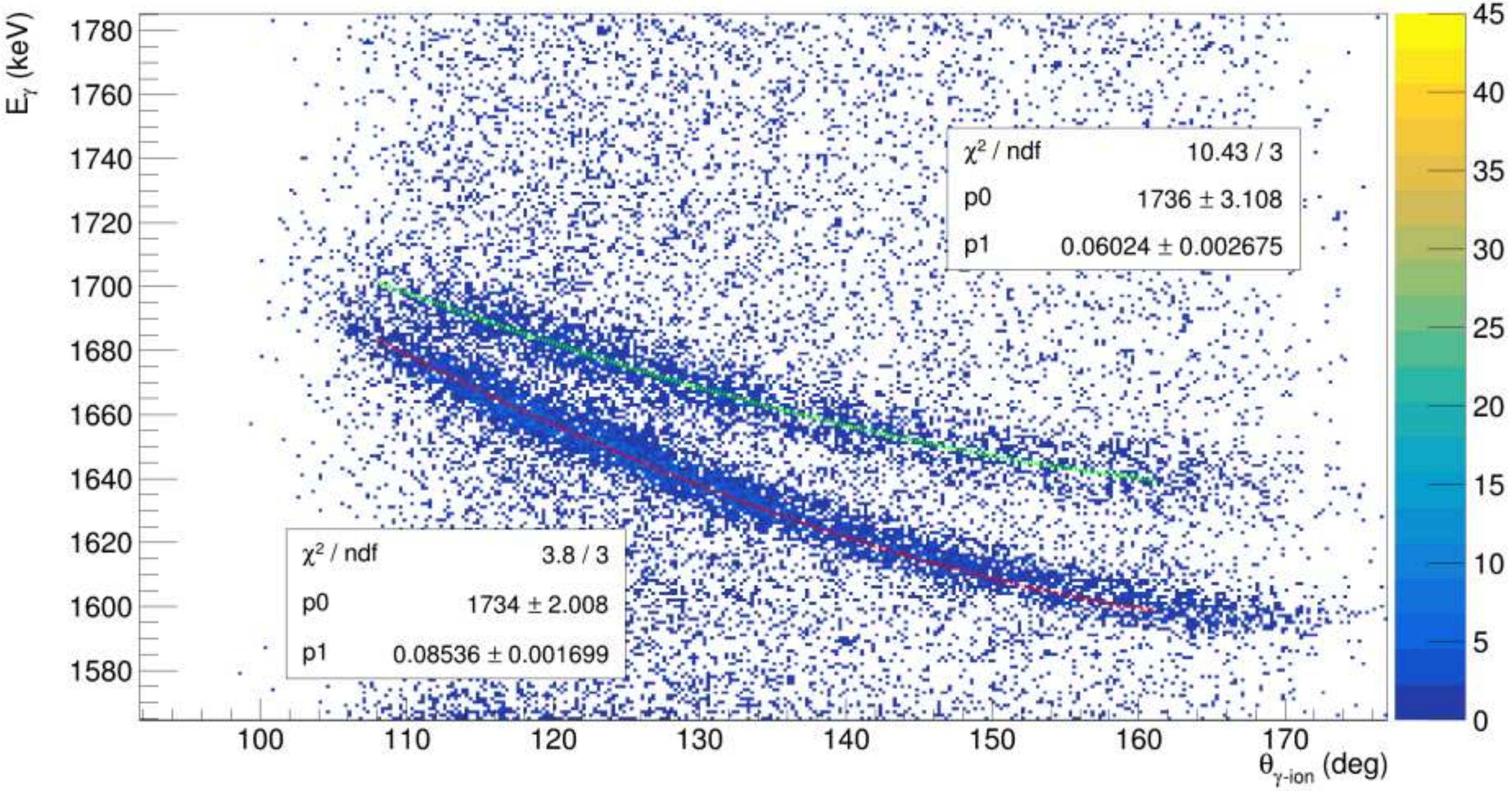
AGATA plunger

- designed specifically for AGATA
- feedback cannot correct for distances shorter then 10µm
- can be used 3-foil plunger – not tested yet
- ***LED indicator on motor, problem for light-sensitive detectors!

Plunger device(s)

Exp 031

^{96}Zr $2^+ \rightarrow 0^+$



LaBr

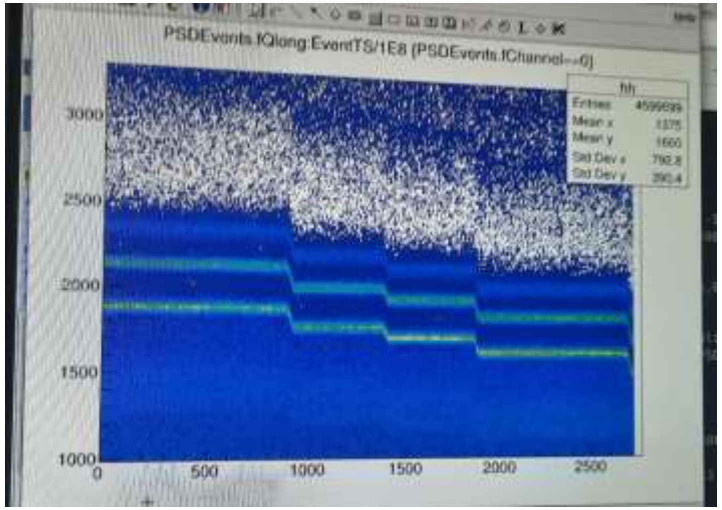
LaBr array

- Exact number of detectors may vary in the experiment
- usually 5 large (3”x3”) and 4 smaller (2”x2”)
- use digitizers with PSD

Known issues

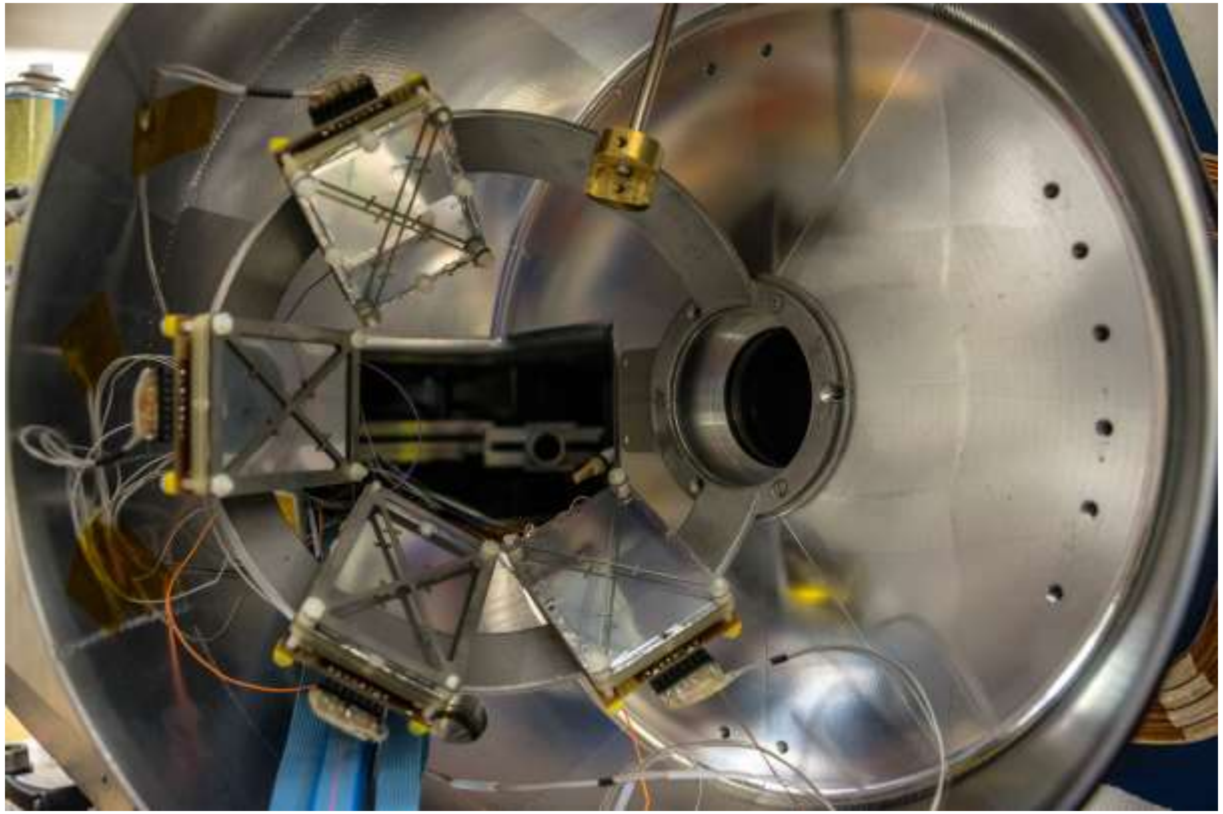
Calibration is dependent on magnetic field

- added more mu-metal for shielding
- if PRISMA is used, plot time vs energy matrix to verify calibration during the experiment



[reference paper 10.1016/j.nima.2013.07.084]

DANTE

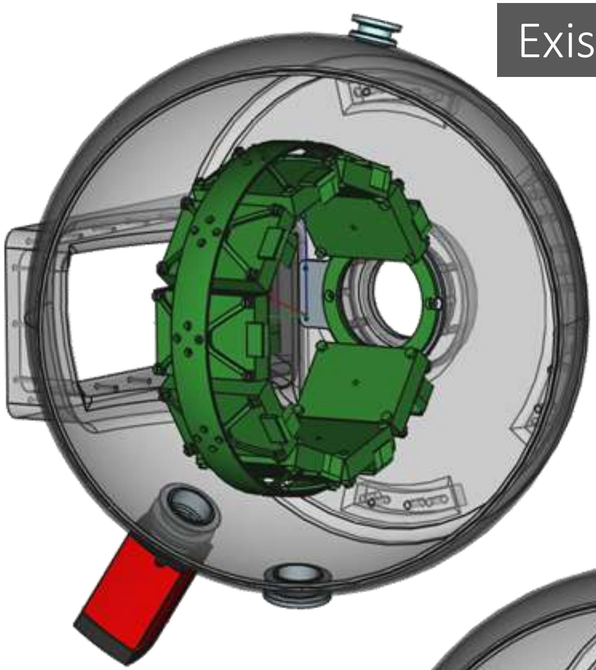


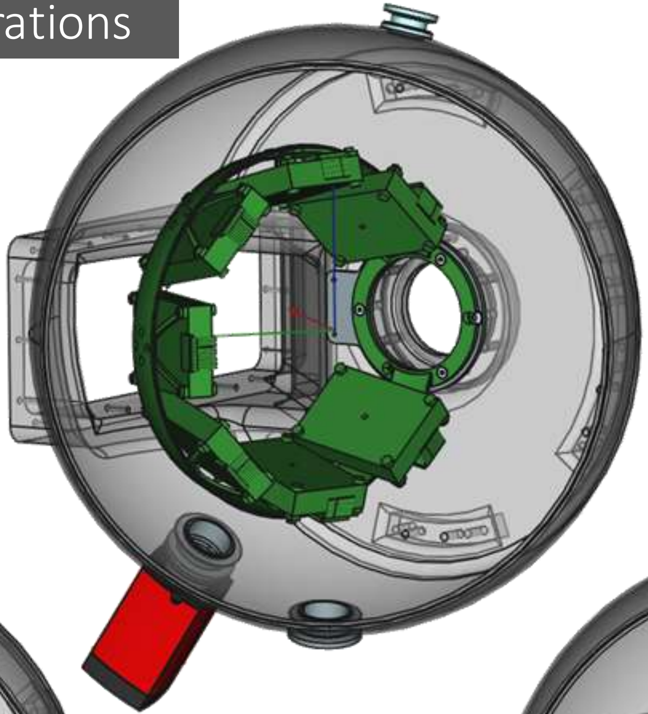
- two MCP in chevron configuration
- size 40x60mm
- resolution
  - time <0.5ns
  - spatial <1mm

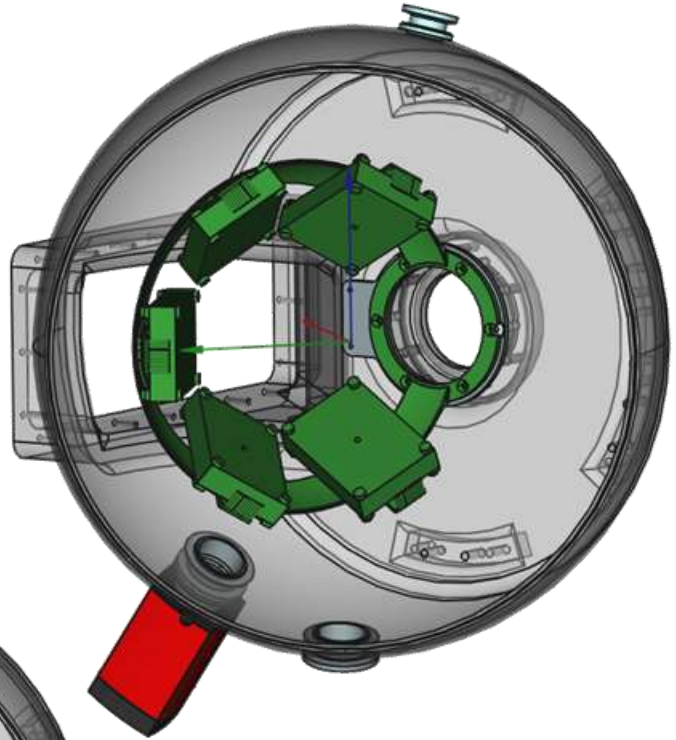
- only 3 confirmed operational (to be verified)

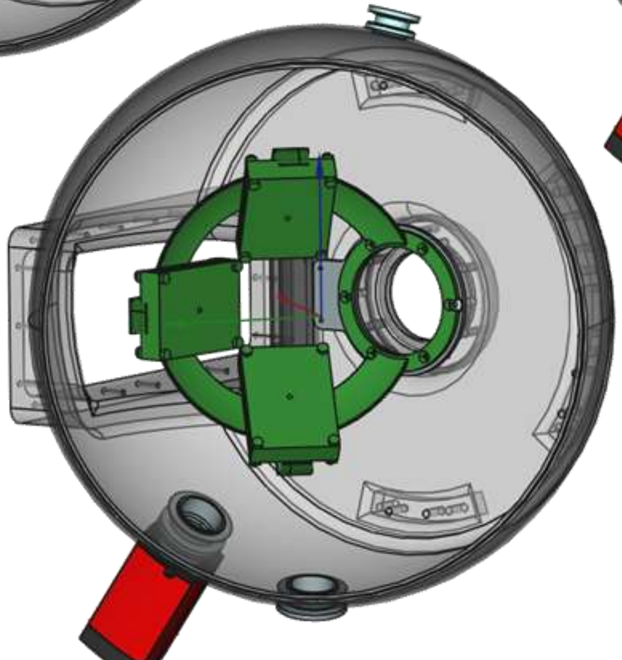
DANTE

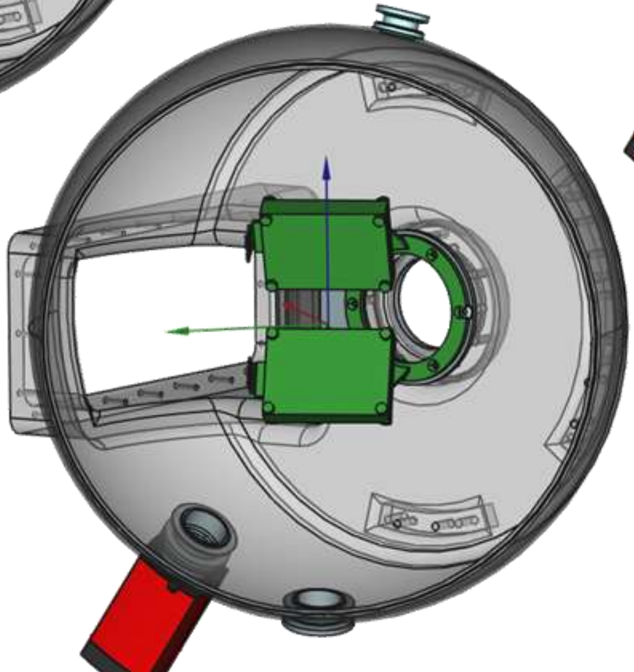
Existing configurations









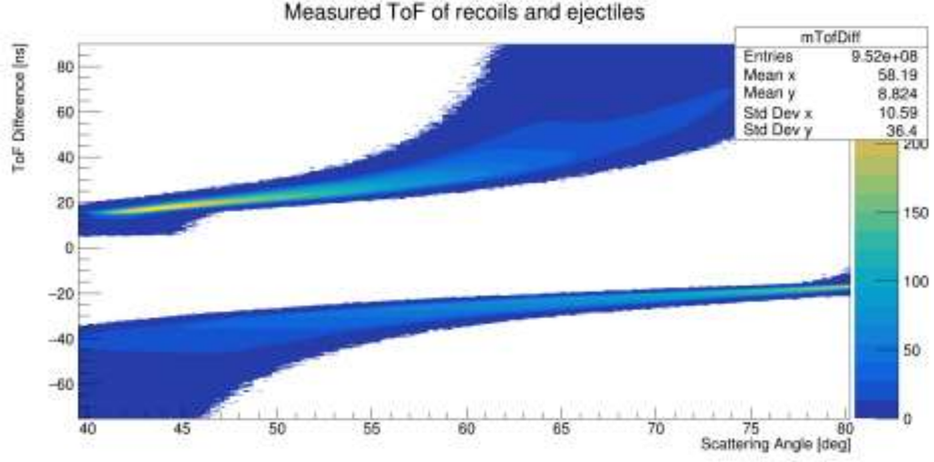


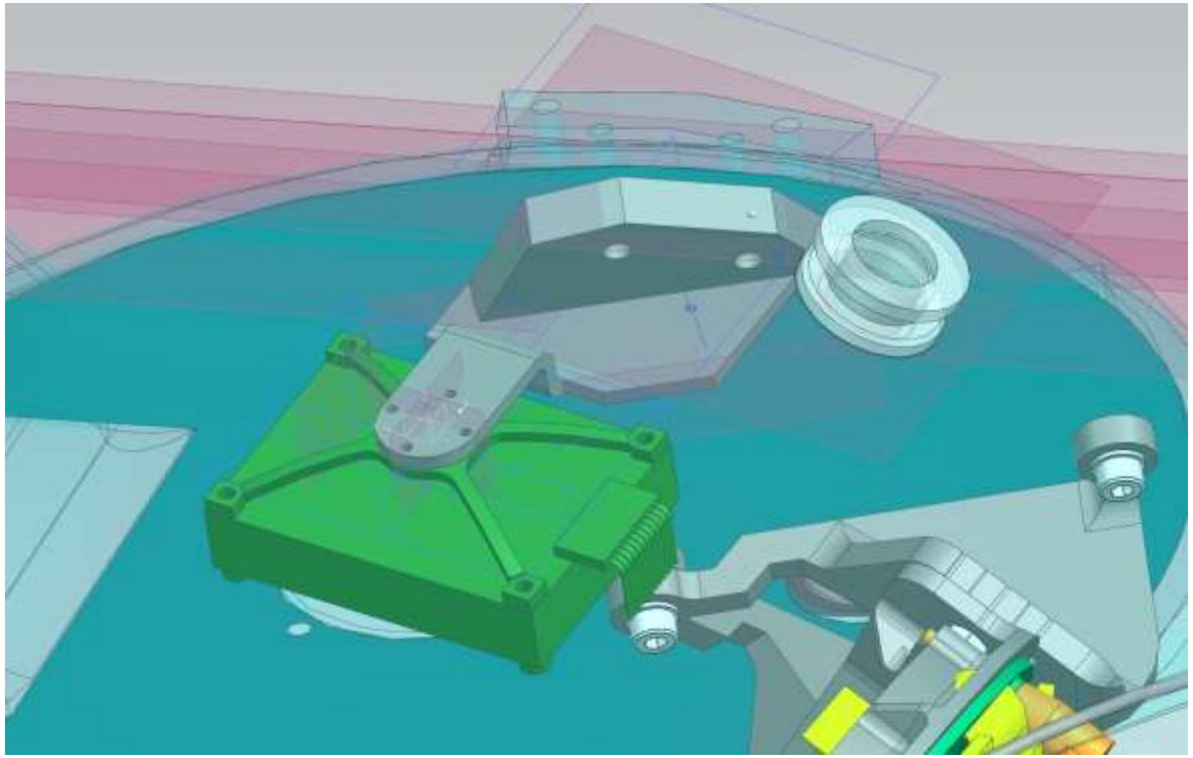
DANTE

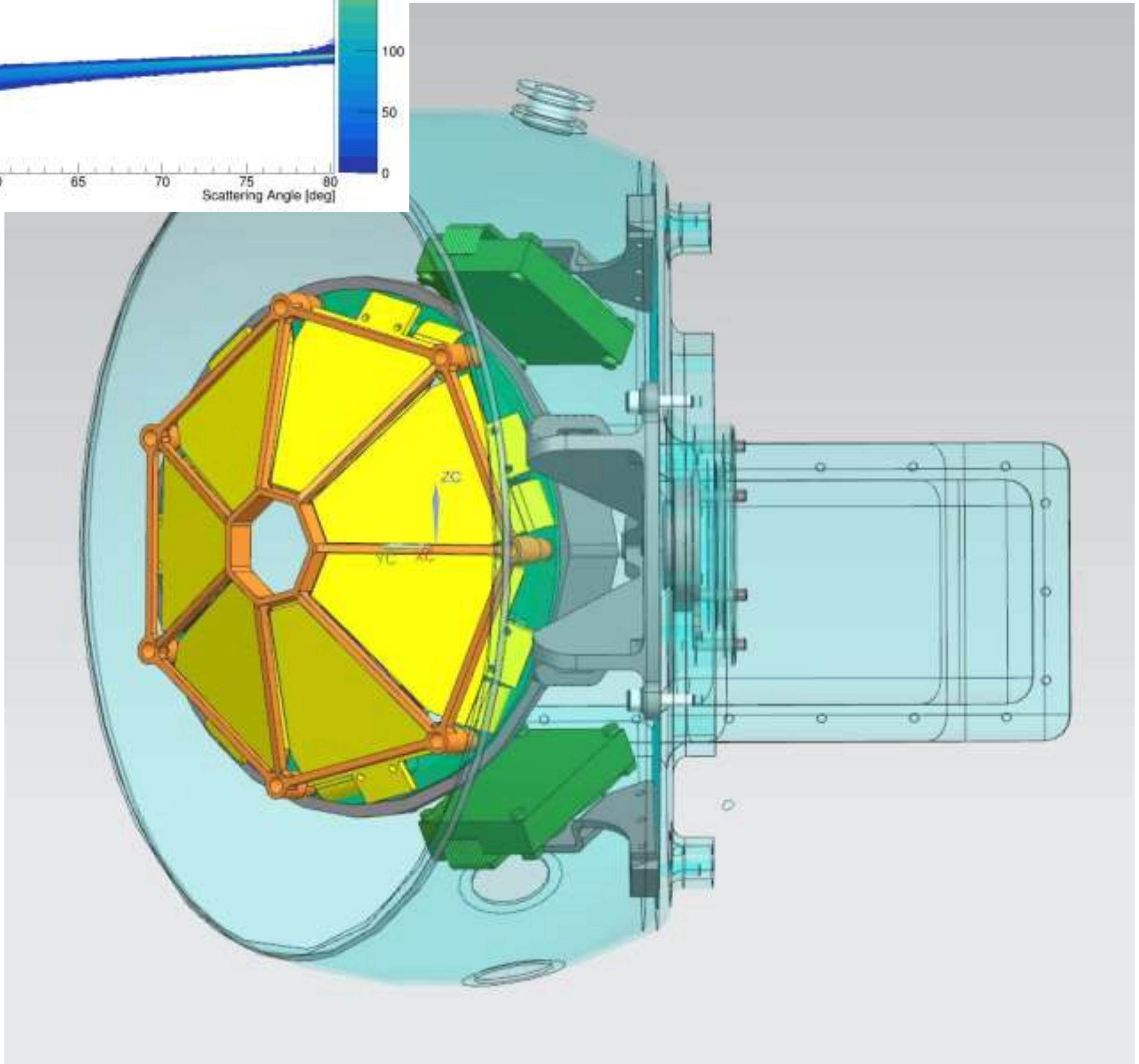
Courtesy of M. Siciliano
$^{197}Au(^{44}Ca)$

New structure!

- intended for Coulex experimen
- with PRISMA @50°:
    - target-MCP 10cm
    - coverage 40-80°

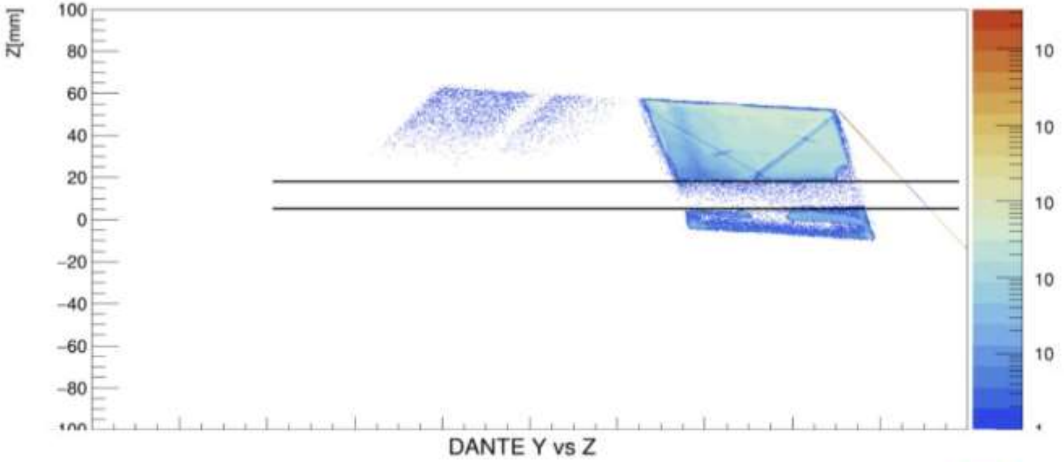


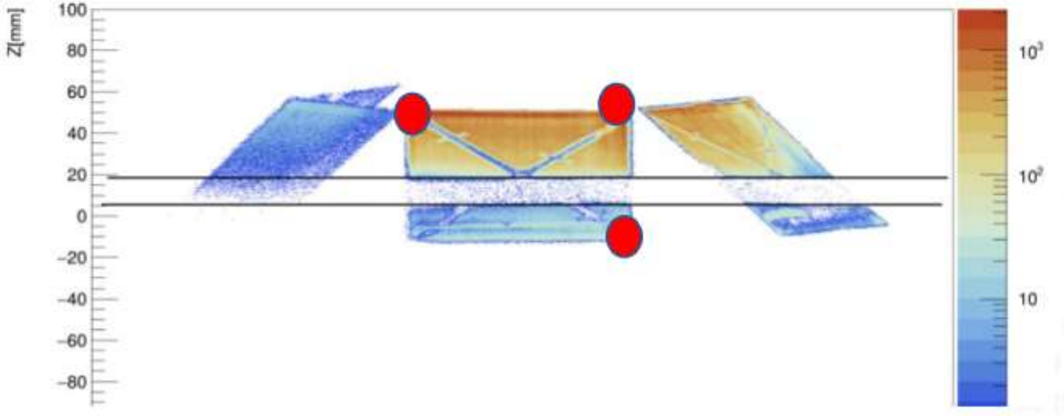


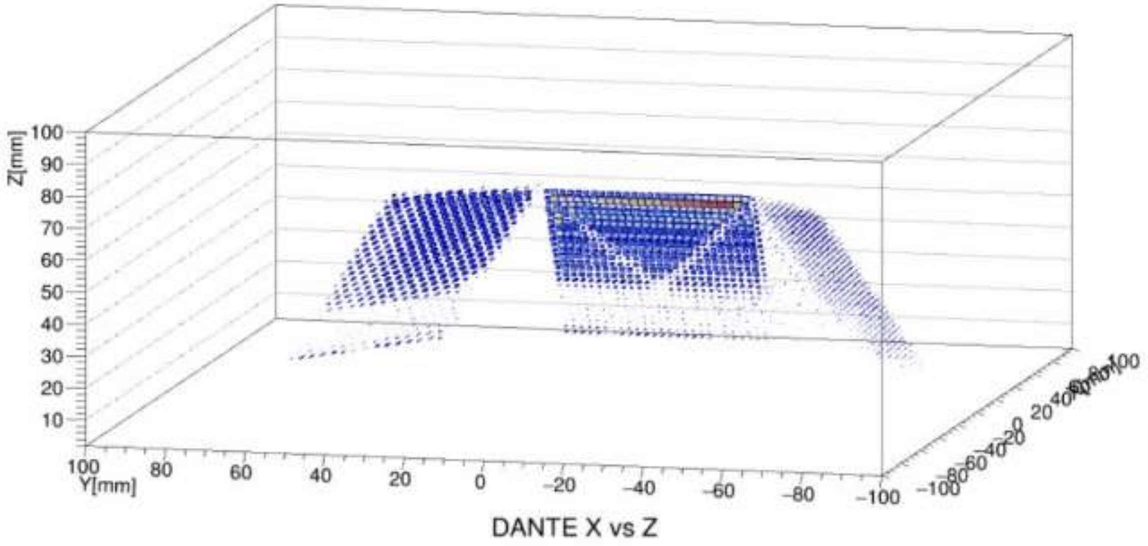


DANTE

- The position is used to refine the Doppler correction







DANTE

Look-up table

- Detector dependent parameters:
  - P1, P2, P3
  - pos1, pos2, pos3
- Channel names distinguish X, Y, T and TOF

main ⌄   agataselector / User / EXP / Template / Conf / LUT / LUT_DANTE_3det_0deg.dat   Find file   Blame   History   Permalink

LUT_DANTE_3det_0deg.dat   2.75 KiB   Edit ⌄

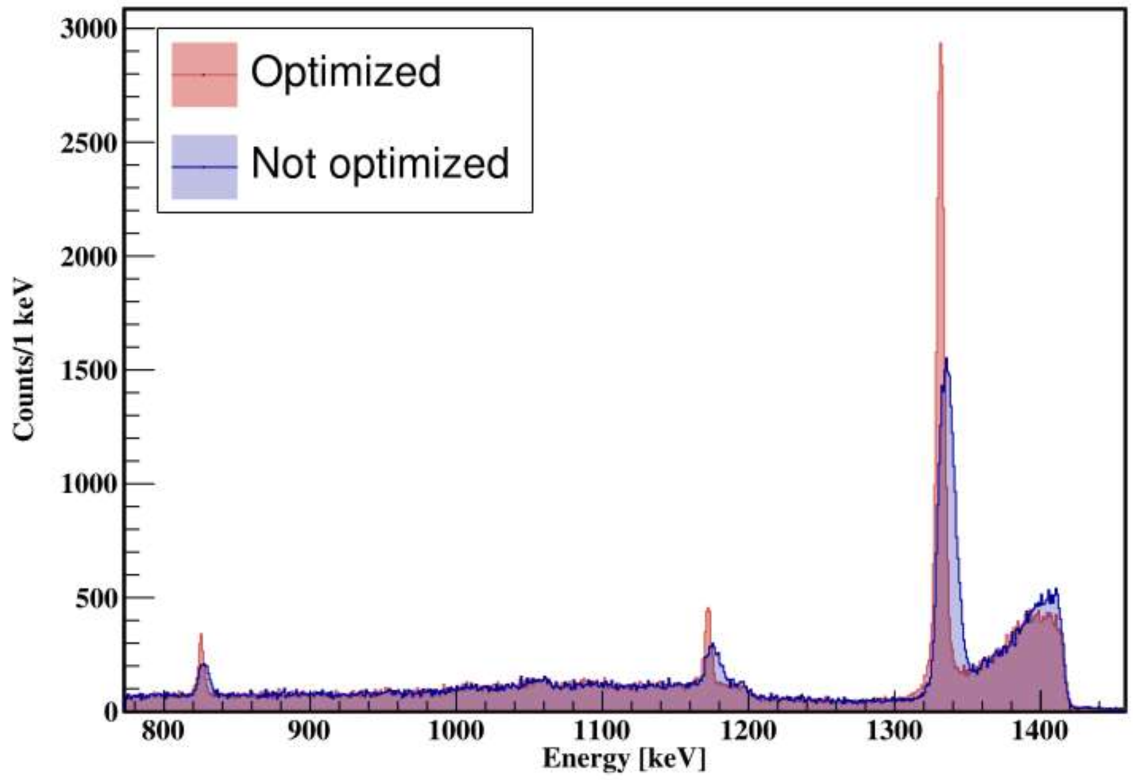
```
#              2                       X          Y          Z
#                  D1      D1P1     72.8361    25.3272    23.7575
#                          D1P2     41.2708    77.7189   -11.2993
#                          D1P3     35.3073    25.3272    57.5486
#            3   1     3
#                          D2P1     72.8935   -25.2499    23.7059
#     D2           X       D2P2     80.2628   -25.2499   -46.4078
#                          D2P3     72.8935    25.2500    23.7059
# 2          1   3     1
#                          D3P1     35.3073   -25.3272    57.5486
#                  D3      D3P2      3.7420   -77.7189    22.4917
#                          D3P3     72.8361   -25.3272    23.7575
#                      2
#
#Board channel name  thr_lo thr_hi  P1(x,y,z)  P2(x,y,z)  P3(x,y,z)  pos1  pos2  po3   Time Offset
1       0      D1X   4726   6700    72.8361    41.2708    35.3073   6700  4726  6700  0
1       1      D1Y   3110   4535    25.3272    77.7189    25.3272   3110  3110  4535  0
1       2      D1T   0      2000    23.7575   -11.2993    57.5486   0     0     0     0
#
1       4      D2X   4060   5990    72.8935    80.2628    72.8935   5990  4060  5990  0
1       5      D2Y   3850   5570   -25.2499   -25.2499    25.2500   3850  3850  5570  0
1       6      D2T   0      2000    23.7059   -46.4078    23.7059   0     0     0     0
#
1       8      D3X   4381   6597    35.3073     3.7420    72.8361   6597  4381  6597  0
1       9      D3Y   3605   5625   -25.3272   -77.7189   -25.3272   3605  3605  5625  0
1       10     D3T   0      2000    57.5486    22.4917    23.7575   0     0     0     0
#
1       12     D4X   10000  5000    36.0146   -24.5866    59.1902   5000  2200  5000  0
1       13     D4Y   10000  3500   -27.7491   -60.1032   -52.9991   2100  2100  3500  0
1       14     D4T   0      2000    56.3766    40.5354    19.2878   0     0     0     0
```

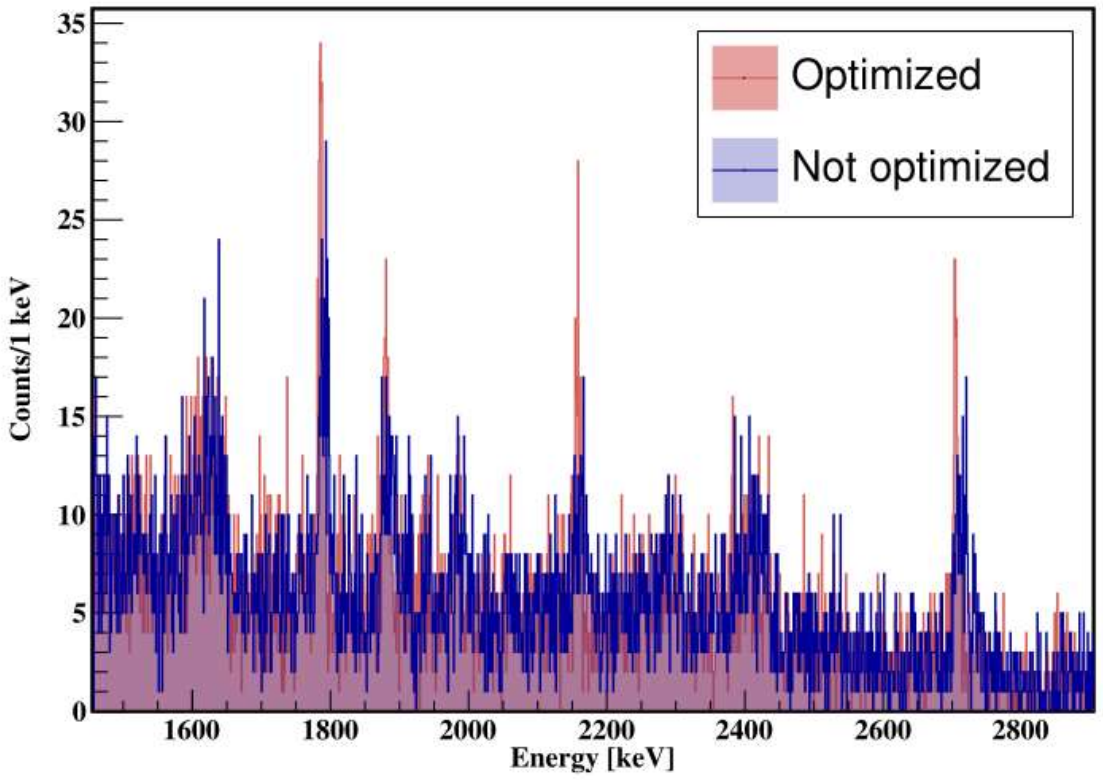
The lookup table also performs the 3D position reconstruction of DANTE, mapping 2D points (pos1, pos2, pos2) to 3D points (P1, P2, P3)

Selector’s optimizators

Minimizer

- experiment dependent
- cost function based on DC, Q value or excitation energy





Grid search

- Fine-tuning position of highly segmented detectors for each pixel/detector individually
- Cost function is customizable by user – requirement is the *m_detectorID_XXX* matrix produced by selector

- exhaustive documentation in selector's README

Grid search

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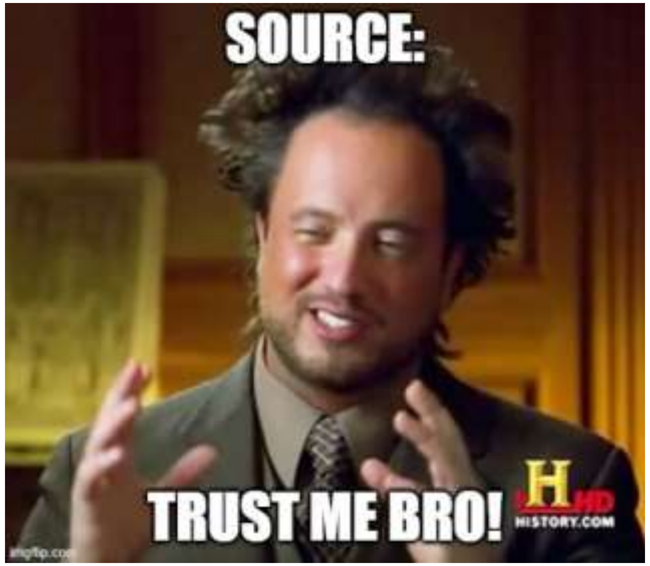
- Cost function is customizable by user – requirement is the *m_detectorID_XXX* matrix produced by selector

- exhaustive documentation in selector's README

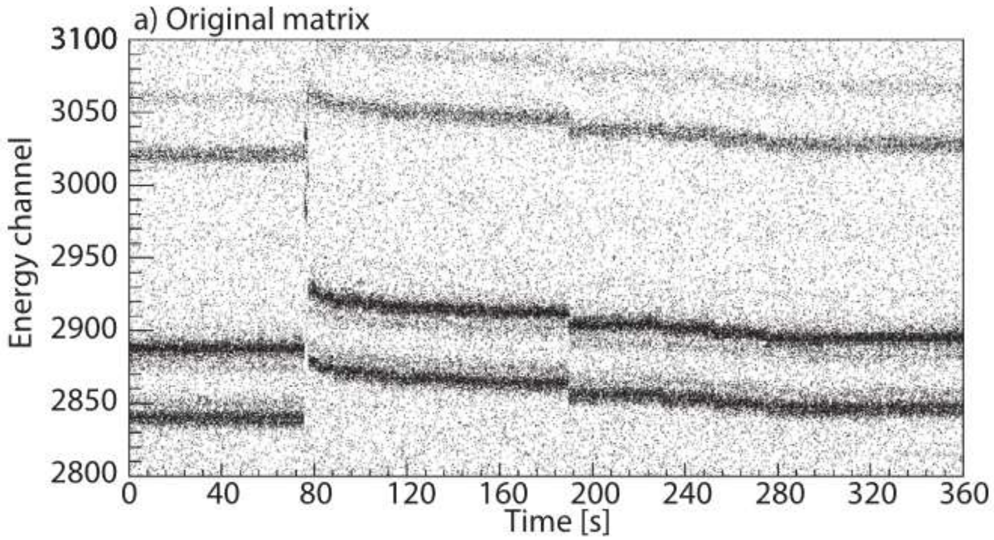
It works!



Time dependent gain correction

Cross-correlation correction method

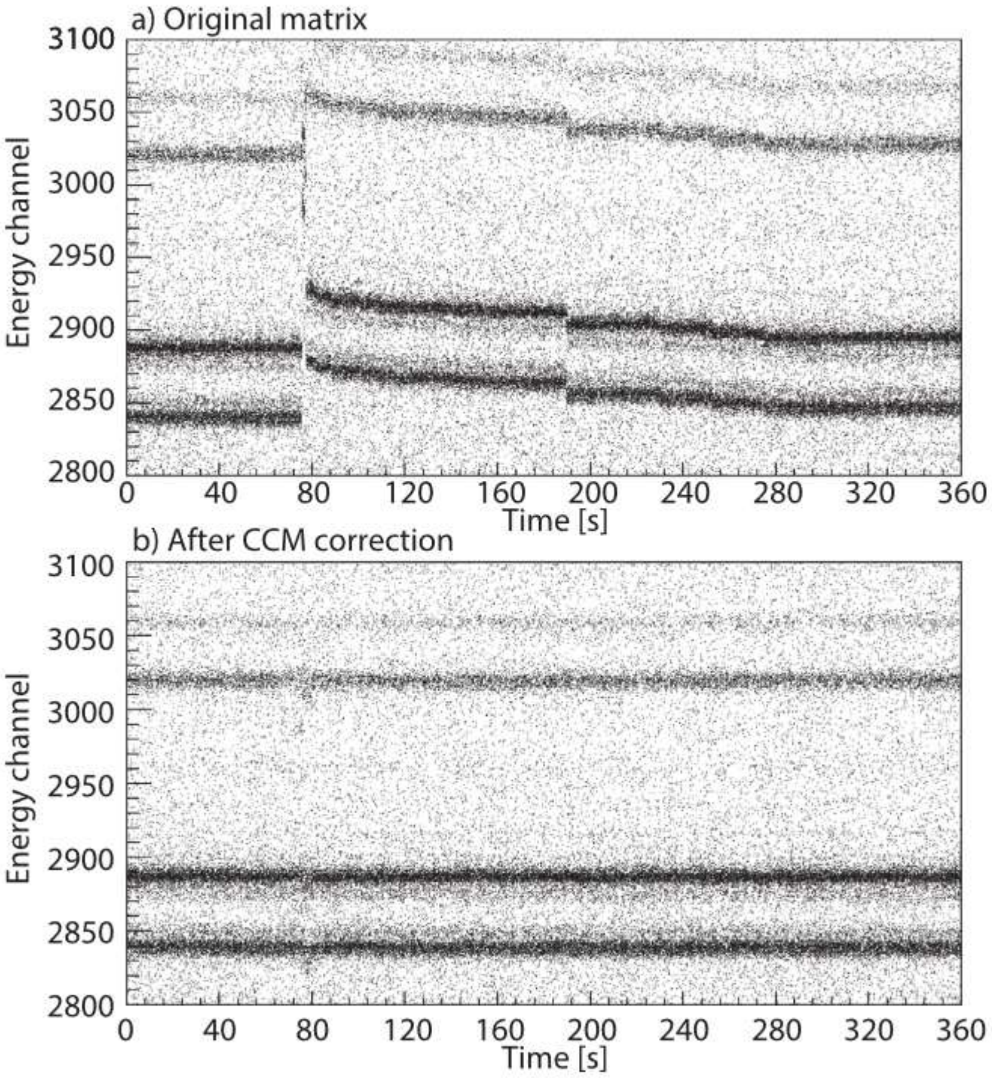
Problem



Cross-correlation correction method

Problem

Solution



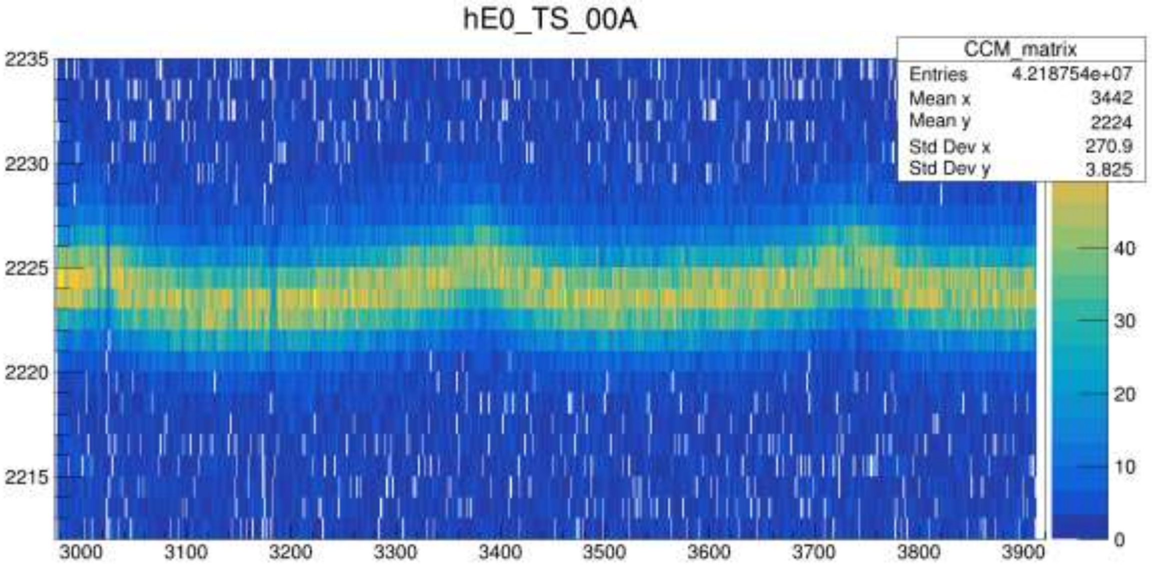
NIM paper: https://doi.org/10.1016/j.nima.2021.165368

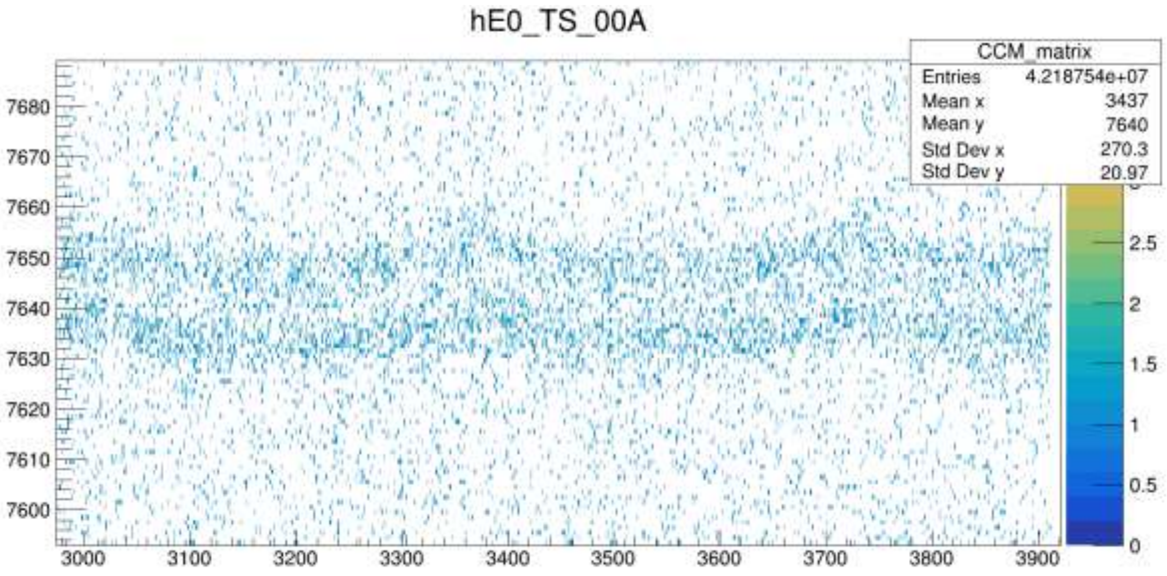
GitHub code: https://github.com/matLogh/CCM

Cross-correlation correction method

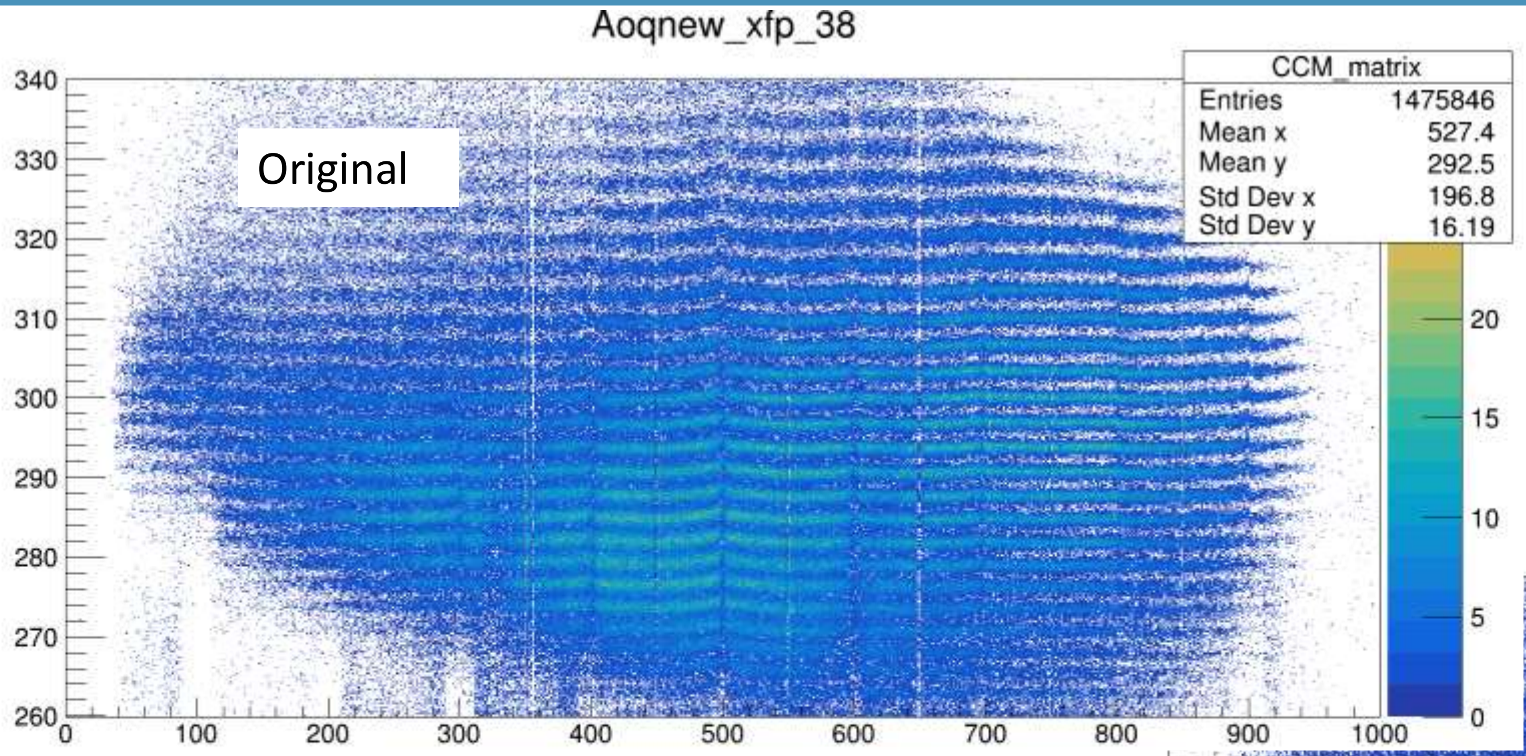
Corrections for AGATA now available in femul: post-PSA, after neutron damage correction but before recalibration

E. Pilotto

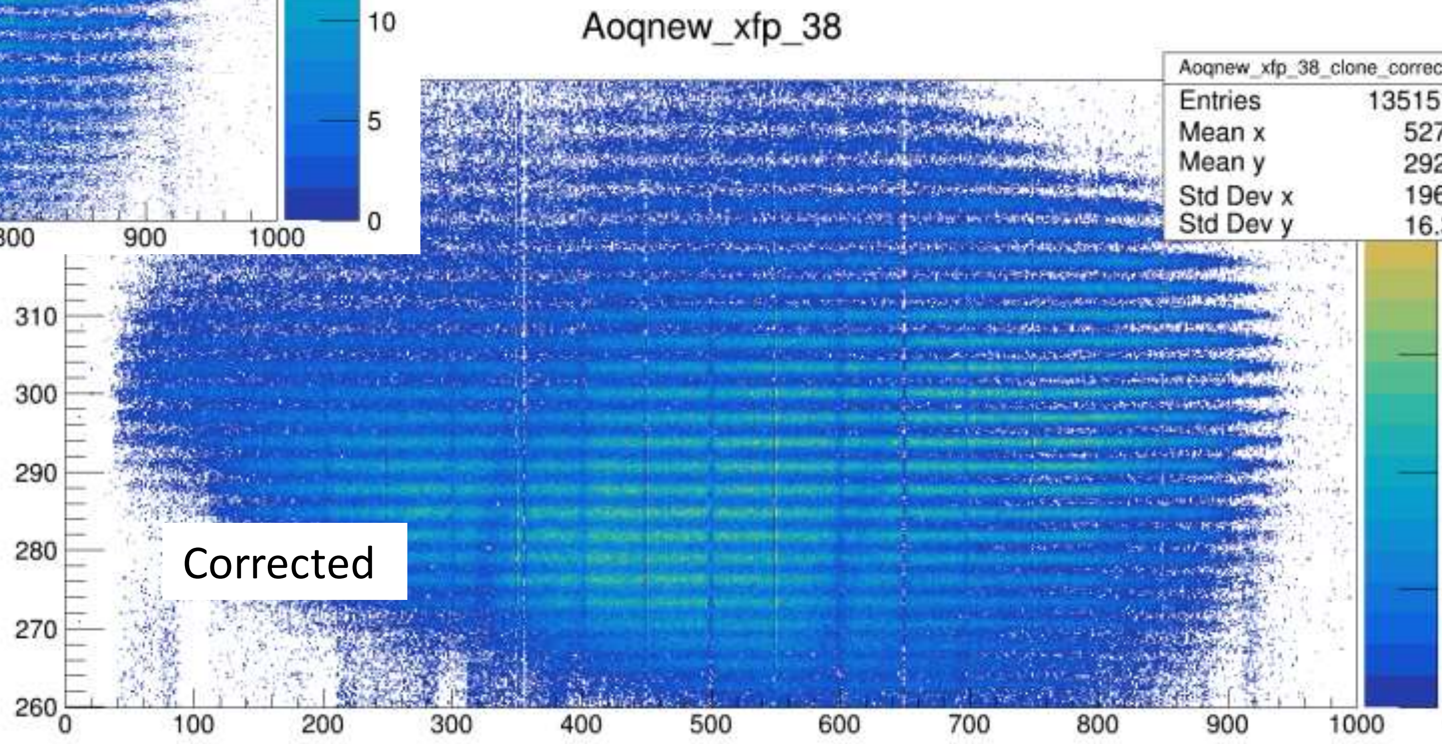




Cross-correlation correction method

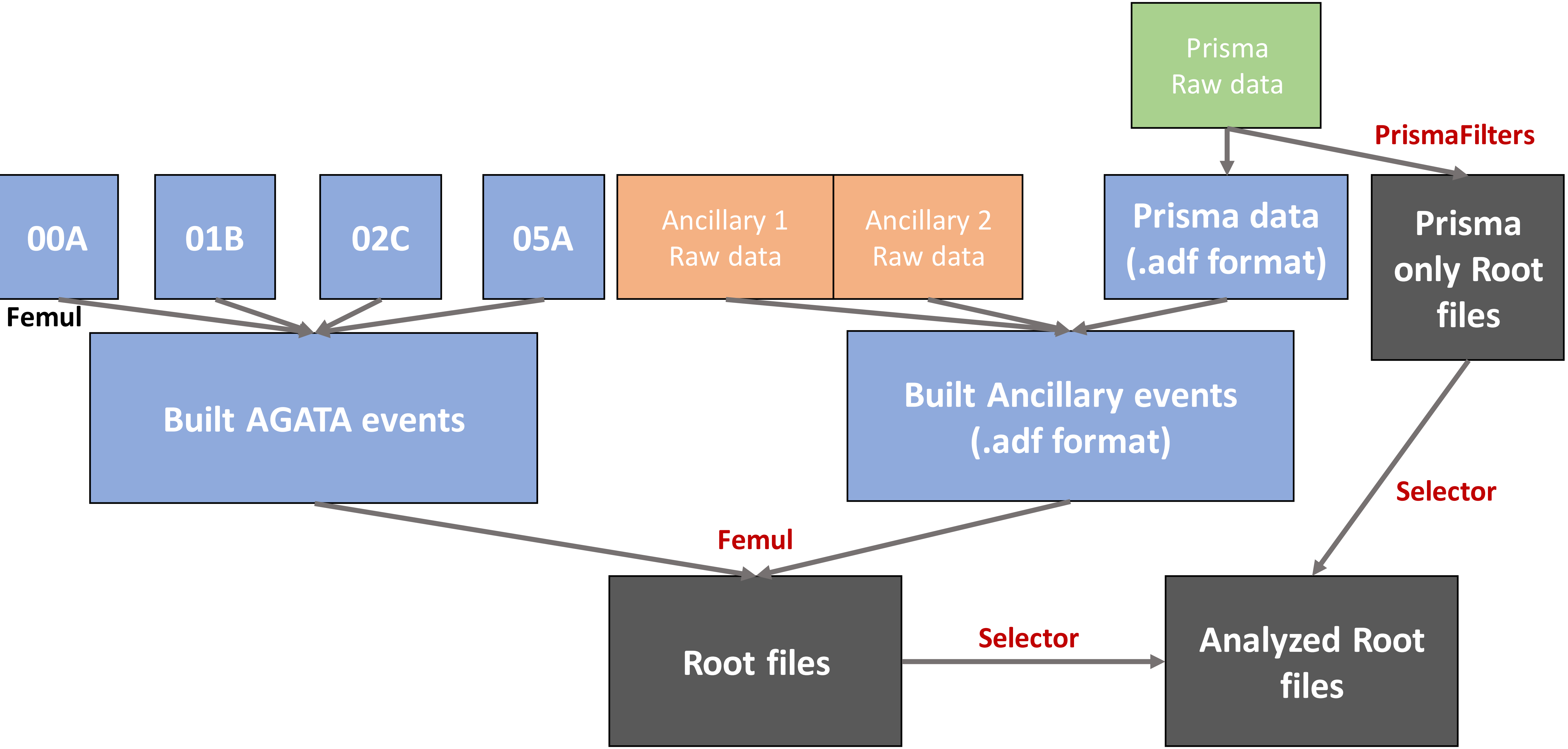


Universal “ironing” tool!

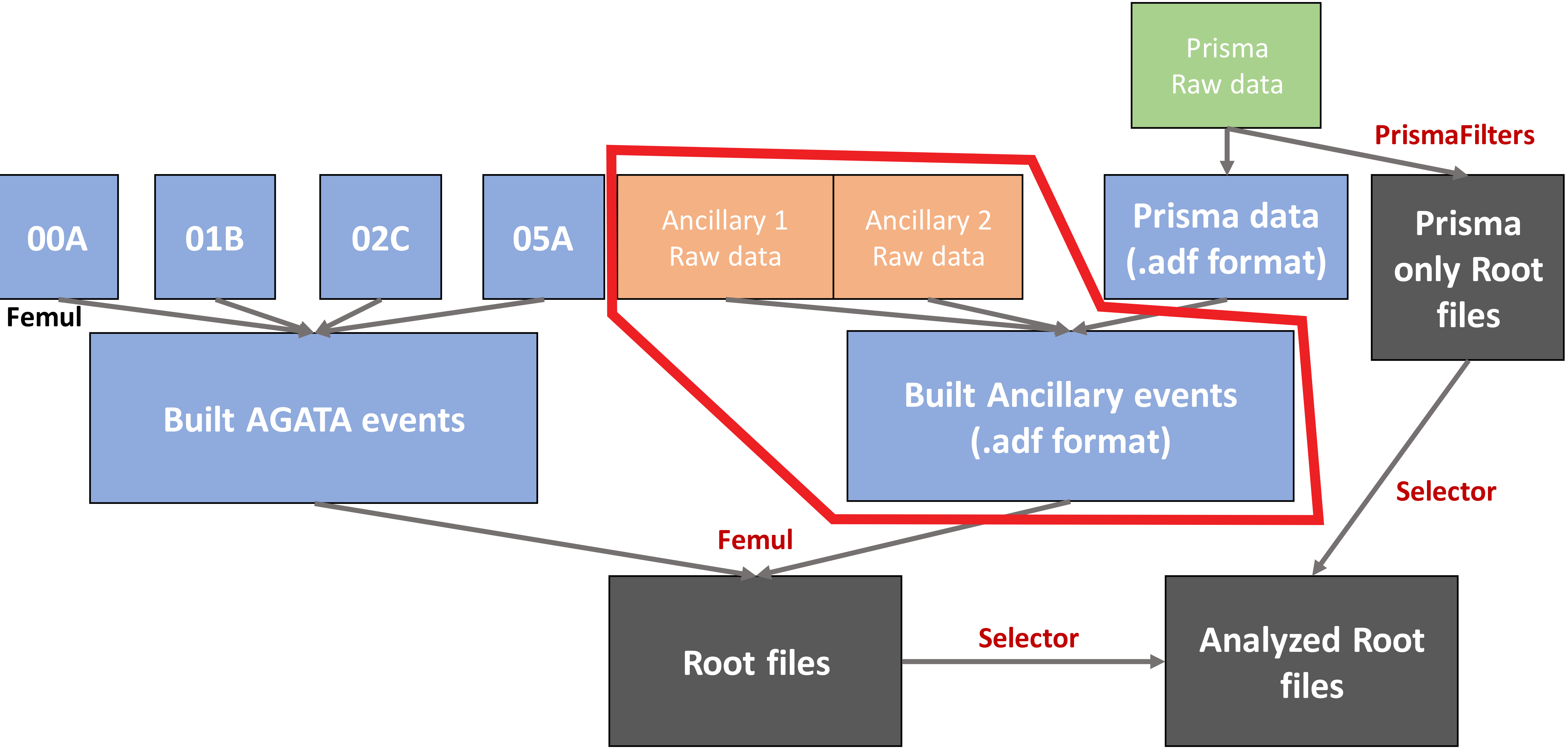


Questions?

Istituto Nazionale di Fisica Nucleare
LABORATORI NAZIONALI DI LEGNARO



Prisma
Raw data
PrismaFilters
00A
01B
02C
05A
Ancillary 1
Raw data
Ancillary 2
Raw data
Prisma data
(.adf format)
Prisma
only Root
files
Femul
Built AGATA events
Built Ancillary events
(.adf format)
Selector
Femul
Root files
Selector
Analyzed Root
files


Prisma
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Ancillaries

Digitizers

DPP-PHA

Digital Pulse Processing for the Pulse Height Analysis

TS, PHA, TDC

CAEN V1725
14bit, 250MS/s

CAEN V2740
14bit, 125MS/s

- SPIDER
- EUCLIDES
- DANTE

- *beam monitor*
- *SAURON (S1)*
- *OSCAR*

DPP-PSD

Digital Pulse Processing for Charge Integration and Pulse Shape Discrimination

TS, TDC, QDC, CFD, PSD

CAEN V1730
14bit, 500MS/s

- LaBr
- neutron detector

Ancillaries

Digitizers

DPP-PHA

Digital Pulse Processing for the Pulse Height Analysis

TS, PHA, TDC

CAEN V1725

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- SPIDER
- EUCLIDES
- DANTE

- *beam monitor*
- *SAURON (S1)*
- *OSCAR*

DPP-PSD

Digital Pulse Processing for Charge Integration and Pulse Shape Discrimination

TS, TDC, QDC, CFD, PSD

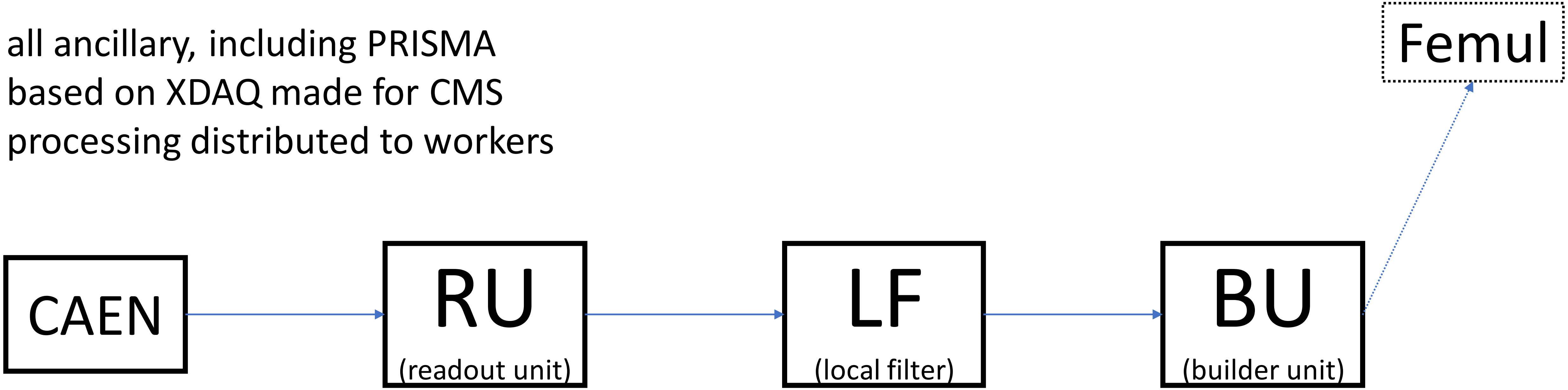
CAEN V1730

14bit, 500MS/s

- LaBr
- neutron detector

Ancillary readout chain

- all ancillary, including PRISMA
- based on XDAQ made for CMS
- processing distributed to workers



- readout of data flow (CAEN data frames)
- set CAEN registers

- converts CAEN frames to ADF frames (AGATA data format)

- builds events
- encapsulate ADF frames into composite frames, adds time stamp

Ancillary “raw” data

- all workers (can) dump data on disk as (specific arrangement depends on the experiment)

- e.g. latest folder arrangement:

X – index (redundant info)
Y – run number
Z – file number (max file size 4GB)

Readout unit + Local filter

*AGATAD_P2_EXP_019/run_0102_TIME/**Data/caen_digitizers/RU_caendig_iX_Y_Z.caendat***

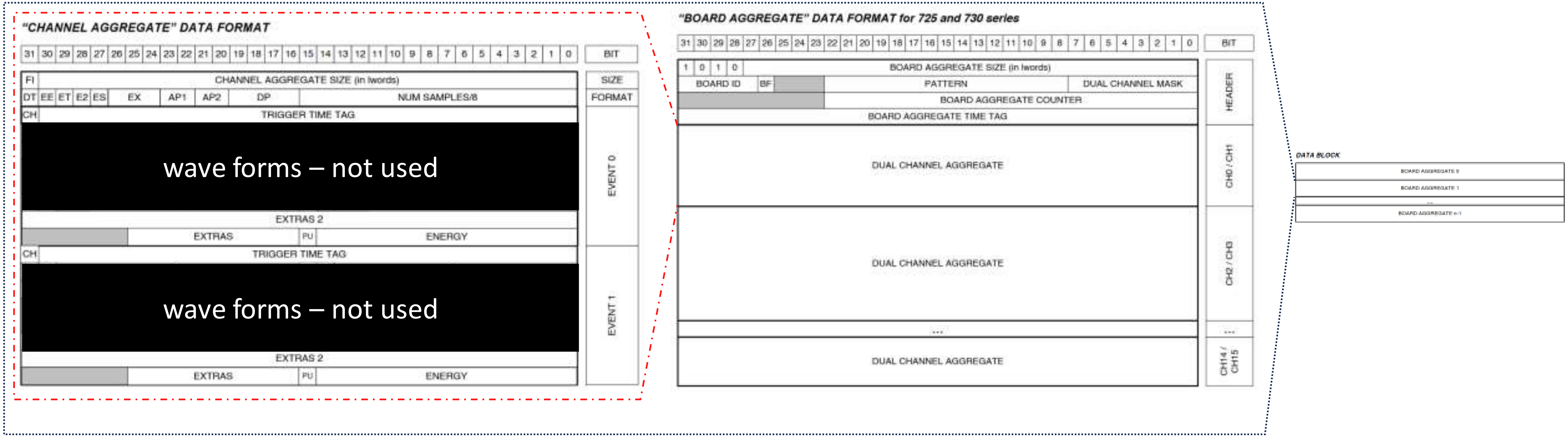
*AGATAD_P2_EXP_019/run_0102_TIME/**Data/caen_digitizers/LF_caendig_iX_Y_Z.adf***

Builder unit

*AGATAD_P2_EXP_019/run_0102_TIME/**Data/ancillaries/BU_ancillaries_iX_Y_Z.adf***

RU data format - .caendat

- programable using registers, may vary between experiments
- different for PHA and PSD boards
- complicated…

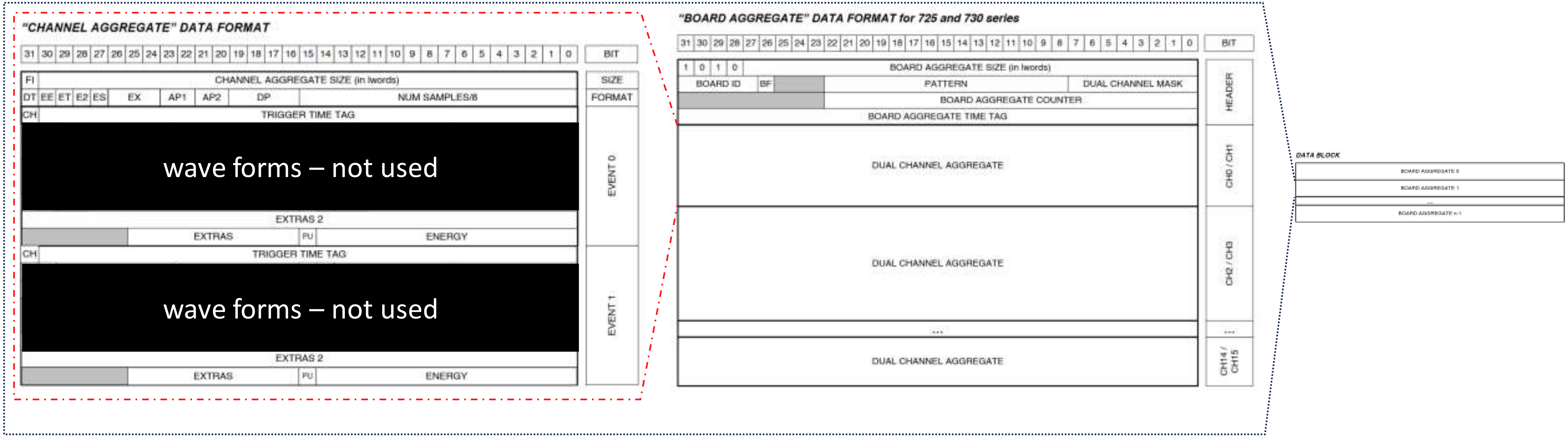


For more details consult manual for CAEN 725-730 series boards

RU data format - .caendat

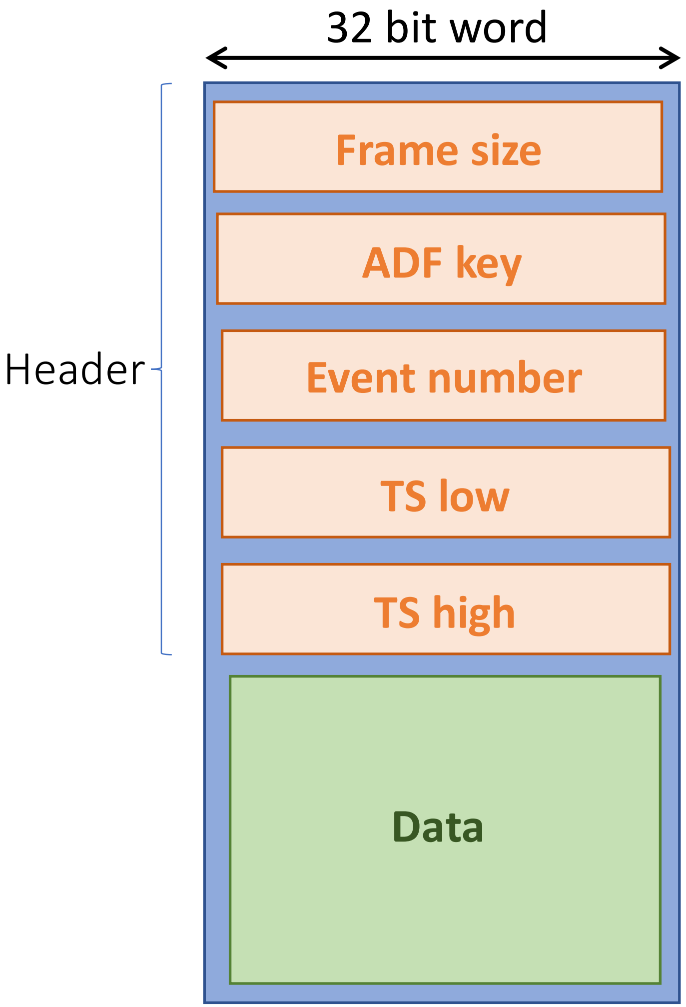
- programable using registers, may vary between experiments
- different for PHA and PSD boards
- complicated…

can be read using ReadCaenRaw.cxx code, part of AGATA selector!

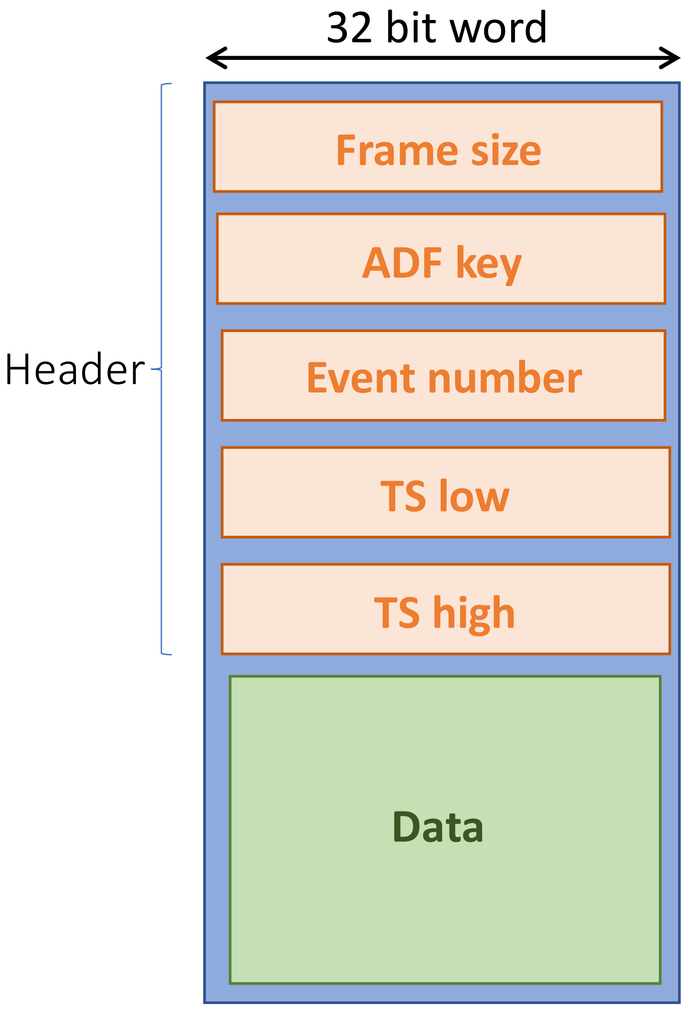


For more details consult manual for CAEN 725-730 series boards

LF data format - general ADF



LF data format - general ADF



size of the whole frames in bytes, including header and data

unique for different detectors:

0xFA0201A0	Prisma RAW
0xFA0201A1	Prisma Analyzed
0xFA0201A2	SPIDER
0xFA0201A3	DANTE
0xFA0201A4	EUCLIDES
0xFA0201A5	LaBr3

"Not used" (e.i. can be repurposed)

can be read using **ListFrames** command!

LF format - .adf

PHA dataframe

(SPIDER, EUCLIDES, DANTE)

<table>
<tr><th>bits</th><th>32</th><th>31</th><th>30</th><th>29</th><th>28</th><th>27</th><th>26</th><th>25</th><th>24</th><th>23</th><th>22</th><th>21</th><th>20</th><th>19</th><th>18</th><th>17</th><th>16</th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td rowspan="5">Header</td><td colspan="33">frame size</td></tr>
<tr><td colspan="33">ADF key</td></tr>
<tr><td>E</td><td>D</td><td colspan="12"></td><td>C</td><td>B</td><td>A</td><td colspan="8">board nb</td><td colspan="8">channel nb</td></tr>
<tr><td colspan="33">Timestamp_0</td></tr>
<tr><td colspan="33">Timestamp_1</td></tr>
<tr><td>Data</td><td colspan="17">time (CFD)</td><td colspan="16">energy</td></tr>
</table>

data types

<table>
<tr><td colspan="3">uint32_t</td></tr>
<tr><td colspan="3">uint32_t</td></tr>
<tr><td>bitarray<16></td><td>uint8_t</td><td>uint8_t</td></tr>
<tr><td colspan="3">uint32_t</td></tr>
<tr><td colspan="3">uint32_t</td></tr>
<tr><td>uint16_t</td><td colspan="2">uint16_t</td></tr>
</table>

PSD dataframe

(LaBr, neutron det.)

<table>
<tr><th>bits</th><th>32</th><th>31</th><th>30</th><th>29</th><th>28</th><th>27</th><th>26</th><th>25</th><th>24</th><th>23</th><th>22</th><th>21</th><th>20</th><th>19</th><th>18</th><th>17</th><th>16</th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
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<tr><td colspan="33">Timestamp_0</td></tr>
<tr><td colspan="33">Timestamp_1</td></tr>
<tr><td rowspan="2">Data</td><td colspan="17">Qshort</td><td colspan="16">Qlong</td></tr>
<tr><td colspan="33">CFD</td></tr>
</table>

data types

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<tr><td colspan="3">uint32_t</td></tr>
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<tr><td>bitarray<16></td><td>uint8_t</td><td>uint8_t</td></tr>
<tr><td colspan="3">uint32_t</td></tr>
<tr><td colspan="3">uint32_t</td></tr>
<tr><td>uint16_t</td><td colspan="2">uint16_t</td></tr>
<tr><td colspan="3">float32_t</td></tr>
</table>

Flags

A	Pile-up rejection
B	Trapezoidal saturation
C	Input saturation
D	Board fail (PLL unlock or temperature)
E	IDLE

ADF keys

0xFA0201A0	Prisma RAW
0xFA0201A1	Prisma Analyzed
0xFA0201A2	SPIDER
0xFA0201A3	DANTE
0xFA0201A4	EUCLIDES
0xFA0201A5	LaBr3

LF format - .adf

PHA dataframe
(SPIDER, EUCLIDES, DANTE)

<table>
<tr><th>bits</th><th>32</th><th>31</th><th>30</th><th>29</th><th>28</th><th>27</th><th>26</th><th>25</th><th>24</th><th>23</th><th>22</th><th>21</th><th>20</th><th>19</th><th>18</th><th>17</th><th>16</th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
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<tr><td colspan="33">Timestamp_1</td></tr>
<tr><td>Data</td><td colspan="17">time (CFD)</td><td colspan="16">energy</td></tr>
</table>

data types

uint32_t		
uint32_t		
bitarray<16>	uint8_t	uint8_t
uint32_t		
uint32_t		
uint16_t	uint16_t	

PSD dataframe
(LaBr, neutron det.)

<table>
<tr><th>bits</th><th>32</th><th>31</th><th>30</th><th>29</th><th>28</th><th>27</th><th>26</th><th>25</th><th>24</th><th>23</th><th>22</th><th>21</th><th>20</th><th>19</th><th>18</th><th>17</th><th>16</th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
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<tr><td>E</td><td>D</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>C</td><td>B</td><td>A</td><td colspan="8">board nb</td><td colspan="8">channel nb</td></tr>
<tr><td colspan="33">Timestamp_0</td></tr>
<tr><td colspan="33">Timestamp_1</td></tr>
<tr><td rowspan="2">Data</td><td colspan="17">Qshort</td><td colspan="16">Qlong</td></tr>
<tr><td colspan="33">CFD</td></tr>
</table>

data types

uint32_t		
uint32_t		
bitarray<16>	uint8_t	uint8_t
uint32_t		
uint32_t		
uint16_t	uint16_t	
float32_t		

Repurposed Event number to save space

Flags

- A Pile-up rejection
- B Trapezoidal saturation
- C Input saturation
- D Board fail (PLL unlock or temperature)
- E IDLE

ADF keys

0xFA0201A0	Prisma RAW
0xFA0201A1	Prisma Analyzed
0xFA0201A2	SPIDER
0xFA0201A3	DANTE
0xFA0201A4	EUCLIDES
0xFA0201A5	LaBr3

LF format - .adf

PHA dataframe
(SPIDER, EUCLIDES, DANTE)

bits	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Header	frame size																																
	ADF key																																
	E	D													C	B	A	board nb								channel nb							
	Timestamp_0																																
	Timestamp_1																																
Data	time (CFD)																	energy															

data types

uint32_t			
uint32_t			
bitarray<16>		uint8_t	uint8_t
uint32_t			
uint32_t			
uint16_t		uint16_t	

PSD dataframe
(LaBr, neutron det.)

bits	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Header	frame size																																
	ADF key																																
	E	D													C	B	A	board nb								channel nb							
	Timestamp_0																																
	Timestamp_1																																
Data	Qshort																	Qlong															
	CFD																																

data types

uint32_t			
uint32_t			
bitarray<16>		uint8_t	uint8_t
uint32_t			
uint32_t			
uint16_t		uint16_t	
float32_t			

Flags

A Pile-up rejection
B Trapezoidal saturation
C Input saturation
D Board fail (PLL unlock or temperature)
E IDLE

ADF keys

0xFA0201A0	Prisma RAW
0xFA0201A1	Prisma Analyzed
0xFA0201A2	SPIDER
0xFA0201A3	DANTE
0xFA0201A4	EUCLIDES
0xFA0201A5	LaBr3

Frame sizes for ancillary (beside PRISMA) are fixed 0x18 (PHA) and 0x1C (PSD)

PRISMA – raw ADF frame

raw PRISMA dataframe

<table>
<tr><th>bits</th><th>32</th><th>31</th><th>30</th><th>29</th><th>28</th><th>27</th><th>26</th><th>25</th><th>24</th><th>23</th><th>22</th><th>21</th><th>20</th><th>19</th><th>18</th><th>17</th><th>16</th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><th rowspan="5">Header</th><td colspan="33">frame size</td></tr>
<tr><td colspan="33">ADF key (0xFA0201A0)</td></tr>
<tr><td colspan="33">Event number (0x0)</td></tr>
<tr><td colspan="33">Timestamp_0</td></tr>
<tr><td colspan="33">Timestamp_1</td></tr>
<tr><th>Data 1</th><td colspan="17">ADC value</td><td colspan="8">board</td><td colspan="8">channel</td></tr>
<tr><th>Data 1</th><td colspan="17">ADC value</td><td colspan="8">board</td><td colspan="8">channel</td></tr>
<tr><th>...</th><td colspan="17"></td><td colspan="8"></td><td colspan="8"></td></tr>
<tr><th>Data N</th><td colspan="17">ADC value</td><td colspan="8">board</td><td colspan="8">channel</td></tr>
</table>

data types →

uint32_t		
uint32_t		
uint32_t		
uint32_t		
uint32_t		
uint16_t	uint8_t	uint8_t
uint16_t	uint8_t	uint8_t
uint16_t	uint8_t	uint8_t

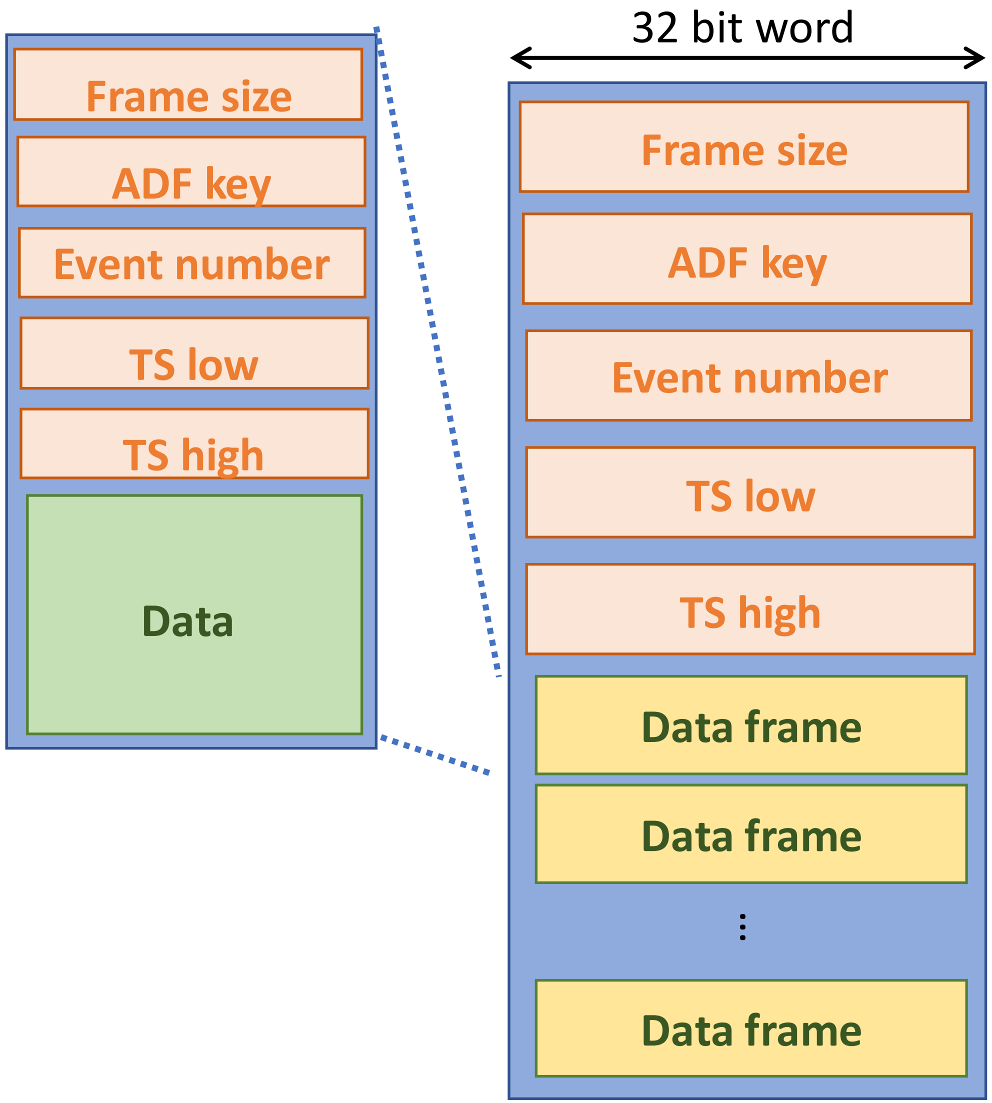
variable frame size

PRISMA – analysed ADF frame

	Type	What	Comment
Header	uint32_t	**Size**	25*4
	uint32_t	**Key**	0xFA0201A1
	bitset<32>	**flags**	flags on valid events (mcp_ok, side_ok, traj_ok, ...)
	uint32_t	**TSTAMP_0**	AGAVA - local TS - low part
	uint32_t	**TSTAMP_1**	AGAVA - local TS - high part
Data	float	**monitor_0**	MONITOR 0 energy
	float	**monitor_1**	MONITOR 1 energy
	float	**mcp_x**	MCP X [mm]
	float	**mcp_y**	MCP Y [mm]
	float	**mcp_q**	MCP Charge
	float	**mcp_theta**	MCP Theta for PRISMA Analysis (degree)
	float	**mcp_phi**	MCP Phi for PRISMA Analysis (degree)
	float	**x_fp**	Position X focal plane [mm]
	float	**y_fp**	position Y focal plane [mm]
	float	**tof**	Time of flight [ns]
	float	**ic_e**	Total Energy [a.u.]
	float	**ic_de_a**	Energy loss first raw [a.u.]
	float	**ic_de_ab**	Energy loss first two raws [a.u.]
	float	**ic_range**	Range of the ion in the IC [a.u.]
	float	**ic_drift**	Drift time on the C-section [a.u.]
	uint8_t	**ic_a_numpads**	Number of pads A hit
	uint8_t	**ic_b_numpads**	Number of pads B hit
	float	**theta**	Recoil Theta in the AGATA frame of reference for Doppler Correction [deg]
	float	**phi**	Recoil Phi in the AGATA frame of reference for Doppler Correction [deg]

	Type	What	Comment
Data	float	**beta**	Recoil Beta for DC [v/c]
	float	**length**	calculated Trajectory length [mm]
	float	**radius**	Calculated trajectory radius in the dipole [mm]
	float	**rbeta**	Beta for DC [v/c]
	float	**a_over_q**	Calculated A/q
	float	**qvalue**	Calculated Q-Value for the event [MeV]
	float	**theta_bp**	Binary partner Binary partner Theta in the AGATA frame of reference for Doppler Correction [deg]
	float	**phi_bp**	Binary partner Phi in the AGATA frame of reference for Doppler Correction [deg]
	float	**beta_bp**	Binary partner Beta for DC [v/c]
	float	**tac_lt_ts**	TAC between LT and VTS [ns]
	uint8_t	**z_nbr**	Atomic number corresponding to the gate on the IC (IC_DE(A) vs IC_E or IC_DE(AB) vs IC_E or
	uint8_t	**q_nbr**	Charge state corresponding to the gate put on Radius*Beta vs IC_E (after Z-gate)
	uint8_t	**a_nbr**	Mass corresponding to the cut on A/q*q vs x_fp (after Z and q gates)
	bool	**mcp_ok**	
	bool	**tof_ok**	
	bool	**traj_ok**	
	bool	**side_ok**	
	bool	**ic_ok**	
	bool	**z_ok**	
	bool	**q_ok**	
	bool	**a_ok**	

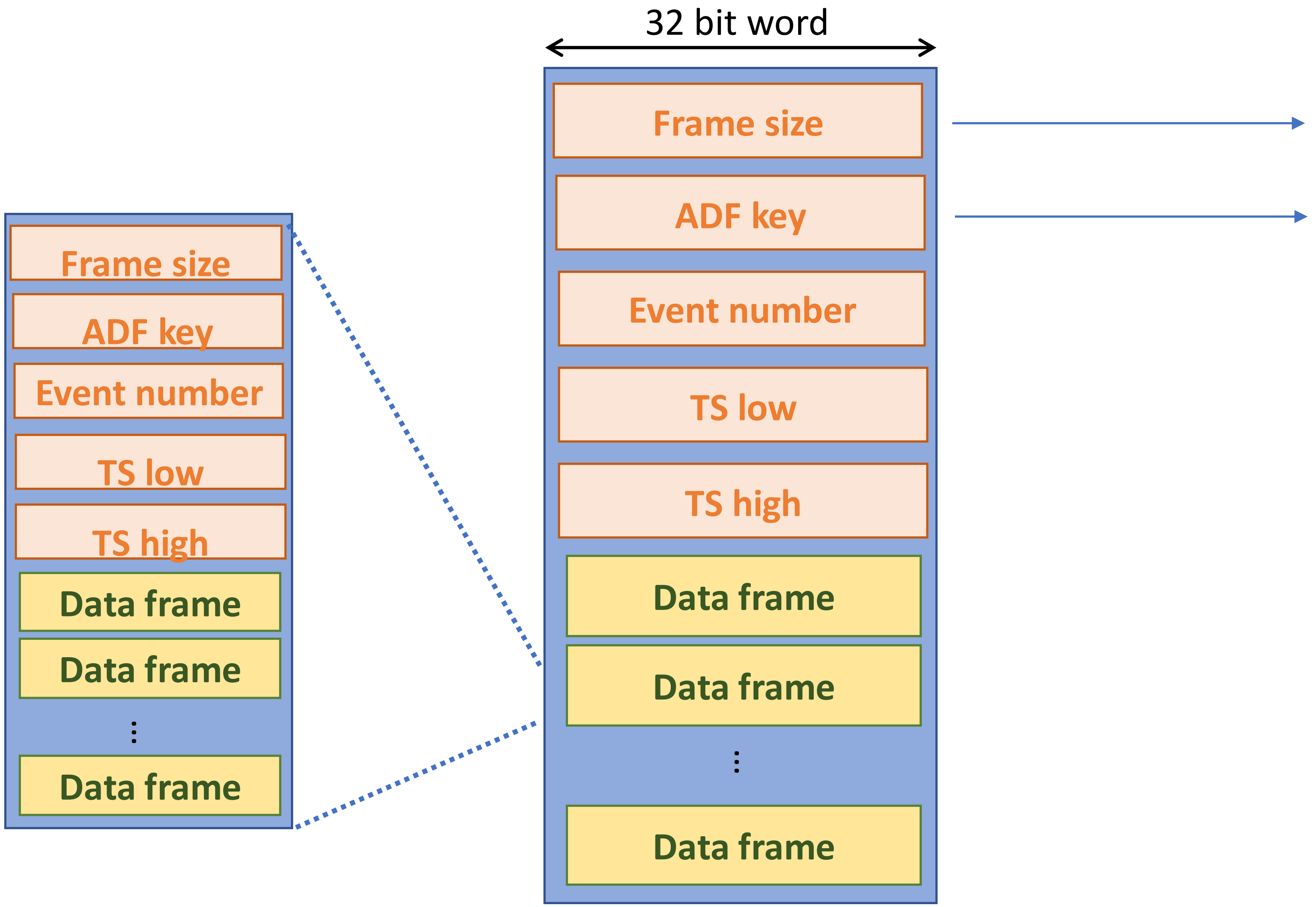
BU data format - general ADF



size of the whole frames in bytes

key **0xCA??????** denotes composite frame

BU data format - general ADF

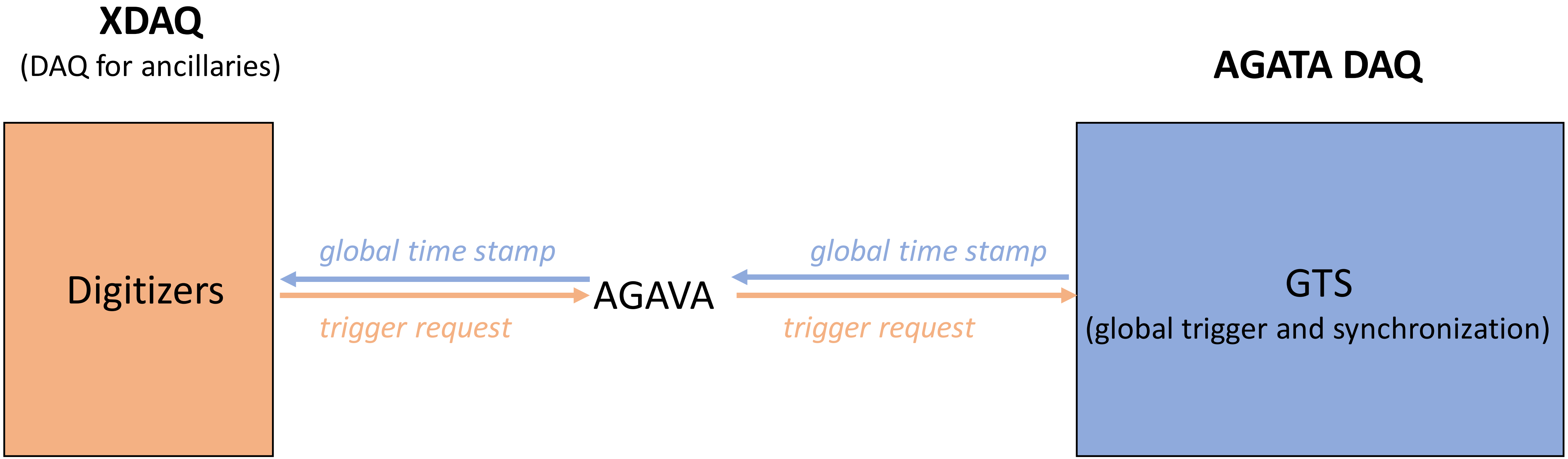


size of the whole frames in bytes

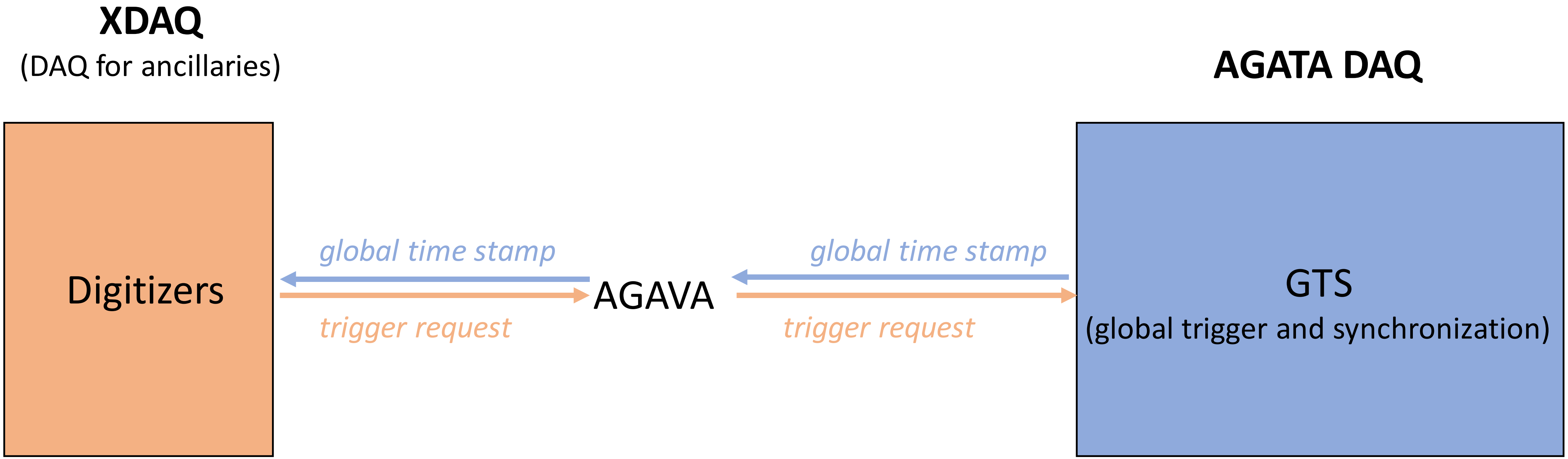
key **0xCA??????** denotes composite frame

composite frame can contain other composite frames

Timestamp problem



Timestamp problem



It can happen that AGAVA board is in busy state while starting run – it will not propagate the initial time stamp

<u>Ancillaries will start with timestamp 0!!!</u>

Timestamp problem

Ancillaries will start with timestamp 0!!!

Solution

1. identify initial first TS of AGATA to get approximate offset
2. correlate every ancillary-AGATA events, for which

$$TS_{min} < (TS_{agata} - TS_{anc} - TS_{offset}) < TS_{max}$$

3. Identify coincidence peak or change T_{min}, T_{max} and go to 2.
4. Apply offset
5. Replay data

Timestamp problem

Ancillaries will start with timestamp 0!!!

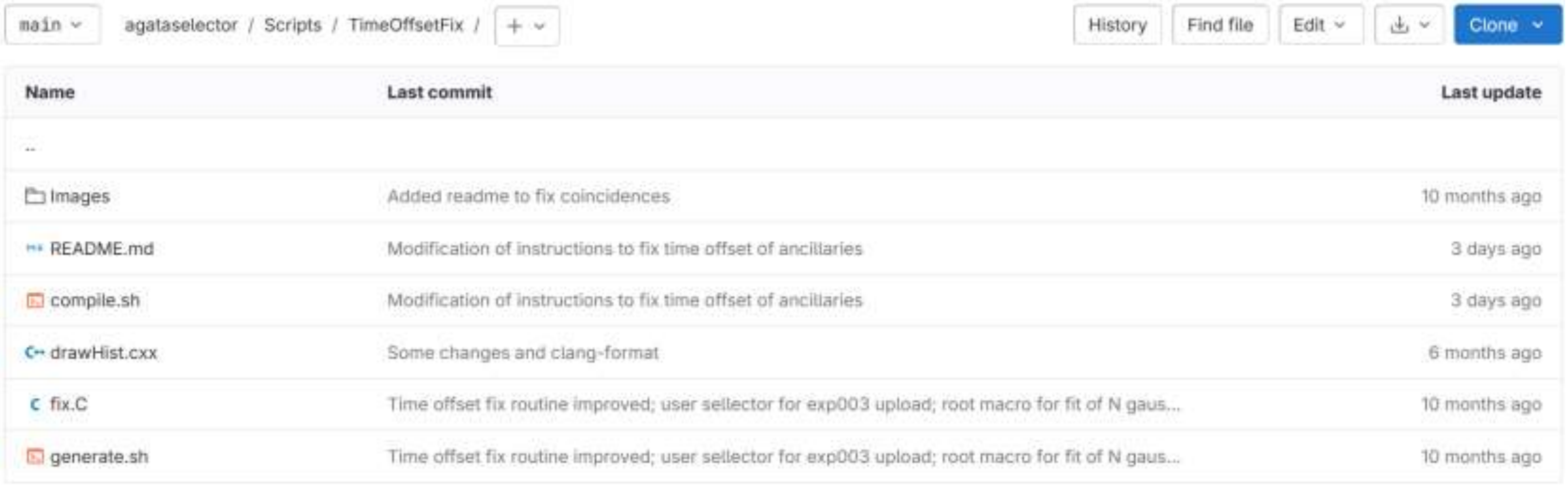
Solution

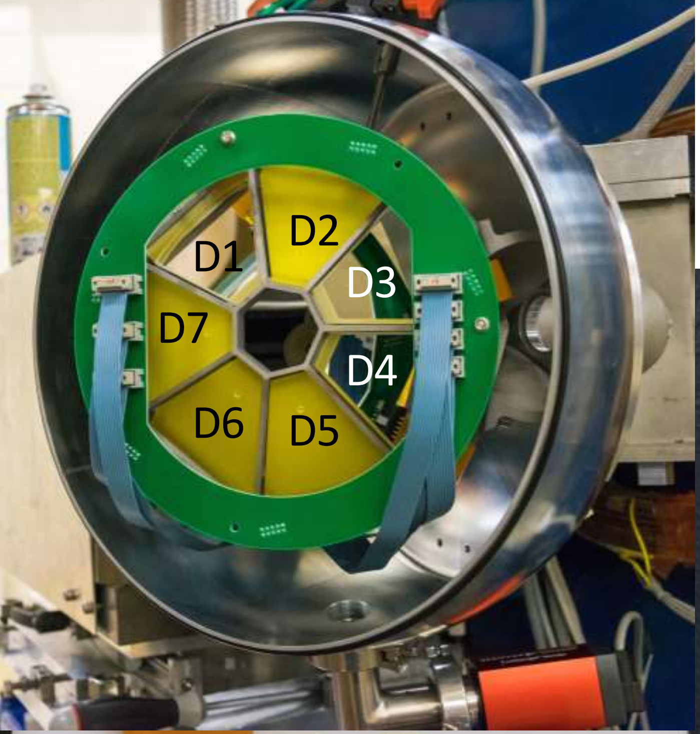
1. identify initial first TS of AGATA to get approximate offset
2. correlate every ancillary-AGATA events, for which

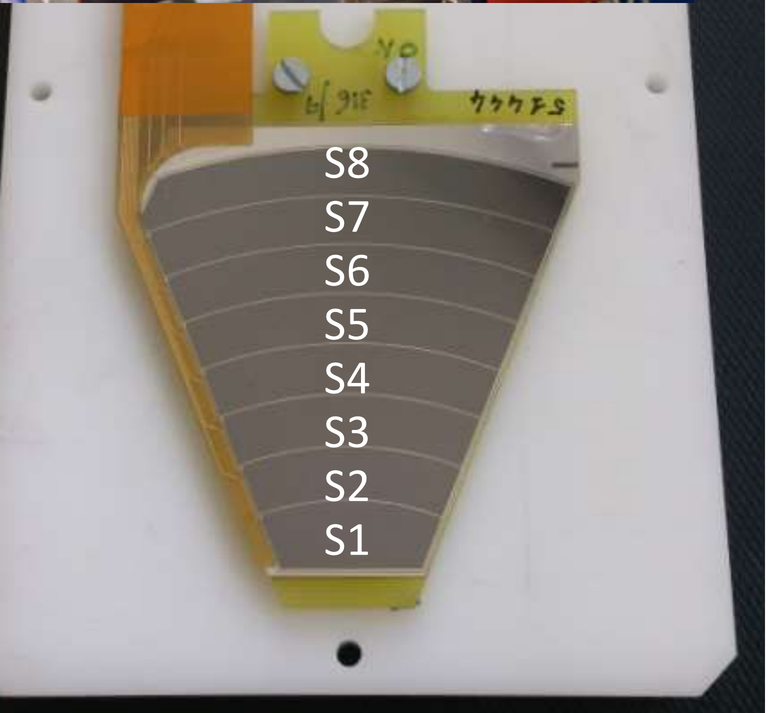
$$TS_{min} < (TS_{agata} - TS_{anc} - TS_{offset}) < TS_{max}$$

3. Identify coincidence peak or change T_{min}, T_{max} and go to 2.
4. Apply offset
5. Replay data

Ready to use code in
agataselector/Scripts/TimeOffsetFix
(with manual!)



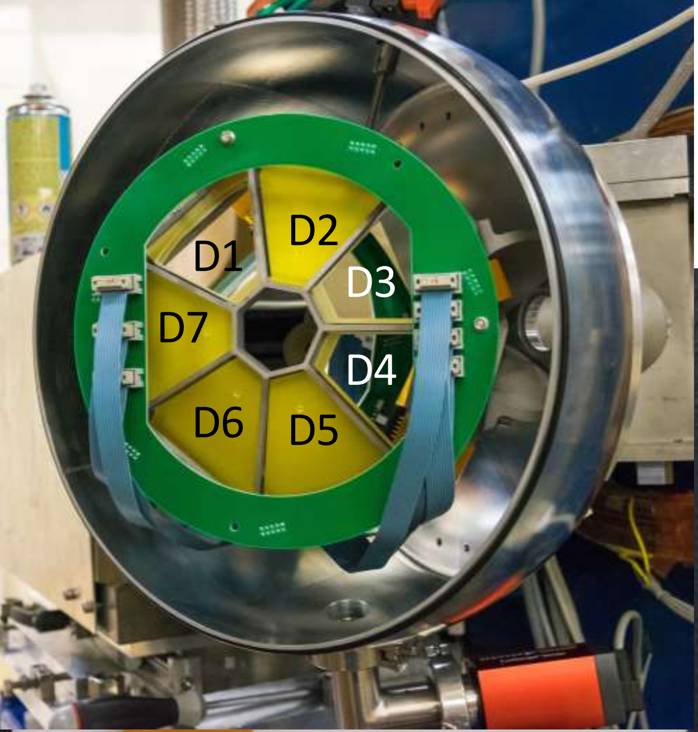


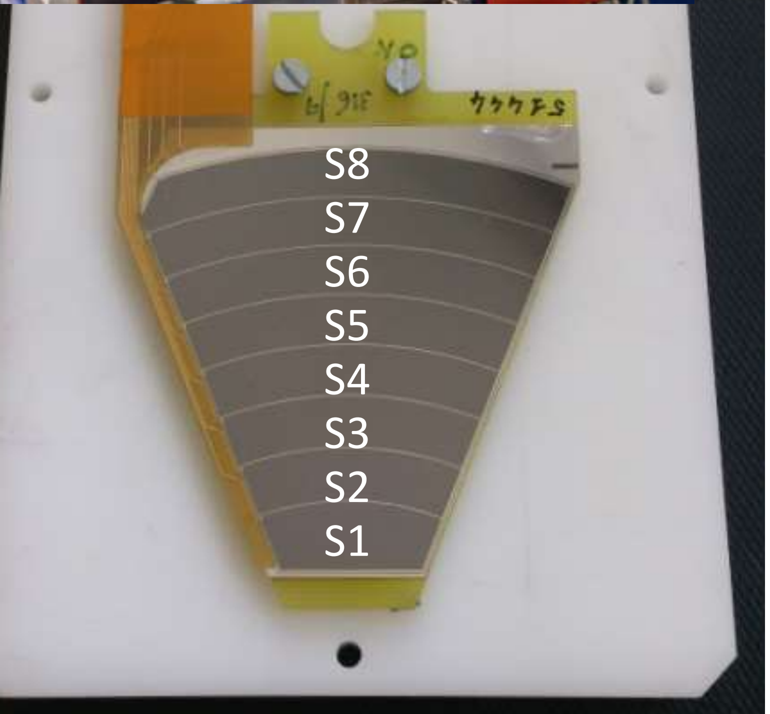


Look-up table

```
####### SPIDER ######
#
# Board channel map     name    thr_lo  thr_hi  theta    phi TimeOffset  ncalpar calpars
2   0   11  D2S2    5.00    200.00  155.2   103.99  0   2   0.015509 0.007579
2   1   10  D2S1    5.00    200.00  159.6   103.99  0   2   -0.007763 0.007412
2   2   13  D2S4    5.00    200.00  146     103.99  0   2   -0.106650 0.007794
2   3   12  D2S3    5.00    200.00  150.6   103.99  0   2   -0.053865 0.007696
2   4   15  D2S6    5.00    200.00  136.8   103.99  0   2   0.024495 0.007678
2   5   14  D2S5    5.00    200.00  141.4   103.99  0   2   -0.105075 0.008076
2   6   17  D2S8    5.00    200.00  128     103.99  0   2   0.596364 0.006813
2   7   16  D2S7    5.00    200.00  132.3   103.99  0   2   -0.007975 0.007406
2   8   1   D1S2    5.00    200.00  155.2   52.56   0   2   -0.020980 0.007575
2   9   0   D1S1    5.00    200.00  159.6   52.56   0   2   0.020538 0.007667
2   10  3   D1S4    5.00    200.00  146     52.56   0   2   -0.074459 0.007833
2   11  2   D1S3    5.00    200.00  150.6   52.56   0   2   0.069455 0.007586
2   12  5   D1S6    5.00    200.00  136.8   52.56   0   2   0.069455 0.007586
2   13  4   D1S5    5.00    200.00  141.4   52.56   0   2   0.002820 0.007616
2   14  7   D1S8    5.00    200.00  128     52.56   0   2   -0.068986 0.007928
2   15  6   D1S7    5.00    200.00  132.3   52.56       0   2   -0.069752 0.007978
3   0   21  D3S2    5.00    200.00  155.2   155.42  0   2   -0.092525 0.007750
3   1   20  D3S1    5.00    200.00  159.6   155.42  0   2   0.019792 0.007567
```

digitizer details [board, channel]



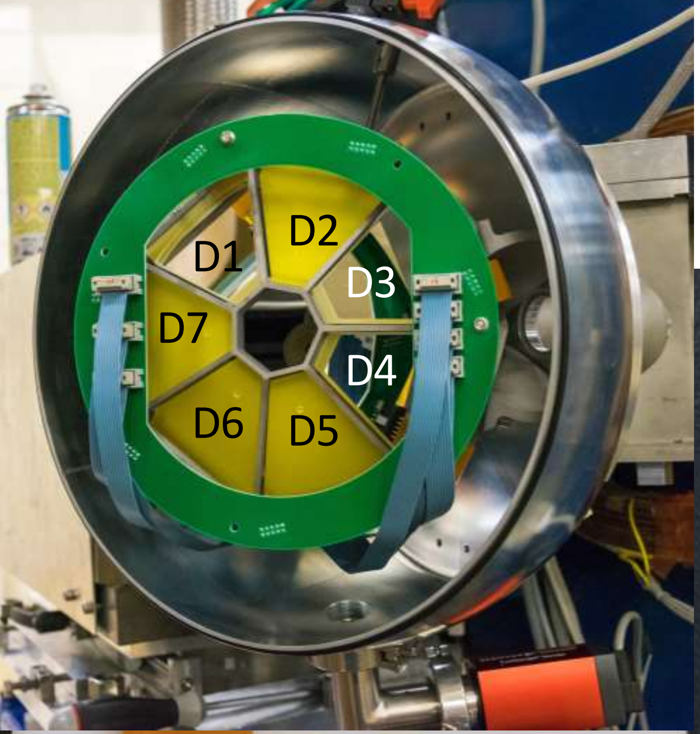


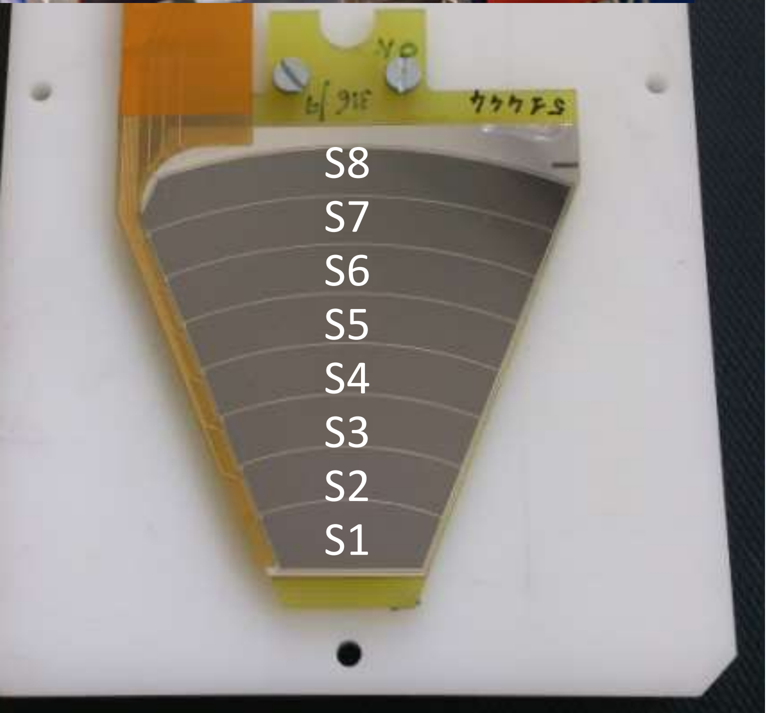
Look-up table

```
####### SPIDER ######
#
# Board channel map     name    thr_lo  thr_hi  theta    phi TimeOffset  ncalpar calpars
2    0    11   D2S2    5.00    200.00  155.2   103.99  0    2    0.015509 0.007579
2    1    10   D2S1    5.00    200.00  159.6   103.99  0    2    -0.007763 0.007412
2    2    13   D2S4    5.00    200.00  146     103.99  0    2    -0.106650 0.007794
2    3    12   D2S3    5.00    200.00  150.6   103.99  0    2    -0.053865 0.007696
2    4    15   D2S6    5.00    200.00  136.8   103.99  0    2    0.024495 0.007678
2    5    14   D2S5    5.00    200.00  141.4   103.99  0    2    -0.105075 0.008076
2    6    17   D2S8    5.00    200.00  128     103.99  0    2    0.596364 0.006813
2    7    16   D2S7    5.00    200.00  132.3   103.99  0    2    -0.007975 0.007406
2    8    1    D1S2    5.00    200.00  155.2   52.56   0    2    -0.020980 0.007575
2    9    0    D1S1    5.00    200.00  159.6   52.56   0    2    0.020538 0.007667
2    10   3    D1S4    5.00    200.00  146     52.56   0    2    -0.074459 0.007833
2    11   2    D1S3    5.00    200.00  150.6   52.56   0    2    0.069455 0.007586
2    12   5    D1S6    5.00    200.00  136.8   52.56   0    2    0.069455 0.007586
2    13   4    D1S5    5.00    200.00  141.4   52.56   0    2    0.002820 0.007616
2    14   7    D1S8    5.00    200.00  128     52.56   0    2    -0.068986 0.007928
2    15   6    D1S7    5.00    200.00  132.3   52.56        0    2     -0.069752 0.007978
3    0    21   D3S2    5.00    200.00  155.2   155.42  0    2    -0.092525 0.007750
3    1    20   D3S1    5.00    200.00  159.6   155.42  0    2    0.019792 0.007567
```

unique identifiers [map, name]

the "map" number conversion into detector and strip:
strip = (map % 10) + 1
detector = (map / 10) + 1



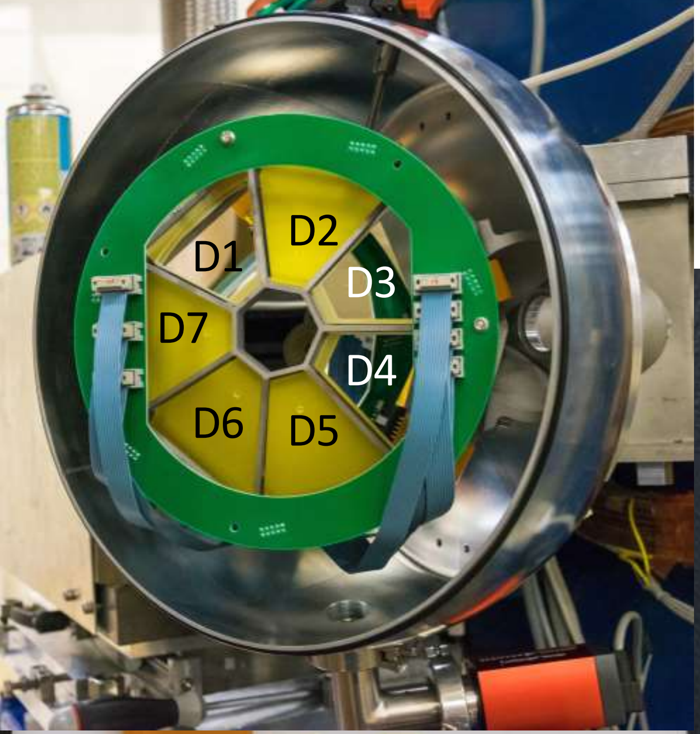


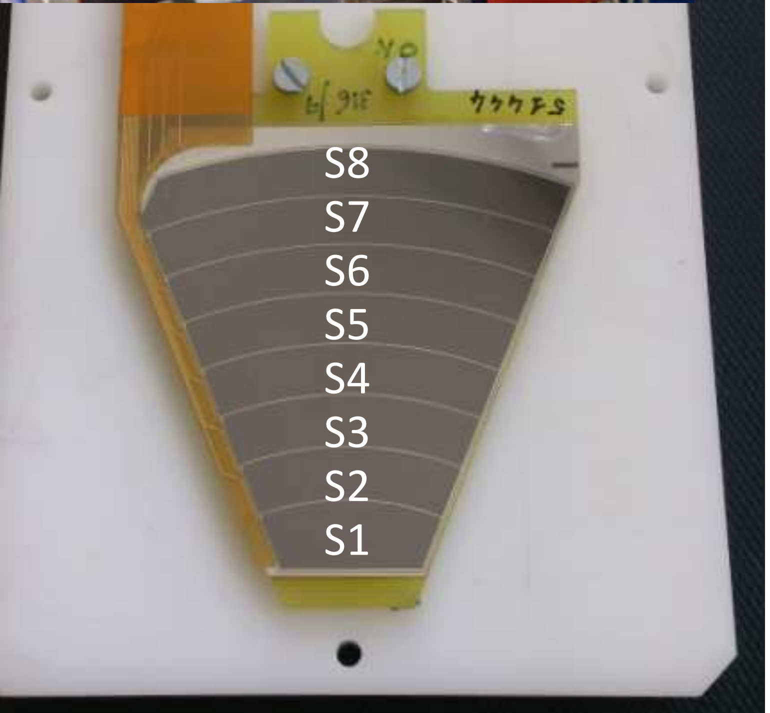
Look-up table

```
####### SPIDER ######
#
# Board channel map      name    thr_lo  thr_hi  theta    phi TimeOffset  ncalpar calpars
2    0    11   D2S2    5.00      200.00  155.2    103.99   0    2     0.015509 0.007579
2    1    10   D2S1    5.00      200.00  159.6    103.99   0    2     -0.007763 0.007412
2    2    13   D2S4    5.00      200.00  146      103.99   0    2     -0.106650 0.007794
2    3    12   D2S3    5.00      200.00  150.6    103.99   0    2     -0.053865 0.007696
2    4    15   D2S6    5.00      200.00  136.8    103.99   0    2     0.024495 0.007678
2    5    14   D2S5    5.00      200.00  141.4    103.99   0    2     -0.105075 0.008076
2    6    17   D2S8    5.00      200.00  128      103.99   0    2     0.596364 0.006813
2    7    16   D2S7    5.00      200.00  132.3    103.99   0    2     -0.007975 0.007406
2    8    1    D1S2    5.00      200.00  155.2    52.56    0    2     -0.020980 0.007575
2    9    0    D1S1    5.00      200.00  159.6    52.56    0    2     0.020538 0.007667
2    10   3    D1S4    5.00      200.00  146      52.56    0    2     -0.074459 0.007833
2    11   2    D1S3    5.00      200.00  150.6    52.56    0    2     0.069455 0.007586
2    12   5    D1S6    5.00      200.00  136.8    52.56    0    2     0.069455 0.007586
2    13   4    D1S5    5.00      200.00  141.4    52.56    0    2     0.002820 0.007616
2    14   7    D1S8    5.00      200.00  128      52.56    0    2     -0.068986 0.007928
2    15   6    D1S7    5.00      200.00  132.3    52.56         0    2     -0.069752 0.007978
3    0    21   D3S2    5.00      200.00  155.2    155.42   0    2     -0.092525 0.007750
3    1    20   D3S1    5.00      200.00  159.6    155.42   0    2     0.019792 0.007567
```

Thresholds in MeV [min,max]

Look-up table

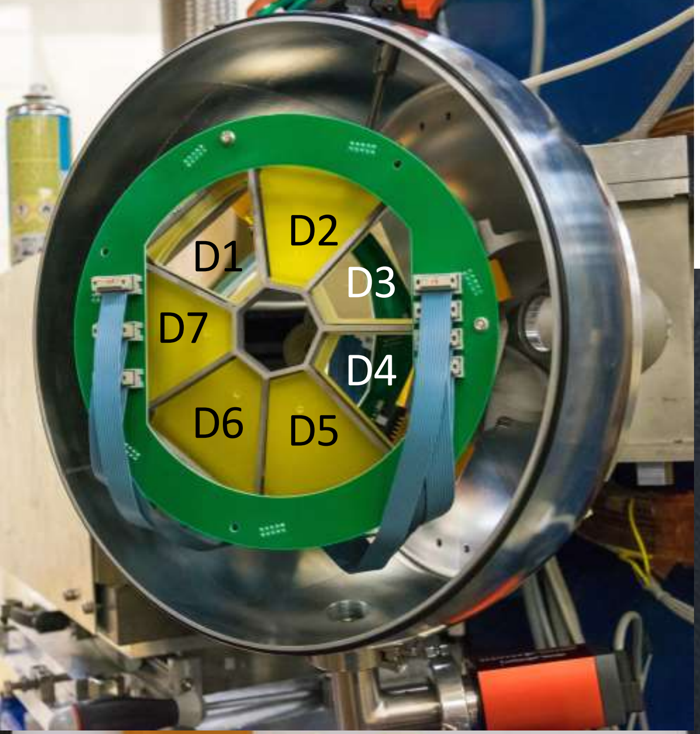


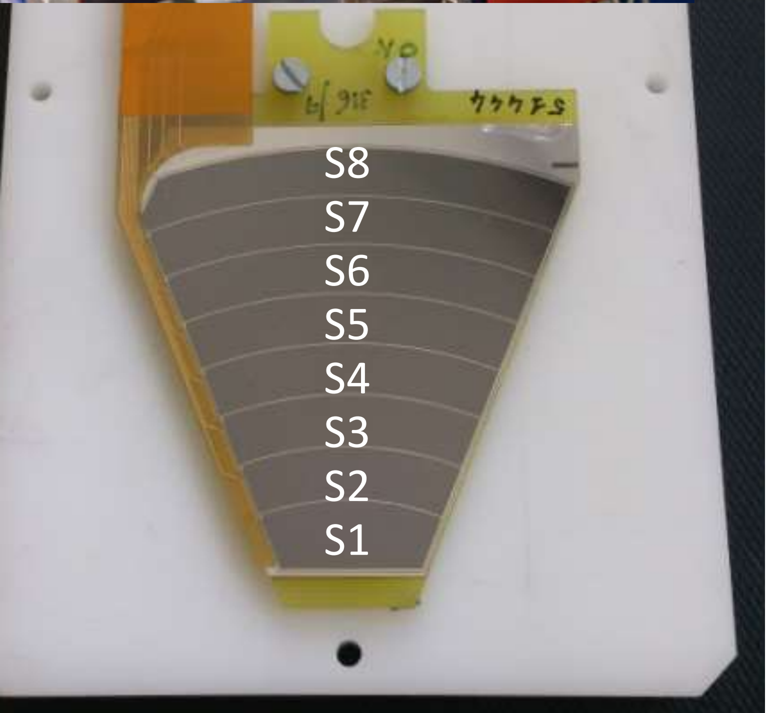



```
####### SPIDER ######
#
# Board channel map     name    thr_lo  thr_hi  theta    phi TimeOffset  ncalpar calpars
2   0   11  D2S2    5.00    200.00  155.2    103.99  0   2    0.015509 0.007579
2   1   10  D2S1    5.00    200.00  159.6    103.99  0   2    -0.007763 0.007412
2   2   13  D2S4    5.00    200.00  146      103.99  0   2    -0.106650 0.007794
2   3   12  D2S3    5.00    200.00  150.6    103.99  0   2    -0.053865 0.007696
2   4   15  D2S6    5.00    200.00  136.8    103.99  0   2    0.024495 0.007678
2   5   14  D2S5    5.00    200.00  141.4    103.99  0   2    -0.105075 0.008076
2   6   17  D2S8    5.00    200.00  128      103.99  0   2    0.596364 0.006813
2   7   16  D2S7    5.00    200.00  132.3    103.99  0   2    -0.007975 0.007406
2   8   1   D1S2    5.00    200.00  155.2    52.56   0   2    -0.020980 0.007575
2   9   0   D1S1    5.00    200.00  159.6    52.56   0   2    0.020538 0.007667
2   10  3   D1S4    5.00    200.00  146      52.56   0   2    -0.074459 0.007833
2   11  2   D1S3    5.00    200.00  150.6    52.56   0   2    0.069455 0.007586
2   12  5   D1S6    5.00    200.00  136.8    52.56   0   2    0.069455 0.007586
2   13  4   D1S5    5.00    200.00  141.4    52.56   0   2    0.002820 0.007616
2   14  7   D1S8    5.00    200.00  128      52.56   0   2    -0.068986 0.007928
2   15  6   D1S7    5.00    200.00  132.3    52.56       0   2    -0.069752 0.007978
3   0   21  D3S2    5.00    200.00  155.2    155.42  0   2    -0.092525 0.007750
3   1   20  D3S1    5.00    200.00  159.6    155.42  0   2    0.019792 0.007567
```

Physical position [theta,phi]

Look-up table






```
####### SPIDER ######
#
# Board channel map     name    thr_lo  thr_hi  theta   phi TimeOffset  ncalpar calpars
2   0   11  D2S2    5.00    200.00  155.2   103.99  0   2   0.015509 0.007579
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2   2   13  D2S4    5.00    200.00  146     103.99  0   2   -0.106650 0.007794
2   3   12  D2S3    5.00    200.00  150.6   103.99  0   2   -0.053865 0.007696
2   4   15  D2S6    5.00    200.00  136.8   103.99  0   2   0.024495 0.007678
2   5   14  D2S5    5.00    200.00  141.4   103.99  0   2   -0.105075 0.008076
2   6   17  D2S8    5.00    200.00  128     103.99  0   2   0.596364 0.006813
2   7   16  D2S7    5.00    200.00  132.3   103.99  0   2   -0.007975 0.007406
2   8   1   D1S2    5.00    200.00  155.2   52.56   0   2   -0.020980 0.007575
2   9   0   D1S1    5.00    200.00  159.6   52.56   0   2   0.020538 0.007667
2   10  3   D1S4    5.00    200.00  146     52.56   0   2   -0.074459 0.007833
2   11  2   D1S3    5.00    200.00  150.6   52.56   0   2   0.069455 0.007586
2   12  5   D1S6    5.00    200.00  136.8   52.56   0   2   0.069455 0.007586
2   13  4   D1S5    5.00    200.00  141.4   52.56   0   2   0.002820 0.007616
2   14  7   D1S8    5.00    200.00  128     52.56   0   2   -0.068986 0.007928
2   15  6   D1S7    5.00    200.00  132.3   52.56       0   2   -0.069752 0.007978
3   0   21  D3S2    5.00    200.00  155.2   155.42  0   2   -0.092525 0.007750
3   1   20  D3S1    5.00    200.00  159.6   155.42  0   2   0.019792 0.007567
```
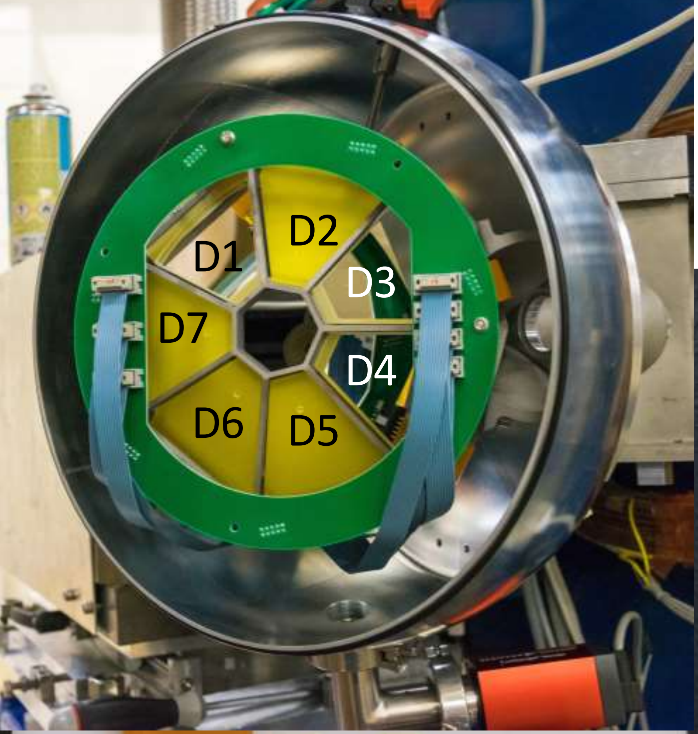
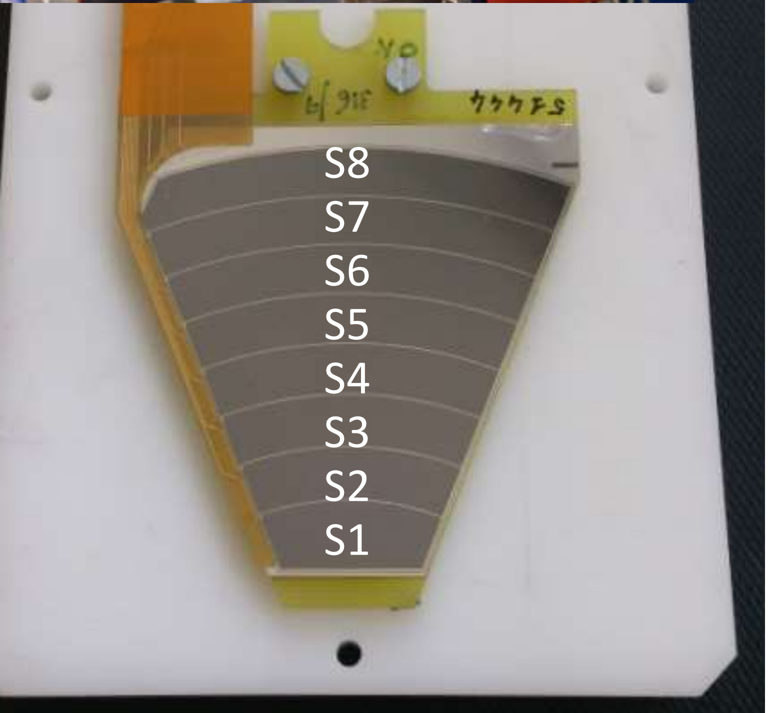

Time offset in 10ns





Look-up table

```
####### SPIDER ######
#
# Board channel map     name    thr_lo  thr_hi  theta    phi TimeOffset  ncalpar calpars
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2   2   13  D2S4    5.00    200.00  146     103.99  0   2    -0.106650 0.007794
2   3   12  D2S3    5.00    200.00  150.6   103.99  0   2    -0.053865 0.007696
2   4   15  D2S6    5.00    200.00  136.8   103.99  0   2    0.024495 0.007678
2   5   14  D2S5    5.00    200.00  141.4   103.99  0   2    -0.105075 0.008076
2   6   17  D2S8    5.00    200.00  128     103.99  0   2    0.596364 0.006813
2   7   16  D2S7    5.00    200.00  132.3   103.99  0   2    -0.007975 0.007406
2   8   1   D1S2    5.00    200.00  155.2   52.56   0   2    -0.020980 0.007575
2   9   0   D1S1    5.00    200.00  159.6   52.56   0   2    0.020538 0.007667
2   10  3   D1S4    5.00    200.00  146     52.56   0   2    -0.074459 0.007833
2   11  2   D1S3    5.00    200.00  150.6   52.56   0   2    0.069455 0.007586
2   12  5   D1S6    5.00    200.00  136.8   52.56   0   2    0.069455 0.007586
2   13  4   D1S5    5.00    200.00  141.4   52.56   0   2    0.002820 0.007616
2   14  7   D1S8    5.00    200.00  128     52.56   0   2    -0.068986 0.007928
2   15  6   D1S7    5.00    200.00  132.3   52.56       0   2    -0.069752 0.007978
3   0   21  D3S2    5.00    200.00  155.2   155.42  0   2    -0.092525 0.007750
3   1   20  D3S1    5.00    200.00  159.6   155.42  0   2    0.019792 0.007567
```

energy calibration [Npar, par1,..., parN]