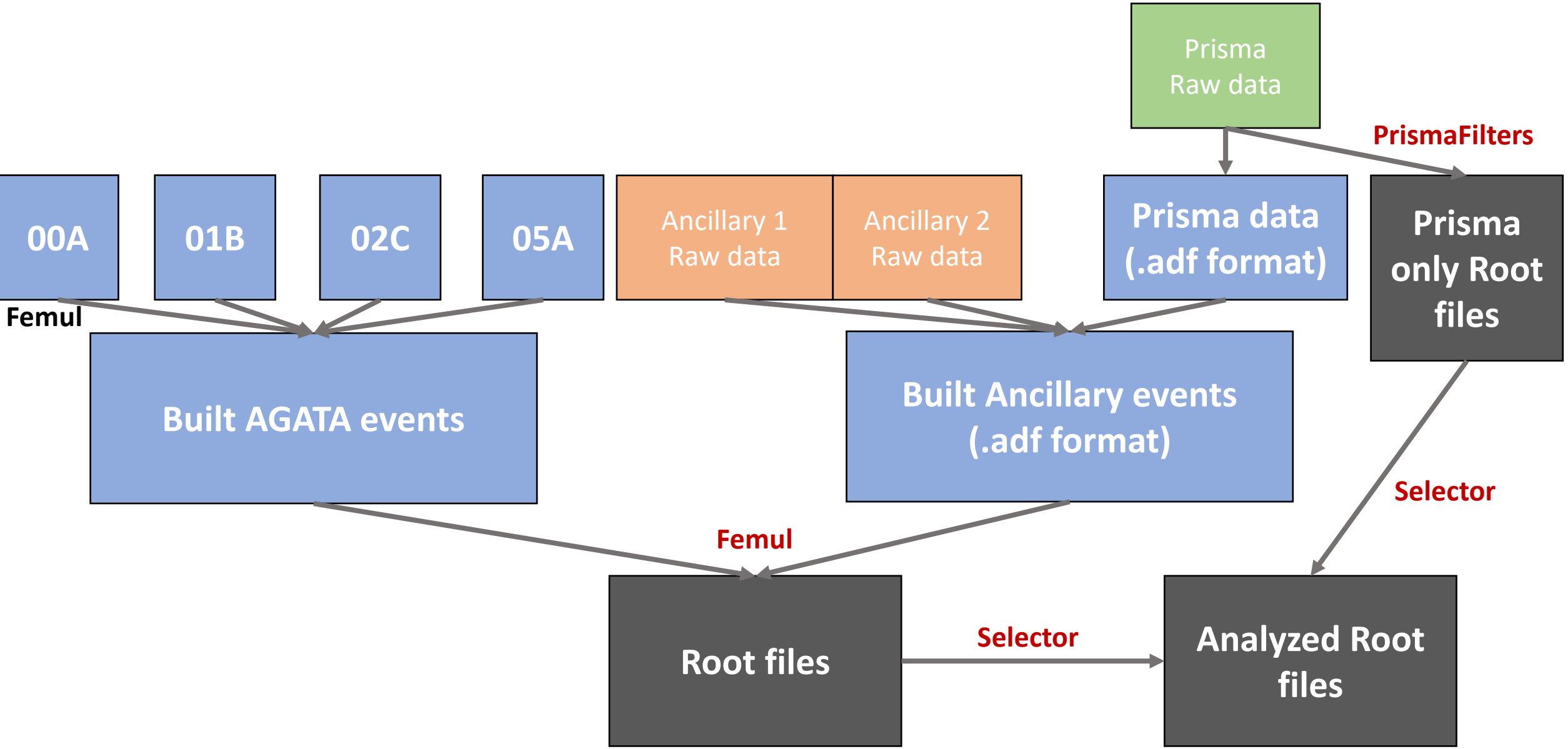
Istituto Nazionale di Fisica Nucleare
LABORATORI NAZIONALI DI LEGNARO

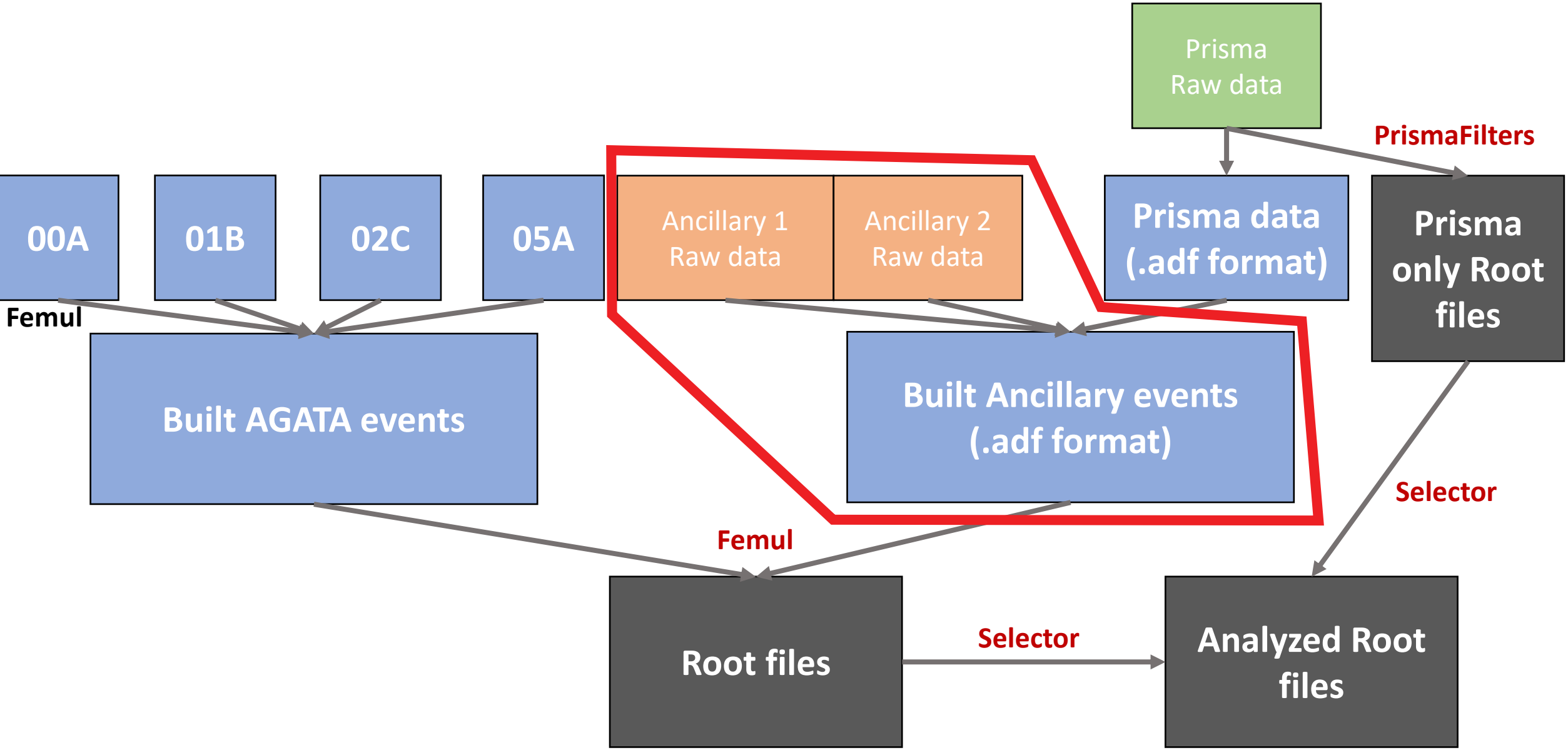
AGATA analysis workshop 2023

Ancillaries of AGATA

M. Balogh *on behalf of local AGATA group*

matus.balogh@lnl.infn.it


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
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

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

DPP-PSD

Digital Pulse Processing for Charge Integration and Pulse Shape Discrimination

TS, TDC, QDC, CFD, PSD

CAEN V1725

14bit, 250MS/s

CAEN V2740

14bit, 125MS/s

CAEN V1730

14bit, 500MS/s

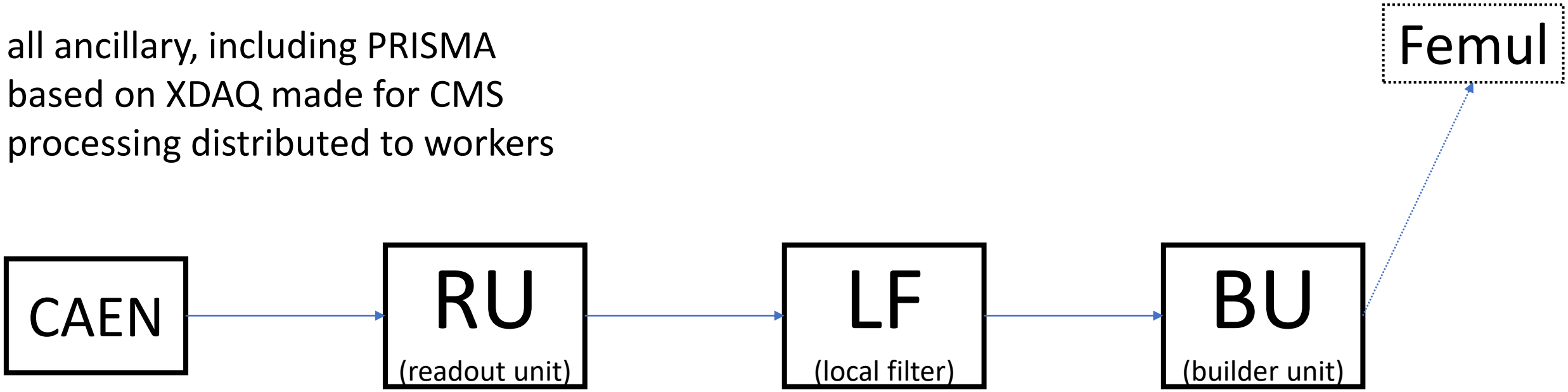
- SPIDER
- EUCLIDES
- DANTE

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

- 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***

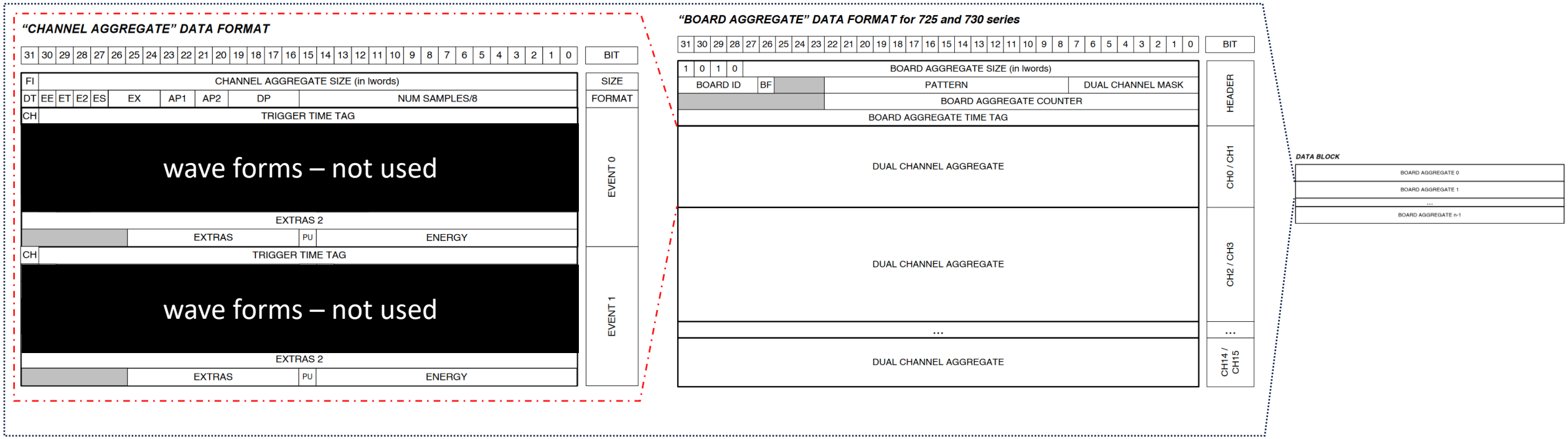
*AGATAD_P2_EXP_019/run_0102_TIME/**Data/caen_digitizers/LF_caendig_iX_Y_Z.adf***

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…

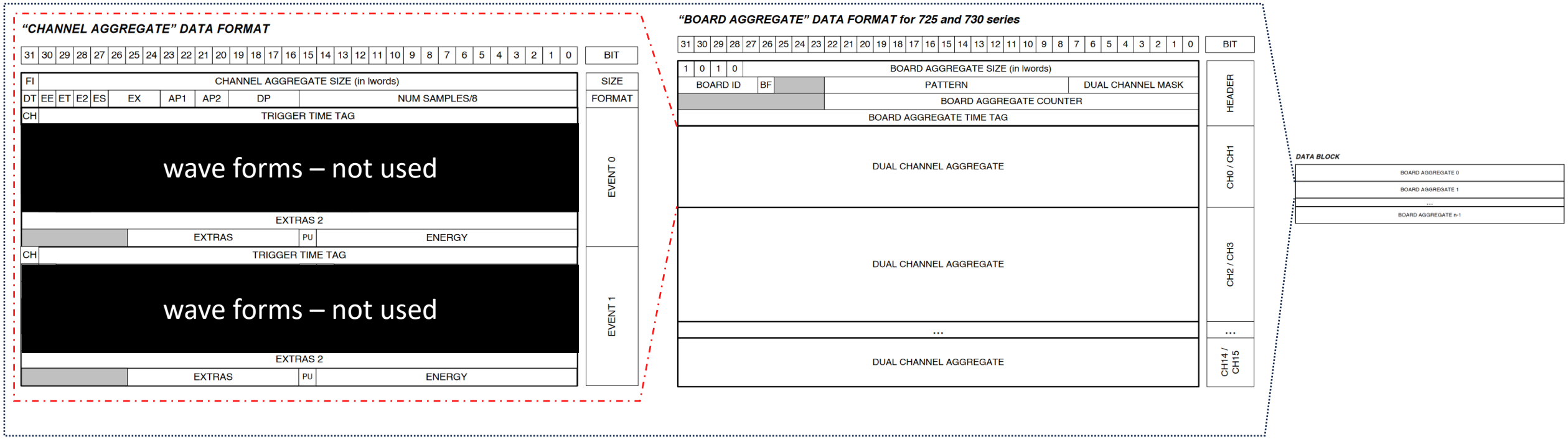


For more details consult manual for CAEN 725-730 series boards

RU data format - .caendat

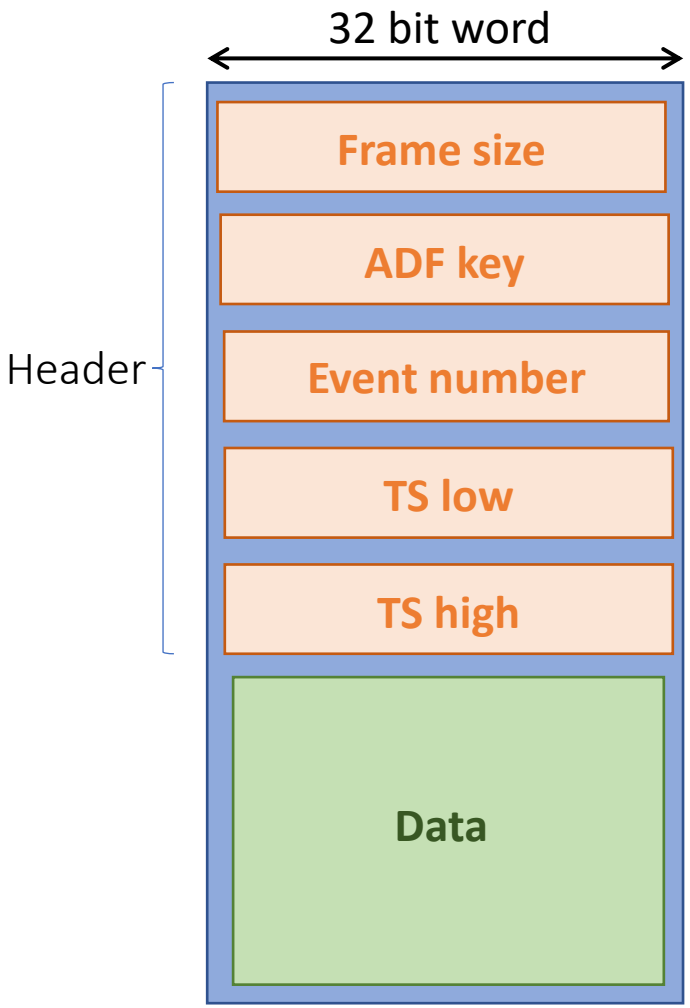
- programable using registers, may vary between experiments
- different for PHA and PSD boards
- complicated…

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

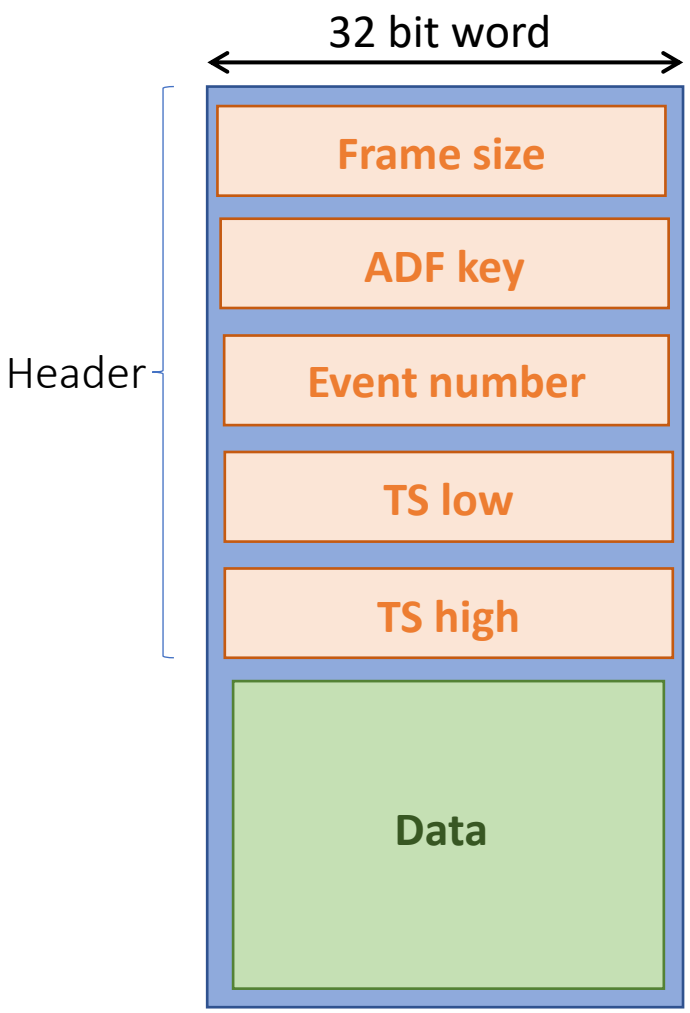


For more details consult manual for CAEN 725-730 series boards

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)

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

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		

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

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 (0xFA0201A0)																																
	Event number (0x0)																																
	Timestamp_0																																
	Timestamp_1																																
Data 1	ADC value																	board								channel						
Data 1	ADC value																	board								channel						
…																																	
Data N	ADC value																	board								channel						

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

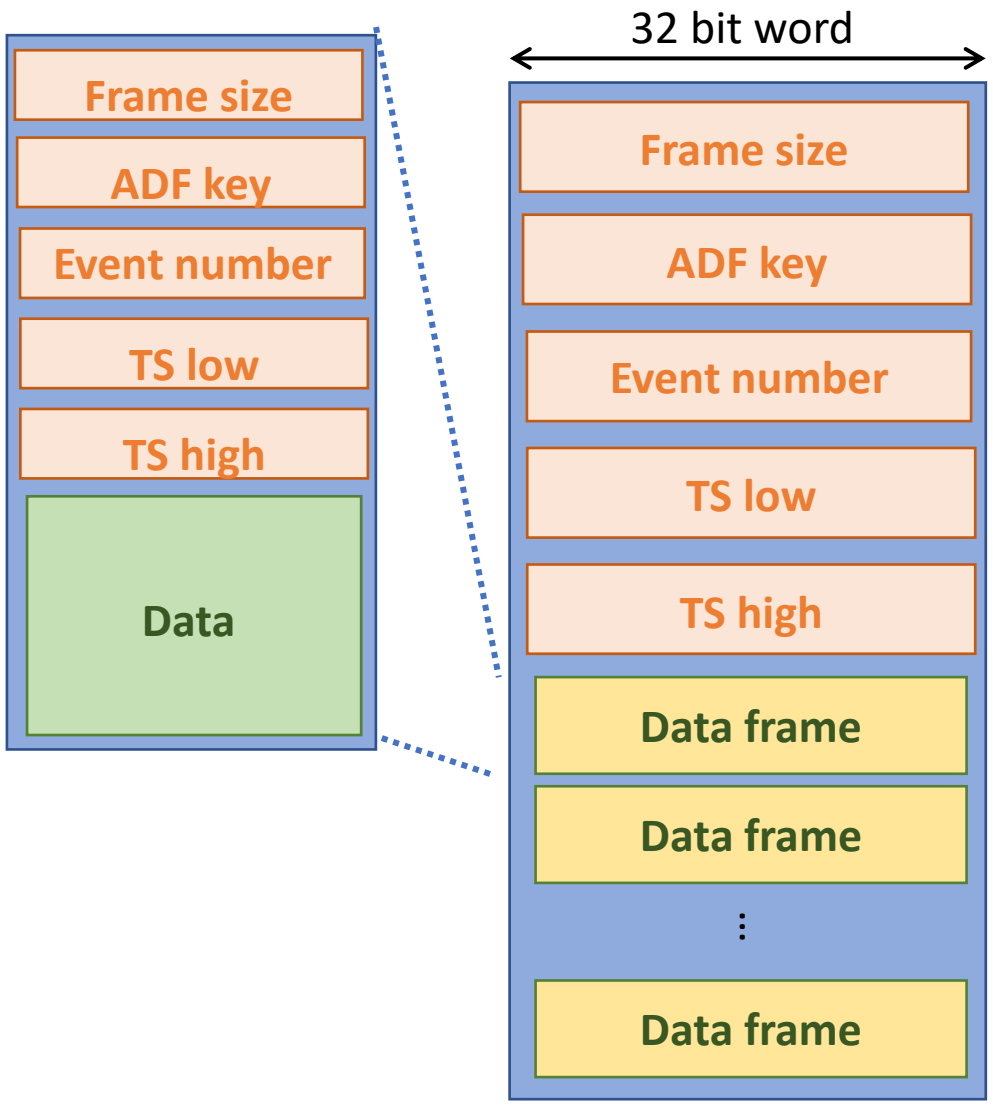
variable frame size

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]

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**	

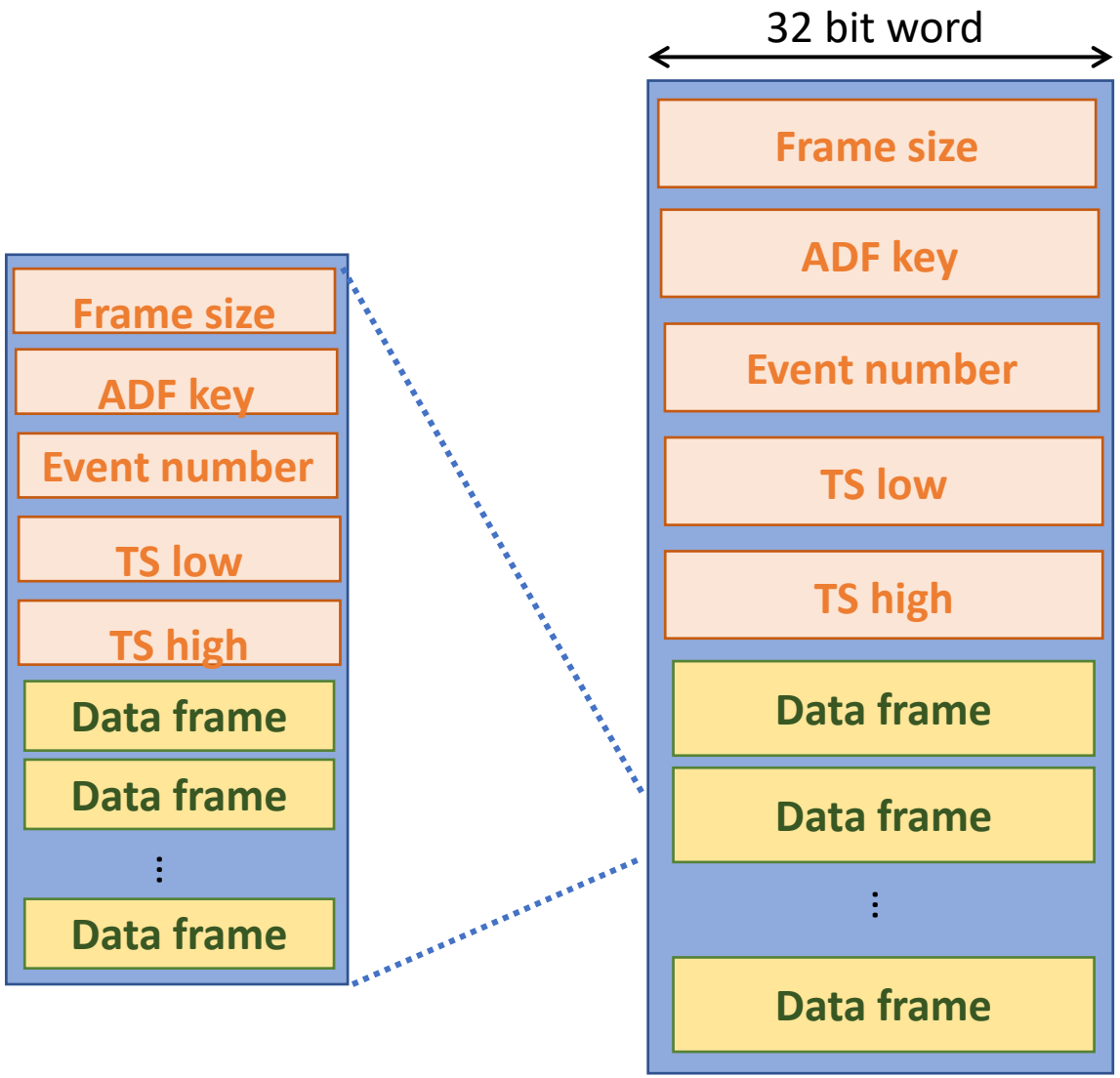
BU data format - general ADF



size of the whole frames in bytes

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

BU data format - general ADF

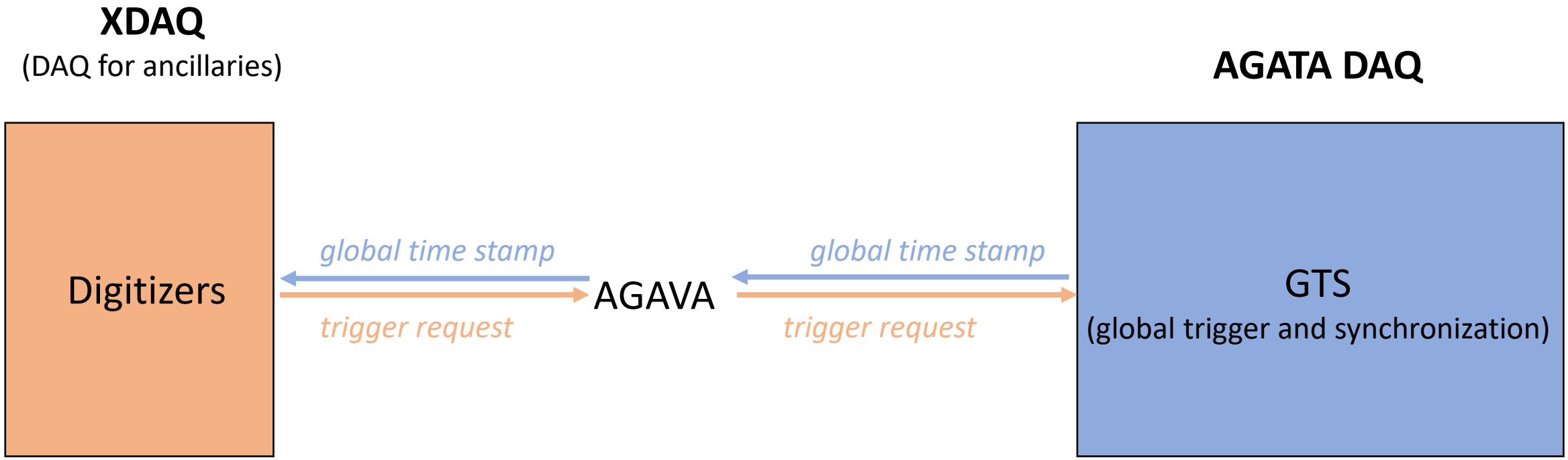


size of the whole frames in bytes

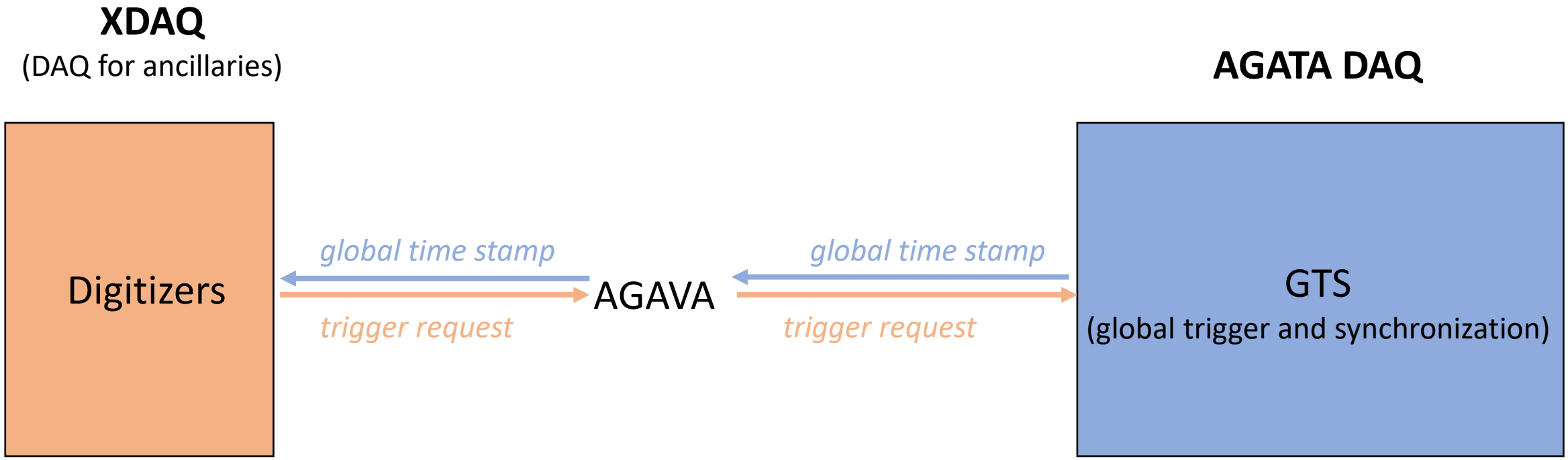
key **0xCA??????** denotes composite frame

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

Ancillaries will start with timestamp 0!!!

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

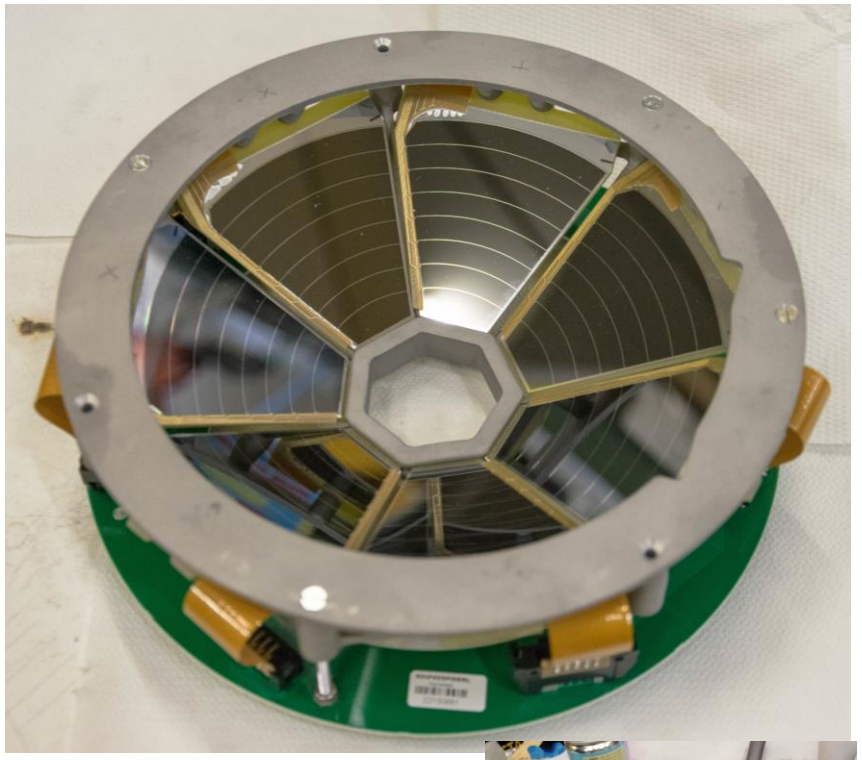
Ready to use code in
agataselector/Scripts/TimeOffsetFix
(with manual!)

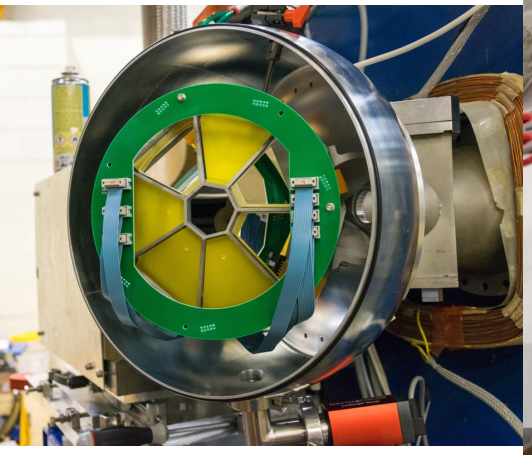
main / agataselector / Scripts / TimeOffsetFix / + | History | Find file | Edit | Clone

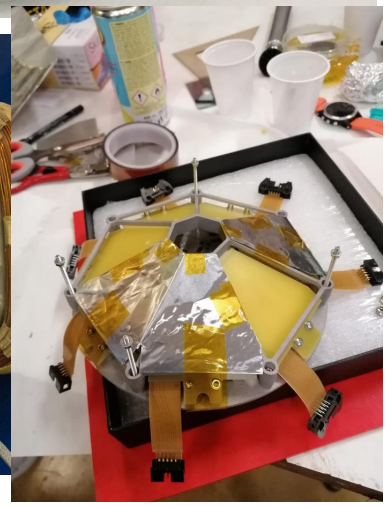
Name	Last commit	Last update
..		
Images	Added readme to fix coincidences	10 months ago
README.md	Modification of instructions to fix time offset of ancillaries	3 days ago
compile.sh	Modification of instructions to fix time offset of ancillaries	3 days ago
drawHist.cxx	Some changes and clang-format	6 months ago
fix.C	Time offset fix routine improved; user sellector for exp003 upload; root macro for fit of N gaus...	10 months ago
generate.sh	Time offset fix routine improved; user sellector for exp003 upload; root macro for fit of N gaus...	10 months ago

Detectors

SPIDER





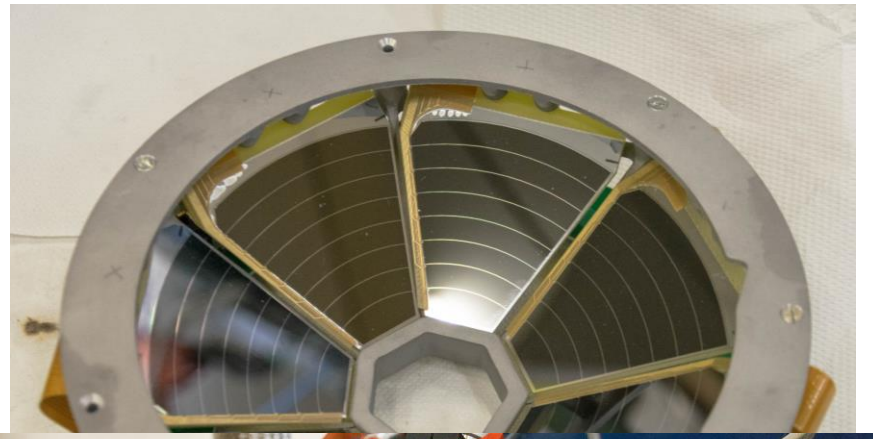


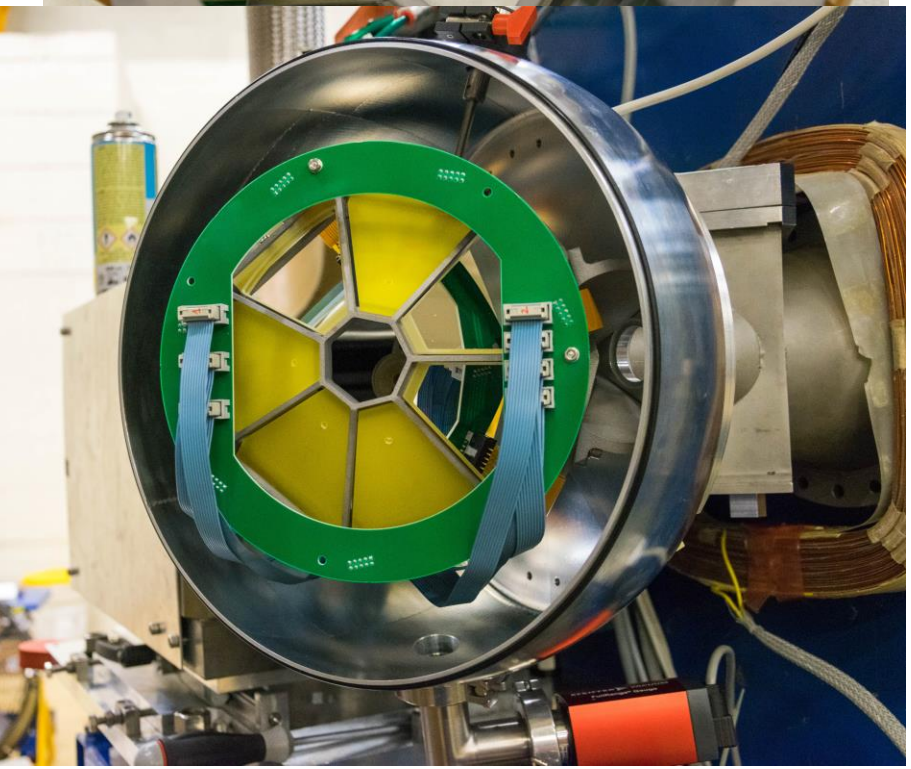
Silicon PIe DEtectoR

- 7 trapezoidal detectors, each segmented to 8 strips
- $300\mu m$ thick

Reference paper 10.1016/j.nima.2020.164030

SPIDER





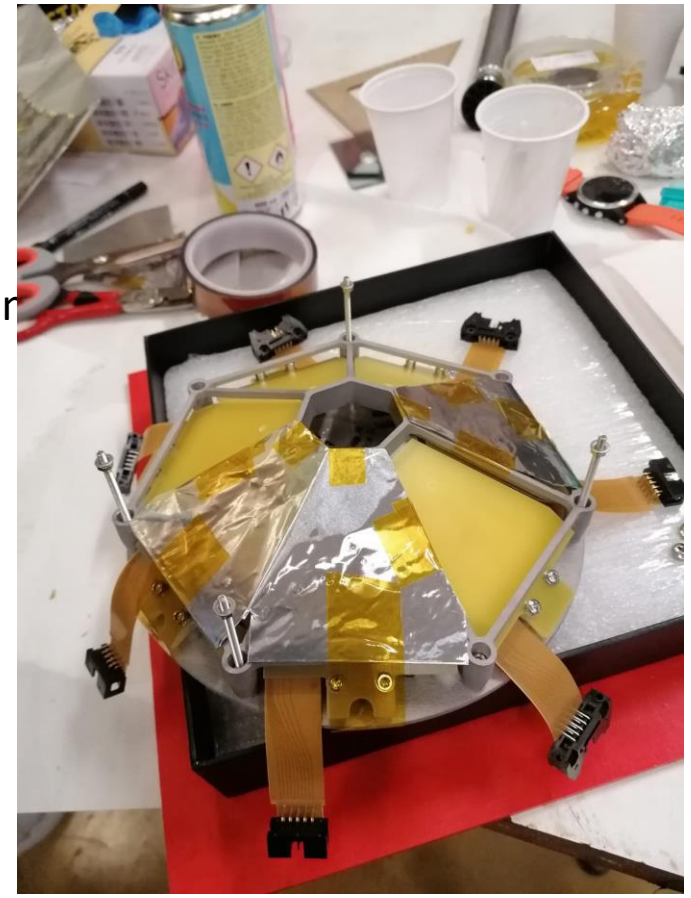
Silicon PIe DEtectoR

- 7 trapezoidal detectors, each segmented to 8 strips
- $300\mu m$ thick

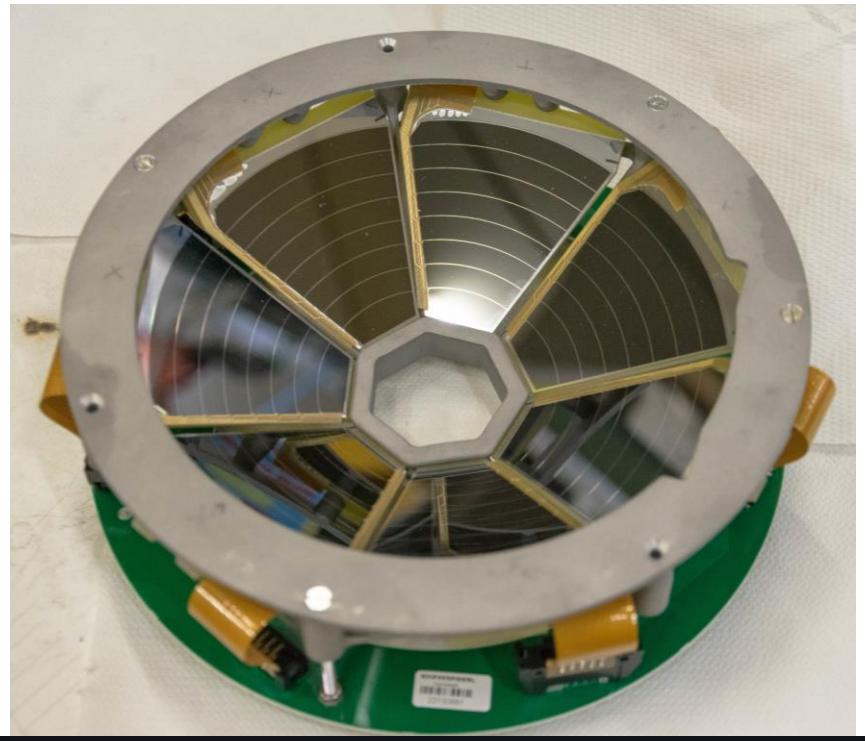
Hardware issues

No backing on several detectors

- getting hit with scattered beam/electron
- now fixed



SPIDER



Silicon PIe DEtectoR

- 7 trapezoidal detectors, each segmented to 8 strips
- $300\mu m$ thick

Hardware issues

No backing on several detectors

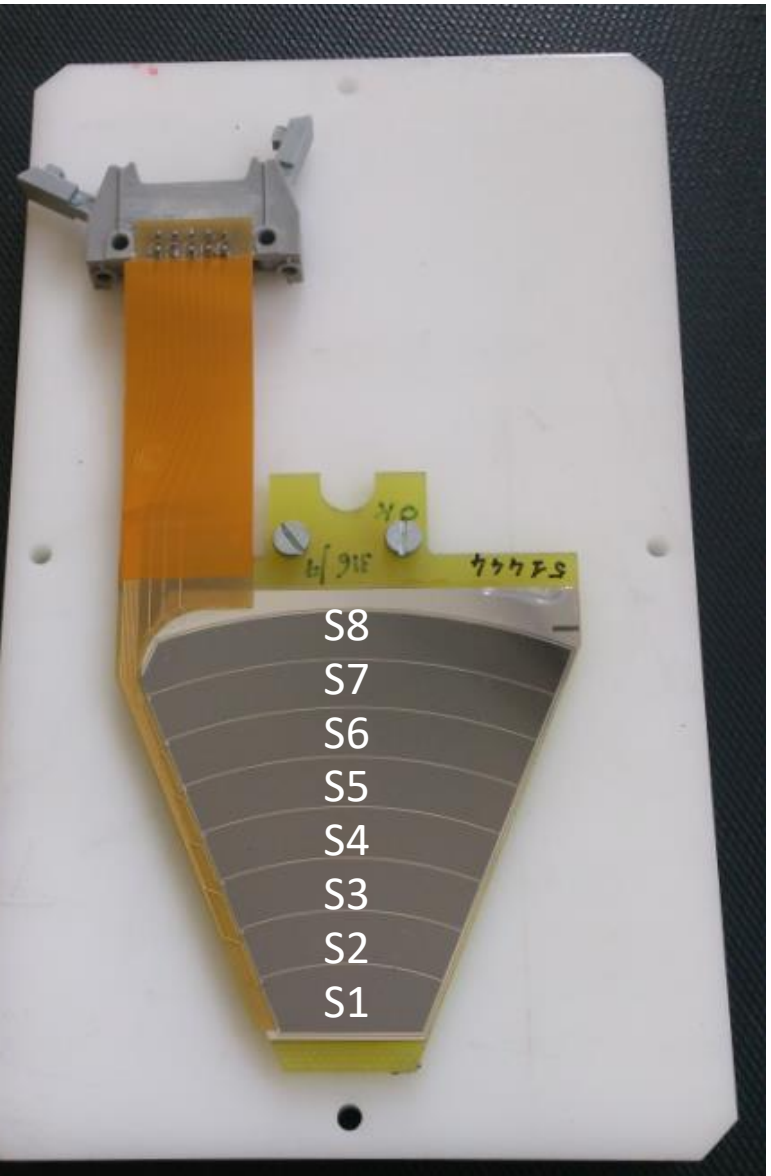
- getting hit with scattered beam/electrons
- now fixed

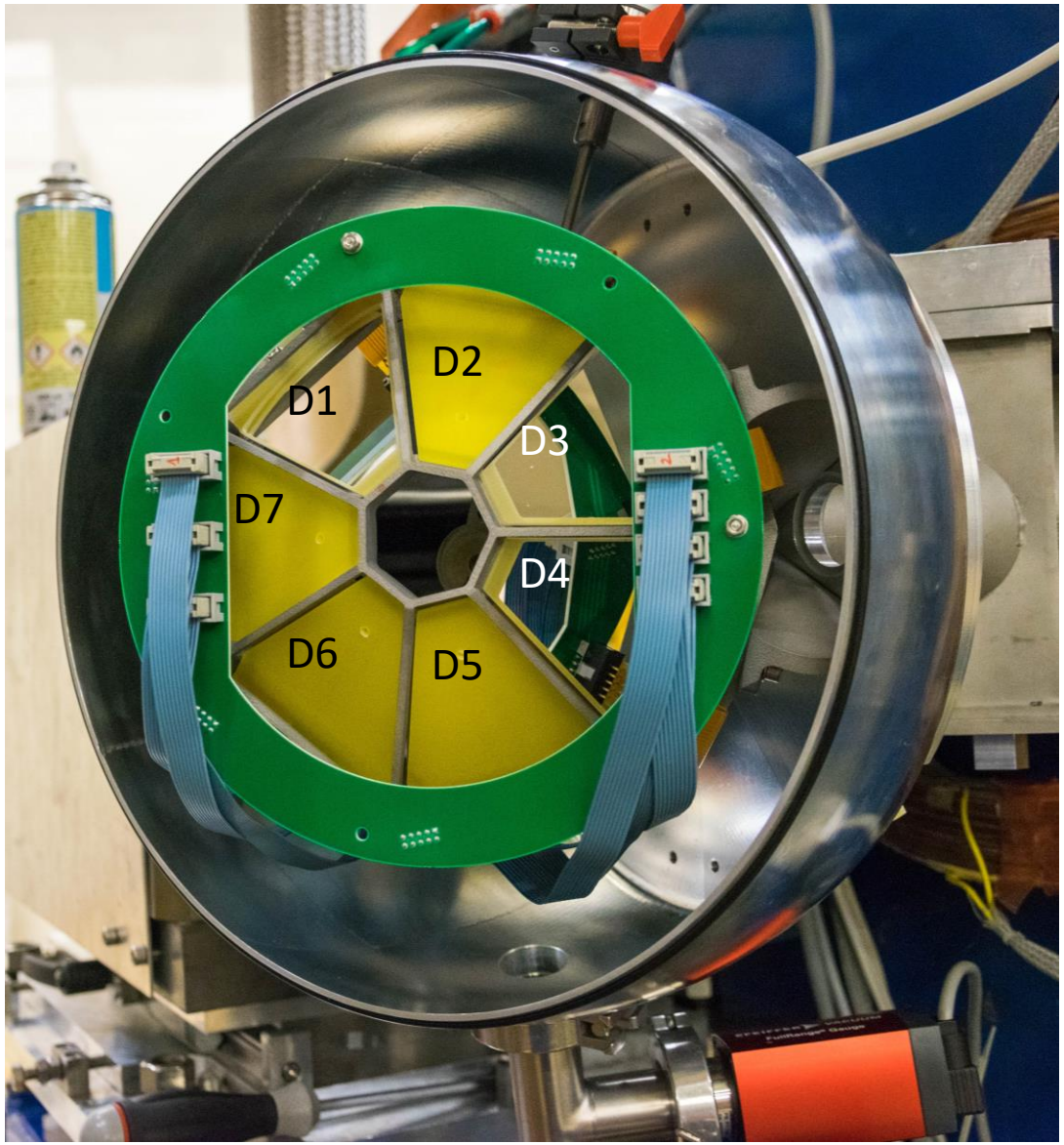
Keep in mind

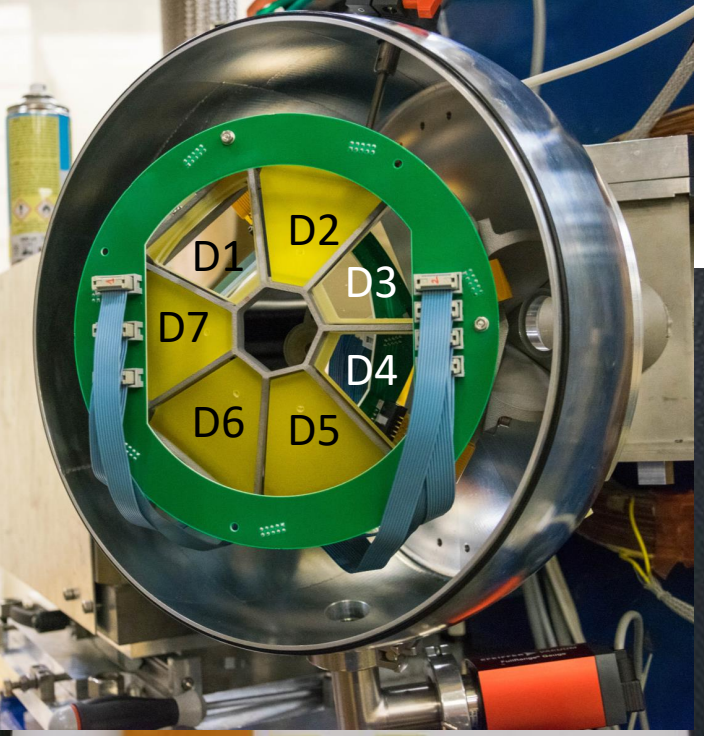
Leakage current

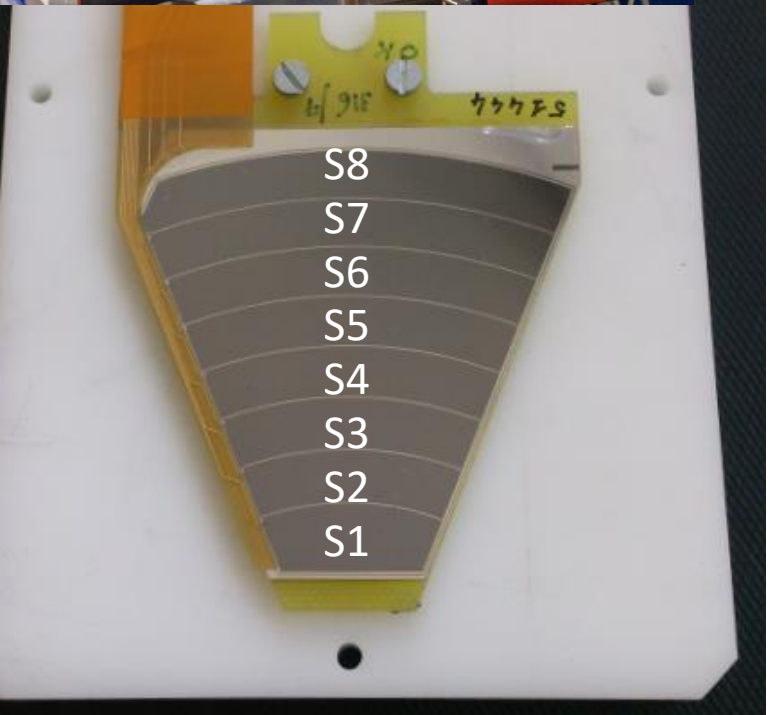
- damage induced leakage current decreases effective HV applied thus reduces the depleted region
- check your energy calibration as a function of time!

“sitting on beam” looking on the target view





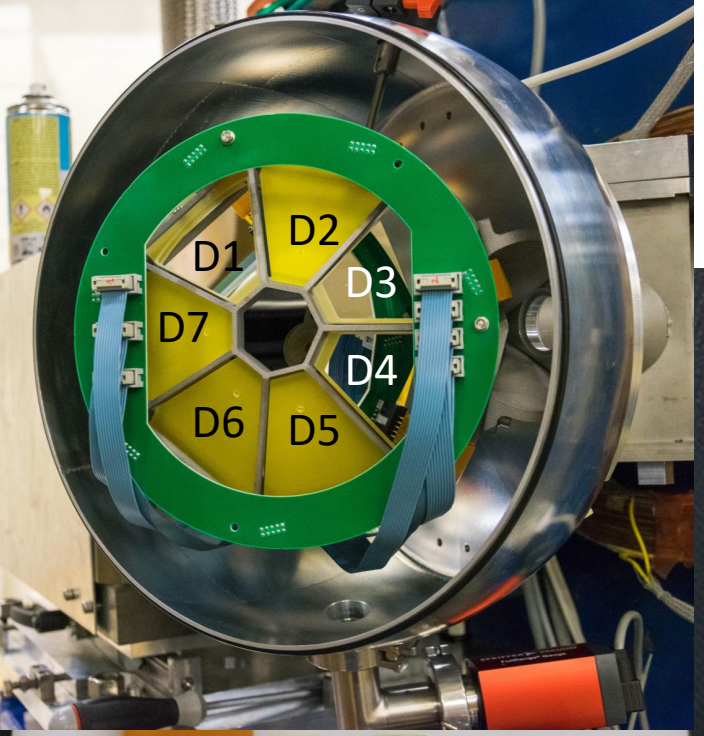


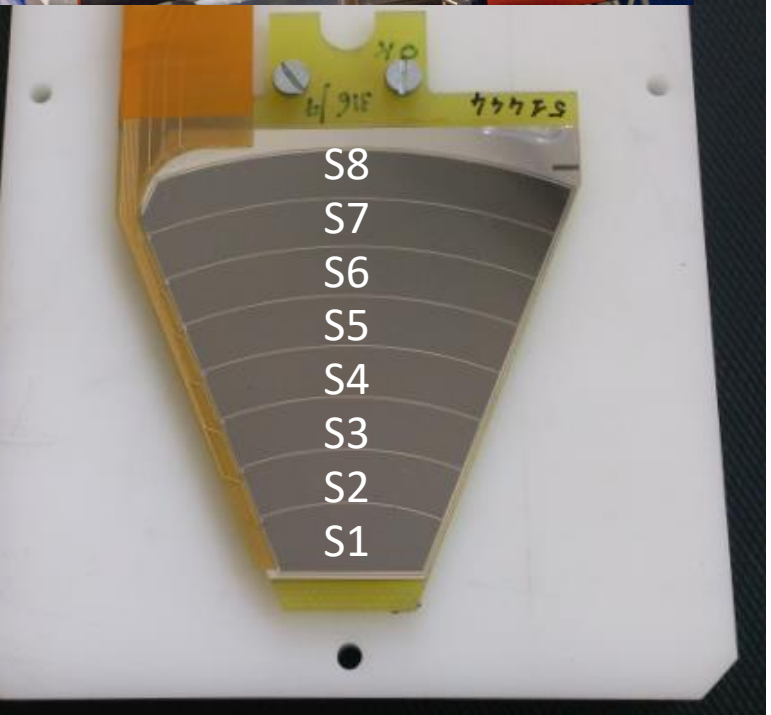


Look-up table

```
####### 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]



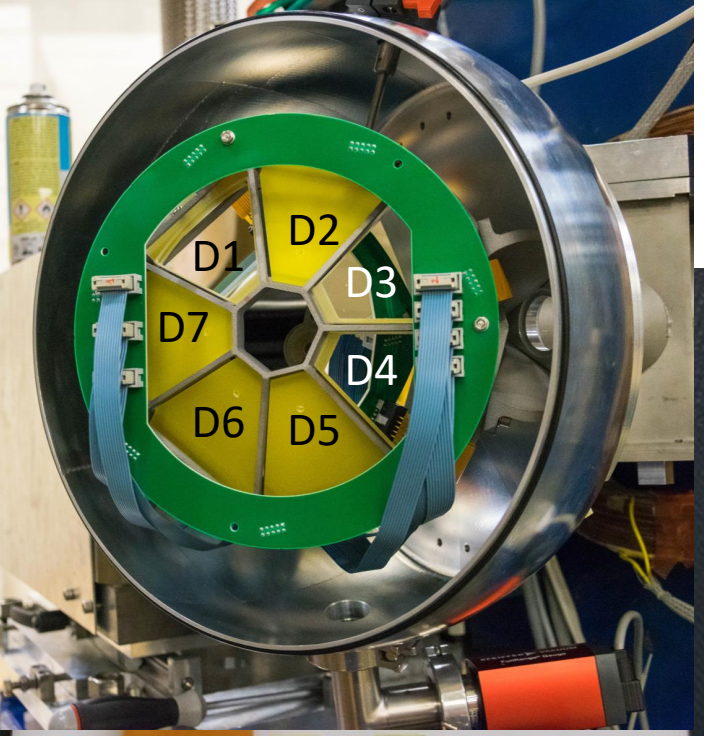


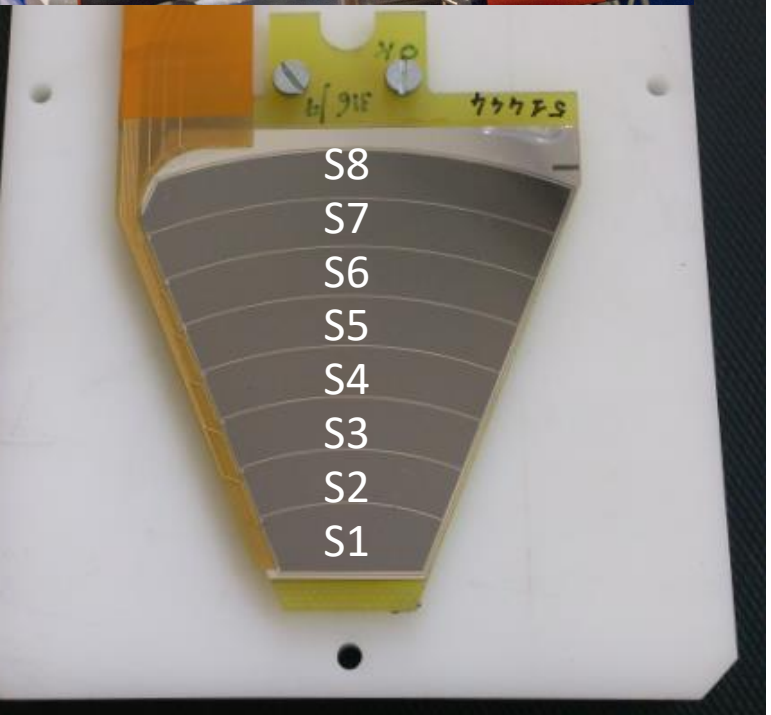
Look-up table

```
####### 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

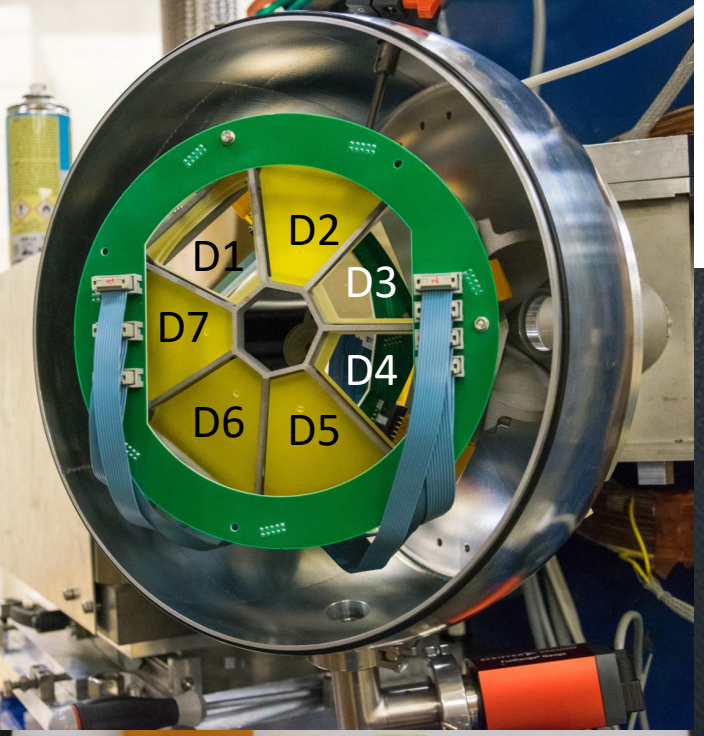


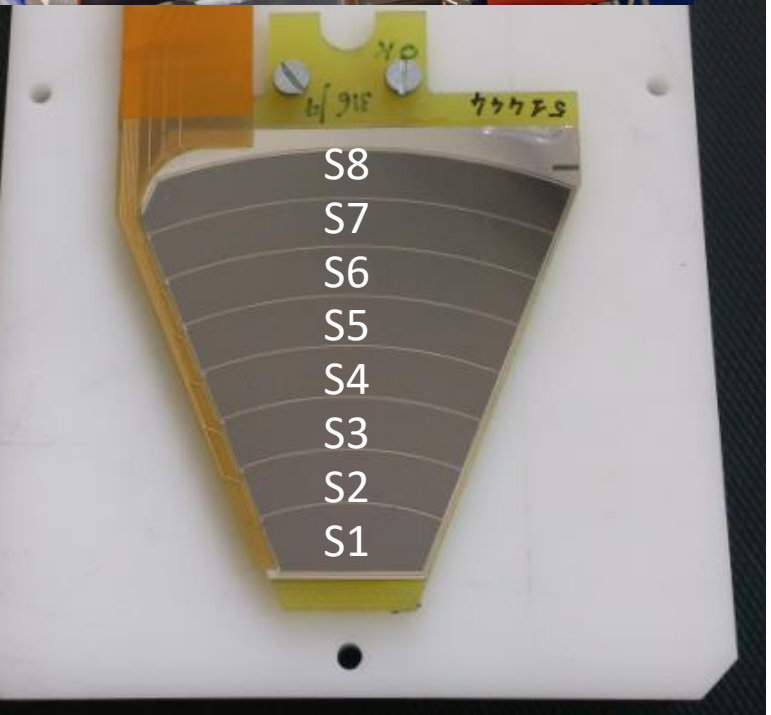


Look-up table

```
####### 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]

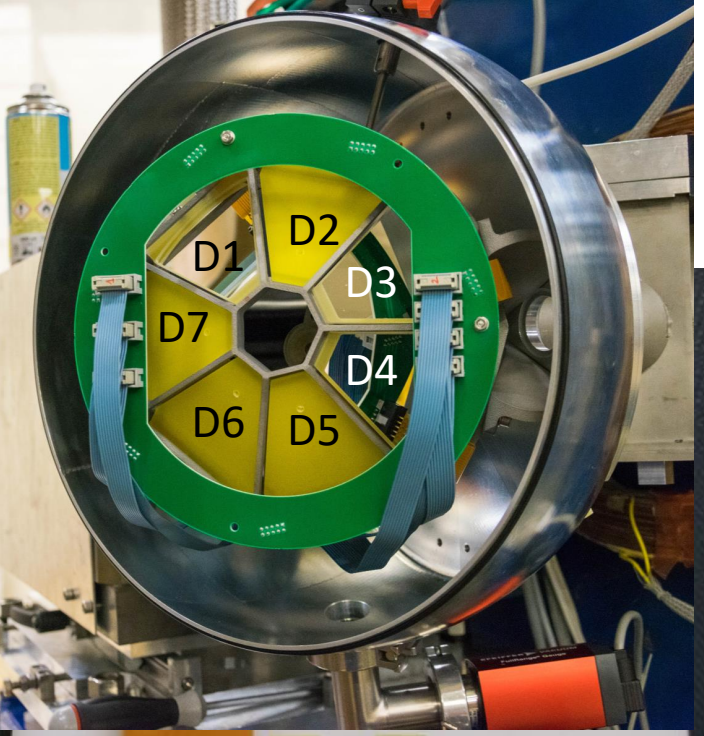


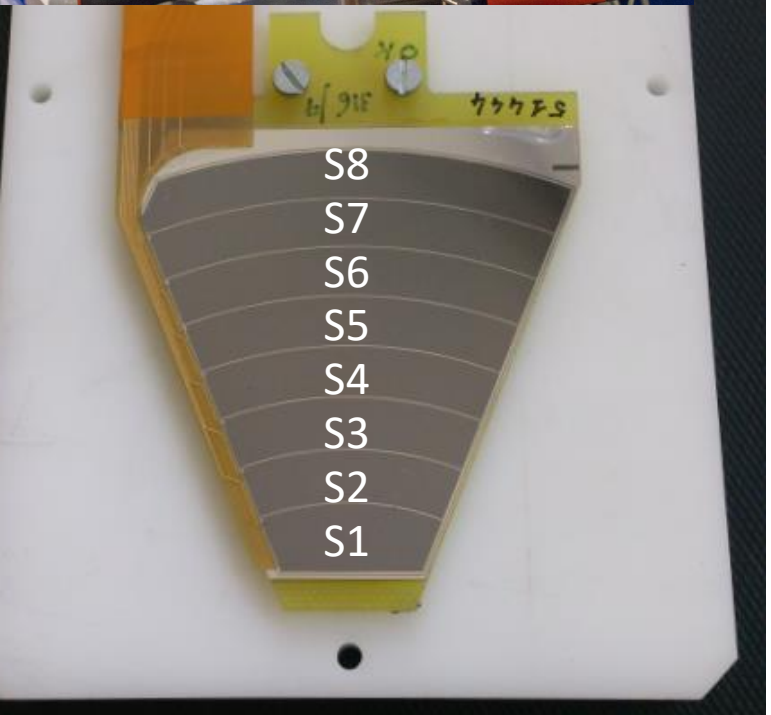


Look-up table

```
####### 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]

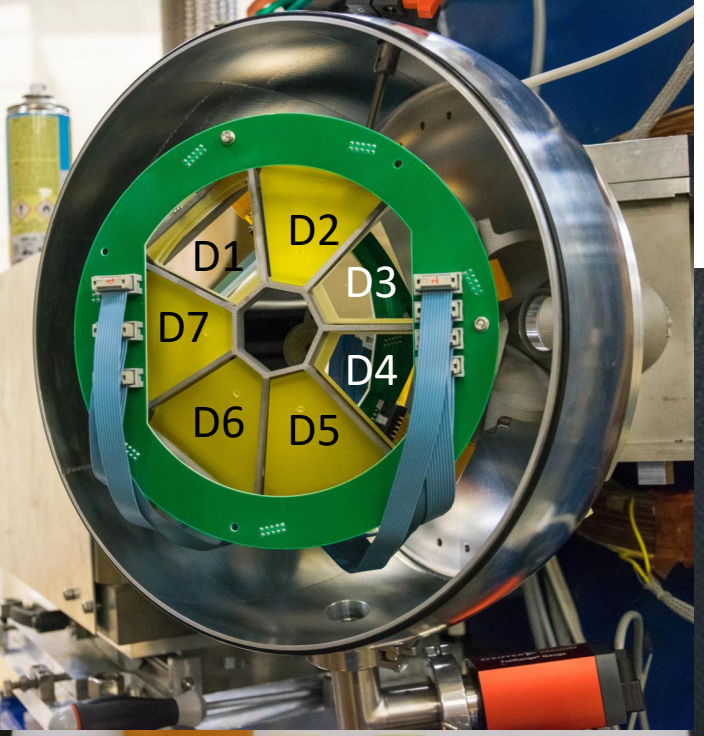


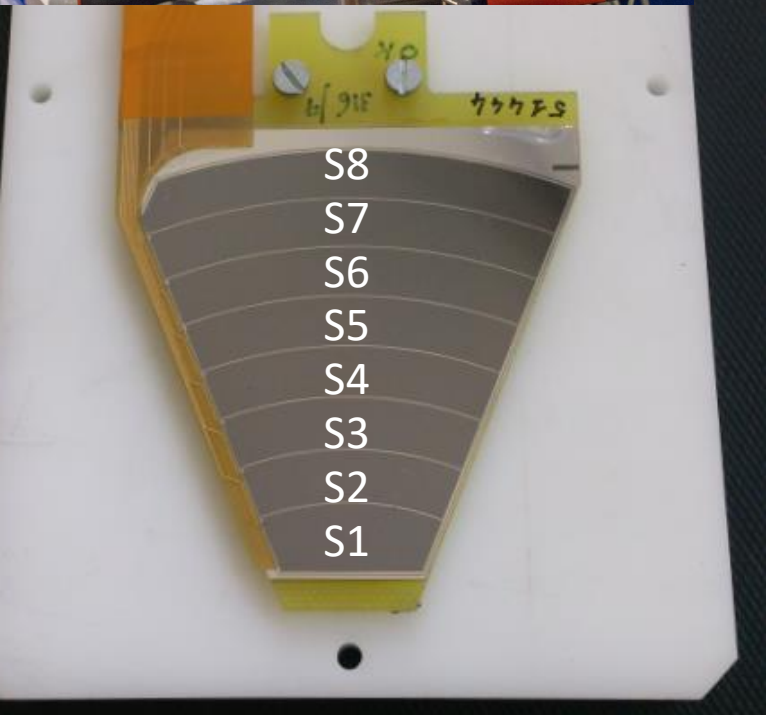


Look-up table

```
####### 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
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
```

Time offset in 10ns



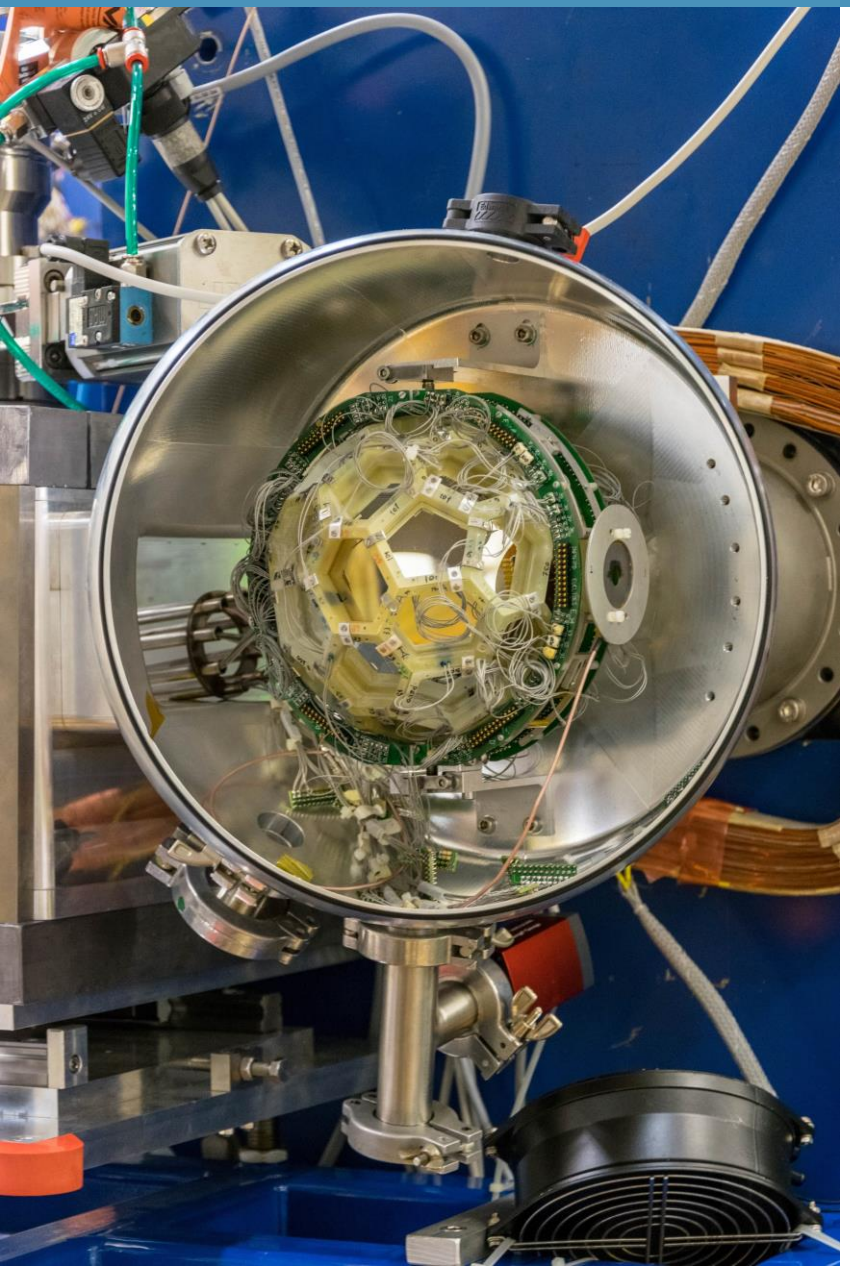


Look-up table

```
####### 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
```

energy calibration [Npar, par1,…, parN]

EUCLIDES



EUCLIDES

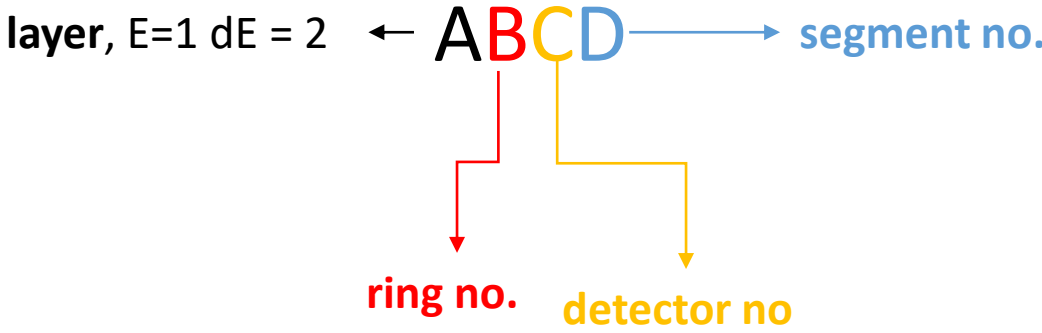
- array of dE-E telescopes, 130μm and 1000μm thick
- 4π coverage
- 5 rings composed of pentagonal or hexagonal detectors
  - forward most ring is has segmented hexagons

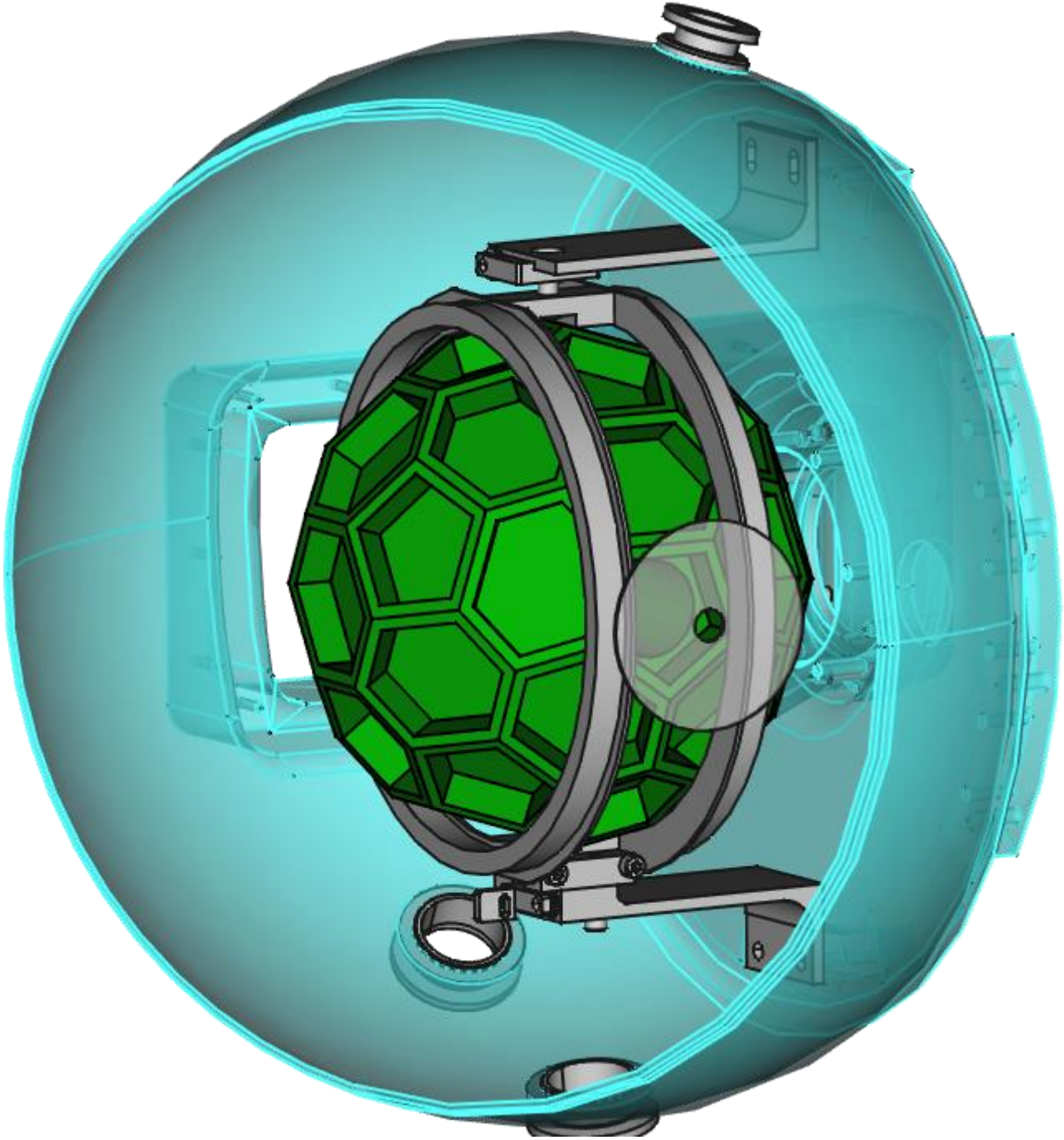
Reference paper 10.1140/epja/i2019-12714-6

EUCLIDES

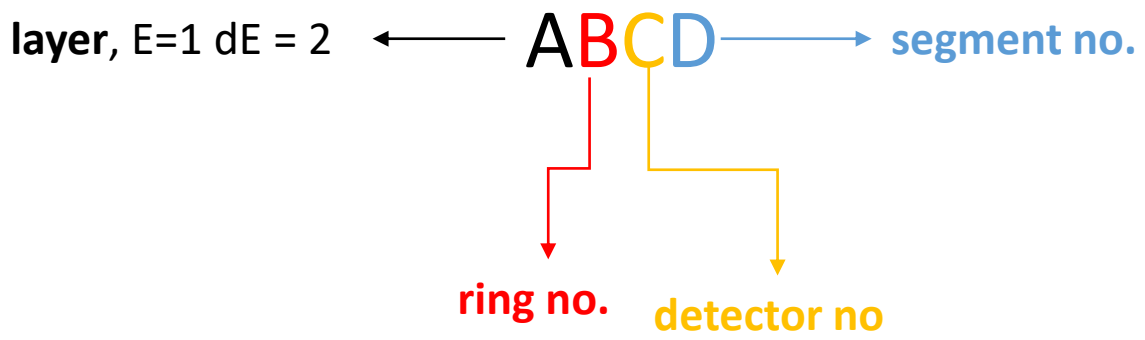
```
#       Board   channel map     name    thr_lo  thr_hi  theta   phi     TimeOffset      ncalpar calpars
#       2       0       1000    ring0_det0_E    5       100000  148.281 90      0       2       0.0000  1.0000
#       2       0       2000    ring0_det0_dE   5       100000  148.281 90      0       2       0.0000  1.0000
#       2       0       1010    ring0_det1_E    5       100000  148.286 161.999 0       2       0.0000  1.0000
#       2       0       2010    ring0_det1_dE   5       100000  148.286 161.999 0       2       0.0000  1.0000
#       2       0       1020    ring0_det2_E    5       100000  148.279 -125.995        0       2       0.0000  1.0000
#       2       0       2020    ring0_det2_dE   5       100000  148.279 -125.995        0       2       0.0000  1.0000
#       2       0       1030    ring0_det3_E    5       100000  148.279 -54.005 0       2       0.0000  1.0000
#       2       0       2030    ring0_det3_dE   5       100000  148.279 -54.005 0       2       0.0000  1.0000
#       2       0       1040    ring0_det4_E    5       100000  148.286 18.001  0       2       0.0000  1.0000
#       2       0       2040    ring0_det4_dE   5       100000  148.286 18.001  0       2       0.0000  1.0000
#
#       5       0       1100    phiphin_E       5       100000  116.565 90      0       2       0.0000  1.0000
#       5       0       2100    phiphin_dE      5       100000  116.565 90      0       2       0.0000  1.0000
        2       2       1110    P800_E  5       100000  121.72  125.996 0       2       0.0000  1.0000
        2       3       2110    P800_dE 5       100000  121.72  125.996 0       2       0.0000  1.0000
        5       6       1120    P500_E  5       100000  116.564 162.003 0       2       0.0000  0.00169
        5       7       2120    P500_dE 5       100000  116.564 162.003 0       2       0.0000  0.00189
#       2       0       1130    H7A_E   5       100000  121.717 -162.006        0       2       0.0000  1.0000
#       2       0       2130    H7A_dE  5       100000  121.717 -162.006        0       2       0.0000  1.0000
        5       4       1140    P101_E  5       100000  116.562 -125.999        0       2       0.0000  1.0000
        5       5       2140    P101_dE 5       100000  116.562 -125.999        0       2       0.0000  1.0000
        5       2       1150    H551_E  5       100000  121.719 -90     0       2       0.0000  1.0000
        5       3       2150    H551_dE 5       100000  121.719 -90     0       2       0.0000  1.0000
        5       0       1160    H0_E    5       100000  116.562 -54.001 0       2       0.0000  1.0000
#       5       1       2160    H0_dE   5       100000  116.562 -54.001 0       2       0.0000  1.0000
        0       8       1170    P10_E   5       100000  121.717 -17.994 0       2       0.0000  0.00176
        0       9       2170    P10_dE  5       100000  121.717 -17.994 0       2       0.0000  0.00177
        0       12      1180    H29_E   5       100000  116.564 17.997  0       2       0.0000  0.00178
        0       13      2180    H29_dE  5       100000  116.564 17.997  0       2       0.0000  0.00195
        0       6       1190    P600_E  5       100000  121.72  54.004  0       2       0.0000  0.00161
        0       7       2190    P600_dE 5       100000  121.72  54.004  0       2       0.0000  0.00192
#
```

Look-up table structure same as SPIDER





Using “map” value to identify detector:

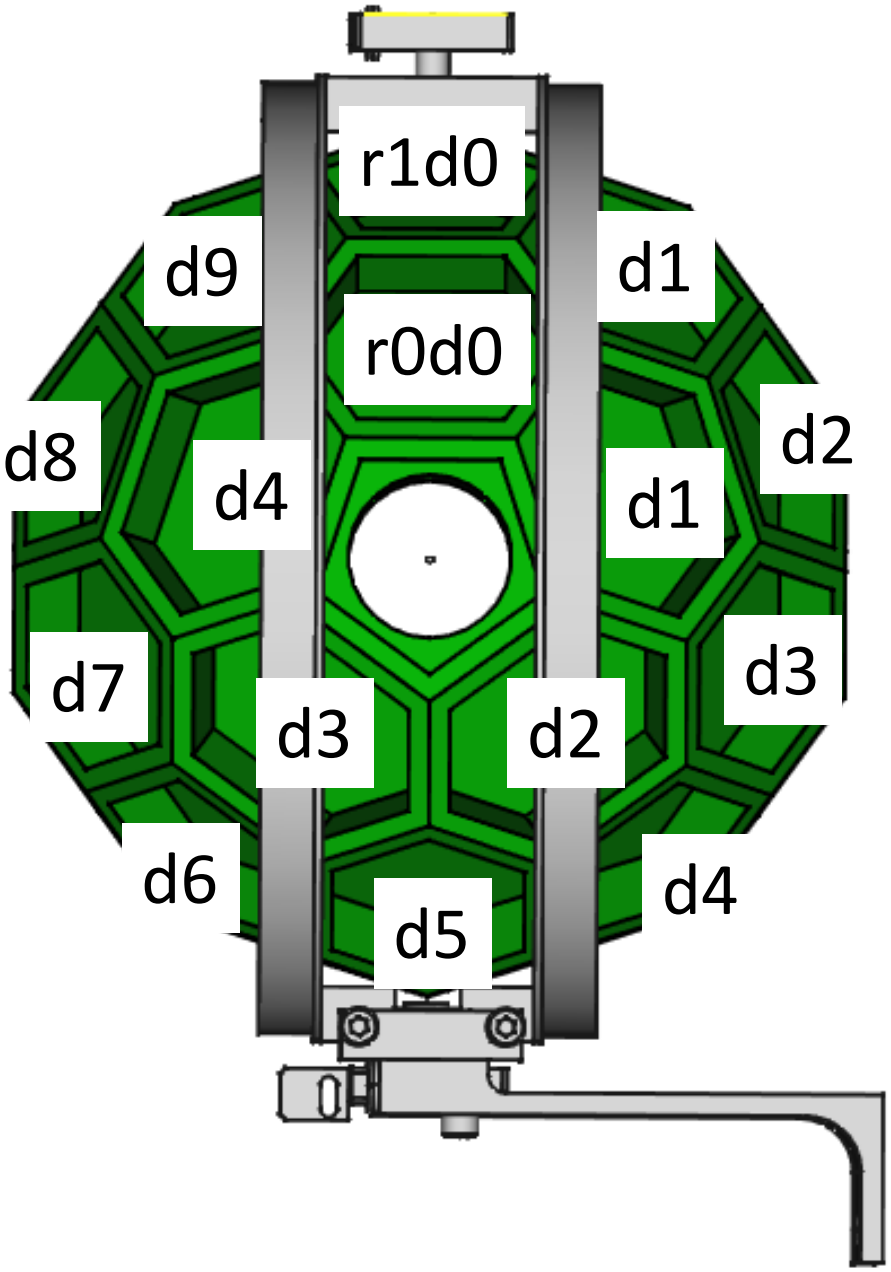


Rings are numbered from back (0) to front (4)

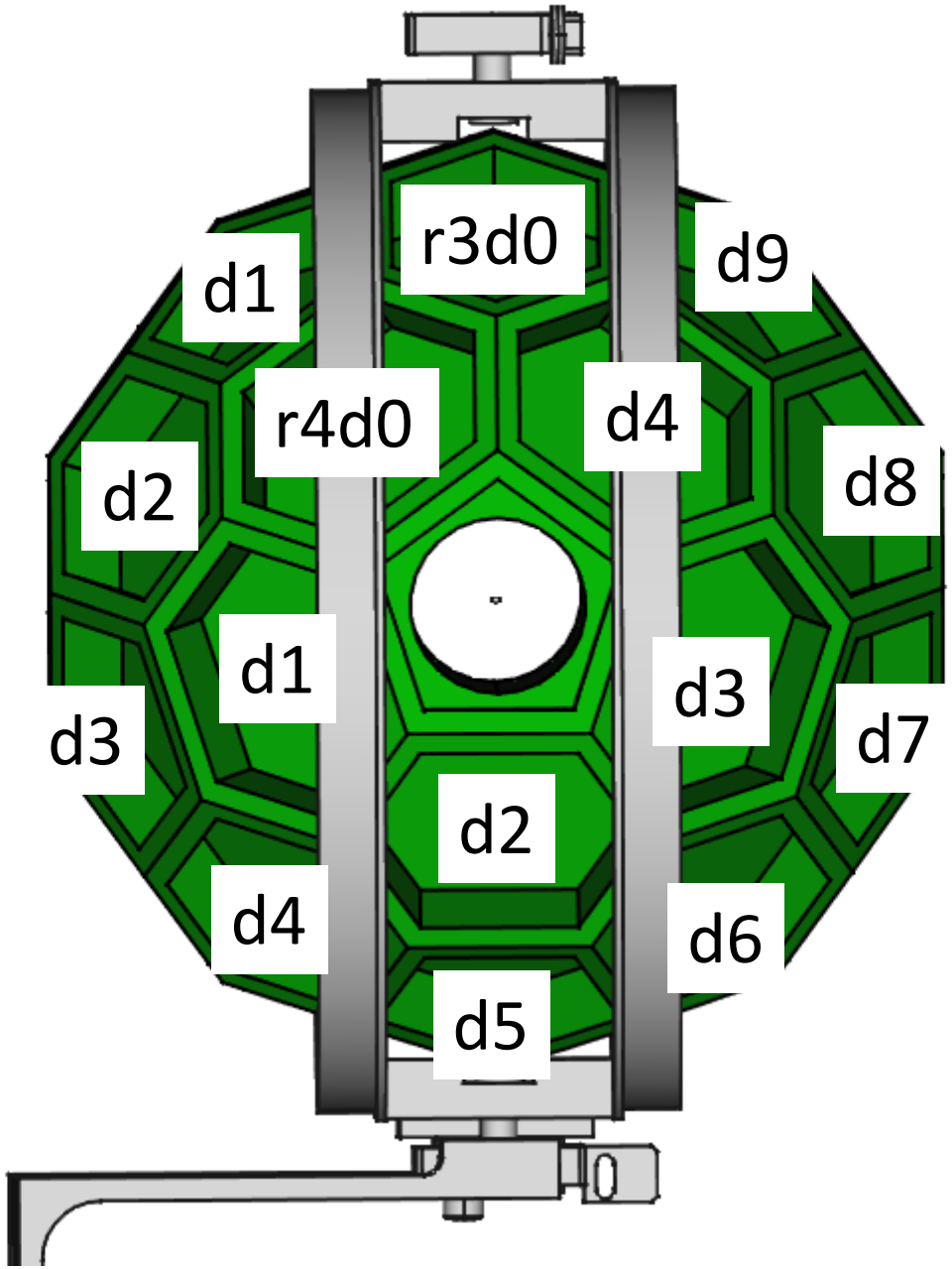
Detector number: from 0 clockwise, starting from the top. If the top has 2 detectors, count from the right one

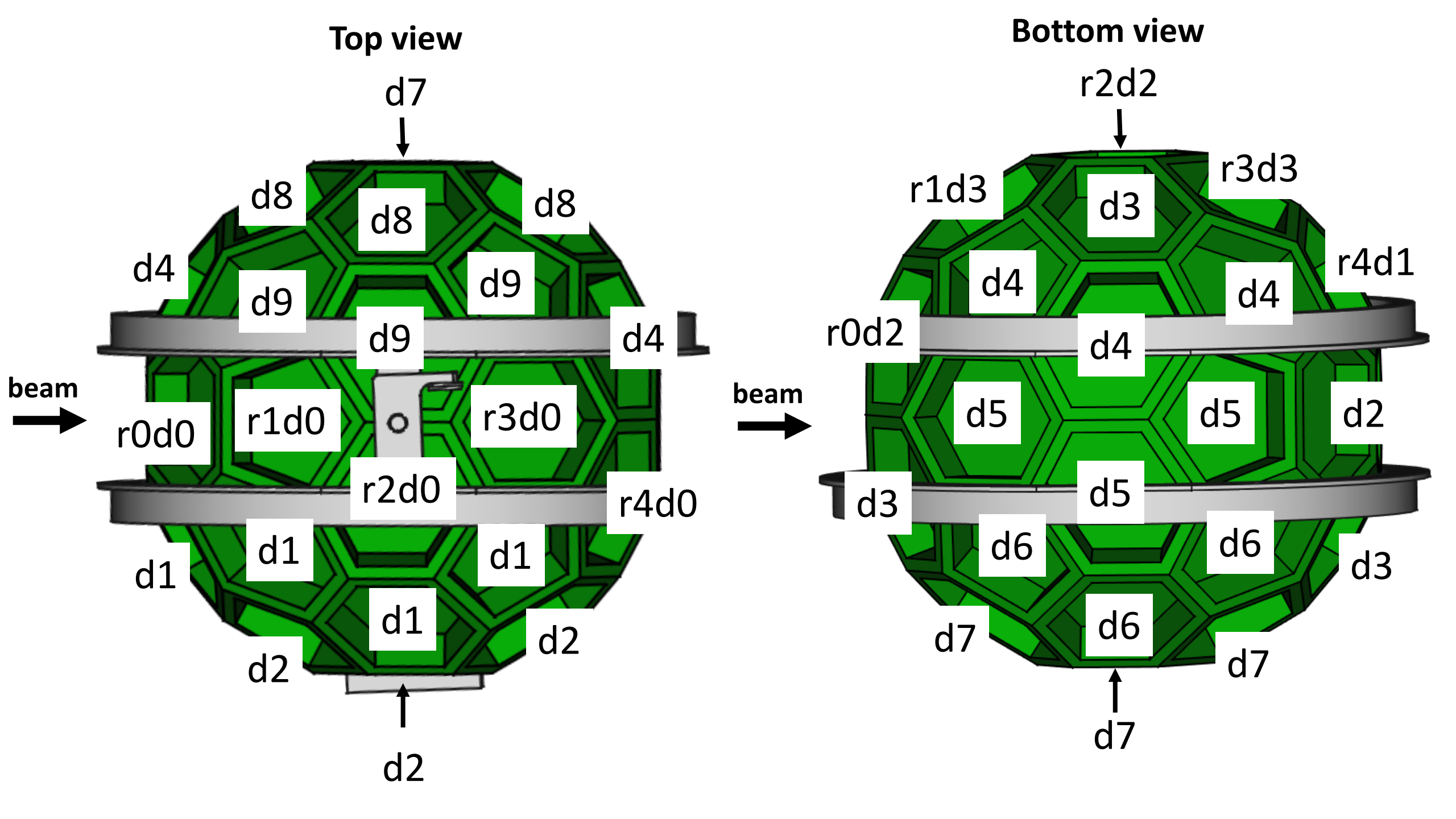
Segment 0 = not segmented, 1-4 segments A-D

Front (beam entering) view



Front (beam exiting) view



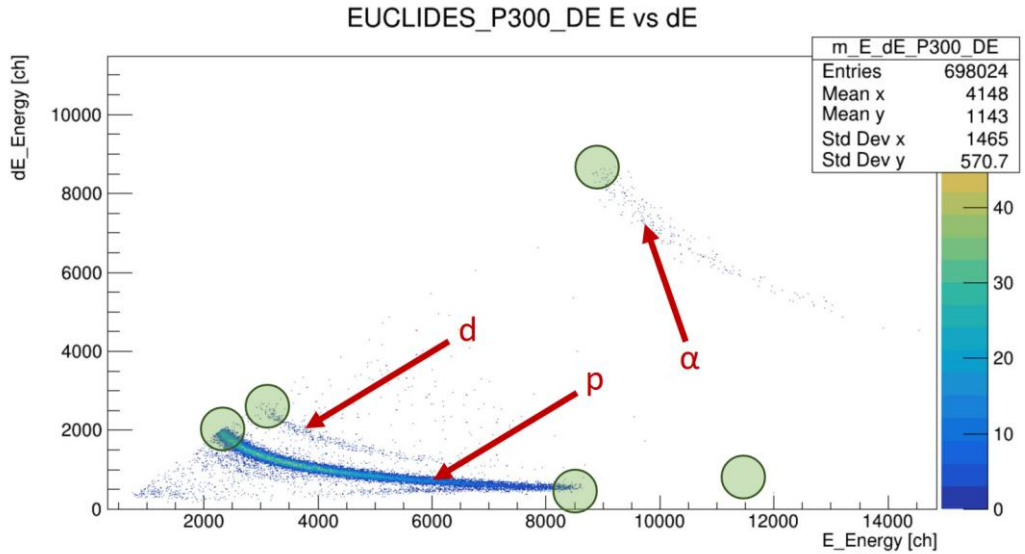

Top view
d7
d8
d8
d8
d4
d9
d9
d9
d4
beam
r0d0
r1d0
r3d0
r2d0
r4d0
d1
d1
d1
d1
d2
d2
d2
Bottom view
r2d2
r1d3
r3d3
d3
d4
r4d1
d4
d4
r0d2
d4
d5
d5
d2
beam
d3
d5
d6
d6
d3
d6
d7
d7
d7

Calibrations and optimizations

Energy calibration

- 3 alpha source
- pulser
- elastic channel
- punch-through

Work on automated procedures is in progress, available (hopefully) in next 1-2 months

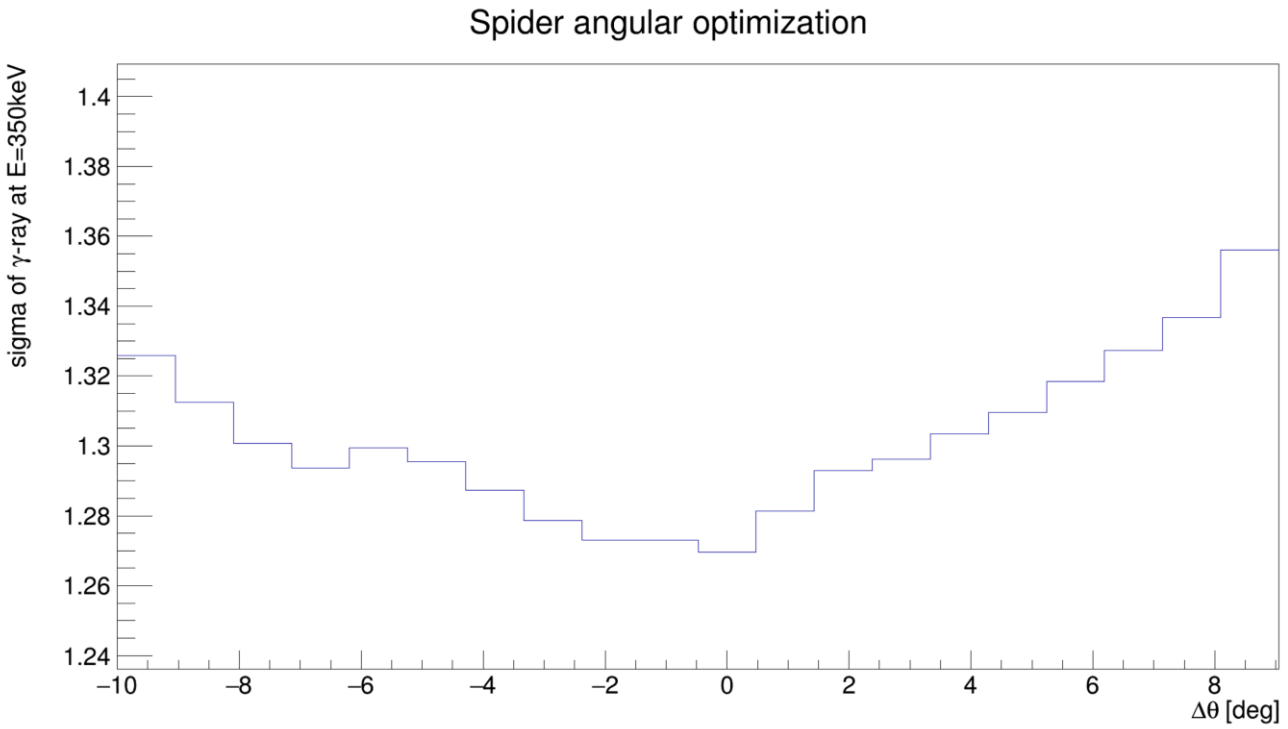


Mirco Del Fabbro PhD Thesis

Calibrations and optimizations

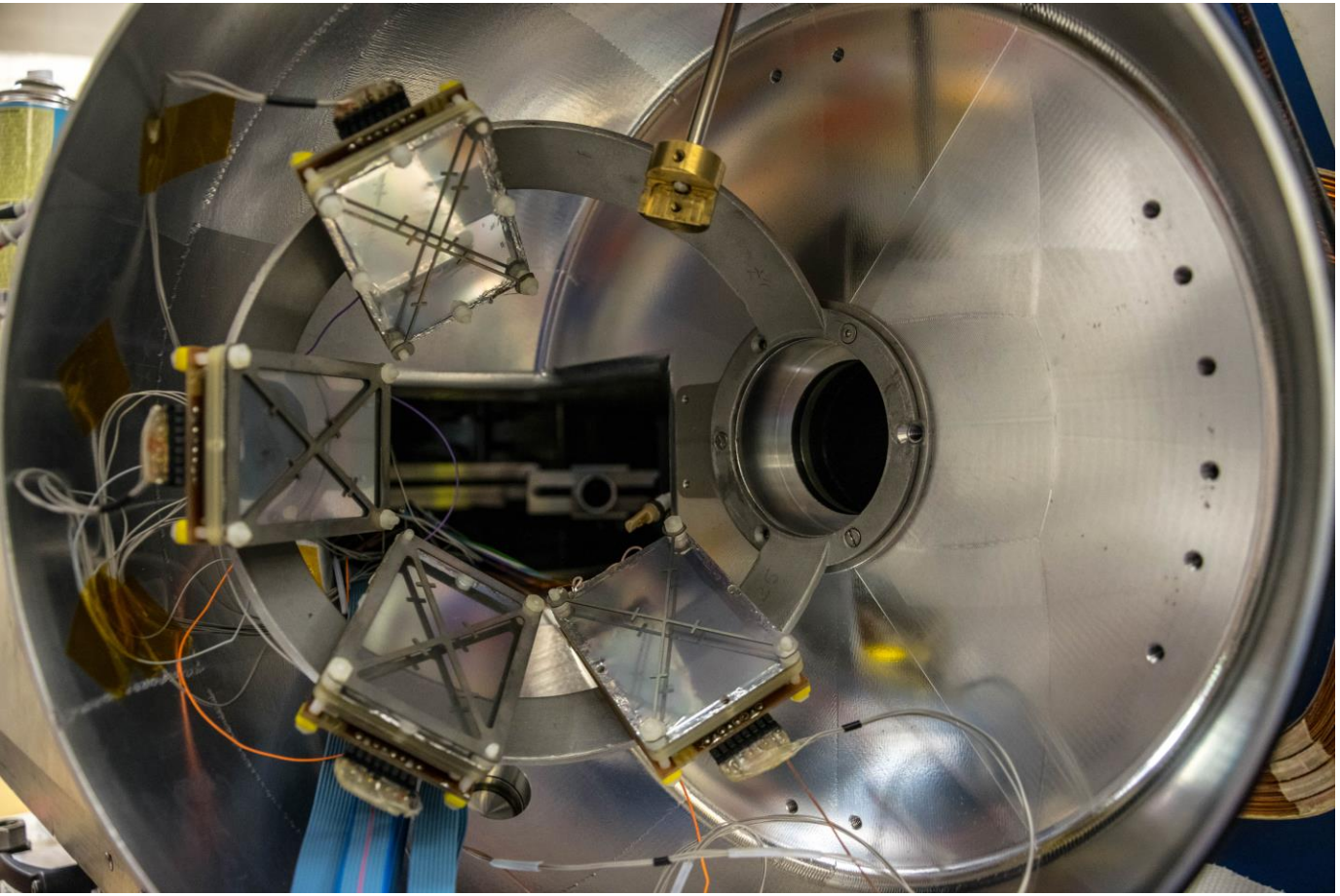
Angular calibration

- vary (θ,ϕ) position of a detector and monitor doppler correction of a selected gamma-ray



Work on automated procedures is in progress, available (hopefully) in next 1-2 months

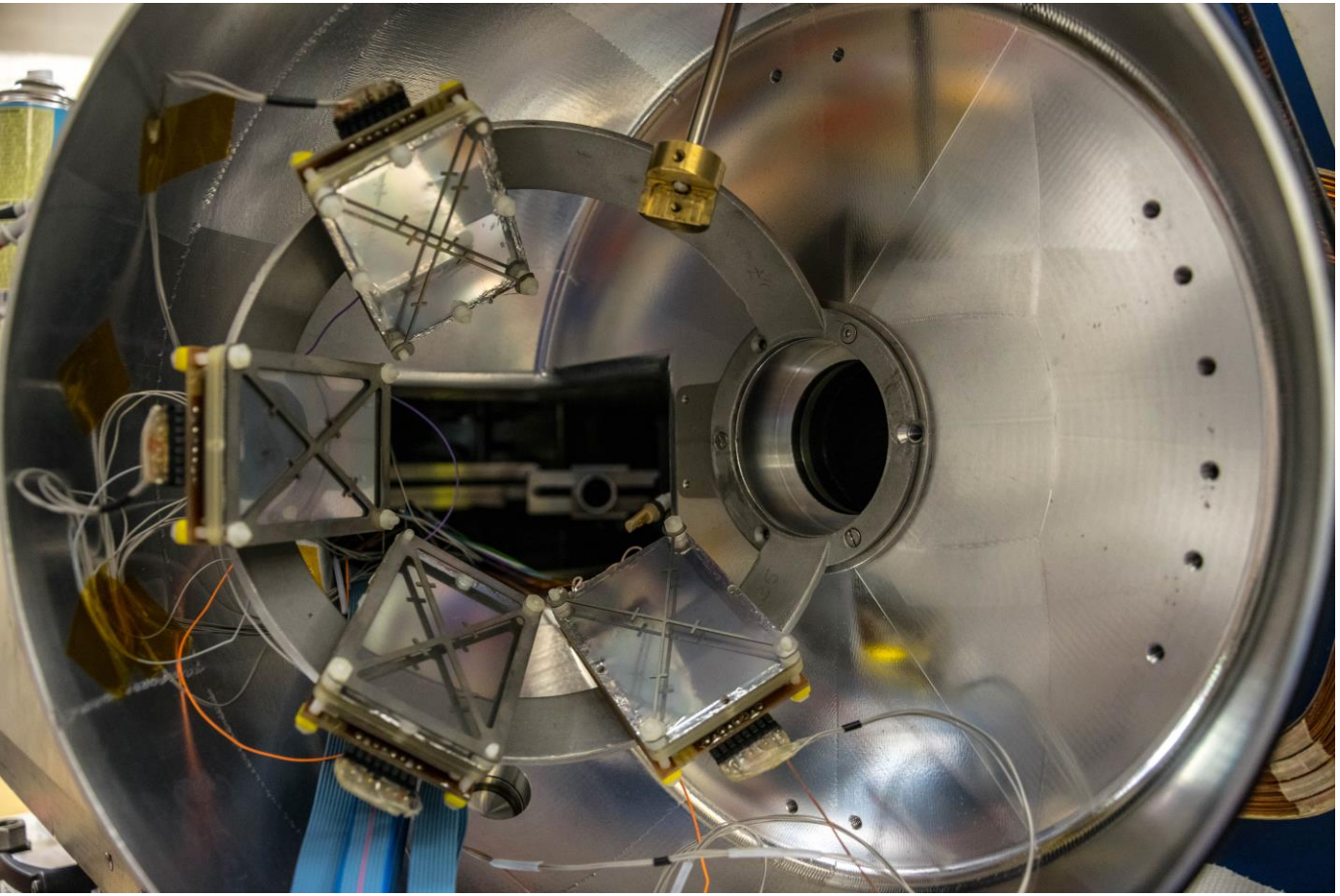
DANTE



DANTE

- MCP detectors
- size 40x60mm

DANTE



DANTE

- MCP detectors
- size 40x60mm

DANTE

Look-up table

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

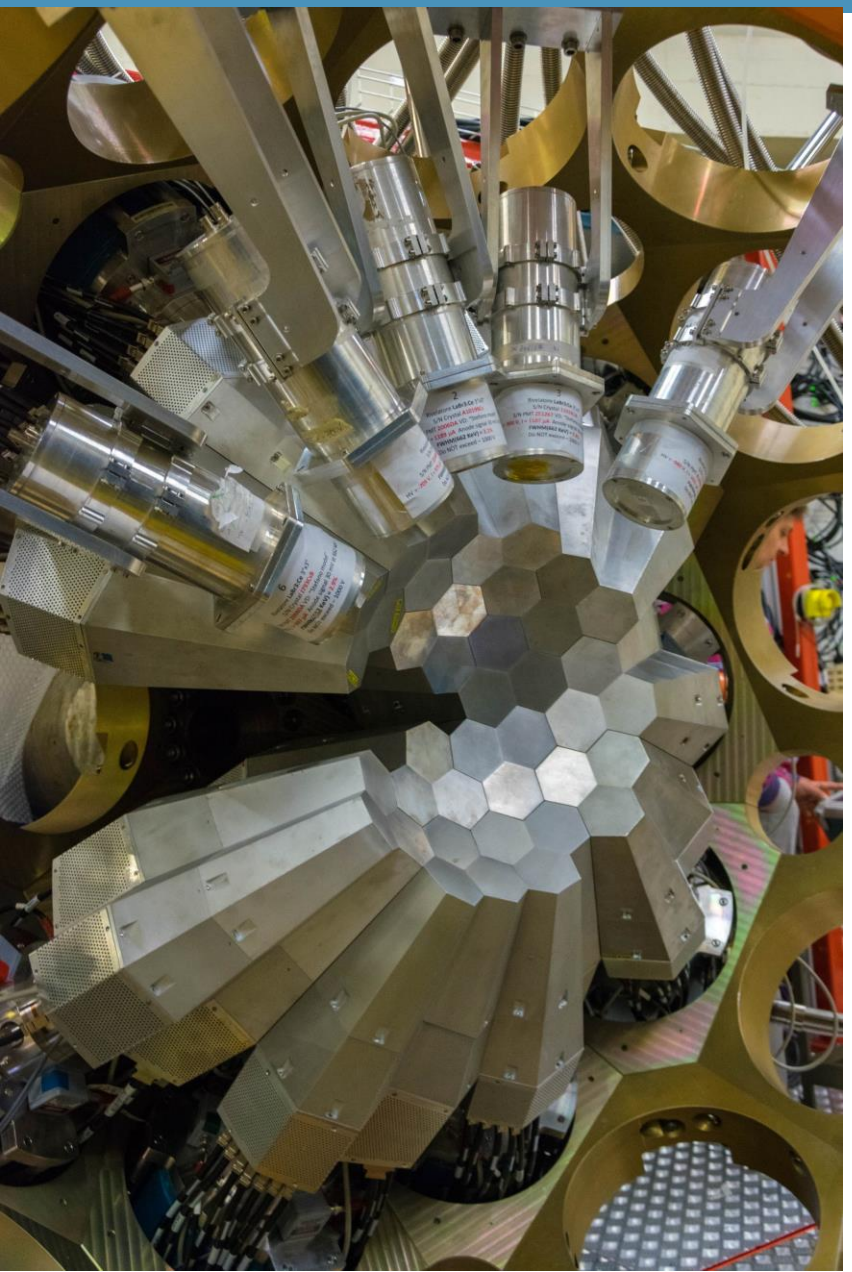
main ⌄ agataselector / User / EXP / Template / Conf / LUT / LUT_DANTE_3det_0deg.dat Find file Blame History Permalink

LUT_DANTE_3det_0deg.dat 2.75 KiB Edit ⌄

```
#               2 ┌────┐             X         Y         Z
#                 │    │    D1P1  72.8361   25.3272   23.7575
#                 │ D1 │    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)

LaBr

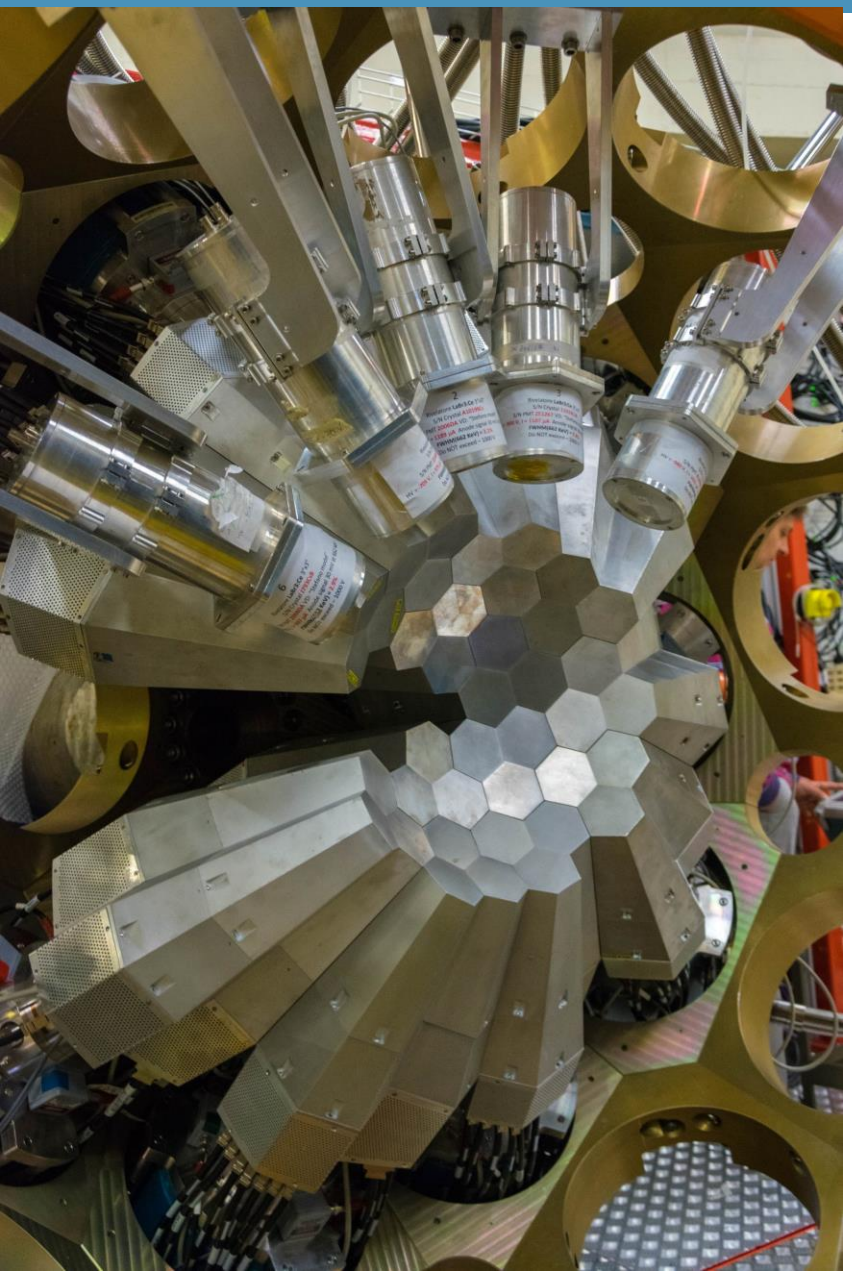


LaBr array

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

reference paper 10.1016/j.nima.2013.07.084

LaBr



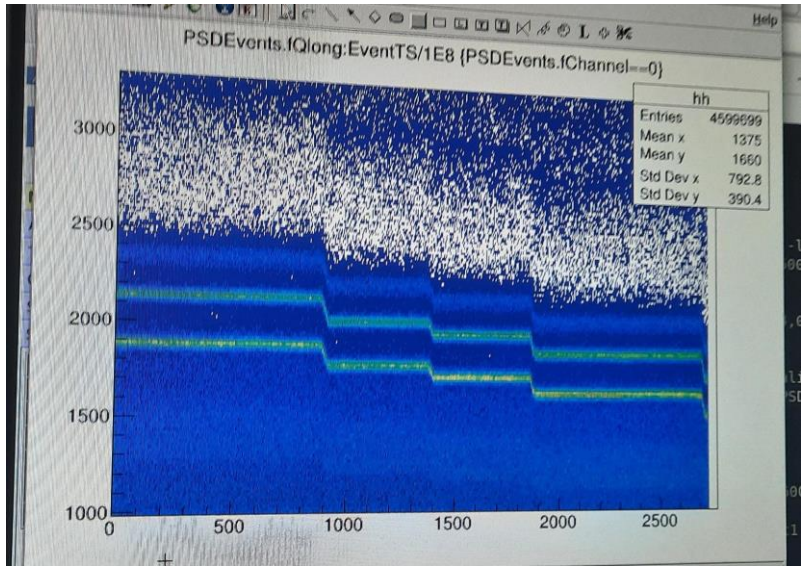
LaBr array

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

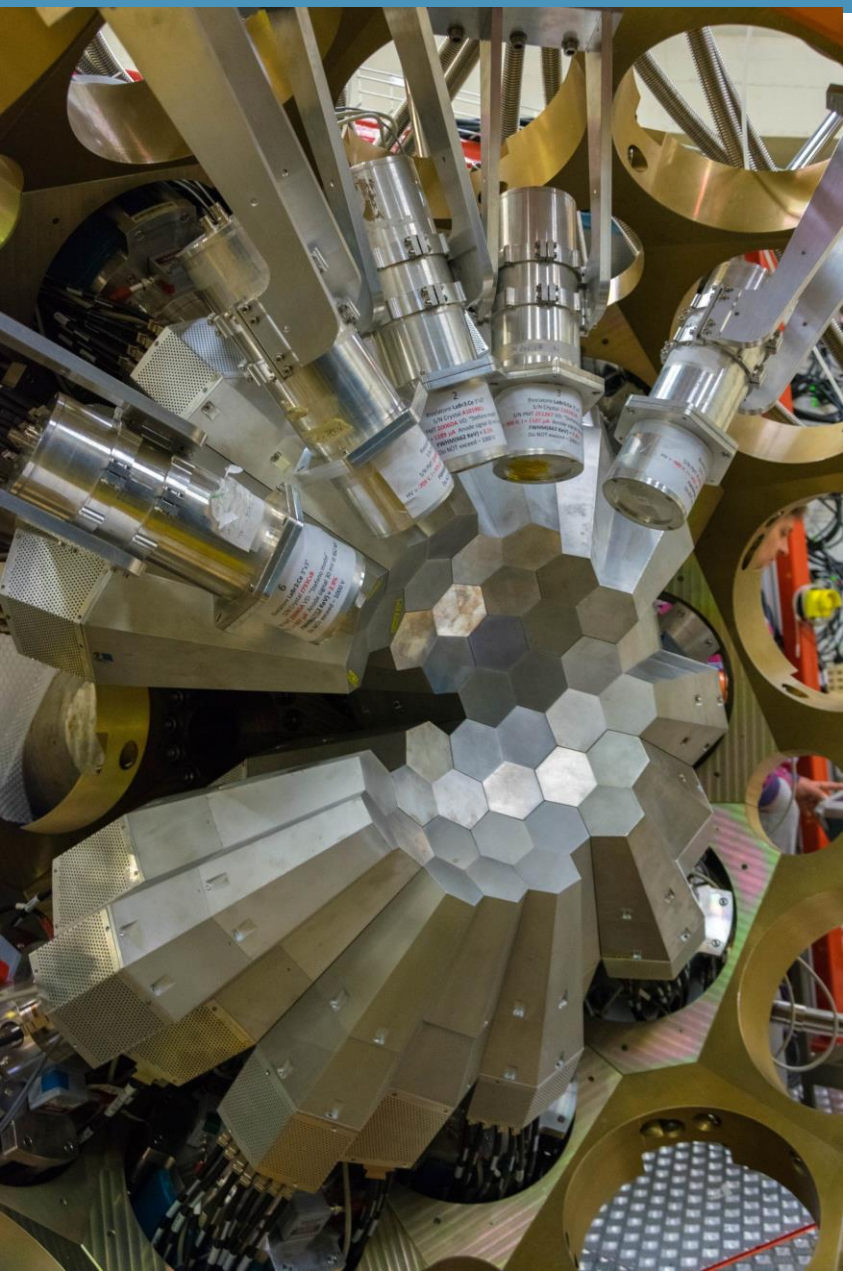
Known issues

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



LaBr

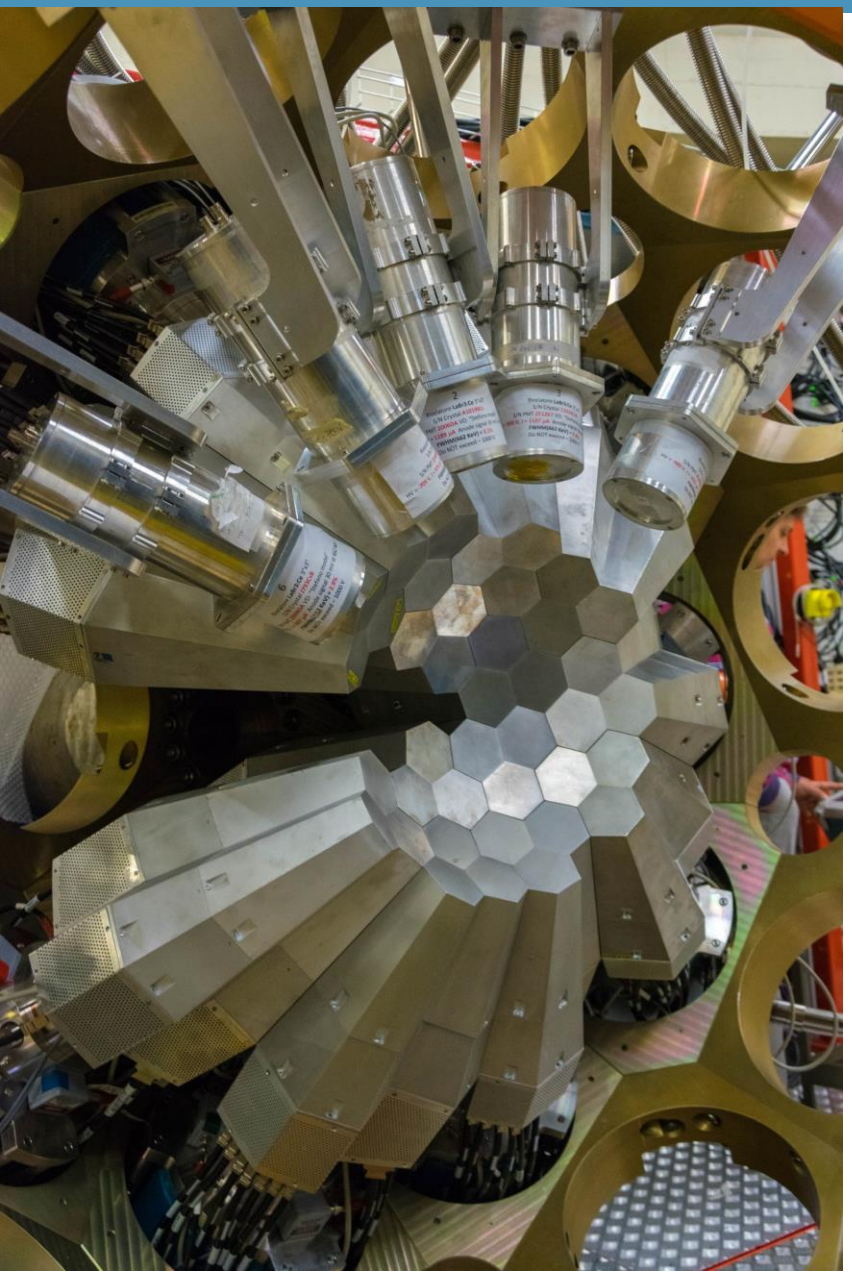


Look-up table

#board	(V1730)	channel	map	name	thr_lo	thr_hi	theta	phi	TimeOffset	npar_gl	p0_ql	p1_q2	npar_qs	p0_qs	p1_qs
1	0	0	D0	0	16000	90.422684	124.92098	0	2	-8.590549465	0.5683940043	2	-16.614035	0.584031	
1	1	1	D1	0	16000	84.308418	97.489398	0	2	4.994643769	0.441859949	2	10.570262	0.443247	
1	2	2	D2	0	16000	90.572804	73.768608	0	2	-4.882700373	0.4567364497	2	-9.782321	0.473778	
1	3	3	D3	0	16000	99.968116	51.748253	0	2	-2.68135951	0.4616749283	2	-9.040133	0.473527	
1	4	4	D4	0	16000	93.353077	26.901224	0	2	-3.368474921	0.4774816369	2	0.609657	0.481297	
1	9	9	D5	0	16000	94.007297	1.3778600	0	2	0	1	2	0	1	
1	5	5	D6	0	16000	99.883486	-28.723198	0	2	10.52197059	0.4435828877	2	18.918459	0.444711	
1	6	6	D7	0	16000	86.180070	-45.908423	0	2	12.53667474	0.4240481389	2	28.411274	0.421525	
1	7	7	D8	0	16000	91.699165	-66.505287	0	2	16.78408614	0.3897415818	2	35.049303	0.387539	
1	8	8	D9	0	16000	85.591641	-95.344627	0	2	-12.39452343	0.4289130669	2	-38.673472	0.452371	

energy calibration of qlong,
Npar, par1, … parN

LaBr



Look-up table

#board	(V1730)	channel	map	name	thr_lo	thr_hi	theta	phi	TimeOffset	npar_gl	p0_ql	p1_q2	npar_qs	p0_qs	p1_qs
1	0	0	D0	0	16000	90.422684	124.92098	0	2	-8.590549465	0.5683940043	2	-16.614035	0.584031	
1	1	1	D1	0	16000	84.308418	97.489398	0	2	4.994643769	0.441859949	2	10.570262	0.443247	
1	2	2	D2	0	16000	90.572804	73.768608	0	2	-4.882700373	0.4567364497	2	-9.782321	0.473778	
1	3	3	D3	0	16000	99.968116	51.748253	0	2	-2.68135951	0.4616749283	2	-9.040133	0.473527	
1	4	4	D4	0	16000	93.353077	26.901224	0	2	-3.368474921	0.4774816369	2	0.609657	0.481297	
1	9	9	D5	0	16000	94.007297	1.3778600	0	2	0	1	2	0	1	
1	5	5	D6	0	16000	99.883486	-28.723198	0	2	10.52197059	0.4435828877	2	18.918459	0.444711	
1	6	6	D7	0	16000	86.180070	-45.908423	0	2	12.53667474	0.4240481389	2	28.411274	0.421525	
1	7	7	D8	0	16000	91.699165	-66.505287	0	2	16.78408614	0.3897415818	2	35.049303	0.387539	
1	8	8	D9	0	16000	85.591641	-95.344627	0	2	-12.39452343	0.4289130669	2	-38.673472	0.452371	

energy calibration of qshort,
Npar, par1, … parN

Questions?

Istituto Nazionale di Fisica Nucleare
LABORATORI NAZIONALI DI LEGNARO