

How to collect data

Japan Atomic Energy Agency

Hiroyuki Makii

What is a data collection device?

→ A device that selects and records the necessary information from the signals output from the detector A device that selects and records the necessary information

In this exercise, in addition to the elastic scattering monitor installed in the target scattering tank , installed at the focus of the JAEA-RMS,

MCP detector

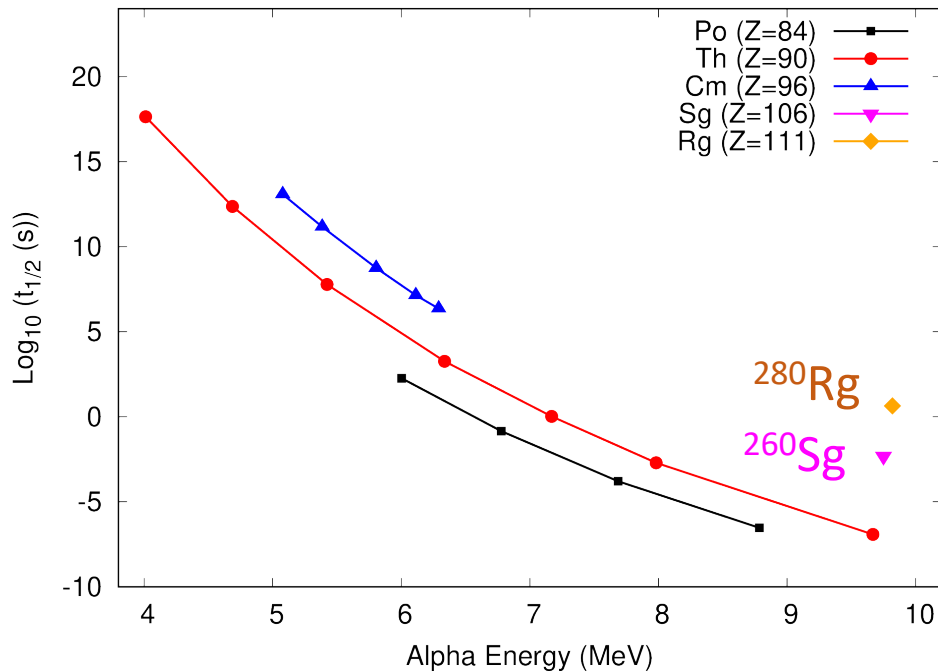
- Si Strip detector

The information necessary to identify what nuclei (isotopes) and how many of them were formed by the evaporated residual nuclei that flew by processing the analog signal from the I will record the information needed to determine what kind of nuclei (isotopes) were created by the evaporated residuals.

Let us consider what information is actually needed.

What information do you need for this exercise?

Systematics of alpha decay (from Ricardo's data)



Energy of emitted alpha particles
Elapsed time until emitted



From this information, it is possible to estimate what nuclides (isotopes) were produced in the reaction.

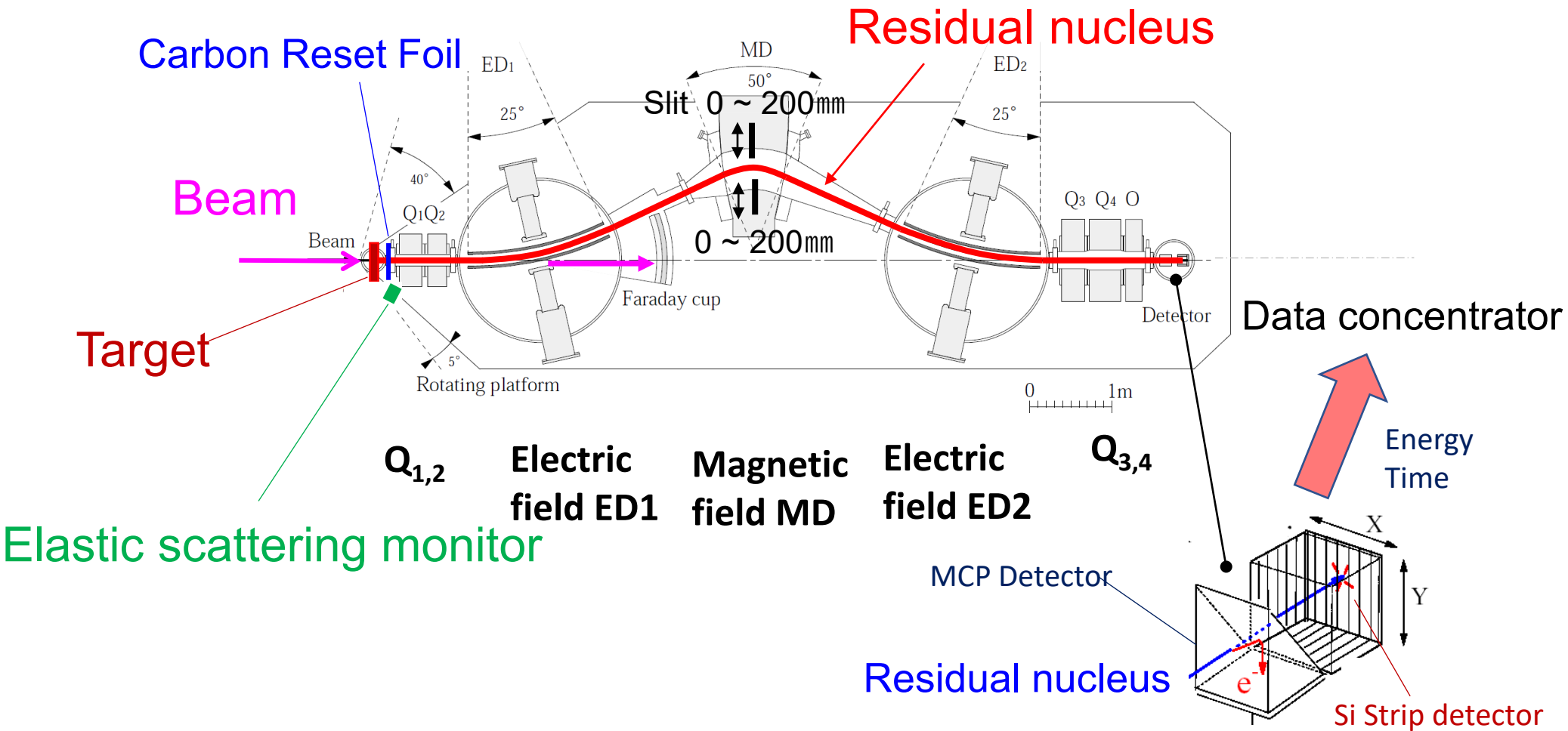


The energy and time information of the alpha particles emitted by the residual nuclei and their daughter nuclei separated by the JAEA-RMS are recorded to find out what kind and how many nuclei were produced.

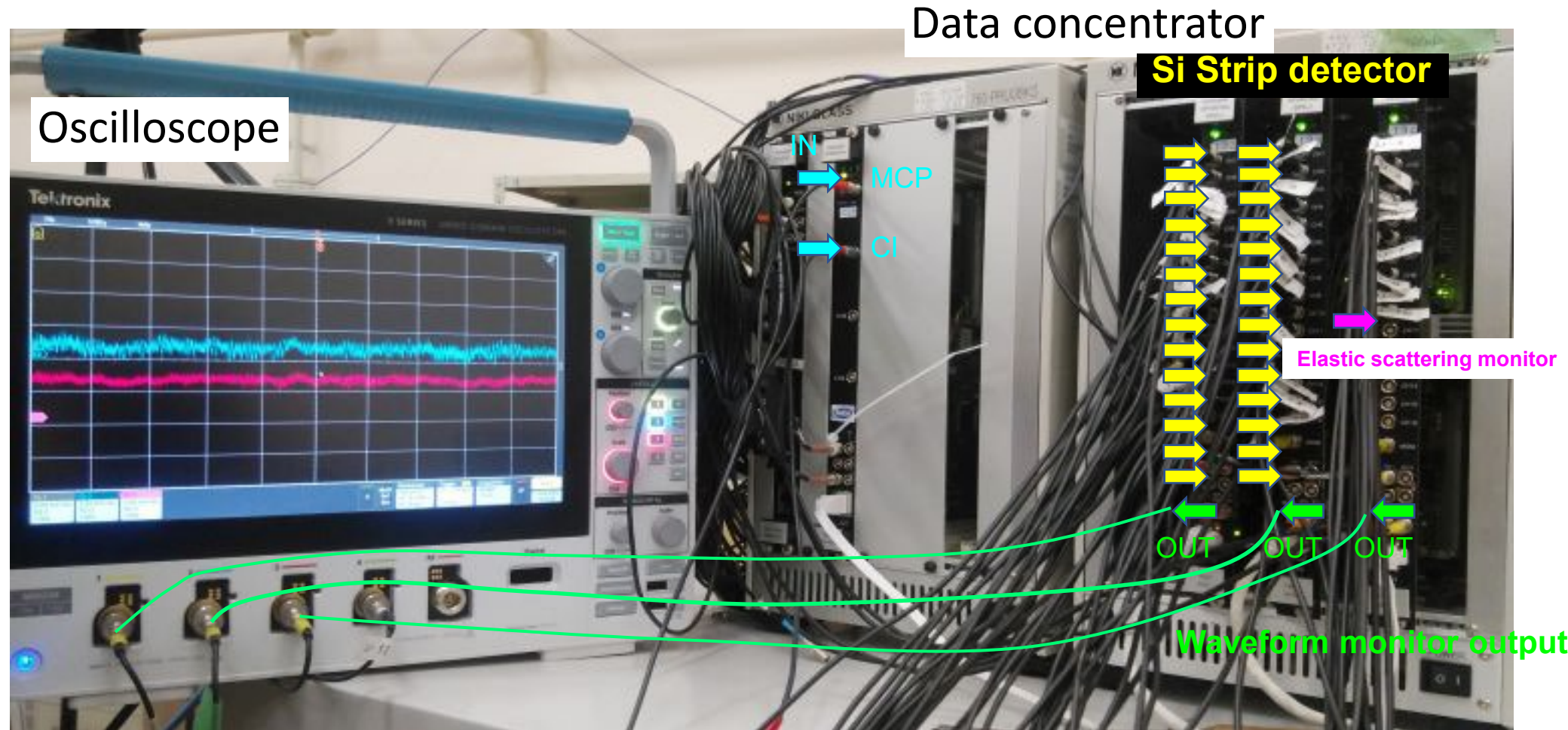
As indicated in the previous lecture, there is a correlation between the energy and half-life of the emitted α -particles, which we would like to exploit.

JAEA-RMS

Residual nuclei produced in the reaction being separated by JAEA-RMS

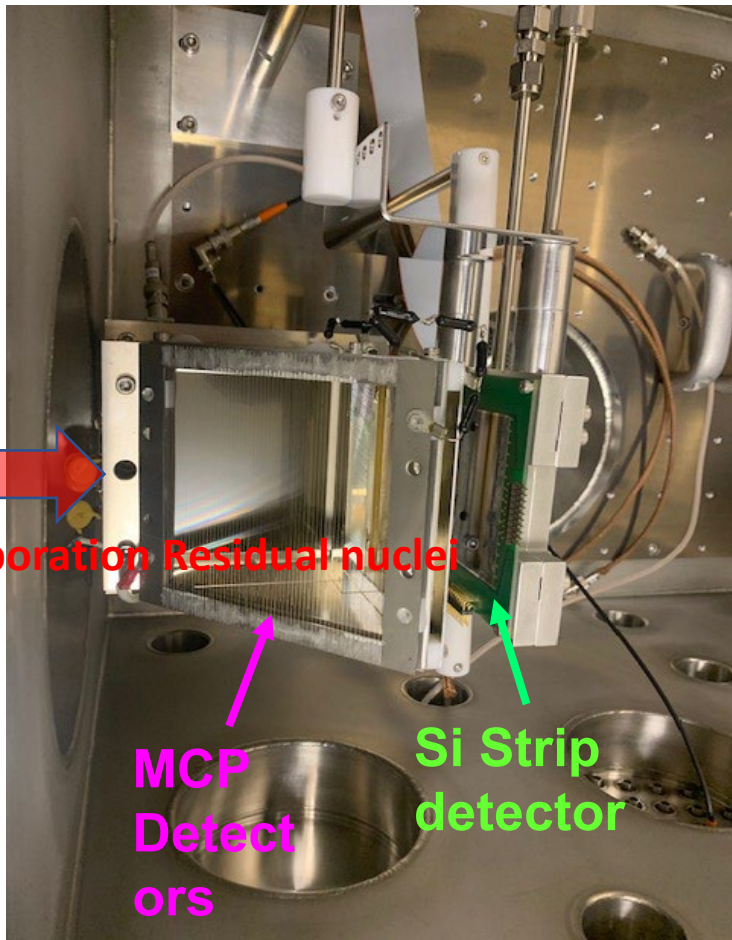


Data Acquisition Equipment - Appearance

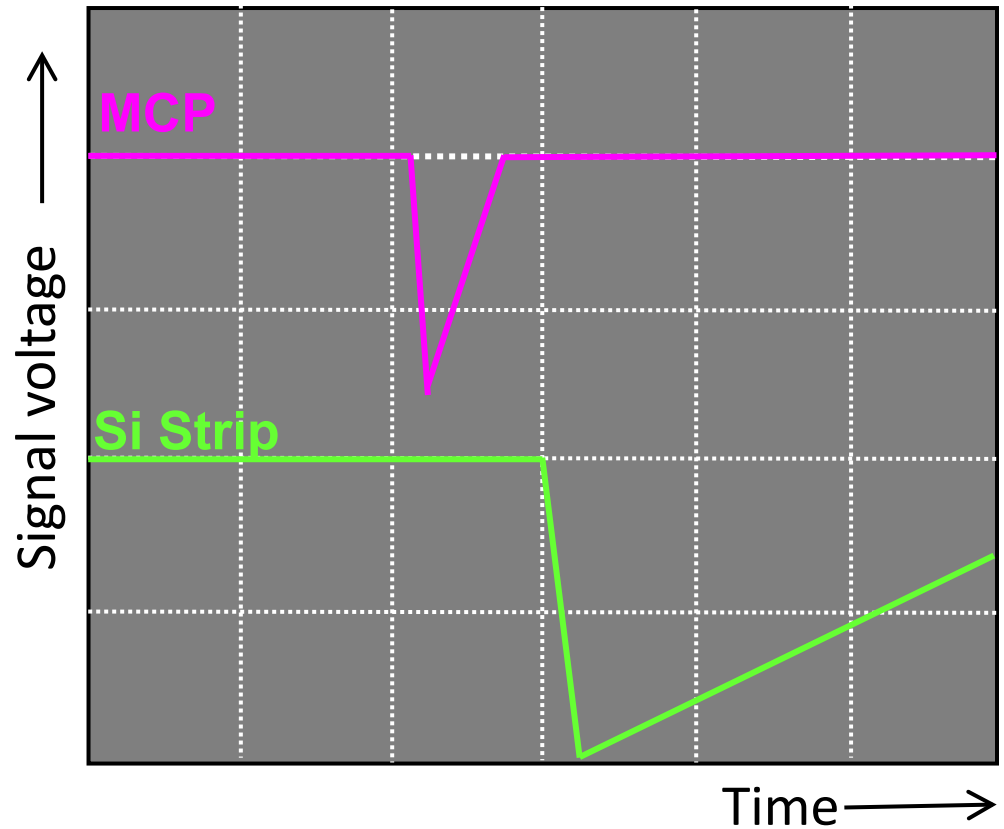


Focus Detector - "Striking Event"

MCP Detector + Si Strip detector



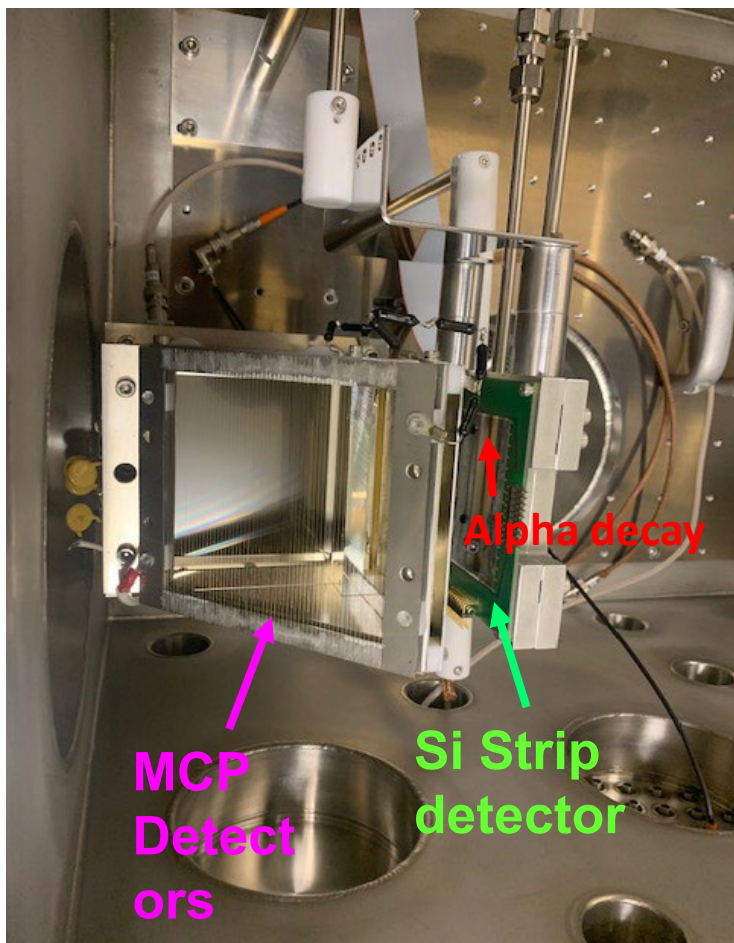
Observing the signal output with an oscilloscope...



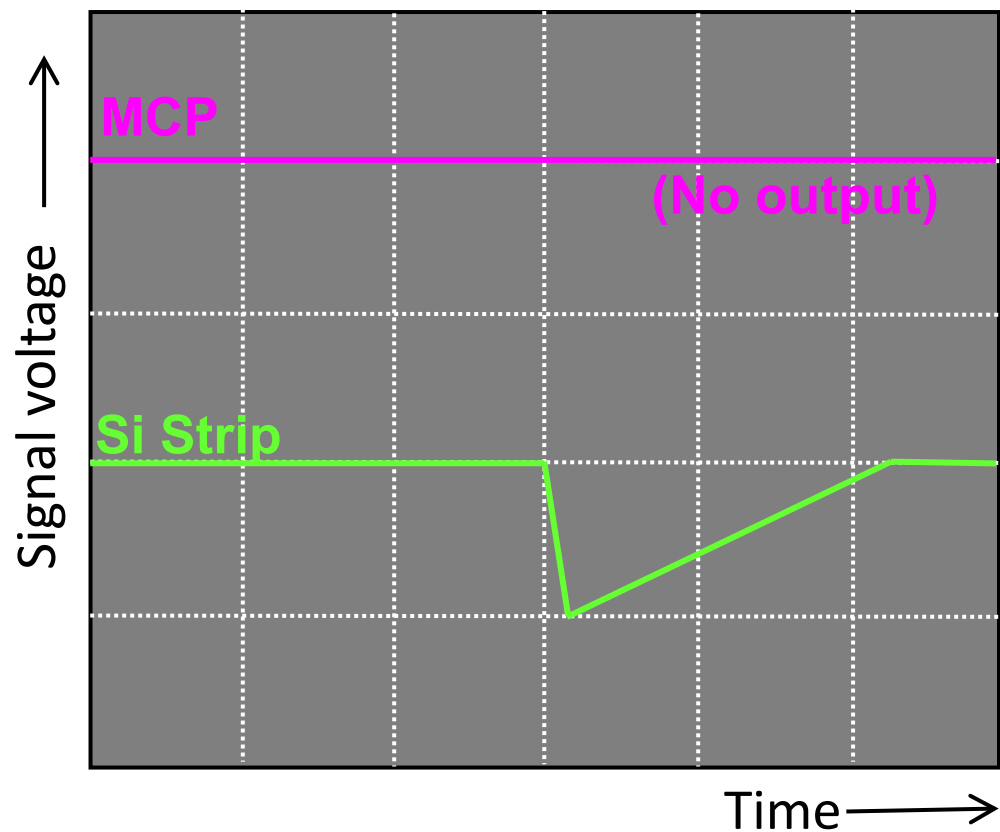
Actual waveforms may be seen at the time of measurement...

Focus Detector - "Alpha Decay Event"

MCP Detector + Si Strip detector

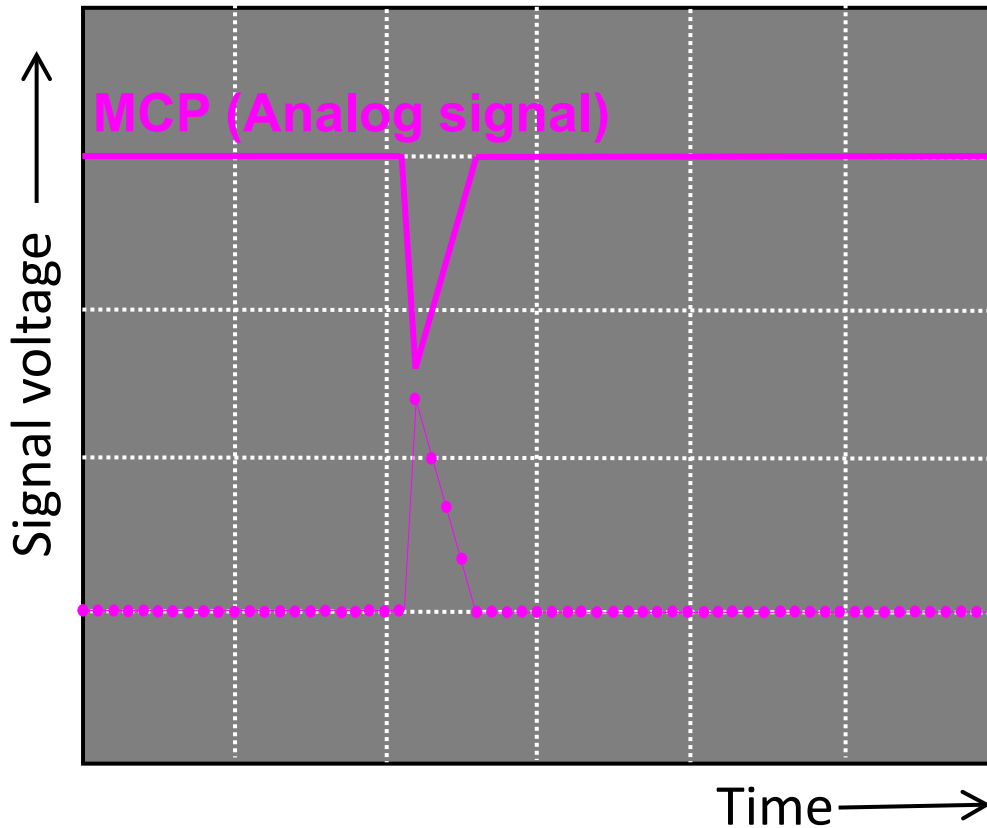


信号出力をオシロスコープで観察すると...



Data Acquisition Equipment - Signal Processing (Input)

For MCP detector (just need to know if there is a signal...)



Input analog signals, Convert to digital data



The input voltage is measured every 1 nanosecond and stored in memory.

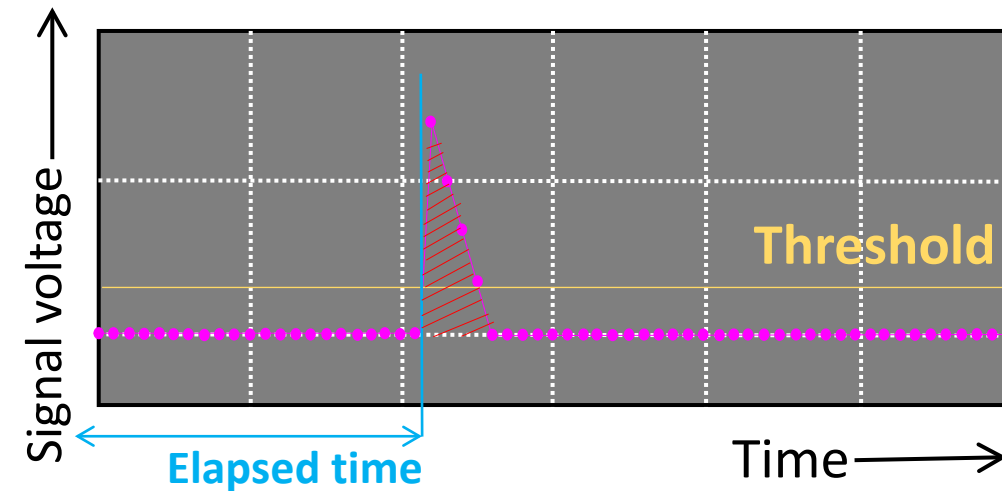
※ 1 nanosecond: one billionth of a second



Processes analog circuits in memory to simulate analog circuits.

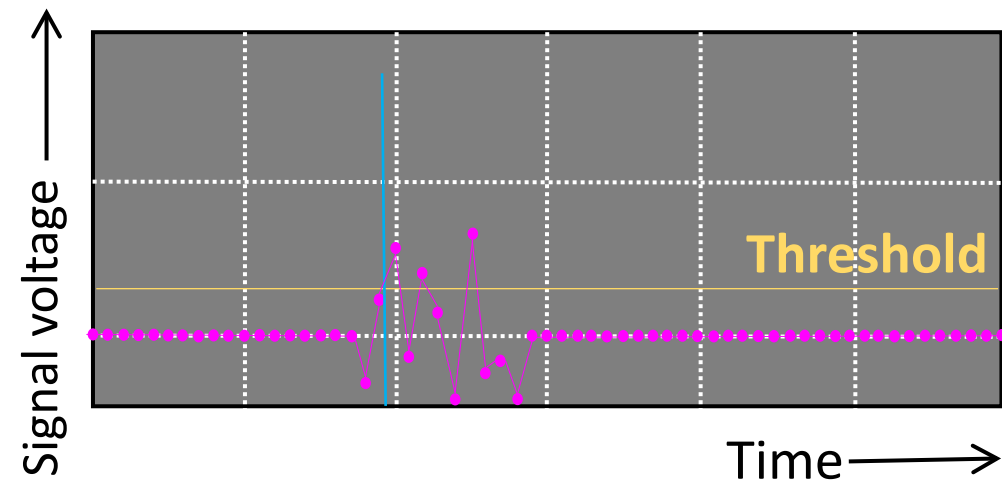
Data Acquisition Equipment - Signal Processing (Information Extraction)

For MCP detector (just need to know if there is a signal...)



Of the input whose voltage exceeds the **threshold** value is recorded

- **Elapsed time from the start of measurement (Time stamp)**
- **The area of the waveform (Energy information)** is recorded.

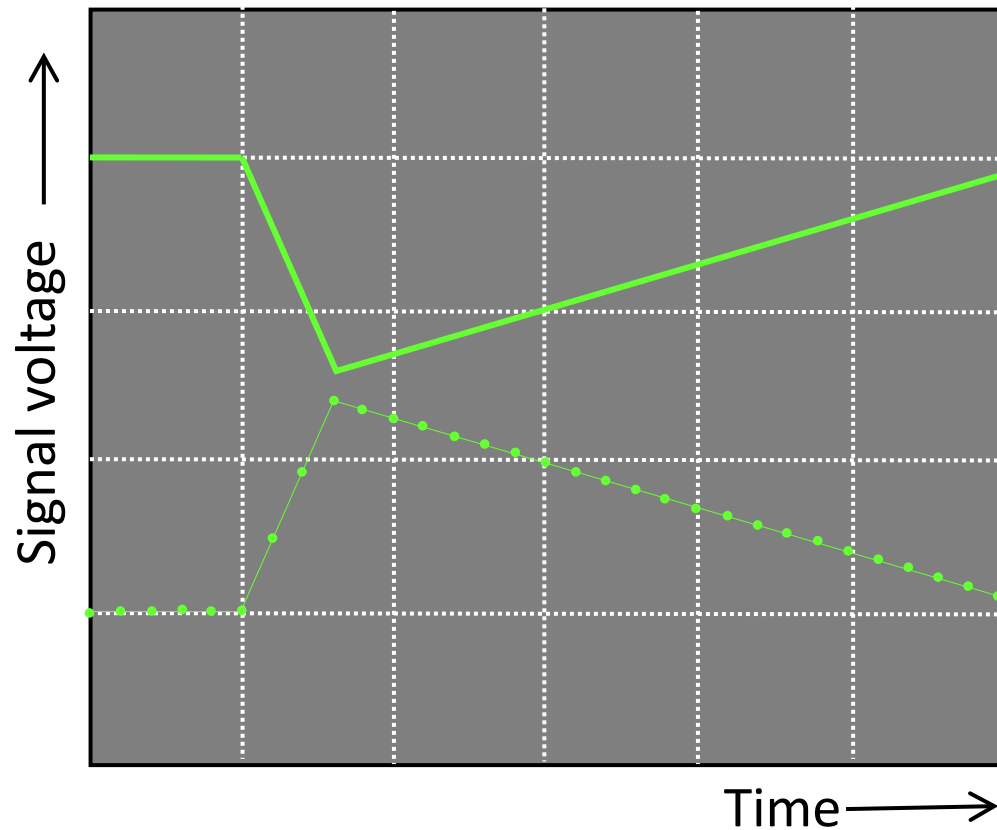


The area of the waveform is recorded to distinguish between noise and signal that cannot be removed by simply setting the threshold.

← Noise signal area is small.

Data Acquisition Equipment - Signal Processing (Input)

Si Strip detector - I want to obtain energy information with high accuracy.



To improve energy accuracy, the signal decay time is increased.



Inputs analog signals and converts them to digital data



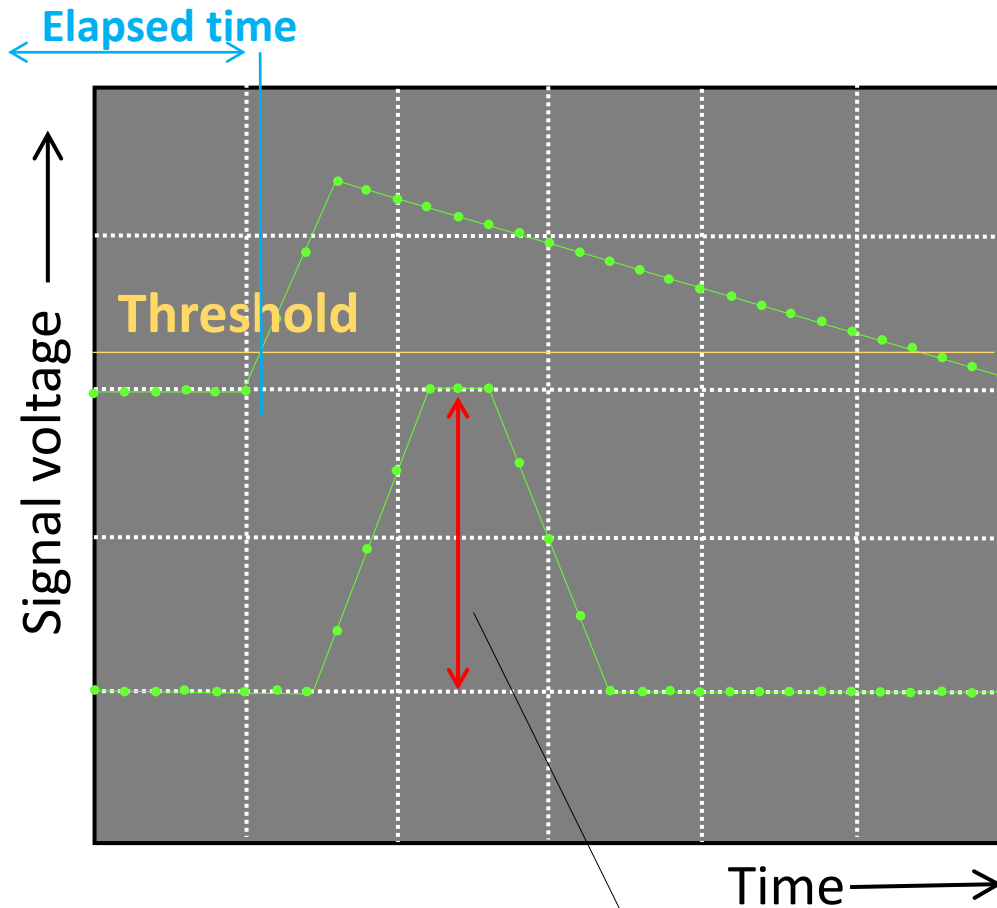
The input voltage is measured every **10** nanoseconds and stored in memory.



Signal processing in memory

Data Acquisition Equipment - Signal Processing (Signal Processing)

Si Strip detector - I want to obtain energy information with high accuracy.



To improve energy accuracy, the signal decay time is increased.

Since signal processing is time-consuming as it is, it is converted to pseudo-triangular waveform pulses.

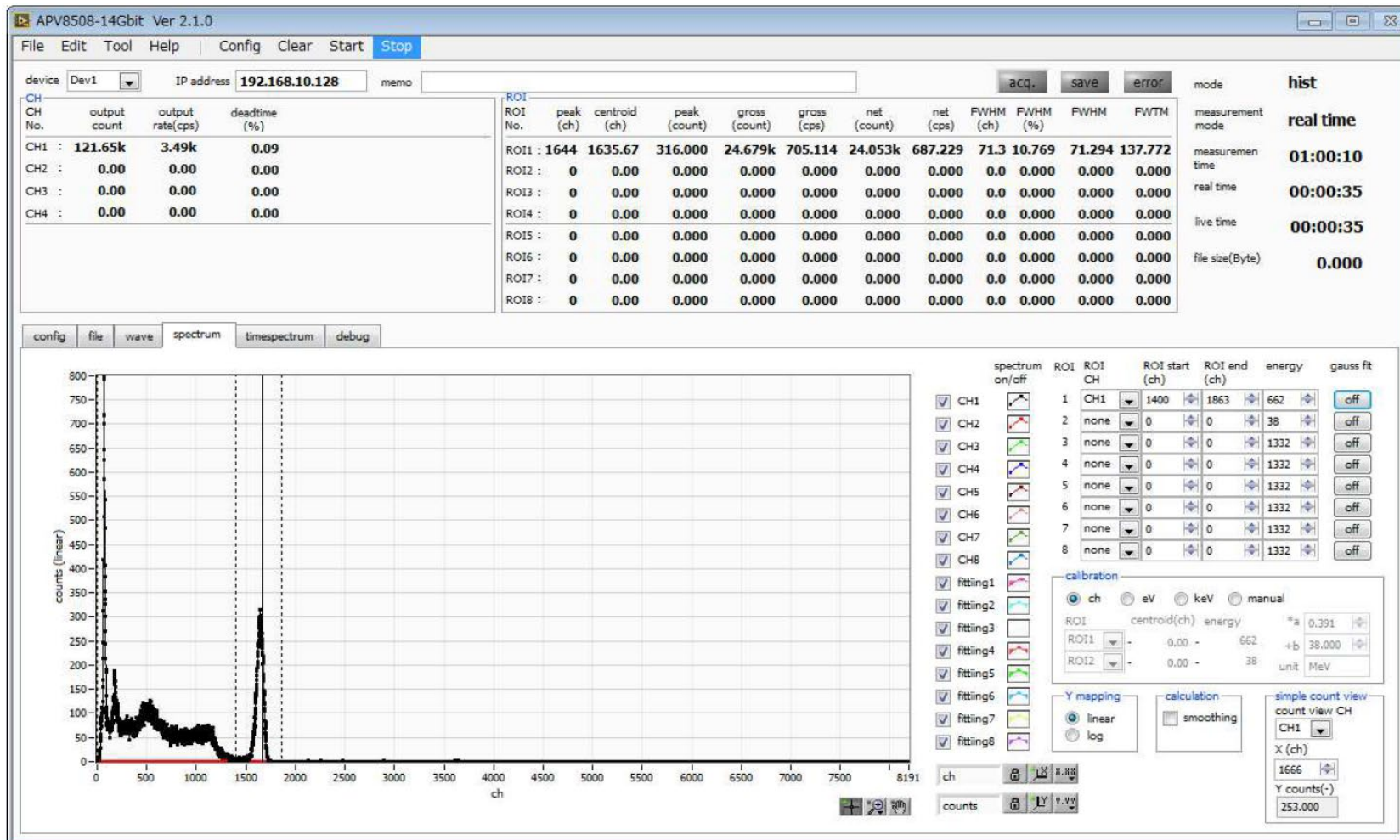


Energy information is recorded from the height of the triangular waveform together with the acquisition **time stamp**.

Height of triangular waveform is proportional to energy

Data Acquisition Equipment - Software

For MCP detector (for specific use, etc., in actual measurement.)



Data Acquisition Equipment - Software

For Si strip detector (for specific use, etc., in actual measurement.)

The screenshot displays the DSP MCA APV8016A software interface. At the top, the menu bar includes File, Edit, Config, Clear, Start, and Stop. Below the menu, the module is set to DSP1, IP address is 192.168.10.130, and memo is Test. The measurement mode is 'list', measurement time is 01:00:02, measurement mode is 'real time', real time is 00:00:38, and list file size is 1.32M. The interface is divided into several sections:

- CH config status:** A table showing configuration for 16 channels (CH1 to CH16). The table has columns for ON, analog coarse gain, ADC gain, timing (fast diff, fast integral, fast pole zero, fast trigger threshold), energy (slow risetime, slow flat top time, slow pole zero, slow trigger threshold), LLD, ULD, pile up rejector, polarity, digital coarse gain, digital fine gain, timing select, CFD function, CFD delay, inhibit width, analog pole zero, and DAC monitor CH.
- ROI Table:** A table showing ROI settings for each channel. The columns are CH, ROI, ROI start (keV), ROI end (keV), and energy (keV).
- Histogram Plot:** A plot showing counts (near) on the y-axis and keV on the x-axis. The x-axis ranges from 0 to 8192 keV. Two vertical dashed lines are visible at approximately 1224 keV and 1653 keV.

CH	ROI	ROI start (keV)	ROI end (keV)	energy (keV)
CH1	1	1224	1653	662
CH2	2	none	9900	5895
CH3	3	none	9260	5895
CH4	4	none	1173	662
CH5	5	none	9160	662
CH6	6	none	1173	662
CH7	7	none	1173	662
CH8	8	none	1173	662
CH9	9	none	1173	662
CH10	10	none	1173	662
CH11	11	none	1173	662
CH12	12	none	1173	662
CH13	13	none	1173	662
CH14	14	none	1173	662
CH15	15	none	1173	662
CH16	16	none	1000	662

Data Acquisition Equipment - Software

At the time of measurement

The screenshot displays two software windows on a Windows desktop. The top window is 'APP8000N Control Software Version 1.0.0', which shows a table of ROI data for 8 channels (CH1-CH8). The bottom window is 'DSP MCA APV8016A v1.2.2', which shows a histogram measurement mode with a real time of 00:01:37 and a list size of 0.00 bytes.

APP8000N Control Software ROI Data:

ROI No.	peak (ch)	centroid (ch)	peak (count)	gross (count)	gross (cps)	net (count)	net (cps)	PWHM (ch)	PWHM (%)	PWHM	PVTM
ROI1	3862	3862.00	1.000	1.000	10.204m	1.000	10.204m	1.0	0.151	1.000	500.000
ROI2	0	0.00	0.000	0.000	0.000	0.000	0.000	0.0	0.000	0.000	0.000
ROI3	0	0.00	0.000	0.000	0.000	0.000	0.000	0.0	0.000	0.000	0.000
ROI4	0	0.00	0.000	0.000	0.000	0.000	0.000	0.0	0.000	0.000	0.000
ROI5	0	0.00	0.000	0.000	0.000	0.000	0.000	0.0	0.000	0.000	0.000
ROI6	0	0.00	0.000	0.000	0.000	0.000	0.000	0.0	0.000	0.000	0.000
ROI7	0	0.00	0.000	0.000	0.000	0.000	0.000	0.0	0.000	0.000	0.000
ROI8	0	0.00	0.000	0.000	0.000	0.000	0.000	0.0	0.000	0.000	0.000

DSP MCA APV8016A v1.2.2 Measurement Data:

module	DSP1	IP address	192.168.10.132	memo	Test	mode	histogram	measurement time	100:00:00	measurement mode	real time	real time	00:01:37	list file size	0.00							
CH	config	status																				
DSP	OPTION																					
CH1	ON	x2	8192	100	20	150	25	6000	500	520	200	20	8192	OFF	pos	x8	0.5645	CFD	0.25	40	7	255
CH2	ON	x2	8192	100	20	150	25	6000	500	520	200	20	8192	OFF	pos	x8	0.4425	CFD	0.25	40	7	255
CH3	ON	x2	8192	100	20	150	25	6000	500	520	200	20	8192	OFF	pos	x8	0.4375	CFD	0.25	40	7	255
CH4	ON	x2	8192	100	20	150	25	6000	500	520	200	20	8192	OFF	pos	x8	0.4475	CFD	0.25	40	7	255
CH5	ON	x2	8192	100	20	150	25	6000	500	520	200	20	8192	OFF	pos	x8	0.4440	CFD	0.25	40	7	255
CH6	ON	x2	8192	100	20	150	25	6000	500	520	200	20	8192	OFF	pos	x8	0.4354	CFD	0.25	40	7	255
CH7	ON	x2	8192	100	20	150	25	6000	500	520	200	20	8192	OFF	pos	x8	0.4390	CFD	0.25	40	7	255
CH8	ON	x2	8192	100	20	150	25	6000	500	520	200	20	8192	OFF	pos	x8	0.4425	CFD	0.25	40	7	255
CH9	ON	x2	8192	100	20	150	25	6000	500	520	200	20	8192	OFF	pos	x8	0.4590	CFD	0.25	40	7	255
CH10	ON	x2	8192	100	20	150	25	6000	500	520	200	20	8192	OFF	pos	x8	0.4440	CFD	0.25	40	7	255
CH11	ON	x2	8192	100	20	150	25	6000	500	520	200	20	8192	OFF	pos	x8	0.4430	CFD	0.25	40	7	255
CH12	ON	x2	8192	100	20	150	25	6000	500	520	200	20	8192	OFF	pos	x8	0.4425	CFD	0.25	40	7	255
CH13	ON	x2	8192	100	20	150	25	6000	500	520	200	20	8192	OFF	pos	x8	0.4465	CFD	0.25	40	7	255
CH14	ON	x2	8192	100	20	150	25	6000	500	520	200	20	8192	OFF	pos	x8	0.4455	CFD	0.25	40	7	255
CH15	ON	x2	8192	100	20	150	25	6000	500	520	200	20	8192	OFF	pos	x8	0.4410	CFD	0.25	40	7	255
CH16	ON	x2	8192	100	20	150	25	6000	500	520	200	20	8192	OFF	pos	x8	0.4390	CFD	0.25	40	7	255

Data Acquisition Equipment - Examples of data to be acquired

Record energy and time stamps for each detector

Have the PC record the list data including information on which detector it is.

Data is expressed in binary numbers (one event is 80 binary digits)

80 bits per event (10Byte, 5WORD)

79	Time stamp (3)	ABS[47..32]	64
63	Time stamp (2)	ABS[31..16]	48
47	Time stamp (integer part 1)	ABS[15..0]	32
31	Time stamp (decimal portion)	ABS_FP[7..0]	16
15		EMPTY[0] UNIT[2..0] CH[3..0]	8
	WAV[0] [0]	PHA[13..0]	Energy information (14 digits)

Detector No. (4 digits)

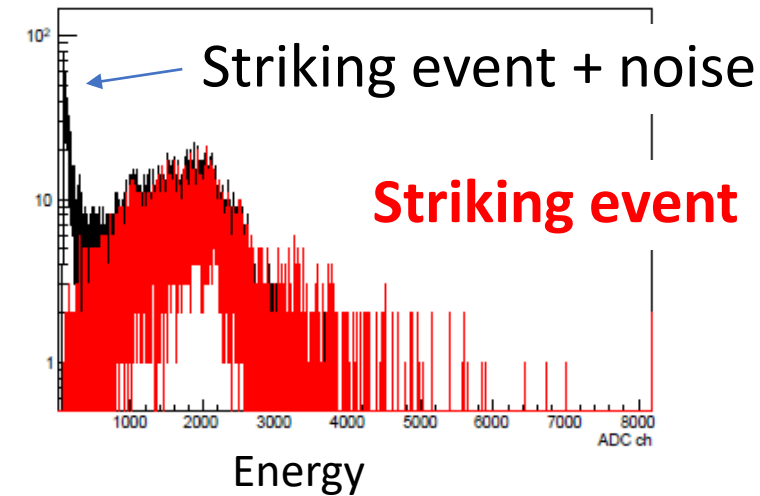
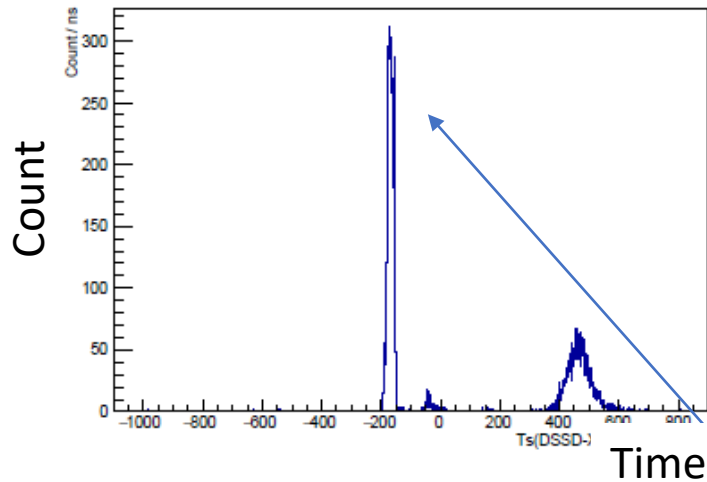
Board number (3 digits)

48 digits in total

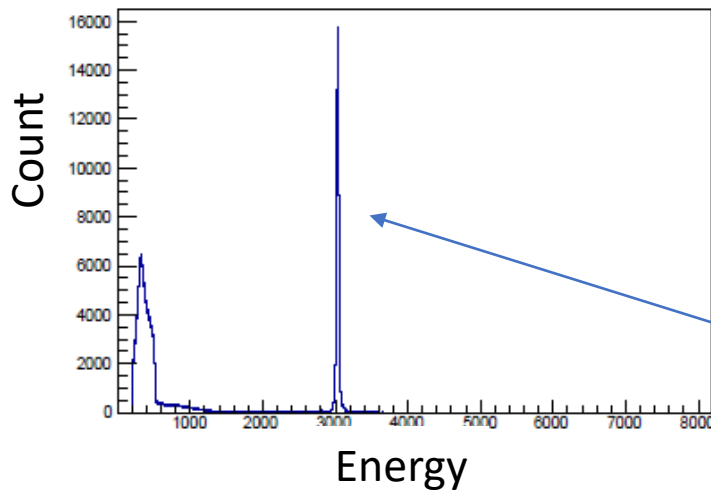
(Reading the list data is difficult, so I will omit it this time...)

Data Collection Equipment - Examples of Information Obtained

Time difference between MCP and strip detector Wave Height Distribution of MCP



Wave height distribution of elastic scattering monitor



⊗ Sharp peaks strike event

Sharp peaks are elastic scattering events

Data Collection Equipment - Examples of Information Obtained

We will give you the information obtained by organizing the list data.

	A	B	C	D	E
1	TimeStamp(ns)	Mod	Ch	Adc	
2	-5394778686.56	1	9	4067	
3	180442687.66	1	9	3305	
4					
5	-5983555329.26	1	9	4216	Evaporation Residual Nucleus Launch (Next event)
6	95841212.50	1	9	3600	
7					Evaporation Residual Nucleus Launch (Next event)
8	-13918182010.08	1	9	3722	
9	142534564.14	1	9	3706	
10					
11	-15044722119.02	1	9	460	Energy Information (Digital value)
12	268347222.73	1	9	3479	
13					
14	-15522956964.26	1	9	3592	
15	420321848.48	1	9	3716	

Striking event (5.4 seconds after the start of measurement)

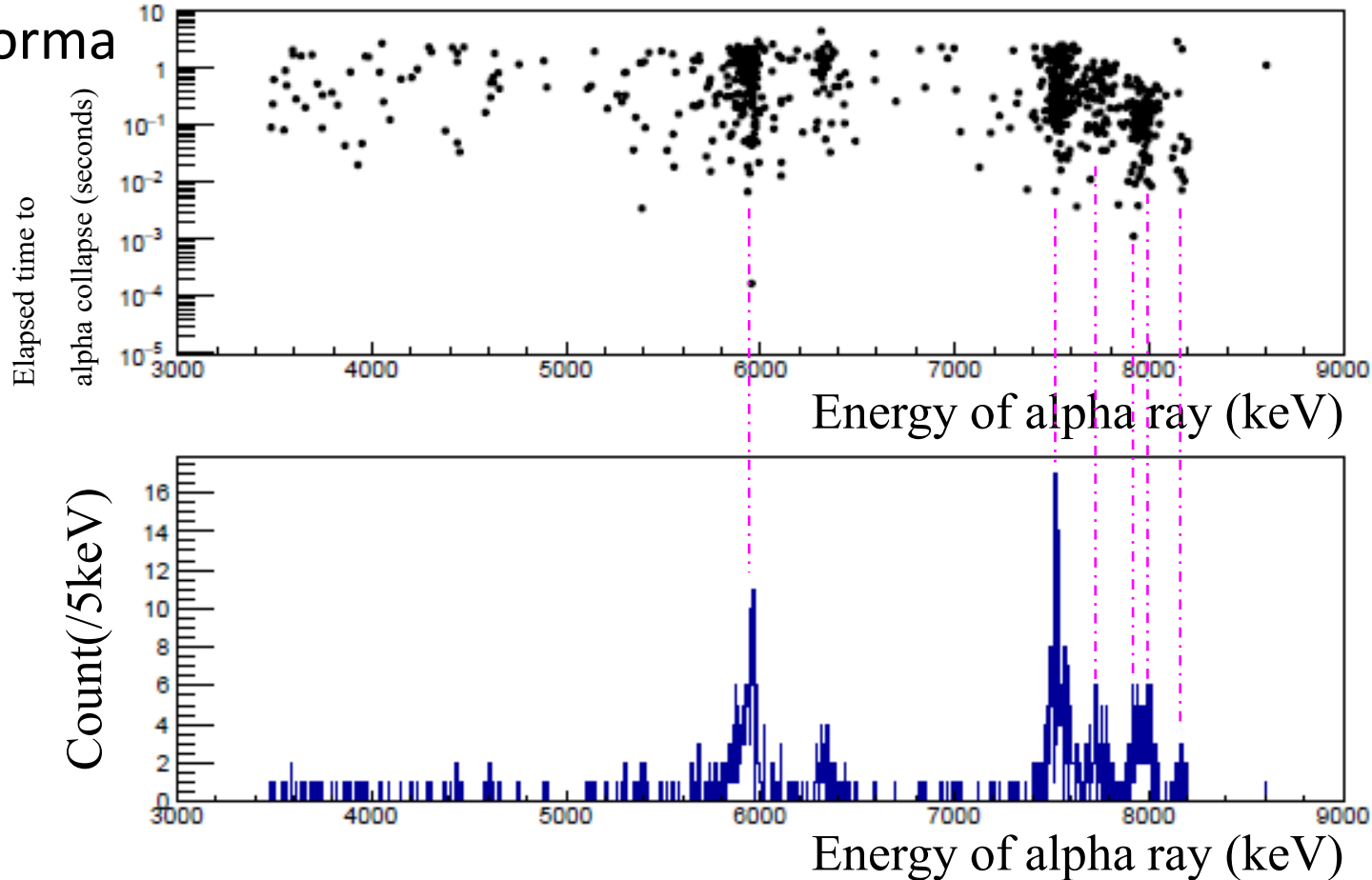
Time until alpha particles are emitted (ns)

Strip No.

The strip detector is always 1.

Data Acquisition Equipment - Example of Data Analysis

A good organization of the data you have given us will provide the following information



Let's count how many nuclei of any kind were made in the actual measurement.