

氫硼核融合實作

Practical course on proton-boron nuclear fusion



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2025 summer break

7/14(Mon.) – 7/18(Fri.) 14:00-17:40

Lecture 4

<https://capst.ncku.edu.tw/PGS/index.php/teaching/>

Final presentation



On Friday, 5 mins presentation for each person (20 %):

1. How did you analyze the data.
2. The histogram table.
3. The histogram plot.
4. Provide the histogram table in excel.

Final writing report (20 %):

1. 實驗設備之原理。
2. 數據分析原理說明。
3. 數據分析結果。
4. 討論。

若週四實驗課缺課，則報告為0分。

- From the histogram plot and table:
 - If energy loss of the proton generated from the DD fusion is neglected, what is the energy of T and ${}^3\text{He}$?
 - What's the peak energy of alphas from p-B fusion?

Final presentation



- Every student will analyze one set of p-B fusion data and D-D fusion data.
 - The data set is assigned to each student.
 - Data needs to be converted from psdata format to csv format.
 - Analyze the data. A excel file and a figure is generated.
 - Generate the histogram plot and table.
 - p-B fusion: 0~20, each bin has a width of 0.4, i.e., 50 bins.
 - DD fusion: 0~6, each bin has a width of 0.01, i.e., 600 bins.
- The analyzing program is provided. Student can pick either the matlab code or the python code to analyze the data.

Provided programs

- The analyzing program is provided. Student can pick either the matlab code or the python code to analyze the data.
- The converting program “PicoScope_7_TandM_7.1.50.5777.exe” is provided.
- Table of assigned data set:

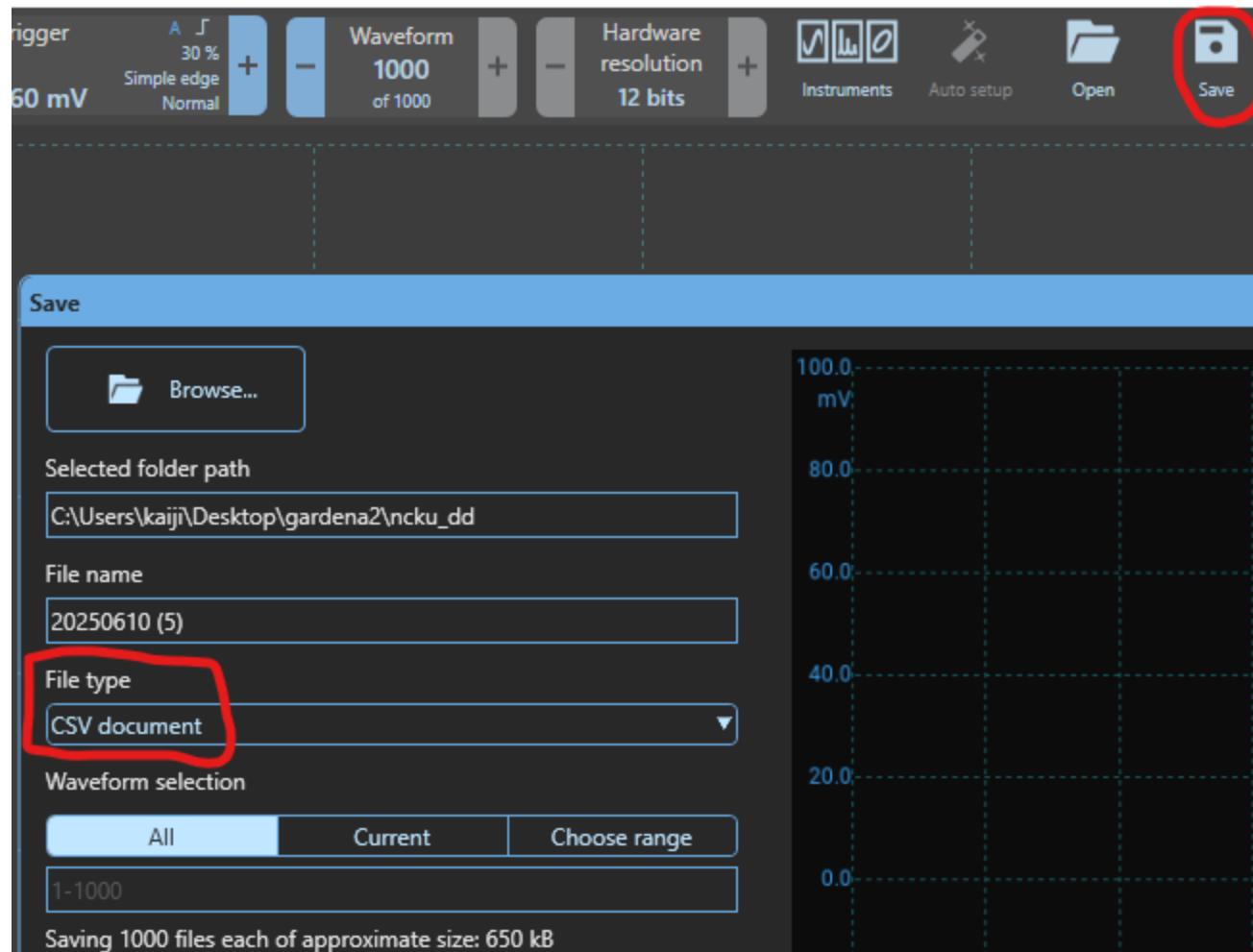
Students	p-B fusion	D-D fusion
陳崇文	75keV_30Hz_5pct(20)	20250610(20)
許哲瑜	75keV_30Hz_5pct(21)	20250610(21)
許源凱	75keV_30Hz_5pct(22)	20250610(22)
劉于華	75keV_30Hz_5pct(23)	20250610(23)
黃雅筠	75keV_30Hz_5pct(24)	20250610(24)
盧宣嘉	75keV_30Hz_5pct(25)	20250610(25)
廖奕涵	75keV_30Hz_5pct(26)	20250610(26)
關運澤	75keV_30Hz_5pct(27)	20250610(27)
葉柏廷	75keV_30Hz_5pct(28)	20250610(28)
賴資佳	75keV_30Hz_5pct(29)	20250610(29)
李政穎	75keV_30Hz_5pct(30)	20250610(30)



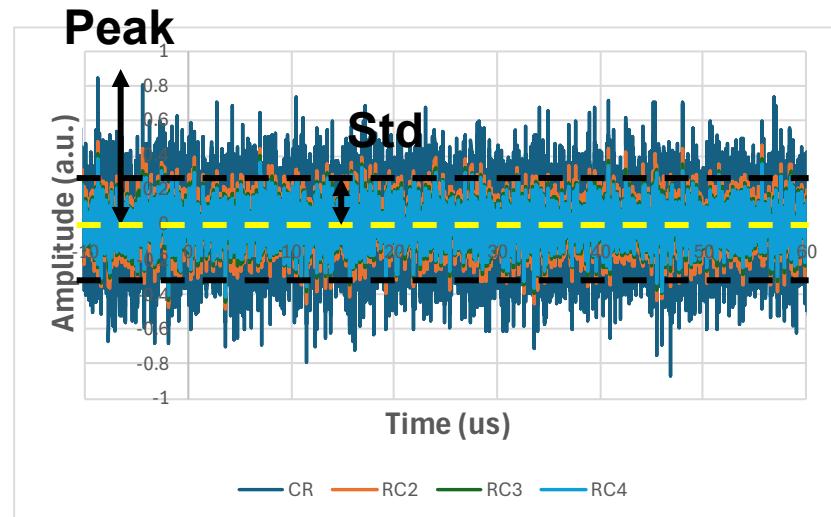
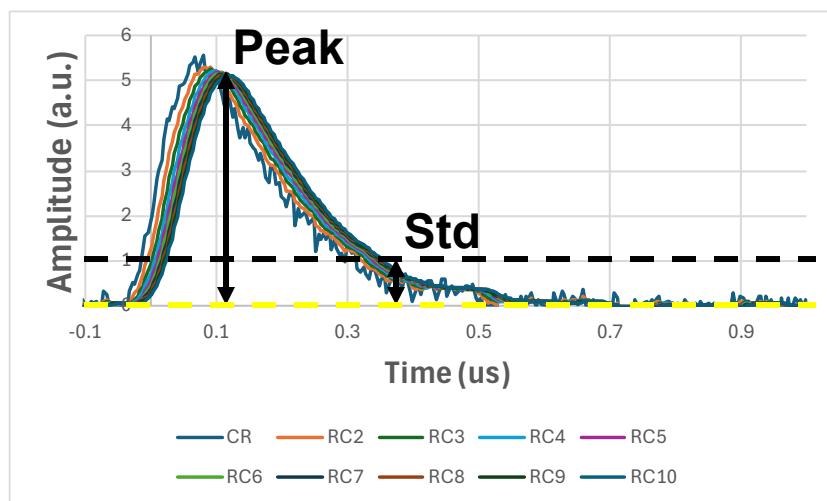
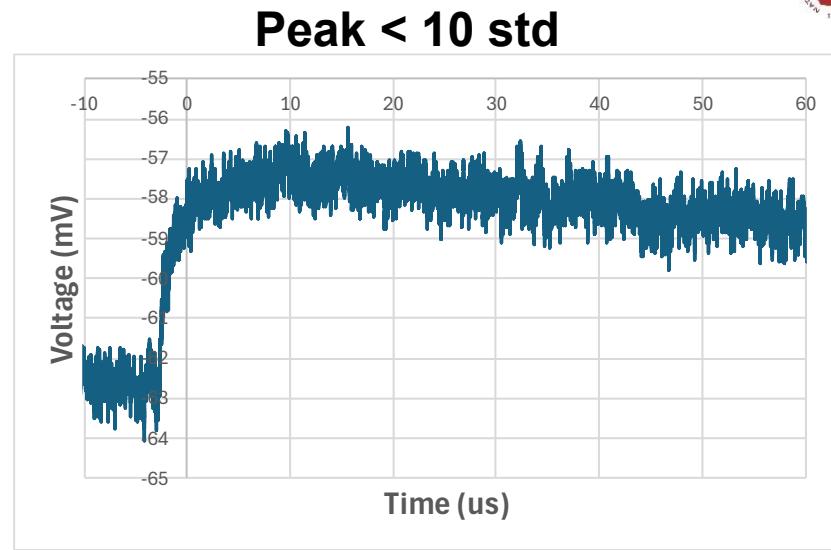
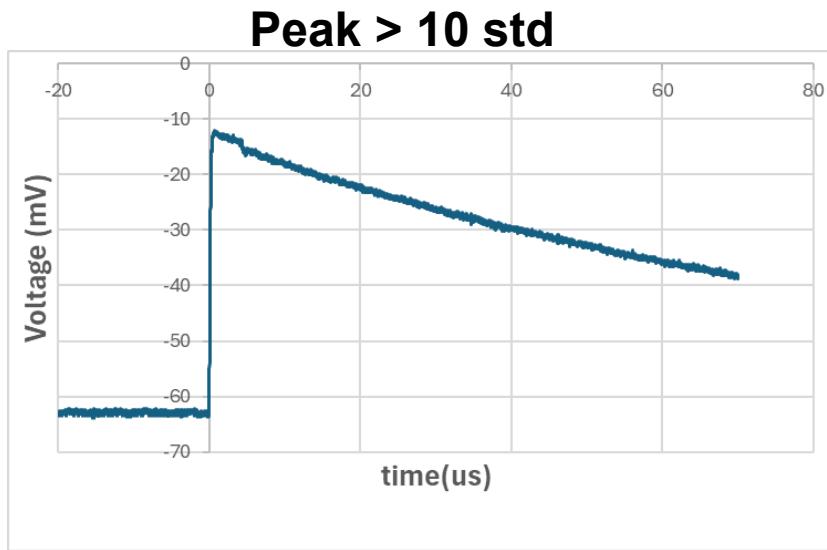
psdata is converted to csv using PicoScope program



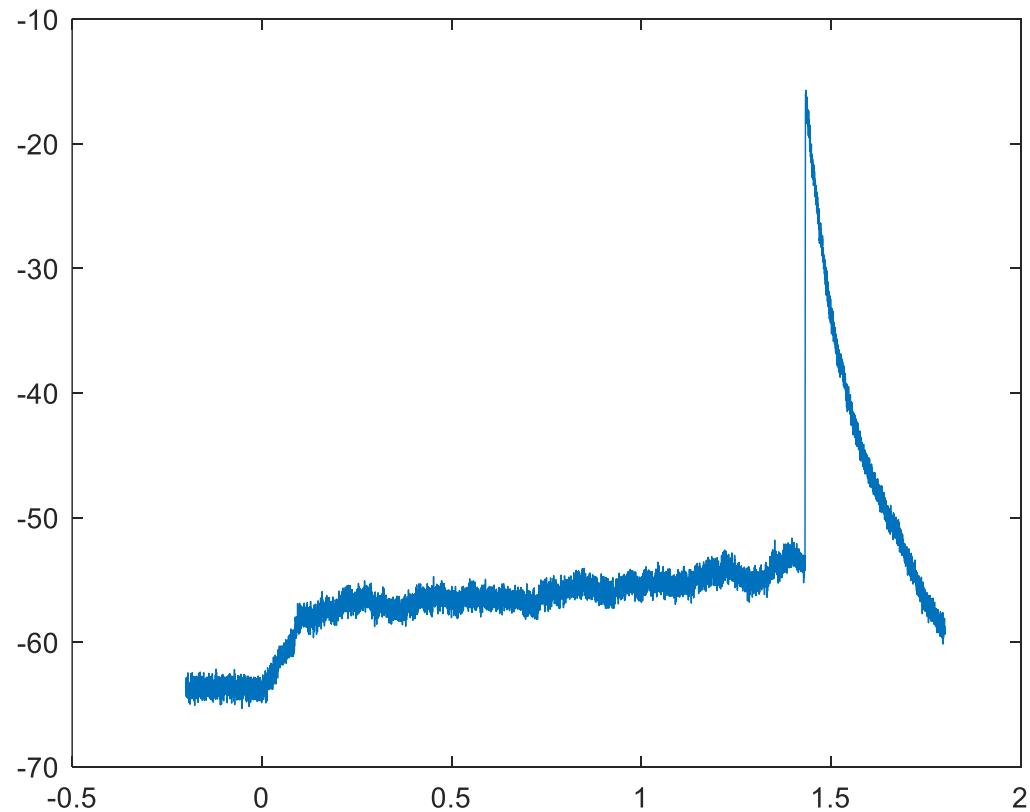
PicoScope_7_TandM_7.1.50.5777.exe



Data is saved when the peak is 10 times larger than the standard deviation



The signal may be mixed with the noise



Generate histogram using excel - 1



Screenshot of Microsoft Excel showing a histogram setup.

The ribbon menu is visible with the "檔案" tab circled in red. The formula bar shows the file name: 20250610(10).wHistogram - 複製.xlsx.

The data is organized into columns:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
1	Energy(a.u.)	folder	eventNumber			Bin																	
2	4.762369	10		1			1	0.01															
3	0.8981926	10		2			2	0.02															
4	4.857612	10		3			3	0.03															
5	1.44137	10		4			4	0.04															
6	0.9083873	10		5			5	0.05															
7	4.866261	10		6			6	0.06															
8	1.363468	10		7			7	0.07															
9	4.809048	10		8			8	0.08															
10	1.64176	10		9			9	0.09															
11	0.9106567	10		10			10	0.1															
12	1.566556	10		11			11	0.11															
13	4.449653	10		12			12	0.12															
14	4.71235	10		13			13	0.13															
15	0.9443364	10		14			14	0.14															
16	4.865753	10		15			15	0.15															
17	4.810346	10		16			16	0.16															
18	4.82144	10		17			17	0.17															
19	4.732153	10		18			18	0.18															
20	4.851197	10		19			19	0.19															
21	4.915464	10		20			20	0.2															
22	1.574656	10		21			21	0.21															
23	0.972246	10		22			22	0.22															
24	0.7761735	10		23			23	0.23															
25	4.829608	10		24			24	0.24															
26	1.59033	10		25			25	0.25															
27	4.763879	10		26			26	0.26															
28	1.536165	10		27			27	0.27															

Generate histogram using excel - 2



20250610(10)_wHistogram - 複製.xlsx

早安

新增

空白活頁簿 導覽 歡迎使用 Excel 開始使用 公式 數學課程 單元格分析工具 甘特圖專案規劃工具 每週排程規劃工具 里程碑資訊圖表時間表

搜尋

最近 我的最愛 與我共用

名稱	修改日期
20250610(10)_wHistogram - 複製.xlsx X: > CPU_Collected > ncku_dd	剛剛
20250610(10)_wHistogram.xlsx X: > CPU_Collected > ncku_dd	剛剛
75keV_30Hz_5pct(5).xlsx X: > CPU_Collected > pB_demo_psdata	18 分鐘前
75keV_30Hz_5pct(4).xlsx X: > CPU_Collected > pB_demo_psdata	18 分鐘前
75keV_30Hz_5pct(3).xlsx X: > CPU_Collected > pB_demo_psdata	19 分鐘前
75keV_30Hz_HistogramTest.xlsx X: > CPU_Collected > pB_demo_psdata	34 分鐘前

COMSOL 帳戶 選項

Generate histogram using excel - 3



Excel 選項

一般 公式 資料 校訂 儲存 語言 協助工具 進階

自訂功能區 快速存取工具列

增益集 (選中)

信任中心

檢視與管理 Microsoft Office 增益集。

增益集

名稱 ^	位置	類型
作用中應用程式增益集		
COMSOL 6.0	file:///C:/Program Files/COMSOL/COMSOL60/Mul	COM 增益集
National Instruments TDM Importer for MS Excel	C:\Program Files\National Instruments\Shared\TD	COM 增益集
中文繁簡轉換增益集	C:\Program Files\Microsoft Office\root\Office16\A	COM 增益集
分析工具箱	C:\Program Files\Microsoft Office\root\Office16\Li	Excel 增益集
非作用中應用程式增益集		
Euro Currency Tools	C:\Program Files\Microsoft Office\root\Office16\Li	Excel 增益集
Inquire	C:\Program Files (x86)\Microsoft Office\Office16\	COM 增益集
Microsoft Actions Pane 3		XML 擴充套件
Microsoft Data Streamer for Excel	C:\Program Files\Microsoft Office\root\Office16\A	COM 增益集
Microsoft Power Map for Excel	C:\Program Files\Microsoft Office\root\Office16\A	COM 增益集
Microsoft Power Pivot for Excel	C:\Program Files\Microsoft Office\root\Office16\A	COM 增益集

增益集: COMSOL 6.0
發行者: <無>
相容性: 沒有相容性資訊可提供
位置: file:///C:/Program Files/COMSOL/COMSOL60/Multiphysics/ext/LiveLink/Excel\\LiveLinkForExcel.vsto|vstolocal
描述: COMSOL LiveLink for Excel

管理(A): Excel 增益集 執行(G)...

確定 取消

Generate histogram using excel - 4



Screenshot of Microsoft Excel showing a histogram setup.

The ribbon menu is visible with the "資料" (Data) tab highlighted (circled in red).

The "分析" (Analysis) button in the Data tab is also circled in red.

The worksheet contains data from row 1 to 28, with columns A through M. Column A lists Energy values, column B lists folder numbers, and column C lists event numbers. Column E is labeled "Bin" and contains numerical values from 1 to 27, corresponding to the bins for the histogram.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
1	Energy(a.u.)	folder	eventNumber		Bin																		
2	4.762369	10	1		1	0.01																	
3	0.8981926	10	2		2	0.02																	
4	4.857612	10	3		3	0.03																	
5	1.44137	10	4		4	0.04																	
6	0.9083873	10	5		5	0.05																	
7	4.866261	10	6		6	0.06																	
8	1.363468	10	7		7	0.07																	
9	4.809048	10	8		8	0.08																	
10	1.64176	10	9		9	0.09																	
11	0.9106567	10	10		10	0.1																	
12	1.566556	10	11		11	0.11																	
13	4.449653	10	12		12	0.12																	
14	4.71235	10	13		13	0.13																	
15	0.9443364	10	14		14	0.14																	
16	4.865753	10	15		15	0.15																	
17	4.810346	10	16		16	0.16																	
18	4.82144	10	17		17	0.17																	
19	4.732153	10	18		18	0.18																	
20	4.851197	10	19		19	0.19																	
21	4.915464	10	20		20	0.2																	
22	1.574656	10	21		21	0.21																	
23	0.972246	10	22		22	0.22																	
24	0.7761735	10	23		23	0.23																	
25	4.829608	10	24		24	0.24																	
26	1.59033	10	25		25	0.25																	
27	4.763879	10	26		26	0.26																	
28	1.536165	10	27		27	0.27																	

Generate histogram using excel - 5



Screenshot of Microsoft Excel showing a histogram setup.

The Excel ribbon tabs are visible, including 資料 (Data) which is selected. The Data tab ribbon includes the following sections:

- 從文字/CSV, 從 Web, 從表格/範圍, 取得資料, 從现有連線, 從文字/CSV, 從 Web, 從表格/範圍, 取得資料, 從现有連線
- 查詢與連線, 全部重新整理, 內容, 活頁簿連結
- 股票 (Engli...), 貨幣 (Engli...)
- 排序, 排序與篩選
- 資料剖析, 清除, 重新套用, 過濾, 進階...
- 資料工具, 模擬分析, 預測, 工作表
- 組成群組, 取消群組, 小計
- 大綱, 分析

The main worksheet area shows a table with columns A through W. Column A contains values for Energy (a.u.), column B contains folder numbers, column C contains event numbers, and column E contains Bin values. The formula bar shows the current cell is M17.

A context menu is open over the data, titled "資料分析" (Data Analysis). The menu lists various statistical tools:

- 雙因子變異數分析：無重複試驗
- 相關係數
- 共變數
- 敘述統計
- 指數平滑法
- F-檢定：兩個常態母體變異數的檢定
- 傅立葉分析
- 直方圖** (highlighted with a red oval)
- 移動平均法
- 亂數產生器

The "確定" (OK) button is highlighted in blue.

Generate histogram using excel - 6



Screenshot of Microsoft Excel showing the creation of a histogram.

The Excel interface includes the ribbon with tabs like 檔案, 常用, 插入, 繪圖, 頁面配置, 公式, 資料, 校閱, 檢視, 自動化, 增益集, 說明, and COMSOL 6.0. The Data tab is selected.

The worksheet contains data in columns A through I. Columns A, B, C, D, and E represent individual energy values. Column F is labeled "Bin" and contains bins for grouping these values. Column G contains bin widths (e.g., 0.01, 0.02, 0.03, 0.04, 0.05, 0.06, 0.07, 0.08, 0.09, 0.1, 0.11, 0.12, 0.13, 0.14, 0.15, 0.16, 0.17, 0.18, 0.19, 0.2, 0.21, 0.22, 0.23, 0.24, 0.25, 0.26, 0.27). Column H contains the count of events falling into each bin. Column I contains the cumulative percentage of events up to that bin.

A context menu is open over the data in columns F, G, and H, showing options like "查詢與連線" (Query & Relationship), "資料重新整理" (Data Refresh), "內容" (Content), "活頁簿連結" (Worksheet Link), "排序" (Sort), "篩選" (Filter), "重新套用" (Apply), "資料剖析" (Data Analysis), "模擬分析" (Simulation Analysis), "預測" (Forecast), "工作表" (Worksheet), and "組成群組" (Group).

A "Histogram" dialog box is displayed, overlaid on the Excel window. It has the following settings:

- 輸入**:
 - 輸入範圍(I):
 - 組界範圍(B):
 - 標記(L)
- 輸出選項**:
 - 輸出範圍(O):
 - 新工作表(P):
 - 新活頁簿(W)
 - 柏拉圖(經排序的直方圖)(A)
 - 累積百分率(M)
 - 圖表輸出(C)

The "確定" (OK) button is highlighted with a blue border.

Generate histogram using excel - 7



自動儲存 關閉 檔案 常用 插入 繪圖 頁面配置 公式 資料 校閱 檢視 自動化 增益集 說明 COMSOL 6.0

受保護的檢視 小心，來自於網際網路的檔案可能有病毒。除非您需要這些檔案，請勿開啟。

M6 : fx

Histogram data

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
1	Energy(a.u.)	folder	eventNumber			Bin	組界	頻率	bin	組界	頻率												
2	4.762369	10	1			1	0.01	0.01	0	0.05	0.05	0											
3	0.8981926	10	2			2	0.02	0.02	0	0.1	0.1	0											
4	4.857612	10	3			3	0.03	0.03	0	0.15	0.15	0											
5	1.44137	10	4			4	0.04	0.04	0	0.2	0.2	0											
6	0.9083873	10	5			5	0.05	0.05	0	0.25	0.25	0											
7	4.866261	10	6			6	0.06	0.06	0	0.3	0.3	0											
8	1.363468	10	7			7	0.07	0.07	0	0.35	0.35	0											
9	4.809048	10	8			8	0.08	0.08	0	0.4	0.4	1											
10	1.64176	10	9			9	0.09	0.09	0	0.45	0.45	2											
11	0.9106567	10	10			10	0.1	0.1	0	0.5	0.5	5											
12	1.566556	10	11			11	0.11	0.11	0	0.55	0.55	3											
13	4.449653	10	12			12	0.12	0.12	0	0.6	0.6	1											
14	4.71235	10	13			13	0.13	0.13	0	0.65	0.65	6											
15	0.9444364	10	14			14	0.14	0.14	0	0.7	0.7	3											
16	4.865753	10	15			15	0.15	0.15	0	0.75	0.75	10											
17	4.810346	10	16			16	0.16	0.16	0	0.8	0.8	9											
18	4.82144	10	17			17	0.17	0.17	0	0.85	0.85	32											
19	4.732153	10	18			18	0.18	0.18	0	0.9	0.9	57											
20	4.851197	10	19			19	0.19	0.19	0	0.95	0.95	99											
21	4.915464	10	20			20	0.2	0.2	0	1	1	70											
22	1.574656	10	21			21	0.21	0.21	0	1.05	1.05	21											
23	0.972246	10	22			22	0.22	0.22	0	1.1	1.1	3											
24	0.7761735	10	23			23	0.23	0.23	0	1.15	1.15	1											
25	4.829608	10	24			24	0.24	0.24	0	1.2	1.2	1											
26	1.59033	10	25			25	0.25	0.25	0	1.25	1.25	2											
27	4.763879	10	26			26	0.26	0.26	0	1.3	1.3	2											
28	1.536165	10	27			27	0.27	0.27	0	1.35	1.35	1											
29	1.524268	10	28			28	0.28	0.28	0	1.4	1.4	7											
30	4.861436	10	29			29	0.29	0.29	0	1.45	1.45	14											
31	1.425424	10	31			30	0.3	0.3	0	1.5	1.5	45											

圖表標題

直方圖