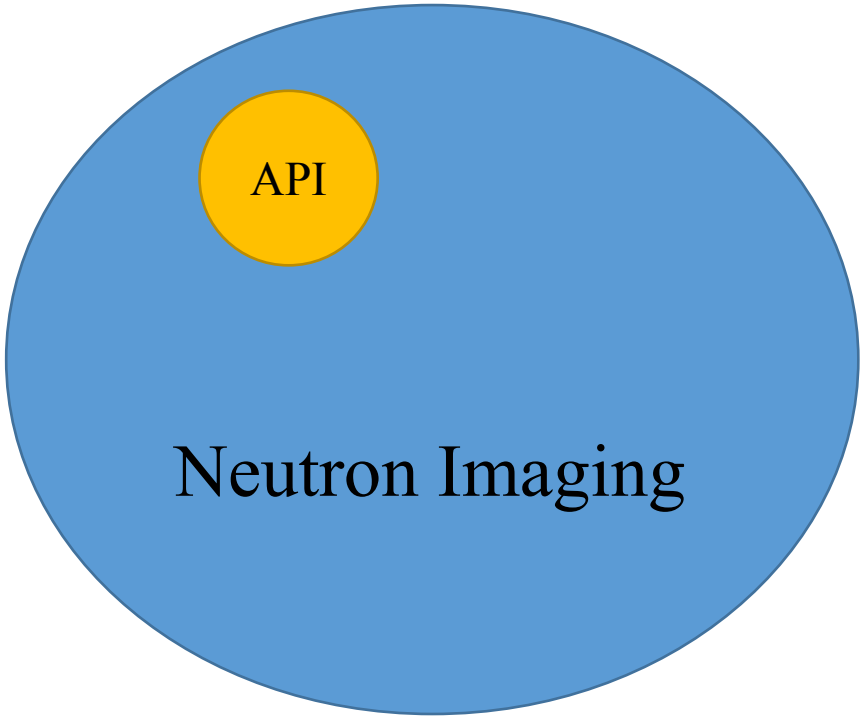
Study on the Uncertainty of Neutron Angle in Associated Particle Imaging(API)

ZHAO Shan-peng，XU Peng，SU Ming，ZHANG Kai，LUAN Guang-yuan，XIONG Zhong-hua，GONG wei,JIANG shi-wen

catalogue :

- 1.What is the associated particle imaging(API)?
- 2.The major work we have done.

1.What is API?



Traditional neutron imaging

nerton source

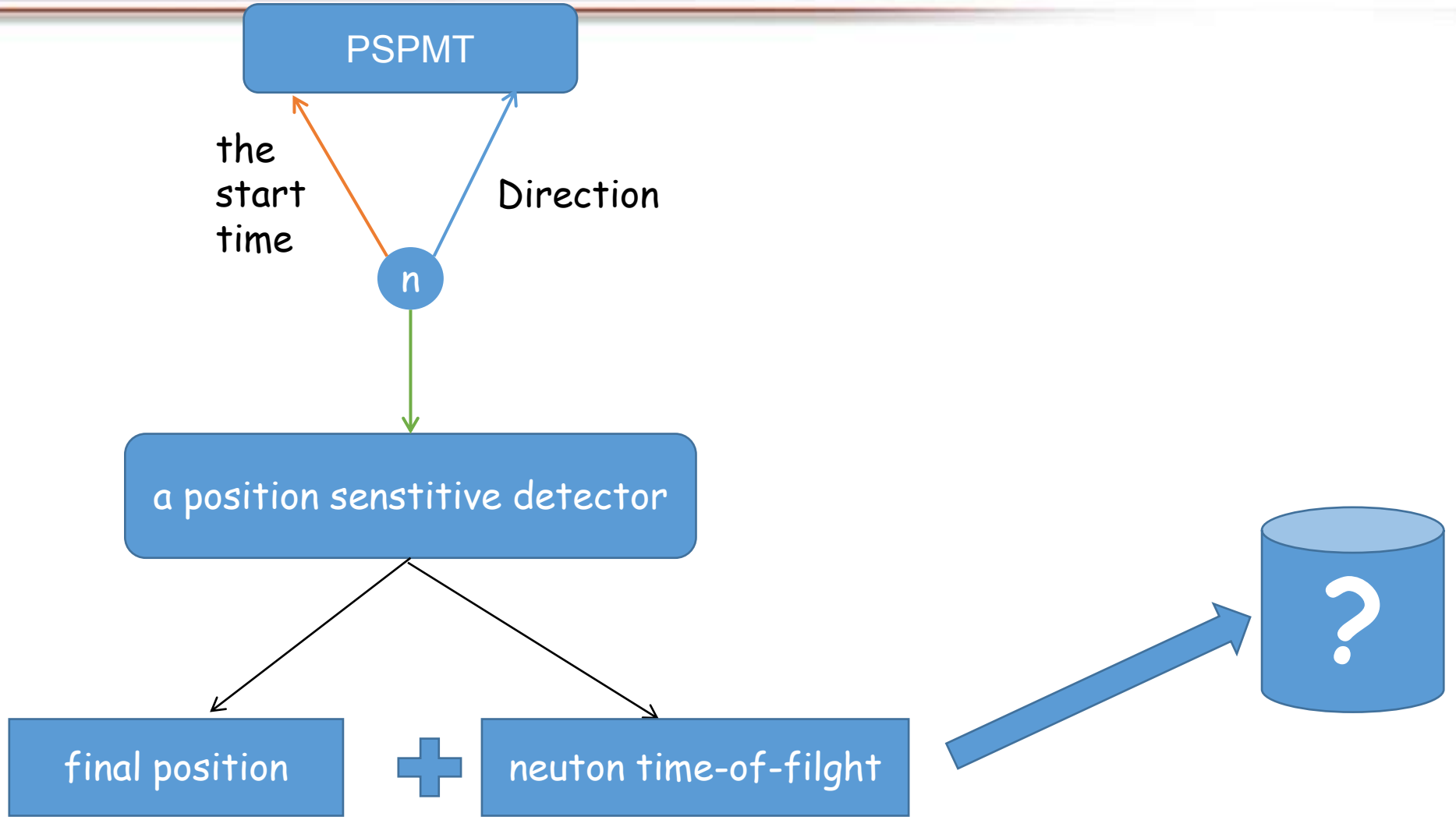
collimator

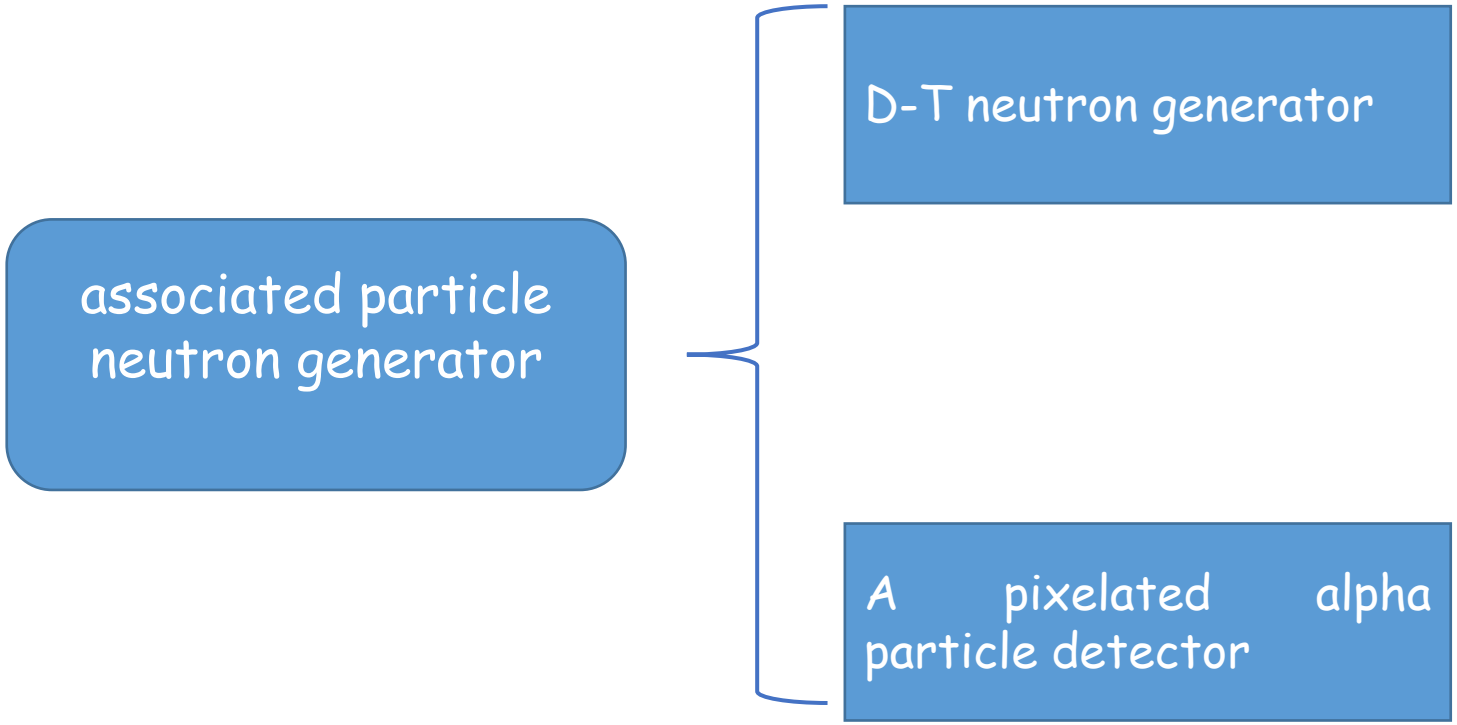
imaging device

API

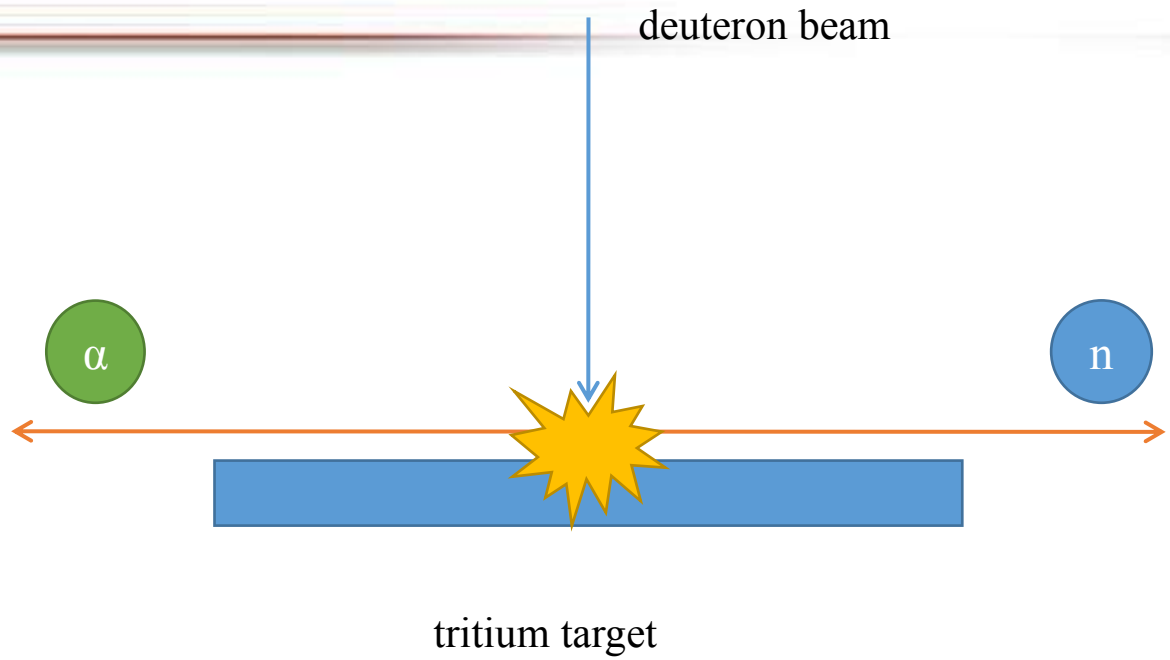
associated particle neutron generator

detectors


PSPMT
the start time
Direction
n
a position senstitive detector
final position
neuton time-of-filght
?


associated particle neutron generator
D-T neutron generator
A pixelated alpha particle detector

D-T reaction



$$D+T\rightarrow{}^{4}He+n+Q$$

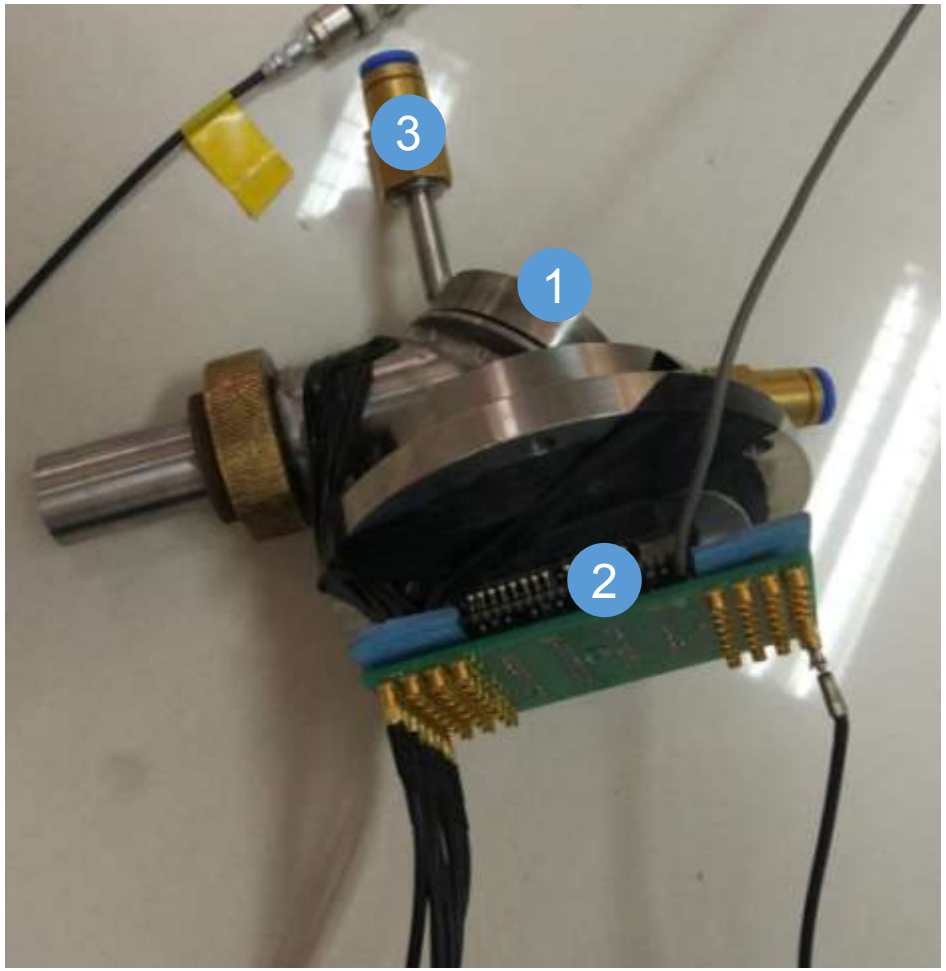
$$T_{\alpha}=\frac{m_n}{m_n+m_{\alpha}}Q=0.201279Q=3.54035MeV$$

$$T_{n}=\frac{m_{\alpha}}{m_n+m_{\alpha}}Q=0.798721Q=14.0489MeV$$

2.The Major Work

1. Design an associated particle neutron generator
2. Design the corresponding electronic circuits
3. Measure the uncertainty of neutron angle

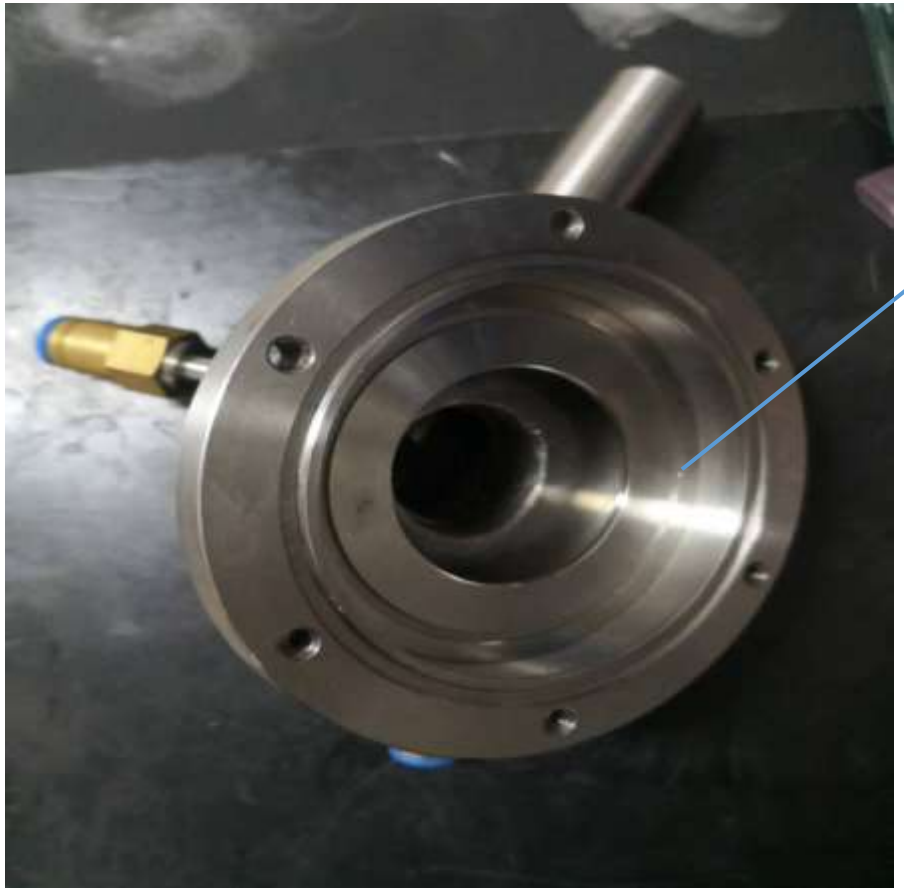
THE ASSOCIATED PARTICLE NEUTRON GENERATOR



1 Tritium target

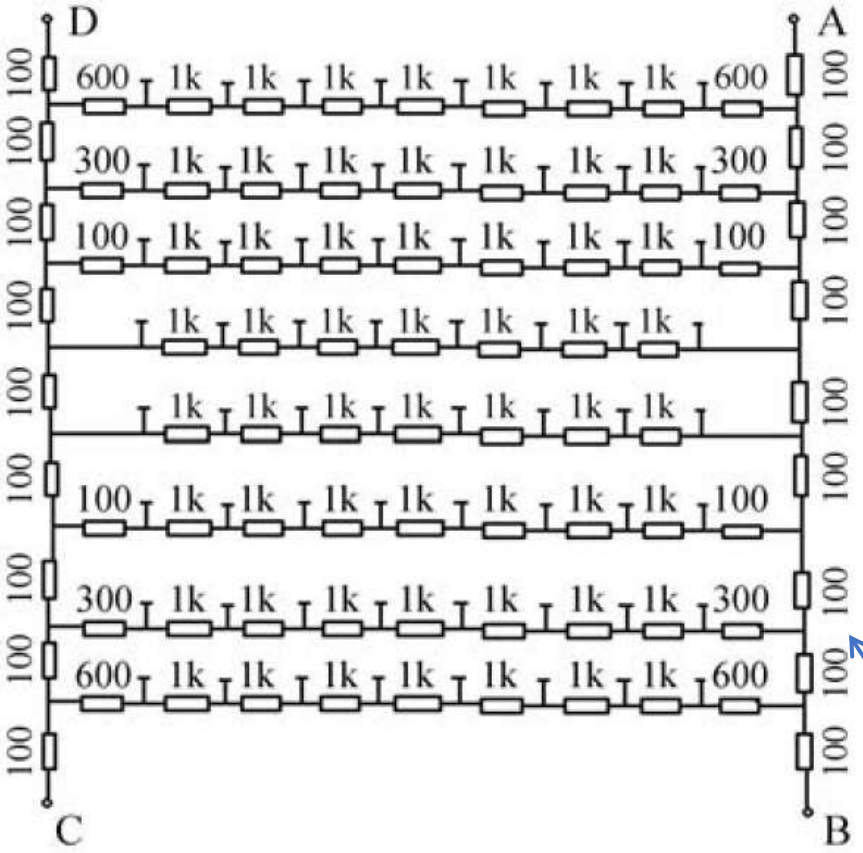
2 Pixelated alpha detector and reading circuit

3 Water cooling system



There is also an aluminum film which is to prevent deuterium particles and the light which is produced by the D-T reaction .

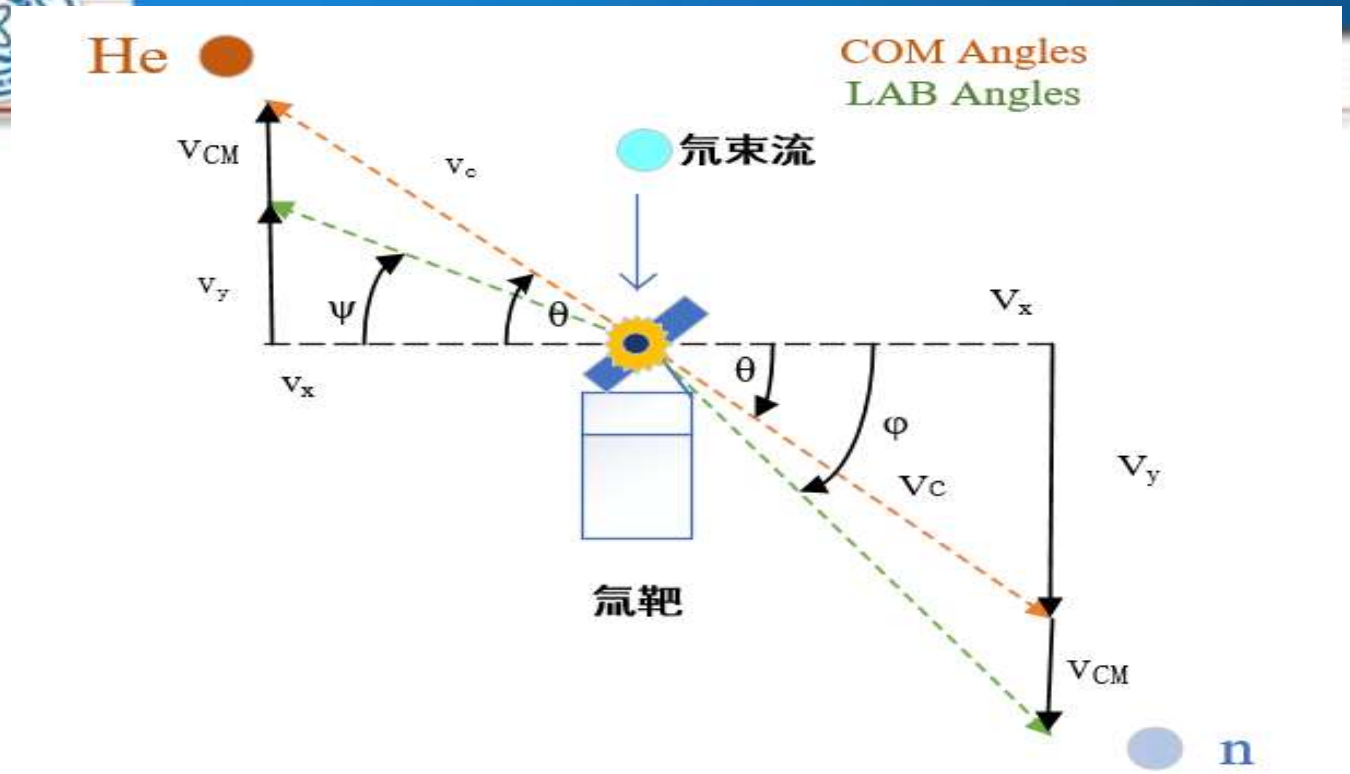
Such as H8500, there are 64 discrete anode signals.The readout circuit will be very complex, and the subsequent signal processing and acquisition system will become very large and expensive.So we use discretized position circuit (DPC) to merge channel.



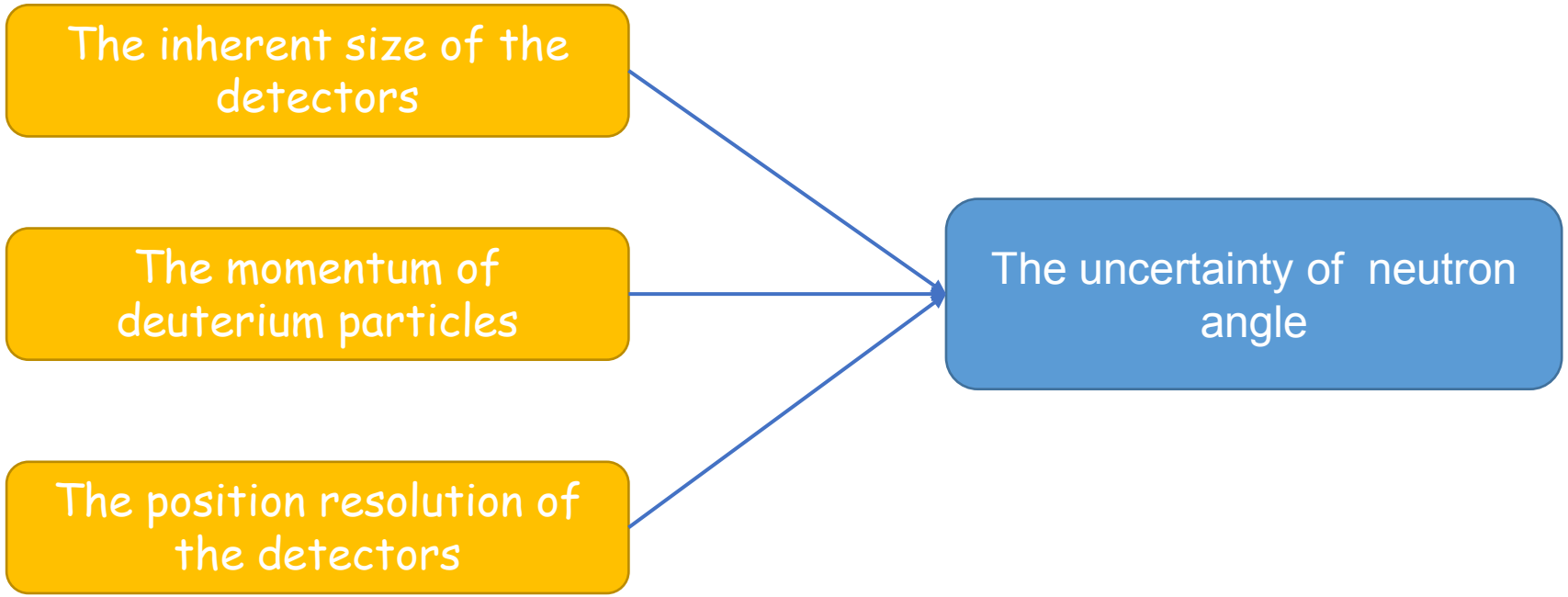
$$X = \frac{(V_A + V_B) - (V_C + V_D)}{V_A + V_B + V_C + V_D}$$

$$Y = \frac{(V_A + V_D) - (V_C + V_B)}{V_A + V_B + V_C + V_D}$$

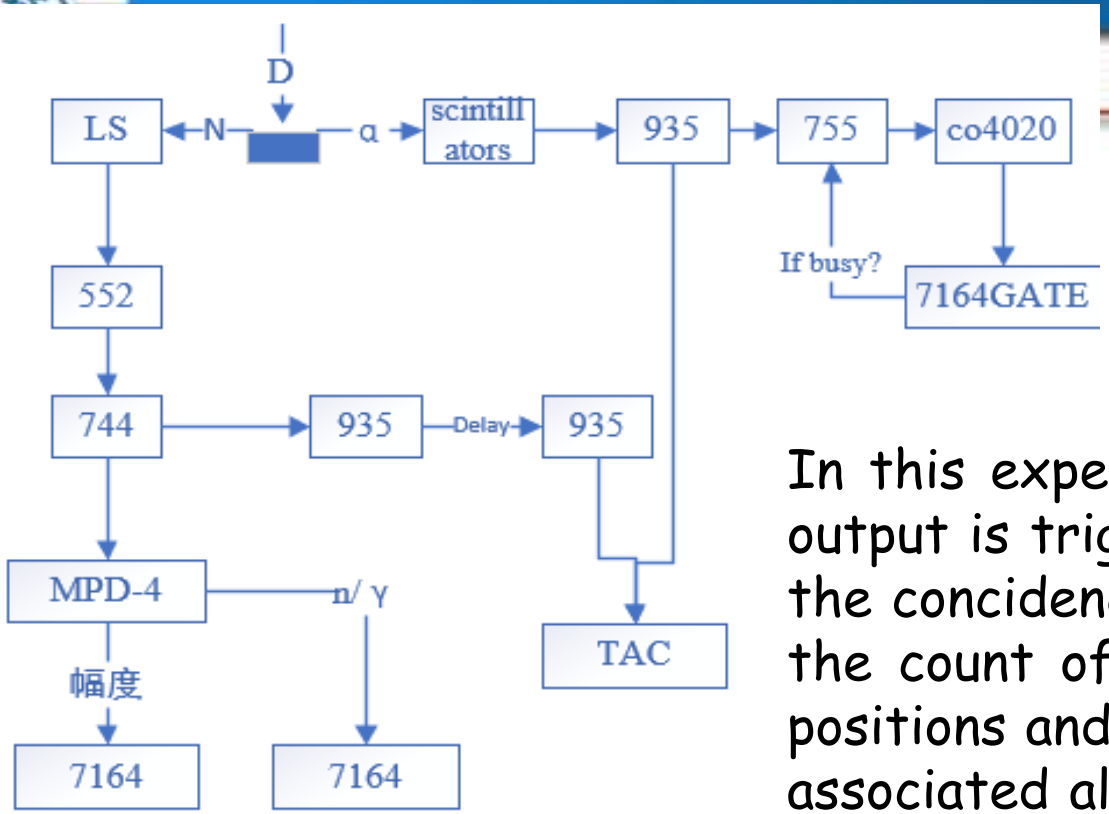
This is DPC's resistor chain charge division circuit.



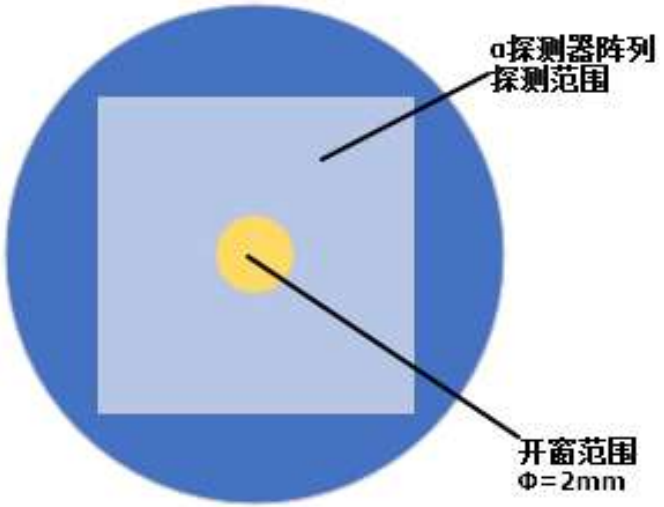
For some reasons, there must be uncertainty in the angle of neutron. So we design the corresponding experiments to measure it.

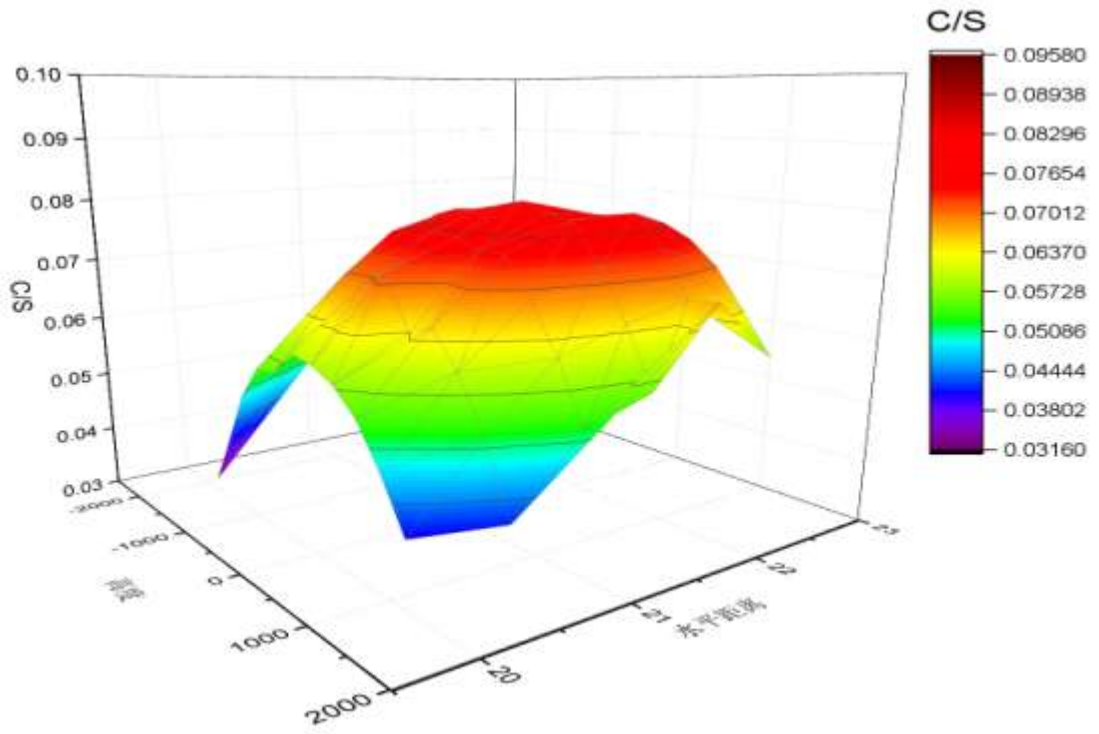

The inherent size of the detectors
The momentum of deuterium particles
The position resolution of the detectors
The uncertainty of neutron angle

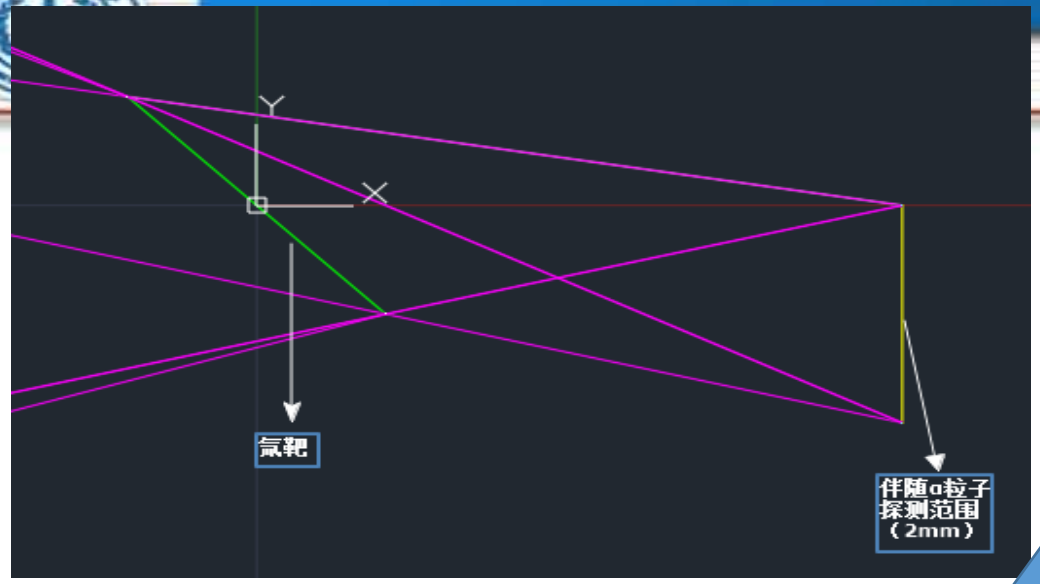
1. BC-5001A Liquid scintillator detector
2. An associated particle neutron generator
3. Electrostatic accelerator

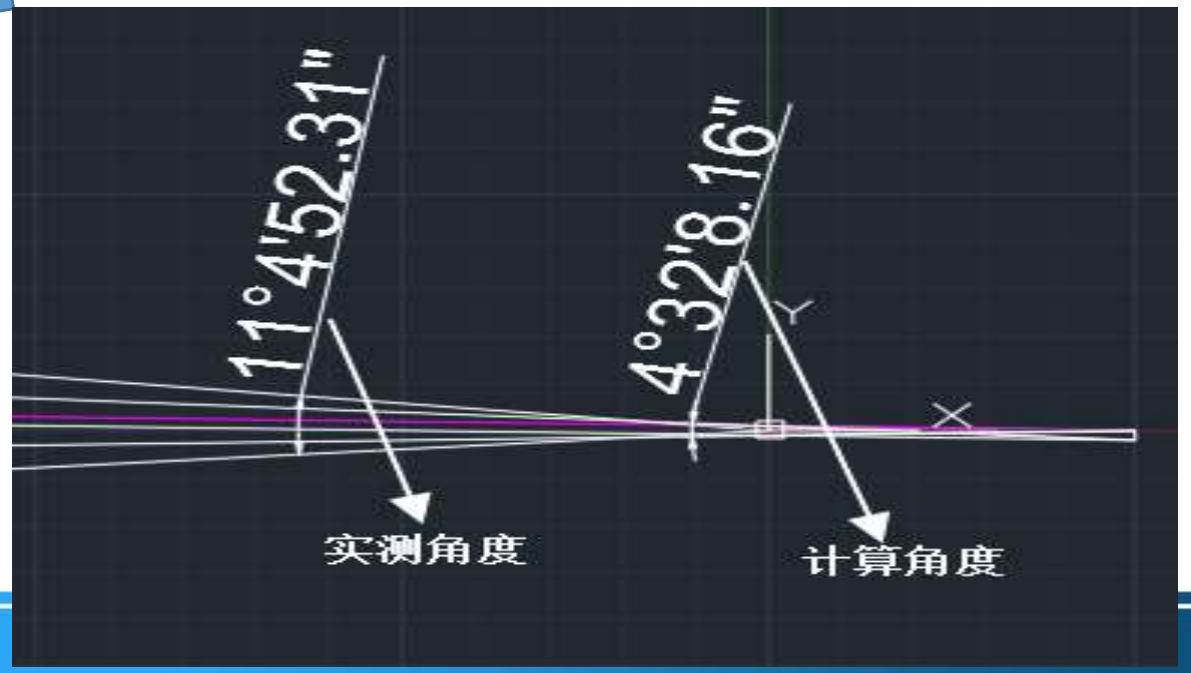


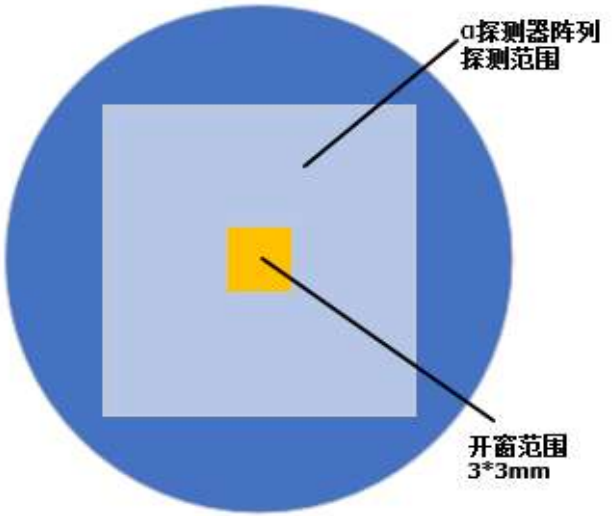
In this experiment, the signal which is a H9500's anode output is trigger signal and we can detect the neutron by the concidence between alpha particles and neutrons. C is the count of associated neutrons in different detecting positions and S ,detected by PSPMT, is the total count of associated alpha particles. The FWHM of C/S cure is the distribution of neutron angle. The range of neutron angle can also be calculated by the size of detector and FWHM of C/S.

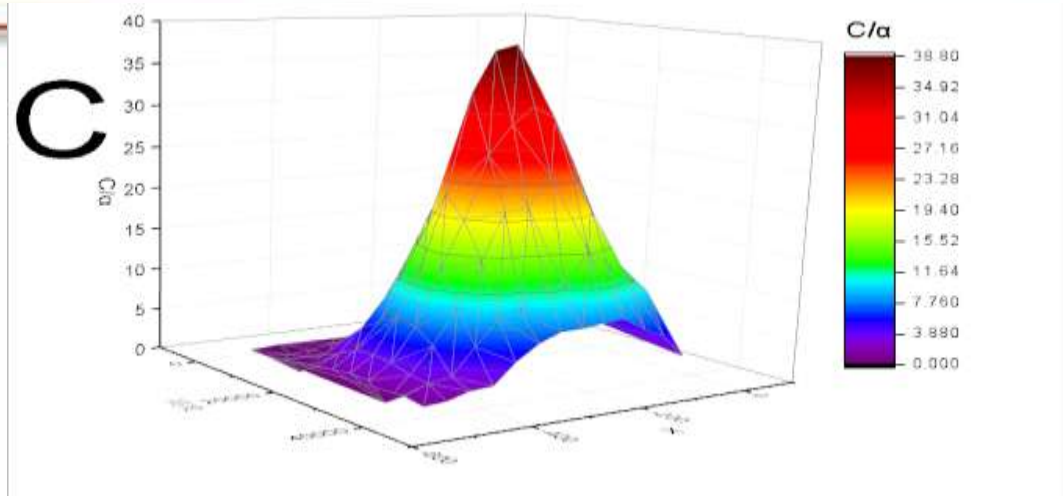

α探测器阵列
探测范围
开窗范围
Φ=2mm

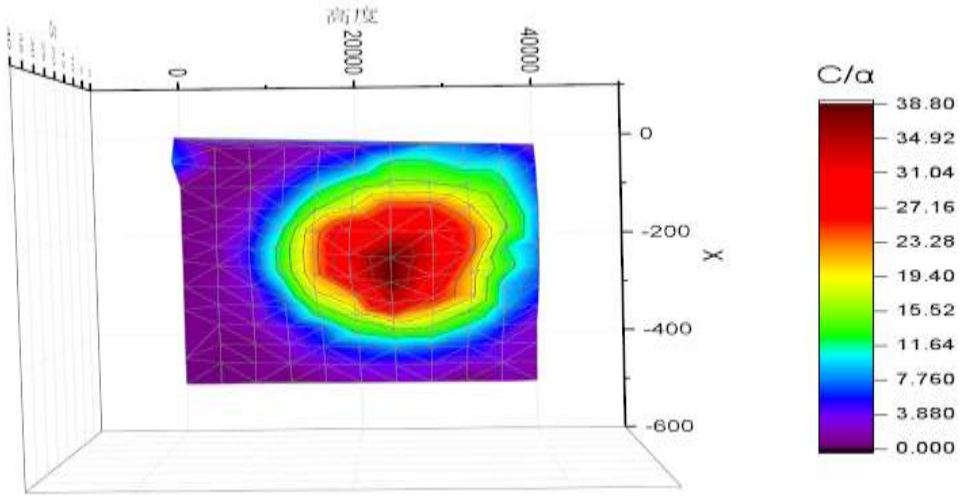

C/S
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
-2000
-1000
0
1000
2000
20
21
22
C/S
0.09580
0.08938
0.08296
0.07654
0.07012
0.06370
0.05728
0.05086
0.04444
0.03802
0.03160


Y
X
氚靶
伴随α粒子
探测范围
（2mm）

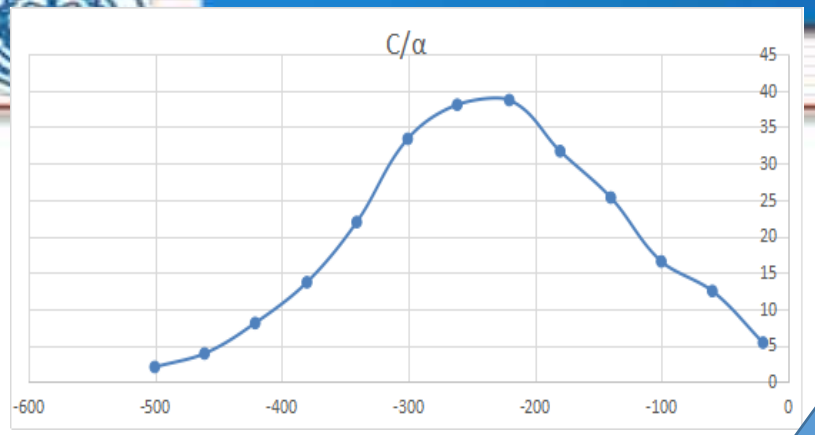

11°4'52.31"
4°32'8.16"
Y
X
实测角度
计算角度

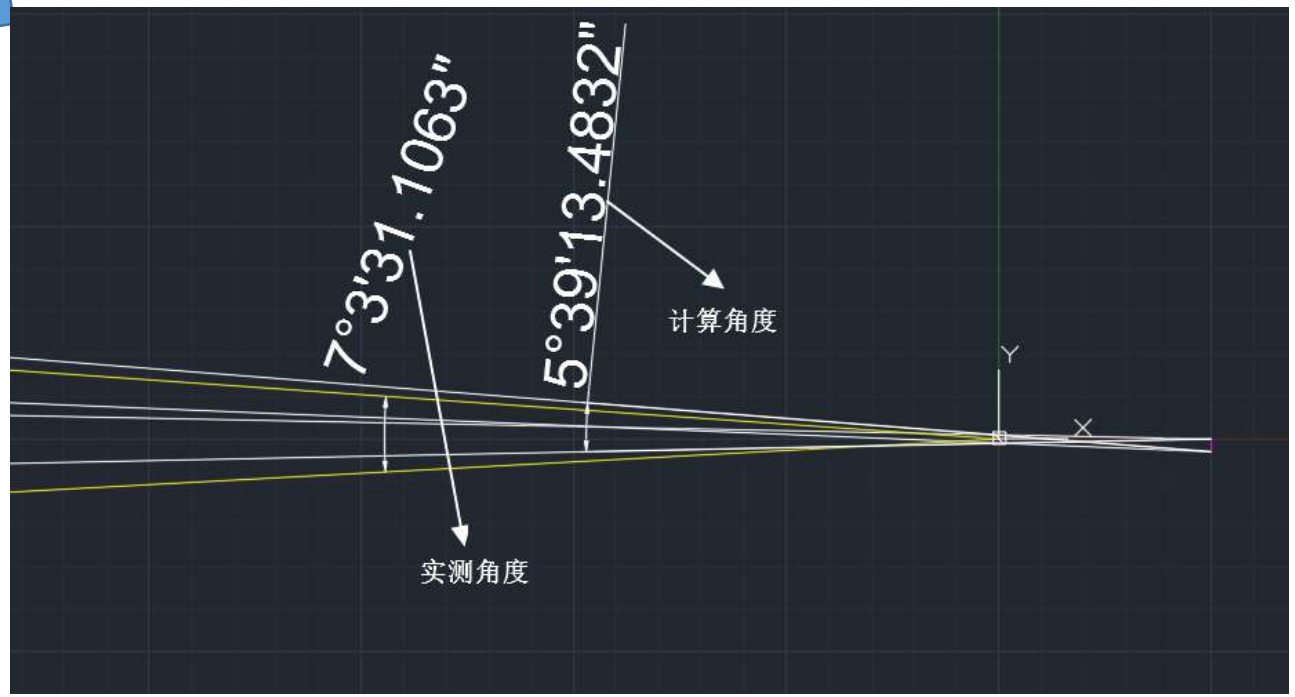

α探测器阵列
探测范围
开窗范围
3*3mm


C
C/α
40
35
30
25
20
15
10
5
0
38.80
34.92
31.04
27.16
23.28
19.40
15.52
11.64
7.760
3.880
0.000

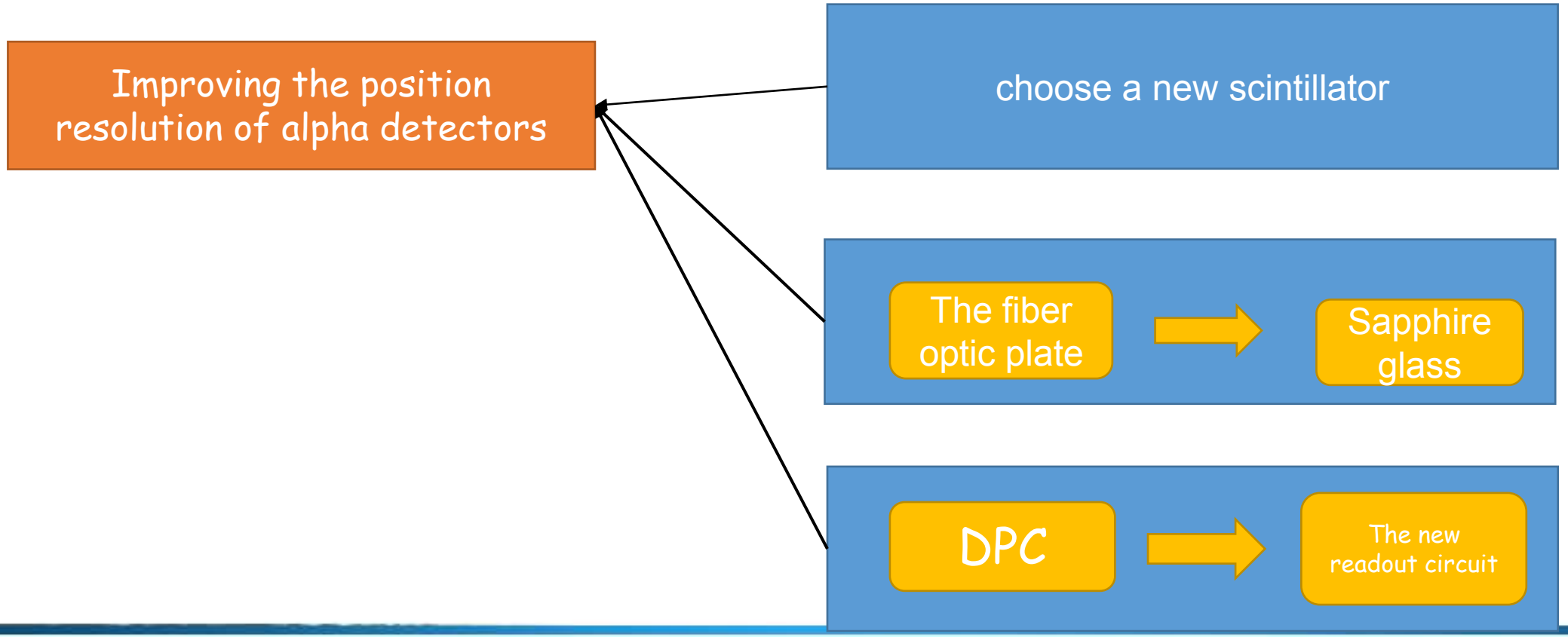

高度
0
20000
40000
0
-200
-400
-600
X

C/α
38.80
34.92
31.04
27.16
23.28
19.40
15.52
11.64
7.760
3.880
0.000


C/α
45
40
35
30
25
20
15
10
5
0
-600
-500
-400
-300
-200
-100
0


7°3'31.1063"
5°39'13.4832"
计算角度
实测角度
Y
X

How to improve the ability of the system?



That's all !

Thank you !