Measurement of excess heat and nuclear products by using a closed D_2O system

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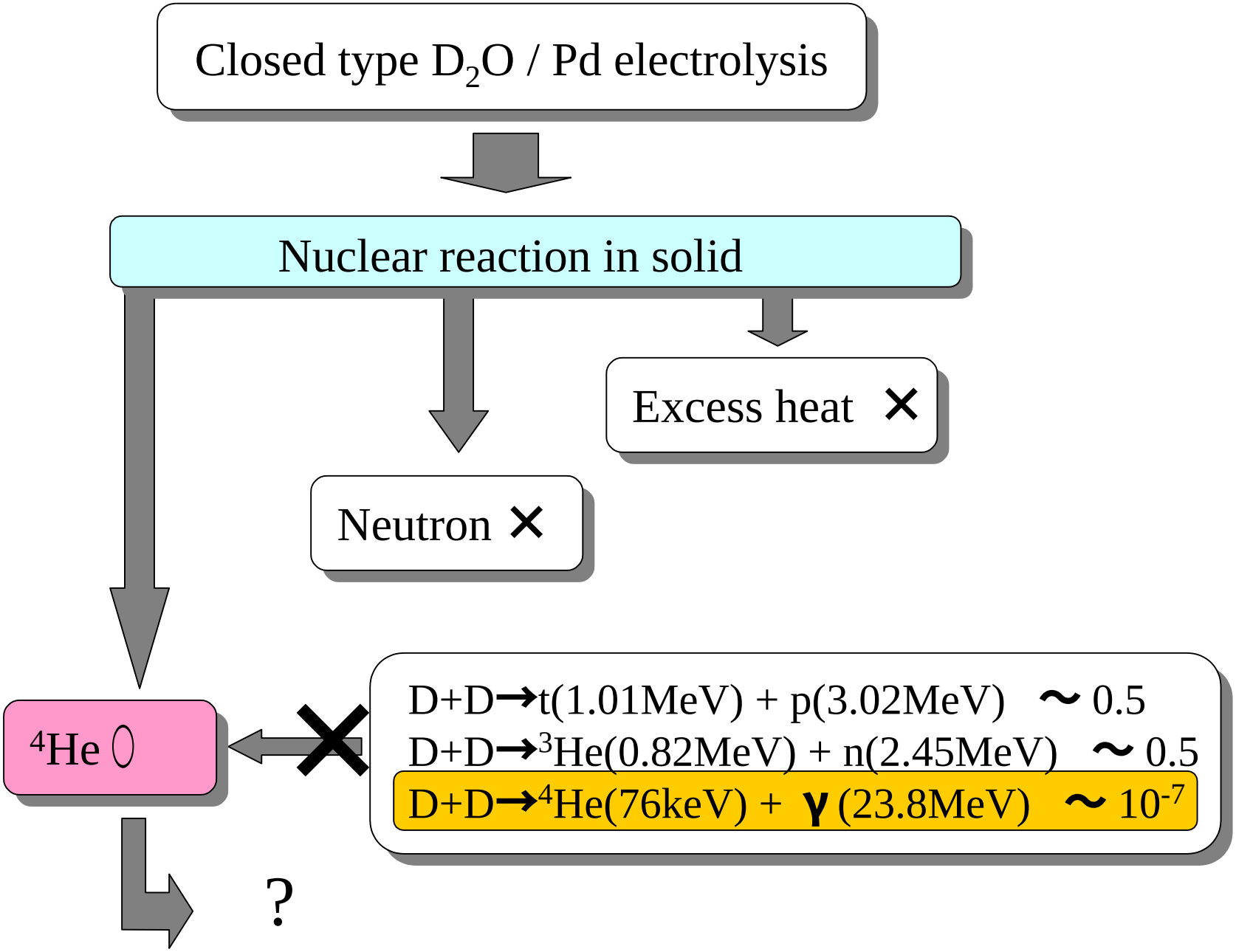
Analysis of Distribution of D density near the surface

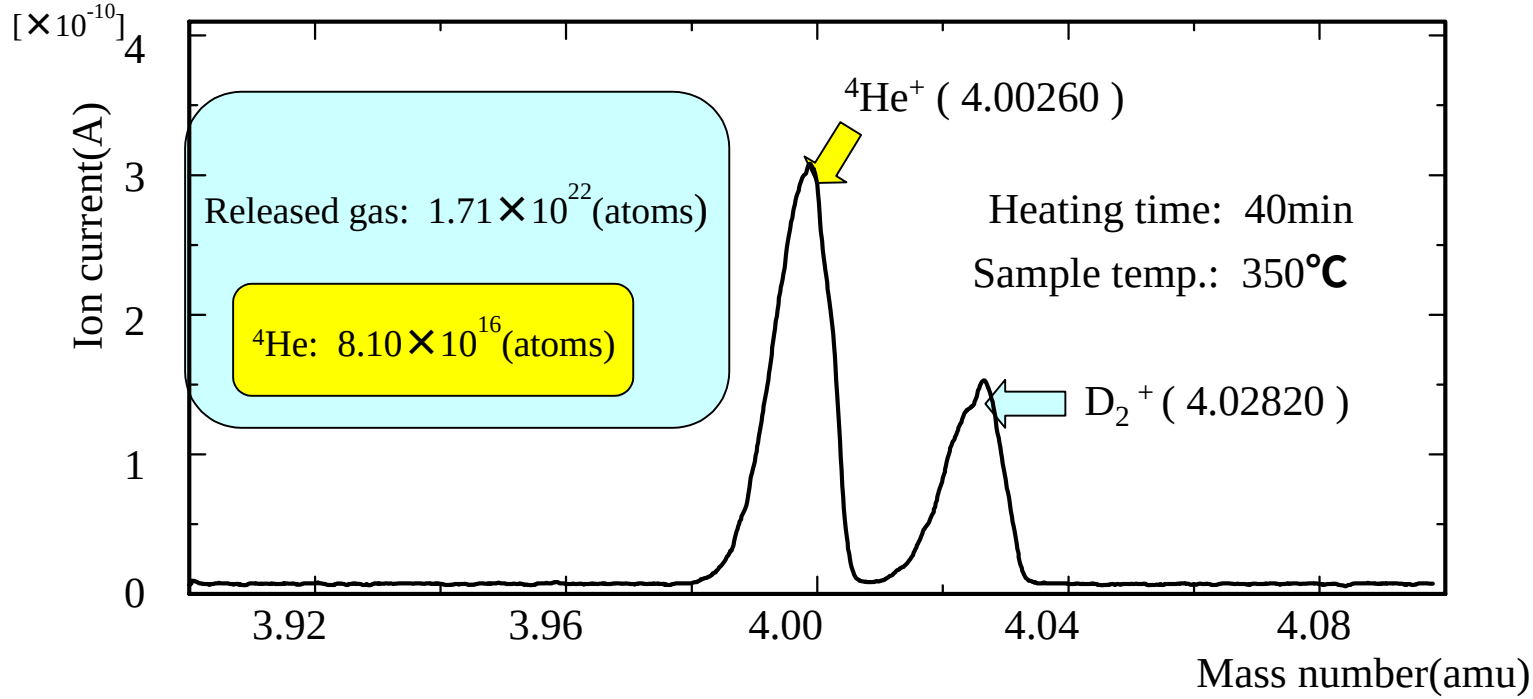
Pd-Ce/D_2O electrolysis experiment


Closed type D_2O / Pd electrolysis
Nuclear reaction in solid
Excess heat ×
Neutron ×
^4He
D+D→t(1.01MeV) + p(3.02MeV) ～ 0.5
D+D→^{3}He(0.82MeV) + n(2.45MeV) ～ 0.5
D+D→^{4}He(76keV) + γ (23.8MeV) ～ 10^{-7}
?

- In some experiments,significant amount of ^{4}He (10^{16}) was detected in the gas released from the electrolyzed Palladium cathode coated with metal layer. Some nuclear reaction may take place during electrolysis, because contamination from air into mass analysis system was little.

- It seemed that there was no correlation between ^{4}He generation and the neutron emission.

Exp.4



Mass spectrum of released gas from heated cathode

the activation energy of ^{4}He atoms for migration of interstitial site was so high.

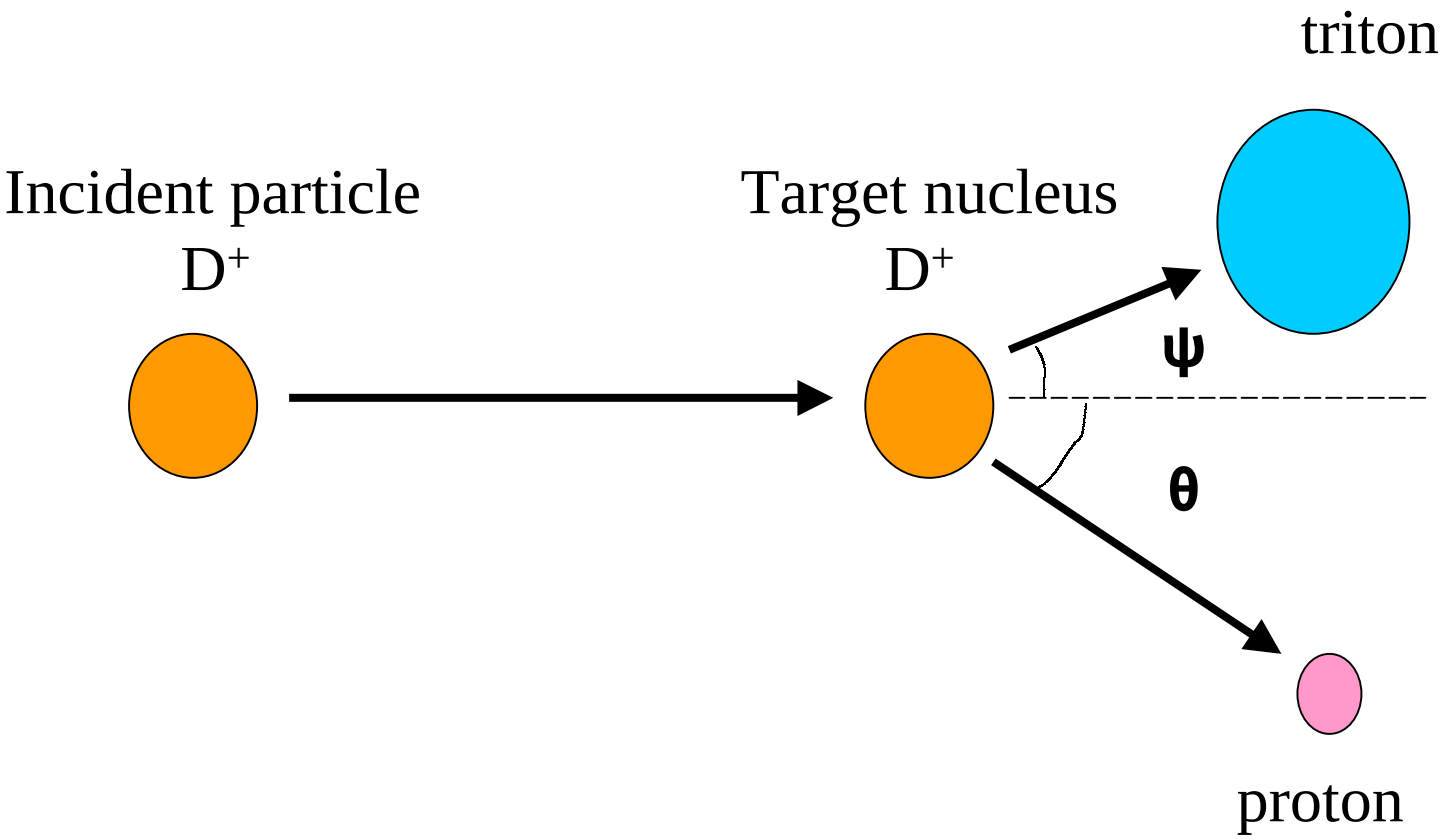
Heating temperature ; 350℃

Possibility of NRS near the surface coated with metal layer

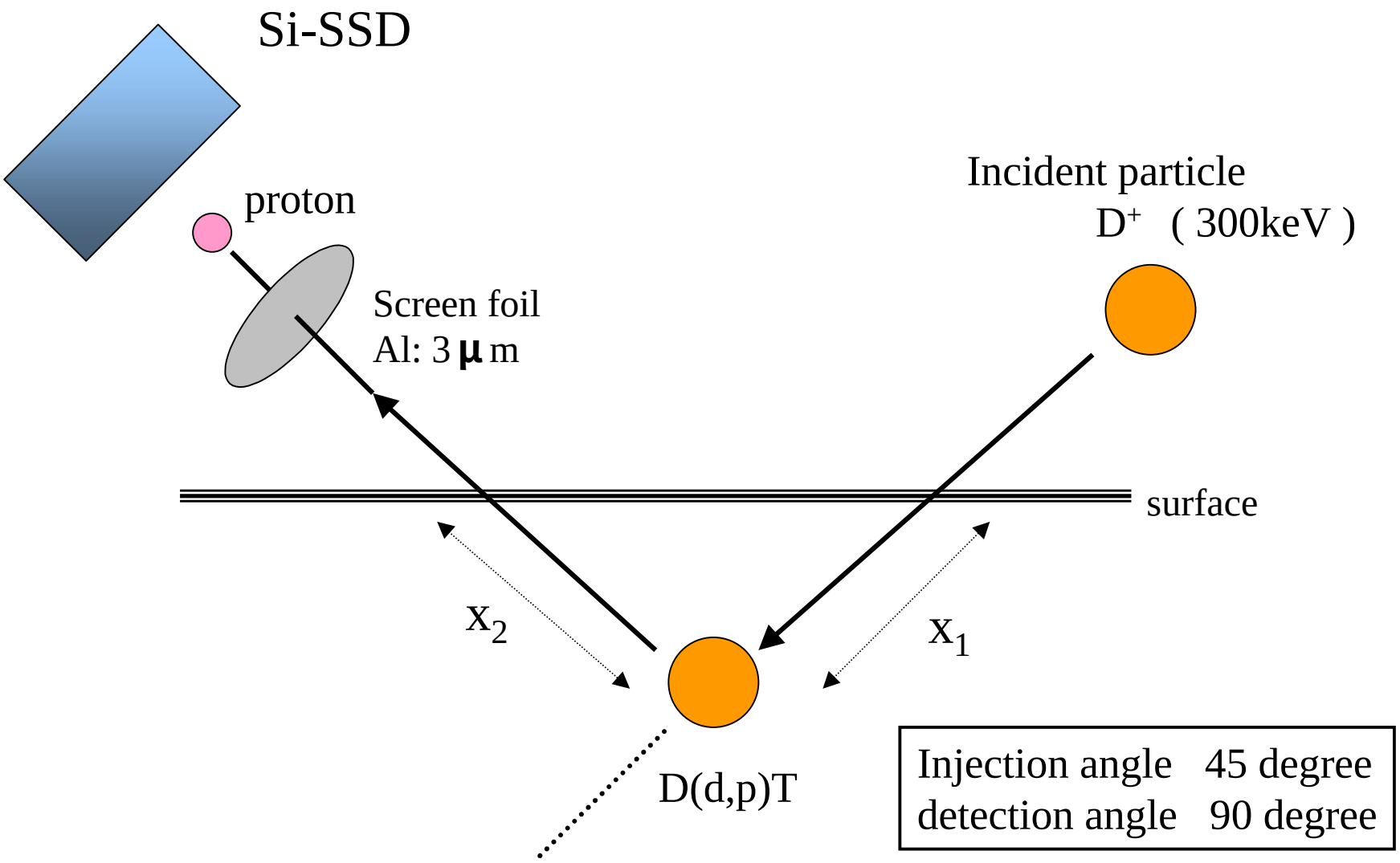
The metal layer could block diffusion of D ?

Analysis of PdDx coated with metal layer by NRA

Distribution of D-density near the surface



NRA (Nuclear Reaction Analysis)


Si-SSD
proton
Screen foil
Al: 3 μm
Incident particle
D+ (300keV)
surface
x2
x1
D(d,p)T
Injection angle 45 degree
detection angle 90 degree

$$Y(Ep) = N(x_1)\frac{d\sigma}{d\Omega}\Delta\Omega\ \frac{It}{e}$$

$$N(x_1) = \frac{Y(Ep)e}{\frac{d\sigma}{d\Omega}\Delta\Omega\, It}$$

$N(x_1)$; D density (cm^{-2})

$Y(E_p)$; Proton yield

$\Delta\Omega$; Solid angle (sr)

$d\sigma/d\Omega$; Differential cross-section (cm^2/sr)

I = Ion beam current (A)

t = Irradiation time (s)

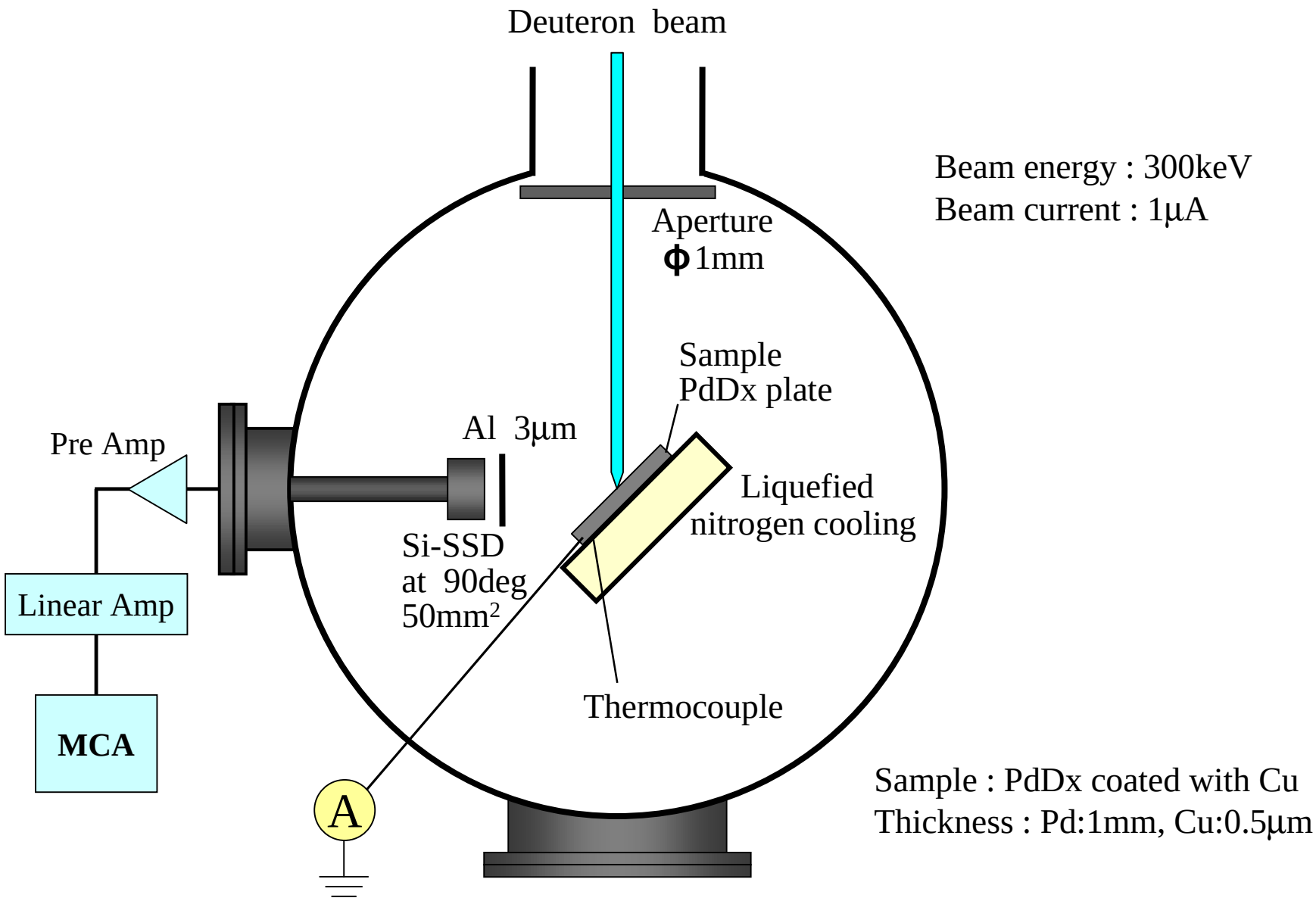
e ; 1.602×10^{-19} (c^{-1})

Sample

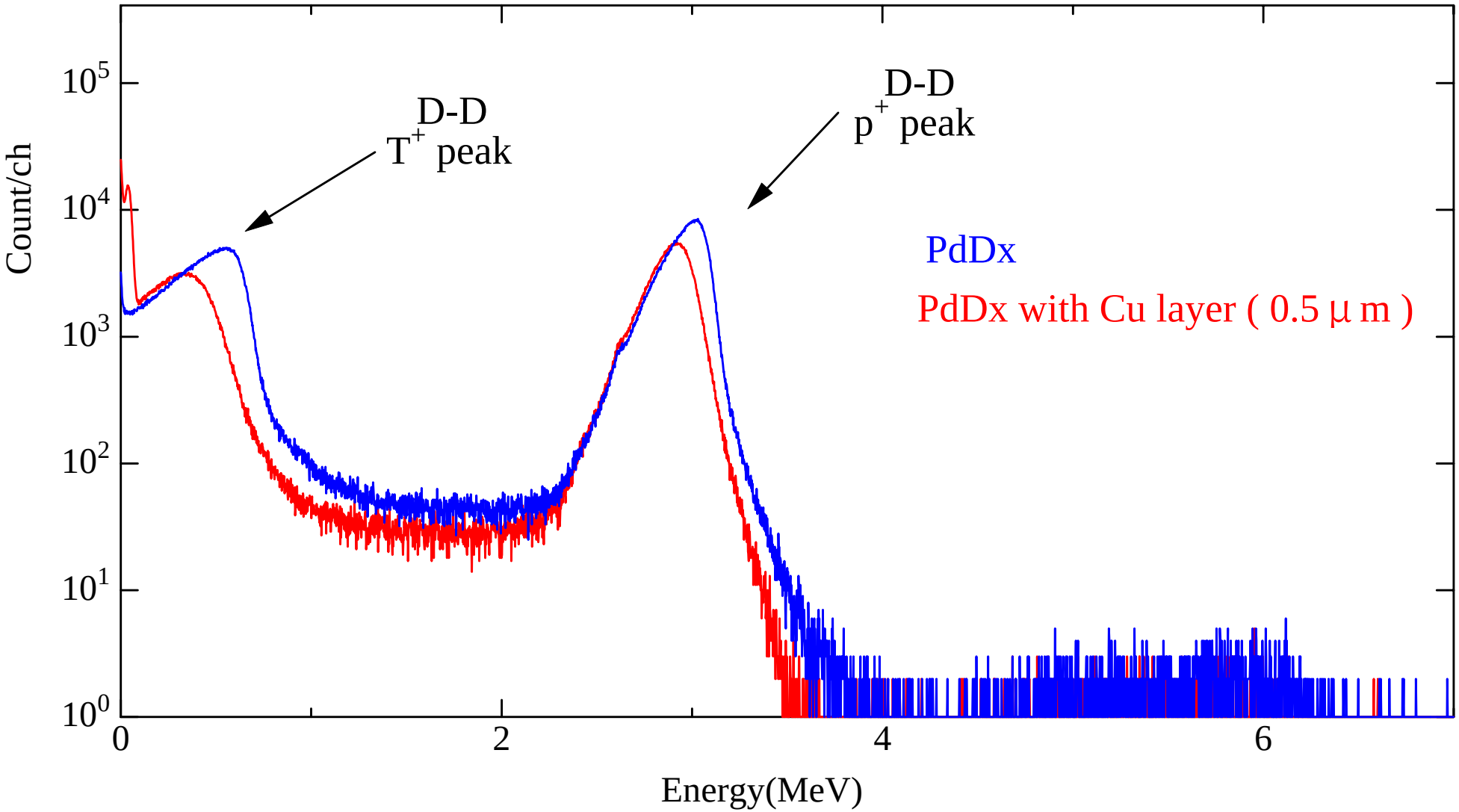
Sample ; A PdDx

Sample ; B PdDx coated with Cu (0.5 μm)

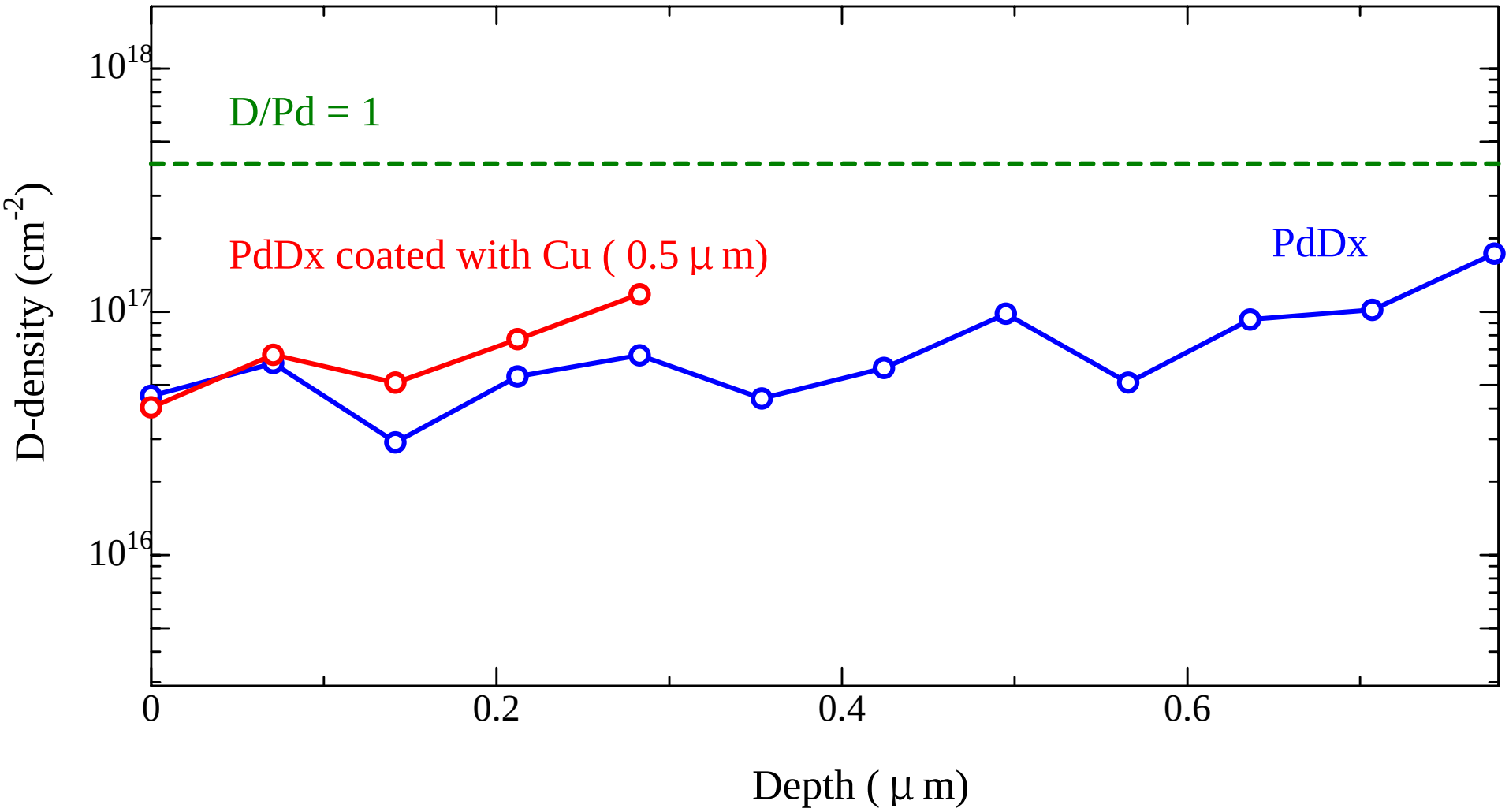
Size ; 25mm ✕ 25mm ✕ 1mm



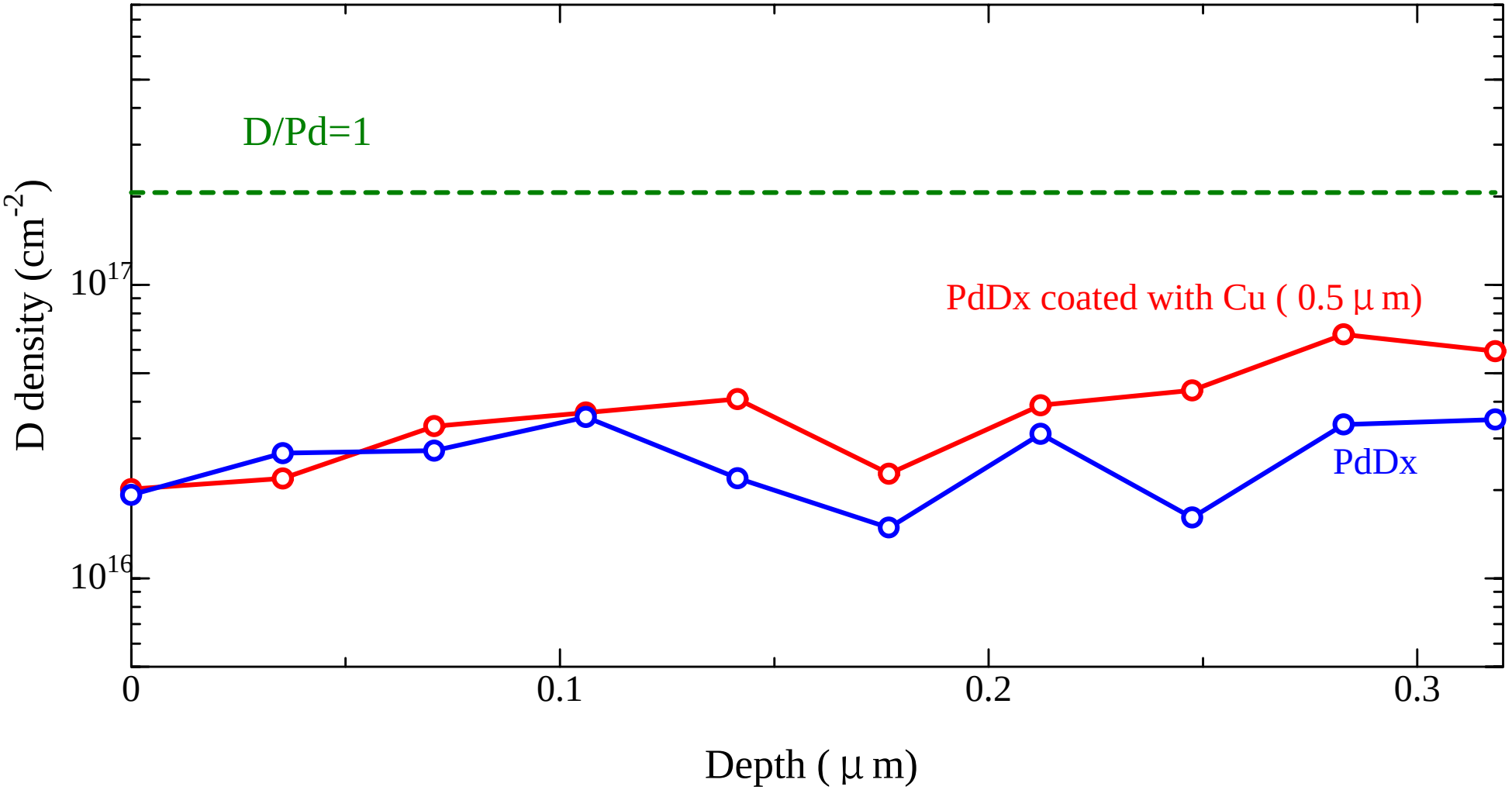
Schematic view of the experimental setup under D^+ beam implantation



Energy spectrum of D-D reaction in PdDx



Distribution of D-density near the surface (0～0.7 μ m)



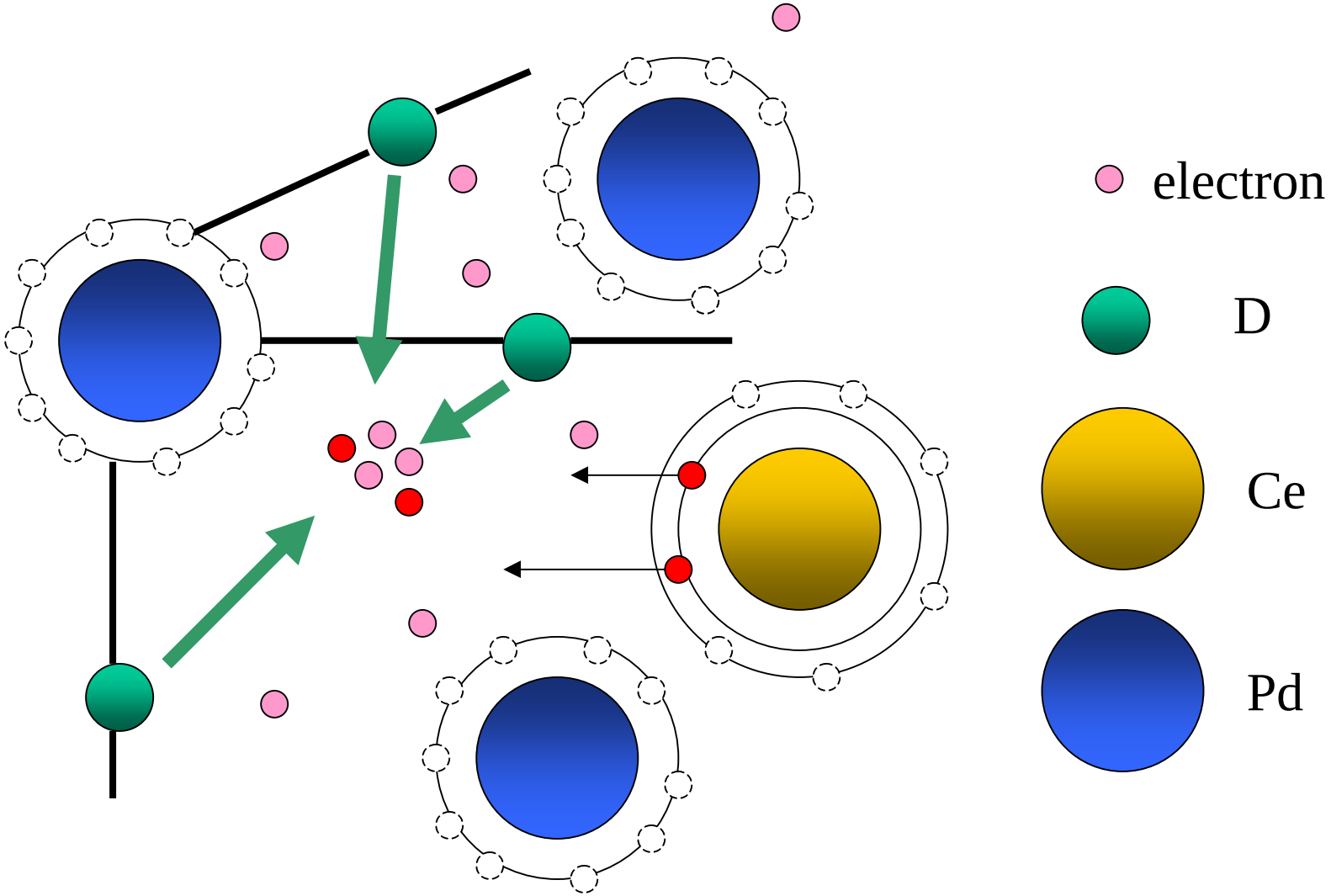
Distribution of D-density near the surface (0～0.3 μ m)

Summary

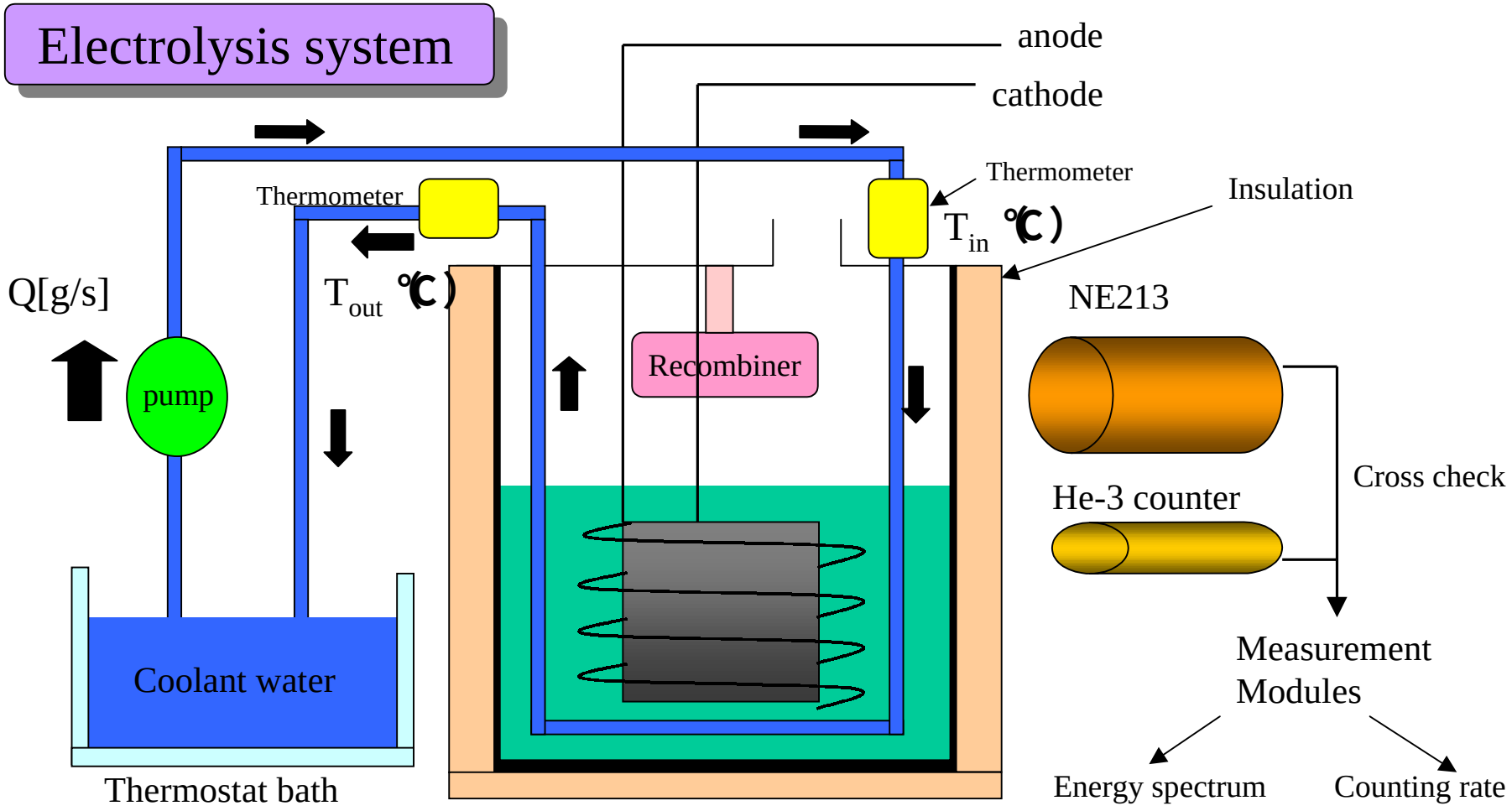
D density near the surface in PdDx coated with Cu was higher than PdDx.

It seemed that the metal layer could block diffusion of D near the surface.

Pd-Ce/D_2O electrolysis experiment


electron
D
Ce
Pd

Electrolysis system



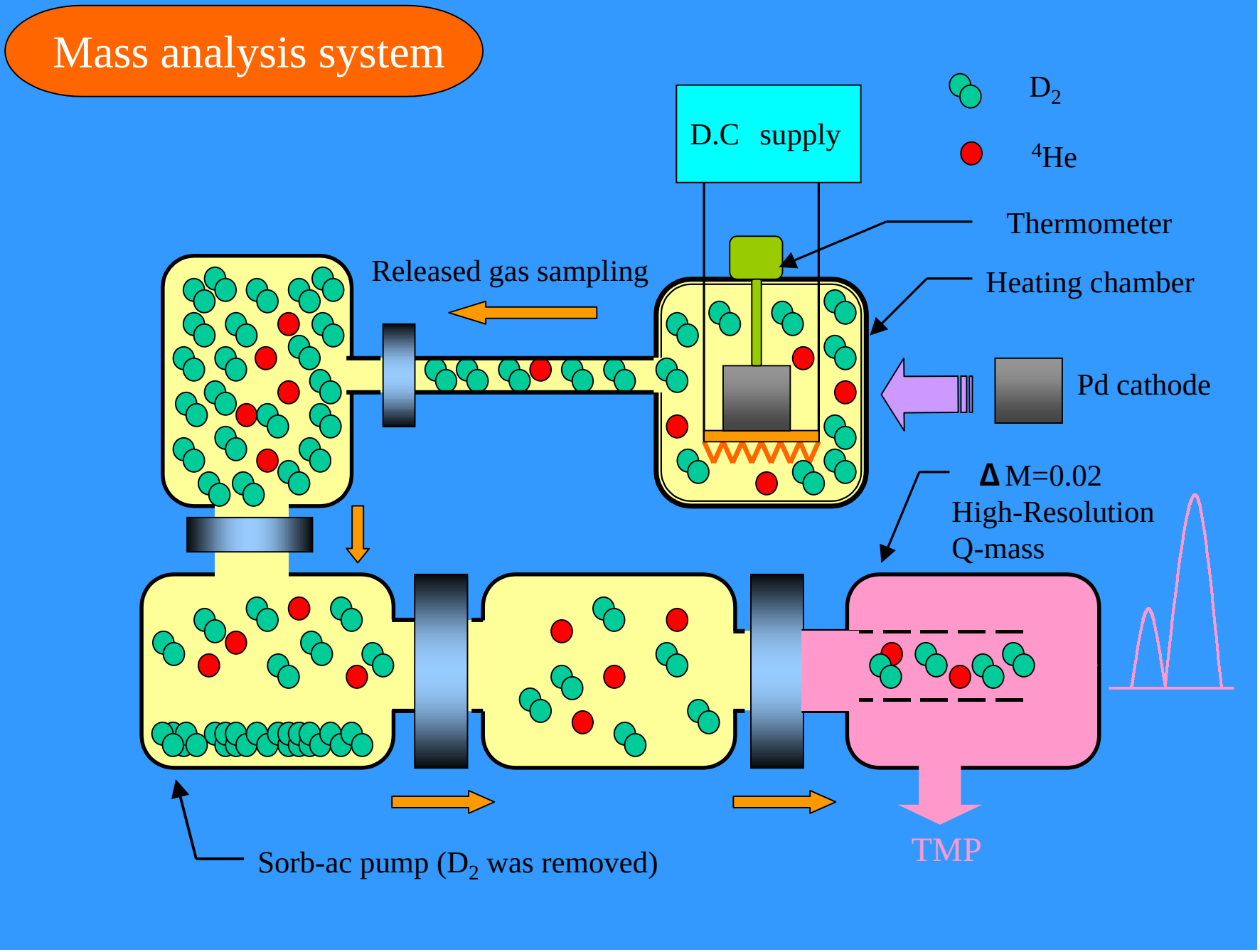
Cell	Open type
Cathode	Pd-Ce
Anode	Pt wire
Electrolyte	0.2M LiOD
Current mode	step-up mode

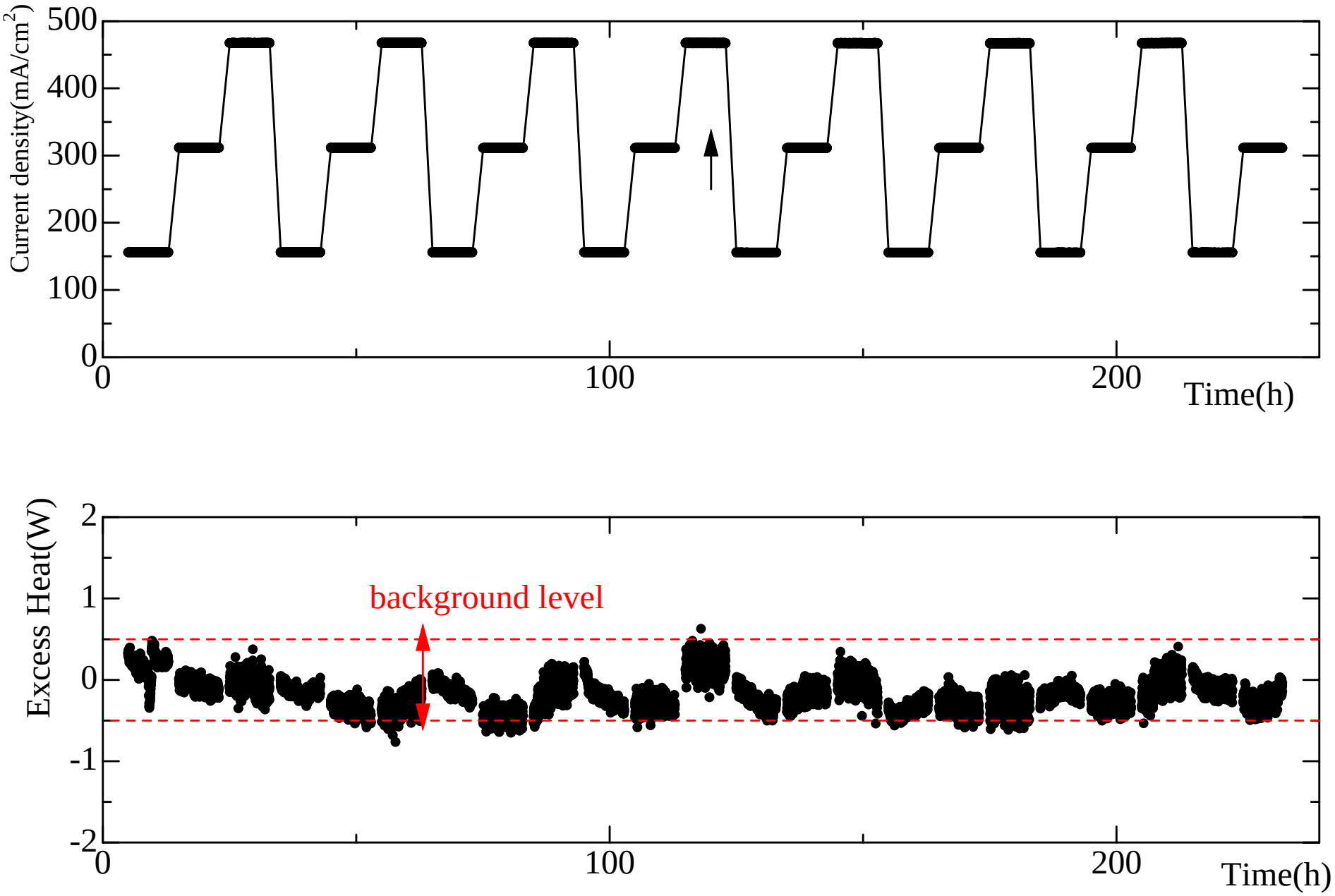
Input (W) = V × I

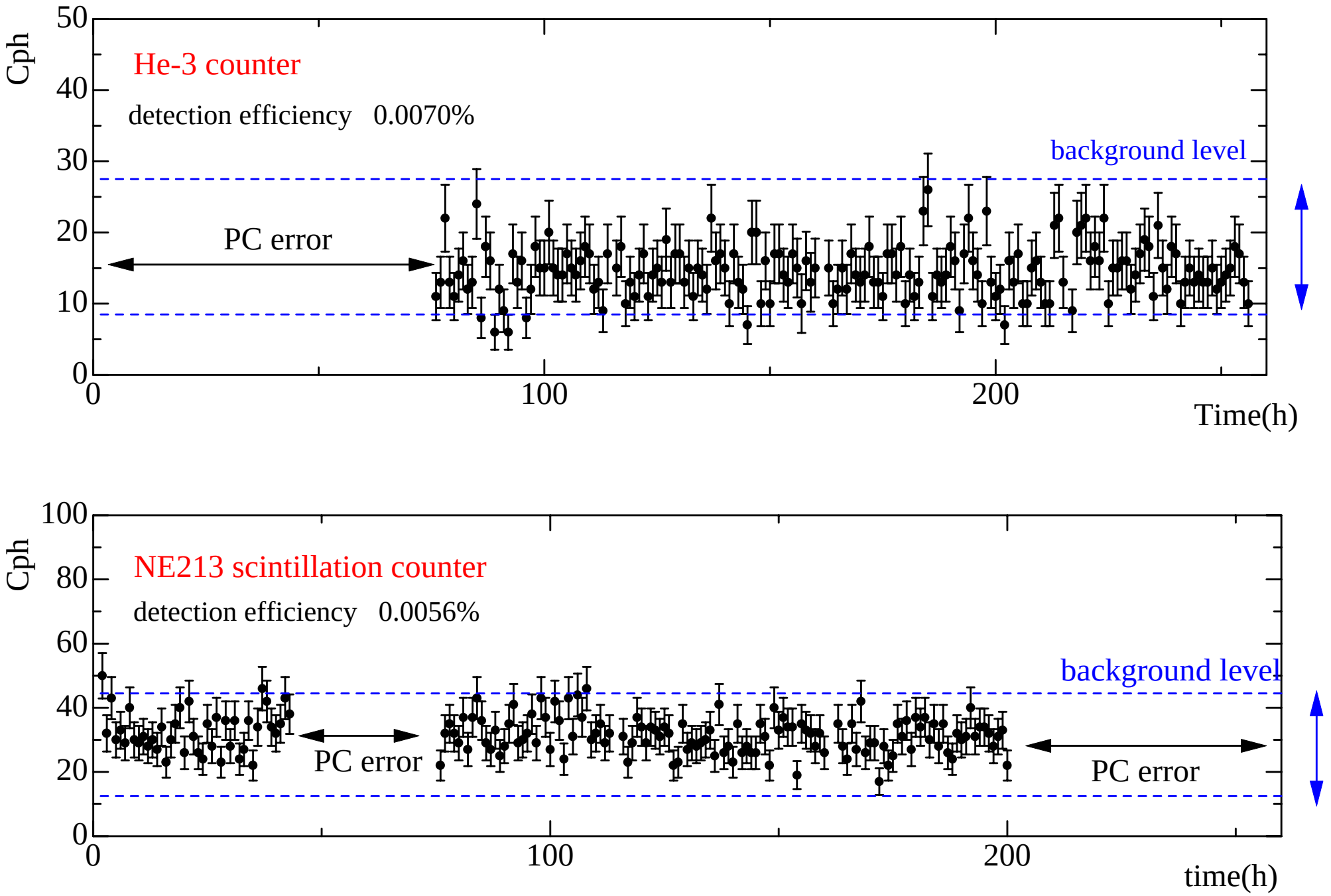
Output (W) = $4.1816 \times Q \times (T_{out} - T_{in})$

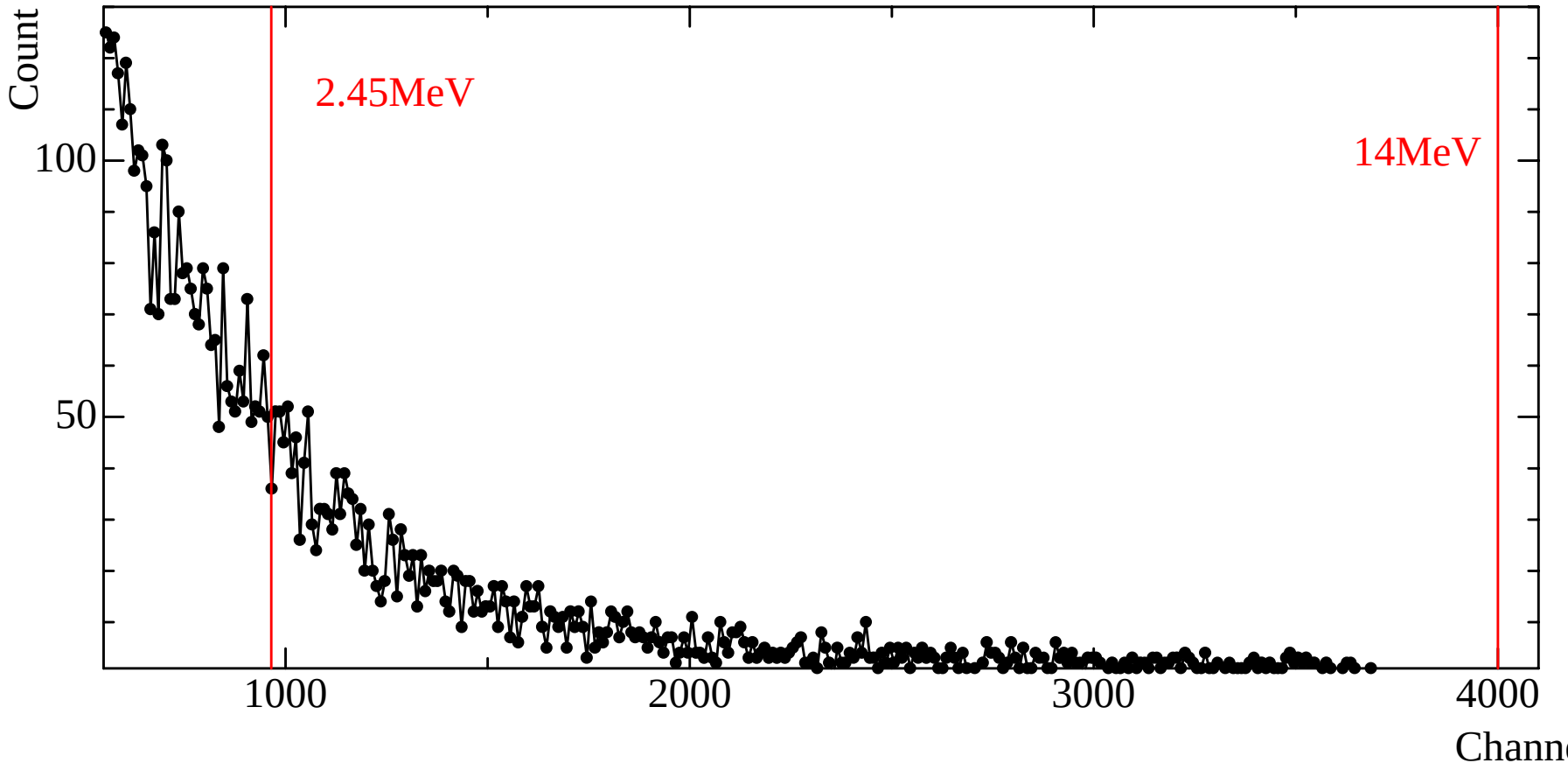
Excess heat (W) = Output − (α × Input)

Mass analysis system

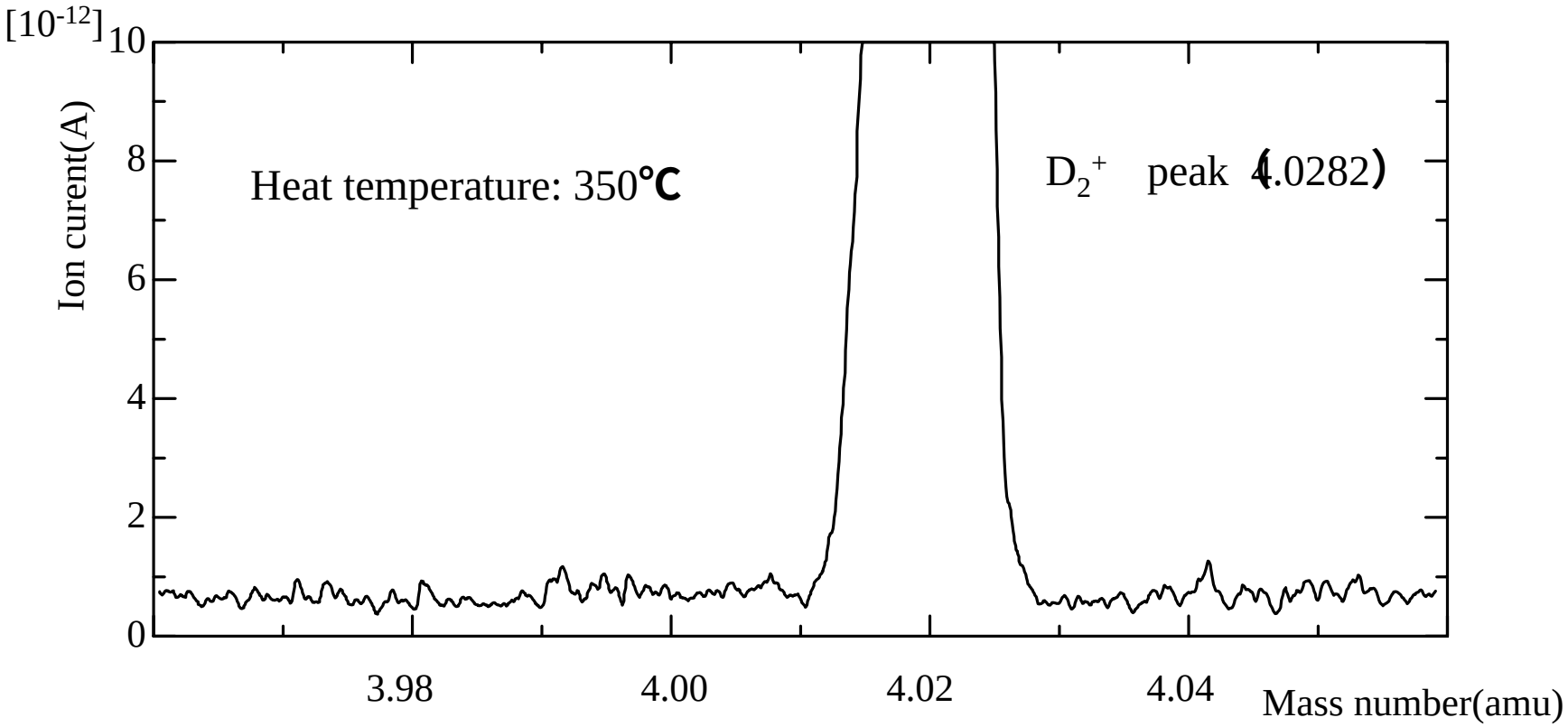



Current density(mA/cm^2)
500
400
300
200
100
0
0
100
200
Time(h)
Excess Heat(W)
2
1
0
-1
-2
background level
0
100
200
Time(h)


He-3 counter
detection efficiency 0.0070%
background level
PC error
Cph
Time(h)
0
10
20
30
40
50
0
100
200
NE213 scintillation counter
detection efficiency 0.0056%
background level
PC error
PC error
Cph
time(h)
0
20
40
60
80
100
0
100
200



Recoil proton energy spectrum during electrolysis (NE213 scintillation counter)


[10-12]
10
8
6
4
2
0
Ion curent(A)
Heat temperature: 350℃
D2+ peak (4.0282)
3.98
4.00
4.02
4.04
Mass number(amu)

Summary

In this experiment,there was no correlation between ^{4}He , neutron and excess heat.

There was possibility that ^{4}He was trapped at deeper site from the surface.

Future

NRA

- It was important to investigate the distribution of D-density around the deep area in PdDx coated with Cu.
- It was necessary to investigate the correlation between distribution of D-density and the thickness of metal layer.

Pd-Ce/D_2O electrolysis experiment

- It was necessary to change ratio ; Ce/Pd and rise the heating temperature.