II

X X

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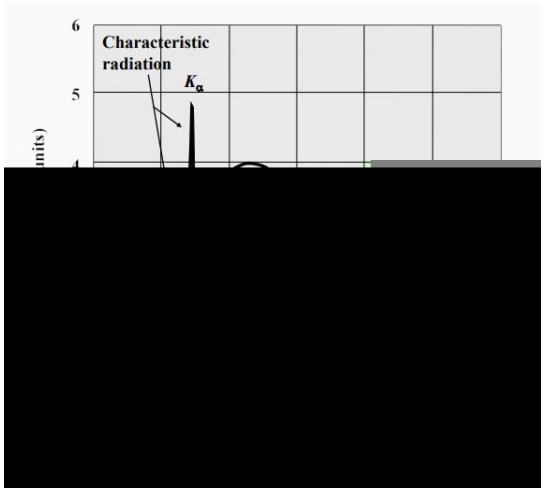

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X X

202111140061 2024/03/29

X X X X X $\lambda_1 = 0.061$ nm $\lambda_2 = 0.069$ nm
X X Duane-Hunt $h = 6.7119 \times 10^{-34}$; J · s 1.29

1

1895 X
X 1912 X X 0.1nm X X X
X
X X X X X [?]

2

2.1 X X

X X X X X X
X 1% X X
X X X X $\lambda_{\min}, \lambda_{\min}$ V
X
X $\lambda_{\min}$ X
X V

$$\lambda_{\min} = \frac{hc}{eV} = \frac{1.24 \times 10^3}{V} \text{ nm} \tag{1}$$

U Volt(V), Duane-Hunt U $\lambda_{\min}$, Planck h
Z X U I

- U X $\lambda_{\min}$ X $\lambda_{\max}$;
- U I X $\lambda_{\min}$ $\lambda_{\max}$
- Z X $\lambda_{\min}$ $\lambda_{\max}$;
- I $I = k\, IZV^2$

X X V
$h\nu = E_{n_2} - E_{n_1}$ K K L K X
$\mathbb{K}_\alpha$ 1 2
X :

- X ;
- V_{th} V_{th} X Z X 20 kV
- U V_{th} X U I V_{th}

$$I = k\, I(V - V_{\text{th}})^m \tag{2}$$

K $m = 1.5$,L $m = 2$

2.2 X

X

- -
- X

$$\Delta\lambda = \frac{h}{m_e c}(1 - \cos 2\theta) \tag{3}$$

- X X X X
  X X

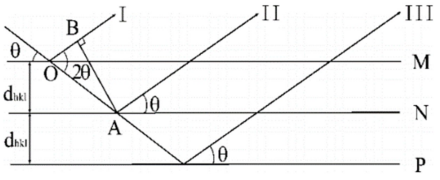

Figure 1: X

Figure 1 X $\delta = 2d\sin\theta$ δ X λ n

$$2d\sin\theta = n\lambda, \quad n \in \mathbb{Z} \tag{4}$$

n (**??**)

2.3 X

X X X , Figure 2 X X $\theta : 2\theta$

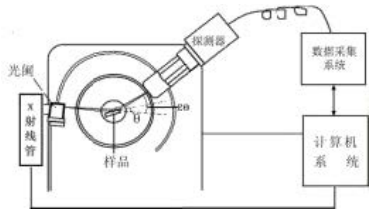

Figure 2: X

3

1.

X $U = 35$ kV $I = 1.00$ mA (COUPLED) $\beta_{\min} = 2°, \beta_{\max} = 25°,$ $\Delta\beta = 0.1°$ $\Delta t = 10$s "SCAN"

2. X X
   $U = 15$ kV $I = 1$ mA $\beta_{\min} = 2°, \beta_{\max} = 10°$
   5 kV 35 kV

3. X X
   $U = 35$ kV, $I = 0.4$ mA,$\beta_{\min} = 6°, \beta_{\max} = 7.5°$ 0.1 mA 1 mA

4

4.1

Figure 3 $\beta : 2° \sim 25°$ $U = 35$kV (**??**) ($d = 0.282$nm)
X

$$\lambda_1 = 0.061\,\text{nm} \tag{5}$$
$$\lambda_2 = 0.069\,\text{nm} \tag{6}$$

Table 1: X ,$U = 35$kV

n	1		2		3	
$\theta/^\circ$	6	6.9	12.6	14.2	19.3	21.9
λ_1/nm	0.059		0.062		0.062	
λ_2/nm		0.068		0.069		0.070
$\overline{\lambda_1}$/nm	0.061					
$\overline{\lambda_2}$/nm	0.069					

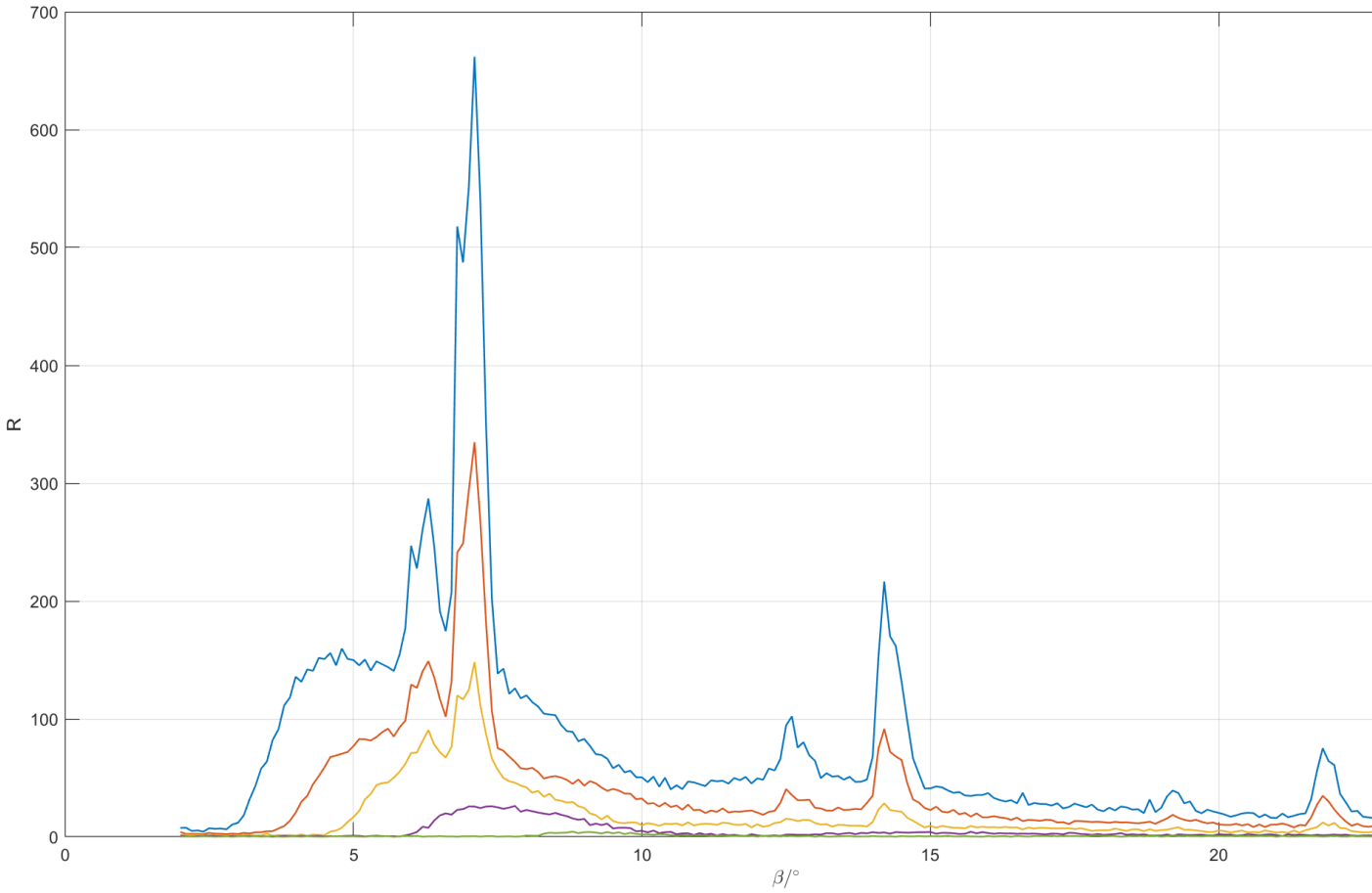

Figure 3: $35, 30, 25, 20, 15$ kV β

$I = 1$ mA $15 \sim 35$ kV

- Figure 3 U X $\lambda_{\min}$;
- X ;
- Figure 3 $U = 15$ kV,20 kV X V_{th} $20 \sim 25$ kV

10 Figure 3 10 2 : 1 X X X

:

- $\Delta\beta = 0.1^\circ$
-

4.2 V_{th}

Figure 4 $U > 20$ kV $U = 20$ kV ( ) $V_{\text{th}} = 20$ kV

( ) $\theta = 7.2°$
$T = 10$ s

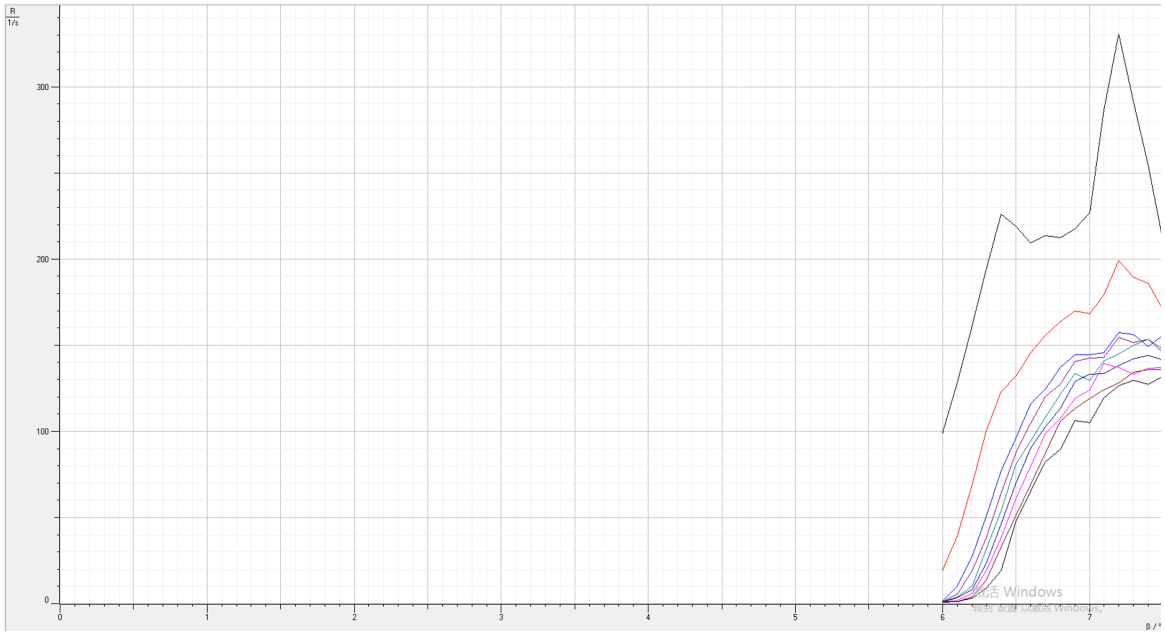

Figure 4: $22, 21, 20.5, 20.4, 20.3, 20.2, 20.1, 20, 19.9$ kV β

4.3 Duane-Hunt

Duane-Hunt (??) (??) $\lambda_{\min}$($U : 15 \sim 35$ kV) $\lambda_{\mathrm{dh}}, \lambda_{\mathrm{brg}}$ $U = 15$kV

Table 2: Duane-Hunt $\lambda_{\min}$

U/kV	15	20	25	30	35
$\theta/°$	8.4	6.1	4.7	3.7	2.8
λ_{brg}/nm	0.082	0.060	0.046	0.036	0.028
λ_{dh}/nm	0.083	0.062	0.050	0.041	0.035

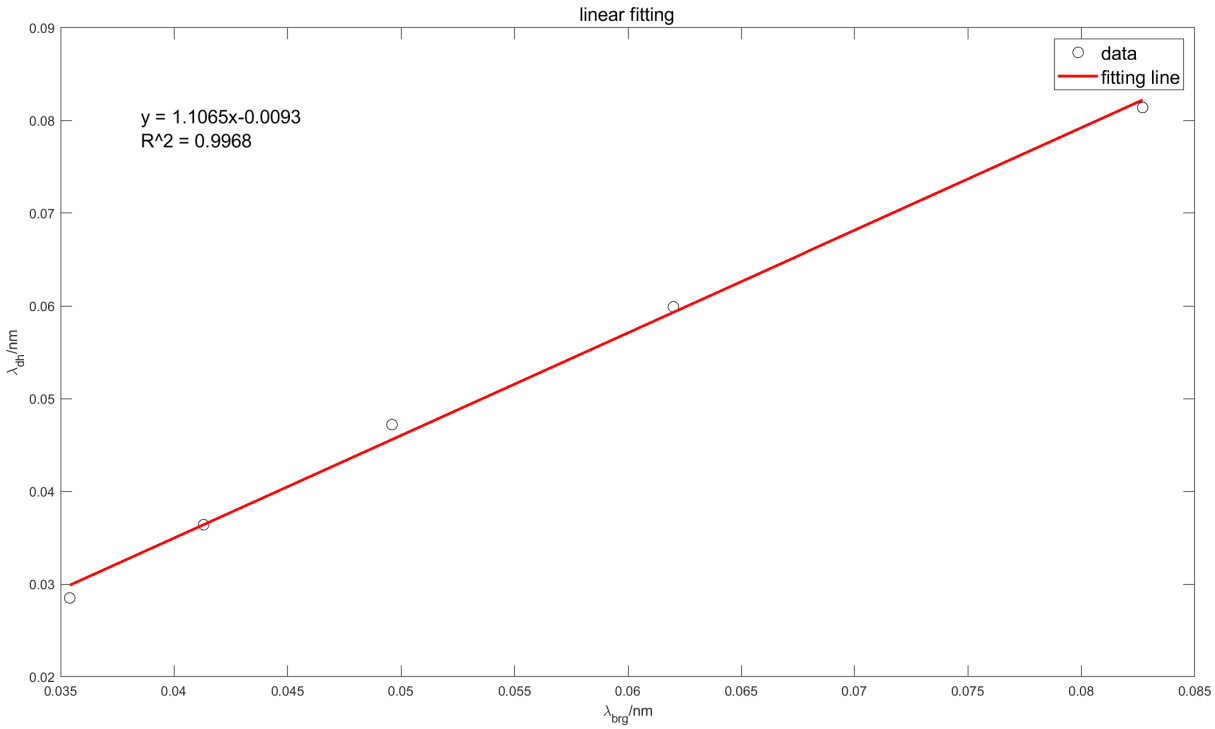

Figure 5: Duane-Hunt $\lambda_{\min}$

Figure 5 Python scipy.stats linregress

$$\lambda_{\mathrm{dh}} = 0.892\lambda_{\mathrm{brg}} + 0.009(\,\mathrm{nm}), \qquad R^2 = 0.9993901058 \tag{7}$$

$\lambda_{\mathrm{brg}} = \lambda_{\mathrm{dh}}$, :Duane-Hunt

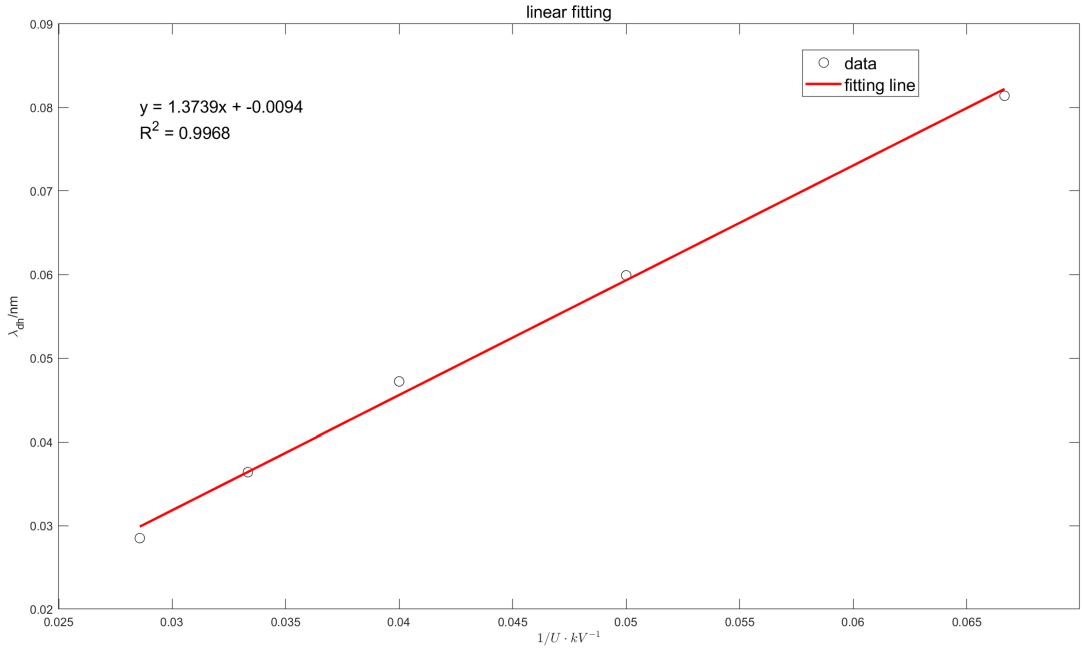

Figure 6: $\lambda_{\min}$ X U

(??) $\lambda_{\min}$ X U

$$\lambda_{\min} = \frac{1.2559\ \mathrm{kV}}{U} - 0.0007(\,\mathrm{nm}), \qquad R^2 = 0.9991820854 \tag{8}$$

$\lambda_{\min}$ $1/U$ $k = 1.2559\ \mathrm{kV}\cdot\,\mathrm{nm}$, c e

$$h = \frac{ek}{c} = 6.7119 \times 10^{-34}\ \mathrm{J}\cdot\mathrm{s} \tag{9}$$

$h_{\mathrm{re}} = 6.62607015 \times 10^{-34}\ \mathrm{J \cdot s}$ $\delta = 1.29\%$

- $\Delta\beta = 0.1°$
-

4.4 X X

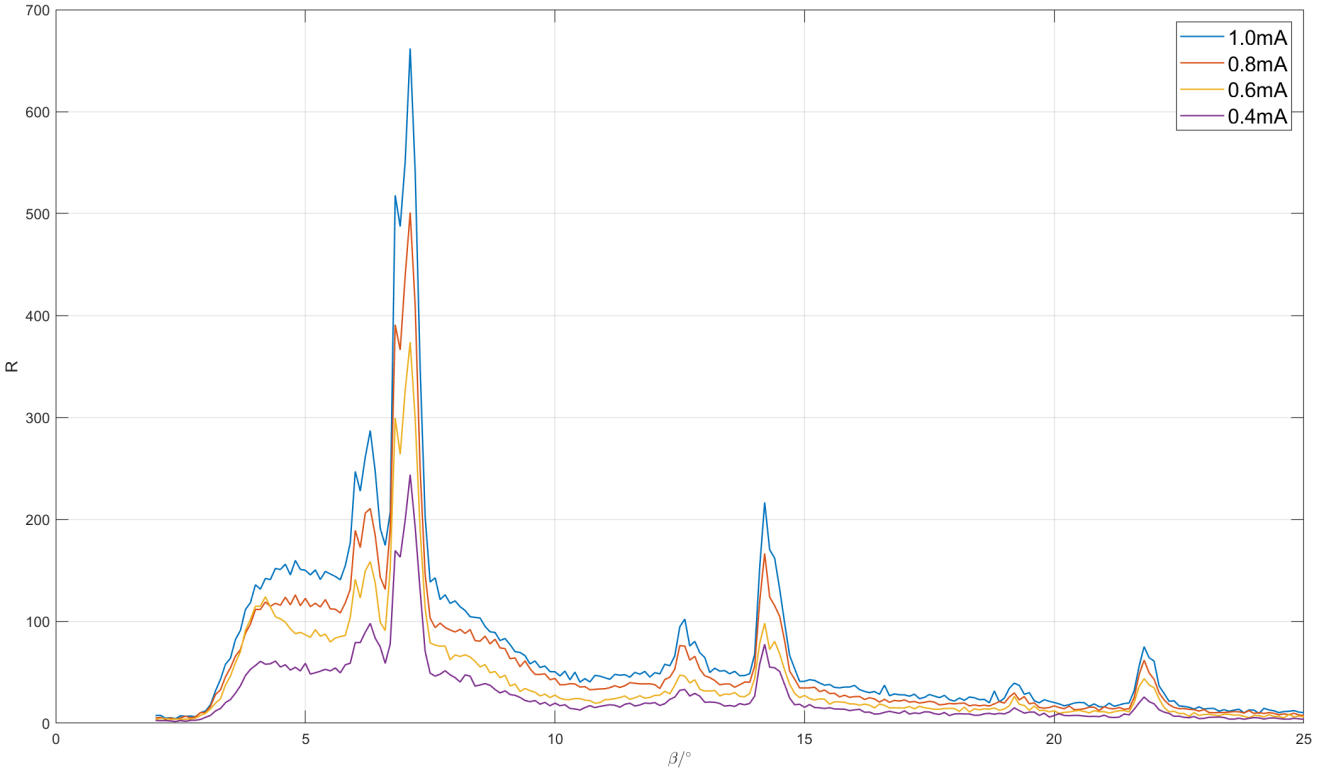

Figure 7: $1, 0.8, 0.6, 0.4$ mA β

Figure 7

- $U = 35\mathrm{kV}$ I X
- β λ X

5

X X :$\lambda_1 = 0.061$ nm $\lambda_2 = 0.069$ nm X X
V X $\lambda_{\min}$ X V_{th} Duane-Hunt
$h = 6.7119 \times 10^{-34}\ \mathrm{J \cdot s}$ 1.29% X X I X X