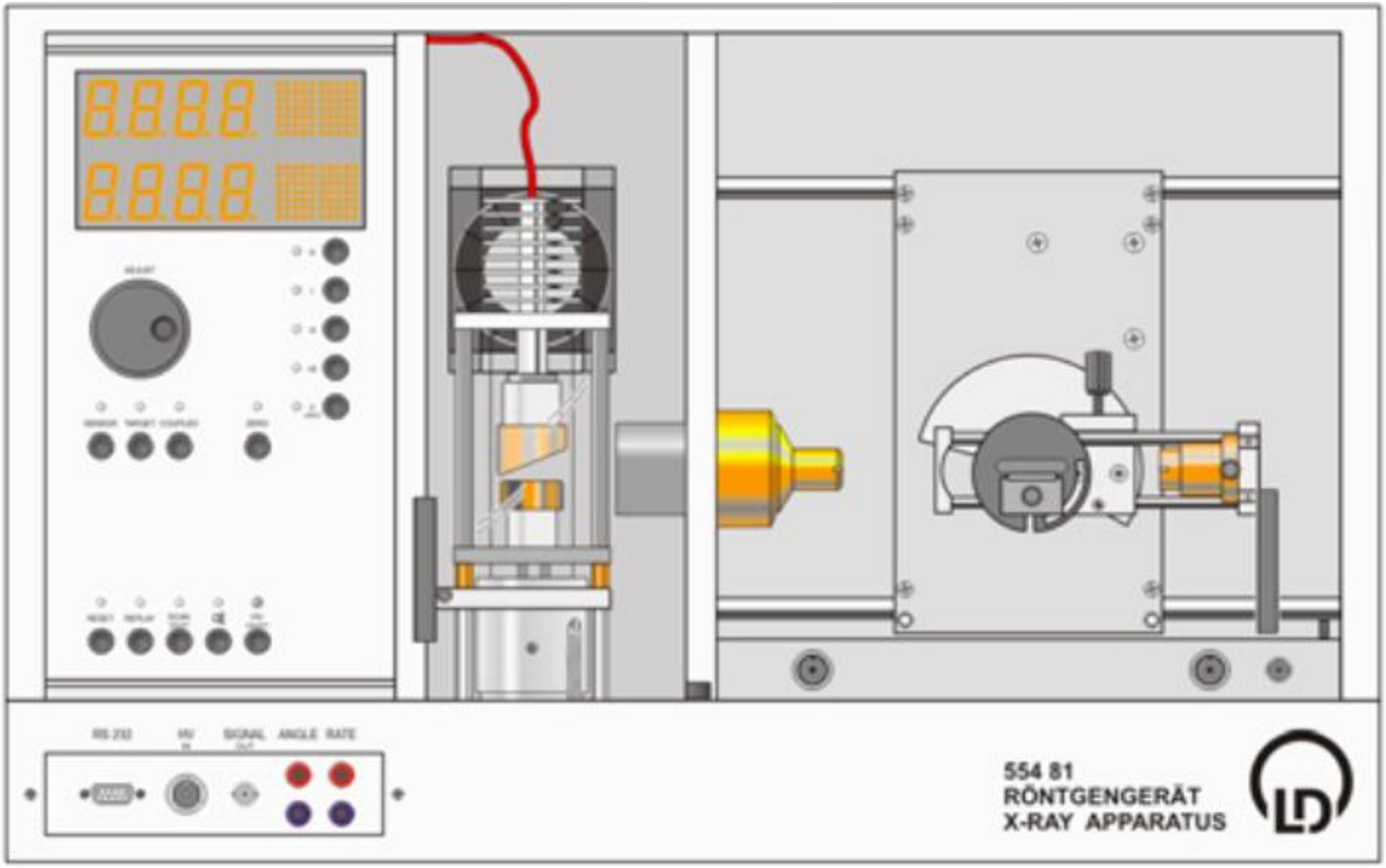
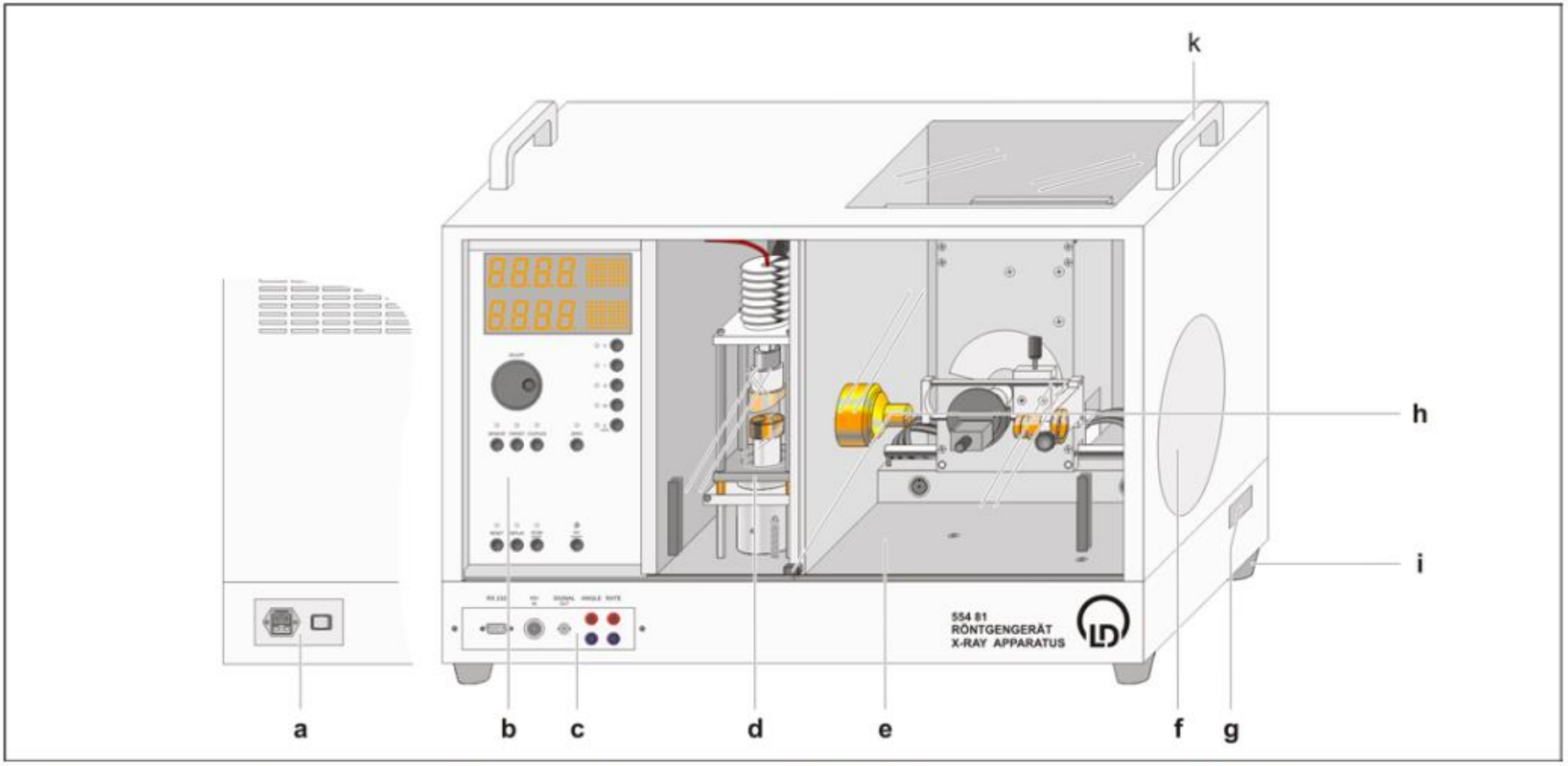
Difração de Raio X

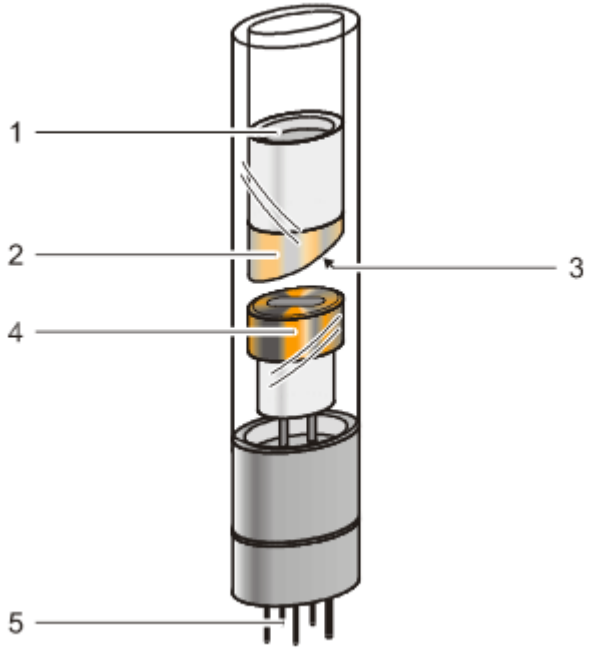
J. Kogler – EP USP

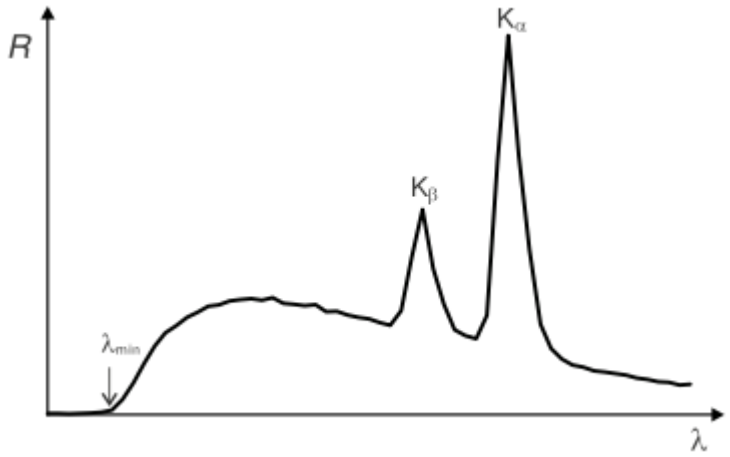
2016

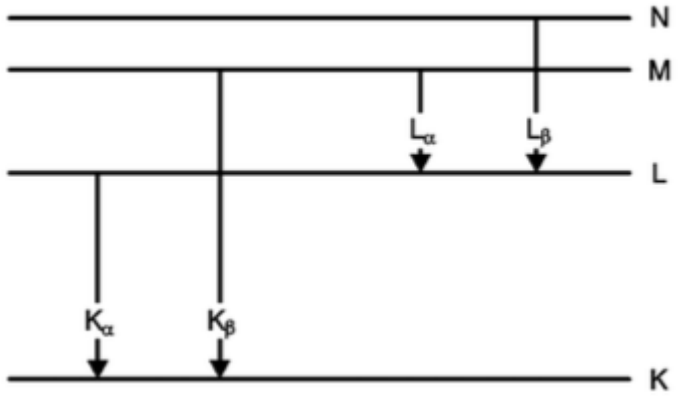

RS 232
I/U
SIGNAL OUT
ANGLE
RATE
554 81
RÖNTGENGERÄT
X-RAY APPARATUS

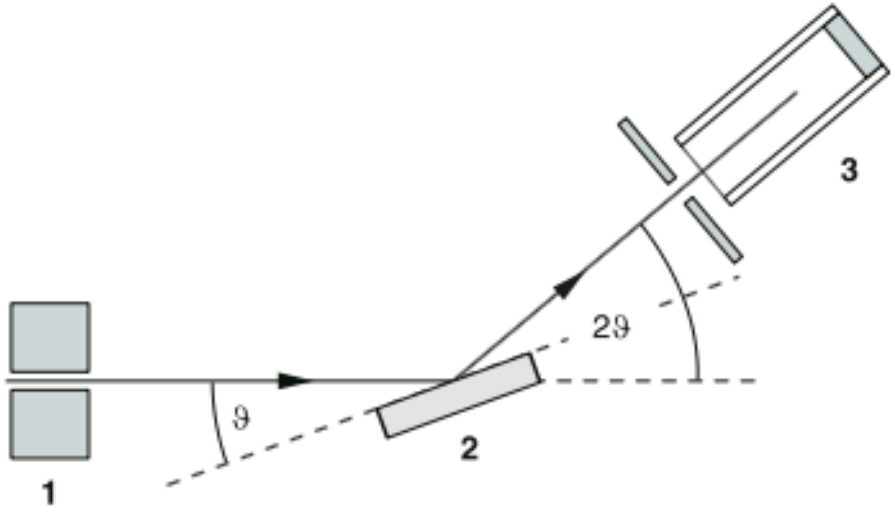


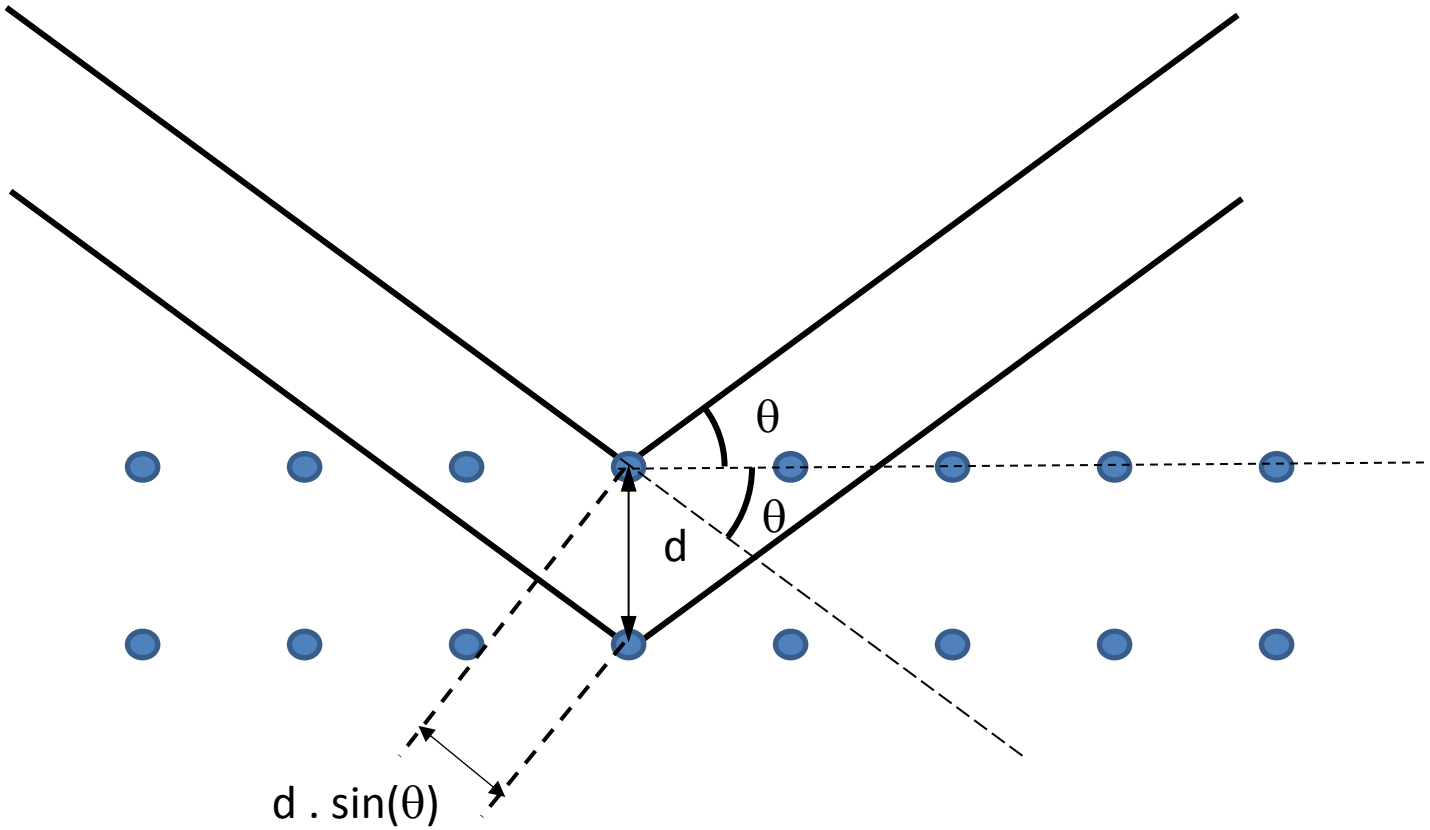
a Campo de conexão à rede
b Campo de comando
c Campo de conexão
d Câmara do tubo (com tubo de raios X)
e Câmara de experiências (aqui com goniômetro)
f Tela fluorescente
g Canal livre
h Tecla de bloqueio
i Pés
k Alças de transporte

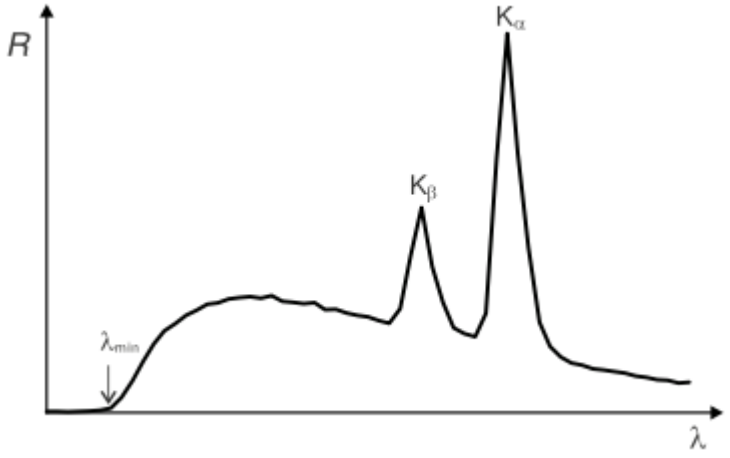

1
2
3
4
5

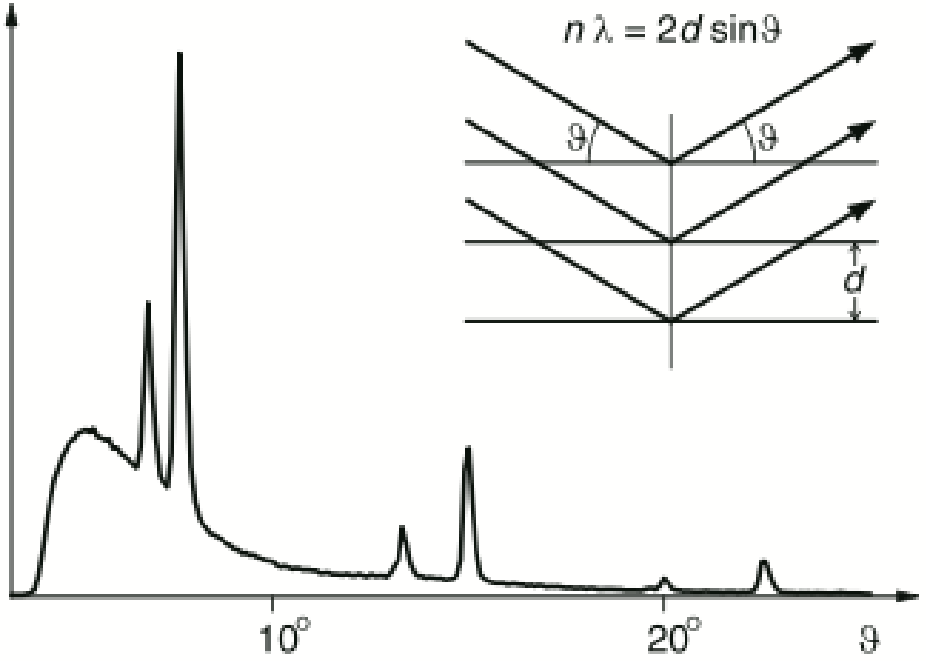

R
K_α
K_β
λ_{min}
λ


N
M
L
K
L_α
L_β
K_α
K_β


1
2
3
ϑ
2ϑ


θ
θ
d
d . sin(θ)


R
K_α
K_β
λ_{min}
λ


$n\lambda = 2d\sin\vartheta$
ϑ
ϑ
d
10°
20°
ϑ

X-Ray Apparatus

00:04:36

Bragg | Planck | Transmission | Moseley

β / °

R
1/s

10
5
0

0 10 20 30 40 50 60
β / °

X-Ray Apparatus

U = 5.0 kV
I = 0.00 mA
Δt = 1 s
Δβ = 0.1 °

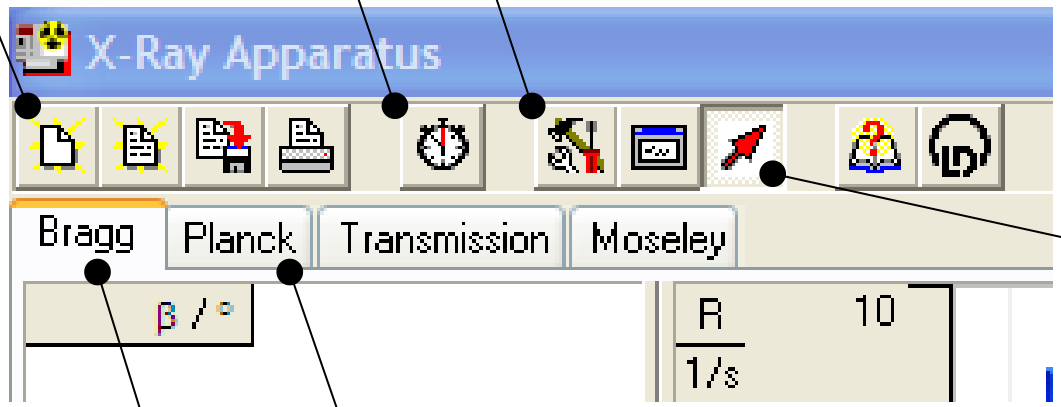
0 /s
0.0 °
0.0 °

Iniciar | X-Ray Apparatus | 10:13

Salvar / apagar area de trabalho

Parar / reiniciar medições

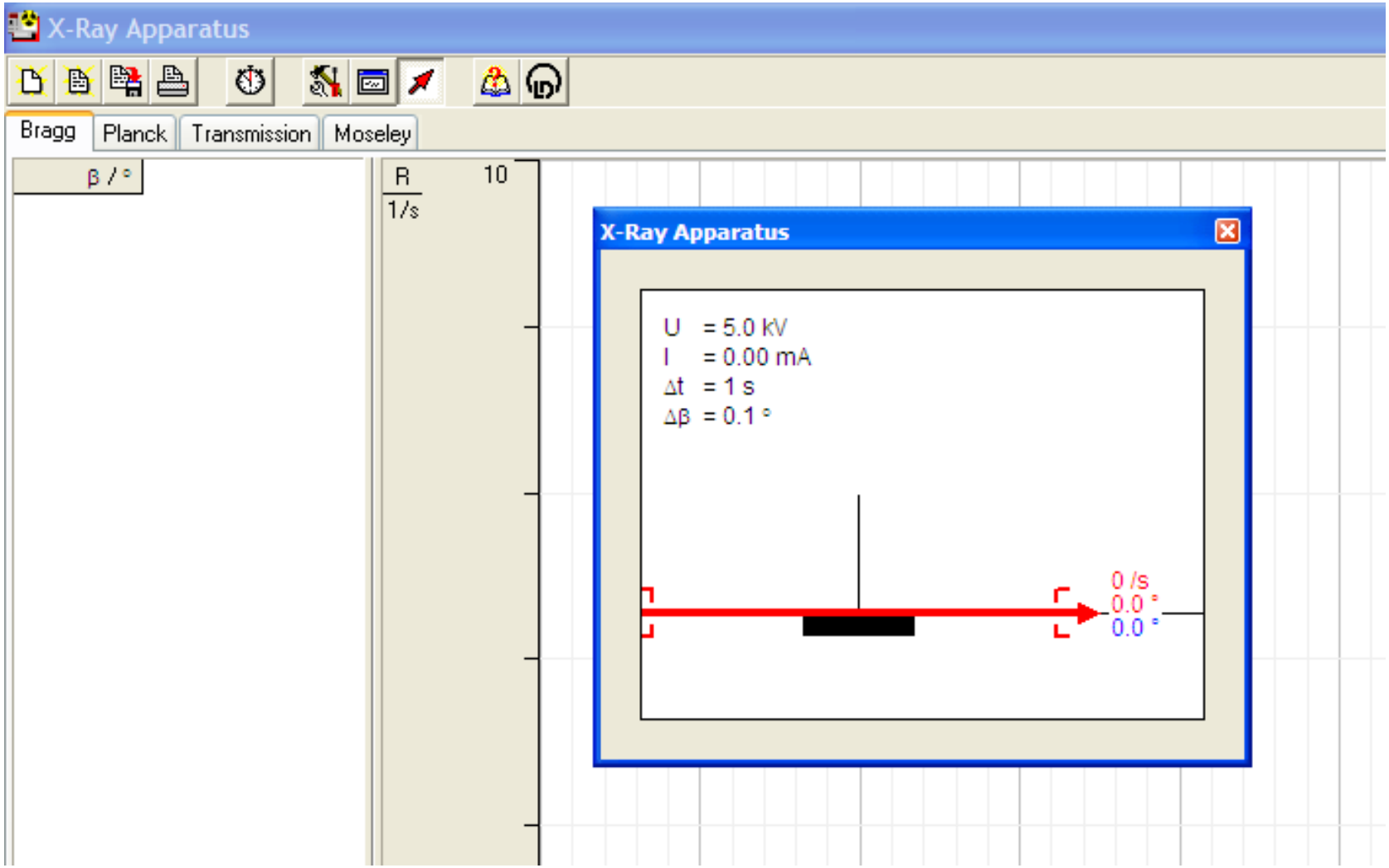
Ajustes dos parâmetros experimentais

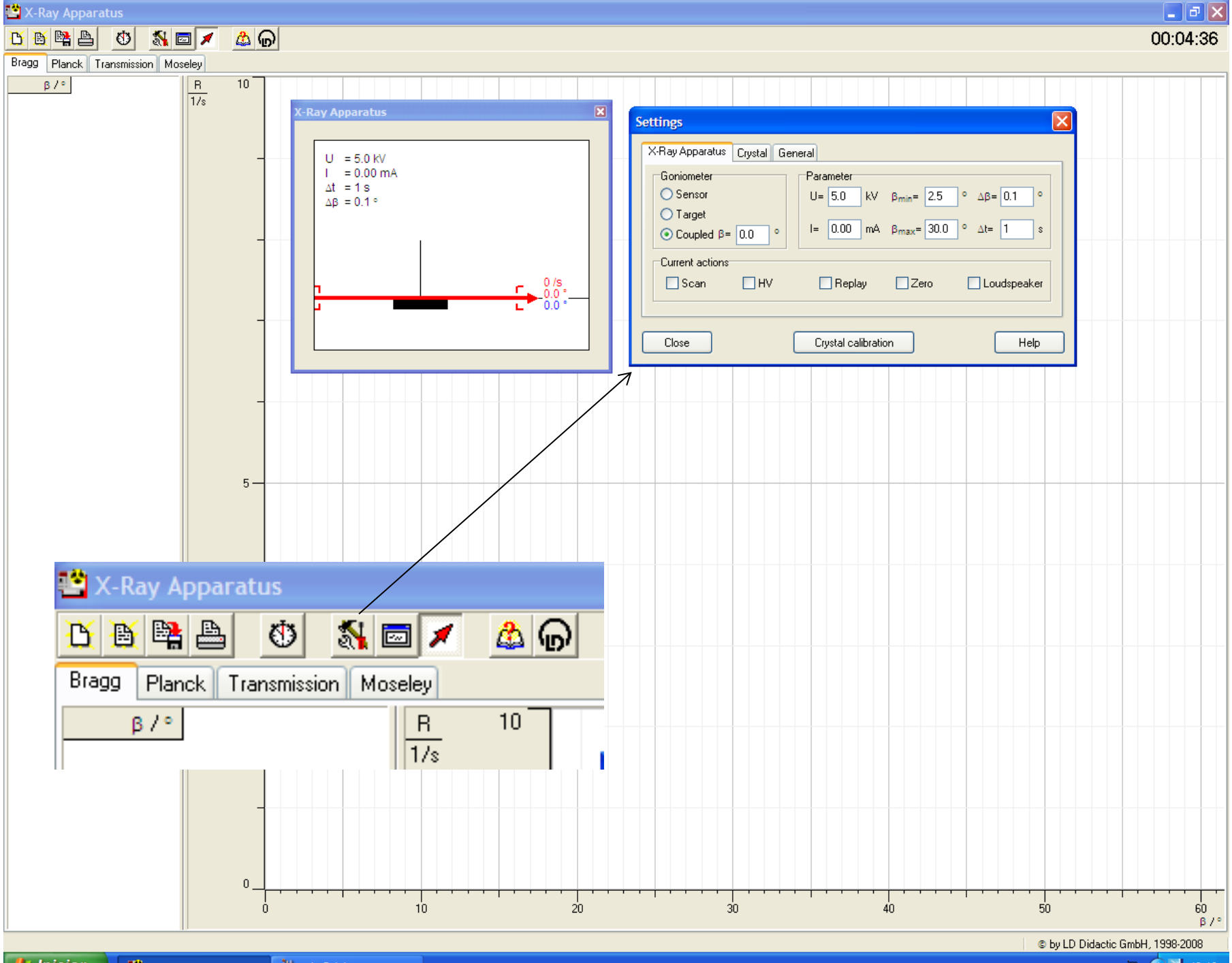


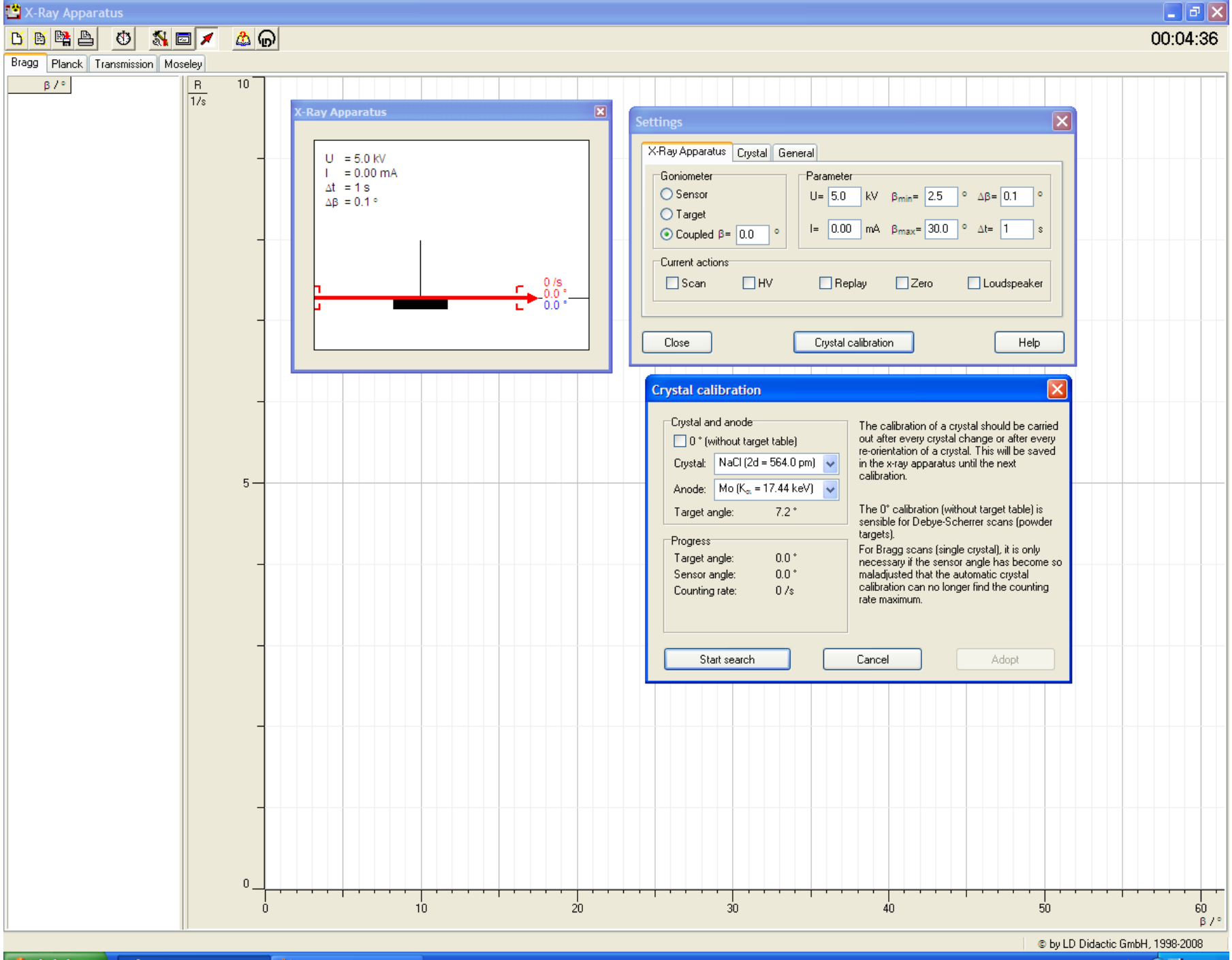
Visualização dos ângulos

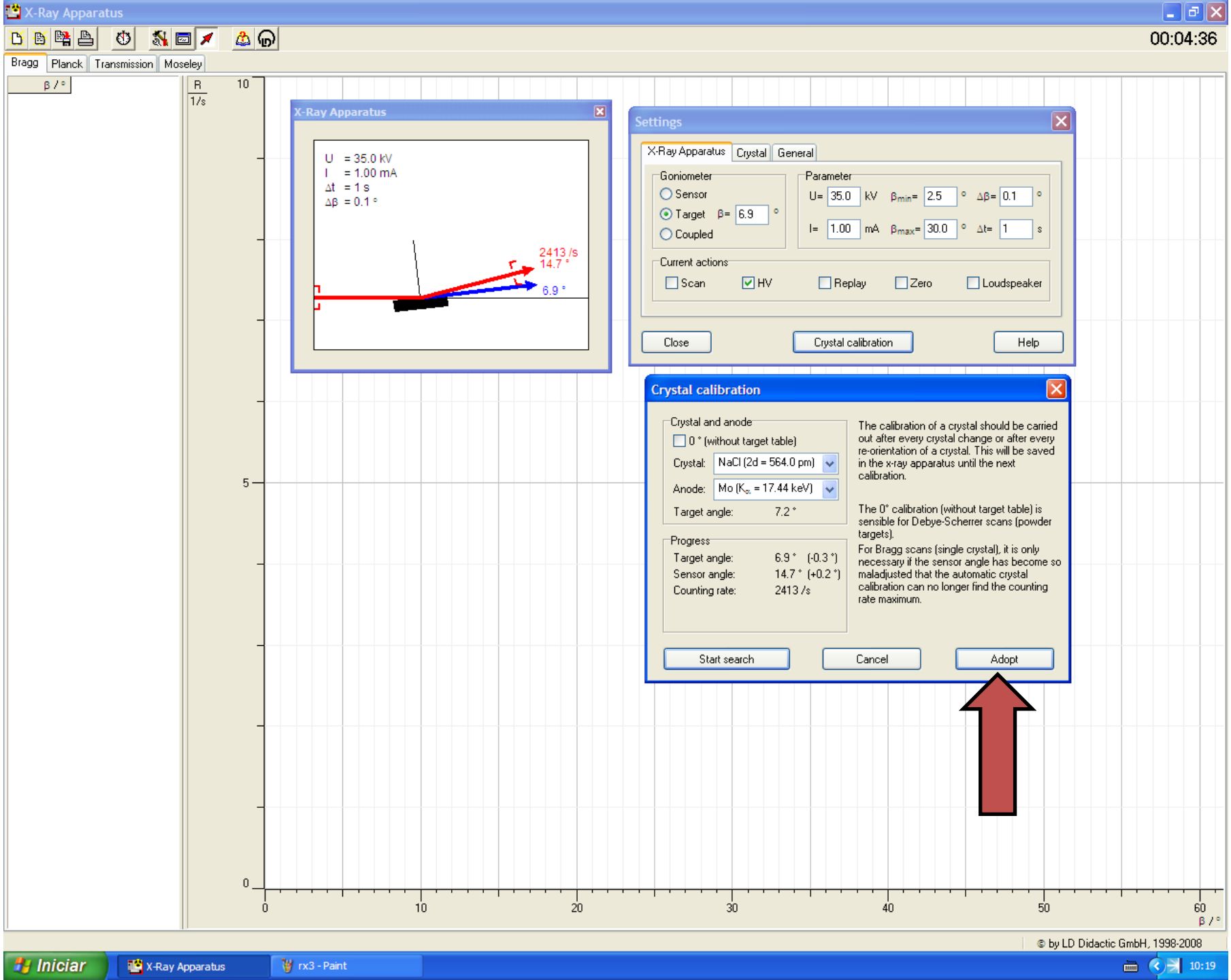
2ª parte – determinação de ***h*** via Duane-Hunt

1ª parte – difratometria de Bragg p/medir "***d***"


X-Ray Apparatus
Bragg
Planck
Transmission
Moseley
β / °
R
1/s
10
X-Ray Apparatus
U = 5.0 kV
I = 0.00 mA
Δt = 1 s
Δβ = 0.1 °
0 /s
0.0 °
0.0 °


X-Ray Apparatus
00:04:36
Bragg
Planck
Transmission
Moseley
β / °
R
1/s
10
5
0
0
10
20
30
40
50
60
β / °
X-Ray Apparatus
U = 5.0 kV
I = 0.00 mA
Δt = 1 s
Δβ = 0.1 °
0 /s
0.0 °
0.0 °
Settings
X-Ray Apparatus
Crystal
General
Goniometer
Sensor
Target
Coupled β= 0.0 °
Parameter
U= 5.0 kV
I= 0.00 mA
βmin= 2.5 °
βmax= 30.0 °
Δβ= 0.1 °
Δt= 1 s
Current actions
Scan
HV
Replay
Zero
Loudspeaker
Close
Crystal calibration
Help
X-Ray Apparatus
Bragg
Planck
Transmission
Moseley
β / °
R
1/s
10
© by LD Didactic GmbH, 1998-2008
Iniciar
X-Ray Apparatus
rx1 - Paint
10:16


X-Ray Apparatus
00:04:36
Bragg
Planck
Transmission
Moseley
β / °
R
1/s
10
5
0
0
10
20
30
40
50
60
β / °
X-Ray Apparatus
U = 5.0 kV
I = 0.00 mA
Δt = 1 s
Δβ = 0.1 °
0 /s
0.0 °
0.0 °
Settings
X-Ray Apparatus
Crystal
General
Goniometer
Sensor
Target
Coupled β= 0.0 °
Parameter
U= 5.0 kV
I= 0.00 mA
βmin= 2.5 °
βmax= 30.0 °
Δβ= 0.1 °
Δt= 1 s
Current actions
Scan
HV
Replay
Zero
Loudspeaker
Close
Crystal calibration
Help
Crystal calibration
Crystal and anode
0 ° (without target table)
Crystal: NaCl (2d = 564.0 pm)
Anode: Mo (Kα = 17.44 keV)
Target angle: 7.2 °
Progress
Target angle: 0.0 °
Sensor angle: 0.0 °
Counting rate: 0 /s
The calibration of a crystal should be carried out after every crystal change or after every re-orientation of a crystal. This will be saved in the x-ray apparatus until the next calibration.
The 0° calibration (without target table) is sensible for Debye-Scherrer scans (powder targets).
For Bragg scans (single crystal), it is only necessary if the sensor angle has become so maladjusted that the automatic crystal calibration can no longer find the counting rate maximum.
Start search
Cancel
Adopt
© by LD Didactic GmbH, 1998-2008
Iniciar
X-Ray Apparatus
rx2 - Paint
10:16


X-Ray Apparatus
00:04:36
Bragg
Planck
Transmission
Moseley
β / °
R
1/s
10
5
0
0
10
20
30
40
50
60
β / °
X-Ray Apparatus
U = 35.0 kV
I = 1.00 mA
Δt = 1 s
Δβ = 0.1 °
2413 /s
14.7 °
6.9 °
Settings
X-Ray Apparatus
Crystal
General
Goniometer
Sensor
Target β= 6.9 °
Coupled
Parameter
U= 35.0 kV βmin= 2.5 ° Δβ= 0.1 °
I= 1.00 mA βmax= 30.0 ° Δt= 1 s
Current actions
Scan
HV
Replay
Zero
Loudspeaker
Close
Crystal calibration
Help
Crystal calibration
Crystal and anode
0 ° (without target table)
Crystal: NaCl (2d = 564.0 pm)
Anode: Mo (Kα = 17.44 keV)
Target angle: 7.2 °
Progress
Target angle: 6.9 ° (-0.3 °)
Sensor angle: 14.7 ° (+0.2 °)
Counting rate: 2413 /s
The calibration of a crystal should be carried out after every crystal change or after every re-orientation of a crystal. This will be saved in the x-ray apparatus until the next calibration.
The 0° calibration (without target table) is sensible for Debye-Scherrer scans (powder targets).
For Bragg scans (single crystal), it is only necessary if the sensor angle has become so maladjusted that the automatic crystal calibration can no longer find the counting rate maximum.
Start search
Cancel
Adopt
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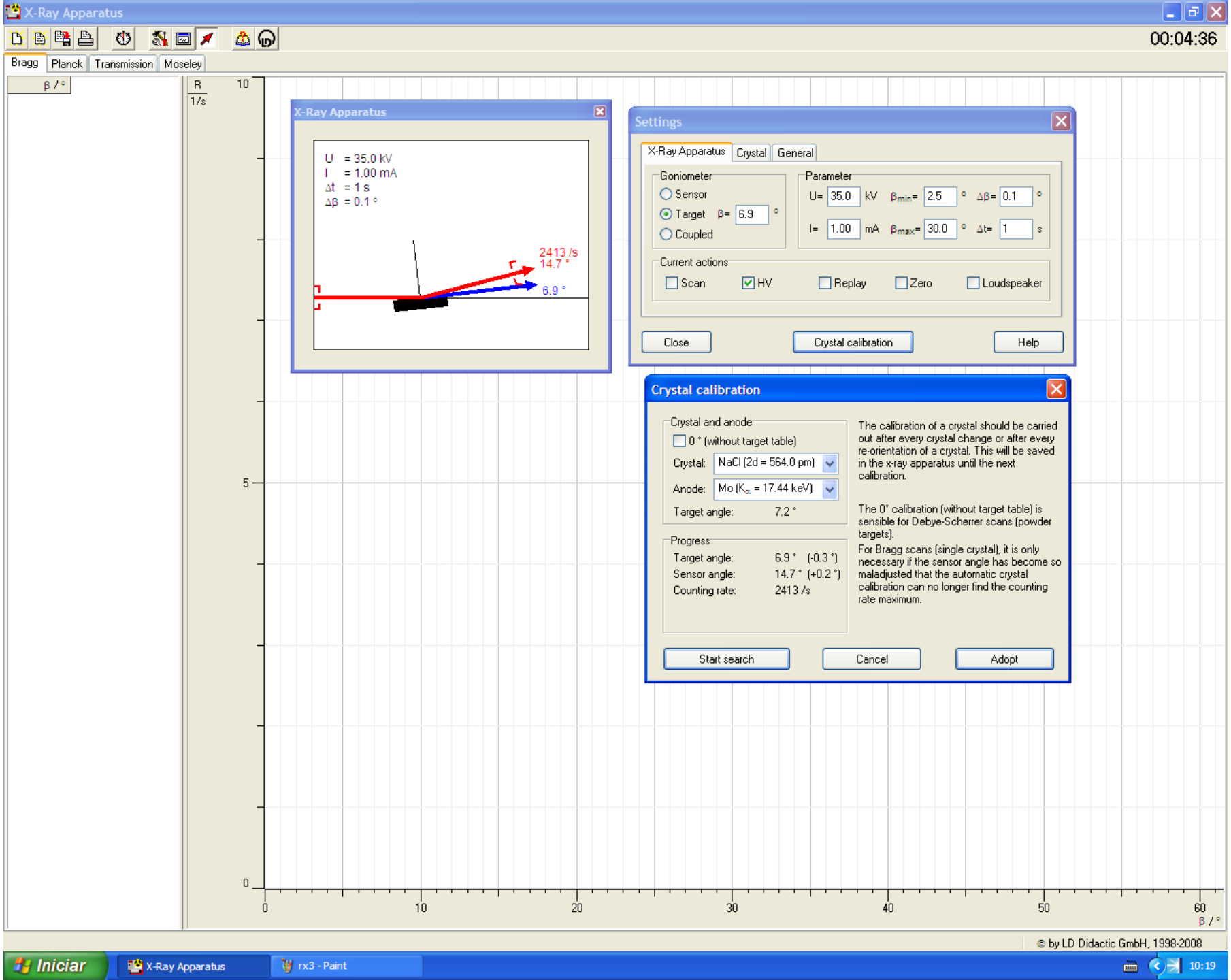
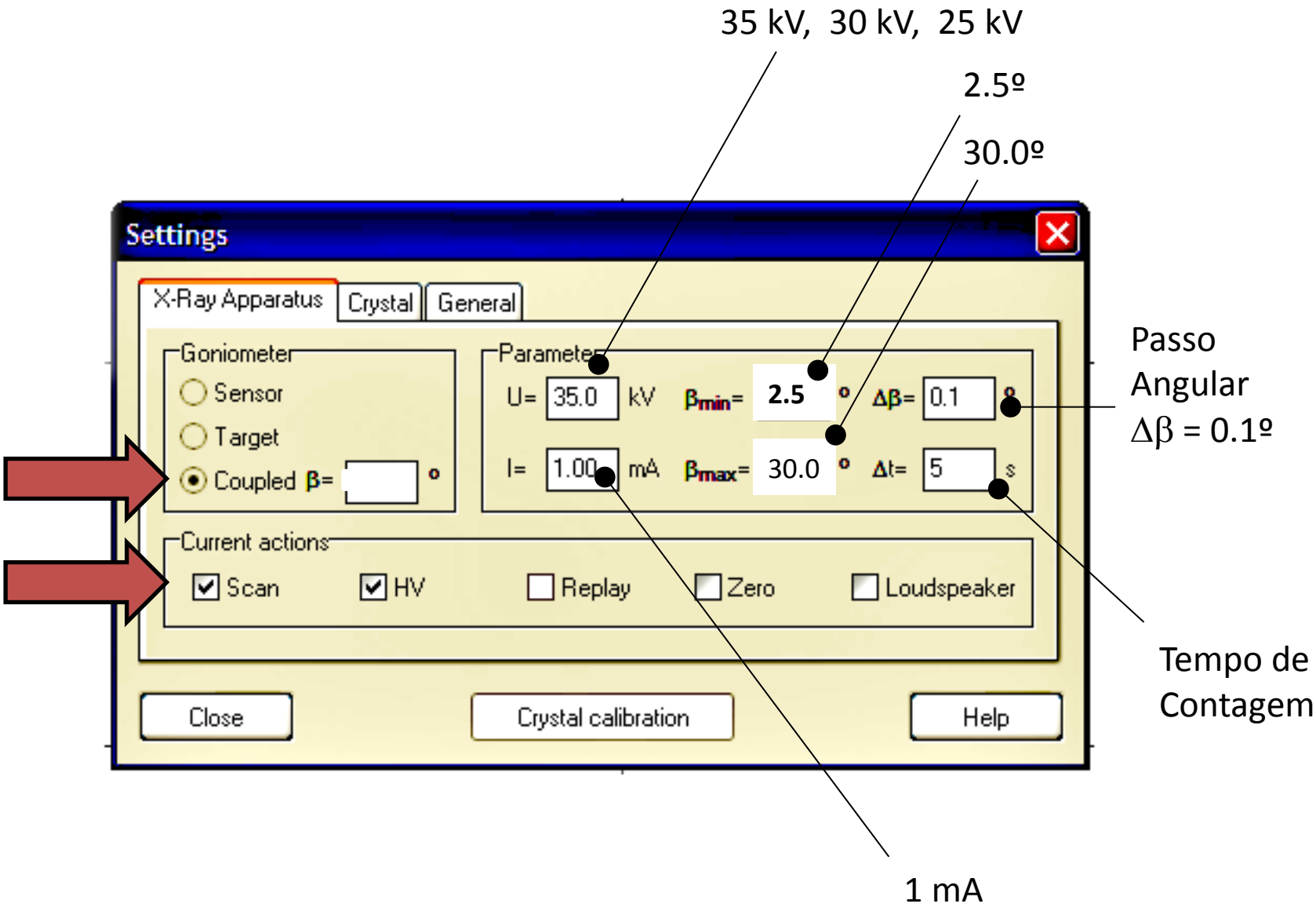
Iniciar
X-Ray Apparatus
rx3 - Paint
10:19


X-Ray Apparatus
00:04:36
Bragg
Planck
Transmission
Moseley
β / °
R
1/s
10
5
0
0
10
20
30
40
50
60
β / °
X-Ray Apparatus
U = 35.0 kV
I = 1.00 mA
Δt = 1 s
Δβ = 0.1 °
2413 /s
14.7 °
6.9 °
Settings
X-Ray Apparatus
Crystal
General
Goniometer
Sensor
Target β= 6.9 °
Coupled
Parameter
U= 35.0 kV
βmin= 2.5 °
Δβ= 0.1 °
I= 1.00 mA
βmax= 30.0 °
Δt= 1 s
Current actions
Scan
HV
Replay
Zero
Loudspeaker
Close
Crystal calibration
Help
Crystal calibration
Crystal and anode
0 ° (without target table)
Crystal: NaCl (2d = 564.0 pm)
Anode: Mo (Kα = 17.44 keV)
Target angle: 7.2 °
Progress
Target angle: 6.9 ° (-0.3 °)
Sensor angle: 14.7 ° (+0.2 °)
Counting rate: 2413 /s
The calibration of a crystal should be carried out after every crystal change or after every re-orientation of a crystal. This will be saved in the x-ray apparatus until the next calibration.
The 0° calibration (without target table) is sensible for Debye-Scherrer scans (powder targets).
For Bragg scans (single crystal), it is only necessary if the sensor angle has become so maladjusted that the automatic crystal calibration can no longer find the counting rate maximum.
Start search
Cancel
Adopt
© by LD Didactic GmbH, 1998-2008
Iniciar
X-Ray Apparatus
rx3 - Paint
10:19

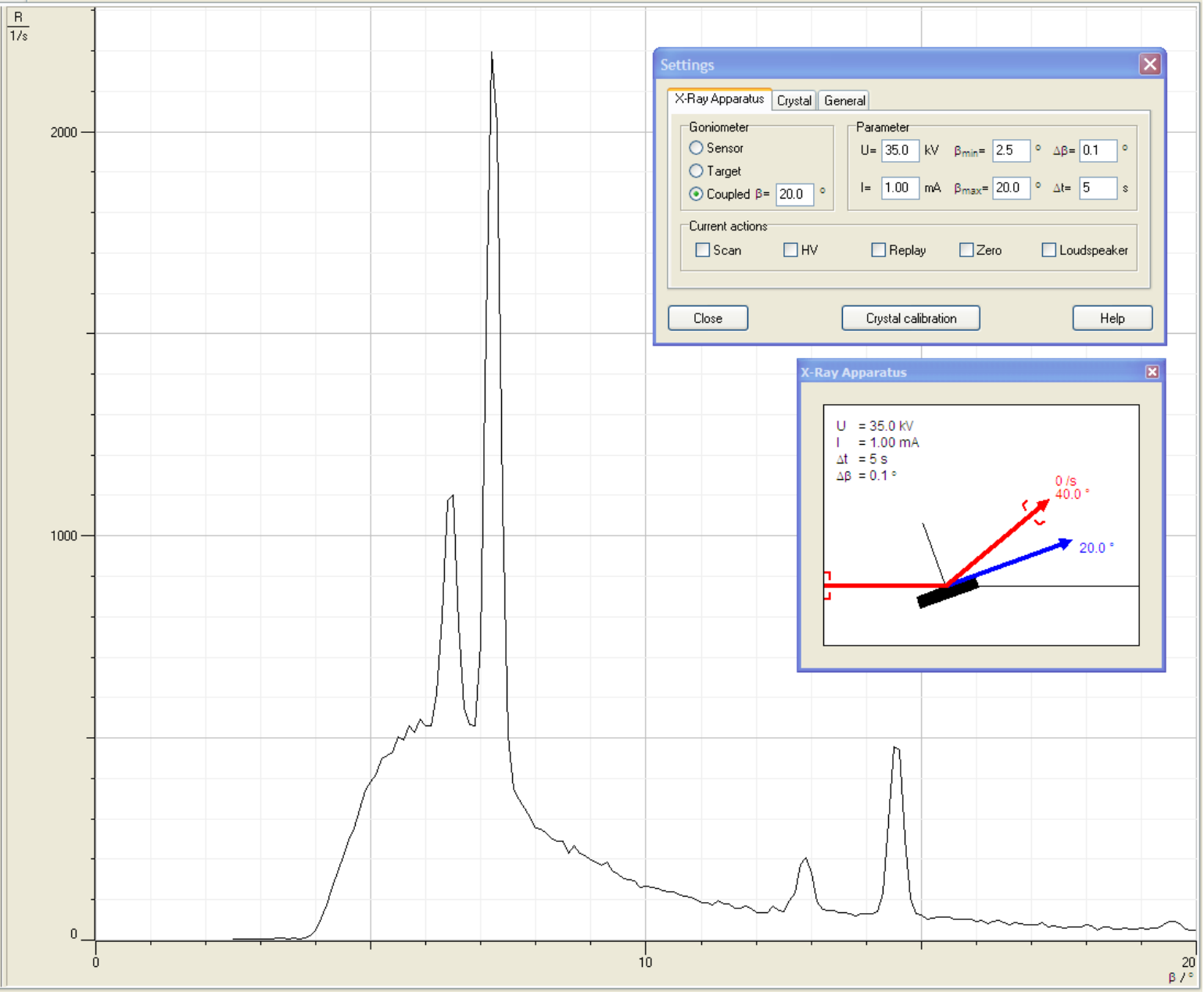

35 kV, 30 kV, 25 kV
2.5º
30.0º
Settings
X-Ray Apparatus
Crystal
General
Goniometer
Sensor
Target
Coupled β=
o
Parameter
U= 35.0 kV
βmin= 2.5 o
Δβ= 0.1 o
I= 1.00 mA
βmax= 30.0 o
Δt= 5 s
Current actions
Scan
HV
Replay
Zero
Loudspeaker
Close
Crystal calibration
Help
Passo Angular Δβ = 0.1º
Tempo de Contagem
1 mA

X-Ray Apparatus

00:14:40

Bragg | Planck | Transmission | Moseley

β / °	R_0 / 1/s
15.3	56.4
15.4	56.0
15.5	56.6
15.6	52.4
15.7	52.8
15.8	51.2
15.9	51.0
16.0	45.2
16.1	48.6
16.2	40.2
16.3	45.0
16.4	49.0
16.5	44.2
16.6	39.2
16.7	44.4
16.8	40.4
16.9	38.4
17.0	38.8
17.1	37.6
17.2	43.4
17.3	33.0
17.4	34.0
17.5	32.8
17.6	29.6
17.7	33.0
17.8	32.6
17.9	31.6
18.0	37.4
18.1	35.0
18.2	25.4
18.3	32.0
18.4	33.2
18.5	26.8
18.6	27.0
18.7	28.6
18.8	27.4
18.9	27.4
19.0	29.0
19.1	26.6
19.2	30.0
19.3	30.0
19.4	38.2
19.5	47.0
19.6	47.2
19.7	40.4
19.8	28.2
19.9	24.6
20.0	24.8



Settings

X-Ray Apparatus | Crystal | General

Goniometer
- Sensor
- Target
- Coupled β= 20.0 °

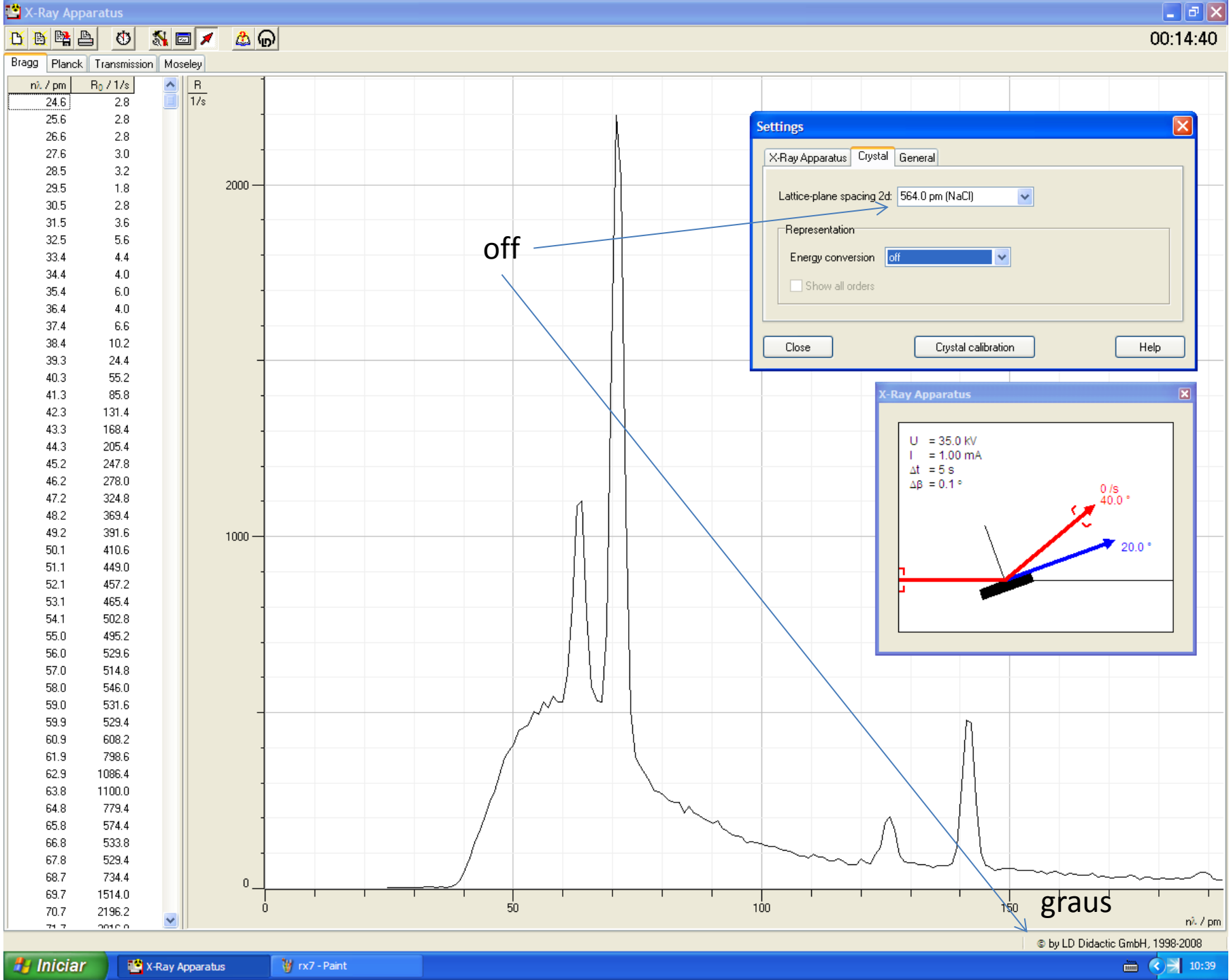
Parameter
U= 35.0 kV β_{min}= 2.5 ° Δβ= 0.1 °
I= 1.00 mA β_{max}= 20.0 ° Δt= 5 s

Current actions
Scan | HV | Replay | Zero | Loudspeaker

Close | Crystal calibration | Help

X-Ray Apparatus

Iniciar | X-Ray Apparatus | rx6 - Paint | 10:37


X-Ray Apparatus
00:14:40
Bragg
Planck
Transmission
Moseley
nλ / pm
R0 / 1/s
24.6 2.8
25.6 2.8
26.6 2.8
27.6 3.0
28.5 3.2
29.5 1.8
30.5 2.8
31.5 3.6
32.5 5.6
33.4 4.4
34.4 4.0
35.4 6.0
36.4 4.0
37.4 6.6
38.4 10.2
39.3 24.4
40.3 55.2
41.3 85.8
42.3 131.4
43.3 168.4
44.3 205.4
45.2 247.8
46.2 278.0
47.2 324.8
48.2 369.4
49.2 391.6
50.1 410.6
51.1 449.0
52.1 457.2
53.1 465.4
54.1 502.8
55.0 495.2
56.0 529.6
57.0 514.8
58.0 546.0
59.0 531.6
59.9 529.4
60.9 608.2
61.9 798.6
62.9 1086.4
63.8 1100.0
64.8 779.4
65.8 574.4
66.8 533.8
67.8 529.4
68.7 734.4
69.7 1514.0
70.7 2196.2
R
1/s
2000
1000
0
0
50
100
150
nλ / pm
off
graus
Settings
X-Ray Apparatus
Crystal
General
Lattice-plane spacing 2d:
564.0 pm (NaCl)
Representation
Energy conversion
off
Show all orders
Close
Crystal calibration
Help
X-Ray Apparatus
U = 35.0 kV
I = 1.00 mA
Δt = 5 s
Δβ = 0.1 °
0 /s
40.0 °
20.0 °
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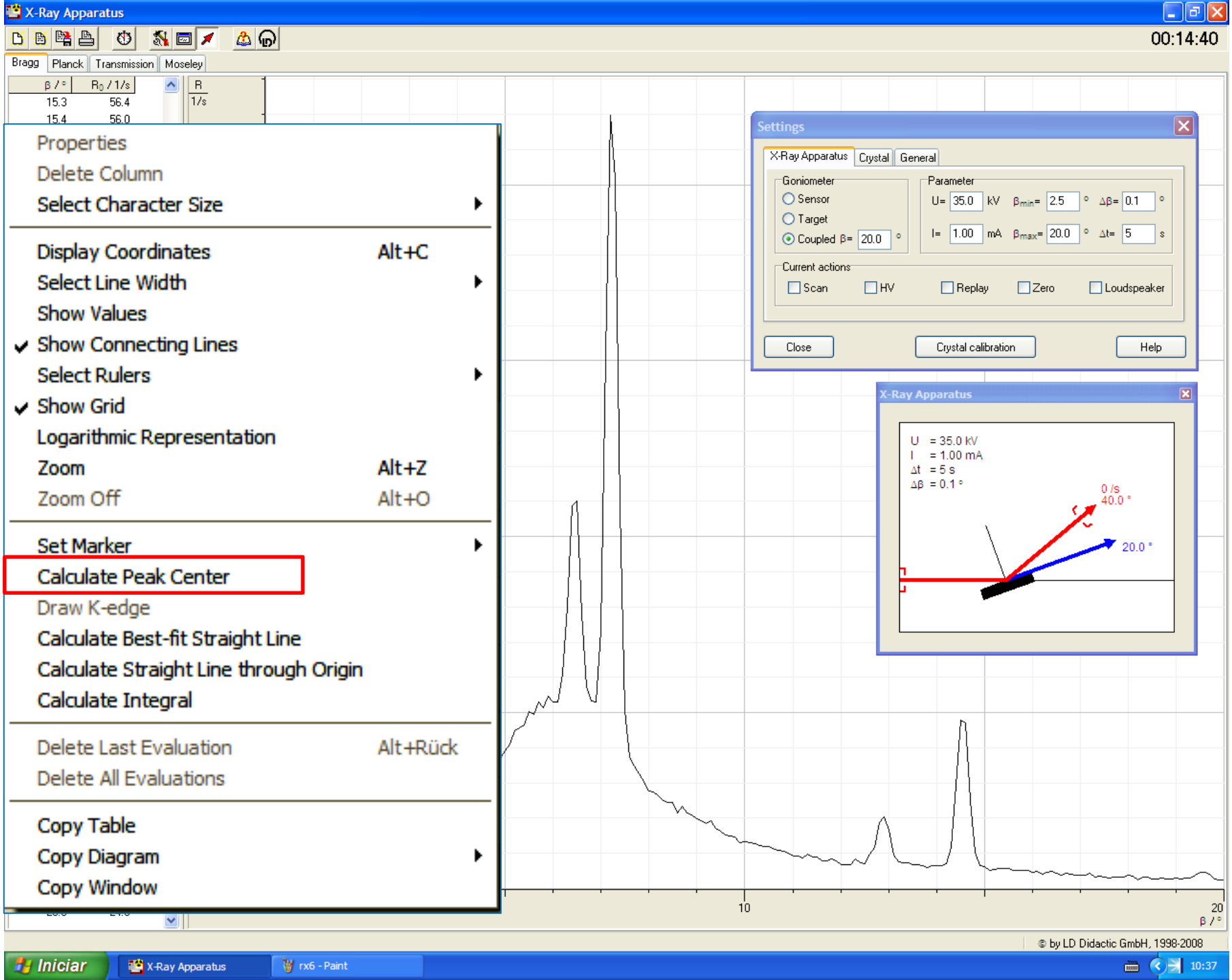
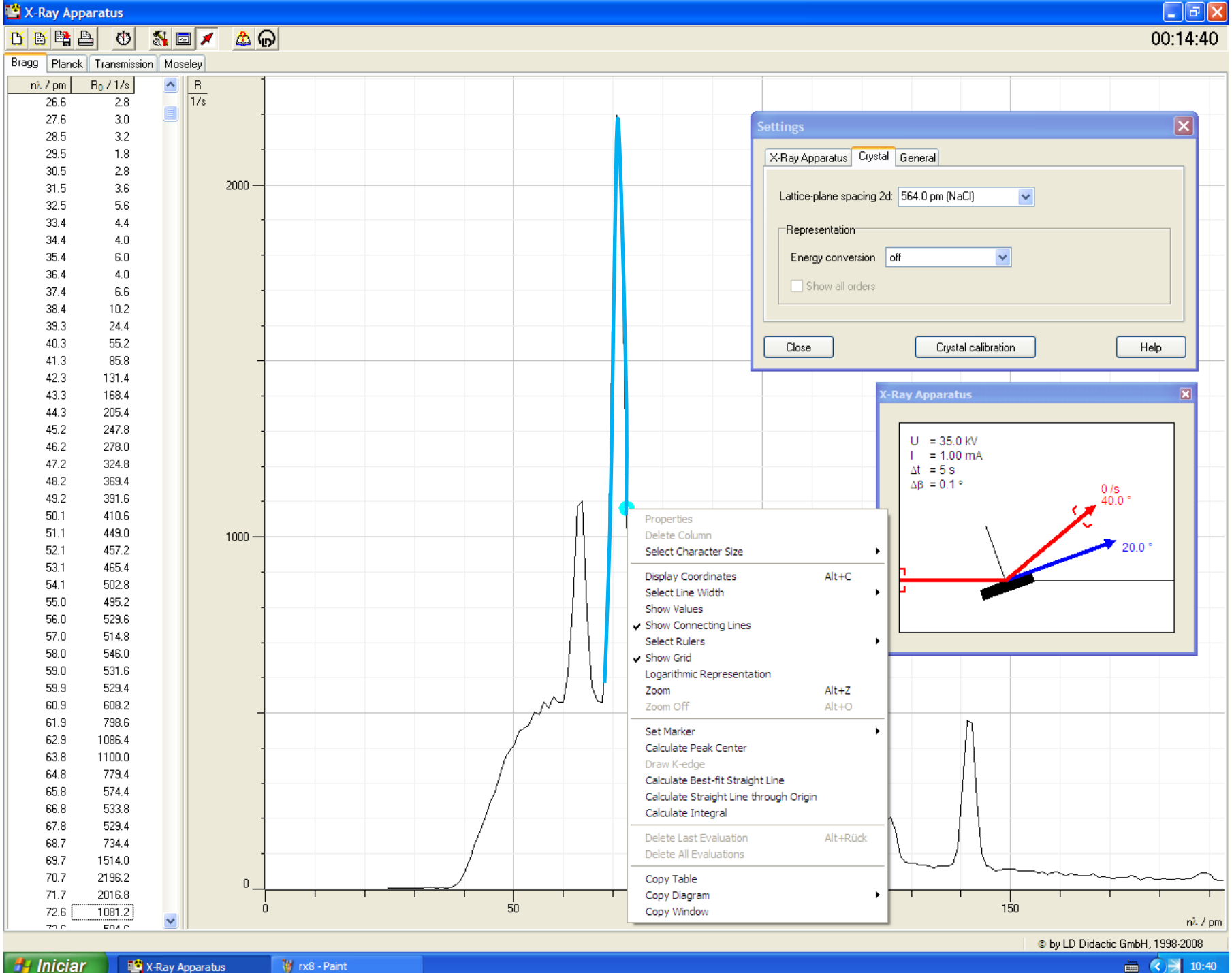
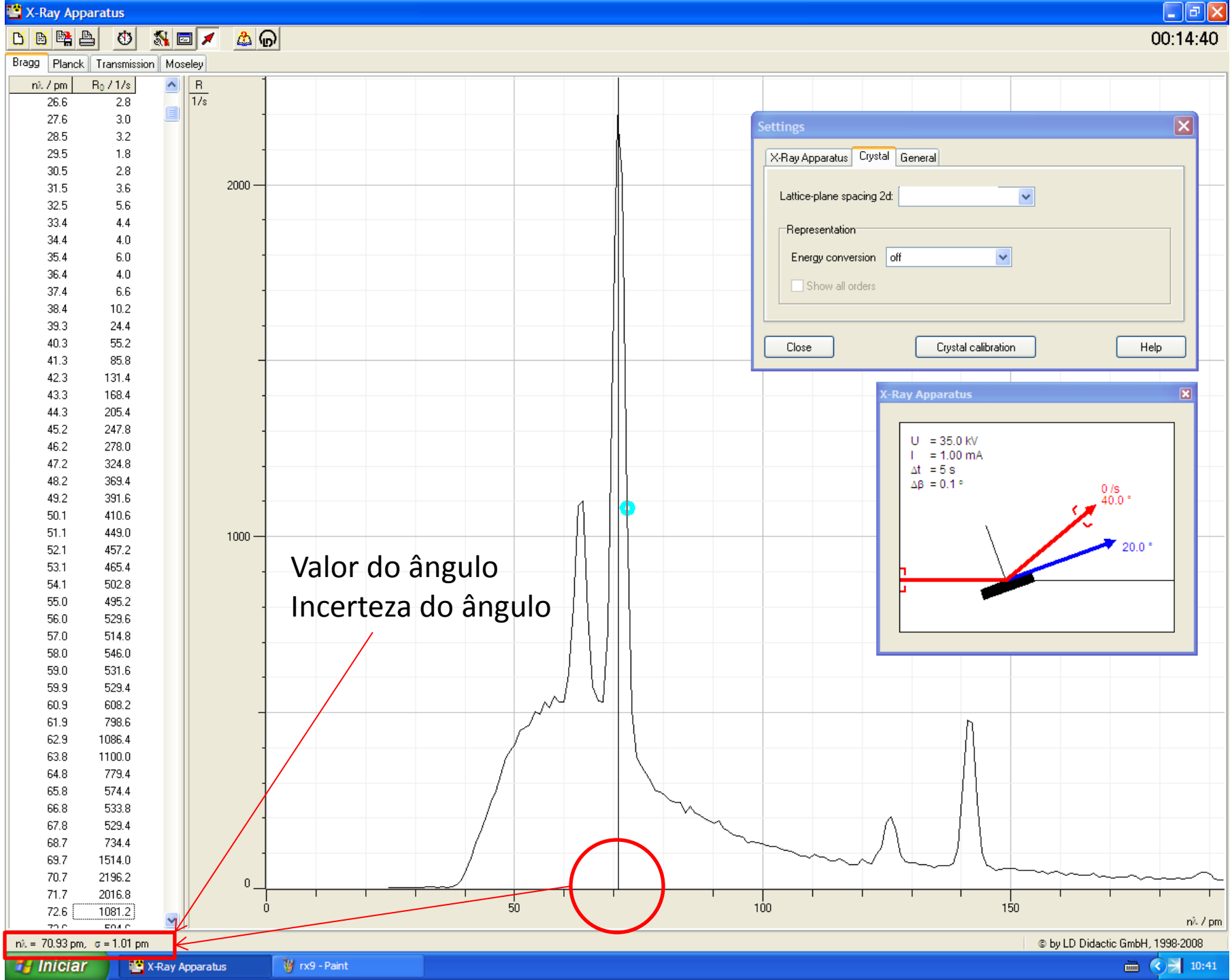
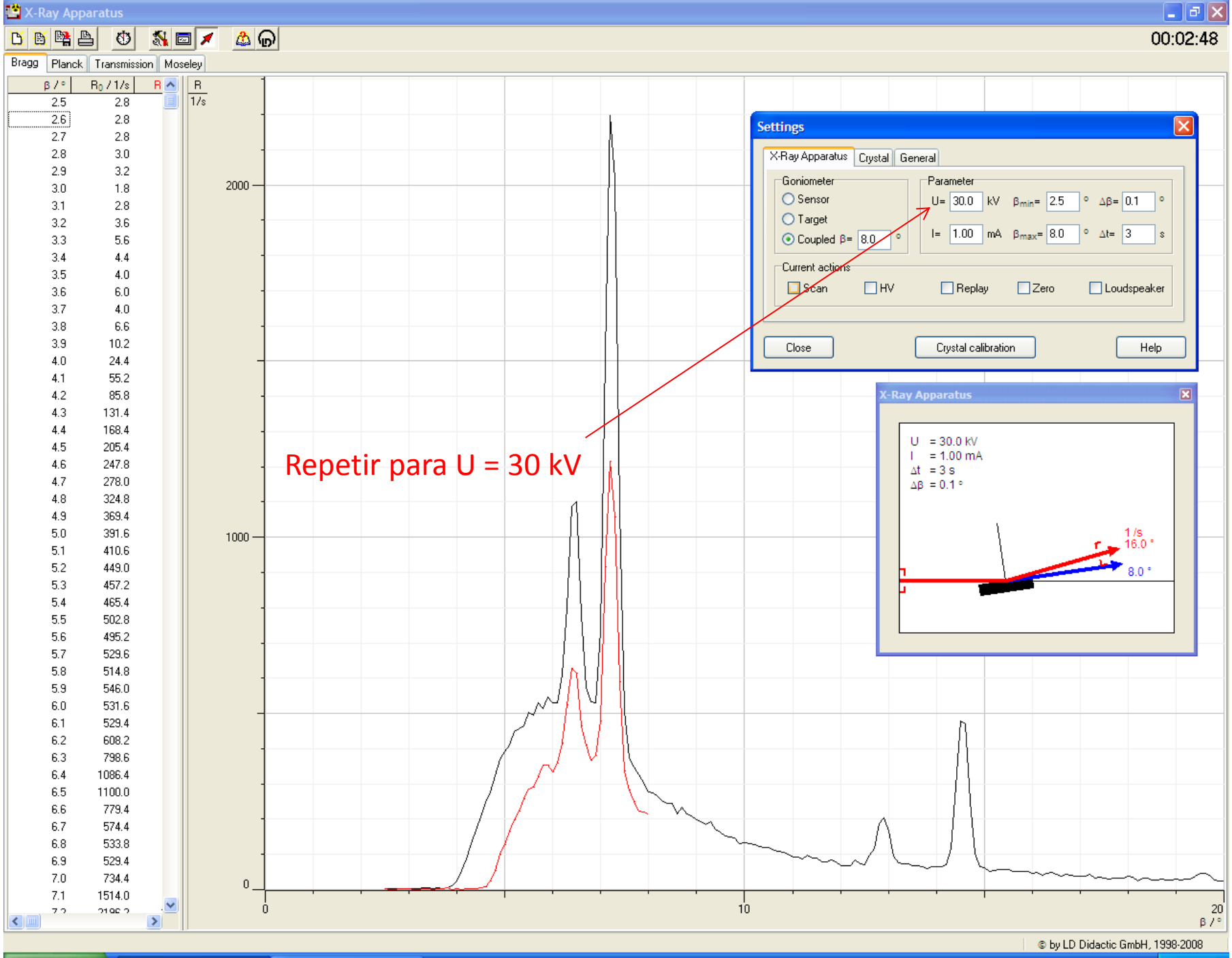
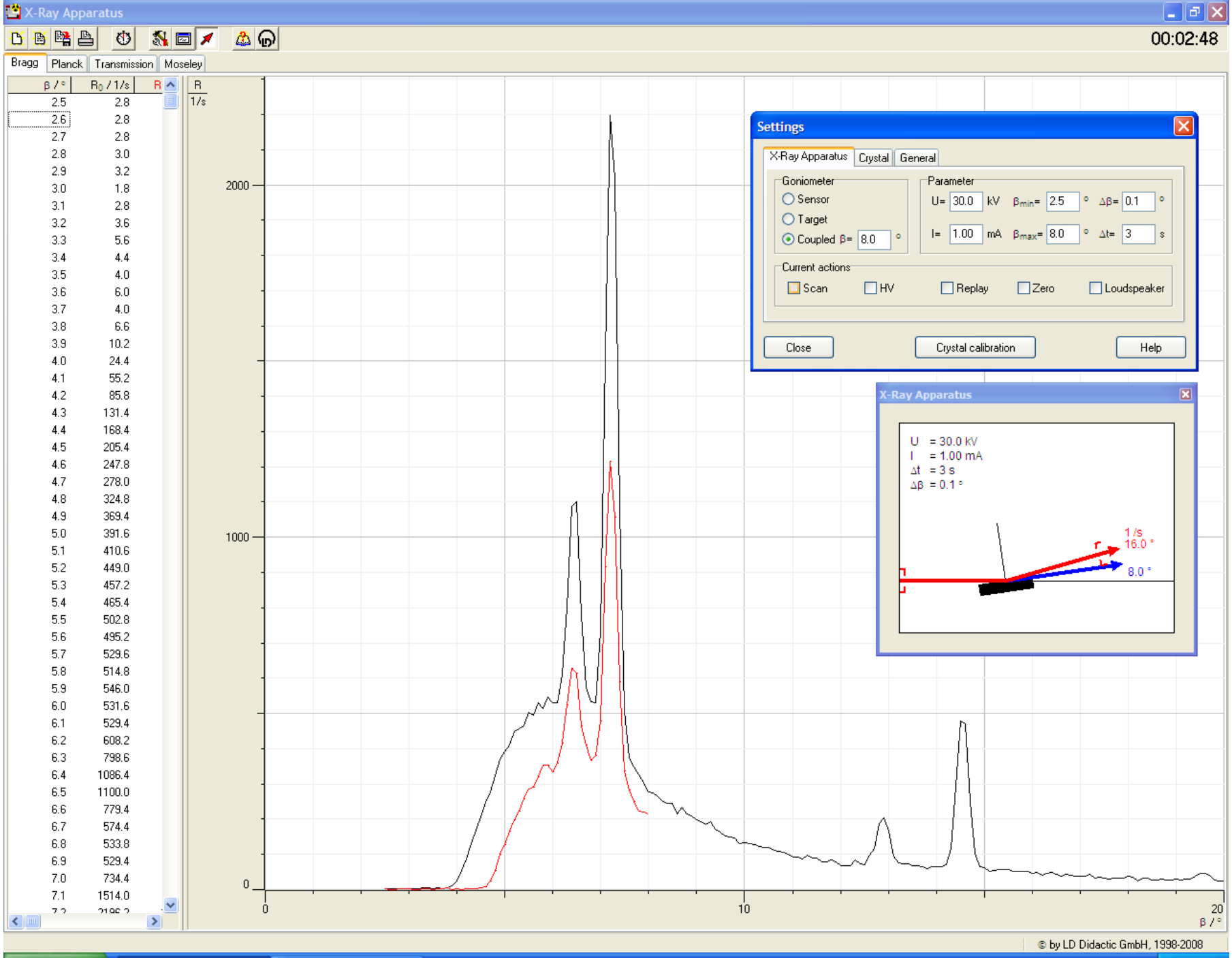
Iniciar
X-Ray Apparatus
rx7 - Paint
10:39

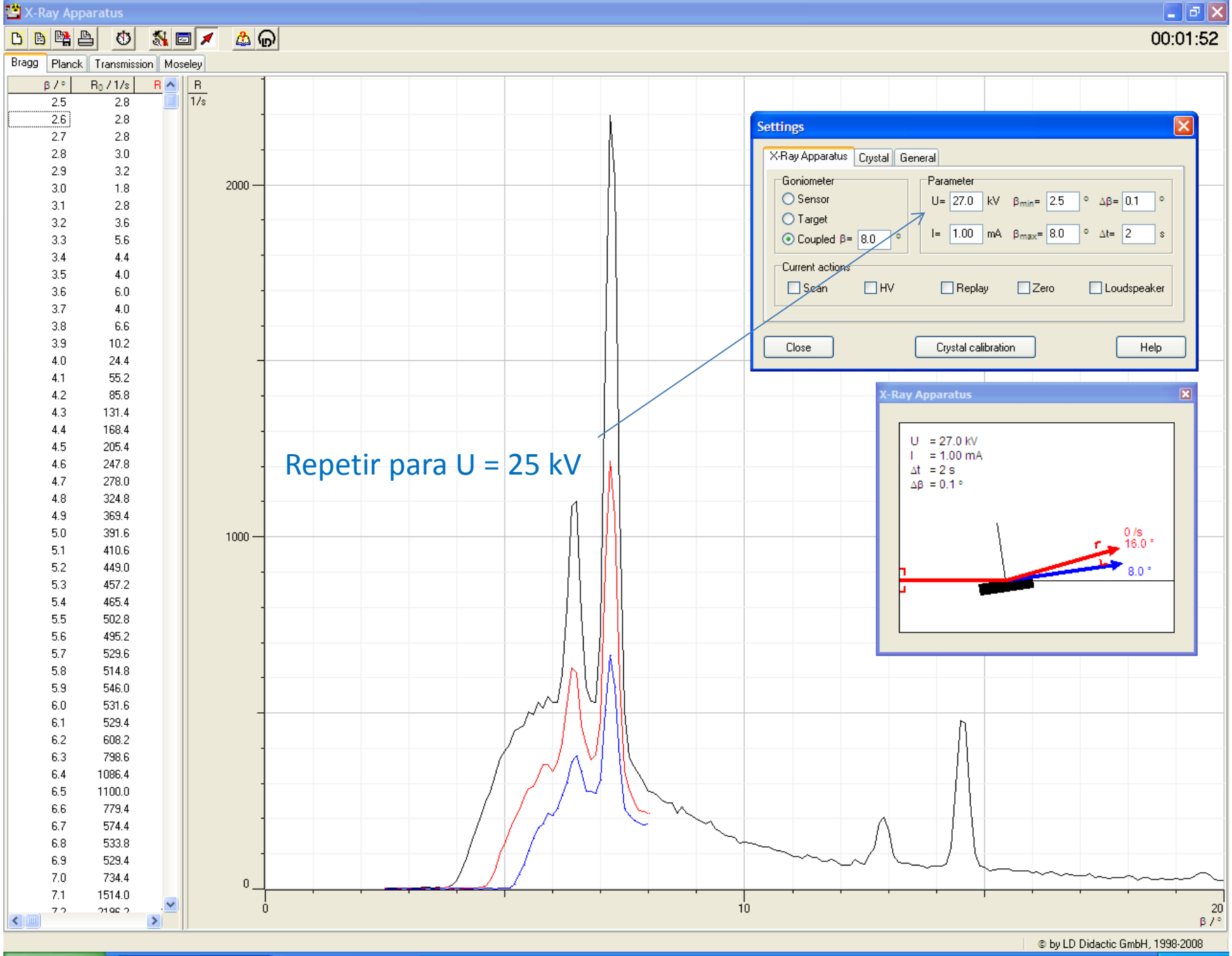

X-Ray Apparatus
00:14:40
Bragg
Planck
Transmission
Moseley
β / °
R0 / 1/s
15.3
56.4
15.4
56.0
R
1/s
Properties
Delete Column
Select Character Size
Display Coordinates Alt+C
Select Line Width
Show Values
Show Connecting Lines
Select Rulers
Show Grid
Logarithmic Representation
Zoom Alt+Z
Zoom Off Alt+O
Set Marker
Calculate Peak Center
Draw K-edge
Calculate Best-fit Straight Line
Calculate Straight Line through Origin
Calculate Integral
Delete Last Evaluation Alt+Rück
Delete All Evaluations
Copy Table
Copy Diagram
Copy Window
Settings
X-Ray Apparatus
Crystal
General
Goniometer
Sensor
Target
Coupled β= 20.0 °
Parameter
U= 35.0 kV
βmin= 2.5 °
Δβ= 0.1 °
I= 1.00 mA
βmax= 20.0 °
Δt= 5 s
Current actions
Scan
HV
Replay
Zero
Loudspeaker
Close
Crystal calibration
Help
X-Ray Apparatus
U = 35.0 kV
I = 1.00 mA
Δt = 5 s
Δβ = 0.1 °
0 /s
40.0 °
20.0 °
10
20
β / °
© by LD Didactic GmbH, 1998-2008
Iniciar
X-Ray Apparatus
rx6 - Paint
10:37

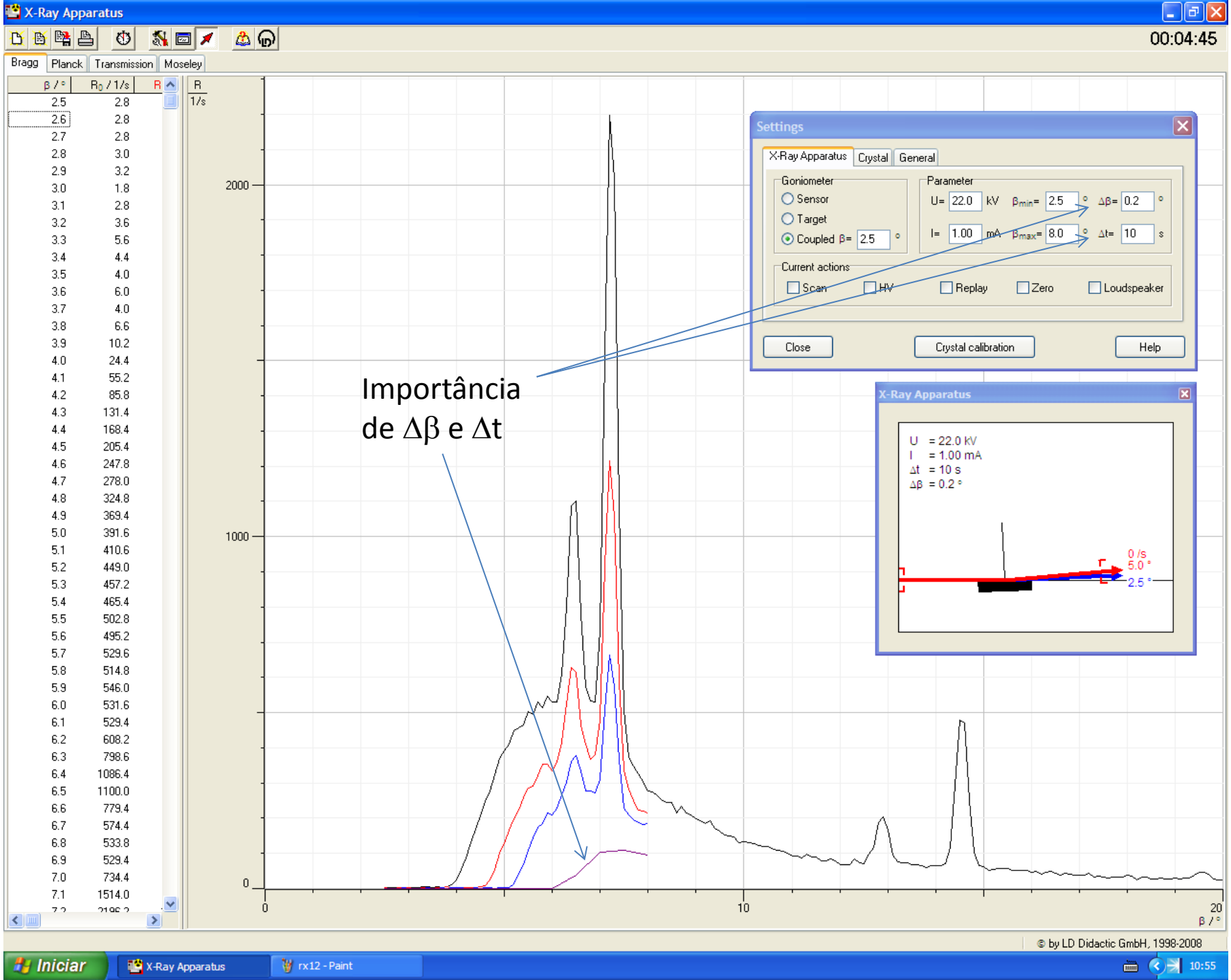

X-Ray Apparatus
00:14:40
Bragg
Planck
Transmission
Moseley
nλ / pm
R0 / 1/s
26.6 2.8
27.6 3.0
28.5 3.2
29.5 1.8
30.5 2.8
31.5 3.6
32.5 5.6
33.4 4.4
34.4 4.0
35.4 6.0
36.4 4.0
37.4 6.6
38.4 10.2
39.3 24.4
40.3 55.2
41.3 85.8
42.3 131.4
43.3 168.4
44.3 205.4
45.2 247.8
46.2 278.0
47.2 324.8
48.2 369.4
49.2 391.6
50.1 410.6
51.1 449.0
52.1 457.2
53.1 465.4
54.1 502.8
55.0 495.2
56.0 529.6
57.0 514.8
58.0 546.0
59.0 531.6
59.9 529.4
60.9 608.2
61.9 798.6
62.9 1086.4
63.8 1100.0
64.8 779.4
65.8 574.4
66.8 533.8
67.8 529.4
68.7 734.4
69.7 1514.0
70.7 2196.2
71.7 2016.8
72.6 1081.2
R
1/s
2000
1000
0
0
50
150
nλ / pm
Settings
X-Ray Apparatus
Crystal
General
Lattice-plane spacing 2d: 564.0 pm (NaCl)
Representation
Energy conversion off
Show all orders
Close
Crystal calibration
Help
X-Ray Apparatus
U = 35.0 kV
I = 1.00 mA
Δt = 5 s
Δβ = 0.1 °
0 /s
40.0 °
20.0 °
Properties
Delete Column
Select Character Size
Display Coordinates Alt+C
Select Line Width
Show Values
Show Connecting Lines
Select Rulers
Show Grid
Logarithmic Representation
Zoom Alt+Z
Zoom Off Alt+O
Set Marker
Calculate Peak Center
Draw K-edge
Calculate Best-fit Straight Line
Calculate Straight Line through Origin
Calculate Integral
Delete Last Evaluation Alt+Rück
Delete All Evaluations
Copy Table
Copy Diagram
Copy Window
© by LD Didactic GmbH, 1998-2008
Iniciar
X-Ray Apparatus
rx8 - Paint
10:40


X-Ray Apparatus
00:14:40
Bragg
Planck
Transmission
Moseley
nλ / pm
R0 / 1/s
26.6 2.8
27.6 3.0
28.5 3.2
29.5 1.8
30.5 2.8
31.5 3.6
32.5 5.6
33.4 4.4
34.4 4.0
35.4 6.0
36.4 4.0
37.4 6.6
38.4 10.2
39.3 24.4
40.3 55.2
41.3 85.8
42.3 131.4
43.3 168.4
44.3 205.4
45.2 247.8
46.2 278.0
47.2 324.8
48.2 369.4
49.2 391.6
50.1 410.6
51.1 449.0
52.1 457.2
53.1 465.4
54.1 502.8
55.0 495.2
56.0 529.6
57.0 514.8
58.0 546.0
59.0 531.6
59.9 529.4
60.9 608.2
61.9 798.6
62.9 1086.4
63.8 1100.0
64.8 779.4
65.8 574.4
66.8 533.8
67.8 529.4
68.7 734.4
69.7 1514.0
70.7 2196.2
71.7 2016.8
72.6 1081.2
R
1/s
2000
1000
0
0
50
100
150
nλ / pm
Settings
X-Ray Apparatus
Crystal
General
Lattice-plane spacing 2d:
Representation
Energy conversion
off
Show all orders
Close
Crystal calibration
Help
X-Ray Apparatus
U = 35.0 kV
I = 1.00 mA
Δt = 5 s
Δβ = 0.1 °
0 /s
40.0 °
20.0 °
Valor do ângulo
Incerteza do ângulo
nλ = 70.93 pm, σ = 1.01 pm
© by LD Didactic GmbH, 1998-2008
Iniciar
X-Ray Apparatus
rx9 - Paint
10:41


X-Ray Apparatus
00:02:48
Bragg
Planck
Transmission
Moseley
β / °
R0 / 1/s
R
1/s
2.5 2.8
2.6 2.8
2.7 2.8
2.8 3.0
2.9 3.2
3.0 1.8
3.1 2.8
3.2 3.6
3.3 5.6
3.4 4.4
3.5 4.0
3.6 6.0
3.7 4.0
3.8 6.6
3.9 10.2
4.0 24.4
4.1 55.2
4.2 85.8
4.3 131.4
4.4 168.4
4.5 205.4
4.6 247.8
4.7 278.0
4.8 324.8
4.9 369.4
5.0 391.6
5.1 410.6
5.2 449.0
5.3 457.2
5.4 465.4
5.5 502.8
5.6 495.2
5.7 529.6
5.8 514.8
5.9 546.0
6.0 531.6
6.1 529.4
6.2 608.2
6.3 798.6
6.4 1086.4
6.5 1100.0
6.6 779.4
6.7 574.4
6.8 533.8
6.9 529.4
7.0 734.4
7.1 1514.0
2000
1000
0
0
10
20
β / °
Repetir para U = 30 kV
Settings
X-Ray Apparatus
Crystal
General
Goniometer
Sensor
Target
Coupled β= 8.0 °
Parameter
U= 30.0 kV
βmin= 2.5 °
Δβ= 0.1 °
I= 1.00 mA
βmax= 8.0 °
Δt= 3 s
Current actions
Scan
HV
Replay
Zero
Loudspeaker
Close
Crystal calibration
Help
X-Ray Apparatus
U = 30.0 kV
I = 1.00 mA
Δt = 3 s
Δβ = 0.1 °
1/s
16.0 °
8.0 °
© by LD Didactic GmbH, 1998-2008
Iniciar
X-Ray Apparatus
rx10 - Paint
10:47


X-Ray Apparatus
00:02:48
Bragg
Planck
Transmission
Moseley
β / °
R0 / 1/s
R
1/s
2.5 2.8
2.6 2.8
2.7 2.8
2.8 3.0
2.9 3.2
3.0 1.8
3.1 2.8
3.2 3.6
3.3 5.6
3.4 4.4
3.5 4.0
3.6 6.0
3.7 4.0
3.8 6.6
3.9 10.2
4.0 24.4
4.1 55.2
4.2 85.8
4.3 131.4
4.4 168.4
4.5 205.4
4.6 247.8
4.7 278.0
4.8 324.8
4.9 369.4
5.0 391.6
5.1 410.6
5.2 449.0
5.3 457.2
5.4 465.4
5.5 502.8
5.6 495.2
5.7 529.6
5.8 514.8
5.9 546.0
6.0 531.6
6.1 529.4
6.2 608.2
6.3 798.6
6.4 1086.4
6.5 1100.0
6.6 779.4
6.7 574.4
6.8 533.8
6.9 529.4
7.0 734.4
7.1 1514.0
2000
1000
0
0
10
20
β / °
Settings
X-Ray Apparatus
Crystal
General
Goniometer
Sensor
Target
Coupled β= 8.0 °
Parameter
U= 30.0 kV
βmin= 2.5 °
Δβ= 0.1 °
I= 1.00 mA
βmax= 8.0 °
Δt= 3 s
Current actions
Scan
HV
Replay
Zero
Loudspeaker
Close
Crystal calibration
Help
X-Ray Apparatus
U = 30.0 kV
I = 1.00 mA
Δt = 3 s
Δβ = 0.1 °
1/s
16.0 °
8.0 °
© by LD Didactic GmbH, 1998-2008
Iniciar
X-Ray Apparatus
rx10 - Paint
10:47


X-Ray Apparatus
00:01:52
Bragg
Planck
Transmission
Moseley
β / °
R0 / 1/s
R
1/s
2.5 2.8
2.6 2.8
2.7 2.8
2.8 3.0
2.9 3.2
3.0 1.8
3.1 2.8
3.2 3.6
3.3 5.6
3.4 4.4
3.5 4.0
3.6 6.0
3.7 4.0
3.8 6.6
3.9 10.2
4.0 24.4
4.1 55.2
4.2 85.8
4.3 131.4
4.4 168.4
4.5 205.4
4.6 247.8
4.7 278.0
4.8 324.8
4.9 369.4
5.0 391.6
5.1 410.6
5.2 449.0
5.3 457.2
5.4 465.4
5.5 502.8
5.6 495.2
5.7 529.6
5.8 514.8
5.9 546.0
6.0 531.6
6.1 529.4
6.2 608.2
6.3 798.6
6.4 1086.4
6.5 1100.0
6.6 779.4
6.7 574.4
6.8 533.8
6.9 529.4
7.0 734.4
7.1 1514.0
2000
1000
0
0
10
20
β / °
Repetir para U = 25 kV
Settings
X-Ray Apparatus
Crystal
General
Goniometer
Sensor
Target
Coupled β= 8.0 °
Parameter
U= 27.0 kV
βmin= 2.5 °
Δβ= 0.1 °
I= 1.00 mA
βmax= 8.0 °
Δt= 2 s
Current actions
Scan
HV
Replay
Zero
Loudspeaker
Close
Crystal calibration
Help
X-Ray Apparatus
U = 27.0 kV
I = 1.00 mA
Δt = 2 s
Δβ = 0.1 °
0 /s
16.0 °
8.0 °
© by LD Didactic GmbH, 1998-2008
Iniciar
X-Ray Apparatus
rx11 - Paint
10:50


X-Ray Apparatus
00:04:45
Bragg
Planck
Transmission
Moseley
β / °
R0 / 1/s
R
1/s
2.5 2.8
2.6 2.8
2.7 2.8
2.8 3.0
2.9 3.2
3.0 1.8
3.1 2.8
3.2 3.6
3.3 5.6
3.4 4.4
3.5 4.0
3.6 6.0
3.7 4.0
3.8 6.6
3.9 10.2
4.0 24.4
4.1 55.2
4.2 85.8
4.3 131.4
4.4 168.4
4.5 205.4
4.6 247.8
4.7 278.0
4.8 324.8
4.9 369.4
5.0 391.6
5.1 410.6
5.2 449.0
5.3 457.2
5.4 465.4
5.5 502.8
5.6 495.2
5.7 529.6
5.8 514.8
5.9 546.0
6.0 531.6
6.1 529.4
6.2 608.2
6.3 798.6
6.4 1086.4
6.5 1100.0
6.6 779.4
6.7 574.4
6.8 533.8
6.9 529.4
7.0 734.4
7.1 1514.0
2000
1000
0
0
10
20
β / °
Importância
de Δβ e Δt
Settings
X-Ray Apparatus
Crystal
General
Goniometer
Sensor
Target
Coupled β= 2.5 °
Parameter
U= 22.0 kV
βmin= 2.5 °
Δβ= 0.2 °
I= 1.00 mA
βmax= 8.0 °
Δt= 10 s
Current actions
Scan
HV
Replay
Zero
Loudspeaker
Close
Crystal calibration
Help
X-Ray Apparatus
U = 22.0 kV
I = 1.00 mA
Δt = 10 s
Δβ = 0.2 °
0 /s
5.0 °
2.5 °
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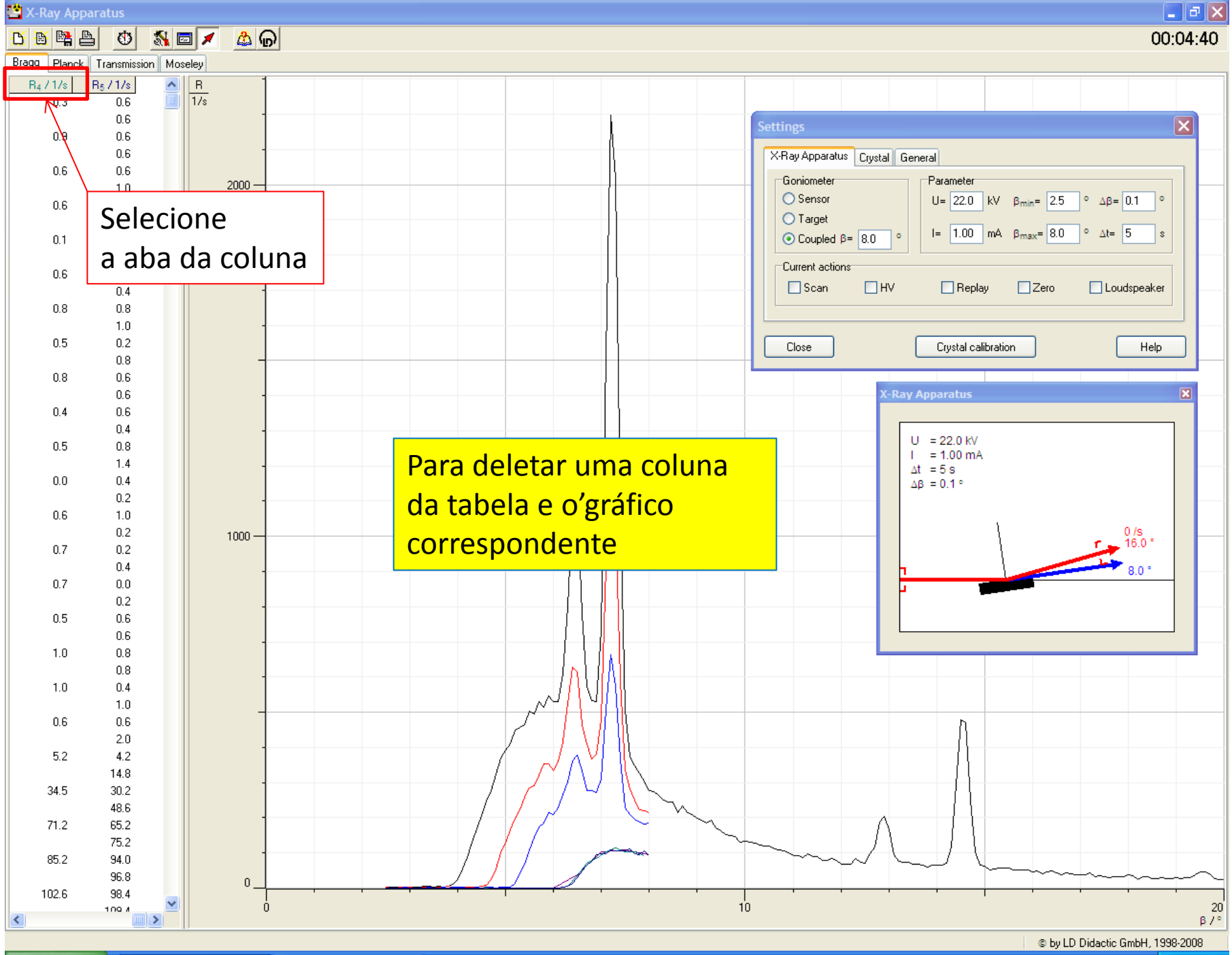
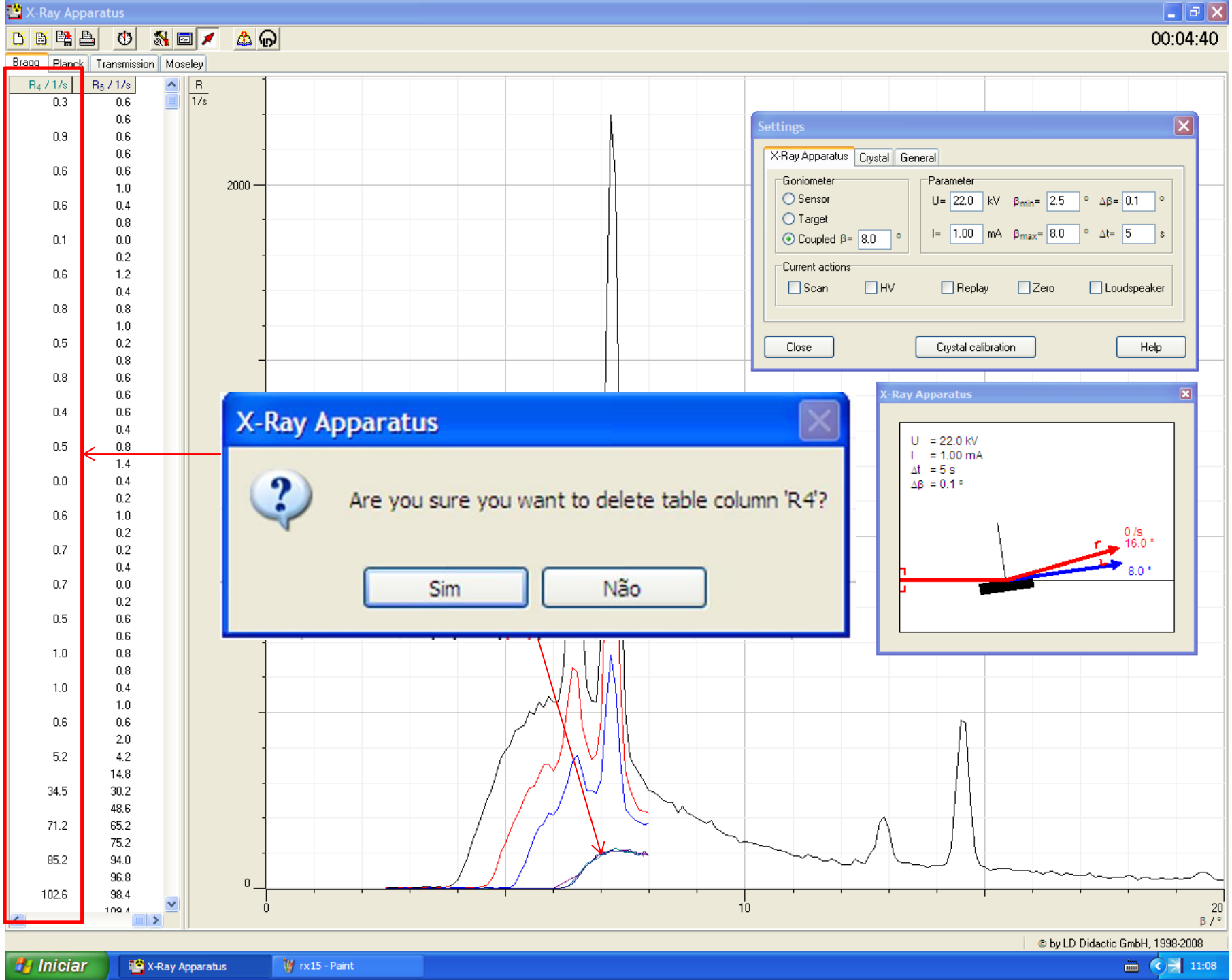
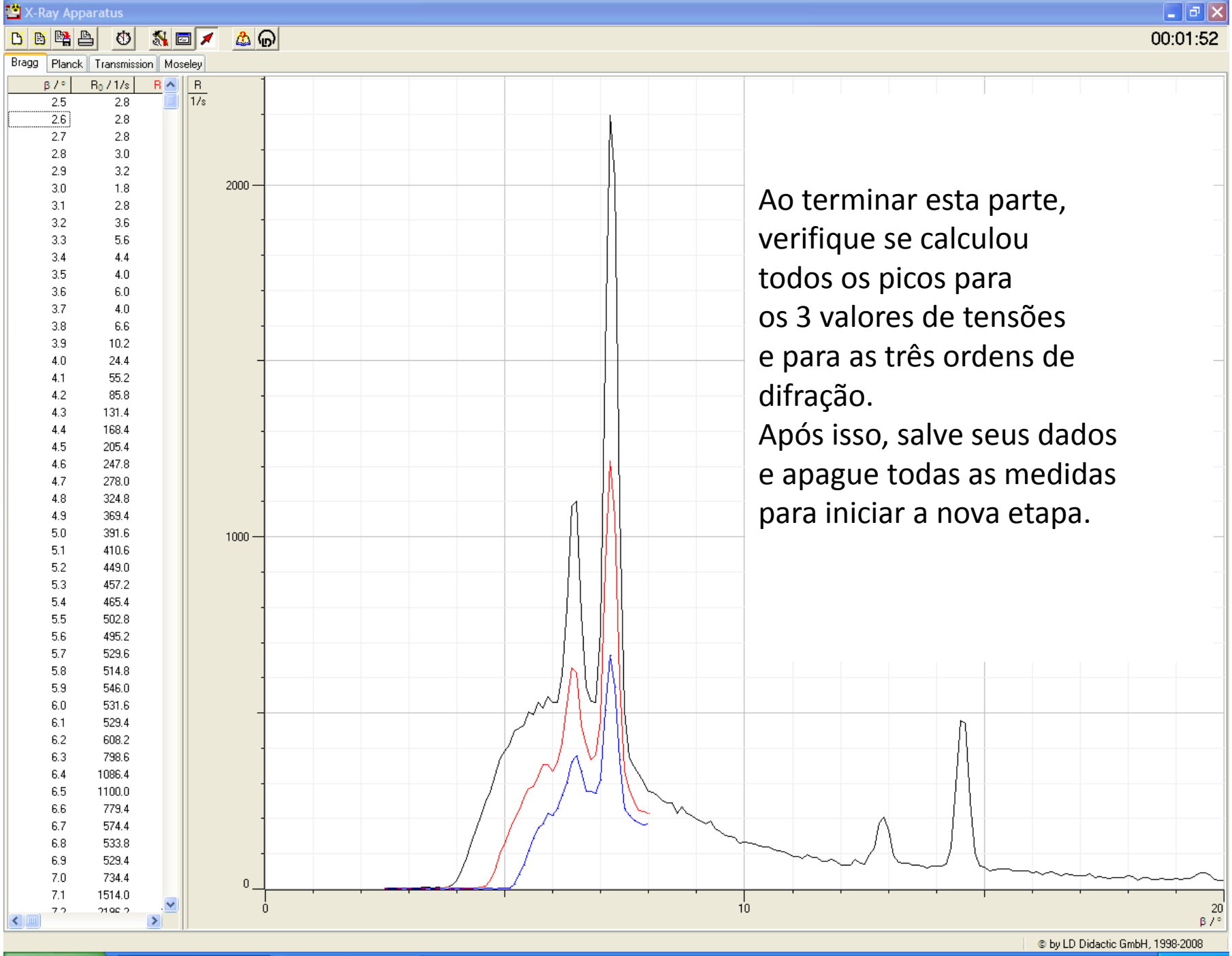
Iniciar
X-Ray Apparatus
rx12 - Paint
10:55


X-Ray Apparatus
00:04:40
Bragg
Planck
Transmission
Moseley
R4 / 1/s
R5 / 1/s
R
1/s
Selecione
a aba da coluna
Settings
X-Ray Apparatus
Crystal
General
Goniometer
Sensor
Target
Coupled β= 8.0 °
Parameter
U= 22.0 kV
βmin= 2.5 °
Δβ= 0.1 °
I= 1.00 mA
βmax= 8.0 °
Δt= 5 s
Current actions
Scan
HV
Replay
Zero
Loudspeaker
Close
Crystal calibration
Help
X-Ray Apparatus
U = 22.0 kV
I = 1.00 mA
Δt = 5 s
Δβ = 0.1 °
0 /s
16.0 °
8.0 °
Para deletar uma coluna
da tabela e o'gráfico
correspondente
2000
1000
0
0
10
20
β / °
© by LD Didactic GmbH, 1998-2008
Iniciar
X-Ray Apparatus
rx15 - Paint
11:08

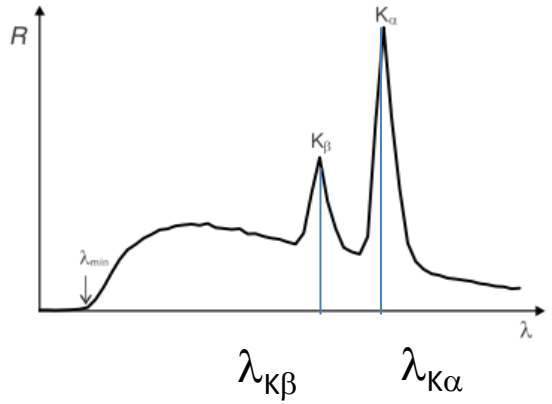

X-Ray Apparatus
00:04:40
Bragg
Planck
Transmission
Moseley
R4 / 1/s
R5 / 1/s
R
1/s
2000
0
0
10
20
β / °
Settings
X-Ray Apparatus
Crystal
General
Goniometer
Sensor
Target
Coupled β= 8.0 °
Parameter
U= 22.0 kV
βmin= 2.5 °
Δβ= 0.1 °
I= 1.00 mA
βmax= 8.0 °
Δt= 5 s
Current actions
Scan
HV
Replay
Zero
Loudspeaker
Close
Crystal calibration
Help
X-Ray Apparatus
Are you sure you want to delete table column 'R4'?
Sim
Não
X-Ray Apparatus
U = 22.0 kV
I = 1.00 mA
Δt = 5 s
Δβ = 0.1 °
0 /s
16.0 °
8.0 °
© by LD Didactic GmbH, 1998-2008
Iniciar
X-Ray Apparatus
rx15 - Paint
11:08


X-Ray Apparatus
00:01:52
Bragg
Planck
Transmission
Moseley
β / °
R0 / 1/s
R
1/s
2000
1000
0
0
10
20
β / °
Ao terminar esta parte,
verifique se calculou
todos os picos para
os 3 valores de tensões
e para as três ordens de
difração.
Após isso, salve seus dados
e apague todas as medidas
para iniciar a nova etapa.
© by LD Didactic GmbH, 1998-2008
Iniciar
X-Ray Apparatus
rx11 - Paint
10:50

Valores dos comprimentos de onda das transições K do Mo

	$\frac{E}{\text{keV}}$	$\frac{\nu}{\text{EHz}}$	$\frac{\lambda}{\text{pm}}$
K_α	17.443	4.2264	71.080
K_β	19.651	4.8287	63.095

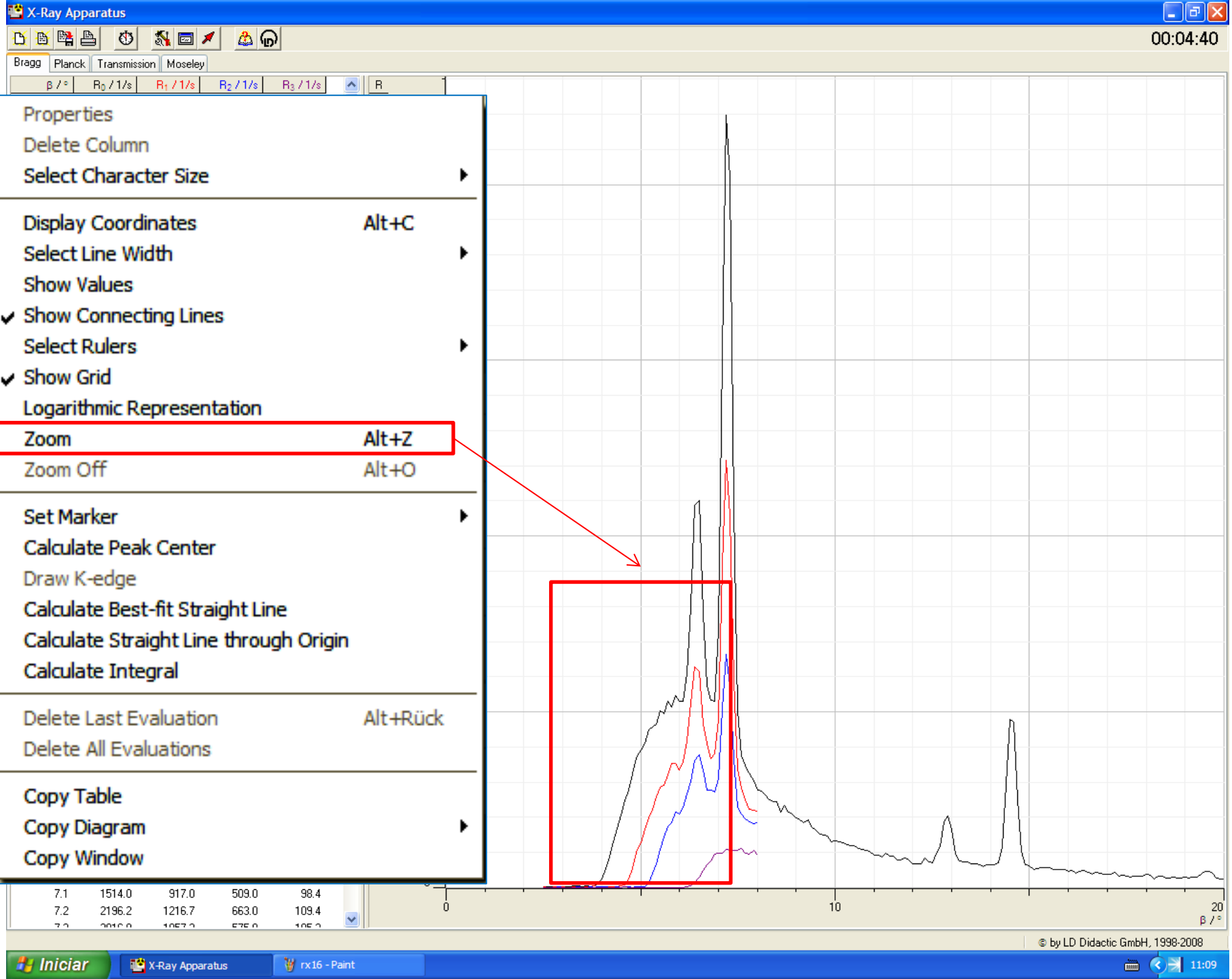
$\text{keV} = 10^3\ \text{eV}$, $\text{EHz} = 10^{18}\ \text{Hz}$, $\text{pm} = 10^{-12}\ \text{m}$



A duração aproximada da tomada de dados do primeiro experimento é de 90 minutos (3 sessões de 30 minutos, uma para cada valor de U).

A duração aproximada da tomada de dados do segundo experimento é de 40 minutos (8 sessões de acordo com a tabela abaixo).

Antes de começar o 2º experimento, verifique se calculou todos os picos para os 3 valores de tensões do 1º experimento e para as três ordens de difração. Após isso, salve seus dados e apague todas as medidas para iniciar o 2º experimento com a tela limpa.

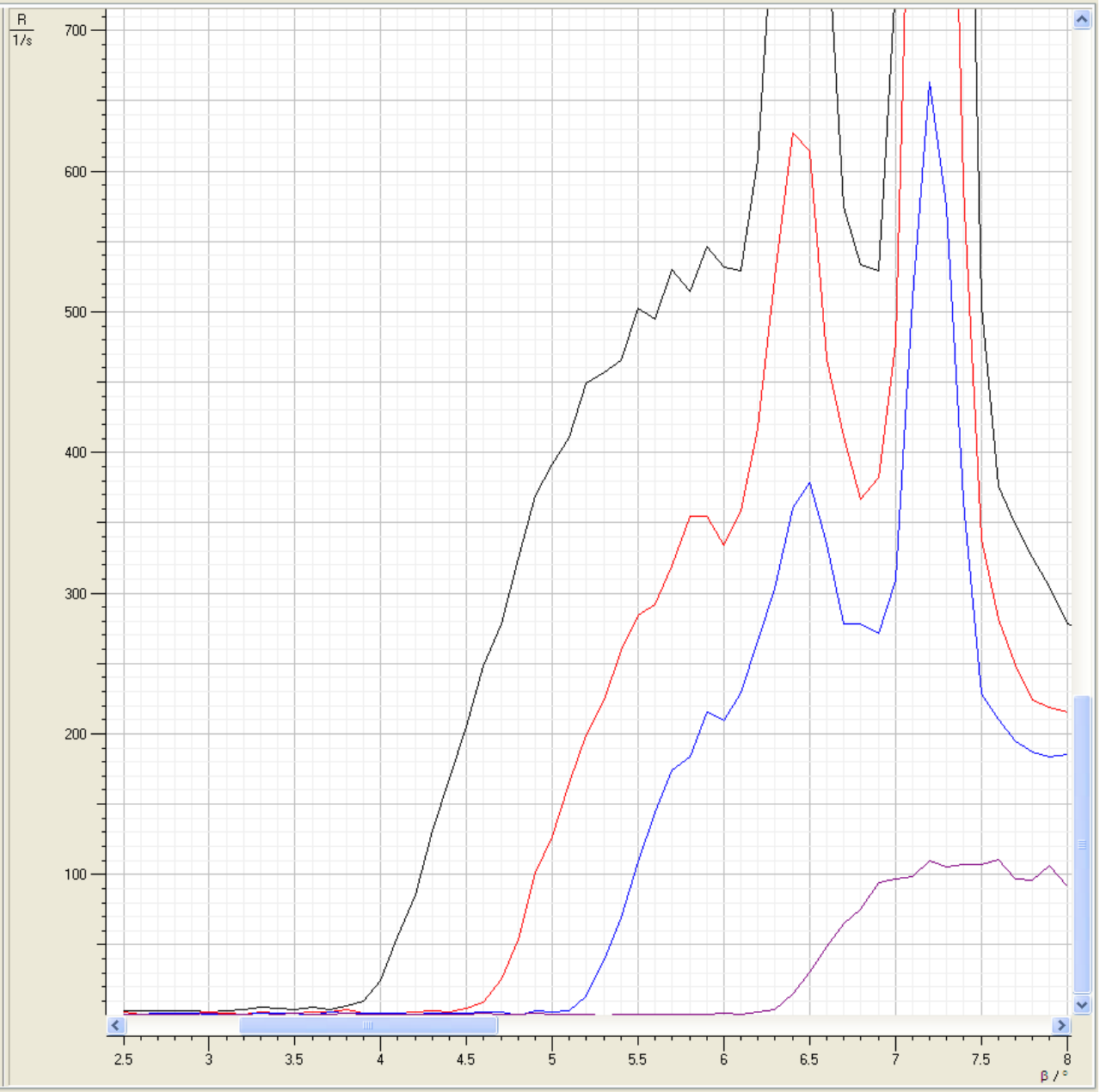

X-Ray Apparatus
00:04:40
Bragg
Planck
Transmission
Moseley
β / °
R0 / 1/s
R1 / 1/s
R2 / 1/s
R3 / 1/s
R
Properties
Delete Column
Select Character Size
Display Coordinates Alt+C
Select Line Width
Show Values
Show Connecting Lines
Select Rulers
Show Grid
Logarithmic Representation
Zoom Alt+Z
Zoom Off Alt+O
Set Marker
Calculate Peak Center
Draw K-edge
Calculate Best-fit Straight Line
Calculate Straight Line through Origin
Calculate Integral
Delete Last Evaluation Alt+Rück
Delete All Evaluations
Copy Table
Copy Diagram
Copy Window
7.1 1514.0 917.0 509.0 98.4
7.2 2196.2 1216.7 663.0 109.4
0
10
20
β / °
© by LD Didactic GmbH, 1998-2008
Iniciar
X-Ray Apparatus
rx16 - Paint
11:09

X-Ray Apparatus

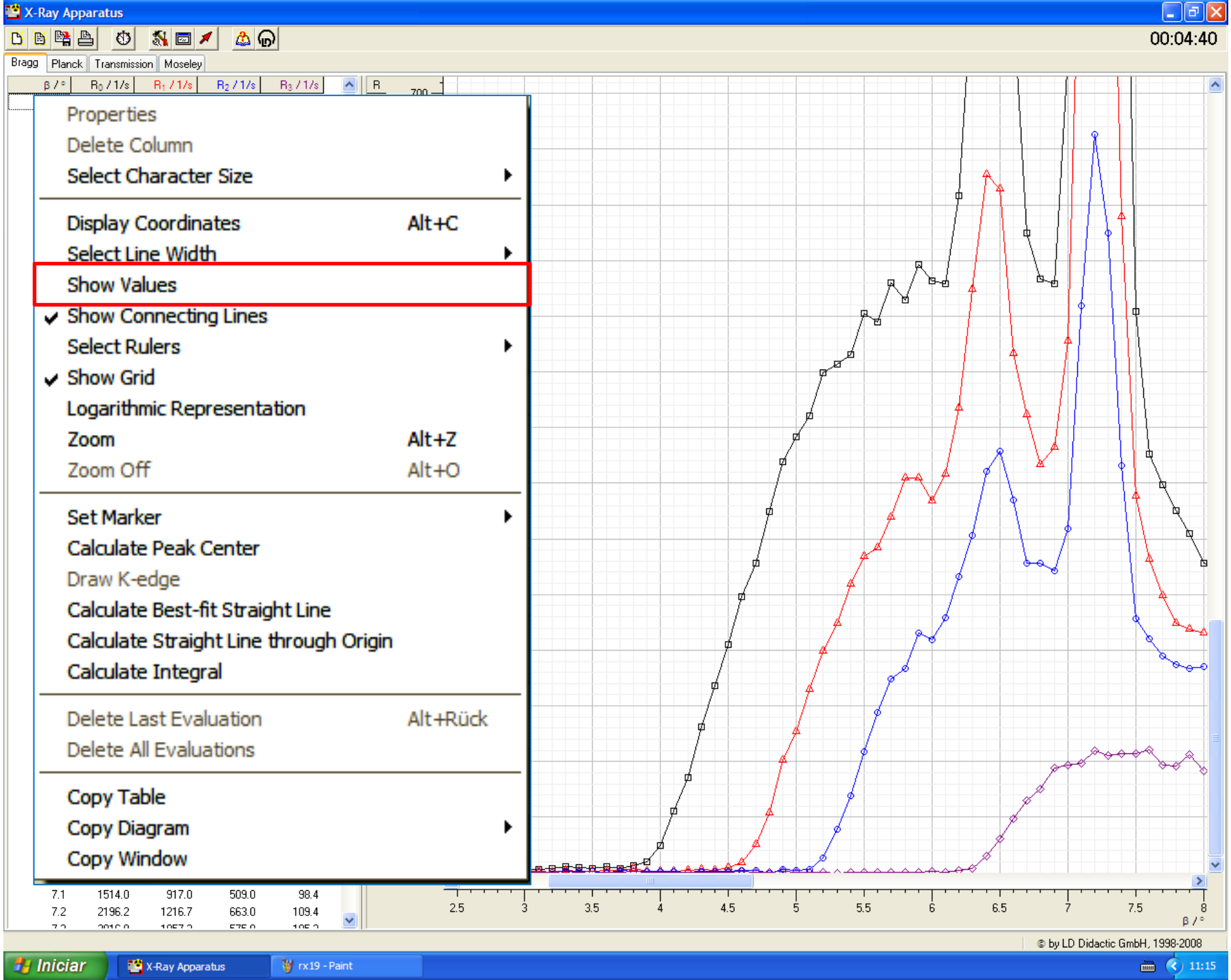
00:04:40

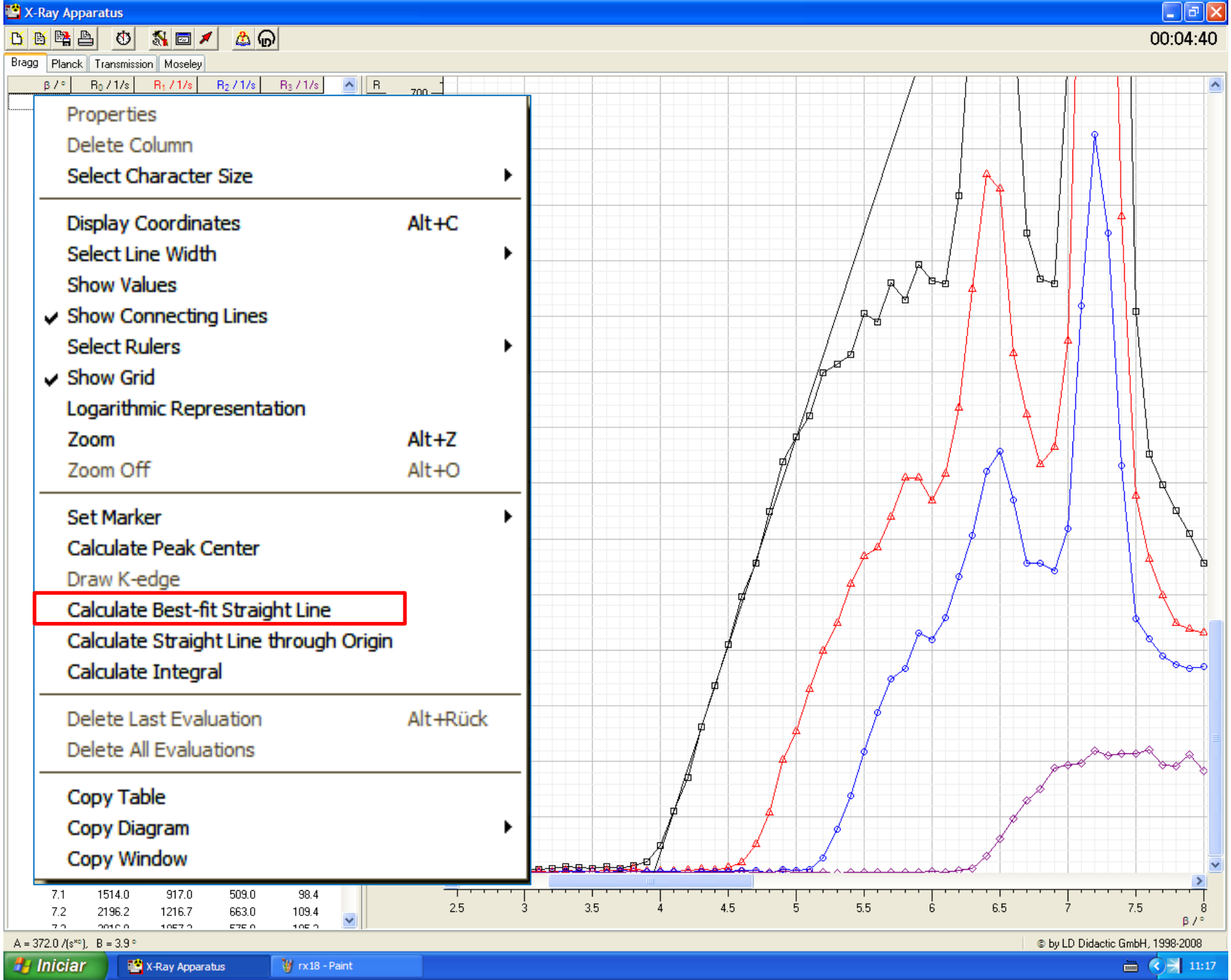
Bragg | Planck | Transmission | Moseley

β / °	R_0 / 1/s	R_1 / 1/s	R_2 / 1/s	R_3 / 1/s
2.5	2.8	2.3	0.5	0.6
2.6	2.8	0.3	0.5	0.6
2.7	2.8	1.3	1.0	0.6
2.8	3.0	1.7	1.0	0.6
2.9	3.2	1.7	1.5	0.6
3.0	1.8	2.3	0.5	1.0
3.1	2.8	1.3	0.5	0.4
3.2	3.6	0.7	0.5	0.8
3.3	5.6	2.3	1.0	0.0
3.4	4.4	1.7	1.5	0.2
3.5	4.0	1.0	1.0	1.2
3.6	6.0	2.3	0.0	0.4
3.7	4.0	2.3	2.5	0.8
3.8	6.6	4.3	1.0	1.0
3.9	10.2	1.3	1.5	0.2
4.0	24.4	1.7	1.5	0.8
4.1	55.2	1.3	1.5	0.6
4.2	85.8	2.3	0.5	0.6
4.3	131.4	3.0	1.0	0.6
4.4	168.4	2.0	1.5	0.4
4.5	205.4	4.7	1.0	0.8
4.6	247.8	9.0	2.5	1.4
4.7	278.0	25.0	2.0	0.4
4.8	324.8	54.0	0.0	0.2
4.9	369.4	100.7	3.0	1.0
5.0	391.6	127.0	2.0	0.2
5.1	410.6	165.0	3.5	0.2
5.2	449.0	199.0	13.5	0.4
5.3	457.2	223.7	39.5	0.0
5.4	465.4	259.0	69.0	0.2
5.5	502.8	284.3	108.5	0.6
5.6	495.2	291.7	144.0	0.6
5.7	529.6	319.7	174.5	0.8
5.8	514.8	354.7	184.0	0.8
5.9	546.0	354.3	215.5	0.4
6.0	531.6	334.3	209.0	1.0
6.1	529.4	358.0	229.5	0.6
6.2	608.2	417.3	266.0	2.0
6.3	798.6	524.0	303.0	4.2
6.4	1086.4	627.0	360.5	14.8
6.5	1100.0	614.0	379.0	30.2
6.6	779.4	466.0	334.5	48.6
6.7	574.4	411.0	278.5	65.2
6.8	533.8	367.0	278.0	75.2
6.9	529.4	382.0	271.0	94.0
7.0	734.4	477.3	309.0	96.8
7.1	1514.0	917.0	509.0	98.4
7.2	2196.2	1216.7	663.0	109.4



Iniciar | X-Ray Apparatus | rx19 - Paint | 11:15


X-Ray Apparatus
00:04:40
Bragg
Planck
Transmission
Moseley
β / °
R0 / 1/s
R1 / 1/s
R2 / 1/s
R3 / 1/s
R
Properties
Delete Column
Select Character Size
Display Coordinates Alt+C
Select Line Width
Show Values
Show Connecting Lines
Select Rulers
Show Grid
Logarithmic Representation
Zoom Alt+Z
Zoom Off Alt+O
Set Marker
Calculate Peak Center
Draw K-edge
Calculate Best-fit Straight Line
Calculate Straight Line through Origin
Calculate Integral
Delete Last Evaluation Alt+Rück
Delete All Evaluations
Copy Table
Copy Diagram
Copy Window
7.1 1514.0 917.0 509.0 98.4
7.2 2196.2 1216.7 663.0 109.4
2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8
β / °
© by LD Didactic GmbH, 1998-2008
Iniciar
X-Ray Apparatus
rx19 - Paint
11:15


X-Ray Apparatus
00:04:40
Bragg
Planck
Transmission
Moseley
β / °
R0 / 1/s
R1 / 1/s
R2 / 1/s
R3 / 1/s
R
Properties
Delete Column
Select Character Size
Display Coordinates Alt+C
Select Line Width
Show Values
Show Connecting Lines
Select Rulers
Show Grid
Logarithmic Representation
Zoom Alt+Z
Zoom Off Alt+O
Set Marker
Calculate Peak Center
Draw K-edge
Calculate Best-fit Straight Line
Calculate Straight Line through Origin
Calculate Integral
Delete Last Evaluation Alt+Rück
Delete All Evaluations
Copy Table
Copy Diagram
Copy Window
7.1 1514.0 917.0 509.0 98.4
7.2 2196.2 1216.7 663.0 109.4
2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8
β / °
A = 372.0 /(s²), B = 3.9 °
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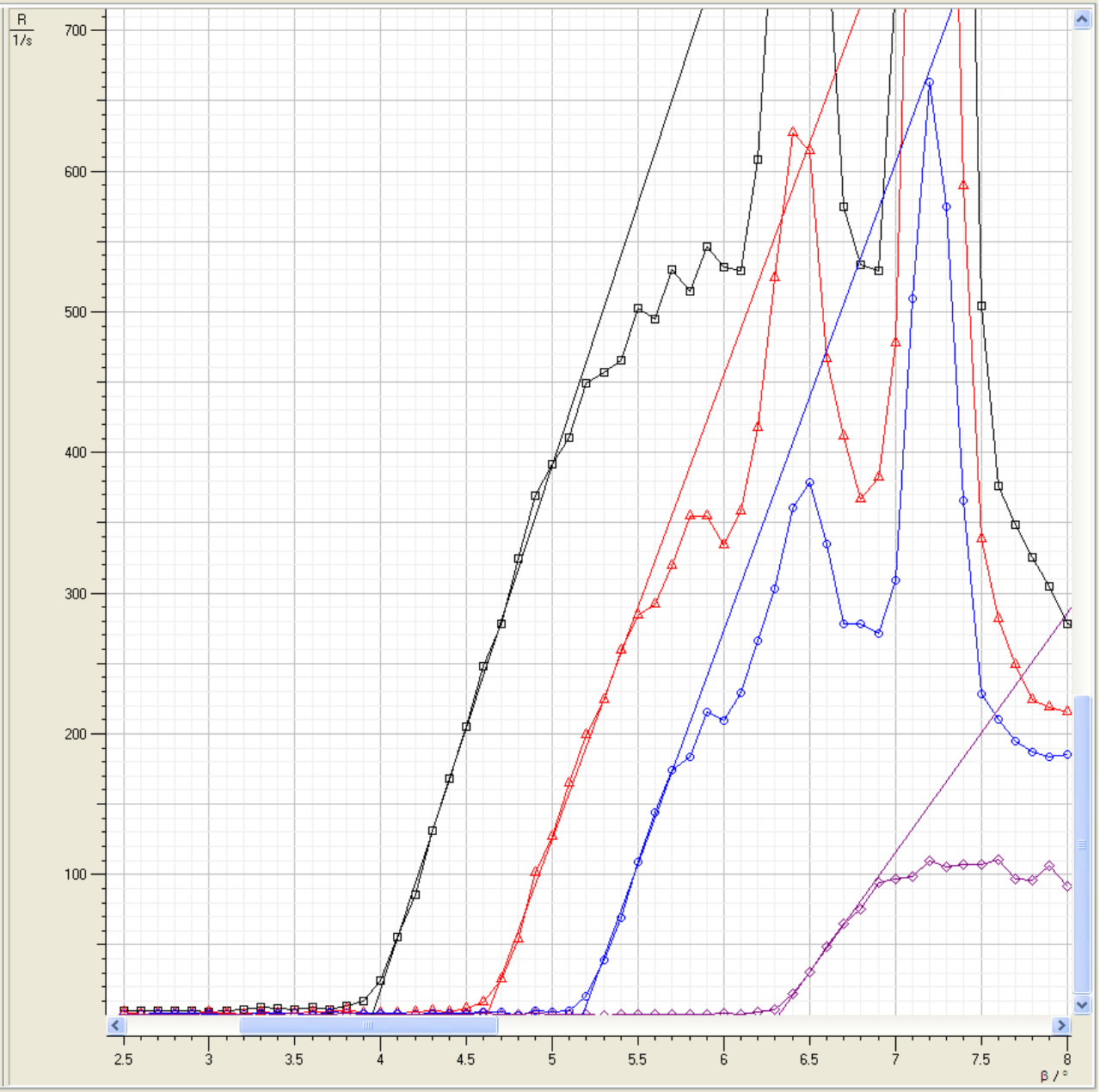
Iniciar
X-Ray Apparatus
rx18 - Paint
11:17

X-Ray Apparatus

00:04:40

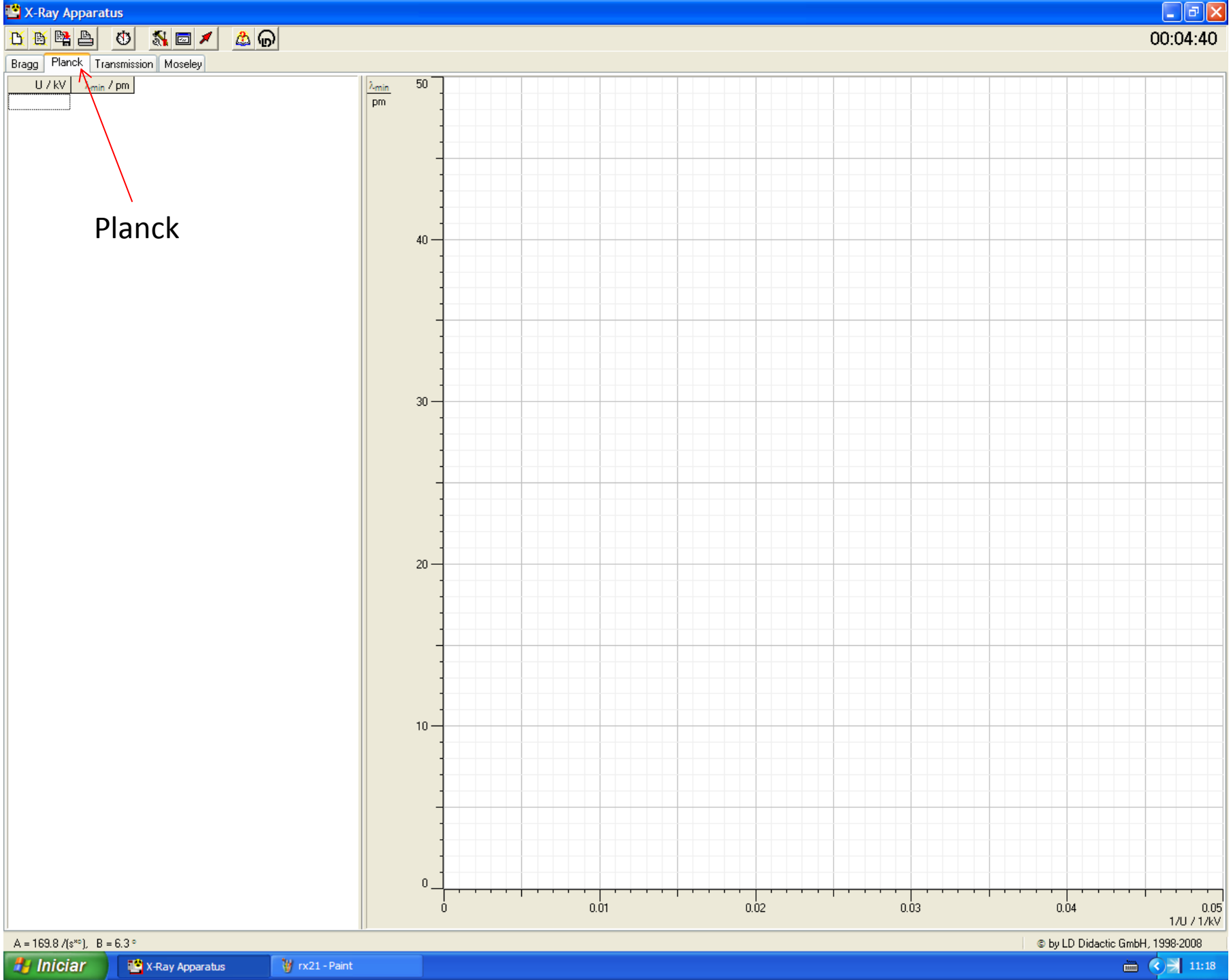
Bragg | Planck | Transmission | Moseley

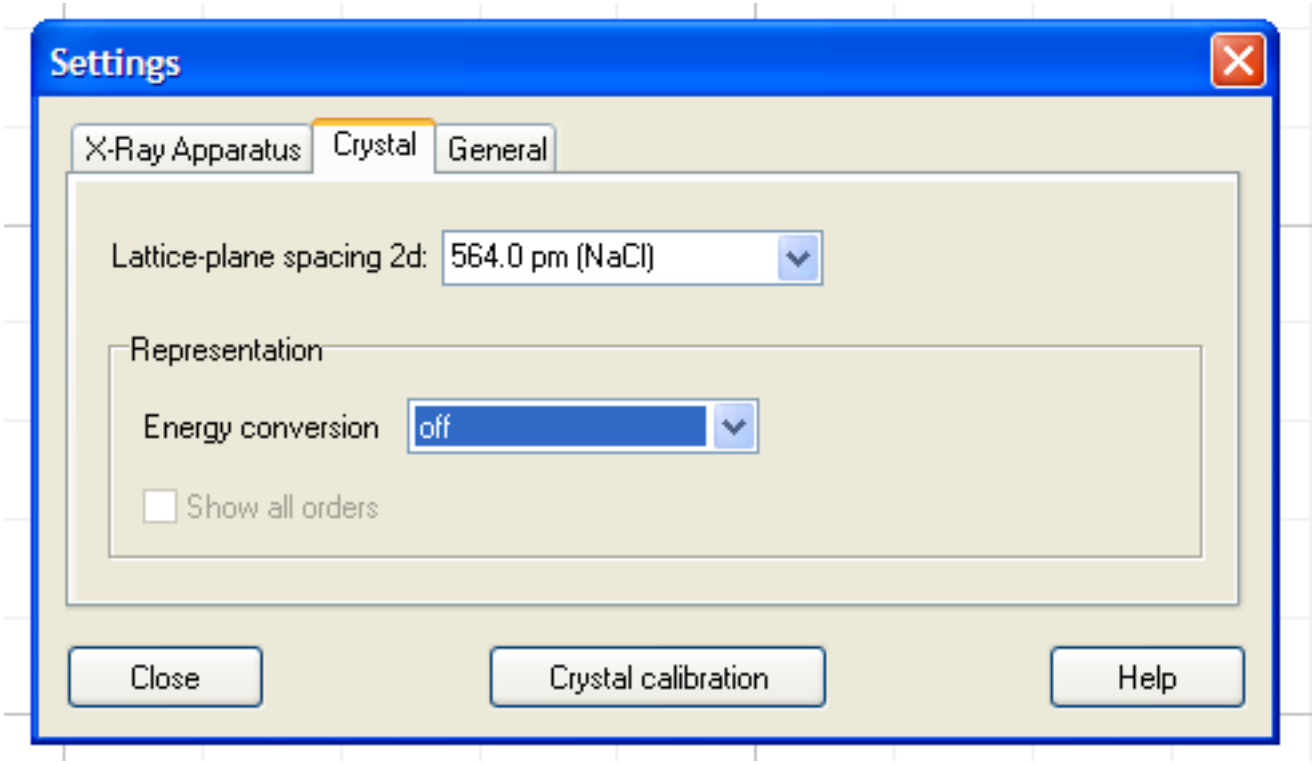
β / °	R_0 / 1/s	R_1 / 1/s	R_2 / 1/s	R_3 / 1/s
2.5	2.8	2.3	0.5	0.6
2.6	2.8	0.3	0.5	0.6
2.7	2.8	1.3	1.0	0.6
2.8	3.0	1.7	1.0	0.6
2.9	3.2	1.7	1.5	0.6
3.0	1.8	2.3	0.5	1.0
3.1	2.8	1.3	0.5	0.4
3.2	3.6	0.7	0.5	0.8
3.3	5.6	2.3	1.0	0.0
3.4	4.4	1.7	1.5	0.2
3.5	4.0	1.0	1.0	1.2
3.6	6.0	2.3	0.0	0.4
3.7	4.0	2.3	2.5	0.8
3.8	6.6	4.3	1.0	1.0
3.9	10.2	1.3	1.5	0.2
4.0	24.4	1.7	1.5	0.8
4.1	55.2	1.3	1.5	0.6
4.2	85.8	2.3	0.5	0.6
4.3	131.4	3.0	1.0	0.6
4.4	168.4	2.0	1.5	0.4
4.5	205.4	4.7	1.0	0.8
4.6	247.8	9.0	2.5	1.4
4.7	278.0	25.0	2.0	0.4
4.8	324.8	54.0	0.0	0.2
4.9	369.4	100.7	3.0	1.0
5.0	391.6	127.0	2.0	0.2
5.1	410.6	165.0	3.5	0.2
5.2	449.0	199.0	13.5	0.4
5.3	457.2	223.7	39.5	0.0
5.4	465.4	259.0	69.0	0.2
5.5	502.8	284.3	108.5	0.6
5.6	495.2	291.7	144.0	0.6
5.7	529.6	319.7	174.5	0.8
5.8	514.8	354.7	184.0	0.8
5.9	546.0	354.3	215.5	0.4
6.0	531.6	334.3	209.0	1.0
6.1	529.4	358.0	229.5	0.6
6.2	608.2	417.3	266.0	2.0
6.3	798.6	524.0	303.0	4.2
6.4	1086.4	627.0	360.5	14.8
6.5	1100.0	614.0	379.0	30.2
6.6	779.4	466.0	334.5	48.6
6.7	574.4	411.0	278.5	65.2
6.8	533.8	367.0	278.0	75.2
6.9	529.4	382.0	271.0	94.0
7.0	734.4	477.3	309.0	96.8
7.1	1514.0	917.0	509.0	98.4
7.2	2196.2	1216.7	663.0	109.4



A = 169.8 /(s²°), B = 6.3 °

Iniciar | X-Ray Apparatus | rx20 - Paint | 11:18


X-Ray Apparatus
00:04:40
Bragg
Planck
Transmission
Moseley
U / kV
λmin / pm
Planck
λmin
pm
50
40
30
20
10
0
0
0.01
0.02
0.03
0.04
0.05
1/U / 1/kV
A = 169.8 /(s²), B = 6.3 °
© by LD Didactic GmbH, 1998-2008
Iniciar
X-Ray Apparatus
rx21 - Paint
11:18

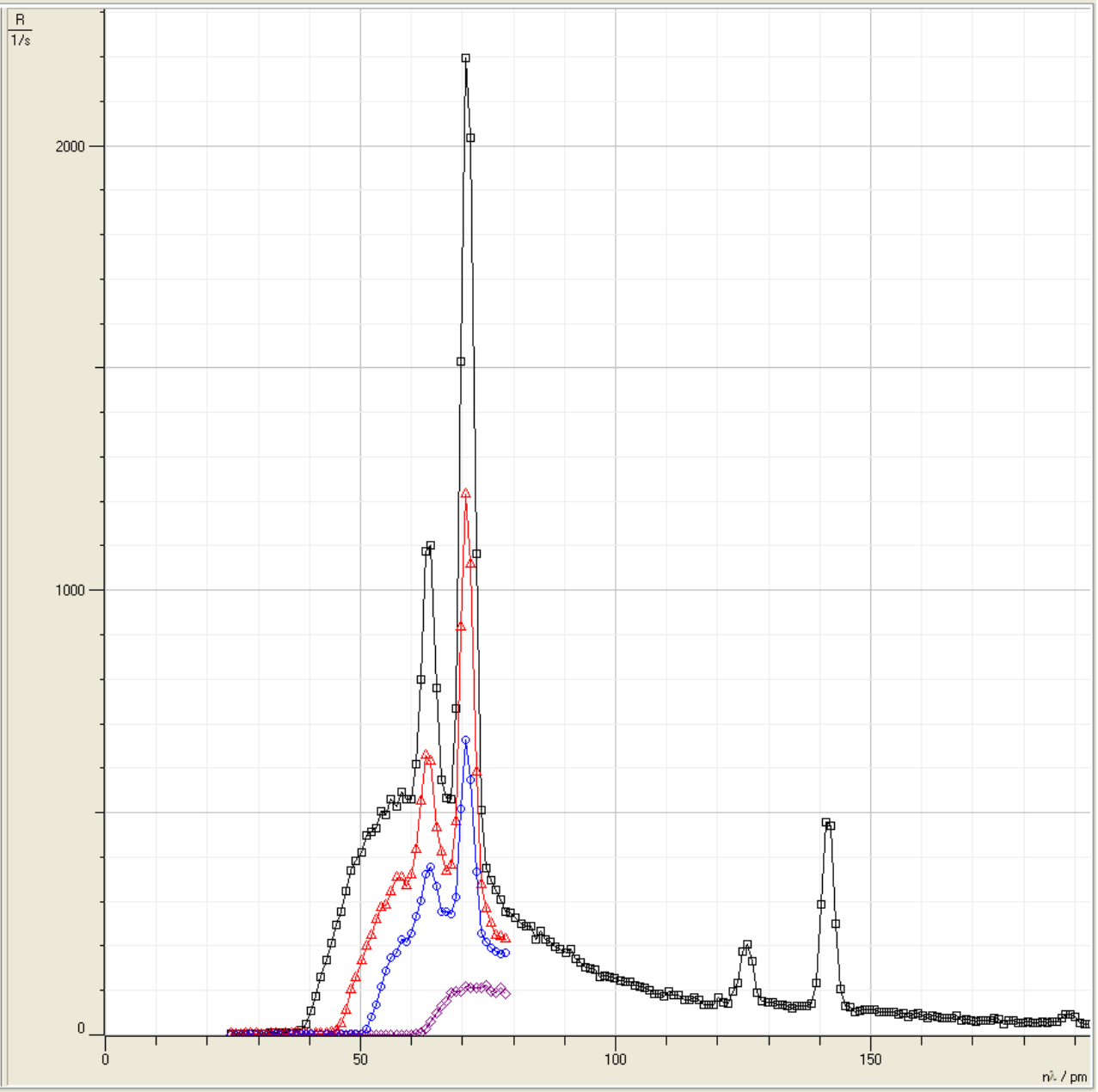

Settings
X-Ray Apparatus
Crystal
General
Lattice-plane spacing 2d:
564.0 pm (NaCl)
Representation
Energy conversion
off
Show all orders
Close
Crystal calibration
Help

X-Ray Apparatus

00:04:40

Bragg | Planck | Transmission | Moseley

nλ / pm	R_0 / 1/s	R_1 / 1/s	R_2 / 1/s	R_3 / 1/s
24.6	2.8	2.3	0.5	0.6
25.6	2.8	0.3	0.5	0.6
26.6	2.8	1.3	1.0	0.6
27.6	3.0	1.7	1.0	0.6
28.5	3.2	1.7	1.5	0.6
29.5	1.8	2.3	0.5	1.0
30.5	2.8	1.3	0.5	0.4
31.5	3.6	0.7	0.5	0.8
32.5	5.6	2.3	1.0	0.0
33.4	4.4	1.7	1.5	0.2
34.4	4.0	1.0	1.0	1.2
35.4	6.0	2.3	0.0	0.4
36.4	4.0	2.3	2.5	0.8
37.4	6.6	4.3	1.0	1.0
38.4	10.2	1.3	1.5	0.2
39.3	24.4	1.7	1.5	0.8
40.3	55.2	1.3	1.5	0.6
41.3	85.8	2.3	0.5	0.6
42.3	131.4	3.0	1.0	0.6
43.3	168.4	2.0	1.5	0.4
44.3	205.4	4.7	1.0	0.8
45.2	247.8	9.0	2.5	1.4
46.2	278.0	25.0	2.0	0.4
47.2	324.8	54.0	0.0	0.2
48.2	369.4	100.7	3.0	1.0
49.2	391.6	127.0	2.0	0.2
50.1	410.6	165.0	3.5	0.2
51.1	449.0	199.0	13.5	0.4
52.1	457.2	223.7	39.5	0.0
53.1	465.4	259.0	69.0	0.2
54.1	502.8	284.3	108.5	0.6
55.0	495.2	291.7	144.0	0.6
56.0	529.6	319.7	174.5	0.8
57.0	514.8	354.7	184.0	0.8
58.0	546.0	354.3	215.5	0.4
59.0	531.6	334.3	209.0	1.0
59.9	529.4	358.0	229.5	0.6
60.9	608.2	417.3	266.0	2.0
61.9	798.6	524.0	303.0	4.2
62.9	1086.4	627.0	360.5	14.8
63.8	1100.0	614.0	379.0	30.2
64.8	779.4	466.0	334.5	48.6
65.8	574.4	411.0	278.5	65.2
66.8	533.8	367.0	278.0	75.2
67.8	529.4	382.0	271.0	94.0
68.7	734.4	477.3	309.0	96.8
69.7	1514.0	917.0	509.0	98.4
70.7	2196.2	1216.7	663.0	109.4



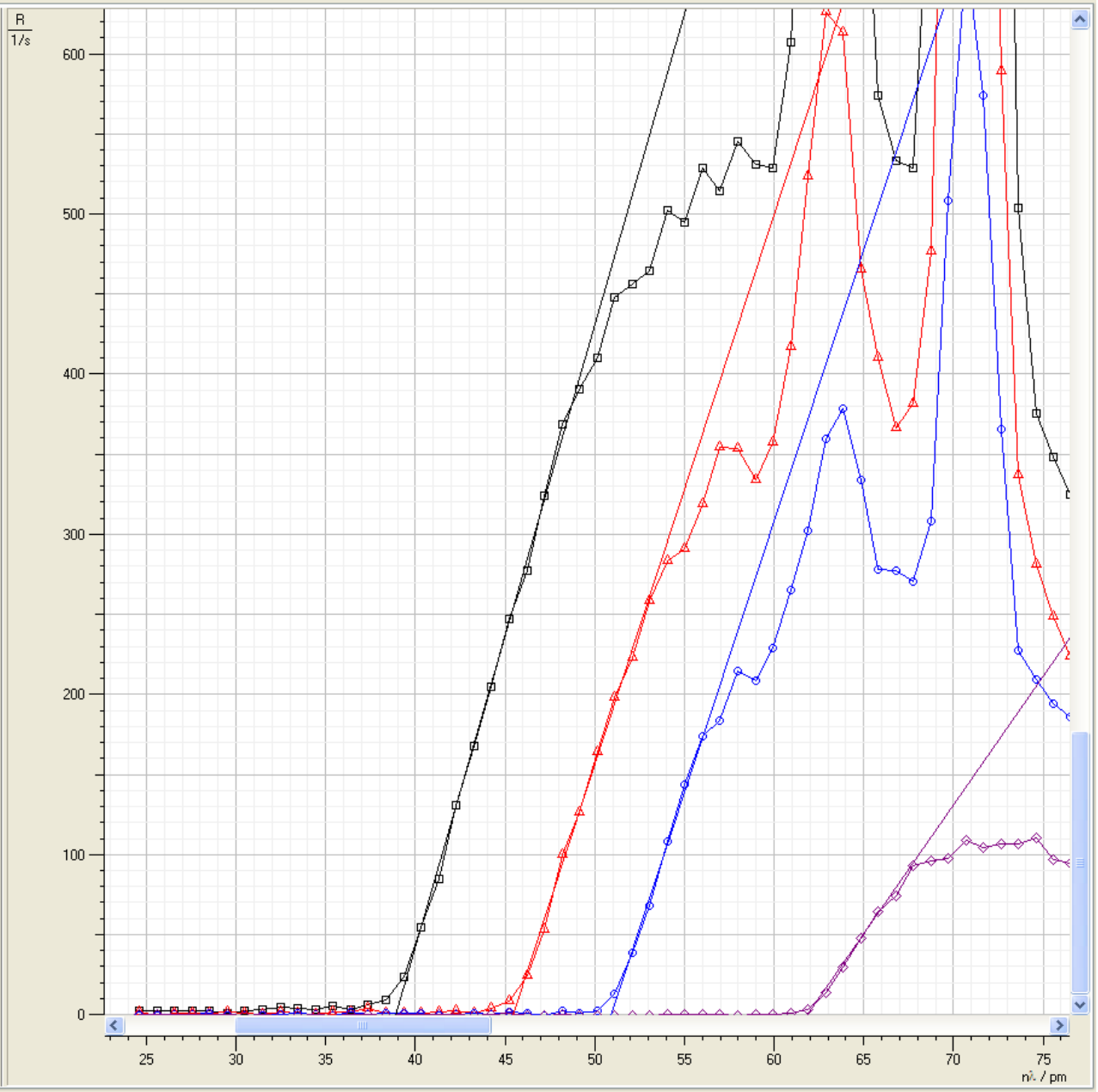
Iniciar | X-Ray Apparatus | rx22 - Paint | 11:20

X-Ray Apparatus

00:04:40

Bragg | Planck | Transmission | Moseley

nλ / pm	R_0 / 1/s	R_1 / 1/s	R_2 / 1/s	R_3 / 1/s
24.6	2.8	2.3	0.5	0.6
25.6	2.8	0.3	0.5	0.6
26.6	2.8	1.3	1.0	0.6
27.6	3.0	1.7	1.0	0.6
28.5	3.2	1.7	1.5	0.6
29.5	1.8	2.3	0.5	1.0
30.5	2.8	1.3	0.5	0.4
31.5	3.6	0.7	0.5	0.8
32.5	5.6	2.3	1.0	0.0
33.4	4.4	1.7	1.5	0.2
34.4	4.0	1.0	1.0	1.2
35.4	6.0	2.3	0.0	0.4
36.4	4.0	2.3	2.5	0.8
37.4	6.6	4.3	1.0	1.0
38.4	10.2	1.3	1.5	0.2
39.3	24.4	1.7	1.5	0.8
40.3	55.2	1.3	1.5	0.6
41.3	85.8	2.3	0.5	0.6
42.3	131.4	3.0	1.0	0.6
43.3	168.4	2.0	1.5	0.4
44.3	205.4	4.7	1.0	0.8
45.2	247.8	9.0	2.5	1.4
46.2	278.0	25.0	2.0	0.4
47.2	324.8	54.0	0.0	0.2
48.2	369.4	100.7	3.0	1.0
49.2	391.6	127.0	2.0	0.2
50.1	410.6	165.0	3.5	0.2
51.1	449.0	199.0	13.5	0.4
52.1	457.2	223.7	39.5	0.0
53.1	465.4	259.0	69.0	0.2
54.1	502.8	284.3	108.5	0.6
55.0	495.2	291.7	144.0	0.6
56.0	529.6	319.7	174.5	0.8
57.0	514.8	354.7	184.0	0.8
58.0	546.0	354.3	215.5	0.4
59.0	531.6	334.3	209.0	1.0
59.9	529.4	358.0	229.5	0.6
60.9	608.2	417.3	266.0	2.0
61.9	798.6	524.0	303.0	4.2
62.9	1086.4	627.0	360.5	14.8
63.8	1100.0	614.0	379.0	30.2
64.8	779.4	466.0	334.5	48.6
65.8	574.4	411.0	278.5	65.2
66.8	533.8	367.0	278.0	75.2
67.8	529.4	382.0	271.0	94.0
68.7	734.4	477.3	309.0	96.8
69.7	1514.0	917.0	509.0	98.4
70.7	2196.2	1216.7	663.0	109.4



λmin = 61.8 pm

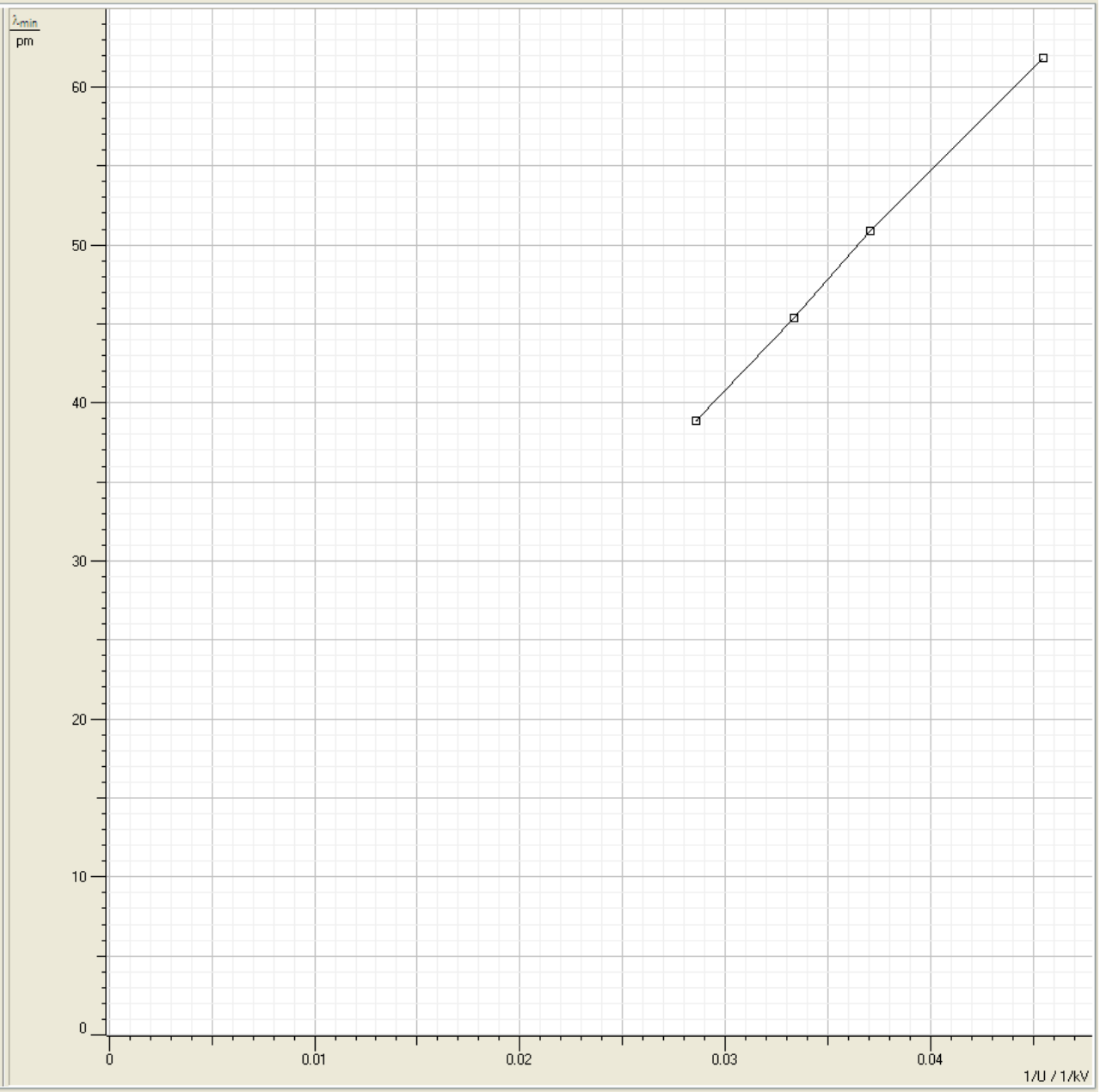
Iniciar | X-Ray Apparatus | rx23 - Paint | 11:21

X-Ray Apparatus

00:04:40

Bragg | Planck | Transmission | Moseley

U / kV	λmin / pm
35.0	38.9
30.0	45.4
27.0	50.9
22.0	61.8



λmin = 61.8 pm

Iniciar | X-Ray Apparatus | rx24 - Paint | 11:22