TOPOTACTIC REDUCTION: FROM SOFT CHEMISTRY TO SOFT PHYSICS

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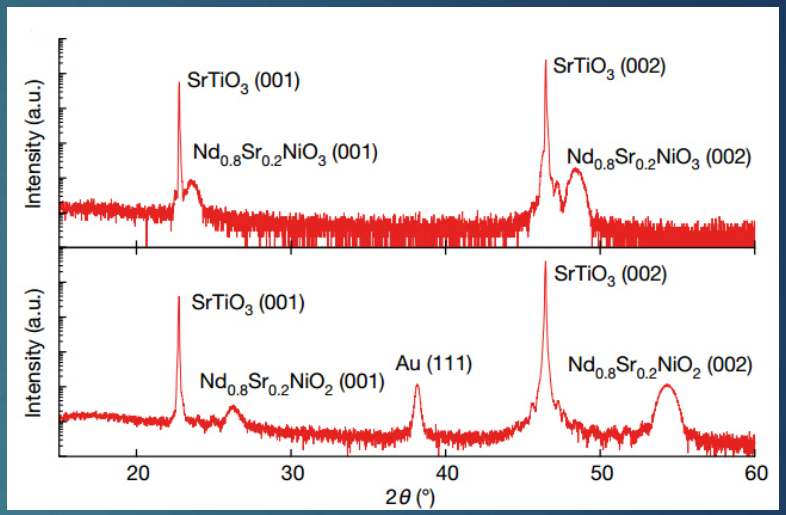
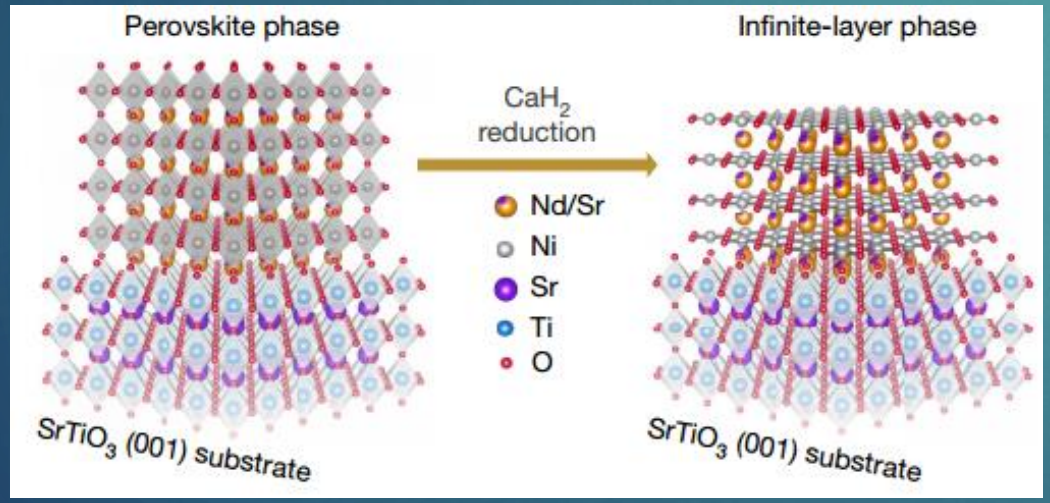
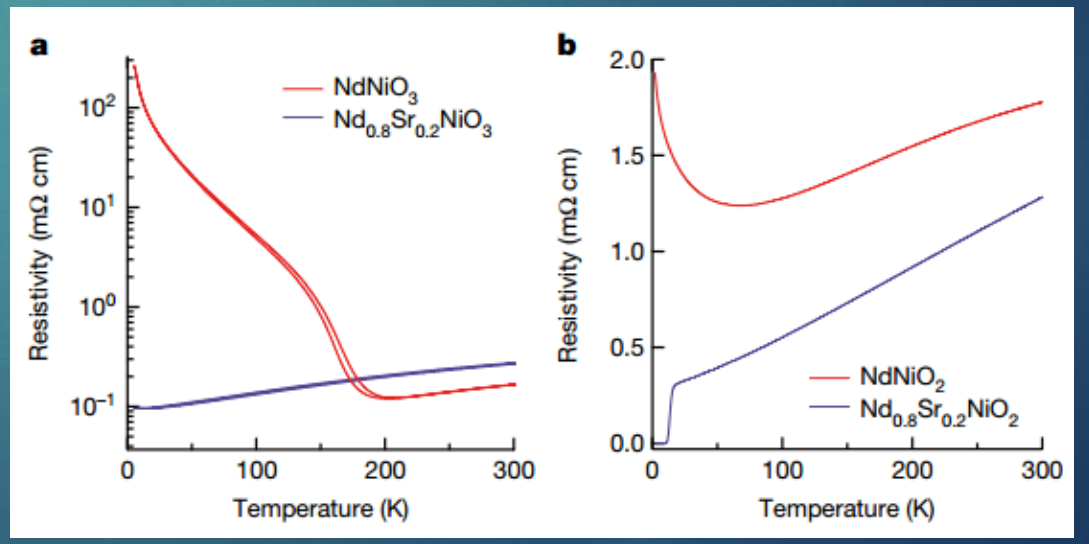
General introduction to the topic

- Supraconductivity in nickelates
- Influence of doping and crystal structure
- Chemical topotactic reduction approach
- A more « physical » approach

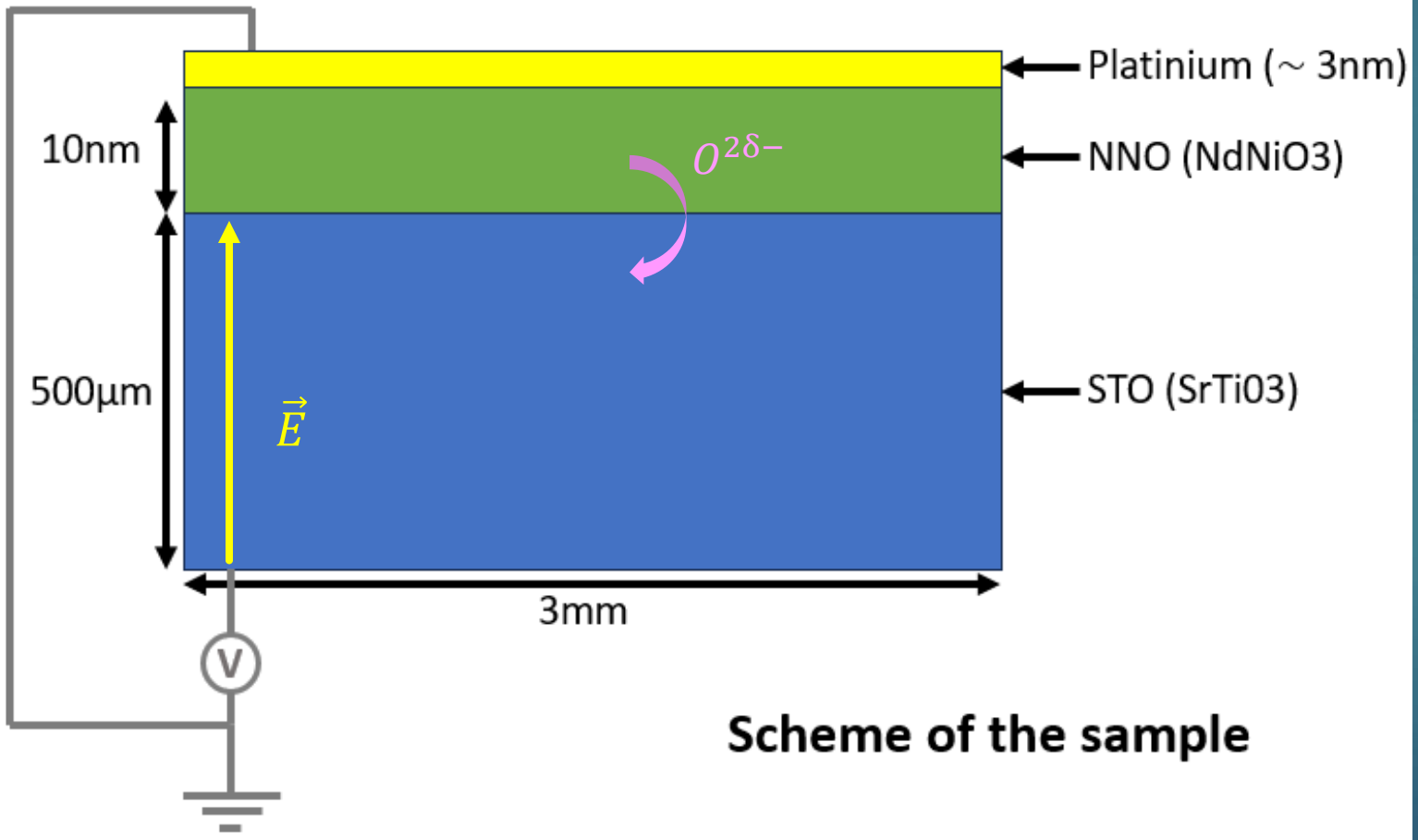




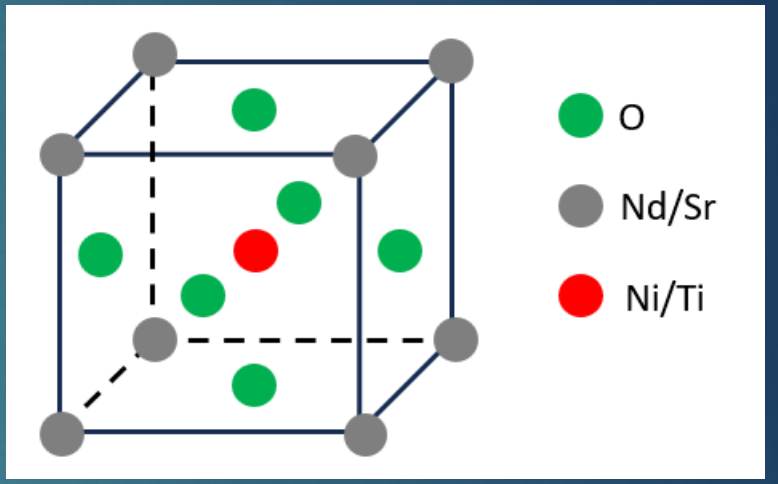


Superconductivity in an infinite-layer nickelate
Danfeng & al., Nature, 2019

Presentation of the approach

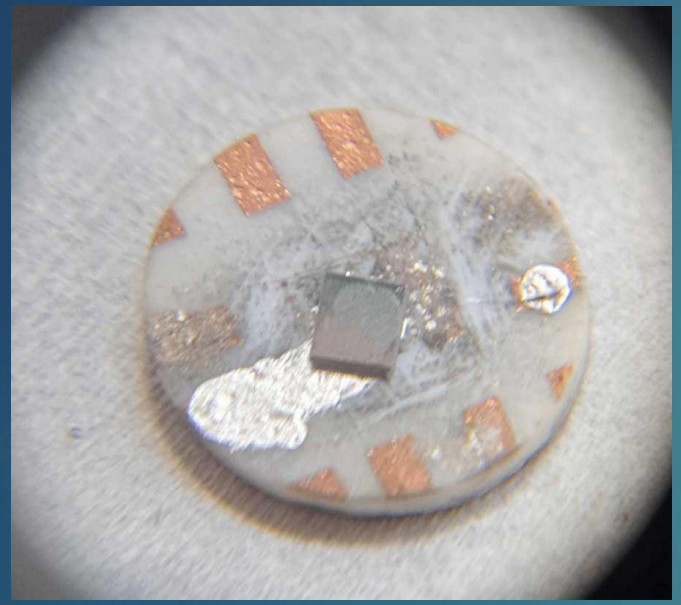


Scheme of the sample



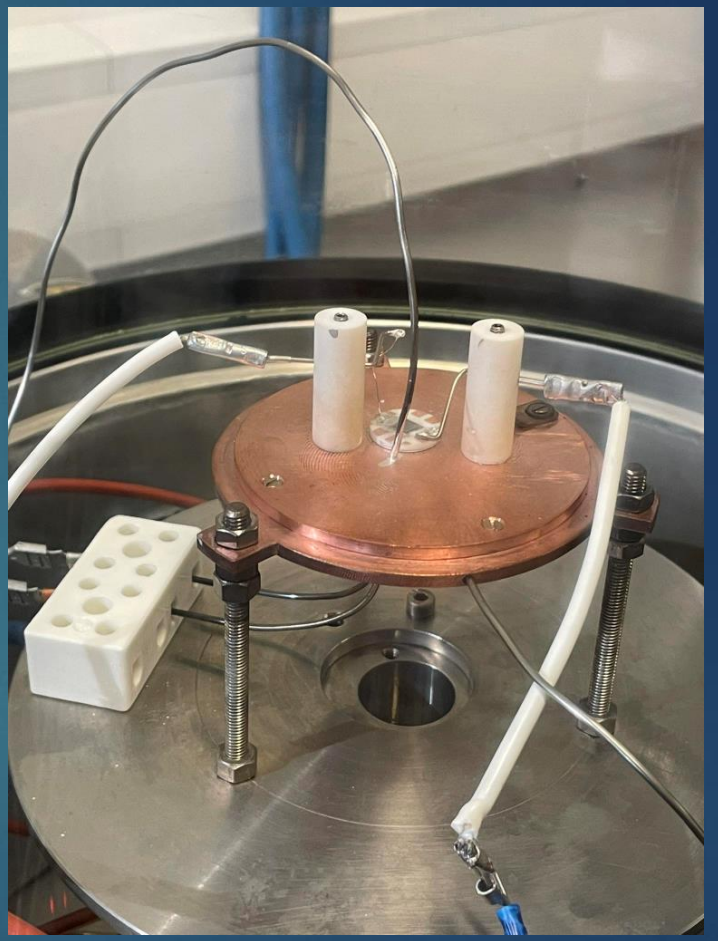
Crystal perovskite structure

Experimental device (1)



MACOR support on which the sample is fixed using silver paste

Wire connection used to apply an electric field through the sample

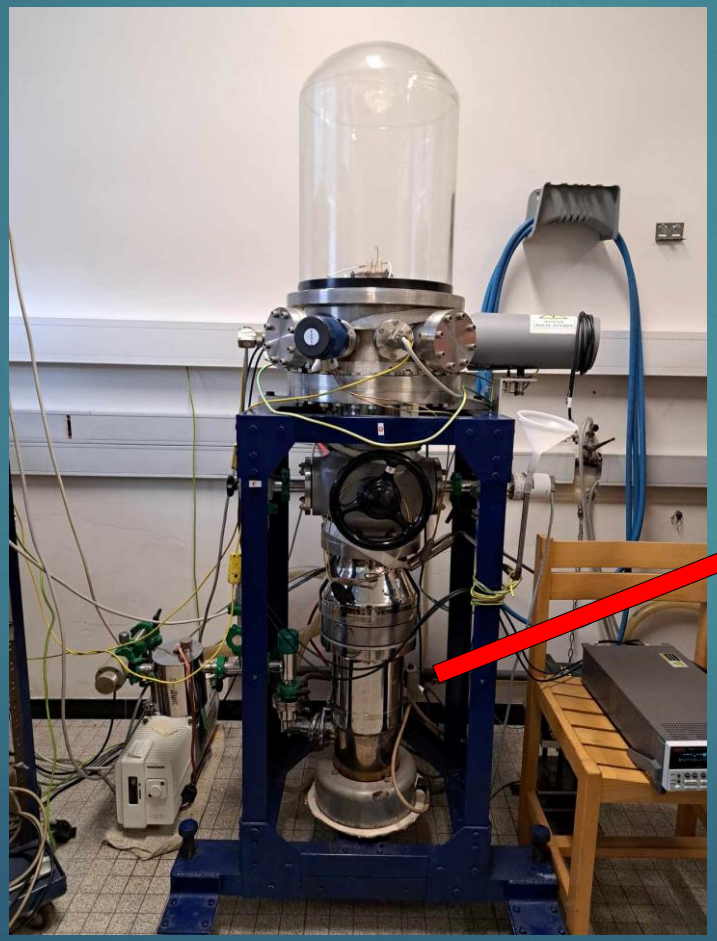


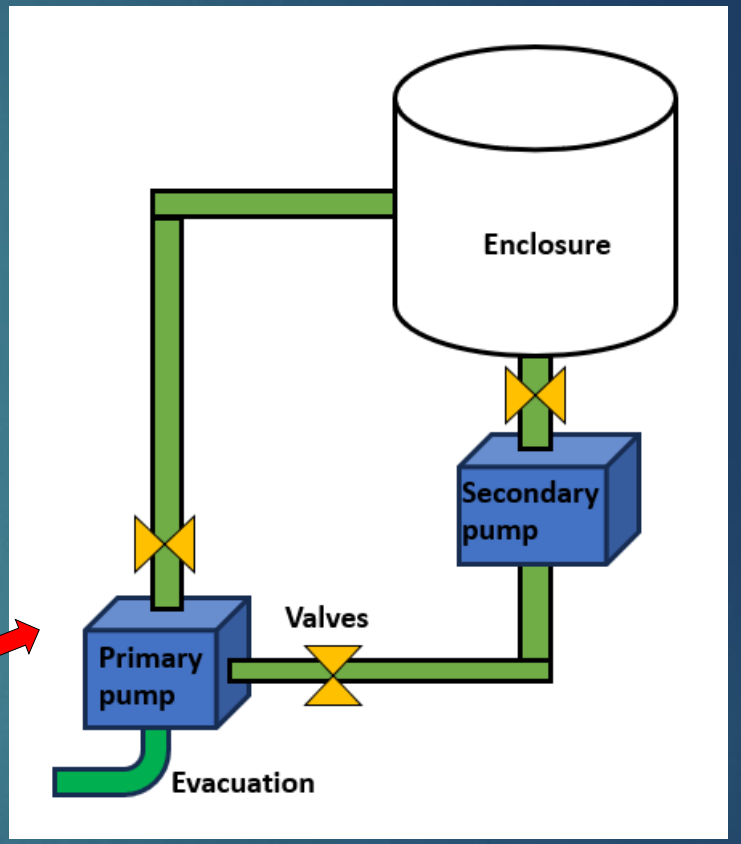
Thermocouple

Experimental device (2)

Central control pannel (pumps + thermocouple)

Primary+Secondary pumping system

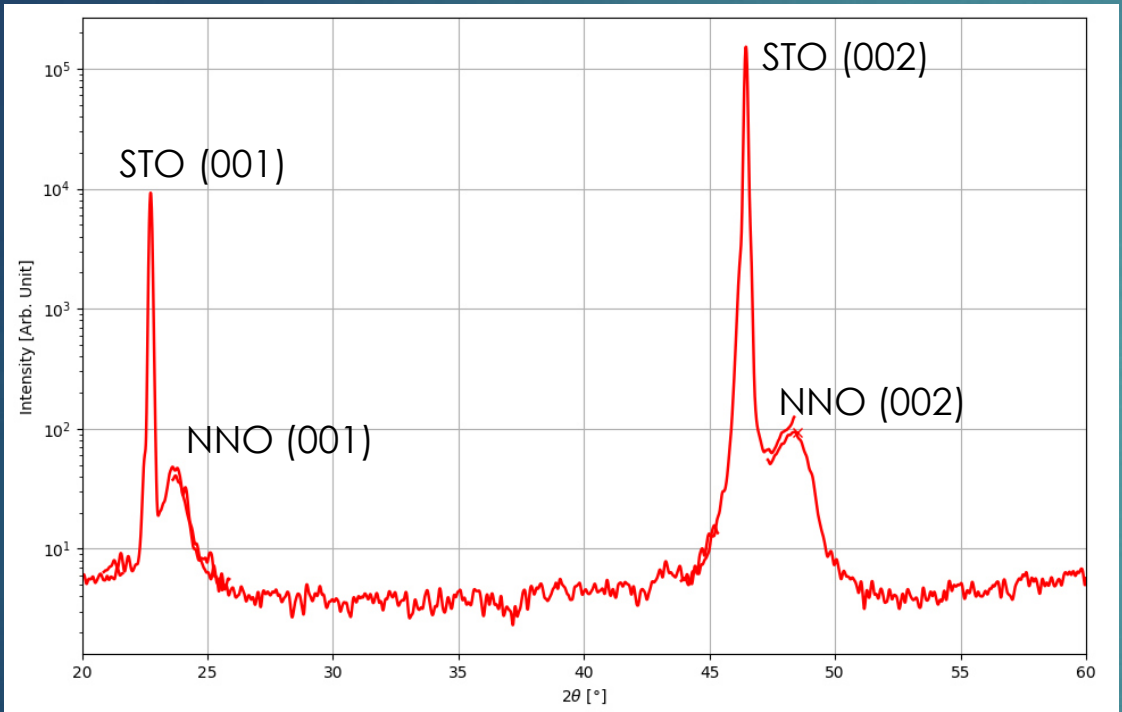




Pumping system scheme

X-rays diffraction

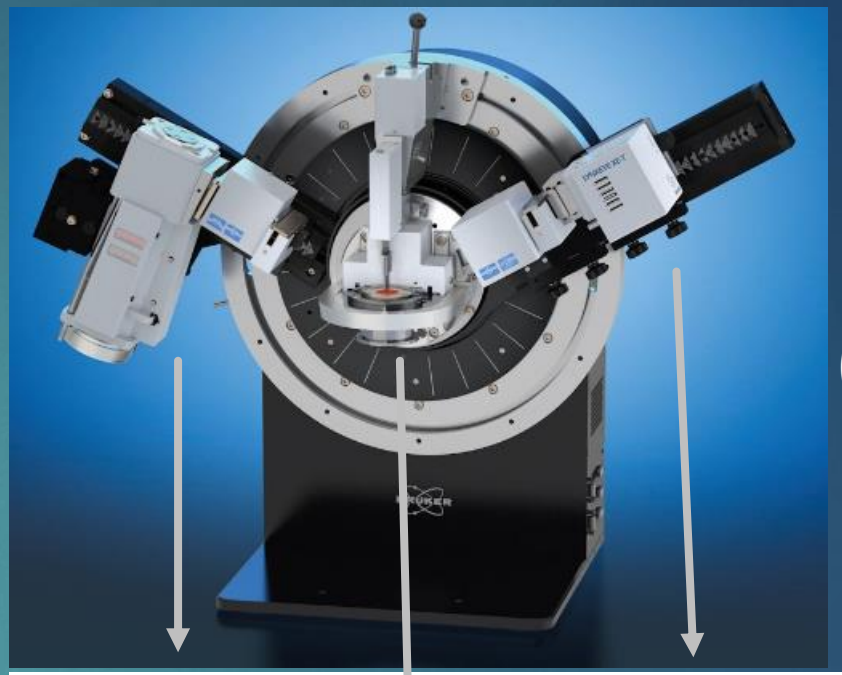
Bragg's law : nλ = 2d sinθ



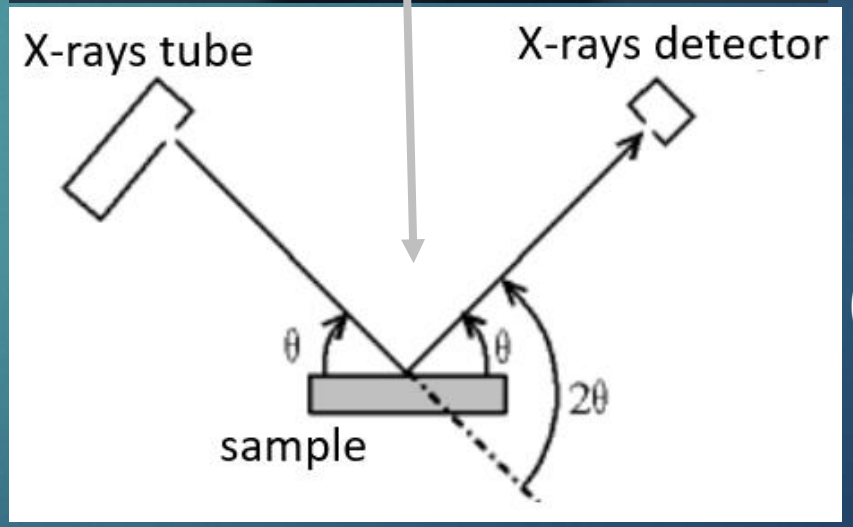
Diffraction spectrum of the sample before reduction

X-ray spectra plotting application

http://deuns.chez.com/sciences/drx/drx2.html



(a)

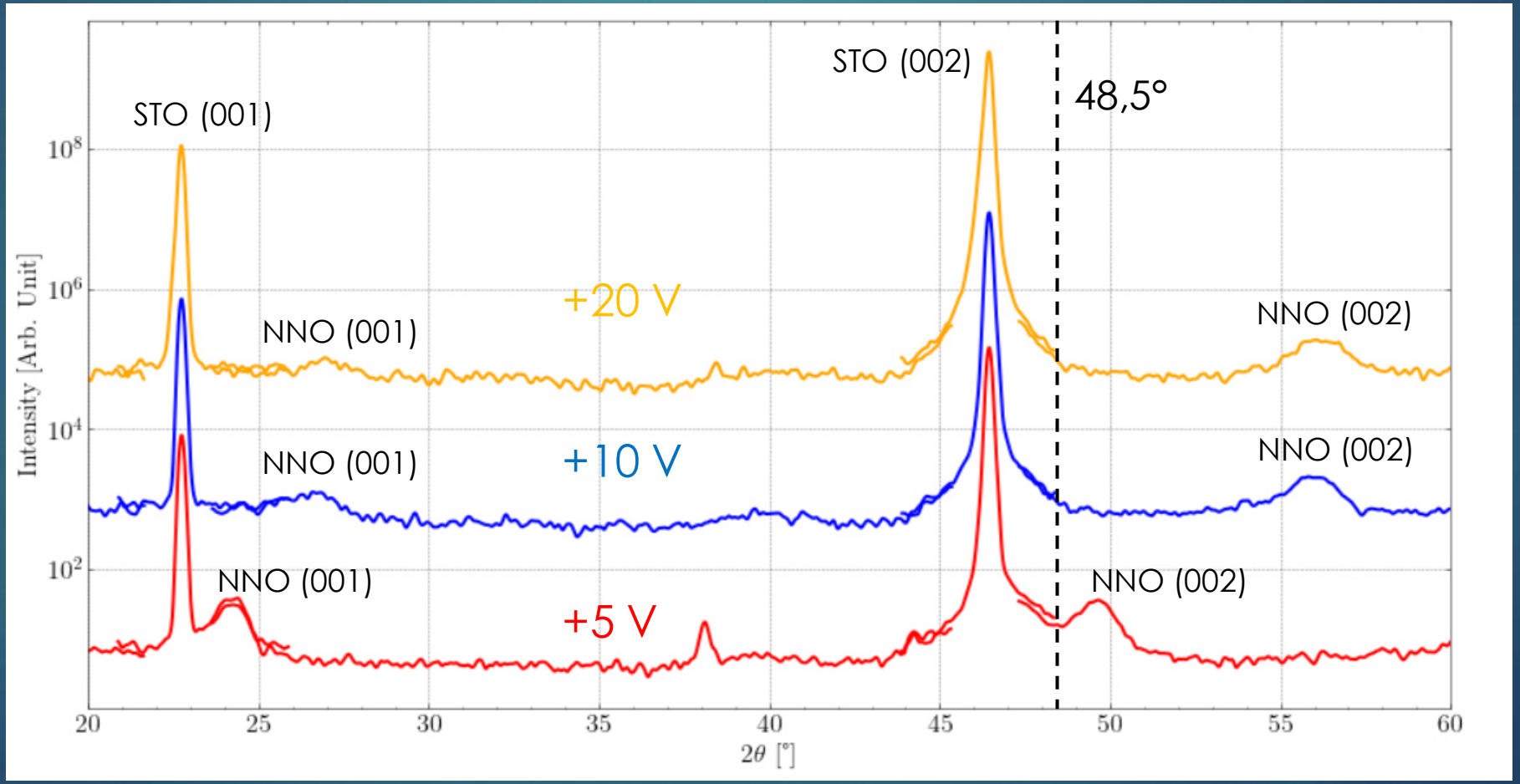


(b)

Image of a diffractometer (a) and scheme of a diffractometer (b)

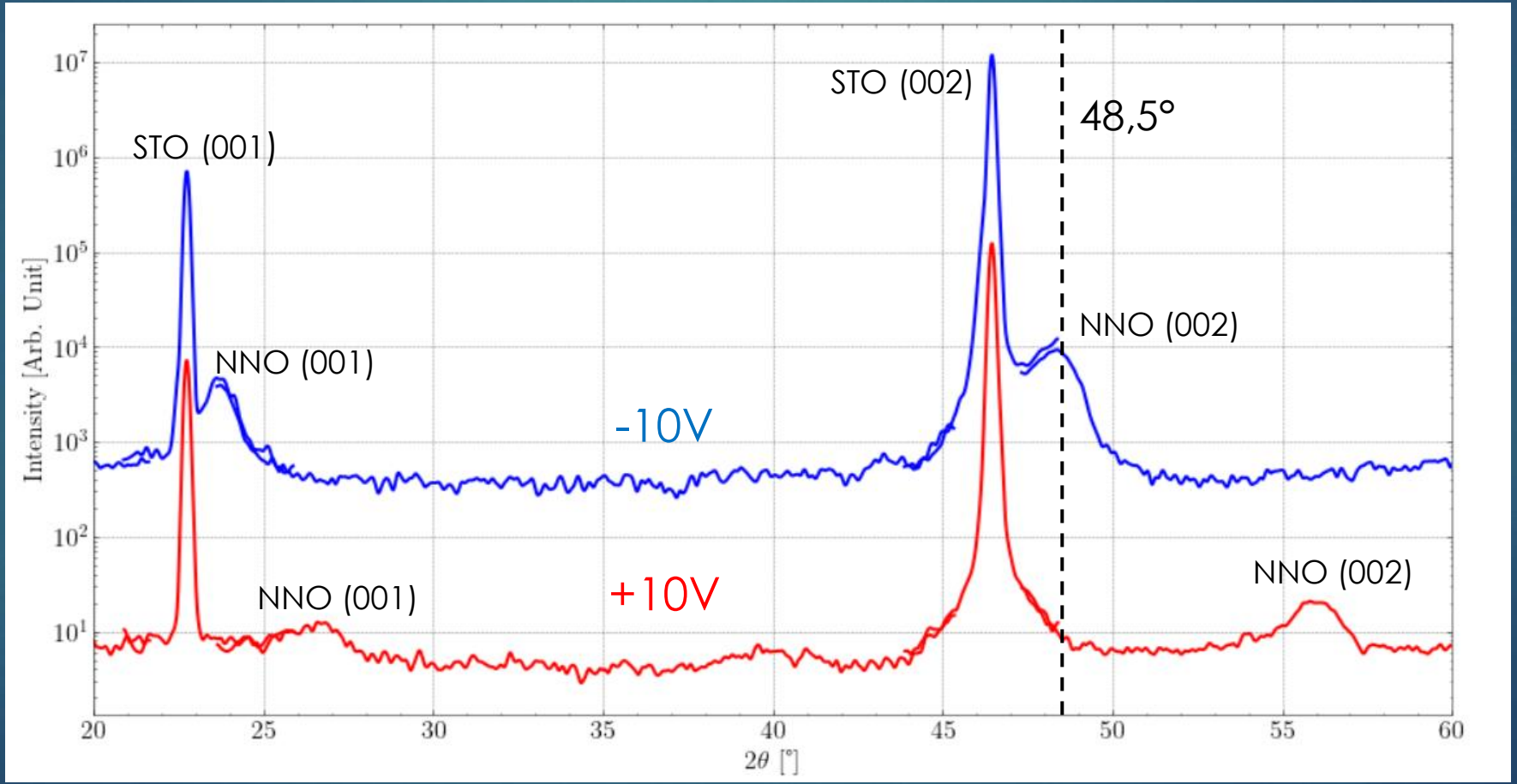
Effect of voltage

- Diffraction spectra of NdNiO3 samples, with parameters : 6 hours, 300°C



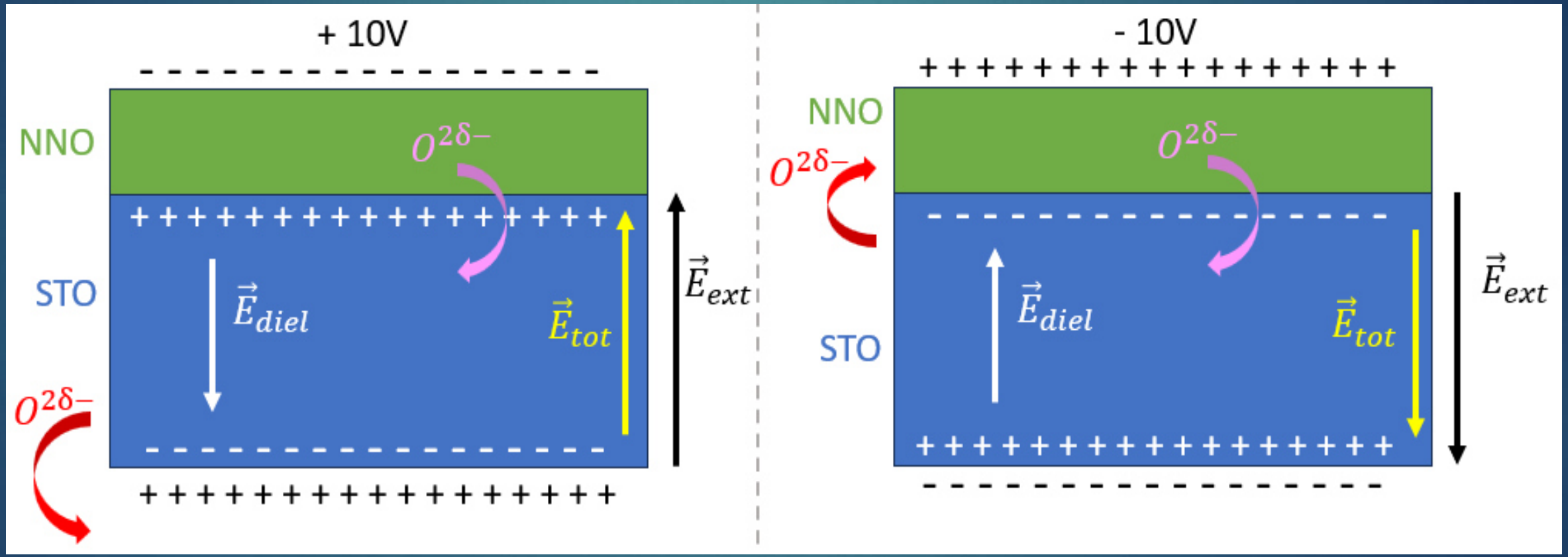
Effect of voltage direction

- Diffraction spectra of NdNiO3 samples, with parameters : 6 hours, 300°C



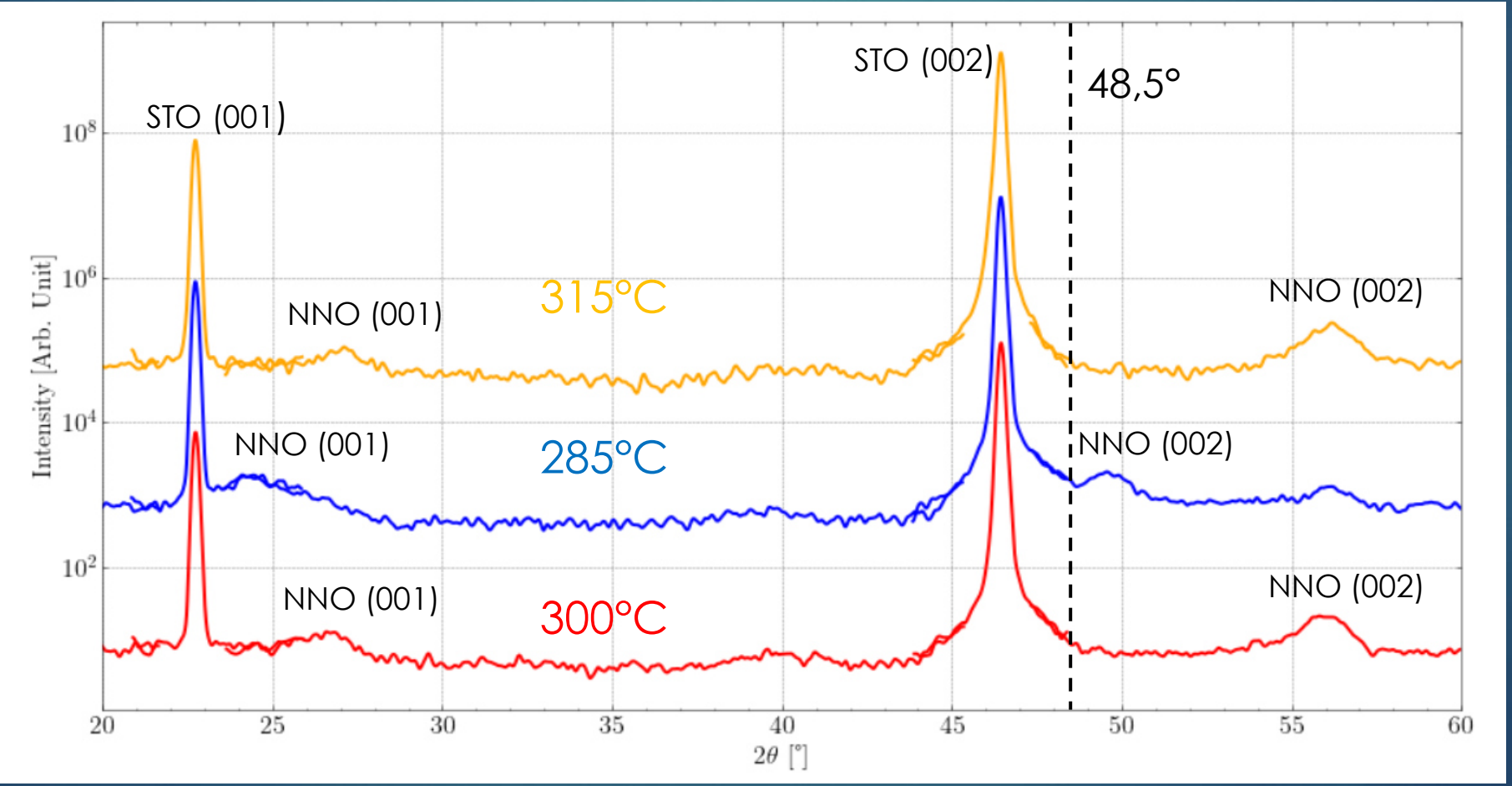
no shift for -10V !

Why is there no peak shift at -10V ?



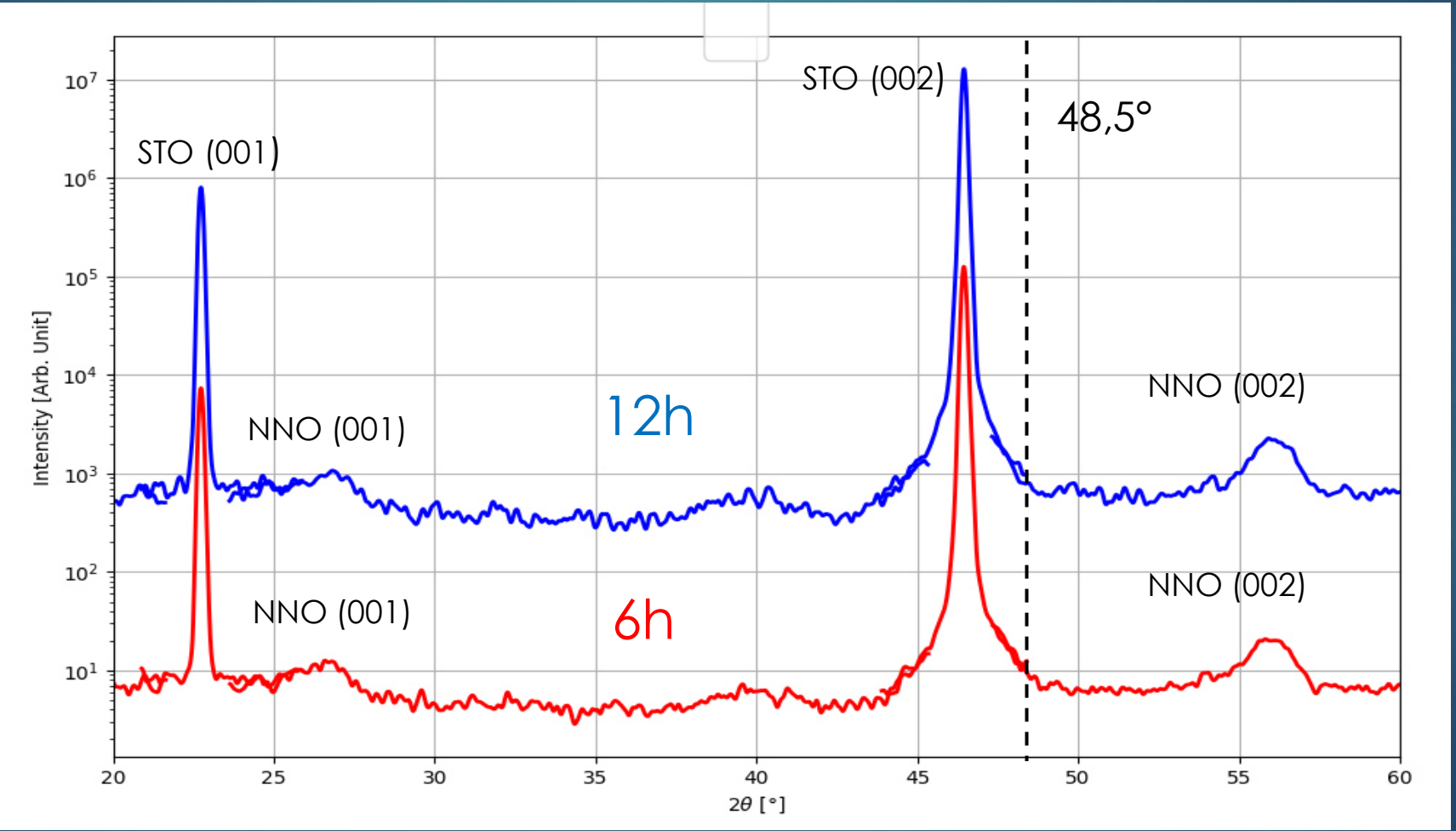
Effect of temperature

- Diffraction spectra of NdNiO3 samples, with parameters : 6 hours, +10 V



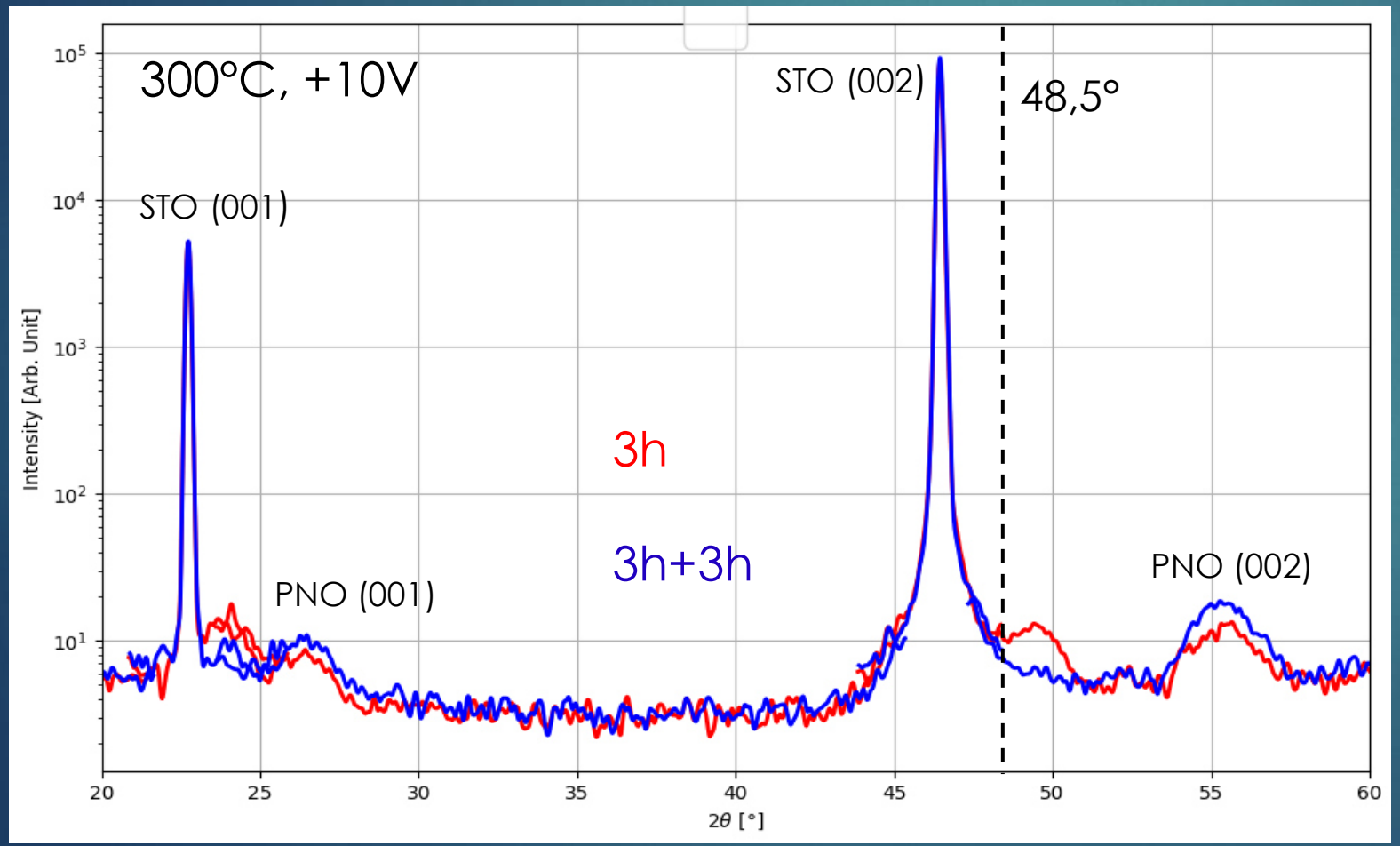
Effect of time

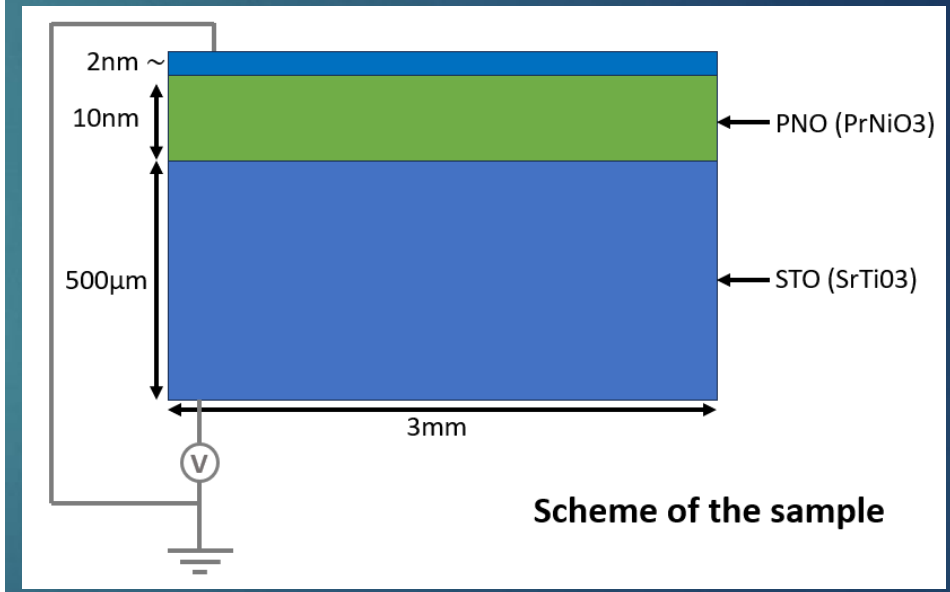
- Diffraction spectra of NdNiO3 samples, with parameters : +10V, 300°C



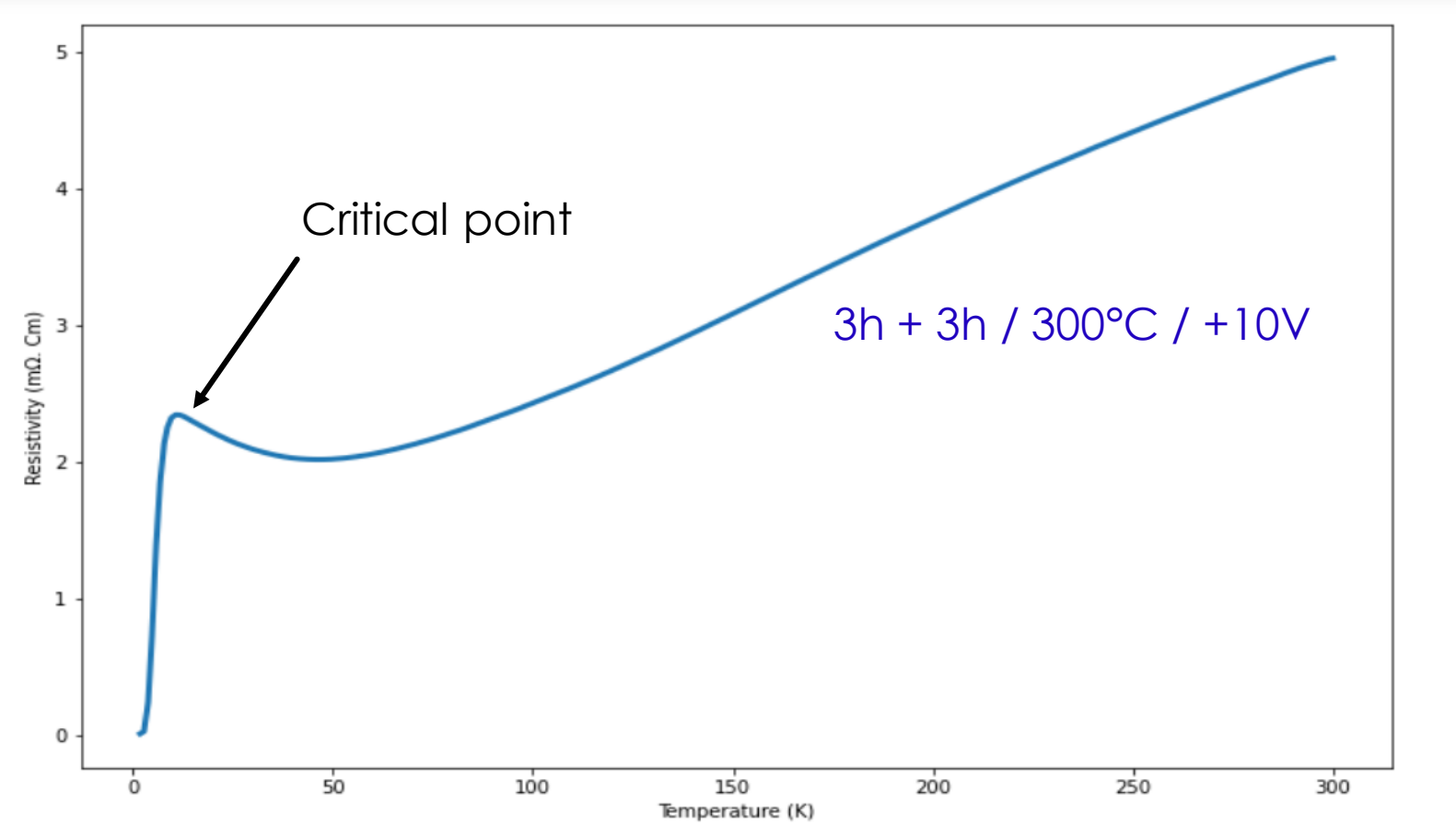
Trials on a new sample : From NNO to PNO

- Structure and properties of the new sample, new approach for the reduction





Transport measurement of PNO



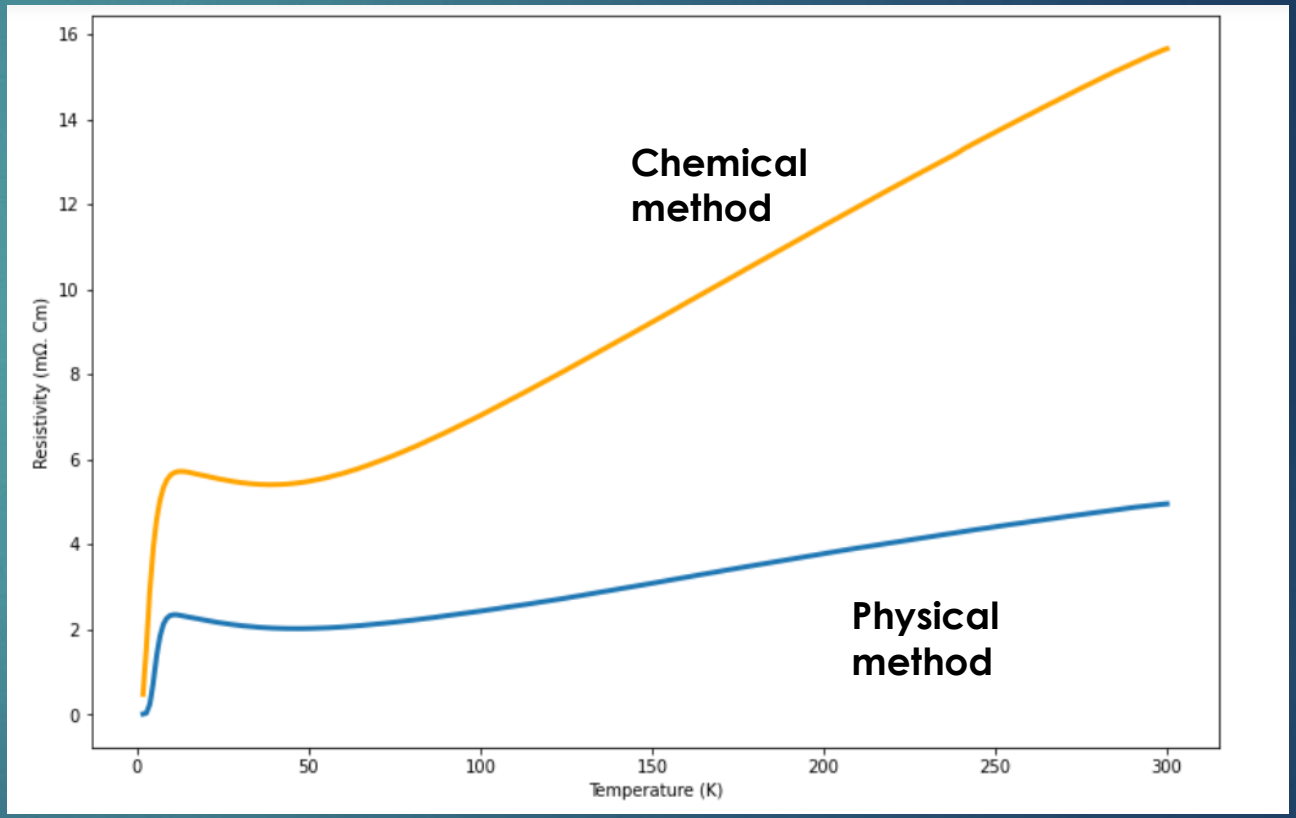
- Transport measurement on PNO sample obtained via physical approach (DS100C)
- Critical Temperature ~ 9.6 K

Discovery of supraconductivity in PNO via physical approach

Conclusion

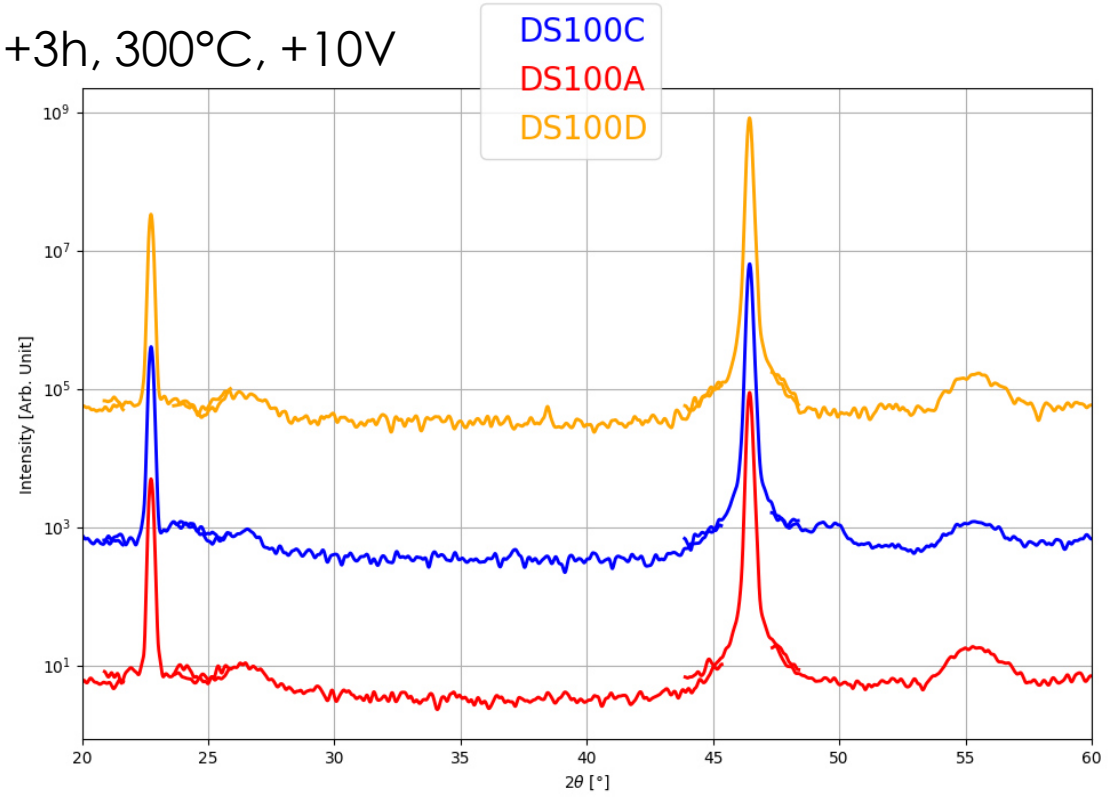
- Success of the new physical method
- Advantages and Disadvantages
- Next step: apply this to more samples

Transport measurements of PNO

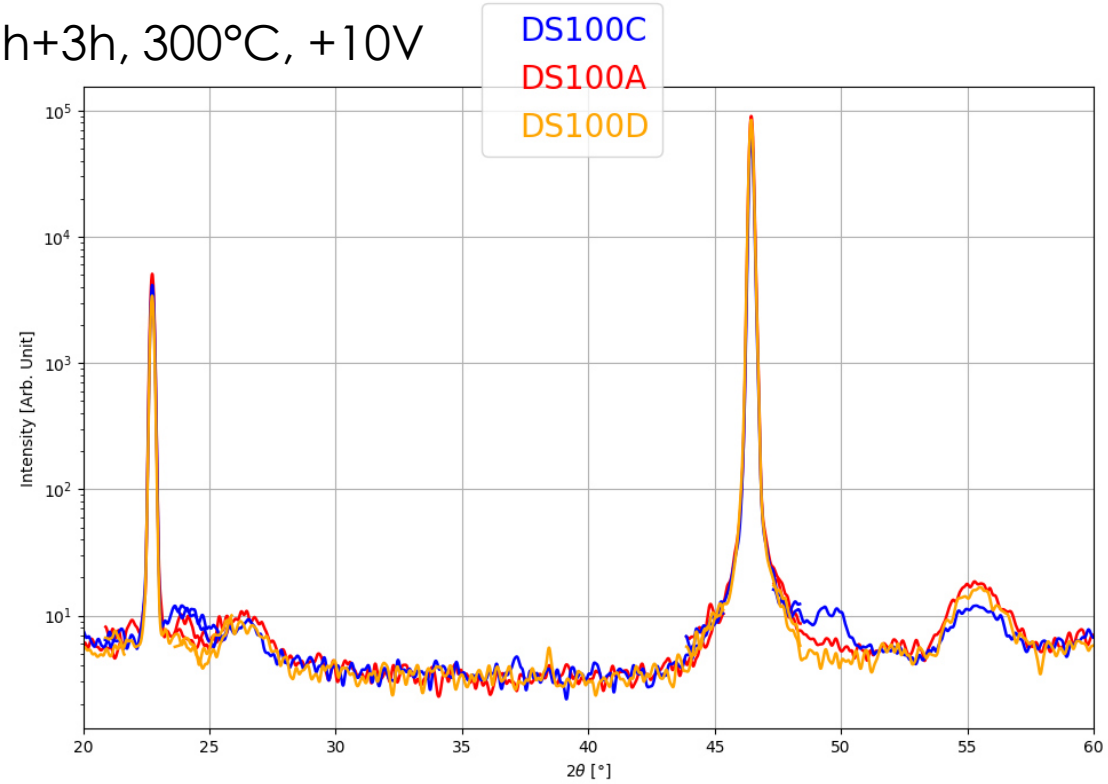


Annex

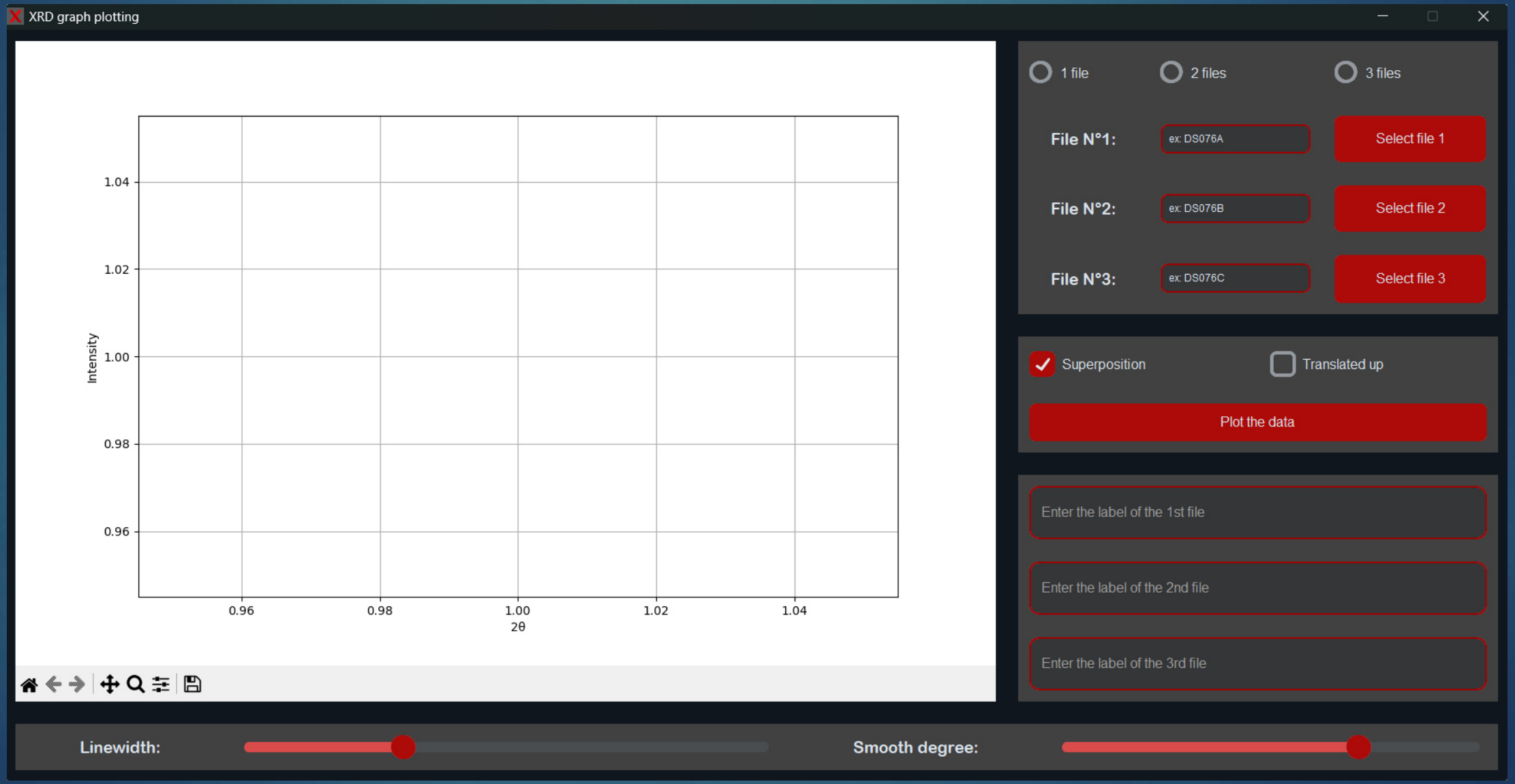
3h+3h, 300°C, +10V



3h+3h, 300°C, +10V



Annex


XRD graph plotting
1.04
1.02
1.00
0.98
0.96
Intensity
0.96
0.98
1.00
1.02
1.04
2θ
1 file
2 files
3 files
File N°1:
ex: DS076A
Select file 1
File N°2:
ex: DS076B
Select file 2
File N°3:
ex: DS076C
Select file 3
Superposition
Translated up
Plot the data
Enter the label of the 1st file
Enter the label of the 2nd file
Enter the label of the 3rd file
Linewidth:
Smooth degree:

Annex

Sample name	Voltage (V)	Temperature (°C)	Time (hours)
DS076A	+5	300	6
DS076B	experience stopped due to a burning wire		
DS076C	+10	300	6
DS076D	+20	300	6
DS076E	+10	315	6
DS076F	+10	285	6
DS076G	-10	300	6
DS076H	+10	300	12
DS076I	+10	315	6

Table 1: Experience parameters of STO/NNO/Pt

Bragg's law : $n\lambda = 2d \sin\theta$

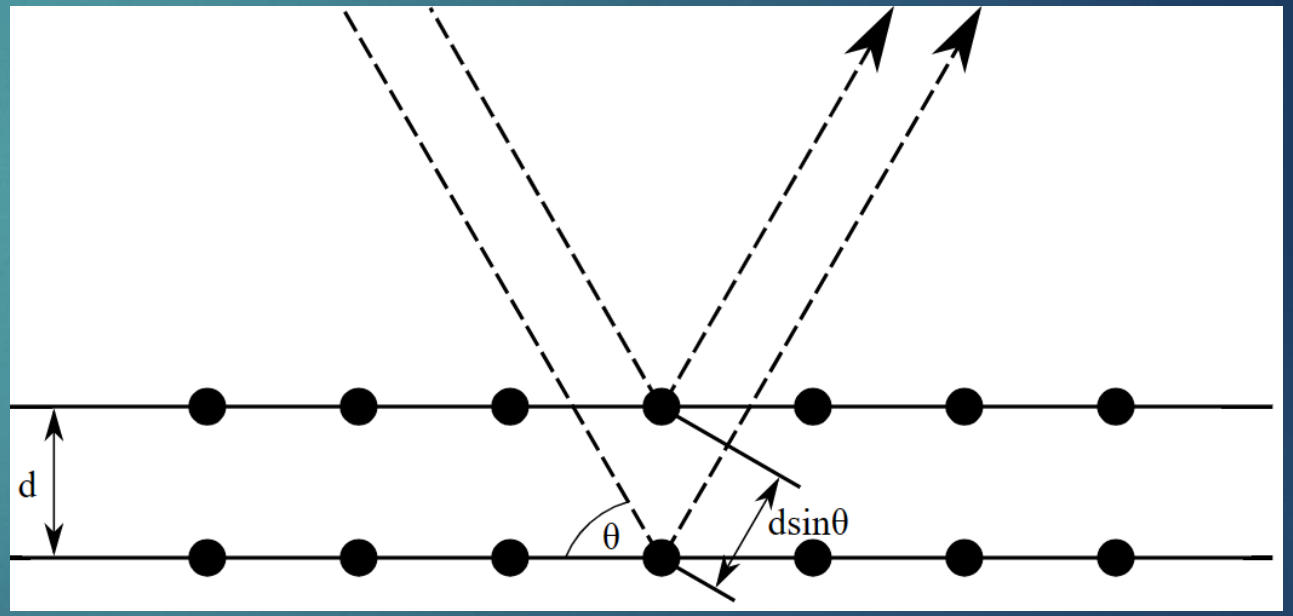


Illustration of Bragg's law