10th IFAST WP9 meeting

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LOT, Institut für Werkstofftechnik, Universität Siegen

(Novel accelerator technology for efficient light sources NOVALIS)

14 Sept. 2023

Tasks at Uni Siegen

1. Deposition studies:

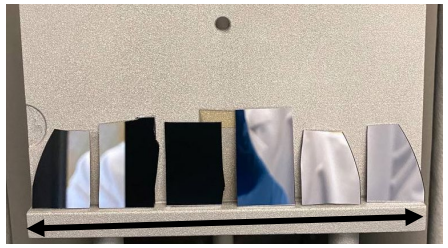
   Nb, NbN, **NbTiN**, Nb_3Sn as well as MgB_2 sputter-coatings on

   Nb and Cu flat samples and ALD-coated flat samples

   + repair of the CC800 heater

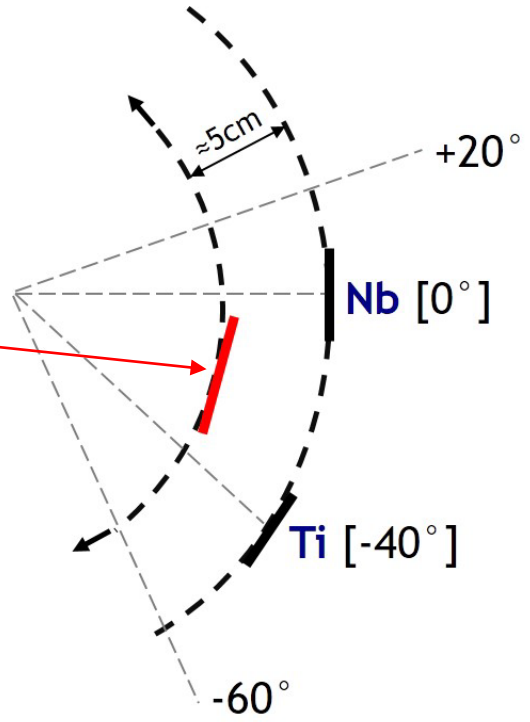
2. Substrate preparation: **Cu** and **?Nb?** samples
3. Sample characterization: microstructure, SC and RF properties
4. Developments and upgrades

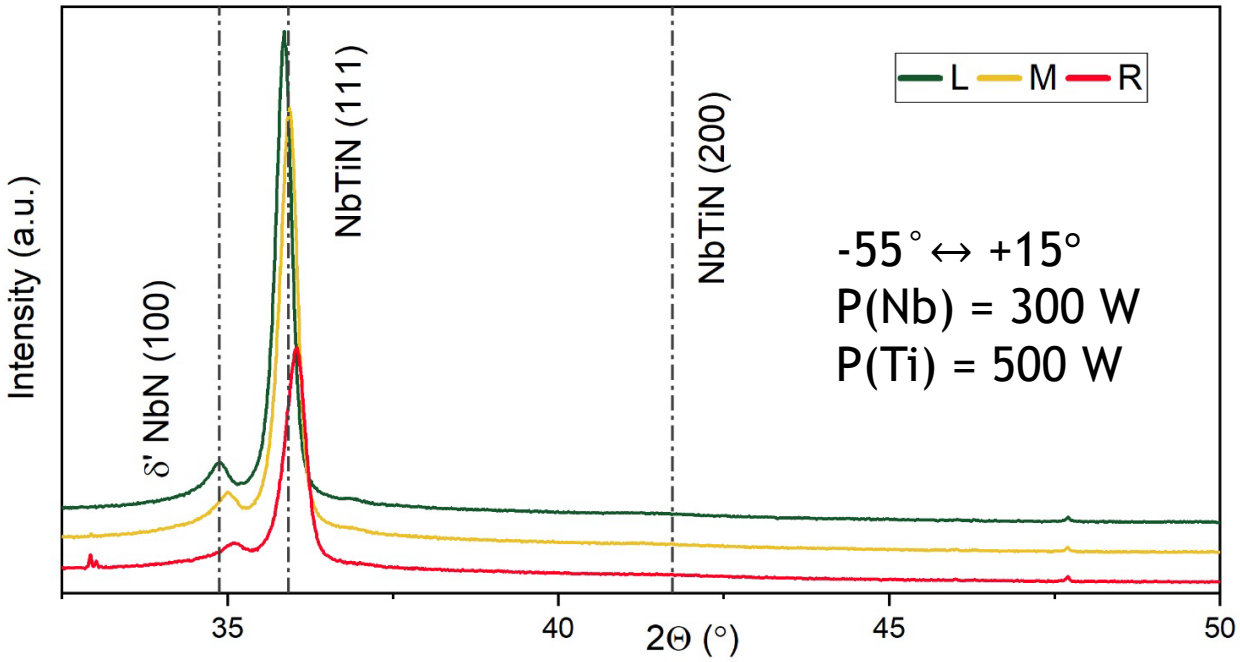
1a. co-NbTiN: rocking angle



Sample stage 120mm

Rocking angle	
-60	+20



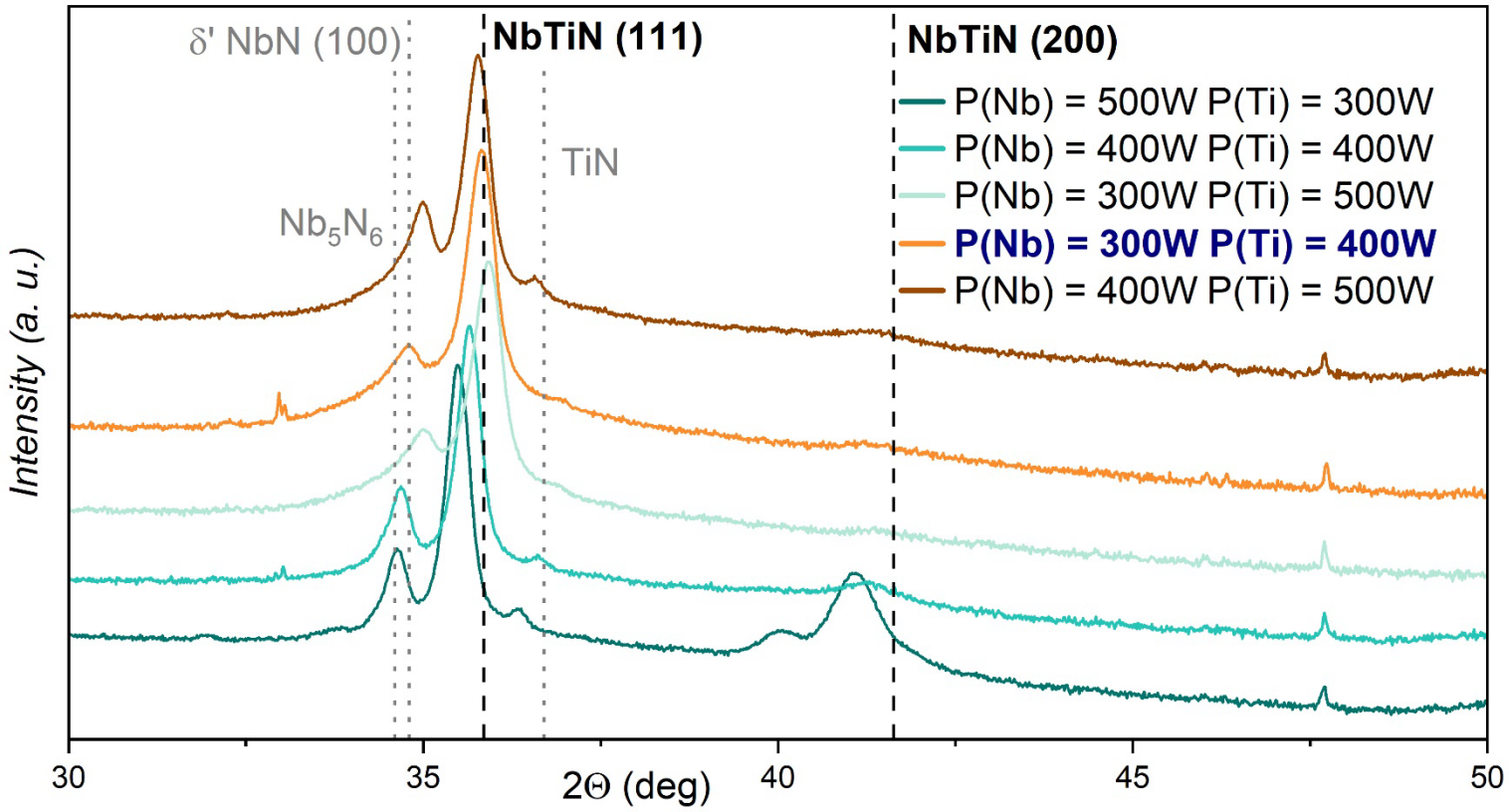


Change the Ti/Nb power ratio:

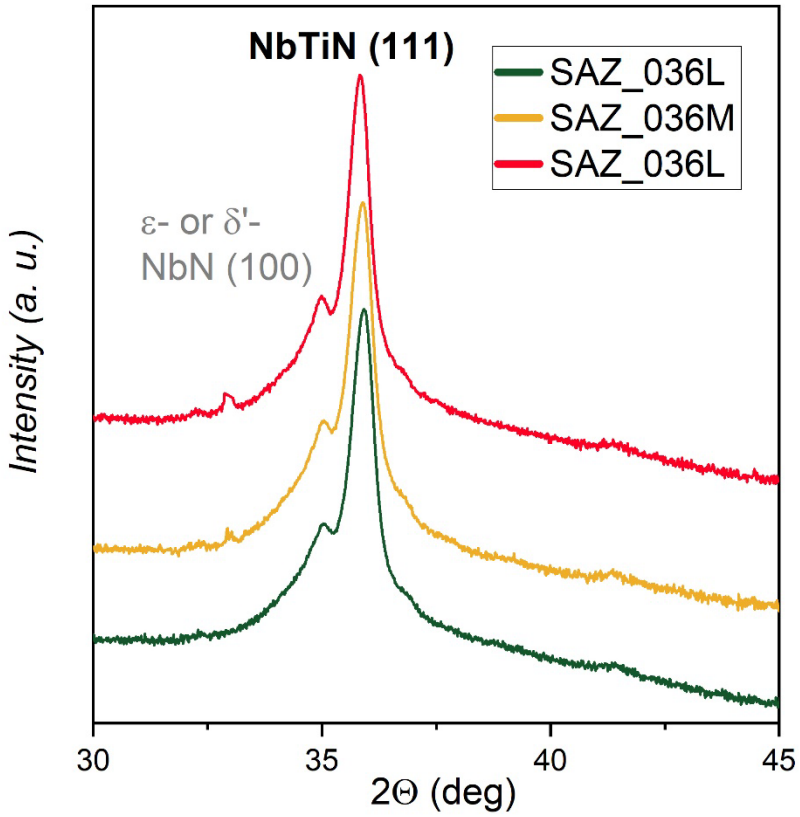
- Optimum around 500W/300W
- Rocking angle [-60° ↔ +20°]
- Needs to vary other parameters: p, Ar/N_2, bias…

1b) co-NbTiN: cathode power

Optimal? ration: $\mathcal{P}$(Nb) = 300W, $\mathcal{P}$(Ti) = 400W [on Si(001)]

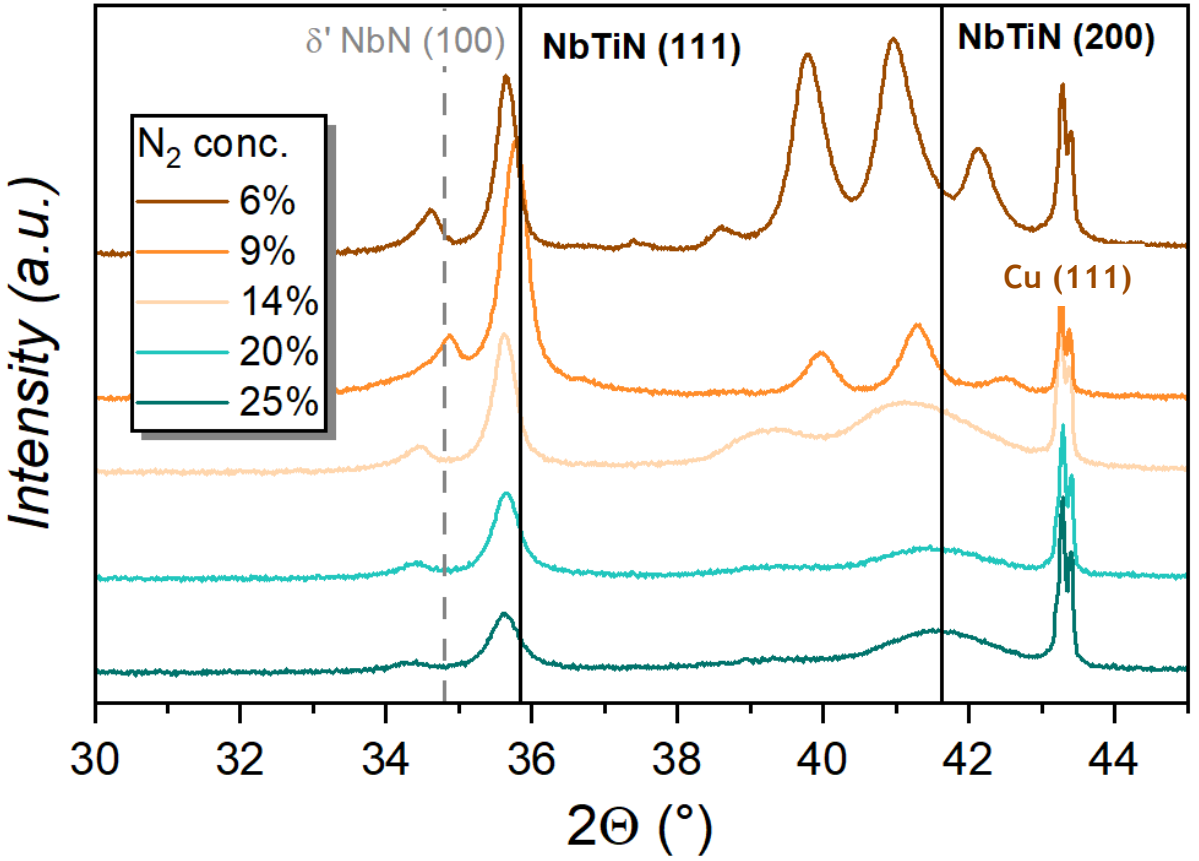


Impurity phase doesn't depend on the sample position



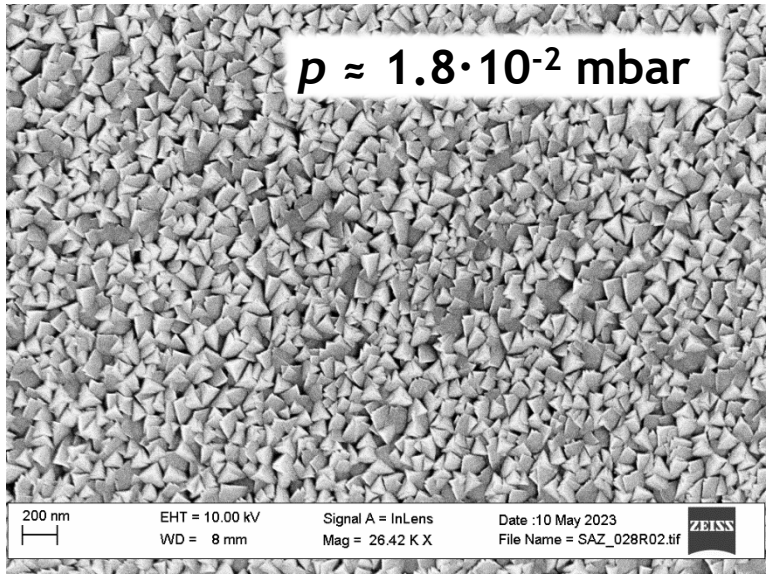
1c) co-NbTiN: N_2 concentration

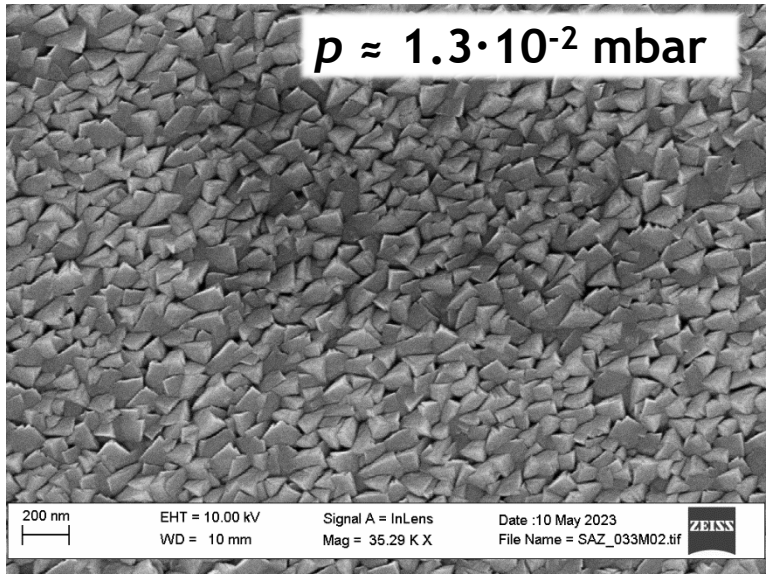
$\mathcal{P}$(Nb) = 300W, $\mathcal{P}$(Ti) = 400W, $p_{dep} \approx$ 1.25Pa [on Cu]

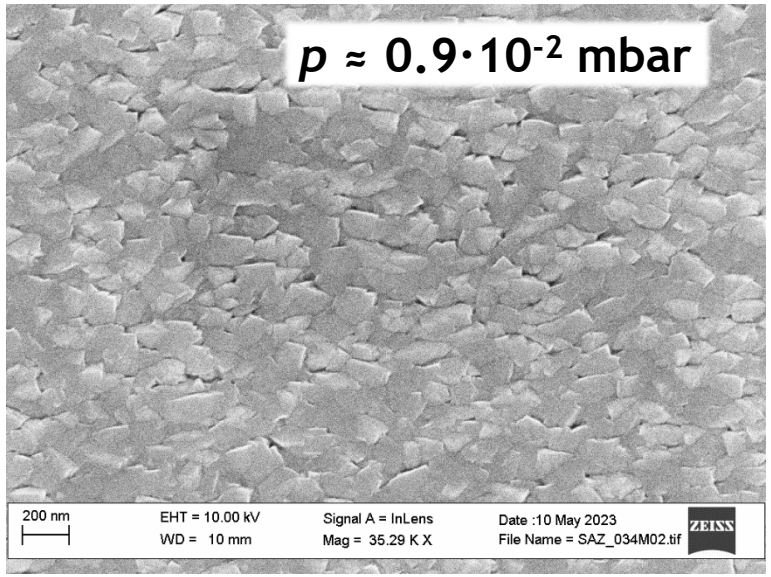


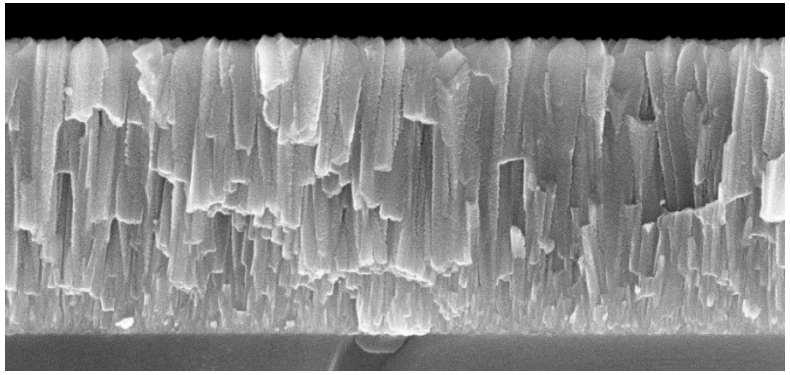
1d) co-NbTiN: deposition pressure

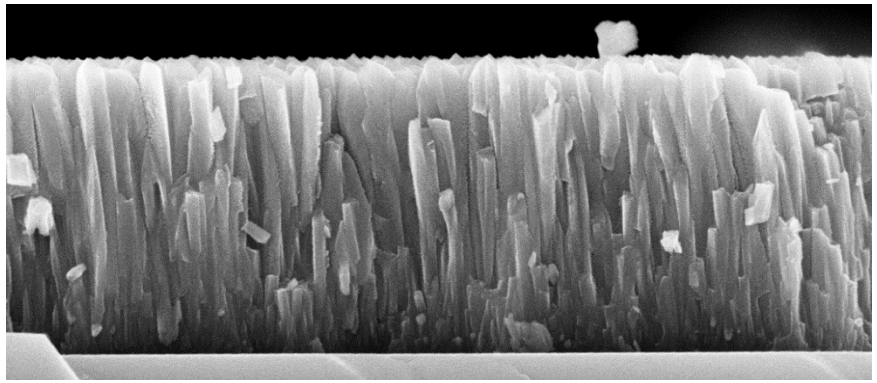
$\mathcal{P}$(Nb) = 300W, $\mathcal{P}$(Ti) = 500W, 9% of N_2 [on Si(001)]

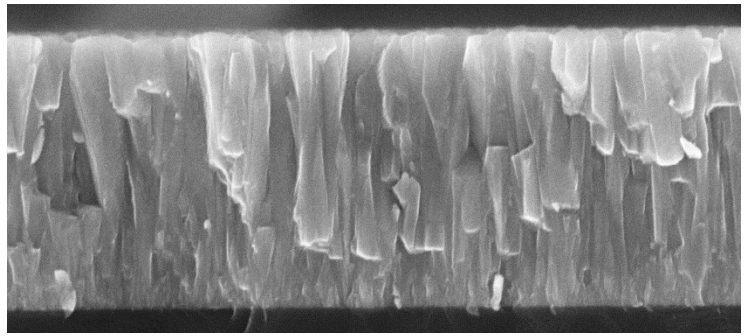












Heater repair

mid-July – end of August
a month and a half there were no coatings

co-NbTiN: variation of parameters

Parameters	Influence
Cathode power on Nb target	Too high: delamination, **NbN** parasitic phases Too low: bad performance, pyramid-head columns
N_2 concentration	> 10% better, but still not a single-phase
Pressure	Deposition at low *p*, but still not a single-phase

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NbTiN thin films deposited by hybrid HiPIMS/DC magnetron co-sputtering

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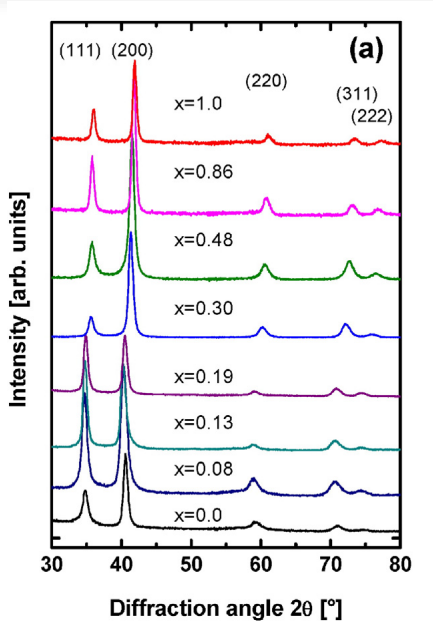
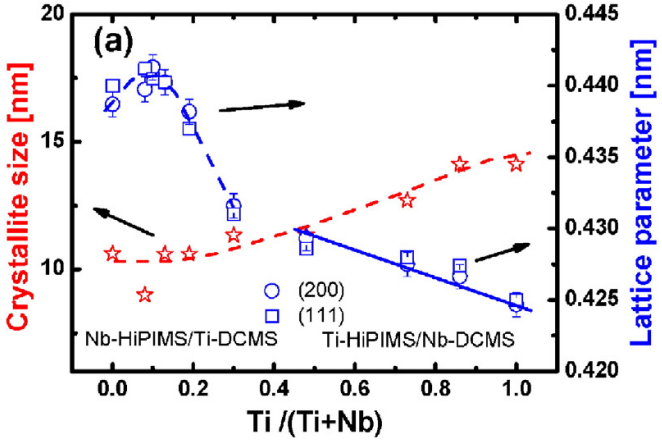
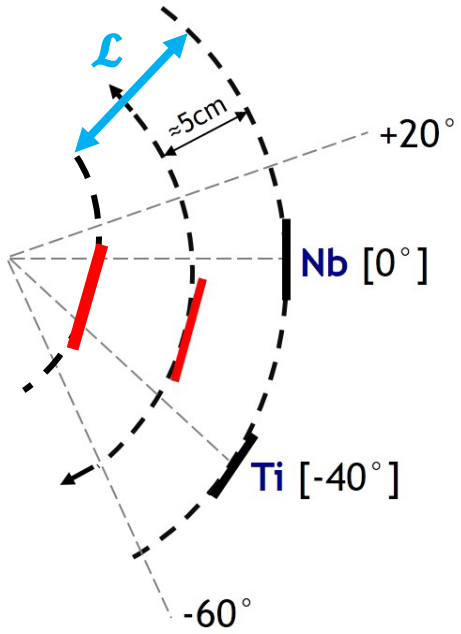


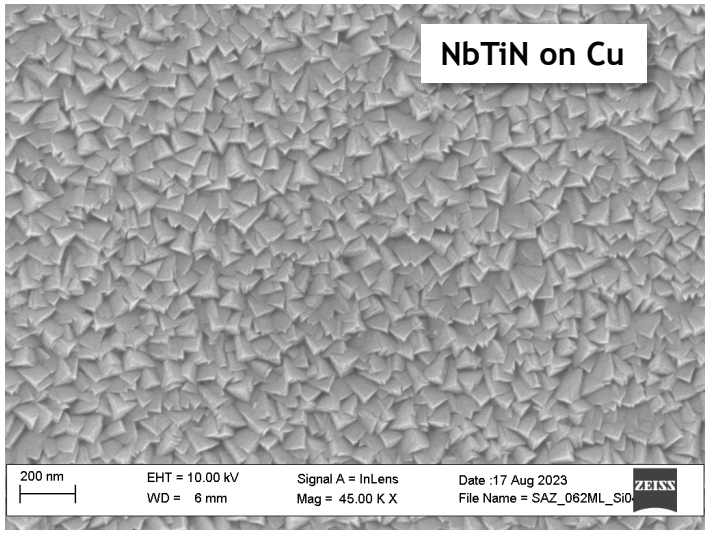


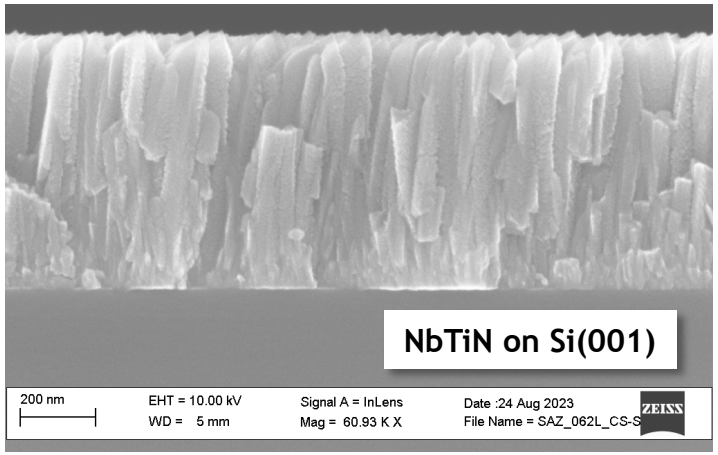
Nb-HiPIMS/Ti-DCMS and Ti-HiPIMS/Nb-DCMS

co-NbTiN: variation of parameters

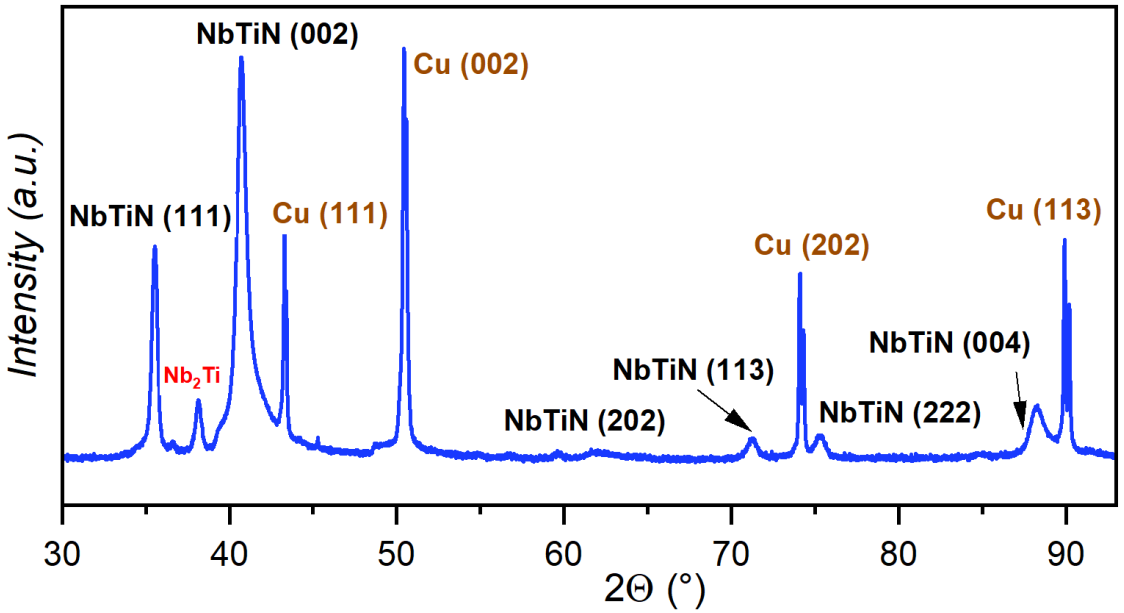
Increase sub.-target distance $\mathcal{L}$





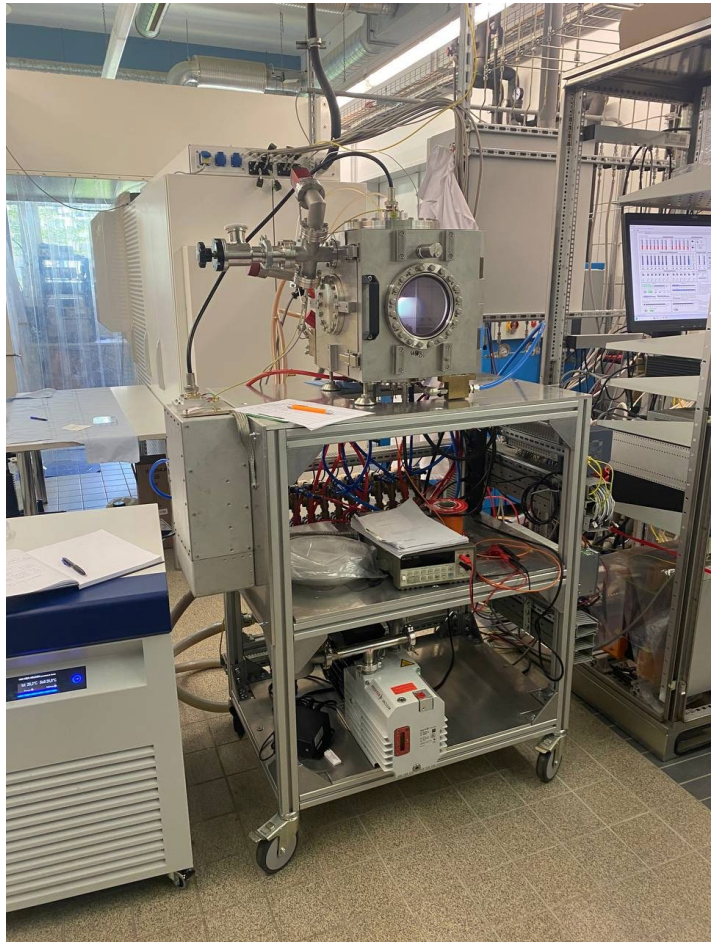


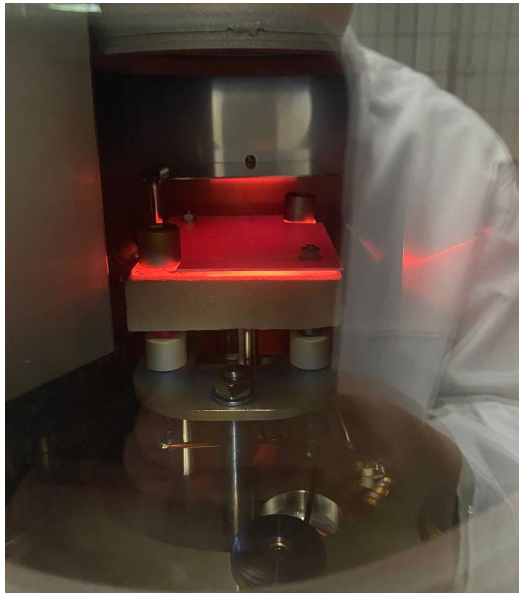
Conditions:
$\mathcal{P}$(Nb) = 400W, $\mathcal{P}$(Ti) = 400W, $p_{dep} \approx$ 1.25Pa, 9% of N_2
$\mathcal{L} \approx$ 13 cm



Film composition: Nb/Ti ≈ 0.83/0.17

1 RF-magnetron sputtering of MgB_2



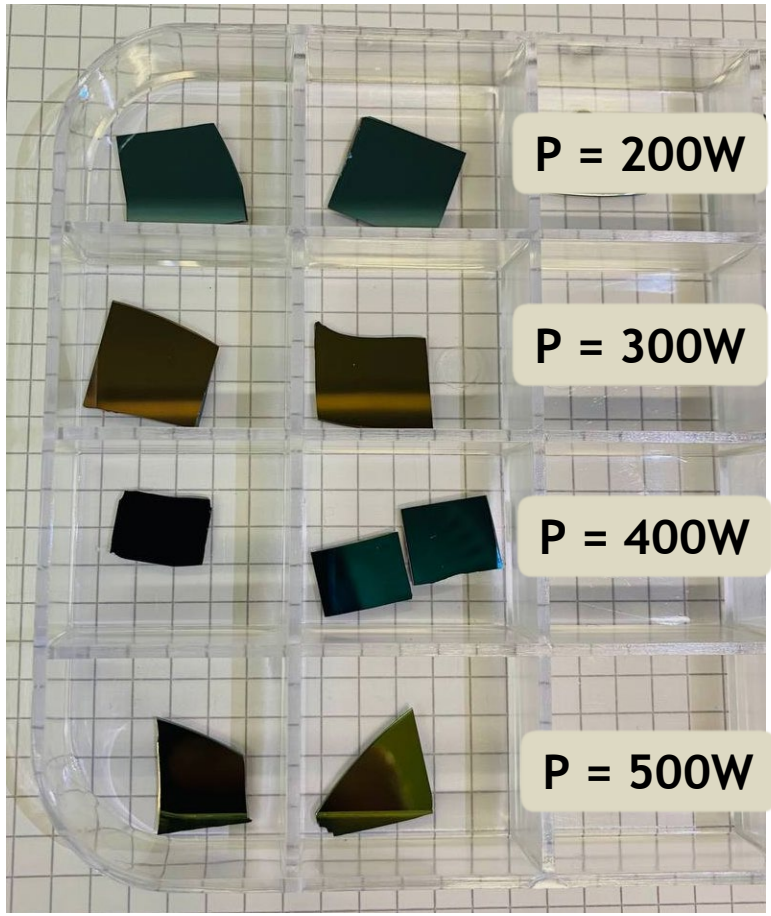


Substrate temperature up to 1500°C

BoxCoater works!!!

MgB_2 sputtering in Ar

1 RF-magnetron sputtering of MgB_2



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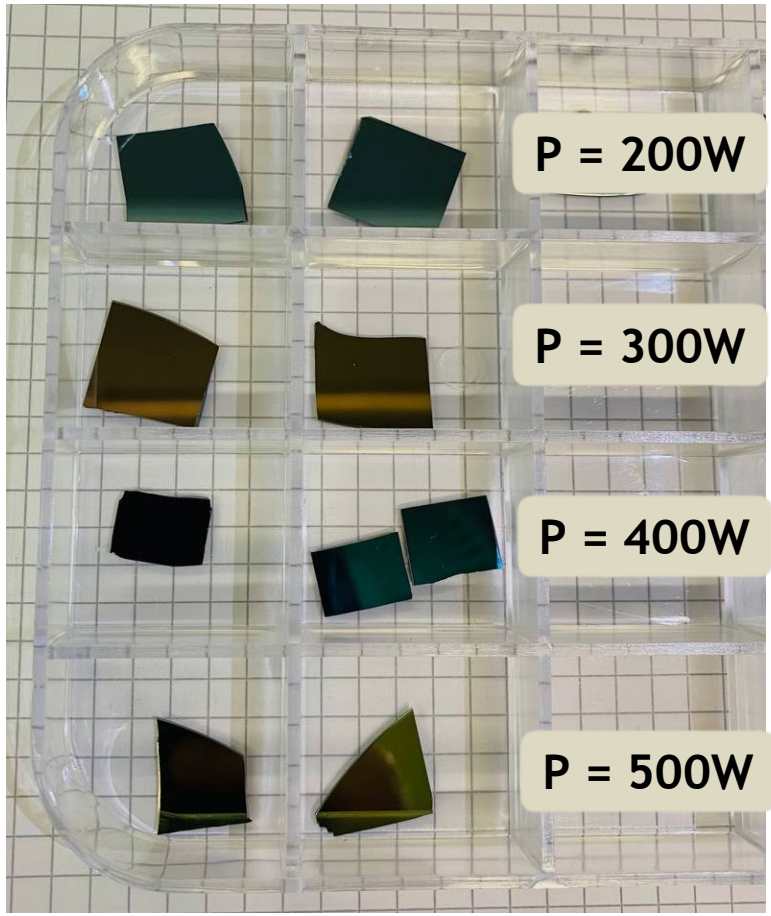
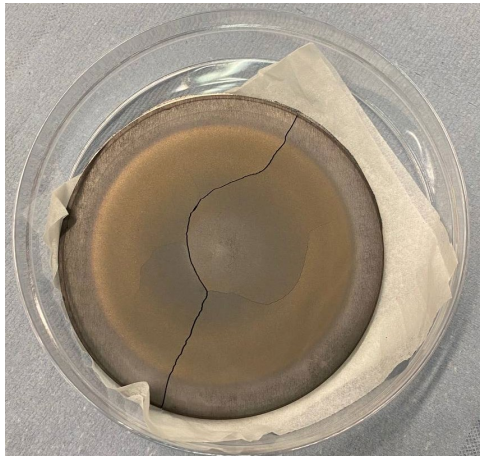
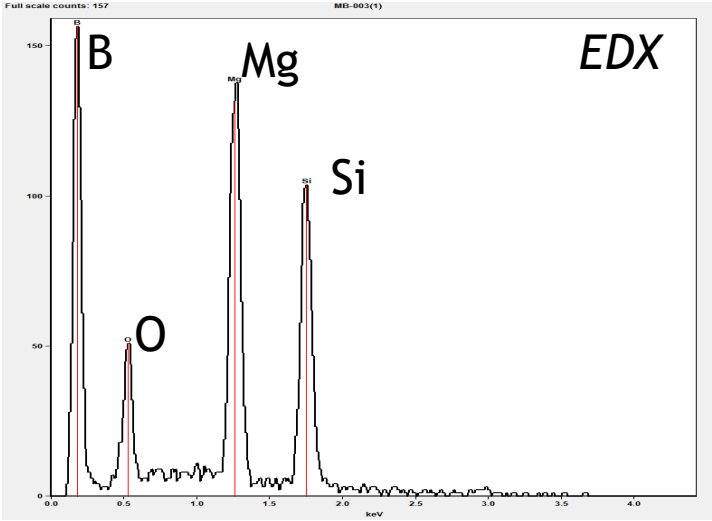
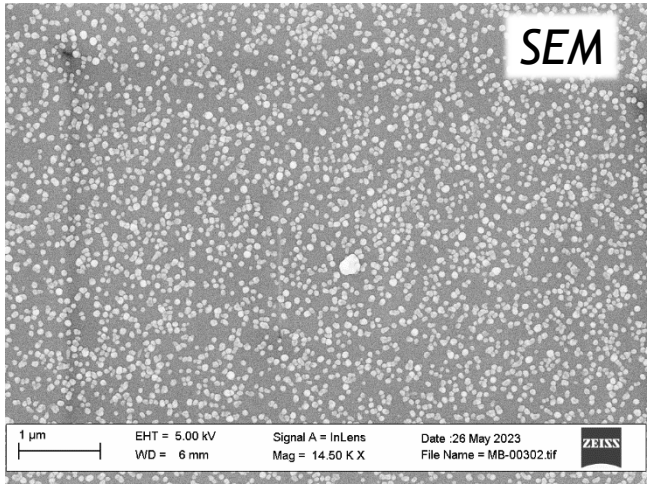


Challenges of the MgB_2 sputtering:

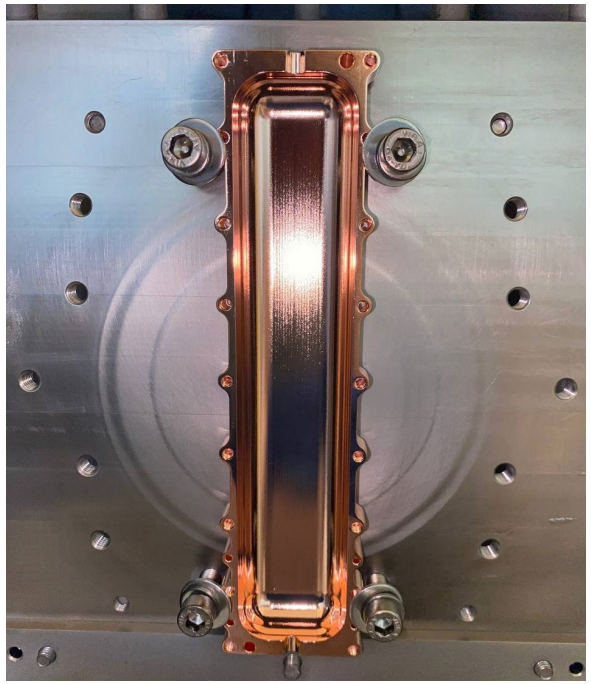
- Brittle material → deposition limits
- Composition ↔ Cathode power
- Oxygen contamination of the surface
- Often high Mg vapor pressure is required...





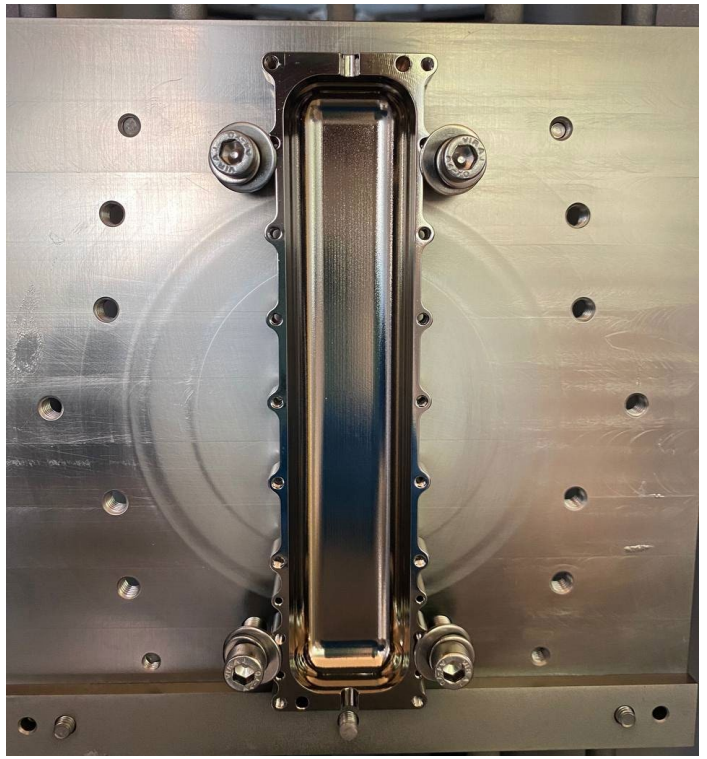


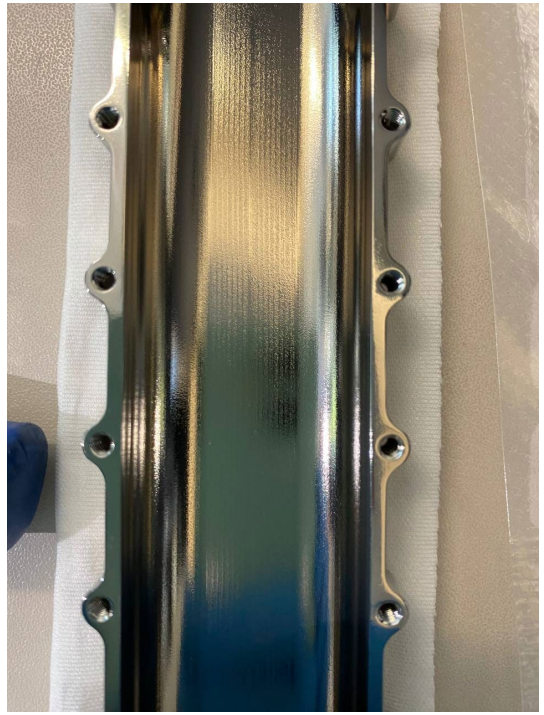
Coating of the split cavity (RASTA project)



Cu split cavity

NbN, ~2µm





Plans and outlook

- Co-sputtering of **NbTiN** on **Cu substrates**, tuning the deposition window, subs.-target $\mathcal{L}$ → deposition of multilayer (SS or SIS) structures
- Plan **B**: sputtering from a single alloy **NbTi** target (already bought)
  → usage of HiPIMS or DC cathodes
- Development of **MgB_2** deposition, get at least something **crystalline**
- Characterization by XRD, SEM, AFM, SIMS, … → good **NbTiN** films for SC properties
- Nb substrates – can be prepared outside the university

THANK YOU FOR YOUR ATTENTION!