Update DIFFER activities in SPB 2025

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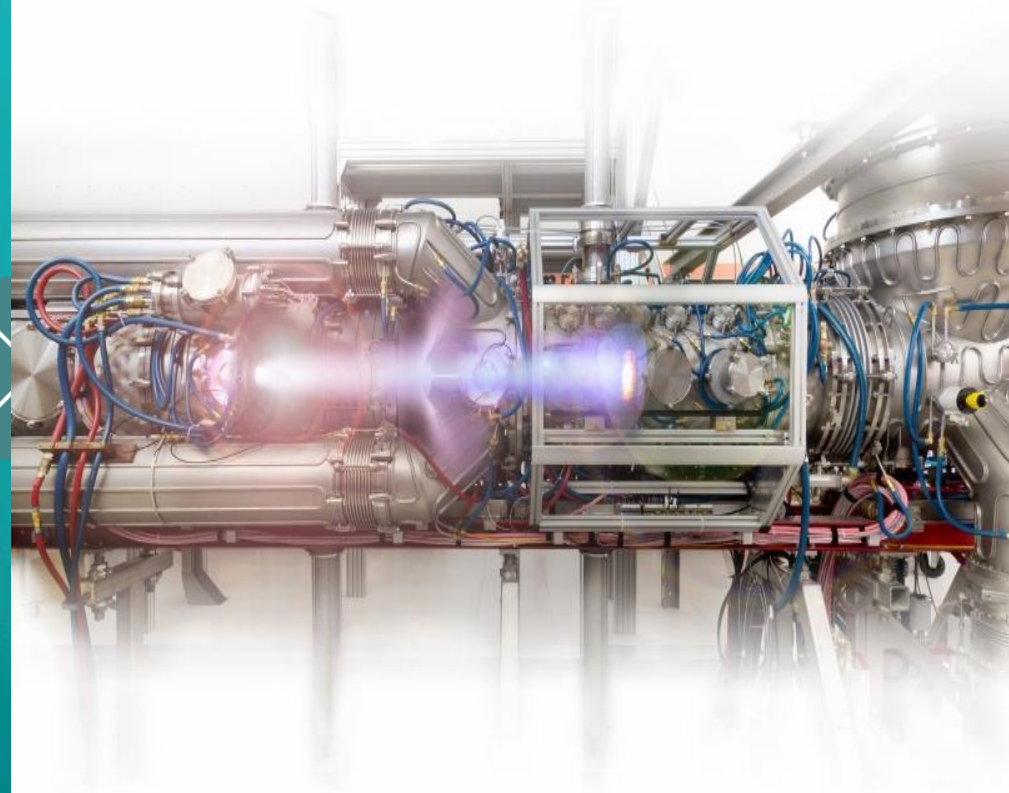
DIFFER

NWO



Deliverable and outline

Deliverable: Erosion rates of W model systems and re-deposited W with different morphologies and compositions as well as formation and erosion rates of thick re-deposits in MAGNUM-PSI at different fluxes and fluences

1. Cross machine study GyM, PSI-2 and Magnum-PSI for sputtering of Ar^+ by W (standard case).
    - Measurement done, not discussed further here
2. Production of thick re-deposition layers (B) as expected in ITER

3. Investigate B chemical erosion

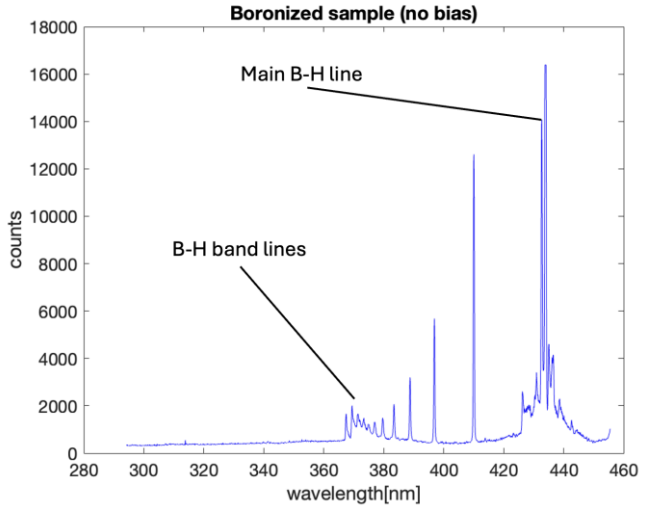
Chemical erosion of B layers

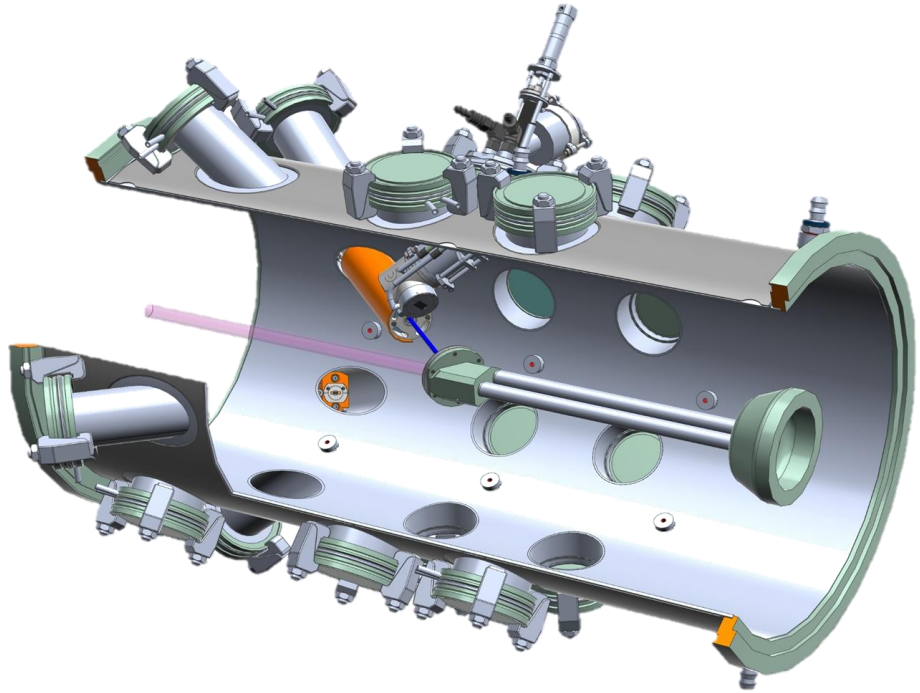
Boron to be used as low-Z oxygen getter in ITER via repeated boronization

Lifetime of boron layer depends on erosion rates

Chemical erosion by B-H formation is indicated in earlier experiments, but little literature information available

Investigated B chemical erosion rate in UPP using in-situ Elastic Backscattering Spectroscopy





Chemical erosion results

Pre-produced B layer ~1 um thick produced by PLD (PoliMo)

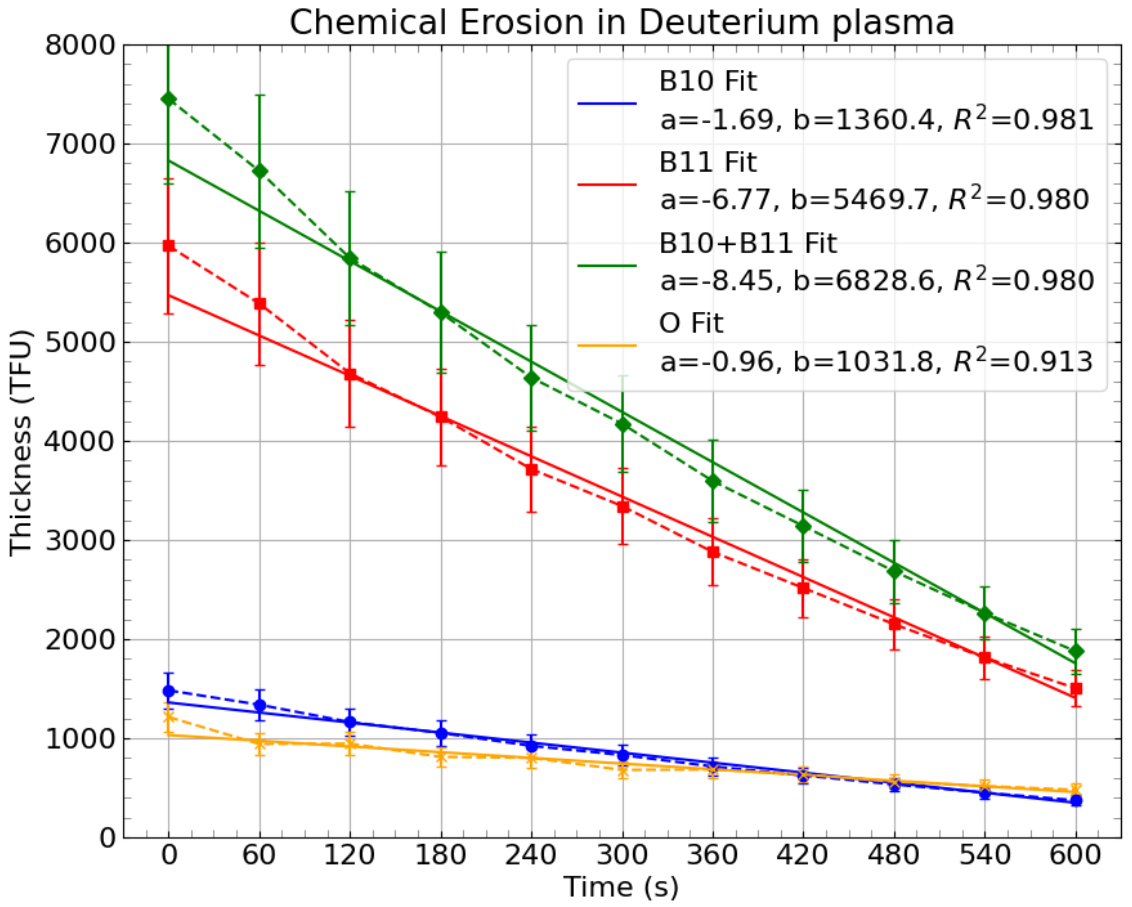
Exposed to D plasma under floating conditions (E_i~5 eV) for repeated 60 s exposures – only chemical erosion

450 nm in 600 s of plasma with a flux of approx. 8.61e23 ions/m2

Results:

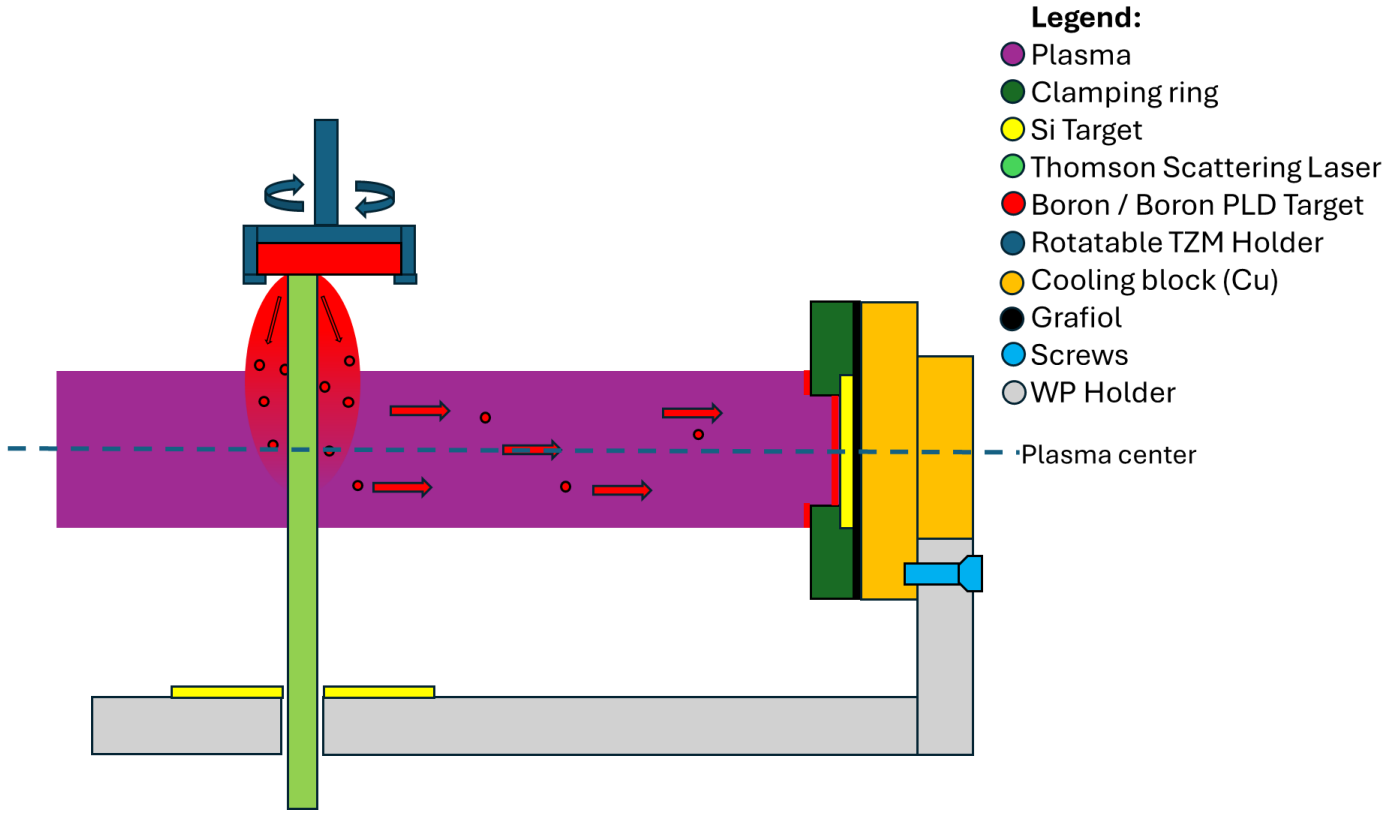
- Erosion rate: 0.75 nm/s
- Yield: 2.34e-3 atoms/ion

Next steps: erosion as function of ion energy (2025) and surface temperature (2026)



Plasma-Assisted PLD

- B eroded from FW over time in ITER will accumulate at inner divertor to form thick layers (~5 um in 2 weeks at ITER)
- Re-create layers in-situ via plasma-assisted pulsed laser deposition (currently UPP, later Magnum-PSI)
  - Recreation in-situ = no atmospheric effects
  - Can co-deposit plasma species, mix in other elements e.g. W
  - Try to make realistic layers



Results PA-PLD

Carried out parameter scan w/o plasma changing

- Laser deposition energy
- Background pressure
- B-field (effect on ions from plume)

With He plasma demonstrated clear entrainment effect, can create thick layers

Next steps:

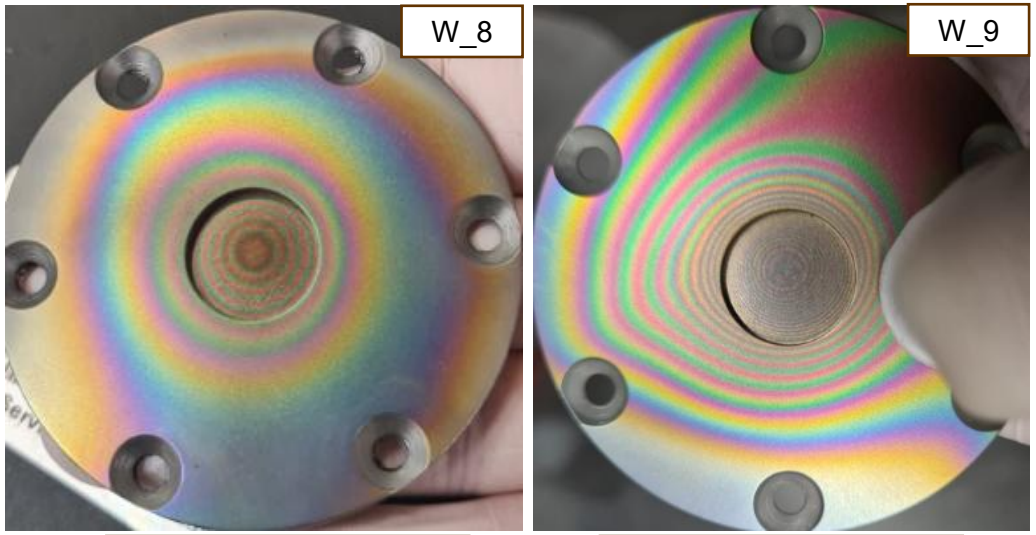
Characterize layer purity in-situ (B, O, C, N content) via EBS and optimize process (2025)

Characterize layer adhesion and dust formation as function of surface roughness, deposition rate, thickness (2025-2026)

Exposure time

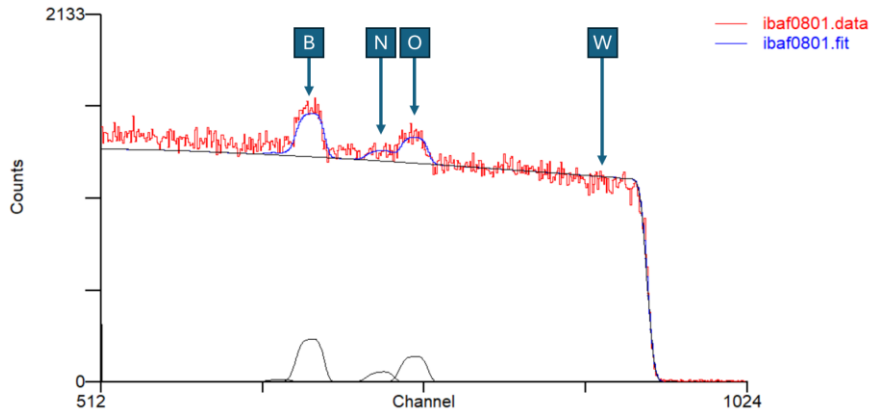
17 min

67 min



Thickness = 0.85 um

Thickness = 2.4 um



Conclusions

- Can measure chemical erosion in-situ and determine erosion rate of B

- Technique to grow B layers in-situ via PA-PLD looks promising, to be developed further and characterize layers

Questions?