



TOF-ERDA analyses of WEST samples

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Outline

- Analysis of selected marker tiles C3-C5
- Analysis of inertial standard inner/outer tiles from **sectorQ4A** (max OSP/max ISP)
- Analysis of ITER like PFU samples



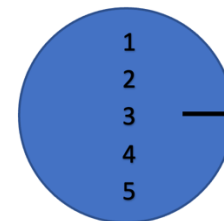
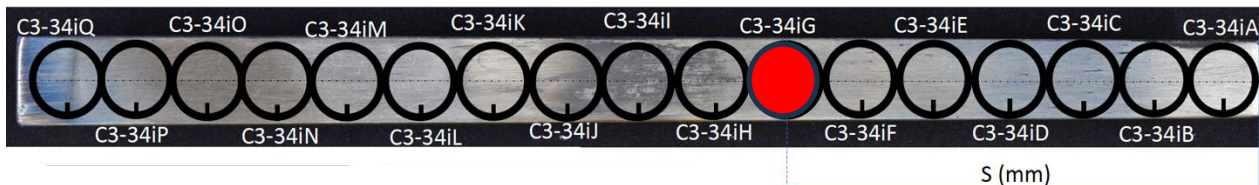
Analysis of marker tiles iG from C3-C5



Private Flux
Region (PFR)

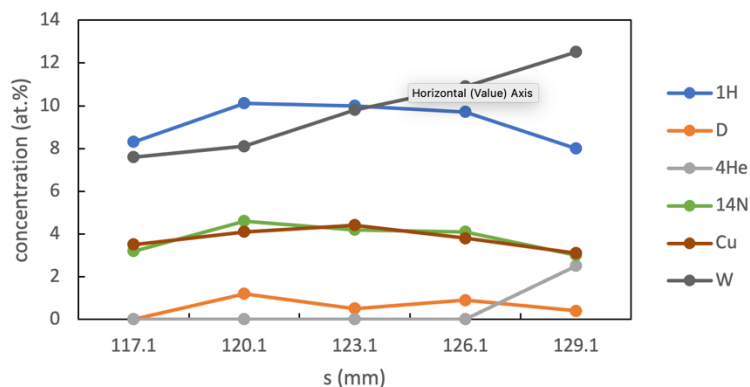
Extraction of 17 core samples from the inner
tile 940G193_EM (Gi193EM)

High Field
Side (HFS)

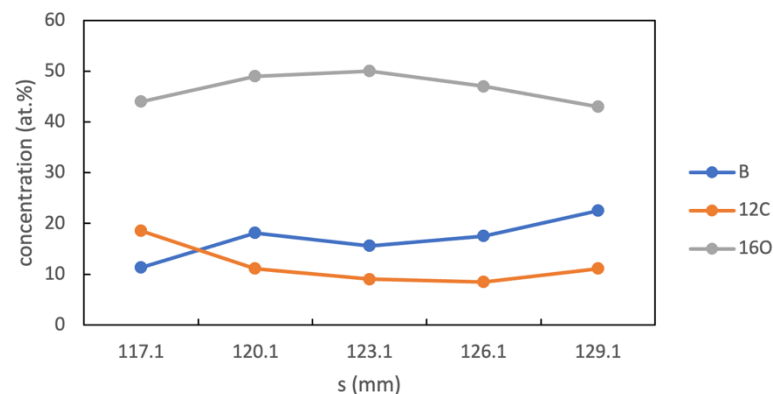


C3-34iG on 4 different points, C4-32iG, C5-33iG on 5 different points

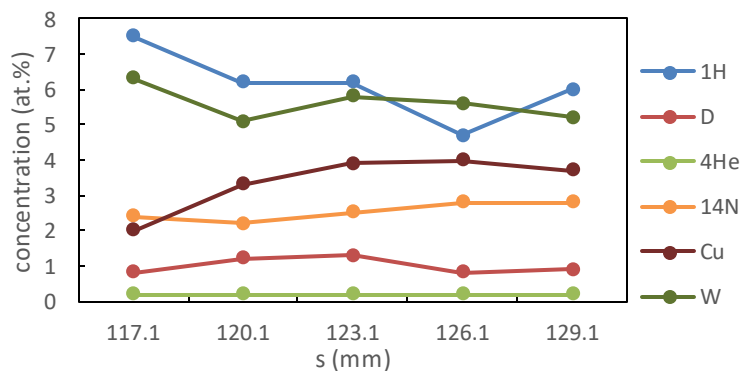
C4-32iG



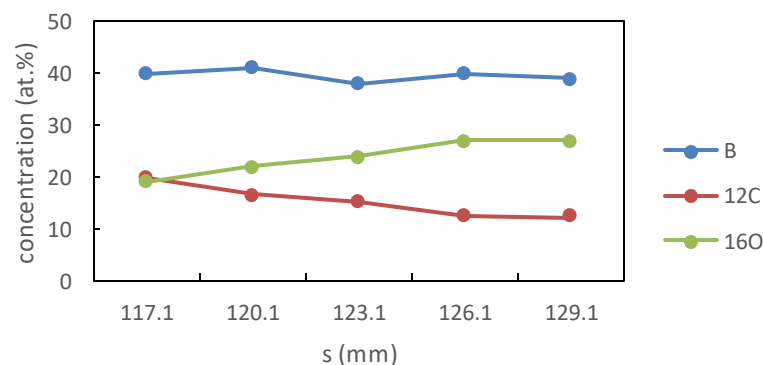
C4-32iG



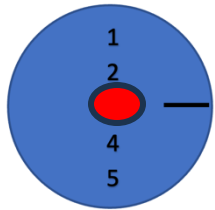
C5-33iG



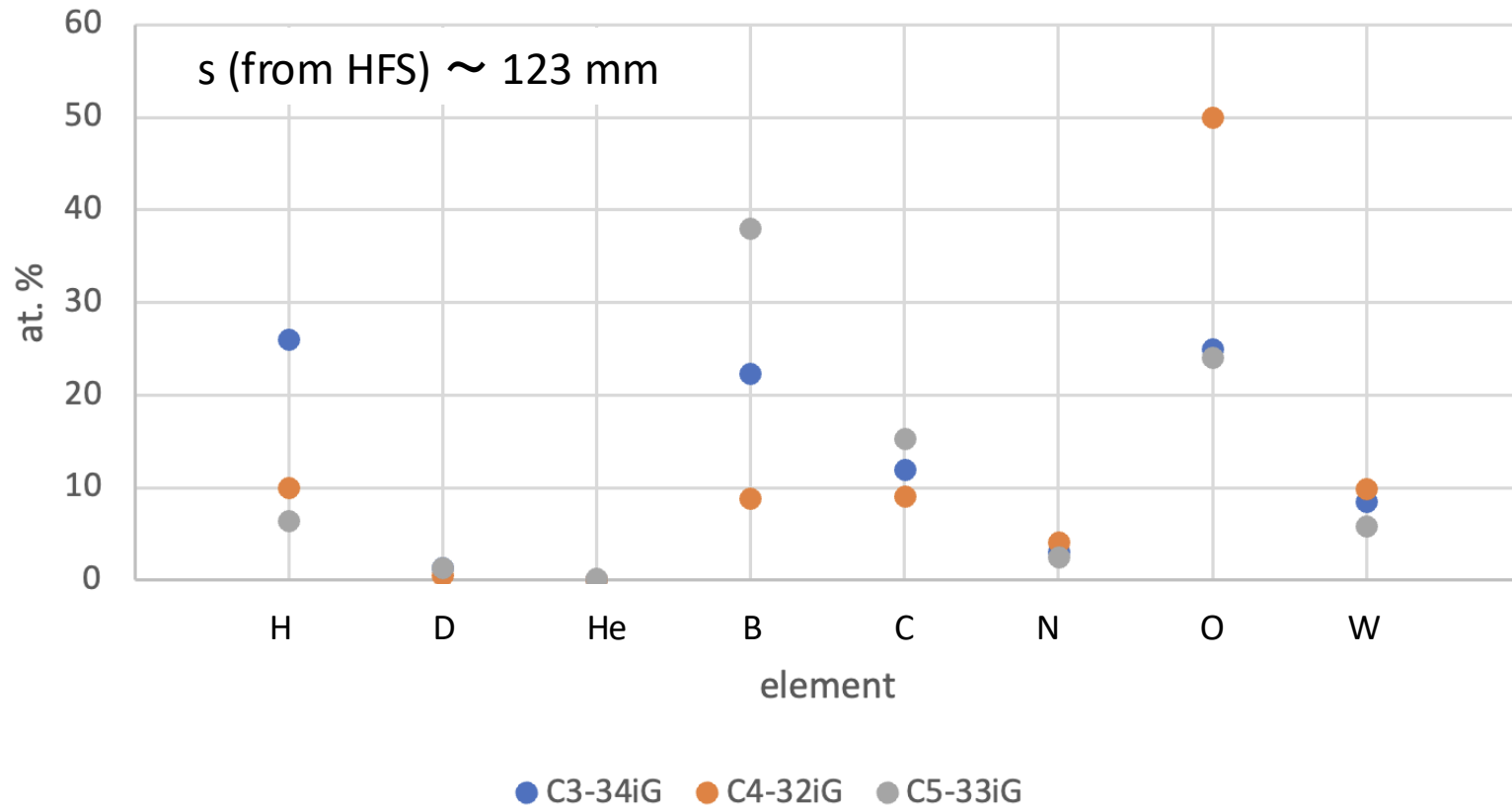
C5-33iG



Analysis of marker tiles iG from C3-C5



Near surface elemental composition between different campaigns
Concentration depth range: (300-700) · 10¹⁵ atoms/cm²



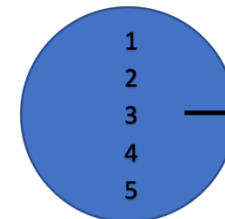
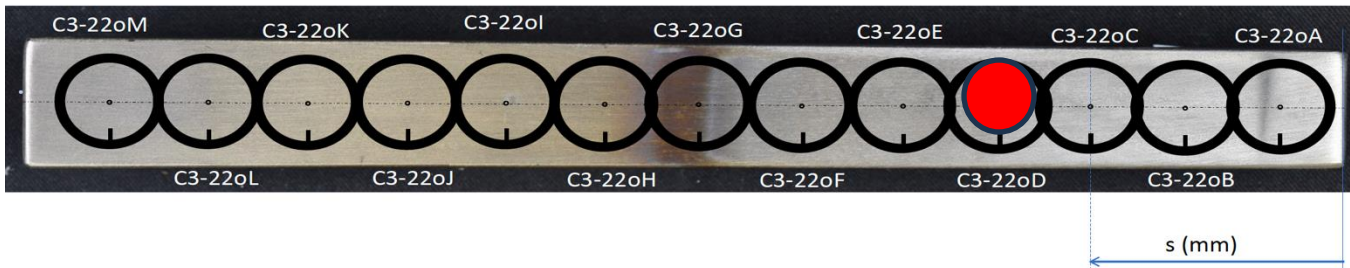
ToF ERDA of marker tiles oD from C3-C5



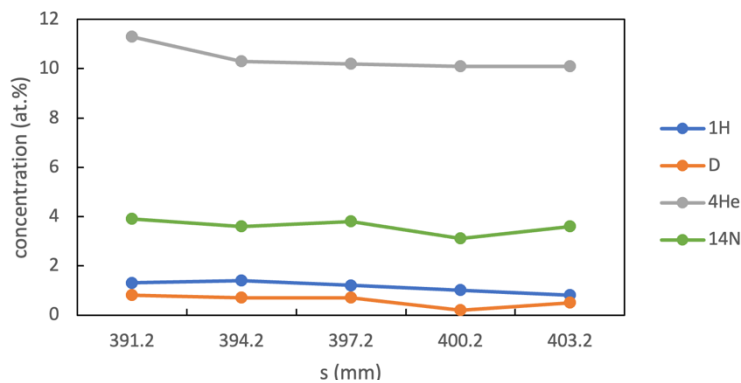
Low Field Side (LFS)

Extraction of 13 core samples from outer tile
941G142_EM (Go142EM)

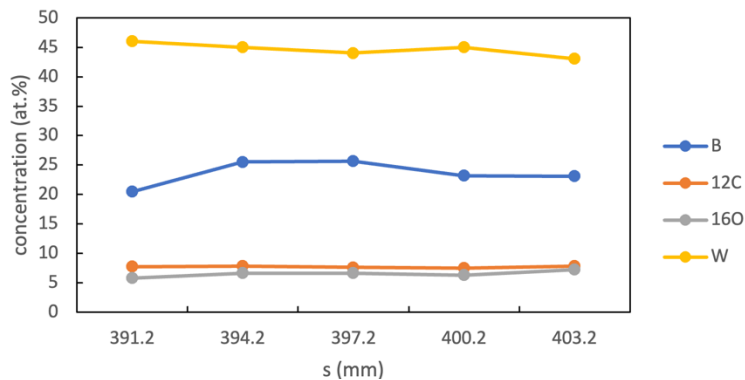
Private Flux Region (PFR)



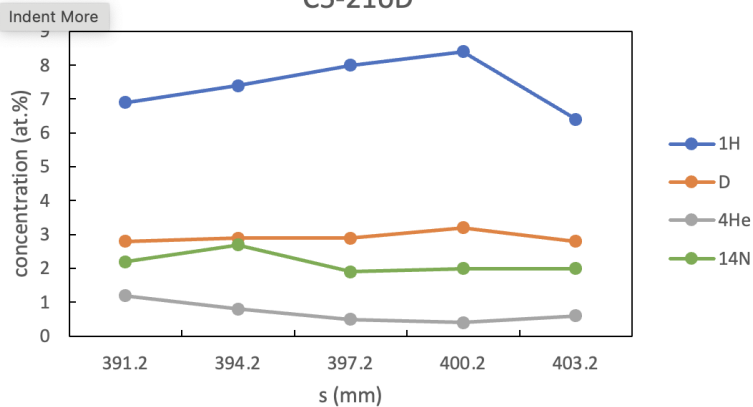
C4-20oD



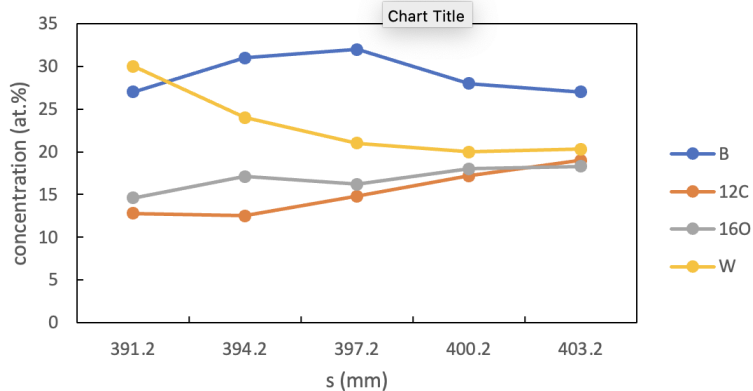
C4-20oD



C5-21oD



C5-21oD

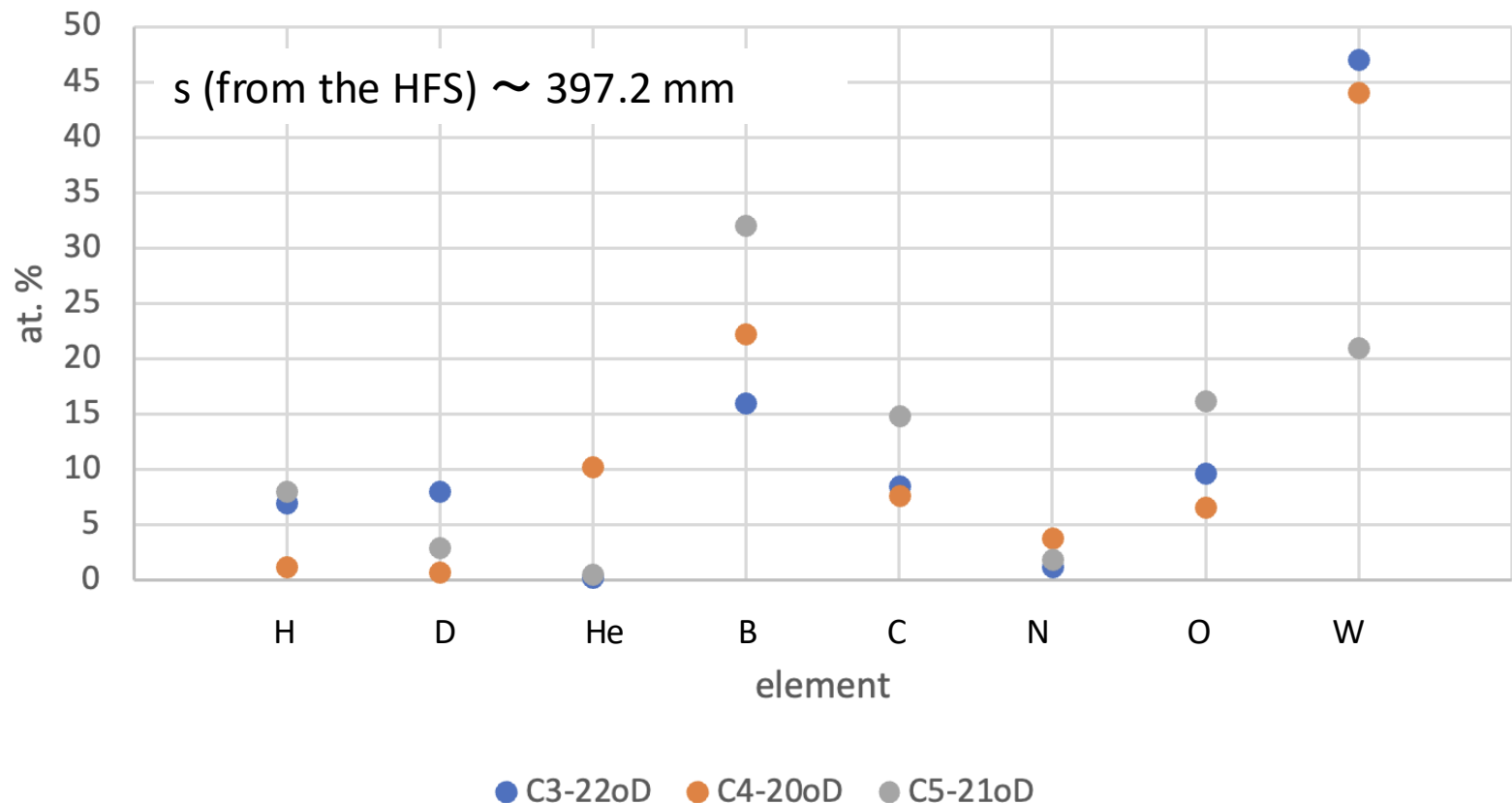
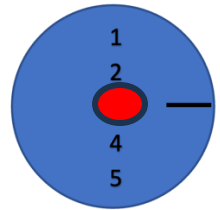


ToF ERDA of marker tiles oD from C3-C5



C3-22oD on 4 spots , C4-20oD, C5-21oD on 5 different points

- Comparison of near surface composition between different campaigns
- **Concentration depth range: $(300-700) \cdot 10^{15}$ atoms/cm²**



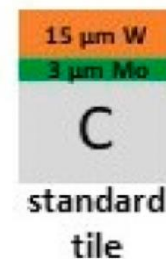


WEST C4 campaign

- dedicated He campaign (~45 min. plasma operation) was executed at the end of the C4 campaign in 2019 in the full tungsten WEST tokamak, cumulating ~2000 s of repetitive L mode discharges
- goal to investigate W surface morphology changes under He plasma exposure in a tokamak environment (formation of He nanobubbles and W fuzz)
- campaign designed to meet conditions for W fuzz formation @ OSP on inertial PFU (target for fuzz formation : $E_{inc} > 20$ eV, fluence $> 10^{24}$ He/m², $T_{surf} > 700^{\circ}\text{C}$)

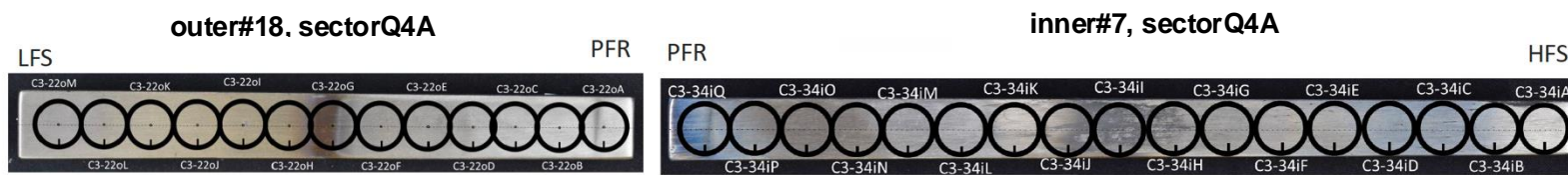


Inertial standard inner/outer tiles from **sectorQ4A** (max OSP/max ISP) cored for ToF-ERDA at the VTT, Finland



- 17 samples from inner sector – 7iA to 7iQ
- 13 samples from outer sector – 18oA to 18oM

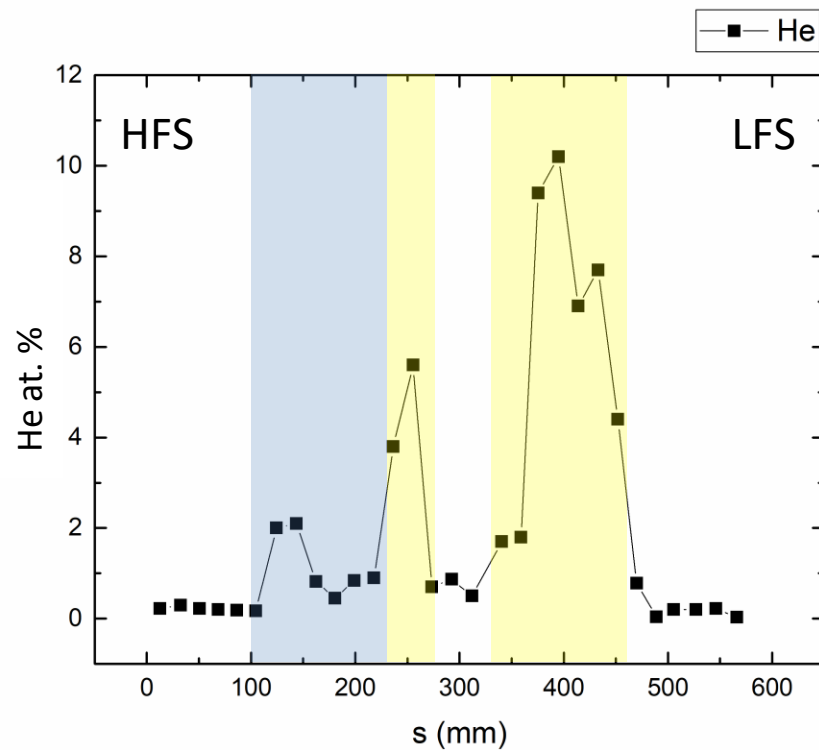
TOF ERDA was performed along the poloidal direction, from high-field side (HFS) to low-field side (LFS).



- each sample was measured in the middle
- beam spot size $\sim 2 \times 3 \text{ mm}^2$



TOF ERDA He concentration (at.%) in poloidal direction



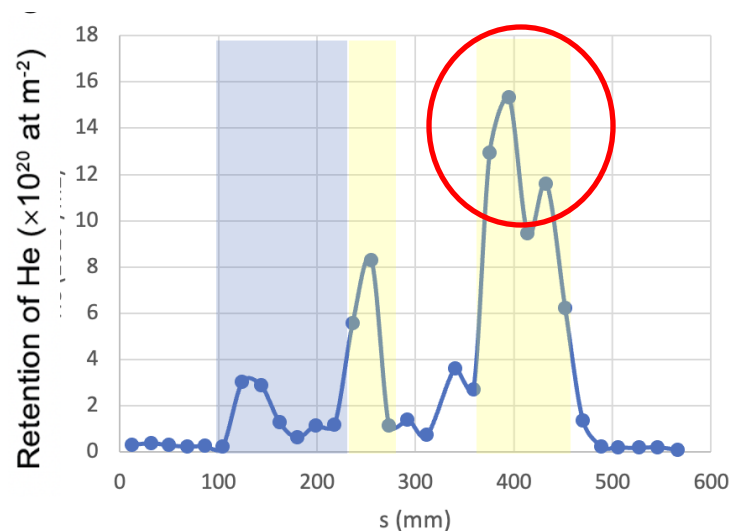
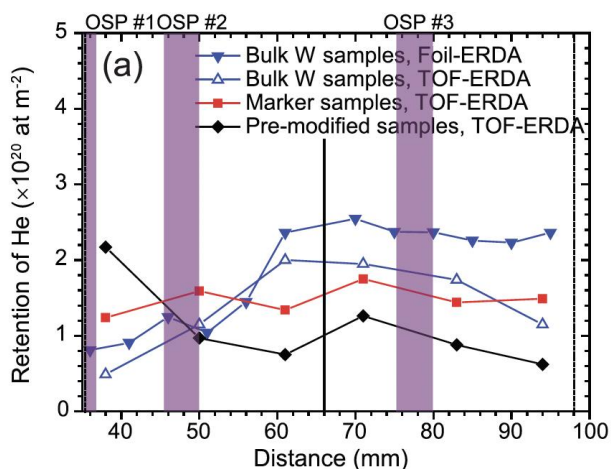
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- significant He content found in the strike point area (up to ~ 6% at ISP and ~ 10% at OSP)



Comparison with dedicated helium campaign in 2015 in the full W ASDEX upgrade

- in both cases conditions for fuzz formation reached $E_{inc} > 20$ eV, fluence $> 10^{24}$ He/m², $T_{surf} > 700^\circ\text{C}$



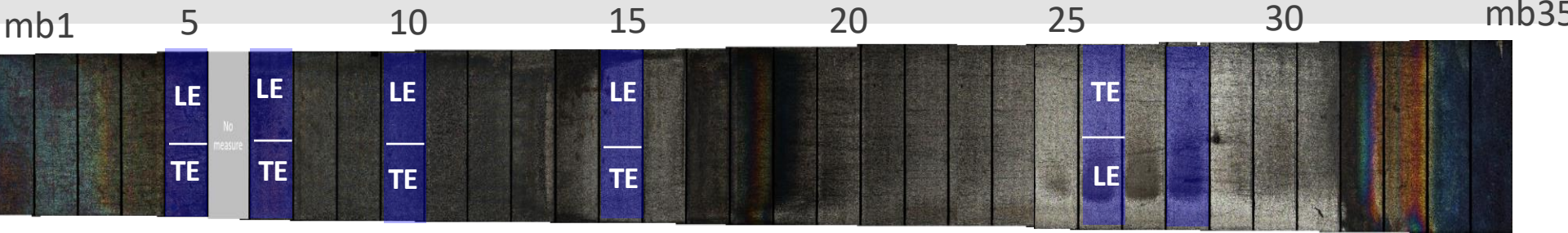
dedicated helium campaign in 2015 in the full W ASDEX upgrade

A. Hakola et al., Nucl. Fusion 57 (2017) 066015

WEST C4

surface density $> 10^{21}$ He/m² at the OSP

ITER like PFU WECN001



Batch B – « He and W microstructure »

MB 5-7-10-15-26-28

IBA: RBI, Croatia

11 samples 12x14x5 mm³

MB5-LE

MB5-TE

MB7-LE

MB7-TE

MB10-LE

MB10-TE

MB15-LE

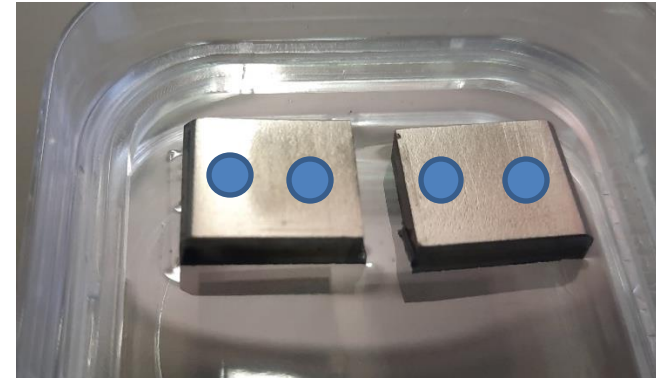
MB15-TE

MB26-LE

MB26-TE

REFERENCE_MB15back

2 measurements
for each sample



1 sample 12x28x8 mm³

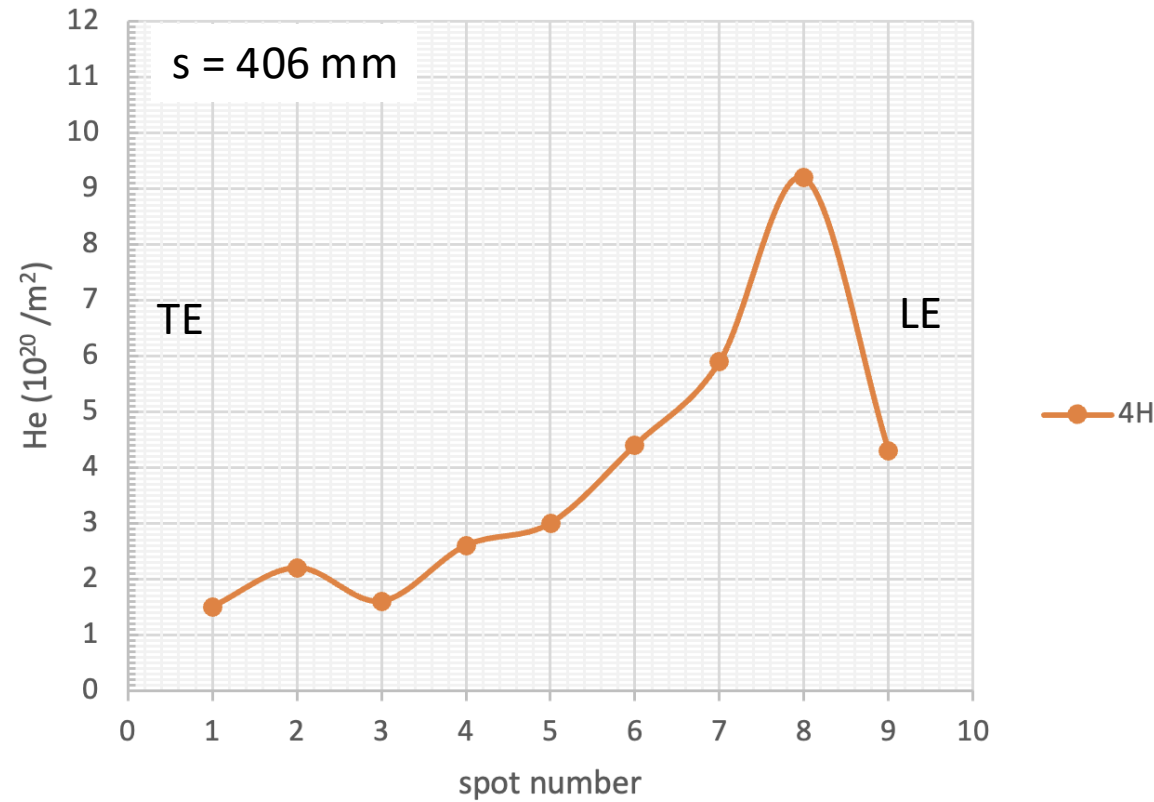
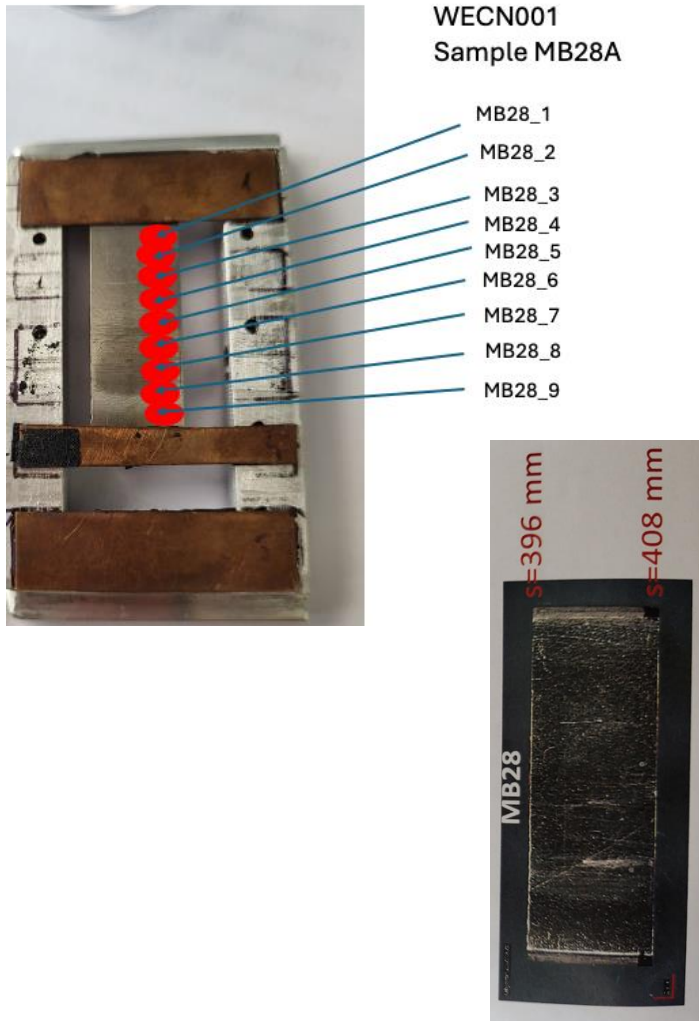
MB28 (NRA analysis already
performed at Demokritos)



WECN001 MB28



– all together, 9 points were measured at the sample



He profile along the toroidal direction

LE

Thank you for your attention



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A. Hakola, J. Likonen, T. Vuoriheimo