



WP PWIE SP B.2 & SP B.3, Review meeting

Overview of IBA analyses performed on WEST divertor tiles

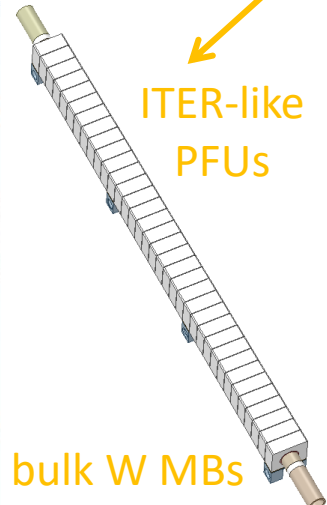
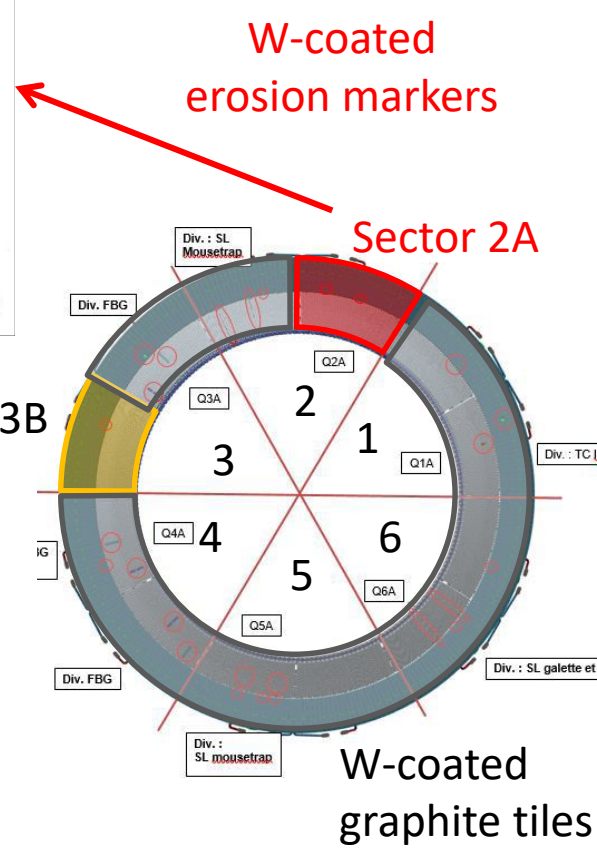
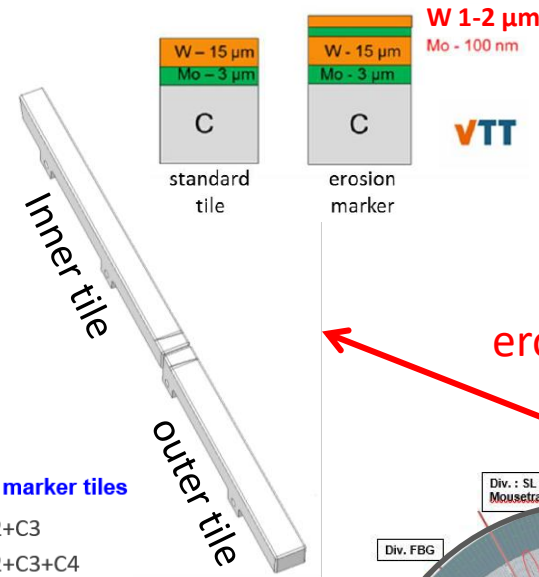
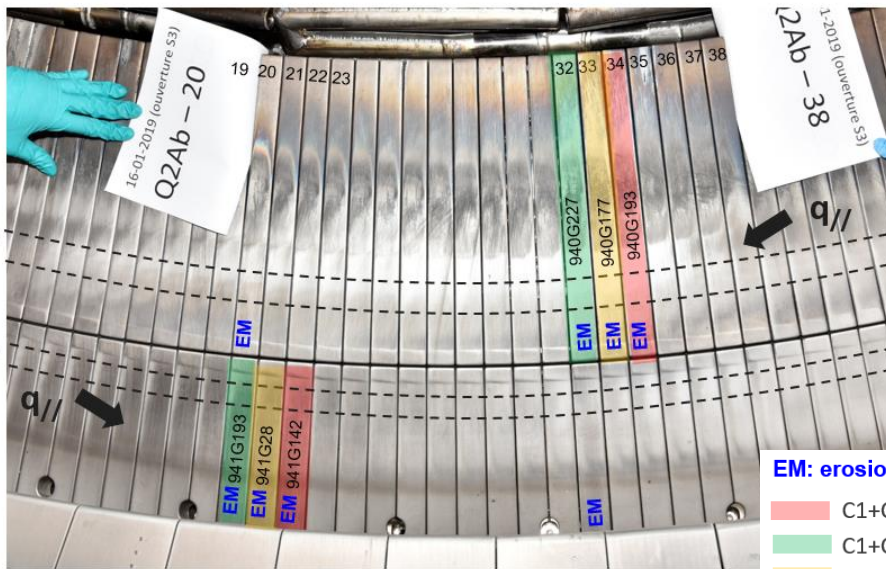
Mathilde DIEZ (CEA), Martin BALDEN (MPG), Matej MAYER (MPG)

October 17, 2022

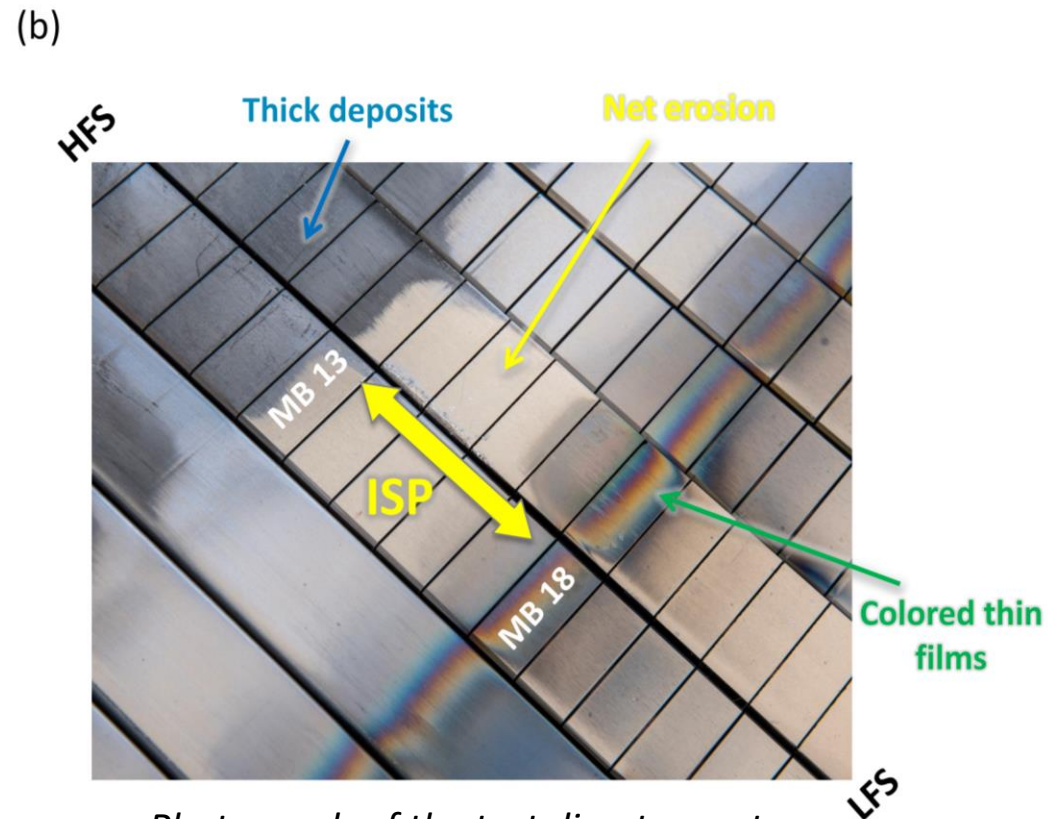
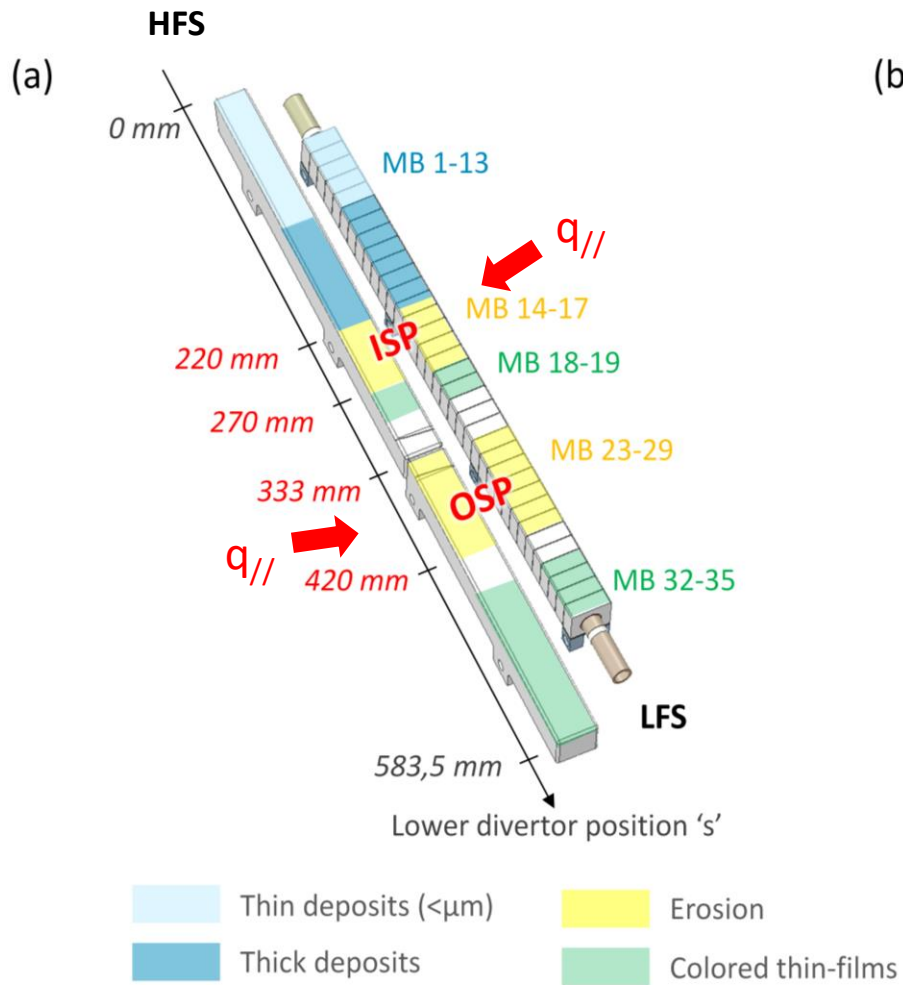


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Reminder: divertor tiles installed in WEST during phase I



Complex erosion/redeposition pattern observed on the divertor



A vast post-mortem program to study PWI in WEST



1st step

Non-destructive analyses performed on the entire WEST tiles (no cutting) to better identify erosion/redeposition patterns:

	SEM/FIB MPG	RBS/NRA MPG	Confocal micros. CEA, MPG	Emissivity CEA	XRF CEA
C3 marker tiles	done	done	no	done	no
C4 marker tiles	done	done	no	done	no
C5 marker tiles	on-going	pending	no	done	no
C4 ITER-like PFU	done	done	done	done	done

This talk

2nd step

Analyses performed on the WEST samples (after cutting):

	LIBS UT	SIMS VTT	GDOES IAP	SEM/EDS/FIB IPPLM, NCRSD	IBA* JSI, NCRSD, RBI, IST, VR
C3 marker tiles	done	done	done	done	done
C4 marker tiles	done?	done?	done?	done	done?
C5 marker tiles	pending	pending	pending	pending	pending
C4 ITER-like PFU	Done on a few MBs: SEM/EDS/Raman/confocal microscopy For the rest: cutting machine available in January 2023				

Cross-data analysis on-going

*PIXE, NRA, RBS, μ NRA, ERDA

No data received yet

Summary of RBS/NRA analyses



Erosion markers

- C1-C3 marker tiles
- C1-C4 marker tiles

Where ? Top surface

ITER-like PFU

- 1 PFU exposed to C3+C4

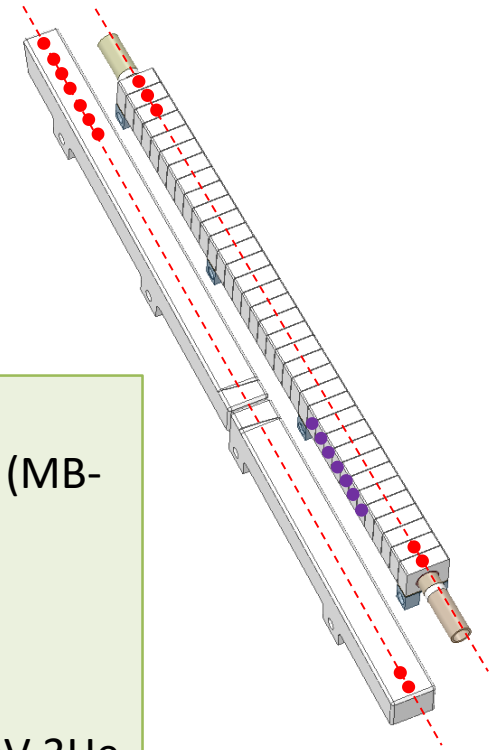
Where ? Top surface
Poloidal side at OSP

Experimental procedure

- On top surface on all tiles : measurement made every 12.5 mm (MB-width) along central line
- On poloidal side: depth profile in OSP area
- Spot size area $\sim 2 \text{ mm}^2$
- RBS: 3.0 MeV protons at 165° (1.5 MeV protons at 165° ; 2.5 MeV 3He at 165°)
- NRA: 2.5 MeV 3He at 150°

Obtained information

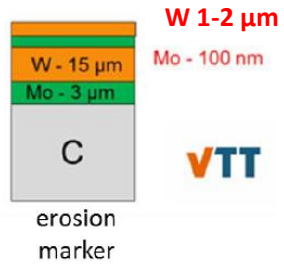
- Amount of **W** above thin Mo interlayer → erosion
- Amount of **D, B, C** (partially with depth information) → deposition
- Presence of **O**



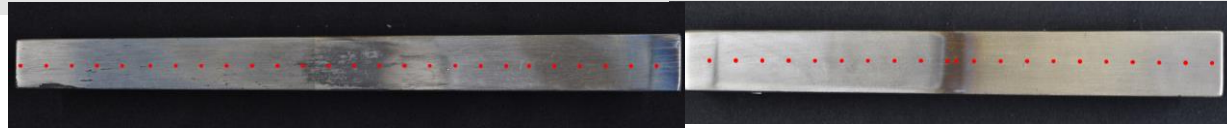
IBA performed by

- *Matej MAYER*
- *Martin BALDEN*
- *Bryan BLIEWERT*

Identification and evolution of erosion areas



VTT

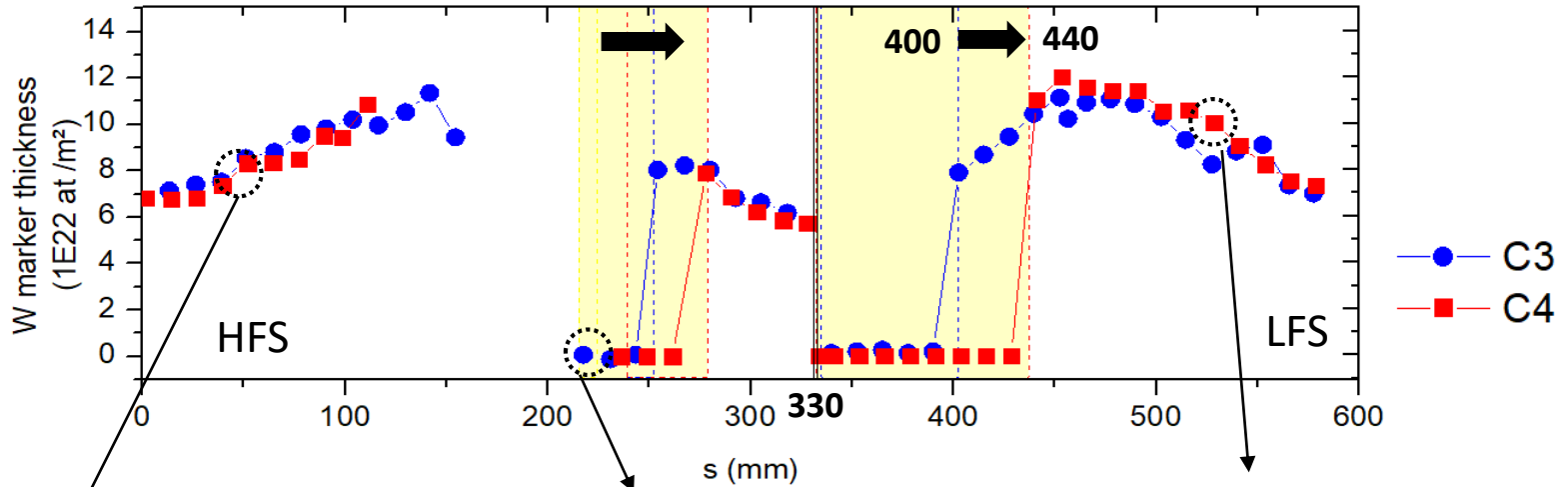


C3 $s_{\text{ERO}}=217-254$ mm
C4 $s_{\text{ERO}}=235-278$ mm

Shift of ISP erosion area

Expansion of OSP erosion area

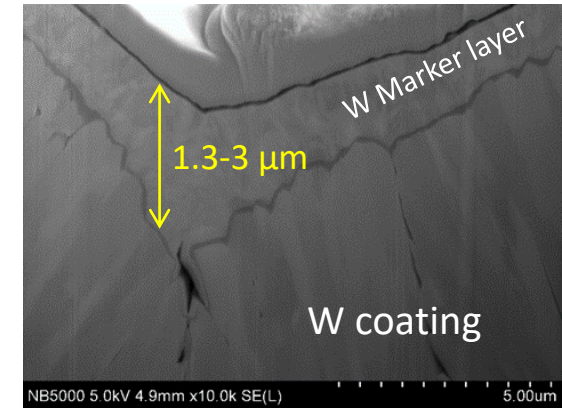
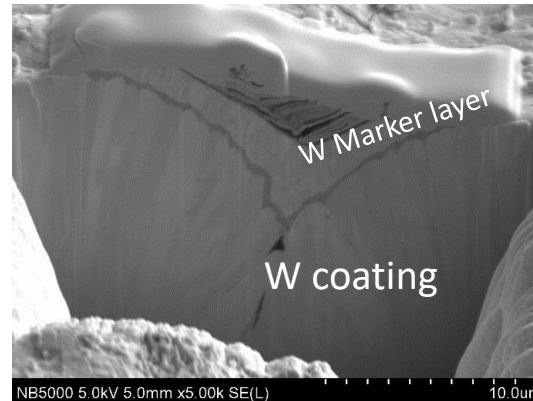
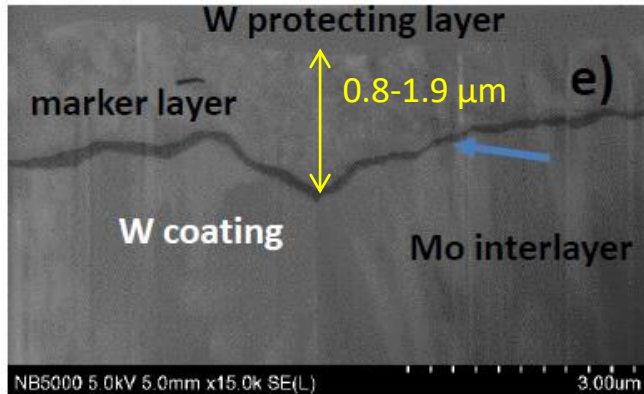
C3 $s_{\text{ERO}}=330-400$ mm
C4 $s_{\text{ERO}}=330-440$ mm



C3-34iC, $s = 50$ mm
W marker partially eroded

C3-34iL, $s = 218$ mm
W marker totally eroded at the « tops »

C4-20oK, $s = 530$ mm
W marker in 'as-received' state



IBA on C3, C4 marker tiles (top surface)



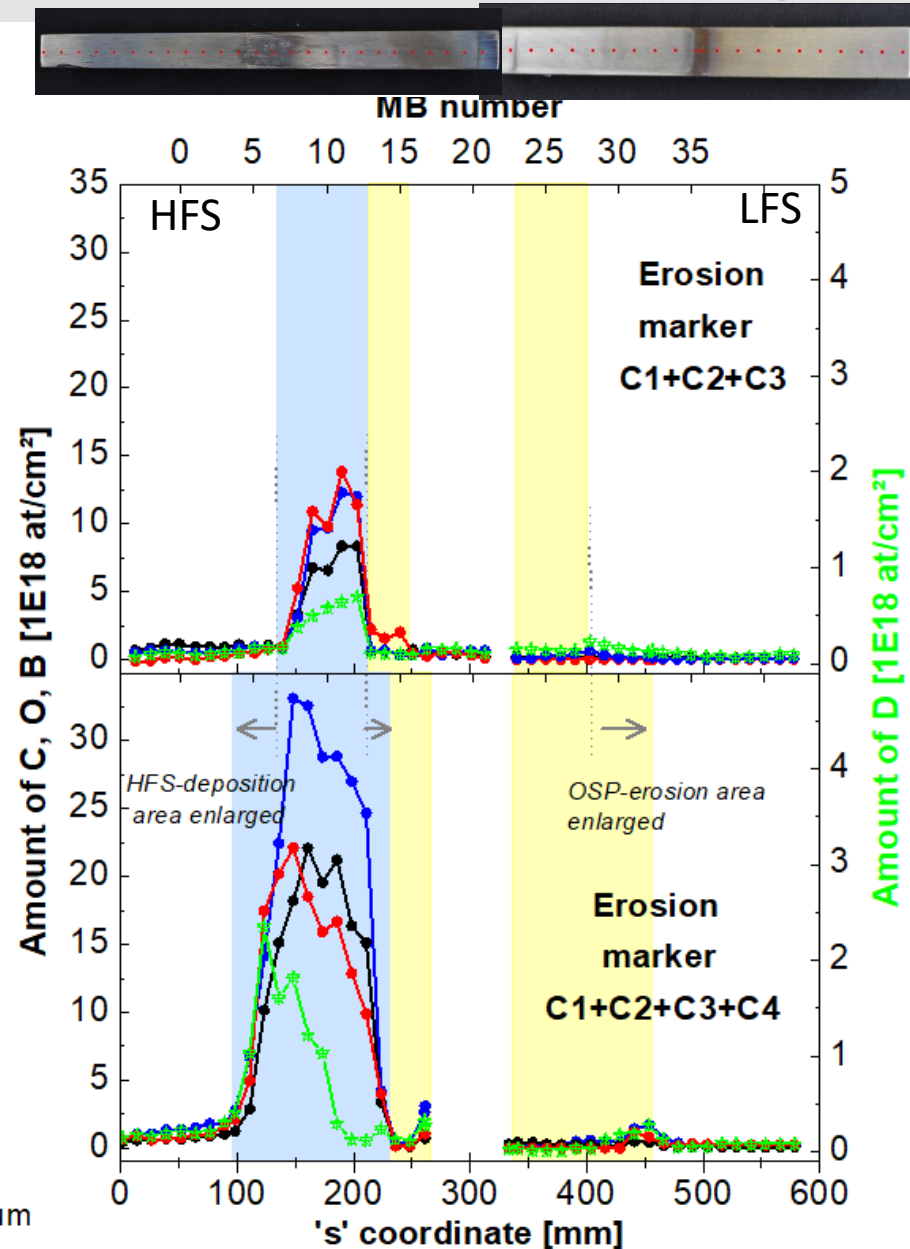
Main conclusions:

- Confirmation of a strong HFS/LFS asymmetry in redeposition pattern
- B, C, O, D as identified light impurities, in line with conditioning and WEST environment
- Quantification of impurities (multiplied by 2-3 between C3 and C4)
- Changes in the spatial distribution: expansion of redeposition area after C4
 C3 s= 140-210 mm
 C4 s= 100-235 mm



Strong input for the analysis of the erosion marker samples

- Boron
- Carbon
- Oxygen
- ★ Deuterium

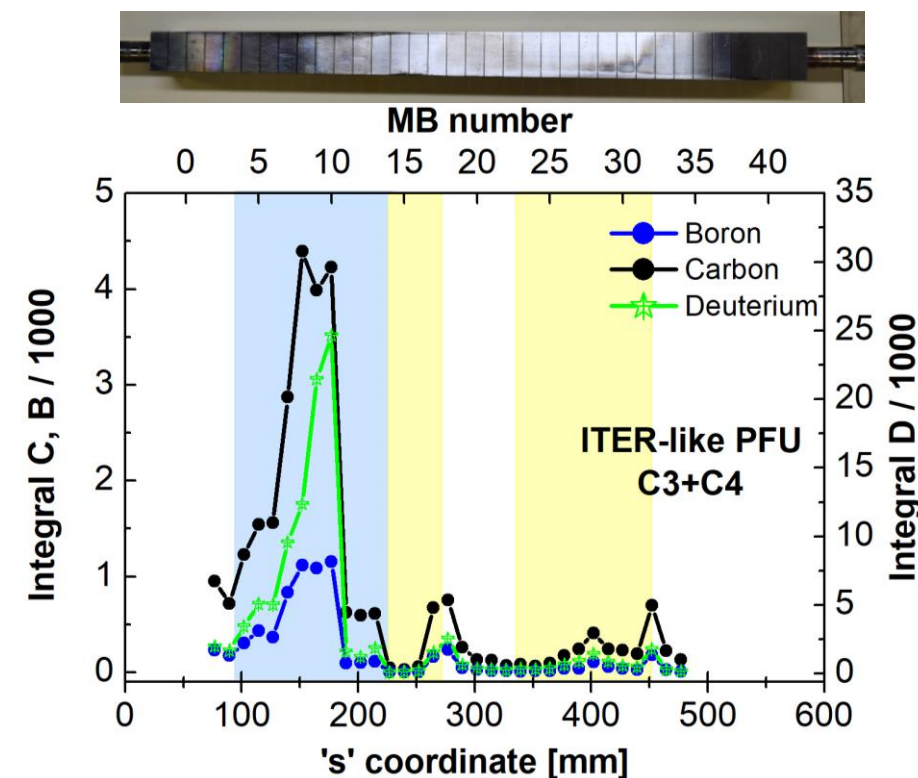


IBA on C4 ITER-like PFU (top surface)



Main conclusions:

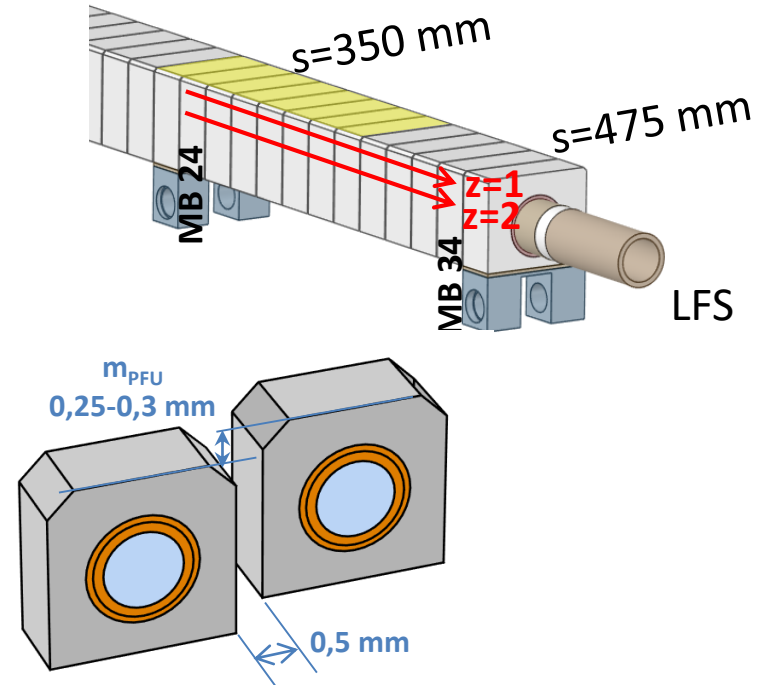
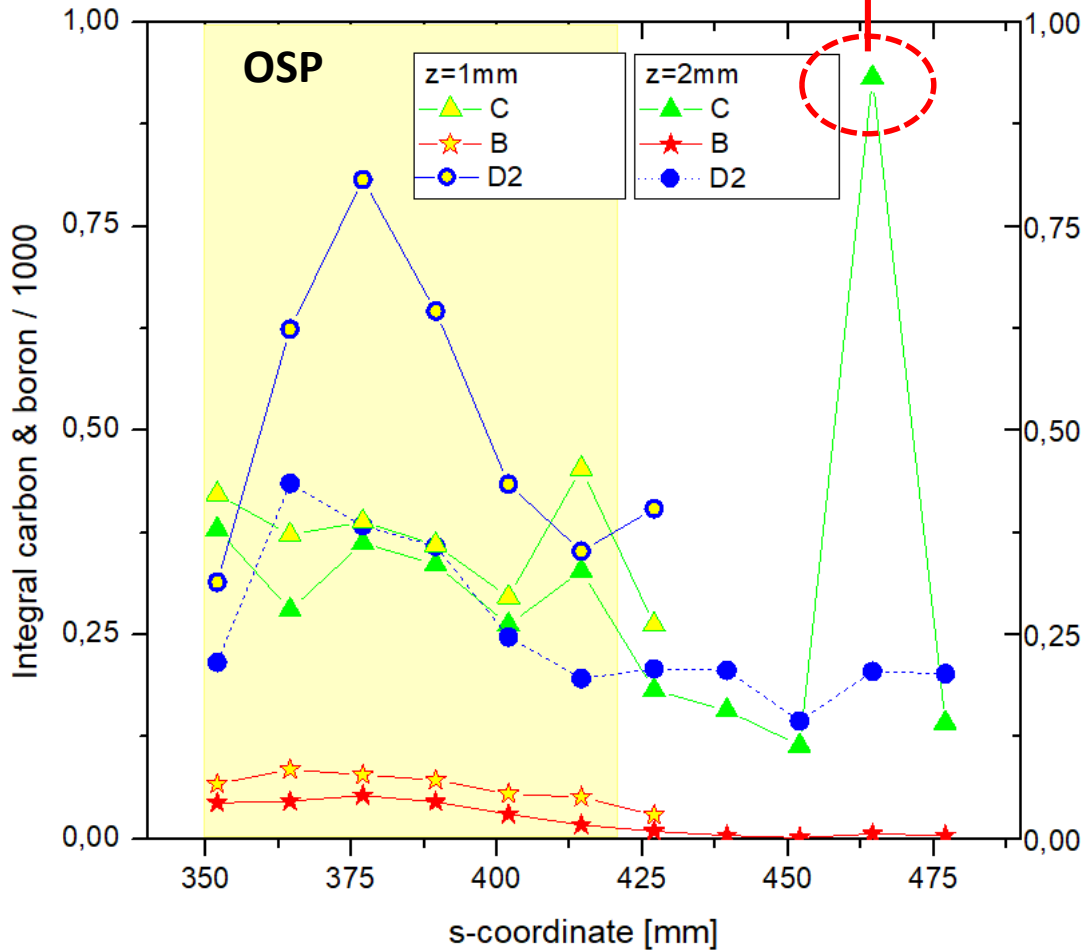
- Evaluation to obtain amounts ongoing (simple scaling not possible) with ITER-like PFUs : difficult to do quantification and comparison with erosion markers
 - BUT same spatial distribution of erosion/redeposition pattern than erosion markers
- > suggest a toroidal homogeneity over the divertor



IBA on C4 ITER-like PFU (OSP poloidal side)

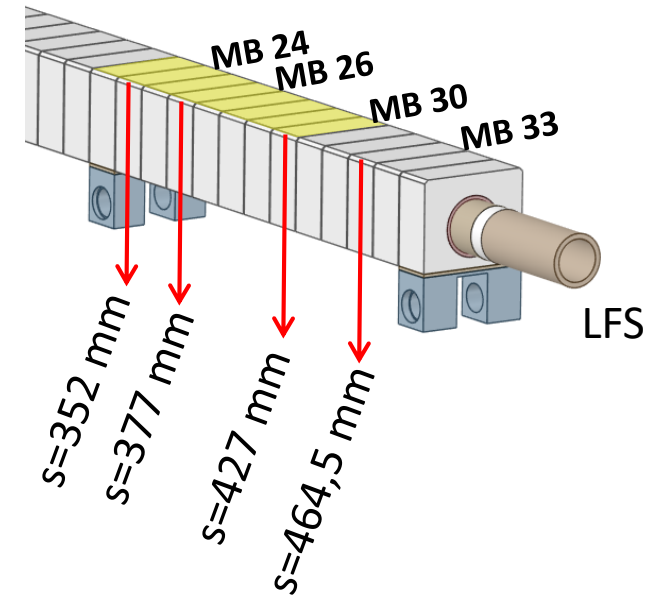
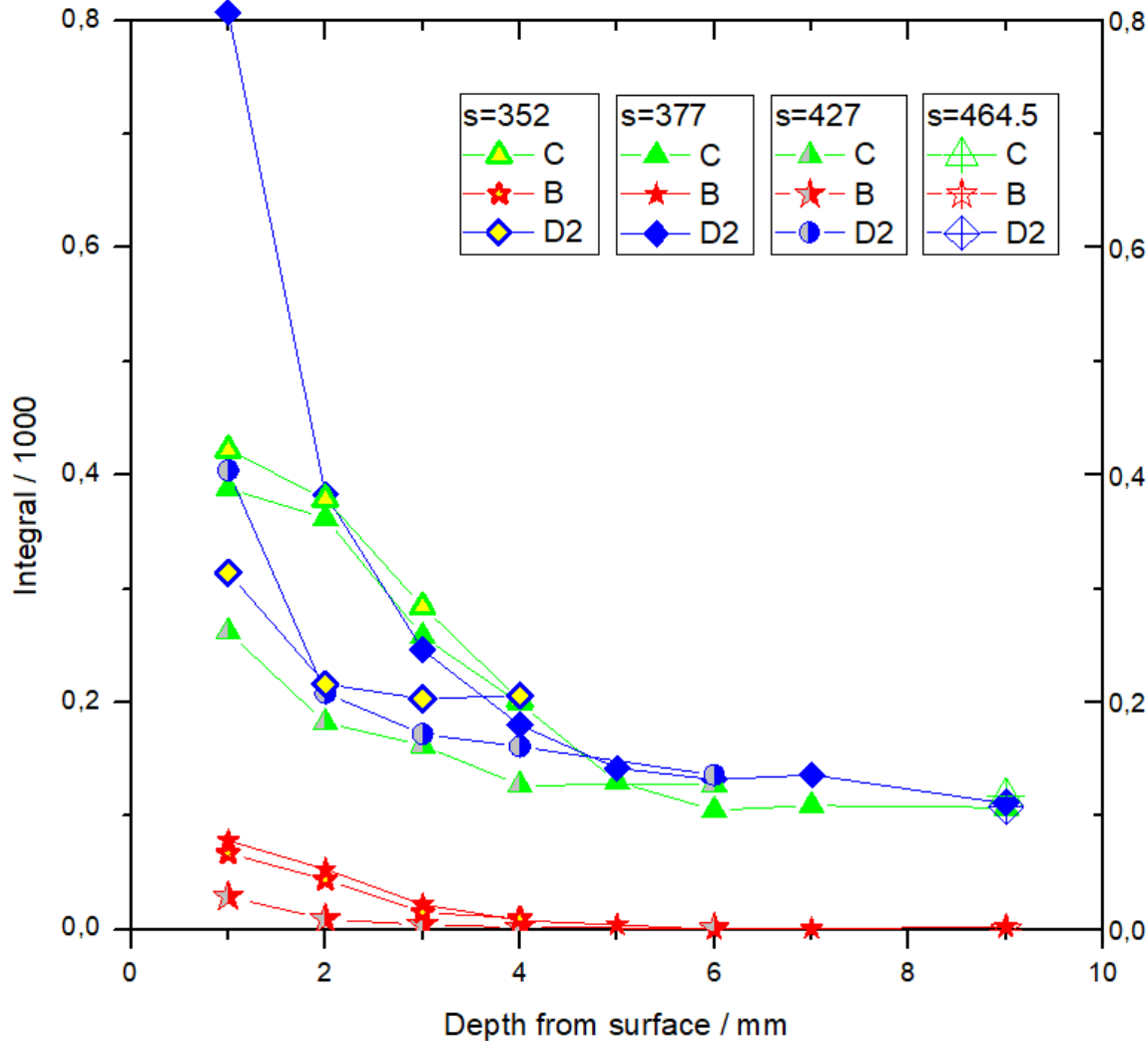


In agreement with top surface measurement
 → Very local redeposition ?



First evidence of redeposition into the poloidal gaps !

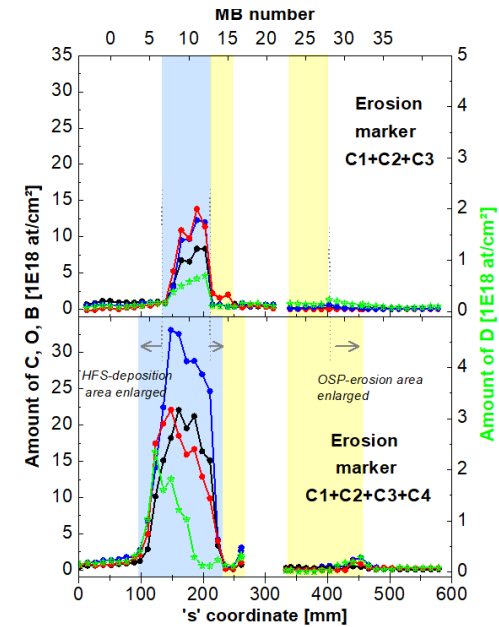
IBA on C4 ITER-like PFU (OSP poloidal side)



Conclusions



- Monitoring of erosion/redeposition pattern after each WEST campaign conducted by IBA analysis on the entire C3 and C4 erosion marker tiles + on one ITER –like PFU
- IBA on entire C5 markers tiles scheduled soon → should provide more data about spatial distribution and quantification
- Analysis of the poloidal sides of ITER-like PFUs should be extended to other PFUs (coupled with FIB cuts?)
- IBA analysis on the erosion samples should proceed on 2023 and 2024



Analyses on the WEST samples (after cutting)

	LIBS <i>UT</i>	SIMS <i>VTT</i>	GDOES <i>IAP</i>	SEM/EDS/FIB <i>IPPLM, NCRSD</i>	IBA* <i>ISI, NCRSD, RBI, IST, VR</i>
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2023,
2024