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Glow discharge boronization uniformity studies in WEST

A. Gallo, M. Diez, S. An, V. Rohde, T. Wauters, B. Guillermin, J. Gunn, K. Krieger, C. Martin, E. Pitthan-Filho, P. Tsavalas, E. Fortuna-Zalesna, Ph. Moreau, T. Alarcon, Y. Corre, J. Gaspar, A. Grosjean, P. Manas, J. Cazabonne, P. Maget, E. Tristrone, A. Hakola, A. Goriaev, D. Douai, S. Brezinsek, the WEST team, the EUROfusion TE and PWIE teams

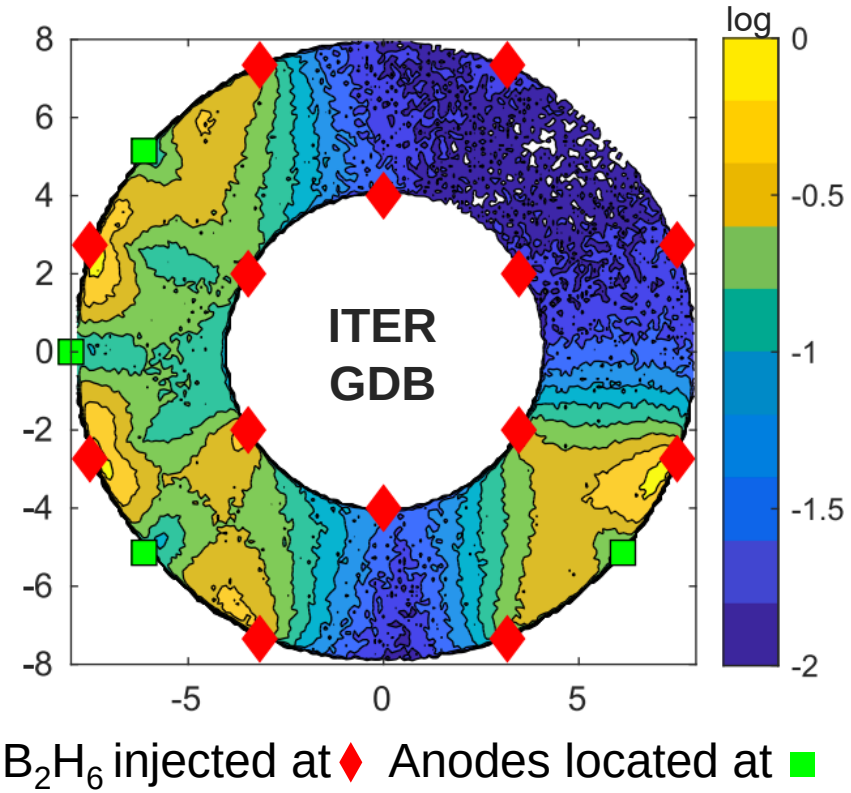
EUROfusion PWIE SP-F Monitoring Meeting, 28 oct 2026

Collector probes for GDB spatial (non-)uniformity

According to Monte Carlo modeling [Wauters NME 2025], the toroidally non-symmetric ITER glow discharge system planned for the SRO phase might lead to a non-uniform GDB layer : could this hamper full-W ITER operations?

Need to study ‘uniform’ vs ‘non-uniform’ GDB in existing W tokamaks [Rohde NME 2025] [Gallo NME 2026]

Normalized B_2H_6 reaction distribution



Collector probes for GDB spatial (non-)uniformity

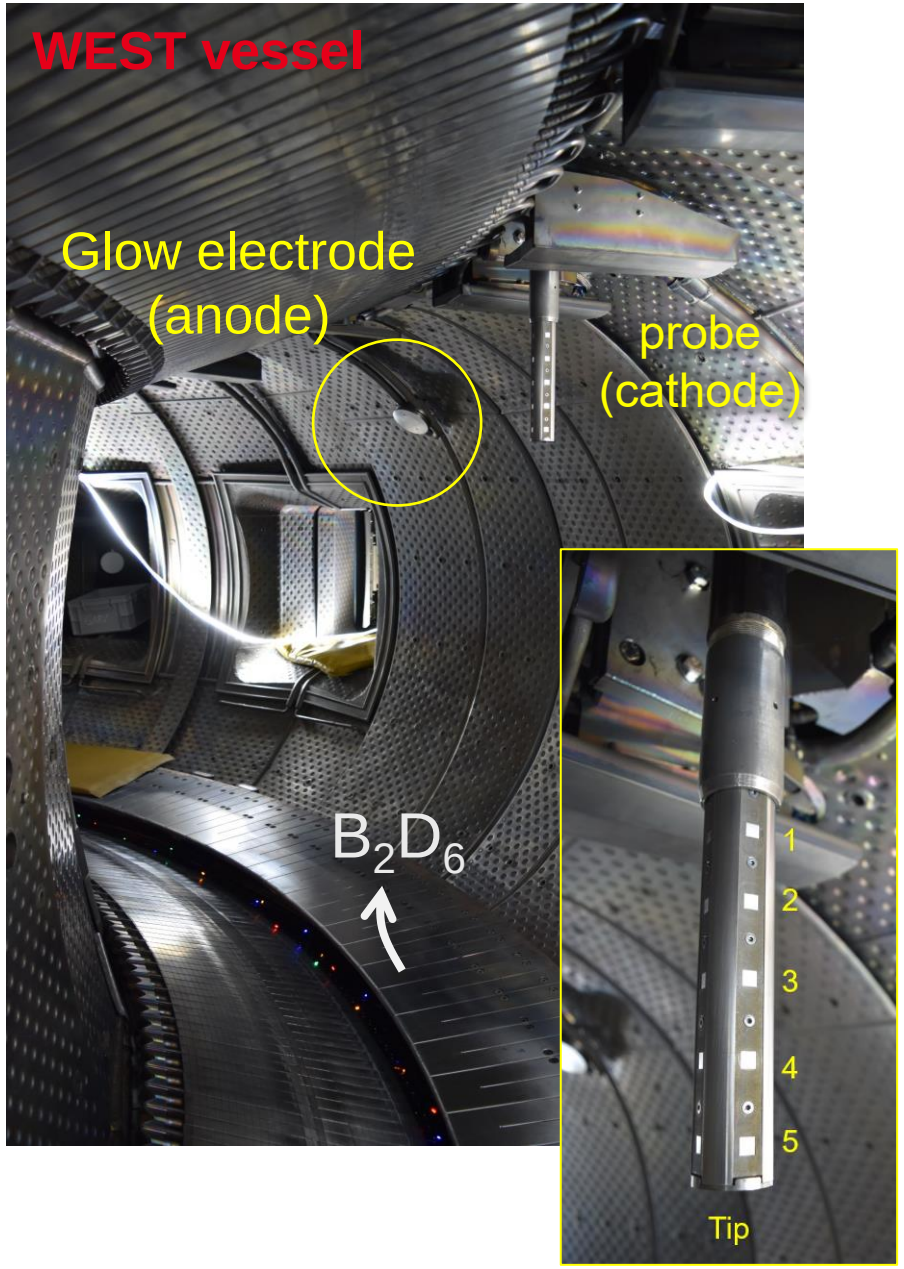
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Multi-year effort to collect GDB layers deposited in WEST at two toroidal locations before any exposure to plasma for extensive material characterization (PWIE network) :

- Thickness
- Morphology
- Composition
- Density...

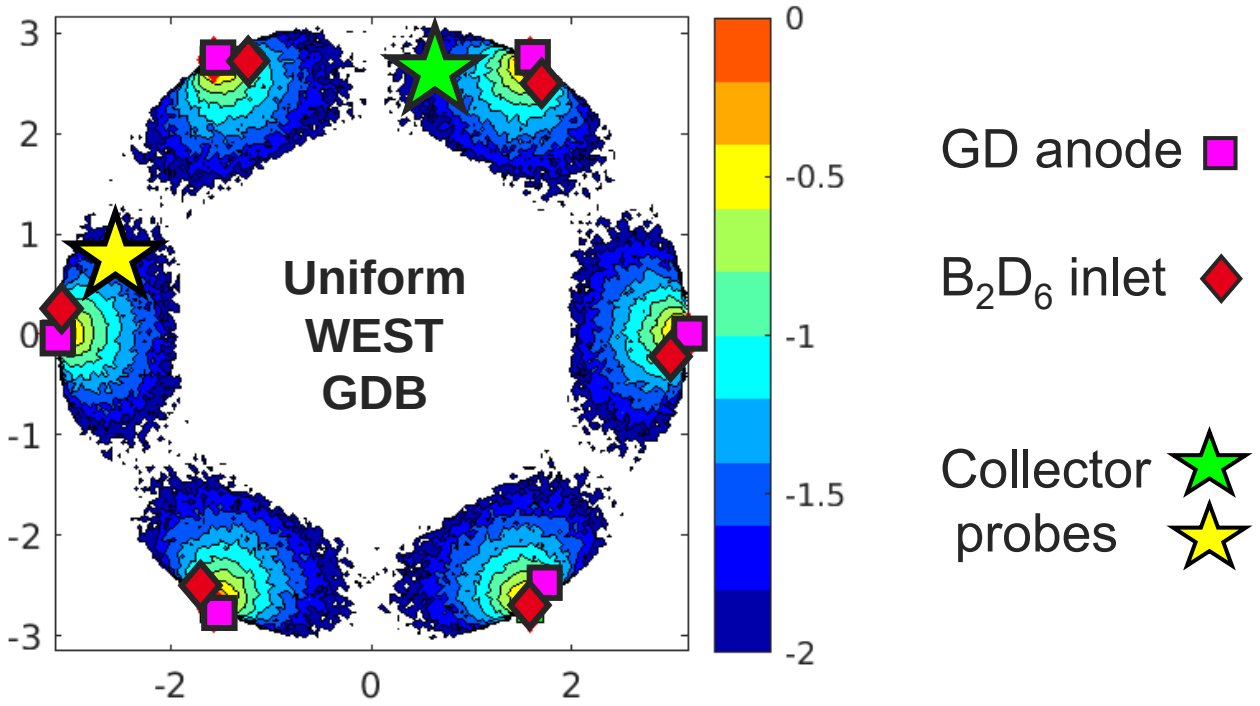
42 samples
W and SS



GDB (non-)uniformity varied via B_2D_6 inlet distribution

Monte Carlo modeling of B_2D_6 reaction distribution: precursor of B:D deposition [Wauters NME 2025]

Uniform GDB with 6/6 B_2D_6 inlets (standard)
==> toroidally symmetric B_2D_6 reactions

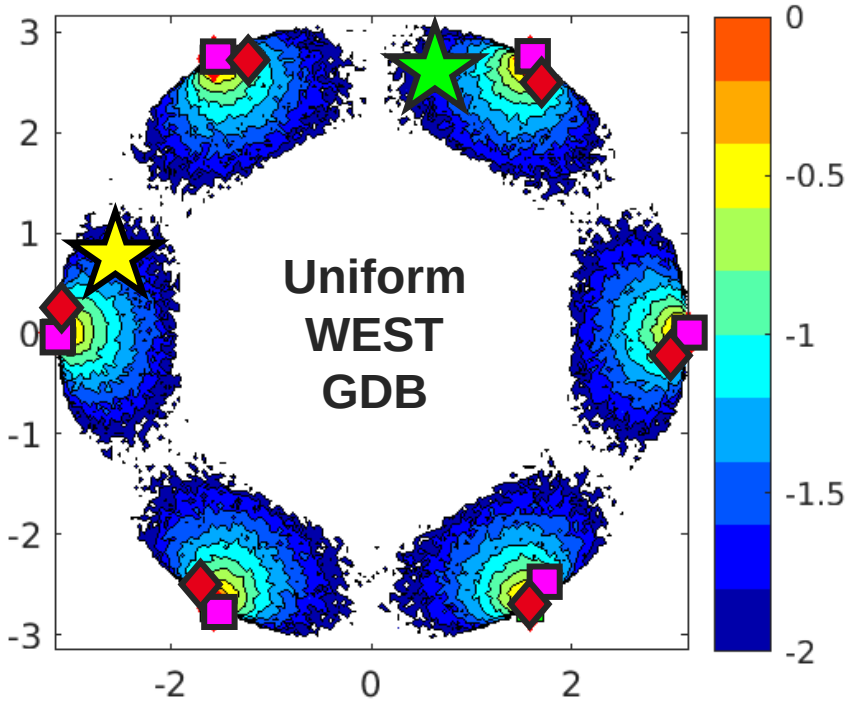


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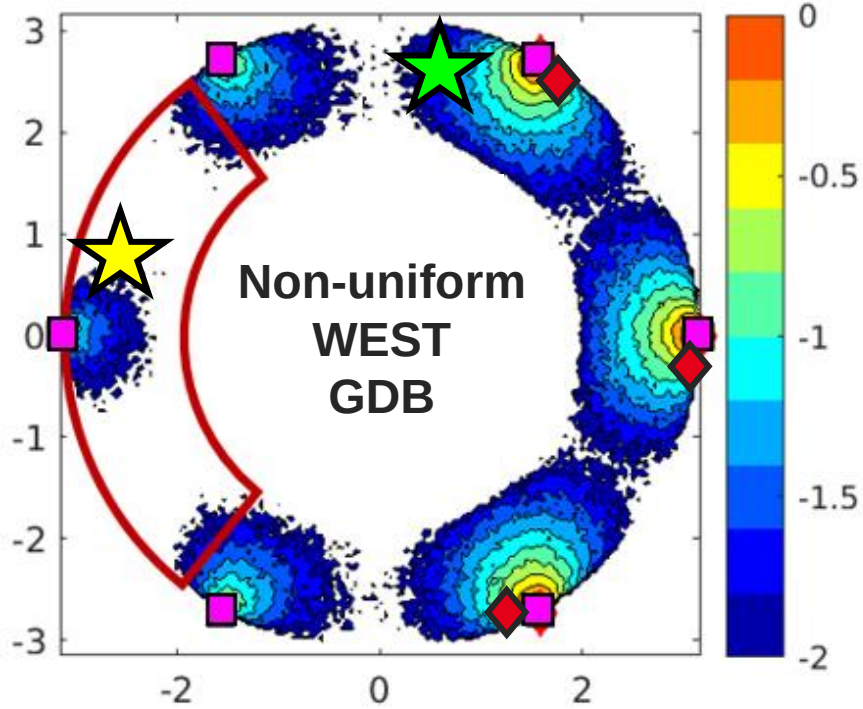
Non-uniform GDB **with 3/6 B_2D_6 inlets**
==> **B_2D_6 reaction-depleted region**



GD anode

B_2D_6 inlet

Collector probes

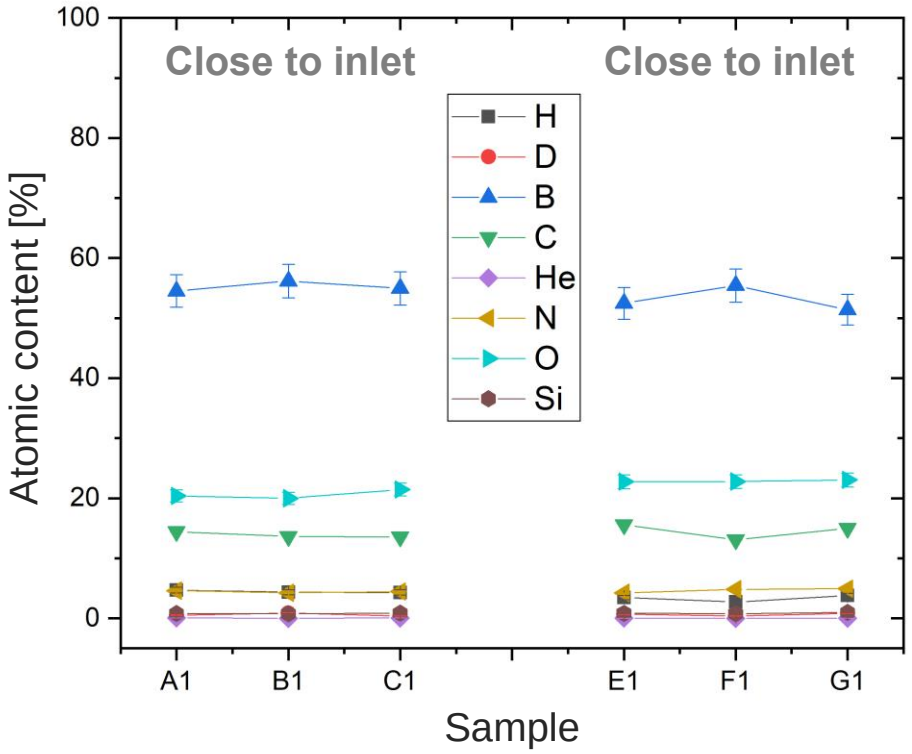


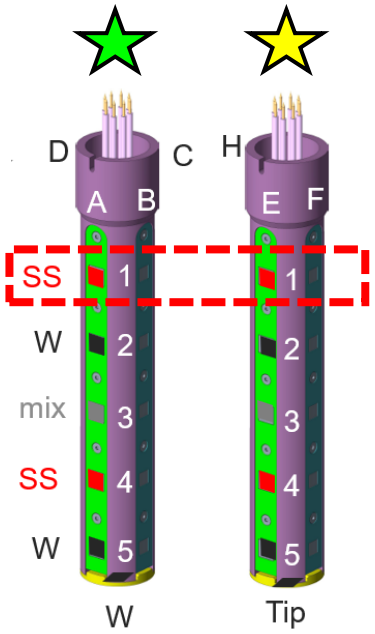
Complementary experiment on AUG : GDB with 4/4 vs 2/4 GD anodes [An NME accepted]

Better gettering in B-depleted layers far from inlet

ToF-ERDA measurements of layers collected on SS substrate during GDB (retrieved before plasma) :

Uniform GDB :
- similar atomic content of **B**, **D**, gettered impurities at both toroidal locations





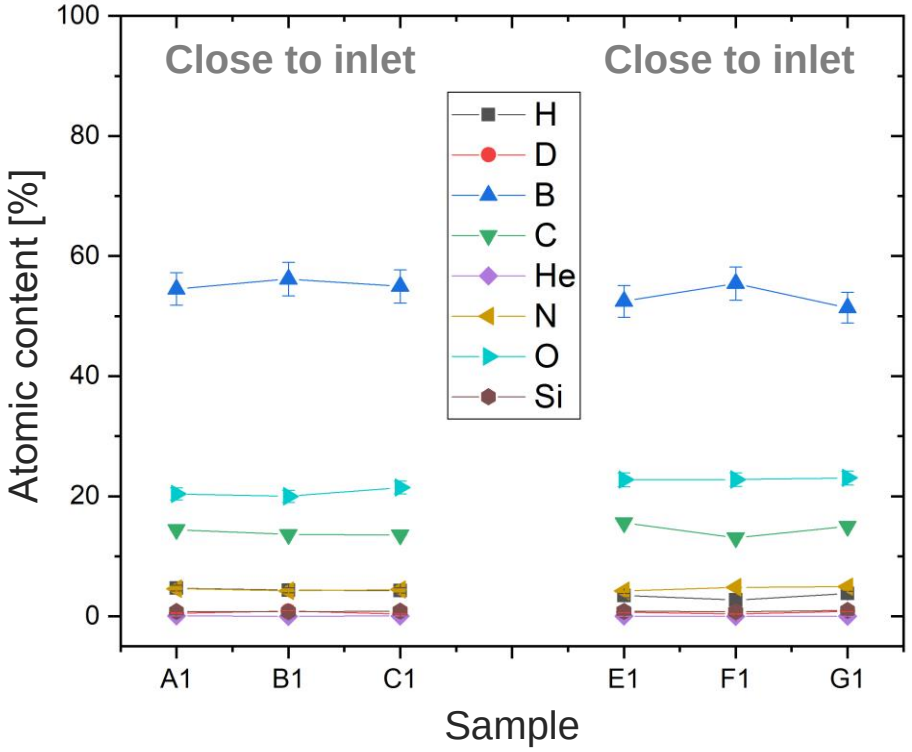
[E. Pitthan-Filho, in prep]

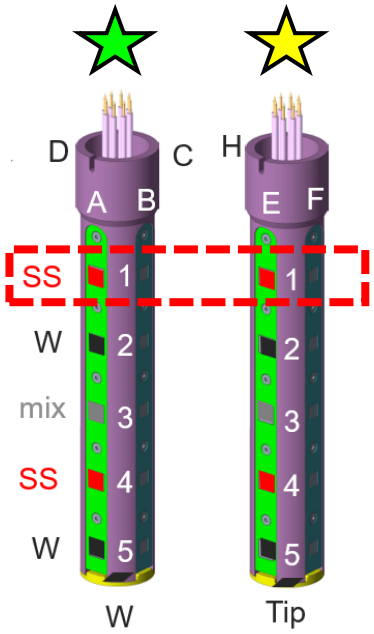
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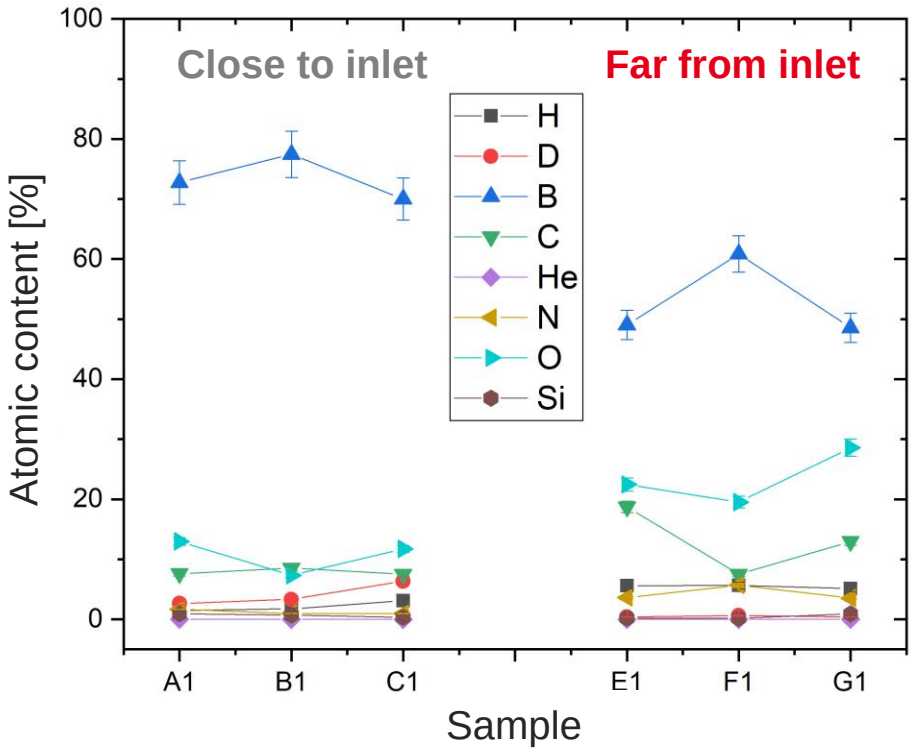
ToF-ERDA measurements of layers collected on SS substrate during GDB (retrieved before plasma) :

Uniform GDB:
- similar atomic content of **B**, **D**, gettered impurities at both toroidal locations

Non-uniform GDB :
- more **B** and **D** close to B_2D_6 inlet
- lower gettered impurities close to B_2D_6 inlet







[E. Pitthan-Filho, in prep]

Ongoing analyses of GDB samples from WEST

- EBS+NRA+PIXE and ToF-ERDA measurements of uniform + non-uniform GDB (all sets)
  → atomic % and areal density of B, D, gettered impurities (sensitive to B_2D_6 inlet)

- IBA+SEM+EDXS measurements of 2 non-uniform GDB (B_2D_6 inlets 1-2-3 and 4-5-6)
  → confirms higher B content at bottom of probe (closer to B_2D_6 inlets)

- SEM+TEM+EDXS+AFM meas of 2 non-uniform GDB (B_2D_6 inlets 1-2-3 and 4-5-6)
  → thickness and areal density trends presented [Martin PSI 2026]

- NRA measurements of non-uniform GDB (B_2D_6 inlets 1-2-3, 4-5-6 ongoing)
  → non trend of B, D areal density with substrate material or probe face

- SEM+FIB+TEM measurements from 2 non-uniform GDB (B_2D_6 inlets 1-2-3 and 4-5-6)
  → thickness of GDB layers, surface morphology (surface blisters in some samples)