P38B

Ion beam analysis of ^{13}C and deuterium deposition in DIII-D and their removal by in-situ oxygen bake

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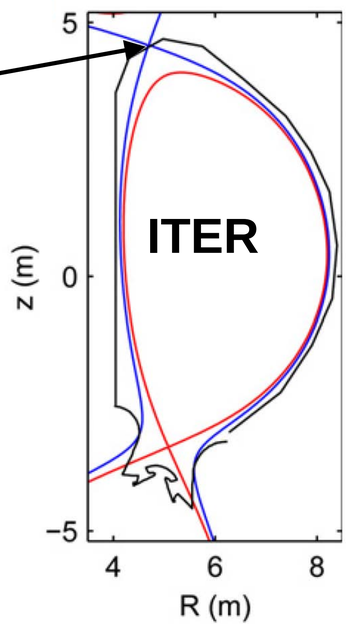
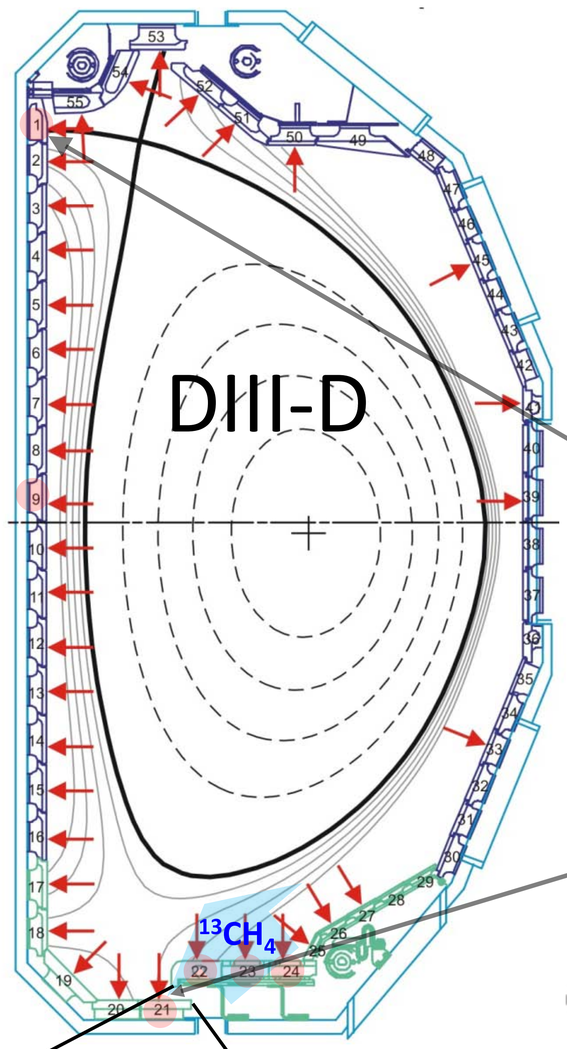
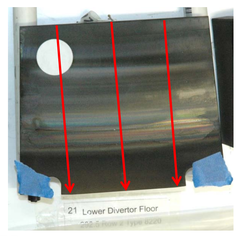
and the DIII-D ^{13}C and oxygen bake experimental teams

Purpose

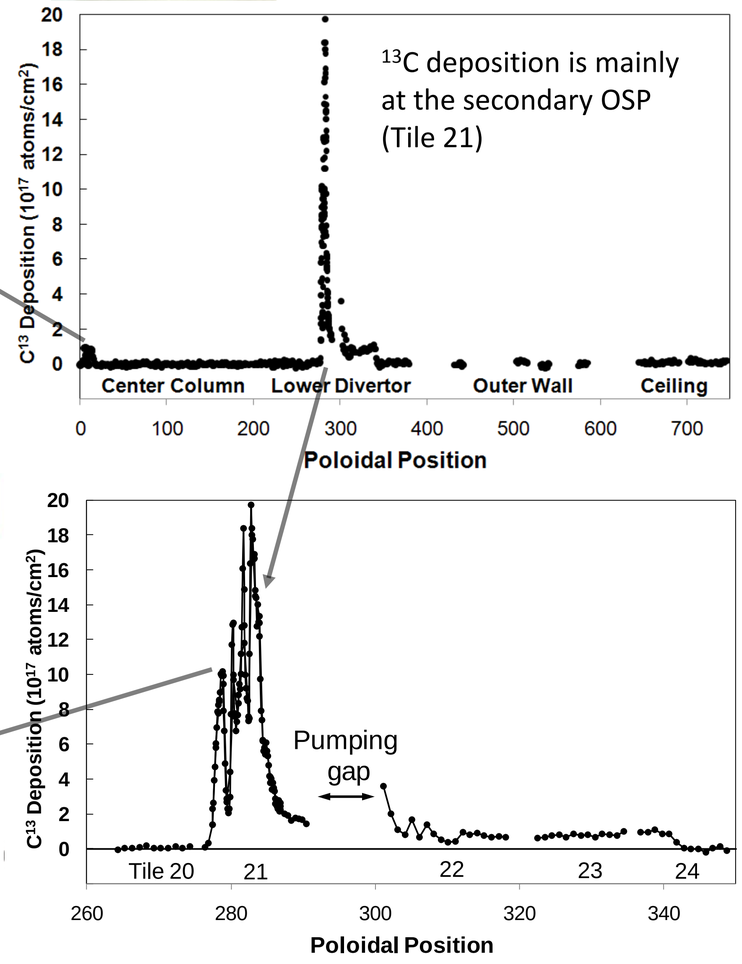
- Material eroded from the ITER main chamber wall near the secondary separatrix may redeposit locally along with tritium.
- Codeposited tritium will be more difficult to remove from the main chamber than from the divertor (lower maximum temperature and not designed for replacement).
- This experiment shows where material entering the SOL near the secondary OSP is deposited for an unbalanced double-null plasma configuration as planned for ITER.
- Removal of deposited deuterium/carbon by in-situ baking in oxygen is also examined.





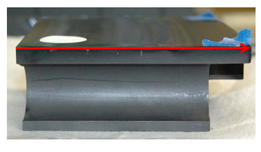


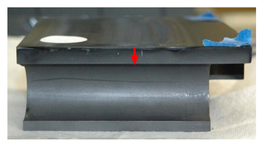
^{13}C and D coverage measured along 3 poloidal scans on each of 37 tiles

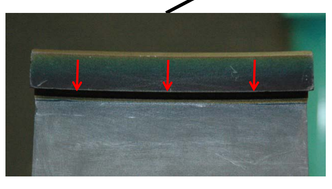


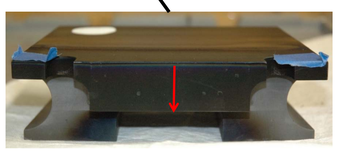
Experiment

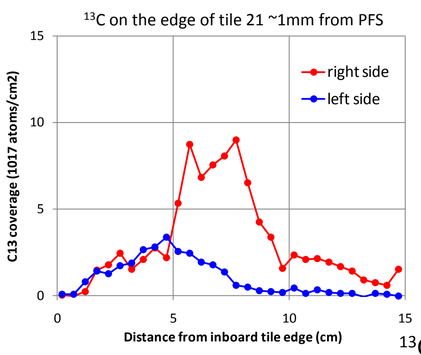
- Examine carbon deposition from plasma-wall interaction at the secondary separatrix with biased double null plasmas, with n_e=1x10^{19}m^{-3}and T_e=10eV comparable to conditions projected for the secondary separatrix in ITER.
- Inject $^{13}CH_4$ (800 Torr-liters) through the lower outer pumping plenum (torroidally symmetric) into 18 ELMy H-mode plasmas in DIII-D.
- Measure ^{13}C coverage by $^{13}C(^3He,p)^{15}N$ NRA (±2x10^{16} atoms/cm^2), and deuterium coverage within 7µm by $D(^3He,p)^4He$ NRA (2.5 MeV ^3He).
- 6 tiles were oxygen baked in DIII-D at 350^{o}C for 2 hours, 10 Torr 20%O_2 80% He, and re-analyzed

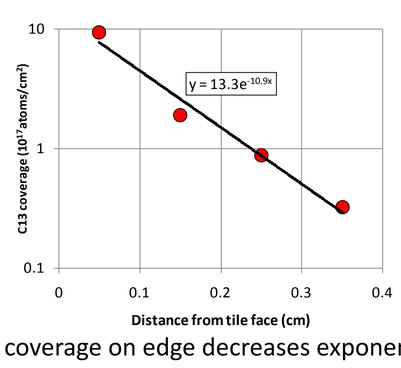


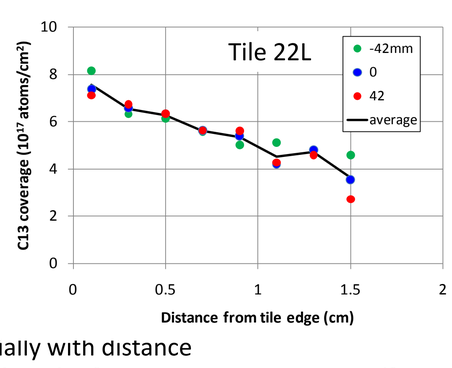


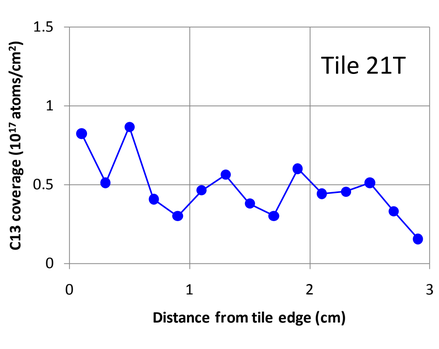










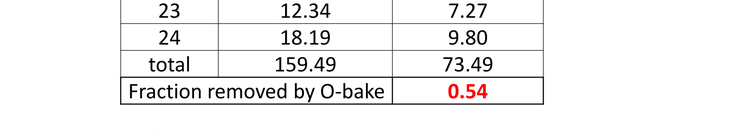


^{13}C coverage on edge decreases exponentially with distance from plasma-facing surface with e-folding length of 0.9 mm

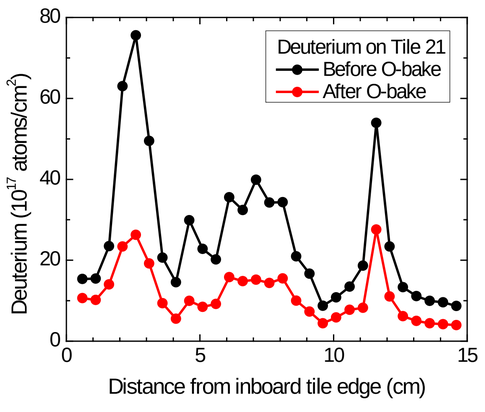
^{13}C & D were also measured on the edges of tiles 1 & 21.

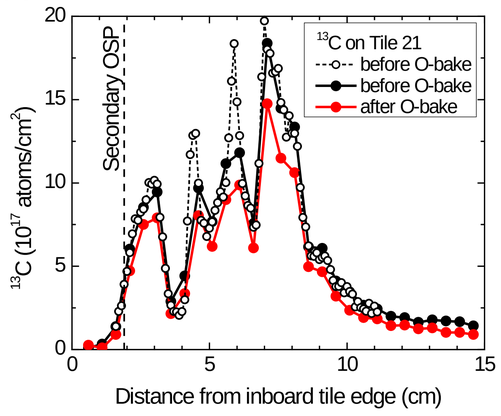
Quantity of ^{13}C in tile gaps is very small compared to plasma-facing surfaces.

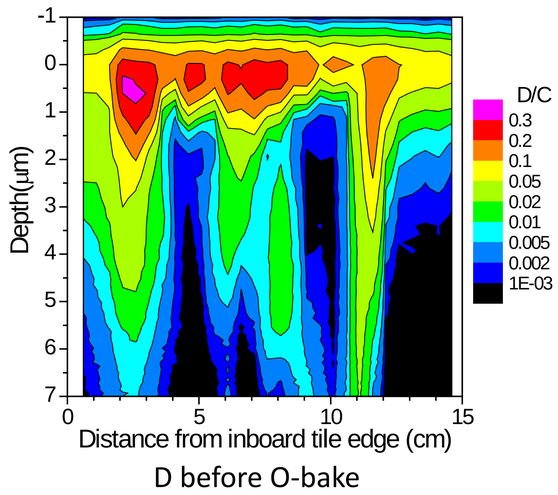
Significant ^{13}C deposition was found inside the pump duct on surfaces shadowed from ion flux.



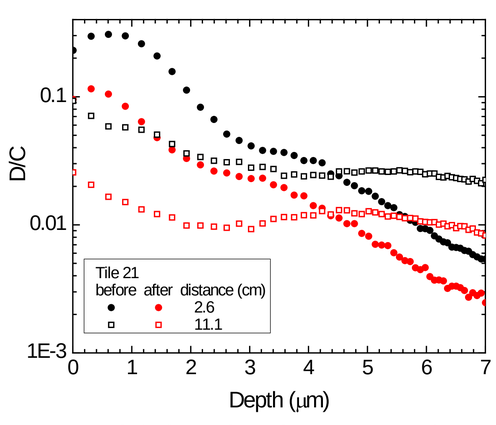
In-situ oxygen bake



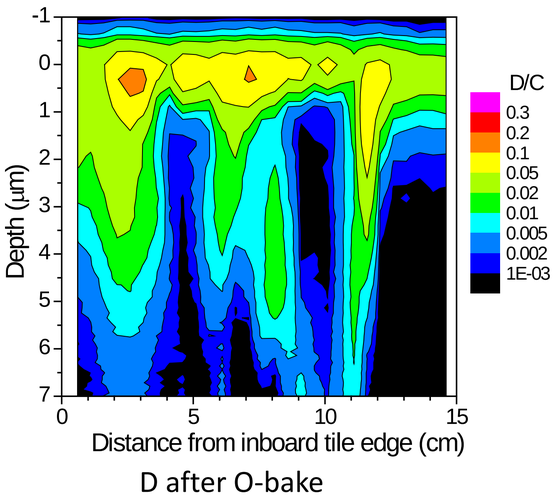




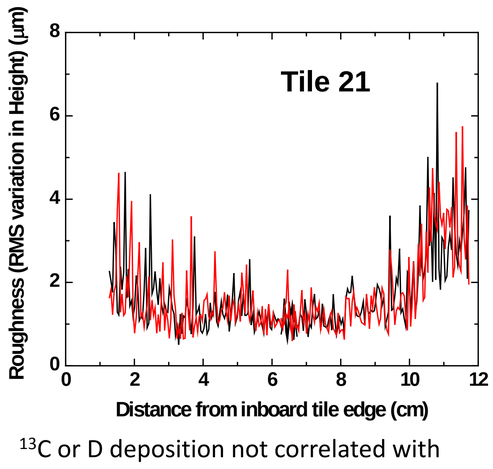
D before O-bake



O-bake reduced D concentration throughout the codeposited layer



D after O-bake



^{13}C or D deposition not correlated with surface roughness (contact & optical profilometry)

NRA Measurements of ^{13}C and D before and after oxygen bake

	Measured ^{13}C (10^{20} atoms)	
tile	Before bake	After bake
1	2.96	3.32
21	69.22	54.84
21T	1.28	0.80
22	14.61	10.84
22L	7.66	5.15
23	9.94	7.97
24	5.17	5.03
Total measured	110.8	87.9
Injected	255	
Fraction measured	**0.44**	
Fraction removed by O-bake		**0.21**

- **44% of injected ^{13}C was found (assuming toroidally symmetric deposition) mainly near secondary OSP**
- **21% of ^{13}C was removed by O-bake**

	Average D areal density within 4 microns (10^{17} atoms/cm^2)	
tile	Before bake	After bake
1	60.45	23.17
9	11.76	9.56
21	24.07	10.47
21T	3.09	1.03
22	17.36	8.19
22L	12.23	3.99
23	12.34	7.27
24	18.19	9.80
total	159.49	73.49
Fraction removed by O-bake		**0.54**

- **54% of D was removed by O-bake consistent with ex situ O-bake experiments**

Conclusions

- **44% of injected ^{13}C was found (assuming toroidal symmetry) mainly near secondary OSP close to the point of injection.**
- **This shows that most of the CH_4 dissociated & ionized outside the secondary separatrix.**
- **Previous similar experiments with ^{13}C injected into the top of lower single-null plasmas show deposition is mainly in the divertor.**
- **This indicates that material sputtered from the wall in ITER may deposit near the secondary strike points in the upper main chamber. Tritium accumulation by codeposition with Be may occur at this location.**
- **In-situ oxygen bake in DIII-D at 350^{o}C removed 54% of deuterium and 21% of ^{13}C, however the efficacy may differ for Be codeposits.**

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