Plasma Effects on Condenser Optics in the Engineering Test Stand

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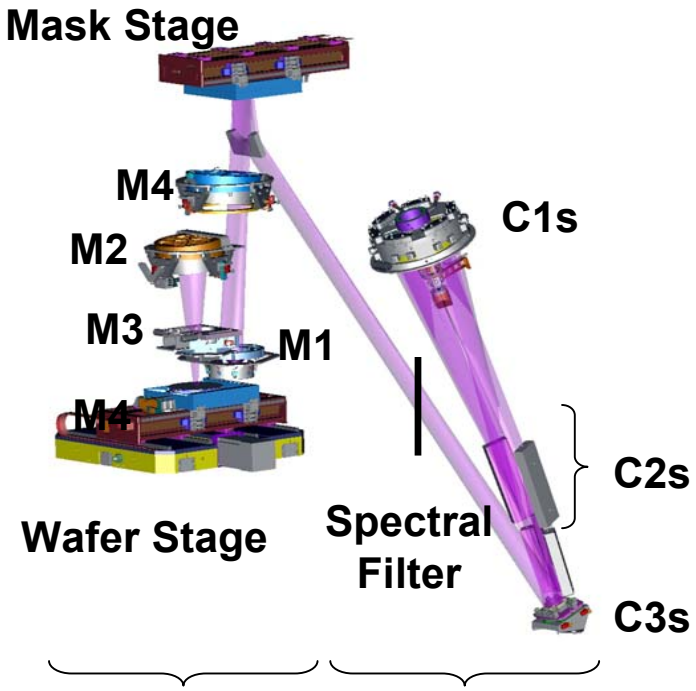
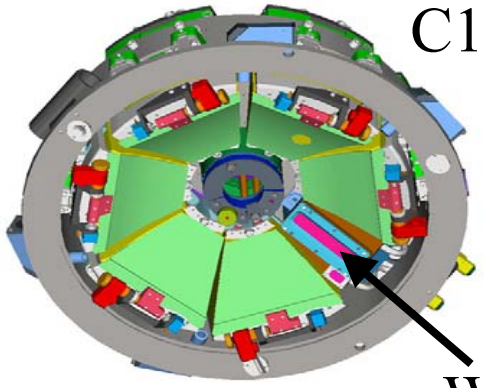
C1 Erosion Monitored





C1 assembly

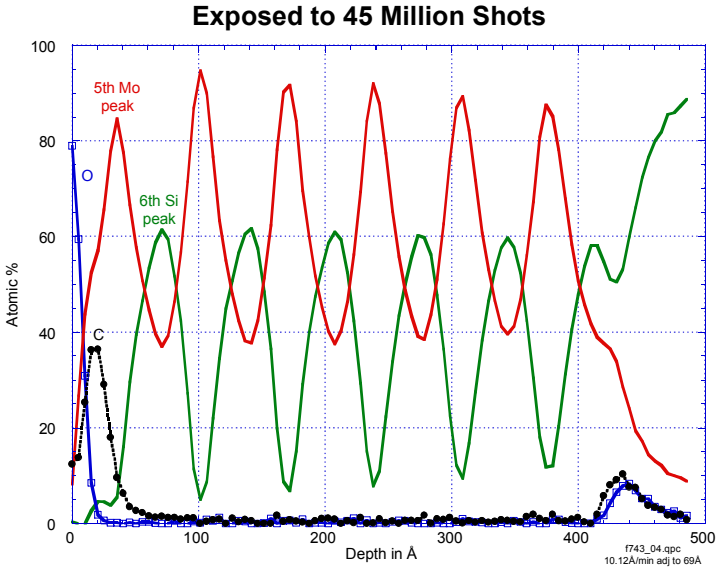
Witness Plate

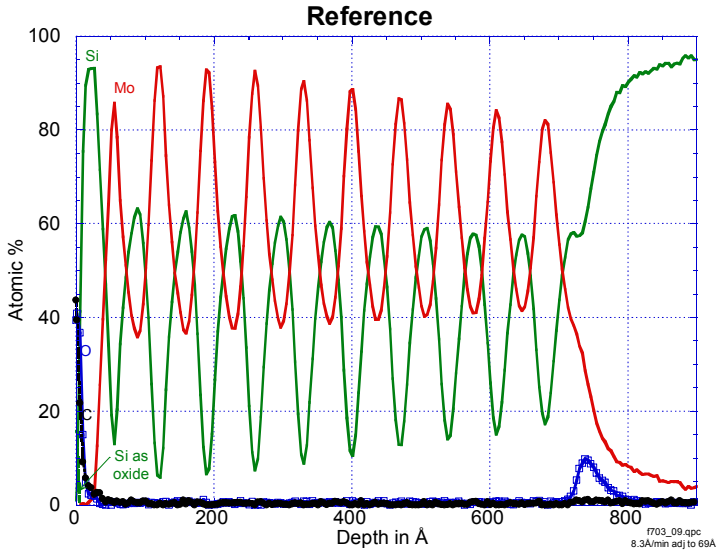
Plasma

EUV ETS houses LPP Source in Illuminator Chamber

Plasma exposes C1 element from 12 - 15 cm.
Plasma - C1 interaction monitored with Mo/Si witness

C1 Erosion Measured

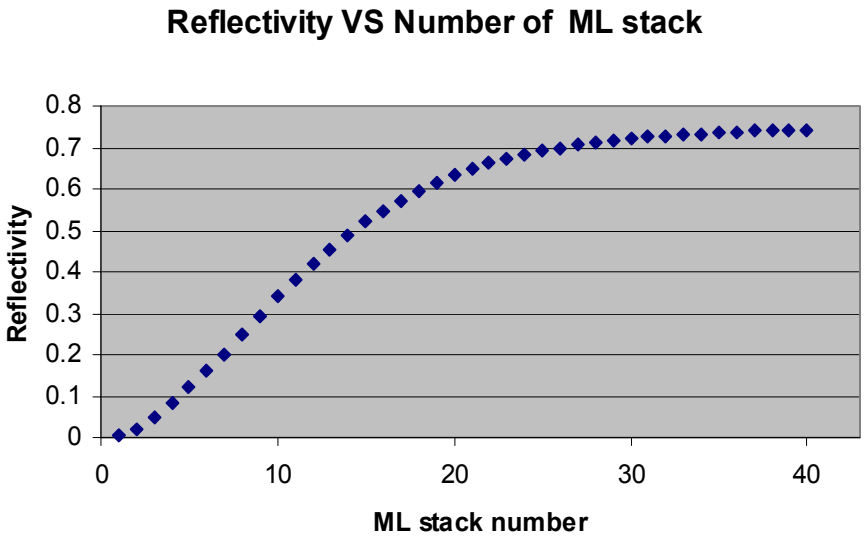


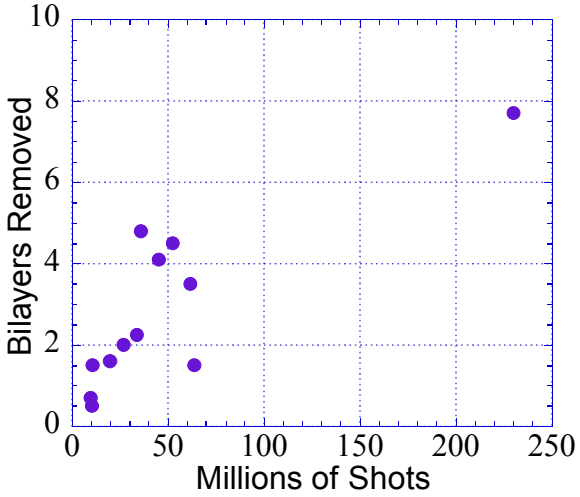


Analysis of C1 witnesses indicate LPP removes Mo/Si layers from optic

C1 Erosion Measured

Loss of layers leads to loss of reflectivity





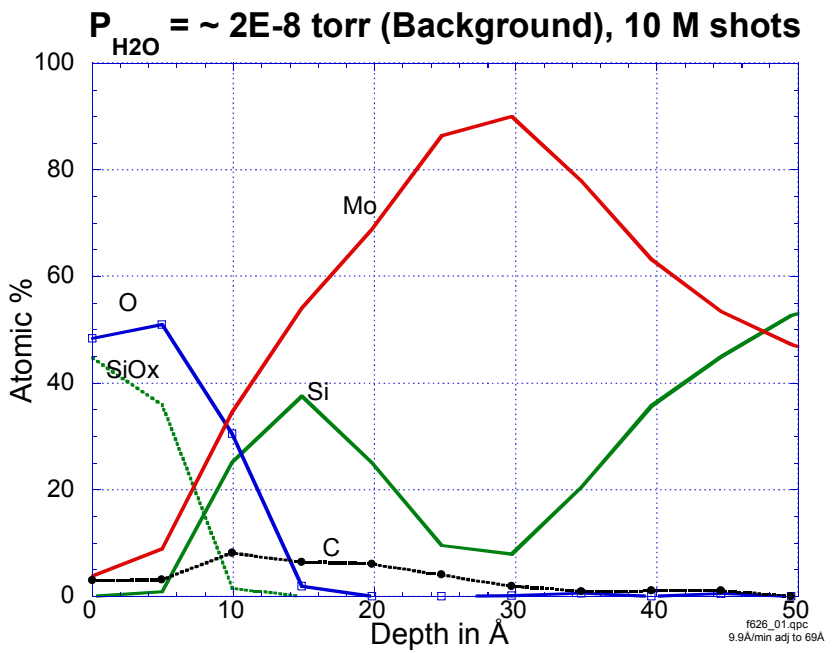
Approximate erosion rate 1 bilayer pair per 15 million shots

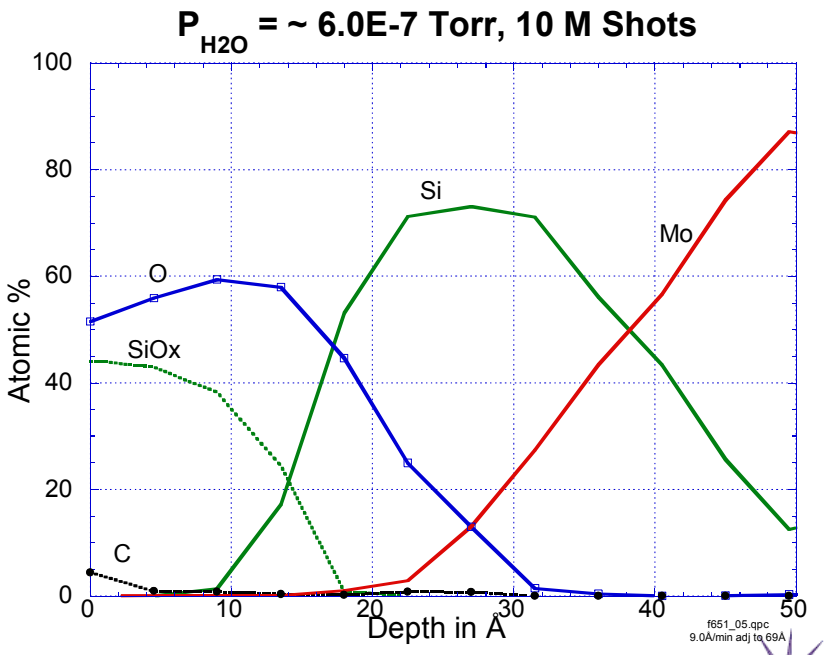
C1 Oxidation Caused by Water

Increased background water vapor leads to

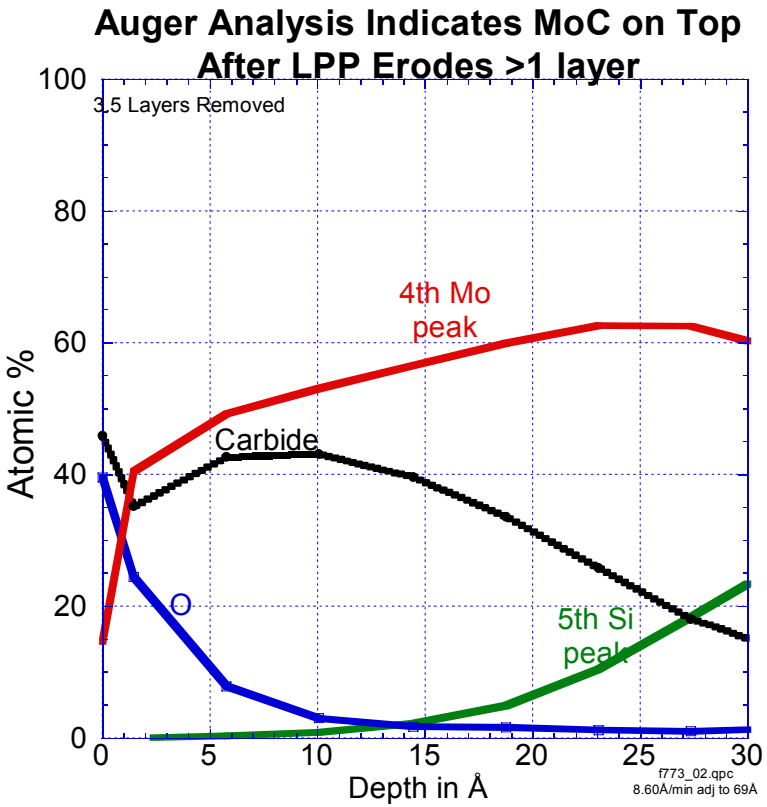
- Greater Si oxide growth at C1 witness
- Slows erosion

Vapor change small (~1E-6 T H_2O in 1E-3 T Xe)

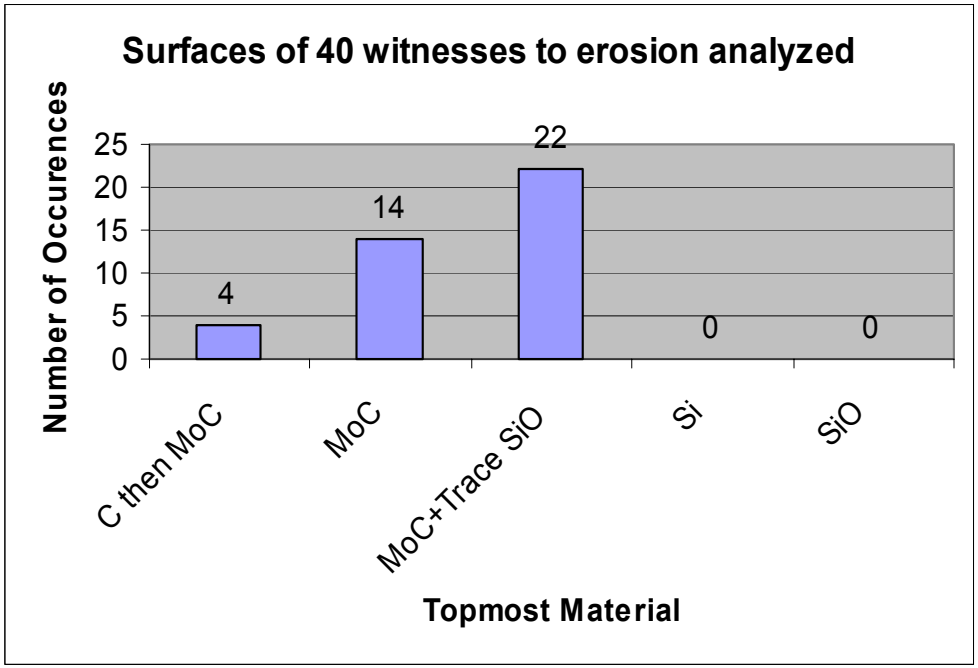




Erosion Appears Slower on Mo than Si



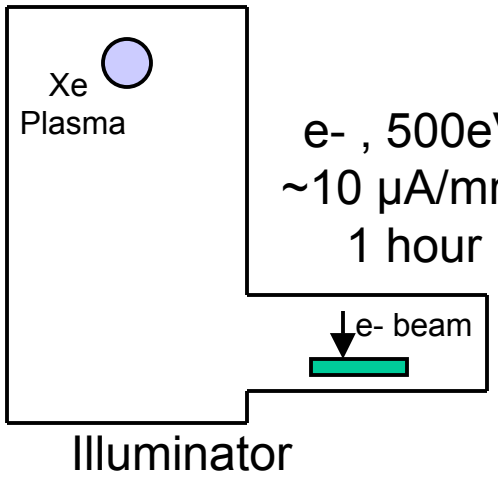
When >1 bilayer removed, MoC found on Mo/Si witness surface



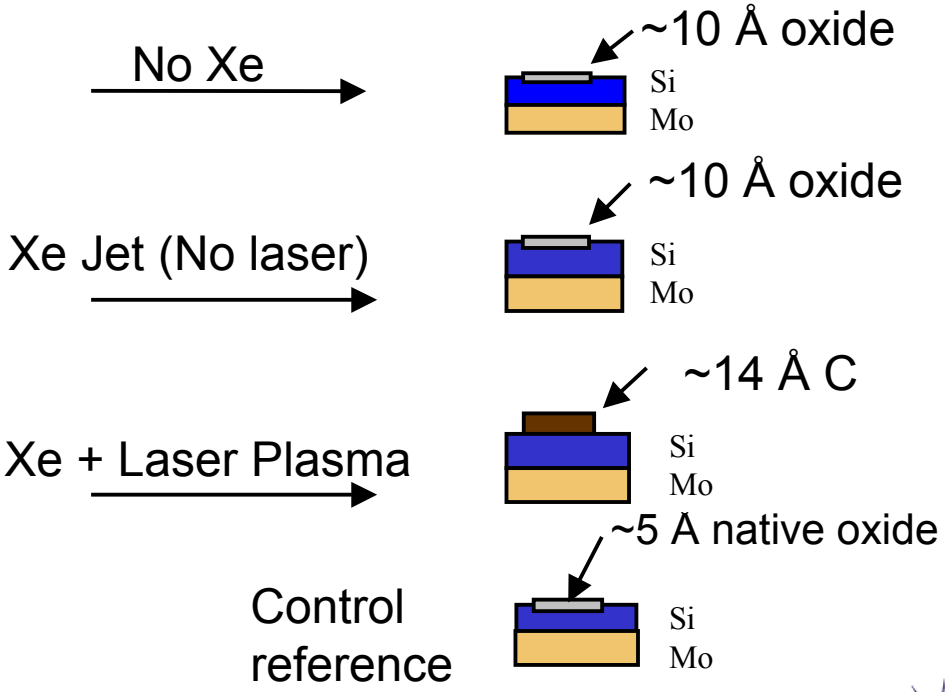
- Multilayer has more Si than Mo
- Xe/Mo sputters faster than Xe/Si

∴ For pure sputter process, Mo on top statistically unlikely

Plasma changes Illuminator environment from oxidative to carbon forming

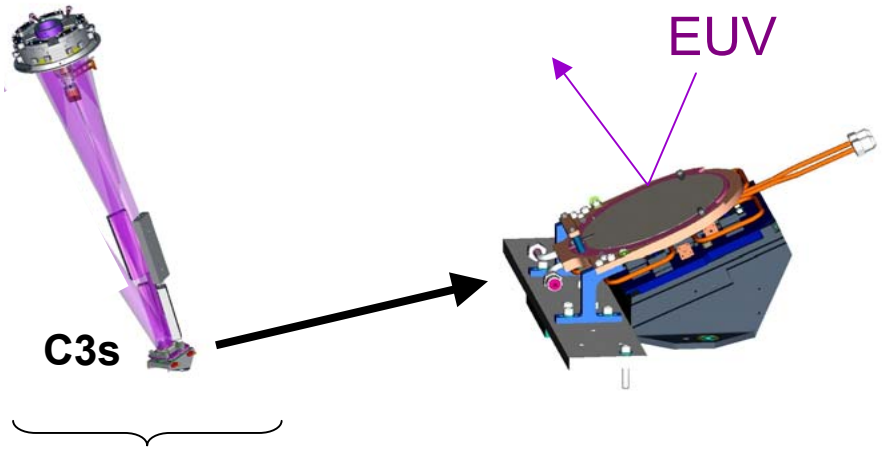


E-beam exposures show running of plasma converts environment from oxidative to C forming



E-beam station on Illuminator allows e-stimulation of Mo/Si sample out of plasma line-of-sight.

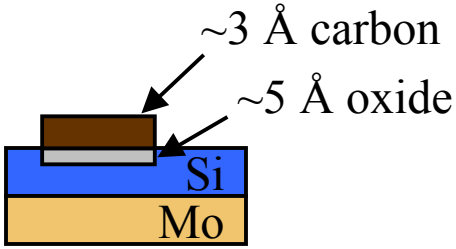
C3 witness confirms carbon forming result with EUV

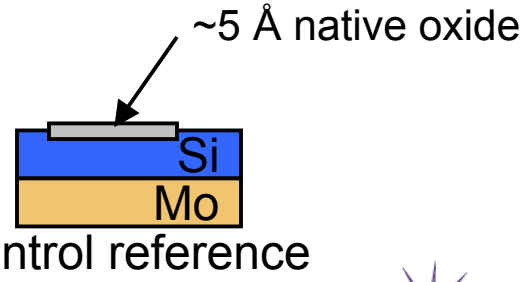


Witness hardware installed at C3

10 million LPP Shots

Witness at C3

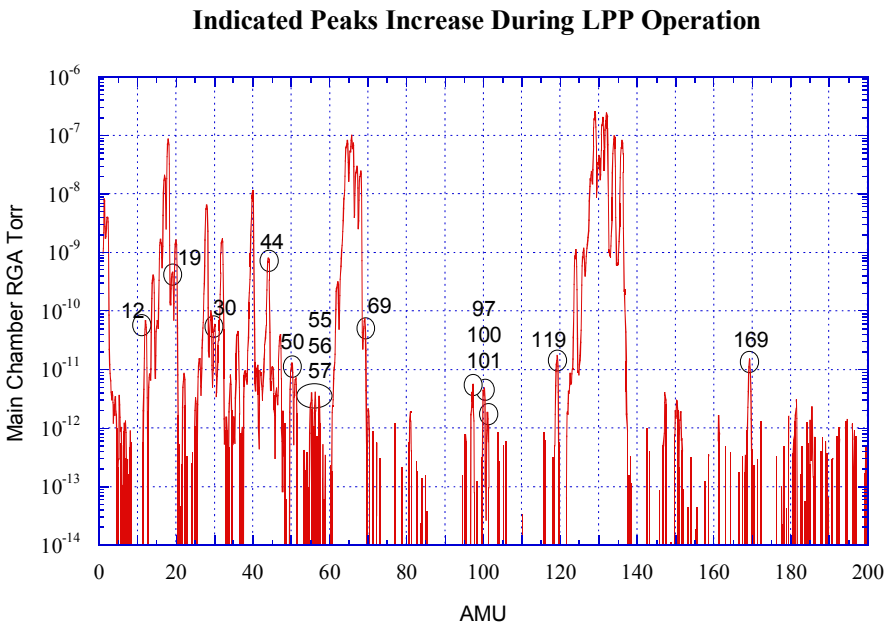


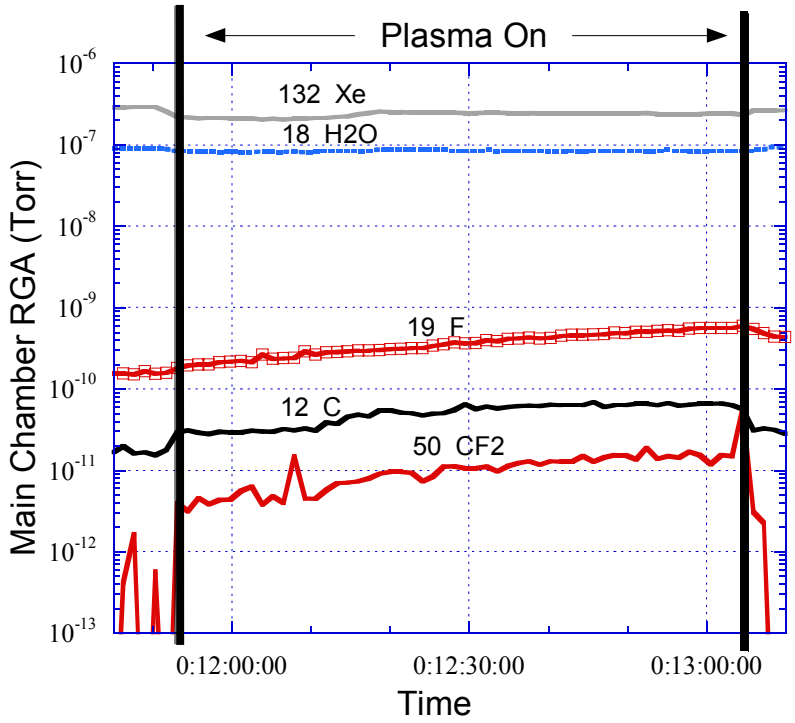


Mo/Si witness at C3 confirms C forming result with EUV

Volatile FCs formed by Plasma

RGA gas analysis indicates volatile FCs formed synchronous with plasma





Plasma-hardware interaction an important environmental issue for Illuminator systems