NSTX

# Assessment of helium conditioning on confinement

Charles Skinner et al.,

Boundary Physics Session

NSTX Research Forum September 2002

- Extend OP-XP-13 (July 2000) to NBI discharges
- Conditioning surface physics
- Discussion on link to performance

**NSTX EXPERIMENTAL PROPOSAL**

**TITLE:** Assessment of Helium Discharge Conditioning & Ohmic Confinement **NUMBER:** Rev 1

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### 1.0 Overview of the Planned Experiments

On TFTR, high-powered helium ohmic discharges were often used both to improve wall conditioning and as fiducials to assess wall conditioning. Because helium has a very high recycling coefficient, the density rise for a helium prefill discharge with no high current gas puff was a good indicator of the wall conditioning and was the most rapid means of reconditioning the walls, i.e. removing excess deuterium. Historically, newly commissioned toroidal devices used helium discharges as a means of accessing high density ohmic discharges (e.g. T-3, PLT, TFTR). Here we wish to develop and use high current helium discharges as a means of improving NSTX wall conditions, accessing high density, and studying ohmic confinement.

We propose to execute helium discharges at 2 different plasma currents and assess performance relative to deuterium discharges, both prior reference discharges and ones taken directly after the helium discharges.

An overview of execution is given below:

a) HeGDC for a few hours before the experiment.
b) Helium prefill only discharges if possible; symmetric, inner-wall limited configuration
c) Helium density scan at $I_p$ ~ 400 kA at different densities.
d) Helium density scan at $I_p$ ~ 700 kA at different densities.
e) Deuterium comparison shots at both values $I_p$ and mid-range density value

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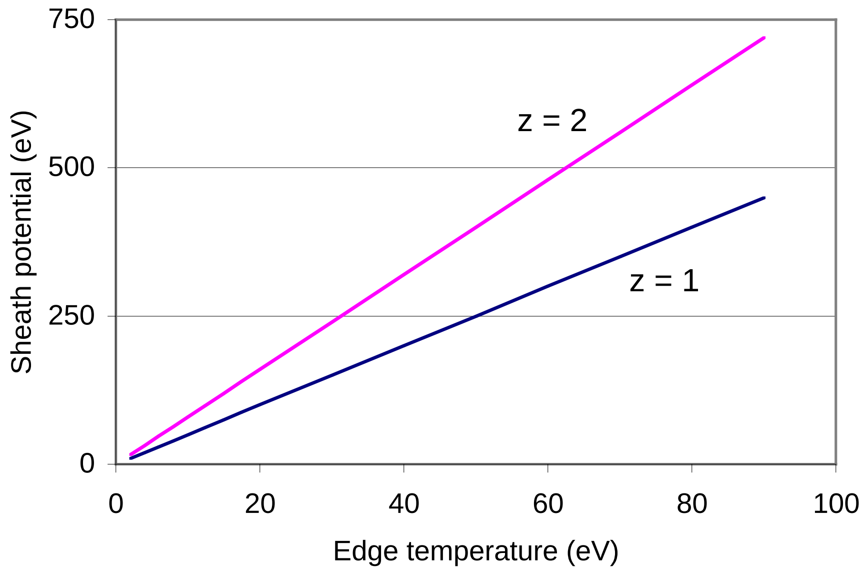
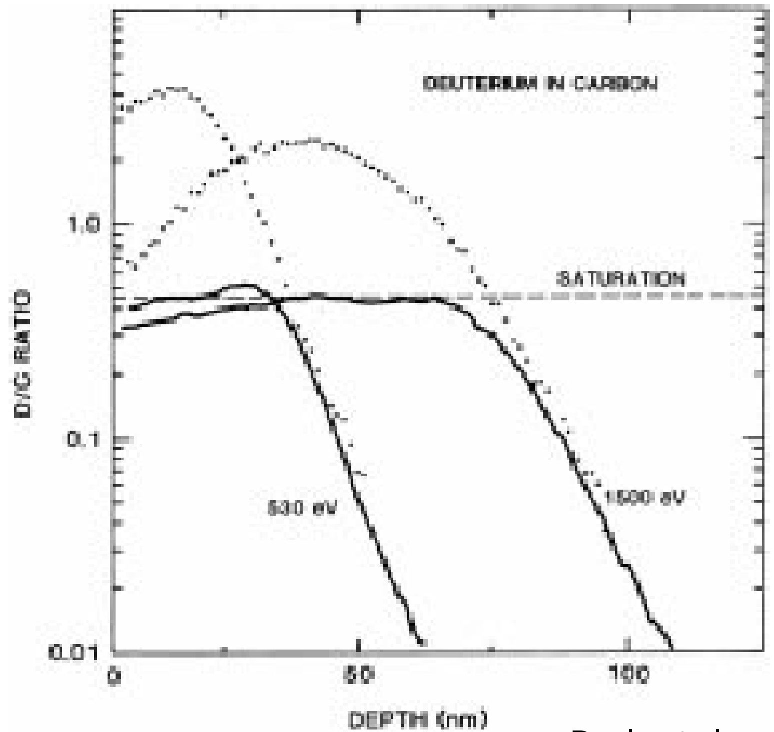
*Extend OP-XP-13 to:*

- *Well boronized, low Zeff machine*
- *Density scan with He fuelled LSN D-NBI discharges*
- *Consider sweeping strikepoint*
- *Correlate conditioning with performance as much as possible*
- *Take advantage of full diagnostic suite to characterize changes with conditioning - edge density, edge density gradients, edge pressure, fueling efficiency, plasma rotation, H-alpha/CII emission ....*
- *Look for 'control knobs' on confinement time.*
- *Include VB calibration*
  - *OP-XMP-11 " NSTX calibration density scan".*
- *Discussion:*

# *High performance shots access depths into wall untouched by He glow GDC.*

## *Interaction Depth:*




Doyle et al.,

Figure 33. Depth profiles measured by secondary ion mass spectroscopy (SIMS) of deuterium implanted at 530 and 1500 eV into carbon at room temperature at fluences of $10^{22}$ D·m$^{-2}$ (solid lines) and $10^{20}$ D·m$^{-2}$ (dotted curves). For comparison, the low dose curves are scaled up by a factor of 100. (Reproduced with permission from Ref. [449].)

Plasma ions approaching the material surfaces are accelerated by the sheath potential to an energy of

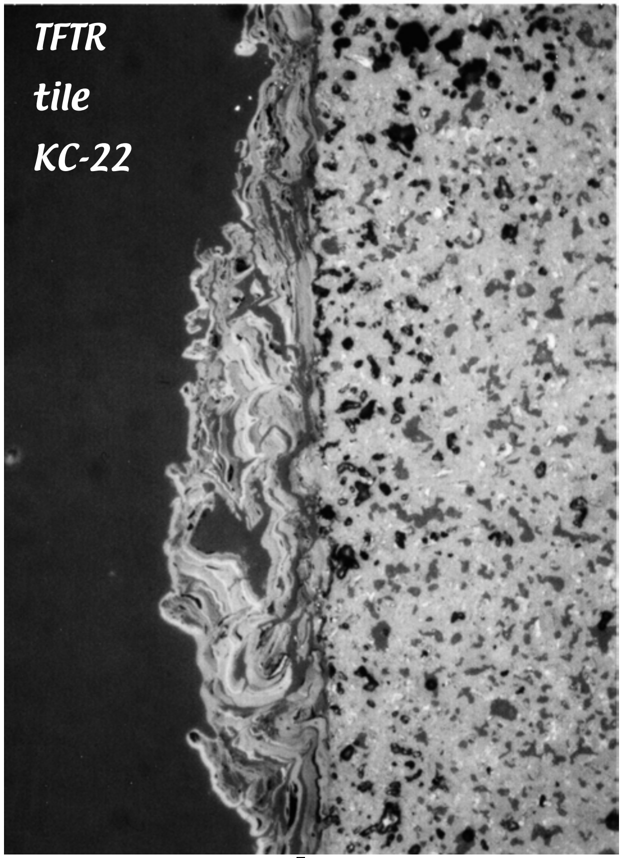
$$E \approx 2T + 3ZT,$$

where $T$ is the plasma temperature adjacent to the material and $Z$ is the ion charge.

***He++ impacts at higher energy than D+***
***Consider adding neon also***

# Complex non-linearly coupled plasma - wall system.

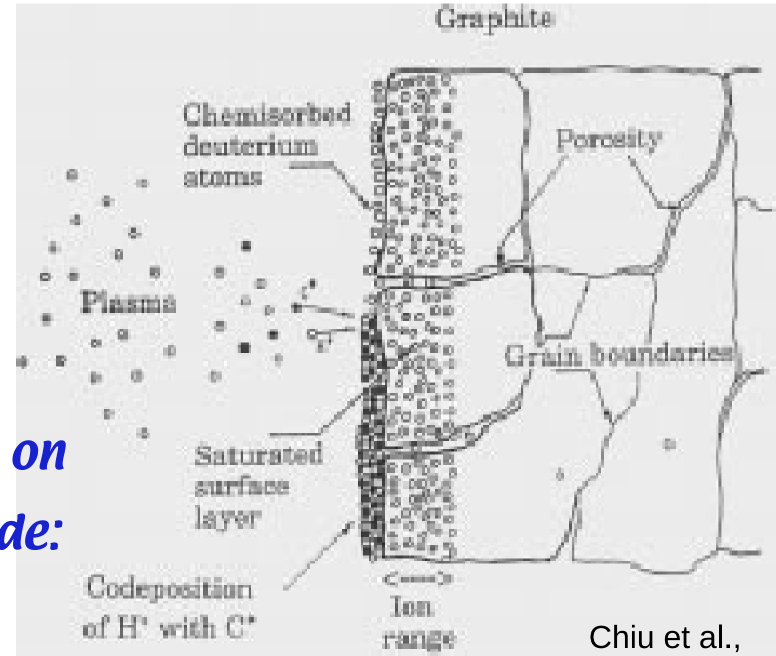
## Microscopic-scale perspective




200 µm

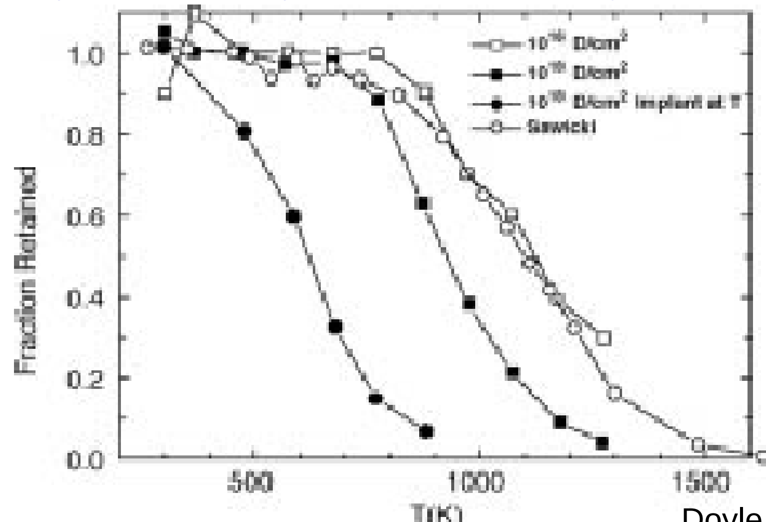
*codeposit* | *original tile*

*processes on wall include:*




Chiu et al.,

*desorption complicates density control*




Doyle et al.,

*convoluted, highly porous structure*
*codeposit poorly thermally connected*

**Discussion:**

- *Results Review/Forum had many plots presented of performance vs. plasma parameters but…*
- *- no plots of performance vs. wall conditioning*
- *Can we develop a metric of wall conditions ?*
- *What is best correlator to high performance*
  *(e.g. Ha/CII on TFTR)*

- *Wall geometry is very different on MAST. Is this significant ?*

- *Input from ISD group ?*

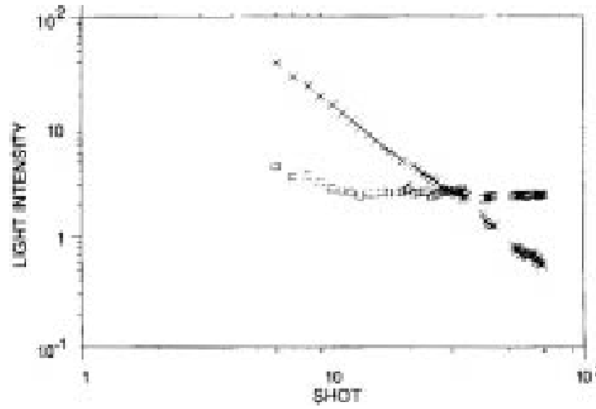



**Figure 56.** Deuterium (×) and carbon (□) influx in helium discharge cleaning pulses following a 1 MA ohmic disruption in TFTR. (Reproduced with permission from Ref. [109].)

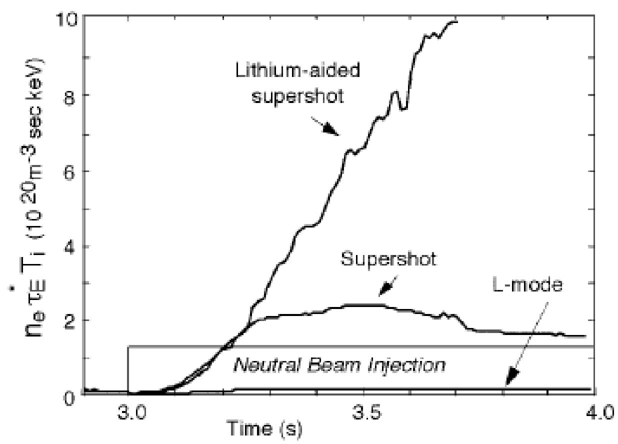



**Figure 2.** Showing the dramatic 64 × increase in the fusion triple product $n_e \tau_E T_i$ in TFTR with wall conditioning.