1. Density Control through plasma termination control.

C. H. Skinner, D. Mueller, R. Maingi

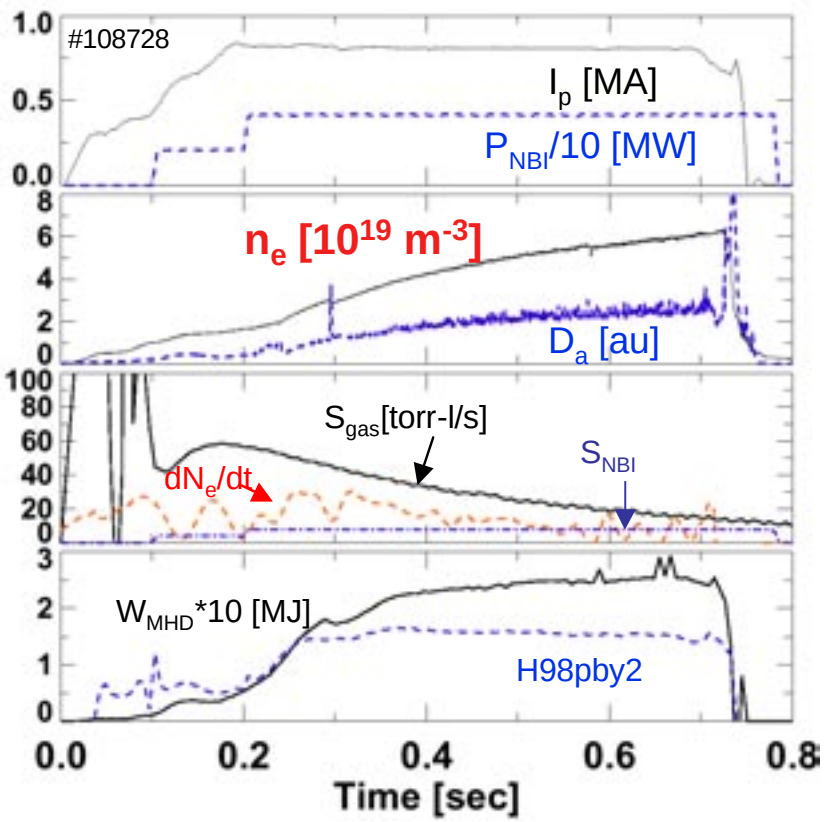
Boundary Physics session

NSTX Research Forum Nov 10-12, 2003

Motivation:

The IPPA 5 year goal for end FY 2005 includes:
"Determine the ability for managing intense energy and particle fluxes in the edge geometry and for increasing pulse durations..."

Uncontrolled (non-disruptive) density rise in long pulse H-modes



From Maingi 'BP_NSTX_5yrpln_061703.ppt'

Initial work done in FY2003 XP304:

Goal 1: Assess role of divertor temperature in density rise and impurity generation by strike point jog.
Result: roll over in density observed after jog, but motion away from CS caused major part.

Goal 2: Reduce density rise by depleting D in divertor with He conditioning with NBI
Result: Modest change - after 17 discharges D-alpha decreased by 40% cf x10 TFTR.

Potential factors :

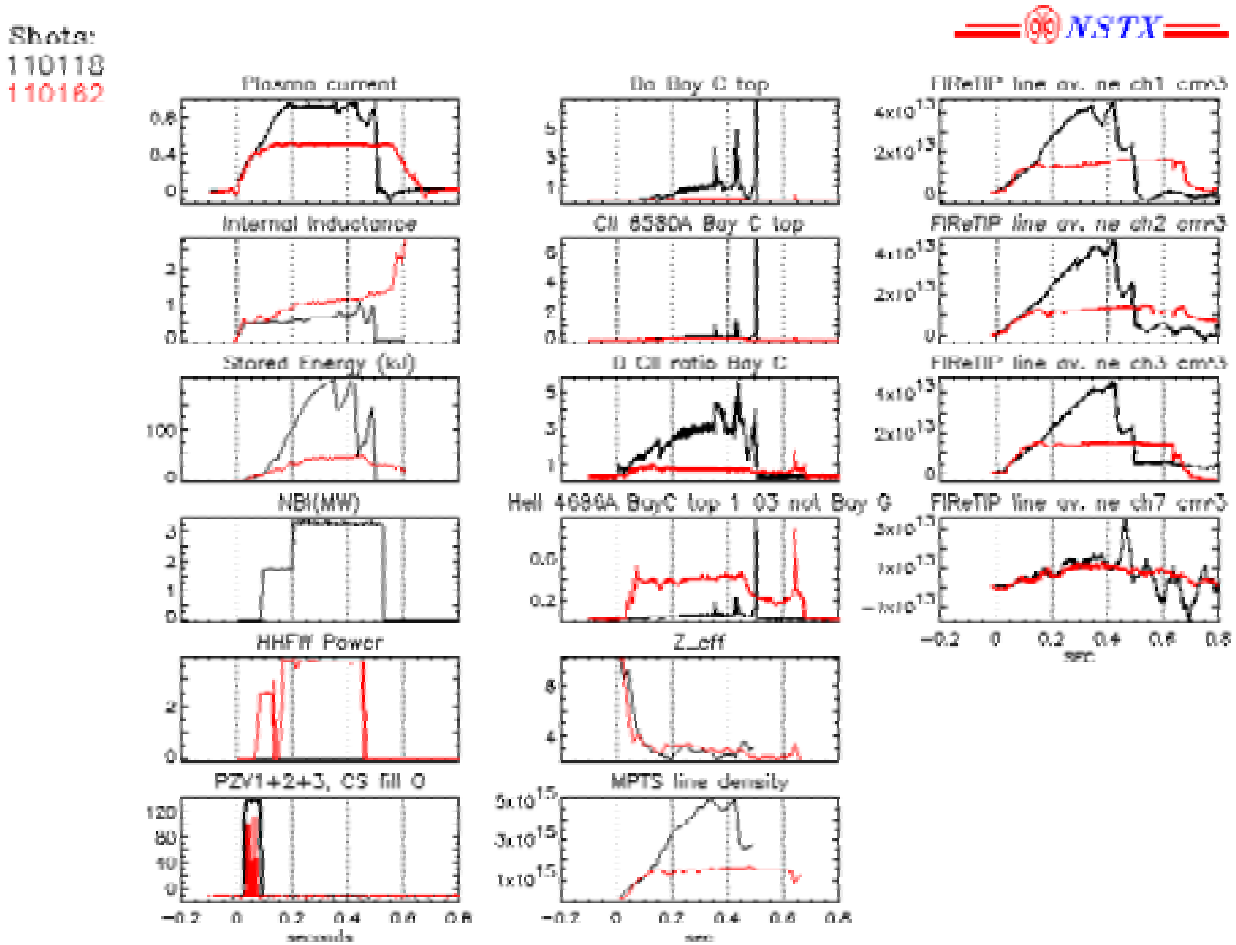
- Heat flux profiles on divertor not matched
- Inefficient gas fueling during discharge (unlike TFTR)
- H-mode physics (SOL transparency, transport barrier)
- Tail end disruptions.

RF helium discharges did better

RF current drive XP on next day (Feb 11th 2003) showed dramatic reduction in density.

- Much better job of degassing tiles than NBI heated He discharges.
- Every He conditioning discharge ended with a disruption whereas Dennis took care that RF discharges did not.
- This may be key step to controlling H-mode density rise.

Comparison of 110118 (toward end of He conditioning XP304 11 Feb 2003) and
110162 (toward end of HHFW CD XP 312 12 Feb 2003)



Propose to explore effect of plasma termination on density rise in dedicated XP in upcoming run.

Draft Conceptual Proposal for XP:

- Establish long pulse H-mode fiducial
- Run RF heated He discharges of XP 312 Feb 12th 2003 to deplete limiter
- Repeat attempts at long H-modes - check for reduced density rise.
- Identify density rise dependence on:
  - plasma termination
  - RF power
  - He gas feed
  - .....

2.Deposition measurements in NSTX

C. H. Skinner, H. Kugel and the NSTX team

Boundary Physics session

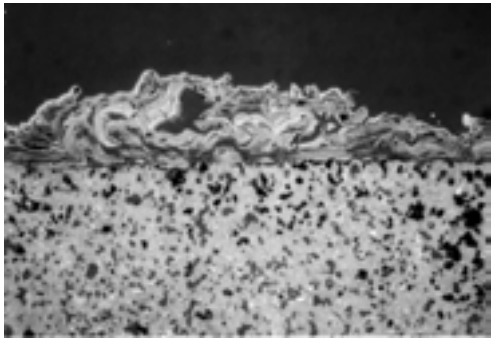
NSTX Research Forum Nov 10-12, 2003

Motivation:

- *Condition of plasma facing surfaces is key factor in plasma performance, but generally remains hidden and undiagnosed.*
- *Deposition affects recycling, covers up boronized layer*
- *Deposition coats diagnostic windows & mirrors*
- *Deposition is cause of tritium retention*

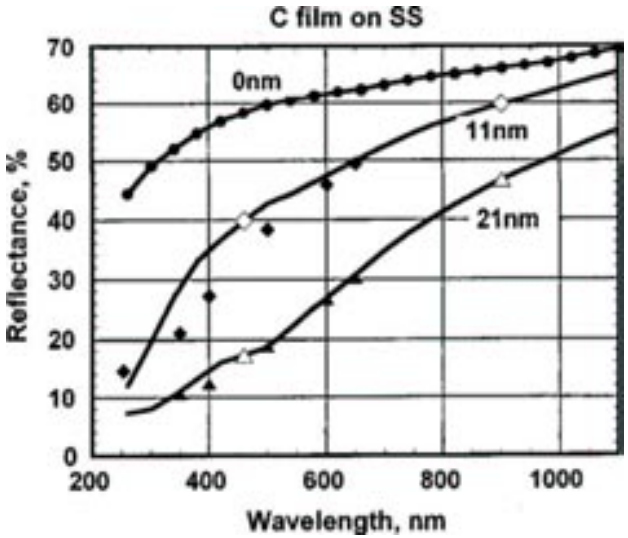
Real-time deposition measurements are crucial to obtain understanding and control of deposition.

Deposition on TFTR graphite tile



S Willms and W Reisiwig LANL

Deposition on mirrors



Experimentally measured solid points and calculated lines with corresponding open markers spectral dependencies of effective reflectance for clean SS and for SS with carbon coating of thickness shown on each curve.
Voitsenya et al., Rev. Sci. Instrum. 72 (2001) 480.

NSTX Deposition Monitor at Bay K

- *Principle: quartz crystal oscillates at ~ 6 MHz, exact frequency depends on mass and on temperature - not affected by EMI .*
- *Deposition inferred from change in frequency (measured to ~1Å, ~1Hz)*
- *Detector is located in 4" tube outside main plasma chamber ~ 77 cm from last closed flux surface*
- *Detector configuration mimics typical diagnostic windows and mirrors,*
  - samples neutrals deposited on NSTX wall away from plasma.
- *Gate valve permits sample retrieval for surface analysis without machine vent*
- *Data obtained January/February '03*

detector inside

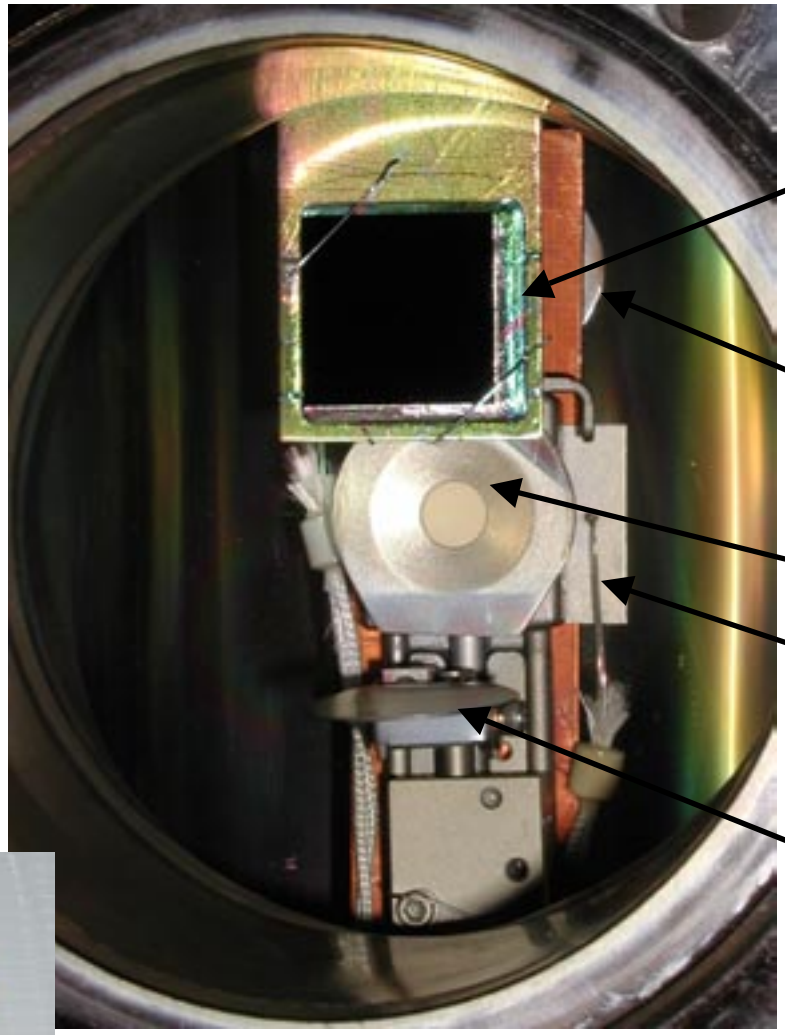
oscillator

crystal @ R= 231 cm
~ 77 cm from last closed flux surface 33 cm below midplane

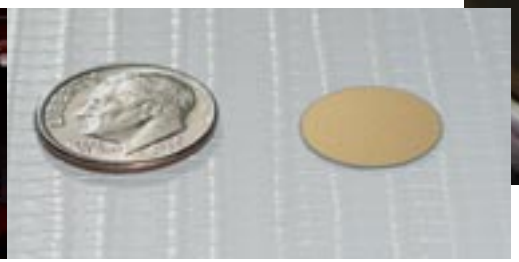
Quartz crystal microbalance

Infincon XTM/2 with bakable crystal
Specification:

- *Detector resolution ≈1 Å (≈ one monolayer).*
- *Accuracy 0.5%*
- *Bakeable to 450°C - water cooled during deposition monitoring.*
- *Built in shutter on plasma facing detector.*
- *Thermocouples on both detectors record temperature.*



Realtime readout

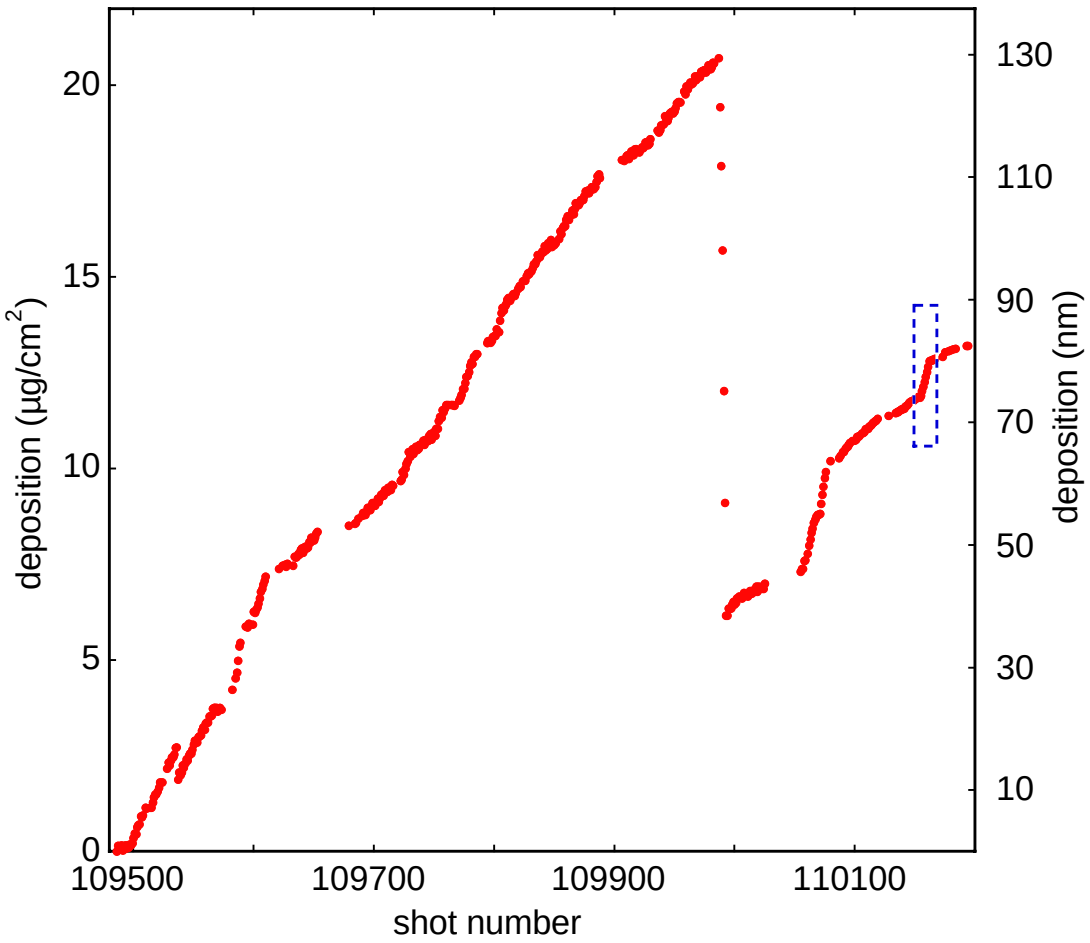


Gold coated quartz crystal

Time resolved deposition

Summary of data presented at DPP-APS meeting:

- NSTX shows net deposition on wall, heaviest at midplane and near gas injectors
- 29 µg/cm^2 deposition accumulated over 4 weeks and 497 discharges with 16 µg/cm^2 material loss over 7 discharges.
- Deposited layers are mostly carbon with some oxygen and deuterium.
- Deposition recorded on surface facing away from plasma from low sticking probability radicals at 10% rate of plasma facing surface.
- Mass of deposited layer independently confirmed by ion beam analysis.
- No detailed correlation of higher deposition discharges or material loss with diagnosed plasma parameters.
- Surprising indications that about only half of deposition occurs promptly after discharges.

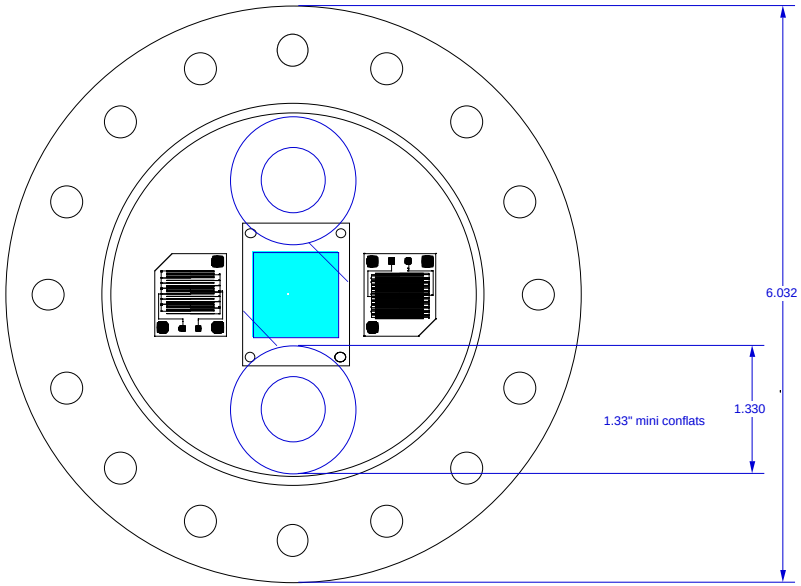


Deposition over period
January 10th - February 14th 2003

Improvements for 2004

- RS232 data acquisition improves resolution x4.
- Back and front facing time-resolved measurements.
- Add spectroscopic confirmation of timing.
- Data achived in database automatically
- Additional particulate diagnostic ->>>
- Option to move to Bay C bottom port later in campaign.

Dust Particle diagnostic at Bay C bottom



Deposition - plan for 2004

- Start with piggy back expts at Bay K
- Measure front & back deposition in real time.
- see deposition changes with
  - disruption,
  - attached/detached divertor,
  - He/D gas feed,
  - He glow discharge
  - Correlate with fast RGA, gas pressure
  - Correlate with particulate detection
  - Write dedicated XP to confirm correlations.

- Repeat at Bay C bottom later in campaign

- Compare results to John Hogan BBQ model

- Present at PSI 2004 conference.