# Deposition measurements in NSTX

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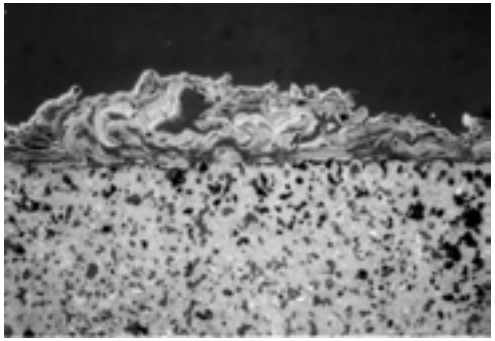
NSTX Research Forum Nov 10-12, 2003

## 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

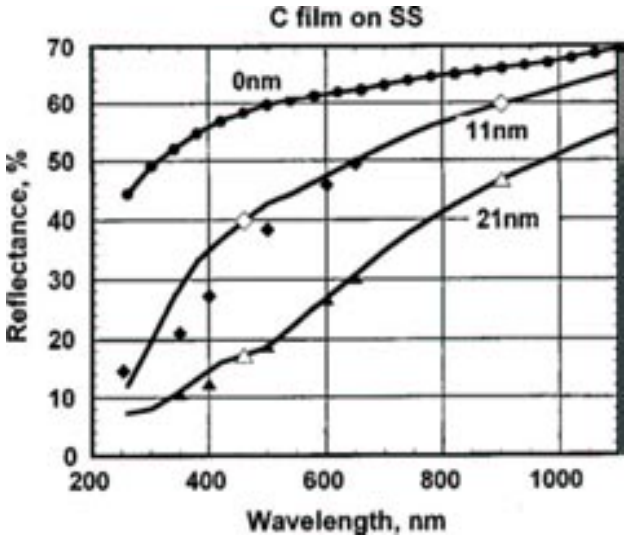
Real-time deposition measurements are crucial to obtain understanding and control of deposition.

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

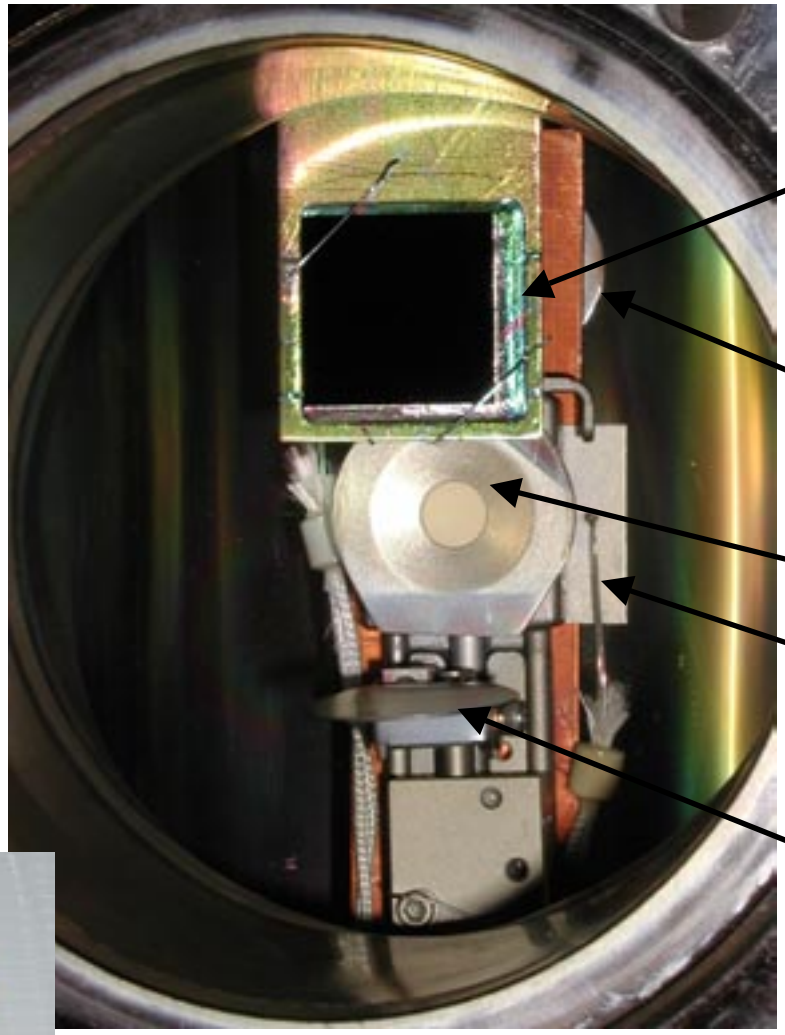
oscillator

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

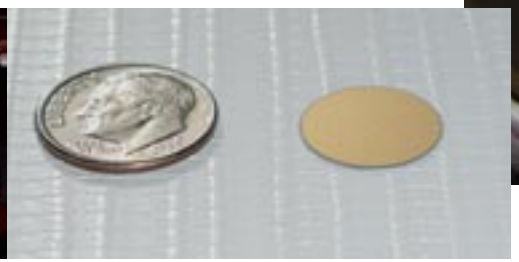
# Quartz crystal microbalance

*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

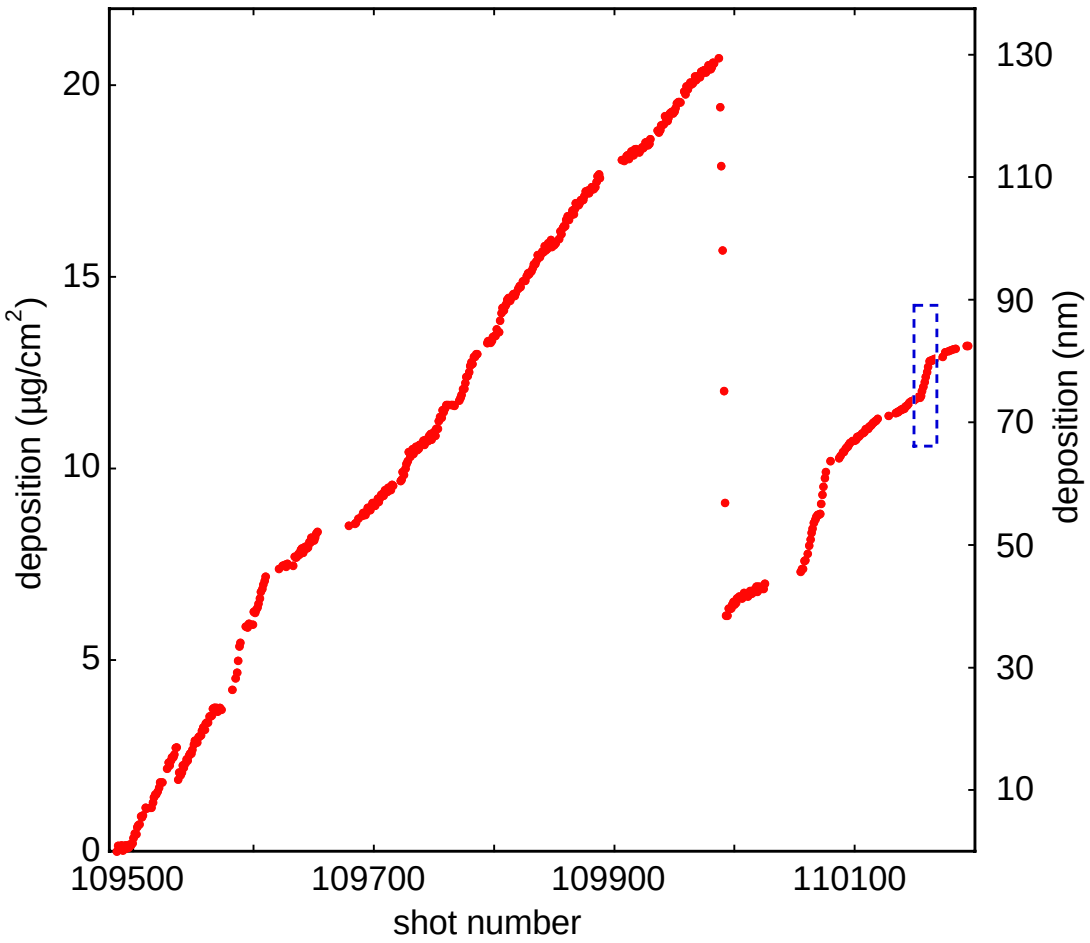


Gold coated quartz crystal

# Time resolved deposition

Conclusions from data
January 10th - February 14th 2003

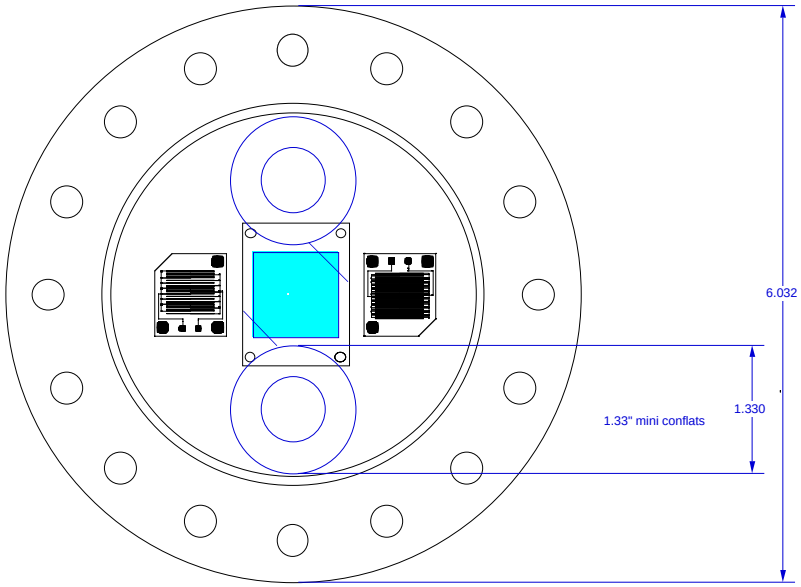
- NSTX shows net deposition on wall, heaviest at midplane and near gas injectors
- 29 µg/cm$^2$ deposition accumulated over 4 weeks and 497 discharges with 16 µg/cm$^2$ material loss over 7 discharges.
- Deposited layers are mostly carbon with some oxygen and deuterium.
- Deposition recorded on surface 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.
- 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.



# Proposed plan for 2004

- Start with piggy back expts at Bay K
- Write dedicated XP
- 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

- Repeat at Bay C bottom later in campaign

- Compare results to John Hogan BBQ model
- Present at PSI 2004 conference.