# NIST EUV metrology programs

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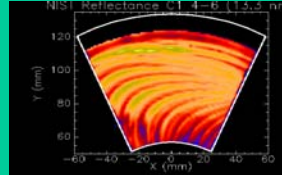
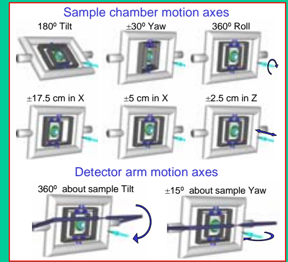
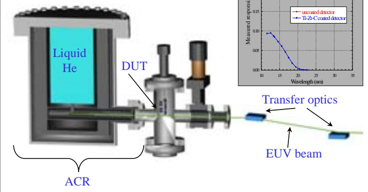
## NIST/DARPA EUV Reflectometry Facility

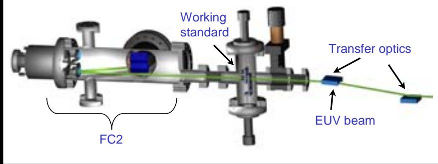
The NIST/DARPA EUV Reflectometry Facility is a multi-axis reflectometer (see right) capable of precisely positioning optics up to 35 cm in diameter and 40 kg in mass. Shown below are a visible-light photo and 2D EUV reflectivity map of a damaged sector of the ETS C1, or first condenser, optic.



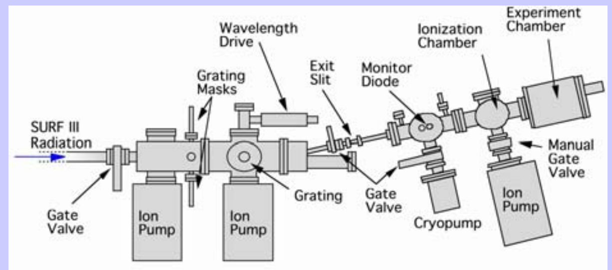



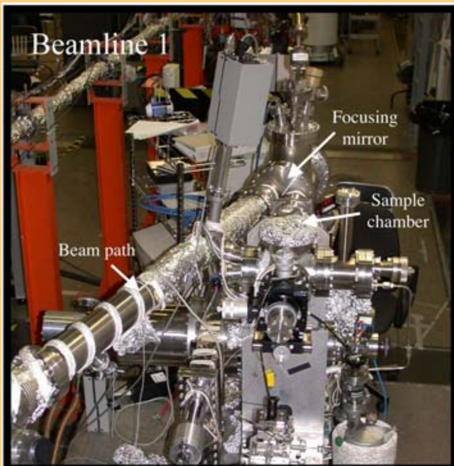




Recently the NIST/DARPA facility has been upgraded to allow the calibration of assembled radiometric instruments. Shown to the left is the scheme for calibrating transfer standard EUV detectors using direct comparison to an absolute cryogenic radiometer (ACR). To the right is the scheme for calibrating a Flying Circus using an ACR-calibrated transfer standard detector.



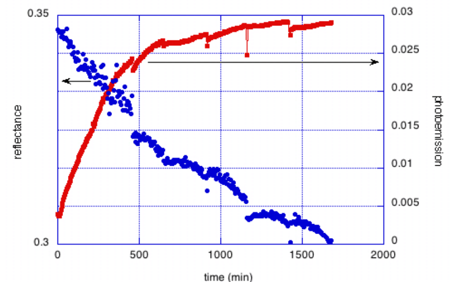

The EUV Detector Calibration Facility is capable of calibrating detectors using a variety of techniques. A rare-gas ionization chamber serves as an absolute reference. Under normal circumstances a transfer-standard detector is used, such as those calibrated using the ACR. The facility is also used to calibrate filter transmittances and occasionally assembled instruments such as the Solar EUV Monitor.




The long-term multilayer exposure facility is used to expose multilayers to EUV radiation in the presence of potentially damaging chemical species such as water vapor. The average EUV flux is 5 mW/mm$^2$, and water vapor levels can be controlled between $10^{-9}$ Torr and $10^{-5}$ Torr. Additional reactive gases such as hydrocarbons may also be introduced.

Shown to the right is the reflectivity and normalized secondary-electron emission from a standard multilayer mirror. The conditions for this exposure were 5 mW/mm$^2$ and $2\times10^{-6}$ Torr water vapor




### Future plans:

- Reflectometer monochromator upgrade
- Laser-produced plasma-based responsivity measurements of an assembled FC2
- New beamline to expand long-term testing capacity
- Expanded ACR-based transfer standards

### Summary:

The National Institute of Standards and Technology has expanded and improved its EUV metrology program to aid in the commercialization of EUV lithography. This includes the development of calibration facilities and facilities for studying damage to EUV optical components.