High-Speed EUV-Reflectometer with Compact Discharge EUV-Source Designed for Mask-Blank Inspection

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A reflectometer for masks and mask blanks is currently under development. This tool shall solve one essential task in mask and mask blank development in industrial laboratories supplementing beamline based metrology. Guidelines of the development was to fulfill the demands on metrology as defined in the SEMI specifications (e.g. $\Delta\lambda < 0.004$ nm; DR < 1% absolute; <0.1% repr.) and be adequate to expected demands for production-like tools for masks and mask blanks:.

- high throughput (< 10 s per spot, > 20 spots per mask with about 3 masks per hour),
- small spot sensitivity (< 0.1 mm²) and
- integration into pilot line automation.

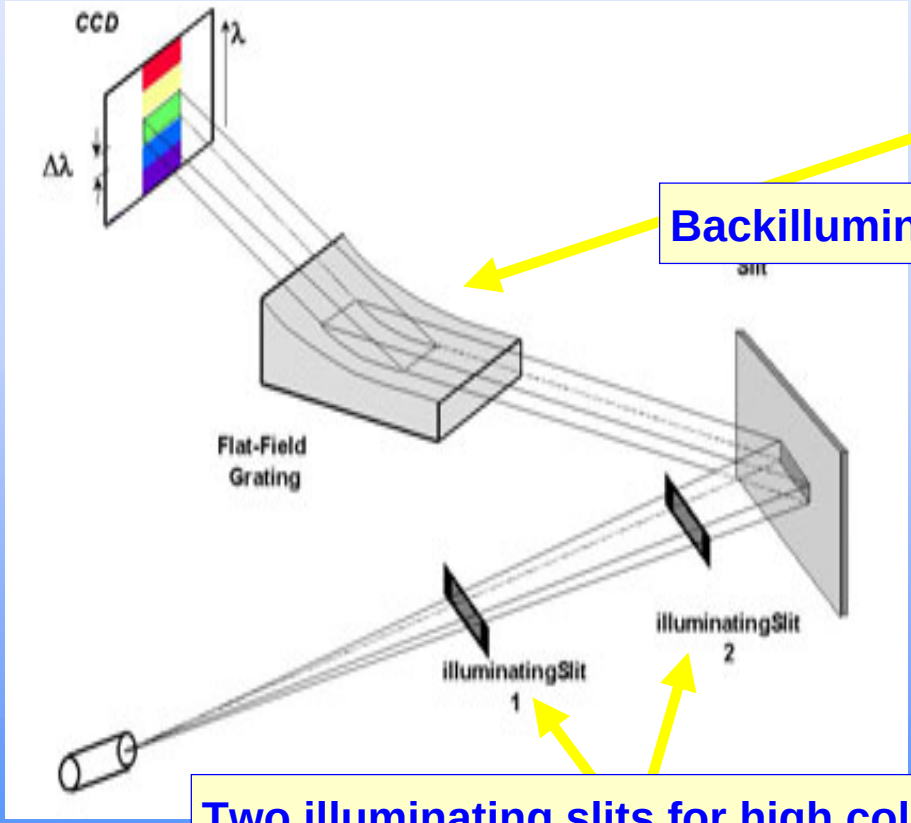
Effective use of the emission from the source is achieved by a ”polychromatic” concept, which has been shown to deliver results about a factor of 100 faster and with less overhead than with conventional monochromatic reflectometry with the same source power. The ”demonstrator” is developed for SCHOTT Lithotec by AIXUV with the support of the Fraunhofer-ILT and key suppliers. The Physikalisch-Technische Bundesanstalt’s laboratory for radiometry at BESSY II supports the traceability to storage ring metrology, the calibration and the validation of the concepts.

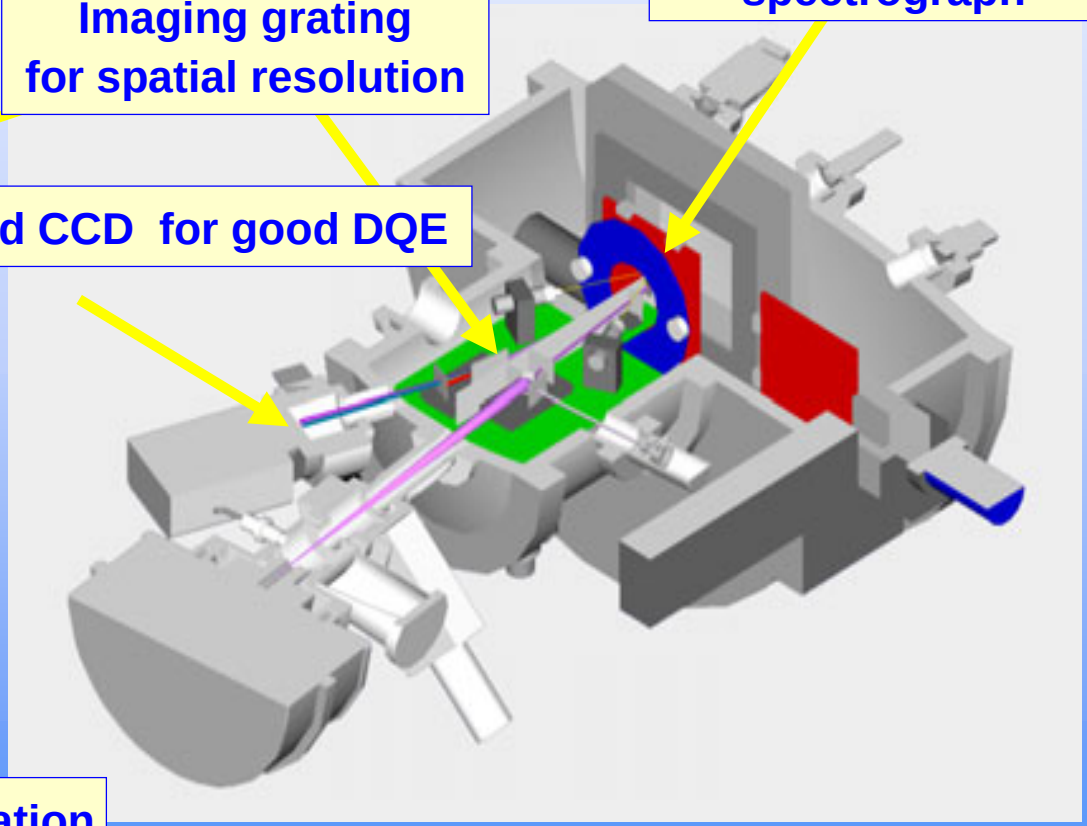
Concept of High Throughput Reflectometer

Illuminated area on sample is virtual entrance slit for spectrograph

Imaging grating for spatial resolution

Backilluminated CCD for good DQE



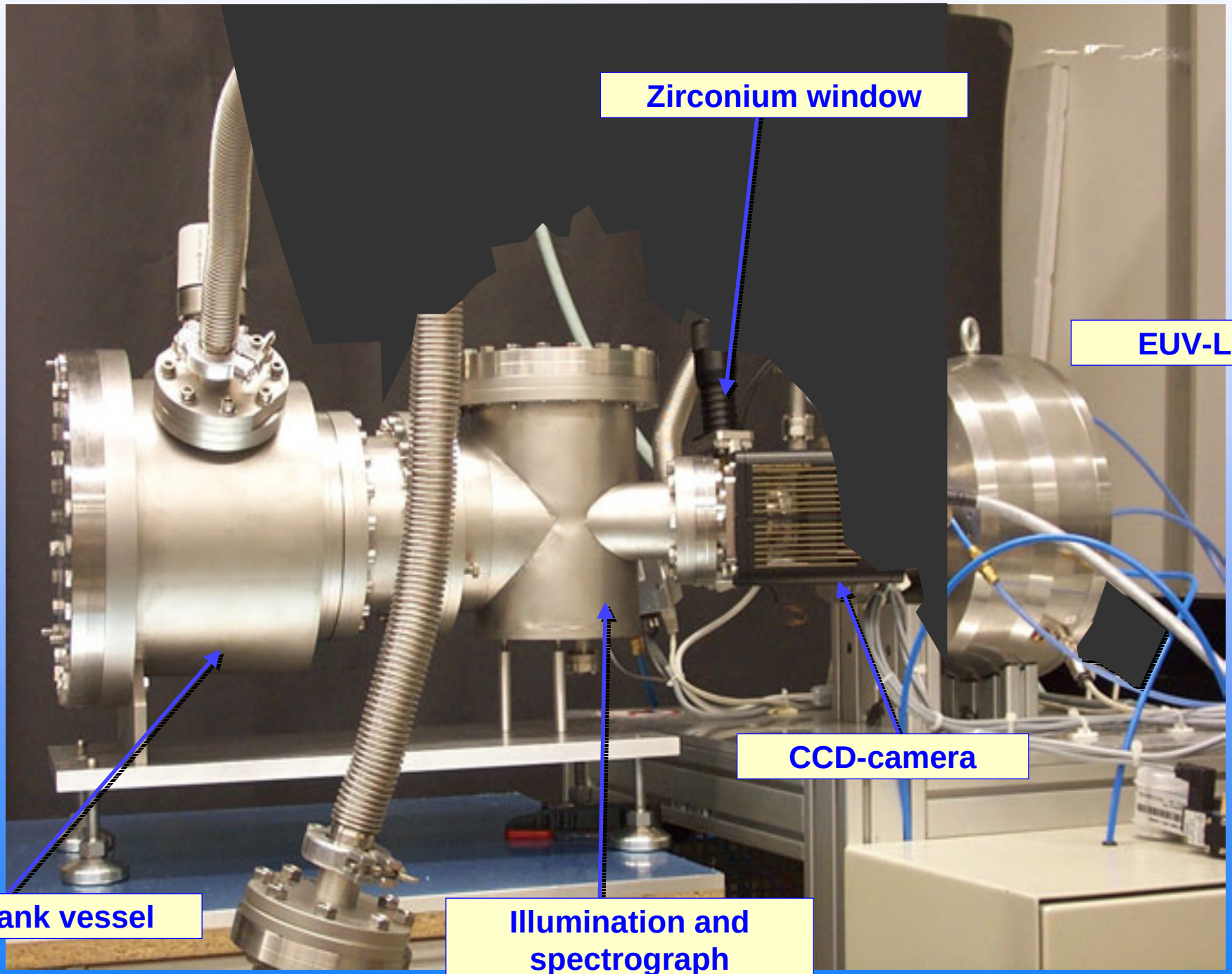


Two illuminating slits for high collimation
==> wavelength resolution

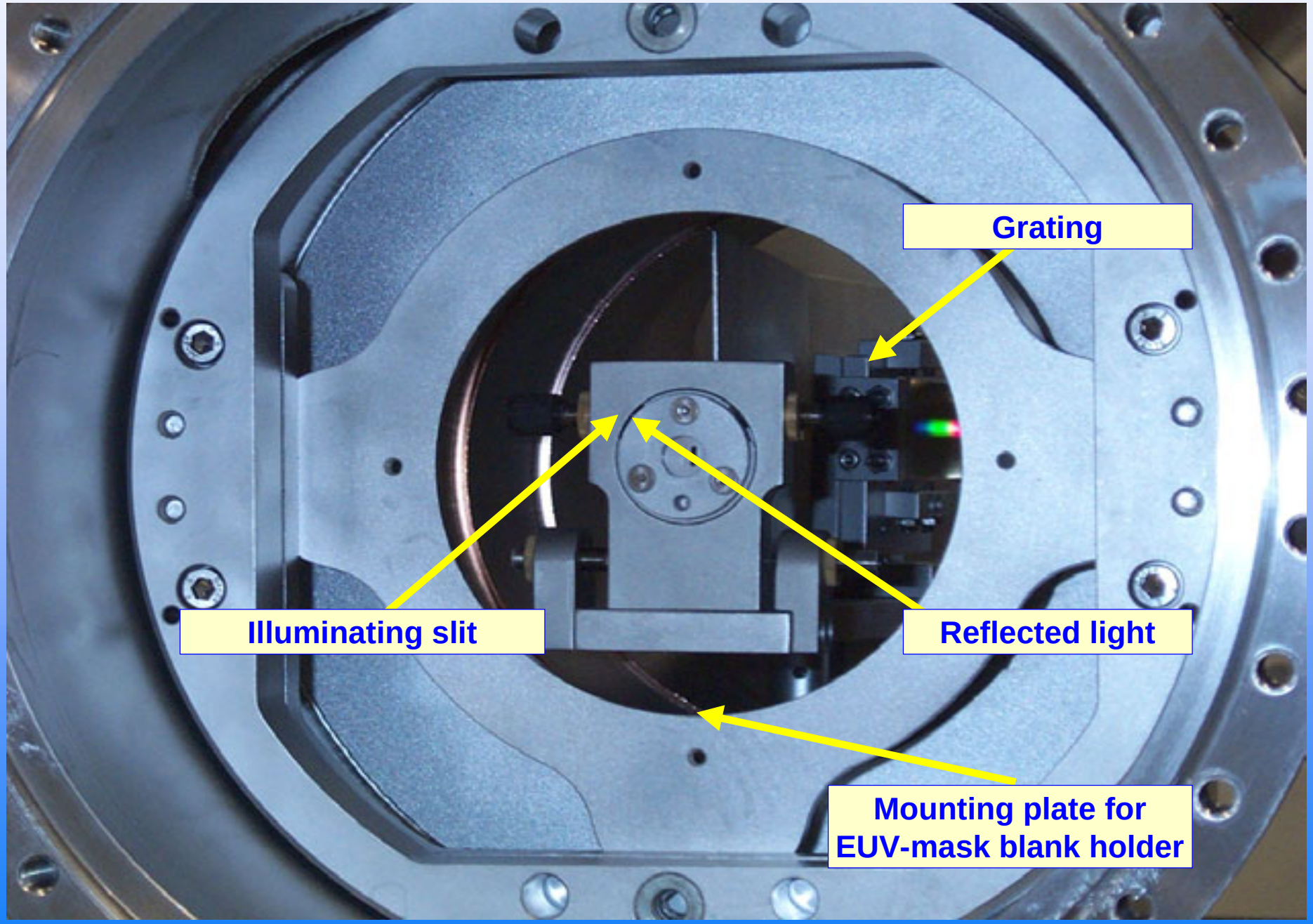
A special concept has been patented to match low power source.

Patents applied for by FhG-ILT; licensed to AIXUV GmbH

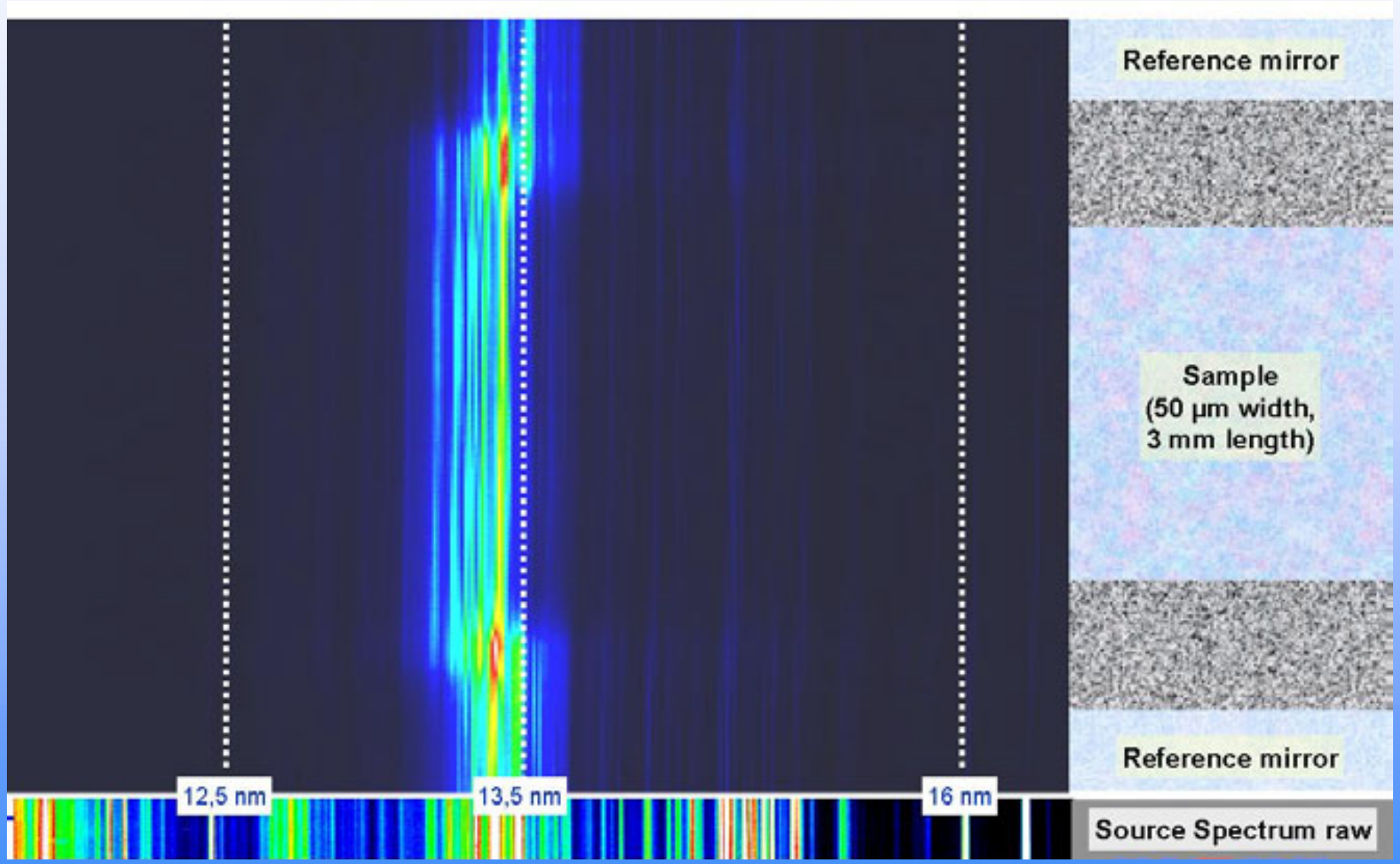
Laboratory Test Stand for Proof of Principle



Mask Blank Illumination and Reflection Detection



Results from similar Mirrors

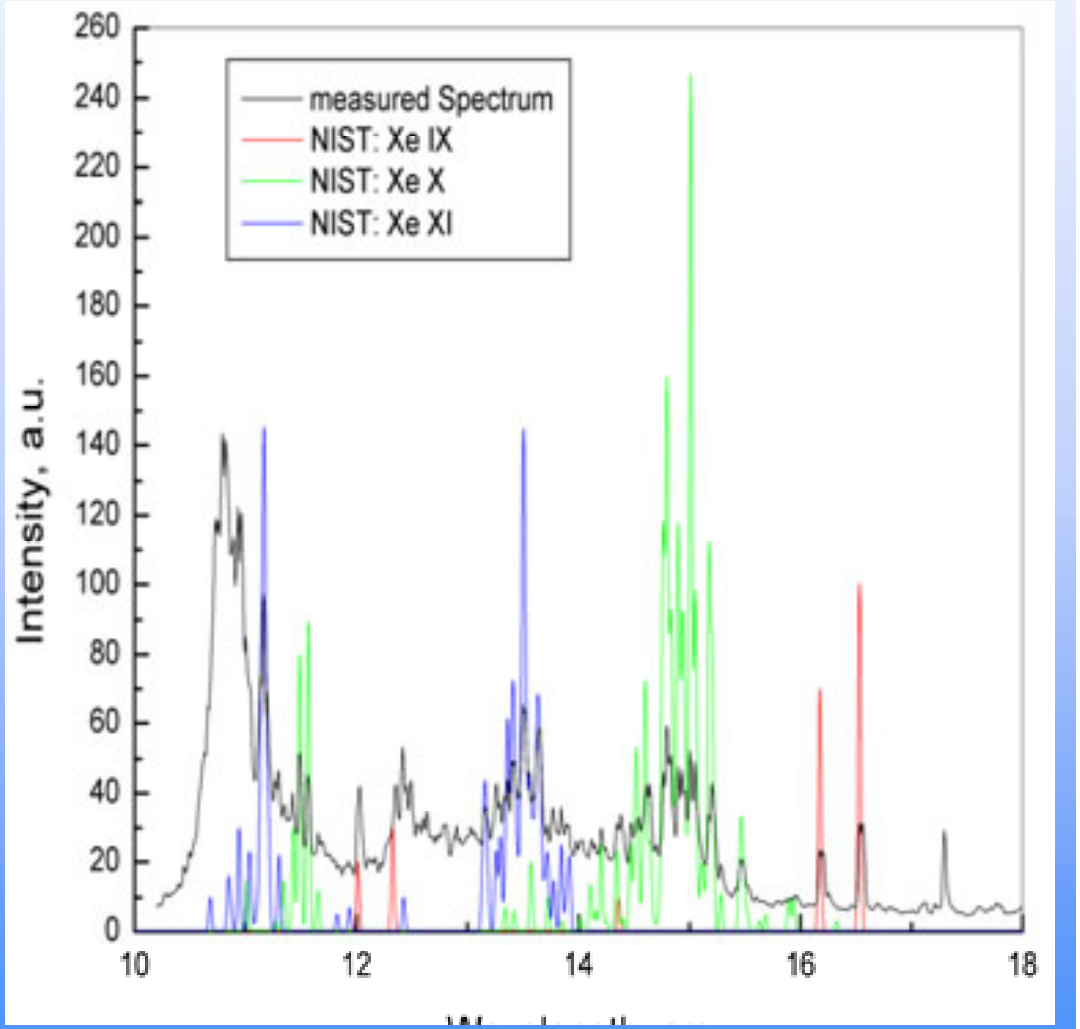


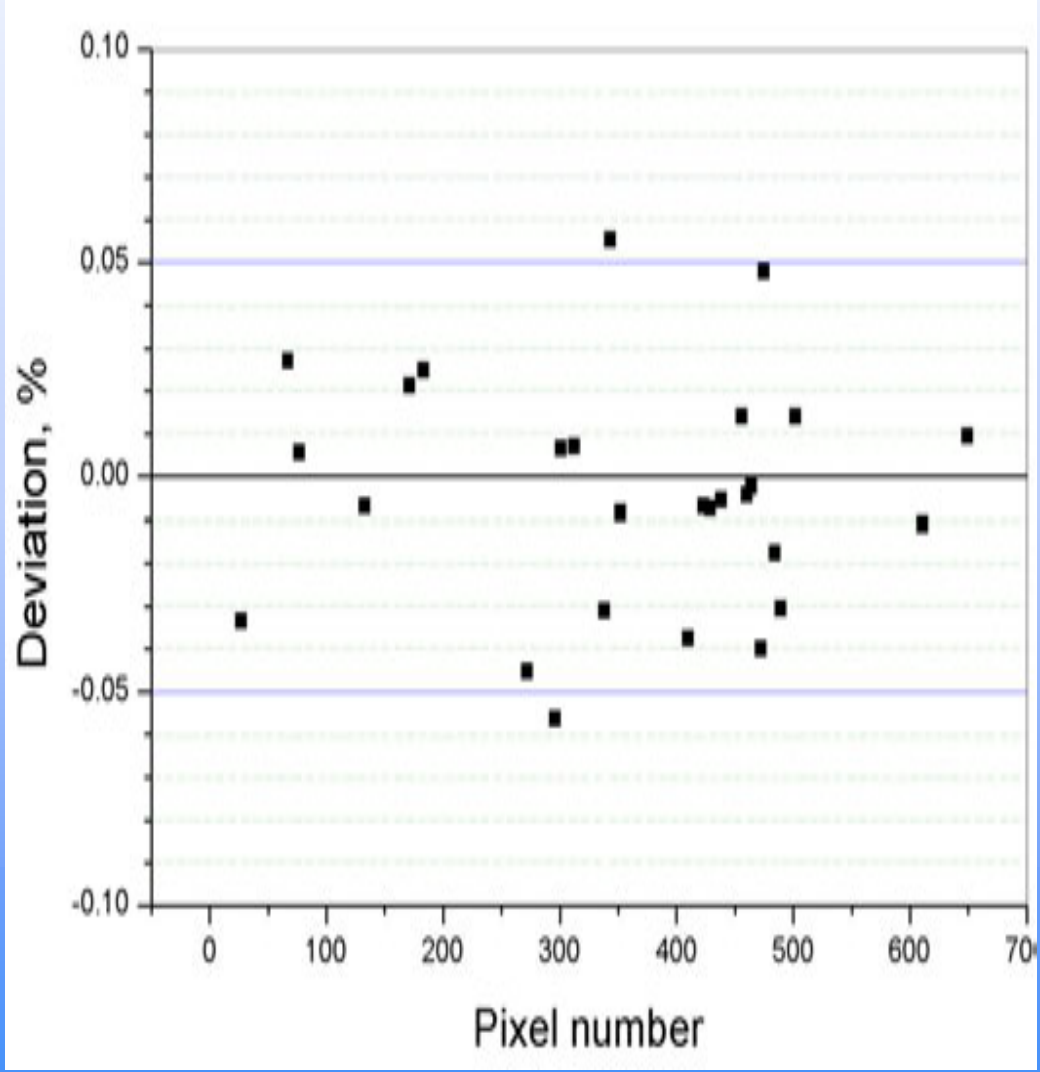
If sample and reference are of similar spectral shape reflectivity, bandwidth and central wavelength deviation are easily detected by 0., 1. and 3. order component of ratio.

Demonstrator for Mask Blank Characterization under Construction

Better resolution of spectrograph is required.	$\lambda/\Delta\lambda$ > 2000 resolution 2048×2048 CCD-chip
Precise adjustment of reference mirror close to sample.	Nulling sensors and closed-loop controlled positioning
Angle of incidence on sample to be controlled to better than 0.5’	Closed-loop tilt control
Automatic, numerical evaluation has to be developed.	Embedded and stand-alone evaluation package
Much higher spatial resolution is obtainable with less than 1 min/spot.	Checking reference mirrors for degradadion.
Broadband mirrors will be calibrated as reference.	Broadband mirrors will be calibrated as reference.

Wavelength Calibration

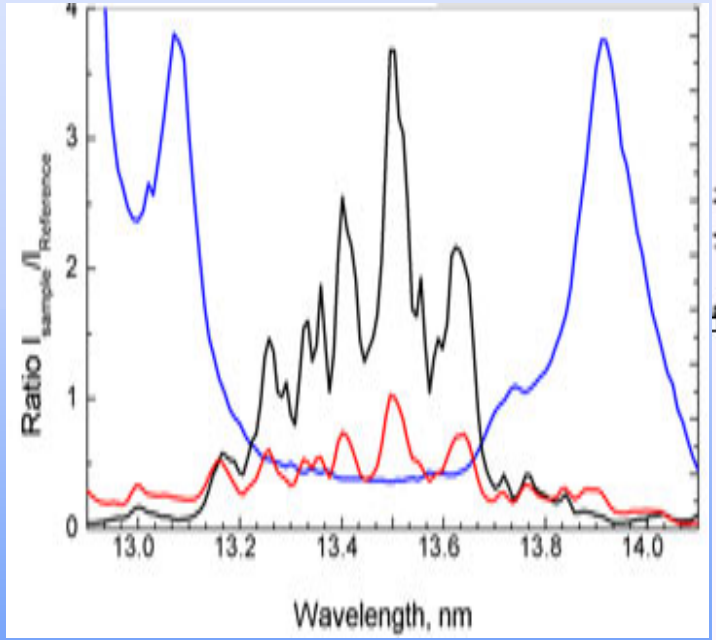


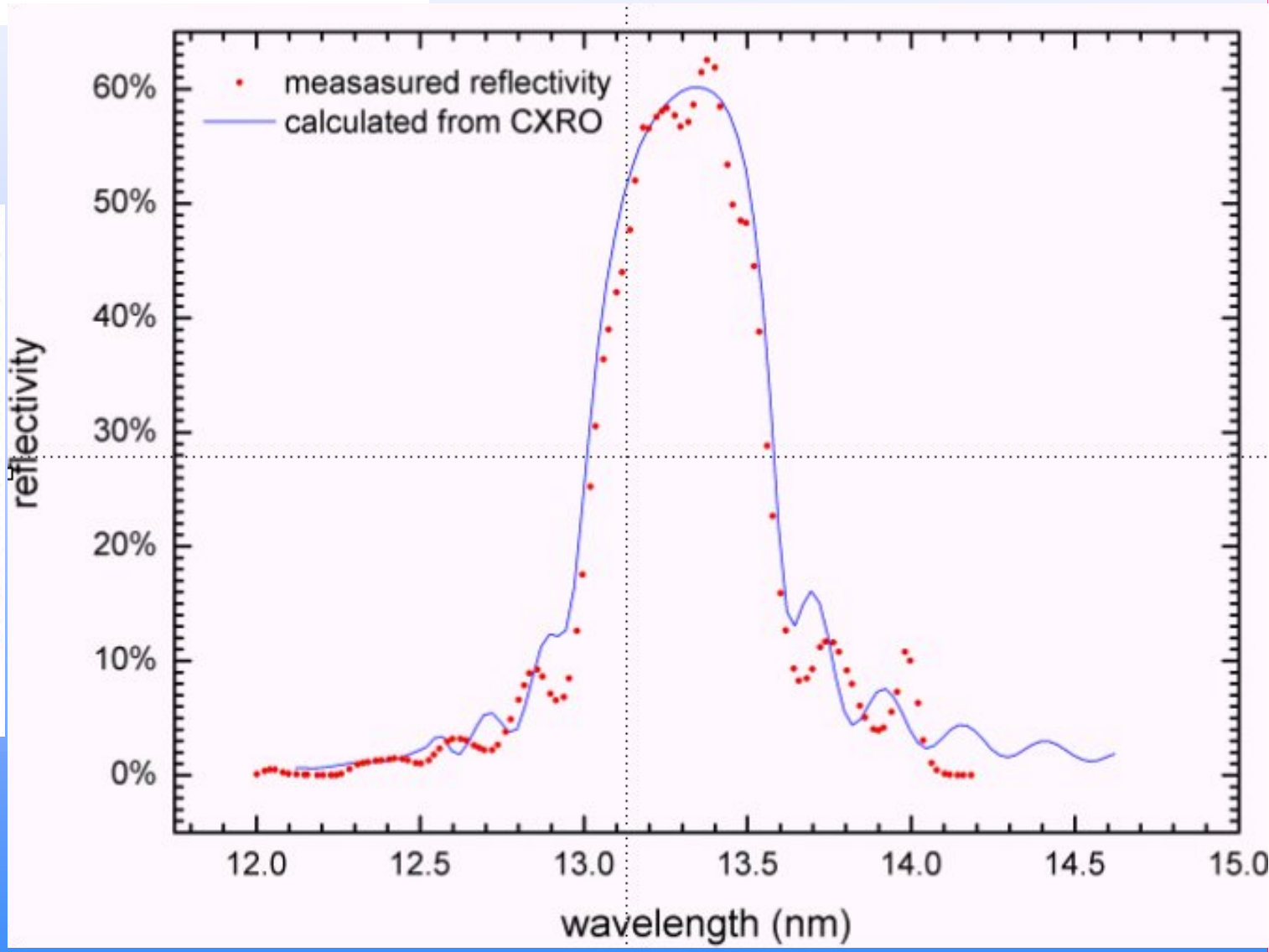


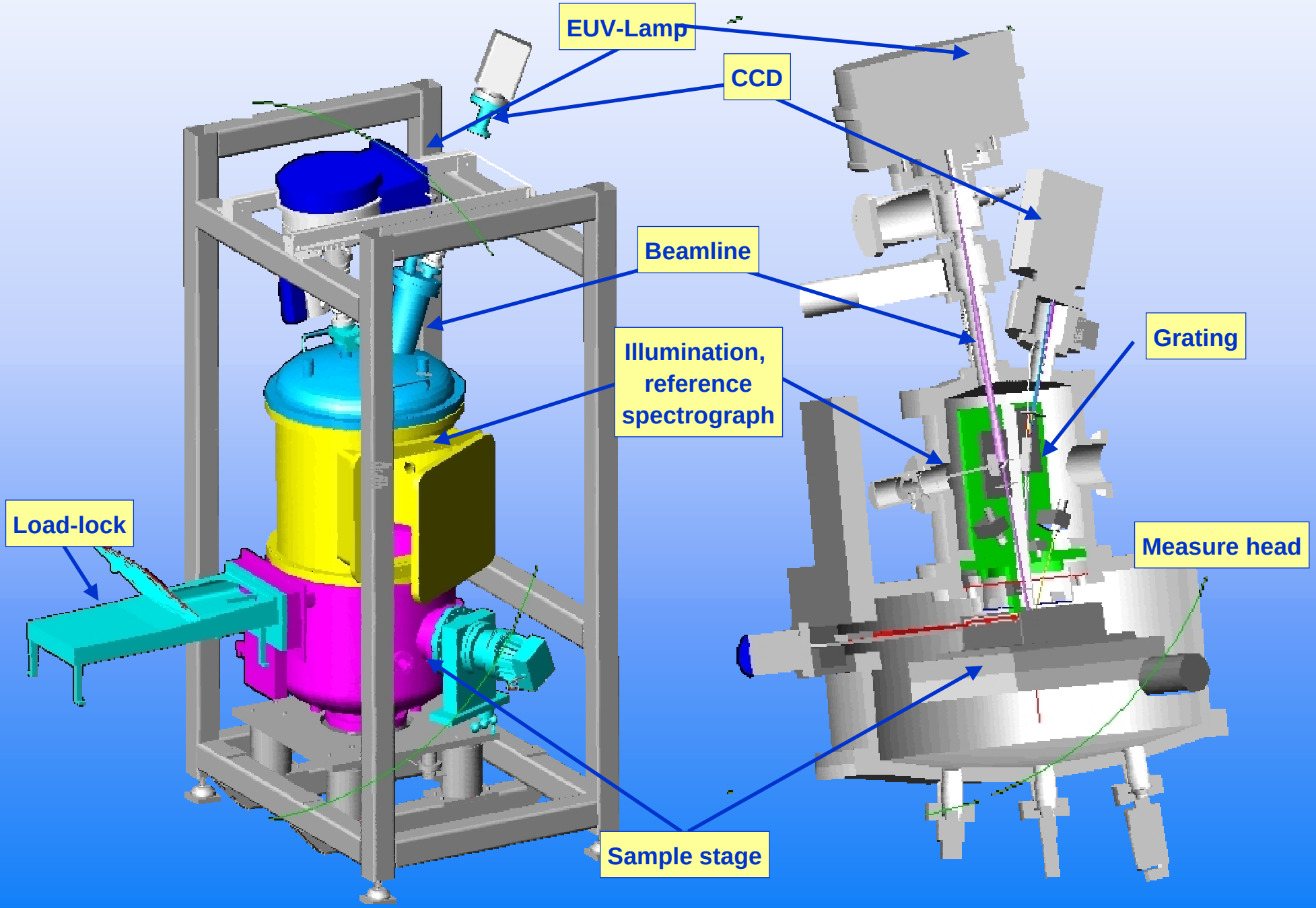
Lines of EUV-Lamp are identified and can be attributed to lines whose wavelengths are published by NIST.

Best fit on dispersion is better than 0.05 % RMS ($\lambda/\Delta\lambda > 2000$) with $\lambda/\Delta\lambda > 600$ spectrograph

Result : Ratio between Sample and Reference





By measuring both spectra the ratio between reference and sample is determined.
Fit with some calculated spectra as first step of evaluation.

Design of the High-Speed EUV-Reflectometer being set-up