Results from our recently delivered EUV Laser Plasma Reflectometer for the measurement of reflectivity and uniformity of EUV Lithography Mask Blank Multilayer Coatings

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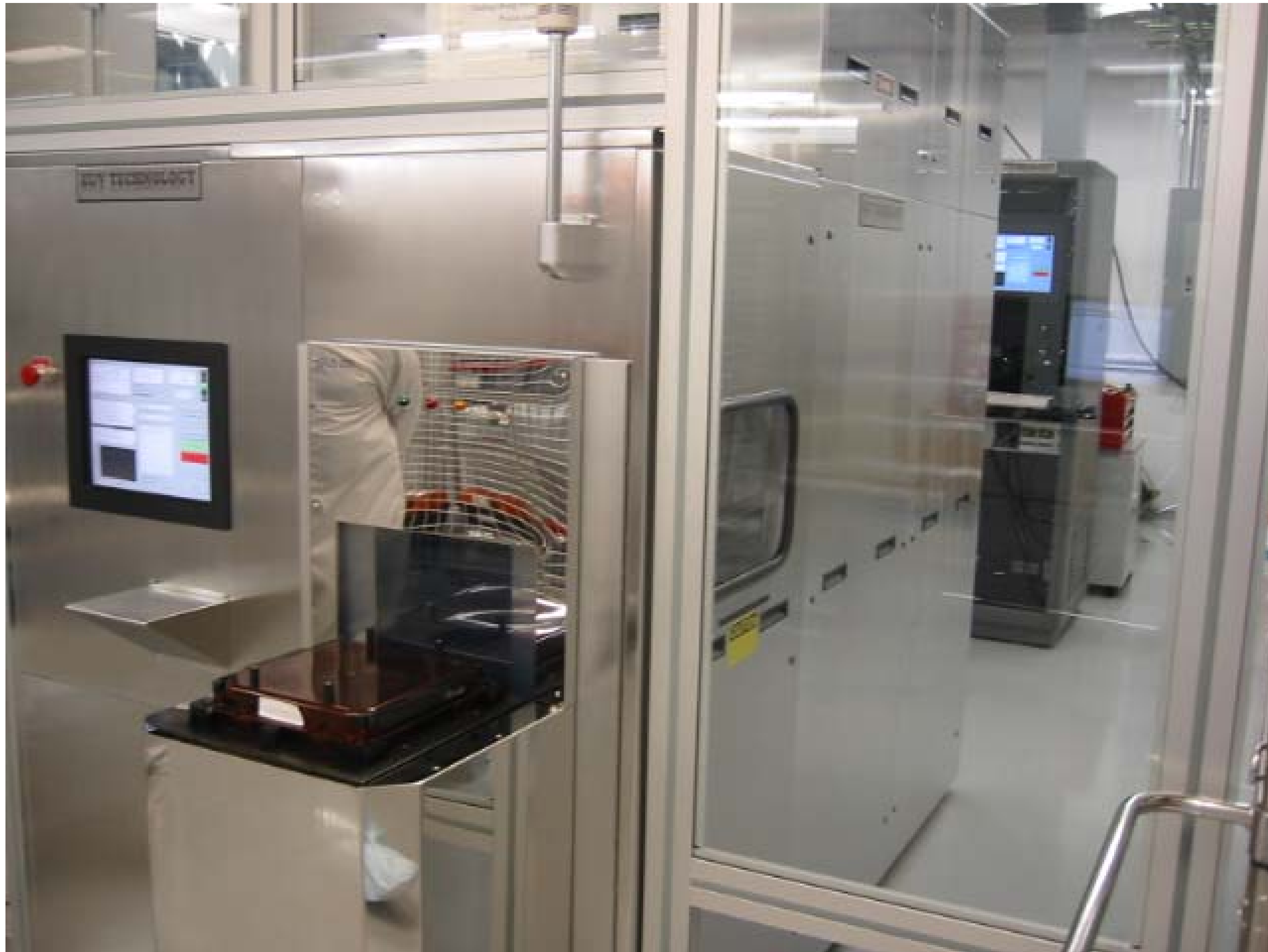
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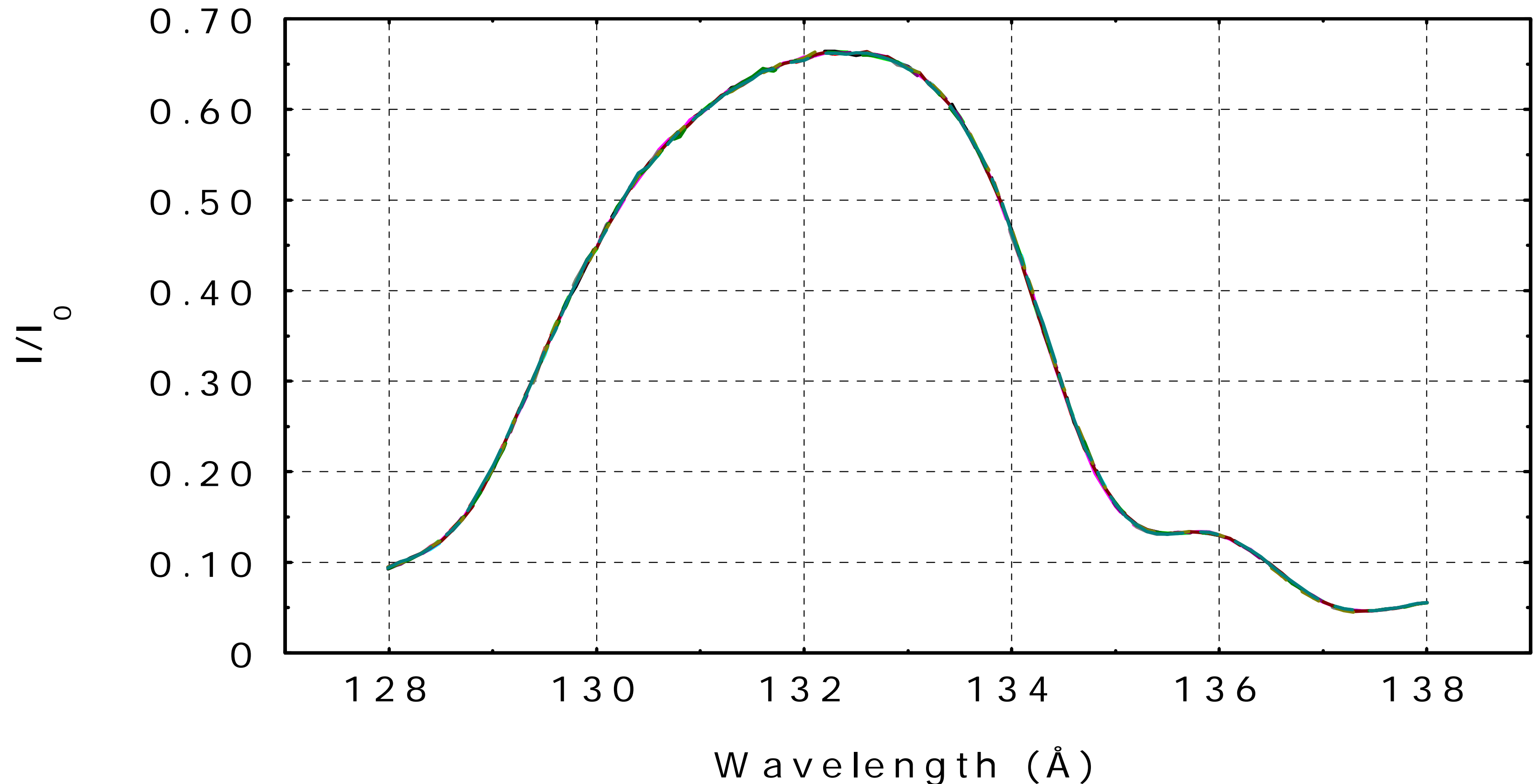
An example of reflectivity curves obtained with our instrument



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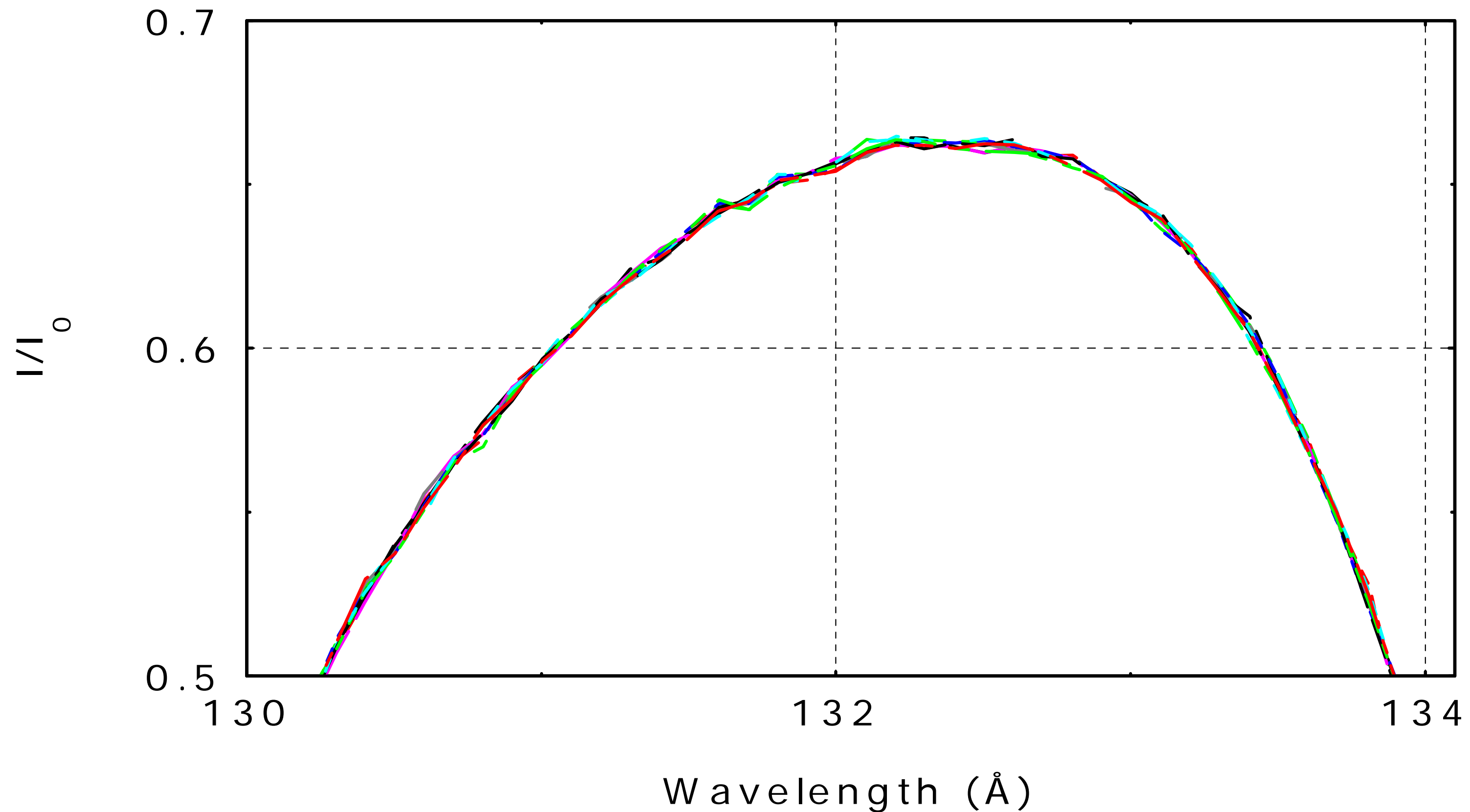

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Recent Results

Centroid Wavelength (nm)

	ALS	LPR	Precision	Accuracy
Reticle 1	13.1744	13.1743	0.00055	0.0001
Reticle 2	13.3212	13.3201	0.00056	0.0011
Reticle 3	13.6054	13.6051	0.00063	0.0003

Peak Reflectivity %

	ALS	LPR	Precision	Accuracy
Reticle 1	66.03	65.83	0.12	0.20
Reticle 2	65.27	65.31	0.14	0.04
Reticle 3	65.34	65.49	0.16	0.15

FWHM (nm)

	ALS	LPR	Precision	Accuracy
Reticle 1	0.487	0.479	.00097	0.008
Reticle 2	0.502	0.490	.00068	0.012
Reticle 3	0.534	0.523	.00051	0.011

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Source

- The target is a copper foil in the form of a thin tape through a reel-to-reel mechanism which can be quickly replaced in a manner analogous to a cassette tape recorder. (Can be replaced in about 30 minutes
- More than 12,000 individual measurements can be made with a single cassette
- The used tape cassette should be shipped back to EUV Technology for refurbishment and reloading

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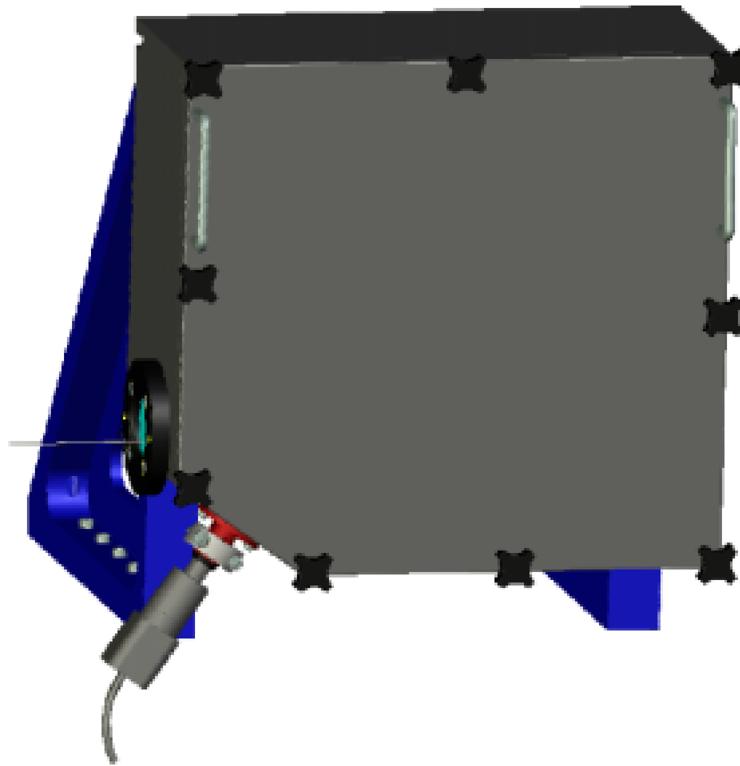
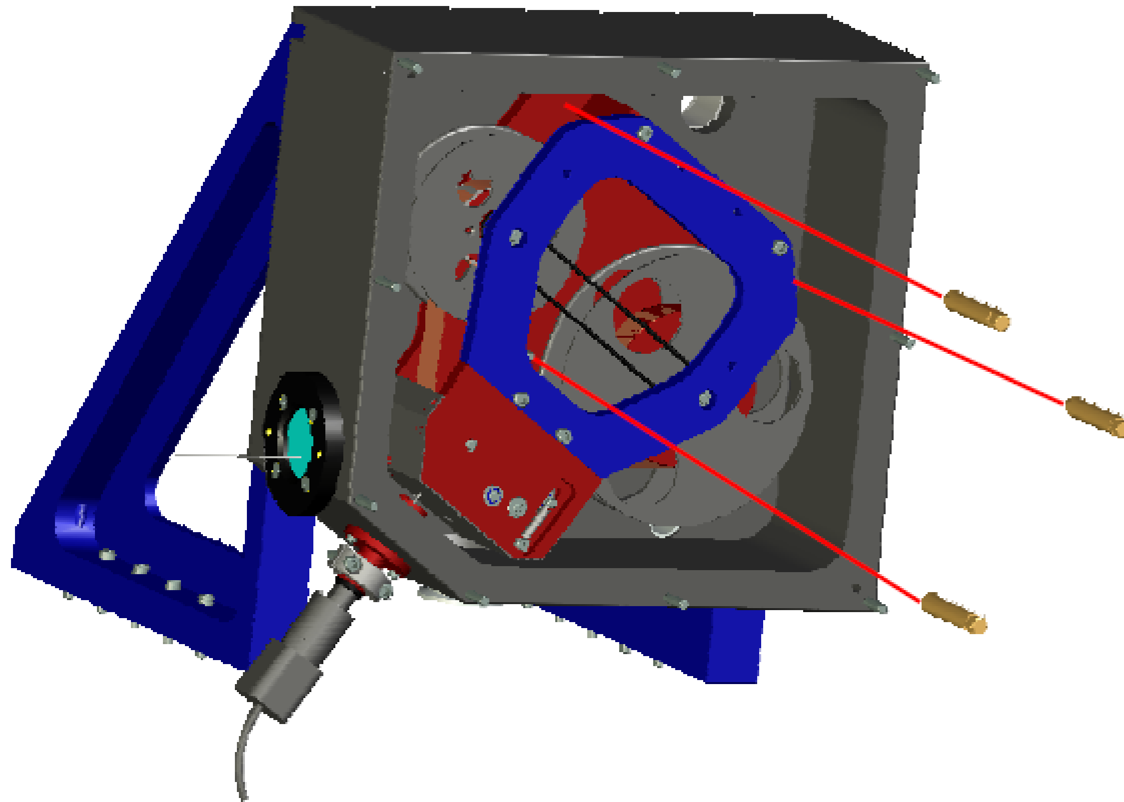
Cassette Replacement





LPR Networked touch screen displays and computer system

- One touch-screen display at SMIF pod loading station for recipe selection and execution start.
- One touch-screen display at control rack for service panel control and data management services.
- Computers running Linux hosting running operator interfaces and non time-critical software.

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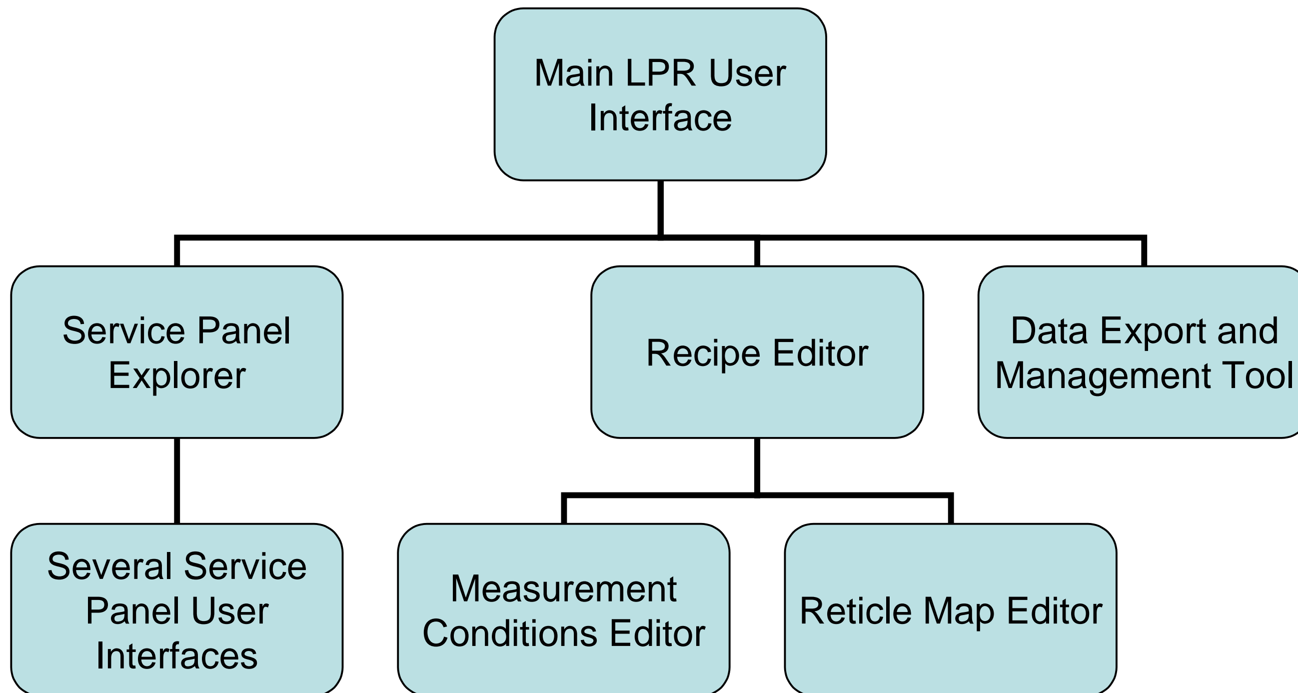
LPR Software Overview



LPR Main User Interface

The main user interface provides the main point-of-entry into the LPR's service panels and configuration panels.

System Status
Recipe Engine: running
Reticle Position: STAGE
Transfer System: loaded
Reflectometer System: ready

Recipe Activity
Running

Progress

EUV Reflectometer
by

2004-09-20
06:58:09 PM

Recipes
jim
jim3
jim7
Recipe_01
Recipe_02
Recipe_03
Recipe_04
Recipe_05
testrecipe1
testrecipe2

Reticle Serial Number
ALB060

Operator Name
jkring

Comments
reflectivity measurement of ALB060 reticle

Unload Reticle at completion
YES

Open Keyboard

Open Service Panels

Open Recipe Editor

View & Export Data

Run Recipe

Load Reticle

EXIT

Execute a scan

- Place a reticle (RSP 200) in the SLS 200.
- Select a recipe to execute.
- Select "Start Scan" to begin automated reticle transfer and measurement operations.
- Observe basic status on GUI.
- Remove RSP 200 pod when scan is done.

Output File

EUVT LPR Summary File Version 1.0

RecipeName	05PointReference
OperatorName	jimkring
ReticleSerialNumber	Reference
OperatorComments	
Run Start Time	9/6/2004 17:16
Run End Time	9/6/2004 17:25
ScanRangeStart(Angstrom)	129
ScanRangeStop(Angstrom)	137
ScanResolution(Angstrom)	0.2
NumberofShotsPerPoint	1

measurment	file	X (mm)	Y (mm)	Rmax	FWHM (A)	Centroid (A)
1	refl_001.dat	0	-95.25	0.655	5.398	132.994
2	refl_002.dat	0	-95.25	0.657	5.423	132.983
3	refl_003.dat	0	-95.25	0.660	5.420	132.975
4	refl_004.dat	0	-95.25	0.661	5.414	132.971
5	refl_005.dat	0	-95.25	0.662	5.429	132.969
			AVE	65.915	5.417	132.978
			STD	0.299	0.012	0.010

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Generate a recipe

- Open recipe editor
  - Create, edit, and save a reticle map file (creates X,Y scan coordinate pattern).
  - Create, edit, and save a measurement condition file (creates spectral scan range and step size settings).
- Create, edit, and save a recipe file by linking a map file and a measurement condition file to the recipe.

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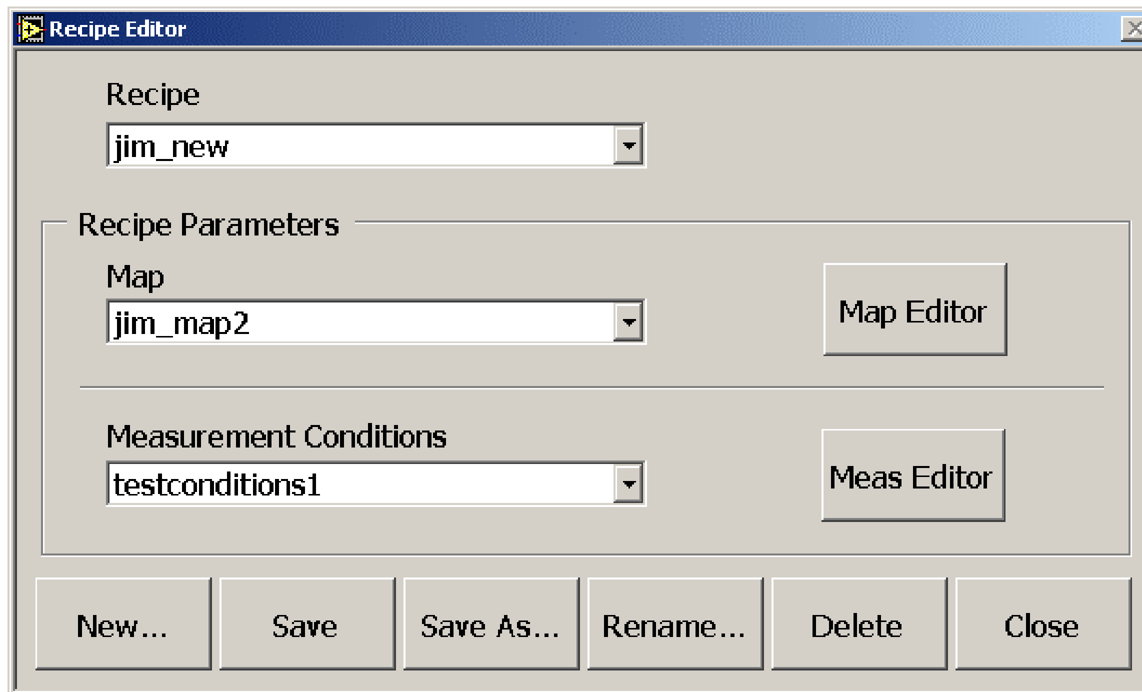
Recipe Editor

The recipe editor allows the operator to configure and manage a “recipe” consisting of a reticle map file and a measurement condition file.



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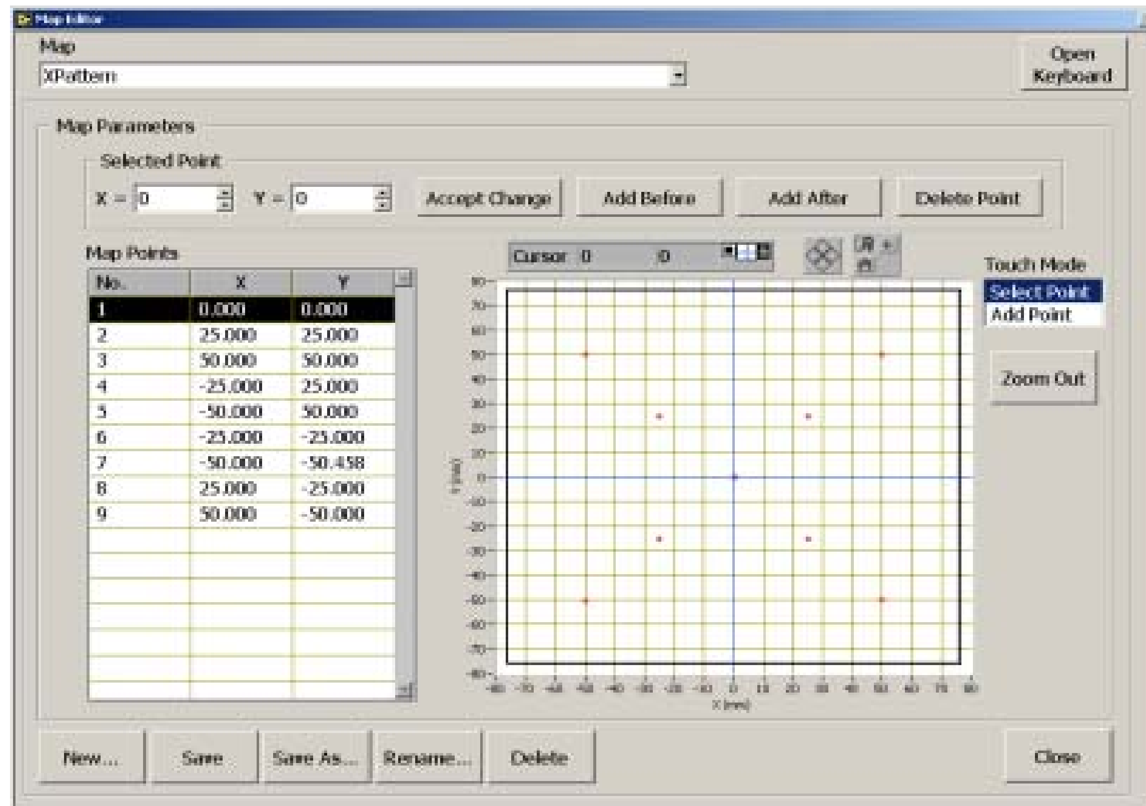
Reticle Map File Editor

The reticle map file editor allows the user to configure and manage a map file consisting of X,Y coordinates. This file is used during automated recipe execution.



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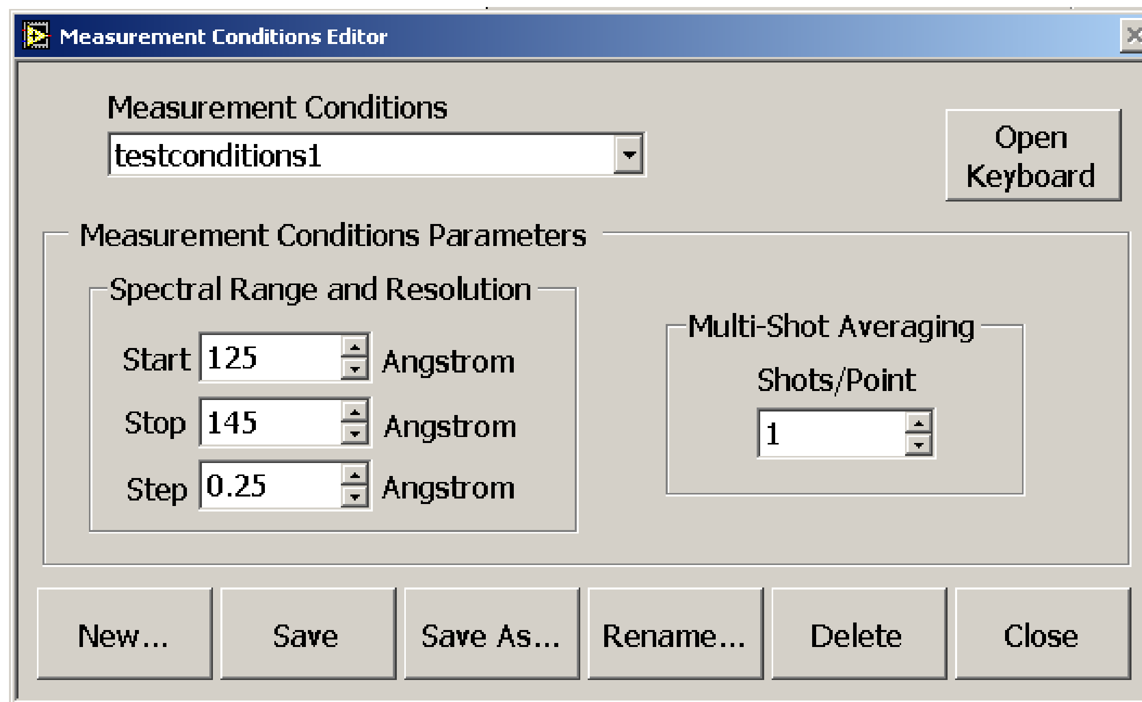
Measurement Condition File Editor

The measurement conditions editor allows the user to configure and manage a measurement condition file consisting of spectral range and resolution parameters. This file is used during automated recipe execution.



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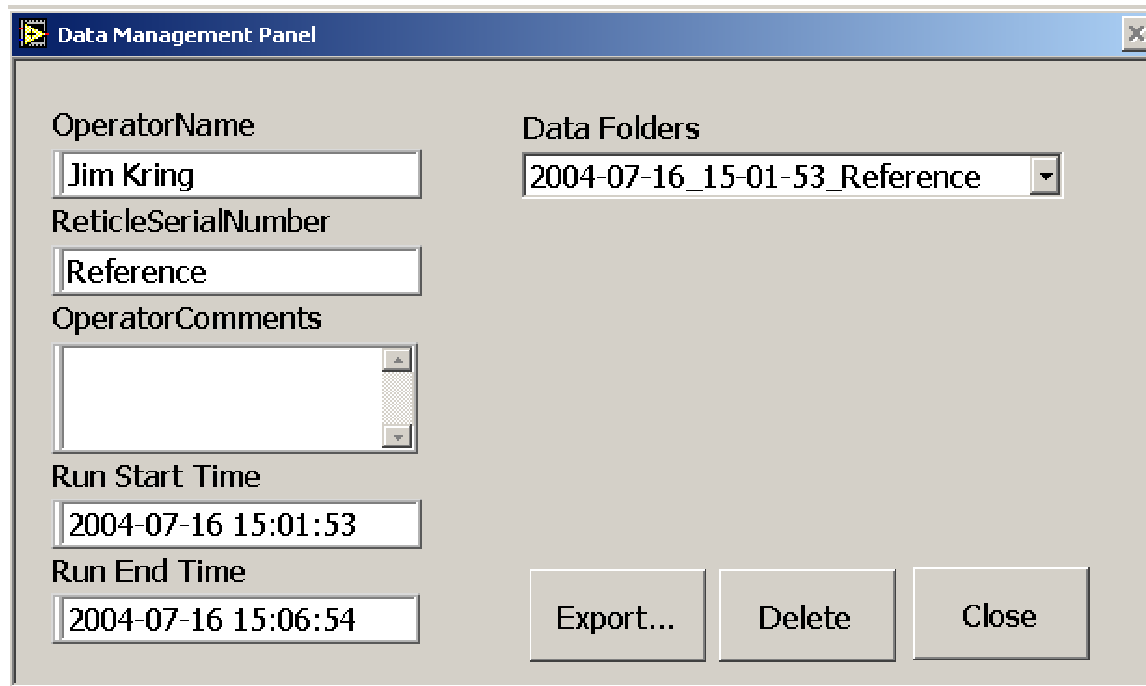
Data Management/Export Panel

The data management panel allows the user to manage and export the saved data from the LPR to a USB drive.



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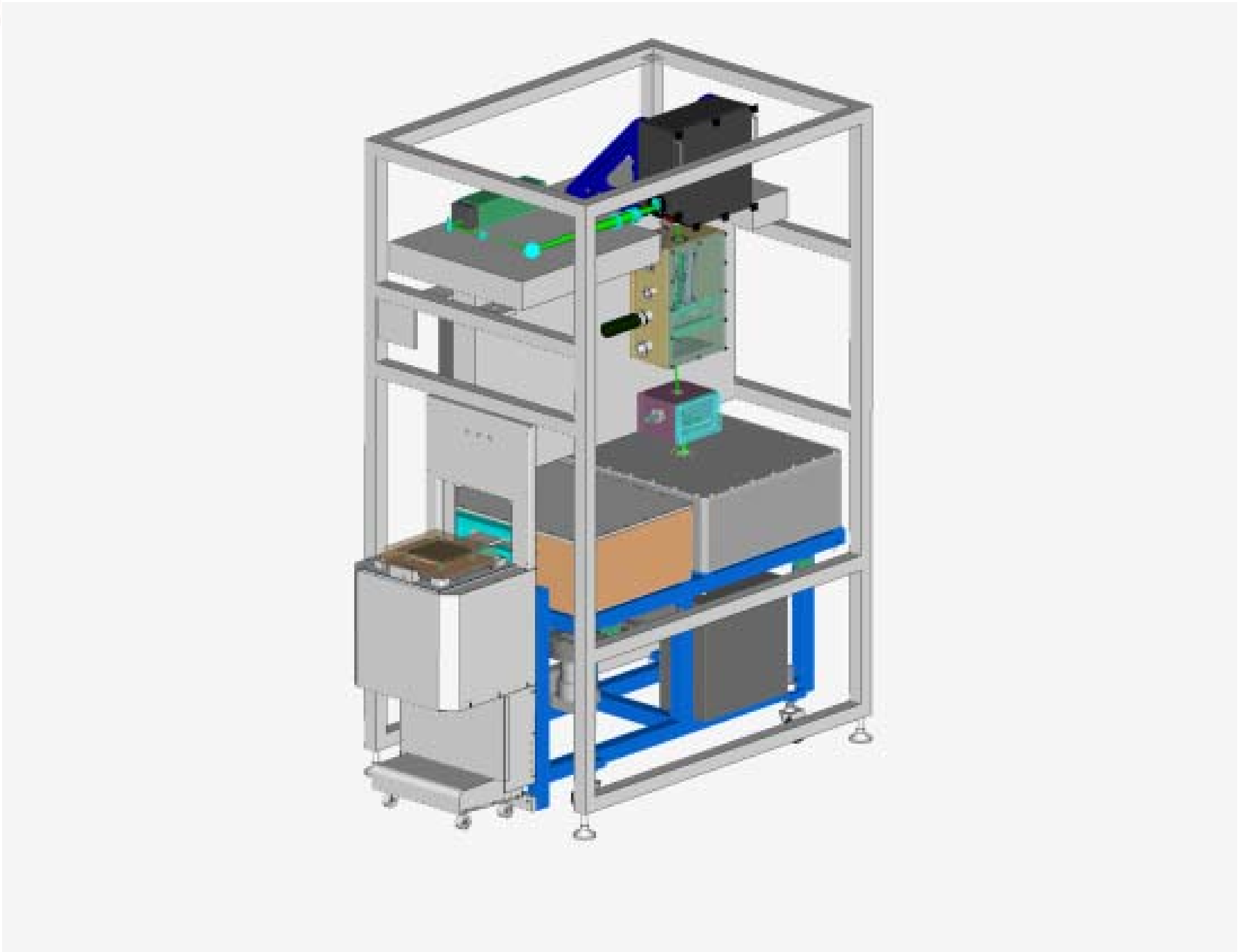

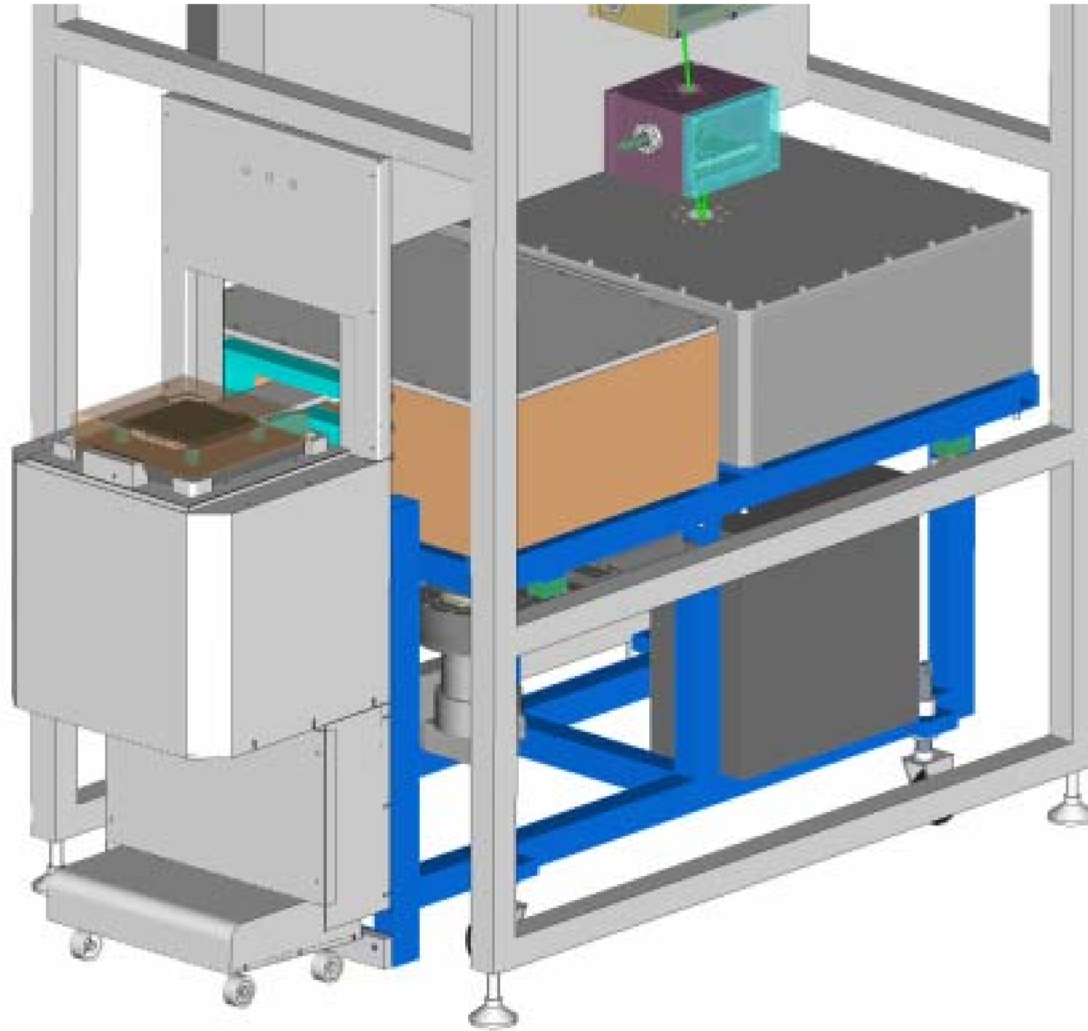

SLS 200 200 mm SMIF pod loader

- SEMI and CE certified
- Compatible with SEMI E19 and E63 for reticle POD management.
- Standard compliance: SEMI E19; SEMI E63; SEMI S2-00; SEMI S8-95
- PWP $< 10^{-5}$ particles/cm^2/pass.
- MCBF 500000 cycles
- MTTR < 30 minutes

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AVR 3000 Vacuum Robot

- SEMI and CE certified
- Standard compliance: SEMI E19; SEMI E63; SEMI S2-00; SEMI S8-95
- Less than class 1 clean room compatible.
- MTBF 50,000 hours
- MTTR < 90 minutes

Specifications of the EUV Reflectometer Model No. LPR1016-FS1515

- Substrate dimensions- 152 mm x 152 mm x 6.25 mm.(6" sq.)
- Measurement area – 147 mm x 147 mm of the mask blank.
  Positioning accuracy of 0.1 mm to mask edges.
  Reporting accuracy of 0.1 mm to mask edges.
- Measurement spot size – 3 mm diameter.
- Wavelength range – 10 to 16 nm.
- Wavelength resolution – 500
- Wavelength precision & accuracy (1σ) – < 0.005 nm (0.04%)
- Peak Reflectivity Resolution(absolute) – < 0.1%
- Reflectivity precision absolute (1σ) – less than 0.5% compared to a reflectivity standard measured at ALS.
- Peak reflectivity capability – 10 to 100 %

Specifications of the EUV Reflectometer Model No. LPR1016-FS1515

- Data rate – 1 point/sec at 1 laser shot per point.
  - Multiple measurements on a single reticle.
  - Capable of data averaging over several pulses.
- Can obtain a complete reflectance measurement in 30 seconds.
- Over 12,000 reflectance measurements without changing the laser target.
- Laser target can be replaced in less than 30 minutes.
- Throughput for 10 measurement sites per mask – about 2 masks/hr.
- Footprint of the instrument is about 2.0 m by 2.0 m.

Specifications of the EUV Reflectometer Model No. LPR1016-FS1515

- User friendly LabView based software to control the instrument and to analyze the reflectance measurements so that a less skilled personal can operate it.
- Recipe handling, manual parameter setup from GUI and remote accessible.
- Out put – peak reflectivity, FWHM, centroid wavelength and period (d-spacing) of the mask blank multilayer coating as a function of the position in Excel or .CSV
- Fixed angle of incidence range (from normal)- 6 degrees
- Angle of incidence precision- less than 0.05 degrees.

Specifications of the EUV Reflectometer Model No. LPR1016-FS1515

- Extremely reliable cassette-based, MESC compatible vacuum mask blank handling transfer system to load the mask blanks from a standard container (RSP 200).
- Particle adders - < 0.06 cm^{-2}.
- Clean-room compatible.
  - (can reside in a class 1 clean room)

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Conclusions

- **Demonstrated performance of the commercially available EUV Reflectometer Model No. LPR1016-FS1515**
  - **Wavelength to ± 0.001 nm**
  - **Reflectance to less than ± 0.2 %**
  - **Fab compatible**
  - **Set up time is considerably faster**
  - **Turn around time is even faster**
  - **Time per measurement comparable to SR facilities**
  - **Can be installed and used on the shop floor**

- **Laser Plasma Reflectometry is clearly a viable option for mask measurement**
  - **Need SR facilities like ALS, HIT, PTB etc. to make accurate EUV measurements and for standardization.**