Overview of SEMATECH's Actinic Blank Inspection Program

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Outline of Presentation

- Introduction
- SEMATECH Project Plan
- Actinic Blank Inspection System
- Defect Review Microscope Mode
- Simulation of Defect Inspection
- Conclusions

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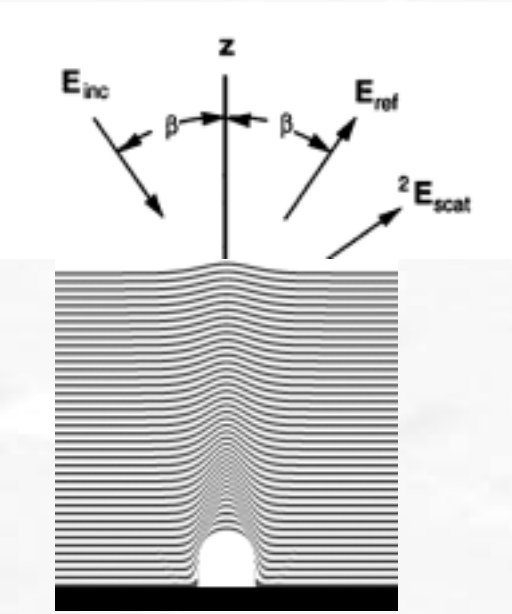
Role of Actinic Blank Inspection

Project Objective:

To carry out actinic inspection of EUV mask blanks and correlate with results of visible inspection to determine if actinic blank inspection will be required for EUVL.



		Printable defect	
		Defect	**No defect**
Non-actinic inspection result	**Defect**	Inspection is correct (desired result)	False positive (mask is actually OK)
	No defect	False Negative (defect exists but is not found)	Inspection is correct (desired result)

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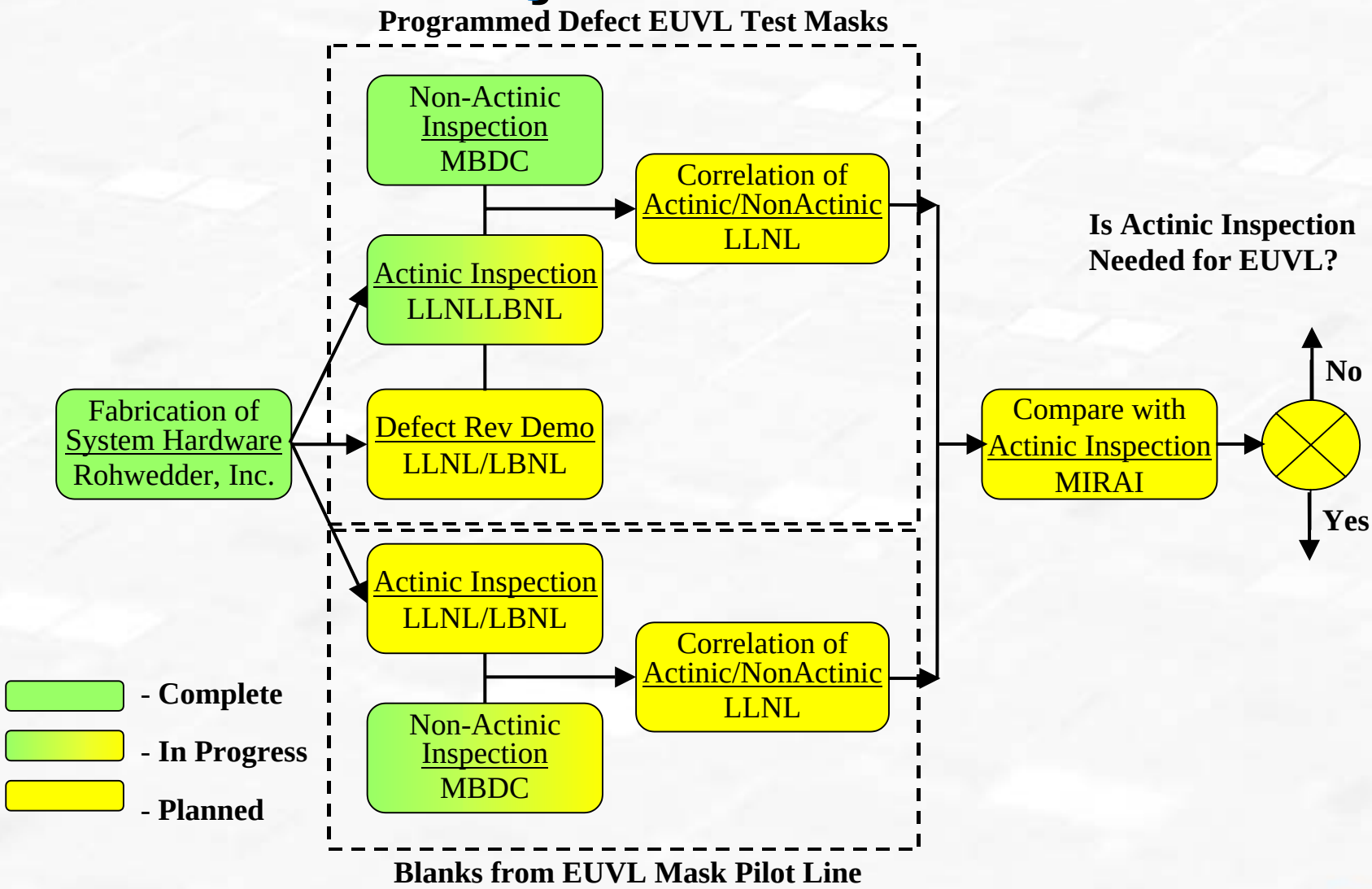
Sematech Project Plan



Q2	Q3	Q4	Q1	Q2	Q3	Q4
2004			2005			

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Inspection System Schematic

Scanning mode

Optics:
20x Schwarzschild illuminates mask

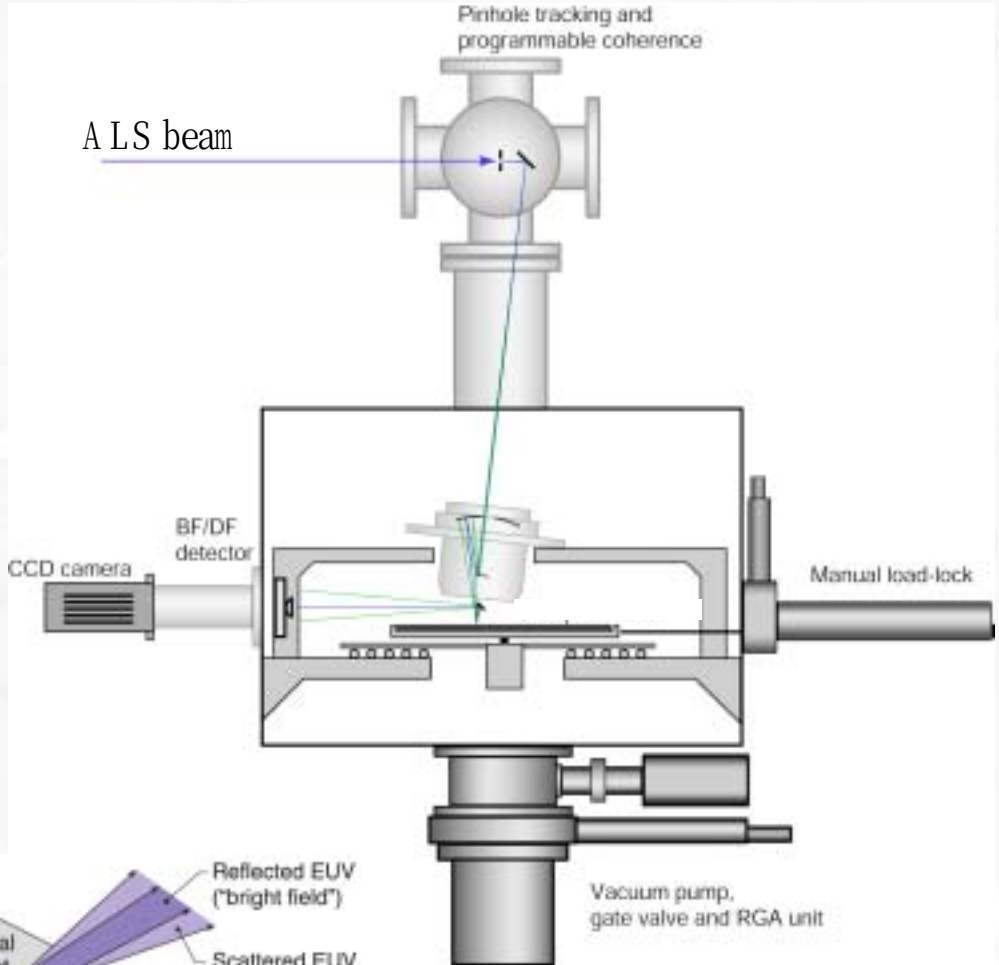
Scanned spot size:
1µm dia.

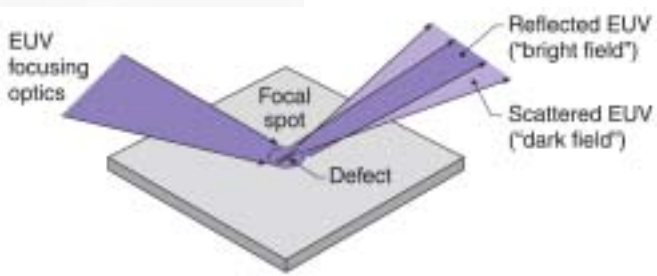
Scan speed:
2cm²/hr

Scanning sensitivity:
50nm PSL

Defect location:
10µm or better over 6”x6” mask

Added defects:
< 1 per cm²





Imaging mode

Optics:
Zone plate images mask at 500x mag.

NA to mask:
Emulates 0.25NA EUVL stepper

Field of view:
5µm square
1024x1024 pixels

Exposure time:
15sec - 1min

Time to change to imaging mode:
<30 min

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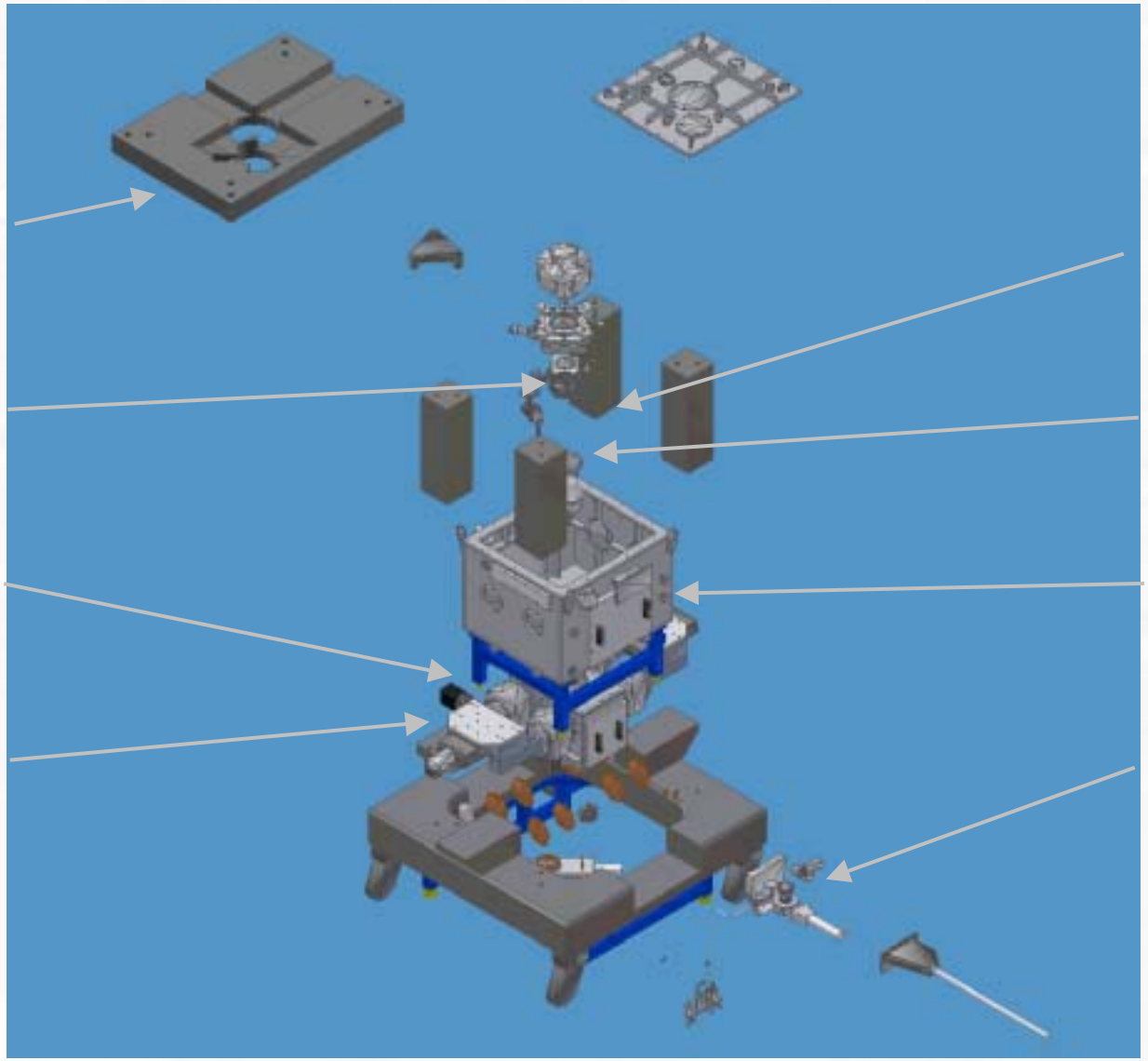
End-Station Design



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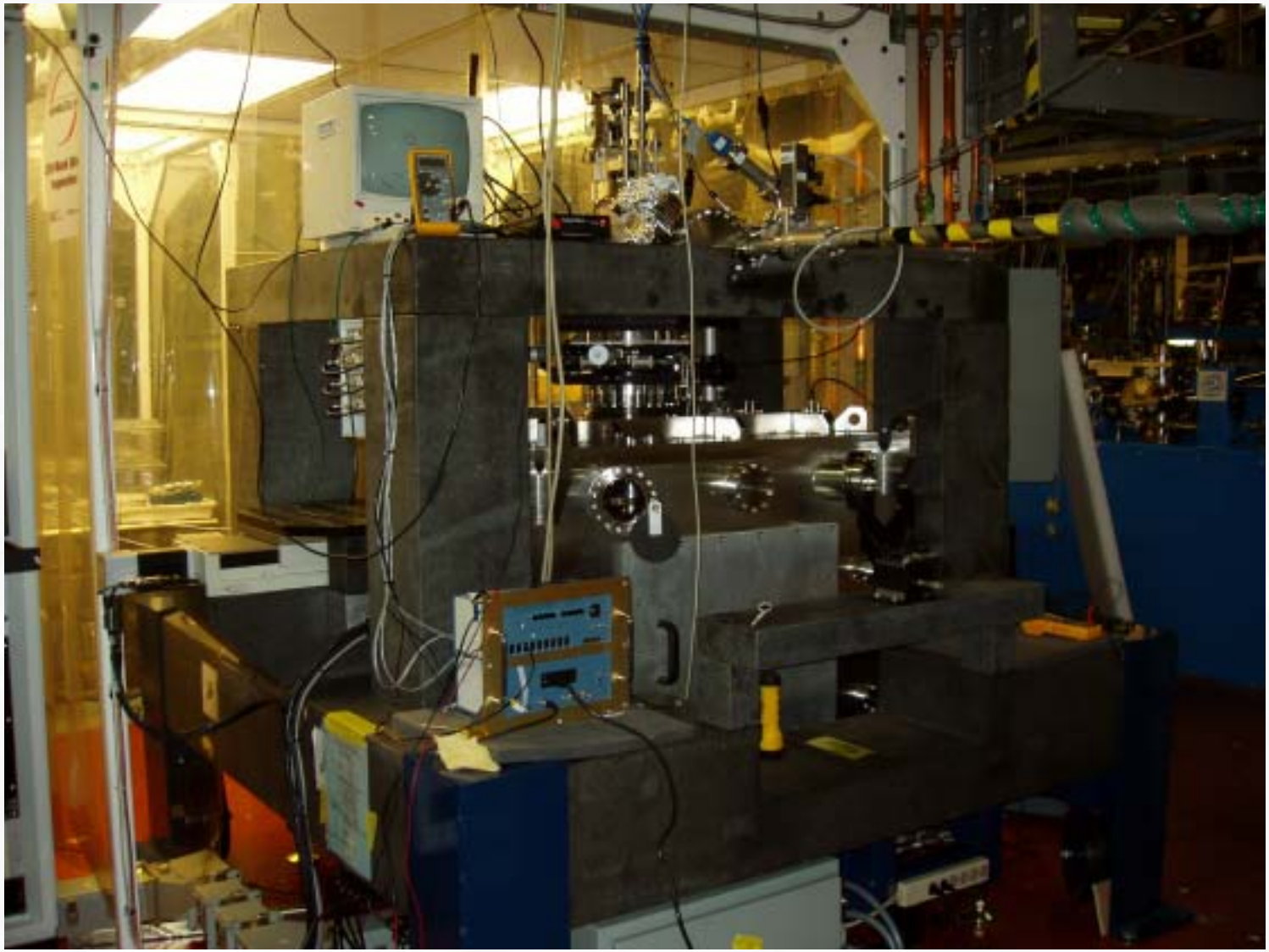
Current Hardware Status



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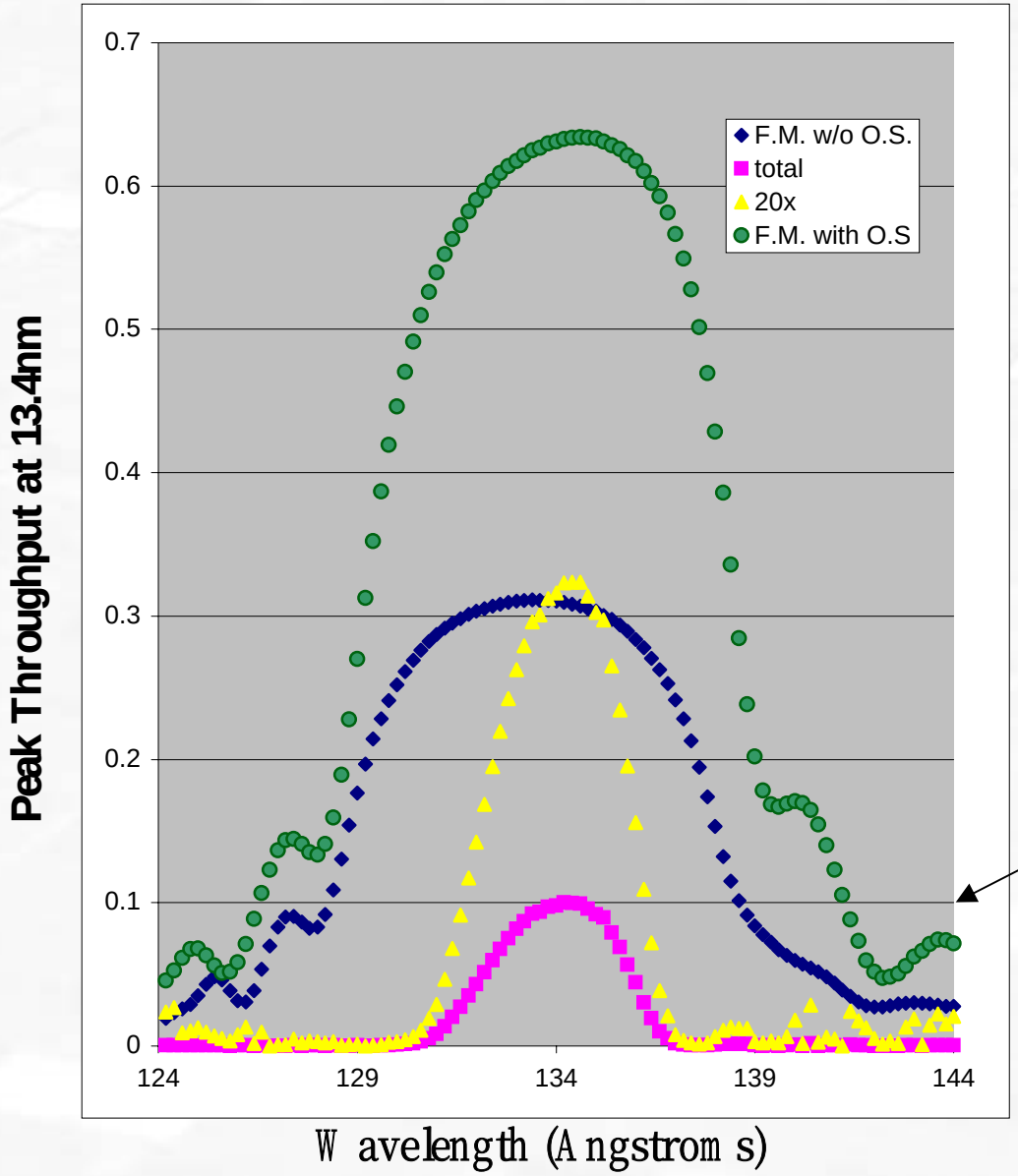
Current Beamline Status



1µW EUV light in a 1µm spot at the mask

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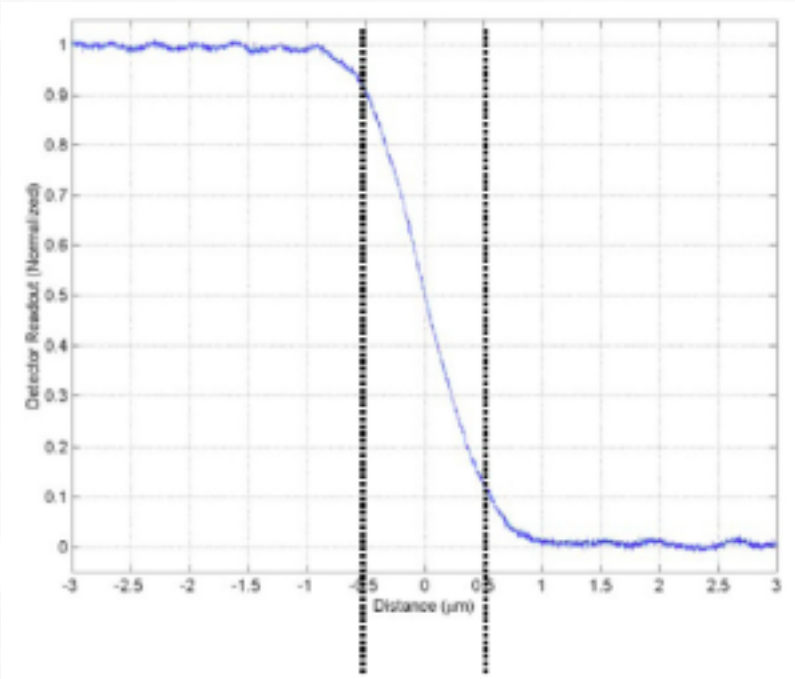
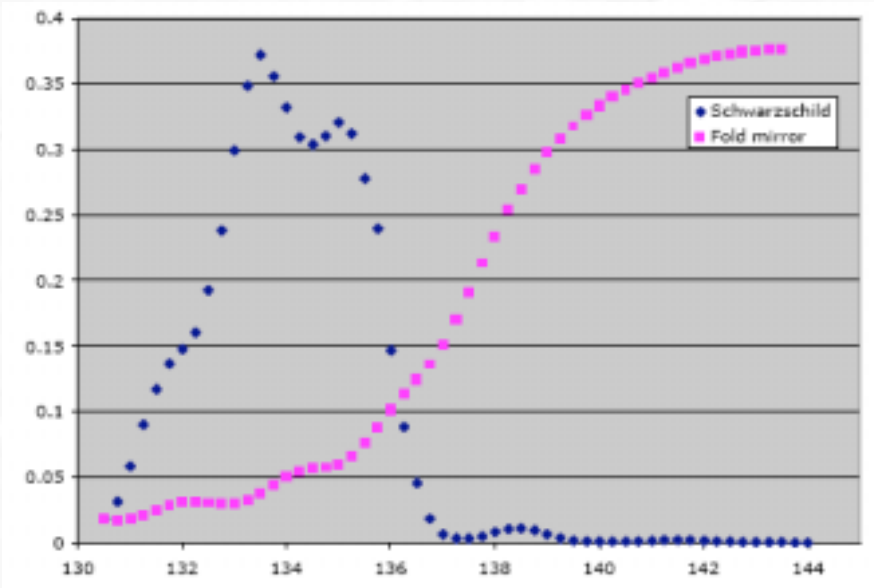
Results of Illumination Optic Tests

Knife Edge Test of Spot Size



Measurement of System Throughput



Conclusions: 1. 80% of transmitted energy is in 1 µm diameter spot.
2. Measured throughput consistent with individual element reflectivities of 60.8%.

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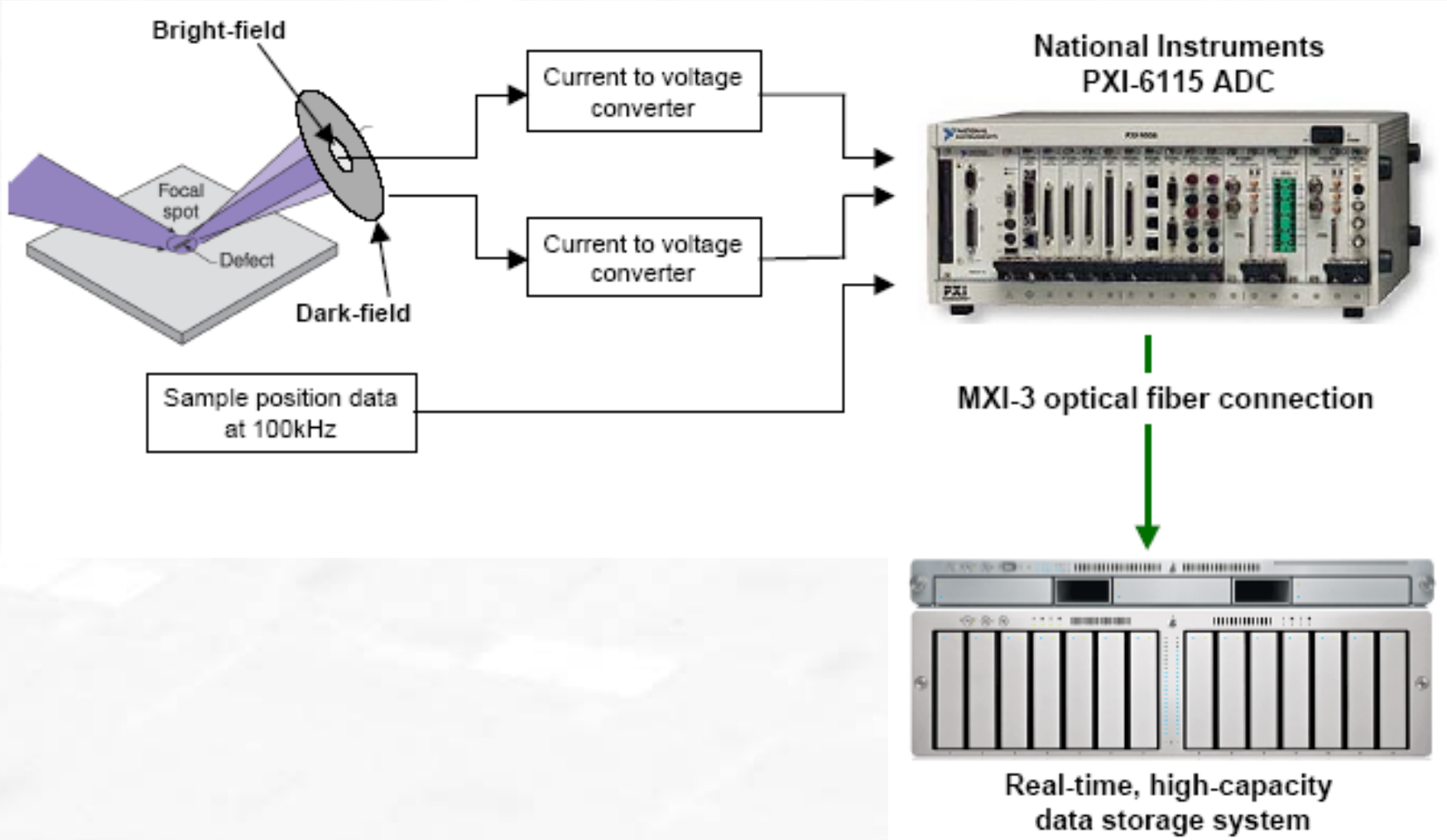
Data Acquisition System Test



Result: Continuous dual-channel data acquisition successfully demonstrated at 200 kHz (target rate = 100 kHz).

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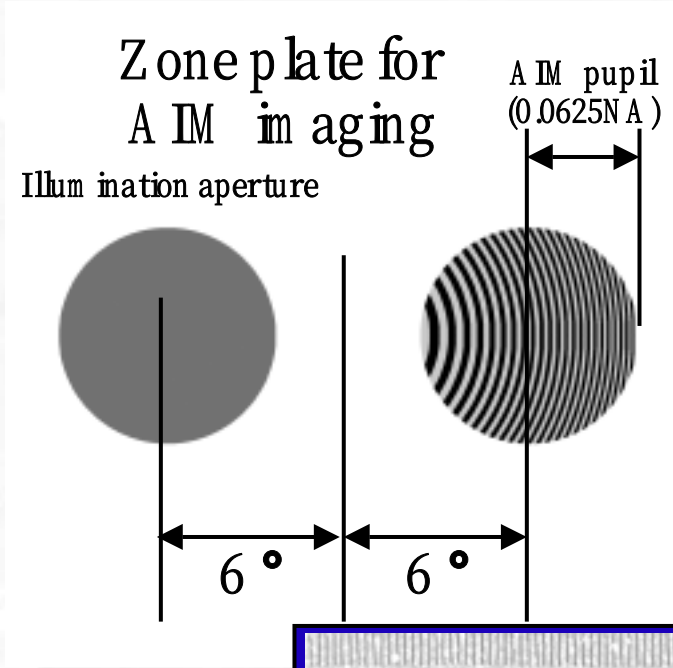
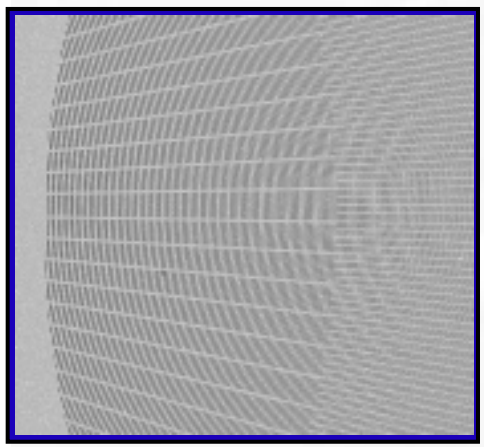
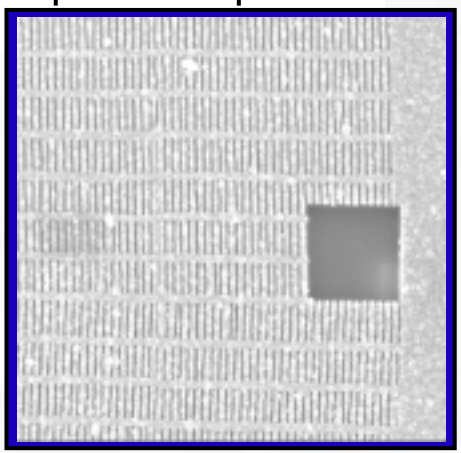
Defect Review Microscope Mode







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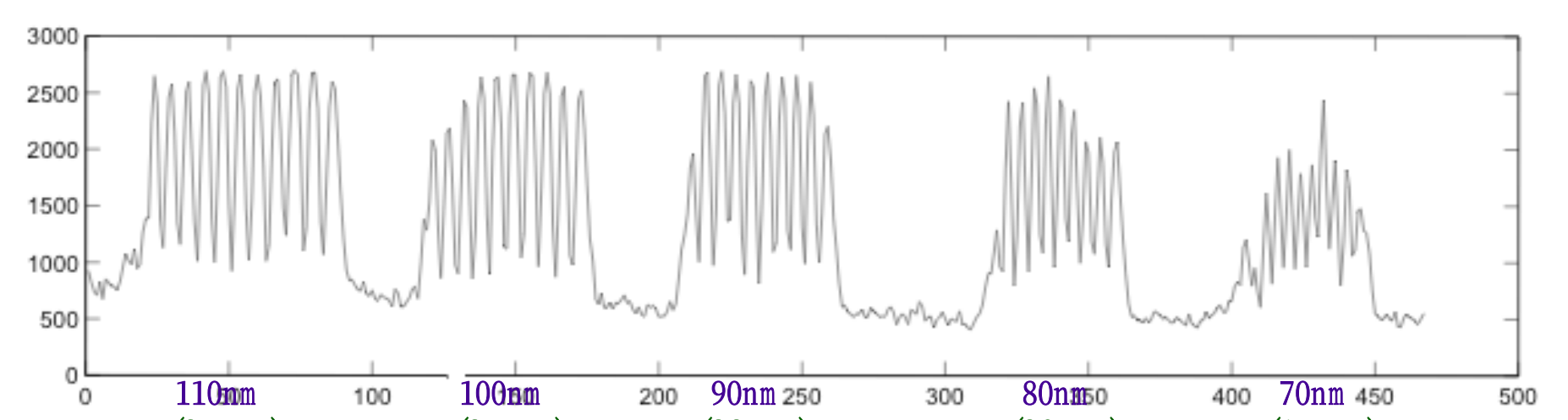
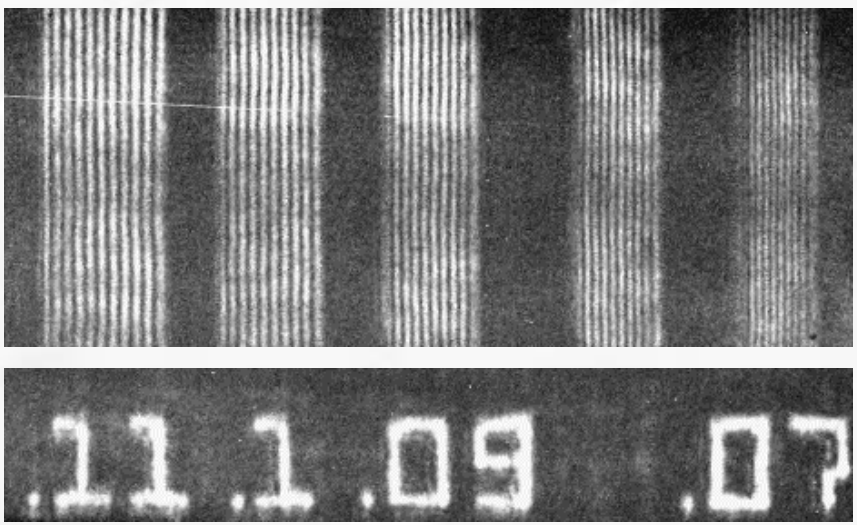
Zone Plate Performance





110nm ,100nm ,90nm ,80nm ,70nm at mask
27nm ,25nm ,22nm ,20nm ,17nm at wafer

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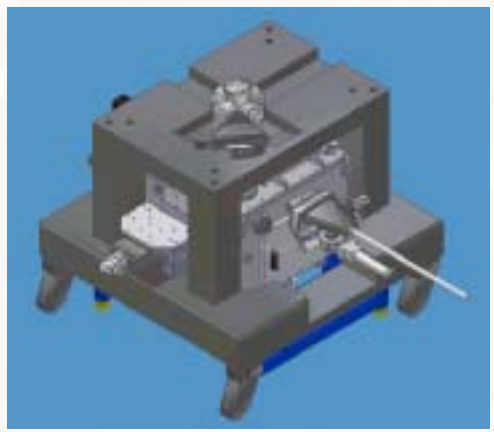
Modeling of Defect Inspection

- **Non-Actinic Inspection**
  - Model performance of commercial, non-actinic EUV mask blank inspection system
  - Compare modeled and measured performance
  - Predict performance of next-generation tools

- **Actinic Inspection**
  - Model performance of actinic mask blank inspection system
  - Validate EUV scattering models
  - Compare modeled and measured performance



- **EUV Printability**
  - Compare actinic and non-actinic inspection
  - Are all detected defects printable?
  - Are any printable defects not detected?

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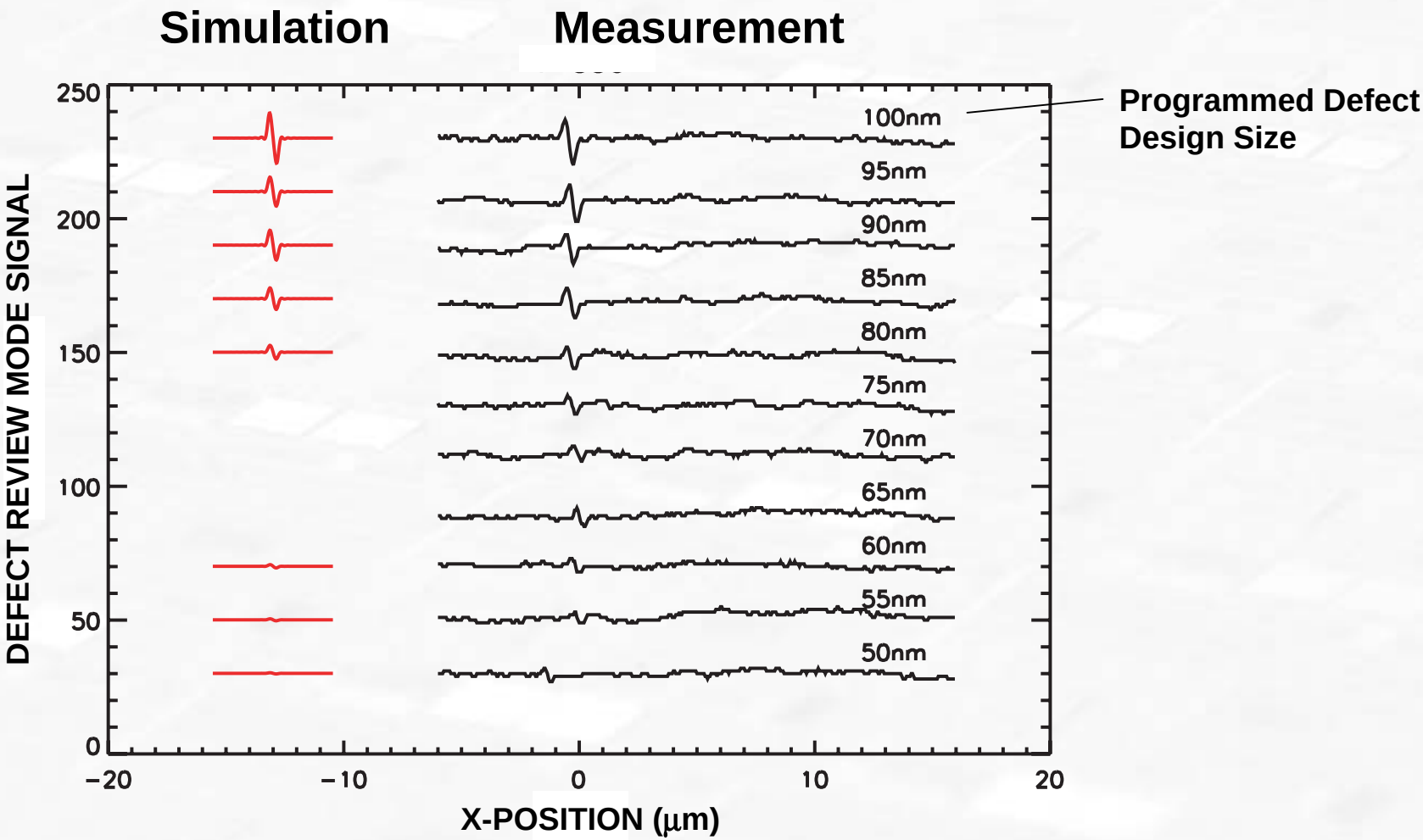
Non-Actinic Modeling Results



Method: Confocal microscopy of scattered visible light from multilayer defects nucleated by particle on the blank substrate

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Conclusions

- **Activities – In Progress:**
  - Install actinic defect inspection system at the ALS.
  - Model scattering from mask defects and EUV defect printability.
  - Demonstrate high-resolution EUV imaging of mask defects.
  - Collect actinic defect data from ≥ 300 cm^2 of area on blanks from EUVL mask pilot line.
  - Correlate actinic and non-actinic defect data from same samples.
- **Activities – Planned:**
  - Inspect samples with repaired multilayer defects.
  - Compare modeled inspection system signal with experiment.
  - Upgrade inspection system to allow phase contrast imaging.
  - Compare results with data from MIRAI EUV inspection system.

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