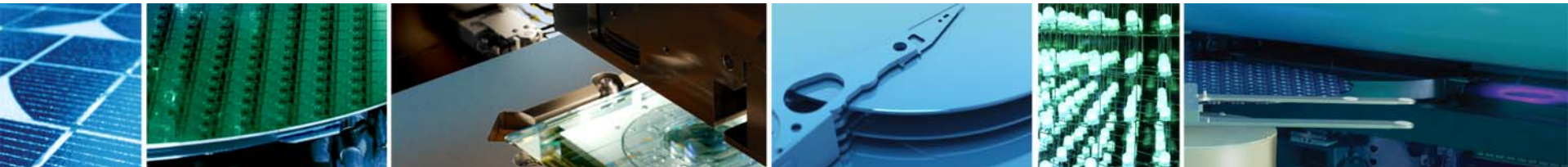
KLA-Tencor
Accelerating Yield

Solutions for EUV Mask and Blank Inspections

Dan Wack, Yalin Xiong, Gregg Inderhees

October 17, 2011

Reticle Product Division (RAPID)



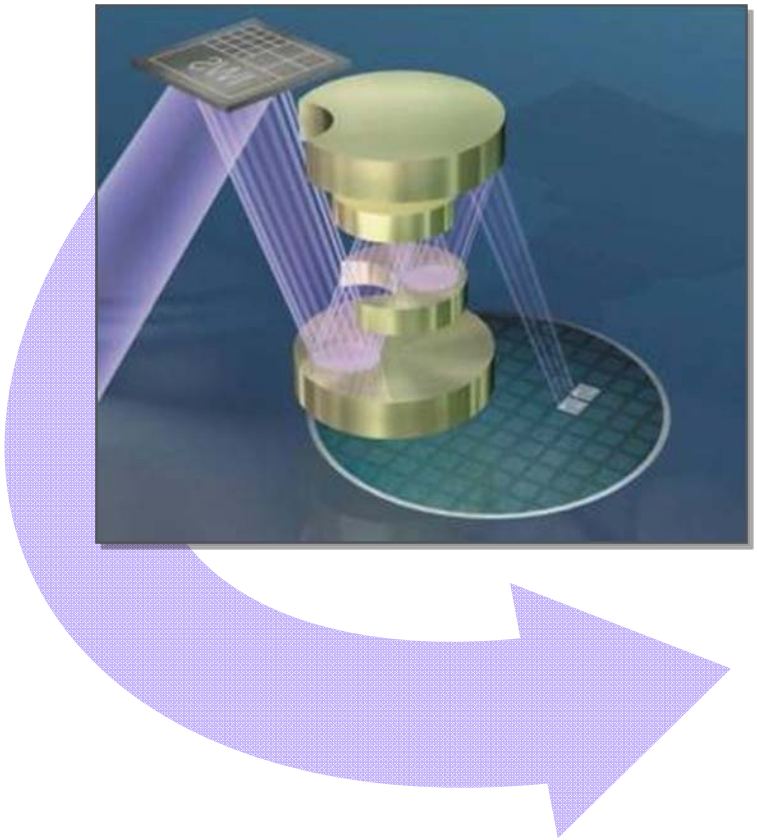
EUV Reticle Inspection Product Portfolio

	Released	Development	Development	Investigation
	32 nmm HP 22 nm L	22 nm HP 15 nm L	16 nm HP 11 nm L	11 nm HP 8 nm L
Blank	Teron 610	Teron 630	Teron 630	710b
Pattern			710	720
Requal			Teron 630	710

- Comprehensive suite of mask inspection products for EUV
- Covers all use cases: Blank Insp, Pattern Insp, Fab Re-Qual
- Meet economic & technical requirements (32nmHP to 11 nm HP)
- Product timing consistent with both R&D and Production ramps

IPRO5 EUV Registration Metrology Available Today

Support for 32 and 22 nm hp Production

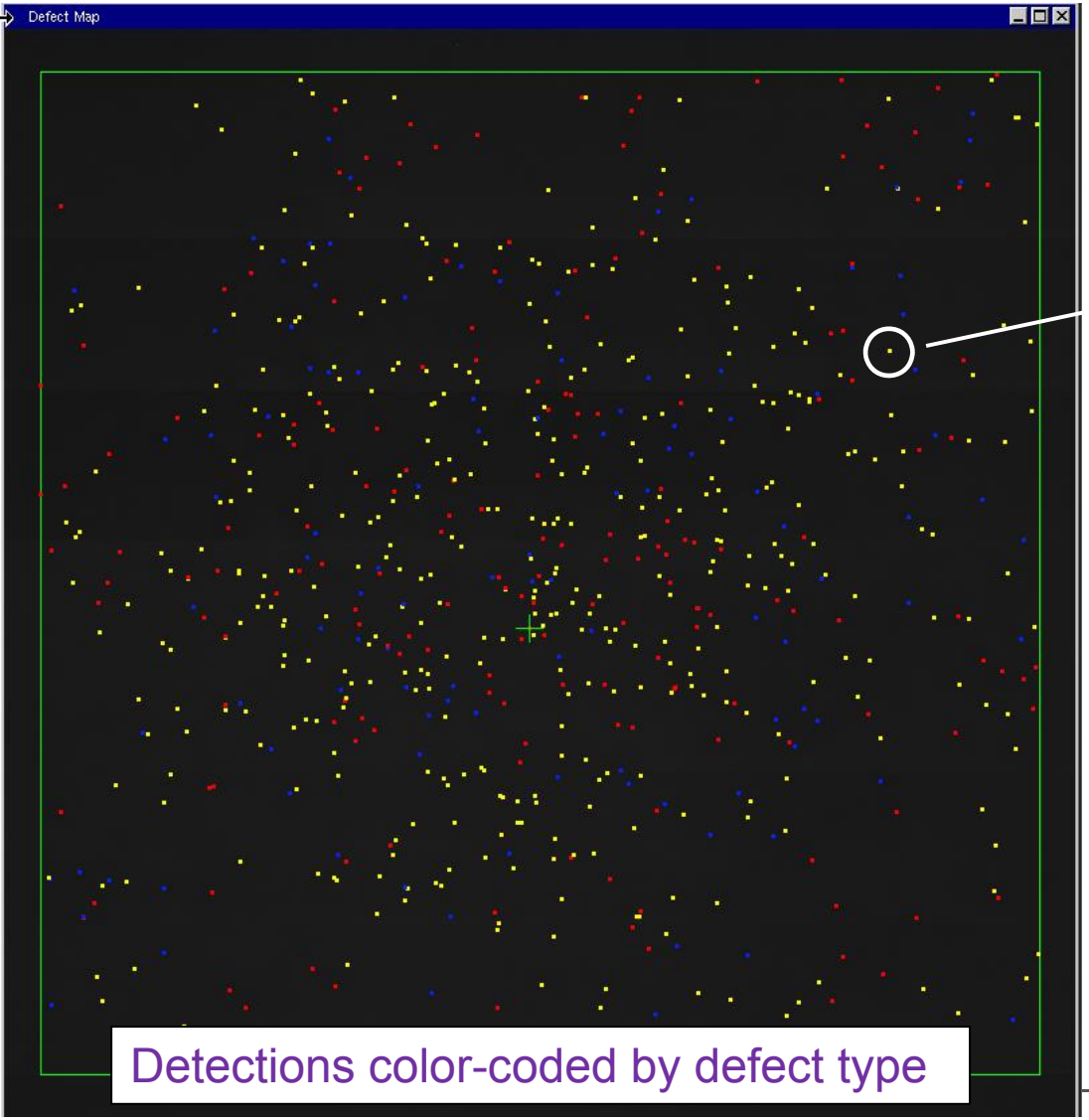


- **60% Improved Measurement Performance vs. IPRO4**
- **50% Improved Optical Resolution**

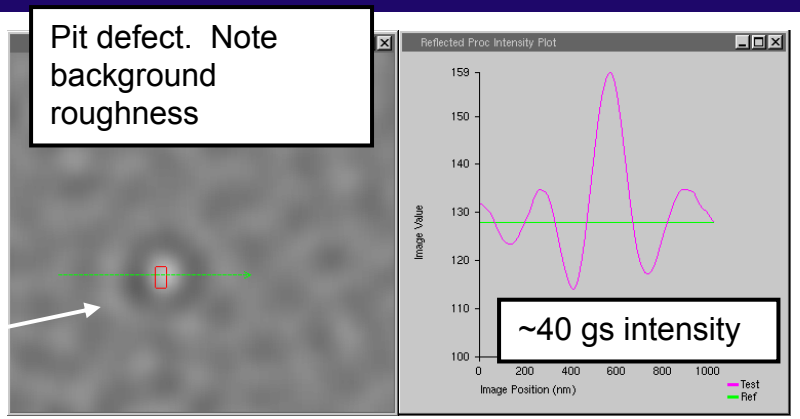
KLA Tencor

"Champion" EUV Blank With Teron 610 Phasur™

- Blanks still have a few 100's of yield-limiting phase defects



Detections color-coded by defect type



- Mitigation by hiding defect under absorber or in non-critical area enabled by accurate Phasur™ defect location.
- Phasur™ provides data on bumps vs. pits, and defect volume.
- Defectivity increases exponentially with size → 22 nm HP even more challenging!

KLA Tencor

Teron 630

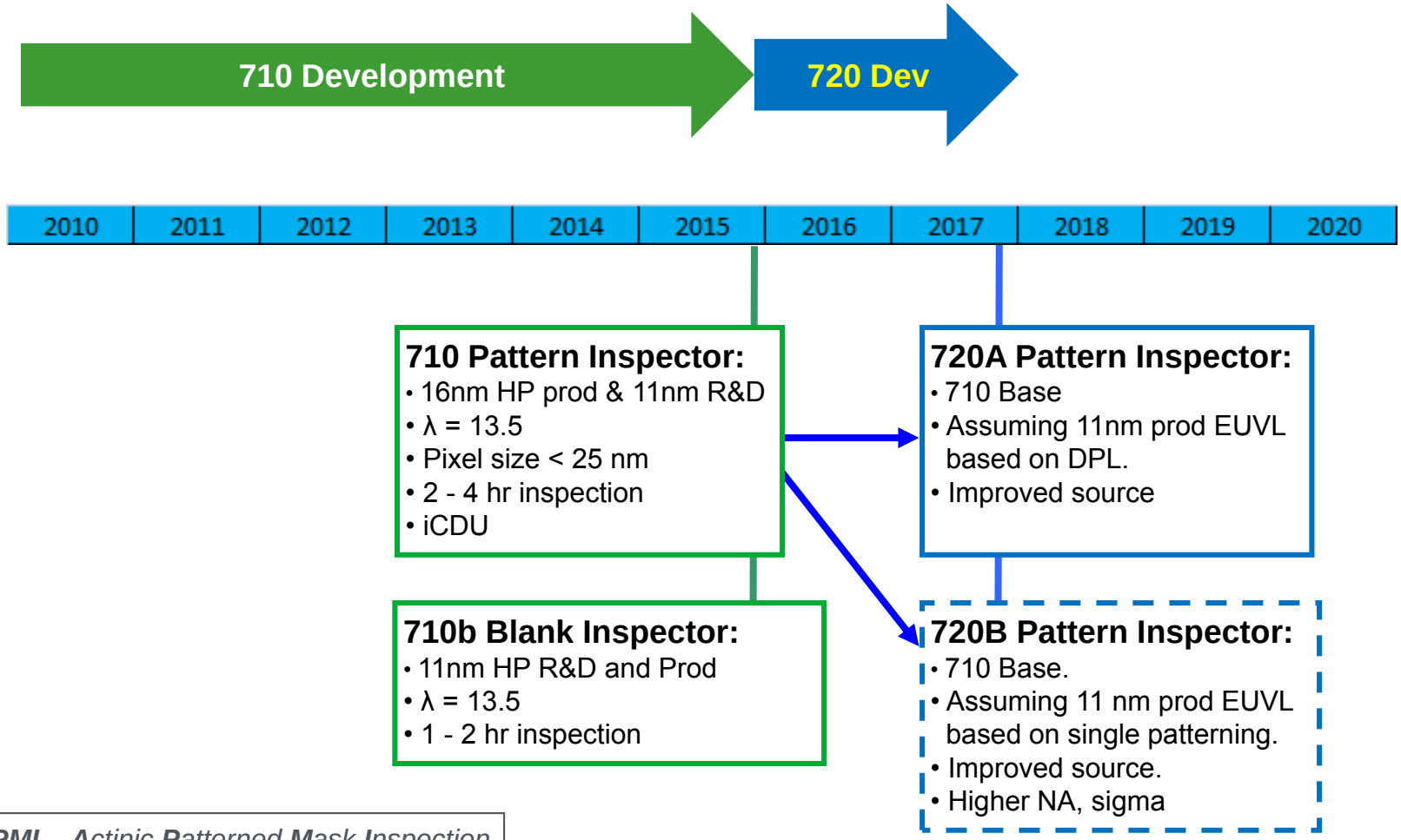
Major extension of Teron 610 platform based on new RET technology, designed to meet mask shops' reticle inspection needs for 22 HP & 15 L

- Target Applications
  - Pattern inspection for next-gen mask manufacturing
    - Development & production for 22 HP & 15 L (EUV & 193i)
    - Development for EUV masks below 22 HP
  - EUV blank inspection (Phasur™) to 16 nm hp
- Key Attributes
  - 2 - 4 hour scan time with 10% ΔCD sensitivity
  - RET: Off-axis illumination and polarization
  - 2x improvement in algo modeling with mask 3D & aberration correction
  - 40% improvement in autofocus accuracy
  - EUV pod Type A mask handling / improved cleanliness
  - Improved stage accuracy in Phasur mode (30nm 3σ)
  - Next gen image computer (UIC30) & data prep (DP-7)

KLA Tencor

Actinic 700-Series System Roadmap

High-NA version for Pattern, Lower-NA for Blank

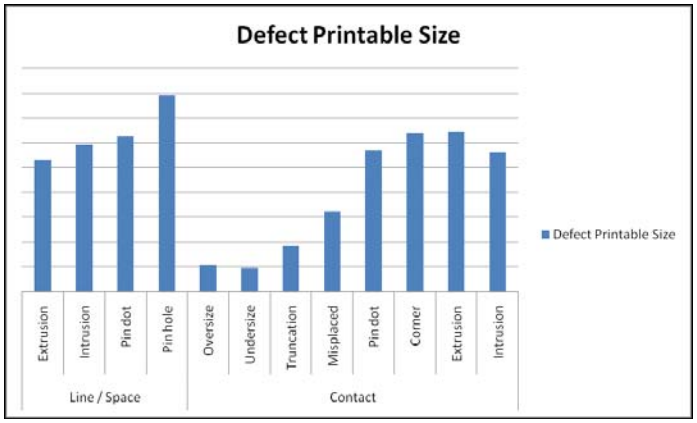


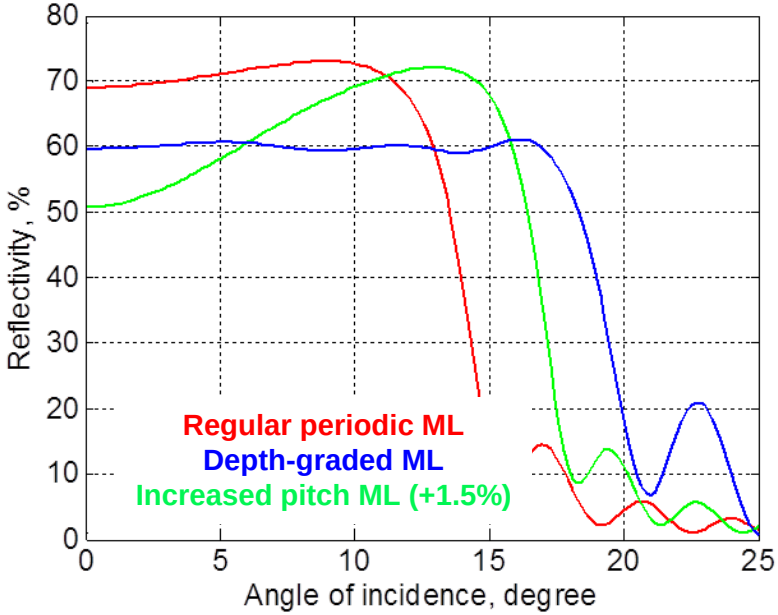
***APMI** – **A**ctinic **P**atterned **M**ask **I**nspection*

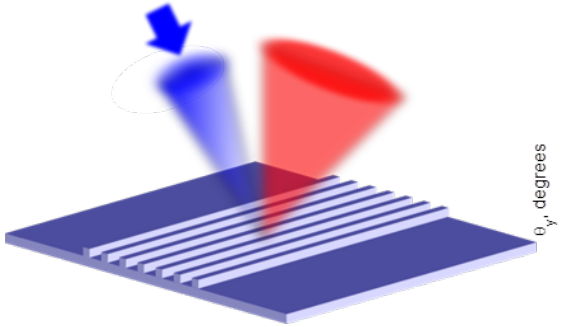
KLA-Tencor

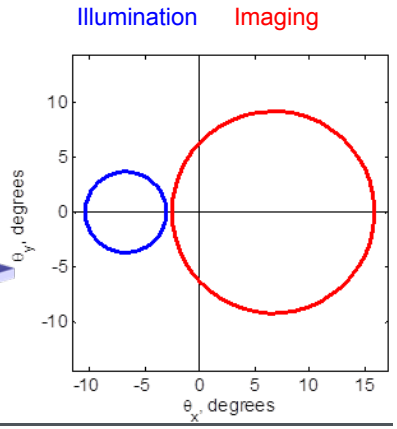
710 Design - targeting 16 *and* 11nm HP EUVL mask defects

- Method: For a given Imaging NA, illumination/imaging pupil configuration is chosen to maximize the ***weakest*** critical-size defect signal at 11nm HP
  - Single exposure lithography: EUV mask with modified-pitch multilayer
  - Double exposure lithography: 16HP (“regular”) periodic ML
  - Pattern defect examples:







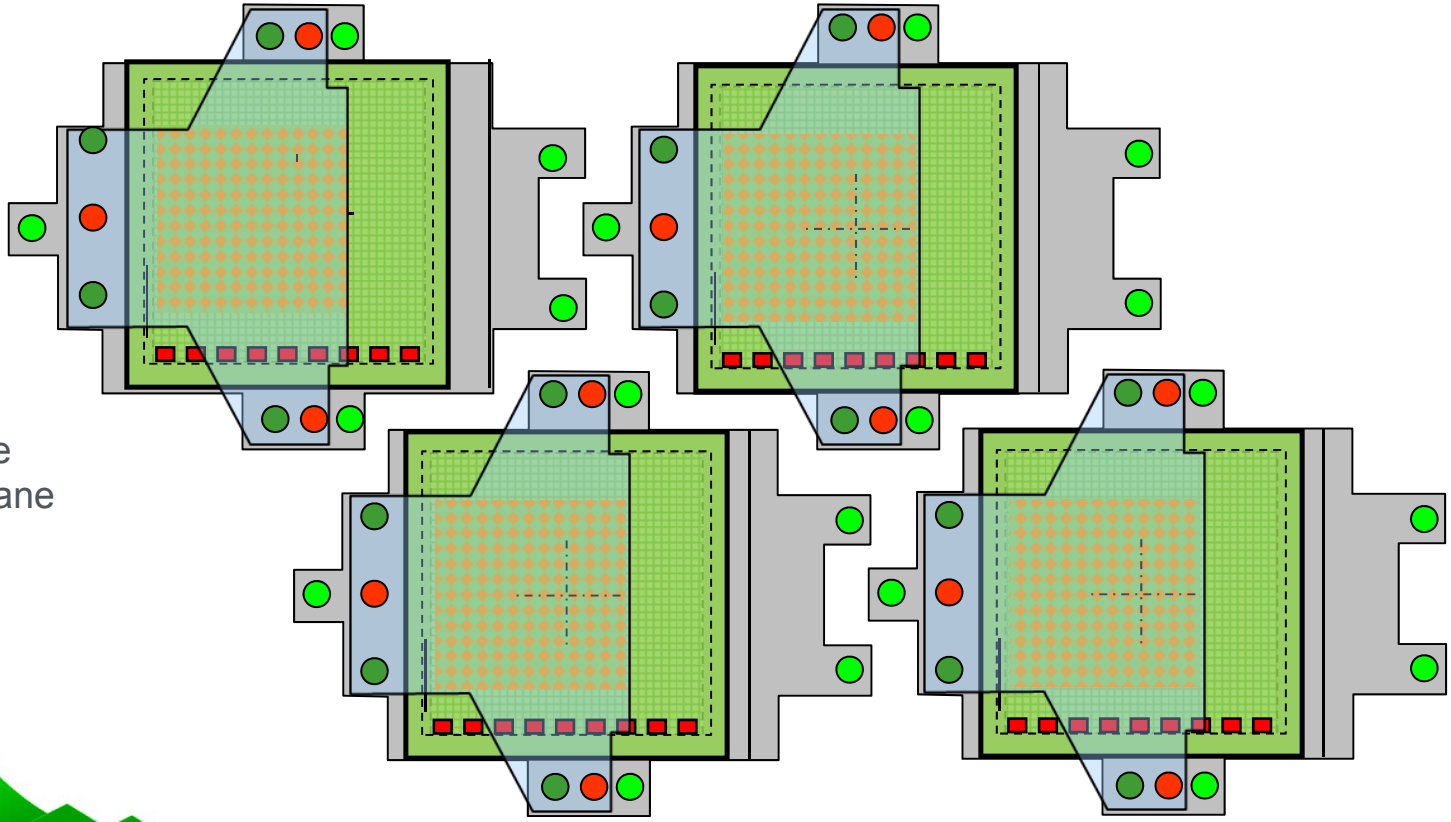


KLA Tencor

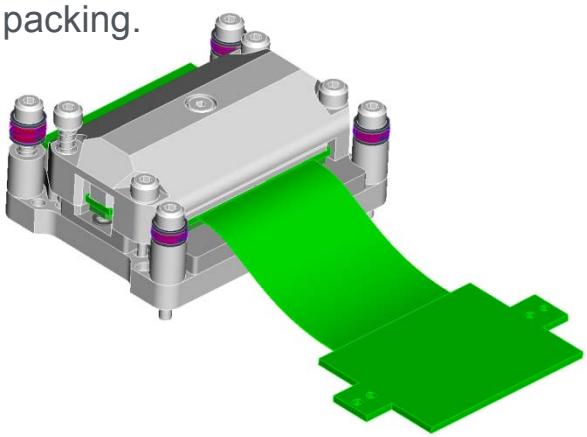
EUV Sensor Technology

– established feasibility of arrayed, vacuum-compatible EUV sensors

<u>Example</u>
2x2 Sensor Array



Conpact sensor package enables dense image plane packing.



Efficient packing of sensors enables substantial reduction of inspection time and source brightness requirement.

KLA-Tencor Confidential

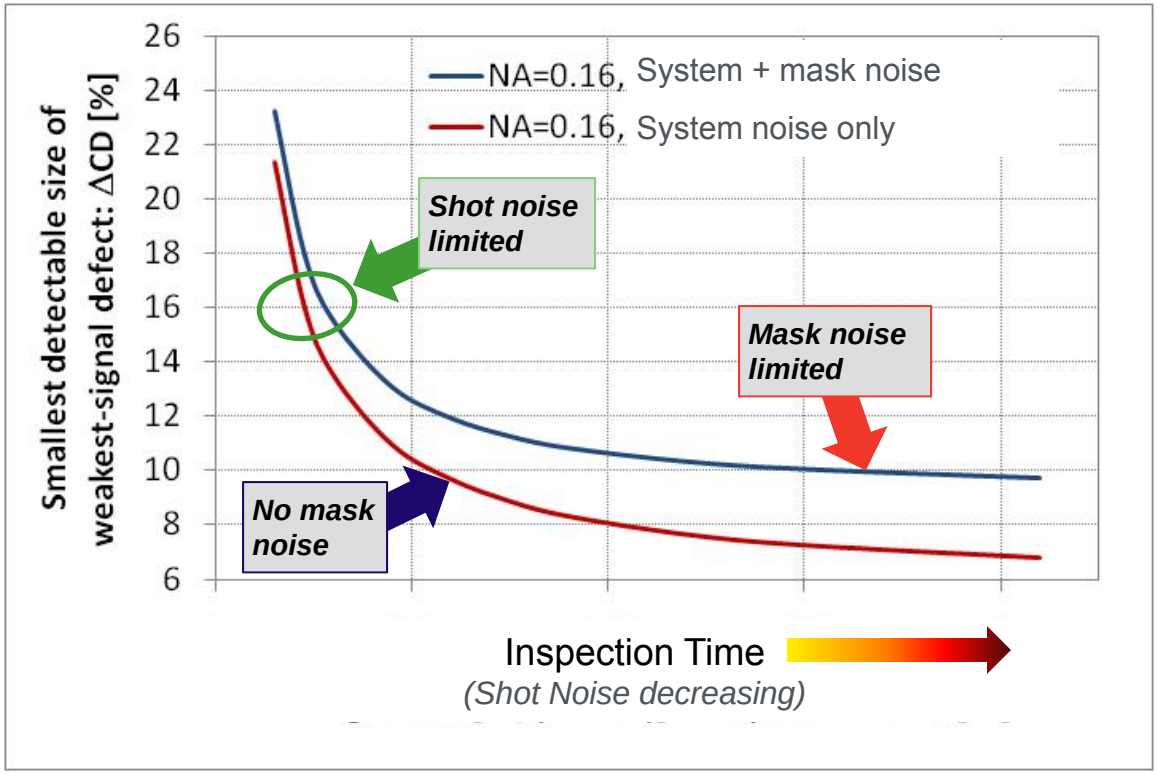
KLA-Tencor

APMI Performance Analysis - example at 16 nm HP

– *Dependence of defect sensitivity on inspection time*

- Defect SNR estimated for various optical architectures (NA, obscuration) and mask noise models
- Enables cost/performance tradeoff studies for optical architecture decisions

- ***Key finding:***
  - ***inspection sensitivity driven by absorber LER and multilayer roughness***

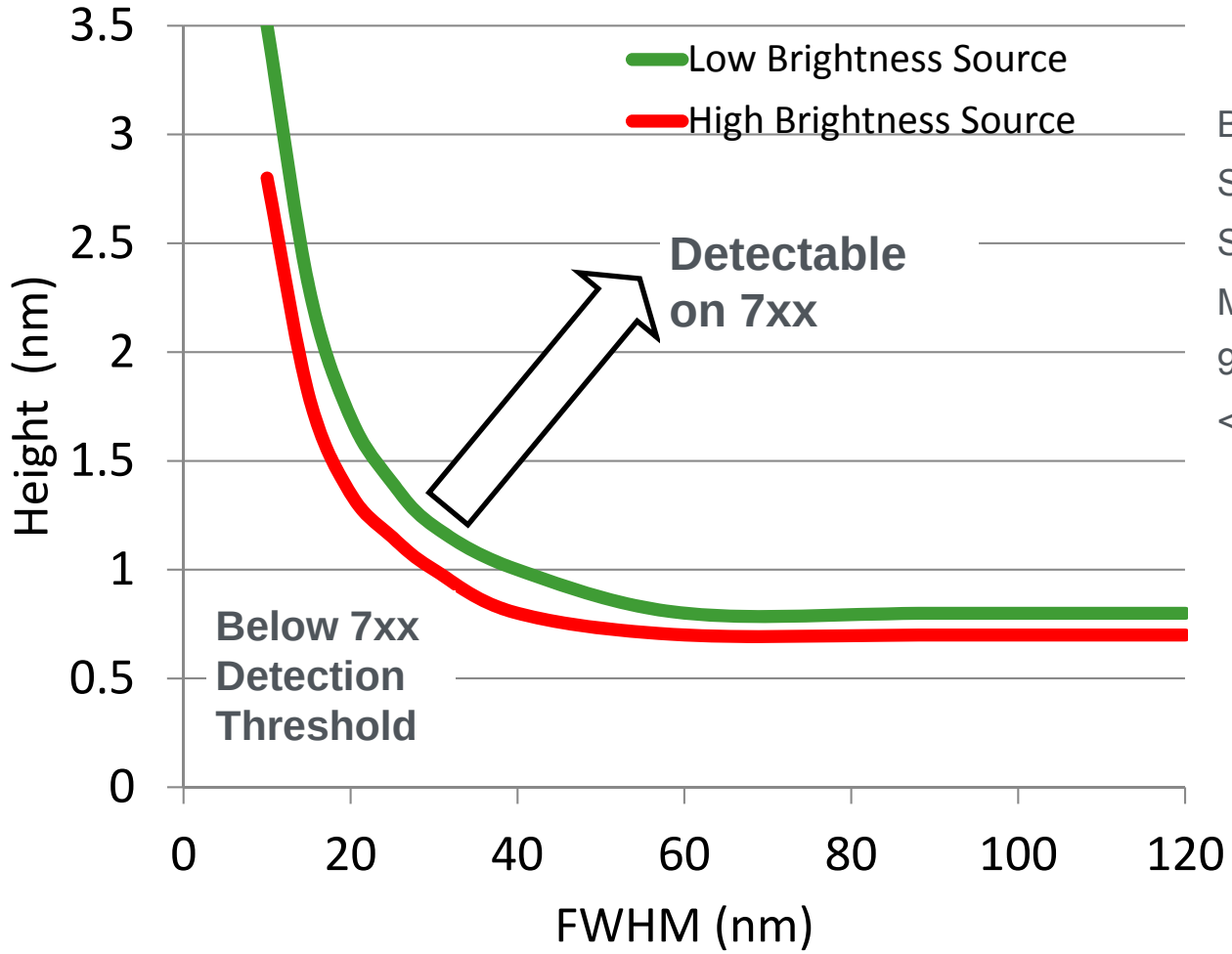


Model parameters:
16N, 1D defects
80pm (rms) ML roughness
0.4nm (rms) LER

Detection probability 99.8% (3σ)
Number of false defects: 100

KLA Tencor

Actinic (BF) Signal of Blank Phase Defects



Bright Field 0.0825 NA

Scan Area (141 mm)^2

Scan Time ~ 4 Hours

ML Roughness 100 pm *

99.7% Capture Rate

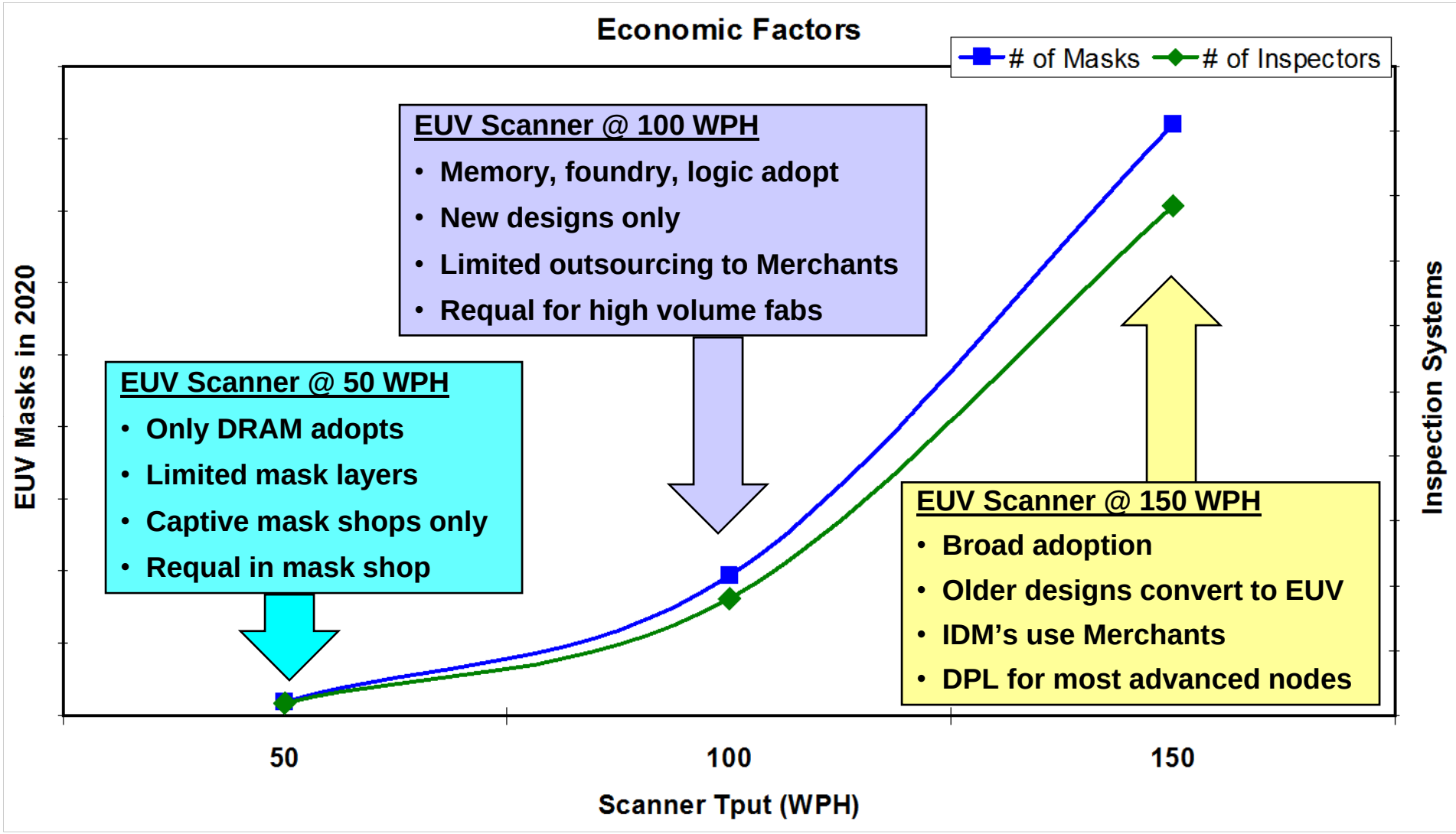
< 100 False Detections

- Defect signal estimates improved – thin-mask approx replaced with 3D EM calculations
- Multilayer roughness scattering included

KLA Tencor

Infrastructure Market Depends on Scanner Tput

Model developed to estimate EUV demand thru 2020



KLA Tencor

KLA-Tencor

Accelerating Yield

Copyright © 2010 KLA-Tencor Corporation