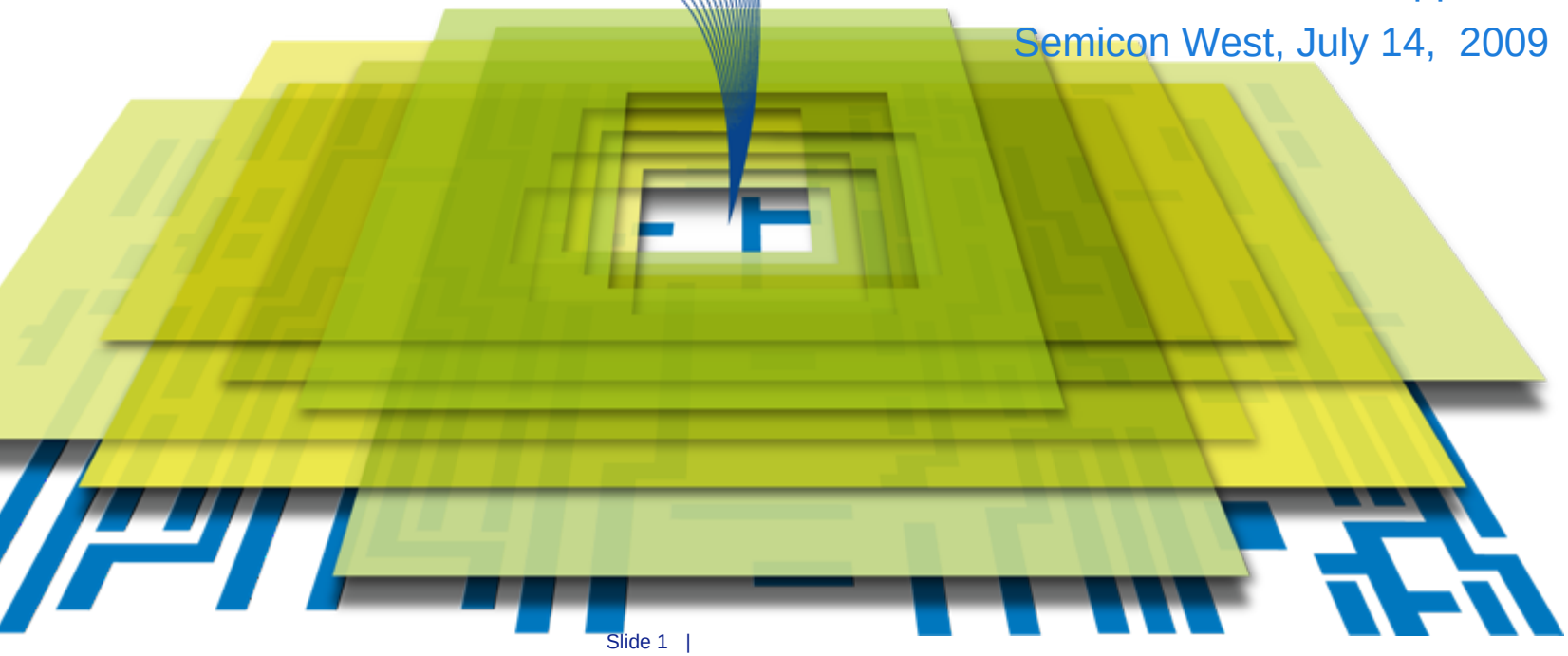
ASML Holistic Lithography

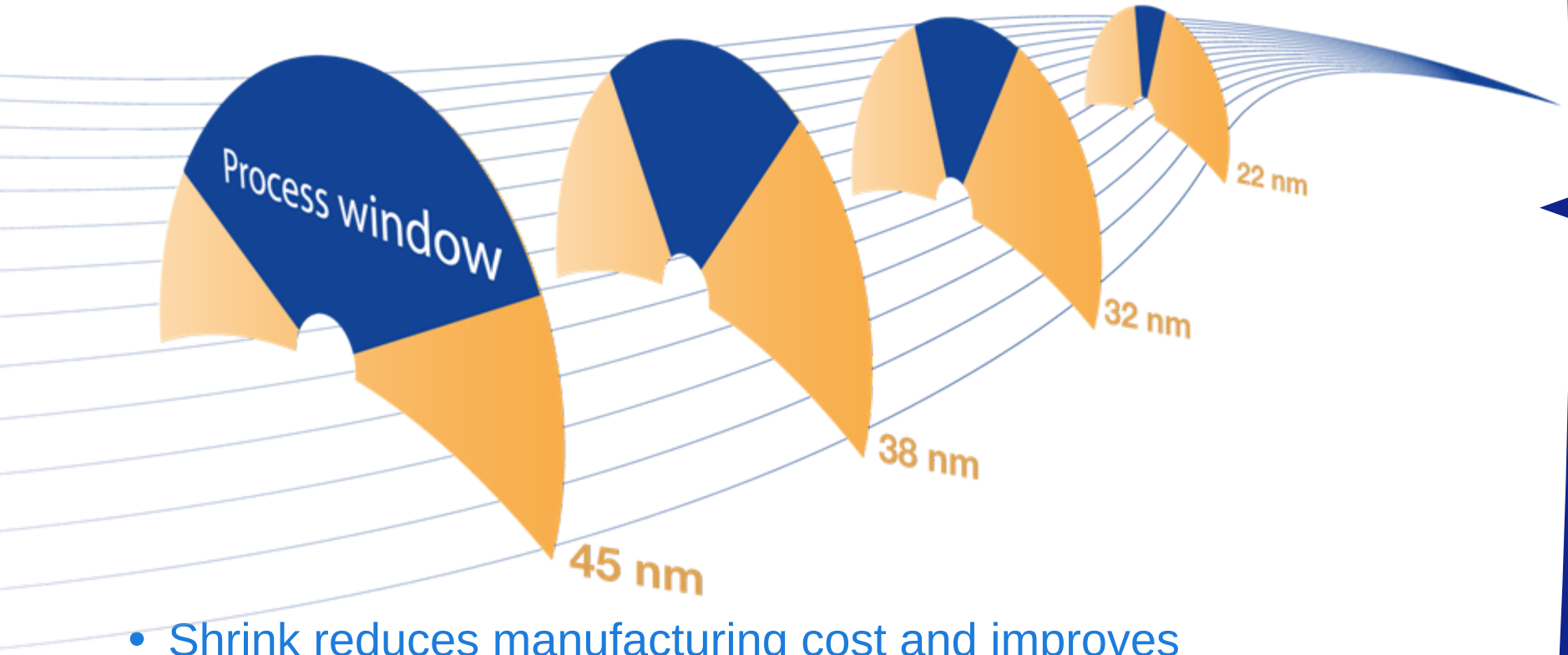
Open Your Window to Shrink

Bert Koek, SVP litho applications

Semicon West, July 14, 2009



Shrink is good…except when it's not



- Shrink reduces manufacturing cost and improves device performance
- **However**, shrink results in smaller process windows which compromise yield by restricting production tolerances

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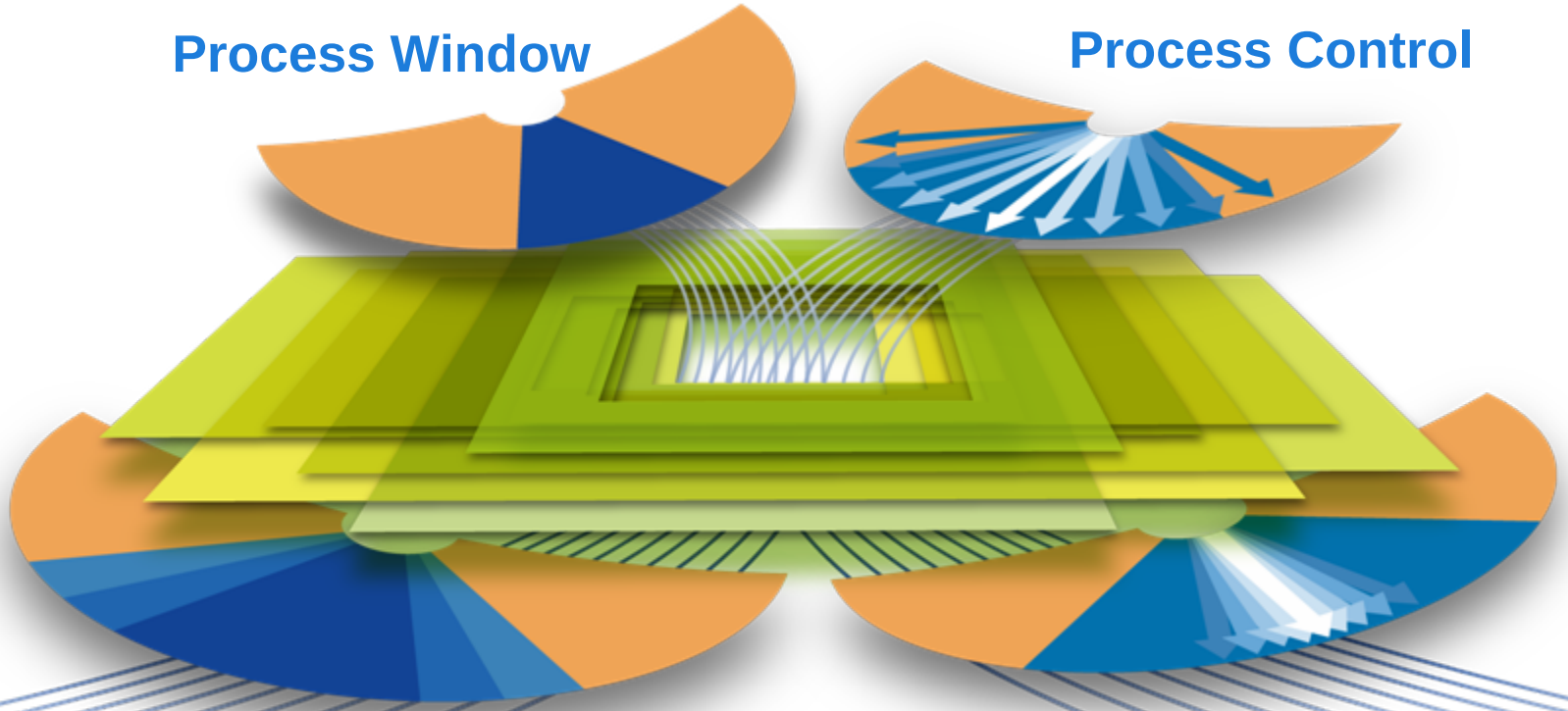
Holistic lithography provides a window to shrink



- Holistic lithography is the intelligent integration of computational lithography, wafer lithography and process control.
  - Before manufacturing, holistic lithography optimizes the process window at lower R&D cost
  - During manufacturing, holistic lithography keeps the process in the “sweet spot” of the window.

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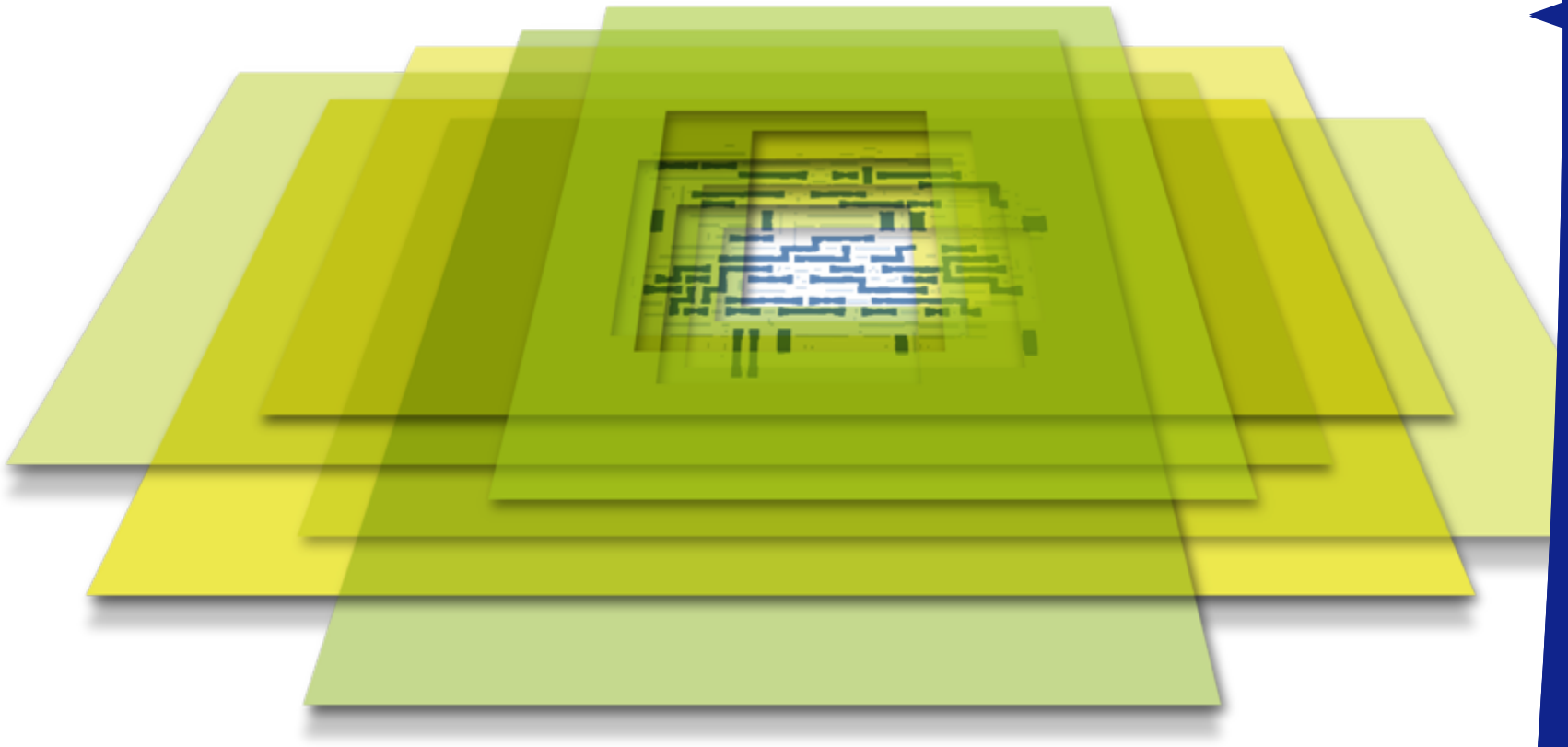
Optimized process window



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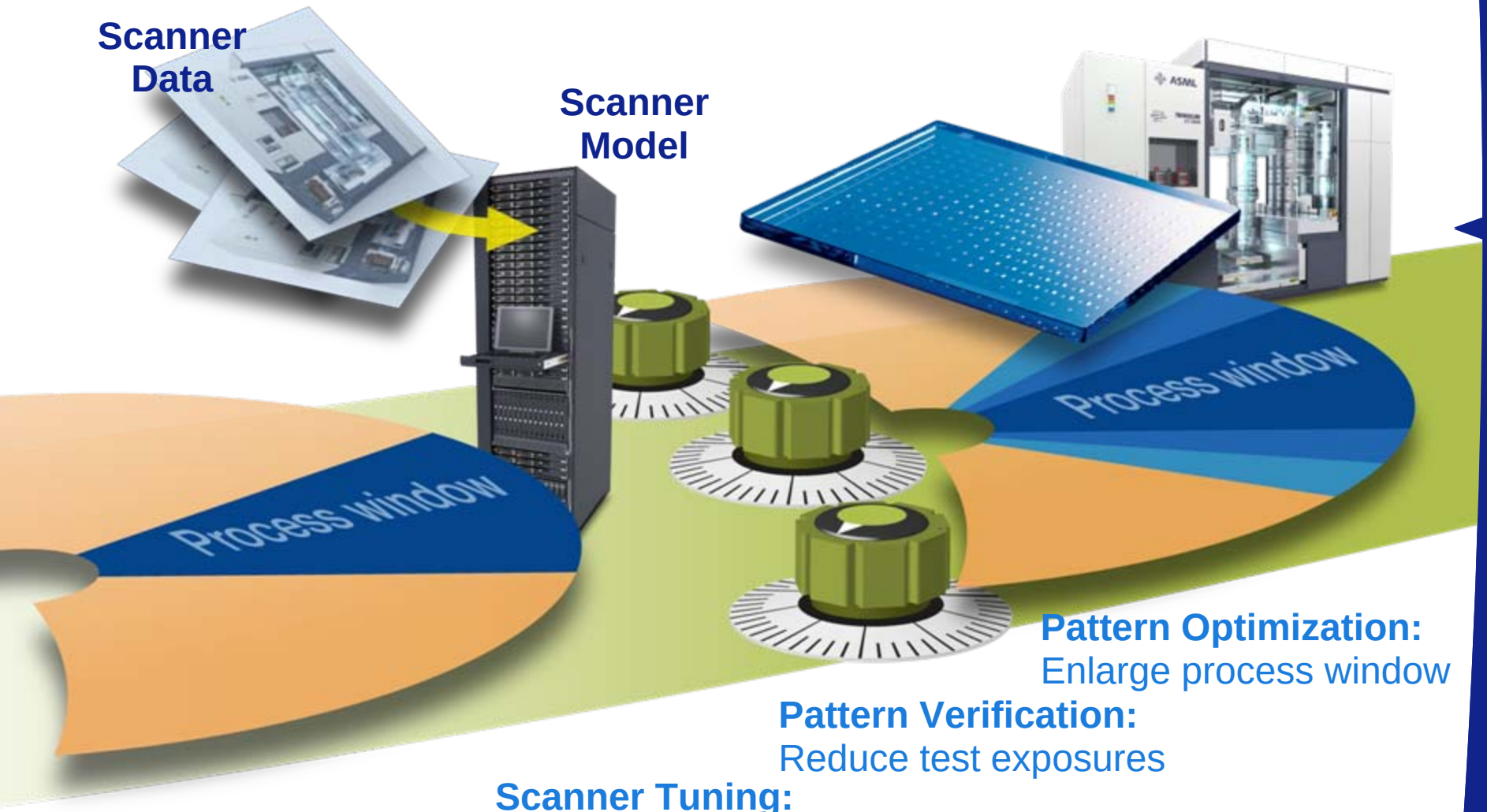
Actual scanner data enables better process window



Pattern Optimization:
Enlarge process window

Pattern Verification:
Reduce test exposures

Scanner Tuning:
Define optimum scanner setting

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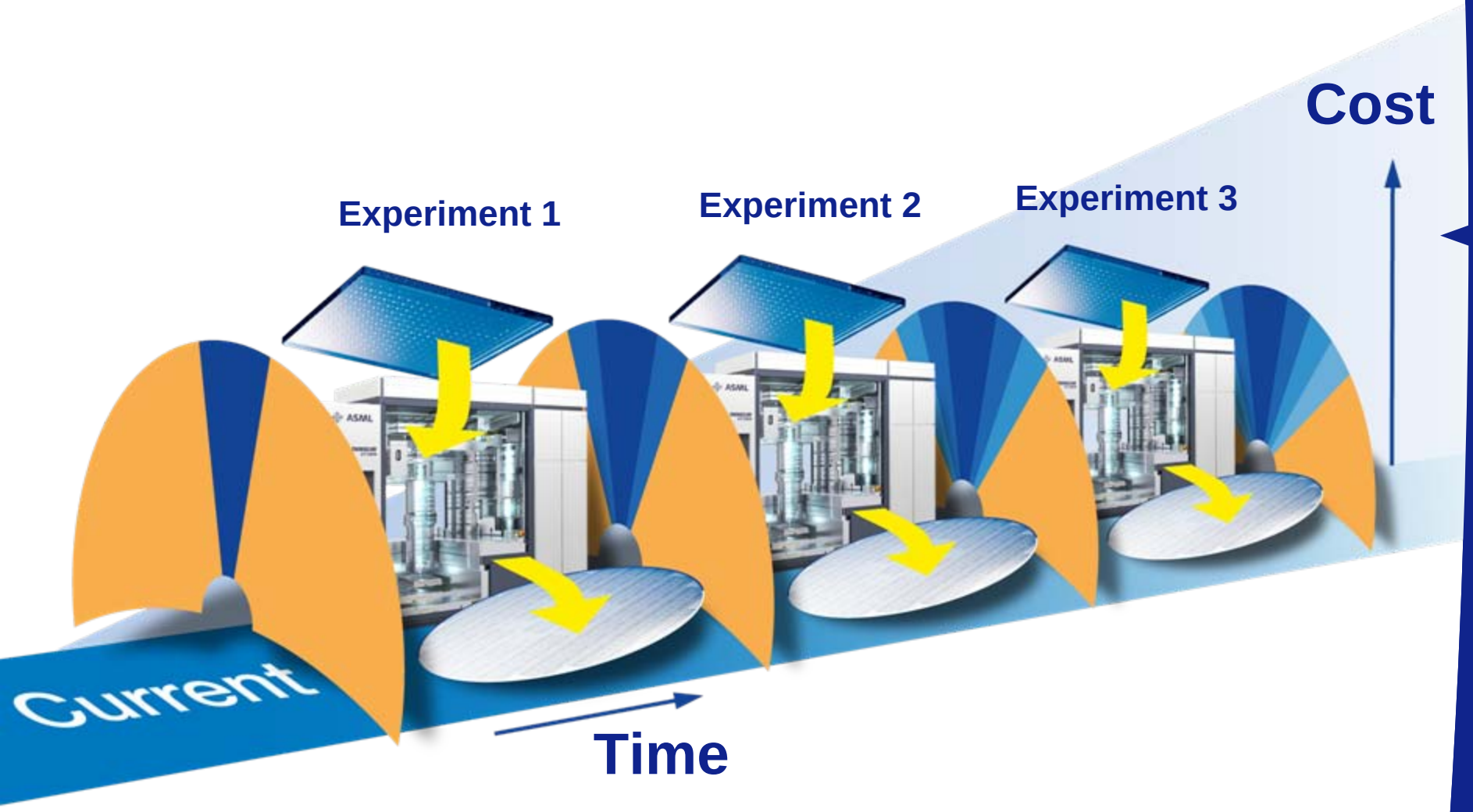
Faster time-to-money



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Faster time-to-money

Design verification is known much earlier:

- reducing design proofs
- reducing R&D cost
- reducing time to volume ramp-up
- higher yield at ramp to volume

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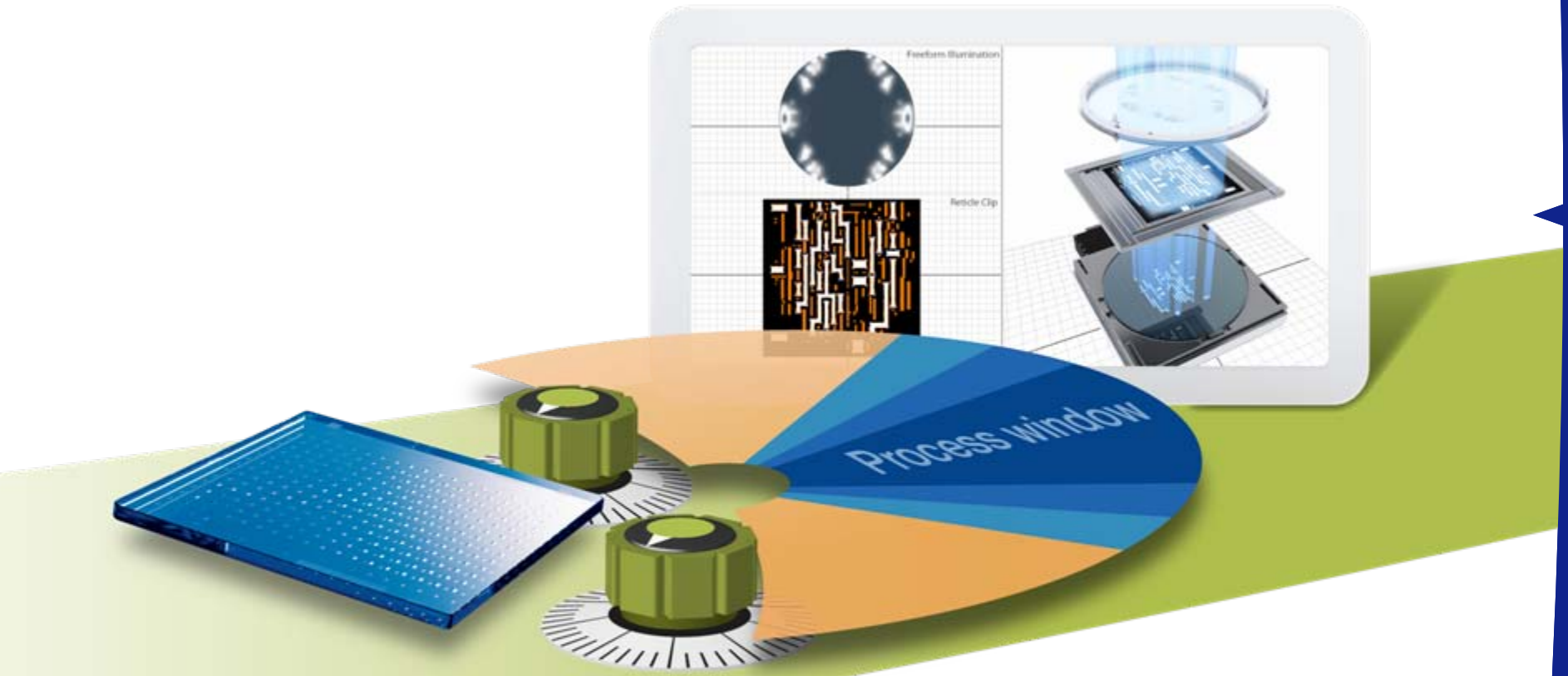
Tachyon SMO (Source Mask Optimization)



By co-optimizing the illumination and reticle, SMO will calculate perfect light conditions and line shapes for an optimal process window.

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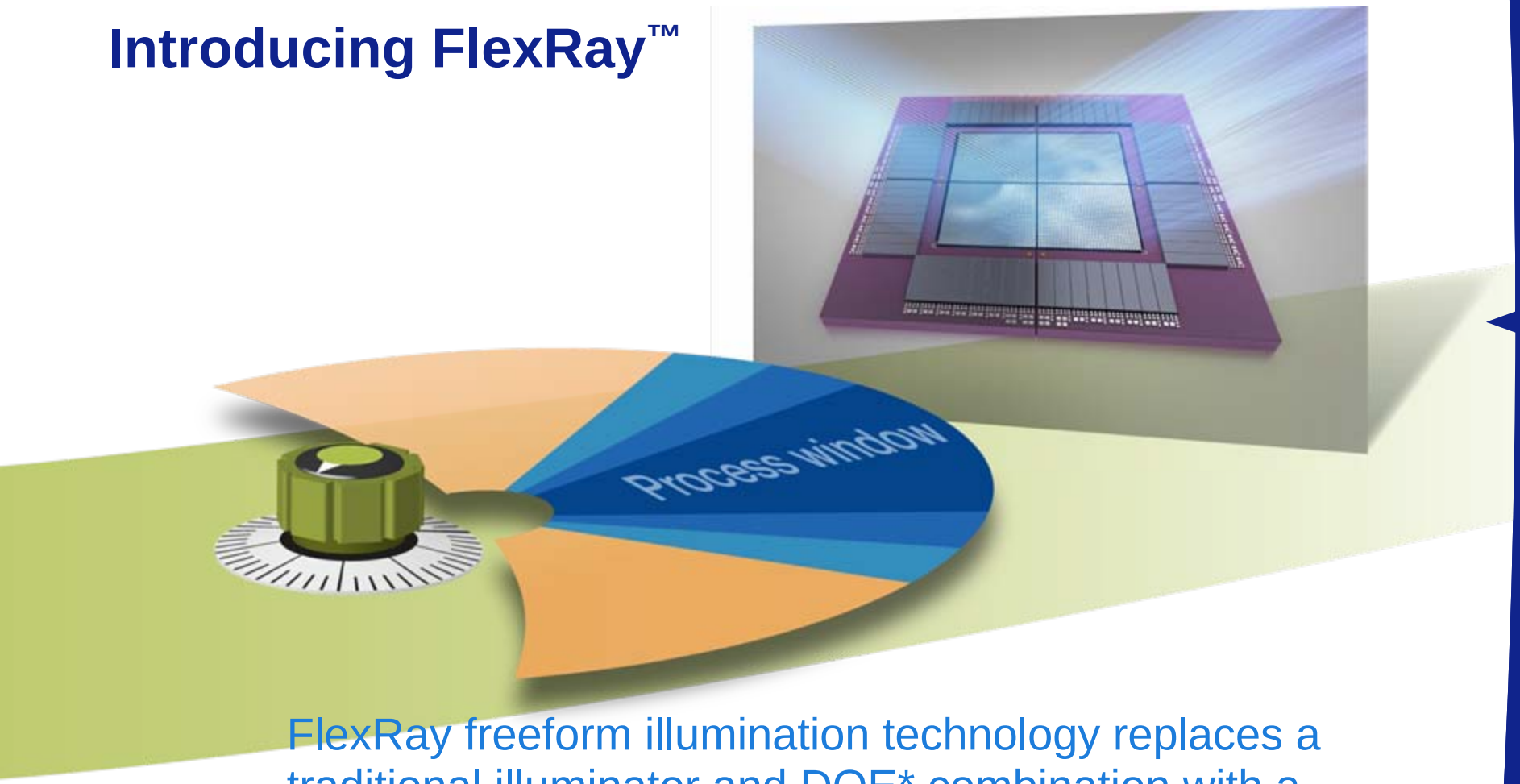
Introducing FlexRay™



FlexRay freeform illumination technology replaces a traditional illuminator and DOE* combination with a programmable micro-mirror array. This allows it to render any SMO** defined pupil shape in a matter of minutes.

* diffractive optical element

** source mask optimization

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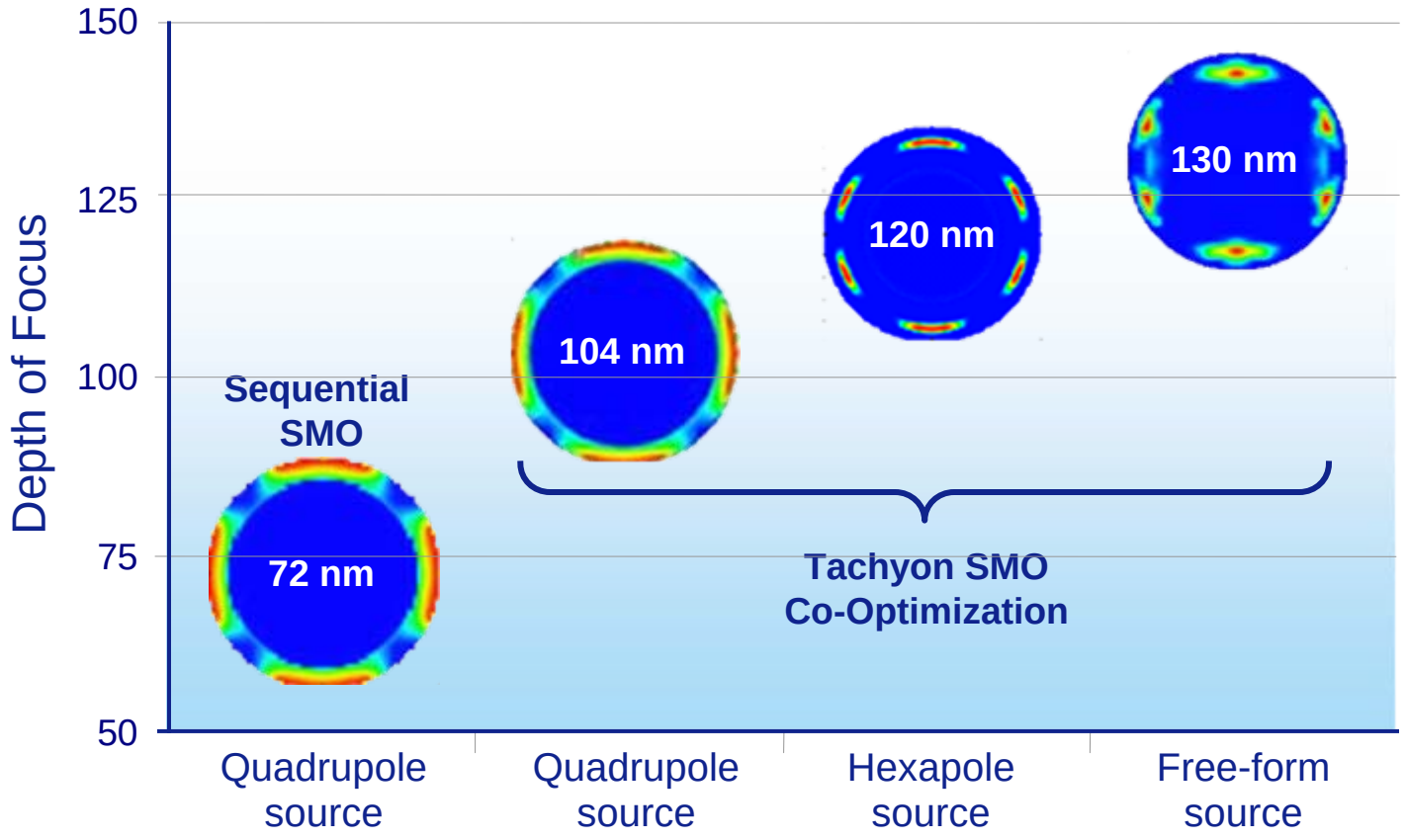
Mask and freeform source co-optimization improve process window



4x node
DRAM Contact

- XT:1900i, 1.35NA
- 6% AttPSM
- k1 < 0.35

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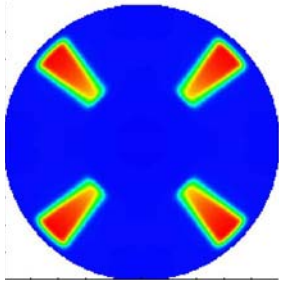
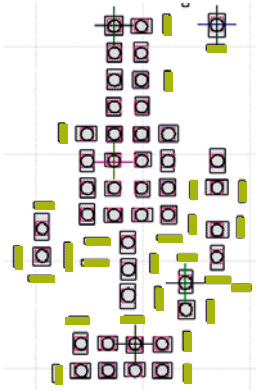
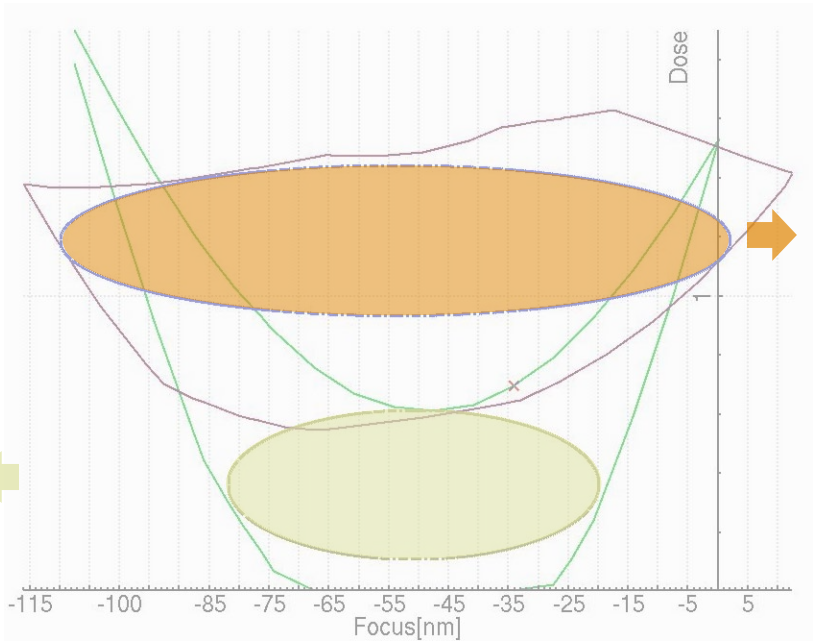
Tachyon SMO & FlexRay in Logic contact pattern:

Results in larger process window and lower mask complexity

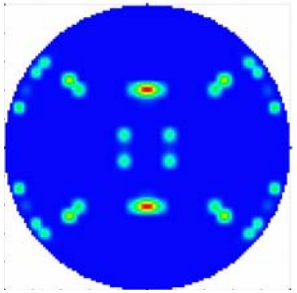
ASML quadrupole illumination shape

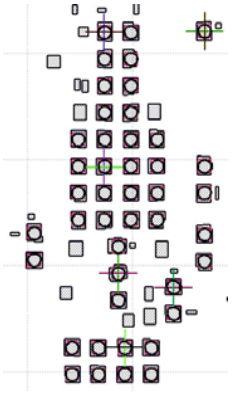






ASML freeform illumination shape





74 nm Depth of Focus @ 5% EL

110 nm Depth of Focus @ 5% EL

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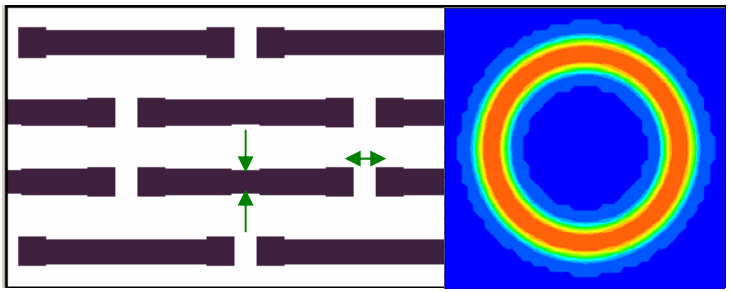
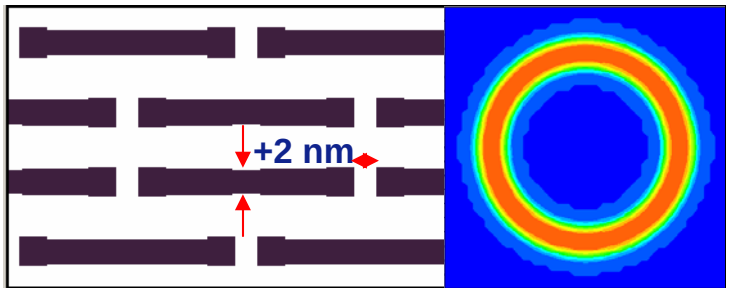
Reticle Specific Optimization combined with FlexRay illumination source adjustment

Compensating reticle bias errors while maintaining OPC validity



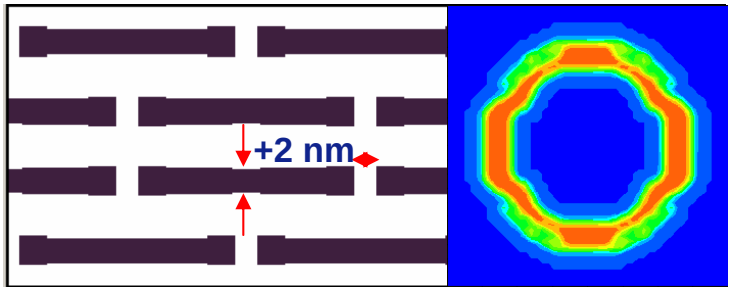
Wafer CD

Width = 44.1 nm
Gap = 58.4 nm



+2 nm bias error yields 6.5 nm gap error

Width = 44.1 nm
Gap = 51.9 nm



Source adjustment

Width = 44.1 nm
Gap = 58.4 nm

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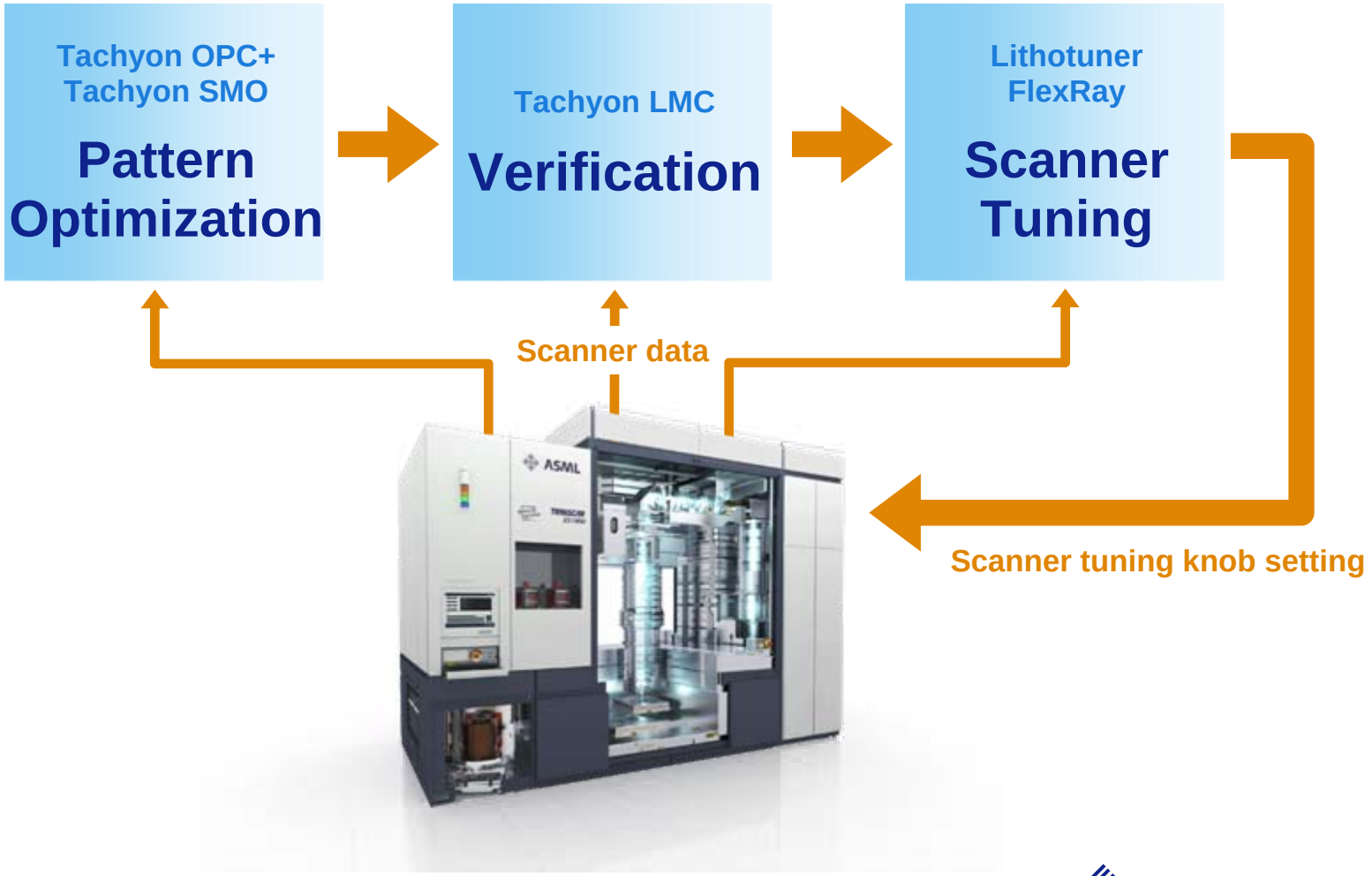
ASML holistic lithography application flow to optimize the process window



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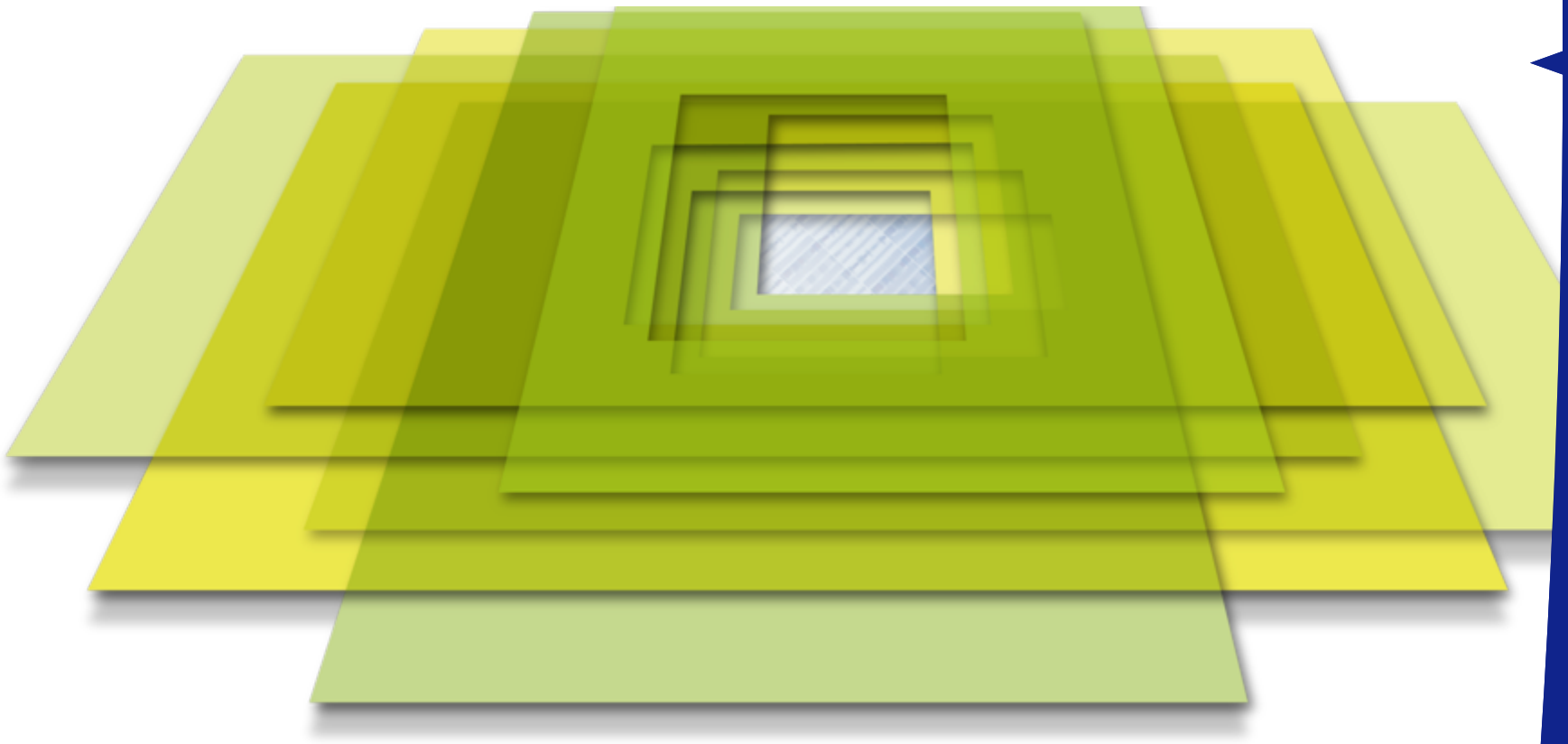
Improved production control



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Scanner tuning pre-sets and control loops for better production control

Measurement
Mask design
Monitor wafers
Process wafers

Tuning
Scanner tuning
Scanner Setting Verification
Process Control

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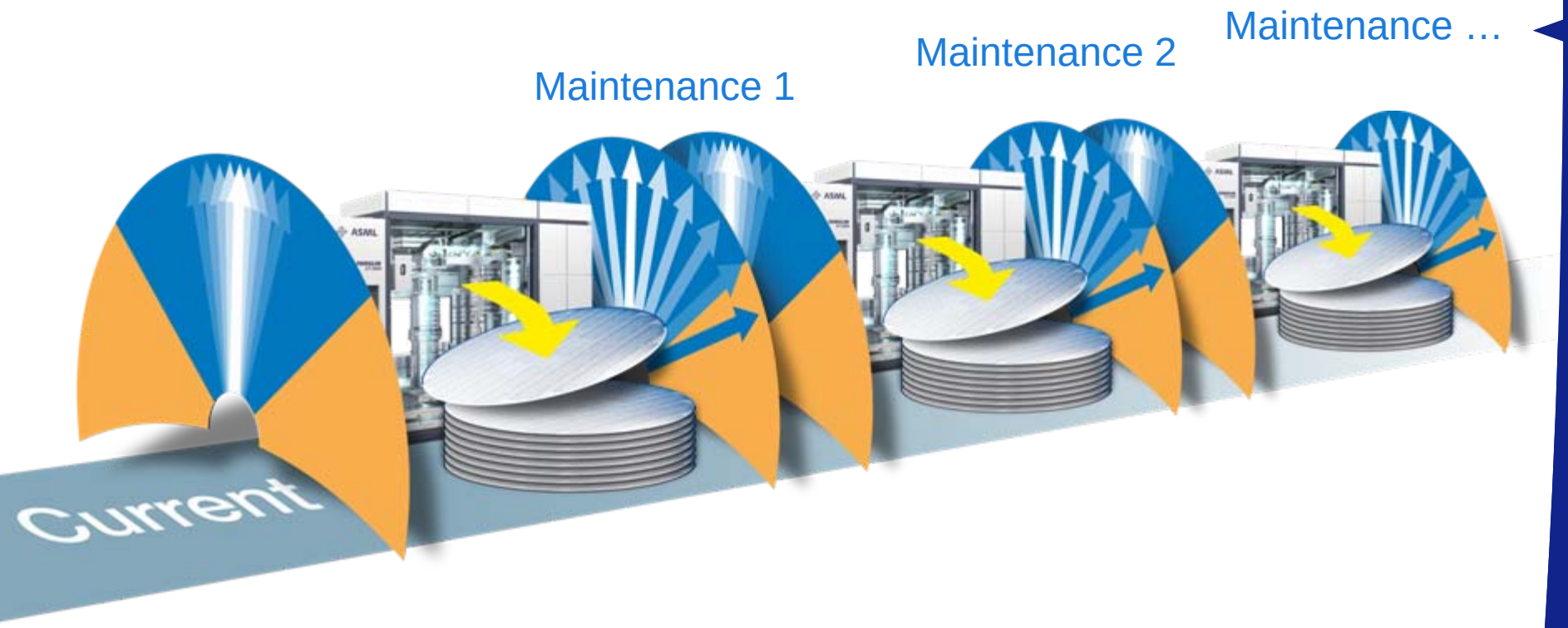
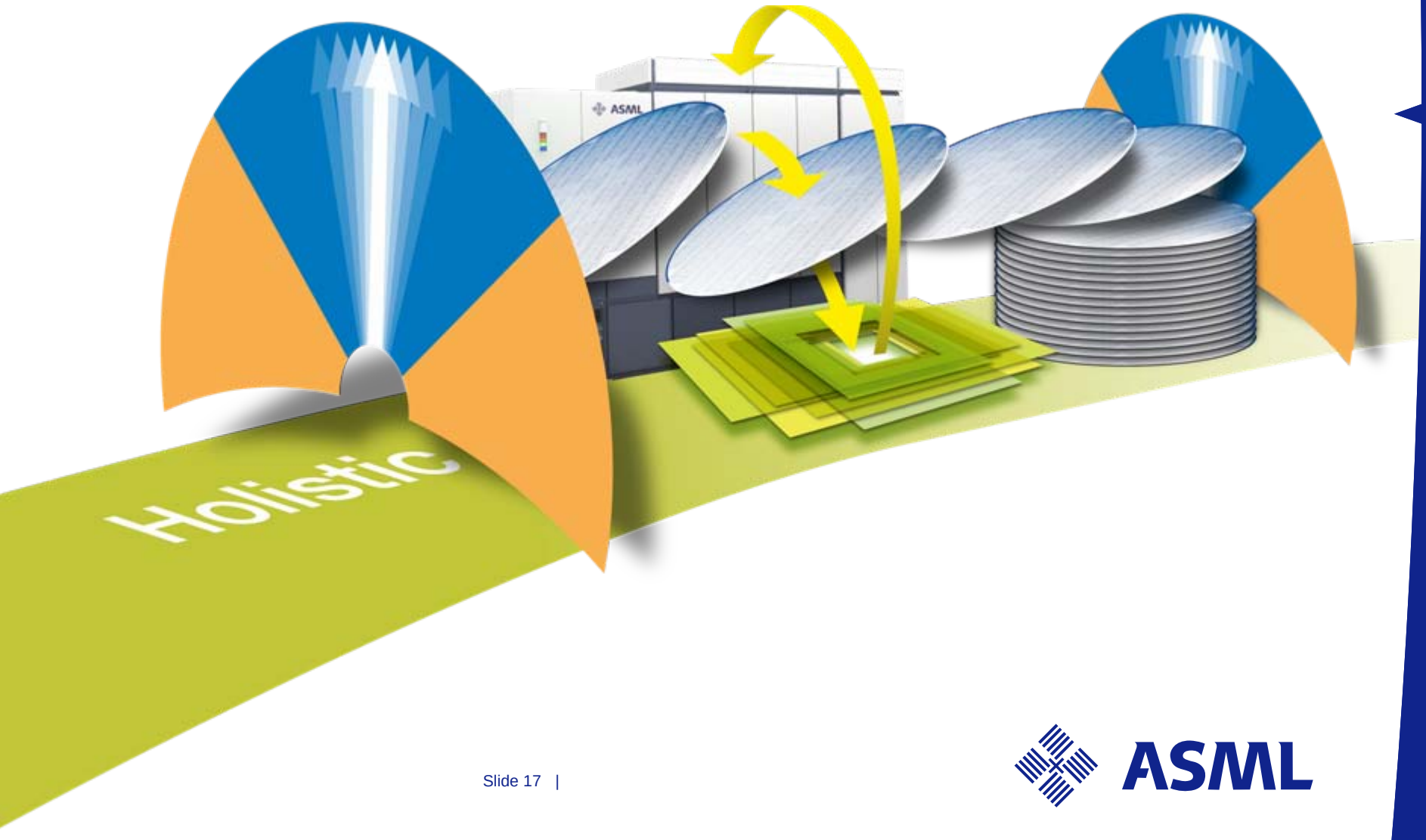
Better control for higher yield



Better control for higher yield



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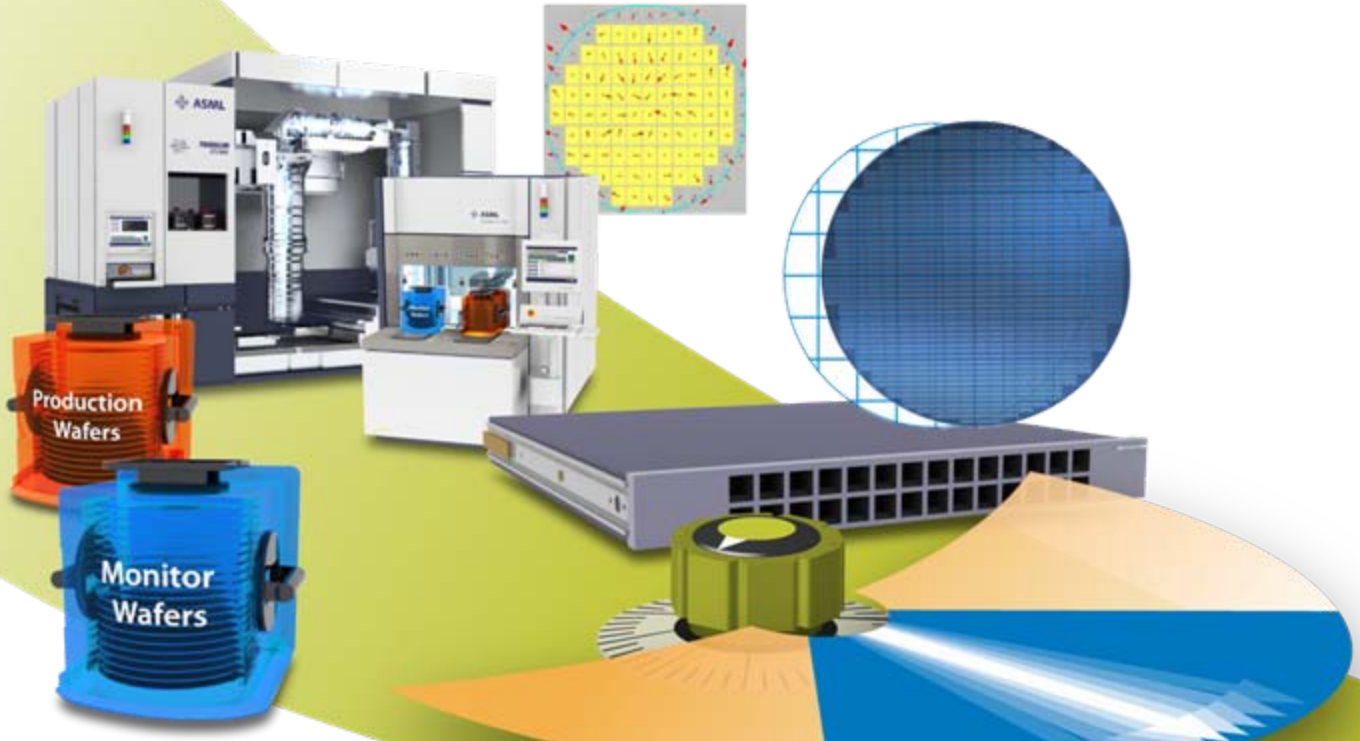
BaseLiner™ scanner stability



BaseLiner scanner stability is a complete scanner enhancement solution which maintains overlay and focus stability of TWINSCAN while increasing system availability.

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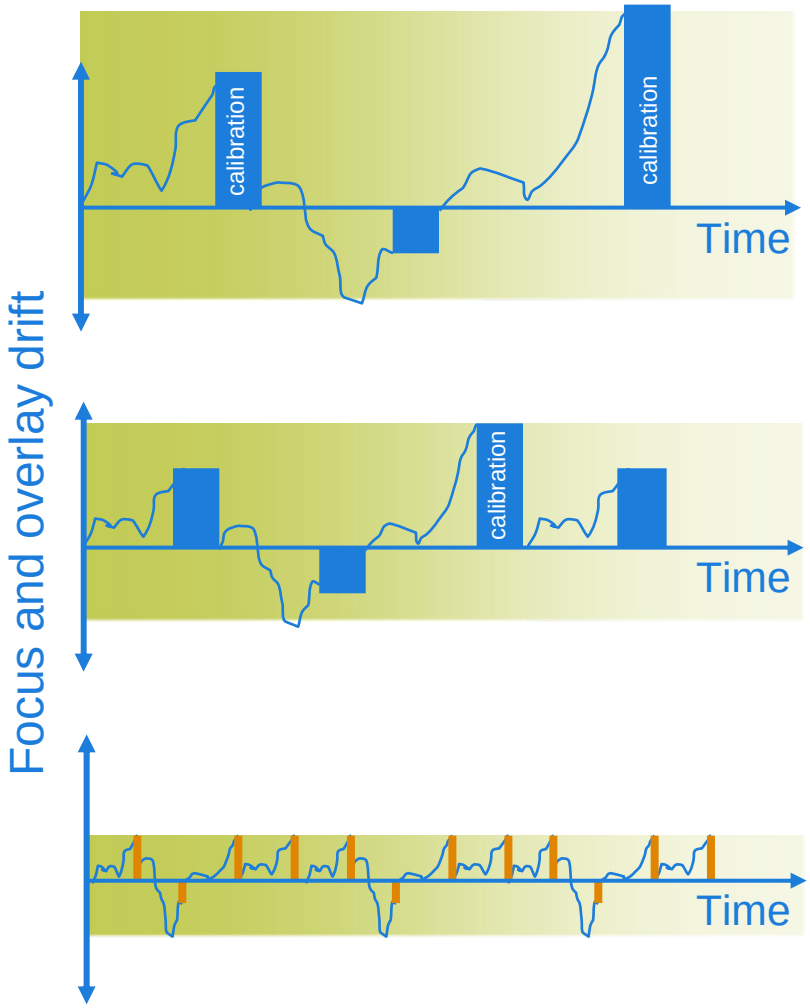
BaseLiner:
Smaller variation in process window, increased availability



System standard

System drift is countered by performing regular on-tool calibrations according to the ASML maintenance schedule to maintain the system within specified performance.

Tighter control to support smaller process window

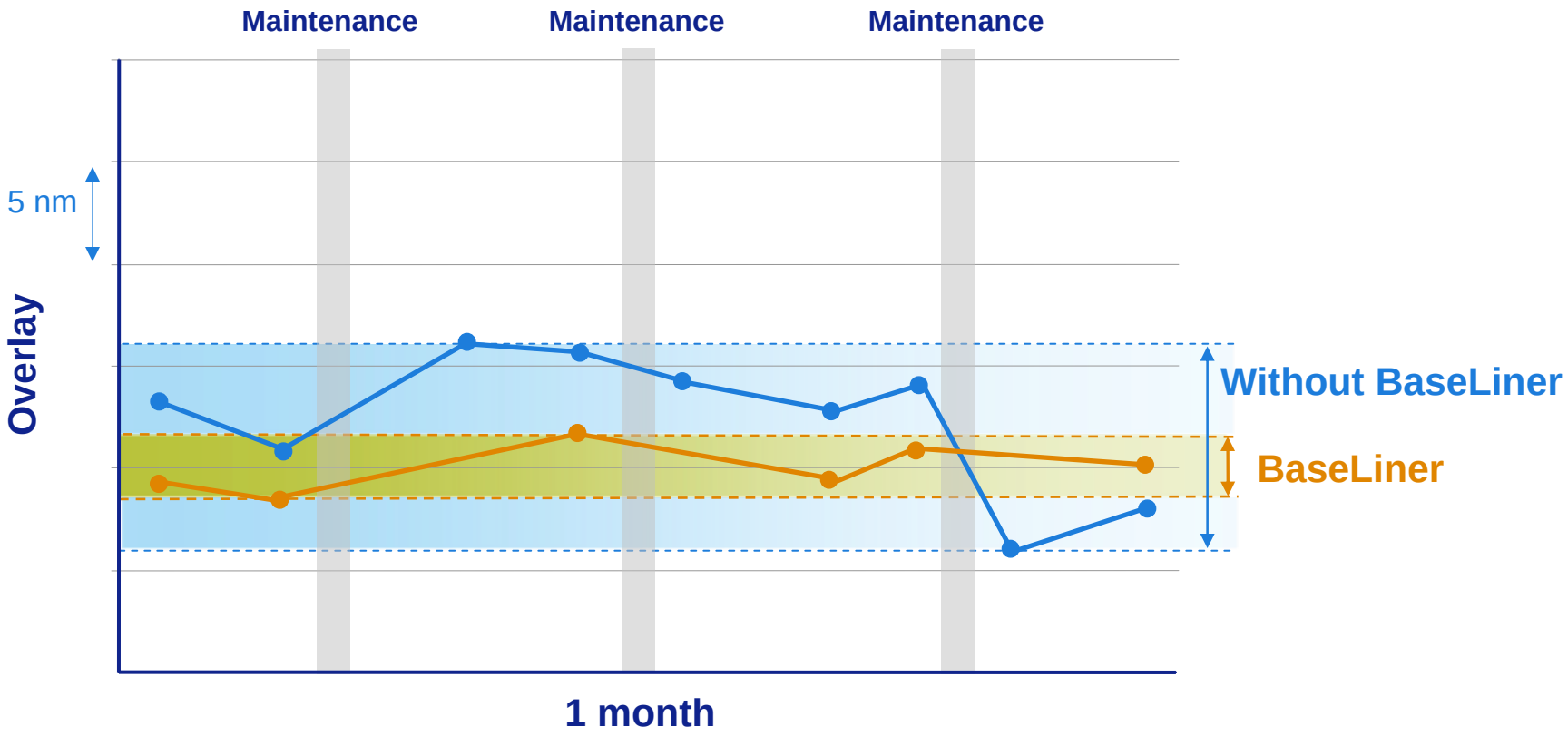
The process window can be maintained by performing more frequent calibrations, but this reduces availability/productivity and therefore decreases wafers-per-day.

BaseLiner

BaseLiner eliminates additional calibrations and applies corrections more frequently. Measurements are done off-tool using monitor wafers. Tighter control with increased wafers-per-day

BaseLiner: overlay stability improvement*

Including strategy to maintain stability



* Matched, full wafer on XT:1900i

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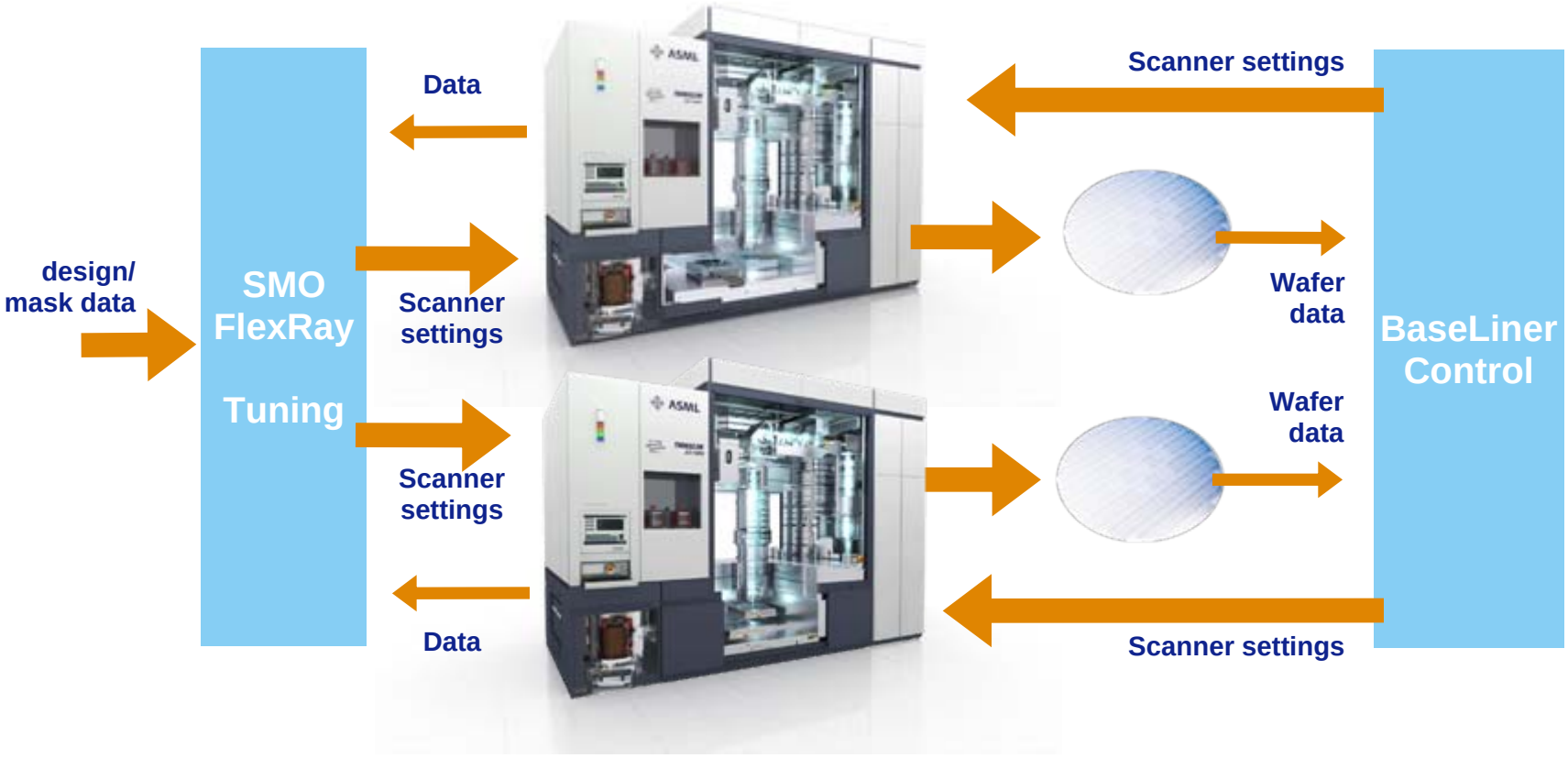
ASML holistic lithography flow for manufacturing

Faster ramp up and higher yield



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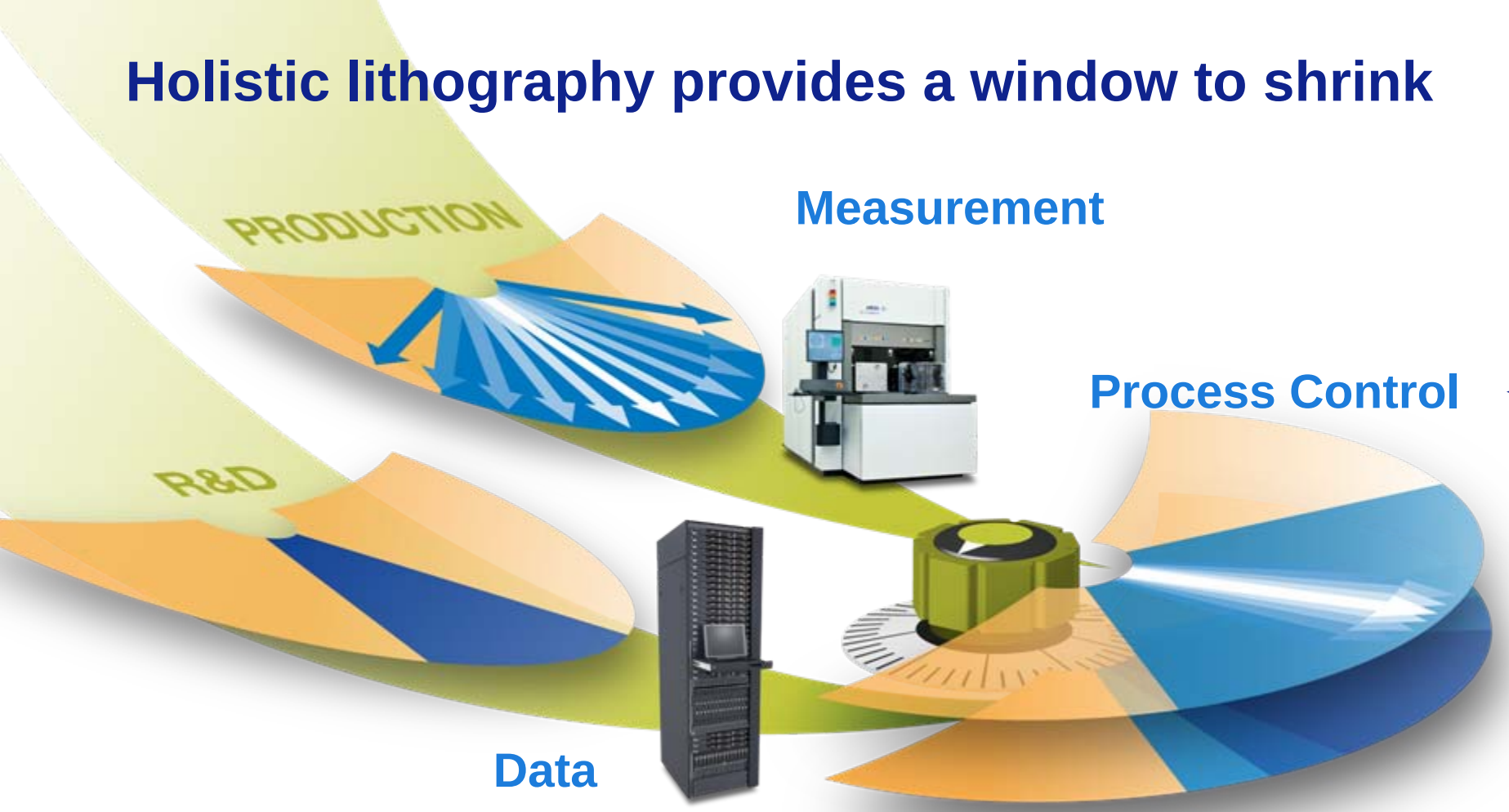
Holistic lithography provides a window to shrink



- Holistic lithography is the intelligent integration wafer lithography, computational lithography and process control
- Holistic lithography leverages increased and improved data integration to provide more control, better performance and higher yield

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Eclipse™ Holistic Lithography packages

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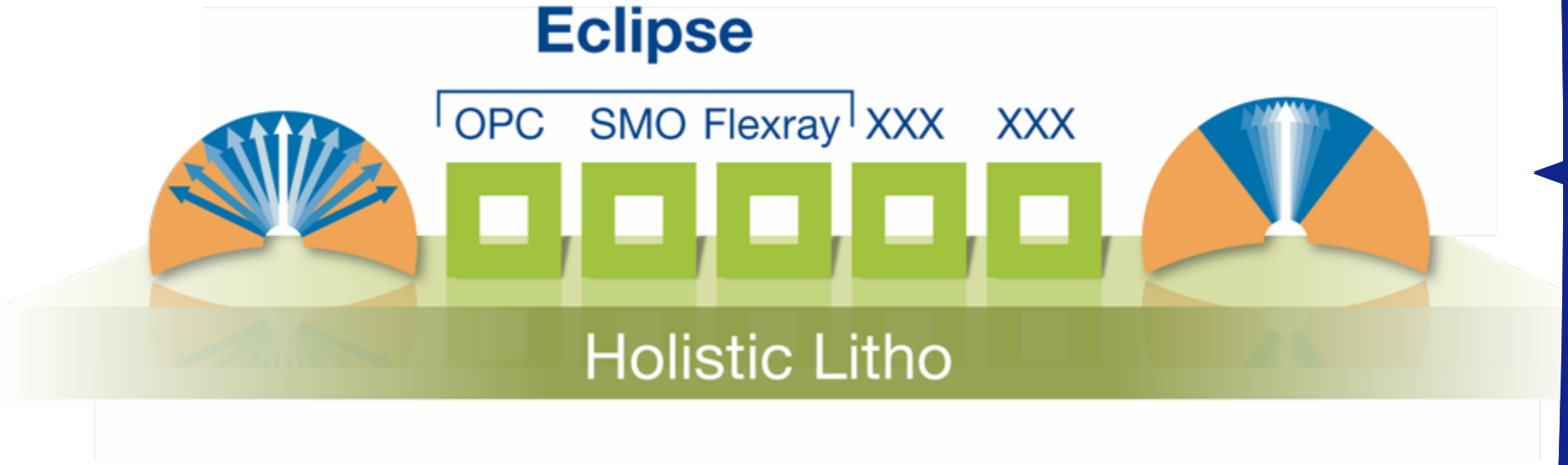
ASML makes Holistic Litho available via Eclipse



- Eclipse is a package of application- and node-specific products and services from our Holistic Lithography portfolio
- Eclipse packages provide chipmakers a window to shrink with cost reduction beyond traditional cost-per-layer

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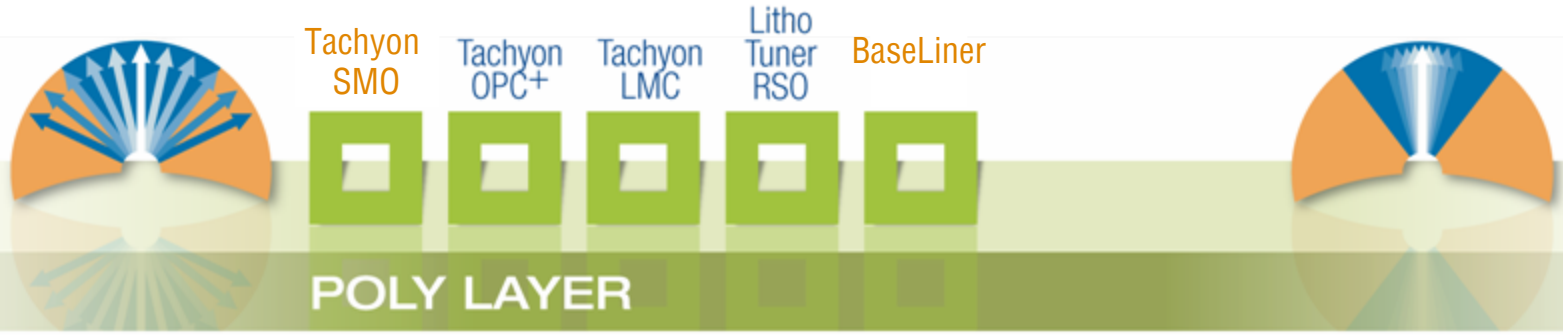
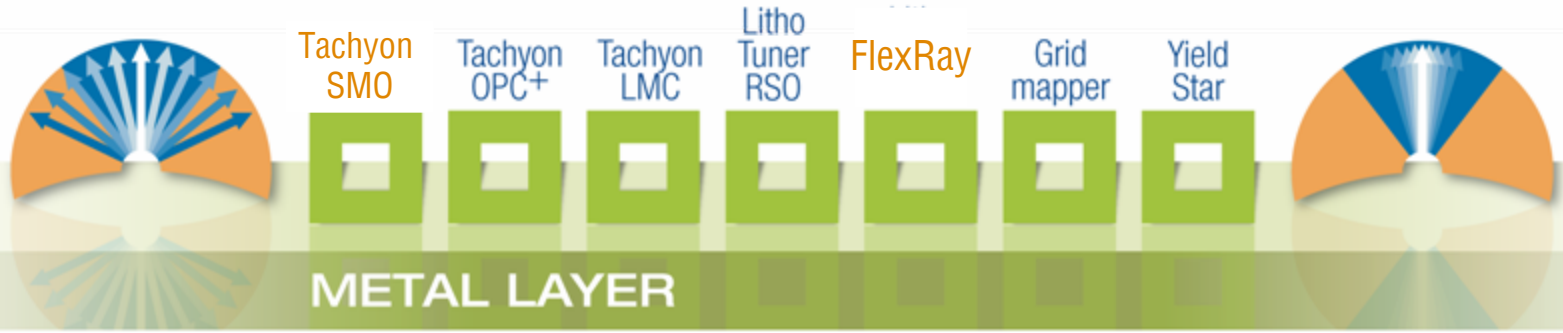
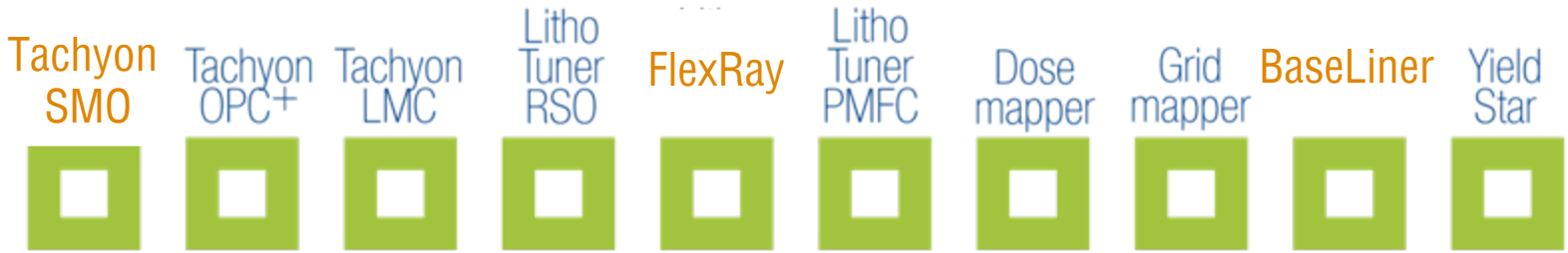
ASML makes Holistic Litho available via Eclipse







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