



ASML

Yieldstar Introduction

Training Dept.

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content

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- YS limitations
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 - Layout of YieldStar
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 - Flow and Temperature control
 - Wafer Positioning
 - Metrology
 - Wafer Handling
- General Diagnostics

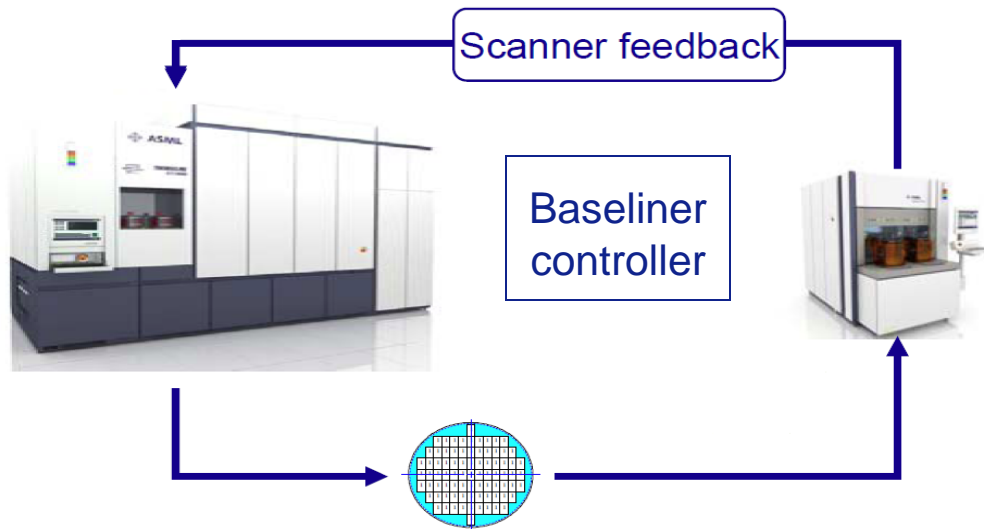
Metrology: Litho performance improvement with YieldStar

Goal:

- Improve Litho performance for CD and Overlay by measuring many points on the wafer using very fast metrology sensor
- Enable closed loop inter/intra-field corrections in the scanner.
 - On average 30-40% fab time is consumed by metrology

Introduction

- Metrology Tool
- Helps improve CD and Overlay
- Scatterometry
- Closed loop inter/intra field corrections
- 2 System types: Standalone (S) and Integrated (T)



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Metrology: Litho performance improvement with YieldStar

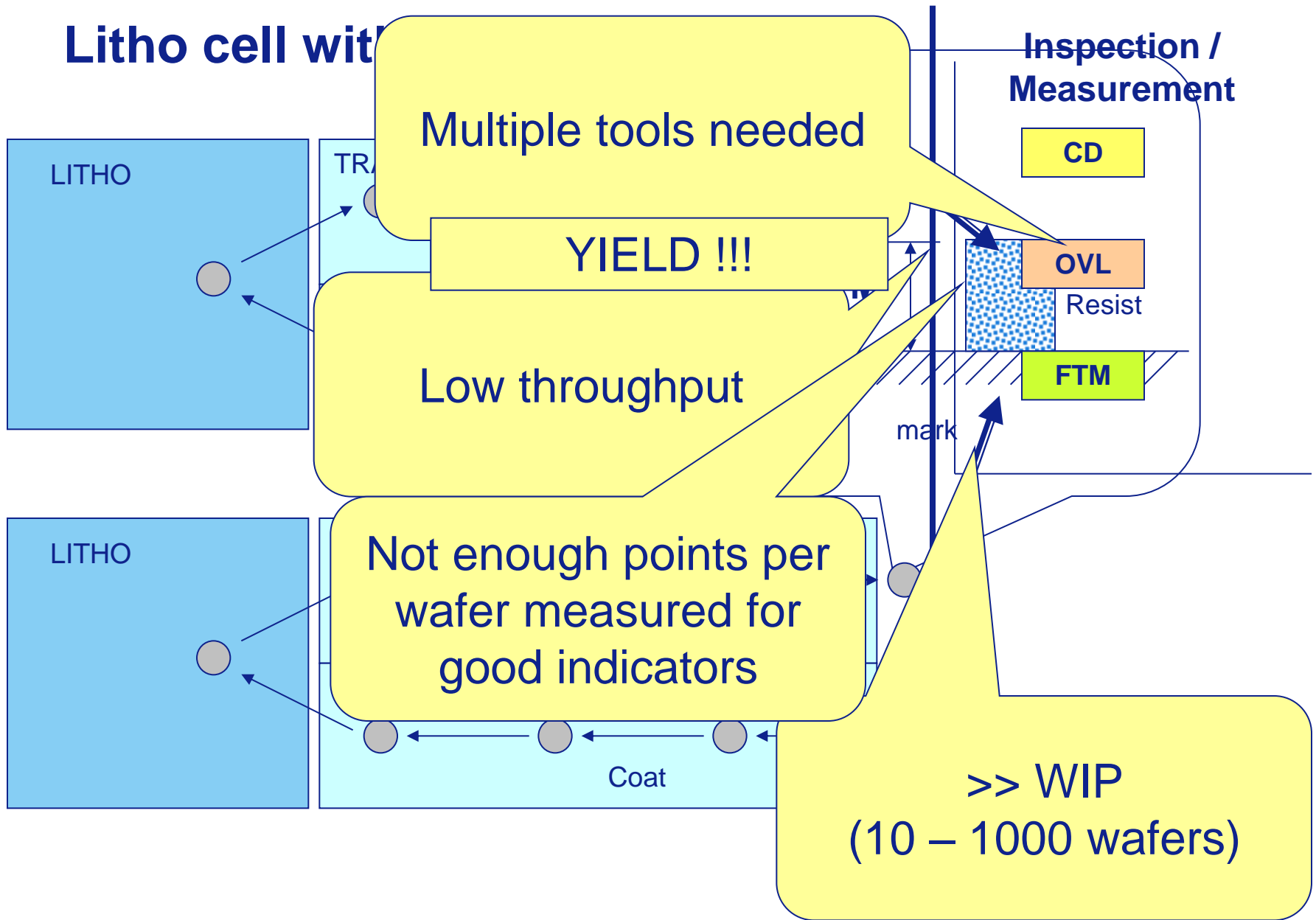
Concept:

- Optical concept allows CD and Overlay measurements, later versions, Film Thickness Measurements and Focus-Dose determination within lot.
- High brightness sensor, allows shorter measurement times using small marks.
- Fast inline measurement and feedback, within the lot CD/Overlay correction done by scanner → lower cycle times, less rework/scrap and optimized product.
- YieldStar technology enables small form factor metrology tool, suitable for integration into processing equipment.

Why use Integrated metrology?

- Lithography and process tool cost driving productivity.
- Process control requirements driving increased sampling.
- Factory automation is increasingly sophisticated.
- Fast production tools, required quick turn around data feedback time.

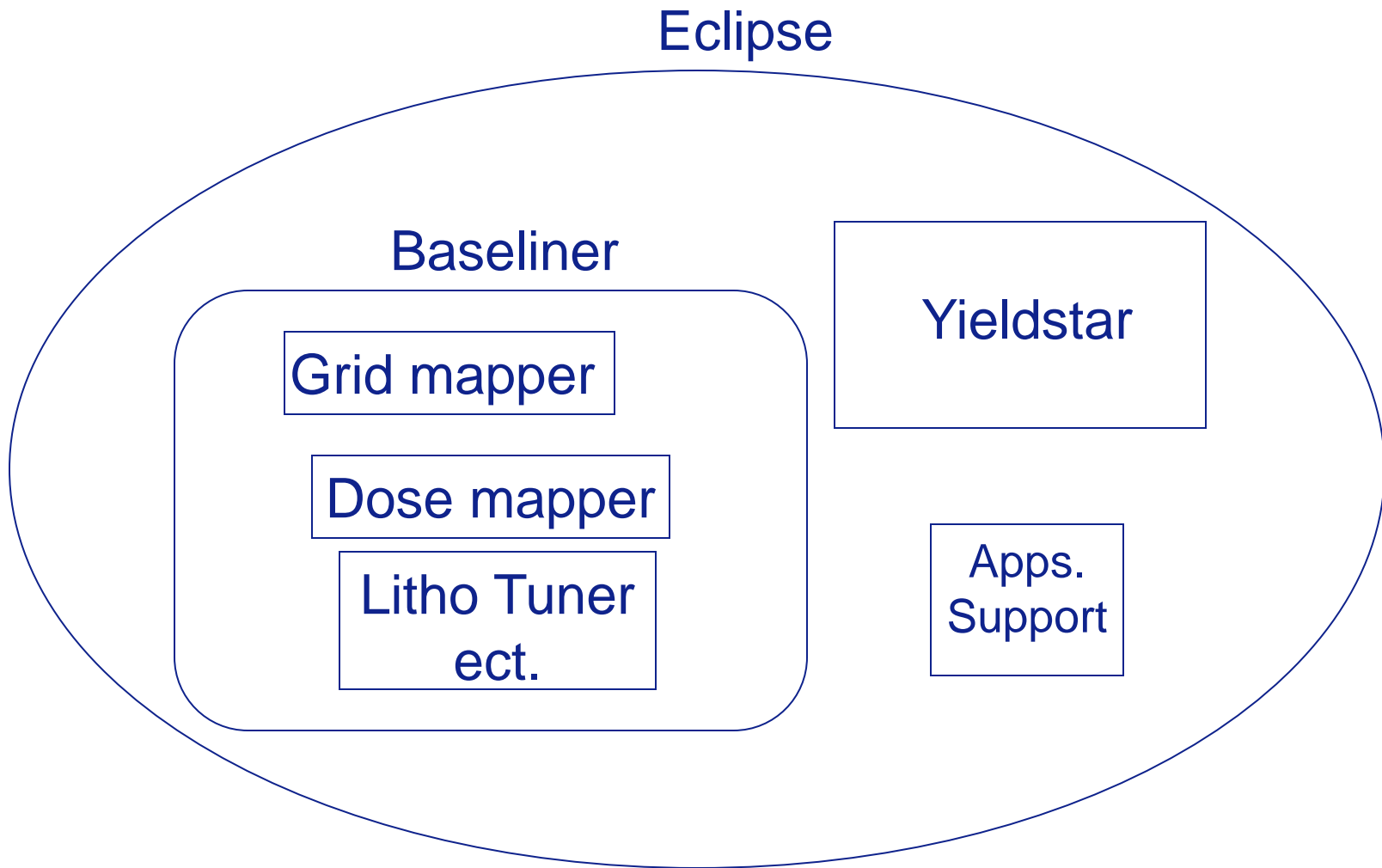
Litho cell with



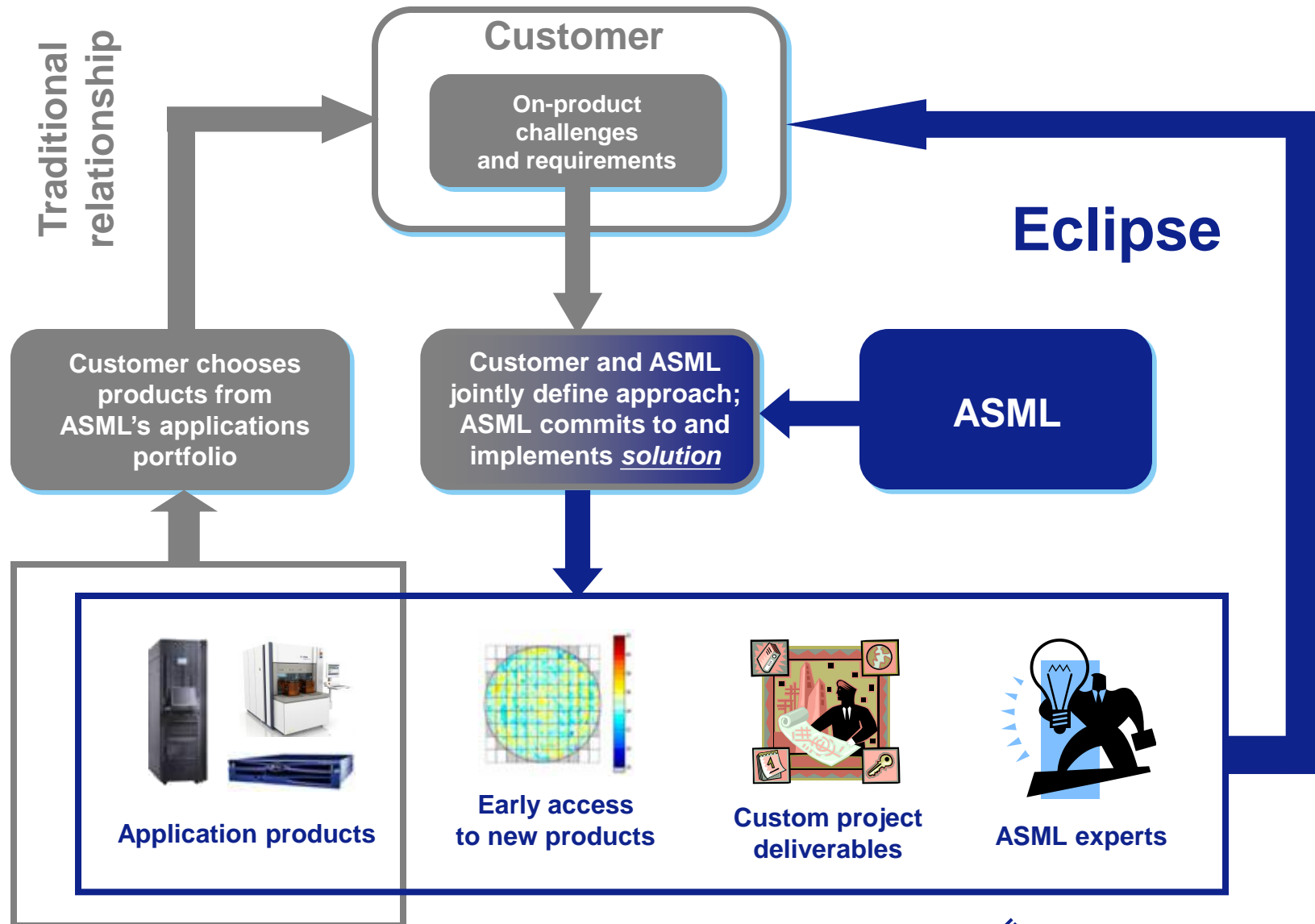
Key focus area's of the ASML solution

- **Throughput**
 - Able to measure all wafers in the lot at required sampling rate
 - High speed stages enabling short move acquire move (MAM) times
 - Short acquisition time enabled by high intensity spot
- **Feedback to Litho**
 - Direct link to TWINSCAN through DoseMapper and GridMapper
- **One tool for Process Control Metrology**
 - Overlay, CD, focus/dose, resist thickness and refractive index
 - Foot print reduction for stand alone, only one location in the track required.
 - Less engineering attention required (matching and maintenance)

Product hierarchy

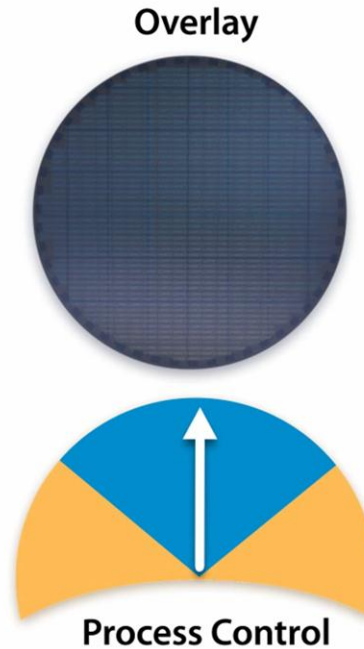


Eclipse model: beyond the traditional relationship

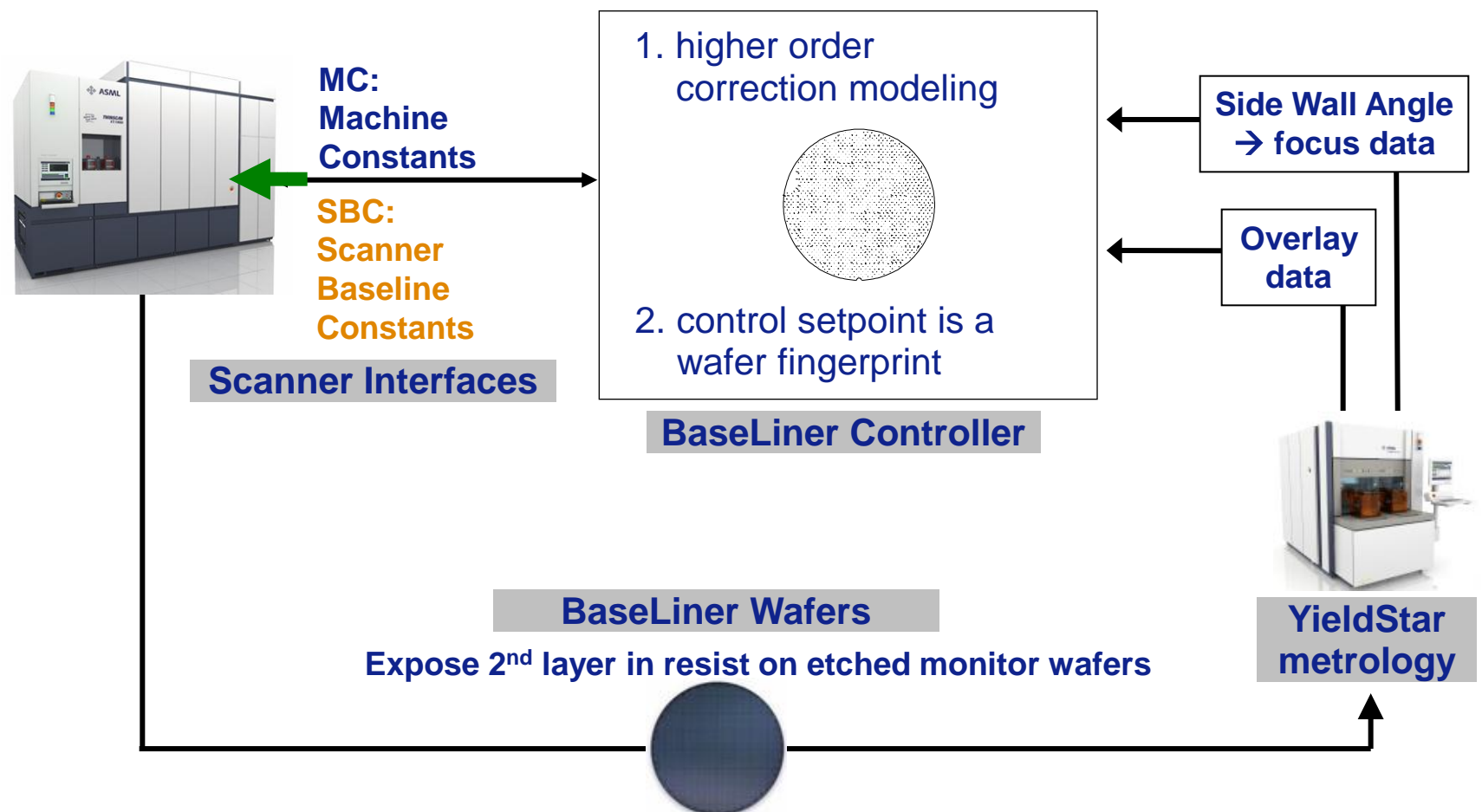


Baseliner: Overlay and Focus stability control

Generic Control



BaseLiner Stability controls Overlay & Focus with a Monitor Wafer



Value To Customers

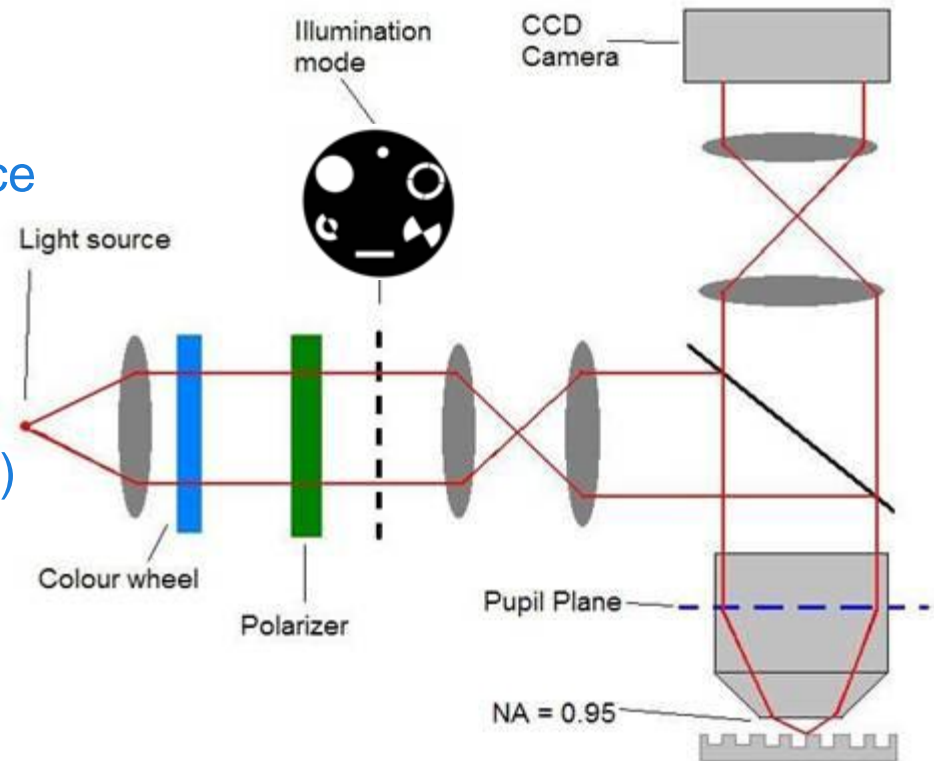
- Dynamic correction per wafer
- Single sensor for CD and Overlay
- System benefits:
 - No compatibility issues
 - Fast info transfer between litho tool and YS
 - Shorter measuring times
 - Very high repeatability
 - High throughput (200wph)
 - Non-destructive measurements
 - Low level of machine maintenance
 - Relatively low cost

Baseliner

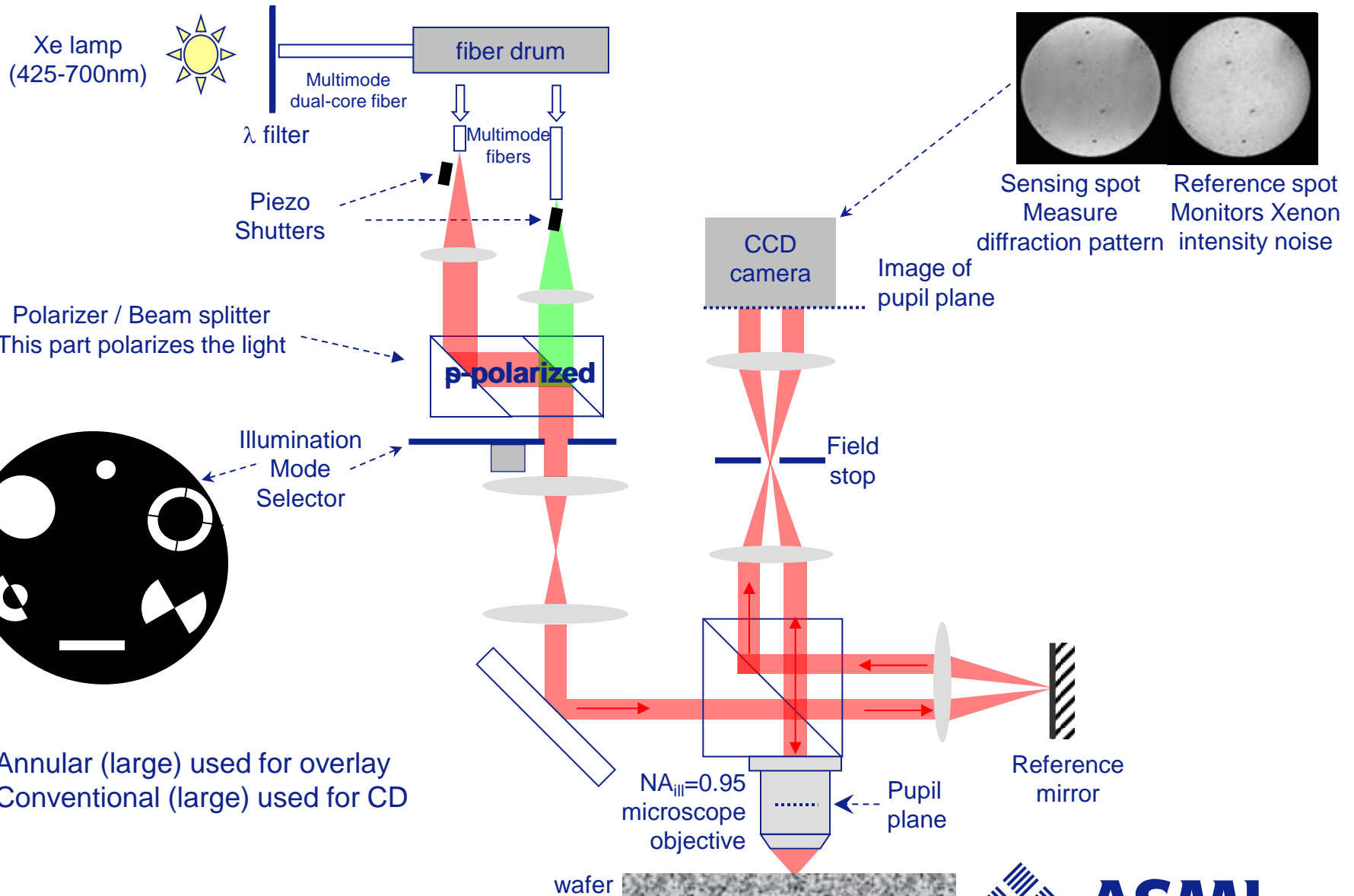


Optical Components

- Adjustable: color filter (λ), polarizer & illumination setting
- Multiple wavelength light source (Xenon lamp)
- 7 filters from 425nm – 700nm
- 2 polarizer settings (2 fibers)
- Large Numerical Aperture (NA)
- Sensing CCD camera focused on pupil plane, not wafer
- Limitless sensitivity; heavily dependant on light uniformity



Optical overview



YieldStar Principles

- Metrology Language
- What is Scatterometry?
 - OVL Measurements
 - CD Measurements

Metrology Language Explained



Low Accuracy
High Precision



High Accuracy
Low Precision



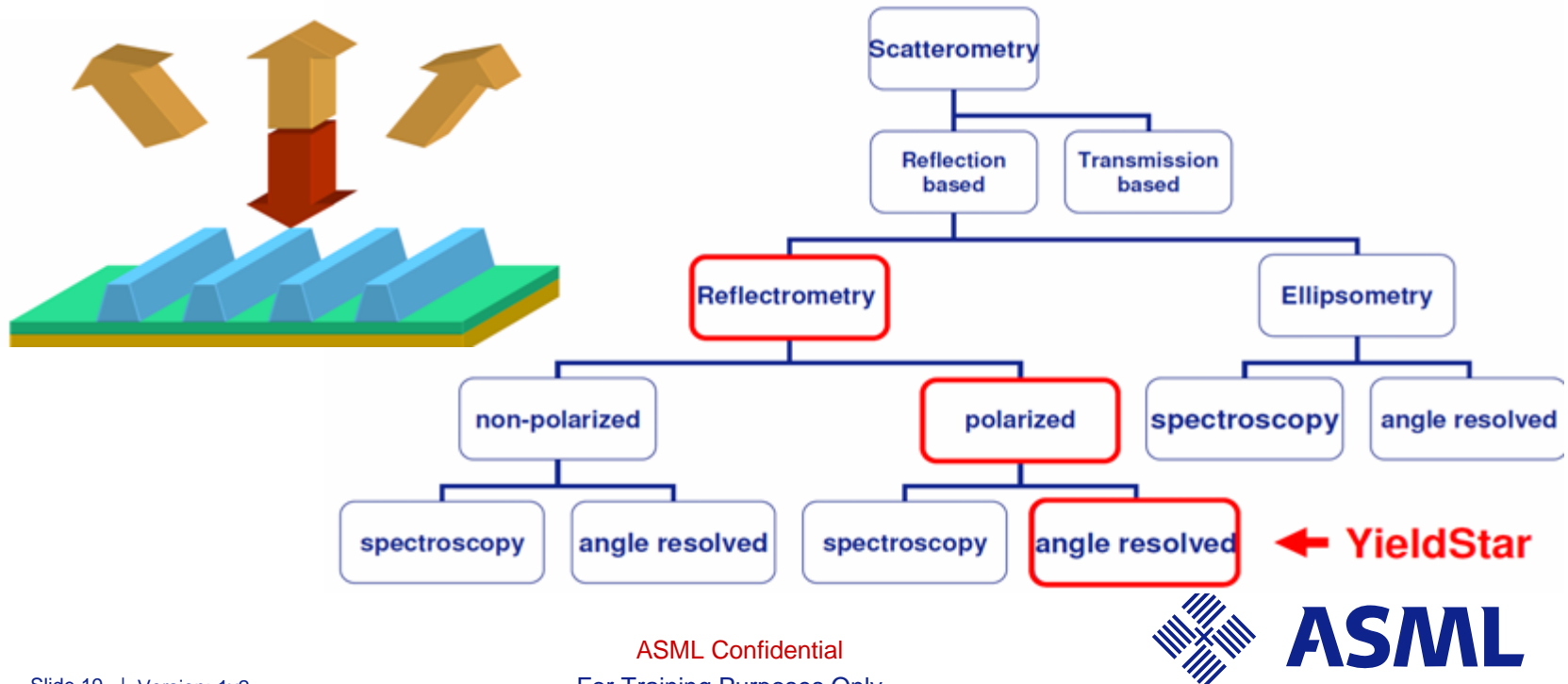
High Accuracy
High Precision

- Precision
 - Precision is how close the measured values are to each other (reproducibility)
- Accuracy
 - Accuracy is how close the measured value is to the actual (true) value
- TIS (Tool Induced Shift)
 - TIS is a measure of the systematic error contribution to the overlay measurement resulting from the imperfection of the measurement system (tool-target optical interaction)



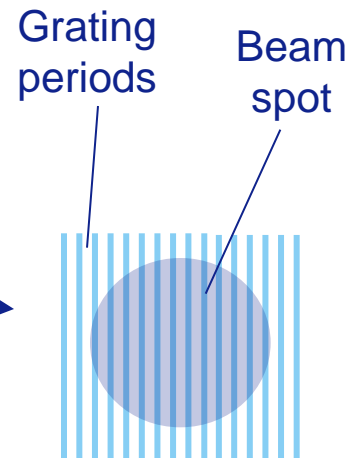
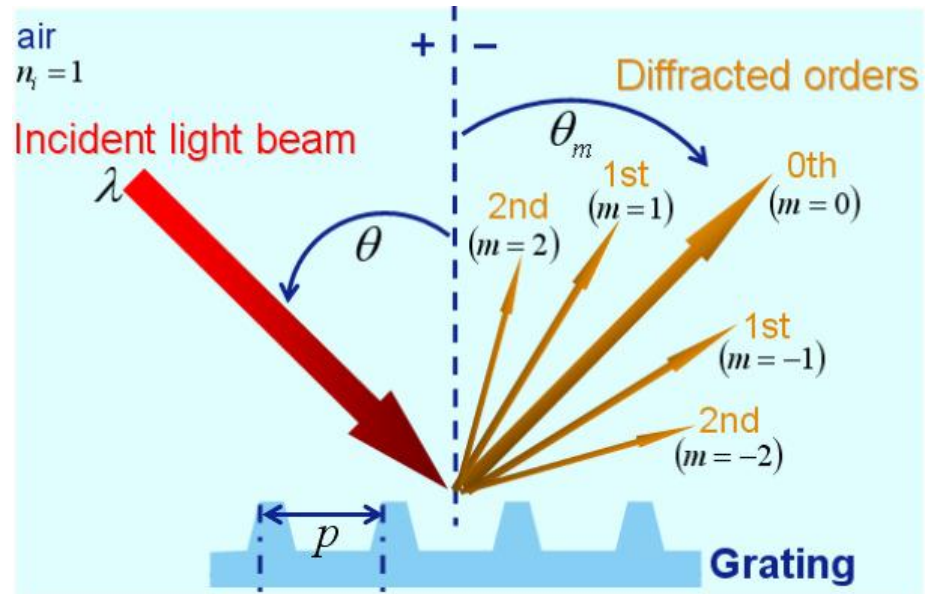
Yieldstar Scatterometry

- Scatterometry is based on the reconstruction of a grating profile from its optical diffraction response.
- Many scatterometry types
- KLA machines use ellipsometry
 - Ellipsometry more sensitive to different geometry types but with longer calculation times



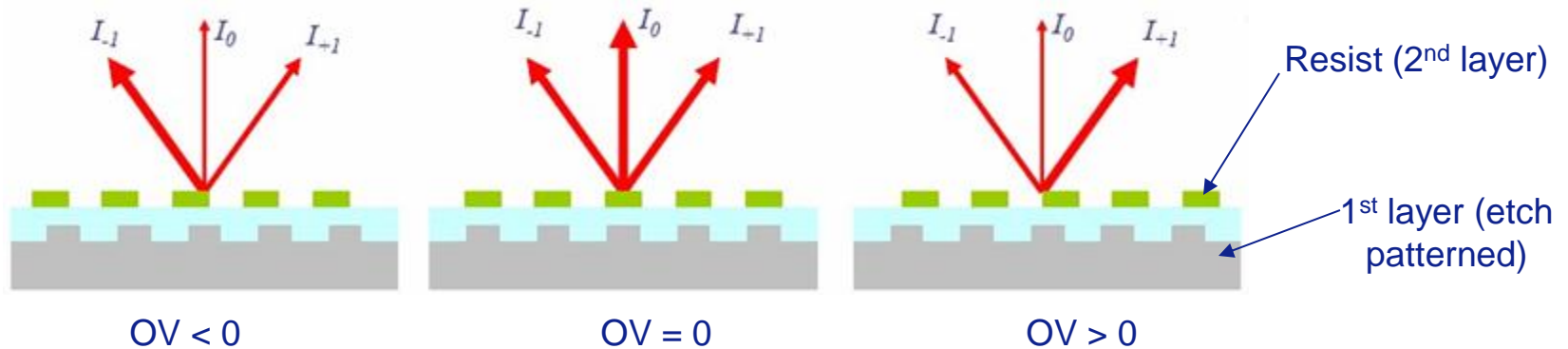
Scatterometry

- Based on diffraction of light
- 1st step: Diffraction response of grating acquired (hardware)
- 2nd step: Geometry is quantified (software)
- Single lines cannot be measured, average is found
- Actual beam width covers dozens of gratings (recommended at least 25 lines)



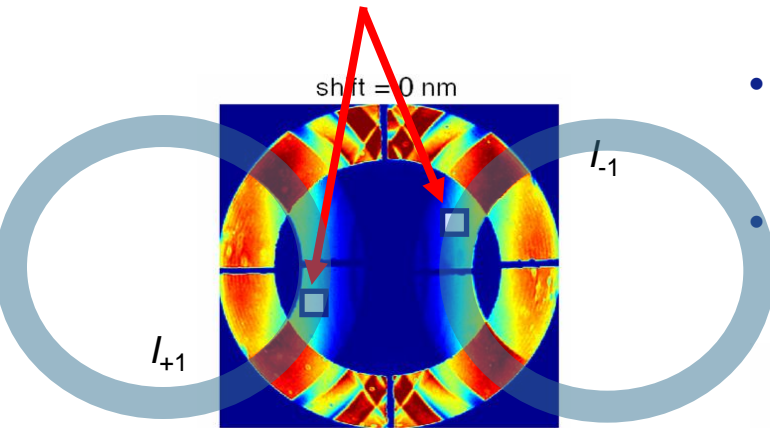
YieldStar Overlay principle

- Optical measurement technology based on the analysis of light scattered from periodic features (grating).
- YieldStar measure the difference in intensities of the diffracted light from the grating.
- Difference in intensity = asymmetry, which is then use for overlay calculation.
- 0 order intensity varies symmetrically as a function of overlay
- +1 and -1 order intensities vary anti-symmetrically as a function of overlay

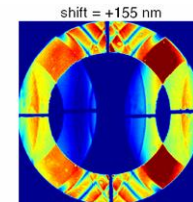
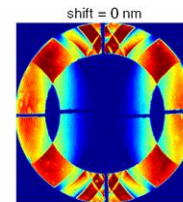
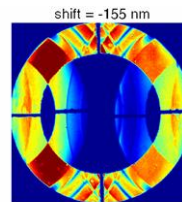


Overlay Measurement

Pixel pair



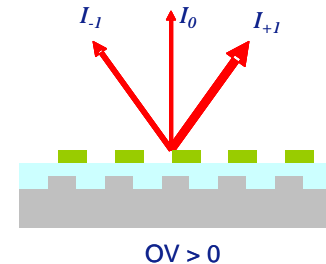
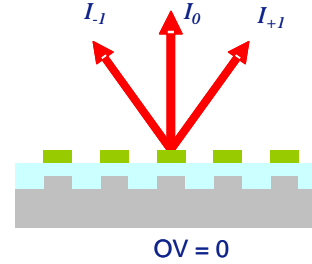
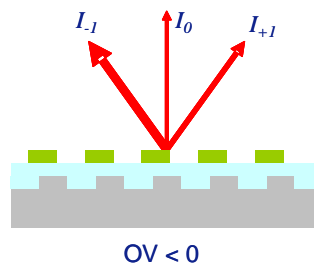
- Asymmetry in the image is a measure of overlay
- Use an annular aperture to get 1st orders that are not overlapped by any other order
- Measures relative intensity of pixel pair



Shift in (-) direction

Symmetrical

Shift in (+) direction



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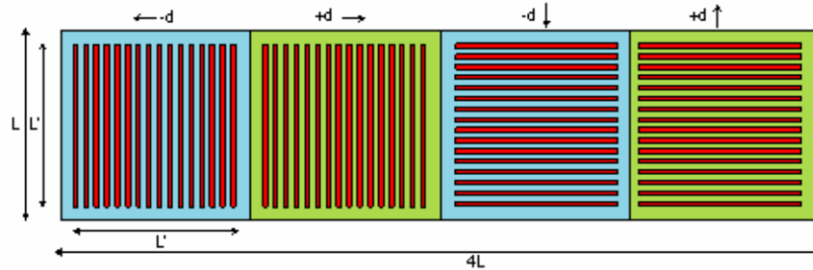
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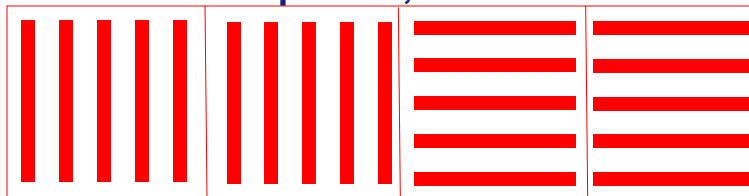
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Basic Overlay Measurement: Grating

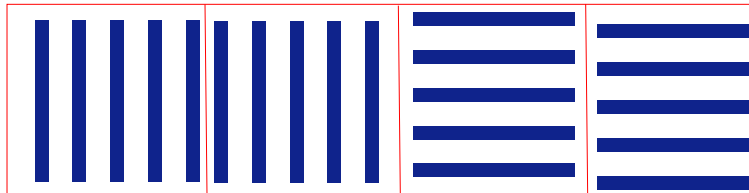
$L = 40$ or 50 , Pitch 500nm , duty cycle 50%



1st exposure, no bias

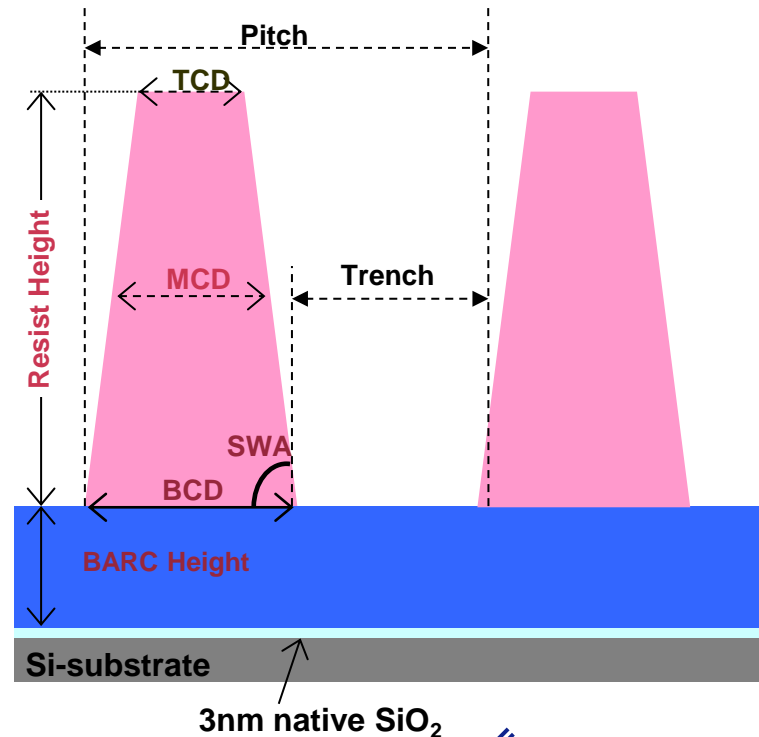


2nd exposure, bias target



CD Measurement

- More complex measurement and calculation than overlay
- Output: TCD, MCD, BCD, SWA, Resist Height, and BARC Height.
- Number cruncher: Up to 5 blade boards with 12 CPUs in each
- Model input needed



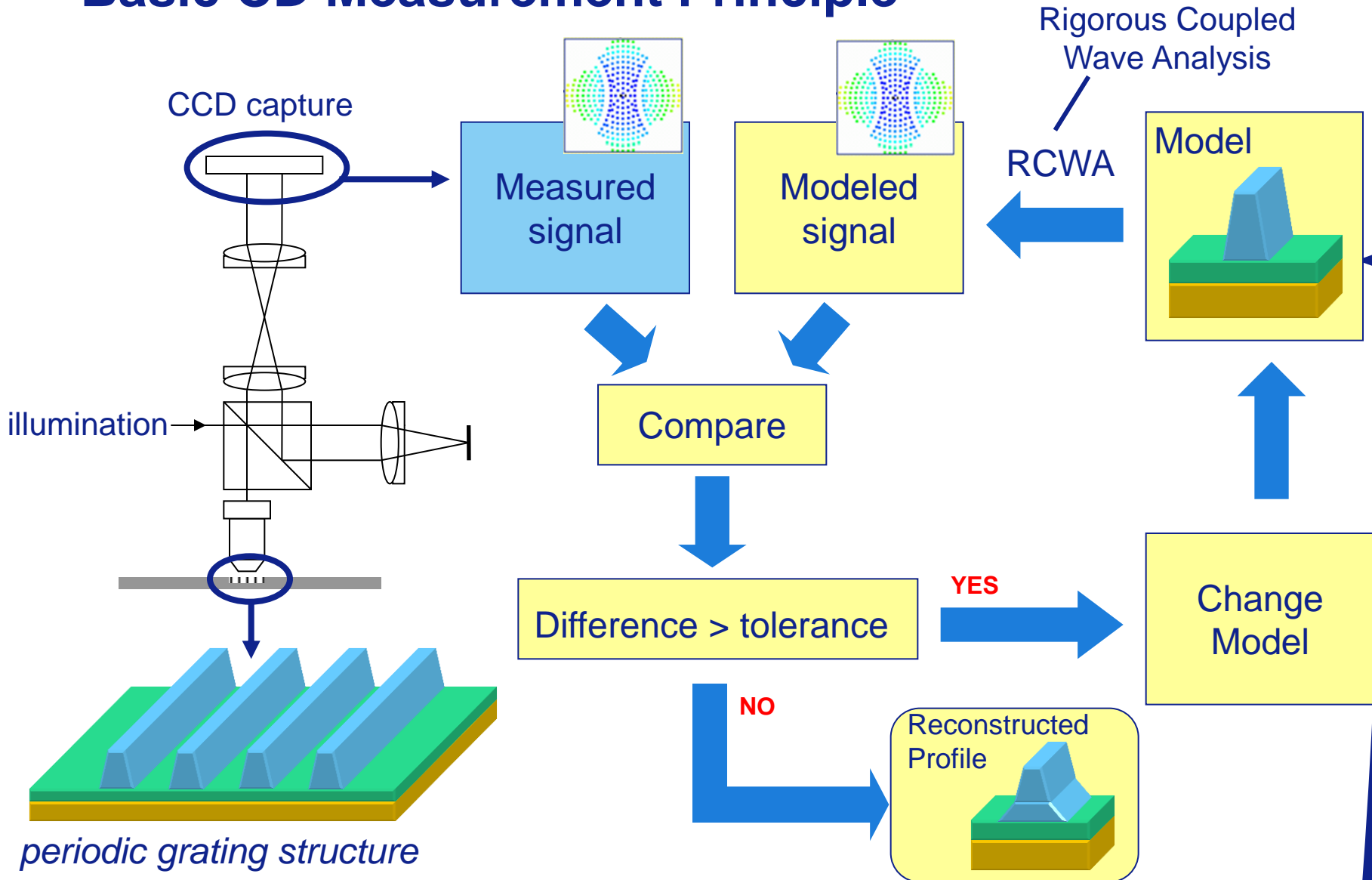
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Basic CD Measurement Principle



periodic grating structure

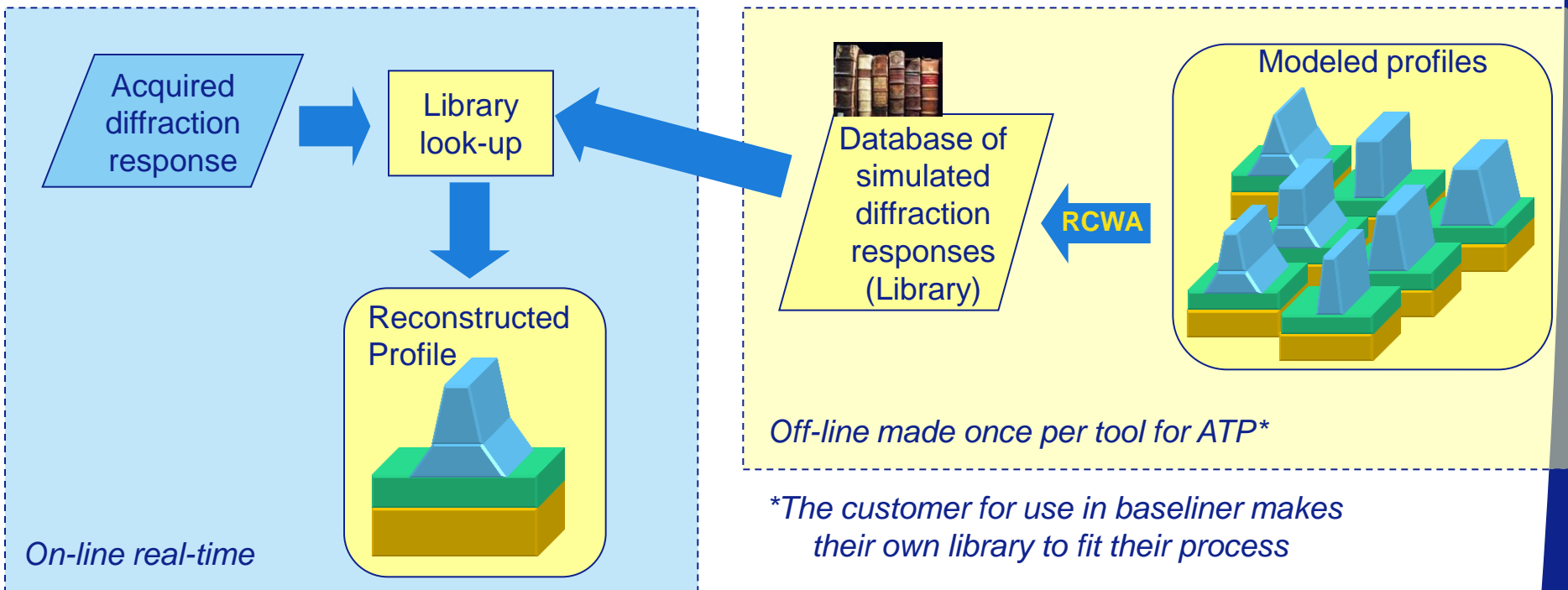
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Basic CD Measurement Principle - Libraries

- Measured diffraction response is compared against the library to find the closest match



Limitations

- Not sensitive to local CD variations
- Cannot measure non-grating features (circuit features ect.)
- Defects (particles, fallen lines)
- No concrete reference of CD (can't be verified: $\mu\text{m} \neq \mu\text{m}$)
 - Note: Same applies for all scatterometry based systems

Layout & module overview

Content

- Layout of YieldStar
- Mechanical lay-out
- Software layout
- Flow and Temperature control
- Wafer Positioning
- Metrology
- Wafer Handling

Layout of S100 vs T/S 200

S100



S200



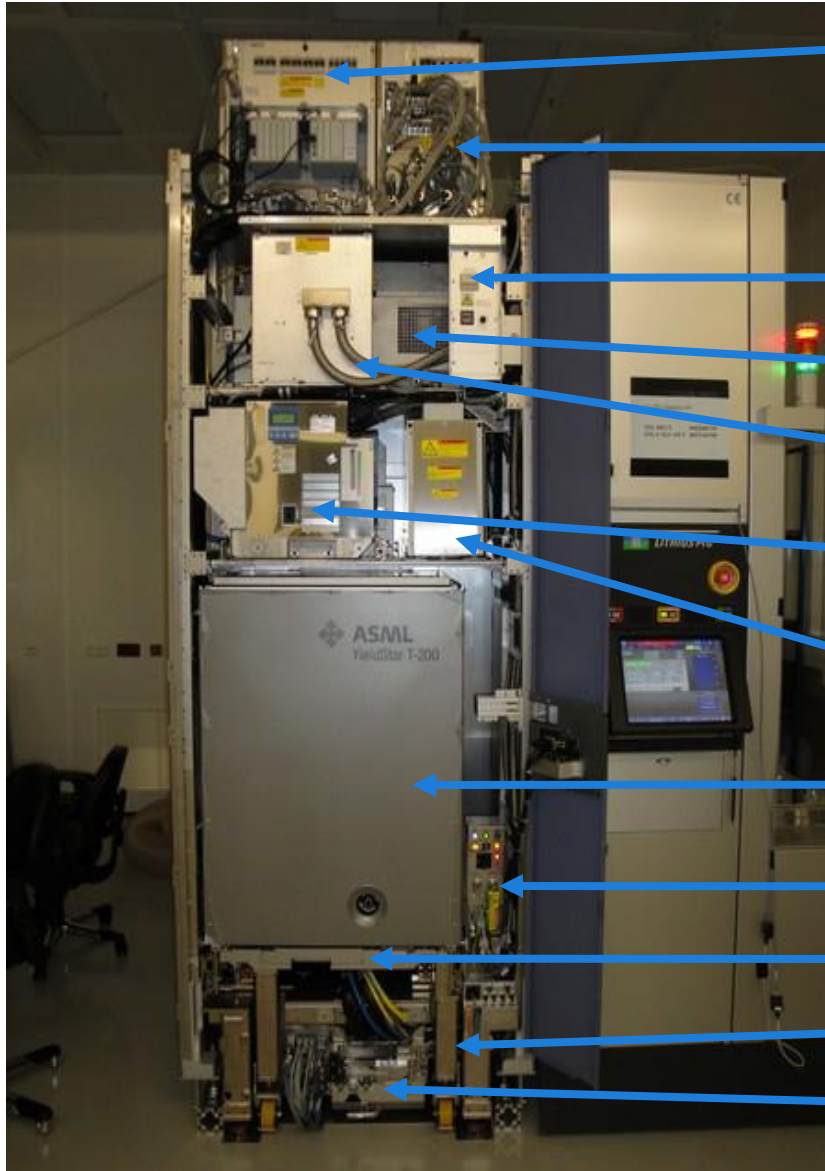
T200



S200



Front view Yieldstar T/S-200



YMCR (Yieldstar Motion Control Rack)

MSMR TM
(Mains Safety Miscellaneous Rack Track Module)

Flow Adjustment TEL Track (not ASML)

FFU (Fan Filter Unit)

PFU (Pressure Facility Unit)

TCU (Temperature Control Unit)

Lamp Module

MMA (Main Metrology Module Assy)
Waferpositioning and Metrology

TUIB (Track User Interface Box)

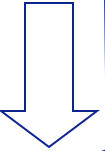
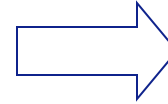
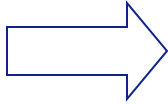
Service Slide Mechanism

Base Frame

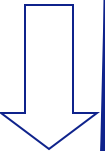
TMCP (Track Module Connection Plate)



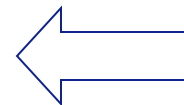
MMA Front View YS T/S-200 (Main Metrology Module Assy)



Easy accessibility
for service !!



MMA



ASML

MECA (Metrology Electronic Cabinet Assy)



EFU (Exhaust Fan Unit)

MSMR MECA
(Mains Safety Miscellaneous Rack)

PC2

OIU (Operator Interface Unit)

MNCR (Measurement Number
Cruncher Rack)

LAN switch (Local Area Network)

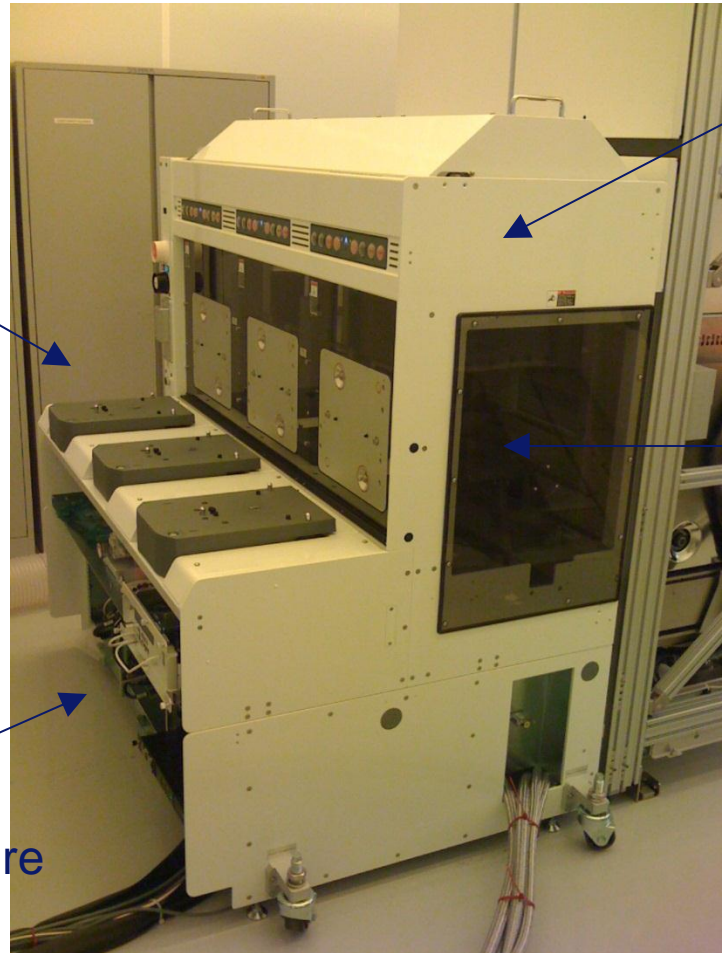
WAN switch
(Wide Area Network(FAB))

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Waferhandler (EFEM)



Mini-Environment

Load Port

Wafer Engine

Front Electrical Enclosure



Software Layout

Software Layout

OIU (Operator Interface Unit)

Windows 7



Main computer is PC2

Waferhandler SW (windows2000) via PC5
and Spartan PC (interface)

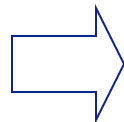
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Location of PC2

MECA (Metrology Electronic Cabinet Assy)



Software layout in IPC2

- Operating system
 - Windows XP -> **Windows 7 2011** (SP2+update SP3) & drivers software
 - Pre-installed in the IPC2
- Yieldstar release
 - 2.2.0.c Patch 9
- 3rd party software
 - Cognex, Smart-plus, etc.
- Remote control possible

SuperMicro Measurement Number Cruncher Rack (MNCR)



- Up to 5 blade boards with 12 CPUs in each
- CD calculation

Network Communication

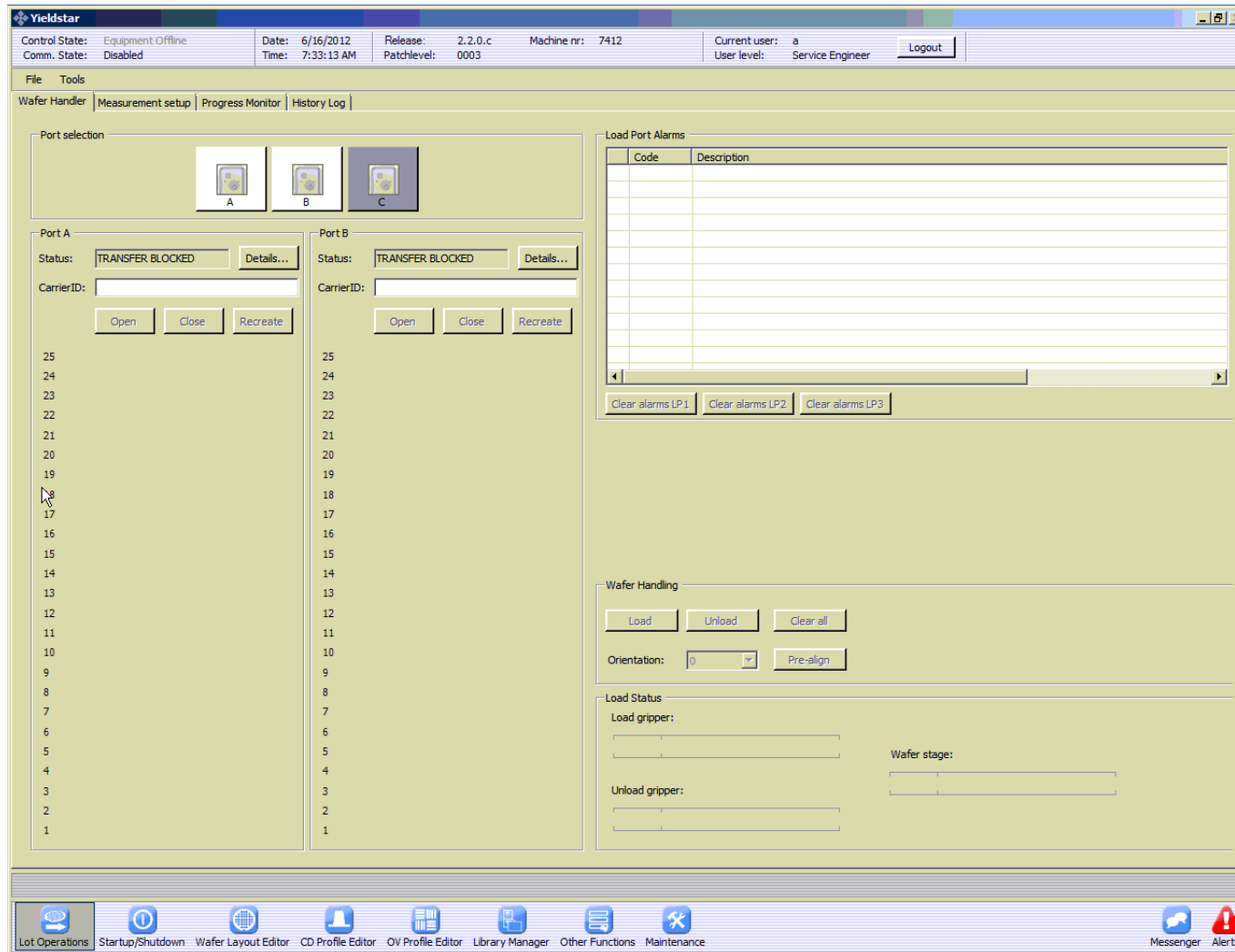


LAN switch (Local Area Network)

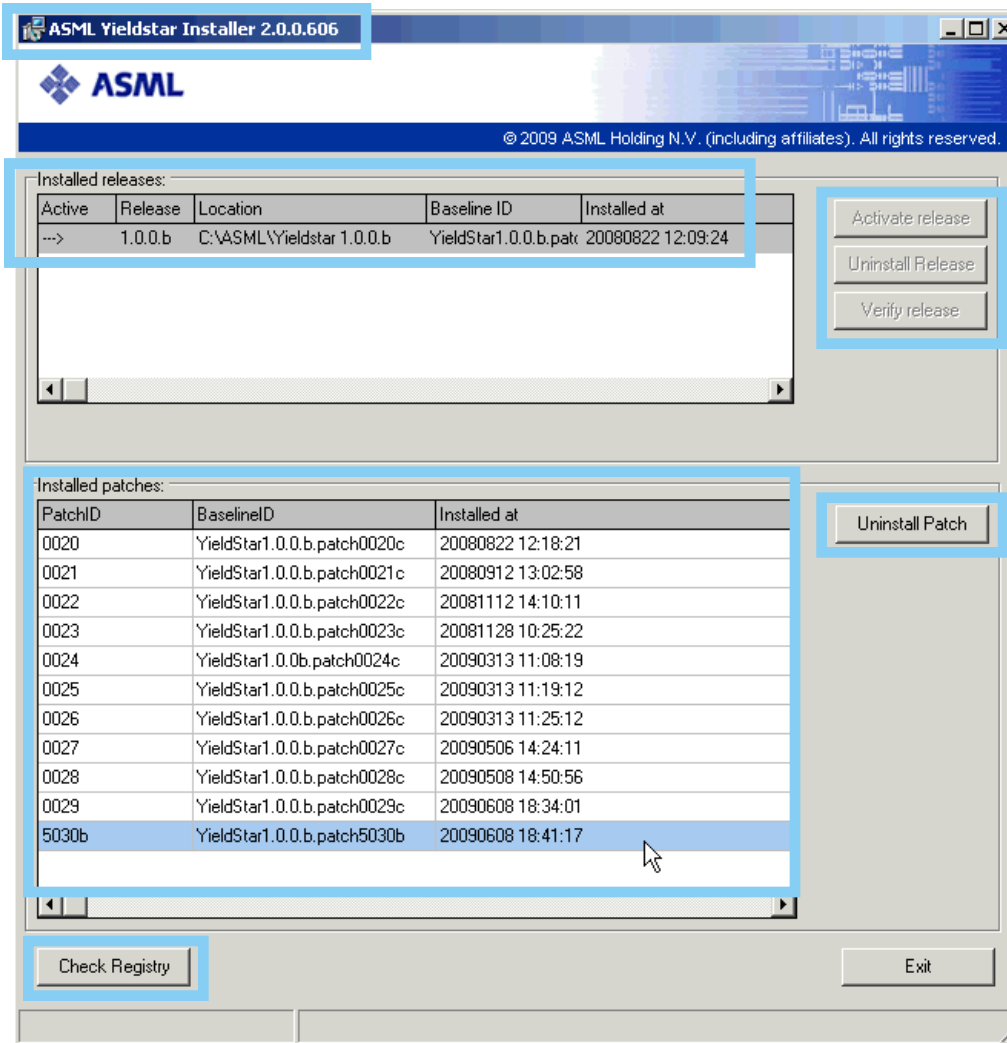
WAN switch (Wide Area Network(FAB))

Direct accessible for laptop

Software Layout example (Lot operation UI)



Software Layout (Yieldstar installer)

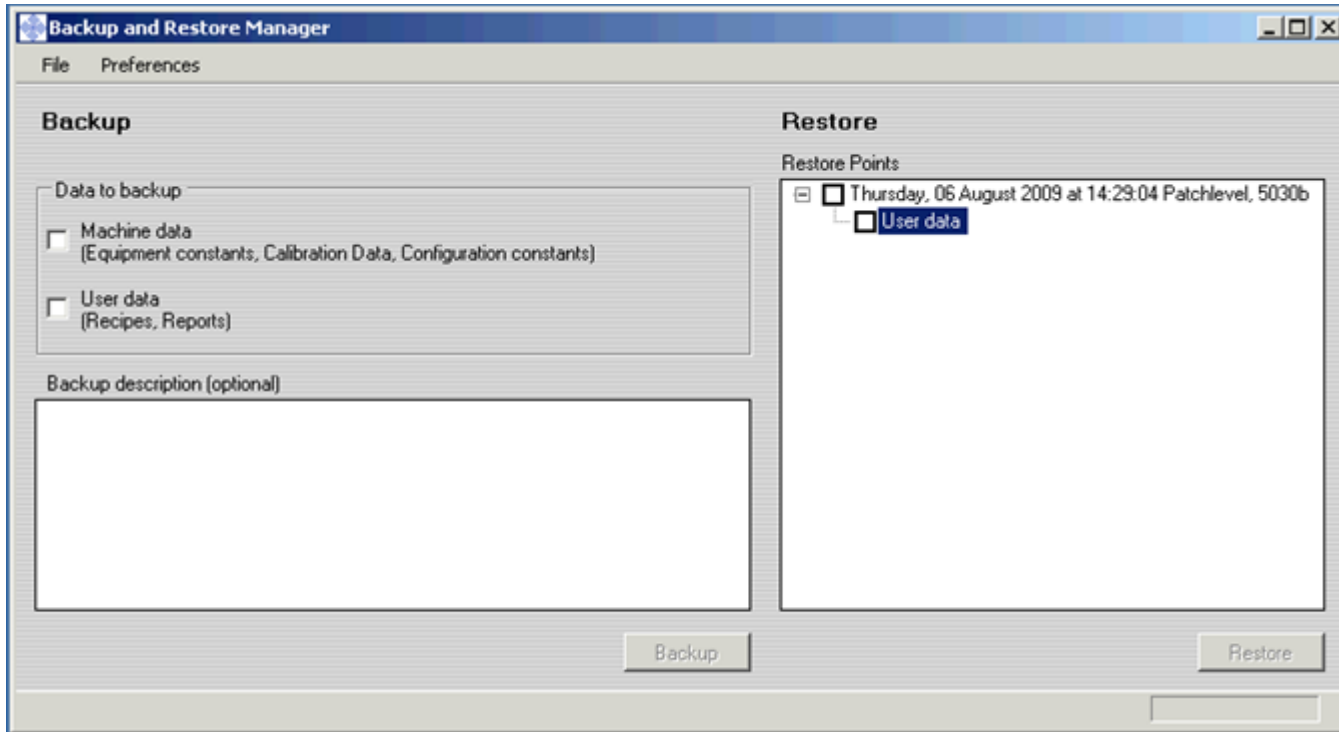


Uninstallation software available in procedure :

File path

C:\ASML\Installer\bin\
ASML Yieldstar Installer.exe

Software Layout (Yieldstar backup)



- Backup / restore procedure : fsl001.adj
 - strongly advise to backup **outside of PC2**
- Data scope : machine data and/or user data
- Restoring machine data should be on the same patch level

F & T (Flow and Temperature Control)

F & T (Flow and Temperature Control)

- F & T consists of:
 - PFU (Pressure Facility Unit)
 - TCU(Temperature Control Unit)
 - Cooling system for sensor and wafer stage.
 - Not used in S-100, only used in T/S -200.
 - FFU (Fan Filter Unit)
 - Clean Air system.



TCU

PFU



PFU

- Connects, Regulates and Monitors CDA (Clean Dry Air) and Vacuum from the fab, to the correct values for the machine.
- Connects with (manual) valves and distributes the CDA and Vacuum to the different modules.



S100



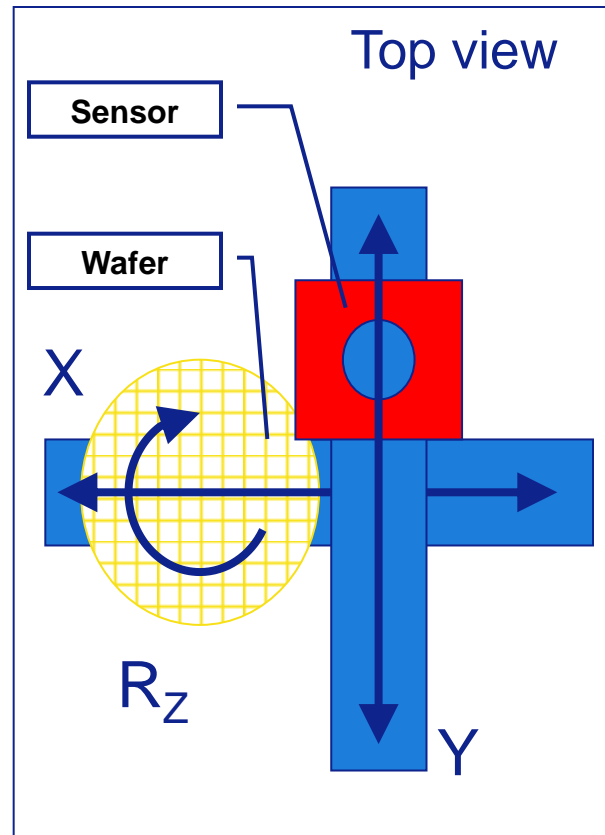
T/S 200



Wafer Positioning

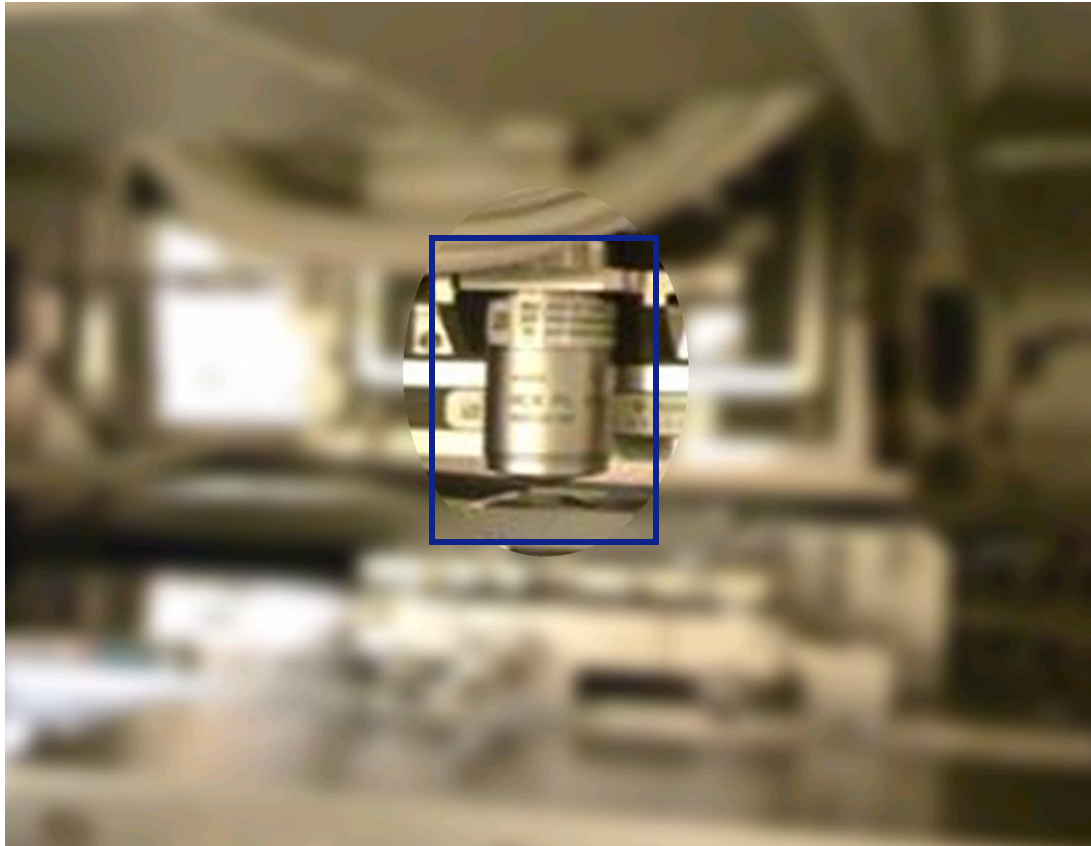


YS stage coordination



T/S-200 front

YS Piezo (Lorentz) Stage



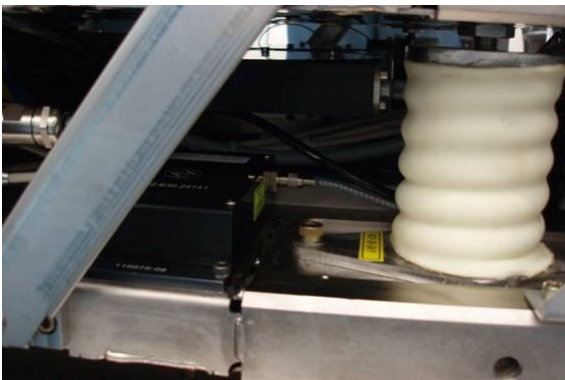
- Piezo (Loretz) stage move Lens Objective in Z-direction

Stages

- T/S-200 uses a balance mass system for the stages to prevent forces applied to the track system.
- Uses motion control and software from Bosch Rexroth
- Controls:
 - Wafer stage
 - Sensor stage
 - Rotary stage with wafer table
 - E-pin unit
 - Z-unit focus
- Isolated from outside world by metal springs:
 - Vibration Isolation Shield (VIS)

Vibration Isolation Shield (VIS)

- Vibration Isolation Shield (VIS) dampens frame vibrations



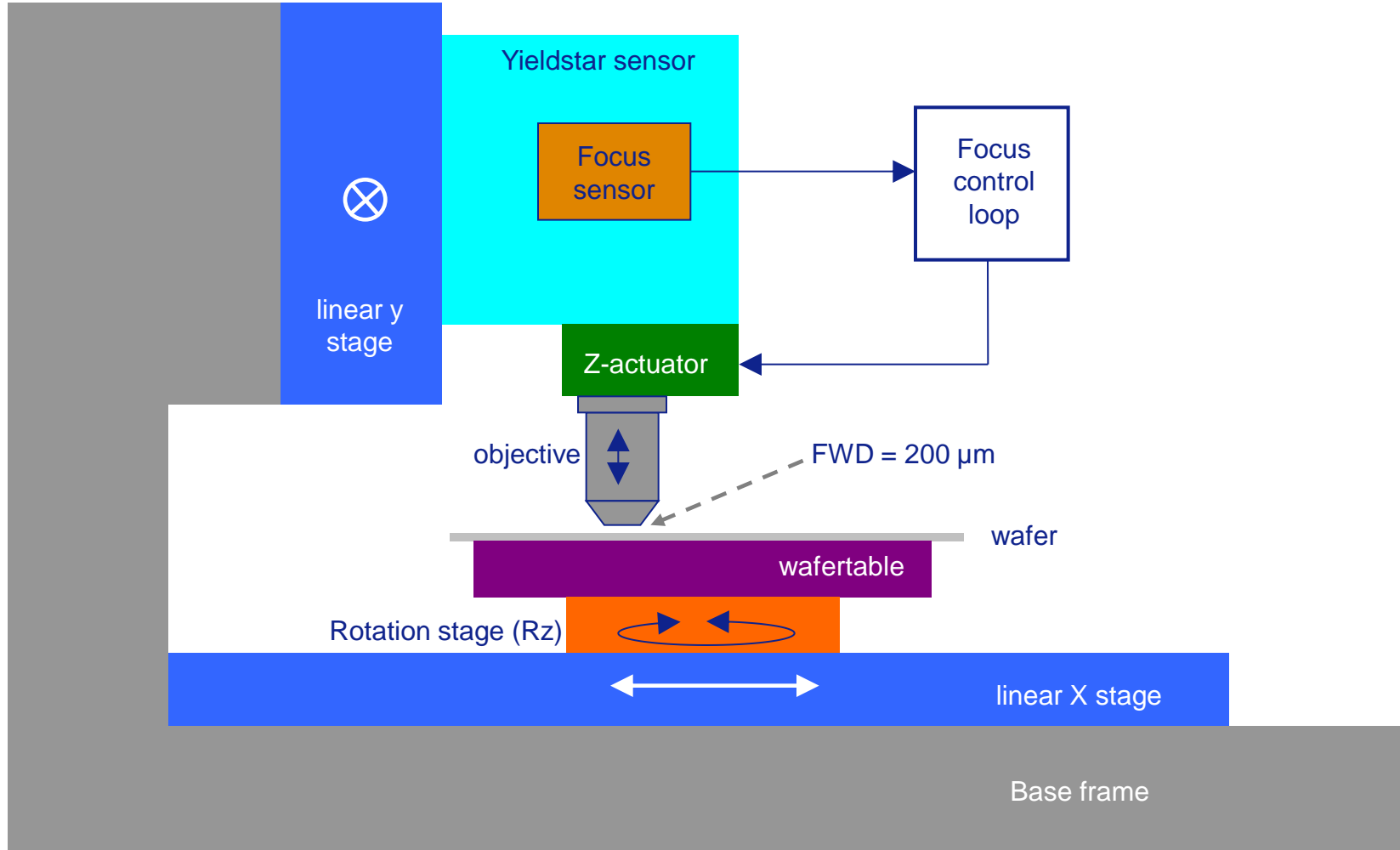
4x VIS

Sensor (metrology module)

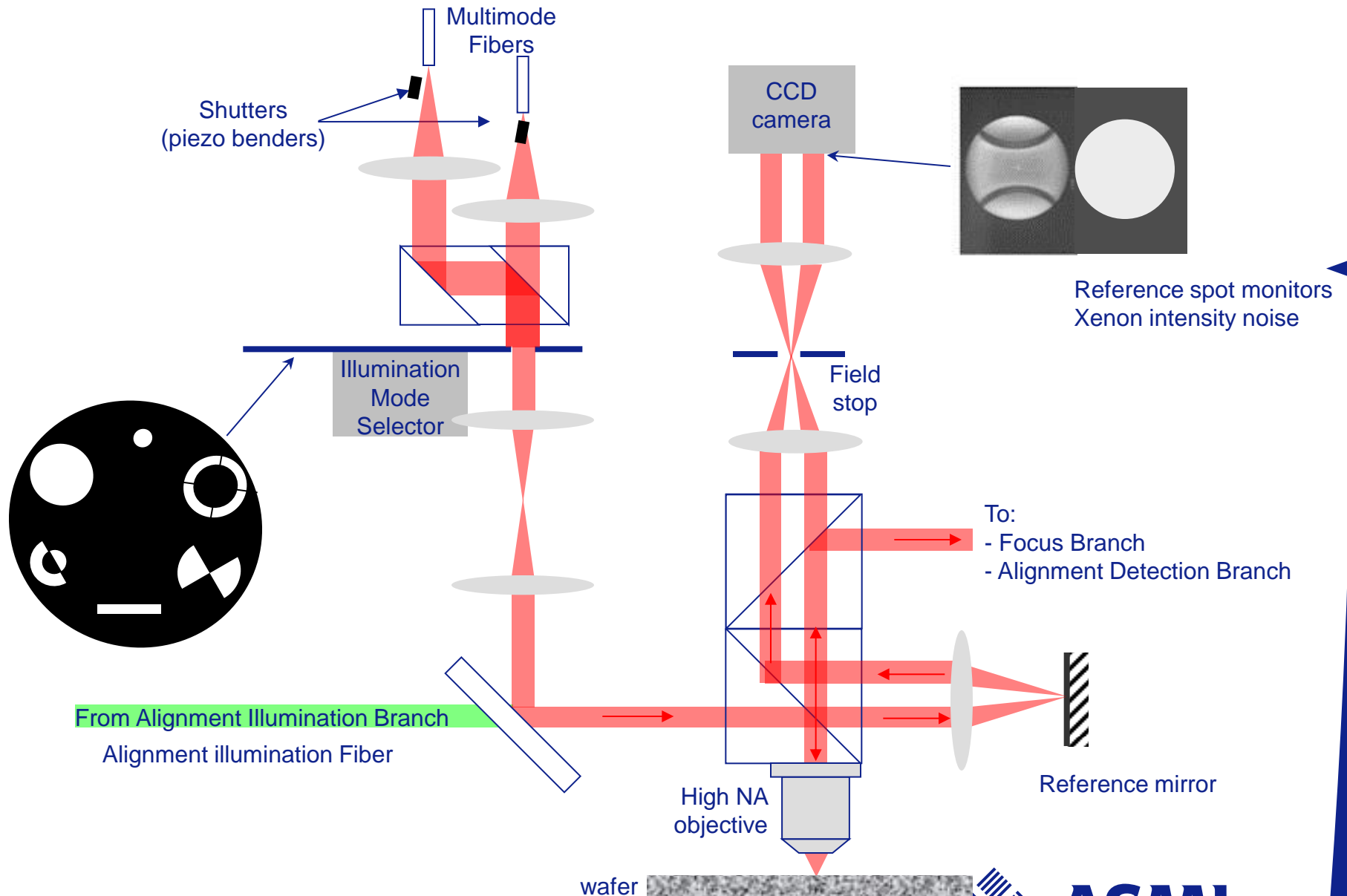
YS Sensor (metrology module)

- Basic Schematic of metrology module
- Optical design
- Illumination sources
- Fiber deliver system
- Fiducial

YS Basic Schematic of metrology module



YS Sensor optical design metrology module



YS Sensing and Alignment

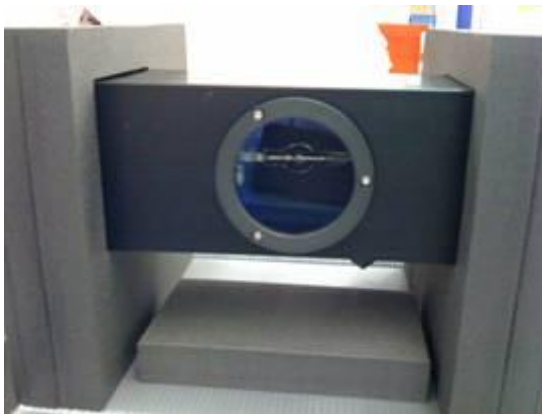
- 2 light sources: Xenon lamp for CD & OVL measurement and LED for alignment
- 2 cameras: CCD focused on pupil plane and alignment camera focused on the wafer surface (alignment marks)
- Microscope objective can move 800μm in Z
- Piezo shutters select which polarization setting is used

YS Illumination Sources

S100

- 2 light sources:

- One Xenon short arc lamp for focus and sensing
- LED for Alignment



T/S 200

- 3 light sources:

- Sensing : Xenon arc lamp (2fibres)
- Focus : Two laser diodes (1fiber)
- Alignment : LED light source (in sensor)

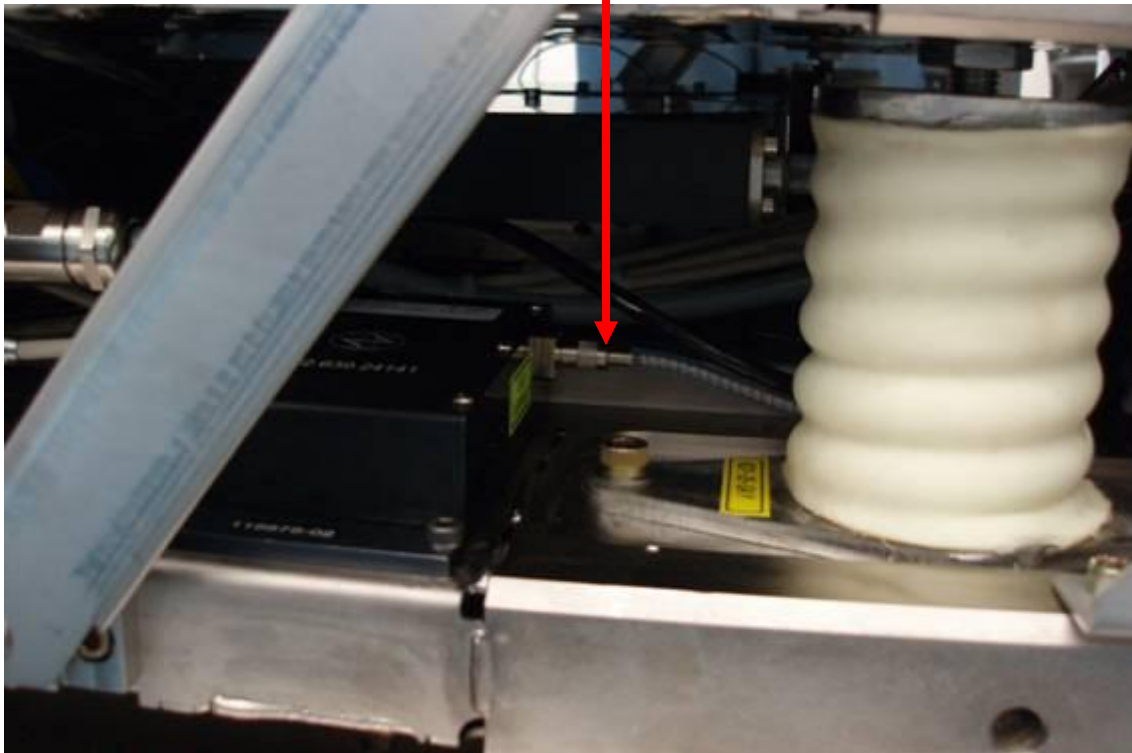
YS Illumination Sources

FIA (Focus Illumination Assy)

Box contains two diode light sources:

- Laser diode for Red 675 nm wavelength
- Super luminescence diode (SLD) 820 nm

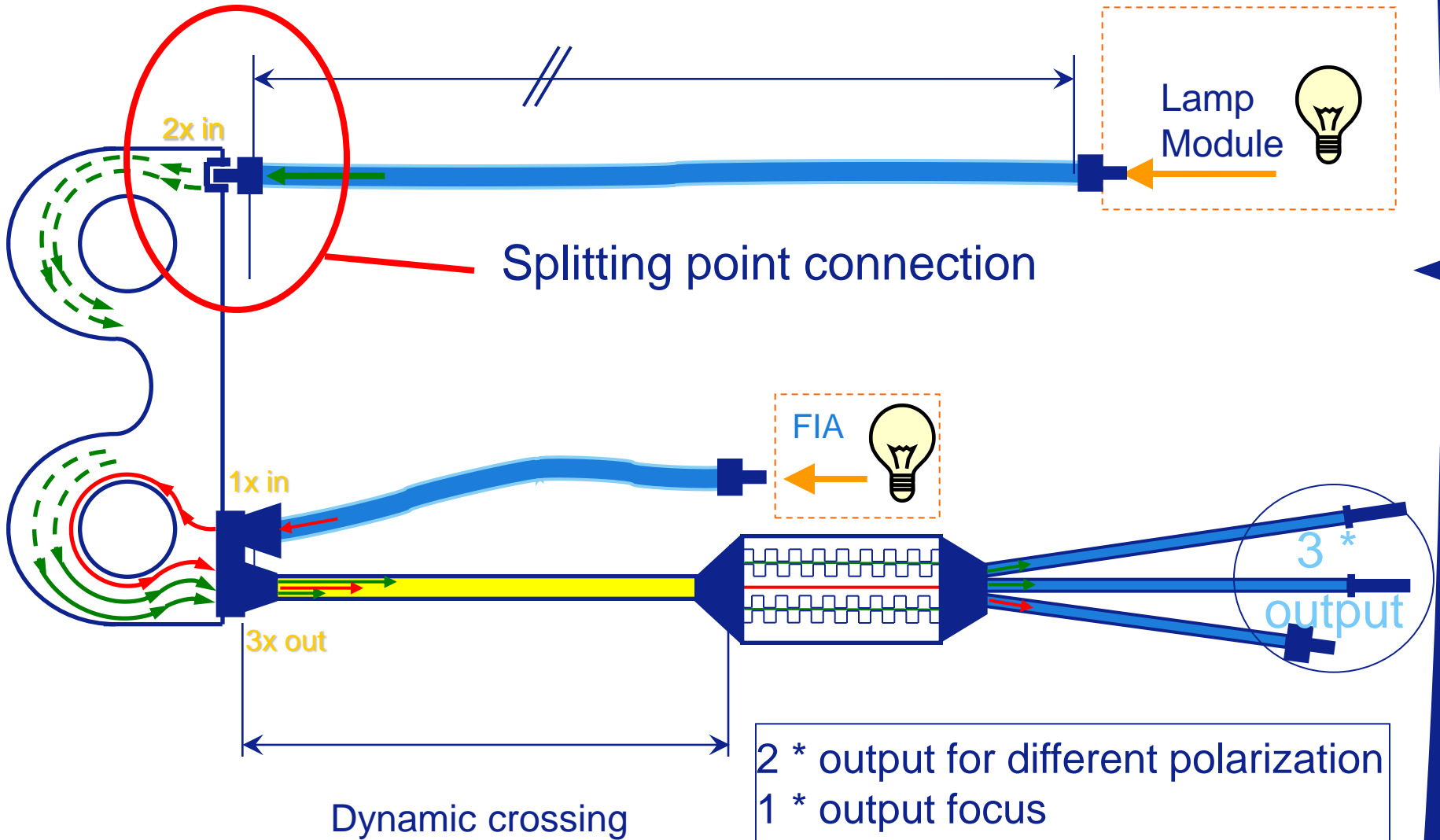
Fiber connection



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YS Fiber Deliver System



YS Fiber Deliver System



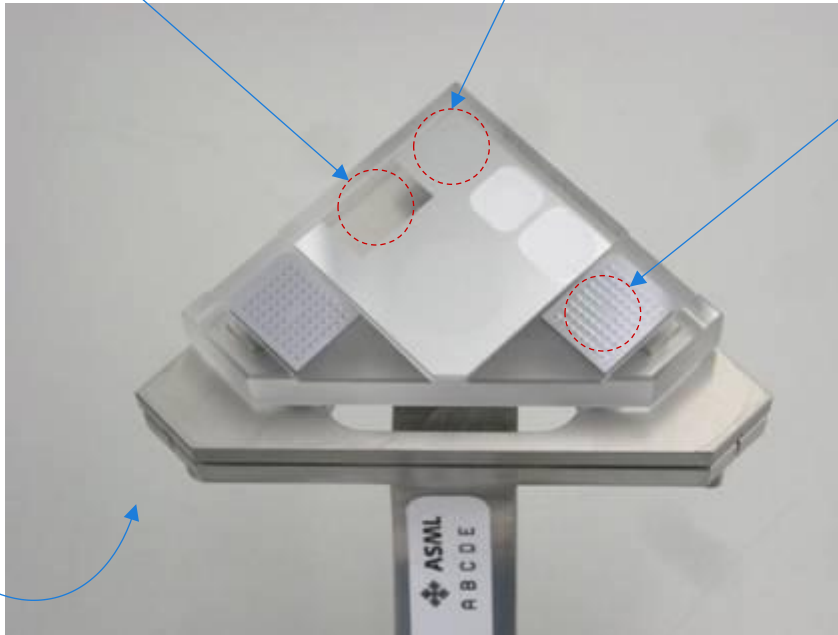
- Fiber drum improves light homogeneity
- 200 μ m core diameter
- 20 meters

YS Fiducial of S-100

Glass fiducial
(uncoated BK7
glass area)

Parkmirror fiducial
(aluminum mirror)

BareSi fiducial
(silicon area)



Fiducial support for
Z, Rx and Ry
adjustment (via
bottom side)

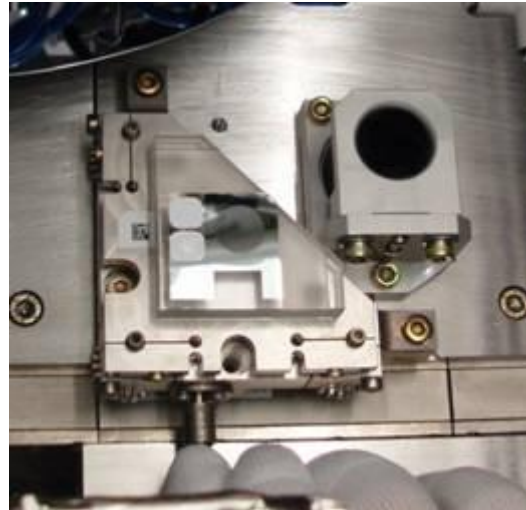
Two Fiducials for S/T-200

Purpose:

- Performance checks
- Monitoring
- Calibrations

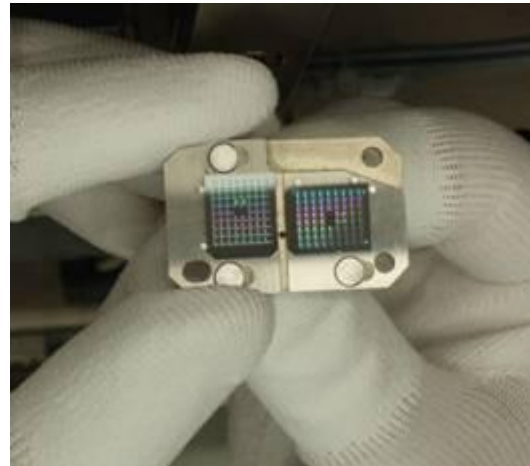
Balance mass fiducial

- Aluminum fiducial
- Glass fiducial



Wafer carrier fiducial

- Target field fiducial





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YS WaferHandling

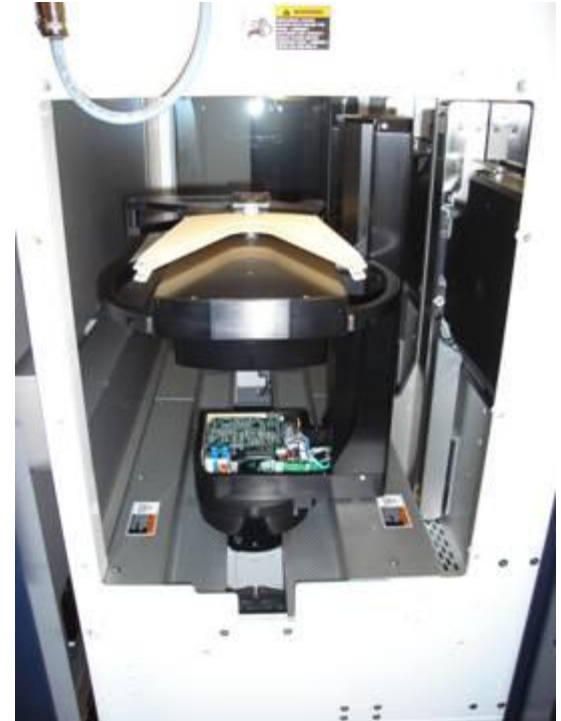
EFEM (Equipment Front End Module)

Wafer Handling

EFEM (Equipment Front End Module)

YS Waferhandling

- Pick/place wafer from FOUP to wafer stage and vice versa
- 3 load ports
- 2 grippers, parallel load/unload action
- Visual / default coarse alignment (teach pendant)
- Fine alignment with edge sensor

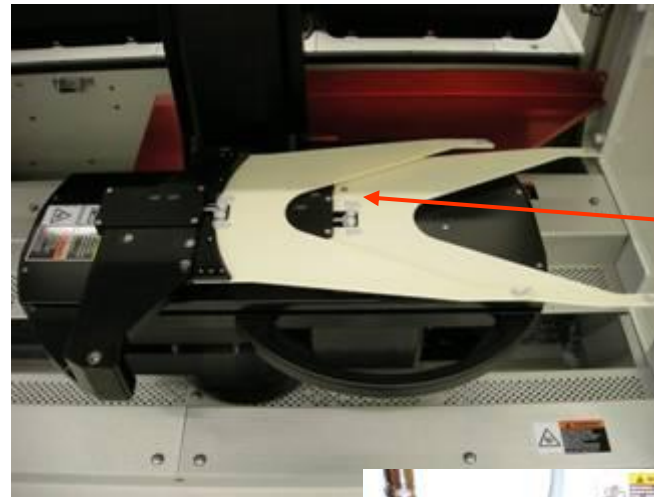


YS Wafer Handling

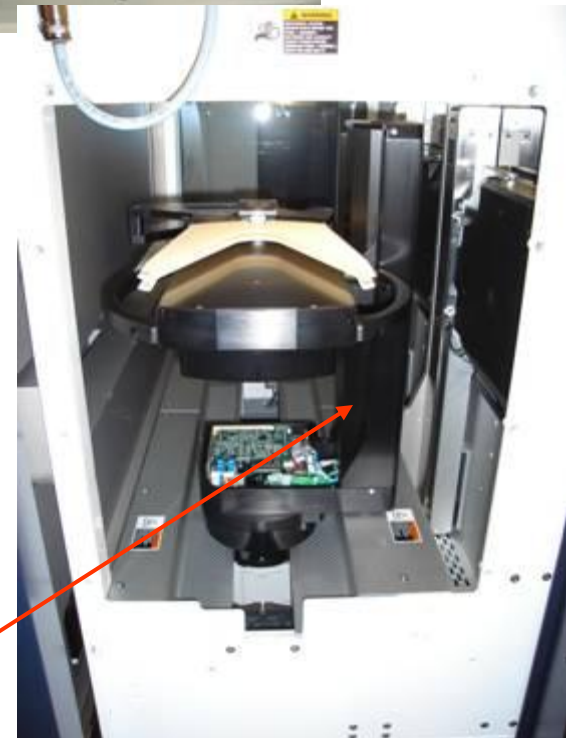
Fan filter unit



PC 5



Grippers



Robot



ASML

HTML GUI: System / Wafer Engine / Motor Control.

Asyst Technologies, Inc : Confidential - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Search Favorites Media

Address http://192.168.192.226/Page-Framesets/Sys_WfEng_MotorControl-Frameset.htm

Host: Wed Aug 05 2009 02:35:10 PM
Communications Connected: 5020-0003-0000

Message:

ASYST Spartan Wafer Engine: Motor Control

Logout

Overview Host Communications OCR DIO Pressure Control Wafer Flipper **Wafer Tracking Deactivated** Load Ports Wafer Engine Pre-Aligner

Z Axis Motor
ACTIVATED Current Position: 252.000
Deactivate motor Move to Position:
Lower Lower Lower Raise Raise Raise

R1 (Upper End Effector) Axis Motor
ACTIVATED Current Position: -3.224
Deactivate motor Move to Position:
Retract Retract Retract Extend Extend Extend

R2 (Lower End Effector) Axis Motor
ACTIVATED Current Position: 0.000
Deactivate motor Move to Position:
Retract Retract Retract Extend Extend Extend

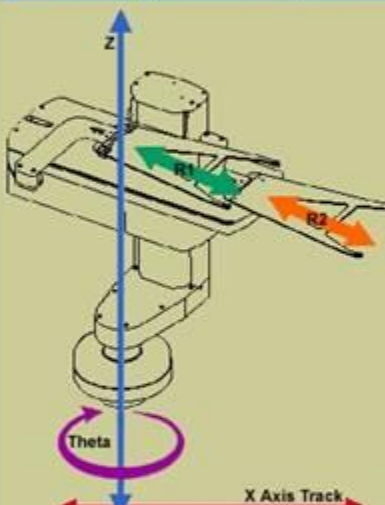
Theta Axis Motor
ACTIVATED Current Position: -90.000
Deactivate motor Move to Position:
CCW CCW CCW Clockwise Clockwise Clockwise

X Axis Motor
ACTIVATED Current Position: 370.000
Deactivate motor Move to Position:
Left Left Left Right Right Right

Wafer Engine Status: AtStation

Jobs System Recipes System Log Setup Simulation Alarms Help

http://192.168.192.226/Page-Framesets/Sys_PresContrl-Frameset.htm



ASML Confidential

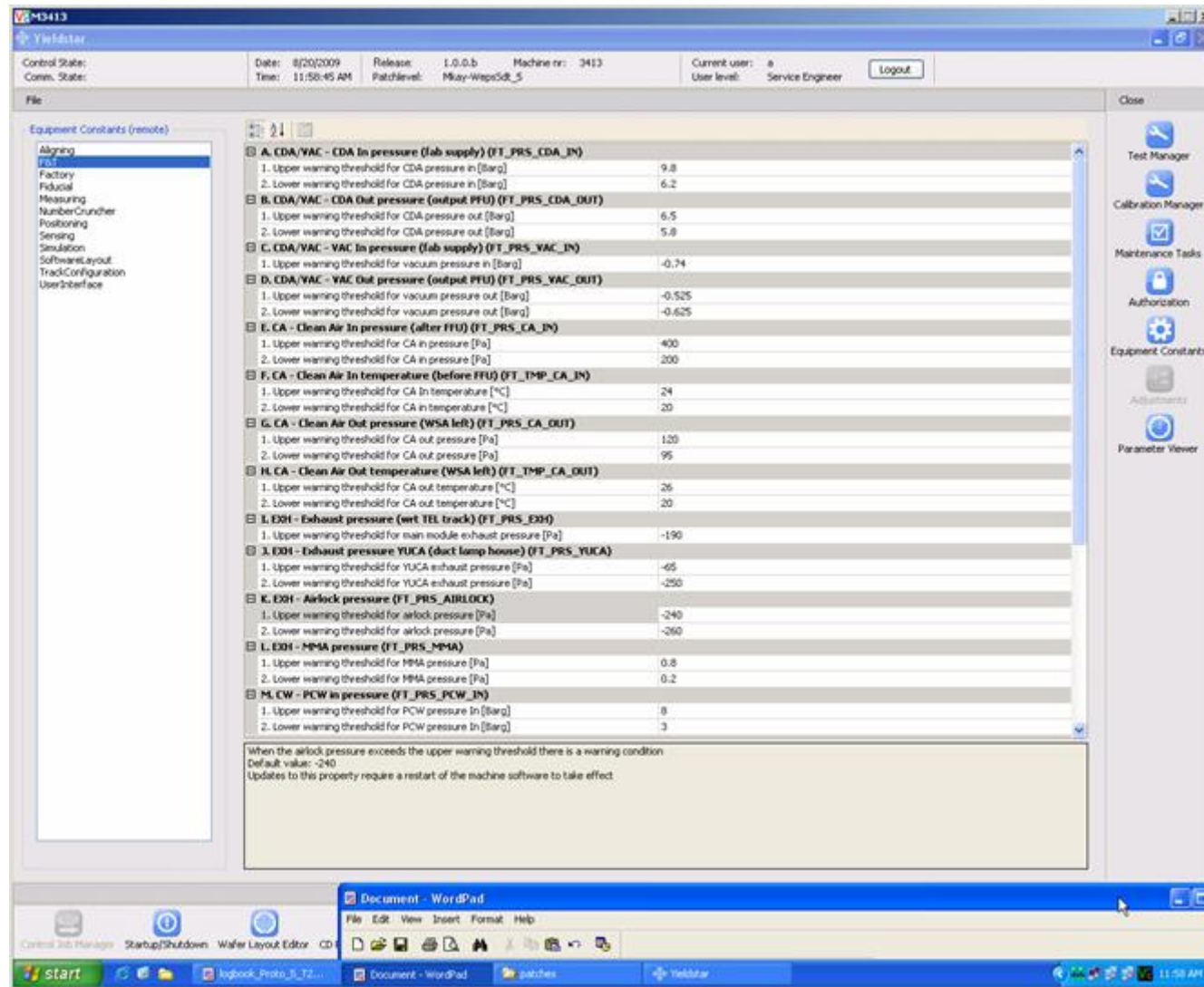
For Training Purposes Only



General Diagnostics (SW)

- EC (Equipment Constants) editor
- ParameterViewer
 - View SW parameters on tool (including history graphs) or with remote connection
- SDT
 - View parameters/error log etc. remote on tool/history on PMA database
 - Install SDT YS
- BRES
 - Remote control/diagnostics if access granted by customers

EC editor (T/S-200)

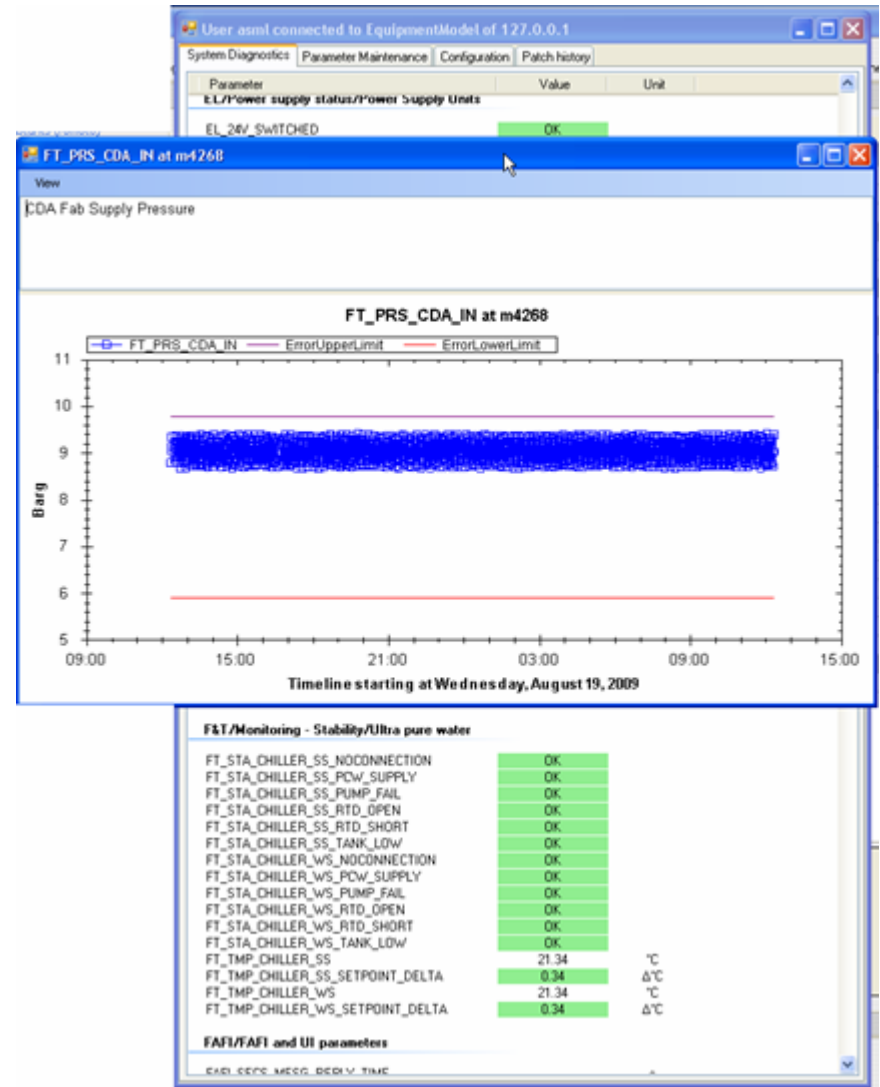
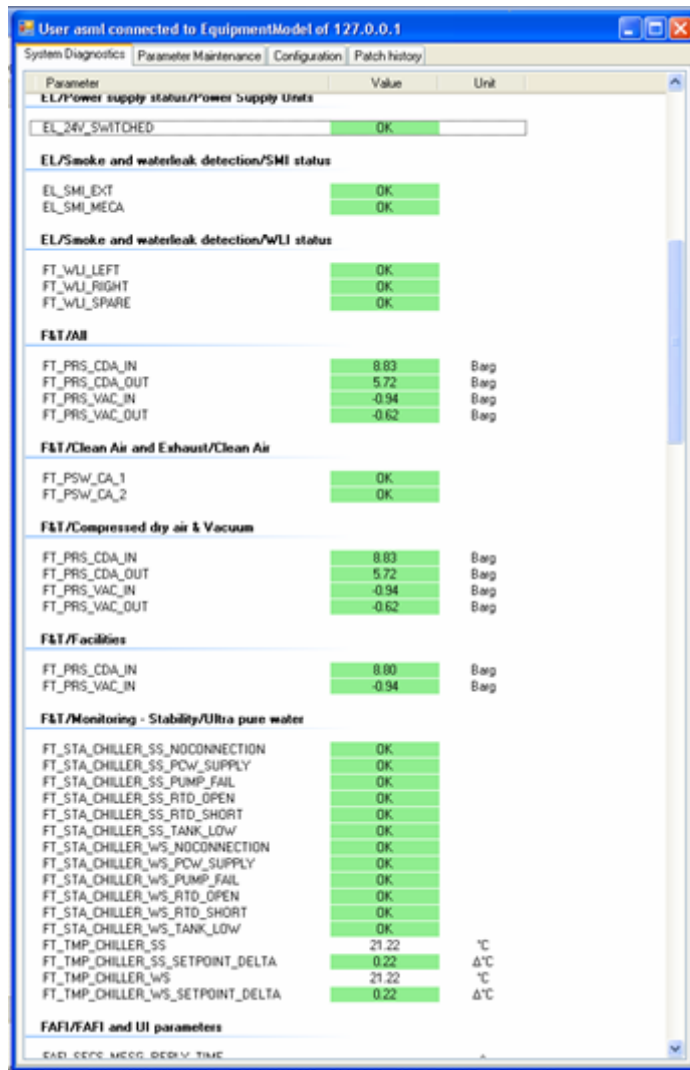


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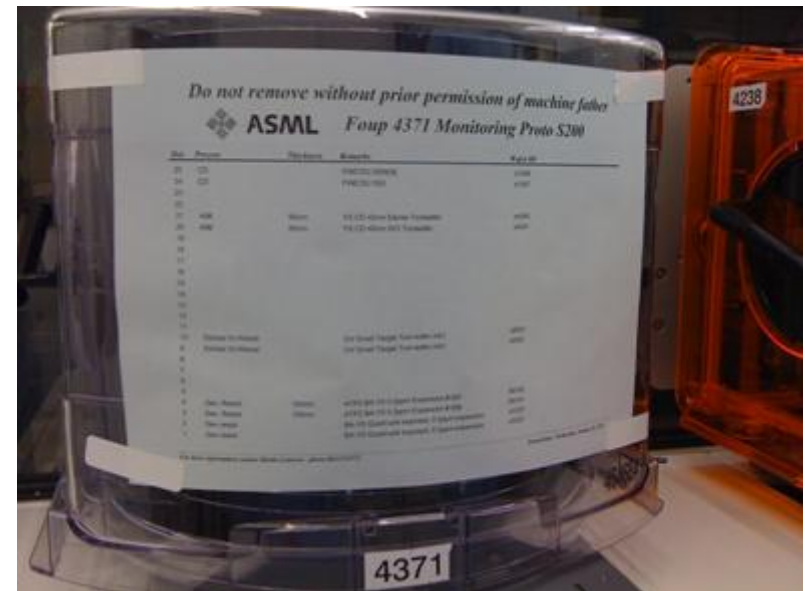


Parameter Viewer



ASML

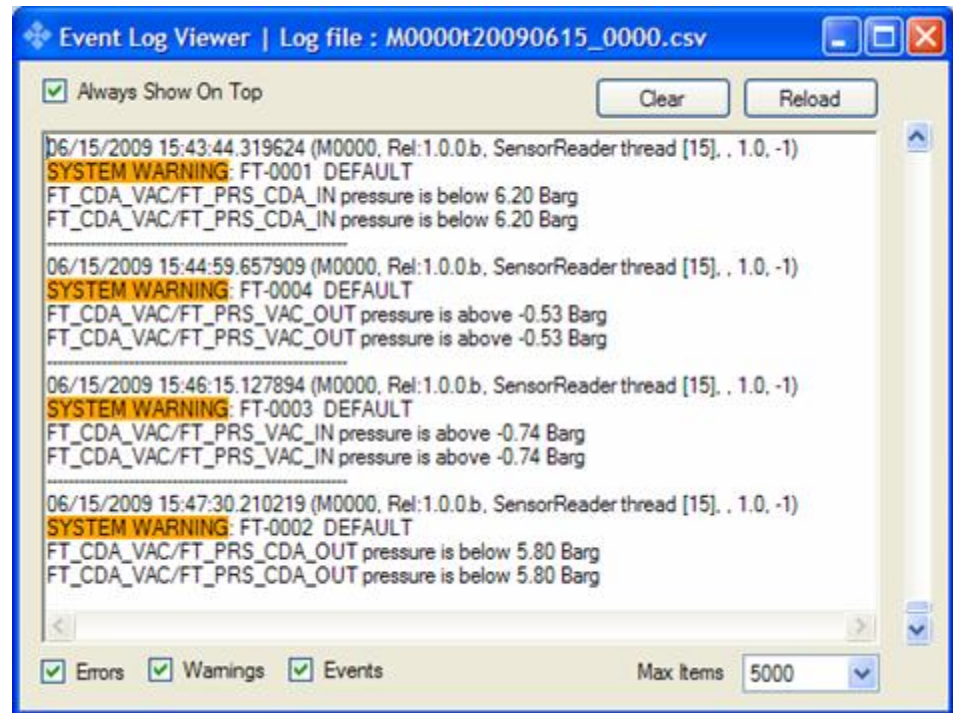
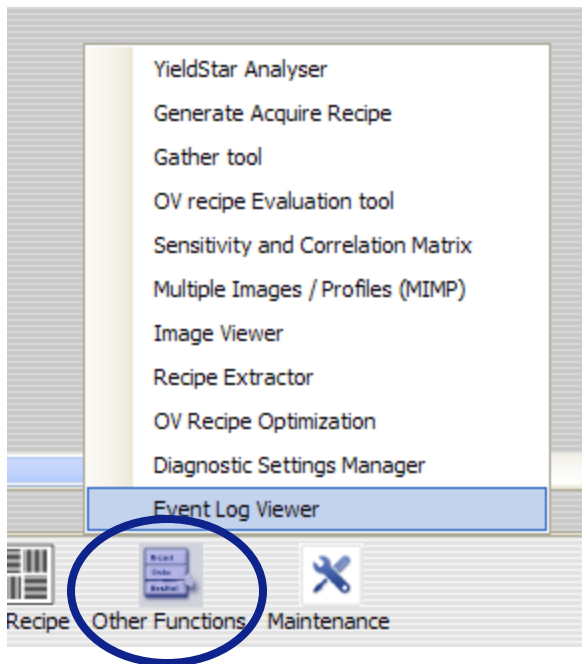
Daily Operation



Daily operations

Event logging or error logging

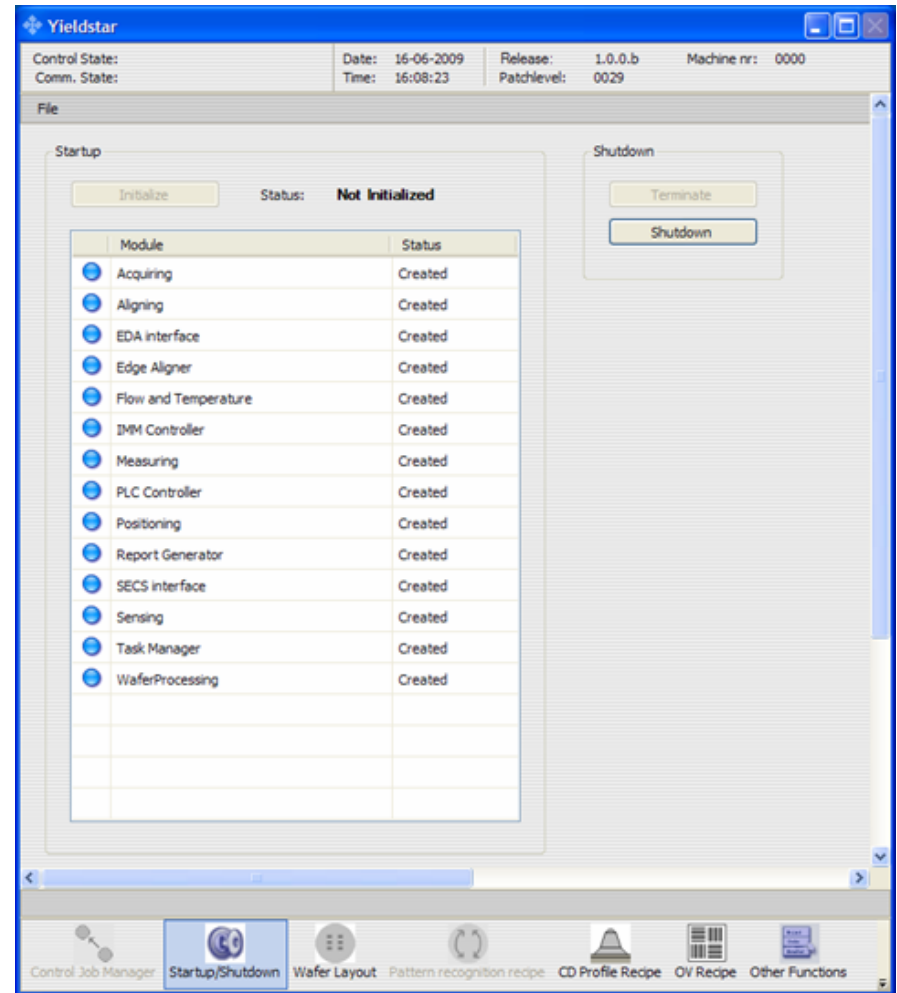
- Event log viewer displays the systems' events, errors and warnings
- Start the event log viewer via "Other functions"



Daily operations

Initialization and Shutdown

- Initialization is done via the Startup/Shutdown screen
- If successful all modules show green
- Yellow during init, Red when failed
- Individual module init is not possible
- Re-init can be done if one or more drives failed
- Previously initialized drives remain initialized



Questions?