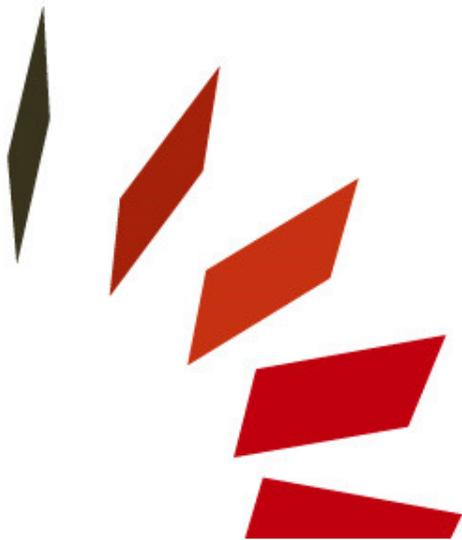




MEYER BURGER

# Manufacturing Execution System in a High Performance Pilot Cell Production

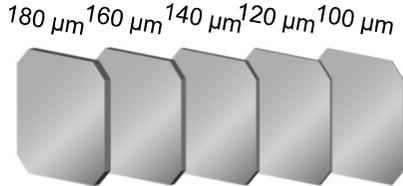
Marcel Leonhardt, Frank Allenstein, Heiko Mehlich, Ina Kutscher, Michael Mrosko



# HJT Technology

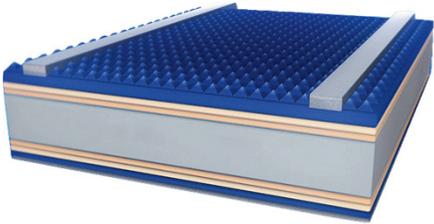
**A**

Wafer



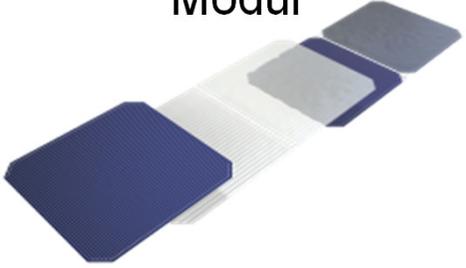
**B**

Cell

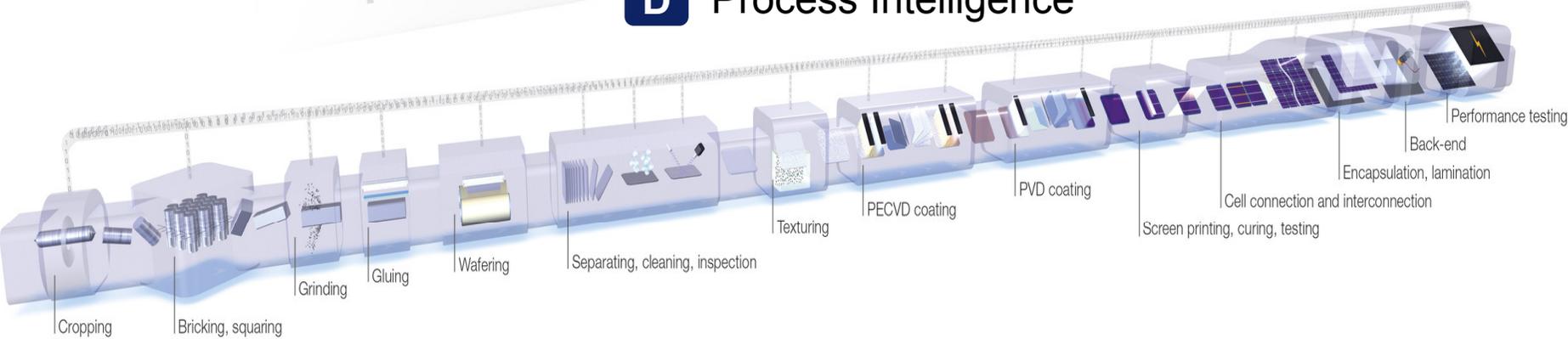


**C**

Modul



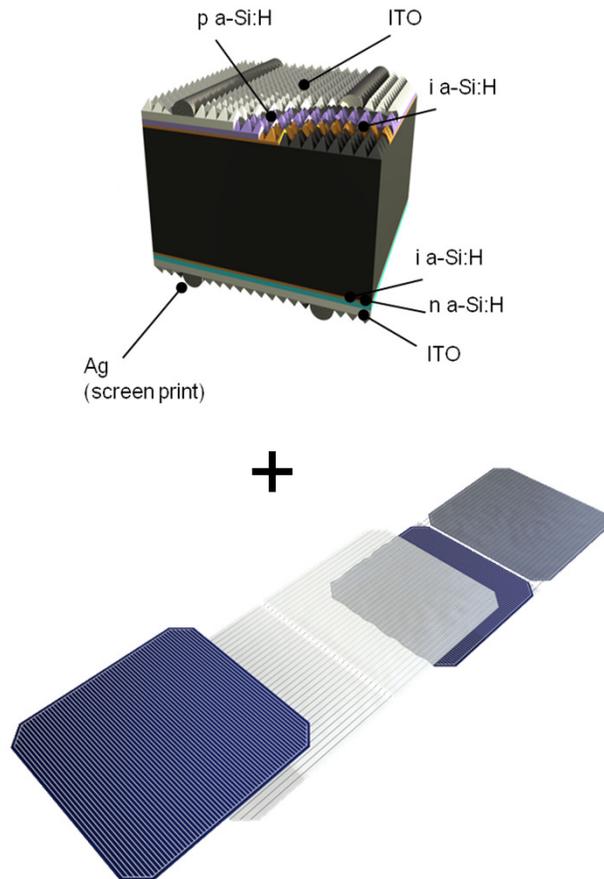
## **D** Process Intelligence



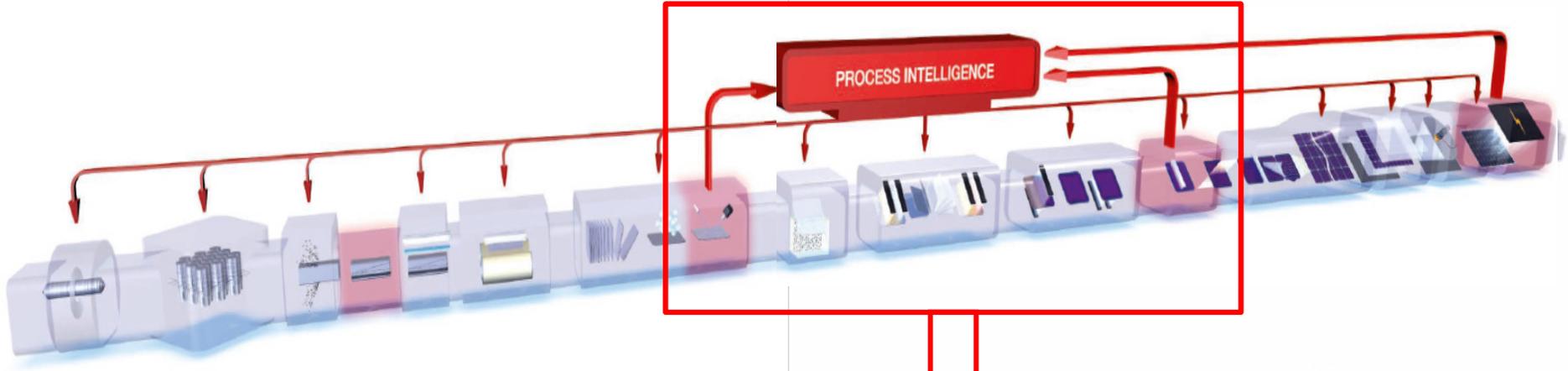


# Outline

- Heterojunction Cell Pilot Line
- MES
- Metrology
- User Storys
- Summary

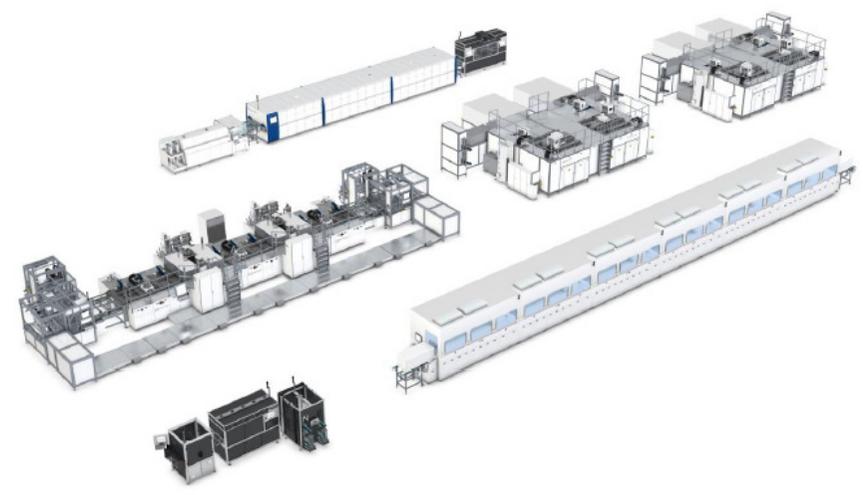


# HJT Technology – Cell Pilot Line

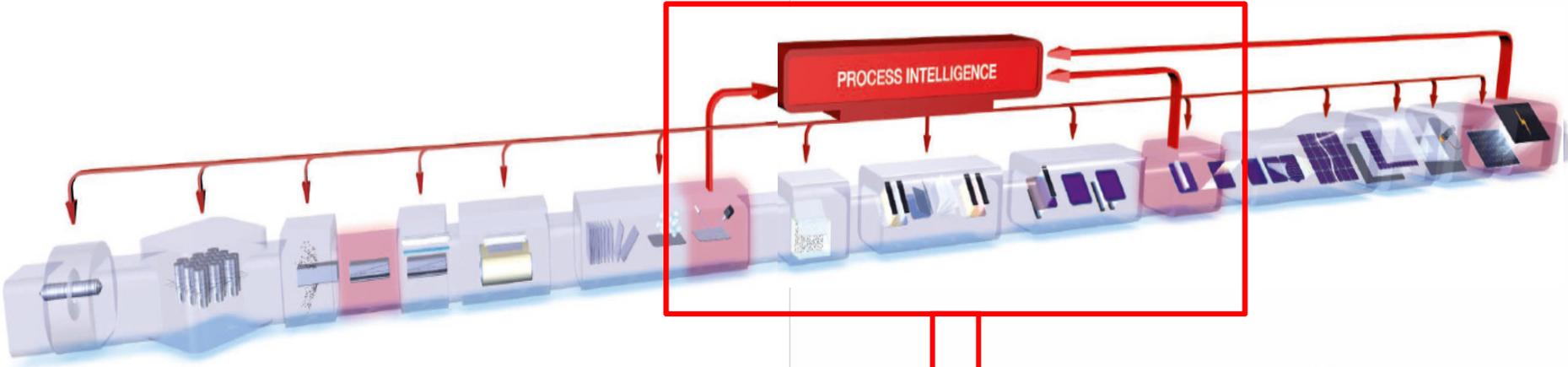


- HJT Cell Line - MB Germany
- [Video](#)

 A member of Meyer Burger Group

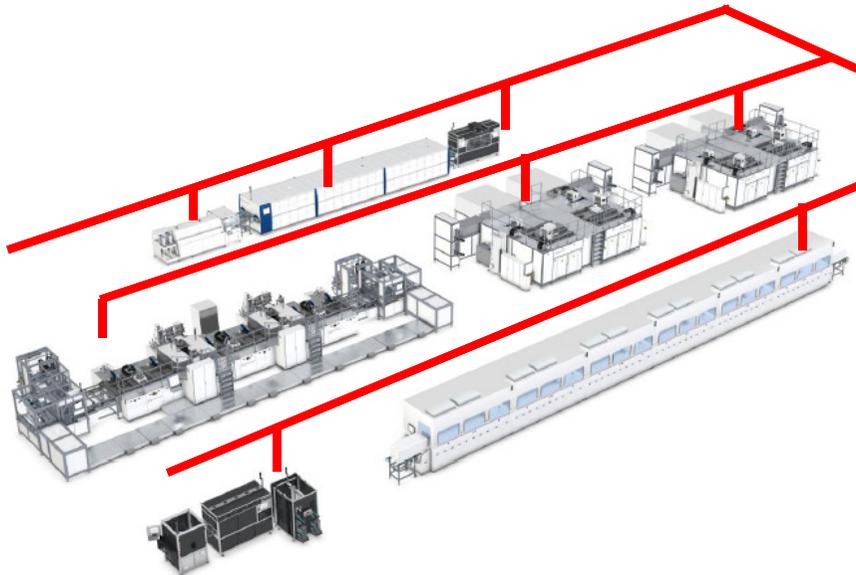


# HJT Technology – Manufacturing Execution System



- HJT Cell Line - MB Germany

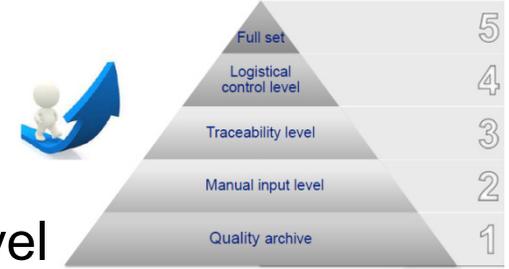
 A member of Meyer Burger Group



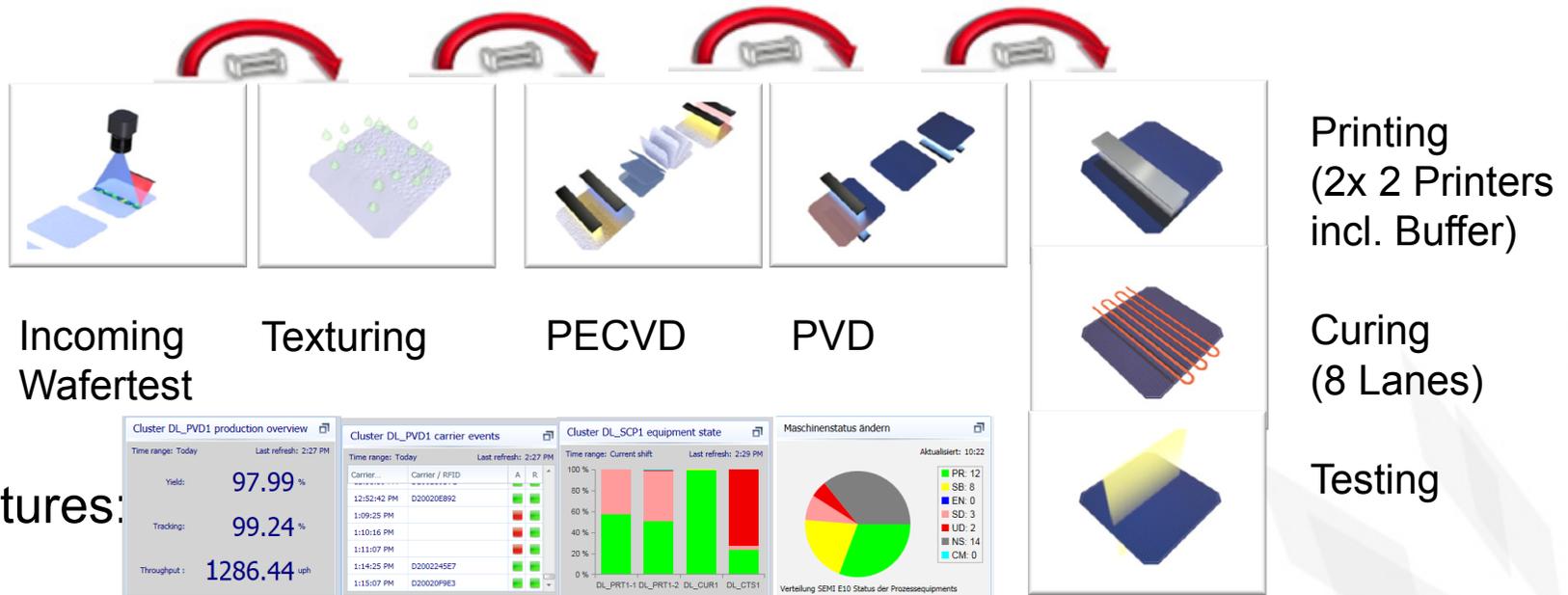
Visualize,  
Control &  
Report

**FabEagle**<sup>®</sup> MES

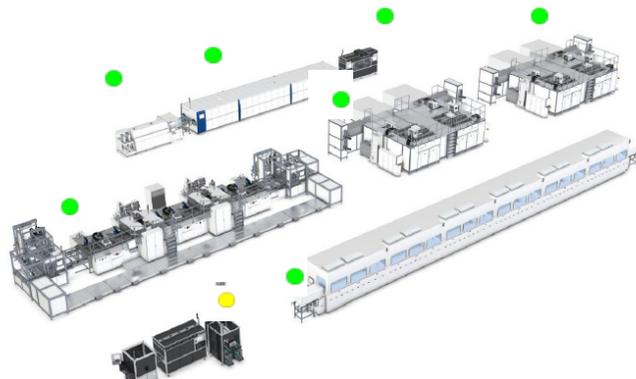
# HJT Technology – MES



- System Setup: Functionality up to logistical control level
- Cell Pilot Line – Virtual Wafer Tracking → Carrier based with RFID



## Features:



**Production control & monitoring**  
 realtime monitoring and instant messaging  
 (SEMI E10, Yield, Throughput, ...)

# HJT Technology – MES

- Features:

- Online SPC

Rule violations announced by instant messaging  
(e-mail, logbook, entries)

- Scheduled Reporting

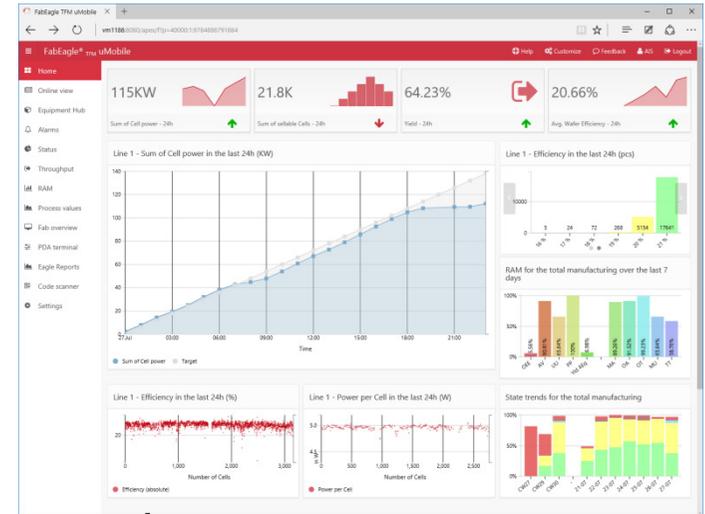
Using your predefined report filters the system creates an report and sends e.g: scheduled e-mails

- Web Dashboards

HTML5/CSS3 based with responsive design for

e.g. PC, Smartphone and Tablet and all operation systems

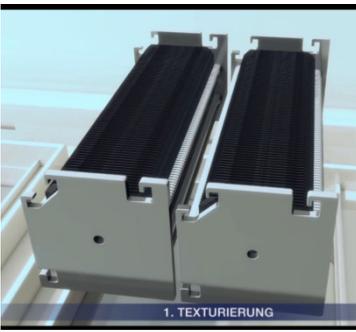
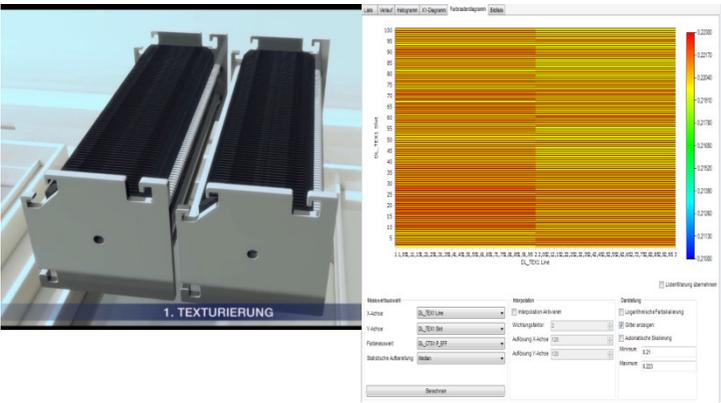
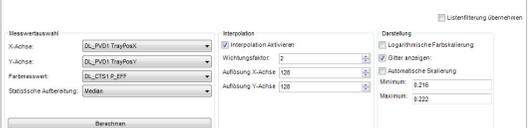
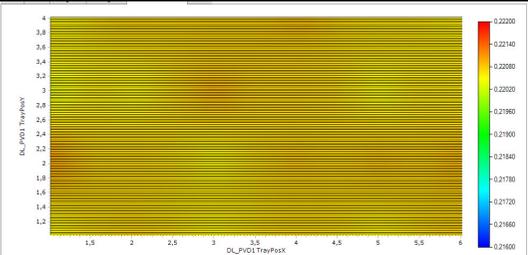
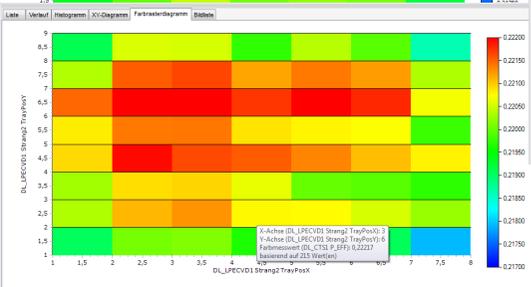
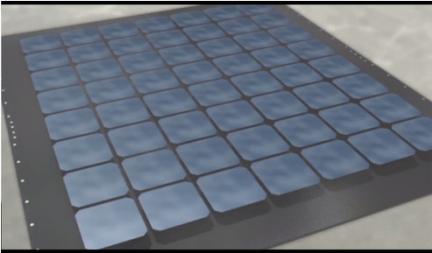
- Tracking based reports



# HJT Technology – MES

## Tracking based reporting → Traymaps/Heatmaps

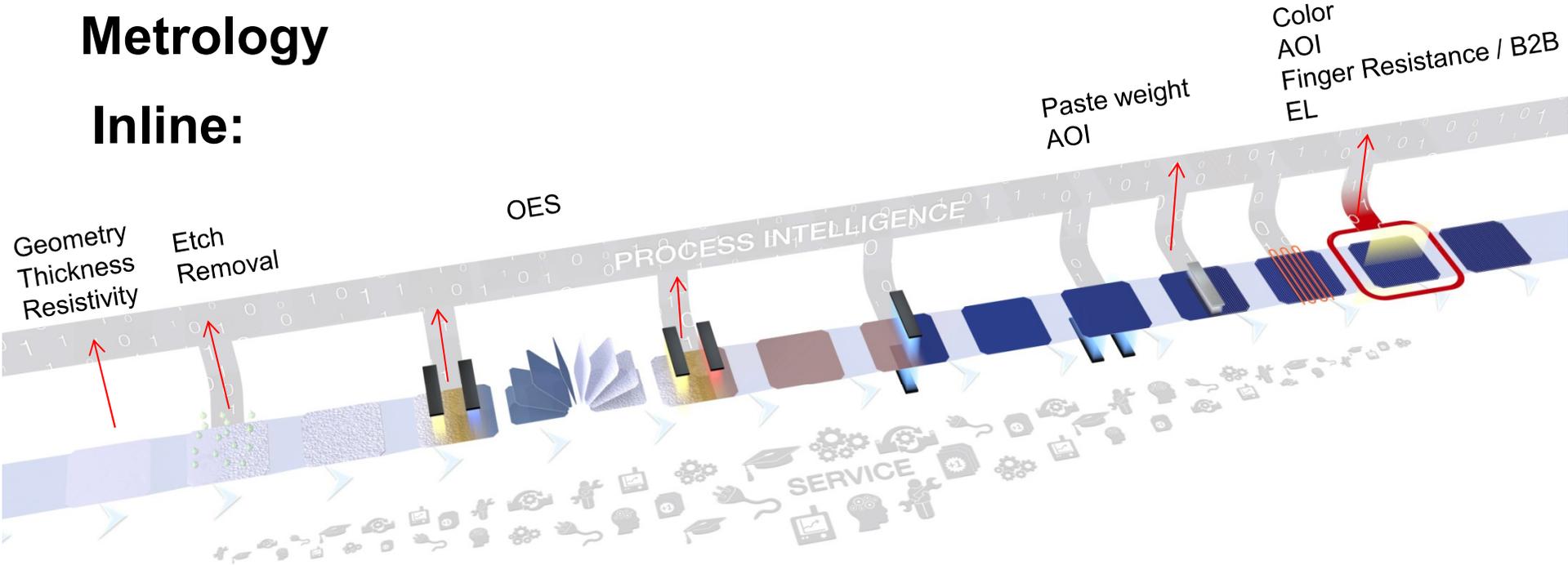
- Usage of the tracking information of wafers or cells to plot electrical results or parameters by its processing position
- e.g.: Tray PECVD (3 trays)
- e.g.: Tray PVD
- e.g.: Texturing



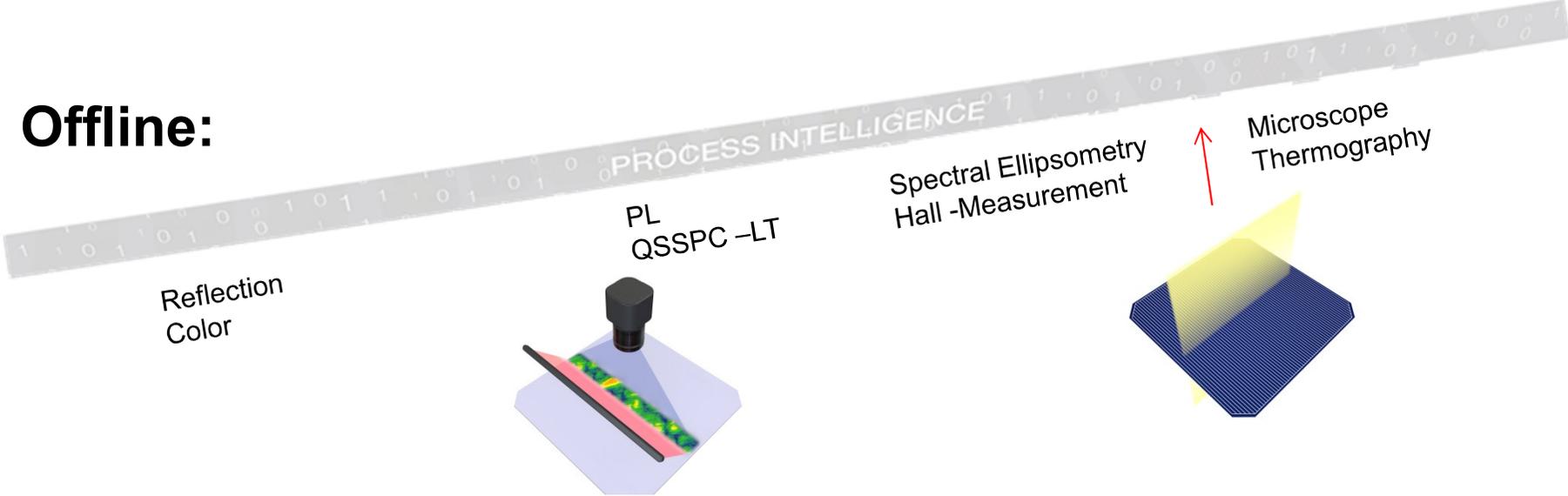
1. TEXTURIERUNG

# Metrology

## Inline:

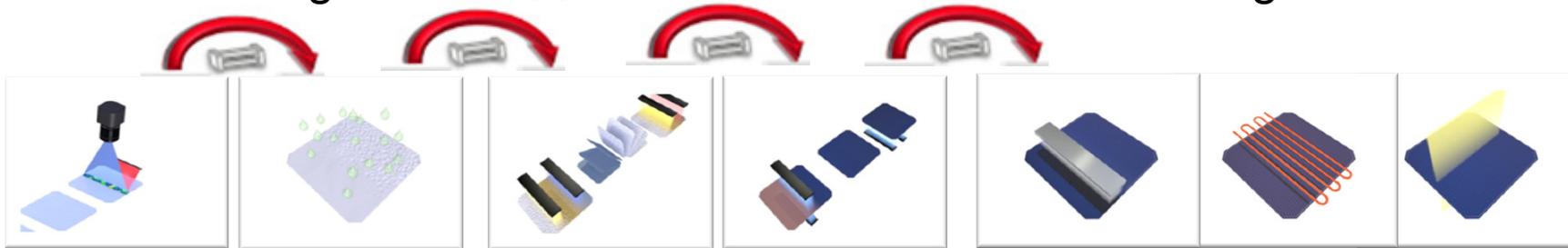


## Offline:



# Example 1– Tracking & Cell-Efficiency

- Challenges and Opportunities of virtual wafertracking



IWT

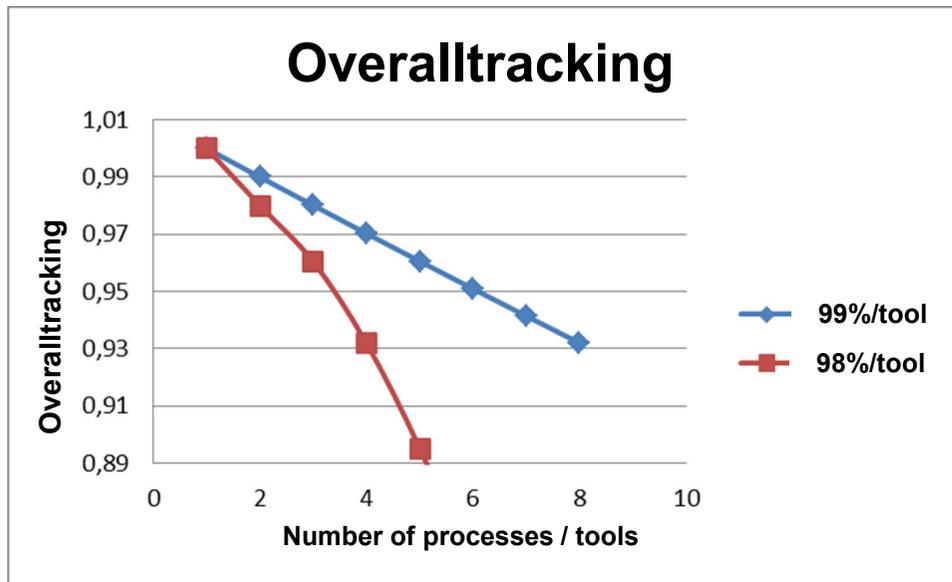
Texturing

PECVD

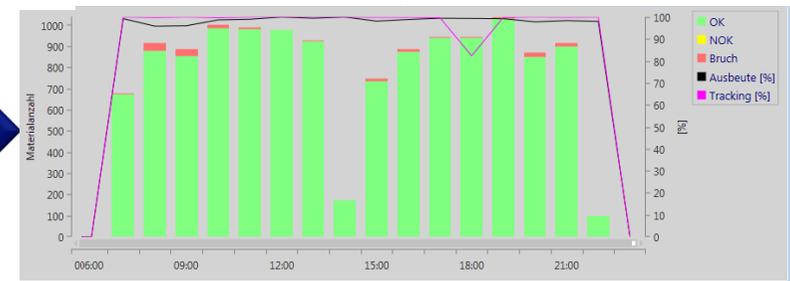
PVD

Backend

- In each tool its possible to loose the tracking of cells



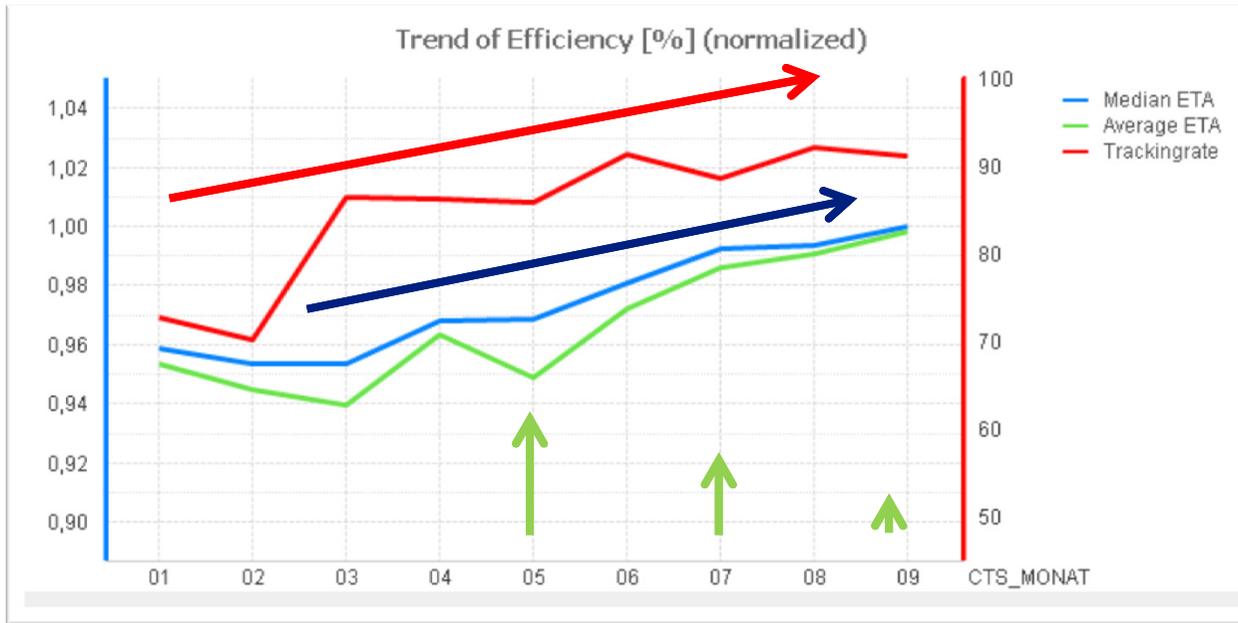
- establish 98,5% tracking for each tool



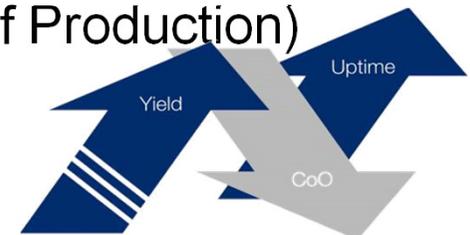
- establish >90% for Line

# Example 1– Tracking & Cell-Efficiency

- Usage of the opportunities of the MES system (e.g.: the cockpit)



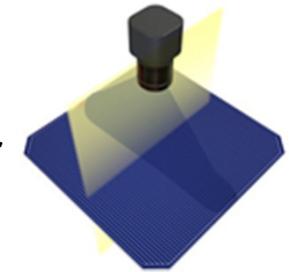
- Trend over the year:
  - Tracking ~90%
  - Improve GridTouch measured Efficiency (Median of Production)
  - Improve the Average Cell-Efficiency



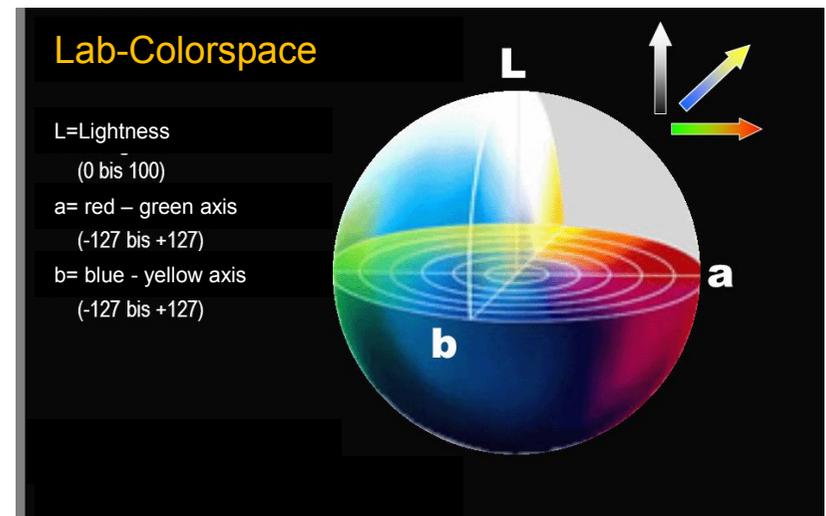
# Example 2– Monitoring of PVD Magnetron Lifecycle

- Observation: Color measurement is high sensitive to PVD process
- Question: When is the end of lifetime of PVD targets without yield loss and maximum usage?

- Inline color measurement of cells in the Hennecke Celltester
  - Monitoring of cellcolor with L,a,b – Colorspace

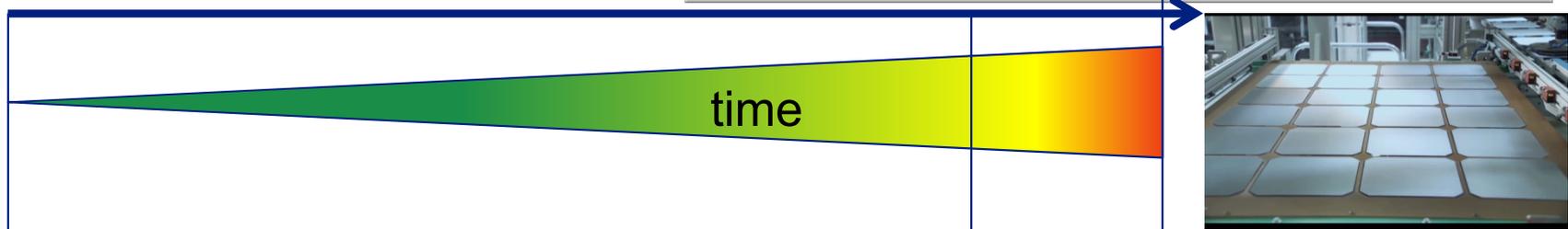
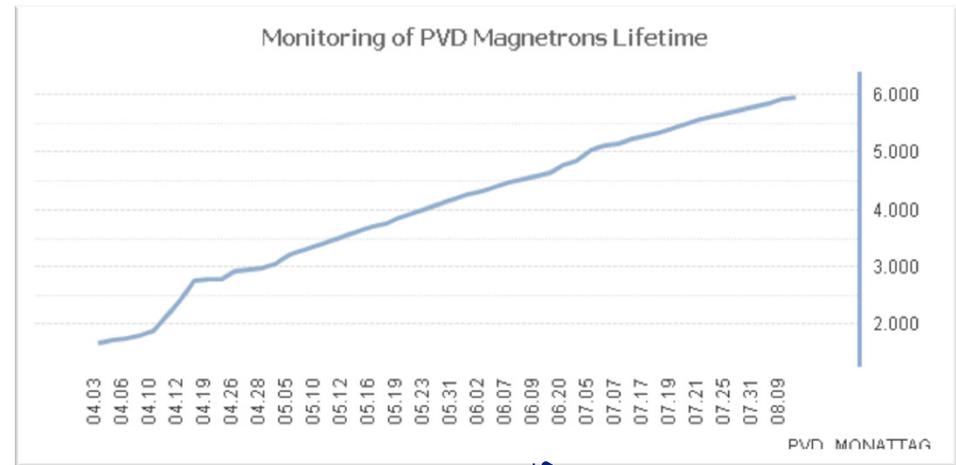


- Tracking of
  - PVD-Target lifetime
  - Trayinformation
  - Cellposition
- Combination in MES System



# Example 2– Monitoring of PVD Magnetron Lifecycle

- Sputtered power applied to the target = value lifetime in [kWh]
- Mapping of CTS\_Isc



...	...	1	2	3	4	5	6
A		9,266	9,266	9,265	9,266	9,261	9,262
B		9,271	9,273	9,274	9,274	9,274	9,274
C		9,277	9,280	9,280	9,277	9,278	9,279
D		9,283	9,285	9,288	9,282	9,284	9,284

ISC vs. Traymap PVD

first month/  
starting point

...	...	1	2	3	4	5	6
A		9,268	9,286	9,305	9,304	9,290	9,246
B		9,300	9,311	9,318	9,321	9,309	9,290
C		9,302	9,320	9,322	9,319	9,314	9,289
D		9,303	9,315	9,330	9,323	9,314	9,295

ISC vs. Traymap PVD

last month/  
warning point

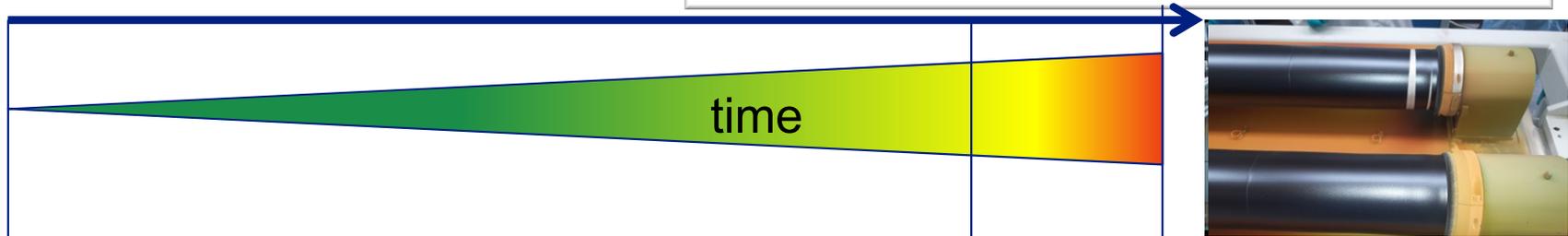
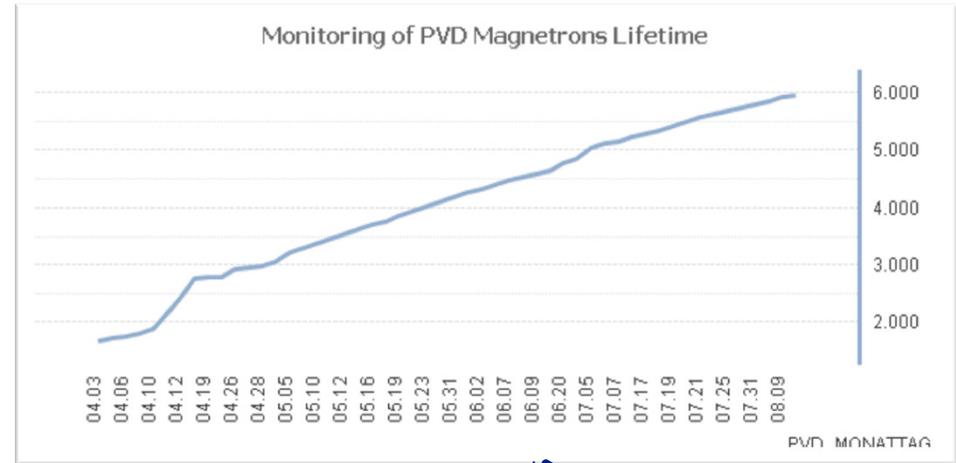
...	...	1	2	3	4	5	6
A		9,197	9,224	9,229	9,241	9,209	9,144
B		9,218	9,248	9,254	9,263	9,246	9,195
C		9,218	9,252	9,263	9,264	9,244	9,180
D		9,219	9,243	9,261	9,257	9,238	9,190

ISC vs. Traymap PVD

last day/  
Yield loss

# Example 2– Monitoring of PVD Magnetron Lifecycle

- Sputtered power applied to the target = value lifetime in [kWh]
- Mapping of **CTS\_Isc** & **Color\_L**



...	...	1	2	3	4	5	6
A		5,51	5,53	5,41	5,42	5,42	5,63
B		5,45	5,45	5,35	5,41	5,36	5,51
C		5,43	5,42	5,35	5,38	5,36	5,49
D		5,44	5,49	5,39	5,41	5,40	5,52

ColorL vs. Traymap

first month/  
starting point

...	...	1	2	3	4	5	6
A		5,13	4,87	4,74	4,72	4,93	5,89
B		5,02	4,76	4,67	4,66	4,83	5,72
C		4,97	4,77	4,67	4,67	4,81	5,63
D		4,99	4,84	4,71	4,71	4,88	5,72

ColorL vs. Traymap

last month/  
warning point

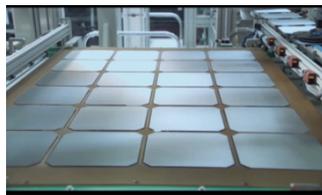
...	...	1	2	3	4	5	6
A		5,10	4,87	4,84	4,82	4,98	5,87
B		5,11	4,88	4,74	4,72	4,92	5,87
C		5,10	4,90	4,76	4,74	4,92	5,81
D		5,08	4,92	4,80	4,76	4,93	5,84

ColorL vs. Traymap

last day/  
Yield loss

# Example 2– Monitoring of PVD Magnetron Lifecycle

- Result: combined monitoring of machine and substrate values

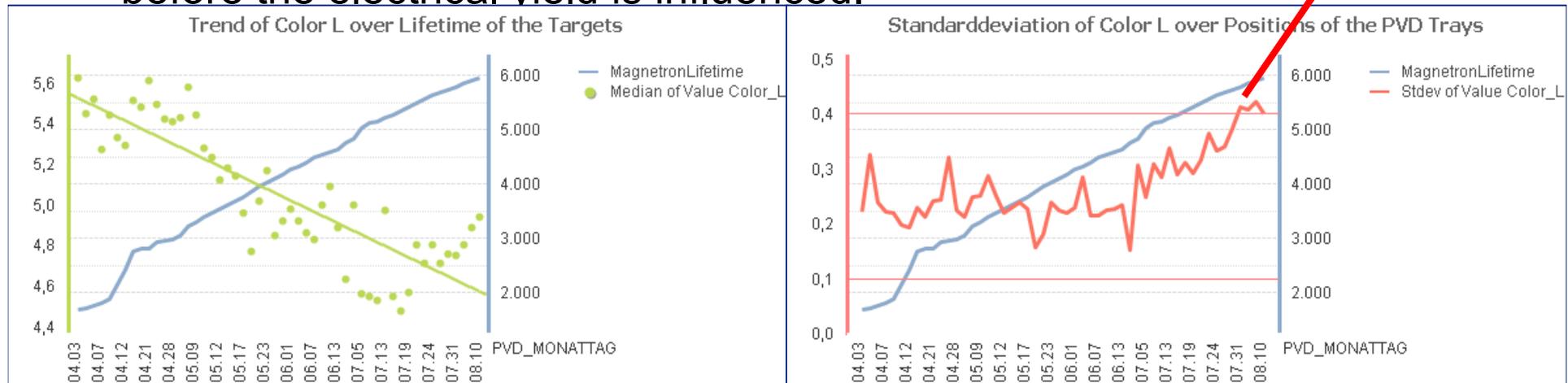


	1	2	3	4	5	6
A	9,197	9,224	9,229	9,241	9,209	9,144
B	9,218	9,248	9,254	9,263	9,246	9,195
C	9,218	9,252	9,263	9,264	9,244	9,180
D	9,219	9,243	9,261	9,257	9,238	9,190

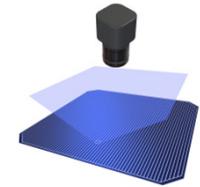
	1	2	3	4	5	6
A	5,10	4,87	4,84	4,82	4,98	5,87
B	5,11	4,88	4,74	4,72	4,92	5,87
C	5,10	4,90	4,76	4,74	4,92	5,81
D	5,08	4,92	4,80	4,76	4,93	5,84



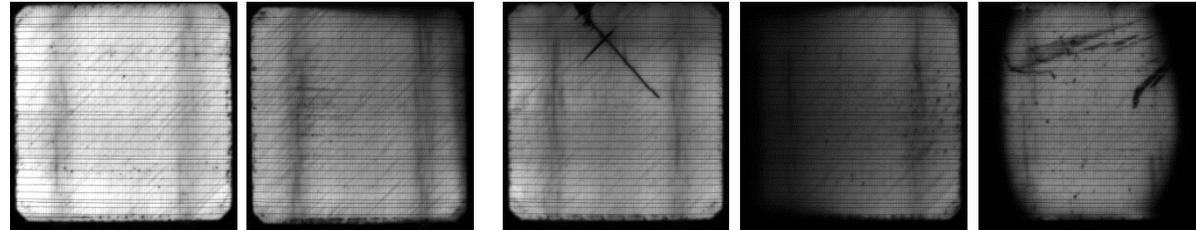
enables to use a inline measured value that reacts before the electrical yield is influenced.



## Example 3– Monitoring of PECVD



- Observation: EL measurement shows characteristic signatures for certain problems



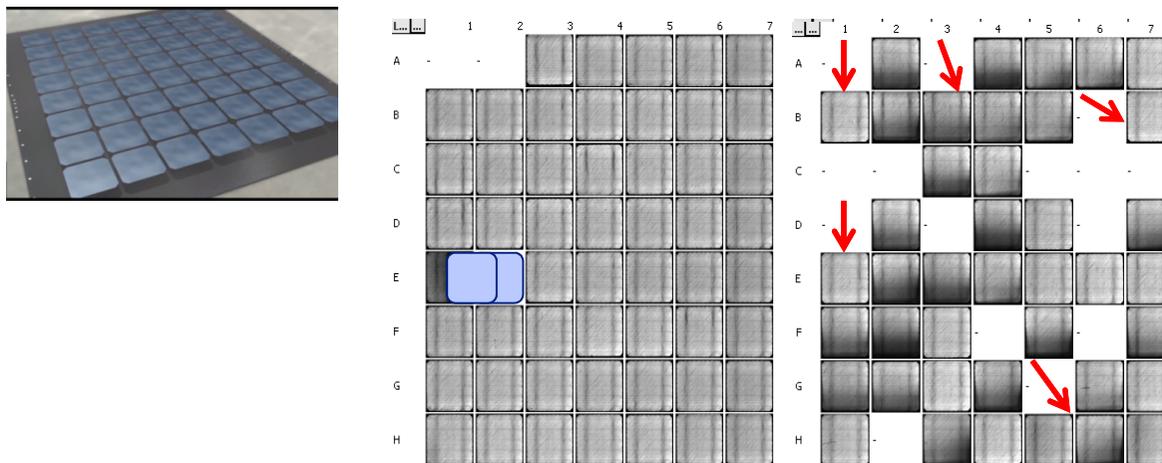
- Inline EL measurement of cells in the Hennecke Celltester
- Tracking of
  - Trayinformation PECVD
  - Cellposition
  - EL-Pictures
- Combination in MES System

## Example 3– Monitoring of PECVD

- Result: combined monitoring of machine and substrate values



- Picturemapping of EL Images to get the Possibility to use the 2D Information of the EL-Picture



- Wafer loss on Automation Gripper
- Mispositioning of wafers with Automation (sensor and settingproblem)

# Summary

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- Improvement of Median and Average Efficiency with the Fabeagle MES
- Implementation of Cockpit Items and Usage of Instant Messaging for Yield improvement
- Generation of Traymaps based on tracking related Information
- Combination with Inline Metrology enables to monitor processes and equipment with the chance for yield improvement due to more sensitive control
- Automatically generated Picturemaps enable to use 2D information



MEYER BURGER

**«Your task is not to foresee the future,  
but to enable it!»**

Antoine de Saint-Exupéry



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**Thank you!**