



## Cell EL Inspection: Challenges and benefits

The screenshot shows the pi4\_control 9.0 - Cell EL Inspection software interface. The window title is "pi4\_control 9.0 - Cell EL Inspection" and the version is "Version v11467-144-g2a97773-NOI-MASTER". The user is "Administrator" and the operation mode is "MANUAL". The current product is "170310\_WA\_PERC\_Sbb\_1\_04198".

The interface includes a search bar, a search button, and a search by dropdown menu. The search results table is as follows:

Tracking ID	Timestamp	Res.	H.Class	Classes	Bit code	Bin	Prod.name	Image file
20171020102025102	2017-10-20 10:20:25	NG	4	9h	0	15	170310_WA_PERC_Sbb_1_04198	C:\pi4_rs\
20171020102029591	2017-10-20 10:20:29	NG	6	39h	0	15	170310_WA_PERC_Sbb_1_04198	C:\pi4_rs\
20171020102032557	2017-10-20 10:20:32	NG	6	31h	0	15	170310_WA_PERC_Sbb_1_04198	C:\pi4_rs\
20171020102038742	2017-10-20 10:20:38	NG	3	5h	0	15	170310_WA_PERC_Sbb_1_04198	C:\pi4_rs\
20171020102043769	2017-10-20 10:20:43	NG	2	3h	0	15	170310_WA_PERC_Sbb_1_04198	C:\pi4_rs\
20171020102046087	2017-10-20 10:20:46	NG	17	10035h	0	17	170310_WA_PERC_Sbb_1_04198	C:\pi4_rs\
20171020102049973	2017-10-20 10:20:49	NG	18	30033h	0	18	170310_WA_PERC_Sbb_1_04198	C:\pi4_rs\

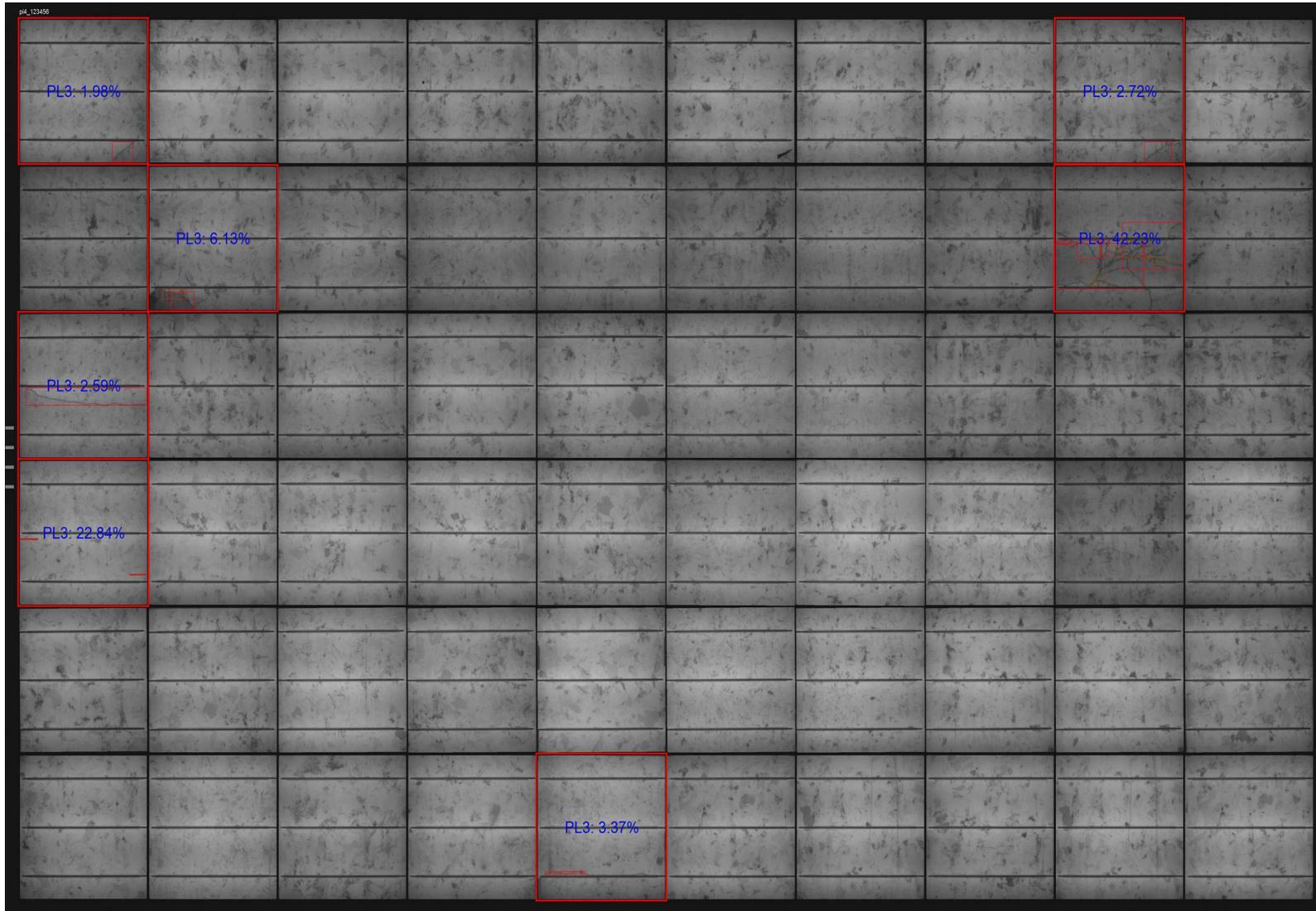
The interface also includes a search by dropdown menu with options for ID, Highest class, Bin, and Result. The search by dropdown menu is currently set to "Result". The search by dropdown menu has a "Search by" dropdown menu with options for "ID", "Highest class", "Bin", and "Result". The search by dropdown menu has a "Search by" dropdown menu with options for "ID", "Highest class", "Bin", and "Result".

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Ralph Schmidt  
pi4\_robotics GmbH Berlin

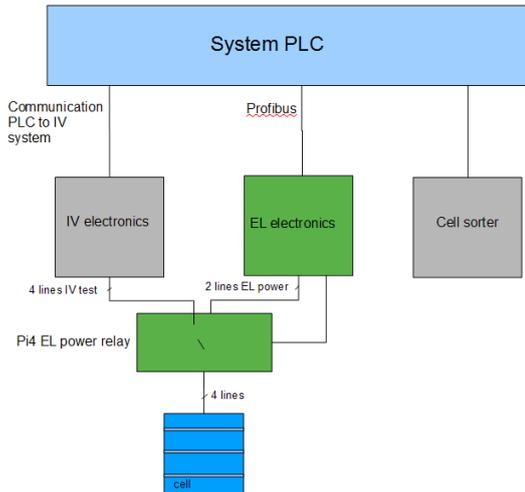
# You are familiar with the benefits of EL inspection in module production...



# pi4 Electroluminescence Systems

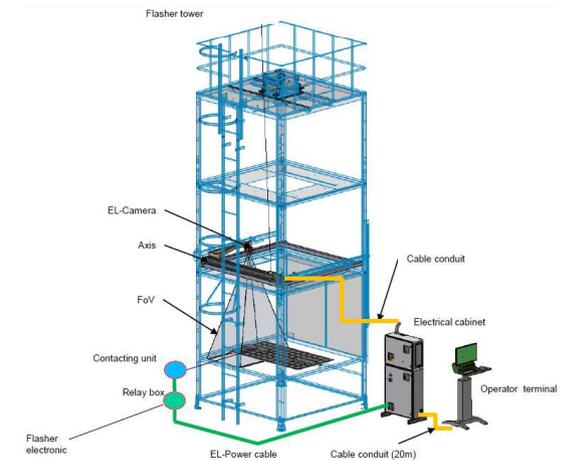


## Electrical Block Diagram



## Inline Cell EL-Inspection

## Automatic Inline Module EL-Inspection



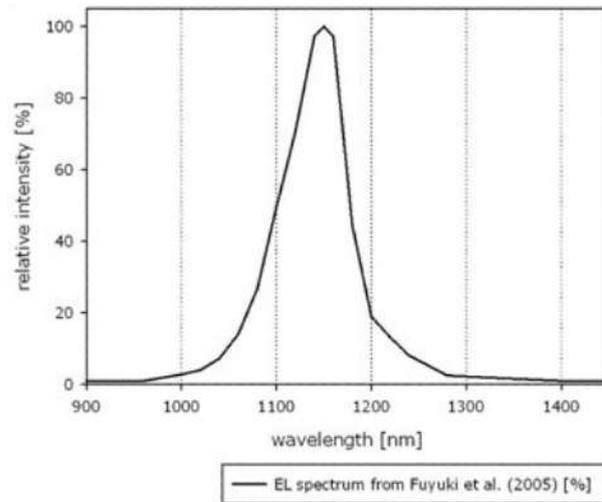
## EL offline systems for Modules

## Automatic Inline EL for Thin Film Modules

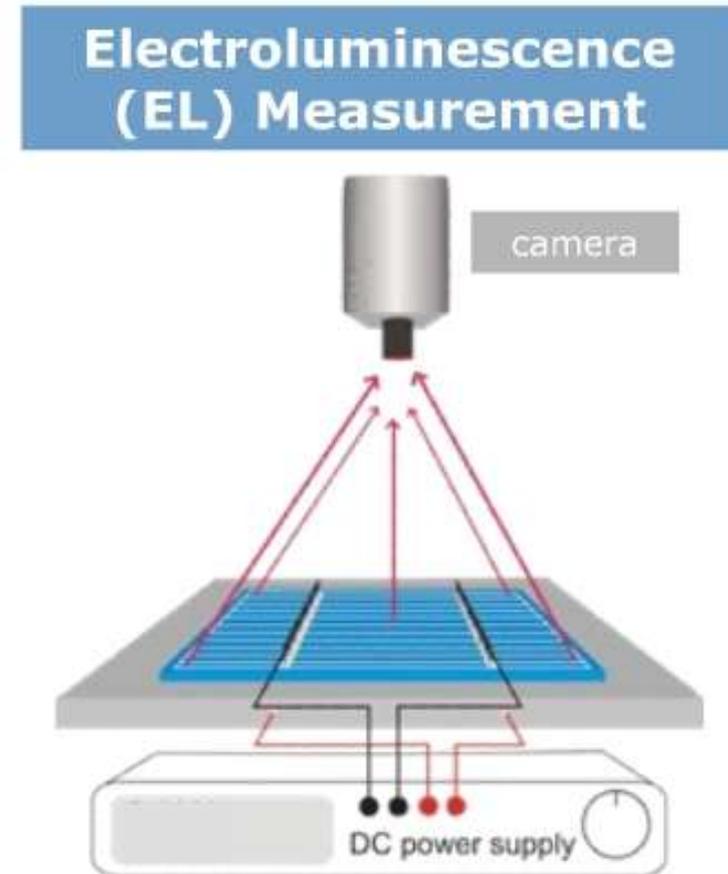
## EL-Flasher-Integration

## Basic Principle of EL Inspection

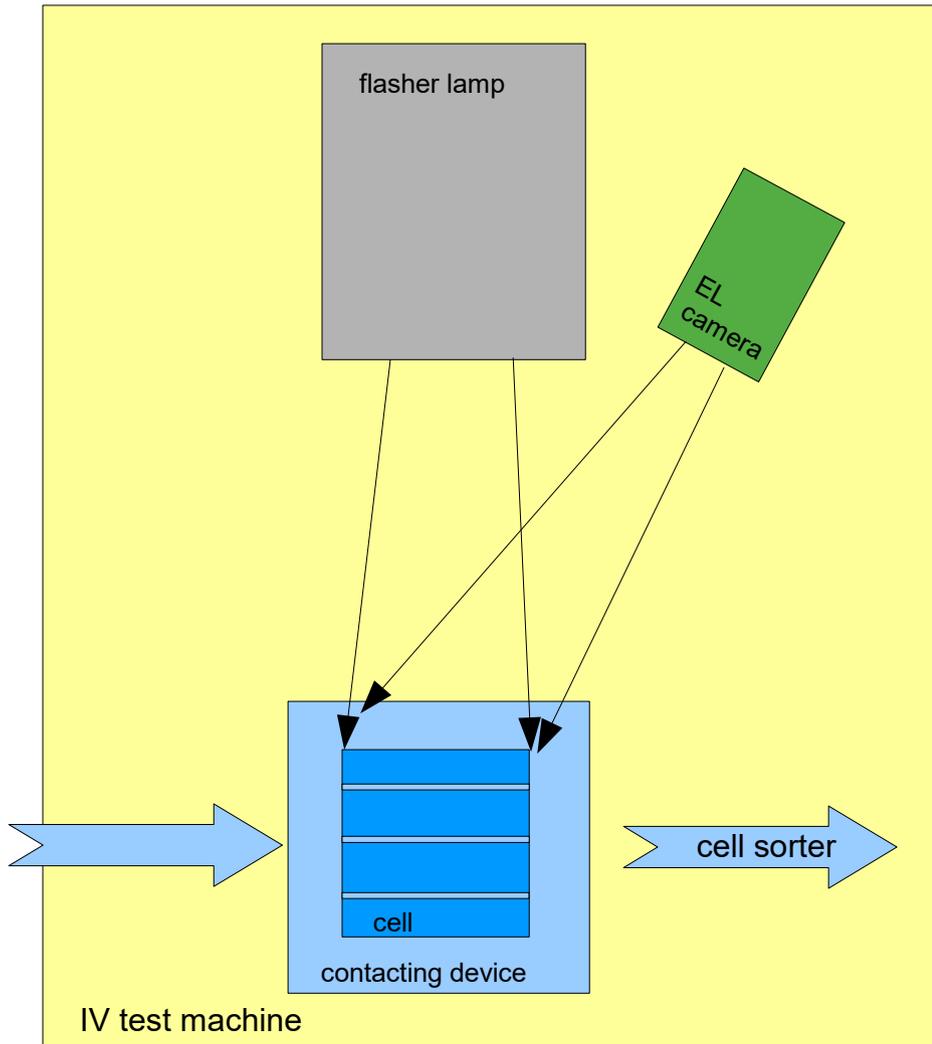
- ◆ Feeding a constant current to cells:  
8 A / 60 V DC → 60 x 1 V per Cell



- ◆ EL only possible with special NIR-cameras (NIR = Near Infrared)
- ◆ Usage of NIR optimized lenses
- ◆ Absolute darkness necessary
- ◆ Inspection in motion not possible (exposure time)

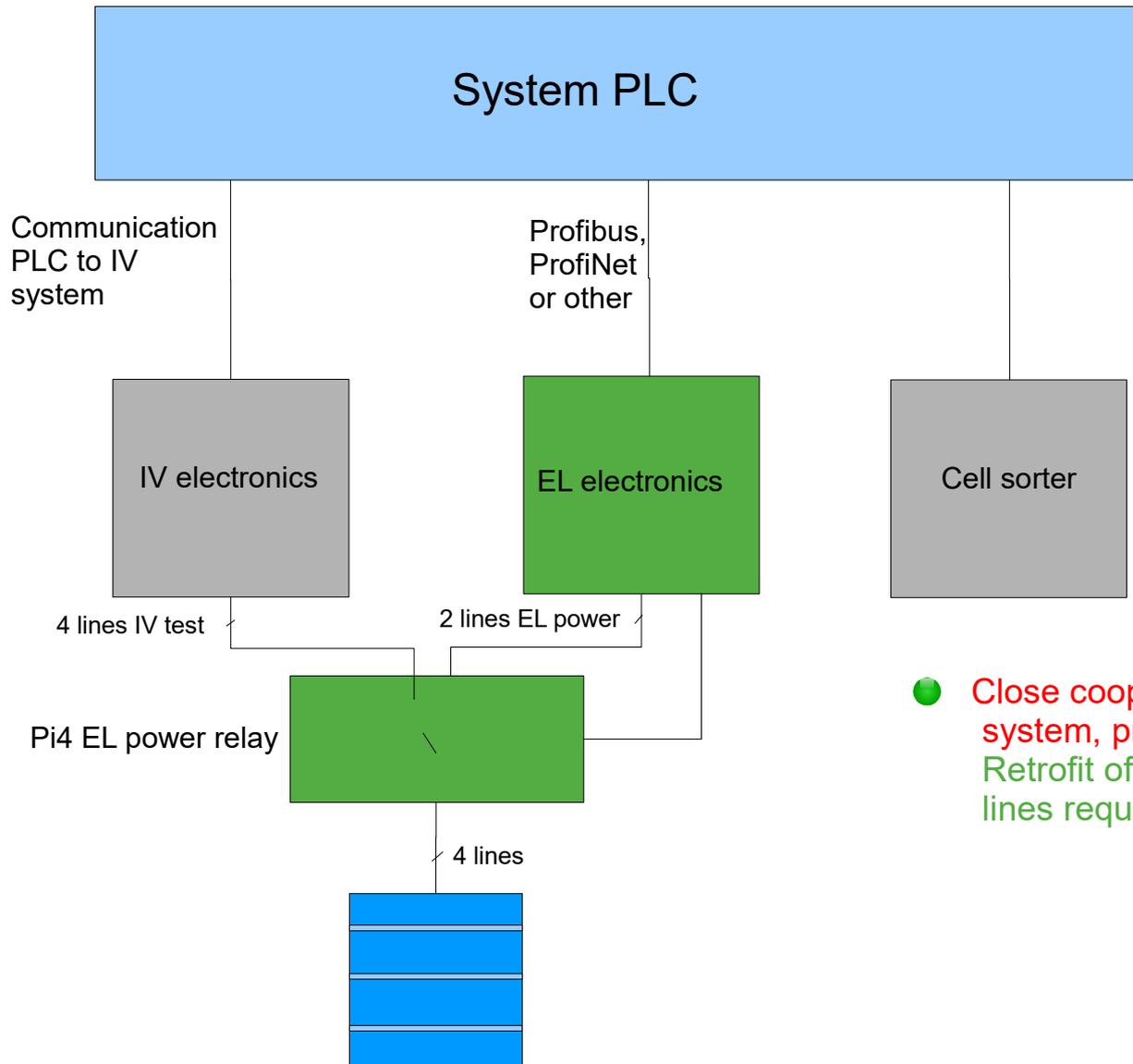


## Challenge 1: Mounting EL camera in IV System Unit



- **Camera mounted at non perpendicular angle to cell:**  
Geometrical distortion of images must be compensated by software
- **Line cycle time must be shared by IV and EL system:**  
For fast lines with cycle time  $< 1.5$  s, time for image acquisition is  $< 300$  ms  
With silicon cameras cycle times can be realized as follows:
  - Multi crystalline cells  $< 300$  ms
  - Mono crystalline cells  $< 150$  ms
  - Advanced cells like PERC  $< 20$  ms
- **Cell Contacting device must be shared:**  
IV load and measuring cables cannot be used, EL power supply must be switched to contacting unit

## Challenge 2: Interfacing to existing and new lines

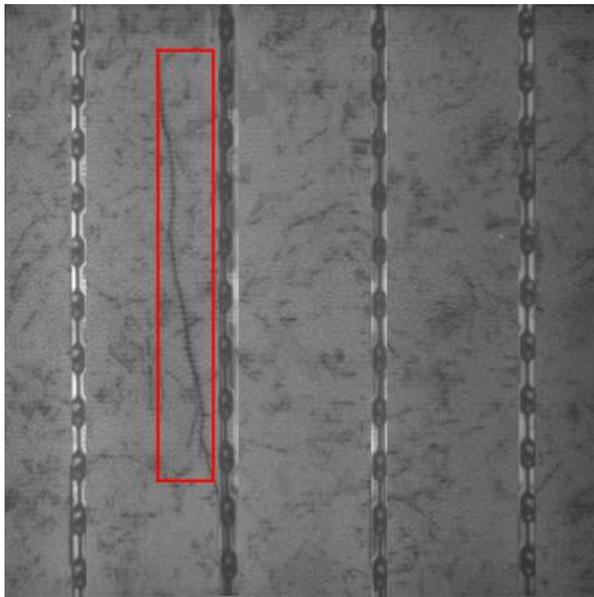


- Close cooperation with producers of IV system, production line and cell sorter: Retrofit of existing lines and setup in new lines requires high degree of flexibility

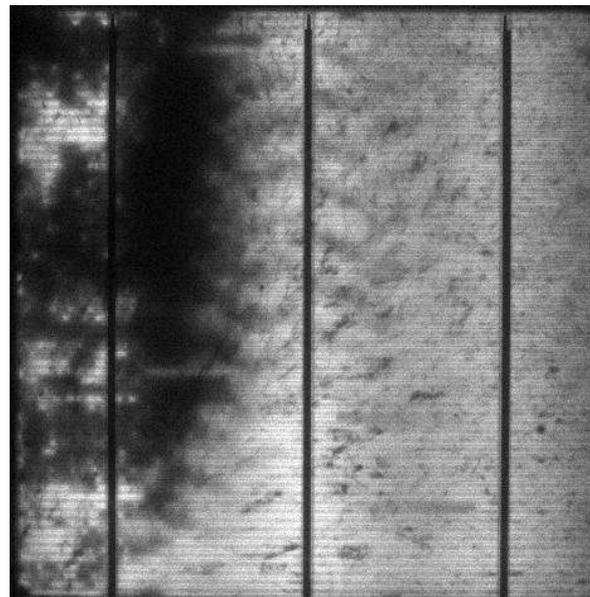
## Challenge 3: Reliable automatic inspection of all typical defects



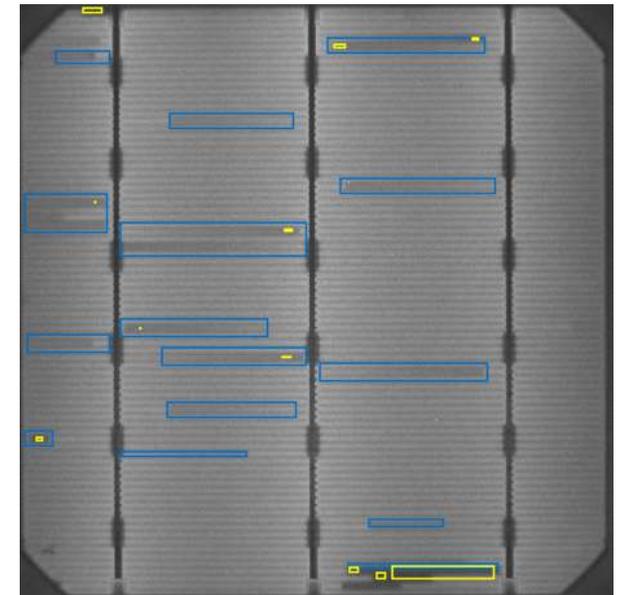
- **All types of cell technologies must be processed:**  
Monocrystalline, multicrystalline and PERC cells
- **No operator intervention possible:**  
Due to the short cycle times automatic detection and quality judgement must be very reliable.



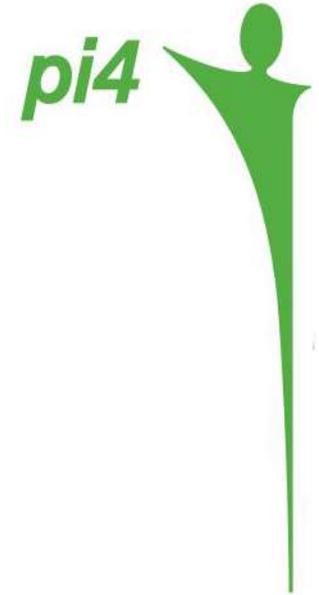
Cracks and other mechanical cell damages



Cell processing flaws



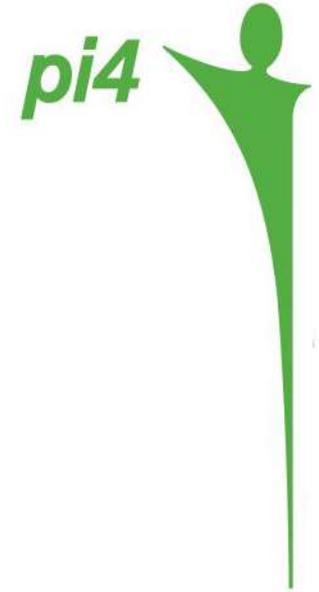
Screen printing issues



## Challenge 4: Contacting and positioning of cells must be reproducible and reliable

- **Poor Contacting:**  
Is not a problem for the IV system, but can produce dark areas in the EL image of varying size and position
- **Poor Cell Positioning:**  
Can result in poor cell contacting

# Benefits of Inline Cell EL Inspection



## 1. Detection of all quality and process related defects automatically

Micro cracks, active and inactive

Gridfinger defects

Dark spots

Chipped edge

Cell brightness classification

## 2. Detecting defects not visible without EL:

Some process issues are not detectable by visible light AOI systems and cannot be classified by IV system

# Benefits of Inline Cell EL Inspection



## 3. Detecting defects inline:

Immediate feedback about process issues to line operators by inline sorting

Tracking ID	Timestamp	Res.	H. Class	Classes	Bit code	Bin	Prod.name	Image file
20171020102025102	2017-10-20 10:20:25	NG	4	9h	0	15	170310_WL_PERC_Sbb_1_04198	C:\pi4_rs\...
20171020102025991	2017-10-20 10:20:29	NG	6	39h	0	15	170310_WL_PERC_Sbb_1_04198	C:\pi4_rs\...
20171020102032557	2017-10-20 10:20:32	NG	6	33h	0	15	170310_WL_PERC_Sbb_1_04198	C:\pi4_rs\...
20171020102038742	2017-10-20 10:20:38	NG	3	9h	0	15	170310_WL_PERC_Sbb_1_04198	C:\pi4_rs\...
20171020102043769	2017-10-20 10:20:43	NG	2	9h	0	15	170310_WL_PERC_Sbb_1_04198	C:\pi4_rs\...
20171020102046687	2017-10-20 10:20:46	NG	17	10035h	0	17	170310_WL_PERC_Sbb_1_04198	C:\pi4_rs\...
20171020102049973	2017-10-20 10:20:49	NG	18	30033h	0	18	170310_WL_PERC_Sbb_1_04198	C:\pi4_rs\...

Statistics and image data stored in a data base may can be viewed on remote workstations in the network, giving process and quality management full access

Timestamp	01	02	03	04	05
2017-10-20 10:00	7	2	2	2	4

## **Conclusion**

**A well designed automatic inline Cell EL system can:**

- increase consistency of product quality**
- detect process issues earlier**
- avoid production losses by early process interaction**

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