



# Inline Computational Imaging: Single Sensor Technology for Simultaneous 2D/3D High Definition Inline Inspection

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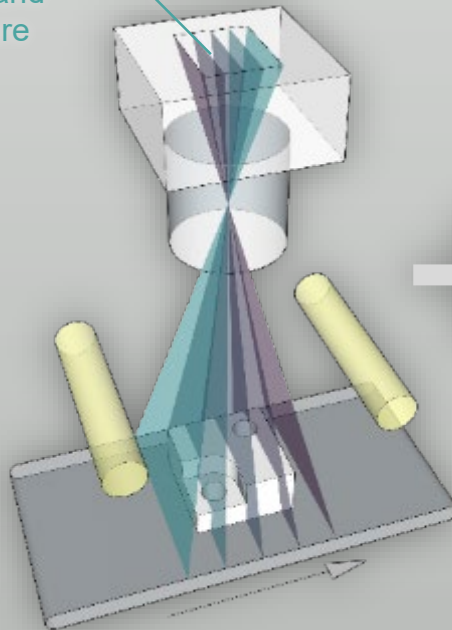
[www.ait.ac.at/hpv](http://www.ait.ac.at/hpv)



# AIT Inline Computational Imaging: Single Sensor Technology for Simultaneous 2D/3D Inline Inspection

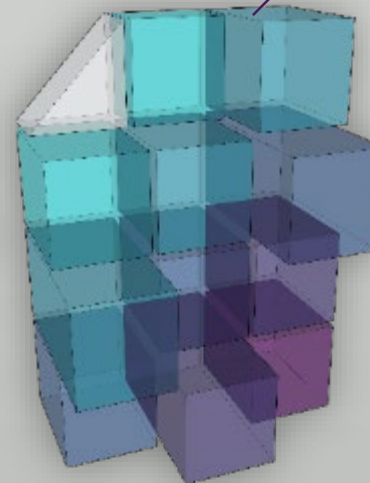
## ICI Sensor System

Single Sensor Technology for  
Simultaneous Light Field and  
Photometric Stereo Capture

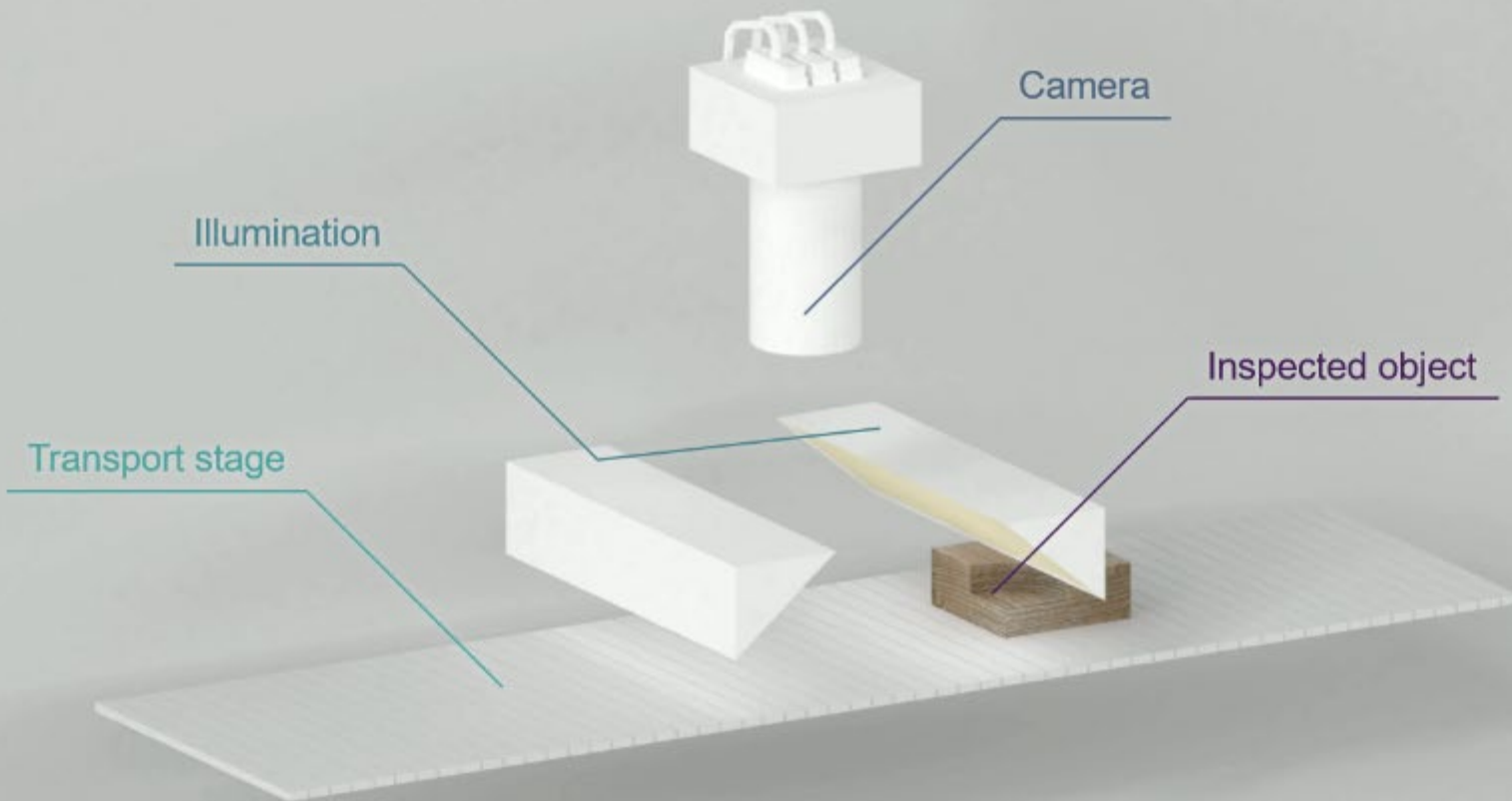


## ICI Software Modules

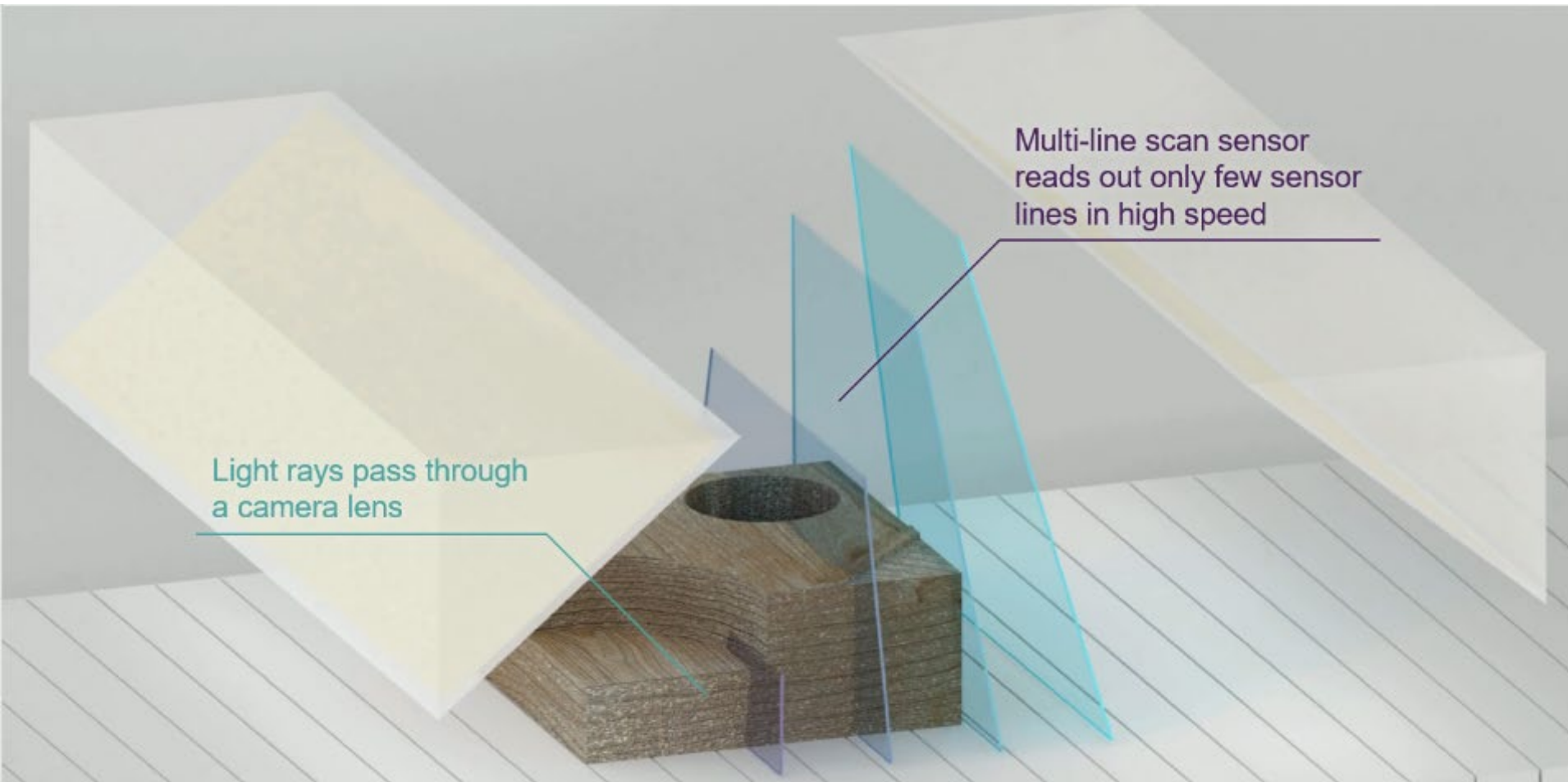
Generic Computational  
Imaging Library for  
2D/3D Tasks



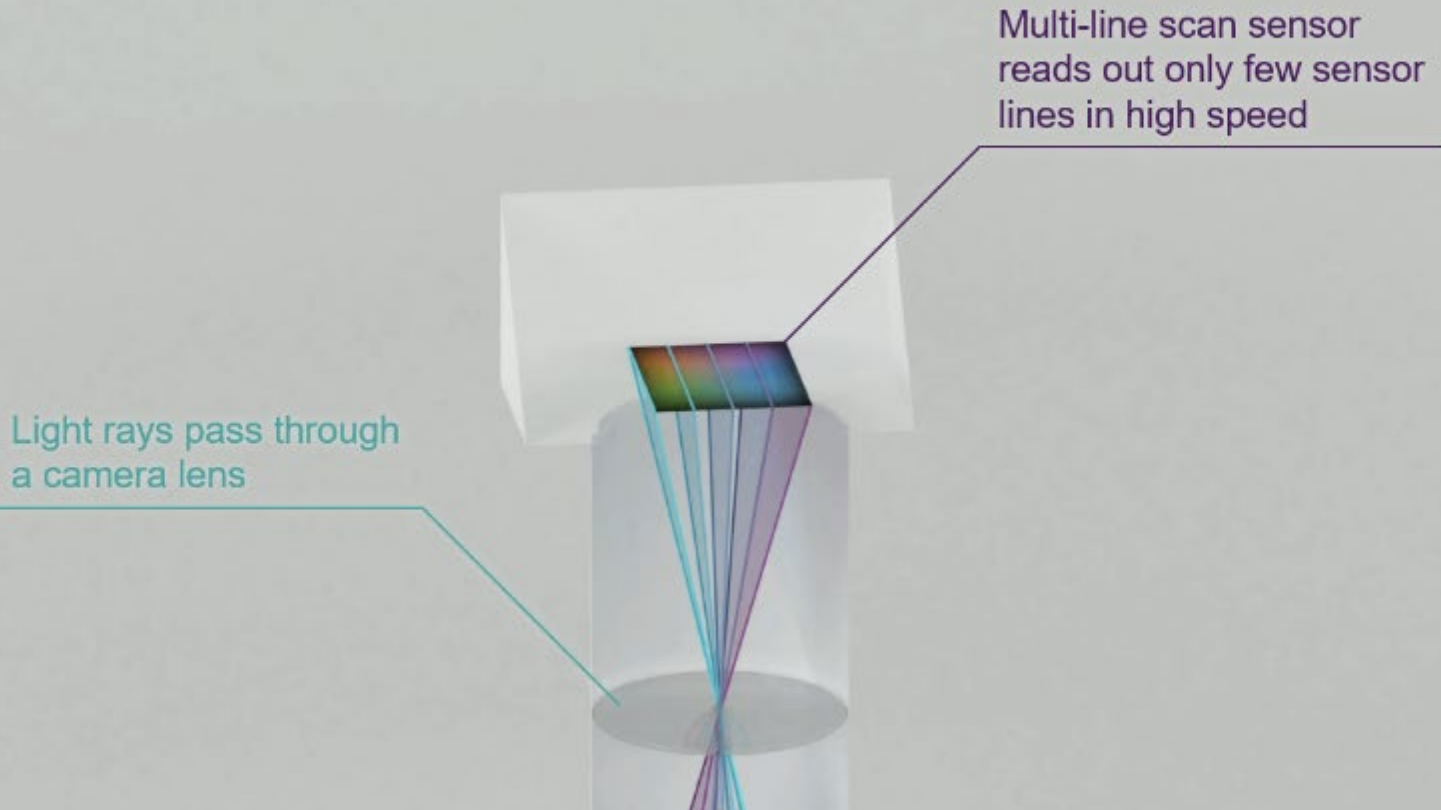
# AIT Inline Computational Imaging: Working Principle



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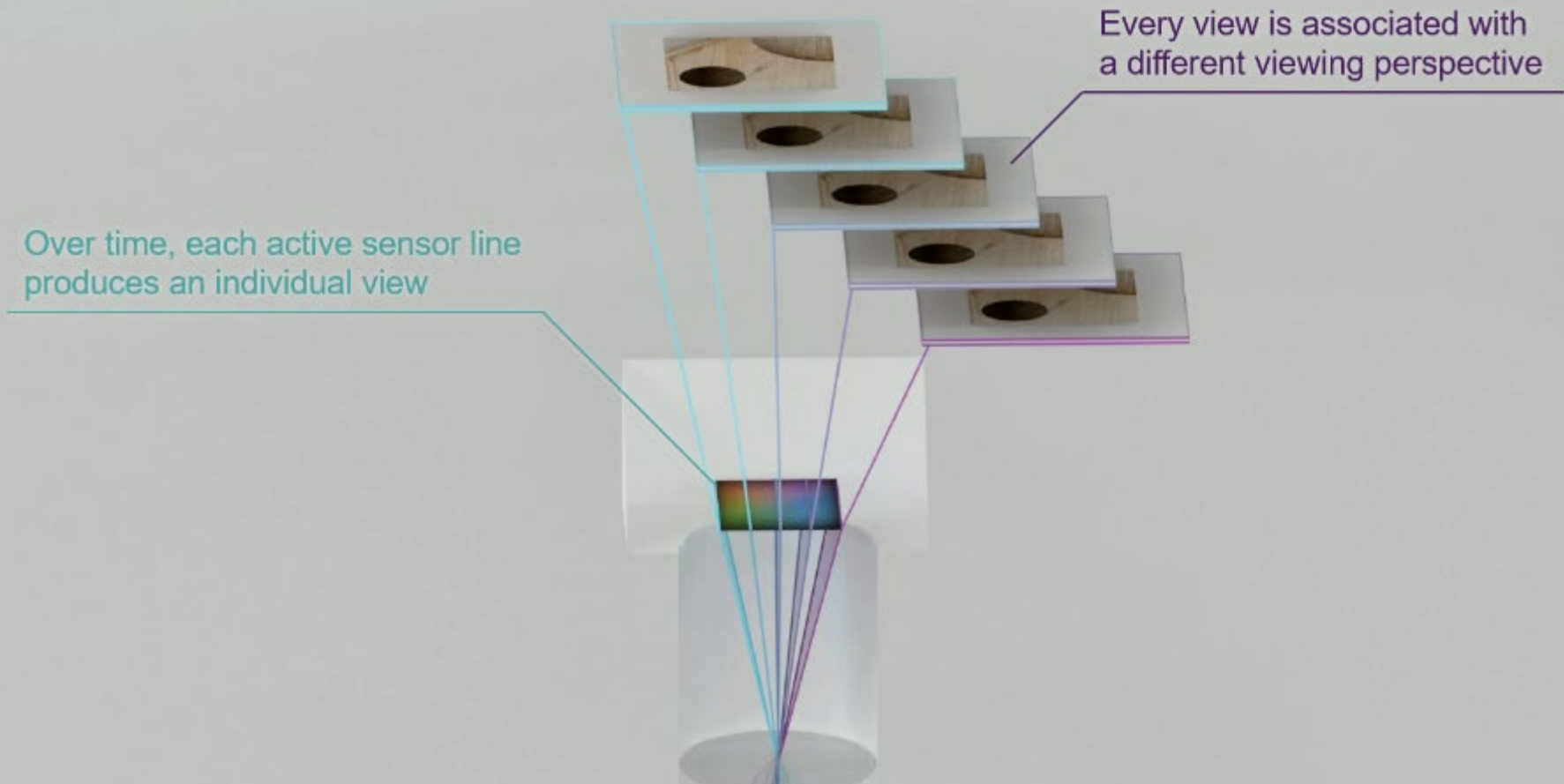


# AIT Inline Computational Imaging: Working Principle

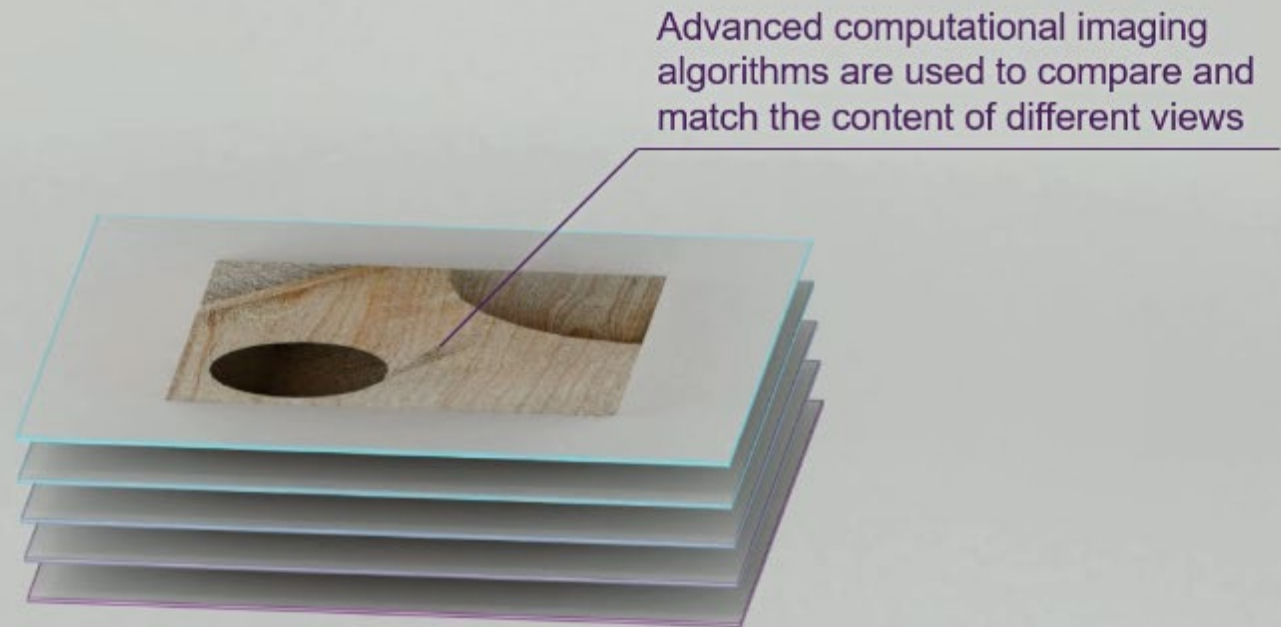




# AIT Inline Computational Imaging: Working Principle

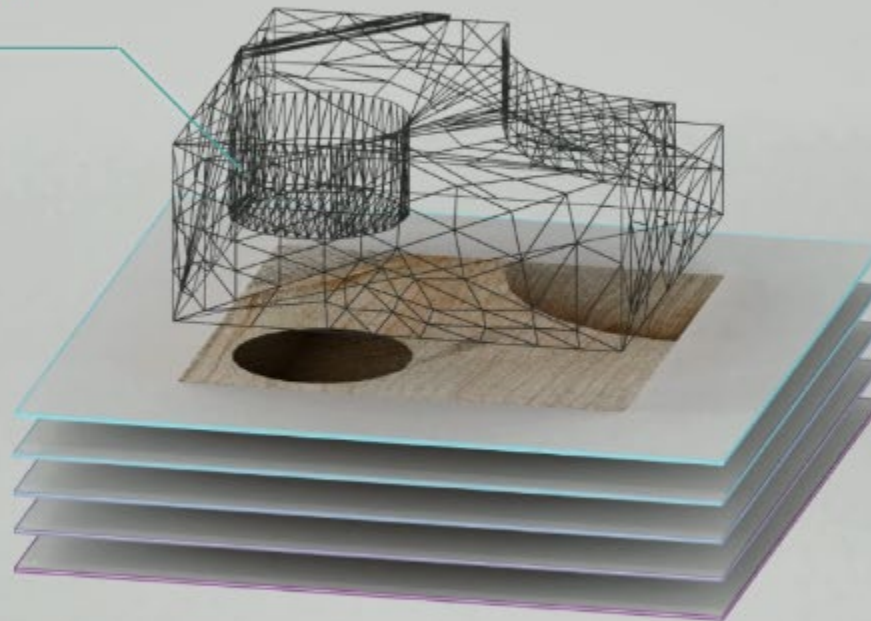


# AIT Inline Computational Imaging: Working Principle



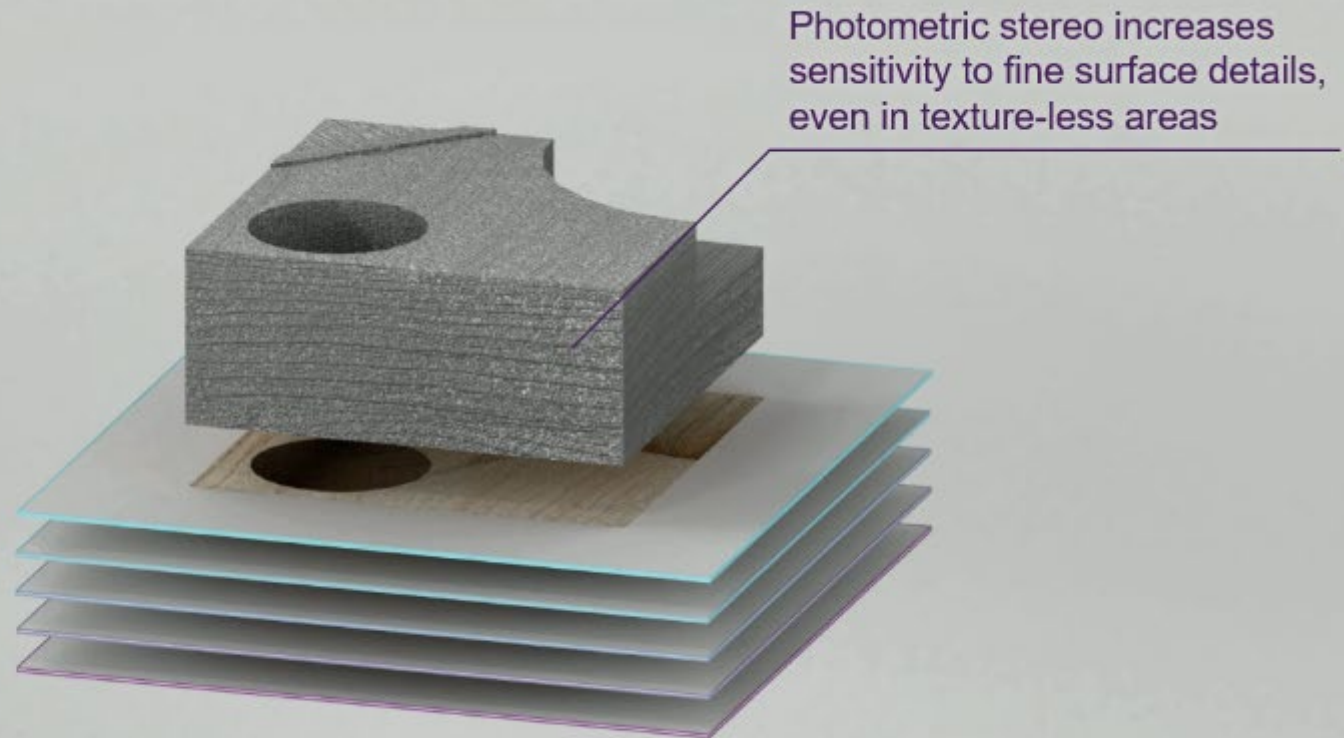
# AIT Inline Computational Imaging: Working Principle

Multiple views of the light field  
allow for reconstruction of  
an accurate 3D model



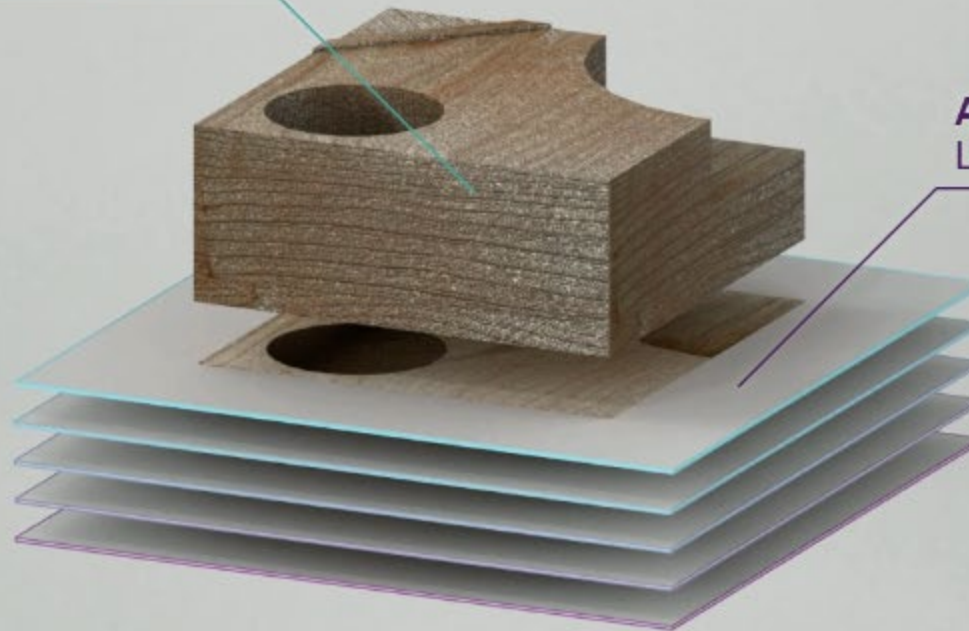


# AIT Inline Computational Imaging: Working Principle



# AIT Inline Computational Imaging: Working Principle

Pixel-precise de-noised 2D texture  
can be extracted from multiple views



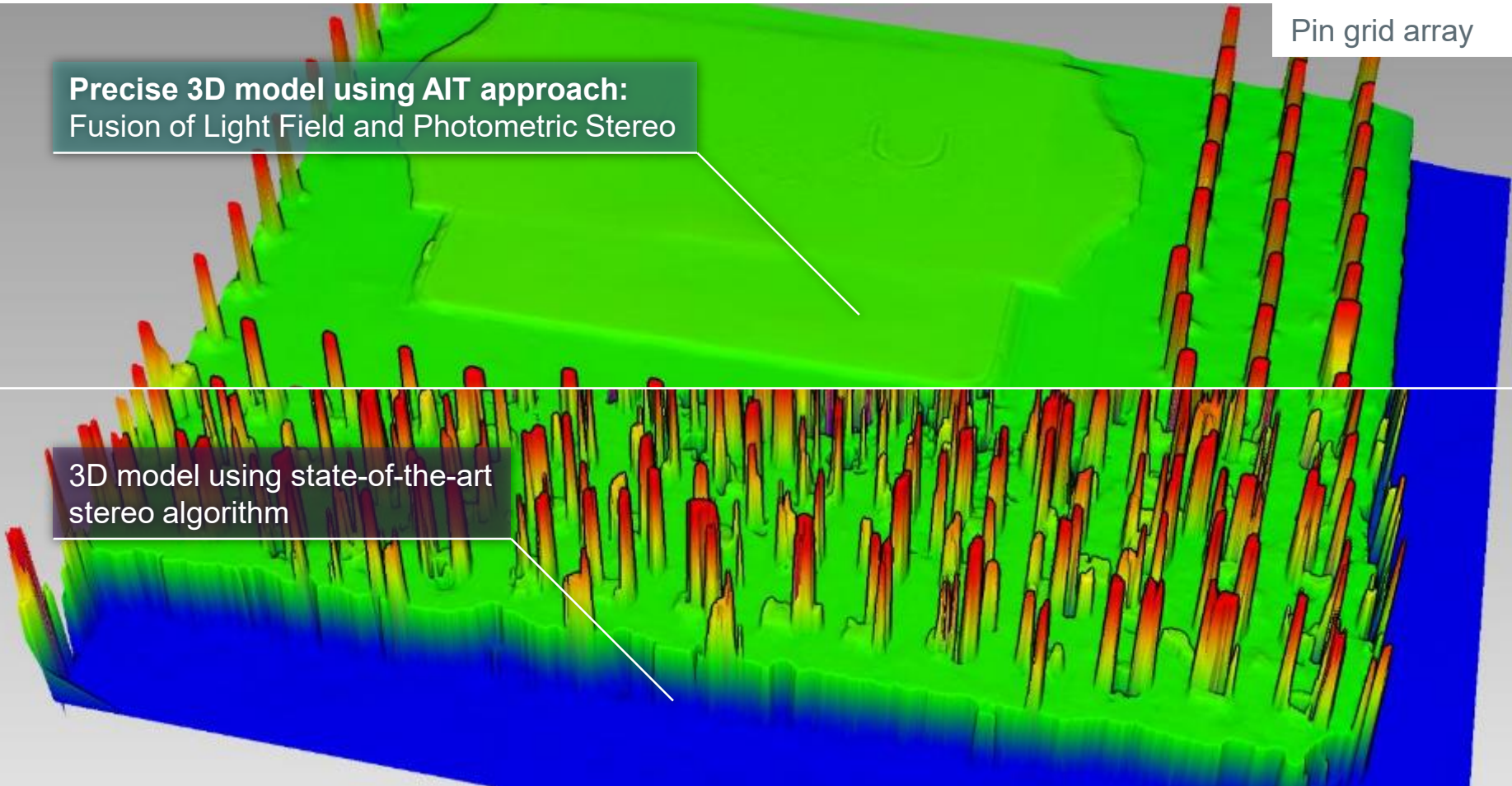
**And much more!**  
Let's take a closer look...

# AIT Inline Computational Imaging: Simultaneous Capture of Multiple Viewing Perspectives





# AIT Inline Computational Imaging: 3D Sensing



# AIT Inline Computational Imaging: Robust to Material Reflectance Properties

Scene containing various material types

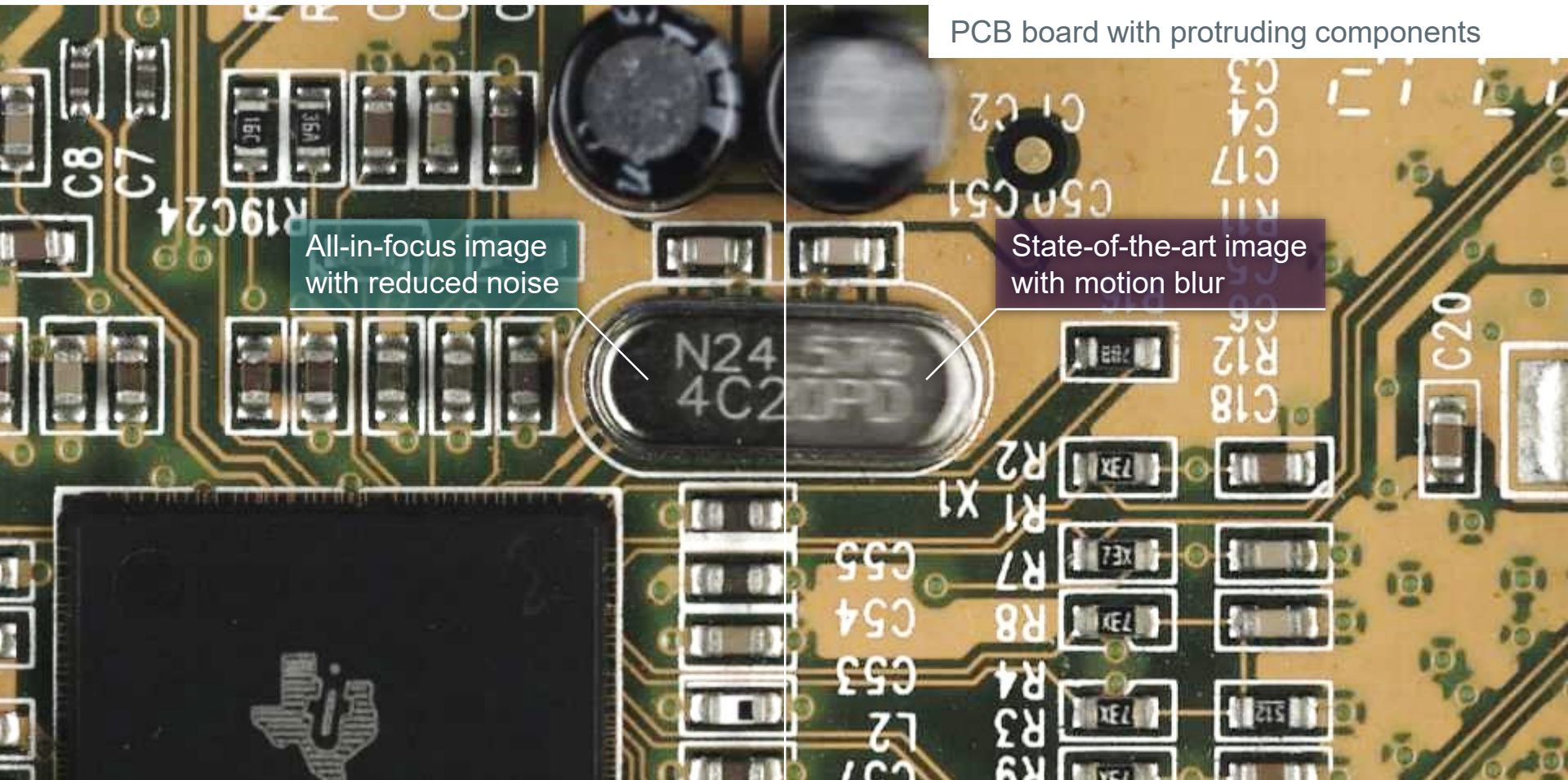
Color image

Precise 3D model using AIT approach

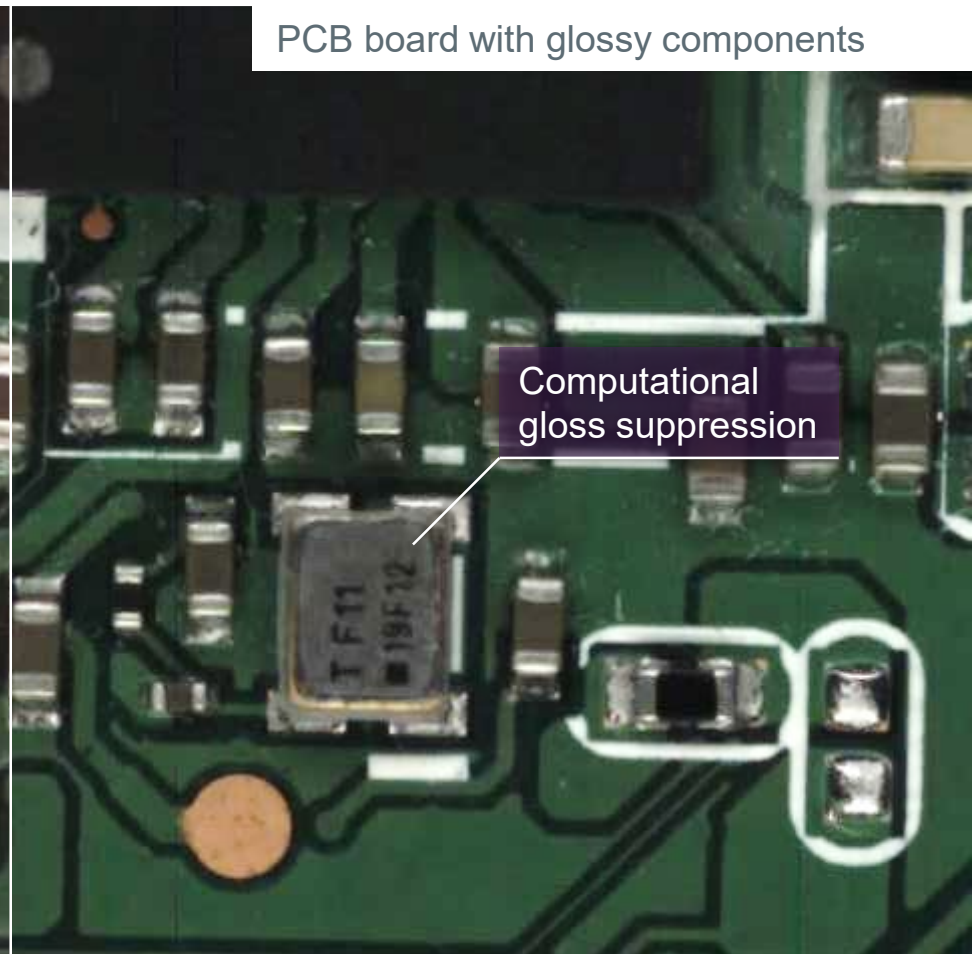
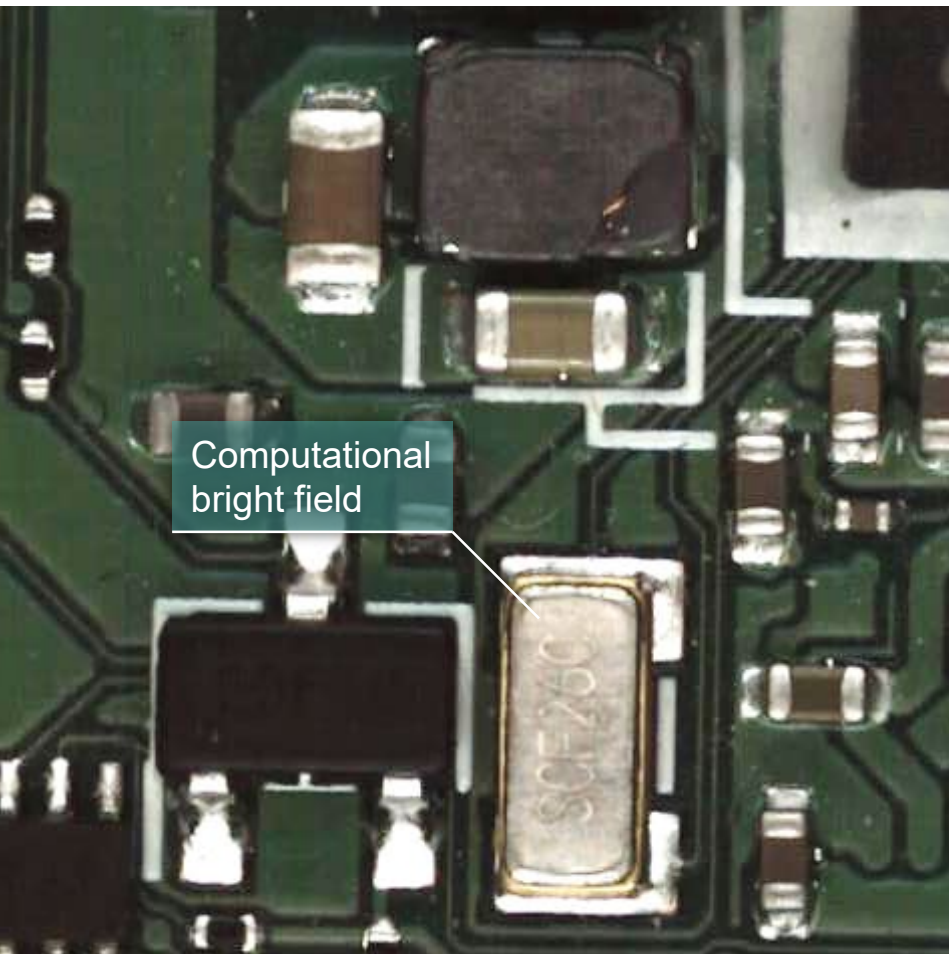
3D model using state-of-the-art  
stereo algorithm



## AIT Inline Computational Imaging: Sharper Images with All-in-Focus / 3D-TDI

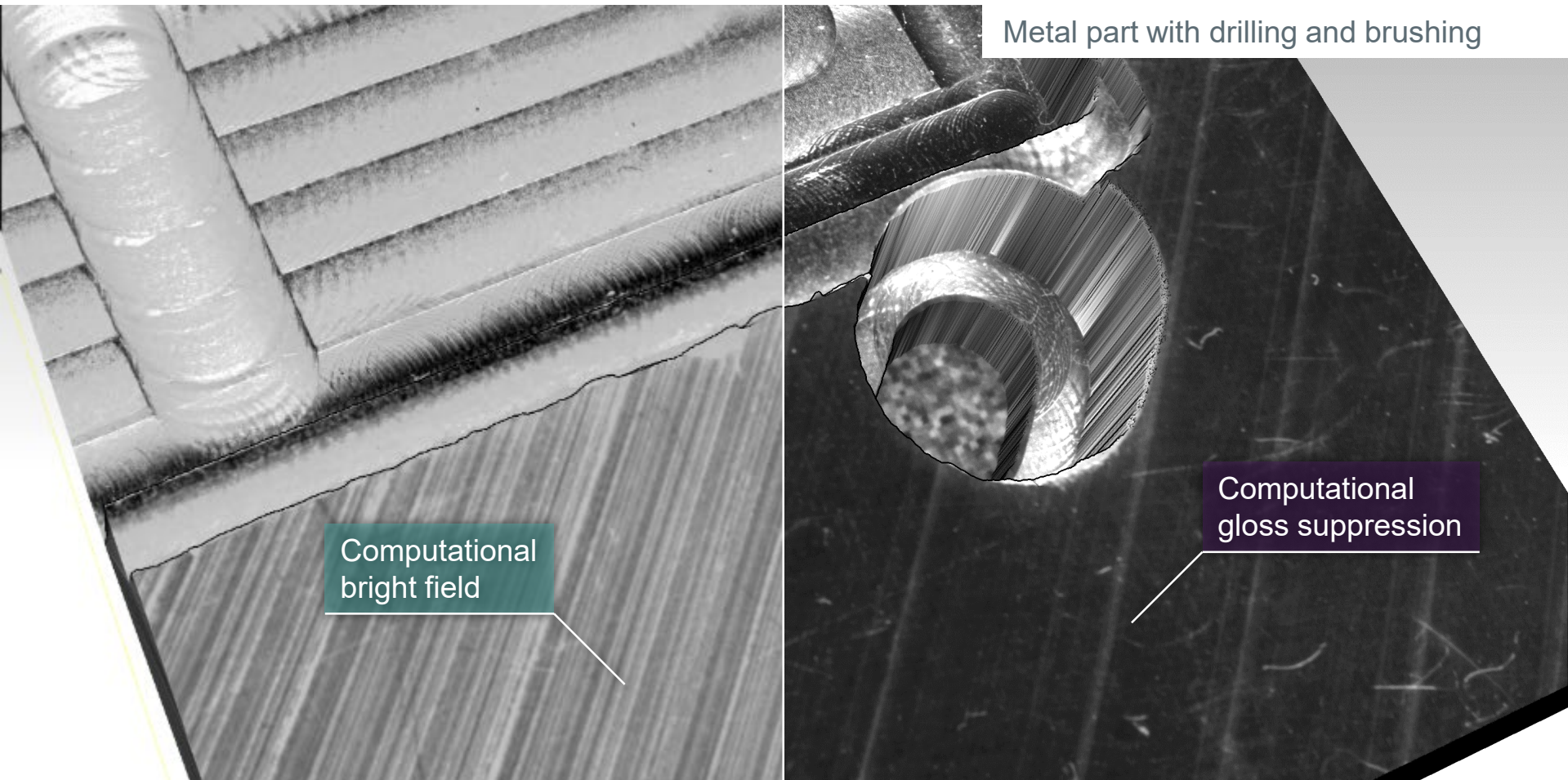


# AIT Inline Computational Imaging: Computational Bright Field and Gloss Suppression

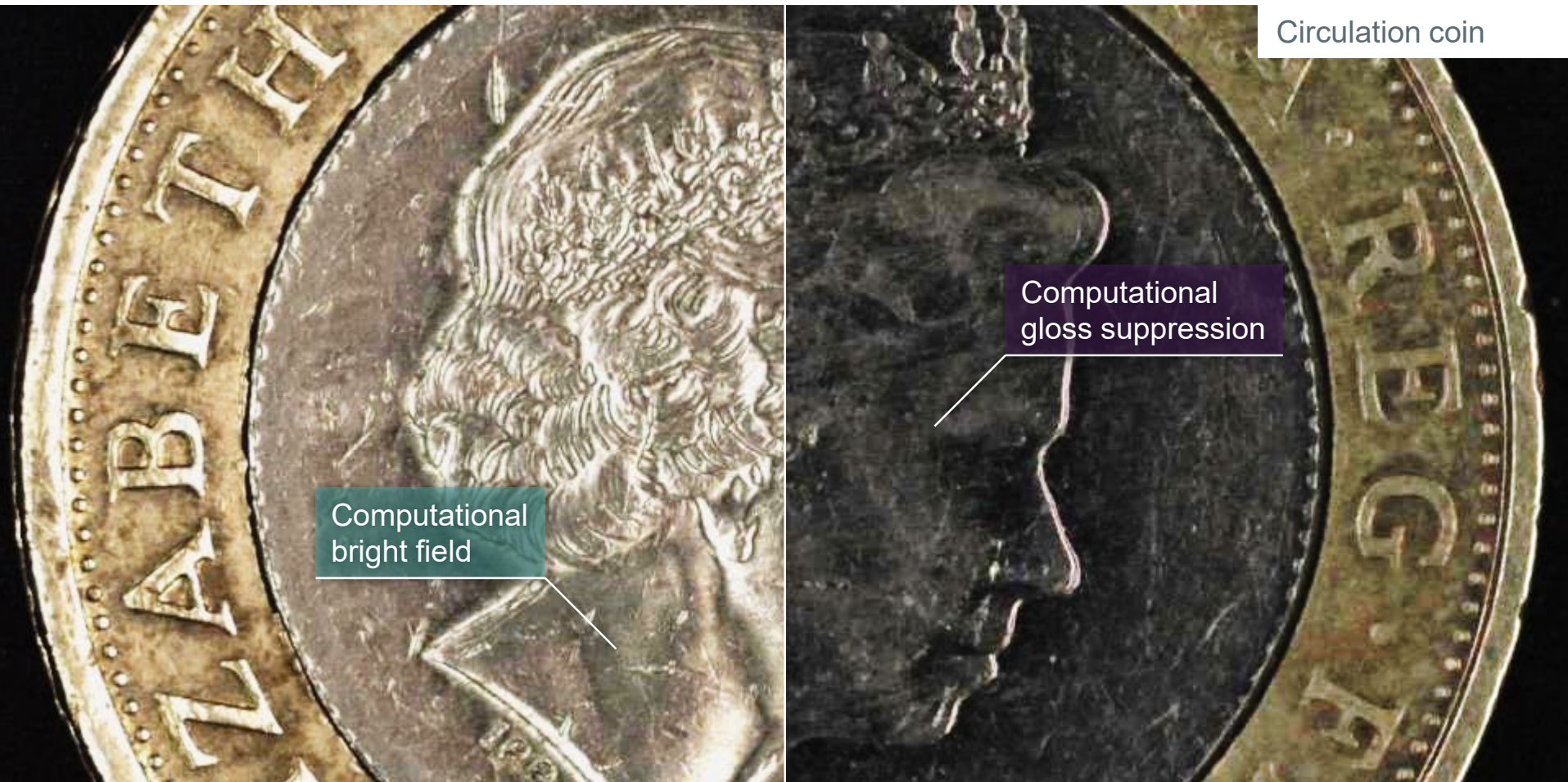




# AIT Inline Computational Imaging: Computational Bright Field and Gloss Suppression



# AIT Inline Computational Imaging: Computational Bright Field and Gloss Suppression



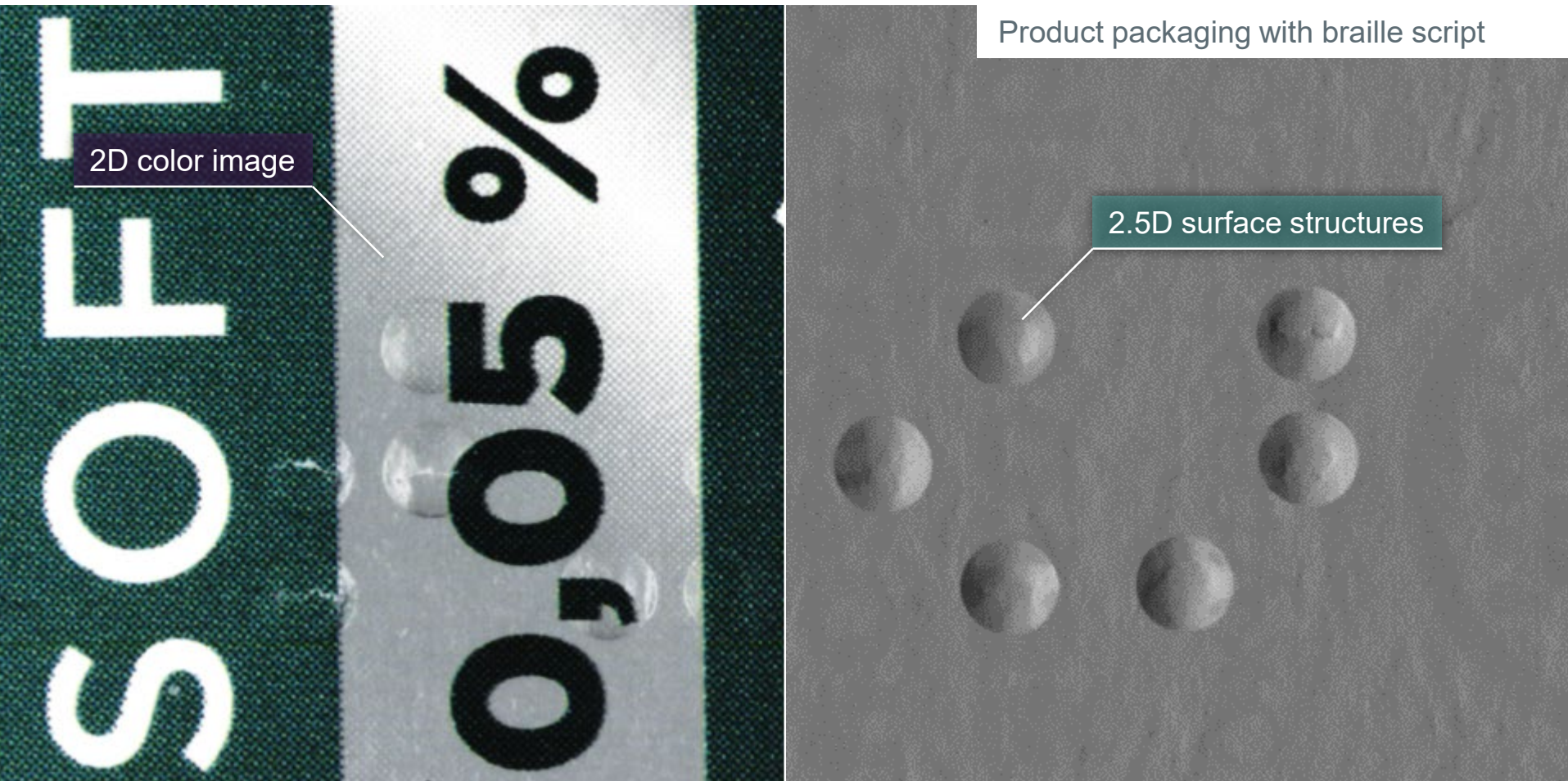


# AIT Inline Computational Imaging: Fine Surface Structures via Photometric Stereo

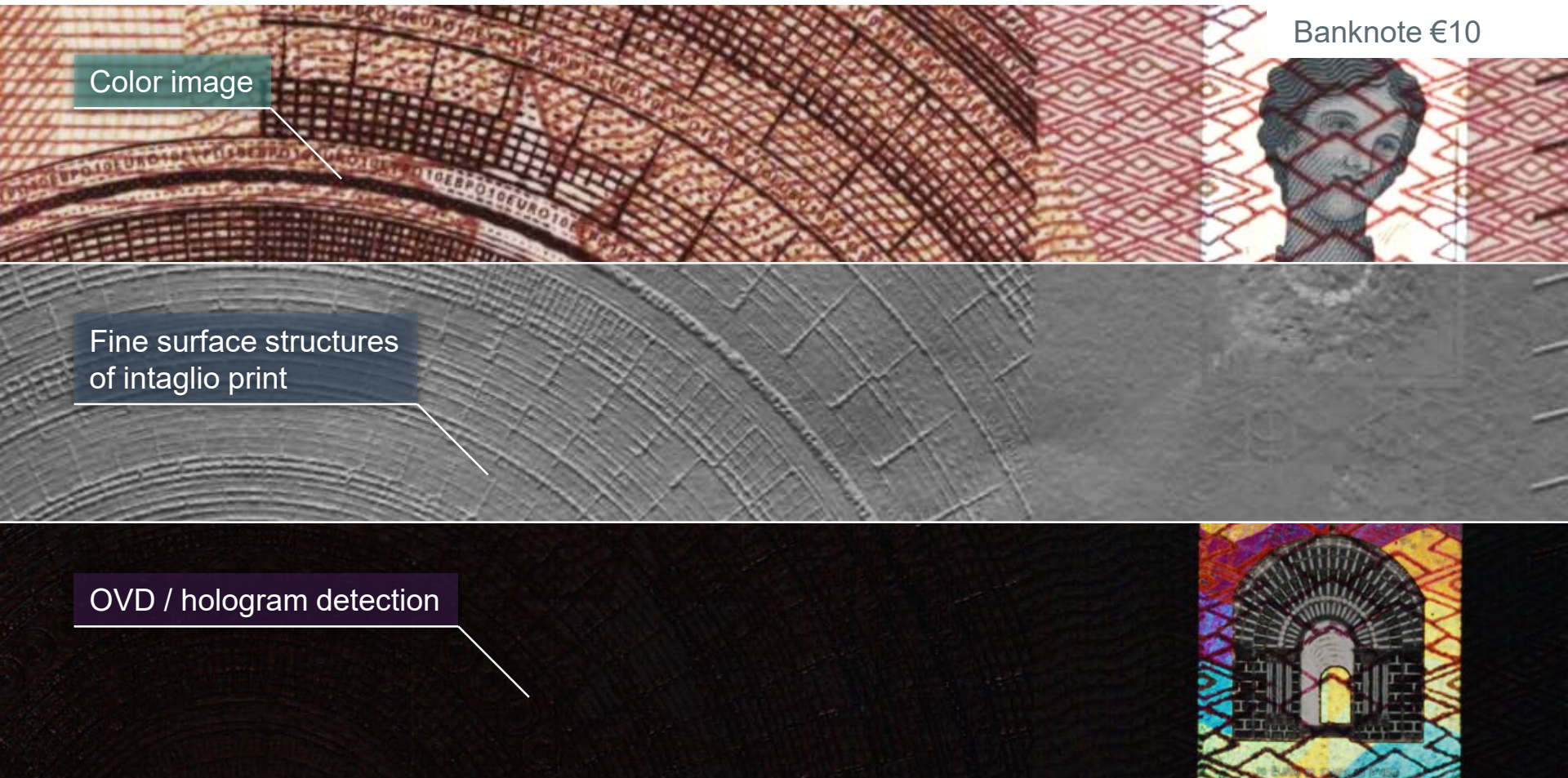




# AIT Inline Computational Imaging: Fine Surface Structures via Photometric Stereo



# AIT Inline Computational Imaging: Security Print and Optical Variable Devices



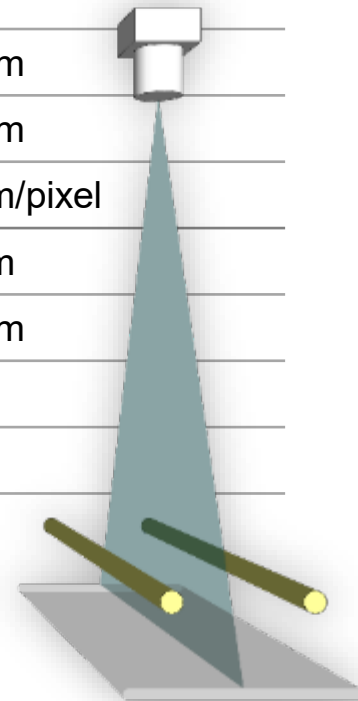
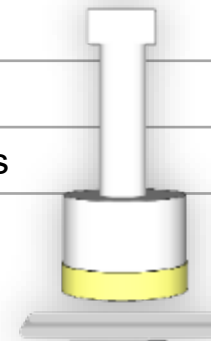
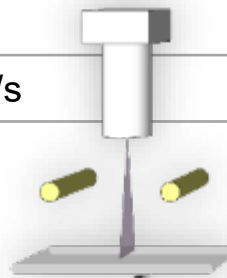


# ICI Sensor System: Scalable Optical Configurations

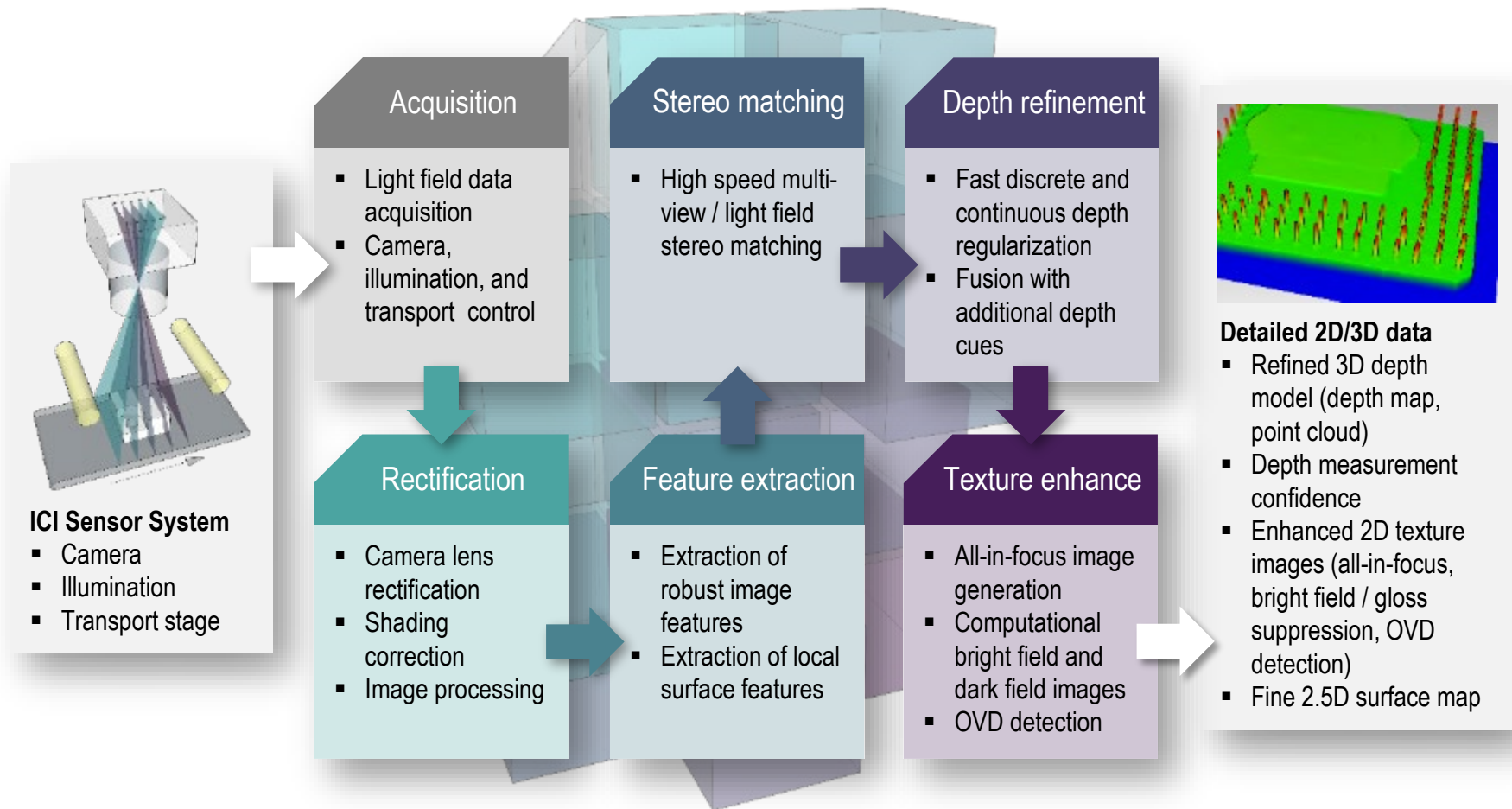
## Configuration Examples

	Standard Scale	Micro Scale	Large Scale
<i>Optics</i>	45mm f/4	Modified 10x industrial inspection microscope with NA=0.28	20mm f/2.8
<i>Working distance</i>	128 mm	34 mm	570 mm
<i>Field of view</i>	46 mm	1 mm	462 mm
<i>Lateral resolution</i>	20 $\mu\text{m}/\text{pixel}$	1 $\mu\text{m}/\text{pixel}$	200 $\mu\text{m}/\text{pixel}$
<i>Depth resolution *)</i>	20 $\mu\text{m}$	1 $\mu\text{m}$	100 $\mu\text{m}$
<i>Depth range</i>	10 mm	300 $\mu\text{m}$	200 mm
<i>Min. / typ. viewing angles</i>	3 / 11	3 / 30	3 / 11
<i>Typical acquisition speed</i>	100 mm/s	10 mm/s	1 m/s

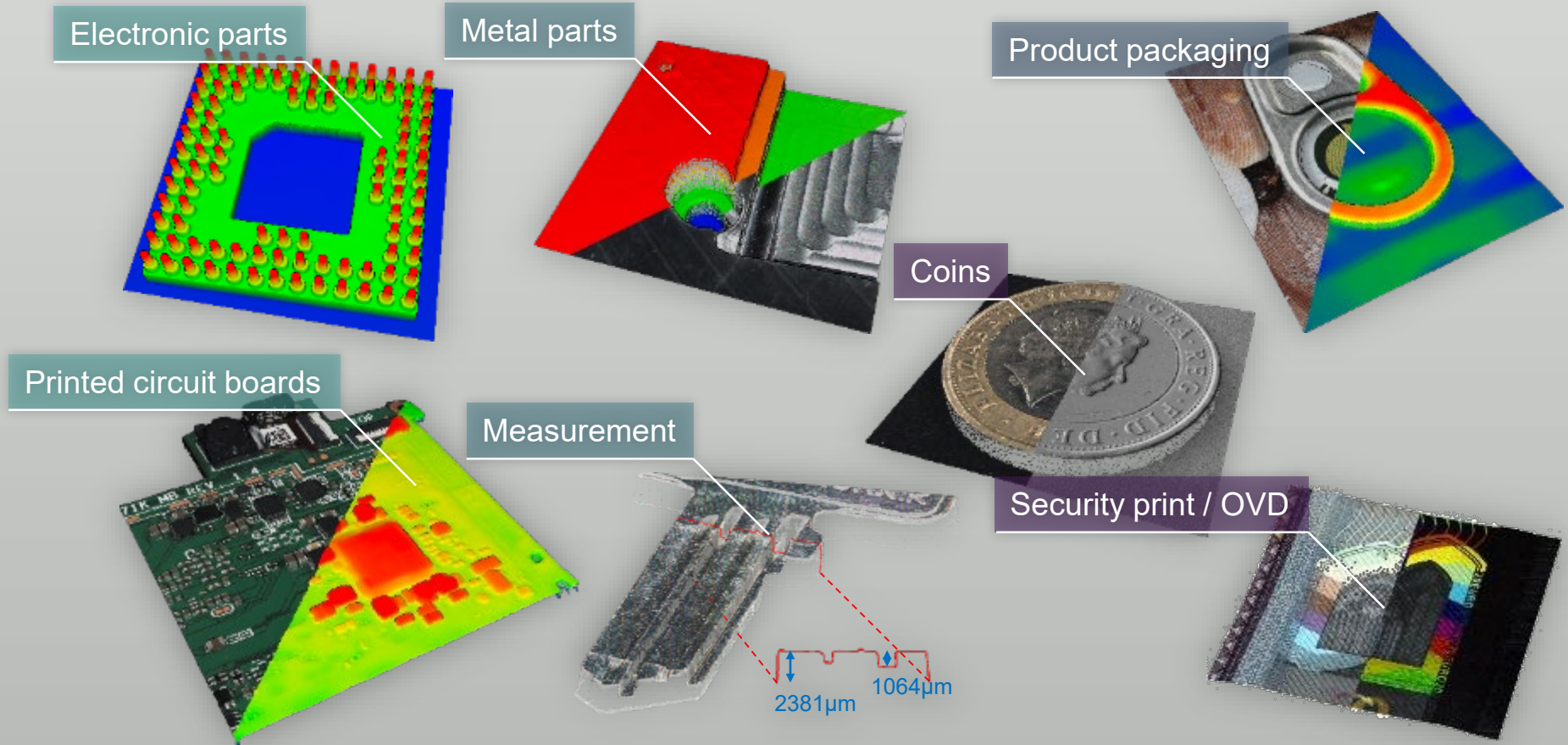
\*) using Light Field and Photometric Stereo



# ICI Software Modules: Generic Computational Imaging Library for 2D/3D Tasks



# AIT Inline Computational Imaging: Industrial Use Cases





# AIT Inline Computational Imaging: Conclusions

ICI can also perform  
presence but also to check for  
elements (3D depth)  
s, etc.  
coatings and lacquered

## HIGHLIGHTS

- Multiple viewing & illumination angles simultaneously
- Works with diverse material types (glossy, matt) at the same time
- Simultaneous 2D and 3D inline inspection
- One system for 2D and 3D inspection
- Compact setup suitable for challenging inspection tasks
- Single sensor system with standard machine vision components
- Flexible for a wide range of industrial inspection tasks
- High speed and high accuracy at the same time

axial | diffuse

00 Braille embossing & print inspection  
//07 Embossing

## METAL

//08 Coin 3D and texture  
//09 Material classification  
blue = matt | red = semi-glossy | yellow = glossy

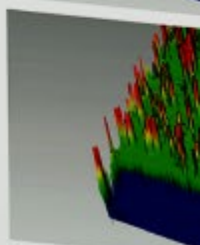
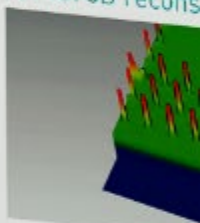
- Enhanced 2D imaging
- all-in-focus, high-dy
- Simultaneous 2D an
- 3D measurements c
- Advanced inline ins
- materials with chall
- Material classificat
- Inspection of optica
- Detection of defect

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AIT ICI 3D recons



State-of-the-art

# Thank you!

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