

# Viscom AG

## X-Ray Inspection - as much as necessary

and

## How artificial intelligence AI can support AOI/AXI programmers and operators

by Michael Muegge, Viscom AG, Sales



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- 1984 German High School Matura
- 1984-1987 Apprenticeship as Radio Technician  
at Fuba Hans Kolbe & Co in Bad Salzdetfurth
- 1987-1988 Military Service
- 1988-1992 Studies of Electronics at College FH Hannover,  
Degree: Dipl.-Ing.(FH), Bachelor of Arts
- 1992-2001 Manufacturing Engineer at Fuba Hans Kolbe & Co.,  
from 1995: Fuba Automotive GmbH (Delphi-Group),  
in Bad Salzdetfurth
- 2001-2002 Manufacturing Engineer at Bosch Blaupunkt in Hildesheim
- 2002-2005 Manufacturing Engineer at Bosch Elektronik GmbH in Salzgitter
- 2005- . . . . Sales Engineer at Viscom AG in Hannover



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Leiterplatten- & Elektronikfertigung

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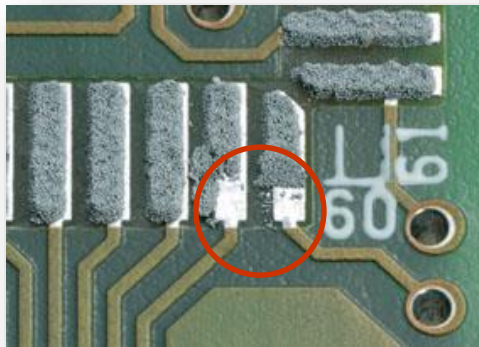
**Linked in**®

**XING**

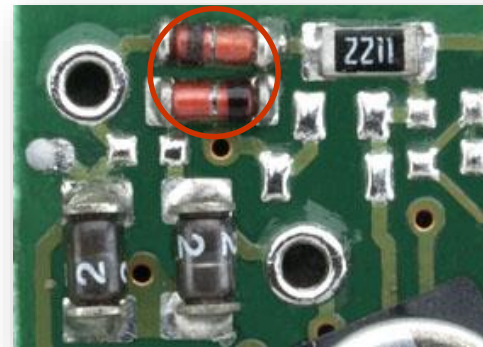
# Contents

- Application examples AOI/AXI/MXI
- Comparison AOI/AXI
- Artificial Intelligence AI in context with AOI/AXI Programming and defect classification
- Conclusion and outlook

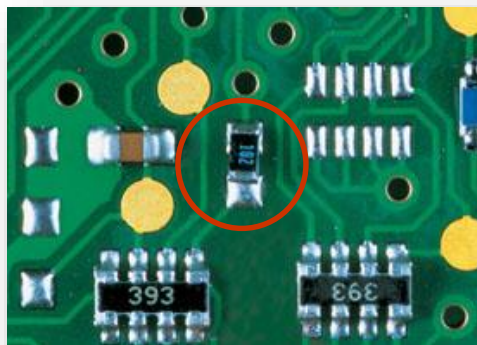
# Defects detectable using AOI Systems



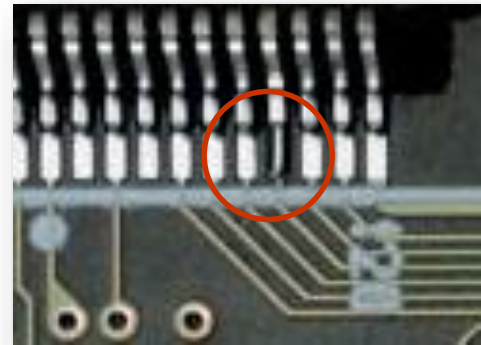
Paste Print missing or smeared paste



Component Placement polarity and alignment



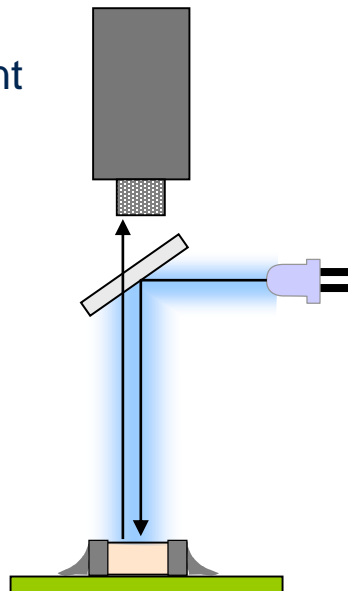
Solder Joint Tombstone



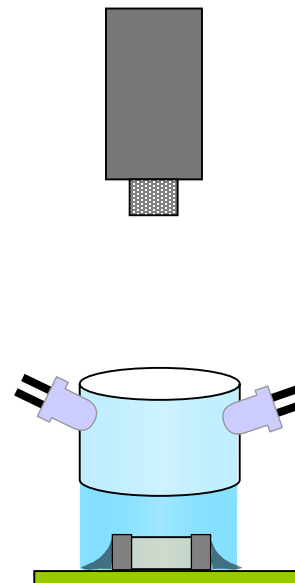
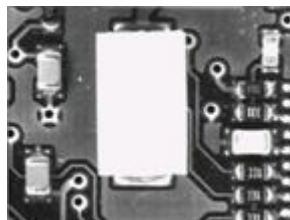
Solder Joint lifted lead

# AOI: Various Illumination Types for Defect Detection

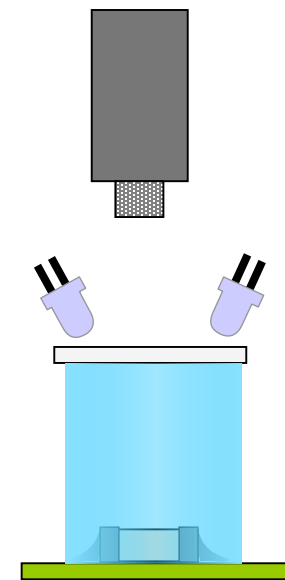
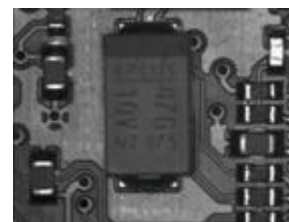
- Emphasizes relevant quality features
- Minimizes interferences



Direct top illumination



Indirect diffuse illumination



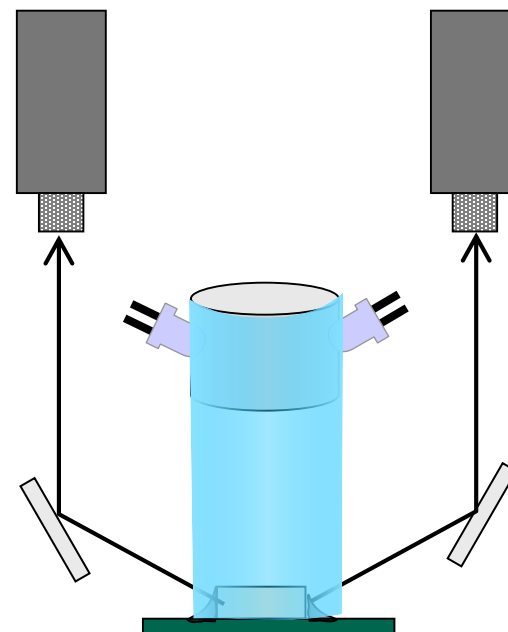
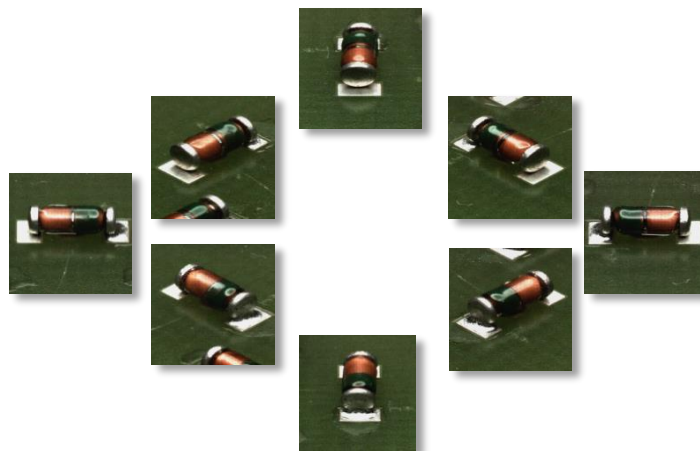
Narrow angle diffuse illumination



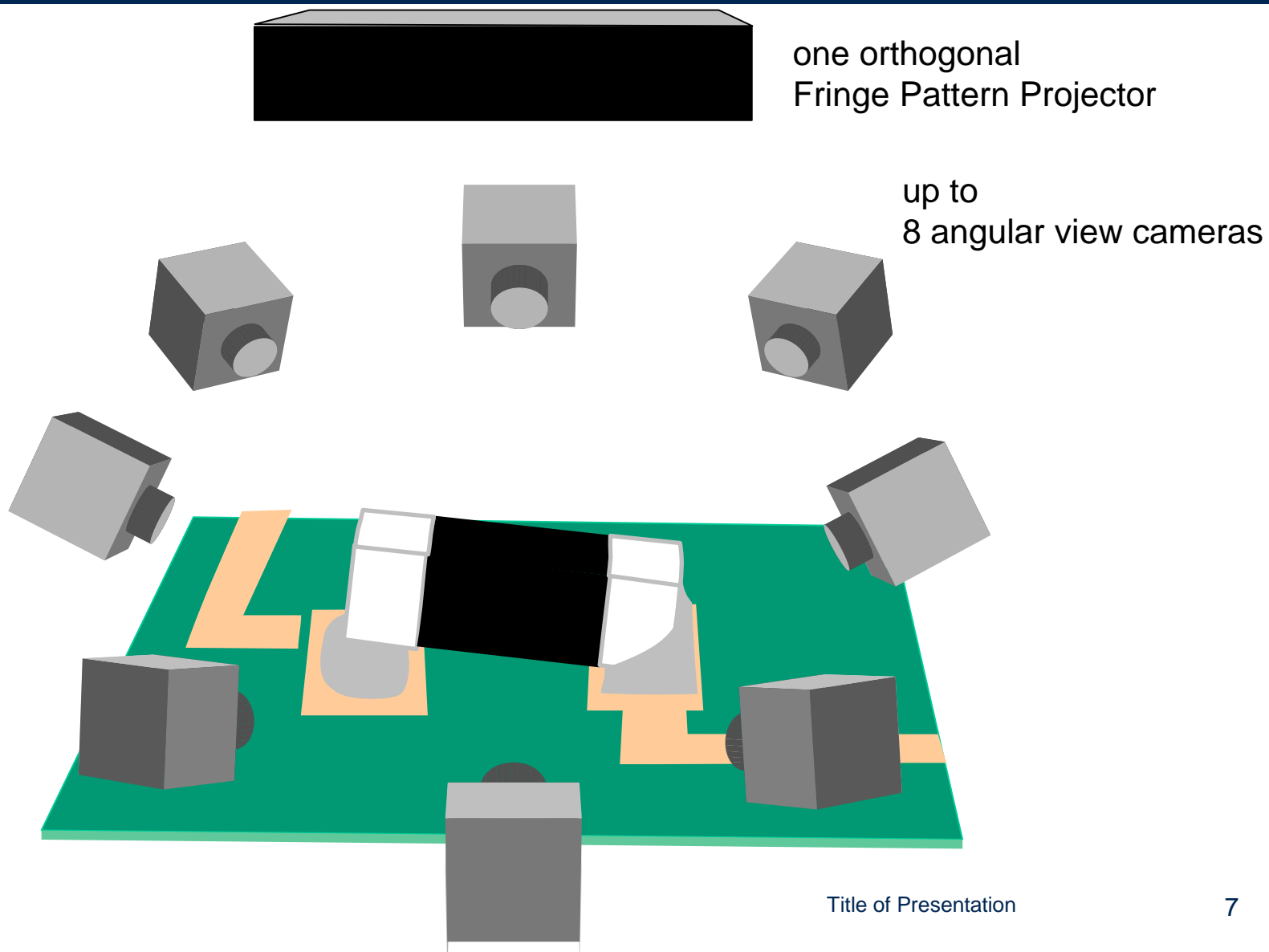


# Angle View for Greater Inspection Coverage

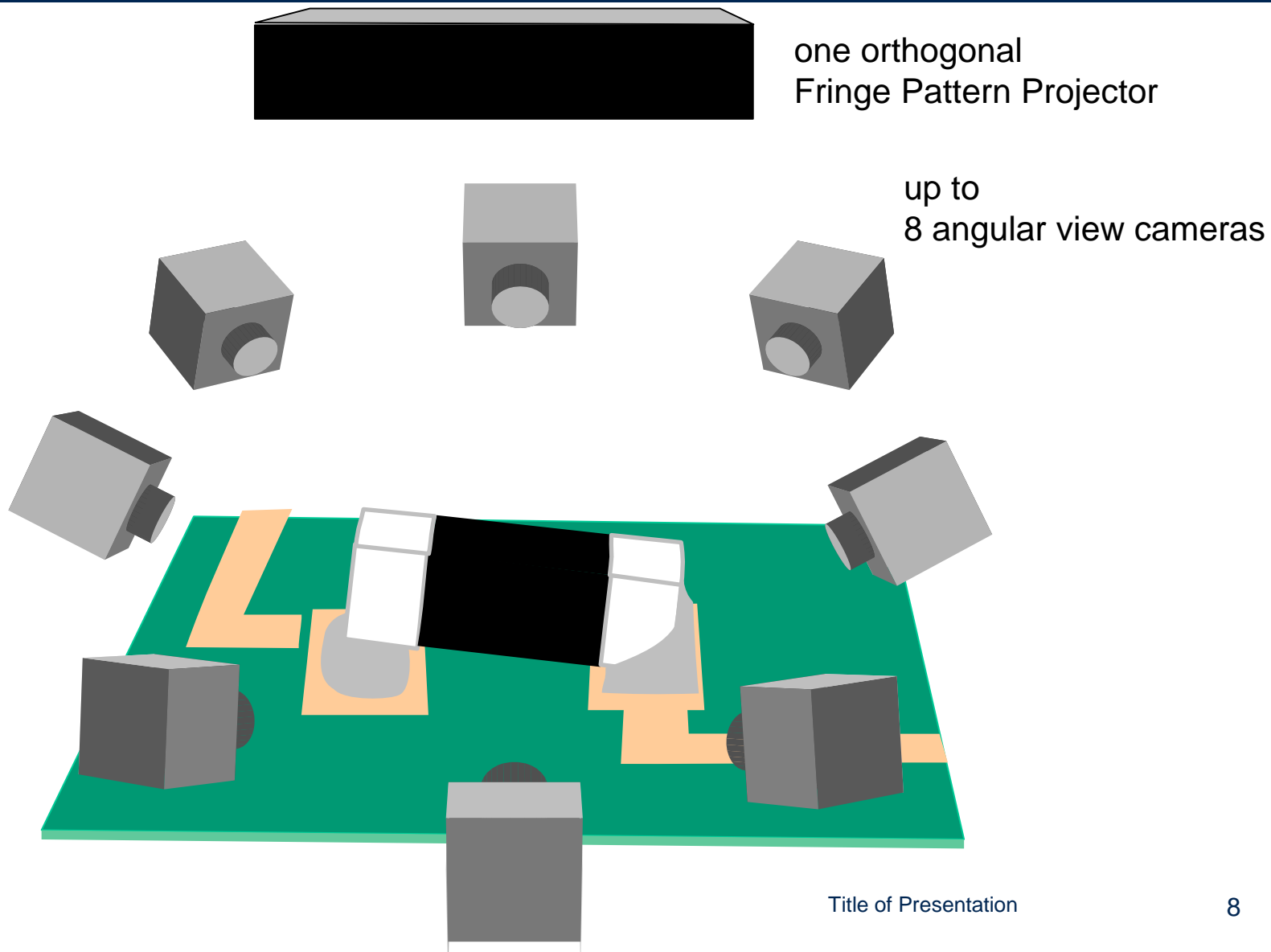
- Use of 4 or 8 cameras, oriented through mirrors at an angle to the surface
- 4 cameras inspect every 90° angle
- 8 cameras every 45° angle (shadowing)



# 3D AOI



# 3D AOI



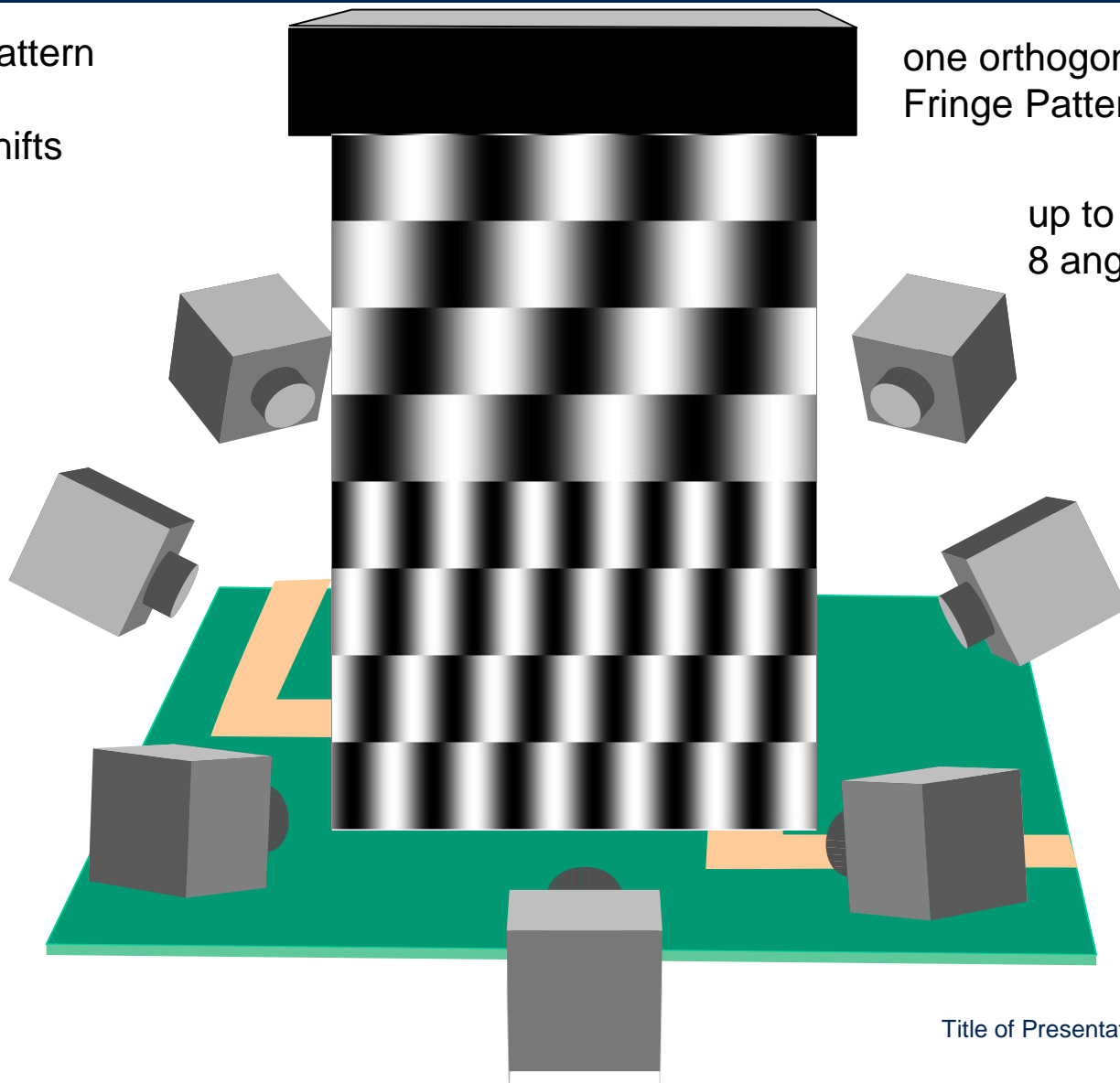


## 3D AOI

Two fringe pattern  
frequencies  
two phase shifts

one orthogonal  
Fringe Pattern Projector

up to  
8 angular view cameras

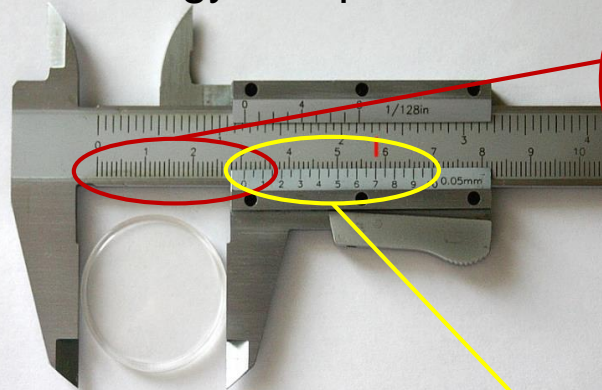


## 3D AOI

Two fringe pattern frequencies  
two phase shifts

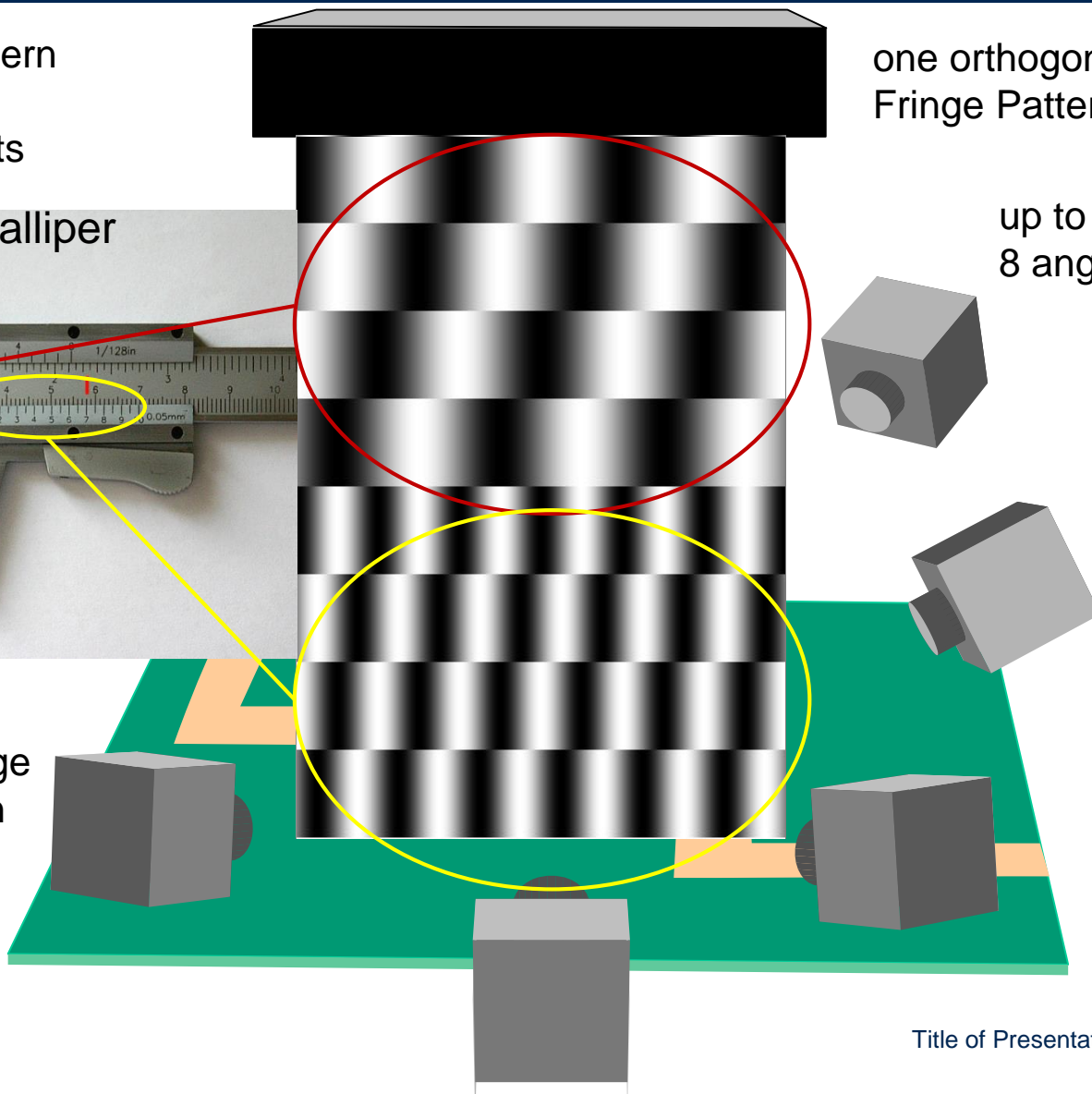
one orthogonal  
Fringe Pattern Projector

Analogy Calliper

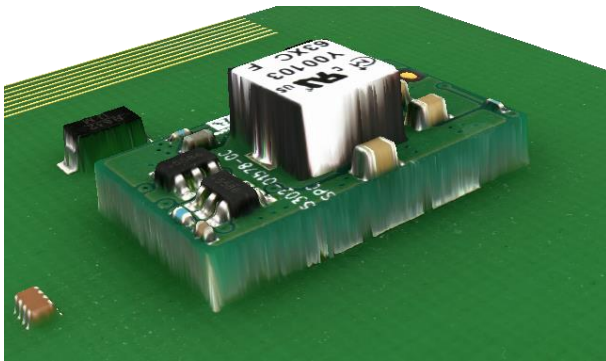


up to  
8 angular view cameras

Featuring  
30mm high range  
0.5 $\mu$ m resolution

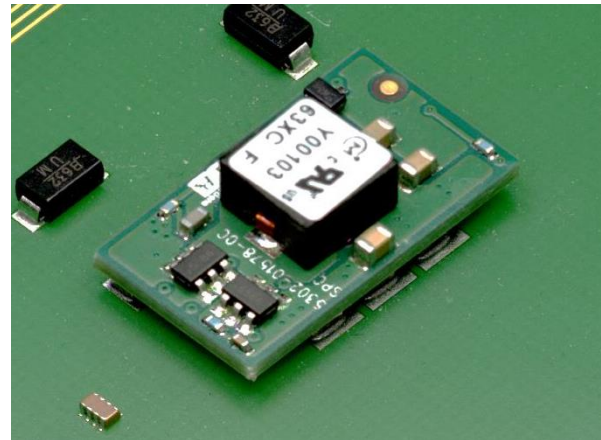


## 3D AOI



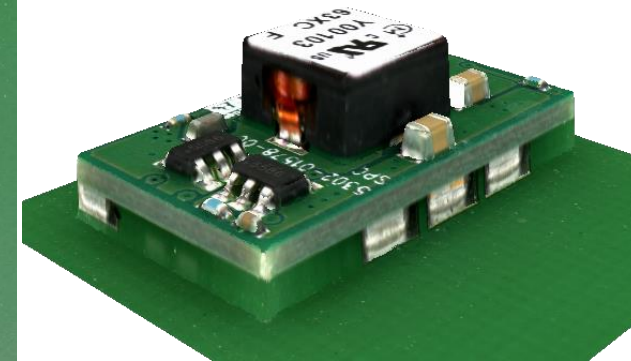
252\_Package\_AV\_225.png

A 3D reconstruction can't show the region below the package. It appears as if a curtain covers the sides



251\_Package\_AV\_225.png

A reliable analysis of the solder joints below the package is possible using angular view cameras (2.5D AOI) (peeking under the bed)

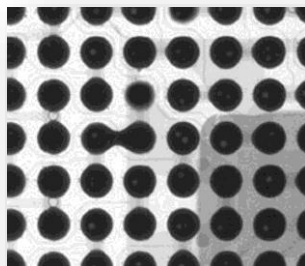


254\_Package\_3D+\_224.png

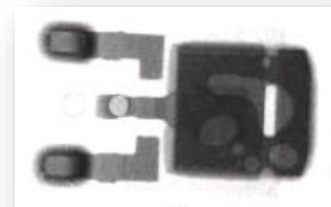
Viscom's 360° Rekonstruktion combines the advantages provided by both angular view 2.5D optical inspection and 3D reconstruction. Angular view images are being projected on the curtains.

# Defects which require X-Ray analysis

- Hidden solder joints



- Voids

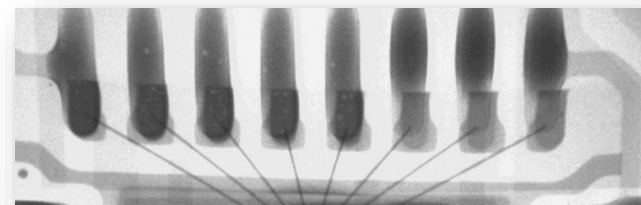


- THT solder joints

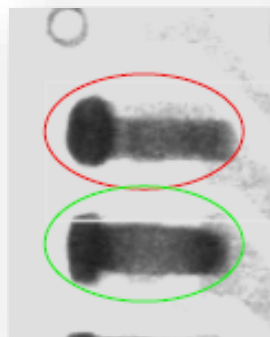


„bad“

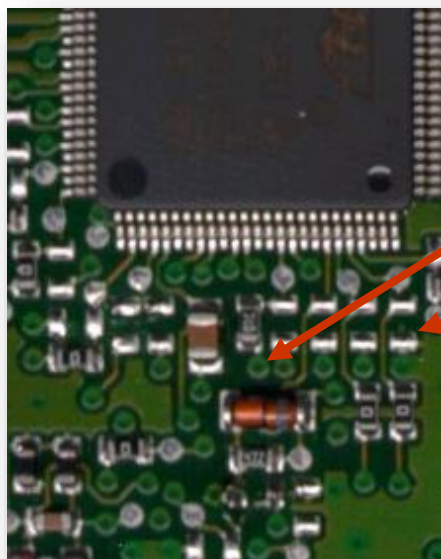
- Analysis of QFN (Quad Flat No Lead)



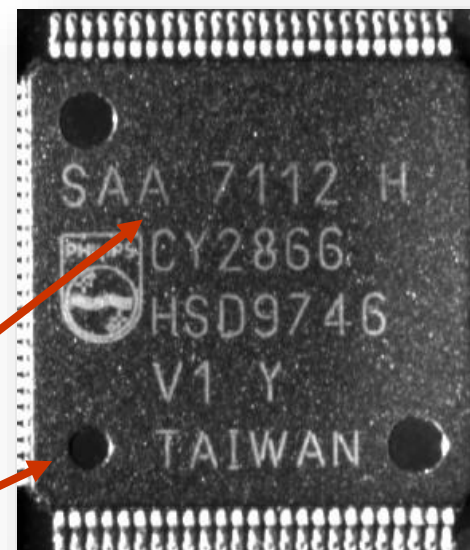
- J-Lead heal meniscus verification



# Defects not detectable using X-Ray



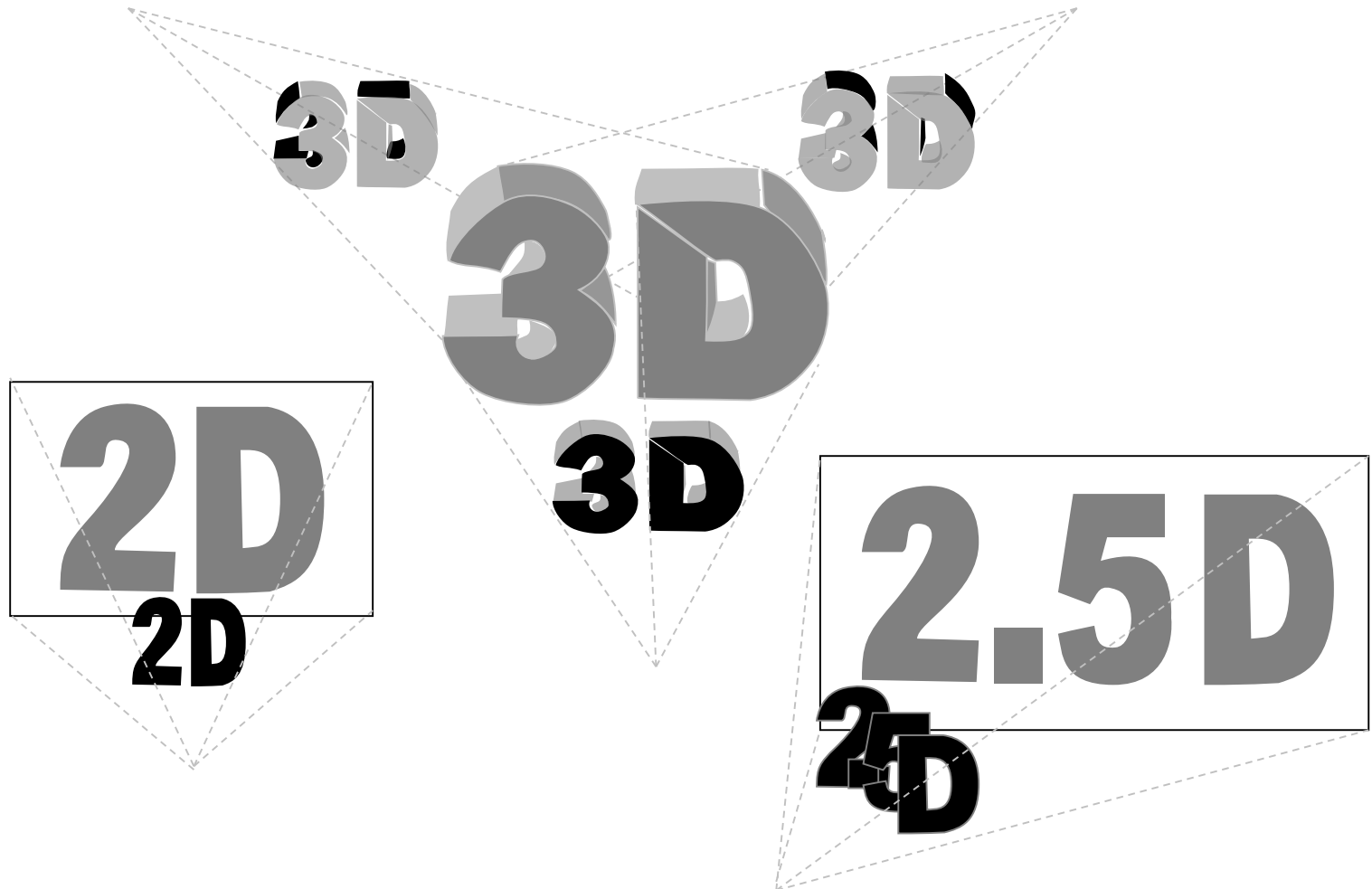
Polarity,  
alignment,  
flipped  
components,  
colour coded  
components



OCR, Traceability  
plastic moulded polarity marks



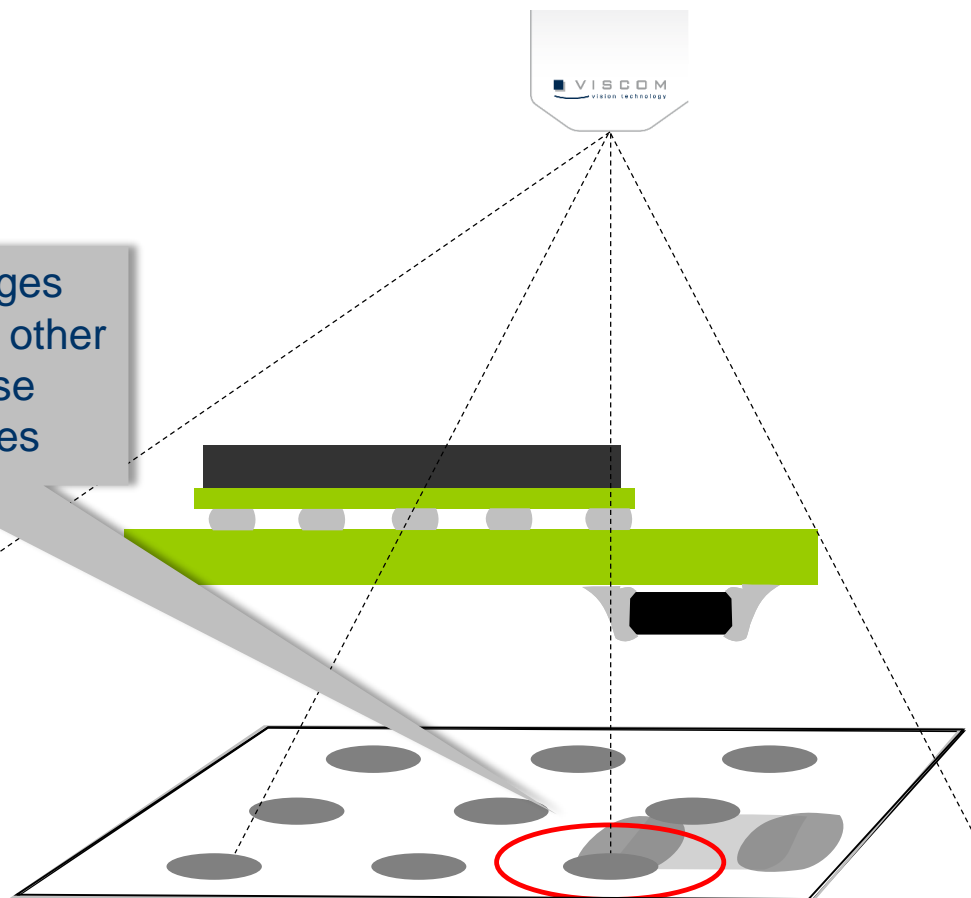
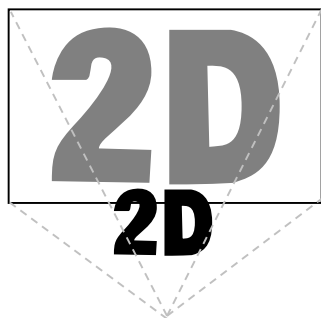
# Methods of Automatic X-Ray Inspection





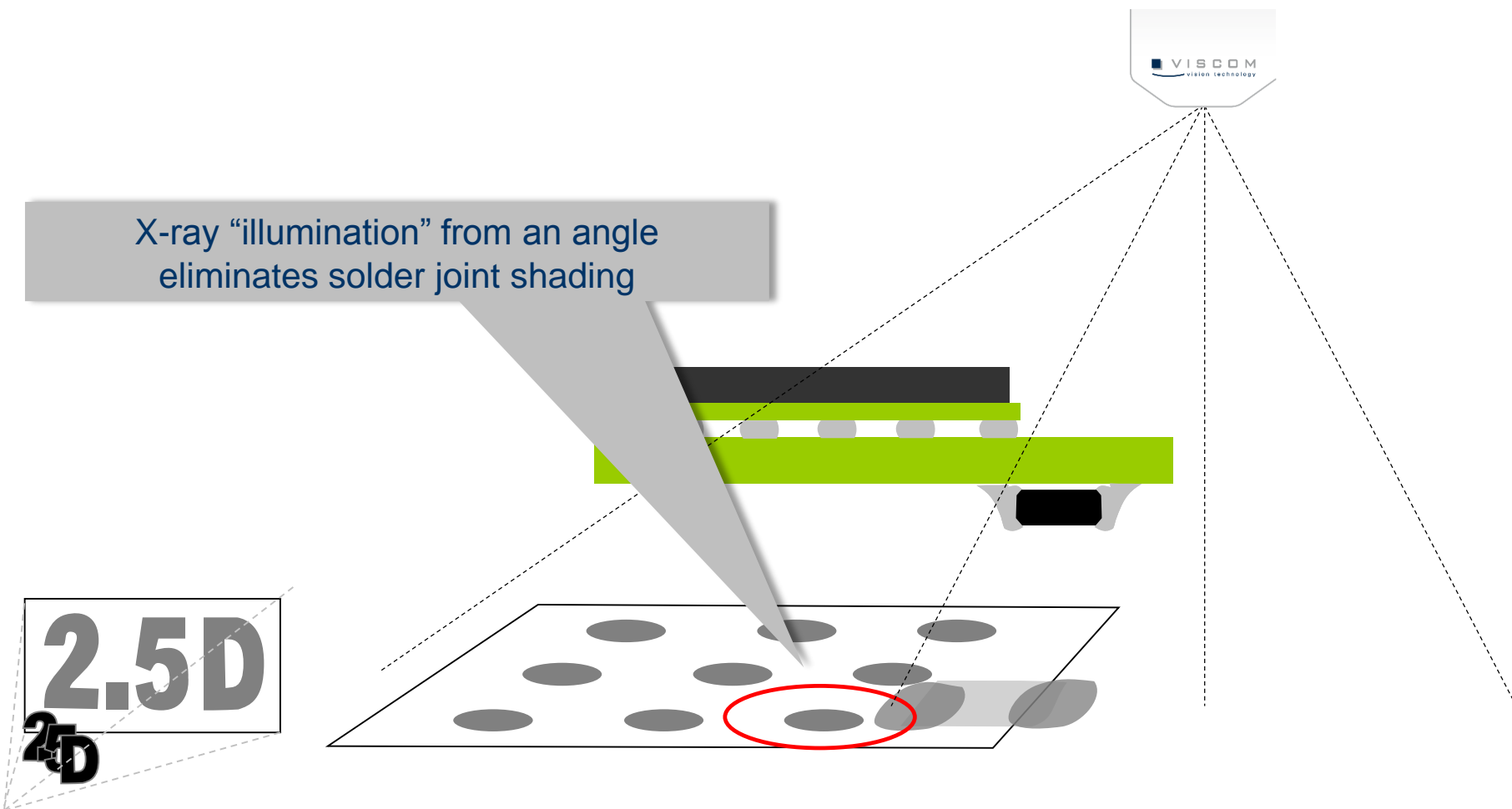
# 2-D X-Ray Inspection

In 2-D X-ray images  
solder joints on the other  
board side cause  
disturbing shades



## 2-D X-Ray Inspection

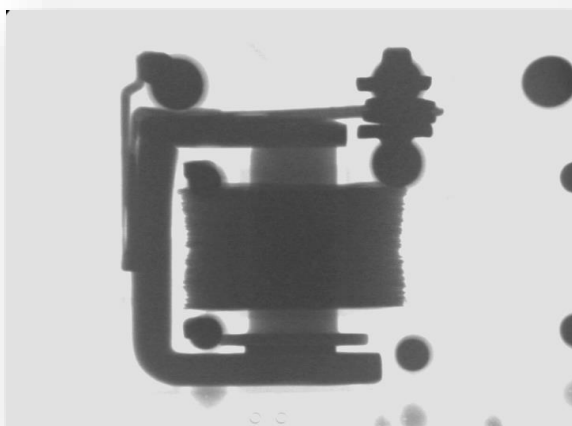
X-ray "illumination" from an angle eliminates solder joint shading



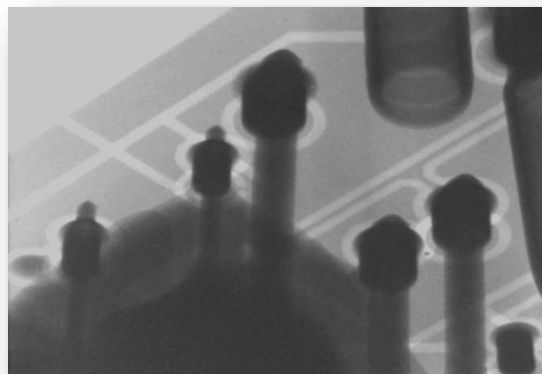
# Solder Joints which always require 2.5-D X-Ray

THT solder joint filling level

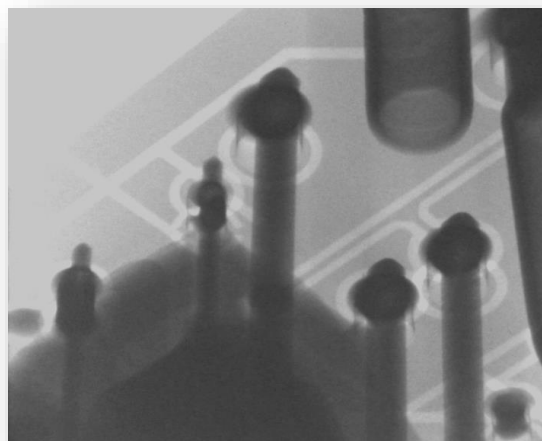
Example relay:



X-Ray Settings:  
80 kV, 20  $\mu$ A



„Good“



„Bad“

## 3D Approach



voxel room

The detector only shows the shade.  
It doesn't tell where exactly the absorbing material is

X-Ray absorbing material causes a shade on the X-Ray detector

X-Ray detector

## *3D Approach*

**VISCOM**  
vision technology

X-Ray  
source

voxel room

The absorbing material  
could be anywhere  
between the X-Ray  
source and the X-Ray  
detector

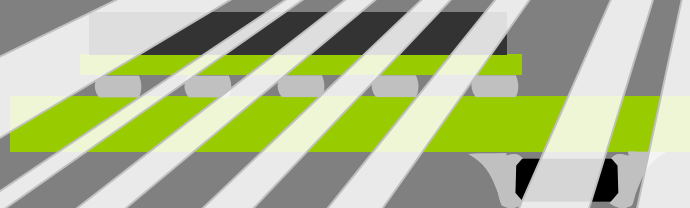
X-Ray detector

## 3D Approach



voxel room

X-Ray images are  
taken from  
different views



X-Ray detector

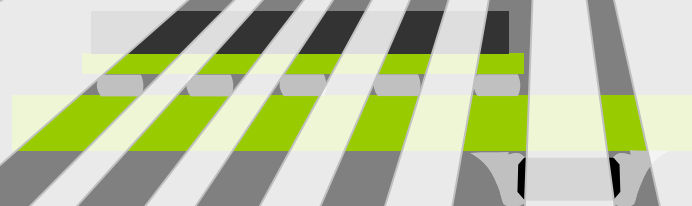


## *3D Approach*



voxel room

X-Ray images are  
taken from  
different views



X-Ray detector

# 3D Approach

**VISCOM**  
vision technology

voxel room

X-Ray images are  
taken from  
different views

X-Ray detector

 **VISCOM**  
vision technology

## *3D Approach*

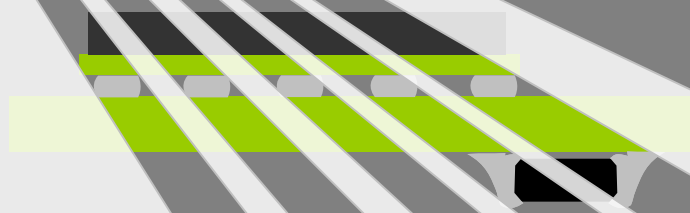
voxel room

X-Ray detector



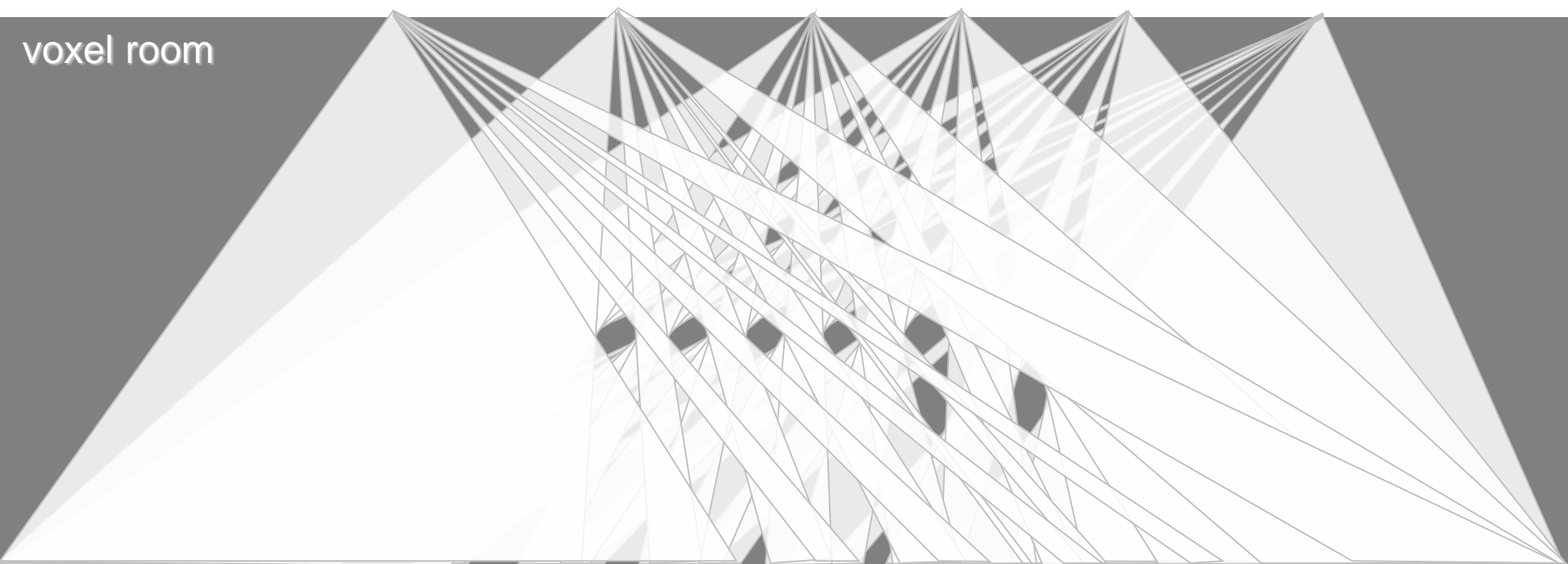
## *3D Approach*

voxel room



X-Ray detector

# Tomosynthesis



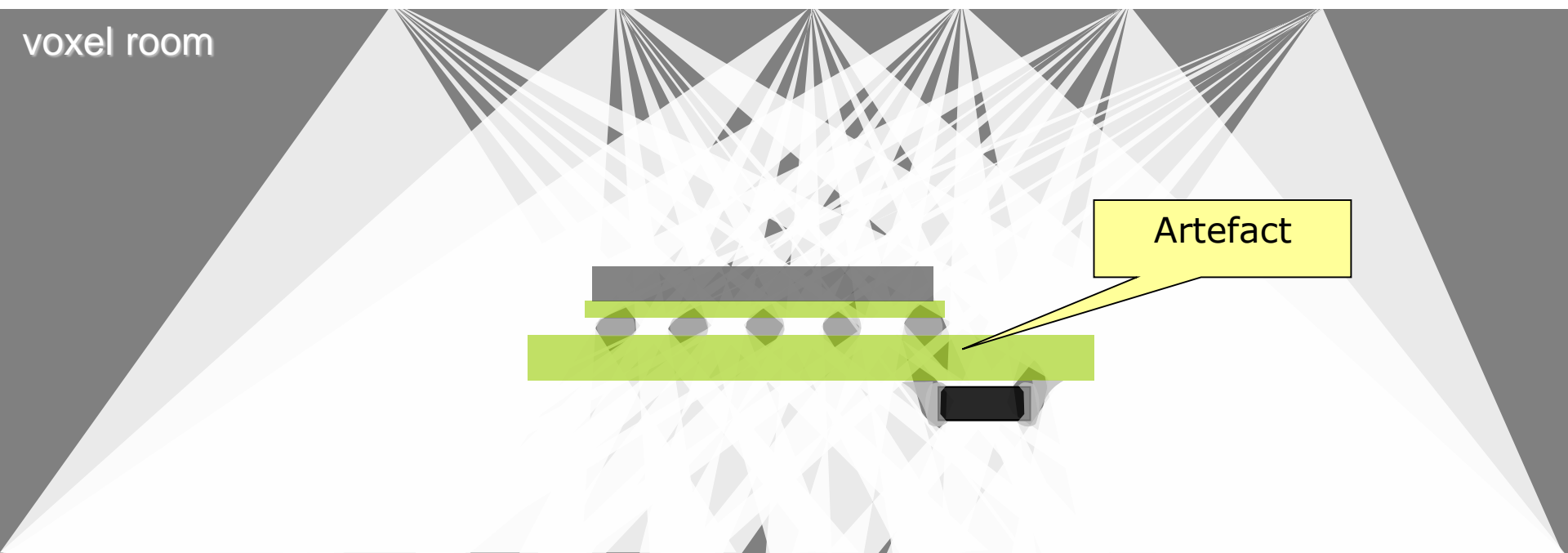
# Tomosynthesis

voxel room

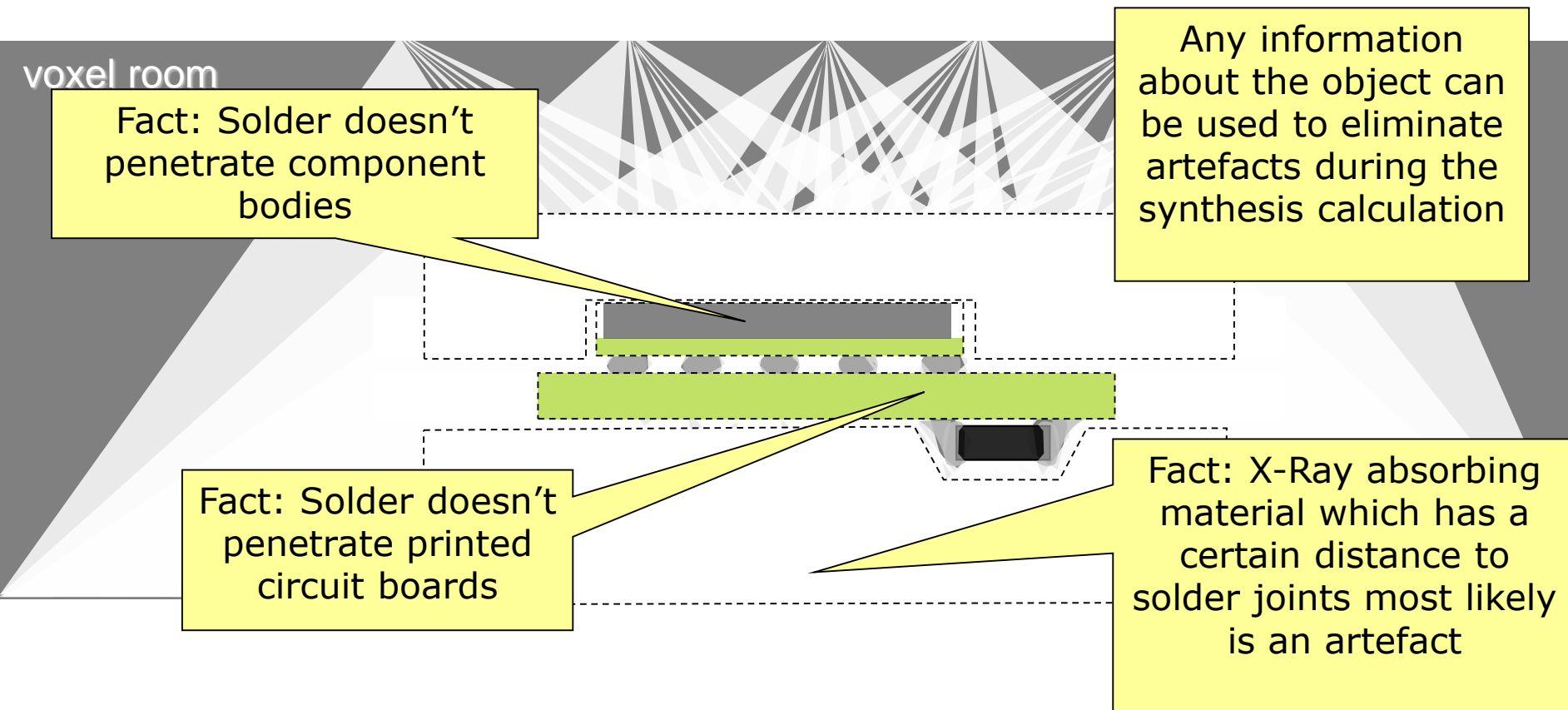
The more X-Ray pictures are taken from different views the more detailed is the calculated synthetic model



# Tomosynthesis



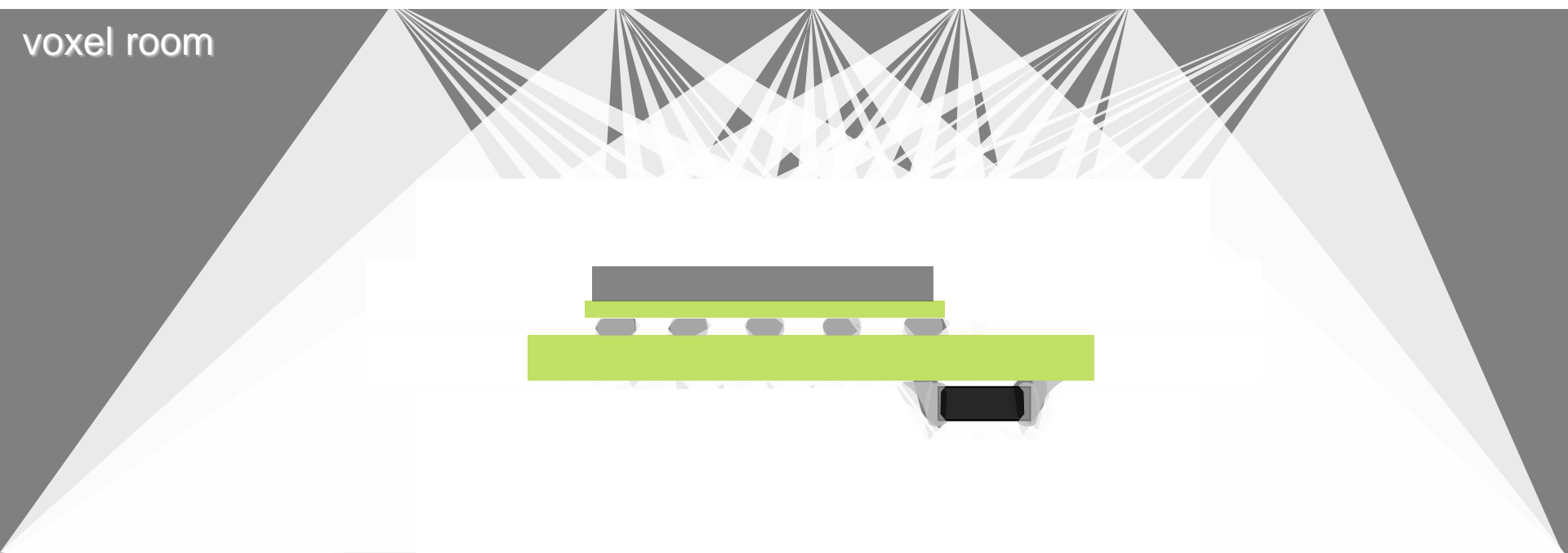
# Tomosynthesis



# Tomosynthesis

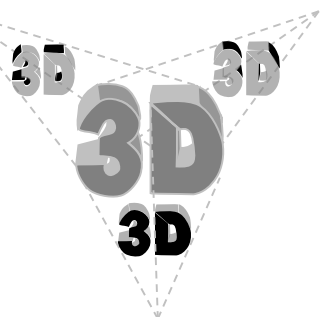
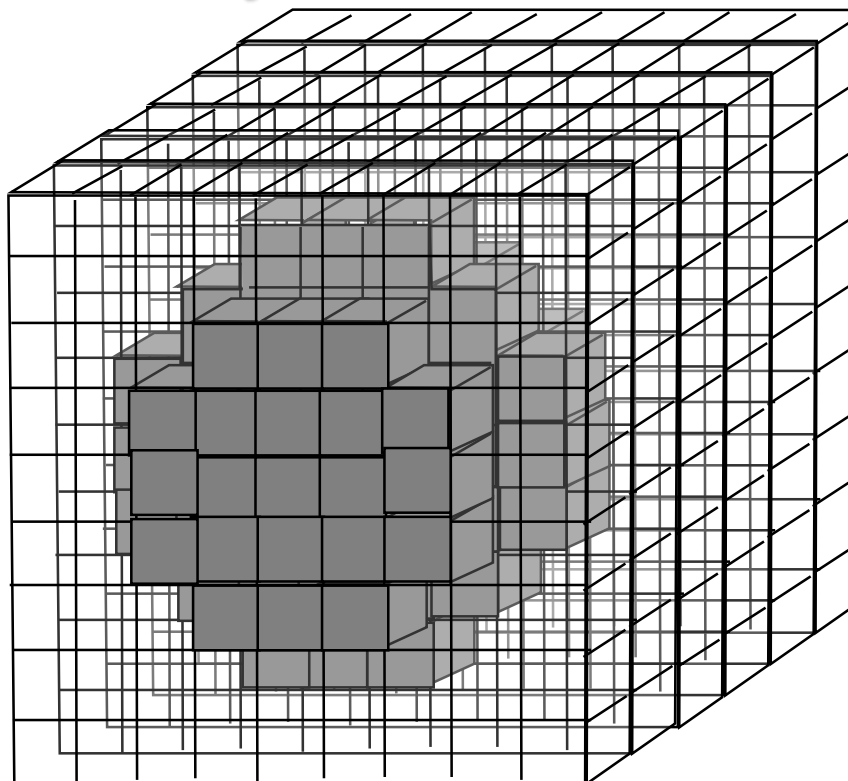


# Tomosynthesis

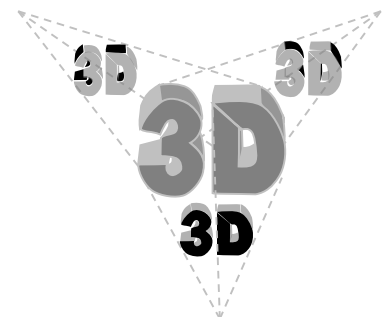
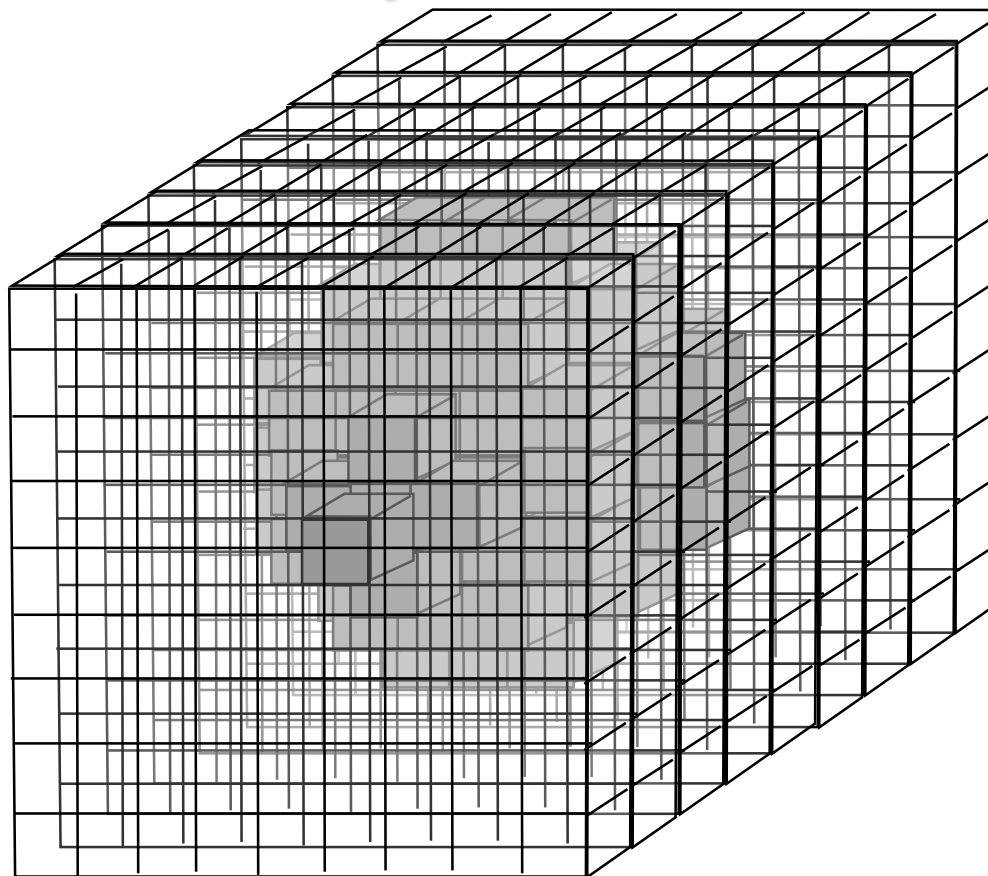


The calculated  
vertical voxel layers  
are stacked to a  
virtual voxel volume

# Tomosynthesis



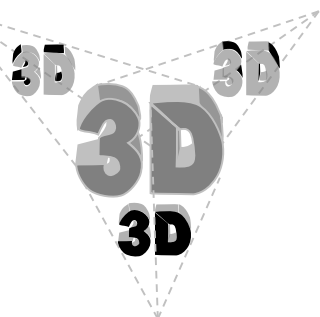
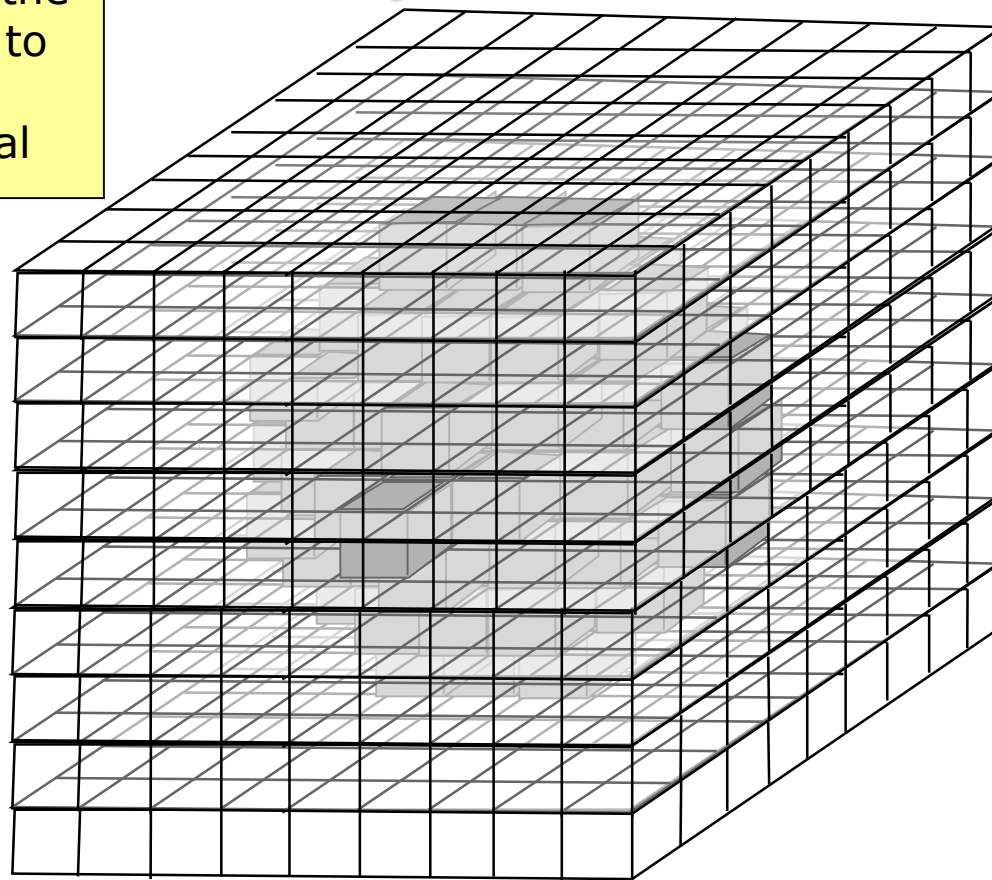
# Tomosynthesis





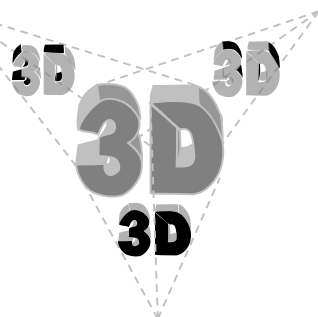
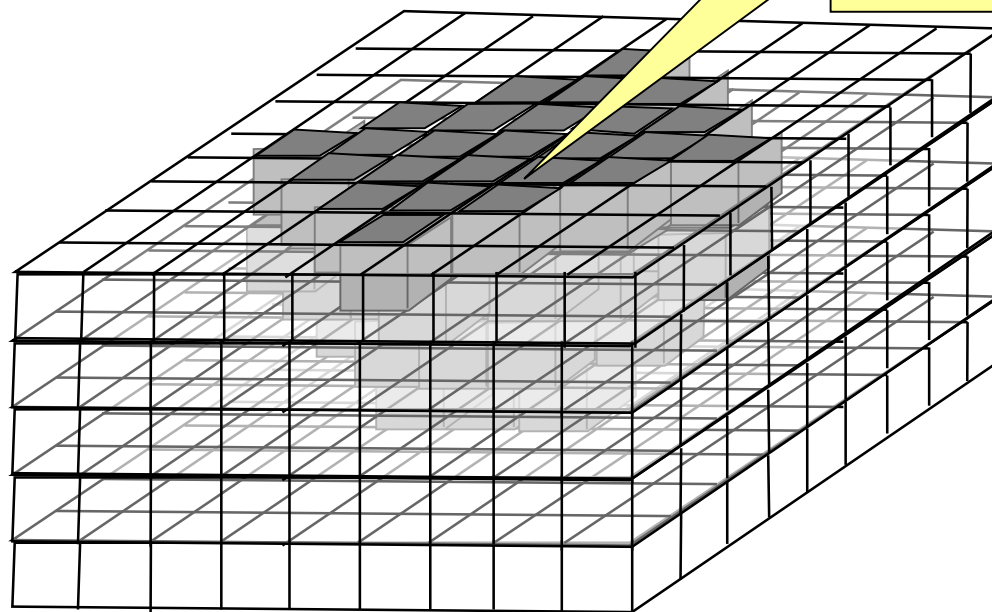
Now it's possible to cut virtual layers from the voxel volume and to look inside the absorbing material

## Tomosynthesis



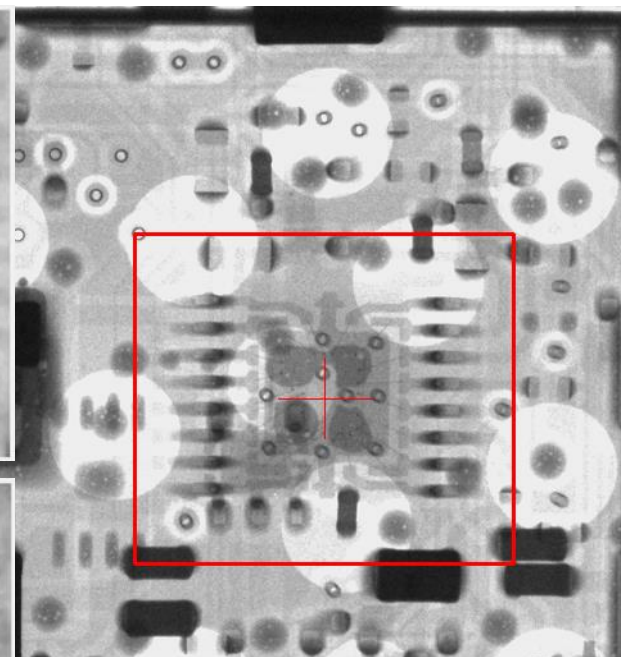
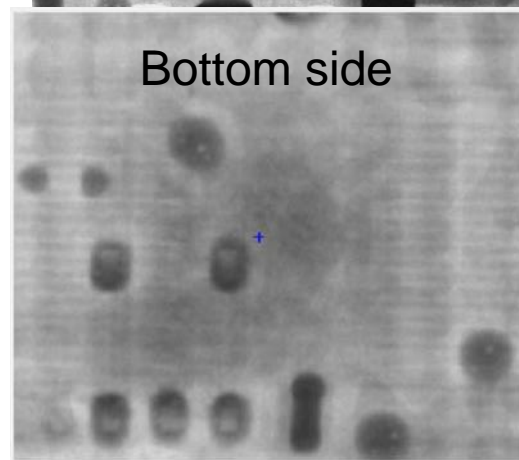
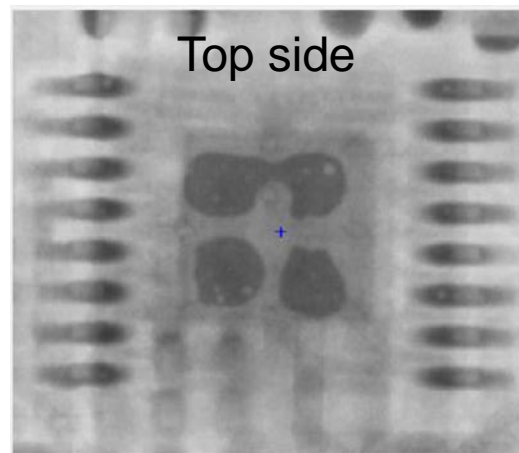
# Tomosynthesis

Automatic X-Ray  
Inspection AXI  
analyzes the layer  
which provides most  
of the solder joint  
information



# Inline X-Ray System X7056-II

- Flat Panel Detector (FPD) with xy axis
- Planar CT generated from up to 66 angular views
- Separation of top and bottom side

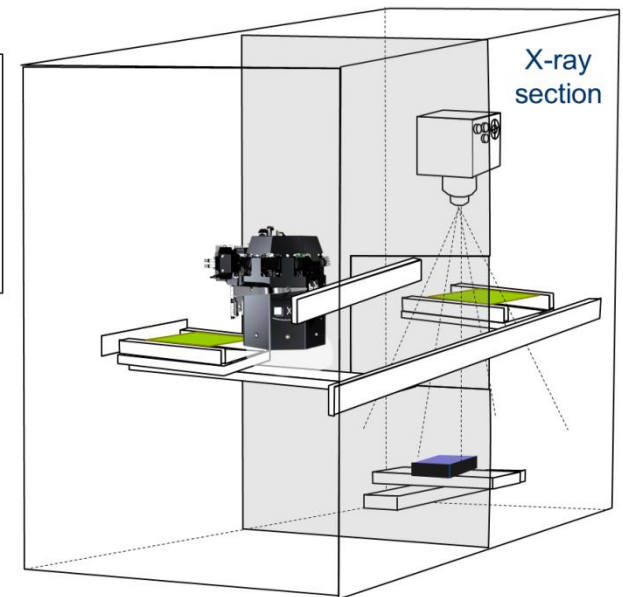
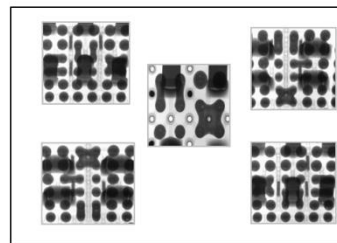


# Comparison: Light versus X-Ray „illumination“

	Visible light	X-Ray „Light“
<b>qty of simultaneous sources</b>	multiple	single
<b>Source variation speed</b>	faster	slower
<b>image acquisition speed</b>	faster	slower
<b>wavelength range (Information range)</b>	wide	narrow
<b>information carrier</b>	reflections in many directions from the object	shadow in one direction from the object
<b>source-object-sensor distances (machine z-size)</b>	smaller	larger
<b>object travel range to allow full size inspection (machine x/y-size)</b>	smaller	bigger
<b>resulting inspection performance</b>	more	less

# Viscom X7056-II AOXI

Viscom inline Combi-Inspection System X7056-II  
3D-AOI and 3D X-Ray inspection in one single cabinet



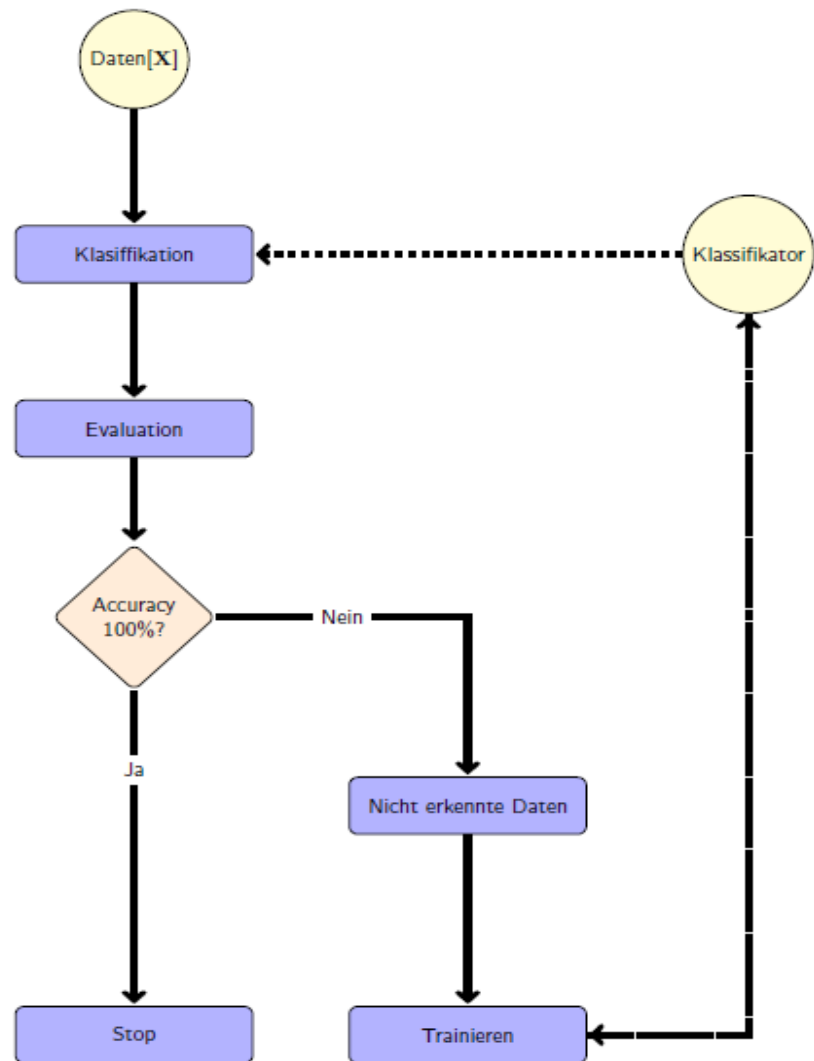
# Recommendations

- Use Automatic Optical Inspection as much as possible because it is the fastest and most reliable inspection method.
- Apply Automatic 2D or 2.5d X-Ray analysis if this is sufficient to analyze solder joint quality. Only one image from an angular view is necessary.
- Apply Automatic 3D X-Ray Analysis only if you need to separate information of absorbing material on one side of the pcb from the one on the other side (Shadowing)
- Apply AXI using the information which AOI provides to increase performance and to decrease false calls.



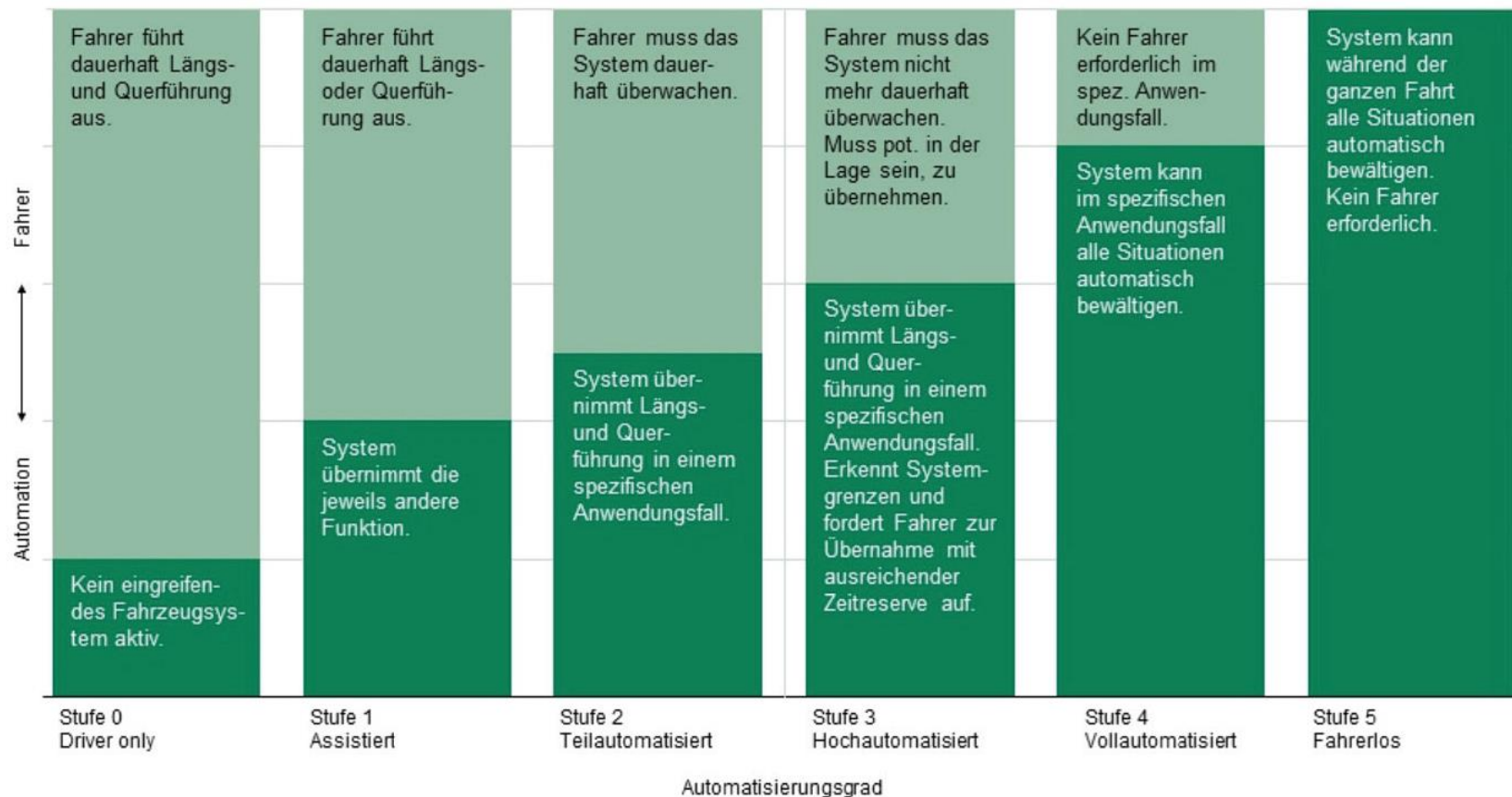
# Artificial Intelligence - Deep Learning

- Deep Learning supports defect classification at the verification station
- Deep Learning supports program generation





# Automatic or autonomous driving?



Source: VDA

autonomous means without driver

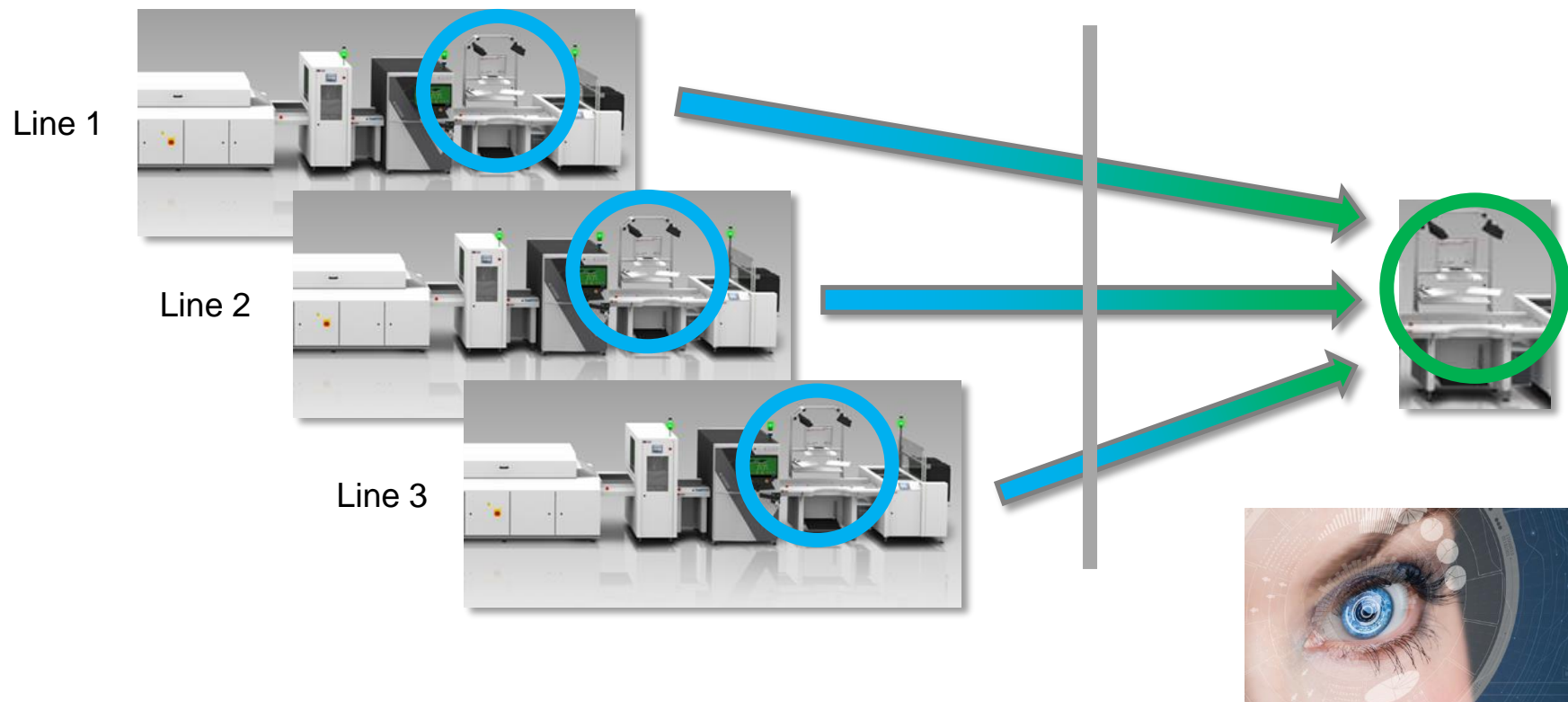
# Partially automated driving



Quelle: VDA

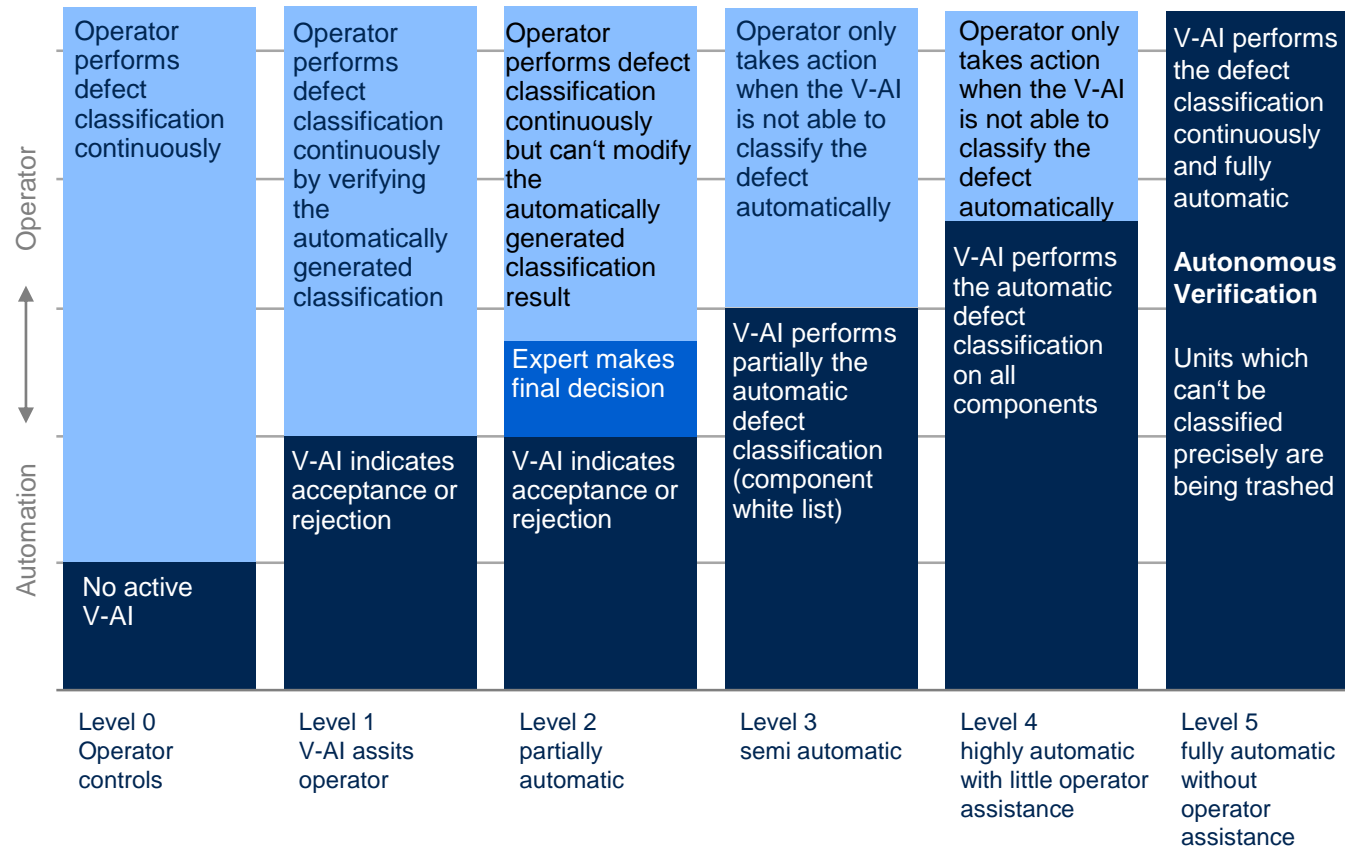
objective: driver assistance and safety increase

# Partially automated defect verification



objective: operator assistance and quality increase

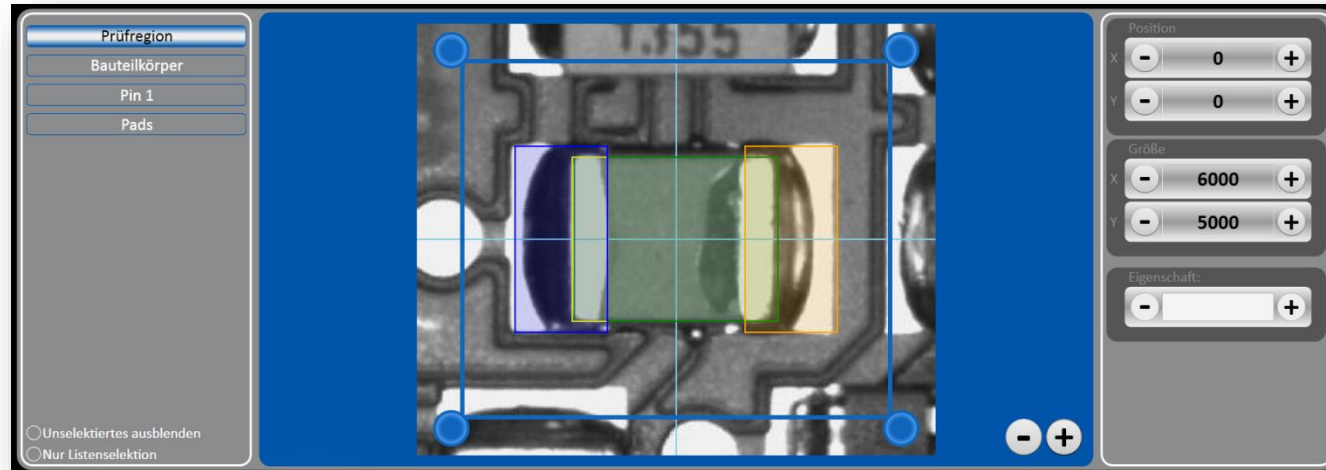
# V-AI: Automatic Verification using AI



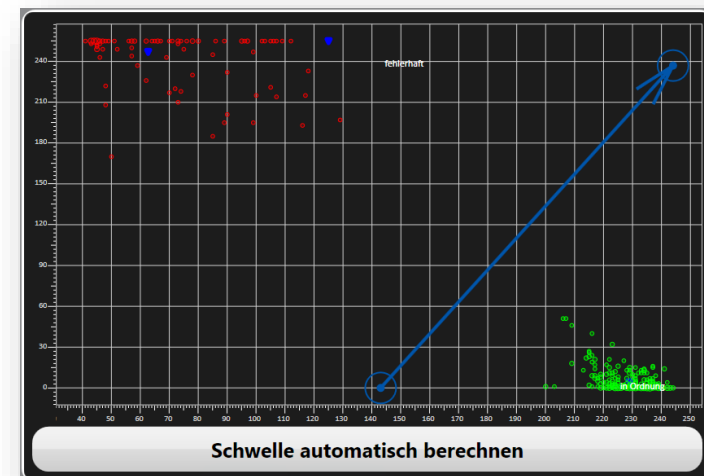
Automatisation level



# Deep Learning supported program generation



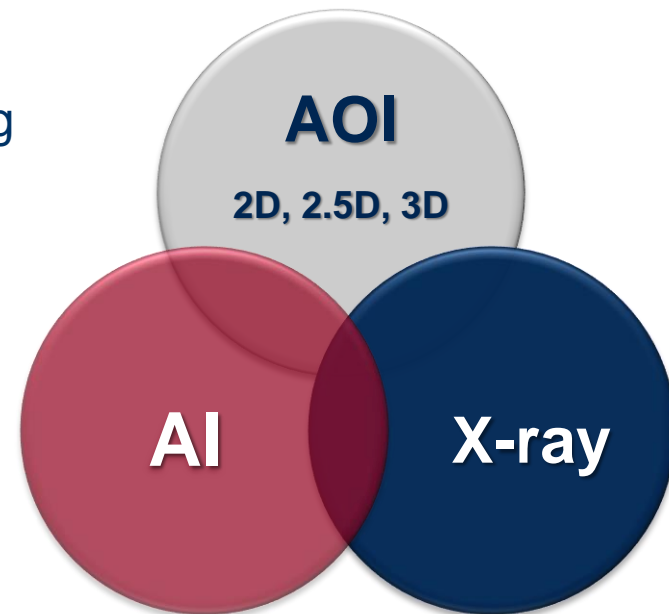
- Automatic component type identification (NPI)
- Automatic program optimization
- Automatic fine tuning (integrated defect verification)



# AI: Viscom Strategy

**General target: „zero escapes / zero false calls“,**

- False classifications can be avoided by combining diverse technologies like 3D AOI, 3D X-ray und AI
- Elimination of false calls and escapes resulting from human errors by using proven functions like the Integrated Classification Verification
- Keep the process transparent and support the operator's decision making.



## Conclusion

If you have to reduce your ppm rates of defects from single digits down to zero then you have to use both AOI and AXI Inspection Technology.

If you don't have much floor space available for automatic inspection then you should choose a small combined inline inspection system

If you look for a supplier which offers

35 years experience in AOI and

25 years experience in AXI then you should talk to Viscom AG in Hannover, Germany

For more information, visit us at the E&A, booth 7A059 (Smd-Tec + Demo-plein)



# Future events



**Viscom Technologie-Forum 2019**  
05.06.2019 - 06.06.2019, Hannover, Deutschland



**Motek 2019**  
07.10.2019 - 10.10.2019, Stuttgart, Deutschland  
Internationale Fachmesse für Produktions- und Montageautomatisierung



**LED meets SMT**

**LED meets SMT**  
24.10.2019, Regensburg, Deutschland  
2. Fachforum



Accelerating Innovation

**productronica 2019**  
12.11.2019 - 15.11.2019, München, Deutschland