



Defects and their Relation to Playability for the New High Density Formats



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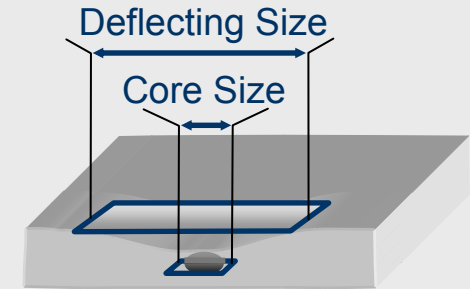


Feedback from Blu-Ray and HD-DVD Production



Evaluated two main topics for Blu-Ray respectively HD-DVD production together with major disc replicators worldwide:

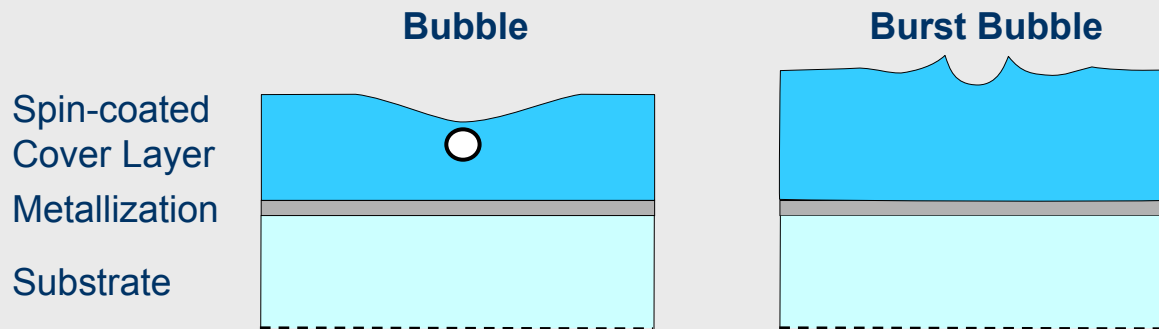
- **Local defects with deformation and their influence on playability**



Local Defect with Deformation

Deflecting Defects on Spin-coated Blu-Ray

- The spin-coating process is becoming more and more accepted for Blu-ray Disc production
- Compared to the sheet-bonding process, the spin-coating process is more susceptible to create local bumps (e.g. from bubbles or burst bubbles)



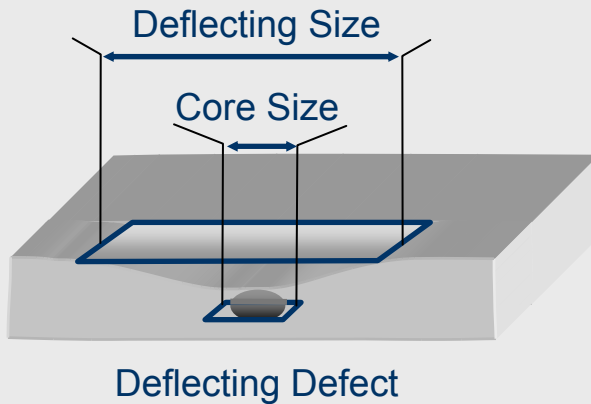
- Such local DEFLECTING defects cause playability problems and therefore have to be reliably sorted out

Core Size and Deflecting Size

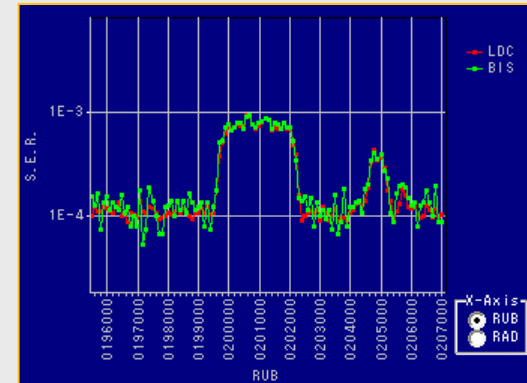


Evaluated the most important DEFLECTING defects and their influences on the playability

BD ROM Defect



Playability



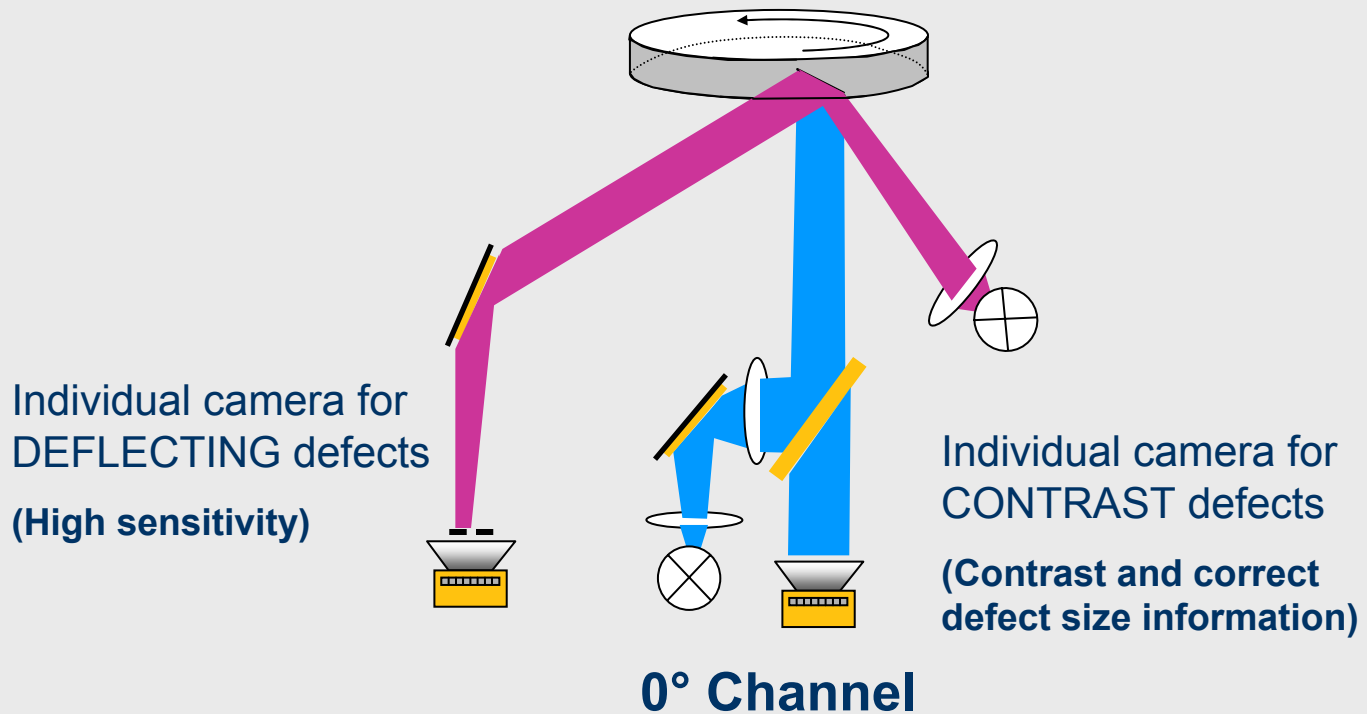
Sony BD Drive



ISM.blue+ with 2-Camera Channels

Solution for Efficient BD Inspection

High Density Format Playability

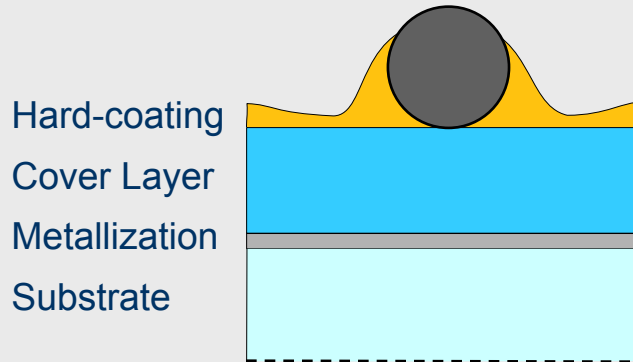




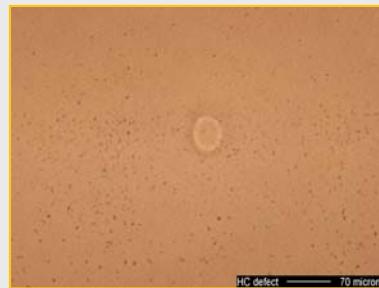
Hard-Coating Defect (Spot)

Defect Description and Defect Causes

Local defect/deformation on hard-coating layer caused by contamination



Microscopic image of defect for reference



- ✓ Inclusion of contamination e.g. cover-sheet particles before hard-coating process
- ✓ Back splash from spin bowl

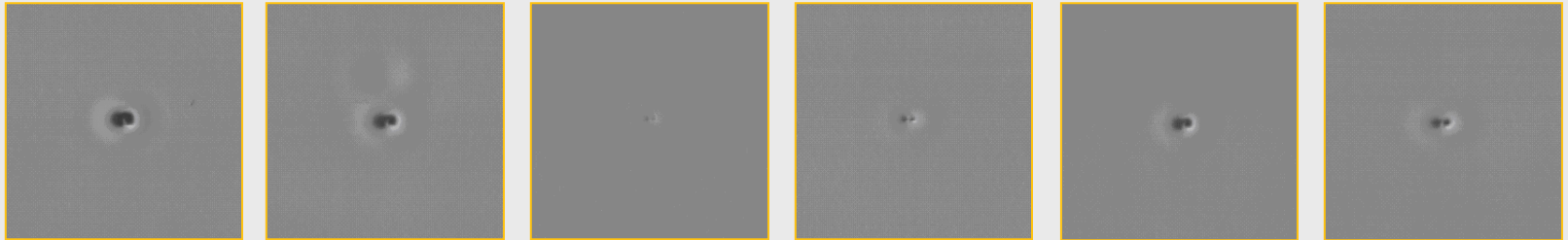
	Typical Ranges	
	from [μm]	to [μm]
Core Size	10	200
Deflecting Size	200	600



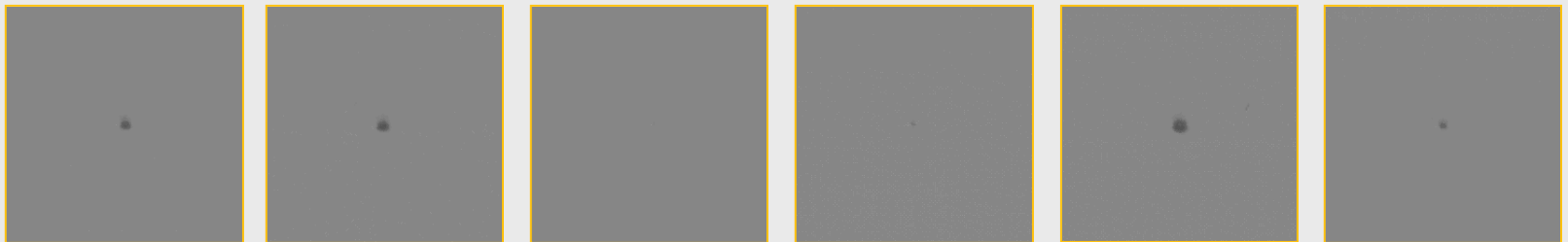
Hard-Coating Defect (Spot)

Typical High Resolution Images of Hard-coating Defects

Near Dark-field Image – Deflecting Size



Contrast Image – Core Size

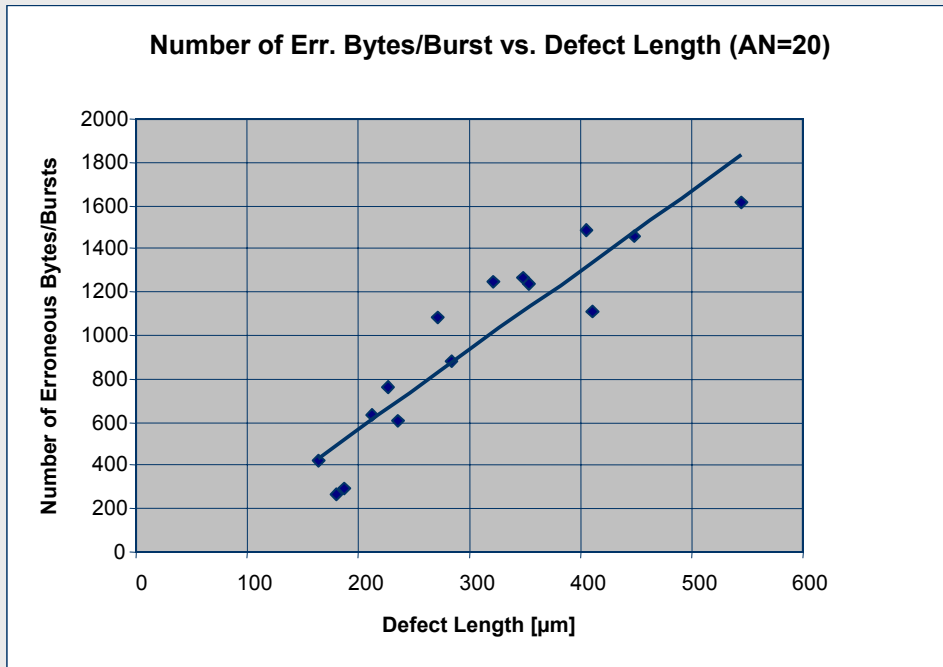


High Density Format Playability

Hard-Coating Defect (Spot)



Influences on Playability



	Critical Ranges in [µm]	
	Deflecting Length	Core (*) Length
NDF Threshold AN 14 / CDF 0	220 ... 250	BD-ROM 300 BD-R/RE 150
NDF Threshold AN 20 / CDF 0	170 ... 200	BD-ROM 300 BD-R/RE 150

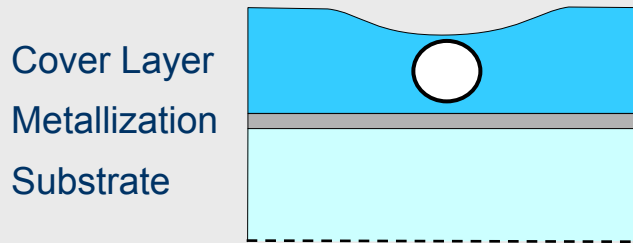
(*) With reference to BD specifications



Spin-Coating Spot / Bubble

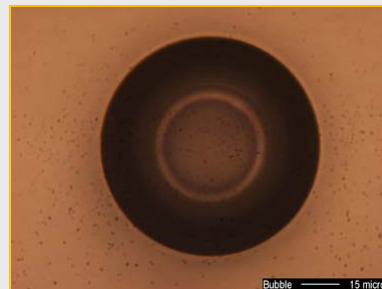
Defect Description and Defect Causes

Air bubbles trapped inside the cover layer



- ✓ Inclusion of air bubble within the cover layer material

Microscopic image of defect for reference



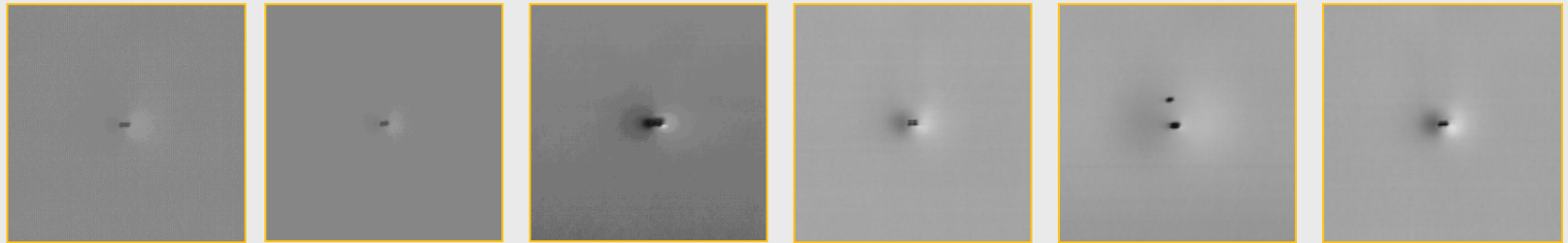
	Typical Ranges	
	from [μm]	to [μm]
Core Size	40	75
Deflecting Size	300	1000



Spin-Coating Spot / Bubble

Typical High Resolution Images of Deflecting Bubbles

Near Dark-field Image – Deflecting Size



Contrast Image – Core Size



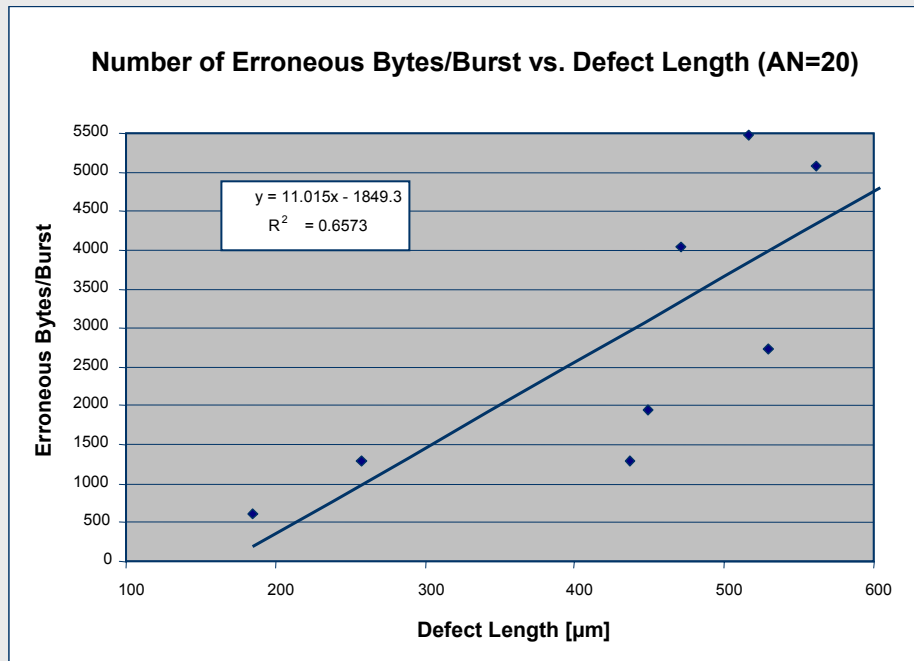
High Density Format Playability



Spin-Coating Spot / Bubble

Influences on Playability

High Density Format Playability



	Critical Ranges in [µm]	
	Deflecting Length	Core (*) Length
NDF Threshold AN 14 / CDF 0	300	100
NDF Threshold AN 20 / CDF 0	200	100

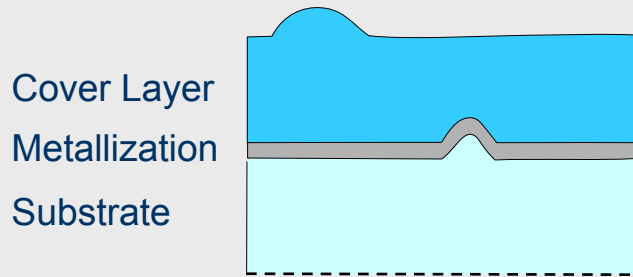
(*) With reference to BD specifications



Bump

Defect Description and Defect Causes

Small local elevation within information layer or on cover layer surface



- ✓ Cover-sheet deformation
- ✓ Stamper defect
- ✓ Burst Bubble

Microscopic image of defect for reference



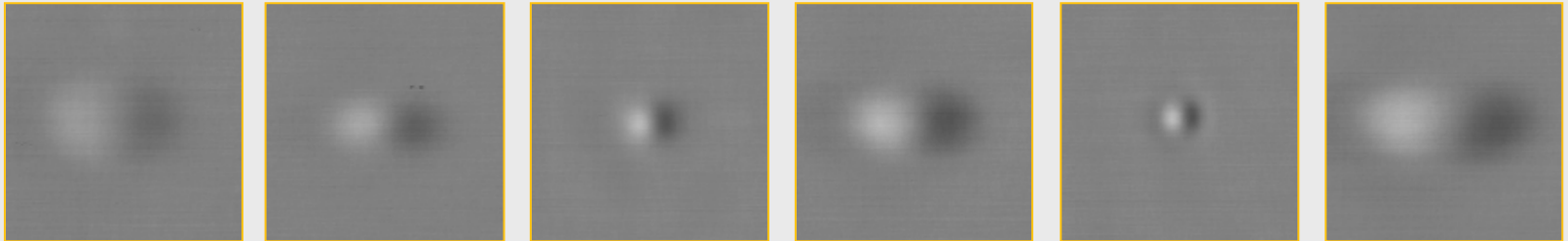
	Typical Ranges	
	from [μm]	to [μm]
Core Size	0	0
Deflecting Size	400	1500

Bump

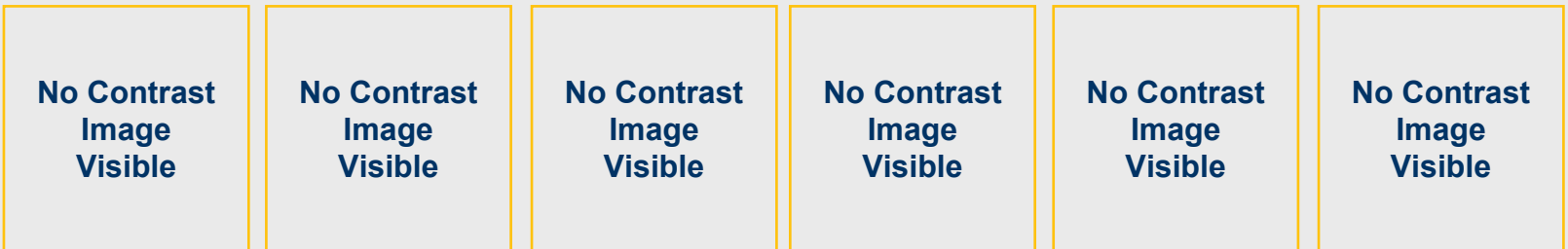


Typical High Resolution Images of Bumps

Near Dark-field Image – Deflecting Size



Contrast Image – Core Size

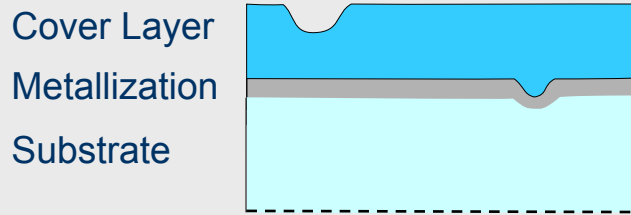




Dent

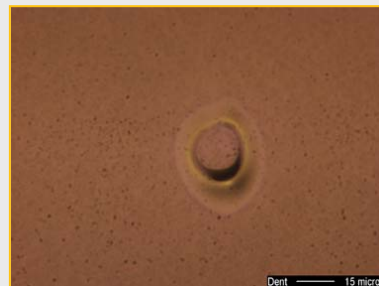
Defect Description and Defect Causes

Small local cavity within information layer or on cover layer surface



- ✓ Stamper defect
- ✓ Cover-sheet deformation
- ✓ Burst Bubble

Microscopic image of defect for reference



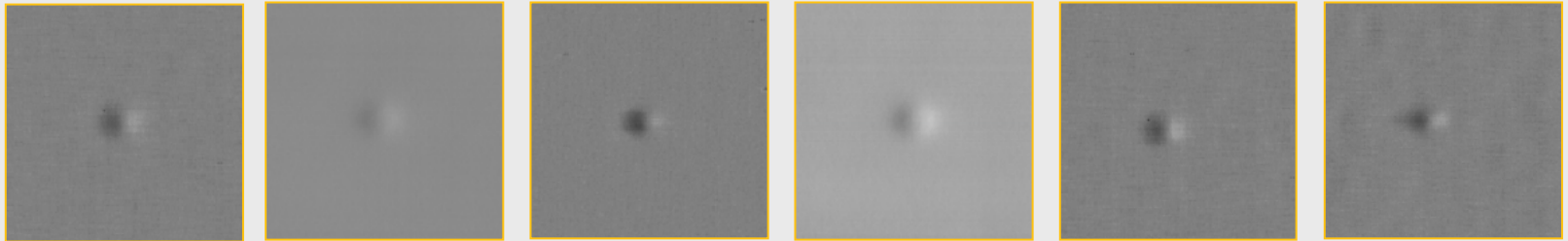
	Range	
	from [μm]	to [μm]
Core Size	0	0
Deflecting Size	400	1500

Dent

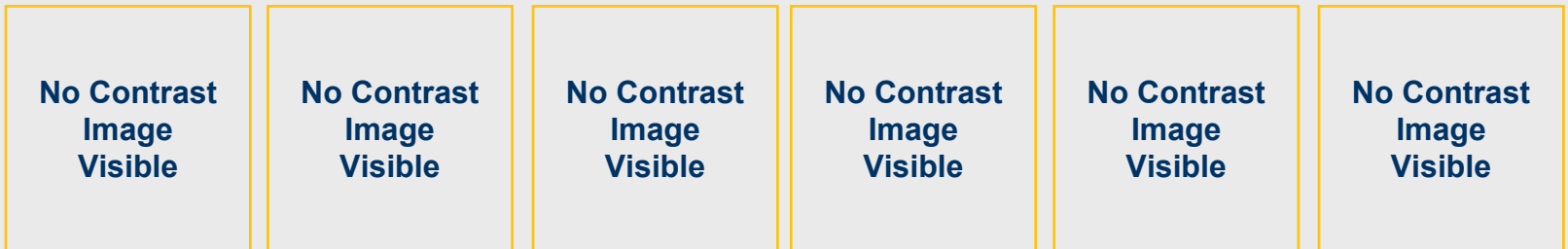


Typical High Resolution Images of Dents

Near Dark-field Image – Deflecting Size



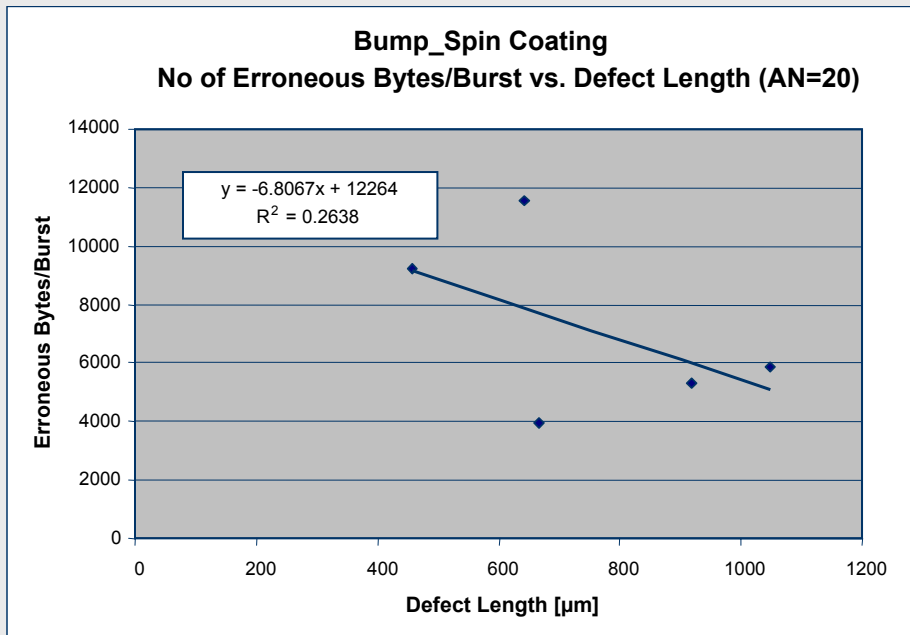
Contrast Image – Core Size



Bump and Dent



Influences on Playability

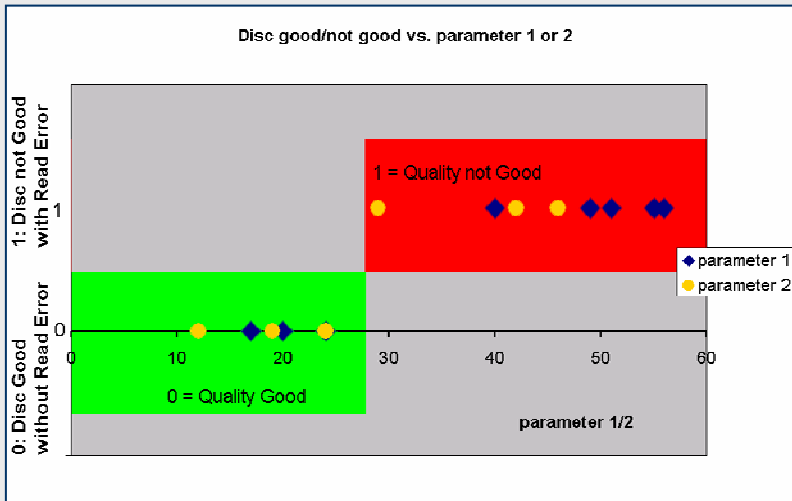


	Critical Ranges in [µm]	
	Deflecting Length	Core Length
NDF Threshold AN 14 / CDF 0	not applicable	not available
NDF Threshold AN 20 / CDF 0	not applicable	not available

Bump and Dent



Influences on Playability

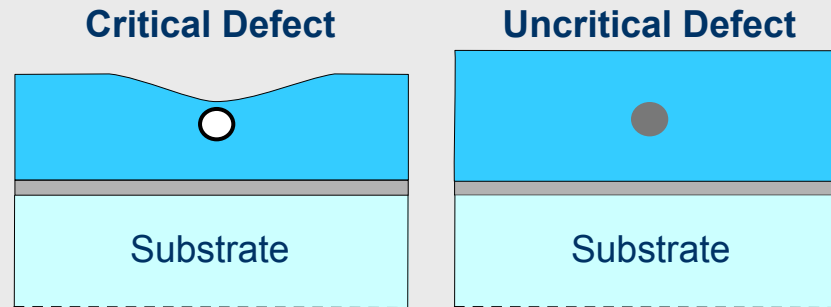


	Critical Value
Parameter 1	30
Parameter 2	30
Parameter 3	60

Critical Defects on Spin-Coated BD



- Conventional Blu-ray Disc inspection systems with only one camera are only sufficient for the sheet-bonding process, they are not able to fulfill the special requirements of a spin-coating process
- One-camera systems do not have the ability to distinguish between critical (deflecting) defects and uncritical defects



- One-camera systems reject even good discs with only uncritical defects, resulting in an extremely high False Detection Rate that causes a low production yield

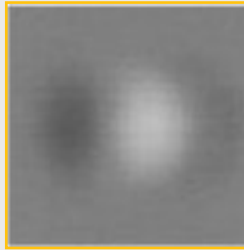
Highest Inspection Sensitivity



Comparison of Same Defect: Dent

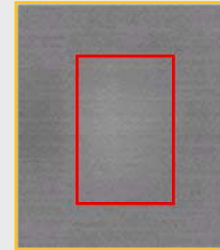
2-Camera System

Original defect image
from individual
camera only for
DEFLECTING defects
(High sensitivity)



1-Camera System

Original defect image
from camera for
deflecting and
contrast defects
(Low sensitivity due to
compromise setting)



- **2-Camera System:** Highest sensitivity for critical deflecting defects
- **2-Camera System:** Best signal-to-noise ratio for critical deflecting defects

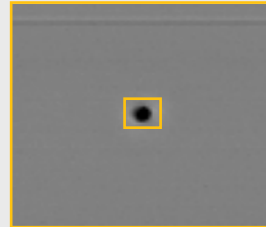
More Defect Information

Comparison of Same Defect: Spin-coating Spot

2-Camera System

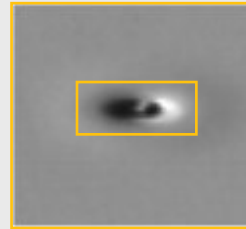
Defect image from individual camera for CONTRAST defects

(Contrast information e.g. Core Size)

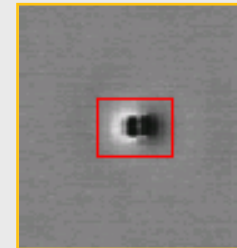


Defect image from individual camera for DEFLECTING defects

(Deflecting information e.g. Deflecting Size)



1-Camera System



Defect image from camera for deflecting and contrast defects

(Not enough information about the defect)

- **2-Camera System:** Independent information about a defect from TWO individual cameras
- **2-Camera System:** Contrast information, as well as deflecting information available

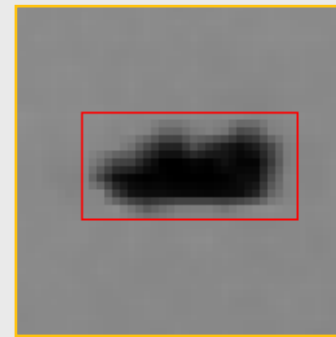
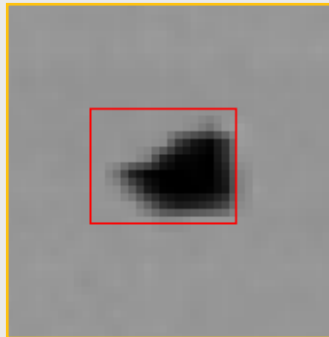
Correct Defect Size Determination

Comparison of Same Defect: Surface Contrast Defect

2-Camera System

1-Camera System

Defect image from individual camera for CONTRAST defects with 0° angle of incident
(Correct defect size)



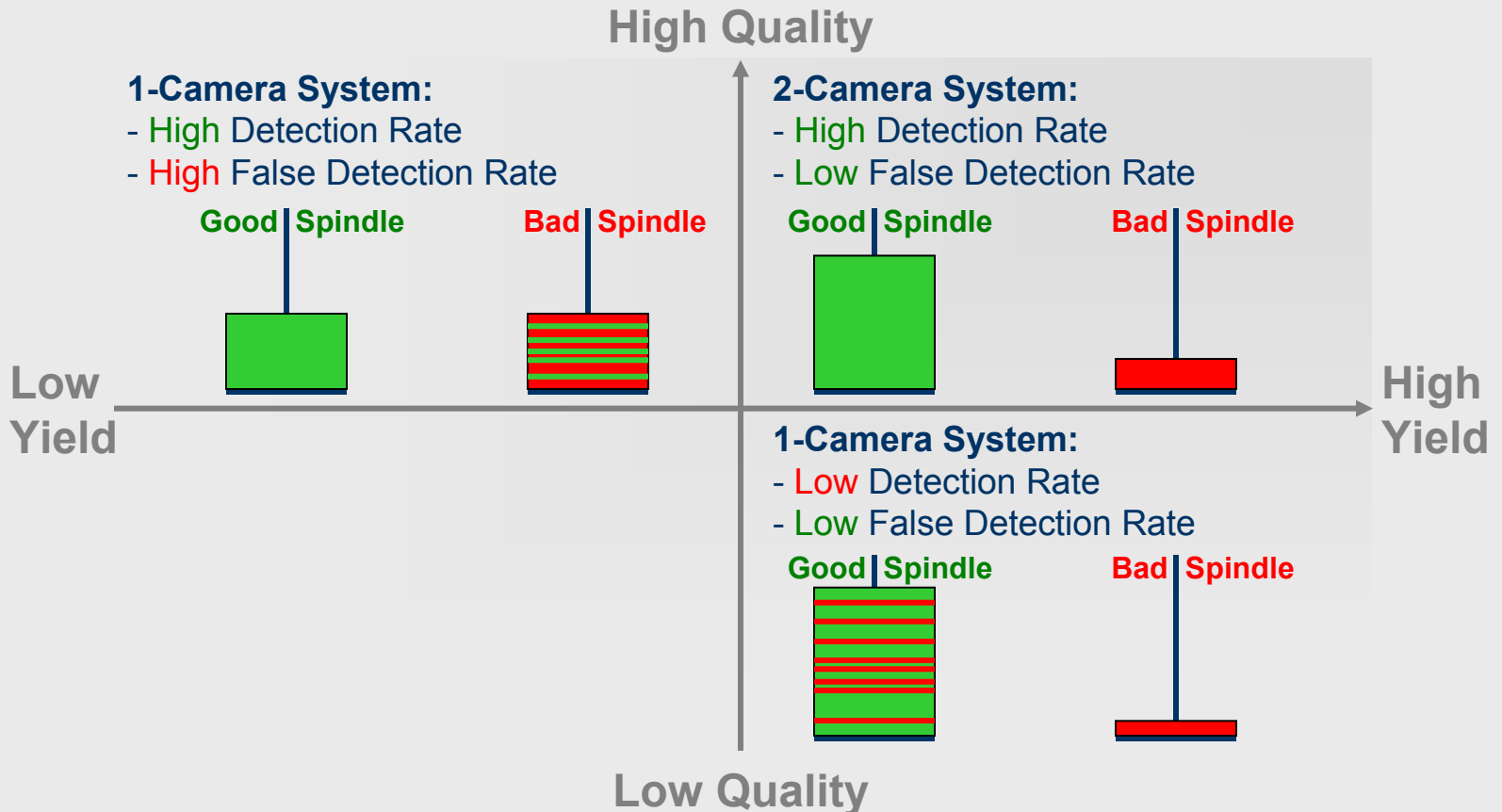
Defect image from camera for deflecting and contrast defects with 30° angle of incident
(Defect oversized)

- **2-Camera System:** Correct defect size determination for surface contrast defects with 0° Channel



High Yield without Compromise on Quality

High Density Format Playability



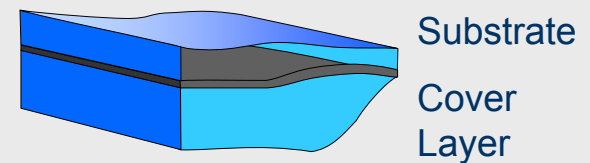
- Blu-Ray requires an inspection system with TWO individual cameras:
 - **High Detection Rate for High Quality** and at the same time a
 - **Low False Detection Rate for High Yield**



Feedback from Blu-Ray and HD-DVD Production

Evaluated two main topics for Blu-Ray respectively HD-DVD production together with major disc replicators worldwide:

- **Physical properties of Discs on outer radius > 57.0 mm**



Physical Properties of BD



Physical Properties at Outer Radius > 57.0 mm

- Keeping physical properties well within specification up to radius 57.0 mm is state of the art
- However, the outer 1.5 mm area between radius 57.0 and 58.5 mm is the critical area for High Density Disks, particularly dual layer

This outer area often shows:

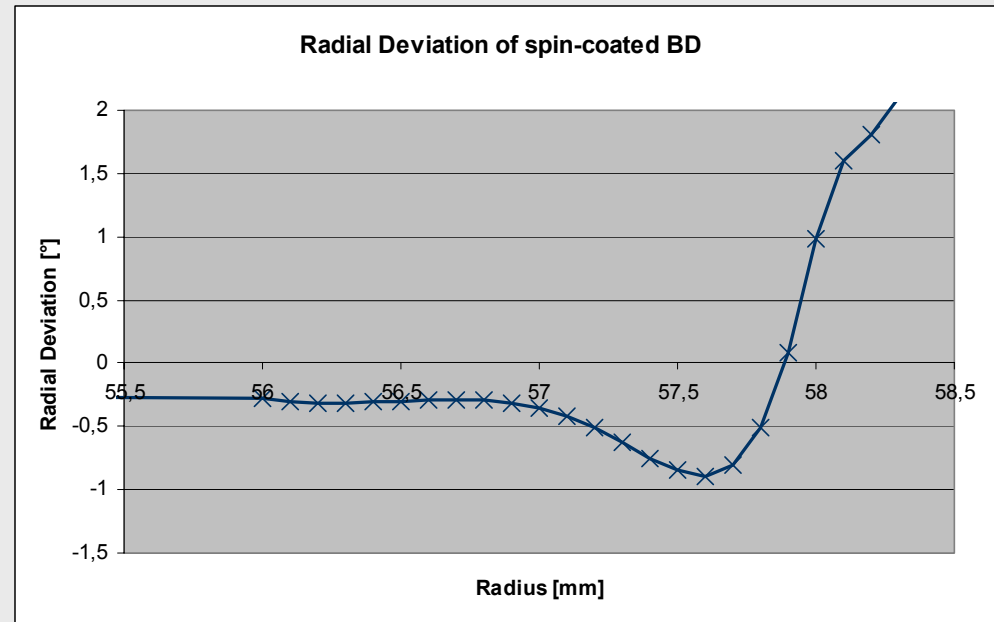
- High radial deviation which can be far beyond specification (>> 0.7° / 0.8°)
- High variation of space layer and cover layer thickness which can be up to 2 - 4 µm within 0.1 mm in radial direction

Deviation of Blu-ray Disc



High Resolution Radial Deviation Measurement

- High sampling rate
- High radial resolution of 100 μm



- High resolution radial deviation measurement enables deviation profile measurement of the interesting outer area of the disc



Space Layer / Cover Layer Thickness

High Density Format Playability

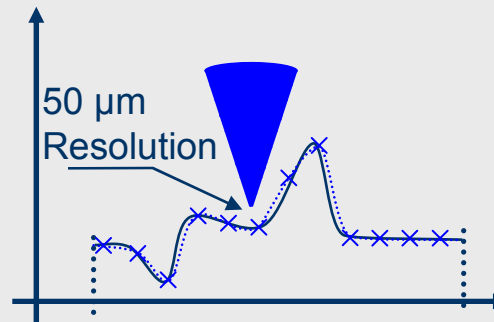
	Interferometer	Spectrometer
Measurement Principle	Laser Interferometer developed by Dr. Schenk	White Light Spectrometer
Local Resolution	< 50 μm	~ 500 μm

Cover Layer Thickness Measurement:

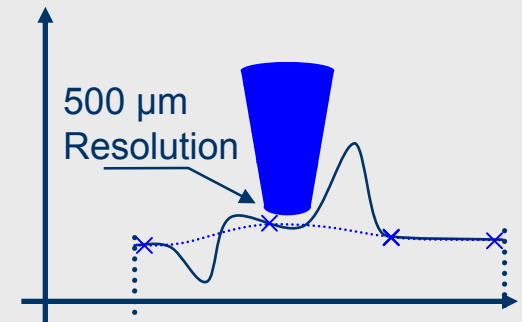
— Layer Thickness

⋯×⋯ Evaluated Thickness

Laser Interferometer



White Light Spectrometer

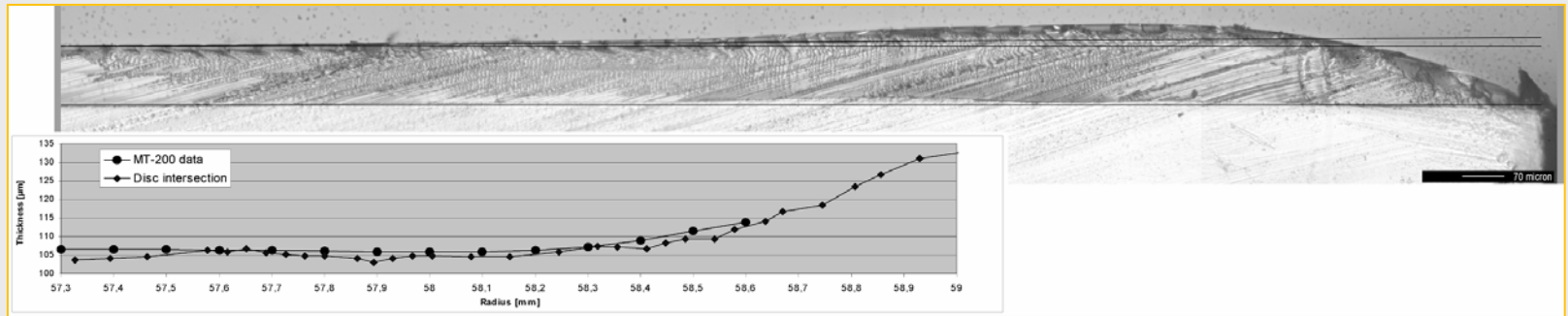


Cover Layer Thickness



High Resolution Laser Interferometer

- Measurement spot size < 50 μm
- High sampling rate
- High radial resolution of 100 μm possible



- Local variations and high gradients are only measurable with Laser Interferometer

Newest Developments



Cover Layer and Space Layer Measurement

- At the current state of process development some spin-coating processes require a higher spatial resolution in radial direction

➡ **Option: Inline 8-radii Layer Thickness Measuring Unit**

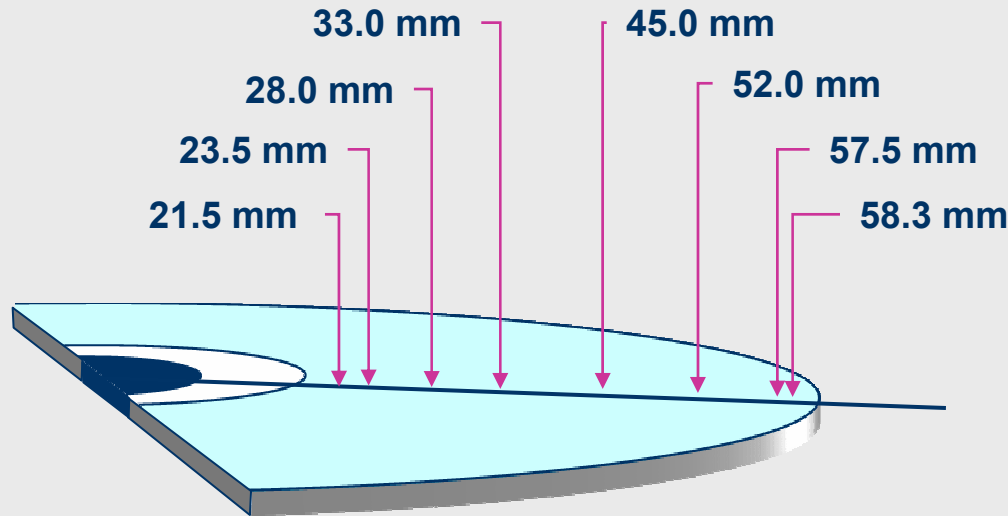
Deflecting Defect Detection

- Higher sensitivity is required when highest demands are made on the detection of deflecting defects due to their influence on the residual tracking error (9 nm)

➡ **Option: Enhanced ACC-Channel**

Cover Layer and Space Layer Measurement

- ▶ Dr. Schenk offers an 8-radii inline cover and space layer thickness measurement unit with process adapted radial resolution to meet the requirements of current process optimization while using high resolution laser interferometry
(Standard: 4-radii with outermost radius 58.3 mm)



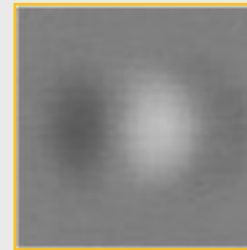
Deflecting Defect Detection

- Dr. Schenk offers an Enhanced ACC-Channel providing ultra high sensitivity for deflecting defects

Dr. Schenk

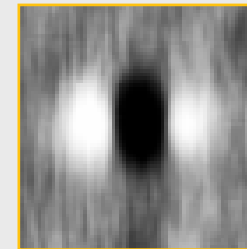
Original defect image from individual camera only for DEFLECTING defects

(High sensitivity)



Enhanced ACC-Channel with special evaluation of the acceleration force

(Ultra high sensitivity)

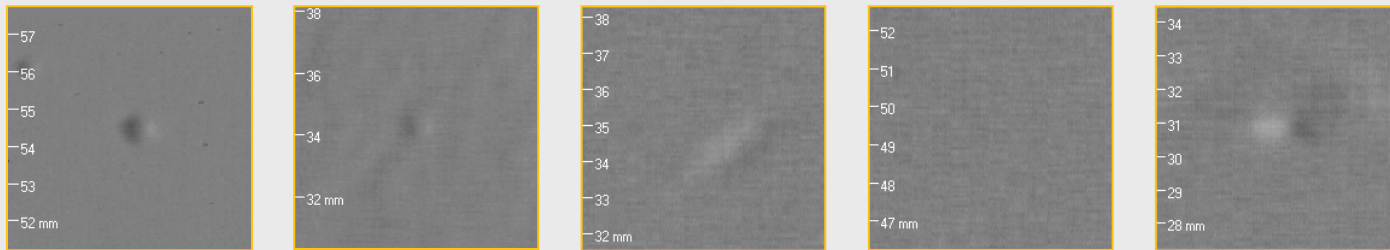




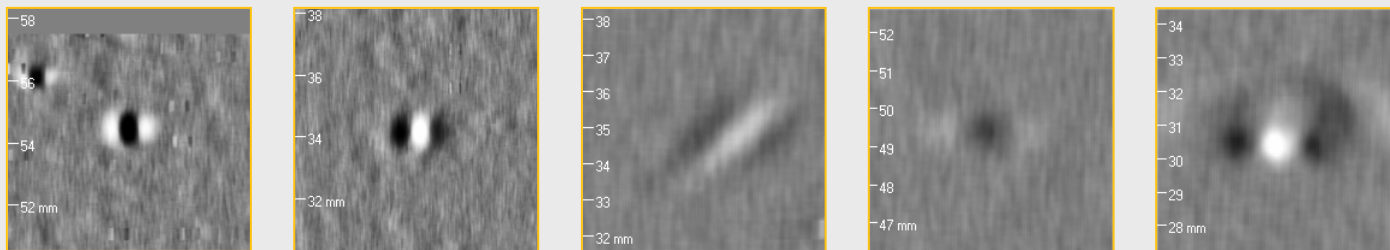
Enhanced ACC-Channel Examples

Typical Enhanced ACC Images of Bumps and Dents

Near Dark-field Image – Deflecting Size



Enhanced ACC Image – Acceleration Force Information



High Density Format Playability

Dr. Schenk Worldwide



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