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Experiment of Measure Effect of Image Focus on Defect Detection and Measurement

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Outline

- Background
- Focus Sensitivity
- Design of Experiment
- Summary

Background

- **Obtaining a sharp image of the fiber end face requires a focus operation prior to image capture**
- **Repeatability of this focus affects inspection repeatability**
- **Two ways repeatability is impacted by focus changes:**
 - **Detection: blurring reduces contrast, which impacts probability of detection**
 - **Measurement: blurring also affects the measured dimensions, making defects either smaller or larger depending on exact method of measurement**

Sources of Non-Repeatability for Fiber Defects

- Variations in focus
- Lighting changes
- Camera (video) noise
- Orientation of part (for non-keyed circular ferrules)

- For remainder of this talk, focus entirely on focus

Focus Methods

- Fiberscopes use fixed magnification and working distance (WD) lenses.
- The magnification, WD, NA and other characteristics of the lens are part of the design of individual scopes
- Most scopes use Z-axis (optical axis) motion in order to focus on the end face.
- Measurements of a Figure of Merit (FoM) that is related to focus quality, usually contrast based, are made as a function of Z position.
- The location that corresponds to the peak (or fitted peak) in this focus data is the optimal focus point
- The lens is returned to this focus point, ready for image capture

Sources of Focus Variation

- **Noise in the focus FoM measurement**
- **Position measurement errors**
- **Movement errors, especially in the move that returns the lens to the optimal focus location**

Focus Effect Experiment Goals

- **Measure the sensitivity to focus for a number of fiber scopes**
- **Determine the range of focus, based on positional error or FoM error that yields a given amount of variation in detection and measurement error**

Design of Experiment

- **Select samples with reasonable contrast and small number of fixed defects**
- **Collect data under normal operation to determine the nominal repeatability of the test scope(s)**
- **Collect sets of data with a forced fixed offset in focus position.**
 - **Fixed offset by separate movement of part for non-FiberQA devices. Modify code to adjust focus final position for FastMT**
 - **At each focus offset position, collect set of data to determine repeatability at each offset**
 - **Repeat for number of offsets spanning the peak in focus FoM**

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