

IOWA STATE UNIVERSITY

**CASR**

FAA Center for Aviation Systems Reliability

CASR FPI – Engineering  
Studies:  
Penetrant Application



**Lisa Brasche**

Center for Nondestructive Evaluation

Iowa State University

lbrasche@iastate.edu

(515) 294-5227

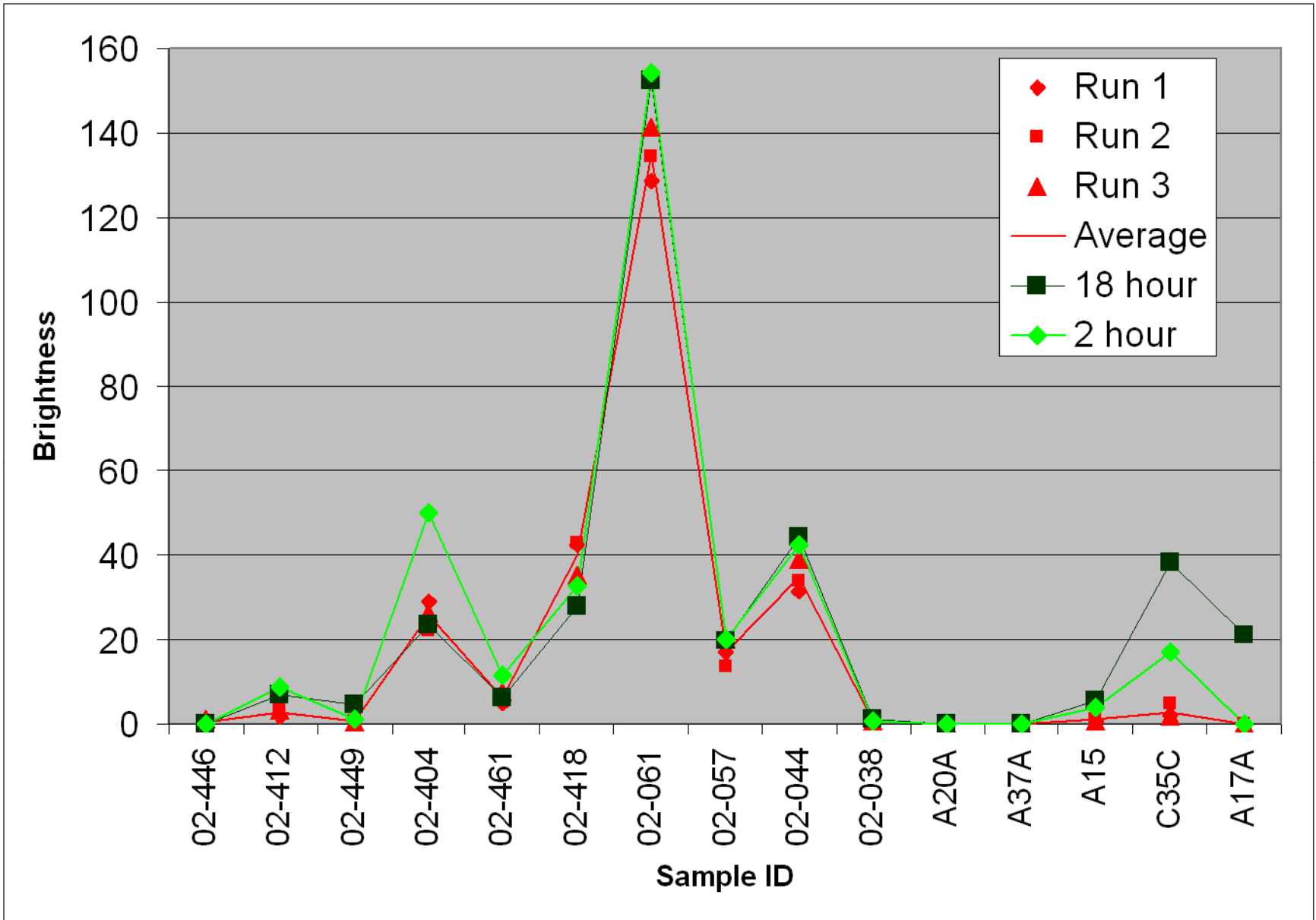


<http://www.cnde.iastate.edu/faa-casr/fpi/index.html>

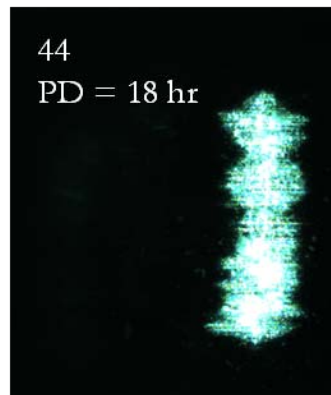
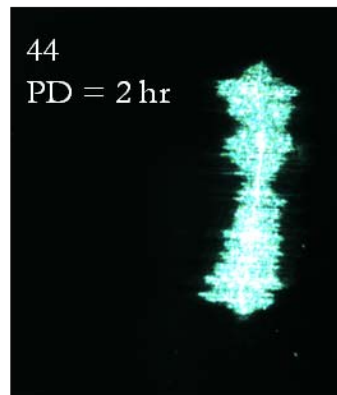
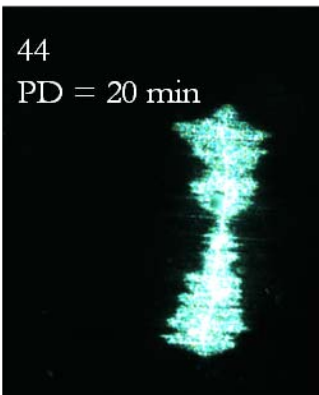
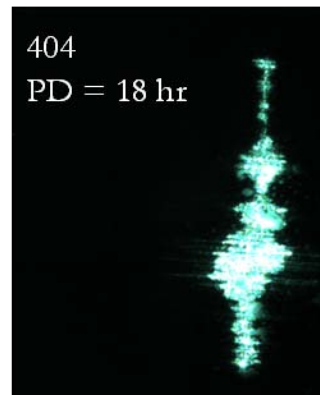
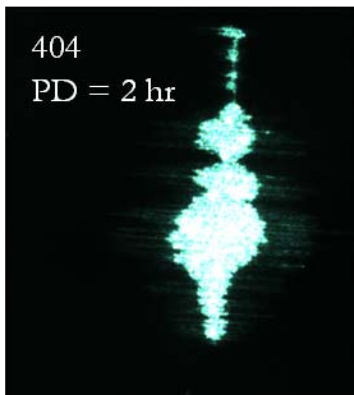
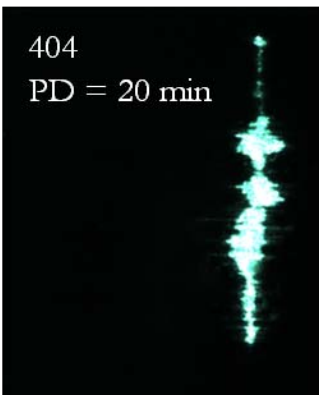
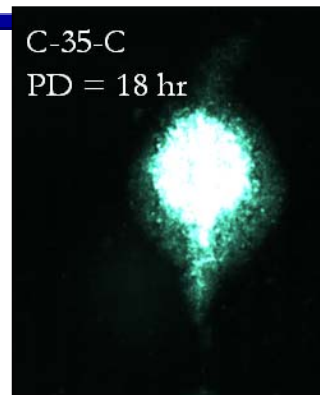
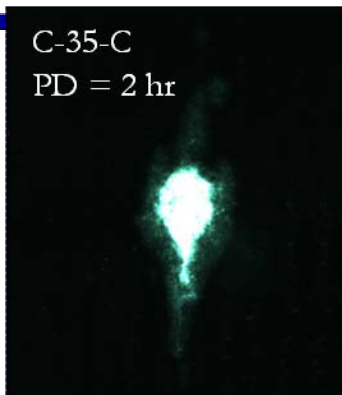
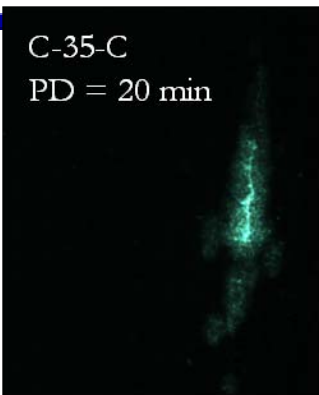


- Evaluate effect of penetrant dwell time on crack brightness
- All samples hand processed with Level 4 PE penetrant (ZL-37)
- Ten ISU and five RR samples selected
  - RR samples tighter, intermittent cracks in as-machined or shot peened surfaces
- Three baseline runs – penetrant dwell time of 20 minutes
- 18 hour dwell time – penetrant applied followed by 18 hour dwell prior to further processing
- 2 hour dwell time – penetrant applied followed by 2 hour dwell prior to further processing

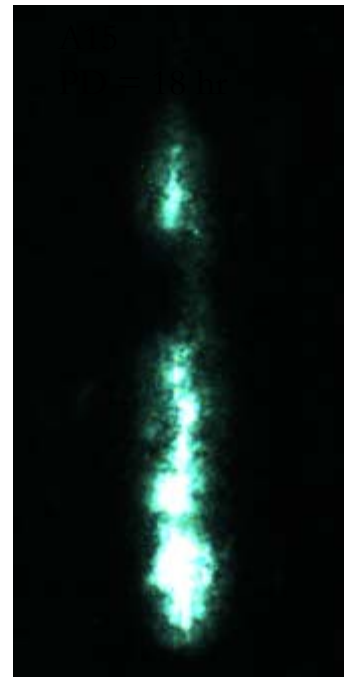
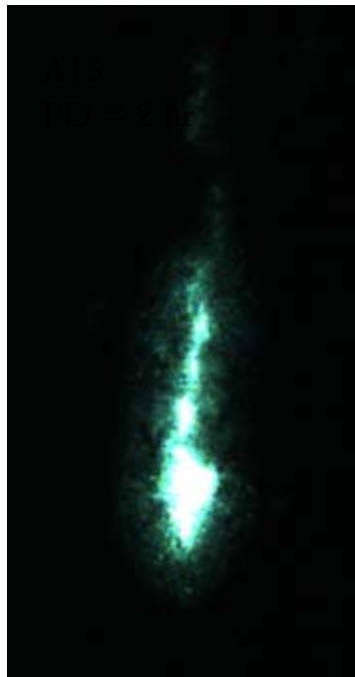
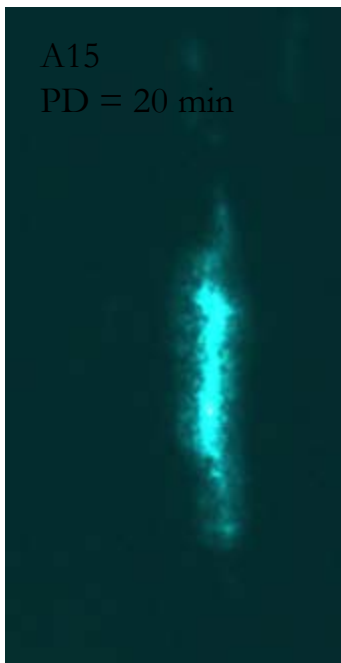
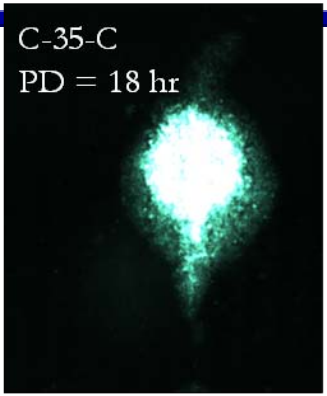
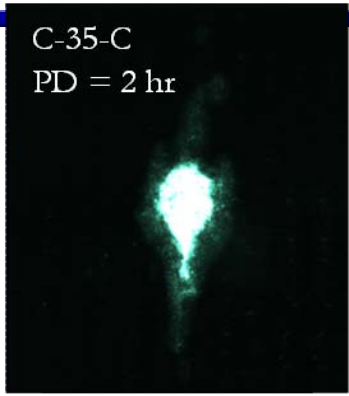
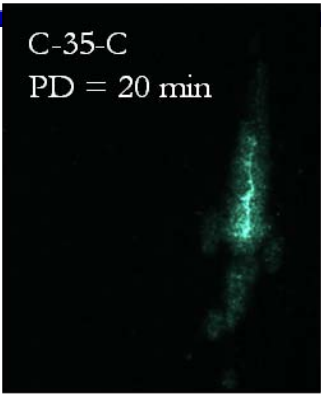
# Penetrant Dwell Time

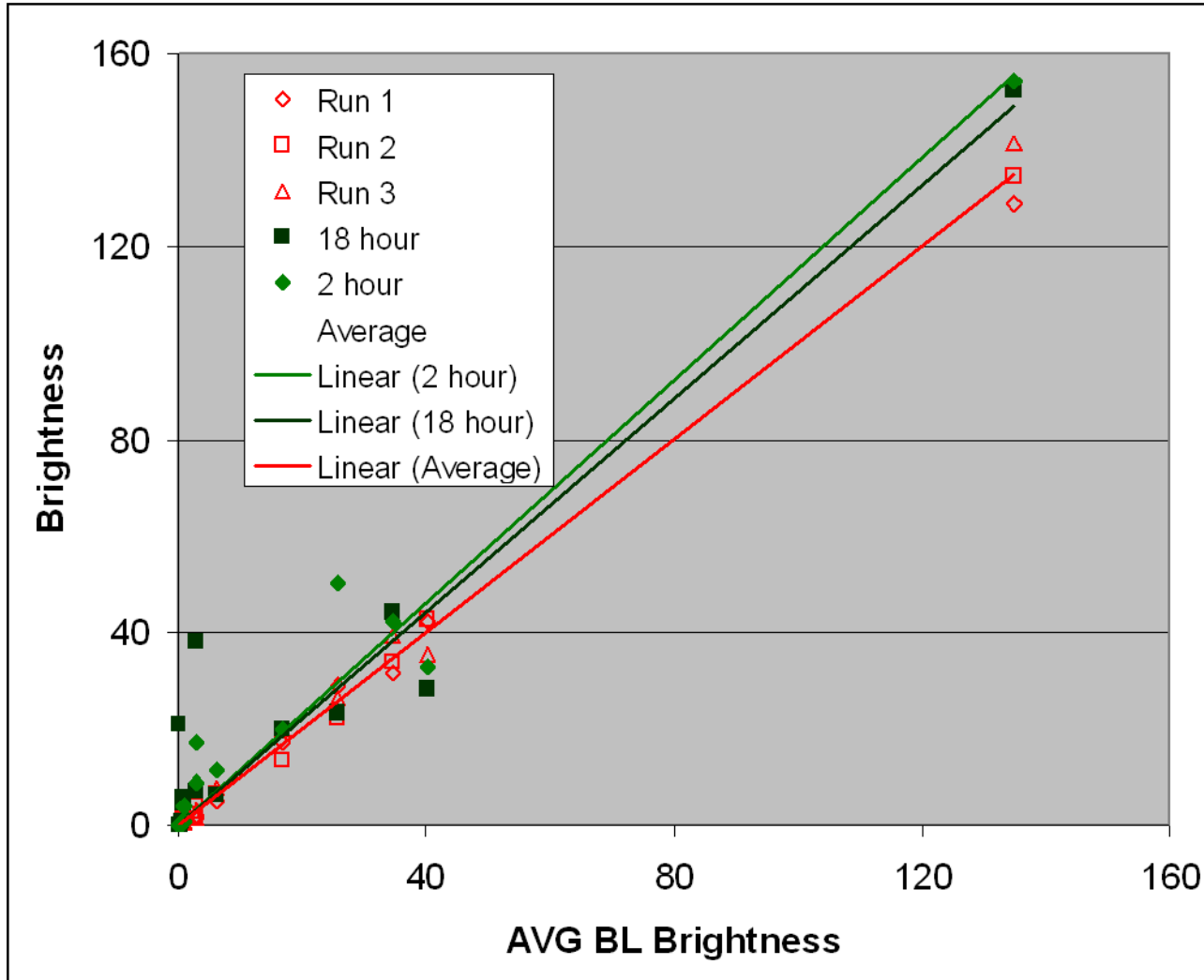


# UV-A Images



# UVA Images





- Brightness plotted versus average of three baseline runs
- Improvement found in most samples
- Similar results for 2 hour and 18 hour dwell time
- 18 hour better for tightly closed cracks

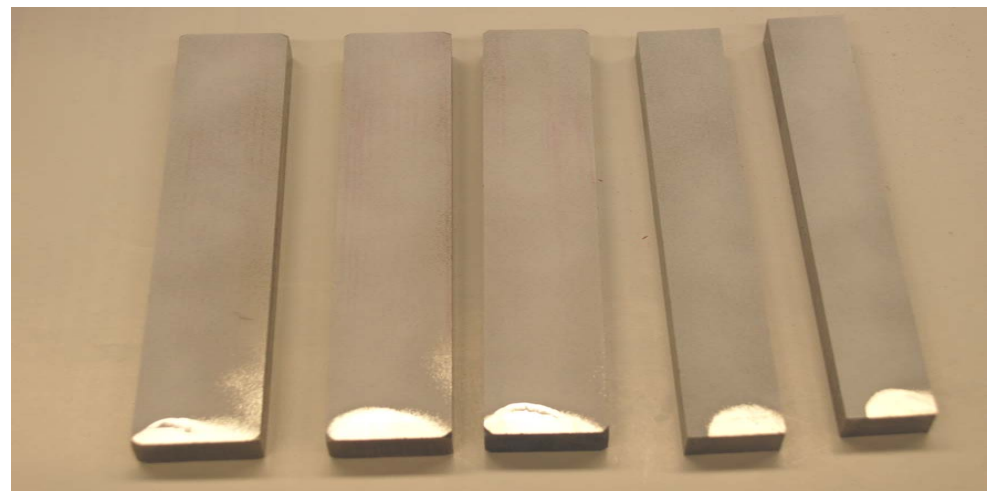
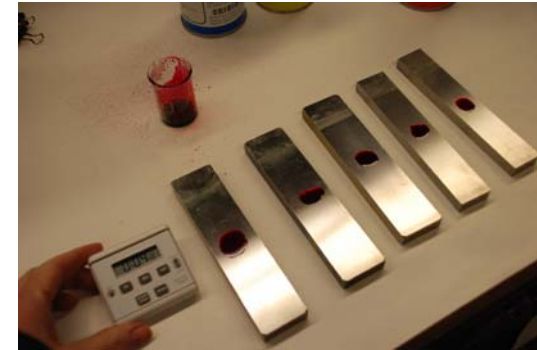


- Longer duration penetrant dwell times lead to improved brightness
- Consideration should be given to stress state – for highly stressed regions consider longer dwell time or use of alternative method
- Study underway to look at range of dwell times (5, 10, 20 and 30 minutes)

## Effect of Red Dye

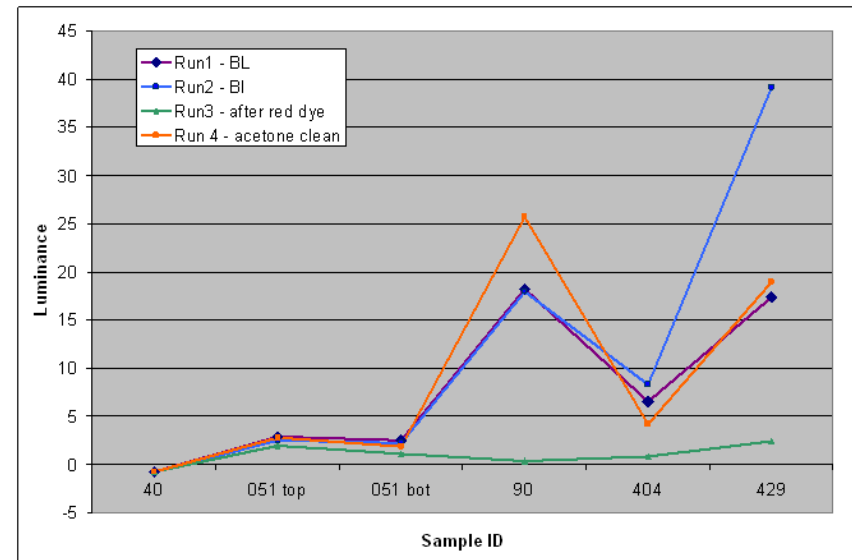


- Establish baseline luminance values for FPI
- Process samples with contrast red dye (5 min penetrant dwell, 10 min developer dwell)
- Solvent wipe clean
- Reprocess with FPI
- Significant reduction in brightness
- Reclean with acetone
- Brightness restored



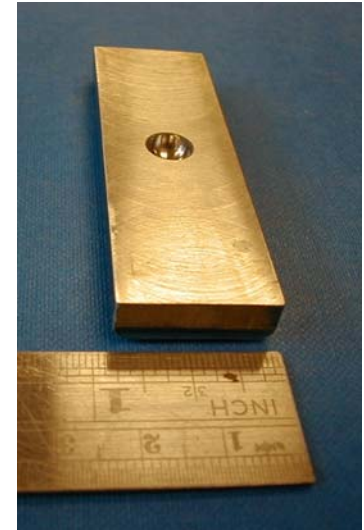


- Red dye does have detrimental effect on subsequent FPI
- Repeat runs needed
- Additional studies to look at cleaning practices planned





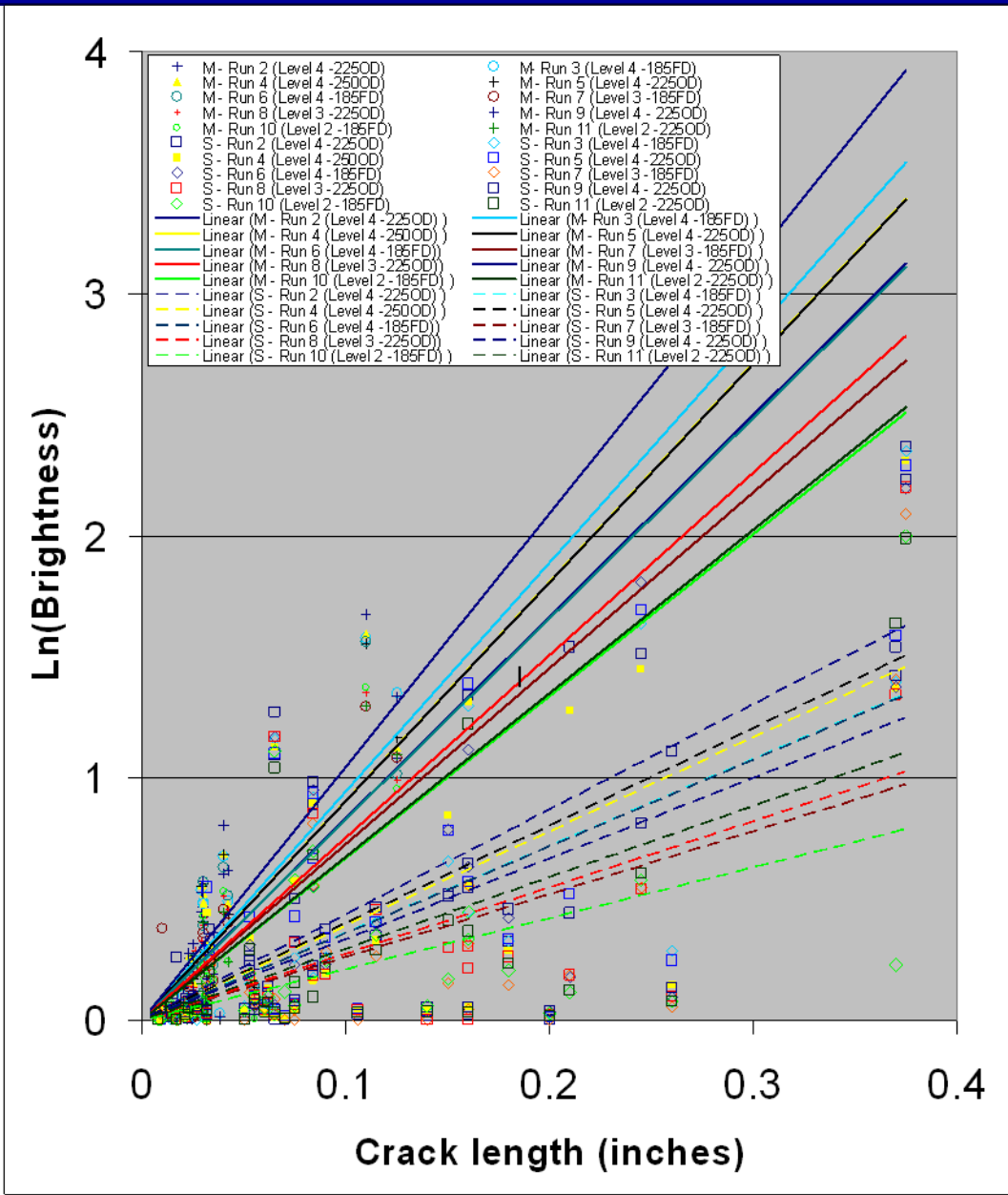
- Samples included shot peened and as machined surfaces
- Penetrants
  - Level 4 ultrahigh postemulsifiable: Magnaflux ZL – 37
  - Level 3 surfactant based water wash: Magnaflux ZL – 67
  - Level 2 oil based water wash: Magnaflux ZL – 60D
- Additional drying parameters
- POD data generated



# Penetrant Level Results

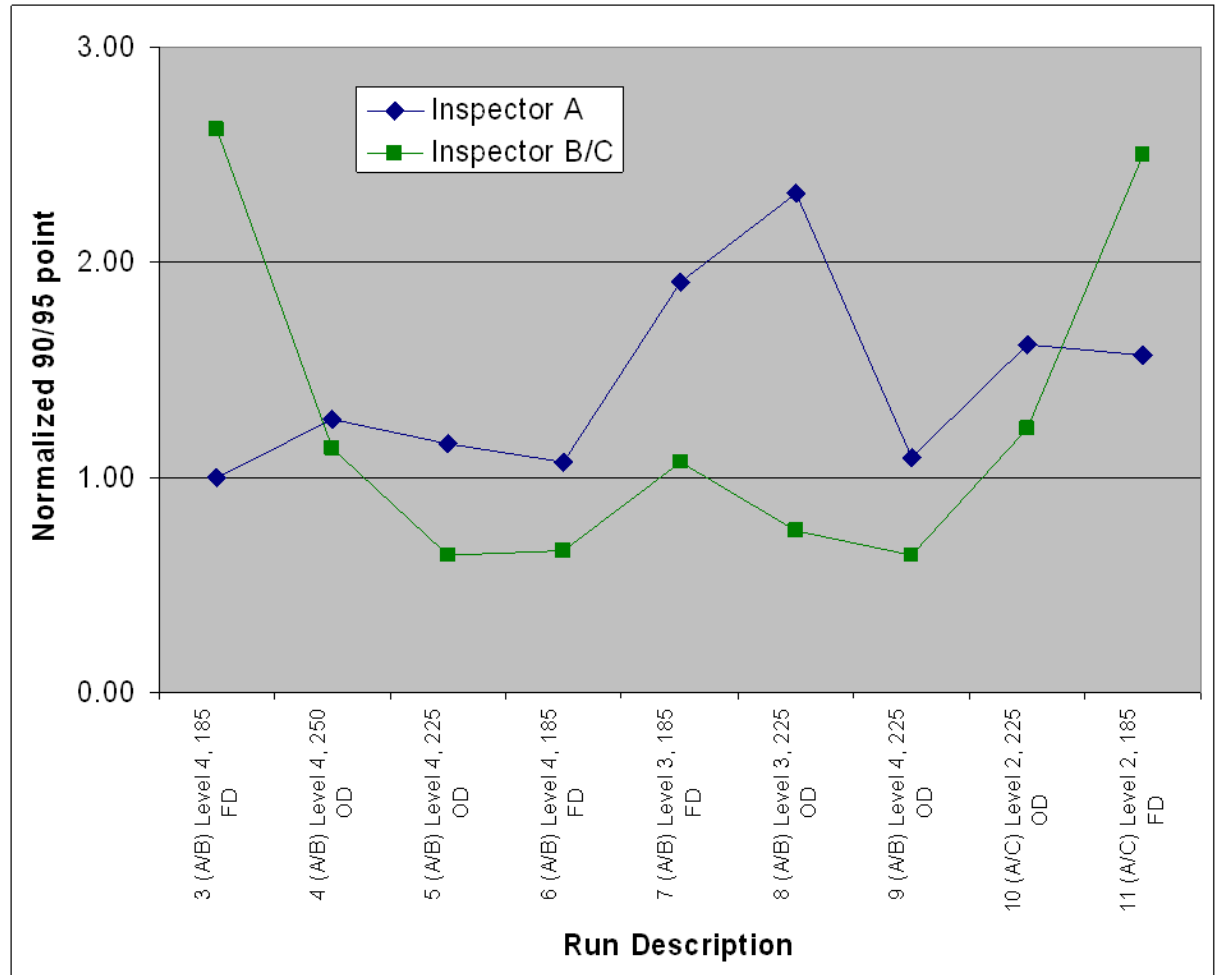


- Results analyzed as function of penetrant method, drying parameter, and surface finish
- Strongest factor was surface finish
- Expected differences found between penetrant levels with Level 4 penetrant have better performance (higher luminance) than Level 3 and 2





- Better POD results for Level 4 than Level 2 and 3





- Increased penetrant dwell time can improve brightness performance, particularly for “tight cracks”
- Use of red dye prior to FPI led to detrimental effect on luminance of subsequent FPI processing
- Differences were found between penetrant method with Level 4 found to be more sensitive than Levels 3 or 2. Differences between levels 2 and 3 were not significant for the rinse times used in this study.