# SINGLE COTTON FIBER QUALITY CHARACTERIZATION BY USING FRAUNHOFER DIFFRACTION

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## OBJECTIVES

- ❑ Conduct a fundamental study on the optical properties of individual cotton fibers with the interaction of a laser beam
- ❑ Relate the optical properties to cotton fiber quality parameters such as fineness, maturity, and micronaire
- ❑ Develop a sensing tool that may be used for cotton fiber quality mapping

## INTRODUCTION

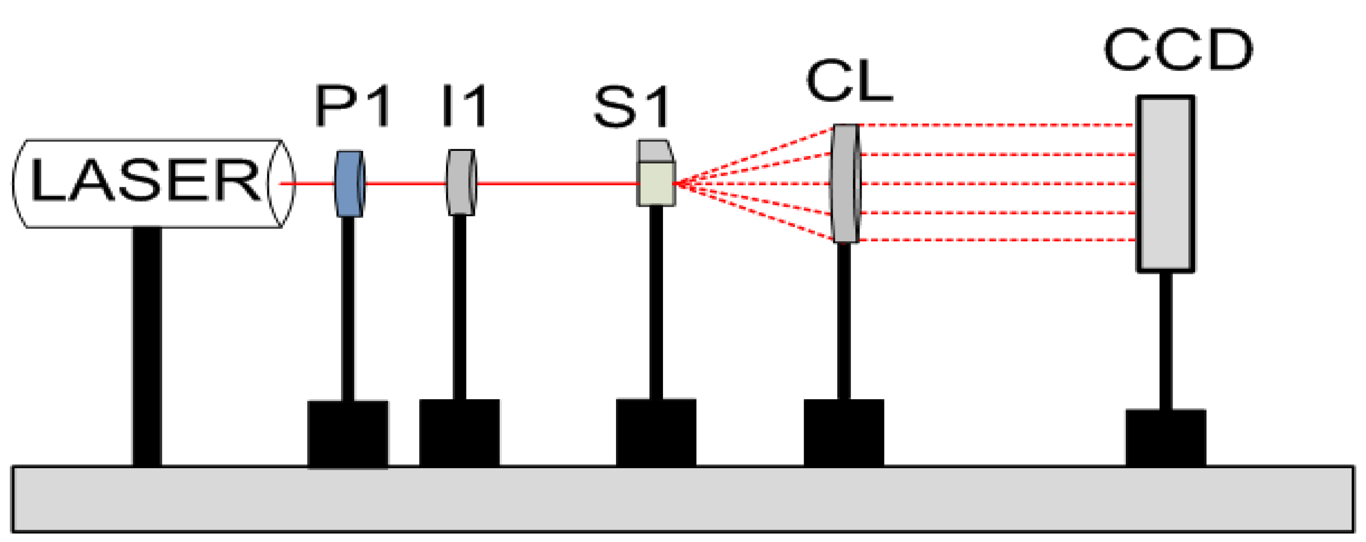
- ❑ Cotton fiber quality varies from seed to seed, boll to boll, plant to plant, and field to field
- ❑ Cotton producers and processors need a universal sensing tool to characterize cotton fiber quality
- ❑ Analysis of single cotton fiber quality not currently possible using HVI systems and AFIS.
- ❑ Characterization of single cotton fiber quality is a more fundamental approach to better characterization of the fiber quality of bulk samples

## MATERIALS & METHOD

- ❑ Eight (8) cotton varieties
- ❑ Cotton samples were obtained from the:
  - USDA classing office
  - UGA microgin laboratory
- ❑ ½" fibers were studied for each experiment
- ❑ Over 50 diffraction patterns obtained for each cotton fiber were obtained
- ❑ Diffraction patterns generated were captured by a linear CCD camera (3648 pixels, each pixel = 8µm)
- ❑ Very fine quartz (SiO2) fibers were used for calibration

$$D=\left[\frac{\lambda f}{X_2-X_1}\right]$$

$\lambda$ = wavelength of the laser light
f = focal length of collecting lens
$X_2$ - $X_1$= distance between fringes




P1 = Polaroid lens, I1 = Iris,
S1 = Cotton fiber holder
CL = Collecting lens, CCD = CCD line camera

**Figure 1. Schematic of experimental setup**

## RESULTS

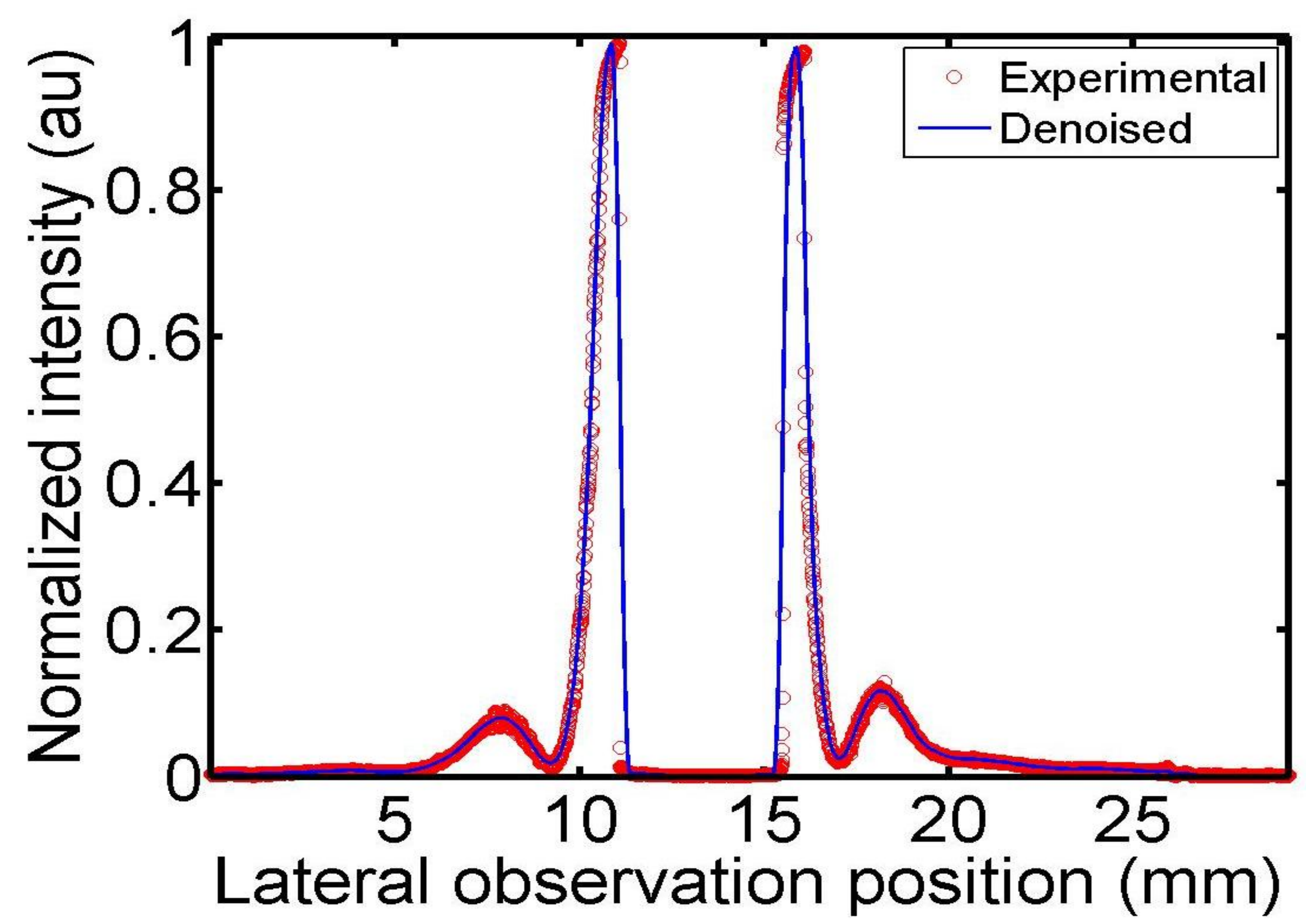



**Figure 2. Diffraction pattern generated from Lint_101**

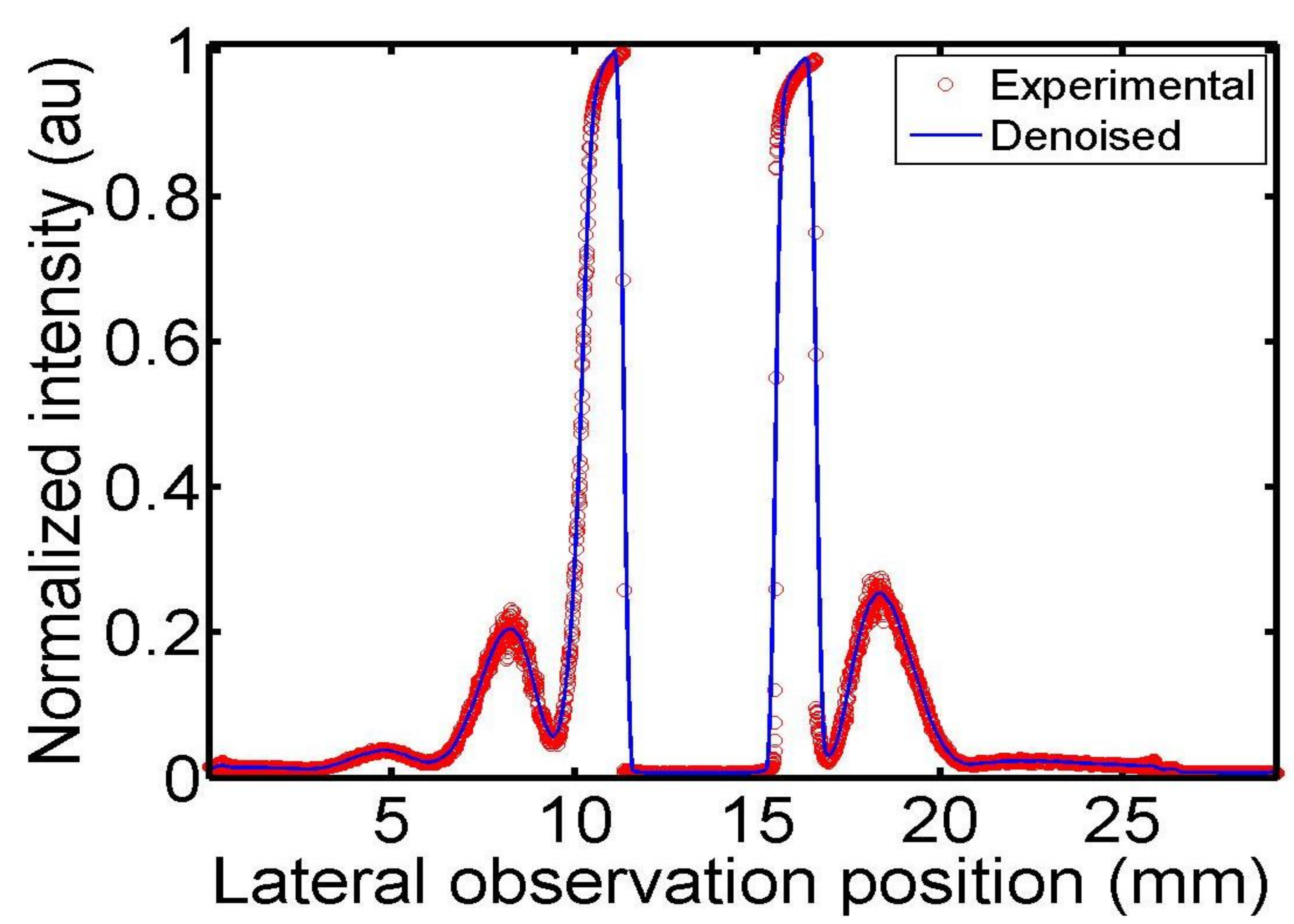



**Figure 3. Diffraction pattern generated from Lint_203**

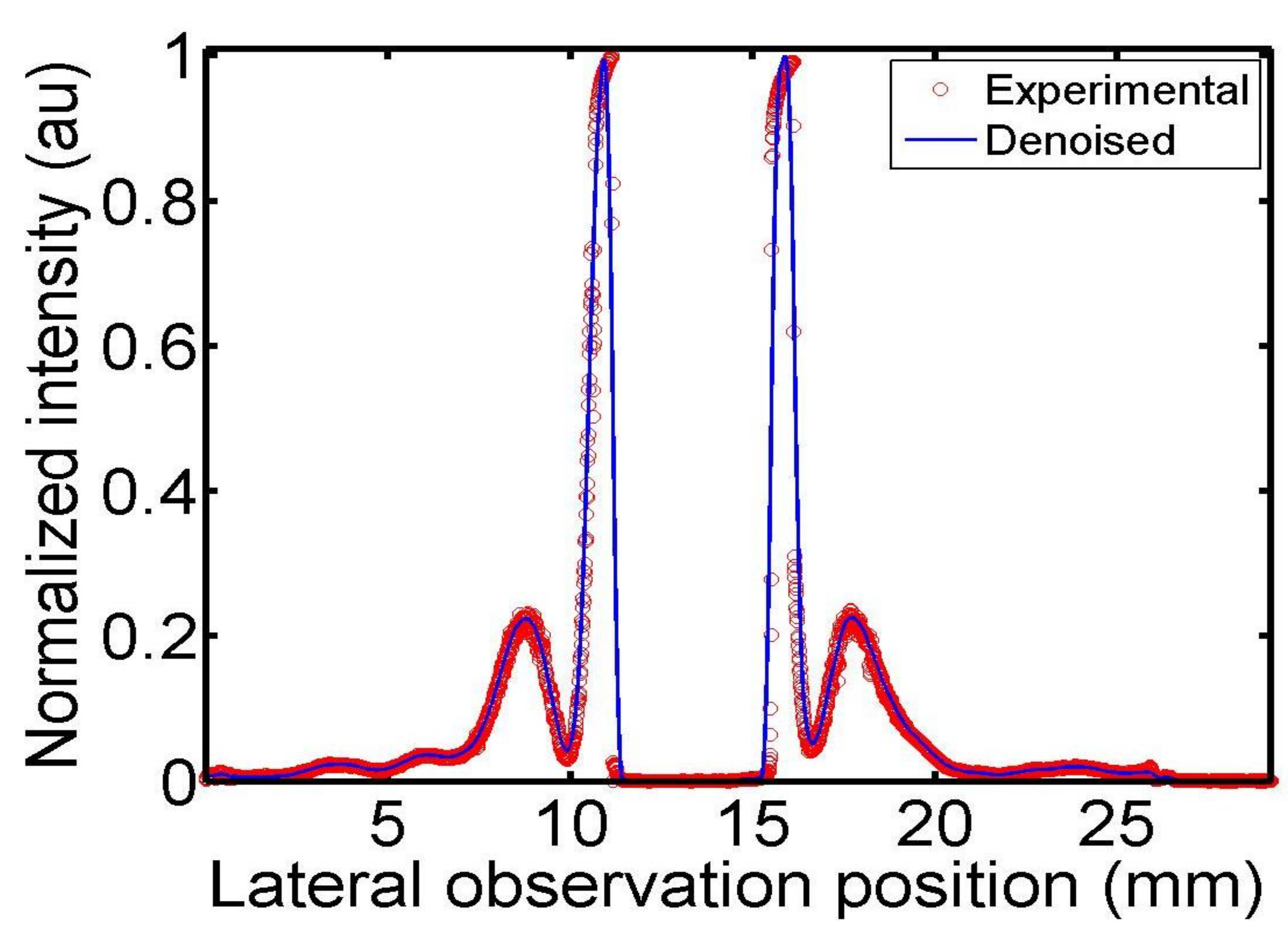



**Figure 4. Diffraction pattern generated from USDA 5.47**

| Cotton Variety | Average Diameter (µm) |
|---|---|
| LINT 101 | 16.51710772 |
| LINT 108 | 15.5213136 |
| LINT 110 | 15.3542335 |
| LINT 203 | 15.60971598 |
| LINT 205 | 17.18199866 |
| LINT 209 | 16.57846479 |
| USDA 2.6 | 15.19580543 |
| USDA 5.47 | 15.07276141 |

**Table 1. Average diameters obtained from diffraction patterns generated by illuminating each fiber with a monochromatic laser light (λ ≈ 633nm).**

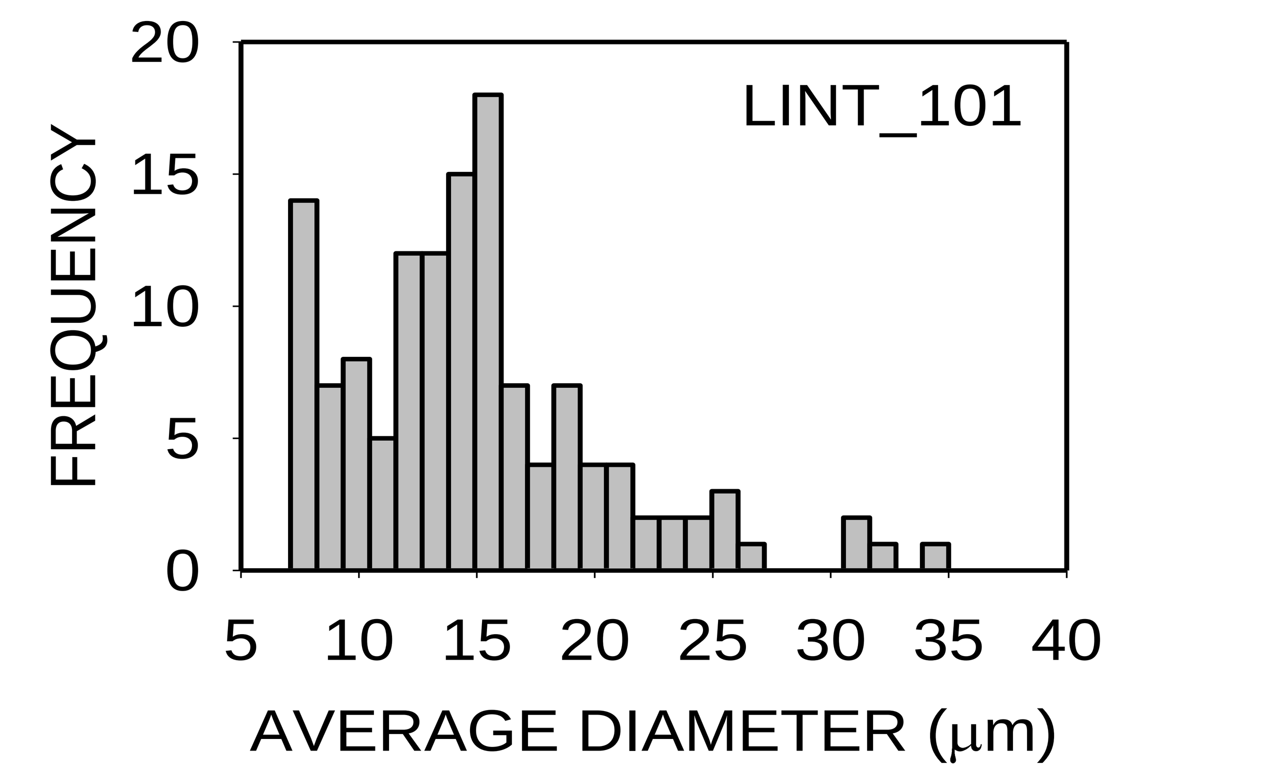



**Figure 5. Variation in cotton fiber diameter for LINT_101**

## CONCLUSION

- ❑ Current setup cam be used to observe and obtain diffraction patterns generated by illuminating single cotton fibers with laser light
- ❑ Relatively simple and inexpensive technique has been developed to measure single cotton fiber diameter (ribbon width)
- ❑ Diffraction patterns generated by illuminating each cotton fiber with a laser beam has been observed

## FUTURE WORK

- ❑ Correlate diameter of single cotton fiber to cotton fiber quality parameters such as fineness and maturity
- ❑ Compare diameter measured by using current laser setup to known fiber cross-sectional diameter
- ❑ Use current setup to develop a sensing tool that may be used for cotton fiber quality maps

## ACKNOWLEDGEMENT

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