Rochester Imaging Detector Laboratory

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R·I·T

Spot-Projector System for the Measurement of Intra-Pixel Response

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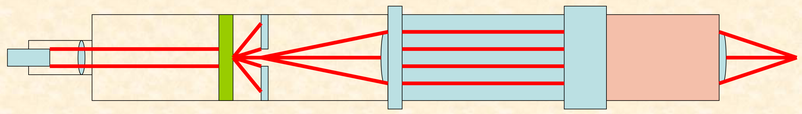
Background

- Pixels in imaging sensors do not have uniform response across the pixel area
- Intra-pixel sensitivity is important for analysis requiring high photometric precision

Goals

- Fabricate a spot-projector capable of producing a spot much smaller than the size of a pixel
- Validate the spot-projector's capability
- Measure the intra-pixel response for a hybrid CMOS detector

Spot-Projector Fabrication



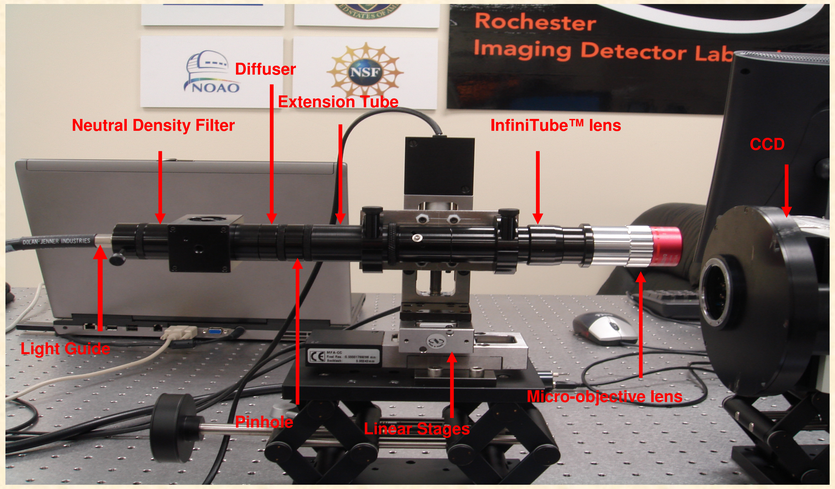


Figure 1: **Top**: Schematic diagram of optical components of the spot-projector with ray tracing (Red). **Bottom**: Setup of spot-projector system.

Spot-Projector Properties

- Able to produce a spot as small as 5.7 µm to as large as 1 mm
- Capability to move spot images in three independent axes
- Able to produce images over a broad wavelength range

Expected Spot Size

- Diffraction limit = 1.22 λ f/D= 1.22 λ f/# = 0.61 λ/N.A. = 2.78 µm
- Demagnification = 10X
- Spot Size = sqrt($(\text{Dia.}_{\text{diffraction limit}})^2$ + $(\text{Demagnification of Image})^2$)
- Calculations use 632 nm wavelength light

Pinhole size	Expected Spot Size (w/o Diffraction)	Expected Spot Size (w/Diffraction)
10 mm	1 mm	1 mm
10 µm	1 µm	5.7 µm

Result

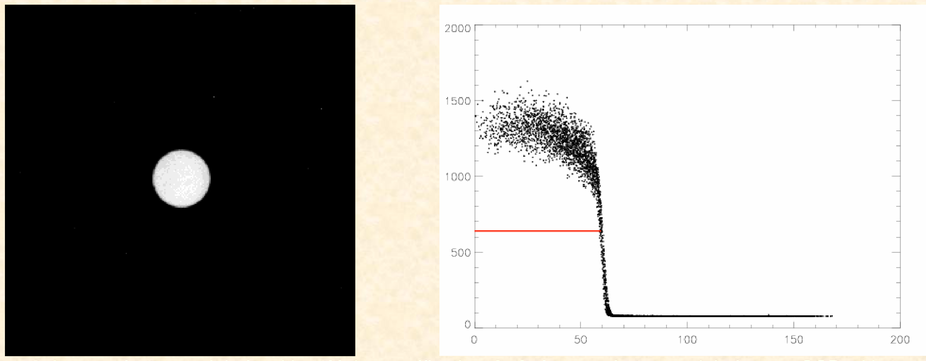


Figure 2. Image of 10 mm pinhole with 10X demagnification. **Left**: Image of 10 mm pinhole on a CCD with 9 µm pixel pitch. **Right**: Plot of intensity vs. radial distance from the center of the spot. Red line is at the FWHM (59.5 pixel radius).

Spot Size Calculation

- FWHM diameter = 119 pixels
- Pixel pitch = 9 µm/pixel
- Pinhole image size = 119 pixels x 9 µm/pixel = 1.07 mm
- Expected image size = 1.0 mm

Summary

- Demonstrated that our spot-projector is successfully working (Fig. 2)
- Measured demagnification is within 10% of the calculated value

Future Work

- Measure the point spread function of the spot-projector using the knife-edge technique and a 10 µm pinhole
- Measure the intra-pixel response of a hybrid CMOS image sensor

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