Collection path scanning to study exciton transport in GaAs stacking faults

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What is a stacking fault?

- **Perfect crystal** layers in [111] direction are ordered ABC ABC...
- **Stacking fault** = interruption in the stacking sequence
  - Intrinsic: ABC AB_ ABC Extrinsic: ABC B ABC

![Illustration of Perfect Crystal, Intrinsic Fault, and Extrinsic Fault](image-url)
Background: Stacking Faults

- SF pyramid grows from defect in the substrate, 2D stacking fault planes propagate in [111] direction, terminate in oval defects at GaAs surface
- Extremely narrow excitonic emission linewidths, exciton transport on 10 μm scale...
Background: Confocal Imaging System

- **Spatially and spectrally resolved** scans of photoluminescence (PL) from samples in the cryostat
- Excitation and collection at the **same location**
- **Excitation spot** scanned across sample
- Used to study photoluminescence emission of excitons bound to stacking faults in GaAs
Collection Path Scanning

• Excitation beam stationary, collection point scanned across sample
• Study transport of excitons around stacking faults

• Observations OVERVIEW:
  – 2D exciton transport on 10 μm scale
  – 2D excitons trapped at 1D edges
  – 2D exciton transport to another plane
Collection Scanning Optical Design

- Confocal scanning system designed so excitation beam is stationary on final aspheric lens
- **Potential issue:** collection scanning design has different $d_1$ for excitation and collection paths
Conclusion: Possible Darkening in scan corners
Collection Scan Uniformity

• **Problem:** $d_1$ now different for excitation and collection paths
  – $\sim 55$ mm for excitation $\rightarrow \sim 165$ mm for collection
• How does difference in $d_1$ affect scan uniformity?
  – Analyze video from CCD camera of collection scanning PL spot
Collection Scan Uniformity

Collection Scanning Uniformity Test 1:
Integrated spots with radius = 70 pixels

~ 5.7% variation

Collection Scanning Uniformity Test 2:
Integrated spots with radius = 70 pixels

~ 5.8% variation