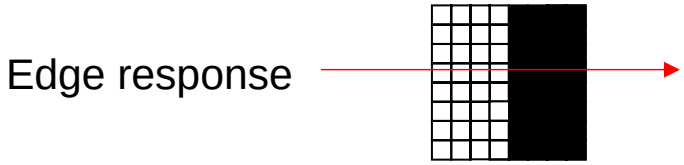
Opti 415/515

SFR – spatial frequency response (short)

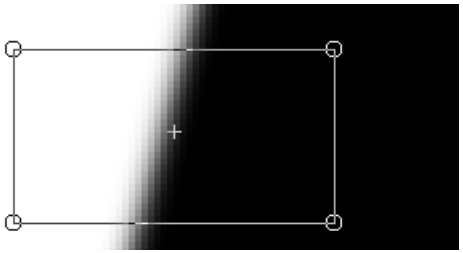
SFR

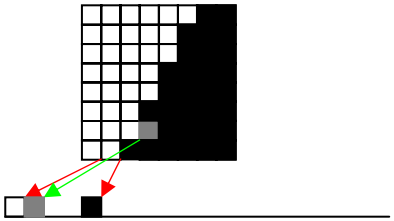
- Spatial Frequency Response – it is a means of obtaining MTF measurements by a different name with a different standard (ISO 12233)
- PSF – point spread function – can calculate MTF in all directions
- LSF – line spread function – can calculate MTF in 1 direction
  - Derivative of an edge (step) is a point (delta function)
- Want to test a lens and detector combination – can calculate edge response easily, but Nyquist limit of measurement is 1 cycle per 2 pixels (0.5 cycles/pixel)



SFR (2)

- SFR uses a slanted edge to obtain multiple, phase shifted samples across edge – synthesize a supersampled edge to beat Nyquist limit
  - Can't go too far – samples are not points, but averages over pixel size
  - 4x oversampling generally works well
  - Must have at least one sample per bin
  - Multiple samples are averaged
  - Edge must not be vertical, horizontal or at 45 degrees
- Full algorithm must find edge in each row, uses set of edge location to calculate slope of edge, uses slope to bin the samples
- Algorithm does not requires precision control of target orientation to work

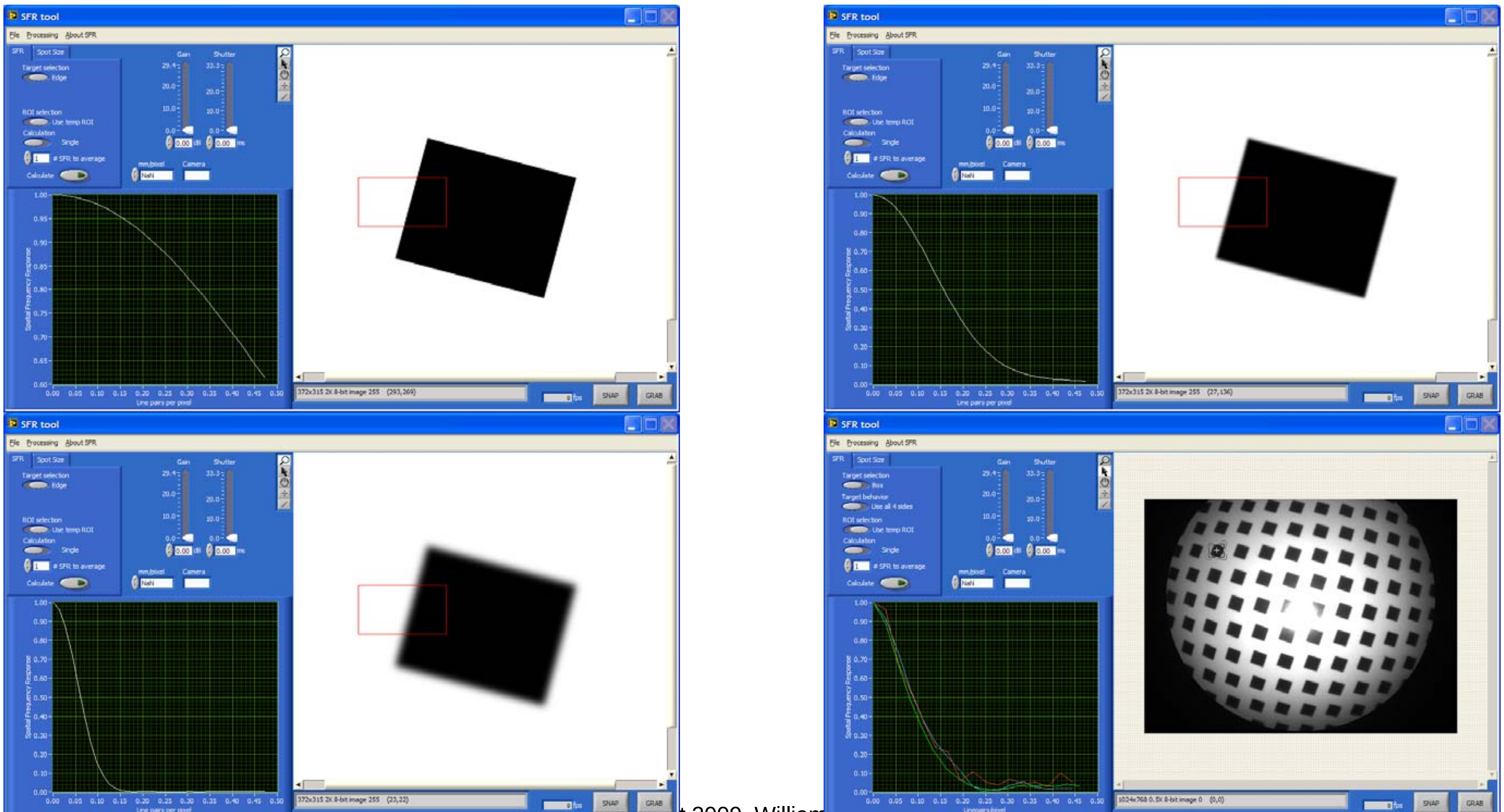




Supersampled edge (bins)

Example SFR calculations

- Simulated images (3)
- Real target – allows for distortion, boresight, and clocking too



SFR Summary

- Calculation of MTF requires one to account for pixel size
- Can produce an inline test system for say cell phone cameras
- Can build a tool to guide a technician in real-time to align an optical system
- Assumes MTF is constant over sample area

- ISO 12233:2000 – Electronics still-picture cameras – Resolution measurements
- Targets from Applied Image Group, Edmund Optics, or custom for special purposes
- Software – Imatest, SFR2 (matlab code), others