Validation of Sensor Effects in Phosim

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Goals

- All sensor effects are implemented at the device physics level (like drift/diffusion in E fields) – quite complex, needs verification

- Validation: sanity checks & comparison to data
  - Tree rings, edge effects (Nomerotski, Beamer et al)
  - Brighter-Fatter effect (Walter, Rasmussen et al)
  - Long list of other sensor effects: fringes, brick-wall pattern, midline, blooming, diffusion etc

- Want to do the first pass, agree on defaults, hand to the project for MC production

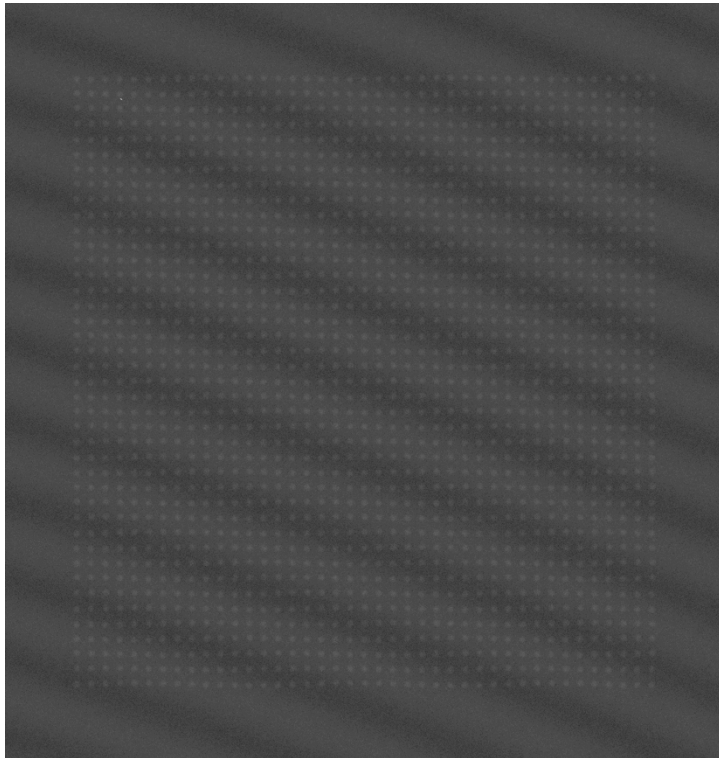- Discussed in Phosim bi-weekly meetings (Peterson et al)

Tree Rings in DES

Transverse electric fields' effects in the Dark Energy Camera CCDs

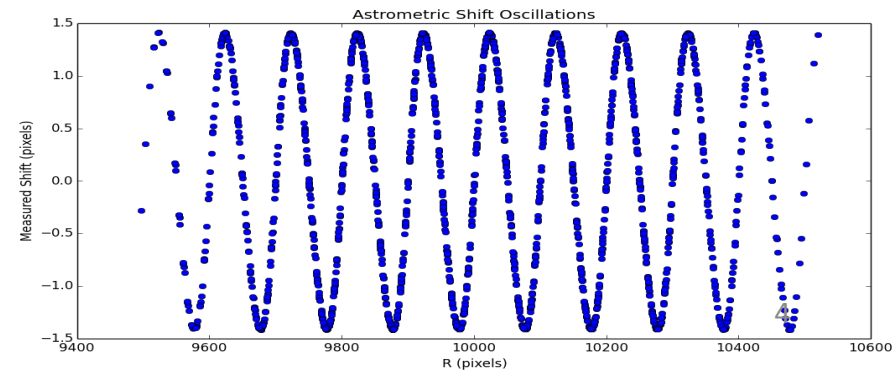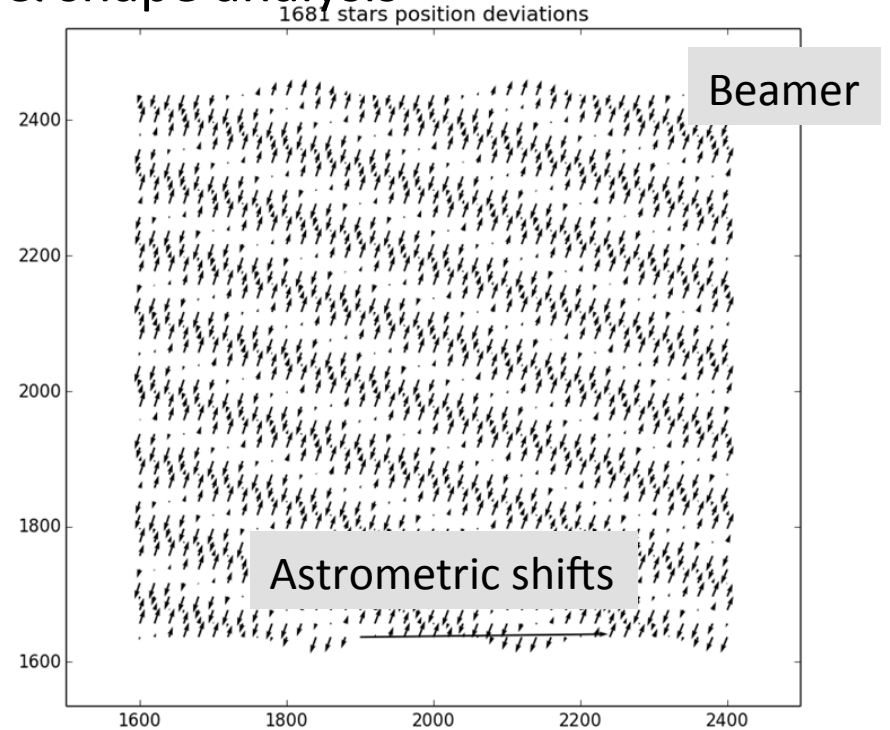A. A. Plazas[a†], G. M. Bernstein[b], & E. S. Sheldon[a]
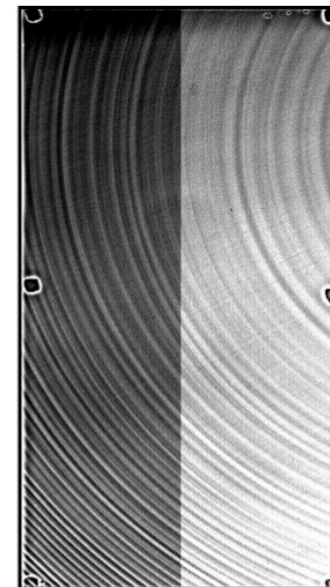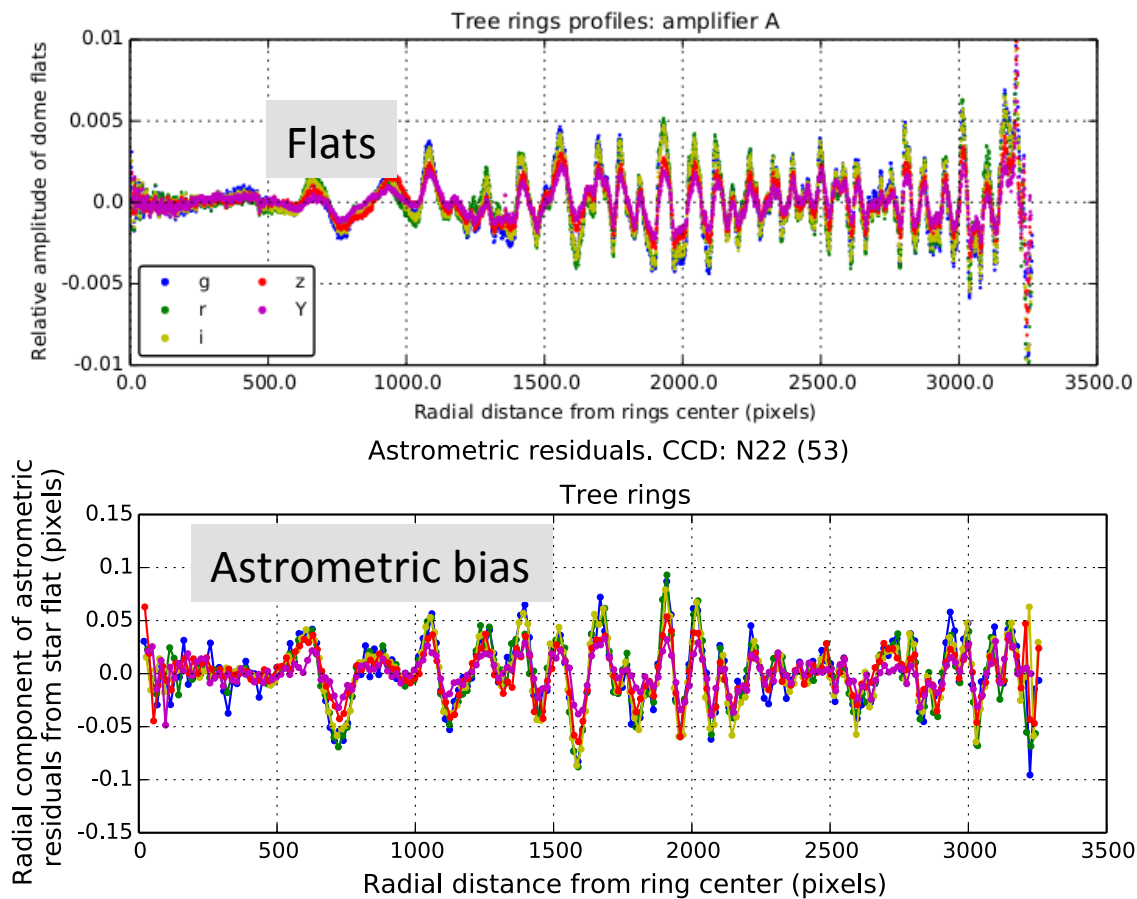
Tree Rings in Phosim

- Used grid of stars
- Ideal optics
- Sextractor/DMstack for centroiding & shape analysis

Overlaid tree rings and stars

1681 stars position deviations

Beamer

Astrometric shifts

Astrometric Shift Oscillations

# Astrometric shifts vs tree ring amplitude and color

- DES data corresponds to a few % doping variation (Phosim default is 1%)
- Latest LSST prototypes "do not have" TRs but absence in final sensors is not guaranteed

420 nm
600 nm
700 nm
800 nm
950 nm
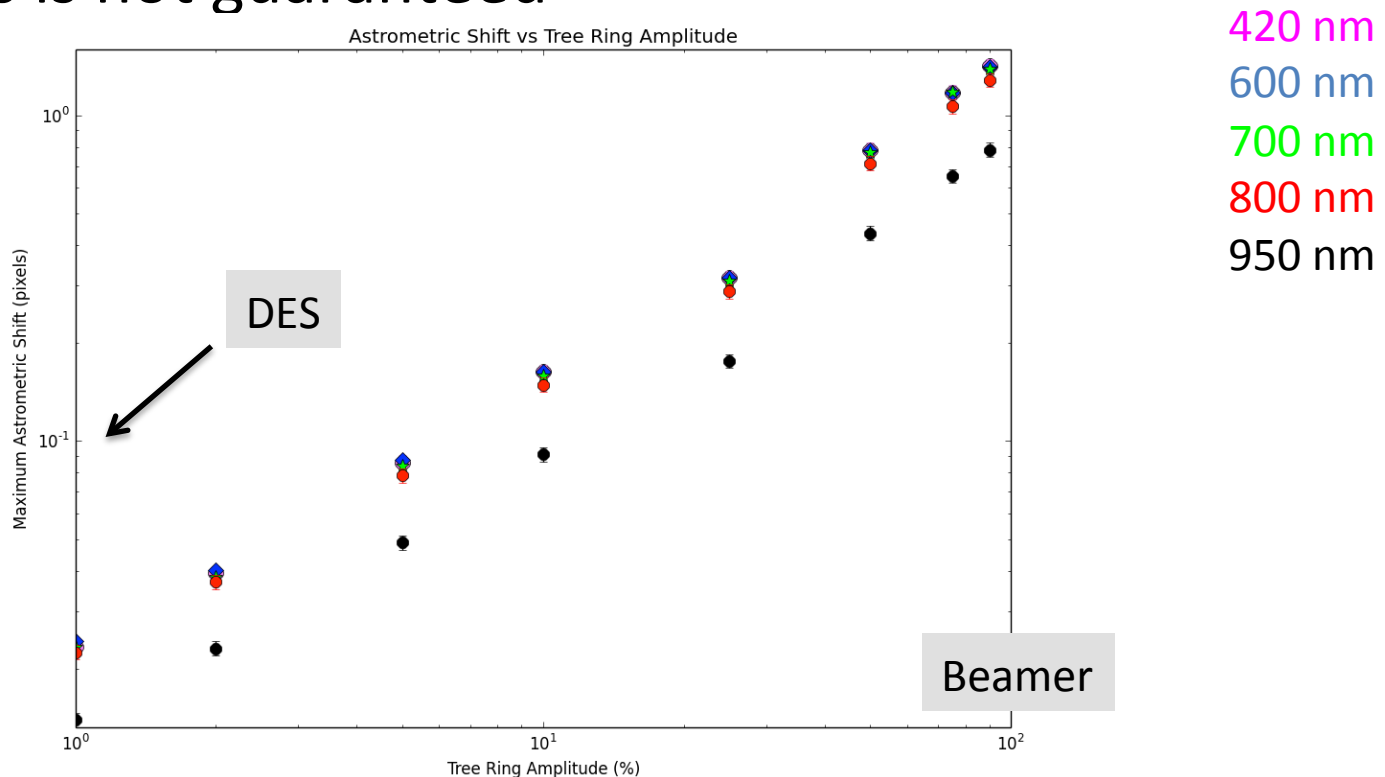
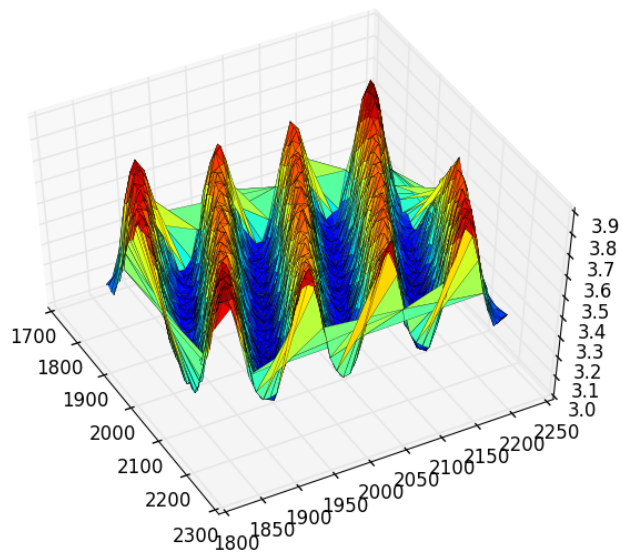IR is shifted less as expected

PSF and Tree rings

- Focussing /defocussing effects of lateral fields lead to PSF oscillations
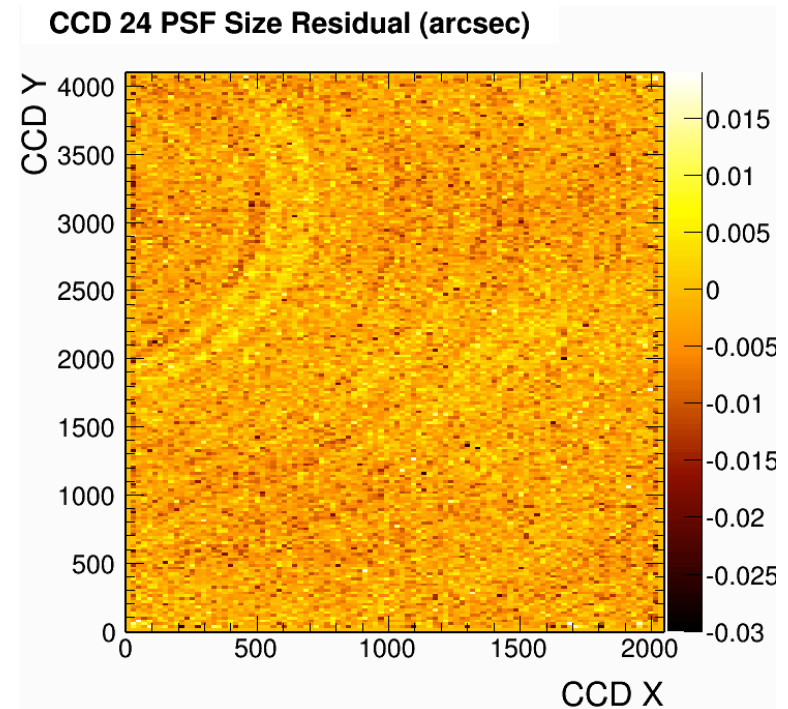 - PSF orientation flips back and forth
  - PSF size oscillates

Neff and lateral E field

Arrows show lateral E

1681 420nm stars ellipticities
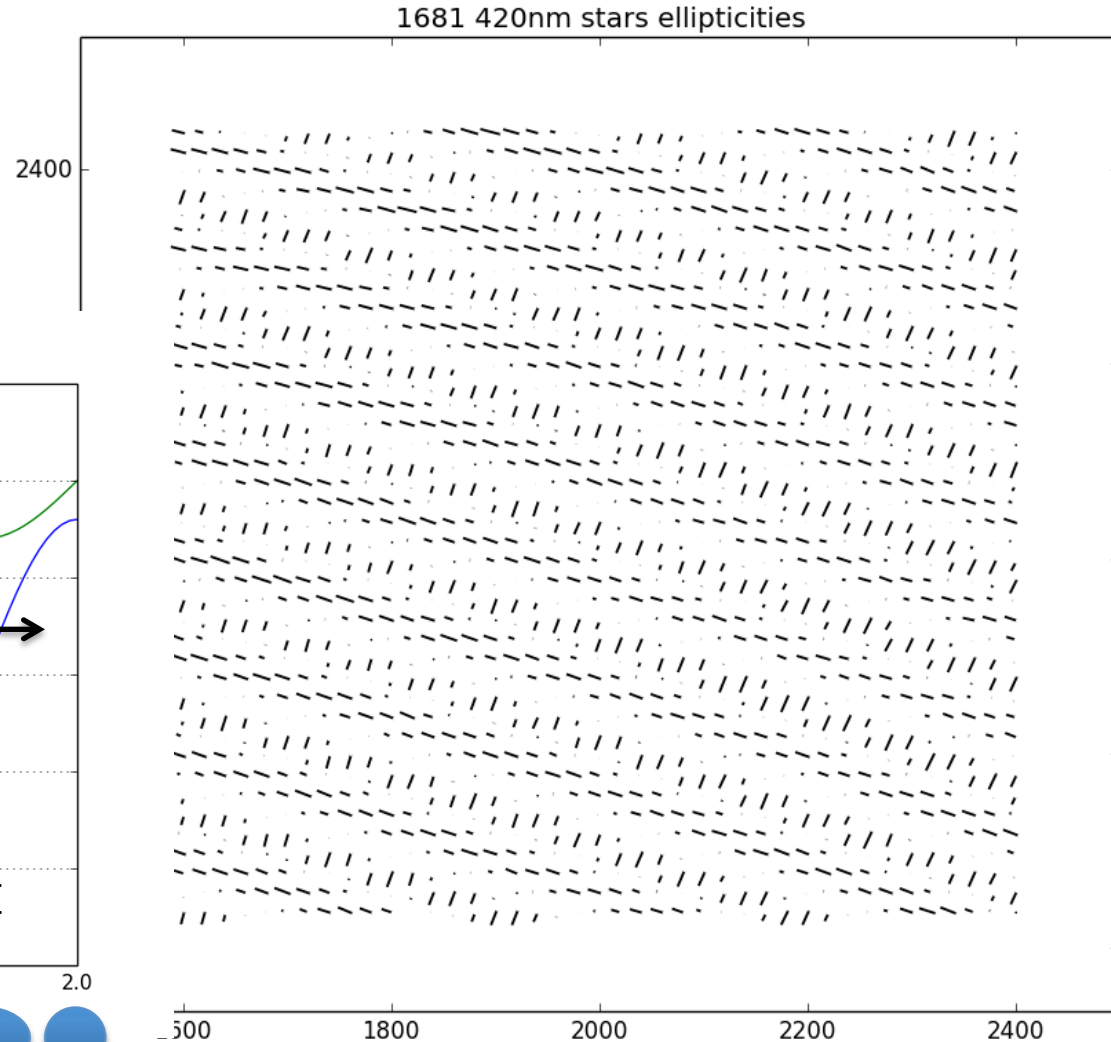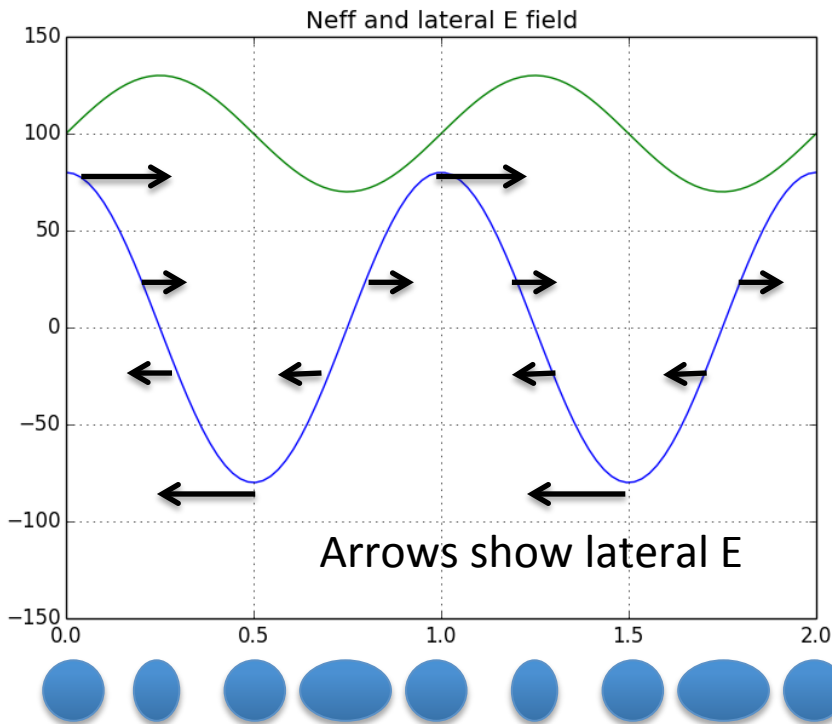
PSF size oscillations in Phosim (and DES)

Phosim

DES data, B.Armstrong

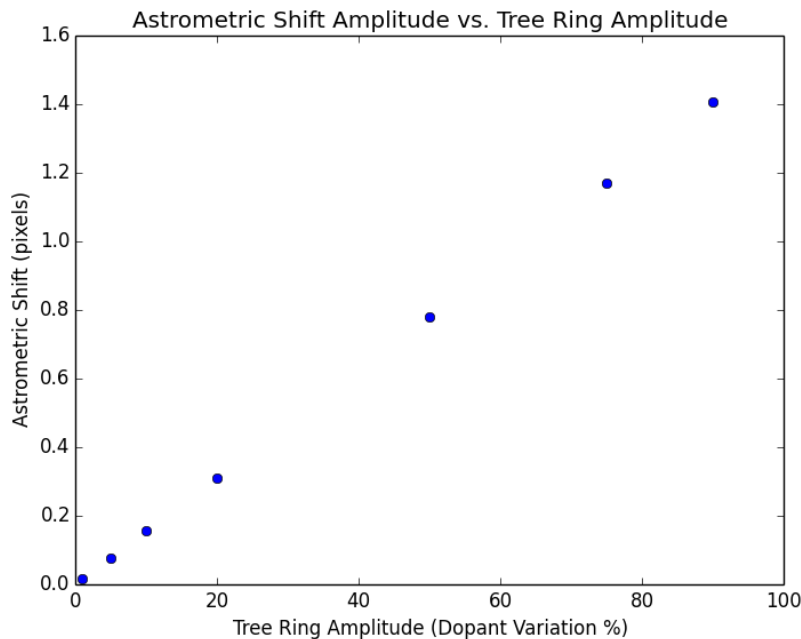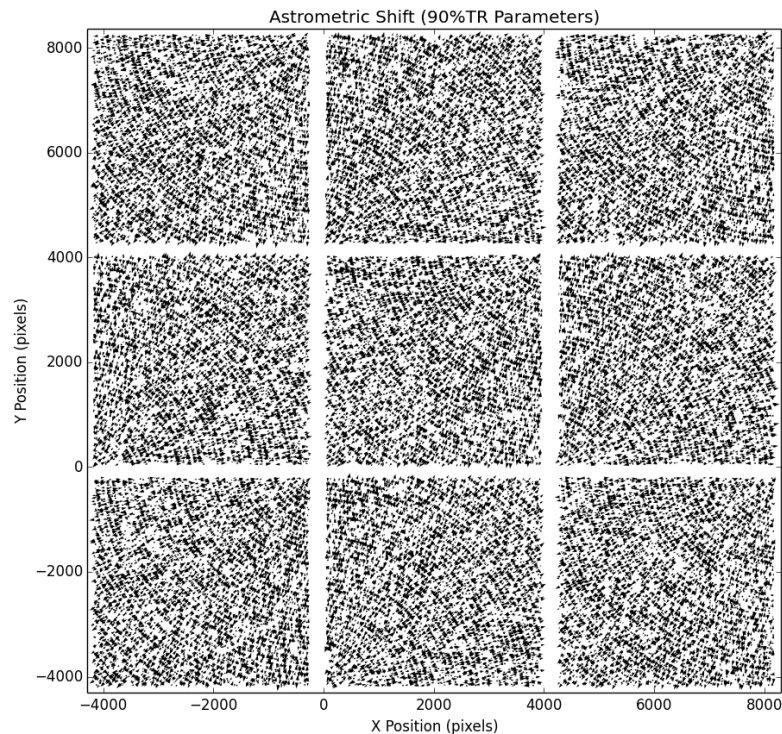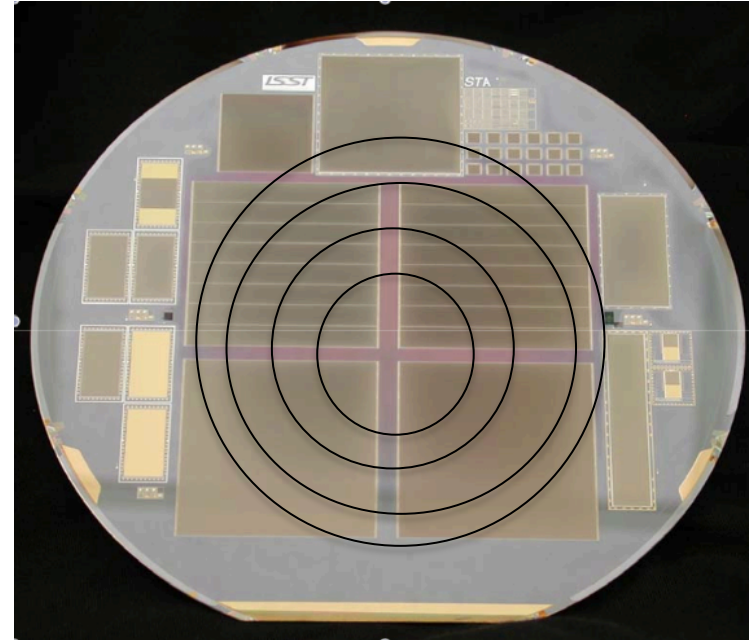

Ellipse area, pix^2

Remaining issues for Tree Rings

- Tree Ring Period Dependence
  - Required modification of field modeling
- Too uniform and periodic now compared to DES
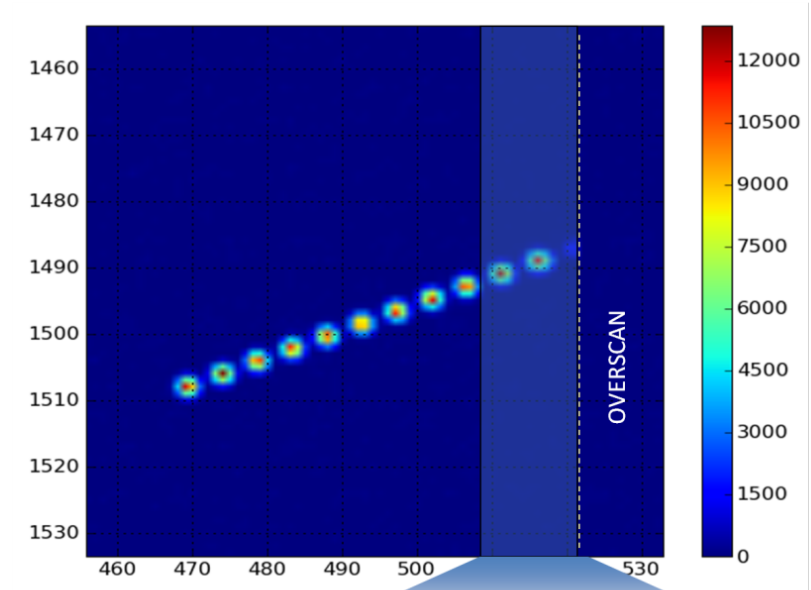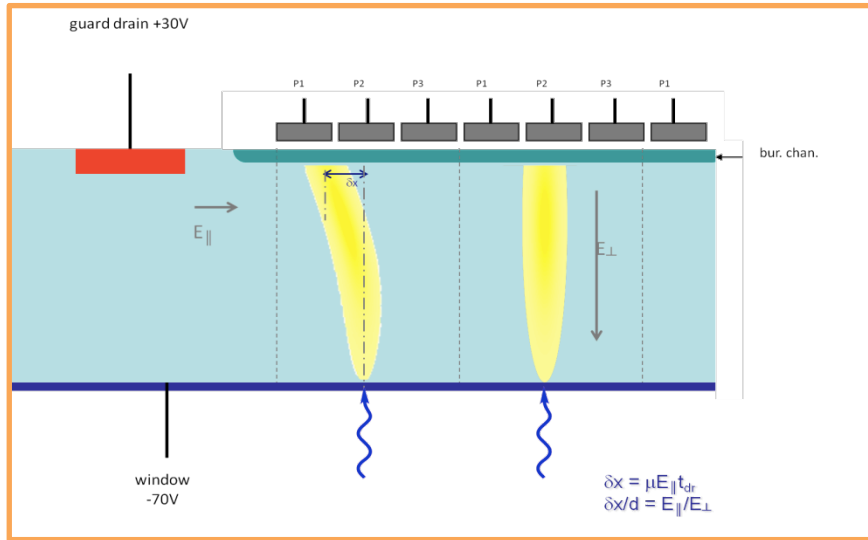- Tree ring origin, next slide
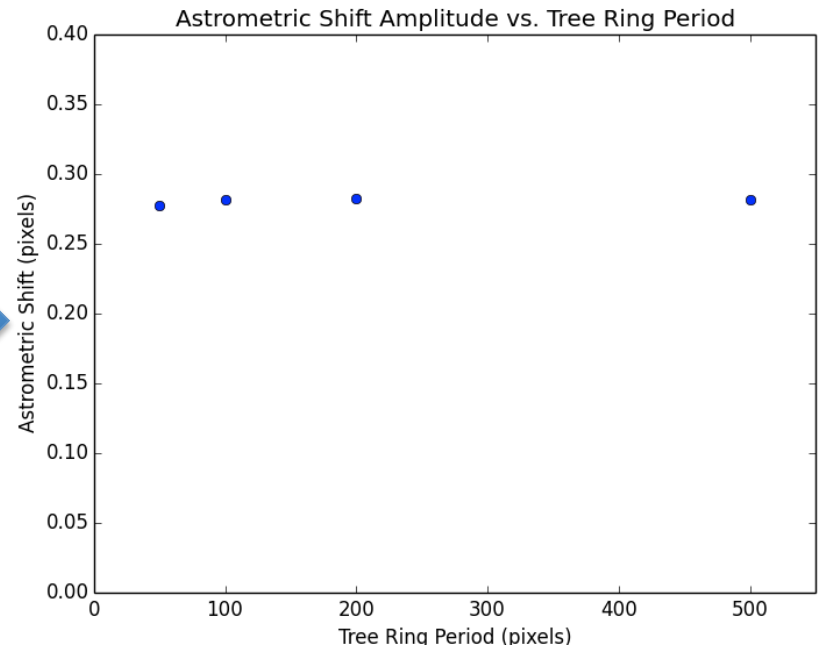
Tree ring origin

- Tree ring geometry is fixed, what's random is orientation of tree rings in the raft since sensors come from different location on the wafer

- Simulating this with Phosim – in progress
  - Until recently TR origin was randomized
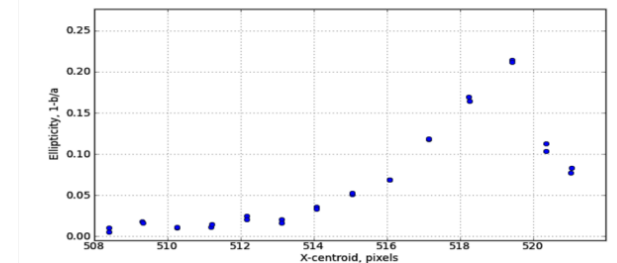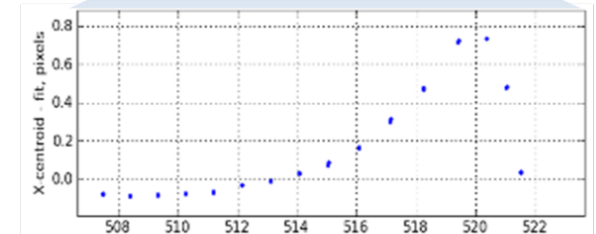 - Now can control it for each sensor

Validation of Edge Roll-off

guard drain +30V

P1 P2 P3 P1 P2 P3 P1

bur. chan.

$E_\parallel$

$E_\perp$

window
-70V

$\delta x = \mu E_\parallel t_{dr}$
$\delta x/d = E_\parallel/E_\perp$

OVERSCAN

P.O'Connor

- On the egde:

  – Position shifts up to 50%
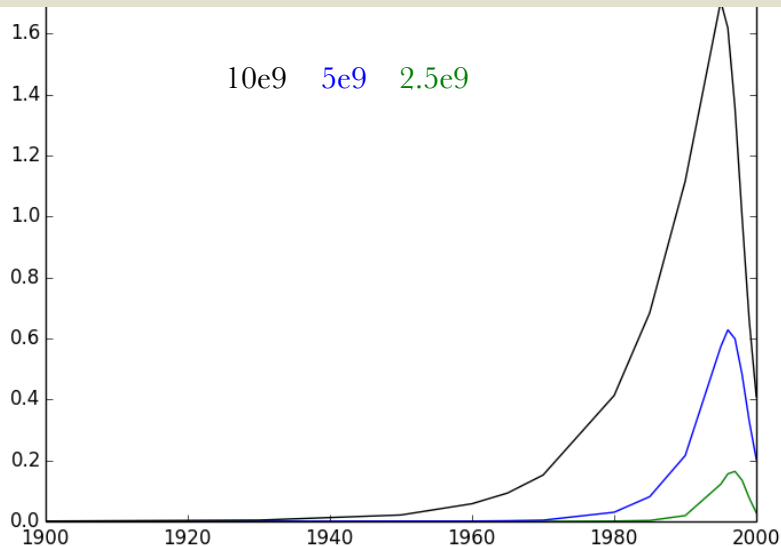
  – Ellipticity up to 20%
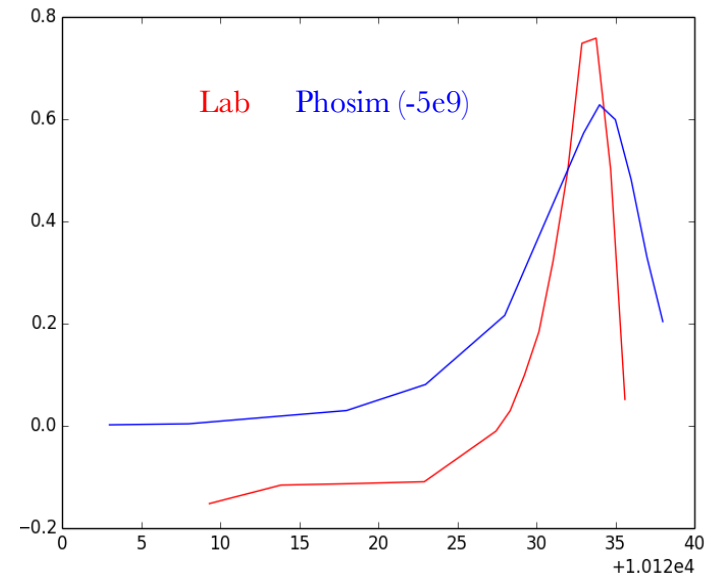
Edge Effect in Phosim

- Controlled by surface charge on the sensor edge
- Study using star grids as for TRs
- Same analysis chain as for lab data
- Tuned amplitude but see different roll-off: we are investigating this
  - Should compare same size spots
  - May need to tune the surface charge configuration
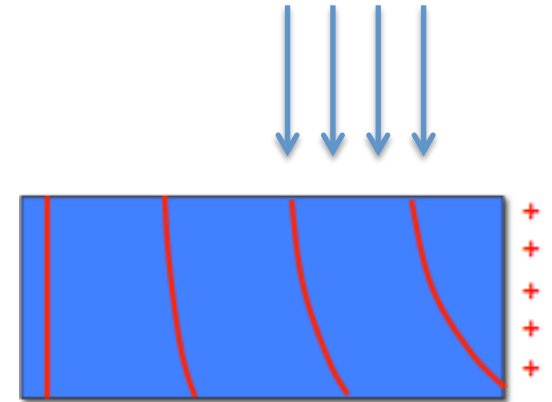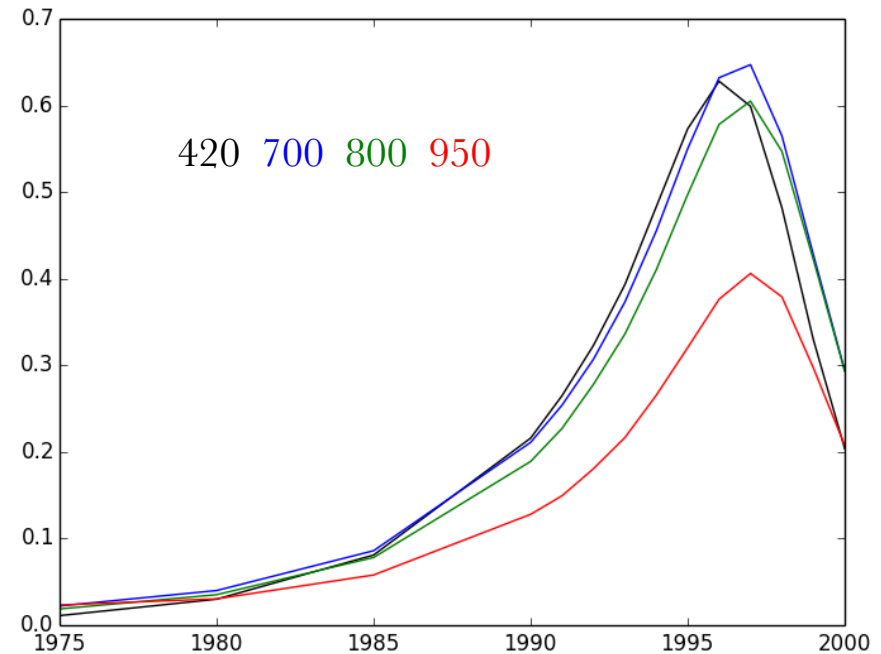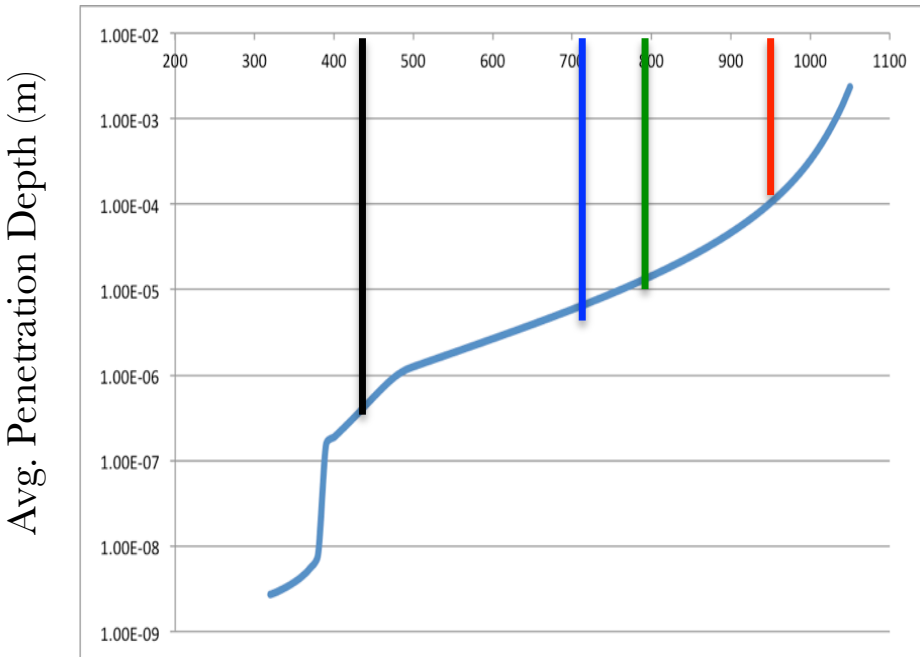
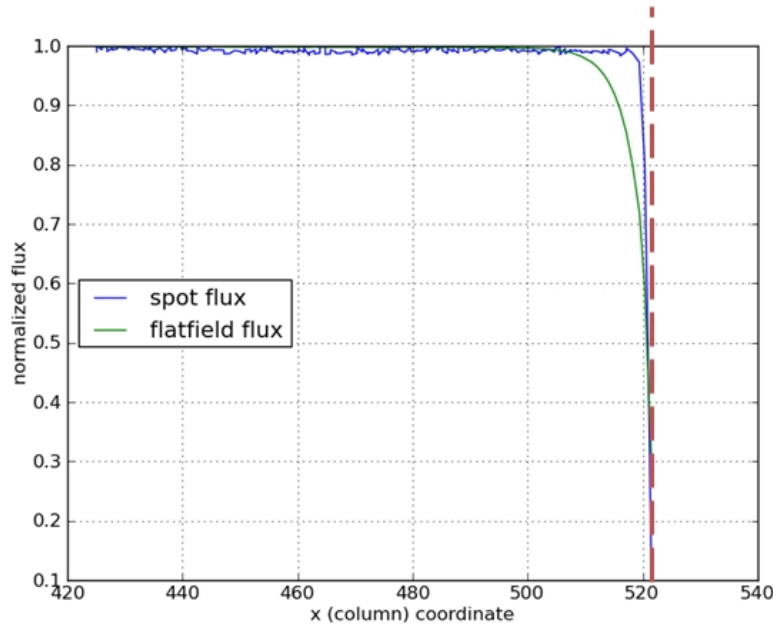Astrometric shift [pix] vs distance to edge [pix]

Duncan

Color Dependence

- Noticeable effect for IR
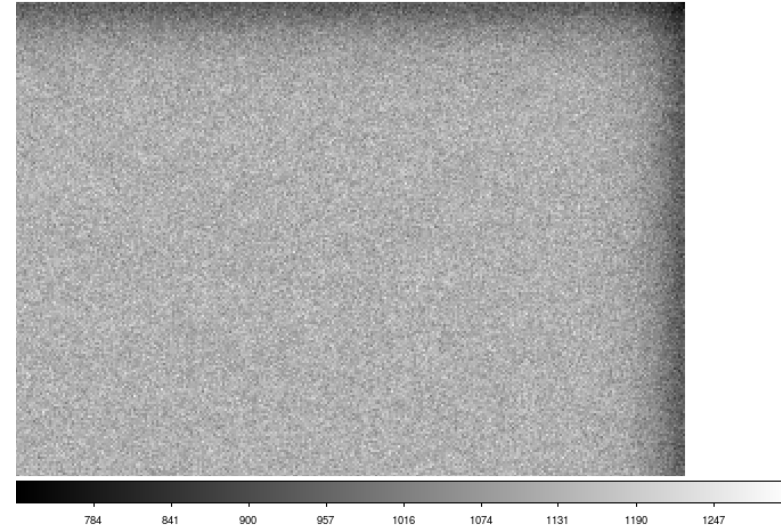- There are no lab measurements for different wavelengths – in progress

Remaining Issues for Edge Effect

Spot flux does not trace flatfield flux

Lab data; O'Connor

Flat-field

Phosim flat; Beamer

Spots and flat field behave differently in data, need to compare in simulations

– due to space charge effects? – similar to BF effect

Summary

Validation:

– So far : tree rings and edge effect are mostly ok but need to be tuned

– Brighter-fatter effect requires more work

– Other effects are waiting

- Should be able to finish the first pass by Jan 2015

– How do we converge? Requirements? Timeline?