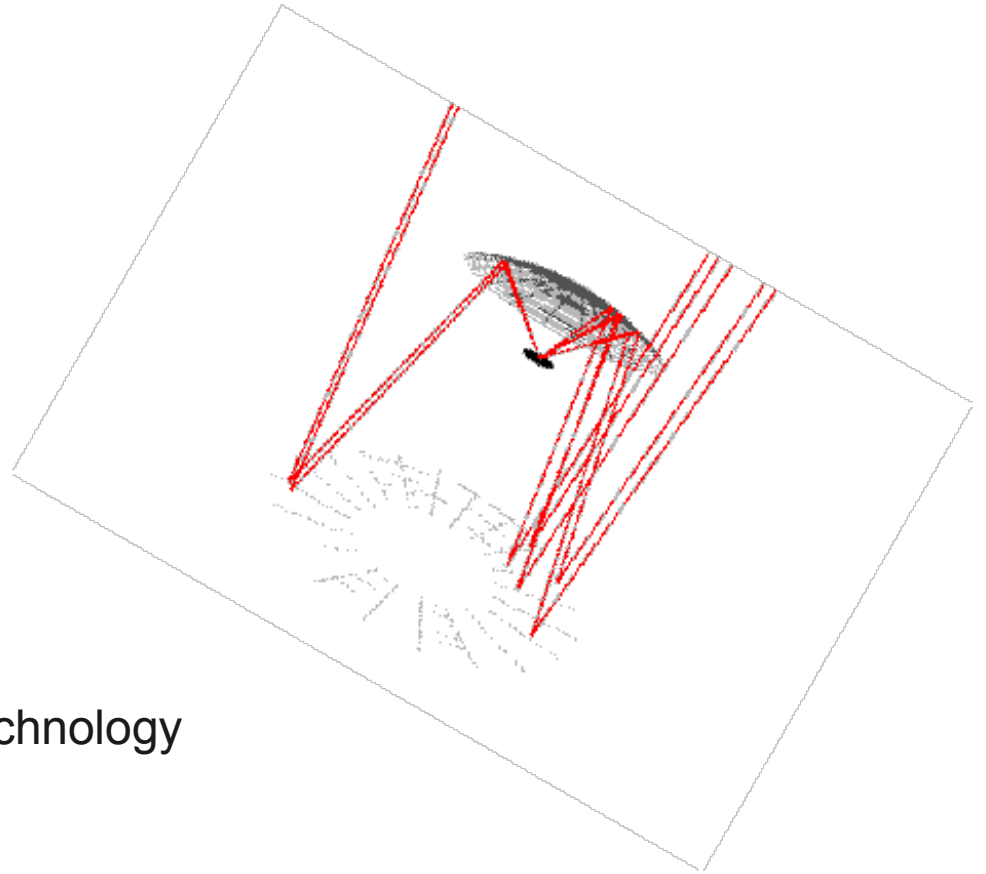


# GrOptics and CARE



Nepomuk Otte, Georgia Institute of Technology  
Charlie Duke, Grinnell College  
Akira Okumura, Nagoya University  
Heike Prokoph, DESY

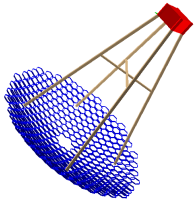
# GrOptics [1]

## Ray-Tracing Code for ACT-Telescope Arrays

Charlie Duke  
Grinnell College

Akira Okumura  
Nagoya University

- **Pure-Virtual Telescope Base Class with:**



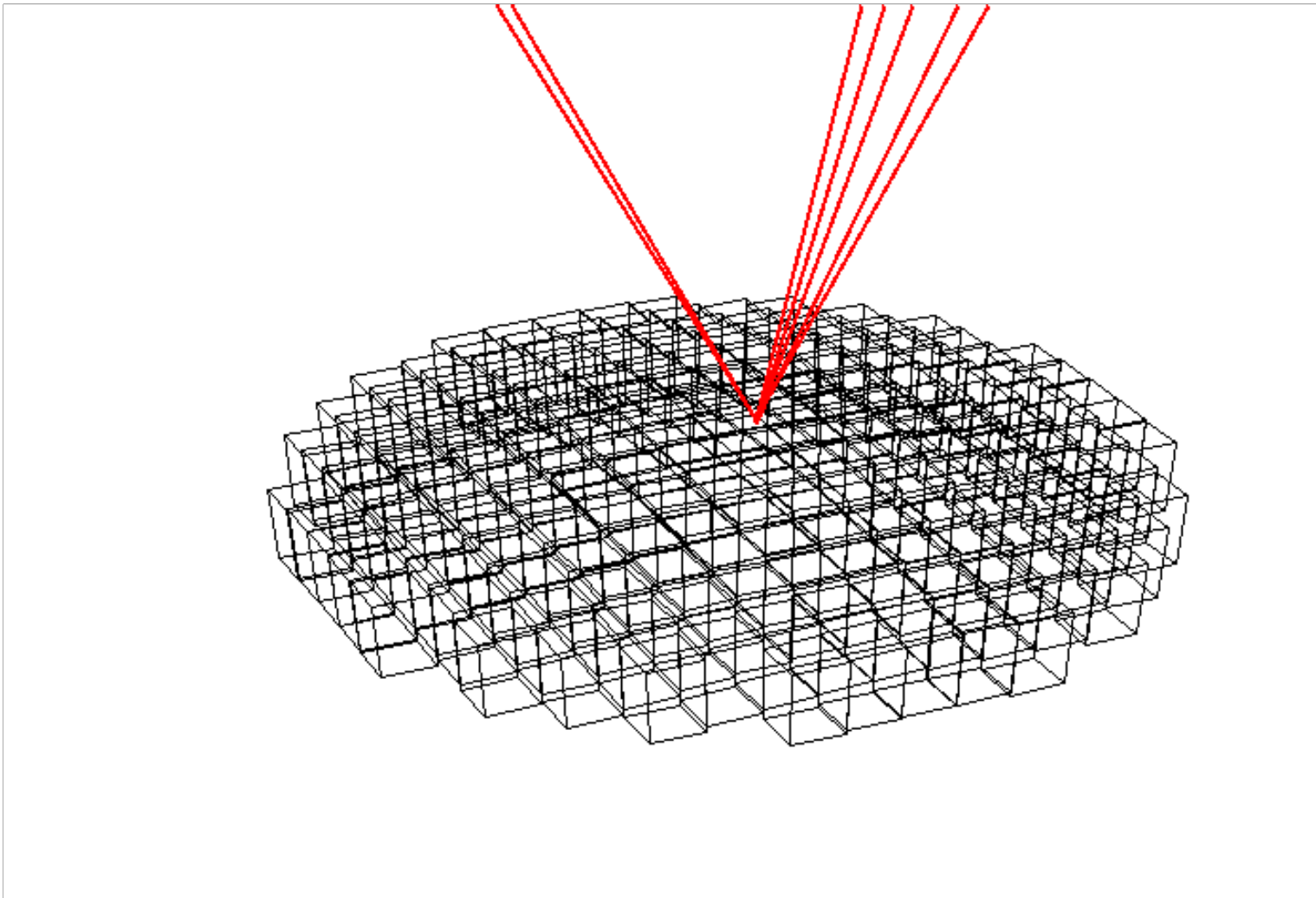
- **VERITAS Davies-Cotton Telescope**
  - **grisudet-based ray tracing**
  - **ROOT geometry libraries for photon shadowing**
- **Schwarzschild-Couder Telescope**
  - **Based on ROBAST [2] ray-tracing package:**  
**AGeoSphericDisk shape class plus**  
**ROOT geometry libraries**

**No intrinsic limit on number or type of telescopes**  
**ROOT output trees interface with CARE**

[1] [svn.slac.stanford.edu/nfs/slac/g/agis/repo/subversion/trunk/simulation/edu/GrOptics](https://svn.slac.stanford.edu/nfs/slac/g/agis/repo/subversion/trunk/simulation/edu/GrOptics)  
or contact Charlie Duke at [duke@grinnell.edu](mailto:duke@grinnell.edu)

[2] [arxiv.org/abs/1110.4448](https://arxiv.org/abs/1110.4448) and [sourceforge.net/projects/robast](https://sourceforge.net/projects/robast)

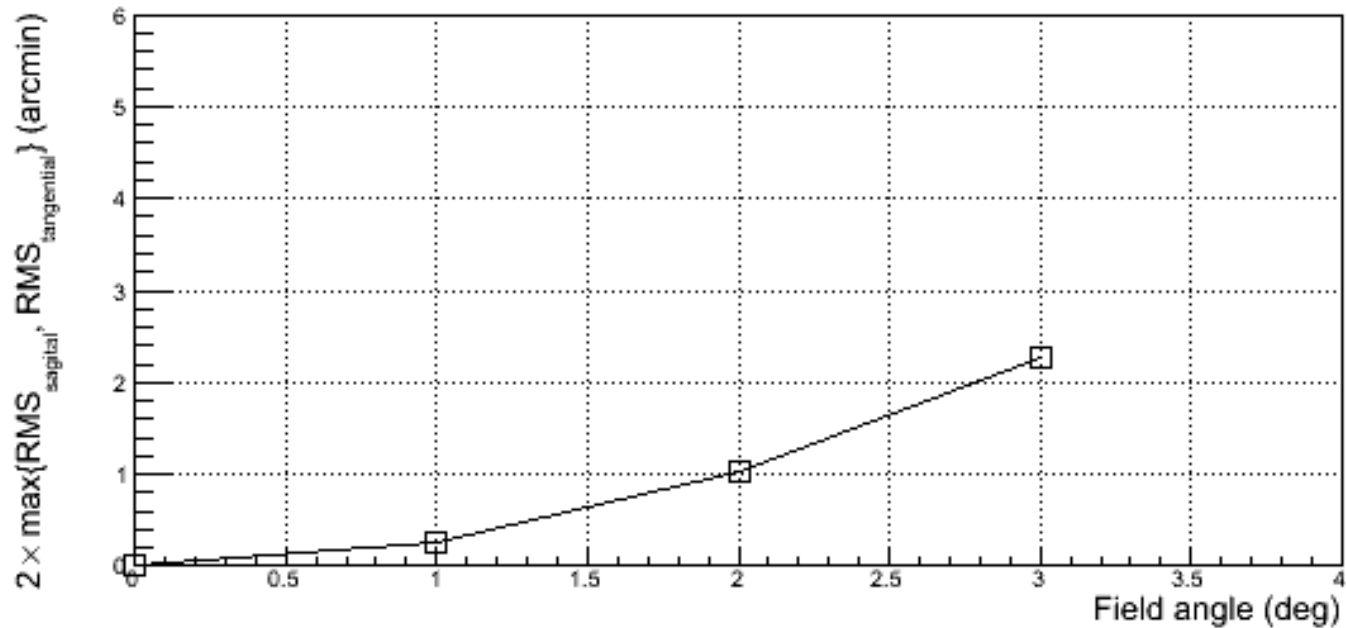
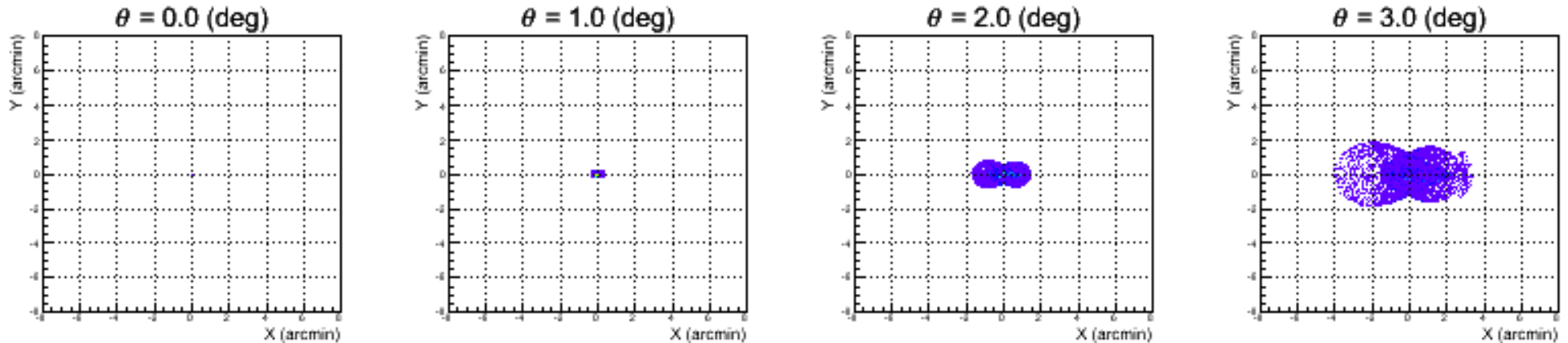
# Schwarzschild-Couder Telescope: MAPMT camera



# OS8: Schwarzschild-Couder Telescope

See memo "Optical Systems of Schwarzschild Telescope for CTA, Vladimir V. Vassiliev, Oct. 25, 2010

**No camera: focal surface only**



# CARE: Camera and Readout

Resulted from a trigger simulation code for AGIS

Evolved into a fully fledged  
simulation package of ACT cameras including trigger and FADC

Output files: root, VBF

Main features for CTA-(US):

- Can do hybrid arrays
- >250 telescopes with less than 2GB memory (grid requirement)
- Proper SiPM simulation
- Sumtrigger with clipping
- No constraints on camera geometry
- Array trigger

# CARE: Camera and Readout

## Photon detectors: PMTs & SiPMs:

- Square, circular, hexagonal pixel shapes
- Uses measured or Gaussian pulse shapes
- Wavelength dependent QE
- Afterpulsing
- Single pe amplitude jitter
- Pixel to pixel variations of gain and QE
- Crosstalk
- .....

## SiPM only:

- Correct simulation of dynamical behavior
- Optical crosstalk

## Trigger:

- Constant fraction discriminator capabilities (delay, attenuation)
- Next neighbor multiplicity requirement
- Sumtrigger including clipping
- Array trigger
- .....

**Geometry: No constraints on camera topology or trigger topology**

## FADC:

- Hi/lo gain
- QDC is an option
- .....

# Status and next Steps

GrOptics code is up and running

Commissioning of CARE after rewrite is complete (finally)

GrOptics and CARE are used by the VERITAS Collaboration

→ Code validation on real data, results are trustworthy

We are setting up a repository for GrOptics and CARE that is accessible by everyone in CTA and VERITAS