# CTA 報告 113：Schwarzschild-Couder 光学系を用いた小・中口径望遠鏡の開発

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名古屋大学 NAGOYA UNIVERSITY　ISEE Institute for Space-Earth Environmental Research　cta cherenkov telescope array

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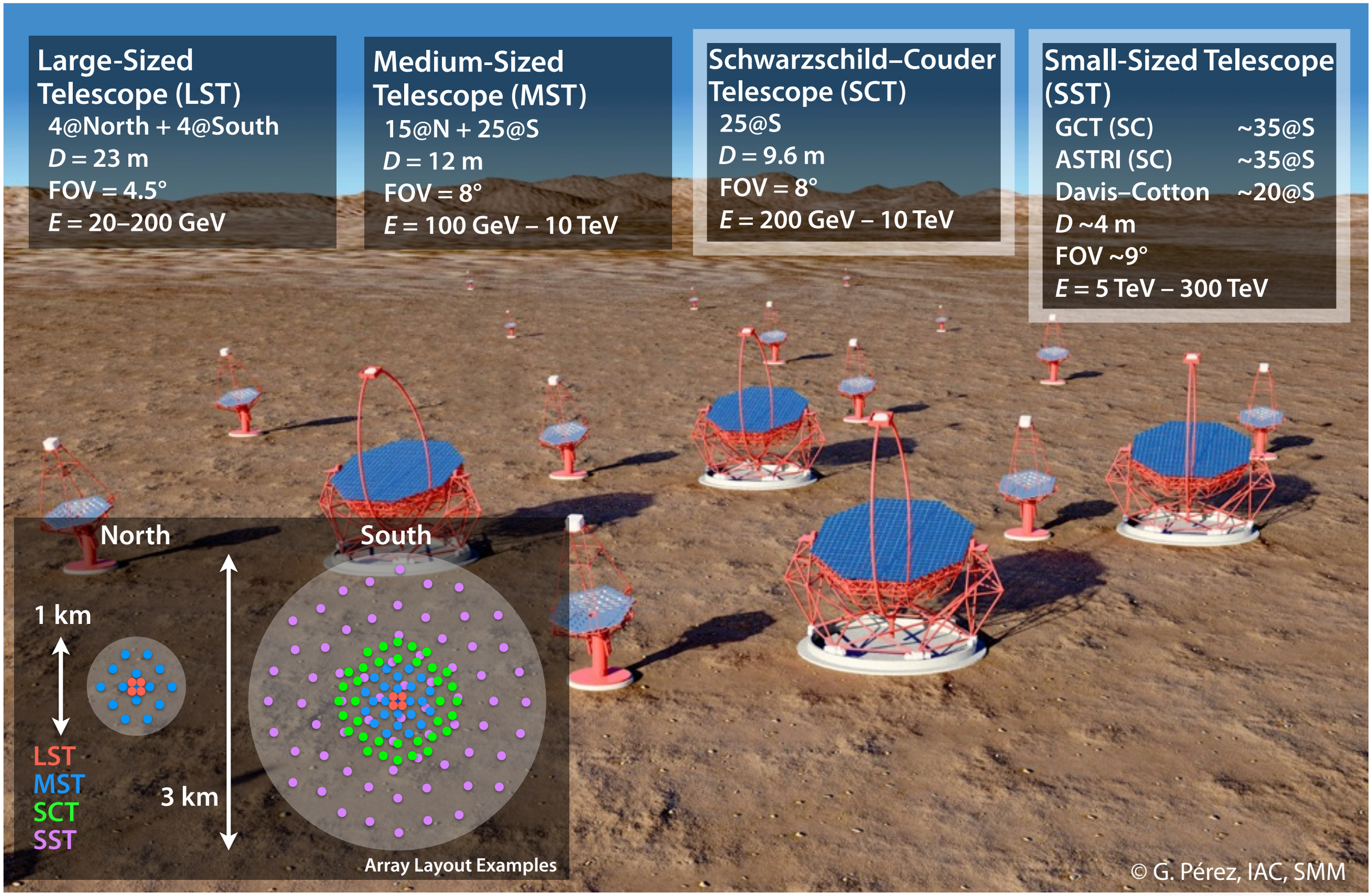
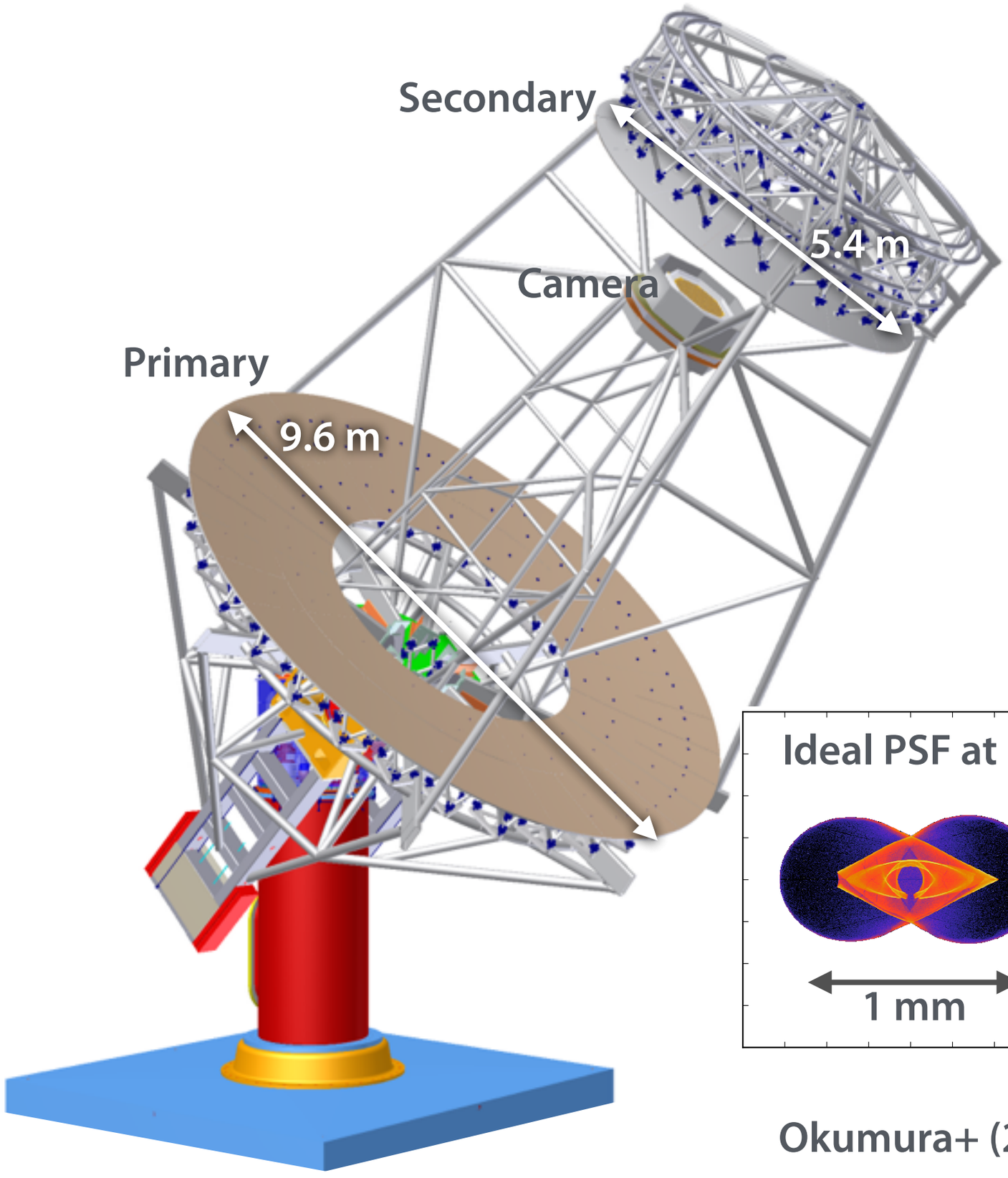
# Cherenkov Telescope Array (CTA)



# Schwarzschild–Couder Telescope (SCT)





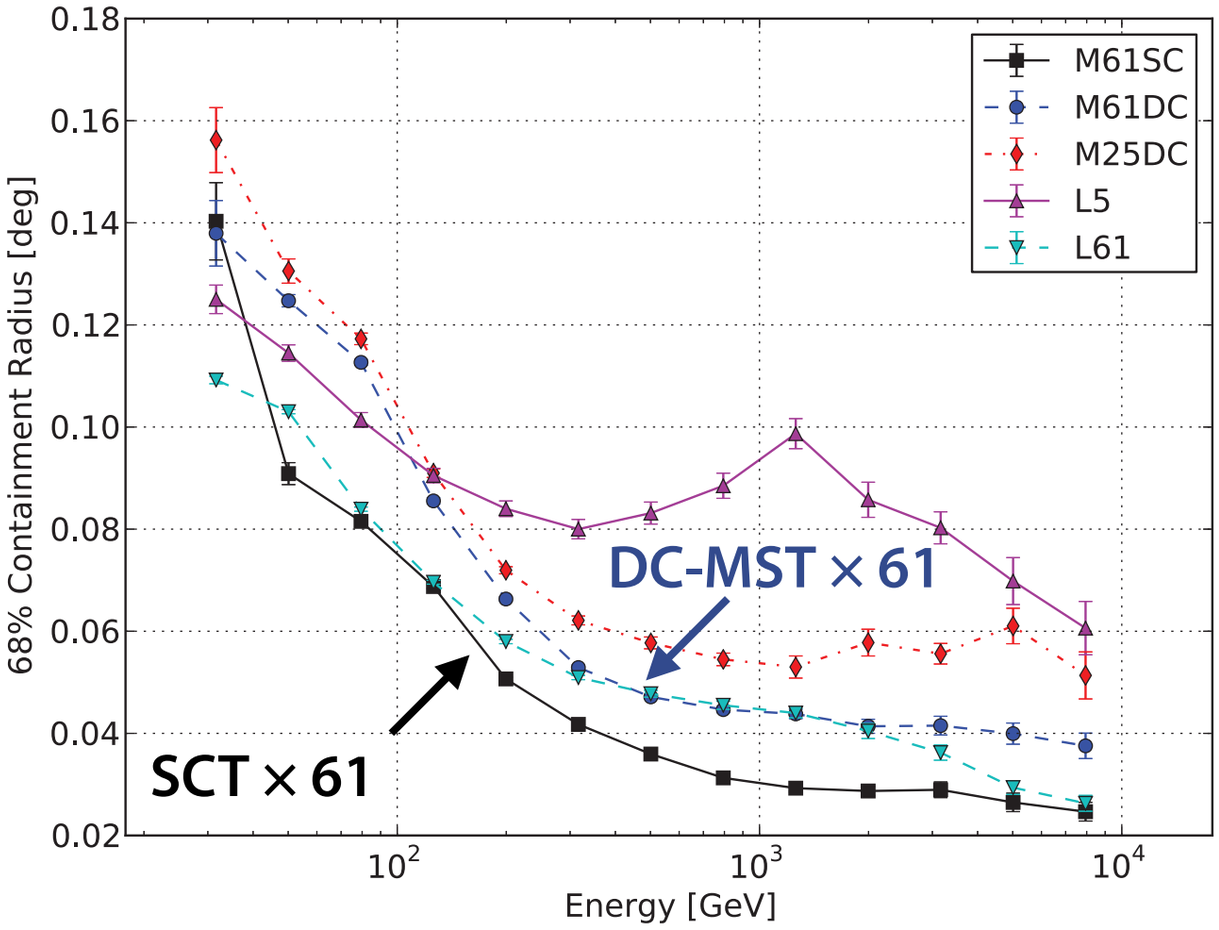


Okumura+ (2016)

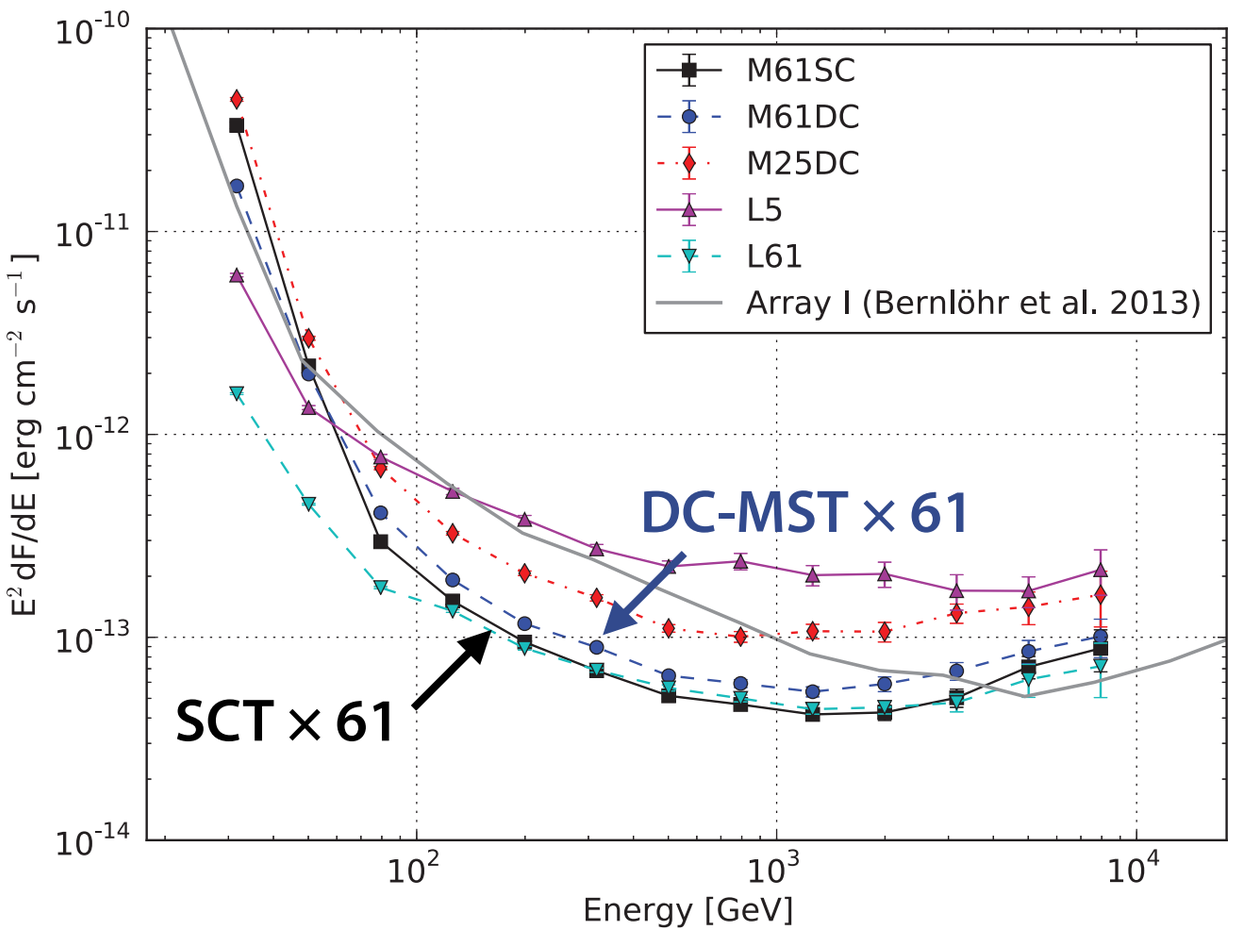
- At first, proposed as Advanced Gamma-ray Imaging System (AGIS)
- Now an extension for the CTA South
  - Will improve the sensitivity in 100 GeV – 10 TeV
  - Davies–Cotton MST × 25
  - Schwarzschild–Couder × 25
- Challenges
  - High-quality mirrors and fine alignment
  - SiPM array and ASIC
- Will realize a large FOV of 8° and fine angular resolution of ~0.06°

# SCT Advantages

## Angular Resolution



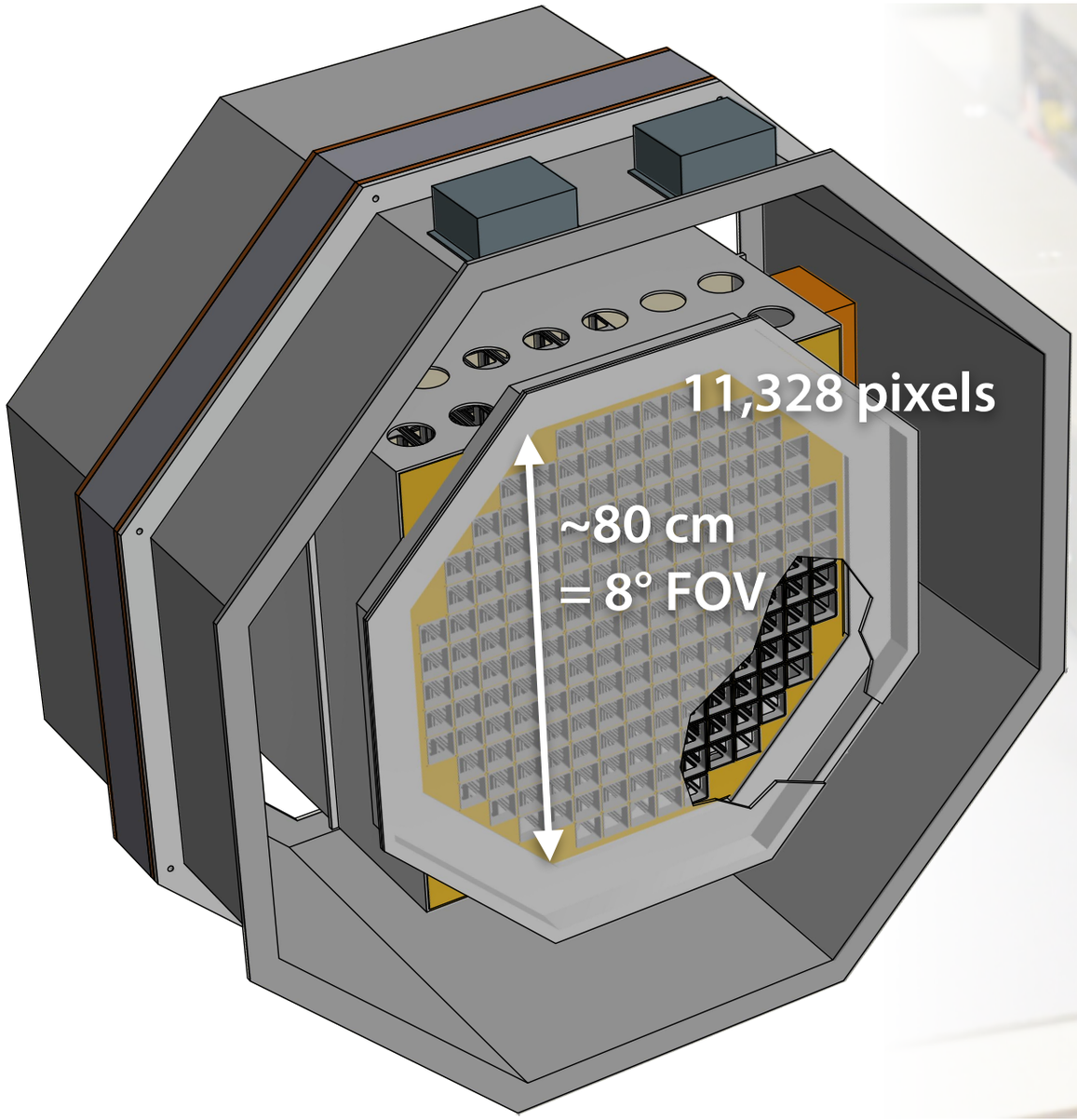

## Point Source Sensitivity

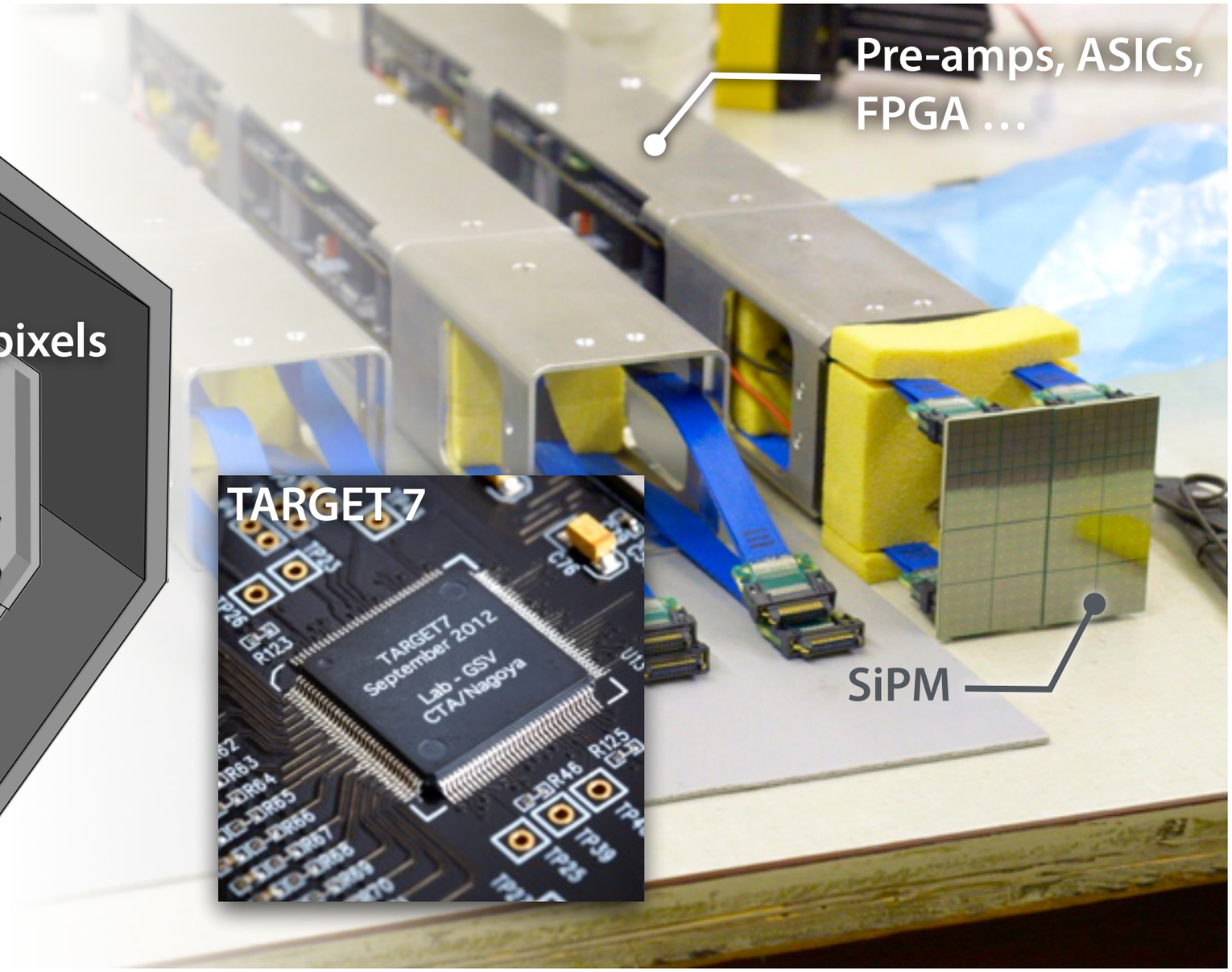



Wood+ (2016)

- MC study shows SCTs have better angular resolution of arrival direction by a factor of ~1.5 than Davies–Cotton MSTs
- ~30% better sensitivity for point sources
- Less expensive camera pixel cost

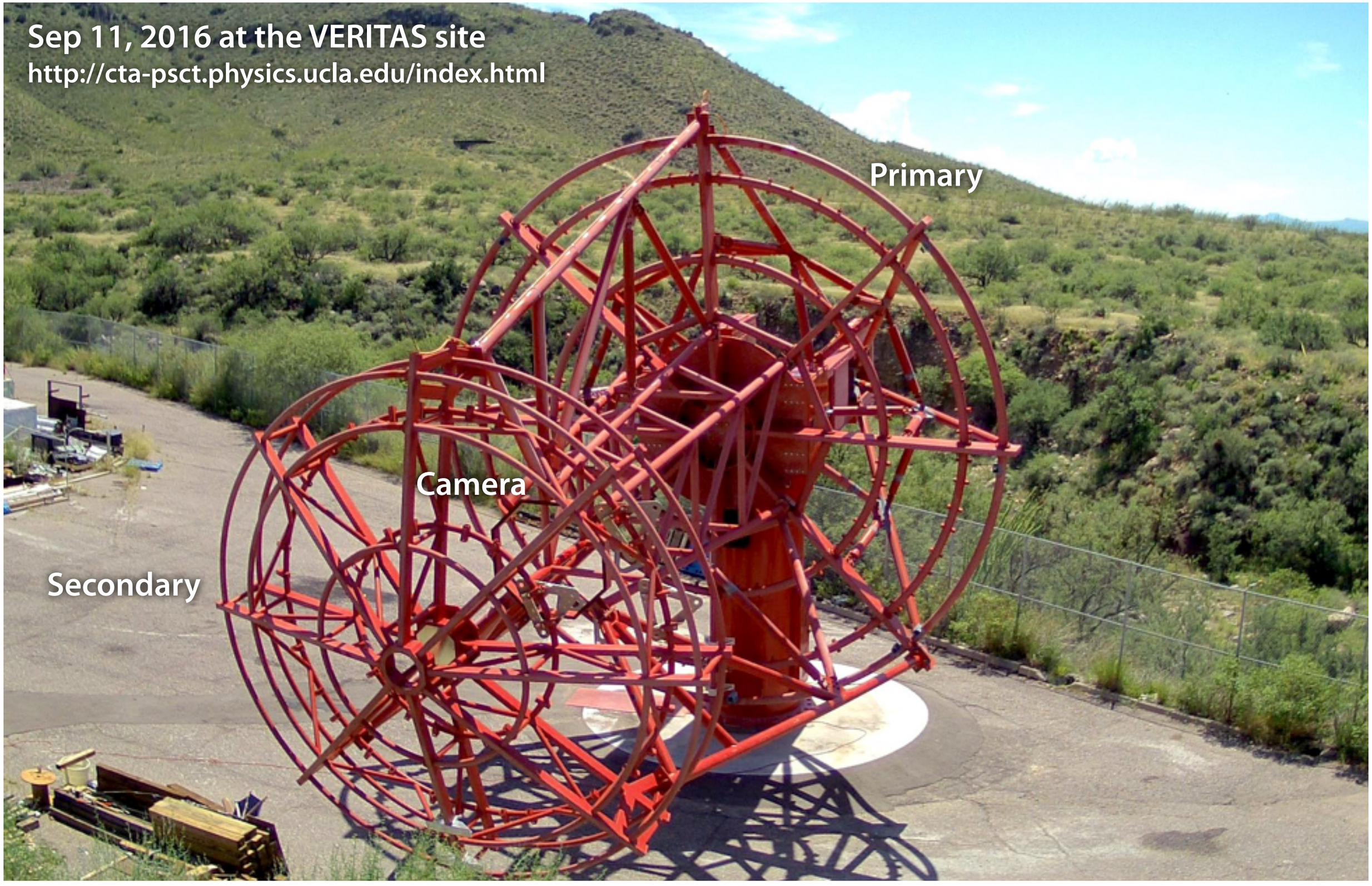
# The SCT Camera



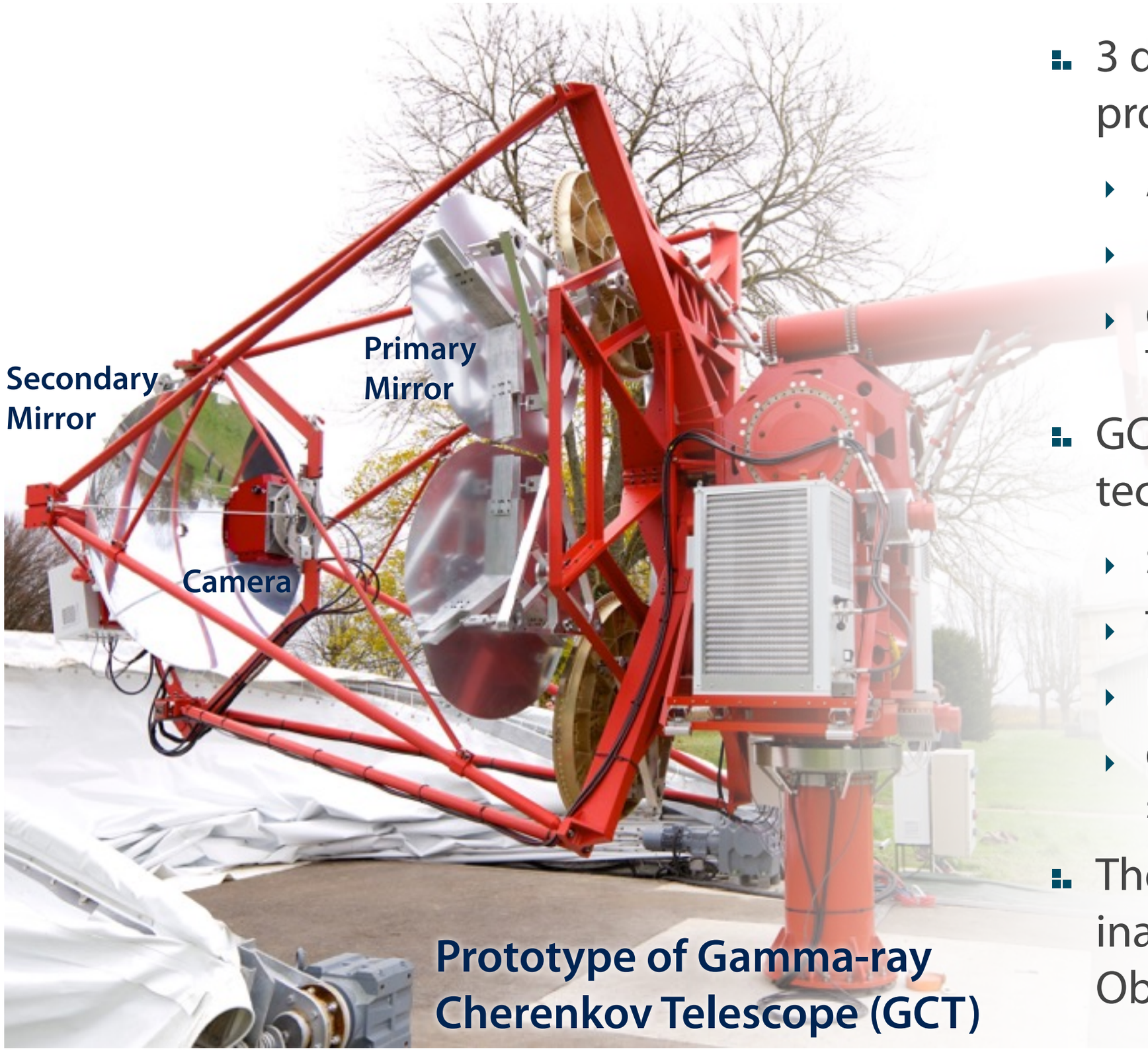




- The plate scale of 97.5 mm/deg and FOV of 8° require SiPM or MAPMT camera modules
- The focal plane is covered with 11,328 SiPM pixels
- 64 pixels per module are readout by 4 TARGET ASICs

# The SCT Prototype is under Construction



# Small-Sized Telescope (SST)

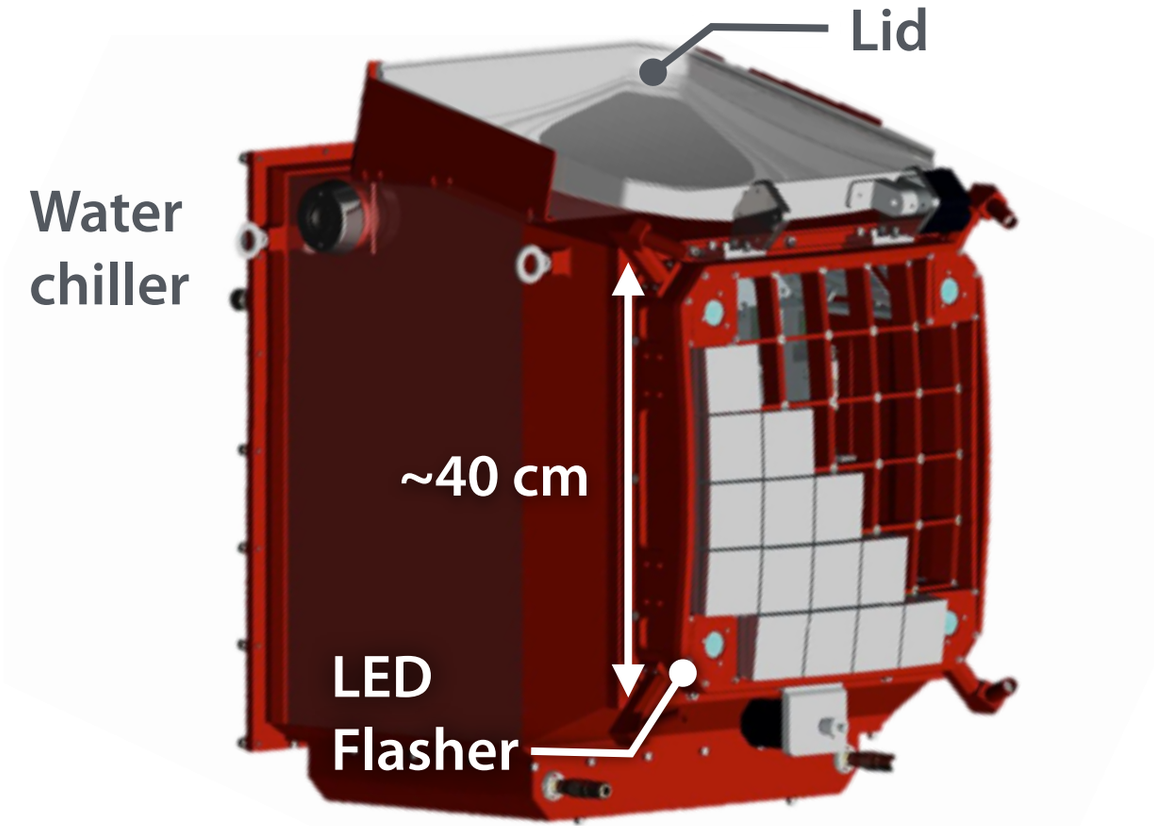


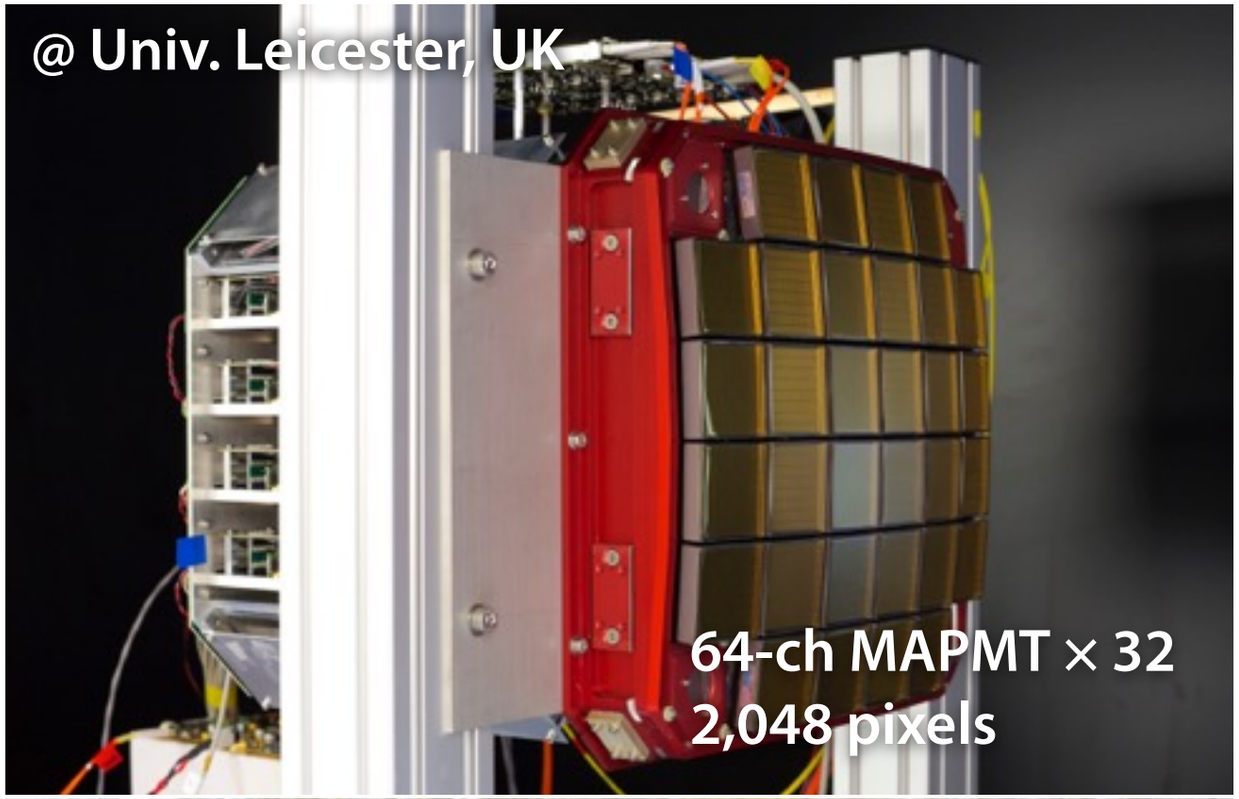

Prototype of Gamma-ray Cherenkov Telescope (GCT)

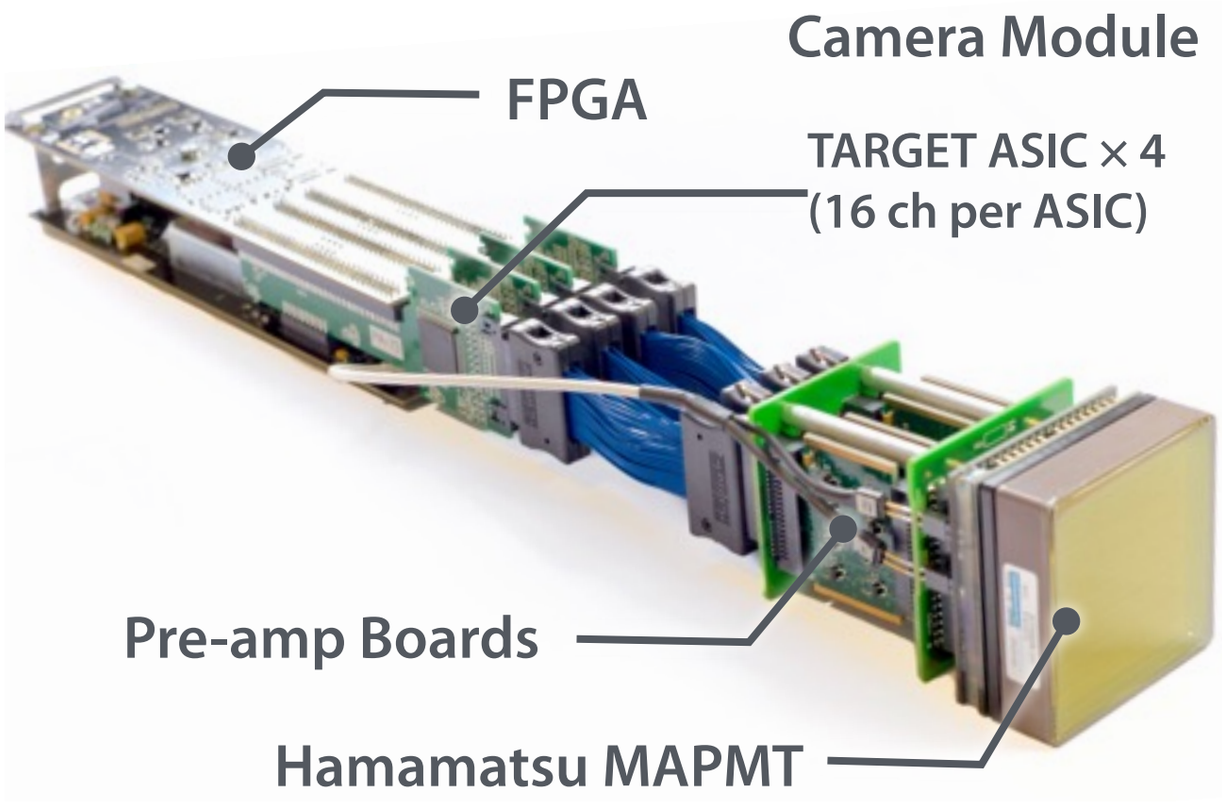
- 3 different designs proposed
  - ASTRI
  - 1M-SST (Davies–Cotton)
  - Gamma-ray Cherenkov Telescope (GCT)
- GCT uses similar techniques as in SCT
  - SC optics
  - TARGET modules and SiPMs
  - Backplane board
  - Camera control and DAQ software
- The GCT prototype was inaugurated at the Paris Observatory in Dec 2015

# Inauguration of the GCT Prototype (Dec 2015)

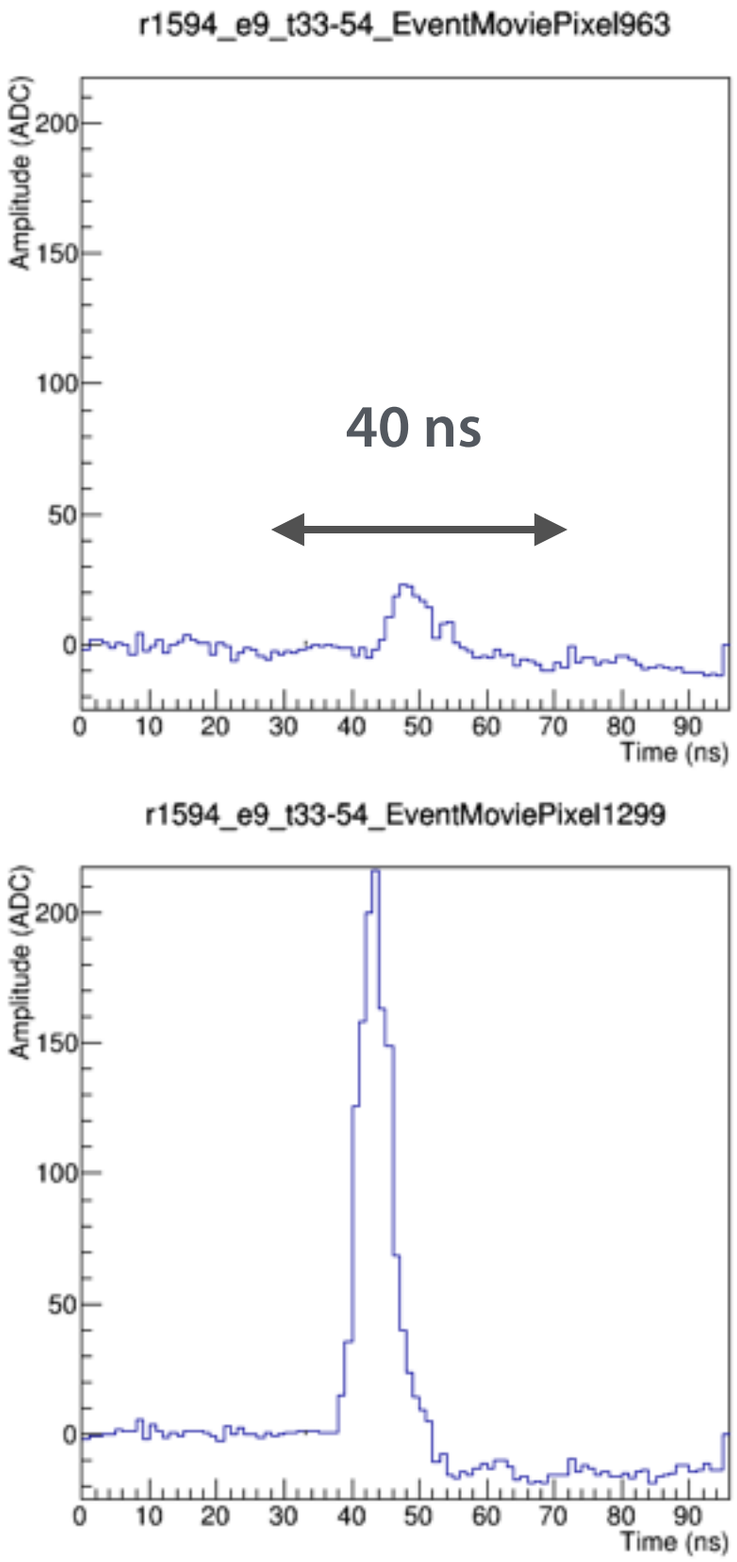
# The GCT Camera Prototype (with MAPMTs)

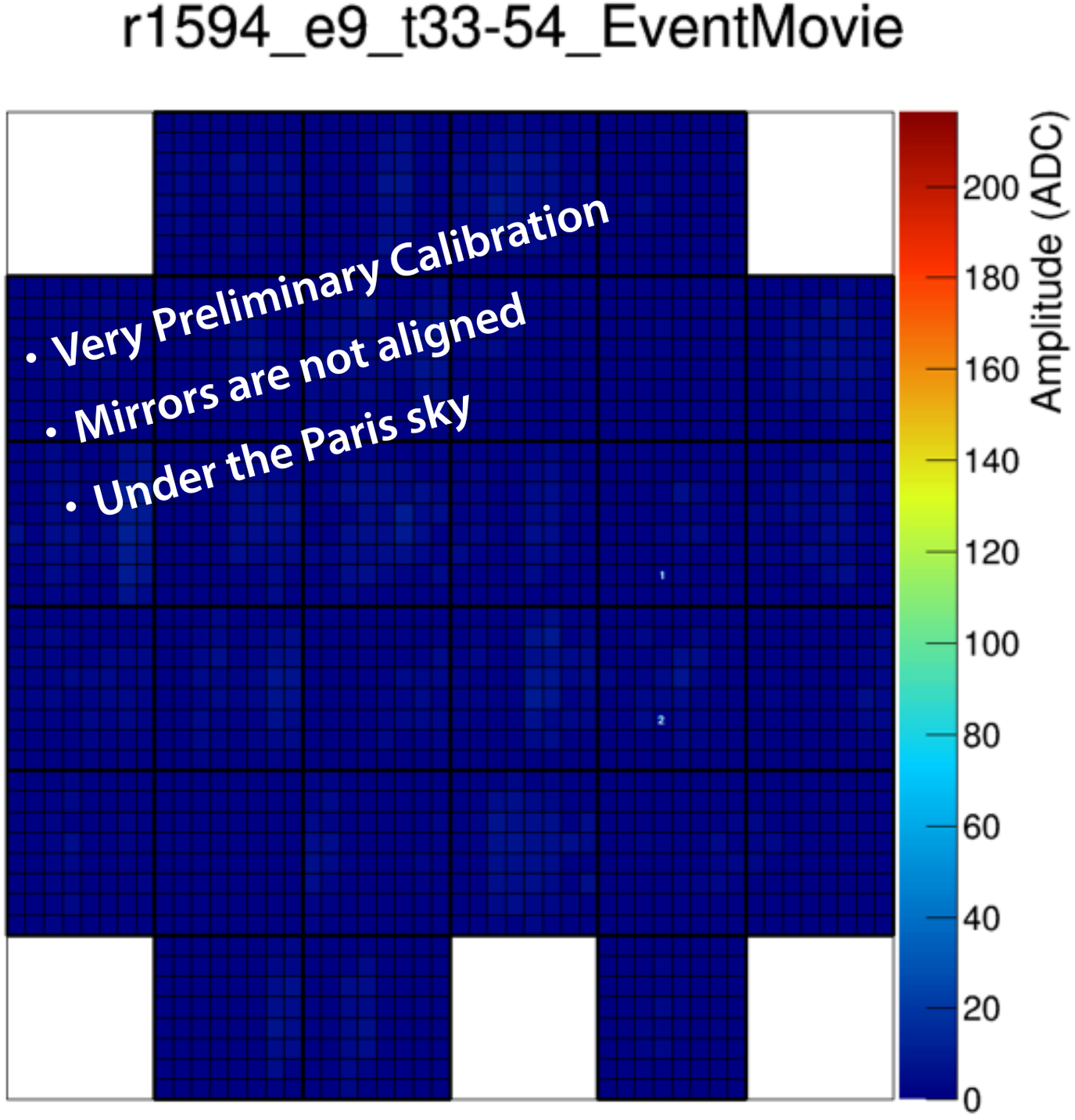


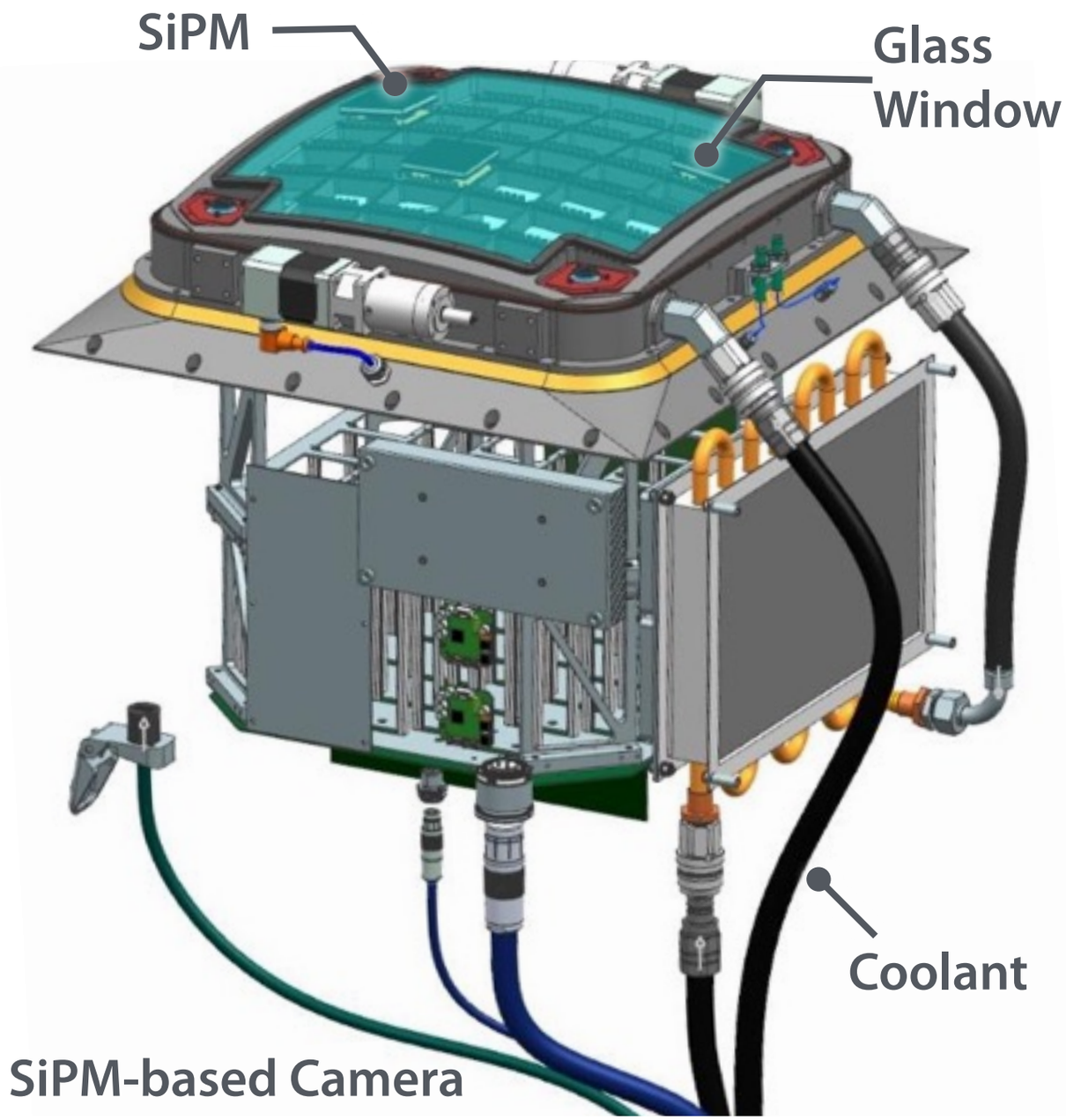

# The First Cherenkov Light in CTA (Nov 26, 2015)



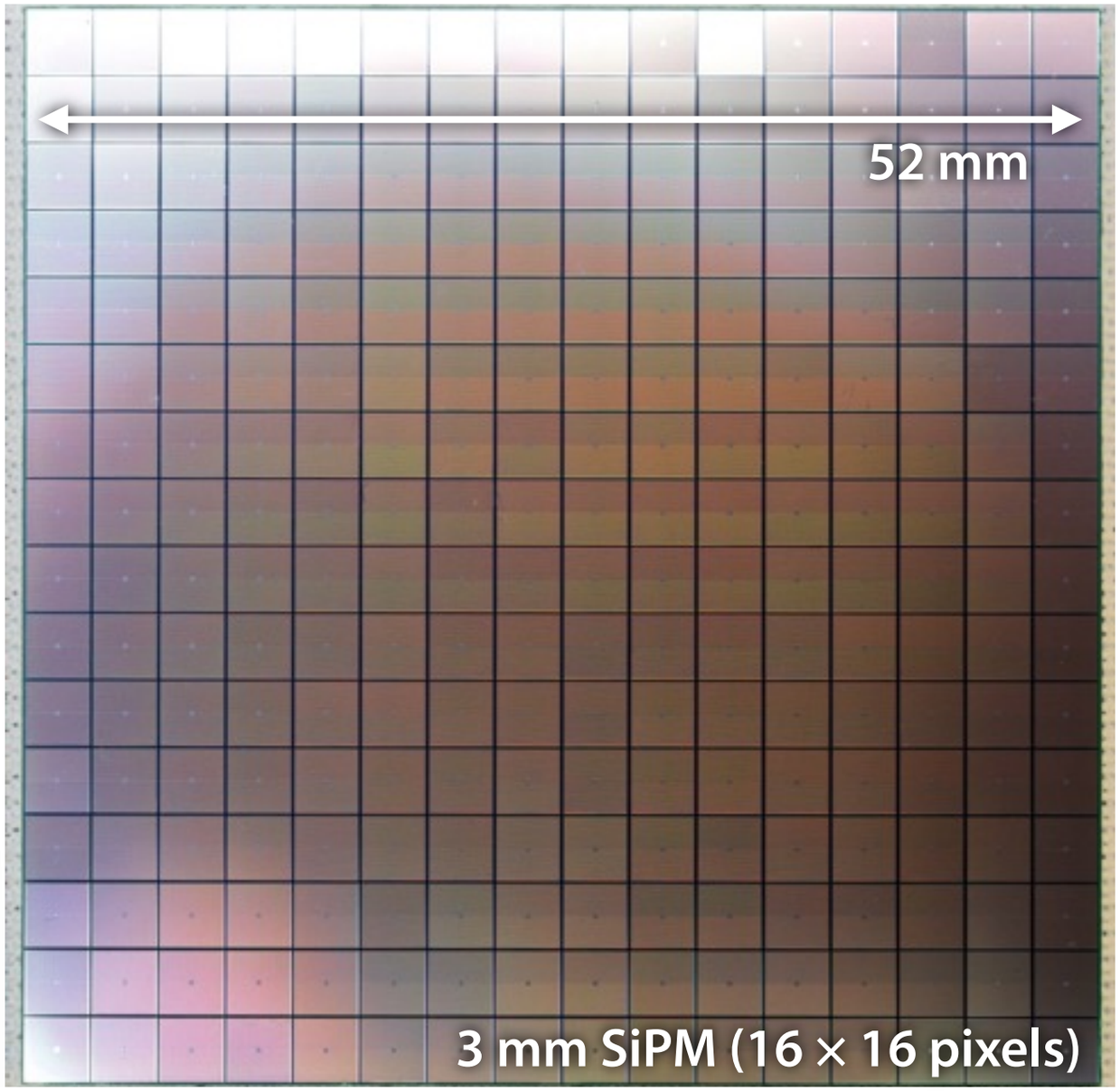




**Thu Nov 26 18:53:37 2015 (UTC)**
**First GCT-M On-Sky Data, Peak values ~275 p.e.**

# SiPM-based GCT Camera



SiPM-based Camera

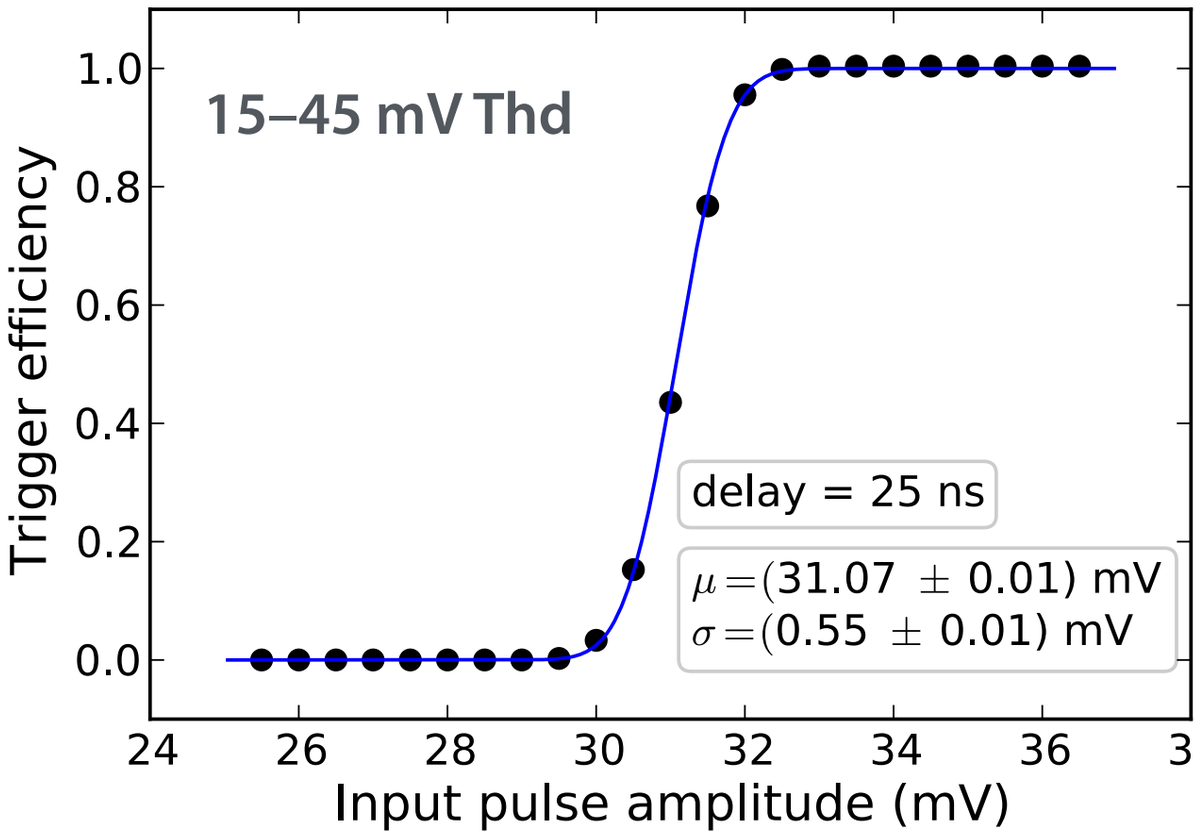


3 mm SiPM (16 × 16 pixels)

- 32 MAPMTs will be replaced by SiPMs, and the latest TARGET ASICs will be used
- A prototype with improved camera mechanics will be built in 2017
- Three production telescopes will be at the CTA South in 2018

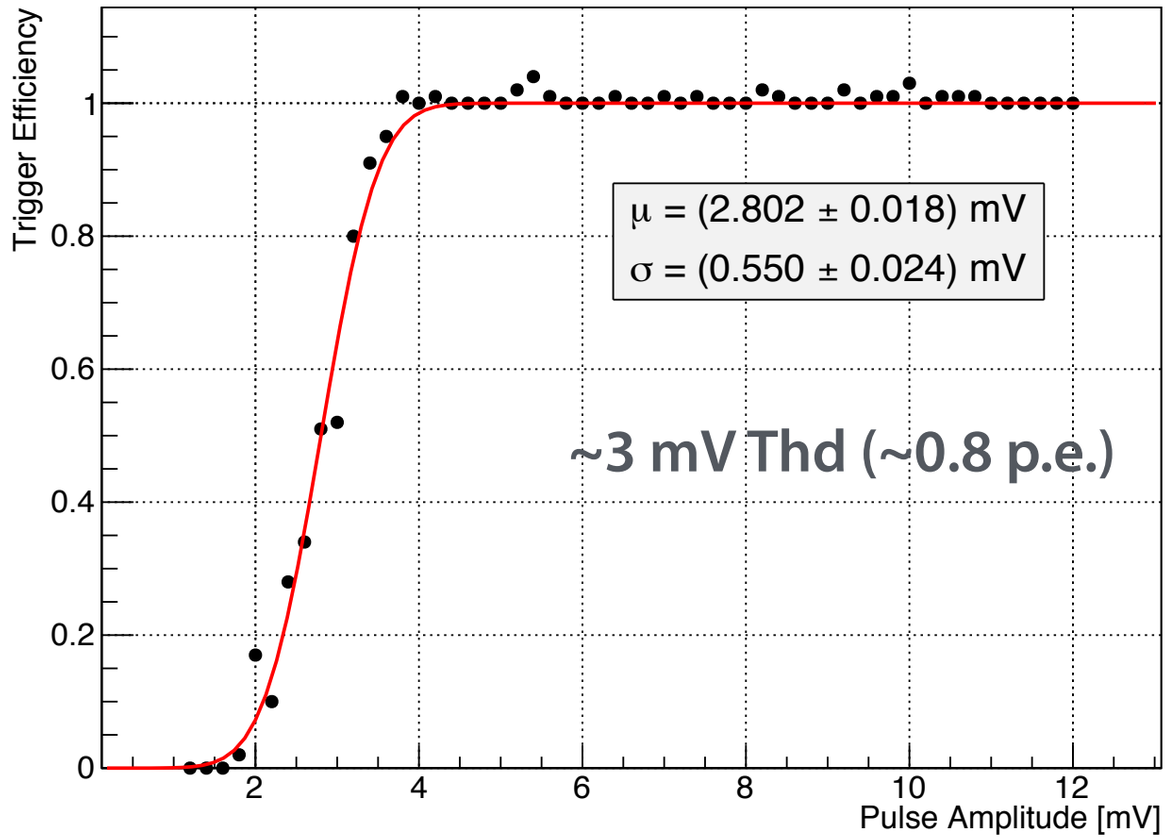
# TARGET ASIC – 16-ch Readout and Trigger

## TARGET 5




Albert+ (2016)

## T5TEA

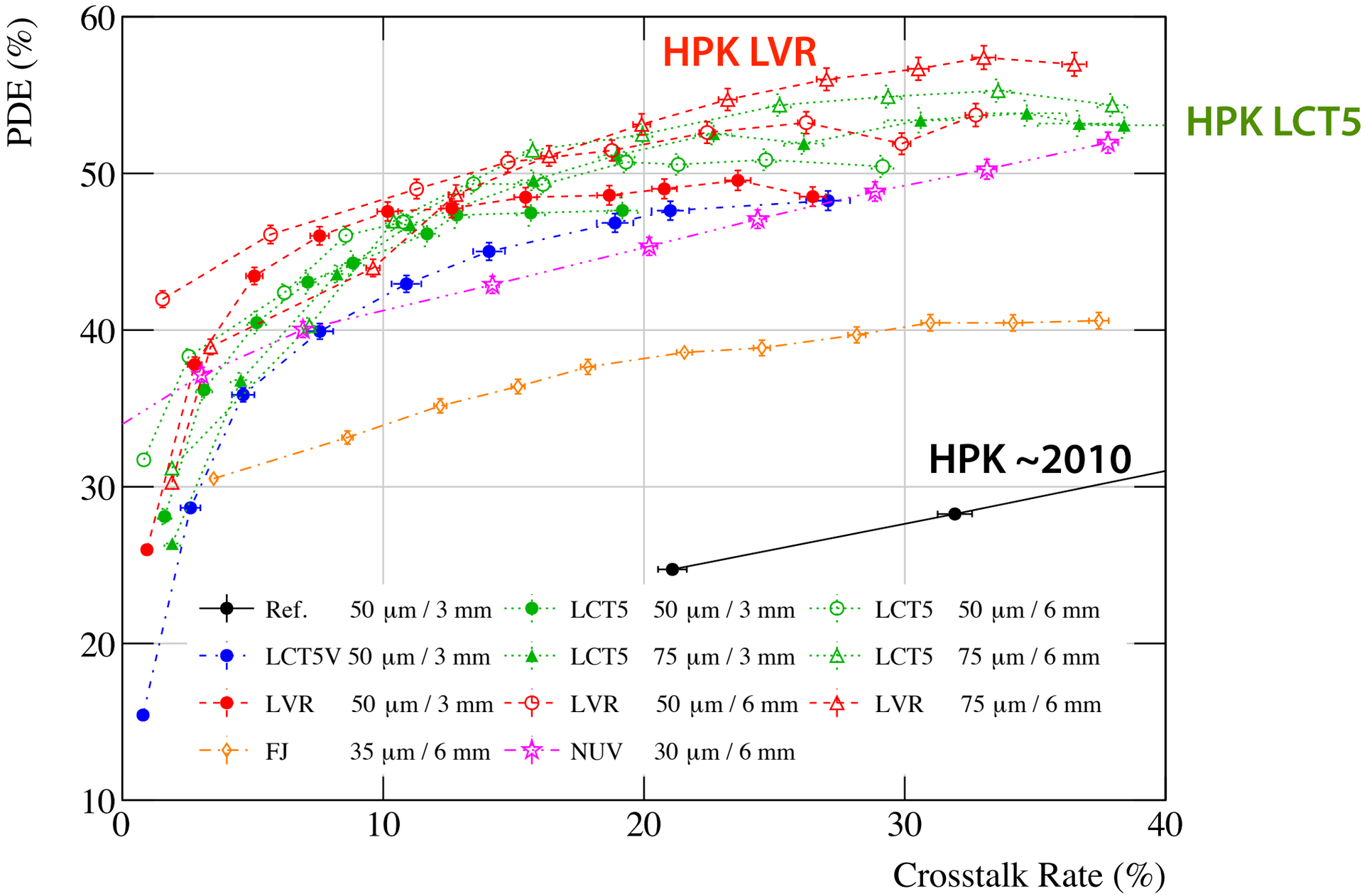



Funk+ (2016)

- We have been developing TARGET ASICs since 2009
- The trigger performance was worse than expected in T1, T5, and T7 (TARGET variants)
- Finally satisfactory trigger performance achieved in the latest design (TARGET C & T5TEA)

# SiPM Characterization for SCT and SST

See 山根暢仁 24aSG-10




- SiPM characterization in various temperature/voltage conditions underway
- Recent SiPMs have lower crosstalk rate and higher PDE compared to ~2010
- PDE ~60% is expected with a lens array

# Summary

- We have developed
  - Schwarzschild–Couder telescopes for CTA Medium and Small-Sized Telescopes
  - Cameras with the TARGET ASIC technology and SiPMs
- The prototype of GCT (a Small-Sized Telescope design) was inaugurated at the Paris Observatory Dec 2015
- The first Cherenkov events ever in CTA were recorded

- Further improvements of TARGET, photodetectors, and camera mechanics foreseen