MCAT

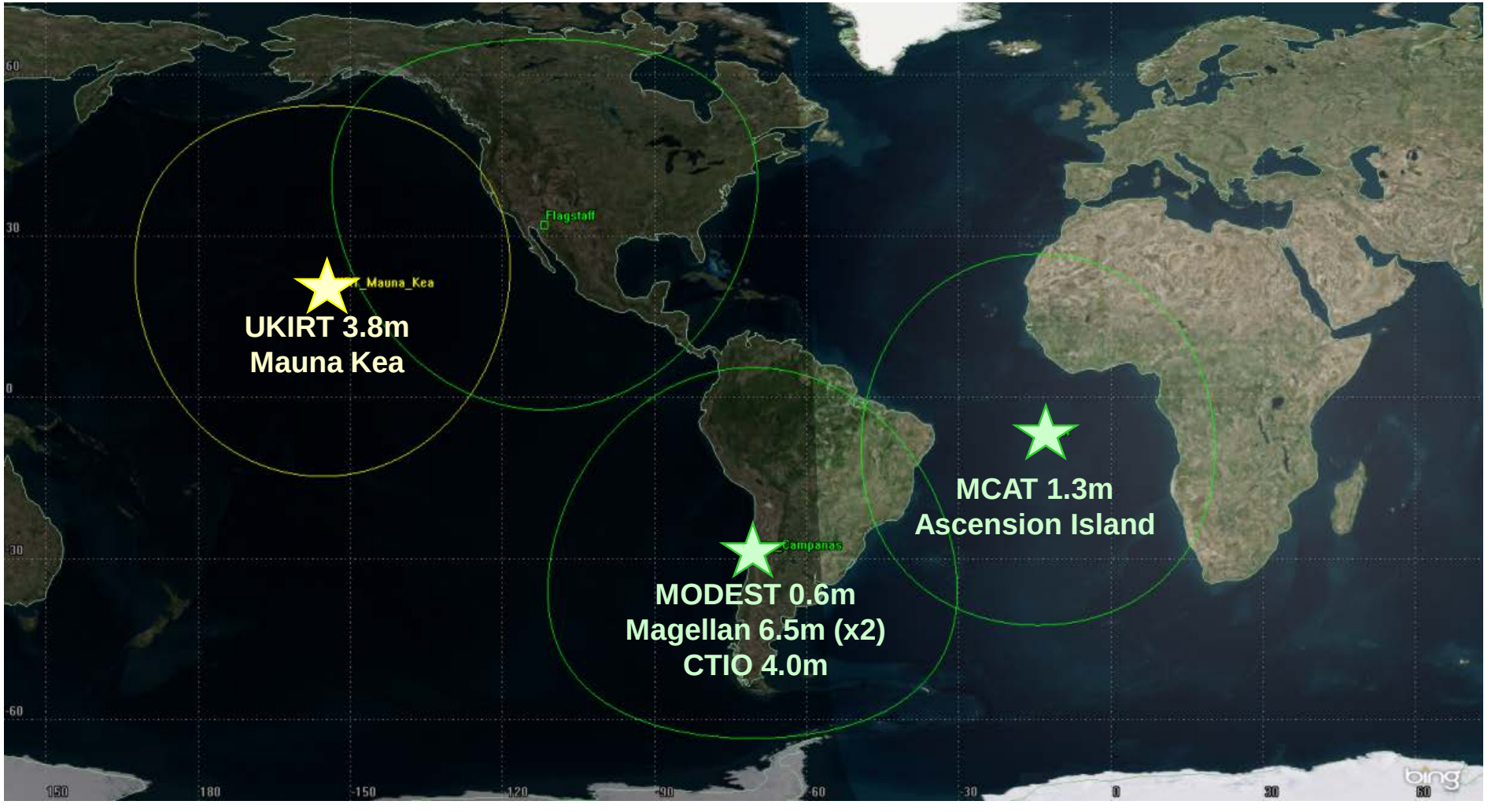
Meter Class Autonomous Telescope

Dr. Sue Lederer

National Aeronautics and Space Administration

Orbital Debris Program Office

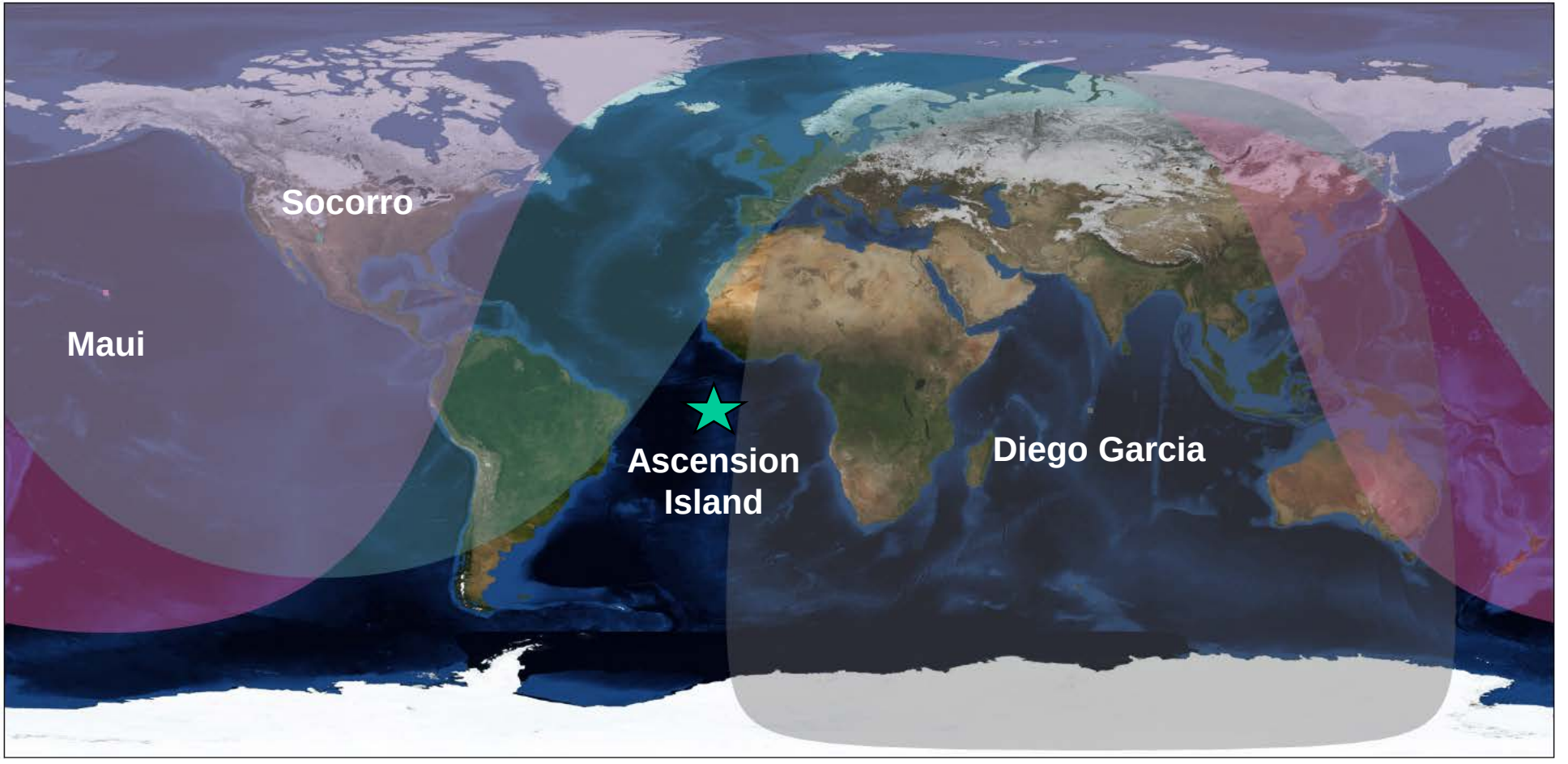
NASA's Optical and IR Assets: MCAT, MODEST, and UKIRT



NASA/AFRL joint project

- **NASA**
  - Principal Investigator: Sue Lederer
  - Project Management & Logistics: Lisa Pace
  - ODPO Office, Gene Stansbery
  - JETS contractor staff: Heather Cowardin, Brent Buckalew, James Frith
- **Air Force Research Laboratory (AFRL)**
  - AFRL Maui: Paul Kervin
  - Schafer Corp: Hardware integration: Tom Glesne
  - Pacific Defense Solutions, Integrity Applications Inc.: Daron Nishimoto, Riki Maeda,
  - Air Force Nuclear Weapons Center (AFNWC):
    - Architectural contract
- **Air Force 45th Space Wing**
  - Detachment 2 Ascension Auxiliary Airfield, Ascension Island
  - Cape Canaveral Air Force Station, Andy Duce (POC)
    - Construction contract

MCAT Location on Ascension Improves GEODSS Network Coverage



Ascension: views from ISS & from sea

Aeronautics and Space Administration

Ascension Island

Future MCAT site


Location
of NASA MCAT
(7° 58’ S; 14° 24’ W
~350’ Elevation; Google Earth Image)

MCAT Timeline

Systems Testing

- July 2013: Telescope testing
- Aug 2013-June 2014: Software/Hardware integration testing

Construction

- Sept 2014, Ground-breaking
- Sept-March/April 2015: Main facility construction
- March-April 2015: Dome installation
- April-June 2015: Telescope installation

Acceptance Testing

- June 2015: First light
- June-August: Initial testing phase

Full Integration/ Data Collection

- Sept-Dec 2015: Fully Integrated Systems testing and data collection
- Full operations expected for 20+ years

MCAT Construction

ODPO/MCAT Goals (BIG PICTURE)

MCAT Goals:

Characterize the orbital debris risk to GEO satellites

Characterize the orbital debris environment in under-sampled orbits

Additional (nice to have) goal:

Share serendipitous observations with the Space Situational Awareness (SSA) and Near Earth Object (NEO) communities, or take dedicated observations requested when resources allow

ODPO/MCAT Objectives (BIG PICTURE)

Primary:

Distribution Function (#, size, type) for **GEO-GTO*** debris field
Achieved via sweep of inertial volume near GEO altitudes spanning inclinations expanded by solar lunar perturbations (stable plane).

Secondary:

Debris type determination through multi-band (g′r′i′z′ or BVRI) photometric or spectroscopic

Rapidly respond to break-up event – *time evolution of cloud*

Distribution Function (#, size, type) for **LEO-MEO*** debris field extending to 0º inclination – *achieved via static or orbit scan survey with subsequent tracking*
Fast tracking telescope/dome can easily track Low Inclination Leo Objects (LILO)

Tertiary:

SSA Coverage of Unique Longitude as contributing sensor of global sensor network – *Supports Space Situational Awareness (SSA) activities*

Receive **target Hand-offs** from other global sensors – *better orbit determination*

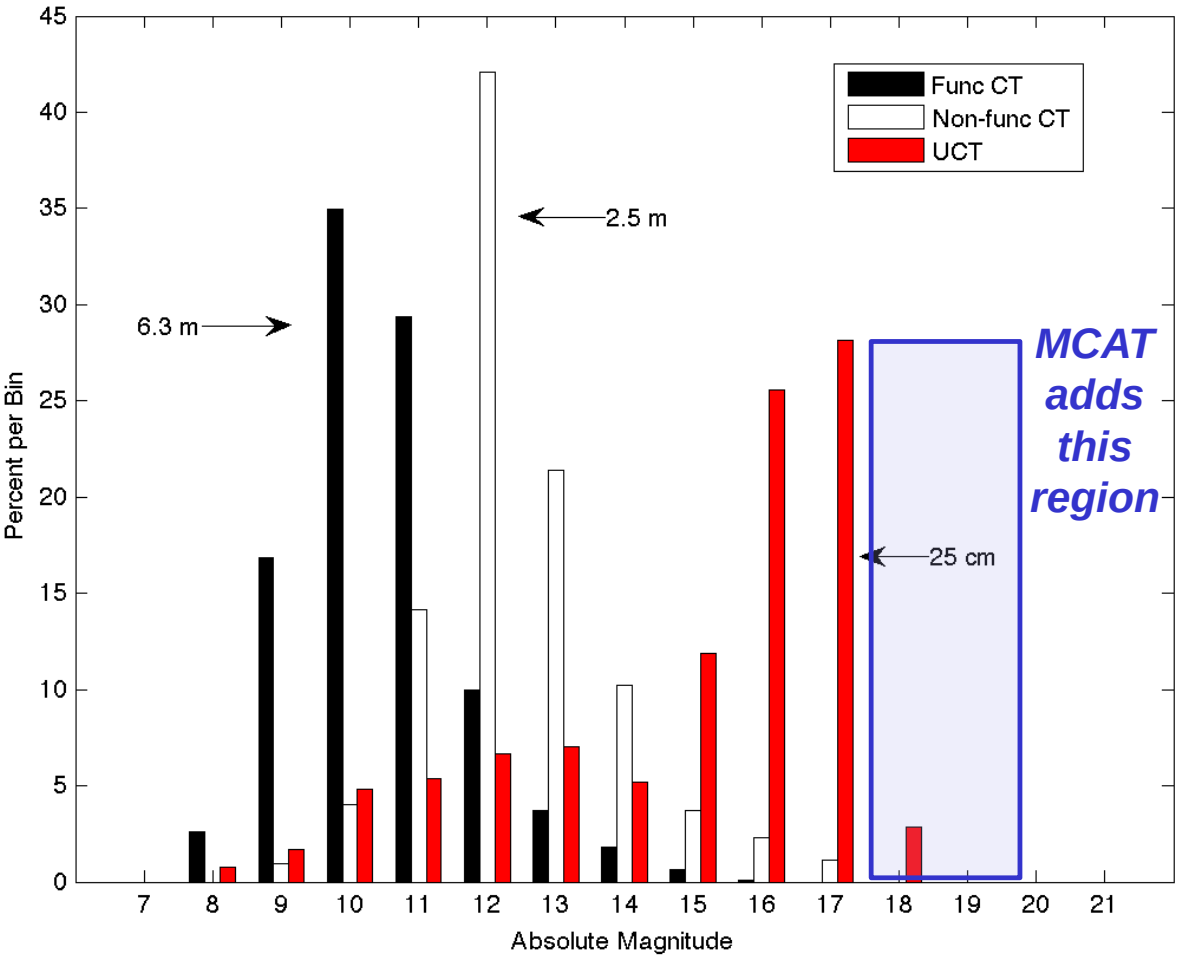
Simultaneous Radar and Optical observations – *in depth assessment of debris properties*

**GEO = Geosync; HEO = High Earth Orbit; GTO = Geo Transfer Orbit; LEO = Low Earth Orbit; MEO = Middle Earth Orbit*

MCAT Performance at GEO

- **Limiting magnitude** seen by other telescopes around the world is dependent upon a variety of variables
  - Atmospheric stability (seeing)
  - Site conditions (extinction due to e.g. altitude, atmospheric aerosols)
  - Telescope through-put
  - Filter chosen
  - Telescope mirror quality

- Assume MCAT experiences:
  - 1.5″ seeing on Ascension Island
  - Telescope encircled EE of 70%
  - → **18.9mag**
  - → **13cm at GEO** assuming 0.175 albedo and very good atmospheric conditions



UKIRT

United Kingdom Infrared Telescope

Mauna Kea, Hawaii

UKIRT

- **NASA**
  - Principal Investigator: Sue Lederer
  - ODPO Office, Gene Stansbery
  - JETS contractor staff: James Frith, Heather Cowardin, Brent Buckalew

- **Management**
  - Lockheed Martin contract
  - U Arizona subcontract to manage day-to-day operations

UKIRT's approximate field of regard

- **Thirty years of operations supporting advanced astronomical science.**
  - UKIRT Infrared Deep Sky Survey (UKIDSS) Surveyed 7500 deg^2 of the Northern sky in the JHK bands down to 18.3 Mag in K-band

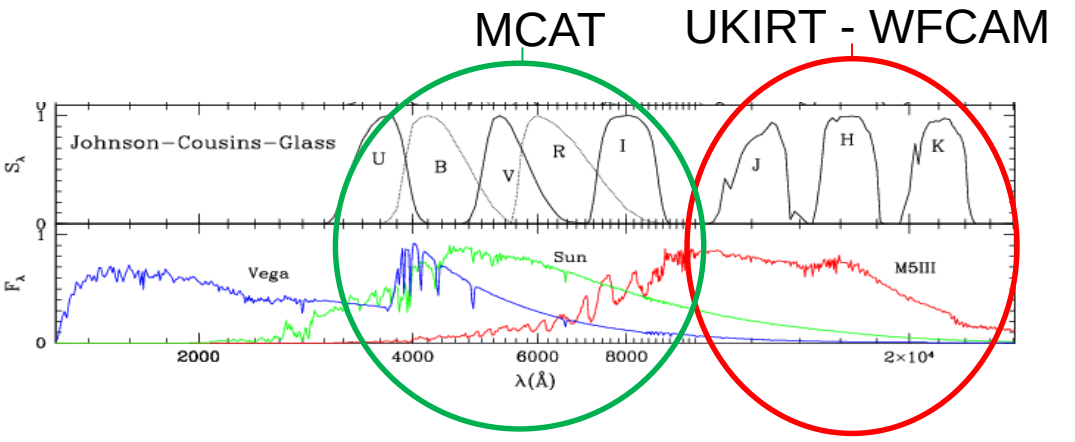
- **Orbital Debris**
  - 35% of observing time guaranteed for NASA's orbital debris studies

United Kingdom Infrared Telescope (UKIRT)

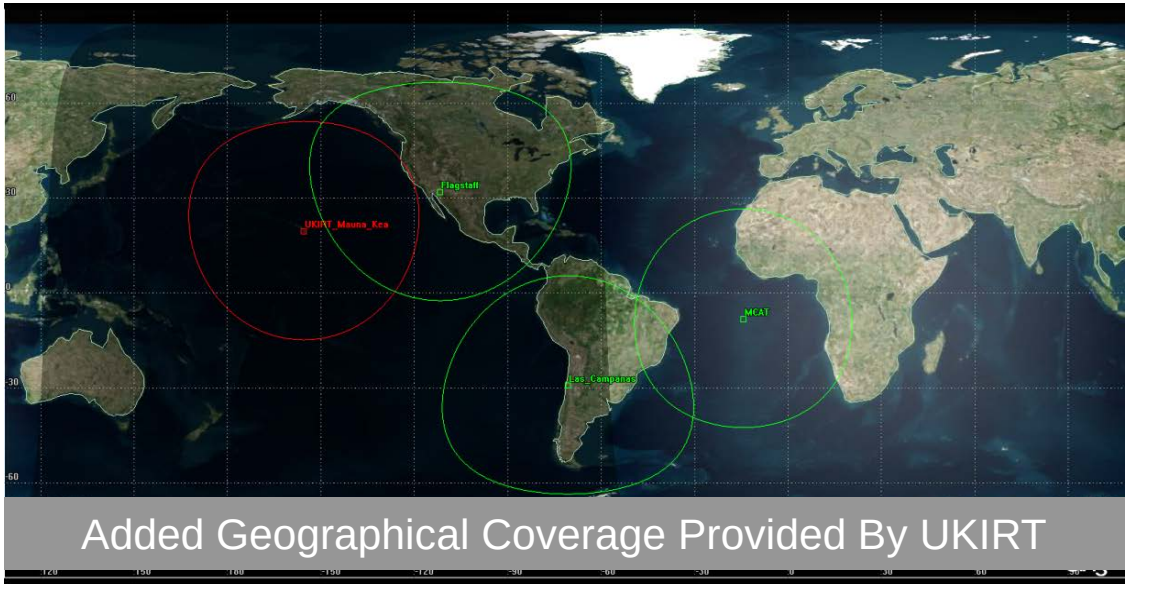
- **UKIRT**
  - 3.8 meter telescope
  - 0.4”/pixel, FOV: 0.8 sq. deg
  - Optimized for near-mid infrared (0.8 – 25 μm)
- **Location:**
  - Mauna Kea, Big Island, Hawaii
  - 13,800 feet (4200m) above sea level
  - Arguably the best ground based infrared observing location in the world

Applications of UKIRT

- Increases **spectral** and **geographical coverage** of GEO belt
- **Instrumentation**
  - Wide Field Camera (WFCAM) photometry, ZYJHK (0.8-2.4 μm)
  - Imager/spectrometers
    - UIST (1-5 μm)
    - Michelle: (8-25 μm)
- **IR + Vis photometry + albedo**
  - provides insight into material types and sizes
- **Spectra**
  - characterize surface material of orbital debris and targets of interest

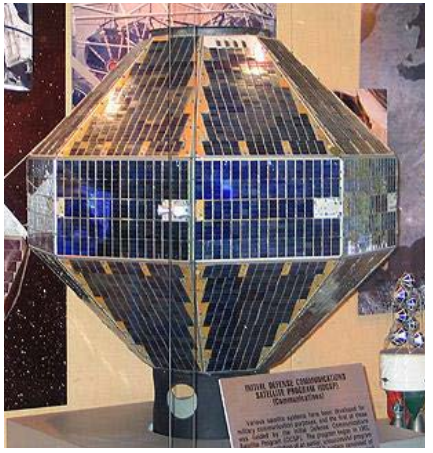


Added photometric coverage of UKIRT



Added Geographical Coverage Provided By UKIRT

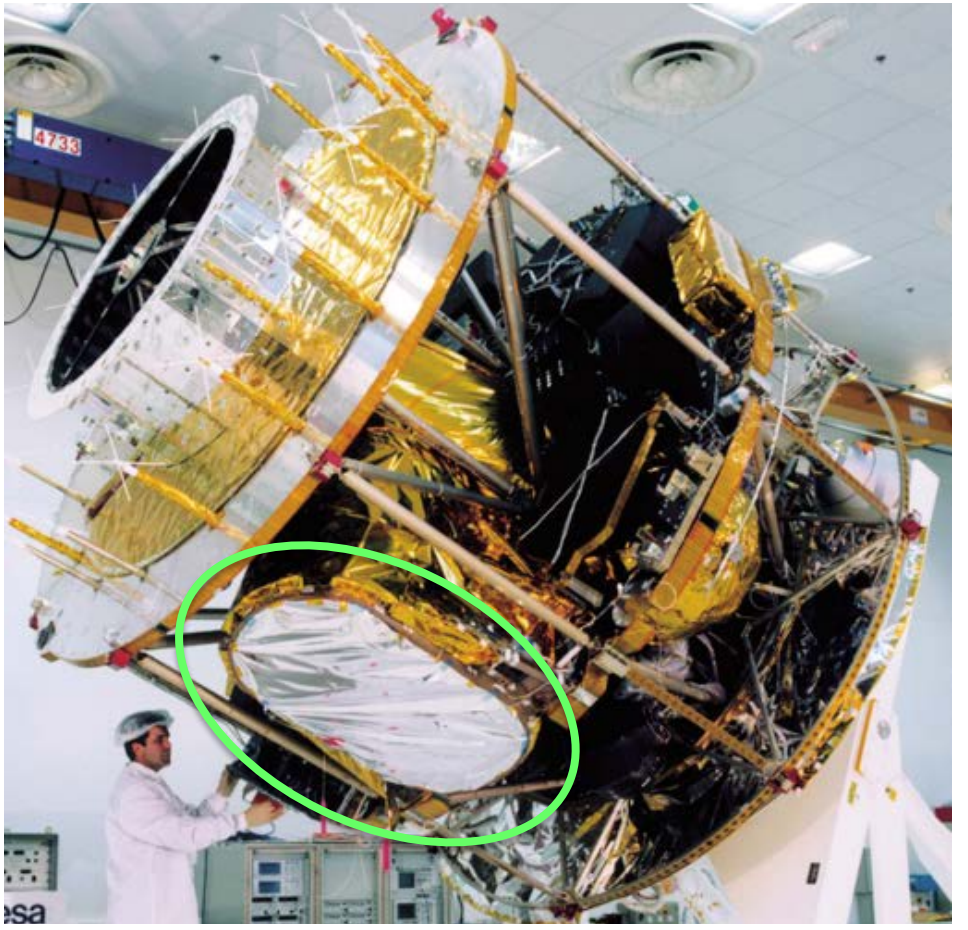
Targets for WFCAM Observations
March, April 2014



IDCSP

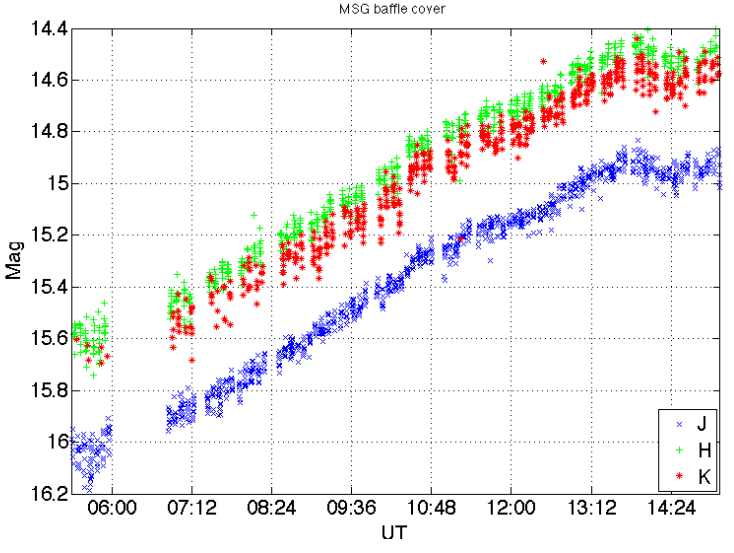
Baffle cover

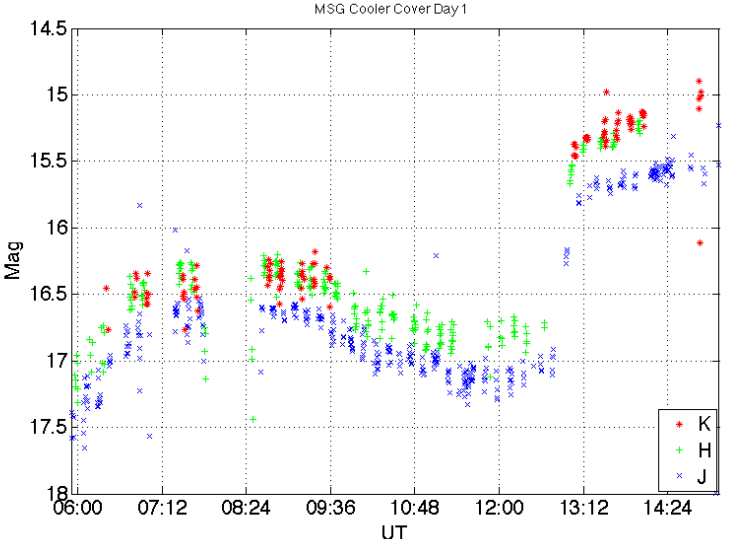
MSG Cooler Cover



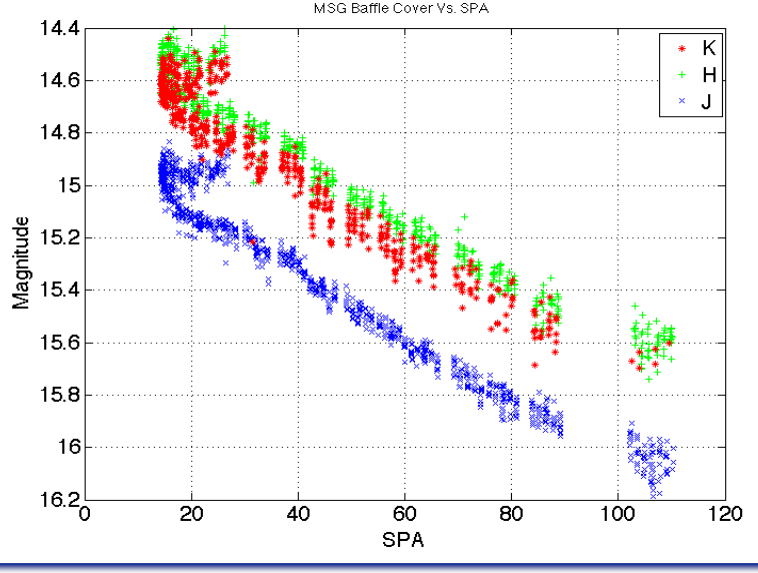
MSG spacecraft and Baffle Cover

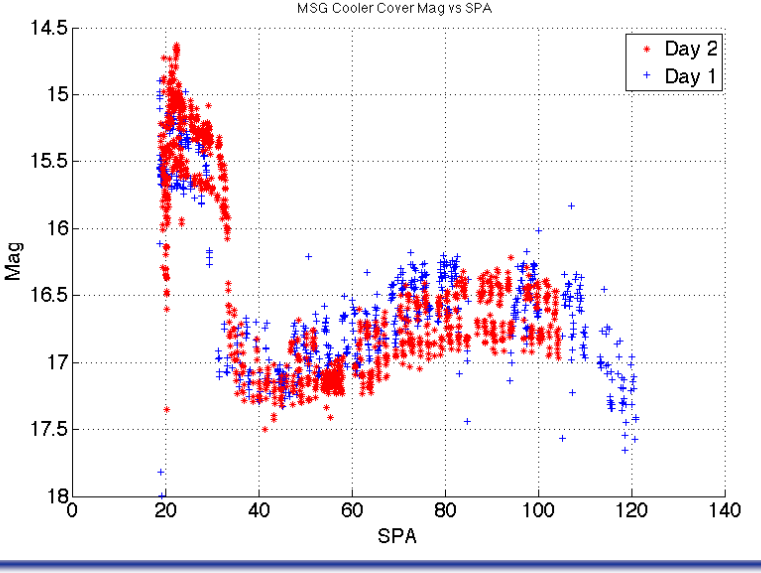
MSG Baffle Cover & Cooler Cover



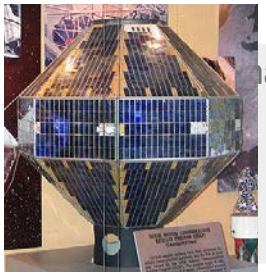


vs UT

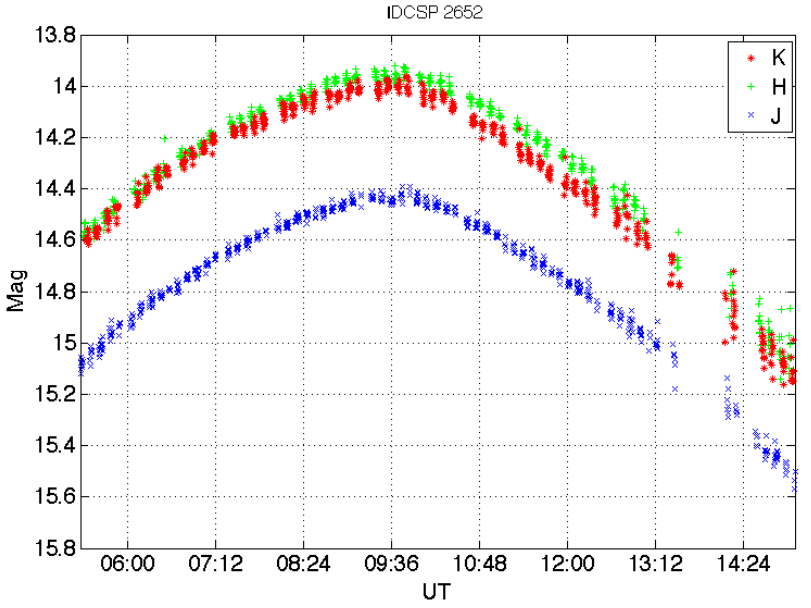


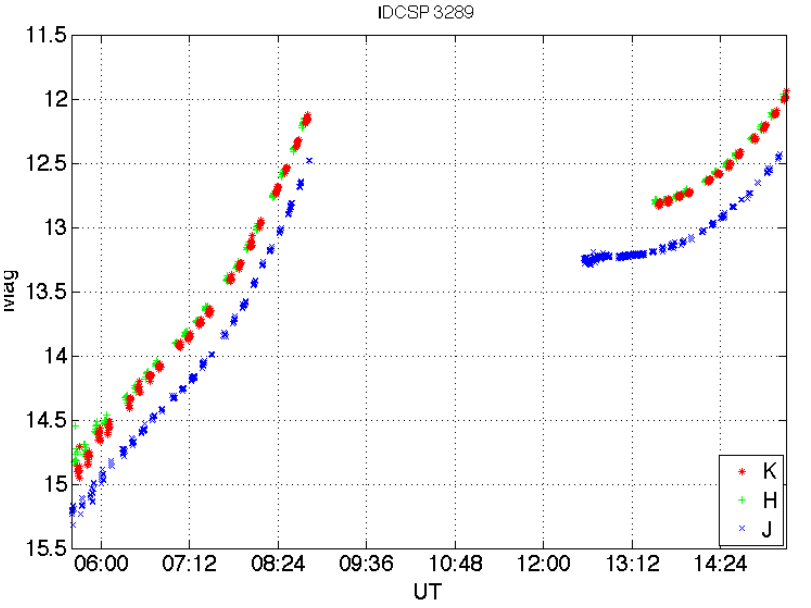


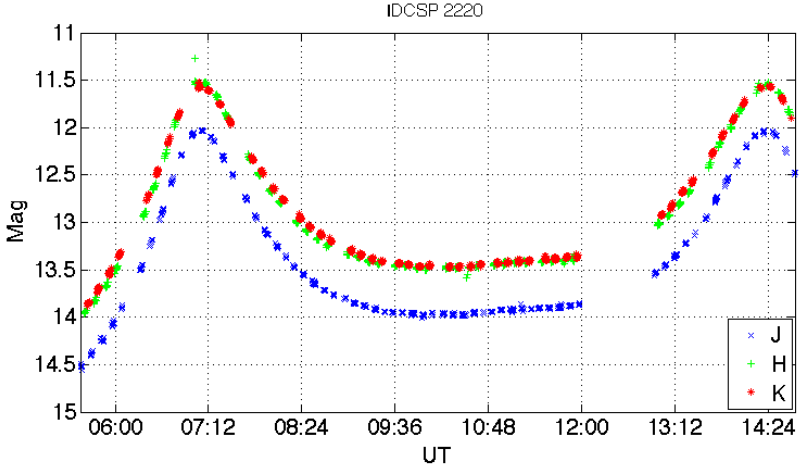
vs SPA

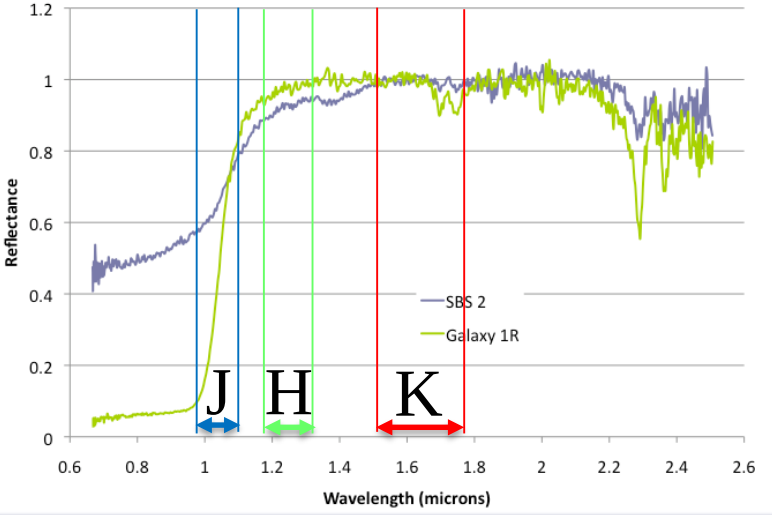


IDCSP Lightcurves & IRTF Spectra









All spectra are scaled to 1.0 at 1.6 microns. Abercromby et al., 2009

SSN 25126

Top Spectrum

Bottom Spectrum

x 10^4

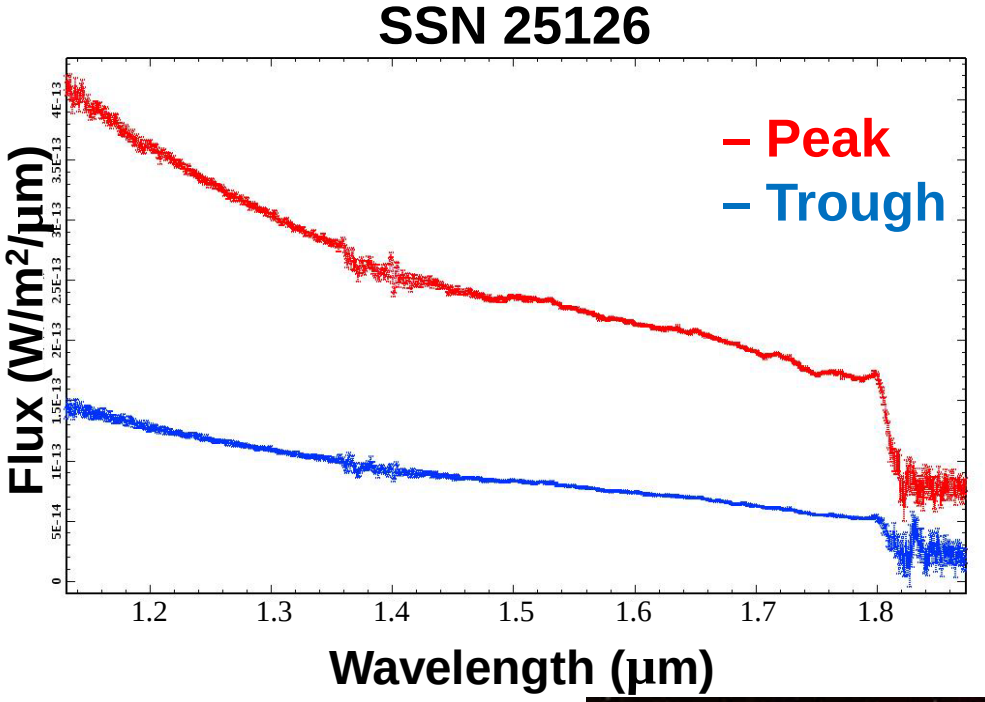
2.5
2
1.5
1
0.5

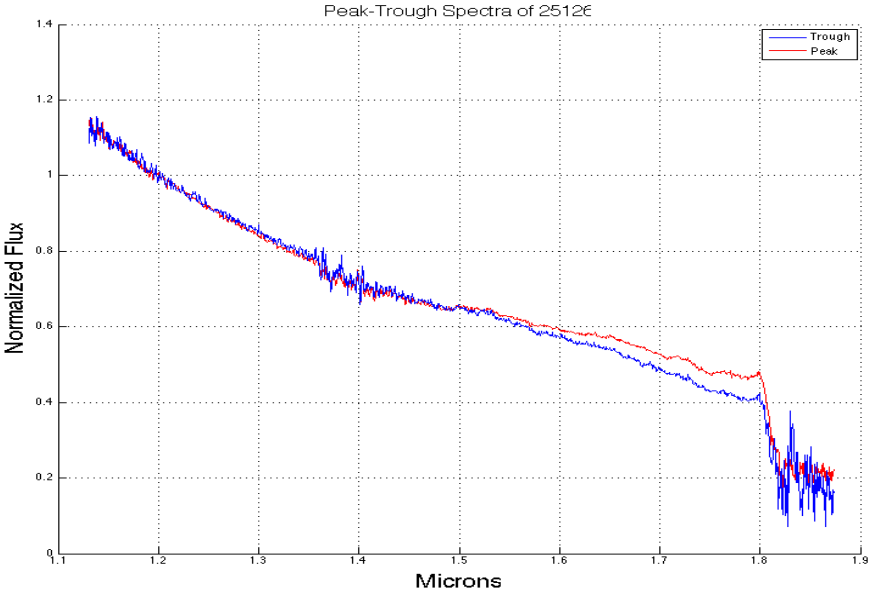
Guider Counts

03:10
03:15
03:20
03:25
03:30
03:35

HST

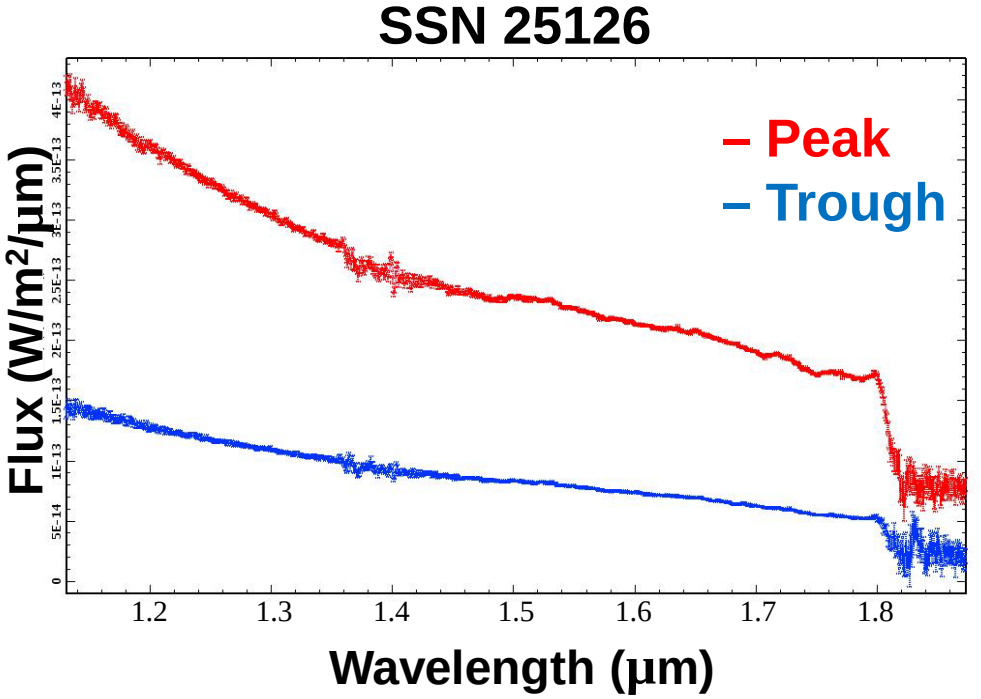
SSN 25126 (AsiaSat) Spectra

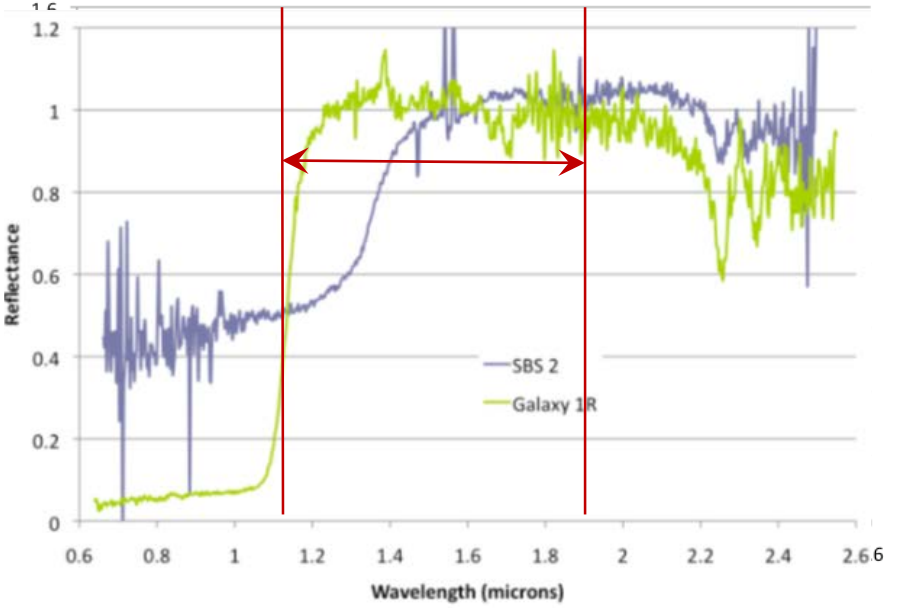




- **Normalized by solar analog to account for atmospheric lines**
- **Note the differing wavelength regimes (x-axis)**

SSN 25126 (AsiaSat) Spectra





IRTF spectra
Scaled to 1.0 at 1.6µm
Abercromby et al., 2009

- **Normalized by solar analog to account for atmospheric lines**
- **Note the differing wavelength regimes (x-axis)**

UKIRT

- **Future work**
  - Full Near-IR 1-5 μm spectra from UIST
    - Similar features to the IRTF spectra are seen in some targets
  - Mid-IR photometry and spectroscopy from Michelle (8-25 μm)
  - More WFCam photometry
    - Debris from GEO: Titan, Ekran
    - Non-functional satellites
    - Rocket bodies


NASA

Backup Slides