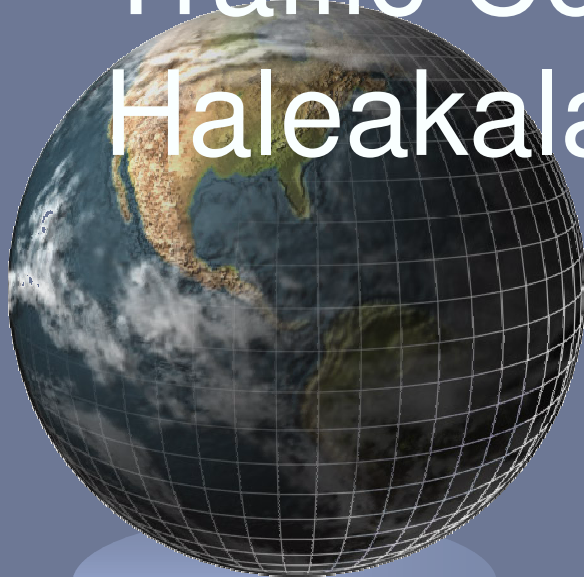
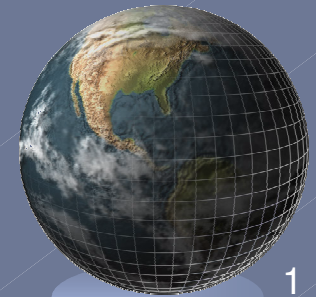


Implementation of the LASER Traffic Control System at Haleakala Observatories



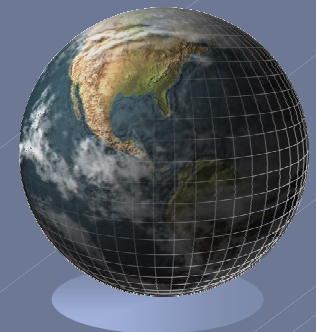
D.O'Gara, E.Kiernan-Olson, C.Giebink, University of Hawai`i Institute for Astronomy
D.Summers, W.M.Keck Observatory

17th International Workshop on LASER Ranging Bad Kötzting, Germany,
May 16 – 20, 2011



Background Story

- LURE operates at Haleakala Observatories from 1972-2004. The only other University of Hawai`i observatory is Mees solar observatory.
- Pan-STARRS (Panoramic Survey Telescope and Rapid Response System) is constructed at the LURE site. First light for PS1 was June 2006. Possibly 4 Telescopes in Final Configuration.
- TLRS-4 is installed at Haleakala in 2006 on the condition that the LASER does not interfere with Pan-STARRS operations.



“Streaks” in our Image

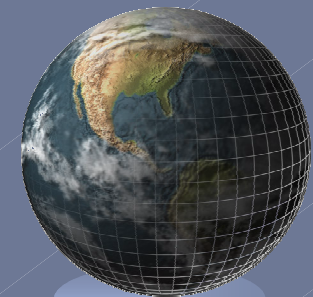
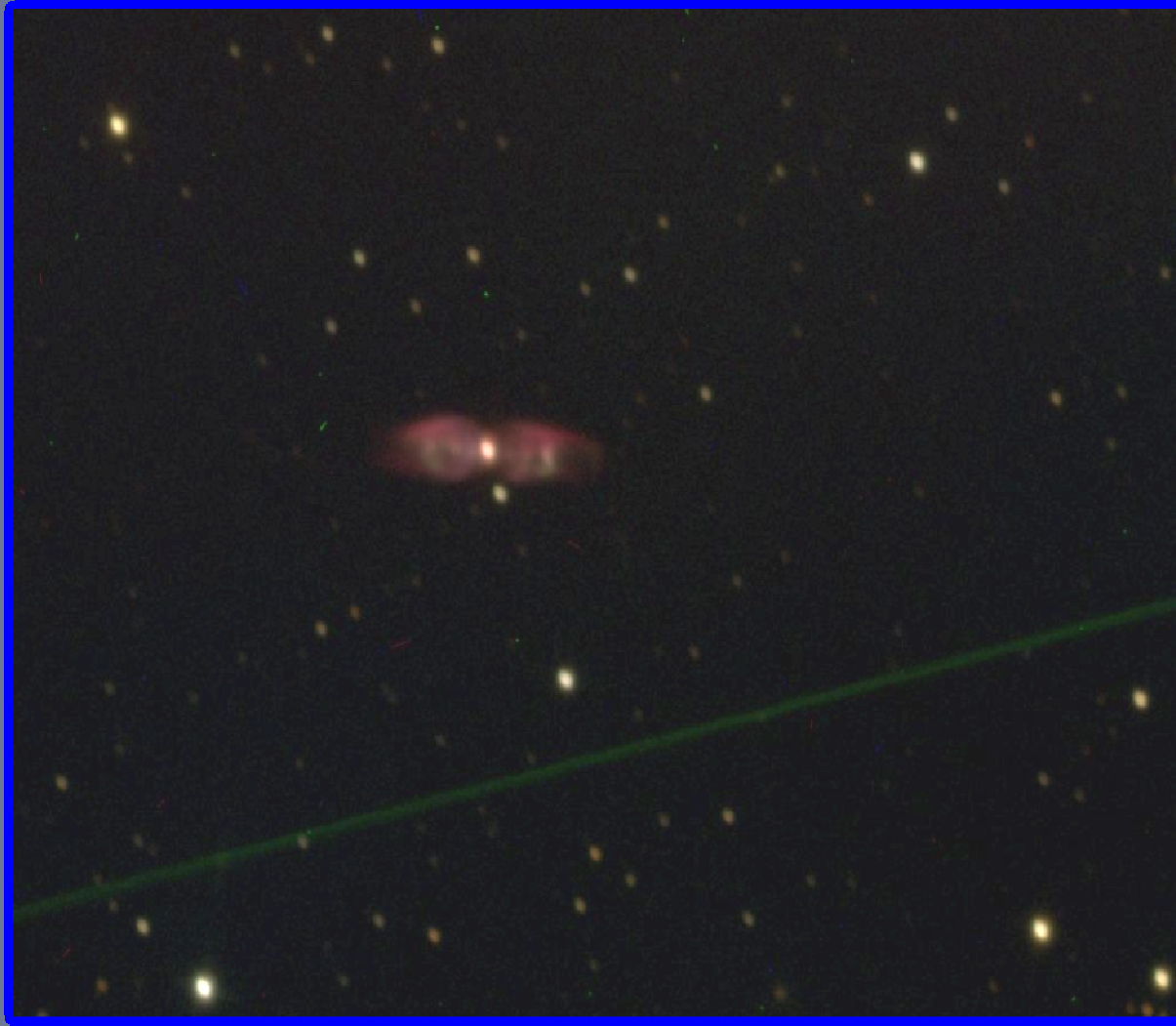
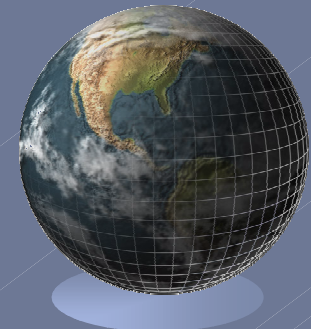


Image Courtesy LCOGT FTN

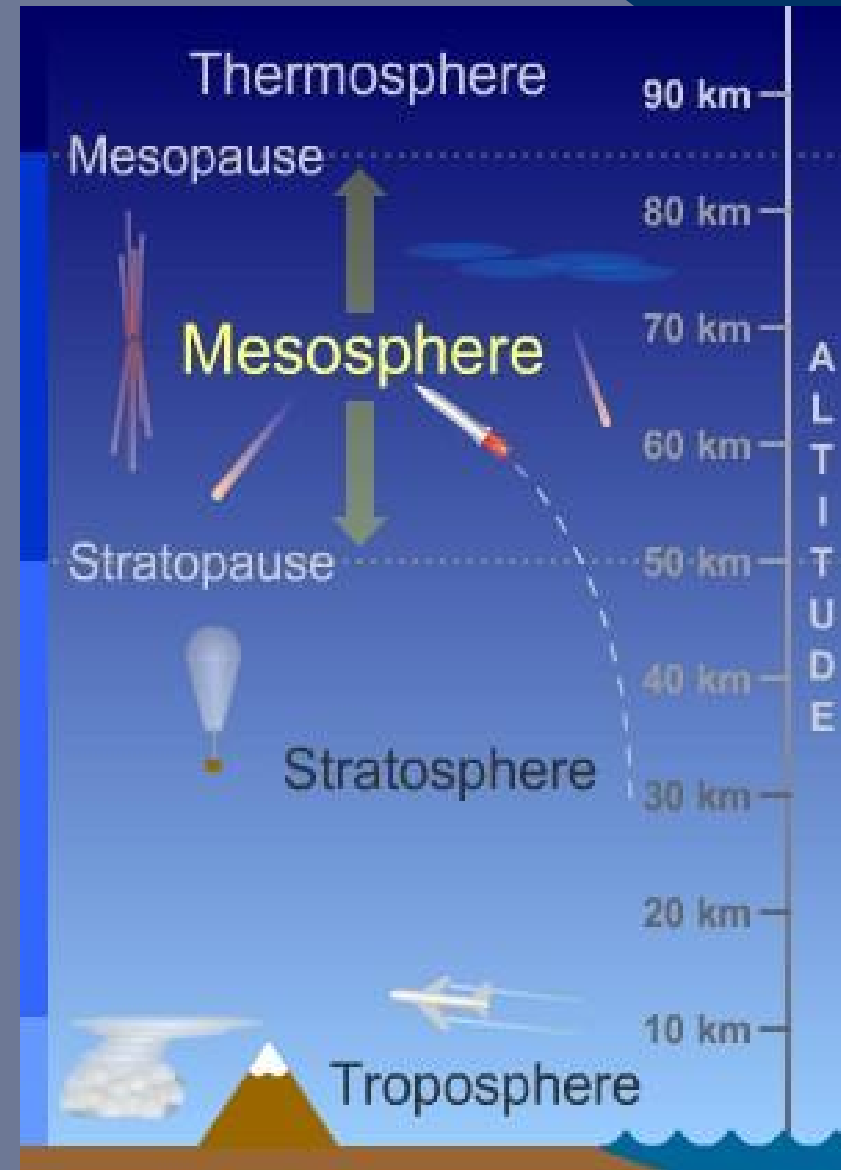


- The Mauna Kea Observatories has already solved a similar problem caused by the introduction of Adaptive Optics (AO) lasers in the early 2000's with the "LASER Traffic Control System".
- Maybe this "LTCS" can be used at Haleakala?



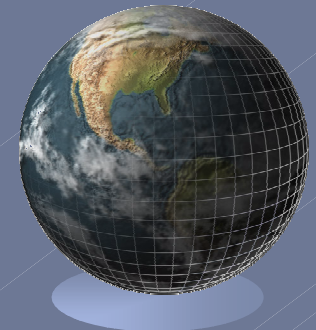
What is the LTCS?

- A Solution that prevents “collisions” between Laser Guide Stars (LGS) and another telescope’s FOV “cone”.
- AO Lasers cause fluorescence of the sodium layer in the upper Mesosphere (80-100 Km) to generate a Laser Guide Star.
- Rayleigh Scattering occurs in the lower atmosphere to about 50 Km (Troposphere and Stratosphere).



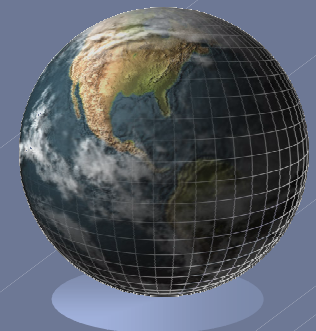
What is the LTCS?

- The Laser Traffic Control System (LTCS) developed by Mauna Kea Observatories.
- In use at Mauna Kea since 2002 (Keck I and II, Gemini North and Subaru Observatories).
- ...and by the William Herschel Telescope at La Palma since 2006.
- Discussions in progress for use at Gemini South.

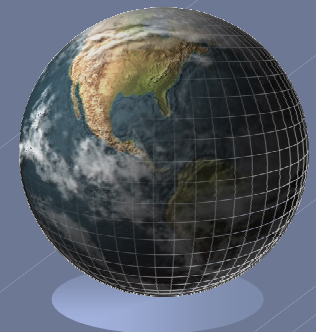


What is the LTCS?

- A Web based Client/Server system.
- Client observatories provide pointing information to the server via a URL (Universal Resource Locator).
- The server will analyze the geometry of all telescope pointing angles and FOV's to determine "collisions".
- Based on priority settings, lasers will be "shuttered" or not.
- System is usable for SLR by simple configuration changes.
- But there are incompatibilities!

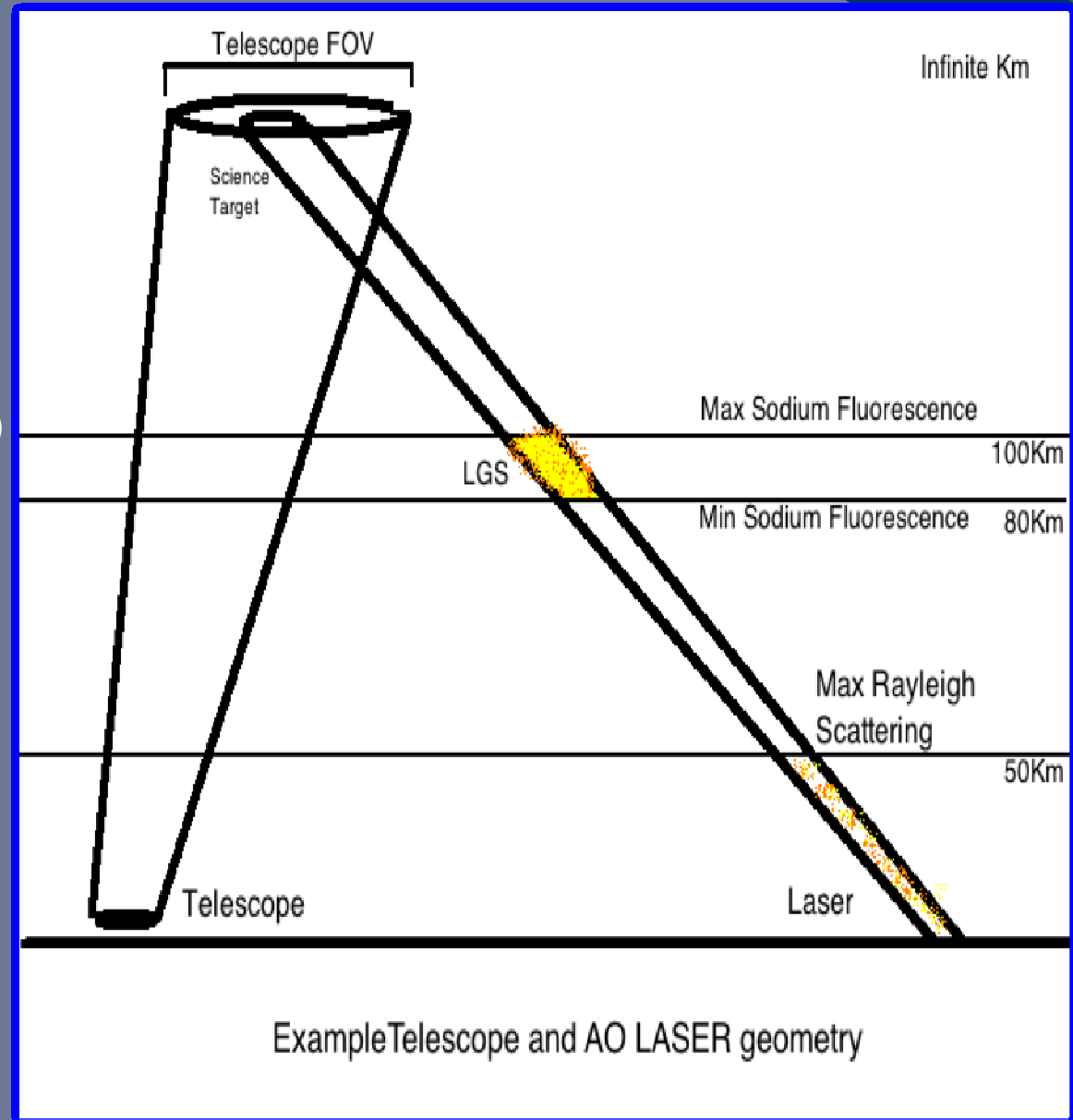


LTCS for AO
vs.
LTCS for SLR



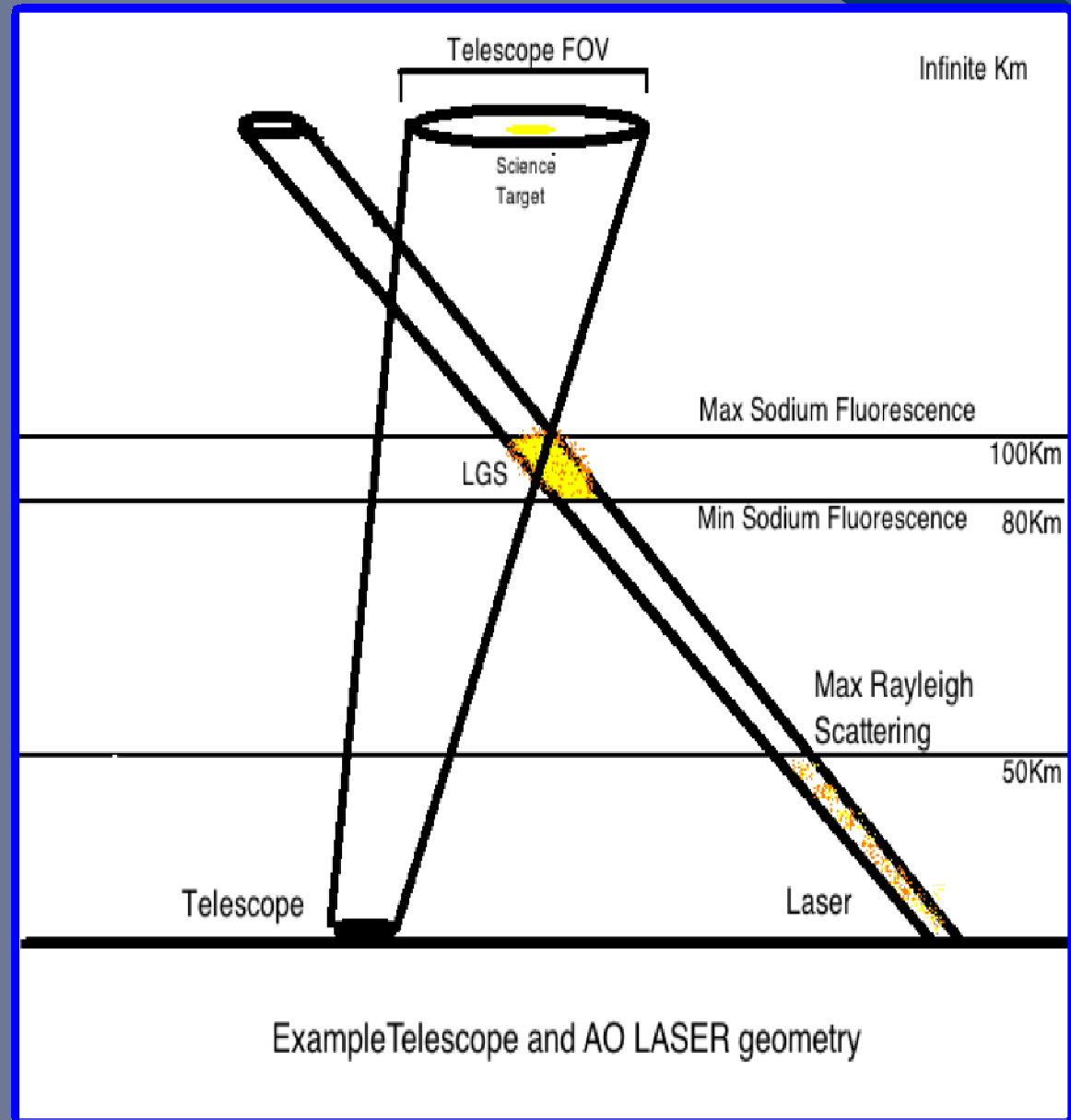
LTCS for AO

- Collision occurs if the Rayleigh backscatter or laser induced fluorescence (LGS) from an AO equipped telescope is detected by another telescope at the site.
- This is **NOT** an example of a collision.



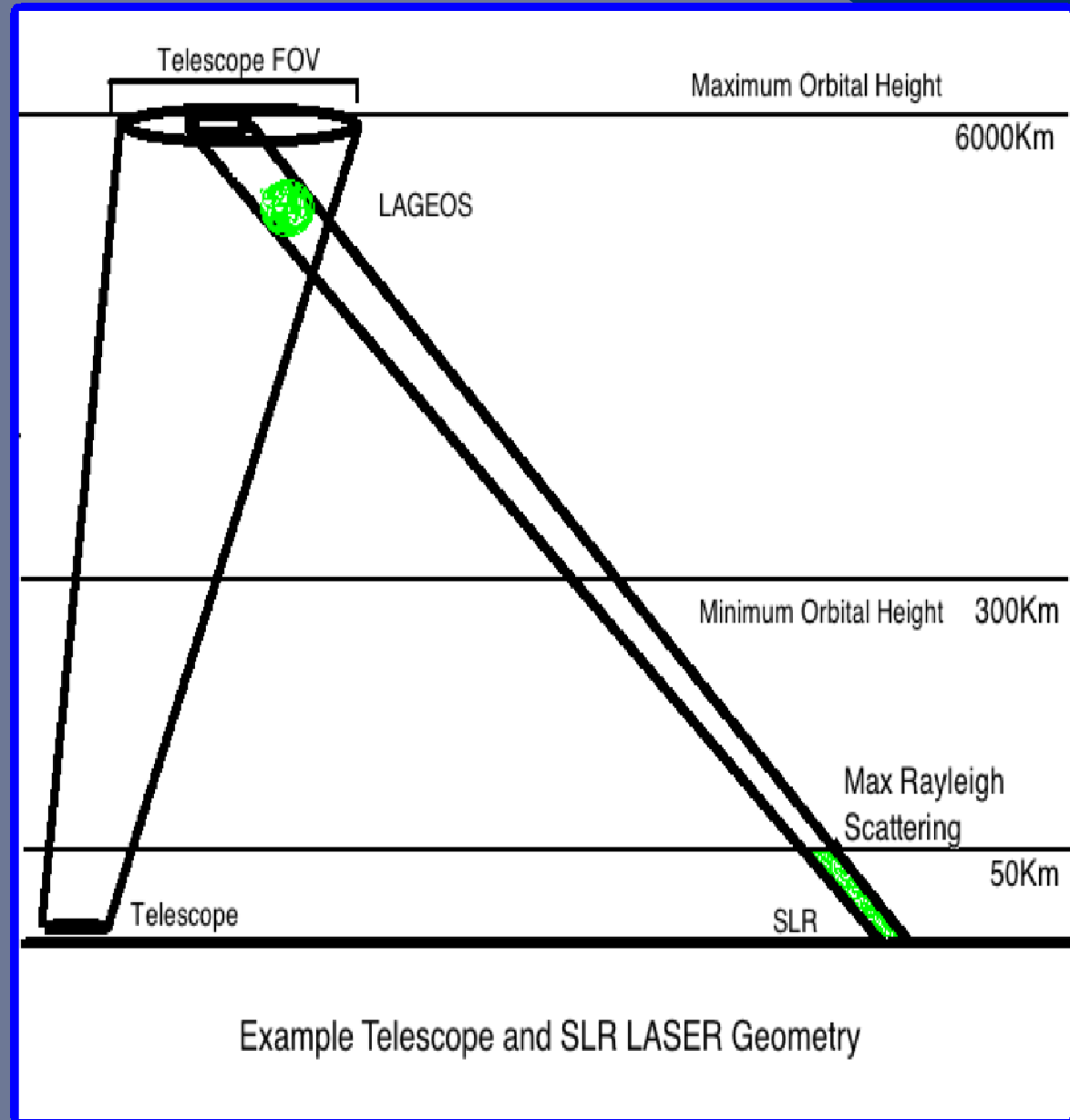
LTCS for AO

- This example of a Laser Guide Star (LGS) collision with a Telescope that is tracking a “Science Target”
- This **IS** an example of a collision.



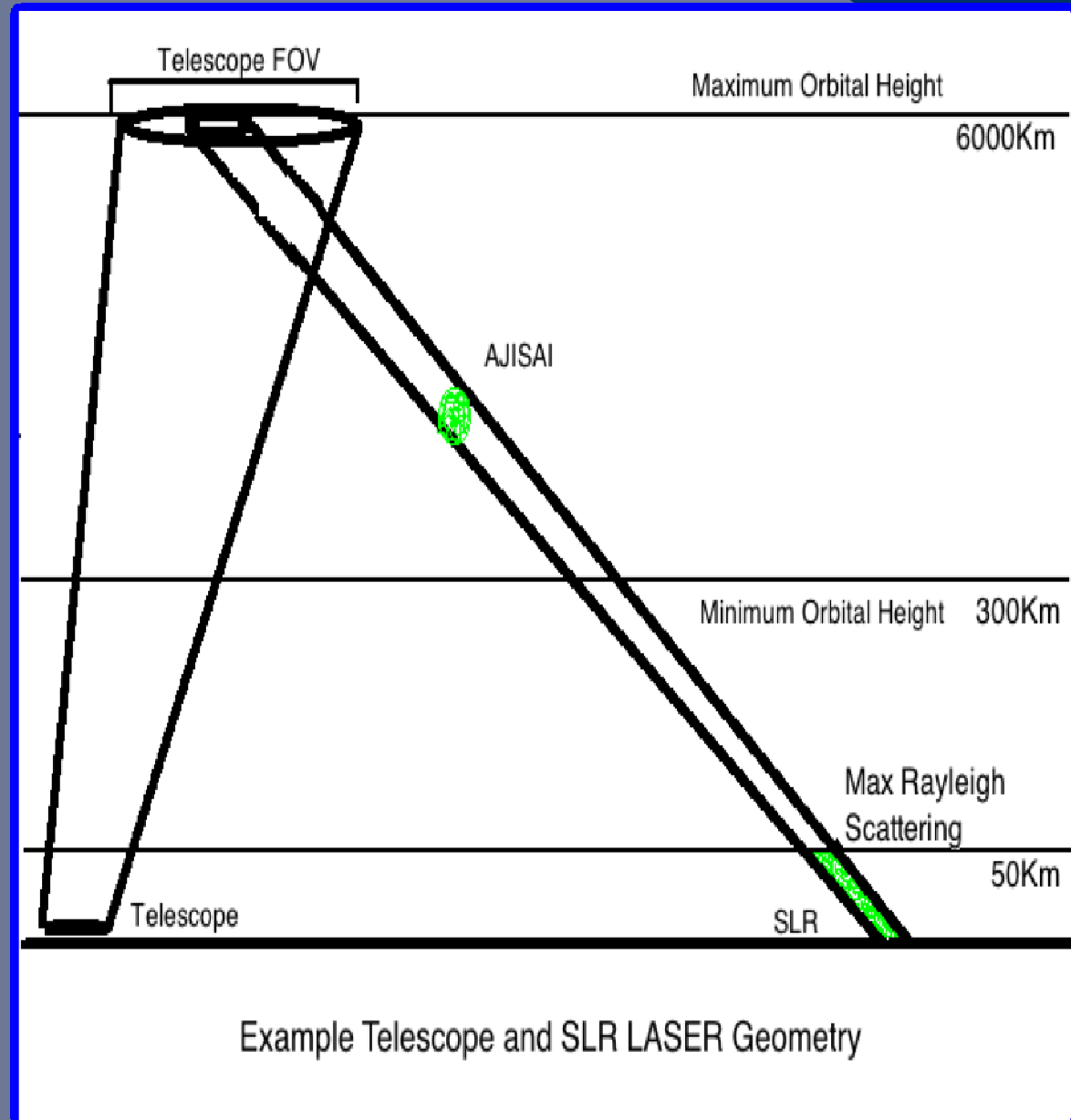
LTCS for SLR

- Redefine min and max heights for sodium layer to be min and max orbital heights
- Collision occurs if satellite tracks through the telescopes FOV.



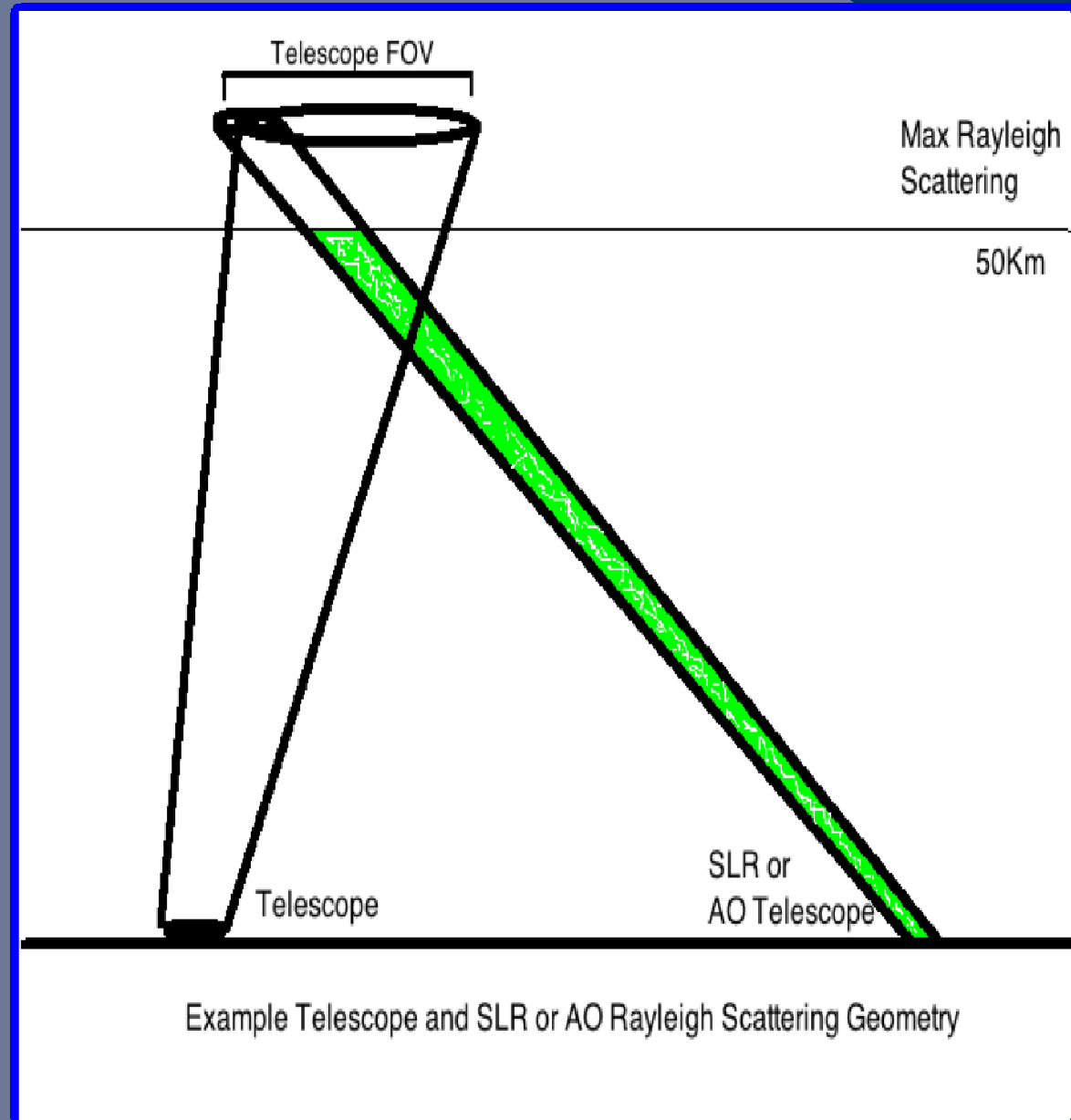
LTCS for SLR

- Collision occurs if SLR “Cone” tracks through the telescopes FOV.
- This is a **FALSE POSITIVE** collision.



LTCS for SLR

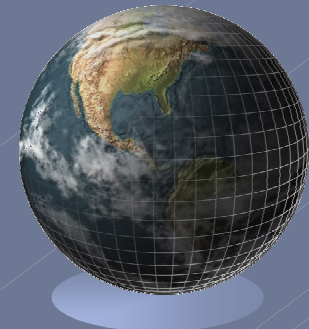
- Rayleigh Scattering collision is correctly calculated for SLR or AO equipped Telescope.



LTCS Requirements

- Telescope positions need to be fairly well determined.
- Schedules and pointing angles for all telescopes must be accessible.
- Sample URL. Retrieved by the Server via HTTP.

- `TIMESTAMP1=1304228999` # Time of URL update in Unix Seconds
- `TELESCOPE=TLRS4` # Telescope Name
- `RA= 4.60881` # Telescope Right Ascension in Hours
- `DEC= 61.87089` # Telescope Declination in Degrees
- `EQUINOX=2011.32943300` # Equinox and Epoch of coordinates
- `FOV=1.667` # Diameter of telescope Field Of View (FOV)
- `LASER_IMPACTED=NO` # Telescope is (or is not) LASER sensitive
- `LASER_STATE=ON` # Telescope is (or is not) projecting LASER light
- `LOG_DATA=ON` # Flag to enable/disable logging of pointing data
- `TIMESTAMP2=1304228999` # Time of URL update in Unix Seconds



LTCS at Halealaka Observatories



LTCS Haleakala Main Page

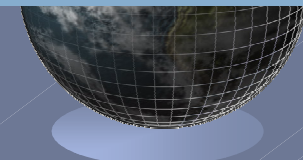
Status & Alarm Summary : Shows the current state of all lasers and telescopes, the collision predictions, laser shutter events, current collisions, and LTCS system health status.

Configuration : Overrides the values from the URL for a specific telescope (laser impacted, FOV, data logging).

Query Tool : Runs a simulation query mode where the user provides pointing info for a telescope or laser. Any predicted collision will be displayed to include who has priority in the collision.

[LTCS Main Page](#)
[Status & Alarms Summary](#)
[Configuration](#)
[Query Tool](#)

Original version from: CARA, W.M. Keck Observatory.



LTCS at Halealaka Observatories

Haleakala LTCS Status & Alarms Summary

Observatories

	URL State	OVR State	Laser Sensitive
FTN	OK	NO	YES
PS1	OK	NO	YES
PS2	OK	NO	YES
TLRS4	OK	NO	NO

Lasers

	Laser State	Shutter Event (site,duration)	Predictions (number, site list)
TLRS4	Shuttered	PS1, 2604 (secs)	None

Collisions

Laser	Scope	Started	Ends	Priority
TLRS4	PS1	18:10:43	18:54:08	PS1

Laser "ON" Preview (Predictions & Collisions)

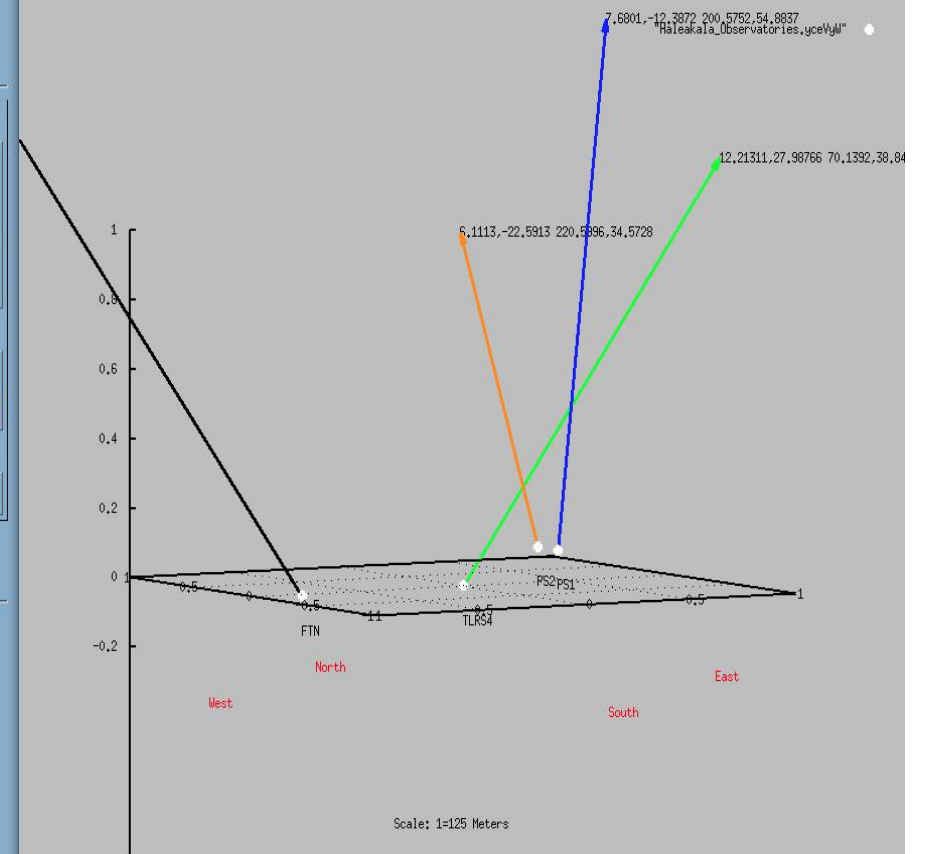
Laser	Scope	Starts	Ends	Priority
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Heartbeat Status

: Collector GA_Engine Status_Mgr

[LTCS Main Page](#)
[Status & Alarms Summary](#)
[Configuration](#)
[Query Tool](#)

Original version from: CARA, W.M. Keck Observatory.



Conclusions

- The basic design of the system has shown that it can be used by SLR sites that are also home to optical telescopes only.
- In order to be used at sites that operate SLR and AO lasers along with optical telescopes, methods to handle combined Laser Guide Star and SLR targets will need to be developed.
- Interface changes to support non-sidereal target modeling would prove beneficial for astronomical and SLR use. This feature enhancement has been discussed and may be added to LTCS in a future update.



Mahalo!

