

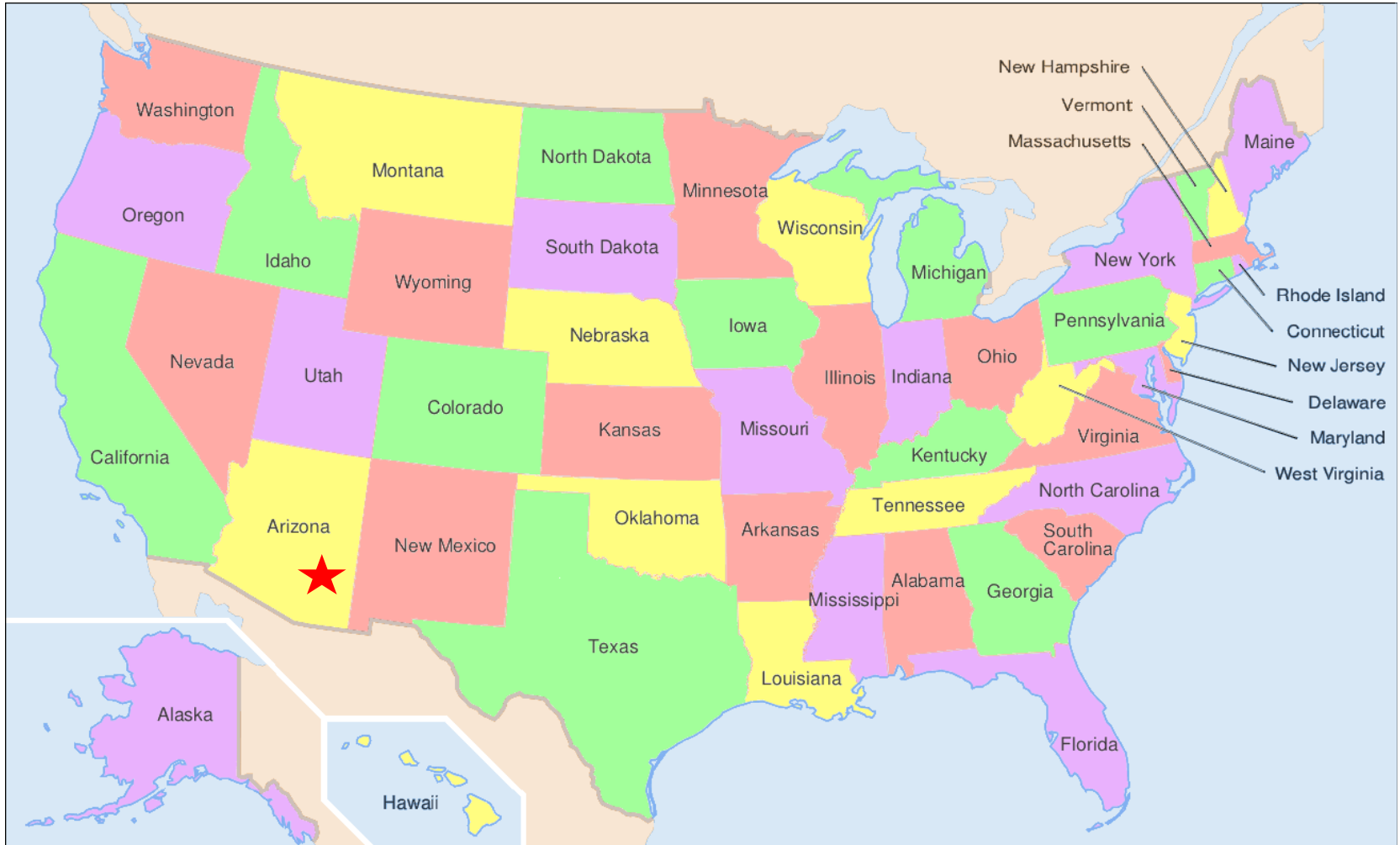
LGS Operations at the Large Binocular Telescope Observatory

Gustavo Rahmer
Laser Systems Engineer / LSO
Large Binocular Telescope Observatory
University of Arizona

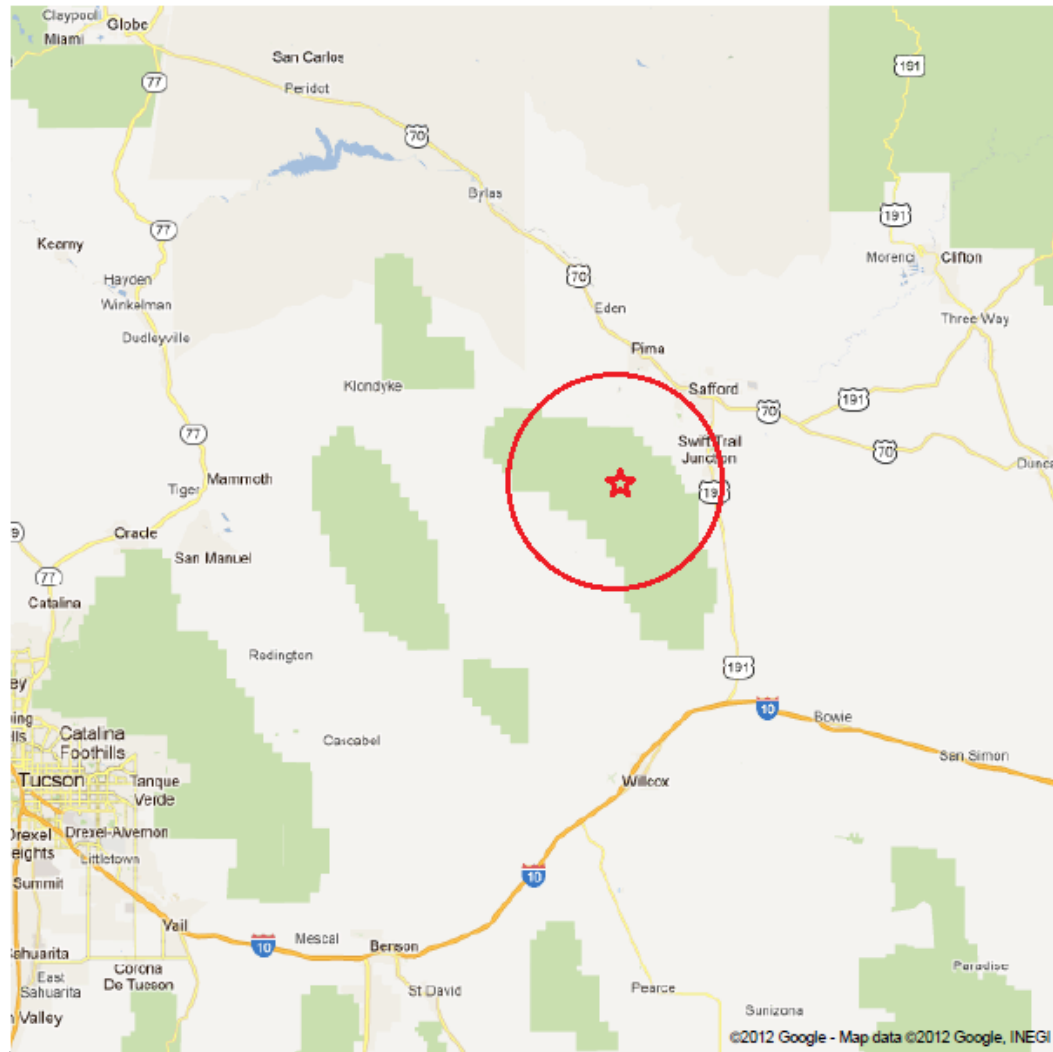
grahmer@lbto.org



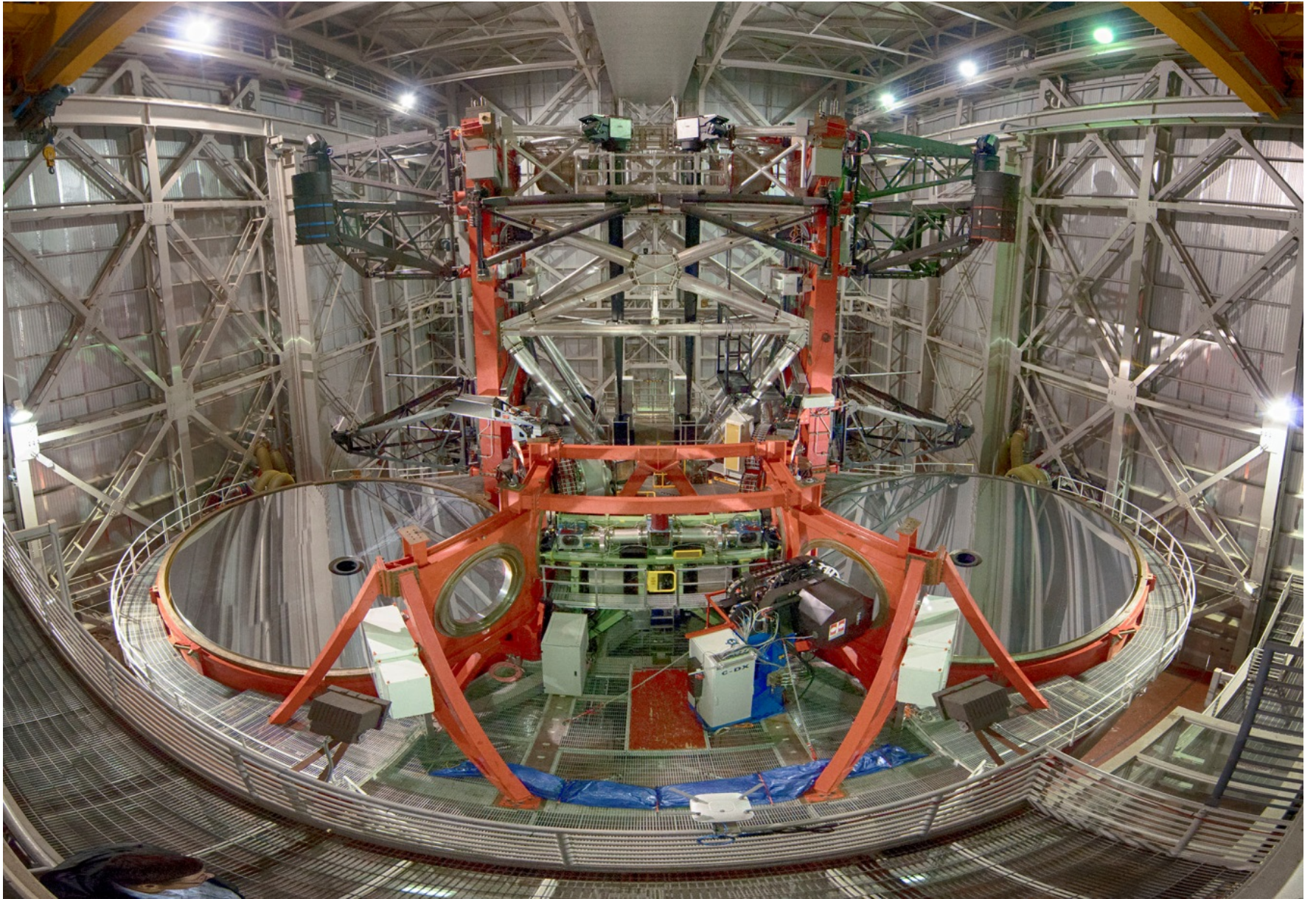
Where is the LBT?



Where is the LBT?

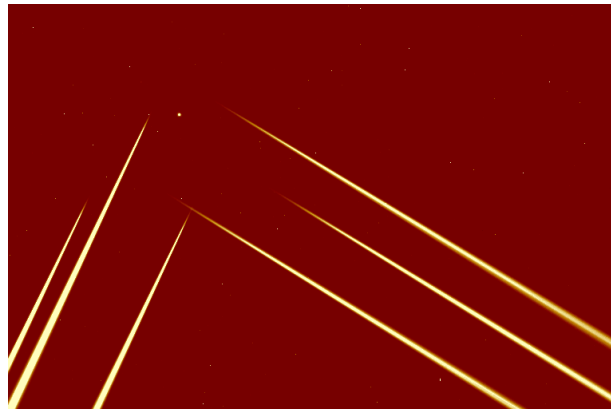
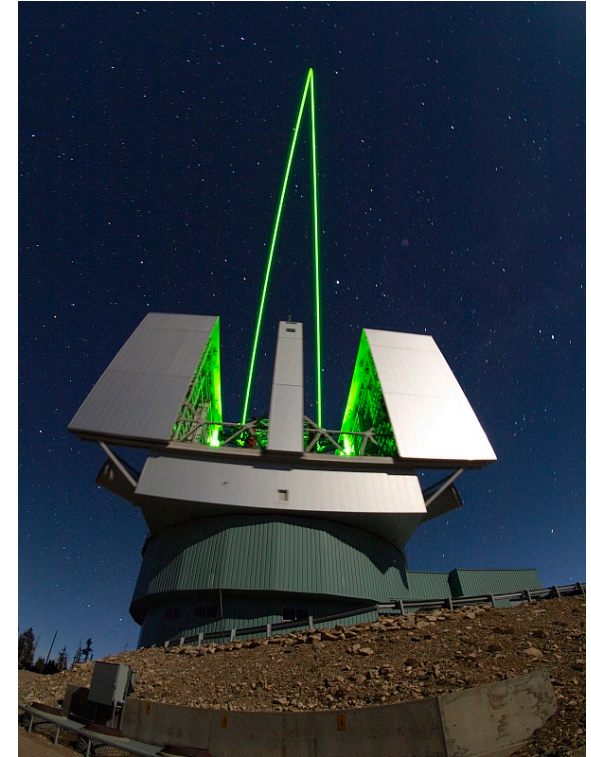




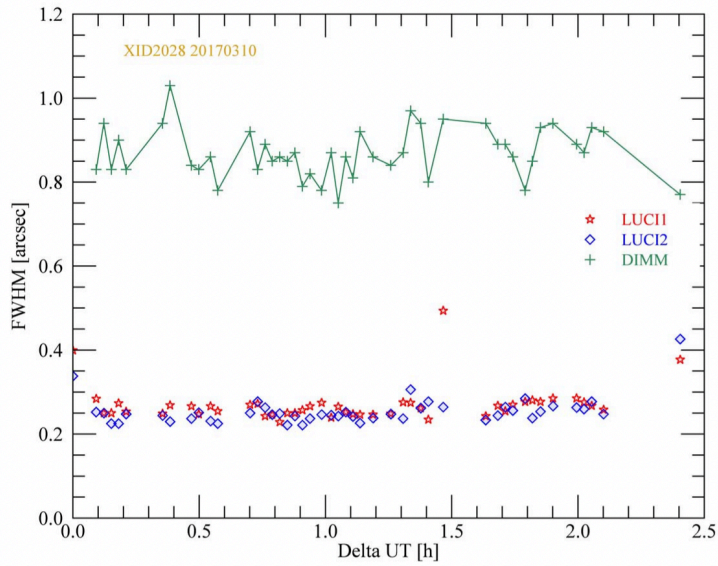


ARGOS: Ground-layer LGS @LBT

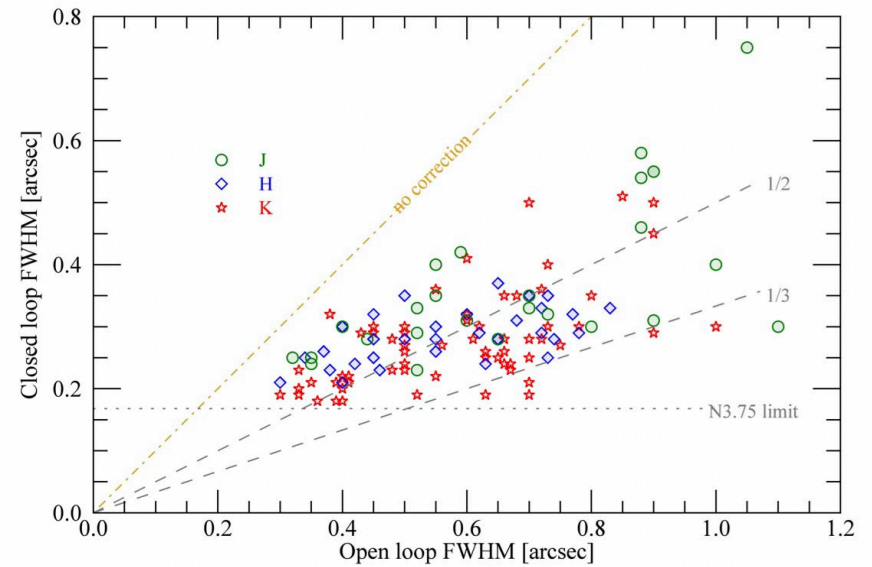
- Ground-layer AO for wide-field corrections (4x4 arcmin) → Correction factor of 2-3
- 3 “Rayleigh beacons” at 12 Km (above each mirror)
- Each laser: Nd:YAG, 18 W, pulsed @10KHz, 532 nm
- Designed to work with the two LUCI instruments (near-IR multimode)



ARGOS Performance



Temporal evolution of an imaging observation

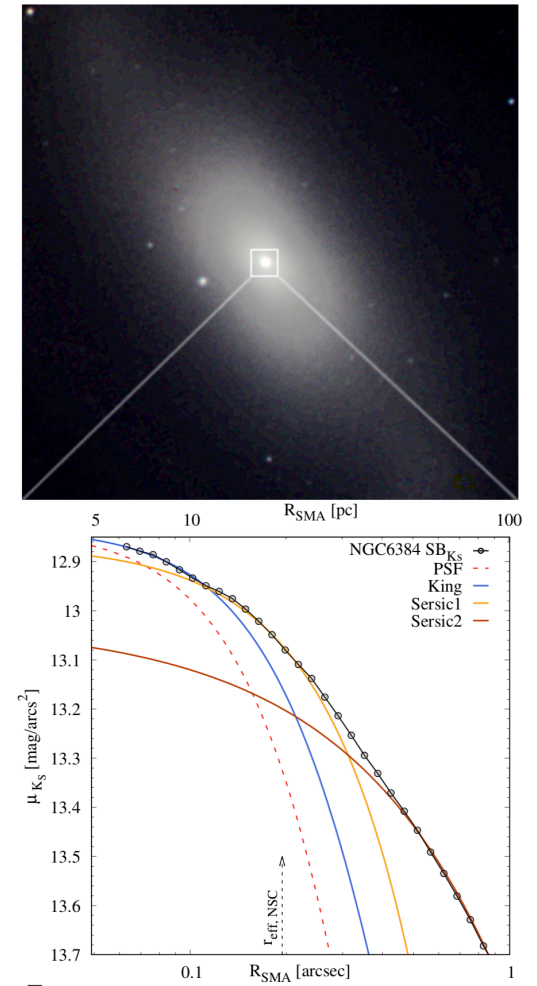


ARGOS commissioning performance plot

Science with ARGOS

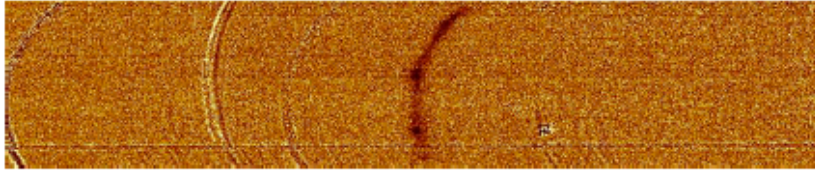


NGC 6384

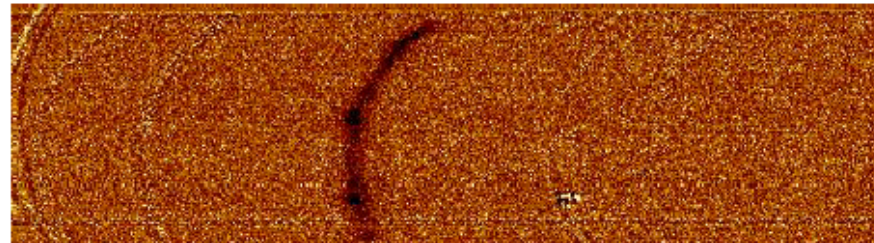
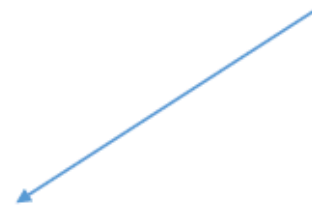
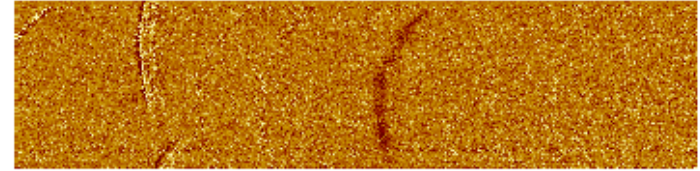


Science with ARGOS

LUCI1



LUCI2



Gravitational lensed arc $z=2.48$
SDSSJ1110. . Identical MOS Masks
with curved slits observed with
LUCI1 & LUCI2 simultaneously. 2h
integration time on each side add
up to 4h total on the H α line.

Science with ARGOS



NGC 2903

Laser Operations Challenges

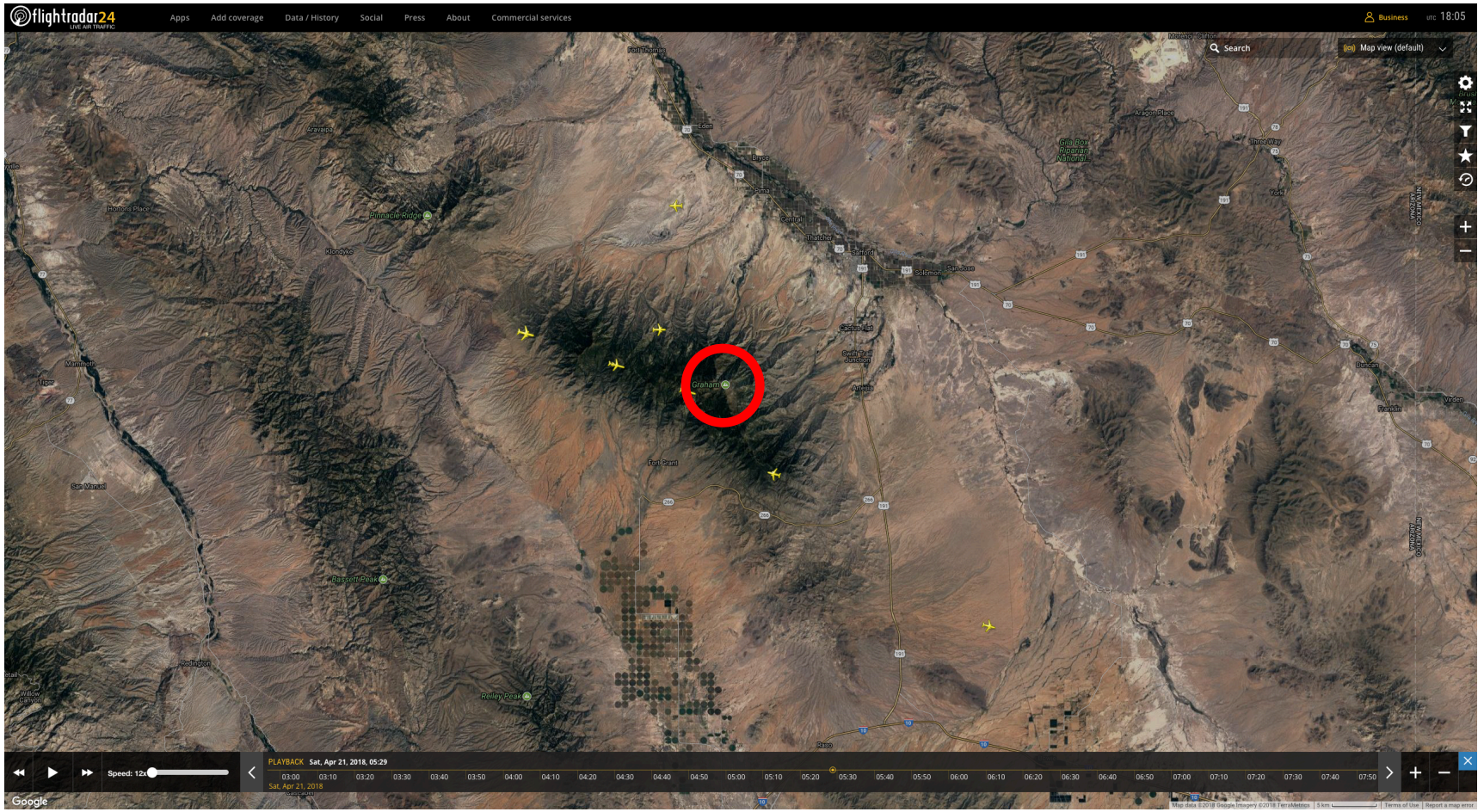
- Airplanes



- Satellites



Aircraft Safety



Aircraft Safety

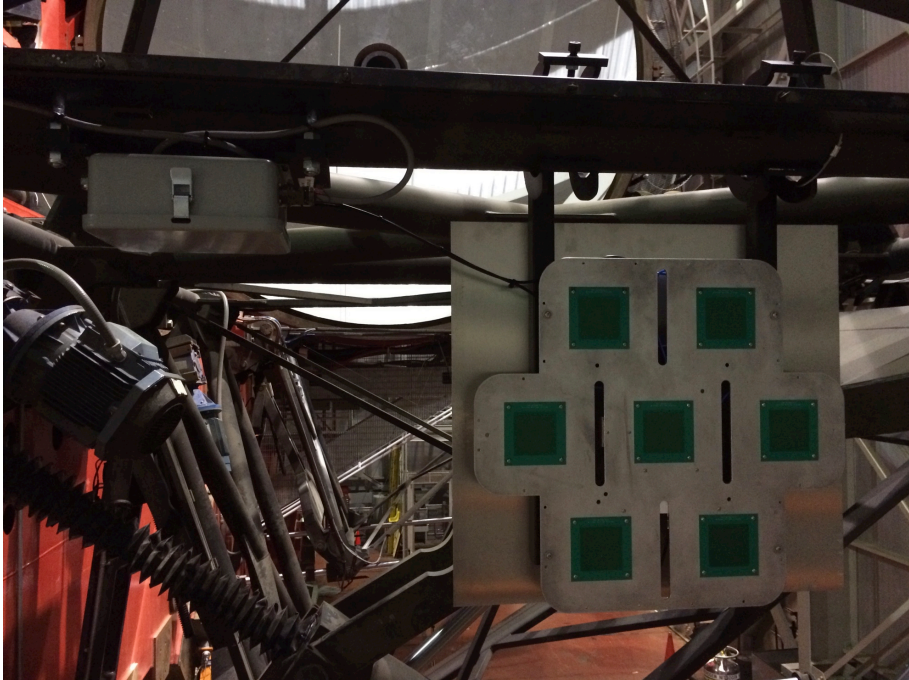
- Regulated by the FAA
- FAA Advisory Circular 70-1
- Registration process: Form 7140-1 Notice of Proposed Outdoor Laser Operations
- Letter of Determination:
 - Location
 - Minimum elevation angle
 - Aircraft spotters
 - Coordination requirements (ATC, Military)



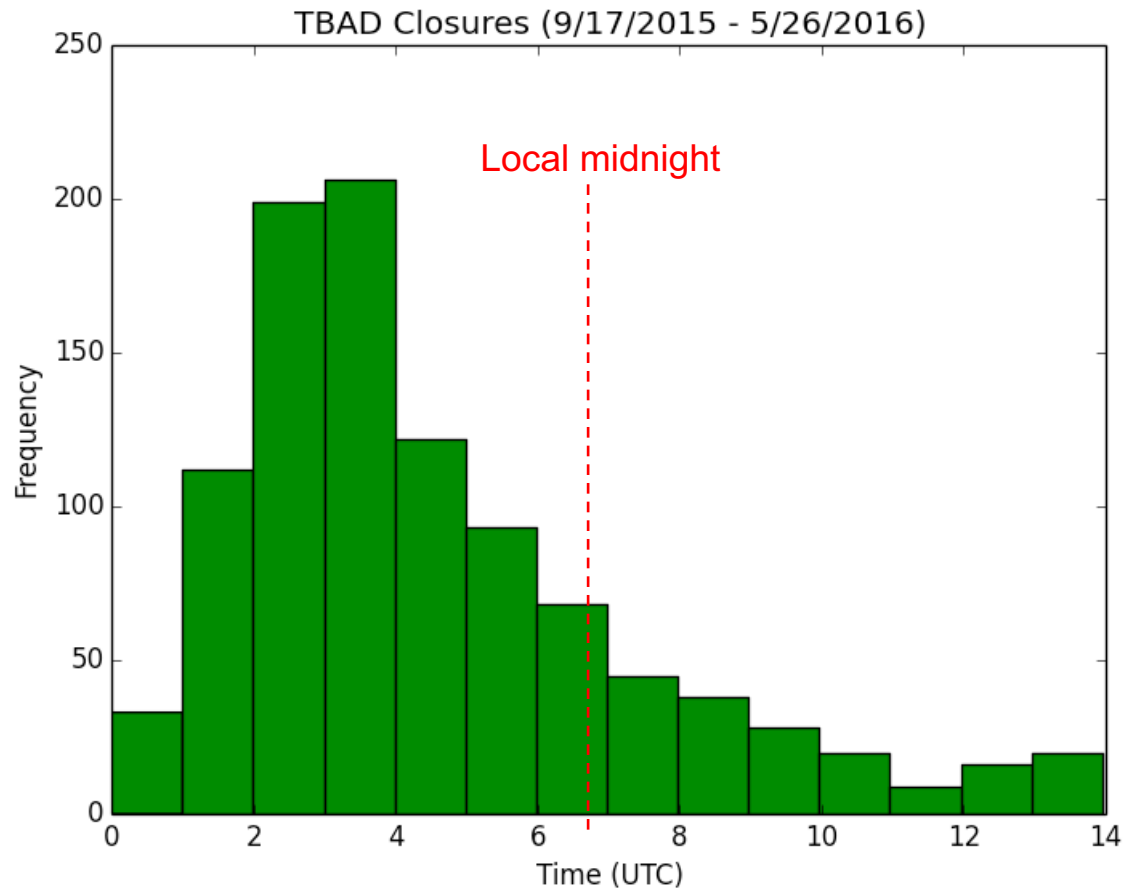
Aircraft Safety

- Automatic aircraft detection:
 - Local radar.
 - Cameras (Vis/IR).
 - TBAD (Transponder-Based Aircraft Detection).
- SAE AS6029A, “Performance Criteria for Laser Control Measures Used for Aviation Safety” (2013).
- LOD (Letter of Determination) for TBAD-only operation received on October 2018, following LBTO’s statement of compliance with SAE AS6029A.

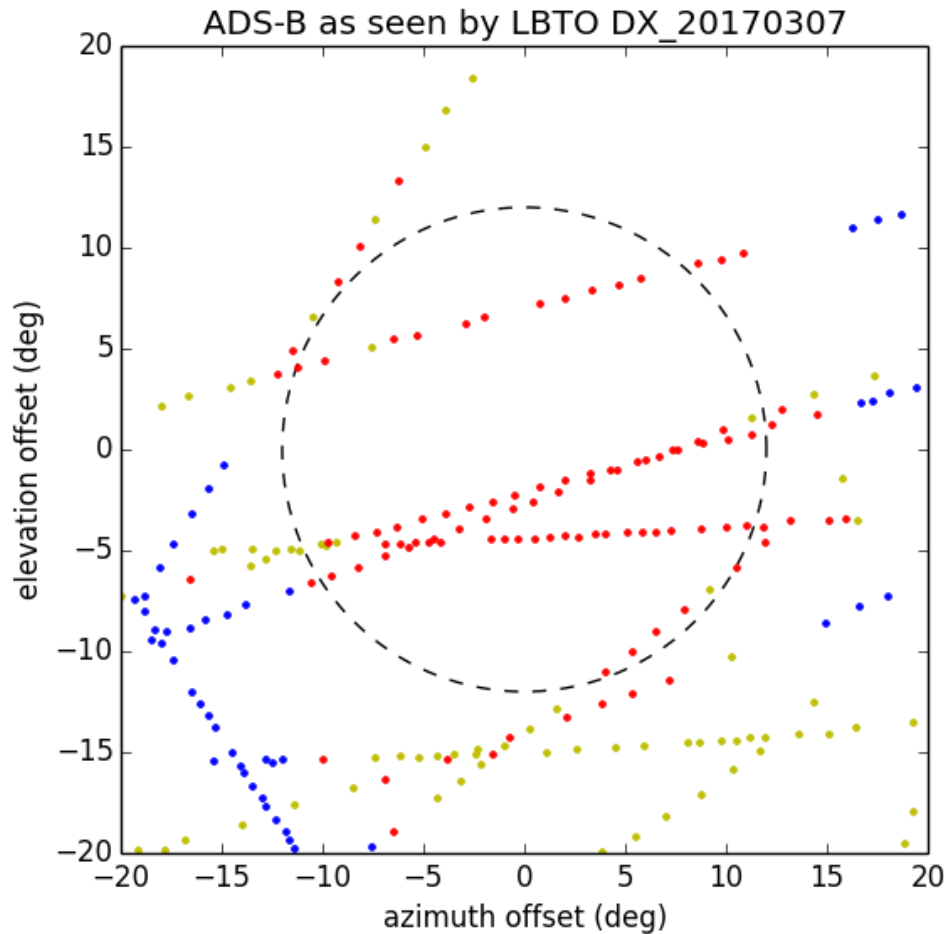
TBAD @LBTO



TBAD Detections Temporal Distribution



Trajectories computed from ADS-B data



Red: "in-beam," shuttered

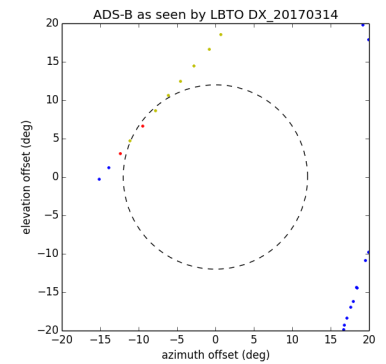
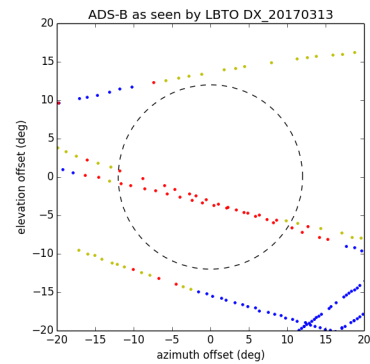
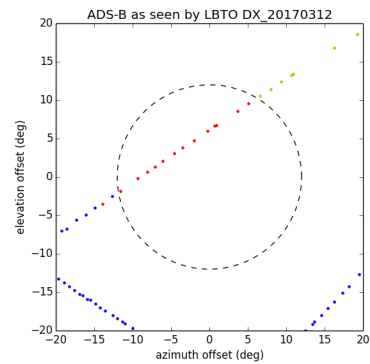
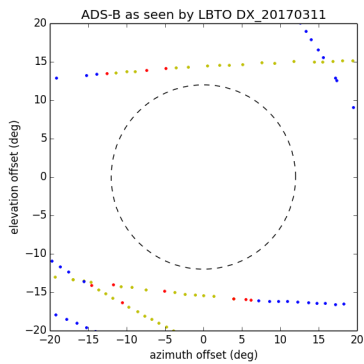
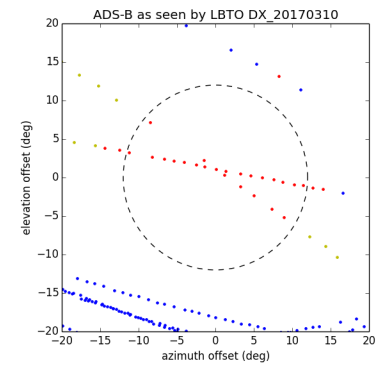
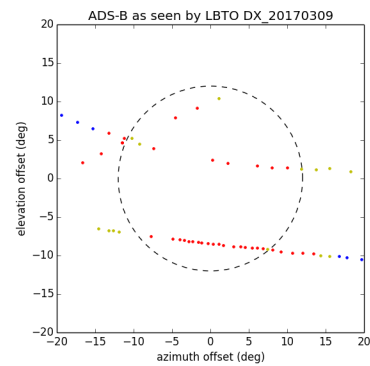
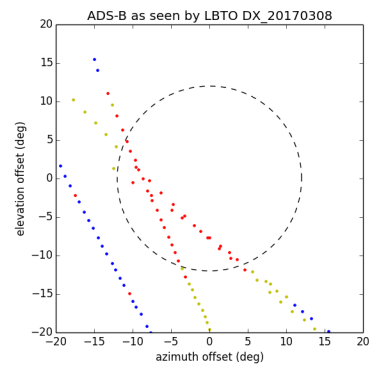
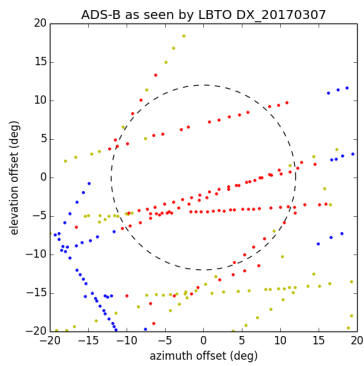
Yellow: shuttered

Blue: not shuttered

Self-assessment based on transmitted lat/lon and TBAD disposition to that transmission

(*) Automatic Dependent Surveillance – Broadcast

Trajectories computed from ADS-B data



LGS Operation Issues @LBTO

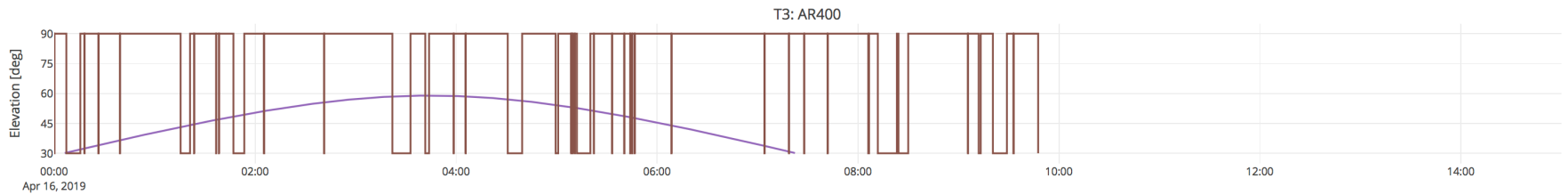
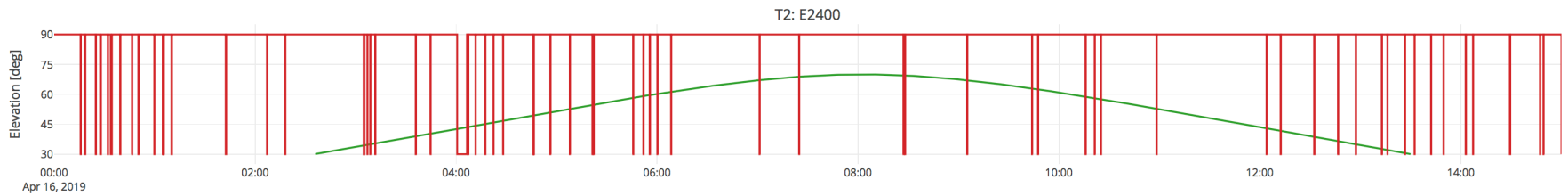
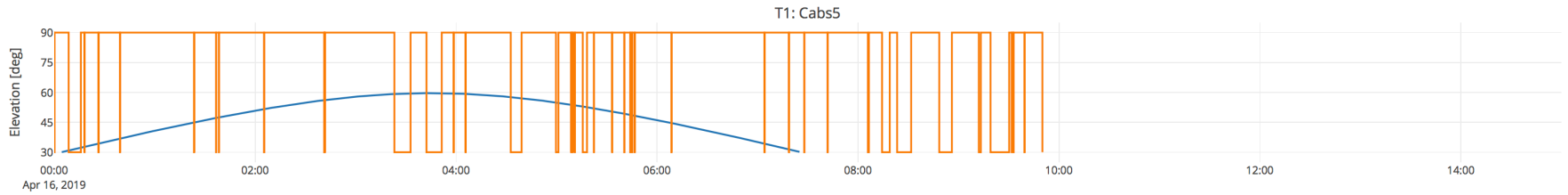
- Air traffic:
 - Nearby airports: PHX and TUS.
 - Higher frequency during the first third of the night.
 - Traffic mostly West – East (California to Texas/Florida).
 - Human spotters interaction (not anymore!).
 - TBAD keeps shutter signal active for 10 sec after end of detection.
 - Science camera execution script is manually paused when there is a chance of closure.

Satellite Avoidance

- DOD Instruction 3100.11, “Illumination of Objects in Space by Lasers”
- Groups involved:
 - US Strategic Command's Joint Functional Component Command for Space (JFCC SPACE).
 - Joint Space Operations Center (JSpOC).
 - Laser Clearinghouse (LCH).

Satellite Closures

Satellite Closures (2019-04-16 UTC)



LGS Operation Issues @LBTO

- Satellites:
 - Mostly very short closures (3-10 seconds).
 - Extra guard of 2 seconds before and after.
 - Keep-Out-Cone: no apparent impact of reducing half-angle from 1.8° to 1.0°
 - Blanket closures not a regular occurrence.
 - A few cases of targets almost completely blocked.

