Towards Turnkey SLR Systems:

New ESA Laser Ranging Station (ELRS)

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21st International Workshop on Laser Ranging, Canberra, November 5-9, 2018

Introduction

- A bit of history ...
  - Initial ideas iterations started at the beginning of 2016
  - Modern SLR system, but low budget, COTS driven implementation satisfying the high performance requirements for the variety of planned usage
  - ELRS project started at the beginning of 2018
  - Contract duration of 24 months including commissioning (Tenerife reference site)

- ESA/ESOC objectives for own SLR station (ELRS)
  - State-of-the-art
  - Turnkey solution
  - Flexible
    - Multi-mission, multi-customer LRS for various applications (Space Situational Awareness, Space Traffic Mgmt., collision avoidance, re-entry prediction, contingencies, ILRS, ERS, ENVISAT, CryoSat, spacecraft fine positioning, electric propulsion monitoring from GTO to GEO, GNSS orbit calibration, precise orbit monitoring for science gravimetry, emergency spacecraft support, etc.)
    - Optical Ground Station for Space-to-Ground Laser Comm links from LEO / Lunar Orbits
    - Test bed for critical optical sensor technology developments & support industry in maturing commercial products
    - Gain operational expertise, advance station autonomy, etc.

ELRS Site

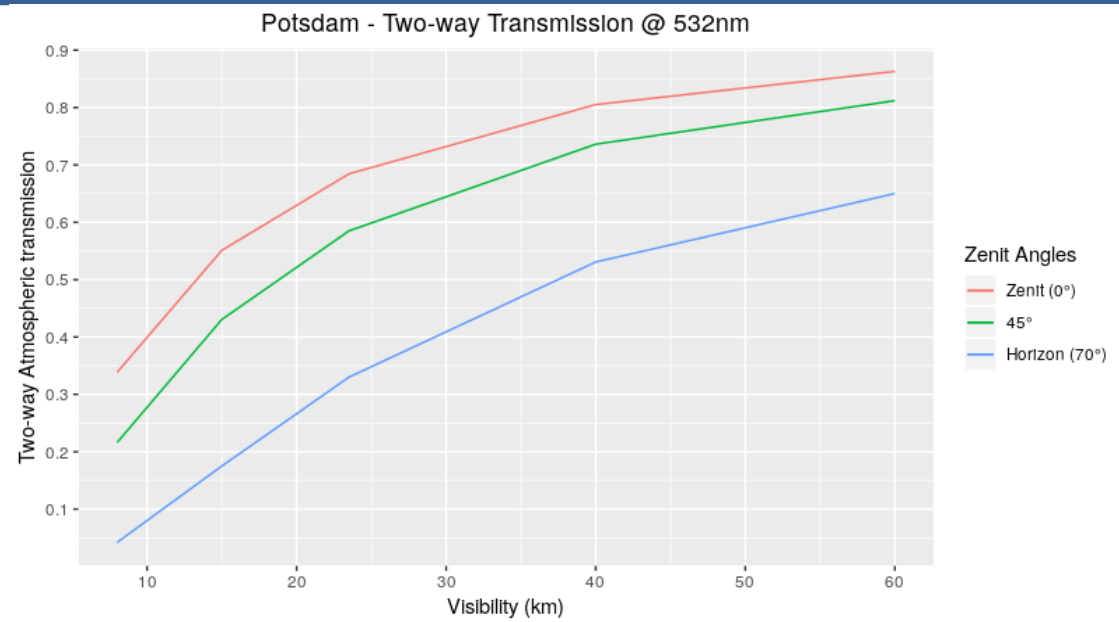
- Planned installation site
  - Observatorio del Teide on Tenerife/Spain
  - 2300m above MSL with very good seeing / atmospheric conditions
  - Limitation: Use of IR lasers at night only

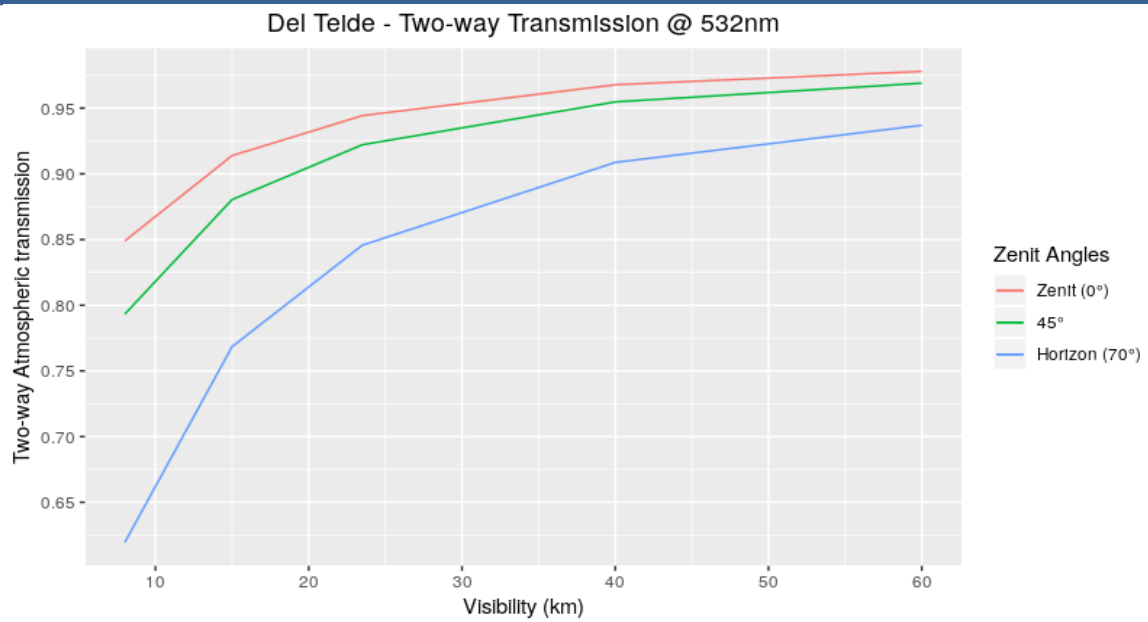
By Google Maps

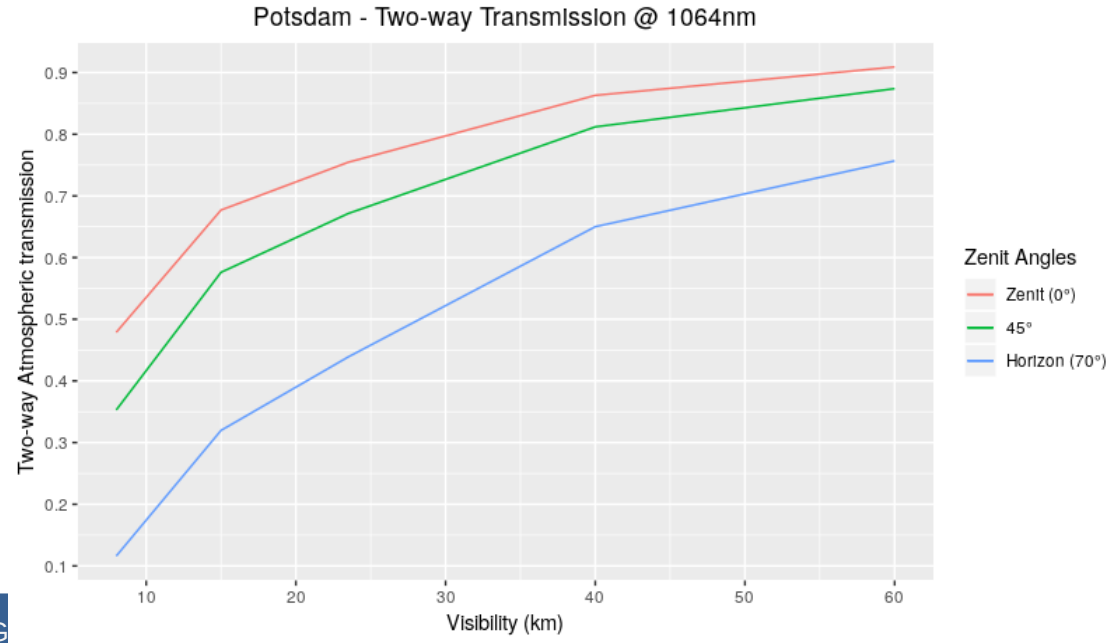
By Instituto de Astrofísica de Canarias - IAC

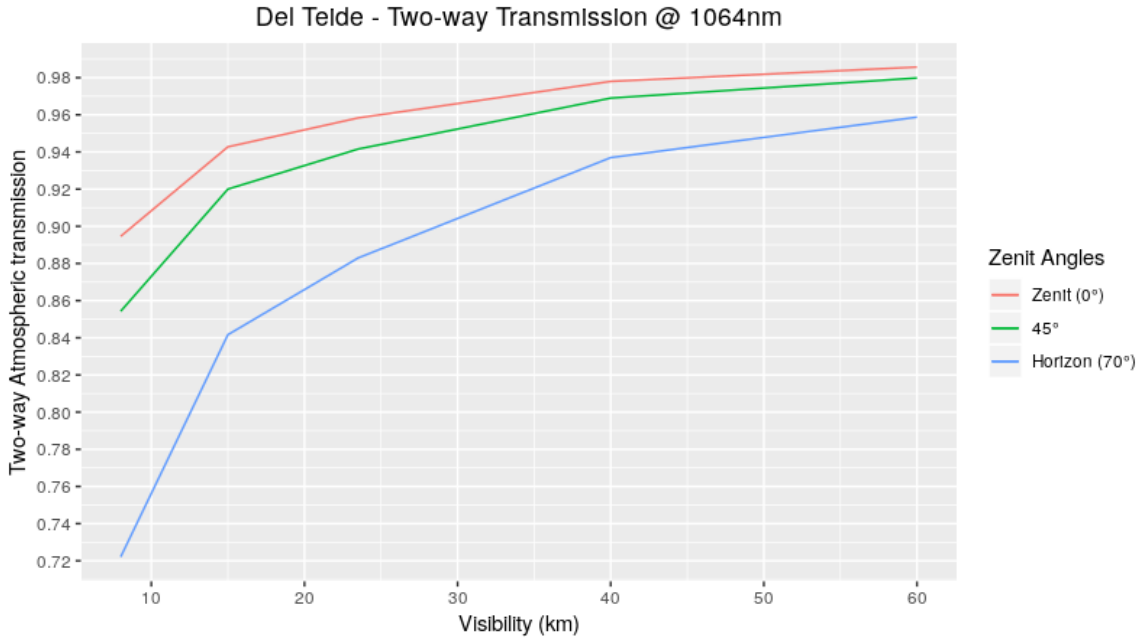
- Backup site
  - La Silla/Chile

Atmospheric Conditions: Potsdam vs. Observatorio del Teide









ELRS Team

- Consortium of European companies and institutes (D, A, CH, LV)
- Prime: DiGOS Potsdam GmbH (D)
- Team members:
  - Space Research Institute (IWF, A), Austrian Academy of Sciences [Graz SLR Station]
  - Astronomical Institute of University of Bern (AIUB, CH) [Zimmerwald SLR Station]
  - Institute of Astronomy, University of Latvia (LV) [Riga SLR Station]
  - ASA Astrosysteme GmbH (A)
  - Baader Planetarium GmbH (D)
  - Eventech Ltd. (LV)

ELRS Requirements

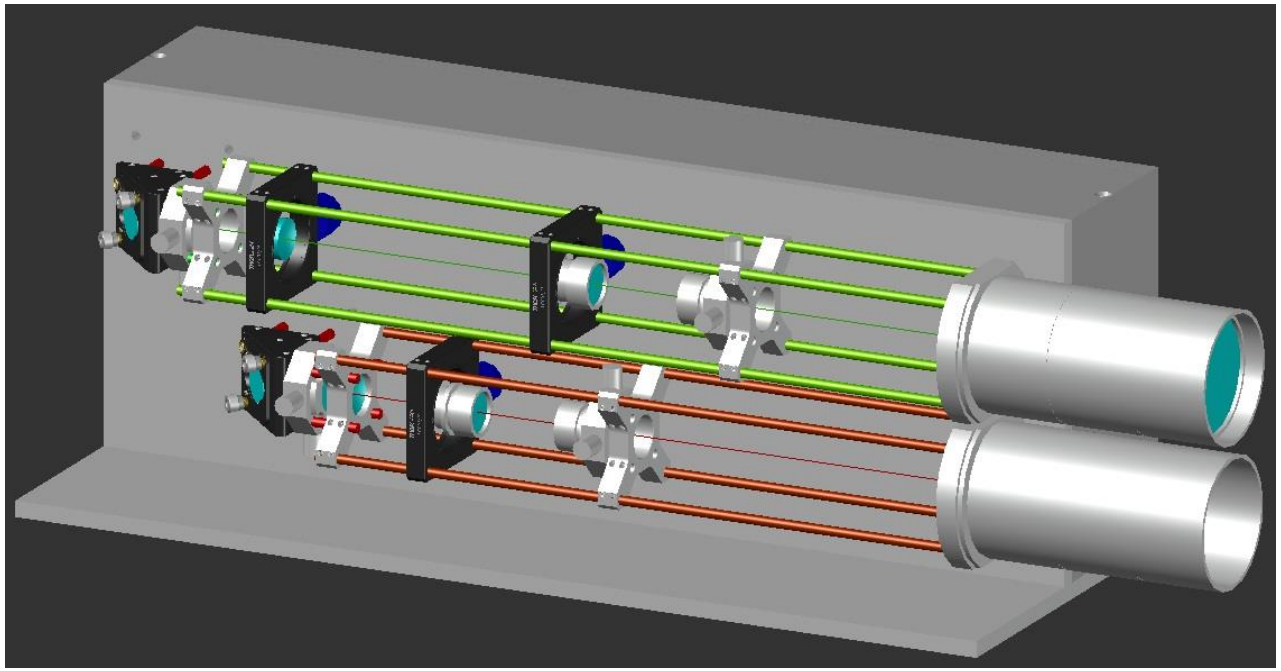
- Technical Key Requirements
  - Laser Ranging to cooperative targets as starting point
  - Telescope: 80cm, 4 foci, >85% reflectivity, blind pointing accuracy <5arcsec, jitter <1arcsec
  - Laser & detector: 532 & 1064nm operation
  - Debris camera: Demonstration of passive-optical space debris observation
  - Laser ranging tracking performance:
    - Galileo NP accuracy 10mm over 5min (goal: 5mm down to 15° elevation)
    - General tracking down to 15° elevation
  - Remote operation including station protection & laser safety subsystems
  - Site infrastructure: Building and interfaces are customer provided
- Flexible & support easy future upgrade capabilities
  - Space-to-ground laser communication
  - Laser ranging to non-cooperative (e.g. space debris) targets
  - General test-bed for other optical technologies
  - Full automated & autonomous operation

ELRS Design Overview / Key Elements

- Comprises mostly COTS based elements
- Astronomical telescope 4 foci (2 Nasmyth, 2 folded Cassegrain)
  - Off the shelf astronomical telescope with slight adaptations
  - Ritchey-Chrétien, 80cm main mirror, AltAz mount
  - Special feature: No Coudé path
- Picosecond laser
- Detector package attached to Nasmyth focus/port
- Debris camera for passive-optical space debris observation
- Eventech Event Timer & DiGOS/GFZ Range Gate Generator
- Slit-type dome for easy, weather independent access during HW upgrades, experiments, etc.
- SCOPE control, monitoring & operation system

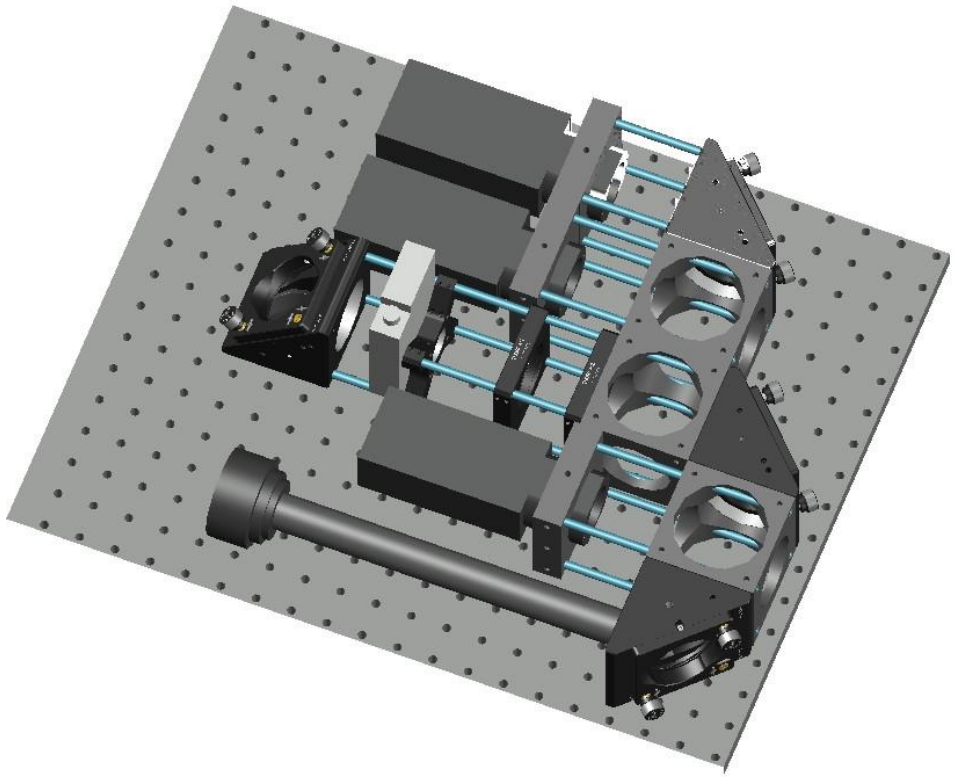
ELRS Laser Package

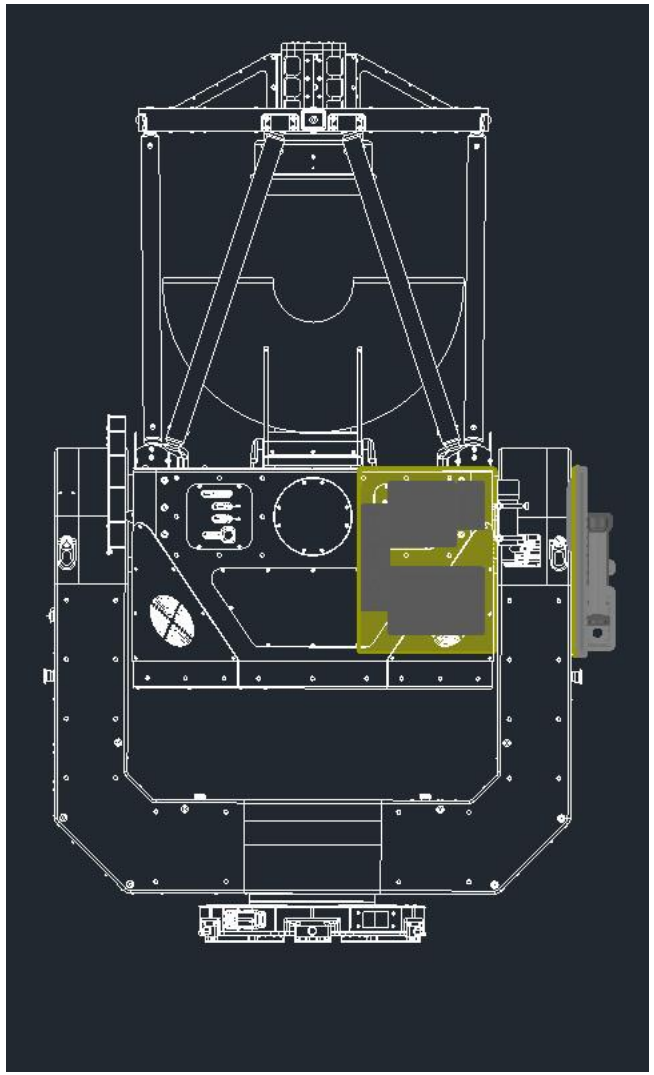
- 400Hz Picosecond laser
- 532 & 1064nm wavelengths (switchable)
- Two transmit telescopes/optics in one package
- Piggyback installation onto telescope
- Separate laser head & pumping unit
- Based on proven IWF/SP-DART & GFZ expertise



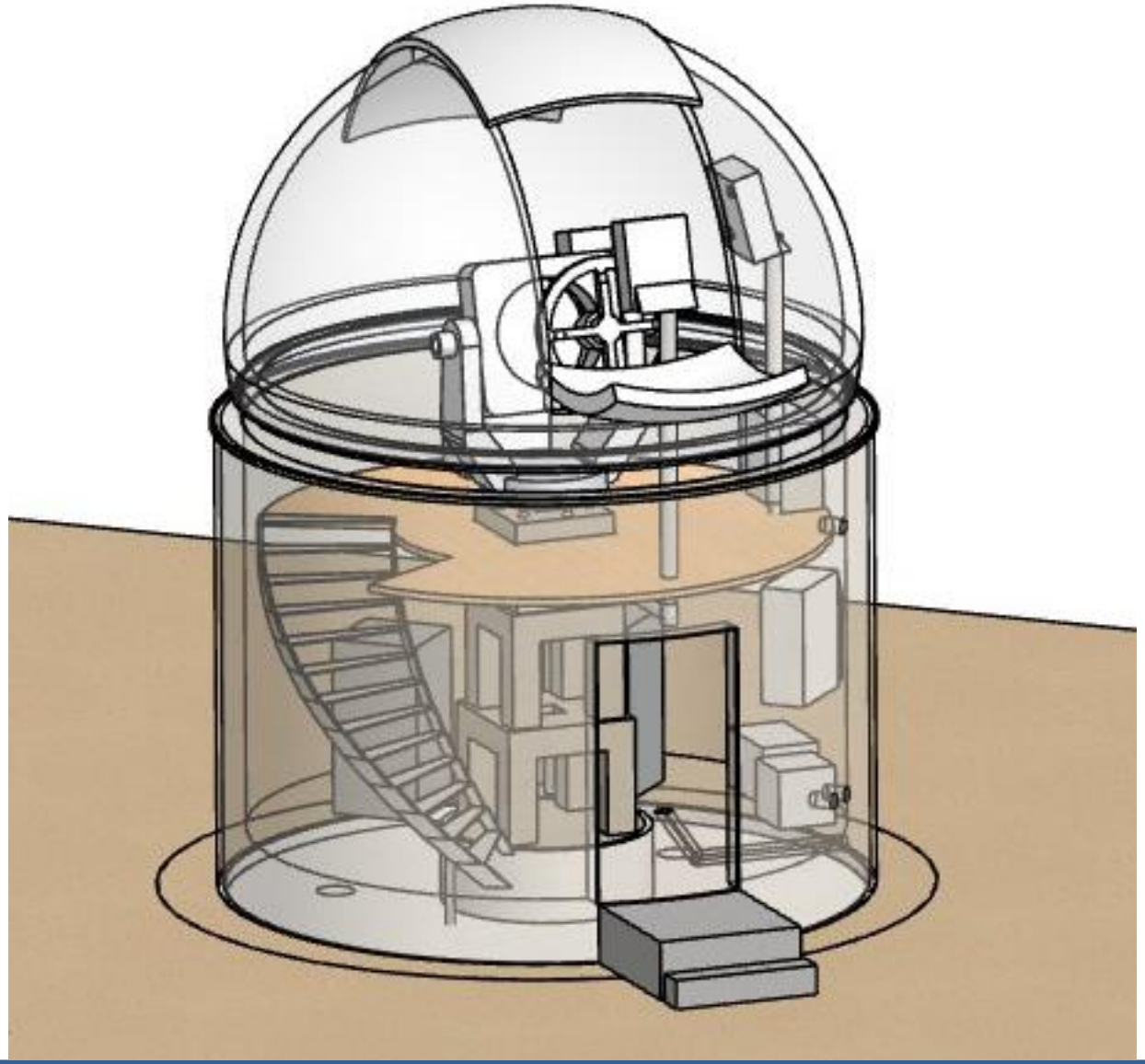
ELRS Detector Package

- 532 & 1064nm detectors
- Light curves detector (prepared)
- Camera for star calibration / mount model
- Based on proven IWF/SP-DART

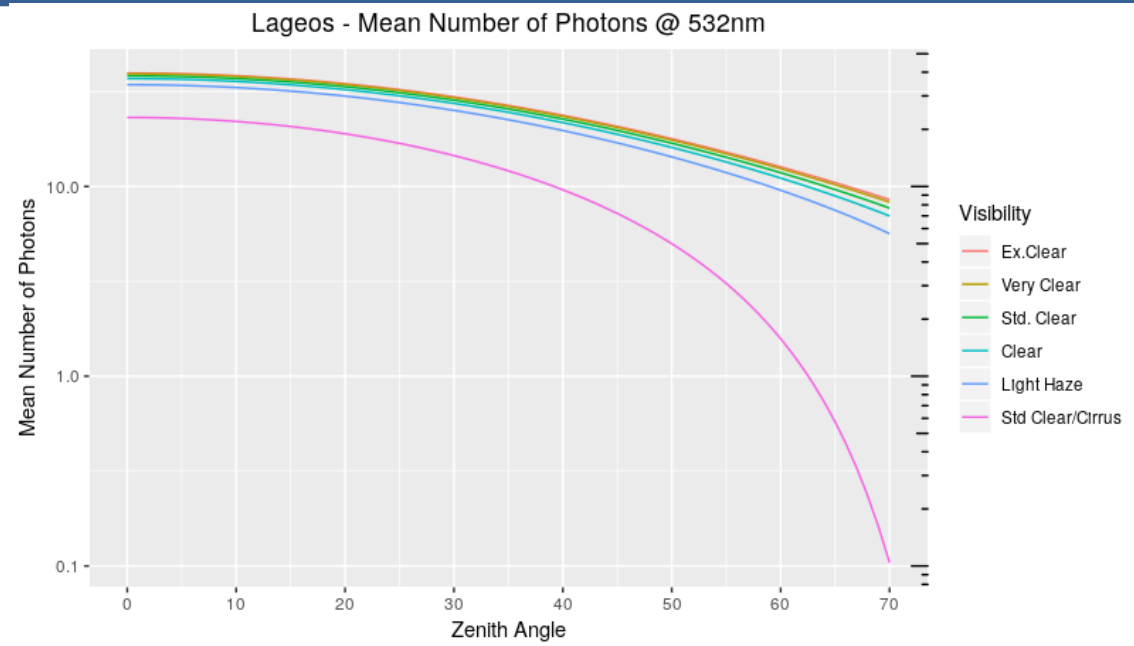


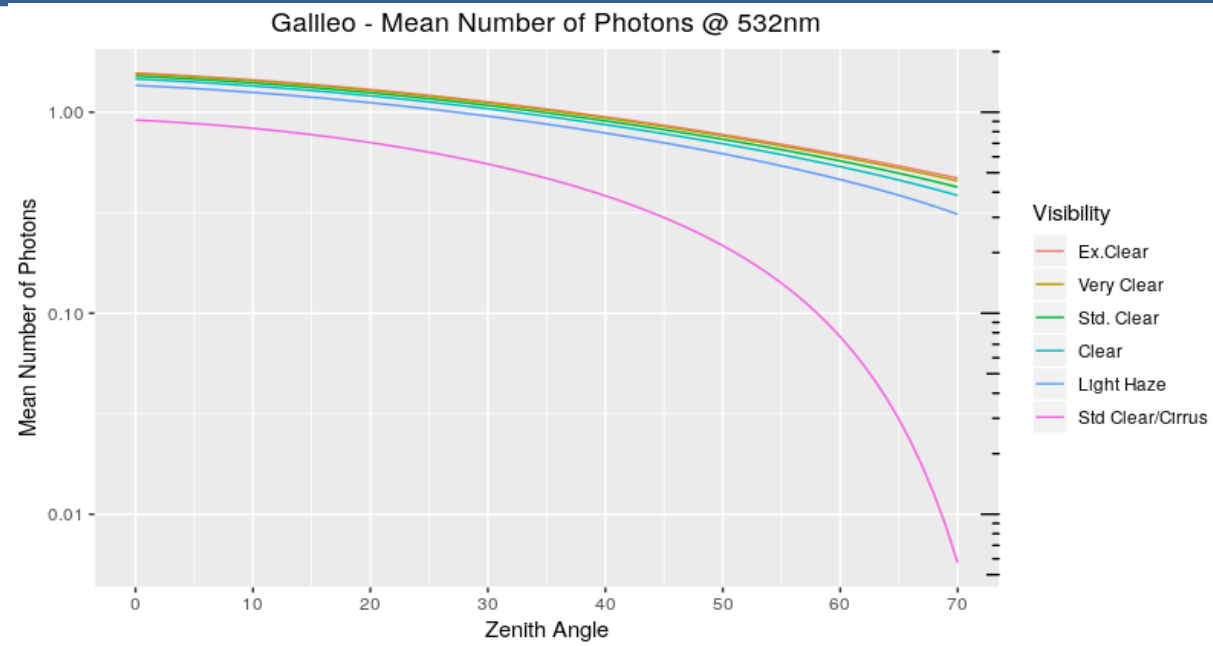


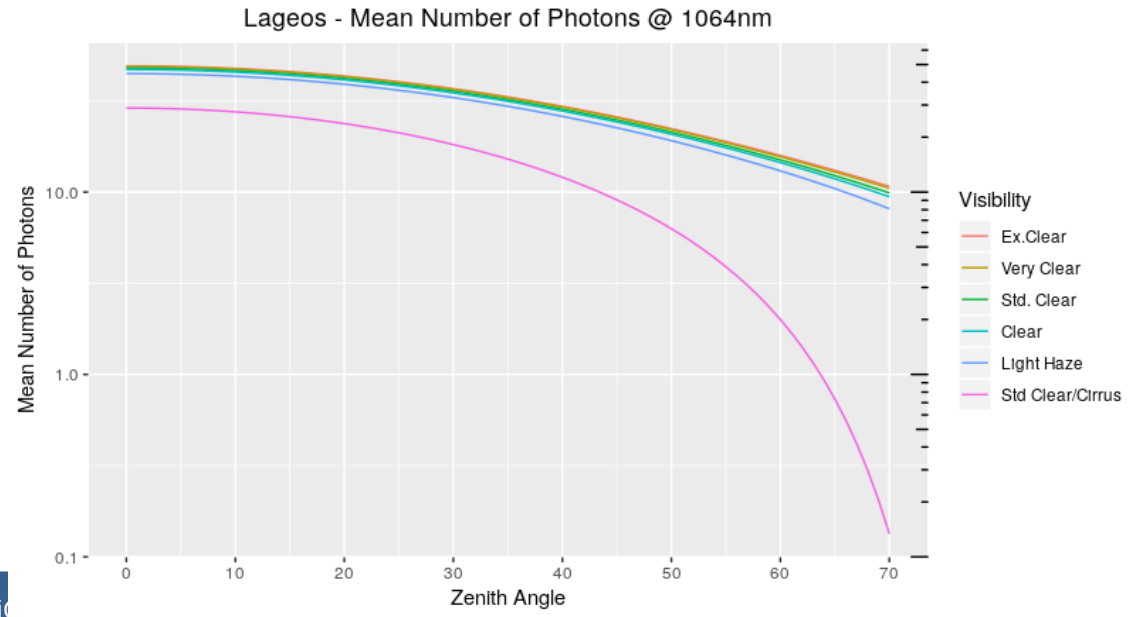
ELRS Station Layout

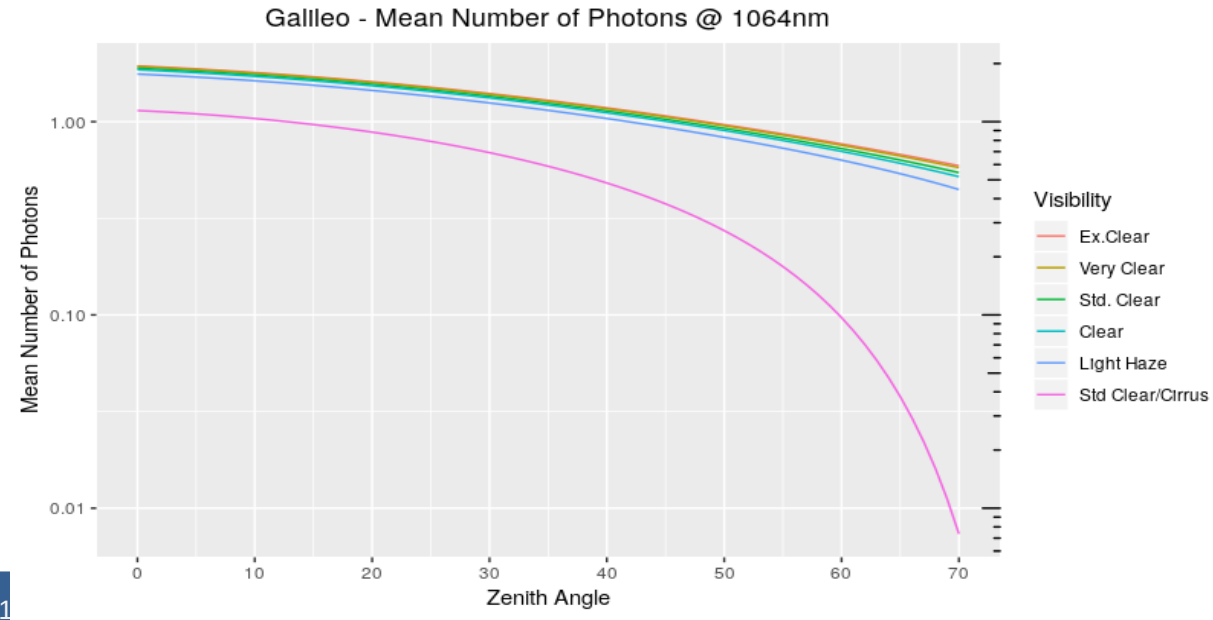


ELRS Expected Performance (Returns)









ELRS Status

- Schedule
  - Station Requirements Review (SRR) & Design Review (DR) successfully completed
  - Manufacturing ongoing, first components deliveries expected end 2018/spring 2019
  - First observations summer 2019
  - FAT with pre-integrated system (except for dome) at telescope producer site autumn 2019
  - Delivery/final Installation & commissioning up to end of 2019

→ Operational before next workshop ☺