LUPM RAMAN LIDAR STATUS & PLANNING

(CTAO SOUTH SITE LIDAR)

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ATMOHEAD 2026

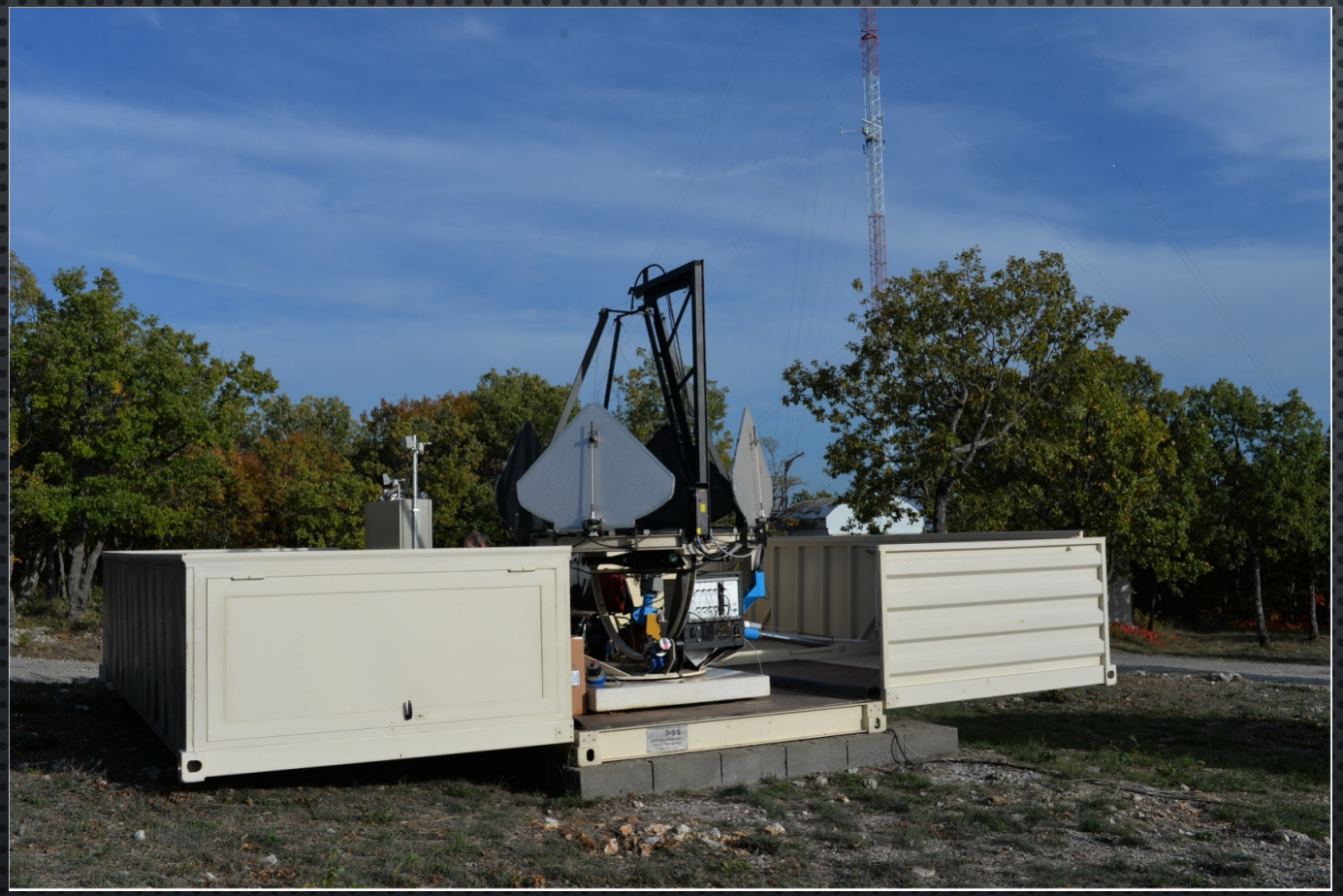
LUPM LABORATOIRE MONTPELLIER UNIVERS & PARTICULES

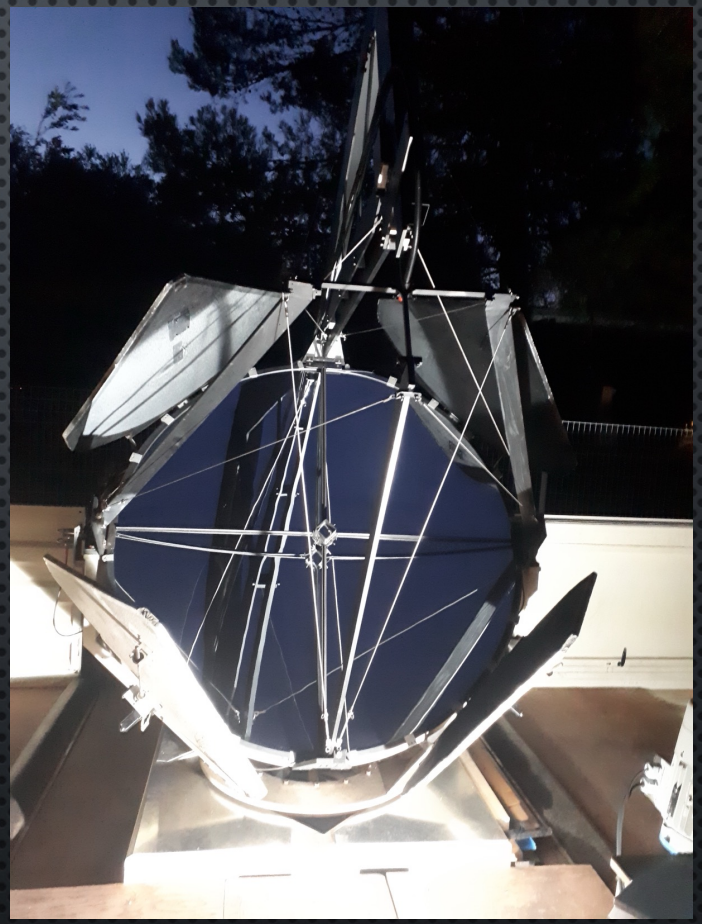
CTAO Cherenkov Telescope Array Observatory

Historique (in brief)

- 2010 Start of the CTAO Raman Lidar project at LUPM
- 2019 First data taken on site at Montpellier
  - First proof that the concept works
- 2023 Installation at OHP for two years
  - Tests of several design concepts
    - PMT Gating
    - Automatic alignment
  - Data taking
- 2025 Back at Montpellier
    - List of tasks to accomplice …

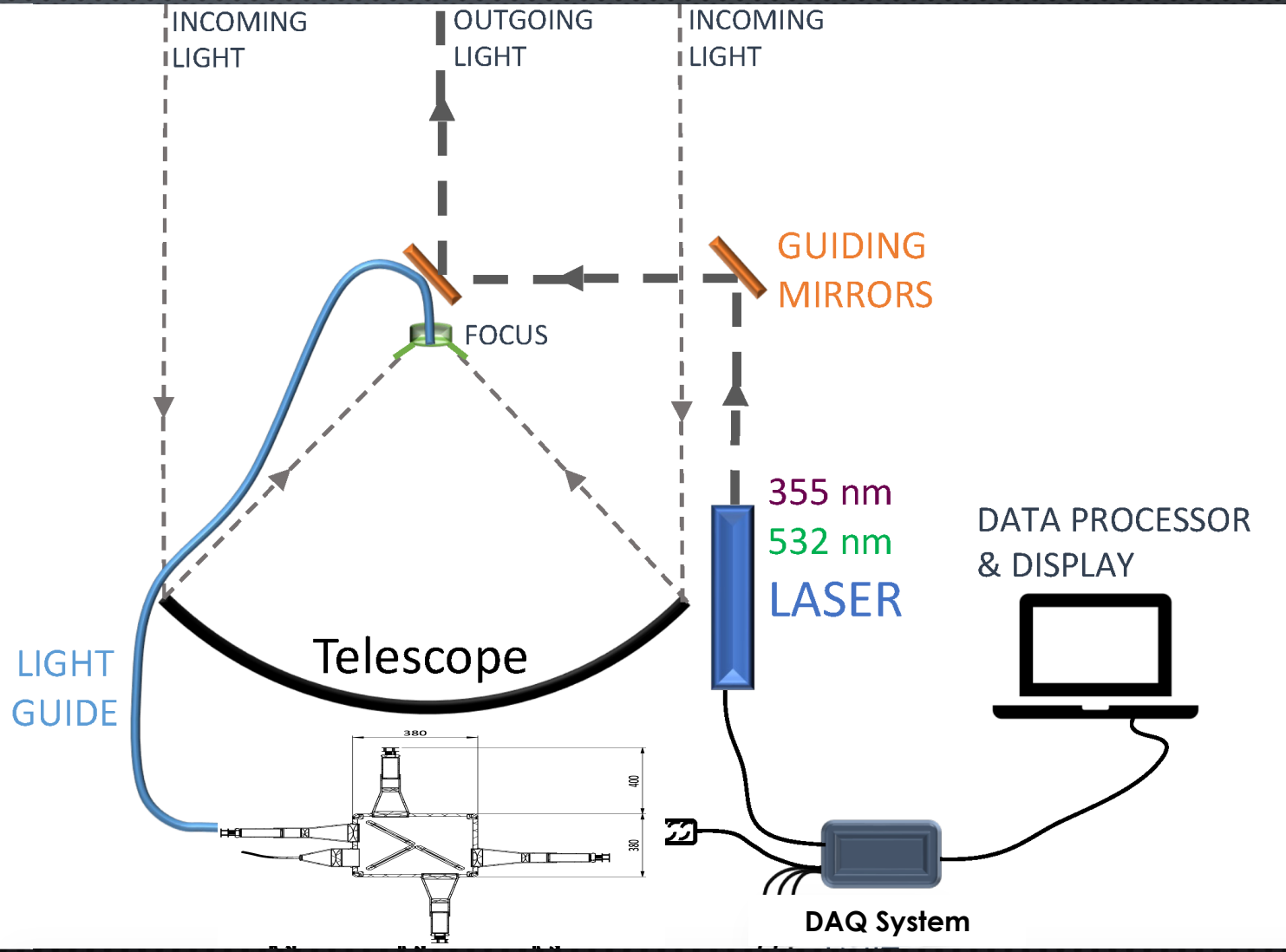
OHP SITE





RAMAN DESIGN

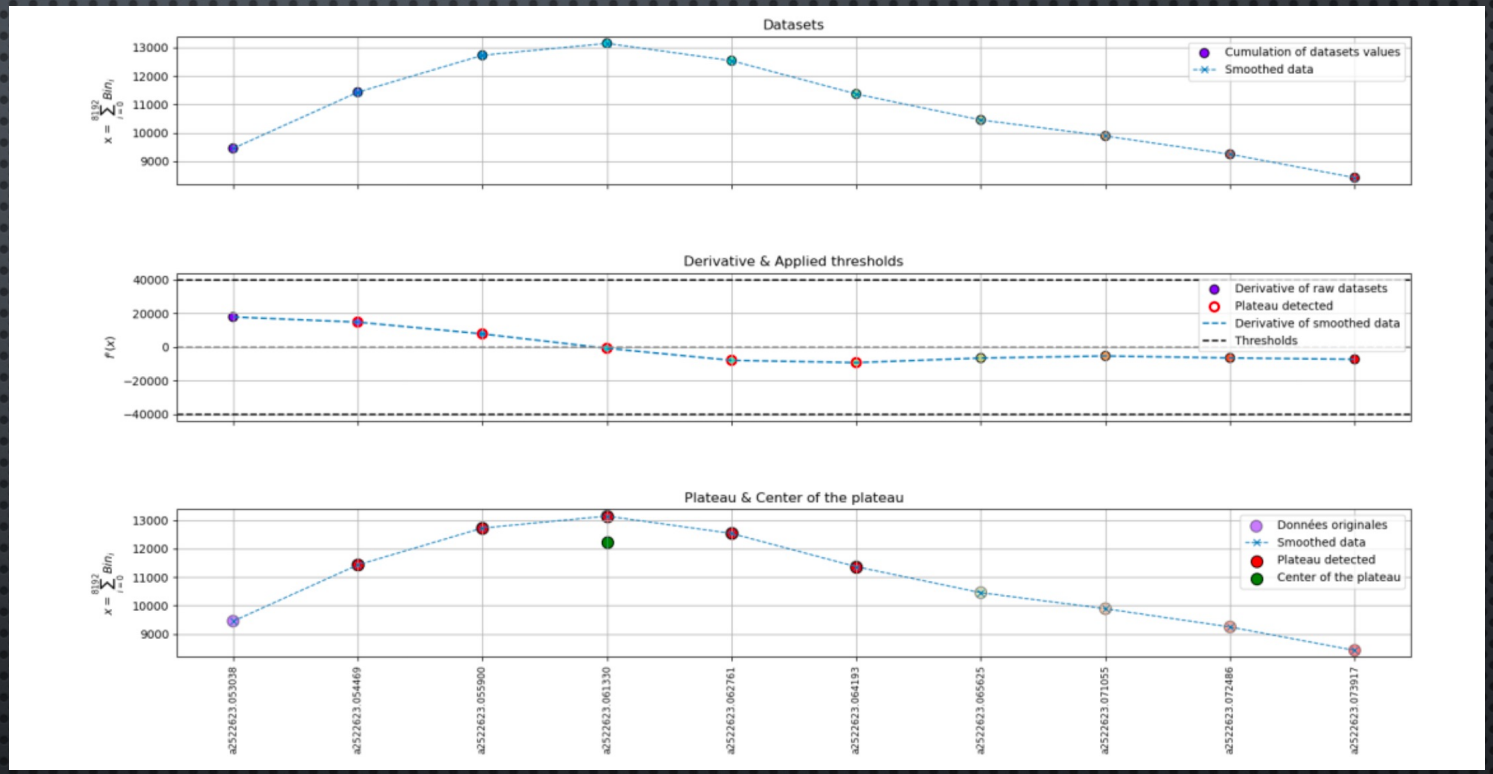
Element	Choice
Telescope & Container (CLUE experiment)	1.8m diameter F1 aperture 10mm spot size
Elastic & Raman Lines	355nm, 532nm 387nm, 607nm
Laser (3W power rating)	Quantel CFR 400 90mJ@355nm 10ns / 20Hz
Polychromator	RAYMETRICS-LUPM
DAQ system	LICEL 12 bits
Photodetector	HAMAMATSU R329 12 dynodes
Light Guide	LUMATEC 300 series High UV efficiency 8mm diameter
Weather	Wind & Rain detection system
Automation	Beckhoff



KEY FEATURES : PMT GATING

- LUPM DESIGN AND BUILT GATED PMT TRIGGER LOGIC
- TRIGGERED BY THE LASER PULSING SYSTEM
- PERMIT TO "BLIND" THE PMTS FOR A USER-DEFINED INTERVAL
- FAST RECOVERY TIME 700NSEC
- PERMIT TO ELIMINATE LIGHT DETECTION FROM LASER PULSING FOR THE FIRST FEW 10S OF METERS
- REDUCED PMT NOISE
- INCREASE CAPABILITIES TO DETECT LIDAR SIGNALS FROM LOW ALTITUDES (180M INSTEAD OF 1.2KM)
- INCREASE CAPABILITIES TO DETECT LIDAR SIGNALS FROM HIGH ALTITUDES (30KM+)
- NO LICEL SATURATION (WORKING RANGER 0-500MV)

KEY FEATURES : AUTOMATIC ALIGNMENT

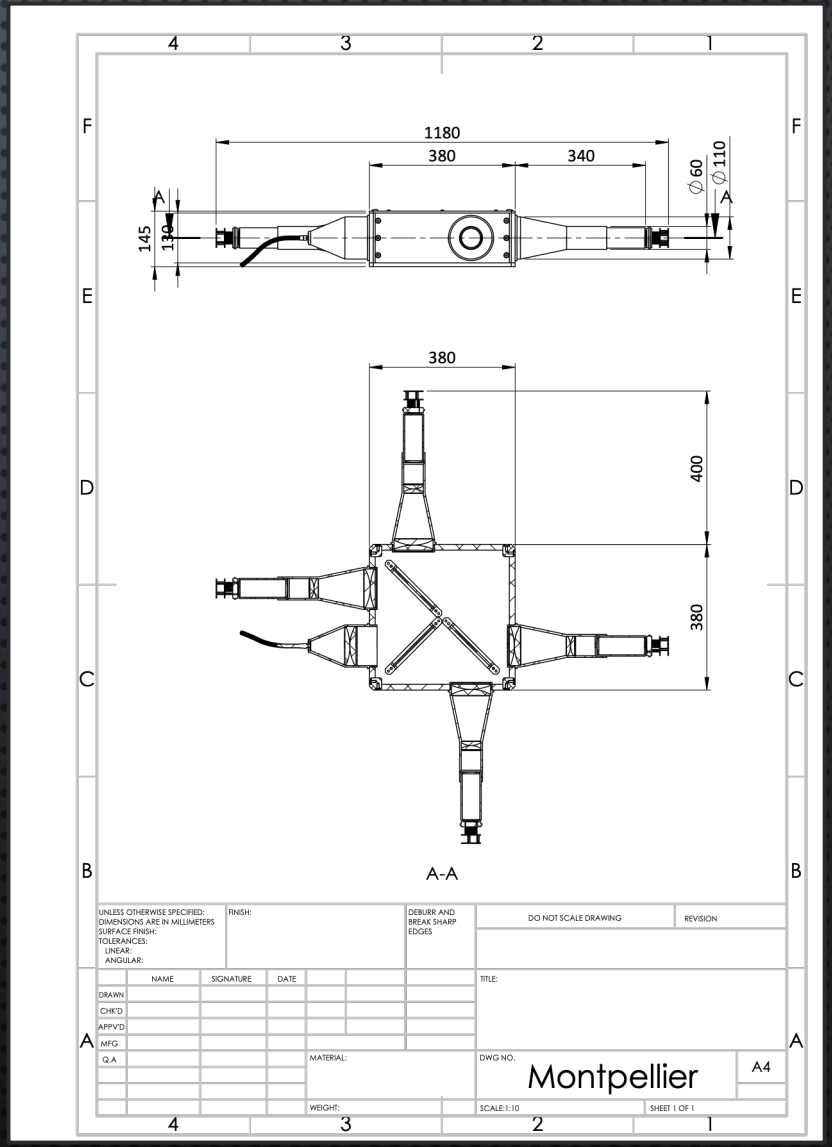


X,Y mirror axis displacement

- AUTOMATIC ALIGNMENT PROCEDURE
  - X-Y SCAN OF THE EXIT MIRROR
  - FIND PLATEAU
  - CALCULATE MID OF PLATEAU FOR EACH AXIS
  - ALIGNED !!!

KEY FEATURES : RAYMETRICS POLYCHROMATOR

- CUSTOM MADE BY RAYMETRICS
- ZEEMAX SIMULMATIONS SUGGEST OPERATION CONDITION STARTING AT 500M
  - DUE TO ABERRATIONS
  - FOCUS DEPTH
- SET OF OPTICAL ELEMENTS PER CHANNEL
  - OPTIMIZE FOR UNIFORM DETECTION
  - MINIMIZE LEAKAGE



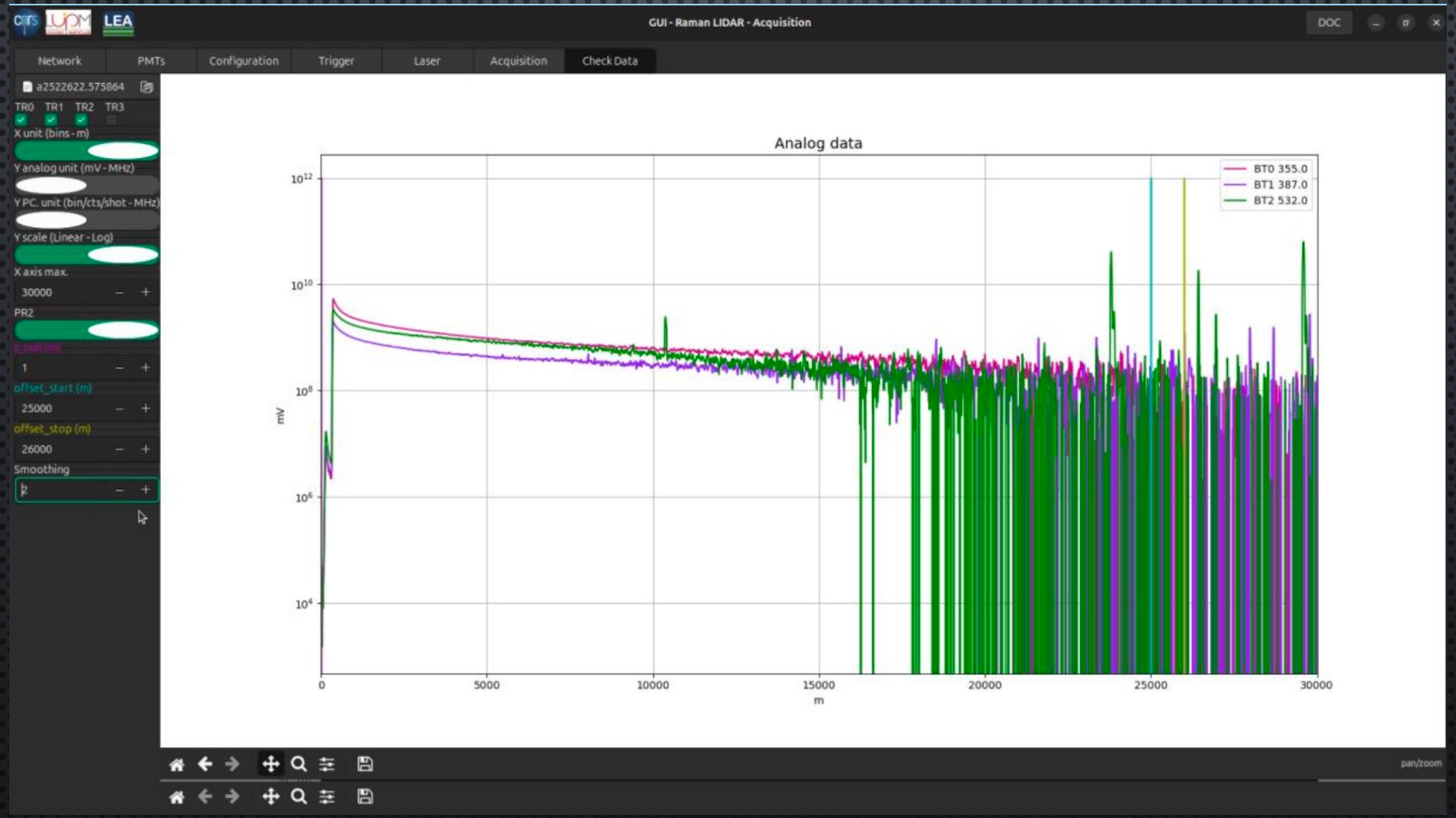
KEY FEATURES : RAYMETRICS POLYCHROMATOR

- Barr/Chroma/laseroptik optical elements
- Four lines
  - 355 and 532 nm elastic
  - 387 and 607 nm Raman
  - All optics 2 inches size
- Beam splitter
  - Chroma custom made
  - Dimensions 12x20cm
- Line interference
  - Leakage better than $< 10^{10}$

RESULTS

- LUPM lidar installed for testing at OHP for 2 year.
- Data acquired in variable conditions
  - issues with local humidity and laser failure
- Experience gained as of problems we have to take care
- Results shown are not based on the LPP SW package even if it function perfectly since
  - Due to licel failure modules datasets have mixed wvl channels….
- Data shown are based on a laser that fires at 1/3 of its nominal power
  - 28mJ instead of 90mJ at 355nm
  - 8mJ instead of 24mJ at 532nm
  - Reason was damaged 3Ω 355nm cavity.

PERFORMANCE STUDIES (OHP) (*ANALOG ONLY*)



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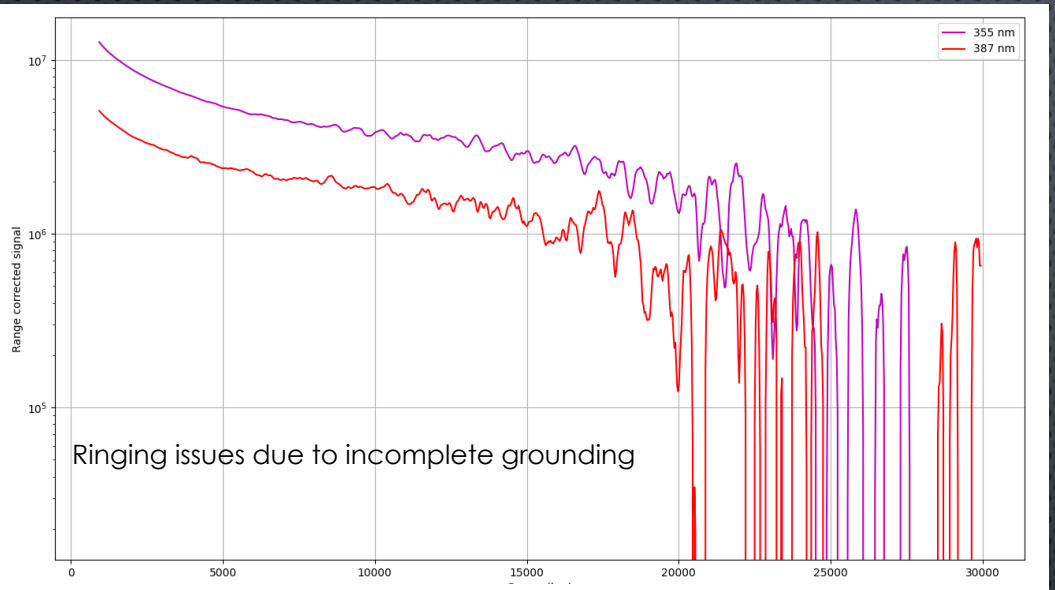
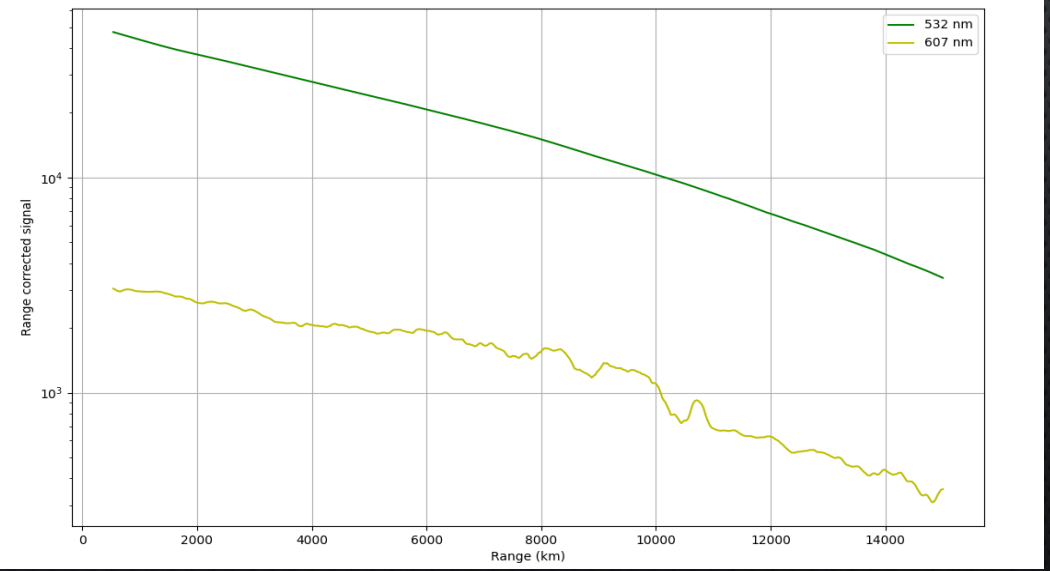
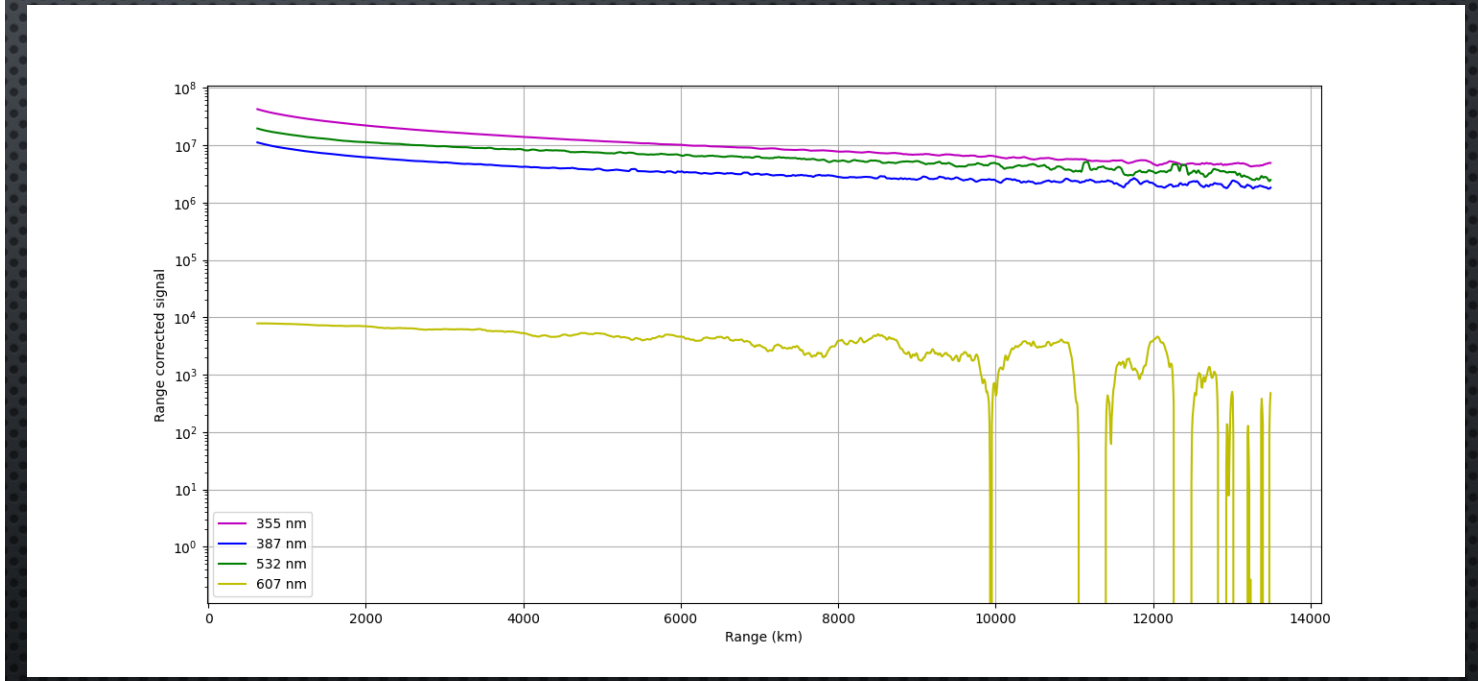
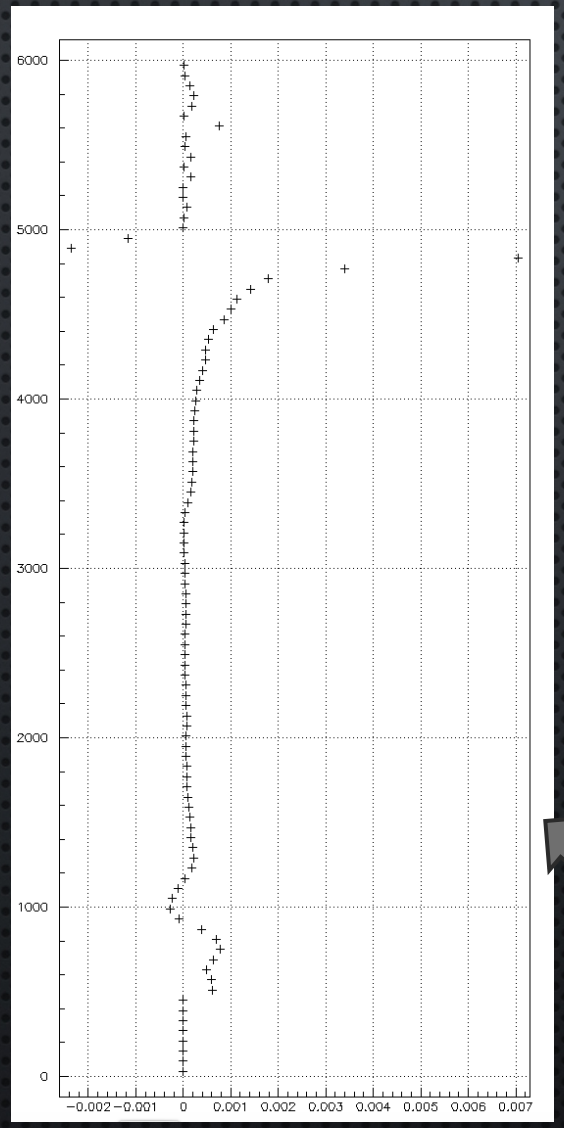
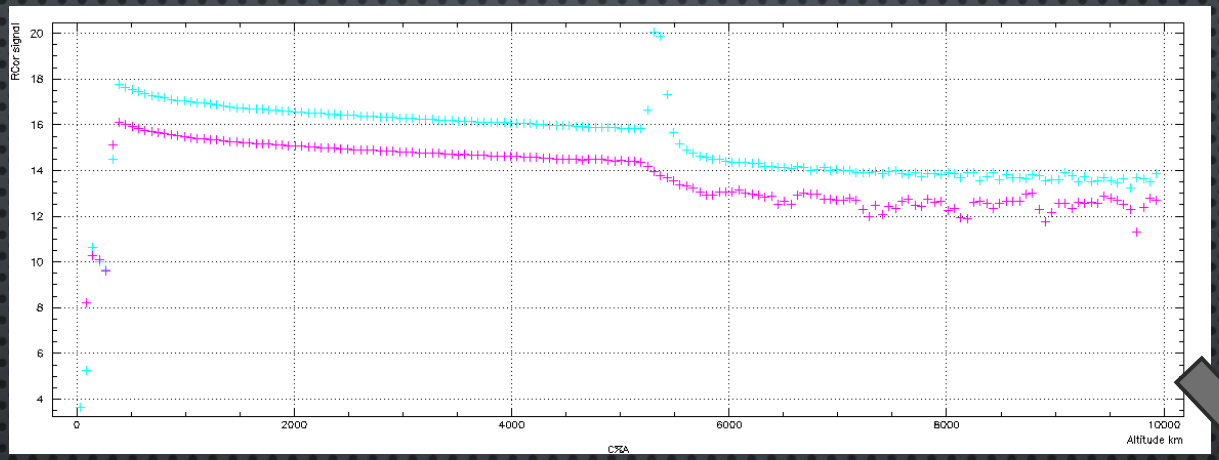




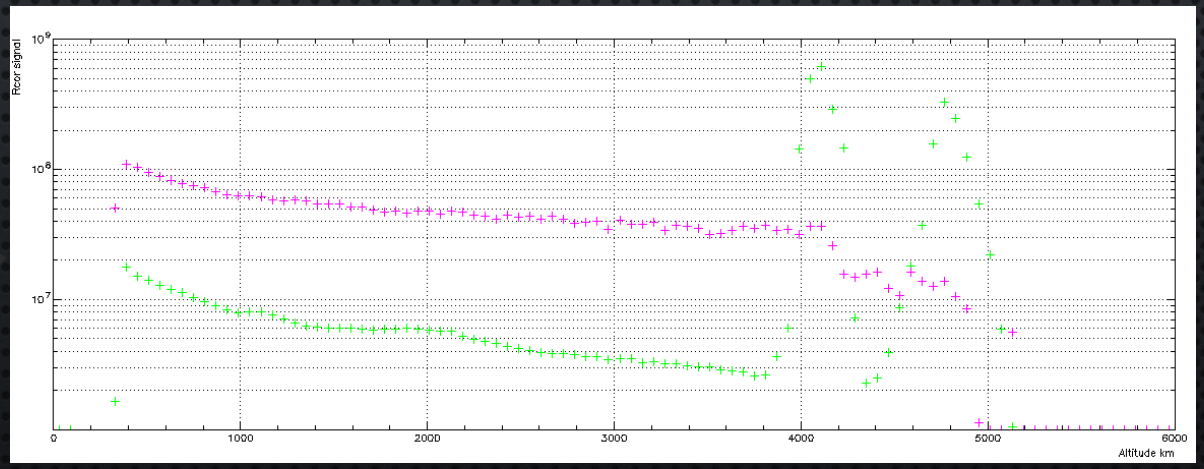


EXTINCTION CALCULATION (355 & 532 NM)

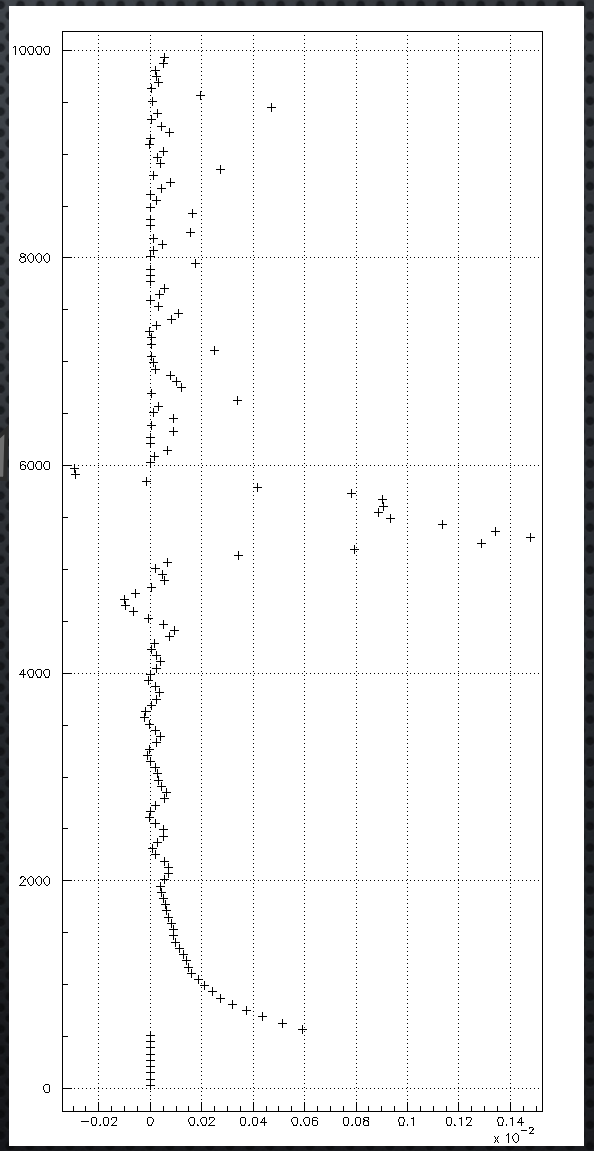




355nm



532nm



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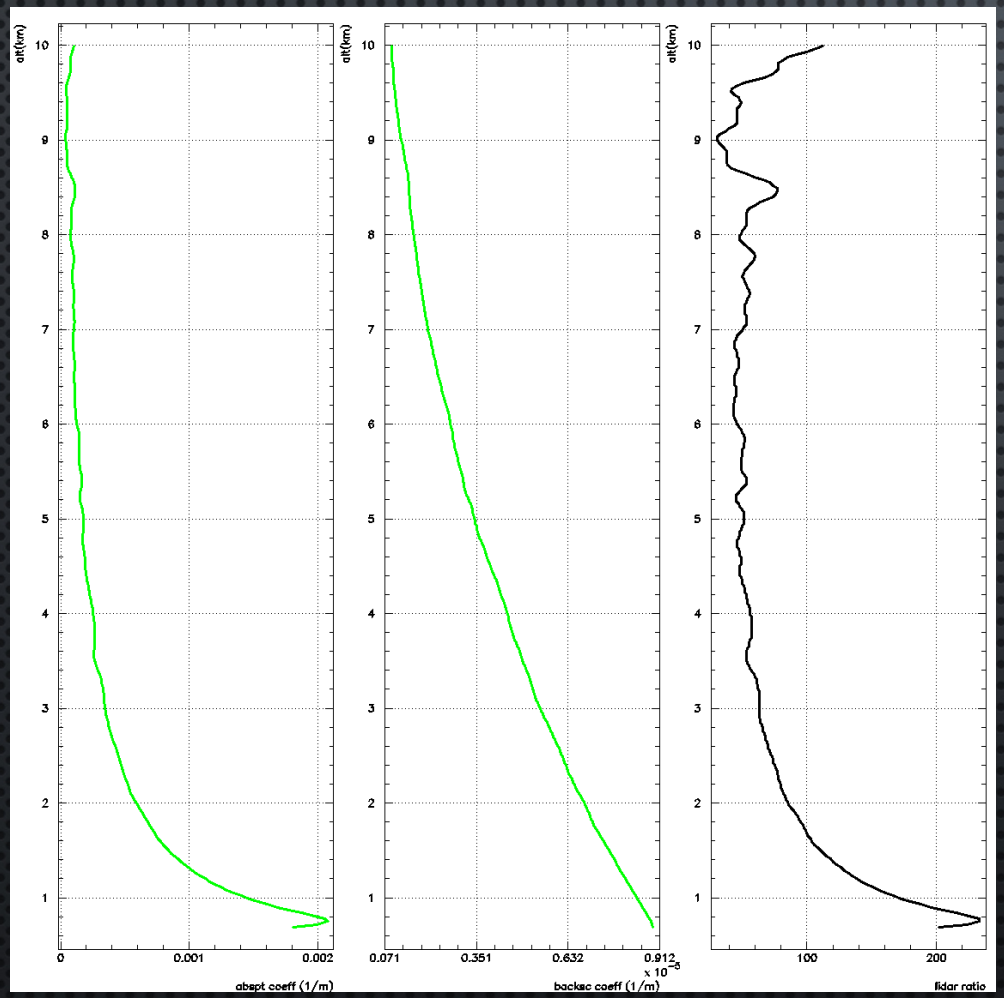
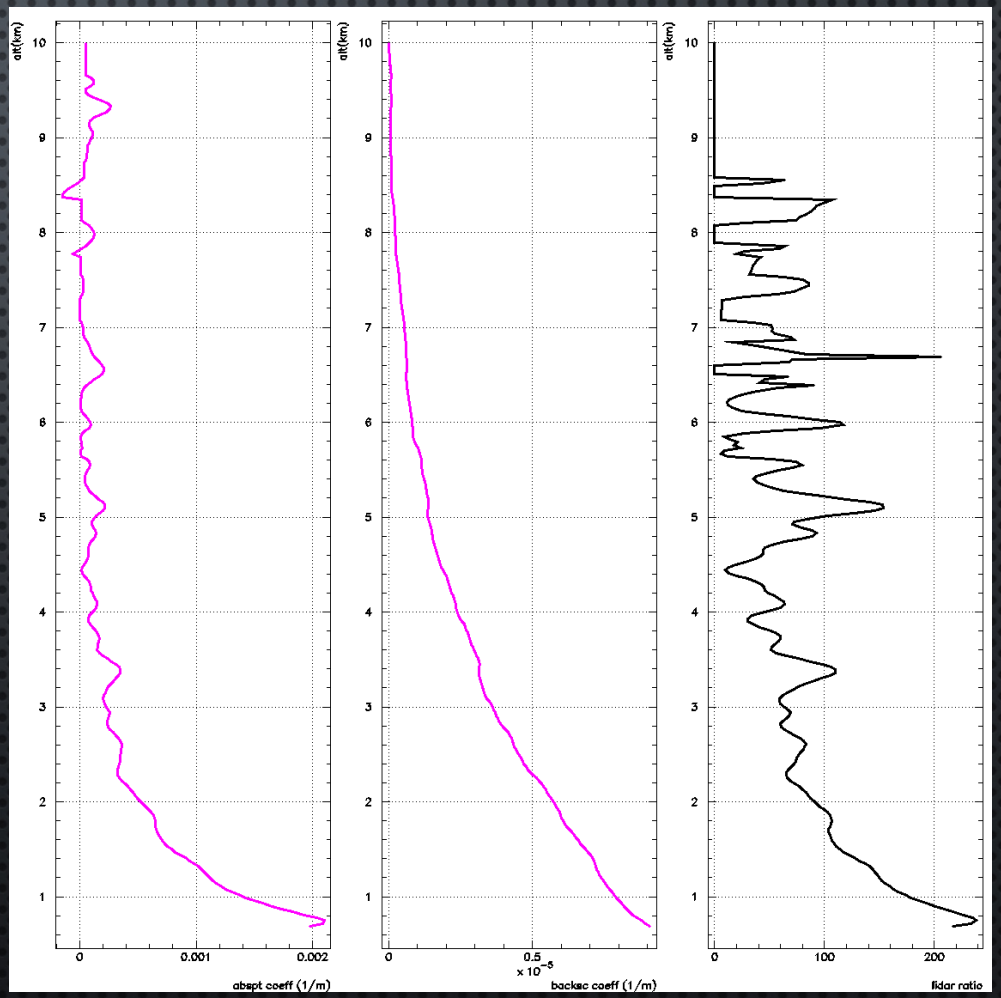


355nm



532nm

Planning 2026

- Seismic studies
  - LLR/IJCLab coll.
- Hazard/risk analysis
  - Ctao management
- Renew plc
- Conformity with ctao rules
  - Container
  - Electric
  - Grounding
  - Laser security
- Preparation for the cdmr (Dec 2026)
  - Common with the Barcelona lidar

POST 2026

- Data taking at Montpellier
  - Verify that everything is CTAO compatible
- Continue working on container issues
  - CTAO conformity
  - Seismic analysis implementation
  - Hazard analysis implementations
- Air traffic control protocol
  - ESO/CTAO guidance
- Preparing shipping on site
  - Hoping for first semester 2028 !!!
- Tests on CTAO south site
  - Current 2028

THANK YOU