arcade

Atmospheric Research for Climate and Astroparticle Detection

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RICAP 14

UNIVERSITÀ DEGLI STUDI DI TORINO
ALMA UNIVERSITAS TAURINENSIS

INFN Istituto Nazionale di Fisica Nucleare

MINISTERO DELL'ISTRUZIONE, DELL'UNIVERSITÀ E DELLA RICERCA

FUTURO IN RICERCA

COLORADO SCHOOL OF MINES
EARTH • ENERGY • ENVIRONMENT

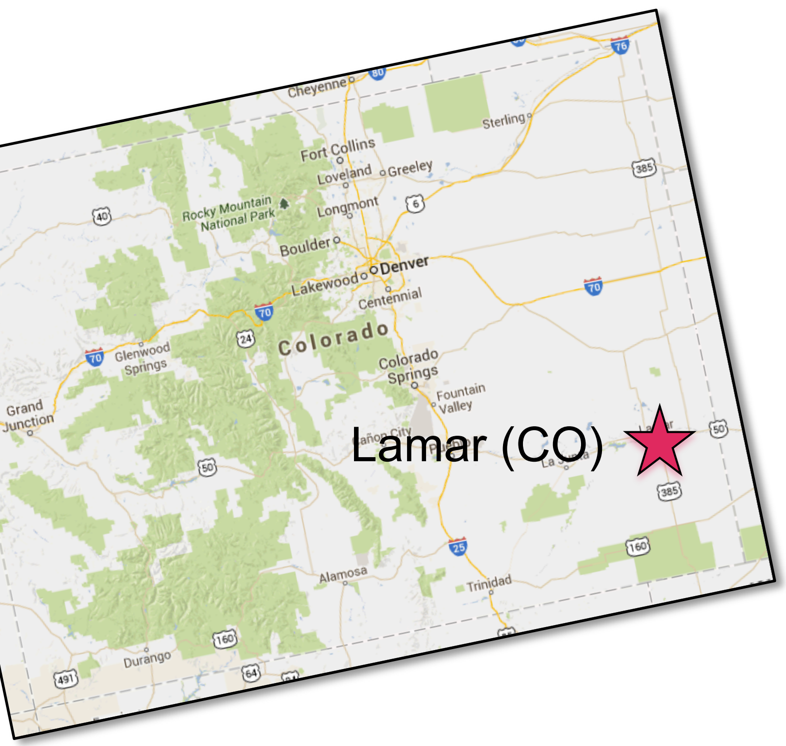
CETEMPS
Integration of remote sensing techniques and modeling for the forecast of severe weather

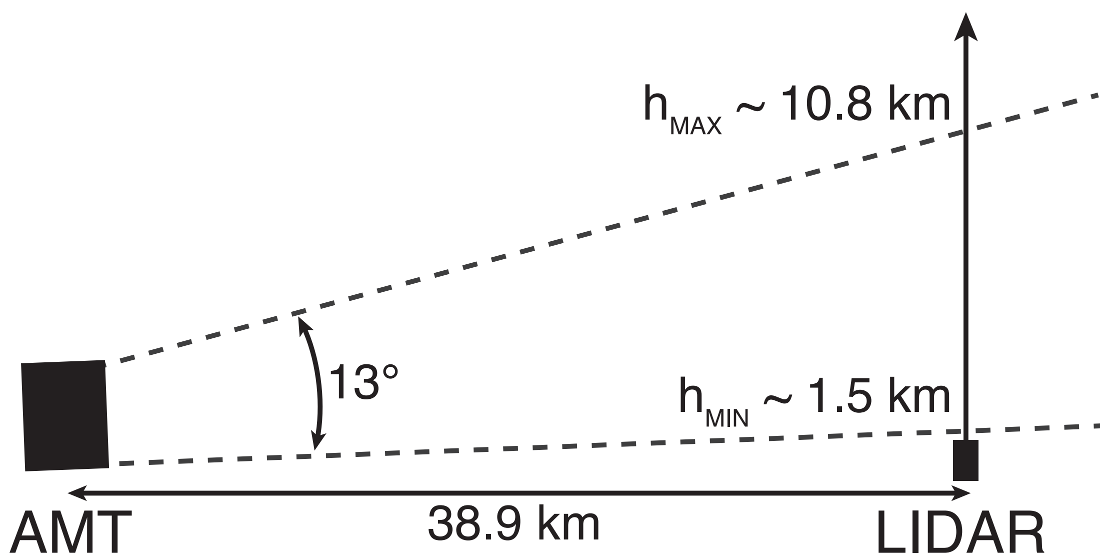
CAEN Tools for Discovery

Aim of the project

Perform measurements of the aerosol attenuation of UV light in atmosphere **simultaneously and on the same air mass** using the typical techniques mainly used in cosmic ray observatories:

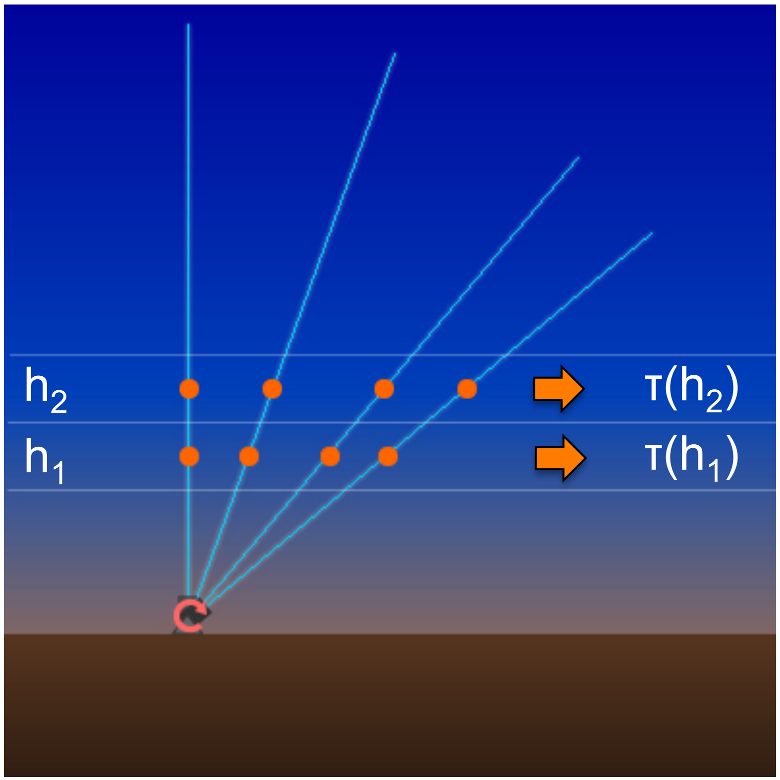
Distant Laser Facility - Elastic and Raman LIDAR





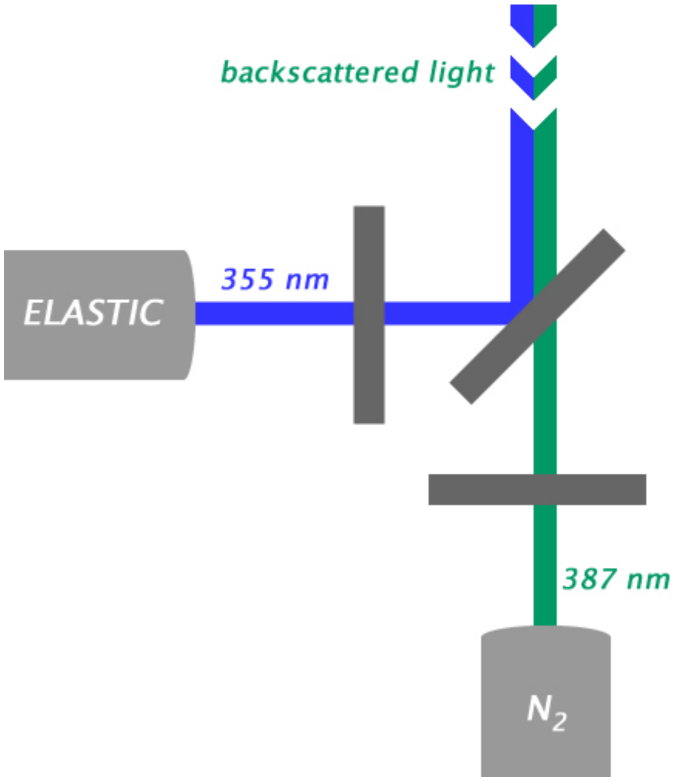
Four techniques compared

ELASTIC LIDAR
Multi-angle analysis



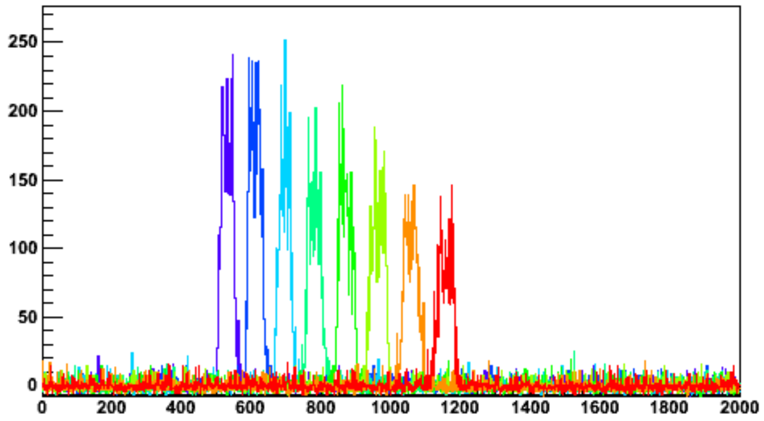
Hp: horizontally homogeneous atmosphere.
Faster method.

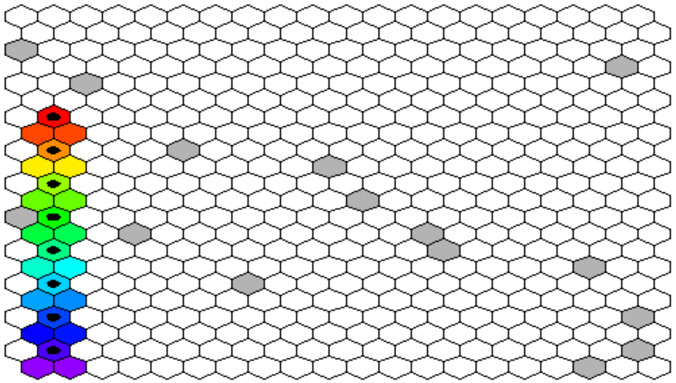
RAMAN LIDAR
Vertical and inclined shots



2 equations for two unknowns.
It needs a powerful laser.

Four techniques compared





LIDAR+AMT
Data Normalized Analysis

Comparison of measured light profiles with reference clear night profiles (~ molecular atmosphere)

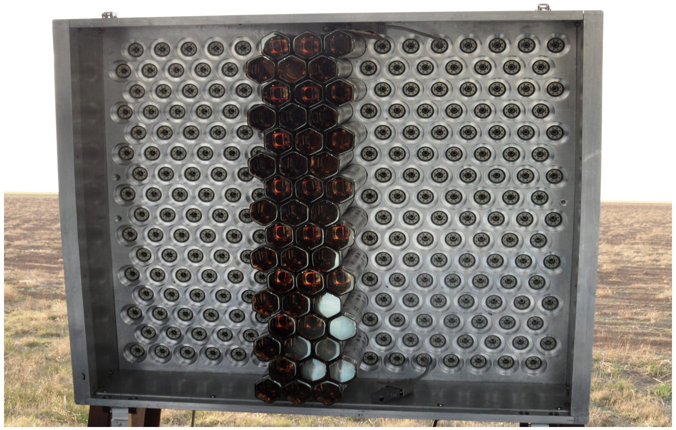
Selection cross-checked with lidar measurements.

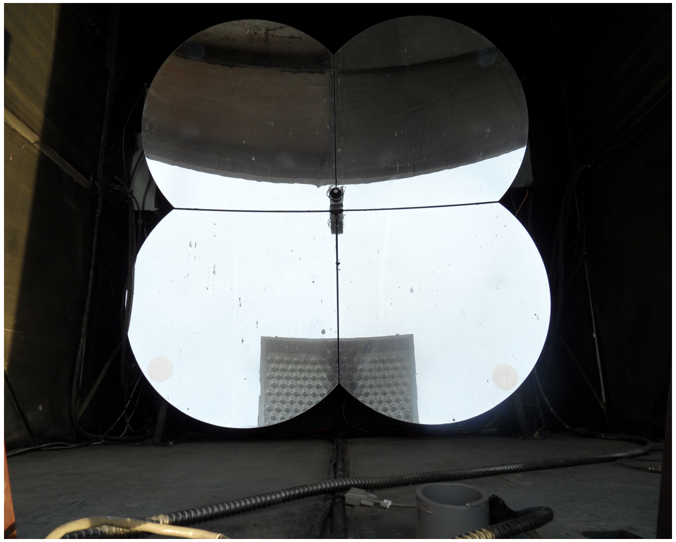
LIDAR+AMT
Laser Simulation Analysis

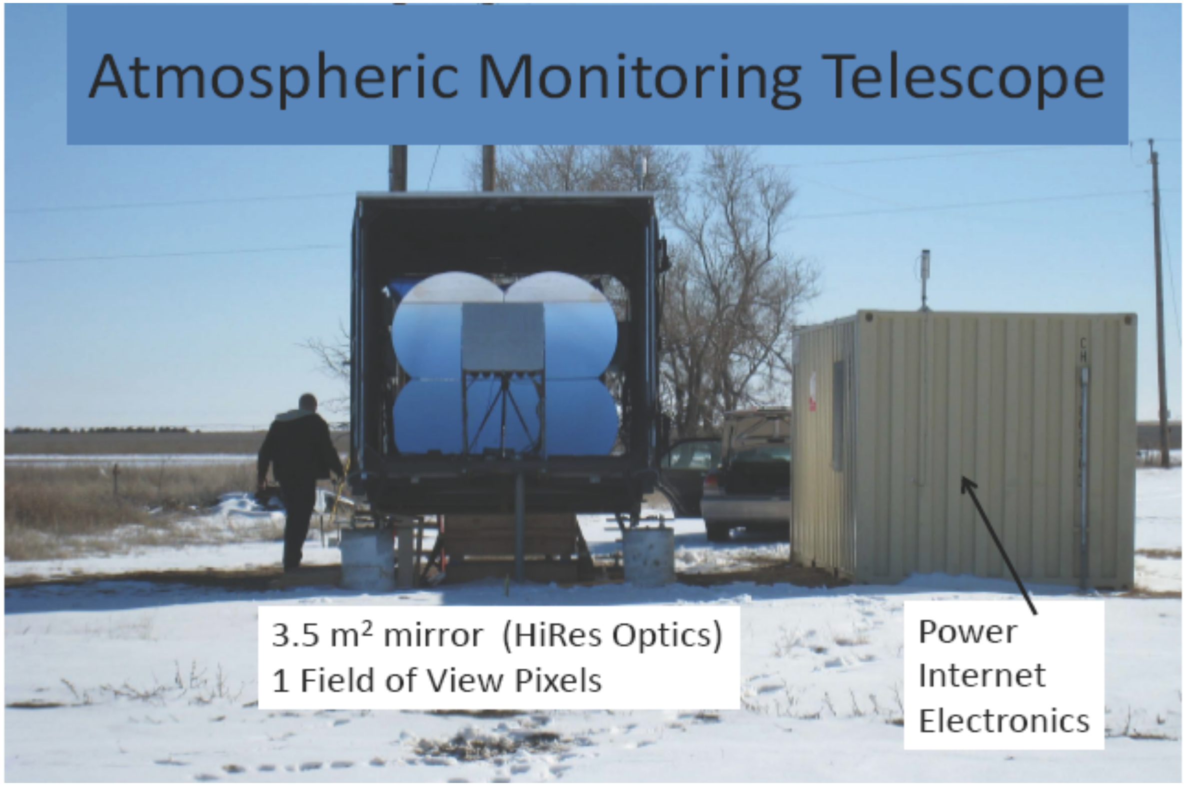
Comparison of measured light profiles with modeled atmosphere.

Aerosol attenuation described by a parametric model (2-3 parameters).

Atmospheric Monitoring Telescope (AMT)







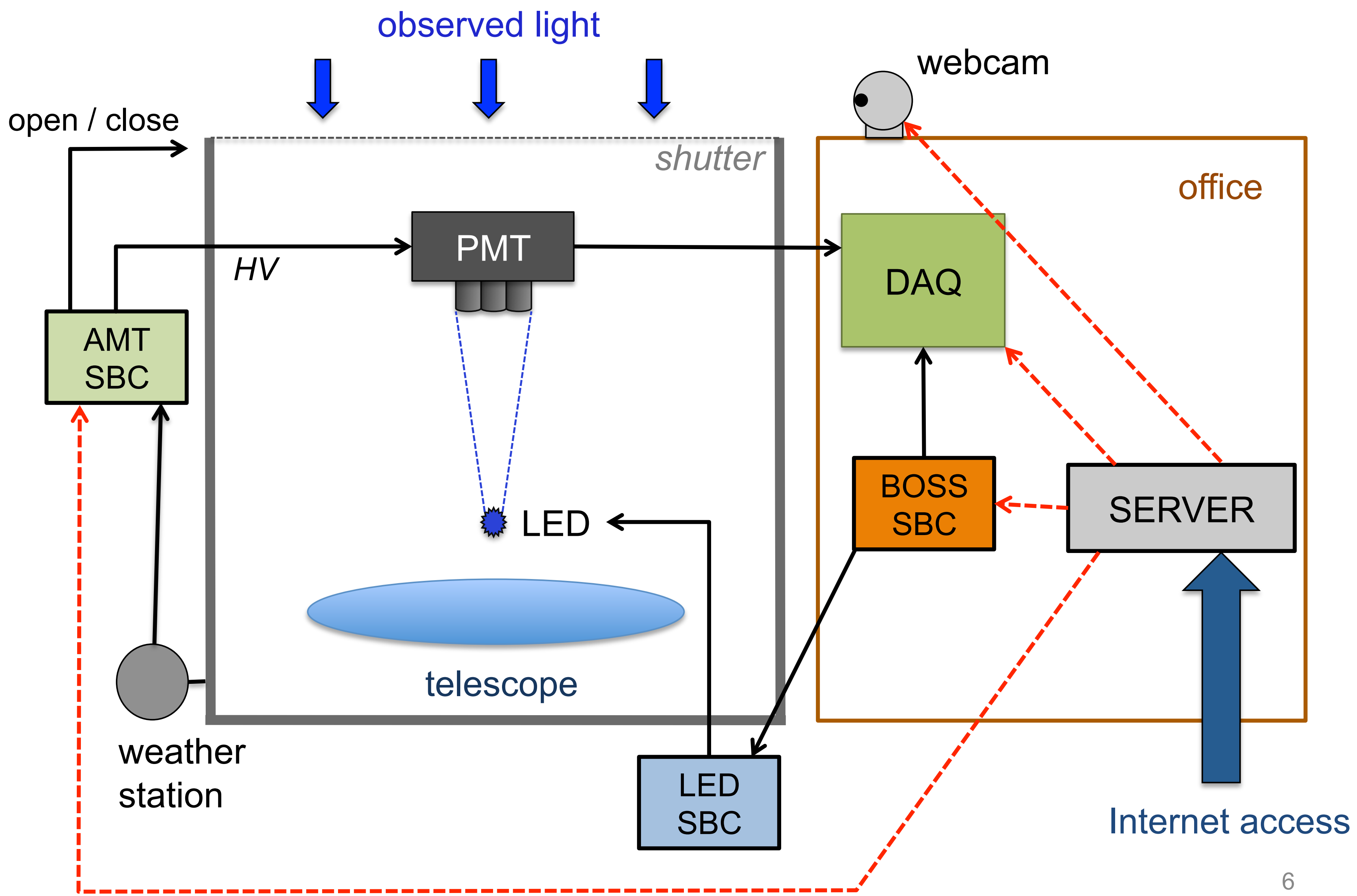
Camera inherited from HiRes
owned by Colorado School of Mines
three columns of 16 PMTs, UV bandpass filter

AMT installation

April - May 2014

L. Wiencke, M. Coco, J. Eser, M. Buscemi and L. Valore

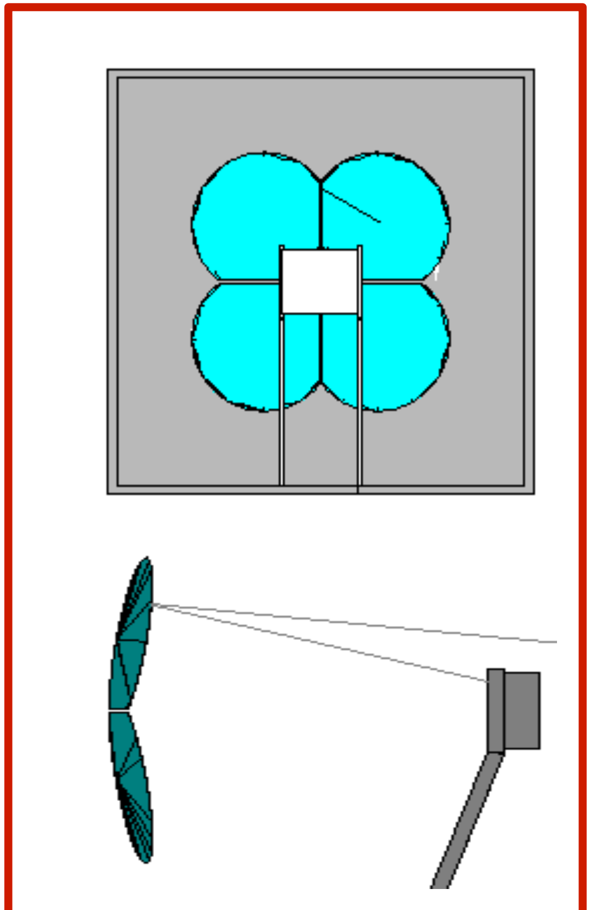
AMT system



observed light
webcam
open / close
shutter
office
PMT
HV
DAQ
AMT
SBC
BOSS
SBC
SERVER
LED
telescope
weather
station
LED
SBC
Internet access

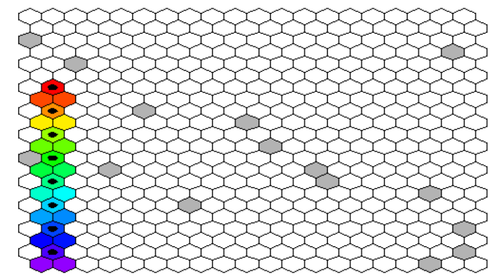
AMT simulation

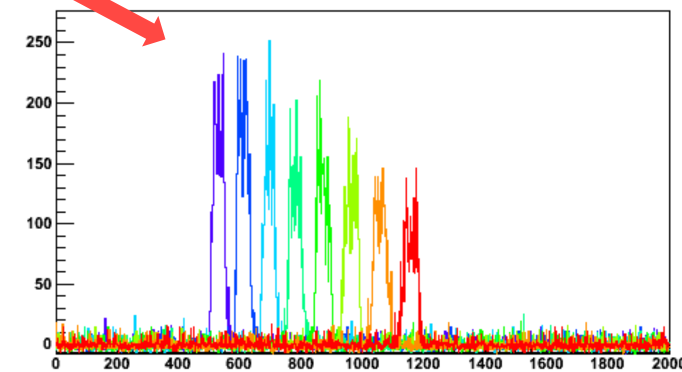
Simulation of the telescope via Geant4 + simulation of the laser track and transmission in atmosphere using the Auger software



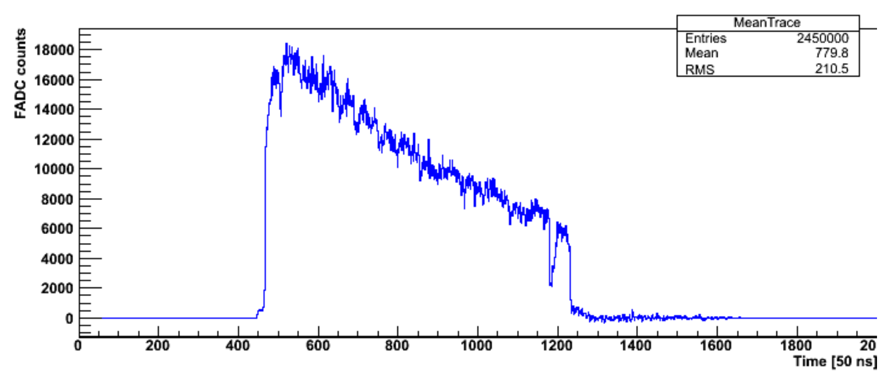
Telescope simulation

Simulated signals

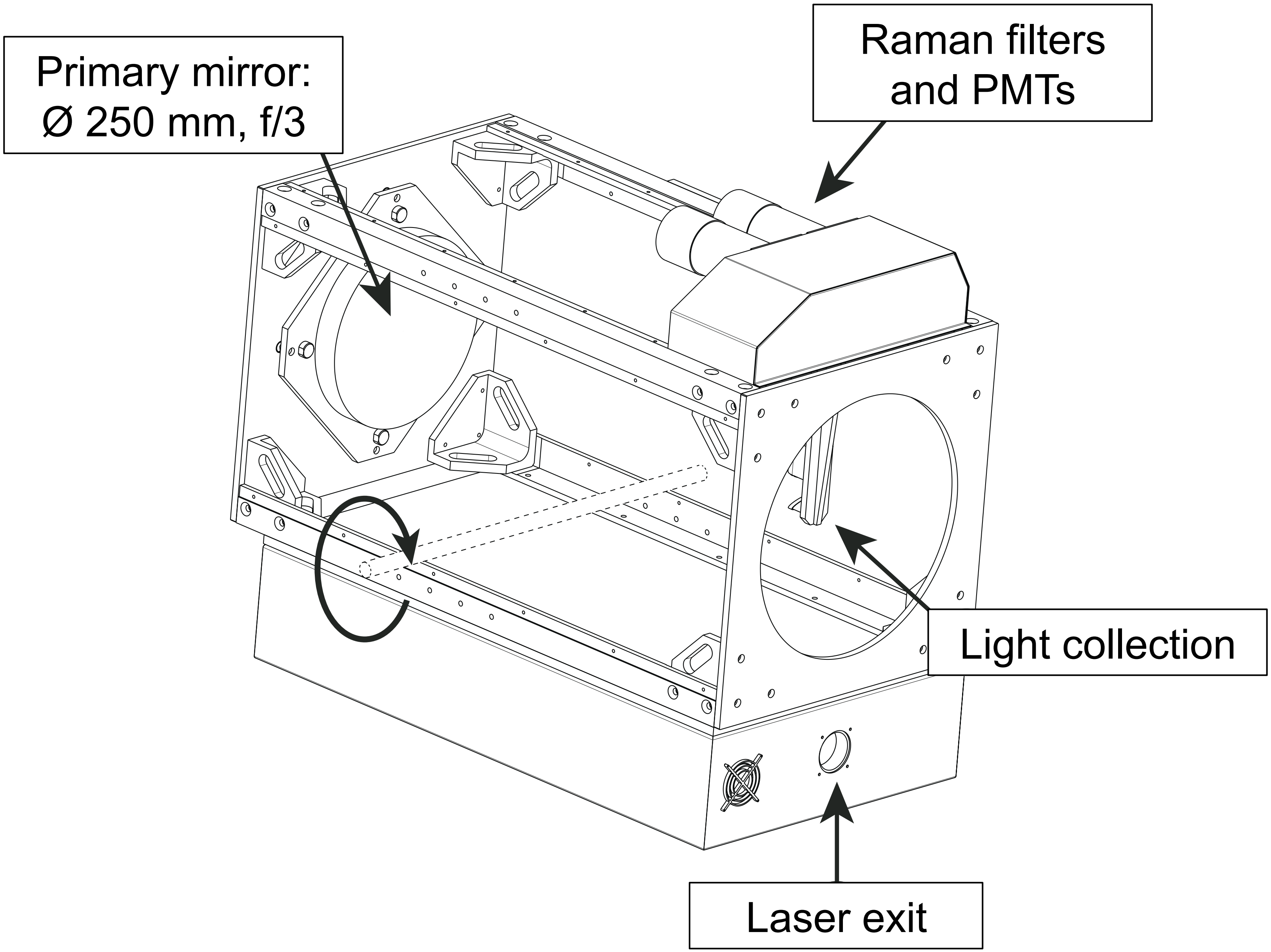




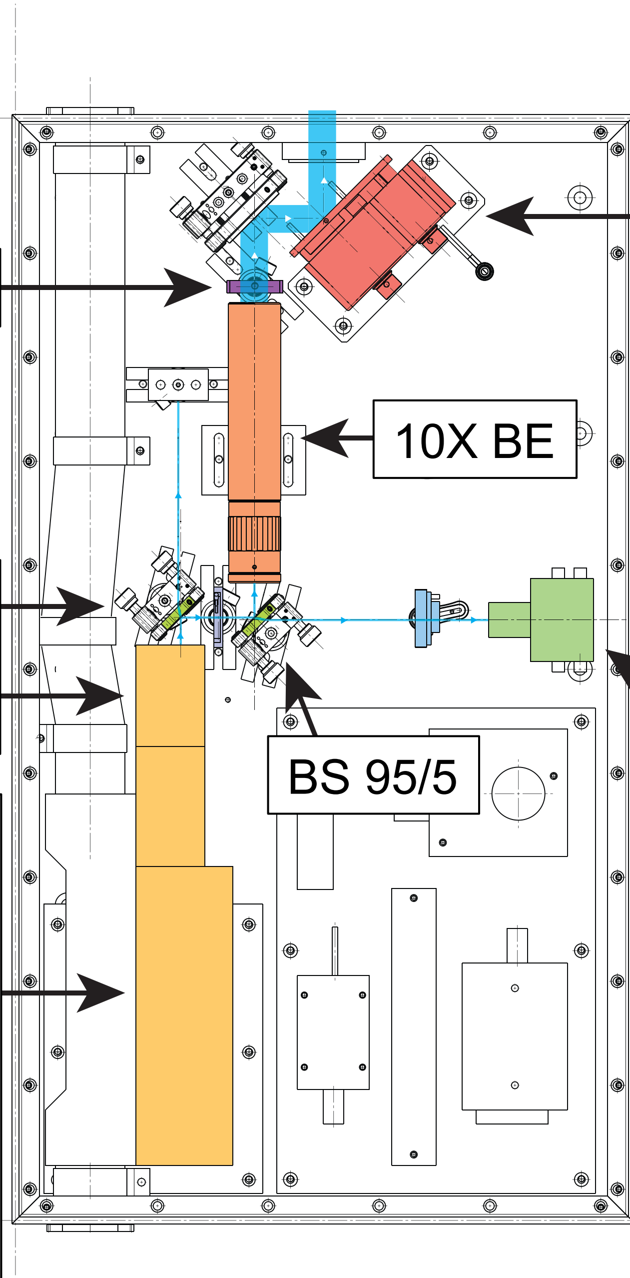
Reconstructed profile of photons at the camera

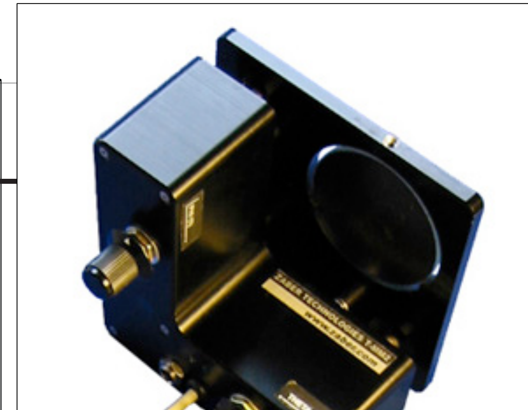


Raman LIDAR design



Laser bench



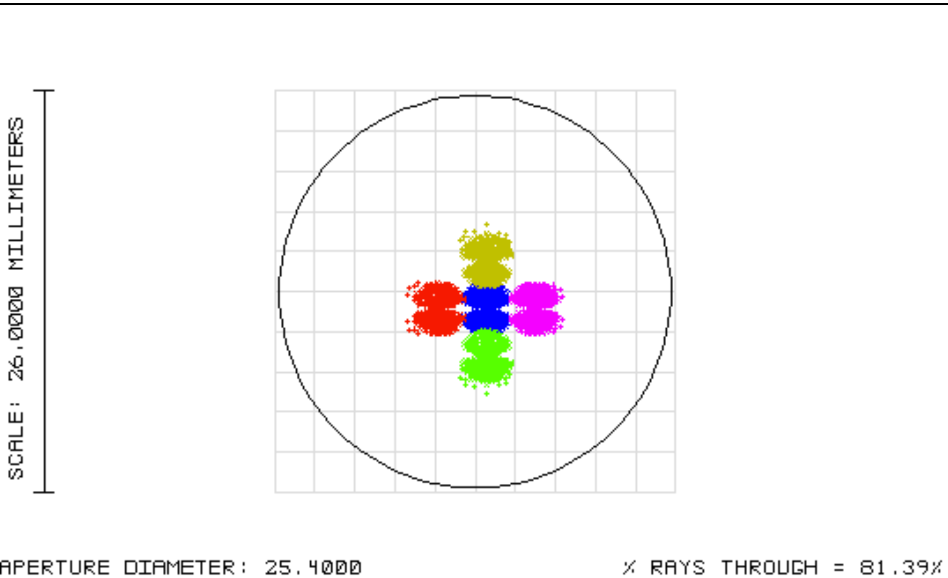


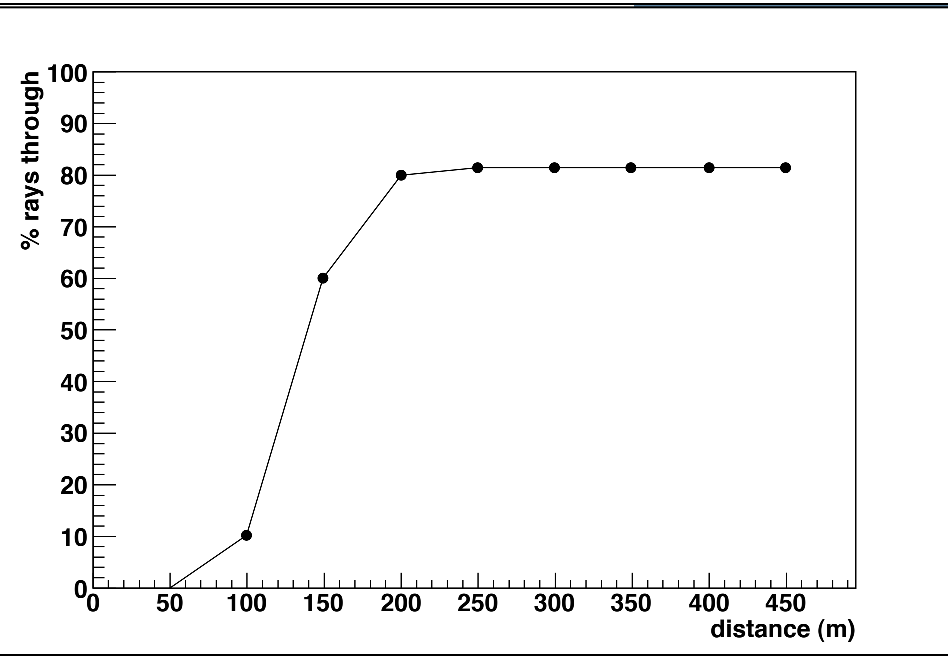
Zaber motorized mirror mount: computer-controlled fine alignment

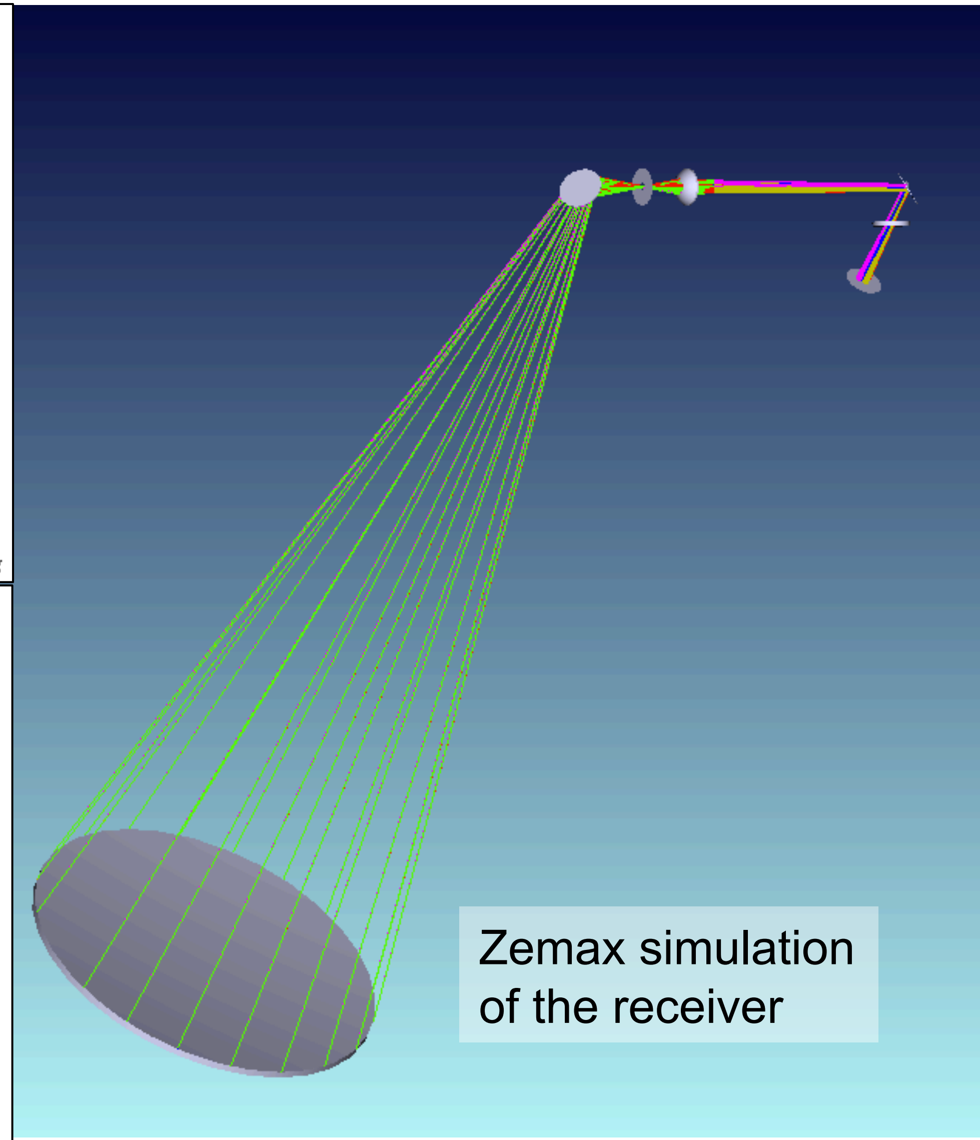
Laser probe RjP-445

Quantel Centurion Nd:YAG laser

Receiver design

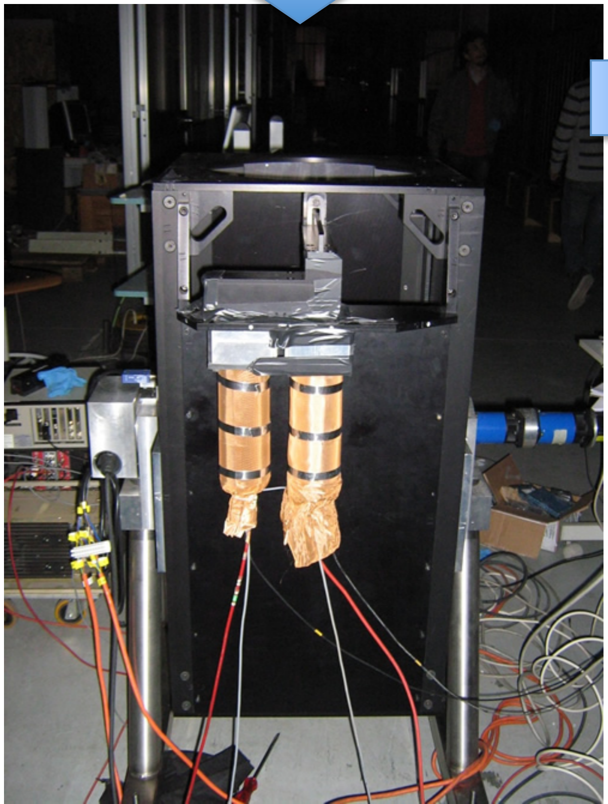






Data acquisition

E	Beam Splitter	Materion	Transmit avg > 90% 380-420 nm, Reflect > 90% at 354.7 nm 25.4 x 36 mm, 45° incidence angle
F	Bandpass Filter	Materion	notch @ 386.7±0.15 nm, OD 10 @ 354.7, 532, 1064 nm
G	Bandpass Filter	Materion	notch @ 354.7±0.15 nm

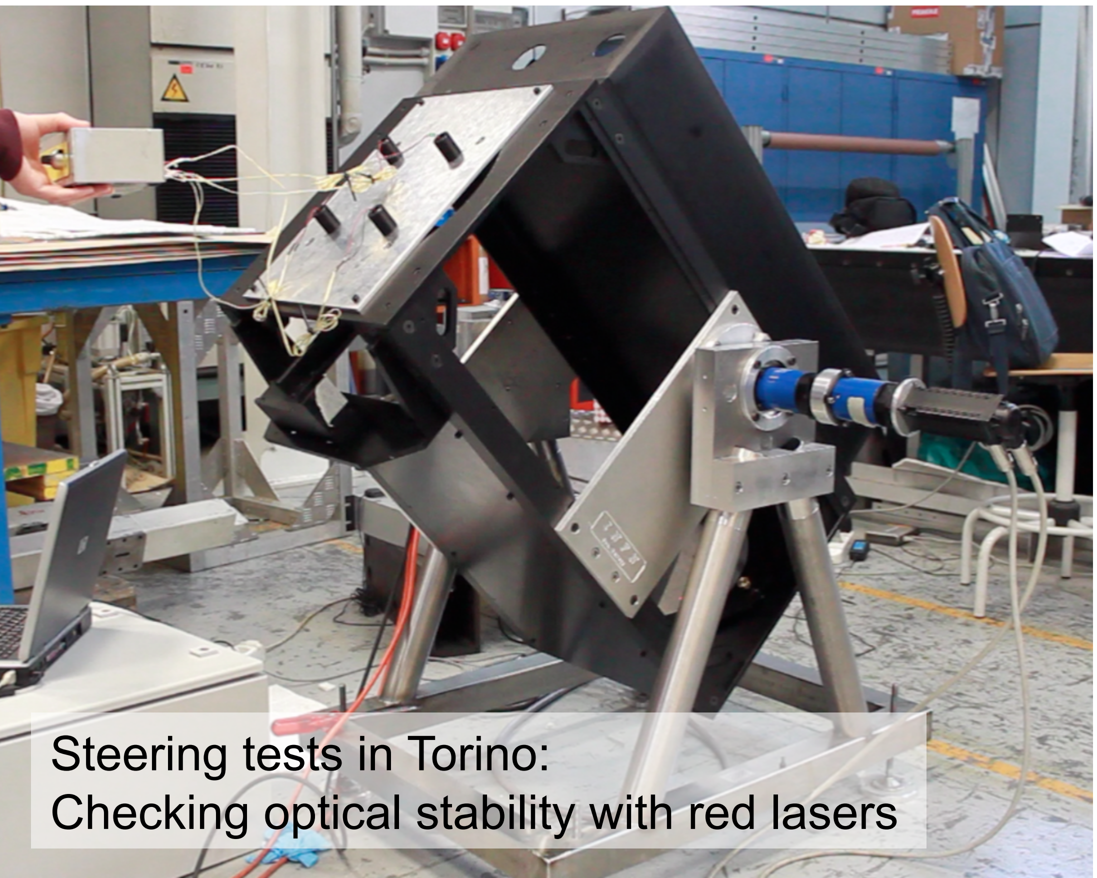


Signals are amplified 20X and then sampled with the CAEN digitizer DT5751 (1Vpp - 10bit – 1GS/s)

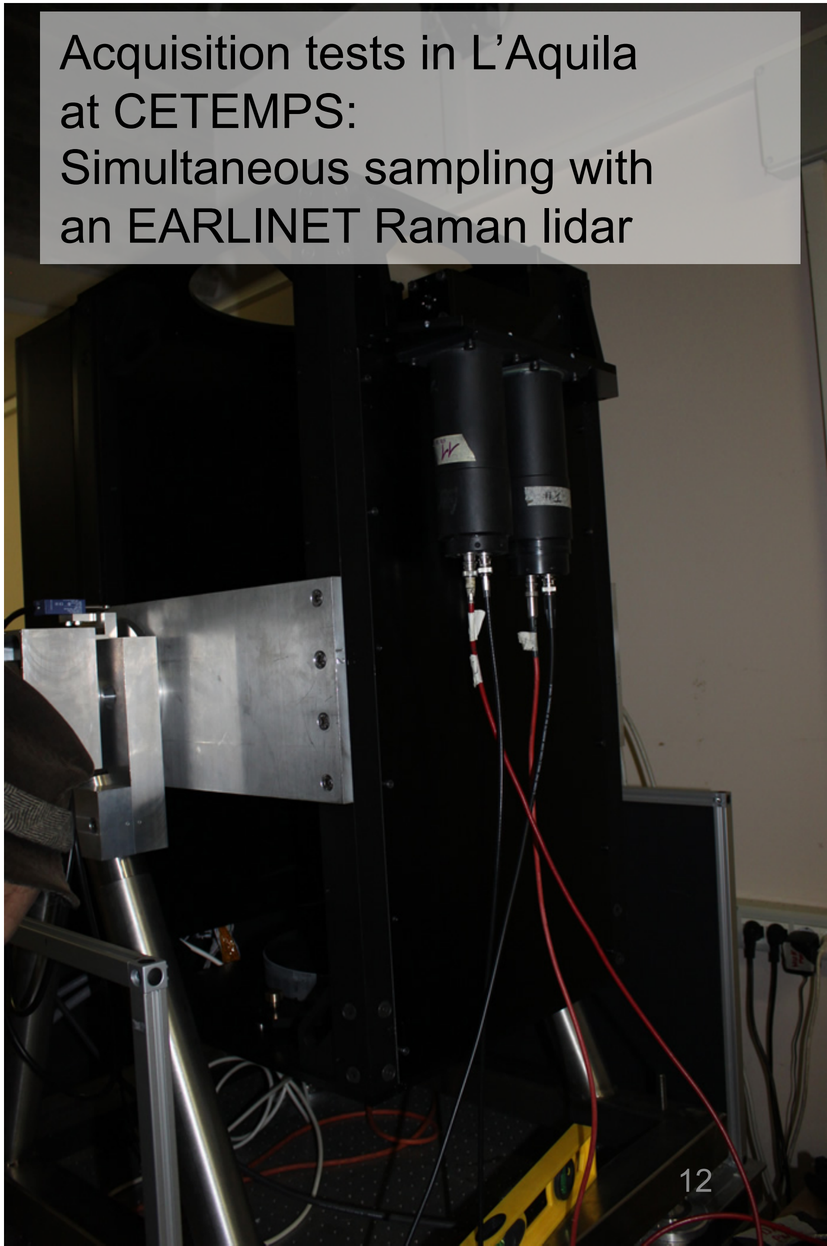
Software-based signal processing (charge integration, photon counting)

Steerable Raman LIDAR

Steerable Raman lidar
based on a Nd:YAG laser (6mJ - λ=355nm)

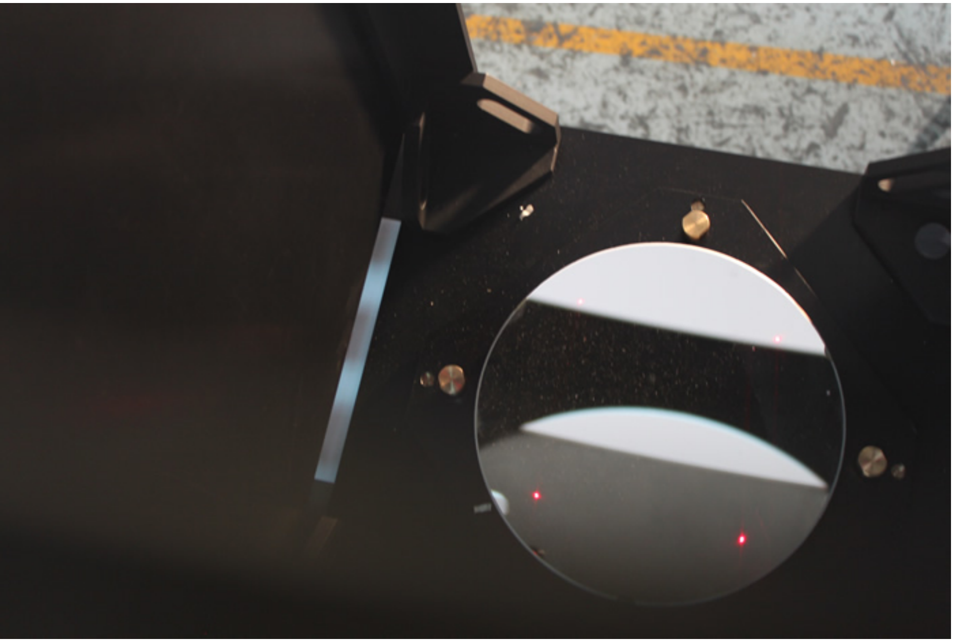


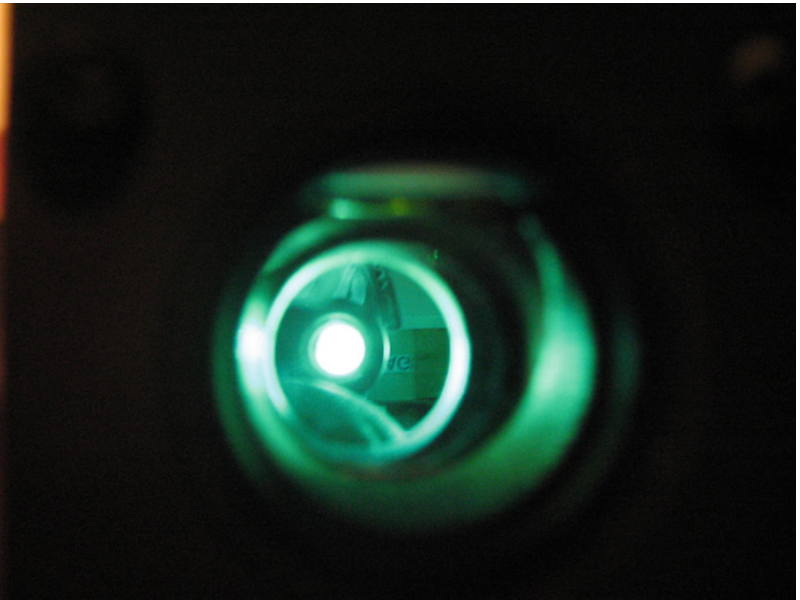
Steering tests in Torino:
Checking optical stability with red lasers

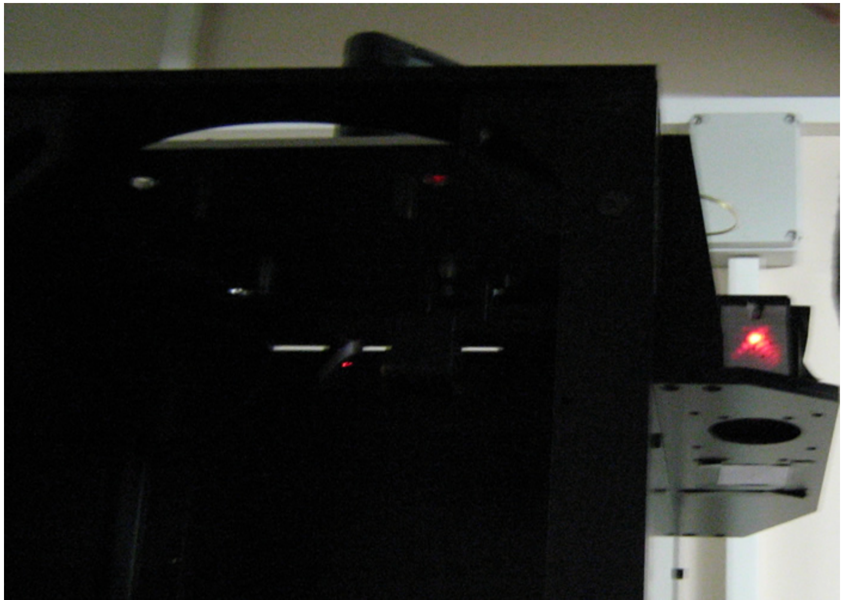


Acquisition tests in L'Aquila at CETEMPS:
Simultaneous sampling with an EARLINET Raman lidar

Receiver alignment

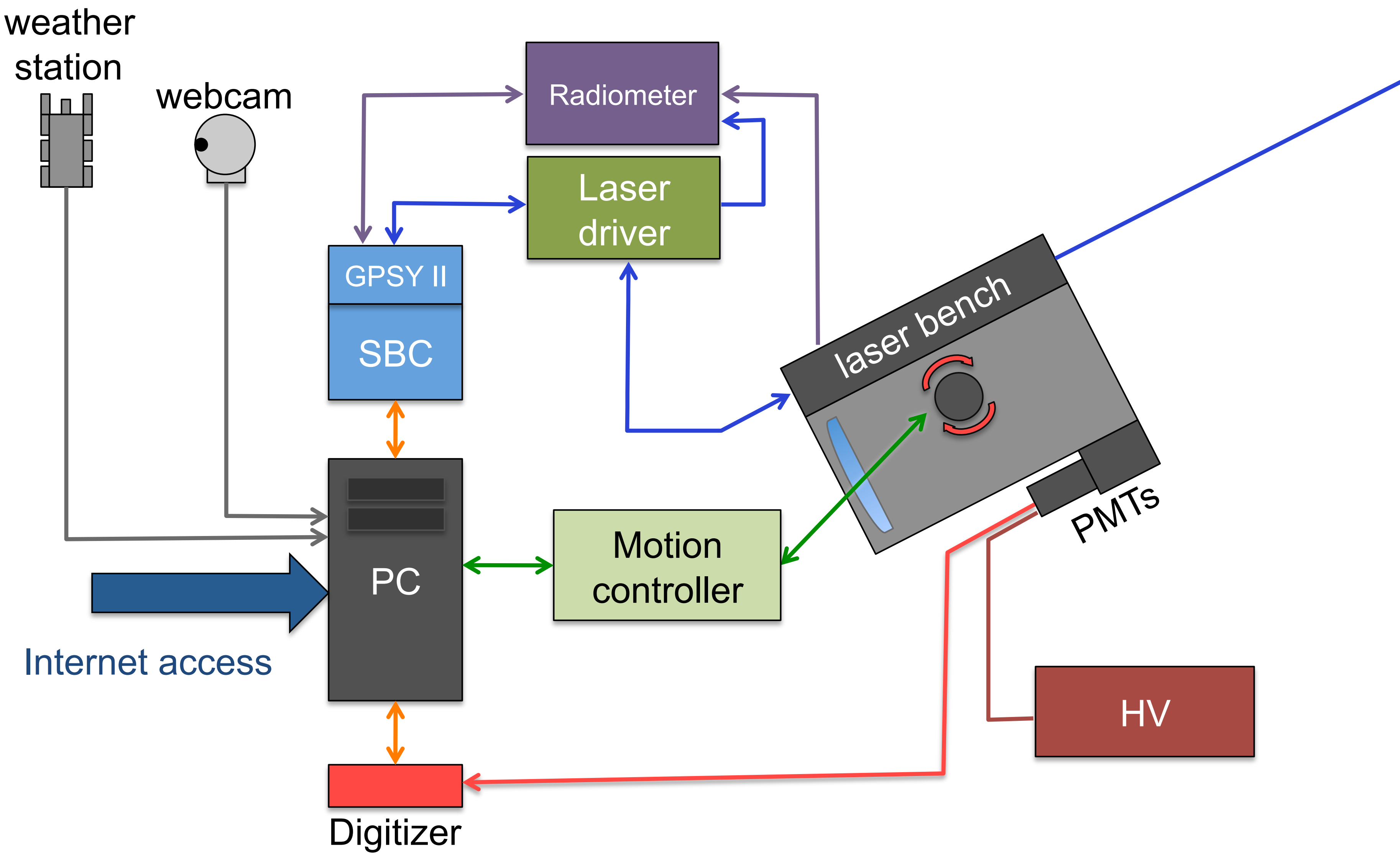






Lidar installation

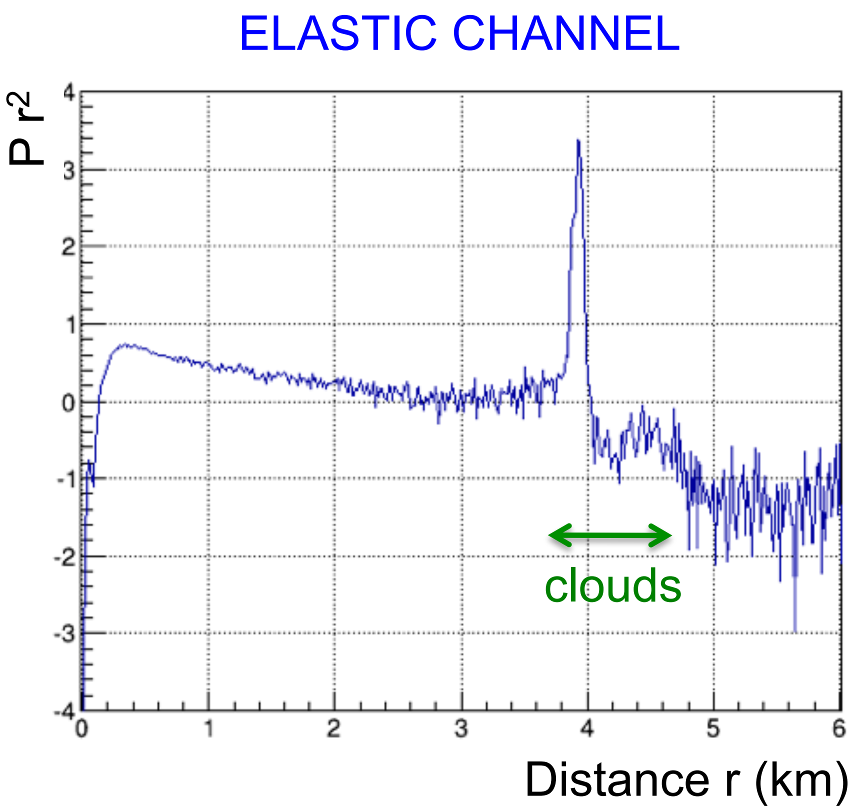
Lidar system

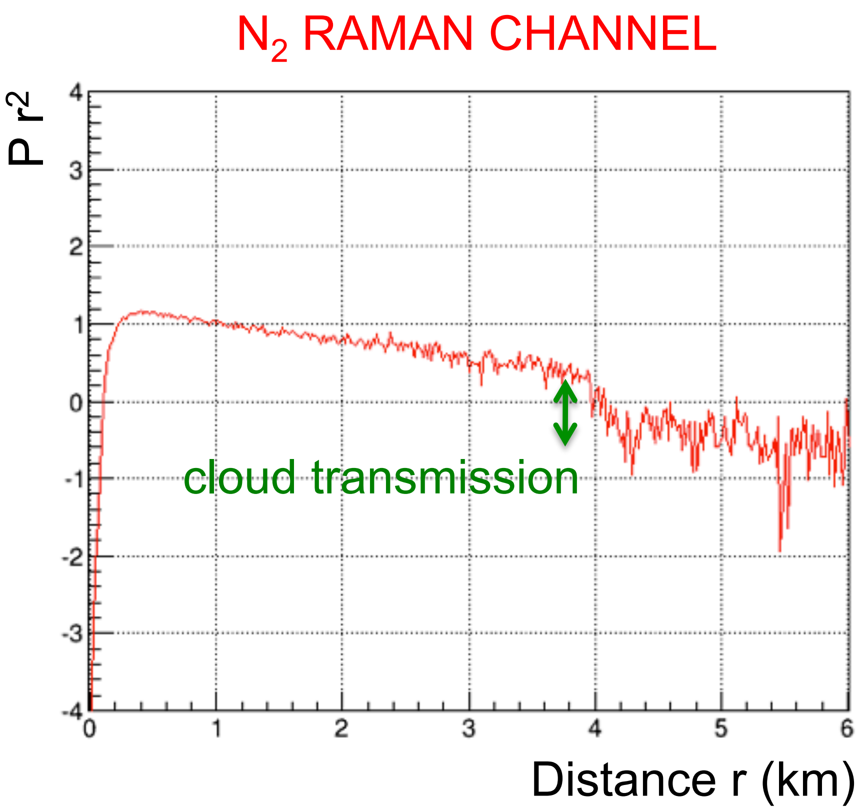


Built for remote operation

Lidar data

Vertical scan: *signals are the sum of 25k laser shots.*

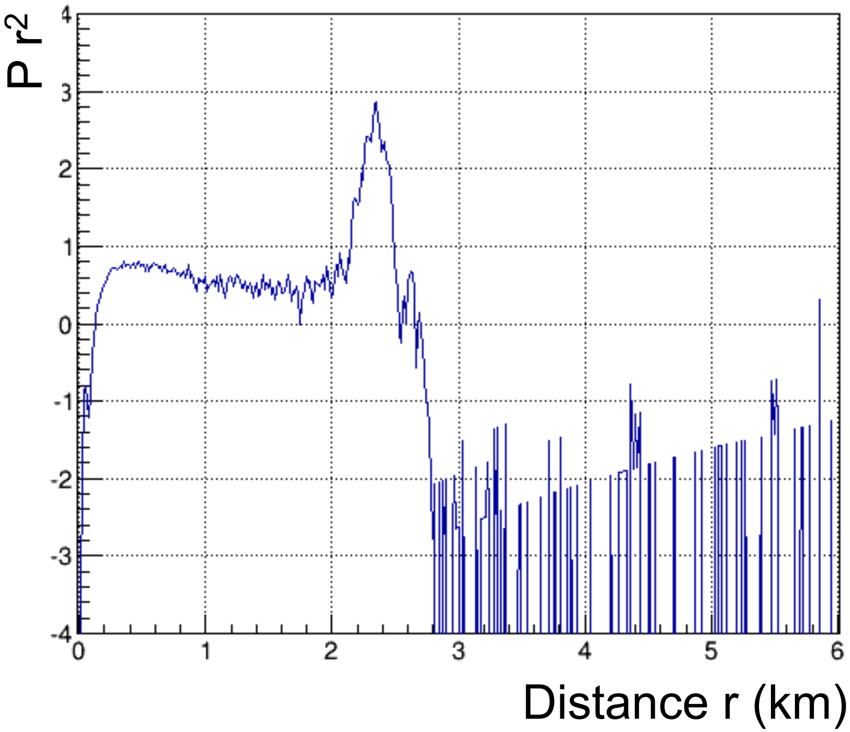




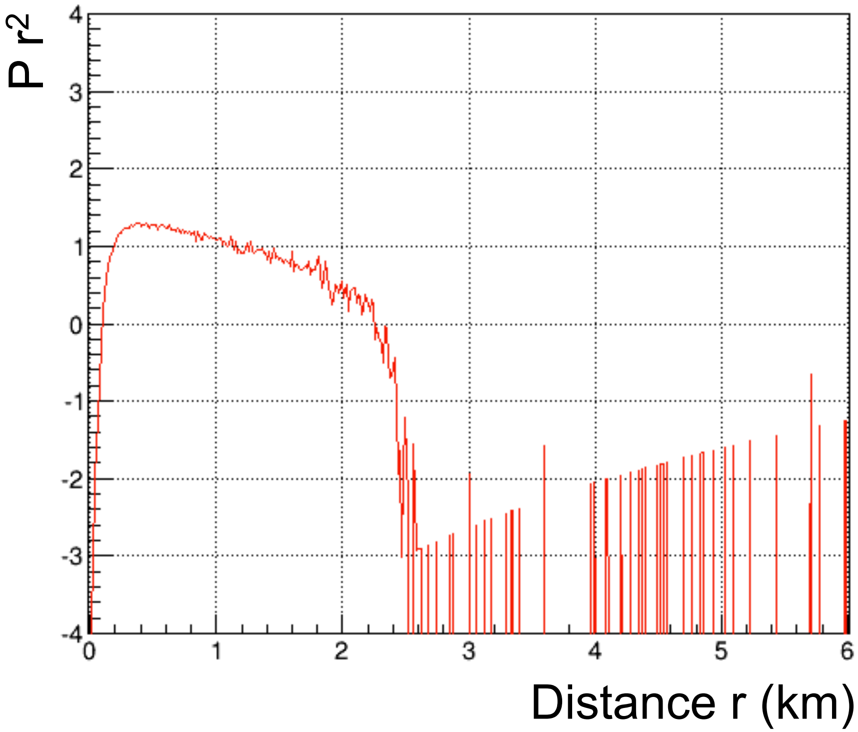
Lidar data

***Vertical scan**: signals are the sum of 5k laser shots.*

ELASTIC CHANNEL



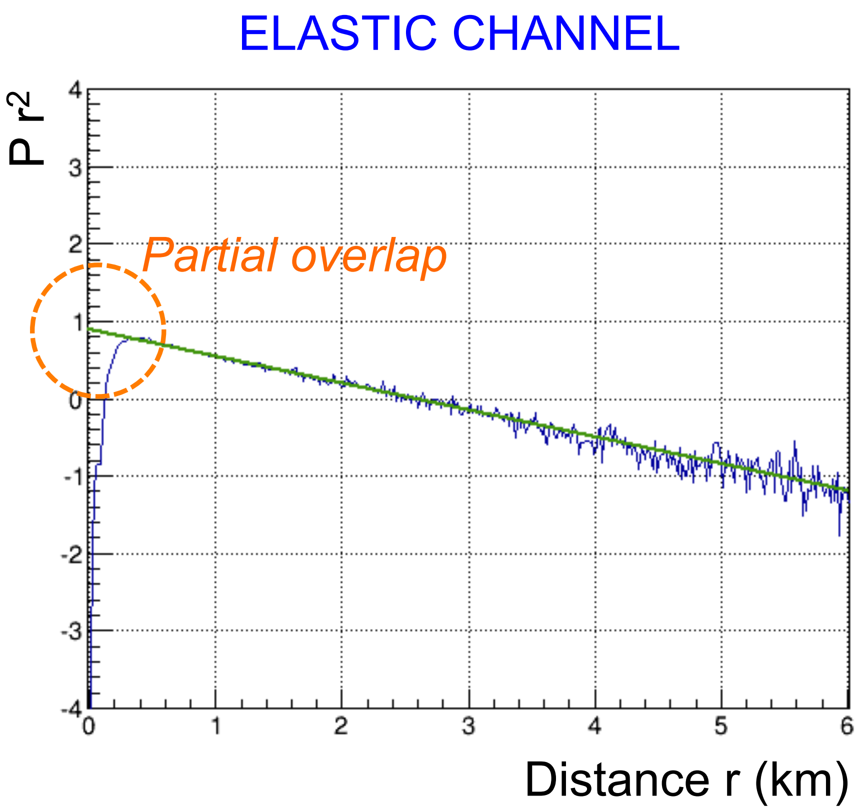
N_2 RAMAN CHANNEL

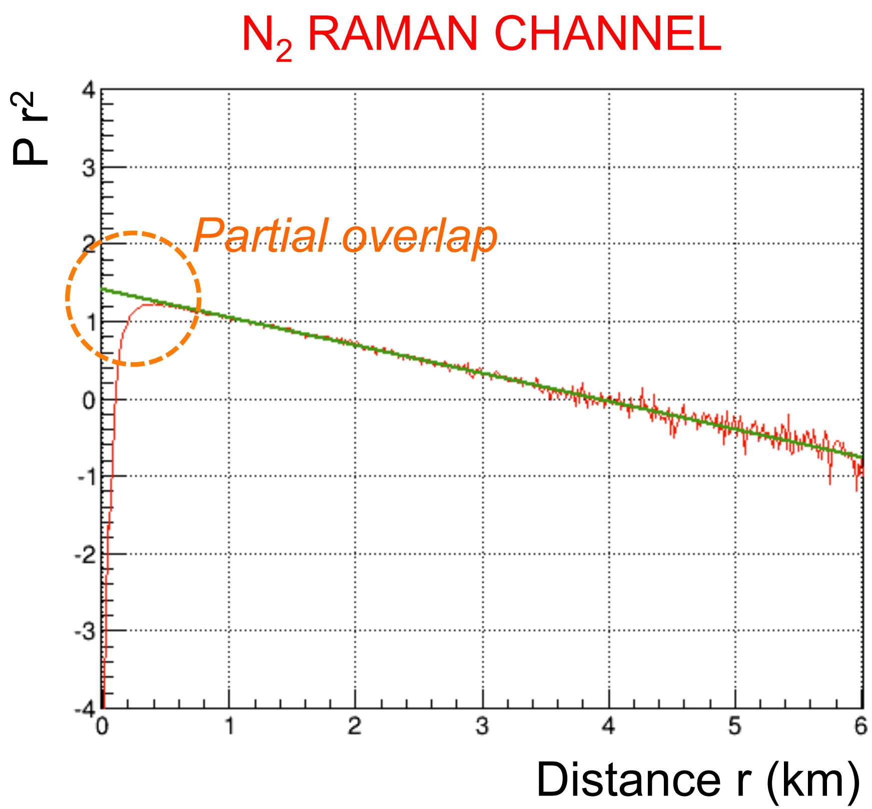


Extreme case: high peak in elastic channel, no contamination on Raman channel

Lidar data

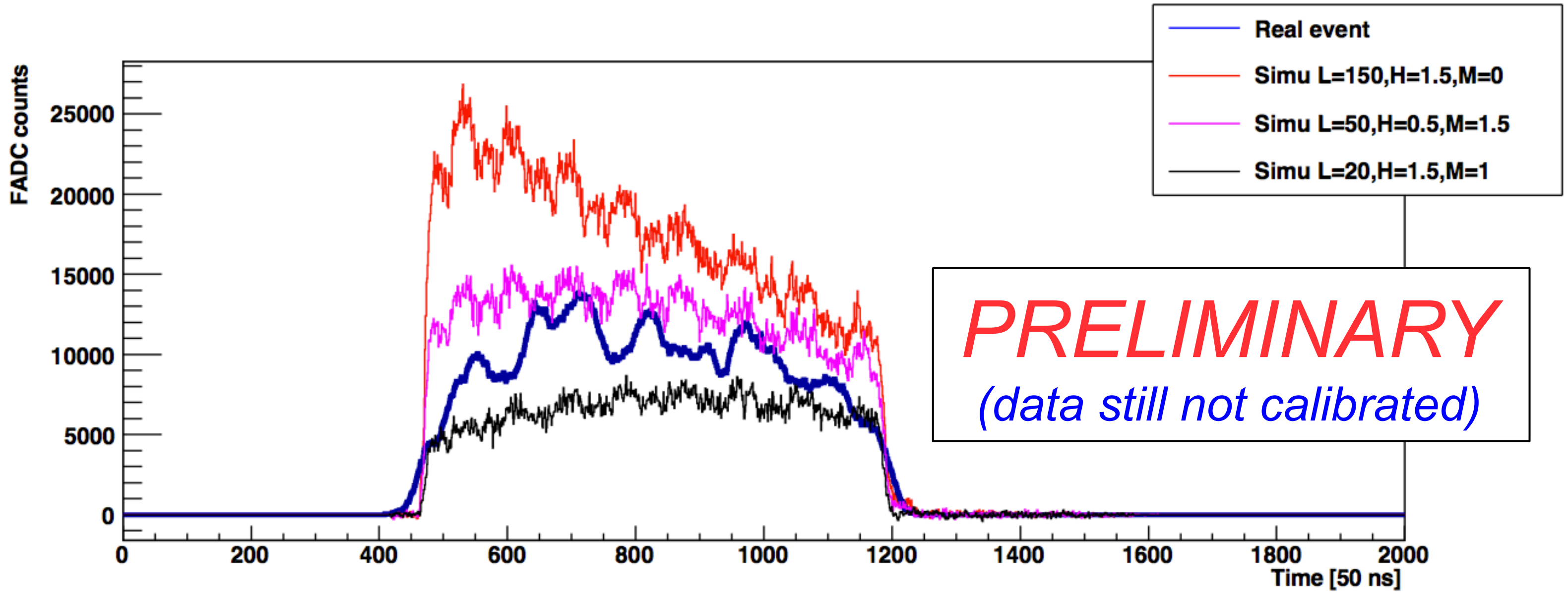
***Horizontal scan**: signals are the sum of 100k laser shots.*

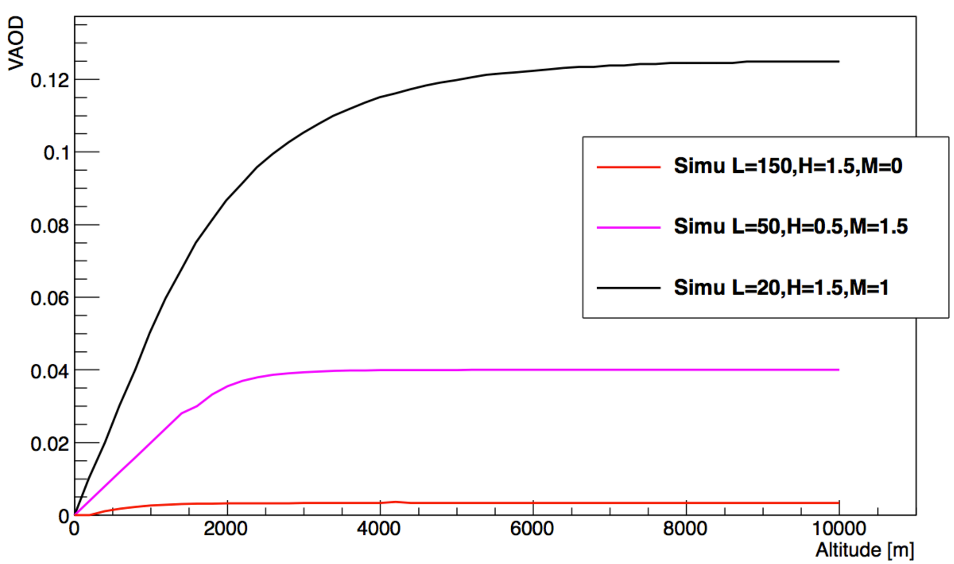




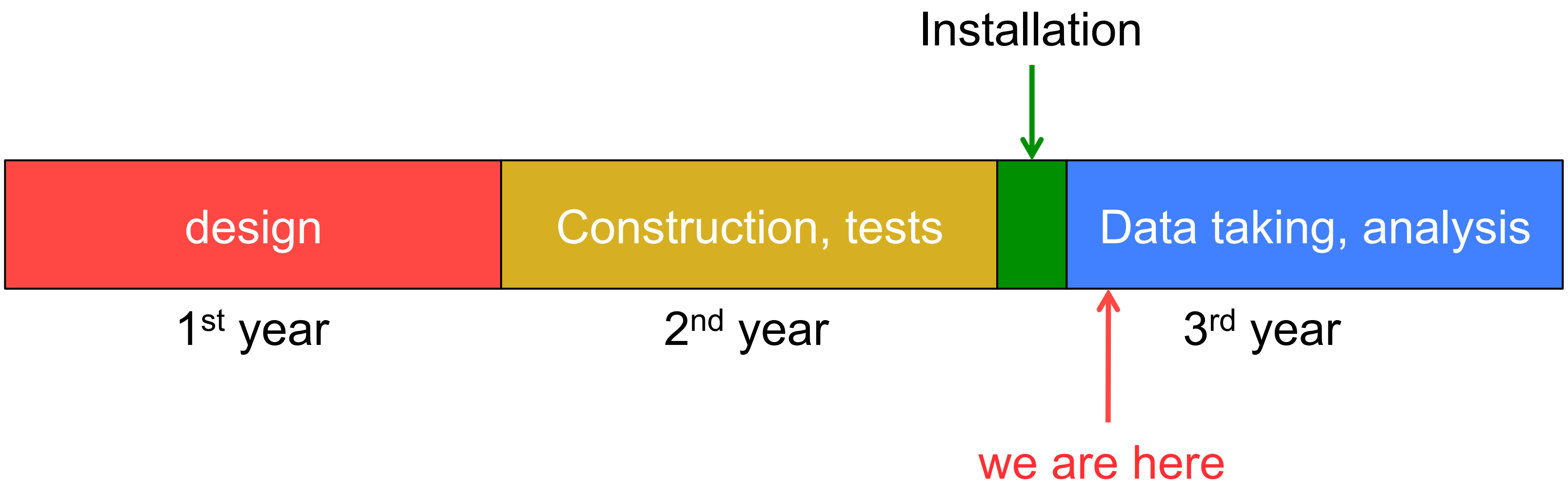
AMT data

Sum of 250 side scattering laser events *compared to different simulated events.*





Outlook



We are working to stabilize the acquisition
Data analysis has just started
Analysis comparisons will start soon!

Future plans: from ARCADE to CTA

In late 2015 the Raman lidar of ARCADE will be improved:
- new HV control
- new PMTs
- additional H_2O Raman channel

Extensive tests of the upgraded system in L'Aquila

This lidar will be **a reference for the Raman lidars** designed for CTA and will perform a **first characterization of CTA sites**.