esyLIDAR

PUBLIC

EPFL ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

INOE 2000

PRIVATE

CIMEL.FR

METEK

Sintégra

ESYCH

ESYRO

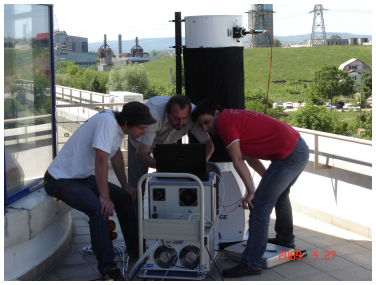
PARTNERSHIP

EnviroScopY SA

Dr Ioan **BALIN**

ioan.balin@enviroscopy.com

Phone +41 21 693 9000



Mihai Cazacu, Ion Vetres, Pablo Ristori, Pascal Mark, Ovidiu Tudose, Doina Nicolae, Dana Dorohoi, Ioan Balin, …..

EnviroScopY

...Building future

...Preserving past

Environmental Monitoring and Modeling

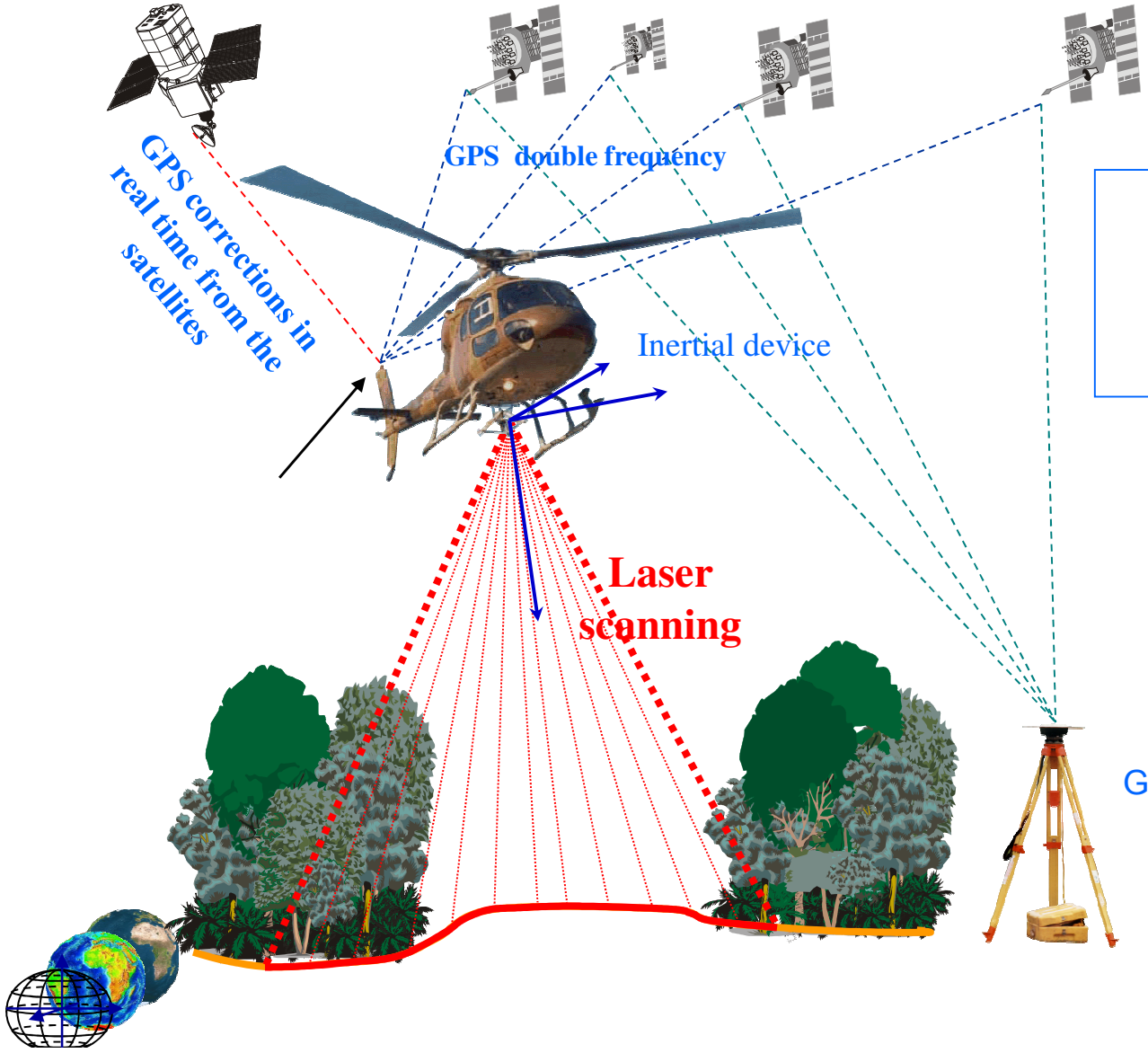
ESYCH and ESYRO and more to come

PROBLEM ???

- Floods Spring 2006 - extreme event?
- Humans and $$$ dimensions
- **MMDD (RO) - new defense dams&lines**

SOLUTION !!!

- **RE consideration of Danube Flood Plain**
  - **Risk Management and Assessment**
    - **DTM – Digital Terrain Modeling**
      - **LIDAR airborne technique**



REAL TIME

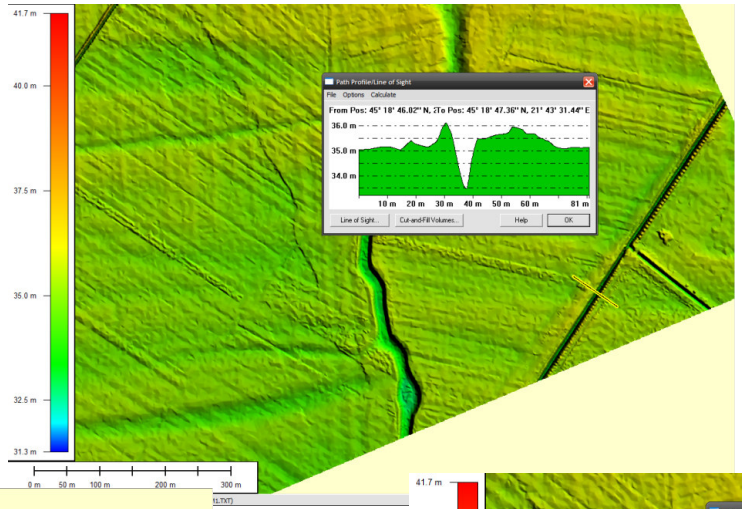
GPS BASED

Navigation System

Airborne LIDAR PartenAvia (APEI SA)

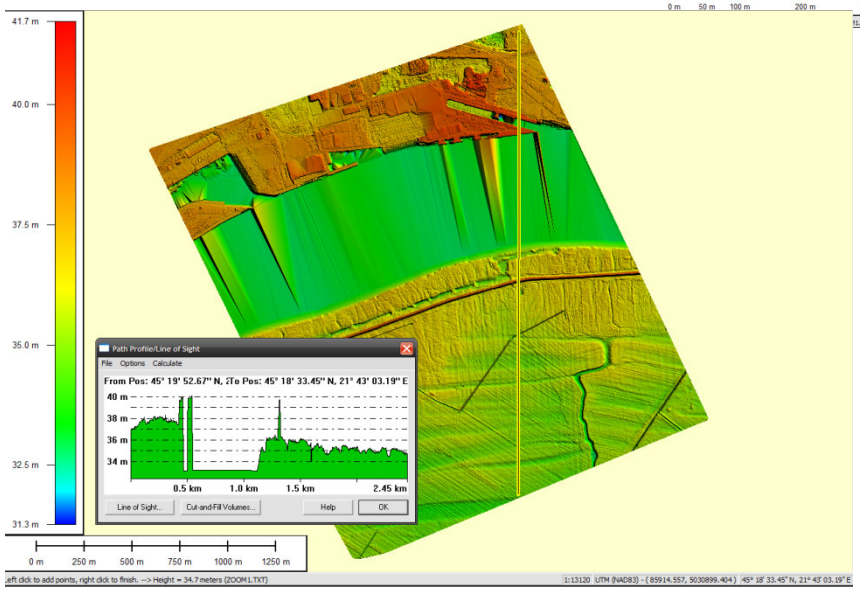
DTM-LIDAR flight parameters	Value
Flight alltitude	450 m
Speed flight	45 m/s
Band width	520 m
Lateral coverage bands/Overlapping	20%
Distance between bands	415 m
Laser emmision frequency	65 kHz
Scanning angle	60^0 (+/- 10^0)
Scanning frequency	75 Hz
(Standard deviation) total planimetric precision of the measured laser points	20 cm
Medium density of laser points	3-5 pts / m^2 4-5 pts/m2
Medium distance between laser points (flight direction and perpendicular)	0,6 m

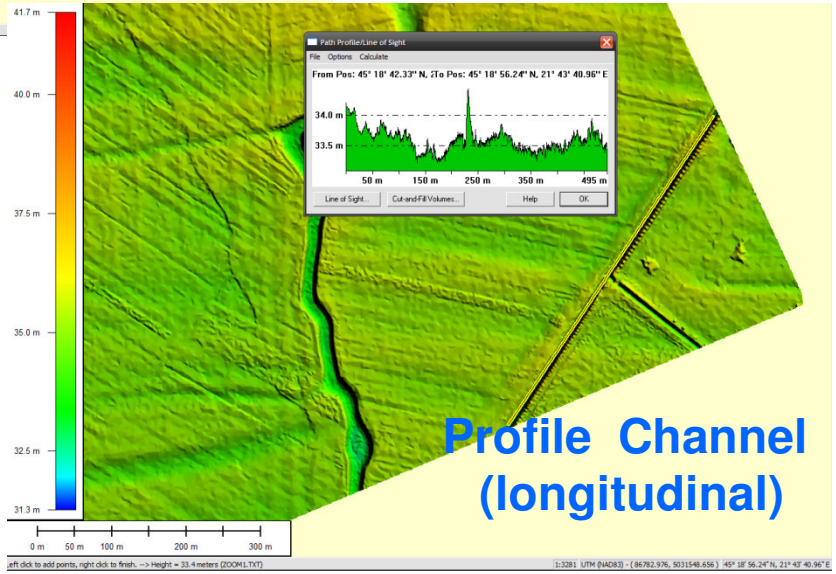
QUANTITATIVE DATA



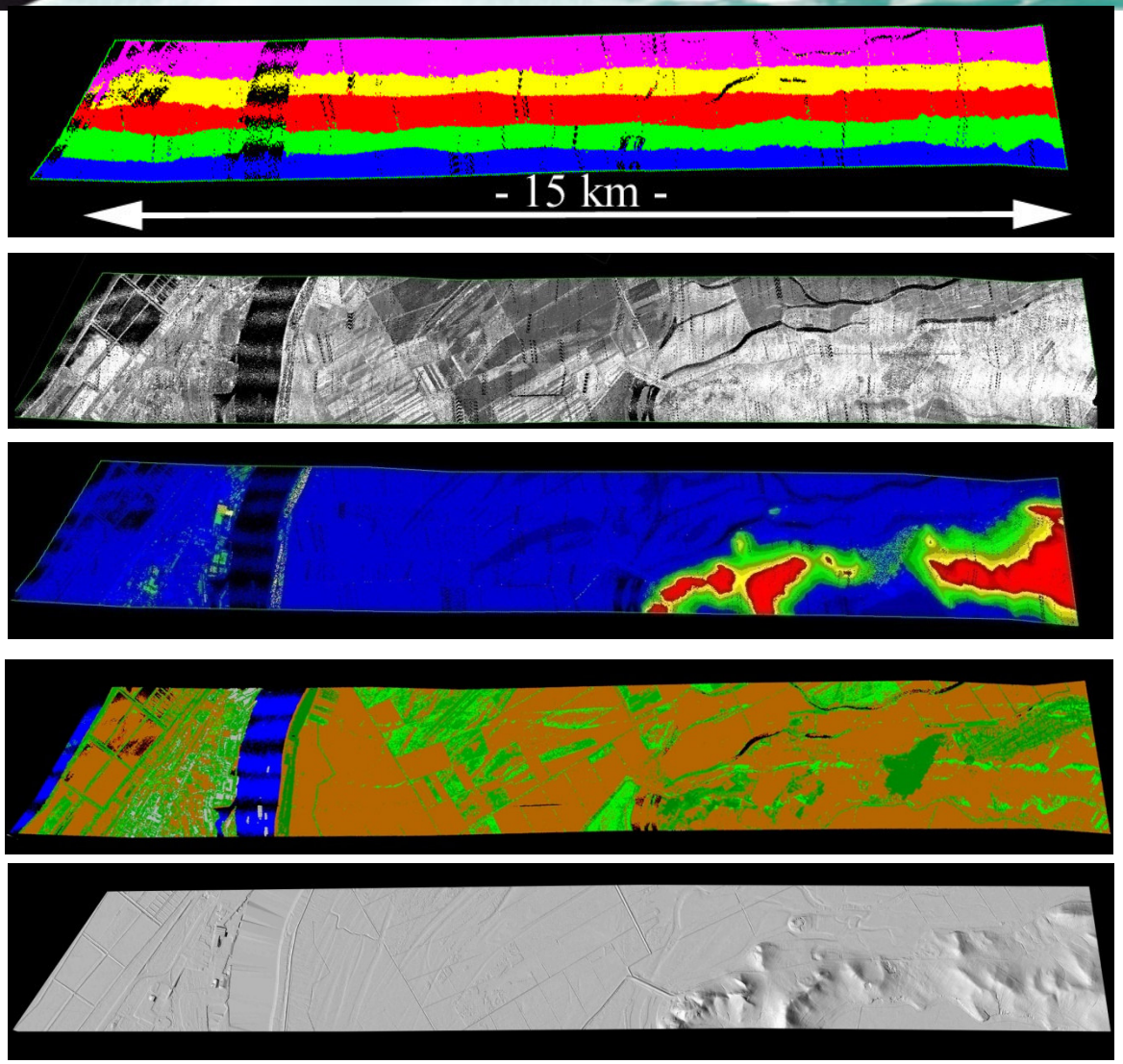
Profile - Channel (transversal)

Profile Danube (transversal)





Profile Channel (longitudinal)



Bands from LIDAR: length of 15 km and width of 500 meters each

The intensity of LIDAR signal's echo („albedo"). Danube - black color in the left, that means lack of LIDAR signal.

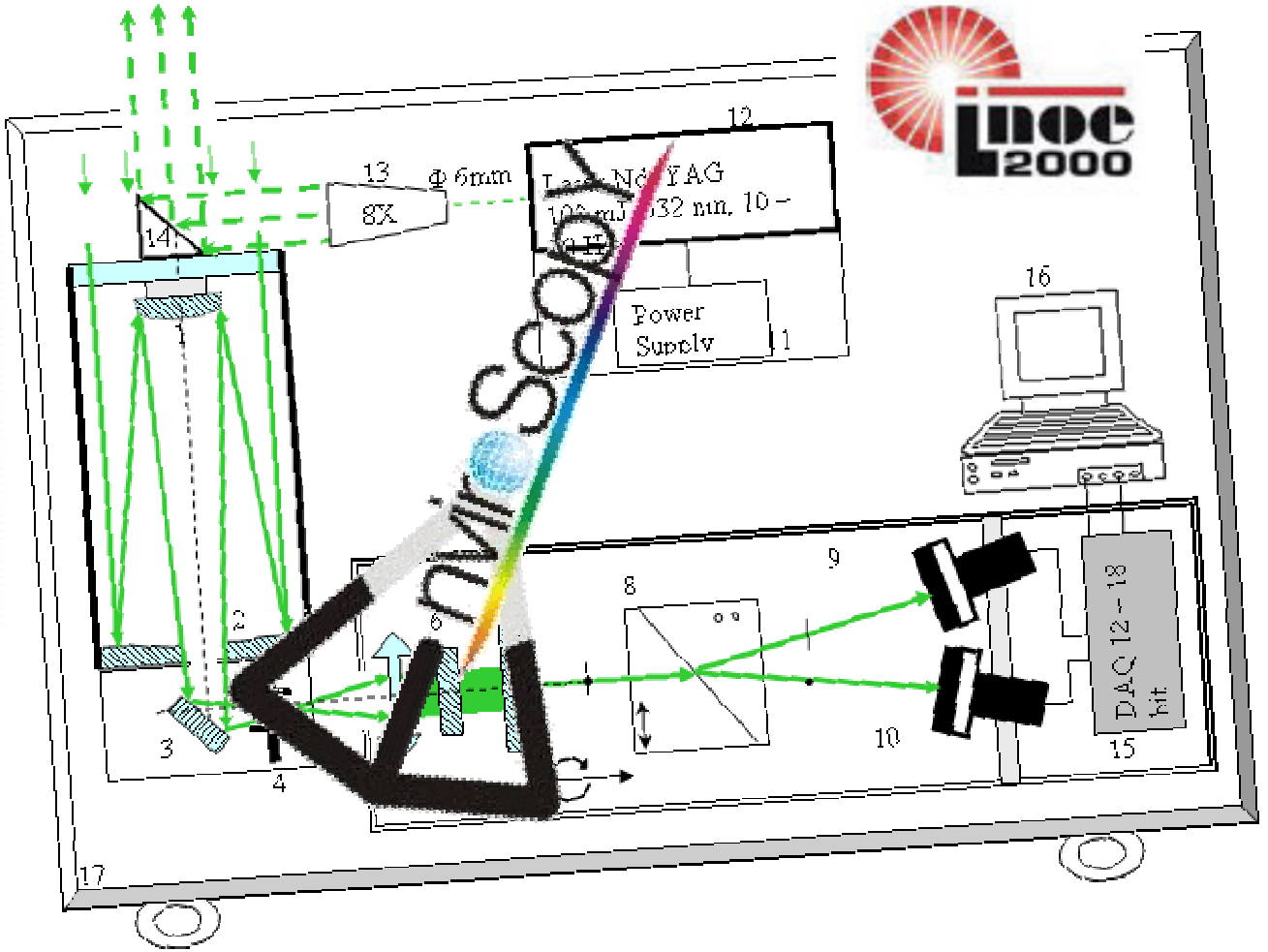
Altitude- Danube in black color, the higher areas – green to red.

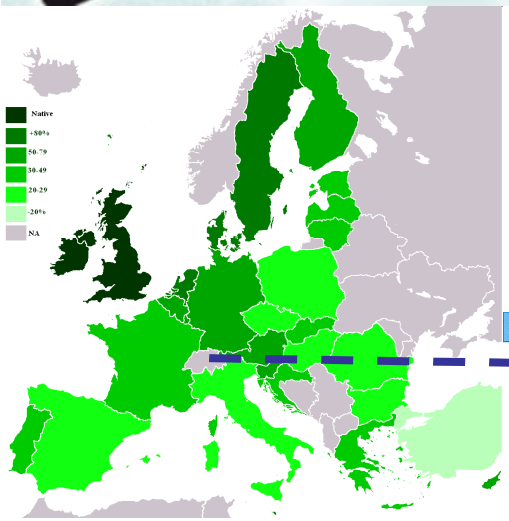
Altitude class i.e. low vegetation

Ground DTM: see clearly the Danube, the hills

ROLINET 2007-2010 = ROmanian LIdar NETwork

ADMINISTRATIA NATIONALA DE METEOROLOGIE





ROLINET – **RO**manian **LI**dar **NET**work and the

ESYRO station at TehnopolIS Iasi station

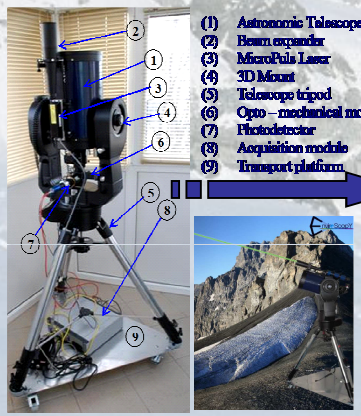
mESYLIDAR: a new cost-effective powerful lidar configuration for tropospheric aerosols and clouds investigations

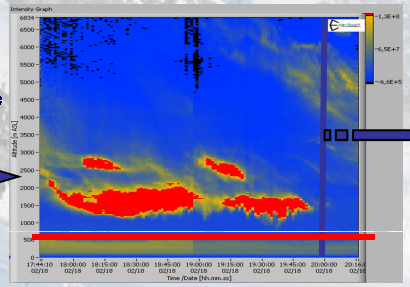
M.M. Cazacu[1,3], P. Ristori[2], O. Tudose[1], A. Balanici[1], D. Nicolae[4], V. Ristici[5], D. Balin[6], I. Balin[1,2]

(1)ESYRO (EnviroScopY SRL), Iasi, Romania (mihai.cazacu@enviroscopy.com) , (2) ESYCH (EnviroScopY SA), PSE - EPFL, Lausanne, Switzerland (ioan.balin@enviroscopy.com), (3) Alexandru Ioan Cuza University, Faculty of Physics, Iasi, Romania , (4) National Institute of Research & Development for Optoelectronics, INOE, Bucharest, Romania, (5) National Meteorogical Administration, Bucharest, Romania, (6) Faculty of Geosciences and Environment, Lausanne, Switzerland

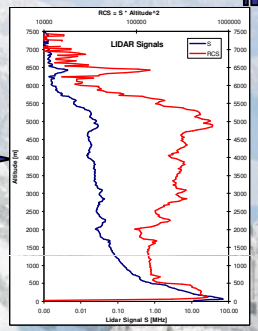
ESYCONTACT : ioan.balin@enviroscopy.com

FROM a μESYLIDAR – microlidar system .....



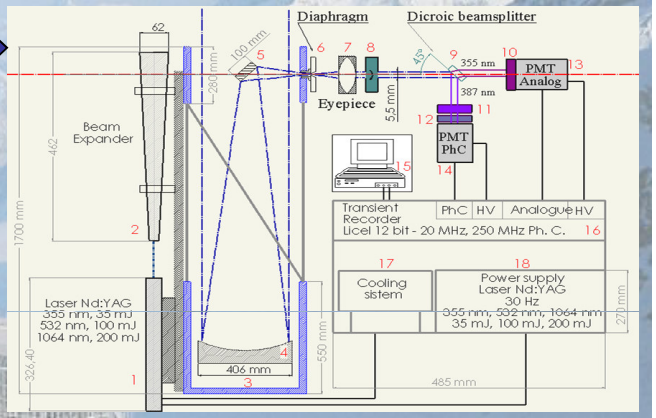


3D profiles from 18.02.2009



RCS one single profile from 18.02.2009

...TO a NEW mESYLIDAR !?



1. Laser Nd:YAG
2. Beam Expander
3. Newtonian telescope
4. Primary mirror of telescope
5. Secondary mirror of telescope
6. Iris diaphragm
7. Eyepiece
8. Polarizing linear filter
9. Dicroic beam splitter
10, 11. Interferential filters
12. Neutral density filter
13. Analogue Photomultiplier
14. Photon counting
15. Computer
16. Acquisition part, analogue/ digital conversion and datas transmitions
17. Cooling system for laser
18.Laser power supply

ESYLIDAR APPLICATIONS

- 3D monitoring (clouds, aerosols, dust , pollens,...);
- Planetary Boundary Layer (height, dynamics, structure, ...;
- Aerosols characterization (extinction and backscattering coefficients, size....)
- Anti-hail and fight against fire and droughts complementary tool.

CONCLUSIONS

- the 532 nm ESY microlidar system is operational from (100m) to 7.5 km night and 3-5km (day), 30m /2min
- « atmospheric piston effect » - in cold seasons we clearly report a ~ 500 m stable layer over Bucarest area !!!
- a new ESY minilidar was designed with two channels (A and PhC), up to 6, from 2-300m to 10-15km, 7.5m/30min

mESYLIDAR Keywords

- Low cost, easy up-gradable , versatile and modular;
- High spatial (m) and temporal (min) resolution and 3D scan;

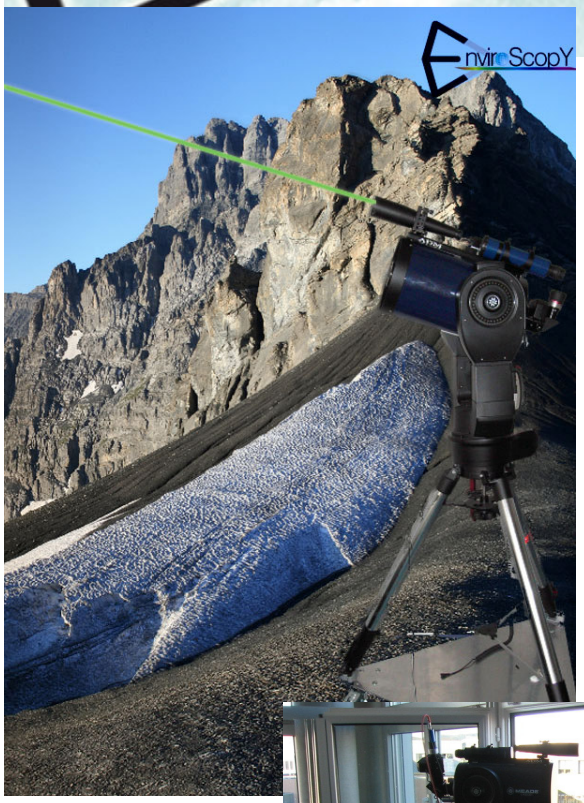
Specifications of emission part (mESYLIDAR)		Specifications of detection part (mESYLIDAR)	
Laser	**Nd:YAG**	**Telescope**	Light Bridge
Energy	35 mJ, 100 mJ, 200 mJ	Type	Newtonian
Wavelength	355 nm, 532 nm, 1064 nm	Diameter of primary mirror	406 mm
Beam diamter	0.6 mm	Focal length	1829 mm
Pulse width	6 – 9 ns	Focal ratio	f/4.5
Divergence	0.75 mrad	Power	70X

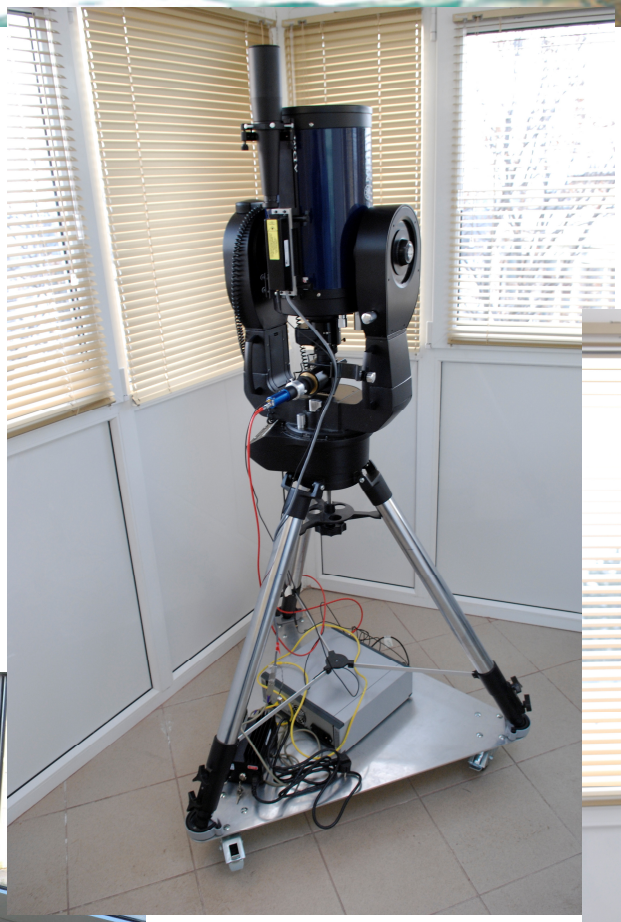
References:

1. Ioan Balin, *Measurement and analysis of aerosols, cirrus-contrails, water vapor and temperature in the upper troposphere with the Jungfraujoch LIDAR system.* Thèse EPFL, no 2975 (2004 – web: http://library.epfl.ch/theses/?nr=2975
2. D. Nicolae, E. Carstea, I. Balin, A. Balanici, G. Picoulet, P. Ristori, *MicroLIDAR System for Detection of Aerosol and Atmospheric Clouds 3D Profiles*, patent, 2008; A/00694/09.09.2008
3. „ROmanian Lidar NEwTwork" – ROLINET; National Research Project PNCDI – II, PO-04-Ed1-R0-F5
4. S. Stefan, D. Nicolae, M. Caian, *Secretele aerosolului atmosferic în lumina laserilor*, 2008

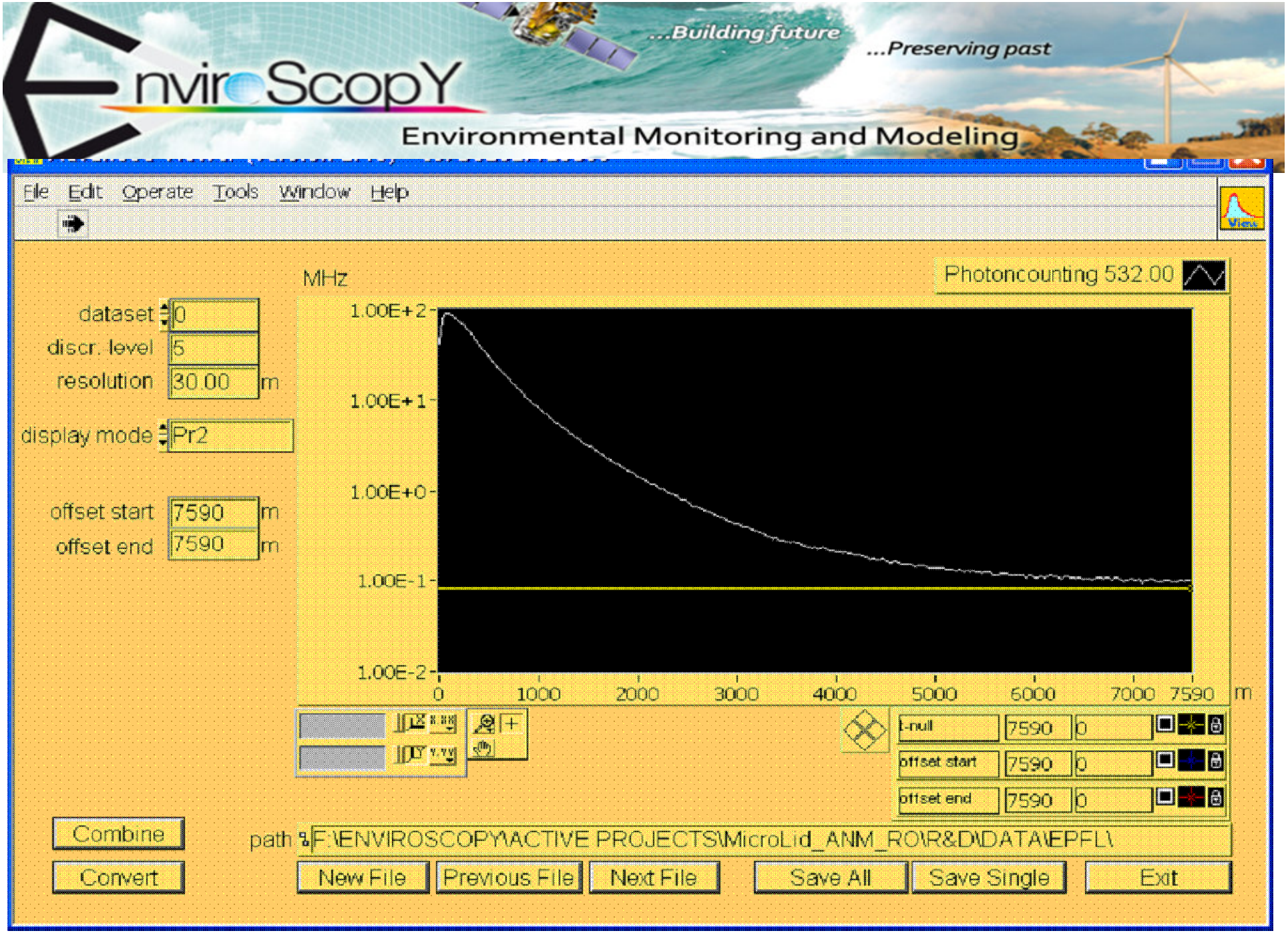
©ESY2009

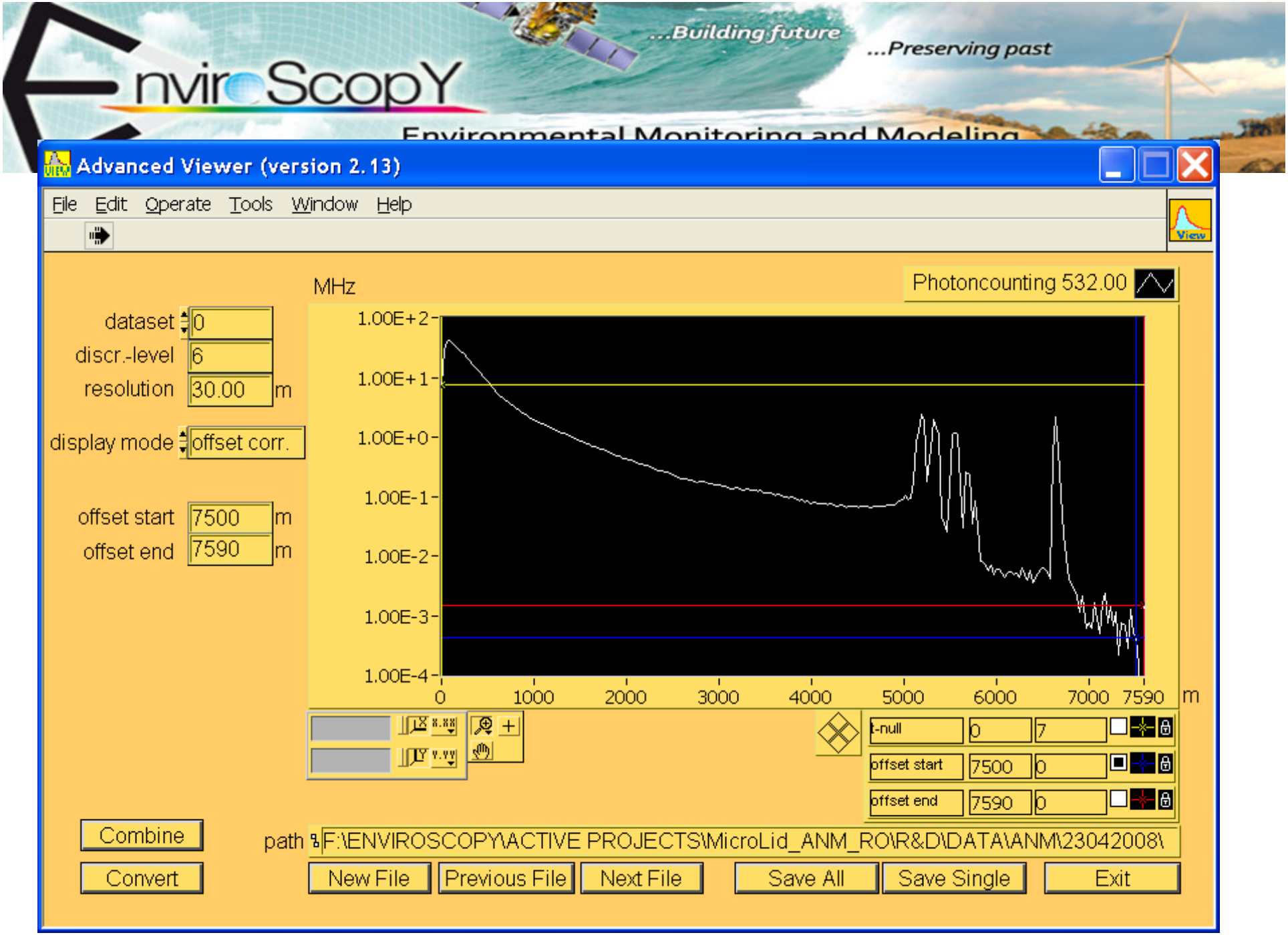

EnviroScopY
...Building future
...Preserving past
Environmental Monitoring and Modeling

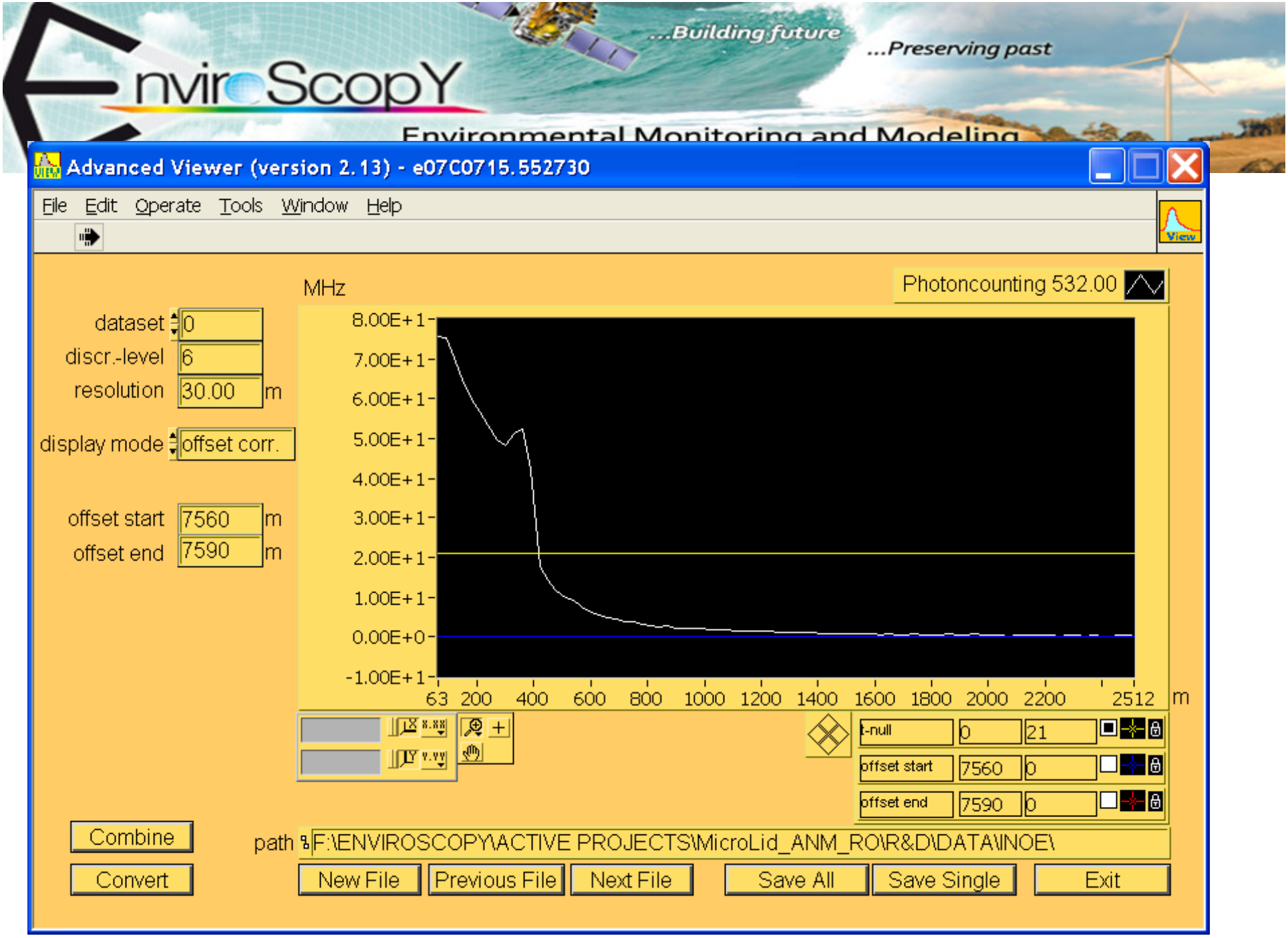

EnviroScopY

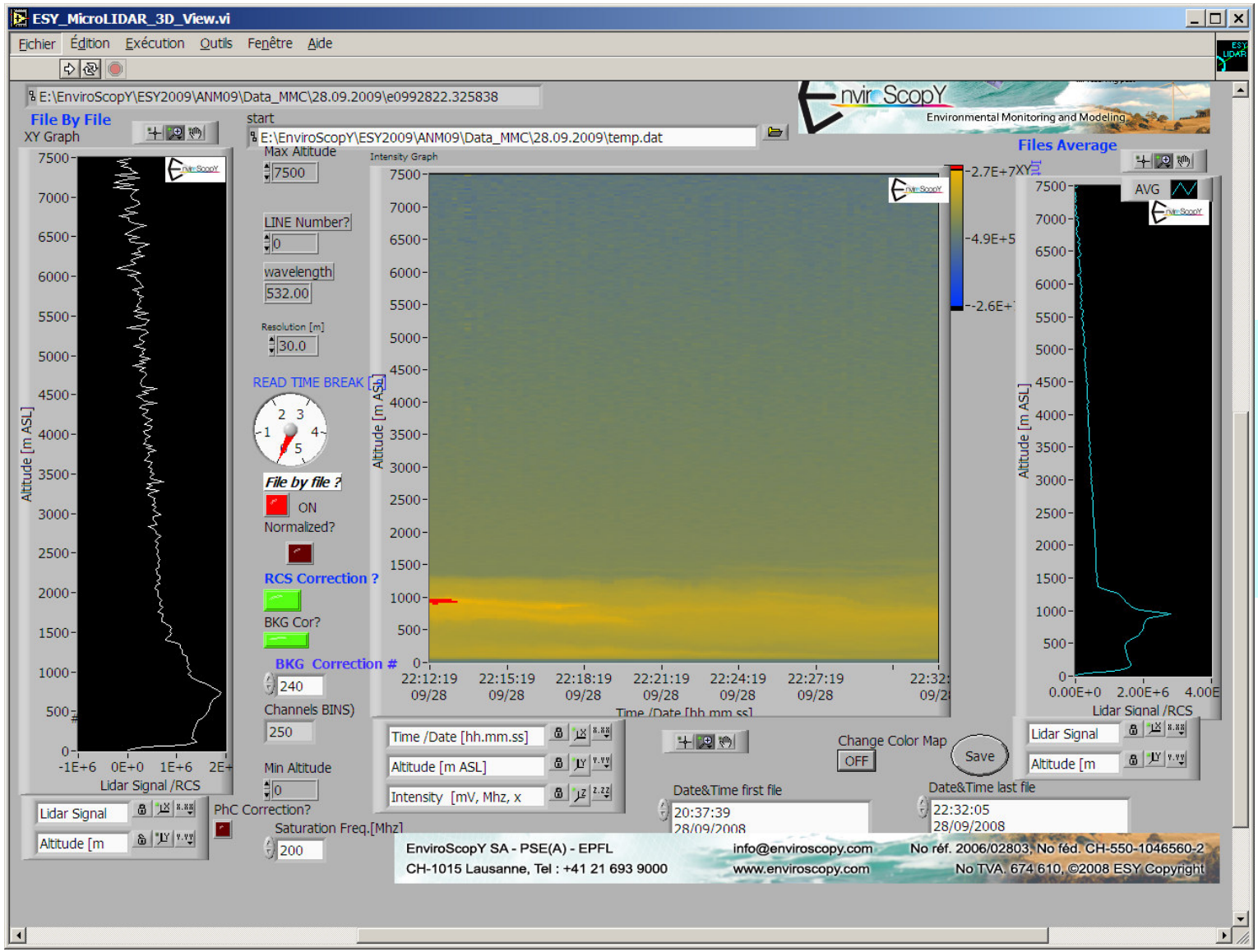



MEADE


EnviroScopY
...Building future
...Preserving past
Environmental Monitoring and Modeling
File Edit Operate Tools Window Help
MHz
Photoncounting 532.00
dataset 0
discr. level 5
resolution 30.00 m
display mode Pr2
offset start 7590 m
offset end 7590 m
1.00E+2
1.00E+1
1.00E+0
1.00E-1
1.00E-2
0 1000 2000 3000 4000 5000 6000 7000 7590 m
t-null 7590 0
offset start 7590 0
offset end 7590 0
Combine
Convert
path F:\ENVIROSCOPY\ACTIVE PROJECTS\MicroLid_ANM_RO\R&D\DATA\EPFL\
New File
Previous File
Next File
Save All
Save Single
Exit


...Building future
...Preserving past
Environmental Monitoring and Modeling
Advanced Viewer (version 2.13)
File Edit Operate Tools Window Help
View
MHz
Photoncounting 532.00
dataset 0
discr.-level 6
resolution 30.00 m
display mode offset corr.
offset start 7500 m
offset end 7590 m
1.00E+2
1.00E+1
1.00E+0
1.00E-1
1.00E-2
1.00E-3
1.00E-4
0 1000 2000 3000 4000 5000 6000 7000 7590 m
t-null 0 7
offset start 7500 0
offset end 7590 0
Combine
Convert
path F:\ENVIROSCOPY\ACTIVE PROJECTS\MicroLid_ANM_RO\R&D\DATA\ANM\23042008\
New File
Previous File
Next File
Save All
Save Single
Exit


...Building future
...Preserving past
Environmental Monitoring and Modeling
Advanced Viewer (version 2.13) - e07C0715.552730
File Edit Operate Tools Window Help
View
MHz
Photoncounting 532.00
dataset 0
discr.-level 6
resolution 30.00 m
display mode offset corr.
offset start 7560 m
offset end 7590 m
8.00E+1
7.00E+1
6.00E+1
5.00E+1
4.00E+1
3.00E+1
2.00E+1
1.00E+1
0.00E+0
-1.00E+1
63 200 400 600 800 1000 1200 1400 1600 1800 2000 2200 2512 m
t-null 0 21
offset start 7560 0
offset end 7590 0
Combine
Convert
path F:\ENVIROSCOPY\ACTIVE PROJECTS\MicroLid_ANM_RO\R&D\DATA\INOE\
New File
Previous File
Next File
Save All
Save Single
Exit

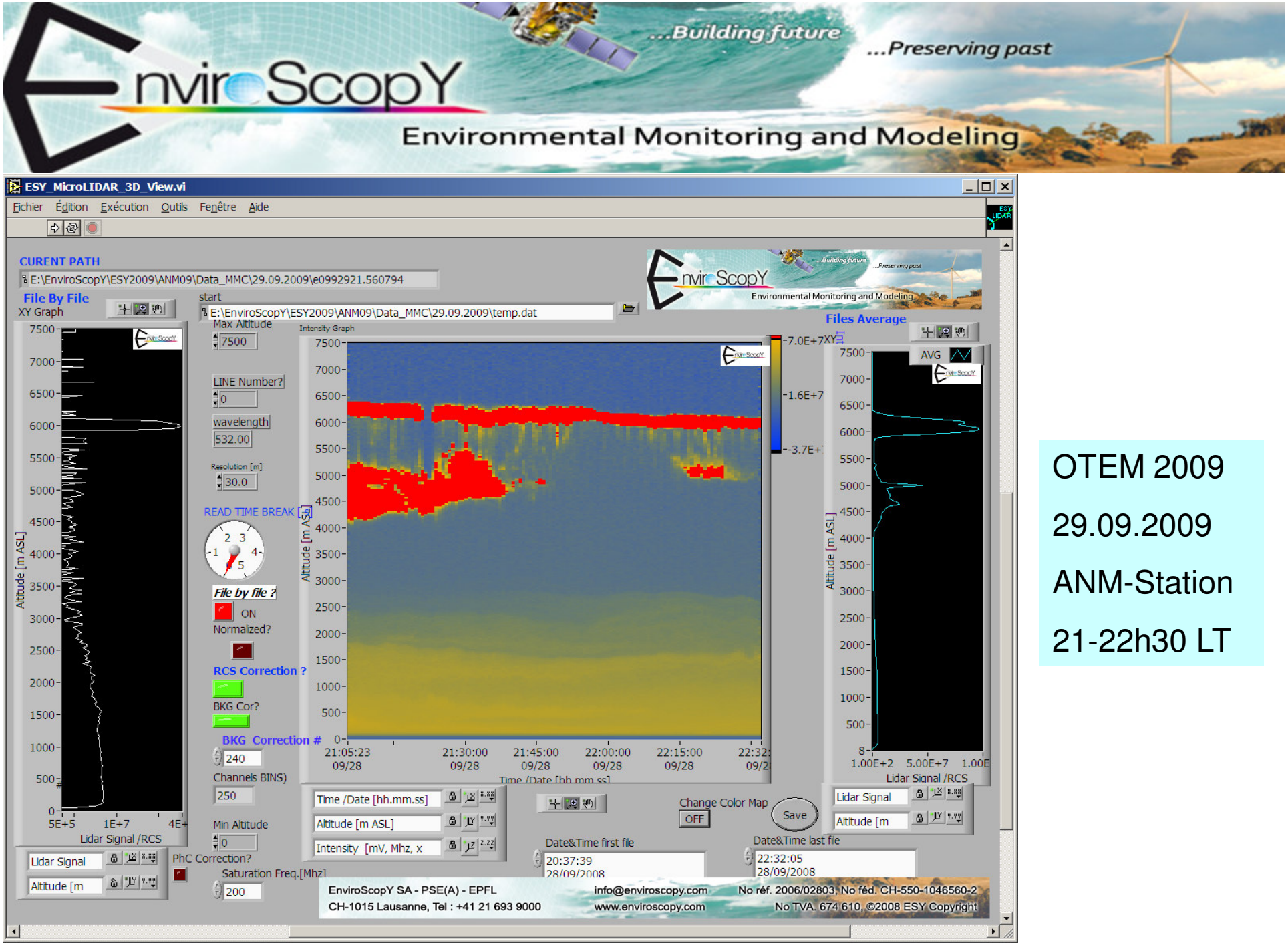


OTEM 2009

28.09.2009

ANM-Station

22-22h30 LT

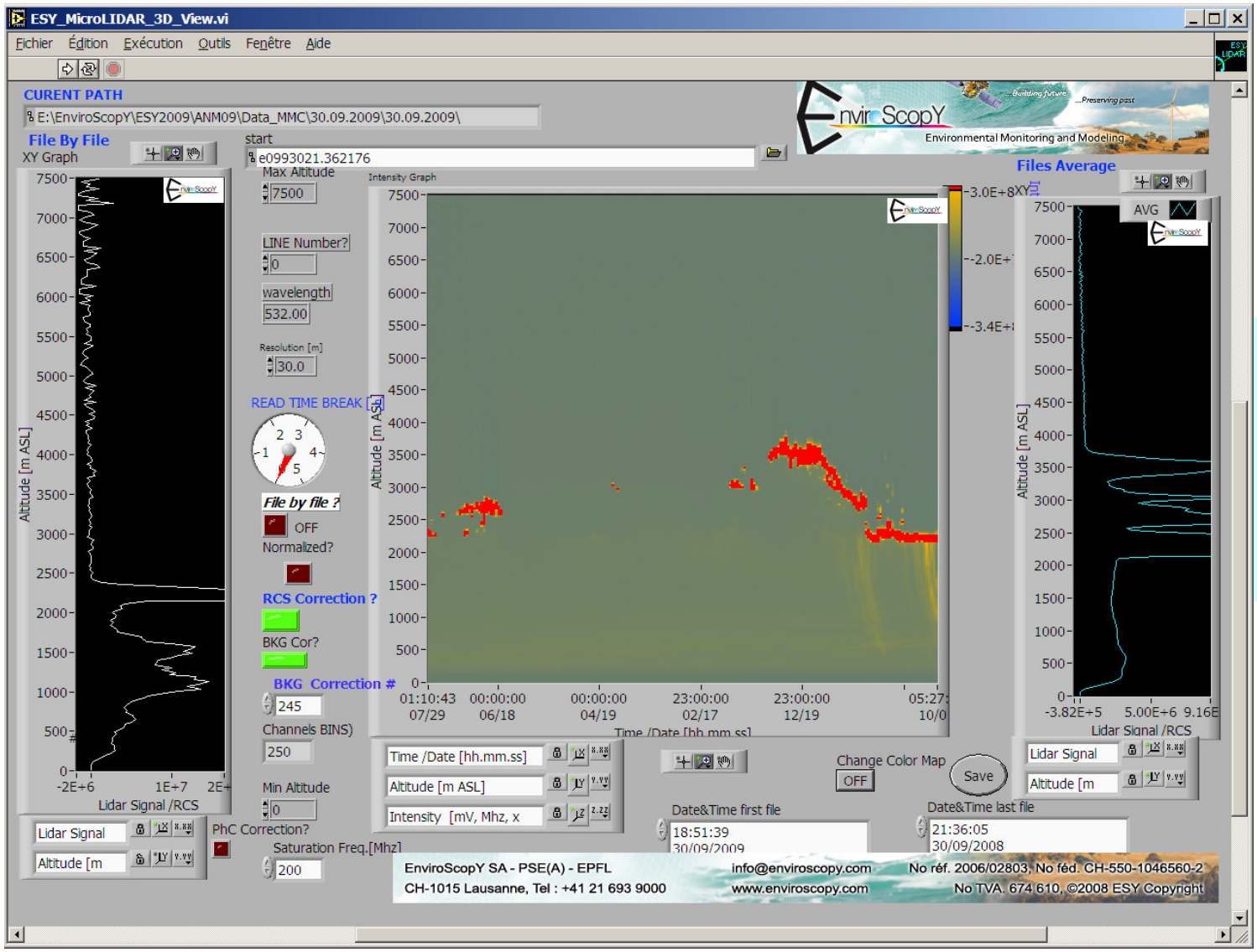


OTEM 2009

29.09.2009

ANM-Station

21-22h30 LT



OTEM 2009

30.09.2009

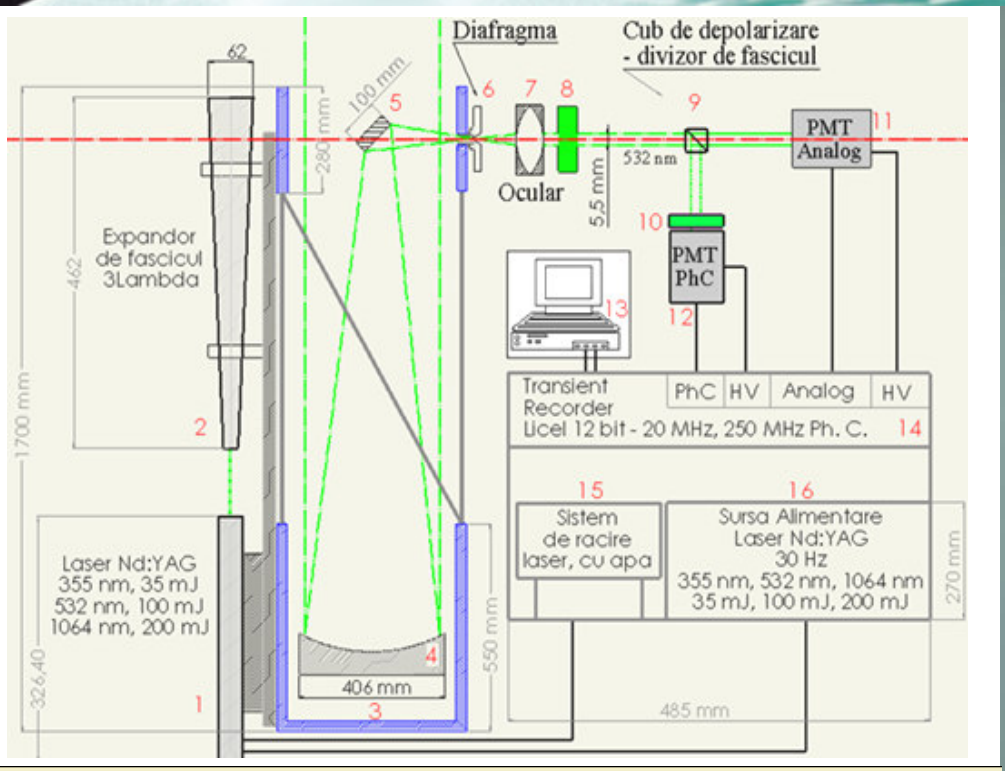
ANM-Station

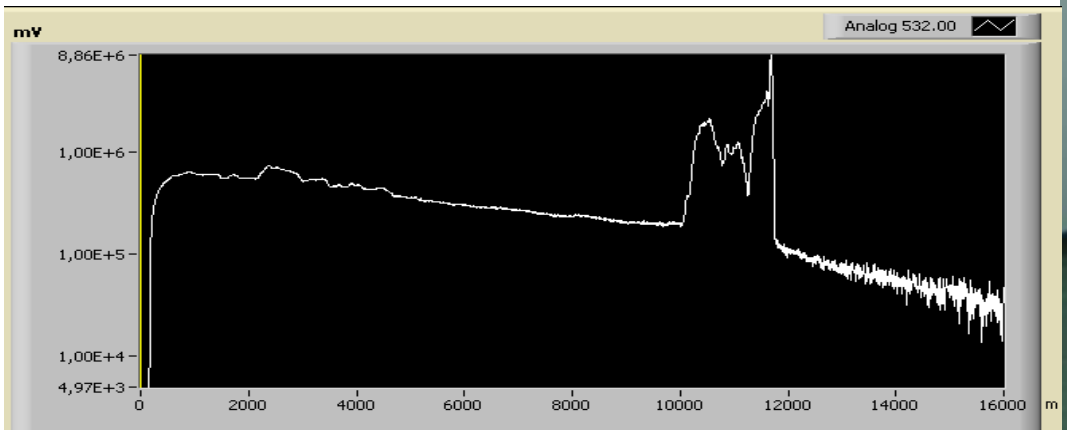
19-21h30 LT

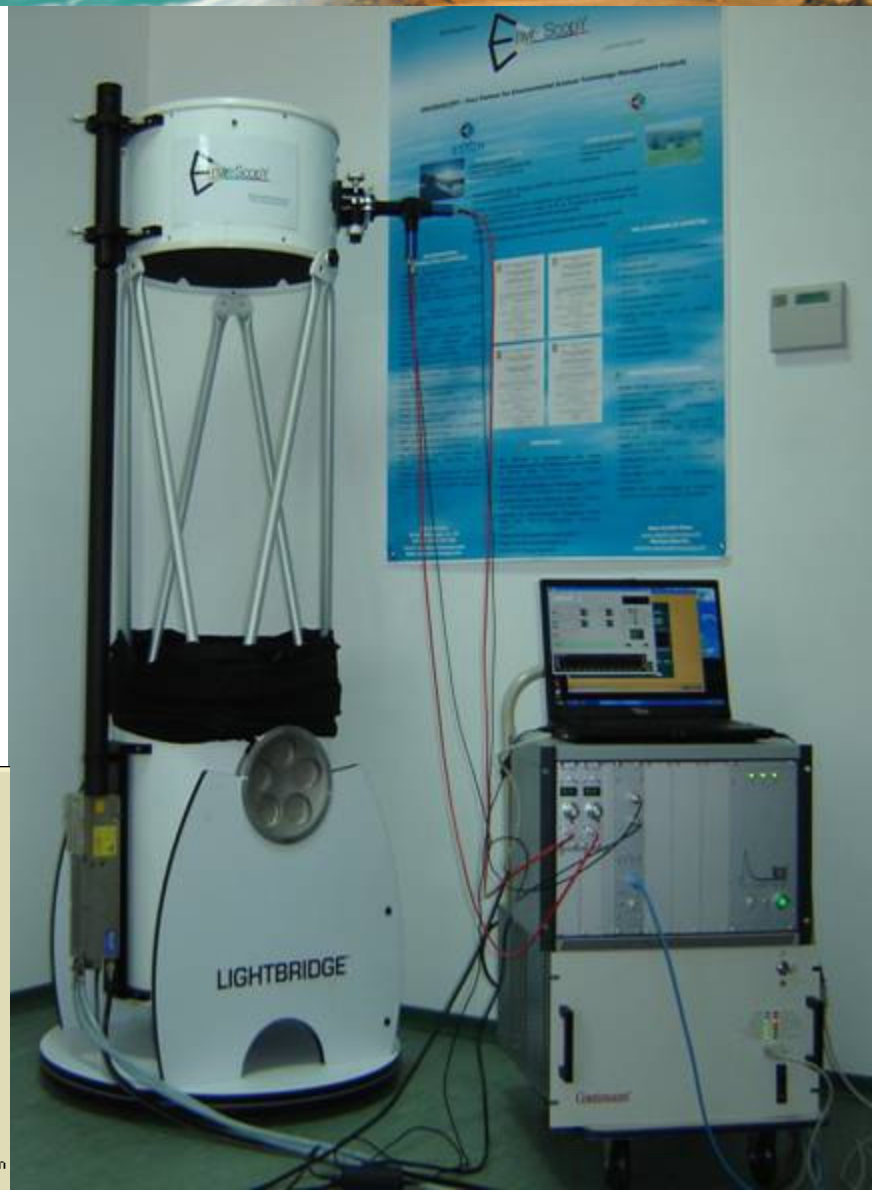

EnviroScopY
...Building future
...Preserving past
Environmental Monitoring and Modeling


mESY LIDAR

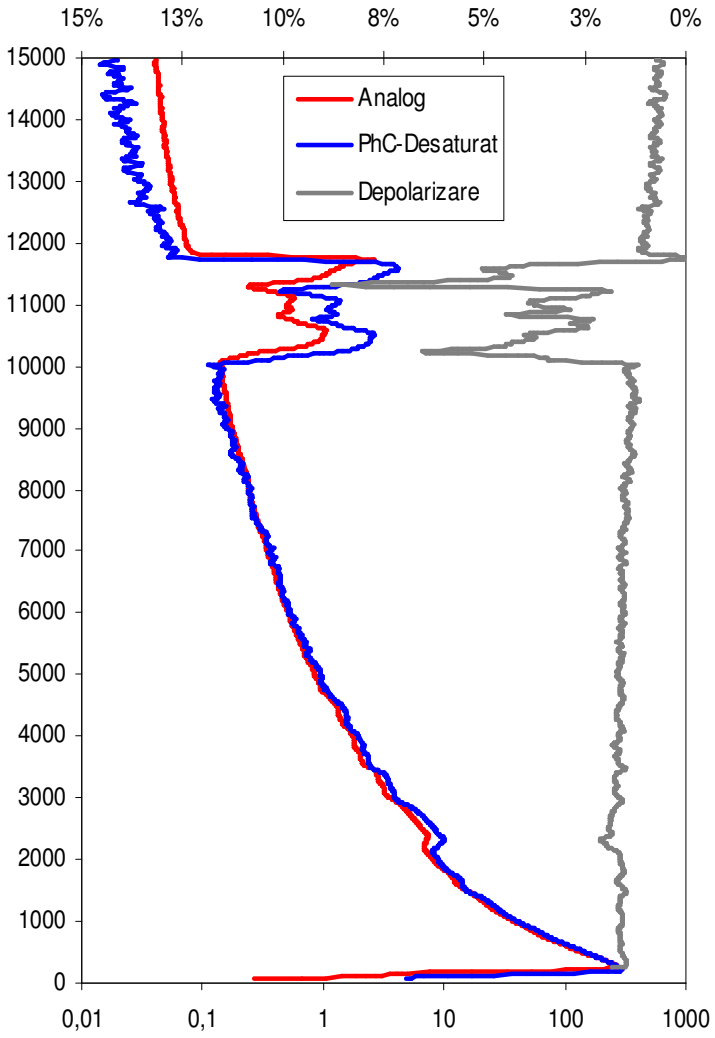

...Building future
...Preserving past
EnviroScopY
Environmental Monitoring and Modeling

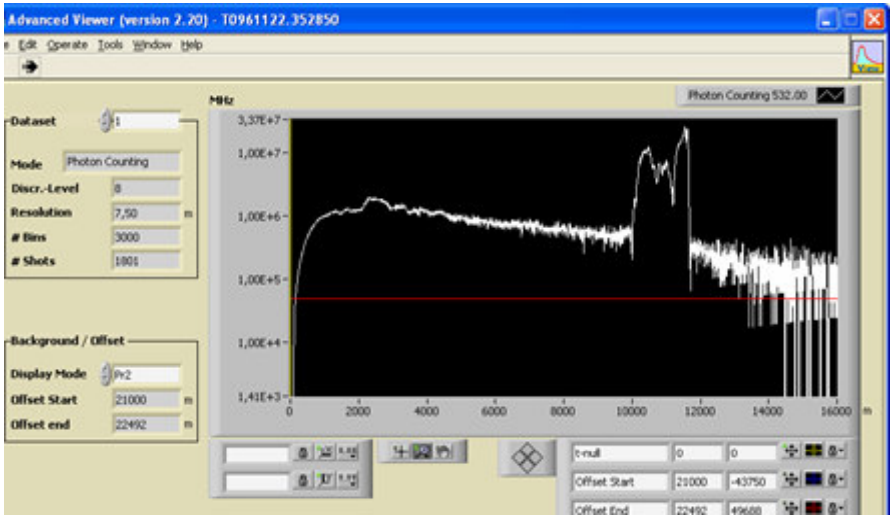

Diafragma
Cub de depolarizare
- divizor de fascicul
62
100 mm
280 mm
5
6
7
8
9
PMT
Analog
11
Ocular
5,5 mm
532 nm
10
PMT
PhC
12
13
Expandor
de fascicul
3Lambda
462
1700 mm
2
Transient
Recorder
Licel 12 bit - 20 MHz, 250 MHz Ph. C.
PhC
HV
Analog
HV
14
15
16
Sistem
de racire
laser, cu apa
Sursa Alimentare
Laser Nd:YAG
30 Hz
355 nm, 532 nm, 1064 nm
35 mJ, 100 mJ, 200 mJ
270 mm
Laser Nd:YAG
355 nm, 35 mJ
532 nm, 100 mJ
1064 nm, 200 mJ
326,40
1
4
406 mm
3
550 mm
485 mm

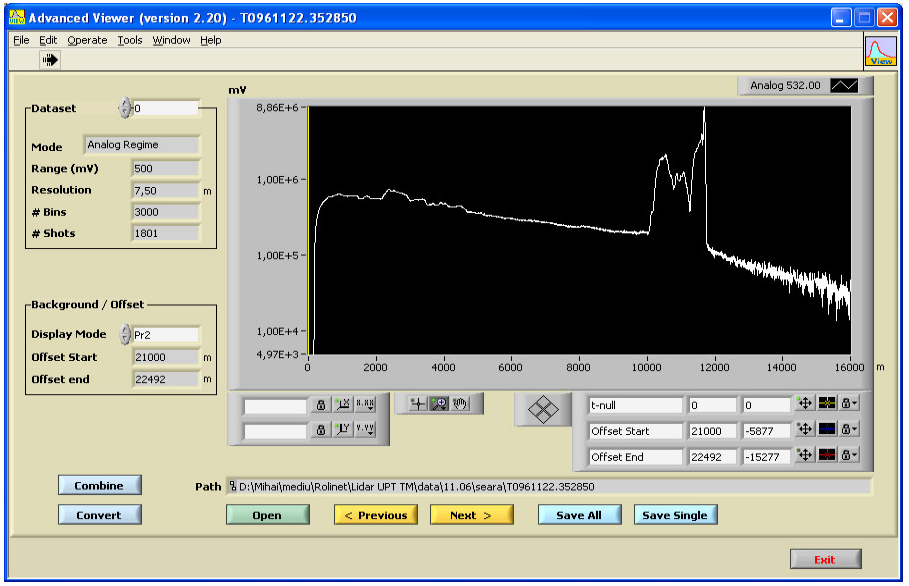

mV
Analog 532.00
8,86E+6
1,00E+6
1,00E+5
1,00E+4
4,97E+3
0
2000
4000
6000
8000
10000
12000
14000
16000
m


LIGHTBRIDGE

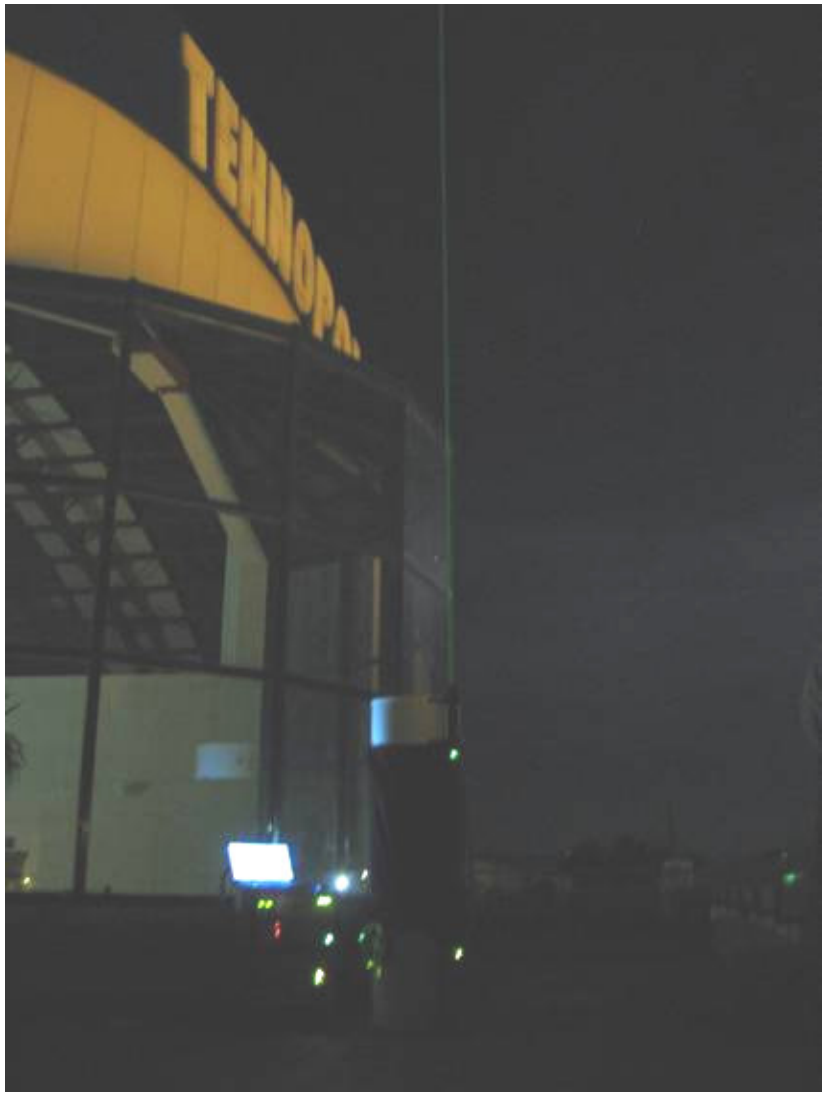

...Building future
...Preserving past
EnviroScopY
Environmental Monitoring and Modeling

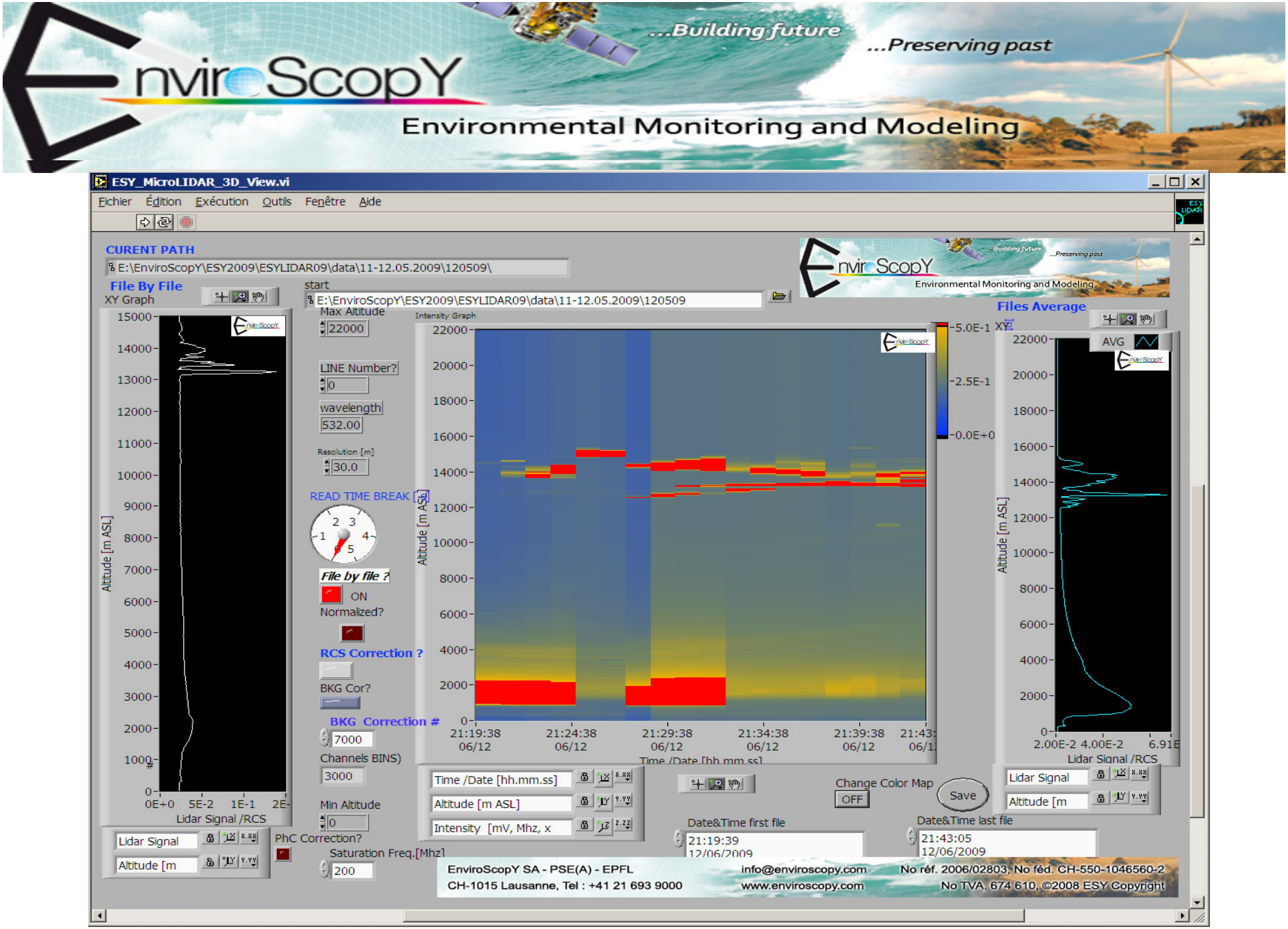

15%
13%
10%
8%
5%
3%
0%
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0,01
0,1
1
10
100
1000
Analog
PhC-Desaturat
Depolarizare


Advanced Viewer (version 2.20) - T0961122.352850
Edit Operate Tools Window Help
MHz
Photon Counting 532.00
Dataset
Mode
Photon Counting
Discr.-Level
Resolution
7,50
Bins
3000
Shots
1801
Background / Offset
Display Mode
Pr2
Offset Start
21000
Offset end
22492
3,37E+7
1,00E+7
1,00E+6
1,00E+5
1,00E+4
1,41E+3
0
2000
4000
6000
8000
10000
12000
14000
16000
t-null
Offset Start
Offset End


Advanced Viewer (version 2.20) - T0961122.352850
File Edit Operate Tools Window Help
mV
Analog 532.00
Dataset
Mode
Analog Regime
Range (mV)
500
Resolution
7,50
Bins
3000
Shots
1801
Background / Offset
Display Mode
Pr2
Offset Start
21000
Offset end
22492
8,86E+6
1,00E+6
1,00E+5
1,00E+4
4,97E+3
0
2000
4000
6000
8000
10000
12000
14000
16000
t-null
Offset Start
-5877
Offset End
22492
-15277
Combine
Convert
Path
D:\Mihai\mediu\Rolinet\Lidar UPT TM\data\11.06\seara\T0961122.352850
Open
< Previous
Next >
Save All
Save Single
Exit


EnviroScopY
...Building future
...Preserving past
Environmental Monitoring and Modeling

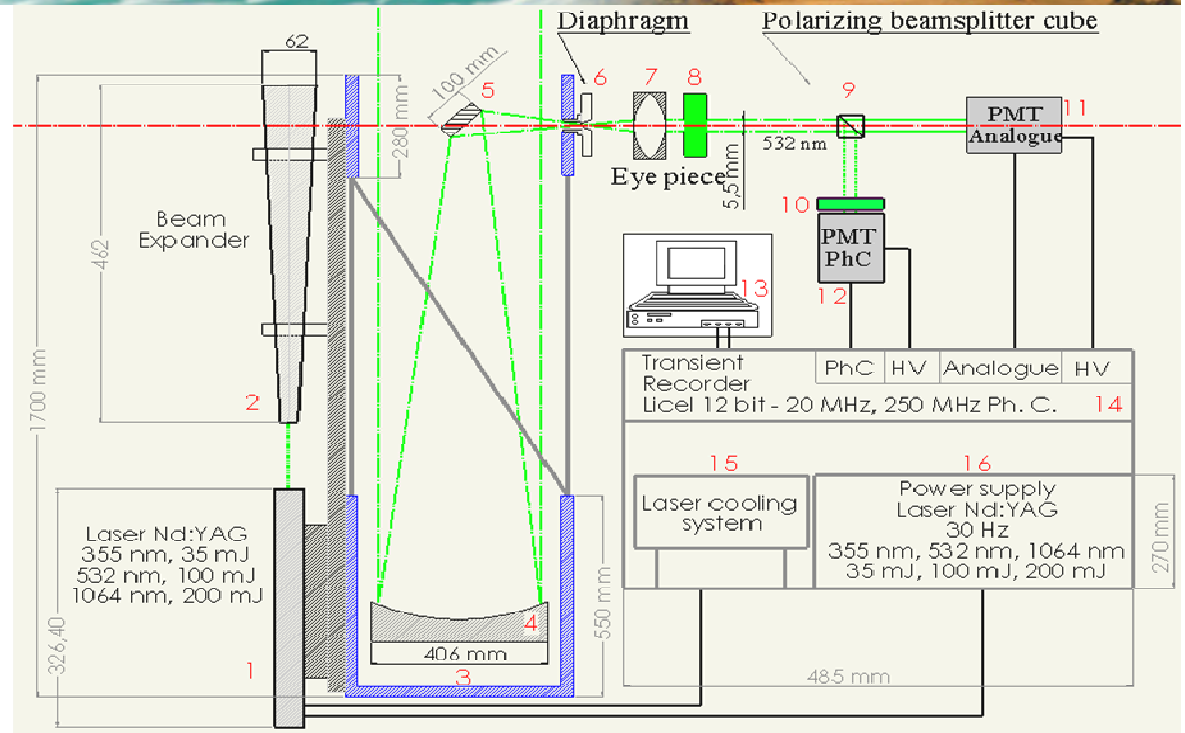



...Building future
...Preserving past
EnviroScopY
Environmental Monitoring and Modeling
ESY_MicroLIDAR_3D_View.vi
Fichier Édition Exécution Outils Fenêtre Aide
CURENT PATH
E:\EnviroScopY\ESY2009\ESYLIDAR09\data\11-12.05.2009\120509\
File By File
XY Graph
start
E:\EnviroScopY\ESY2009\ESYLIDAR09\data\11-12.05.2009\120509
Max Altitude
22000
LINE Number?
0
wavelength
532.00
Resolution [m]
30.0
READ TIME BREAK [s]
File by file ?
ON
Normalized?
RCS Correction ?
BKG Cor?
BKG Correction #
7000
Channels BINS)
3000
Min Altitude
0
PhC Correction?
Saturation Freq.[Mhz]
200
Intensity Graph
Altitude [m ASL]
Time /Date [hh.mm.ss]
Altitude [m ASL]
Intensity [mV, Mhz, x
Change Color Map
OFF
Save
Date&Time first file
21:19:39
12/06/2009
Date&Time last file
21:43:05
12/06/2009
Files Average
AVG
Lidar Signal /RCS
Lidar Signal
Altitude [m
EnviroScopY SA - PSE(A) - EPFL
CH-1015 Lausanne, Tel : +41 21 693 9000
info@enviroscopy.com
www.enviroscopy.com
No réf. 2006/02803, No féd. CH-550-1046560-2
No TVA. 674 610, ©2008 ESY Copyright

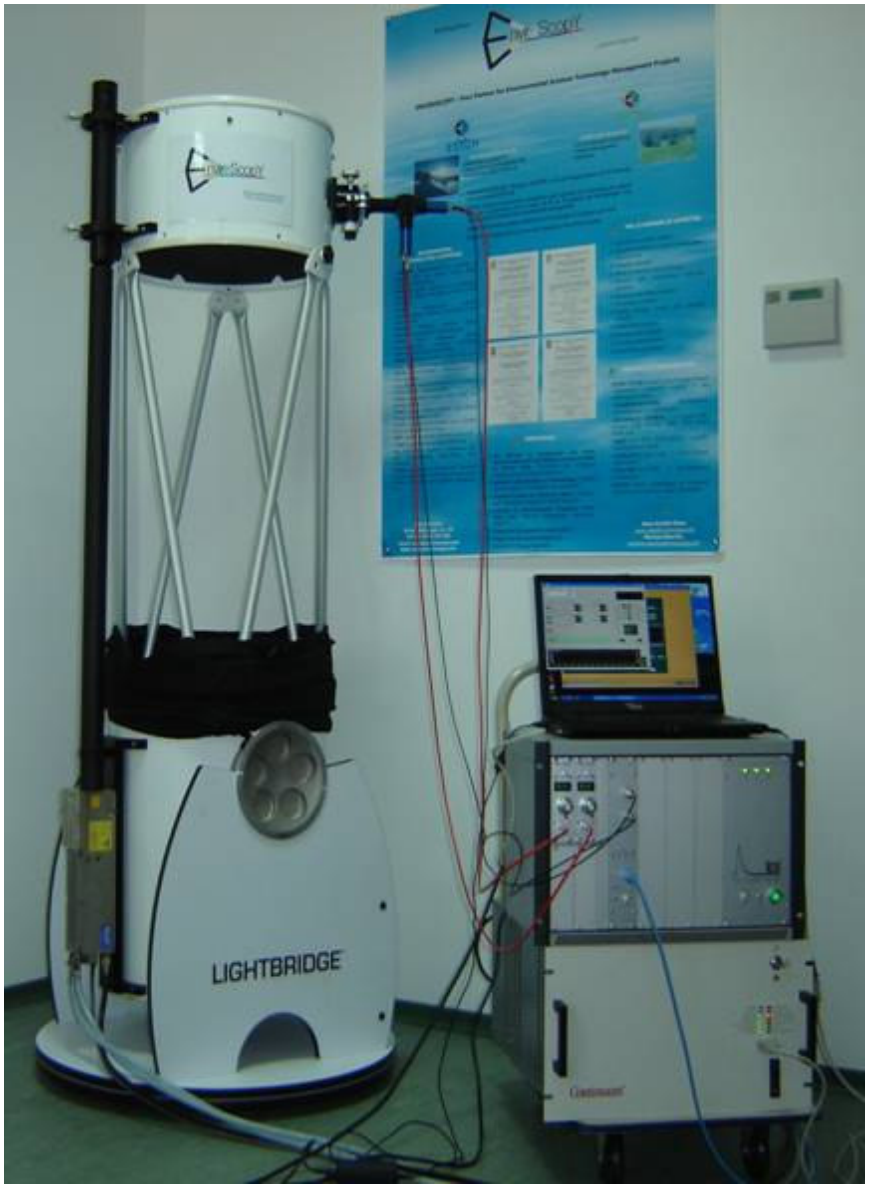
starting from …..

Configuration of the mESYLIDAR

1. Laser
2. Beam expander
3. Newtonian telescope
4. Parabolic primary mirror
5. Secondary mirror
6. Diaphragm
7. Eyepiece
8. Interferential filter
9. Polarizing beamsplitter cube
10. Neutral density filter
11. Analogue photodetector
12. Photon counting photodetector
13. Computer
14. Transient recoder – Licel
15. Laser cooling system
16. Laser power supply



Specifications of emission part (mESYLIDAR)	Specifications of detection part (mESYLIDAR)
Laser Nd:YAG, Repetition rate: 30Hz	Telescope: LightBridge
Energy: 35 mJ, 100 mJ, 200 mJ	Type: Newtonian
Wavelength: 355 nm, 532 nm, 1064 nm	Diameter of primary mirror: 406 mm
Laser Beam diameter: 0.6 mm	Focal length: 1829 mm
Laser Beam Divergence : 0.75 mrad	Focal Number: F/4,5
Pulse width: 6 – 9 ns	Magnification: 70X
3 λ Beam expander: 5X Coaxial Emission LIDAR Beam Divergence = 0,15 mrad	Interferential filters: FWHM 532 ± 1nm Polarizing beamsplitter cube: 420 – 680 nm Photomultipliers: analogue and photon counting



The NEW mESYLIDAR

Low-cost
Easy
Upgradeable

Easy to clean optics,
Modular and
Versatile

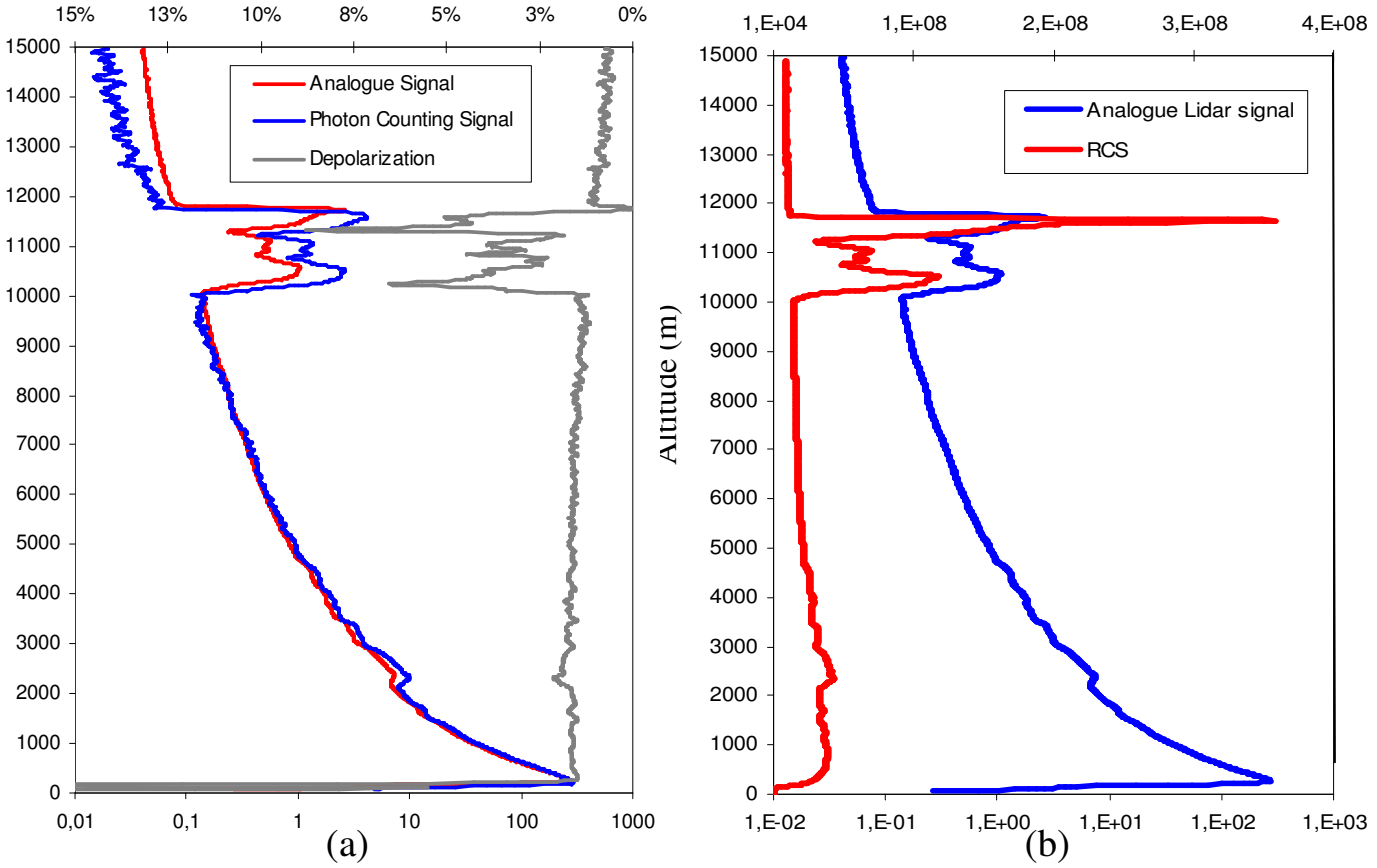
mESYLIDAR Basic Specifications

- Altitude: from 170 m to 15 km
- Temporal resolution: 1 min/ 5 min/ 30 min
- Spatial resolution: 7,5 m
-

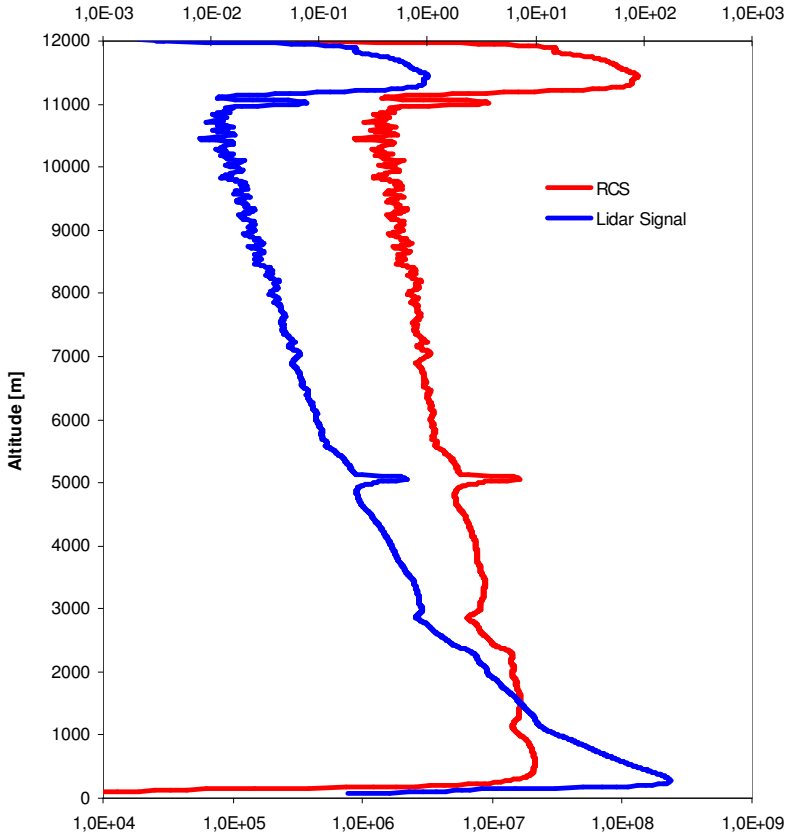
mESYLIDAR Applications

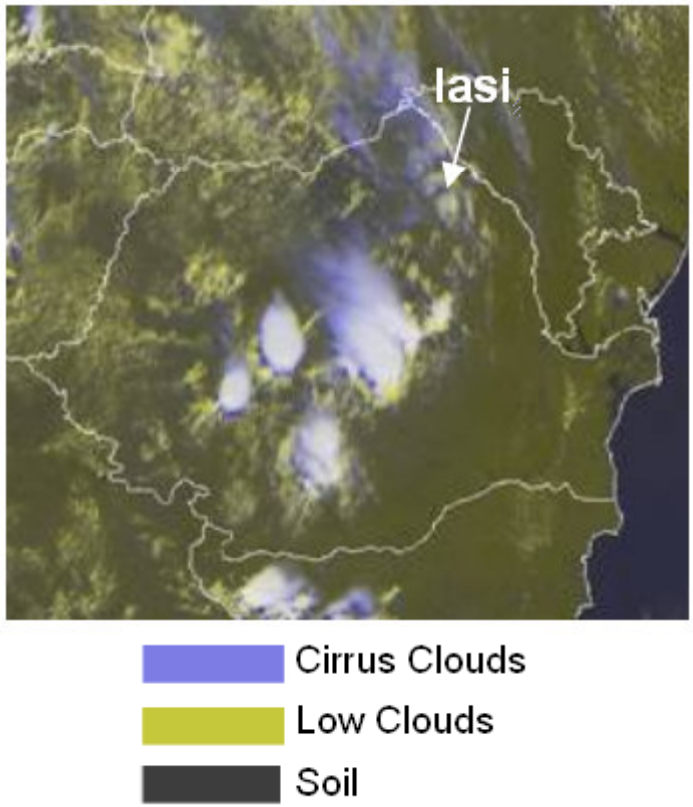
- 3D monitoring (clouds, aerosols, dust , pollens,…) very practically in terrain campaigns
- Planetary Boundary Layer (height, dynamics, structure, …)
- Anti-hail and fight against fire and droughts complementary tool
- Aerosols characterization (extinction and backscattering coefficients, size….)

First depolarization study (a) and Range Corrected Signal (b) 11.06.2009 – 00.35h (UT) Iasi Station (Technopolis), 7,5 m spatial resolution, 1 min integration time, 80-90% of laser maximum power

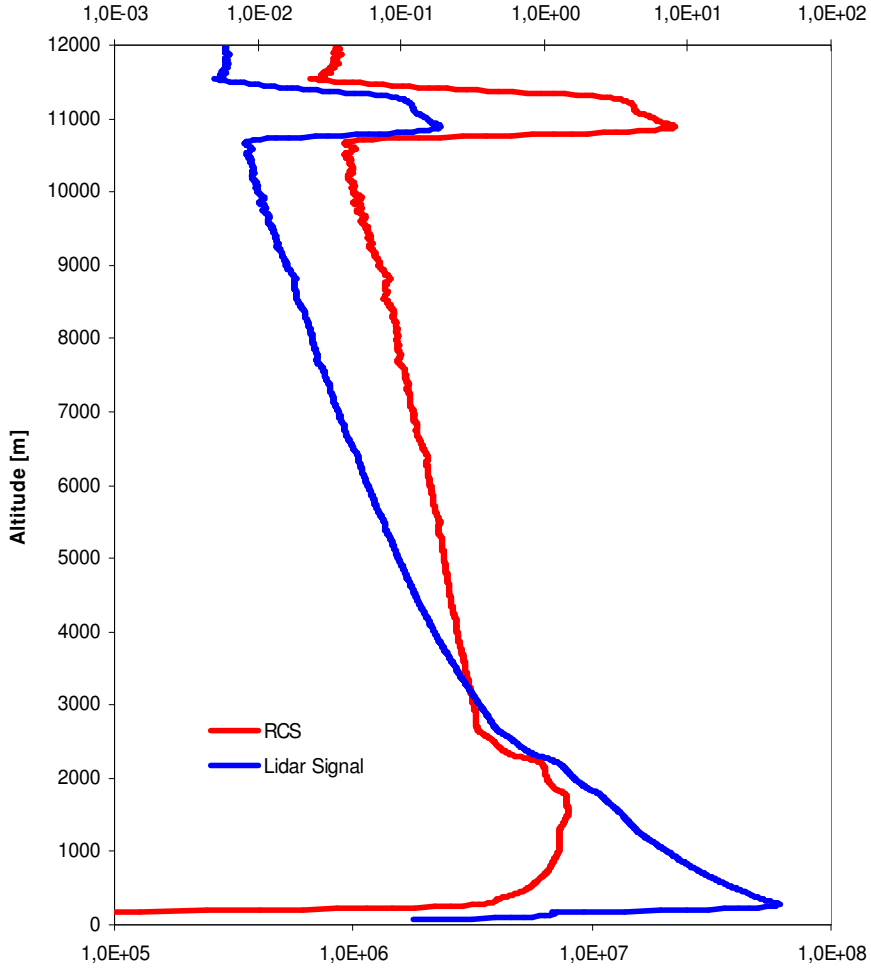


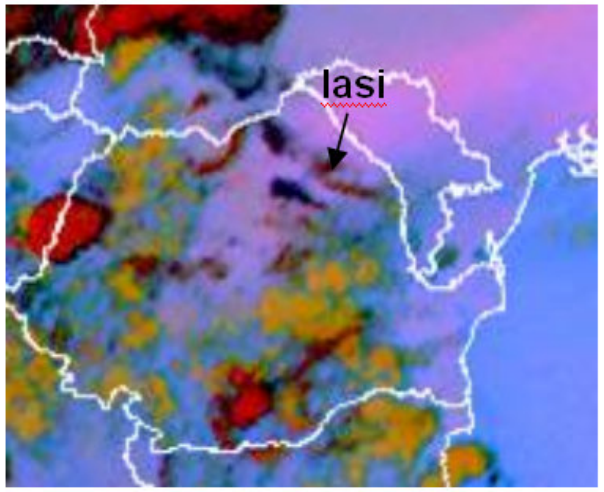
Backscattering Lidar day profiles and RCS profile – 11.50h UT(left) and IR (RGB 100) satellite images (right) from IR (RGB 100) satellite images – 11.30h UT from 11.06.2009 7,5 m spatial resolution, 4 min integration time, 90% of laser maximum power





Lidar night profiles and RCS profile – 01.18h UT (left) and
IR (RGB 019) satellite images (right) from 3.07.2009 – 01.00h UT
7,5 m spatial resolution, 5 min integration time, 80-90% of laser maximum power

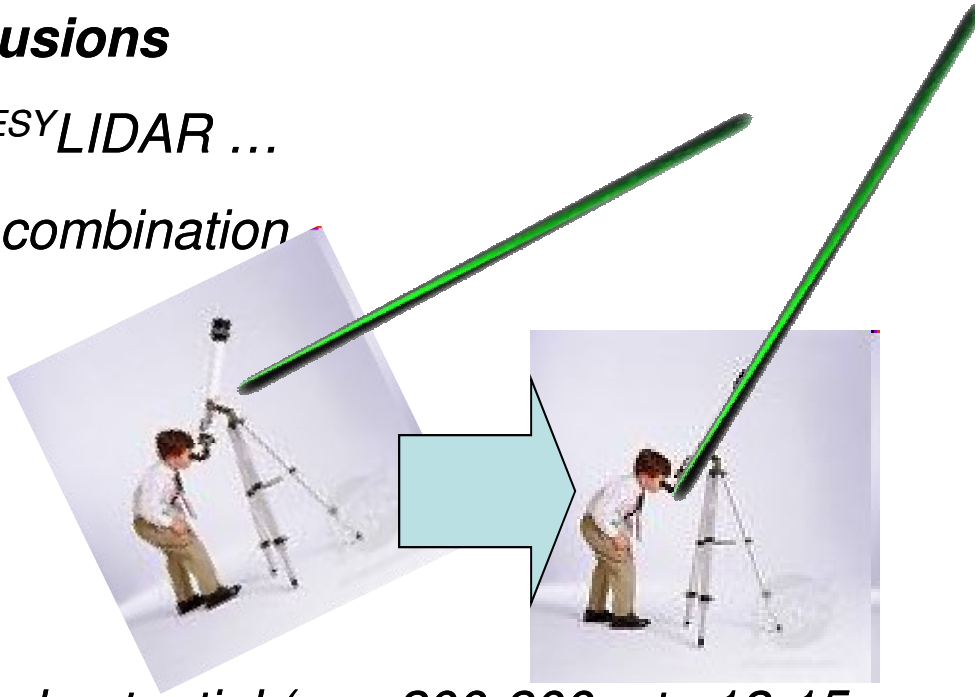




high clouds - thick, cold
Cirrus thin clouds
low clouds (cold atmosphere, Europe)
low clouds (warm atmosphere, Africa)
dust storms

Conclusions

The new mESY LIDAR …



- *basic configuration of two channels combination*
  - *532nm (parallel and cross)*
  - *532 nm & 607 nm*
  - *355 nm and 387 nm*
  - *any other 2 channels*
- *first testing measurements quite good potential (e.g. 200-300m to 12-15 km ~ useful dynamic range for 1minute integration time, 7.5 m resolution)*
- *the system is easy up-gradable to UV (355nm, Raman: N2 – 387 nm and H2O – 407 nm) and NIR (1064 nm) separate (interchangeable) or combined modules*
- *$ cost effective*