

Python Utility: Laser-atmosphere interaction extended to Network Data Management

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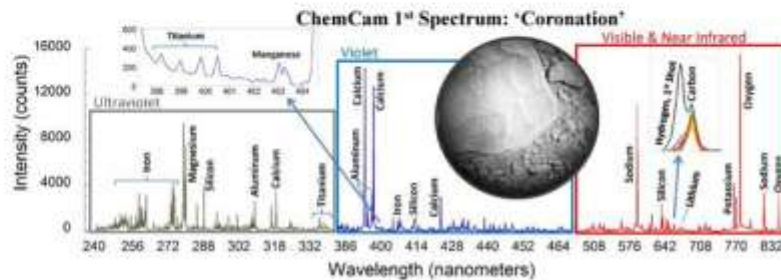
Atmosphere Optics, Spectroscopy and Lasers Laboratory **LOA-SL**

Remote Sensing by Laser-Induced Plasmas. <http://libs.lanl.gov/>

see also: [The ChemCam Instrument Suite on the Mars Science Laboratory Rover Curiosity](#)



First laser spectrum from ChemCam, sent back from Mars on August 19, 2012



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visitors from 1 December 2011

Erosion of Dielectric Walls in Hall Effect Thrusters (HET)

Context ...

- HET as propulsion solution for spacecrafts: ESA mission SMART-1 to the Moon (2003-2006)
- 300 eV plasma in Xe; BNSiO_2 as typical material for the manufacturing of HET dielectric walls; Life-time limitation due to erosion
- Presence of numerous complex processes like electron secondary emission, sputtering, normal or ab-normal erosion, sheath potential modifications or solid particle emission - difficult to completely control and parameterize the dielectric wall behaviour
- Deposition of energy by the plasma discharge modifies the surface temperature and consequently affects the evolution of the different wall processes
- In order to better understand the effects of an energy flux on the wall, we try to simulate the energy deposition by irradiating the dielectric surface with a laser

↪ *Laboratory experiments (pulsed & cw lasers)*

↪ *Implementation on the French national facility PIVOINE - Orléans*

**GdR « Plasma Space Propulsion »
CNES/SNECMA/CNRS/Universités**

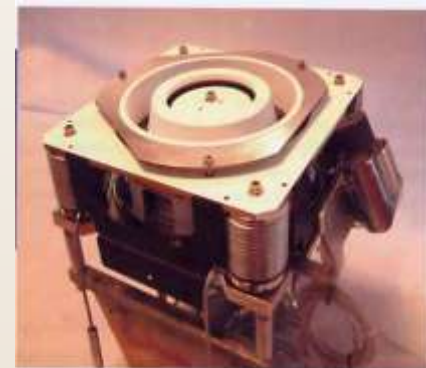
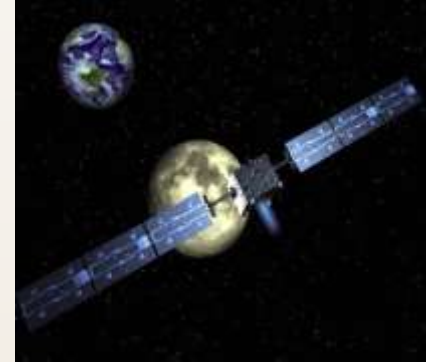


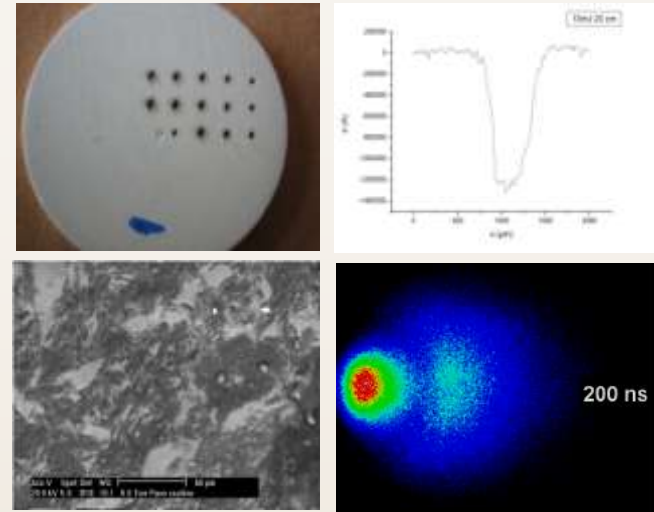
Figure 1. Démonstrateur technologique PPS-X000 ; au banc d'essai des technologies. (Photo : SNECMA Motors)



Laboratory experiments

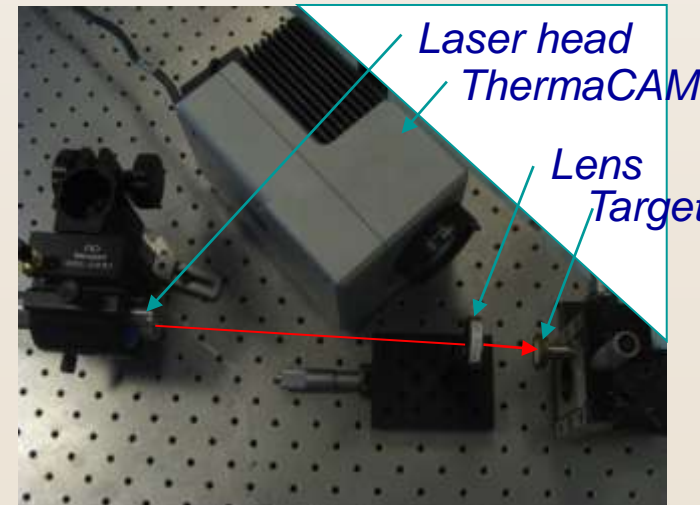
Pulsed Lasers ...

- Nd:YAG (532 & 355 nm) laser irradiation of ceramic samples (BNSiO_2 , Al_2O_3 , MgO) placed in vacuum (10^{-6} Torr)
- The modifications induced by laser irradiation on the BNSiO_2 targets are analysed by profilometry and scanning electron microscopy
- The plasma created by laser ablation is characterized by optical (ICCD) and spectral (OES) methods

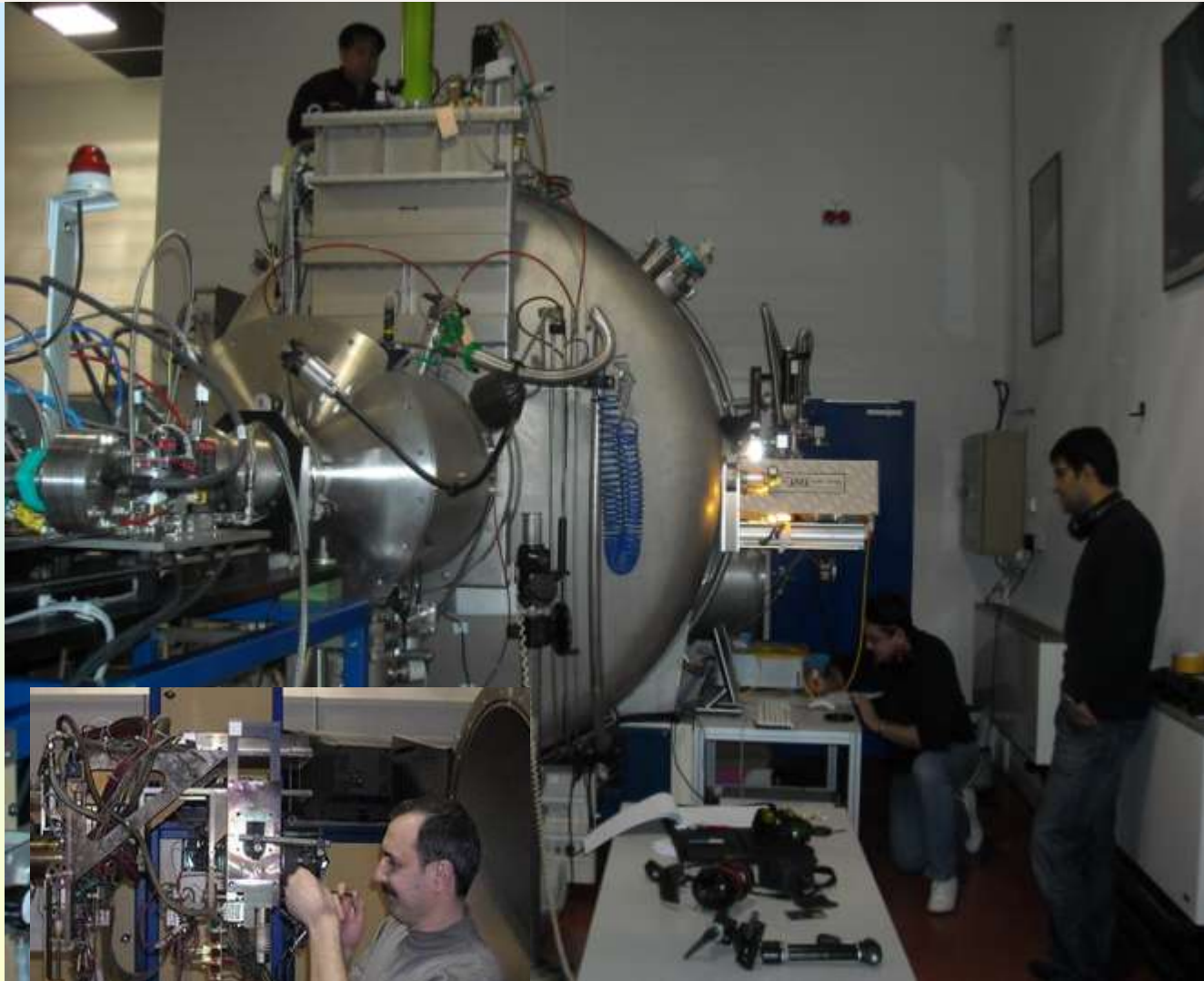


CW Lasers ...

- Laboratory experiments on BNSiO_2 samples in air
- CW YLF fiber laser (IPG, 1070 nm, 0-100 W) focused on the sample surface to spot diameters 0.1 – 1 mm
- ThermaCAM (FLIR) real-time thermal monitoring



Experiments on the French national PIVOINE infrastructure



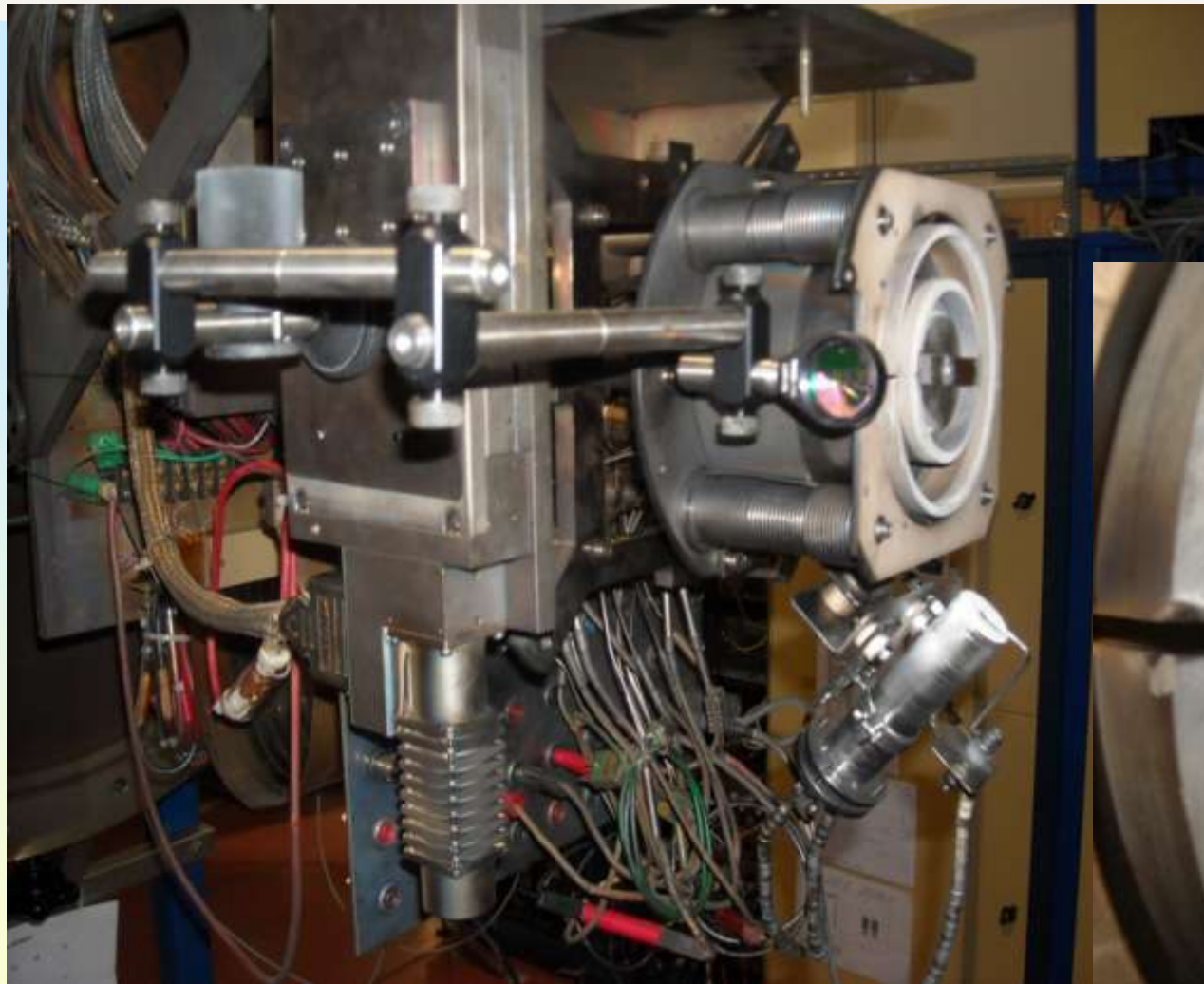
PIVOINE-2G

ICARE laboratory
(Orléans, France)

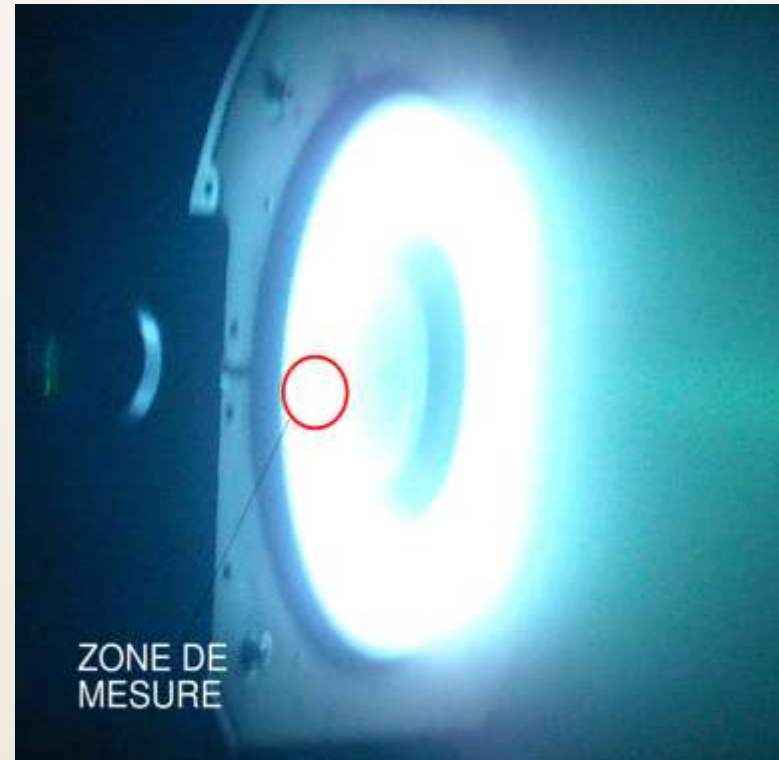
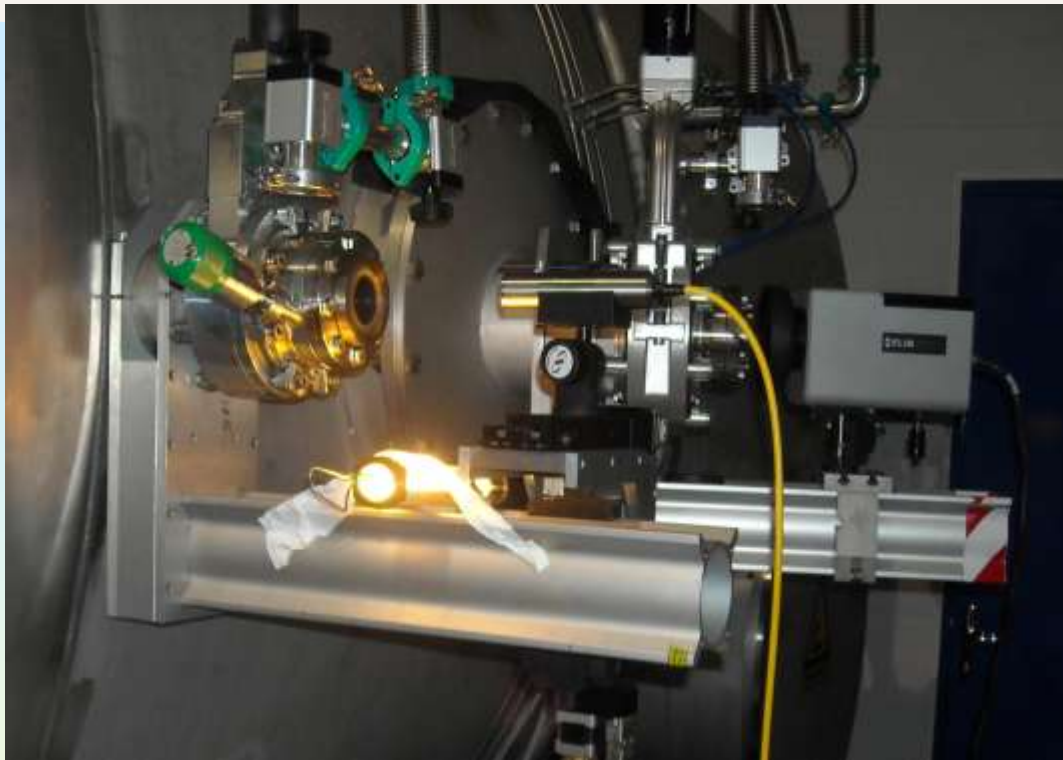
- Large vacuum chamber (diameter 2 m, length 7 m)
- cryogenic pumping system (150 000 L/s)

Pressure:
 $2 \cdot 10^{-5}$ mbar
(with 5 mg/s Xe flow)

GdR « Plasma Space Propulsion »
CNES/SNECMA/CNRS/Universités



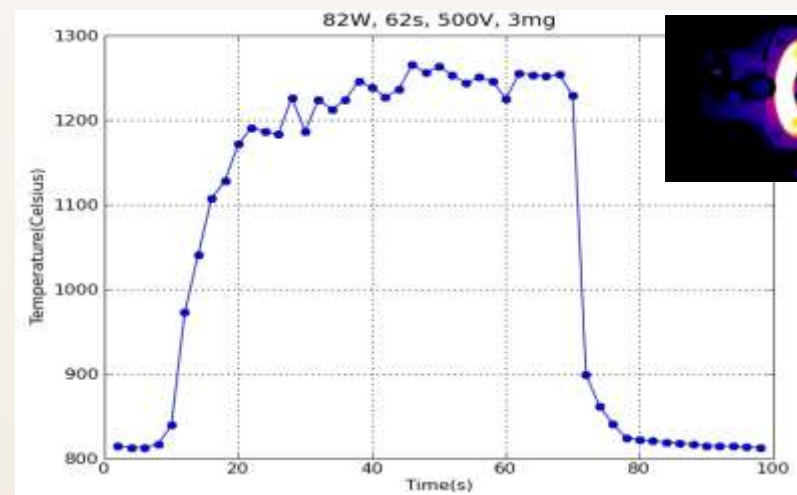
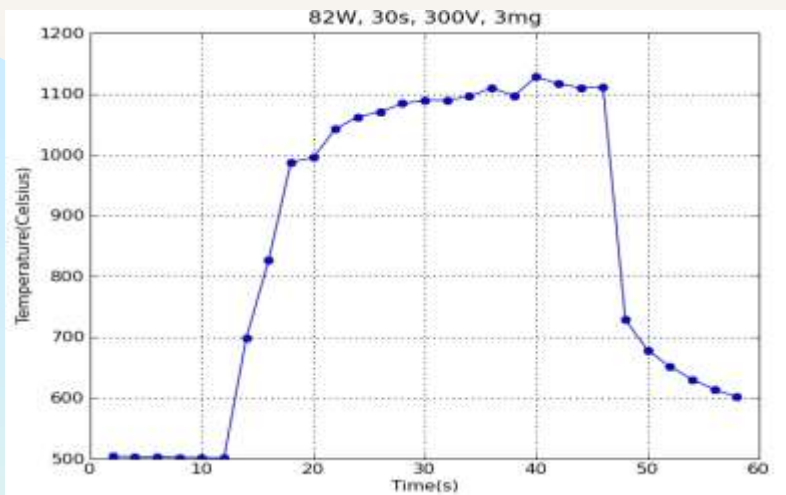
*Use laser ablation in the running thruster
in order to generate an “accelerated erosion” of the walls.*



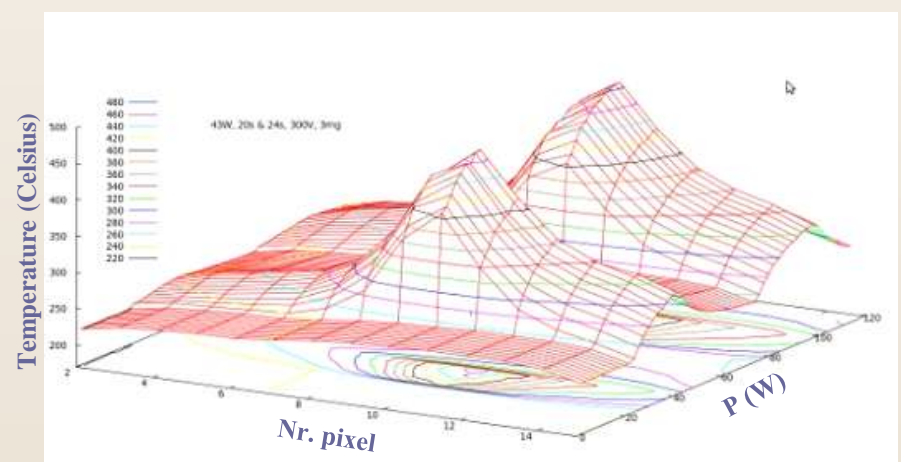
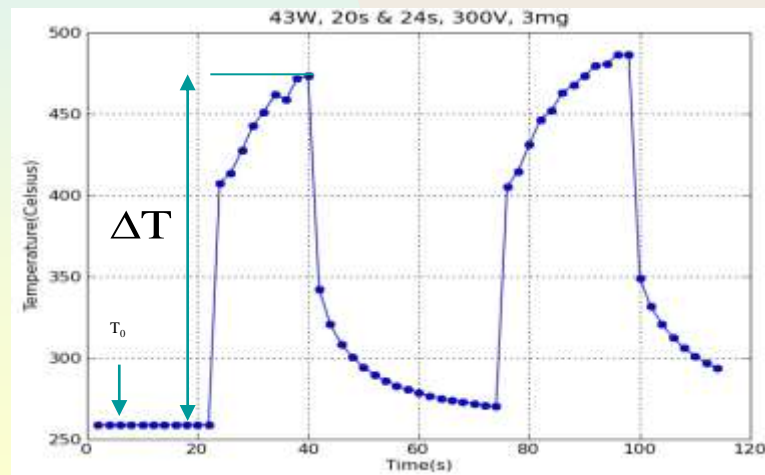
HOT SPOTS Problem ...

- ***Try to create topological and thermal defects by pulsed & CW laser irradiation***
- ***Various thruster regimes (PPS100 – ML)***
- ***IR thermography and optical emission spectroscopy***
- ***Profilometry and scanning electron microscopy***



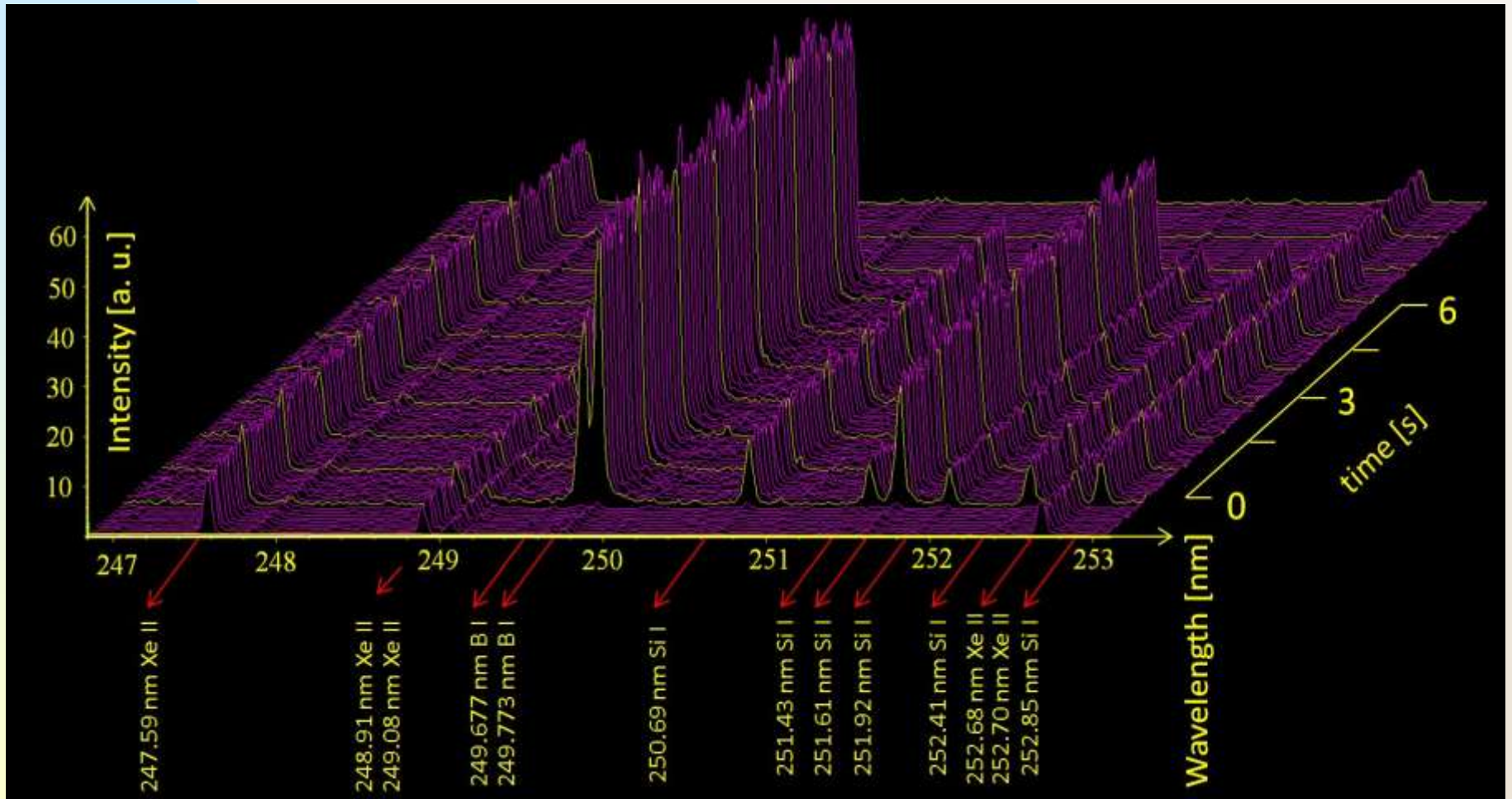


Temporal evolution of the temperature in the irradiated HET wall region
 Experimental conditions: $P_{laser} = 82 \text{ W}$, discharge voltage $U = 300 \text{ V}$ and 500 V



Temporal evolution of the temperature in the irradiated HET wall region for 20s and 24s successive laser irradiations. Experimental conditions: $P_{Laser} = 43 \text{ W}$, discharge voltage $U = 300 \text{ V}$

Acton 2750i, PI-MAX,
2400 l/mm, 25 ms gate, 255 gain



Laser-atmosphere interaction

Despite a large volume of publications, experimental results and theoretical data, because of their complex and multitudinous of transient processes, covering different time scales and different research fields of physics, the laser-matter interaction mechanisms topic is far from being solved.

- Depending on the space-time chemical compositions, source types activity or process, meteorological conditions, air pollutants (both organic and inorganic compounds), generally, air pollution causes significant damage to human health and environment, dramatically influencing the climate changes. Thus, a complex panel of atmospheric pollution tools, satellite data and forecast models must be taken into account.

- **The impact of urban-enhanced aerosol concentrations, research subject of high interest, must include new models because they may induce a significant turbulence on the dynamics and microphysics of convective air masses but also upon the storm development and precipitations.**

ROLINET

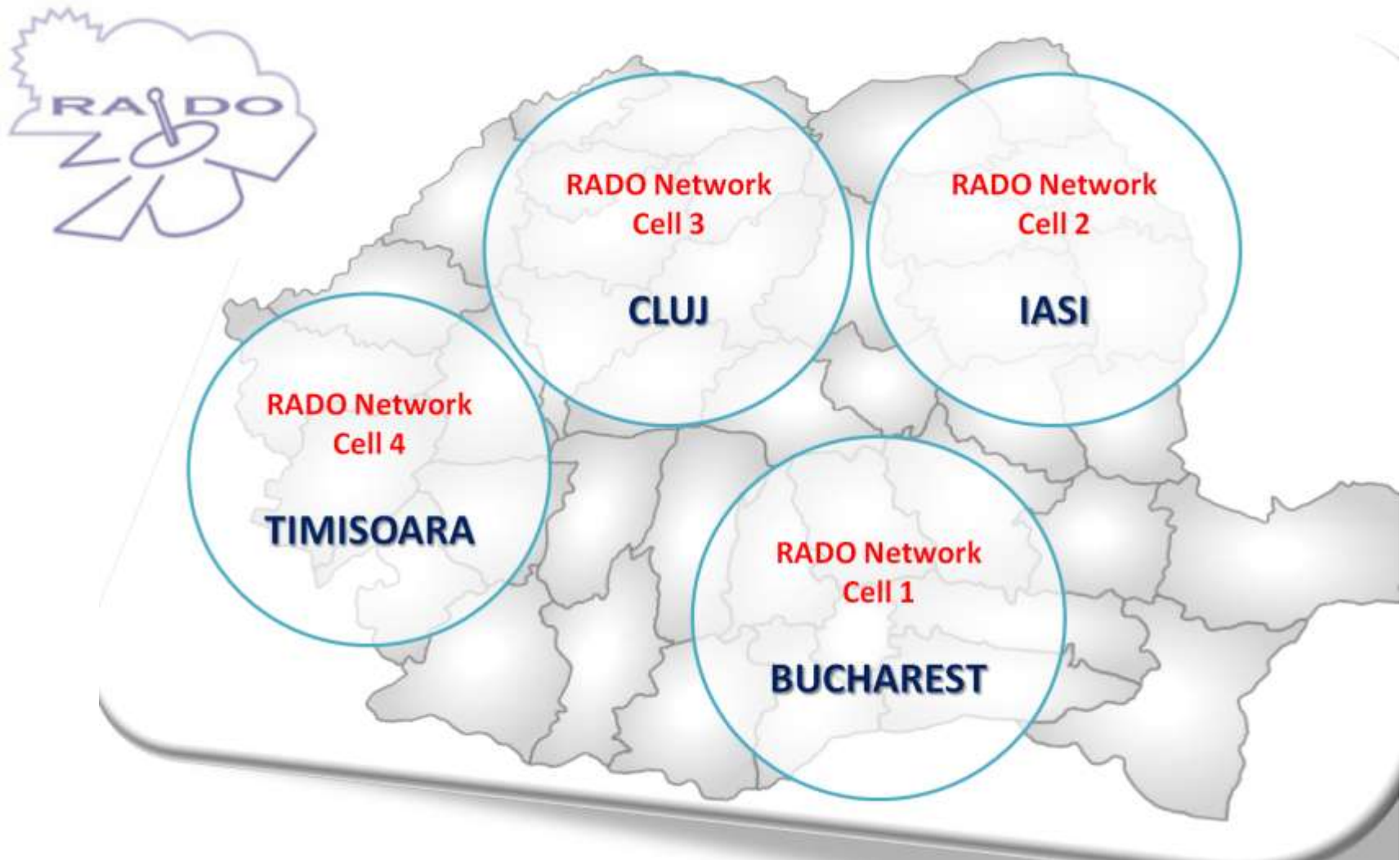
(ROmanian LIdar NETwork)

RADO

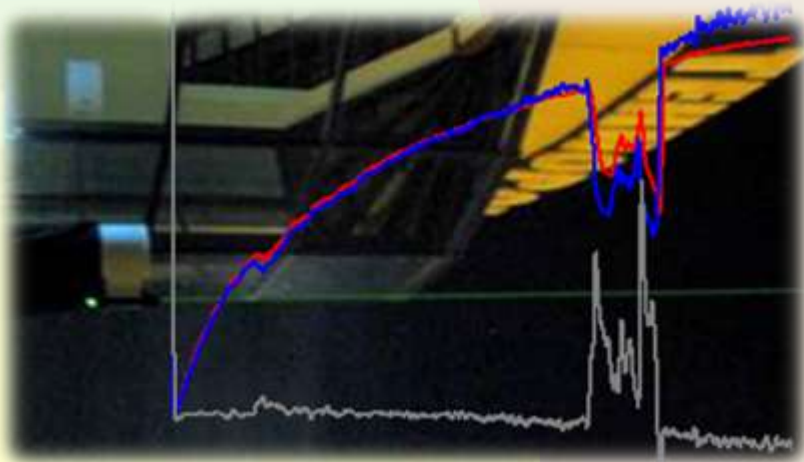
(Romanian Atmospheric 3D
Observatory) projects

.....a complex research of the atmosphere requires cutting-edge remote sensing spectral techniques based on the LASER-atmosphere interactions, such as LIDAR (Light Detection And Ranging).

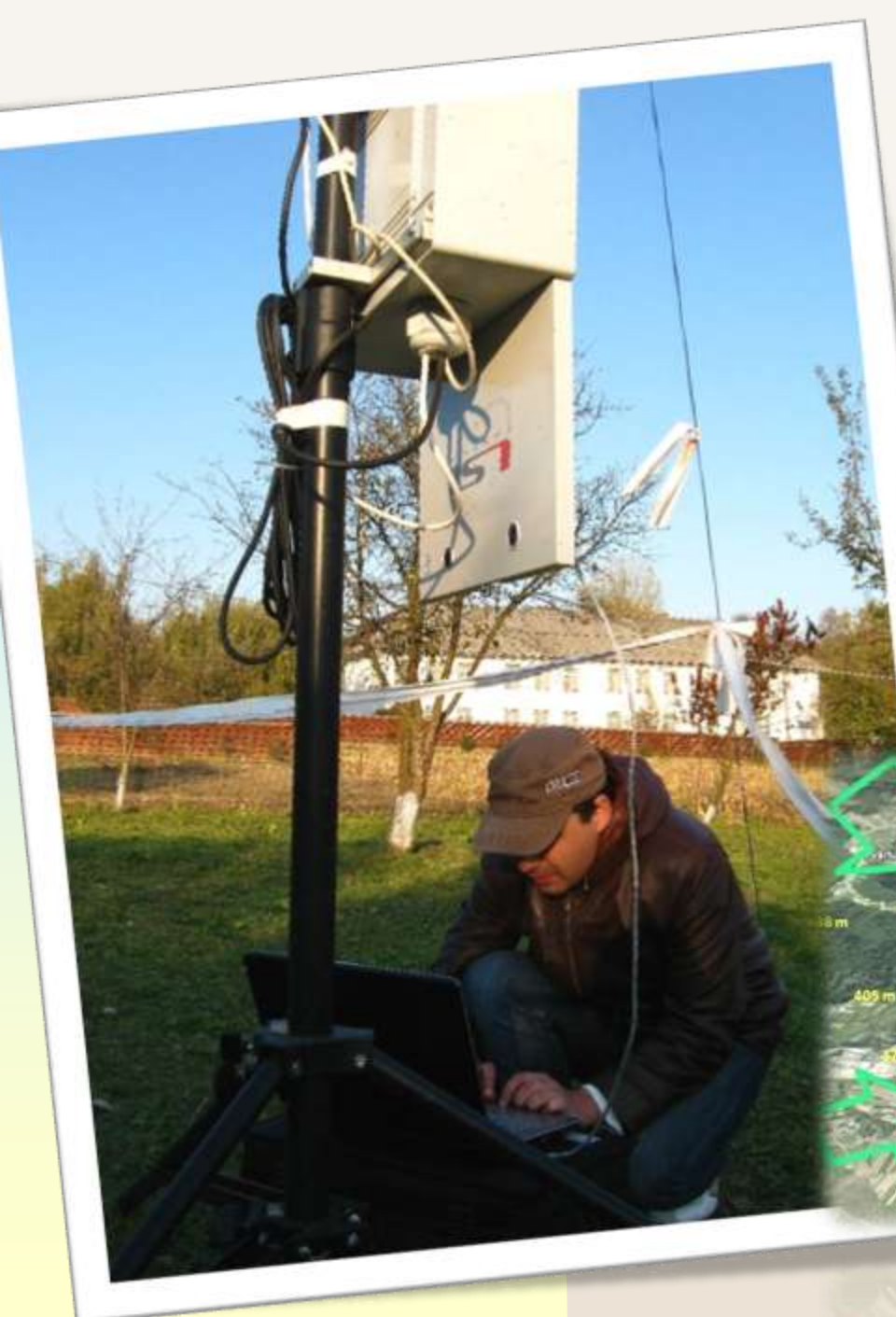
The high spatial and temporal resolutions (3.5 meters and 1 minute respectively) and the possibility to monitor Earth's atmosphere to heights up to 100 kilometers, make the LIDAR a very attractive and necessary system. The variety of interactions between the atmospheric constituents and the radiation emitted by the LIDAR, allows the determination of the atmospheric variables of state (i.e. temperature, pressure, air density) and the determination of the aerosol concentration.



The laser-atmosphere remote sensing spectral techniques study on the national RADO-network cell-grid infrastructure



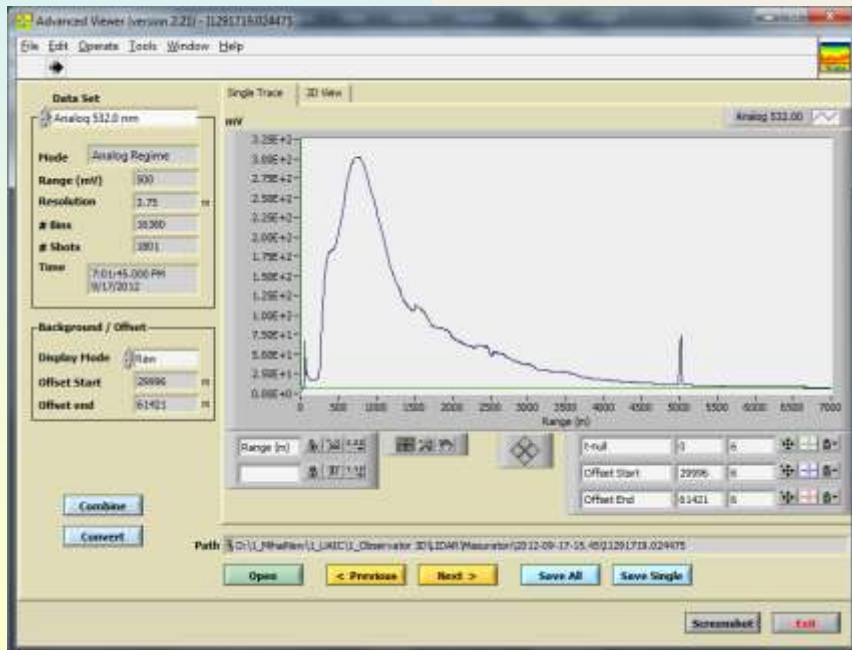
Cacica region



Campaign field measurements - Astronomical Observatory

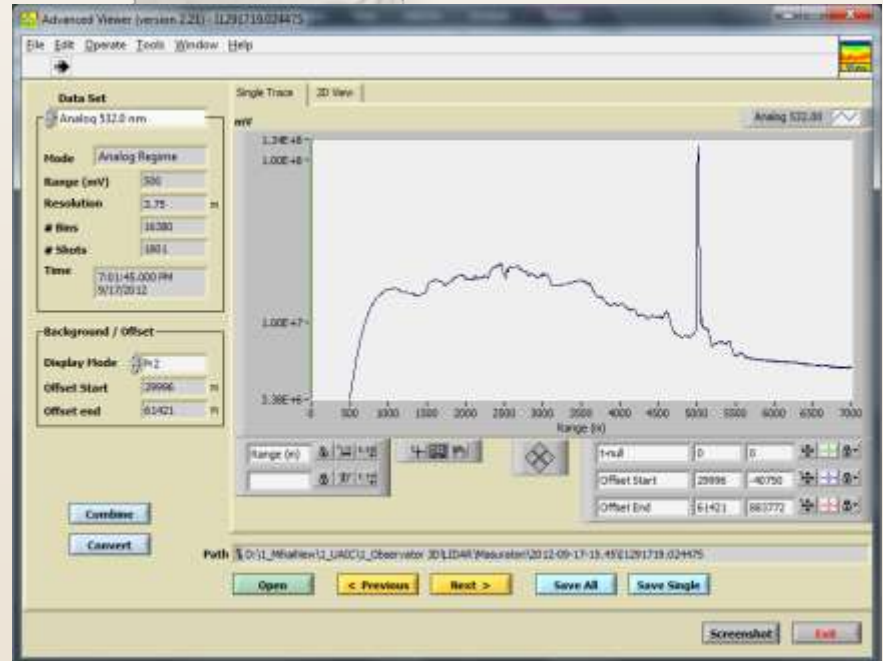


Data Recorder procedures



LIDAR Profile – Un-processed

Signal 532 nm elastic channel, Spatial Resolution: 3.75 m,
Temporal Resolution: 60 s (1800 profiles/ min)



RCS LIDAR (Range Corrected Signal)

RCS = distance * squared signal

The implementation of **Python programming** for the analysis and interpretation of LIDAR signals may be a useful tool in obtaining **the Range Corrected Signal Time Series**, the atmosphere's molecular parameters and the atmospheric variables of state at the national GRID sites. Also, together with the Telecover method, one can determine if the LIDAR system is properly aligned. The measurements were made with the mini-LIDAR system from the Atmosphere Optics, Spectroscopy and Lasers Laboratory, "Alexandru Ioan Cuza" University of Iasi (LOA-SL)





Transient Recorder



Data files processing



Dark File

```

E1101121.002556
CaMca - 11/10/2011 21:02:57 11/10/2011 21:04:22 0437 0025.9 0047.6 00
000000 7000 0025562 data 01
C1101121.025971
CaMca - 11/10/2011 21:01:51 11/10/2011 21:02:50 0437 0025.9 0047.6 00 01#
000000 7000 0025972 data 01
C1101121.033105
CaMca - 11/10/2011 21:00:05 11/10/2011 21:01:01 0437 0025.9 0047.6 00 1#
000000 7000 0027000 01# 01
1 0 2 02500 1 0000 3.75 00532.o 0 0 00 000 12 A20225 0.500 01#
532.000 .o analog 0 607.000 .o photon 0
0.0003 0.0000
0.0005 0.0000
0.0002 0.0000
0.0153 0.0000
0.0208 0.0000
0.2600 0.0000
0.0055 0.0000
0.0500 0.0000
0.0400 0.0000
0.0476 0.0000
0.0274 0.0000
0.0303 0.0000
0.0274 0.0000
0.0278 0.0000
0.0193 0.0000
0.0170 0.0000
0.0153 0.0000
0.0137 0.0000
0.0122 0.0000
0.0115 0.0000
0.0100 0.0000
0.0093 0.0000
0.0085 0.0000
0.0078 0.0000
0.0072 0.0000
0.0067 0.0000
0.0061 0.0000
0.0057 0.0000
- - - - -

```



subtract

```

E1101121.000531
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000000 7000 0027010 0010 01
1 0 2 02500 1 0000 3.75 00532.o 0 0 00 000 12 A20224 0.500 01#
1 0 2 02500 1 0000 3.75 00532.o 0 0 00 000 12 A20224 0.500 01#
122.000 .o analog 0 307.000 .o photon 0
0.0005 0.0000
0.0003 0.0000
0.0002 0.0000
0.0173 0.0000
0.0204 0.0000
0.0572 0.0000
0.0400 0.0000
0.0476 0.0000
0.0372 0.0000
0.0235 0.0000
0.0204 0.0000
0.0274 0.0000
0.0200 0.0000
0.0100 0.0000
0.0100 0.0000
0.0100 0.0000
0.0100 0.0000
0.0117 0.0000
0.0100 0.0000
0.0095 0.0000
0.0087 0.0000
0.0080 0.0000
0.0075 0.0000
0.0068 0.0000
0.0063 0.0000
0.0058 0.0000
0.0054 0.0000
0.0050 0.0000
0.0047 0.0000
0.0044 0.0000
0.0041 0.0000
0.0039 0.0000

```


Dark corrected files

n

File no.

2

3

1

```

C11A1121.042236
Cacica 11/10/2011 21:02:57 11/10/2011 21:04:22 0437 0025.9 0047.6 00
000000 7000 0026980 0010 01
1 0 2 02500 1 0800 3.75 00532.0 0 0 00 000 12 420196 0.500 BT0
1 0 2 02500 1 0800 3.75 00532.0 0 0 00 000 12 420234 0.500 BT0
532.000 .o analog 0 607.000 .o photon 0
0.0040 0.0000
0.0041 0.0000
0.0060 0.0000
0.0156 0.0000
0.0394 0.0000
-----

C11A1121.025671
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000000 7000 0026980 0010 01

C11A1121.013105
Cacica 11/10/2011 21:00:05 11/10/2011 21:01:31 0437 0025.9 0047.6 00
000000 7000 0027009 0010 01
1 0 2 02500 1 0800 3.75 00532.0 0 0 00 000 12 420225 0.500 BT0
1 0 2 02500 1 0800 3.75 00532.0 0 0 00 000 12 420234 0.500 BT0
0.0059 0.0000
0.0063 0.0000
0.0082 0.0000
0.0173 0.0000
0.0204 0.0000
0.0572 0.0000
0.0606 0.0000
0.0544 0.0000
0.0462 0.0000
0.0335 0.0000
0.0286 0.0000
0.0254 0.0000
0.0208 0.0000
0.0190 0.0000
0.0160 0.0000
0.0142 0.0000
0.0128 0.0000
0.0117 0.0000
0.0104 0.0000
0.0095 0.0000
0.0087 0.0000
0.0080 0.0000
0.0075 0.0000
0.0068 0.0000
0.0063 0.0000
0.0058 0.0000
0.0054 0.0000
0.0050 0.0000
0.0047 0.0000
0.0044 0.0000
0.0041 0.0000
0.0038 0.0000
    
```

Value

Value position

Channel No.



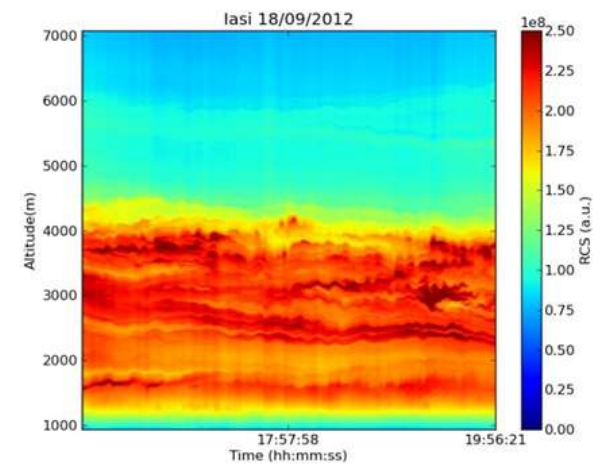
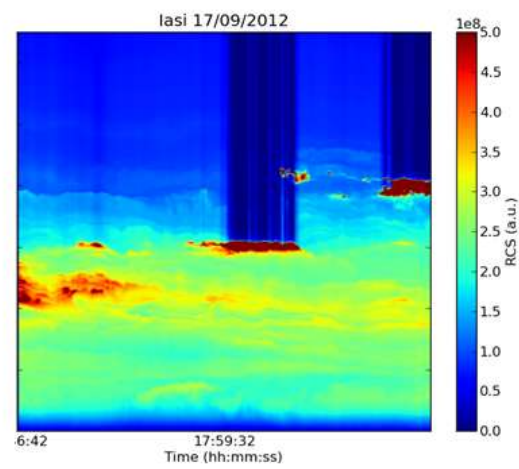
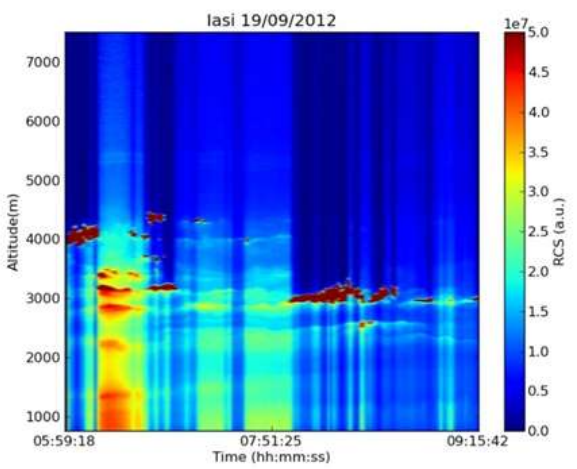
3D array: values[fn][cn][vp] = value

Value x (value position x spatial resolution) ² = Range Corrected Signal (value)
 FROM ONE FILE!

Altitude



Plot 3D array ← 3D array: RCS[fn][cn][vp] = value



Future work

