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iosf®

integra Open Space fire

NeoLIDAR

AUTOMATIC FAST FIRE DETECTION SYSTEM FOR OPEN SPACES

(iosf has already been awarded with 2 First Prizes)

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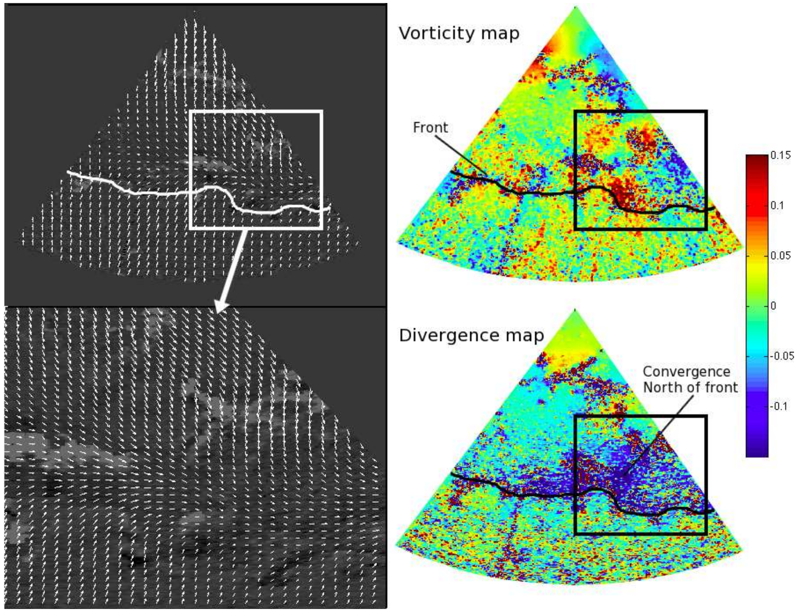
1. The ideas behind @osf® (I)

@integra has developed a new **technology** for the detection of just-started fires, which has materialized in the product @osf®. The technology is called **O**ptical **P**seudo-random **S**ignal **E**xtraction and **N**oise **E**limination (**OPSENE**), or with the more intuitive name of **NeoLIDAR**, as it shows similarities with the well known LIDAR technology. It is based on the capture and analysis of the radiation scattered by the smoke particles as they are illuminated by the so-called **P**seudo-**R**andom **M**odulated **B**eam (**PRMB**), generated by the system itself.

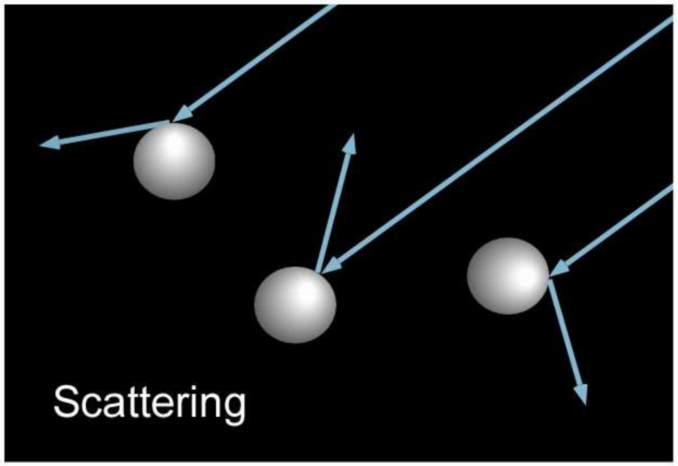


1. The ideas behind @osf® (II)

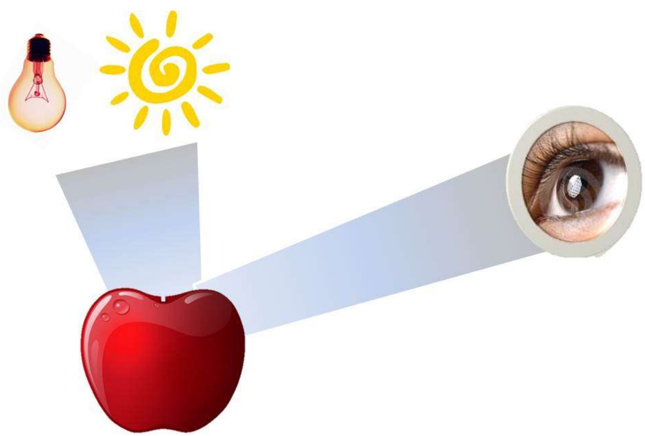
The system @osf® is based on the **NeoLIDAR** technology, developed and patented by *@integra*, and it shows the following main features:

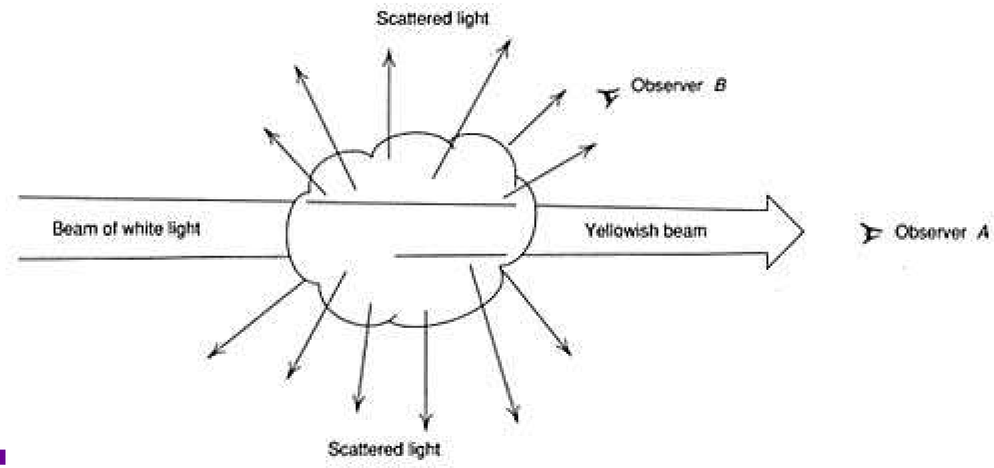
- It does not detect heat, nor depends on the source temperature. It is not a thermal system.
- It detects thin pollutant plumes beyond 3 km, in less than 3 minutes (daylight conditions).
- It is much more efficient at nighttime than at daytime.
- It scans the surveyed area (360 deg) in some 3 minutes.
- It detects fire when flame is still barely visible.
- Real time monitoring of detected fire plumes.

1. The ideas behind iosf® (III)



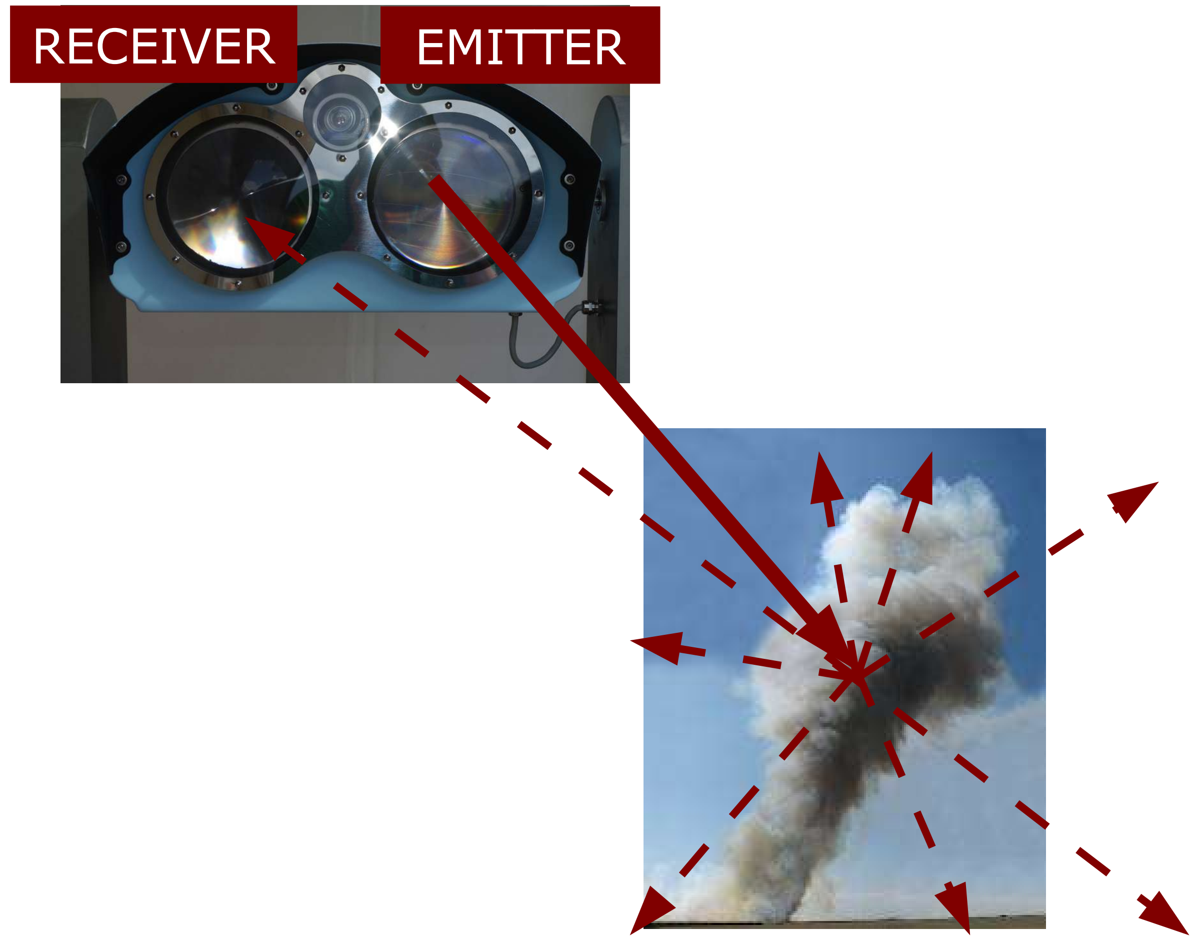
Light scattering is generated when the electromagnetic (EM) radiation interacts with the particles of a smoke plume. The EM wave energy is affected by the extinction = scattering + absorption.





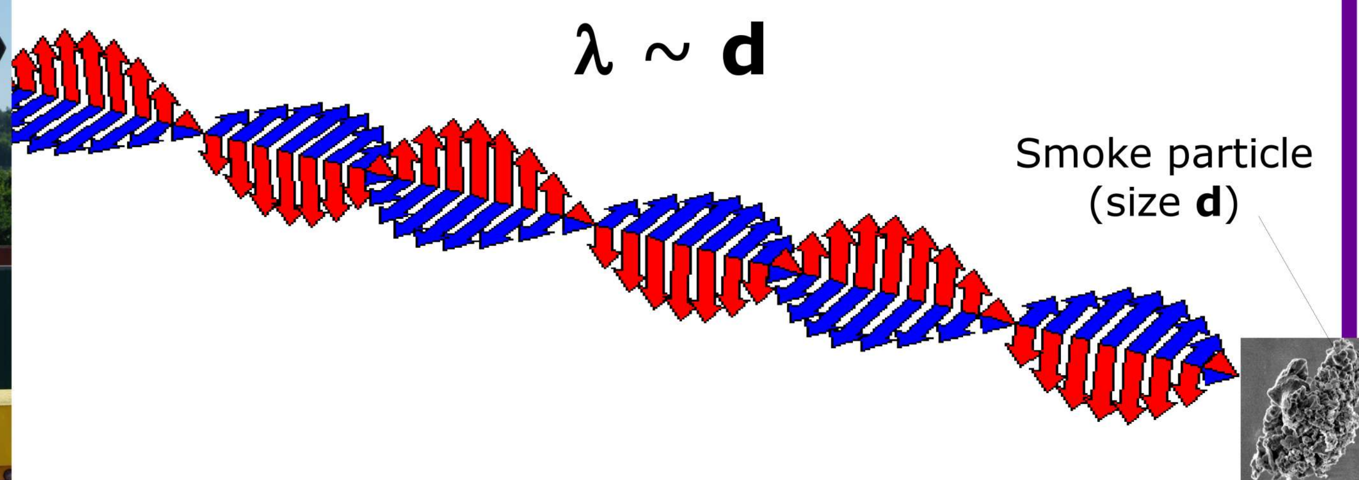
1. The ideas behind @osf® (IV)

The @osf® detection mechanism is similar to that used by LIDAR, although with remarkable differences. The emitter sends to infinity a **P**seudo-**R**andom **M**odulated **B**eam (**PRMB**), with very special characteristics known to the system. As it hits a smoke plume above horizon, the **PRMB** is scattered in all directions. A tiny fraction of this scattered **PRMB** gets back to the unit (backscattering), where it is detected.



1. The ideas behind iosf® (V)

The scattering mode and the detection capability depends on the ratio between wavelength (λ) and the average particle size (**d**) which is meant to be detected. If the wavelength λ is much larger than the smoke or dust particle size, **d**, the scattering will be very weak. On the other hand, the longer the wavelength the larger the detection range.

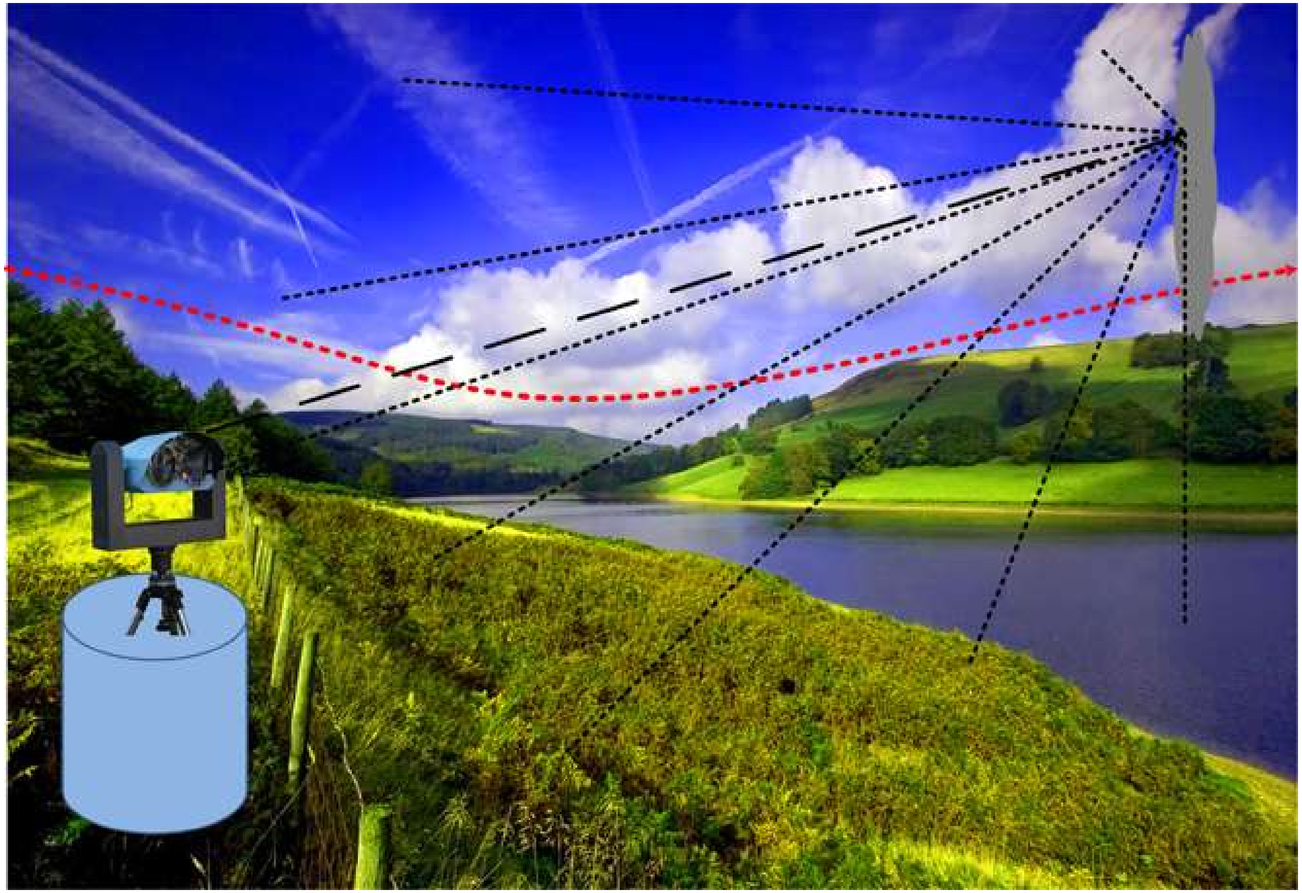


1. The ideas behind ⓘosf® (VI)

The PRMB is sent over the horizon, above any existing obstacle. If the PRMB does not impinge on any plume, it will be lost to infinity and no backscattered PRMB will reach the system. This is the normal state of ⓘosf® .

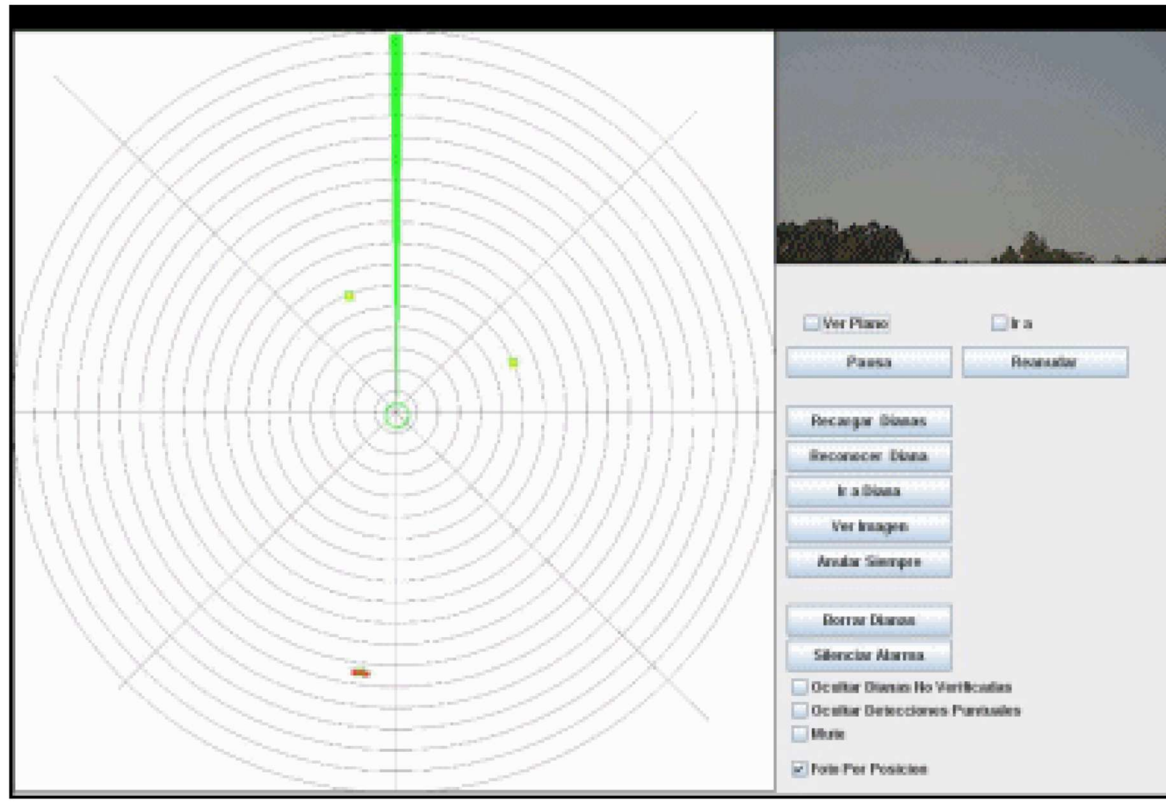
1. The ideas behind iosf® (VII)

When the emitted PRMB hits a smoke plume, it is scattered in all directions, and a tiny fraction gets back to the receiver. A target analysis is carried out by iosf®. If it gets through the false alarm filters, the camera will take a picture of the smoke plume and send the information to the Control Centre.



1. The ideas behind ⓘosf® (VIII)

The software located at the Control Centre receives the event of a smoke plume, together with the picture taken by the camera. The operator then decides what to do, based on the information put in. The measured detection curves generated by ⓘosf® are shown in another screen. The software shows in real time the active smoke plumes (colour code).



Grey: Signal still to be confirmed. **Yellow**: Feeble confirmed Target. **Red**: Strong confirmed Target. **Brown**: Ignored Target

1. The ideas behind iosf® (and IX)

The most important features of iosf® are the capability to detect forest or industrial fires or emission of atmospheric contaminants at a very early stage (in the case of fires even when there is no open flame), the ability to reduce false alarms and the real time tracking of all existing plumes.

2. @osf® components (I)

EMITTER

The Emitter generates the PRMB and modulates it with a predetermined code, so that the System can recognise it when detected. The light source is not a LASER. The wavelength is matched to the average smoke particle size (1μm, infrared).

The signal is continuously emitted with a configurable power, depending on the azimuth angle. @osf® checks that a signal exists at any time.

EMITTER

2. @osf® components (II)

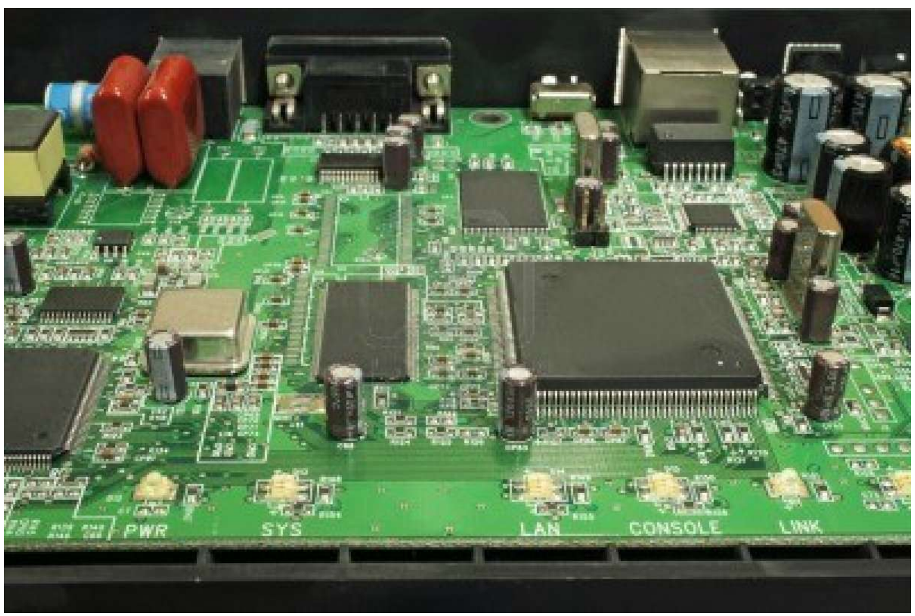
RECEIVER

The Receiver is made up of a great optical system in whose focal plane an advanced electronic sensor is accurately positioned. The system sensitivity is extraordinary, specially if one takes into account that it discriminates solar radiation ($I_{bs}/I_{sun} < 10^{-9}$). This is why it performs much better at nighttime.

@osf® is able to detect very tiny fractions of scattered PRMB.

2. @osf® components (III)

ELECTRONIC BOARDS
(distributed intelligence)



The detection process is based on the repeated application of powerful algorithms, able to obtain the desired signal within an enormous noise level. The system is endowed with 5 microprocessors, each executing a different task: mathematical calculations, global system management, gimbal mount movement, video management, communication control, compensation from external perturbations,...

2. iosf® components (IV)

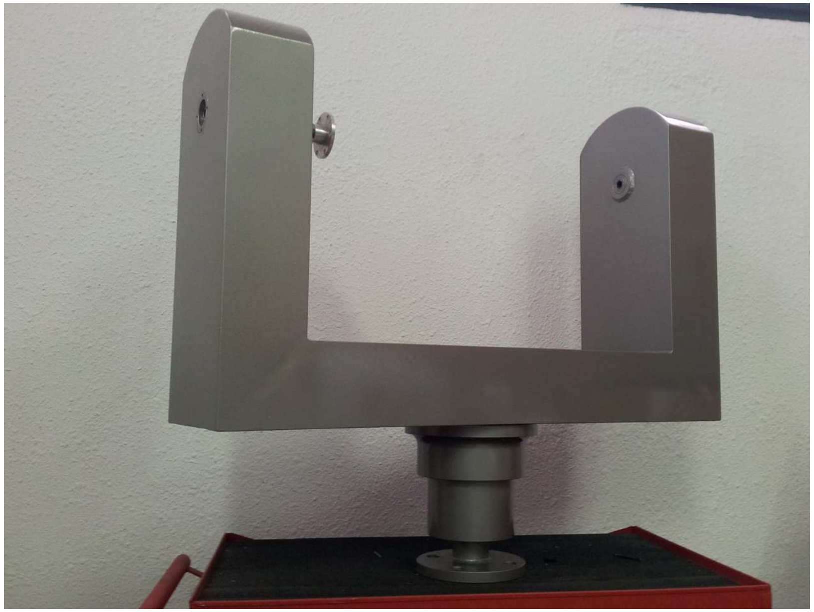
CAMERA

The camera is only used when iosf® has detected some backscattered PRMB, after the system verifies twice that it is not a false alarm.

The camera is <u>only employed to supply evidence to the operator</u>. It is not part of the active detection process. iosf® can host more than one camera, and each can be of any type: standard, infrared, thermal,...

2. iosf® components (V)

GIMBAL MOUNT



iosf® gimbal mount allows for a rotating movement around the azimuth and zenith axis. It is controlled by one of the system's microprocessor. It is very rugged, resists easily the harshest environmental conditions, it withstands a far greater load than that of actual iosf®, and it shows an excellent repeatability.

It integrates vibration, movement, inclination and orientation sensors, in order to endow it with a superior mechanical stability. It completes a full rotation in less than 3 minutes.

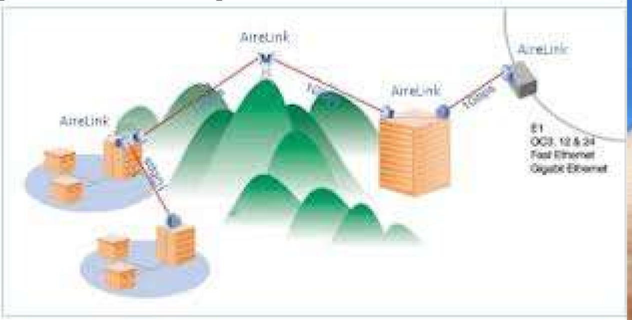
2. iosf® components (VI)

TELECOMMUNICATION SYSTEM

The system communicates through standard WiFi (industrial environment), UMTS/3G or GSM/GPRS (forestry). The data traffic is small and the system will perform properly above 300 kbps.

Other communication alternatives:

- •Terrestrial Trunked Radio (TETRA).
- •Radio-link.
- •Satellite communications.
- •Zigbee.



2. iosf® components (VII)

POWER SUPPLY

The system just needs 12Vdc/18W to carry out the detection process and to monitor the area under its surveillance. Thus, if such a small power supply is available at the installation place, the system will feed from it.

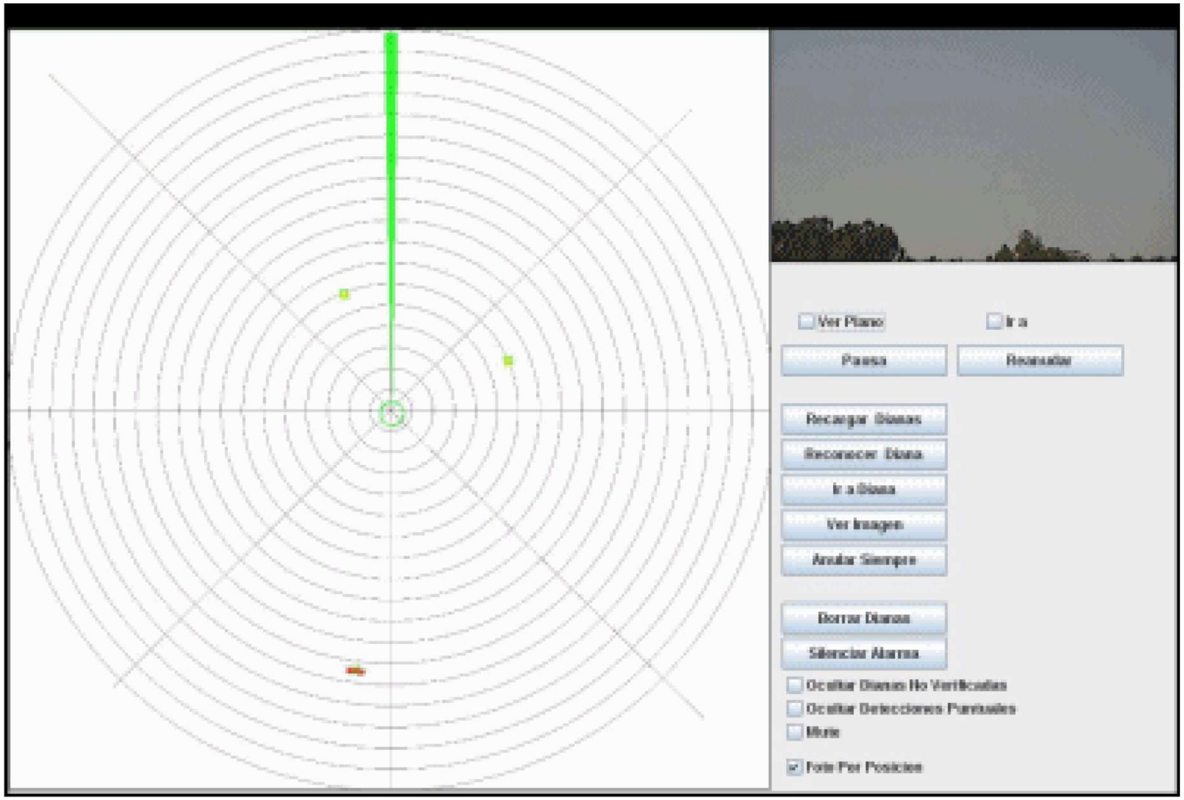
Other alternatives for the system are:

- Solar panel.
- Micro-wind generator.
- Direct Methanol Fuel Cell
- Replaceable batteries.

2. @osf® components (and VIII)

SOFTWARE

The software analyses the signals that hint the detection of a faint PRMB scattered by the smoke plume.



@osf® will capture an image of the target generating the signal, and will send the information to the Control Centre, where a human operator will make a final operational decision.

3. Technical issues related to @osf® (I)

1. Field of vision (I)

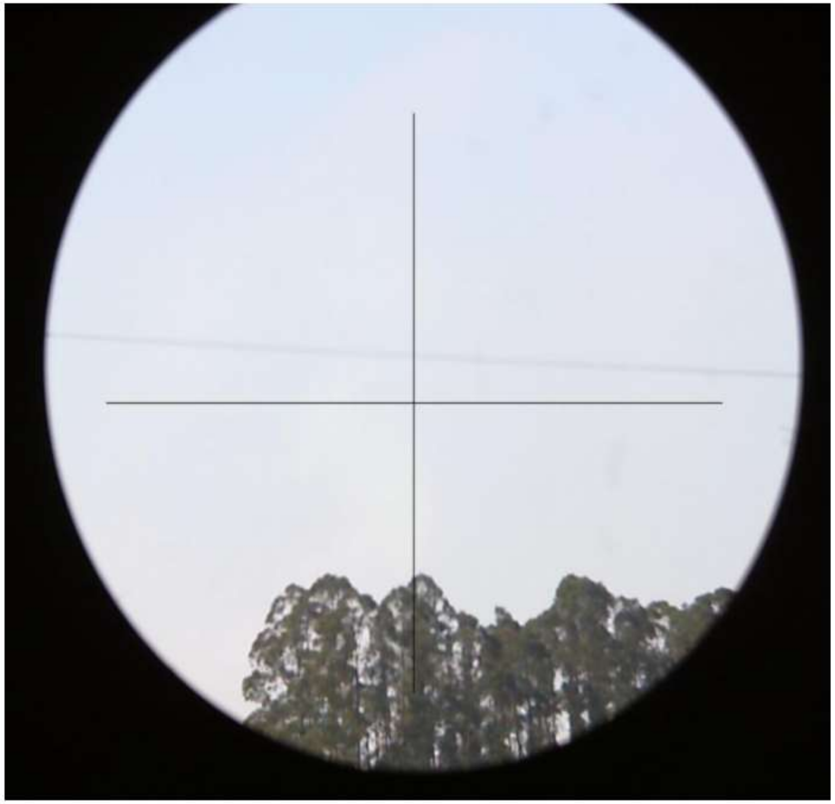
The system has been optimally designed to send out the PRMB in steps of a certain angle until it covers the required zone. @osf® can rotate 360 degrees or any fraction thereof. It can have different emission power, sensitivity, repetition rate, sampling time, detection threshold,... for each azimuth.

When the emitter sends out the PRMB, both the emitter and the detector must be perfectly aligned. Performing that action continuously, the system covers the area under its influence in a 24*7 regime.

3. Technical issues related to iosf® (II)

1. Field of vision (and II)

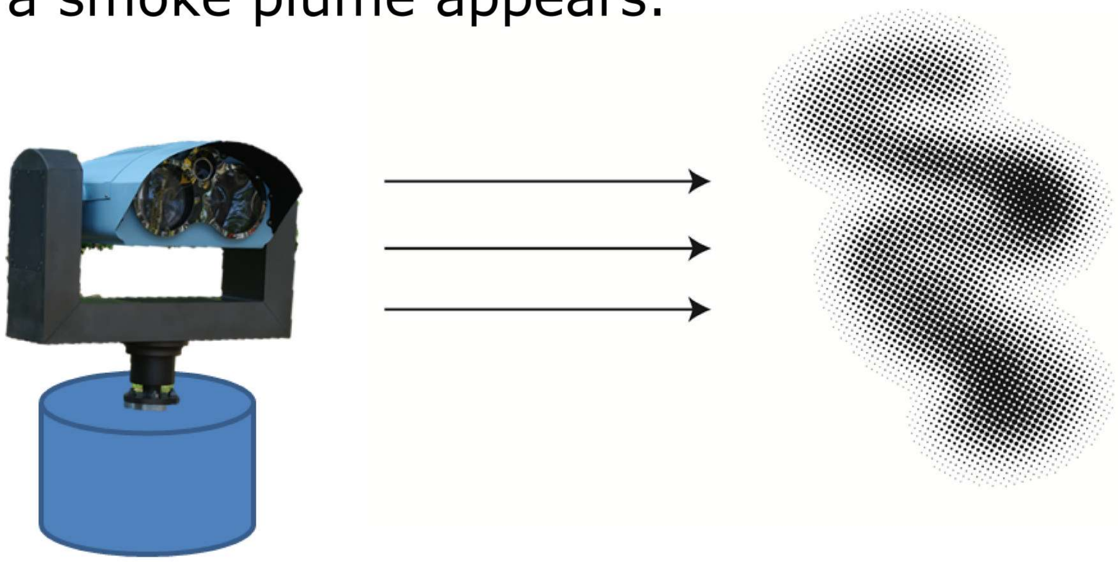
The picture shows an image of the iosf® camera in the forest. The measurements of the incoming light are done for each movement of the system, covering a small circle of few degrees above horizon. The camera has deliberately a much more wide view, to improve the vision of the detected incidents.



3. Technical issues related to @osf® (III)

2. PRMB reception (I)

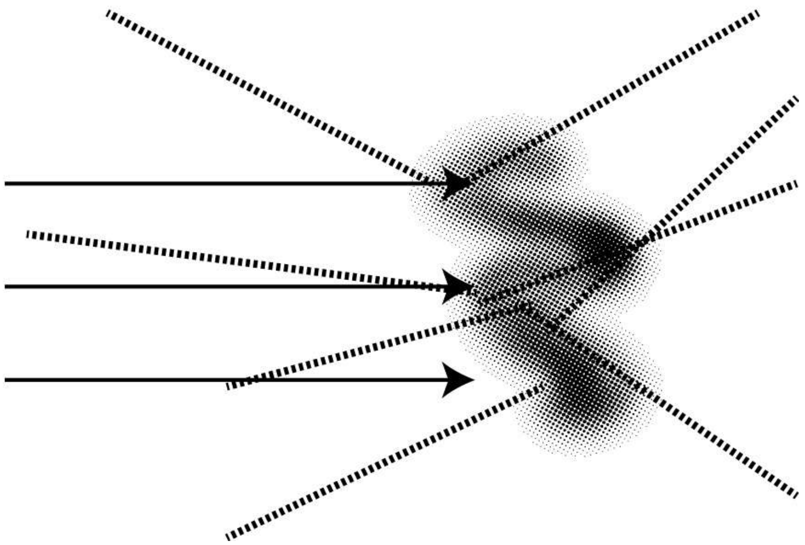
The system is sending the PRMB out continuously above the skyline (made of buildings and warehouses in an industrial estate, or mountains and trees in forest environment). The PRMB is lost to infinity, unless a smoke plume appears.



3. Technical issues related to iosf® (IV)

2. PRMB reception (II)

The PRMB, which normally stretches to infinity, hits a smoke plume which has shown over horizon. The PRMB is scattered in all directions, including the one at 180 degrees (backscattering) that leads back to the Receiver.

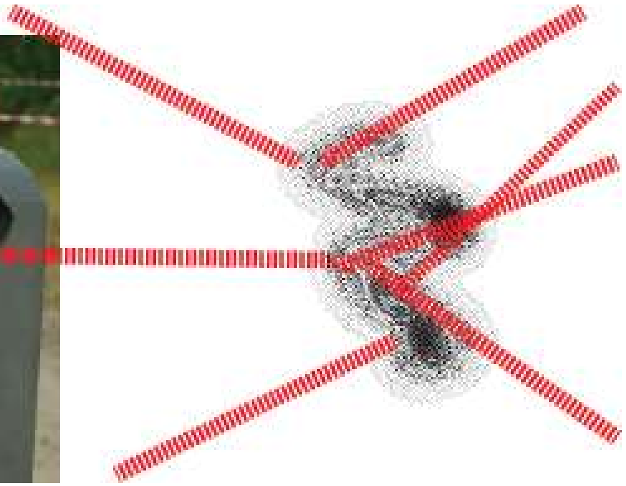


iosf® recognises its own emitted light when the Receiver detects it. The PRMB detection is caused by the presence of a target above horizon. The software analyses the received signal and discriminate the false alarms.

3. Technical issues related to iosf® (and V)

2. PRMB reception (and III)

The Detector picks up the backscattered light generated in the impact of PRMB with the smoke plume. The feeble received signal is strongly amplified, the software discriminates the false alarms and, if a positive identification results, a potential fire alarm warning is sent to the Control Centre with a picture to assess the situation.



4. Assessment of currently available systems (I)

Nowadays, apart from the traditional solution to detect fires that means a person with binoculars, there are basically two advanced systems to detect fires (without using satellites). Both systems are passive.

❶ System based on intelligent analysis of pictures. The images of an area are analysed and, through algorithms over the pixels, it could conclude the existence of fires.

❷ System based on infrared or thermal cameras. Fires and other hot spots can be detected based on their emission of heat.

4. Assessment of currently available systems (II)

❶ System based on intelligent image analysis.

The system based on intelligent image analysis takes different pictures of the same landscape and applies an algorithm on their pixels. Analysing the above pictures the algorithm would conclude the existence of a smoke plume in the first one (naïve explanation).

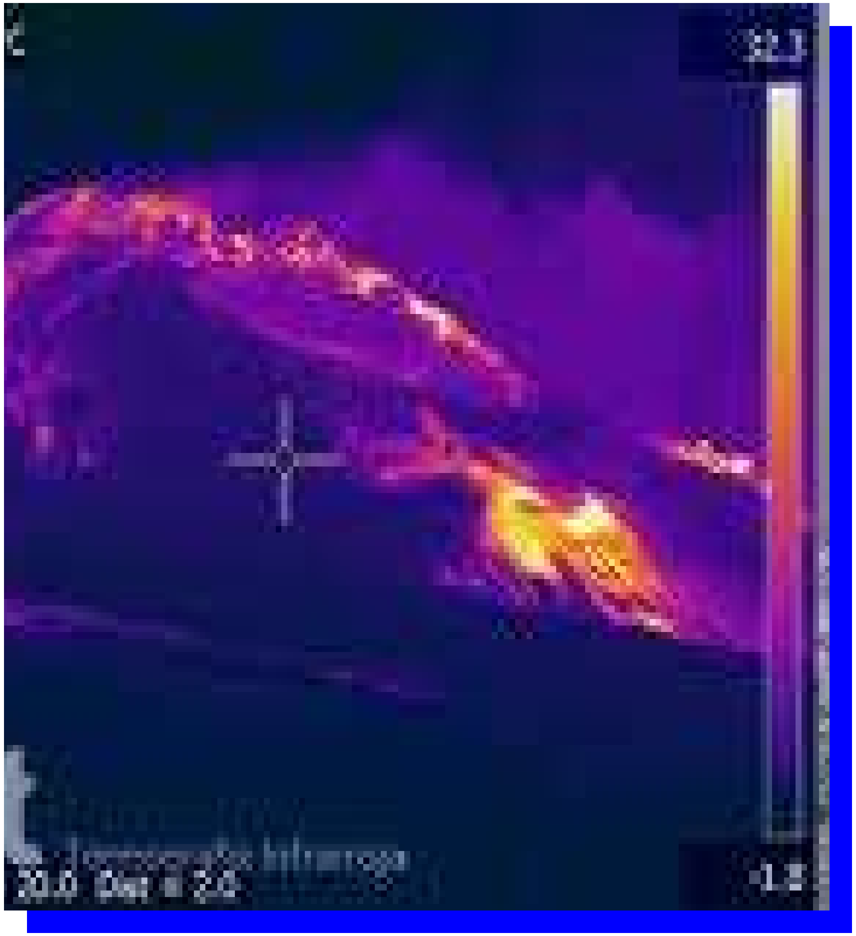
This system is not early-warning at all, as it needs a fairly large smoke plume to yield a reliable alarm. Being very slow in smoke detection, the fire would probably be too large to be put out easily. Another problem may arise when the smoke plume could be mistaken with surrounding clouds. Besides, the system has a poor performance during nighttime.

4. Assessment of currently available systems (III)

❷ The system based on infrared or thermal imaging cameras can detect the existence of incidents based on the heat emission by hot objects or their combustion.

The system would not detect any hot spot behind another object (trees, unevenness of the terrain...). Besides, in order to detect at great distance the fire must be intense and extensive, thus it is not an early-warning system. It is also quite prone to false alarms, as it will detect any hot spot, including house lights, vehicle headlights,...

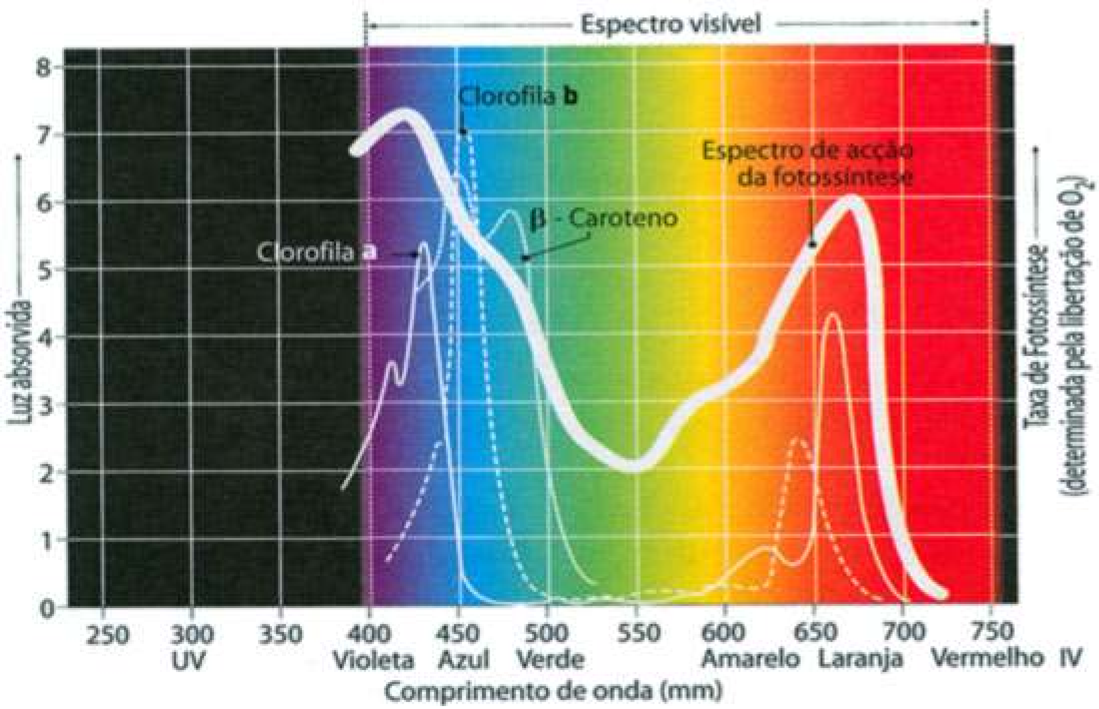
In hot summer days the sensitivity of these systems would be severely diminished.



4. Assessment of currently available systems (and IV)

A type of system that is beginning to be used is the spectrometer. It would determine the absorption spectrum of a smoke plume (at day), or its emission spectrum (at night), provided it is hot enough.

They should be able to identify the nature of the smoke. These systems are very expensive and slow, as they have to analyse the spectra of the received light in all directions. They are excellent identifiers, but poor detectors.



5. Main features of @osf® (I)

- @osf® generates its own PRMB with known characteristics.
- @osf® can detect minute fractions of the scattered PRMB due to a triple amplification (optical, electronic and algorithmic). This is why it can detect feeble smoke plumes at a very early stage.
- @osf® sweeps its surveillance area in some 3 minutes.
- @osf® detects feeble smoke at 3 km and denser smoke at higher range (> 5 km).
- @osf® has a validation process that reduces false alarms. The system acts as a radar which tracks/monitors all active plumes.
- @osf® helps in the decision making process sending pictures or video recordings of the detected smoke plume.

5. Main features of iosf® (and II)

- iosf® operates on a 24x7 basis and its detection is enhanced in nighttime operation.
- iosf® is autonomous and automatic, and does not require continuous human intervention. It must only be attended when a plume is detected.
- iosf® only responds to its own emitted light. Besides, it is extremely sensitive to this light ($<10^{-9}$).
- Manual remote control of iosf® from Control Centre is possible.
- iosf® software is remotely updated, even the firmware. The units are kept updated without physically going to them.
- iosf® sends periodically warnings about its state, in order to facilitate the maintenance and remote diagnose of any problem.

6. Possible uses (I)

- Forest fires and large agroforestry units fires.
- Fires in open spaces (industrial estate, storage areas, free ports, container storage, critical infrastructures…).
- Detection of chemical leaks, toxic leaks, atmospheric pollutants, oil and gas pipelines...
- Industrial emissions into the atmosphere (manufactures, incinerators, recycling plants, industrial complexes,...).
- Organic emissions from grain silos, fodder factories,...
- Dust clouds thrown into the air by vehicles as they cross borders through dusty roads (border surveillance, troop movements in desert areas...).
- Applications in chemical and bacteriological warfare.

7. Test results (I)

iosf® range is only limited by the PRMB emitted power. The following case shows the results obtained in an actual test with a non-laser PRMB of 3 W of optical power. The target is a small smoke plume from a stubble burning located some 3 km away from the System. The test in conducted in day conditions.

7. Test results (II)

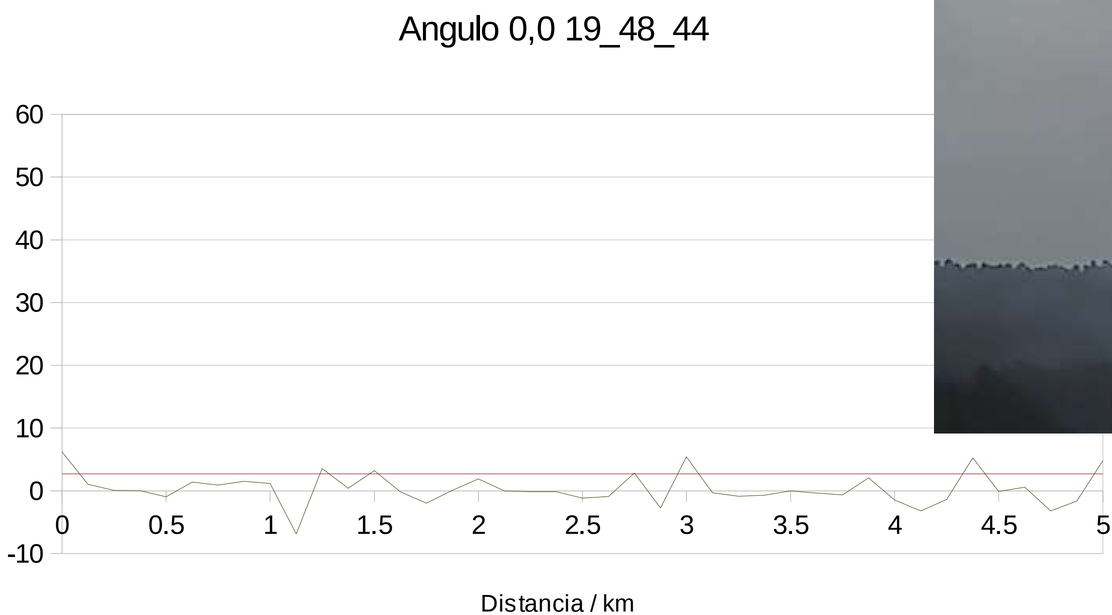
Results when the PRMB is directed to infinity. No effective detection.

Red circle above: Surveyed area

Red line: Detection threshold
Black line: NeoLIDAR signal

7. Test results (III)

Results with PRMB at some 4 deg. above horizon. Very thin smoke.



Red circle above: Surveyed area

Red line: Detection threshold
Black line: NeoLIDAR signal

7. Test results (IV)

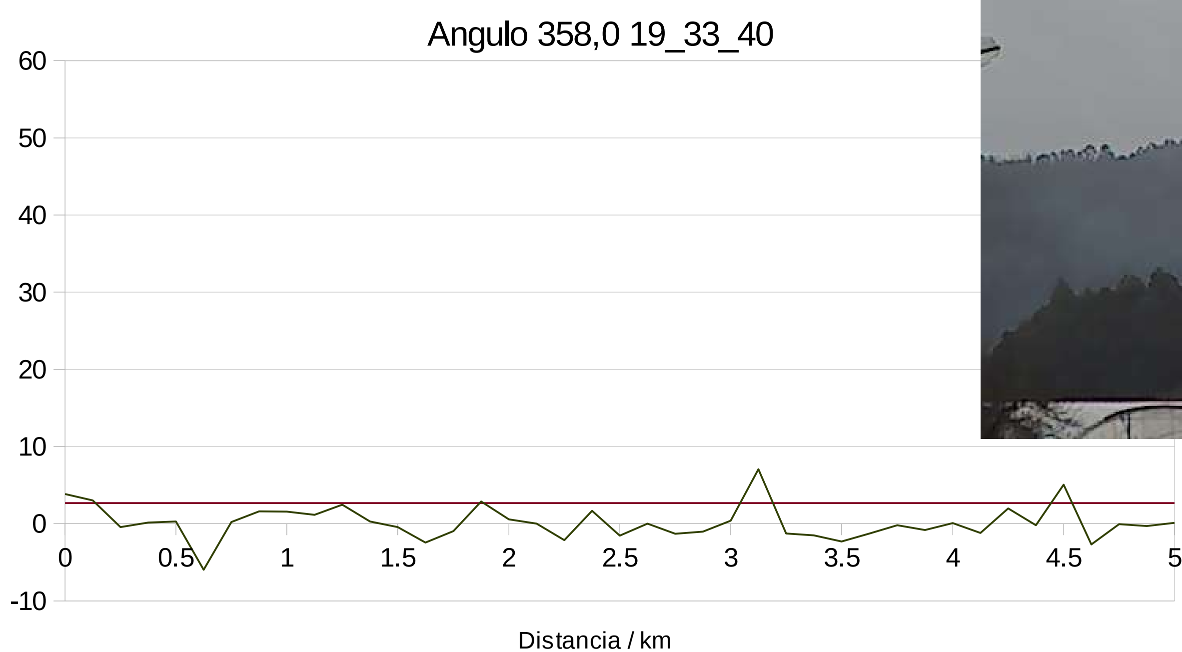
Results with PRMB at some 4 deg. above horizon. Very thin smoke.
Helicopter within field.

Red circle above: Surveyed area

Red line: Detection threshold
Black line: NeoLIDAR signal

7. Test results (and V)

Results with PRMB at some 1 deg. above horizon. Very thin smoke.



Red circle above: Surveyed area

Red line: Detection threshold
Black line: NeoLIDAR signal

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THANK YOU VERY MUCH FOR YOUR ATTENTION

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