Federal Agency for Cartography and Geodesy

Assessing WLRS In-Sky-Safety Methods

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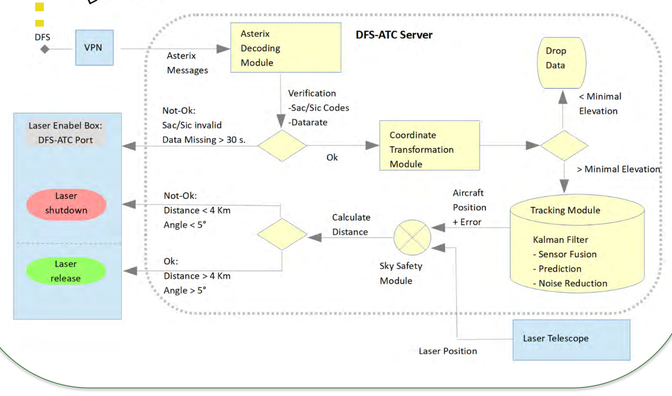
DFS-ATC

Primary long range system

Air-traffic information from the surrounding 5 DFS primary radar stations are received and evaluated by the GOW DFS-ATC In-Sky-Safety system



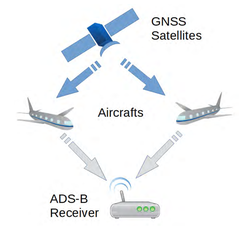
Introduction

Laser In-Sky-Safety is a critical issue in satellite laser ranging where non-eye-safe short laser pulses are sent from ground stations to objects in space. This is of special concern for GGOS sites, where RADAR systems need to be avoided due to their radiation interfering with the broadband microwave receivers of VLBI telescopes.

At the Geodetic Observatory Wettzell we operate multiple non-radiating In-Sky-Safety systems for object detection in the direction of the laser beam. Each of these techniques is optimized for a specific detection range and the design goal was to make each of them redundant.

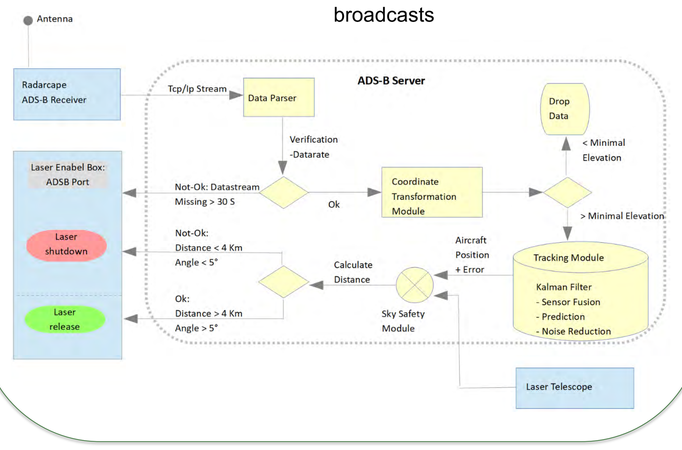
ADS-B

Secondary long range system



ADS-B - How it works

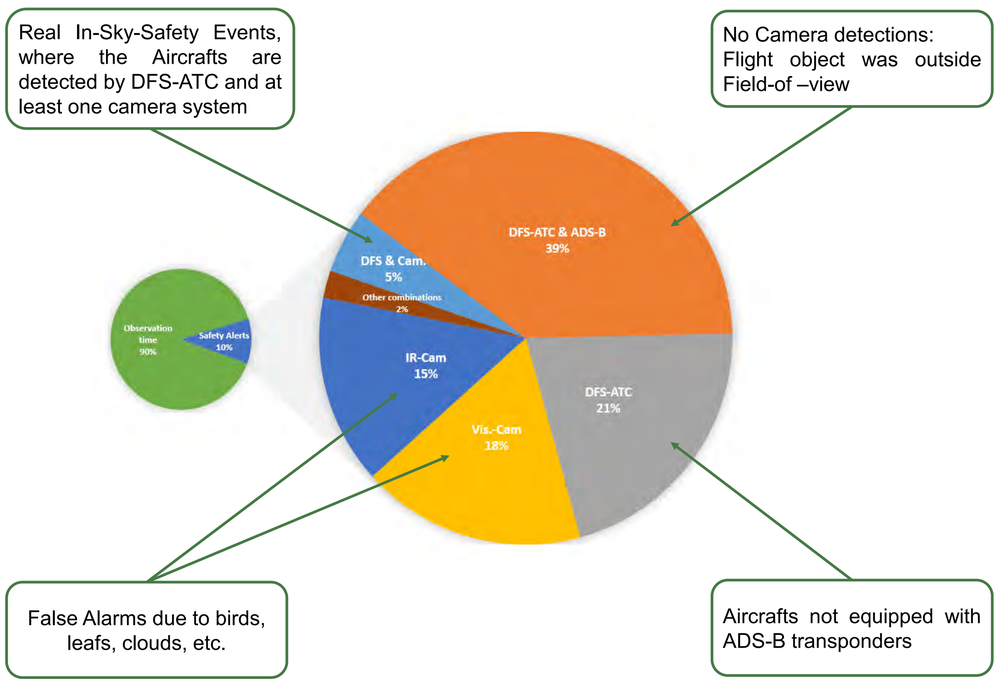
1. Aircraft determines position information via GNSS
2. Aircraft is broadcasting position, speed, height and additional Data
3. Ground stations receive the broadcasts



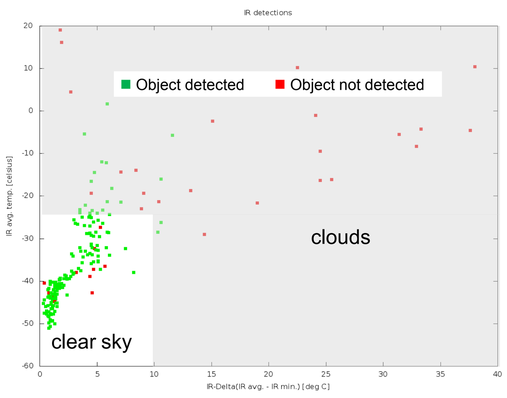
Major strengths and weaknesses of the individual systems

	DFS-ATC	ADS-B	Infrared camera	Visual camera
Long range protection	++	++	+	+
Short range protection	+	+	++	++
Weather independence	++	++	- -	- -
Night operation	++	++	++	-
Precision of protection area	- -	- -	++	++
Noise ratio	+	++	-	- -

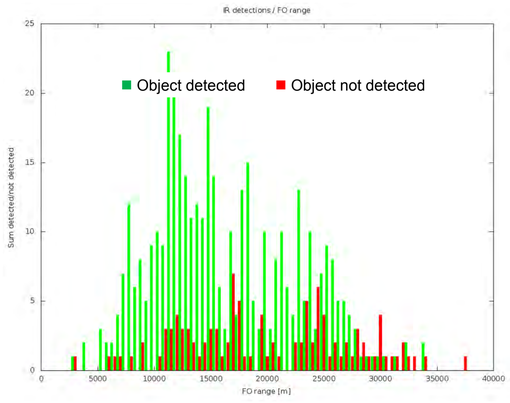
Interruptions of SLR observations by the different systems



Assessment examples - IR-Camera performance



Influence of background temperature (IR avg.) and temperature distribution caused by clouds (IR delta) on the detection result of air traffic (source is DFS traffic data).



Distribution of Aircraft detections by distance to the telescope (FO range) within a 3 month period and less than 2° to the laser beam. The not detected objects below 10 km distance are caused by inaccurate position information of the DFS-ATC data.

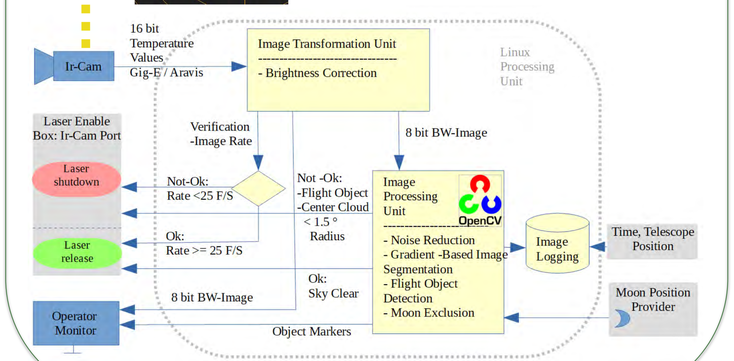
DFS-ATC data is the most comprehensive data source for real air traffic. The inherent inaccurate position predictions on the other hand lead to long disruptions of SLR observation. The events caused by flight objects like gliders and balloons with no DFS-ATC data are very rare (< 1%) and therefore not visible in the diagram.

Infrared camera

Primary short range system

Camera Specification

- Manufacturer: Infratec
- Spectral range: 8 – 12 um
- Resolution: 1024 x 768 pixel
- Refresh rate: 30 Hz
- Field-of-view (w. 120 mm lens): +/- 4° horizontal, +/- 3° vertical



Conclusion

Permanent monitoring of the different In-Sky-Safety systems is necessary not only to gain information about their current status, it also provides information to assess its performance and the influence to the SLR operations. This results in a better understanding of the individual characteristics and the direction for further improvements to reach the best possible SLR observation performance while keeping the system as save as possible.

Visual camera

Secondary short range system

Camera Specification

- Manufacturer: IDS
- Resolution: 2448 x 2048 pixel
- Refresh rate: 22 Hz
- Field-of-view (w. 75mm lens): +/- 3° horizontal, +/- 2.5° vertical