ILRS Workshop Stuttgart Germany 2019: Session 5 Summary
Session 5: Safety and Security
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In an email to the ILRS during the summer of 2019 the co-chairs gave suggested topics for this Session's presentations and posters. These were:

- What are the laser safety regulations in the different countries. Are there regulations?
- What are the current safety standards (with a focus on SLR)?
- What are the major safety considerations for SLR systems?
- Is radar in the context of co-located sites still an option?
- What alternatives do we have for aircraft safety (Camera systems, ADS-B, ...)?
- What do stations implement as the hardware-software interface when using software based In-Sky-Safety-Systems, and what is the requirement from the functional safety of the instrument?
- What is the limit of eye-safe SLR?
- What is the current state of lasers and detectors at eye-safe wavelengths?
- How do we protect our SLR systems from being hacked? This is an especially relevant question as our stations become more automated – even for remotely operated systems.
- What are the safety and security implications for automating an SLR system?

There were seven abstracts submitted to this Session. Six were given as presentations and one was a poster. The titles and presenters were:

Presenter	Title of presentation / poster
Jean-Marie Torre	European Laser Safety: Laser Emitters and Flight Safety
Andreas Leidig	Free space laser safety system for Aircraft Camera Detection in the Infrared
Matthew Wilkinson	Optically Detecting Aircraft for In-Sky Safety in Daylight Conditions
Toshimichi Otsubo	ADS-B aircraft safety system assembled at less than EUR/USD 100
Theodor Bachem	Web-based approach for system monitoring and remote SLR control
Jan McGarry	SGSLR safety & security across global locations
Howard Donovan	NASA SGSLR Power and Lightning Protection (poster)

The first presentation (Torre) gave an overview of requirements for laser safety in Europe and the steps needed to be followed for safety. Three of the talks in this session were on specific techniques of laser safety; these were the second (infrared camera - Leidig), third (optical camera - Wilkinson) and fourth presentations (ADSB – Otsubo). The fifth presentation talked about an approach to monitoring the stations – an important aspect of safety and security at SLR stations. The last presentation presented an overview of the NASA SLR approach to safety and security.

The poster (Donovan) was on lightning protection, including lessons learned from a severe 2015 lightning strike, and the design for SGSLR to protect from future strikes.

During the presentations and discussions, the use of radars, cameras, ADSB, no-fly zones, laser kill switches, observers, and eye-safe laser pre-fires were all discussed as laser safety / aircraft safety techniques. It was clear that each technique has its issues and/or challenges.

There were lively discussions in the session after most talks, but especially following those talks on laser safety. The final discussion period also saw a large audience participation. The discussions centered about laser safety and aircraft safety. Consensus from the audience was that (1) all stations need to regularly evaluate their situations and ensure that they are ensuring laser safety at their sites, (2) more than a single technique should be used when possible to decrease the risk of human / aircraft exposure, and (3) future Workshops should include a similar Session on Safety & Security.

The following is a brief summary of each of the presentations and the poster.

1- Optically Detecting Aircraft for In-Sky Safety in Daylight Conditions
   1- European Laser Safety: Laser Emitters and Flight Safety
   This was an overview of laser safety requirements for European lasers. It discussed safety rules for class 4 lasers, talked about MPE and NOHD, gave airspace restrictions for non-eye-safe lasers, and listed multiple important documents related to laser safety.

   2- Free space laser safety system for Aircraft Camera Detection in the Infrared
   This talk presented the Wettzell team's development of an infrared camera to image aircraft, along with the algorithms and software used to distinguish targets (aircraft, balloons, gliders, etc) in various orientations. OpenCV image processing library was used to recognize the targets. Steps in the processing of images were given and dealing with cloud cover was discussed. Advantages of using an infrared camera over other techniques were given as well as some of the challenges of this technique. This technique looks promising.

   3- Optically Detecting Aircraft for In-Sky Safety in Daylight Conditions
   This aircraft detection technique is being developed at Herstmonceux. Herstmonceux currently uses radar, ADSB and observer. They would like to replace the observer with a

technique that is passive but can spot the closer in targets, like gliders, balloons, etc that do not have an onboard transponder. The method for finding the target was described and shown through an example. Successful detection and tracking of aircraft was shown by video. The development is now moving from B&W to a color camera to provide more information for use in target detection. So far this technique is still in development and has only been used in daylight but looks promising.

4- ADS-B aircraft safety system assembled at less than EUR/USD 100
This was a very interesting presentation of what one student of Toshimichi Otsubo did in the design and initial build of a low cost aircraft detection system. The system uses a Raspberry Pi card along with an ADS-B antenna and a FlightAware ADS-B USB receiver. Software for the system was written in Python which ties all of the hardware together and provides plots of aircraft in the sky. Initial testing was done that looked promising but it is very early in the development process of a laser safety system.

5- Web-based approach for system monitoring and remote SLR control
This presentation from the Wettzell team discussed monitoring as well as scheduling and control of a remote or automated station. Various open source software was used including Zabbix for ingesting and Grafana for plotting. Example plots of data trending at the station were shown along with Web based control.

6- SGSLR safety & security across global locations
This presentation gave SGSLR's approach to safety and security during design and development. The SGSLR hazard analysis was described, along with safety controls and example mitigation techniques. Human, system and aircraft safety were discussed for the first three locations for SGSLR (Goddard, McDonald and Ny-Ålesund). Physical and IT security for these three sites were also presented.

7- NASA SGSLR Power and Lightning Protection (poster)
A severe lightning strike in 2015 severely damaged a large number of the NGSLR subsystems. This was described to provide the motivation for an improved lightning protection design for SGSLR. The improved design was shown in this poster along with pictures of the first implementation of this lightning protection system at Goddard's SGSLR facility.