Laser Safety at NASA's New Laser Ranging Stations

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Laser Safety

https://archive.org/details/gov.ntis.ava13574vnb1

Standards and Guidelines

- AS-6029 - **Performance Criteria for Laser Control Measures Used for Aviation Safety**
- ANSI Z136.1 - **American National Standard for Safe Use of Lasers**
- IEC 60825-1:2014 - **Safety of laser products - Part 1: Equipment classification and requirements**
- **SAE ARP5293A - Safety Considerations for Lasers Projected in the Navigable Airspace**
- **FAA AC.70-1B – Advisory Circular on Outdoor Laser Operations**

… and more, depending on locale

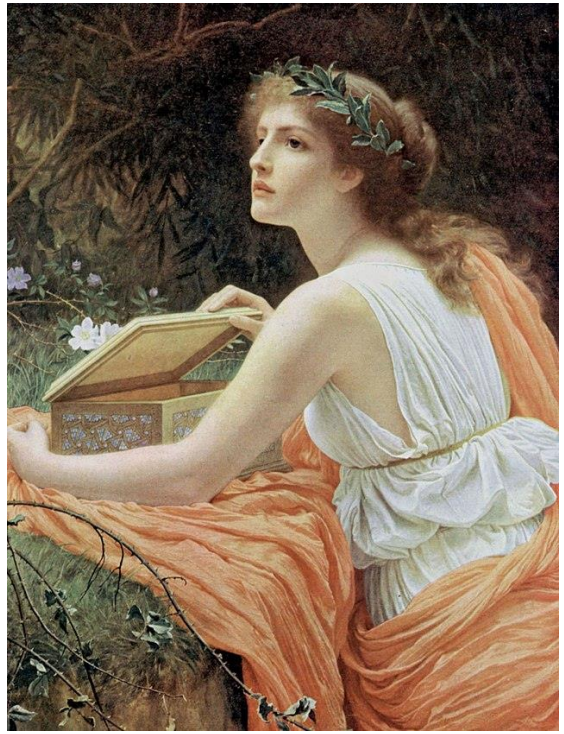
Requirements for SGSLR's Laser Safety

- Support local, remote, fully automated operations
- Protect people on the ground as well as aircraft
- FAIL-SAFE
- Completely Separated from the Operational Software

Completely Separated from Operational Software

Why?

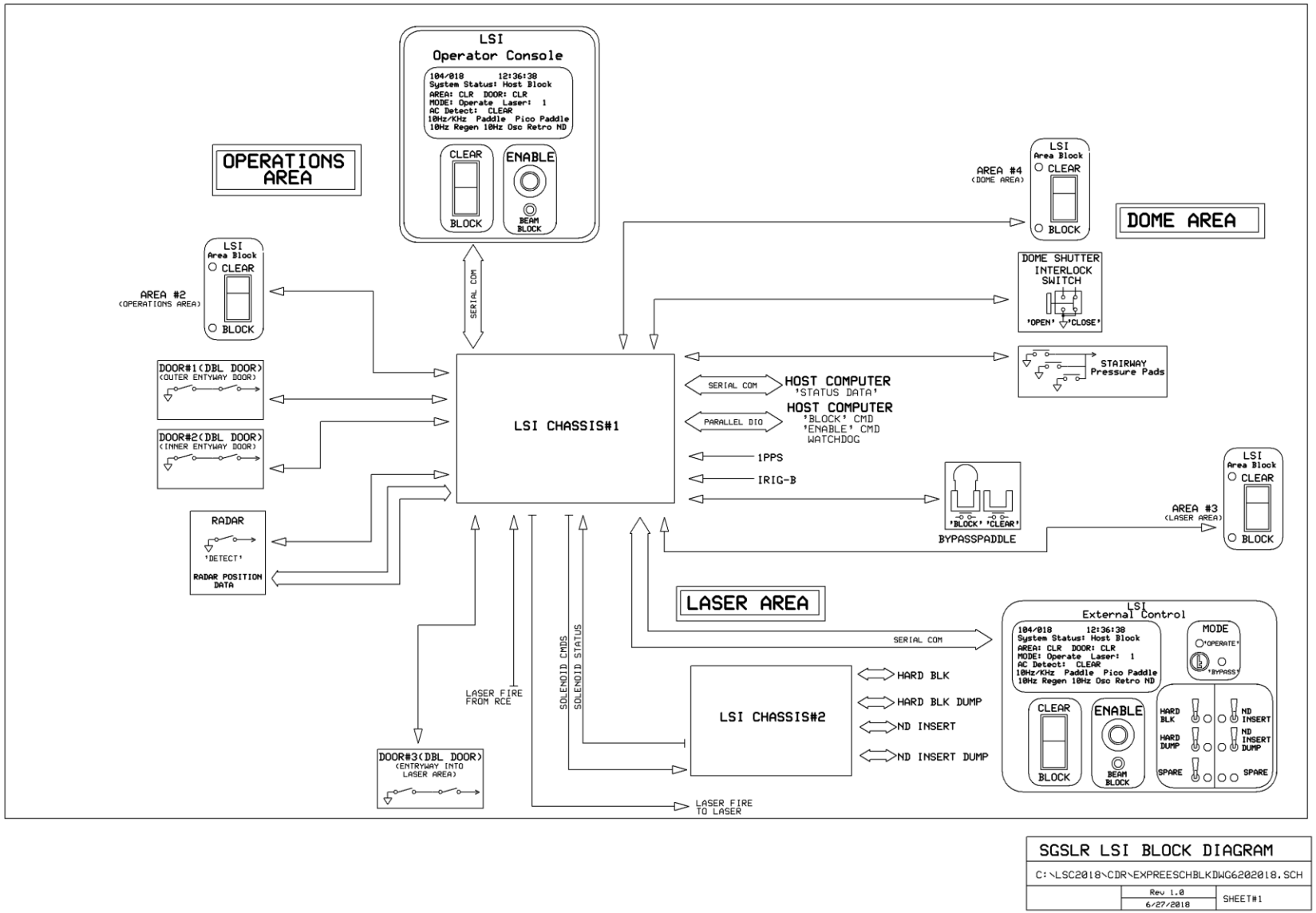
- NASA-GB-8719.13 Software Safety Handbook (available to the public)
- Safety-critical software includes hazardous software (which can directly contribute to, or controls hazard)
- A hazard is the presence of a potential risk situation that can result in or contribute to a mishap
- A mishap is an unplanned event or series of events that results in death, injury, occupational illness, or damage to or loss of equipment, property, or
  damage to the environment; an accident
- All software identified as safety-critical must undergo an increasingly rigorous and independent testing process dependent on classified criticality
- Safety critical software is expensive and time consuming, Pandora's Box



Software Strategy

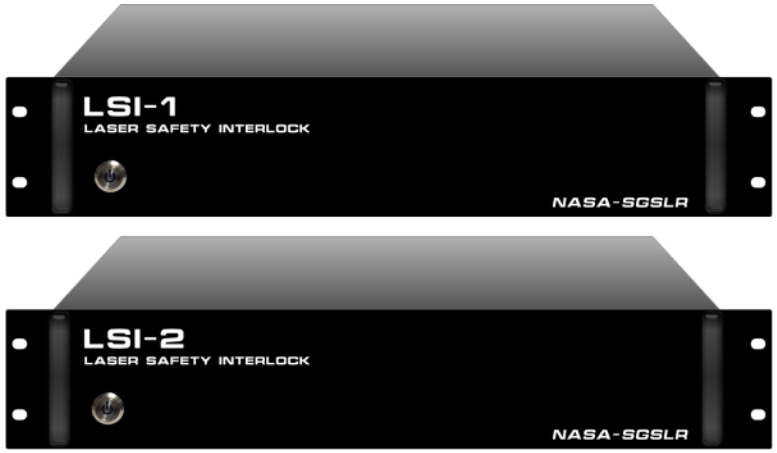
- **ELIMINATE** - Don't include any safety reliant features in the operational software, rely on hardware and simple firmware
  - Software can read statuses and 'enable' the removal of blocks, but cannot make other safety decisions
- **ISOLATE** – If any safety reliant code is deemed necessary, isolate it from the main software package as much as possible
- **SIMPLIFY**– Small programs, easy to read

Block Diagram



Developed by KBR
Preliminary Design

Equipment for the Ground



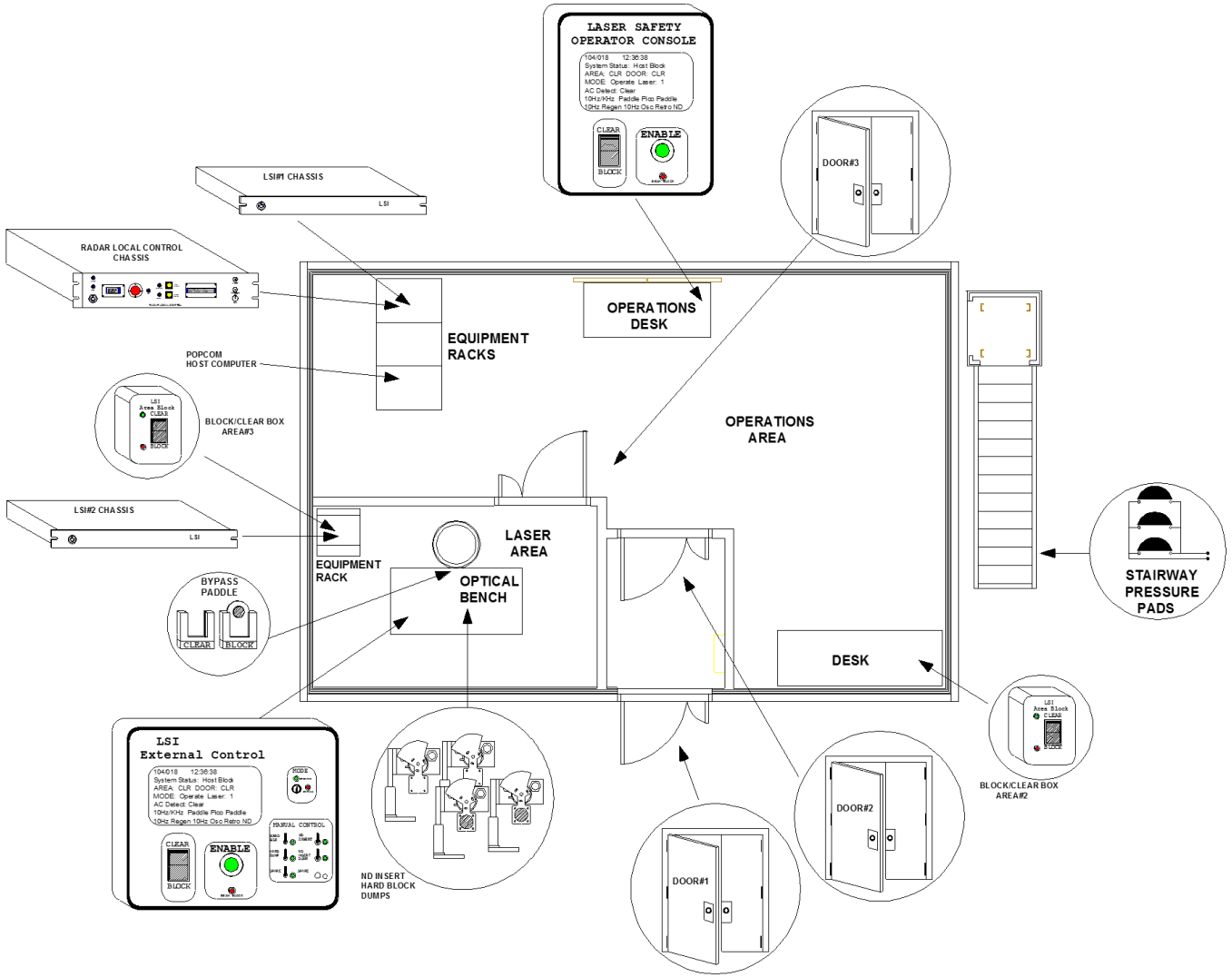
Entryway Interlocks

Fail-safe blocks/attenuators

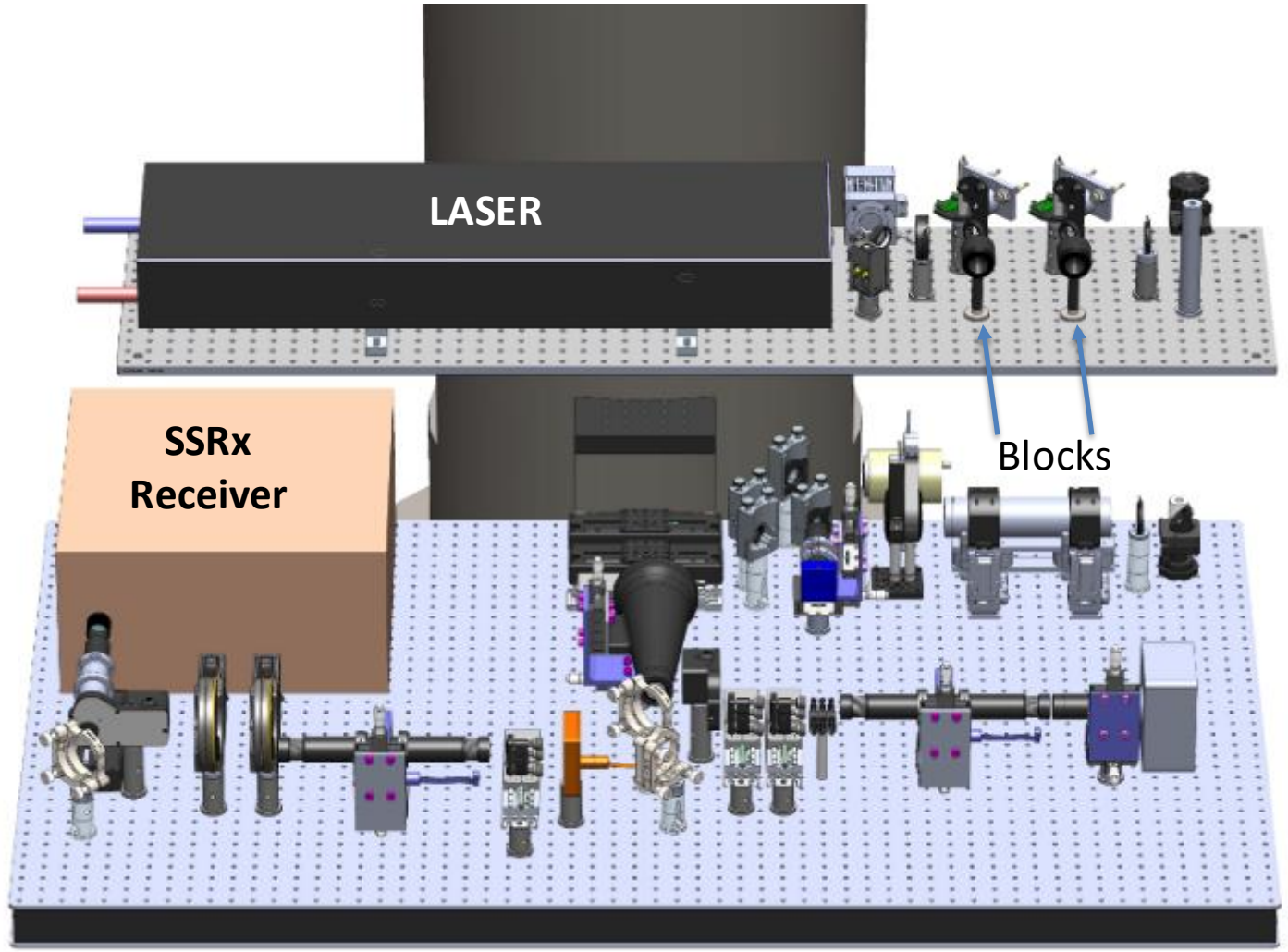
Pressure Pads

- Designed, built and tested by KBR/Wyle
- Uses heritage design with innovations
- Upgraded electronics and fail-safe connections for sensors

Sensor Placement in the SGSLR Shelter

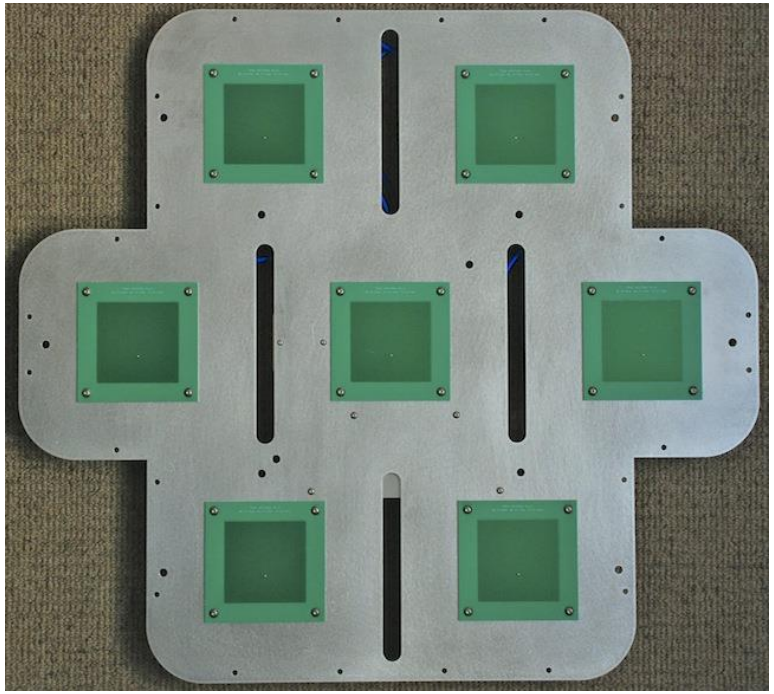


GTA, Optical Bench, and Dome



Aircraft Detection Methods

Active Radar



TBAD
Transponder

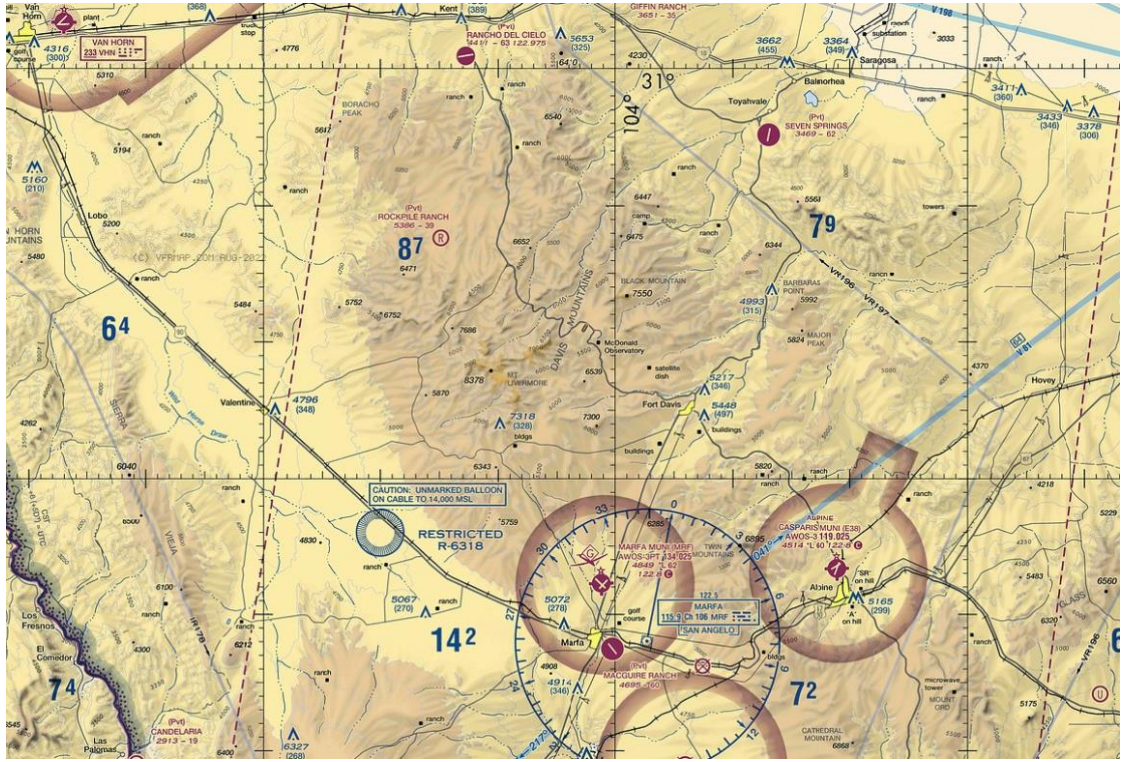
ADS-B Receiver

Mount Observers

Site Placement Matters

Airspace comparison between two core sites:

GGAO



MGO

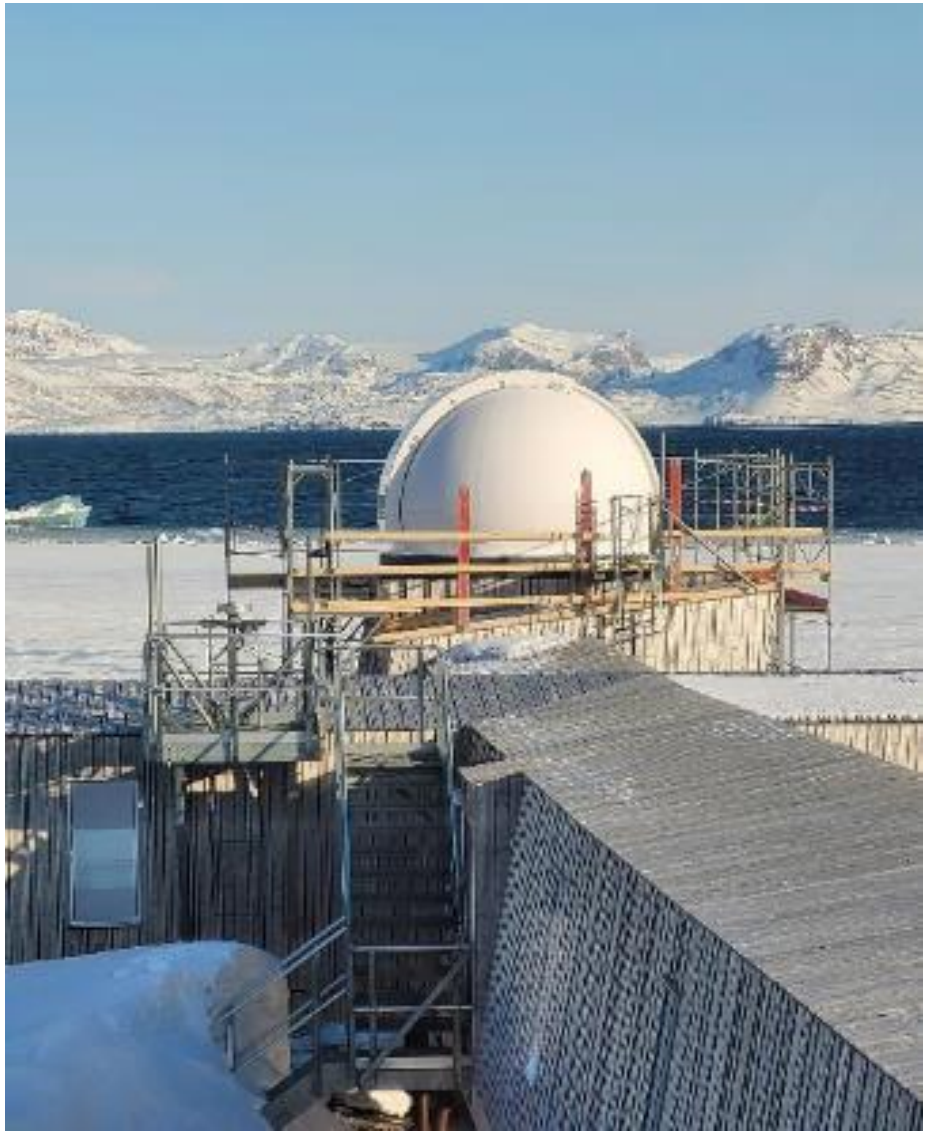
Aircraft Detection Methods

Method	Why use?	Sites
Active Radar*	Detects non-cooperative targets, Approved by FAA in high air traffic areas	MOBLAS 4,5,6,7,8, GGAO, MGO
TBAD Transponder	Directional, No Angle computation required, Computationally Simple	APLLRS
ADS-B Receiver	Economical and Ubiquitous	Ny-Ålesund
Mount Observers	Can be used anywhere	TLRS 3,4

*When collocated with VLBI, masking and coordination need to take place. The main lobe of an active radar can damage the receiver, while even side lobes can saturate the signal

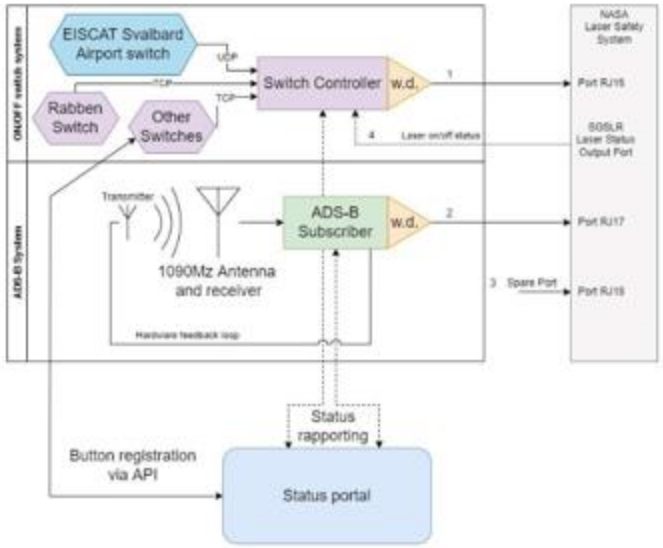
Ny-Ålesund

- Aircraft avoidance system (AAS) for the Laser Safety Subsystem in Ny-Ålesund is being developed by the Norwegian Mapping Authority
- Will be the first operational station in the NASA Network to utilize ADS-B (radio silence required by law, so no radar)
- Unique shelter and sensor placement considerations



Ny-Ålesund

- Interface Control Document describes coupling of NASA/KBR Laser Safety Electronics with NMA developed AAS
- AAS modularly connects to standard SGSLR electronics with minimal modification
- AAS handles locale specific requirements, such as airport communication



For more information on the AAS, please see the poster
Laser Safety in Ny-Aalesund: Aircraft Avoidance System (AAS)

See below

Thank you!