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Skyguide and Flarm
2 in-sky-laser-safety systems used at Zimmerwald

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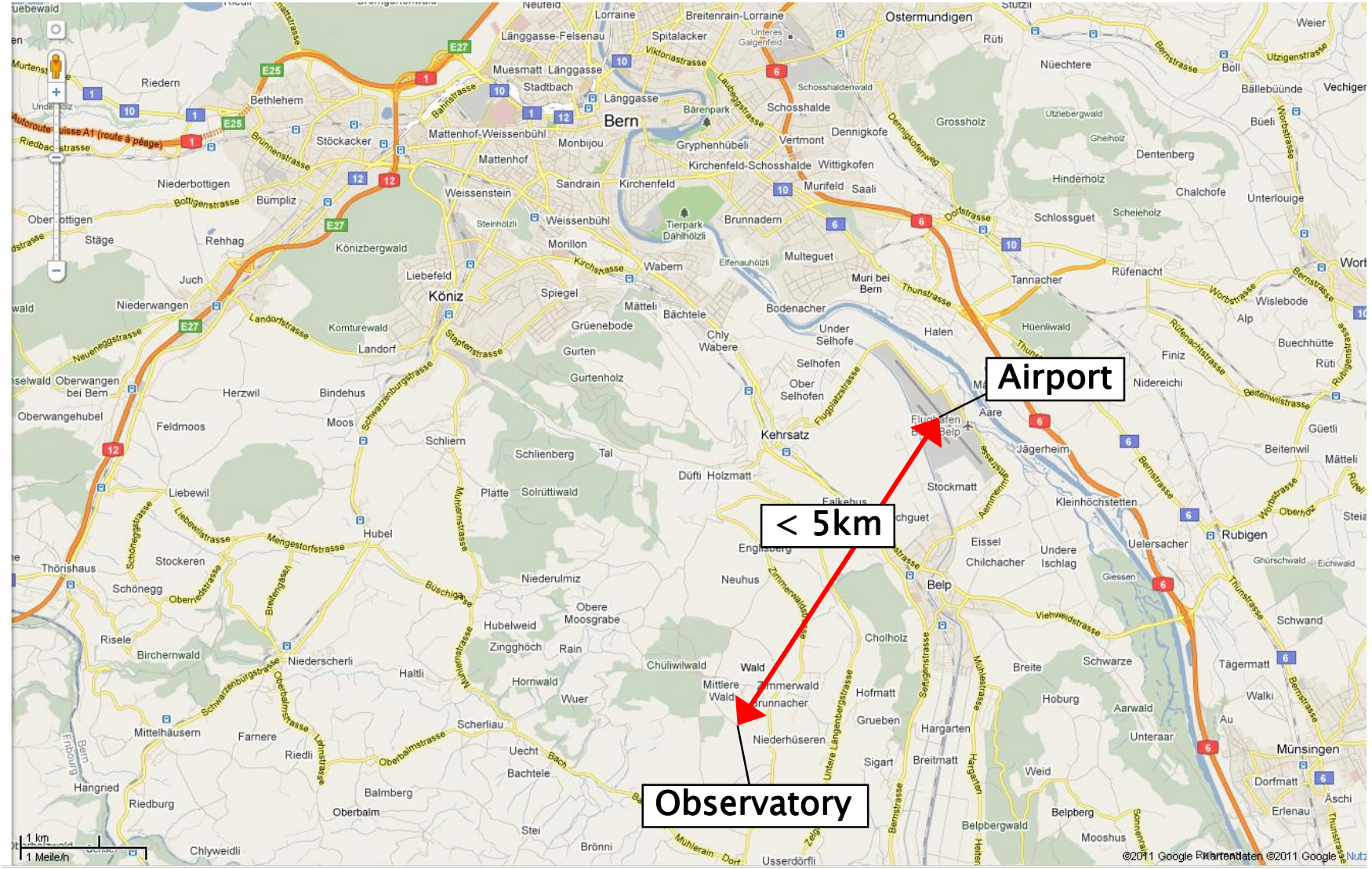
Observatory Zimmerwald



In-Sky Laser safety systems

- SLR station Zimmerwald is located about 5km south-west of the airport Bern/Belp
- Aeroplanes are flying sometimes in very low altitude over the station.
- The airport is frequently used for the start of gliders and helicopters of the REGA (air-rescue organisation)
- SLR measurements are performed in case of good weather conditions 24 hours per day
- Most of the time the system is running in an automatic mode without any interaction of an operator
- During the flyover the SLR measurements have to be automatically suspended due to safety reasons
- Two systems are used: SKYGUIDE and FLARM

Skyguide

- Skyguide is commissioned by the Swiss government to manage and monitor all air traffic in the country's airspace
- Since 2001, skyguide's mandate has covered both civil and military air traffic
- The radar data (time, position relative to Zürich Airport, velocity and aircraft identification code for all aircrafts) is provided through a VPN connection to a Skyguide server in a continuous data stream.
- A software module provided by Skyguide receives and decodes the binary data, extracts and reformats the track data needed by the SLR system and makes it available as ASCII records.
- Especially gliders or other light aircrafts are often not recorded
- A second in-sky laser safety system is essential for the safety of the above mentioned aircraft types ⇒ FLARM

FLARM

- FLARM® is a low-cost collision-warning unit for gliders and light aircrafts.
- More than 12'000 own devices manufactured by FLARM® plus over 5'000 devices manufactured by licensed 3rd parties are in use in many countries and continents.
- FLARM is the only prevalent alternative to the commercial airliners' expensive ACAS/TCAS system
- 16-channel high-precision uBlox GPS module
- serial data output (RS232)
- operates in a license-free radio band, typically 4-8km radio range
- Compatible systems, which use the same hardware architecture and licensed core software are available from the following companies:
  - LXNAV, LX Navigation, Tiadis, Ediatec, Swift Avionics, Artronic

Roof of the Station Zimmerwald

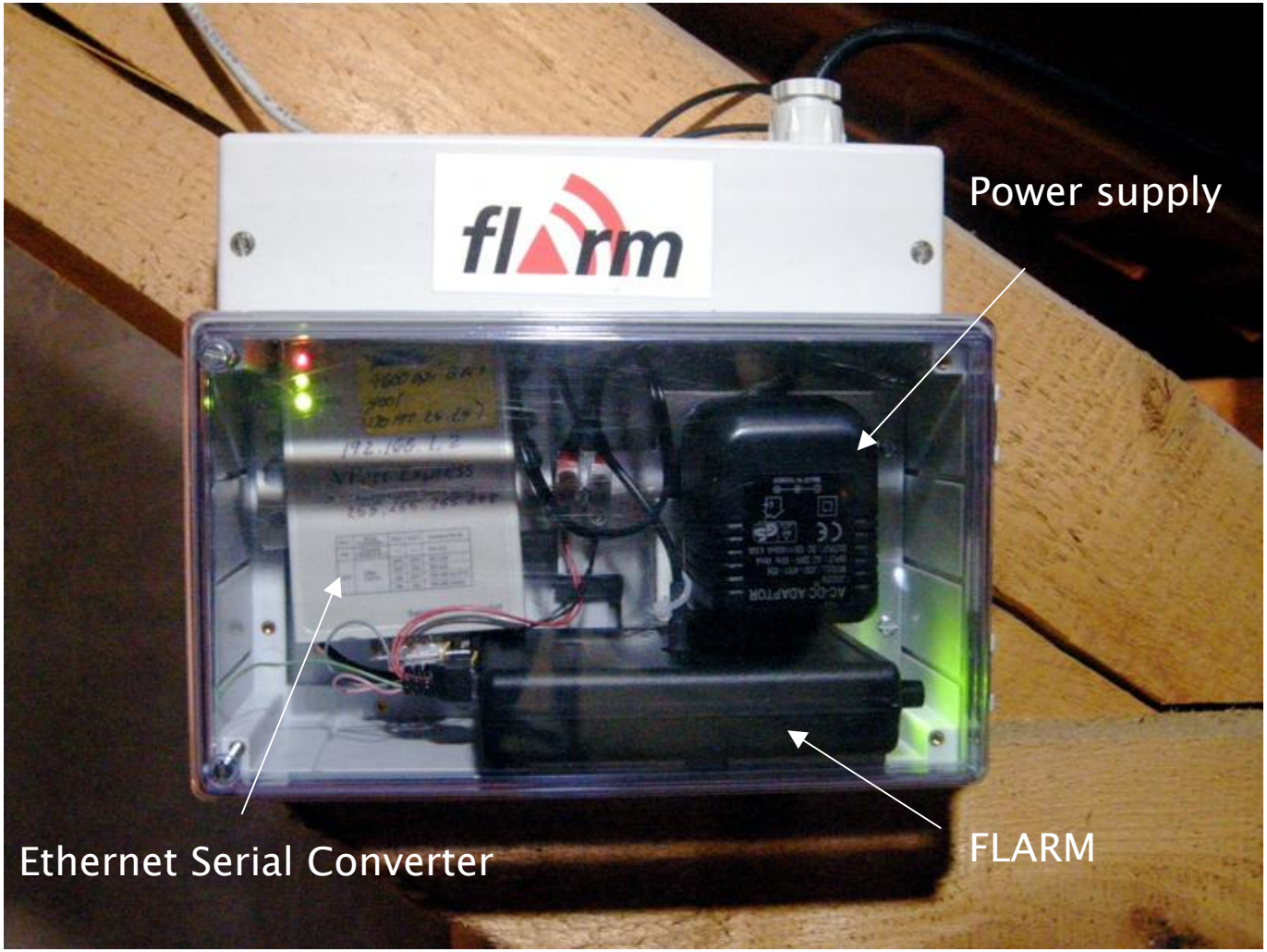
How it works

- FLARM receives position and velocity information from an internal 16 channel GPS receiver with an external antenna.
- A pressure sensor further enhances the accuracy of position measurements.
- The predicted flight path is calculated by FLARM and the information – including a unique identifier – transmitted by radio signals at one-second intervals.
- Provided they are within receiving range, the signals are almost at the same time received by further aircrafts also equipped with FLARM.
- The incoming signal is compared with the flight path predicted by calculation for the second aircraft.
- If FLARM determines the risk of dangerous proximity to one or more aircrafts or obstacles, the unit gives the pilot warning of the greatest danger at that moment.

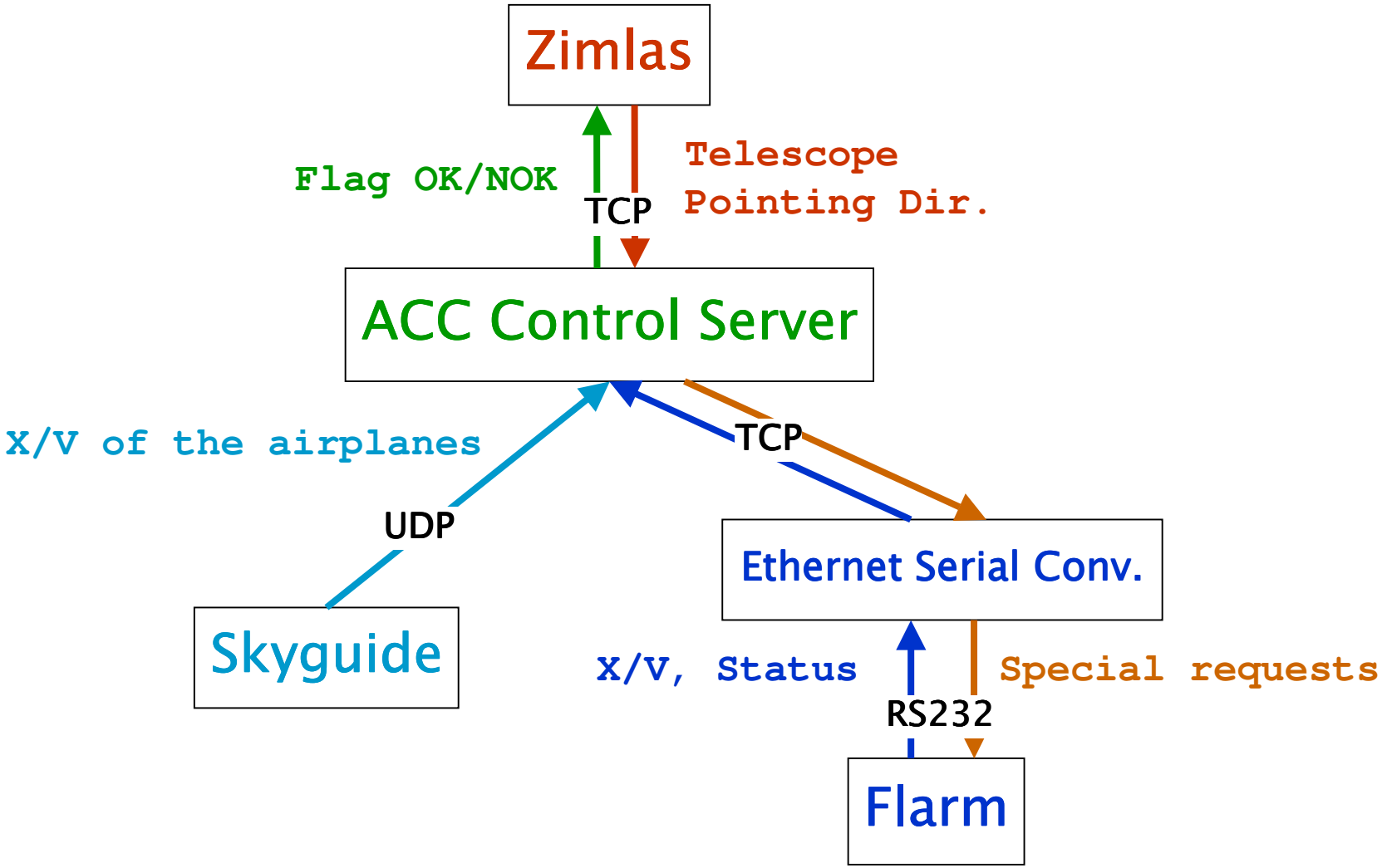
How it works

- The GPS and collision information received from other aircrafts can be made available for third party equipment via a serial data output.
- The following data streams will be sent continously without any request:
  - Operation Status (Power, GPS and Transmission Status)
  - Alarm Level
  - Position relative to Zimmerwald
  - Velocity (ground speed, rate of climb, rate of turn)
  - Aircraft Type
  - Aircraft Identification Code
  - Barometric pressure of Zimmerwald
- The operating range is very dependent upon the antenna installation in the aircraft. The typical range is 3 -5km

Image of FLARM



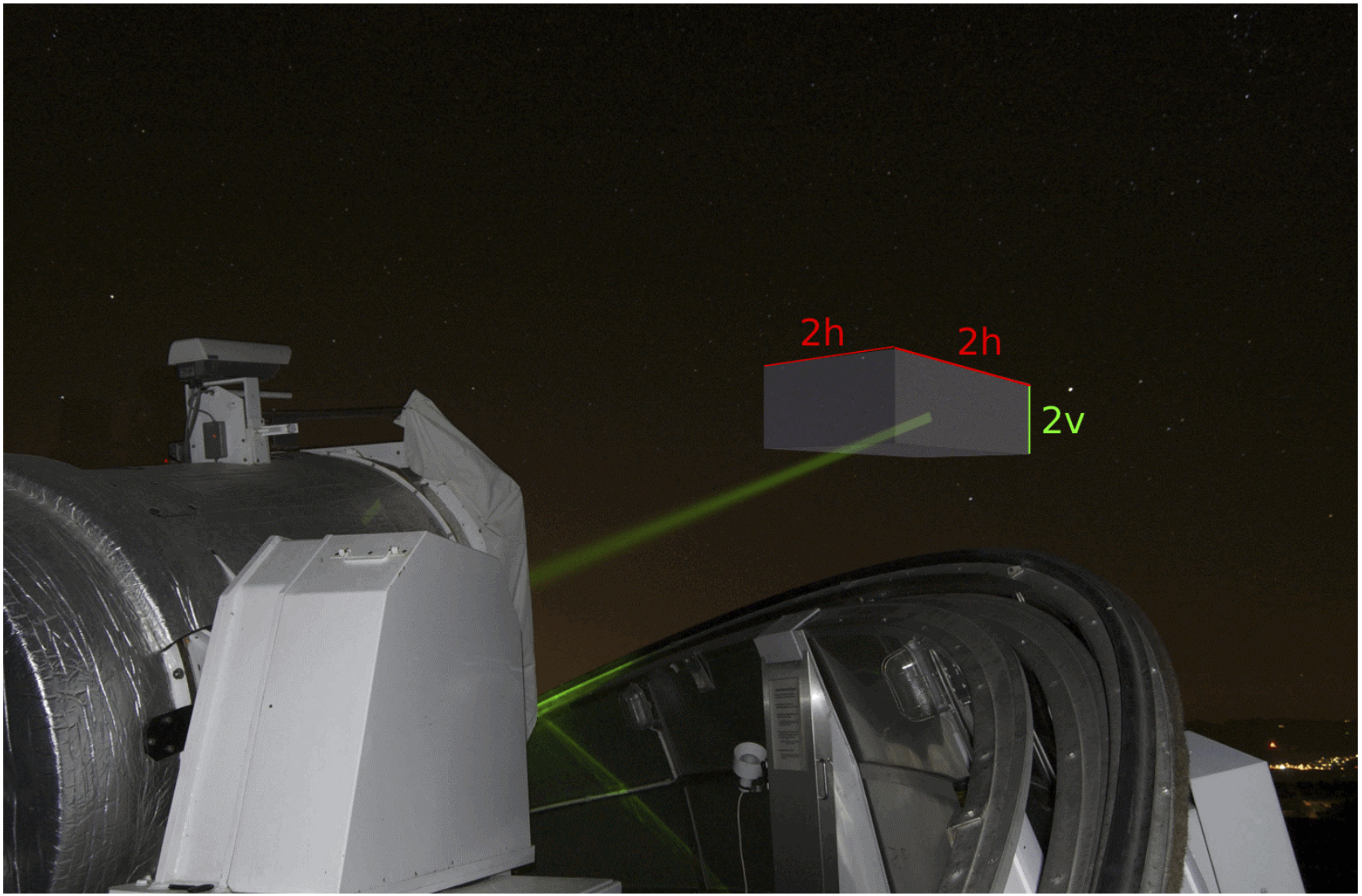
Implementation



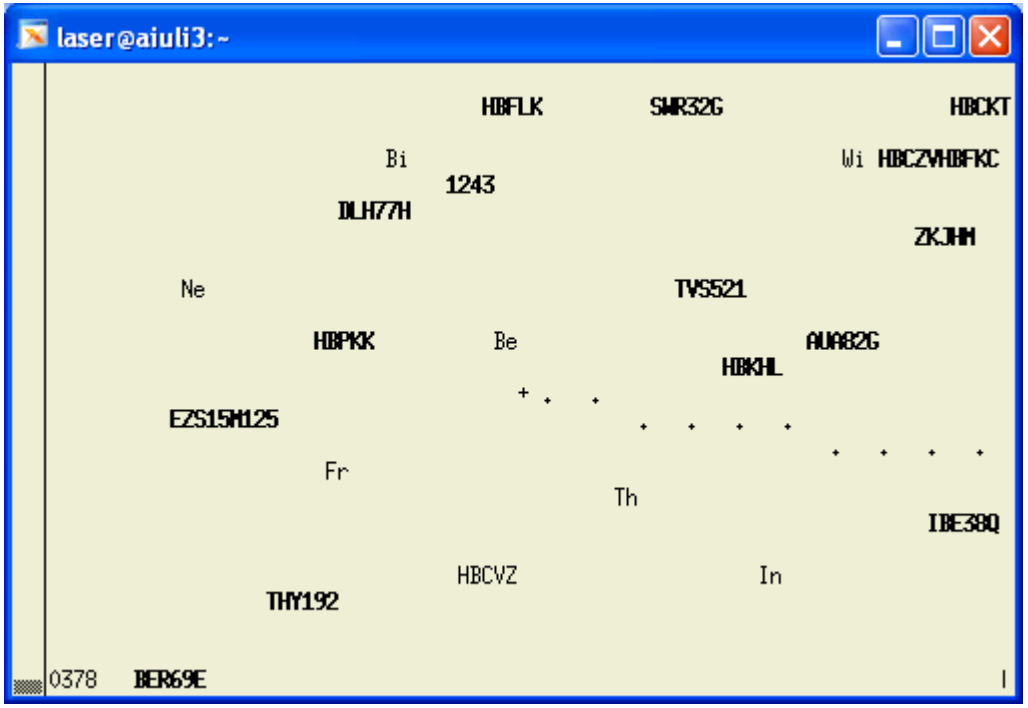
Aircraft Control Server

- The ACC server receives the data from Skyguide via an UDP connection and the data from FLARM via a TCP connection.
- The server builds/maintains a table of all aircraft positions.
- A client can send the pointing direction of the telescope to the ACC server.
- The server checks the pointing vector against all aircraft positions for a given instant of time. Aircraft positions will be extrapolated if necessary and an OK or not-OK message and the number of the checked aircrafts will be replied.
- The minimum allowed horizontal and vertical distance can be adjusted independently for Skyguide and FLARM data (depending on update rate):
  - Skyguide:1000/400m minimum h/v distance
  - FLARM: 500/200m minimum h/v distance

Aircraft Box



Operator Screen



Thank you very much for your attention!