

MIE LIDAR PROPOSED FOR THE GERMAN SPACE SHUTTLE MISSION D2

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For more than 15 years now, proposals for spaceborne lidars have been discussed by many research groups. Technical feasibility studies for different lidar designs were performed in the US as well as in Europe, and scientific working groups from NASA and ESA were and still are elaborating new applications of lidar technique, weighing the benefit against competitive methods and in combination with passive sensors.

There are firm plans for a second German spacelab mission (D2- mission) originally scheduled for late 1988 which will be basically a zero-g mission, but will also include earth observation experiments. Encouraged by our experience with airborne lidar systems and the results from theoretical studies, we have proposed a backscatter lidar for this mission.

Since the lidar is only a "parasitic" instrument on the D2- mission, and since the available time to construct the experiment is extremely short, we are deriving the following guidelines:

- Use presently available techniques
- Use available space proofed pressurized containers for housing the various critical subcomponents (e.g. laser, power supplies) to minimize qualification testing
- Demonstrate the expected benefit of active technique in combination with passive sensors
- Validate lidar data by independent measurements

With these limitations, we are aiming at the following experiment parameters:

- Nd-YAG Laser, 10 Hz (700 m horizontal resolution)
400 mJ at 1064 nm, 120 mJ at 532 nm
- Cassegrainian Telescope, 50 cm diam., FOV 0.2... 1 mrad
- Receiver: APD (1.06 μm), PMT (0.53 μm)
- 12 bit digitization at 3 MHz (50 m vertical resolution)
Photon counting for nighttime measurements
- optional experiment equipment is a 10 μm radiometer

The laser with power supply and alignment control mechanism will be mounted in a Getaway-Special (GAS) container to avoid time-consuming qualification procedures. The receiving telescope with signal and alignment detectors will either be mounted in a second GAS container with lid or externally. The structures are fixed onto the Unique Support Structure (USS) of the spacelab facility and utilize the standard interface to spacelab. The lidar can be reflown on later shuttle missions without major modifications.

The D2-lidar facility will allow us to perform a number of different measurements with the goal to obtain performance data for the design of future operational spaceborne lidar instruments:

- Cloud top heights

Accurate knowledge of cloud top height together with data from passive sounders promises to increase the accuracy of the height assignment from wind-, temperature- and humidity measurements. Data from spaceborne lidar are required to answer the questions about the required horizontal resolution for useful average values, optimum vertical resolution, the influence of the spot size on the measurement accuracy, etc.

- Height of planetary boundary layer

The height of the PBL is not only an important climate parameter, but also the major parameter for pollutant transport. The data from the D2-lidar will allow us to assess the feasibility to extract the PBL-height from the backscatter data.

- Optical thickness and cloud base height of thin and medium thick clouds

The source of incorrect temperature soundings at cloud top levels is often the unknown emissivity of clouds which is coupled to their optical depth. In addition even subvisible thin cirrus clouds which are not detectable by present passive methods are masking any measurements of passive optical sensors. By the D2-lidar these thin clouds can easily be detected and the lidar derived optical quantities could help for corrections.

- Ice-/water phase discrimination for clouds

This information can be yielded by cross polarization measurements and is of importance for heat budget studies and weather forecast.

- Tropopause height

Lidar measurements performed in the past show in many cases a distinct change in the lidar return at tropopause level due to the blocking effect of this temperature inversion. Spaceborne lidar data are needed to verify this measurement capability of lidar.

- Tropospheric aerosols

Lidar profiles can help to determine the extent of distributed aerosol layers, their transport and the change of optical properties of the atmosphere by changing aerosol loads.

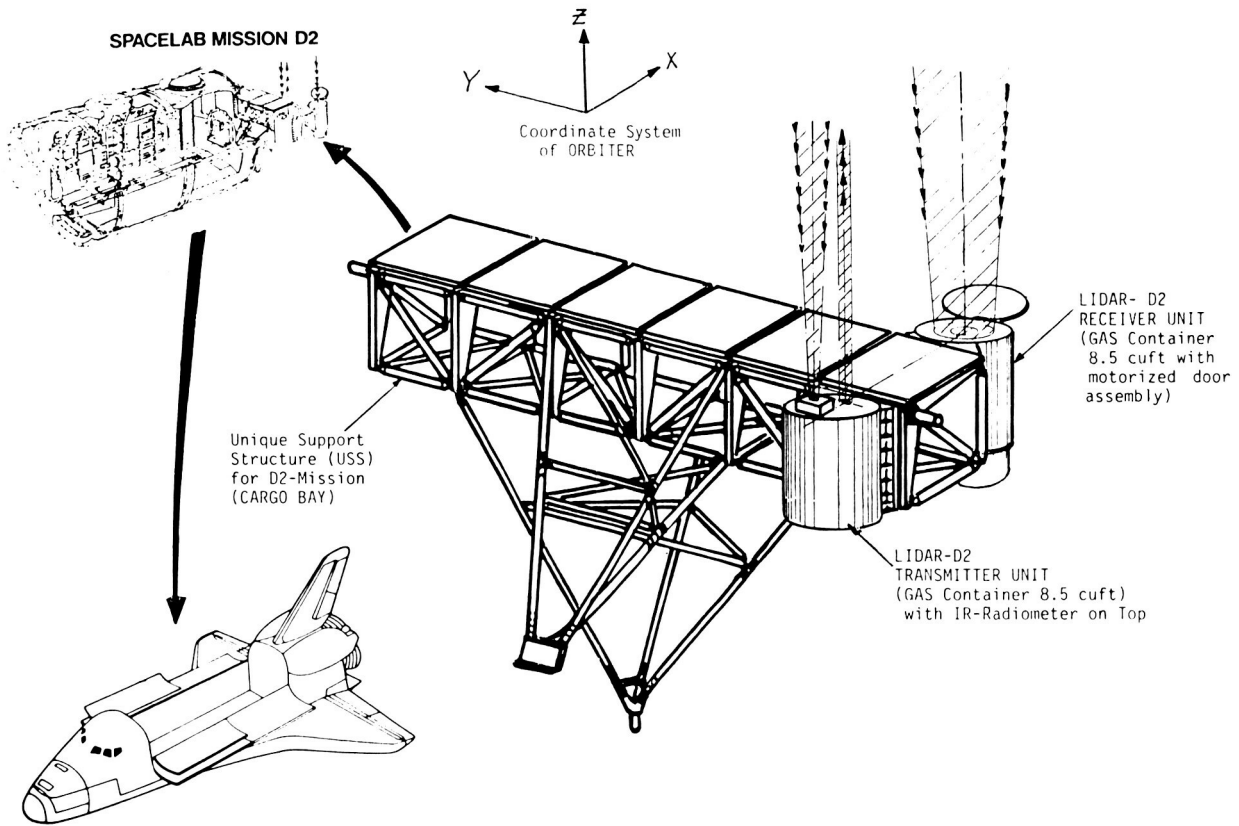
- Stratospheric aerosols

Stratospheric aerosol model assumptions are by now well established to derive aerosol mass loading from lidar data and to calculate effects on the stratosphere (climate, optics).

To validate data gathered by the D2 lidar, a limited ground truth campaign at areas with good probability for adequate weather conditions (like in North Africa) is planned.

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Experiment Proposal for D2 Facilities
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EXAMPLE FOR LIDAR-D2 ACCOMMODATION ON THE UNIQUE SUPPORT STRUCTURE