

SATELLITE LASER RANGING (SLR) DEVELOPMENT FOR ANTARCTICA

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Abstract

The Antarctic is the only major continent from which SLR has not been obtained. It is a site of great geodynamic interest, and an almost optimum site for a wide range of geodetic and orbit support operations. There are strong moves in Australia to deploy SLR to Antarctica, provided the considerable technical obstacles can be overcome. The technical challenges and program status are described, including a conclusion that Antarctic SLR is possible, and a successful deployment is likely within 2-3 years.

1. RATIONALE

The Antarctic continent is of great interest for tectonic and geodynamic studies. Fundamental measurements made in an earth-centred reference frame with millimetre accuracy would make an immense contribution to global tectonics.

As a site for orbit support, Antarctica is arguably unmatched. Although some satellites in low orbit may not be visible at all from most Antarctic sites, many higher satellites are visible on almost every pass. A high output SLR site would be invaluable for higher satellite missions.

Local geodesy has been very active in Antarctica, and SLR sites would be of great value in support of programs investigating post-glacial rebound, intra-plate stability, and ice thickness.

The large interest in Antarctic astronomy is also supporting SLR technology development, as many of the problems associated with optical instrumentation are common to both astronomy and SLR.

2. SCHEDULE

The Antarctic SLR deployment is presently unfunded, and the design effort has been pursued by EOS since 1996 under internal research programs for infrared astronomy and orbit support from Antarctica.

Provided the technical obstacles can be overcome, funding could be available for SLR deployment against the following schedule:

- July 1996 R&D commencement
- July 1999 Budget commitment
- July 2000 System complete, colocation at Mount Stromlo
- December 2000 Transfer to Antarctica
- 26 January 2001 Operational

3. DEVELOPMENT ISSUES

The Antarctic environment has much in common with space, in terms of demands placed on SLR equipment, but Antarctica adds extra requirements:

- **Temperature.** Extremes of temperature must be tolerated in *operation*.
- **Size.** Shipping space required to ship the system is absolutely minimal.
- **Power consumption.** Electrical power in Antarctica is locally generated under strict environmental conditions, and use must be minimised.
- **Wind.** The rock surface, needed for SLR is away from the pole, and therefore subject to strong winds.
- **Snow drift.** Access to the system, and its operation, must be continued under up to 2m of snow, plus drifts.
- **Anti-fogging.** The air humidity is usually low, due to low temperatures, but fogging will be a permanent problem due to the presence of heat near the equipment.
- **Power fail recovery.** The system must recover reliably from frequent power failures to prevent icing up.
- **Automation.** Manpower is not available.
- **Lifetime of key components.** Mean time between failure (MTBF) of key components must be sufficient to meet the long and seasonal service intervals.

It is not intended to give a full exposure of all the design requirements here, but by way of example of the types of issues addressed in the design, the following low temperature issues are being addressed.

- Bearings and motors
- Lubricants and seals
- Cables
- Calibration
- Laser alignment
- Laser cooling

4. DESIGN STATUS

The current design can be seen in Figures 1-3. Key features of the design are;

- All SLR equipment is contained in a single 7m column. The laser and electronics are contained in the telescope „pier“.
- The enclosure is based on proven „typhoon“ dome technology, with increased insulation. The material is fibreglass composite.

- The structure is asymmetric to allow orientation with wind direction (reasonably uniform) so that snowdrift is controlled.
- There is special access at 2m, to allow for snow and ice build-up in winter.
- The system can withstand long periods at $-30\text{ }^{\circ}\text{C}$.
- The compact 75cm telescope provides a substantial capability to all high satellites.
- The laser uses cooling system designs from military lasers built to NATO winter specifications, and will not be damaged at $-50\text{ }^{\circ}\text{C}$.
- The laser is able to generate stable output when good ambient temperature stability cannot be maintained.
- Volume is minimised to meet shipping requirements, and also to minimise power consumption to control temperature within.
- The enclosure doubles as the shipping container, minimising handling.
- A support trailer can be butted to the SLR system but is not essential.

5. CONCLUSIONS

The Antarctic SLR development and design could be completed for deployment by 2001.

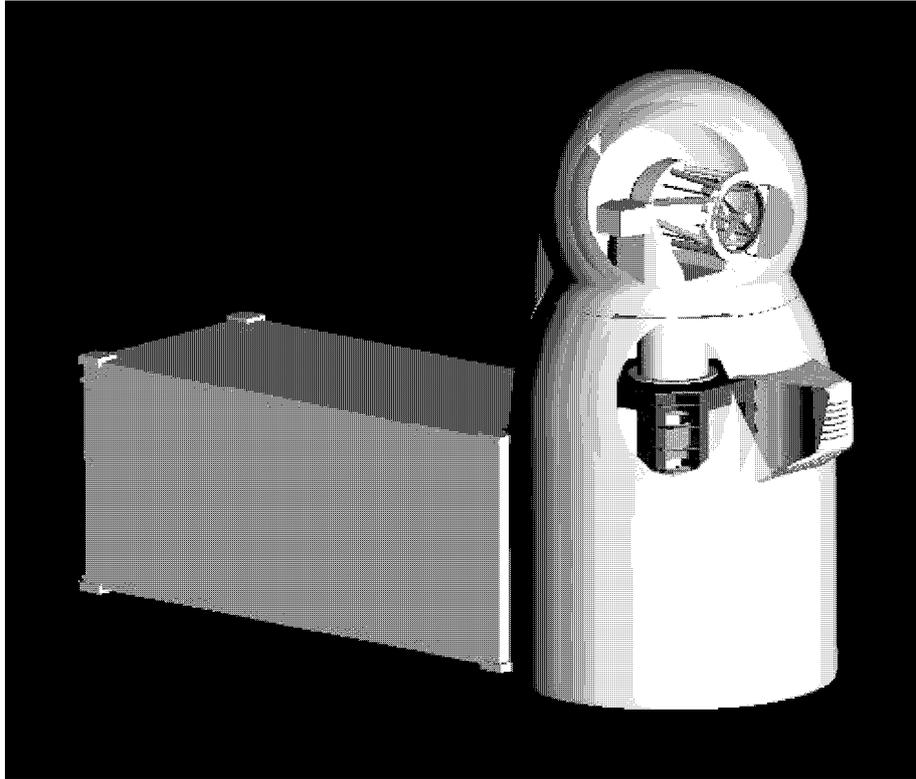


Figure 1: Antarctic SLR System and Support Trailer

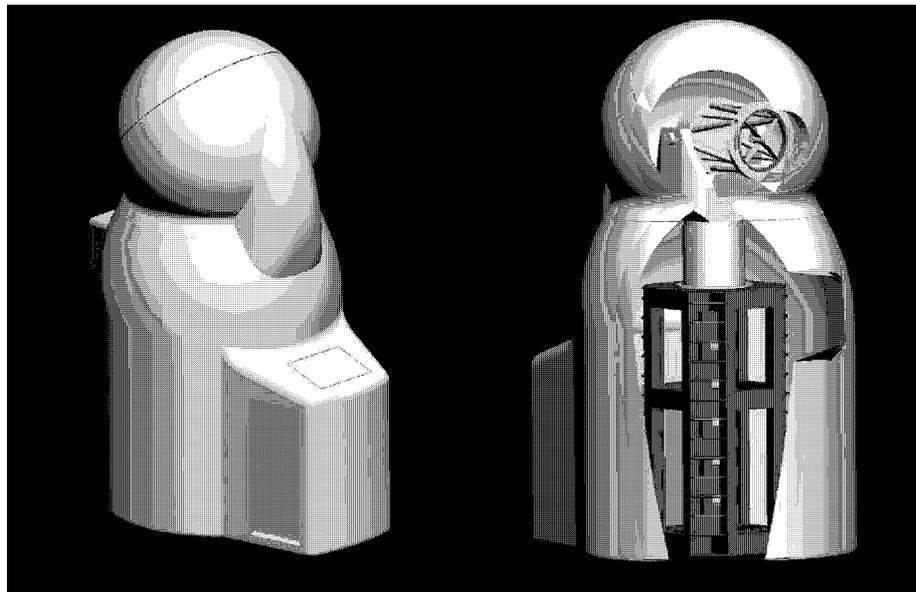


Figure 2: Fully Self-Contained Antarctic SLR System

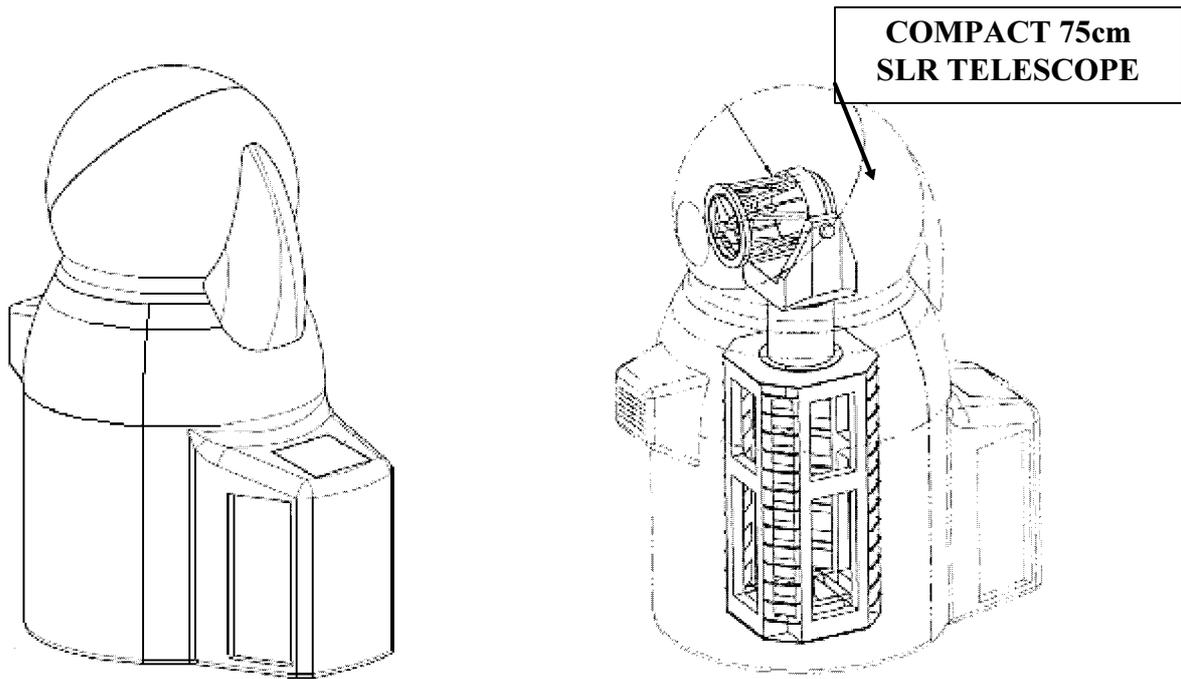


Figure 3(a): Design Details, Antarctic SLR System

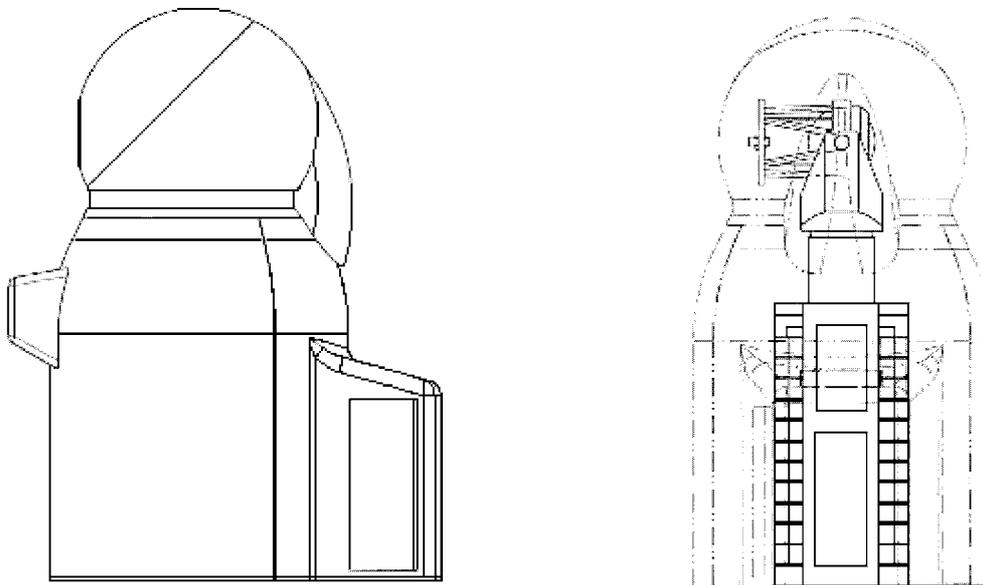


Figure 3(b): Design Details, Antarctic SLR System