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OVERVIEW OF LIDAR ACTIVITIES AT NASDA

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SPACE-BORNE LIDAR

Although NASDA has been engaged in remote sensing activities since mid 1970's, it was only in late 80's that lidar was identified as one of the possible spaceborne instruments Japan might develop in the future. In 1989, NASA's LAWS (Laser Atmospheric Wind Sounder) instrument was proposed as an instrument to be flown on board JPOP (Japanese Polar Orbiting Platform). This drew much attention from Japanese lidar researchers, who, until then, had been concentrated in ground-based or airborne lidar instruments. NASDA had asked the Japanese geophysicists and remote sensing scientists to form a committee to work out a scenario of earth observation for the next decade. As the lidar researchers were not in the committee members list at the time, they were hastily included in the relevant working groups in the Earth Environment Observation Committee.

JPOP, which originally conceived as a long-life platform to be maintained by in-orbit servicing, was found to be too ambitious as the next-step project, and gave its way to the more practical ADEOS-II. LAWS was also withdrawn in due course, but a lidar instrument remained to be a candidate sensor for ADEOS-II until the middle of 1991.

Based on the scenario worked out by the forgoing committee in early 1990, instrument development activity was initiated at the Specific Equipment Laboratory (SEL), Tsukuba Space Center, in the same year. Purpose of the work for that year was;

1) to identify the mission parameters of the LIDAR to be flown on board ADEOS-II
2) availability and trends of the relevant technologies.

ADEOS, which is the predecessor of ADEOS-II, is scheduled to be launched by H-II from Tanegashima Space Center in 1996. Its total weight is 3,500kg and its solar paddle generates 4,500W of power. In the 1990 study, no specific constraints on weight and power figures were assumed, but the orbit was assumed to be the same as that of ADEOS; sun-synchronous with 800km altitude.

Four categories of lidar were studied; altimeter, atmospheric lidar (to measure Mie scattering of aerosol), differential absorption lidar (DIAL) and coherent lidar.

To meet the reliability requirements inherent to space application, diode pumped solid state laser was found to be the most preferable laser source. Preliminary mission parameters such as laser power and pulse repetition frequency were identified. In the case of atmospheric lidar, required transmitting power per pulse was 1-2 J/pulse with PRF of 10Hz. Required diameter of the receiving mirror was about 1m.

Based upon the study, it was learned that atmospheric lidar was likely to be best suited for the first generation space mission, at least for Japan. The other options seemed to pose more technical difficulties, which were suitable to be experimented further on the ground.

In the next year, attempts to make the atmospheric lidar, by now called E-LIDAR (Experimental Lidar), as a core sensor of ADEOS-II was made by a small group of people at NASDA. In the middle of the year, it was forced to drop out of ADEOS-II mission in favor of another optical sensor and this arouse despair among the scientists, who whereupon made a formal protest to the STA, NASDA's parent agency. Nevertheless, study on the lidar was continued in that year. Design study of the atmospheric lidar for ADEOS-II with allowed weight of 350kg and power of 1,200W was conducted. Design study of DIAL for ADEOS-II was also conducted, but showed that it becomes

too heavy and consumes too much power.

Due to the decision not to be flown on ADEOS-II, other options such as mission for the small satellite and aircraft were considered and added to the year's work. In that year, budget for the development of a new all-solid fueled small launch vehicle, called J-I, was approved and it was encouraged to utilize it by developing small satellites. It was the fashion at that time and is even now to say that small satellites can do things much quicker than the larger ones as they are inexpensive to build and launch.

AIRBORNE LIDAR

In 1992, works on the airborne lidar systems were initiated at SEL. Two systems are now being constructed in parallel. These systems are for experimental manufacturing of space hardware as well as for lidar observations from the aircraft. There is a managerial difficulty in this dual purpose scheme that arises from the fact that space hardware never needs to be flown in an aircraft before they are qualified.

One system uses Nd:YAG while the other uses ND:YLF as the laser rods. Both are pumped by laser diode arrays to produce 100mJ/pulse power. The power will be attenuated to the eye-safety standard level.

Because of the budgetary constraints, the systems are being built progressively over the years, and at the time of this report, laser transmitters and receiving telescopes have been built and tested for each of the two systems. Based upon the present funding level, these systems will be ready to be flown in 1996. The aircraft will be Beech craft B-200.

SUMMARY

NASDA's establishment law specifies that NASDA shall conduct its activities in accordance with the Prime-Ministerial Basic Plan for Space Development. Not all the activities laid out in the basic plan are going to be done at NASDA. This is especially true with earth observation sensors. For example, ILAS (Improved Limb Atmospheric Spectrometer) for ADEOS is being developed at NIES, and IMG (Interferometric Monitor for Greenhouse Gases) for ADEOS, and ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer) for NASA's EOS-AM are being developed at MITI.

The lidar activities discussed so far is only preliminary to these framework of national planning and agency-to-agency division of responsibility. There are a lot to be done yet before a lidar space-flight project be included in the Prime-Ministerial plan. What SEL shall do in these efforts are pre-project technical feasibility studies on such much-talked-about matters as reliability of hardware and eye-safeness. It is hoped that the development of the airborne lidar systems contributes much in resolving these problems.

Lastly, it should be mentioned that a number of scientists from national research institutes and universities are working with SEL in advisory basis, and their continued support will much appreciated in keeping the activities on the right track.