The Large Millimeter and Submillimeter Array — An Observatory at 5000 m

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The Large Millimeter and Submillimeter Array (LMSA) project [1] of the Japanese astronomical community will lead the way to sensitive and high-resolution submillimeter-wave observations of the universe. It will consist of fifty high-precision 10 m antennas located at a high-altitude ($\simeq$ 5000 m) dry site, probably in northern Chile (Fig. 1). The LMSA is expected to achieve a spatial resolution up to 0.01″ (1/360000 degrees) and a sensitivity equivalent to a 71 m single-aperture antenna in a wavelength range from 4 to 0.35 mm, allowing deep penetration into visibly opaque regions of the universe. With these features, the LMSA will be a very powerful tool to explore a great variety of important issues in natural science, such as the formation of the universe, galaxies and the solar system, and the origin of life. For more information, visit our www site at http://www.nro.nao.ac.jp/~lmsa/.

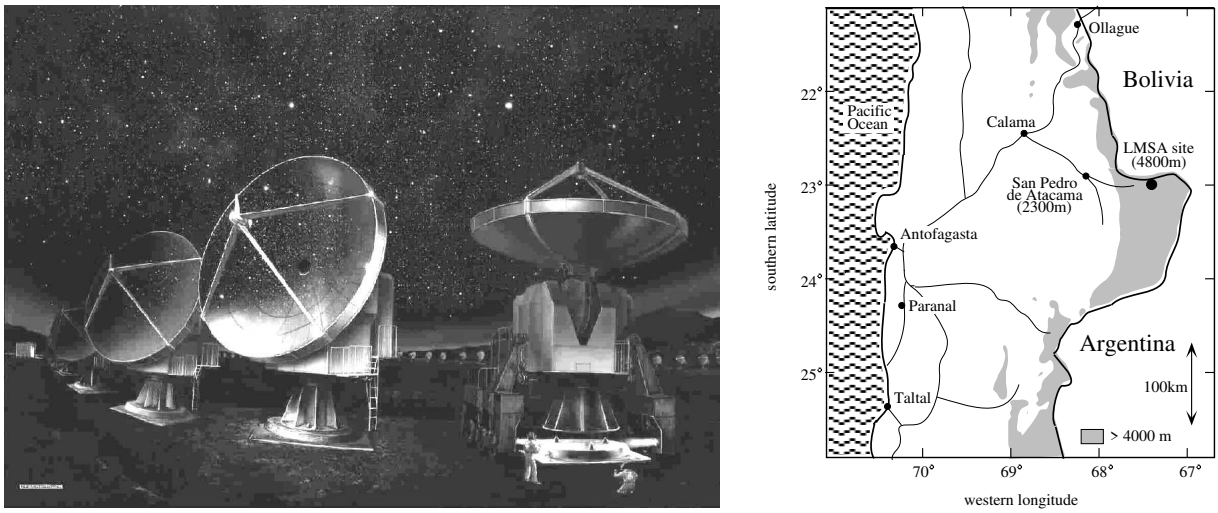

Fig. 1. (*left*) Artist's impression of the Large Millimeter and Submillimeter Array. (*right*) Map of northern Chile near the probable LMSA site.

The LMSA Observatory will be one of the highest ground-based observing sites in the world, and scientists and engineers there will be continually exposed to high-altitude conditions. Site evaluation for astronomical use has been carried out in northern Chile more than twenty times since 1992, in collaboration with the University of Chile, the National Radio Astronomy Observatory, and the European Southern Observatory. About twenty Japanese astronomers and engineers have visited several 4000–5000 m sites so far, and the next site-testing expedition is expected in 1998 June (Chilean winter).

For safe site testing, construction, and operation of the LMSA the following issues must be addressed:

- Safety rules and medical check lists for workers. When work should be stopped?
- Long-term impact of high-altitude environments on health. How can it be minimized?

- Neccessity for a first-aid station at the telescope site.
- Methods of oxygen enrichment. Concentration, pressurization, or both?
- Workers' timetable.
- Human loss of working efficiency at high altitude. How can we quantitatively measure it?
- Health aptitude tests for candidate workers. How reliable they are and which is the easiest?

As a first step, we measured our arterial oxygen saturation (SpO_2), blood pressure, and subjective symptoms once a day at the 4800 m site and twice (before and after work) a day at the 2300 m base for about two weeks. We learned through these experiments that (1) person-to-person differences in the adaptability to high altitudes can be much larger than the individual daily variation, (2) subjective symptoms appear to be related with SpO_2 though the correlation is not very tight, and (3) we may diagnose one's adaptability to high altitudes from measurements at base camps at moderate altitudes ($\simeq$ 2500 m) as shown in Fig. 2. We also confirmed that abdominal respiration increases SpO_2 by $\simeq$ 10% at high altitude.

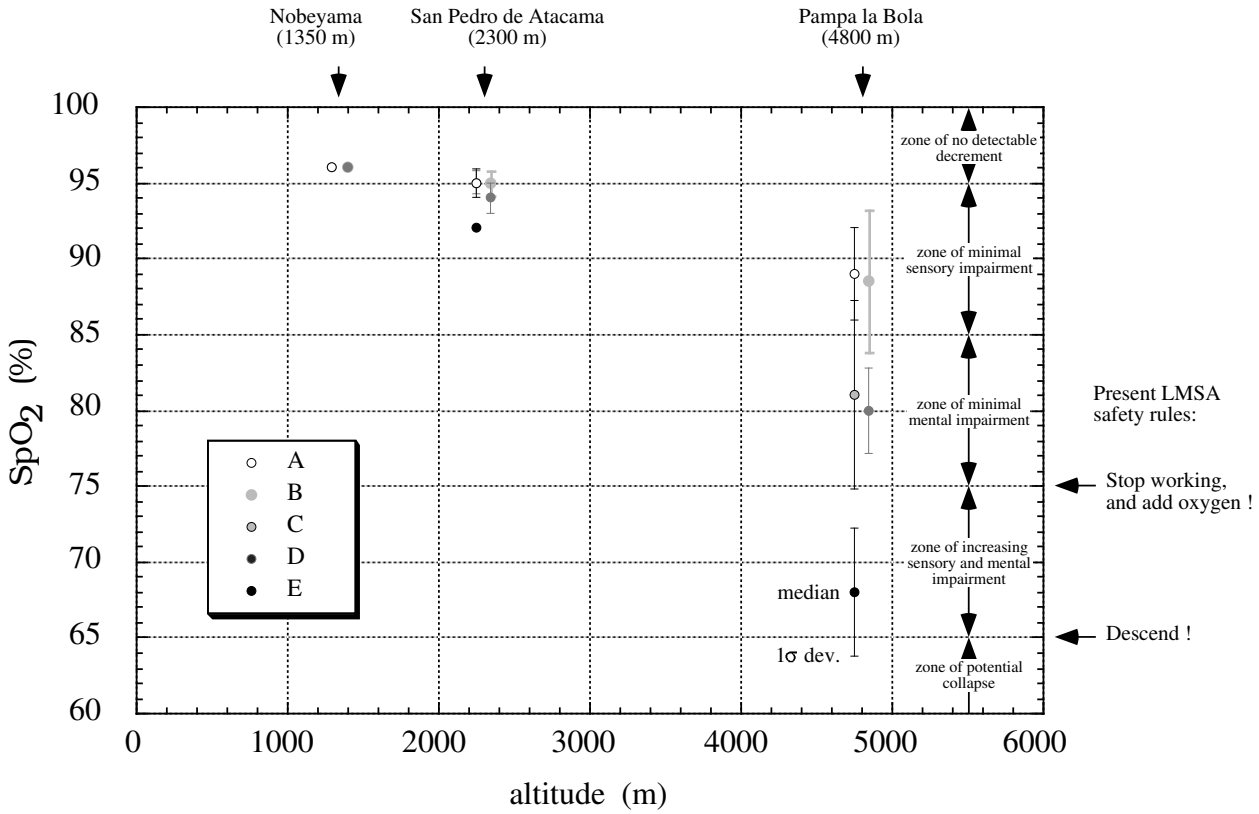

Fig. 2. Arterial oxygen saturation (SpO_2) of subjects without oxygen enrichment as a function of altitude. Subject E already shows hints of SpO_2 decrease at 2300 m.

Obviously, we need further medical experiments and consultation with medical professionals both in Japan and in Chile.

REFERENCES

[1] Ishiguro M, LMSA Working Group (1998) Japanese Large Millimeter and Submillimeter Array. In: Astronomical Telescopes and Instrumentation, in press