

INTRODUCTION

*Robert Brown and Richard Kurz
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The Atacama Large Millimeter/Submillimeter Array (ALMA) is a revolutionary instrument in its scientific concept, its engineering design, and its organization as a global scientific endeavor. ALMA will provide scientists with precise images of galaxies in formation seen as they were twelve billion years ago; it will reveal the chemical composition of heretofore unknown stars and planets still in their formative process; and it will provide an accurate census of the size and motion of the icy fragments left over from the formation of our own solar system that are now orbiting beyond the planet Neptune. These science objectives, and many hundreds more, are made possible owing to the design concept of ALMA that combines the imaging clarity of detail provided by a 64-antenna interferometric array together with the brightness sensitivity of a single dish antenna.

The challenges of engineering the unique ALMA telescope begin with the need for the telescope to operate in the thin, dry air found only at elevations high in the Earth's atmosphere where the *light* at millimeter and submillimeter wavelengths from cosmic sources penetrates to the ground. ALMA will be sited in the Altiplano of northern Chile at an elevation of 5000 meters (16,500 feet) above sea level. The ALMA site is the highest, permanent, astronomical observing site in the world. On this remote site the 64 12-meter diameter ALMA antennas will each operate superconducting receivers that are cryogenically cooled to less than 4 degrees above absolute zero. The signals from these receivers are digitized and transmitted to a central processing facility where they are combined and processed at a rate of 1.6×10^{16} operations per second. As an engineering project, ALMA is a concert of 64 precisely-tuned mechanical structures each weighing more than 50 tons, superconducting electronics cryogenically cooled, and optical transmission of terabit data rates--all operating together, continuously, on a site more than 3 miles high in the Andes mountains.

ALMA is a joint endeavor of nations and science institutes worldwide. The cost and burden of building and operating ALMA will be shared among the participants. This cooperation brings to the Project a broad base of experienced people and resources. Properly used, this breadth of experience has the potential to reduce risk in many areas. Here the challenge is to

manage the combined resources in a way that empowers the participants and effectively coordinates their efforts.

The ALMA Project Book is the key used to unlock much of the solution to the scientific, engineering and organizational challenges facing the Project. For ALMA, the Project Book is the description of the science requirements, the technical specifications, the schedule on which tasks are to be accomplished, and the task responsibilities. Where one task interacts with another either in design or integration, the interface requirements are specified.

The Project Book is the controlled configuration for the Project. Specifications in the Project Book--technical specifications, interface specifications or schedule—are controlled by ALMA System Engineering. Changes cannot be made to the configuration without the process specified by System Engineering, through the Control Board, being followed and approval gained.

The Project Book is the fundamental reference for what is, and is not, in the Project. As decisions are made and implemented by System Engineering, or by the Control Board in the case of changes, those decisions will be incorporated into the Project Book. The Project Book is kept electronically and is always available on-line for reference by the Project and interested others. A revision history is included to aid change tracking. Maintenance of the Project Book is the responsibility of ALMA System Engineering.

The ALMA Project Book serves to cement the scientific, technical and organizational aspects of the Project together. For the geographically distributed ALMA Project, the Project Book serves as a crucial facility to aid communication within the Project and to anchor decisions. Although the Project Book is a living document and will evolve, it is at all times the current, and complete, Project configuration to which all participants in the Project are working to achieve.