MMA PROJECT BOOK: INTRODUCTION

Robert Brown
Last modified 1999-Apr-26

Revision History
1998-07-30: First version
1999-04-26: Added Table 1.1

Design of the Millimeter Array (MMA) is an ambitious undertaking. Uniquely, it is designed as a complete imaging instrument with the capability to image astronomical objects on angular scales from milliarcseconds to many degrees. It will measure fluctuations in the microwave background that are isotropically distributed all over the sky and it will image the kinematics of streams of gas smaller than 500 parsecs in length that are flowing onto the massive blackholes of quasars 3000 Megaparsecs away from us. MMA imaging on this tremendous range in angular scales, from degrees to less than 50 micro-arcseconds, brings with it both enormous capabilities for astrophysical research and enormous challenges for the technical design of the instrument. It is the purpose of the MMA Project Book to provide a comprehensive account of the scientific requirements of the MMA and the approaches being taken in design, fabrication and integration of the instrument to reach those goals.

The Millimeter Array will be constructed in two stages: a 3-year Design and Development (D&D) phase will be followed by six years of construction. The Design and Development effort has as its goal completion of designs for the array instrumentation including prototypes of the highest risk instruments or modules and decisions made among competing designs where that is necessary. The D&D work has a specified task, staff, timescale and budget. The D&D effort is very well defined. In contrast, the construction planning for the MMA involves open questions, answers for which are among the products or deliverables of the D&D work. The operations model for the MMA is even less well developed because it hinges not only on a clear understanding of what must be operated and maintained--the product of the D&D work--but also on a realistic assessment of what operational aspects of the MMA can and cannot be done in the vicinity of the MMA site, elsewhere in Chile, or which must be done at a U.S. base. The answers to these questions will become clear as experience is gained in Chile. Nevertheless, this MMA Project Book includes a description of the state of planning for the entire project.

For each task the MMA Project Book summarizes requirements and the technical approach being taken to meet those requirements. Where one task interacts with another either in design or integration, the interface requirements are specified and the integration assumptions being made are noted--or noted as missing and in need of definition.

The Project Book is meant to be the fundamental reference manual for what is and is not planned in the project. It is written by those people working in the project and its principal readership is meant to be other people in the project. As decisions are made or options are adopted the Project Book will evolve; that will be done using an audit trail of additions and changes appended to each chapter. The Project Book is of value only if it is kept up-to-date. For this reason the Project Book will be kept on line: the version that is printed from the web will always be the latest version.

In 1999 the U.S. MMA Project will become subsumed by the international Atacama Large Millimeter Array (ALMA) Project. The Project Book will evolve in response to this transition and will appear subsequently as the ALMA Project Book.

Table 1.1 Summary of MMA Specifications

Array		
	Number of Antennas	> 30
	Total Collecting Area	> 2500 m^2
	Angular Resolution	0".07 λ (mm)
Configuration		
	Compact:	70 m
	Intermediate (2)	250 m, 900 m
	High Resolution	3000 m
Antennas		
	Diameter	12 m
	Precision	< 25 micrometers RSS
	Pointing Precision	0".8 RSS
	Fast Switching	Cycle < 10 seconds
	Total Power	Instrumented
	Transportable	By vehicle with rubber tires, on roads
Receivers		
	28 - 45 GHz HFET	T(Rx) < 20 K
	67 - 95 GHz HFET	T(Rx) < 40 K
	91 - 119 GHz HFET or SIS	T(Rx) < 50 K
	125 - 163 GHz SIS	T(Rx) < 6*h*nu/k SSB
	163 - 211 GHz SIS	T(Rx) < 6*h*nu/k SSB
	211 - 275 GHz SIS	T(Rx) < 6*h*nu/k SSB
	275 - 370 GHz SIS	T(Rx) < 6*h*nu/k SSB
	385 - 500 GHz SIS	T(Rx) < 6*h*nu/k SSB
	602 - 720 GHz SIS	T(Rx) < 8*h*nu/k SSB
	Dual Polarization	All receivers
SIS Mixers		
	Image Separating	All SIS frequency bands
	Balanced	All SIS frequency bands
	Integrated with IF amplifier	All SIS frequency bands
Intermediate Frequency (IF)		
	Bandwidth	8 GHz, each polarization
Correlator		
	Baselines	> 600
	Bandwidth	16 GHz per baseline
	Spectral Channels	4096 per IF