MMA Correlator Development Estimates

Andrew Dowd
May 19, 1992

I. Introduction

This document will focus on the development phase of the MMA correlator. This is the first attempt to elucidate some of the costs and goals of the MMA correlator development phase. The estimates are meant to represent only the development phase. This document does not address the construction and final design phase of the project. The development phase has signficant overlap with other design groups. In particular, the design efforts of the samplers, delay network and downconverter (from IF) are of interest to the signal transmission and IF development groups. It's important that these groups maintain communcation to avoid unnecessary work.

The design of the correlator can be separated into two steps: the development phase and the instrument design phase. The development phase will resolve controversial issues and perform any important component development. The instrument design phase will use the results of the development stage and combine them into a design of the entire instrument.

The primary design decision that will drive the MMA correlator development is the choice of an FX or XF architecture. The selection of the primary architecture will be strongly driven by the level of integration possible on a custom or semicustom chip. Each architecture has a number of advantages and disadvantages. Similarly, each approach has inherent efficiencies and inefficiences that will affect the size, cost and reliability of the final correlator. Therefore, a very thorough strawman design of each is required to make an appropriate choice. The strawman design will include the first stages of Custom/Semi-Custom chip design. Sometime during the chip design, it will be possible to choose one architecture. Thereafter, one approach will be stopped, with all effort contining on the prefered architecture.

The next section will discuss some of the development stages in slightly more detail. This is followed by some tables of cost and labor estimates. The last page is a Gantt chart of the development steps.

II. Development Stages

1. Cal-Tech/NRAO correlator board

This involves design of a correlator board around the CSO correlator chip to verify its performance. Although this chip is not directly applicable to the MMA, the approach holds great promise for reducing the size and cost of an XF-type array correlator.

2. MMA prototype

If a prototype MMA telescope is built, it is possible to apply the Cal-Tech/NRAO correlator board to make a prototype spectrometer and/or cross-correlator.

3 and 4. Strawman XF/FX

Two separate efforts should be started to design a suitable instrument applying both architectures. The resulting designs will be used to guide the Custom/Semi-Custom chip development. This development effort should try to use the advantages of VLSI designs to reduce connectors and support electronics. In other words, this effort should be geared towards guiding the chip development to produce an optimum VLSI chip.

5. FX Simulations

The architecture of the FX correlator has enough complexity to warrant some computer simulations. One important result of this program is to optimize data representation. This program can use the VLBA simulations as a starting point

6 and 7. XF/FX chip development

Working together with the strawman design, it should be possible to design a custom chip. The XF chip will include the correlators and as much mode selection hardware as is feasible. The most likely approach will be a full-custom design using the MOSIS system. The FX chip will implement the FFT algorthym in silicon. The most likely approach is an advanced gate-array, although a full-custom design should be considered.

8. Analog delay testing

It may be appropriate to apply fiber optic cables to implement long delays. The stablity and reliablity of this approach must be tested.

9. Connector Testing and Evalution

The MMA correlator will require a large number of RF grade connectors. If these connectors are unreliable or expensive, it could seriously affect the MMA project. Consequently, a development effort should be started to evaluate and test some of different approaches.

10. Sampler Development (Downconverter)

The sampler development will be affected by the choice of architecture (FX or XF). This development group should also consider using a high speed sampler to replace the final down conversion. This would require a more expensive sampler than is necessary, but will save the analog hardware in the downconverter. It would also be appropriate to start prototyping downconversion modules.

III. Development labor estimates

Estimates are in man-years

	Engineer	Tech
1. CSO-NRAO correlator	0.5	0.5
2. CSO-NRAO MMA prototype (optional)	1	0.75
3. Strawman XF design	0.33	0
4. Strawman FX design	0.5	0
5. FX simulations	0.33	0
6. XF custom chip develop.	2	0.5
7. FX chip development	2	0.5
8 Analog delay testing	0.5	0.33
9. Connector testing	0.5	0.33
10. Sampler development	1.0	0.5
Sub-Totals	8.66	3.41
(Savings after selection of one architecture)	-1.5	-0.41
Totals (development man-years)	7.16	3.0

Man power costs (Assume engineer cost 60,000/yr tech. costs 30,000/yr)

Labor costs	429,600	90,000
Total labor cost	$ 519,600	

IV. Material and test equipment costs during development phase of MMA correlator (in thousands of 1992 dollars)

	Material	Test Equipment
1. CSO-NRAO correlator	20	17
2. CSO-NRAO MMA prototype (optional)	20	5
3. Strawman XF design	1	0
4. Strawman FX design	1	0
5. FX simulations	1	0
6. XF custom chip develop.	70	20
7. FX chip development	60	10
8 Analog delay testing	5	30
9. Connector testing	5	10
10. Sampler development	20	70
Sub-total	203	162
Total	365	
Total including labor (in 1992 dollars)	$ 884,600	

V. Gantt chart of MMA correlator development