From rbradley Sat May 31 11:22:22 1997
Received: (from rbradley@localhost)
by polaris.cv.nrao.edu (8.8.5/8.8.5/CV-2.2) id LAA54682;
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Date: Sat, 31 May 1997 11:22:21 -0400
From: Richard Bradley <rbradley@NRAO.EDU>
Message-Id: <199705311522.LAA54682@polaris.cv.nrao.edu>
To: jwebber@polaris.cv.nrao.edu
Subject: 1998 LO Budget Estimate for MMA
Status: RO

John,

Here is the budgetary estimate that you requested.

Rich.

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1998 Millimeter Array Local Oscillator Development

Richard F. Bradley

May 30, 1997

Purpose

Local oscillator development for the mmA is divided into two distinct programs: 1) the photonics-based system, and 2) the conventional RF source/multiplier system. The plan presented here addresses the conventional system, both the near-term LO development for the prototype mmA system as well as the long-term requirements for the completed mmA operating up to 700 GHz. Toward a prototype system, the work in 1998 will focus on understanding the noise behavior of various LO schemes and create a standard to which ALL conceivable mmA LO systems should be compared. Toward the operational array, the work in 1998 will be directed toward a reliable LO for 700 GHz, which may also be used in a heterodyne tipping radiometer for site surveys. The purpose of this memorandum is to outline the development plan and present a 1998 budgetary estimate for the development of a conventional LO system. A manpower estimate is also included.

Development Plan : For Prototype mmA

It is important to underscore the fact that, at the present time, the LO requirements for the prototype mmA are dynamic in nature and a

development plan for this phase must be flexible enough to meet the changing needs. Issues such as power level, tuning range, tuning resolution, and fringe rotation implementation are all examples of such evolving requirements. Although these issues are important and should be kept in mind during the early development stage, the details can be addressed at a later date. However, obtaining a reliable, tunable LO that meets the fundamental amplitude and phase noise requirements for the array is not a trivial matter and the type of system chosen to meet this single requirement will have an enormous impact on the entire mmA system design, both in the degree of complexity and the overall cost. It is therefore proposed here that the work in 1998 primarily address this single fundamental issue.

The AM and PM noise will be evaluated for several proposed LO schemes operating at the mmA frequency near 100 GHz. This frequency was chosen because Gunn oscillators and associated phase-lock circuitry are currently available at the CDL laboratory. A standard system must be developed for phase noise measurement. It is proposed here to purchase a complete HP phase noise measurement system together with the necessary mixers to translate the 100 GHz signals down to the operating range of the instrument. A stable reference oscillator and distribution system should also be purchased. The above system should be used to measure the phase noise of two Gunn oscillators at 100 GHz. The results of this test will form the standard to which all other LO systems will be measured against. Two YIG based LO systems will be constructed and evaluated: 1) 8-18 GHz YIG/ X3 mult/ MMIC amplifier/X3 multiplier, and 2) 26-40 GHz YIG/ MMIC amplifier/ X3 multiplier. The components for both systems can be purchased commercially. It is important that the measurement system developed here be used to evaluate the photonics-based LO system when it becomes available.

Amplitude noise in ALL of the proposed LO systems must also be studied. A 100 GHz SIS mixer, which is currently available at the CDL, can be used for this purpose. However, a balanced schottky system for dedicated AM noise measurement may be constructed. The advantages are that the system will not require cooling and the balanced nature of the design results in the LO noise directed to a separate IF port.

The LO for the 230 GHz frequency of the prototype mmA requires a reliable, fixed-tuned, wideband frequency tripler. A whisker-contacted version of this tripler is available commercially but a planar version is not and so a modest development effort for this multiplier should be implemented in 1998. An MMIC based power amplifier at 100 GHz may also be required. The budget includes money

to establish contracts with groups manufacturing planar varactors and MMIC amplifier chips.

Development Plan: Long term mmA Requirements

The demands for LO systems up to 700 GHz will require a considerable development effort and so it is proposed here that a modest effort begin in 1998. A prototype 700 GHz LO system consisting of a source near 100 GHz (either a Gunn oscillator or a YIG-based system) followed by several multiplier stages should be developed. UVa Ph.D. candidate K.S. Saini is recommended for this task. Planar varactor fabrication willalso be required here.

Budgetary Estimate: 1998

Phase Noise Measurement System:		
HP3048AR Phase noise measurement system includes HP 11848 Phase Noise Interface, dynamic signal analyzer, and pc-based measurement software	$ 35,900	
HP 11729C Carrier Noise Test Set	$ 36,500	
External Mixers for 100 GHz downconversion	$ 10,000	
Reference Source and distribution	$ 5,000	$87,400
Spectrum Analyzer with harmonic mixers:		
Tektronix 2787 + mixers to 220 GHz	$ 70,000	$70,000
Gunn-Gunn Reference Test:		
Harmonic Mixers Qty 2	$ 1,000	$15,000
Gunn Oscillators Qty 2	$ 10,000	
Phase-lock systems for Gunn Oscillators	$ 4,000	
Evaluation of LO Scheme #1:		
YIG Oscillator 8-18 GHz	$ 4,000	
Tripler to 26-40 GHz	$ 2,000	
Tripler to 75-110 GHz	$ 1,600	
Phase-lock system for YIG	$ 3,000	
26 - 40 GHz MMIC amplifiers (parts/ materials)	$ 5,000	$15,600
Evaluation of LO Scheme #2:		
Phase-lock system for YIG (YIG borrowed from UVa)	$ 3,000	$3,000

230 GHz LO:		
Tripler to 230 GHz (parts and materials)	$ 5,000	$15,000
W-band power amplifier (parts and materials)	$ 10,000	
Contract for varactor development:	$ 100,000	
Contract for MMIC amplifier development:	$ 100,000	
Components for AM balanced mixer test set:	$ 20,000	
Long Term Development: 700 GHz LO multipliers	$ 20,000	
Laboratory tools and supplies (tools, waveguide, adaptors, small instruments, etc.)	$ 30,000	
TOTAL	$ 476,000	

Manpower Estimate (1998):

0.5 Ph.D. Engineer (oversee entire development effort and develop 230 GHz multiplier)

1.0 B.S. Engineer (design test sets and conduct measurements)

1.0 Technician (component assembly)

1.0 Ph.D. Student (700 GHz LO system)

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