

Technical Evaluation of UVa SEAS Proposal No. EE-NRAO-8184-99

Submillimeter-Wave Multiplier Development for the MMA

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The long term goal of this research project is to develop planar submillimeter wave frequency multipliers that meet the requirements for the MMA. This work will be performed in close collaboration with the LO development group at NRAO over a period of several years. Researchers at the Applied Electrophysics Laboratory (AEpL) of the University of Virginia have many years of experience in the development of planar GaAs Schottky diodes for both mixer and frequency multiplier applications at millimeter and submillimeter wavelengths. The fundamental process for the GaAs/quartz integration (termed the MASTER process) has already been developed by the AEpL group. The background and experience of the researchers are adequate for the tasks outlined in the proposal. The work can be performed with the fabrication equipment currently available at the AEpL.

The AEpL researchers have also submitted a proposal to NSF, separate from this NRAO proposal, for core funding to develop a broad range of submillimeter wave frequency multipliers over a period of three years. The NRAO proposal has two-fold significance: 1) to stimulate early development of submillimeter wave frequency multipliers deemed critical for the success of the MMA prior to receiving the core funding, and 2) to augment the core funding to meet the specific LO requirements of the MMA. However, if the AEpL core funding is not received, a limited frequency multiplier research effort will continue under the NRAO proposal but will be confined to the requirements of the MMA and will require additional time for successful completion.

The progress of this collaborative effort toward meeting the long term goal of this project will be evaluated on a yearly basis. Successful completion of the tasks described in this first proposal will be gauged in the following manner:

- 1) *The supply of discrete varactor diodes.* The circuits for MMA frequency multipliers below 250 GHz require the use of discrete diodes or diode sets for balanced circuits. A wafer of diodes that meet the needs of our current NRAO research and development effort will be supplied.
- 2) *The fabrication of a batch of integrated balanced doubler chips.* These circuits will have the GaAs diodes integrated onto the quartz substrate. A batch of circuits will be fabricated for use in the current frequency doubler designs operating below 250 GHz for direct comparison with doublers made from discrete varactors. The feasibility of using the GaAs/quartz technology will be evaluated on the basis of performance, thermal properties, and mechanical integrity when operating at cryogenic temperatures.
- 3) *Initial development of quartz based MMIC multiplier technology.* A set of test structures will be fabricated by UVa and modeled by NRAO in preparation for the development of the MMIC multipliers. The structures will include various transmission lines, bridges, tee junctions, and SiO₂ capacitors. The goal of this task is to refine the fabrication procedure and verify the electrical models of the various circuit structures needed for the quartz-based MMIC multipliers.