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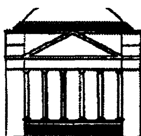

SUPERCONDUCTING DEVICE LABORATORY
OF THE APPLIED ELECTROPHYSICS LABORATORIES

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Dear John, August 8, 2000

This letter is in response to your request for documentation concerning Inductively Coupled Plasma (ICP) Reactive Ion Etching (RIE) [http://www.oxfordplasma.de/technols/rie_icp.htm] technology and its benefits to NRAO and my research. ICP RIE is a new technology for enhancing the anisotropy, plasma density and etch rates of conventional RIEs at lower RF powers and hence platter voltages. The ability to accurately etch well defined thin film features is critical to successful fabrication of complex mixer circuits. For NRAO's ALMA plans of balanced and sideband separating SIS mixers, it will not only improve the accuracy and repeatability of our mixer fabrication process, but will also enable NRAO to greatly simplify the number of separate chip components which must now be assembled together to form a single mixer. We propose to use the ICP RIE as a "dicing saw" to essentially cut out the final mixer chips. However; while we are limited to simple four sided rectangular shapes with a dicing saw, with the ICP RIE we will be able to define any desired perimeter chip shape. For the case of a balanced sideband separating mixer, the mixer assembly would be reduced from 9 separate quartz chips which would have to be soldered together, to one integrated chip fabricated in a single wafer run. In addition to the manpower, time and cost savings, the single integrated mixer would have improved sideband separation and LO noise rejection and would also make the different mixers more uniform so that the pass-bands would be better aligned. A simple analysis yields a reduction in assembly and testing times from 78 to at least 62 hours. Assuming $25/hr x 1.3 (benefits) x 1.88 (overhead) or $61/hr for a technician, the integrated assembly would save NRAO $978 per mixer. Assuming 64 antennas and 154 mixers per band (including 20% spares) the integrated assembly would save NRAO $150,000 per band. With the present plans calling for NRAO responsibility for two bands, this gives a total cost savings of $300,000.

I have thoroughly researched the available technologies for performing this quartz micro-machining from laser cutting to ion track etching. The only viable technology for this application is ICP RIE. In particular, Oxford Plasma Technology has the most advanced systems [http://www.oxfordplasma.de/systems/100ll.htm] and established deep quartz etch processes [http://www.oxfordplasma.de/process/sio_deep.htm]. Total system cost is $500,000. I would like to write a proposal to the NSF MRI equipment program [http://www.nsf.gov/pubs/1999/nsf99168/nsf99168.htm]. The MRI program requires 30% matching funds. I propose that NRAO commit to funding half of the 30% matching requirement, or $75,000, while I will raise the other $75,000 internally at U.Va. The proposal due date is mid January of the year 2001 with awards expected in August of 2001. Since I have just obtained a new 3 year NSF research award, the timing is good for submitting such a research proposal in the first year of the new grant (will get the support of my grant monitor). I submit that $75,000 is a relatively small investment for the potential savings of $300,000, not to mention the real time saved and improved performance of the resulting mixers.

Sincerely,

Arthur Lichtenberger