National Radio Astronomy Observatory
Tucson, Arizona
10 August, 1992

MEMORANDUM

To: mmA Antenna Memo Series

From: James Lamb

Subject : Composite Optics

Composite Optics is a company based in San Diego which specializes in the fabrication of precision reflector assemblies of carbon-fiber composites. I have been contacted by Shel Kulick who wished to make known his companies capabilities.

Their credentials are in the satellite reflector antenna field and they have made more such reflectors than any other company other than Hughes. They also claim to have made larger and higher precision reflectors than anyone else. Currently their R&D is directed at surface accuracies on the order of 1 μm. Their largest reflectors are 3.3 m in diameter with the specified surface accuracy of 50 μm, though the precision could be much greater than that for that size of reflector. They have developed a metalization process which can be used with a number of different metals (nickel, aluminum, copper) and is very tough — in pull tests the composite substrate fails before the bond. The surface is also quite rough, which would help to diffuse solar radiation in the visible and infrared.

Recently they have had discussions with Bill Bruckman and Eric Silverberg at SAO and are interested in building the primary mirror for a sixth antenna for them. They are also interested in the mmA antennas and believe that they can design and fabricate reflectors with the required specifications. Their concept is to make the surface and backing structure completely from carbon composite materials. Rather than a traditional space-frame structure they would use a truss design. They have the structural capabilities (NASTRAN/PATRAN) to analyze the gravitional, wind, and thermal distortions. They do not believe that humidity would be a problem as they use cyanate esters rather than epoxy in the matrix and these are a factor of a few to ten

better in this respect. Some very preliminary estimates based on their work for the SAO are that the complete backing structure and surface would weigh about 2 tonne and cost $1M. The company is relatively small (~150 employees) so the rate at which they could manufacture antennas may be low compared to our hoped-for timetable. Kulick thought that it would take about 10 weeks per antenna, which is about half the rate that we would like. It is possible that the process could be speeded up by licensing work to other companies.

From our point of view what does this mean? The idea of a stable passive structure is certainly very attractive. The lighter weight would help somewhat with the transportability but more so with the ability to rapidly position switch the antenna. I believe that truss structures are generally less favorable than space frame structures as far as the homology is concerned, but the superior structural properties of the composite compared to steel could out-weigh that concern. The fact that there are no metal joints required should have some advantages. The cost is higher than our preliminary estimates ($1M *vs* $0.75M) and it is unlikely that the difference could be made up by the need to have fans and blowers for a more conventional design, or a cheaper transporter for a lighter antenna. It may be that the price could come down with the falling price of composite materials or because of improvements in design.

What should we do? At this point in the project we do not need to decide on any particular construction. However this technology is probably so different from conventional constructions that it may be worth spending some money for a study contract before bids are opened for a prototype antenna. One possibility is that we collaborate with SAO on their sixth antenna, which they would be interested in fabricating from carbon composite, but I think that it could be risky to be linked too closely to another project with different specifications and timetables.

In conclusion, the proposal by Composite Optics is interesting and the cost estimates, while high, are not so far out to put them out of contention. It is best however if we continue to develop a design on more conventional techniques, but keep an eye on the possibilities for a composite structure at the same time.