HYDROGEN MASERS OR A SATELLITE LINK?

1. INTRODUCTION

ATDOC104 discussed the improvement of the long term phase stability of remotely located Rubidium oscillators by means of a satellite-link using the Australian commercial satellite AUSSAT. The required long-term phase stability could instead be achieved by installing hydrogen maser oscillators at Culgoora, Fleurs, Hobart, Alice Springs and Carnarvon (dispensing with the satellite link) and using the microwave ground link to stabilize Siding Spring and Parkes with respect to Culgoora.

The advantages and disadvantages of both systems are set out in Section 3, from which we conclude in Section 4 that a hydrogen maser system is to be preferred.

2. HYDROGEN MASER OSCILLATORS

Hydrogen masers can be purchased from Oscilloquartz (Neuchâtel, Switzerland) for SF510K (approx. $230K) per unit, from Smithsonian Astrophysical Observatory (R. Vessot) for $260K ($220K physics package + $40K electronics (parts and labour)) and from Johns Hopkins University (V. Reinhardt) for $350K. They have to be installed in temperature controlled rooms ($\Delta T<0.1K$ in 15 minutes).

Experience at other observatories with hydrogen masers shows that very little maintenance is required once they are running. The expectation amongst manufacturers is that the lifetime of a hydrogen maser should be 20 years or more, although replacement of parts can be expected in the course of time.

It should be noted that the U.S., European and Canadian VLBI systems are, or will be, H-maser based.

H-maser costs:		
	capital investment (5 Oscilloquartz masers + 5 Rb oscillators + temperature stabilization of rooms)	$1300K
	operating costs for the 5 masers per annum (replacement costs of $100K per maser per 20 years)	$ 25K

For comparison (ATDOC104),

Satellite-link costs:

capital investment + manpower	$ 600-800K
operating costs per annum	$ 65K

3. A COMPARISON OF THE SATELLITE-LINK AND HYDROGEN MASER SYSTEMS

(1) Satellite-link

Advantages	Disadvantages
1. smaller initial investment than H-masers	1. manpower intensive in design and construction
2. utilises the "high-visibility" technology of AUSSAT	2. high operating costs
3. large Australian content	3. operation is dependent on factors outside our control (e.g. satellite reliability)
	4. long periods of phase stable operation with Rb oscillators at 22GHz will be difficult
	5. cannot be used for international experiments
	6. the high performance link requires cooled receiver systems and thus expert maintenance

(2) Hydrogen masers

Advantages	Disadvantages
1. proven technology - working units can be purchased	1. higher initial investment than satellite link
2. stable enough for observations at frequencies up to at least 100GHz	2. no commercial supplier of H-masers in Australia
3. international observations will require H-masers at each participating Australian telescope	
4. Tidbinbilla already has an H-maser	
5. low operating costs	

4. CONCLUSIONS

(1) the ease of procurement and operational simplicity of hydrogen masers compared to a satellite-linked system seems to us to give advantages which outweigh the difference in initial investment costs.

(2) negotiations should be carried out with Oscilloquartz to try to reduce the unit price of their H-masers. The unit price for the other two manufacturers appears to be at rock-bottom already.

(3) one hydrogen maser should be procured at an early stage for Parkes to enable it to take part in international experiments. This maser could be moved later on to Culgoora.