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Subject: MMA rx group meeting (reminder)

AGENDA FOR MMA RECEIVER GROUP MEETING, 98/01/21

(Organised by Larry d'Addario)

This meeting is intended to be devoted to discussion of cryogenics. It would be helpful to have the comments of the committee on the following issues:

1. What is our present best estimate of the heat load at each heat sink temperature? Please see the rough guesses in Attachment A below, and supply your corrections and comments.
2. Is it acceptable to have only two refrigeration stages if the first stage is at about 50K and the second at 4K? A possible arrangement of components for such a configuration is given in Attachment B below; please comment. It involves splitting the HEMT amplifier receivers so that only 1 or 2 stages are at 4K. It is assumed that the SIS receivers will include 1-2 HEMT IF stages integrated with each mixer, but that other HEMT IF stages will be at warmer temperatures (even if a 3-stage refrigerator is available); is this reasonable?
3. A major objective of the MMA cryogenics design is to reduce the input power requirement significantly compared with present practice. One of the most effective ways of doing this is to keep the heat load low and to match the refrigerator capacity closely to that load. There have been suggestions that some types of Gifford-McMahon refrigerator have much reduced MTBF when heavily loaded, so that it might be better to over-design (power consumption notwithstanding); does anyone have solid data to this effect, or an explanation of why this might be true?
4. Another major objective is to improve reliability compared with present practice. For this reason, pulse tube refrigerators are under consideration, at least for some stages. But none of these is yet commercially available. Do we want to pursue our own development effort (either in-house or by contract)? How much money and time can be spent?
5. There has been some discussion of splitting the receivers between two dewars, requiring separate refrigerators. Does anyone want to argue that this is a good idea? A single-dewar design will be our baseline unless strong arguments can be made for something different.
6. The choice of thermodynamic cycle also has a big effect on power efficiency. The usual GM cycle is rather inefficient, and is used primarily for its convenience features (compressor can be remotely mounted). At 4K, the JT cycle is significantly more efficient than GM. Sterling is most efficient, but inconvenient and possibly very expensive. All this can be discussed if time permits.

PRELIMINARY COOLING LOAD ESTIMATES FOR MMA RECEIVERS

LRD 971121

Total of 10 separate receivers on different bands:

3 HEMT amplifier + 7 SIS mixer, or

2 HEMT amplifier + 8 SIS mixer

One feed horn per receiver, cold.

HEMT receivers: Two channels (both polarizations); about 5 stages/chan.

SIS mixer receivers: Two mixers (both polarizations)

Four IF channels (both polarizations, both sidebands)

Two IF amplifier stages per channel integrated w/ mixers

REFRIGERATION STAGES:

4.0K nominal with good stability:

10mK p-p in 1 minute

100mK p-p in 1 day

4.5K maximum before maintenance; 1 year desired.

"Warm" stages: one or two stages at temperatures TBD,
somewhere between 15K and 80K.

REFRIGERATION LOADS: Very rough guesses, from experience

Heat Source	Warm Stage	4K Stage
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Radiation shields, intercepting 300K	10 W	0
Radiation, 80K shields to 4K		16 mW
Windows: leakage past IR blocks		*50 mW
Electrical dissipation:		
HEMT amplifiers - 2 receivers only		
2 stages 4K @10mw,		
3 stages warm @20mw	0.16 W	80 mW
LO multipliers or photo mixers	0.5 W	0
Conduction: Waveguides, coax	*2.0 W	50 mW
Conduction: JT circuit parts, if any	1.5 W	10 mW
Miscellaneous, margin	1.0 W	50 mW
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TOTALS	16.16 W	256 mW
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* These estimates may be subject to especially large errors.
All numbers are rather uncertain at this time.

POSSIBLE REFRIGERATOR CONFIGURATIONS FOR MMA

LRD 971121

TWO STAGES

1st stage	~50K	~20W	Radiation shields Cable and WG heat sinks HEMT amplifiers, RF and IF, stages 3--5 (x36) LO multipliers or photodiodes HEMT receiver mixers
2nd stage	4.0K	~0.3W	All feedhorns (10 ea.) SIS mixers (7 or 8 ea.) HEMT amplifiers, RF and IF, stages 1 and 2 only (x36).

THREE STAGES

1st stage	~75K	~20W	Radiation shields Cable and WG heat sinks LO multipliers or photodiodes HEMT receiver mixers
2nd stage	~15K	~ 1W	Cable and WG heat sinks HEMT receiver feed horns (2ea) HEMT amplifiers, RF, 5 stages (x4) HEMT amplifiers, IF, 3 stages (x32)
3rd stage	4.0K	~0.3W	SIS mixers (8 ea.) SIS receiver feed horns (8 ea.) HEMT amplifiers, IF, stages 1 and 2 only (x32)

(Larry d'Addario, 1/20/98)