Summary of Results

ALMA Front End Cryogenics and Optics Meeting

26 and 27 September 2001

Rutherford Appleton Laboratory

09 October 2001, W. Wild

1. General

On 26 and 27 September, a series of ALMA front end technical meetings was held at Rutherford Appleton Laboratory. These included

- Cryogenics and optics meeting (organized by M. Carter and A. Orlowska)
- Mixer meeting (organized by B. Lazareff)
- Photonics LO meeting (organized by B. Ellison)

At the same time, small scale WVR and antenna meetings were held, and on 28 and 29 September, an E-AEC meeting was held.
This note summarizes the results of the cryogenics and optics meeting.

2. Agenda and Attendees

The agenda and list of attendees are given in Annex B and C, respectively.

3. Purpose of the meeting

The aims and objectives of the cryogenics and optics meeting were

- to present the current status of the cryostat and optics design
- to give RAL the "go ahead" for the construction of a prototype cryostat (engineering model), in particular
    - reach agreement on overall concept
    - confirm design solutions (avoid later re-design)
    - identify problems and outstanding technical issues
    - Discuss and try to resolve outstanding issues
- to become aware of anything in the FE design affecting cryogenics and optics

4. Main results

The meeting was held in a very collaborative atmosphere, and open and fruitful discussions took place. Basically all objectives have been reached during the 1.5 day meeting. Where issues could not be resolved during the meeting, deadlines for corresponding action items have been set (see below). The main results are:

- The RAL cryostat design is advanced enough to start building a prototype (engineering model).

- An electromagnetic analysis of the optics design has been carried out by MRAO, and a detailed report was presented (available at: http://www.mrao.cam.ac.uk/~cytham/).
- It was decided at the meeting to have identical mechanical cartridge interfaces to the RAL prototype cryostat and the Japanese ASTE cryostat (although this means rebuilding parts of the ASTE cryostat, and some redesign of the RAL cryostat). In principle, this makes changing cartridges between the RAL and ASTE cryostats possible.
- The RAL prototype cryostat and ASTE cryostat will have different thermal links. This was not considered to be a problem as long as the cartridges are interchangeable.
- Three different cartridge structures were proposed, the so-called "cylinder" and "truss" structures by RAL, and a "column" structure by NAOJ. Their pro and cons were discussed to some extent, but it was felt that no decision between the structures is needed now. Fabrication, use and measurements with different structures would give necessary data for taking a decision.
- The following dear windows are foreseen: plastic lenses (bands 1 and 2), quartz (bands 3 to 6), TBD – possibly quartz (bands 7 to 10). Calculations for the high freq bands are pending.
- The cryostat thermal model includes a number of wires (see Annex A), and the cartridge groups are asked to review the assumptions and send comments to RAL.
- The so-called "70 K stage" can have a temperature of 85 +/- 15 K (i.e. between 70 and 100 K).
- The issue of optical alignment and alignment stability was discussed. Further work will be done by B. Lazareff in collaboration with the cartridge and cryostat groups.

5. Action items

The following action items (ordered from early to late deadline) were agreed at the meeting. When sending information, please send always a copy to Payne, Sekimoto, and Wild. [Note added in final version: action items A1, A3, A4, and A5 completed.]

Item	By when	Who	Action
A1	08 Oct 2001	M. Harman	• Provide new cartridge drawings to cartridge groups
A2	15 Oct 2001	B. Ellison	• collect and distribute electronically meeting viewgraphs to attendees
A3	15 Oct 2001	G. Ediss	• Check with LO multiplier group if new "70 K stage" temperature of 85 K +/- 15 k ok • Send result to A. Orlowska
A4	15 Oct 2001	G. Ediss	• Check with LO multiplier group how much space is needed at 90 K stage for LO components • Results to RAL and cartridge groups [(a)]
A5	15 Oct 2001	G. Ediss	• Calculate quartz windows for high frequency bands 7 to 10 • Send results to M. Carter
A6	15 Oct 2001	Cartridge groups [(a)]	• Determine minimum distance between 4 K stage and dewar top • Check if 188 mm is ok (ASTE distance) • Send results to M. Carter and A. Orlowska
A7	15 Oct 2001	B. Lazareff	• Release version 1.98 of optics alignment and tolerance report
A8	31 Oct 2001	Cartridge groups [(a)]	• Provide info about needed access to cartridge (size of cut-away holes etc.) to M. Harman
A9	31 Oct 2001	S. Navarro	• Send information about IR filter properties (as far as known) to A. Orlowska

A10	31 Oct 2001	Cartridge groups [(a)]	• Revise A. Orlowska's thermal load sheet (see Annex A) and give feedback to her
A11	31 Oct 2001	Cartridge groups [(a)]	• Inform M. Carter about exact position of dewar window for respective band
A12	01 Nov 2001	R. Brown	• Provide number of windows simultaneously covered with solar filters to M. Carter
A13	15 Nov 2001	R. Hills, M. Carter	• R. Hills to provide WVR size to M. Carter • M. Carter and R. Hills to agree on WVR space within FE widget space
A14	30 Nov 2001	A. Orlowska	• Measure dewar cool down time • Add heat switches and pre-cooling loop(s) to present design • Assess what is required to reach 24 h cool down time
A15	30 Nov 2001	M. Harman	• Explore tube cartridge structure with larger access holes • Perform FE analysis • Results to cartridge groups
A16	01 Apr 2002	J. Payne	• produce band 6 OMT (demonstrate feasibility)
A17	01 Apr 2002	IRAM	• Provide prototype windows to RAL

[(a)] The following persons should be contacted regarding frequency cartridge issues (the "cartridge groups"):
J. Payne
G. Ediss
C. Cunningham
A. Baryshev
S. Claude
V. Belitsky
Y. Sekimoto
W. Wild

Annex A: Included heat loads in RAL thermal model.

(Sheet distributed by A. Orlowska at the cryogenics and optics meeting)

Thermal model

The thermal model has included the following wiring for each of bands 3-10. We have also assumed 36 mW additional load at 4K for each band that is on. Please let me know if there are major problems with these assumptions.
Anna Orlowska

Interface 12 - 4K	No. of Cables	Type	Heat Load (ESATAN)
SIS Mixer Bias	16 (4 per mixer)	125μm dia. BeCu	0.078mW
Magnet Bias	8 (2 per mixer)	125μm dia. Cu	6.588mW
LNA Bias	20	125μm dia. BeCu	0.097mW
IF Cable	4 (1 per mixer)	0.085 inch SS-SS	0.554mW
W/G LO Input	2	TBD	TBD
4K Temp. Sensor	16 (4 sensors)	125μm dia. BeCu	0.078mW
Stage heater	4 (paired)	125μm dia. BeCu	00.019mW

ALMA SIS Receiver Cartridge Cabling Heat Load Estimate on 4 K Stage

Interface 70 - 12K	No. of Cables	Type	Heat Load (ESATAN)
SIS Mixer Bias	16 (4 per mixer)	125μm dia. BeCu	1.561mW
Magnet Bias	8 (2 per mixer)	125μm dia. Cu	31.003mW
LNA Bias	20	125μm dia. BeCu	1.951mW
IF Cable	4 (1 per mixer)	0.085 inch SS-SS	22.874W
W/G LO Input	2	TBD	TBD
12K Temp. Sensor	8 (2 sensors)	125μm dia. BeCu	0.780mW
Stage heater	4 (paired)	125μm dia. BeCu	0.390mW

ALMA SIS Receiver Cartridge Cabling Heat Load Estimate on 12 K Stage

Interface 300 -70K	No. of Cables	Type	Heat Load
SIS Mixer Bias	16 (4 per mixer)	125μm dia. BeCu	14.360mW
Magnet Bias	8 (2 per mixer)	125μm dia. Cu	44.940mW
LNA Bias	20	125μm dia. BeCu	17.950mW
IF Cable	4 (1 per mixer)	0.085 inch SS-SS	188.490W
W/G LO Input	2	TBD	TBD
70K Temp. Sensor	8 (2 sensors)	125μm dia. BeCu	7.180mW
Stage heater	4 (paired)	125μm dia. BeCu	3.590mW

ALMA SIS Receiver Cartridge Cabling Heat Load Estimate on 70 K Stage

Annex B: Cryogenics and Optics Meeting Agenda

ALMA Front-end Cryogenics and Optics Meeting

Rutherford Appleton Laboratory

Conference Room 12, Building R68

Wednesday 26th September, 2001

9:00	Welcome	RAL
9:05	Aims and objectives of front-end meeting	Wolfgang Wild
9:15	Front-end noise gain budget	Gie Han Tan

Cryogenics Meeting:

9:25	Review of cryostat requirements and specifications	Anna Orlowska
9:35	Cryostat mechanical and thermal design, including report on thermal link performance Receiver cartridge designs inc. allowable component mass & power budget Prototype construction and test schedule	Anna Orlowska /Mark Harman
11:00	Preliminary open discussion on cryostat design	All
10.45	COFFEE BREAK – PLUS …	

Receiver Optics Meeting:

11:00	Overview of current optics design & specifications	Matt Carter
11:10	Cartridge designs *These presentations on the different bands must be limited to their impact on the cryostat. The times indicated are maximum times. These should include any changes in the optics from the Lamb report, weight , tolerances LO,etc.. It would be appreciated if as much information as possible can circulated before the meeting.*	
	Bands 1 and 2 and common optics	Matt Carter
	Band 3, 6 and OMTs	John Payne
	Bands 4, 8 and 10	Yutaro Sekimoto
	Band 7	Stefan Claude
	Band 9	Andrey Barychev
	Local oscillator and amplifier requirements	John Webber
12:15	Preliminary optics discussion period	All
13:00	BUFFET LUNCH	
14:00	ALMA band optics calculations	Choy Y. Tham

14:15	New Tolerance budget	Bernard Lazareff
14:25	WVR	Richard Hills
14:35	Calibration issues	Matt Carter
14:45	Calibration at ASTE	Kotaro Kohno
14:55	Windows and filters. Discussion with contributions from Ediss,Carter,Lazareff, Navarro and Yoong Tham	
15:45	Coffee Break	
16:00	Open discussion to re. cryostat and optic design issues. For example, LO requirements, cryostat windows, interfaces, integration and assembly.	All
17:15	Performance of cryocoolers	Hideo Ogawa
	Progress on Japanese cryostat	Yutaro Sekimoto
17:45	Summary of the day	Wild
18:00	FINISH AND TRANSPORTATION TO ACCOMMODATION	
19:30	**Evening reception at the Cosener's House, Abingdon.**	

ALMA Front-end Cryogenics and Optics Meeting

Rutherford Appleton Laboratory

Conference Room 3, Building R61

Thursday 27th September

9:00	Review of previous day's contributions and discussions	Matt Carter Anna Orlowska
9:45	Cryostat: Resolution of outstanding issues and concerns relevant to and affecting construction of the pre-production prototype.	Anna Orlowska Matt Carter
10:30	COFFEE BREAK	
10:45	continuation	
11:45	Future work for the optics and cryogenics groups	Anna Orlowska Matt Carter
12:15	Resume of meeting	Wolfgang Wild
12:30	LUNCH	
13:30	LAB VISITS	
14:00	MIXER MEETING	Bernard Lazareff
18:00	FINISH AND TRANSPORTATION TO ACCOMMODATION	

The above session will take place in parallel with the Photonics Workshop which will be located in CR12, R68. Participants of the Cryogenics and Optics meetings are welcome to attend the Photonics Workshop.

Annex C: Cryogenics and Optics Meeting Attendees and e-mail addresses

Attendees (some of them only the first day):

Alessandro Navarrini <navarrin@iram.fr>,
Andrey Baryshev <A.M.Baryshev@sron.rug.nl>,
Anna Orlowska <A.H.Orlowska@rl.ac.uk>,
Bernard Lazareff <lazareff@iram.fr>,
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Geoff Ediss <gediss@nrao.edu>,
Gie Han Tan <ghtan@eso.org>,
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Richard Hills <richard@mrao.cam.ac.uk>,
Richard Kurz <rkurz@eso.org>,
Richard Simon <rsimon@nrao.edu>,
Robert Brown <rbrown@nrao.edu>,
Ronald Hesper <hesper@sron.rug.nl>,
Stephane Claude <claude@iram.fr>,
Tetsuo Hasegawa <tetsuo.hasegawa@nao.ac.jp>
Ueda Akitoshi <a.ueda@nao.ac.jp>,
Victor Belitsky <belitsky@oso.chalmers.se>,
Wolfgang Wild <wild@astro.rug.nl>,
Yutaro Sekimoto <sekimoto@nro.nao.ac.jp>

Unable to attend:

Eric Bryerton <ebryerto@nrao.edu>,
Gene Lauria <glauria@nrao.edu>,
James Lamb <lamb@ovro.caltech.edu>,
John Webber <jwebber@nrao.edu>,
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