Appendix M

Thermal design and analysis of the FMOS IR Camera

Allan Dowell (Rutherford Appleton Laboratory, UK)



Thermal Design and Analysis of the FMOS IR Camera





Allan Dowell Allan Dowell Thermal Engineering Group, RAL Email: A.Dowell@rl.ac.uk www.sstd.rl.ac.uk/thermal

Overview

- 1. Title
- 2. Introduction
- 3. Requirements
- 4. Thermal Design & ESARAD
- 5. ESATAN
- 6. RAL AIT
- 7. Results
- 8. Oxford and Hawaii Integratio
- 9. TEG RAL Ground Projects VISTA Camera
- 10. Contact details & further link



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Requirements (1)

Parameter	Spectrograph	Camera	Detector
Life	10 years	10 years	
Absolute temperature	190 К-200 К	<77 K	Controllable within range 70 K <t<77 K to accuracy of 0.1K</t<77
Temperature stability	1 K/5mins	1K/min	0.1 K/hr
Temperature drift over life	+/-2.5K	N/A	2К
Temperature gradient	N/A stability: stable to 1K/5mins	200 K – 77K (TBC) stability: N/A	0.1 K stability: stable to 0.01 K/min
Maximum cooling rate for lenses	10 K/hr	10 K/hr	N/A
Maximum cold-warm- cold cycle time	48 hrs	<1week	<1week

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Thermal Design / ESARAD Geometric Model



ESARAD Geometric Model (Cross-Section)

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RAL AIT (2)

Testing of the Camera without Spectrograph in room temperature at RAL

LN2 pre-cooling

GN2 + heater warm-up

Detector overheating from feedback sensor error

Strap/sensor attachment

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Cryogenic Testing - RAL Results

Steady State

Part	Requirement / K	Lab (Room Temperature) Actual / K	Cooldown with LN2 = 24 hrs (without predicted 60 hrs)
Front Window	200	284.9	
Lens 1 Centre	190	(Estimate) 180	Warmup with GN2 = 65 hrs
Lens 1 Mount		150	
Filter Centre	<148	117.7	
Filter Mount	-	84.4	
Lens 6	< 87	76.1	
Detector	70-77	70.0	
Copper Block	70-77	70.0	
Coldhead 1 st stage	-	45.2	
Coldhead 2 nd stage	-	37.4	

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Oxford University - In Spectrograph

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