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CHANGE RECORD

Issue	Date	Section affected	Change Description
1.0	20/3/03		First version. Revised for clarity following JAC comments.
1.1	9/10/03	2.1	Updated throughput numbers to include effect of revised coating plans Included crosstalk non-compliance

APPLICABLE DOCUMENTS

Reference	Document Title	Document Number	Issue & Date
AD1	Functional Performance and Requirements Document	1.1 d 035 G	2.0

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1. INTRODUCTION

This documents lists the currently anticipated areas of WFCAM non-compliance with the FPRD.

Formal acceptance of these non-compliant areas is required by JAC for the project to proceed with the current design.

2. AREAS OF NON-COMPLIANCE

2.1 WFCAM OPTICAL THROUGHPUT

2.1.1 predicted performance

FPRD Requirement 1.4b: The Telescope + WFCAM throughput, excluding filter and detector, should be greater than 60% in all bands and over the entire science field.

Original estimates anticipated we would meet this requirement. However pupil image aberrations, focal plane mechanics and cold baffle requirements have made it more difficult than expected. In addition, a decision was made to abandon the original SESO multi-layer coating after the company had major problems coating the large optics with it. Instead we have agreed a single layer MgF coating on all optics except the corrector plate and field flattener. The last has already been coated with the multi-layer coating. The current estimated throughput performance with all known effects included is as follows,

	J	H	K
inner corner	52%	55%	53%
outer corner	49%	52%	51%

2.1.2 impact of predicted performance

Optical throughput is only one of a number of factors which influence sensitivity and survey speed. Others are filter transmission, detector QE and observing efficiency. Of these, broadband filter transmission may be considered to be approximately the same in all instruments. Observing efficiency is dealt with in a separate FPRD requirement and budget. So if we fold detector QE into the calculation then the following throughput*QE products is achieved.

	Throughput	detector QE	product
J requirement	0.60	0.4	0.24
J predicted	0.49	0.68	0.33
H requirement	0.60	0.5	0.3
H predicted	0.52	0.77	0.40
K requirement	0.60	0.6	0.36
K predicted	0.51	0.76	0.39

The better-than-expected measured detector QEs result in a camera performance better than anticipated, despite the non-compliant throughput.

There is another important change in going to single-layer coatings from the original SESO multi-layer coating. The original coating had difficulty in achieving good throughput at CCD autoguider wavelengths. With single layer coatings this has dramatically improved now. The average throughput*QE for the autoguider has improved by a factor of 1.75. This in turn results in a higher probability of finding guide stars and so less autoguider acquisition inefficiency. Folding the improved throughput into the autoguider model shows that inefficiency should drop from 7.7% to 3.3%.

2.1.3 Scope for improving the performance to meet the requirement

There is little scope for this. All relevant sub-systems have already been optimised to keep the throughput as high as possible. Coatings have been agreed with SESO and are in the process of being carried out.

2.2 IMAGE QUALITY

2.2.1 predicted performance

FPRD requirement 1.4b: Optics MTF requirement : >0.5/sec(z)$^{3/5}$ at 1.2 cycles per arcsecond following refocusing and hexapod (secondary mirror) adjustment from a look-up table.

At zenith the MTF should be above 50%, and there is formal non-compliance in the corner as shown, in Y band only.

	centre	edge	corner
Y	65.3	58.6	**49.7**
J	64.4	59.8	54.5
H	62.2	62.2	57.9
K	52.9	55.3	51.9

The estimates are the result of a process in which the optical design model was perturbed with different effects (optics misalignment, manufacturing errors etc) and a distribution of final effects on MTFs produced. The MTF number quoted is then the conservative 2-sigma value. That is, assuming Gaussian statistics the probability that these MTF numbers or better will be achieved is ~98%.

2.2.2 impact of predicted performance

The non-compliance is well within errors of the calculation, and negligible.

2.2.3 scope for improving the performance to meet the requirement

The entire optical system has already had extensive optimisation. No significant improvements are possible without major re-designs.

3. CONTROLLER CROSSTALK

3.1.1 measured performance

a. **FPRD requirement 1.3b:** The electrical crosstalk rejection in the controllers shall be more than 94 db

Our original specification for the SDSU controllers specified a 94 db electrical crosstalk rejection (0.02% of crosstalk between channels) requirement between channels in the controller. We have now received all controllers and have conducted various tests with them. The measured crosstalk is 0.046%, or twice the specification.

3.1.2 impact of predicted performance

There is another source of crosstalk in the system - that due to the circuitry in the Rockwell Hawaii-2s themselves. We have measured this in science device 41 and found it to be 0.17%, three times that due to the controllers. So the system crosstalk is detector limited, and the level will require crosstalk removal in software. The effect of increased controller crosstalk is therefore small.

3.1.3 scope for improving the performance to meet the requirement

None at this stage. It would require an electronic redesign.

4. DETECTOR SPACING

4.1.1 predicted performance

FPRD requirement 1.9a: The focal plane configuration shall have 4 detectors spaced by 90 ± 1 % of their active area on a NSEW grid.

Following revisions to the focal plane assembly design, required to ensure detector stability during thermal cycling, a focal plane spacing of 94% is now required for mechanical components and features.

4.1.2 impact of predicted performance

The main effect is that during jitter observations, some of the jitter images will be on a different detector. This is a software issue which should not affect performance, though re-sampling is required.

4.1.3 scope for improving the performance to meet the requirement

The re-design of the focal plane is not complete in detail, so we will work to get as close to 90% as possible. However, for the moment 94% appears to be the practical limit.