Integration of the OMC and WFS at the ATC

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1. Introduction

This document is intended to provide guidance in selecting the approach to the integration of the OMC and the WFS at the ATC. Many of the points presented may be obvious and possibly trivial but the author hopes that their documentation will help in arriving at a decision.

2. General Discussion

As a starting point the two extreme approaches to the integration will be addressed. At one extreme the minimum possible set of tests would be performed. These tests would verify that the OMC and WFS perform all basic functions, transmit images through the entire optical train and produce correct output data These data would include signals indicating positions and states of motorised components together with WFS camera data and signals from the pre-correction camera. WFS camera data would be evaluated for the correct format in its range of operating modes but there would be no real-time image processing . Tests assessing measurement accuracy, reliability, sensitivity to thermal changes and vibration would not be performed at this stage. Only problems that would absolutely prohibit one from progressing to the next stage of testing would be corrected during this phase. The philosophy here is to proceed to complete system testing at Durham as rapidly as possible. Extensive testing would be performed at the system level and correction of problems would be performed in parallel.

At the other extreme one would perform thorough testing to uncover as many faults as possible; this approach might involve shipping part of the RTCS to the ATC. It would certainly involve the use of some auxiliary equipment and software to process output data from the WFS. All faults would be corrected before shipment to Durham. Proponents of one of these extreme approaches may well regard the other approach as ridiculous but , depending on the circumstances, either approach may be used. There is, of course, the option of choosing middle ground.

The choice of the integration approach depends on several factors. These include at least the following:

1. The nature of the problem, i.e. software, mechanical, electrical, environmental, system control, etc.

2. The level at which the problem can be first identified, i.e. subsystem testing, OMC/WFS integration at the ATC or system integration at Durham.

2. The time and effort required to correct the problem.

3. The availability of the required resources.

4. The probability of schedule delays elsewhere in the project (e.g. in software development) and their effect on the adopted plan.

Risk assessment can help in evaluating these factors but in reality one seldom has the time or money to perform a thorough risk assessment. Given NAOMI’s present circumstances, i.e. time limitations and limited risk assessment, one can do little more than perform a cursory evaluation of the above factors. The consequence may be that one will encounter problems that were completely unanticipated.

The first approach may be quite acceptable if one is confident that most problems will occur during system integration, e.g. software problems associated with system control, and that these problems could not be readily identified at an earlier stage. The assumption here is, of course, that one is in a position to proceed rapidly to system integration. There is the risk that during system integration one may have to ship a component or even the WFS back to the ATC to correct a problem or send ATC personnel to Durham. However with this approach one should allow for such contingencies. An advantage is that one can correct problems in parallel. Any problem that requires substantial time to correct will have serious consequences for either approach.

The other extreme obviously requires greater resources at the ATC, including additional test equipment. At first sight correcting problems sequentially would appear undesirable from the schedule viewpoint. However if there are schedule slippages elsewhere and the faults uncovered during the OMC/WFS integration require little time to correct, this approach may well be acceptable. It should minimise the number of problems uncovered later during system integration and testing but it provides no guarantee that the OMC and WFS will be completely free of faults. Thus even for this extreme approach there is a still a risk, albeit very small, that one may have to ship the WFS or an OMC component back to the ATC or send ATC personnel to Durham.

3. Suggested Levels of Integration Tests.

Table 1 has been divided into four levels of integration tests. The division of tests between the two intermediate levels is somewhat arbitrary and one could add levels if desired. The maximum level stops at open-loop tests. Closed-loop tests would require much of the RTCS at the ATC and as such it would almost amount to performing the system integration at the ATC. At the time of writing the author finds it difficult to make a strong recommendation based on a cursory assessment. The uncertainty in the delays associated with software development and the transfer of the WFS to the ATC contribute to the difficulty. Selection of the either the second intermediate level or the maximum is suggested.

Table 1. Suggested levels of integration testing for the OMC, NCU and WFS.

Category	Summary of Integration Tests	Comments
Minimum level of integration tests.	Determine that all mechanical interfaces are satisfactory and that there are no mechanical interferences. Verify all basic OMC & WFS functions using engineering level software and WFS independent control module. Verify that images are received by pre-correction camera, IR/optical science ports and WFS but exclude a quantitative evaluation of image quality. WFS tests limited to only those possible with pixel stream from the WFS camera, i.e. no real-time image processing capability. Optical flat used in place of DM but mechanical interface with DM would be checked. Note: Tests will <u>not</u> assess sensitivity to temperature changes and vibration, repeatability, reliability, noise and failure modes.	<u>Advantages</u> Shortest route to evaluation of entire system. No additional equipment and/or software required. <u>Disadvantages</u> Highest risk. Major concern is that failure to uncover any vibration or stability problems could lead to significant delay later.
First intermediate level.	All tests in first category plus the following: Limited open-loop tests of FSM (probably using position-sensing detector at f/16.8 focus). Assessment of vibration effects with accelerometers if sensitivity is sufficient. Simple static wavefronts generated by the NCU and	<u>Advantages</u> Moderate risk. Limited evaluation of vibration effects. Provides initial but

	received by the WFS will be measured and displayed. Performance variation with light level will be investigated. Limited open-loop test of WFS dynamic response using tip/tilt injection capability of the NCU. Distortion mapping over the WFS field using the NCU's array of point sources. OMC/NCU/WFS sensitivity and repeatability evaluated when subjected to temperature cycling (within limits set by laboratory environment) will be assessed. Note: DM would be replaced by optical flat as for minimum level.	incomplete assessment of temperature effects, stability and repeatability. <u>Disadvantages</u> Requires additional equipment and software for display and processing of WFS spots. No information on DM interaction with subsystems.
Second intermediate level.	All tests in above categories plus limited use of the DM as follows: Verification of method of aligning DM to WFS. Generation of simple wavefronts with DM and NCU point source. Measurement of these wavefronts with the WFS.	<u>Advantage</u> Further reduction of risk. <u>Disadvantage</u> Additional software and test effort.
Maximum level of integration testing without use of RTCS.	All tests in above categories plus the following: Determination of non-common-path aberrations using IR camera at science port. Full completion of open-loop characterisation tests not already covered above. Assessment of vibration effects with simultaneous open-loop operation of both the FSM and DM. (Note: Approach suggested by RMM requires further study.) Rigorous evaluation of image quality at all ports. Measurements of noise over full range of light levels.	<u>Advantages</u> Lowest risk. Well characterised subsystems provided for system integration. Provides earliest detection of most problems associated with the OMC/NCU/WFS as an integrated assembly. Unlikely to require return of components to ATC for correction of faults. <u>Disadvantages</u> Longest route to evaluation of entire system. Substantial effort required by ATC with some support from Durham. Sequential correction of problems may cause

		significant delays.