Proposed Approach to the OMC/ WFS Integration at the ATC

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1. Introduction

An earlier document (Number AOW/GEN/RAH/9.0/02/98/OMC/WFS Integration) presented four possible approaches to the integration of the OMC and the WFS at the ATC. As a result of further discussions between the project scientist (PS) and the project engineer a new approach is now proposed.

2. General Discussion

The minimum level of integration testing presented in the earlier document was rejected as it provided little information, presented high risk and it did not characterise the performance of the integrated subsystems. There appears to be little evidence that the shortest route to system integration at Durham provided any significant overall benefit to the project. At the other extreme, the highest level of testing requires a significant level of proven software as well as part of the RTCS. We strongly advise against tests at this stage that involve considerable real-time or interpretative software. The risk here is that we might be making the implicit assumption that the software was reliable whereas we need an integrated system to verify its reliability.

The proposed approach outlined below does not match exactly any of the four levels described earlier. It lies between the second intermediate level and the maximum level except that we recommend tests with the DM to be carried out at Durham. We believe that Durham will be better equipped to perform these tests, e.g. the availability of the Electra system and a suitable interferometer. Furthermore, the project would save on shipping, installation and operating costs. The PS estimates that 3 staff from Durham would be required at the ATC for at least one week. If this approach is followed the DM x-y stage would be shipped to Durham together with accelerometers, if needed, supplied by the ATC. An optical flat would be substituted for the DM for the integration tests at the ATC. The one disadvantage of this approach is that the DM/FSM interaction would not be evaluated until system integration. However, as additional time and effort required to carry this evaluation at the ATC, we do not view this as a significant disadvantage.

We propose that the ATC be provided with the capability to acquire, process and display diagnostic frames from the WFS. Processing would be limited primarily to a determination of spot centroids and a non-real-time wavefront reconstruction using Electra software. The objective is to allow simple but useful tests to be performed, e.g. mapping of distortions over the field, a measurement of spot offsets, etc. There is no intent to provide a dynamic, real-time capability. We also suggest that a WFS camera/controller be provided to Durham, when convenient for both the ATC and Durham, for preliminary integration, interface checkout and software testing. We view this approach as a risk-reduction measure that could significantly reduce the problems encountered during both the OMC/WFS integration and the system integration.

3. Proposed Tests

The test sequence given below is preliminary and it may not be optimum. Note that an optical flat will be substituted for the DM. The mechanical DM interface with the x-y stage will be checked at Durham.

3.1 Determine that all mechanical interfaces are satisfactory and that there are no mechanical interferences.

3.2 Perform a safety audit to verify that the equipment does not present any hazards. This operation should include the NCU laser, all moving components and all electrical equipment that may present a potential hazard.

3.3 Verify all basic OMC and WFS functions using engineering level software and the WFS independent control module. Verify that images are received by the pre-correction camera, IR/optical science ports and the WFS. Note that quantitative measurements of wavefront quality are performed later in the integration process.

3.4 Perform open-loop tests of both the FSM and the NCU tip/tilt injector. The suggested approach would be to use a calibrated position-sensing detector at the f/16.8 focus and monitor the drive signals (sinusoidal input) and the detector output. We anticipate that the NCU laser source would be required to provide adequate signal/noise and resolution from the detector. Comparison of the input/output signals could provide information on vibration effects but it is suggested that accelerometers are also used to assess vibration effects.

3.5 Measure the non-dynamic transfer function of the WFS using both the WFS calibration source and the NCU. Note that "non-dynamic" indicates that one is unable to make a proper phase-lag measurement at this time, i.e. the real-time processing latency would not be included.

3.6 Determine the Hartmann spot offsets with both the WFS calibration source and the on-axis NCU point source. The former provides a measure of the WFS internal aberrations and the latter includes both the WFS and on-axis OMC aberrations. Wavefront reconstruction would be performed, possibly off-line, using Electra software.

3.7 Measure simple static wavefronts, i.e. tilt, defocus and low-order aberrations from the aberration generator, using the WFS and NCU. The WFS performance variation with light level would be investigated.

3.8 Perform distortion mapping of the WFS field using the NCU's array of point sources. The Hartmann spot offsets would be determined at selected field points and wavefront reconstruction performed to assess the off-axis aberrations.

3.9 Assess the proposed technique to align the DM to the WFS. This test would be carried out by placing a mask over the optical flat to simulate a single segment of the DM. The entire flat would be moved using the x-y stage until the "segment" is centred in a WFS subaperture. The sensitivity and repeatability of this alignment operation would be determined. Note that this test would involve open-loop operation with manual input; an automated procedure is not proposed at this stage.

3.10 Evaluate the OMC/NCU/WFS sensitivity and repeatability when subjected to temperature cycling. This test will be restricted to the limits set by the laboratory environment.

3.11 Limited measurements of non-common-path aberrations are suggested, subject to an evaluation of technical feasibility and the evaluation of equipment and resources.
The wavefront aberrations at the IR and optical science ports could be measured at selected field points using a self-referencing interferometer, e.g. a Smartt interferometer (aka a point-diffraction interferometer). The interferometer would need to be mounted on an x-y stage to cover the field of view. Concerns include the required source brightness and the choice of sensor to be used with the interferometer. We note that the NCU's array of point sources, as currently proposed by ROE, will only be diffraction limited as seen by the WFS subapertures and thus this array is not suitable for use with a Smartt interferometer at visible wavelengths, i.e. the pinholes are too large. The wavefront errors seen by the WFS would be determined as outlined in section 3.6 above.

3.12 Verify that any special handling equipment performs satisfactorily and that components fit properly in their shipping containers to insure safe transport.