MANIFEST - a many-instrument fiber positioning system for GMT


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ABSTRACT MANIFEST is a proposed fiber-positioning facility for the GMT, capable of feeding other instruments as needed. It is a simple, flexible and modular design, based on Starbugs. Hexabundles, fiber tapers, together with extensive use of standard telecommunications fiber technology. Up to 2000 individually deployable Starbugs are envisaged, with a wide variety of aperture types (single-aperture, image-slicing, IFU). MANIFEST allows (a) full use of the GMT’s 20’ field-of-view, (b) a multiplexed IFU capability, (c) closely pack spectrums on the detectors, (d) greatly improved spectral resolution via image-slicing, (e) simultaneous observing with multiple instruments, (f) OH-suppression in the near-infrared. Together, these gains make GMT the most powerful of the ELT’s for wide-field spectroscopy.

INTRODUCTION MANIFEST (the Many Instrument Fiber System) positions fiber apertures over the full 20’ GMT focal plane, feeding all of the proposed natural-seeing/GLAO (ground-layer adaptive optics) spectrographs (GMACS, NIRMOS, and G-CLEF), with a wide variety of aperture geometries. The design concept for MANIFEST presented an intriguing challenge. The GMT spectrographs can accommodate more targets than can readily be achieved with pick-and-place positioners (like 2dF), which are limited by retractor volumes, fiber crossings of the focal plane, and reconfiguration times. A positioning system based on fixed patrol areas (such as FMOS/Echidna or LAMOST) would not give the desired capabilities to observe clustered targets, or to have a choice of aperture geometries for each target. Our proposed design removes the need for retractors, eliminates fiber crossings of the focal plane, and has short reconfiguration times, while allowing very large numbers of targets, with great flexibility in terms of aperture geometries and target configurations.

APERTURE TYPES AND NUMBERS MANIFEST provides a wide variety of aperture geometries. These include single apertures of around 0.75”, and several IFU/image-slicing modes with individual apertures size about 0.25”. Other modes, e.g. extreme image-slicing, or pupil imaging, are possible and will be considered as part of the feasibility study.

FROM STARBUG TO SPECTROGRAPH All fibers will have 250µm outer diameters (including cladding and buffer), to allow commercial ribboning and connectorisation techniques to be used. Each sets of Starbugs and fibers sufficient to fill a single spectrograph form a single module, which terminates in a connectorised plug. The spectrographs are fed via fiber slits, each with its own connectorised socket. The modules are then interchangeable between the spectrographs, and vice versa. Modules can also be added, upgraded or replaced as desired. GMACS will be fed via fold mirrors. For NIRMOS, it is proposed that the fibers will run into the fore-dewar, which will be evacuated and cooled to ~50°C, to allow use over the full H-band (1.81µm). For G-CLEF, the fibers will run back up to the G-CLEF front end on the instrument platform via a cable wrap.

PERFORMANCE Resolution: Image-slicing improves spectral resolution by a factor ~3 over a seeing-limited slit, for all proposed spectrographs. Larger gains, up to a factor ~7, would be straightforward to achieve for GMACS and G-CLEF.

MANIFEST SCIENCE GAINS MANIFEST gives multiple scientific gains to the instruments it feeds. These include: • Access to the full 20’ field-of-view • Efficient spectra packing onto detectors • Increased resolution, by factors 3-8 • Multiplexed, deployable IFU’s in various sizes • Simultaneous use of multiple instruments Survey speeds are increased by an order of magnitude for many of GMT’s main science drivers (Ly-suppression, galaxy assembly. Galactic archeology). OH suppression would give another order of magnitude sensitivity improvement in J+H bands. Overall, MANIFEST gives GMT the largest AO of any of the ELT’s, and hence makes it the most powerful ELT for survey work.

THE MANIFEST FEASIBILITY STUDY In January 2010, the GMTO Board announced that...
HEXABUNDLES AND TAPERS For image-slicing aperture geometries, we propose to
Enough apertures will be provided to fill each spectrograph in each of the geometries of interest.
A total of up to 2000 separately deployable Starbugs are envisaged, as laid out below:

<table>
<thead>
<tr>
<th>Starbug</th>
<th>Focal Plane</th>
<th>Fiber Size</th>
<th>Number of Fibers</th>
<th>MANIFEST Capacity</th>
<th>GMS Capacity</th>
<th>NIRMO Capacity</th>
<th>Total Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single</td>
<td>1.5 - 7.7</td>
<td>1200</td>
<td>300</td>
<td>1200</td>
<td>300</td>
<td>50</td>
<td>2000</td>
</tr>
</tbody>
</table>

as yet uncertain. We will design for both full-OH suppression, and also a demonstrator capability.

REFERENCES

MANIFEST is likely to be a very high priority second generation instrument" and supported a feasibility study, starting in July 2010, to develop MANIFEST as a telescope facility for GMT. The amount of OH-suppression that can actually be implemented depends on the cost, which is

The feasibility study will establish the interfaces between MANIFEST and the other instruments and the telescope itself. It will also seek to retire the risks associated with the various novel technologies (Starbugs, Hexabundles, tapers, cooled fibers, glass fieldplate) through prototyping and testing.