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**IRMOS Feasibility Study
August 2005 Monthly Report**

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Abstract

Progress continues on the Initial Operational Concepts Definition Document. Optical designs have been explored to provide the Science Team feasible performance estimates.

Revision Sheet

Release No.	Date	Revision Description
Rev. 1	8/31/05	Initial report by R. Dekany, with significant input from R. Ellis

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1 GENERAL

1.1 Acronyms and Names

AO	Adaptive optics
CW	Continuous wave
DM	Deformable mirror
ELT	Extremely large telescope
FoV	Field of view (the field observed by a single detector array)
FoR	Field of regard (the field over which science objects may be selected)
FFPRD	Final IFPRD
FOCDD	Final IOCDD
FSR	Feasibility Study Report
FPRD	Functional and Performance Requirements Document
IFU	Integral field unit (a type of spectrograph)
IFPRD	Initial FPRD
IOCDD	Initial OCDD
IPT	Integrated product team
LAM	Laboratoire d'Astrophysique de Marseille
LGS	Laser guide star
MEMS	Micro-electro-mechanical systems
MCAO	Multi-conjugate AO
MOAO	Multi-object AO (having one DM per spectrograph)
Na	Sodium
NIR	Near infrared (typically 1-2.5 microns wavelength)
NSF	National Science Foundation
OCDD	Operation Concept Definition Document
PI	Principal Investigator
PDR	Preliminary design review
PSF	Point spread function
RMS (also rms)	Root mean-squared
SAC	Science advisory committee
SLGLAO	Single-laser Ground Layer Adaptive Optics
SRD	Science Requirements Document
TBD	To be determined
TBR	To be reviewed
TiPi	Name of Caltech's version of IRMOS
TMT	Thirty-Meter Telescope Observatory
WFE	Wavefront error

1.2 Purpose

The purpose of this report is to document monthly activities accomplished toward the IRMOS Feasibility Study underway at Caltech.

1.3 Scope

This report covers the period July 16, 2005 to Aug 15, 2005.

1.4 Definitions

None.

1.5 Assumptions

None.

1.6 Related Documents

Caltech's IRMOS Feasibility Study web site at <http://www.astro.caltech.edu/oir/irmos>, which includes study deliverables and past monthly reports.

2 SCIENCE REQUIREMENTS

The science team had two telecons in early August and devoted most of the first part of the month drafting their component of the IOCDD. Three external members visited Pasadena for some or all of the period August 1-7 and good progress was made in three areas (i) defining each science case and technical program in the format required for the OCDD, (ii) interacting with the instrument team on design parameters, (iii) undertaking the necessary modeling for demonstrating the feasibility of the science programs.

Taking each activity in turn: Five science programs were defined by the team including that featuring in the original SAC's Detailed Science Case. The team took the latter (most familiar) case, the resolved study of $z \sim 2$ galaxies, and as an example for later work, completed the OCDD entry for this program. Excellent progress was made on a second application, emission line mapping in various fields, which is particularly suited to the TiPi design. Actions were agreed for the remaining science programs. With a modest amount of editing, this will complete the science input into the interim OCDD, which should be submitted well before Aspen TMT Week (September 26-30, 2005).

A set of key questions was posed in several team meetings with the instrument team, not just in the instrumental parameters noted in our previous report, but also in the mode of operation. As discussed in the instrument section, each of these was dealt with and reported back to the science team.

As discussed in the original application, the team has developed and now implemented two very different simulation models for IRMOS - one based on detailed numerical simulations of galaxies where the physical input is a priori known, the other more empirical and developed for early applications with Keck's OSIRIS. Both simulations were compared and cross-calibrated and their results have been incorporated in the draft OCDD.

3 DESIGN DESCRIPTION

Significant investigation of the optical design of the Caltech tiled focal plane IRMOS concept has been performed.

3.1 Acquisition strategy

Detailed consideration of the acquisition strategy for IRMOS has been made. We have embraced the concept of a full-field imaging acquisition camera to provide context for each of the deployable IFU fields-of-regard. The mapping of the IFU pointing onto the tiled focal plane

is made using an IFU back-illumination technique, with the camera detector serving as the astrometric fiducial. In addition, we are exploring the scientific need and feasibility of one or more dedicated point spread function (PSF) monitoring camera, which would provide additional astrometric reference for acquisition and possibly for plate scale monitoring.

3.2 Acquisition camera design

A full-field acquisition camera design has been developed that utilizes the unique ability of the TiPi concept to steer the beam independently for each focal plane tile. Details will be included in the deliverable documentation.

3.3 Throughput and Emissivity Budgets

Emissivity calculations have been performed. At this point, an exact operating temperature requirement for the optical surfaces of IRMOS is not established, as several assumptions regarding material properties need to be verified. It is believed that to meet the emissivity target specified in the SRD, temperatures for the IRMOS 'Cold Box' must be between -35 and -40C.

Furthermore, a study was conducted to ascertain whether the spectrograph optics, particularly the grating and MEMS deformable mirror devices, are required to be held at cryo- temperatures, or whether the Cold Box temperature range was sufficient. We determined that, aside from the possibility of using small internal heaters on the MEMS devices (should they be necessary and desirable), the remainder of the spectrograph does, indeed, require cryo- temperatures, typically 77K.

3.4 Optical Design

Our collaborator from Laboratoire d'Astrophysique de Marseille (LAM), Eric Prieto, visited Caltech for 10 days beginning on August 5, 2005. We conducted a range of optical investigations of the TiPi design that will be reported on in the IOCDD. In particular, the input Offner relay for TiPi was revised to accommodate our current thinking regarding the required stroke for the M6 global woofer (which is 12 microns of surface). Furthermore, Eric has simplified the original concept by Dekany, eliminating the need for a toroidal M4 mirror. Finally, Eric has simplified the laser guide star wavefront sensing light pickoff scheme using an 800mm diameter dichroic mirror, at normal incidence angle, to account for the differential 2.3m back focal distance for the LGS return light.

3.5 Mechanical Design

We have conducted an initial investigation into the mechanical packaging of IRMOS onto the Nasmyth platform. This will be reported upon in the IOCDD.

4 OBSERVATORY INTERFACES

4.1 Laser Guide Star Facility

Based on guidance from Brent Ellerbroek, we are now considering the use of 150 W of (true) CW laser power delivered to the sodium laser, assuming optical pumping and return levels recently published by the Starfire Optical Range (SOR). The SOR result for their 20 W CW laser is particularly encouraging, but requires independent validation before becoming the TMT 'standard candle' for laser return.

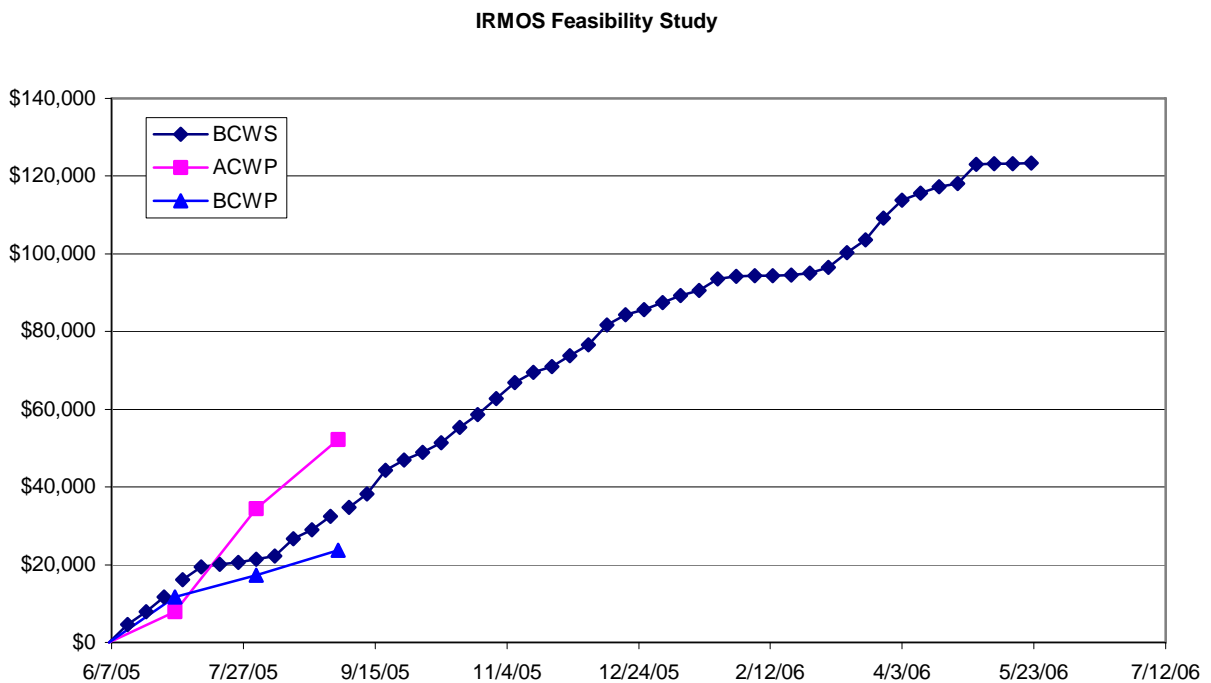
To accommodate our strategy of compensating for field rotation, the asterism of LGS beacons must be rotatable on the sky (but fixed in relative orientation/geometry).

4.2 Nasmyth Platform Layout

The footprint of TiPi on the Nasmyth platform is approximately a 3m diameter circle, including space for electronics racks. No holes are required to be cut into the platform to accommodate the TiPi spectrograph. The height of the full TiPi instrument off the Nasmyth platform is approximately 7-9m, with more detail to be reported in the IOCDD. This tower is fixed (e.g. does not rotate, as field rotation is accommodated by motion of the TiPi spectrograph on a large (upward-looking) rotation stage).

5 COSTS

5.1 Incurred to Date



To date, a total of approximately \$52,300 has been costed or committed under this contract. There is the indication of a divergence of Cost Variance that will be closely monitored. These numbers are approximate due to a time lag in correct reporting of Keith Taylor's labor during the month's of June 2005 and July 2005. When these figures are available, this EV plot will be updated accordingly, but are thought to be accurate to +/- 10%.

We believe this is due to some inefficiency incurred as we have been bringing a new OIR engineer up to speed on the IRMOS project, and significant use of more senior personnel (Taylor) in lieu of junior engineers, including the aforementioned for whom we have been awaiting.

These effects combined are a significant concern to study management. We will work to address this divergence through better control of Taylor's involvement in this project (vs. other work currently ongoing within OIR). In addition, we will reduce the amount of effort spent on instrument feasibility design details and concentrate on improving the operational and requirements definition. However, it should be mentioned that we do believe that the feasibility design work completed to date is necessary to provide appropriate push-back to the science team and for understanding the performance scope and basic cost trades for IRMOS.

5.2 Construction Cost Targets

Cost estimation for IRMOS will begin in January 2006.

6 GOALS FOR NEXT TWO MONTHS

The project schedule calls for, in the coming two months:

1. Submission of the IOCDD and IFPRD
2. Adoption of science-driven first light and upgrade path strategies
3. Refinement of the optical design based on the IFPRD
4. AO sky coverage estimation for the initial operational modes

Eric Prieto will visit Caltech for 10 days, beginning on August 5, 2005.