- TMT -

ASSOCIATION OF CANADIAN UNIVERSITIES FOR RESEARCH IN ASTRONOMY
ASSOCIATION OF UNIVERSITIES RESEARCH IN ASTRONOMY
CALIFORNIA INSTITUTE OF TECHNOLOGY
UNIVERSITY OF CALIFORNIA

7/31/05

IRMOS Feasibility Study
July 2005 Monthly Report

R. Dekany, Study Manager
and R. Ellis, Principal Investigator

Caltech Optical Observatories
California Institute of Technology
Pasadena, CA 91125

Abstract

Kickoff of the IRMOS feasibility study at Caltech has occurred with the initial tasks concentrating on further development of the science case, observing scenarios, and functional requirements. A project web page has also been established to facilitate communications.

Revision Sheet

Release No.	Date	Revision Description
Rev. 1	7/31/05	Initial report by R. Dekany

TABLE OF CONTENTS

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	Laboratorie 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 from start of contract (June 13, 2005) to (July 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.

2 SCIENCE REQUIREMENTS

Science team activities:

The science team activities were initiated on 6/24 with a review of available relevant documents. After some discussion, those Detailed Science Cases prepared by the SAC relevant to IRMOS were made available to all team members, of which two reside in Europe. The PI led a tutorial on the merits and flexibility of the TiPi design with respect to a more conventional multi-object deployment technique and emphasized the need to exploit this for a wider range of science than that currently listed in the SRD and DSC documents.

Two interim tasks were agreed with an internal deadline of early August, one directly applicable to each of the IOCDD and the IFRDD.

2.1 Operational Concepts

(i) Broadening the Science Case:

The original case for IRMOS centers around resolved multi-object spectroscopy of z~2 galaxies for which dynamical, excitation and other diagnostics are sought across a 2-5 arcmin field. We will refer to this as the `prime program'. The team has agreed on the need to develop, to a similar level of maturity, other science topics in order to better characterize the instrument and possibly raise its prominence in the ranking of first light instruments.

Accordingly, 5 new science topics were selected by the PI and team members were charged to develop a case for each, noting the flexibility of IFU deployment in the TiPi concept. A particularly interesting area which has been the subject of some discussion is blind field mapping where the contiguous IFU possibilities can be exploited for faint emission line surveys. The goal is to discuss each of these cases, plus further examples, and to select one or more for more detailed evaluation by the time of the final OCDD. At the time of writing, some but not all of these science cases have been delivered.

2.2 Functional Requirements

(ii) Considering the Instrument Parameters:

The PI defined a range of starting instrument parameters to the team and indicated those for which early evaluation is needed, particularly for the prime program. In early August detailed modeling tools will be established which will enable accurate deductions concerning signal/noise and physical parameter recovery. Prior to this effort, the multi-object aspects of the prime program have been the subject of analysis by David Law, a Caltech grad student working under the joint supervision of Chuck Steidel and the PI.

The surface density of accessible objects has been evaluated in various photometric redshift interval and, using GOODS data, the size and surface brightness distribution of sources checked with respect to the patrol field and IFU size. Next steps will examine angular distributions and the success of the TiPi concept in deploying a fixed number of IFUs.

2.3 Project Web Site

An IRMOS Team web site has been established at:

http://astro.caltech.edu/oir/irmos

containing contact information for our science team, our engineering team, and University of Florida / HIA science team; reference material including relevant portions of the SRD and detailed science case, working documents (such as technical memos), simulated PSFs, and project planning and controls documents.

IRMOS IPT meetings have been scheduled weekly on Monday morning at 8:30am (PDT).

3 DESIGN DESCRIPTION

Although the initial month of activity under the SOW concentrates on the development of requirements, some adaptive optics systems engineering has occurred.

3.1 Point Spread Function Modeling

Initial PSF models have been generated by team member Matthew Britton for the cases of seeing-limited observations and SLGLAO compensated observations. These have been provided to the science team as initial input to their science-based requirements definition. Additional, full MEMS-based MOAO PSFs have been simultaneously requested of Don Gavel, coordinated with B. Ellerbroek under his independent TMT contract. These are anticipated within a couple months.

3.2 Throughput and Emissivity Budgets

A review of the NFIRAOS reference design assumptions for throughput and emissivity has been made. These will be followed to promote consistency among AO systems.

3.3 Optical Design

An Offner-based optical relay has been adopted as an input relay for the TiPi spectrograph. This input relay will provide compensation (using one DM) to the entire science field and the laser

guide stars. For SLGLAO, this is the entire adaptive correction. In the case of MOAO, this serves to reduce the stroke and linearity requirements on MEMS DMs.

Initial consideration of the residual stroke requirements in each spectrograph (MOAO mode) has been made and preliminary consideration of the cost/benefit trade of using (very small) aspheric mirrors in the spectrograph collimator has been made.

Further details of the optical design will be addressed upon completion of the IOCDD and IFPRD.

3.4 Visible / Dual-channel Mode (not to be considered)

The decision was made to set aside consideration of inclusion of an additional visible spectrograph channel for each science target. Although the SRD lists wavelength coverage as "0.8 - 2.5 microns", we note that it is possible, with the TiPi architecture to consider shorter wavelength science channels. However, since this interesting science capability is outside the scope of this study, we will not pursue it at this time.

4 OBSERVATORY INTERFACES

Discussions regarding TMT LGSF requirements have been held during weekly AO coordination meetings chaired by B. Ellerbroek. Determination of the initial requirements for IRMOS cannot be made until completion of the IFPRD.

5 COSTS

5.1 Incurred to Date

Because of delays in establishing the governing SOW, Caltech accounting has not yet generated actual costs. Based on labor use and rates to date, ACWP during the period is approximately $1,400, while BCWP is $5,100. BCWS, however, is $13,200 indicating a slower than expected start to the project (e.g. Taylor and Britton travel to Ringberg Instrumentation for ELTs conference). Future reporting will provide earned value metrics versus time.

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. Drafting 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. Development of throughput and emissivity budgets
5. AO sky coverage estimation for the initial operational modes

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