

# **Time Domain Astronomy at WMKO**

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# 1 Introduction

This is WMKO’s response to the proposal from X. Prochaska on implementing a more sophisticated approach to Time Domain Astronomy (TDA) here at W. M. Keck Observatory.

Below we describe the Observatory flexibility and constraints on TDA. Note that we assume continuation of the existing “classical” mode of observing. Because this will be input to an ongoing discussion between the scientists and the Observatory, there will be some questions throughout that can be discussed further.

As is customary, we define two types of TDA: cadence, which can be scheduled in advance (during the usual semester scheduling process); and targets of opportunity (TOOs) that are not predictable in advance and hence cannot be scheduled through the normal semester scheduling process. There are, of course, “hybrid” situations, in which a TOO could lead to a request for cadence observations to track the evolution of some phenomenon. It is suggested that we treat all of these nights as TOO.

This document was prepared with extensive help and valuable advice from Randy Campbell, Rich Matsuda, Barbara Schaefer, and others.

# 2 Instrument availability

Instruments that are readily available, and are “hot” (i.e. prepared for observing) will be eligible for a TOO observation. In general, cadence observing will be scheduled when the appropriate instrument is already in use by the primary observer. (For example, we will try to schedule NIRSPEC cadence observing together with normal NIRSPEC observers, not with NIRC2 observers.) However, this will not be a hard and fast rule; it is only done to decrease the overheads of switching instruments at night.

Instruments are considered readily available if the OA can reconfigure from one instrument to another simply by commanding the tertiary mirror or the AO bench fold mirror to direct the telescope light to a different focus. *Instruments that require one or more people to physically reconfigure the telescope are not allowed at night.* This is for both resource and safety considerations.

Tables 1 and 2 show the instrument availability for Keck I and II when one instrument is scheduled. Table cells in which the deployable tertiary mirror will potentially allow access that is not currently available are highlighted in yellow.

**Table 1. Availability of Keck I instruments. If the telescope is scheduled with the instrument in the left-hand column, reading across for green cells with “OK” in them tells you which other instruments are available. The cells colored yellow are not currently available, but could be once the deployable tertiary is operational. However, only one of MOSFIRE or LRIS will be available with the deployable tertiary installed.**

TO:	HIRES	LRIS	LRISp <sup>1</sup>	MOSFIRE	OSIRIS	PCS/SSC
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FROM:						
HIRES	OK	no	no	no	OK	OK
LRIS	no	OK	no	no	no	no
LRISp <sup>1</sup>	no	no	OK	no	no	no
MOSFIRE	no	no	no	OK	no	no
OSIRIS	OK	no	no	no	OK	OK
PCS/SSC	OK	no	no	no	OK	OK

Note:

1. With the polarimetry module installed, LRIS is limited to single-object spectroscopy because of the highly reduced field of view.

**Table 2. Availability of Keck II instruments**

TO: FROM:	DEIMOS	ESI	KCWI	NIRC2	NIRES	NIRSPAO	NIRSPEC	PCS/SSC
DEIMOS	OK	no	no	OK	OK	sometimes <sup>2</sup>	no	OK
ESI	no	OK	no	no	no	no	no	no
KCWI	no	no	OK	OK	OK	sometimes <sup>2</sup>	no	OK
NIRC2	sometimes <sup>1</sup>	no	sometimes <sup>1</sup>	OK	OK	sometimes <sup>2</sup>	usually <sup>1</sup>	OK
NIRES	sometimes <sup>1</sup>	no	sometimes <sup>1</sup>	OK	OK	sometimes <sup>2</sup>	usually <sup>1</sup>	OK
NIRSPAO	sometimes <sup>1,2</sup>	no	sometimes <sup>1,2</sup>	OK	OK	OK	no	OK
NIRSPEC	no	no	no	OK	OK	no	OK	OK
PCS/SSC	sometimes <sup>1</sup>	no	sometimes <sup>1</sup>	OK	OK	sometimes <sup>2</sup>	usually <sup>1</sup>	OK

Note:

1. Either NIRSPEC, DEIMOS, or KCWI can be available on the right Nasmyth platform, but not more than one. Currently we try to keep NIRSPEC available at that focus.
2. NIRSPAO (NIRSPEC moved to behind the AO system) is only available during scheduled NIRSPAO observing runs. We do not have a policy for keeping an instrument (either DEIMOS or KCWI) in-beam on the right Nasmyth platform while NIRSPEC is in the AO enclosure.

Even if the table shows that an instrument could be available, that instrument may not be “hot,” i.e. ready for observing. We need to take instruments off-line in order to perform regular maintenance tasks, as well as more involved troubleshooting and repair tasks. The Observatory will maintain a Web page that lists the currently available instruments for each night. We expect to define one week per month per instrument when that instrument will be unavailable.

## **2.1 Daytime calibrations**

Performing calibrations for impromptu TOOs can also be challenging. The instruments will be available for calibrations in the morning only until 7 a.m. The OAs can arrange for the dome to be dark, the telescope and dome positioned properly, and the dome flat lamps turned on until this time. But the OAs will not stay later than it takes to set up these conditions.

Cadence observers should plan on getting their calibrations the afternoon before their observations, unless those calibrations do not require specific dome and telescope states (such as dome dark, telescope stationary). Many DEIMOS, ESI, HIRES, and NIRSPEC calibrations can often be done under any arbitrary telescope and dome states.

## **3 Instrument reconfigurations (slitmasks, gratings, etc.)**

Instruments such as LRIS and DEIMOS can be configured with different sets of slitmasks, but also different gratings and filters. Changing these configurable components takes daycrew time, and in general we do not support changing these at night, due to resource and safety considerations. We would propose that any TOO observer would be able to make use of whatever components are installed in the instrument at the time. This is especially true when observers are scheduled with that instrument, as they will have their own set of component requirements.

Cadence observers will be placed on the telescope schedule in advance, and will have to coordinate with the other observing team or teams also scheduled on their night. This is what split-night observers must currently do.

In some situations we may get a request to do an instrument reconfiguration specifically for TDA. We will limit this to twice a semester for each of LRIS and DEIMOS, and only under exceptional circumstances.

The red and blue cross-dispersers in HIRES are interchangeable only during the daytime. However we will not support any *extra* daytime changes of these optics for TDA, and we will not support night-time changes.

## **4 Observer support**

Cadence observers can expect a Support Astronomer (SA) to be available only in the first hour of each night. TOO observers should not expect to have an SA available at all hours of the night except as on-call emergency support.

## **5 LGS-AO**

### **5.1 Keck I**

We will allow TOOs requiring LGS-AO on Keck I only after TBAD is commissioned on Keck I. (We expect this to be in June 2014.) At that time we will allow scheduling of cadence TDA in advance (during normal semester scheduling) even if that night has no other LGS-AO scheduled. The SA will perform the LGS-AO checkout (currently taking about an hour) at the start of the night, independent of when during the night the cadence

observing will occur. As it currently is, the checkout time will be charged as science time, not as engineering time, as it is an overhead to performing LGS-AO science.

## **5.2 Keck II**

We will only allow LGS-AO TDA (both cadence and TOO) if the night is already scheduled as LGS-AO. This is because of the increased time and overhead of running the current Keck II laser system. This policy will be reviewed after we commission the next generation laser on Keck II and retire the current dye laser.

## **5.3 Advanced notice**

LGS-AO TOOs will require advance notice of the target coordinates—at least 12 hours advance notice for nights already scheduled as LGS-AO and at least 24 hours on other nights—so that we have time to coordinate with U. S. Space Command (USSC). This may change once we implement a “tiled” request, similar to how LGS-AO surveys handle USSC coordination<sup>1</sup>.

Note that we can pre-approve TOO targets with coordinates known in advance. (An example is flaring in the Crab Nebula. The coordinates are well known, but the TOO nature is *when* something interesting will happen. A counterexample would be a nearby supernova—you don’t know *when or where* the event will occur.) LGS-AO TDA observers should contact WMKO support staff in advance if they want a coordinate regularly included in the target lists sent to USSC.

# **6 Engineering**

We would like to include engineering time in this concept as well. TOOs will be able to interrupt engineering time, and urgent engineering time will be able to interrupt scheduled science observing. (Note that we currently do this by taking up to an hour away from any appropriate science night. We will still plan the bulk of our engineering on pre-scheduled engineering nights, but on occasion there are engineering tasks that we would like to carry out on relatively short notice. When possible, we coordinate with the observers to select the best time to perform the engineering task.)

Note that some types of engineering are not conducive to science interrupts. Usually this is because some equipment (instrument, AO component, etc.) is being tested, and the telescope, AO bench, or instrument is not in a state that allows for science. Because this is a judgement call, the WMKO person in charge of the engineering will make the definitive call as to whether to allow an interrupt.

# **7 Special cases**

There may be circumstances in which you do not want to allow a program to be interrupted. An example might be an exoplanet transit program that requires a minimum

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<sup>1</sup> In the “tiled” approach an observatory requests closures for many relatively large (azimuth, elevation) sections of the sky. The TOO observations are then coordinated for a time when the target is in a tile during a time when there are no closures.

baseline of time to be scientifically useful. Another example could be a high priority program that you want to complete data taking as quickly as possible.

## 8 Time accounting

We will use the Program Identification GUI (PIG) to indicate when programs change. It will be important for observers to faithfully use this tool to accurately reflect which program is being done at any given time.

Time balances will be kept to a fraction of an hour (nominally to 0.1 hours).

For every hour of TDA observing time, the accounting system might use a multiplier (e.g. so that 1 hour of TDA counts as two hours against that institution for an inter-institutional interruption).

## 9 Miscellanea

In general WMKO personnel will not be responsible for setting up and observing TDA targets.

We will support full remote observing as we currently do. In particular we will not support running observing software from anywhere (home, hotel rooms, etc.)<sup>2</sup>. Eavesdrop mode from places other than the approved remote observing rooms might be considered.

Condition-based flexible observing will not be implemented by the Observatory. Partner institutions may come up with a process that does not involve Observatory resources. (Note that condition-based flexible observing in the Prochaska proposal was discussed in terms of a backup observing plan in situations of poor conditions, not as overrides generated because of excellent conditions.) This type of observing can be treated as a TOO, in the sense that a different program takes over observing for a period of time from the scheduled program. However, while you might want to restrict the amount of time that a TOO takes from the scheduled observer, in the case of a poor seeing queue, you might want to allow a larger amount of time (for example, as long as the seeing stays above some threshold).

## 10 Considerations for the institutions

There are a number of questions that should be discussed with the institutions. Among them are:

- What should the Keck I Cassegrain instrument be once the DTM is deployed? Should we adjust the timing of the changeouts so that MOSFIRE is in during bright time, LRIS during dark time, or just try to keep one of them in beam all the time?

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<sup>2</sup> The issue here is not that the computer used be able to reliably run VNC, but rather that usually these informal observing locations rely on a commercial internet service provider (ISP). These usually have smaller bandwidth and higher latency than university networks, and there is a significant potential for problems with routers and firewalls along the path and outside of our control.

- The institutions should also consider RNAS on Keck II: NIRSPEC, DEIMOS, or KCWI?
- We need to develop a mechanism for telling when an instrument is not “hot” and hence unavailable for TDA. We might use a regular maintenance cadence for each instrument, or schedule maintenance around cadence and normal observing requirements.
- What to do about conflicting TOO groups? Should TACs communicate with each other to discuss deconfliction? Should WMKO have any role in this?
- Should there be programs that are “immune” from interrupts? How do we decide on these, and communicate and bookkeep that fact?
- How is overhead, such as LGS-AO checkout or calibration standards, handled?
- Do you want any restrictions, such as not allowing interrupts or cadence during split nights?
- We need a list of approved TOO programs each semester.
- We need to get some of the accounting infrastructure in place before handling cross-institutional TDA. (Institutions themselves may want the accounting software in place before they move forward even with intra-institutional TDA.)
- It would be easier to schedule cadence if TDA were cross-institutional.
- Can we limit the number of TOO interrupts, at least at the beginning? Perhaps to seven per semester.
- Do we allow the scheduled PI to finish his/her exposure, target, etc. before a TOO takes over?
- Should the time accounting be 1:1? (The Prochaska proposal suggests that if one institution takes an hour from another institution, the originally scheduled institution should get two hours in return.)
- Should we discuss a poor weather (aka backup) queue? If the institutions are interested in such a queue they should develop the methodologies, trigger protocol, time accounting, etc. completely within their resources.

## 11 Resource estimates

WMKO also needs to estimate how much time various tasks will take. For example:

- Creating a Web page that displays currently available instruments, and the interfaces that allow WMKO to efficiently maintain this information.
- Creating the time accounting software, including software to mine the PIG logs for exact start and stop times.
- Extra daycrew time to do additional instrument and telescope reconfigurations. (*4 person-hours per reconfig*)
- Extra cross-training for SAs to allow support of instruments that could become activated by a TOO.
- Is anything missing from this list?