



K1DM3 Design Note
Prototype for the K1DM3 Project
Version 1.3, March 9, 2015

By J. Xavier Prochaska, Chris Ratliff, Dave Cowley, Sean Adkins, Jerry Cabak

INTRODUCTION

The Keck I Deployable Tertiary Mirror (K1DM3) is being designed to replace the current tertiary module (M3) within the Keck I tertiary tower without modification to the latter. Given our prior experience with installing systems within the tower (e.g. the Atmospheric Dispersion Corrector) and the tight tolerances on space for the design, we intend to bring a prototype of K1DM3 to WMKO during detailed design and test its interfaces with the tower. Our current plan is to manufacture the outer drum of the K1DM3 module and attach several exterior pieces to serve as the prototype.

PREREQUISITES

The following areas of the K1DM3 system must be brought to the Detailed Design level (or close to it) prior to full fabrication of the prototype:

- The outer drum including defining point interface details with full adjustability
- The inner drum and its positioning system [??]
- The swing arm assembly system [DONE]
- The bipod struts [DONE]
- The rotation bearings [IN PROGRESS]
- The location of the module defining points [IN PROGRESS]
- The outer rollers for installation [DONE]
- The anti-tip assembly [IN PROGRESS]

FABRICATION OF THE PROTOTYPE

The principal component of the prototype is the outer drum of the K1DM3 module. Attached to this will be several components used to interface to the tertiary tower. In addition, we will test whether the K1DM3 system interferes with several items at the top of the tower (e.g. the forward baffle mounts) or with the interior of the tower during installation. Note that we do not expect to be able to rotate any part of the prototype.

These tests require the fabrication of the following components:

1. The outer drum piece, fabricated by Tapemation, Master Metals or a similar shop.
2. The module defining points, attached to the outer drum.
3. The rollers used for installation of K1DM3 within the tower including new anti-tip assembly.
4. Mock mechanism that engages the tertiary tower chain to assist in moving the module in and out of the tower.



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5. A mock rotation drive motor.
6. Inner drum pneumatic detent positioner (or a mock-up).
7. A tower clearance spider. A sheet of large gauge mesh positioned normal to the tower axis, to travel through tower with Prototype. The mesh would be trimmed to clear any and all obstacles. The final product would be the thru-clearance footprint of the tower. This is the maximum envelope profile that can pass safely thru the tower.
8. A mock set of bipod struts. These should be placed at the position most likely to interfere with the upper tower components.
9. A mock swing arm with mock actuators that can retract to the nominal position. This should be attached at the nominal retracted position most likely to interfere.
10. A custom fixture used to measure the locations/orientations of the three defining points of the existing tertiary module. [AVOID]

The figure below shows a diagram of the proposed prototype.

[TBD]

TESTING PROCEDURE AT WMKO

After fabricating the prototype at UCO, we will ship it to WMKO for testing within the tertiary tower. The following table summarizes the tasks (in order), the personnel involved, an estimate of the time to complete, and additional comments. During many of the activities, we would need a person to photograph the process. We currently estimate the process will require one work week from the start of unpacking to the completion of repacking, especially as one allows for other summit activities.

Activity	Personnel	Duration	Comments
Package the prototype at UCO for shipping	UCO staff	3 days	Minimize disassembly (e.g. of the mock swing arm)
Ship prototype to WMKO	UCO staff	1 week	Air Freight to KOA
Transport prototype to summit	WMKO staff?	1 day	Check whether early arrival is acceptable. i.e. Is there sufficient storage space at WMKO? Depends on size of crate.
Unpack at WMKO	WMKO, UCO staff	4 hours	Save packaging
Remove existing tertiary module from the tower. Lower to dome floor. Store on the floor cart.	WMKO staff	½ day	Will require jib crane, telescope movement, access restrictions.
Measure the 3 defining points of existing tertiary module with a custom fixture	WMKO, UCO staff	3 hours	Requires existing tertiary module on handling cart. Can do in parallel with assembly of prototype.



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Activity	Personnel	Duration	Comments
Assemble prototype	UCO, WMKO staff	4 hours	Will this be necessary? Most likely shipped assembled with exception perhaps of the clearance spider.
Transport prototype to the deck. Hoist from dome floor.	WMKO staff	2 hours	Requires jib crane, telescope movement.
Mount prototype on handling cart	WMKO staff	4 hours	
Adjust prototype defining points using custom fixture	UCO staff	2 hours	UPDATE
Insert prototype into tertiary tower and attach to defining points.	WMKO staff	6 hours	Check clearances & trim spider as needed.
Survey prototype location relative to optical axis.	WMKO/UCO staff	2 hours	Check K1DM3 cross-hairs with an alignment telescope and existing cross-hairs for aligning the current tertiary module.
Evaluate & note clearance of bipods	UCO/WMKO staff	1 hour	Photos from manlift
Evaluate & note clearance of retracted swing arm	UCO/WMKO staff	1 hour	Photos
Assess vignetting with PCS camera	WMKO staff	3 hours	Daytime only, if possible.
Remove K1DM3 from tertiary tower. Place on handling cart.	WMKO staff	1-2 hours	
Remove K1DM3 from handling cart. Lower to dome floor.	WMKO staff	1 hour	Requires jib crane, telescope movement.
Hoist existing tertiary from floor cart to deck.	WMKO staff	2 hours	Requires jib crane, telescope movement.
Place existing tertiary on handling cart.	WMKO staff	1 hour	
Package K1DM3 for return trip	WMKO/UCO staff	4 hours	
Ship K1DM3 to UCO	WMKO staff	1 hour	

For several of these activities (e.g. attaching K1DM3 to the tower defining points), we should generate a more detailed procedure.

SCHEDULING

Prior to placing an order for the outer drum, the project wishes to hold a review of those drawings and a comprehensive discussion of any other pieces of K1DM3 that affect that drum's design. We plan to hold this on March XX, 2015 at UCO.



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We will need to schedule the tests at WMKO during a 5+ night run with MOSFIRE. This will insure that neither the existing tertiary module nor the ADC are installed. We are communicating with the scheduler at WMKO to identify time in August or September 2015.

Here is a draft timeline leading to the prototype activities at WMKO.

Date	Activity	Comments
3/9/2015	Today	
3/30/2015	Design review	Outer drum and any parts with major impact on its design. UCO + WMKO.
Early May	Select vendor	Submit RFQ; submit PO [5 weeks]
April-Aug	DD	Design work; mock fabrications (bipods); actual fabrications (rollers, defining points)
-2 weeks	Package prototype	Ship to WMKO
September	Tests at WMKO	

TOP CONCERNS/RISKS

- Is there a spare handling cart for the prototype? Can we use K2's? No. We'll store the existing tertiary on the floor cart.
- How does one adjust with the kinematic defining points during installation?
- Where do we store the existing module during these tests?

OTHER CONSIDERATIONS

- We will appropriate shim stock for adjusting the prototype fixtures
- Bring necessary set of tools including disk grinder
- Can the PCS be used to check for vignetting during the daytime?