F/5 Wave Front Sensor for the 6.5m MMT

CE Review

Agenda

- System Overview / Operational and Science Requirements
- Mechanical Details
- Electrical Details
- Instrument Control and Software
- Handling, Assembly, Integration
- Schedule
- Q & A / Discussion

The Team

- Dan Fabricant - *Science*
- Ed Hertz - *Project / Mechanical*
- Mark Mueller - *Mechanical Engineer*
- Henry Bergner - *Structural Engineer*
- Mike Honsa - *Mechanical Design*
- Tom Gauron - *Electrical Engineer*
- Everett Johnston - *Electrical Engineer*
- David Weaver - *Electrical Engineer*
- Florine Collette - *Electrical Technician*
- John Roll - *Software Engineer*

Science Requirements

- Used to optimize image quality at the 6.5m MMT telescope for the f/5 optical system.
  - Ensure best focus, collimation, and figure of the primary mirror.
- Perform calibration for best image.
  - Look up table to command active optical elements of telescope.
- Monitor image quality during observations.
  - Apply image correction 1-4 times per hour

System Overview

- Mounted to telescope instrument rotator at opposite (top) surface to f/5 instruments.
- Located within the “cone” of the 6.5m primary mirror support structure.
- Power, Ethernet, and cooling only– all electronics are internal.
- Weight = ~550lbs

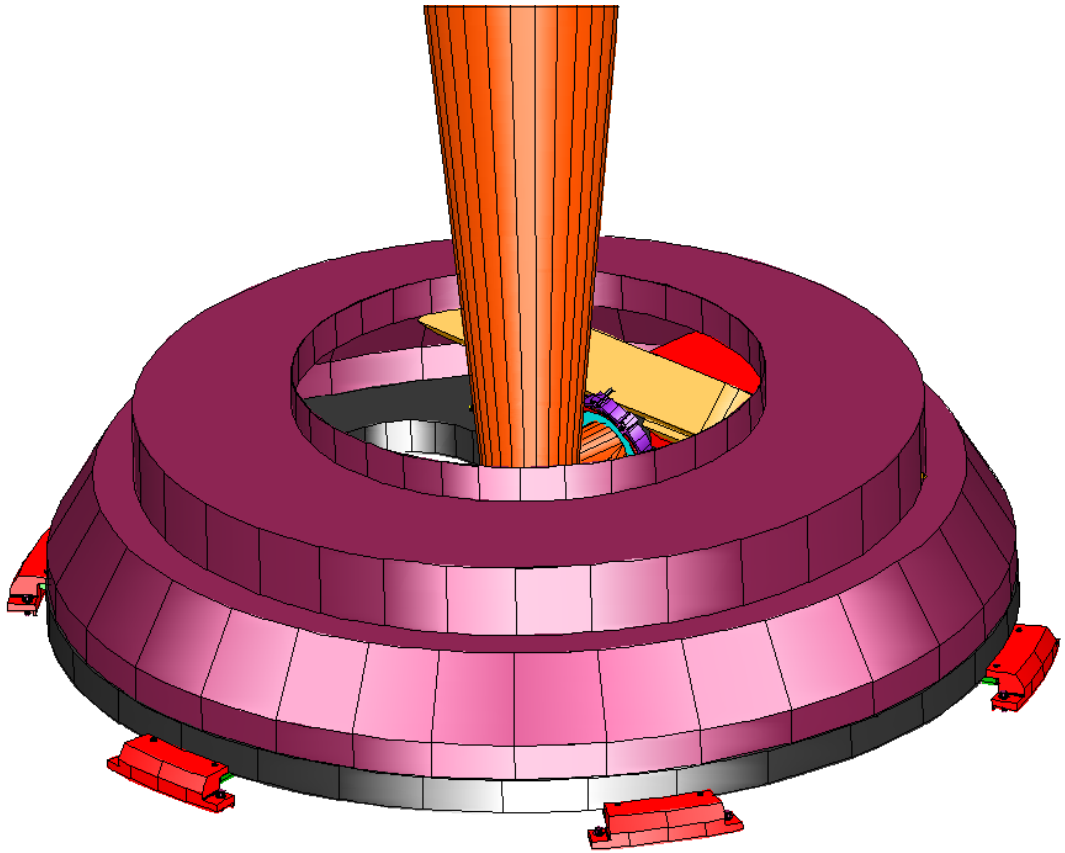
Instrument Requirements

- Must fit in the “cone” of the primary mirror support structure.
- Must be able to be stowed to a non-blocking position during f/5 instrument operation.
- Must provide a stable image during calibration and image monitoring functions.
- Must be delivered to the telescope before end of calendar 2002 (i.e. November).
- Instrument Budget = ~ $225K

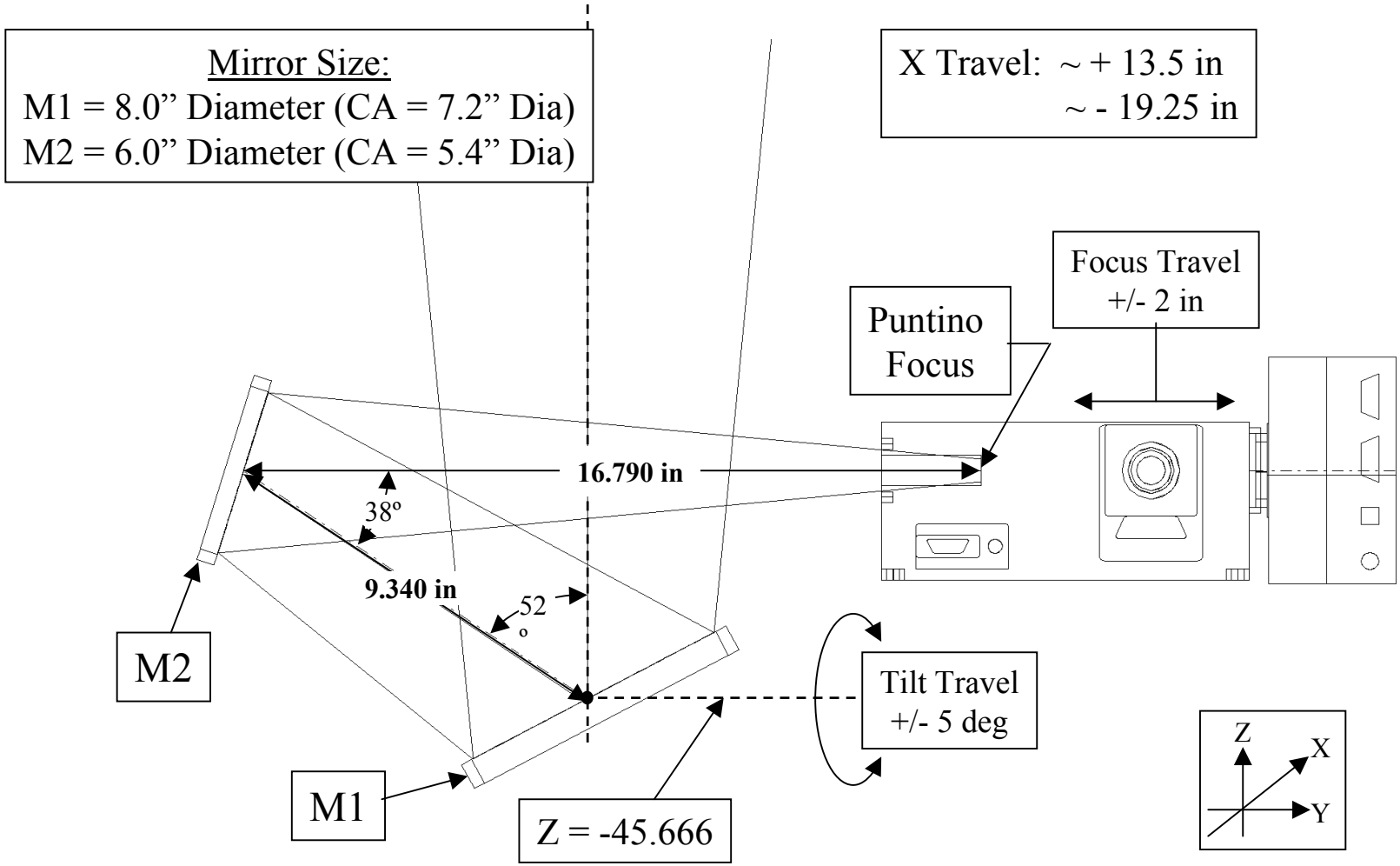
Image Stability

- Maintain relative focus of the instrument focus to the f/5 focal plane (~50 um).
- Minimize movement of image across the camera focus during instrument operation due to component movement (~50 um).
- Minimize movement of image across the camera focus as a function of component tilt (worst case = ~ 30 arc-seconds at 1st fold mirror).

WFS System Design



WFS Optical Path



WFS Major System Components

- Puntino – Shack Hartman Sensor Assembly
  - Spot Optics – Padova, Italy
    - SBIG cooled CCD camera for acquiring SH Frames
    - Uncooled CCD camera for acquiring guide stars
- Translation / Rotation Assemblies
  - THK America – Boston Office
    - Field translation axis: +13.5 inch / -19.25 inch travel
    - Camera select axis: +/- 2.88 inch travel
    - Camera focus axis: +/- 2 inch travel
    - Mirror tilt axis: +/- 5 º travel
- WFS Structural Platform
  - Newport Corporation – Irvine, CA
    - Stainless steel vented honeycomb core with stainless steel face sheets.

WFS Major System Components

- Science Camera w/ Filter Wheel Assembly
  - Apogee Instruments – Auburn, CA
    - AP8 cooled CCD camera for imaging
  - Optec, Inc. – Lowell, MI
    - Four filters and a blank
- Relay Mirrors (M1 & M2)
  - Janos Technology – Townshend, VT
    - Aluminum coated, Pyrex plano mirrors (8” & 6” Dia, 90% CA)
    - ~ 6/1 ratio of diameter to thickness
    - A-thermalized RTV mounts

Weight Summary

• Tilt Mirror Assembly	30 lbs
• Focus Assembly	22 lbs
• Camera Select Assembly (includes Focus Assembly)	28 lbs
• M2 Mirror Assembly	6 lbs
• Field Translation Assembly (includes All Above Assemblies)	125 lbs
• Platform Assembly	350 lbs
• **Total Weight**	**550 lbs**

Mechanical Details

M1 & M2 Mirror Mounts

- Aluminum coated Pyrex mirrors
- 90% clear aperture
- RTV mounted in an Aluminum Bezel
  - 3 discreet pads
  - Axial and radial restraint
- M1 – one axis rotation
- M2 – fixed
- Alignment required at integration - shims.

Tilt Mirror Assembly

- Tangent Arm Drive Mechanism
- +/- 5 degrees tilt (+/- 8 degrees available)
  - 1 degree / second
- 6mm lead ball screw drive
- Kollmorgen brushless DC motor
  - 21.5 oz-in continuous
  - 56.3 oz-in peak
- 1000 PPR rotary encoder – quadrature output
- 3.5 arc-second resolution
- Power-off brake on tilt axis
- Counter-weighted to reduce drive requirements

Camera Focus Assembly

- THK Custom Assembly with added outrigger rail and guide block for added stability.
- +/- 2 inches travel (+/- 2.25 in available)
- 6 mm lead ball screw drive
  - 10 mm / second
- Kollmorgen brushless DC motor
  - 35.3 oz-in continuous
  - 101 oz-in peak
- 0.5um resolution Renishaw linear encoder
- Power-off brake

Camera Select Assembly

- THK Custom Assembly with added outrigger rail and guide block for added stability.
- +/- 2.875 inches travel (+/- 3.2 in available)
- 6 mm lead ball screw drive
  - 25 mm / second
- Kollmorgen brushless DC motor
  - 35.3 oz-in continuous
  - 101 oz-in peak
- 0.5um resolution Renishaw linear encoder
- Power-off brake

Field Translation Assembly

- THK HSR 25 LA-M Rails – C0 Preload
  - 2 Blocks - Drive Side.
  - 1 Block - Far Side.
- NSK Stainless Ball Screw
  - 10 mm lead
  - 100 mm / second
- + 13.25” /- 19.25” inches travel (35” available)
- Kollmorgen brushless DC motor
  - 1.90 lb-ft continuous available
  - 5.46 lb-ft peak available (~1 lb-ft required).
- 1.0 um resolution RSF linear encoder
- Power-off brake

Performance Summary

- Defocus Error Requirement = 50um
  - Predicted < 50 um
    - Stiffness of Newport platform.
    - Stiffness of field translation beam.
    - Material CTE variation (Aluminum vs. Steel)
- Image Stability Requirement = 50um
  - Predicted < 50um
    - Stiffness of Newport stages.
    - Stiffness of field translation beam.
    - Stability of M1 Mirror Axis.

Electrical Details

Instrument Control and Software

Instrument Control & Software

- Computer - components chosen for small size/ low power
  - Via Flex ATX small form factor motherboard
  - Via C3 low power 800MHZ CPU
  - Laptop hard drive
  - Micro ATX Compatible 145 Watt Power Supply

- Motion Control
  - Delta Tau PMAC PCI 4 Axis servo controller
  - Integrated into MMTI PMAC Motion interface
  - Controlled with vendor supplied PMAC-PCI PTalk ActiveX Com Object

Instrument Control & Software

- Data Acquisition
  - Apogee Science Camera
  - Integrated into MMTI Science data system
  - Controlled with vendor supplied ActiveX Com Object
- SBIG Shack-Hartman Camera
  - Integrated into MMTI Science data system
  - Send FITS images to MMT wavefront analysis system (Steve West)
  - Controlled with Vendor Supplied Dynamic library
- Pixelink Seeing Camera
  - Integrated into MMTI Science data system
  - Controlled with Vendor Supplied Dynamic library
- USB A/D Temperature Monitoring
  - Integrated into MMTI PMAC Motion interface
  - Controlled with Vendor Supplied Dynamic library

Handling, Assembly, Integration

Handling Cart

- 3” x 1.5” welded tubular construction
- Hydraulic (hand actuated) lifting cylinder.
- 6” OD locking casters
- Counterweight loading points to minimize lifting/lowering torque requirements.
- Trailer hitch for lab towing.
- Weight = ~300 lbs (without counterweights).

Schedule

Schedule

- Puntino – delivery early November.
- THK – delivery early November.
- Complete Design and Analysis of Field Translation Beam.
- Parts need to be made immediately!!!
  - Reduced instruction-set drawings.
  - Machine from CAD database.
- Instrument Delivery – end of November.

Q & A / Discussion