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Prime Focus Imaging  
Spectrograph  

Status  

• Optics repair - in progress!  
• Status of other fix and improvement projects  
• Focus tilt analysis - not as bad as you thought  
• Detector issues - efficiency closet issues  
• Commissioning progress - polarimetry  
• Budget  

Last Meeting: Throughput/ Ghosts  

• Inspection + laser in-situ measurements:  
  – Yellow ghost due to coating problem on dewar window  
  – Grey loss in camera and possibly collimator "main group"  
  – UV loss in 3 subassemblies  

• Instrument removed (Nov), optics shipped to Pilot Group in Calif (Dec)  
• Disassembled into multiple, throughput measured by monochromator (Feb-Mar):
Throughput – Collimator

- No grey loss
- Sharp UV loss at 380 nm in both triplet and doublet
- Agrees with collimator laser measurements
- Solgel coatings good

Throughput - Camera

- Grey loss in camera triplet
- Same UV loss signature seen in camera quartet and triplet
- Agrees with camera laser measurement
- Transmission loss seen in field flattener (dewar window) consistent with coating problem
Comparison with on-sky

- Stacking all transmission measurements and dividing by expected (from coating witnesses and design): Agrees well!
- => 2 small problems and one big one:
  - flattener coating
  - camera triplet grey loss
  - UV loss signature in 4 multiplets

Flattener Coating Repair

- Vendor (Spectrum Thin Films) agrees front surface is bad. The other surface (same coating) is good.
- Witness sample curve from run looks good.
- Flattener has unique coating: humidity-resistant multilayer on fused silica. 3 other SPT multilayers on silica are good. Presume one-time process problem.
- Too risky to chemically remove bad coating - now being polished off by lens figuring vendor (Janos)
- SPT to recoat gratis, also apply new water resistant overcoat if UV tests good
- Will remeasure transmission after recoat
Camera Triplet – Grey Loss

- Seen as bright disk looking back into camera after removing detector
- Bright disk is at center of curved interface between NaCl and Silica in camera triplet (last element)
- Camera Triplet is the only multiplet with grey loss
- Fluid expansion bladder found to be empty. Bladder is common to both gaps.
- Bright disk vanishes when bladder refilled and pressure slowly released from multiplet. No apparent damage to optical surfaces
- No explanation for fluid loss: no evidence of leakage. Other multiplets OK so far.
- Currently watching fluid levels, experimenting to see if fluid is absorbed into RTV; will remeasure triplet transmission.

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UV Throughput Problem - Cause

- Common spectral signature + no substrate / coating in common
- Only multiplets => coupling fluid (0.8 mm pathlength)? Yes, 1 mm fluid samples all show signature
- Fluid shows signature after incubation with polyurethane (expansion bladders)
- Also see UV rolloff from viton in O-rings. Verified by Goodman spectrograph fluid (3 yrs)

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Compatibility Experiments

- Need to change fluid and/or bladder and O-ring material: incubate at 35°C & measure transmission (1 mm path)
- UV Fluids: current Cargille LL5610 ("solixane") or new LL3421 ("perfluorocarbon")
- Bladder: current polyurethane, bad with both fluids: need to change. 3 materials compatible
- O-ring: current viton OK with new LL3421 fluid. Current fluid only good with silicone O-Rings
- Fluid: new fluid OK with other materials in multiplets

UV Throughput repair

- Current plan: flush/ replace fluid with LL3421, replace bladder with compatible material
- Can be done without disassembling multiplets
  - Pro: avoid risk of contaminating coatings, exposing NaCl
  - Con: additional 1% transmission loss in 18 fluid/ glass interfaces since index match not as good
Repair plan

Mechanical Fixes/ Improvements

- Slitmask mechanism
  - severe reliability problems due to difficulty of aligning magazine, carrier, and focal plane chute
  - redesigned, rebuilt, in bench testing
- Grating stage flexure
  - out-of-spec flexure perpendicular to dispersion
  - repair current grating stage; purchase new, improved one
- Etalon flexure
  - ring centers do not flex the same: dual etalon difficulty
  - etalon seat redesigned; in machining
- Improve filter barcode reading reliability: done
- Fix guider interference (limits field): not done
- Improve baffling
  - moving baffle damage, maintainability. Material received
  - payload/ instrument interface. Material received
- Mount UW startracker. 7 deg field video; outreach webcam of telescope FOV. Interfaced
Spare Control System

• Full-up spares control boxes
• Mechanism simulators
• swap out failed box, troubleshoot on ground
• done - in checkout

Focus Tilt

• RSS Longslit PV PI's found unexpected focus gradation across spectrum, especially with narrow 0.6" slit where spectrograph focus contributes
  – Find magnitude of effect at least 3x expected from known longitudinal chromatic aberration
  – Suspect intended fixed detector tilt varied under flexure due to poor seating of detector, corrected in Nov 2006 (16.6' = 4500 microrad)
• Analyzed what would be ultimate performance if tilt mechanism added
Tilting the Detector

- With 0.6 arcsec slit, fixed tilt gives maximum 13% focus gradation
- With adjustable tilt, typical effect 2-3%, except ~5% in UV
- Design implications
  - tricky redesign of detector interface to minimize flexure
  - use PZT + DAC to avoid use of control axis
- Do we want to do this?

Detector – Full Well

- RSS detector gains were set such that the lowest gain ("BRIGHT/FAST") just saturates the A/D when the summing well is full (saturated 2x2 binning).
- PV observations found saturation at 25% A/D saturation, requiring 4x as many readouts for high S/N targets
- Dave Carter finds that CCD spec fine print says summing well is 4 pixels deep only in "low sensitivity" mode, where noise is >2x the standard ("high sensitivity") mode, which has 1 pixel deep fullwell.
- khn proposal: replace BRIGHT/FAST with low sensitivity mode, decrease gain in FAINT/FAST to improve dynamic range. Reasoning:
  - BRIGHT/FAST: for high photon rate projects
  - FAINT FAST: for projects requiring many readouts

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Detector - Overhead/ Reliability

- During polarimetric commissioning, found that detector readout overhead 2-4x actual readout time (time used in PIPT), e.g.
  - 2x2 Fnt/Slw: 25 sec, should be 12
  - 2x2 Fnt/Fs:t 16 sec, should be 4
- For any mode requiring many readouts, a serious efficiency hit 10-20% on 100sec readouts.
- Why?
  - unnecessary prep time? (S/W being modified)
  - disk save time. Does seem quite long
  - transfer to Quack? Quite variable
- Detector susceptible to crashing if click mouse at wrong time. Can cause severe extra "overhead" plus operator frustration.
- => Hardware and/ or software architecture may be inadequate to service I/O and user interface.
- (khn opinion) PDET HW/SW should be re-assessed from ground up.

Commissioning

Nov 2006 Polarimetric. Calibration:
- Linear polarimetric efficiency and position angle zeropoint with QTH lamp and polaroids
- Linear instrumental polarization with 2 standard stars in 300 and 900 l/mm gratings with M30 globular cluster in imaging mode
- Linear polarization position angle calibration and repeatability with 3 standard polarized stars in 300 and 900 l/mm grating
- After RSS return: < 400 nm
Polarimetry P-V

November 2006 Polarimetric PV

- SNe. 300 l/mm. 4 epochs of SN2006mq (late SNIa); 5 of SN2006mr (premax SNIa). Imaging pol of fields. (Nordsieck/Hole)
- High spectral resolution spectropolarimetry. T Ori, MWC120 (Herbig AeBe), 2300 l/mm, 0.6 arcsec (R ~ 10,000) at H alpha. (Vink, Armagh)
- Longslit spectropolarimetry of Orion nebula in support of FP polarimetry
- Fast spectropolarimetry (~100 sec) on Blazar PKS0537-441. (Fairall)
- All-Stokes spectropolarimetry of mCV (Potter, Brink)
- Analysis software still in work (UW)

Cost to Completion

- Includes repair cost estimate
- Still predicting CTC ~20% over CDR budget