ZWICKY TRANSIENT FACILITY

Commissioning Plan

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Outline

- ZTF Technical Commissioning Activities
  - Pre-commissioning Activities
    - HPWREN
  - PTF Decommissioning Activities
  - Metrology Activities
    - Telescope alignment
    - Dome and telescope drive optimization
    - Focal Plane Array alignment
  - “First Light” Activities
    - Transmission validation
    - DIQ validation
  - Reference Fields and the Onset of Transient Science
  - Ongoing Maintenance Activities

ZTF PRE-COMMISSIONING ACTIVITIES

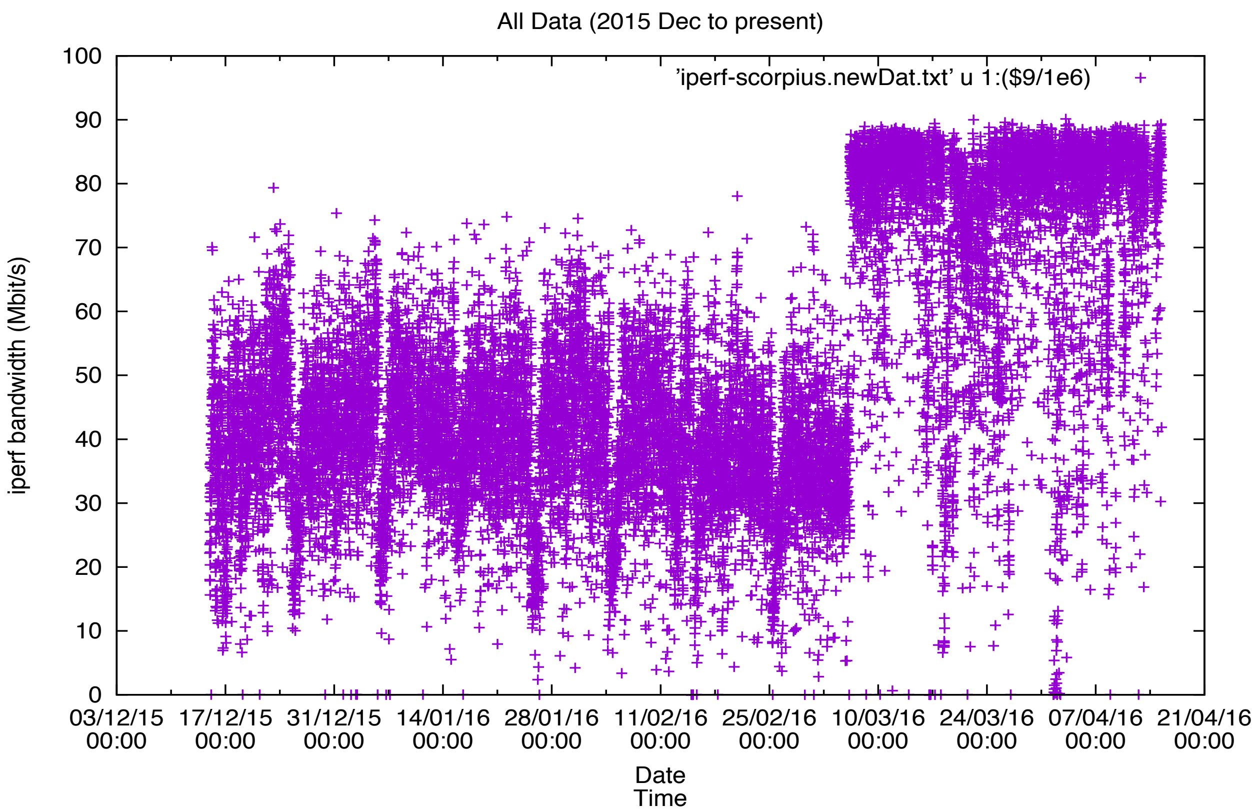
HPWREN

- HPWREN (High-Performance Wireless Research and Education Network) administered by UCSD/San Diego Supercomputing Center
- HPWREN dates from 2000, and Palomar has been an HPWREN partner since inception.
- Currently (2011) we are an HPWREN Tier-1 Partner, and have made an open-ended institutional commitment to remain so
- HPWREN supports ALL internet connectivity to/from Palomar (data transfer, telepresence & remote observing, personal use)

http://hpwren.ucsd.edu/

ZTF Pre-Commissioning Activities

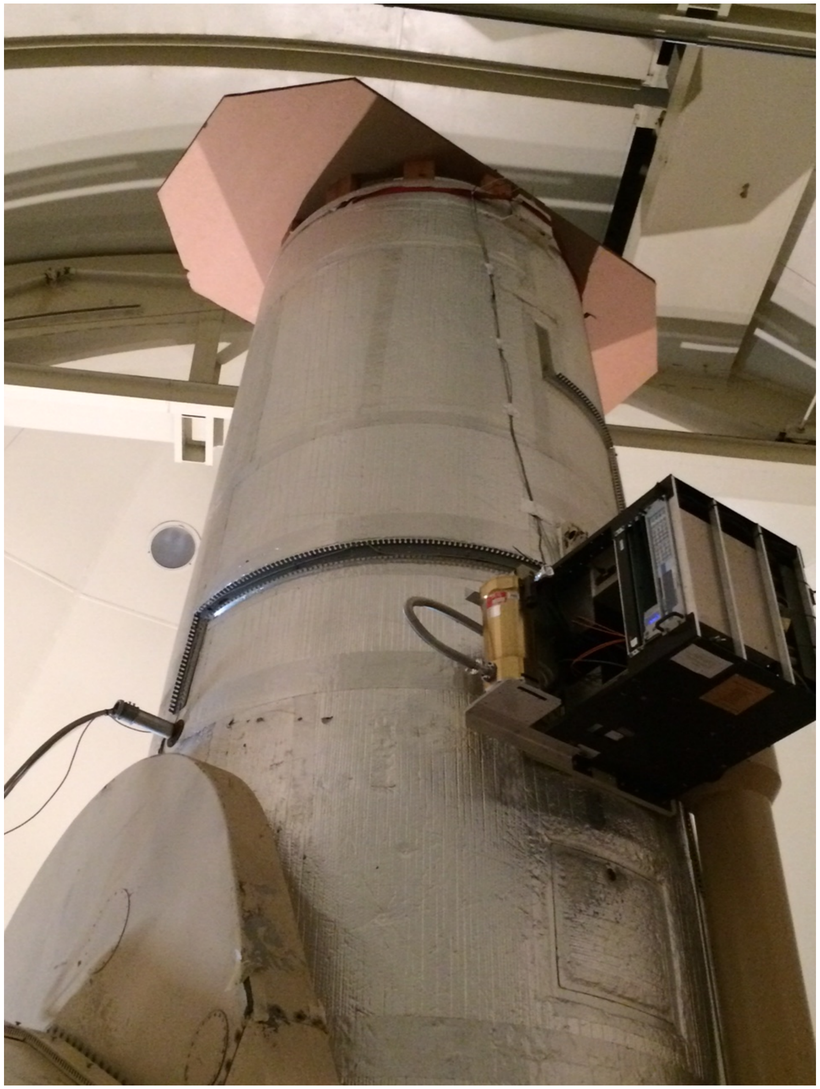
- HPWREN
  - ZTF requires > 80 Mbit/sec average downlink from Palomar to keep up with the nominal 30 + 15 sec imaging cadence



DESY shutter installation

- In order to:
  - Minimize P48 downtime
  - Gain long time baseline experience with operations
  - Reduce ZTF risk
- We propose to:
  - Install the DESY/Bonn exposure shutter in Fall 2016
  - If delivery slips into Winter 2016, shutter installation could slip until Spring (due to P200 aluminizing, cold working conditions) and we'll miss a season's experience

Shutter mock-up test on P48



New P48 Telescope Control Software

- Legacy robotic control software for P48 provided by Vertex RSI
  - Based on defense antenna technology
  - Comprehensive source code unavailable
  - Missing certain common astronomical TCS functions
- New TCS under development by Palomar Observatory
- Initial rollout tests scheduled for Summer 2016
  - Goal is to prove new TCS well ahead of iPTF decommissioning

IPTF DECOMMISSIONING ACTIVITIES

iPTF Decommissioning Activities

- The exact date of the last iPTF observing night remains unknown
  - Working with Palomar Chief Engineer, Jeff Zolkower, the project is developing a telescope conversion schedule
- Our guiding principles are:
  - Perform as many ZTF upgrade non-invasively beforehand to minimize total P48 downtime during ZTF conversion
    - Will still require (latest est.) 6-10 weeks of telescope downtime
  - Decommission iPTF sufficiently early to keep summit activities off the critical path for ZTF “First Light” activities

- Not a guarantee, but project detailed schedule is showing 28 Feb 2017 at the last iPTF observing night

ZTF METROLOGY ACTIVITIES

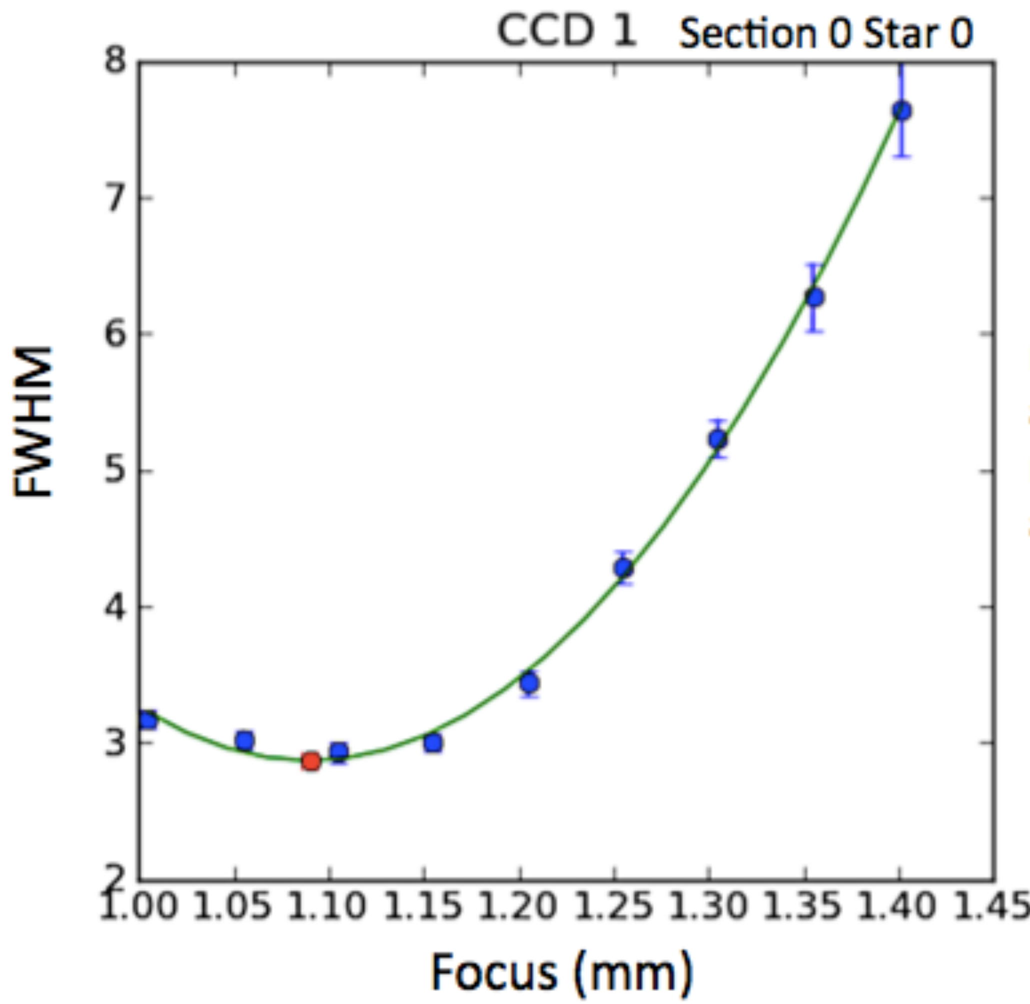
ZTF Metrology Activities

- P48 Telescope
  - Initially, a small FoV test camera will be used to realign Schmidt Doublet (after maintenance activities) and Trim Plate
  - Allows confirmation of telescope and dome drive slew by the new TCS
- ZTF Camera
  - Focal Plane alignment critical at +- 10 micron relative in tip, tilt, and piston of each of the 16 science CCDs w.r.t. best focus surface of the telescope
  - Based on experimental results by Gina Duggan, project has adopted 'on-sky' metrology measurement as the fundamental strategy for aligning the FPA
    - Lab metrology system deemed too costly, too great schedule impact, and ultimately not the right metric, as telescope details are not sufficiently precisely known
    - Alignment depends on camera position on the prime focus hub (controlled by hexapod), & the optical figure details of Schmidt Doublet and Trim Plate

ZTF Metrology Activities

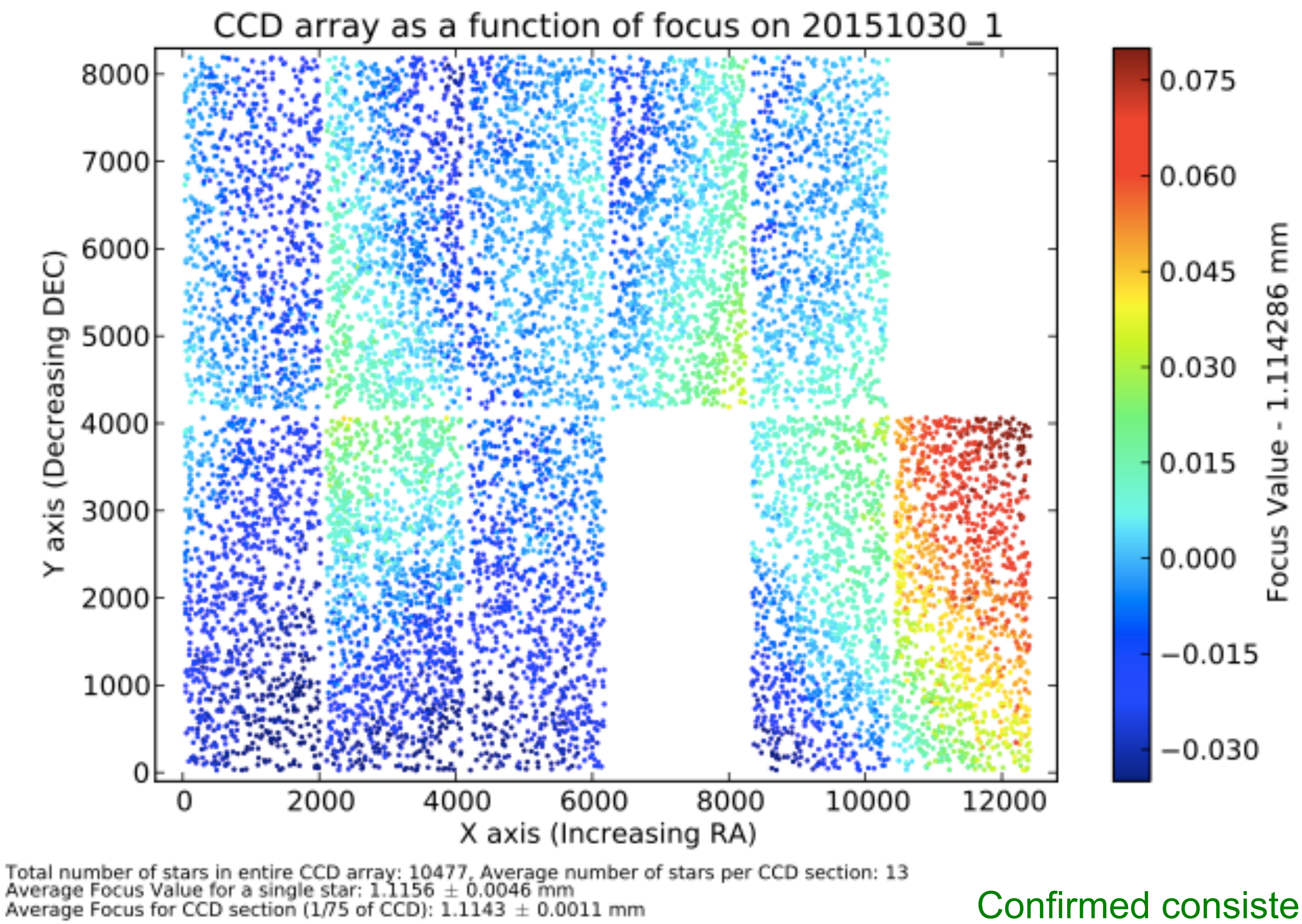
- Filter Exchanger Install and First Test
  - First opportunity to access the telescope to test filter exchange operation in the telescope environment (following extensive lab testing at Caltech)
- Dry Air Handling System Demonstration
  - We must maintain clean, dry air in the environment of the ZTF cryostat window

FPA Metrology Test using iPTF



Error in focus measurement for a single star is 4.6 microns on average

FPA Metrology Test using iPTF



Confirmed consistent with PTF lab profilometer metrology

ZTF FIRST LIGHT ACTIVITIES

ZTF First Light Activities

- First Light images will be the first in-focus images across the array
  - Confirm the delivered image quality (DIQ) budget
  - Evaluate impact of tube and dome seeing following telescope mods
  - Confirm ZTF optical transmission
  - Confirm the observing efficiency budget
  - Commission ZTF guide / focus loop
    - Control tip, tilt, focus of the ZTF cryostat as well as HA, Dec guiding of P48
    - Evaluate figure monitoring of P48 primary with focuser imagery

ZTF REFERENCE FIELDS AND THE ONSET OF TRANSIENT SCIENCE

ZTF Reference Fields

- Beginning shortly after First Light we will begin archiving individual 3k x 3k quadrant images
- Over time, according to scheduling, weather, individual noise properties, etc., these quadrant images will reach a sufficient SNR to enable transient responses
- The ZTF sky will ‘open up’ to transient science on quadrant image at a time, until the full footprint has achieved sufficient reference depth

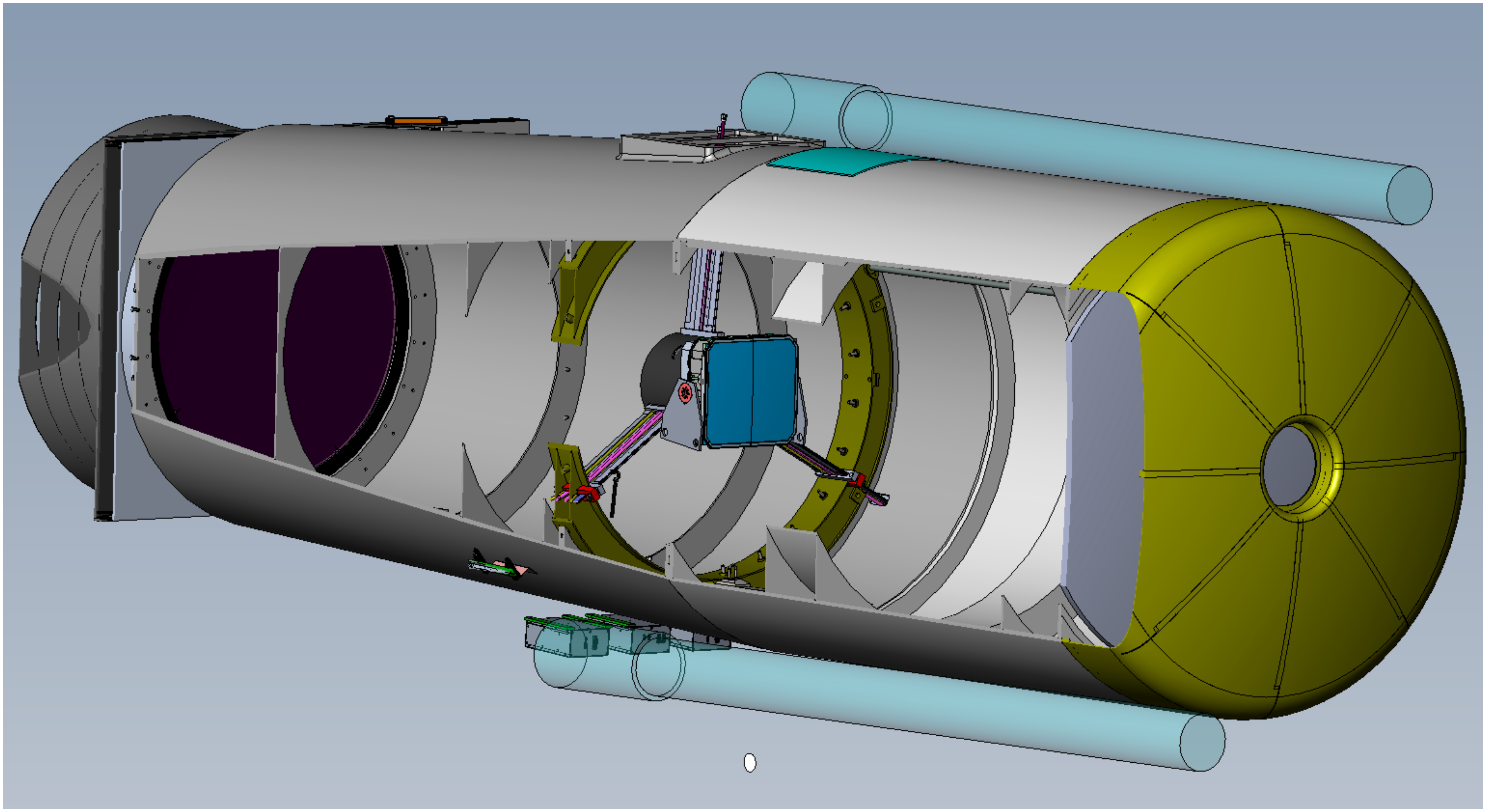
BACKUP SLIDES

Flow-down of DIQ allocation to optomech spec’s

		u' filter	g' filter	R filter	i' filter						
	Wavelength	3250-3550-3850	3980-4670-5360	5930-6580-7230	7195-8220-9245						
	QE	TBD	TBD	TBD	TBD						
		Est. only			Est. only						
DIQ Goal (1D FWHM, arcsec)		N/A	2.20	2.00	N/A	Area-weighted average across focal plane. Only r' and g' drive design.					
Error Term	Allocation										
Atmospheric Effects (z = **30 deg**)		1.30	1.25	1.16	1.11						
	Free Atmospheric Seeing	1.24	1.18	1.10	1.05	Based on 1.1" FWHM average (30 degees zenith angle) from 2006/07 P18 MASS/DIMM measurement for Palomar					
	Dome and Mirror Seeing	0.35	0.35	0.35	0.35	uncertain					
	Atmospheric Refraction	0.13	0.23	0.07	0.04	refraction from Fillipenko 82					
Telescope		0.99	0.97	1.02	1.02		ALLOCATED TOLERANCES				
	M1 Figure	0.40	0.40	0.40	0.40	uncertain					
	Tracking Errors*	0.50	0.50	0.50	0.50	PTF Measured 0.92? TBC					
	Vibration	0.39	0.39	0.39	0.39	RMS temporal (high frequency) error =	10	microns	implies at F/2.45 and	0.39	arcsec
	Hub Tilt Rel to Optical Axis	0.40	0.40	0.40	0.40	PTF Measured: 0.27	17.7	microns	implies "	0.40	arcsec
	M1 (Optical Axis) Tilt Rel to Cell	0.39	0.39	0.39	0.39		10	microns	implies "	0.39	arcsec
	Schmidt Plate Axial Position	0.04	0.04	0.04	0.04		10000	microns	implies "	0.04	arcsec
	Schmidt Plate Decenter	0.10	0.10	0.10	0.10	(TBC feasibility w/ P. Gardner)	1000	microns	implies "	0.10	arcsec
	Schmidt Plate Tilt	0.10	0.03	0.10	0.10		34.9	milliradians	implies "	0.10	arcsec
	Schmidt Plate Aspheric Coeff	0.19	0.09	0.19	0.19		5%		implies "	0.19	arcsec
	Schmidt Plate Index of Refraction	0.17	0.17	0.28	0.28		0.05	index uncertainty	results in	0.28	arcsec
	Schmidt Plate Abbe Number	0.13	0.13	0.21	0.21		1.00	Abbe V uncertainty	results in	0.21	arcsec
Instrument		1.84	1.57	1.14	1.61						
	Optical Design IQ (full field avg)	1.60	1.29	0.83	1.40	based on ZTF spot size .zpl macro					
	Cryostat Decenter	0.18	0.18	0.16	0.18		150	microns (1-D)	results in	0.18	arcsec
	Deviation from Best Focus (Hub motion)*	0.31	0.28	0.31	0.31		10	microns	implies "	0.31	arcsec
	Cryostat Window Rel to FPA	0.10	0.10	0.03	0.10		290	microns (1-D)	results in	0.10	arcsec
	Cryostat Window Opt v. Mech Axis	0.19	0.19	0.05	0.19		500	microns (1-D)	results in	0.19	arcsec
	Cryostat Window Center Thickness	0.12	0.12	0.07	0.12	assume telescope refocus	100/-500	microns		0.12	arcsec
	Cryostat Window Glass Melt Index, n	0.12	0.12	0.08	0.12		0.002	index	results in	0.12	arcsec
	Cryostat Window Thermal Variation in n	0.06	0.06	0.06	0.06		30	K radial gradient	results in	0.06	arcsec
	Optics Manufacturing Surface Errors	0.23	0.23	0.23	0.23	Amplitude (1/2 P-V) error =	10	microns	implies "	0.23	arcsec
	Mosiac Tilt Rel to Cryostat	0.21	0.21	0.21	0.21	Amplitude (1/2 P-V) tilt over 373 mm at	0.05	milliradian error	implies "	0.21	arcsec
	CCD Surface Relative to Plate	0.27	0.27	0.27	0.27	Amplitude (1/2 P-V) flatness =	12	microns	implies "	0.27	arcsec
	FPA Plate Height Relative to Hub	0.11	0.11	0.11	0.11	Amplitude (1/2 P-V) flatness =	5	microns	implies "	0.11	arcsec
	Field Flattener Tilt	0.10	0.10	0.05	0.10		9.4	milliradian error	results in	0.10	arcsec
	Field Flattener Decenter	0.10	0.07	0.10	0.10		310	microns (1-D)	results in	0.10	arcsec
	Field Flattener Opt v. Mech Axis	0.16	0.12	0.16	0.16		500	microns (1-D)	results in	0.16	arcsec
	Field Flattener Power	0.10	0.10	0.10	0.10		10%	error	results in	0.10	arcsec
	Field Flattener Final Temperature	0.02	0.02	0.02	0.02		10	K uncertainty	results in	0.02	arcsec
	CCD Lateral Diffusion	0.63	0.63	0.48	0.42	uncertain (esp. vs. wavelength)					
Margin (Unmodelled / Implimentation Errors)		0.25	0.25	0.56	0.25	Allocation					
RMS Total DIQ		2.47	2.24	2.00	2.22	arcsec FWHM	assuming all terms are Gaussian				

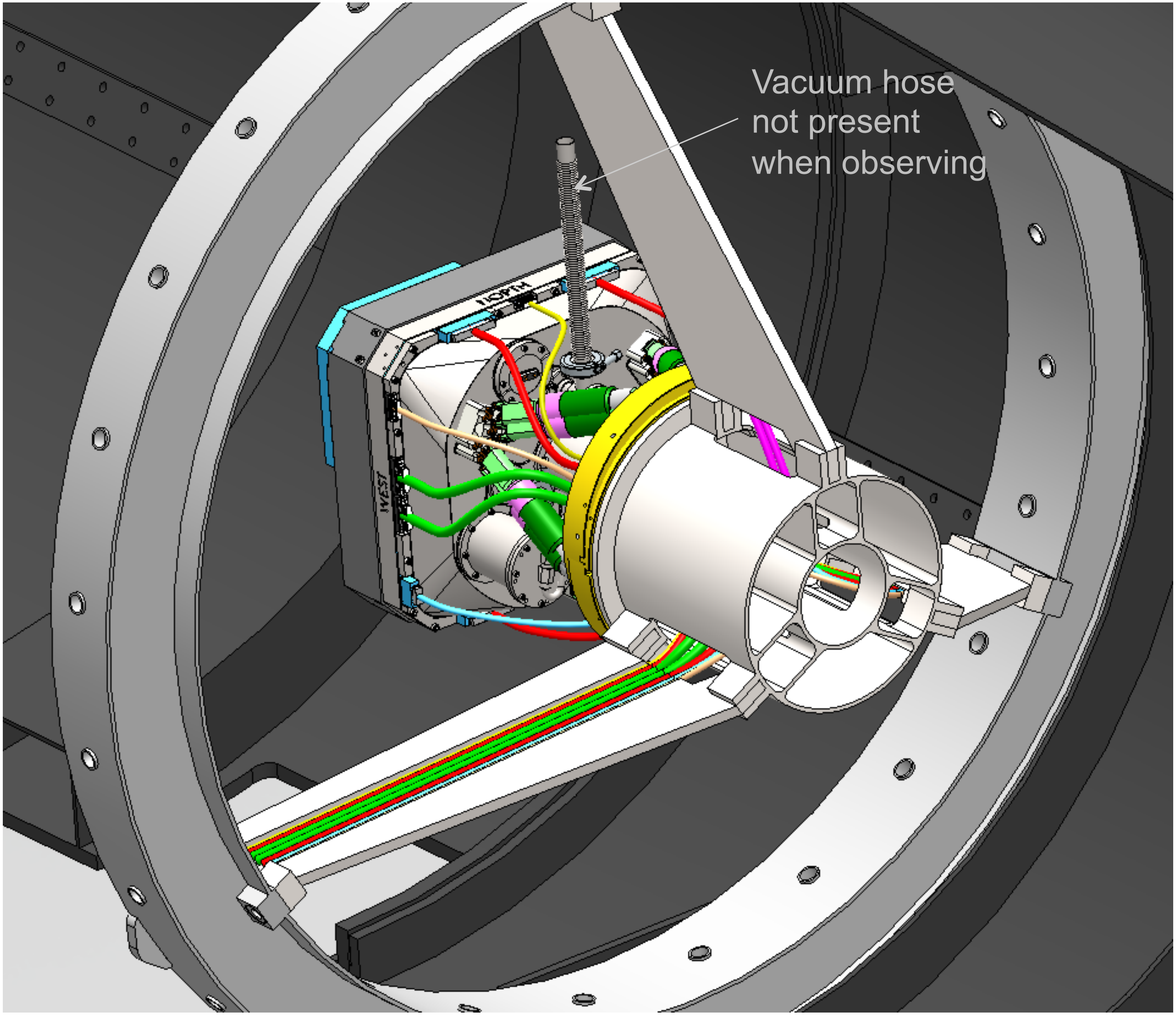
R Seeing for other zeniths	
45	degrees
1.24	arcsec

Legend:
- given
- assumptions--presently unmodeled/unverified
- potential for improvement?
- dewar design constraints



The Caltech engineers have been developing

- New spiders, incl. ring
- New articulated ZTF camera mount
- New access hatches
- Bonn shutter interface
- Schmidt trim plate mount
- New baffles
- Cable routing
- Tube balance


Vacuum hose
not present
when observing