

ZWICKY TRANSIENT FACILITY

Commissioning and Management Update

Richard Dekany ZTF Collaboration Meeting California Institute of Technology 30 November 2016

ZTF Commissioning Overview

- Pre-commissioning Activities using iPTF
 - Shutter environmental evaluation
 - Wind shake evaluation
 - TCS upgrade and motion optimization
- ZTF Camera Alignment Activities
 - Handling and installation procedures
 - EMI validation
 - Focal plane metrology
 - CCD focused imagery
 - Hub flexure evaluation
- ZTF First Light Commissioning Activities
 - Optical transmission validation
 - Delivered Image Quality (DIQ) validation
 - Filter exchange and M1 safety validation
 - Autoguider / autofocus validation
 - Full robotic operation / software validation
- Science Validation Activities
- Survey Operations Begin

ZTF PRE-COMMISSIONING ACTIVITIES

Shutter environmental evaluation Wind shake evaluation TCS upgrade and motion optimization

ZTF exposure shutter complete

- Provided to ZTF by DESY through BonnShutter
 - Klaus Reif, Philipp Mueller, Martin Polder, Marek Kowalski
 - Interface & baffle by Michael Feeney, COO







New P48 Telescope Control Software

- Legacy robotic control software for P48 provided by Vertex RSI
 - Based on aerospace antenna controller
 - Comprehensive source code unavailable
 - Missing certain common astronomical TCS functions
- New TCS under development by John Henning at Palomar Observatory
 - Required to realize survey timing efficiency budget via optimized motion profiles for minimum-time telescope and dome motions
- Initial rollout tests scheduled for December 2016
 - Optimization phase with goal of stable, tested TCS ahead of iPTF decommissioning

P48 RA drive has been upgraded

to support fast slew commensurate with 15s observation overhead



iPTF Decommissioning Activities

Last expected night of iPTF science observations:

28 February 2017

- Kicks off approximately 9 weeks of telescope engineering in preparation for ZTF
 - Building and Infrastructure
 - Telescope Access, Balance, Corrector, Prime Focus, Safety
 - Dry Air System and Monitoring
 - TCS Software
 - ZTF Camera Cooling, Electrical, Communications, Safety
 - Handling Fixtures

	b	-					ZTF talescope changeover work plan V2 RGD update
р —	Task Name	Duration	Start	Rinish	Predecessors	Successors	μ_{0} (a) μ_{0} (b) μ_{0} (c) μ_{0
1	PT F/ 2TF Changeo ver	127 days	Wed 3/1/17	Thu 8/24/17			
2	PTF removal	2 days	Wed 3/1/17	Thu 3/2/17		3	-0%
3	Primary mirror removal	1 day	Fri 3/3/17	Fri3/3/17	2	4	3-095
4	Dummy mirror in stall	1 day	Mon 3/6/17	Mon 3/6/17	3	,	1 0%
5	Doublet as s'ly removal and c'wgt in stall	1 day	Tue 3/7/17	Tue 3/7/17	4	10FS+2 days,6FS+	* 0%
6	Doublet optics removal from cell	1 day	Thu 3/9/17	Thu 3/9/17	5 F5+1 day	7	1.0%
7	Doubletcell dean and replate	3 wks	Fri 3/10/17	Thu 3/30/17	5	9 PS+4 days	
8	Primary re-aluminize	5 days	Mon 4/10/17	Fri4/14/17	1755+3 days		0%
9	Doublet cell/optics assembly	3 days	Thu 4/6/17	Mon 4/10/17	7 PS+4 days		0%
10	Enlarge access hatch in tube	3 days	Fri 3/10/17	Tue 3/14/17	5 FS+2 days	11	↓ 0%
11	Cut CC D cable port holes in tube	1 day	Wed 3/15/17	Wed 3/15/17	10	12F5+1 day	* 0%
12	Weld in instr support to ring gird er	2 days	Fri 3/17/17	Mon 3/20/17	11F5+1 day	13F5+2 days	↓ 0%
13	Add elect, rack mtg features to tube	1 day	Thu 3/23/17	Thu 3/23/17	12FS+2 days	14	5,0%
14	Add primary end trim-less c'wgt mounts	1 day	Fri 3/24/17	Fri 3/24/17	13	15	*q%
15	Install filter exchanger mount features	2 days	Mon 3/27/17	Tue 3/28/17	14	17F5+2 days,16	
16	Install M1 deployable cover	5 days	Wed 3/29/17	Tue 4/4/17	15	17	* oni
17	Clean, prep and paint tube inside	6 days	Wed 4/5/17	Wed 4/12/17	15F5+2 days,16	855+3 d ays,18FS+	
18	Install instr support assy/hexapod	4 days	Fri 4/14/17	Wed 4/19/17	17FS+1 day	19,20	0%
19	Install internal dry air plumbing	1 day	Thu 4/20/17	Thu 4/20/17	18		* 0%
20	Install cable management hard ware	2 days	Thu 4/20/17	Fri4/21/17	18	21,22F5+1 day	<u>↓</u>
21	Cable routing & mgt system install	2 days	Mon 4/24/17	Tue 4/25/17	20		- 0%
22	Install Cryotiger & glycol plumbing lines	1 day	Tue 4/25/17	Tue 4/25/17	20FS+1 day	23FSH2 days	↓_ _0%
23	Install doublet, trim plate & shutter	2 days	Fri 4/28/17	Mon 5/1/17	22FS+2 days	26F5+2 days,25,2	4-096
24	Dryair system testing	2 days	Tue 5/2/17	Wed 5/3/17	23		096
25	ZT FIC Sand TCS testing	5 days	Tue 5/2/17	Mon 5/8/17	23		- 0%
26	Install and align primary mirror	Z days	Thu 5/4/17	Fri 3/3/17	23F5+2 days	28F5+1 day 27F5+	- 0%
27	ZT Fcamera transport to summit	1 day	Wed 5/10/17	Wed 5/10/17	26FS+2 days	28	0%
28	Initial installation of ZTE camera	Ridays	Du 3/11/17	Mon 3/13/17	265541 day 27	79	
29	Install erack	1 dev	Due 5/16/17	Tue 5/15/17	20/0/2009,27	20	× 0%
30	77 Ecomora functional varification	2 days	Med 9/47/47	The \$/40/47	20	50	
21	21 Feamera Functional Vermication	2 0075	web 3/ 1//1/	Thu 5/10/17	2.9		0.0
	The comercia Augument Cressing	200040	Fri 5/15/17	hten 6/8/47			
	21 F camera and cabing removal	2 0875	FI 6/2/1/	Mon 6/3/17	51	5.5	
	install testing c wgts & camera surrogate	1 089	100 6/6/1/	100 6/6/1/	52	54F3F108y	
	relescope orive a rus testing	5 cays	nu 6/8/17	Weg 6/14/17	5 SF371 08Y		
	install niter exchanger	s days	INU 6/15/17	Mon 6/19/17	-	50	
36	Hiter exchanger testing	3 days	Tue 6/20/17	Thu 6/22/17	53	s aF5+2 days	
37	Uncoated 2TF trim plate install & c'wgt adjust	2 days	5at 6/10/17	Mon 6/12/17			
38	ZTE camera reinstal	3 days	rue 6/27/17	Thu 6/29/17	s 6F5+2 days	59	
39	2TF First Light	1 day	Wed 6/21/17	Wed 6/21/17	38	40	4 0%
40	Camera, filter exchanger en gineering check-out in cl. DIQ verification, scattered (ght eval.)	3 days	Thu 6/22/17	Wed 6/28/17	39	41	0%
41	Pull robotic operations check-out (open/close, weather interrupts, fault recovery, queue I/F, safety)	15 d'eys	Thu 6/29/17	Wed 7/19/17	40	42F5-5 days	<u>↓</u> 0%
42	Operational efficiency optimization	10 days	Thu 7/13/17	Wed 7/26/17	41FS-5 days	43	· −0%
43	Coated ZTF trim plate install & dwgt adjust	2 days	Thu 7/27/17	Fri 7/28/17	42	44	<u>≭ qs</u> s
44	DIQ as sessment with final trim plate	3 days	Mon 7/31/17	Wed 8/2/17	43	43	*0%
45	Engineering con tingency	15 days	Thu 8/3/17	Wed 8/23/17	44	46	* 01
46	Begin ZTF Science Verification		Thu 8/24/17		45		वें ब
47	1						

Key Commissioning Dates (tent.)

- 1 March 2017
- 19 May 2017
- 10 July 2017
- 19 July 2017
- 29 July 2017
- 8 Aug 2017
- 24 Aug 2017
- Late 2017

- iPTF removal
- ZTF camera alignment at P48
- Trim Plate Install (goal)
- ZTF First Light
- **ZTF Robotic Ops Demonstration**
- **DIQ and Operations Optimization**
- Start of Science Verification
- (Handover from Development Team)
- Start of Routine Survey Ops

ZTF CAMERA ALIGNMENT

Handling and installation procedures EMI validation Focal plane metrology CCD focused imagery Hub flexure evaluation

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

Focal Plane Metrology Test using iPTF



Focal Plane Metrology Test using iPTF



Total number of stars in entire CCD array: 10477, Average number of stars per CCD section: 13 Average Focus Value for a single star: 1.1156 \pm 0.0046 mm Average Focus for CCD section (1/75 of CCD): 1.1143 \pm 0.0011 mm

Confirmed consistent with PTF lab profilometer metrology

ZTF FIRST LIGHT COMMISSIONING ACTIVITIES

Optical transmission validation Delivered Image Quality (DIQ) validation Filter exchange and M1 safety validation Autoguider / autofocus validation Final trim plate installation Full robotic operation / software validation

Trim Plate still driving schedule

- The project schedule critical path depends on delivery of a large new 'trim plate'
 - Modifies the Schmidt corrector aspheric coeff by ~ -10%
 - Needed to compensate for telescope and cryostat window aberrations
 - Two procurements proceeding in parallel
 - Rayleigh Optical Systems
 - Nanjing Institute for Astronomical Optics & Technology



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

Stow filter: Filter undocked from window frame and stored



Kuka KR + Filter Exchanger Prototype Dock/Undock



Key Commissioning Dates (tent.)

- 1 March 2017
- 19 May 2017
- 10 July 2017
- 19 July 2017
- 29 July 2017
- 8 Aug 2017
- 24 Aug 2017
- Late 2017

- iPTF removal
- ZTF camera alignment at P48
- Trim Plate Install (goal)
- ZTF First Light
- **ZTF Robotic Ops Demonstration**
- **DIQ** and Operations Optimization
- Start of Science Verification
- (Handover from Development Team)
- Start of Routine Survey Ops

The Amazing ZTF Development Team

Observing System - Caltech

Roger Smith – Observing System Lead • Richard Dekany – Project Manager Eric Bellm – Próject Scientist Justin Belicki – Electronics John Cromer – Instrument Software Alex Delacroix – Cryo & FPA Mechanical Gina Duggan – FPÁ Metrology Michael Feeney – Cryo & P48 Mechanical David Hale – Camera & Filter Exchanger Software Steve Kaye – VIB & Detector Testing Thomas Kupfer – Ops Planning Peter Mao – Detector Test Automation Jennifer Milburn – Autoquider Software Patrick Murphy – Electronics & Cryo Reston Nash – Exchanger Mechanical Michael Porter – Filter Exchanger Lead Dan Reiley – Optics Lead Reed Riddle – Software Lead James Wincentsen – ZTF Documentation

Jeff Zolkower – P48 Chief Engineer Bruce Baker – P48 Supervisor Tom Barlow – P48 Operations John Henning – P48 TCS Dan McKenna – P48 Telescope Engineering Victor Tapia – P48 Engineering Richard Walters – P48 Operations

Observing System - DESY

Klaus Reif – Shutter Lead
Philipp Mueller – Systems Engineering
Martin Polder - Mechanical

Data System

 Frank Masci – Data System Lead Ron Beck – Pipeline Operations Lee Bennett – Systems Engineering Imel David – IPAC Manager Steve Groom – Archive Architect George Helou – IPAC Director Ed Jackson – Database Mngt Russ Laher – Pipeline Infrastructure; Ingest; Test Ben Rusholme – Data xfre; Pipeline; Config. Mngt David Shupe – Source Matching; Astrometry Jason Surace – Image Simulation; Data Analysis Lin Yan – Marshal Planning & Summer School

Education and Public Outreach

 Andy Boden – E/PO Lead and HPWREN Bryan Penprase – Undergraduate Education

Shri Kulkarni, Principal Investigator & Eric Bellm, Project Scientist