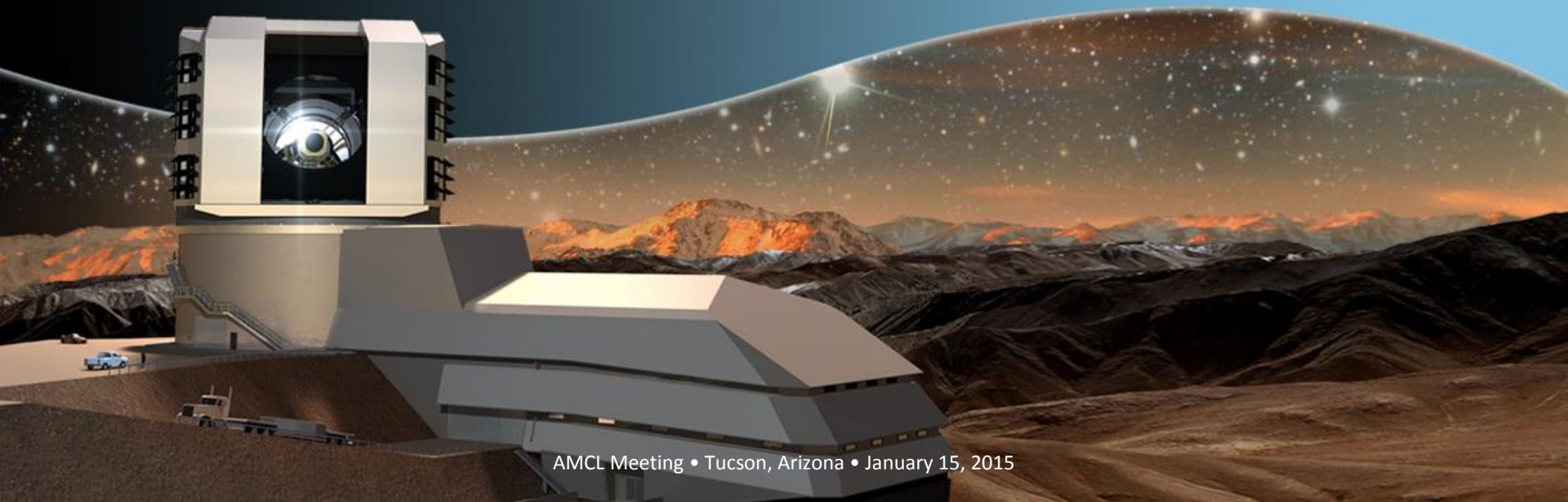


AURA MANAGEMENT COUNCIL FOR LSST AMCL MEETING

Telescope and Site Status

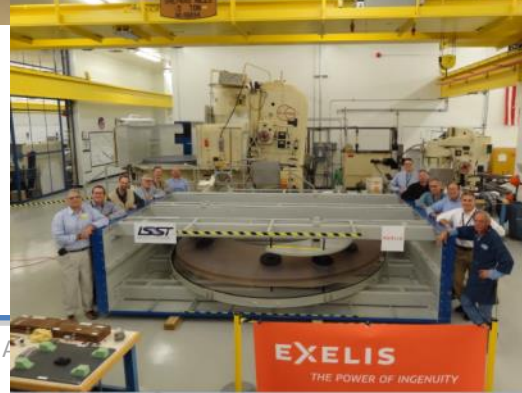
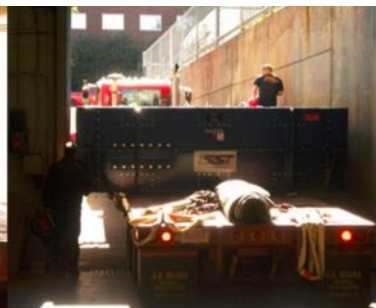
William Gressler
Telescope and Site Manager



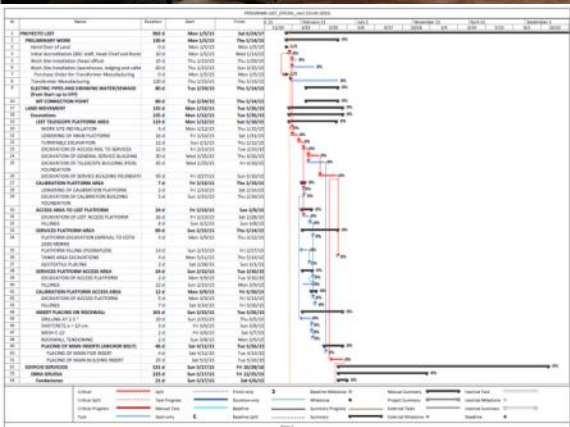
- Contract Milestones
 - M2 Substrate delivered to Exelis Nov 22, 2014
 - Summit Facility Construction contract signed Dec 10, 2014
 - Dome System Bid Evaluation/Recommendation completed Jan 8, 2015
 - M1M3 Acceptance Testing ongoing
- Reviews and Workshops
 - Telescope Control Software Workshop November 11-14 (CCS/DAQ/OCS/DM)
- T&S Team Growing to Support Construction
 - Upcoming Tucson Hires: T&S Project Scientist (Sandrine Thomas), Technical Manager (Shawn Callahan), Calibration Hardware Scientist (Patrick Ingraham), Optics Engineer (offer pending)
 - Upcoming Interviews: M1 Electrical Engineer, Coatings Engineer

M2 Blank successfully moved from Harvard storage (Cambridge, MA) to Exelis (Rochester, NY)

- Departed Oct 20, 2014 / Delivered Oct 22, 2014
 - Phase B Kick-off Meeting to initiate Cell Assembly effort
 - Focus on metrology and mirror support hardware



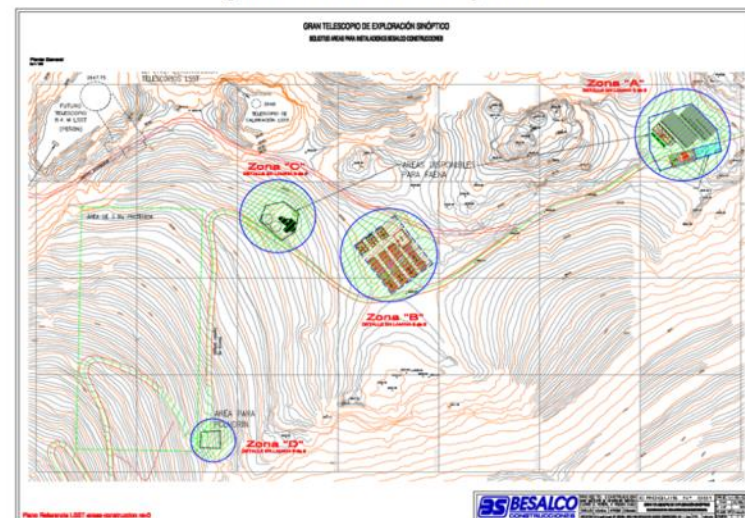
- “Value Engineering” phase completed (~8% savings identified)
- Site transferred on Jan 5th (begins 30 month period of performance)
- Besalco subcontractor Rocterra to resume final excavation effort
 - 10x10 work shift, 2 shifts, 20 workers/shift
 - Permanent field supervisor plus safety officer
 - Work schedule to coordinate daily activities



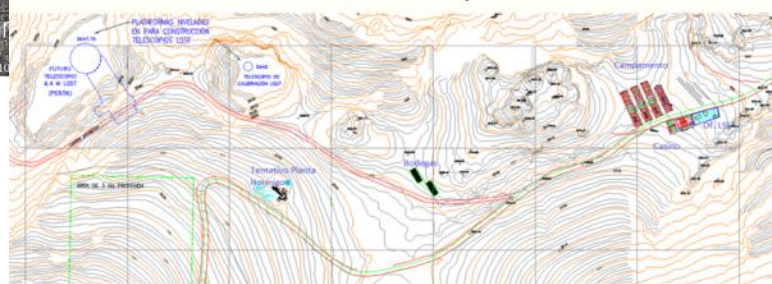
- Besalco unlikely to use concrete mix plant on summit
 - Proposed contractor camp near LSST shed
 - Rocterra to use remodeled 20-unit and cafeteria



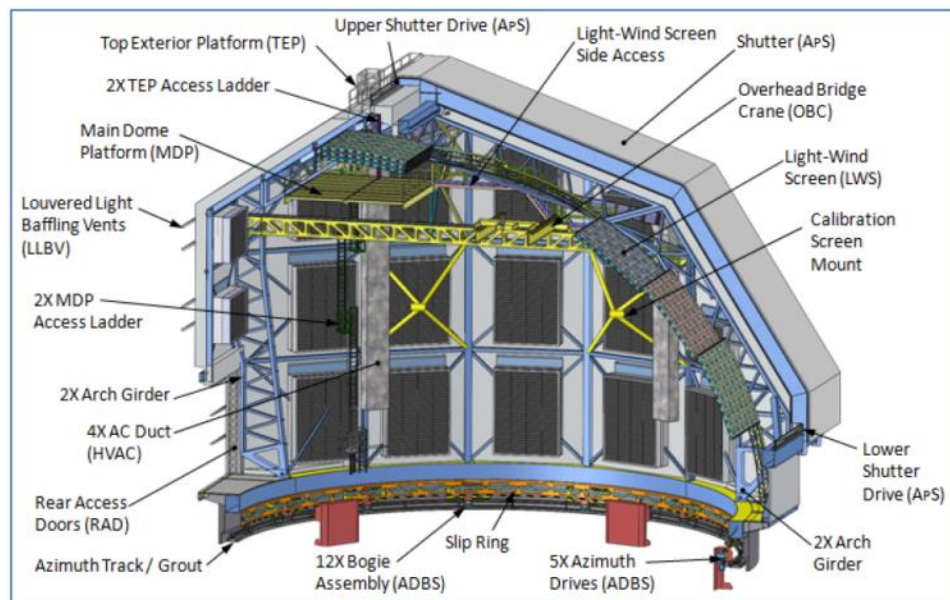
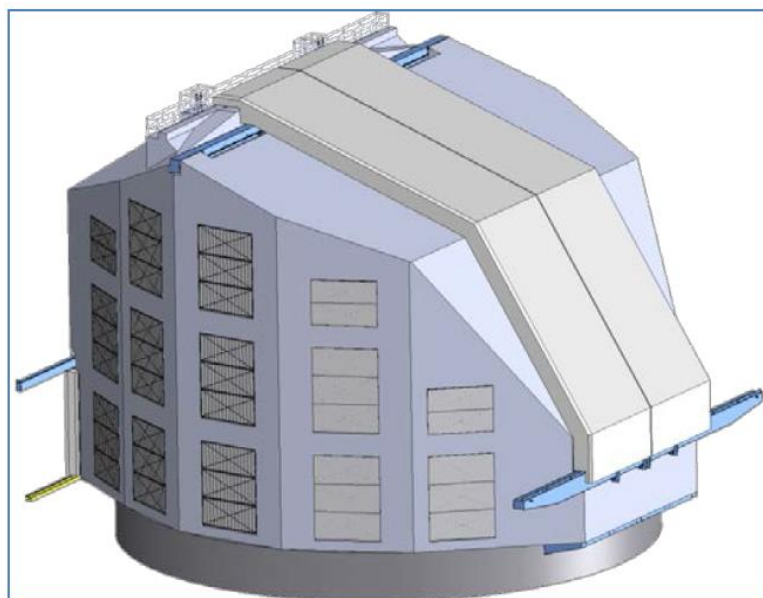
Original Construction Facility Plan



Revised Construction Facility Plan



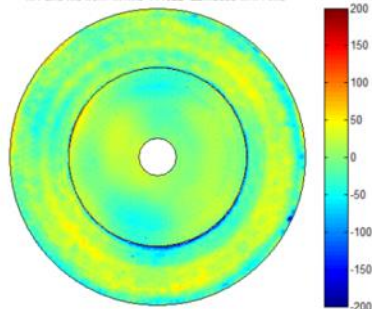
- Two fully compliant bids received October 5, 2014 (5 no-bids)
 - 33 month period of performance
 - Includes shipping and onsite installation
- Vendor site visits/bid clarifications completed Dec 10, 2014
- Updated bid proposals/additional information received Dec 23, 2014
- Bid Review Committee Recommendation Report submitted Jan 8, 2015



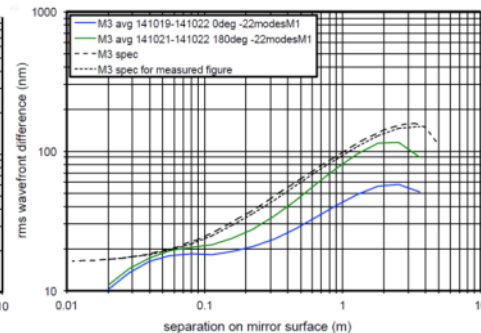
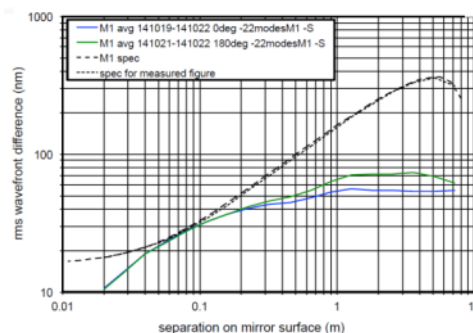
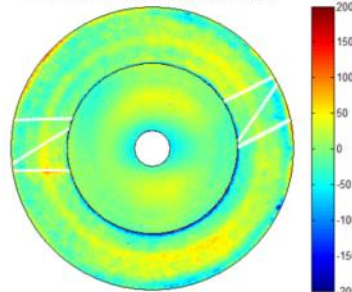
- Transport box delivered to SOML on Nov 20, 2014
 - Logistics plan developed to move M1M3 to local storage
 - Fence/gate modifications and storage conditions understood
- SOML Lifting Fixture assembled and ready
- Preliminary M1M3 optical test data reviewed
- M1M3 completion event held Jan 10, 2015



M1 and M3 from 'M1M3 141022 -22modes M1FA.hs'



M1 and M3 from 'M1M3 141027 -22modes M1FA.hs'



M1M3 Acceptance Testing has been ongoing for the last few months

- Acceptance Testing Continues
 - SOML test plan document approved
 - 24 of 47 measurements documented
 - Preliminary structure function tests
 - Documentation key for future tests
 - M3 Crow's Feet impact being assessed

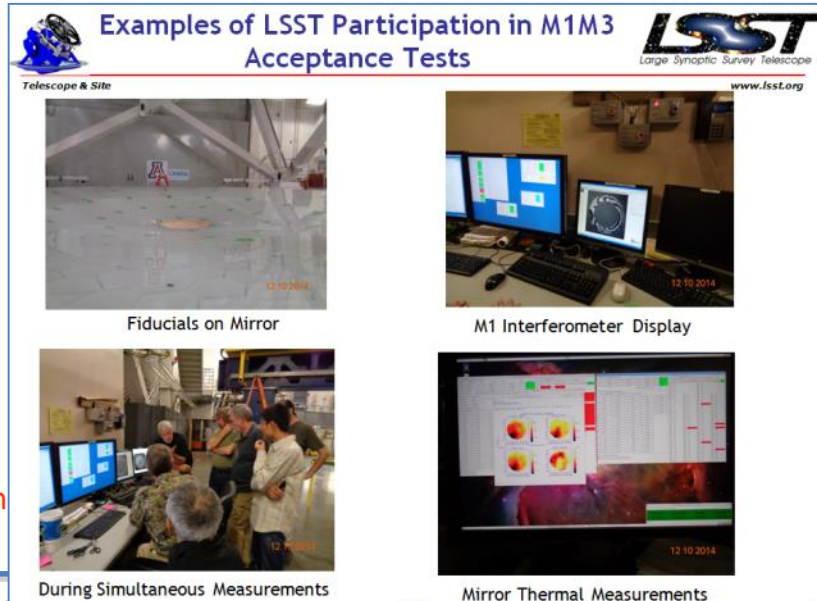
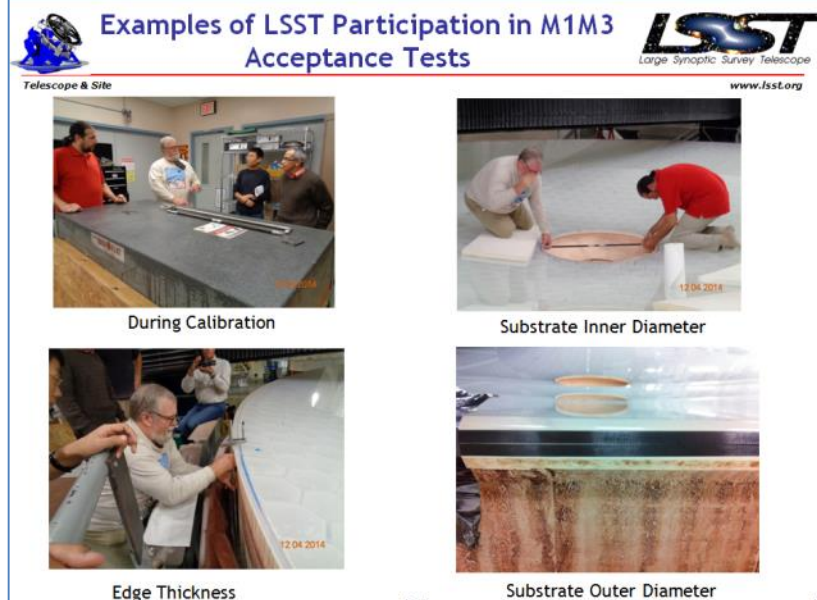
Contents

Scope of this report.....	4
Documents Referenced	5
Zemax Files	6
Acceptance Test Plan	6
1.1 Mirror Substrate.....	6
1.1.1 Bulk Material.....	6
1.1.2 Physical Parameters.....	7
1.1.3 Blank casting.....	8
1.1.4 Blank Generation.....	8
1.1.5 Polishing Cell.....	9
1.1.6 Mirror Support.....	9
1.2 Optical Prescription.....	10
1.2.1 Surface Figure.....	10
1.2.2 Clear Aperture.....	13
1.3 Polishing.....	13
1.3.1 Polish Area.....	13
1.3.2 Back Surface.....	14
1.3.3 Surface Accuracy.....	14
1.3.4 Microroughness.....	15
1.3.5 Scratches.....	16
1.3.6 Quality of Finish.....	16
1.3.7 Bubbles.....	16
1.4 Optical Surface Geometries.....	17
1.4.1 M1 Optical Surface.....	17
1.4.2 M3 Optical Surface.....	17
1.4.3 Mirror Fiducials.....	18
1.5 Metrology.....	19
1.5.1 Support During Testing.....	19
1.5.2 Test Tower Geometry.....	19
1.5.3 Test Environmental Conditions.....	19
1.5.4 Fiducial Measurement.....	20
1.5.5 Test Methods.....	20
1.5.6 Test Records.....	23
1.6 Mirror Performance.....	25
1.7 Mirror Operational Conditions.....	26



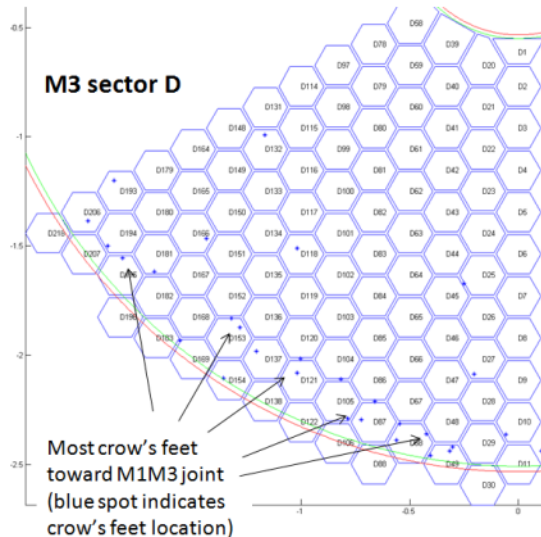
On hold until crow's feet resolution

To be completed in Jan

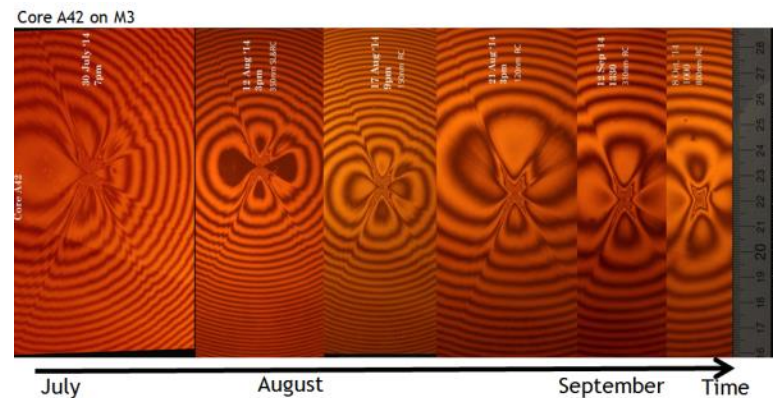
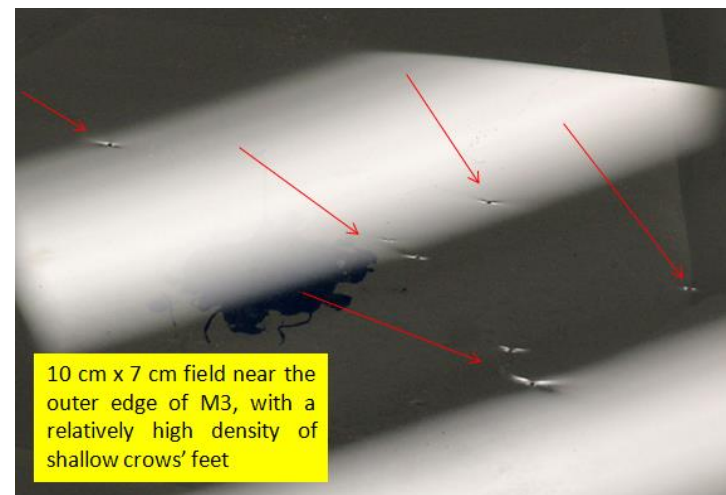


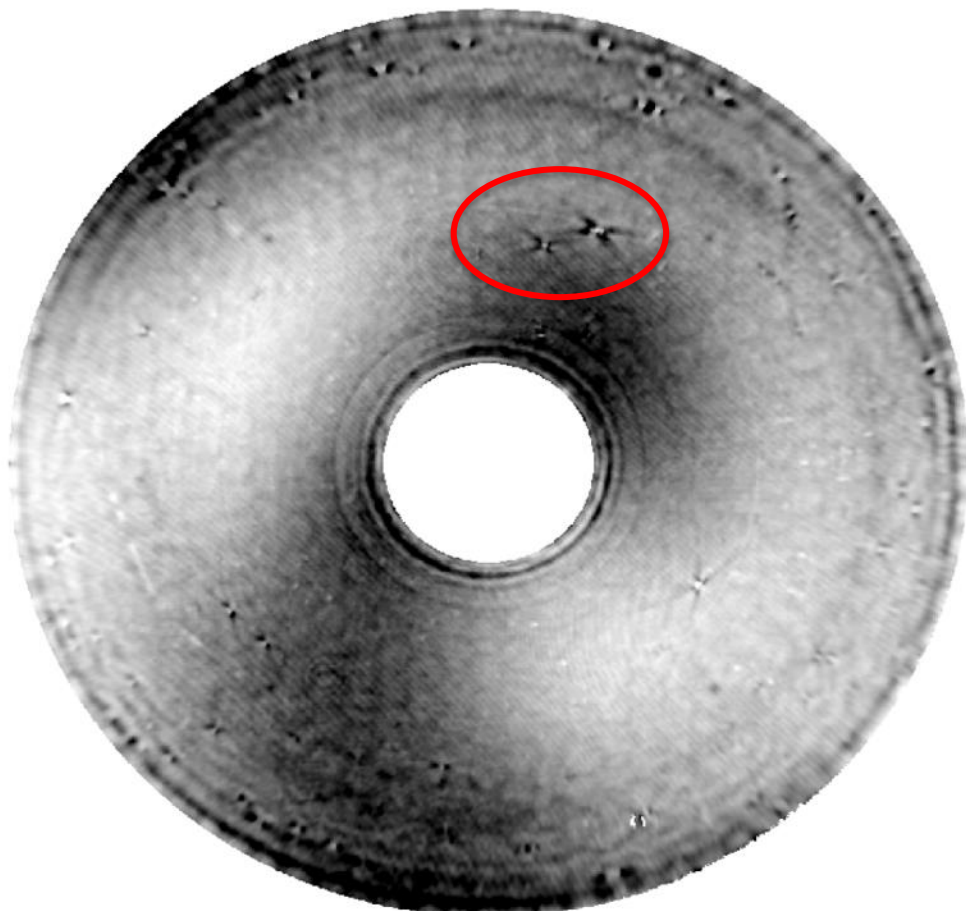
- Crow's foot pattern caused by tool motion across the bubble
- M1 features were polished out (a few left), but M3 ones were not
- M3 fine scale structure and depth reduced (Fizeau test plate monitored, but not removed)
- M3 sector D thoroughly inspected
 - Representative of whole mirror
 - Input used to gauge performance effects

30 crow's feet with 22 of them beyond a 2.16m radius (D136) and only 2 of them below a 1.68m radius (D117).



Core ID	ID	Length mm	Width mm
	D10	7	2
	D25	10	3
	D27	5	1.5
	D49	1	7
		2	6
	D68	1	6
		2	7
	D82		6
	D87	1	7
		2	6
		3	6
	D105	1	8
		2	8
	D118		7
	D121	1	7
		2	6
	D132		15
	D137		8
	D153	1	5
		2	5
	D154		5
	D166		6
	D183		5
	D181/D182		8
	D193		6
	D195	1	9
		2	5
	D206		11
	D207	1	7
		2	7

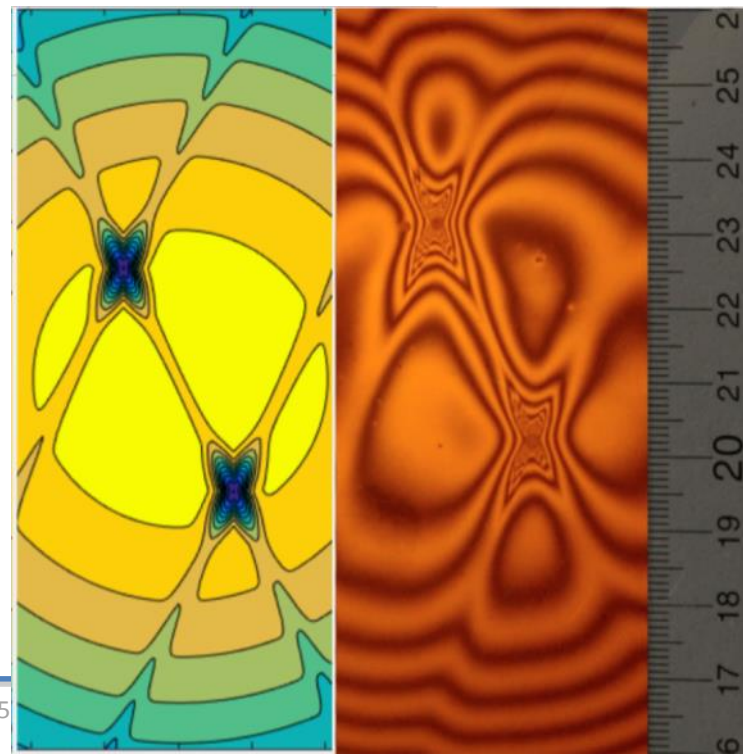


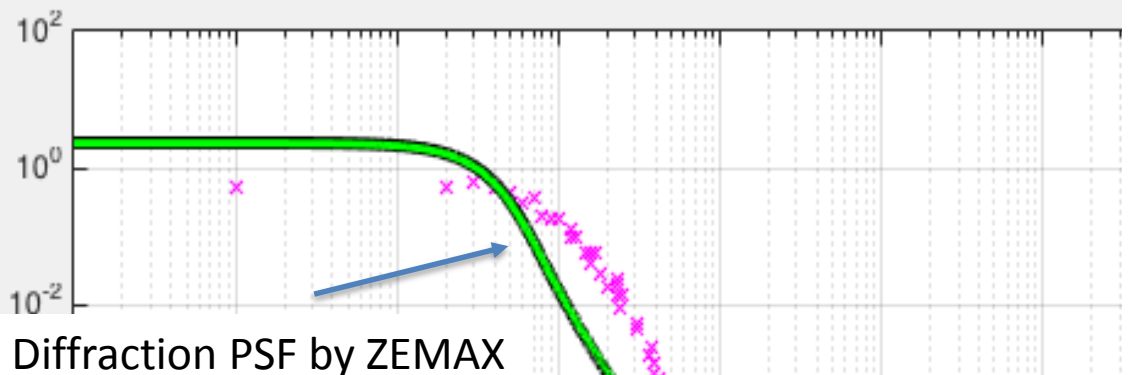


- Interferometer pixel resolution 5mm
 - “Washes out” high spatial frequency features (high slopes)
- Synthesized surface
 - 25 large crow's feet (10-20 cm)
 - 300 small crow's feet (1-10 cm)



Synthesized crow's feet
compared to local Fizeau test

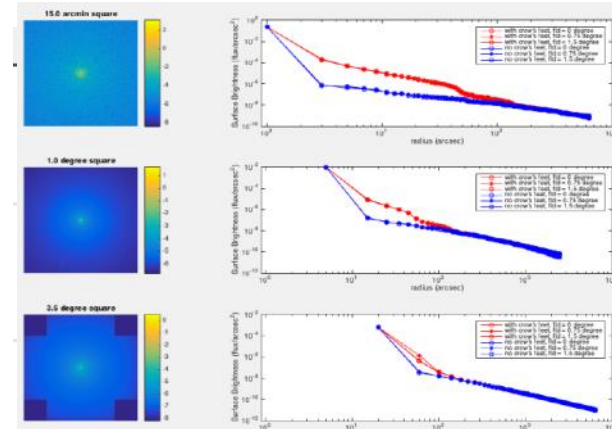




15"

1°

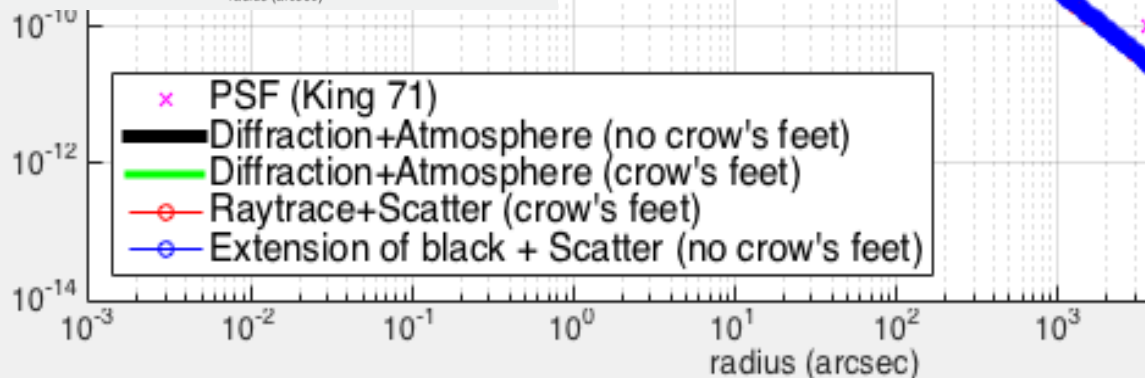
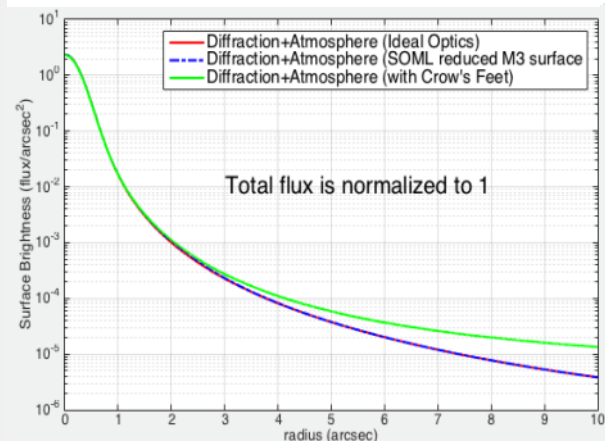
3.5°



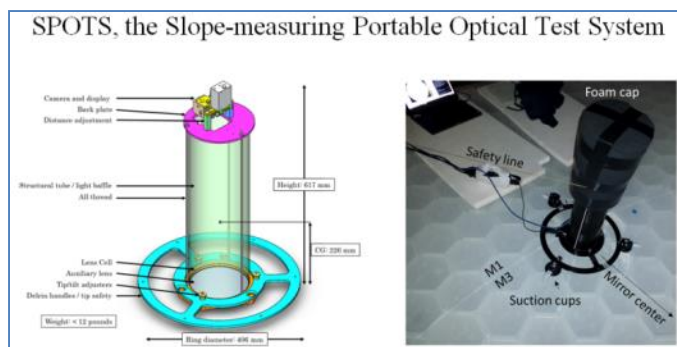
Scattered tail by FRED

Loss: 3% sensitivity, 0.8% area

	Due to CR	Total telescope
Normalized sensitivity	0.97	0.84
Δm_5 (mag)	0.016	0.094
Sky area loss due to	With CR	Without CR
Bright stars (<10 th mag)	885 deg ²	736 deg ²



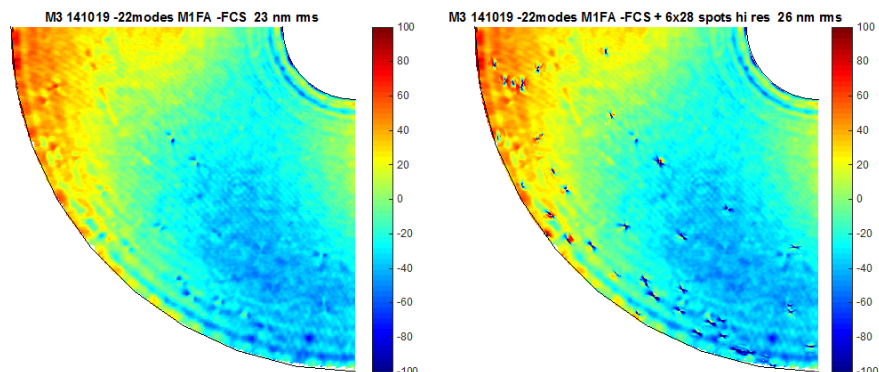
- SPOTS test moves beyond 20mm minimum structure function separation
- SOML combined SPOTS maps with M3 interferometer data
 - SOML Conclusion = no significant impact
 - Data to LSST team this week for analysis



Model of M3 consists of SPOTS maps added to interferometer map

- Visual inspection found 30 crows' feet in sector D with visual length ≥ 5 mm.
 - D is typical in number and size. In fact it's the most representative sector.
- We have 17 SPOTS maps of crows' feet in sector D.
 - 2 of the SPOTS maps include 2 crows' feet.
 - For the remaining 11 crows' feet found in the visual inspection, we use SPOTS maps of other crows' feet with the same length.
- We add these 28 SPOTS maps at their positions in the M3 interferometer map.
 - This over counts slightly because interferometer map contains low-resolution representations of the crows' feet.
- We duplicate the 28 SPOTS maps at slightly randomized positions in the other 5 sectors.
 - Positions are varied with $\sigma = 10$ cm in x and y.
 - Total of 168 SPOTS maps embedded, equal to number of crows' feet with length ≥ 5 mm found on M3.
- Combined map (interferometer + 168 SPOTS maps) has 2 mm sample spacing on M3.
 - Original SPOTS data have 0.2 mm sampling.
 - Original interferometer map has ~ 10 mm sampling before morphing, 5 mm sampling after morphing.
 - PSF computation samples pupil at 5 mm spacing, equivalent to 2.4 mm on M3.

M3 interferometer map, with and without 168 SPOTS maps

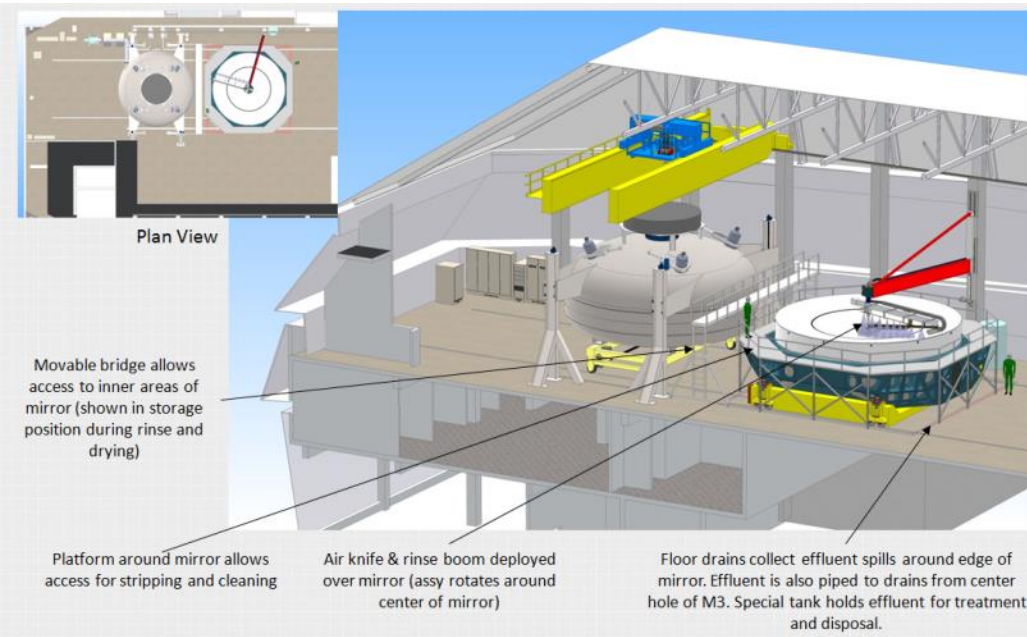


M3 interferometer map

M3 interferometer map with
168 SPOTS maps added

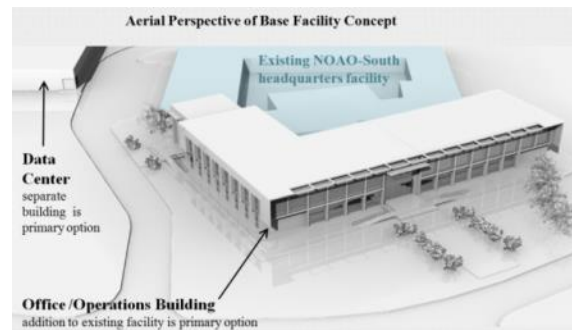
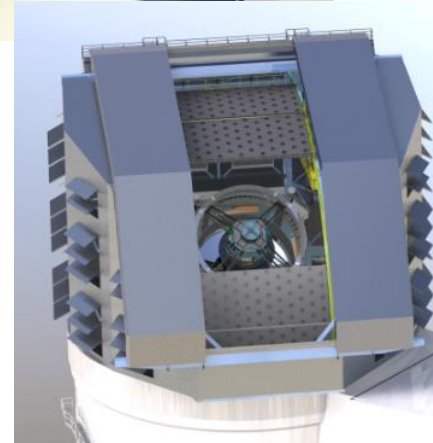
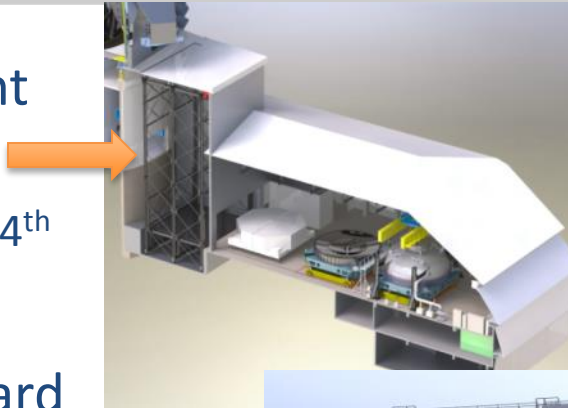
	Measured parameter	Notes
Diameter	M1 – 8.4 m M3 – 5.1 m	
Co-aligned forever	0.5 mm concentricity 1 arcsec coaxial	Meets accuracy specification
Surface metrology	Surfaces mapped interferometrically over full aperture	Both mirrors meet structure function specification.
Figure quality	M1 – 19 nm rms M3 – 18 nm rms 80% Strehl ratio	Surface error Each mirror diffraction-limited at 500 nm wavelength
Measurements beyond specification	≤ 0.01 mag photometric loss < 0.001 arcsec image broadening (FWHM)	High-resolution detail study enabled by hi-res method (SPOTS). Effects calculated for images in 0.5 arcsec seeing (Kolmogorov + aureole)
Examination of small-scale features via new technology	$< 20\%$ increase in faint ($\sim 10^{-4}$) halo at 2.5 – 10 arcsec radius	

- Another impact of the many bubbles on mirror surface is reflective coating durability and contamination
- Current LSST plan to use air knife (used on Gemini & VLT) to dry mirror instead of hand drying (used on MMT, LBT, & Magellan)
- Investigating the potential of filling the small holes
 - Must be compatible with glass, stripping chemicals, and vacuum
 - Lab test with small coated borosilicate sample



Small coated Borosilicate sample with holes under test

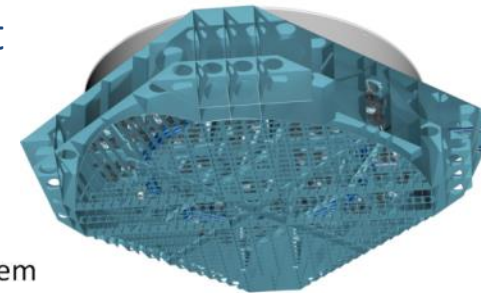
- Summit excavation oversight
 - Finalize Pflow lift contract
 - “First Stone” ceremony Apr 14th
- Support Dome contract award
 - Cost/price analysis
 - Contract award negotiations
- Prepare for Base Facility A&E work
 - Update of requirements document
 - Review with CTIO/Gemini/SOAR



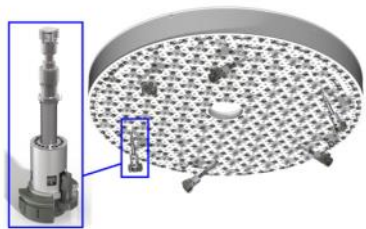
- Support M2 contract effort as necessary
- Complete M1M3 acceptance testing and move to storage
- TMA Design Reviews
 - Tucson workshop Feb 9-11
 - New mount manager on-board
- Support Hexapod/Rotator Phase B Kick-off
- Software workshops
 - SysML/UML training Jan 20-24
 - CCS/OCS/DM workshop Feb 19-20

- Advance M1M3 Cell Assembly design
 - Complete mirror cell interfaces to prepare for procurement
 - Update support hardware designs and prototype
 - Prepare to fabricate hard points

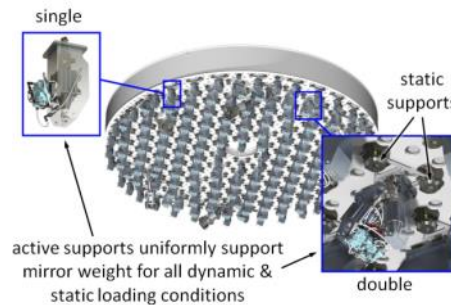
Mirror Cell Structure



Hard Points Define Mirror Position

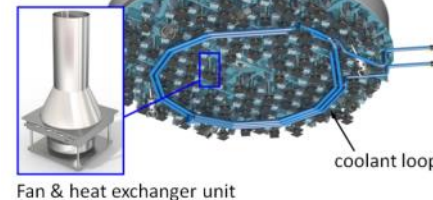


Mirror Supports



Thermal Control System

injects conditioned air into mirror cores to minimize thermal distortion of optical surface





- Finalize documentation to prepare for Coating Chamber procurement











There are a total of 71 risks with a total expected FY2013 USD exposure cost of
\$ 14,141.8 K

and total expected then-year USD exposure cost of
\$ 16,381.12 K

 30 days or less since review
  31 to 90 days
  More than 90 days

Click on boxed column headers to sort by that heading
Secondary sort always by expected exposure cost

Risk ID# (Hover)	Edit Risk (Click)	Title	Review Status (days)	Trigger Date	Probability	Possible Tech Margin Remedy	Non-labor Cost (2013USD)	Schedule Cost (2013USD)	Expected Exposure Cost (2013 K-USD)	Expected Exposure Cost (then-year)	Estimator	Row # Sort Total Cost
TS-054	Detail & Edit	M1M3 mirror damage during summit integration requiring repair at SOML	 1	2019-03-01	5-10%	No	\$2,500 K	\$16,200 K	\$1,403 K	\$1,675 K	Gressler	1
TS-034	Detail & Edit	M2 mirror breaks during handling at Exelis during fabrication	 1	2016-07-01	5-10%	No	\$11,000 K	\$7,200 K	\$1,365 K	\$1,492 K	Gressler	2
TS-088	Detail & Edit	Summit Facility Late Delivery	 1	2018-06-01	10 - 25%	No	\$0 K	\$8,000 K	\$1,360 K	\$1,577 K	Barr	3
TS-061	Detail & Edit	M2 mirror damage during summit integration requiring repair at Exelis	 1	2018-11-01	5-10%	No	\$1,300 K	\$16,200 K	\$1,313 K	\$1,522 K	Gressler	4
TS-005	Detail & Edit	Contractor default	 1	Random	5-10%	No	\$13,750 K	\$480 K	\$1,067 K	\$1,241 K	Gressler	5
TS-089	Detail & Edit	Dome Late Delivery	 1	2018-02-01	25 - 50%	No	\$500 K	\$2,000 K	\$925 K	\$1,072 K	Barr	6
TS-249	Detail & Edit	Telescope mount interfaces to camera must be modified	 1	2016-06-01	10 - 25%	No	\$1,500 K	\$400 K	\$323 K	\$353 K	Gressler	7
		Mount dynamic performances	 1									

The total expected exposure cost in FY2013 USD is: \$ 14141.8 K\$ The total expected exposure cost in then-year USD is: \$ 16381.12 K\$