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TLRS-3 Return to Operations

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Topics of Discussion

- History of the TLRIS-3 in Arequipa, Peru
- TLRIS-3 Return to Operations Strategy
- Significant engineering issues
- Planned and implemented upgrades
- Testing results
- Current status
- Future plans



History of TLRS-3 in Arequipa Peru

- TLRS-3 replaced the SAO-2 system as the tracking station in Arequipa, Peru with an ERS-1 pass on August 7, 1992.
- TLRS-3 operated under agreement with the Universidad Nacional De San Agustin (UNSA) with engineering support provided by HTSI.
- TLRS-3 tracked its last pass, Starlette, on January 27, 2004.
- In Fall 2005, HTSI was tasked by NASA to return TLRS-3 to operations
- The UNSA crew returned to the station on December 12, 2005 to begin the restart of the system.
- HTSI returned to the station in January 2006.
- HTSI working with NASA and UNSA began restoring the TLRS-3 to full operations.
- This work was done concurrently with the TLRS 4 Return to Operations.





TLRS-3 Return to Operations Strategy

- Implement repairs to TLRS-3 following 2 years of inactivity in an unclimitized environment
- Implement the upgrades that were performed on the TLRS-4 system in 2005
- Validate system performance
- Perform a full system characterization through SOVT process
- Validate calibration and tracking data prior to release of data to ILRS



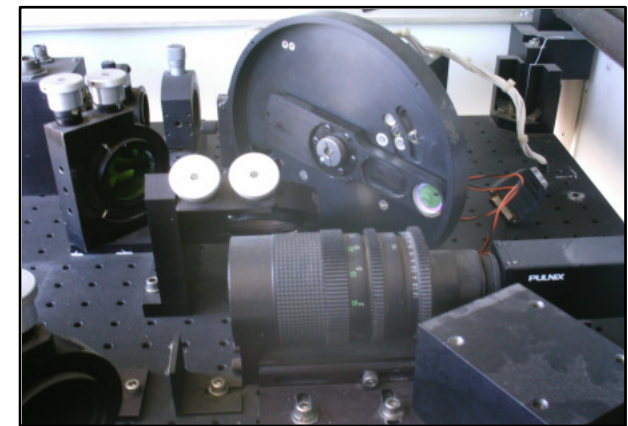
TLRS-3 with DORIS





Significant Engineering Issues

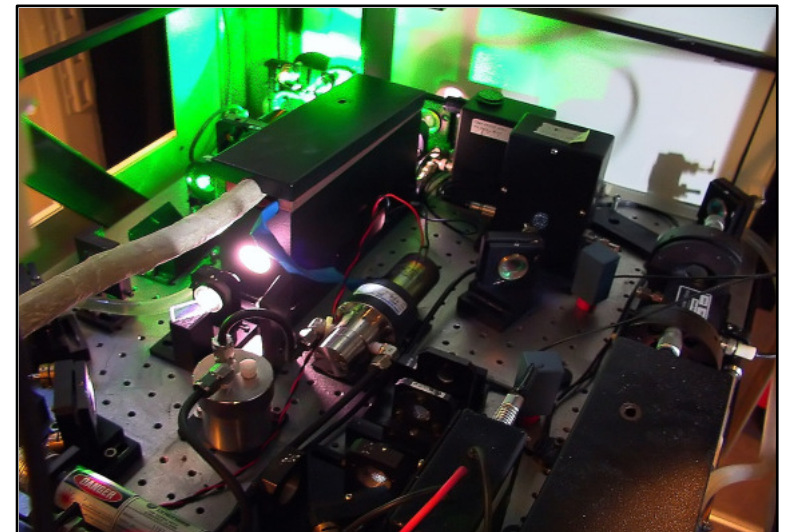
- System Off Line for over 2 years
 - No HVAC
 - No humidity control
 - No air filtration
- System not exercised
- Corrosion Issues
 - wire wrap boards, ICs, connectors, switches, etc.
 - metal surfaces (e.g. bearings)
- No Site or Station maintenance
- Temperature Cycling





Planned and Implemented Upgrades

- Upper Deck Upgrade
 - Enclosed Entire Upper Deck Optical Train
 - Assist in keeping upper deck optics clean
 - Improve optics life
 - Improved daylight tracking
 - Additional operator safety
 - Camera assisted star calibration
 - No optics removed to perform star calibration
 - Camera assisted laser co-alignment
- New 10Å Daylight Filter
 - Efficiency 68%
 - More temperature stable





Planned and Implemented Upgrades

- Telescope
 - Disassembled/Cleaned
 - Increased telescope throughput from ~50 % to ~80 %
 - Efficiency of a new telescope is 87 %
- T/R Switch Upgrade
 - Improved stepper motor design
 - Old design was very temperature sensitive
- Photek MCP / Tennelec CFD
 - Replaced failing ITT MCP
 - Newly calibrated CFD





Planned and Implemented Upgrades

- Controller Computer
 - Sattrk Program & Monitor Program
 - Window/Window width upgrade
 - Mode Change Bias Reset
 - Enhance “Record All Frames” Function
 - 5pps & 4pps Thread Matching
 - 5pps & 4pps Automated Switching
 - Sun Avoidance
 - Horizon Mask
 - Go/NoGo Software
 - HVPS Scaling
- New Trackball Design
 - New microprocessor design
- Site Power Transformer Maintenance





Current Status

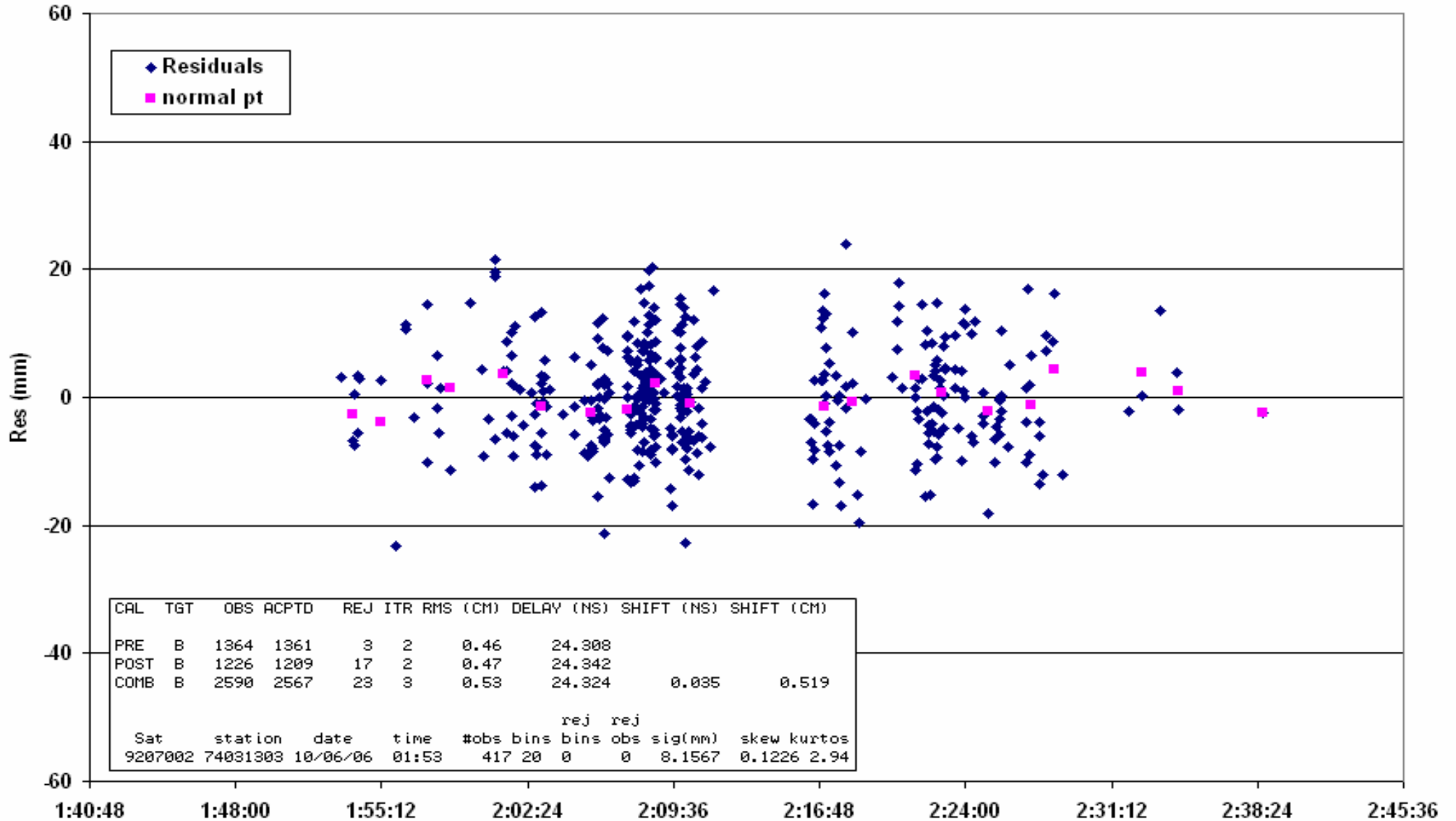
- Engineering Status
 - Accumulating data to resolve gimbal issues
 - Monitoring station performance
- Producing quality data
 - Received over 90 pass segments
 - <10mm on Lageos
 - <20mm on Ajisai
 - <10mm on Starlette
 - Have tracked CHAMP and Grace B
 - 5.4 mm average Calibration RMS

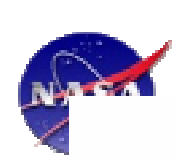


Test Results

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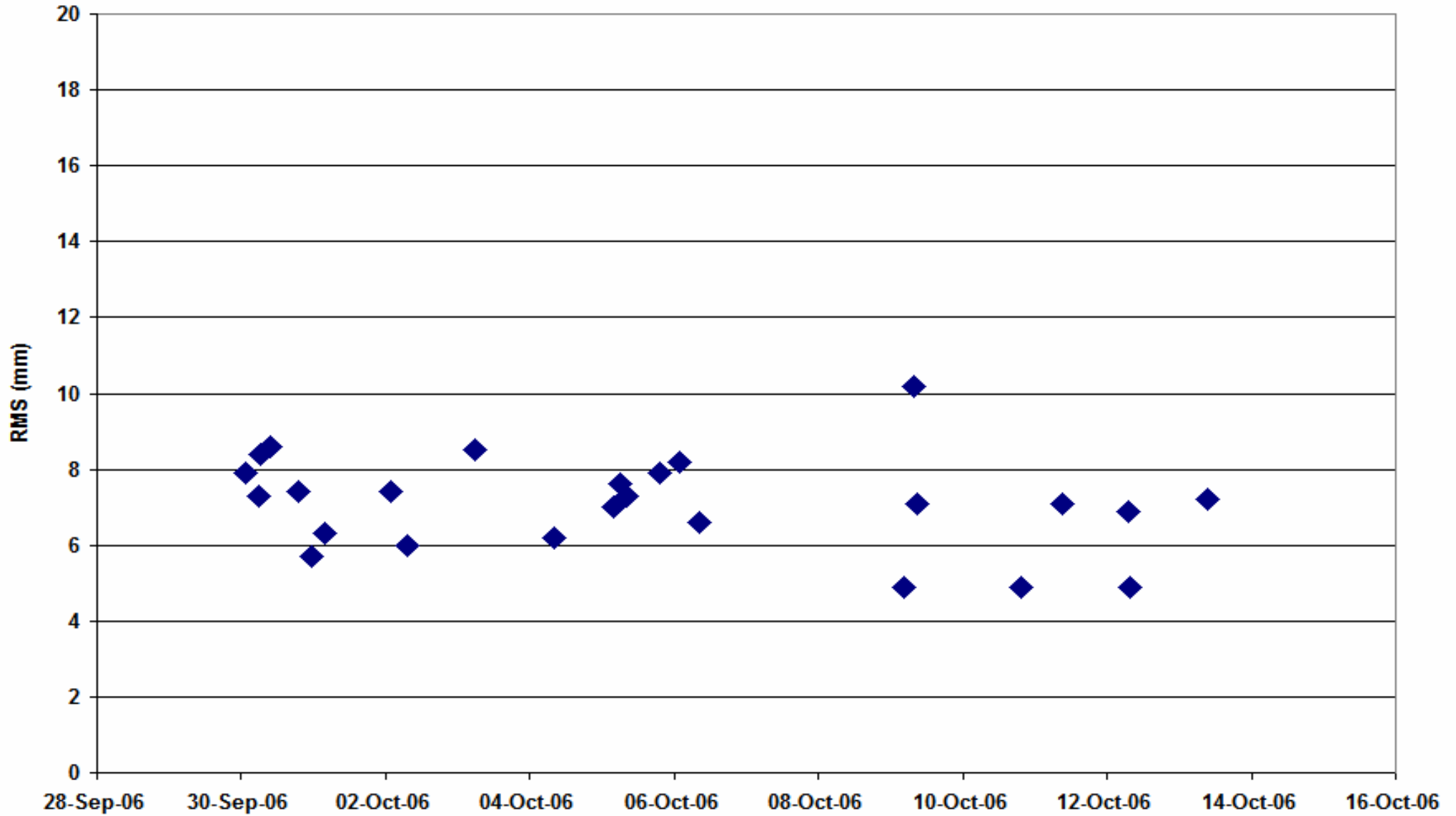
TLRS-3 Lageos-2 DOY 279 @01:52





Test Results

TLRS-3 Lageos Satellite RMS

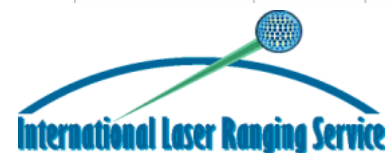




Test Results



PASS DATE	OCC NUM	SATID	TARGET	TARGET DISTANCE	# CAL OBS	# CAL REJ	CAL RMS (mm)	APPLIED DELAY	SHIFT (mm)	# SAT OBS	# SAT REJ	SAT RMS (mm)	MEAN TEMP ©	MEAN PRESS (mbars)	HUMIDIT Y (%)	NUM NP DATA BINS	NUM NP
29-Sep-06 00:53	03	1500	BC	105981	1948	14	4.5	3637.2	-1.07	93	15	22.2	13.32	761.2	51	30	18
30-Sep-06 01:21	03	5986	BC	105981	2188	9	5.9	3643.9	6.16	92	0	7.9	12.31	760.5	46	4	4
30-Sep-06 01:43	03	4378	BC	105981	2188	9	5.9	3643.9	6.16	19	6	4.2	11.73	760.6	45	28	6
30-Sep-06 02:03	03	1500	BC	105981	2188	9	5.9	3643.9	6.16	341	23	17.3	11.57	760.7	45	20	19
30-Sep-06 05:51	03	5986	BC	105981	2046	5	6.4	3643.5	-1.46	10	0	7.3	10.27	759.7	43	2	2
30-Sep-06 06:11	03	1155	BC	105981	2046	5	6.4	3643.5	-1.46	224	1	8.4	10.29	759.5	42	13	13
30-Sep-06 06:56	03	317	BC	105981	2034	4	6.4	3644.6	0.65	343	23	14.2	9.88	759.5	41	27	19
30-Sep-06 08:05	03	1134	BC	105981	2065	10	5.9	3646.7	1.72	100	7	8.4	8.91	759.6	45	5	5
30-Sep-06 08:52	03	643	BC	105981	2014	1	5.8	3646.2	-0.95	67	3	10	9.51	759.7	42	4	4
30-Sep-06 09:52	03	5986	BC	105981	2043	1	6.4	3646.4	1.37	159	1	8.6	9.15	760	39	14	10
30-Sep-06 18:58	03	1155	BC	105981	2249	10	5	3646.2	-0.35	132	1	7.4	23.14	760.5	15	6	6
30-Sep-06 23:04	03	1134	BC	105981	2022	3	5	3644.5	2.06	372	63	8.9	16.08	761.7	28	19	13
30-Sep-06 23:31	03	5986	BC	105981	2022	3	5	3644.5	2.06	38	1	5.7	14.37	762.1	32	10	8
01-Oct-06 01:11	03	1500	BC	105981	2233	16	4.7	3640	2.66	1063	231	21.7	11.35	762.5	39	17	17
01-Oct-06 02:37	03	6179	BC	105981	2015	32	4.4	3641.1	2.11	43	0	19.9	10.51	762.6	36	5	5
01-Oct-06 03:05	03	6178	BC	105981	2015	32	4.4	3641.1	2.11	127	14	22.4	10.7	762.6	32	6	6
01-Oct-06 03:13	03	5557	BC	105981	2015	32	4.4	3641.1	2.11	109	12	6.1	10.55	762.5	31	7	7
01-Oct-06 03:33	03	5986	BC	105981	2015	32	4.4	3641.1	2.11	109	3	6.3	8.9	762.3	36	13	11
02-Oct-06 00:34	03	4378	BC	105981	2131	39	4.6	3638.1	-0.65	192	3	7.3	12.12	761.9	35	27	23
02-Oct-06 01:13	03	8004	BC	105981	2157	60	4.7	3637.3	-1.4	402	22	14.6	11.46	762.2	35	45	34
02-Oct-06 01:31	03	5986	BC	105981	2157	60	4.7	3637.3	-1.4	405	4	7.4	10.85	762.2	36	21	18
02-Oct-06 02:36	03	6178	BC	105981	2455	66	4.8	3636.3	1.11	59	8	8	10.9	762.2	32	11	10
02-Oct-06 05:14	03	8501	BC	105981	2059	43	5.3	3639.4	-1.09	44	1	6.8	8.48	761.1	37	7	6
02-Oct-06 05:28	03	317	BC	105981	2059	43	5.3	3639.4	-1.09	192	15	14.3	8.69	760.8	35	26	12
02-Oct-06 06:53	03	8501	BC	105981	2083	28	5.3	3638.1	-0.4	8	0	10.1	8.2	760.2	34	2	2
02-Oct-06 06:55	03	1134	BC	105981	2083	28	5.3	3638.1	-0.4	168	10	10.7	8.18	760.2	34	10	10
02-Oct-06 07:05	03	1155	BC	105981	2083	28	5.3	3638.1	-0.4	38	0	6	8.29	760.1	36	3	3
02-Oct-06 07:19	03	317	BC	105981	2083	28	5.3	3638.1	-0.4	371	40	9.3	7.7	760.1	34	34	21
02-Oct-06 07:59	03	643	BC	105981	2025	19	5.4	3638.4	0.16	13	0	5.7	7.41	760.1	36	3	3
02-Oct-06 08:48	03	1134	BC	105981	2035	7	5.5	3640.3	0.91	30	3	7.9	7.8	759.9	34	4	4
02-Oct-06 12:57	03	1500	BA	105981	1018	8	6.3	3645.6	0	460	65	16.3	18.1	761.4	18	12	12
03-Oct-06 01:32	03	1500	BB	105981	1007	32	4.8	3636.8	0	182	5	14.8	10.52	761.4	41	4	4
03-Oct-06 02:48	03	5557	BC	105981	2031	139	5.3	3638.3	-0.94	99	6	7.6	10.69	761.7	40	10	8
03-Oct-06 04:45	03	317	BC	105981	1837	27	5.2	3639.4	-1.4	157	6	9.9	9.58	760.6	40	21	18
03-Oct-06 05:32	03	1155	BC	105981	2034	37	5	3638.3	1.67	243	3	8.5	9.13	760.3	41	12	12
03-Oct-06 06:19	03	8501	BC	105981	2039	41	5	3639.6	-0.1	129	15	16.9	9.6	759.8	36	4	4
03-Oct-06 06:40	03	317	BC	105981	2039	41	5	3639.6	-0.1	119	2	8.5	8.85	759.5	36	11	11
03-Oct-06 07:16	03	1134	BC	105981	2017	34	5.3	3640.5	2.09	17	0	6.9	9.2	759.3	32	1	1
04-Oct-06 05:48	03	8501	BC	105981	2031	6	5.1	3644.3	1.81	165	7	7.2	9.8	759.4	33	9	9
04-Oct-06 07:38	03	1134	BC	105981	2040	8	5.1	3643.3	-0.55	272	8	7.9	8.42	758.6	32	7	7
04-Oct-06 07:49	03	317	BC	105981	2040	8	5.1	3643.3	-0.55	26	0	7.1	8.99	758.5	30	7	7

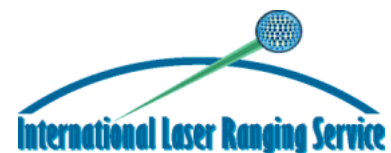




Test Results



PASS DATE	OCC NUM	SATID	TARGET	TARGET DISTANCE	# CAL OBS	# CAL REJ	CAL RMS (mm)	APPLIED DELAY	SHIFT (mm)	# SAT OBS	# SAT REJ	SAT RMS (mm)	MEAN TEMP ©	MEAN PRESS (mbars)	HUMIDIT Y (%)	NUM NP DATA BINS	NUM NP
04-Oct-06 07:49	03	317	BC	105981	2040	8	5.1	3643.3	-0.55	26	0	7.1	8.99	758.5	30	7	7
04-Oct-06 07:53	03	1155	BC	105981	2040	8	5.1	3643.3	-0.55	12	0	6.2	8.61	758.6	34	6	5
05-Oct-06 02:11	03	6179	BC	105981	1237	15	5	3643.2	-1.85	249	55	7.9	10.57	760	41	22	20
05-Oct-06 02:29	03	5557	BC	105981	1237	15	5	3643.2	-1.85	23	1	9.7	10.5	760.1	40	2	2
05-Oct-06 02:40	03	6178	BC	105981	1237	15	5	3643.2	-1.85	346	23	8.9	10.61	760.2	39	20	19
05-Oct-06 02:47	03	8002	BC	105981	1237	15	5	3643.2	-1.85	109	6	10.8	10.47	760.2	39	16	11
05-Oct-06 03:54	03	5986	BC	105981	2277	59	5.5	3642.8	1.2	119	1	7	9.88	759.6	39	17	17
05-Oct-06 05:10	03	317	BC	105981	2046	10	5.5	3643.1	1.29	59	3	10.3	9.7	758.9	34	18	8
05-Oct-06 06:12	03	1155	BC	105981	2146	8	5.5	3647.4	0.67	109	0	7.6	9.37	758.3	22	12	4
05-Oct-06 07:04	03	317	BC	105981	2146	8	5.5	3647.4	0.67	306	20	11.1	8.84	758.1	21	19	19
05-Oct-06 07:54	03	1134	BC	105981	2143	8	5.5	3647.9	1.36	405	51	11.1	9.59	757.8	18	11	11
05-Oct-06 08:20	03	643	BC	105981	2143	8	5.5	3647.9	1.36	130	11	6.7	9.38	757.7	17	6	6
05-Oct-06 08:28	03	5986	BC	105981	2143	8	5.5	3647.9	1.36	54	0	7.3	9.31	757.6	17	8	6
05-Oct-06 18:05	03	8501	BC	105981	2060	10	6.7	3655.7	-7.68	47	2	5.9	23.44	758	16	6	6
05-Oct-06 19:22	03	1155	BC	105981	1687	20	5.5	3654.1	1.19	15	1	7.9	23.11	757.5	17	3	2
05-Oct-06 22:41	03	1500	BC	105981	2064	11	5.6	3654.2	1.87	700	91	21.9	18.21	758.7	22	19	19
06-Oct-06 01:53	03	5986	BC	105981	2590	23	5.3	3646	5.19	417	0	8.2	12.35	760.9	33	24	20
06-Oct-06 03:03	03	5557	BC	105981	2174	5	5.4	3649.3	-1.43	33	3	6.1	10.5	761	35	3	3
06-Oct-06 03:19	03	6179	BC	105981	2174	5	5.4	3649.3	-1.43	127	9	7	11.17	761.1	33	9	9
06-Oct-06 06:16	03	317	BC	105981	2063	5	5.6	3650.2	-0.2	450	19	13.1	10.39	759.9	34	27	25
06-Oct-06 06:28	03	1134	BC	105981	2063	5	5.6	3650.2	-0.2	202	41	9.4	10.33	759.9	33	5	5
06-Oct-06 08:14	03	1155	BC	105981	2021	6	5.6	3652.2	0.49	110	0	6.6	10.14	759.2	30	22	15
08-Oct-06 21:59	03	1500	BC	105981	2026	54	4.7	3655.6	0.51	1417	260	17.7	19.89	760.3	24	25	24
08-Oct-06 23:21	03	4378	BC	105981	2192	106	5.2	3653.8	2.72	116	11	7.5	15.79	761	33	20	14
09-Oct-06 04:10	03	317	BC	105981	1527	175	5.7	3649.4	-1.07	11	0	6.5	11.4	761.6	34	2	2
09-Oct-06 04:30	03	1155	BC	105981	1527	175	5.7	3649.4	-1.07	44	5	4.9	11.34	761.4	32	8	7
09-Oct-06 05:37	03	1134	BC	105981	1540	151	5.5	3647.1	-0.87	134	25	6.9	11.5	760.8	29	5	5
09-Oct-06 07:46	03	1155	BC	105981	2063	181	5.4	3647.1	1.83	39	1	10.2	10.03	760	29	6	4
09-Oct-06 08:15	03	643	BC	105981	2063	181	5.4	3647.1	1.83	33	5	6.5	9.1	759.9	25	2	2
09-Oct-06 08:56	03	5986	BC	105981	2044	259	5.4	3647.1	-2.6	272	23	7.1	9.24	760	23	20	14
10-Oct-06 19:01	03	1134	BC	105981	1234	3	6	3660.7	5.77	241	19	7.1	22.35	761.9	20	20	12
10-Oct-06 19:35	03	1155	BC	105981	1234	3	6	3660.7	5.77	60	1	4.9	22.97	761.8	20	5	5
11-Oct-06 09:10	03	5986	BA	105981	1020	1	5.3	3658.7	0	56	0	7.1	12.22	760.9	17	17	6
12-Oct-06 04:42	03	1134	BC	105981	2048	6	5.1	3660	0.29	156	6	5.9	11.84	762.6	29	14	5
12-Oct-06 06:39	03	8501	BC	105981	2023	5	5	3660.5	-0.34	10	0	8.4	11.4	761.5	31	2	2
12-Oct-06 07:11	03	1155	BC	105981	2124	5	4.8	3661.4	-0.14	108	0	6.9	11.57	761.2	30	6	6
12-Oct-06 07:34	03	1155	BC	105981	2124	5	4.8	3661.4	-0.14	32	0	4.9	11.96	761.2	29	6	6
12-Oct-06 08:31	03	643	BC	105981	2092	9	4.5	3659.8	-0.08	96	12	9.5	11.16	761.1	30	4	4
12-Oct-06 10:03	03	1500	BC	105981	2051	8	5	3658.9	-0.77	1083	111	17	11.35	761.6	30	17	17
12-Oct-06 10:56	03	4378	BC	105981	2019	6	5.6	3662.9	2.36	24	0	6	11.6	762	30	6	6
12-Oct-06 17:52	03	1134	BC	105981	1926	17	5	3666.7	-0.02	133	7	7	24.29	761.1	16	14	10
13-Oct-06 08:09	03	643	BB	105981	1041	47	7.3	3654	0	48	3	16.5	9.6	761.1	36	4	2
13-Oct-06 09:39	03	5986	BC	105981	2085	46	6.3	3656.2	-0.8	377	2	7.2	9.03	761.4	36	14	13





Future Plans

- Complete Gimbal Optimization
- Complete 4pps Upgrade
- Complete Software Upgrades
 - Controller
 - Processor
- Complete Crew Training
- Perform Site Survey
- Calibrate System Equipment
- Restock System Spares
- Site Safety Inspection