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A SINGLE BEAM LASER TRACKER AS AN ALIGNMENT TOOL * **

B.T.Wand, C. LeCocq, M. Gaydosh, R.E.Ruland

Stanford Linear Accelerator Center, Stanford University, Stanford Ca, 94309

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1. ABSTRACT

In December 1991 the Survey and Alignment team of the Stanford Linear Accelerator Center (SLAC) purchased a Chesapeake single beam laser tracker. This paper will discuss first experiences and applications with this new type of an alignment instrument.

2. INTRODUCTION

The Chesapeake Laser Systems Coordinate Measurement System (CMS) 3000 (Figure 1) is a servo controlled tracking laser interferometer measurement tool. The tracker follows a retro target while giving real time coordinate information of the retro center location. The coordinates are given in a spherical coordinate system where the distance is measured by the interferometer and the horizontal and vertical angles are determined by rotary encoders. The system is powered by a remote power supply which can be located up to 50 feet away. Into the power supply is a weather station incorporated which allows the measurement of air pressure and humidity. The temperature is measured at the tracker unit. The system computer is a COMPAQ 486/33 which communicates with the tracker unit via a Tracker Interface Board (TIB) designed by Chesapeake. The laser is a class 2 Helium Neon Laser. The instrument meets the requirements of the Food and Drug Administration, Center for Devices and Radiological Health, Federal Register 21 CFR parts 1000 and 1040 [1].

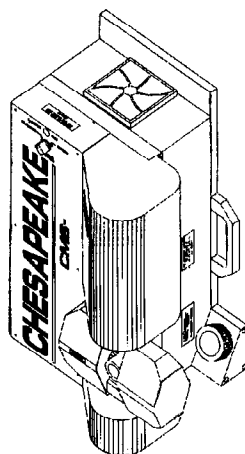


Fig 1: The CMS-3000

There are many different applications where tracking interferometry can enhance and in many ways revolutionize the conventional methods currently employed. Some of the applications include:

- Robot calibration and dynamic mapping
- Machine tool volumetric calibration
- Large assembly inspection
- Part digitization and profiling
- Reverse engineering applications
- Alignment measurements



Figure 2 represents a compressed list of the system specifications.

SYSTEM SPECIFICATIONS	
CMS-3000 Tracker Head:	
Width:	12.5"
Height:	23.0"
Depth:	7.5" min, 9.2" max
Weight:	80.0 lbs
Remote Power Unit (RPL):	
Width:	9.5"
Height:	12.0"
Depth:	17.0"
Weight:	25 lbs
Typical Tooling Stand:	Weight: 204 lbs
Assembly Floor Load:	Average = 37.5 lbs/sq. ft
Repeatability:	At least 5 ppm of measurement
Resolution:	Angular = 1 arc-second per angular unit Radial = from 0.5 to 5 microns per distance unit
Velocity:	From 1 to 6 meters/sec.
Acceleration:	> 2 g's
Distance Range:	0.17 meters (min.) to 30 meters (max.)
Elevation Range:	± 55 degrees
Azimuth Range:	>270 degrees

Fig 2: System specifications of the CMS-3000

3. CONCEPT OF OPERATION

Tracking interferometry is a technology which utilizes the accuracy of laser interferometry with the flexibility of automated tracking. The instrument gathers target position information in a three dimensional spherical coordinate system. In this format, the range to the target is measured with a laser interferometer which is locked onto the target's optical center by a servo feedback system. The servo motors drive the interferometer's steering optics to keep in step with the target motion. This enables the interferometer to keep a continuous return beam from the target for an uninterrupted fringe count which determines the target range within the resolution of a wavelength of red light ($0.6238 \mu\text{m}$). The angular information is monitored by laser rotary encoders which are affixed to each servo axis for azimuth and elevation position in arc second resolution. The output information is converted to rectangular X, Y, Z format in a user defined coordinate system [1,3].

Tracking interferometry differs from conventional measurement techniques such as theodolites in that its strength is in the range information along the beam. The greatest strength in conventional theodolite measurement is in the angular information. Typically, the best geometry for the greatest accuracy in theodolite use is in a set up which enhances the measurement area by using as much angular information as possible and therefore increases the redundancy of the data set. The idea is similar with trackers as we increase the redundancy by introducing a highly accurate range information with each measurement.

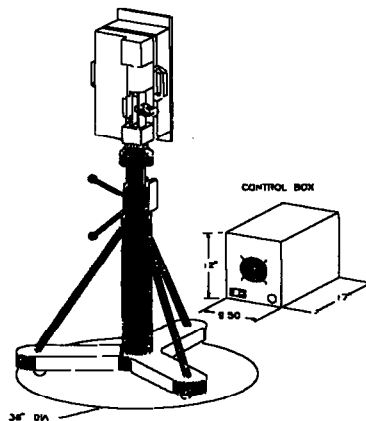


Fig 3: CMS-3000 on a tooling stand with power supply



4. CALIBRATION AND SETUP CONSIDERATIONS

After the system has been powered up and stabilized (approximately 30 min.), a local scaling procedure should be done. This can be done by placing the reflector in the TMR (Tracker Mount Reset) from which we know the distance to the center of the tracker or by measuring a scale bar. This establishes the true initial distance from the target center to the tracker. The TMR reset procedure has to be re-executed should a beam interruption occur.

Before each measurement set a field calibration should be performed. Part of the tracker system is a calibration dome with 16 mounted reflectors and 16 mirrors. These 32 targets are spread over the complete measurement range of the tracker unit. The tracker in its calibration mode will measure unattended all the targets of the dome in direct and reverse measurements. The calibration software will then calculate 12 independent parameters of a mathematical model which compensates for various tracker errors. This approach is similar to the determination of theodolite axis errors only that a tracker model has to allow for more additional degrees of freedom than a theodolite. These errors have to be seen as unavoidable deviations from a perfect assembly. Once these parameters are determined they serve as filters for the measurement data.

Initially, the tracker was not stable enough for the calibration parameters to remain approximately the same between calibrations. After the problem was discovered and fixed, the parameters stay in general the same to within 10 % change. From calibration to calibration the tracker was carted around and handled like we would expect it to be handled in the field. To date a calibration takes still about 2 hours and can not be executed completely unattended. We believe that the calibration time will be reduced to less than an hour and we anticipate a complete unattended calibration procedure in the near future.

A typical measurement session has an error budget. In each session it is attempted to hold most measurement errors to a minimum. Considerations for error sources for the system include:

- Target offset error
- Target nest repeatability
- Local environment characteristics
- Physical changes of the stand or measured object.
- Atmospheric conditions and their changes.

5. MEASUREMENTS AND RESULTS

5.1. TEST NETWORK

For the testing of the laser tracker a network was established, with its configuration similar to the conditions we will encounter for its intended use during the FFTB (Final Focus Test Beam) survey. As a test site we chose our calibration laboratory. The survey calibration laboratory is an underground chamber approximately 5 x 30 meters, located at sector 10 of the LINAC (LINear ACcelerator) and at the same level as the accelerator. The atmospheric conditions of this laboratory are very stable e.g. the temperature is stable to within 1 °C. The targets are reflector cups bolted to the walls and to the floor. The targets are distributed evenly horizontally and vertically along the chamber.

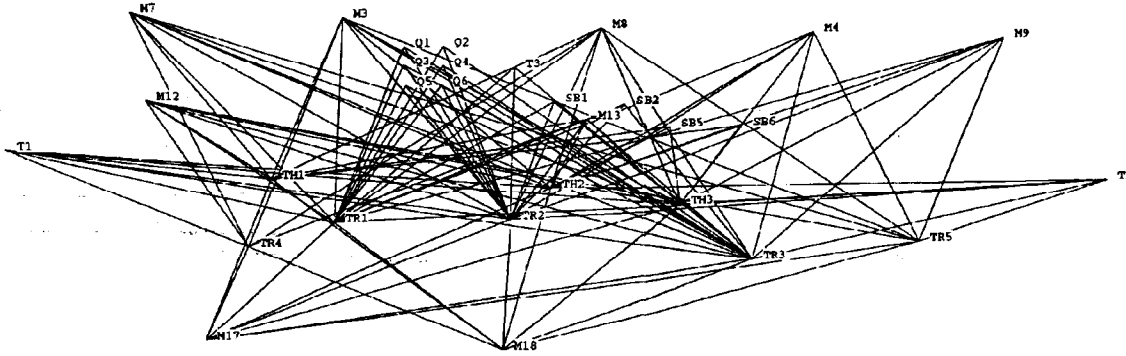


Fig 4: Network configuration sector 10. Plan view.

5.2. BUNDLE ADJUSTMENT

Part of our SIMS (SLAC Industrial Measurement System) is a rigorous bundle adjustment. It's major strength is that we don't assume the measurement stations to be leveled. The measurement stations are defined by three coordinates and three orientation angles with respect to the network reference system. This feature is a requirement for laser tracker measurements as there is no mechanical way to link the tracker stations orientation to the gravity vector. We also expanded this adjustment to allow for additional observation types like the distance information from the interferometer and elevation or leveled height differences between targets. All the observations are input for the rigorous least square adjustment package which calculates the X, Y and Z positions and the three rotations of the measurement stations as well as the positions of the targets. The output includes statistical information which allows us to predict the reliability of the calculated results as a function of the geometry and quality of the measurements. The SIMS bundle adjustment is the only available package to incorporate 4 types of observations which are directions, distances between points (e.g. scale bars), radial distances and leveled height differences.

Furthermore we introduced an additional parameter for each station. This unknown represents a constant distance offset. The tracker distance has to be set initially by placing the reflector into the TMR (Tracker Mount Reset). This reset depends on the calibrated distance value stored for the position of the cup as well as the quality of the positioning (e.g. dust particles). We are interested in error ellipses of less than 0.1 mm. Because of this goal we chose not to assume this initial distance to be accurate enough and rather treat it as an additional unknown. The calculation of the parameter is optional. The introduction of these additional parameters might introduce some unwanted correlation between the parameters. Simulations showed an improvement of the model, the calculated parameters appear to be significant and independent. Although computer simulations indicate good results the tracker field test represents its real test.

5.3. DATA SETS

All measurements were done over a time period of one week. The accuracy for the observations for all data sets was assumed as follows:

Directions tracker	0.0015 [gon]
Directions theodolite	0.0005 [gon]
Distances	0.015 [mm]
Height differences	0.050 [mm]



All observations were done in direct and reverse mode. The table below shows the differences between the direct and reverse observations for the station #2. A complete comparison is listed in Appendix A.

Point	AZ Diff. Direct - Reverse [GON]	V Diff. Direct - Reverse [GON]	Dist. Diff. Direct - Reverse [μm]
M3	0.0004	0.0098	1
M4	0.0074	0.0108	-2
M7	0.0037	0.0093	-6
M8	0.0097	0.0028	-6
M12	0.0058	0.0078	-6
M13	0.0108	0.0068	5
M17	0.0070	0.0051	-1
M18	0.0066	0.0109	-6

The following tables show the results associated with the eight targets observed by all the stations (with exception of tracker station #2 from where M9 couldn't be observed. The complete data sets (input and output from the bundle solution) are listed in the Appendices B - E.

5.3.1. 5 TRACKER STATIONS

Listings in Appendix B, σ_0 (a posteriori) = 0.72, Degrees of freedom = 176

TARGET	X [mm]	Y [mm]	Z [mm]	SDX [mm]	SDY [mm]	SDZ [mm]
M3	4588.02357	1996.20073	1688.87771	.01728	.02172	.03445
M4	11022.4104	1849.73053	1609.86889	.01645	.02770	.04533
M7	1673.27299	2029.64173	275.31464	.01636	.02877	.05242
M8	8106.78439	1901.70430	756.91189	.01339	.01475	.03361
M9	13606.2873	1776.69178	485.16377	.01594	.03482	.06725
M12	1813.88824	832.54137	-1111.7839	.01583	.03547	.04333
M13	7932.22290	715.55259	-1075.5558	.01303	.02124	.02232
M17	2776.21535	-2432.6019	644.61513	.01368	.02521	.03986
M18	6785.68686	-2520.3748	523.07001	.01188	.01382	.02490

5.3.1.1. WITHOUT ADDITIONAL CONSTANT PARAMETER

Listings in Appendix C, σ_0 (a posteriori) = 0.74, Degrees of freedom = 181

TARGET	X [mm]	Y [mm]	Z [mm]	SDX [mm]	SDY [mm]	SDZ [mm]
M3	4588.02408	1996.20748	1688.88029	.01717	.02037	.03522
M4	11022.4148	1849.73471	1609.86957	.01654	.02697	.04618
M7	1673.27351	2029.65447	275.31401	.01582	.02797	.05370
M8	8106.78480	1901.71154	756.91241	.01370	.01048	.03443
M9	13606.2941	1776.68810	485.16813	.01554	.03458	.06882
M12	1813.88790	832.55131	-1111.7927	.01522	.03577	.04363
M13	7932.22291	715.55962	-1075.5600	.01328	.02010	.02187
M17	2776.21859	-2432.6238	644.62493	.01181	.02250	.04065
M18	6785.69306	-2520.3810	523.07222	.01130	.00922	.02545



5.3.1.2. HEIGHT DIFFERENCES AS ADDITIONAL OBSERVATIONS

Listings in Appendix D, σ_0 (a posteriori) = 0.71, Degrees of freedom = 183

TARGET	X [mm]	Y [mm]	Z [mm]	SDX [mm]	SDY [mm]	SDZ [mm]
M3	4588.02271	1996.20031	1688.87731	.01522	.02037	.02895
M4	11022.4097	1849.73058	1609.87138	.01457	.02639	.03155
M7	1673.27290	2029.64164	275.31308	.01601	.02819	.03391
M8	8106.78415	1901.70448	756.91182	.01291	.01431	.02789
M9	13606.2872	1776.69192	485.16964	.01558	.03407	.03662
M12	1813.88882	832.54238	-1111.7850	.01326	.03384	.02741
M13	7932.22366	715.55246	-1075.5556	.01037	.02031	.02000
M17	2776.21513	-2432.6021	644.61132	.01332	.02469	.02863
M18	6785.68673	-2520.3748	523.07075	.01161	.01352	.02331

5.3.2. 5 TRACKER STATIONS AND 3 THEODOLITE STATIONS

Listings in Appendix E, σ_0 (a posteriori) = 1.12, Degrees of freedom = 229

A special target was manufactured which consists of a 1.5 in diameter cut out steel sphere with a optical target centered within less than 20 μ m (Figure 5).

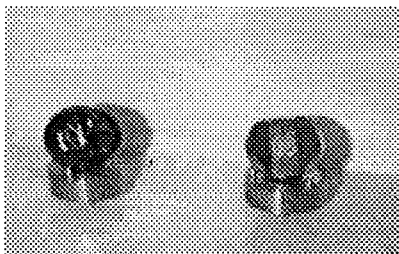


Fig 5: Tracker target and theodolite target with magnetic target cups.

TARGET	X [mm]	Y [mm]	Z [mm]	SDX [mm]	SDY [mm]	SDZ [mm]
M3	4587.96333	1996.16712	1688.95010	.02515	.02702	.03972
M4	11022.3692	1849.82115	1609.89199	.02415	.03689	.05428
M7	1673.24356	2029.63939	275.43896	.02306	.03962	.06041
M8	8106.74636	1901.74396	756.88819	.01987	.01957	.03626
M9	13606.2863	1776.73491	485.23482	.02270	.05051	.07917
M12	1813.89205	832.66319	-1111.7074	.02192	.04346	.05420
M13	7932.28516	715.49466	-1075.6316	.01892	.02430	.02619
M17	2776.21508	-2432.6495	644.62459	.01962	.03429	.05186
M18	6785.67392	-2520.4043	523.05607	.01776	.01748	.03365

5.4. RESULTS

Initially a datum for the network had to be defined. In this case the tracker station 2 (1-2) has been chosen as the origin with its rotations being fixed to zero in order to define the three axis. Additionally two scale bars have been introduced to supply the scale for the network. The comparison of the direct and reverse measurements indicates that the angles are not comparing as well as we are used to from theodolite observations. This was to be expected since the encoders have a resolution of only 1 arc second. As a



result we weighed the tracker directions one third less as we weighed a theodolite direction. The distances in comparison show differences within the μm range.

When comparing the results between the introduction of the additional distance offset parameters (5.3.1. or Appendix B) and the classical approach (5.3.1.1. or Appendix C), the first observation is the remarkable stability. The output coordinates are similar, the distribution of the residuals are similar and the computed distance offsets range from $4\mu\text{m}$ up to $40\mu\text{m}$. In fact the introduction of an extra unknown per station confirms that the model improves as the residuals get overall smaller. The other impact is a globally smaller standard error in Z (within μm range) and a higher standard error in X or Y depending on the location of the points with respect to the stations. This last observation is a direct consequence of the network geometry. The points are distributed along a line, the maximum difference in X is 12 meters versus 1.5 meters in Y. Although the gain is very small (within μm range), it has to be noted that initially the tracker offsets have been calibrated very accurately (better than $40\mu\text{m}$) and nonetheless the introduction of these additional parameters indicate a stable condition and better results.

The introduction of leveled height differences improves our accuracy in Z even further (5.3.1.2. or Appendix D). Our attempt to improve the accuracy by introducing highly accurate directions with theodolites didn't materialize (5.3.2. or Appendix E). By splitting the data and consider either theodolites or trackers the solutions converged well with a σ_0 (a posteriori) well below one. The target locations (magnetic target cups) though were substantially different (~ 0.1 [mm]) and appeared to have moved. It was discovered that the target cups showed wear. The steel pins of the target cups had to be replaced.

6. CONCLUSION

We can conclude from these tests that we are able to achieve standard errors of less than $40\mu\text{m}$ in X, Y and Z by using the laser tracker in combination with a highly accurate leveling system like a hydrostatic water level [2]. The introduction of leveled height differences will be essential to hold the standard errors for the elevations below $40\mu\text{m}$. The tracker hardware appears to be in working condition. The tracker software is still in an evolutionary stage and needs considerable improvements. At this point of time we are in the process of interfacing the Chesapeake tracker to our SIMS (SLAC Industrial Measurement System) package. We work towards a unified industrial package which allows the combined usage of theodolites, laser trackers and hydrostatic levels. This package is developed under Microsoft Windows 3.1..

7. BIBLIOGRAPHY

1. CMS-3000 Users manual.
2. Pellissier, P., Pellissier H5 Hydrostatic level, Instruction manual.
3. Riemensperger M., Gottwald R., "Kern-Smart 310 - Leica's Approach to High Precision Dynamic 3D Coordinate Determination", Proc. of the 2nd Intern. Workshop on Acceler. Alignm., Sep. 10 - Sep 12 1990 DESY Hamburg FDR, pp 183-200.



APPENDIX A

Laser Tracker Distance Comparison					
(First 3 tracker stations only)					
Measurements taken on June 1, 1992					
		Direct	Reverse	Average	Difference
Pos #	Point	Dist (meter)	Dist (meter)	Dist (meter)	Dir-Rev (micron)
1	M3	3.085524	3.085521	3.085523	3
1	M4	7.053975	7.053971	7.053973	4
1	M7	4.069856	4.069847	4.069852	9
1	M8	4.439855	4.439854	4.439855	1
1	M9	9.366236	9.366236	9.366236	0
1	M12	3.553852	3.553852	3.553852	0
1	M13	3.935194	3.93506	3.935127	134
1	M17	2.466533	2.466536	2.466535	-3
1	M18	2.787714	2.787721	2.787718	-7
2	M3	3.827782	3.827781	3.827782	1
2	M4	4.974635	4.974637	4.974636	-2
2	M7	5.949621	5.949627	5.949624	-6
2	M8	2.896216	2.896222	2.896219	-6
2	M12	5.569009	5.569015	5.569012	-6
2	M13	2.280502	2.280497	2.280500	5
2	M17	4.512092	4.512093	4.512093	-1
2	M18	1.806886	1.806892	1.806889	-6
3	M3	6.641781	6.641775	6.641778	6
3	M4	3.426418	3.426416	3.426417	2
3	M7	9.170632	9.170633	9.170633	-1
3	M8	3.825404	3.825408	3.825406	-4
3	M9	4.538623	4.538628	4.538626	-5
3	M12	8.806444	8.806452	8.806448	-8
3	M13	3.373334	3.373335	3.373335	-1
3	M17	7.552699	7.55271	7.552705	-11
3	M18	3.673152	3.673161	3.673157	-9

		Laser Tracker Direction Comparision						(5 tracker stations)	
		Measurements taken on June 1, 1992							
		Direct	Direct	Reverse	Reverse	Average	Average	Diff. (Dir -	(Dir + Rev -
Pos.#	Point	AZ (GON)	V (GON)	AZ (GON)	V (GON)	AZ (GON)	V (GON)	Rev) AZ	400) V
1	M3	246.5437	71.7603	46.5414	328.2503	246.5425	71.7550	0.0023	0.0106
1	M4	321.8163	89.1363	121.8073	310.8661	321.8118	89.1351	0.0090	0.0024
1	M7	195.4804	101.0633	-4.5277	298.9444	195.4764	101.0595	0.0081	0.0076
1	M8	304.9148	94.7402	104.9072	305.2621	304.9110	94.7390	0.0076	0.0023
1	M9	328.9122	99.6334	128.9043	300.3713	328.9083	99.6311	0.0079	0.0047
1	M12	180.2628	126.9604	-19.7449	273.0437	180.2590	126.9584	0.0077	0.0041
1	M13	319.3494	124.3618	119.3392	275.6409	319.3443	124.3604	0.0102	0.0026
1	M17	100.0120	92.8481	-99.9953	307.1646	100.0084	92.8418	0.0073	0.0127
1	M18	389.1647	97.1373	189.1550	302.8799	389.1598	97.1287	0.0098	0.0172
2	M3	254.5677	77.9664	54.5673	322.0435	254.5675	77.9615	0.0004	0.0098
2	M4	364.1377	84.2343	164.1303	315.7765	364.1340	84.2289	0.0074	0.0108
2	M7	230.6612	101.2337	30.6576	298.7756	230.6594	101.2291	0.0037	0.0093
2	M8	326.5107	91.9167	126.5011	308.0861	326.5059	91.9153	0.0097	0.0028
2	M12	218.7702	117.3891	18.7645	282.6187	218.7674	117.3852	0.0058	0.0078
2	M13	338.2387	144.4461	138.2279	255.5608	338.2333	144.4427	0.0108	0.0068
2	M17	175.2610	96.4113	-24.7460	303.5938	175.2575	96.4088	0.0070	0.0051
2	M18	105.6419	95.3172	-94.3647	304.6936	105.6386	95.3118	0.0066	0.0109
3	M3	211.2779	87.3067	11.2722	312.6970	211.2750	87.3049	0.0057	0.0037
3	M4	293.9535	76.7682	93.9476	323.2338	293.9506	76.7672	0.0059	0.0020
3	M7	201.3844	100.6365	1.3780	299.3647	201.3812	100.6359	0.0063	0.0011
3	M8	240.3180	93.7340	40.3168	306.2711	240.3174	93.7314	0.0012	0.0052
3	M9	331.3985	98.7097	131.3908	301.3015	331.3946	98.7041	0.0078	0.0111
3	M12	193.5858	110.7942	-6.4189	289.2062	193.5834	110.7940	0.0047	0.0004
3	M13	223.2684	128.5575	23.2643	271.4434	223.2663	128.5570	0.0041	0.0009
3	M17	168.0778	97.8994	-31.9276	302.1030	168.0751	97.8982	0.0055	0.0024
3	M18	155.6803	97.9374	-44.3248	302.0669	155.6777	97.9353	0.0051	0.0043
4	M3	285.0665	73.3645	85.0646	326.6391	285.0655	73.3627	0.0019	0.0036
4	M4	345.3666	89.0073	145.3621	311.0063	345.3644	89.0005	0.0045	0.0136
4	M7	232.1196	99.7966	32.1154	300.2045	232.1175	99.7961	0.0042	0.0011
4	M8	330.9251	93.9460	130.9201	306.0653	330.9226	93.9403	0.0051	0.0114
4	M9	351.9567	98.5606	151.9518	301.4559	351.9543	98.5524	0.0050	0.0166
4	M12	219.6614	128.7930	19.6561	271.2084	219.6588	128.7923	0.0053	0.0014
4	M13	343.0654	118.5440	143.0607	281.4712	343.0630	118.5364	0.0047	0.0151
4	M17	114.8771	87.2364	-85.1253	312.7744	114.8759	87.2310	0.0024	0.0108
4	M18	398.4767	95.6131	198.4703	304.4094	398.4735	95.6018	0.0064	0.0225
5	M3	141.9404	91.5348	-58.0650	308.4716	141.9377	91.5316	0.0054	0.0064
5	M4	189.1195	80.1981	-10.8864	319.8068	189.1166	80.1956	0.0058	0.0049
5	M7	136.2150	101.5812	-63.7902	298.4277	136.2124	101.5767	0.0052	0.0089
5	M8	156.2739	97.7590	-43.7315	302.2440	156.2712	97.7575	0.0054	0.0030
5	M9	243.5195	102.1886	43.5175	297.8190	243.5185	102.1848	0.0020	0.0075
5	M12	129.6624	109.7551	-70.3438	290.2551	129.6593	109.7500	0.0061	0.0101
5	M13	141.9698	120.8786	-58.0350	279.1286	141.9674	120.8750	0.0048	0.0072
5	M17	109.4419	99.5186	-90.5645	300.4959	109.4387	99.5114	0.0064	0.0145
5	M18	102.1833	100.6410	-97.8227	299.3742	102.1803	100.6334	0.0060	0.0152



APPENDIX B

SLAC 3 D C D - ORIENTATION DATA CAPTURE

PROJECT = Laser Tracker Test SRV2
 TASK = Test Laser Tracker in Sector 10
 DATE = Fri, Jun-01-92

LISTING = STATS

Theodolite Stations

1 1	4600.53818	-838.92121	390.14000	.00000	.00000	.00
000						
	1.00E+04	1.00E+04	1.00E+04	1.0E-01	1.0E-01	1.0E
-01						
1 2	6945.01800	-725.62400	390.14000	.00000	.00000	.00
000						
	1.00E-05	1.00E-05	1.00E-05	1.0E-05	1.0E-05	1.0E
-05						
1 3	10243.14664	-1189.91759	390.14000	.00000	.00000	.00
000						
	1.00E+04	1.00E+04	1.00E+04	1.0E-01	1.0E-01	1.0E
-01						
1 4	3856.45667	-1142.81212	390.14000	.00000	.00000	.00
000						
	1.00E+04	1.00E+04	1.00E+04	1.0E-01	1.0E-01	1.0E
-01						
1 5	12457.65696	-1015.24227	790.14000	.00000	.00000	.00
000						
	1.00E+04	1.00E+04	1.00E+04	1.0E-01	1.0E-01	1.0E

END

Object Points

T1	0.06500	0.03600	0.01500
	1.00E+03	1.00E+03	1.00E+03
T2	15000.06500	0.03600	0.01500
	1.00E+03	1.00E+03	1.00E+03
T3	6500.06500	1400.03600	0.01500
	1.00E+03	1.00E+03	1.00E+03
T4	6500.06500	1400.03600	0.01500
	1.00E+03	1.00E+03	1.00E+03
M3	4539.40300	1944.34000	1689.91600
	1.00E+03	1.00E+03	1.00E+03
M4	10974.84700	1929.30400	1575.83600
	1.00E+03	1.00E+03	1.00E+03
M7	1616.94900	1927.28900	291.85700
	1.00E+03	1.00E+03	1.00E+03
M8	8054.21200	1926.99200	738.71600
	1.00E+03	1.00E+03	1.00E+03
M9	13553.56100	1916.24600	433.83700
	1.00E+03	1.00E+03	1.00E+03
M12	1774.28500	741.69500	-1103.45600
	1.00E+03	1.00E+03	1.00E+03
M13	7893.90800	748.60100	-1100.31000
	1.00E+03	1.00E+03	1.00E+03
M17	2811.86800	-2513.92600	627.55400
	1.00E+03	1.00E+03	1.00E+03
M18	6821.65700	-2519.88500	484.34700
	1.00E+03	1.00E+03	1.00E+03
Q1	5451.92700	1513.12400	644.25100
	1.00E+03	1.00E+03	1.00E+03
Q2	5734.26300	1515.15500	643.18800

	1.00E+03	1.00E+03	1.00E+03
Q3	5454.36800	1328.20900	645.59900
	1.00E+03	1.00E+03	1.00E+03
Q4	5736.57700	1330.06300	644.56100
	1.00E+03	1.00E+03	1.00E+03
Q5	5455.67300	1214.60600	468.11900
	1.00E+03	1.00E+03	1.00E+03
Q6	5738.25800	1216.98000	468.20300
	1.00E+03	1.00E+03	1.00E+03
Qb1	5451.92700	1513.12400	644.25100
	1.00E+03	1.00E+03	1.00E+03
Qb2	5734.26300	1515.15500	643.18800
	1.00E+03	1.00E+03	1.00E+03
Qb3	5454.36800	1328.20900	645.59900
	1.00E+03	1.00E+03	1.00E+03
Qb4	5736.57700	1330.06300	644.56100
	1.00E+03	1.00E+03	1.00E+03
Qb5	5455.67300	1214.60600	468.11900
	1.00E+03	1.00E+03	1.00E+03
Qb6	5738.25800	1216.98000	468.20300
	1.00E+03	1.00E+03	1.00E+03
SB1	7427.83800	789.75100	-152.74300
	1.00E+03	1.00E+03	1.00E+03
SB2	8427.17900	788.43400	-152.62700
	1.00E+03	1.00E+03	1.00E+03
SB3	4000.83800	789.75100	-152.74300
	1.00E+03	1.00E+03	1.00E+03
SB4	5000.17900	788.43400	-152.62700
	1.00E+03	1.00E+03	1.00E+03

END

Distances

SB1	SB2	999.30500	.00100		
SB3	SB4	999.31600	.00100		
1 1	M3	3085.35700	.01500	T	0.0 0.2
1 1	M4	7053.80700	.01500	T	0.0 0.2
1 1	M7	4069.68600	.01500	T	0.0 0.2
1 1	M8	4439.68900	.01500	T	0.0 0.2
1 1	M9	9366.07000	.01500	T	0.0 0.2
1 1	M12	3553.68600	.01500	T	0.0 0.2
1 1	M13	3934.96100	.01500	T	0.0 0.2
1 1	M17	2466.36900	.01500	T	0.0 0.2
1 1	M18	2787.55200	.01500	T	0.0 0.2
1 1	Q1	2516.73100	.01500	T	0.0 0.2
1 1	Q2	2627.33100	.01500	T	0.0 0.2
1 1	Q3	2345.97200	.01500	T	0.0 0.2
1 1	Q4	2464.02100	.01500	T	0.0 0.2
1 1	Q5	2226.14300	.01500	T	0.0 0.2
1 1	Q6	2351.15500	.01500	T	0.0 0.2
1 1	SB1	3301.29100	.01500	T	0.0 0.2
1 1	SB2	4188.14300	.01500	T	0.0 0.2
1 1	T1	4691.15300	.01500	T	0.0 0.2
1 1	T2	10436.13000	.01500	T	0.0 0.2
1 1	T3	3186.30600	.01500	T	0.0 0.2
1 2	T1	6990.58600	.01500	T	0.0 0.2
1 2	T2	8094.32800	.01500	T	0.0 0.2
1 2	T3	2107.81900	.01500	T	0.0 0.2
1 2	M3	3827.61600	.01500	T	0.0 0.2
1 2	M4	4974.47000	.01500	T	0.0 0.2
1 2	M7	5949.45800	.01500	T	0.0 0.2
1 2	M8	2896.05300	.01500	T	0.0 0.2

ALL5.INP

1 2	M12	5568.84600	.01500	T	0.0	0.2
1 2	M13	2280.33400	.01500	T	0.0	0.2
1 2	M17	4511.92700	.01500	T	0.0	0.2
1 2	M18	1806.72300	.01500	T	0.0	0.2
1 2	Q1	2701.48600	.01500	T	0.0	0.2
1 2	Q2	2558.07100	.01500	T	0.0	0.2
1 2	Q3	2549.39500	.01500	T	0.0	0.2
1 2	Q4	2396.94100	.01500	T	0.0	0.2
1 2	Q5	2444.08800	.01500	T	0.0	0.2
1 2	Q6	2285.06200	.01500	T	0.0	0.2
1 2	SB1	1667.81000	.01500	T	0.0	0.2
1 2	SB2	2177.83400	.01500	T	0.0	0.2
1 3	T1	10316.69800	.01500	T	0.0	0.2
1 3	T2	4914.53800	.01500	T	0.0	0.2
1 3	M3	6641.61200	.01500	T	0.0	0.2
1 3	M4	3426.25100	.01500	T	0.0	0.2
1 3	M7	9170.46700	.01500	T	0.0	0.2
1 3	M8	3825.24000	.01500	T	0.0	0.2
1 3	M9	4538.46000	.01500	T	0.0	0.2
1 3	M12	8806.28200	.01500	T	0.0	0.2
1 3	M13	3373.16900	.01500	T	0.0	0.2
1 3	M17	7552.53900	.01500	T	0.0	0.2
1 3	M18	3672.99100	.01500	T	0.0	0.2
1 3	Q2	5263.76500	.01500	T	0.0	0.2
1 3	Q3	5416.18100	.01500	T	0.0	0.2
1 3	Q4	5169.27200	.01500	T	0.0	0.2
1 3	Q5	5356.50000	.01500	T	0.0	0.2
1 3	Q6	5106.68900	.01500	T	0.0	0.2
1 3	SB1	3476.54200	.01500	T	0.0	0.2
1 3	SB2	2730.30000	.01500	T	0.0	0.2
1 4	T1	4056.79900	.01500	T	0.0	0.2
1 4	T2	11201.25900	.01500	T	0.0	0.2
1 4	T4	3967.05100	.01500	T	0.0	0.2
1 4	SB3	2005.39100	.01500	T	0.0	0.2
1 4	SB4	2120.41400	.01500	T	0.0	0.2
1 4	Qb1	3166.44200	.01500	T	0.0	0.2
1 4	Qb2	3318.46600	.01500	T	0.0	0.2
1 4	Qb3	3010.78000	.01500	T	0.0	0.2
1 4	Qb4	3170.20200	.01500	T	0.0	0.2
1 4	Qb5	2899.60300	.01500	T	0.0	0.2
1 4	Qb6	3065.65400	.01500	T	0.0	0.2
1 4	M3	3515.48600	.01500	T	0.0	0.2
1 4	M4	7877.19100	.01500	T	0.0	0.2
1 4	M7	3853.32500	.01500	T	0.0	0.2
1 4	M8	5249.61900	.01500	T	0.0	0.2
1 4	M9	10179.24900	.01500	T	0.0	0.2
1 4	M12	3170.14700	.01500	T	0.0	0.2
1 4	M13	4682.97800	.01500	T	0.0	0.2
1 4	M17	1718.43000	.01500	T	0.0	0.2
1 4	M18	3243.74800	.01500	T	0.0	0.2
1 5	T1	12507.75700	.01500	T	0.0	0.2
1 5	T2	2740.82000	.01500	T	0.0	0.2
1 5	T4	6040.16300	.01500	T	0.0	0.2
1 5	SB3	9002.03200	.01500	T	0.0	0.2
1 5	SB4	8021.16100	.01500	T	0.0	0.2
1 5	Qb1	7415.94500	.01500	T	0.0	0.2
1 5	Qb2	7150.26300	.01500	T	0.0	0.2
1 5	Qb3	7355.61200	.01500	T	0.0	0.2
1 5	Qb4	7087.79400	.01500	T	0.0	0.2
1 5	Qb5	7320.27900	.01500	T	0.0	0.2

ALL5.INP

1 5	Qb6	7050.91900	.01500	T	0.0	0.2
1 5	M3	8498.14000	.01500	T	0.0	0.2
1 5	M4	3361.11900	.01500	T	0.0	0.2
1 5	M7	11211.80100	.01500	T	0.0	0.2
1 5	M8	5241.35600	.01500	T	0.0	0.2
1 5	M9	3018.80400	.01500	T	0.0	0.2
1 5	M12	10938.21100	.01500	T	0.0	0.2
1 5	M13	5125.58700	.01500	T	0.0	0.2
1 5	M17	9786.76200	.01500	T	0.0	0.2
1 5	M18	5870.80800	.01500	T	0.0	0.2

END

Observations

1 1	M3	246.54252	71.75496	.00150	.00150
1 2	M3	254.56749	77.96146	.00150	.00150
1 3	M3	211.27504	87.30487	.00150	.00150
1 1	M4	321.81179	89.13512	.00150	.00150
1 2	M4	364.13401	84.22888	.00150	.00150
1 3	M4	293.95056	76.76724	.00150	.00150
1 1	M7	195.47637	101.05947	.00150	.00150
1 2	M7	230.65941	101.22905	.00150	.00150
1 3	M7	201.38121	100.63590	.00150	.00150
1 1	M8	304.91099	94.73902	.00150	.00150
1 2	M8	326.50588	91.91532	.00150	.00150
1 3	M8	240.31742	93.73144	.00150	.00150
1 1	M9	328.90827	99.63107	.00150	.00150
1 3	M9	331.39465	98.70412	.00150	.00150
1 1	M12	180.25898	126.95836	.00150	.00150
1 2	M12	218.76736	117.38518	.00150	.00150
1 3	M12	193.58343	110.79403	.00150	.00150
1 1	M13	319.34433	124.36045	.00150	.00150
1 2	M13	338.23330	144.44266	.00150	.00150
1 3	M13	223.26632	128.55702	.00150	.00150
1 1	M17	100.00837	92.84176	.00150	.00150
1 2	M17	175.25754	96.40878	.00150	.00150
1 3	M17	168.07510	97.89823	.00150	.00150
1 1	M18	389.15984	97.12872	.00150	.00150
1 2	M18	105.63857	95.31179	.00150	.00150
1 3	M18	155.67772	97.93527	.00150	.00150
1 1	Q1	270.00040	92.95185	.00150	.00150
1 2	Q1	263.80152	93.84693	.00150	.00150
1 1	Q2	276.46260	93.28870	.00150	.00150
1 2	Q2	269.71182	93.48953	.00150	.00150
1 3	Q2	213.69717	96.69641	.00150	.00150
1 1	Q3	271.78157	92.38591	.00150	.00150
1 2	Q3	261.27294	93.41645	.00150	.00150
1 3	Q3	210.11402	96.77117	.00150	.00150
1 1	Q4	278.60425	92.79453	.00150	.00150
1 2	Q4	267.41102	92.98302	.00150	.00150
1 3	Q4	211.75294	96.61833	.00150	.00150
1 1	Q5	273.00228	97.06182	.00150	.00150
1 2	Q5	259.56228	97.74872	.00150	.00150
1 3	Q5	208.92794	98.84516	.00150	.00150
1 1	Q6	280.06346	97.23119	.00150	.00150
1 2	Q6	265.85886	97.54716	.00150	.00150
1 3	Q6	210.53513	98.77596	.00150	.00150
1 1	SB1	314.64334	110.08624	.00150	.00150
1 2	SB1	321.16572	120.22861	.00150	.00150
1 3	SB1	218.32108	109.50236	.00150	.00150
1 1	SB2	322.32153	107.96488	.00150	.00150
1 2	SB2	350.85379	115.21232	.00150	.00150

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1 3	SB2	232.04363	112.04644	.00150	.00150
1 1	T1	159.36542	104.77516	.00150	.00150
1 2	T1	207.85769	103.67773	.00150	.00150
1 3	T1	186.66737	102.39510	.00150	.00150
1 1	T2	342.79079	102.32157	.00150	.00150
1 2	T2	395.62568	102.53364	.00150	.00150
1 3	T2	363.75858	104.39464	.00150	.00150
1 1	T3	299.19781	107.38131	.00150	.00150
1 2	T3	299.55407	111.37938	.00150	.00150
1 4	T1	190.99403	104.63920	.00150	.00150
1 4	T2	364.92255	101.14813	.00150	.00150
1 4	T4	327.06039	103.99739	.00150	.00150
1 4	SB3	264.53648	113.53657	.00150	.00150
1 4	SB4	296.14982	112.59554	.00150	.00150
1 4	M3	285.06551	73.36267	.00150	.00150
1 4	M4	345.36438	89.00048	.00150	.00150
1 4	M7	232.11749	99.79605	.00150	.00150
1 4	M8	330.92259	93.94034	.00150	.00150
1 4	M9	351.95425	98.55235	.00150	.00150
1 4	M12	219.65875	128.79227	.00150	.00150
1 4	M13	343.06301	118.53640	.00150	.00150
1 4	M17	114.87592	87.23097	.00150	.00150
1 4	M18	398.47352	95.60182	.00150	.00150
1 4	Qb1	305.42187	92.19833	.00150	.00150
1 4	Qb2	310.11476	92.54380	.00150	.00150
1 4	Qb3	307.45453	91.77859	.00150	.00150
1 4	Qb4	312.27476	92.17964	.00150	.00150
1 4	Qb5	308.82097	95.38788	.00150	.00150
1 4	Qb6	313.71205	95.60003	.00150	.00150
1 5	T1	124.56566	102.88888	.00150	.00150
1 5	T2	298.35891	112.40198	.00150	.00150
1 5	T4	144.41568	105.85880	.00150	.00150
1 5	SB3	131.69438	105.05160	.00150	.00150
1 5	SB4	133.00015	105.64900	.00150	.00150
1 5	Qb1	141.07794	99.26961	.00150	.00150
1 5	Qb2	141.91231	99.24587	.00150	.00150
1 5	Qb3	139.57100	99.24795	.00150	.00150
1 5	Qb4	140.35416	99.22275	.00150	.00150
1 5	Qb5	138.63010	100.78536	.00150	.00150
1 5	Qb6	139.38728	100.80853	.00150	.00150
1 5	M3	141.93770	91.53161	.00150	.00150
1 5	M4	189.11657	80.19562	.00150	.00150
1 5	M7	136.21238	101.57672	.00150	.00150
1 5	M8	156.27117	97.75747	.00150	.00150
1 5	M9	243.51851	102.18478	.00150	.00150
1 5	M12	129.65929	109.74998	.00150	.00150
1 5	M13	141.96741	120.87497	.00150	.00150
1 5	M17	109.43867	99.51136	.00150	.00150
1 5	M18	102.18029	100.63344	.00150	.00150

END

Control Information

Fixed Coordinates

1 2	6945.01800	-725.62400	390.14000	.00000	.00000	.00000
1 2	.00000	.00000	.00000	.00000	.00000	.00000

END

Relative error point pairs

END

.

```

3333333333 DDDDDDDDD      CCC      DDDDDDDDD
33333333333 DDDDDDDDD      CCCCCC      DDDDDDDDD
      333 DDD      DDD      CCC      CCC      DDD      DDD
      333 DDD      DDD      CCC      CCC      DDD      DDD
3333333333 DDD      DDD      CCC      CCC      DDD      DDD
3333333333 DDD      DDD      CCC      CCC      DDD      DDD
      333 DDD      DDD      CCC      CCC      DDD      DDD
      333 DDD      DDD      CCC      CCC      DDD      DDD
33333333333 DDDDDDDDD      CCCCCC      DDDDDDDDD
3333333333 DDDDDDDDD      CCC      DDDDDDDDD
    
```

Bundle Adjustment Output File

SLAC Three-Dimensional Coordinate Determination

```

Job Id   : Laser Tracker Test SRV2
Part Id  : Test Laser Tracker in Sector
Date     : Fri, Jun-01-92
File     : ALL5.3DD
Run      : 06-16-1992 at 09:17:52
    
```

```

5  Number of stations
29 Total number of object points
99 Number of distances
0  Number of height differences
97 Total number of angle observation pairs
    
```

Iteration Summary	X	Y	Z
-----	---	---	---
XYZ Position Corrections :	75.63727	43.90437	24.26149
XYZ Position Corrections :	1.72095	4.52948	1.04331
XYZ Position Corrections :	.01293	.01039	.01105

XYZ Position Corrections : .00000 .00000 .00000

BUNDLE: Solution has converged after 4 iterations

Reference standard deviation = .72
Degrees of freedom = 176

Horizontal and vertical angle residuals (gons)

```

-----
1 1      M3      .00188      -.00050
1 2      M3      .00226      -.00012
1 3      M3      .00056      -.00065
1 1      M4      .00038      .00065
1 2      M4      -.00239      .00053
1 3      M4      .00462      .00074
1 1      M7      -.00130      -.00068
1 2      M7      -.00028      -.00029
1 3      M7      -.00103      .00042
1 1      M8      .00059      .00000
1 2      M8      .00108      .00045
1 3      M8      .00083      -.00034
1 1      M9      -.00044      .00096
1 3      M9      .00175      -.00014
1 1      M12     .00011      -.00015
1 2      M12     -.00143      -.00023
1 3      M12     -.00131      .00004
1 1      M13     -.00039      -.00240
1 2      M13     -.00127      -.00045
1 3      M13     -.00186      .00081
1 1      M17     .00003      -.00099
1 2      M17     -.00093      -.00126
1 3      M17     -.00013      -.00097
1 1      M18     -.00104      .00074
1 2      M18     .00168      -.00001
1 3      M18     -.00052      -.00141
1 1      Q1      .00109      -.00027
1 2      Q1      .00052      .00027
1 1      Q2      -.00026      .00009
1 2      Q2      -.00003      .00015
1 3      Q2      -.00037      -.00040
1 1      Q3      .00048      .00057
1 2      Q3      -.00023      -.00038
1 3      Q3      -.00083      -.00058
1 1      Q4      .00075      .00018
1 2      Q4      .00203      .00017
1 3      Q4      .00012      -.00049
1 1      Q5      .00034      .00031

1 2      Q5      .00107      -.00015
1 3      Q5      -.00029      -.00038
1 1      Q6      .00052      .00010
1 2      Q6      .00115      .00002
1 3      Q6      .00003      -.00023
1 1      SB1     -.00087      .00048
1 2      SB1     .00008      -.00050
1 3      SB1     -.00122      .00036
1 1      SB2     .00065      .00030
1 2      SB2     -.00083      -.00014

```

1 3	SB2	.00000	.00007
1 1	T1	.00108	.00085
1 2	T1	-.00066	.00073
1 3	T1	-.00040	.00090
1 1	T2	-.00153	.00076
1 2	T2	-.00126	.00073
1 3	T2	.00006	-.00006
1 1	T3	-.00207	-.00115
1 2	T3	-.00057	.00057
1 4	T1	-.00031	-.00147
1 4	T2	-.00153	.00022
1 4	T4	-.00015	-.00108
1 4	SB3	.00053	-.00007
1 4	SB4	.00044	.00004
1 4	M3	.00223	.00123
1 4	M4	-.00147	.00051
1 4	M7	-.00022	.00037
1 4	M8	-.00046	-.00008
1 4	M9	-.00181	.00055
1 4	M12	-.00113	.00092
1 4	M13	-.00123	.00004
1 4	M17	.00049	.00136
1 4	M18	-.00105	.00131
1 4	Qb1	.00159	-.00001
1 4	Qb2	.00071	.00006
1 4	Qb3	.00101	-.00002
1 4	Qb4	.00081	-.00001
1 4	Qb5	.00095	.00013
1 4	Qb6	.00058	.00013
1 5	T1	.00080	-.00005
1 5	T2	.00098	-.00071
1 5	T4	-.00080	.00172
1 5	SB3	.00015	.00027
1 5	SB4	.00005	.00013
1 5	Qb1	-.00039	-.00015
1 5	Qb2	-.00031	-.00024
1 5	Qb3	-.00014	-.00009
1 5	Qb4	-.00034	-.00012
1 5	Qb5	-.00032	-.00036
1 5	Qb6	-.00028	-.00033
1 5	M3	-.00127	-.00021
1 5	M4	-.00050	-.00134
1 5	M7	-.00029	.00084
1 5	M8	-.00032	-.00026
1 5	M9	.00022	-.00021
1 5	M12	.00159	.00073
1 5	M13	.00066	.00055
1 5	M17	.00060	-.00075
1 5	M18	-.00009	-.00140

Distance residuals

SB1	SB2	-.00003
SB3	SB4	.00000
1 1	M3	-.00751
1 1	M4	-.00330
1 1	M7	.00320

1 1	M8	.00639
1 1	M9	.00741
1 1	M12	.00678
1 1	M13	-.02816
1 1	M17	-.00649
1 1	M18	.00554
1 1	Q1	-.00368
1 1	Q2	.00720
1 1	Q3	.00722
1 1	Q4	-.00561
1 1	Q5	-.00441
1 1	Q6	-.00504
1 1	SB1	.00665
1 1	SB2	-.00255
1 1	T1	.00485
1 1	T2	.00509
1 1	T3	.00642
1 2	T1	.00512
1 2	T2	-.01140
1 2	T3	-.00760
1 2	M3	.01638
1 2	M4	-.00279
1 2	M7	.00071
1 2	M8	.00189
1 2	M12	-.01523
1 2	M13	.01483
1 2	M17	-.00185
1 2	M18	.01068
1 2	Q1	.00445
1 2	Q2	-.01284
1 2	Q3	-.01279
1 2	Q4	.00152
1 2	Q5	.00504
1 2	Q6	.00450
1 2	SB1	-.00908
1 2	SB2	.00847
1 3	T1	.00227
1 3	T2	-.00014
1 3	M3	-.00101
1 3	M4	.00506
1 3	M7	-.00826
1 3	M8	.00117
1 3	M9	-.00763
1 3	M12	-.00151
1 3	M13	-.00073
1 3	M17	-.00368
1 3	M18	-.00976
1 3	Q2	.00968
1 3	Q3	.01157
1 3	Q4	.00355
1 3	Q5	-.00205
1 3	Q6	-.00095
1 3	SB1	.01031
1 3	SB2	-.00788
1 4	T1	-.00569
1 4	T2	.00803
1 4	T4	.00096
1 4	SB3	-.00043
1 4 ..	SB4	-.00001

1 4	Qb1	.00099
1 4	Qb2	.00066
1 4	Qb3	.00068
1 4	Qb4	.00086
1 4	Qb5	.00093
1 4	Qb6	.00073
1 4	M3	-.00616
1 4	M4	-.00225
1 4	M7	.00367
1 4	M8	-.01016
1 4	M9	-.00552
1 4	M12	.00580
1 4	M13	.01374
1 4	M17	.00773
1 4	M18	-.01457
1 5	T1	-.00664
1 5	T2	-.00198
1 5	T4	.00002
1 5	SB3	.00078
1 5	SB4	.00233
1 5	Qb1	.00335
1 5	Qb2	.00148
1 5	Qb3	.00225
1 5	Qb4	.00182
1 5	Qb5	.00226
1 5	Qb6	.00138
1 5	M3	.00076
1 5	M4	-.00219
1 5	M7	.00059
1 5	M8	.00021
1 5	M9	.00572
1 5	M12	.00383
1 5	M13	-.01639
1 5	M17	.00464
1 5	M18	-.00424

Final station parameters (rads)

1 1				
RxRyRz :	-.003761	-.007297	-.838551	.004636
xyz :	4600.99411	-795.38833	374.98734	
1 2				
RxRyRz :	.000000	.000000	.000000	.006097
xyz :	6945.01800	-725.62400	390.14000	
1 3				
RxRyRz :	-.005821	-.002039	-.345105	.004226
xyz :	10233.03243	-1258.45943	403.56471	
1 4				
RxRyRz :	-.009041	.000963	-.463678	.016824
xyz :	3857.29488	-1144.91339	289.59057	
1 5				
RxRyRz :	-.002922	-.002923	-1.277030	-.020017
xyz :	12459.45466	-1013.70138	593.53635	

Final object point coordinates

	X	Y	Z
	---	---	---
T1	19.21123	133.65705	-13.55848
T2	15013.86394	-170.48676	67.99171
T3	6930.50736	1348.55904	15.35816
T4	6930.51958	1348.55024	15.21559
M3	4588.02357	1996.20073	1688.87771
M4	11022.41047	1849.73053	1609.86889
M7	1673.27299	2029.64173	275.31464
M8	8106.78439	1901.70430	756.91189
M9	13606.28736	1776.69178	485.16377
M12	1813.88824	832.54137	-1111.78393
M13	7932.22290	715.55259	-1075.55581
M17	2776.21535	-2432.60198	644.61513
M18	6785.68686	-2520.37484	523.07001
Q1	5497.16065	1540.14775	650.82584
Q2	5779.49174	1536.47999	651.28329
Q3	5495.84681	1355.26117	653.32951
Q4	5777.96178	1351.33421	653.79506
Q5	5495.73801	1240.49685	476.55783
Q6	5778.30549	1237.15327	478.15836
Qb1	5497.14071	1539.60817	650.82703
Qb2	5779.42534	1535.88659	651.29003
Qb3	5495.78996	1354.65407	653.16613
Qb4	5777.94597	1350.80915	653.64689
Qb5	5495.73221	1240.09058	476.33569
Qb6	5778.30450	1236.76247	477.92242
SB1	7462.10747	771.94480	-130.92266

SB2	8461.16346	750.35183	-125.31685
SB3	3674.08972	802.85229	-151.05898
SB4	4672.61581	763.55296	-145.25674

Coordinate standard errors

	SX	SY	SZ
-----	--	--	--
1 1	.00619	.01206	.02058
1 2	.00000	.00000	.00000
1 3	.00787	.01737	.03041
1 4	.00737	.01597	.02633
1 5	.00935	.02772	.04551
SB1	.00937	.01548	.02305
SB2	.00930	.01773	.02755
SB3	.01219	.02290	.04397
SB4	.01199	.02159	.04251
T1	.01219	.04808	.05994
T2	.01082	.05011	.06496
T3	.01752	.01494	.03016
T4	.01377	.02250	.06269
M3	.01728	.02172	.03445
M4	.01645	.02770	.04533
M7	.01636	.02877	.05242
M8	.01339	.01475	.03361
M9	.01594	.03482	.06725
M12	.01583	.03547	.04333
M13	.01303	.02124	.02232
M17	.01368	.02521	.03986
M18	.01188	.01382	.02490
Q1	.01809	.01479	.03288
Q2	.01417	.01424	.03086
Q3	.01364	.01484	.02962
Q4	.01344	.01440	.02903
Q5	.01301	.01456	.02852
Q6	.01280	.01415	.02793
Qb1	.01511	.01950	.05762
Qb2	.01493	.01963	.05895
Qb3	.01455	.01990	.05501
Qb4	.01435	.02013	.05649
Qb5	.01404	.01928	.05348
Qb6	.01384	.01956	.05510



APPENDIX C

SLAC 3 D C D - ORIENTATION DATA CAPTURE

PROJECT = Laser Tracker Test SRV2
 TASK = Test Laser Tracker in Sector 10
 DATE = Fri, Jun-01-92

LISTING = STATS

Theodolite Stations

1 1	4600.53818	-838.92121	390.14000	.00000	.00000	.00
000						
	1.00E+04	1.00E+04	1.00E+04	1.0E-01	1.0E-01	1.0E
-01						
1 2	6945.01800	-725.62400	390.14000	.00000	.00000	.00
000						
	1.00E-05	1.00E-05	1.00E-05	1.0E-05	1.0E-05	1.0E
-05						
1 3	10243.14664	-1189.91759	390.14000	.00000	.00000	.00
000						
	1.00E+04	1.00E+04	1.00E+04	1.0E-01	1.0E-01	1.0E
-01						
1 4	3856.45667	-1142.81212	390.14000	.00000	.00000	.00
000						
	1.00E+04	1.00E+04	1.00E+04	1.0E-01	1.0E-01	1.0E
-01						
1 5	12457.65696	-1015.24227	790.14000	.00000	.00000	.00
000						
	1.00E+04	1.00E+04	1.00E+04	1.0E-01	1.0E-01	1.0E
-01						

END

Object Points

T1	0.06500	0.03600	0.01500
	1.00E+03	1.00E+03	1.00E+03
T2	15000.06500	0.03600	0.01500
	1.00E+03	1.00E+03	1.00E+03
T3	6500.06500	1400.03600	0.01500
	1.00E+03	1.00E+03	1.00E+03
T4	6500.06500	1400.03600	0.01500
	1.00E+03	1.00E+03	1.00E+03
M3	4539.40300	1944.34000	1689.91600
	1.00E+03	1.00E+03	1.00E+03
M4	10974.84700	1929.30400	1575.83600
	1.00E+03	1.00E+03	1.00E+03
M7	1616.94900	1927.28900	291.85700
	1.00E+03	1.00E+03	1.00E+03
M8	8054.21200	1926.99200	738.71600
	1.00E+03	1.00E+03	1.00E+03
M9	13553.56100	1916.24600	433.83700
	1.00E+03	1.00E+03	1.00E+03
M12	1774.28500	741.69500	-1103.45600
	1.00E+03	1.00E+03	1.00E+03
M13	7893.90800	748.60100	-1100.31000
	1.00E+03	1.00E+03	1.00E+03
M17	2811.86800	-2513.92600	627.55400
	1.00E+03	1.00E+03	1.00E+03
M18	6821.65700	-2519.88500	484.34700
	1.00E+03	1.00E+03	1.00E+03
Q1	5451.92700	1513.12400	644.25100
	1.00E+03	1.00E+03	1.00E+03
Q2	5734.26300	1515.15500	643.18800

	1.00E+03	1.00E+03	1.00E+03
Q3	5454.36800	1328.20900	645.59900
	1.00E+03	1.00E+03	1.00E+03
Q4	5736.57700	1330.06300	644.56100
	1.00E+03	1.00E+03	1.00E+03
Q5	5455.67300	1214.60600	468.11900
	1.00E+03	1.00E+03	1.00E+03
Q6	5738.25800	1216.98000	468.20300
	1.00E+03	1.00E+03	1.00E+03
Qb1	5451.92700	1513.12400	644.25100
	1.00E+03	1.00E+03	1.00E+03
Qb2	5734.26300	1515.15500	643.18800
	1.00E+03	1.00E+03	1.00E+03
Qb3	5454.36800	1328.20900	645.59900
	1.00E+03	1.00E+03	1.00E+03
Qb4	5736.57700	1330.06300	644.56100
	1.00E+03	1.00E+03	1.00E+03
Qb5	5455.67300	1214.60600	468.11900
	1.00E+03	1.00E+03	1.00E+03
Qb6	5738.25800	1216.98000	468.20300
	1.00E+03	1.00E+03	1.00E+03
SB1	7427.83800	789.75100	-152.74300
	1.00E+03	1.00E+03	1.00E+03
SB2	8427.17900	788.43400	-152.62700
	1.00E+03	1.00E+03	1.00E+03
SB3	4000.83800	789.75100	-152.74300
	1.00E+03	1.00E+03	1.00E+03
SB4	5000.17900	788.43400	-152.62700
	1.00E+03	1.00E+03	1.00E+03

END

Distances

SB1	SB2	999.30500	.00100		
SB3	SB4	999.31600	.00100		
1 1	M3	3085.35700	.01500	K	0.0 0.2
1 1	M4	7053.80700	.01500	K	0.0 0.2
1 1	M7	4069.68600	.01500	K	0.0 0.2
1 1	M8	4439.68900	.01500	K	0.0 0.2
1 1	M9	9366.07000	.01500	K	0.0 0.2
1 1	M12	3553.68600	.01500	K	0.0 0.2
1 1	M13	3934.96100	.01500	K	0.0 0.2
1 1	M17	2466.36900	.01500	K	0.0 0.2
1 1	M18	2787.55200	.01500	K	0.0 0.2
1 1	Q1	2516.73100	.01500	K	0.0 0.2
1 1	Q2	2627.33100	.01500	K	0.0 0.2
1 1	Q3	2345.97200	.01500	K	0.0 0.2
1 1	Q4	2464.02100	.01500	K	0.0 0.2
1 1	Q5	2226.14300	.01500	K	0.0 0.2
1 1	Q6	2351.15500	.01500	K	0.0 0.2
1 1	SB1	3301.29100	.01500	K	0.0 0.2
1 1	SB2	4188.14300	.01500	K	0.0 0.2
1 1	T1	4691.15300	.01500	K	0.0 0.2
1 1	T2	10436.13000	.01500	K	0.0 0.2
1 1	T3	3186.30600	.01500	K	0.0 0.2
1 2	T1	6990.58600	.01500	K	0.0 0.2
1 2	T2	8094.32800	.01500	K	0.0 0.2
1 2	T3	2107.81900	.01500	K	0.0 0.2
1 2	M3	3827.61600	.01500	K	0.0 0.2
1 2	M4	4974.47000	.01500	K	0.0 0.2
1 2	M7	5949.45800	.01500	K	0.0 0.2
1 2	M8	2896.05300	.01500	K	0.0 0.2

1 2	M12	5568.84600	.01500	K	0.0	0.2
1 2	M13	2280.33400	.01500	K	0.0	0.2
1 2	M17	4511.92700	.01500	K	0.0	0.2
1 2	M18	1806.72300	.01500	K	0.0	0.2
1 2	Q1	2701.48600	.01500	K	0.0	0.2
1 2	Q2	2558.07100	.01500	K	0.0	0.2
1 2	Q3	2549.39500	.01500	K	0.0	0.2
1 2	Q4	2396.94100	.01500	K	0.0	0.2
1 2	Q5	2444.08800	.01500	K	0.0	0.2
1 2	Q6	2285.06200	.01500	K	0.0	0.2
1 2	SB1	1667.81000	.01500	K	0.0	0.2
1 2	SB2	2177.83400	.01500	K	0.0	0.2
1 3	T1	10316.69800	.01500	K	0.0	0.2
1 3	T2	4914.53800	.01500	K	0.0	0.2
1 3	M3	6641.61200	.01500	K	0.0	0.2
1 3	M4	3426.25100	.01500	K	0.0	0.2
1 3	M7	9170.46700	.01500	K	0.0	0.2
1 3	M8	3825.24000	.01500	K	0.0	0.2
1 3	M9	4538.46000	.01500	K	0.0	0.2
1 3	M12	8806.28200	.01500	K	0.0	0.2
1 3	M13	3373.16900	.01500	K	0.0	0.2
1 3	M17	7552.53900	.01500	K	0.0	0.2
1 3	M18	3672.99100	.01500	K	0.0	0.2
1 3	Q2	5263.76500	.01500	K	0.0	0.2
1 3	Q3	5416.18100	.01500	K	0.0	0.2
1 3	Q4	5169.27200	.01500	K	0.0	0.2
1 3	Q5	5356.50000	.01500	K	0.0	0.2
1 3	Q6	5106.68900	.01500	K	0.0	0.2
1 3	SB1	3476.54200	.01500	K	0.0	0.2
1 3	SB2	2730.30000	.01500	K	0.0	0.2
1 4	T1	4056.79900	.01500	K	0.0	0.2
1 4	T2	11201.25900	.01500	K	0.0	0.2
1 4	T4	3967.05100	.01500	K	0.0	0.2
1 4	SB3	2005.39100	.01500	K	0.0	0.2
1 4	SB4	2120.41400	.01500	K	0.0	0.2
1 4	Qb1	3166.44200	.01500	K	0.0	0.2
1 4	Qb2	3318.46600	.01500	K	0.0	0.2
1 4	Qb3	3010.78000	.01500	K	0.0	0.2
1 4	Qb4	3170.20200	.01500	K	0.0	0.2
1 4	Qb5	2899.60300	.01500	K	0.0	0.2
1 4	Qb6	3065.65400	.01500	K	0.0	0.2
1 4	M3	3515.48600	.01500	K	0.0	0.2
1 4	M4	7877.19100	.01500	K	0.0	0.2
1 4	M7	3853.32500	.01500	K	0.0	0.2
1 4	M8	5249.61900	.01500	K	0.0	0.2
1 4	M9	10179.24900	.01500	K	0.0	0.2
1 4	M12	3170.14700	.01500	K	0.0	0.2
1 4	M13	4682.97800	.01500	K	0.0	0.2
1 4	M17	1718.43000	.01500	K	0.0	0.2
1 4	M18	3243.74800	.01500	K	0.0	0.2
1 5	T1	12507.75700	.01500	K	0.0	0.2
1 5	T2	2740.82000	.01500	K	0.0	0.2
1 5	T4	6040.16300	.01500	K	0.0	0.2
1 5	SB3	9002.03200	.01500	K	0.0	0.2
1 5	SB4	8021.16100	.01500	K	0.0	0.2
1 5	Qb1	7415.94500	.01500	K	0.0	0.2
1 5	Qb2	7150.26300	.01500	K	0.0	0.2
1 5	Qb3	7355.61200	.01500	K	0.0	0.2
1 5	Qb4	7087.79400	.01500	K	0.0	0.2
1 5	Qb5	7320.27900	.01500	K	0.0	0.2

ALL5NOC.INP

1	5	Qb6	7050.91900	.01500	K	0.0	0.2
1	5	M3	8498.14000	.01500	K	0.0	0.2
1	5	M4	3361.11900	.01500	K	0.0	0.2
1	5	M7	11211.80100	.01500	K	0.0	0.2
1	5	M8	5241.35600	.01500	K	0.0	0.2
1	5	M9	3018.80400	.01500	K	0.0	0.2
1	5	M12	10938.21100	.01500	K	0.0	0.2
1	5	M13	5125.58700	.01500	K	0.0	0.2
1	5	M17	9786.76200	.01500	K	0.0	0.2
1	5	M18	5870.80800	.01500	K	0.0	0.2

END

Observations

1	1	M3	246.54252	71.75496	.00150	.00150
1	2	M3	254.56749	77.96146	.00150	.00150
1	3	M3	211.27504	87.30487	.00150	.00150
1	1	M4	321.81179	89.13512	.00150	.00150
1	2	M4	364.13401	84.22888	.00150	.00150
1	3	M4	293.95056	76.76724	.00150	.00150
1	1	M7	195.47637	101.05947	.00150	.00150
1	2	M7	230.65941	101.22905	.00150	.00150
1	3	M7	201.38121	100.63590	.00150	.00150
1	1	M8	304.91099	94.73902	.00150	.00150
1	2	M8	326.50588	91.91532	.00150	.00150
1	3	M8	240.31742	93.73144	.00150	.00150
1	1	M9	328.90827	99.63107	.00150	.00150
1	3	M9	331.39465	98.70412	.00150	.00150
1	1	M12	180.25898	126.95836	.00150	.00150
1	2	M12	218.76736	117.38518	.00150	.00150
1	3	M12	193.58343	110.79403	.00150	.00150
1	1	M13	319.34433	124.36045	.00150	.00150
1	2	M13	338.23330	144.44266	.00150	.00150
1	3	M13	223.26632	128.55702	.00150	.00150
1	1	M17	100.00837	92.84176	.00150	.00150
1	2	M17	175.25754	96.40878	.00150	.00150
1	3	M17	168.07510	97.89823	.00150	.00150
1	1	M18	389.15984	97.12872	.00150	.00150
1	2	M18	105.63857	95.31179	.00150	.00150
1	3	M18	155.67772	97.93527	.00150	.00150
1	1	Q1	270.00040	92.95185	.00150	.00150
1	2	Q1	263.80152	93.84693	.00150	.00150
1	1	Q2	276.46260	93.28870	.00150	.00150
1	2	Q2	269.71182	93.48953	.00150	.00150
1	3	Q2	213.69717	96.69641	.00150	.00150
1	1	Q3	271.78157	92.38591	.00150	.00150
1	2	Q3	261.27294	93.41645	.00150	.00150
1	3	Q3	210.11402	96.77117	.00150	.00150
1	1	Q4	278.60425	92.79453	.00150	.00150
1	2	Q4	267.41102	92.98302	.00150	.00150
1	3	Q4	211.75294	96.61833	.00150	.00150
1	1	Q5	273.00228	97.06182	.00150	.00150
1	2	Q5	259.56228	97.74872	.00150	.00150
1	3	Q5	208.92794	98.84516	.00150	.00150
1	1	Q6	280.06346	97.23119	.00150	.00150
1	2	Q6	265.85886	97.54716	.00150	.00150
1	3	Q6	210.53513	98.77596	.00150	.00150
1	1	SB1	314.64334	110.08624	.00150	.00150
1	2	SB1	321.16572	120.22861	.00150	.00150
1	3	SB1	218.32108	109.50236	.00150	.00150
1	1	SB2	322.32153	107.96488	.00150	.00150
1	2	SB2	350.85379	115.21232	.00150	.00150

1 3	SB2	232.04363	112.04644	.00150	.00150
1 1	T1	159.36542	104.77516	.00150	.00150
1 2	T1	207.85769	103.67773	.00150	.00150
1 3	T1	186.66737	102.39510	.00150	.00150
1 1	T2	342.79079	102.32157	.00150	.00150
1 2	T2	395.62568	102.53364	.00150	.00150
1 3	T2	363.75858	104.39464	.00150	.00150
1 1	T3	299.19781	107.38131	.00150	.00150
1 2	T3	299.55407	111.37938	.00150	.00150
1 4	T1	190.99403	104.63920	.00150	.00150
1 4	T2	364.92255	101.14813	.00150	.00150
1 4	T4	327.06039	103.99739	.00150	.00150
1 4	SB3	264.53648	113.53657	.00150	.00150
1 4	SB4	296.14982	112.59554	.00150	.00150
1 4	M3	285.06551	73.36267	.00150	.00150
1 4	M4	345.36438	89.00048	.00150	.00150
1 4	M7	232.11749	99.79605	.00150	.00150
1 4	M8	330.92259	93.94034	.00150	.00150
1 4	M9	351.95425	98.55235	.00150	.00150
1 4	M12	219.65875	128.79227	.00150	.00150
1 4	M13	343.06301	118.53640	.00150	.00150
1 4	M17	114.87592	87.23097	.00150	.00150
1 4	M18	398.47352	95.60182	.00150	.00150
1 4	Qb1	305.42187	92.19833	.00150	.00150
1 4	Qb2	310.11476	92.54380	.00150	.00150
1 4	Qb3	307.45453	91.77859	.00150	.00150
1 4	Qb4	312.27476	92.17964	.00150	.00150
1 4	Qb5	308.82097	95.38788	.00150	.00150
1 4	Qb6	313.71205	95.60003	.00150	.00150
1 5	T1	124.56566	102.88888	.00150	.00150
1 5	T2	298.35891	112.40198	.00150	.00150
1 5	T4	144.41568	105.85880	.00150	.00150
1 5	SB3	131.69438	105.05160	.00150	.00150
1 5	SB4	133.00015	105.64900	.00150	.00150
1 5	Qb1	141.07794	99.26961	.00150	.00150
1 5	Qb2	141.91231	99.24587	.00150	.00150
1 5	Qb3	139.57100	99.24795	.00150	.00150
1 5	Qb4	140.35416	99.22275	.00150	.00150
1 5	Qb5	138.63010	100.78536	.00150	.00150
1 5	Qb6	139.38728	100.80853	.00150	.00150
1 5	M3	141.93770	91.53161	.00150	.00150
1 5	M4	189.11657	80.19562	.00150	.00150
1 5	M7	136.21238	101.57672	.00150	.00150
1 5	M8	156.27117	97.75747	.00150	.00150
1 5	M9	243.51851	102.18478	.00150	.00150
1 5	M12	129.65929	109.74998	.00150	.00150
1 5	M13	141.96741	120.87497	.00150	.00150
1 5	M17	109.43867	99.51136	.00150	.00150
1 5	M18	102.18029	100.63344	.00150	.00150

END

Control Information

Fixed Coordinates

1 2	6945.01800	-725.62400	390.14000	.00000	.00000	.00000
1 2	.00000	.00000	.00000	.00000	.00000	.00000

END

Relative error point pairs

END

.

```

3333333333 DDDDDDDDD      CCC      DDDDDDDDD
3333333333 DDDDDDDDD      CCCCCCCC DDDDDDDDD
      333 DDD      DDD      CCC      CCC DDD      DDD
      333 DDD      DDD      CCC      CCC DDD      DDD
3333333333 DDD      DDD      CCC      DDD      DDD
3333333333 DDD      DDD      CCC      DDD      DDD
      333 DDD      DDD      CCC      CCC DDD      DDD
      333 DDD      DDD      CCC      CCC DDD      DDD
3333333333 DDDDDDDDD      CCCCCCCC DDDDDDDDD
3333333333 DDDDDDDDD      CCC      DDDDDDDDD
    
```

Bundle Adjustment Output File

SLAC Three-Dimensional Coordinate Determination

Job Id : Laser Tracker Test SRV2
 Part Id : Test Laser Tracker in Sector
 Date : Fri, Jun-01-92
 File : ALL5NOC.3DD
 Run : 06-16-1992 at 09:19:40

5 Number of stations
 29 Total number of object points
 99 Number of distances
 0 Number of height differences
 97 Total number of angle observation pairs

Iteration Summary	X	Y	Z
-----	---	---	---
XYZ Position Corrections :	75.50743	44.09474	23.86237
XYZ Position Corrections :	1.56311	5.38511	1.33509
XYZ Position Corrections :	.01453	.00823	.01174

XYZ Position Corrections : .00000 .00000 .00000

BUNDLE: Solution has converged after 4 iterations

Reference standard deviation = .74
Degrees of freedom = 181

Horizontal and vertical angle residuals (gons)

```

-----
1 1      M3      .00181      -.00051
1 2      M3      .00217      -.00013
1 3      M3      .00055      -.00069
1 1      M4      .00037      .00066
1 2      M4      -.00237      .00054
1 3      M4      .00460      .00080
1 1      M7      -.00148      -.00069
1 2      M7      -.00040      -.00028
1 3      M7      -.00105      .00040
1 1      M8      .00062      .00000
1 2      M8      .00114      .00046
1 3      M8      .00082      -.00033
1 1      M9      -.00050      .00094
1 3      M9      .00169      -.00015
1 1      M12     -.00010      -.00005
1 2      M12     -.00154      -.00014
1 3      M12     -.00132      .00007
1 1      M13     -.00030      -.00234
1 2      M13     -.00113      -.00046
1 3      M13     -.00187      .00084
1 1      M17     .00054      -.00113
1 2      M17     -.00063      -.00139
1 3      M17     .00011      -.00110
1 1      M18     -.00107      .00078
1 2      M18     .00192      -.00008
1 3      M18     -.00032      -.00150
1 1      Q1      .00113      -.00027
1 2      Q1      .00049      .00027
1 1      Q2      -.00022      .00009
1 2      Q2      -.00007      .00015
1 3      Q2      -.00035      -.00042
1 1      Q3      .00052      .00057
1 2      Q3      -.00027      -.00037
1 3      Q3      -.00082      -.00060
1 1      Q4      .00079      .00018
1 2      Q4      .00200      .00017
1 3      Q4      .00013      -.00052
1 1      Q5      .00039      .00032
1 2      Q5      .00103      -.00015
1 3      Q5      -.00028      -.00040
1 1      Q6      .00058      .00010
1 2      Q6      .00111      .00002
1 3      Q6      .00004      -.00025
1 1      SB1     -.00080      .00051
1 2      SB1     .00015      -.00052
1 3      SB1     -.00123      .00037
1 1      SB2     .00072      .00034
1 2      SB2     -.00070      -.00013

```


1 3	SB2	-.00002	.00009
1 1	T1	.00068	.00091
1 2	T1	-.00092	.00077
1 3	T1	-.00051	.00090
1 1	T2	-.00167	.00062
1 2	T2	-.00142	.00052
1 3	T2	-.00016	-.00035
1 1	T3	-.00202	-.00114
1 2	T3	-.00056	.00057
1 4	T1	-.00090	-.00142
1 4	T2	-.00160	.00009
1 4	T4	.00003	-.00107
1 4	SB3	.00028	-.00007
1 4	SB4	.00046	.00003
1 4	M3	.00215	.00127
1 4	M4	-.00142	.00053
1 4	M7	-.00052	.00034
1 4	M8	-.00036	-.00008
1 4	M9	-.00181	.00053
1 4	M12	-.00155	.00097
1 4	M13	-.00105	.00005
1 4	M17	.00109	.00115
1 4	M18	-.00090	.00136
1 4	Qb1	.00164	.00000
1 4	Qb2	.00078	.00008
1 4	Qb3	.00107	.00000
1 4	Qb4	.00089	.00001
1 4	Qb5	.00103	.00015
1 4	Qb6	.00068	.00015
1 5	T1	.00079	-.00009
1 5	T2	-.00021	-.00155
1 5	T4	-.00070	.00172
1 5	SB3	.00027	.00026
1 5	SB4	.00020	.00011
1 5	Qb1	-.00031	-.00018
1 5	Qb2	-.00023	-.00027
1 5	Qb3	-.00006	-.00013
1 5	Qb4	-.00025	-.00016
1 5	Qb5	-.00022	-.00040
1 5	Qb6	-.00018	-.00036
1 5	M3	-.00124	-.00025
1 5	M4	-.00074	-.00147
1 5	M7	-.00024	.00084
1 5	M8	-.00027	-.00027
1 5	M9	-.00044	-.00027
1 5	M12	.00172	.00075
1 5	M13	.00091	.00062
1 5	M17	.00091	-.00099
1 5	M18	.00029	-.00171

Distance residuals

```

-----
SB1      SB2      -.00004
SB3      SB4      .00000
1 1      M3       -.00900
1 1      M4       -.00535
1 1      M7       .00074

```

1 1	M8	.00539
1 1	M9	.00511
1 1	M12	.00366
1 1	M13	-.02958
1 1	M17	-.01396
1 1	M18	-.00003
1 1	Q1	-.00367
1 1	Q2	.00716
1 1	Q3	.00718
1 1	Q4	-.00561
1 1	Q5	-.00444
1 1	Q6	-.00502
1 1	SB1	.00623
1 1	SB2	-.00257
1 1	T1	.00326
1 1	T2	.00540
1 1	T3	.00627
1 2	T1	.00575
1 2	T2	-.00756
1 2	T3	-.00742
1 2	M3	.01711
1 2	M4	-.00262
1 2	M7	.00135
1 2	M8	.00118
1 2	M12	-.01460
1 2	M13	.01378
1 2	M17	-.00159
1 2	M18	.01103
1 2	Q1	.00452
1 2	Q2	-.01269
1 2	Q3	-.01255
1 2	Q4	.00165
1 2	Q5	.00530
1 2	Q6	.00464
1 2	SB1	-.00923
1 2	SB2	.00927
1 3	T1	.00051
1 3	T2	.00631
1 3	M3	-.00006
1 3	M4	.00517
1 3	M7	-.00815
1 3	M8	.00018
1 3	M9	-.00506
1 3	M12	-.00159
1 3	M13	-.00202
1 3	M17	-.00054
1 3	M18	-.00266
1 3	Q2	.00960
1 3	Q3	.01143
1 3	Q4	.00351
1 3	Q5	-.00218
1 3	Q6	-.00098
1 3	SB1	.01133
1 3	SB2	-.00808
1 4	T1	.00308
1 4	T2	.01540
1 4	T4	.00099
1 4	SB3	-.00028
1 4	SB4	-.00010

1 4	Qb1	.00094
1 4	Qb2	.00063
1 4	Qb3	.00064
1 4	Qb4	.00084
1 4	Qb5	.00090
1 4	Qb6	.00072
1 4	M3	-.00506
1 4	M4	.00010
1 4	M7	.00644
1 4	M8	-.00800
1 4	M9	-.00272
1 4	M12	.00993
1 4	M13	.01700
1 4	M17	.01920
1 4	M18	-.00782
1 5	T1	-.01276
1 5	T2	-.01959
1 5	T4	.00029
1 5	SB3	.00005
1 5	SB4	.00226
1 5	Qb1	.00344
1 5	Qb2	.00161
1 5	Qb3	.00236
1 5	Qb4	.00198
1 5	Qb5	.00242
1 5	Qb6	.00158
1 5	M3	-.00083
1 5	M4	-.00230
1 5	M7	-.00060
1 5	M8	.00197
1 5	M9	.00301
1 5	M12	.00204
1 5	M13	-.01328
1 5	M17	-.00345
1 5	M18	-.01058

Final station parameters (rads)

1 1				
RxRyRz :	-.003762	-.007297	-.838551	.000000
xyz :	4600.99251	-795.38791	374.98899	
1 2				
RxRyRz :	.000000	.000000	.000000	.000000
xyz :	6945.01800	-725.62400	390.14000	
1 3				
RxRyRz :	-.005820	-.002039	-.345106	.000000
xyz :	10233.03285	-1258.45840	403.56444	
1 4				
RxRyRz :	-.009042	.000962	-.463678	.000000
xyz :	3857.28863	-1144.92235	289.59243	
1 5				
RxRyRz :	-.002916	-.002923	-1.277030	.000000
xyz :	12459.43907	-1013.67796	593.52039	

Final object point coordinates

	X	Y	Z
	---	---	---
T1	19.20957	133.68580	-13.56345
T2	15013.86858	-170.50633	68.01764
T3	6930.50692	1348.56489	15.35727
T4	6930.51908	1348.56048	15.21350
M3	4588.02408	1996.20748	1688.88029
M4	11022.41485	1849.73471	1609.86957
M7	1673.27351	2029.65447	275.31401
M8	8106.78480	1901.71154	756.91241
M9	13606.29412	1776.68810	485.16813
M12	1813.88790	832.55131	-1111.79276
M13	7932.22291	715.55962	-1075.56002
M17	2776.21859	-2432.62385	644.62493
M18	6785.69306	-2520.38101	523.07222
Q1	5497.15850	1540.15348	650.82646
Q2	5779.49012	1536.48582	651.28377
Q3	5495.84490	1355.26695	653.33009
Q4	5777.96013	1351.34010	653.79567
Q5	5495.73600	1240.50261	476.55806
Q6	5778.30377	1237.15917	478.15860
Qb1	5497.14075	1539.61545	650.82751
Qb2	5779.42541	1535.89416	651.29046
Qb3	5495.79027	1354.66130	653.16679
Qb4	5777.94631	1350.81671	653.64747
Qb5	5495.73234	1240.09789	476.33565
Qb6	5778.30468	1236.77016	477.92232
SB1	7462.10794	771.95103	-130.92430

SB2	8461.16395	750.35852	-125.31867
SB3	3674.08958	802.85977	-151.06288
SB4	4672.61561	763.55901	-145.26016

Coordinate standard errors

	SX	SY	SZ
-----	--	--	--
1 1	.00592	.01105	.02101
1 2	.00000	.00000	.00000
1 3	.00666	.01620	.03105
1 4	.00691	.01527	.02694
1 5	.00683	.02731	.04609
SB1	.00947	.01175	.02346
SB2	.00939	.01431	.02809
SB3	.01181	.02167	.04495
SB4	.01161	.01955	.04349
T1	.00980	.04792	.06127
T2	.00815	.04959	.06597
T3	.01792	.01170	.03088
T4	.01401	.01946	.06425
M3	.01717	.02037	.03522
M4	.01654	.02697	.04618
M7	.01582	.02797	.05370
M8	.01370	.01048	.03443
M9	.01554	.03458	.06882
M12	.01522	.03577	.04363
M13	.01328	.02010	.02187
M17	.01181	.02250	.04065
M18	.01130	.00922	.02545
Q1	.01825	.01157	.03369
Q2	.01421	.01061	.03163
Q3	.01354	.01153	.03035
Q4	.01343	.01074	.02974
Q5	.01287	.01105	.02924
Q6	.01278	.01026	.02863
Qb1	.01517	.01673	.05906
Qb2	.01502	.01669	.06043
Qb3	.01456	.01706	.05638
Qb4	.01440	.01712	.05790
Qb5	.01403	.01617	.05482
Qb6	.01387	.01626	.05648



APPENDIX D

SLAC 3 D C D - ORIENTATION DATA CAPTURE

PROJECT = Laser Tracker Test SRV2
 TASK = Test Laser Tracker in Sector 10
 DATE = Fri, Jun-01-92

LISTING = STATS

Theodolite Stations

1 1	4600.53818	-838.92121	390.14000	.00000	.00000	.00
000						
	1.00E+04	1.00E+04	1.00E+04	1.0E-01	1.0E-01	1.0E
-01						
1 2	6945.01800	-725.62400	390.14000	.00000	.00000	.00
000						
	1.00E-05	1.00E-05	1.00E-05	1.0E-05	1.0E-05	1.0E
-05						
1 3	10243.14664	-1189.91759	390.14000	.00000	.00000	.00
000						
	1.00E+04	1.00E+04	1.00E+04	1.0E-01	1.0E-01	1.0E
-01						
1 4	3856.45667	-1142.81212	390.14000	.00000	.00000	.00
000						
	1.00E+04	1.00E+04	1.00E+04	1.0E-01	1.0E-01	1.0E
-01						
1 5	12457.65696	-1015.24227	790.14000	.00000	.00000	.00
000						
	1.00E+04	1.00E+04	1.00E+04	1.0E-01	1.0E-01	1.0E
-01						

END

Object Points

T1	0.06500	0.03600	0.01500
	1.00E+03	1.00E+03	1.00E+03
T2	15000.06500	0.03600	0.01500
	1.00E+03	1.00E+03	1.00E+03
T3	6500.06500	1400.03600	0.01500
	1.00E+03	1.00E+03	1.00E+03
T4	6500.06500	1400.03600	0.01500
	1.00E+03	1.00E+03	1.00E+03
M3	4539.40300	1944.34000	1689.91600
	1.00E+03	1.00E+03	1.00E+03
M4	10974.84700	1929.30400	1575.83600
	1.00E+03	1.00E+03	1.00E+03
M7	1616.94900	1927.28900	291.85700
	1.00E+03	1.00E+03	1.00E+03
M8	8054.21200	1926.99200	738.71600
	1.00E+03	1.00E+03	1.00E+03
M9	13553.56100	1916.24600	433.83700
	1.00E+03	1.00E+03	1.00E+03
M12	1774.28500	741.69500	-1103.45600
	1.00E+03	1.00E+03	1.00E+03
M13	7893.90800	748.60100	-1100.31000
	1.00E+03	1.00E+03	1.00E+03
M17	2811.86800	-2513.92600	627.55400
	1.00E+03	1.00E+03	1.00E+03
M18	6821.65700	-2519.88500	484.34700
	1.00E+03	1.00E+03	1.00E+03
Q1	5451.92700	1513.12400	644.25100
	1.00E+03	1.00E+03	1.00E+03
Q2	5734.26300	1515.15500	643.18800

	1.00E+03	1.00E+03	1.00E+03
Q3	5454.36800	1328.20900	645.59900
	1.00E+03	1.00E+03	1.00E+03
Q4	5736.57700	1330.06300	644.56100
	1.00E+03	1.00E+03	1.00E+03
Q5	5455.67300	1214.60600	468.11900
	1.00E+03	1.00E+03	1.00E+03
Q6	5738.25800	1216.98000	468.20300
	1.00E+03	1.00E+03	1.00E+03
Qb1	5451.92700	1513.12400	644.25100
	1.00E+03	1.00E+03	1.00E+03
Qb2	5734.26300	1515.15500	643.18800
	1.00E+03	1.00E+03	1.00E+03
Qb3	5454.36800	1328.20900	645.59900
	1.00E+03	1.00E+03	1.00E+03
Qb4	5736.57700	1330.06300	644.56100
	1.00E+03	1.00E+03	1.00E+03
Qb5	5455.67300	1214.60600	468.11900
	1.00E+03	1.00E+03	1.00E+03
Qb6	5738.25800	1216.98000	468.20300
	1.00E+03	1.00E+03	1.00E+03
SB1	7427.83800	789.75100	-152.74300
	1.00E+03	1.00E+03	1.00E+03
SB2	8427.17900	788.43400	-152.62700
	1.00E+03	1.00E+03	1.00E+03
SB3	4000.83800	789.75100	-152.74300
	1.00E+03	1.00E+03	1.00E+03
SB4	5000.17900	788.43400	-152.62700
	1.00E+03	1.00E+03	1.00E+03

END

Distances

SB1	SB2	999.30500	.00100		
SB3	SB4	999.31600	.00100		
1 1	M3	3085.35700	.01500	T	0.0 0.2
1 1	M4	7053.80700	.01500	T	0.0 0.2
1 1	M7	4069.68600	.01500	T	0.0 0.2
1 1	M8	4439.68900	.01500	T	0.0 0.2
1 1	M9	9366.07000	.01500	T	0.0 0.2
1 1	M12	3553.68600	.01500	T	0.0 0.2
1 1	M13	3934.96100	.01500	T	0.0 0.2
1 1	M17	2466.36900	.01500	T	0.0 0.2
1 1	M18	2787.55200	.01500	T	0.0 0.2
1 1	Q1	2516.73100	.01500	T	0.0 0.2
1 1	Q2	2627.33100	.01500	T	0.0 0.2
1 1	Q3	2345.97200	.01500	T	0.0 0.2
1 1	Q4	2464.02100	.01500	T	0.0 0.2
1 1	Q5	2226.14300	.01500	T	0.0 0.2
1 1	Q6	2351.15500	.01500	T	0.0 0.2
1 1	SB1	3301.29100	.01500	T	0.0 0.2
1 1	SB2	4188.14300	.01500	T	0.0 0.2
1 1	T1	4691.15300	.01500	T	0.0 0.2
1 1	T2	10436.13000	.01500	T	0.0 0.2
1 1	T3	3186.30600	.01500	T	0.0 0.2
1 2	T1	6990.58600	.01500	T	0.0 0.2
1 2	T2	8094.32800	.01500	T	0.0 0.2
1 2	T3	2107.81900	.01500	T	0.0 0.2
1 2	M3	3827.61600	.01500	T	0.0 0.2
1 2	M4	4974.47000	.01500	T	0.0 0.2
1 2	M7	5949.45800	.01500	T	0.0 0.2
1 2	M8	2896.05300	.01500	T	0.0 0.2

1 2	M12	5568.84600	.01500	T	0.0	0.2
1 2	M13	2280.33400	.01500	T	0.0	0.2
1 2	M17	4511.92700	.01500	T	0.0	0.2
1 2	M18	1806.72300	.01500	T	0.0	0.2
1 2	Q1	2701.48600	.01500	T	0.0	0.2
1 2	Q2	2558.07100	.01500	T	0.0	0.2
1 2	Q3	2549.39500	.01500	T	0.0	0.2
1 2	Q4	2396.94100	.01500	T	0.0	0.2
1 2	Q5	2444.08800	.01500	T	0.0	0.2
1 2	Q6	2285.06200	.01500	T	0.0	0.2
1 2	SB1	1667.81000	.01500	T	0.0	0.2
1 2	SB2	2177.83400	.01500	T	0.0	0.2
1 3	T1	10316.69800	.01500	T	0.0	0.2
1 3	T2	4914.53800	.01500	T	0.0	0.2
1 3	M3	6641.61200	.01500	T	0.0	0.2
1 3	M4	3426.25100	.01500	T	0.0	0.2
1 3	M7	9170.46700	.01500	T	0.0	0.2
1 3	M8	3825.24000	.01500	T	0.0	0.2
1 3	M9	4538.46000	.01500	T	0.0	0.2
1 3	M12	8806.28200	.01500	T	0.0	0.2
1 3	M13	3373.16900	.01500	T	0.0	0.2
1 3	M17	7552.53900	.01500	T	0.0	0.2
1 3	M18	3672.99100	.01500	T	0.0	0.2
1 3	Q2	5263.76500	.01500	T	0.0	0.2
1 3	Q3	5416.18100	.01500	T	0.0	0.2
1 3	Q4	5169.27200	.01500	T	0.0	0.2
1 3	Q5	5356.50000	.01500	T	0.0	0.2
1 3	Q6	5106.68900	.01500	T	0.0	0.2
1 3	SB1	3476.54200	.01500	T	0.0	0.2
1 3	SB2	2730.30000	.01500	T	0.0	0.2
1 4	T1	4056.79900	.01500	T	0.0	0.2
1 4	T2	11201.25900	.01500	T	0.0	0.2
1 4	T4	3967.05100	.01500	T	0.0	0.2
1 4	SB3	2005.39100	.01500	T	0.0	0.2
1 4	SB4	2120.41400	.01500	T	0.0	0.2
1 4	Qb1	3166.44200	.01500	T	0.0	0.2
1 4	Qb2	3318.46600	.01500	T	0.0	0.2
1 4	Qb3	3010.78000	.01500	T	0.0	0.2
1 4	Qb4	3170.20200	.01500	T	0.0	0.2
1 4	Qb5	2899.60300	.01500	T	0.0	0.2
1 4	Qb6	3065.65400	.01500	T	0.0	0.2
1 4	M3	3515.48600	.01500	T	0.0	0.2
1 4	M4	7877.19100	.01500	T	0.0	0.2
1 4	M7	3853.32500	.01500	T	0.0	0.2
1 4	M8	5249.61900	.01500	T	0.0	0.2
1 4	M9	10179.24900	.01500	T	0.0	0.2
1 4	M12	3170.14700	.01500	T	0.0	0.2
1 4	M13	4682.97800	.01500	T	0.0	0.2
1 4	M17	1718.43000	.01500	T	0.0	0.2
1 4	M18	3243.74800	.01500	T	0.0	0.2
1 5	T1	12507.75700	.01500	T	0.0	0.2
1 5	T2	2740.82000	.01500	T	0.0	0.2
1 5	T4	6040.16300	.01500	T	0.0	0.2
1 5	SB3	9002.03200	.01500	T	0.0	0.2
1 5	SB4	8021.16100	.01500	T	0.0	0.2
1 5	Qb1	7415.94500	.01500	T	0.0	0.2
1 5	Qb2	7150.26300	.01500	T	0.0	0.2
1 5	Qb3	7355.61200	.01500	T	0.0	0.2
1 5	Qb4	7087.79400	.01500	T	0.0	0.2
1 5	Qb5	7320.27900	.01500	T	0.0	0.2

1 5	Qb6	7050.91900	.01500	T	0.0	0.2
1 5	M3	8498.14000	.01500	T	0.0	0.2
1 5	M4	3361.11900	.01500	T	0.0	0.2
1 5	M7	11211.80100	.01500	T	0.0	0.2
1 5	M8	5241.35600	.01500	T	0.0	0.2
1 5	M9	3018.80400	.01500	T	0.0	0.2
1 5	M12	10938.21100	.01500	T	0.0	0.2
1 5	M13	5125.58700	.01500	T	0.0	0.2
1 5	M17	9786.76200	.01500	T	0.0	0.2
1 5	M18	5870.80800	.01500	T	0.0	0.2

END

Height Differences

SB1	SB2	-5.60844	0.05
T1	T2	-81.56054	0.05
M3	M4	79.00604	0.05
M7	M8	-481.59855	0.05
M8	M9	271.74113	0.05
M12	M13	-36.22772	0.05
M17	M18	121.53760	0.05

END

Observations

1 1	M3	246.54252	71.75496	.00150	.00150
1 2	M3	254.56749	77.96146	.00150	.00150
1 3	M3	211.27504	87.30487	.00150	.00150
1 1	M4	321.81179	89.13512	.00150	.00150
1 2	M4	364.13401	84.22888	.00150	.00150
1 3	M4	293.95056	76.76724	.00150	.00150
1 1	M7	195.47637	101.05947	.00150	.00150
1 2	M7	230.65941	101.22905	.00150	.00150
1 3	M7	201.38121	100.63590	.00150	.00150
1 1	M8	304.91099	94.73902	.00150	.00150
1 2	M8	326.50588	91.91532	.00150	.00150
1 3	M8	240.31742	93.73144	.00150	.00150
1 1	M9	328.90827	99.63107	.00150	.00150
1 3	M9	331.39465	98.70412	.00150	.00150
1 1	M12	180.25898	126.95836	.00150	.00150
1 2	M12	218.76736	117.38518	.00150	.00150
1 3	M12	193.58343	110.79403	.00150	.00150
1 1	M13	319.34433	124.36045	.00150	.00150
1 2	M13	338.23330	144.44266	.00150	.00150
1 3	M13	223.26632	128.55702	.00150	.00150
1 1	M17	100.00837	92.84176	.00150	.00150
1 2	M17	175.25754	96.40878	.00150	.00150
1 3	M17	168.07510	97.89823	.00150	.00150
1 1	M18	389.15984	97.12872	.00150	.00150
1 2	M18	105.63857	95.31179	.00150	.00150
1 3	M18	155.67772	97.93527	.00150	.00150
1 1	Q1	270.00040	92.95185	.00150	.00150
1 2	Q1	263.80152	93.84693	.00150	.00150
1 1	Q2	276.46260	93.28870	.00150	.00150
1 2	Q2	269.71182	93.48953	.00150	.00150
1 3	Q2	213.69717	96.69641	.00150	.00150
1 1	Q3	271.78157	92.38591	.00150	.00150
1 2	Q3	261.27294	93.41645	.00150	.00150
1 3	Q3	210.11402	96.77117	.00150	.00150
1 1	Q4	278.60425	92.79453	.00150	.00150
1 2	Q4	267.41102	92.98302	.00150	.00150
1 3	Q4	211.75294	96.61833	.00150	.00150
1 1	Q5	273.00228	97.06182	.00150	.00150
1 2	Q5	259.56228	97.74872	.00150	.00150

1 3	Q5	208.92794	98.84516	.00150	.00150
1 1	Q6	280.06346	97.23119	.00150	.00150
1 2	Q6	265.85886	97.54716	.00150	.00150
1 3	Q6	210.53513	98.77596	.00150	.00150
1 1	SB1	314.64334	110.08624	.00150	.00150
1 2	SB1	321.16572	120.22861	.00150	.00150
1 3	SB1	218.32108	109.50236	.00150	.00150
1 1	SB2	322.32153	107.96488	.00150	.00150
1 2	SB2	350.85379	115.21232	.00150	.00150
1 3	SB2	232.04363	112.04644	.00150	.00150
1 1	T1	159.36542	104.77516	.00150	.00150
1 2	T1	207.85769	103.67773	.00150	.00150
1 3	T1	186.66737	102.39510	.00150	.00150
1 1	T2	342.79079	102.32157	.00150	.00150
1 2	T2	395.62568	102.53364	.00150	.00150
1 3	T2	363.75858	104.39464	.00150	.00150
1 1	T3	299.19781	107.38131	.00150	.00150
1 2	T3	299.55407	111.37938	.00150	.00150
1 4	T1	190.99403	104.63920	.00150	.00150
1 4	T2	364.92255	101.14813	.00150	.00150
1 4	T4	327.06039	103.99739	.00150	.00150
1 4	SB3	264.53648	113.53657	.00150	.00150
1 4	SB4	296.14982	112.59554	.00150	.00150
1 4	M3	285.06551	73.36267	.00150	.00150
1 4	M4	345.36438	89.00048	.00150	.00150
1 4	M7	232.11749	99.79605	.00150	.00150
1 4	M8	330.92259	93.94034	.00150	.00150
1 4	M9	351.95425	98.55235	.00150	.00150
1 4	M12	219.65875	128.79227	.00150	.00150
1 4	M13	343.06301	118.53640	.00150	.00150
1 4	M17	114.87592	87.23097	.00150	.00150
1 4	M18	398.47352	95.60182	.00150	.00150
1 4	Qb1	305.42187	92.19833	.00150	.00150
1 4	Qb2	310.11476	92.54380	.00150	.00150
1 4	Qb3	307.45453	91.77859	.00150	.00150
1 4	Qb4	312.27476	92.17964	.00150	.00150
1 4	Qb5	308.82097	95.38788	.00150	.00150
1 4	Qb6	313.71205	95.60003	.00150	.00150
1 5	T1	124.56566	102.88888	.00150	.00150
1 5	T2	298.35891	112.40198	.00150	.00150
1 5	T4	144.41568	105.85880	.00150	.00150
1 5	SB3	131.69438	105.05160	.00150	.00150
1 5	SB4	133.00015	105.64900	.00150	.00150
1 5	Qb1	141.07794	99.26961	.00150	.00150
1 5	Qb2	141.91231	99.24587	.00150	.00150
1 5	Qb3	139.57100	99.24795	.00150	.00150
1 5	Qb4	140.35416	99.22275	.00150	.00150
1 5	Qb5	138.63010	100.78536	.00150	.00150
1 5	Qb6	139.38728	100.80853	.00150	.00150
1 5	M3	141.93770	91.53161	.00150	.00150
1 5	M4	189.11657	80.19562	.00150	.00150
1 5	M7	136.21238	101.57672	.00150	.00150
1 5	M8	156.27117	97.75747	.00150	.00150
1 5	M9	243.51851	102.18478	.00150	.00150
1 5	M12	129.65929	109.74998	.00150	.00150
1 5	M13	141.96741	120.87497	.00150	.00150
1 5	M17	109.43867	99.51136	.00150	.00150
1 5	M18	102.18029	100.63344	.00150	.00150

END

Control Information

Fixed Coordinates

1 2	6945.01800	-725.62400	390.14000	.00000	.00000	.00000
1 2	.00000	.00000	.00000	.00000	.00000	.00000

END

Relative error point pairs

END

```

3333333333 DDDDDDDDD      CCC      DDDDDDDDD
3333333333 DDDDDDDDD      CCCCCC      DDDDDDDDD
      333 DDD      DDD      CCC      CCC      DDD      DDD
      333 DDD      DDD      CCC      CCC      DDD      DDD
3333333333 DDD      DDD      CCC      DDD      DDD
3333333333 DDD      DDD      CCC      DDD      DDD
      333 DDD      DDD      CCC      CCC      DDD      DDD
      333 DDD      DDD      CCC      CCC      DDD      DDD
3333333333 DDDDDDDDD      CCCCCC      DDDDDDDDD
3333333333 DDDDDDDDD      CCC      DDDDDDDDD
    
```

Bundle Adjustment Output File

SLAC Three-Dimensional Coordinate Determination

Job Id : Laser Tracker Test SRV2
Part Id : Test Laser Tracker in Sector
Date : Fri, Jun-01-92
File : ALL5_L.3DD
Run : 06-17-1992 at 14:00:01

5 Number of stations
29 Total number of object points
99 Number of distances
7 Number of height differences
97 Total number of angle observation pairs

Iteration Summary	X	Y	Z
-----	---	---	---
XYZ Position Corrections :	75.65091	43.92026	24.02015
XYZ Position Corrections :	1.72577	4.53974	.90425
XYZ Position Corrections :	.01300	.01028	.00975

XYZ Position Corrections : .00000 .00000 .00000

BUNDLE: Solution has converged after 4 iterations

Reference standard deviation = .71
Degrees of freedom = 183

Horizontal and vertical angle residuals (gons)

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-----
1 1      M3      .00188      -.00051
1 2      M3      .00227      -.00011
1 3      M3      .00056      -.00066
1 1      M4      .00038      .00065
1 2      M4     -.00238      .00050
1 3      M4      .00462      .00074
1 1      M7     -.00130      -.00069
1 2      M7     -.00028      -.00027
1 3      M7     -.00103      .00041
1 1      M8      .00059      .00002
1 2      M8      .00109      .00045
1 3      M8      .00083      -.00032
1 1      M9     -.00044      .00094
1 3      M9      .00175      -.00016
1 1      M12     .00010      -.00018
1 2      M12     -.00145      -.00022
1 3      M12     -.00132      .00003
1 1      M13     -.00040      -.00238
1 2      M13     -.00130      -.00045
1 3      M13     -.00186      .00082
1 1      M17     .00003      -.00096
1 2      M17     -.00093      -.00121
1 3      M17     -.00013      -.00096
1 1      M18     -.00104      .00071
1 2      M18     .00168      -.00004
1 3      M18     -.00052      -.00143
1 1      Q1      .00109      -.00027
1 2      Q1      .00053      .00027
1 1      Q2     -.00026      .00009
1 2      Q2     -.00003      .00015
1 3      Q2     -.00037      -.00041
1 1      Q3      .00048      .00056
1 2      Q3     -.00023      -.00037
1 3      Q3     -.00083      -.00058
1 1      Q4      .00075      .00018
1 2      Q4      .00204      .00017
1 3      Q4      .00012      -.00050
1 1      Q5      .00034      .00031
1 2      Q5      .00108      -.00015
1 3      Q5     -.00029      -.00038
1 1      Q6      .00052      .00010
1 2      Q6      .00115      .00003
1 3      Q6      .00003      -.00023
1 1      SB1     -.00087      .00050
1 2      SB1     .00007      -.00049
1 3      SB1     -.00121      .00037
1 1      SB2     .00065      .00030
1 2      SB2     -.00083      -.00018

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1 3	SB2	.00000	.00007
1 1	T1	.00108	.00086
1 2	T1	-.00066	.00077
1 3	T1	-.00040	.00091
1 1	T2	-.00153	.00075
1 2	T2	-.00126	.00069
1 3	T2	.00006	-.00007
1 1	T3	-.00207	-.00115
1 2	T3	-.00057	.00057
1 4	T1	-.00030	-.00146
1 4	T2	-.00153	.00022
1 4	T4	-.00015	-.00108
1 4	SB3	.00053	-.00007
1 4	SB4	.00044	.00004
1 4	M3	.00223	.00123
1 4	M4	-.00146	.00052
1 4	M7	-.00022	.00037
1 4	M8	-.00046	-.00006
1 4	M9	-.00181	.00054
1 4	M12	-.00113	.00090
1 4	M13	-.00124	.00005
1 4	M17	.00049	.00139
1 4	M18	-.00105	.00128
1 4	Qb1	.00159	-.00001
1 4	Qb2	.00071	.00006
1 4	Qb3	.00101	-.00002
1 4	Qb4	.00081	-.00001
1 4	Qb5	.00095	.00013
1 4	Qb6	.00058	.00013
1 5	T1	.00080	-.00005
1 5	T2	.00097	-.00071
1 5	T4	-.00080	.00171
1 5	SB3	.00015	.00027
1 5	SB4	.00005	.00012
1 5	Qb1	-.00039	-.00016
1 5	Qb2	-.00031	-.00024
1 5	Qb3	-.00014	-.00009
1 5	Qb4	-.00034	-.00012
1 5	Qb5	-.00032	-.00037
1 5	Qb6	-.00028	-.00033
1 5	M3	-.00127	-.00021
1 5	M4	-.00050	-.00133
1 5	M7	-.00029	.00083
1 5	M8	-.00032	-.00024
1 5	M9	.00022	-.00023
1 5	M12	.00159	.00072
1 5	M13	.00067	.00056
1 5	M17	.00060	-.00075
1 5	M18	-.00009	-.00142

Distance residuals

```

-----
SB1      SB2      -.00003
SB3      SB4      .00000
1 1      M3       -.00751
1 1      M4       -.00330
1 1      M7       .00319

```

1 1	M8	.00639
1 1	M9	.00742
1 1	M12	.00687
1 1	M13	-.02820
1 1	M17	-.00650
1 1	M18	.00556
1 1	Q1	-.00370
1 1	Q2	.00720
1 1	Q3	.00721
1 1	Q4	-.00562
1 1	Q5	-.00441
1 1	Q6	-.00504
1 1	SB1	.00665
1 1	SB2	-.00253
1 1	T1	.00481
1 1	T2	.00506
1 1	T3	.00643
1 2	T1	.00514
1 2	T2	-.01136
1 2	T3	-.00761
1 2	M3	.01635
1 2	M4	-.00276
1 2	M7	.00071
1 2	M8	.00190
1 2	M12	-.01519
1 2	M13	.01475
1 2	M17	-.00184
1 2	M18	.01067
1 2	Q1	.00446
1 2	Q2	-.01285
1 2	Q3	-.01280
1 2	Q4	.00151
1 2	Q5	.00503
1 2	Q6	.00449
1 2	SB1	-.00912
1 2	SB2	.00851
1 3	T1	.00231
1 3	T2	-.00013
1 3	M3	-.00100
1 3	M4	.00505
1 3	M7	-.00826
1 3	M8	.00118
1 3	M9	-.00764
1 3	M12	-.00160
1 3	M13	-.00077
1 3	M17	-.00366
1 3	M18	-.00978
1 3	Q2	.00970
1 3	Q3	.01159
1 3	Q4	.00357
1 3	Q5	-.00204
1 3	Q6	-.00093
1 3	SB1	.01031
1 3	SB2	-.00791
1 4	T1	-.00573
1 4	T2	.00800
1 4	T4	.00096
1 4	SB3	-.00043
1 4	SB4	-.00001

1 4	Qb1	.00099
1 4	Qb2	.00066
1 4	Qb3	.00068
1 4	Qb4	.00086
1 4	Qb5	.00093
1 4	Qb6	.00074
1 4	M3	-.00619
1 4	M4	-.00228
1 4	M7	.00366
1 4	M8	-.01016
1 4	M9	-.00552
1 4	M12	.00588
1 4	M13	.01380
1 4	M17	.00775
1 4	M18	-.01459
1 5	T1	-.00661
1 5	T2	-.00198
1 5	T4	.00002
1 5	SB3	.00079
1 5	SB4	.00234
1 5	Qb1	.00335
1 5	Qb2	.00149
1 5	Qb3	.00225
1 5	Qb4	.00182
1 5	Qb5	.00227
1 5	Qb6	.00139
1 5	M3	.00079
1 5	M4	-.00217
1 5	M7	.00060
1 5	M8	.00022
1 5	M9	.00573
1 5	M12	.00377
1 5	M13	-.01648
1 5	M17	.00463
1 5	M18	-.00421

Height differences residuals

SB1	SB2	-.00122
T1	T2	-.00074
M3	M4	.00011
M7	M8	.00019
M8	M9	-.00105
M12	M13	.00164
M17	M18	-.00298

Final station parameters (rads)

1 1				
RxRyRz :	-.003761	-.007297	-.838551	.004618
xyz :	4600.99411	-795.38833	374.98604	
1 2				
RxRyRz :	.000000	.000000	.000000	.006022
xyz :	6945.01800	-725.62400	390.14000	

1 3				
RxRyRz :	-.005820	-.002039	-.345105	.004159
xyz :	10233.03241	-1258.45939	403.56655	
1 4				
RxRyRz :	-.009040	.000962	-.463678	.016831
xyz :	3857.29496	-1144.91337	289.58864	
1 5				
RxRyRz :	-.002921	-.002923	-1.277030	-.020045
xyz :	12459.45448	-1013.70134	593.53958	

Final object point coordinates

	X	Y	Z
	---	---	---
T3	6930.50749	1348.55915	15.35830
T4	6930.51972	1348.55047	15.21632
Q1	5497.16046	1540.14772	650.82572
Q2	5779.49152	1536.47998	651.28322
Q3	5495.84659	1355.26115	653.32932
Q4	5777.96156	1351.33420	653.79497
Q5	5495.73788	1240.49687	476.55763
Q6	5778.30537	1237.15330	478.15825
Qb1	5497.14044	1539.60813	650.82704
Qb2	5779.42508	1535.88657	651.29019
Qb3	5495.78970	1354.65403	653.16606
Qb4	5777.94571	1350.80913	653.64698
Qb5	5495.73205	1240.09061	476.33558
Qb6	5778.30435	1236.76252	477.92247
SB1	7462.10771	771.94475	-130.92294
SB2	8461.16369	750.35203	-125.31572
SB3	3674.08993	802.85246	-151.06028
SB4	4672.61602	763.55319	-145.25749
T1	19.21140	133.65689	-13.56273
T2	15013.86417	-170.48652	67.99707

M3	4588.02271	1996.20031	1688.87731
M4	11022.40975	1849.73058	1609.87138
M7	1673.27290	2029.64164	275.31308
M8	8106.78415	1901.70448	756.91182
M9	13606.28724	1776.69192	485.16964
M12	1813.88882	832.54238	-1111.78503
M13	7932.22366	715.55246	-1075.55567
M17	2776.21513	-2432.60218	644.61132
M18	6785.68673	-2520.37486	523.07075

Coordinate standard errors

	SX	SY	SZ
-----	--	--	--
1 1	.00606	.01182	.01646
1 2	.00000	.00000	.00000
1 3	.00772	.01701	.02377
1 4	.00721	.01565	.01981
1 5	.00900	.02715	.03171
SB1	.00889	.01492	.02045
SB2	.00882	.01705	.02287
SB3	.01166	.02242	.03937
SB4	.01147	.02112	.03995
T1	.01175	.04710	.03625
T2	.01037	.04905	.03608
M3	.01522	.02037	.02895
M4	.01457	.02639	.03155
M7	.01601	.02819	.03391
M8	.01291	.01431	.02789
M9	.01558	.03407	.03662
M12	.01326	.03384	.02741
M13	.01037	.02031	.02000
M17	.01332	.02469	.02863
M18	.01161	.01352	.02331
T3	.01713	.01463	.02957
T4	.01338	.02202	.06132
Q1	.01767	.01450	.03212
Q2	.01377	.01396	.03019
Q3	.01325	.01454	.02887
Q4	.01305	.01412	.02838
Q5	.01271	.01428	.02778
Q6	.01251	.01387	.02731
Qb1	.01467	.01911	.05593
Qb2	.01449	.01924	.05742
Qb3	.01412	.01950	.05338
Qb4	.01392	.01972	.05502
Qb5	.01371	.01890	.05188
Qb6	.01352	.01917	.05366



APPENDIX E

SLAC 3 D C D - ORIENTATION DATA CAPTURE

PROJECT = Laser Tracker Test SRV2
 TASK = Test Laser Tracker in Sector 10
 DATE = Fri, Jun-01-92

LISTING = STATS

Theodolite Stations

1 1 000	4600.53818	-838.92121	390.14000	.00000	.00000	.00
-01	1.00E+04	1.00E+04	1.00E+04	1.0E-01	1.0E-01	1.0E
1 2 000	6945.01800	-725.62400	390.14000	.00000	.00000	.00
-05	1.00E-05	1.00E-05	1.00E-05	1.0E-05	1.0E-05	1.0E
1 3 000	10243.14664	-1189.91759	390.14000	.00000	.00000	.00
-01	1.00E+04	1.00E+04	1.00E+04	1.0E-01	1.0E-01	1.0E
1 4 000	3856.45667	-1142.81212	390.14000	.00000	.00000	.00
-01	1.00E+04	1.00E+04	1.00E+04	1.0E-01	1.0E-01	1.0E
1 5 000	12457.65696	-1015.24227	790.14000	.00000	.00000	.00
-01	1.00E+04	1.00E+04	1.00E+04	1.0E-01	1.0E-01	1.0E
1 9 000	3629.28958	-203.64691	650.38866	.00000	.00000	.00
-01	1.00E+04	1.00E+04	1.00E+04	1.0E-01	1.0E-01	1.0E
2 9 000	7126.11542	-280.73209	640.46558	.00000	.00000	.00
-01	1.00E+04	1.00E+04	1.00E+04	1.0E-01	1.0E-01	1.0E
3 9 000	9455.70018	-541.09130	620.18247	.00000	.00000	.00
-01	1.00E+04	1.00E+04	1.00E+04	1.0E-01	1.0E-01	1.0E

END

Object Points

T1	0.06500	0.03600	0.01500
	1.00E+03	1.00E+03	1.00E+03
T2	15000.06500	0.03600	0.01500
	1.00E+03	1.00E+03	1.00E+03
T3	6500.06500	1400.03600	0.01500
	1.00E+03	1.00E+03	1.00E+03
T4	6500.06500	1400.03600	0.01500
	1.00E+03	1.00E+03	1.00E+03
M3	4539.40300	1944.34000	1689.91600
	1.00E+03	1.00E+03	1.00E+03
M4	10974.84700	1929.30400	1575.83600
	1.00E+03	1.00E+03	1.00E+03
M7	1616.94900	1927.28900	291.85700
	1.00E+03	1.00E+03	1.00E+03
M8	8054.21200	1926.99200	738.71600
	1.00E+03	1.00E+03	1.00E+03
M9	13553.56100	1916.24600	433.83700

M12	1.00E+03	1.00E+03	1.00E+03
	1774.28500	741.69500	-1103.45600
	1.00E+03	1.00E+03	1.00E+03
M13	7893.90800	748.60100	-1100.31000
	1.00E+03	1.00E+03	1.00E+03
M17	2811.86800	-2513.92600	627.55400
	1.00E+03	1.00E+03	1.00E+03
M18	6821.65700	-2519.88500	484.34700
	1.00E+03	1.00E+03	1.00E+03
Q1	5451.92700	1513.12400	644.25100
	1.00E+03	1.00E+03	1.00E+03
Q2	5734.26300	1515.15500	643.18800
	1.00E+03	1.00E+03	1.00E+03
Q3	5454.36800	1328.20900	645.59900
	1.00E+03	1.00E+03	1.00E+03
Q4	5736.57700	1330.06300	644.56100
	1.00E+03	1.00E+03	1.00E+03
Q5	5455.67300	1214.60600	468.11900
	1.00E+03	1.00E+03	1.00E+03
Q6	5738.25800	1216.98000	468.20300
	1.00E+03	1.00E+03	1.00E+03
Qb1	5451.92700	1513.12400	644.25100
	1.00E+03	1.00E+03	1.00E+03
Qb2	5734.26300	1515.15500	643.18800
	1.00E+03	1.00E+03	1.00E+03
Qb3	5454.36800	1328.20900	645.59900
	1.00E+03	1.00E+03	1.00E+03
Qb4	5736.57700	1330.06300	644.56100
	1.00E+03	1.00E+03	1.00E+03
Qb5	5455.67300	1214.60600	468.11900
	1.00E+03	1.00E+03	1.00E+03
Qb6	5738.25800	1216.98000	468.20300
	1.00E+03	1.00E+03	1.00E+03
SB1	7427.83800	789.75100	-152.74300
	1.00E+03	1.00E+03	1.00E+03
SB2	8427.17900	788.43400	-152.62700
	1.00E+03	1.00E+03	1.00E+03
SB3	4000.83800	789.75100	-152.74300
	1.00E+03	1.00E+03	1.00E+03
SB4	5000.17900	788.43400	-152.62700
	1.00E+03	1.00E+03	1.00E+03
SB5	7362.39951	787.29602	-153.93972
	1.00E+03	1.00E+03	1.00E+03
SB6	8359.53295	721.43277	-152.75064
	1.00E+03	1.00E+03	1.00E+03

END

Distances

SB1	SB2	999.30500	.00100		
SB3	SB4	999.31600	.00100		
SB5	SB6	999.30700	.00100		
1 1	M3	3085.35700	.01500	T	0.0
1 1	M4	7053.80700	.01500	T	0.0
1 1	M7	4069.68600	.01500	T	0.0
1 1	M8	4439.68900	.01500	T	0.0
1 1	M9	9366.07000	.01500	T	0.0
1 1	M12	3553.68600	.01500	T	0.0
1 1	M13	3934.96100	.01500	T	0.0
1 1	M17	2466.36900	.01500	T	0.0
1 1	M18	2787.55200	.01500	T	0.0
1 1	Q1	2516.73100	.01500	T	0.0

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1	1	Q2	2627.33100	.01500	T	0.0	0.2
1	1	Q3	2345.97200	.01500	T	0.0	0.2
1	1	Q4	2464.02100	.01500	T	0.0	0.2
1	1	Q5	2226.14300	.01500	T	0.0	0.2
1	1	Q6	2351.15500	.01500	T	0.0	0.2
1	1	SB1	3301.29100	.01500	T	0.0	0.2
1	1	SB2	4188.14300	.01500	T	0.0	0.2
1	1	T1	4691.15300	.01500	T	0.0	0.2
1	1	T2	10436.13000	.01500	T	0.0	0.2
1	1	T3	3186.30600	.01500	T	0.0	0.2
1	2	T1	6990.58600	.01500	T	0.0	0.2
1	2	T2	8094.32800	.01500	T	0.0	0.2
1	2	T3	2107.81900	.01500	T	0.0	0.2
1	2	M3	3827.61600	.01500	T	0.0	0.2
1	2	M4	4974.47000	.01500	T	0.0	0.2
1	2	M7	5949.45800	.01500	T	0.0	0.2
1	2	M8	2896.05300	.01500	T	0.0	0.2
1	2	M12	5568.84600	.01500	T	0.0	0.2
1	2	M13	2280.33400	.01500	T	0.0	0.2
1	2	M17	4511.92700	.01500	T	0.0	0.2
1	2	M18	1806.72300	.01500	T	0.0	0.2
1	2	Q1	2701.48600	.01500	T	0.0	0.2
1	2	Q2	2558.07100	.01500	T	0.0	0.2
1	2	Q3	2549.39500	.01500	T	0.0	0.2
1	2	Q4	2396.94100	.01500	T	0.0	0.2
1	2	Q5	2444.08800	.01500	T	0.0	0.2
1	2	Q6	2285.06200	.01500	T	0.0	0.2
1	2	SB1	1667.81000	.01500	T	0.0	0.2
1	2	SB2	2177.83400	.01500	T	0.0	0.2
1	3	T1	10316.69800	.01500	T	0.0	0.2
1	3	T2	4914.53800	.01500	T	0.0	0.2
1	3	M3	6641.61200	.01500	T	0.0	0.2
1	3	M4	3426.25100	.01500	T	0.0	0.2
1	3	M7	9170.46700	.01500	T	0.0	0.2
1	3	M8	3825.24000	.01500	T	0.0	0.2
1	3	M9	4538.46000	.01500	T	0.0	0.2
1	3	M12	8806.28200	.01500	T	0.0	0.2
1	3	M13	3373.16900	.01500	T	0.0	0.2
1	3	M17	7552.53900	.01500	T	0.0	0.2
1	3	M18	3672.99100	.01500	T	0.0	0.2
1	3	Q2	5263.76500	.01500	T	0.0	0.2
1	3	Q3	5416.18100	.01500	T	0.0	0.2
1	3	Q4	5169.27200	.01500	T	0.0	0.2
1	3	Q5	5356.50000	.01500	T	0.0	0.2
1	3	Q6	5106.68900	.01500	T	0.0	0.2
1	3	SB1	3476.54200	.01500	T	0.0	0.2
1	3	SB2	2730.30000	.01500	T	0.0	0.2
1	4	T1	4056.79900	.01500	T	0.0	0.2
1	4	T2	11201.25900	.01500	T	0.0	0.2
1	4	T4	3967.05100	.01500	T	0.0	0.2
1	4	SB3	2005.39100	.01500	T	0.0	0.2
1	4	SB4	2120.41400	.01500	T	0.0	0.2
1	4	Qb1	3166.44200	.01500	T	0.0	0.2
1	4	Qb2	3318.46600	.01500	T	0.0	0.2
1	4	Qb3	3010.78000	.01500	T	0.0	0.2
1	4	Qb4	3170.20200	.01500	T	0.0	0.2
1	4	Qb5	2899.60300	.01500	T	0.0	0.2
1	4	Qb6	3065.65400	.01500	T	0.0	0.2
1	4	M3	3515.48600	.01500	T	0.0	0.2
1	4	M4	7877.19100	.01500	T	0.0	0.2

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1 4	M7	3853.32500	.01500	T	0.0	0.2
1 4	M8	5249.61900	.01500	T	0.0	0.2
1 4	M9	10179.24900	.01500	T	0.0	0.2
1 4	M12	3170.14700	.01500	T	0.0	0.2
1 4	M13	4682.97800	.01500	T	0.0	0.2
1 4	M17	1718.43000	.01500	T	0.0	0.2
1 4	M18	3243.74800	.01500	T	0.0	0.2
1 5	T1	12507.75700	.01500	T	0.0	0.2
1 5	T2	2740.82000	.01500	T	0.0	0.2
1 5	T4	6040.16300	.01500	T	0.0	0.2
1 5	SB3	9002.03200	.01500	T	0.0	0.2
1 5	SB4	8021.16100	.01500	T	0.0	0.2
1 5	Qb1	7415.94500	.01500	T	0.0	0.2
1 5	Qb2	7150.26300	.01500	T	0.0	0.2
1 5	Qb3	7355.61200	.01500	T	0.0	0.2
1 5	Qb4	7087.79400	.01500	T	0.0	0.2
1 5	Qb5	7320.27900	.01500	T	0.0	0.2
1 5	Qb6	7050.91900	.01500	T	0.0	0.2
1 5	M3	8498.14000	.01500	T	0.0	0.2
1 5	M4	3361.11900	.01500	T	0.0	0.2
1 5	M7	11211.80100	.01500	T	0.0	0.2
1 5	M8	5241.35600	.01500	T	0.0	0.2
1 5	M9	3018.80400	.01500	T	0.0	0.2
1 5	M12	10938.21100	.01500	T	0.0	0.2
1 5	M13	5125.58700	.01500	T	0.0	0.2
1 5	M17	9786.76200	.01500	T	0.0	0.2
1 5	M18	5870.80800	.01500	T	0.0	0.2

END

Observations

1 1	M3	246.54252	71.75496	.00150	.00150
1 2	M3	254.56749	77.96146	.00150	.00150
1 3	M3	211.27504	87.30487	.00150	.00150
1 1	M4	321.81179	89.13512	.00150	.00150
1 2	M4	364.13401	84.22888	.00150	.00150
1 3	M4	293.95056	76.76724	.00150	.00150
1 1	M7	195.47637	101.05947	.00150	.00150
1 2	M7	230.65941	101.22905	.00150	.00150
1 3	M7	201.38121	100.63590	.00150	.00150
1 1	M8	304.91099	94.73902	.00150	.00150
1 2	M8	326.50588	91.91532	.00150	.00150
1 3	M8	240.31742	93.73144	.00150	.00150
1 1	M9	328.90827	99.63107	.00150	.00150
1 3	M9	331.39465	98.70412	.00150	.00150
1 1	M12	180.25898	126.95836	.00150	.00150
1 2	M12	218.76736	117.38518	.00150	.00150
1 3	M12	193.58343	110.79403	.00150	.00150
1 1	M13	319.34433	124.36045	.00150	.00150
1 2	M13	338.23330	144.44266	.00150	.00150
1 3	M13	223.26632	128.55702	.00150	.00150
1 1	M17	100.00837	92.84176	.00150	.00150
1 2	M17	175.25754	96.40878	.00150	.00150
1 3	M17	168.07510	97.89823	.00150	.00150
1 1	M18	389.15984	97.12872	.00150	.00150
1 2	M18	105.63857	95.31179	.00150	.00150
1 3	M18	155.67772	97.93527	.00150	.00150
1 1	Q1	270.00040	92.95185	.00150	.00150
1 2	Q1	263.80152	93.84693	.00150	.00150
1 1	Q2	276.46260	93.28870	.00150	.00150
1 2	Q2	269.71182	93.48953	.00150	.00150
1 3	Q2	213.69717	96.69641	.00150	.00150

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1 1	Q3	271.78157	92.38591	.00150	.00150
1 2	Q3	261.27294	93.41645	.00150	.00150
1 3	Q3	210.11402	96.77117	.00150	.00150
1 1	Q4	278.60425	92.79453	.00150	.00150
1 2	Q4	267.41102	92.98302	.00150	.00150
1 3	Q4	211.75294	96.61833	.00150	.00150
1 1	Q5	273.00228	97.06182	.00150	.00150
1 2	Q5	259.56228	97.74872	.00150	.00150
1 3	Q5	208.92794	98.84516	.00150	.00150
1 1	Q6	280.06346	97.23119	.00150	.00150
1 2	Q6	265.85886	97.54716	.00150	.00150
1 3	Q6	210.53513	98.77596	.00150	.00150
1 1	SB1	314.64334	110.08624	.00150	.00150
1 2	SB1	321.16572	120.22861	.00150	.00150
1 3	SB1	218.32108	109.50236	.00150	.00150
1 1	SB2	322.32153	107.96488	.00150	.00150
1 2	SB2	350.85379	115.21232	.00150	.00150
1 3	SB2	232.04363	112.04644	.00150	.00150
1 1	T1	159.36542	104.77516	.00150	.00150
1 2	T1	207.85769	103.67773	.00150	.00150
1 3	T1	186.66737	102.39510	.00150	.00150
1 1	T2	342.79079	102.32157	.00150	.00150
1 2	T2	395.62568	102.53364	.00150	.00150
1 3	T2	363.75858	104.39464	.00150	.00150
1 1	T3	299.19781	107.38131	.00150	.00150
1 2	T3	299.55407	111.37938	.00150	.00150
1 4	T1	190.99403	104.63920	.00150	.00150
1 4	T2	364.92255	101.14813	.00150	.00150
1 4	T4	327.06039	103.99739	.00150	.00150
1 4	SB3	264.53648	113.53657	.00150	.00150
1 4	SB4	296.14982	112.59554	.00150	.00150
1 4	M3	285.06551	73.36267	.00150	.00150
1 4	M4	345.36438	89.00048	.00150	.00150
1 4	M7	232.11749	99.79605	.00150	.00150
1 4	M8	330.92259	93.94034	.00150	.00150
1 4	M9	351.95425	98.55235	.00150	.00150
1 4	M12	219.65875	128.79227	.00150	.00150
1 4	M13	343.06301	118.53640	.00150	.00150
1 4	M17	114.87592	87.23097	.00150	.00150
1 4	M18	398.47352	95.60182	.00150	.00150
1 4	Qb1	305.42187	92.19833	.00150	.00150
1 4	Qb2	310.11476	92.54380	.00150	.00150
1 4	Qb3	307.45453	91.77859	.00150	.00150
1 4	Qb4	312.27476	92.17964	.00150	.00150
1 4	Qb5	308.82097	95.38788	.00150	.00150
1 4	Qb6	313.71205	95.60003	.00150	.00150
1 5	T1	124.56566	102.88888	.00150	.00150
1 5	T2	298.35891	112.40198	.00150	.00150
1 5	T4	144.41568	105.85880	.00150	.00150
1 5	SB3	131.69438	105.05160	.00150	.00150
1 5	SB4	133.00015	105.64900	.00150	.00150
1 5	Qb1	141.07794	99.26961	.00150	.00150
1 5	Qb2	141.91231	99.24587	.00150	.00150
1 5	Qb3	139.57100	99.24795	.00150	.00150
1 5	Qb4	140.35416	99.22275	.00150	.00150
1 5	Qb5	138.63010	100.78536	.00150	.00150
1 5	Qb6	139.38728	100.80853	.00150	.00150
1 5	M3	141.93770	91.53161	.00150	.00150
1 5	M4	189.11657	80.19562	.00150	.00150
1 5	M7	136.21238	101.57672	.00150	.00150

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1 5	M8	156.27117	97.75747	.00150	.00150
1 5	M9	243.51851	102.18478	.00150	.00150
1 5	M12	129.65929	109.74998	.00150	.00150
1 5	M13	141.96741	120.87497	.00150	.00150
1 5	M17	109.43867	99.51136	.00150	.00150
1 5	M18	102.18029	100.63344	.00150	.00150
1 9	M3	325.78745	74.82005	.00050	.00050
2 9	M3	244.52825	82.22735	.00050	.00050
3 9	M3	230.47475	88.68770	.00050	.00050
1 9	M7	260.07270	105.19920	.00050	.00050
2 9	M7	225.43400	102.53545	.00050	.00050
3 9	M7	221.18445	101.73810	.00050	.00050
1 9	M12	243.39020	141.46290	.00050	.00050
2 9	M12	214.65150	117.43660	.00050	.00050
3 9	M12	213.40965	112.08660	.00050	.00050
1 9	T1	211.60280	110.29395	.00050	.00050
2 9	T1	204.80530	104.85310	.00050	.00050
3 9	T1	206.58690	103.51675	.00050	.00050
1 9	M17	122.35400	99.61330	.00050	.00050
2 9	M17	175.45370	99.85245	.00050	.00050
3 9	M17	187.49035	99.82170	.00050	.00050
1 9	M18	34.05080	102.16975	.00050	.00050
2 9	M18	122.79010	104.23845	.00050	.00050
3 9	M18	173.53475	102.07475	.00050	.00050
1 9	M13	381.53205	122.08955	.00050	.00050
2 9	M13	314.14365	153.48605	.00050	.00050
3 9	M13	241.27880	132.80185	.00050	.00050
1 9	M8	368.60115	97.69330	.00050	.00050
2 9	M8	311.37885	95.48755	.00050	.00050
3 9	M8	259.35930	96.53780	.00050	.00050
1 9	T2	397.38005	103.18890	.00050	.00050
2 9	T2	393.16650	104.90715	.00050	.00050
3 9	T2	387.46245	107.42135	.00050	.00050
1 9	M4	380.12115	91.77035	.00050	.00050
2 9	M4	357.83100	85.10285	.00050	.00050
3 9	M4	316.28720	78.74265	.00050	.00050
1 9	SB5	378.72180	111.02215	.00050	.00050
2 9	SB5	291.29460	128.68445	.00050	.00050
3 9	SB5	235.66230	113.17980	.00050	.00050
1 9	SB6	383.76790	109.01800	.00050	.00050
2 9	SB6	332.41930	126.46985	.00050	.00050
3 9	SB6	247.43195	117.34820	.00050	.00050
2 9	M9	373.06430	101.10220	.00050	.00050
3 9	M9	354.74685	101.50350	.00050	.00050

END

Control Information

Fixed Coordinates

1 2	6945.01800	-725.62400	390.14000	.00000	.00000	.00000
1 2	.00000	.00000	.00000	.00000	.00000	.00000

END

Relative error point pairs

END

.

```

3333333333 DDDDDDDDD      CCCC      DDDDDDDDD
3333333333 DDDDDDDDD      CCCCCCCC DDDDDDDDD
      333 DDD      DDD      CCC      CCC DDD      DDD
      333 DDD      DDD      CCC      CCC DDD      DDD
3333333333 DDD      DDD      CCC      CCC DDD      DDD
3333333333 DDD      DDD      CCC      CCC DDD      DDD
      333 DDD      DDD      CCC      CCC DDD      DDD
      333 DDD      DDD      CCC      CCC DDD      DDD
3333333333 DDDDDDDDD      CCCCCCCC DDDDDDDDD
3333333333 DDDDDDDDD      CCCC      DDDDDDDDD
    
```

Bundle Adjustment Output File

SLAC Three-Dimensional Coordinate Determination

Job Id : Laser Tracker Test SRV2
Part Id : Test Laser Tracker in Sector
Date : Fri, Jun-01-92
File : ALL8.3DD
Run : 06-16-1992 at 09:10:43

8 Number of stations
31 Total number of object points
100 Number of distances
0 Number of height differences
135 Total number of angle observation pairs

Iteration Summary	X	Y	Z
-----	---	---	---
XYZ Position Corrections :	100.50787	68.10697	24.01043
XYZ Position Corrections :	10.88619	10.74609	8.41898
XYZ Position Corrections :	.33146	.55792	.33757

XYZ Position Corrections : .00058 .00050 .00040

BUNDLE: Solution has converged after 4 iterations

Reference standard deviation = 1.12
 Degrees of freedom = 229

Horizontal and vertical angle residuals (gons)

```

-----
1 1      M3      .00306      -.00145
1 2      M3      .00345      -.00117
1 3      M3      .00137      -.00184
1 1      M4      .00133      .00041
1 2      M4      -.00108      .00029
1 3      M4      .00518      .00136
1 1      M7      -.00127      -.00208
1 2      M7      -.00011      -.00162
1 3      M7      -.00097      -.00112
1 1      M8      .00130      .00045
1 2      M8      .00221      .00102
1 3      M8      .00105      .00013
1 1      M9      -.00032      .00037
1 3      M9      .00191      .00007
1 1      M12     -.00196      -.00149
1 2      M12     -.00283      -.00117
1 3      M12     -.00245      -.00102
1 1      M13     -.00235      -.00164
1 2      M13     -.00434      .00140
1 3      M13     -.00201      .00305
1 1      M17     .00057      -.00248
1 2      M17     -.00031      -.00138
1 3      M17     .00033      -.00068
1 1      M18     -.00174      -.00050
1 2      M18     .00132      .00056
1 3      M18     .00006      .00066
1 1      Q1      .00143      -.00014
1 2      Q1      .00066      .00012
1 1      Q2      .00024      .00029
1 2      Q2      .00021      .00011
1 3      Q2      -.00033      -.00072
1 1      Q3      .00101      .00073
1 2      Q3      -.00003      -.00041
1 3      Q3      -.00078      -.00088
1 1      Q4      .00129      .00031
1 2      Q4      .00226      .00015
1 3      Q4      .00015      -.00075
1 1      Q5      .00078      .00044
1 2      Q5      .00116      -.00019
1 3      Q5      -.00032      -.00062
1 1      Q6      .00097      .00020
1 2      Q6      .00125      .00001
1 3      Q6      -.00001      -.00042
1 1      SB1     -.00092      .00030
1 2      SB1     .00000      -.00061
1 3      SB1     -.00163      .00082
1 1      SB2     .00060      -.00001
1 2      SB2     -.00060      -.00039

```

1 3	SB2	-.00042	.00080
1 1	T1	-.00032	.00031
1 2	T1	-.00147	.00031
1 3	T1	-.00103	.00019
1 1	T2	-.00171	-.00061
1 2	T2	-.00121	-.00059
1 3	T2	-.00009	-.00015
1 1	T3	-.00200	-.00109
1 2	T3	-.00053	.00054
1 4	T1	-.00192	-.00202
1 4	T2	-.00167	-.00110
1 4	T4	-.00005	-.00109
1 4	SB3	.00010	-.00002
1 4	SB4	.00036	.00002
1 4	M3	.00318	.00057
1 4	M4	-.00054	.00034
1 4	M7	-.00022	-.00087
1 4	M8	.00018	.00040
1 4	M9	-.00167	.00002
1 4	M12	-.00324	-.00059
1 4	M13	-.00289	.00074
1 4	M17	.00123	-.00100
1 4	M18	-.00152	.00002
1 4	Qb1	.00209	.00009
1 4	Qb2	.00123	.00015
1 4	Qb3	.00155	.00004
1 4	Qb4	.00137	.00003
1 4	Qb5	.00139	.00018
1 4	Qb6	.00104	.00016
1 5	T1	.00029	-.00049
1 5	T2	.00080	-.00024
1 5	T4	-.00101	.00177
1 5	SB3	-.00007	.00014
1 5	SB4	-.00017	.00013
1 5	Qb1	-.00031	-.00042
1 5	Qb2	-.00024	-.00047
1 5	Qb3	-.00007	-.00028
1 5	Qb4	-.00028	-.00027
1 5	Qb5	-.00032	-.00049
1 5	Qb6	-.00030	-.00041
1 5	M3	-.00050	-.00108
1 5	M4	-.00033	-.00061
1 5	M7	-.00022	-.00038
1 5	M8	-.00022	.00015
1 5	M9	.00034	.00026
1 5	M12	.00060	.00001
1 5	M13	.00064	.00224
1 5	M17	.00101	-.00016
1 5	M18	.00036	.00051
1 9	M3	-.00066	.00002
2 9	M3	-.00060	.00037
3 9	M3	-.00015	.00019
1 9	M7	.00002	.00001
2 9	M7	-.00042	.00048
3 9	M7	-.00009	.00046
1 9	M12	.00034	.00019
2 9	M12	-.00030	.00078
3 9	M12	.00041	.00005
1 9	T1	.00010	-.00028

2 9	T1	.00023	.00030
3 9	T1	.00051	.00089
1 9	M17	-.00058	.00038
2 9	M17	-.00055	-.00021
3 9	M17	.00021	.00071
1 9	M18	.00095	-.00018
2 9	M18	.00135	-.00020
3 9	M18	-.00026	.00035
1 9	M13	-.00106	.00005
2 9	M13	-.00201	.00009
3 9	M13	.00148	-.00230
1 9	M8	.00056	-.00027
2 9	M8	-.00178	-.00028
3 9	M8	-.00101	.00019
1 9	T2	-.00010	.00057
2 9	T2	-.00009	-.00012
3 9	T2	.00020	.00000
1 9	M4	.00010	.00004
2 9	M4	-.00025	-.00053
3 9	M4	-.00080	.00029
1 9	SB5	.00022	-.00057
2 9	SB5	.00039	.00009
3 9	SB5	-.00009	.00030
1 9	SB6	.00013	-.00001
2 9	SB6	-.00033	.00006
3 9	SB6	-.00024	-.00008
2 9	M9	.00036	-.00035
3 9	M9	-.00018	.00020

Distance residuals

SB1	SB2	-.00005
SB3	SB4	.00000
SB5	SB6	.00006
1 1	M3	-.00754
1 1	M4	.00373
1 1	M7	.00441
1 1	M8	.02330
1 1	M9	.00826
1 1	M12	.01667
1 1	M13	-.06356
1 1	M17	-.01593
1 1	M18	.01646
1 1	Q1	-.00469
1 1	Q2	.00784
1 1	Q3	.00758
1 1	Q4	-.00482
1 1	Q5	-.00416
1 1	Q6	-.00439
1 1	SB1	.00446
1 1	SB2	-.00214
1 1	T1	.00621
1 1	T2	.00218
1 1	T3	.00613
1 2	T1	.01131
1 2	T2	-.00457
1 2	T3	-.00729

1 2	M3	.00175
1 2	M4	.00155
1 2	M7	.00124
1 2	M8	.00729
1 2	M12	-.00203
1 2	M13	-.00113
1 2	M17	.00250
1 2	M18	.00435
1 2	Q1	.00573
1 2	Q2	-.01536
1 2	Q3	-.01500
1 2	Q4	-.00115
1 2	Q5	.00392
1 2	Q6	.00288
1 2	SB1	-.00860
1 2	SB2	.01261
1 3	T1	-.00278
1 3	T2	.00229
1 3	M3	-.00211
1 3	M4	-.00100
1 3	M7	-.01268
1 3	M8	-.00946
1 3	M9	-.00544
1 3	M12	-.01410
1 3	M13	.01558
1 3	M17	.00634
1 3	M18	-.01638
1 3	Q2	.01327
1 3	Q3	.01515
1 3	Q4	.00752
1 3	Q5	.00028
1 3	Q6	.00183
1 3	SB1	.01237
1 3	SB2	-.01069
1 4	T1	-.00751
1 4	T2	.00127
1 4	T4	.00129
1 4	SB3	-.00012
1 4	SB4	.00043
1 4	Qb1	.00115
1 4	Qb2	.00088
1 4	Qb3	.00094
1 4	Qb4	.00119
1 4	Qb5	.00123
1 4	Qb6	.00111
1 4	M3	.00478
1 4	M4	.00100
1 4	M7	.00886
1 4	M8	.00526
1 4	M9	-.00855
1 4	M12	.00378
1 4	M13	-.01934
1 4	M17	.00034
1 4	M18	.00203
1 5	T1	-.00750
1 5	T2	-.00186
1 5	T4	.00030
1 5	SB3	.00082
1 5	SB4	.00068

1 5	Qb1	.00437
1 5	Qb2	.00250
1 5	Qb3	.00343
1 5	Qb4	.00300
1 5	Qb5	.00328
1 5	Qb6	.00241
1 5	M3	.00137
1 5	M4	-.00468
1 5	M7	-.00121
1 5	M8	-.01158
1 5	M9	.00652
1 5	M12	-.00524
1 5	M13	.00226
1 5	M17	.01466
1 5	M18	-.01355

Final station parameters (rads)

1 1	RxRyRz :	-.003743	-.007293	-.838548	-.014174
	xyz :	4600.98995	-795.39519	374.95923	
1 2	RxRyRz :	.000000	.000000	.000000	-.017034
	xyz :	6945.01800	-725.62400	390.14000	
1 3	RxRyRz :	-.005848	-.002053	-.345103	-.013763
	xyz :	10233.03390	-1258.44396	403.68521	
1 4	RxRyRz :	-.009018	.000967	-.463675	-.006197
	xyz :	3857.28511	-1144.92456	289.55589	
1 5	RxRyRz :	-.002961	-.002937	-1.277029	-.039447
	xyz :	12459.45385	-1013.67402	593.72229	
1 9	RxRyRz :	-.021017	-.005012	-.009191	.000000
	xyz :	3494.25591	-527.69531	595.82267	
2 9	RxRyRz :	-.021011	-.005005	-.035804	.000000
	xyz :	7542.73472	-694.16026	620.17453	
3 9	RxRyRz :	-.021020	-.005005	-.012927	.000000
	xyz :	10235.29437	-1047.70648	631.68503	

Final object point coordinates

	X	Y	Z
	---	---	---
T1	19.20271	133.74727	-13.51373

ALL8.3DD

T2	15013.88643	-170.47915	68.15845
T3	6930.50605	1348.58169	15.35522
T4	6930.51485	1348.57352	15.22244
M3	4587.96333	1996.16712	1688.95010
M4	11022.36925	1849.82115	1609.89199
M7	1673.24356	2029.63939	275.43896
M8	8106.74636	1901.74396	756.88819
M9	13606.28639	1776.73491	485.23482
M12	1813.89205	832.66319	-1111.70740
M13	7932.28516	715.49466	-1075.63166
M17	2776.21508	-2432.64954	644.62459
M18	6785.67392	-2520.40438	523.05607
Q1	5497.14452	1540.16252	650.83421
Q2	5779.47132	1536.49802	651.28723
Q3	5495.82598	1355.27721	653.33353
Q4	5777.94204	1351.35246	653.79851
Q5	5495.72105	1240.51440	476.55999
Q6	5778.28972	1237.17264	478.15995
Qb1	5497.11556	1539.62641	650.84398
Qb2	5779.40085	1535.90739	651.30580
Qb3	5495.76546	1354.67274	653.18120
Qb4	5777.92213	1350.83051	653.66099
Qb5	5495.71249	1240.11024	476.34739
Qb6	5778.28546	1236.78434	477.93320
SB1	7462.11674	771.96531	-130.92702
SB2	8461.17269	750.37166	-125.31316
SB3	3674.08319	802.87369	-151.05440
SB4	4672.60928	763.57372	-145.25530
SB5	7396.35316	771.12774	-131.52264

SB6 8391.93247 685.15219 -124.85898

Coordinate standard errors

	SX	SY	SZ
-----	--	--	--
1 1	.00913	.01843	.03084
1 2	.00000	.00000	.00000
1 3	.01176	.02641	.04460
1 4	.01062	.02430	.03864
1 5	.01346	.04201	.06590
1 9	.01923	.02963	.03765
2 9	.01530	.02184	.02392
3 9	.02601	.03254	.04479
SB1	.01434	.02199	.03544
SB2	.01422	.02543	.04235
SB3	.01842	.03405	.06742
SB4	.01811	.03174	.06522
SB5	.01844	.02956	.02905
SB6	.01865	.02886	.03158
T1	.01545	.05348	.07025
T2	.01451	.06397	.08600
T3	.02696	.02149	.04645
T4	.02109	.03269	.09616
M3	.02515	.02702	.03972
M4	.02415	.03689	.05428
M7	.02306	.03962	.06041
M8	.01987	.01957	.03626
M9	.02270	.05051	.07917
M12	.02192	.04346	.05420
M13	.01892	.02430	.02619
M17	.01962	.03429	.05186
M18	.01776	.01748	.03365
Q1	.02773	.02119	.05064
Q2	.02160	.02020	.04754
Q3	.02073	.02122	.04562
Q4	.02046	.02042	.04471
Q5	.01977	.02074	.04394
Q6	.01951	.01997	.04303
Qb1	.02299	.02826	.08834
Qb2	.02272	.02839	.09038
Qb3	.02212	.02885	.08438
Qb4	.02183	.02912	.08665
Qb5	.02137	.02781	.08207
Qb6	.02109	.02816	.08454