

Report for Multi-Station Adjustment

Report date: 2024-11-22

Generated by: KCC

Scope: full report

Host application: RiSCAN PRO 2.19

MSA module: 2.13.2-20231124+90b07cd7

Report module: 1.11.1

Platform: Windows-10-10.0.19045-SP0

Hostname: LAP140676

1 Project Summary

Project name: **2024-09-21 B FP 6 28**

Global Coordinate Reference System (GLCS): WGS84 / Geocentric (EPSG::4978)

Report GLCS: WGS84 / UTM zone 47N (EPSG::32647)

Project origin:

Easting [m]: 866692.3463

Northing [m]: 328901.6821

Height [m]: 120.3560

Project Coordinate System (PRCS): levelled Cartesian east, north, up system

GNSS Coordinate Reference Systems:

CRS#1 ... WGS84 / Geographic (EPSG::4979)

Report Coordinate System:

PRCS

number of scan positions: 38

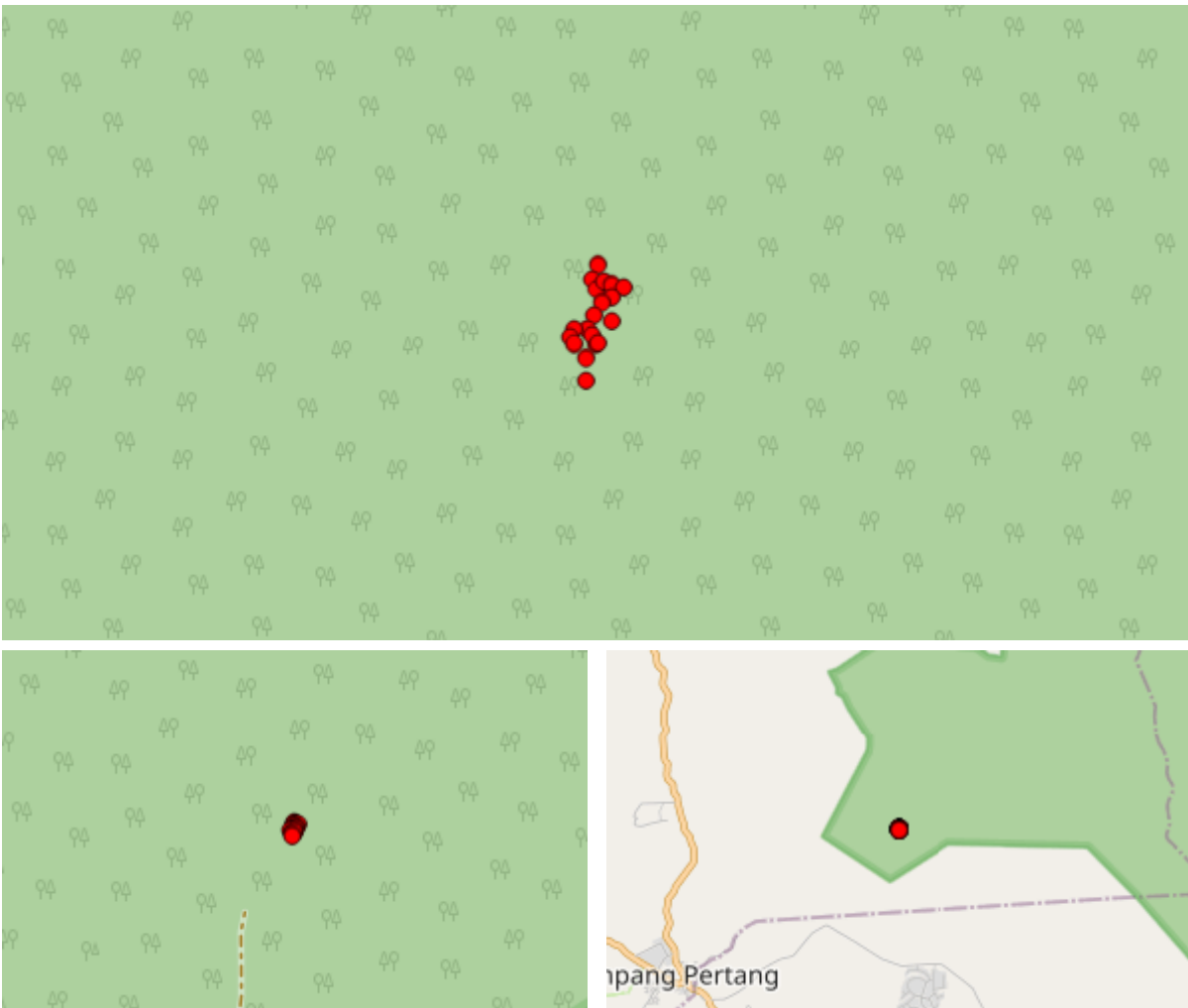
bounding box of scanposition centers: (in PRCS)

direction	from [m]	to [m]	width [m]
east	-5.288	11.160	16.448
north	-32.568	1.720	34.288
height	9.351	14.570	5.219

instruments used:

instrument type: VZ-400i

serial number: H2227243



Map Data © OpenStreetMap contributors

2 Data available in Project

Control point (CtrlP) – Point of known coordinates and accuracy. Control Points are used in multi-station adjustment / scan data adjustment to register pointclouds to a known control survey.

Check point (ChkP) – Check points are a freely selectable subset of the Control points to verify the success of the adjustment process. Check points are not used for pointcloud registration, but serve as an independent set of control.

2.1 Scandata

Name	Date	Time	Horiz. FoV [deg]	Resolution [mdeg]	Point Count	Image Count	Ref. Scans
ScanPos001	2024-09-21	20:50:03	359.87	30.0	41,435,934	0	0
ScanPos002	2024-09-21	20:52:02	360.00	30.0	38,369,225	0	0
ScanPos003	2024-09-21	20:55:27	359.91	30.0	41,906,337	0	0
ScanPos004	2024-09-21	20:57:14	360.00	30.0	37,653,286	0	0
ScanPos005	2024-09-21	21:01:00	359.89	30.0	41,897,760	0	0

Name	Date	Time	Horiz. FoV [deg]	Resolution [mdeg]	Point Count	Image Count	Refl. Scans
ScanPos006	2024-09-21	21:03:19	360.00	30.0	38,814,368	0	0
ScanPos007	2024-09-21	21:06:46	359.84	30.0	42,198,960	0	0
ScanPos008	2024-09-21	21:08:35	359.95	30.0	39,395,101	0	0
ScanPos009	2024-09-21	21:12:18	359.84	30.0	40,559,596	0	0
ScanPos010	2024-09-21	21:14:06	360.00	30.0	37,644,608	0	0
ScanPos011	2024-09-21	21:17:21	359.87	30.0	40,835,857	0	0
ScanPos012	2024-09-21	21:19:21	360.00	30.0	37,319,598	0	0
ScanPos013	2024-09-21	21:23:18	359.68	30.0	41,044,562	0	0
ScanPos014	2024-09-21	21:25:07	359.90	30.0	37,862,995	0	0
ScanPos015	2024-09-21	21:29:06	359.68	30.0	41,298,841	0	0
ScanPos016	2024-09-21	21:31:05	359.83	30.0	36,477,790	0	0
ScanPos017	2024-09-21	21:35:20	359.82	30.0	39,361,365	0	0
ScanPos018	2024-09-21	21:37:14	360.00	30.0	35,177,673	0	0
ScanPos019	2024-09-21	21:40:51	359.90	30.0	39,453,552	0	0
ScanPos020	2024-09-21	21:42:37	360.00	30.0	37,776,676	0	0
ScanPos021	2024-09-21	21:46:39	359.80	30.0	39,858,825	0	0
ScanPos022	2024-09-21	21:48:44	359.95	30.0	37,546,656	0	0
ScanPos023	2024-09-21	21:53:14	359.61	30.0	42,696,975	0	0
ScanPos024	2024-09-21	21:55:07	359.93	30.0	39,365,056	0	0
ScanPos025	2024-09-21	21:59:16	359.75	30.0	43,546,915	0	0
ScanPos026	2024-09-21	22:01:09	360.00	30.0	40,219,372	0	0
ScanPos027	2024-09-21	22:05:47	359.76	30.0	42,172,287	0	0
ScanPos028	2024-09-21	22:07:34	360.00	30.0	40,160,946	0	0
ScanPos029	2024-09-21	22:12:58	359.75	30.0	40,515,801	0	0
ScanPos030	2024-09-21	22:14:44	359.95	30.0	37,478,669	0	0
ScanPos031	2024-09-21	22:18:13	359.79	30.0	40,337,969	0	0
ScanPos032	2024-09-21	22:20:05	359.97	30.0	36,939,495	0	0
ScanPos033	2024-09-21	22:25:05	359.66	30.0	40,737,842	0	0
ScanPos034	2024-09-21	22:26:54	359.90	30.0	38,050,672	0	0
ScanPos035	2024-09-21	22:31:35	359.77	30.0	42,245,923	0	0
ScanPos036	2024-09-21	22:33:32	359.90	30.0	36,764,949	0	0
ScanPos037	2024-09-21	22:38:22	359.78	30.0	41,280,538	0	0
ScanPos038	2024-09-21	22:40:23	359.89	30.0	38,151,036	0	0
Total					1,504,554,010		

2.2 GNSS Measurements

The VZ-400i acquired no GNSS measurements.

2.3 Orientation Measurements

The VZ-400i acquired the following measurements for roll, pitch and yaw angles (all values in deg).

Name	Roll	Pitch	Yaw	Acc. Roll	Acc. Pitch	Acc. Yaw	PoseEstimation Type
ScanPos001	-2.991	1.598	71.718	0.012	0.012	1.000	dynamic
ScanPos002	103.177	-70.855	-10.763	0.143	0.143	1.000	dynamic
ScanPos003	5.747	4.147	147.123	0.018	0.018	1.000	dynamic
ScanPos004	-77.293	-66.143	-163.978	0.142	0.142	1.000	dynamic
ScanPos005	4.170	-1.681	159.200	0.014	0.014	1.000	dynamic
ScanPos006	-153.195	84.645	140.373	0.142	0.142	1.000	dynamic
ScanPos007	-2.141	6.497	124.796	0.018	0.018	1.000	dynamic
ScanPos008	-81.994	-55.549	177.036	0.143	0.143	1.000	dynamic
ScanPos009	-0.392	8.601	70.478	0.021	0.021	1.000	dynamic
ScanPos010	-77.841	-60.221	127.565	0.140	0.140	1.000	dynamic
ScanPos011	-2.775	-3.947	-90.765	0.015	0.015	1.000	dynamic
ScanPos012	82.017	55.606	-39.596	0.143	0.143	1.000	dynamic
ScanPos013	-0.029	-0.728	-150.801	0.008	0.008	1.000	dynamic
ScanPos014	-142.048	83.382	75.387	0.142	0.142	1.000	dynamic
ScanPos015	-0.335	0.486	-12.592	0.008	0.008	1.000	dynamic
ScanPos016	127.844	80.257	100.104	0.141	0.141	1.000	dynamic
ScanPos017	2.386	0.920	-157.922	0.011	0.011	1.000	dynamic
ScanPos018	-121.742	-80.525	-55.265	0.142	0.142	1.000	dynamic
ScanPos019	4.545	3.366	-174.938	0.016	0.016	1.000	dynamic
ScanPos020	118.906	71.167	-63.312	0.136	0.136	1.000	dynamic
ScanPos021	1.168	4.056	140.821	0.014	0.014	1.000	dynamic
ScanPos022	101.723	-67.587	53.189	0.143	0.143	1.000	dynamic
ScanPos023	6.105	-4.635	-152.748	0.019	0.019	1.000	dynamic
ScanPos024	-142.415	-79.915	-33.172	0.137	0.137	1.000	dynamic
ScanPos025	1.686	-1.819	3.158	0.011	0.011	1.000	dynamic
ScanPos026	97.022	-6.341	-3.505	0.139	0.139	1.000	dynamic
ScanPos027	-3.330	-3.294	-157.147	0.014	0.014	1.000	dynamic
ScanPos028	85.534	-8.210	-156.556	0.143	0.143	1.000	dynamic
ScanPos029	4.820	0.461	-140.079	0.015	0.015	1.000	dynamic
ScanPos030	130.911	-81.671	80.874	0.141	0.141	1.000	dynamic
ScanPos031	5.112	1.916	100.721	0.016	0.016	1.000	dynamic
ScanPos032	131.977	80.525	-127.141	0.140	0.140	1.000	dynamic
ScanPos033	5.119	-4.961	-127.390	0.018	0.018	1.000	dynamic
ScanPos034	55.309	80.719	-71.056	0.142	0.142	1.000	dynamic
ScanPos035	7.557	-2.528	-178.445	0.020	0.020	1.000	dynamic
ScanPos036	-137.434	-82.764	-60.477	0.142	0.142	1.000	dynamic
ScanPos037	4.941	-3.852	170.424	0.017	0.017	1.000	dynamic
ScanPos038	143.789	-79.110	22.036	0.136	0.136	1.000	dynamic

2.4 Control Points defined in a coordinate reference system

No Control Points in a coordinate reference system used.

2.5 Check Points defined in a coordinate reference system

No Check Points in a coordinate reference system used.

2.6 Control Points defined in a locally levelled coordinate system

No Control Points in a locally leveled coordinate system used.

2.7 Check Points defined in a locally levelled coordinate system

No Check Points in a locally leveled coordinate system defined.

3 Data used for Multi-station-Adjustment

3.1 Data per Scan Position

Name	Number of Plane Patches			Plane Patches of Phase 3		
	Phase 1	Phase 2	Phase 3	NS	WE	Horiz.
ScanPos001	16,364	3,852	4,042	410	543	1,068
ScanPos002	12,546	2,826	2,964	256	425	801
ScanPos003	16,138	4,018	4,226	437	539	1,137
ScanPos004	11,646	2,964	3,136	358	401	809
ScanPos005	18,542	4,410	4,694	433	667	1,247
ScanPos006	14,730	3,670	3,914	452	655	850
ScanPos007	20,926	4,840	5,088	569	652	1,323
ScanPos008	13,994	3,386	3,506	365	507	881
ScanPos009	16,442	3,680	3,840	480	500	940
ScanPos010	11,596	2,428	2,572	341	323	622
ScanPos011	11,698	2,476	2,578	370	364	555
ScanPos012	8,142	1,790	1,890	264	268	413
ScanPos013	14,890	3,110	3,298	452	482	715
ScanPos014	13,586	3,034	3,150	456	430	689
ScanPos015	18,840	4,198	4,410	591	594	1,020
ScanPos016	13,722	3,346	3,480	520	522	698
ScanPos017	12,226	2,674	2,822	400	426	585
ScanPos018	10,482	2,264	2,320	341	335	484
ScanPos019	13,816	3,112	3,234	400	432	785
ScanPos020	9,866	2,208	2,288	322	291	531
ScanPos021	8,726	1,802	1,928	225	254	485
ScanPos022	6,616	1,350	1,450	226	151	348
ScanPos023	11,328	2,298	2,422	251	304	656
ScanPos024	7,170	1,356	1,416	170	141	397
ScanPos025	10,976	2,206	2,334	262	303	602
ScanPos026	7,314	1,394	1,442	168	233	320

Name	Number of Plane Patches			Plane Patches of Phase 3		
	Phase 1	Phase 2	Phase 3	NS	WE	Horiz.
ScanPos027	10,092	2,016	2,106	201	223	629
ScanPos028	8,544	1,626	1,686	187	197	459
ScanPos029	11,994	2,672	2,784	289	488	615
ScanPos030	9,006	2,068	2,176	243	377	468
ScanPos031	10,216	2,034	2,122	238	355	468
ScanPos032	7,696	1,734	1,810	192	417	296
ScanPos033	11,300	2,468	2,594	315	485	497
ScanPos034	7,626	1,522	1,598	189	287	323
ScanPos035	6,404	1,306	1,356	150	240	288
ScanPos036	4,566	954	1,000	144	181	175
ScanPos037	2,826	492	496	39	49	160
ScanPos038	2,772	488	492	38	59	149

NS ... North-South, WE ... West-East, Horiz. ... Horizontal

3.2 Control Points used for Multi-Station Adjustment

No Control Points used.

3.3 Tie Points used for Multi-Station Adjustment

No Tie Points used.

4 Results of MSA

4.1 General Information

User Settings:

- use CRS control points: False
- use SOCS tie points: False
- use LLCS control points: False
- GNSS measurement usage: no
- gap closure distance: 0.250 m
- adjustment effort: extreme
- adjustment matches: planes to planes
- reporting level: full
- initialize optimization with measurements: False
- maximum target range: 0.000 m

Observations Used:

- # project plane patches: 21,539
- # scan position plane patches: 49,332
- # GNSS measurements: 0
- # orientation measurements: 38

control points in CRS: 0
 # control points in LLCS: 0
 # tie points in PRCS: 0
 # LLCS: 0
 project northing from: GNSS

Adjustment Info:

start time: 2024-11-22T18:26:21
 run time: 00:10:20
 # parameters estimated: 64,843

4.2 Final Poses of Scan Positions

The following positions and orientations have been estimated for the scan positions:

In the PRCS coordinate system:

Name	X [m]	Y [m]	Z [m]	Acc. X [m]	Acc. Y [m]	Acc. Z [m]
ScanPos001	2.957	2.012	9.627	0.000	0.000	0.000
ScanPos002	2.982	1.720	9.351	0.000	0.000	0.000
ScanPos003	1.456	-2.513	10.210	0.000	0.000	0.000
ScanPos004	1.601	-2.786	9.947	0.000	0.000	0.000
ScanPos005	3.017	-5.211	10.596	0.000	0.000	0.000
ScanPos006	2.911	-5.379	10.324	0.000	0.000	0.000
ScanPos007	5.082	-3.051	10.477	0.000	0.000	0.000
ScanPos008	5.135	-3.350	10.206	0.000	0.000	0.000
ScanPos009	7.499	-3.942	10.437	0.000	0.000	0.000
ScanPos010	7.295	-4.183	10.181	0.000	0.000	0.000
ScanPos011	11.160	-4.780	10.308	0.000	0.000	0.000
ScanPos012	10.992	-5.035	10.033	0.000	0.000	0.000
ScanPos013	7.425	-7.897	10.771	0.000	0.000	0.000
ScanPos014	7.188	-8.054	10.479	0.000	0.000	0.000
ScanPos015	4.247	-9.287	10.847	0.000	0.000	0.000
ScanPos016	4.505	-9.388	10.549	0.000	0.000	0.000
ScanPos017	7.365	-15.230	11.652	0.000	0.000	0.000
ScanPos018	7.646	-15.179	11.363	0.000	0.000	0.000
ScanPos019	2.250	-13.465	11.334	0.000	0.000	0.000
ScanPos020	1.995	-13.452	11.019	0.000	0.000	0.000
ScanPos021	-0.241	-17.368	12.117	0.000	0.000	0.000
ScanPos022	0.034	-17.476	11.836	0.000	0.000	0.000
ScanPos023	-3.919	-17.231	12.197	0.000	0.000	0.000
ScanPos024	-3.657	-17.199	11.888	0.000	0.000	0.000
ScanPos025	-5.286	-19.590	12.649	0.000	0.000	0.000
ScanPos026	-5.288	-19.859	12.344	0.000	0.000	0.000
ScanPos027	-3.771	-22.055	13.022	0.000	0.000	0.000
ScanPos028	-3.884	-21.782	12.745	0.000	0.000	0.000

Name	X [m]	Y [m]	Z [m]	Acc. X [m]	Acc. Y [m]	Acc. Z [m]
ScanPos029	2.385	-21.826	12.621	0.000	0.000	0.000
ScanPos030	2.613	-21.659	12.327	0.000	0.000	0.000
ScanPos031	1.327	-19.416	12.412	0.000	0.000	0.000
ScanPos032	1.256	-19.156	12.112	0.000	0.000	0.000
ScanPos033	3.406	-21.395	12.583	0.000	0.000	0.000
ScanPos034	3.234	-21.642	12.321	0.000	0.000	0.000
ScanPos035	-0.426	-25.876	13.322	0.000	0.000	0.000
ScanPos036	-0.159	-25.962	13.033	0.000	0.000	0.000
ScanPos037	-0.395	-32.515	14.570	0.000	0.000	0.000
ScanPos038	-0.144	-32.568	14.256	0.000	0.000	0.000

Name	Roll [deg]	Pitch [deg]	Yaw [deg]	Acc. Roll [deg]	Acc. Pitch [deg]	Acc. Yaw [deg]
ScanPos001	-3.000	1.602	71.848	0.018	0.018	0.001
ScanPos002	89.004	-71.303	3.732	0.019	0.018	0.004
ScanPos003	5.757	4.155	147.916	0.018	0.018	0.001
ScanPos004	-83.229	-66.538	-155.201	0.018	0.018	0.003
ScanPos005	4.181	-1.692	160.455	0.018	0.018	0.001
ScanPos006	-128.903	86.868	167.029	0.025	0.018	0.018
ScanPos007	-2.151	6.505	124.702	0.018	0.018	0.001
ScanPos008	-88.014	-55.818	-176.160	0.018	0.018	0.002
ScanPos009	-0.389	8.615	71.673	0.018	0.018	0.001
ScanPos010	-81.620	-60.547	128.881	0.018	0.018	0.003
ScanPos011	-2.795	-3.957	-90.620	0.018	0.018	0.001
ScanPos012	88.096	55.876	-36.753	0.018	0.018	0.002
ScanPos013	-0.046	-0.730	-150.207	0.018	0.018	0.001
ScanPos014	-125.385	84.972	88.539	0.023	0.018	0.013
ScanPos015	-0.335	0.490	-12.992	0.018	0.018	0.001
ScanPos016	117.816	81.302	96.498	0.020	0.018	0.008
ScanPos017	2.385	0.925	-157.349	0.018	0.018	0.001
ScanPos018	-105.671	-81.620	-62.326	0.021	0.018	0.010
ScanPos019	4.548	3.378	-174.798	0.018	0.018	0.001
ScanPos020	115.735	71.685	-72.844	0.019	0.018	0.005
ScanPos021	1.165	4.068	141.665	0.018	0.018	0.001
ScanPos022	90.960	-68.007	69.689	0.019	0.018	0.005
ScanPos023	6.112	-4.646	-152.031	0.018	0.018	0.001
ScanPos024	-137.253	-80.933	-28.818	0.020	0.018	0.008
ScanPos025	1.689	-1.828	2.500	0.018	0.018	0.001
ScanPos026	95.469	-6.344	-2.846	0.018	0.018	0.002
ScanPos027	-3.349	-3.298	-155.976	0.018	0.018	0.001
ScanPos028	89.714	-8.218	-161.047	0.018	0.018	0.001
ScanPos029	4.830	0.470	-140.087	0.018	0.018	0.001
ScanPos030	116.808	-82.918	104.546	0.023	0.018	0.015

Name	Roll [deg]	Pitch [deg]	Yaw [deg]	Acc. Roll [deg]	Acc. Pitch [deg]	Acc. Yaw [deg]
ScanPos031	5.119	1.914	102.308	0.018	0.018	0.001
ScanPos032	123.040	81.608	-136.807	0.022	0.018	0.012
ScanPos033	5.128	-4.972	-127.265	0.018	0.018	0.001
ScanPos034	69.891	81.880	-59.522	0.023	0.018	0.015
ScanPos035	7.569	-2.538	-176.756	0.018	0.018	0.002
ScanPos036	-121.081	-84.279	-68.946	0.033	0.018	0.027
ScanPos037	4.947	-3.854	172.208	0.018	0.018	0.002
ScanPos038	139.536	-80.051	34.451	0.023	0.019	0.014

In the coordinate reference system:

Name	Easting [m]	Northing [m]	Height [m]	Acc. East [m]	Acc. North [m]	Acc. Up [m]
ScanPos001	866695.3014	328903.7060	129.9834	0.000	0.000	0.000
ScanPos002	866695.3265	328903.4135	129.7069	0.000	0.000	0.000
ScanPos003	866693.8112	328899.1706	130.5663	0.000	0.000	0.000
ScanPos004	866693.9572	328898.8974	130.3026	0.000	0.000	0.000
ScanPos005	866695.3831	328896.4732	130.9524	0.000	0.000	0.000
ScanPos006	866695.2771	328896.3055	130.6805	0.000	0.000	0.000
ScanPos007	866697.4442	328898.6427	130.8333	0.000	0.000	0.000
ScanPos008	866697.4975	328898.3432	130.5620	0.000	0.000	0.000
ScanPos009	866699.8661	328897.7580	130.7931	0.000	0.000	0.000
ScanPos010	866699.6633	328897.5157	130.5369	0.000	0.000	0.000
ScanPos011	866703.5347	328896.9293	130.6635	0.000	0.000	0.000
ScanPos012	866703.3669	328896.6738	130.3891	0.000	0.000	0.000
ScanPos013	866699.8037	328893.7977	131.1273	0.000	0.000	0.000
ScanPos014	866699.5678	328893.6393	130.8348	0.000	0.000	0.000
ScanPos015	866696.6264	328892.3964	131.2026	0.000	0.000	0.000
ScanPos016	866696.8846	328892.2957	130.9045	0.000	0.000	0.000
ScanPos017	866699.7656	328886.4552	132.0083	0.000	0.000	0.000
ScanPos018	866700.0467	328886.5068	131.7190	0.000	0.000	0.000
ScanPos019	866694.6398	328888.2070	131.6904	0.000	0.000	0.000
ScanPos020	866694.3839	328888.2196	131.3752	0.000	0.000	0.000
ScanPos021	866692.1573	328884.2917	132.4735	0.000	0.000	0.000
ScanPos022	866692.4325	328884.1845	132.1918	0.000	0.000	0.000
ScanPos023	866688.4741	328884.4176	132.5528	0.000	0.000	0.000
ScanPos024	866688.7366	328884.4508	132.2442	0.000	0.000	0.000
ScanPos025	866687.1120	328882.0525	133.0046	0.000	0.000	0.000
ScanPos026	866687.1114	328881.7830	132.7001	0.000	0.000	0.000
ScanPos027	866688.6362	328879.5887	133.3778	0.000	0.000	0.000
ScanPos028	866688.5222	328879.8615	133.1009	0.000	0.000	0.000
ScanPos029	866694.7997	328879.8363	132.9766	0.000	0.000	0.000
ScanPos030	866695.0269	328880.0039	132.6831	0.000	0.000	0.000

Name	Easting [m]	Northing [m]	Height [m]	Acc. East [m]	Acc. North [m]	Acc. Up [m]
ScanPos031	866693.7327	328882.2458	132.7682	0.000	0.000	0.000
ScanPos032	866693.6616	328882.5064	132.4677	0.000	0.000	0.000
ScanPos033	866695.8204	328880.2710	132.9394	0.000	0.000	0.000
ScanPos034	866695.6486	328880.0226	132.6775	0.000	0.000	0.000
ScanPos035	866691.9971	328875.7725	133.6779	0.000	0.000	0.000
ScanPos036	866692.2647	328875.6871	133.3889	0.000	0.000	0.000
ScanPos037	866692.0480	328869.1257	134.9256	0.000	0.000	0.000
ScanPos038	866692.2992	328869.0734	134.6118	0.000	0.000	0.000

4.3 Changes in Scan Positions

The following table reflects the change of scan positions with respect to position and orientation in comparison to positions and orientations wrt to prior to multi-station adjustment.

In the PRCS coordinate system:

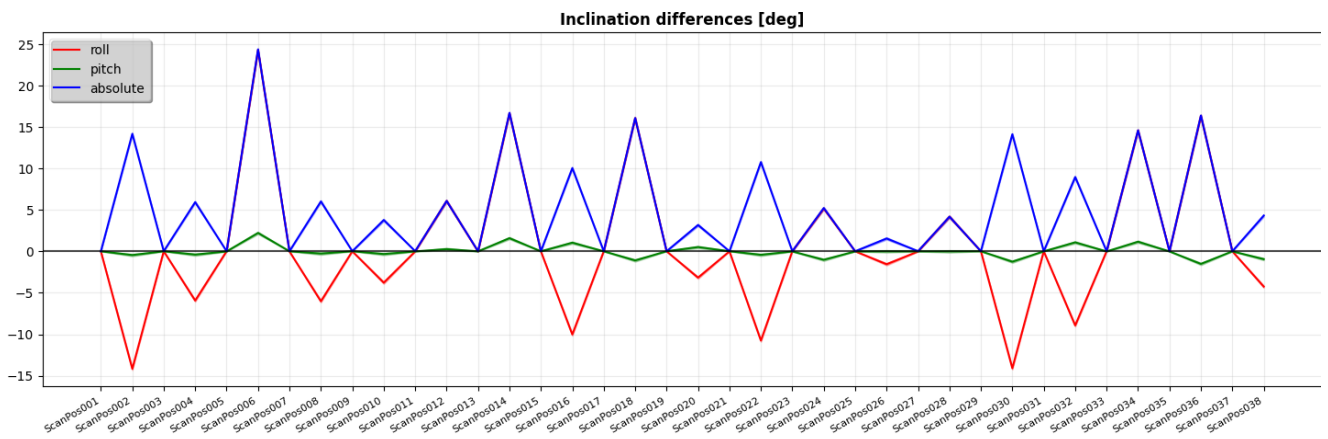
Name	Changes wrt to prior to multi-station adjustment					
	X [m]	Y [m]	Z [m]	Roll [deg]	Pitch [deg]	Yaw [deg]
ScanPos001	0.0003	0.0009	-0.0003	0.0005	0.0076	-0.0033
ScanPos002	0.0008	0.0004	-0.0001	-0.0205	0.0062	0.0147
ScanPos003	-0.0003	0.0004	0.0003	0.0094	-0.0054	-0.0016
ScanPos004	-0.0002	0.0005	0.0006	0.0112	-0.0073	-0.0131
ScanPos005	-0.0002	0.0012	0.0007	0.0113	0.0016	-0.0056
ScanPos006	-0.0003	0.0005	0.0006	0.0955	-0.0053	0.0926
ScanPos007	0.0000	0.0007	-0.0002	0.0060	0.0012	-0.0025
ScanPos008	0.0001	0.0004	-0.0003	0.0058	-0.0027	-0.0087
ScanPos009	0.0002	0.0004	-0.0005	0.0044	0.0034	-0.0040
ScanPos010	-0.0010	0.0001	-0.0005	0.0021	-0.0014	-0.0065
ScanPos011	-0.0001	-0.0009	-0.0006	0.0027	-0.0076	-0.0040
ScanPos012	-0.0009	-0.0007	-0.0001	0.0023	0.0018	0.0013
ScanPos013	-0.0006	-0.0006	0.0005	-0.0018	0.0002	-0.0025
ScanPos014	-0.0001	-0.0002	0.0000	0.0035	0.0031	-0.0024
ScanPos015	0.0000	-0.0002	0.0003	-0.0036	-0.0020	-0.0010
ScanPos016	-0.0003	-0.0000	-0.0006	0.0242	0.0036	0.0228
ScanPos017	-0.0001	0.0003	0.0013	0.0016	-0.0091	-0.0017
ScanPos018	-0.0001	0.0002	0.0014	-0.0678	-0.0032	0.0637
ScanPos019	-0.0006	0.0007	0.0011	0.0044	-0.0028	-0.0044
ScanPos020	-0.0011	0.0016	0.0013	-0.0189	-0.0045	-0.0242
ScanPos021	0.0000	0.0027	-0.0001	0.0003	-0.0075	-0.0038
ScanPos022	0.0020	-0.0002	0.0006	-0.0056	-0.0035	0.0070
ScanPos023	-0.0001	0.0011	0.0004	0.0018	0.0025	0.0009
ScanPos024	0.0011	-0.0006	0.0005	-0.0049	-0.0018	0.0090
ScanPos025	-0.0005	0.0006	-0.0008	-0.0015	-0.0042	-0.0010
ScanPos026	-0.0008	0.0002	-0.0006	0.0038	-0.0063	-0.0000

Changes wrt to prior to multi-station adjustment						
Name	X [m]	Y [m]	Z [m]	Roll [deg]	Pitch [deg]	Yaw [deg]
ScanPos027	-0.0012	0.0002	-0.0006	0.0044	-0.0008	-0.0041
ScanPos028	-0.0005	0.0001	-0.0008	0.0060	-0.0003	-0.0021
ScanPos029	-0.0005	0.0013	-0.0001	0.0047	0.0009	0.0006
ScanPos030	0.0003	0.0012	-0.0005	0.0148	0.0095	-0.0171
ScanPos031	0.0010	-0.0002	0.0001	0.0099	-0.0023	0.0052
ScanPos032	0.0007	0.0001	-0.0001	-0.0074	-0.0027	-0.0114
ScanPos033	-0.0009	-0.0001	0.0004	0.0083	-0.0085	-0.0016
ScanPos034	-0.0026	-0.0035	0.0005	-0.0002	-0.0164	-0.0037
ScanPos035	-0.0002	-0.0000	0.0004	0.0067	-0.0007	-0.0038
ScanPos036	-0.0025	-0.0016	-0.0005	-0.0673	-0.0002	0.0723
ScanPos037	0.0004	0.0007	0.0000	0.0063	0.0043	0.0015
ScanPos038	-0.0001	0.0006	0.0006	-0.0433	0.0089	0.0380

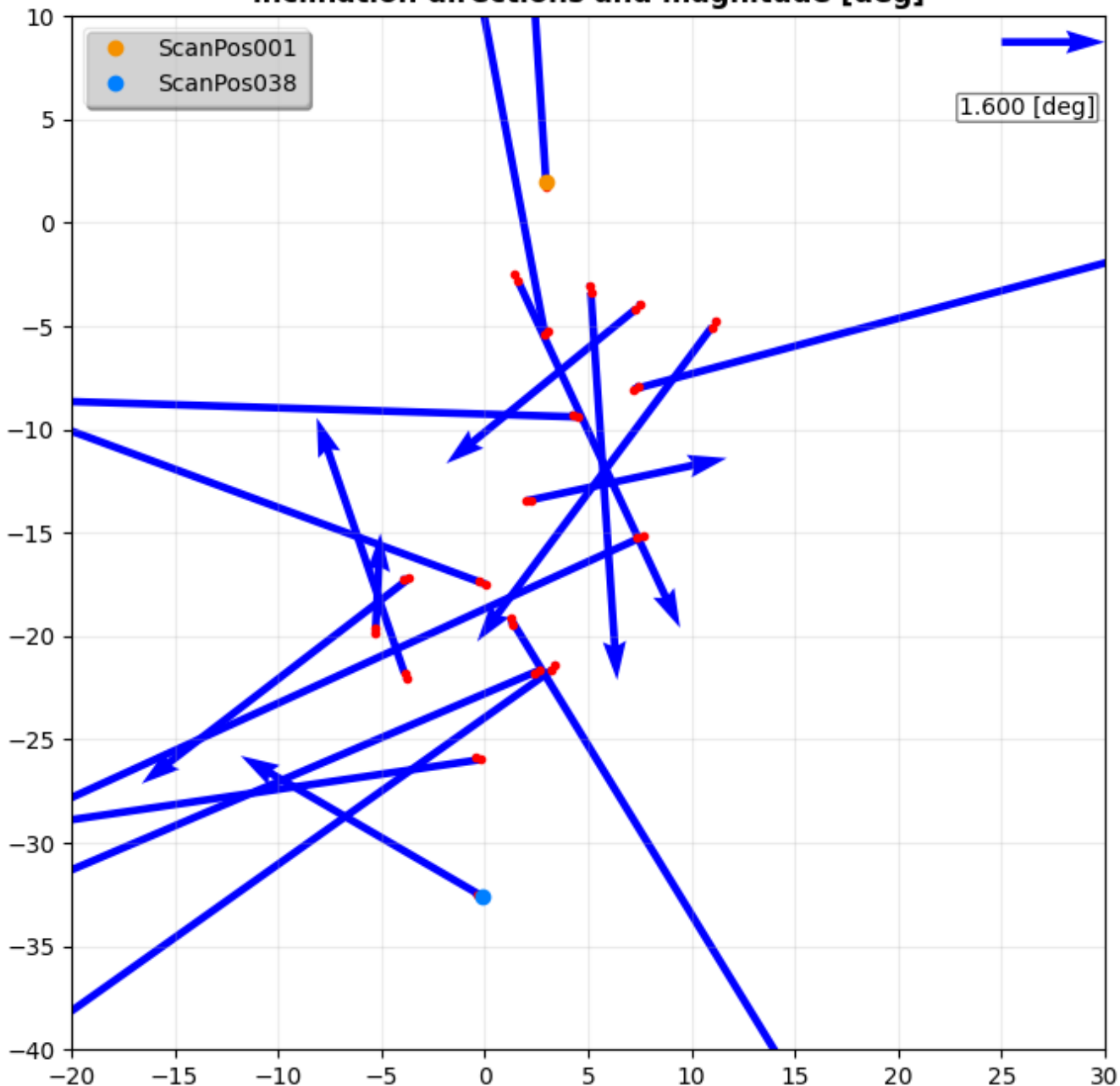
4.4 Residuals

For an assessment of the quality of the multi-station adjustment the following residual deviations (in short residuals) can be observed.

4.4.1 Orientation Measurements



inclination directions and magnitude [deg]



Name	Deviations in PRCS			a priori Accuracies		
	Roll [deg]	Pitch [deg]	Yaw [deg]	Roll [deg]	Pitch [deg]	Yaw [deg]
ScanPos001	-0.0092	0.0037	0.1297	0.012	0.012	10.000
ScanPos002	-14.1733	-0.4481	14.4947	0.143	0.143	10.000
ScanPos003	0.0095	0.0076	0.7927	0.018	0.018	10.000
ScanPos004	-5.9357	-0.3953	8.7767	0.142	0.142	10.000
ScanPos005	0.0116	-0.0117	1.2551	0.014	0.014	10.000
ScanPos006	24.2923	2.2222	26.6558	0.142	0.142	10.000
ScanPos007	-0.0106	0.0074	-0.0948	0.018	0.018	10.000
ScanPos008	-6.0207	-0.2687	6.8037	0.143	0.143	10.000
ScanPos009	0.0031	0.0138	1.1950	0.021	0.021	10.000

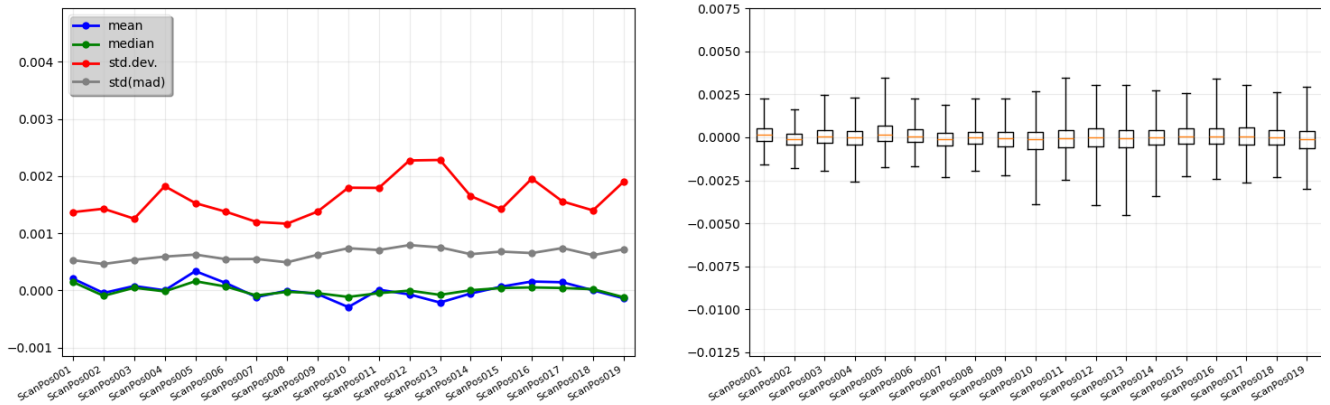
Name	Deviations in PRCS			a priori Accuracies			
	Roll [deg]	Pitch [deg]	Yaw [deg]	Roll [deg]	Pitch [deg]	Yaw [deg]	
ScanPos010	-3.7795	-0.3260	1.3159	0.140	0.140	10.000	
ScanPos011	-0.0198	-0.0099	0.1449	0.015	0.015	10.000	
ScanPos012	6.0782	0.2699	2.8427	0.143	0.143	10.000	
ScanPos013	-0.0164	-0.0021	0.5943	0.008	0.008	10.000	
ScanPos014	16.6636	1.5901	13.1519	0.142	0.142	10.000	
ScanPos015	0.0001	0.0044	-0.4006	0.008	0.008	10.000	
ScanPos016	-10.0282	1.0452	-3.6061	0.141	0.141	10.000	
ScanPos017	-0.0011	0.0051	0.5730	0.011	0.011	10.000	
ScanPos018	16.0704	-1.0951	-7.0611	0.142	0.142	10.000	
ScanPos019	0.0029	0.0117	0.1393	0.016	0.016	10.000	
ScanPos020	-3.1710	0.5179	-9.5322	0.136	0.136	10.000	
ScanPos021	-0.0026	0.0121	0.8443	0.014	0.014	10.000	
ScanPos022	-10.7631	-0.4196	16.4996	0.143	0.143	10.000	
ScanPos023	0.0075	-0.0112	0.7162	0.019	0.019	10.000	
ScanPos024	5.1617	-1.0183	4.3546	0.137	0.137	10.000	
ScanPos025	0.0034	-0.0089	-0.6579	0.011	0.011	10.000	
ScanPos026	-1.5537	-0.0026	0.6583	0.139	0.139	10.000	
ScanPos027	-0.0191	-0.0041	1.1710	0.014	0.014	10.000	
ScanPos028	4.1800	-0.0079	-4.4910	0.143	0.143	10.000	
ScanPos029	0.0098	0.0089	-0.0081	0.015	0.015	10.000	
ScanPos030	-14.1025	-1.2463	23.6720	0.141	0.141	10.000	
ScanPos031	0.0071	-0.0015	1.5871	0.016	0.016	10.000	
ScanPos032	-8.9367	1.0836	-9.6655	0.140	0.140	10.000	
ScanPos033	0.0087	-0.0114	0.1243	0.018	0.018	10.000	
ScanPos034	14.5815	1.1610	11.5339	0.142	0.142	10.000	
ScanPos035	0.0119	-0.0097	1.6890	0.020	0.020	10.000	
ScanPos036	16.3527	-1.5148	-8.4688	0.142	0.142	10.000	
ScanPos037	0.0057	-0.0021	1.7841	0.017	0.017	10.000	
ScanPos038	-4.2531	-0.9411	12.4148	0.136	0.136	10.000	
Statistics	mean	median	std. dev.	std(mad)	min	max	count
Roll [deg]	0.5438	0.0015	8.0920	1.1686	-14.1733	24.2923	38
Pitch [deg]	0.0055	-0.0024	0.7090	0.0212	-1.5148	2.2222	38
Yaw [deg]	2.9455	0.8185	7.9329	1.6195	-9.6655	26.6558	38
Roll [1]	3.730	0.079	57.057	9.902	-99.769	170.582	38
Pitch [1]	0.039	-0.111	5.041	1.204	-10.702	15.604	38
Yaw [1]	0.295	0.082	0.793	0.162	-0.967	2.666	38

4.4.2 Plane Patches

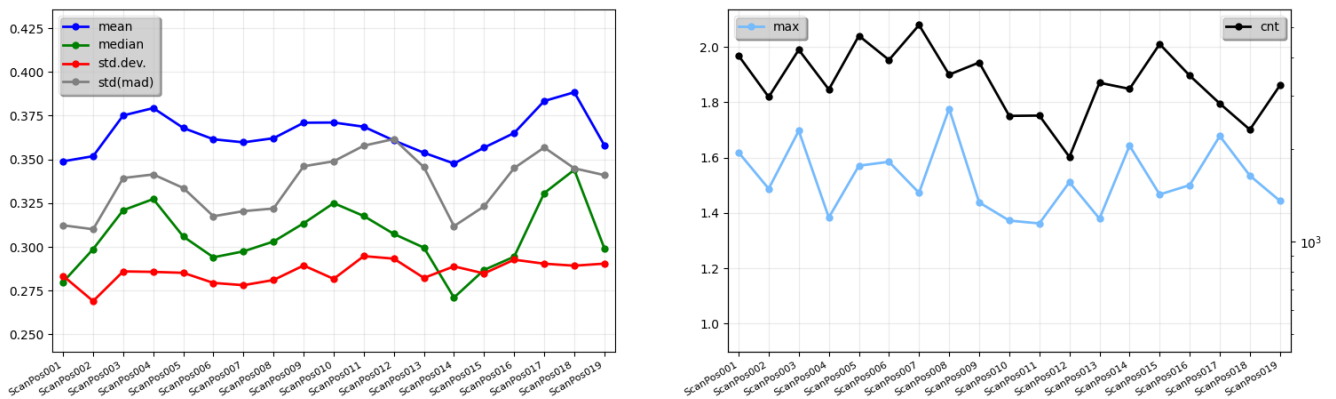
The subsequent figures show the residuals in distance and angle of all plane patches per scan position, expressed as mean, median, standard deviation and median absolute deviation (std(mad)). Additionally, the figures depict the number of plane patches available for every scan position.

For the residuals in distance of the plane patches the boxplot shows the median as orange line. The box is defined by the quantil 25% and 75%. This translates to 50 percent of the total amount of points lie in the range shown by the box. The whiskers are at the quantil 2.5% and 97.5%, containing 95% of all points.

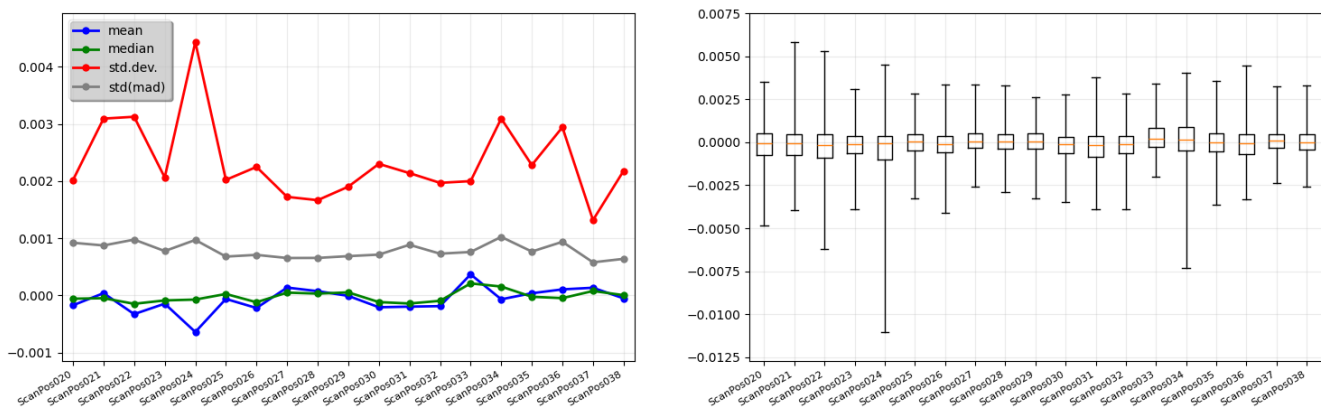
residuals in distance [m]



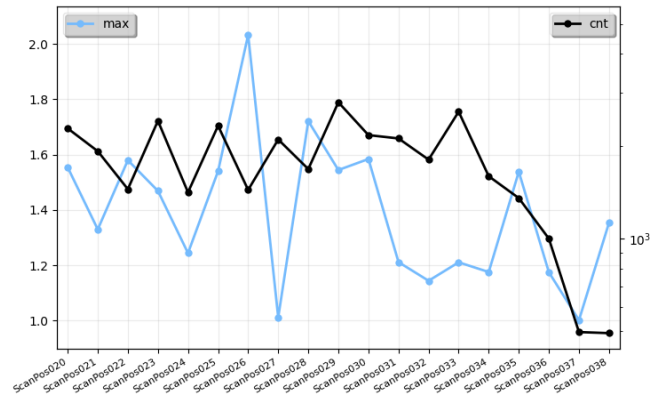
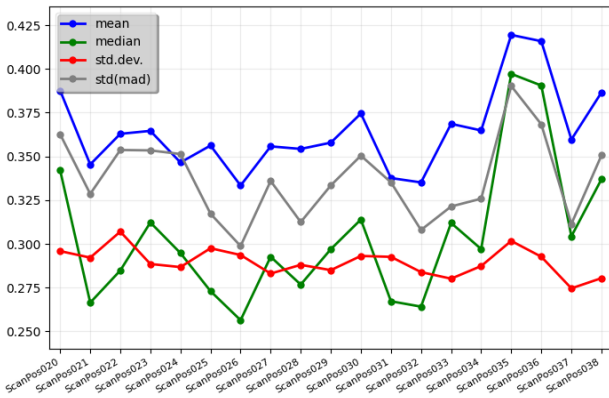
residuals in angle [deg]



residuals in distance [m]



residuals in angle [deg]



Plane Patch Residuals of Distance [m]											
Name	# plane patches	mean	median	std. dev.	std(mad)	min	q2.5%	q25%	q75%	q97.5%	max
ScanPos001	4042	0.0002	0.0001	0.0014	0.0005	-0.0190	-0.0016	-0.0002	0.0005	0.0023	0.0256
ScanPos002	2964	-0.0000	-0.0001	0.0014	0.0005	-0.0103	-0.0018	-0.0004	0.0002	0.0016	0.0288
ScanPos003	4226	0.0001	0.0000	0.0013	0.0005	-0.0252	-0.0019	-0.0003	0.0004	0.0025	0.0149
ScanPos004	3136	0.0000	-0.0000	0.0018	0.0006	-0.0346	-0.0026	-0.0004	0.0004	0.0023	0.0241
ScanPos005	4694	0.0003	0.0002	0.0015	0.0006	-0.0107	-0.0017	-0.0002	0.0007	0.0035	0.0328
ScanPos006	3914	0.0001	0.0001	0.0014	0.0005	-0.0095	-0.0017	-0.0003	0.0005	0.0023	0.0420
ScanPos007	5088	-0.0001	-0.0001	0.0012	0.0006	-0.0119	-0.0023	-0.0005	0.0003	0.0019	0.0145
ScanPos008	3506	-0.0000	-0.0000	0.0012	0.0005	-0.0123	-0.0019	-0.0004	0.0003	0.0022	0.0134
ScanPos009	3840	-0.0001	-0.0000	0.0014	0.0006	-0.0138	-0.0022	-0.0005	0.0003	0.0023	0.0309
ScanPos010	2572	-0.0003	-0.0001	0.0018	0.0007	-0.0195	-0.0039	-0.0007	0.0003	0.0027	0.0135
ScanPos011	2578	0.0000	-0.0000	0.0018	0.0007	-0.0156	-0.0025	-0.0006	0.0004	0.0034	0.0233
ScanPos012	1890	-0.0001	-0.0000	0.0023	0.0008	-0.0279	-0.0039	-0.0005	0.0005	0.0030	0.0184
ScanPos013	3298	-0.0002	-0.0001	0.0023	0.0008	-0.0281	-0.0045	-0.0006	0.0004	0.0030	0.0143
ScanPos014	3150	-0.0001	0.0000	0.0017	0.0006	-0.0098	-0.0034	-0.0004	0.0004	0.0027	0.0198
ScanPos015	4410	0.0001	0.0000	0.0014	0.0007	-0.0113	-0.0022	-0.0004	0.0005	0.0026	0.0264
ScanPos016	3480	0.0002	0.0001	0.0020	0.0007	-0.0115	-0.0024	-0.0004	0.0005	0.0034	0.0295
ScanPos017	2822	0.0001	0.0000	0.0016	0.0007	-0.0144	-0.0026	-0.0004	0.0006	0.0031	0.0147
ScanPos018	2320	0.0000	0.0000	0.0014	0.0006	-0.0155	-0.0023	-0.0004	0.0004	0.0026	0.0117
ScanPos019	3234	-0.0001	-0.0001	0.0019	0.0007	-0.0377	-0.0030	-0.0006	0.0003	0.0029	0.0170
ScanPos020	2288	-0.0002	-0.0001	0.0020	0.0009	-0.0219	-0.0049	-0.0007	0.0005	0.0035	0.0159
ScanPos021	1928	0.0000	-0.0000	0.0031	0.0009	-0.0328	-0.0039	-0.0007	0.0005	0.0058	0.0260
ScanPos022	1450	-0.0003	-0.0001	0.0031	0.0010	-0.0243	-0.0062	-0.0009	0.0004	0.0053	0.0193
ScanPos023	2422	-0.0001	-0.0001	0.0021	0.0008	-0.0320	-0.0039	-0.0007	0.0004	0.0031	0.0197
ScanPos024	1416	-0.0006	-0.0001	0.0044	0.0010	-0.0388	-0.0110	-0.0010	0.0004	0.0045	0.0348
ScanPos025	2334	-0.0001	0.0000	0.0020	0.0007	-0.0227	-0.0033	-0.0005	0.0005	0.0028	0.0229
ScanPos026	1442	-0.0002	-0.0001	0.0022	0.0007	-0.0214	-0.0041	-0.0006	0.0003	0.0034	0.0200
ScanPos027	2106	0.0001	0.0001	0.0017	0.0007	-0.0117	-0.0026	-0.0003	0.0005	0.0033	0.0271
ScanPos028	1686	0.0001	0.0000	0.0017	0.0007	-0.0127	-0.0029	-0.0004	0.0005	0.0033	0.0170
ScanPos029	2784	-0.0000	0.0001	0.0019	0.0007	-0.0359	-0.0033	-0.0004	0.0005	0.0026	0.0184

		Plane Patch Residuals of Distance [m]									
Name	# plane patches	mean	median	std. dev.	std(mad)	min	q2.5%	q25%	q75%	q97.5%	max
ScanPos030	2176	-0.0002	-0.0001	0.0023	0.0007	-0.0458	-0.0035	-0.0006	0.0003	0.0028	0.0223
ScanPos031	2122	-0.0002	-0.0001	0.0021	0.0009	-0.0156	-0.0039	-0.0008	0.0004	0.0038	0.0222
ScanPos032	1810	-0.0002	-0.0001	0.0020	0.0007	-0.0125	-0.0039	-0.0006	0.0003	0.0028	0.0239
ScanPos033	2594	0.0004	0.0002	0.0020	0.0008	-0.0209	-0.0020	-0.0002	0.0008	0.0034	0.0403
ScanPos034	1598	-0.0001	0.0002	0.0031	0.0010	-0.0266	-0.0073	-0.0005	0.0009	0.0040	0.0229
ScanPos035	1356	0.0000	-0.0000	0.0023	0.0008	-0.0141	-0.0036	-0.0005	0.0005	0.0036	0.0283
ScanPos036	1000	0.0001	-0.0000	0.0029	0.0009	-0.0065	-0.0033	-0.0007	0.0005	0.0045	0.0426
ScanPos037	496	0.0001	0.0001	0.0013	0.0006	-0.0041	-0.0024	-0.0003	0.0005	0.0033	0.0103
ScanPos038	492	-0.0001	0.0000	0.0022	0.0006	-0.0193	-0.0026	-0.0004	0.0005	0.0033	0.0064
		Plane Patch Angular Residuals [deg]									
Name	# plane patches	mean	median	std. dev.	std(mad)	min	q2.5%	q25%	q75%	q97.5%	max
ScanPos001	4042	0.3489	0.2799	0.2834	0.3123	0.0004	0.0086	0.0956	0.5608	0.9179	1.6187
ScanPos002	2964	0.3518	0.2987	0.2690	0.3101	0.0004	0.0094	0.1163	0.5585	0.9060	1.4876
ScanPos003	4226	0.3751	0.3209	0.2860	0.3393	0.0004	0.0077	0.1175	0.6044	0.9228	1.6971
ScanPos004	3136	0.3793	0.3273	0.2857	0.3414	0.0007	0.0106	0.1237	0.6066	0.9292	1.3834
ScanPos005	4694	0.3679	0.3059	0.2851	0.3336	0.0007	0.0074	0.1093	0.5924	0.9220	1.5707
ScanPos006	3914	0.3615	0.2940	0.2794	0.3175	0.0007	0.0124	0.1125	0.5820	0.9226	1.5849
ScanPos007	5088	0.3598	0.2974	0.2781	0.3204	0.0008	0.0123	0.1105	0.5790	0.9135	1.4726
ScanPos008	3506	0.3621	0.3031	0.2810	0.3219	0.0008	0.0139	0.1144	0.5801	0.9270	1.7770
ScanPos009	3840	0.3710	0.3135	0.2893	0.3461	0.0002	0.0071	0.1082	0.6060	0.9430	1.4379
ScanPos010	2572	0.3711	0.3250	0.2817	0.3489	0.0002	0.0098	0.1155	0.5914	0.9297	1.3723
ScanPos011	2578	0.3687	0.3176	0.2947	0.3578	0.0008	0.0066	0.1009	0.6116	0.9498	1.3620
ScanPos012	1890	0.3608	0.3074	0.2932	0.3616	0.0008	0.0047	0.0878	0.5929	0.9223	1.5114
ScanPos013	3298	0.3538	0.2995	0.2822	0.3455	0.0003	0.0087	0.0919	0.5713	0.9226	1.3793
ScanPos014	3150	0.3476	0.2710	0.2888	0.3118	0.0005	0.0091	0.0913	0.5700	0.9293	1.6431
ScanPos015	4410	0.3567	0.2868	0.2848	0.3232	0.0009	0.0105	0.0988	0.5766	0.9241	1.4667
ScanPos016	3480	0.3651	0.2944	0.2927	0.3450	0.0005	0.0094	0.0965	0.6066	0.9315	1.5006
ScanPos017	2822	0.3834	0.3307	0.2904	0.3568	0.0005	0.0090	0.1152	0.6146	0.9196	1.6781
ScanPos018	2320	0.3884	0.3440	0.2892	0.3449	0.0010	0.0123	0.1273	0.6295	0.9524	1.5349
ScanPos019	3234	0.3581	0.2991	0.2904	0.3410	0.0005	0.0071	0.0934	0.5903	0.9416	1.4437
ScanPos020	2288	0.3876	0.3420	0.2958	0.3626	0.0015	0.0089	0.1217	0.6158	0.9445	1.5536
ScanPos021	1928	0.3454	0.2663	0.2921	0.3285	0.0011	0.0045	0.0820	0.5806	0.9402	1.3295
ScanPos022	1450	0.3629	0.2847	0.3070	0.3536	0.0007	0.0038	0.0825	0.6108	0.9724	1.5795
ScanPos023	2422	0.3646	0.3122	0.2885	0.3534	0.0004	0.0082	0.1032	0.5940	0.9261	1.4686
ScanPos024	1416	0.3465	0.2947	0.2867	0.3513	0.0008	0.0056	0.0732	0.5818	0.9069	1.2437
ScanPos025	2334	0.3562	0.2729	0.2975	0.3172	0.0003	0.0077	0.0886	0.5922	0.9498	1.5400
ScanPos026	1442	0.3333	0.2563	0.2936	0.2987	0.0006	0.0067	0.0798	0.5424	0.9352	2.0325
ScanPos027	2106	0.3557	0.2926	0.2830	0.3359	0.0011	0.0083	0.0973	0.5844	0.9220	1.0111
ScanPos028	1686	0.3542	0.2767	0.2880	0.3124	0.0005	0.0111	0.0997	0.5820	0.9236	1.7211
ScanPos029	2784	0.3578	0.2969	0.2849	0.3334	0.0010	0.0116	0.1000	0.5753	0.9365	1.5441

		Plane Patch Angular Residuals [deg]									
Name	# plane patches	mean	median	std. dev.	std(mad)	min	q2.5%	q25%	q75%	q97.5%	max
ScanPos030	2176	0.3745	0.3139	0.2930	0.3504	0.0012	0.0102	0.1043	0.6073	0.9424	1.5839
ScanPos031	2122	0.3376	0.2671	0.2925	0.3351	0.0001	0.0046	0.0672	0.5658	0.9358	1.2111
ScanPos032	1810	0.3351	0.2641	0.2838	0.3079	0.0004	0.0071	0.0824	0.5493	0.9370	1.1437
ScanPos033	2594	0.3686	0.3119	0.2801	0.3213	0.0007	0.0113	0.1222	0.5705	0.9426	1.2104
ScanPos034	1598	0.3648	0.2970	0.2873	0.3258	0.0002	0.0104	0.1071	0.6046	0.9369	1.1753
ScanPos035	1356	0.4194	0.3972	0.3016	0.3902	0.0008	0.0113	0.1317	0.6543	0.9693	1.5380
ScanPos036	1000	0.4158	0.3905	0.2926	0.3683	0.0005	0.0154	0.1562	0.6437	0.9537	1.1745
ScanPos037	496	0.3596	0.3043	0.2745	0.3113	0.0007	0.0074	0.1152	0.5854	0.9440	1.0012
ScanPos038	492	0.3865	0.3369	0.2804	0.3506	0.0010	0.0113	0.1421	0.5982	0.9361	1.3533