



ČVUT
FD



DEPARTMENT
OF FORENSIC EXPERTS
IN TRANSPORTATION



Hybridní sběr dat pro dokumentaci dopravních nehod

Zdeněk Svatý

Workshop moderních metod geomatiky

3.12.2024

TESTOVÁNÍ A PRAKTICKÉ
OVĚŘENÍ VYUŽITÍ TECHNOLOGIE
HYBRIDNÍHO SBĚRU DAT PRO
ÚČELY OHLEDÁNÍ V RÁMCI
POLICEJNÍ PRAKCE
CZ.01.01.01/05/23_009/0004003

ZÁŘÍ 2024
Revize 1

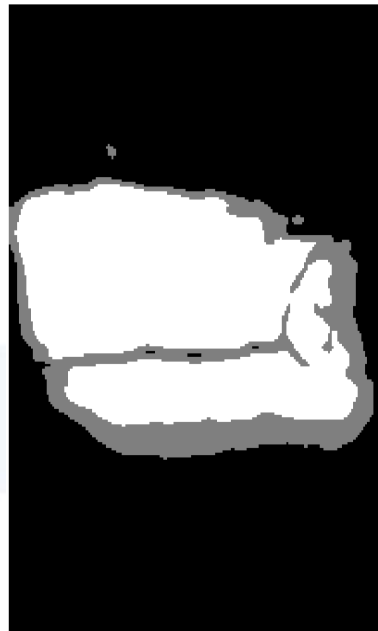
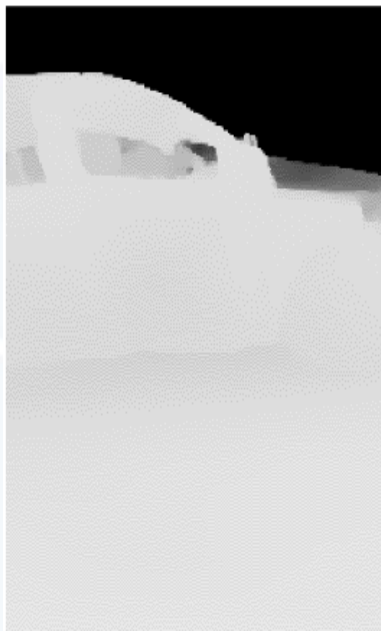


FAKULTA
DOPRAVNÍ
ČVUT V PRAZE

VÝZKUMNÁ ZPRÁVA

ViDoc + iPhone + Pix4Dmatic

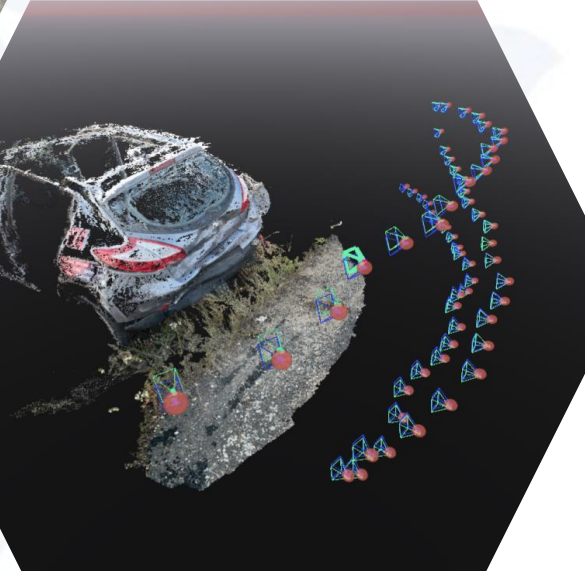
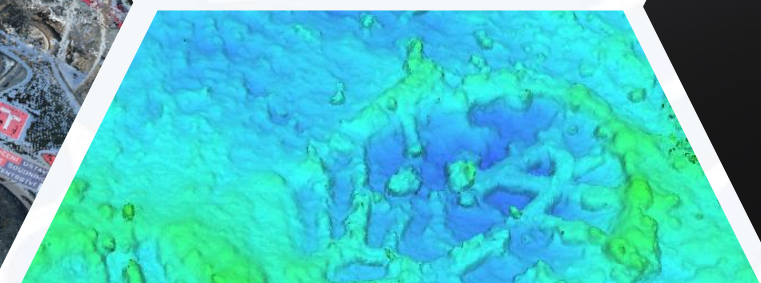
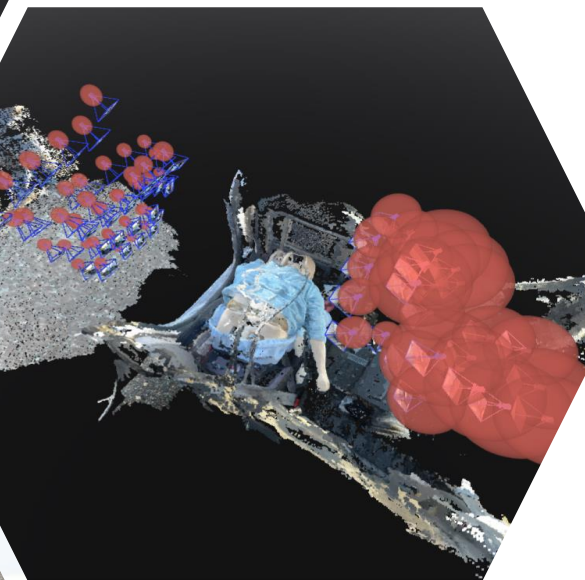
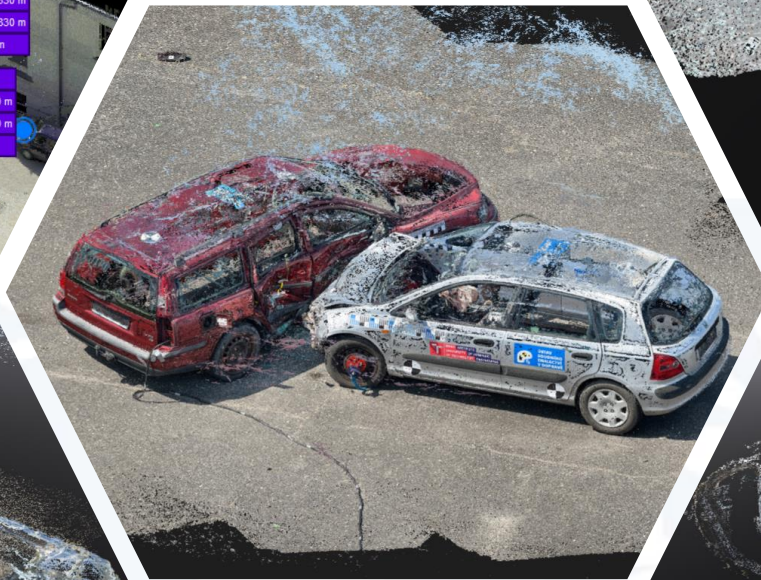
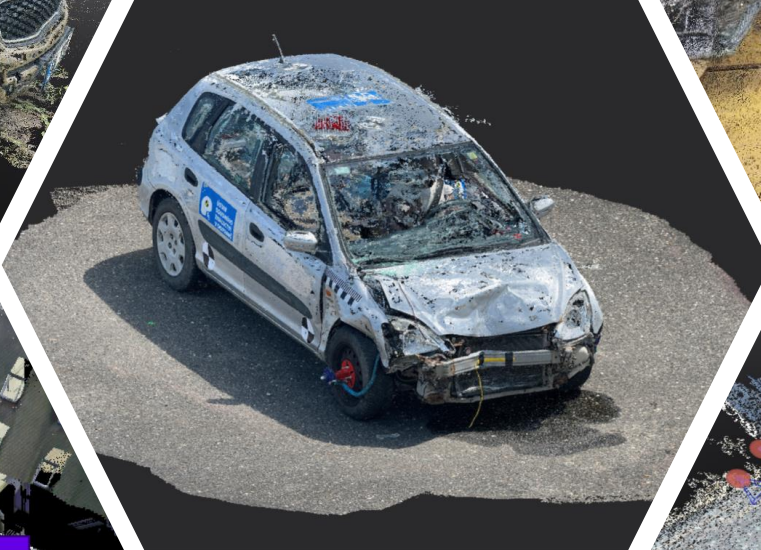
- Sdružený senzor (iPhone 14 a 15 Pro)
 - ToF senzor (256x192 px) + confidence map (0,1,2)
 - Fotoaparát (3024x4032 px)
- GNSS přijímač - viDoc
- Pix4Dmatic / Pix4DSurvey
 - v 1.47-1.51-1.68

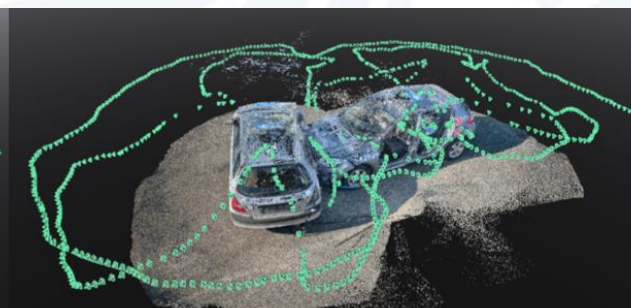
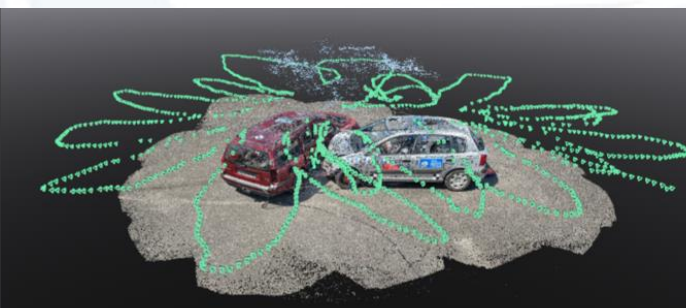
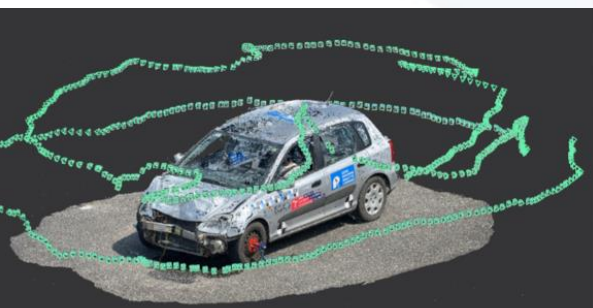
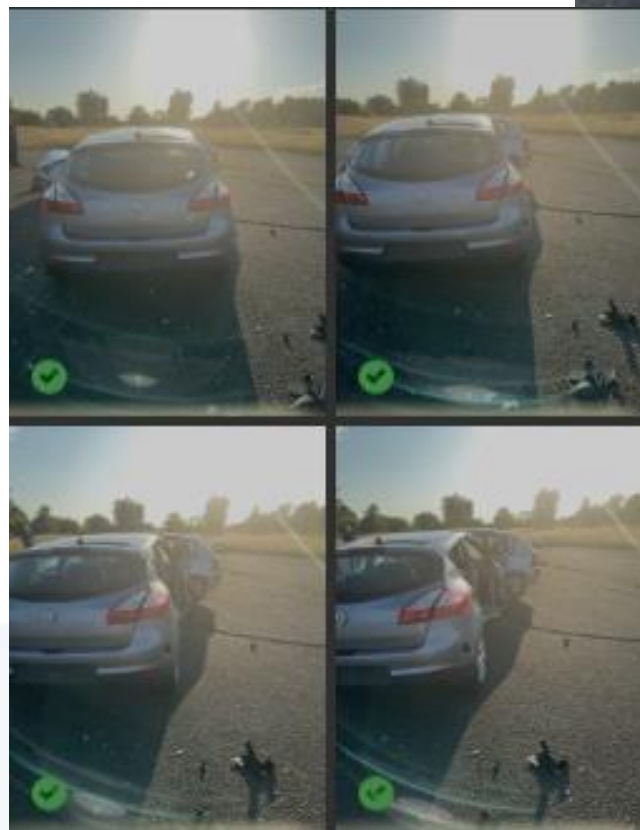


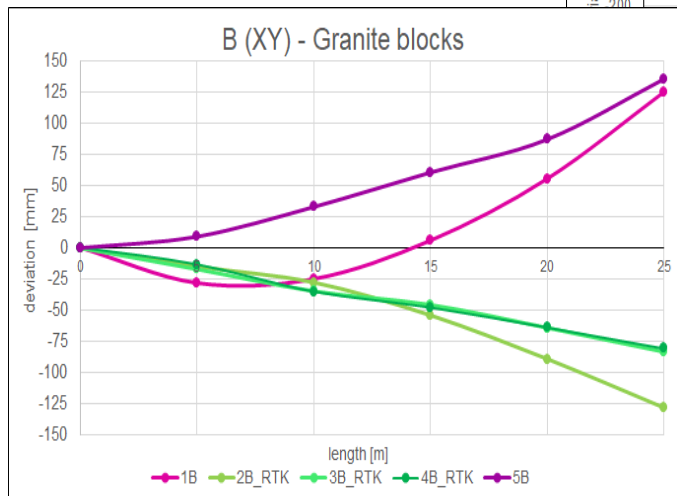
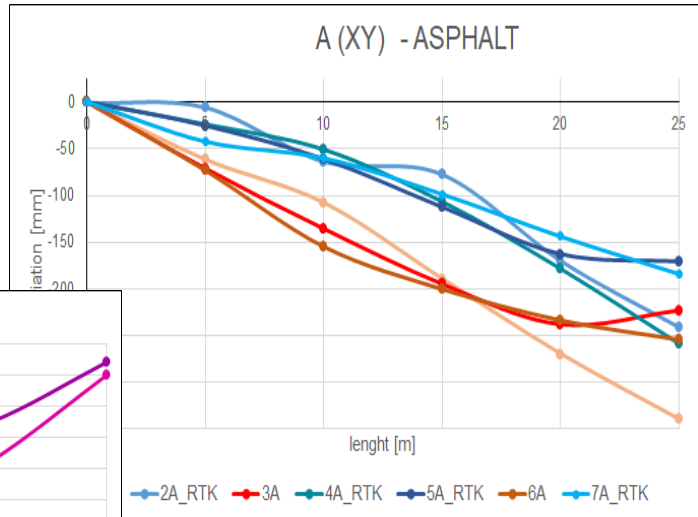
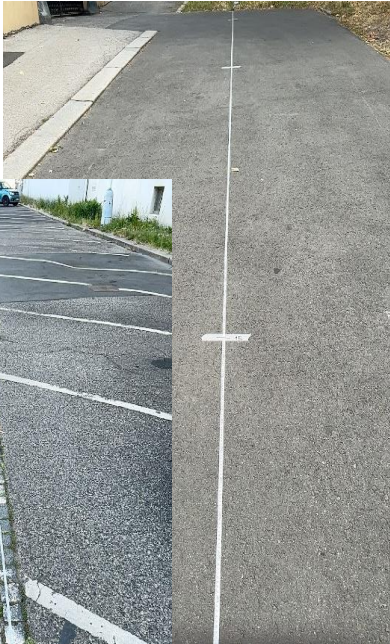
Řešené úlohy

- Dokumentace místa dopravní nehody
- Dokumentace poškození vozidel
- Dokumentace interiéru vozidla









XY Plane

ID	METHOD	RTK	SURFACE	Sections [m]					
				Cummulative error [mm] (XY plane)					
				0	5	10	15	20	25
1A	Device Pose - 1 m	NO	asphalt	0	-62	-108	-189	-270	-340
2A_RTK	Device Pose - 1 m	YES	asphalt	0	-5	-63	-77	-170	-242
3A	Device Pose - 10 cm	NO	asphalt	0	-71	-136	-195	-238	-223
4A_RTK	Device Pose - 10 cm	YES	asphalt	0	-24	-51	-107	-179	-259
5A_RTK	Overlap	YES	asphalt	0	-25	-61	-113	-163	-171
6A	Overlap	NO	asphalt	0	-73	-155	-201	-234	-255
7A_RTK	Overlap	YES	asphalt	0	-42	-60	-98	-144	-184
1B	Device pose	NO	granite	0	-28	-25	6	55	125
2B_RTK	Device pose	YES	granite	0	-15	-28	-54	-89	-128
3B_RTK	Overlap	YES	granite	0	-17	-35	-46	-64	-84
4B_RTK	Overlap	YES	granite	0	-13	-35	-48	-63	-80
5B	Overlap	NO	granite	0	9	33	61	87	135



<

ZS

Point Management

6 Collections

sypka

12

S-JTSK / Krovak East North + Baltic 1977 height - EPSG:...

test3

4

ETRS89 / UTM zone 33N (N-E) + Baltic 1957 height - EP...

park1

12

S-JTSK / Krovak East North + Baltic 1977 height - EPSG:...

< Back

ZS

sypka

12 Points

sypka_global_45

RTK

0,010m

↑v 0,010m

Easting [m]

-746 832,649

Orthometric height [m]

140,051

Northing [m]

-964 815,496

29. 5. 2024 at 10:43

15 seconds

< Back

ZS

RTK

21

RTK FIXED

0,010m

0,010m

HDOP 0,760

VDOP 1,040

14

Acquiring Geolocation...

Please keep your device steady

Cancel

RTK

25

RTK FIXED

0,012m

0,012m

HDOP 0,720

VDOP 1,000

Tag Detection (2/2)

positionCheck_global_1

posi...l_1

positionCheck_global_25

posi..._25

28



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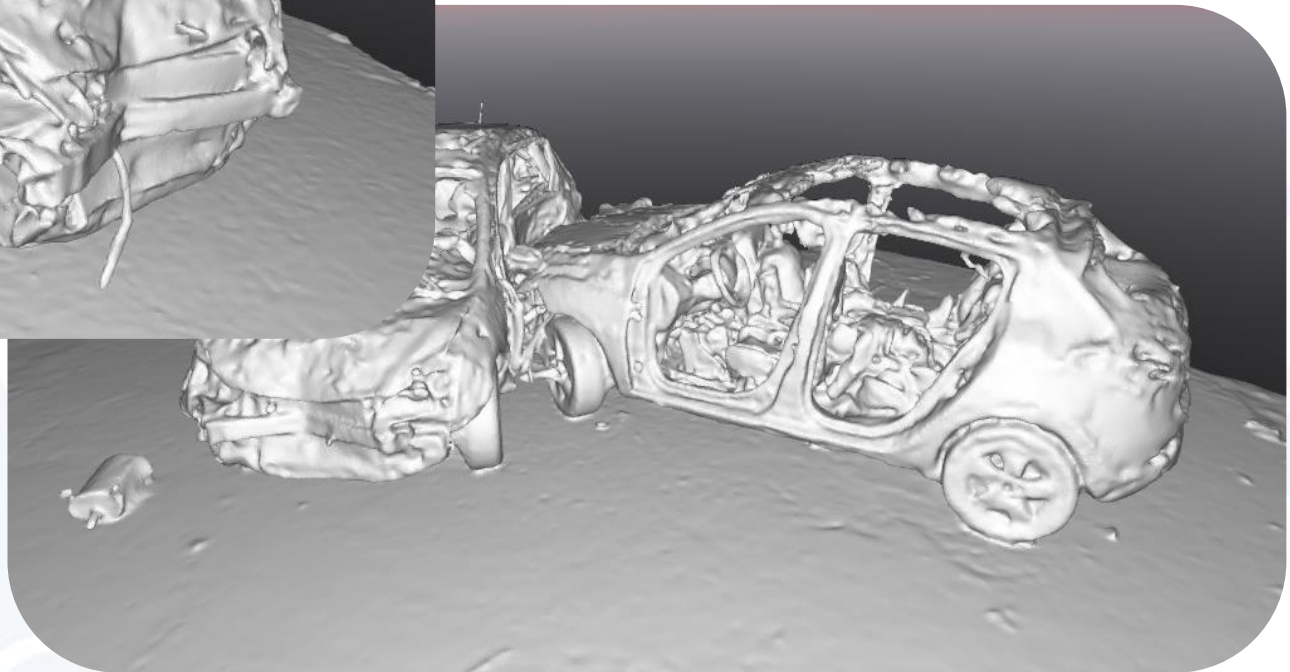
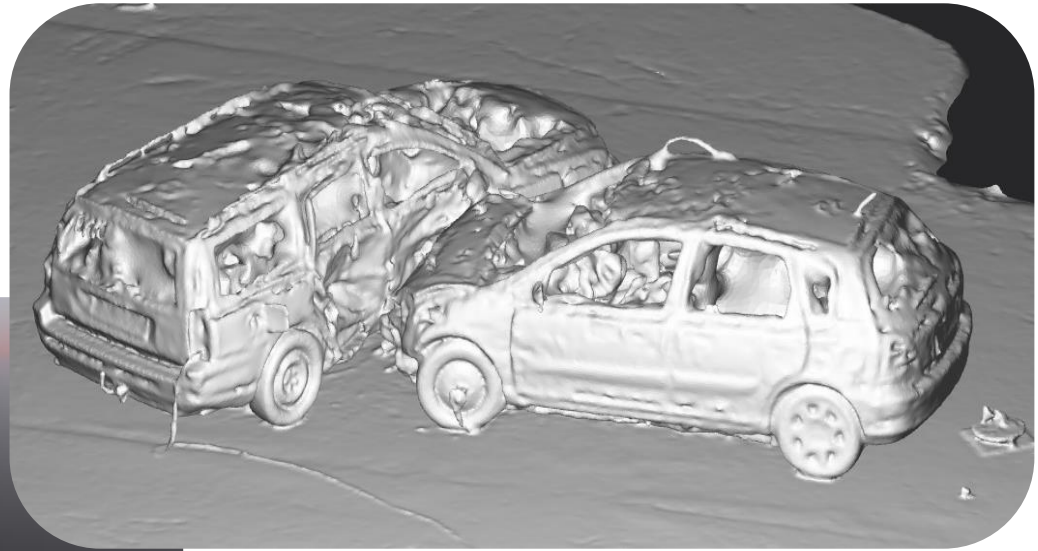
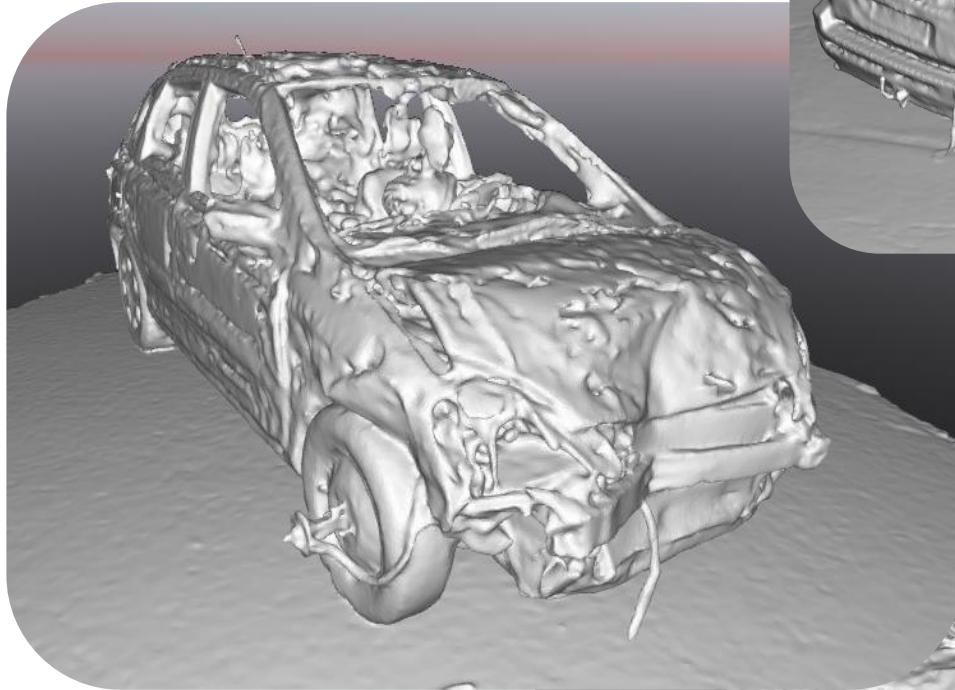
Vlícovací body

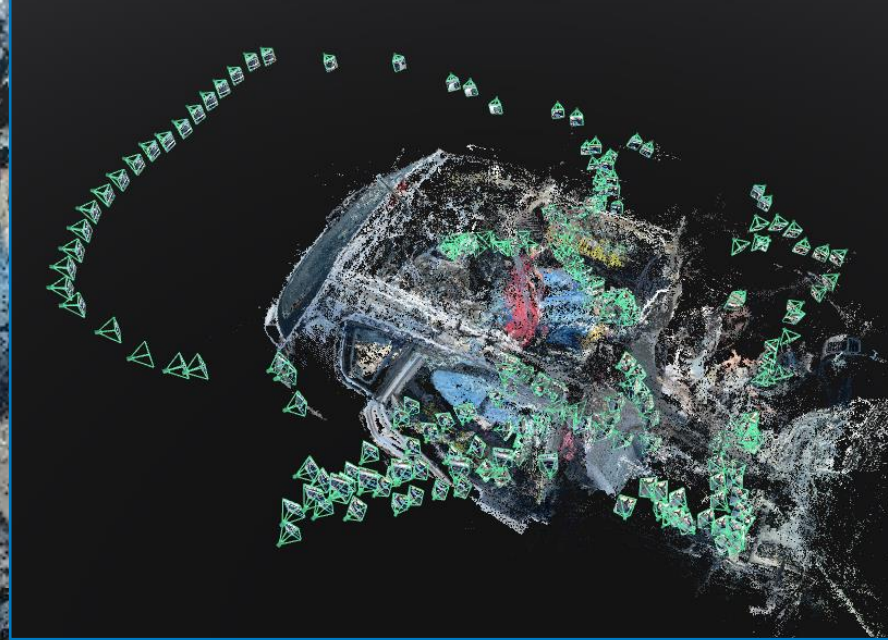
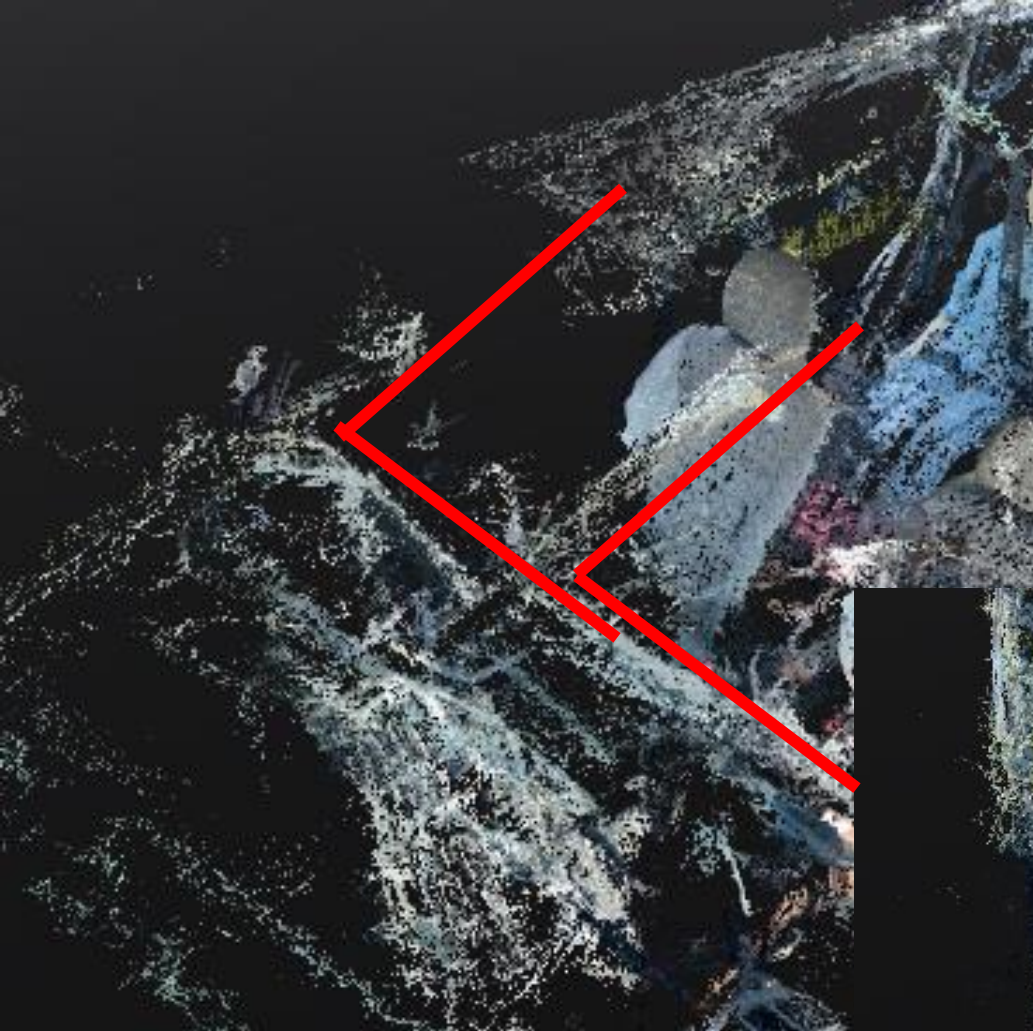
- Leica GS18
 - 2000 bodů
 - 100 měření (10x)
- viDoc
 - 5 s (10 měření)
 - 10 s (10 měření)
 - 15 s (10 měření)
- Souřadnicové systémy
 - S-JTSK + Bpv
 - ETRS89
 - ČÚZK transformace
(ETRS89 -> S-JTSK)

Leica	ETRS			S-JTSK		
	Longitude	Latitude	Height	Y	X	Z
GPS0001	-0.005	0.005	-0.001	-0.002	0.008	-0.001
GPS0002	-0.006	0.006	-0.007	-0.003	0.010	-0.007
GPS0003	-0.004	0.006	-0.004	-0.004	0.006	-0.004
GPS0004	-0.006	-0.003	0.000	0.003	0.009	0.000
GPS0005	-0.005	0.001	-0.005	0.000	0.008	-0.005
GPS0006	-0.004	0.005	-0.003	-0.003	0.006	-0.003
GPS0007	-0.005	0.001	-0.008	0.001	0.007	-0.008
GPS0008	-0.005	0.005	-0.008	-0.002	0.008	-0.008
GPS0009	-0.006	-0.007	-0.004	0.006	0.009	-0.003
GPS0010	-0.002	0.002	-0.002	-0.001	0.003	-0.002

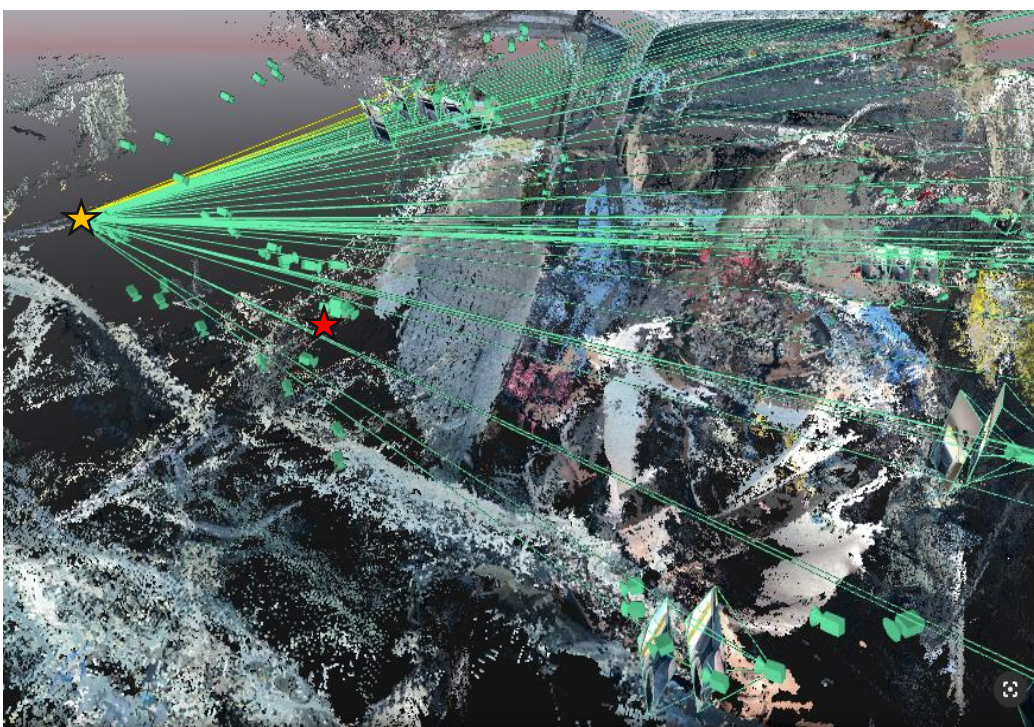
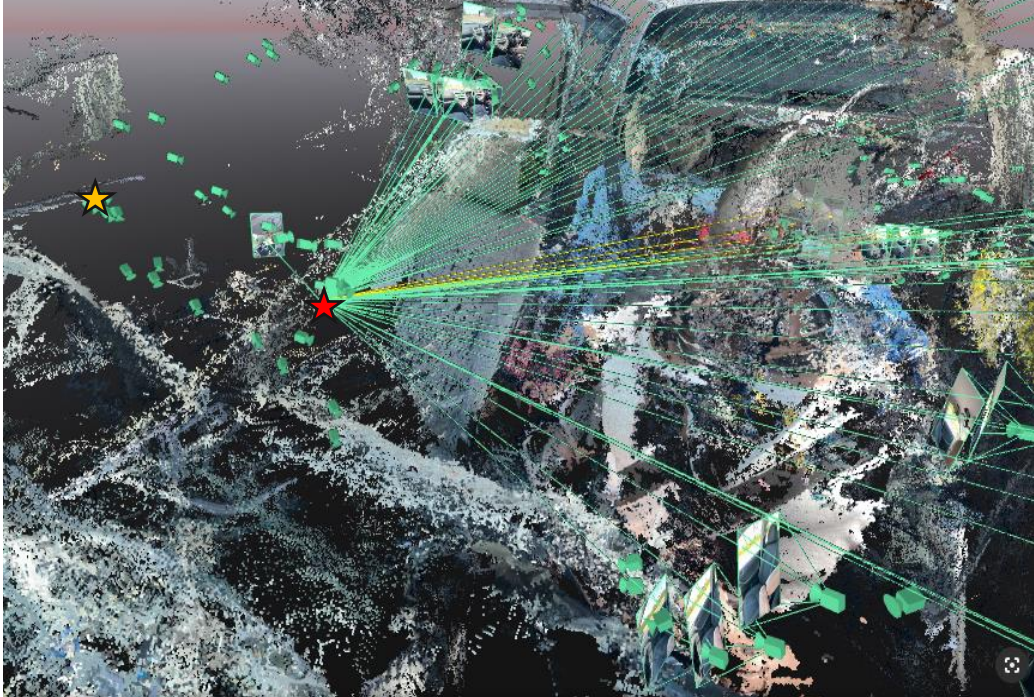
viDoc	ETRS			S-JTSK			S-JTSK (ČÚZK)		
	Longitude	Latitude	Height	Y	X	Z	Y	X	Z
5s_01	0.009	-0.095	-0.010	0.156	-0.123	0.292	0.059	-0.022	-0.010
5s_02	-0.004	-0.084	-0.020	0.148	-0.114	0.287	0.054	-0.001	-0.020
5s_03	0.020	-0.037	0.003	0.172	-0.101	0.287	0.019	-0.035	0.003
5s_04	0.030	-0.045	0.000	0.146	-0.104	0.292	0.022	-0.051	0.000
5s_05	0.017	-0.042	-0.006	0.147	-0.113	0.288	0.023	-0.029	-0.006
5s_06	0.013	-0.025	-0.001	0.141	-0.096	0.296	0.013	-0.022	-0.001
5s_07	0.021	-0.061	0.032	0.151	-0.094	0.302	0.035	-0.039	0.033
5s_08	0.028	-0.068	0.024	0.135	-0.088	0.299	0.037	-0.049	0.024
5s_09	0.019	-0.054	0.016	0.097	-0.067	0.303	0.030	-0.034	0.016
5s_10	-0.015	-0.049	-0.010	0.153	-0.093	0.311	0.034	0.020	-0.010
15s_01	-0.002	-0.046	-0.020	0.132	-0.095	0.307	0.030	0.000	-0.020
15s_02	-0.005	-0.012	-0.018	0.155	-0.105	0.303	0.008	0.007	-0.018
15s_03	0.010	0.009	-0.027	0.158	-0.111	0.306	-0.008	-0.015	-0.027
15s_04	0.002	0.013	-0.027	0.155	-0.103	0.318	-0.009	-0.003	-0.026
15s_05	-0.003	0.019	-0.030	0.152	-0.100	0.311	-0.011	0.006	-0.030
15s_06	-0.021	0.069	-0.035	0.142	-0.093	0.317	-0.039	0.039	-0.035
15s_07	-0.015	0.044	-0.036	0.118	-0.067	0.333	-0.025	0.028	-0.036
15s_08	-0.016	0.023	-0.037	0.144	-0.076	0.335	-0.011	0.027	-0.037
15s_09	-0.013	0.062	-0.034	0.146	-0.075	0.334	-0.037	0.026	-0.034
15s_10	-0.014	0.065	-0.035	0.157	-0.068	0.352	-0.039	0.027	-0.035
30s_01	-0.009	0.053	-0.036	0.151	-0.071	0.352	-0.032	0.019	-0.036
30s_02	-0.010	0.070	-0.032	0.150	-0.067	0.385	-0.043	0.021	-0.032
30s_03	-0.006	0.056	-0.032	0.137	-0.051	0.367	-0.034	0.013	-0.032
30s_04	-0.007	0.049	-0.026	0.131	-0.033	0.374	-0.029	0.016	-0.026
30s_05	0.005	0.010	-0.035	0.139	-0.046	0.372	-0.008	-0.006	-0.034
30s_06	0.005	0.036	-0.029	0.119	-0.038	0.388	-0.024	-0.005	-0.028
30s_07	0.005	0.019	-0.028	0.121	-0.037	0.392	-0.014	-0.006	-0.028
30s_08	0.004	0.026	-0.027	0.147	-0.045	0.398	-0.018	-0.004	-0.026
30s_09	0.002	0.009	-0.029	0.106	-0.028	0.405	-0.007	-0.002	-0.028
30s_10	-0.010	0.046	-0.033	0.093	-0.021	0.425	-0.027	0.019	-0.033
5s aggregated	0.018	0.056	0.012	0.145	0.099	0.296	0.033	0.030	0.012
15s aggregated	0.010	0.036	0.030	0.146	0.089	0.321	0.022	0.018	0.030
30s aggregated	0.006	0.037	0.031	0.129	0.044	0.386	0.024	0.011	0.030

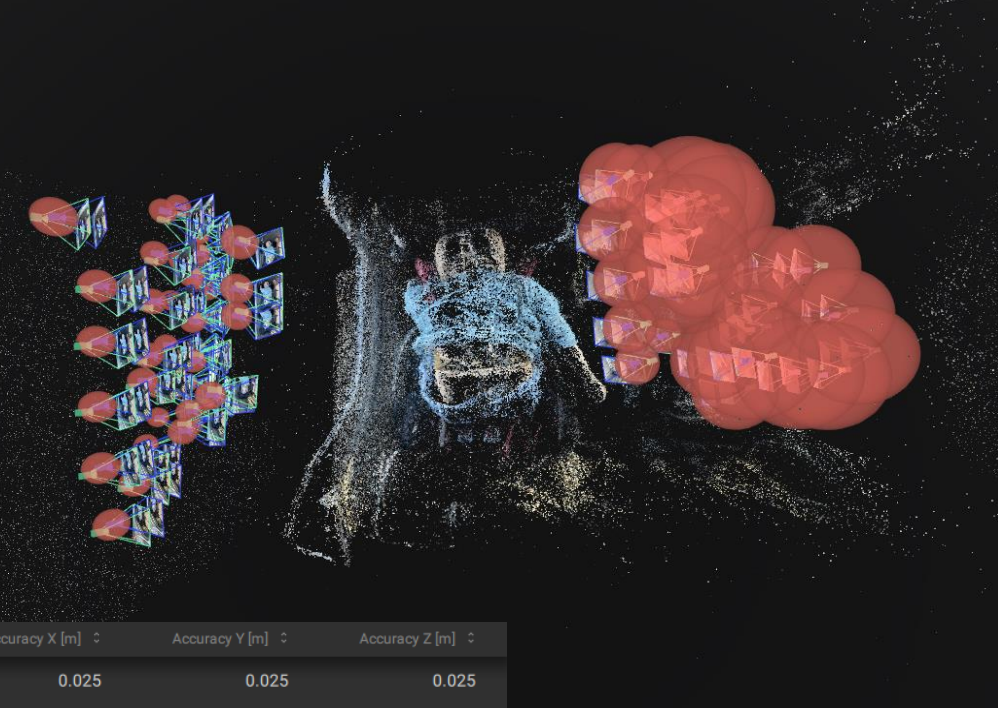
Mesh modely



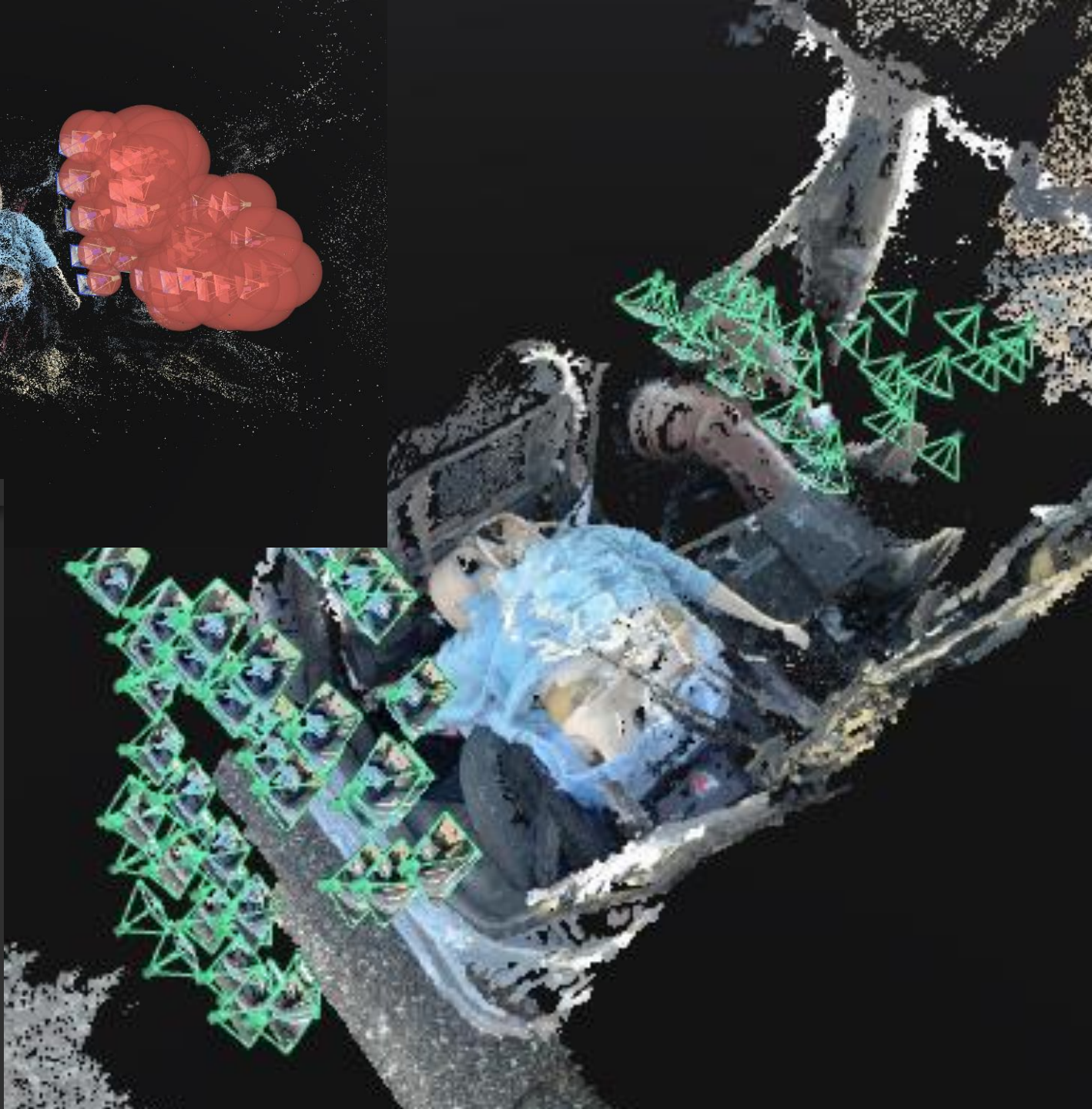


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Accuracy X [m]	Accuracy Y [m]	Accuracy Z [m]
0.025	0.025	0.025
0.026	0.026	0.026
0.027	0.027	0.027
0.031	0.031	0.031
0.040	0.040	0.040
0.047	0.047	0.047
0.053	0.053	0.053
0.059	0.059	0.059
0.064	0.064	0.064
0.069	0.069	0.069
0.073	0.073	0.073
0.077	0.077	0.077
0.081	0.081	0.081
0.085	0.085	0.085
0.089	0.089	0.089
0.092	0.092	0.092
0.095	0.095	0.095
0.099	0.099	0.099
0.102	0.102	0.102
0.105	0.105	0.105





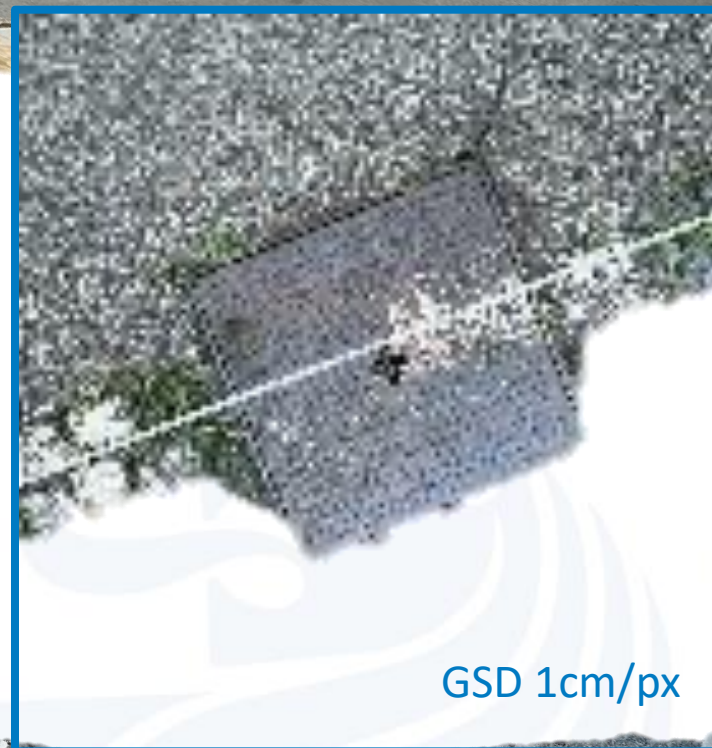
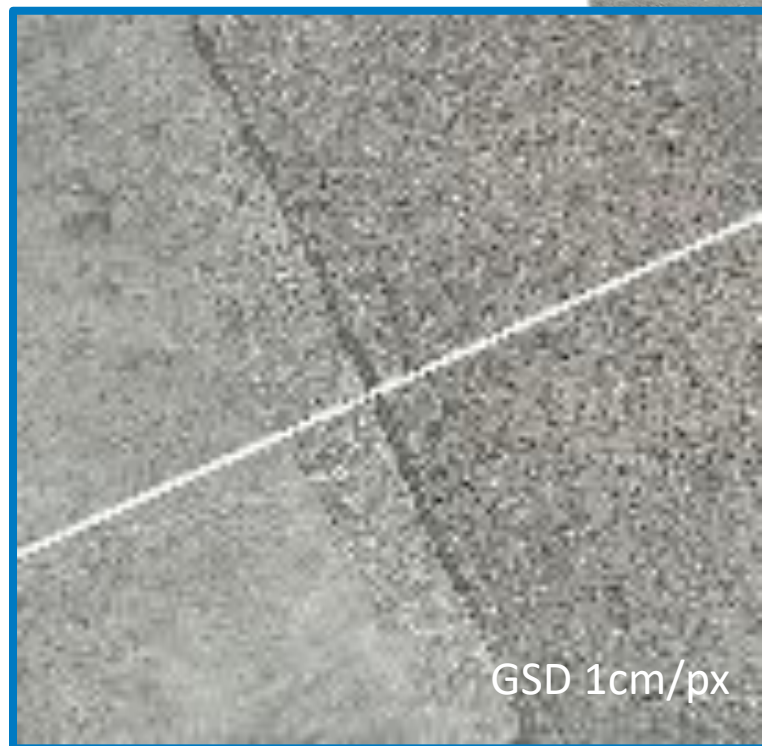
v1.47 vs v1.51

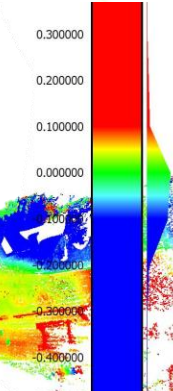
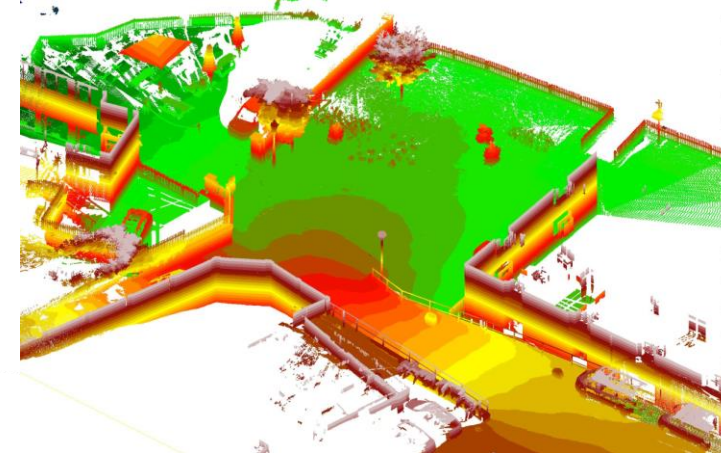
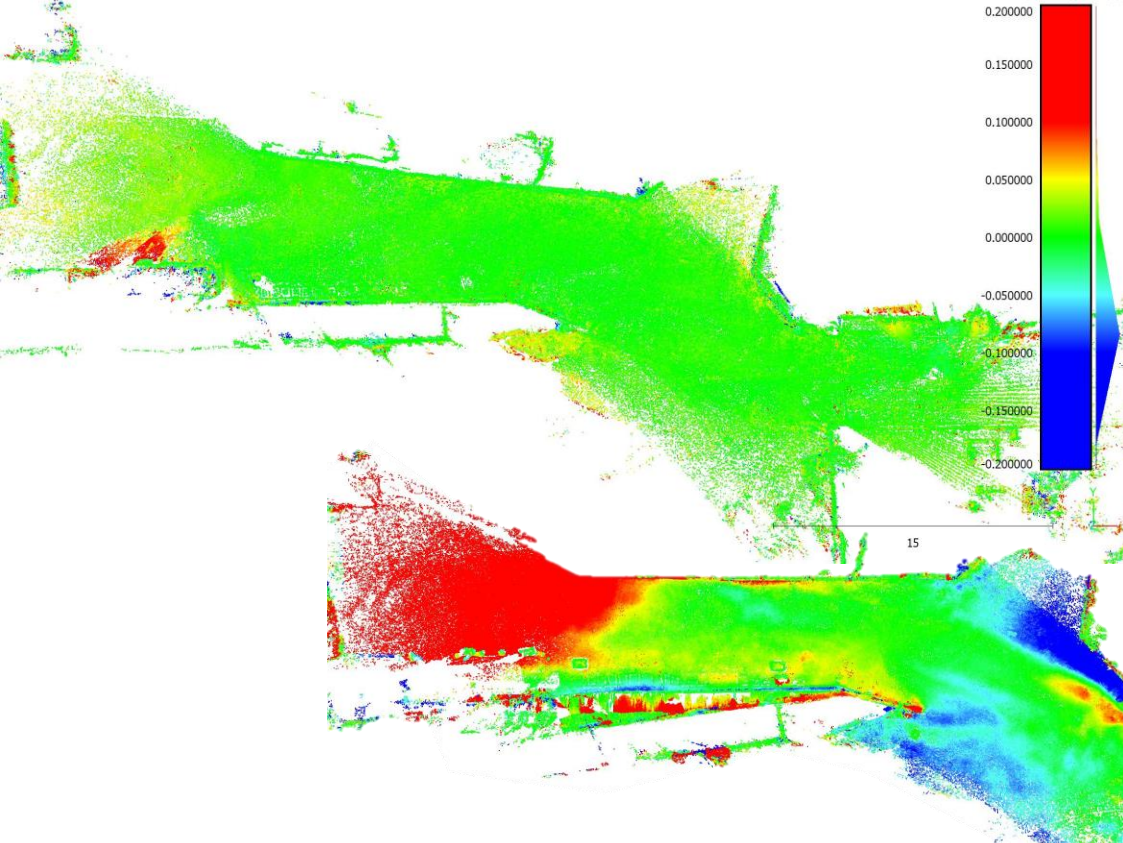


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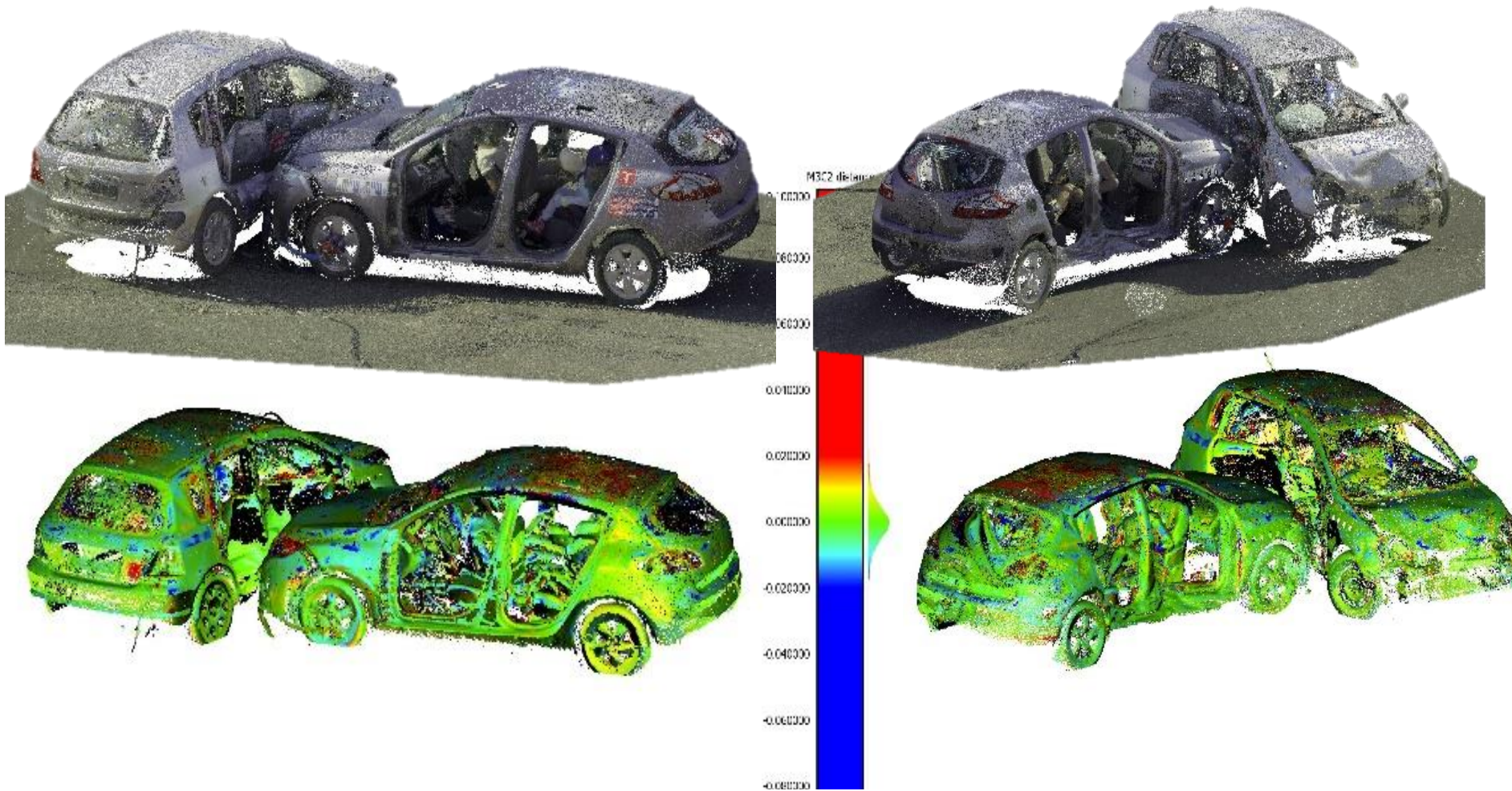
GSD 1cm/px





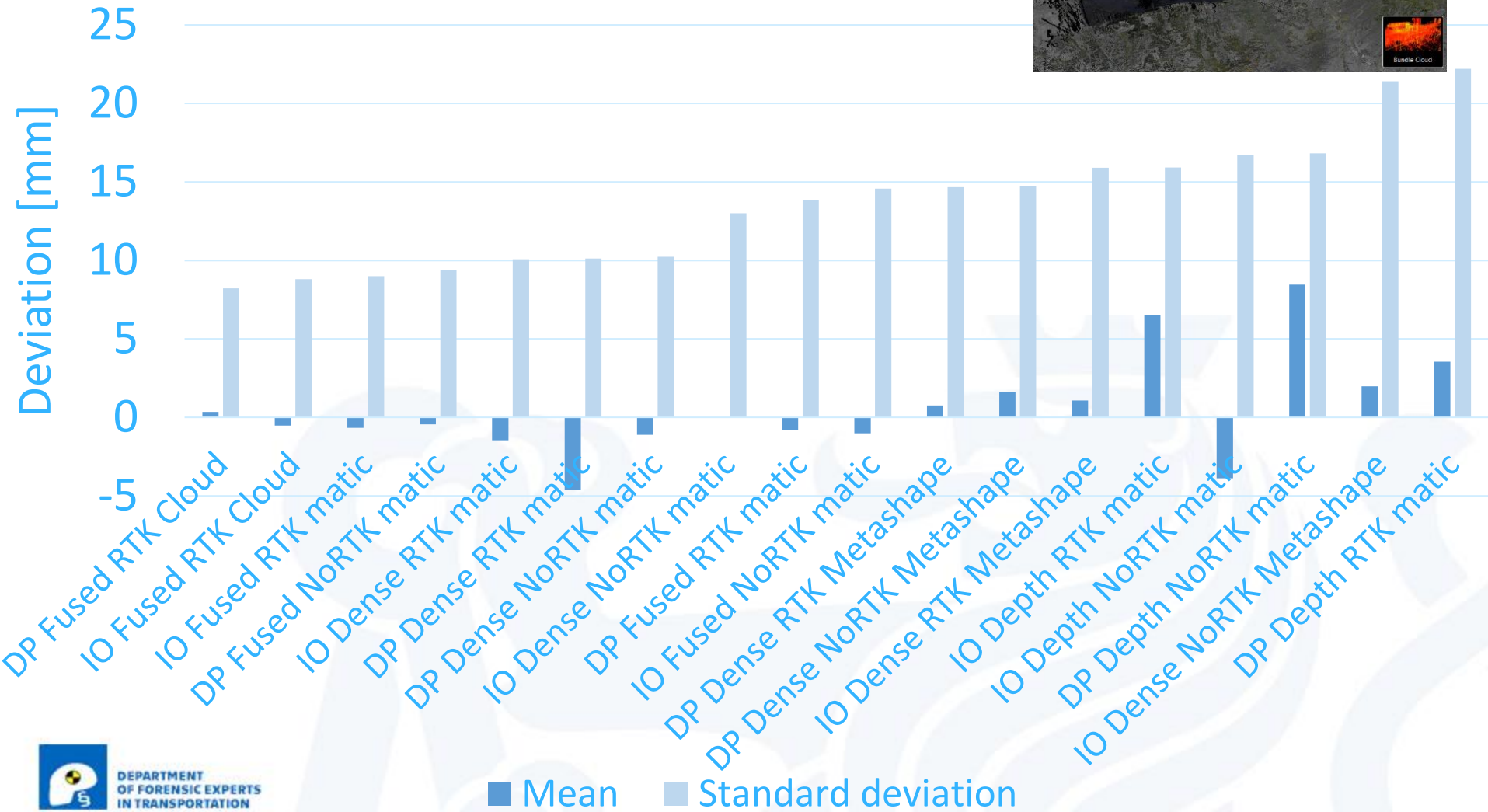
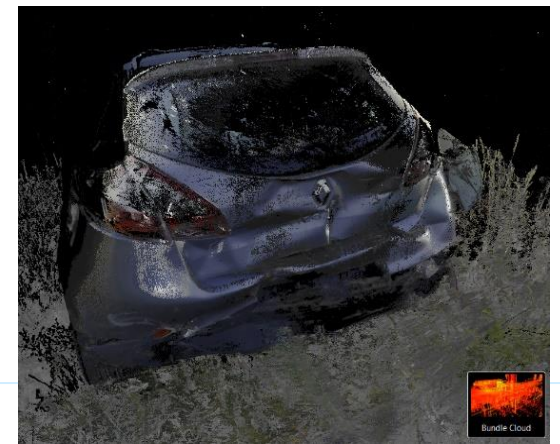
	No alignment - diffA						Fine alignment - diffB					
	XYZ deviation			Z deviation [mm]			XYZ deviation			Z deviation [mm]		
	RMS [mm]	Percentage of points within distance of		Mean	Sigma	RMS	RMS [mm]	Percentage of points within		Mean	Sigma	RMS
		10 mm	100 mm					10 mm	100 mm			
Test01gnss	39	46.06%	98.39%	11	20	23	37	75.16%	98.43%	1	23	23
Test01vidoc	* height difference of 788 mm						45	75.16%	98.43%	1	27	27
Test01vidoc_Zadj	62	6.75%	93.38%	33	28	44	** not used					
Test01noGCP	*** ETRS89 / UTM zone 33N - EPSG:25833						365	16.50%	81.21%	19	140	141
Test02gnss	41	66.91%	98.66%	6	24	25	40	70.27%	98.76%	2	24	24
Test02vidoc	* height difference of 788 mm						48	52.46%	94.47%	3	26	27
Test02vidoc_Zadj	68	8.96%	89.25%	41	35	54	** not used					
Test02noGCP	*** ETRS89 / UTM zone 33N - EPSG:25833						324	25.22%	83.12%	32	158	162

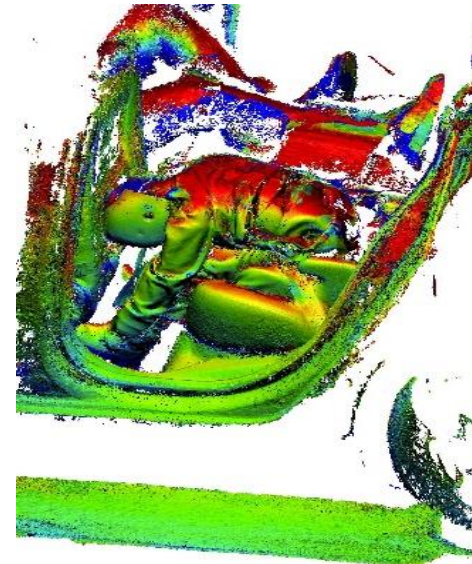




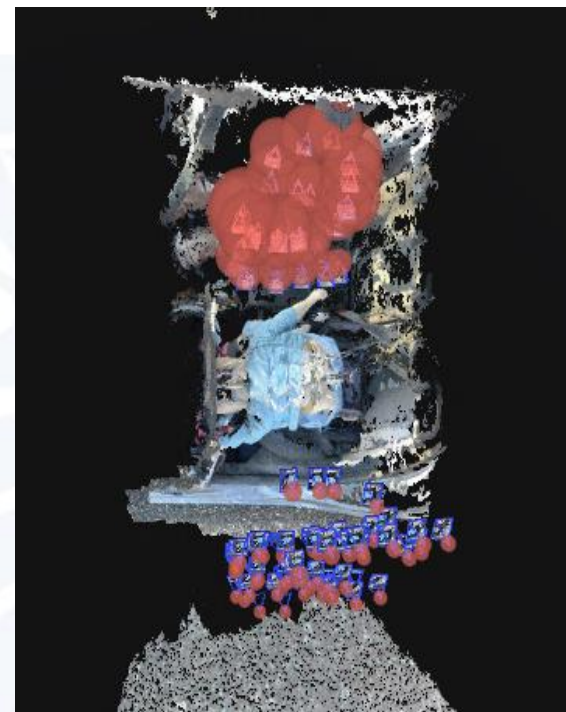
Source	Vehicle (XYZ) deviations			Surface (Z) deviations [mm]		
	RMS [mm]	Percentage of points within range of		Mean	Sigma	RMS
		(-20;20) mm	(-10;10) mm			
Depth	100	68.45%	65.25%	3	8	8
Dense	75	78.59%	62.92%	1	5	5
Fused	59	84.21%	74.89%	1	5	5

Deformace části vozu





	Numebr of points	Deviations (XYZ) [mm]		
		Mean	Sigma	RMS
Pix4Dmatic	2.2 mil	0	15	15
Metashape_RTK	3.0 mil	0	15	15
Metashape_noRTK	3.0 mil	1	27	27



Závěr

- Platí podobné zásady jako v případě digitální obrazové korelace
- Odolnost na zkušenosti a schopnosti osoby provádějící měření
- Odolnost vůči zhoršeným světelným podmínkám
- GNSS přijímač je výhodou, ale není všespásný
- Podrobná hustá bodová mračna – s vysokou mírou šumu
- Vysoká dosahovaná přesnost v případě dokumentace izolovaných objektů
- Vhodná kombinace zdrojů dat – kompenzace vzájemných limitů
- Pro oblasti většího rozsahu – nutno implementovat vlíčovací body



Děkuji za pozornost

