Modeling of the “Plan da Mattun” Archaeological Site

using a combination of different sensors

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Situation

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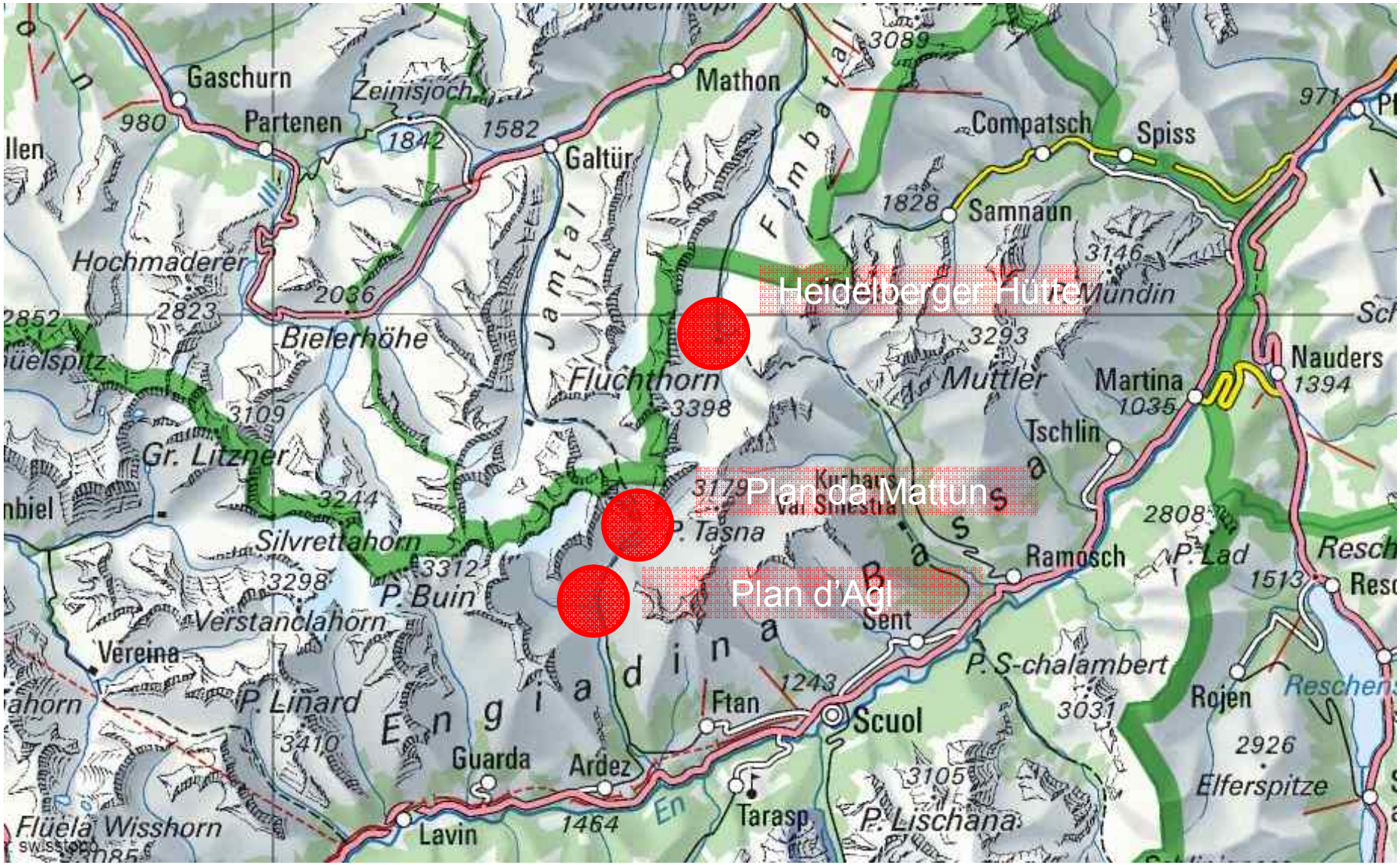
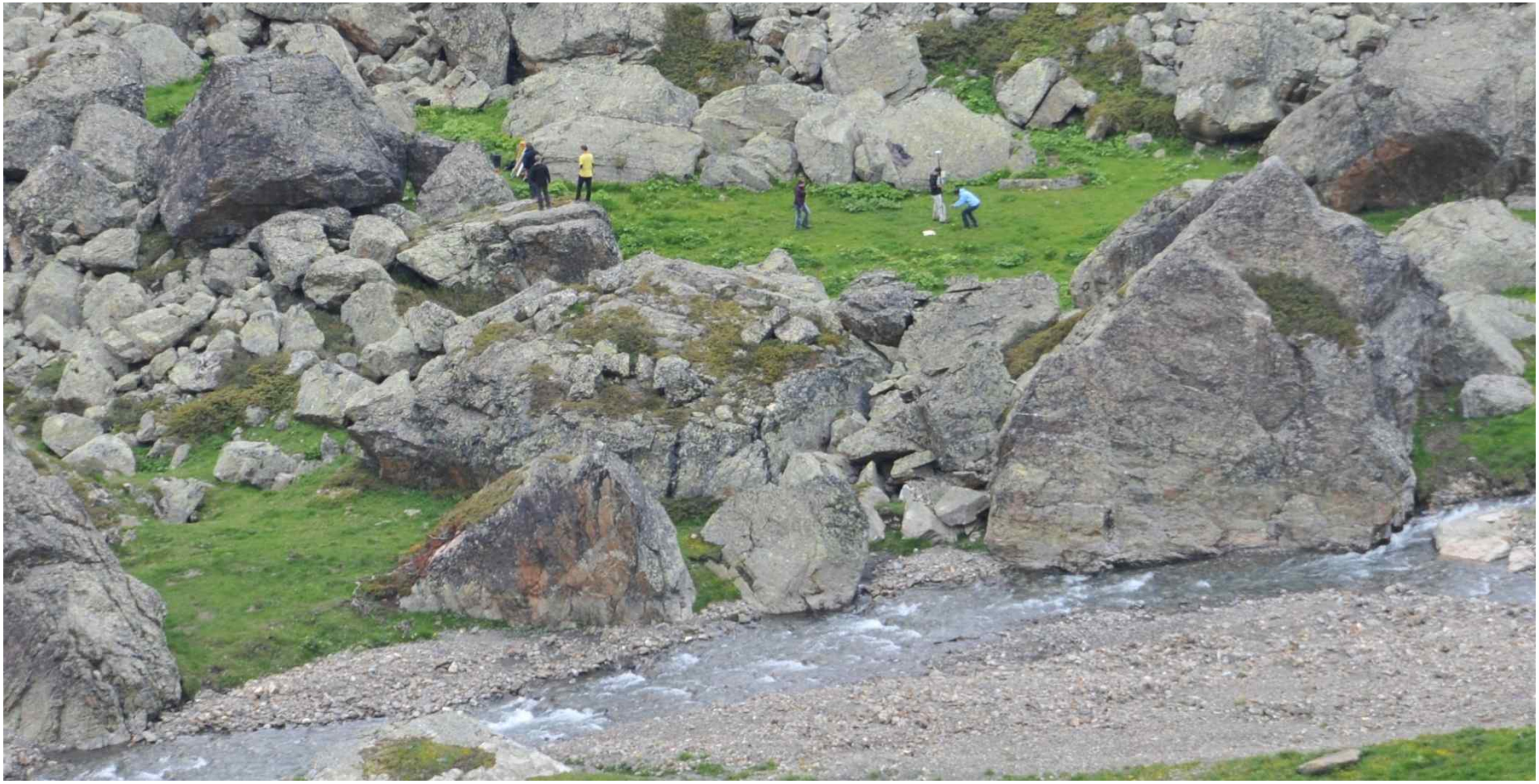
Situation



Archeological Site Plan da Mattun

- finds derive from early alpine dwellers (time of Ötzi)
- overhanging boulders where used as shelter



Plan da Mattun

Plan da Mattun

Archaeological Site Plan da Mattun

- The archaeological site “Plan da Mattun” belongs to the project «*Silvretta historica»* and is part of the *„Alpine Archäologie in der Silvretta“*

- This is a project of the department of Pre- and Protohistory of the Institute of History, University Zurich under the leadership of Dr. Thomas Reitmaier

- Geodetic Project Course of the Institute of Geodesy and Photogrammetry, ETH Zurich
  - Participation of 19 students
  - Duration of 3 weeks

Surveying Work

Goal

Digital terrain model of

•rock stream (located at the end of the valley)

•four larger boulders (2 to 15 meters high)

Challenge

Rough terrain (400m x 200m) at 2400m a.s.l.

–Difficult to access certain areas

–Requires multiple measuring techniques to cover all the objects of interest

Solution

Rock stream

–Combination of laser scanning and unmanned aerial vehicle (UAV) photogrammetry.

Boulders

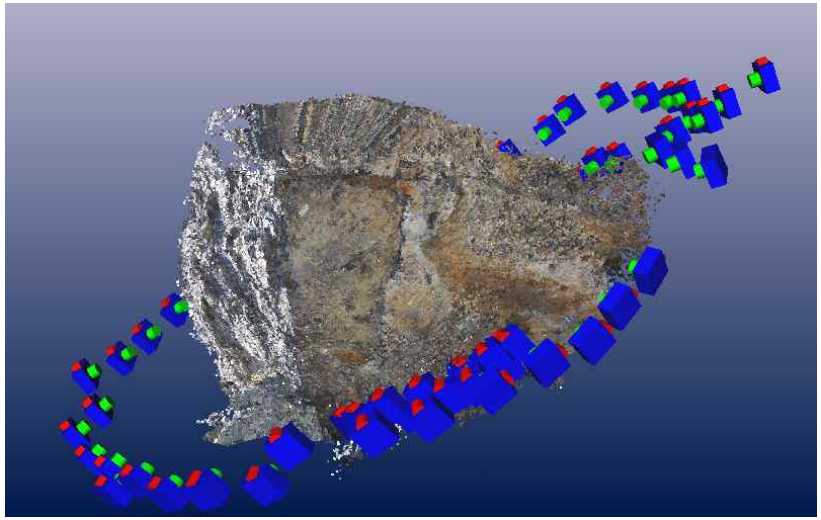
–Laser scanner, terrestrial and UAV photogrammetry.

Georeferencing

- Geodetic reference system within the Swiss coordinate system LV95
- Swipos service could not be used (lack of mobile phone reception)
- Reference points were measured by static GNSS and corrected with a virtual reference station (VRS) in advance. Points used for a GNSS reference station.
- Measure the ground control points for the photogrammetry in real time. (horizontal accuracy of 2 cm and 5 cm in height)
- The georeferencing of the scans was done by
  - Measuring the scanner position
  - Using several sphere targets with known coordinates

Measuring Equipement

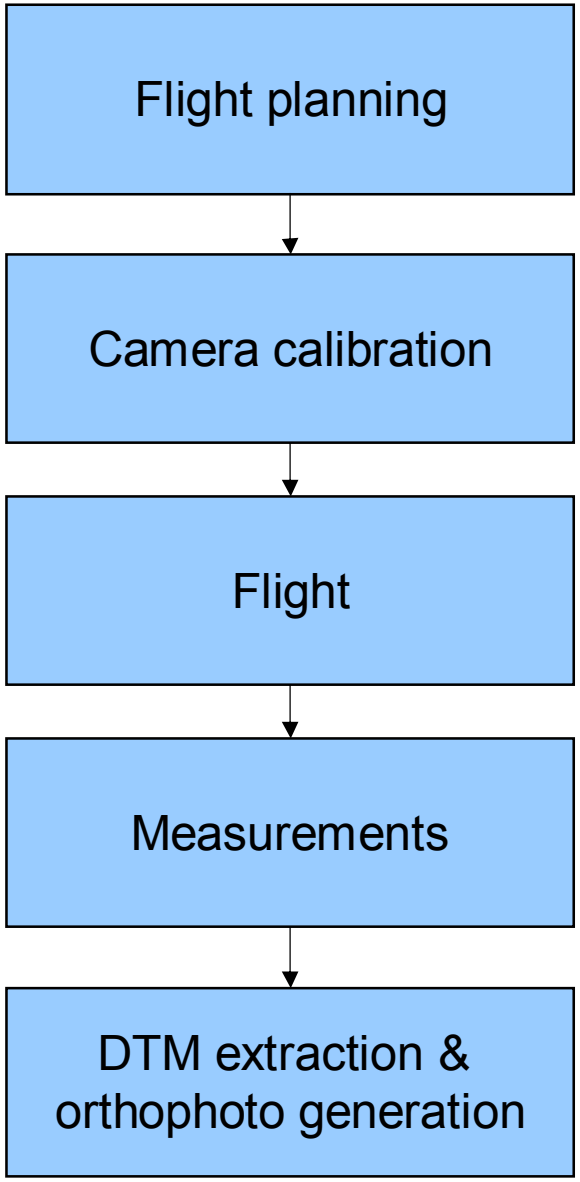
Data Processing



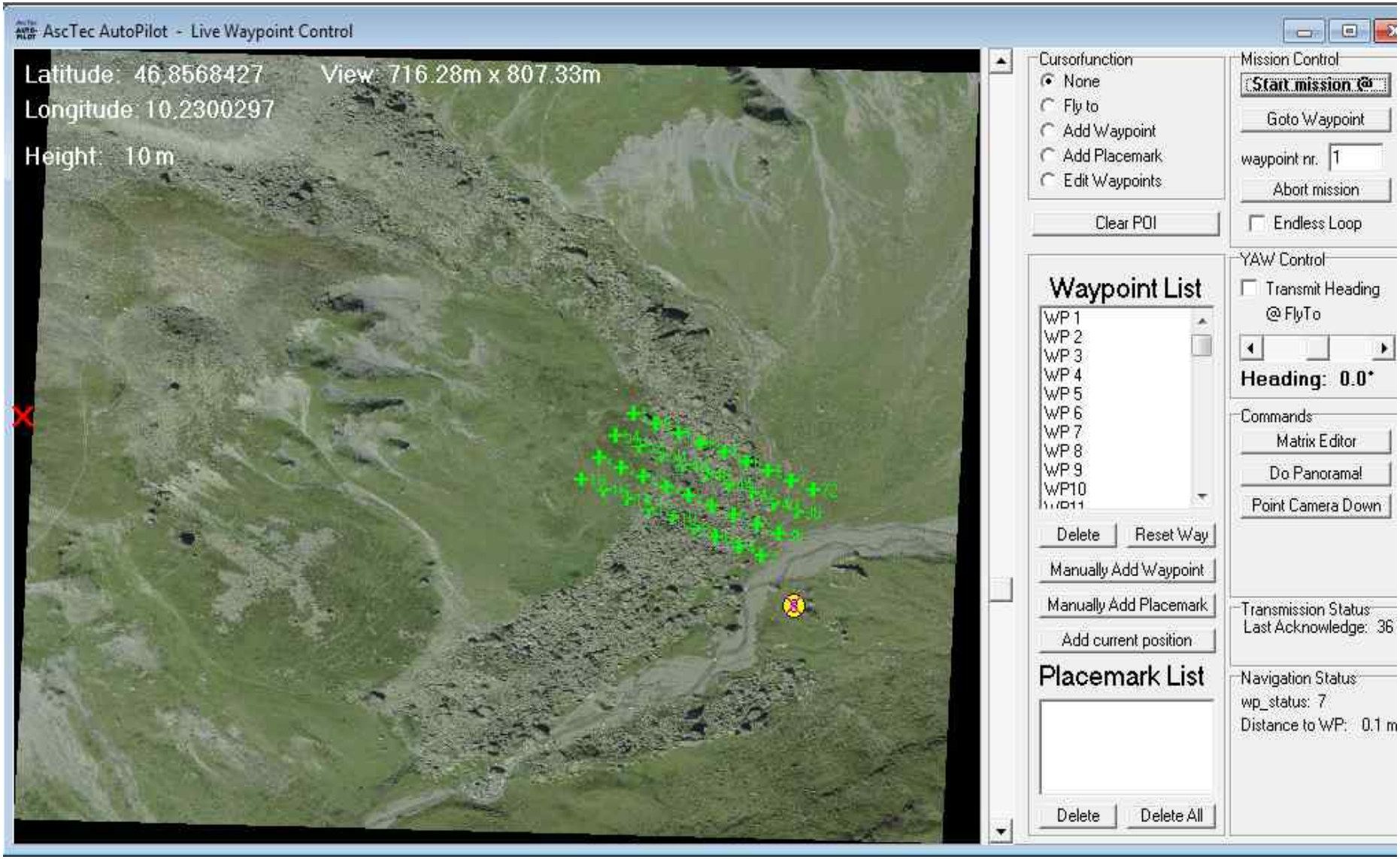
Data Processing

- Digital terrain model (DTM) created with UAV photogrammetry and with terrestrial laser scanner
- Boulders with close range photogrammetry and laser scanner
- Terrestrial laser scanner as base with a resolution of 10 cm
- UAV images with a resolution of 2 cm
- Combination to create a final DTM of 10 cm
- Combined in Geomagic

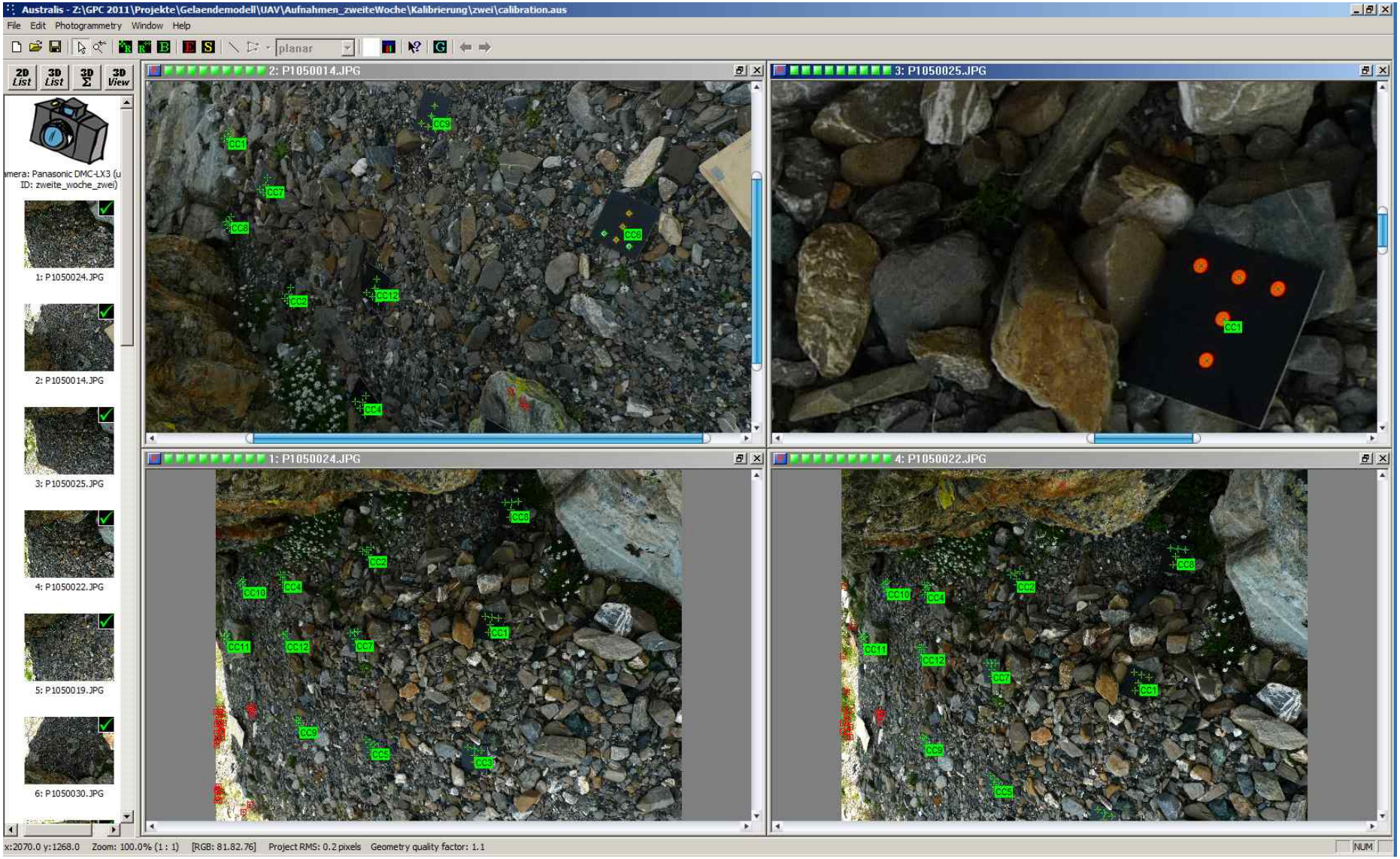
Processing Chain



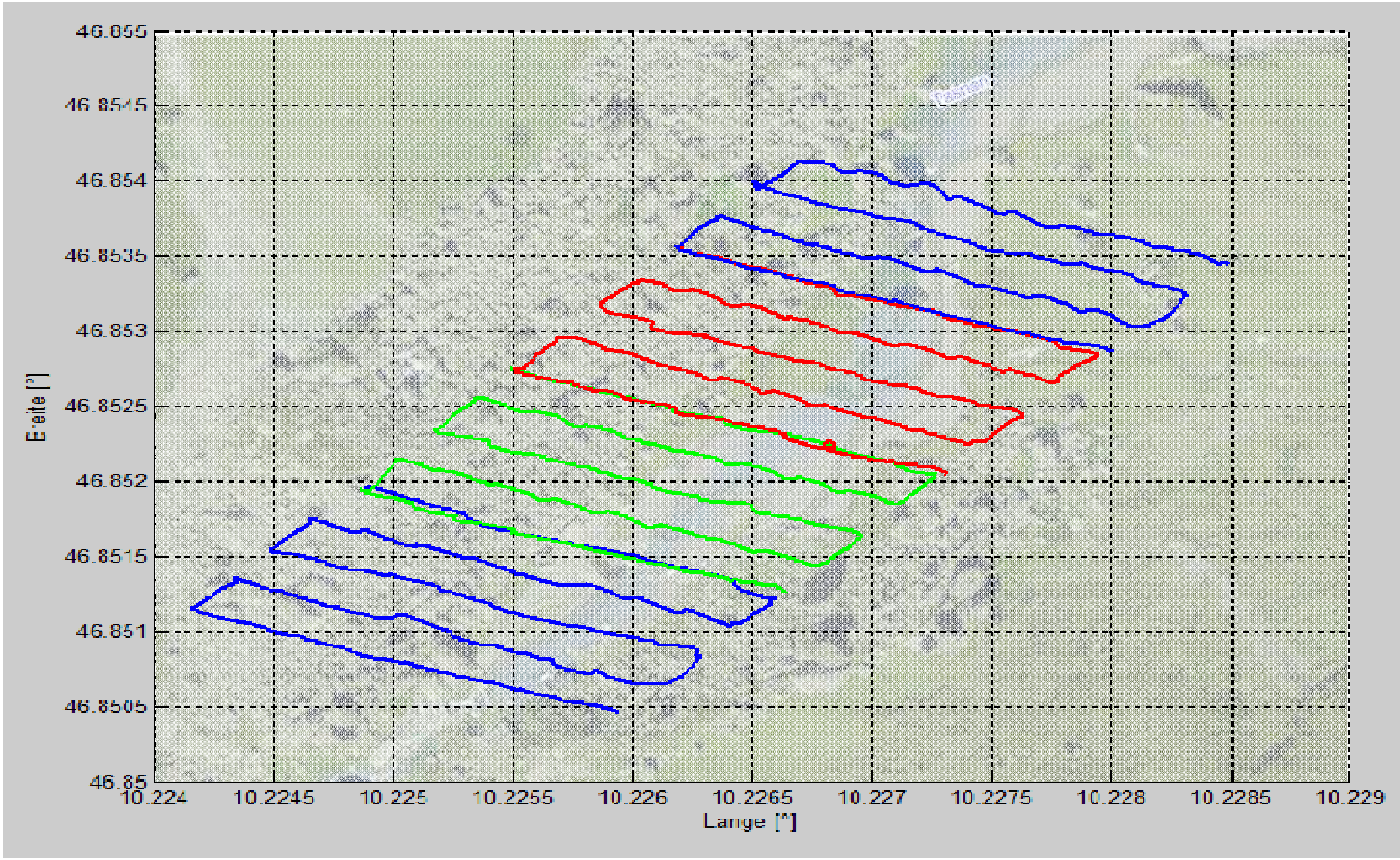
UAV-Flight Planning



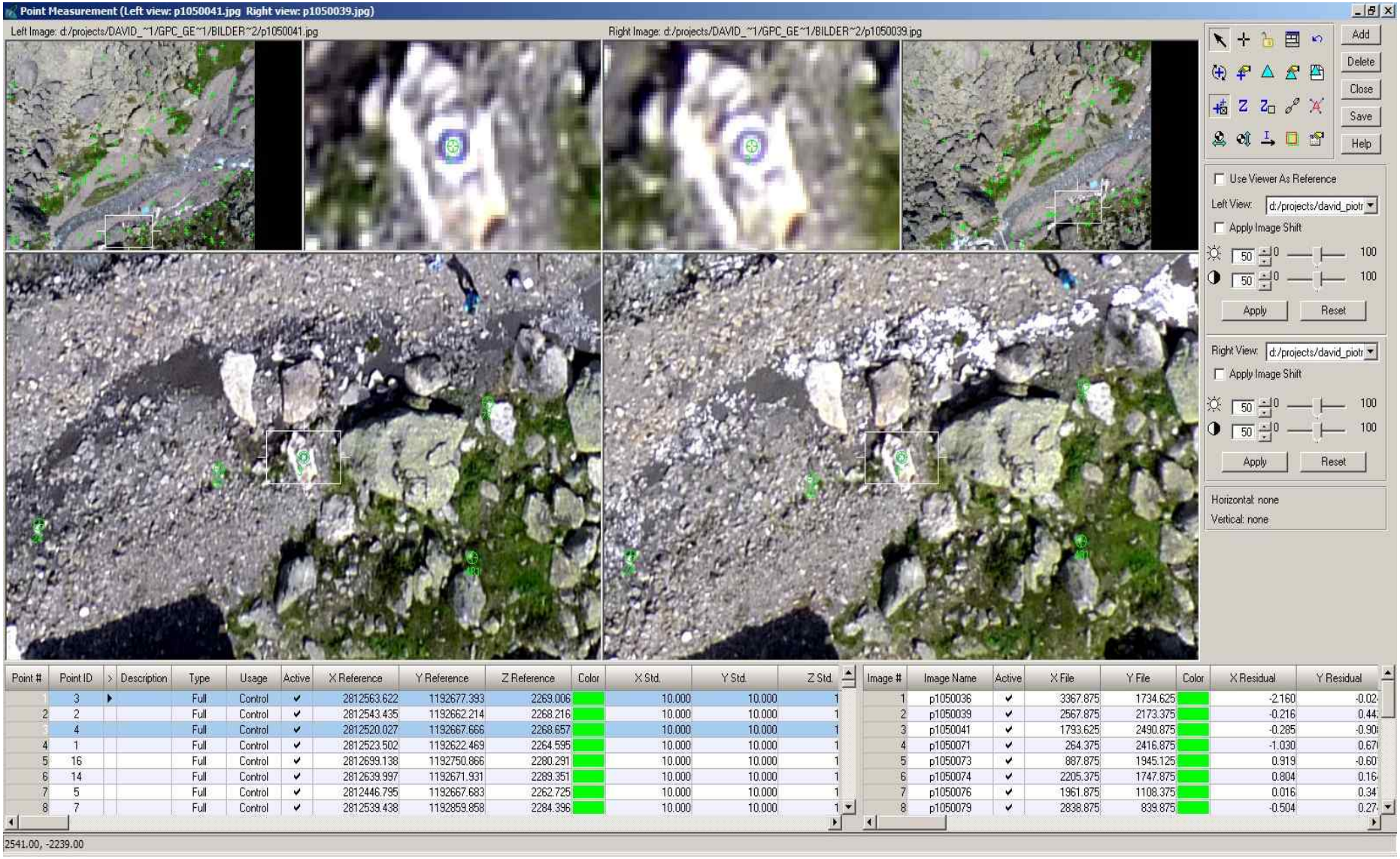
UAV-Camera Calibration



UAV-Flight



UAV-Ground Control Points Measurement



Point #	Point ID	Description	Type	Usage	Active	X Reference	Y Reference	Z Reference	Color	X Std.	Y Std.	Z Std.
1	3		Full	Control	✔	2812563.622	1192677.393	2269.006		10.000	10.000	1
2	2		Full	Control	✔	2812543.435	1192662.214	2268.216		10.000	10.000	1
3	4		Full	Control	✔	2812520.027	1192667.666	2268.657		10.000	10.000	1
4	1		Full	Control	✔	2812523.502	1192622.469	2264.595		10.000	10.000	1
5	16		Full	Control	✔	2812699.138	1192750.866	2280.291		10.000	10.000	1
6	14		Full	Control	✔	2812639.997	1192671.931	2289.351		10.000	10.000	1
7	5		Full	Control	✔	2812446.795	1192667.683	2262.725		10.000	10.000	1
8	7		Full	Control	✔	2812539.438	1192859.858	2284.396		10.000	10.000	1

Image #	Image Name	Active	X File	Y File	Color	X Residual	Y Residual
1	p1050036	✔	3367.875	1734.625		-2.160	-0.02
2	p1050039	✔	2567.875	2173.375		-0.216	0.44
3	p1050041	✔	1793.625	2490.875		-0.285	-0.90
4	p1050071	✔	264.375	2416.875		-1.030	0.67
5	p1050073	✔	887.875	1945.125		0.919	-0.60
6	p1050074	✔	2205.375	1747.875		0.804	0.16
7	p1050076	✔	1961.875	1108.375		0.016	0.34
8	p1050079	✔	2838.875	839.875		-0.504	0.27

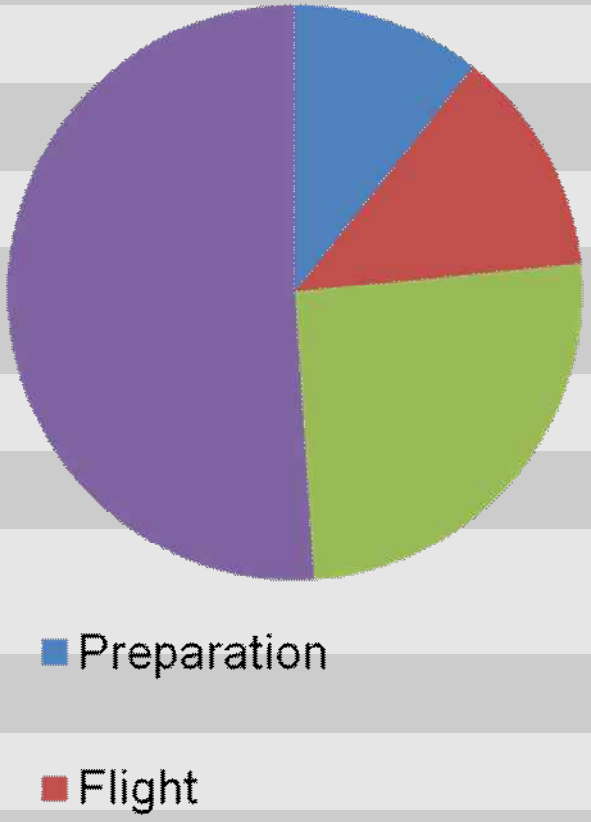
Results – Model from TLS

Results – Model from UAV

Results – Combined Model (TLS & UAV)

Results – Required Time Frame

Pure photogrammetric time frame	
Manual	
Type	**Time (for experts)**
Flight planning	2 h
Flight	3 h
Camera calibration	0.5 h
Image sorting & clean up	2 h
Ground control point measurements in images	2 h
Exterior orientation assignment	2 h
Automated	
Automated tie point measurement & bundle adjustment	2 h
DTM extraction	7 h
Orthophoto generation	3 h
Total	~24 h



Conclusion

- UAV photogrammetry time consuming
- Laser scanner not so mobile
- Combination of laser scanner and photogrammetry is a major improvement over either technique alone
- Dataset for the archaeologists

Thank You