IMAGERY FLIGHT ACQUISITION REPORT

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LAKE ERIE WATERSHED, PA
ORTHO IMAGERY ACQUISITION PROJECT 2015

Woolpert Project Number: 075294

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SECTION 1: OVERVIEW

This report contains a comprehensive outline of the airborne imagery acquisition for Lake Erie Watershed of Pennsylvania. The project area was approximately 583 square miles, which included a 500 foot buffer and full tiles around the outer edge of the County. Sixty lines were flown to acquire digital imagery capable of producing 1"=100' scale digital orthophotos with a 0.5-foot pixel resolution.

Aerial digital imagery was collected by the Leica ADS80 (Airborne Digital Sensor) SH82 in Leica's PAV80 gyro-stabilized mounts. The ADS is a push-broom geometry sensor, collecting multiple spectral bands and angles simultaneously. The digital aerial imagery was collected at the following sensor specifications:

0.5-foot Pixel Resolution:

Ground sample distance (pixel size):	0.5 ft / 15 cm
AGL (Above Ground Level) average flying height:	4,747 ft / 1447 m
MSL (Mean Sea Level) flying height:	5,714 ft / 1,742 m
Average Ground Speed:	150-160 kts / 173-184 mph
Bands Collected:	RGB NIR PANCHROMATIC
Side Lap:	25.0%
Forward Lap:	Continuous (push-broom)

The imagery data was produced in Pennsylvania State Plane North Zone, North American Datum of 1983 (NAD83). Coordinate positions were specified in units of US Survey Feet. The vertical datum used for the project was referenced to North American Vertical Datum of 1988 (NAVD88) in units of US Survey Feet.

Table 1.1: Aerial Imagery Acquisition Specifications

Project	Imagery Resolution	Number of Flight Lines	Number of Collection Days	Acquisition Dates
Erie Lakeshore, PA 0.5-ft GSD Digital Imagery	1"=100'	60	2	April 26, April 29, 2015

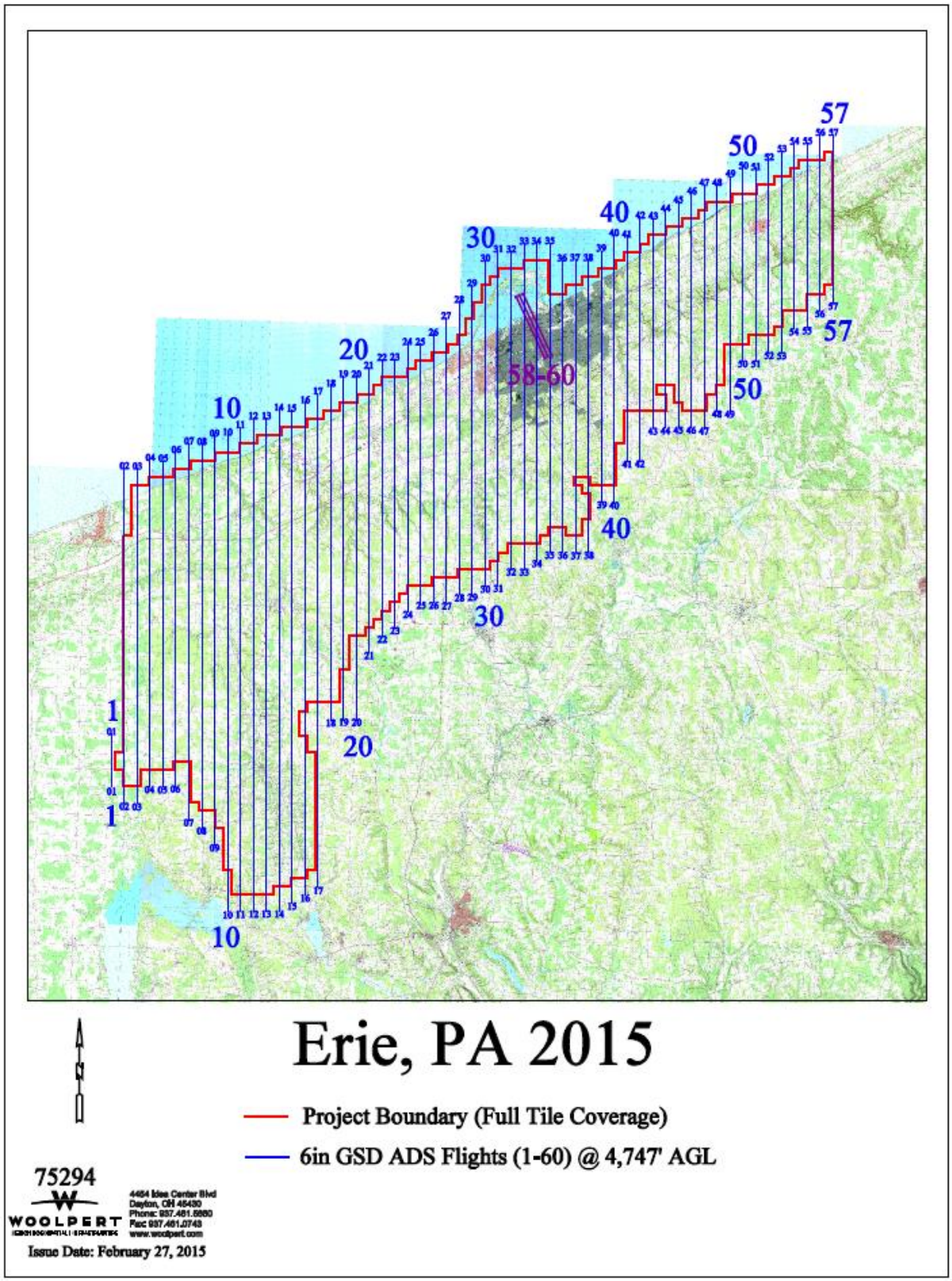
Table 1.2: Aerial Imagery Acquisition Summary – 0.5-ft GSD

Date of Flying	Lines Flown	Time ON/Off Line (UTC)	Time On/Off Line (Local - EDT)
April 26, 2015 Leica ADS80 SH82 S/N 27	1-7, 30-57	15:37-20:09	11:37AM-4:09PM
April 26, 2015 Leica ADS80 SH81 S/N 101	8-29, 58-60	15:55-19:48	11:55AM-3:48PM
April 29, 2015 Leica ADS80 SH82 S/N 27	4-20, 22-31, 35-37, 39-43, 47-49	19:11-20:55	3:11PM-4:55PM

Weather and Ground Conditions

No significant weather issues, flooding, or ponding were observed during the flight missions.

Figure 1.1: ADS Flight Diagram of Lake Erie Watershed, PA



SECTION 2: GPS AND IMAGERY QUALITY ASSURANCE

EQUIPMENT

The Woolpert Aerial Acquisition Team owns all the equipment used for the ground control and ABGNSS missions with the exception of CORS stations.

Flight navigation is performed using IGI CCNS (Computer Controlled Navigation System). The pilots are thoroughly trained and highly skilled at maintaining their planned trajectory, while holding the aircraft steady and level. If atmospheric conditions are such that the trajectory, ground speed, roll, pitch and heading cannot be properly maintained, the mission is aborted until suitable conditions occur.

All of the aircraft are all configured with a NovAtel Millennium 12-channel, L1/L2 dual frequency GNSS receivers collecting at 2 Hz.

All of Woolpert's aerial cameras and sensors are equipped with Litton LN200 series IMU's operating at 200 Hz.

Woolpert's Aerial Acquisition Team coordinated with the necessary Air Traffic Control personnel prior to flying to ensure access.

Flight navigation is performed using IGI CCNS (Computer Controlled Navigation System). The pilots are thoroughly trained and highly skilled at maintaining their planned trajectory, while holding the aircraft steady and level. If atmospheric conditions are such that the trajectory, ground speed, roll, pitch and heading cannot be properly maintained, the mission is aborted until suitable conditions occur.

The aircraft are all configured with a NovAtel Millennium 12-channel, L1/L2 dual frequency GNSS receivers collecting at 2 Hz.

All Woolpert aerial sensors are equipped with Litton LN200 series IMU's operating at 200 Hz.

A base-station unit was mobilized for the acquisition mission, and was operated by a member of the Woolpert survey and/or flight crew. Each base-station setup consisted of one (1) Trimble 5000 series dual frequency receiver, one (1) Trimble Zephyr Geodetic L1/L2 dual frequency antenna, one (1) 2-meter fixed-height tripod, and essential battery power and cabling. Ground planes were used on the base-station antennas. Data was collected at 1 or 2 Hz.

GPS Base Station Information

The following GPS base station was used in support of the aerial acquisition.

Table 2.1: GNSS Base Station Coordinates

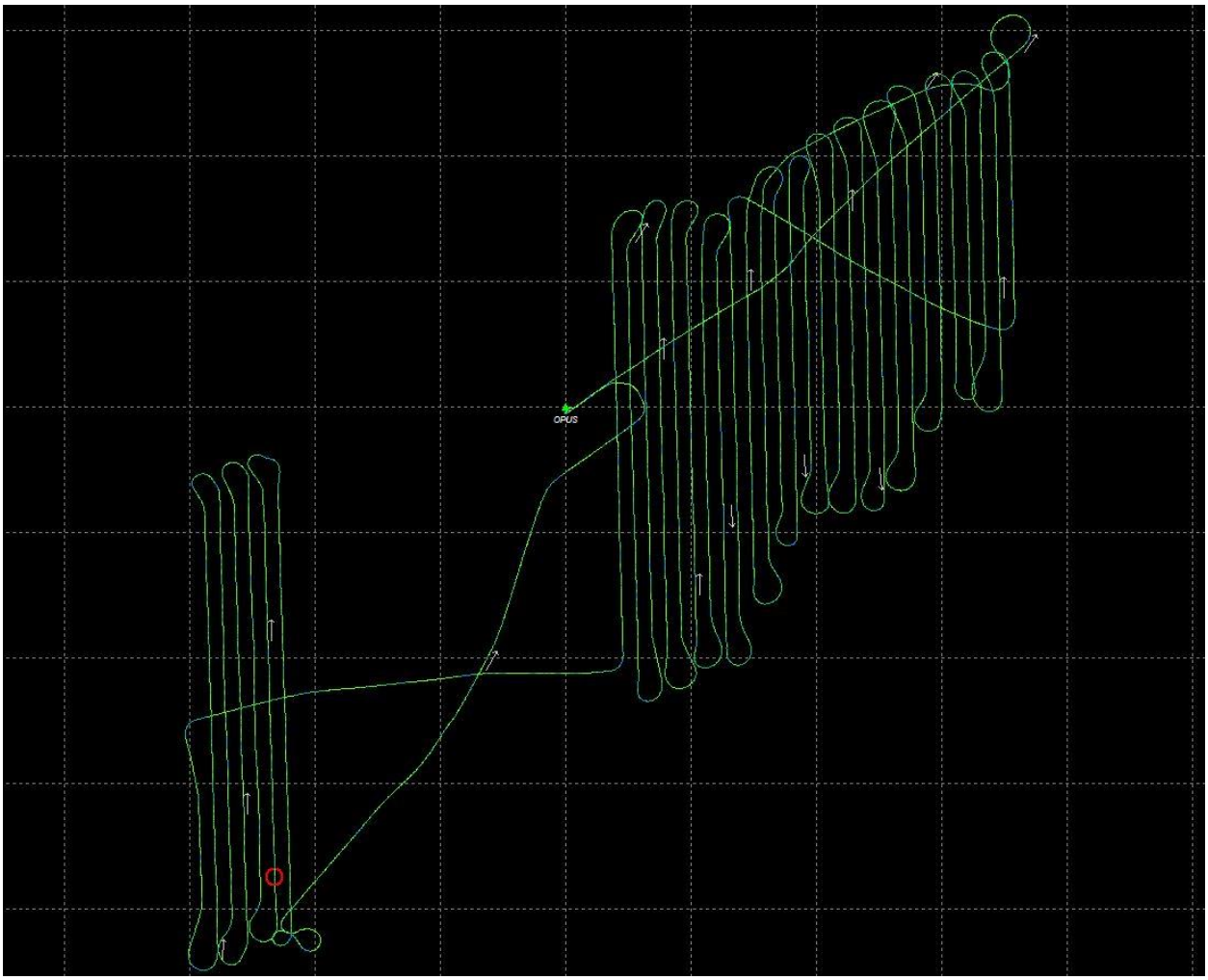
Station Name	Latitude (DMS)	Longitude (DMS)	Ellipsoid Height (L1 Phase Center) Meters
OHAS CORS	N 41° 55' 30.22147"	W 80° 33' 03.84436"	181.660

The collected data was shipped back to the Woolpert Dayton, Ohio office for processing and quality control. All data was downloaded into a standard Woolpert directory structure. The data was immediately checked for missing files, corrupt files, etc. Once verified, the GPS data was processed using Inertial Explorer software, combining airborne GPS data with base station data.

Within the trajectory processing, there are many factors that affect the overall quality, but the most indicative are the Combined Separation, the Estimated Positional Accuracy, and the Positional Dilution of Precision (PDOP).

Trajectory

Figure 2.1: Graph of the Flight Trajectory of Day116, Leica ADS80 SH82 S/N 27, in N404CP

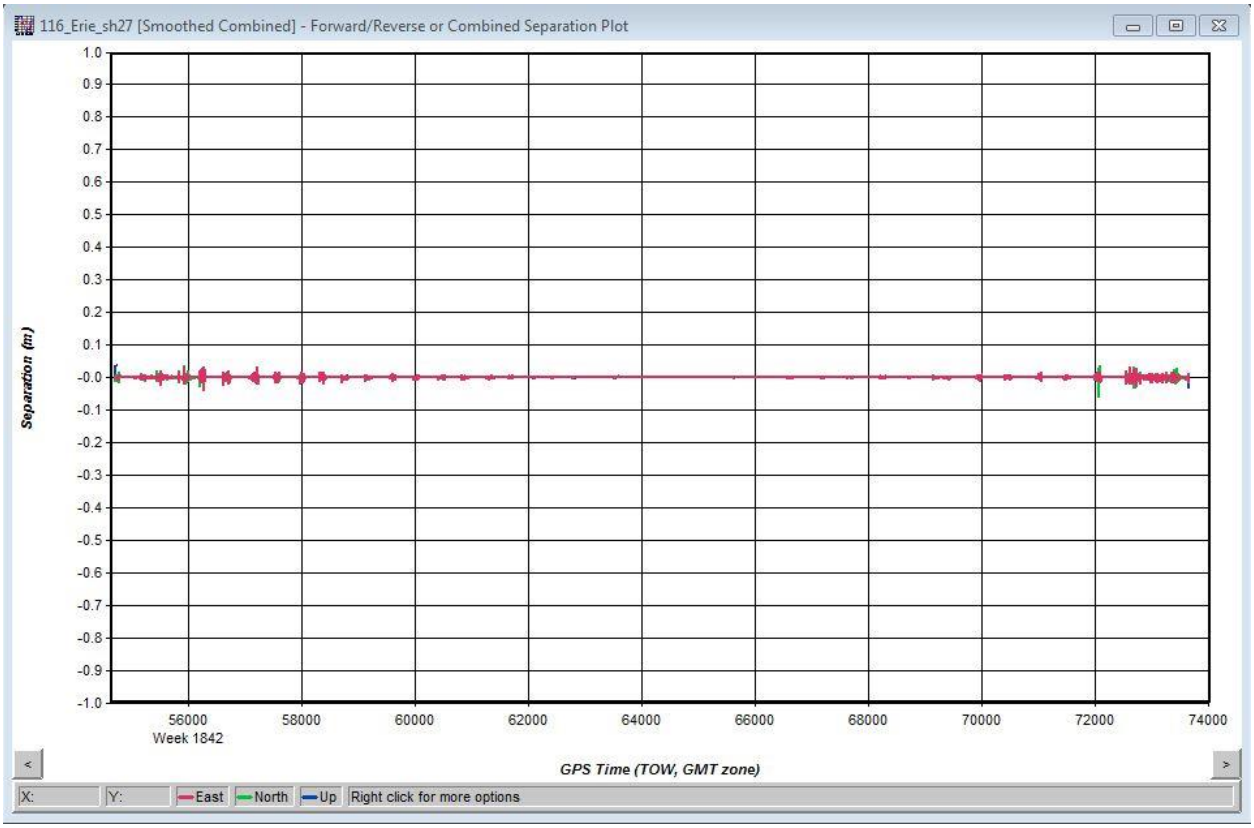


Combined Separation

The Combined Separation is a measure of the difference between the forward run and the backward run solution of the trajectory. The Kalman filter is processed in both directions to remove the combined directional anomalies. In general, when these two solutions match closely, an optimally accurate reliable solution is achieved.

Woolpert's goal is to maintain a Combined Separation Difference of less than ten (10) centimeters. In most cases we achieve results below this threshold.

Figure 2.2: Representative Graph from Day116 of Combined Separation

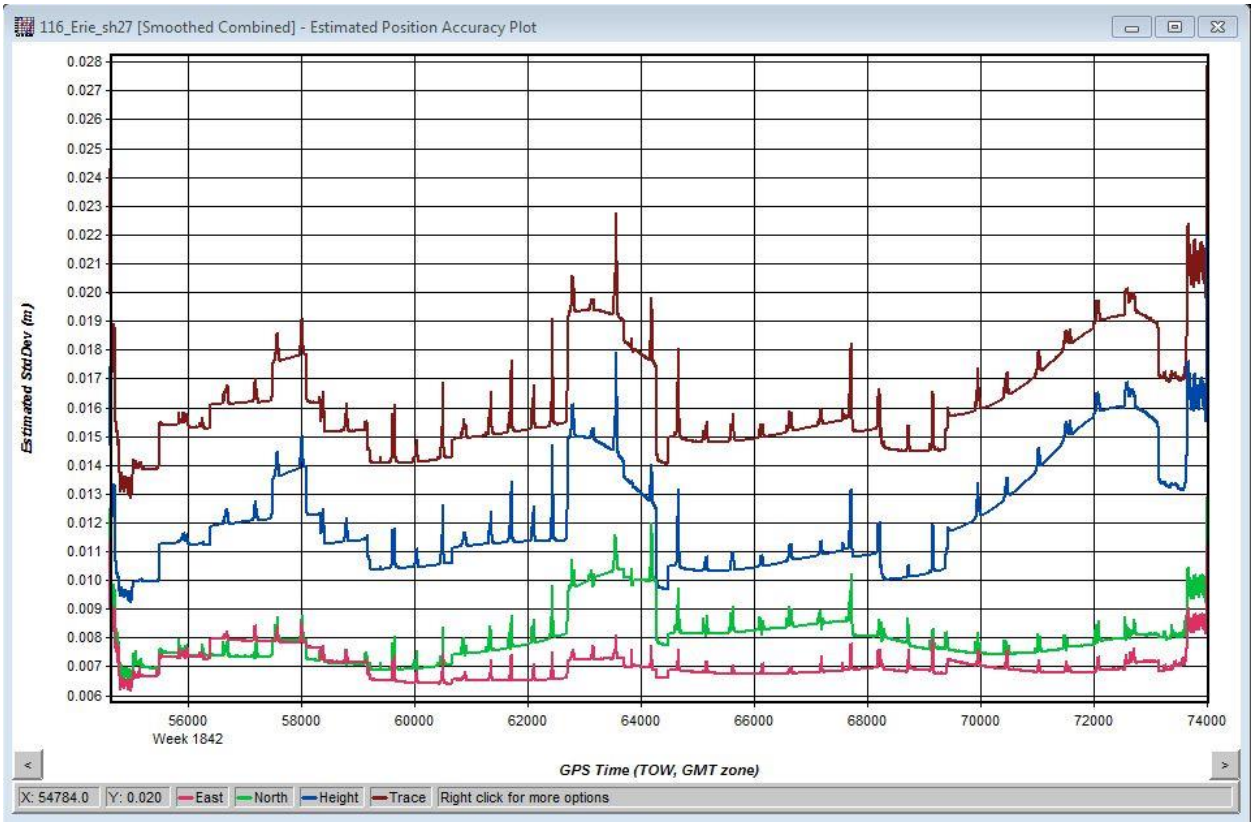


Estimated Positional Accuracy

The Estimated Positional Accuracy plots the standard deviations of the east, north, and vertical directions along a time scale of the trajectory. It illustrates loss of satellite lock issues, as well as issues arising from long baselines, noise, and/or other atmospheric interference.

Woolpert's goal is to maintain an Estimated Positional Accuracy of less than ten (10) centimeters, often achieving results well below this threshold.

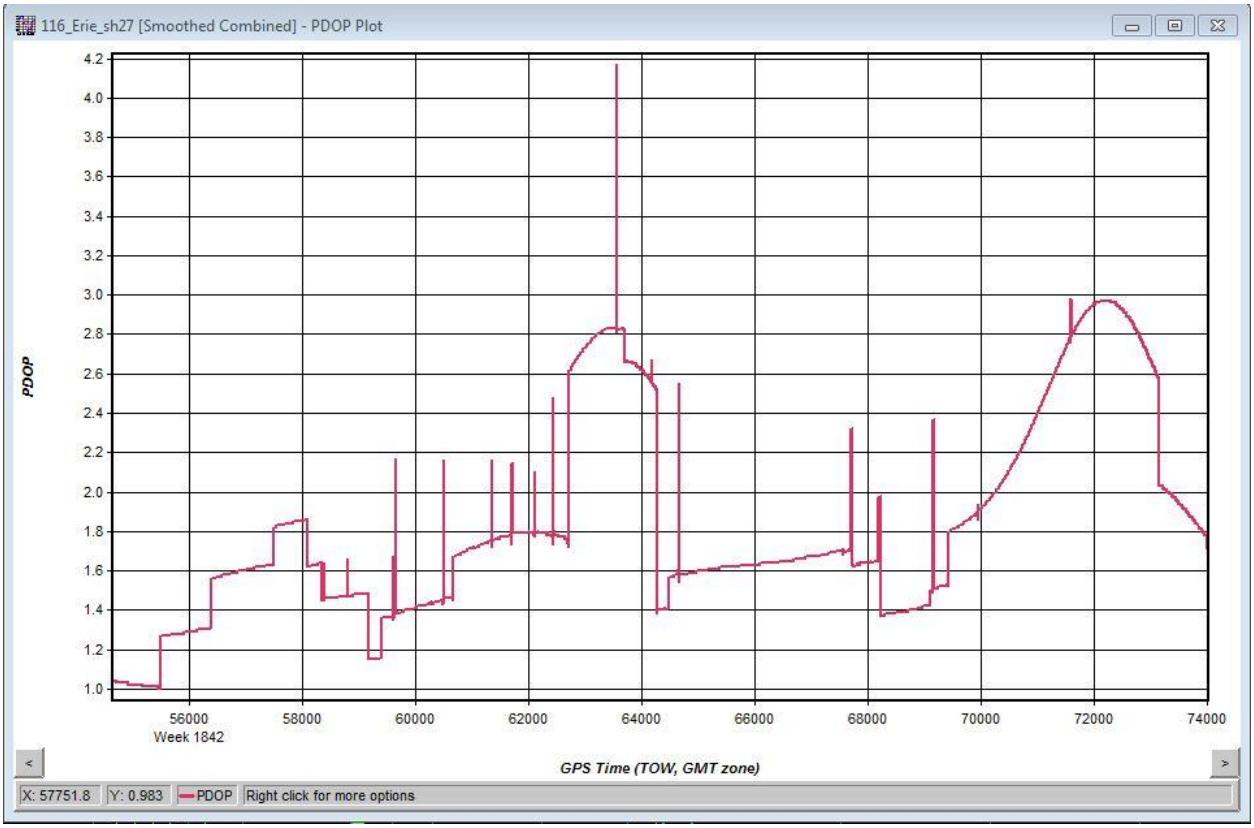
Figure 2.3: Representative Graph from Day116 of Estimated Positional Accuracy



Positional Dilution of Precision (PDOP)

The PDOP measures the precision of the GPS solution in regards to the geometry of the satellites acquired and used for the solution. Woolpert's goal is to maintain an average PDOP value below 3.0. Brief periods of PDOP over 3.0 are acceptable due to the calibration and control process if other metrics are within specification.

Figure 2.4 Representative Graph from Day116 of PDOP



The imagery data was processed using Leica's X-Pro processing software. The processed imagery data was immediately checked against the flight line layout for spatial accuracy and coverage, image quality, and atmospheric anomalies such as clouds, etc.

The results of the GPS/IMU analysis and the analysis of the processed imagery data were immediately provided back to the flight crew so that any necessary re-flights can be acquired as soon as weather conditions permitted.

SECTION 3: IMAGERY EDITING

This section contains the Aerial Digital Imagery Acquisition Editing Report(s) covering the project. The imagery is immediately processed and reviewed by trained professional imagery editors for overall quality and to determine if it meets the project specifications. Anything outside of project specifications is marked for re-flight and re-flown as soon as possible in conditions as similar as possible to the original ground and flying conditions.

ADS Imagery Editing Sheet

Date	Project # / Project #	Start Time UTC	Flight	Attempt #	Waypoints to Use	Flight Direction	Sun Angle	Complete or Patch	GSD	Conditions	Defects / Defect Location / Comments	Flt. Coverage Complete	Sensor Head
116/ 4-26-15	Erie 75294	15:37	40	A	1-21	S	54	C	6 inch	clear on N., cloudy on S.	imagery good / except cld shads wpts 23-24 REFLY 21-25	No	ADS82 SH27
116/ 4-26-15	Erie 75294	15:45	39	A	1-19	N	55	C	6 inch	clear on N., cloudy on S.	imagery good / except cld shads wpts 21-23 REFLY 19-23	No	ADS82 SH27
116/ 4-26-15	Erie 75294	15:53	41	A	1-14	S	56	C	6 inch	clear on N., cloudy on S.	imagery good / except cld shads wpts 16-17 REFLY 14-19	No	ADS82 SH27
116/ 4-26-15	Erie 75294	15:59	42	A	1-15	N	57	C	6 inch	clear on N., cloudy on S.	imagery good / except cld shads wpts 17,19-23 REFLY 15-23	No	ADS82 SH27
116/ 4-26-15	Erie 75294	16:07	43	A	1-15	S	57	C	6 inch	clear on N., cloudy on S.	imagery good / except cld shads wpts 17-18 REFLY 15-20	No	ADS82 SH27
116/ 4-26-15	Erie 75294	16:13	44	A	1-20 All	N	58	C	6 inch	clear on N., cloudy on S.	imagery good / flt comp	Yes	ADS82 SH27
116/ 4-26-15	Erie 75294	16:20	45	A	1-21 All	S	59	C	6 inch	clear on N., cloudy on S.	imagery good / flt comp	Yes	ADS82 SH27
116/ 4-26-15	Erie 75294	16:27	46	A	1-22 All	N	59	C	6 inch	clear on N., cloudy on S.	imagery good / flt comp	Yes	ADS82 SH27
116/ 4-26-15	Erie 75294	16:34	47	A	1-16	S	60	C	6 inch	clear on N., cloudy on S.	imagery good / except multiple cld shads wpt20 REFLY 16-20	No	ADS82 SH27
116/ 4-26-15	Erie 75294	16:41	48	A	1-16	N	61	C	6 inch	clear on N., cloudy on S.	imagery good / except cld shads wpts 18-19,20-21.5 REFLY 16-21.5	No	ADS82 SH27
116/ 4-26-15	Erie 75294	16:48	49	A	1-16	S	61	C	6 inch	clear on N., cloudy on S.	imagery good / except cld shads wpts 21-22 REFLY 16-21	No	ADS82 SH27
116/ 4-26-15	Erie 75294	16:56	50	A	1-18 All	N	61	C	6 inch	clear on N., cloudy on S.	imagery good / flt comp	Yes	ADS82 SH27
116/ 4-26-15	Erie 75294	17:03	51	A	1-18 All	S	61	C	6 inch	clear on N., cloudy on S.	imagery good / flt comp	Yes	ADS82 SH27
116/ 4-26-15	Erie 75294	17:09	52	A	1-18 All	N	61	C	6 inch	clear on N., cloudy on S.	imagery good / flt comp	Yes	ADS82 SH27
116/ 4-26-15	Erie 75294	17:15	53	A	1-19 All	S	61	C	6 inch	clear on N., cloudy on S.	imagery good / flt comp	Yes	ADS82 SH27
116/ 4-26-15	Erie 75294	17:21	54	A	1-17 All	N	61	C	6 inch	clear on N., cloudy on S.	imagery good / flt comp	Yes	ADS82 SH27
116/ 4-26-15	Erie 75294	17:27	55	A	1-17 All	S	61	C	6 inch	clear on N., cloudy on S.	imagery good / flt comp	Yes	ADS82 SH27
116/ 4-26-15	Erie 75294	17:34	56	A	1-17 All	N	61	C	6 inch	clear on N., cloudy on S.	imagery good / flt comp	Yes	ADS82 SH27
116/ 4-26-15	Erie 75294	17:40	57	A	1-16 All	S	61	C	6 inch	clear on N., cloudy on S.	imagery good / flt comp	Yes	ADS82 SH27
116/ 4-26-15	Erie 75294	17:50	38	A	1-27 All	S	61	C	6 inch	clear on N., cloudy on S.	imagery good / flt comp	Yes	ADS82 SH27
116/ 4-26-15	Erie 75294	17:58	37	A	1-20	N	60	C	6 inch	clear on N., cloudy on S.	imagery good / except cld shads wpts 22,23-24,27 REFLY 20-27	No	ADS82 SH27
116/ 4-26-15	Erie 75294	18:06	36	A	1-20	S	60	C	6 inch	clear on N., cloudy on S.	imagery good / except cld shads wpts 22-27 REFLY 20-27	No	ADS82 SH27
116/ 4-26-15	Erie 75294	18:14	35	A	1-24	N	59	C	6 inch	clear on N., cloudy on S.	imagery good / except cld shads wpts 26-29 REFLY 24-29	No	ADS82 SH27
116/ 4-26-15	Erie 75294	18:22	34	A	1-30 All	S	58	C	6 inch	clear on N., cloudy on S.	imagery good / flt comp	Yes	ADS82 SH27
116/ 4-26-15	Erie 75294	18:31	33	A	1-30 All	N	57	C	6 inch	clear on N., cloudy on S.	imagery good / flt comp	Yes	ADS82 SH27
116/ 4-26-15	Erie 75294	18:40	32	A	1-29 All	S	56	C	6 inch	clear on N., cloudy on S.	imagery good / flt comp	Yes	ADS82 SH27
116/ 4-26-15	Erie 75294	18:49	31	A	1-16	N	56	C	6 inch	clear on N., cloudy on S.	imagery good / except cld shads wpts 18-28 REFLY 16-31	No	ADS82 SH27
116/ 4-26-15	Erie 75294	18:58	30	A	1-20	S	54	C	6 inch	clear on N., cloudy on S.	imagery good / except cld shads wpts 23-30 REFLY 20-30	No	ADS82 SH27
116/ 4-26-15	Erie 75294	19:14	1	A	1-5 All	N	53	C	6 inch	clear on N., cloudy on S.	imagery good / flt comp	Yes	ADS82 SH27
116/ 4-26-15	Erie 75294	19:17	2	A	1-31 All	S	52	C	6 inch	clear on N., cloudy on S.	imagery good / flt comp	Yes	ADS82 SH27
116/ 4-26-15	Erie 75294	19:26	3	A	1-31 All	N	51	C	6 inch	clear on N., cloudy on S.	imagery good / flt comp	Yes	ADS82 SH27
116/ 4-26-15	Erie 75294	19:35	4	A	none	S	50	C	6 inch	clear on N., cloudy on S.	imagery good / except cld shads wpts 1-8,22-30 REFLY ALL	No	ADS82 SH27
116/ 4-26-15	Erie 75294	19:44	5	A	none	N	48	C	6 inch	clear on N., cloudy on S.	imagery good / except cld shads wpts 1-6,22-30 REFLY ALL	No	ADS82 SH27
116/ 4-26-15	Erie 75294	19:52	6	A	none	S	47	C	6 inch	clear on N., cloudy on S.	imagery good / except cld shads wpts 1-9,22-30 REFLY ALL	No	ADS82 SH27
116/ 4-26-15	Erie 75294	20:01	7	A	none	N	45	C	6 inch	clear on N., cloudy on S.	imagery good / except cld shads thoughout REFLY ALL	No	ADS82 SH27

ADS Imagery Editing Sheet

Date	Project / Project #	Start Time UTC	Flight	Attempt #	Waypoints to Use	Flight Direction	Sun Angle	Complete or Patch	GSD	Conditions	Defects / Defect Location / Comments	Flt. Coverage Complete	Sensor Head
116/ 4-26-15	Erie,PA 75294	15:55	60	A	1-7 ALL	N	56	C	6 inch	clear N / clouds S end	imagery good / flt comp	Yes	ADS81 SH101
116/ 4-26-15	Erie,PA 75294	15:59	59	A	1-7 ALL	S	57	C	6 inch	clear N / clouds S end	imagery good / flt comp	Yes	ADS81 SH101
116/ 4-26-15	Erie,PA 75294	16:04	58	A	1-7 ALL	N	57	C	6 inch	clear N / clouds S end	imagery good / flt comp	Yes	ADS81 SH101
116/ 4-26-15	Erie,PA 75294	16:11	29	A	1-20	S	58	C	6 inch	clear N / clouds S end	imagery good / except cld shads 22-24,28-29 REFLY 20-29	No	ADS81 SH101
116/ 4-26-15	Erie,PA 75294	16:19	28	A	1-20	N	59	C	6 inch	clear N / clouds S end	imagery good / except cld shads 22-27 REFLY 20-27	No	ADS81 SH101
116/ 4-26-15	Erie,PA 75294	16:28	27	A	1-17	S	60	C	6 inch	clear N / clouds S end	imagery good / except cld shads 19-27 REFLY 17-27	No	ADS81 SH101
116/ 4-26-15	Erie,PA 75294	16:36	26	A	1-13	N	60	C	6 inch	clear N / clouds S end	imagery good / except cld shads 15-25 REFLY 13-25	No	ADS81 SH101
116/ 4-26-15	Erie,PA 75294	16:44	25	A	1-18	S	60	C	6 inch	clear N / clouds S end	imagery good / except cld shads 20-24 REFLY 20-25	No	ADS81 SH101
116/ 4-26-15	Erie,PA 75294	16:51	24	A	1-19	N	61	C	6 inch	clear N / clouds S end	imagery good / except cld shads 21-25 REFLY 19-25	No	ADS81 SH101
116/ 4-26-15	Erie,PA 75294	16:59	23	A	1-18	S	61	C	6 inch	clear N / clouds S end	imagery good / except cld shads 20-25 REFLY 18-25	No	ADS81 SH101
116/ 4-26-15	Erie,PA 75294	17:07	22	A	1-22	N	62	C	6 inch	clear N / clouds S end	imagery good / except cld shads 24-26 REFLY 22-26	No	ADS81 SH101
116/ 4-26-15	Erie,PA 75294	17:16	21	A	1-26 ALL	S	62	C	6 inch	clear N / clouds S end	imagery good / flt comp	Yes	ADS81 SH101
116/ 4-26-15	Erie,PA 75294	17:25	20	A	1-23	N	62	C	6 inch	clear N / clouds S end	imagery good / except cld shads 25-28 REFLY 21-32	No	ADS81 SH101
116/ 4-26-15	Erie,PA 75294	17:34	19	A	1-21-25	S	61	C	6 inch	clear N / clouds S end	imagery good / except cld shads 23-32 REFLY 23-32	No	ADS81 SH101
116/ 4-26-15	Erie,PA 75294	17:44	18	A	1-25-28	N	61	C	6 inch	clear N / clouds S end	imagery good / except cld shads 27-31 REFLY 25-31	No	ADS81 SH101
116/ 4-26-15	Erie,PA 75294	17:53	17	A	1-25	S	61	C	6 inch	clear N / clouds S end	imagery good / except cld shads 27-46 REFLY 25-46	No	ADS81 SH101
116/ 4-26-15	Erie,PA 75294	18:05	16	A	1-24	N	60	C	6 inch	clear N / clouds S end	imagery good / except cld shads 30-46 REFLY 28-46	No	ADS81 SH101
116/ 4-26-15	Erie,PA 75294	18:17	15	A	1-18	S	59	C	6 inch	clear N / clouds S end	imagery good / except cld shads 27-46 REFLY 25-46	No	ADS81 SH101
116/ 4-26-15	Erie,PA 75294	18:29	14	A	1-19	N	58	C	6 inch	clear N / clouds S end	imagery good / except cld shads 26-46 REFLY 24-46	No	ADS81 SH101
116/ 4-26-15	Erie,PA 75294	18:42	13	A	1-22	S	56	C	6 inch	clear N / clouds S end	imagery good / except cld shads 20-45 REFLY 18-46	No	ADS81 SH101
116/ 4-26-15	Erie,PA 75294	18:54	12	A	1-22	N	55	C	6 inch	clear N / clouds S end	imagery good / except cld shads 21-45 REFLY 19-45	No	ADS81 SH101
116/ 4-26-15	Erie,PA 75294	19:07	11	A	1-22	S	53	C	6 inch	clear N / clouds S end	imagery good / except cld shads 24-45 REFLY 22-45	No	ADS81 SH101
116/ 4-26-15	Erie,PA 75294	19:19	10	A	none	N	52	C	6 inch	clear N / clouds S end	imagery good / except cld shads 24-44 REFLY 22-44	No	ADS81 SH101
116/ 4-26-15	Erie,PA 75294	19:30	9	A	1-22	S	50	C	6 inch	clear N / clouds S end	imagery good / except cld shads 24-38 REFLY 22-38	No	ADS81 SH101
116/ 4-26-15	Erie,PA 75294	19:40	8	A	none	N	48	C	6 inch	clear N / clouds S end	imagery good / except cld shads throughout REFLY ALL	No	ADS81 SH101

ADS Imagery Editing Sheet

Date	Project / Project #	Start Time UTC	Flight	Attempt #	Wapoints to Use	Flight Direction	Sun Angle	Complete or Patch	GSD	Conditions	Defects / Defect Location / Comments	Flt. Coverage Complete	Sensor Head
119/ 4-29-15	Erie, PA 75294	14:36	49	B	16-21	S	46	patch	6 inch	clear	patch imagery good / flt comp	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	14:39	48	B	16-21	N	46	patch	6 inch	clear	patch imagery good / flt comp	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	14:42	47	B	16-20	S	47	patch	6 inch	clear	patch imagery good / flt comp	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	14:47	43	B	15-20	N	48	patch	6 inch	clear	patch imagery good / flt comp	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	14:50	42	B	15-23	S	48	patch	6 inch	clear	patch imagery good / flt comp	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	14:55	41	B	14-19	N	49	patch	6 inch	clear	patch imagery good / flt comp	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	14:59	40	B	21-25	S	49	patch	6 inch	clear	patch imagery good / flt comp	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	15:02	39	B	19-23	N	50	patch	6 inch	clear	patch imagery good / flt comp	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	15:05	37	B	20-27	S	50	patch	6 inch	clear	patch imagery good / flt comp	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	15:09	36	B	20-27	N	51	patch	6 inch	clear	patch imagery good / flt comp	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	15:13	35	B	24-29	S	52	patch	6 inch	clear	patch imagery good / flt comp	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	15:17	31	B	16-31	N	52	patch	6 inch	clear	patch imagery good / flt comp	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	15:23	30	B	20-30	S	53	patch	6 inch	clear	patch imagery good / flt comp	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	15:28	29	B	20-27	N	54	patch	6 inch	clear	patch imagery good / flt comp	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	15:32	28	B	20-29	S	54	patch	6 inch	clear	patch imagery good / flt comp	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	15:36	27	B	17-27	N	55	patch	6 inch	clear	patch imagery good / flt comp	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	15:41	26	B	13-25	S	55	patch	6 inch	clear	patch imagery good / flt comp	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	15:46	25	B	18-25	N	56	patch	6 inch	clear	patch imagery good / flt comp	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	15:49	24	B	19-25	S	57	patch	6 inch	clear	patch imagery good / flt comp	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	15:53	23	B	18-25	N	57	patch	6 inch	clear	patch imagery good / flt comp	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	15:57	22	B	22-26	S	57	patch	6 inch	clear	patch imagery good / flt comp	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	16:02	20	B	23-32	N	58	patch	6 inch	clear	patch imagery good / flt comp	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	16:06	19	B	21-32	S	58	patch	6 inch	clear	patch imagery good / flt comp	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	16:11	18	B	23-31	N	59	patch	6 inch	clear	patch imagery good / flt comp	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	16:15	17	B	25-46	S	59	patch	6 inch	clear	patch imagery good / flt comp	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	16:21	16	B	25-46	N	60	patch	6 inch	clear	patch imagery good / flt comp	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	16:28	15	B	23-46	S	60	patch	6 inch	clear	patch imagery good / flt comp	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	16:35	14	B	22-46	N	61	patch	6 inch	clear	patch imagery good / flt comp	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	16:44	13	B	16-46	S	62	patch	6 inch	clear	patch imagery good / flt comp	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	16:52	12	B	17-45	N	62	patch	6 inch	clear	patch imagery good / flt comp	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	17:01	11	B	20-45	S	63	patch	6 inch	clear	patch imagery good / flt comp	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	17:08	10	B	20-44	N	63	patch	6 inch	clear	patch imagery good / flt comp	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	17:15	9	B	20-38	S	63	patch	6 inch	clear	patch imagery good / flt comp	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	17:21	8	B	1-36 All	N	62	full reflt	6 inch	clear	full flight imagery good / flt comp / use this whole flight	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	17:31	7	B	1-35 All	S	62	full reflt	6 inch	clear	full flight imagery good / flt comp / use this whole flight	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	17:40	6	B	1-31 All	N	62	full reflt	6 inch	clear	full flight imagery good / flt comp / use this whole flight	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	17:50	5	B	1-31 All	S	62	full reflt	6 inch	clear	full flight imagery good / flt comp / use this whole flight	Yes	ADS82 SH27
119/ 4-29-15	Erie, PA 75294	17:58	4	B	1-30 All	N	62	full reflt	6 inch	clear	full flight imagery good / flt comp / use this whole flight	Yes	ADS82 SH27

SECTION 4: FLIGHT LOGS

This section contains the Flight Log(s) covering the project. Flight Logs list mission specific details such as crew members, airports, weather conditions, real time PDOP values and document any issues encountered during the mission. Flight Logs are filled out by the sensor operator during the acquisition flight.

Woolpert

ADS80 Imagery	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	4/26/2015	116	75294	02	erie,pa

Operator	Aircraft	HOBBS Start	Local Start Time		Base
SMITH	N475RC	0.0	10:20:00	14:20:00	
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**		**PID**
GEBHART	ADS SH81	7.0	5:20:00	21:20:00	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud		
								Departing	day
								Arriving	day

GSD	Bands to be Collected	"B" Bands	MMS0's
0.5 Ft	Pf Pn Pb Rn Gn Bn IRn Rb Gb Bb IRb	On Off	#'s 1573 & 1542

Target Air Speed	Specified AGL	Terrain Height	Specified MSL		
150	4747 Ft	Ft	5708 Ft	Capacity (Start) 350	Capacity (End) 77

Line #	Dir.	Line Start Time	Line End Time	Int. Time	Speed	SV's	HDOP	PDOP	MSL	Sun Angle	Notes
Test	n/a			n/a	n/a				n/a	n/a	
↓ Times entered are Zulu / GMT ↓									Verify S-Turns Before Mission	Yes	No
60	s	15:55:00	15:56:00	1.92	164	16	0.6	1.1		56	
59	n	15:59:00	16:01:00	2.05	140	17	0.6	1		57	
58	s	16:04:00	16:05:00	1.81	160	18	0.6	1		57	
29	s	16:11:00	16:17:00	2.24	160	18	0.6	1		58	cld shws 23-end
28	n	16:19:00	16:25:00	2.02	140	16	0.6	1.2		59	cld shws end-20
27	s	16:28:00	16:35:00	2.31	161	15	0.6	1.3		60	cld shws 20-end
26	n	16:36:00	16:41:00	2.06	144	15	0.6	1.3		60	cld shws end-15
25	s	16:44:00	16:48:00	2.16	171	16	0.6	1.3		60	cld shws 20-end
24	n	16:51:00	16:57:00	2.02	146	17	0.6	1.2		61	cld shws end-20
23	s	16:59:00	17:04:00	2.15	160	17	0.6	1.4		61	cld shws 20-end
22	n	17:07:00	17:13:00	2.06	145	15	0.6	1.4		62	cld shws end-22
21	s	17:16:00	17:21:00	2.12	162	14	0.6	1.5		62	cld shws 22-end
20	n	17:25:00	17:32:00	2.45	150	15	0.6	1.3		62	cld shws end-22
19	s	17:34:00	17:41:00	2.13	163	19	0.6	1.1		61	cld shws 22-end
18	n	17:44:00	17:50:00	2.07	148	19	0.6	1.1		61	cld shws end-24
17	s	17:53:00	18:02:00	2.11	164	18	0.6	1.2		61	cld shws 20-end
16	n	18:05:00	18:15:00	2	146	17	0.6	1.3		60	cld shws end-24
15	s	18:17:00	18:27:00	2.08	170	17	0.6	1.2		59	cld shws 20-end
14	n	18:29:00	18:40:00	2.14	146	19	0.6	1.1		58	cld shws end-25
13	s	18:42:00	18:52:00	1.94	170	19	0.6	1		56	cld shws 21-end
12	n	18:55:00	19:05:00	2.04	144	20	0.6	1		55	cld shws end-20
11	s	19:07:00	19:16:00	2.09	163	20	0.6	1		53	cld shws 22-end
10	n	19:19:00	19:28:00	2.11	145	19	0.6	1.1		52	cld shws end-22
9	s	19:30:00	19:38:00	1.95	182	19	0.6	1.1		50	cld shws 25-end
8	n	19:40:00	19:48:00	2.12	144	19	0.6	1.1		48	cld shws end-21,7-1
↑ Times entered are Zulu / GMT ↑				Page 2					Verify S-Turns After Mission	Yes	No

Additional Comments:

Woolpert

ADS80 Imagery	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	4/26/2015	116	75294		Lake Erie, PA

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
Burton	N404CP	5124.9	11:24:00	15:24:00	
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
Rader	ADS SH82	5130.0	4:31:00	20:31:00	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud		
040 / 5	10	Clear	0	7	0	29.85	na	Departing	DAY
								Arriving	DAY

GSD	Bands to be Collected	"B" Bands	MM80's
0.5 ft	Pf ☐ Pn ☐ Pb ☐ Rn ☐ Gn ☐ Bn ☐ IRn ☐ Rb ☐ Gb ☐ Bb ☐ IRb ☐	On ☐ Off ☐	#'s 1401A & 1402B

Target Air Speed	Specified AGL	Terrain Height	Specified MSL		
150-160	4747 Ft	Ft	5714 Ft	Capacity (Start)	Capacity (End)

Line #	Dir.	Line Start Time	Line End Time	Int. Time	Speed	SV's	HDOP	PDOP	MSL	Sun Angle	Notes
Test	n/a			n/a	n/a				n/a	n/a	
↓ Times entered are Zulu / GMT ↓									Verify S-Turns Before Mission	Yes X	No
40	S	15:37:00	15:43:00		154	17	0.6	1		54	
39	N	15:45:00	15:51:00		156	17	0.6	1		55	
41	S	15:53:00	15:58:00		154	17	0.7	1.2		56	
42	N	15:59:00	16:05:00		146	17	0.6	1		57	
43	S	16:07:00	16:11:00		154	18	0.6	1		57	
44	N	16:13:00	16:18:00		144	18	0.6	1		58	
45	S	16:20:00	16:25:00		155	16	0.7	1.2		59	
46	N	16:27:00	16:32:00		147	15	0.7	1.3		59	
47	S	16:34:00	16:39:00		156	16	0.7	1.3		60	
48	N	16:41:00	16:46:00		149	16	0.7	1.3		61	
49	S	16:48:00	16:53:00		155	16	0.7	1.2		61	
50	N	16:55:00	17:00:00		148	16	0.7	1.6		61	
51	S	17:03:00	17:07:00		155	17	0.8	1.4		61	
52	N	17:09:00	17:13:00		149	16	0.7	1.6		61	
53	S	17:15:00	17:19:00		155	17	0.7	1.5		61	
54	N	17:21:00	17:25:00		149	16	0.7	1.3		61	
55	S	17:27:00	17:30:00		155	14	0.7	1.2		61	
56	N	17:33:00	17:37:00		148	15	0.7	1.1		61	
57	S	17:39:00	17:43:00		153	19	0.6	1.2		61	
38	S	17:50:00	17:56:00		158	17	0.7	1.2		61	
37	N	17:58:00	18:04:00		147	17	0.7	1.3		60	
36	S	18:06:00	18:12:00		160	18		1.2		60	
35	N	18:14:00	18:21:00		146	17	0.7	1.1		59	
34	S	18:22:00	18:29:00		157	17	0.6	1.1		58	
33	N	18:31:00	18:38:00		154	18	0.7	1		57	
32	S	18:40:00	18:47:00		158	18	0.6	1.1		56	
31	N	18:49:00	18:56:00		148	19	0.6	1		56	
30	S	18:58:00	19:04:00		155	19	0.6	1.1		55	
1	S	19:14:00	19:15:00		155	20	0.6	1.1		54	
2	N	19:17:00	19:24:00		146	19	0.6	1.1		53	
3	S	19:26:00	19:33:00		155	19	0.6	1		52	
↑ Times entered are Zulu / GMT ↑				Page	1				Verify S-Turns After Mission	Yes X	No

Additional Comments:

Woolpert

ADS80 Imagery	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	4/26/2015	116	75294		Lake Erie, PA

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
Burton	N404CP	5124.9	11:24:00	15:24:00	
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
Rader	ADS SH82	5130.0	4:31:00	20:31:00	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud		
040 / 5	10	Clear	0	7	0	29.85	na	Departing	DAY
								Arriving	DAY

GSD	Bands to be Collected	"B" Bands	MM80's
0.5 ft	Pf Pn Pb Rn Gn Bn IRn / Rb Gb Bb IRb	On / Off	#'s 1401A & 1402B

Target Air Speed	Specified AGL	Terrain Height	Specified MSL	Capacity (Start)	Capacity (End)
150-160	4747 Ft	Ft	5714 Ft		

Line #	Dir.	Line Start Time	Line End Time	Int. Time	Speed	SV's	HDOP	PDOP	MSL	Sun Angle	Notes
Test	n/a			n/a	n/a				n/a	n/a	
↓ Times entered are Zulu / GMT ↓									Verify S-Turns Before Mission	Yes	No
4	N	19:35:00	19:42:00		144	19	0.6	1.1		50	
5	S	19:44:00	19:50:00		158	17	0.7	1.3		48	
6	N	19:52:00	19:59:00		143	17	0.7	1.3		47	
7	S	20:01:00	20:09:00		157	18	0.7	1.3		45	

↑ Times entered are Zulu / GMT ↑ Page 2 Verify S-Turns After Mission Yes No

Additional Comments:

ADS Serial Number:

Woolpert

ADS80 Imagery	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	4/29/2015	119	75294		Lake Erie Watershed, PA

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
Burton	N404CP	5123.7	9:05:00	13:05:00	
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
Rader	ADS SH82	5131.4	3:36:00	19:36:00	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud		
Calm	10	clear		9	4	29.94		Departing	DAY
								Arriving	DAY

GSD	Bands to be Collected	"B" Bands	MM80's
0.5 ft	Pf Pn Pb Rn Gn Bn IRn / Rb Gb Bb IRb	On / Off	#'s 1414A & 1415B

Target Air Speed	Specified AGL	Terrain Height	Specified MSL		
150-160	4747 Ft	Ft	5714 Ft	Capacity (Start) 671	Capacity (End) 464

Line #	Dir.	Line Start Time	Line End Time	Int. Time	Speed	SV's	HDOP	PDOP	MSL	Sun Angle	Notes
Test	n/a			n/a	n/a				n/a	n/a	
↓ Times entered are Zulu / GMT ↓									Verify S-Turns Before Mission	Yes X	No
49	S	14:36:00	14:37:00		145	18	0.6	1		46	
48	N	14:39:00	14:40:00		151	18	0.6	1		46	
47	S	14:42:00	14:43:00		148	17	0.6	1.1		47	
43	N	14:47:00	14:48:00		153	18	0.6	1		48	
42	S	14:49:00	14:51:00		145	18	0.6	1		48	
41	N	14:55:00	14:56:00		148	18	0.7	1.1		49	
40	S	14:59:00	15:00:00		151	17	0.7	1.1		49	
39	N	15:02:00	15:03:00		151	17	0.7	1.1		50	
37	S	15:05:00	15:07:00		149	17	0.7	1.1		50	
36	N	15:09:00	15:11:00		151	16	0.7	1.2		51	
35	S	15:13:00	15:14:00		147	16	0.7	1.2		52	
31	N	15:17:00	15:20:00		147	16	0.7	1.2		52	
30	S	15:23:00	15:26:00		147	16	0.7	1.2		53	
29	N	15:28:00	15:30:00		150	17	0.6	1.2		54	
28	S	15:32:00	15:34:00		149	17	0.6	1		54	
27	N	15:36:00	15:38:00		149	17	0.7	1.1		55	
26	S	15:41:00	15:44:00		150	16	0.7	1.1		55	
25	N	15:46:00	15:47:00		150	17	0.7	1.2		56	
24	S	15:49:00	15:51:00		150	18	0.7	1.1		57	
23	N	15:54:00	15:55:00		150	17	0.7	1.1		57	
22	S	15:57:00	15:58:00		150	18	0.7	1		57	
20	N	16:02:00	16:04:00		150	18	0.6	1		58	
19	S	16:06:00	16:09:00		149	17	0.7	1.1		58	
18	N	16:11:00	16:13:00		152	16	0.7	1.2		59	
17	S	16:15:00	16:19:00		149	15	0.7	1.3		59	
16	N	16:21:00	16:26:00		152	16	0.7	1.3		60	
15	S	16:28:00	16:33:00		149	17	0.7	1.3		60	
14	N	16:35:00	16:40:00		149	17	0.7	1.3		61	
13	S	16:47:00	16:50:00		153	17	0.7	1.1		61	
12	N	16:52:00	16:59:00		152	17	0.7	12		62	
11	S	17:01:00	17:06:00		151	16	0.7	1.3		62	
↑ Times entered are Zulu / GMT ↑				Page 1					Verify S-Turns After Mission	Yes X	No

Additional Comments:

Woolpert

ADS80 Imagery	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	4/29/2015	119	75294		Lake Erie Watershed, PA

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
Burton	N404CP	5123.7	9:05:00	13:05:00	
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
Rader	ADS SH82	5131.4	3:36:00	19:36:00	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud		
Calm	10	clear		9	4	29.94		Departing	DAY
								Arriving	DAY

GSD	Bands to be Collected	"B" Bands	MM80's			
0.5 ft	Pf Pn Pb Rn Gn Bn IRn Rb Gb Bb IRb	On Off	#'s	1414A	&	1415B

Target Air Speed	Specified AGL	Terrain Height	Specified MSL	Capacity (Start)	671	Capacity (End)	464
150-160	4747 Ft	Ft	5714 Ft				

Line #	Dir.	Line Start Time	Line End Time	Int. Time	Speed	SV's	HDOP	PDOP	MSL	Sun Angle	Notes
Test	n/a			n/a	n/a				n/a	n/a	
↓ Times entered are Zulu / GMT ↓									Verify S-Turns Before Mission	Yes	No
10	N	17:08:00	17:13:00		155	17	0.7	1.5		63	
9	S	17:15:00	17:19:00		153	18	0.6	1.1		63	
8	N	17:21:00	17:29:00		152	19	0.6	1.1		63	
7	S	17:31:00	17:38:00		159	19	0.6	1.1		62	
6	N	17:40:00	17:47:00		152	18	0.6	1.2		62	
5	S	17:50:00	17:56:00		155	17	0.6	1.2		62	
4	N	17:59:00	18:06:00		147	17	0.6	1.2		62	

↑ Times entered are Zulu / GMT ↑ Page 2 Verify S-Turns After Mission Yes No

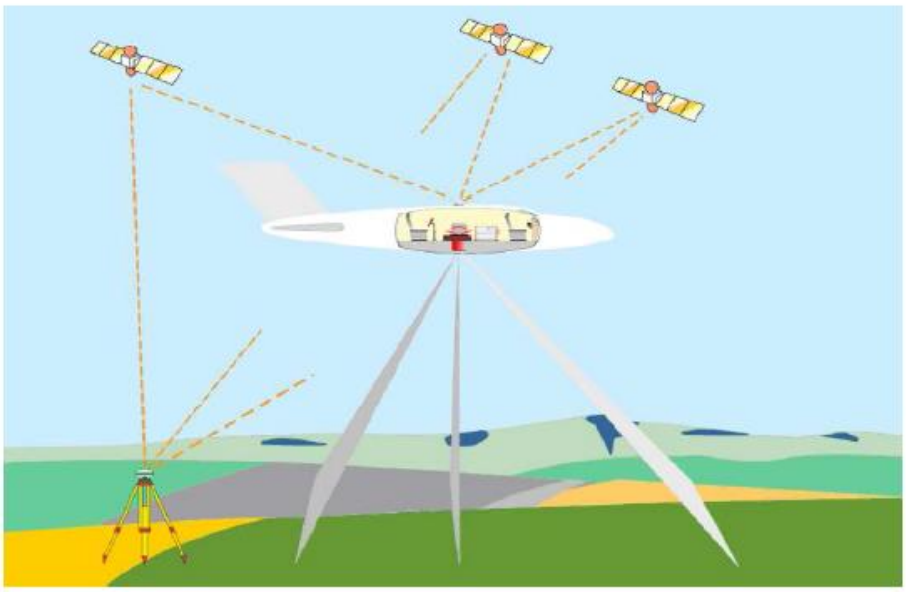
Additional Comments:

ADS Serial Number:

SECTION 5: SENSOR CALIBRATION REPORT

This section contains the Sensor Calibration Report(s) and Sensor Specifications covering the aerial sensor(s) utilized for this project. These are the manufacturer's lab calibrated values.

Leica ADS80 Calibration Certificate



	Sensor Head	Serial Number	Control Unit	Serial Number
This certificate is valid for	***SH82***	***30027***	***CU80***	***1132***

		Inspector
Calibration certificate issued on	***24 October 2011***	M. Adigüzel
by		**Muzaffer Adigüzel**
Certificate and calibration data ID	***763806_30027_111024-1***	Document code 763806

ADS80

Leica Geosystems AG
Heinrich-Wild-Strasse
9435 Heerbrugg
Switzerland

Leica Geosystems

Components

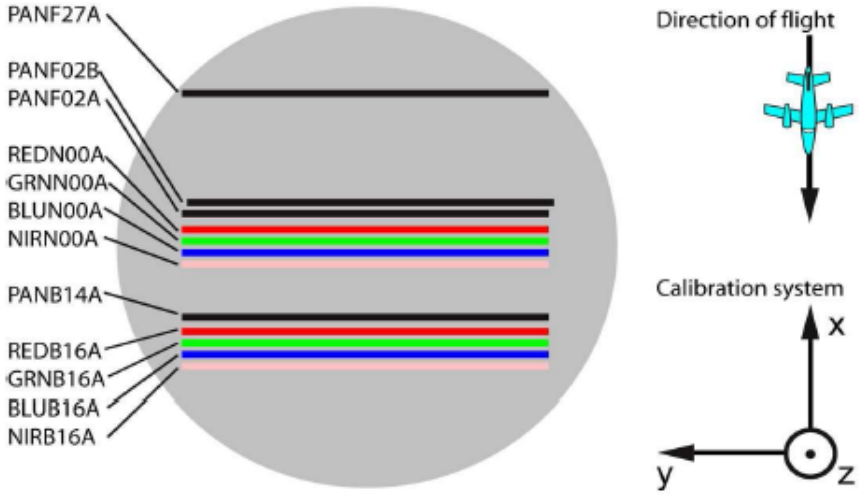
Component	Device	Type	Serial Number
SH82 #30027	Lens system	DO64-810000	21955 / 0025
	Focal Plate Module cover	FCO	78
	Focal Plate Module (FPM)	FPM-A	78
	Inertial Measurement Unit	LN200	
CU80 #1132	Positioning system incl. GPS/GLONASS	IPAS20	1345

Nominal FPM layout of tested system

End pixel coordinates are center of pixel coordinates.
Middle coordinates are between pixels 6000 and 6001.
All values in [mm]

Line Name	X	Y, Pixel 1	Y, Center	Y, Pixel 12000
PANF27A	32.18400	-38.99675	0.00000	38.99675
PANF02B	02.21000	-38.99345	0.00330	39.00005
PANF02A	02.18400	-38.99675	0.00000	38.99675
REDN00A	00.01300	-38.99345	0.00330	39.00005
GRNN00A	-00.01300	-38.99675	0.00000	38.99675
BLUN00A	00.00000	-38.99345	0.00330	39.00005
NIRN00A	00.00000	-38.99675	0.00000	38.99675
PANB14A	-15.81600	-38.99675	0.00000	38.99675
REDB16A	-17.98700	-38.99345	0.00330	39.00005
GRNB16A	-18.01300	-38.99675	0.00000	38.99675
BLUB16A	-18.00000	-38.99345	0.00330	39.00005
NIRB16A	-18.00000	-38.99675	0.00000	38.99675

View from top of Sensor Head



Calibration process

Adjustment of optical systems in optical laboratory

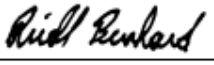
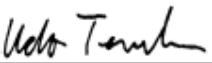
	Passed	Date	Inspector
DSNU (Dark Signal Non Uniformity)	ok	07.12.2009	Bernhard Riedl
PRNU (Photo Response Non Uniformity)	ok	07.12.2009	Bernhard Riedl
MTF	ok	07.12.2009	Bernhard Riedl
Best image plane	ok	07.12.2009	Bernhard Riedl

Flight and data processing

	Passed	Date	Inspector
Test flight	ok	04.10.2011	Customer
GNSS and IMU data processing	ok	13.10.2011	Muzaffer Adigüzel
Image data processing	ok	13.10.2011	Muzaffer Adigüzel
Geometrical calibration	ok	24.10.2011	Muzaffer Adigüzel

Inspection

Inspectors

Name	Bernhard Riedl	24.10.2011	
Position	ADS Production Manager		
Name	Muzaffer Adigüzel	24.10.2011	
Position	ADS Support Engineer		
Name	Udo Tempelmann	24.10.2011	
Position	ADS Software Manager		

Leica ADS80 calibration process specification

	Document code
Inspection plan	862100
Leica ADS80 system calibration process	870106

Maintenance

Last date of service	
Recommendations	

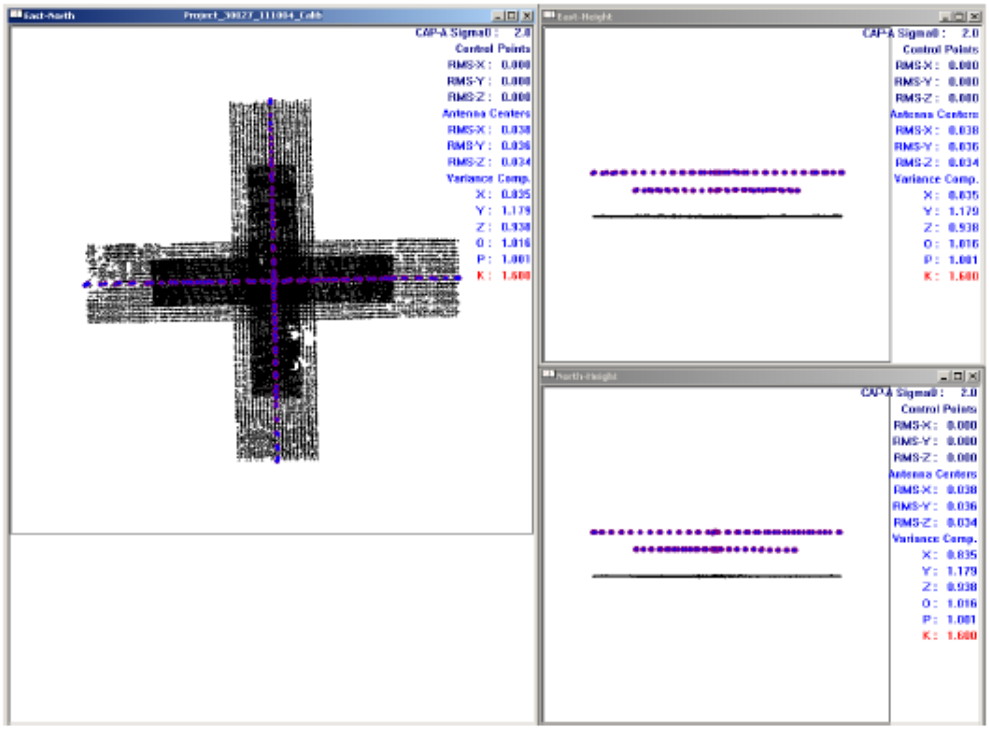
Results of geometrical calibration

Calibrated apparent pixel coordinates for all sensor lines are contained on the calibration file attached to this certificate. File: ***30027-111024-1***.zip

Stereo lines

A-lines	PANF27A PANF02A PANB14A
Calibration method	Estimation of additional parameters in simultaneous bundle adjustment
Sigma naught of bundle adjustment	2.0 micron
Mean local redundancy	> 0.5
Accuracy of calibrated apparent pixel coordinates	±1.0 micron

Final bundle adjustment result after elimination of tie point blunders and before introduction of ground control:



IMU misalignment

Misalignment results in [rad]:	$\omega =$	0.0002456728	± 0.0000025105
	$\phi =$	-0.0000428101	± 0.0000027354
	$\kappa =$	0.0011331775	± 0.0000080083

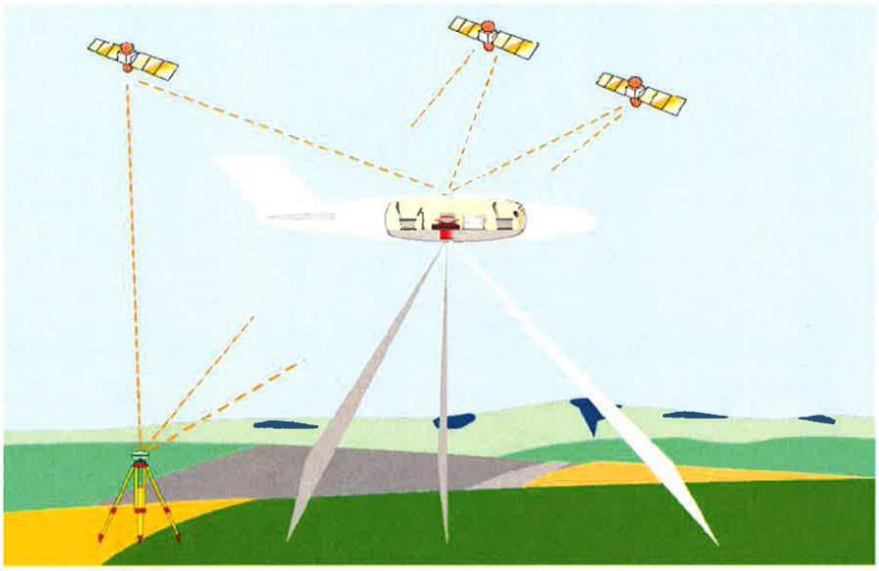
Color lines

Included lines	BLUN00A REDN00A GRNN00A NIRN00A BLUB16A REDB16A GRNB16A NIRB16A
Calibration method	Optimal robust polynomial fit of tie point residuals from bundle adjustment
Mean accuracy of estimated fit for:	
Blue, Green, Red	± 1.6 micron
NIR	± 1.6 micron
Accuracy of apparent pixel-coordinates	± 1 micron

Lines of staggered panchromatic line pair

B-lines	PANF02B
Calibration method	Transfer of A-lines results, using the known offset of the staggered lines
Accuracy of apparent pixel coordinates	Same as for A-lines
Relative accuracy between the lines of a staggered pair	± 0.5 micron

LEICA ADS80
Calibration Certificate



	Sensor Head	Serial Number	Control Unit	Serial Number
This certificate is valid for	***SH81***	***30101***	***CU80***	***1130***
	IMU	Serial Number		
	DUS5	***LN200***	**Inspector**	
Calibration certificate issued on	***25 January 2012***		M. Adigüzel	
by			**Muzaffer Adigüzel**	
Certificate and calibration data ID	***763806_30101_120209-1***		Document code 763806	

Leica Geosystems AG
Heinrich-Wild-Strasse
9435 Heerbrugg
Switzerland

Components

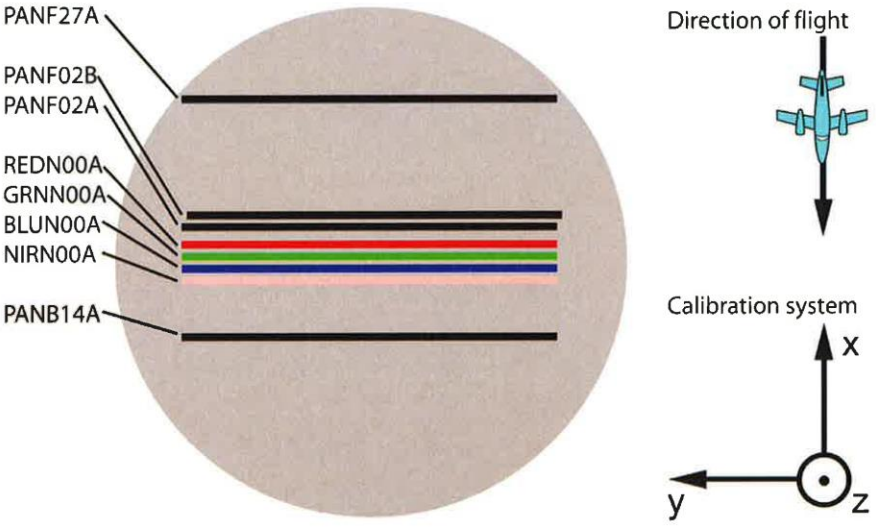
Component	Device	Type	Serial Number
SH81 # 30101	Lens system	DO64-810000	21955 / 0057
	Focal Plate Module cover	FCO	104
	Focal Plate Module (FPM)	FPM-A	104
	Inertial Measurement Unit	DUS5-LN200	
CU80 # 1130	Positioning system incl.GPS/GLONASS	IPAS20	1337

Nominal FPM layout of tested system

End pixel coordinates are center of pixel coordinates.
Middle coordinates are between pixels 6000 and 6001.
All values in [mm]

Line Name	X	Y, Pixel 1	Y, Center	Y, Pixel 12000
PANF27A	32.18400	-38.99675	0.00000	38.99675
PANF02B	02.21000	-38.99345	0.00330	39.00005
PANF02A	02.18400	-38.99675	0.00000	38.99675
REDN00A	00.01300	-38.99345	0.00330	39.00005
GRNN00A	-00.01300	-38.99675	0.00000	38.99675
BLUN00A	00.00000	-38.99345	0.00330	39.00005
NIRN00A	00.00000	-38.99675	0.00000	38.99675
PANB14A	-15.81600	-38.99675	0.00000	38.99675

View from top of Sensor Head



Calibration process

Adjustment of optical systems in optical laboratory

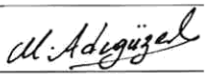
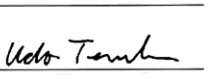
	Passed	Date	Inspector
DSNU (Dark Signal Non Uniformity)	ok	05.01.2012	Bernhard Riedl
PRNU (Photo Response Non Uniformity)	ok	05.01.2012	Bernhard Riedl
MTF	ok	05.01.2012	Bernhard Riedl
Best image plane	ok	05.01.2012	Bernhard Riedl

Flight and data processing

	Passed	Date	Inspector
Test flight	ok	31.01.2012	Customer
GNSS and IMU data processing	ok	01.02.2012	Customer
IMU accelerometer biases	ok	01.02.2012	Customer
Image data processing	ok	06.02.2012	Muzaffer Adigüzel
Geometrical calibration	ok	09.02.2012	Muzaffer Adigüzel

Inspection

Inspectors

Name	Bernhard Riedl	09.02.2012	
Position	ADS Production Manager		
Name	Muzaffer Adigüzel	09.02.2012	
Position	ADS Support Engineer		
Name	Udo Tempelmann	09.02.2012	
Position	ADS Software Manager		

Leica ADS80 calibration process specification

	Document code
Inspection plan	862100
Leica ADS80 system calibration process	870106

Maintenance

Last date of service	
Recommendations	

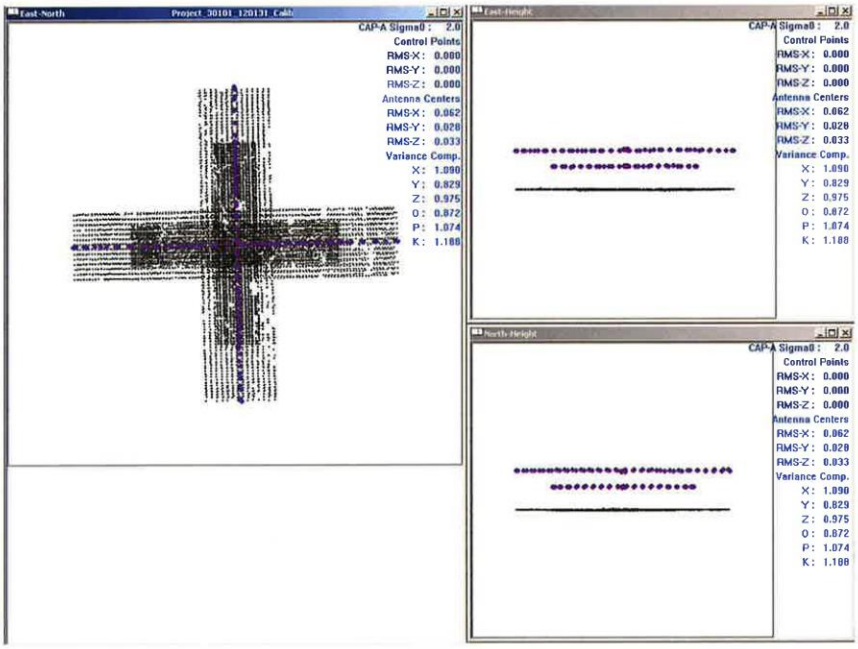
Results of geometrical calibration

Calibrated apparent pixel coordinates for all sensor lines are contained on the calibration file attached to this certificate. File: ***30101-120209-1***.zip

Stereo lines

A-lines	PANF27A PANF02A PANB14A
Calibration method	Estimation of additional parameters in simultaneous bundle adjustment
Sigma naught of bundle adjustment	2.0 micron
Mean local redundancy	> 0.5
Accuracy of calibrated apparent pixel coordinates	±1.0 micron

Final bundle adjustment result after elimination of tie point blunders and before introduction of ground control:



IMU misalignment

Misalignment results in [rad]:	ω =	0.0003701834	± 0.0000026834
	ϕ =	-0.0008142747	± 0.0000028798
	κ =	0.0013142083	± 0.0000076665

Color lines

Included lines	BLUN00A REDN00A GRNN00 NIRN00A
Calibration method	Optimal robust polynomial fit of tie point residuals from bundle adjustment
Mean accuracy of estimated fit for:	
Blue, Green, Red	± 1.5 micron
NIR	± 1.5 micron
Accuracy of apparent pixel-coordinates	± 1 micron

Lines of staggered panchromatic line pair

B-lines	PANF02B
Calibration method	Transfer of A-lines results, using the known offset of the staggered lines
Accuracy of apparent pixel coordinates	Same as for A-lines
Relative accuracy between the lines of a staggered pair	± 0.5 micron