MOBILE GROUND-BASED HYPERSPECTRAL SYSTEM IMAGE GEO-REFERENCING

***BY*: NAOUFAL SASSI**

THIS PRESENTATION IS BASED ON MY THESIS DOCUMENTATION PRESENTED TO THE GRADUATE SCHOOL OF THE UNIVERSITY OF FLORIDA

Committee members and co-authors of the Ms. Thesis paper:

Dr. Amr Abd-Elrahman

Dr. Bon A. Dewitt

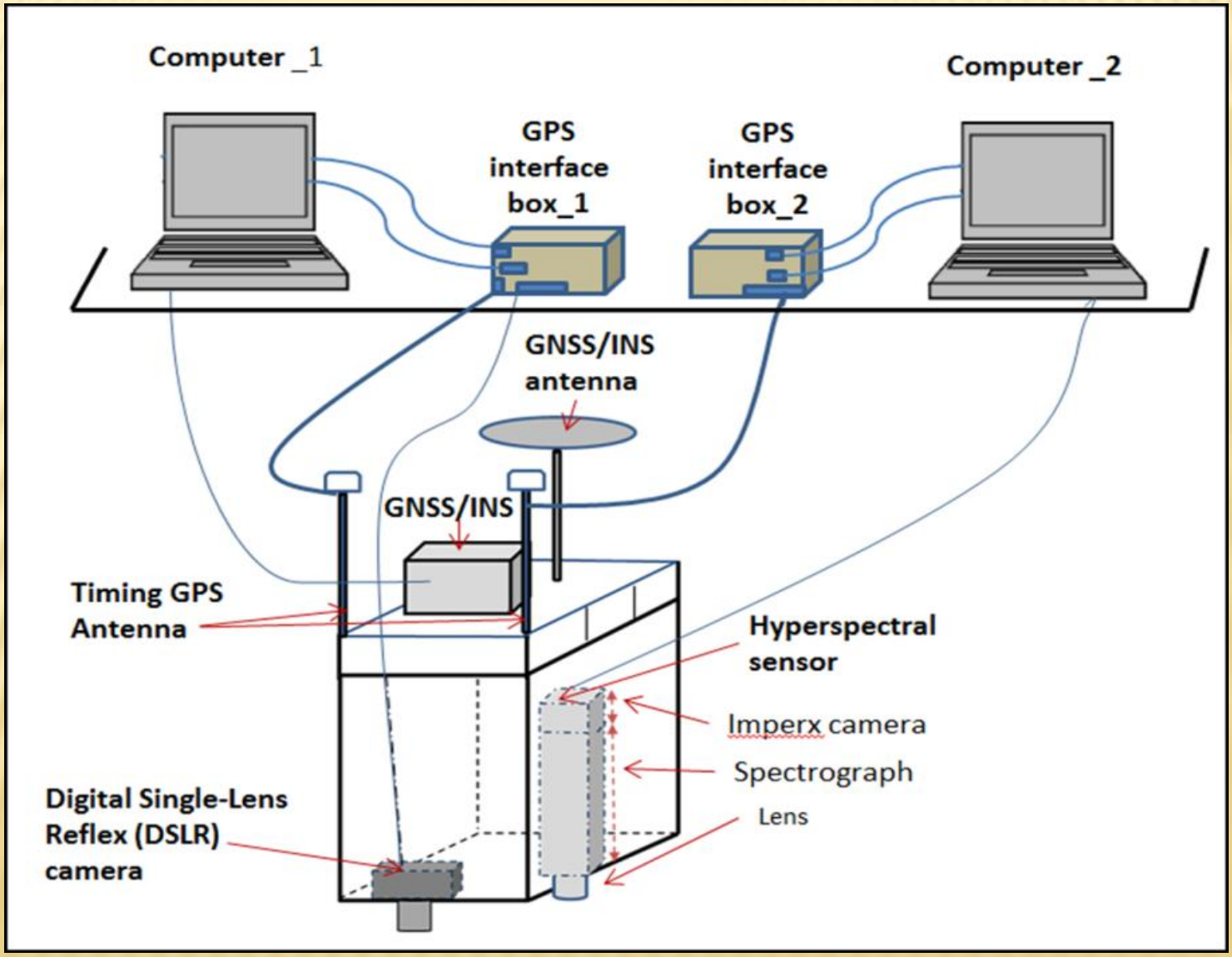
Dr. Ben Wilkinson

Ground-Based Mobile Hyperspectral Imaging System (MHIS)

Objective:

To present a simple method of data acquisition, processing and positional accuracy assessment achieved by utilizing the MHIS

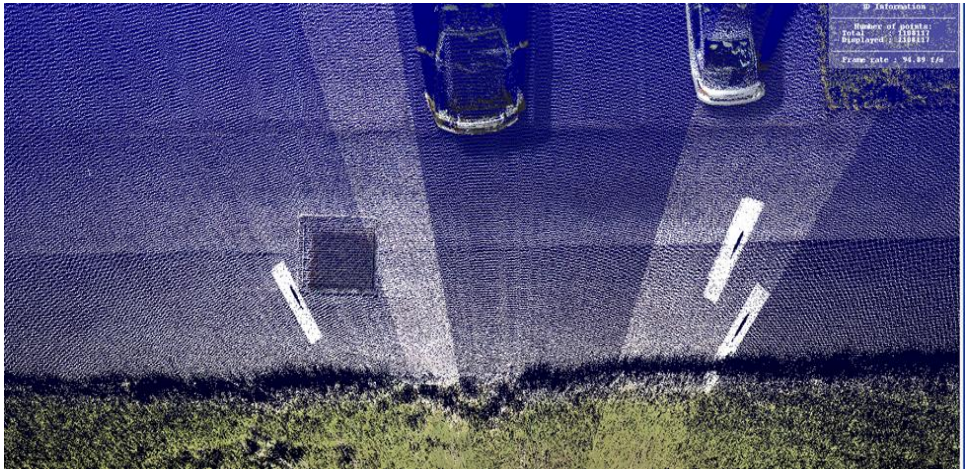
(MHIS) DATA ACQUISITION COMPONENTS

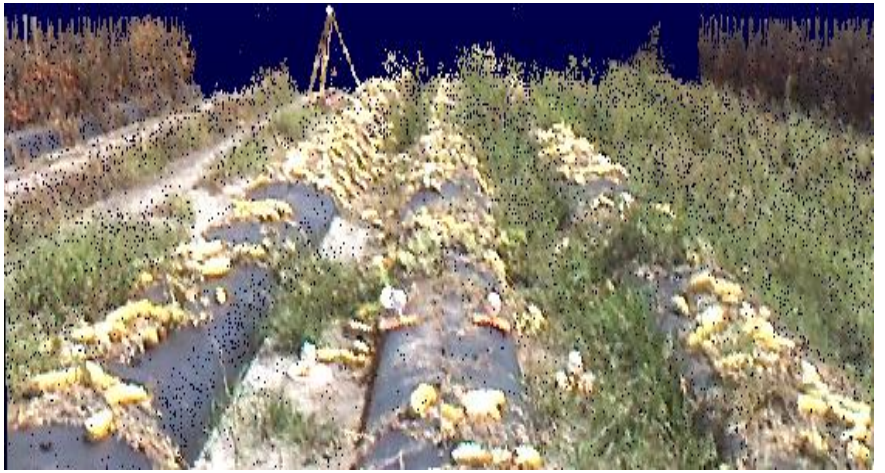


Lidar Scans

- A Trimble GX 3D Scanner was used to collect lidar point clouds
- These lidar point clouds were used to create a Digital Elevation Models (DEM s)
- Using a laser beam and a synchronized video camera, this scanner was able to collect measurements up to 5000 points per second forming very dense point clouds

Lidar scans-continue





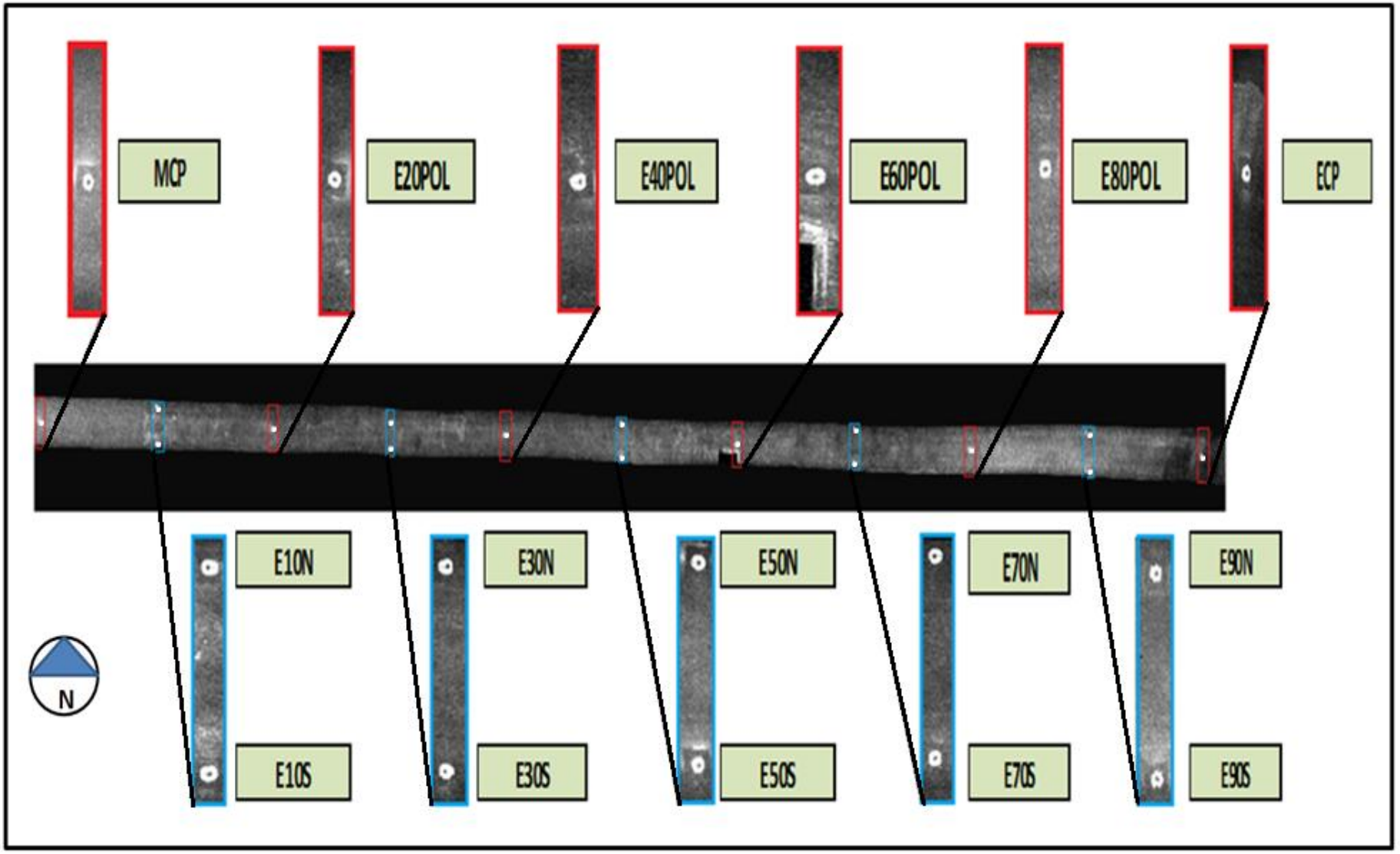
Field Measurements

- Field measurements took place at the University of Florida-Gulf Coast Research and Education Center (GCREC) in Wimauma, FL.

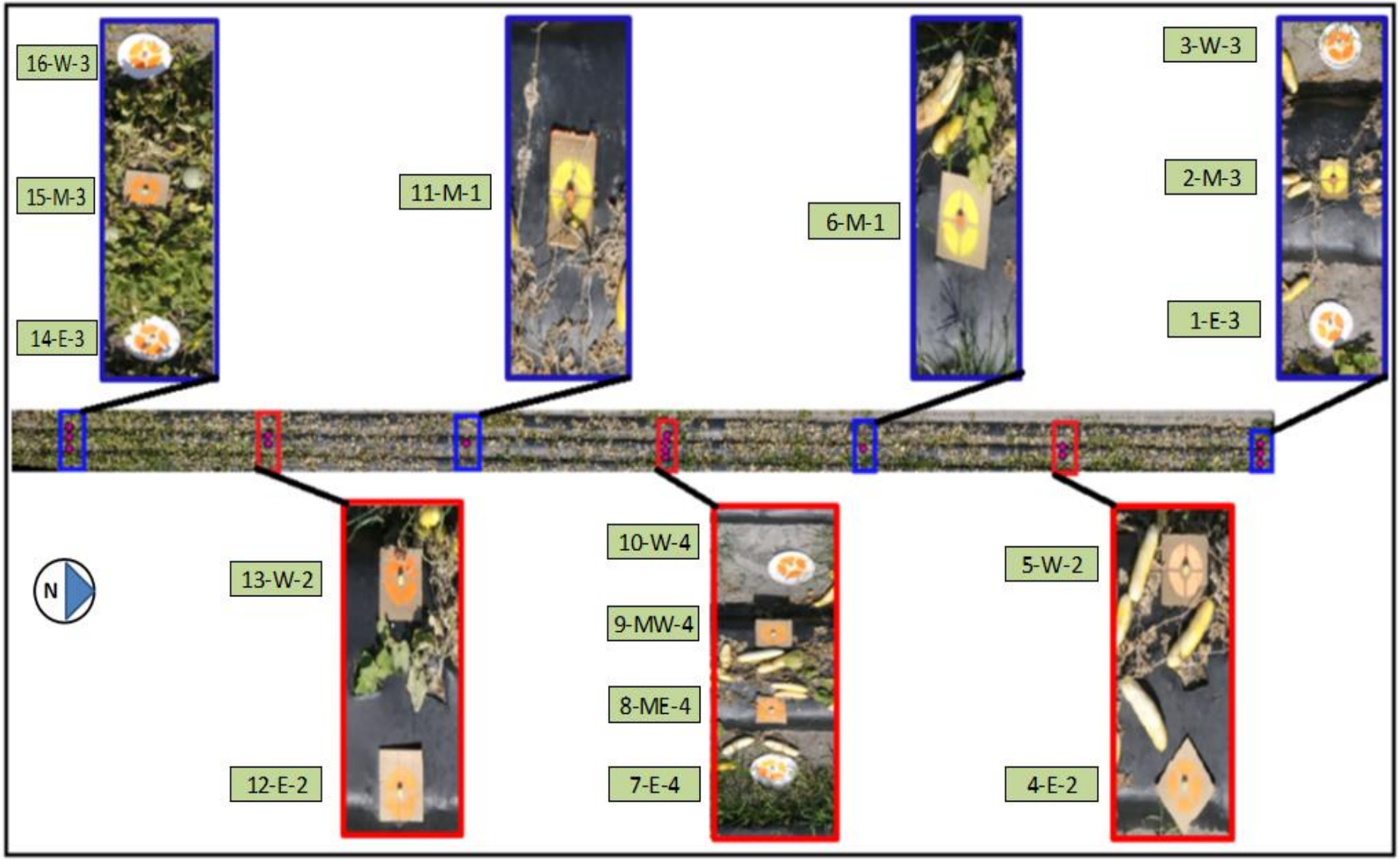
Control points

- A set of sixteen ground control points were set on a pavement driveway stretch
- Another set of sixteen control points were established in the agriculture field
- Ground control locations were surveyed using an R400 Leica total station and multiple Topcon HiperLite+ GNSS receivers

Ground control points on the pavement road surface



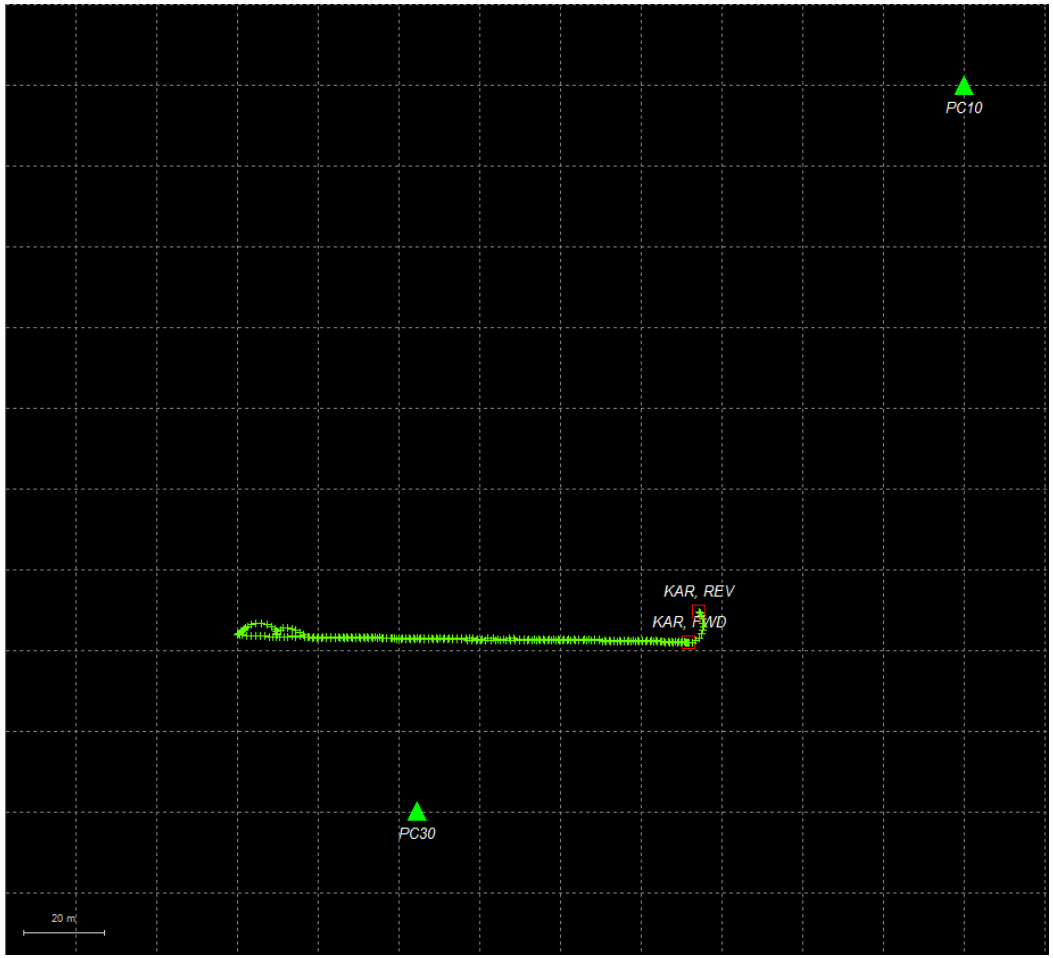
Ground control points set within the agriculture beds.



Post Processing GPS/INS trajectories

- The NovAtel Inertial Explorer 8.10 software was used to post-process the GPS and IMU data in order to produce image trajectories
- This software was utilized to compute integrated inertial navigation solution by combining the raw IMU and GPS data collected with the(MHIS)

Using Inertial Explorer to process the MHIS trajectory

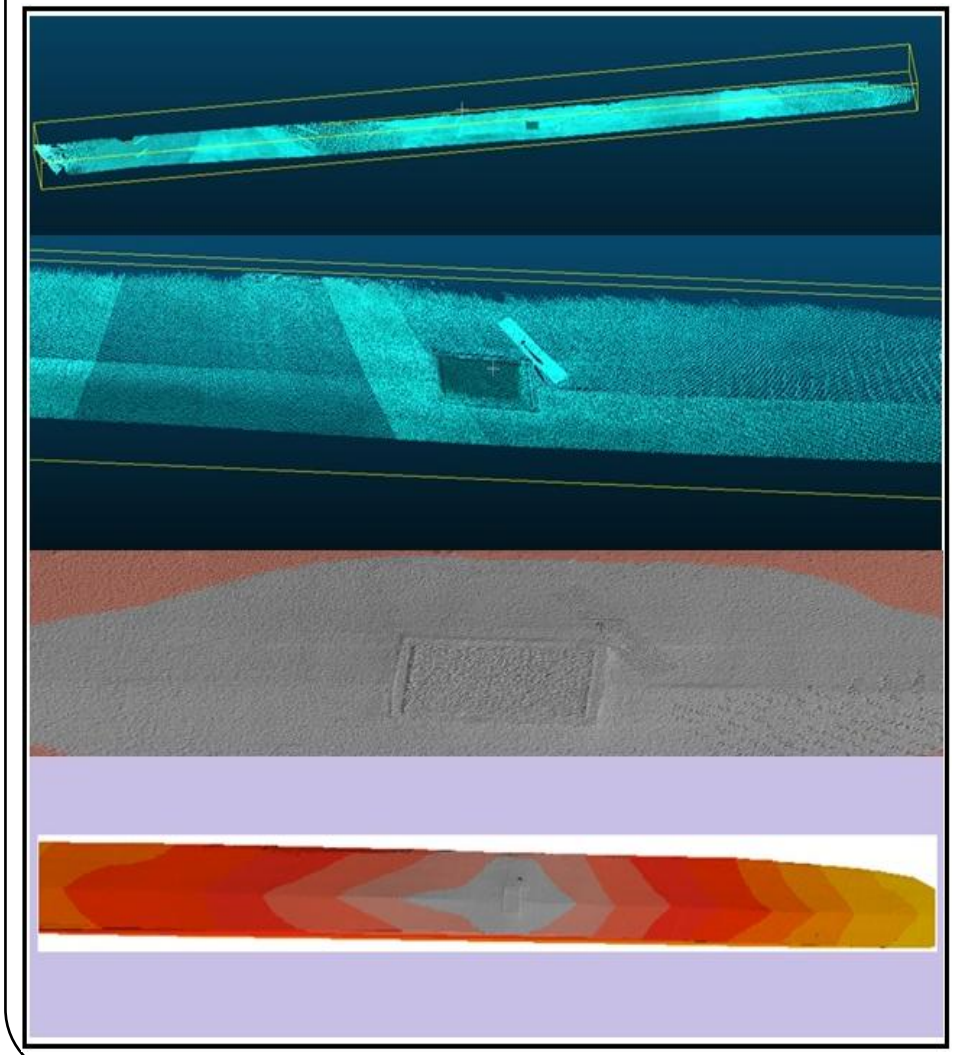


The creation of the Digital Elevation Models

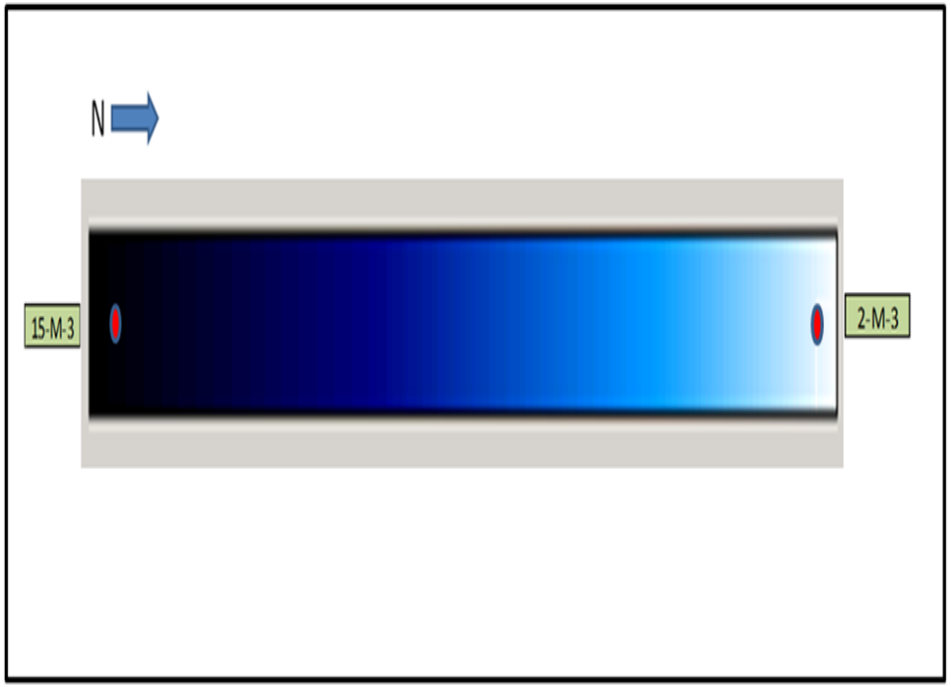
- The ESRI ArcMap10.2 software was the main software used to generate the DEM(s) utilized in this study.
- The first type of DEM was created using lidar point cloud collected in the field with the Trimble GX 3D Scanner
- The second DEM type was designed to be very simplistic. It represented the terrain of the scanned area as a flat rectangular surface with a constant elevation

Digital Elevation Models

The first type of DEM



The second DEM type



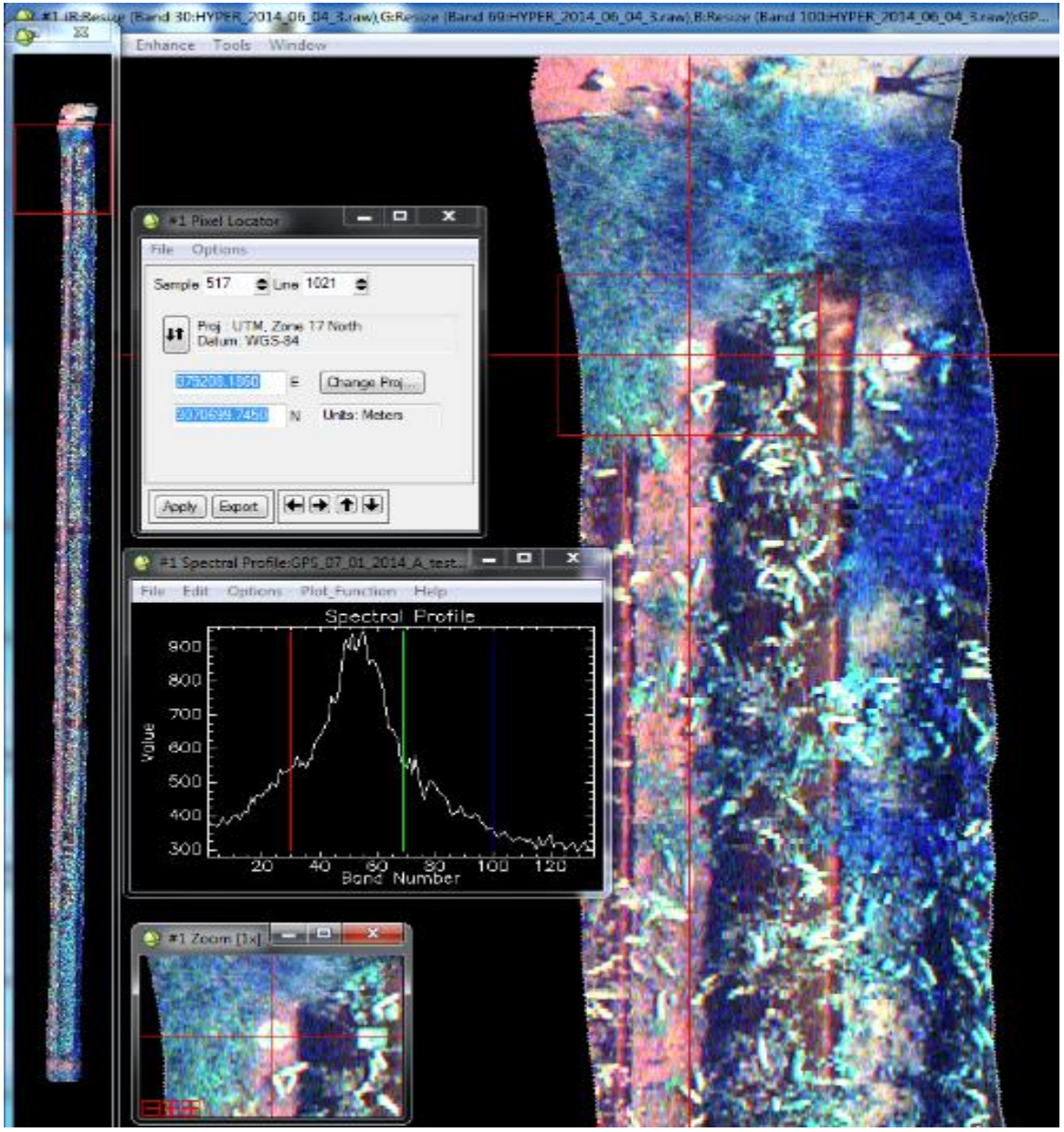
Georeferencing the hyperspectral images

- With the use of PARGE software, a complete georeferencing and ortho-rectification procedure has been implemented
- PARGE reconstructs the scanning geometry for each image pixel using the position, attitude, and terrain elevation data
- Ground control points based procedures have been implemented to recalibrate the bore-sight offsets when needed

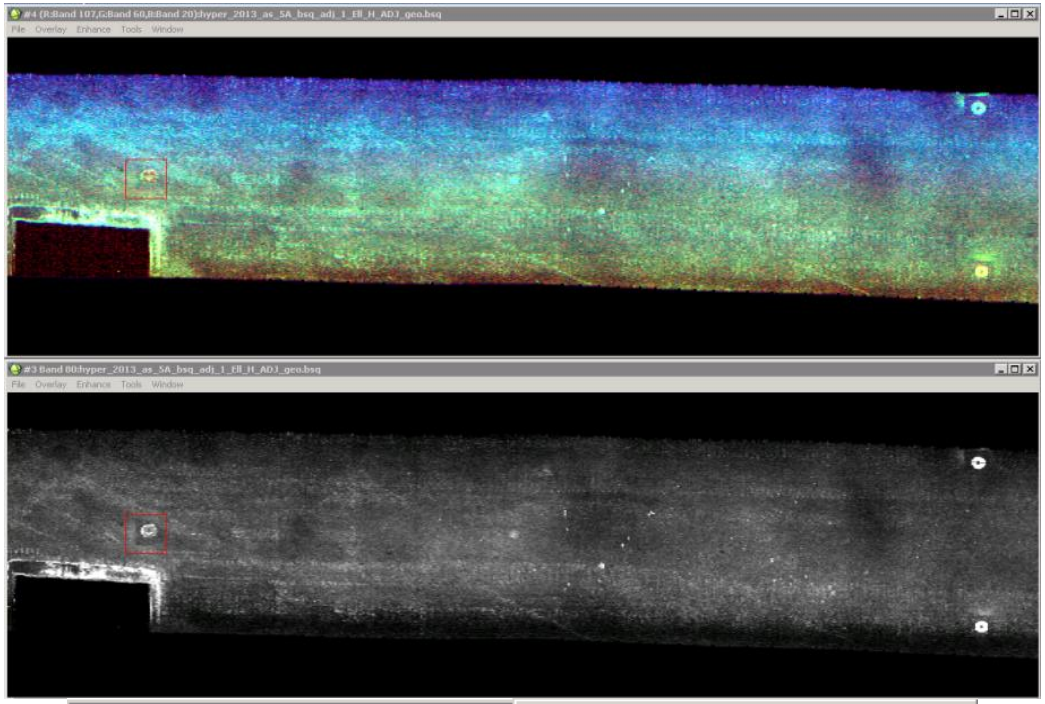
Georeferencing the hyperspectral images (continue)

- Major steps taken in this study to georeference the hyperspectral data using Parge:
- Import the MHIS data
- Define the DEM
- Provide Ground Control Points if needed
- Setting the boresight angle offsets for roll, pitch and heading
- Running the main processor (resample the output to the DEM grid)
- Creating ortho-rectified results

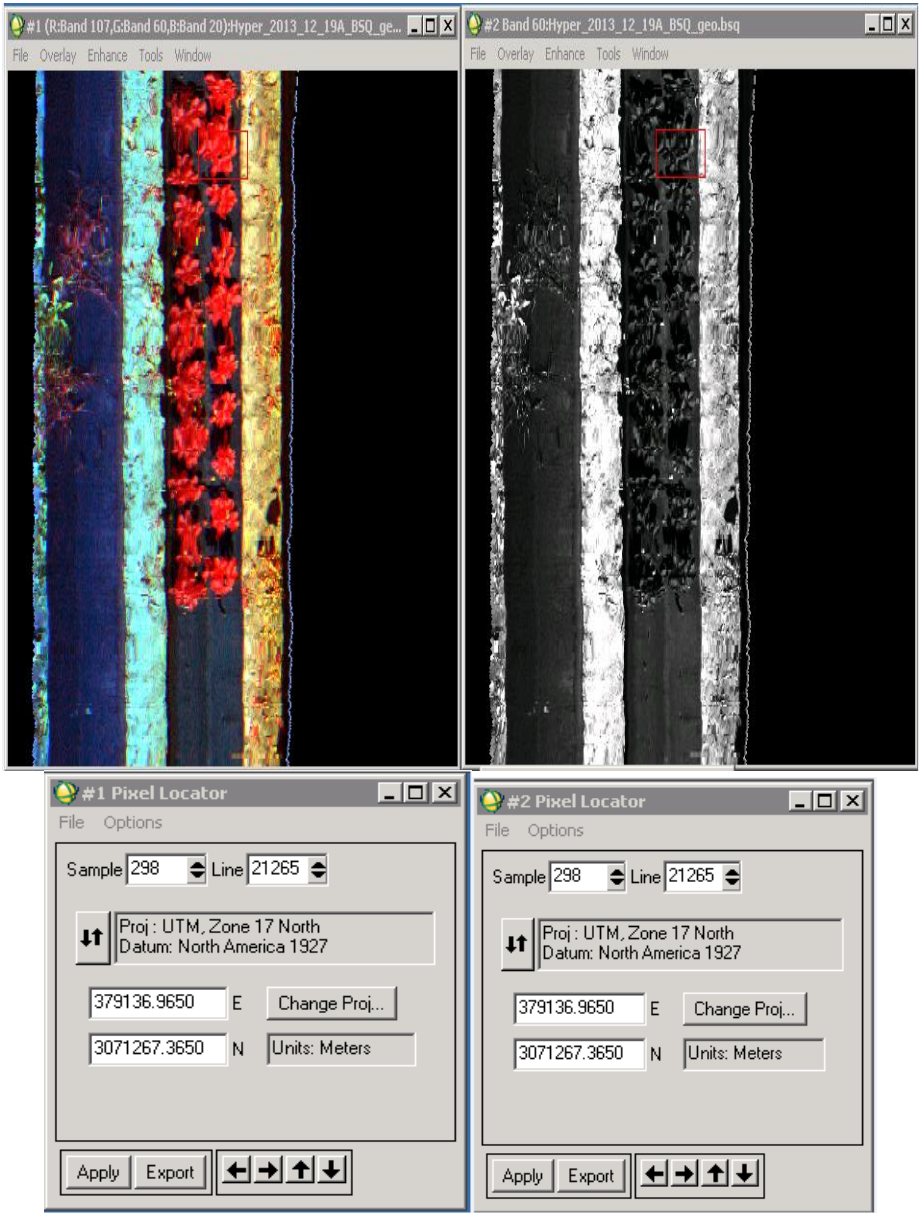
Display of Geo-referenced images using ENVY : Cucumbers



Geo-referenced images:
Pavement section



ENVI: Display of Geo-referenced images: strawberry field



Horizontal positional accuracy : The pavement section

Control point description	Easting (Computed) (meters)	Easting (Surveyed) (meters)	Difference in Easting (meters)	Squared difference in Easting	Northing (Computed) (meters)	Northing (Surveyed) (meters)	Difference in Northing (meters)	Squared difference in Northing
E90N	378893.560	378893.575	0.015	0.000212	3071347.790	3071347.778	-0.012	0.000151
E90S	378893.550	378893.542	-0.008	0.000064	3071345.750	3071345.784	0.034	0.001134
E80POL	378883.560	378883.557	-0.003	0.000012	3071346.970	3071346.973	0.003	0.000011
E70N	378873.590	378873.589	-0.001	0.000001	3071348.240	3071348.177	-0.063	0.003955
E70S	378873.570	378873.539	-0.031	0.000987	3071346.160	3071346.183	0.023	0.000532
E60POL	378863.560	378863.565	0.005	0.000026	3071347.380	3071347.386	0.006	0.000034
E50N	378853.570	378853.583	0.013	0.000161	3071348.620	3071348.589	-0.031	0.000992
E50S	378853.540	378853.543	0.003	0.000010	3071346.540	3071346.584	0.044	0.001977
E40POL	378843.560	378843.564	0.004	0.000014	3071347.780	3071347.789	0.009	0.000084
E30N	378833.560	378833.586	0.026	0.000689	3071349.010	3071348.986	-0.024	0.000581
E30S	378833.550	378833.551	0.001	0.000001	3071346.940	3071346.981	0.041	0.001670
E20POL	378823.560	378823.559	-0.001	0.000001	3071348.190	3071348.185	-0.005	0.000029
E10N	378813.580	378813.581	0.001	0.000001	3071349.430	3071349.391	-0.039	0.001498
E10S	378813.580	378813.547	-0.033	0.001071	3071347.360	3071347.392	0.032	0.001040
		Sum	-0.011	0.0032		Sum	0.018	0.014
		Mean	-0.00075	0.00023		Mean	0.0013	0.00098
			RMSE (x)	**0.015**			**RMSE(y)**	**0.031**
							CSE (39%)	**0.023**

Horizontal positional accuracy :
The agricultural field

Control point description	Easting (Computed) (meters)	Easting (Surveyed) (meters)	Difference in Easting (meters)	Squared difference in Easting	Northing (Computed) (meters)	Northing (Surveyed) (meters)	Difference in Northing (meters)	Squared difference in Northing
1-E-3	379209.670	379209.684	0.014	0.000196	3070699.705	3070699.685	-0.020	0.000400
3-W-3	379208.210	379208.216	0.006	0.000036	3070699.735	3070699.739	0.004	0.000016
4-E-2	379209.070	379209.036	-0.034	0.001156	3070684.745	3070684.733	-0.012	0.000144
5-W-2	379208.450	379208.446	-0.004	0.000016	3070684.735	3070684.739	0.004	0.000016
6-M-1	379208.620	379208.610	-0.010	0.000100	3070669.795	3070669.745	-0.050	0.002500
7-E-4	379209.110	379209.126	0.016	0.000256	3070654.905	3070654.868	-0.037	0.001369
8-ME-4	379208.710	379208.681	-0.029	0.000841	3070654.905	3070654.861	-0.044	0.001936
9-MW-4	379208.110	379208.100	-0.010	0.000100	3070654.895	3070654.868	-0.027	0.000729
10-W-4	379207.640	379207.600	-0.040	0.001600	3070654.985	3070654.963	-0.022	0.000484
11-M-1	379208.130	379208.182	0.052	0.002704	3070639.845	3070639.828	-0.017	0.000289
12-E-2	379208.260	379208.235	-0.025	0.000625	3070624.905	3070624.861	-0.044	0.001936
13-W-2	379207.650	379207.647	-0.003	0.000009	3070624.885	3070624.863	-0.022	0.000484
14-E-3	379208.540	379208.546	0.006	0.000036	3070609.835	3070609.827	-0.008	0.000064
16-W-3	379207.040	379207.022	-0.018	0.000324	3070609.875	3070609.873	-0.002	0.000004
		Sum	-0.079	0.0080		Sum	-0.297	0.010
		Mean	-0.0056	0.00057		Mean	-0.021	0.00074
			RMSE (x)	**0.024**			**RMSE(y)**	**0.027**
							CSE (39%)	**0.026**

CONCLUSION

- The use of the MHIS and the data acquisition method presented in this study was shown to be reliable
- The Control points established in each study site were used to evaluate the positional accuracy of the MHIS data and to estimate a boresight calibration angles when needed
- The data collected from the field experiments was post-processed to create georeferenced hyperspectral images with high spectral and spatial resolution
- The georeferencing accuracy of about 0.025 m was achieved for a series of georeferenced images collected for vehicle in full motion.