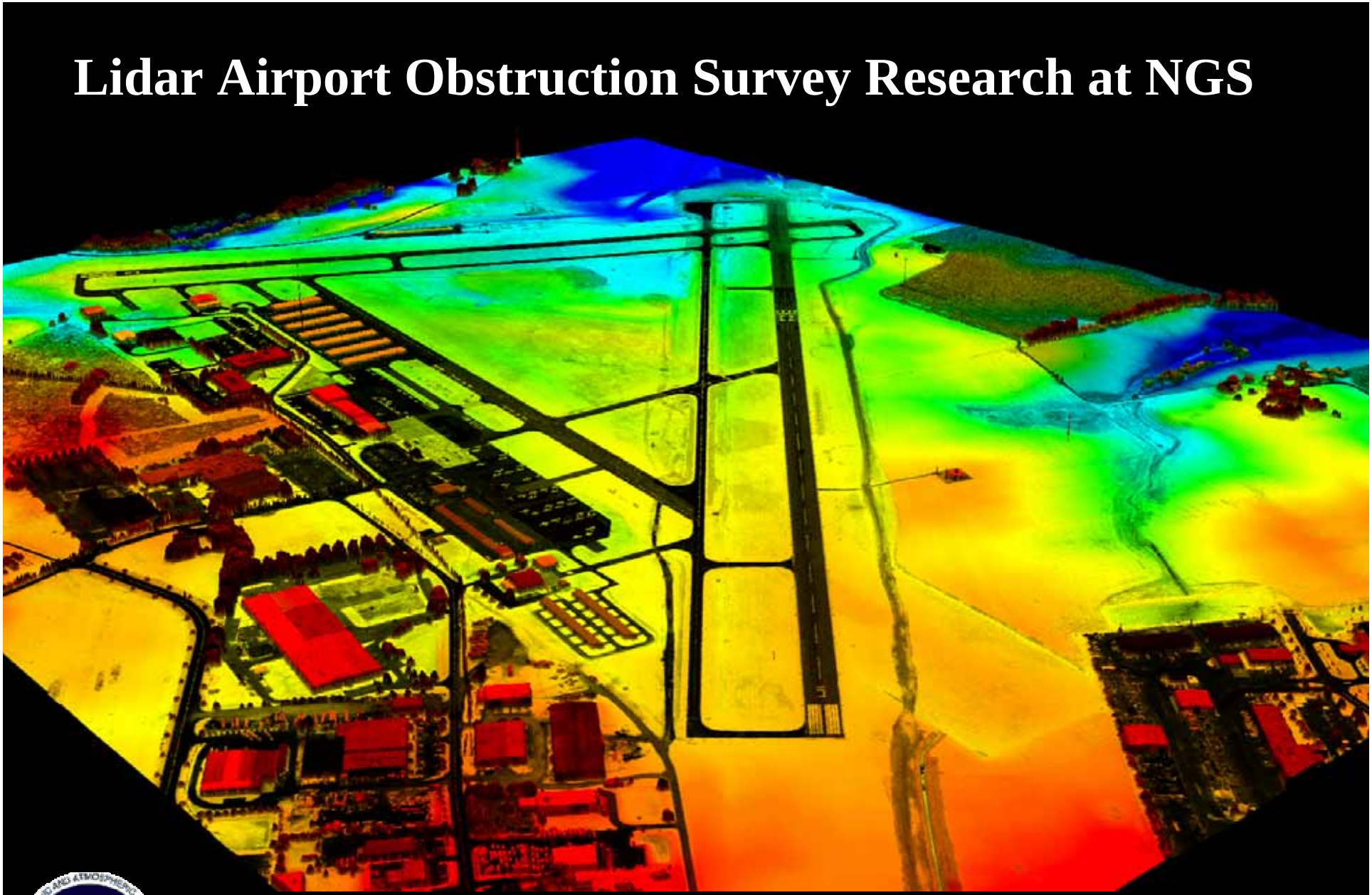
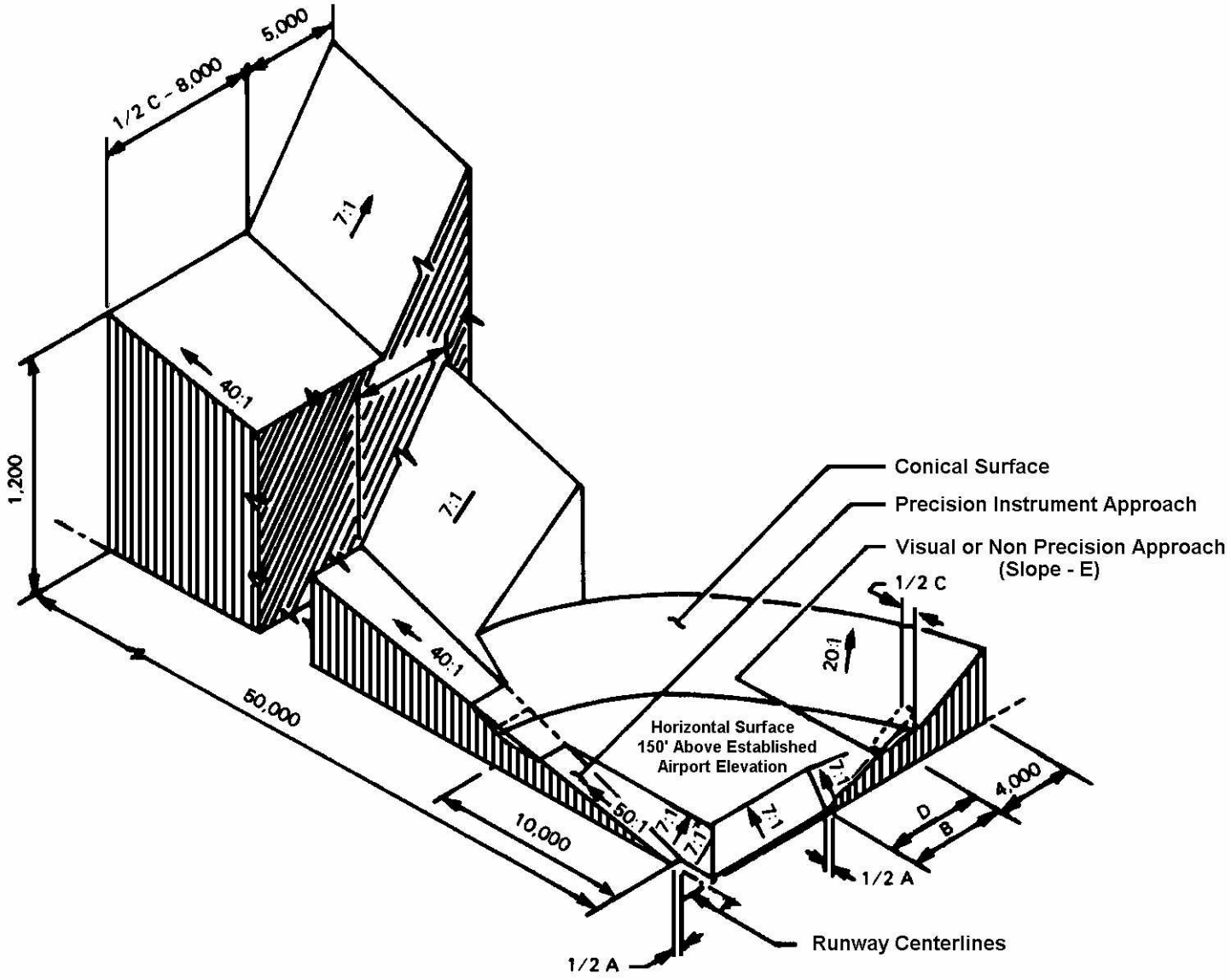
Lidar Airport Obstruction Survey Research at NGS



Chris Parrish

GeoTech 2003

Airport Obstruction Surveying

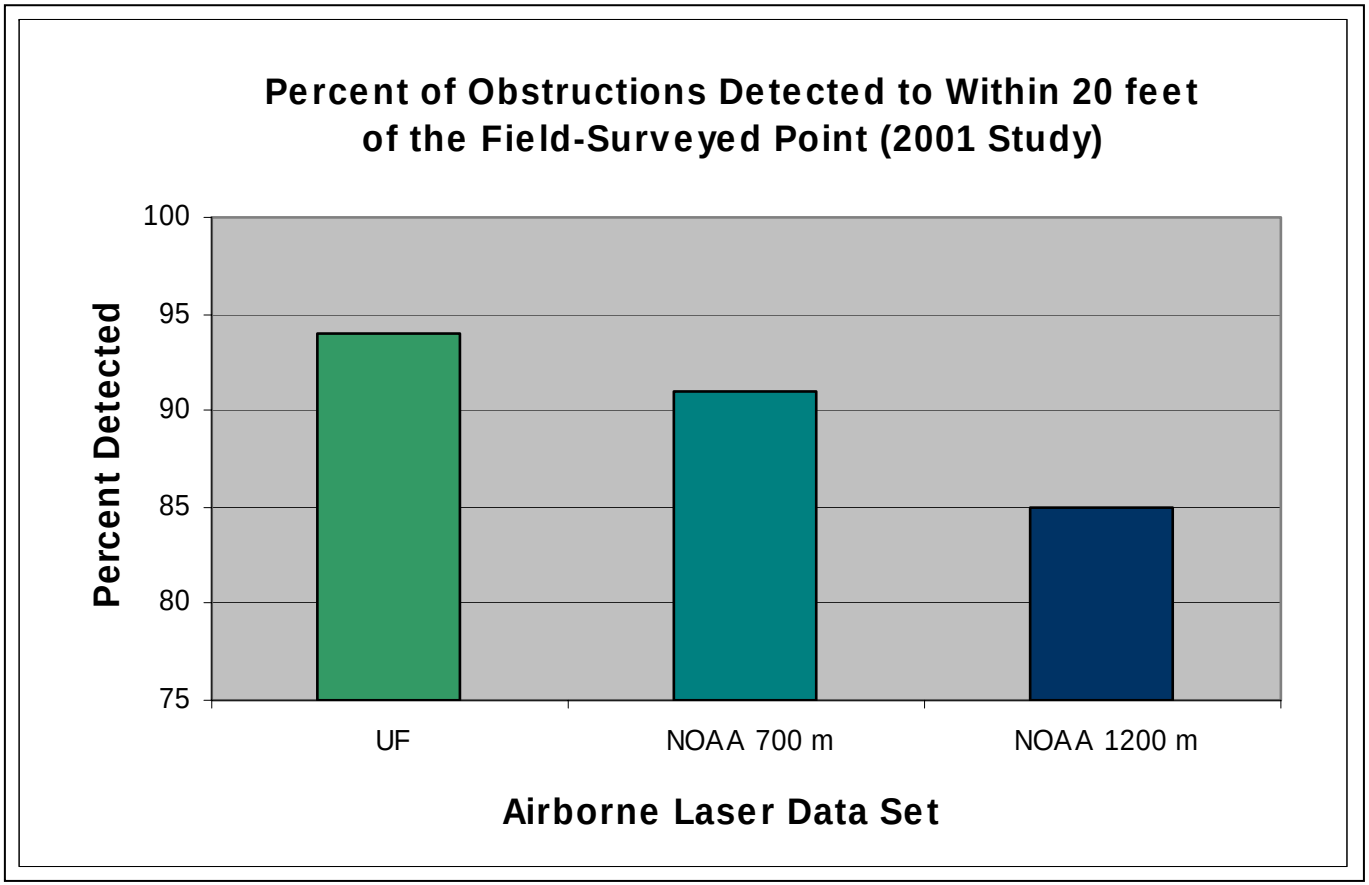


Phase 1 (2001):

- Initial study at GNV
- Joint NGS, FAA, UF, and Optech project

Phase 1 (cont'd):

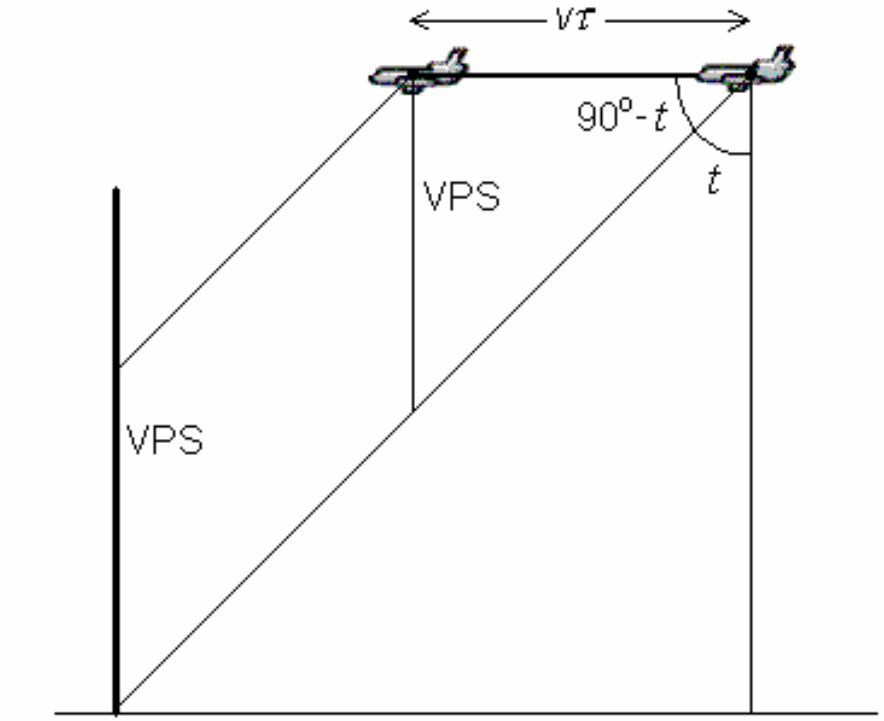
- Used off-the-shelf commercial lidar systems and standard topographic data collection configurations
- At best, only 94% of the field-surveyed obstructions were detected



Underlying Hypothesis for Phase 2:

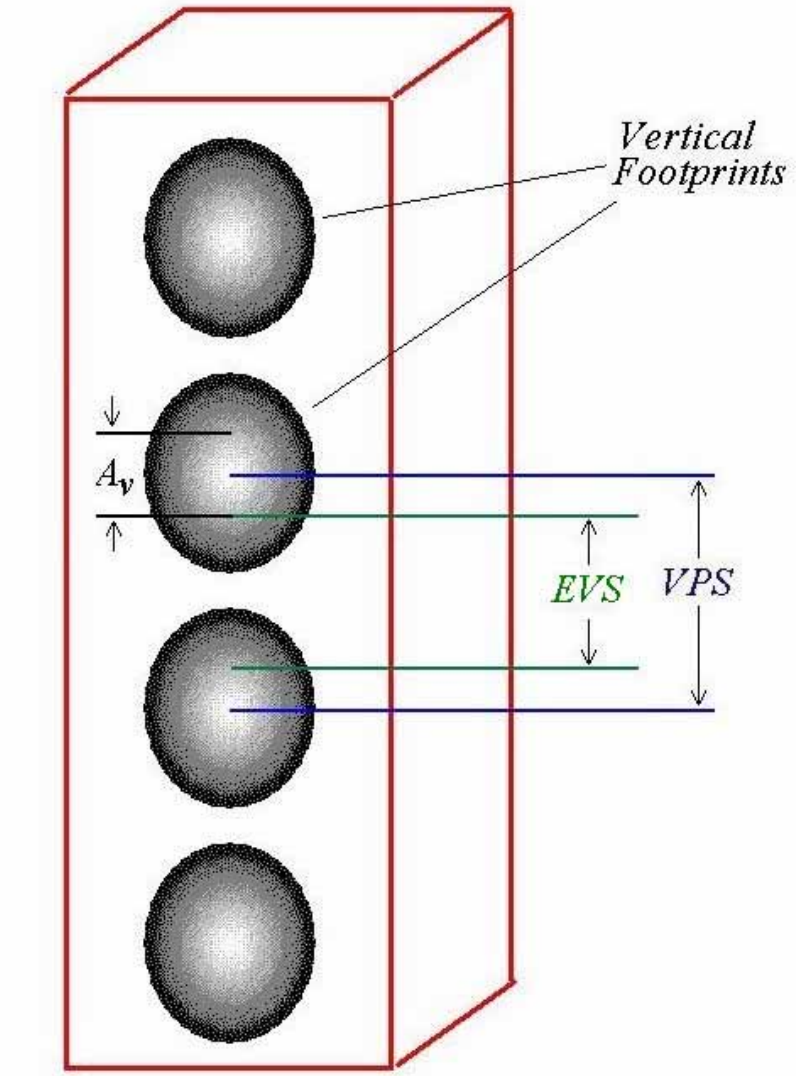
The capability to detect obstructions with an airborne laser scanning system can be substantially enhanced by modifying certain data collection and system parameters.

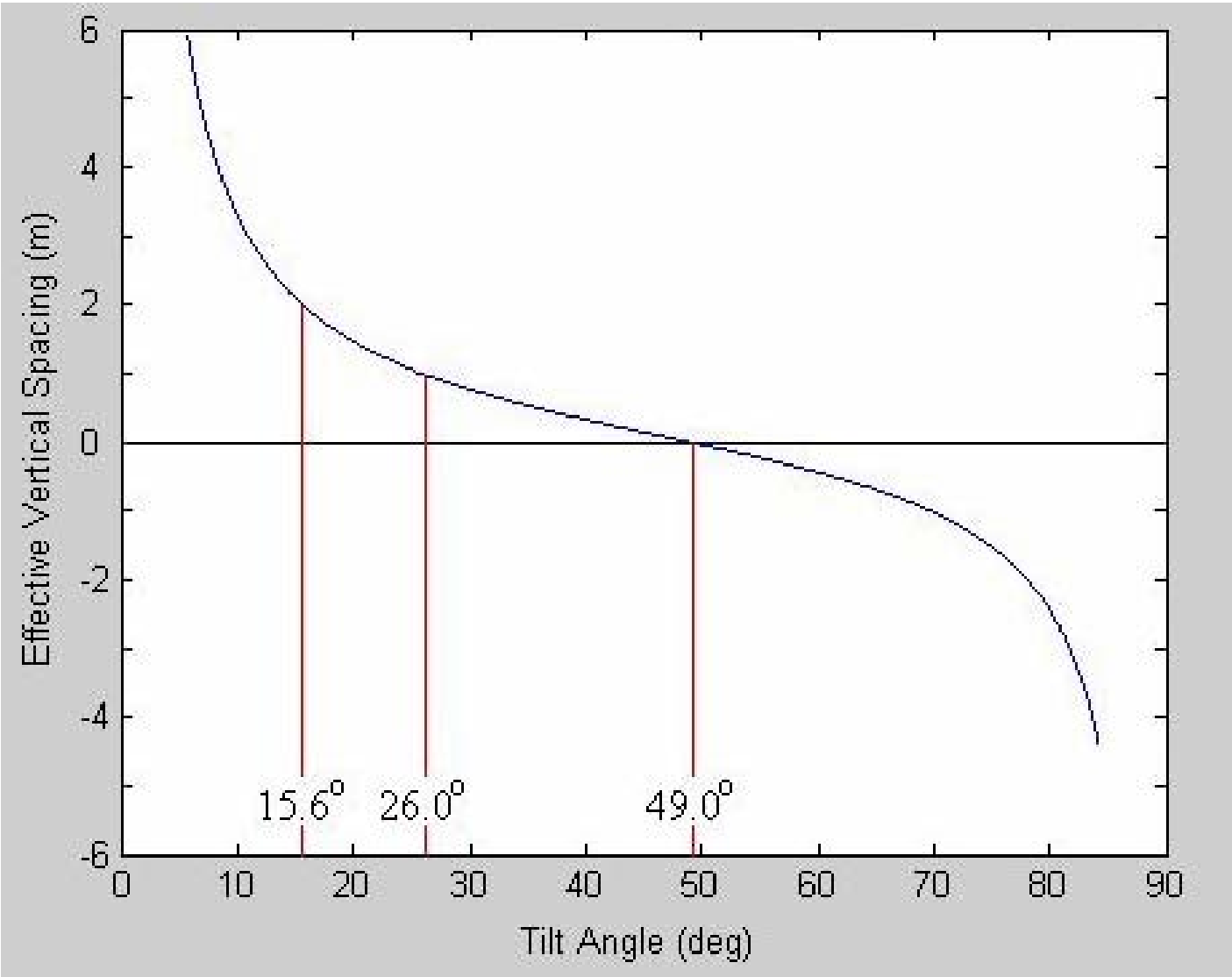
Geometric Considerations in Obstruction Detection



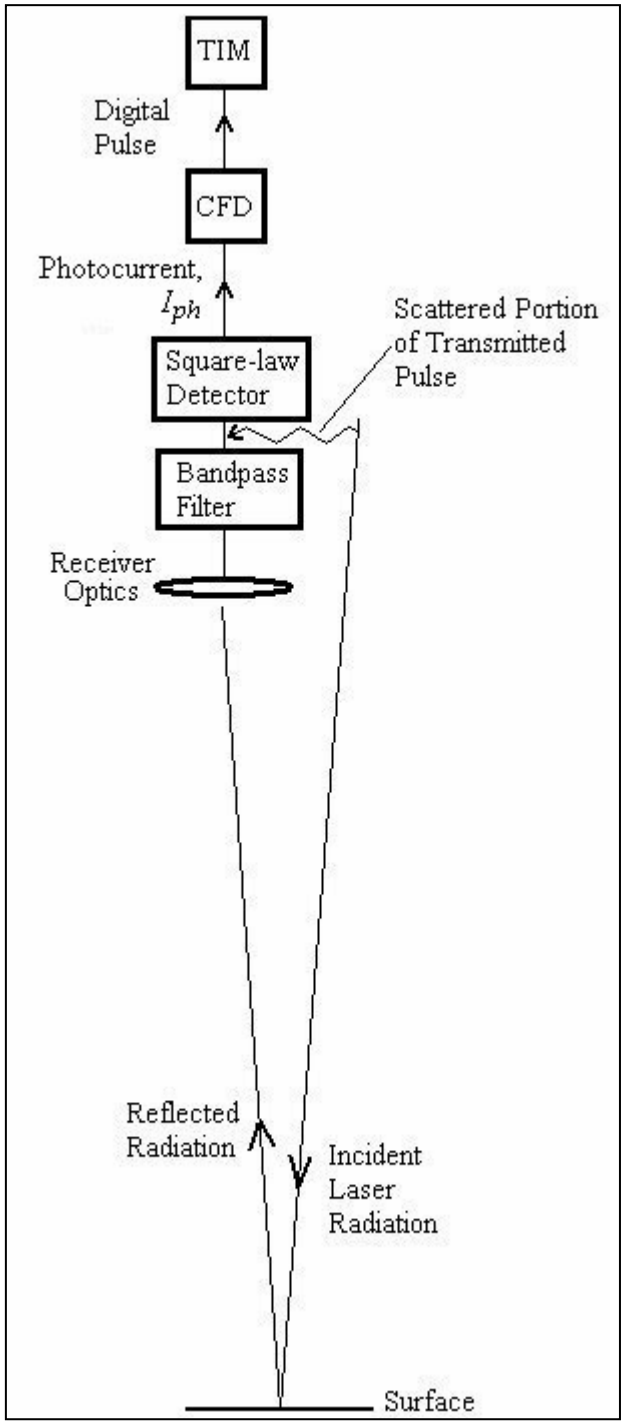
$$\text{VPS} = v\tau[\tan(90^0 - t)]$$

$$= v\tau \cot t$$





Parameters: h = 750 m, v = 55 m/s, τ = 0.019 s, and γ = 0.60 mrad



Radiometric Considerations in Obstruction Detection

$$E_a = \frac{P_T \sigma}{\pi^2 \gamma^2 R^4} T_{ATM}^2$$

= Irradiance $\left(\mathrm{W}/\mathrm{m}^2\right)$ incident on receiver optics

$$P_r = A_r E_a$$

= Power received (W)

$$I_{ph} = \Re P_r T_{SYS}$$

= Generated photocurrent

P_T = transmitted power

σ = effective target cross section

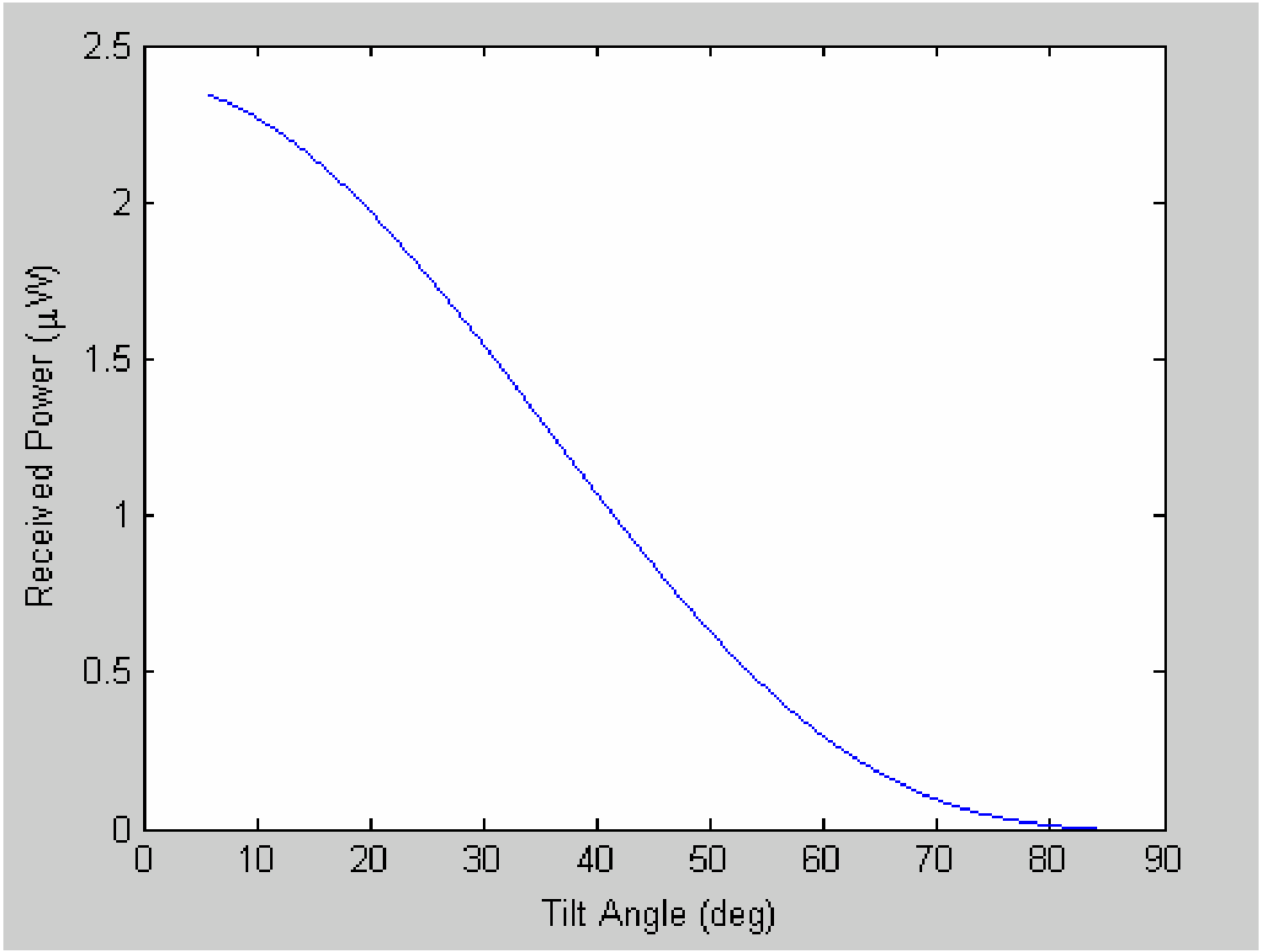
γ = beam divergence

R = range

T_{ATM} = atmospheric transmittance

$\Re$ = responsivity of photodetector

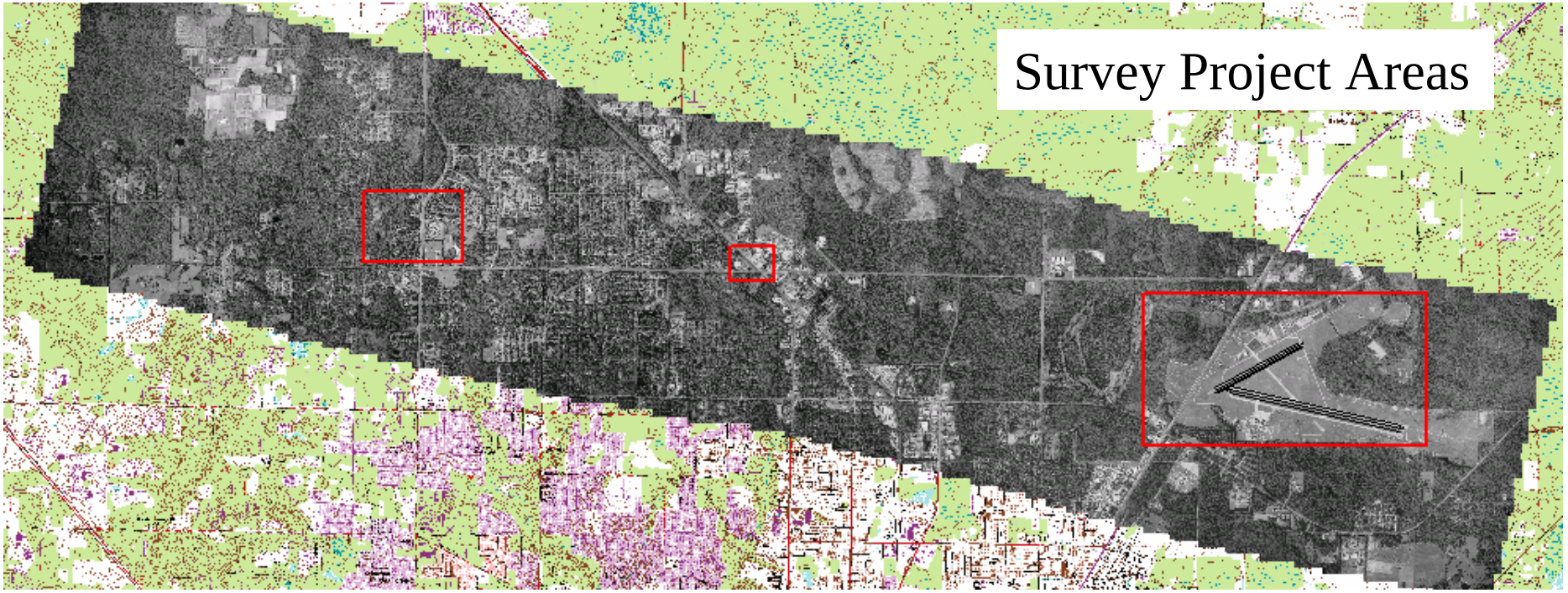
T_{SYS} = system transmittance



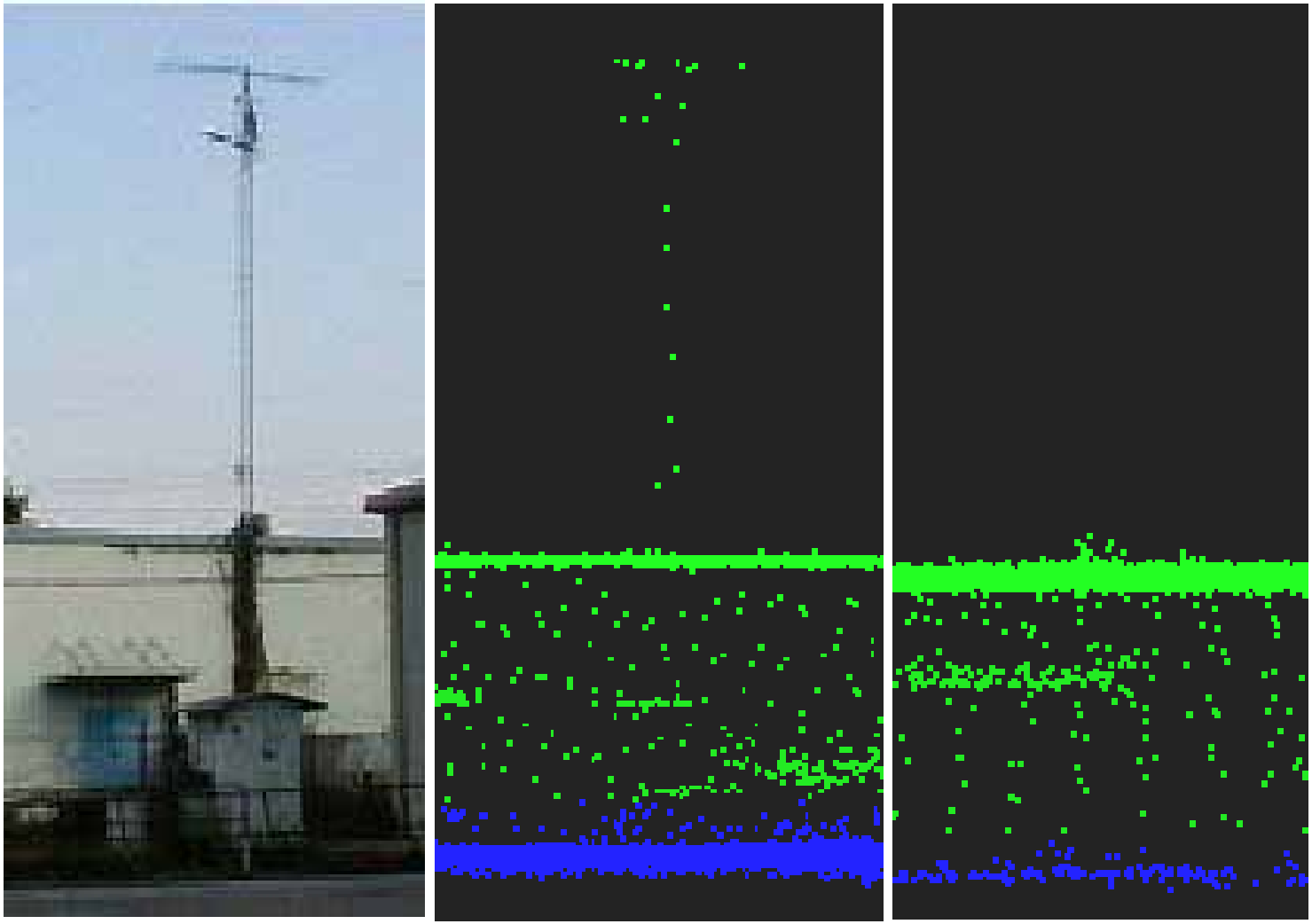
P_T = 11.3 kW (peak, *not* average); γ = 0.6 mrad; T_{ATM} = 0.87; h = 750 m; ρ = 0.318 (reflectance of SPN 452); d = 0.305 m (diameter of SPN 452); $A_r = 1.79 \times 10^{-3}$ m^2

14 Data Collection Configurations

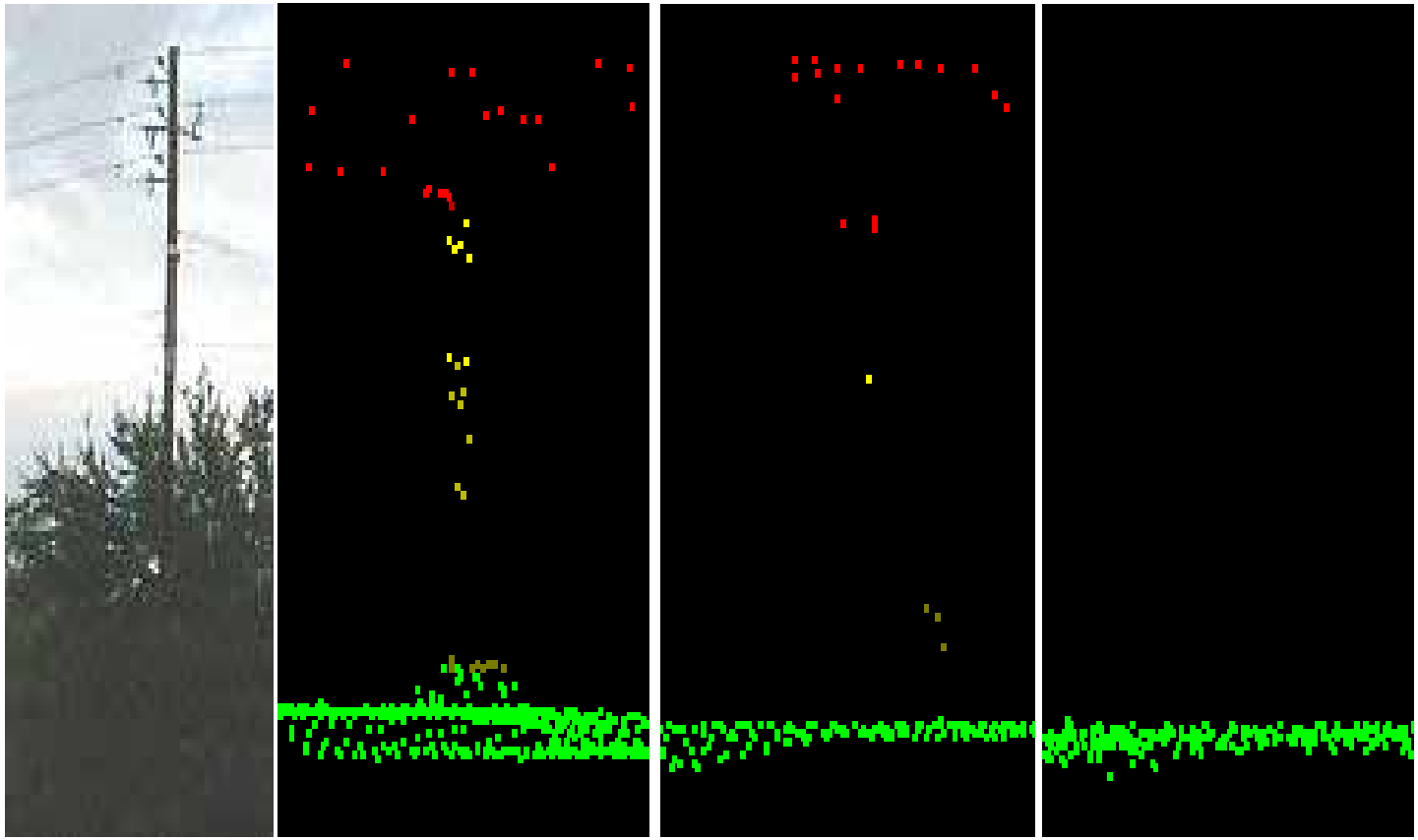
Configuration #	Tilt (deg)	Divergence (Wide/Narrow)	Flying Height (m)	Predicted VPS (m)	Predicted EVS (m)
1	0	N	750	N/A	N/A
2	0	W	750	N/A	N/A
3	10	N	750	5.9	5.0
4	10	W	750	5.9	3.3
5	20	N	750	2.9	2.4
6	20	W	1050	2.9	0.9
7	20	W	1150	2.9	0.7
8	20	W	750	2.9	1.5
9	20	W	850	2.9	1.3
10	20	W	950	2.9	1.1
11	30	N	750	1.8	1.5
12	30	W	750	1.8	0.8
13	40	N	750	1.2	0.9
14	40	W	750	1.2	0.3



Custom sensor mount: 0- 40 deg tilt angle



Left to right: Digital photo of obstruction 452; data points on this object computed from laser returns obtained with Configurations 5 and 14.



Left to right: Digital photo of obstruction 460; data points on this object computed from laser returns obtained with Configurations 5, 8, and 12.

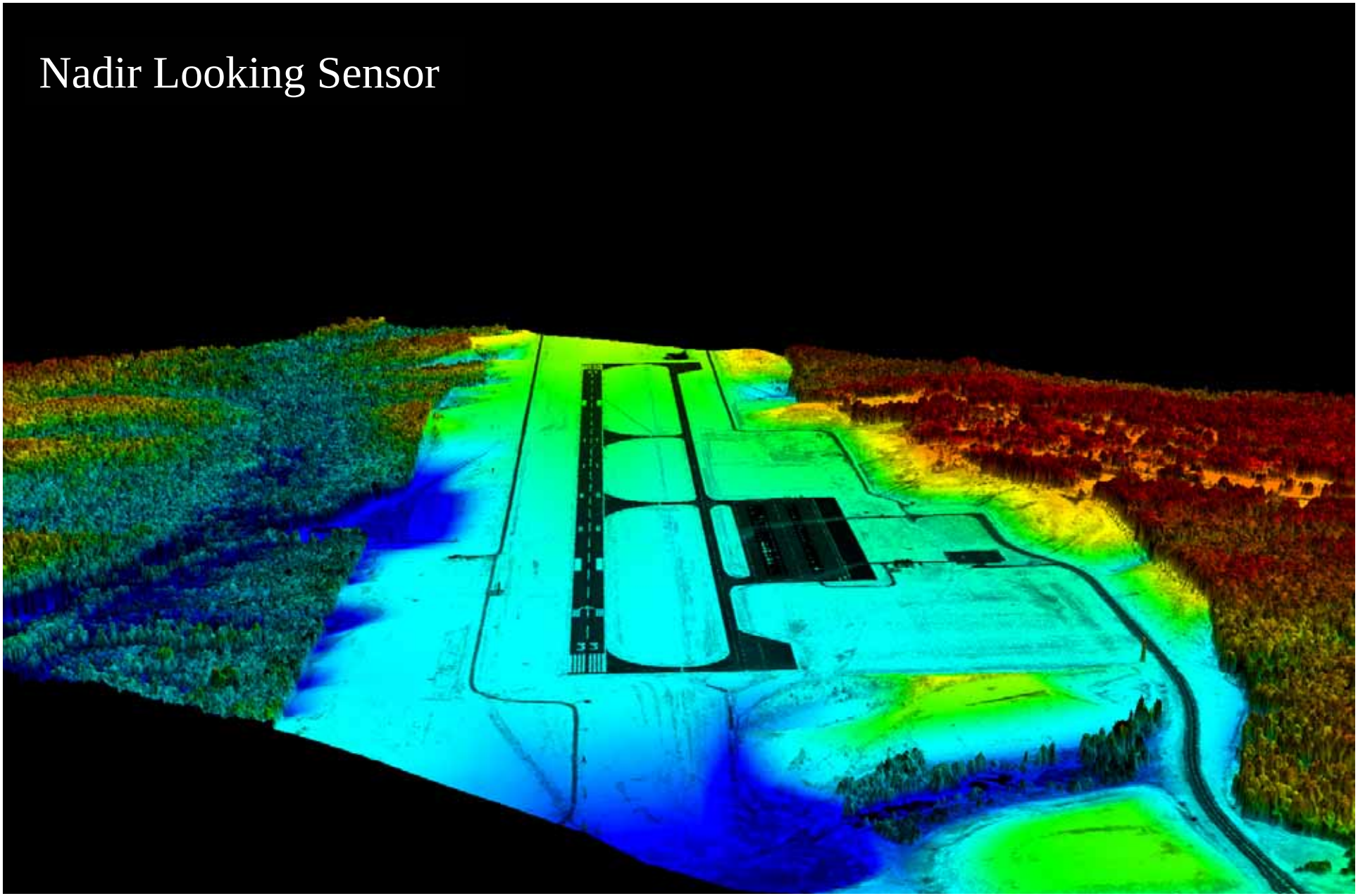
Phase 2:
Obstruction Detection Analysis Results

Config #	Parameters (tilt in deg; wide/narrow divergence; flying height in m)	Percent of Obstructions Detected	RMSE (m)	Accuracy at 95% CL (m)
5	Tilt: 20, Div.: N, FH: 750	100	0.88	1.73
1	Tilt: 0, Div.: N, FH: 750	100	1.04	2.04
8	Tilt: 20, Div.: W, FH: 750	100	1.26	2.46
9	Tilt: 20, Div.: W, FH: 850	98	1.81	3.55
13	Tilt: 40, Div.: N, FH: 750	96	1.14	2.23
2	Tilt: 0, Div.: W, FH: 750	96	1.24	2.42
3	Tilt: 10, Div.: N, FH: 750	94	1.23	2.42
4	Tilt: 10, Div.: W, FH: 750	94	1.27	2.49
10	Tilt: 20, Div.: W, FH: 950	87	1.99	3.91
11	Tilt: 30, Div.: N, FH: 750	85	1.83	3.58
14	Tilt: 40, Div.: W, FH: 750	77	2.13	4.17
7	Tilt: 20, Div.: W, FH: 1150	77	2.16	4.22
6	Tilt: 20, Div.: W, FH: 1050	73	2.02	3.97
12	Tilt: 30, Div.: W, FH: 750	63	2.17	4.25

Phase 3 Study

- Data collection: Sept. 8-11, 2003
- Two 50 kHz ALTMs: one nadir-pointing and one with a 20^{o} tilt angle
- Airports: Frederick, MD (FDK) and Stafford, VA (RMN)

Phase 3 LIDAR Experiment- Stafford Airport



Next Steps

- Compare Phase 3 lidar data against field surveyed obstruction data
- Perform OIS analysis on Phase 3 lidar data and deliver final processed data sets to FAA
- Develop Instrument Approach Procedures from processed lidar data
- Expected completion date: Nov. 14, 2003