



CORPORATION International

Height Estimation using Matched Terrain Processing

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Contract # AFRL/SNRT

Outline

- **Motivation**
- **SBIR Objective**
- **Scenario**
- **MTP Algorithm**
- **Results**
- **Future Research**

Motivation

- Reduce number of assets
- Height Estimation from a single platform

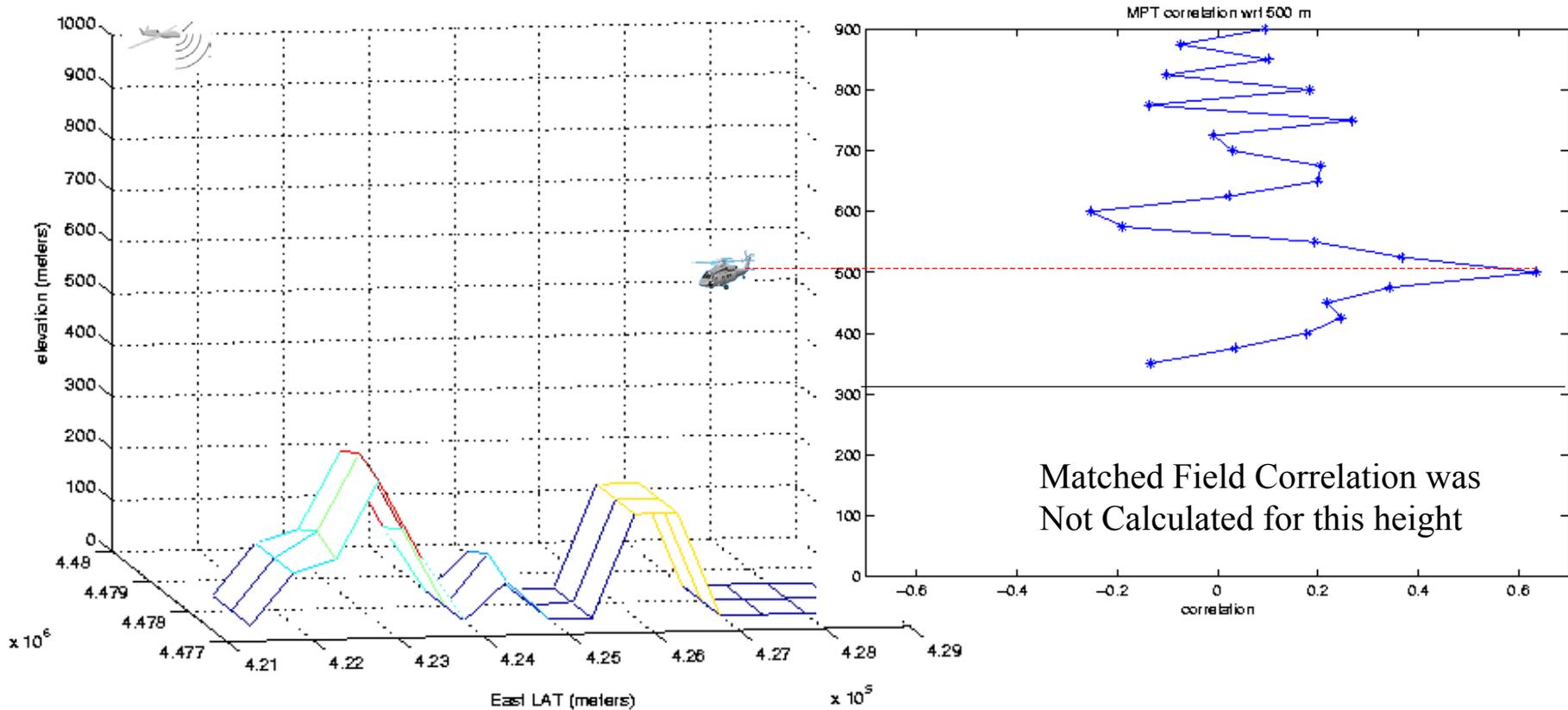


SBIR Objective

- **Determine height estimate**
- **Given DETD & Terrain backscatter**
 - High resolution terrain data
 - Backscatter database
- **Setup a scenario**
- **Develop the MTP algorithm**
 - Leveraging similar algorithm
 - Radar Equation for MTP
 - Patches
- **Results through simulation**

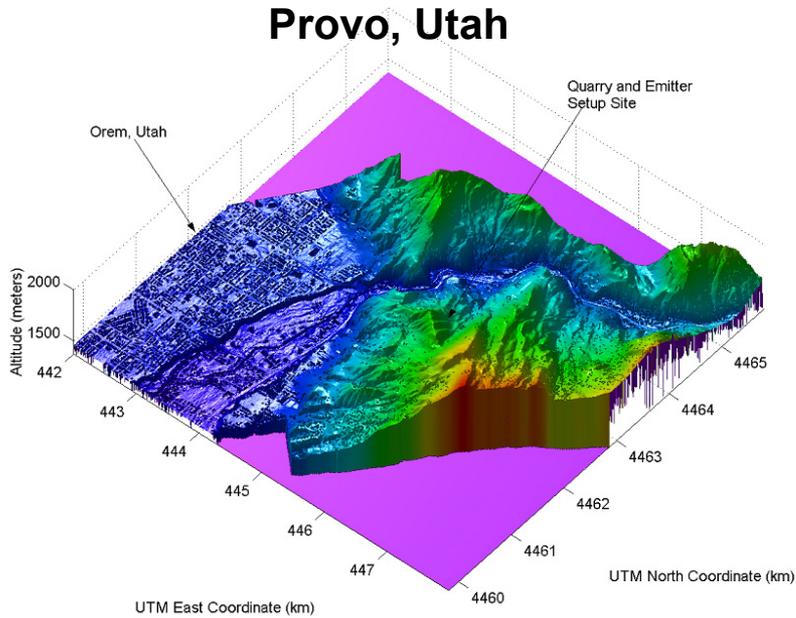


Height Estimate

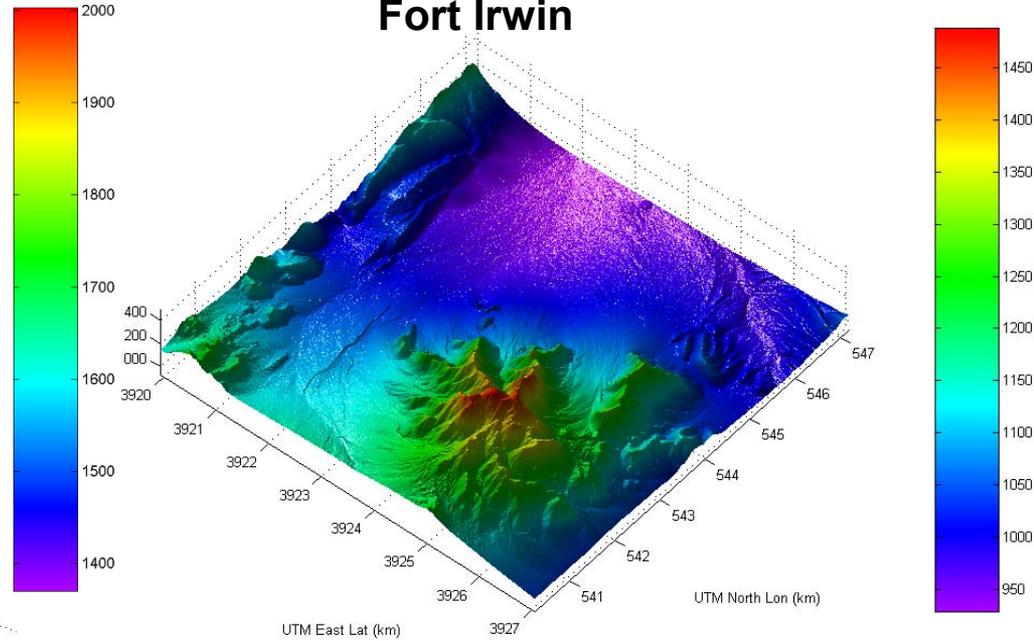


Possible Phase I Scenario

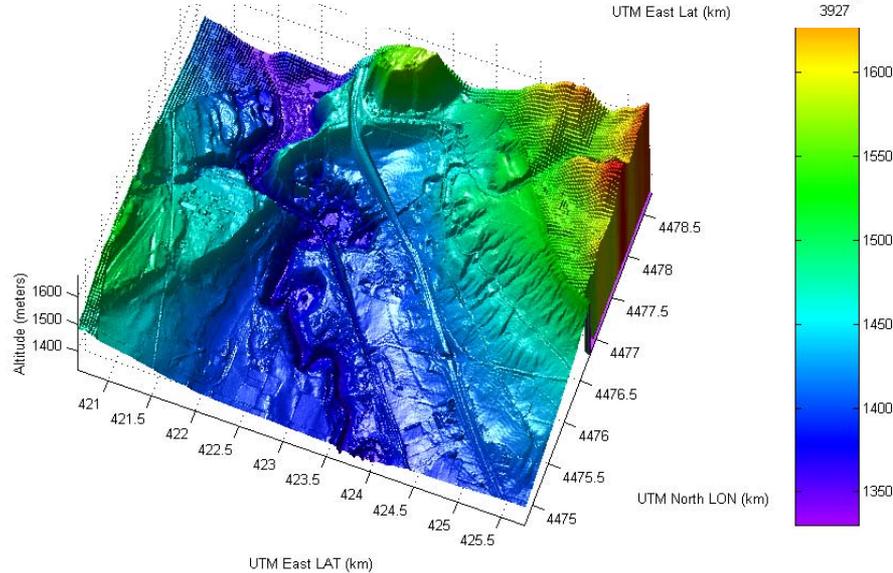
Provo, Utah



Fort Irwin



Point of the Mountain

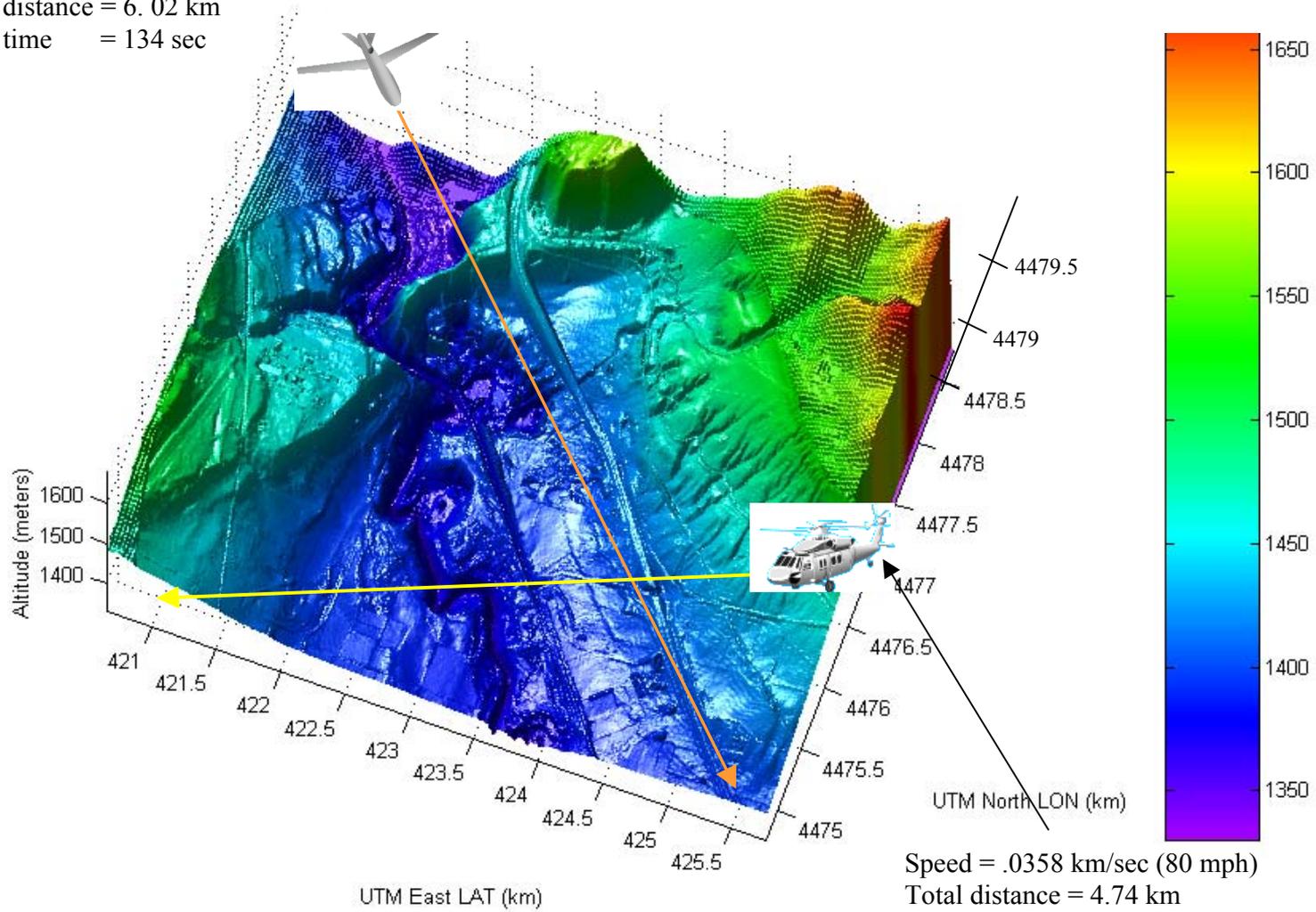


Phase I Scenario – Point of the Mountain, Utah



Phase I Scenario – Point of the Mountain, Utah

Speed = .0447 km/sec (100 mph)
Total distance = 6.02 km
Total time = 134 sec



Speed = .0358 km/sec (80 mph)
Total distance = 4.74 km
Total time = 132 sec



Phase I Scenario – Source and Target Parameters

Source



- Position
 - Initial
 - 4479.5 NL km, 421 EL km,
 - 3500 m height
 - End position
 - 4475 NL km, 425 EL km,
 - 3500 m height
- Total distance
 - 6.02 km
- Velocity
 - 44.80 m/s (100 mph)
- Radar parameters
 - $f = 10$ GHz
 - Pulse duration = 100 ns (10 MHz BW)
 - # Pulses = function of Correlation
 - PRI = 1000

Target



- Position
 - Initial
 - 4477 NL km, 425.5 EL km,
 - 1550 m height
 - End position
 - 4475 NL km, 421 EL km,
 - 1550 m height
- Total distance
 - 4.74 km
- Velocity
 - 33.84 m/s (80 mph)

Phase I Scenario – Terrain Backscatter Justification



(a)



(a)

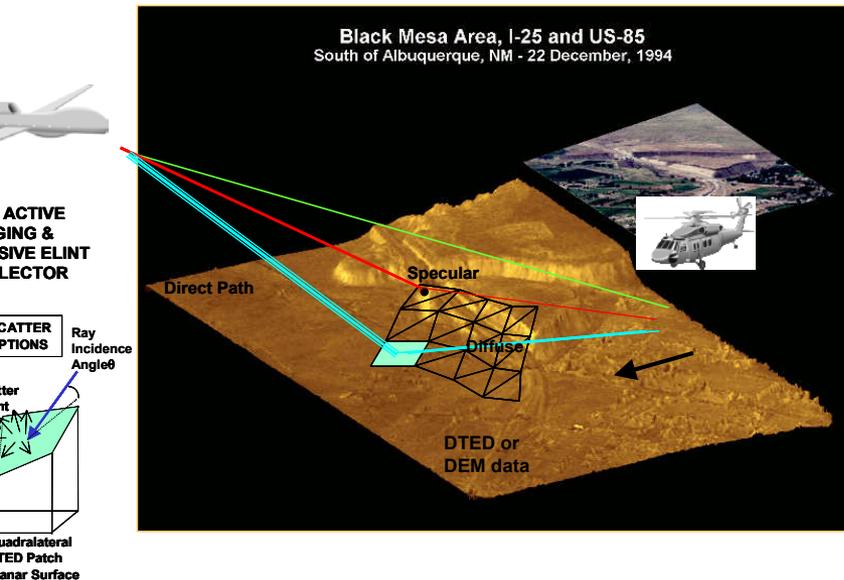


(b)

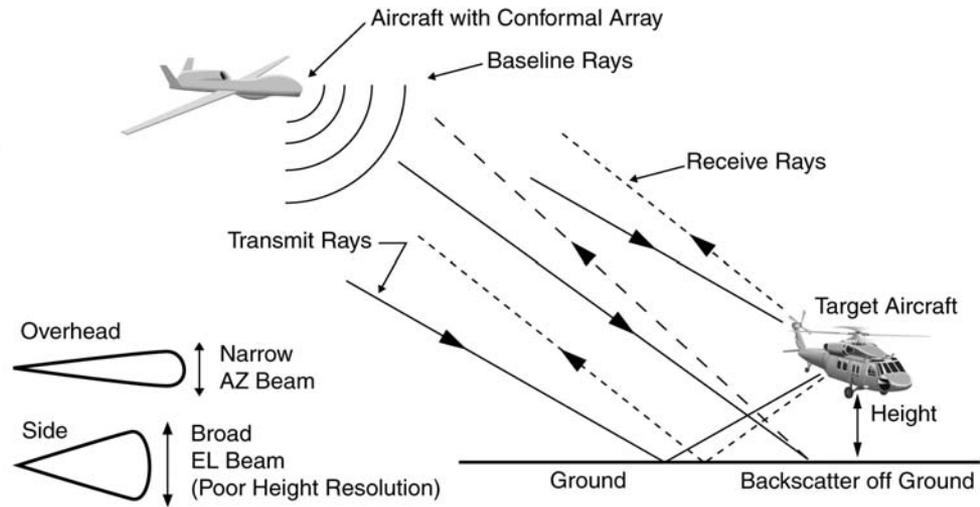


(b)

General MTP Algorithm Concept

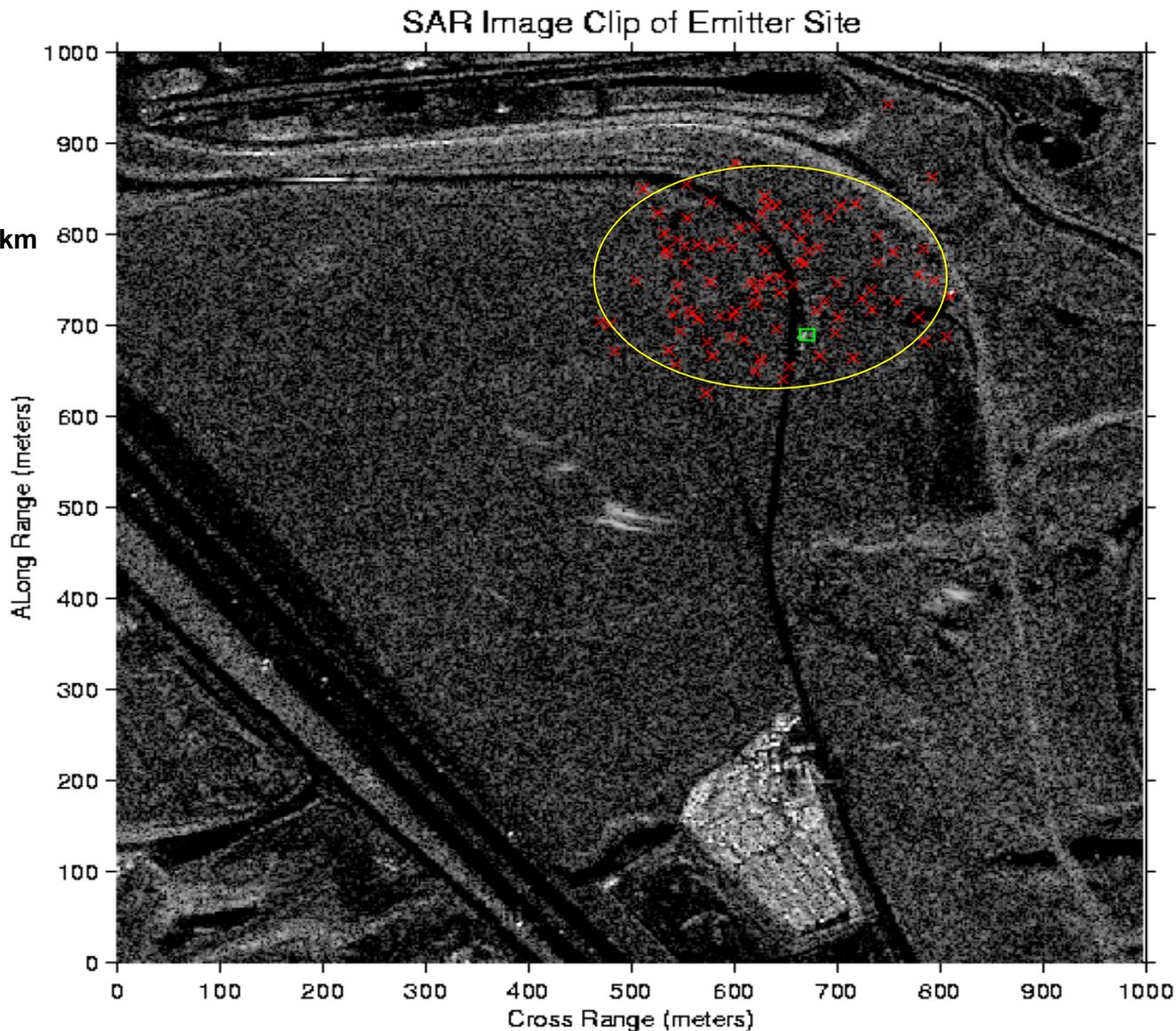


Position (p)
Heading (h)



Leveraging the Success of Another MTP Algorithm

Pass 3663, Aim Point #1
Full DTED (~Level 4—3m)
96 Single Pulse Events
over 28 Seconds (right,
mid, and left of CPA)
Search area: 1.5 km x 1.5 km



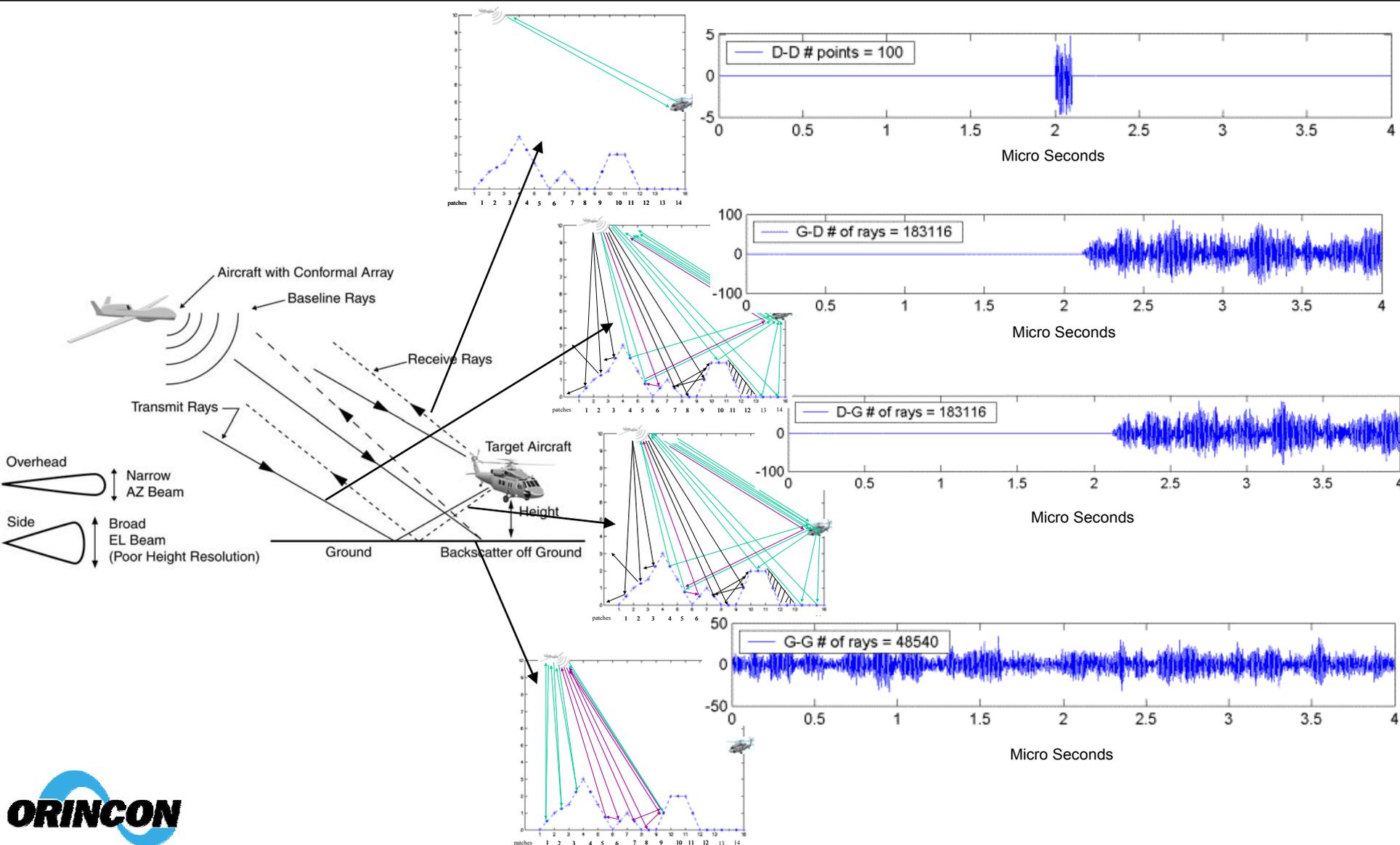
Green Square: true
emitter location

Red Xs: estimated
emitter locations

Yellow Ellipse: 90%
probability region

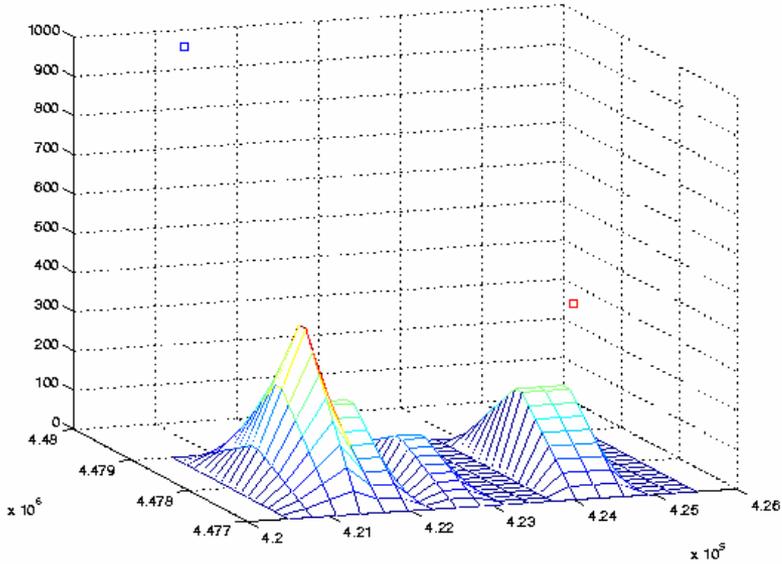


Matched Terrain Processing Concept

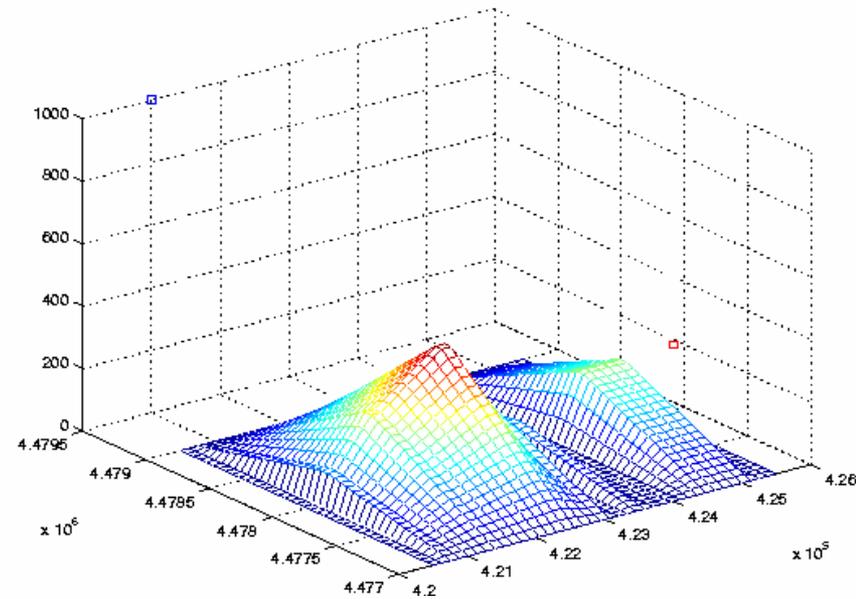


MTP Algorithm – Patch Significance

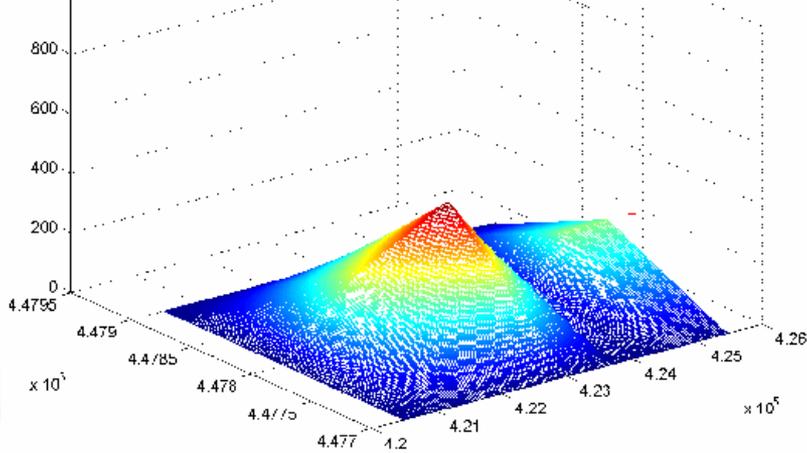
250 meters resolution



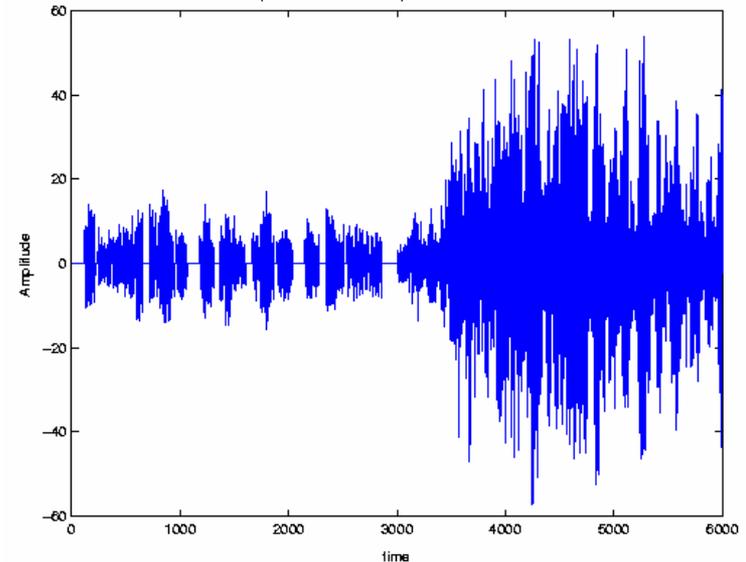
Terrain with resolution = 25 meters



2.5 meter resolution

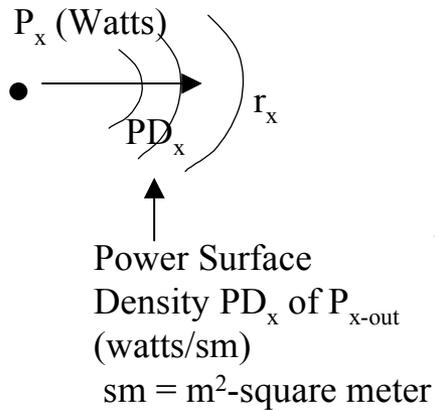


composite waveform with patch resolution = 250 m

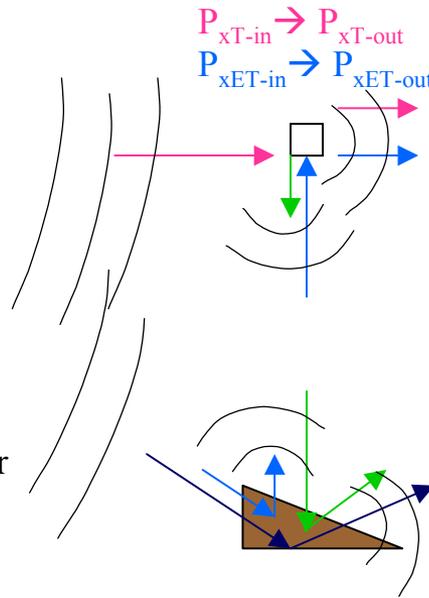


MTP Radar Equation

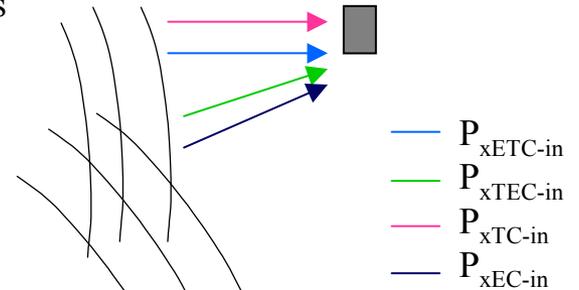
Source
(Xmt Platform)



Target
(Effective Area- Phase I is point like)



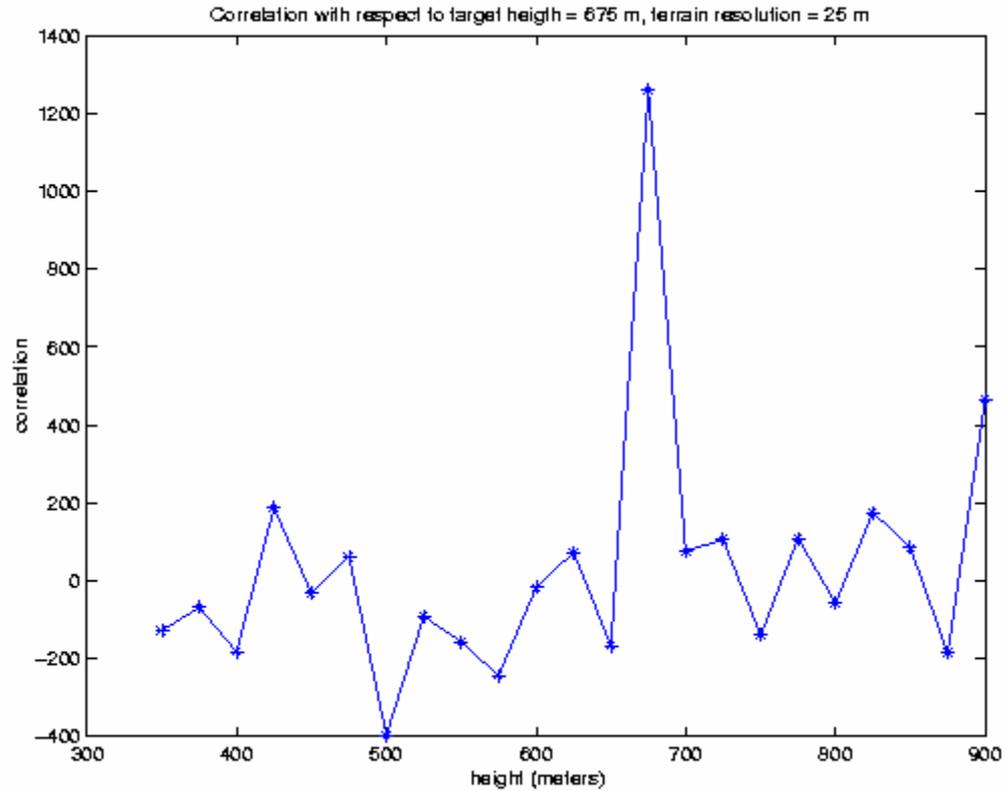
Receive (Same as source)
(A_C - Area of receive Platform)



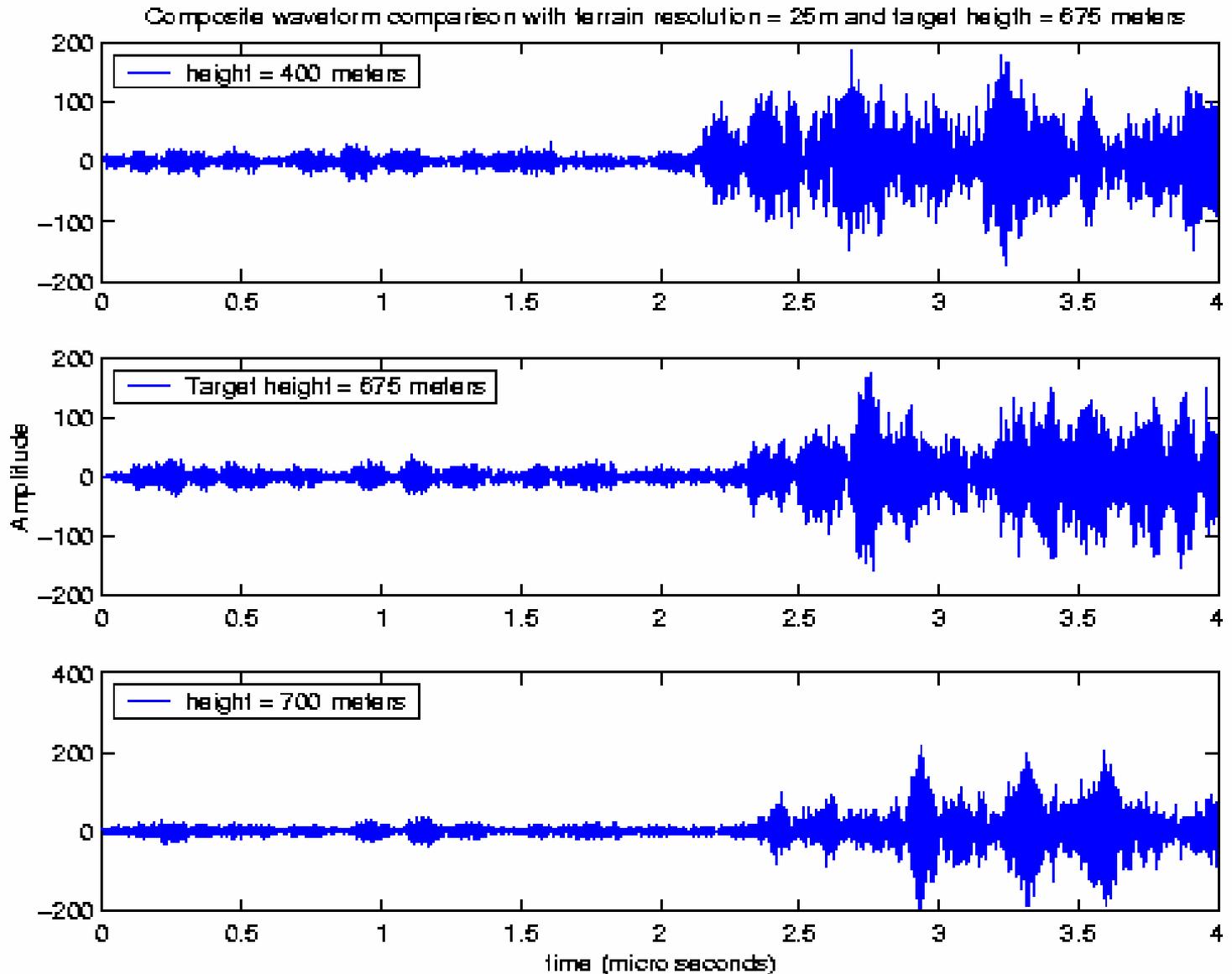
Note:

P – represents Power
 PD – represents Power Surface density

Matched Terrain Correlation



MTP Composite Waveforms



Future

- **Test robustness**
 - Additional Scenarios, Better Backscatter models
- **Enhance fidelity of the models**
 - Target, Terrain, Multiple bounces
- **Increase the problem beyond just height, full Kinematic estimation**
- **Incorporate Tracking across pulses and fusing multiple sensors**
- **Computational implementations**