

Radio Propagation Measurements During a Building Collapse: Applications for First Responders

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Objectives:

- **Better understanding of the complex radio environment faced by first responders**
- **Straightforward, cost effective, reliable, methods to improve radio communications and geolocation for first responders in difficult signal environments**

Sponsors: NIST Office of Law Enforcement Standards (OLES) for the DOJ, Community Oriented Police Services (COPS) program, and Dept. of Homeland Security (DHS)

Focus: Techniques and data immediately useful to first responders and system designers!

Implosion Experiments

Concept: Use selected planned building demolitions as laboratories

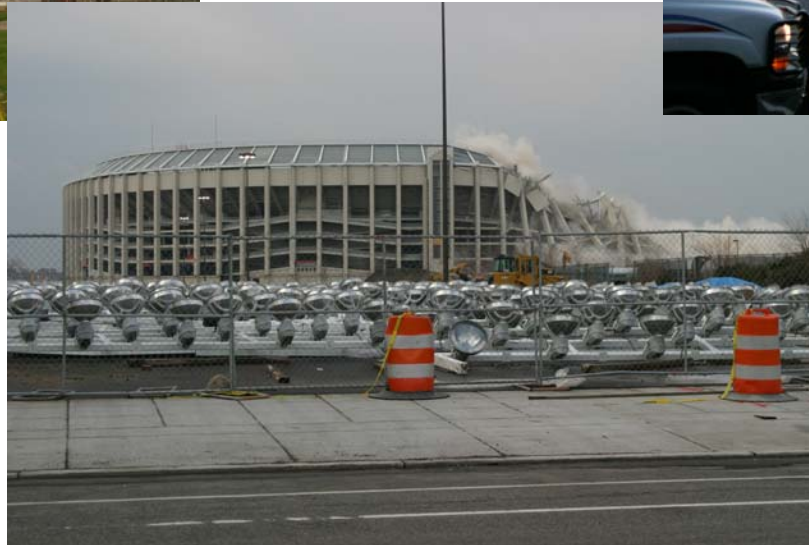


14-story apartment building
New Orleans
January 2004

Veteran's Stadium
Philadelphia
March 2004



Old Convention Center
Washington, D.C.
December 2004



Implosion Experiments

Radios tuned near public safety frequencies are secured throughout large buildings scheduled for implosion



Ruggedized transmitters



Ventilation duct
Washington, DC



Elevator shaft
New Orleans

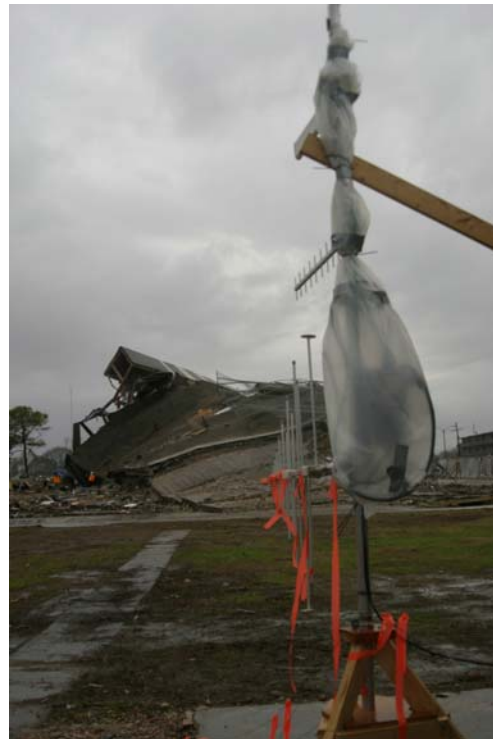
Several experiments are carried out during each implosion

Propagation Measurements

Signals are monitored at fixed and mobile receive sites



Before



After



Mobile receiver

Signal propagation in standing, collapsed building scenarios

Fischer Public Housing Project, New Orleans (Algiers)

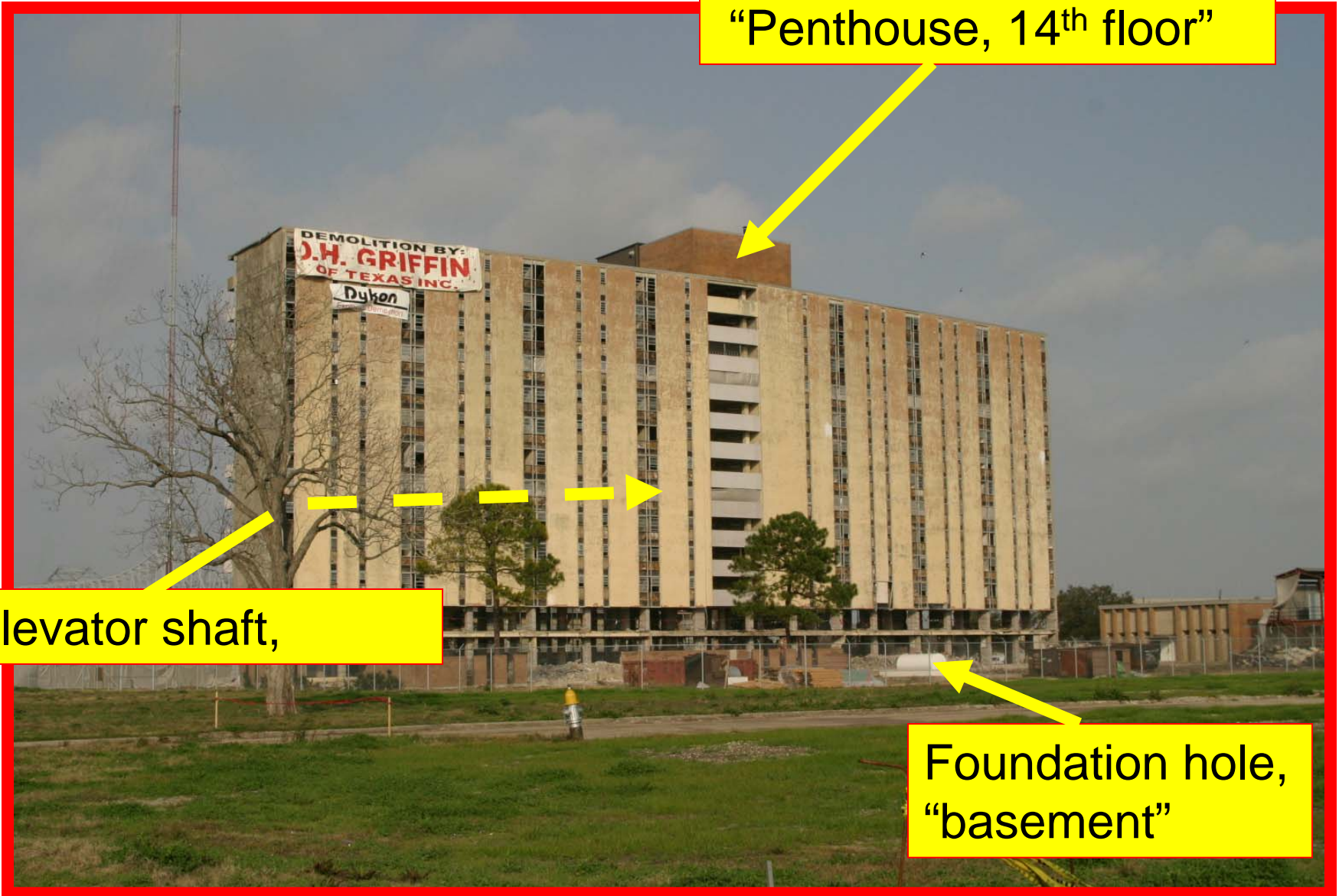


Back side of the building – prepared for implosion

“Penthouse, 14th floor”

Elevator shaft,

Foundation hole,
“basement”



**Penthouse site:
4 Pelican boxes
containing
transmitters,
batteries,
cooling system,
padding and
control**



Elevator door site



Hole jackhammered into the foundation



Guaranteed Outcome

Pre-implosion Propagation Studies



The morning of the implosion

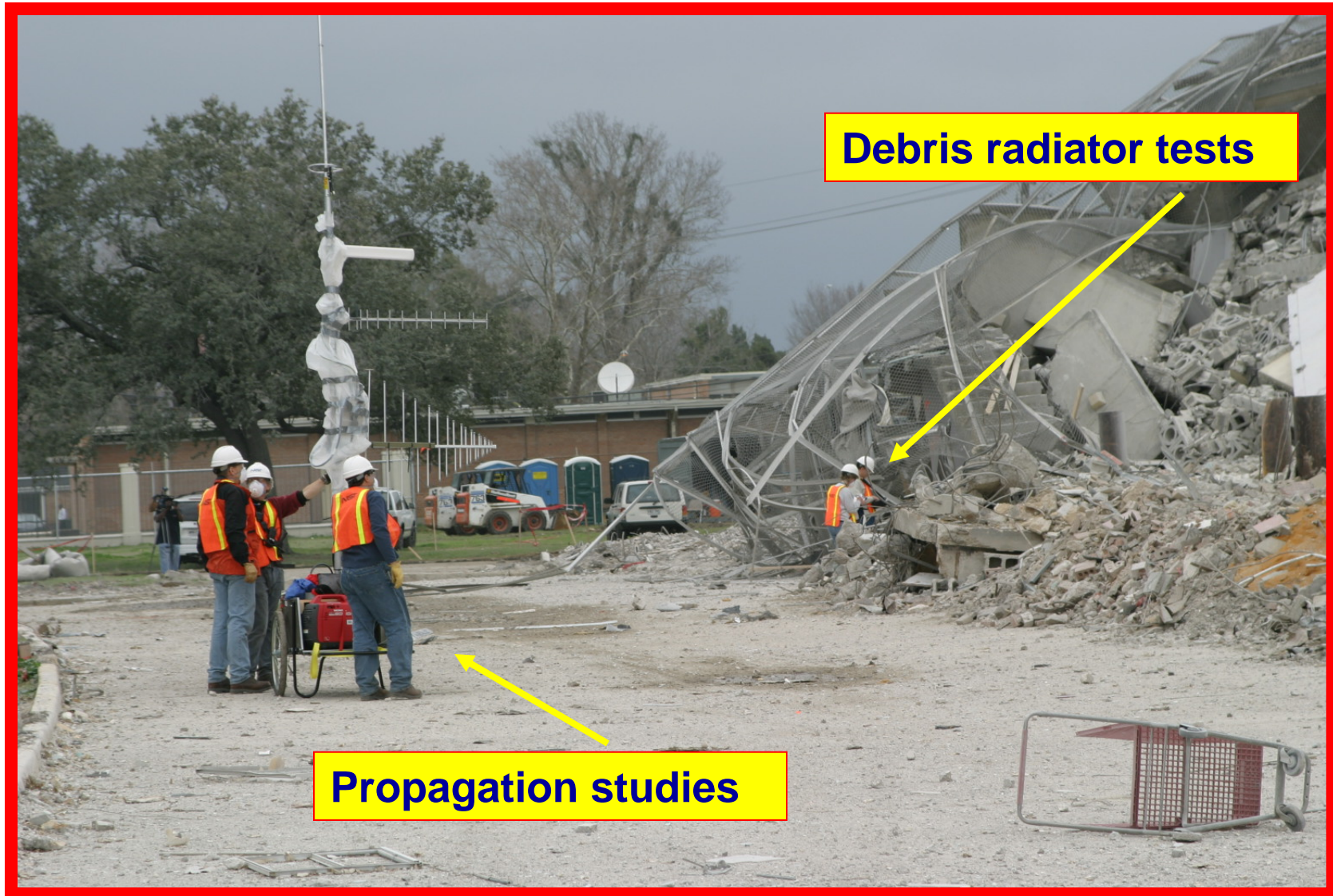


Building Implosion





Post-Implosion Experiments



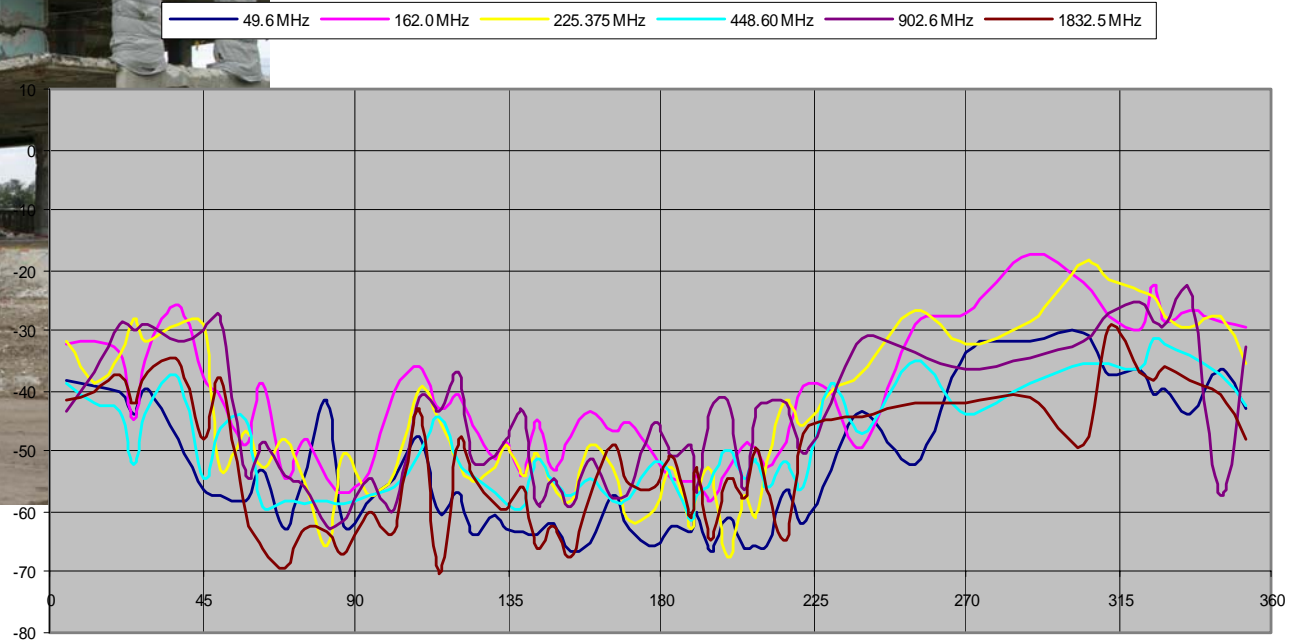
Debris radiator tests

Propagation studies

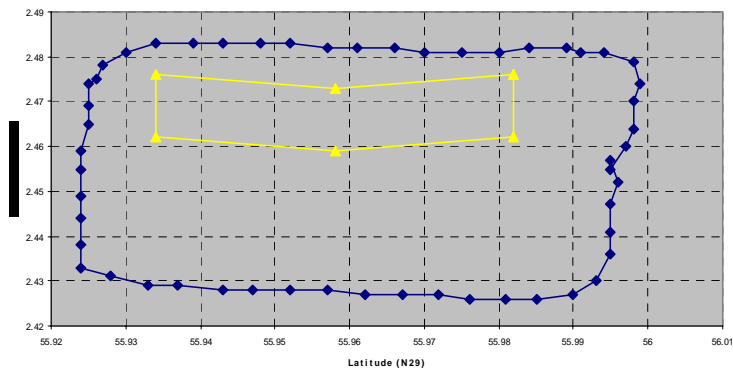
Pre-Implosion Data From Instrument Cart



Walk Around Pre-Blast with Spares

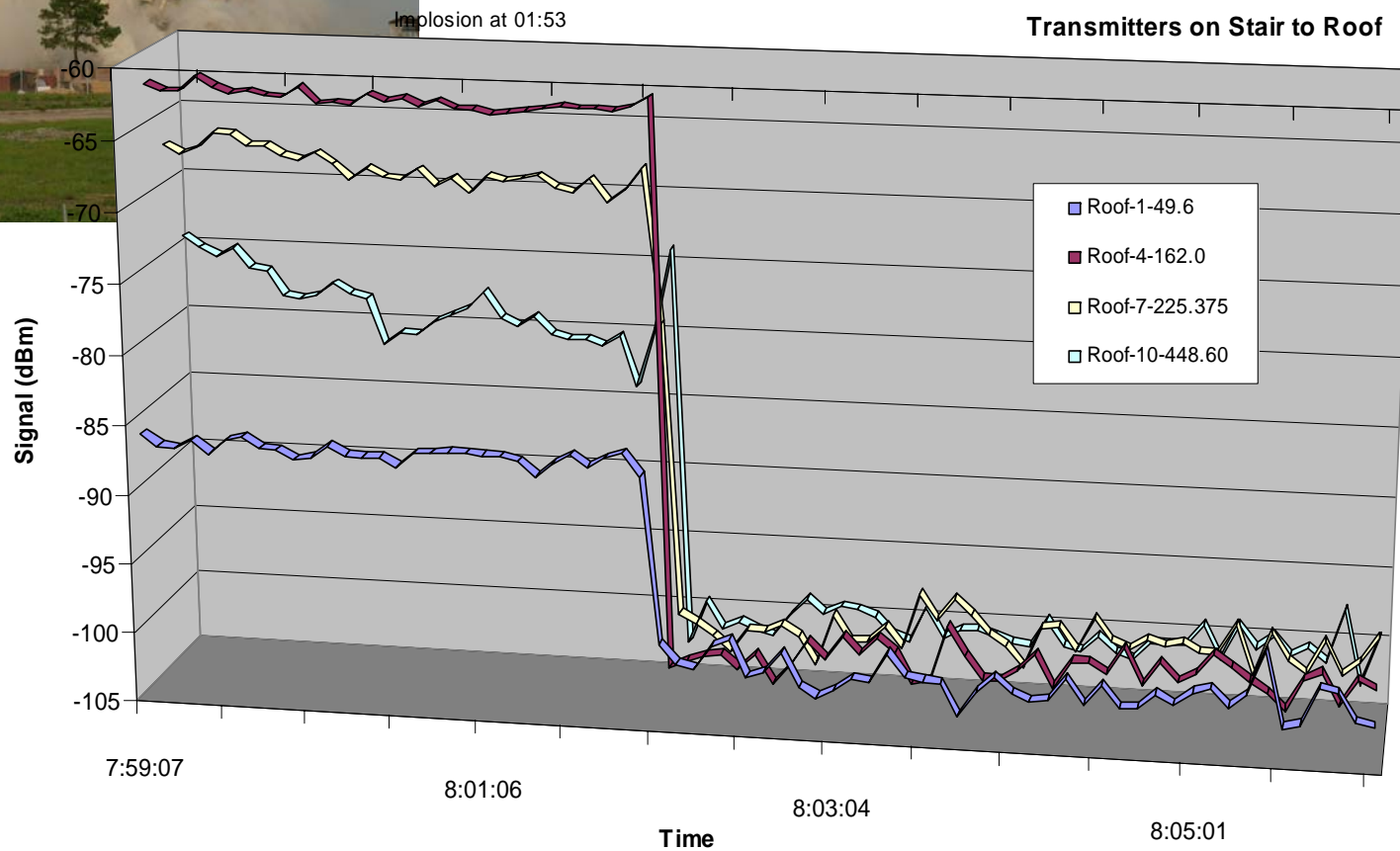


Walk Around Path Pre-Blast

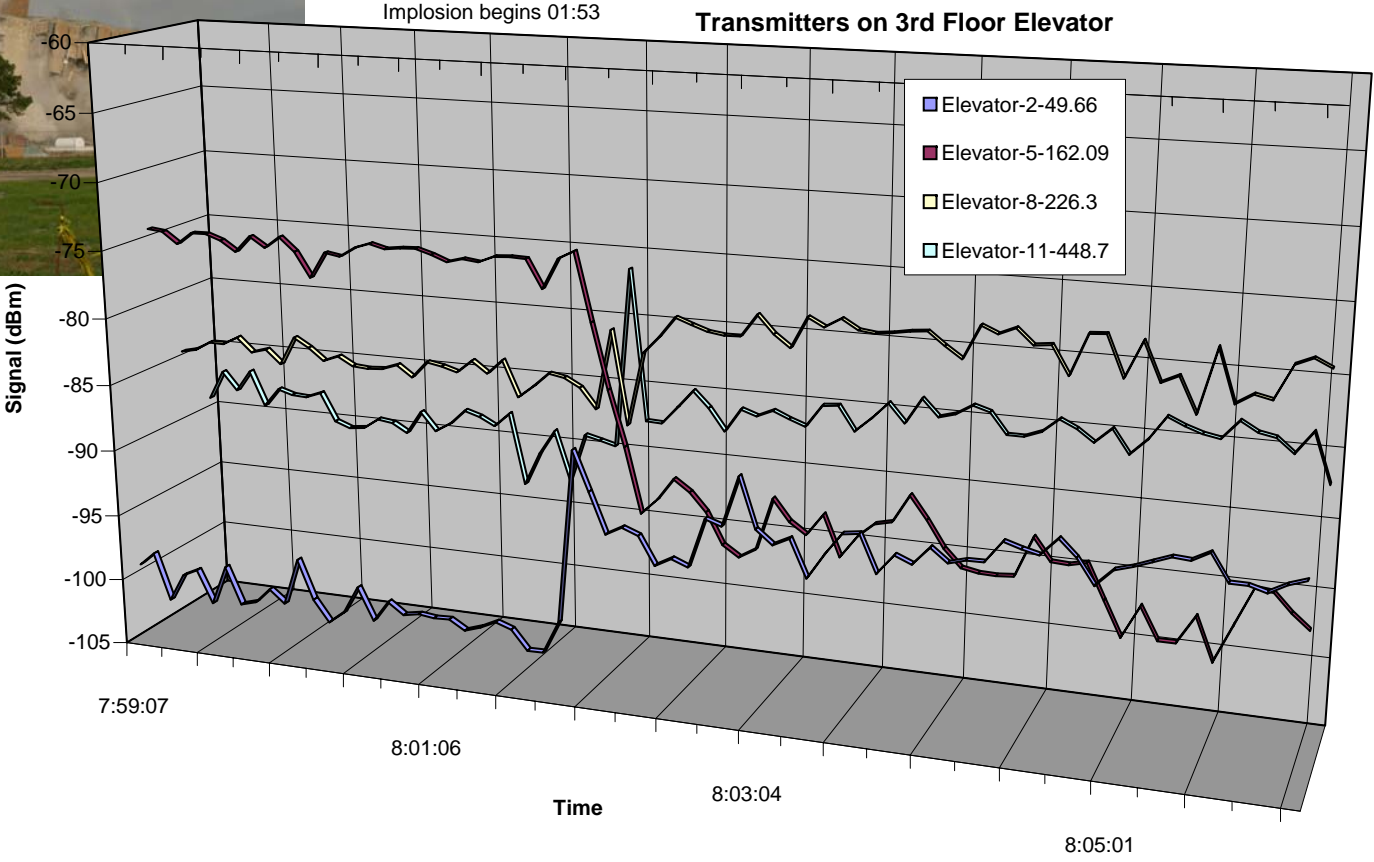
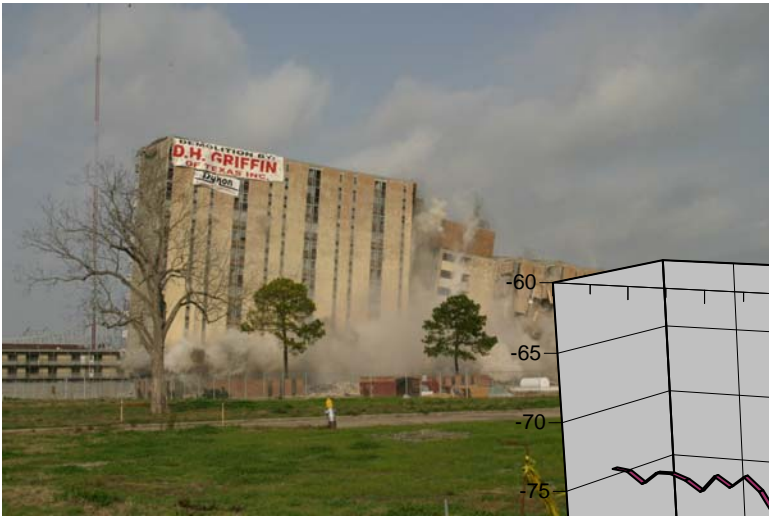


Azimuth from Hole (deg)

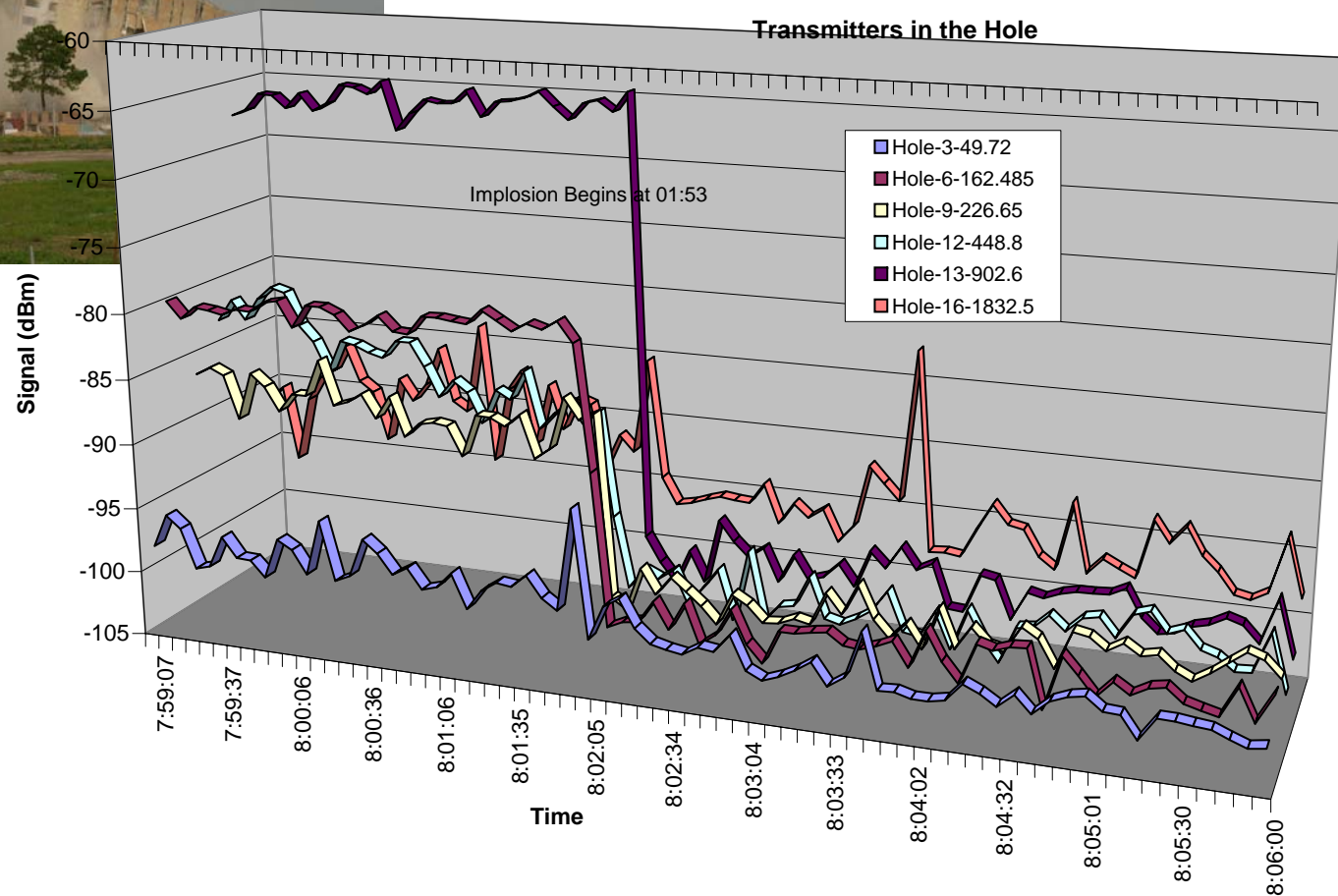
Blast Data: NIST Van (Penthouse)



Blast Data: NIST Van (Elevator door)



Blast Data: NIST Van (Basement)

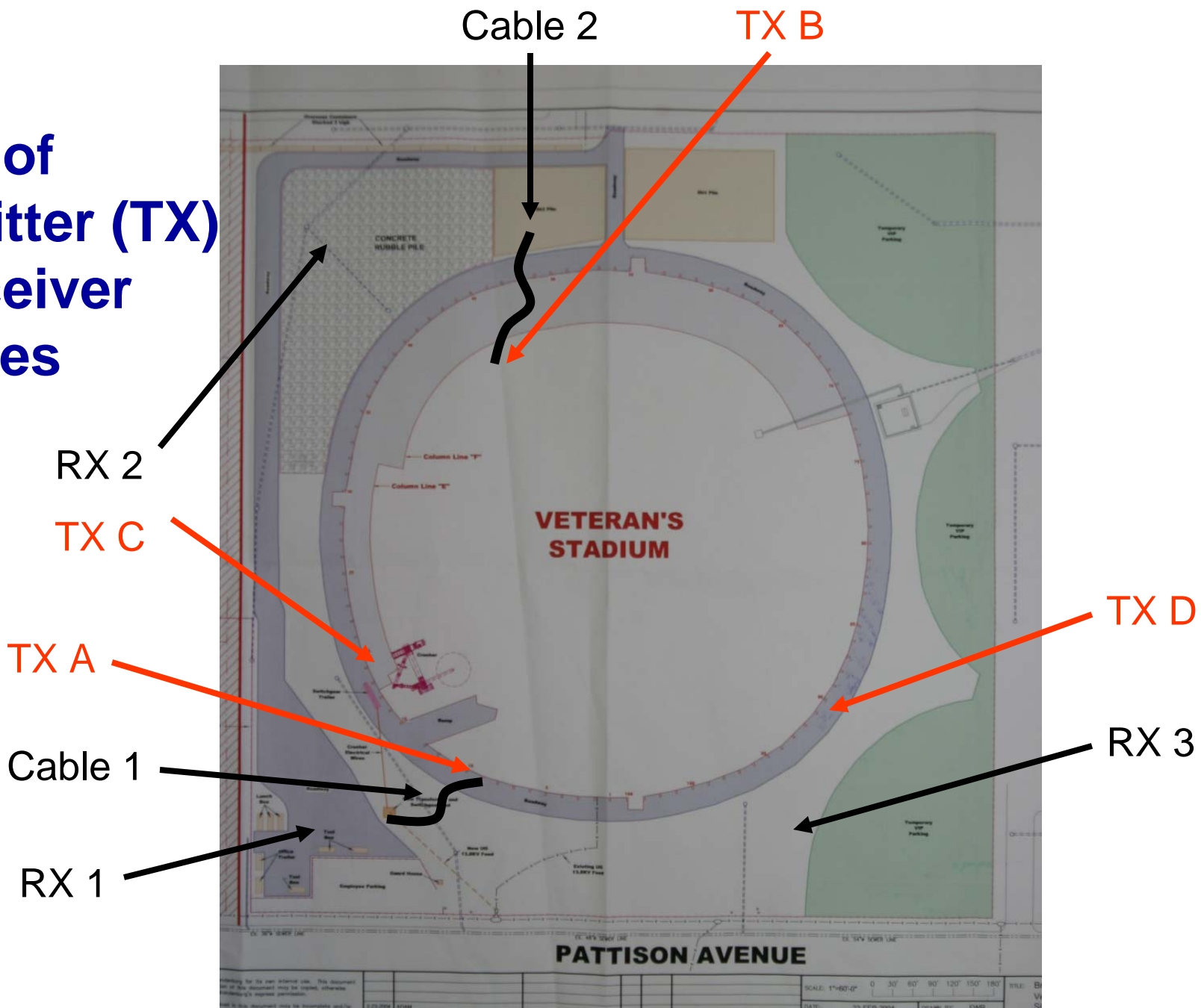




Philadelphia's Veteran's Stadium



Layout of transmitter (TX) and receiver (RX) sites





Transmitters are secured to the wall and protected from falling debris by a board



Final preparations on the playing field



The weather didn't always cooperate

Three receive sites and four transmitter sites























































Mobile cart: antenna, generator, UPS, laptop & spectrum analyzer

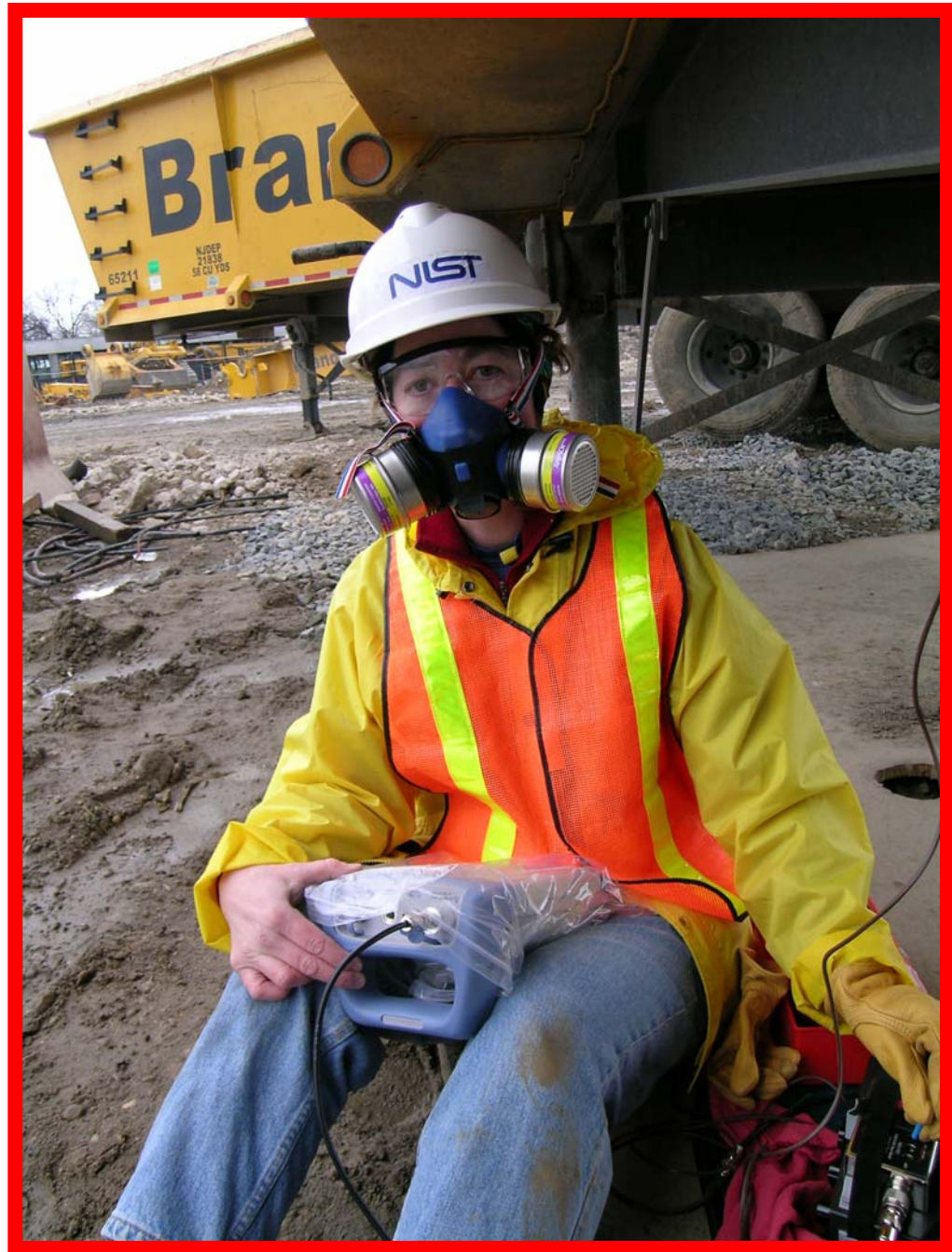


First perimeter scan is carried out

Post blast conductive measurements

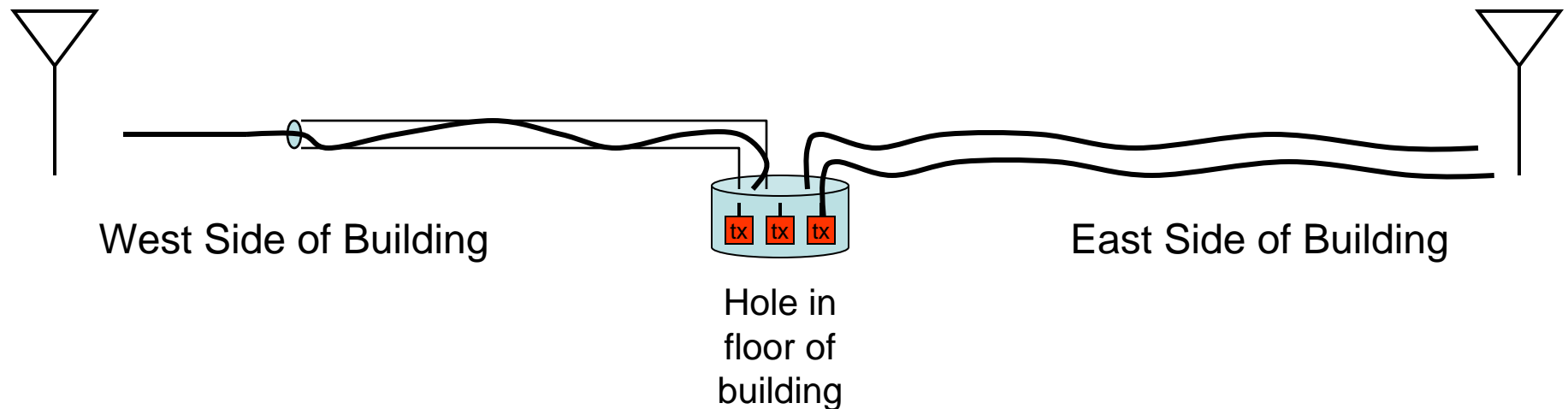


**Debris radiator tests
were carried out
under “adverse”
conditions ...**



Debris Radiator Experiment

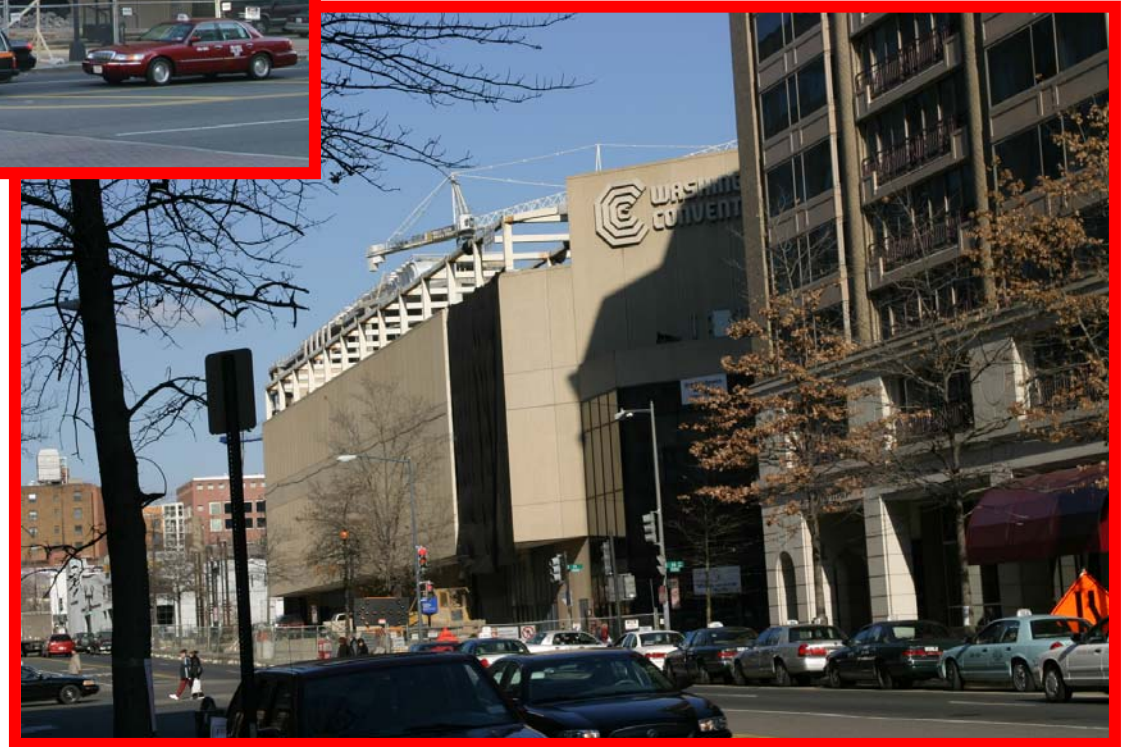
Can we use conduit or cables to help couple energy out of a collapsed building?



Preliminary Results Show:

- 1) Cable and directional antenna comparable for RX when cable protected by pipe
- 2) Attenuation due to debris 60-70 dB for antenna, 70 dB or more for cable
- 3) Additional benefit by attaching transmit antenna to debris
- 4) Detection of weaker signals would be of benefit!

Washington DC Convention Center



Washington DC Convention Center



Washington DC Convention Center



Washington DC Convention Center



Propagation
measurements

Debris Radiator
experiments



An Array of Communication Projects for First Responders



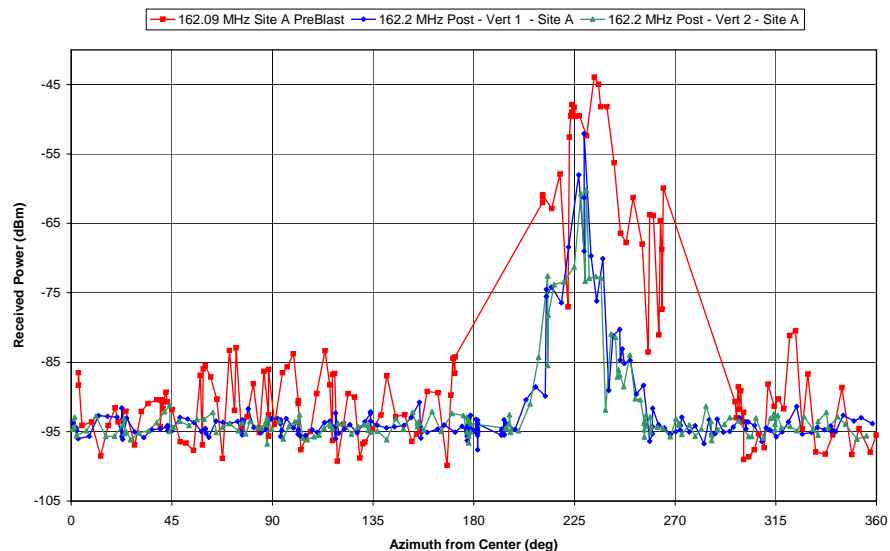
Deliverables:

- Public-domain data on propagation in large public buildings for public safety and commercial system designers
- Improved communications in weak-signal environments
- Correlate field strength with qualitative ratings used by public safety organizations
- Guidelines for efficient search strategies
- Potential for improved public-safety radio system design

Red: before implosion

Blue and green: after implosion

Goal: Maximum utility
for first responders!



Acknowledgements

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- **D.H. Griffin Demolition Contractors**
- **Brandenburg Industrial Service Company**
- **Demolition Dynamics**



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Boulder, CO Simulation of Sarin WMD Attack





Colorado Springs, Simulation of Hotel Emergency

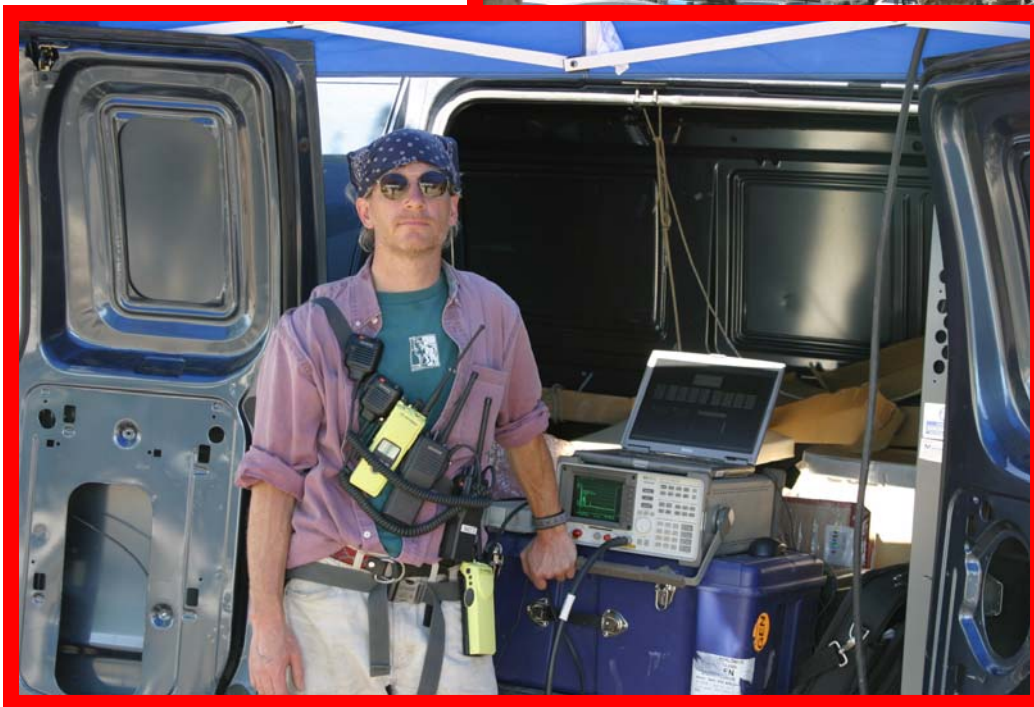


Boulder County Wildfire, Firefighter Communications





Phoenix Firefighter Communications Study



Other Structures



Discovery Channel

