Seismic Source Characterization and Underground Facility Modeling
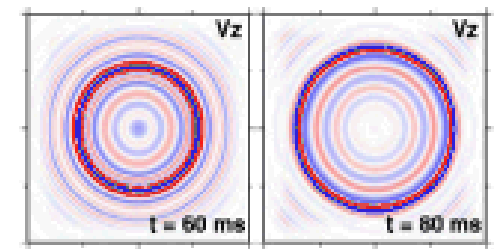
Leiph Preston

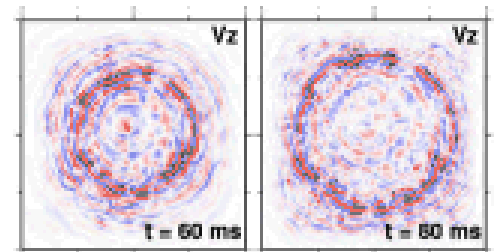Exceptional service in the national interest

Basic Moment Tensor Inversion

- Work for DTRA to characterize sources of interest in fast, user-friendly environment

- Desire source-type (earthquake, explosion, etc.), location and size

- Uses Matlab to display seismic traces, solution and uncertainty analysis, allowing user interaction

- Investigate effects of complex 3-D structure and complex source types

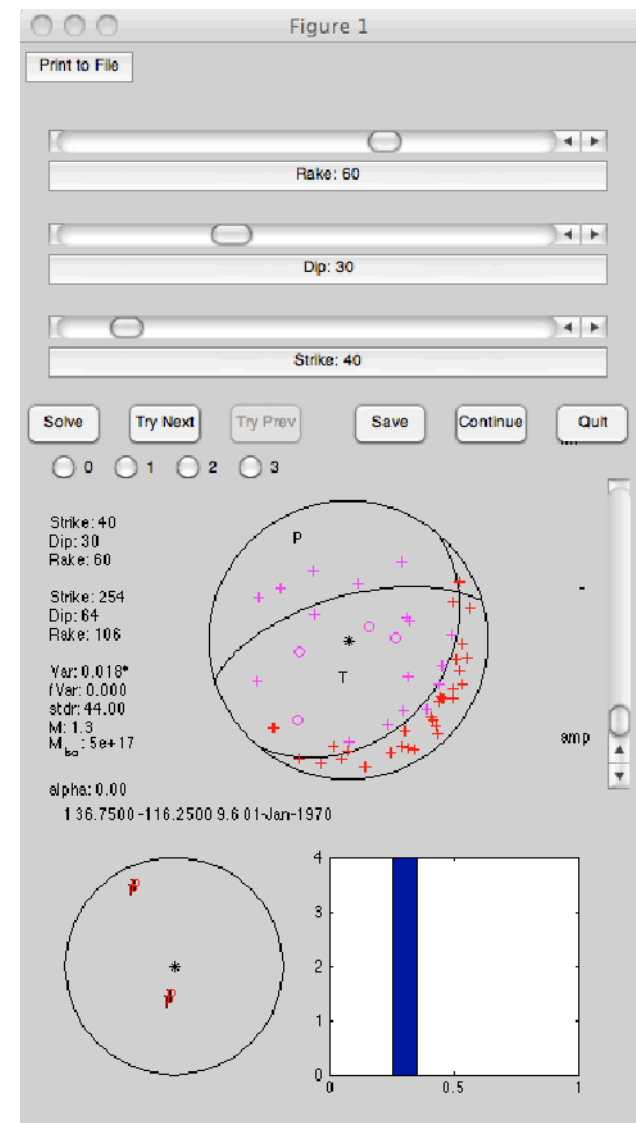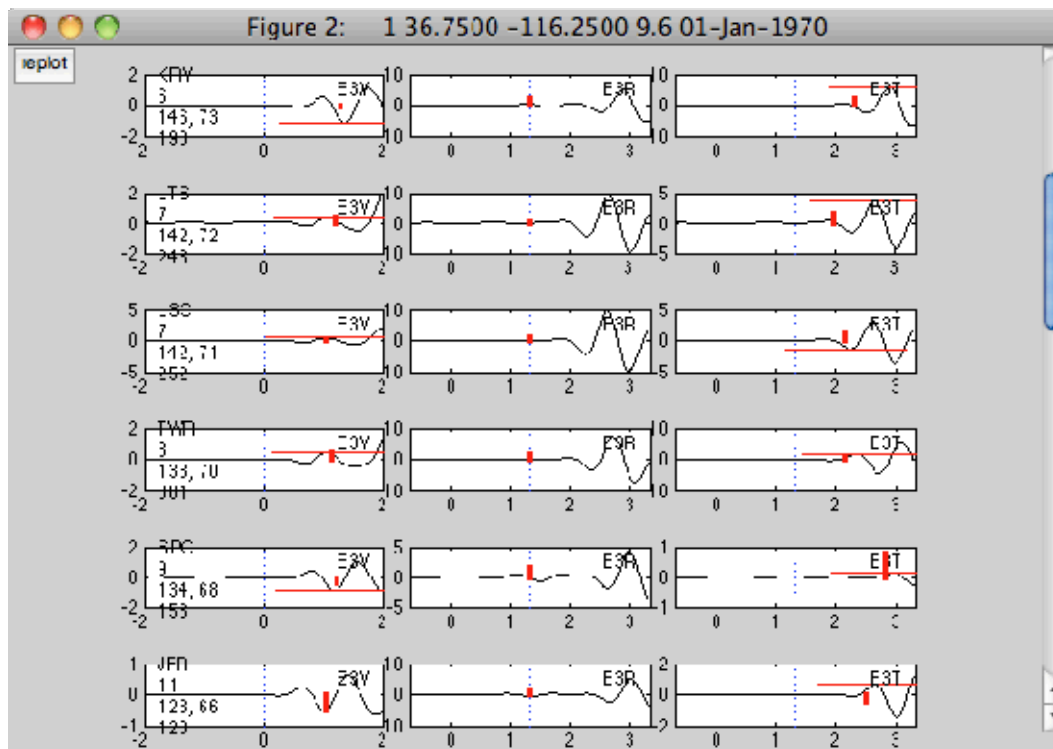**Wavefront Visualizations**
Simple Structure

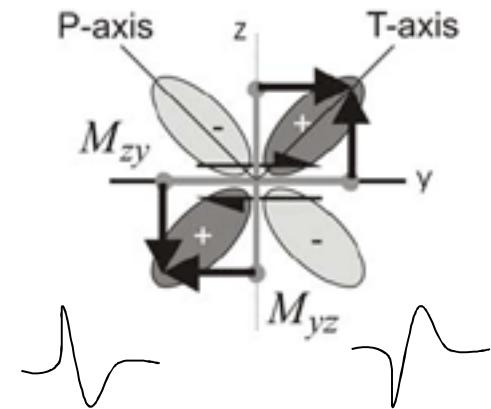**Complex Structure**

SNL Demo Simulations

Current Implementation

- Uses first-motions and P, SV and SH amplitude picks to determine source characteristics
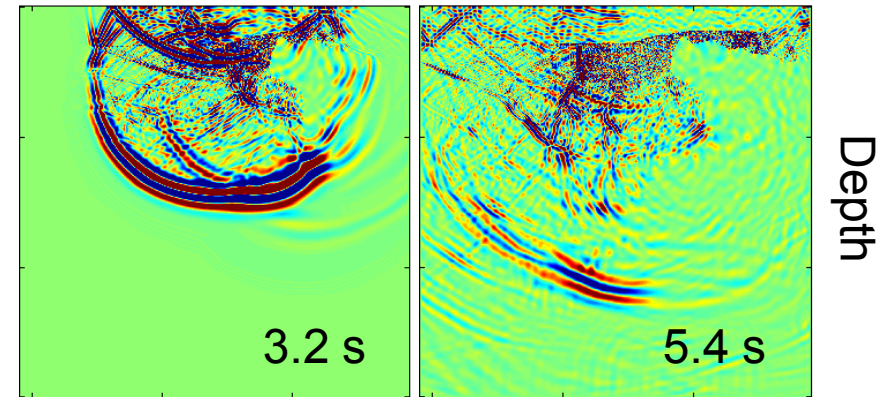
Full Waveform Moment Tensor Inversion

- More general source types
- Inclusion of complex 3-D geologies in forward calculations
- Better sensitivity to hypocentral parameters
- Uses more of the waveform, allowing better constraint with fewer recordings
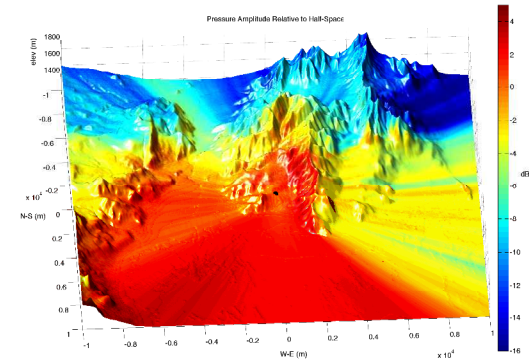
3-D Seismic and Acoustic Modeling

- 3-D finite-difference simulation codes are capable of modeling elastic, acoustic, infrasound, anelastic and poroelastic wave propagation

- Massively parallel design

- Accommodates models with complex realistic 3-D geology, topography, underground voids, and atmospheric conditions including wind

- Many customers utilize these codes including DOE, DOD and private entities

Wavefront Visualizations
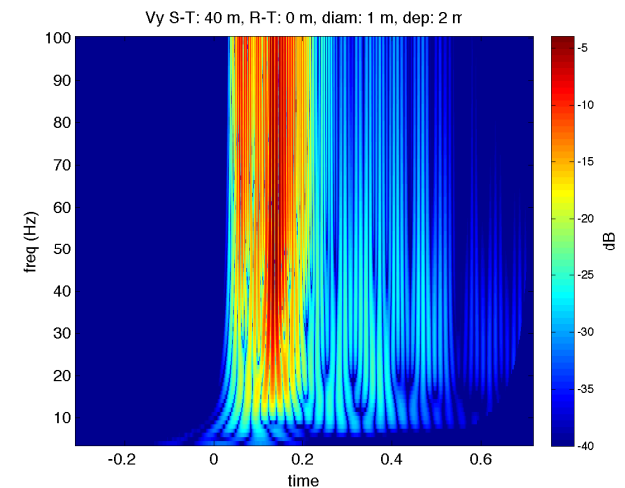
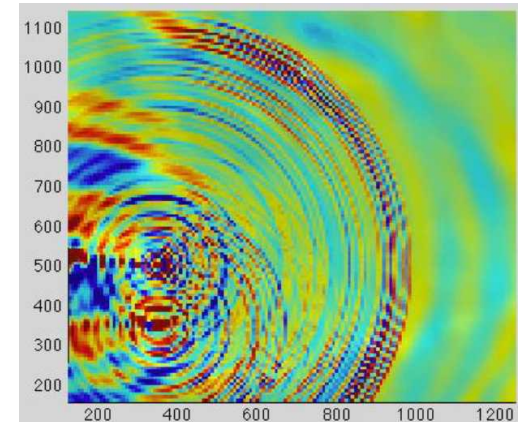**Complex Structure Seismic Simulations**

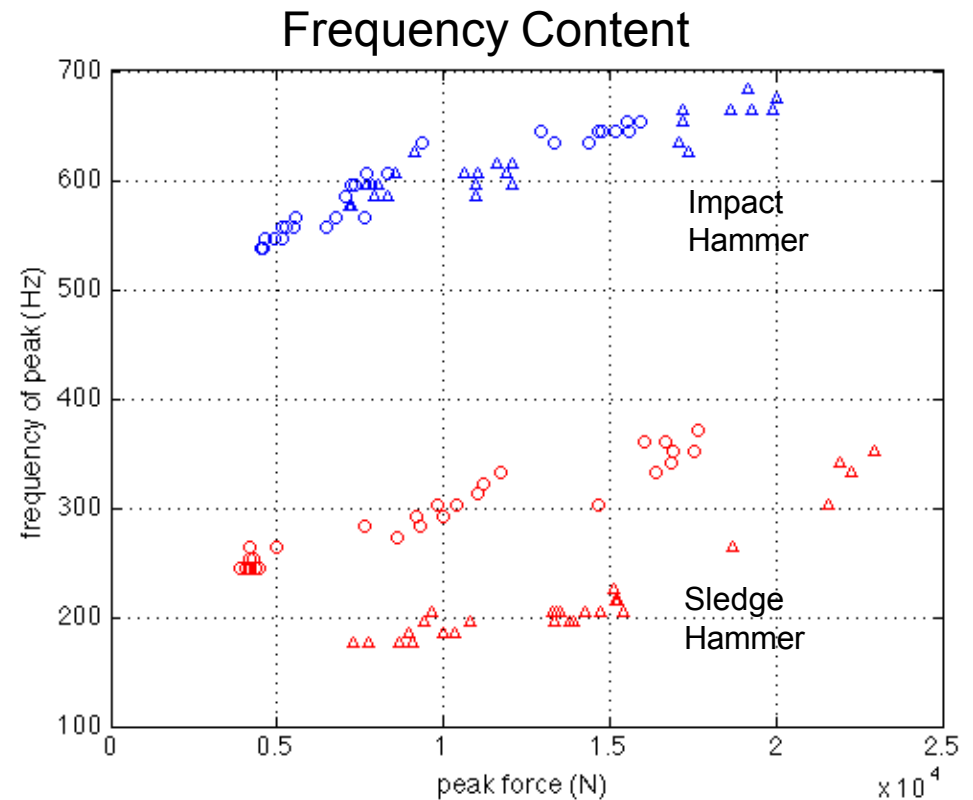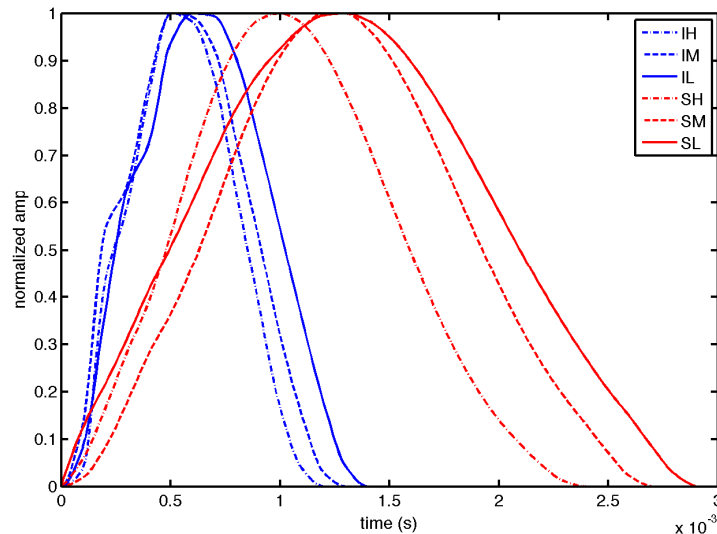3.2 s

5.4 s

Acoustic Simulations

Underground Facility Investigations

- Effects of underground voids on surface wave scattering and back-scattering

- Seismo-acoustic interactions of sources inside facilities

- Tunnel and facility resonances

- Expected ground velocities from sources within facilities

- Sensor placement planning for facility, border or perimeter monitoring

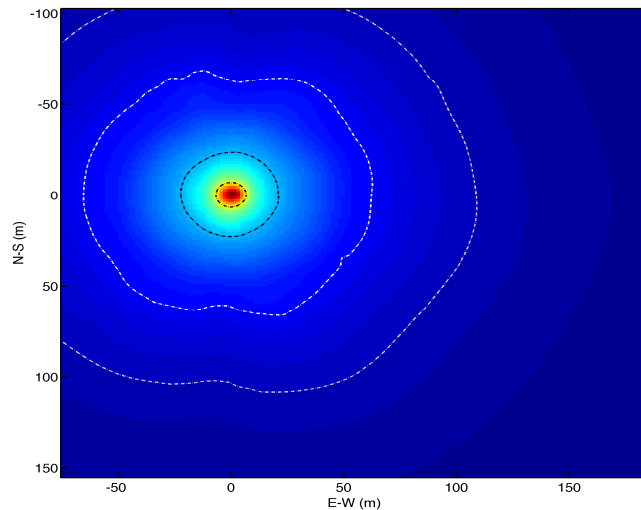Vy S-T: 40 m, R-T: 0 m, diam: 1 m, dep: 2 m

Tunnel Source Investigations

- Study frequency content and source time functions of common hand-held tools in tunnel excavations as a function of impact force
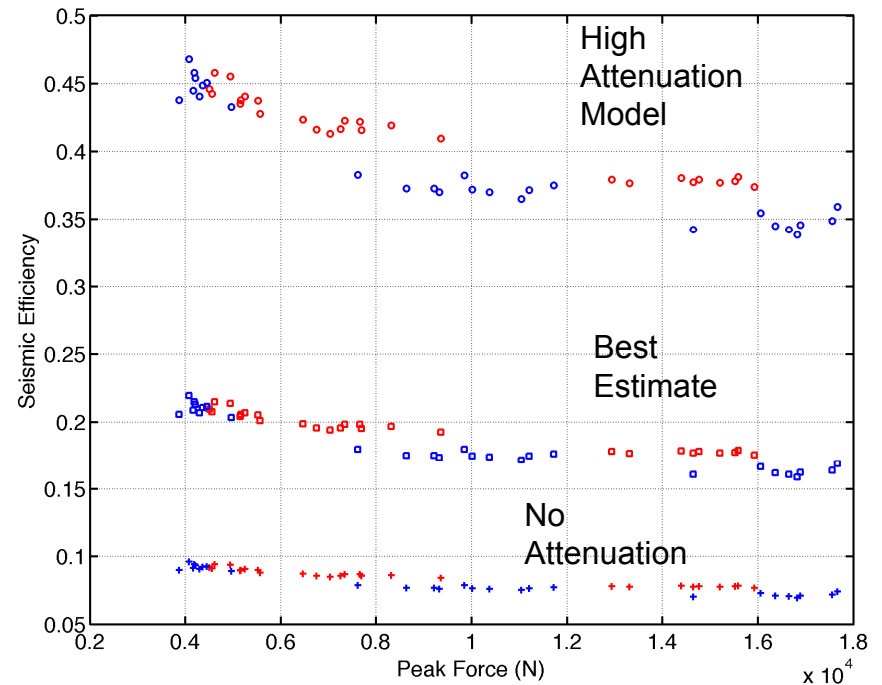
Frequency Content

Source Time Functions

Seismic Efficiency

- Investigate the efficiency of different sources in producing seismic waves, i.e., how much of the energy used in hammering is converted to ground motions

Efficiencies

Ground Motion