Simulating the Shock Wave Response of HE Crystals

**Objectives**
- To simulate the mechanical response of HE crystals under shock wave loading
- Why do energetic crystals react differently when shocked along different crystal orientations?

**Background**
Energetic molecular crystal: pentaerythritol tetranitrate (PETN).
Shock-induced chemical reaction depends strongly on the crystal orientation:

- PETN crystal
- [100] shock
- [110] shock

Data from J.J. Dick, 1997: (WSU alumnus)

- [100] orientation
  - no chemical reaction; insensitive
- [110] orientation
  - chemical reaction; sensitive

**Results**
Simulations of experimental data (Dick and Ritchie, 1994) for PETN crystals shocked to stresses below the threshold for chemical reaction:

- Unhindered shear; [100] shock
- Hindered shear; [110] shock

**Modeling Approach**
- Continuum mechanics calculations to simulate wave profile data
- Model each shear plane in the crystal explicitly

**Summary**
- Different mechanical response for different orientations of PETN crystals under shock wave loading
- Simulations agree well with data for unhindered [100] orientation
- Hindered [110] orientation of PETN loses strength under shock loading; shear cracking model fits data well
- Relate increased chemical reaction sensitivity for [110] PETN to loss of strength under shock wave loading