# Diagnostics for High-Speed Particulate Media Impacts

## An International Collaboration with Osaka, Tohoku & Chubu Universities, Japan

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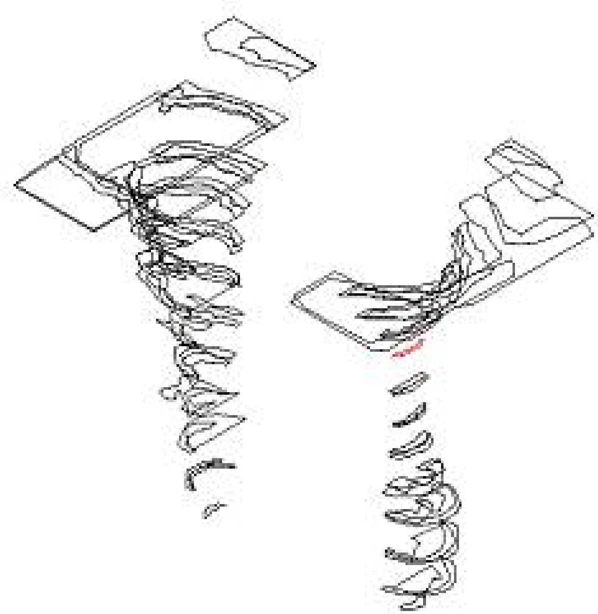
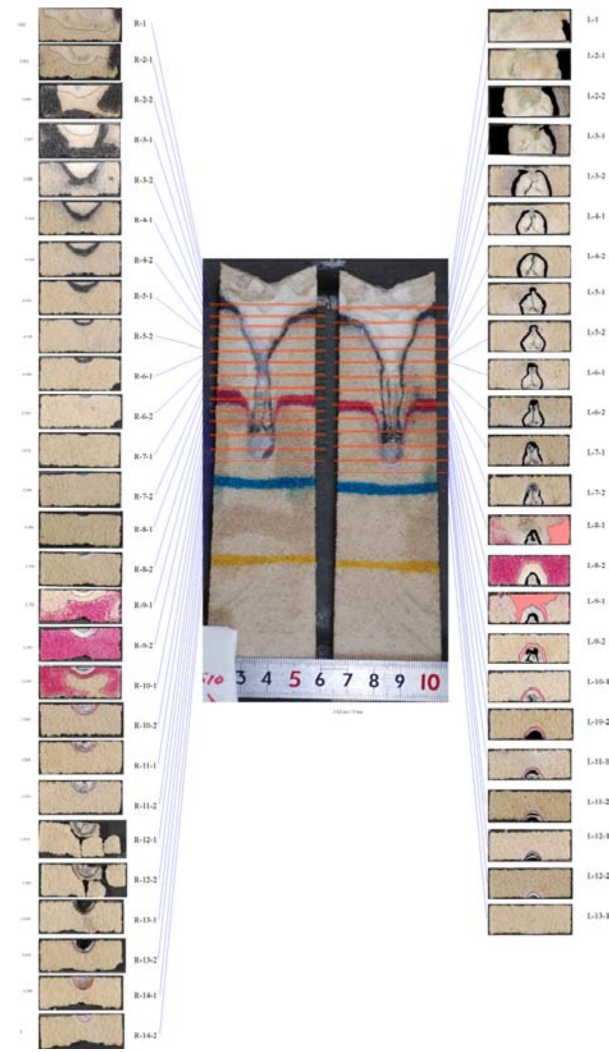
# Agenda

- **Objectives**
- **Why international?**
- **Timelines**
- **Successes**

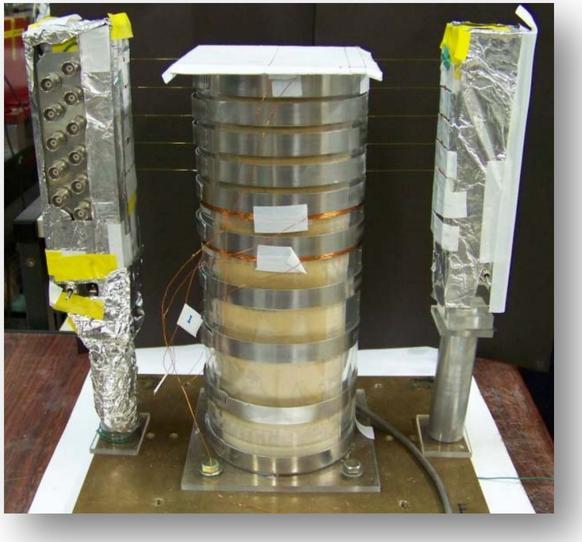




# Objectives



- Develop diagnostics for high-speed impacts with particulate materials
- Leverage world-wide creativity & capabilities
- Learn to think in the way that particulate materials behave
- Shrink the world
- Timeline: 3-year projects administered in 1-Year renewable grants.

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# Why International?

- Access to creative thinkers
- Access to unique facilities
- Excellent research value/$ ratio—Large teams for minimal $
- Research immersion & focus time
- Access to Pacific Rim research community


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# Payoff

- **By the numbers:**
  - 2 years nearly complete
  - $100K AFRL/RW funds invested
  - $100K AFOSR/AOARD funds invested
  - 2 Senior professors
  - 1 Associate Professor
  - 1 PhD Research Associate
  - 3 M.S. Students
  - 4 Presentations
  - 4 Journal Papers

- **International Exchange:**
  - 3 months in Japan performing research (WoW—AFOSR/IO)
  - Japanese PI visited USA for 3 months at no cost

- **150 page Tech Report:**

- 2-D Quasi-static Punch Experiment & Analysis
  - Mechanics models (1,2 & 3) for punch loading force
  - Analysis of rate and size effects
- Model 4: Force Chain Stability Modeling
  - Confining forces PDFs
  - Problems with assuming fixed coefficients of friction
  - Propagation of forces in curved chains w/ friction
  - Special case where inter-granular friction eliminates need for confining forces
    - Estimate of minimum required coefficient of friction
  - Special case of granular contact with rigid surface
    - Estimate of minimum coefficient of friction as function of chain angle relative to wall
- Dynamic Cylinder Impact Experiments & Analysis
  - Internal shearing layer and friction estimates
  - Observations regarding stability of false nose as function of coefficient of friction behavior
- Generalized shearing model for granular, crushed material, and solid surface interfaces
- Dynamic Sphere Impact Experiments & Analysis
  - Impact with glass beads
  - Impact with Eglin sand
  - Internal shearing layer and friction estimates
- Tohoku University High-Speed Impact Experiment
  - General Techniques
  - Triboluminescent Techniques
  - 3-D Sectioning & Mapping Techniques
- Osaka University High-Speed Impact Experiment General Techniques
- New Equipment Designs for Potential Collaborative Experiments
  - Osaka Gun Precision Container Catch Tank
  - Modular Particulate Material Container


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# Presentations



# Papers

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# Questions?


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