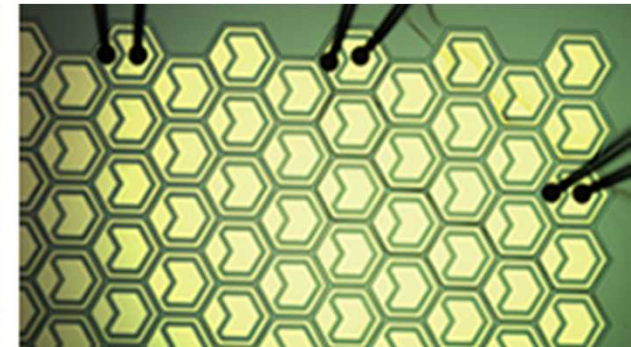
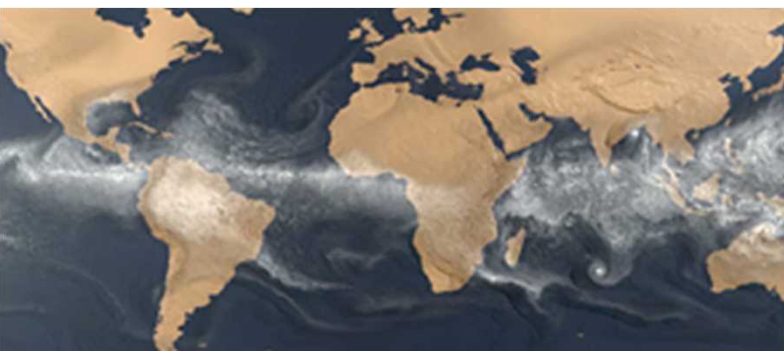


Exceptional service in the national interest



energy.sandia.gov

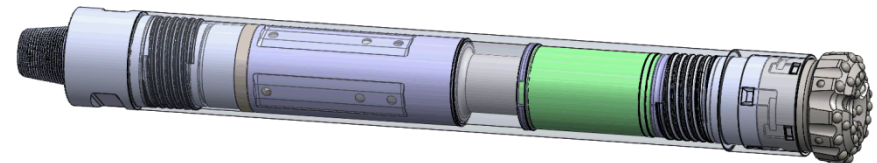


Advanced Percussive Drilling Technology for Geothermal Exploration and Development

Jiann Su

Atlas Copco Partnership

- Headquartered in Stockholm, Sweden
- Industrial group with products and services for mining and construction
 - Compressed air and gas equipment
 - Industrial tools and assembly systems
 - Down the hole hammers suited for geothermal environments
- Production facilities in more than 20 countries
- \$12.5 B revenue in 2013
- Prior SNL work showed promise for hammers in harsh environments
 - Efficient at drilling hard rock
 - Very durable
 - Low weight on bit and torque requirements
- Current work result of competitive bid process for DOE Funding Opportunity Announcement
 - Funded separately by DOE
 - Atlas Copco has cost share \$848K
- Establishing a broader CRADA including others at Sandia
- Synergy between other Sandia work and Atlas Copco needs

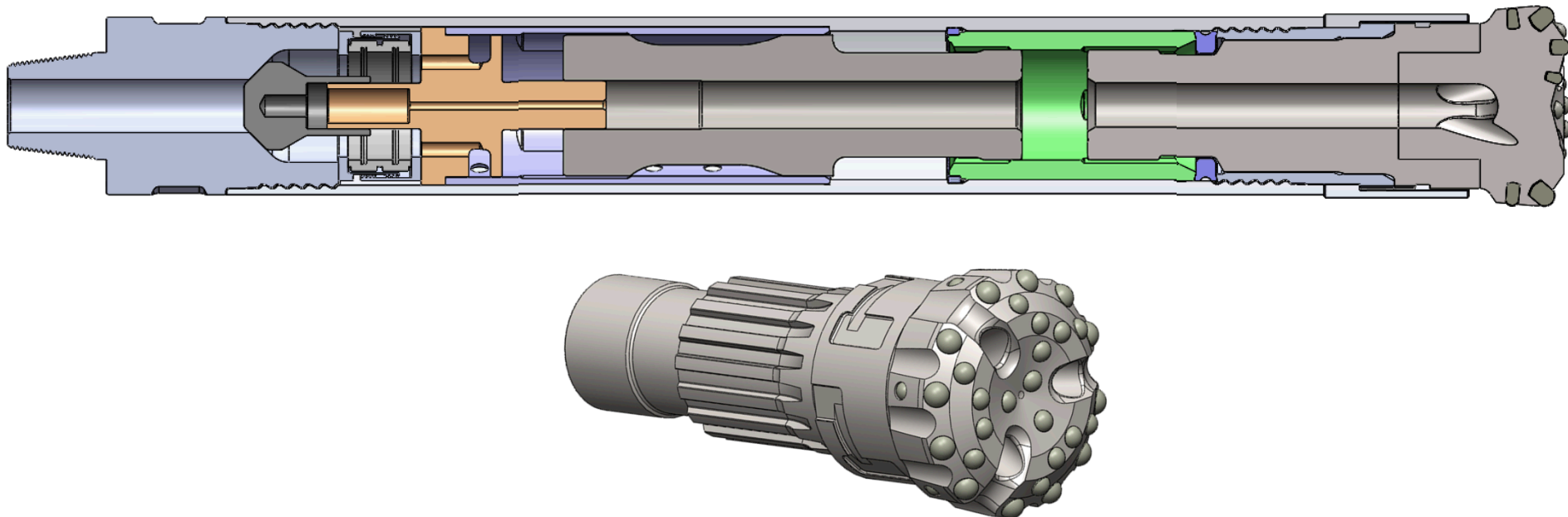


Project Objectives

- To construct the conceptual definition of a High Temperature (HT) pneumatic percussive hammer.
- Identification, testing, evaluation and qualification of constituent materials for this hammer.
- Perform computational modeling of the available power delivery of conceptual designs.
- Provide Proof-of-Concept (POC) validation via laboratory testing of representative design features.
- Implement prototype hardware development of a high temperature pneumatic percussive hammer.
- Conduct laboratory drilling tests to validate performance of prototype hardware at conventional temperatures.
- Perform laboratory drilling tests to validate performance in a high temperature test cell simulating a geothermal drilling environment.

Proof of Concept Hammer

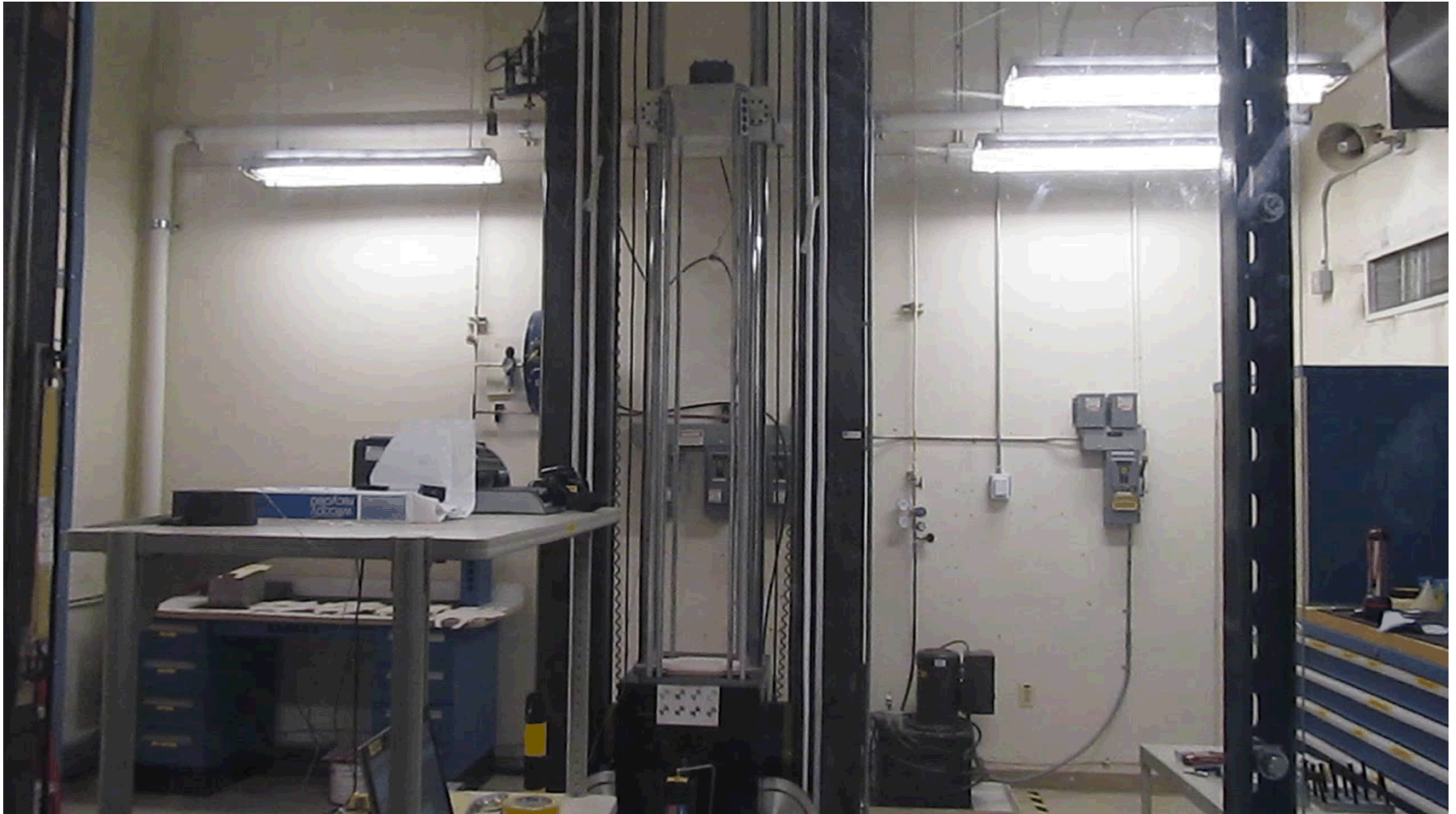
- Valveless cycle
- No polymeric or elastomeric parts or seals
- No fluid lubrication
- Performance comparable to current commercial DTHH



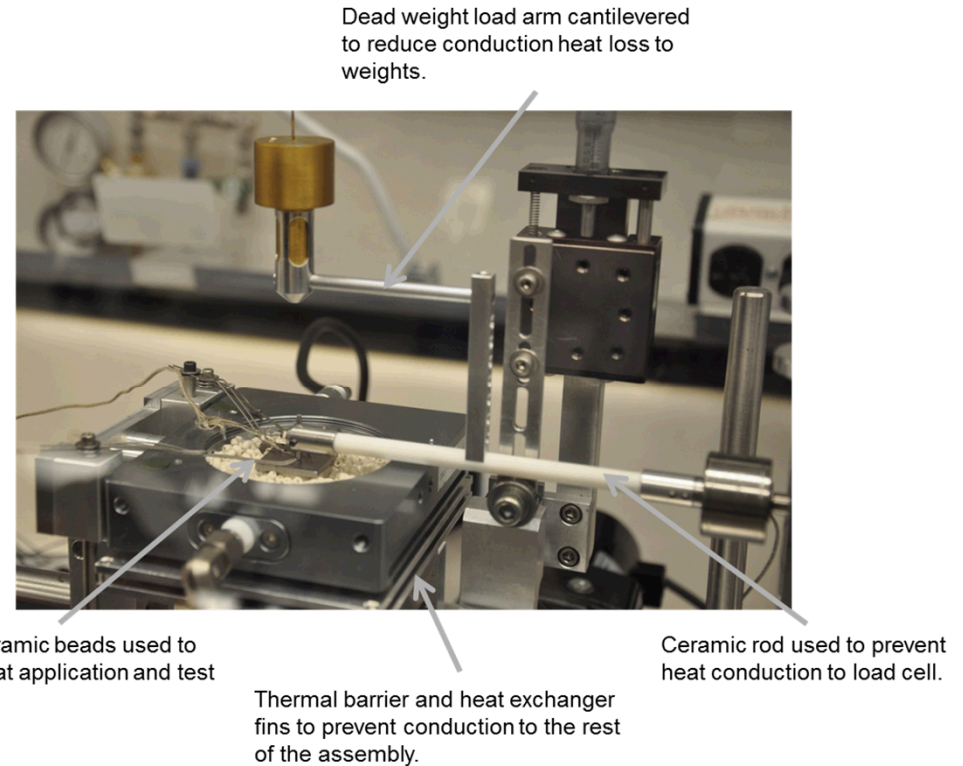
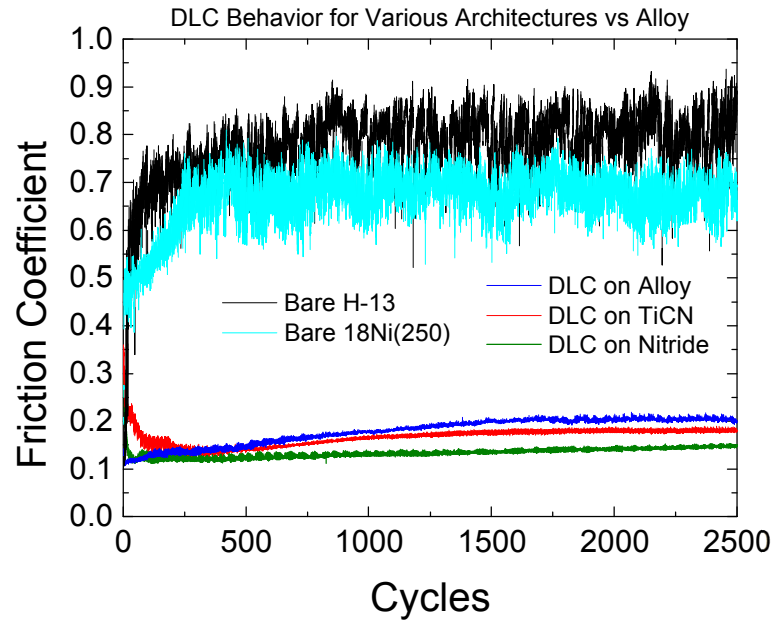
Sandia's Role in the Project

- Unique test capabilities
 - Shock testing
 - High-temperature wear and friction testing
- Materials selection and testing expertise
- Tribology and coatings solutions
- Modeling and simulation
- Development of prototype test facilities



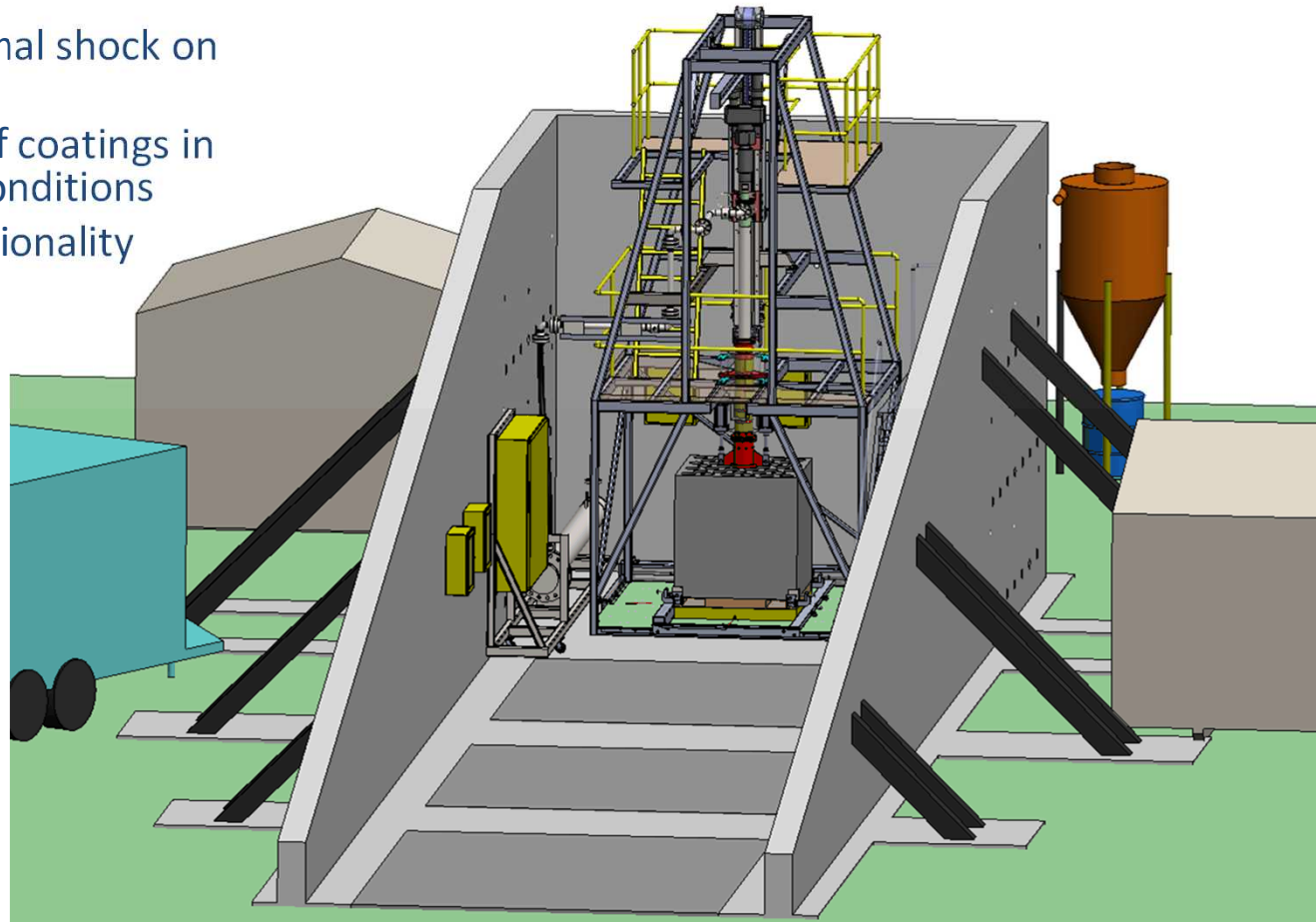


Coatings Friction and Wear Testing

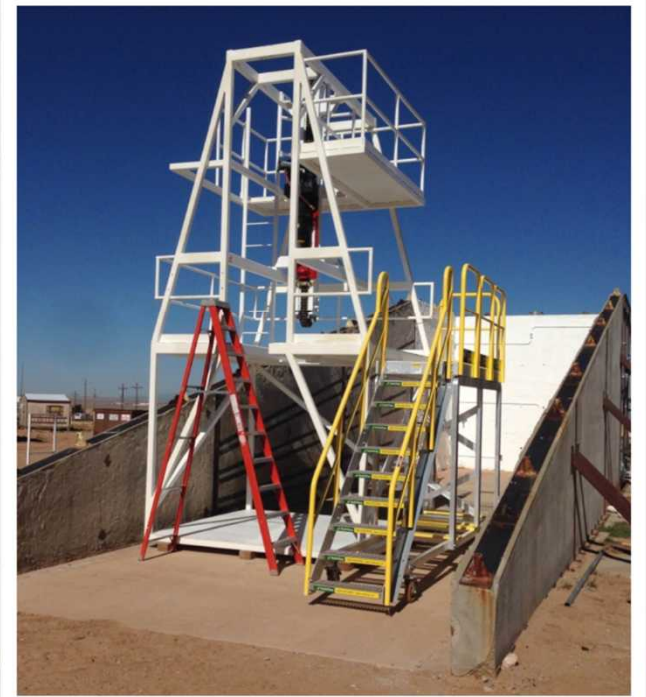


High-Temperature Test Facility

- Capability to simulate high-temperature drilling conditions (up to 300°C)
- Evaluate effects of thermal shock on hammer components
- Evaluate effectiveness of coatings in simulated geothermal conditions
- Automated drilling functionality



High-Temperature Test Facility



High-Speed Drilling in Granite



Drilling in 28-ksi, tombstone-quality granite

High-Speed Drilling in Sandstone



Drilling in 11-ksi, high-quality sandstone

Questions?