Year 3 of 3

Real-time Subsurface Event Assessment and Detection (RESEAD)

SAND2020-0850D

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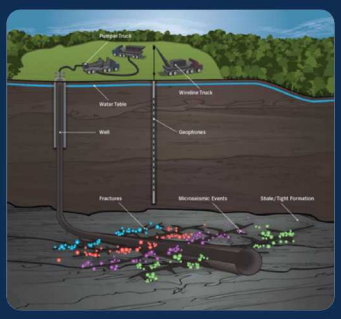
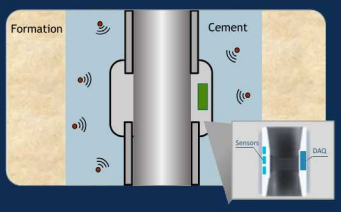
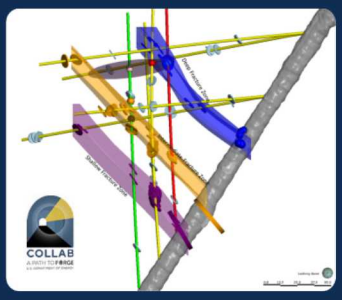
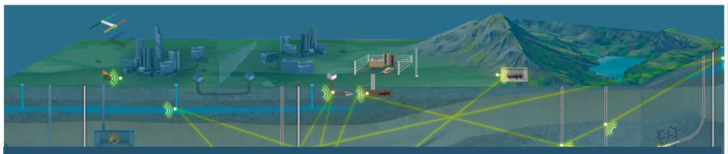
GOAL: To develop a next-generation approach to subsurface sensing that utilizes smart sensors, machine-learning, and geoscience-informed optimization algorithms to dramatically improve event detection and discrimination.









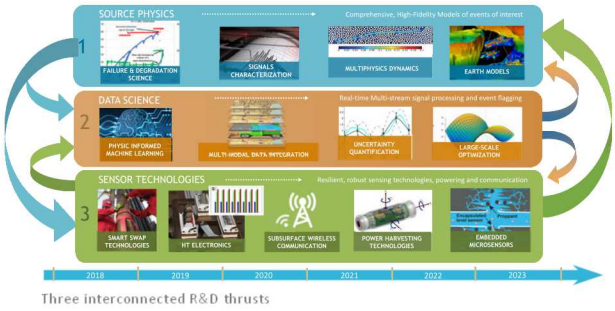
VISION

- Automate event detection/discrimination, prioritize parameter uncertainty, and implement a network of interconnected, machine-learning enabled sensors.
- Testing of novel instrumentation types and installation methods
- Development of capabilities for real-time processing of high-volume datasets to provide timely information for decision making.

Development of new computational capabilities and validation with field measurements, enabling large scale optimization, machine learning, sensing, and computational tools

STRATEGY

- 5-year R&D plan with integrated approach to source physics, data science, and sensor technologies
- Advance/integrate machine learning, data analytics, and sensor technologies
- Leverage existing data sets (e.g., EGS Collab)
- Internet of Things for Subsurface ("IOT4S") to integrate tools



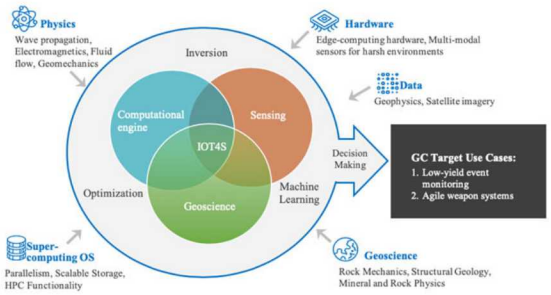
Three interconnected R&D thrusts

DEVELOP DATA ANALYTICS FRAMEWORK

- ✓Real-time Event Monitoring
- ✓Hybrid Machine Learning
- ✓Physics-Based modeling

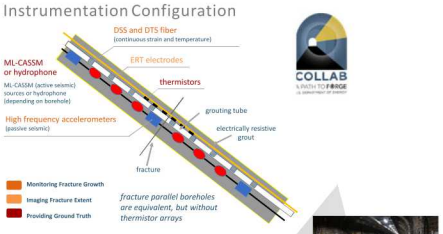
LEVERAGE STATE-OF-THE-ART COMPUTATIONAL TOOLS

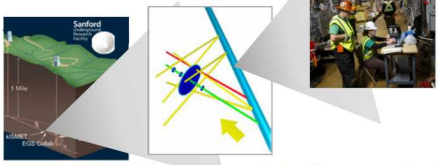
- Peridynamics – computational mechanics tool designed to accurately predict fracturing
- Multiscale/multiphysics interface for large-scale optimization
- Electromagnetic hierarchical simulation
- Ichos seismic full-waveform inversion



EGS COLLAB FRACTURE STIMULATIONS

Instrumentation Configuration





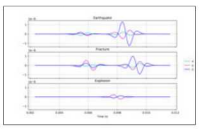
Testing and validating our approaches on subsurface datasets from Collab fracture stimulation

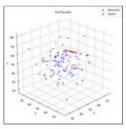
DEEP NEURAL NETWORKS FOR EVENT MONITORING AND DETECTION

Detect -and discriminate type of- local source events while ingesting a continuous network of data in real time.

- Double-couple earthquake
- Mode-one opening-type fracture
- Isotrophic explosion

Worst Station Accuracy: 80.9%
Median Station Accuracy: 93.3%
Best Station Accuracy: 98.9%
Ensemble Accuracy: 94.3%





DNN models trained on simulated Collab-like data set have excellent performance at source discrimination

Event Detector/Classifier then feeds full-waveform inversion to characterize source and subsurface material properties

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