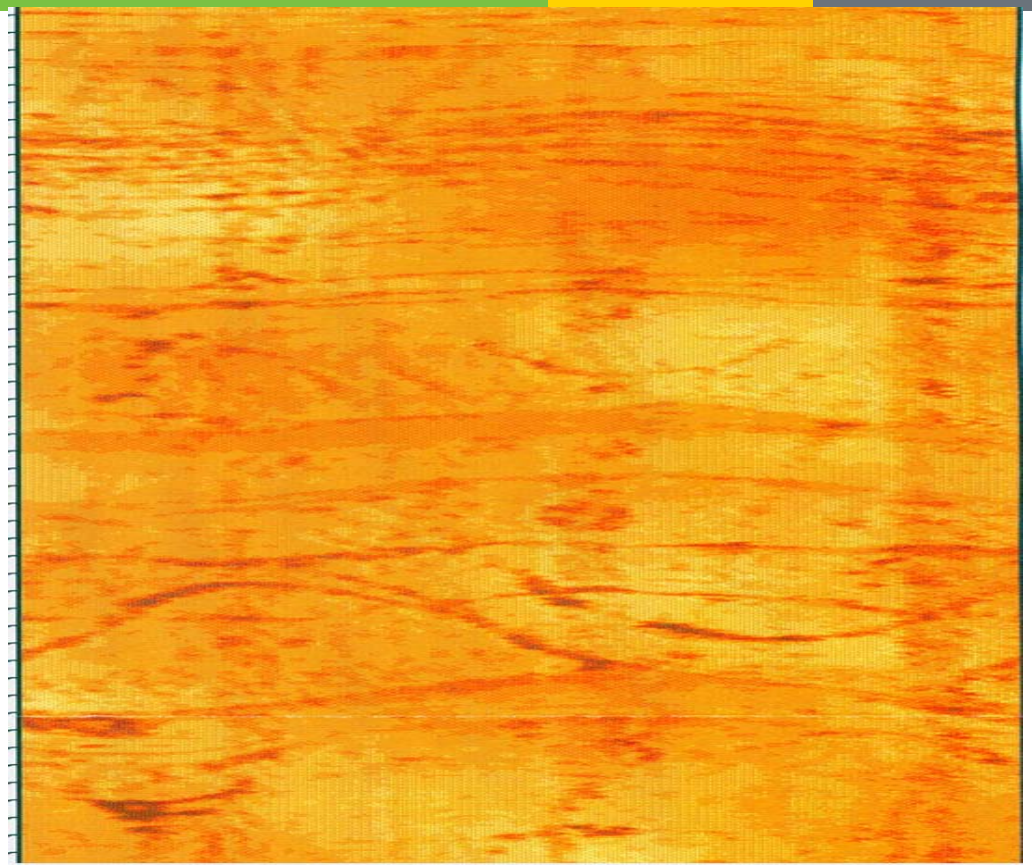

Geothermal Ultrasonic Fracture Imager

GUFI

May 18, 2010

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Oilfield Operations
Incorporated

High Temperature Tools and Drilling

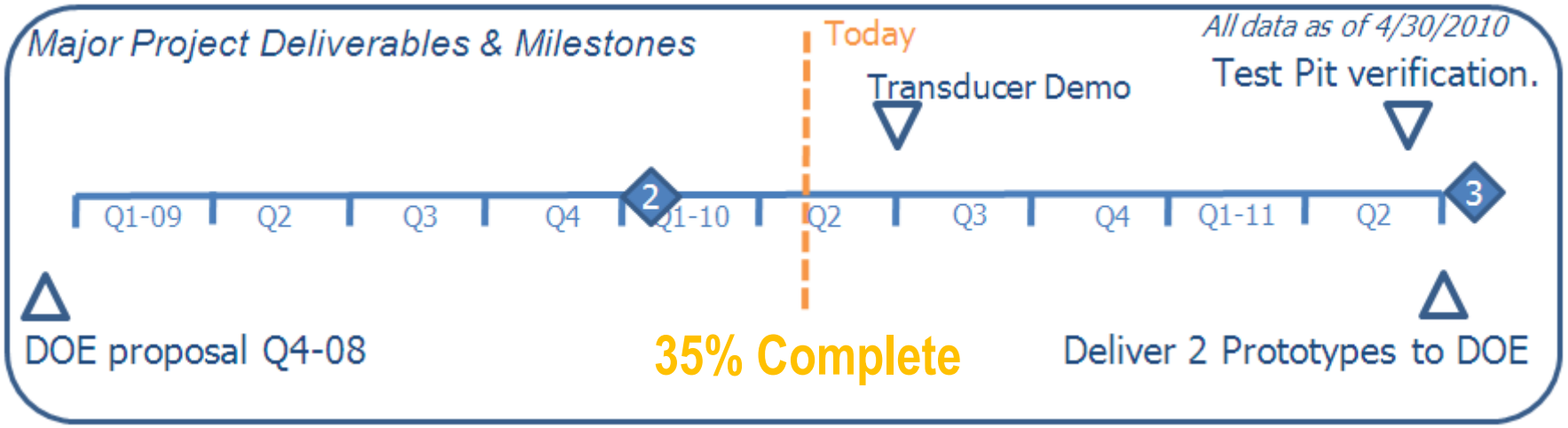
GUFI - Overview

- Development of a downhole wireline tool to characterize fractures in EGS wells in temperatures up to 300° C and depths up to 10,000 m.
- Key challenge is the development of a ultrasonic sensor that operates at 300° C. Unlike other components which can be “flasked” to minimize the temperature the sensor must be in physical contact with the wellbore fluid.
- The associated tool to operate the sensor.

GUFI - Overview

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

- Timeline



GUFI - Overview

	Total	DOE Share	BHI Share
Total Budget	**$ 3,924,207**	**$ 3,139,365**	**$ 784,842**
FY09	$709,966	$567,973	$141,993
FY10	$1,836,584	$1,469,267	$367,317
FY11	$1,377,657	$1,102,125	$275,532
Total Spend	$1,308,791	$1,047,032	$261,759

GUFI Relevance/Impact of Research

- The proper understanding and characterization of fractures, both natural and induced, is critical in the development of Geothermal Reservoirs. This allows for the optimum placement of the injectors and producers to maximize the energy production.

- It is well known in the Oil & Gas industry that ultrasonic borehole images are one of the best means for providing fracture evaluation providing full borehole coverage with high resolution.

GUFI Relevance/Impact of Research

- Key objectives are the developments of:
  - Downhole wireline logging tool to obtain ultrasonic images of “time of flight” and “amplitude” to allow for fracture evaluation
  - An ultrasonic sensor which operates at 300° C
  - Electronics and associated packaging to allow for 300° C operation with appropriate mission time
  - Wiring, connectors, seals and bulkheads for 300° C
  - To be compatible and combinable with other existing downhole services

GUFI Scientific/Technical Approach

- Identify components necessary for acoustic measurement
- Extensive lab testing
  - Materials evaluation for 300° C operation
  - Transducer material compatibility verification
- Acoustic and mechanical optimization of sensor

GUFI Scientific/Technical Approach

- FY09 Milestones
  - Research & Identify Material Options for 300° C operation
    - Piezoelectric options
    - Plastics
    - Coupling Oils
    - Backing Materials
    - Connectivity

GUFI Scientific/Technical Approach

- FY10 Milestones
  - Validate Acoustic Methods for 300° C demonstration (End of June)
    - Piezoelectric options
    - Plastics properties
    - Coupling Oils
    - Backing Materials mixture process
    - Connectivity

GUFI Scientific/Technical Approach

- FY10 Milestones (cont'd)
  - Construct Transducer for 300° C demonstration
    - Measure sensor resolution
    - Acoustic performance
    - Coupling layers
    - Attenuation layers
    - Electrical connectivity

GUFI Accomplishments, Expected Outcomes and Progress

- Piezo material selection and qualification for 300° C downhole operation
- Packaging component and materials for 300° C downhole operation
- Selection of optimal sensor construction and packaging
- Verification and selection of optimal method
- Team expertise
  - Over 120 combined years downhole acoustic system development
  - 3 PhDs, 2 MS, 2 BS, 3 technologists
- Special facilities and equipment
  - 350° C heat chamber
  - AIMS 3D acoustic test tank
  - 40 Kpsi and 370° C test chamber

GUFI Project Management/Coordination

- Schedule
  - On track for Phase 2 completion with 300° C transducer demonstration
- Resources and funds
  - Core team assembled for sensor development
  - Additional staffing being added for remaining tool development
  - Project spend is inline with progress to date
- Project is not affiliated with other program projects
- Coordination with industry - working with DOE to identify field test candidate locations upon verification of prototypes

GUFI Future Directions

- Scope of current project
  - Next phase is the development of the tool system
  - Tool verification at temperature and pressure

- Looking forward
  - Field testing of GUFI in various Geothermal environments
  - Investigate upgrade of support equipment to 300° C
  - Investigate upgrade of other services to provide additional measurements for the Geothermal Industry
  - Investigate the use of multipole borehole acoustic services to evaluate Stoneley Permeability response and fracture characterization away from the borehole

GUFI Mandatory Summary Slide

- 300° C GUFI is feasible
  - Transducer validation and demonstration is progressing to plan with 300° C test by end of June
  - Tool system verification target for July 2011

- Key Technical Targets achieved
  - Piezoelectric sensor material selected
  - 300° C materials selected
  - 300° C compatibility tested
  - Optimum packaging developed