

### DTS Solutions for Earth Sciences

#### Overview

Geothermal power show great promise as an environmentally friendly source for electrical base load generation. Fossil fuel alternatives produce at least an order of magnitude more CO<sub>2</sub> and consume 100 times more water per kWh of energy. Geothermal energy plants have traditionally been limited to the edges of the tectonic plates but recent advances in Enhanced Geothermal Systems (EGS) show promise to open up a much greater geographical range.

With this increased range comes, in some cases, increased well complexity. It is generally agreed upon by experts that improved subsurface visualization is critical to successful and reliable EGS operations. Fiber optic Distributed Temperature Sensing (DTS) technology enables real-time subsurface visualization and understanding of fracture distribution during both fracturing operations and production. DTS technology has been field-tested and proven to be valuable in subsurface monitoring through widespread use in the oil & gas industry. DTS systems have been routinely installed in thermally active, complex wellbores since the mid 1990s.

Subsurface conditions in geothermal wells are very similar to subsurface conditions in heavy oil applications where high temperature steam is injected into tar sand reservoirs. The high temperature steam makes the oil flow easier and the oil can then be pumped out using conventional technology.

An additional benefit to having DTS onsite is that it can also be shared for other applications - such as power cable monitoring for hot spot detection, overheating conditions, and to maximize the available capacity of the monitored circuits while minimizing the risk of damage.



#### Robust Systems for Harsh Conditions

SensorTran DTS units incorporate years of field experience for superior performance in harsh environments and provide cost effective solutions for a wide variety of geothermal monitoring applications. Fiber optic sensing cables employed by DTS systems are non-corrosive and immune to EMI. Fiber optic sensing technology has proven to be capable of providing sub-surface and surface measurements at temperatures up to 300°C.

By combining Distributed Temperature Sensing data with single point pressure data, reservoir engineers are able to update asset models and optimize the efficiency of geothermal power plants. SensorTran is pleased to offer the industry-leading Lynx™ hybrid DTS / Fiber Bragg Grating (FBG) system for this purpose. The Lynx™ system features DataFuser™ software which controls and dynamically integrates and displays distributed temperature sensing data and FBG point sensor data through a single interface. Lynx™ incorporates FBG technology from industry leader Micron Optics.

#### Better Decisions from Better Data

- provides accurate and dynamic information in real-time for up to 40,000 discrete points for complete monitoring
- high speed data reporting enables longer distances or more assets to be monitored with a single unit, increasing efficiency and lowering capital commitments
- improves the accuracy of reservoir models and helps eliminate uncertainty

## System Features and Benefits

**SensorTran** offers a range of intelligent solutions that provide a wealth of features and benefits for both temporary (portable) use and permanent monitoring installations:

- ⇒ up to 50 fiber-optic channels available, providing monitoring for multiple wells and assets from one DTS unit
- ⇒ PerfectVision™ multi-laser technology enables accurate temperature reads even on darkened/attenuated fiber or complex deployments with numerous splices/connectors
- ⇒ open-communications architecture provides reliable and easy interfacing with 3rd party systems and networks (Ethernet, OPC, SCADA, etc.) together with flexible remote control and data output/input capabilities
- ⇒ intelligent and multiple alarm types and configurations can be readily tailored to each specific project to alert the operator to anomalous temperature events or abnormal conditions
- ⇒ each EGS configuration can be defined into unlimited zones with individual alarm types and set-points for each zone, allowing alarms to fully reflect the changing subsurface characteristics
- ⇒ asset-specific visualizations via the SensorTran AssetViewer™ present the data to the operator in a meaningful, representative and intuitive graphical form with tailored report creation facilities
- ⇒ wide range of hardware implementation packages available to meet exacting project requirements
- ⇒ on-board and expandable data storage provides for historical data archiving
- ⇒ extensive self-diagnostics and autonomous operation with safe shut-down and auto-startup
- ⇒ robust optical fiber cable design
- ⇒ suitable for use in hazardous areas and unaffected by electro-magnetic interference

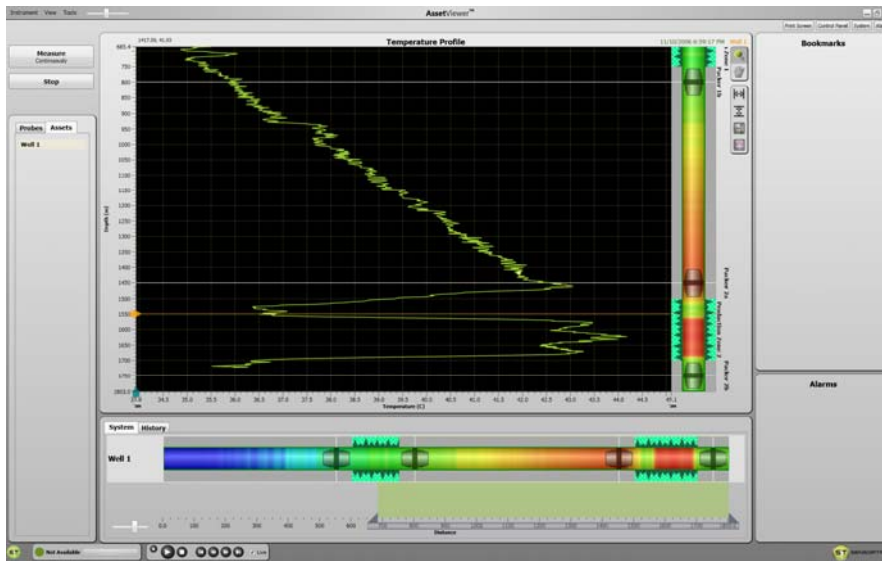
## System Configuration

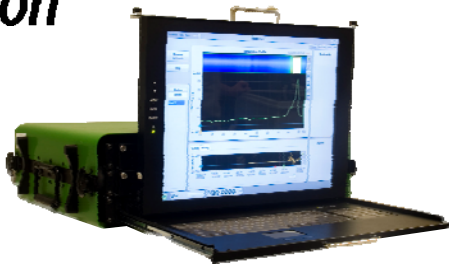
Single or multiple DTS units can be provided within a single control room or field-deployed enclosure. A typical single-DTS unit configuration within a control room cabinet is shown at right. DTS networks can also be readily implemented, providing expanded coverage for multiple wells or site-wide installations that combine monitoring of surface and sub-surface systems. Portable units (shown on next page) are available for mobile deployment and monitoring of exploratory or temporary monitoring applications.

- ◆ Data and alarm output: Ethernet, OPC, SCADA, relay contacts, RS232, RS485, Modbus, DNP3, etc.
- ◆ Remote control and data input: Ethernet, OPC, SCADA, RS232, RS485, Modbus, DNP3, etc.
- ◆ Peripheral equipment: printers, remote displays & keyboards, data back-up, etc.
- ◆ Extensive historian capability able to replay/revisit alarm events and asset performance



SensorTran's AssetViewer™ is an optional software product that provides a graphical visualization of the temperature data. The AssetViewer™ is automatically configured from the settings within SensorTran DTS Commander™ software and requires no additional setup. The software simultaneously displays multiple temperature profiles, summary temperature data, and alarm status information for each zone. Recorded data can also be replayed using the powerful Data Control facility to view historical events at various speeds.


**DTS Technology**

**Triton**


Portable DTS System  
for Earth & Life Sciences

A very short laser light pulse is launched into an optical fiber and the pulse interacts with fused silica in the optical fiber as propagates down the fiber. This interaction causes the light to scatter back to the optical receiver from every point along the full length of the optical fiber. Raman scattering converts a small fraction of power from the launched light pulse into frequency shifted Stokes and anti-Stokes components due to vibrational modes of fused silica glass in the optical fiber. Temperature is calculated as a function of the ratio between the Stokes and anti-Stokes intensity and translated into trace using time-of-flight information. Raman-based Distributed Temperature Sensing (DTS) is the most common Distributed Monitoring System, with widespread adoption across oil & gas, power, fire detection, and other industrial applications.

## Geothermal Applications

DTS systems can provide monitoring for a wide variety of applications. Following are some of the ways that geothermal energy producers and researchers can use DTS data to visualize sub-surface conditions.

- Estimate the production potential in a new well by measuring the distributed temperature and point pressure.
- Determine connectivity between different wells by running pressure build-up tests with pressure monitoring in multiple wells.
- Monitor fracture development during stimulation and fracturing.
- Monitor chemical injection during or after fracturing job.
- Monitor chemical clean-up of the well to wash out mud-cake from the drilling process.
- Monitor scale build-up. Scale will act as an insulating layer and change the temperature profile over depth. Similarly, subsurface chemical clean-up of scale can be monitored.
- Monitor water injection - DTS traces will highlight which zones and fractures take the injected fluid.
- Monitoring of producer wells allows identification of what zones and fracture produce fluids. Geothermal reservoirs are complex areas with fractured rock that change during the life of the well. Similarly, short circuiting can be detected and mitigation options can be planned.
- Integrity monitoring for casing and tubing leaks to avoid contaminate ground water and subsurface aquifers. Additional channels can also monitor surface piping at minimal additional cost.



SensorTran is  
ISO 9001 Certified.

SensorTran has made every effort to ensure information contained in this document is accurate at the time of printing, however, product specifications and features are subject to change without notice.

## The SensorTran Advantage

SensorTran is committed to supplying its customers with smart distributed monitoring solutions. SensorTran's systems are conceived to have a low lifetime cost of ownership (LCO) by way of efficient design, superior engineering and reliable construction. SensorTran's team is dedicated to providing "best-in-industry" customer care from project conception to the development of specifications, through installation, training and beyond.

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Solutions