Advanced Pipeline Monitoring for Flow Assurance with Fiber Optics

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COMPANY DESCRIPTION

- ATI formed in 1994
- Oil and Gas Advanced Instrumentation
  - Deepwater oil & gas
  - Pipeline monitoring
  - Liquefied Natural Gas
- Privately owned, at Houston Ellington Field
- Engineering capabilities include:
  - System integration
  - Real-time embedded systems
  - Experimental stress analysis
  - Fiber optic sensor technology
  - Conventional sensor integration
  - Environmentally hardened systems
  - Software development

Brigham Young University

- Campus located in Provo, UT
- Enrolled Students: 32,980
- 14th Largest US Chemical Engineering Department

Astro Technology Background

- **ATI provides engineering solutions:**
  - **Monitoring of offshore flowlines, SCRs, drilling risers, umbilicals and cables**
  - **Detection of pig and blockage location in pipelines**
  - **Smart fields monitoring of pipelines and subsea fields**
  - **Cable and umbilical splicing and repair**
  - **LNG monitoring**
  - **Instrumenting structures**
  - **Testing solid rocket motors**
  - **Robotics applications (“Robonaut” hand)**
  - **Aerospace vehicles**
  - **Demilitarization of weapons of mass destruction in Russia**

Offshore Projects

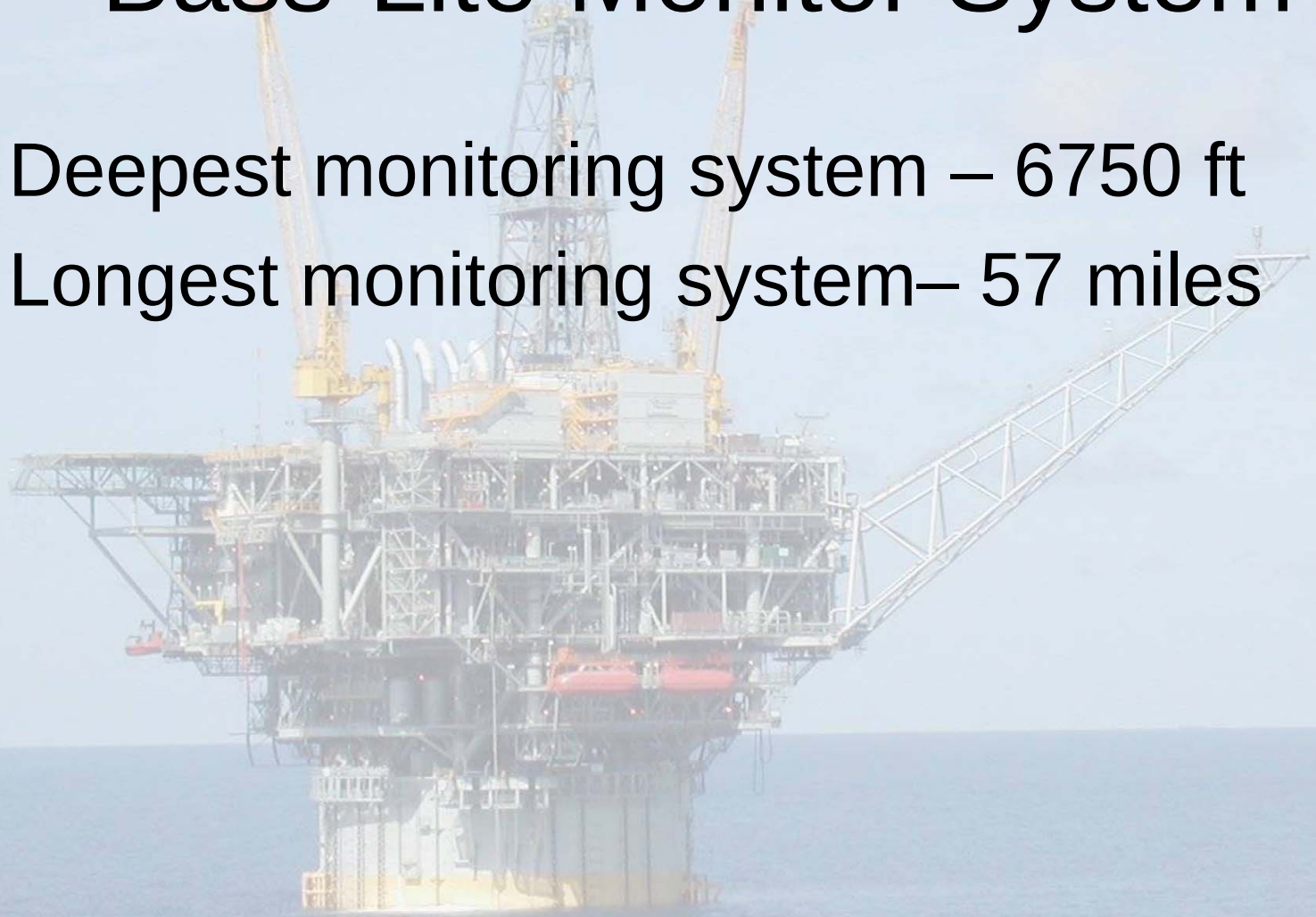
- Bass Lite
- Devils Tower
- Geauxpher
- Troika
- Pluto
- BP Ocean Clipper / Ocean Confidence
- Mardi Gras
- Holstein
- Thunder Horse
- Brass LNG – Engineering phase

OVERVIEW OF INSTRUMENTATION METHODS

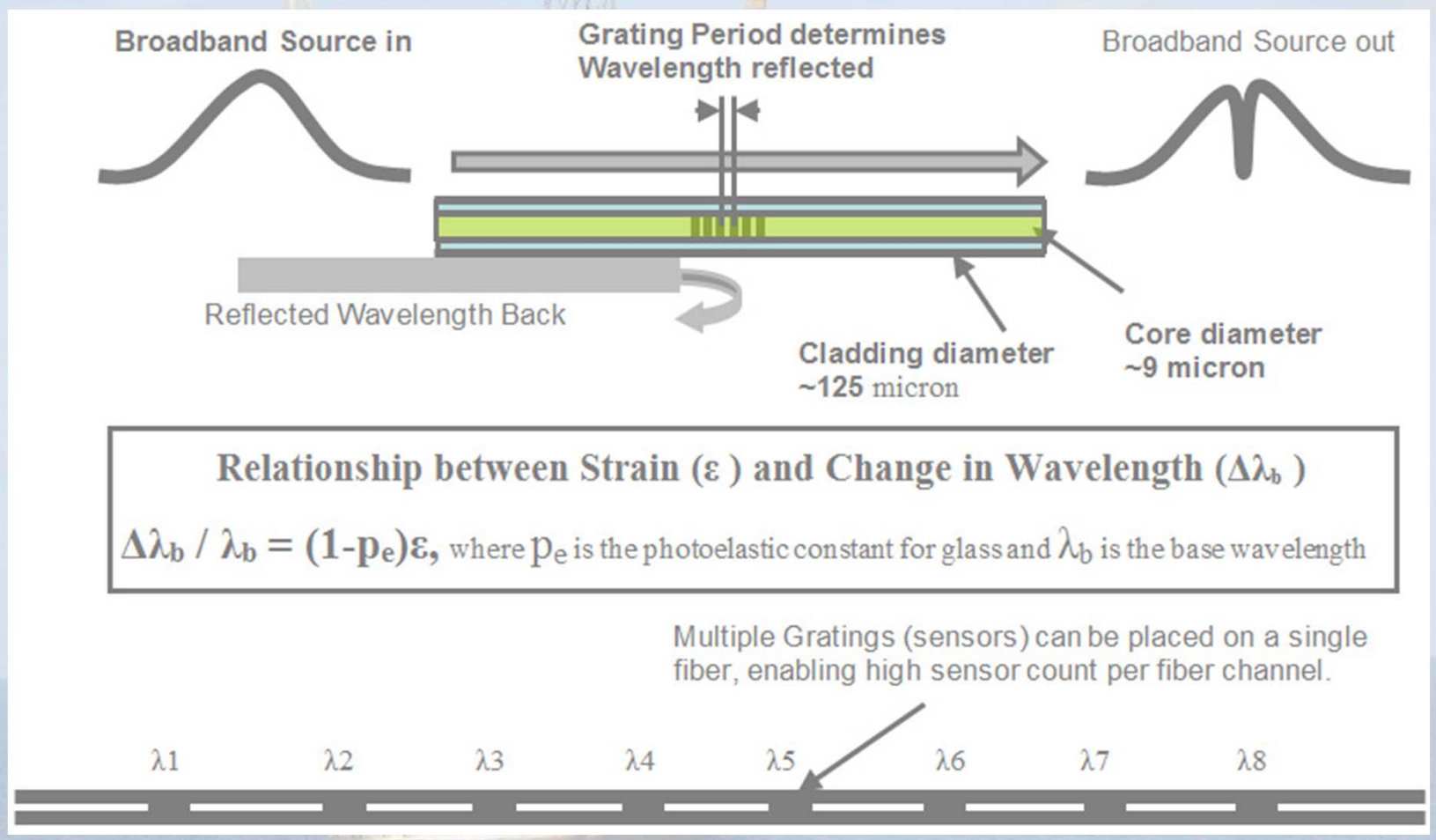
TRIDENT SUBSEA MONITORING SYSTEMS

Bass-Lite Monitor System

- Deepest monitoring system – 6750 ft
- Longest monitoring system– 57 miles



Fiber Optic Monitoring

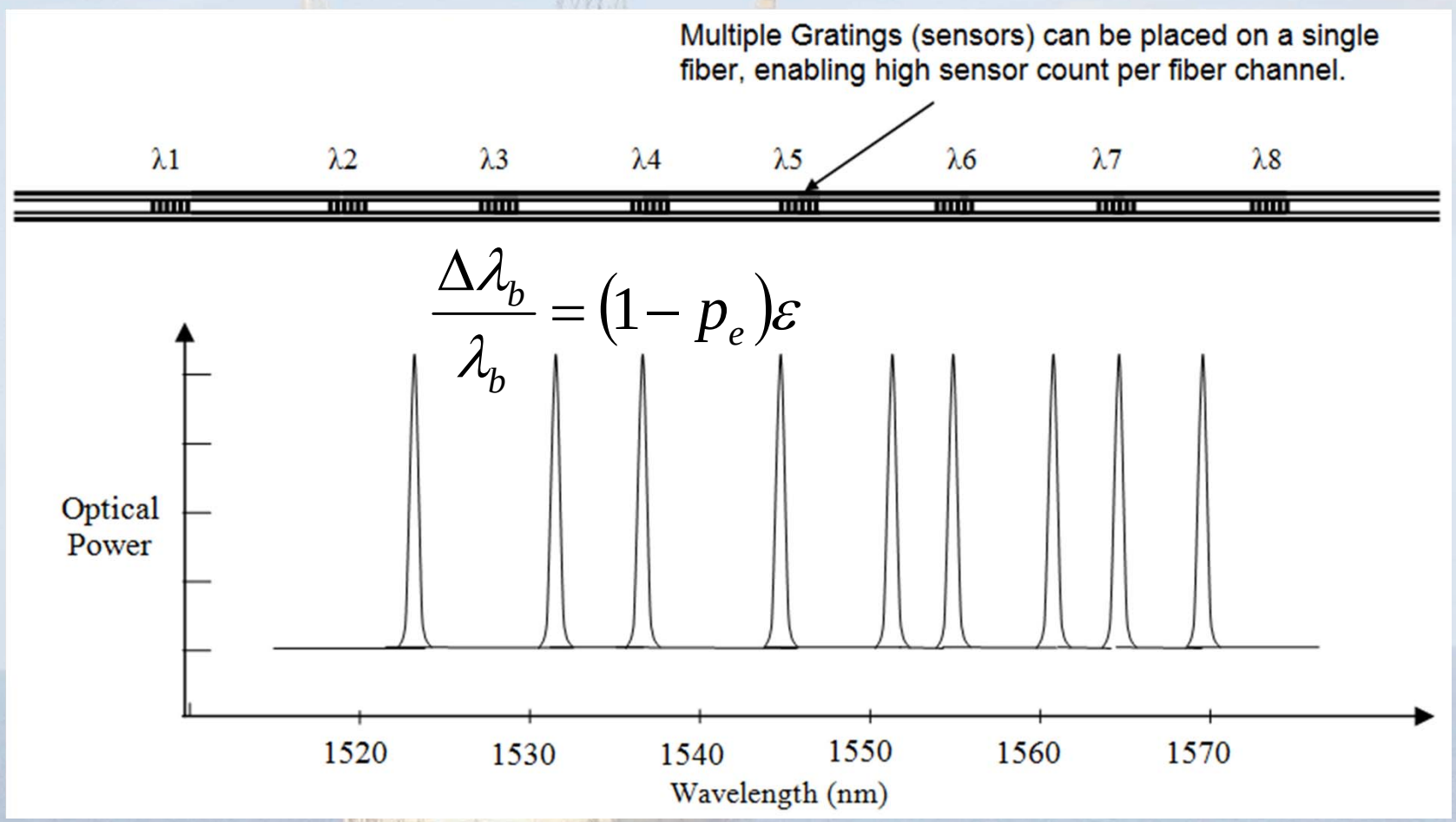


Relationship between Strain (ε) and Change in Wavelength ($\Delta\lambda_b$)

$\Delta\lambda_b / \lambda_b = (1-p_e)\varepsilon$, where p_e is the photoelastic constant for glass and λ_b is the base wavelength

Multiple Gratings (sensors) can be placed on a single fiber, enabling high sensor count per fiber channel.

Monitor Peak Shifts



Monitoring System

- Sensor Station Installation

Monitoring System

- Sensor Station Installation

Monitoring System

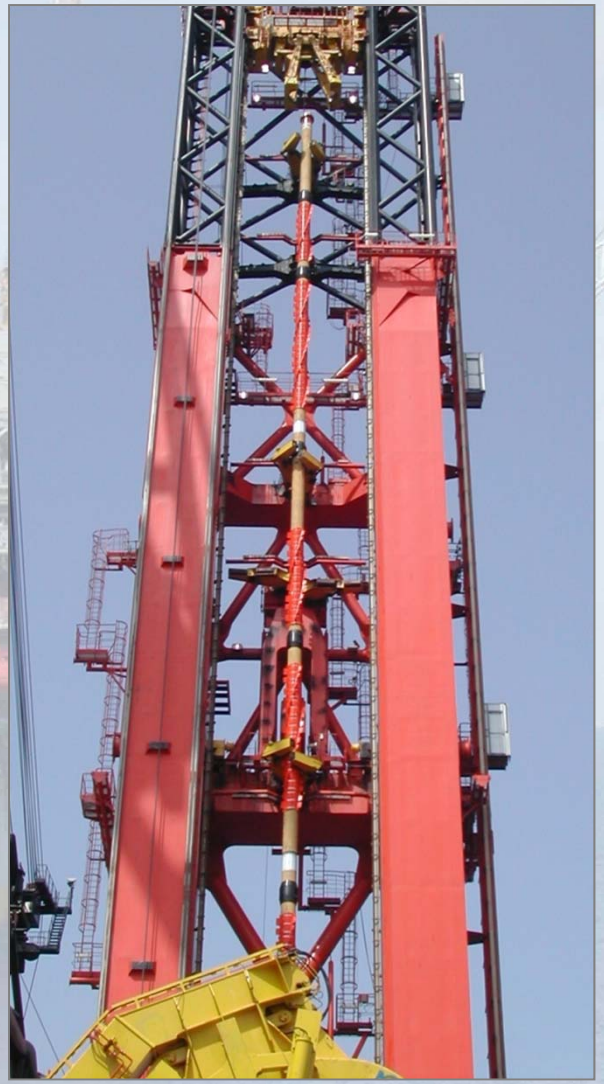
- Offshore Fiber and Electrical Hookup

Monitoring System

- Offshore Cable Installation

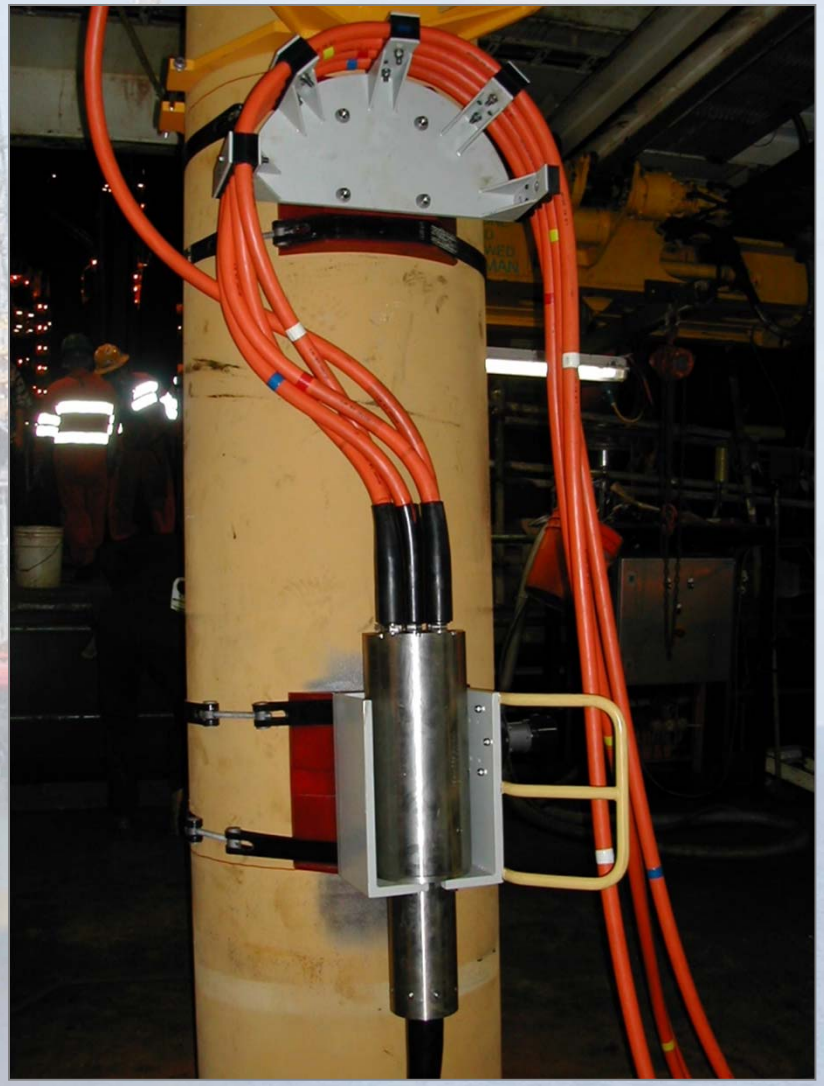
Monitoring System

- Offshore Installation



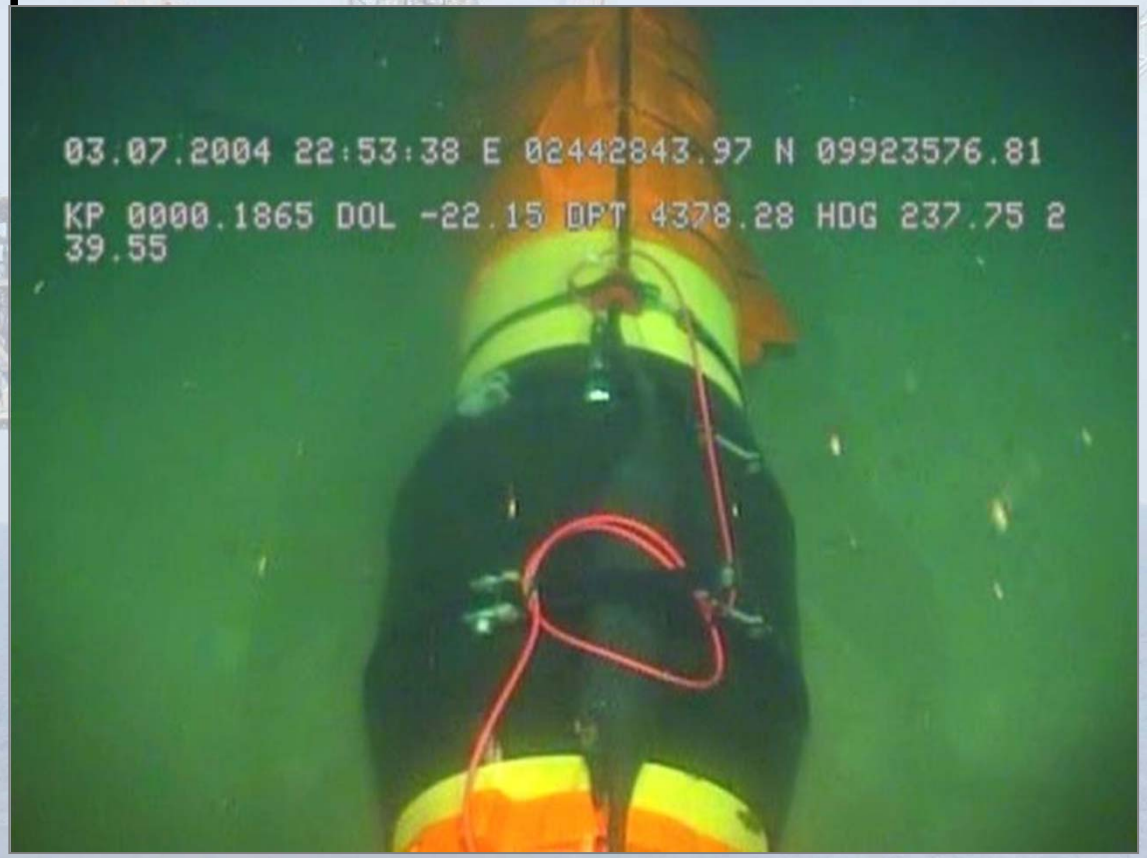
Monitoring System

- Offshore Cable Installation



Monitoring System

- Deepwater Installation



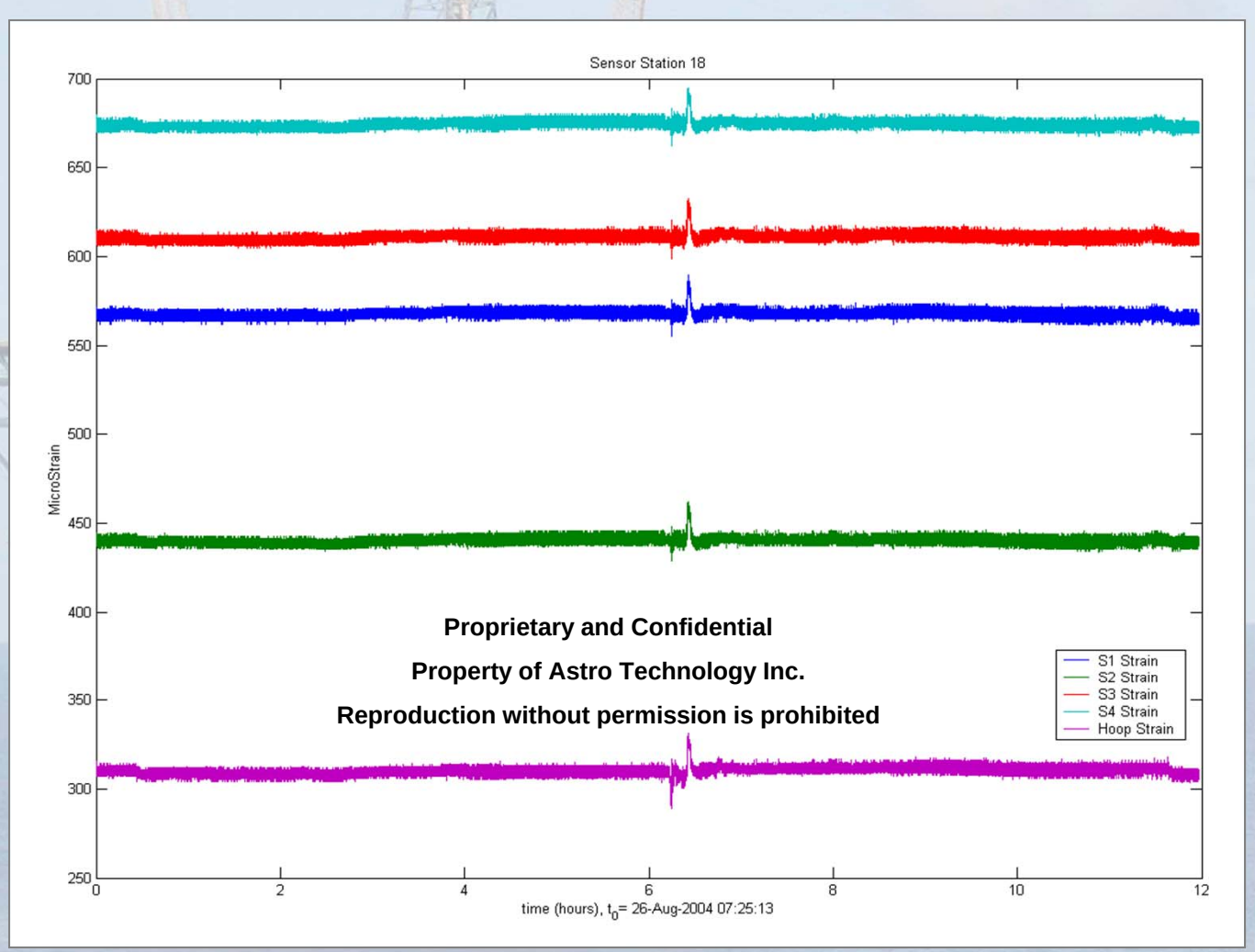
Cabling, Splicing and Connectors

FOBA Examples

Cabling, Splicing and Connectors

FLET Instrumentation

Deepwater Data – Flushing Pig Passage



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Bass Lite Real Time Monitoring

FLMT #2 (18 miles)

T 56.55 °F

Temperature (°F) last 24 hrs

Temperature (°F) last month

P 1588.05 psig

Pressure (psig) last 24 hrs

Pressure (psig) last month

FLMT #1 (36 miles)

T 37.06 °F

Temperature (°F) last 24 hrs

Temperature (°F) last month

P 2255.21 psig

Pressure (psig) last 24 hrs

Pressure (psig) last month

FLET (57 miles)

T 27.32 °F

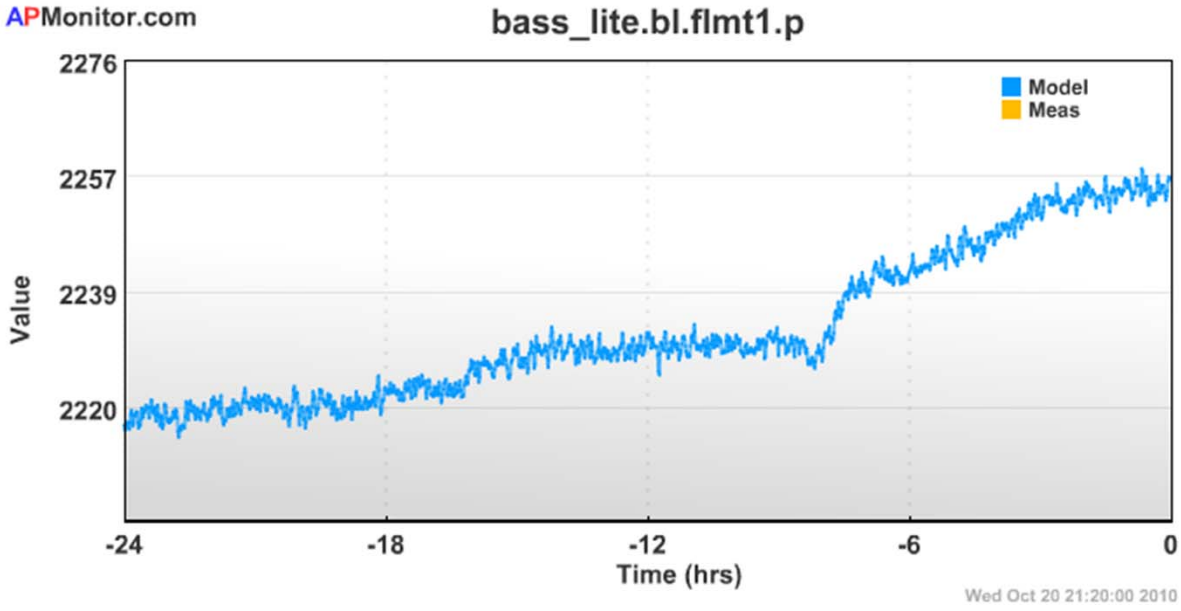
Temperature (°F) last 24 hrs

Temperature (°F) last month

P 2588.79 psig

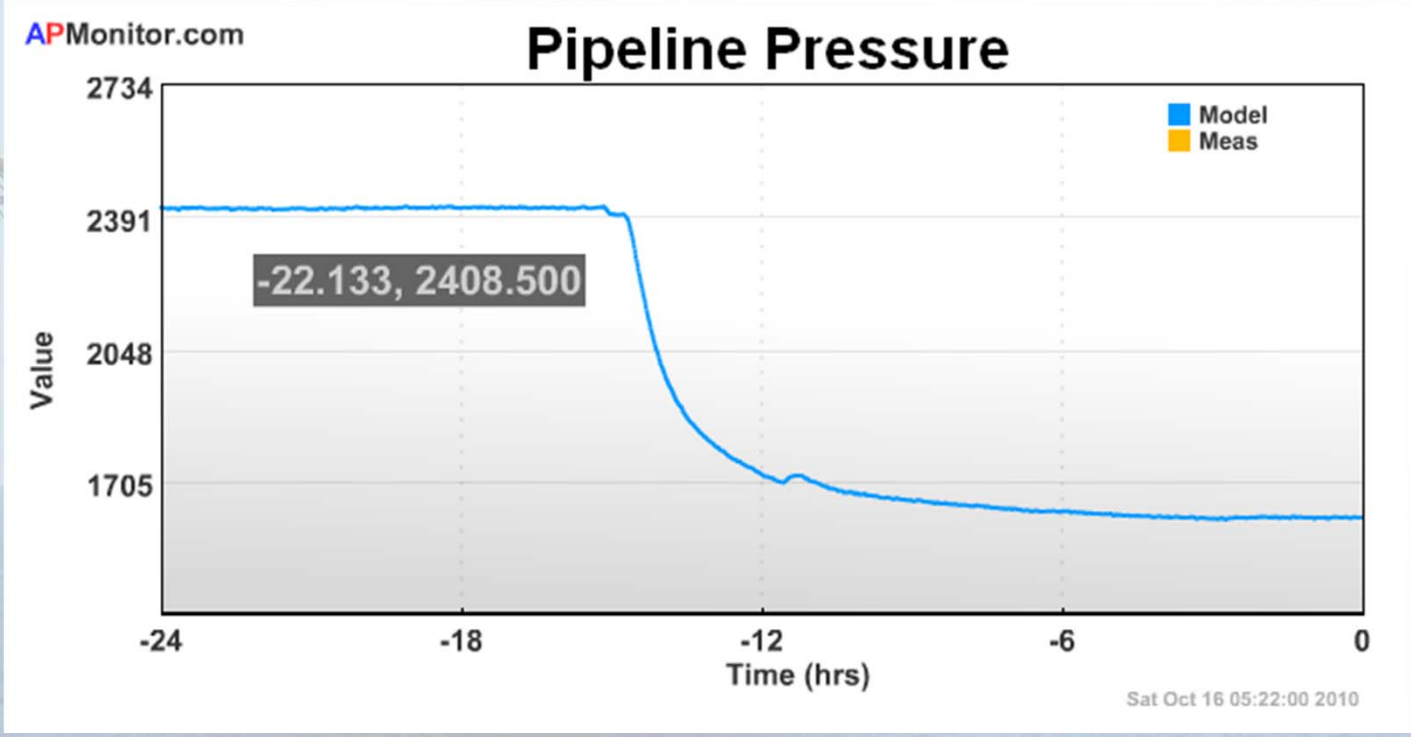
Pressure (psig) last 24 hrs

Pressure (psig) last month



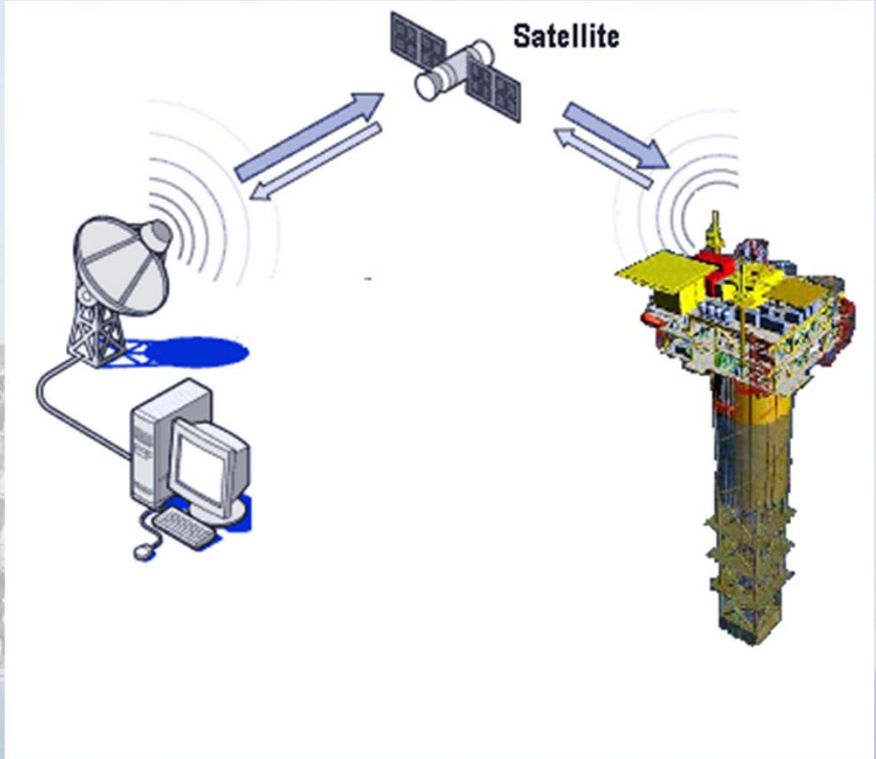
Deepwater Monitoring Software

Connect to live systems
Web accessible configuration and results



Monitoring from Remote Locations

- Remote display of real-time data
- Secure & encrypted data transmission
- Getting the right data to the right people to make the right decisions
- Advanced Process Monitoring:
  - http://apmonitor.com



Software – Process Monitoring

- Fully utilize existing measurements
  - Hundreds of isolated measurements
  - Advanced Monitoring places data in context (as opposed to raw data)
  - Holistic view of available measurements
- Provides Smart Notifications
  - Early leak detection
  - Identify leak location
  - Reduction of unplanned shutdowns due to false alarms
  - Abnormal situation management

Software Benefits

Trident Subsea Systems

- Meet regulatory reporting requirements
- Flow assurance of oil and gas transport pipelines
- Structural characterization
- Visualize data from remote locations
- Reduce alarms by consolidating relevant information
- Improved design and operations
- Improved safety and environmental criteria

Subsea field real time monitoring

- MEG Chemical Injection
  - Control hydrate formation
  - Injection at wellheads and local intervention
- Active Heating
  - Control & mitigation of hydrates
- Pressure / Flow Control
  - Control at wellheads and manifolds
- Mechanical Intervention

CLEAR GULF JIP

- Reduce risk of hydrocarbon spillage
- Improve safety
- Significant cost avoidance and downtime
- Assists in regulatory compliance
- Improved subsea field design
- Low investment cost for JIP participants
- Utilize NASA facilities and expertise
  - US flagship technology organization
- Credible third party involvement