



DEEPWATER MONITORING BASS LITE

31st International Conference on Ocean, Offshore
and Arctic Engineering
ASME / OMAE 2012

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July 2012





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BASS LITE OVERVIEW

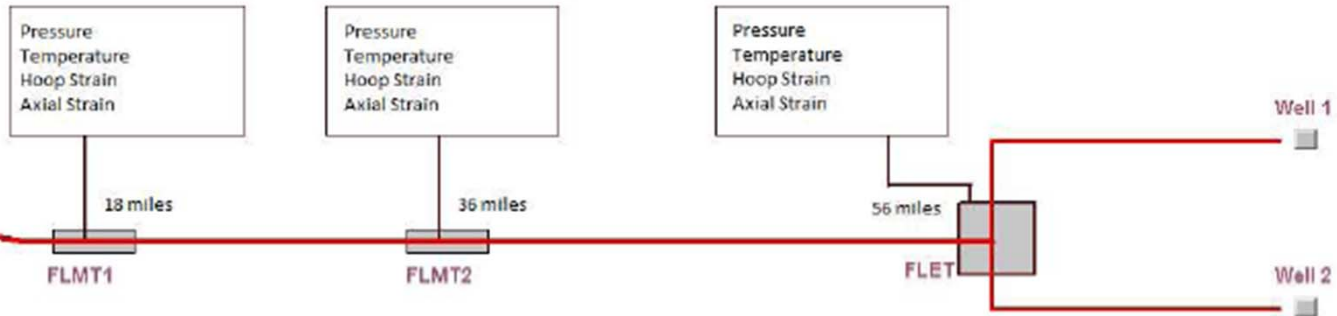
- Located in Atwater Valley Block 426
- Utilizes 20.3-cm (8-in) diameter flowline
- 90-km (56-mi) length
- Ties to Devils Tower in Mississippi Canyon
- Production – up to 130 million cubic feet per day
- Water depth – 2,050 m (6,750 feet)
- Commenced operation in February 2008



BASS LITE INSTRUMENTATION

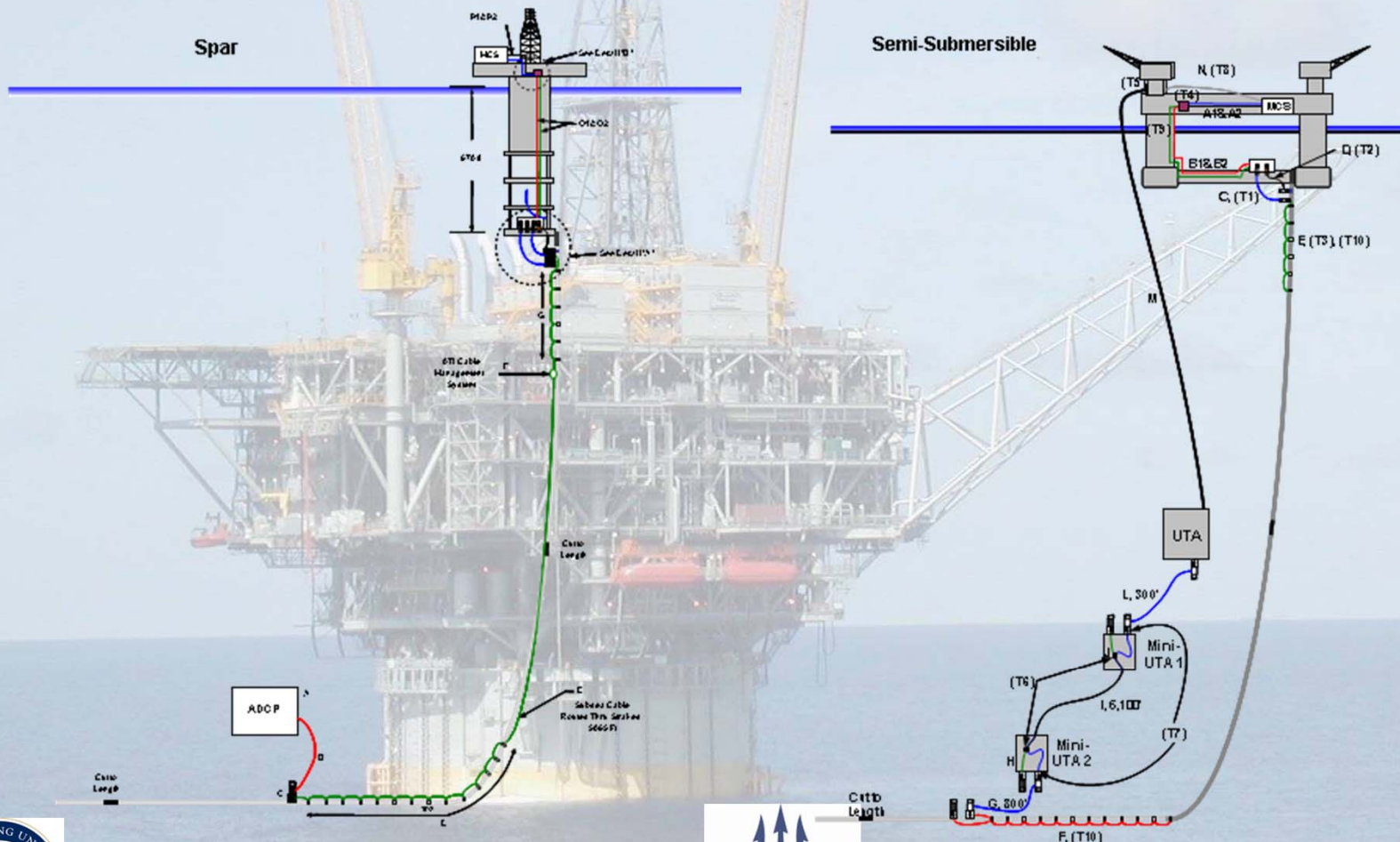


- Fiber Optic sensors used in this application
 - Fiber Bragg Gratings
 - Multiplexing capable
 - Web based signal protocol
 - Remote viewing capability





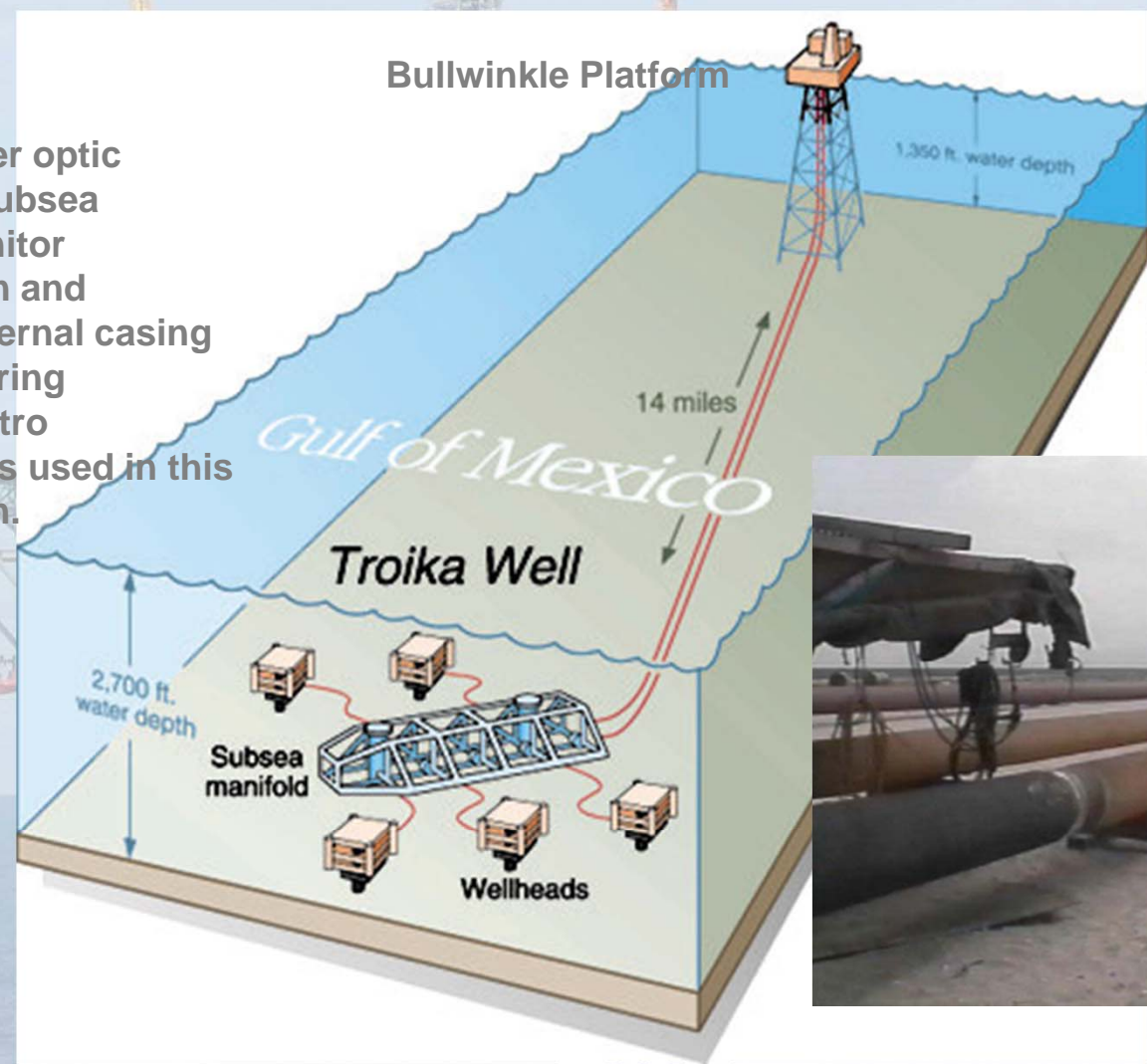
PREVIOUS INSTRUMENTATION DEEPWATER RISERS





Troika - Gulf of Mexico

First use of fiber optic sensors on a subsea pipeline to monitor pressure, strain and vibration in external casing pipe bundle during fabrication. Astro Technology was used in this new application.

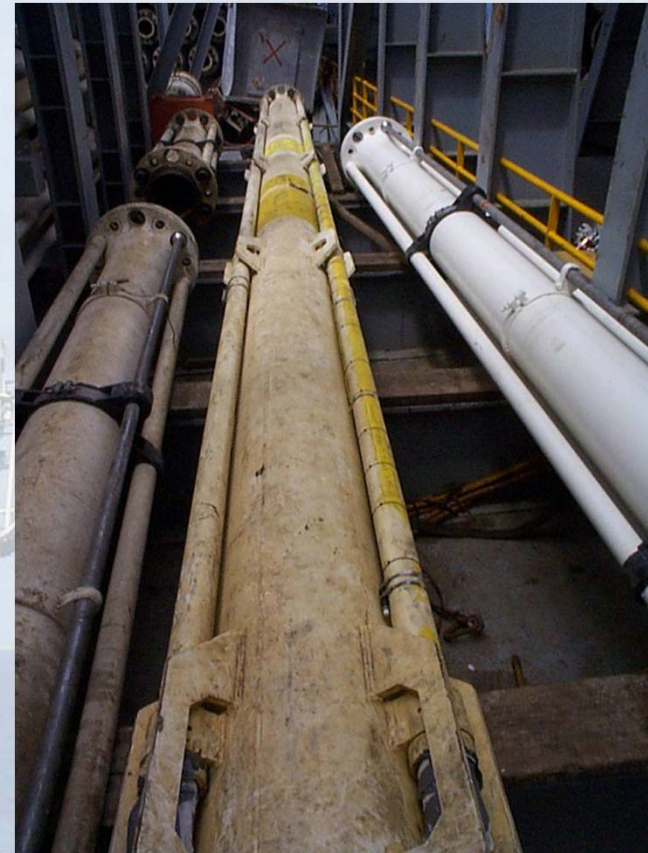




FIBER-OPTIC SENSORS FOR DEEPWATER DRILLING



OCEAN CLIPPER



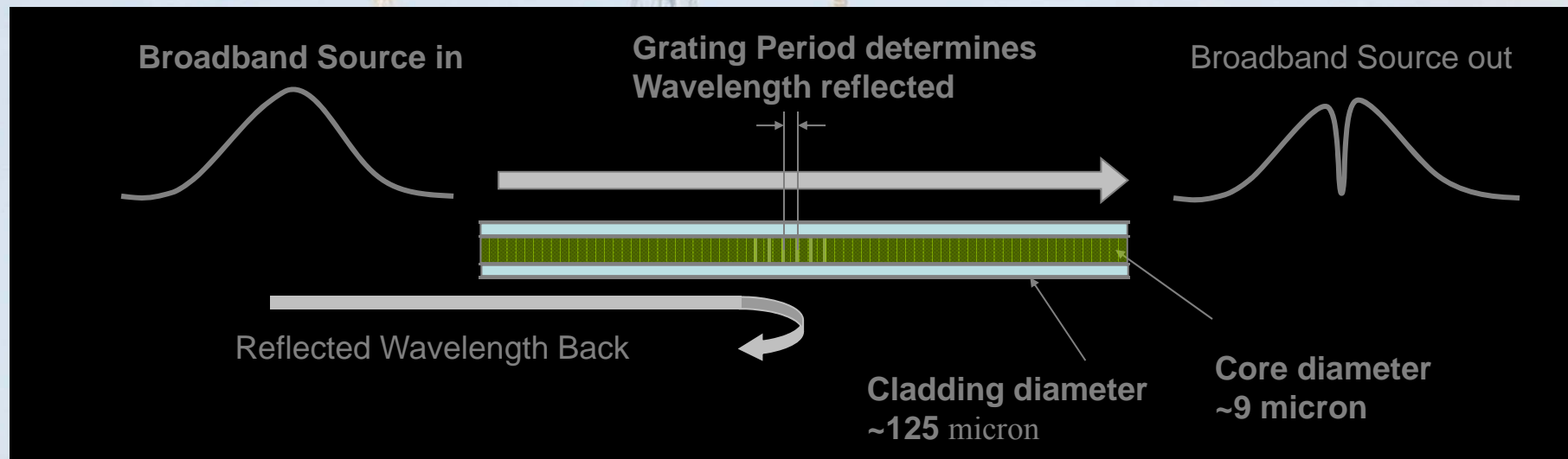


OVERVIEW OF INSTRUMENTATION METHODS

TRIDENT SUBSEA MONITORING SYSTEMS



FIBER BRAGG GRATINGS



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

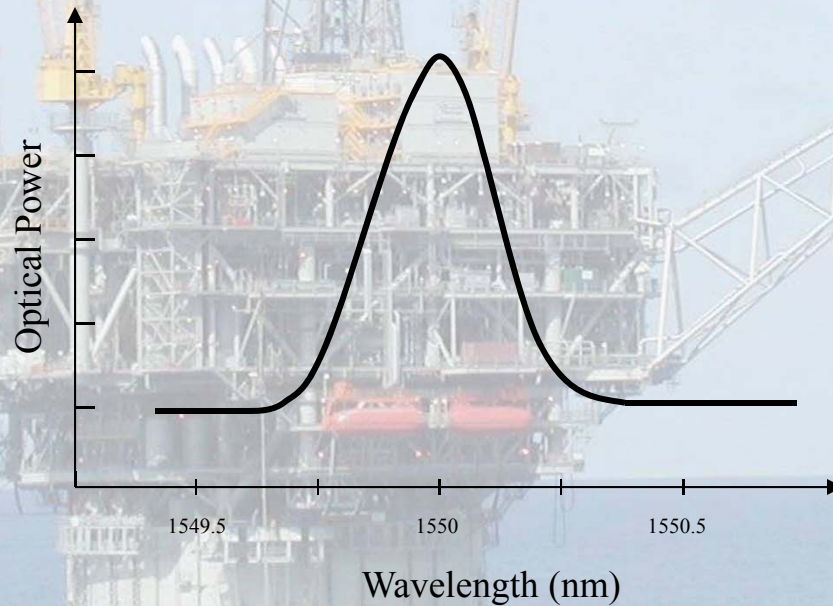
$$\Delta\lambda_b / \lambda_b = (1-p_e)\epsilon$$
 where p_e is the photo elastic constant for glass and λ_b is the base wavelength

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





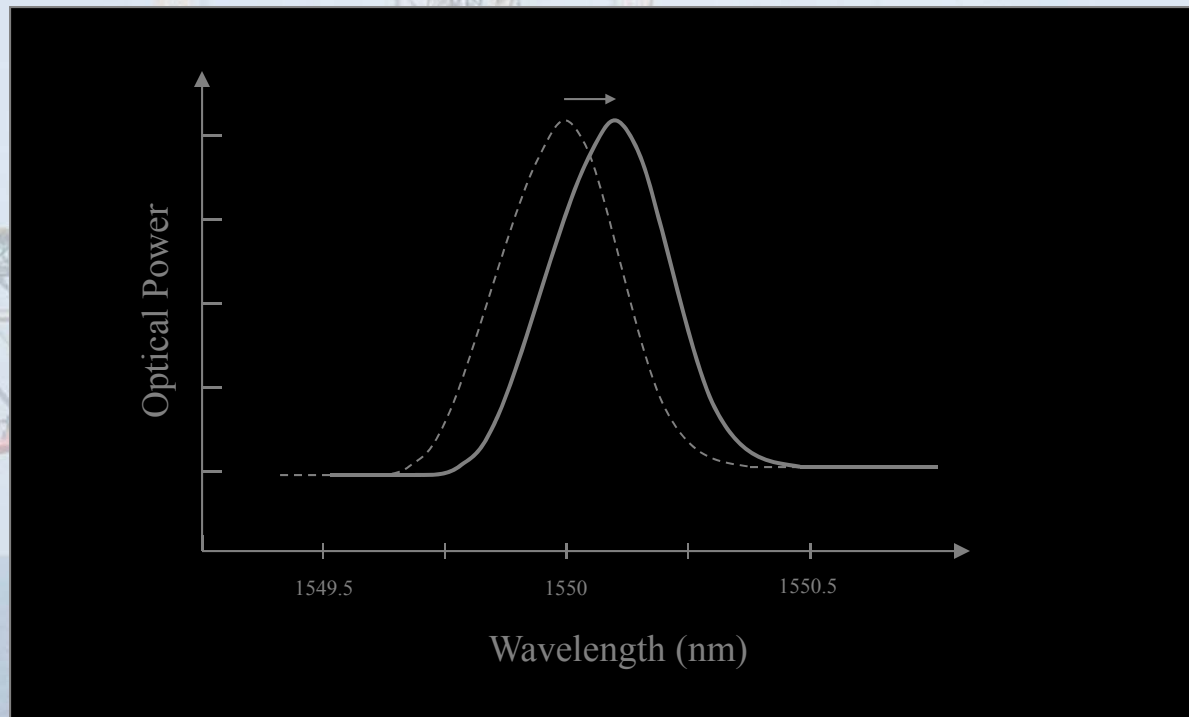
Relationship Between Wavelength and Strain



Example Base Wavelength for a Single FBG

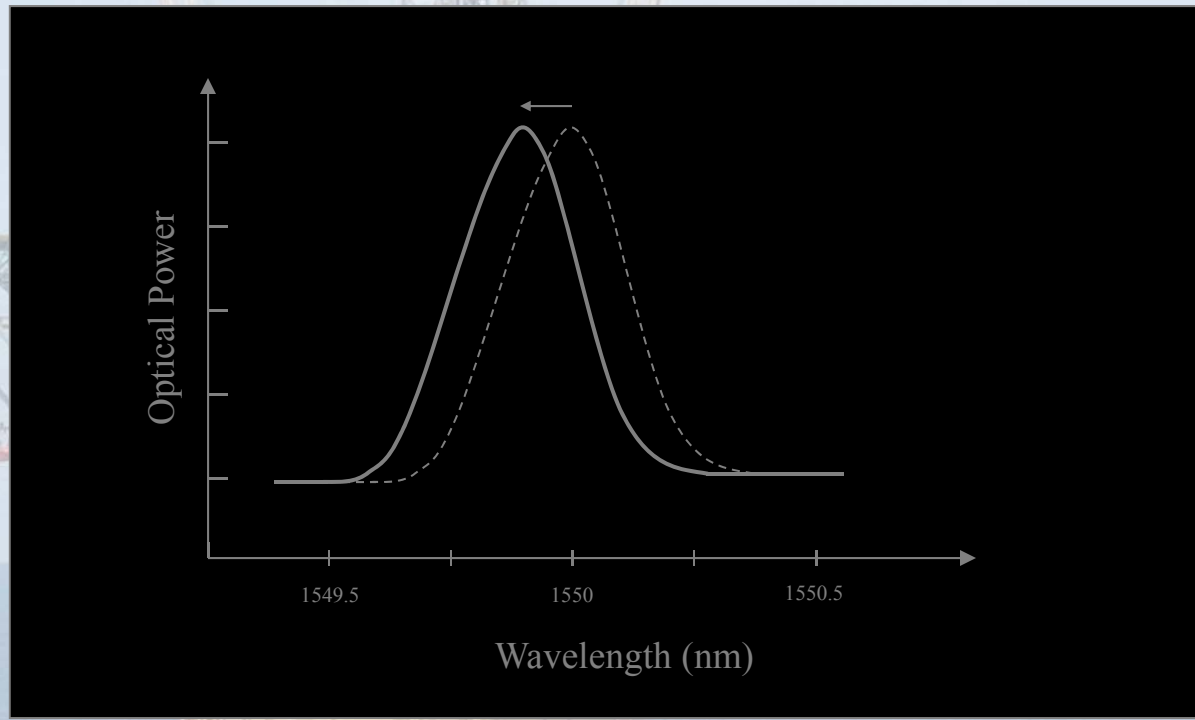


Relationship Between Wavelength and Strain – Tension



Reflected Signal from the Previous FBG in Tension

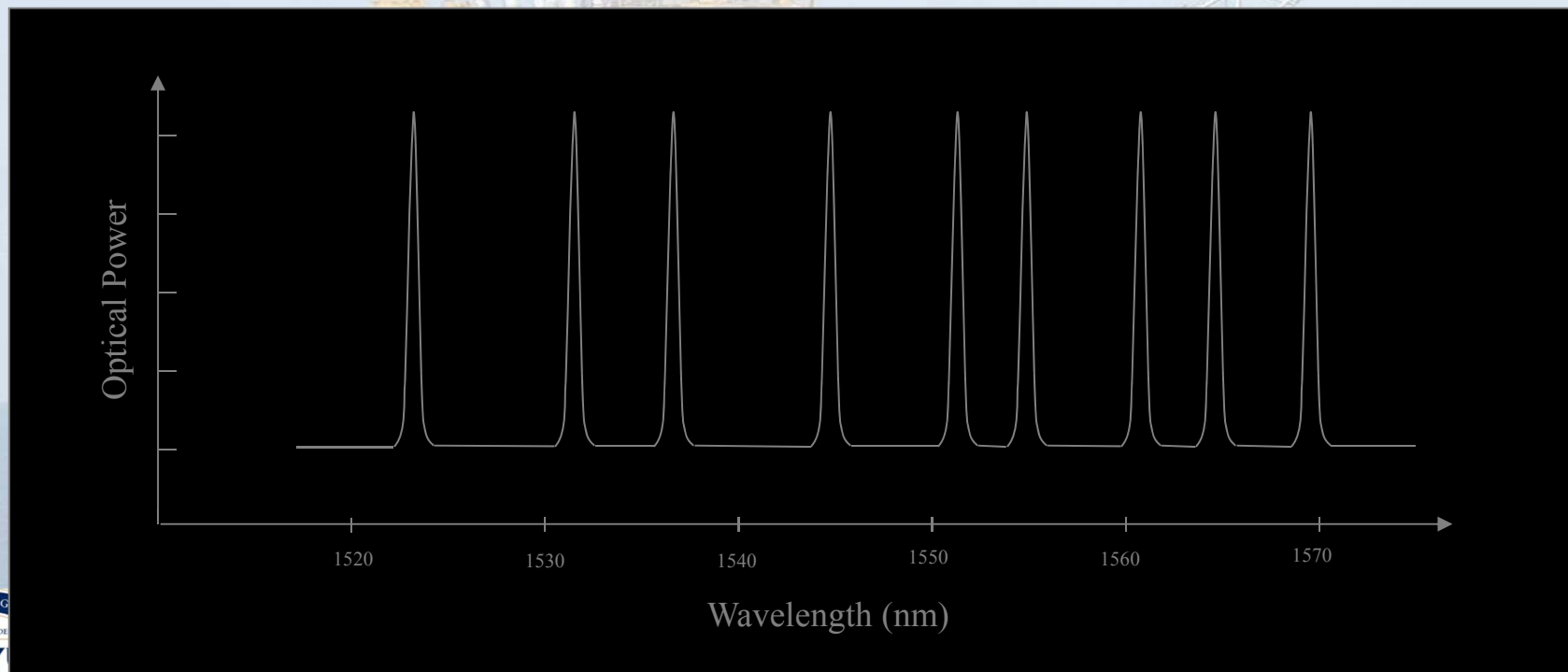
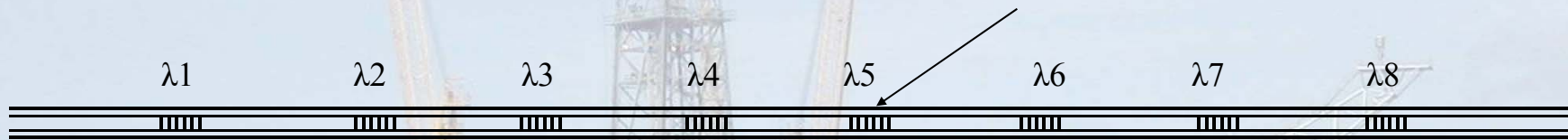
Relationship Between Wavelength and Strain – Compression



Reflected Signal from the Previous FBG in Compression

Example of a Reflected Spectrum from Multiple FBGs on a Single Optical Fiber

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





Monitoring Systems

- Deepest monitoring system – 7500 ft
- Highest monitoring – low earth orbit
- Longest monitoring system– 60 miles @ 7500 ft depth
- Coldest – cryogenic LNG and LN2
- Hot – interior of solid rocket motor





Vision for Offshore Monitoring Technology

- Monitoring Systems as a vital input to long term Riser and Pipeline Integrity Management
- Smart Field Technology supporting Flow Assurance of pipeline systems
- Innovative methods implementation





Cabling, Splicing and Connectors



BASS LITE

PLET Instrumentation





Cabling, Splicing and Connectors

FOBA Examples





Subsea Monitoring System

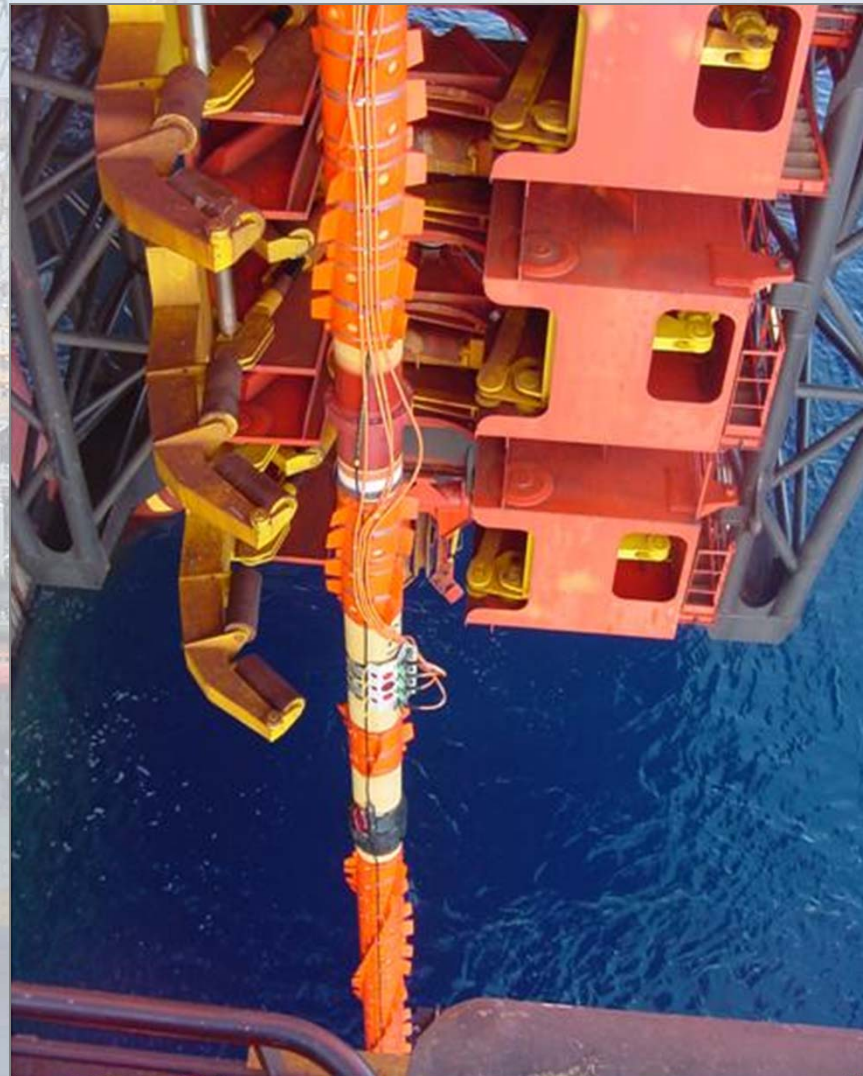
- Topside Equipment Rack Installation





Monitoring System Deployment

- Offshore Installation

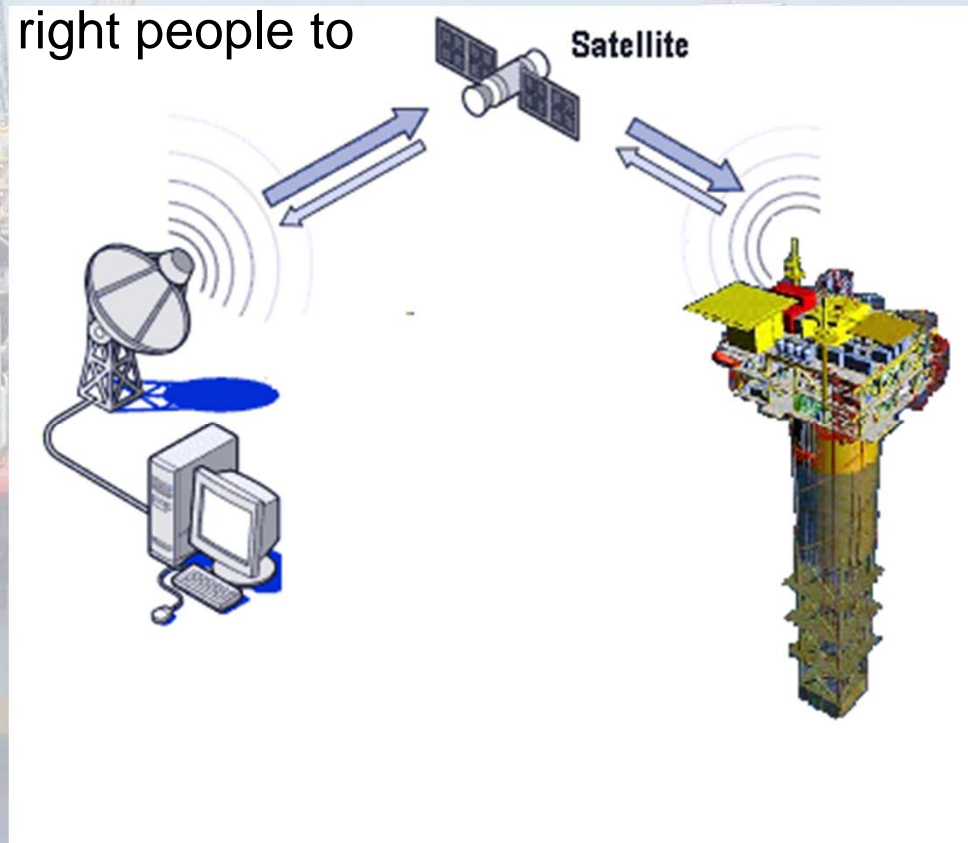


- SUB-SEA SYSTEMS -
ASTRO TECHNOLOGY



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





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)

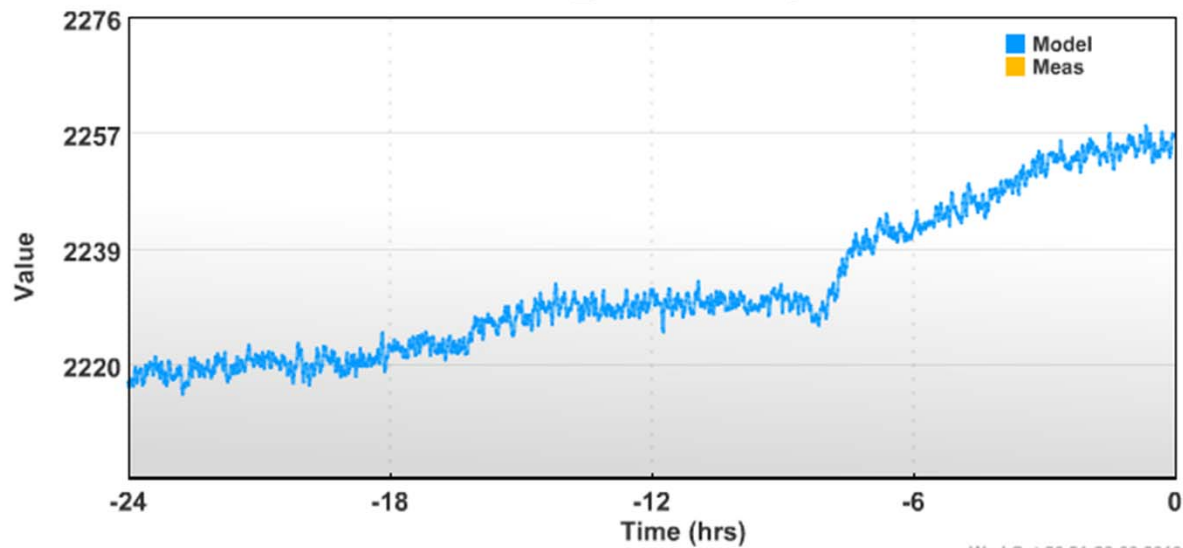
T 27.32°F
[Temperature \(°F\) last 24 hrs](#)
[Temperature \(°F\) last month](#)

P 2588.79 psig
[Pressure \(psig\) last 24 hrs](#)
[Pressure \(psig\) last month](#)



APMonitor.com

bass_lite.bl.flmt1.p



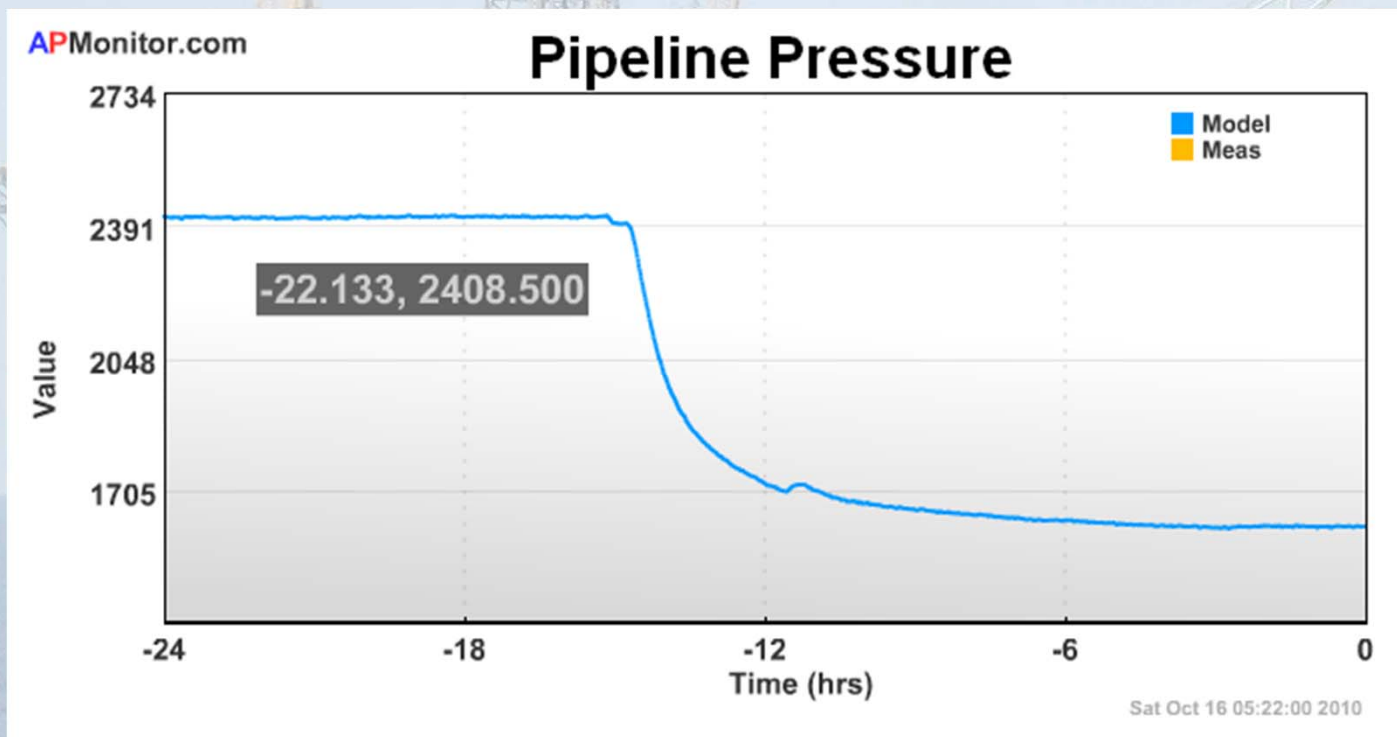
Wed Oct 20 21:20:00 2010





Deepwater Monitoring Software

Connect to live systems
Web accessible configuration and results





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





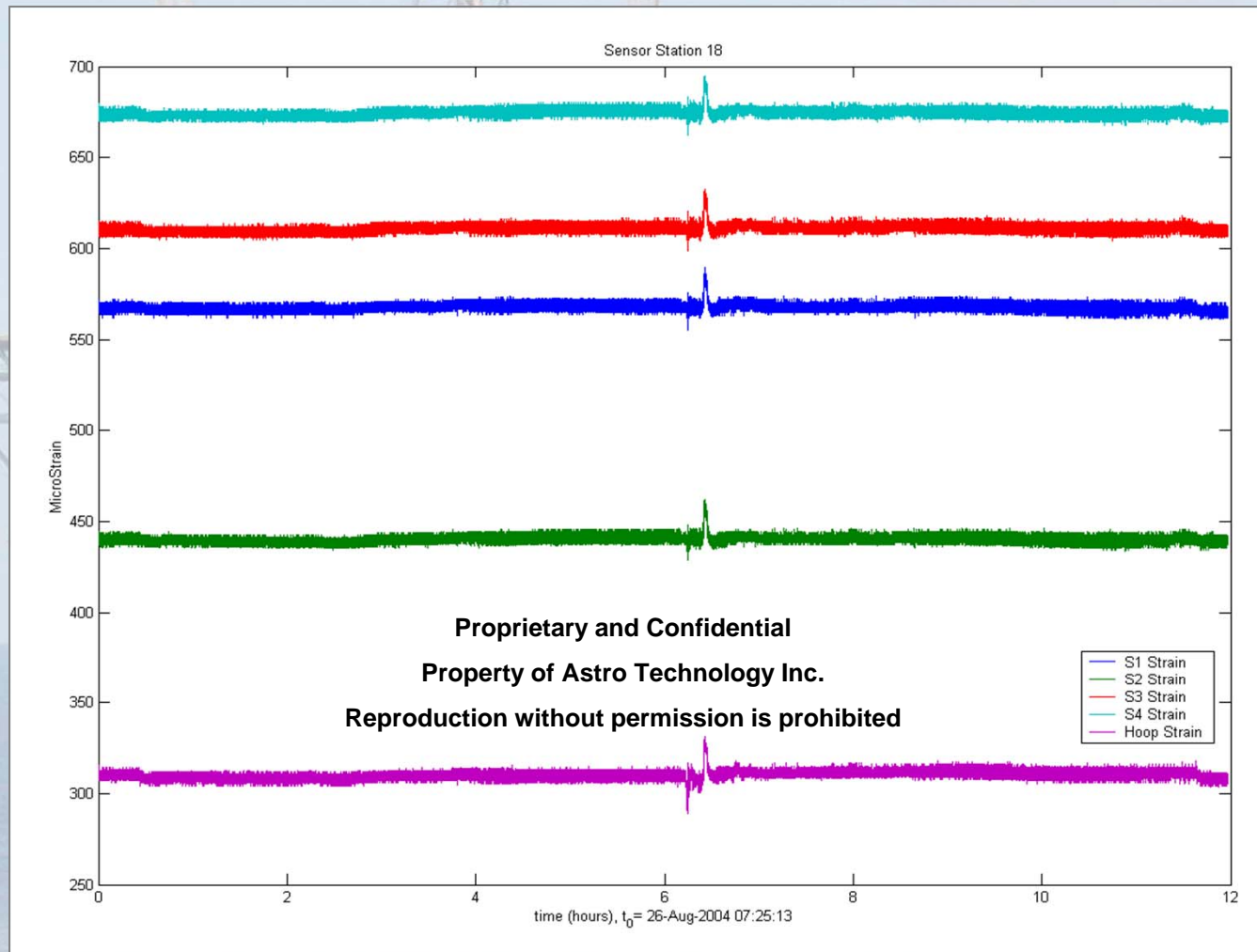
Software Benefits Trident Subsea Systems

- 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



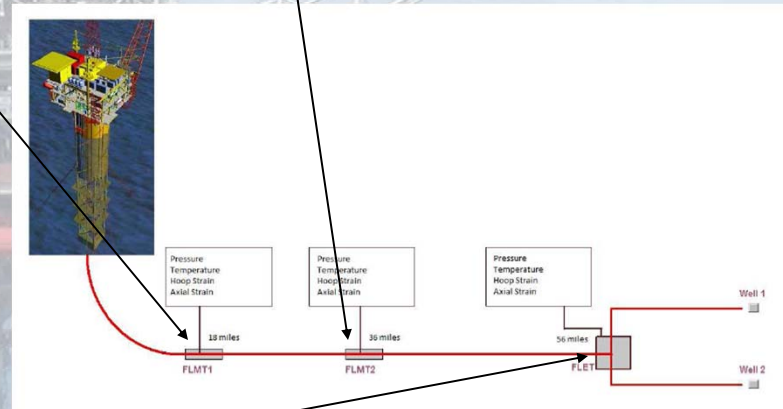
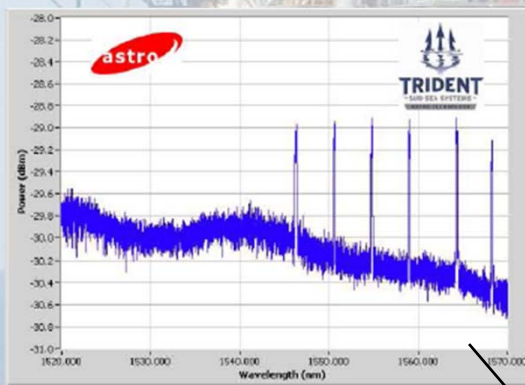
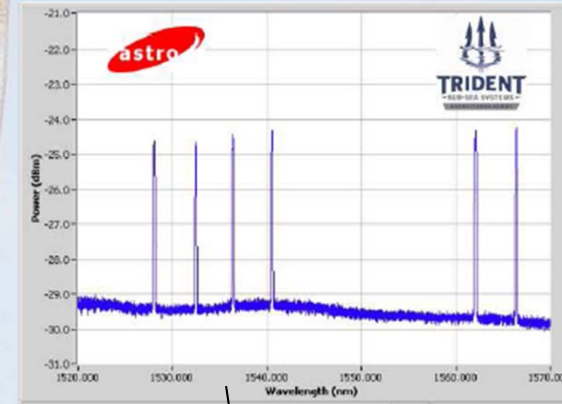
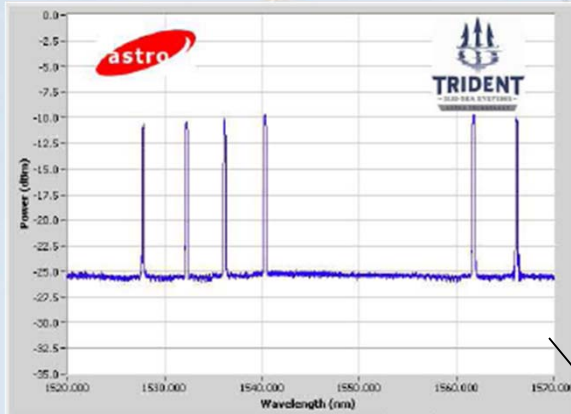


Deepwater Data – Flushing Pig Passage



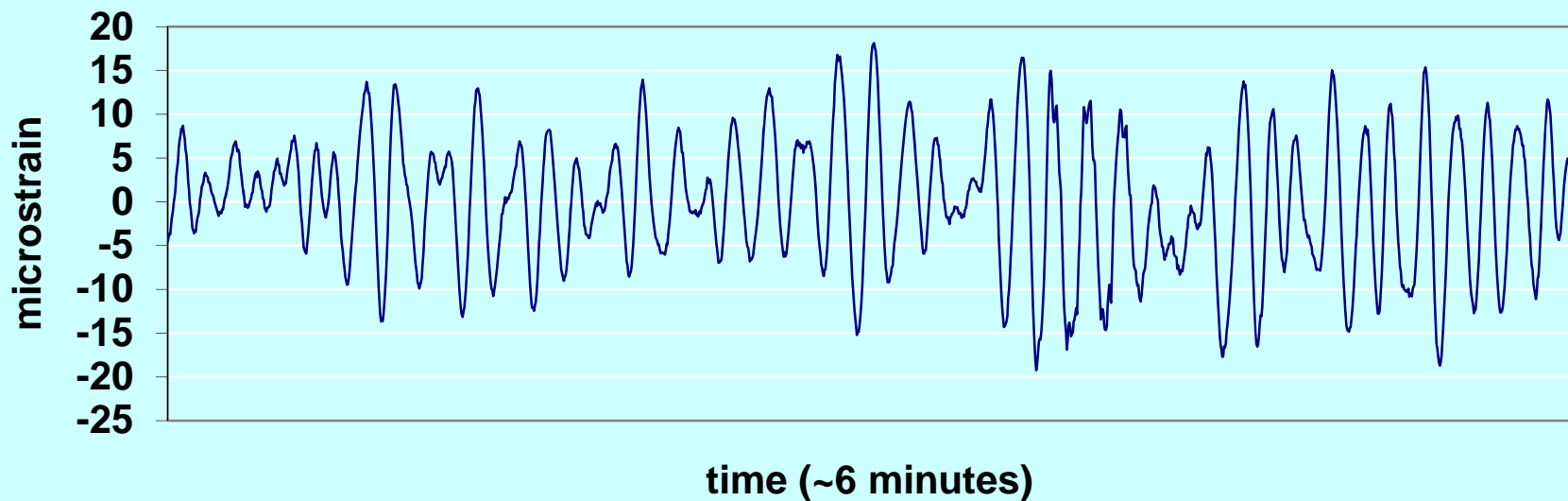


SIGNAL ATTENUATION



Vibration Data

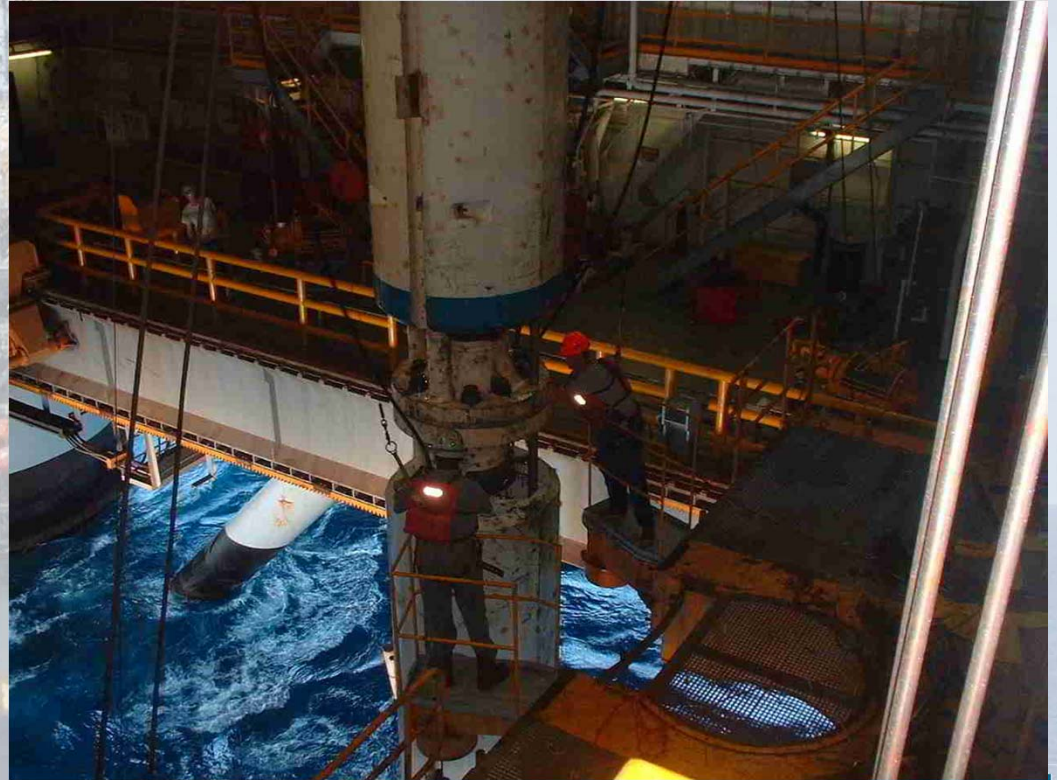
Fiber-optic Sensor Data





Deployment from Drilling Vessel

- Moonpool access to the riser flange



Riser Monitoring System

- Sensor Station Installation





Riser Monitoring System

- Offshore Fiber and Electrical Hookup





Riser Monitoring System

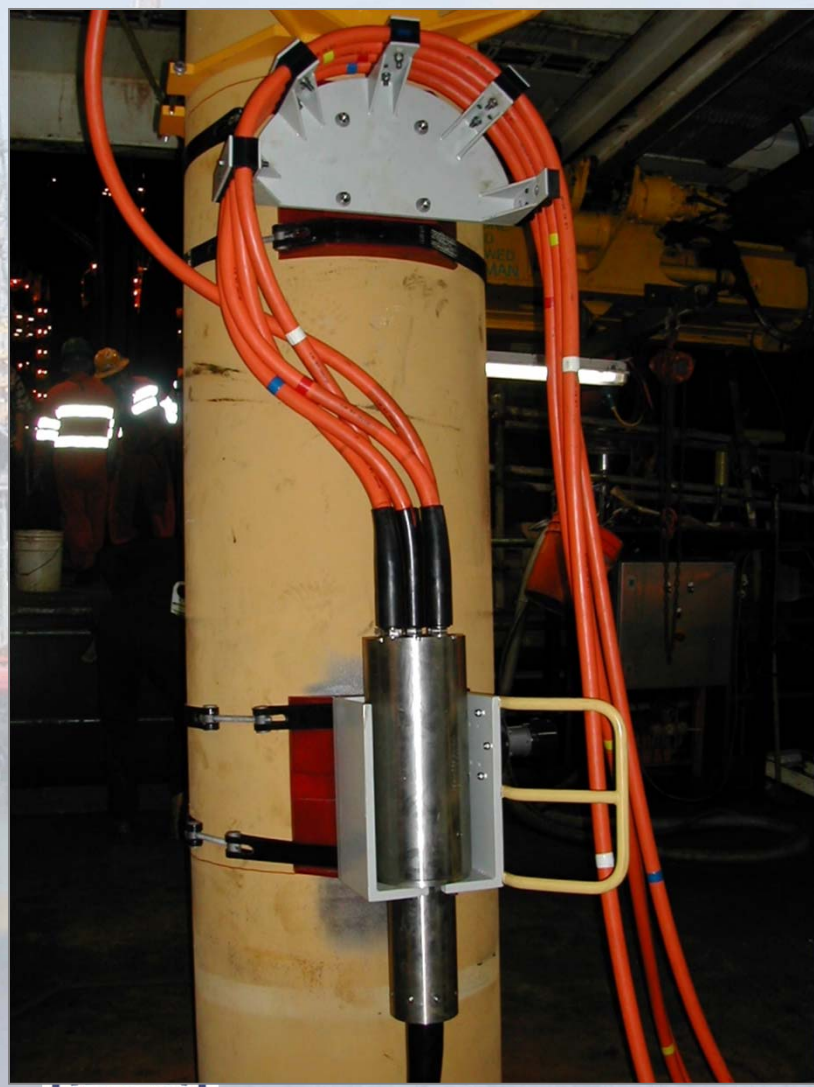
- Offshore Installation





Riser Monitoring System

- Offshore Cable Installation



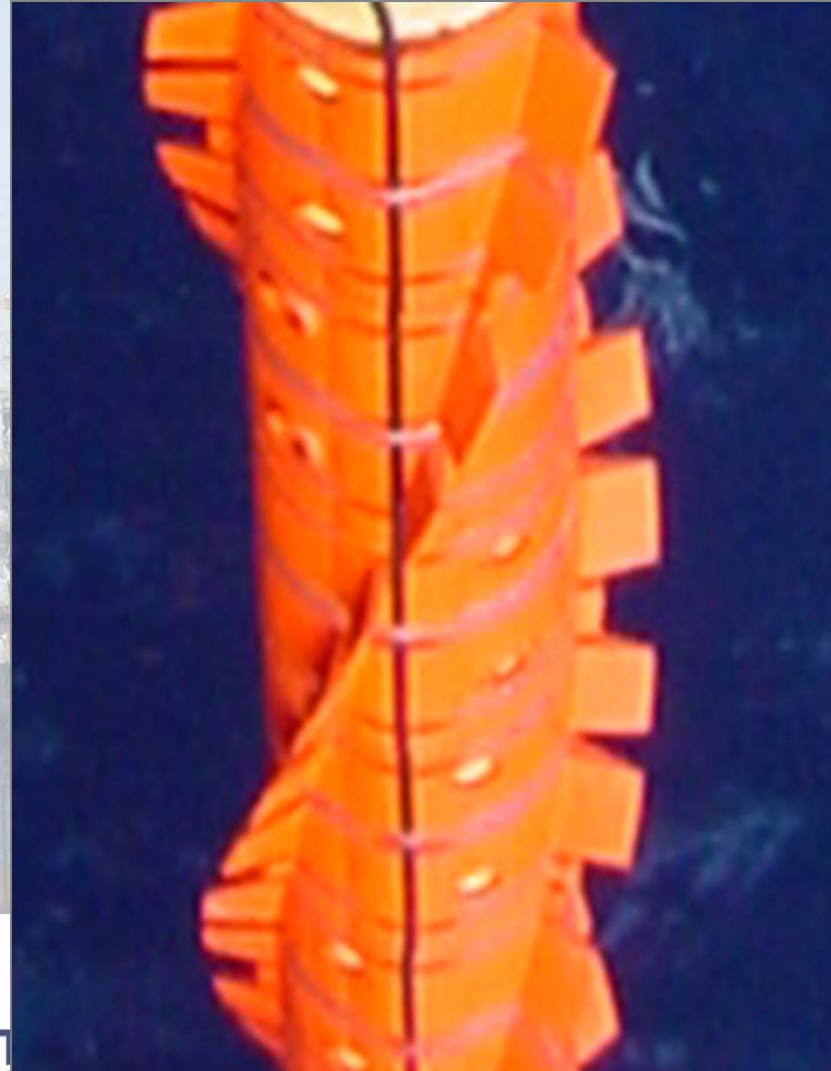
- SUB-SEA SYSTEMS -
ASTRO TECHNOLOGY





Riser Monitoring System

- Offshore Installation



ASTRO TECHNOLOGY





Riser Monitoring System

- Deepwater Installation



SUB-SEA SYSTEMS
ASTRO TECHNOLOGY





Riser Monitoring System

- Deepwater Installation

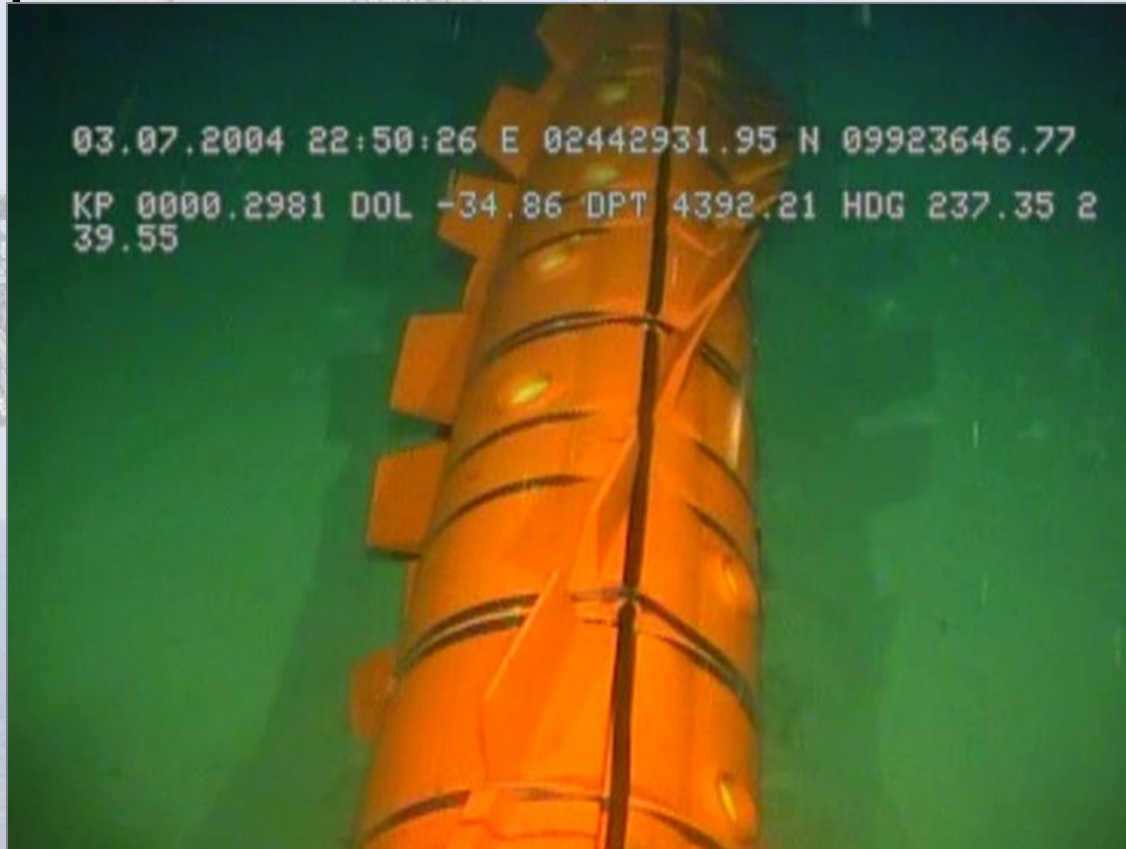


03.07.2004 22:53:38 E 02442843.97 N 09923576.81
KP 0000.1865 DOL -22.15 DPT 4378.28 HDG 237.75 2
39.55



Riser Monitoring System

- Deepwater Installation



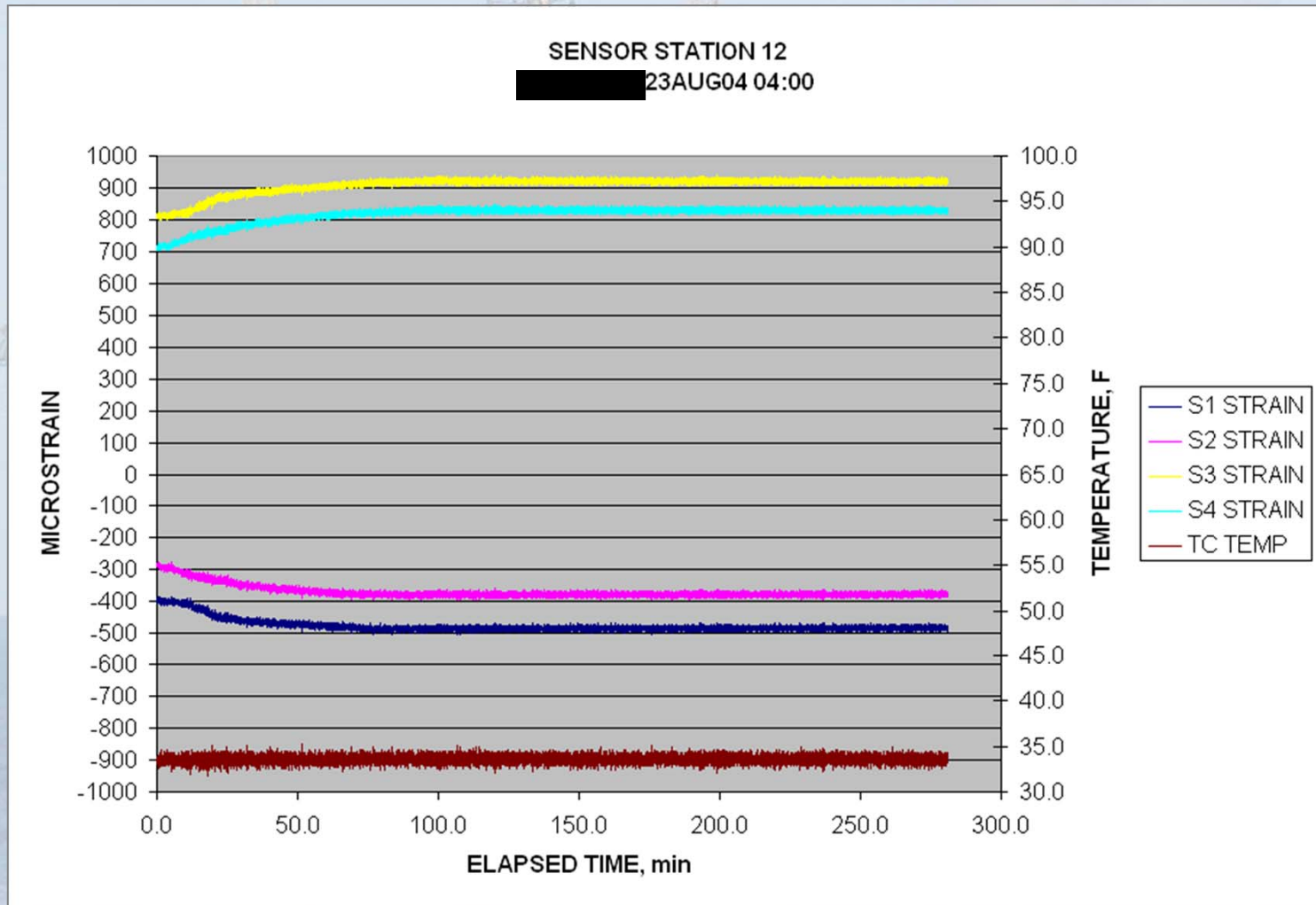
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KP 0000.2981 DOL -34.86 DPT 4392.21 HDG 237.35 2
39.55



Deepwater Data –



Chain Jacks Moving Platform





Riser Monitoring System

- Clamshell Qualification Testing



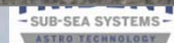
- SUB-SEA SYSTEMS -
ASTRO TECHNOLOGY





Riser Monitoring System

- Sensor Station Installation





Current and Future Work Clear Gulf JIP

- Advancement of Instrumentation Methods in Deepwater
- Participants:
- Astro Technology, NASA, Oil & Gas Companies
- Unitizes expertise of aerospace coupled with oil & gas
- Three Phase Project
 - Phase I – Sensor development
 - Complete
 - Phase II – Advanced development
 - In progress
 - Phase III – Full scale demonstrations
 - Late 2012





Clear Gulf Tasks

- Methods to mitigate structural failure
- Subsea inspection tools
- Flow assurance monitoring
- Slugging – sloshing monitoring
- Leak detection
- Entire subsea field real-time monitoring
- New downhole monitoring methods





CLEAR GULF JIP ADVANTAGES

- 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





Conclusions

- Successful execution of monitoring system on 56 mile flowline
 - Crucial engineering properties: temperature, pressure, strain, vibration, flow assurance properties
 - Longest flowline monitoring to date
 - Both post and pre-deployment installation methods achieved
 - Minimum attenuation achieved
 - Maximizes optical signal in deepwater and extreme length
 - Highly effective software and data analysis developed
- Launch of Clear Gulf JIP
 - NASA, oil & gas companies, Astro Technology

