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- OZ Optics Turkey
- OZ Optics China
Company Background

- Founded in 1985
- Corporate headquarter located in Ottawa, Canada
- Manufacturing facility in Ottawa / Canada, Izmir / Turkey and Jiaxing / China
- Ten Product Groups:
  - Laser-to-Fiber Delivery Systems
  - High Power Fiber Optic Components
  - Polarization Maintaining Products
  - Attenuators
  - Opto-Electronic Packaging
  - Fiber Optic Test Equipment
  - Fiber Optic Sensor Systems
  - Fiber Optics Components for Gyroscope
  - OCT
  - BioPhotonics
- Sales offices in Canada, USA, Europe, Turkey and China
Corporate Statements and Quality Policy

Our Vision
- Capture and expand market share
- Be the preferred supplier of choice
- Maximize shareholder value

Our Mission
To become the leading provider of innovative optical products to telecom and non-telecom sectors

Our Core Values
- Leadership
- Teamwork
- Boldness
- Commitments
- Innovation
- Rewards

Our Quality Policy
Provide our Customers with a competitive advantage, leveraging performance, price and delivery, through a continuous process of Quality advancement in all areas of our Company.

Communicate effectively to our Customers, Suppliers and Shareholders our commitment to Quality, continuous improvement and to abide by any applicable requirements.

Promote opportunities of professional development for all members of our company through education, training and personal challenge.
Company Profile
Over 525 employees worldwide

OZ Canada
263+ Employees

OZ China
97+ Employees

OZ Turkey
165+ Employees
Company Profile

ISO9001:2015 Certified

Advanced Proprietary Processing Technology

Broad Patent Portfolio
Company Profile

OZ Optics is Lead by an Experienced Team:

- Ömür Sezerman, Chairman, President & CEO
  - Founder and CEO since inception (39 years)
- Zahide Sezerman, VP of Human Resources
  - With OZ Optics since inception (39 years)
- Garland Best, VP of Components Division
  - 32 years at OZ Optics
- Gordon Youle, VP of Test Equipment Division
  - 25 years at OZ Optics
- Onur Koca, General Manager of OZ Turkey
  - 2 year at OZ Optics
- Bing Li, General Manager of OZ Optics China
  - 20 years at OZ Optics
Company Profile

Experienced and Well-Trained Staff in Following Fields: Optical, Mechanical, Electronics & Software

- CNC Machine Shop
- Femto-Second Laser Lab
- AR Coating
- Clean Room
- Laser Conditioning/Cleaving
Core Competencies

- Pioneer in Polarization Maintaining (PM) Components
- Leader in Wavelength Flattened, High Power & Low PDL Components
- Leader in High Power Fiber Optic Delivery Systems
- Custom Test Equipment, Including Polarization Test Equipment and FTTH Equipment
- Widest Range in Attenuator Product Offering
- Fiber Optic Distributed Strain and Temperature Sensors
- Complete product line for OCT, Gyroscope & BioPhotonics applications & 2 Micron
- Now available: Spectrometers and Quantum Light Sources
Leading Technology

Three Product Groups
Over 1,000 Products
Leading Edge R&D

- Fiber Optic Sensors: 5%
- Optical Test Equipment: 10%
- Fiber Optic Components: 85%
Leading Technology

Featured Products

Fiber Optic Attenuators for SM, PM, and MM Fibers

- Directional Attenuation
- Multichannel Attenuation
- Single-Wavelength Attenuation
- Single-Multi-Channel Attenuation

Fiber Optic Components for Optoelectronic Packaging

- Hermetically Sealed Patchcords with Glass or Metal Solder
- Single Channel
- Multi-Channel

Fiber Optic Test Equipment

- High Speed Transmission Rate Measurement Systems
- Bragg by Conductive Dye Measurement Systems
- Optical Fiber Length Meters
- Raman Refractometers

Fiber Optic Distributed Strain and Temperature Sensors

- USA Patent Numbers: 7,609,618, 7,936,414, and 8,062,897
- Real-Time Strain and Temperature Monitoring
- Fast, Dynamic Measurement of Stress and Temperature up to 250 ksn/°C
- Ideal for Standard Telecommunications Fibers in Accurate Testing
Leading Technology

Featured Products

Universal Optical DNA Rapid Detection System for Pathogens Including COVID-19, SARS, EBOLA, CHOLERA, SALMONELLA, ETC

LAMPPY™ SERIES

Features:
- Easy to detect viral, fungal, and bacterial DNA/RNA
- Rapid DNA isololation in 30 minutes
- Highly sensitive and specific detection of low levels
- Multiple indicators, high light intensity reading technology
- Multiple analysis available with the included software
- LH holder provides uniform and consistent
- Compact modular design allows for easy cleaning and maintenance
- Endow with electronic features for automatic and software control
- Can be used for simultaneous operations with up to 4 samples simultaneously
- Multi-communication via computers and smartphones detecting
- A fraction of the cost of PCR-based systems
- OX Optics also offers private labeling for volume OEM applications

In a lab study done at Ascension, Wampum using saliva samples taken from patients at Ascension Hospitals, LAMPPY™ was compared to a well-known conventional and PCR-based system in performance and speed. The comparison study was carried out with a study size of 312 using the OX Optics LAMP-based kit on both instruments and then compared with the gold-standard SARS-COV2 (2019) Assay Test PCR Diagnostic kit on a leading brand conventional PCR machine.

Fiber Optic Products for OCT Applications

- OCT Modules
- Non-contact Electrostatics
- Broadband Variable Attenuators
- Broadband lasers
- High Speed Active Fiber Sensors
- Fiber Preparations
- Fiber Connectors / Connectors
- Fiber Connectors / Connectors
- Broadband laser diodes
- High Speed Active Fiber Sensors
- Fiber Optic Connectors
- Fiber Connectors / Connectors

2 micron Fiber Optic Components for PM and SM Fibers

- 2 micron Fiber Optic Components
- Fiber Optic Connectors
- Fiber Connectors / Connectors
- Fiber Connectors / Connectors
- Broadband laser diodes
- High Speed Active Fiber Sensors
- Fiber Preparations
- Fiber Connectors / Connectors
- Broadband laser diodes
- High Speed Active Fiber Sensors
- Fiber Optic Connectors
- Fiber Preparations
- Fiber Connectors / Connectors
- Fiber Connectors / Connectors
- Broadband laser diodes

New Fiber Optic Products

- Broadband Polarization Maintained Transmitter
- Optical Signal to Noise Ratio Generator
- High Speed Polarization Scrambler / Equalizer
- Randomized Wavelength Transmission Filter
- High Power Emitter / Emitter
- Super Fast CO2 Laser
- Laser Diode Pumped
- Fiber Optic Connectors
- Fiber Preparations
- Fiber Connectors / Connectors
- Fiber Connectors / Connectors
- Broadband laser diodes

- Broadband Polarization Maintained Transmitter
- Optical Signal to Noise Ratio Generator
- High Speed Polarization Scrambler / Equalizer
- Randomized Wavelength Transmission Filter
- High Power Emitter / Emitter
- Super Fast CO2 Laser
- Laser Diode Pumped
- Fiber Optic Connectors
- Fiber Preparations
- Fiber Connectors / Connectors
- Fiber Connectors / Connectors
- Broadband laser diodes
Industry Standards

All Products Manufactured are in Strict Accordance with International Industry Standards:

- ISO 9001:2015 Certified (Canada, China and Turkey)
- REACH Compliance
- RoHS Compliance
- CE Compliance
- Telecordia Compliance
- Controlled Goods Directorate Registered
- Critical supplier for F35 and F18 Project
- TSCA (Toxic Substance Control Act) Compliance
- CHEMSHERPA Compliance
- IEC 61010 Compliance
Using our strong direct sales and distributors, we address the following markets:

- Energy – Oil and Gas
- Military and Homeland Security
- Educational
- Industrial
- Telecom / Datacom
- Medical & Pharmaceutical
By leveraging the technology and expertise gained since its inception, OZ Optics has attracted a broad range of customers in the telecom / datacom, medical, military, security, industrial, construction, aerospace, power utilities, petrochemical and educational sectors.
Marketing Strategy
Global Sales Network

OZ Optics has resellers and distributors in over 30 Countries and Regions with over 10,000 customers worldwide:

<table>
<thead>
<tr>
<th>Country</th>
<th>Country</th>
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<th>Country</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>Germany</td>
<td>Luxembourg</td>
<td>Sweden</td>
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<tr>
<td>Belgium</td>
<td>Greece</td>
<td>Netherlands</td>
<td>Switzerland</td>
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<tr>
<td>Brazil</td>
<td>Hong Kong</td>
<td>Norway</td>
<td>Taiwan</td>
<td></td>
</tr>
<tr>
<td>Canada</td>
<td>India</td>
<td>Poland</td>
<td>Thailand</td>
<td></td>
</tr>
<tr>
<td>China</td>
<td>Ireland</td>
<td>Portugal</td>
<td>Turkey</td>
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<td>Denmark</td>
<td>Italy</td>
<td>Singapore</td>
<td>United Kingdom</td>
<td></td>
</tr>
<tr>
<td>France</td>
<td>Japan</td>
<td>South Korea</td>
<td>United States</td>
<td></td>
</tr>
</tbody>
</table>
Operation Strategy

Manufacturing Strategy

Customer

OZ CND Qualification

Customer Qualification

Made in China

OZ Optics Canada

Sub-Components

Worldwide Sourcing

Made in Turkey

R&D/Design/Engineering

OZ Optics Canada

Customer

R&D/Design/Engineering

OZ Optics Canada

Customer

P.O. CND Qualification

Customer Qualification

Made in Canada

OZ Optics Canada

Sub-Components

Worldwide Sourcing

Made in Turkey

R&D/Design/Engineering

OZ Optics Canada

Customer
Marketing & Operation Strategy

Competitive Advantage

- Superior Technology
- Innovative Engineering
- Competitive Pricing
- Global Presence
- Extensive Experience in Fiber Optics Manufacturing
- Exceptional Quality and Service
Branch Network

OZ OPTICS CANADA (Headquarters)

OZ OPTICS TURKEY (Turkey Factory)

OZ OPTICS CHINA (Jiaxing Factory)
Branch Network

Facility - Ottawa Headquarters

- 60,000 sq ft. - Manufacturing and R&D Facilities
- 15,000 sq ft. - Admin, Sales and Marketing
- 15,000 sq ft. - Training and Fitness Facilities
Branch Network
Facility - Ottawa Headquarters

Production Area
Training Centre Building
Meeting Room
Swimming Pool
Branch Network

Facility - Turkey Factory (Izmir, Turkey)

- Operational since 2000
- 33,000 sq ft. Manufacturing Facility
- Located in Free Trade Zone
- Low Tax Rates
- Sub Component Parts Manufacturing
- High Quality Labor
Branch Network

Facility - China Factory (Jiaxing, China)

- Operational since June 2010
- Wholly Foreign Owned Enterprise
- Cost Effective Manufacturing
- High Quality Labor
- Supply Chain Integration
Branch Network

Facility - China Factory (Jiaxing, China)

• Located in Economic Development Zone
• 4000+ sq meters - Total Area
  • 500 sq meters – Admin, Sales and Marketing
• 3500 sq meters – Manufacturing Area
  ✓ 500 sq meter – Class 10,000 Clean Room
  ✓ 300 sq meter – ESD Working Area
OZ Optics China
Zhejiang OZ Optics Technologies Co., Ltd

- Operational since June 2010
- Wholly Foreign Owned Enterprise
- NPI & Production Line Setup
- On-site Training by OZ CND
- Began Mass Production in September 2010
- Completed Main Facility Expansion in 2019
Conventional Temperature & Strain Sensors

- **Temperature Sensor: Thermocouple**
- **Strain Sensor: Electrical Strain Gauge**
  - Temperature Influence
  - Electromagnetic Interference (EMI)
  - Humidity Influence
  - Point Sensor
Fiber Optic Sensors

- **Advantages of Fiber Optic Sensors**
  - Electrically insulating materials (no electrical cables are required) — high voltage environments
  - Chemically passive, not subject e.g. to corrosion
  - Immune to electromagnetic interference (EMI)
  - Wide operating temperature range

- **Fiber Bragg Grating Sensor**
  - Strain resolution and accuracy: < 2 µε
  - Cannot distinguish strain and temperature
  - Point sensor

- **Distributed Fiber Optic Sensors**
  - Raman scattering based — only temperature
  - Brillouin scattering based — both temperature and strain
  - Rayleigh scattering based — DAS, Luna (70 m long sensing fiber)
Fiber Optic Sensors

- **Fiber Bragg Grating Sensor**
  - Sensor medium: Fiber Bragg grating
  - Laser source and data acquisition system: Spectrum analyzer

- **Distributed Fiber Optic Sensors (Brillouin Sensors)**
  - Sensor medium: Conventional communication fiber (such as SMF, LEAF, etc..)
  - Laser source and data acquisition system: Brillouin sensor system
    - **OZ Optics** [Foresight™ DSTS (Distributed Strain and Temperature Sensors)]
    - **Omnisens** (STA)
    - **Yokogawa** (AQ8603) (Discontinued)
    - **Sensornet** (DTSS)
    - **Neubrex** (Neubrescope)
    - **fbrisTerre** (fTB 2505)
    - **febus**
Working Principle — BOTDA

\[ \nu_B = \nu_{B0} + C_T (T - T_0) + C_\varepsilon (\varepsilon - \varepsilon_0) \]

\( T \) and \( \varepsilon \) are variables. In order to differentiate these two variables, Brillouin peak in the spectrum is required.
Working Principle — BOTDA

\[ \nu_1 - \nu_2 = \nu \]

Sensor Medium: Standard Telecom Optical Fiber

When the beat frequency matches intrinsic Brillouin frequency of the fiber \( \nu_B \), we will get maximum of Brillouin spectrum.

\[ \nu_B = \nu_{B0} + C_T (T - T_0) + C_\varepsilon (\varepsilon - \varepsilon_0) \]

\( \nu_B \) changes linearly with the strain and temperature exerted.

Brillouin Spectrum

Loss

\( \nu_B \)

\( \nu_1 - \nu_2 \)
Comparison of BOTDR and BOTDA

**Comparison of BOTDR and BOTDA**

**BOTDR (Brillouin Optical Time Domain Reflector)**

- **Probes Laser** $v_0$
- **Pulse Modulator** $v_0$
- **V$\text{B}$ (V$\text{B}'$)
- **Heterodyne Receiver**
- **Digital Processor**

**Weak signal**

- **10^3 photons** $v_0 + v_\text{B}(v_\text{B}')$
- **Brillouin scattered light** $v_0 + v_\text{B}(v_\text{B}')$
- **at most 1 photon**

**BOTDA (Brillouin Optical Time Domain Analyzer)**

- **Probes Laser** $v_0$
- **Pulse Modulator** $v_0$
- **V$\text{B}$ (V$\text{B}'$)
- **Heterodyne Receiver**
- **Digital Processor**

**High dynamic range**

- **10^3 photons** $v_0 + v_\text{B}(v_\text{B}')$
- **Coherent amplification**
- **Brillouin scattered light** $v_0 + v_\text{B}(v_\text{B}')$
3U + Laptop, 4 Channel Model
Foresight™ DSTS

Awards & Accolades

Silver Level Winner

US Patents #: 7499151, 7599047 and 9568307
Merits of DSTS BOTDA

• Coherent amplification of Brillouin scattering signal
  ⇒ longest measured range (200 km fiber length)

• Narrowest Brillouin spectrum (~ 45 MHz )
  ⇒ highest resolution of strain and temperature

• Special low loss fiber components and electronic processing
  ⇒ high stability of system

• With proprietary techniques, Brillouin frequency is extracted accurately
  ⇒ highest accuracy in measuring strain and temperature
    separately or simultaneously

• New technology
  ⇒ quick measurement of strain and temperature (as low as 1 second: 1 Hz)
Merits of DSTS BOTDR

- **Low noise detection for weak spontaneous Brillouin scattering signal**
  ⇒ long measured range (70 km in one direction)
- **Special low loss fiber components and electronic processing**
  ⇒ high stability of system
- **Sophisticated design**
  ⇒ Small size and light weight
Specifications of other vendor’s products are based on their public datasheets.

1) Based on scientific definition, the spatial resolution is defined by pulse width. 10ns pulse width is equivalent to 1 m spatial resolution while 1ns pulse width is equivalent to 0.1 m spatial resolution.

<table>
<thead>
<tr>
<th>Company</th>
<th>OZ Optics</th>
<th>OmniSens</th>
<th>Neubrex</th>
<th>fibrisTerre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
<td>BOTDA</td>
<td>BOTDA</td>
<td>BOTDA</td>
<td>BOFDA</td>
</tr>
<tr>
<td>Maximum Sensing Range</td>
<td>(fiber length up to 200 km)</td>
<td>60 km (120 km max. total fiber loop distance)</td>
<td>27 km</td>
<td>25km</td>
</tr>
<tr>
<td>Channels</td>
<td>Internal 4 Internal 4 up to 20 channels via external SO-N Switch module</td>
<td>Internal 4</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Highest Spatial Resolution / Spatial step (sample interval)</td>
<td>10 cm / 5 cm</td>
<td>50 cm / 25 cm</td>
<td>2 cm / 1 cm</td>
<td>50 cm / 5 cm</td>
</tr>
<tr>
<td>Dynamic Range at highest spatial resolution</td>
<td>7 dB</td>
<td>N/A</td>
<td>0.5 dB</td>
<td>N/A</td>
</tr>
<tr>
<td>Strain / Temperature Accuracy (Repeatability)(σ)</td>
<td>2 με / 0.1 °C (1 m spatial resolution / 2 km fiber / 1 minute 40 seconds)</td>
<td>2 με / 0.1 °C (1 m spatial resolution / 2 km fiber / 10 minutes)</td>
<td>7.5με / 0.35 °C</td>
<td>2 με / 0.1 °C</td>
</tr>
<tr>
<td>Strain / Temperature Resolution</td>
<td>0.1 με / 0.005 °C</td>
<td>2 με / 0.1 °C</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>
## Single End (R) Competitive Analysis

<table>
<thead>
<tr>
<th>Company</th>
<th>OZ Optics</th>
<th>OmniSens</th>
<th>Neubrex</th>
<th>Febus</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technology</strong></td>
<td>BOTDR</td>
<td>BOTDR</td>
<td>BOTDR</td>
<td>BOTDR</td>
</tr>
<tr>
<td><strong>Channels</strong></td>
<td>Internal 4 External 24 More channels optional</td>
<td>Internal 4 up to 20 channels via external SO-N Switch module</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Maximum Sensing Range</strong></td>
<td>70 km (max 100 km)</td>
<td>45 km</td>
<td>27 km</td>
<td>30 km (max 100 km)</td>
</tr>
<tr>
<td><strong>Highest Spatial Resolution / Spatial step (sample interval)</strong></td>
<td>1 m$^1$ / 5 cm</td>
<td>1.5 m / 25 cm</td>
<td>0.5 m / 5 cm</td>
<td>1 m</td>
</tr>
<tr>
<td><strong>Dynamic Range at highest spatial resolution</strong></td>
<td>10 dB</td>
<td>10 dB</td>
<td>2 dB</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Strain / Temperature Accuracy (Repeatability) (σ)</strong></td>
<td>10 με / 0.5 ºC</td>
<td>20 με / 1 ºC</td>
<td>30 με / 1.5 ºC</td>
<td>10 με / 0.5 ºC</td>
</tr>
<tr>
<td><strong>Strain / Temperature Resolution</strong></td>
<td>0.1με / 0.005 ºC</td>
<td>2 με / 0.1 ºC</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Specifications of other vendor’s products are based on their public datasheets.

1) Based on scientific definition, the spatial resolution is defined by pulse width. 10ns pulse width is equivalent to 1m spatial resolution while 1 ns pulse width is equivalent to 0.1 m spatial resolution.
## Combo Unit Competitive Analysis

<table>
<thead>
<tr>
<th>Company</th>
<th>OZ Optics</th>
<th>OmniSens</th>
<th>Neubrex</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technology</strong></td>
<td>BOTDA</td>
<td>BOTDA</td>
<td>BOTDA</td>
</tr>
<tr>
<td>Maximum Sensing Range</td>
<td>(fiber length up to 160 km)</td>
<td>70 km (max 100 km)</td>
<td>60 km (120 km max. total fiber loop distance)</td>
</tr>
<tr>
<td>Channels</td>
<td>Internal 4</td>
<td>45 km</td>
<td>BotDA</td>
</tr>
<tr>
<td>Highest Spatial Resolution / Spatial step (sample interval)</td>
<td>10 cm / 5 cm</td>
<td>1 m / 5 cm</td>
<td>N/A</td>
</tr>
<tr>
<td>Dynamic Range at highest spatial resolution</td>
<td>7 dB</td>
<td>10 dB</td>
<td>N/A</td>
</tr>
<tr>
<td>Strain / Temperature Accuracy (Repeatability)</td>
<td>2 με / 0.1 °C</td>
<td>20με/1°C</td>
<td>2 με / 0.35 °C</td>
</tr>
<tr>
<td>Strain / Temperature Resolution</td>
<td>0.1 με / 0.005 °C</td>
<td>0.1 με / 0.005 °C</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Specifications of other vendor’s products are based on their public datasheets.

1) Based on scientific definition, the spatial resolution is defined by pulse width. 10ns pulse width is equivalent to 1m spatial resolution while 1ns pulse width is equivalent to 0.1m spatial resolution.
**Detailed Comparison Facts**

**Sensing Range** - The Longest Functional Measurement Fiber Length. Results comparison between OZ unit and other vendor’s unit. Fiber under test is 101km long. Results are displayed below. Same test configurations are applied.

- **Other Vendor**
  - Brillouin Spectrum at 80km. Reasonable Spectrum can be only found at 55km.

- **OZ Optics DSTS**
  - Brillouin Spectrum at 100.5km.
# Comparison: DSTS BOTDA and Raman based DTS

<table>
<thead>
<tr>
<th>Company</th>
<th>OZ Foresight™ DSTS</th>
<th>Raman based DTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Fiber Length</td>
<td>200 km round-trip (physical distance 100 km)</td>
<td>20km (MM)</td>
</tr>
<tr>
<td>Fiber Type</td>
<td>Standard telecom singlemode</td>
<td>Multimode</td>
</tr>
<tr>
<td>Response time @ 20km, 2C Resolution</td>
<td>30 seconds to 3 minutes</td>
<td>More than 10 minutes</td>
</tr>
<tr>
<td>Configuration</td>
<td>Single ended or double ended</td>
<td>Single ended or double ended</td>
</tr>
</tbody>
</table>
| Measurement Base and Precision | Frequency based  
No calibration required after setup  
Not sensitive to attenuation changes | Intensity based  
Require calibrations  
Sensitive to attenuation changes |
| Dynamic Range | 25-30 dB  
Allows better immunity to attenuation  
Wider measurement range and longer use of installed fiber | 3-4 dB  
May fail when attenuation increases |
| Measurand | Temperature and Strain | Temperature |
| Measurement Resolutions | Comparable @ several seconds | Comparable @ over 1 minute |
Competitive Analysis

- Sensornet
- OZ Optics
- Omnisens
- Neubreex
- fibrisTerre
- Febus Optics
New Features

- New GUI
- Full DLL support
- Auto-recovery from power outage
- Auto Channel Switch allows continuous scans between channels.
New GUI Login

Choose Mode

- **B-OTDA**
  - STRAIN & TEMPERATURE
  - HIGH-RESOLUTION
  - HIGH-SPEED
  - BRILLIOUN ANALYZER

- **B-OTDR**
  - LOW-RESOLUTION
  - COMBINED
  - STRAIN & TEMPERATURE
  - BRILLIOUN REFLECTOMETER

**REVIEWS & ANALYZE DATA**

- B-OTDA
- B-OTDR

**DSTS2 Login**

- **Username:**
- **Password:**

- **Buttons:**
  - Login
  - Register/Reset Password
  - Play Video
  - Exit
  - Help
Measurement Screens
OZ Optics Foresight™ DSTS Benefits

- Reducing risk and influence of failure
  - Fast response
  - Status trend in long term
  - Full range of coverage
- Reducing operating expenses
  - No future re-calibration of unit
  - Expected cable life over 20 years
Applications

- Oil and Gas Pipeline Monitoring
- Dyke and Levee Monitoring
- Power Line Monitoring
- Oil and Gas Well Monitoring
- Bridge and Building Monitoring
- Border Security Monitoring
Oil and Gas

- Pipeline Leakage Monitoring
- Well Integrity Management
- Refinery Temperature Monitoring
Pipeline Leakage Monitoring System

- Policy Requirement
- Economic Requirement

Leakage → Liquid Spill → Ambient Temperature Change → Temperature of sensing cable changes → Detected

TCP/IP → SCADA

Local Control Room

Temperature Sensing Cable

Pipeline
• Leakages from a 1/8" orifice with an injection pressure as low as 22 psi, and a temperature difference of 20°F between the soil and line temperatures, have been easily detected and accurately located.

• An impressive leakage detection response time of less than 2 minutes has been achieved.

• Evaluation was done under laboratory conditions over a period of one month, by Southwest Research Institute (SwRI) and funded by major oil companies through a joint industry program.
Performance

Large leakage detection from 1/8” orifice with 400 psi injection pressure, soil temperature before test: 85°F, line temperature: 115°F

Small leakage detection from 1/8” orifice with 50 psi injection pressure, soil temperature before test: 73°F, line temperature: 90°F
Soil Temperature Monitoring
Pipeline Corrosion Monitoring

Pipeline corrosion monitoring in Canmet Materials Technology Laboratory, NRCan, Ottawa, NACE International — Corrosion 2008 Conference and Expo, New Orleans (Louisiana, USA 16-20 March, 2008).
Pipeline Corrosion Monitoring

Pipeline corrosion monitoring in Canmet Materials Technology Laboratory, NRCan, Ottawa, NACE International — Corrosion 2008 Conference and Expo, New Orleans (Louisiana, USA 16-20 March, 2008).
• Refineries use reactors and pressure vessels to transform heavy oil into synthetic crude oil.
• The upgrader reactors are operated at very high temperatures, exceeding 500 °C.
• Due to the thermal stress exerted on the structure of the reactor, a wall-thinning problem might occur, resulting in conductive heat dissipation.
• Without the proper sensing technology, the refinery operator might prematurely shut down operations to perform untimely maintenance, or worse yet, the problem might go unnoticed, resulting in a catastrophic accident.
Pipeline Buckling Detection

Pipeline buckling detection in TransCanada Pipeline Ltd, Calgary, and C-FER Technology, Edmonton
Coating materials and maximum sustainable temperatures

- UV-cured acrylate 100°C
- UV-cured dual acrylate 150°C
- Polyimide 400°C
- Copper + polyimide 400°C
- Aluminum 450°C
- Copper alloy 600°C
- Gold 700°C +
Power Utility

- OPGW Monitoring
- Power Cable (Submarine Cable) Monitoring
- Temperature profile monitoring of an air-cooled gas generator
OPGW Monitoring

- Monitoring the working status of OPGW
- Abnormal event found and located
- Event caused by broken strand, lightning, frost covering, change of strain, etc..
The OPGW is located from Smith Falls to Merivale-Ottawa, Ontario, Canada.

The total fiber length was close to 140 km.

The BOTDA located in Merivale-Ottawa made measurements as often as once every 60 minutes starting in June 2012 and continuing till July 2013.
OPGW Strain Monitoring

Power line/OPGW monitoring in Hydro-Quebec, Montreal
High Voltage Underground Cable with Fiber
Temperature Profile Monitoring of an Air-Cooled Gas Generator
Concrete Beam/Highway Monitoring

Concrete beam/Highway monitoring on HW40/University of Sherbrooke, Dr. Brahim Benmokrane
GeoDetect With Embedded Fibers
CNC ALLIANCE PROJECT FEATURES

Project engineer Stephen Coleman talks about innovative fibre optics to measure settlement
Crack Detection

Crack detection in University of California, Irvine, Dr. Maria Feng, 19th International Conference on Optical Fiber Sensors, Perth (Australia, 14-18 April 2008).
Crack Detection

Crack detection in University of California, Irvine, Dr. Maria Feng, 19th International Conference on Optical Fiber Sensors, Perth (Australia, 14-18 April 2008).

[Images and graphs related to crack detection and strain measurements.]
Brillouin Sensor Monitoring of Telecom Fibers

- Detects minor events that are too small to be seen by OTDRs.
- Can replace OTDRs for monitoring fibers.
- Can be used to monitor new or existing fiber installations.

- Permits performance monitoring of fibers above or below ground.
- Avoids unnecessary replacement of old fibers, saving millions of dollars in installation costs.

Yogokawa’s results from AT&T’s old telecom fiber, very broad Brillouin spectrum, which results in poor resolution and accuracy.

OZ’s results from AT&T’s old telecom fiber, very narrow Brillouin spectrum, which results in high resolution and accuracy.
The Cost of Catastrophic Failure

- Example: Druzhba Pipeline July 2006
- Small 50 cubic meter leak results in:
  - Interruption of $100M/day pipeline
  - Global spike in oil prices
  - Report of environmental catastrophe
  - Months of investigation and ecological monitoring
- Single point of failure in 3,000 km pipeline
The Cost of Catastrophic Failure

- Example 2: Nigerian Pipeline July 2006
- Accidental leak
- 180,000 barrels / day shutdown
- $180,000 * $74 = $13M per day
- 10-day shutdown = $130M
- Brillouin operation << $1/m/year
- Single production shutdown far exceeds lifetime sensor operating costs.
Acknowledgements

- University of California, Irvine, Dr. Maria Feng
- University of Ottawa, Dr. Xiaoyi Bao
- University of Sherbrooke, Dr. Brahim Benmokrane
- TransCanada Pipelines Limited (TCPL)
- C-FER Technologies
- Canmet Materials Technology Laboratory, NRCan
- Hydro-Quebec
- Southwest Research Institute®
- Tencate Geosynthetics
- NZ Transport Agency
- Christchurch Northern Corridor
- CNC Alliance Project
Thank You for Choosing OZ Optics

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