



*Optical Fiber Cable Based
Pipeline Leak and
Intrusion Detection
System Using Distributed
Acoustic Sensing (**DAS**)*

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Introduction



- Pipeline Leak and Intrusion Detection System (PLIDS) is an optical fiber-based pipeline surveillance system that gives early warnings of any third-party intrusion in the Right of Use (ROU) of buried cross-country pipelines.
- Alongside the buried pipelines, OFCs are laid for SCADA and voice communication. In pipeline surveillance applications, spare OFC fiber is used as vibration sensors with the PLIDS equipment pumping coherent laser and collecting the back scattered light. Any excavation in ROU of the pipeline generates vibrations on the ground which are sensed by the fiber and reported to the sensor servers of the PLIDS system. This information is passed on to Graphic User Interface for alarming and analysis for the surveillance operators.
- For sensing it uses a single Optic fiber along Pipeline for Detection and Localization of any.
 - Unintended Damages
 - Deliberate Acts.
- Laser Source is injected in fiber and Analysis of Backscattered signal is done.

■ Pipeline surveillance Systems

- Foot patrolling
- Yearly Line Walk
- Pipeline Markers with Emergency contact Numbers
- Village awareness programs
- Yearly Mock drills with administration
- APPS System



Why PLIDS ??



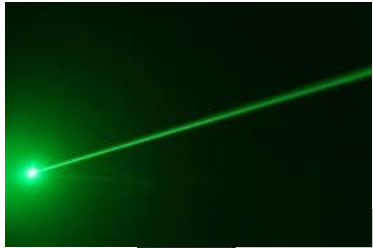
INTRUSION



Optical Fiber - DAS Principle Optical Time Domain Reflectometry



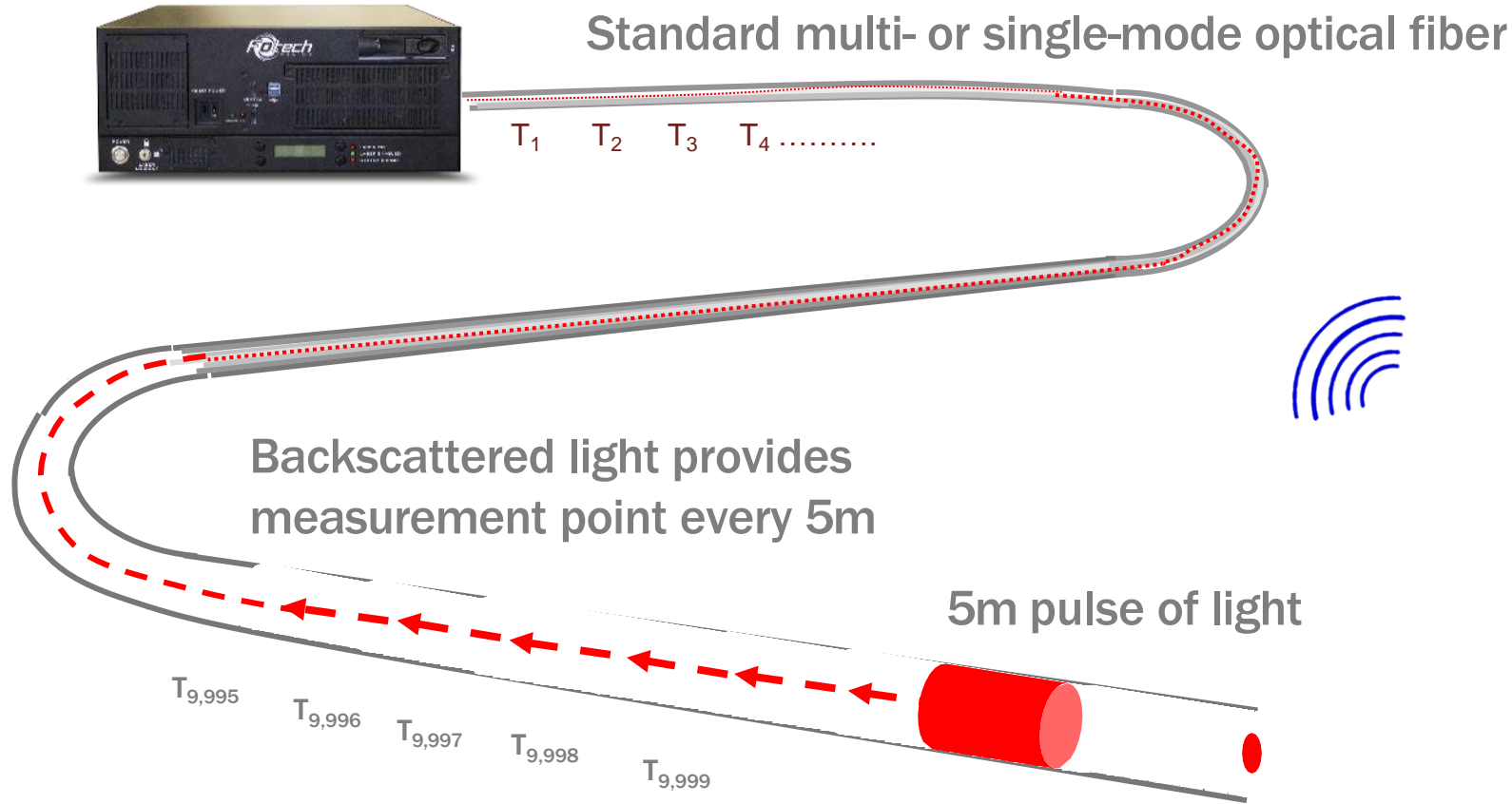
- Probe light pulse from a highly coherent laser is sent down the optical fiber (up to 50km)
- Some of the light returns towards the source due to Rayleigh back-scattering and is directed into a photo-detector
- External acoustic disturbances (such as digging, walking, etc.) around the fiber cause phase changes in the coherent light pulse
- Since the speed of the light pulse is known, the time when it arrives at the photo-detector determines the location from where it was scattered
- The phase changes to the pulse from every location are dynamically processed to extract the acoustic signal generated by the external activity



Optical Fiber - DAS Principle Optical Time Domain Reflectometry



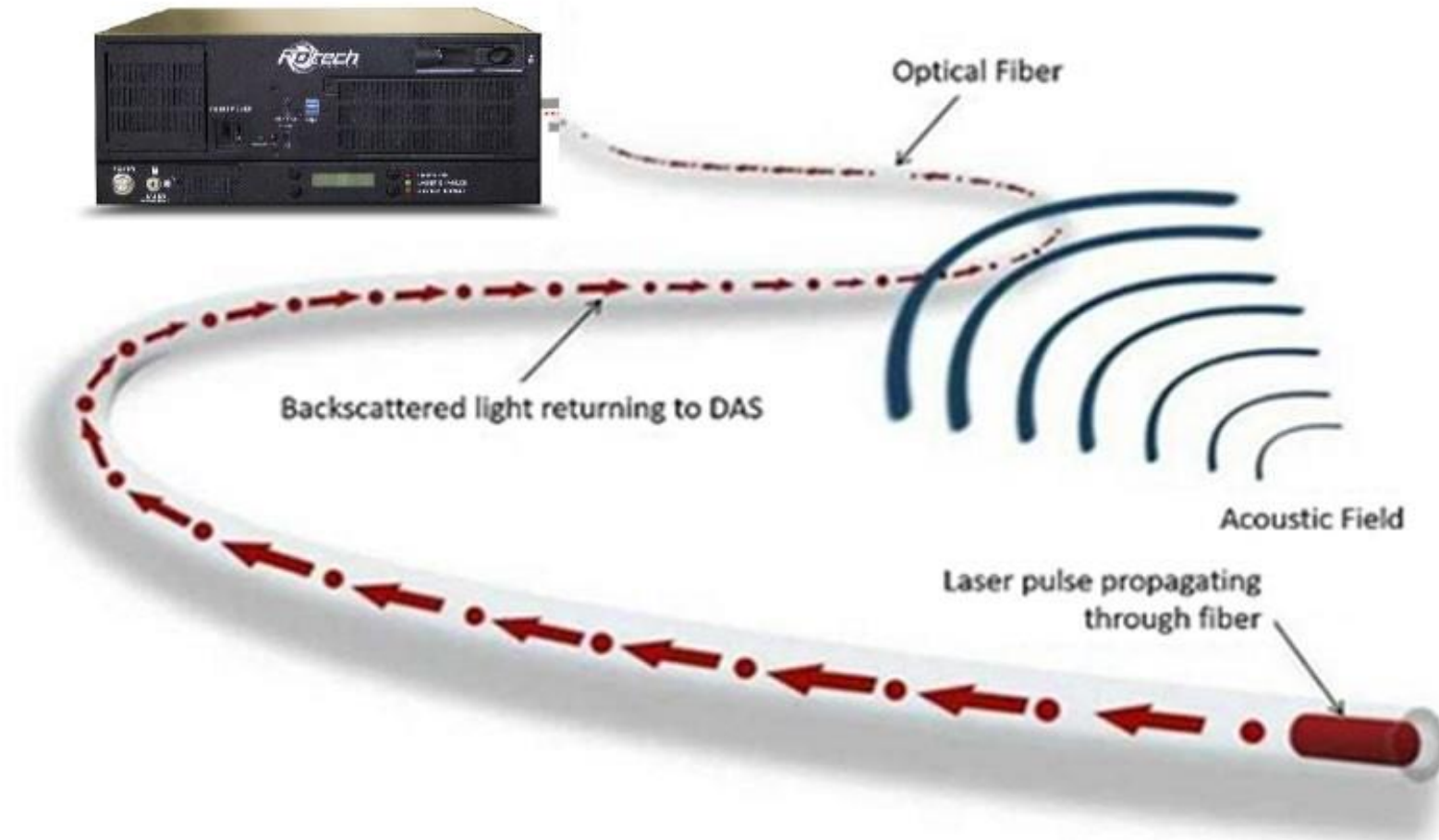
Measurements all along a 20km fiber = 4,000 sensors!!



DAS Components

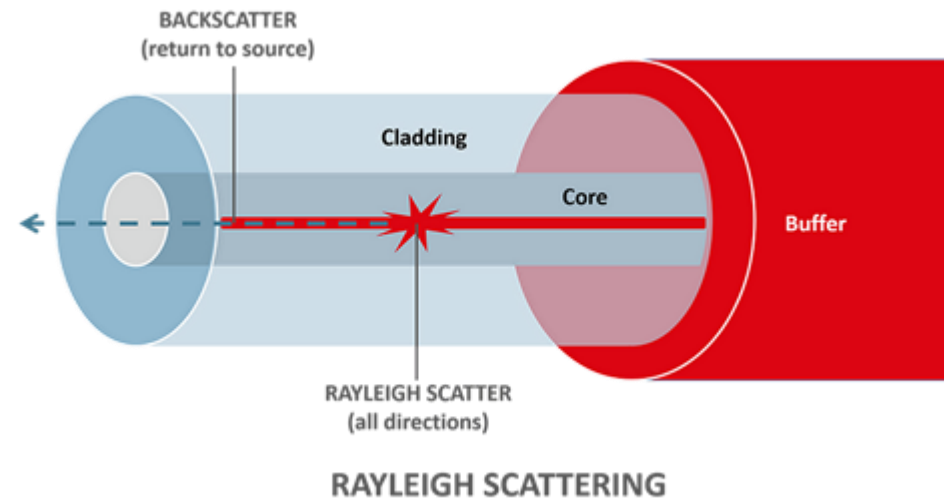


Intelligent Distributed Acoustic Sensor



Backscatter:- (Rayleigh scattering)

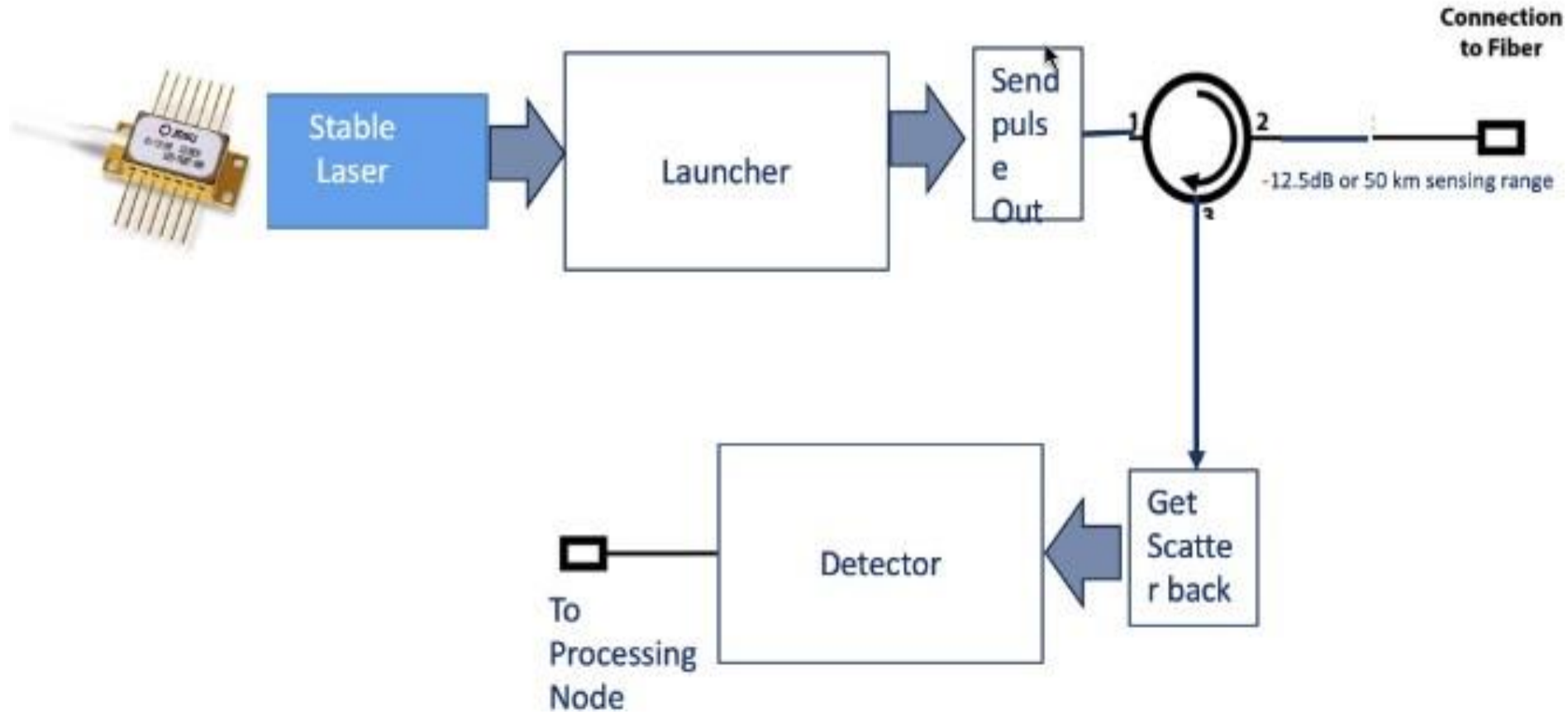
- For glass fibers the foremost type of scattering is Rayleigh scattering. With this process, atoms or other particles within the fiber absorb the light signal and instantly re-emits the light in another direction.
- In this way Rayleigh scattering appears very much like absorption but it absorbs and redirects the light so quickly that is considered scattering.



DAS Components



Typical block diagram of SC-IU/OPS



Data Collection and Tuning



□ Data Collection

- **Fiber Traces:** Check healthiness of fiber using OTDR.
- **Calibration:**
 1. Chainages and GPS coordinates of pipeline route, Physical marker location.
 2. Field condition and terrain, ROU.
 3. Depending on the field condition such as (Road, Farmland, Canal etc) we create zone's and set their threshold's.

□ Tuning :

- In tuning we have to analysis raw data cumulative energy and frequency spectrum and set different parameters such as Optical Parameter, Detection statistic, Indicator, FFT Size, Frequency Bandwidth, Threshold etc.

Library of Detected Activities

Walking



Digging



Excavation



Vehicle



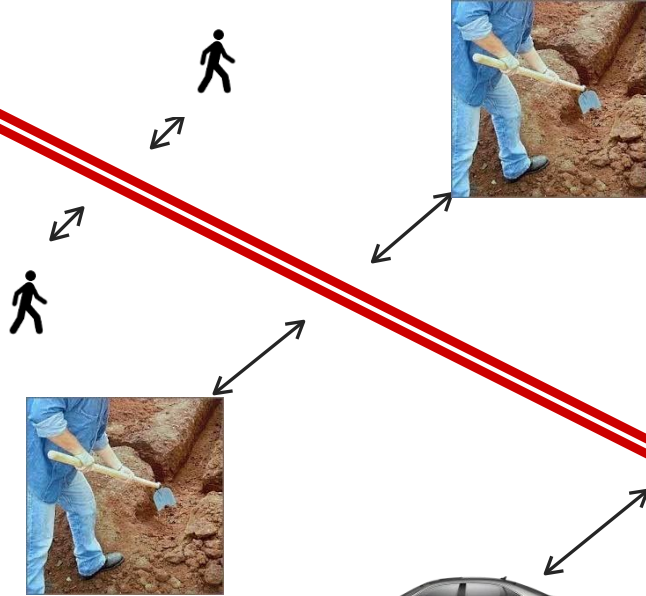
Besides the default activities, new activity types can be added to the library based on situational requirements

INTRUSION DETECTION RANGE



Helios

Footsteps detected between 0 - 2 meters and
Manual Digging Detected between 0 to 10 Metres



Existing OFC

Light Vehicles
Detected between
0 - 10 Metres



Mechanical Digging
between 0 - 20 Metres



Position along Perimeter accurate
to better than 1m (on 5km span)
- Reduced to 10m accuracy on
40km span

**EARLY
WARNING**

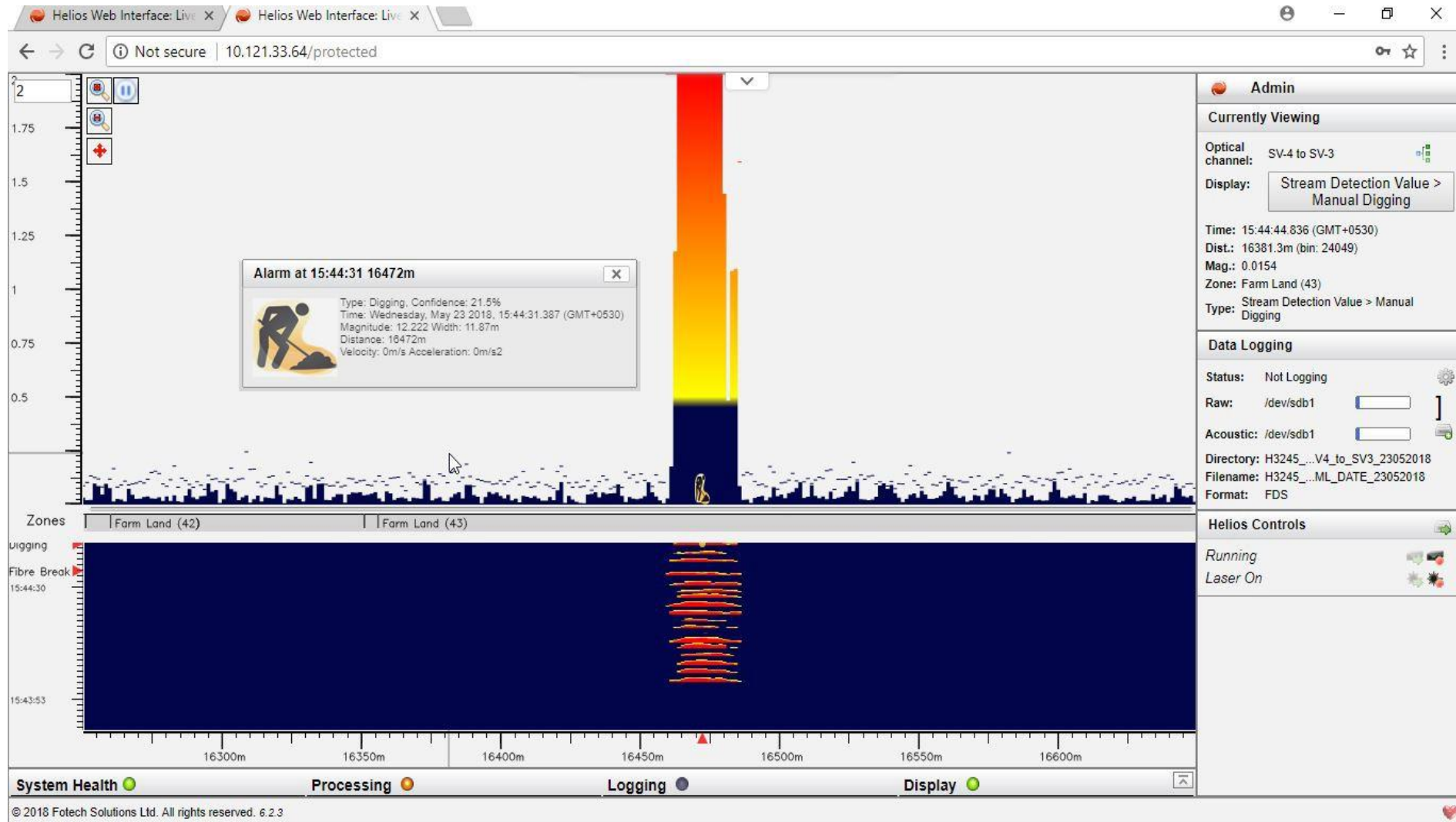


Invulnerable To Defeating By Damaging Or Bypassing





Software Interfaces – Administrator View



HWI – Helios Web Interface

Advanced Configuration for logging of raw data

Software Interfaces – Operator Interface



View intrusion location on interactive map

Alarm!

Type: Digging Detected
Time: Monday, Dec 17 2012, 18:15:58
Status: New

Event Type: Digging
Position On Fibre: 40387m
Fibre Line: Helios 1012, Channel 1

Response History

Type	Time	Comments
Digging Detected	18:15:58	
Walking Detected	18:15:43	
Vehicle Detected	18:14:47	

(All times are given in GMT+0530.)

Outstanding Alarms

- 18:15:58 Digging Detected
- 18:15:43 Walking Detected
- 18:14:47 Vehicle Detected

System Health

- Panoptes ✔
- Helios 1012 ✔

View alarm details like type of activity, time, etc. for current and historical alarms

Check system health



■ Unique advantage of PLIDS in NG Pipeline

- ❑ Identification of Minute Leak Detection
- ❑ Identification and Repair of Pipeline Coating Damage
- ❑ Reduced down time for OFC Leasing business
- ❑ OFC maintenance
 1. Identification of exact fault location
 2. Elimination of OTDR activity in the event of OFC cut
 3. OFC power loss mitigation and loop identification
- ❑ Cost Effective Solution for 24X7 Monitoring of Complete Pipeline

THANK YOU

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