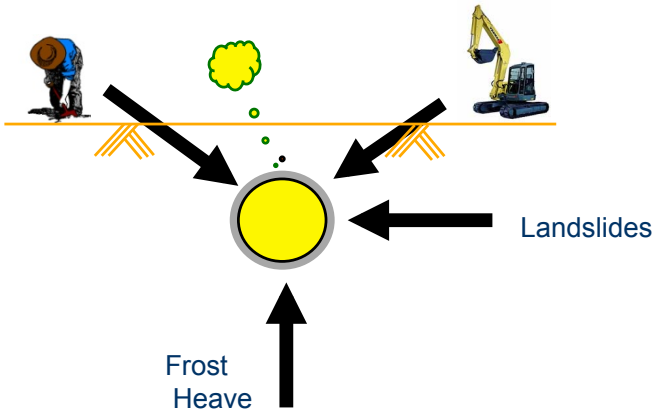
Fibre optic systems

Pipeline condition monitoring system

UKOPA/09/0059

The challenge



Measurands:

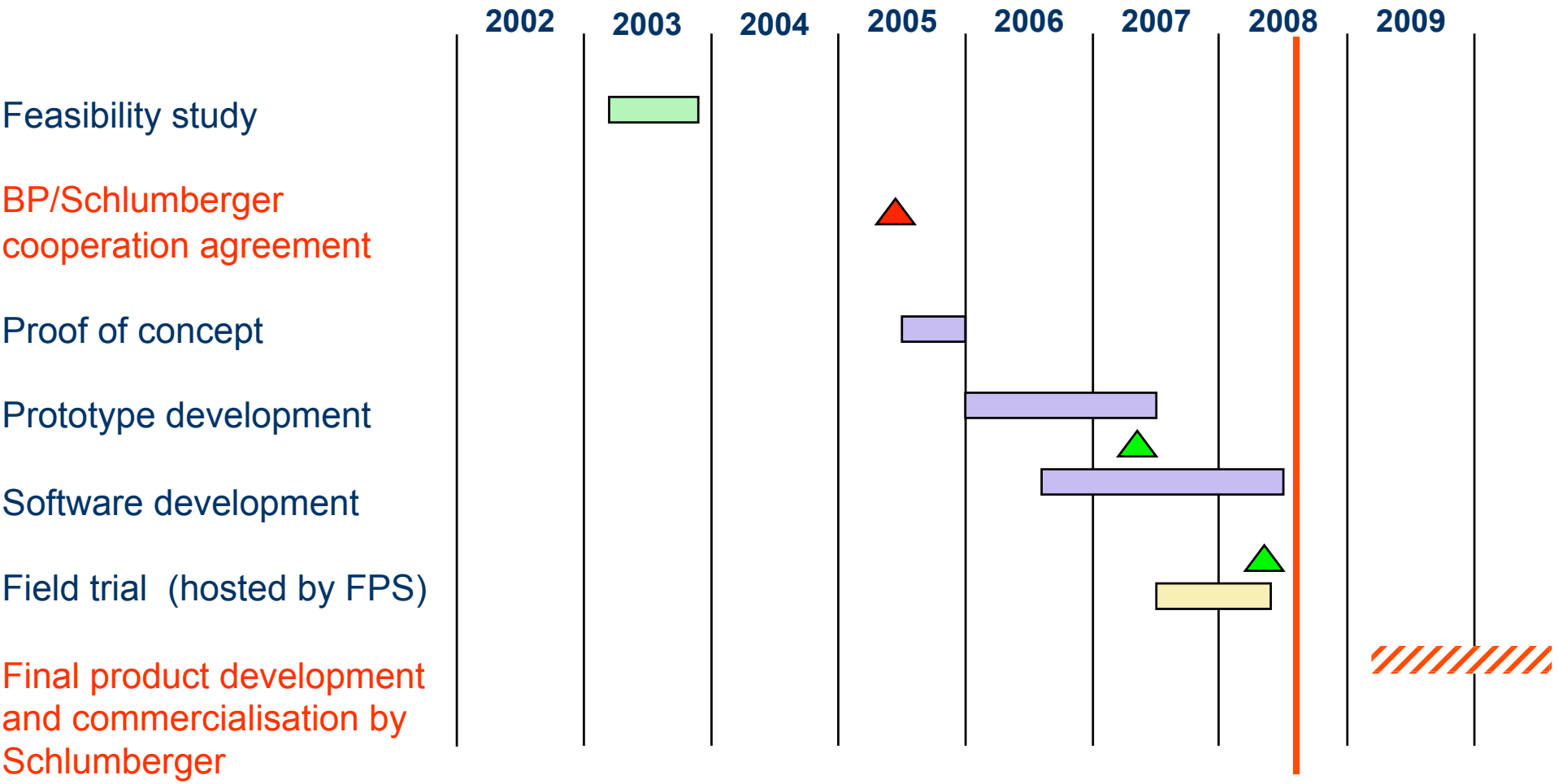
- **Strain**
- **Temperature**
- **Vibration**

Our Challenge in 2003:

Is it feasible to develop a single fibre optic system that will identify the following hazards to an onshore pipeline continuously over a 100 km without infield instrumentation?

- *Detect and locate small to moderate gas leaks*
- *Provide soil temperature distribution (e.g. chiller performance in permafrost)*
- *Detect, locate and monitor ground movement (e.g. landslides)*
- *Detect and locate third party interference (e.g. people, excavators)*

Development Schedule



Integriti – Pipeline Monitoring System

DVS – Distributed Vibration Sensor

- Distributed detection & location of disturbances
- Third party Intrusion
- Acoustic signature of leaks

DSTS – Distributed Strain & Temperature Sensor

- Distributed (independent) measurement of temp and strain
- Ground movement
- Temperature distribution
- Thermal indication of leaks

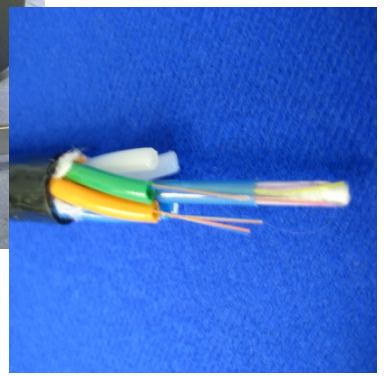
OTDR – Optical Time Domain Reflectometry

- Fibre break detection indicating cut or damaged cable

Remote Optical Amplification

- Pump units provide optical power to remote amplifiers

Direct- bury cable for strain, temperature and vibration sensing



Range	
100km	
Spatial Resolution	**10m**
Temperature Resolution	**± 2°C**
Strain Resolution	**± 40µstrain**

FPS Field Trials

Evaluation of the performance of the PCMS instrumentation to detect the following events, extend event databases and validate event recognition software

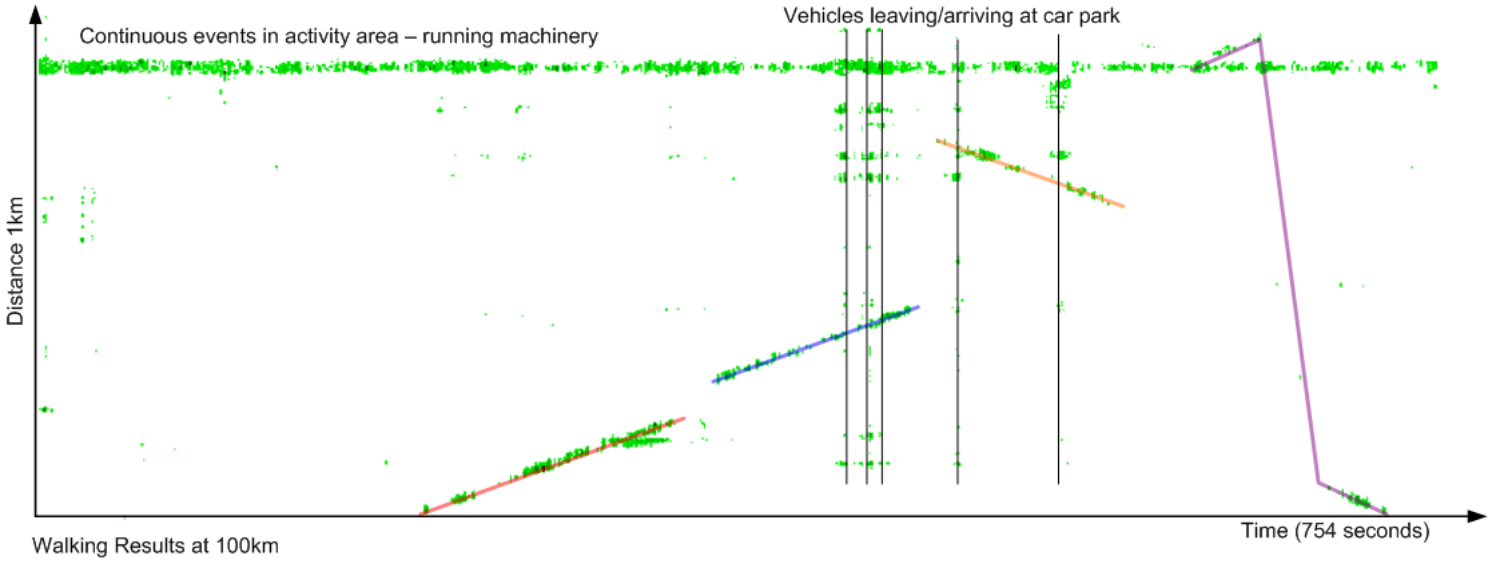
- Ground movement
- Temperature changes
- Gas leaks
- Man walking, running & digging
- Vehicle movements
- Individual vehicle idling
- Fence post installation
- Excavator moving / idling
- Excavator digging
- Cable tolerance to construction damage

All tests TPI tests performed at fibre length greater than 100 km

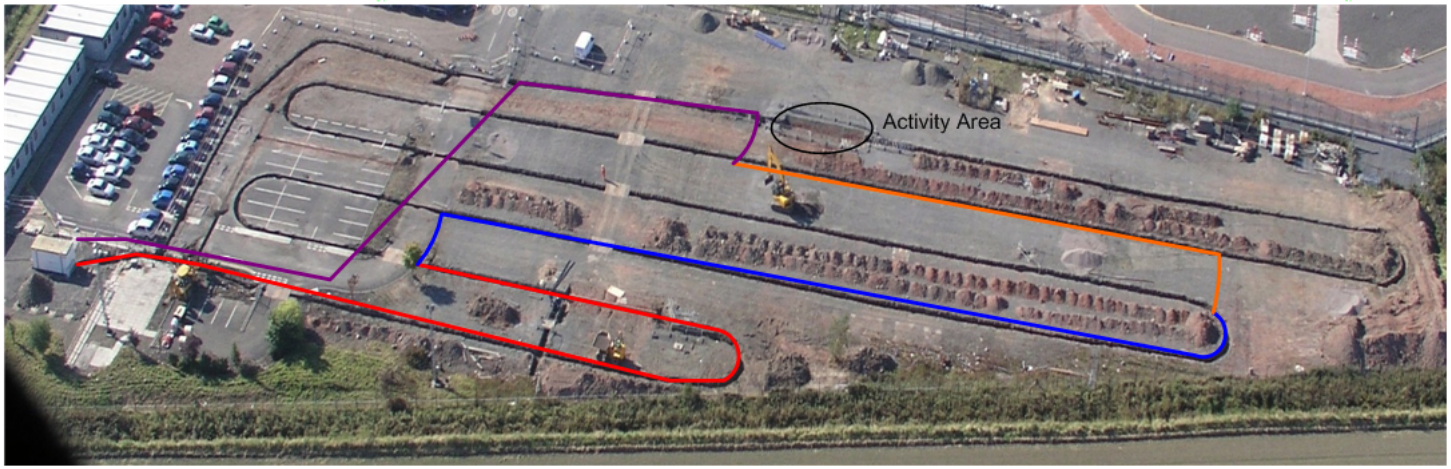
Kinneil Trial Site

Site lay-out

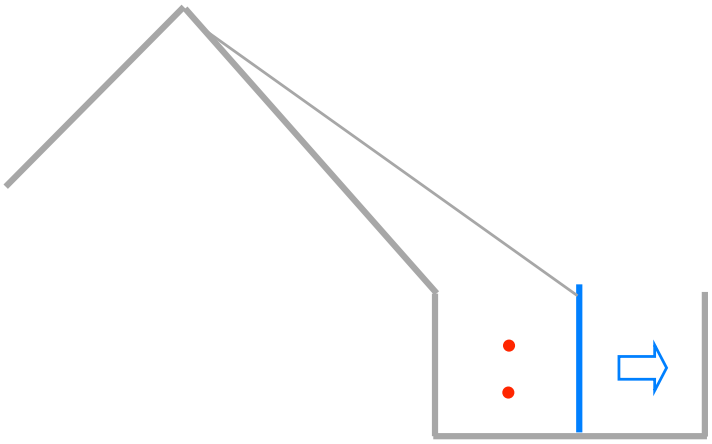
Man walking

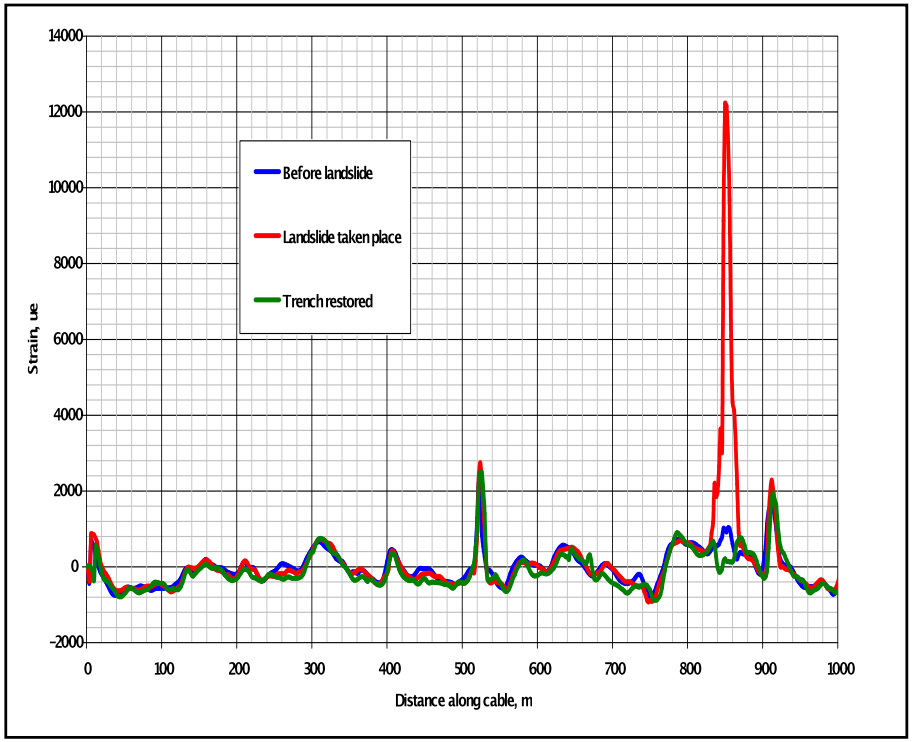


Walking Results at 100km



Kinneil Ground Movement (landslide)



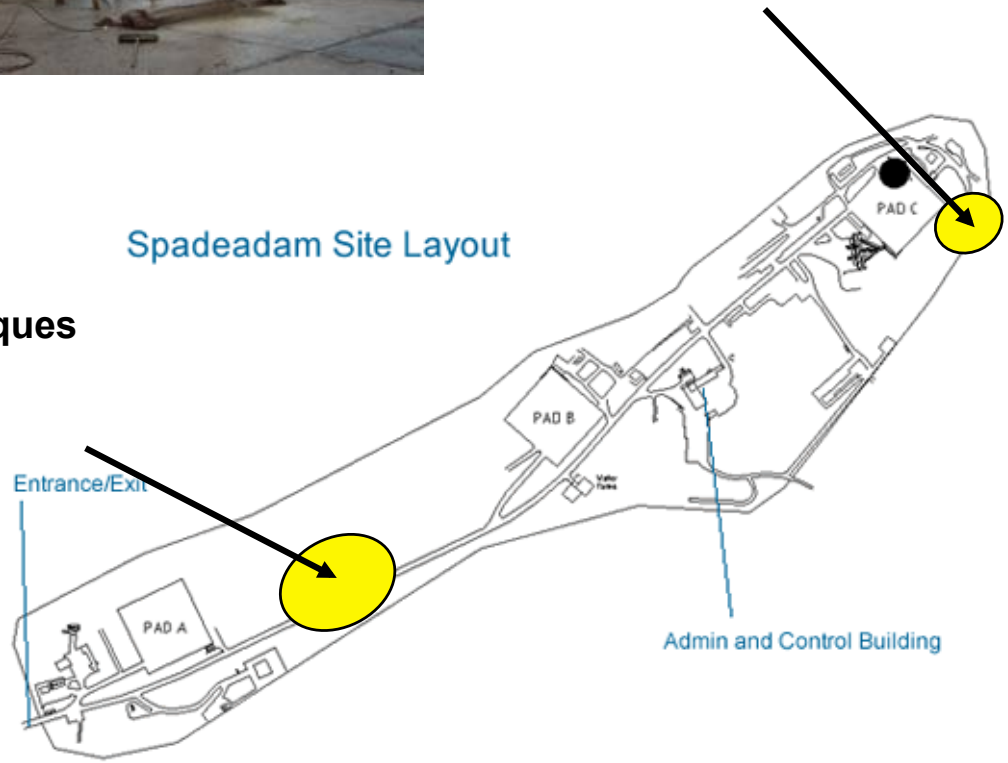


RAF Spadeadam

Advantica Spadeadam

Mechanical tests:
- **Impact**
- **Abrasion**
- **Lateral movement**

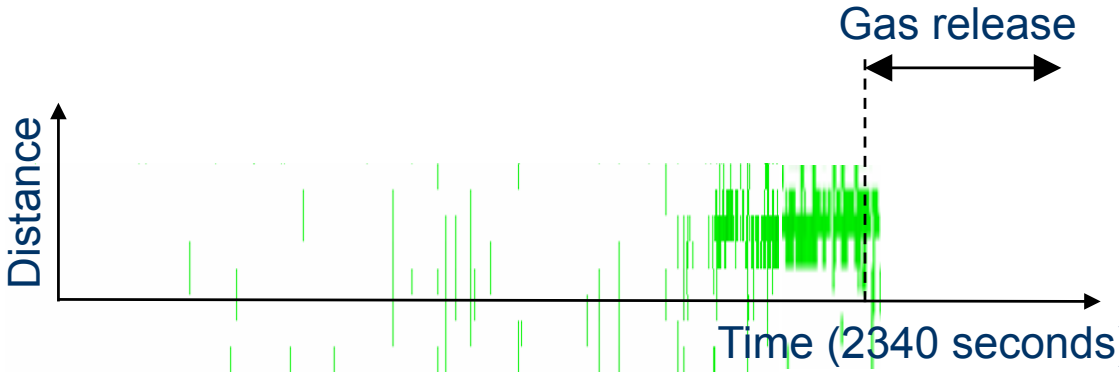
Gas leak trials:
- **Variety of fibre optic techniques**
- **Small & large scale tests**

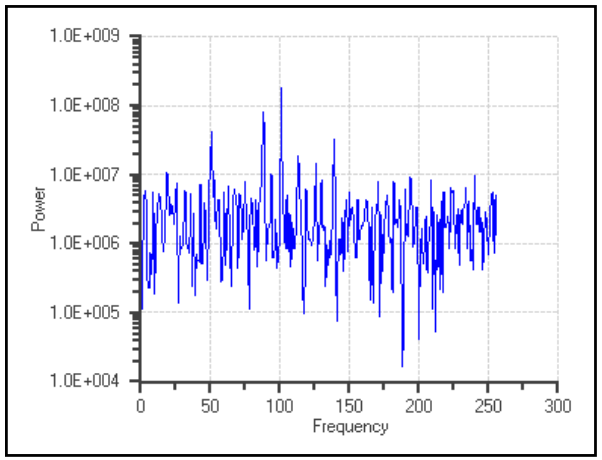


Cable Validation

Advantica Small Scale Gas Release

- 1mm diameter hole
- 100 barg pressure
- Cable 500mm above leak

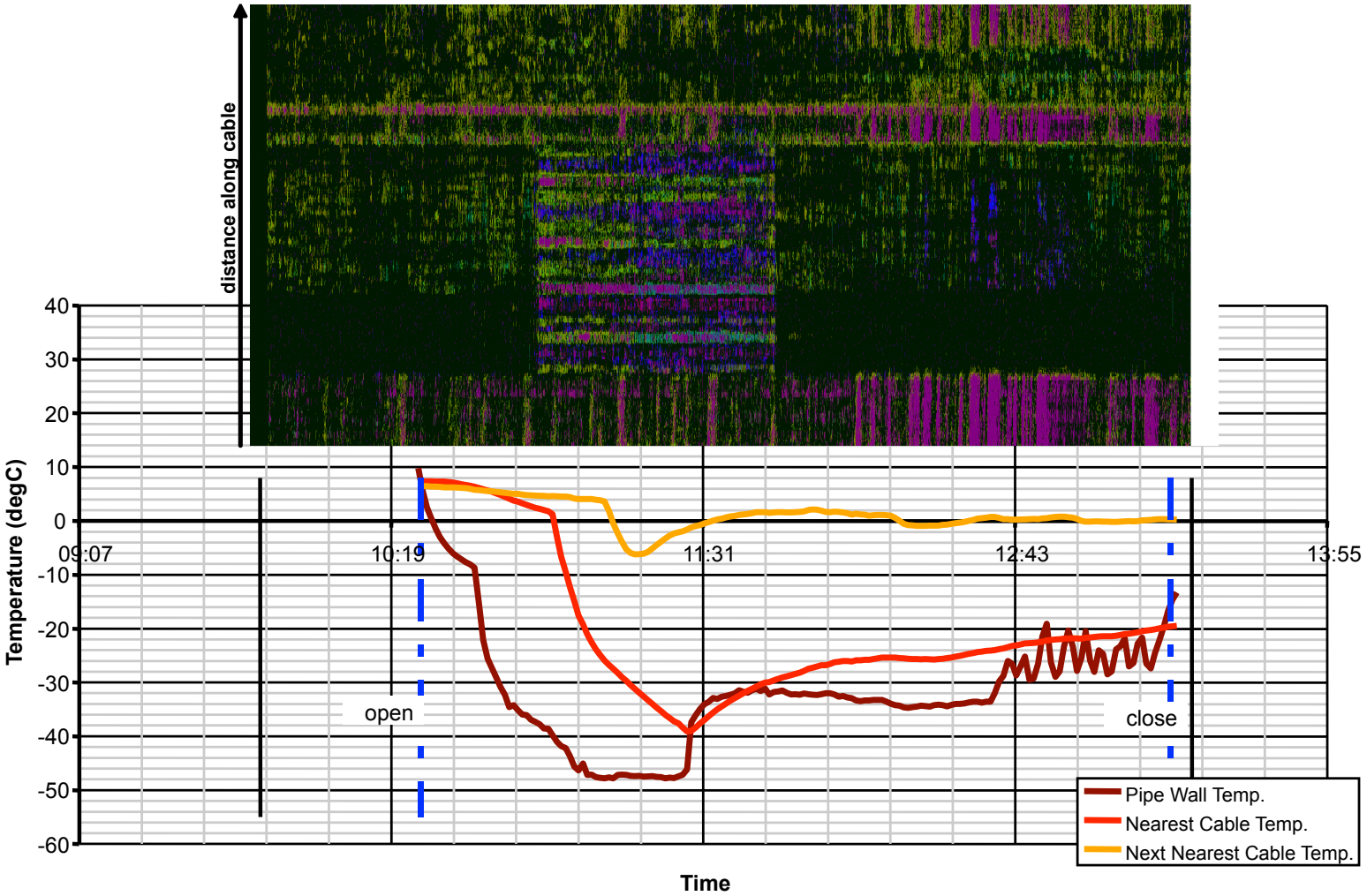




Example of frequency signature of leak

Large Scale Gas Release

Large Scale Gas Release



BTC Pilot Project - Fibre Optics

- To provide third party intrusion detection for BTC pipeline
- Interrogating equipment located in pump station PSG2 in Georgia
- Use made of 100 km of existing fibre optic cable to the west of PSG2
- Mobilising to field on 8th September 2009
- Testing and configuring the system during September/October 2009
- Operational phase in December 2009

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MAP SHOWING LOCALITY OF T IN THE PARK FESTIVAL SITE

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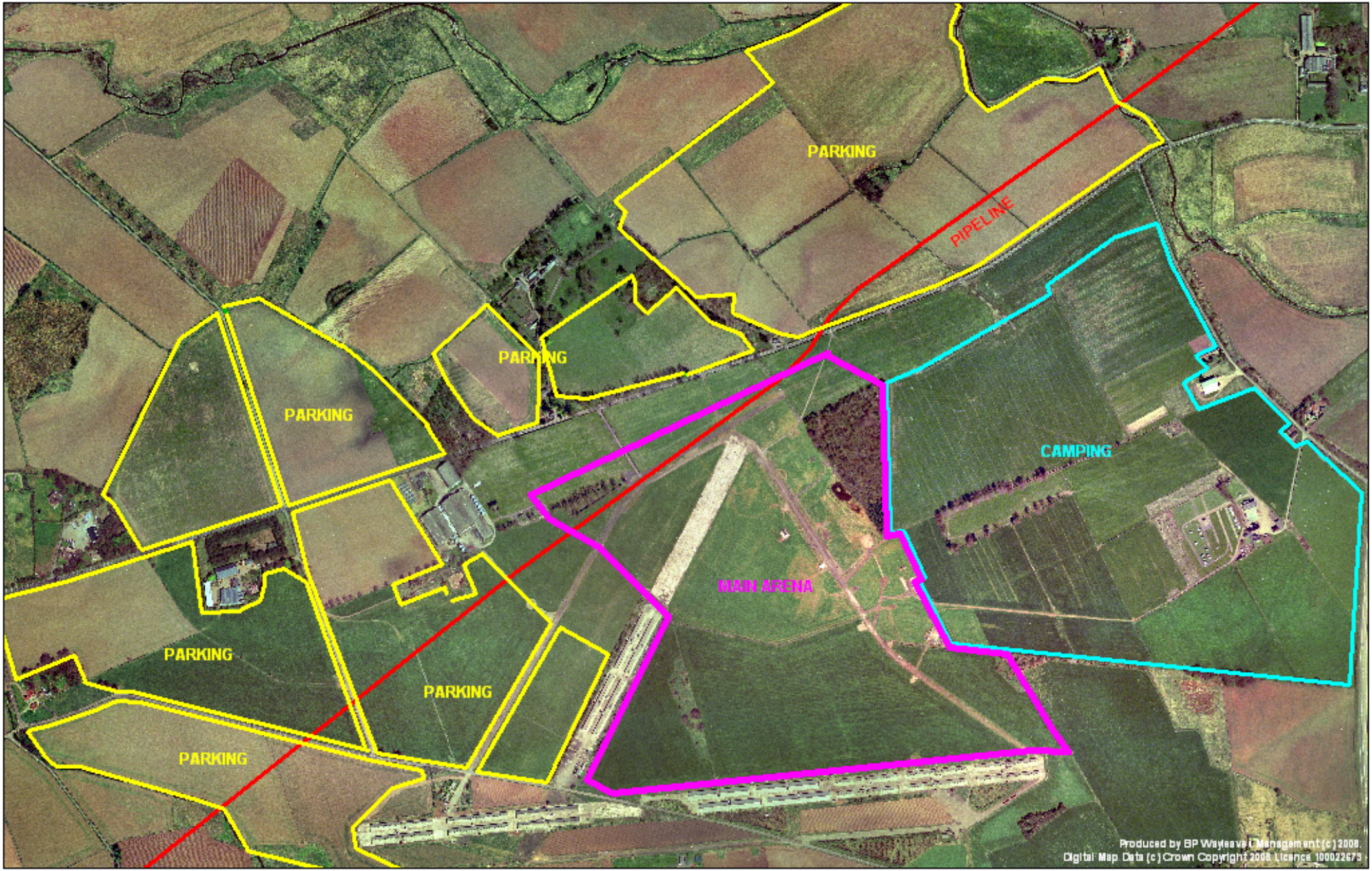

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AERIAL VIEW SHOWING LAYOUT OF T IN THE PARK 2008

N W E S

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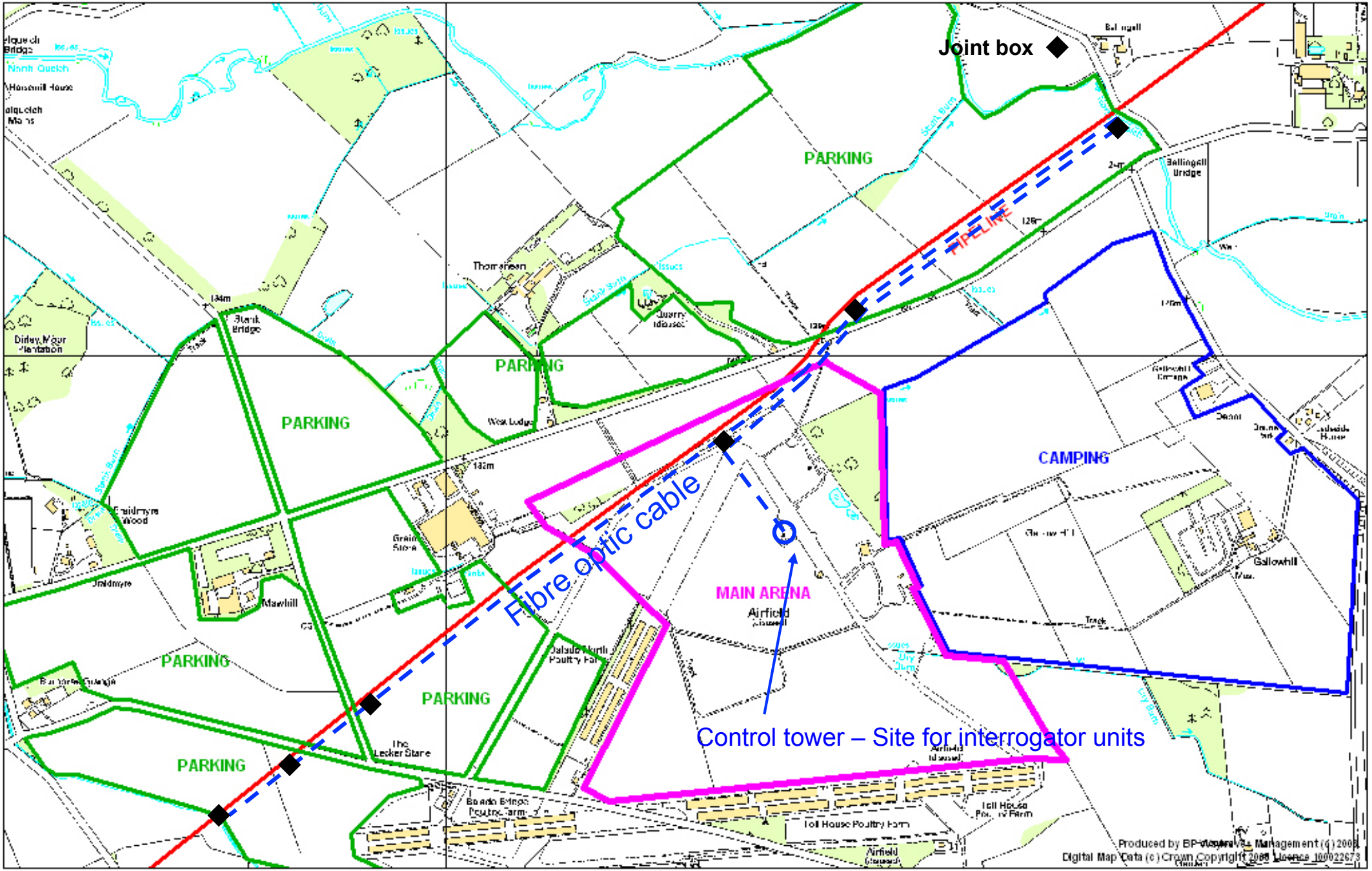

Mark-up of likely fibre optic siting

MAP SHOWING LAYOUT OF T IN THE PARK 2008

T in the Park Event – Information listing

- TitP held mid-July
- 85,000 people attend
- Integriti equipment to be housed in old airfield control room with power supply
- Monitors to be in FPS offices, Hadrian House, Falkirk and FPCC, Kinneil
- Hand held monitor (e.g. PDA - Blackberry Storm) for use on site
- All year coverage required as other events held on site
- Pipe buried 1.2 m – 1.4 m
- Length to be monitored 2.4 km
- Cable to be buried above pipeline to depth of 0.75 m.
- 3 road crossings
- Link output to existing GIS system

Future actions

- Continue deployment of fibre optic system out to BP projects and operations
- Complete the BTC pilot project using an insitu standard data/control cable
- Field trial of remotely deployed fibre optic system retrofitted to an existing pipeline
- Quantify the reduction of risk of pipeline damage due to external threats from the presence of the fibre optic system and other surveillance techniques
- Examine how this will influence our internal assessment of major accident risk

How do we quantify the advantages obtained from all surveillance activities?