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Lite4ce™

Wheel Detection by Fibre Optic Sensors

New Technology and Changeover Strategy

CIE Seminar Taipei, October 2018

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Where are we today?

■ Electromagnetic axle counters have been industry standard for over 50 years

■ But...

- Sensitive to EMI and lightning
- Vandalism (copper cable)
- Bulky sensors
- Need to remove sensors for track maintenance
- Power supply and complex signal transmission

■ 電磁計軸器做為工業標準已有50年之久

■ 但是它們...

- 對電磁與閃電干擾很敏感
- 人為破壞(因使用銅纜)
- 偵測器體積過大
- 於軌道養護工作時需拆除計軸偵測器
- 電源與複雜之信號傳輸

Content 簡報內容

Technology / 產品技術

- Working Principle / 偵測原理
- Product Components / 產品元件
- Lite4ce Sensor Installation / 光纖計軸器之安裝

Upgrade and Integration Strategy 系統升級和整合策略

- Brownfield Applications
整合現有系統與新系統之應用
- Greenfield Applications
新系統應用架構

Status / 現況

- Field Tests Performed / 進行現場測試
- Status and Outlook / 現狀和展望





Working Principles

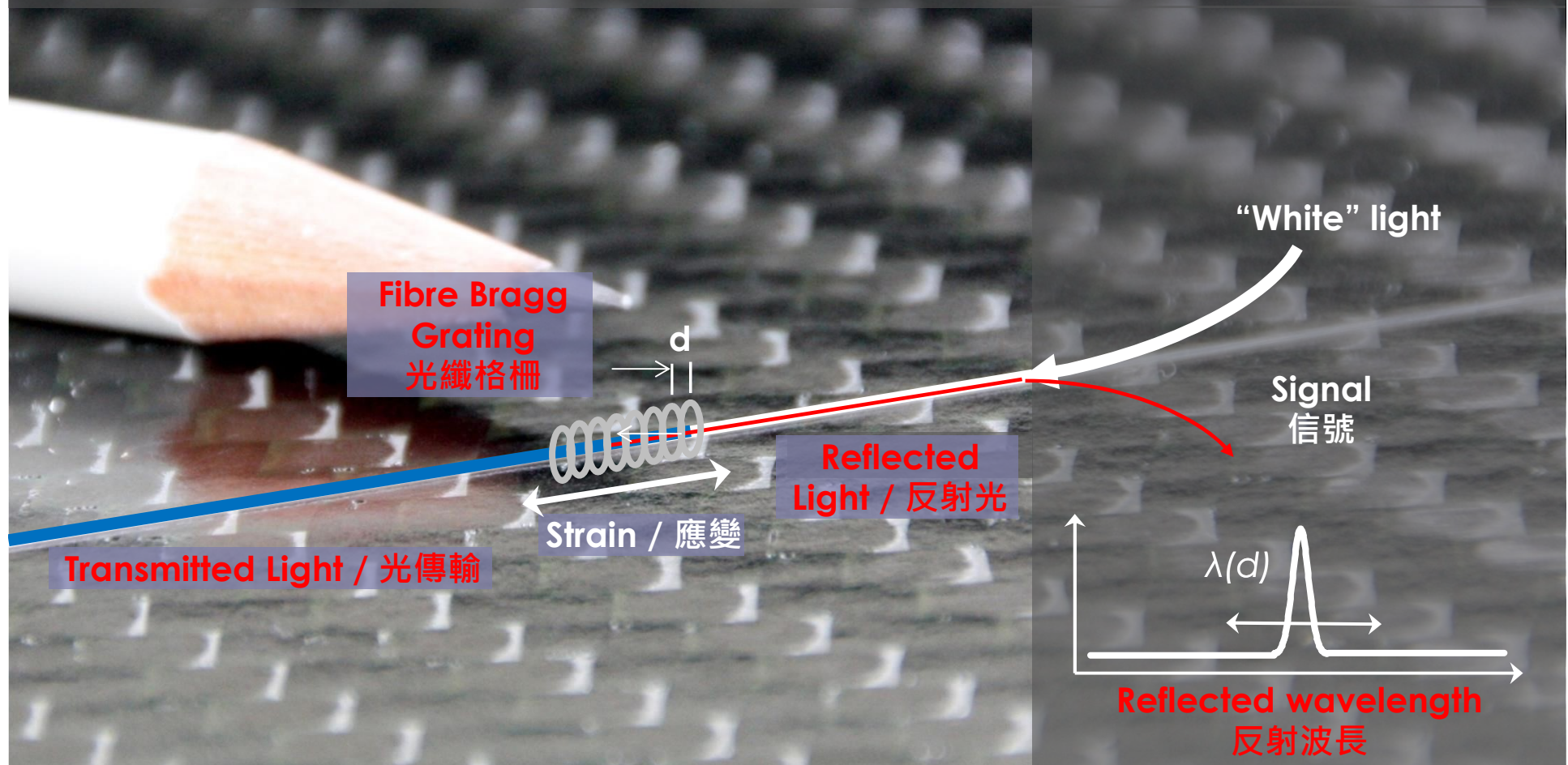
FIBRE OPTICAL WHEEL SENSING
FIBRE BRAGG GRATING
PATENTED WHEEL SENSOR

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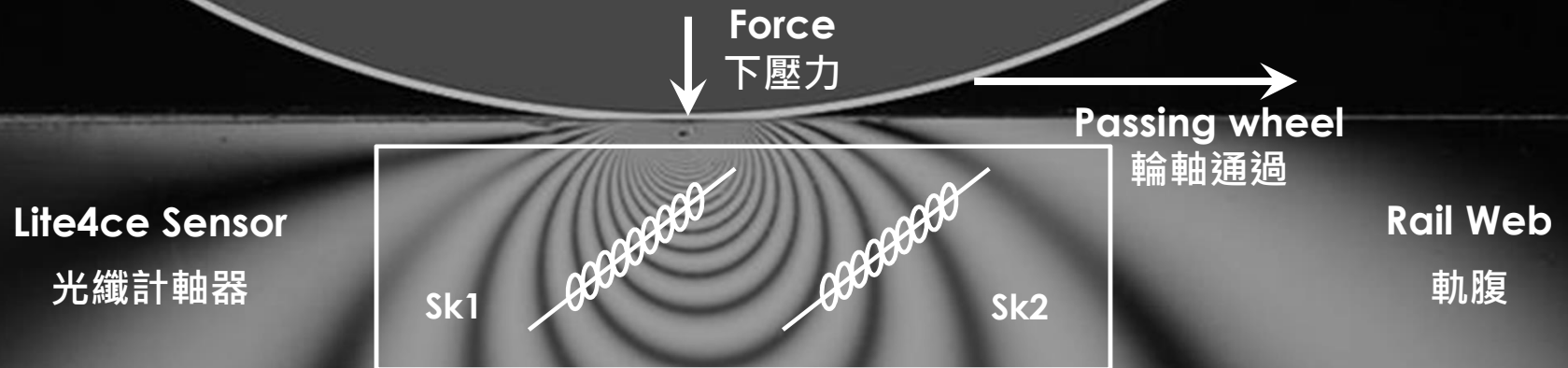


Physical Principle Fibre Bragg Grating 物理原理光纖格柵



Sensor Principle: Detecting Mechanical Strain

偵測器原理：物理應變之偵測



Shear strain inside the rail resulting from a passing wheel

由通過之車輪於鋼軌內產生剪切應變

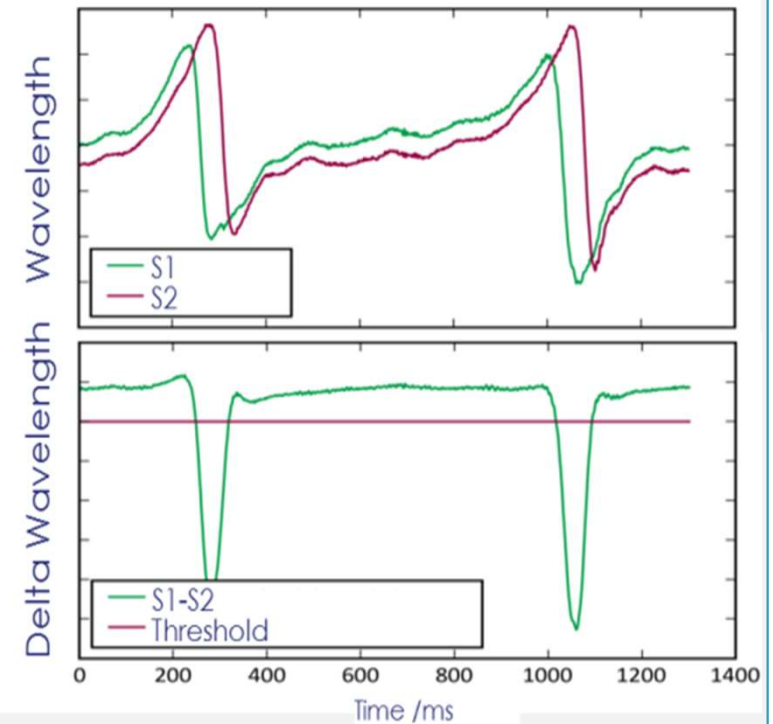
[Show Film](#)

Signal Evaluation / 信號分析

- Opto-electrical components transform the reflected wavelength into an electrical signal
光電元件將反射波長轉換為電信號



- The new Sensor provides almost the same signal as our current technology
光纖計軸器提供與目前技術幾乎相同之信號



> Start film



Lite4ce Product Components

Components for Greenfield Applications
Components for Brownfield Applications

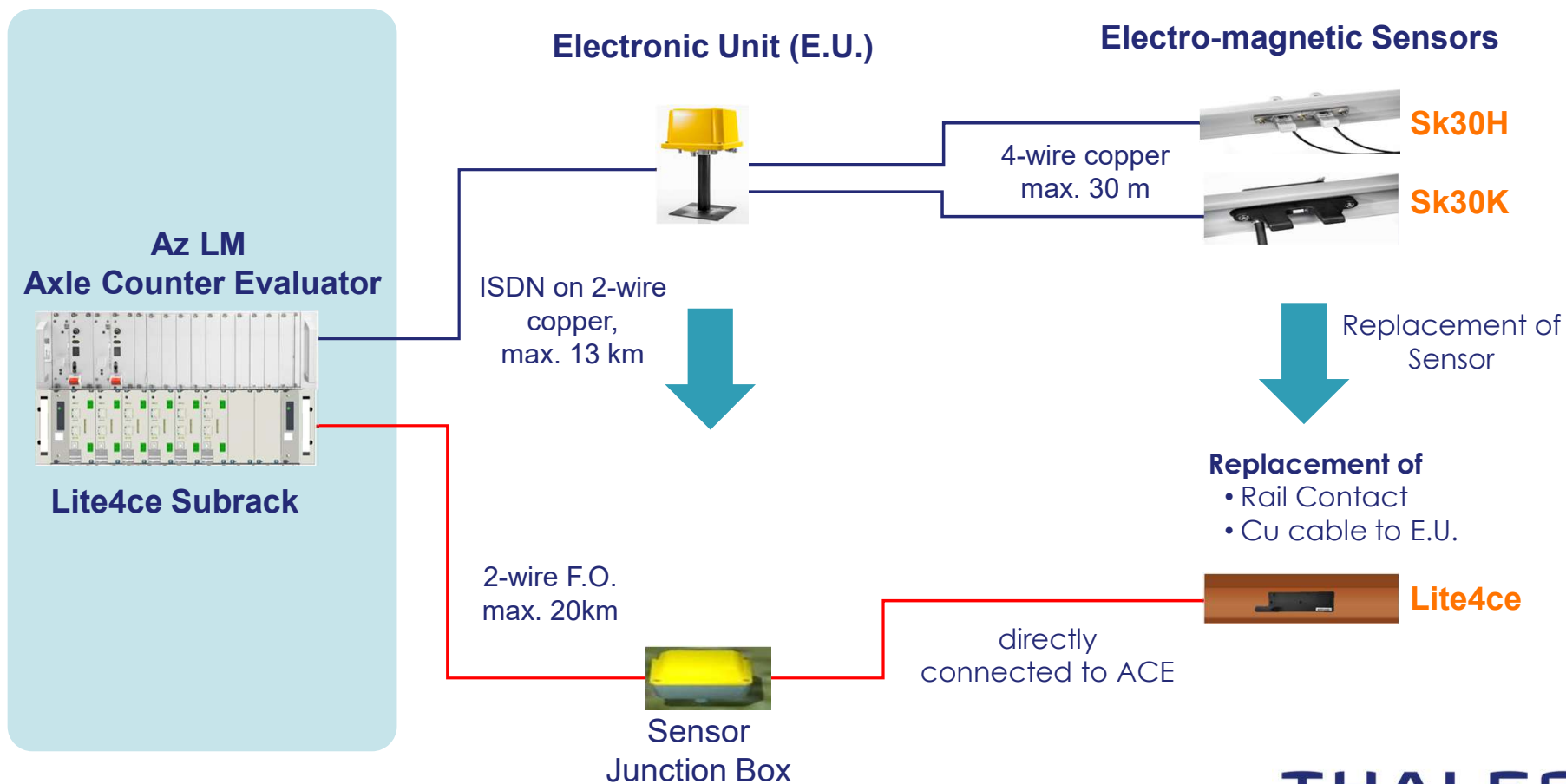
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Upgrading Existing Environment / 現有系統環境設備提升

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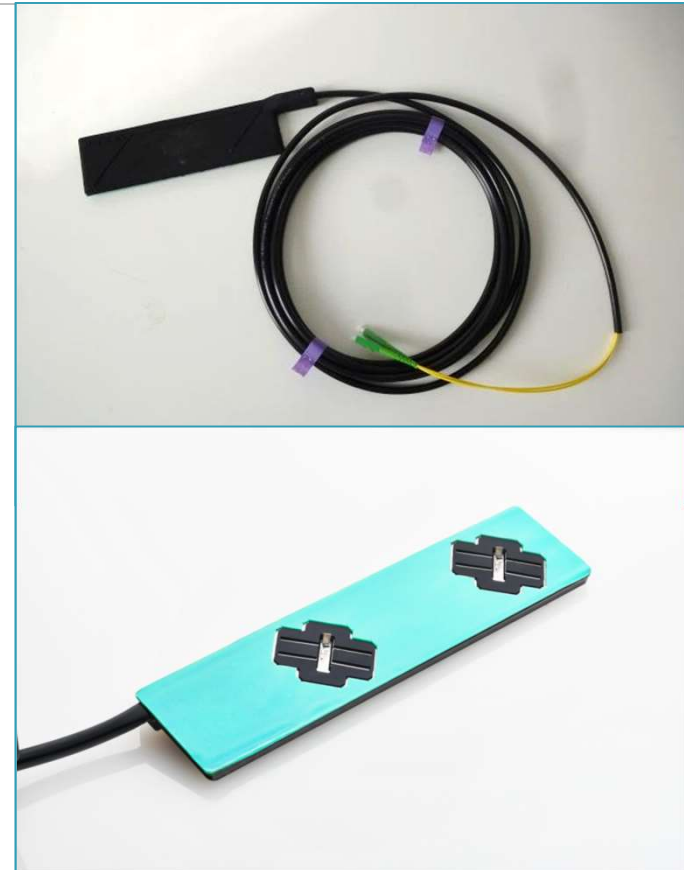


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Lite4ce Sensor / 光纖計軸器 (1/2)

Wheel sensor with 8 m optical tail cable 8m 光纖計軸器

- 40 x 170 x 3 mm, approximately 100 g
光纖計軸器體積 40 x 170 x 3 mm · 重量約 100 g
- 2 optical fibres per wheel sensor (dark fiber)
每組光纖計軸器包含 2 組光纖電纜
- One duplex Lucent connector
一組雙 Lucent 接頭
- Each component of the system is tested at all times with built-in self tests
每一系統元件俱全時段自檢測試程序
- Drop-off detection (closed-circuit principle)
脫落偵測(閉路迴路原理)
- Minimum axle load of 1 ton
標準輪軸之最小重量 1 噸

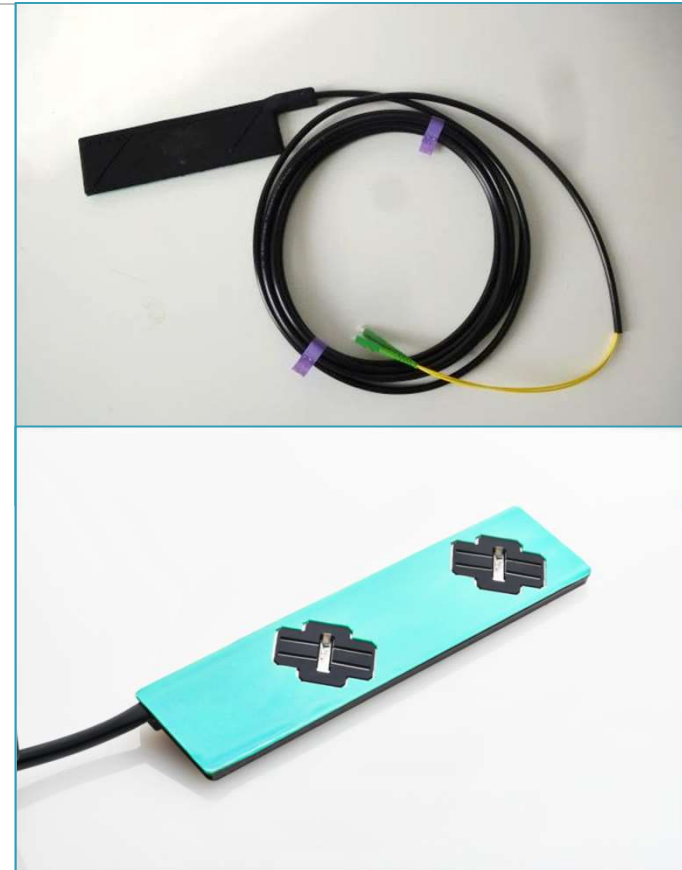


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Lite4ce Sensor / 光纖計軸器 (2/2)

Dry adhesive film on the Sensor 光纖計軸器黏著膠膜

- Sensor is glued to rail and has a built-in drop-off detection
光纖計軸器黏著於鋼軌且具備脫落偵測
- Activated with specific inductive tool set
感應加熱型黏著膠膜
- Installation possible within 10 to 15 min
安裝時間約10~15分鐘
- Fit and forget principle
適應它，忘了它就在那裡



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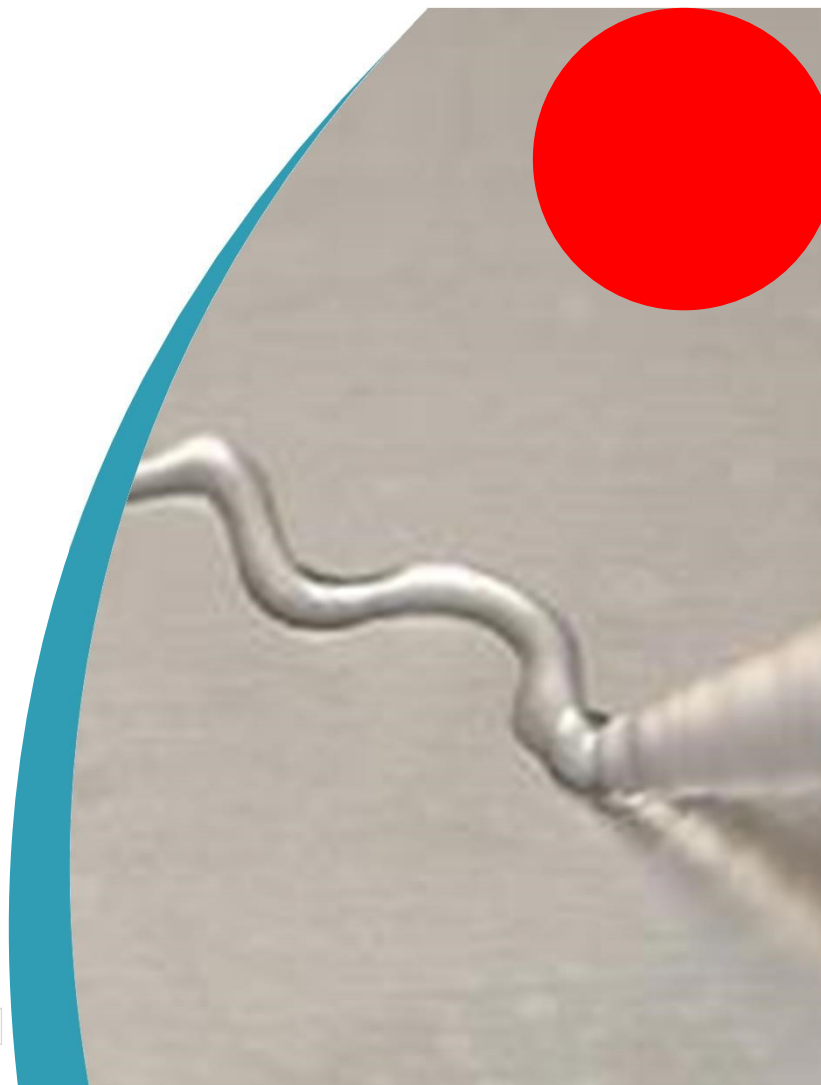


Adhesive Bonding

Using dry adhesive film plus inductive heating
Installation process

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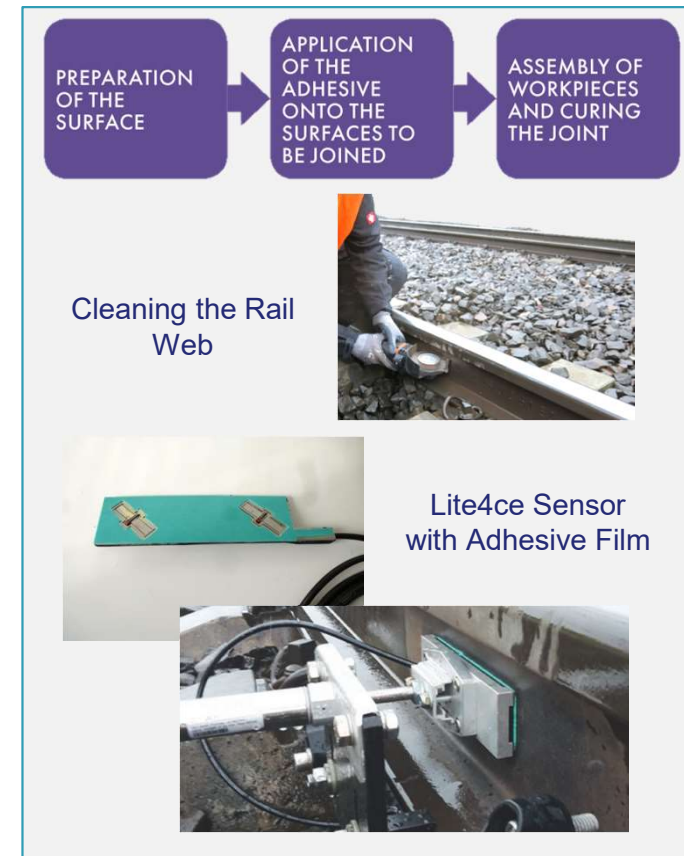
Dry Adhesive Film Activated by Inductive Heating / 熱感應黏著膠膜

Bonding of the wheel sensor to the web of the rail by / 下列步驟為安裝前置作業

- Cleaning of the rail web with a grinder
- Application of the dry adhesive film on the sensor
- Inductive heating in order to impart heat via conduction on metal part causing a bond though selective heating and melting

Fast bonding solutions through inductive heating / 透過熱感應黏著之安裝方式

- Initial strength within seconds
- Final strength within a few minutes
- Working under harsh climatic outdoor conditions



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Adhesive Bonding Tool / 膠膜黏著工具

■ Induction Generator

- External power supply (generator 2kW) required

■ Inductor for adhesive bonding

- Produces inductive heat

■ Bonding on a cleaned rail by inductive means within 60 seconds

■ Tool for commissioning and fault finding

- Reproduces the optical wavelength signals
- Calibrated wavelength reference



Induction Generator



Inductor for adhesive bonding



Optical test equipment

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Mounting Components / 安裝組件

Standard Protecting Tube

標準型保護套管

Sensor Protecting Plate

光纖計軸器保護蓋板



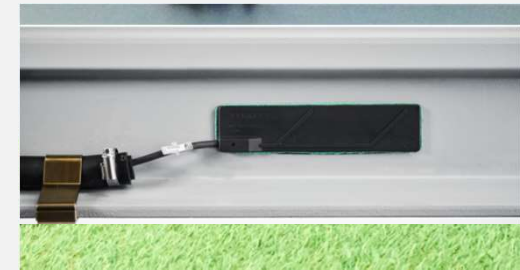
Rail Foot Clamp / 鋼軌底座夾

- Thales cable fixation
- or COTS component
- e.g. Voestalpine ClipFix system

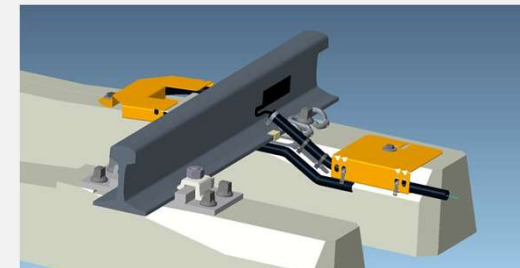


Sleeper Mounting Clamp / 軌枕安裝夾

- inner+outer protecting plate from Thales
- or COTS component



Thales Cable Fixation



Thales Protecting Plates

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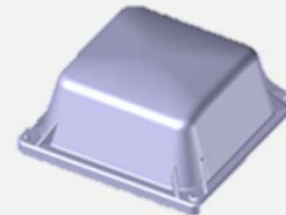
Sensor Connection Box / 光纖計軸器接線盒

Connection box at the track side 道旁接線盒

- COTS component
- Connects the optical fibres to the line side optical cable
- Connection box with terminals for 8 fibres
- For up to 4 Detection Points



Connection Box



Cover



Base

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Lite4ce Components / Lite4ce光纖計軸器組件(1/2)

Lite4ce Sensor / 光纖計軸器

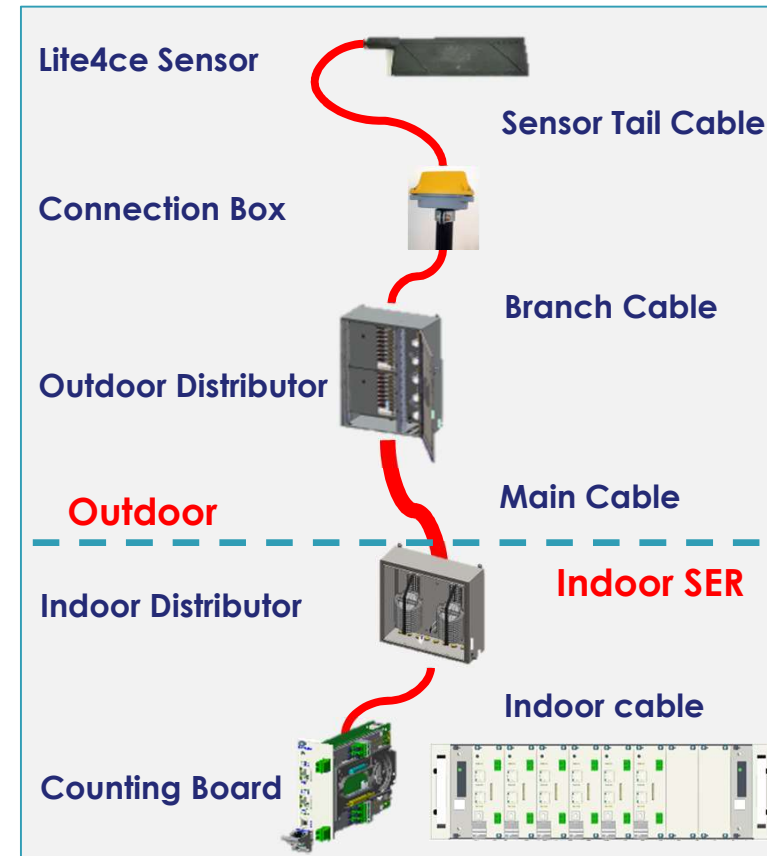
- F.O. tail cable (5,5m or 8m cable) with duplex Lucent connector
光纖計軸器光纜(5,5m or 8m 光纜)包含 duplex Lucent 接頭

Connection Box (COTS) / 接線盒

- Terminals for up to 4 sensors
可連接4組光纖計軸器至端子台

Outdoor Distributor (optional, COTS) 室外光纖分配盤

- Terminal for multiple fibers from the main cable / 光纖分配盤



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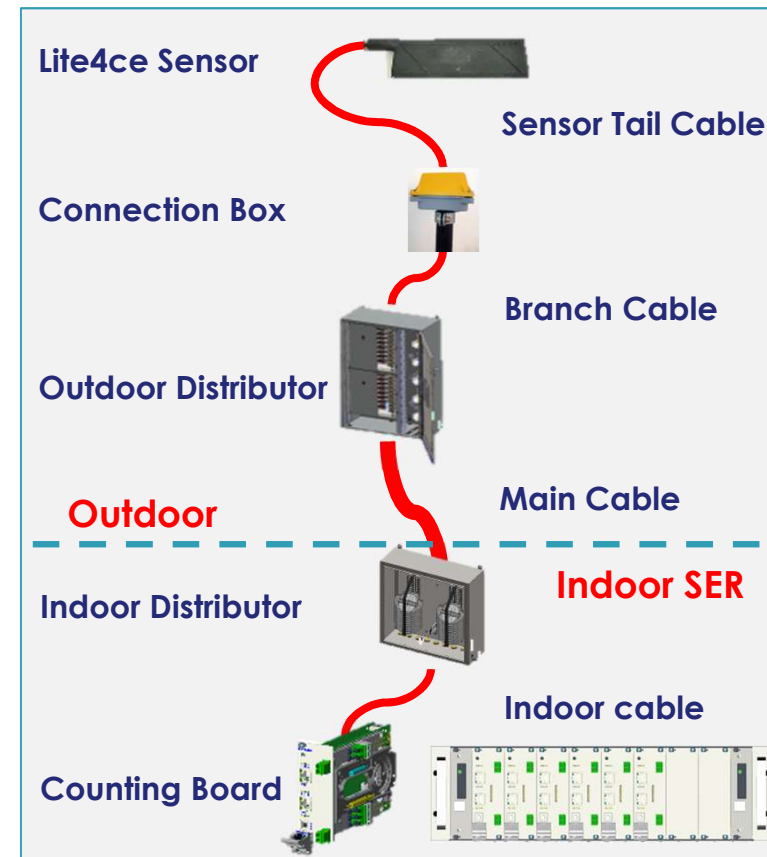
Lite4ce Components / Lite4ce光纖計軸器組件 (2/2)

Indoor Distributor (COTS) 室內光纖分配盤

- F.O. termination rack in SER
號誌室光纖分配機架
- Connects all F.O. Components
連接至光纖元件

Counting Board and CB Subrack 計算板與匯流排機架

- Subrack for up to 32 sensors (16 CB's)
每組計算單元內部可管理32個光纖計軸器分別
於不同匯流排機架上(共16片計算板)
- CAN-Bus to indoor evaluator Unit (ACE)
匯流排機架連接至標準計軸器計算單元



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Lite4ce Counting Board and CB Sub Rack 光纖計軸器計算板與匯流排機架 (1/2)

Lite4ce Counting Board 光纖計軸器計算板

- Connects 1 or 2 Lite4ce sensors for up to 20km distance
連接1或2光纖計軸器，距離可達20公里以上。
- Program plug for site-specific engineering data / 程式資料元件
- Two IP-Interfaces for redundant networks (connection to indoor ACE)
備援IP界面(連結至室內ACE機架)



Lite4ce Counting Board



Program Plugs



Lite4ce Sub Rack

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Lite4ce Counting Board and CB Sub Rack 光纖計軸器計算板與匯流排機架 (2/2)

Lite4ce Counting Board Subrack 光纖計軸器匯流排機架



Lite4ce Sub Rack

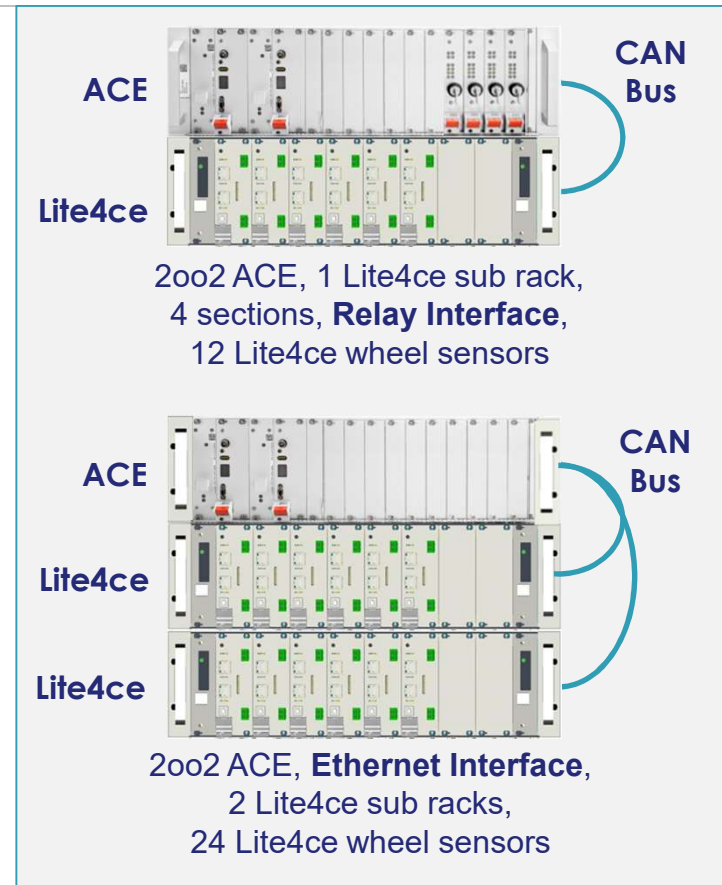
- Max. 8 CB's plus 2 power supply modules in one sub rack
匯流排機架可容納8片計算版及2片電源板
- Maximum 2 fibre optical sub rack can be combined, equal to 32 sensors per ACE
可結合2組匯流排機架，每組計算單元內部可管理32個光纖計軸器
- Power supply and CAN-bus transmission is provided via the backplane
透過背板提供電源及匯流排之傳輸
- All components inside the sub rack communicate via the CAN-bus
機架內部所有元件透過匯流排交換訊息
- Subrack connects to the ACE via CAN Bus / 透過匯流排連結機架與計算單元
- Fully compatible to the Az LM architecture / 與Az LM架構完全兼容

Az LM: Outdoor Revolution - Indoor Evolution

Az LM: 革新之室外設備 – 進化之室內設備

Lite4ce Subrack / 光纖計軸器機架

- Connected via CAN-bus to standard ACE
- Full compatible with all ACE units (2002, 2003)
- Up to 16 fibre optical wheel sensors
- Maximum 32 wheel sensors per axle counter evaluator
- Ethernet Interface
- All DP combinations possible
 - Serial I/O boards to connect conventional Detection Points (Sk30H/K)
 - Parallel I/O boards to connect relay control systems
 - IP Interface to IL and/or DP via network



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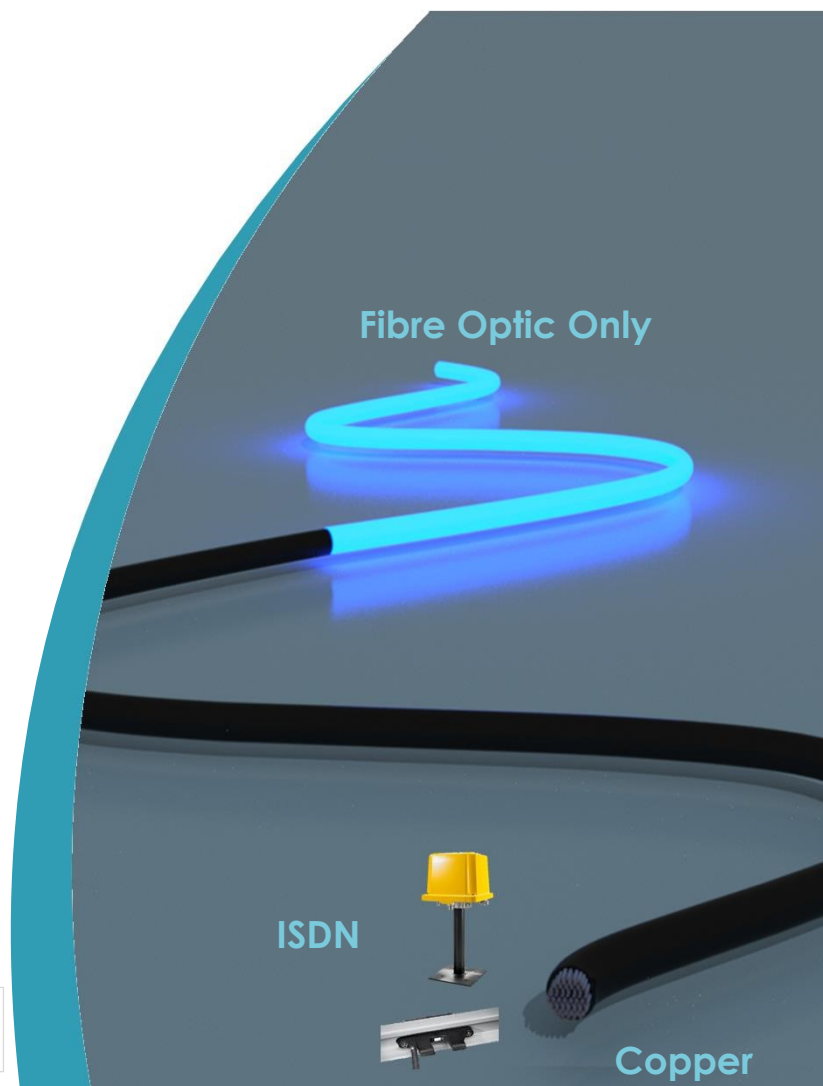


Upgrade and Integration Strategy

Brownfield and Greenfield Application Configurations

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Brownfield Applications

系統整合應用架構

Standard Configuration

Indoor Cabinet 號誌室設備



V.24/ISDN
Converter

..using Ethernet
..using V.24 Transmission
Detection Point Upgrade

2-wire Cu, ISDN,
max. 12 km

Ethernet

Cu, F.O. or
GSM-R

V.24

Outdoor
Cabinet



ISDN/Ethernet
Converter

ISDN/V.24
Converter

Track Side / Track (道旁設備)

Electronic Unit



2-wire Cu,
max. 30m

Electromagnetic
wheel sensors



Sk30H/K

QCD30K

DP upgrade by replacing
sensor and E.U.



F.O.

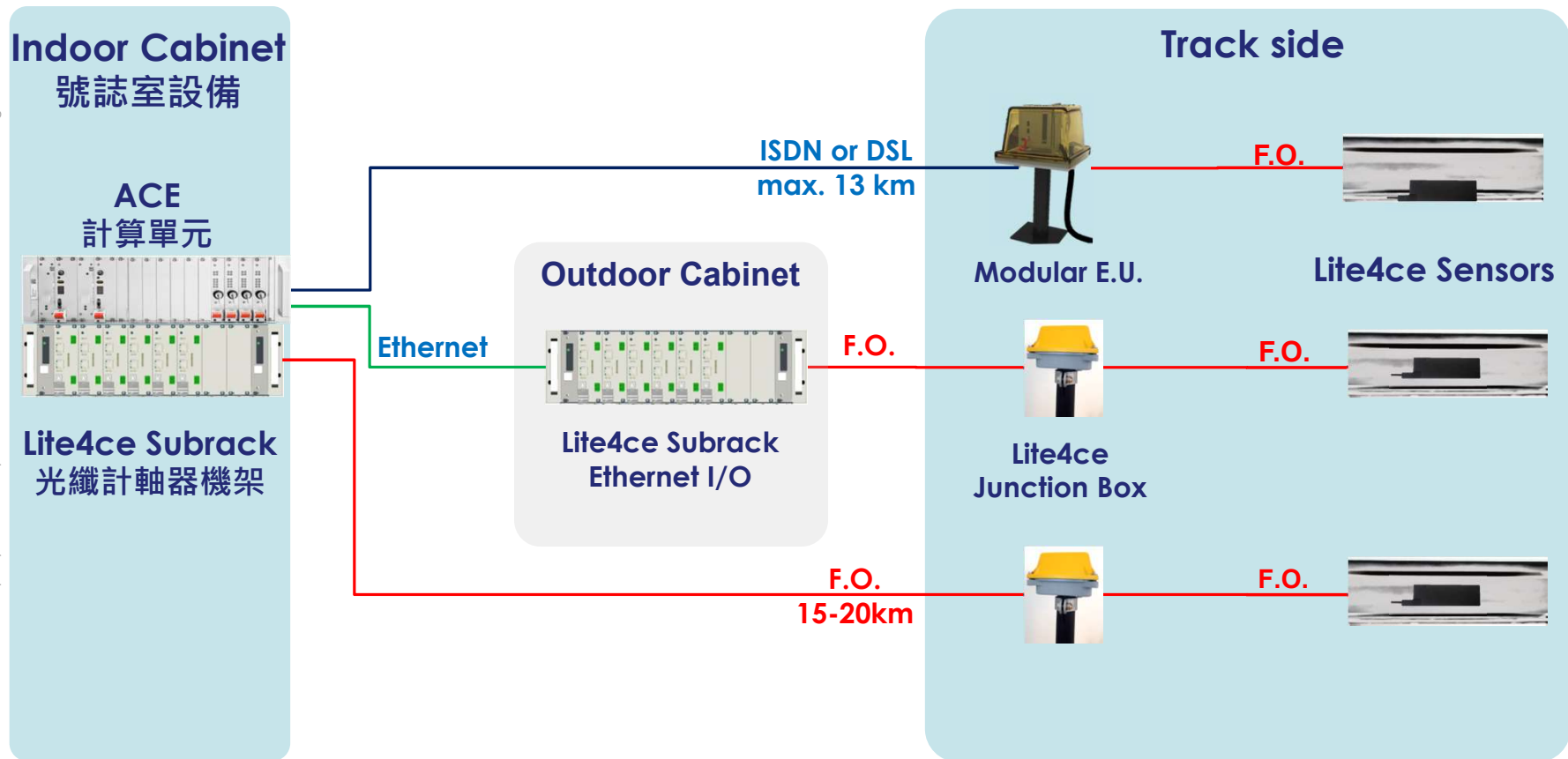
Lite4ce Sensor



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Greenfield Applications / 新系統應用架構

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Brownfield Applications: Modular Detection Point

系統整合應用架構: 模組化計軸偵測器

Housing of classical EAK30H containing the modular Electronic Unit consisting

- 1 power supply board 54-120 VDC/24VDC
- 1 Lite4ce IF board
 - connects 1-2 fibre optical wheel sensors
 - IP / Ethernet interface to ACE
 - carries a program plug containing the site-specific engineering data
- Optional: 1 communication board
 - ISDN
 - DSL



E.U. for Modular Detection Point

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Current Status

Field Tests Performed

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Current Status / 目前現況

- First test started in 2015
- Thales holds patent in 43 countries since 2016
- So far more than 10 Mio axles counted failure free
- Safety Qualification test started (German Railway Approval Authority)
- SIL-4 approval expected by beginning of 2019
- Cross acceptance can commence mid 2019
- Taiwan trial planned to start in 11/2018
- Further applications planned
 - Weight, speed, flat wheels from the same sensors

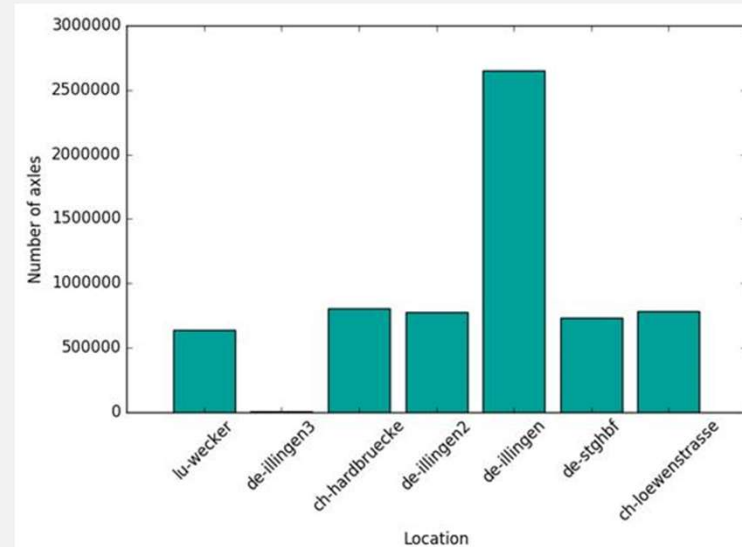
Field Trials / 系統測試

Trials since 2016 (Main Line)

- Swiss Railways, main line
 - Location: Hardbrücke, Switzerland
 - Challenge: heavy vibrations, bridge
- Luxembourg Railways, main line
 - Location: Wecker, Luxembourg
 - Challenge: High train diversity, high EMI
- Swiss Railways, main line
 - Location: Löwenstraße, Switzerland
 - Challenge: slab track, tunnel
- German railways, main line
 - Location: Illingen, Germany
 - Challenge: bad ballast condition, shunting
- More trials in France, UK,...

Urban Rail (Stuttgart, Germany)

- Location: underground, close to main station
- Challenge: light vehicles, high traffic, tight curve radius



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Trial Systems 系統測試

ACID TESTS / 嚴峻考驗

➤ Environmental conditions

- slab track, bridge, bad ballast conditions, Temperature, EMI, vibration, torsion, drop-off detection,...

➤ Operational conditions

- Different train types, shunting, high speed, light vehicles, spinning wheels, breaking conditions, tamping and grinding

Collecting data / 數據收集

- To refine wheel detection algorithm
- To prove safe and reliable wheel detection

Lite4ce Sensor Characteristics / 光纖計軸器要特色 (1/2)

100% passive outdoor components / 100%室外被動元件

- No power and no electronics at track side, no copper cable, no vandalism, no power loss, little power consumption
無室外電源需求、無道旁電子單元、無銅纜需求、無蓄意破壞之問題且電源功耗較小。

Sensor is immune against / 對...免疫

- All sort of EMI radiation, DC and AC back current, lightning, flooding...
電磁干擾、任何頻率直流及交流之迴朔電流、閃電及淹水...
- Magnetic and electro-magnetic fields, Eddy Current Brakes
磁場與電磁場、渦流車輛煞車
- Surges and bursts, „dirty“ Power Supply / 突波及脈衝(短路), 不乾淨的電源
- Weak bonding / 脆弱之接合處(例如: 接地...)
- Environmental factors (temperature, humidity, UV radiation,...)
環境因素(溫度、濕度、紫外線...)
- Mechanical signal disturbance (vibration, rail torsion - and bending)
物理干擾(震動、鋼軌變形...)

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Lite4ce Sensor Characteristics / 光纖計軸器要特色 (2/2)

Environment / 環境

- Sensitive for axle load > 1000 kG / 偵測輪軸之重量>1000KG
 - No disturbance by maintenance vehicle / 不受維修車輛干擾

Very high MTBF / 高可靠度

- Less mechanical and electronic components, electrical joints
極少數之五金配件、電子元件與電子元件間之銜接。

Reduced Life Cycle Cost / 降低生命週期成本

- Cost effective: 30% cheaper than copper cable / 成本效益比銅纜低約30%
- No access to the site for any maintenance (adjustment etc.)
不需進入站場(現場)維護(例如:調整...)
- No dismounting for track works / 於軌道養護工作時不需拆除
- Little Power consumption, no copper / 電源消耗極少、無使用銅纜。



Thank you very much
for your attention!

*Dr. Joachim Härle
Head of System & Technology
Axle Counter Business*

*Phone: + 49 711 869 46593
Mobile: + 49 172 828 1532
Fax: + 49 711 869 43316
joachim.haerle@thalesgroup.com*

*Thales Germany
Thalesplatz 1 – 71254 Ditzingen, Germany*

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