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In-service monitoring and inspection

Monitoring versus inspection

Monitoring	Inspection
Orientated on the fault ▪ <u>fault detection</u>: a system is able to detect a fault which is happening ▪ <u>fault diagnosis</u>: a system is able to diagnose the fault ▪ <u>fault prediction</u>: the system is able to predict a fault a certain amount of time before it will happen	Oriented on safety ▪ identify the assets that do not meet the standards ▪ carry out inspections specified in inspection standards ▪ carry out the inspections in a way that satisfies the inspection requirements (e.g. precision of measurement)
 Monitoring supports efficient maintenance	 Inspection ensures safety

Switch inspection

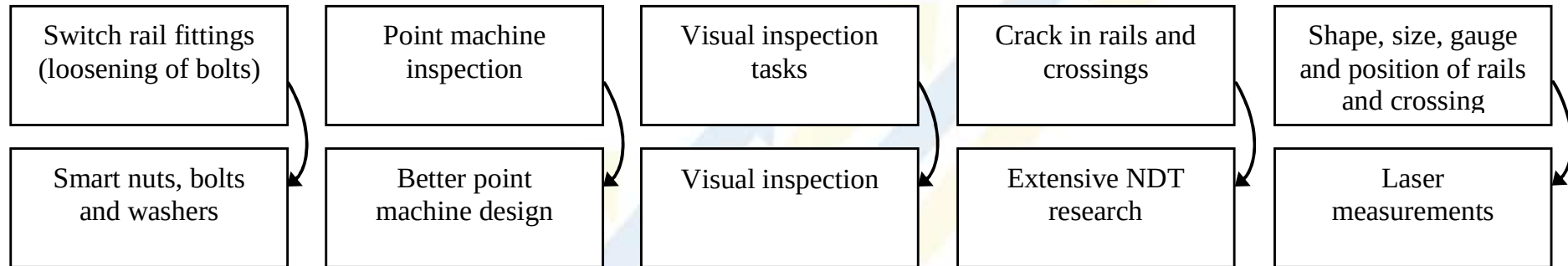
Monitoring	Inspection
Orientated on the fault and it can do: - <u>fault detection</u>: a system is able to detect a fault which is happening - <u>fault diagnosis</u>: a system is able to diagnose the fault - <u>fault prediction</u>: the system is able to predict a fault a certain amount of time before it will happen	Focussed on inspecting the asset according to inspection standards and it can: - identify the assets that do not meet the standards - carry out inspections specified in inspection standards - carry out the inspections in a way that satisfies the inspection requirements (e.g. precision of measurement)

Self inspecting switch

- Current S&C inspection solutions mapped against S&C inspection tasks

Part of S&C	Countries	Inspection task	UK inspection standard that defines it	NL inspection standard that defines it	DE inspection standard that defines it	Average frequency of inspection	Current method used to carry out the inspection
Stock rail inspections	UK, NL, DE	Side wear - measurement of plain rail side wear using NR4 gauge (NR); only in closure panel and transition zones (NL); measured in mm (DE)	NR/L2/TRK/0053, Chapter 8.4, Chapter 13.1	UIC Working Group Switches & Crossings, page 28	RiF 821 - Oberbau inspizieren, page 108	once a month to once a year	manually with a gauge
	NL, DE	Top wear - measurement of plain line top wear in closure panel and transition zones (NL); measured in mm (DE)		UIC Working Group Switches & Crossings, page 29	RiF 821 - Oberbau inspizieren, page 109	once a month to once a year	manually with a gauge

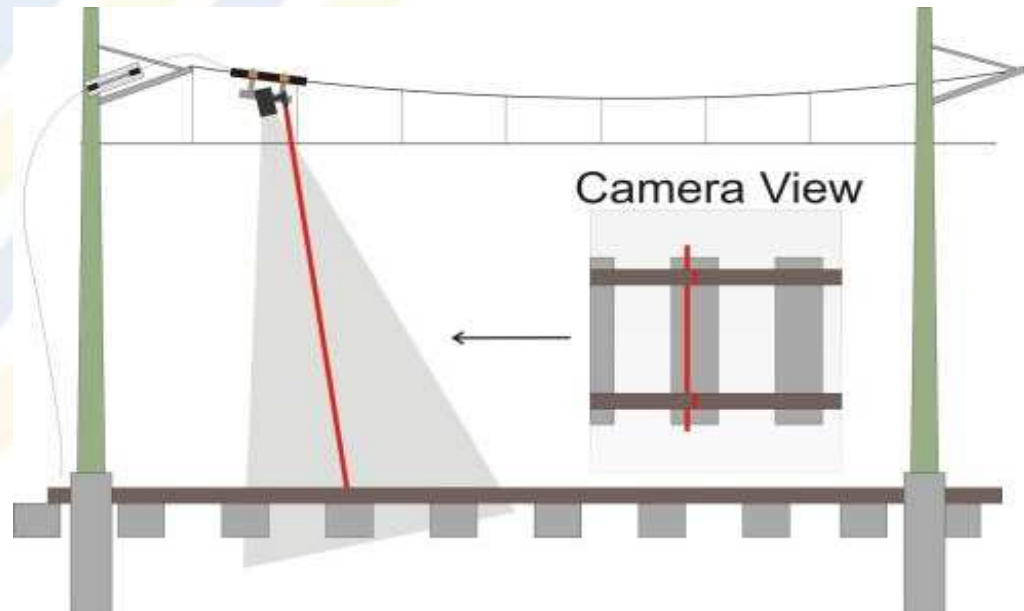
Solutions for improving inspection



- Switch rail fittings – development of smart washers and nuts (NR (with Huddersfield))
- Point machine inspection – study of better machine design (Strukton, ProRail)
- **Visual inspection – SIM, demonstration of overhead camera (Strukton, Damill, Lulea, TV)**
- Cracks in rails and crossings – demonstration of NDT (UoB)
- Shape, size, gauge – demonstration of laser inspection (Strukton – routine)
(UoB, NR – after invasive maintenance)

Overhead Camera Inspection

- Installed in Boden, Sweden



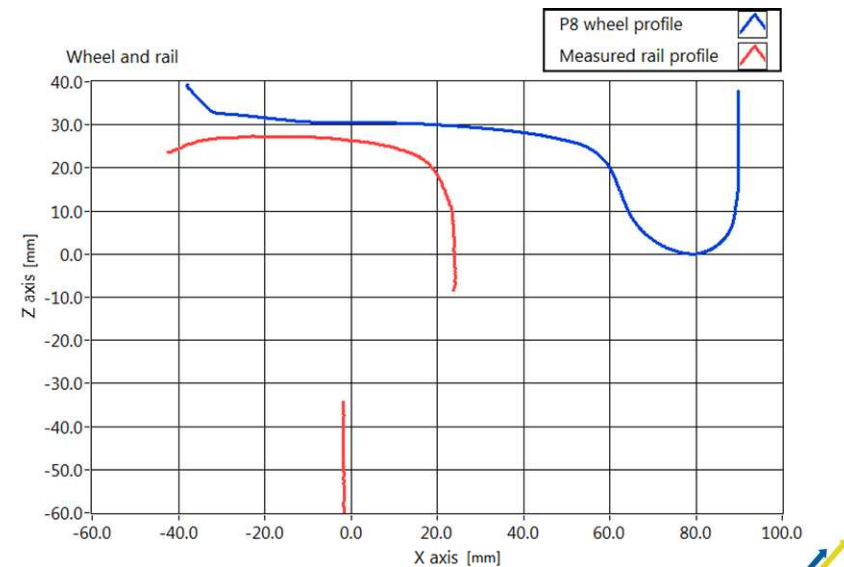
Hand held switch inspection



- A number of switches in the UK have been measured. Meets all NR switch inspection requirements

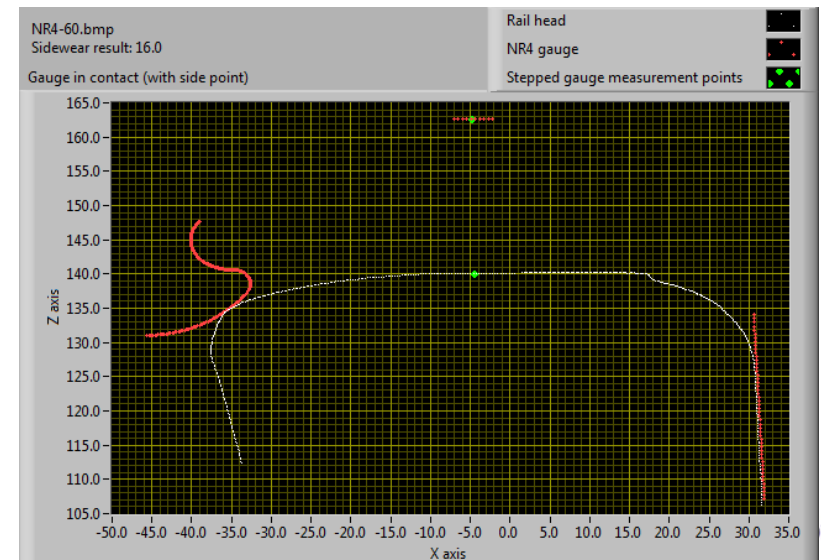
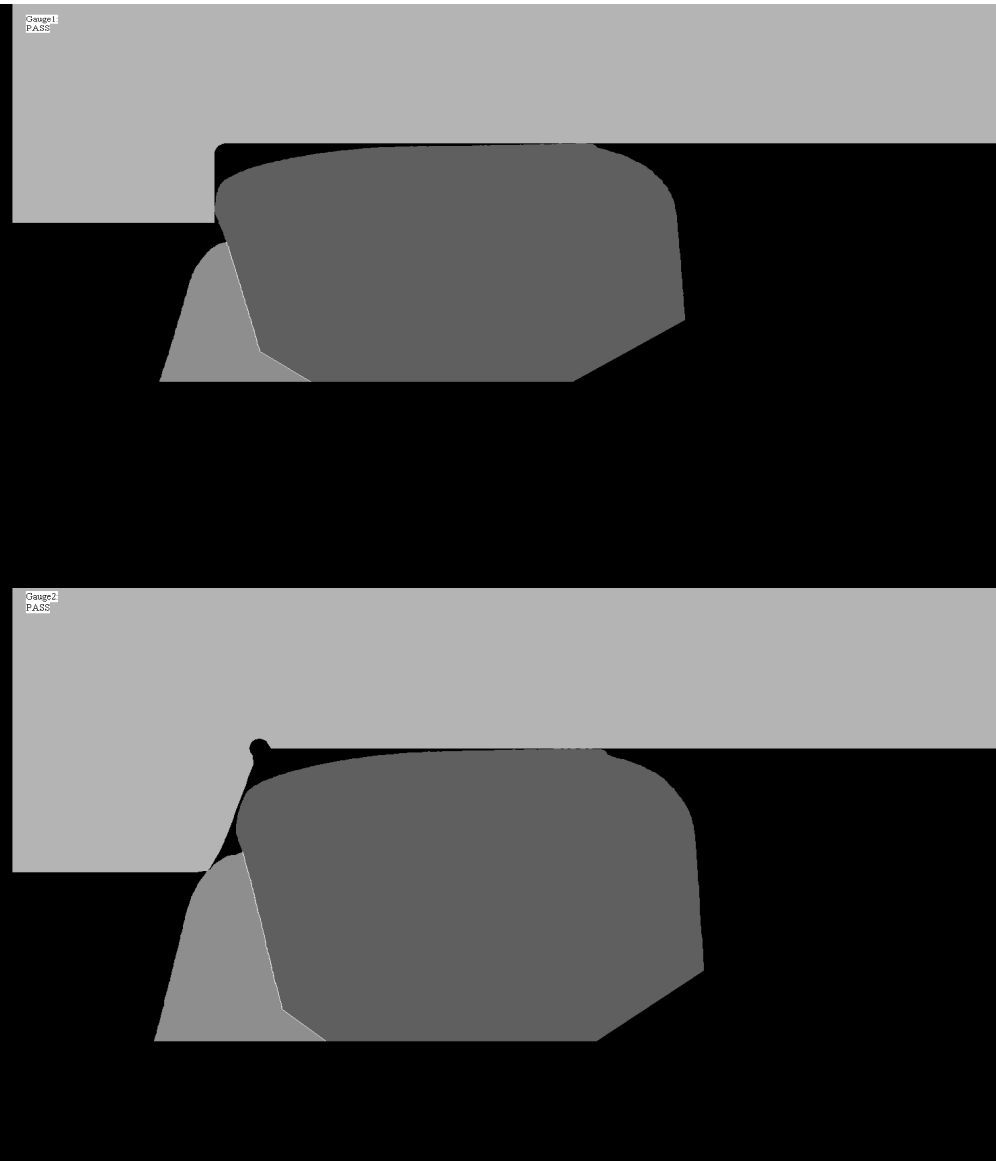
Calculation for 40°
Contact angle 35.0°
Slope 7.5%

Calculation for 40°
Contact angle 35.0°
Slope 7.5%



Hand held switch inspection

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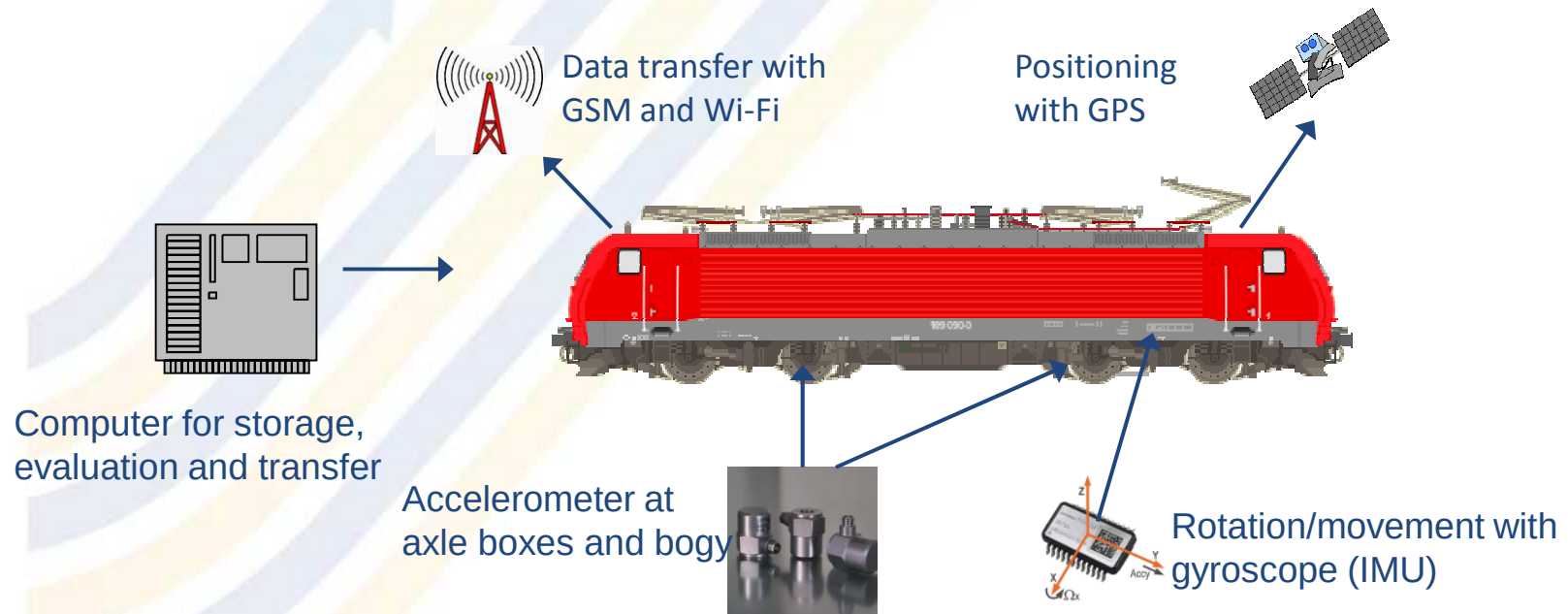
Track monitoring

Monitoring	Inspection
Orientated on the fault and it can do: - <u>fault detection</u>: a system is able to detect a fault which is happening - <u>fault diagnosis</u>: a system is able to diagnose the fault - <u>fault prediction</u>: the system is able to predict a fault a certain amount of time before it will happen	Focussed on inspecting the asset according to inspection standards and it can: - identify the assets that do not meet the standards - carry out inspections specified in inspection standards - carry out the inspections in a way that satisfies the inspection requirements (e.g. precision of measurement)

System design for high quality measurements and long-term stability

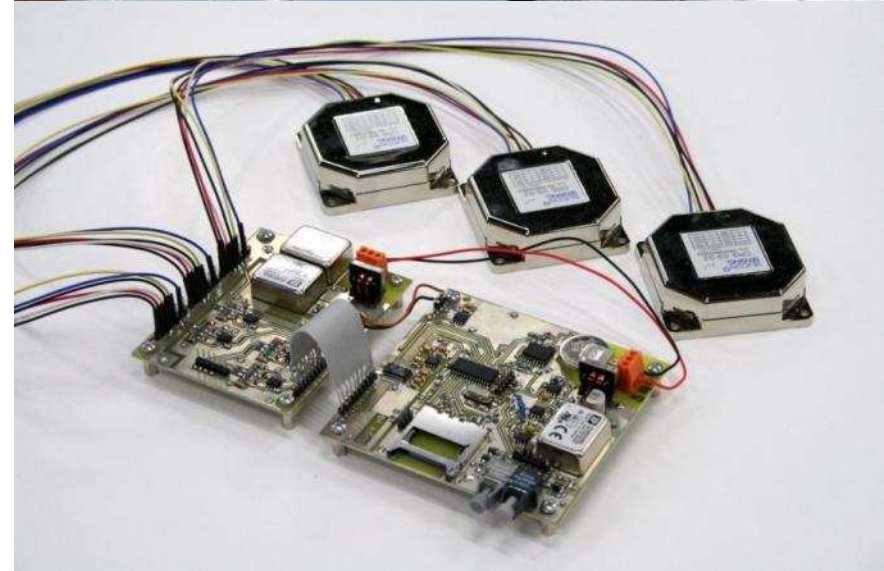
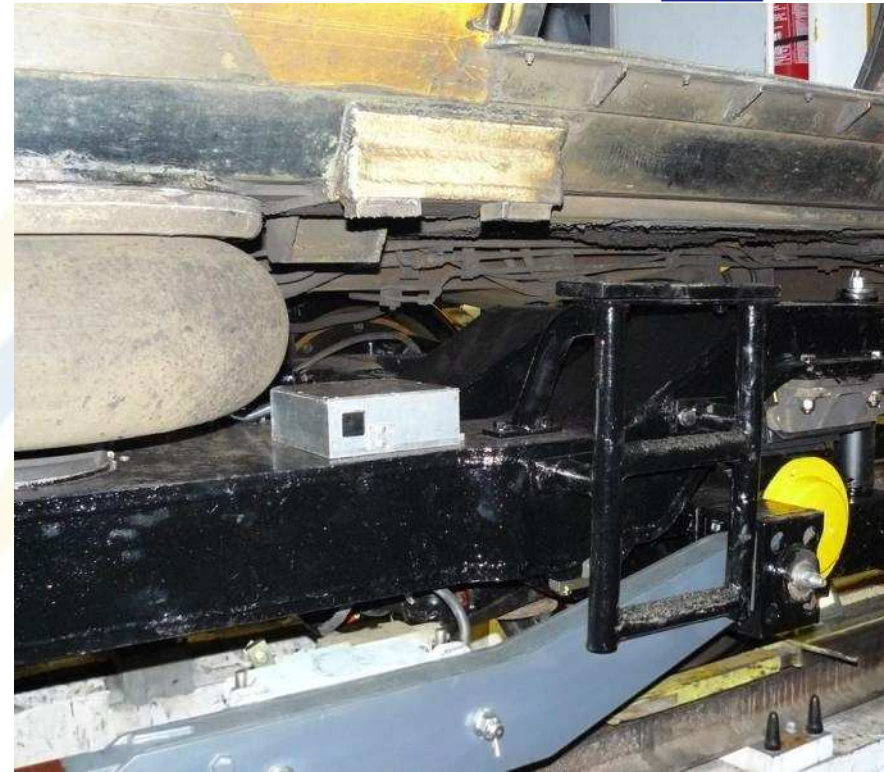
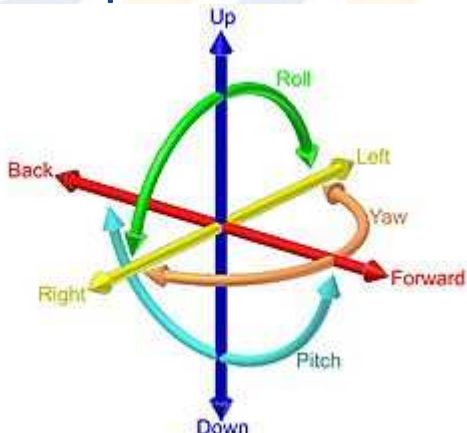
In-service track monitoring using a freight locomotive

System design



Commuter train track monitoring

- Bogie mounted measurement unit
- Location from tacho and GPS (pitch rate gyro and map matching)
- Inertial measurement unit
 - Tri-axis, 10 g accelerometer @ 8kHz
 - 3x Single axis, 100 deg / sec gyroscope @ 8kHz



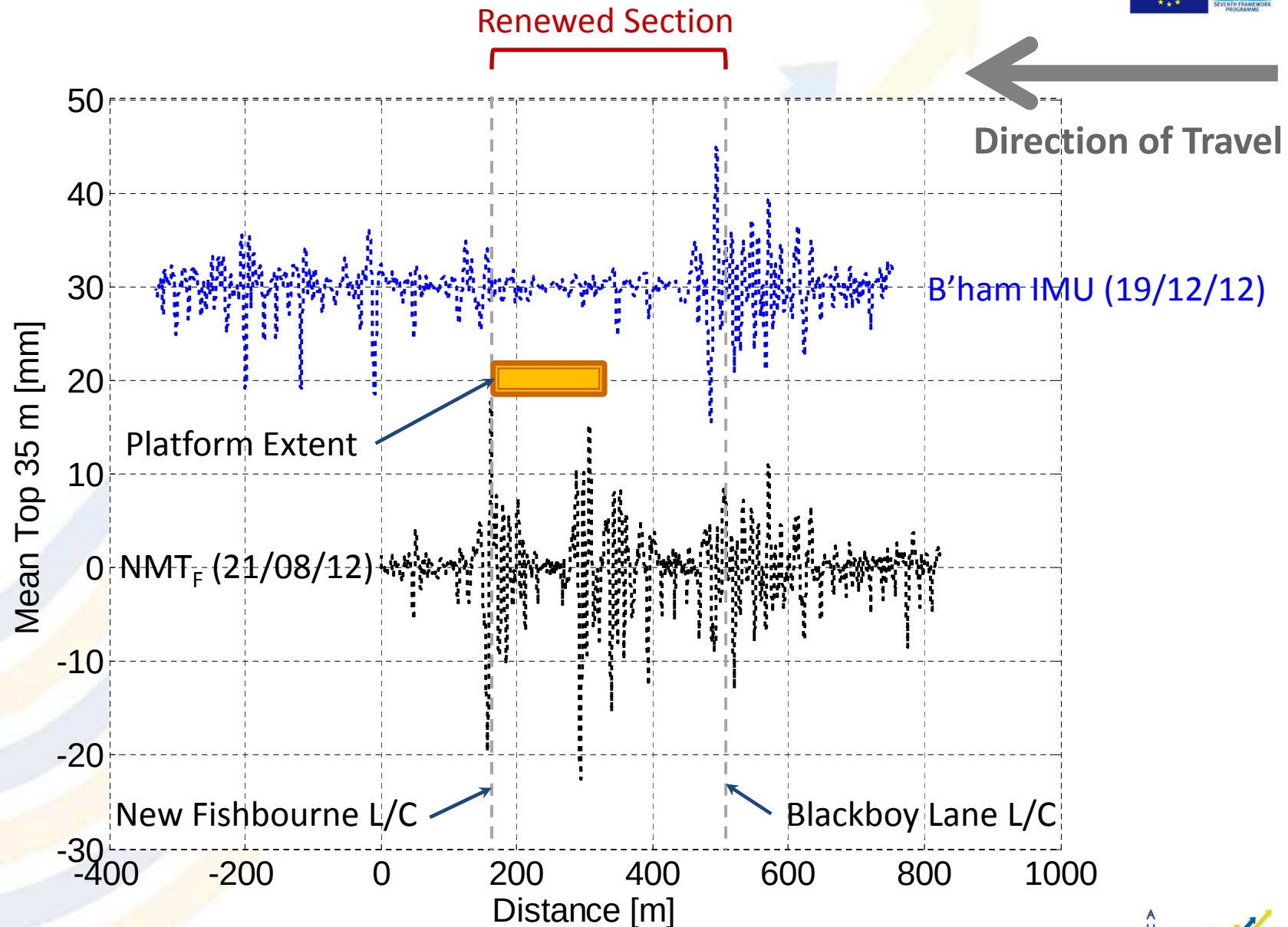
Current in-service instrumentation in UK

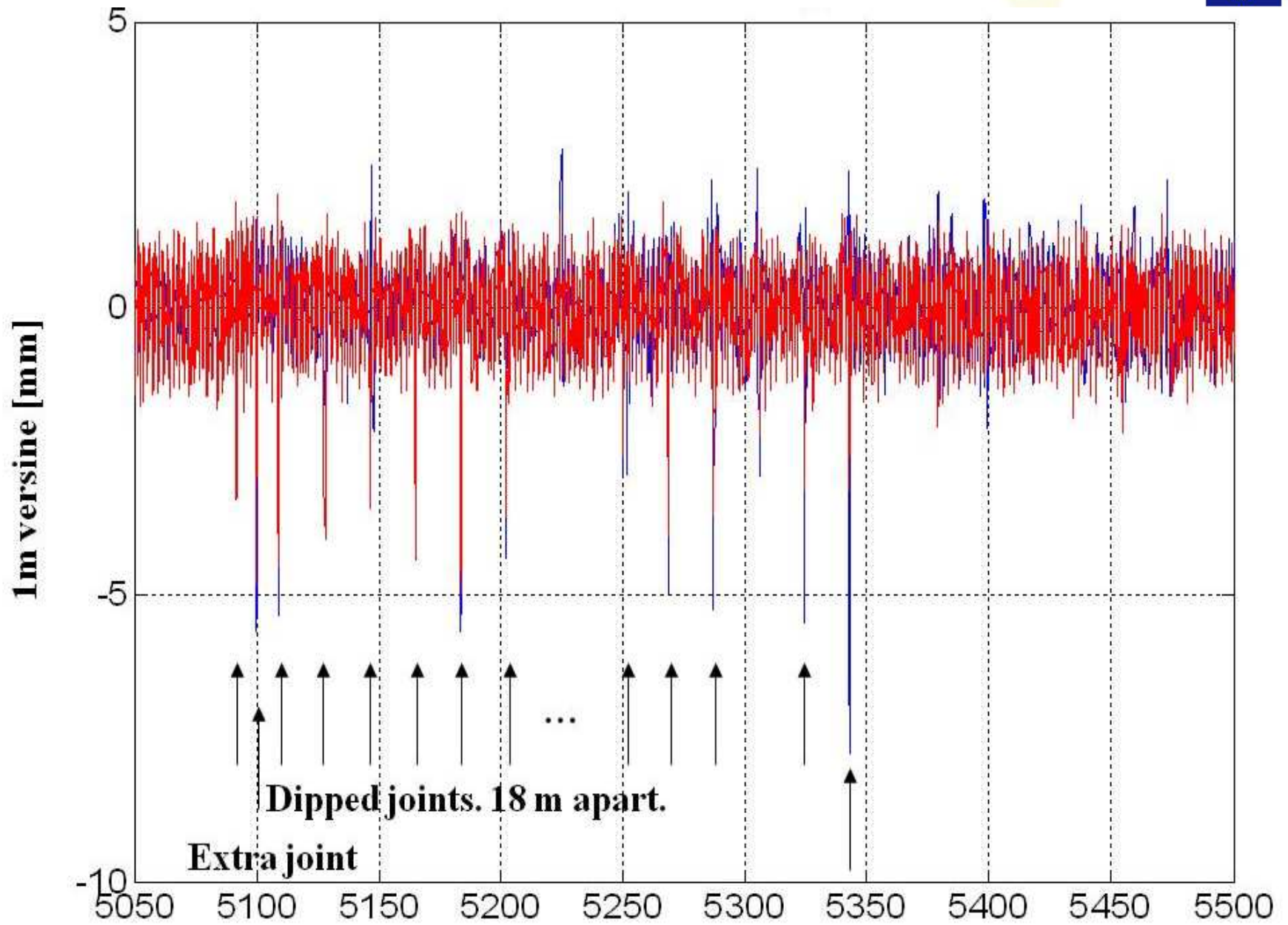


Case Study

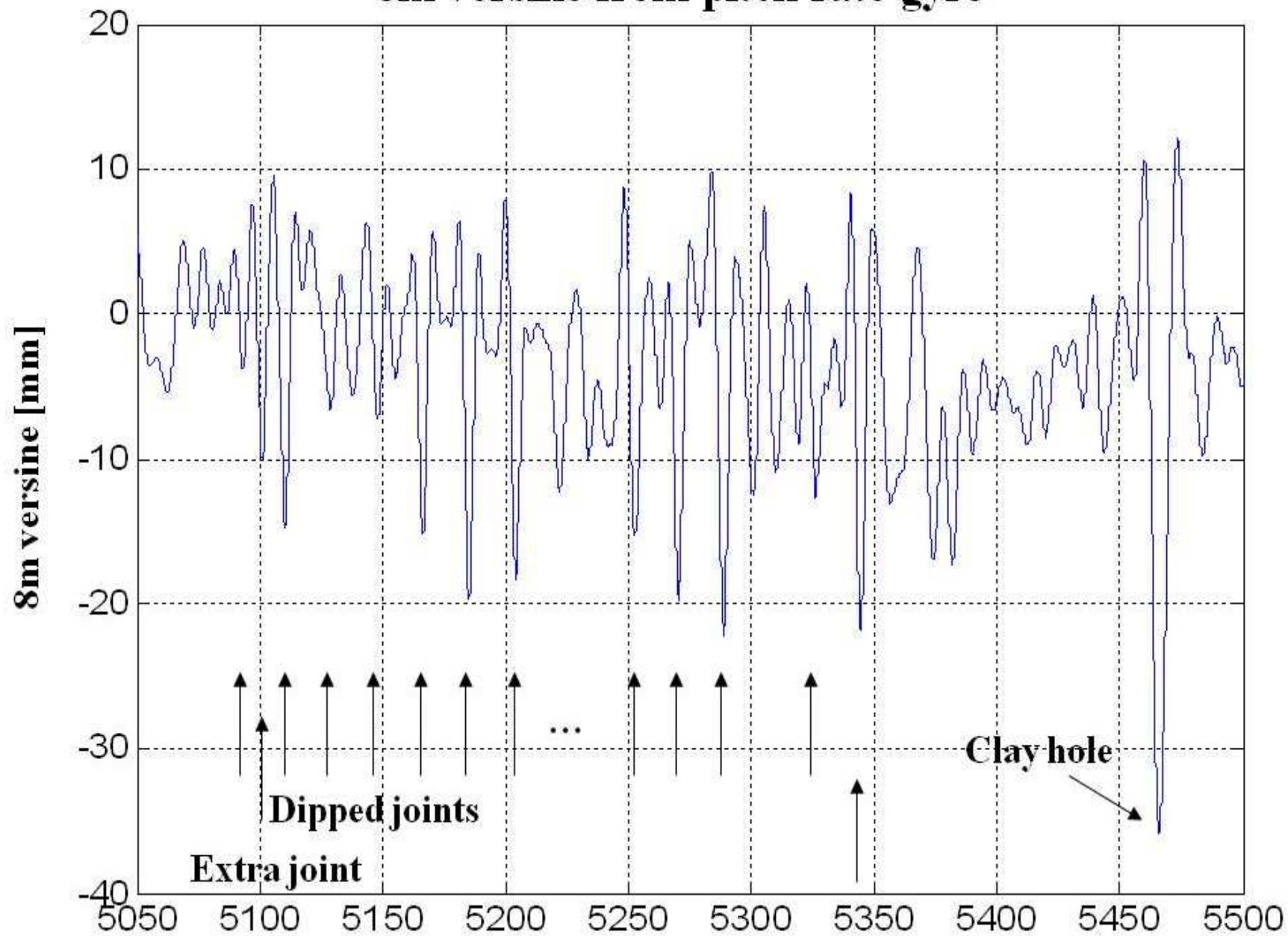
- Fishbourne, Sussex





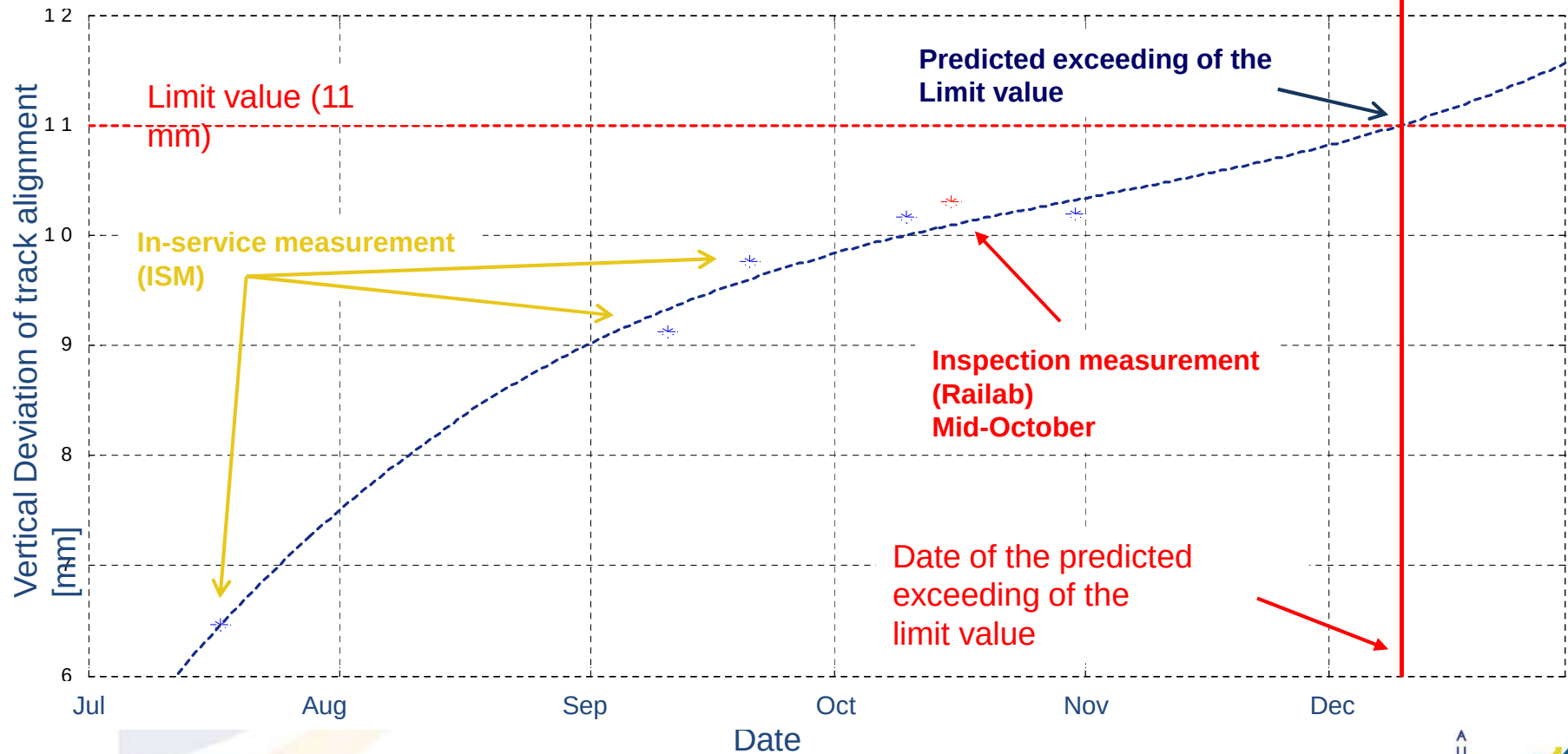


8m versine from pitch rate gyro



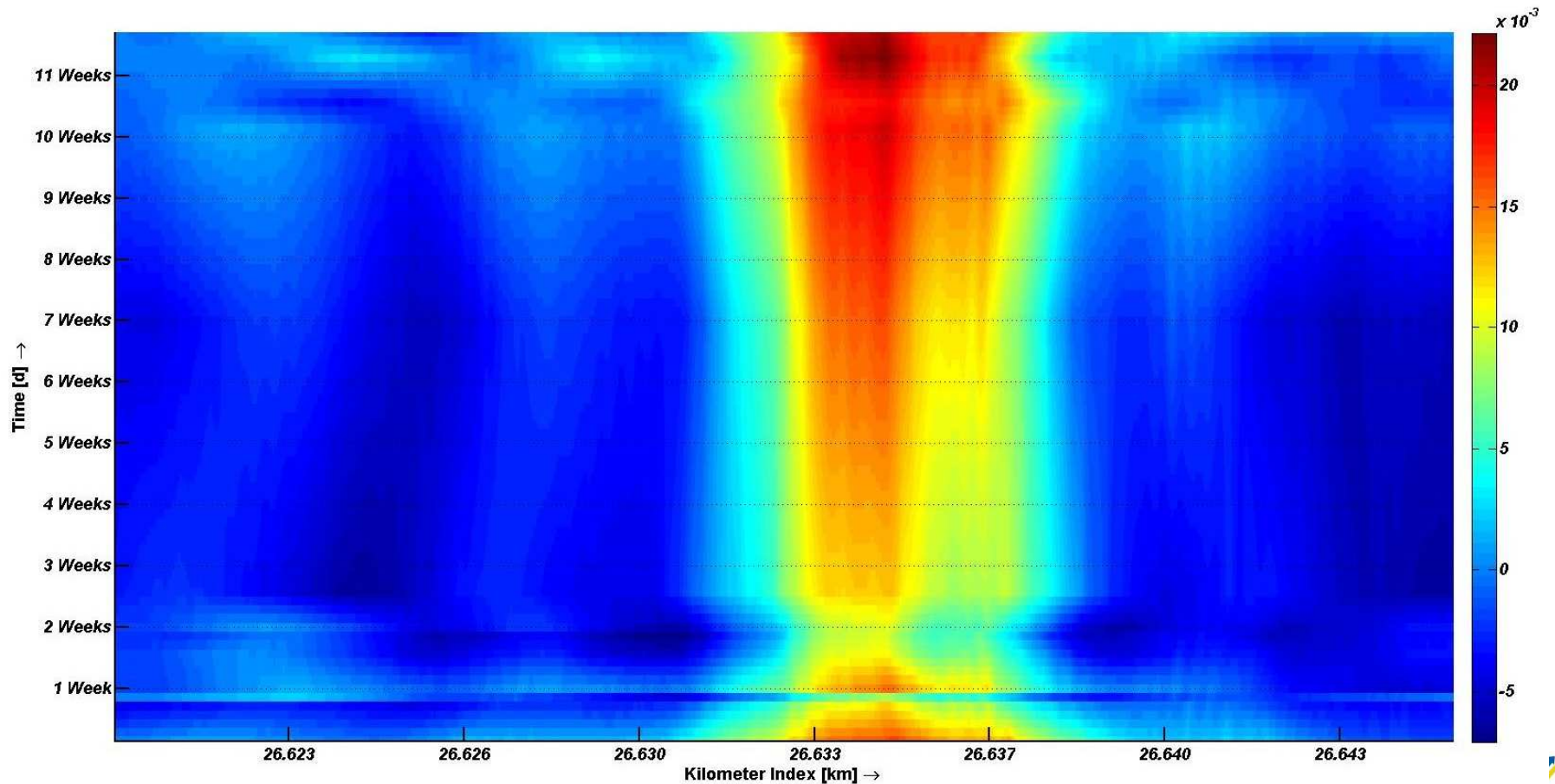
Defect/Failure prediction

Defect growth prediction



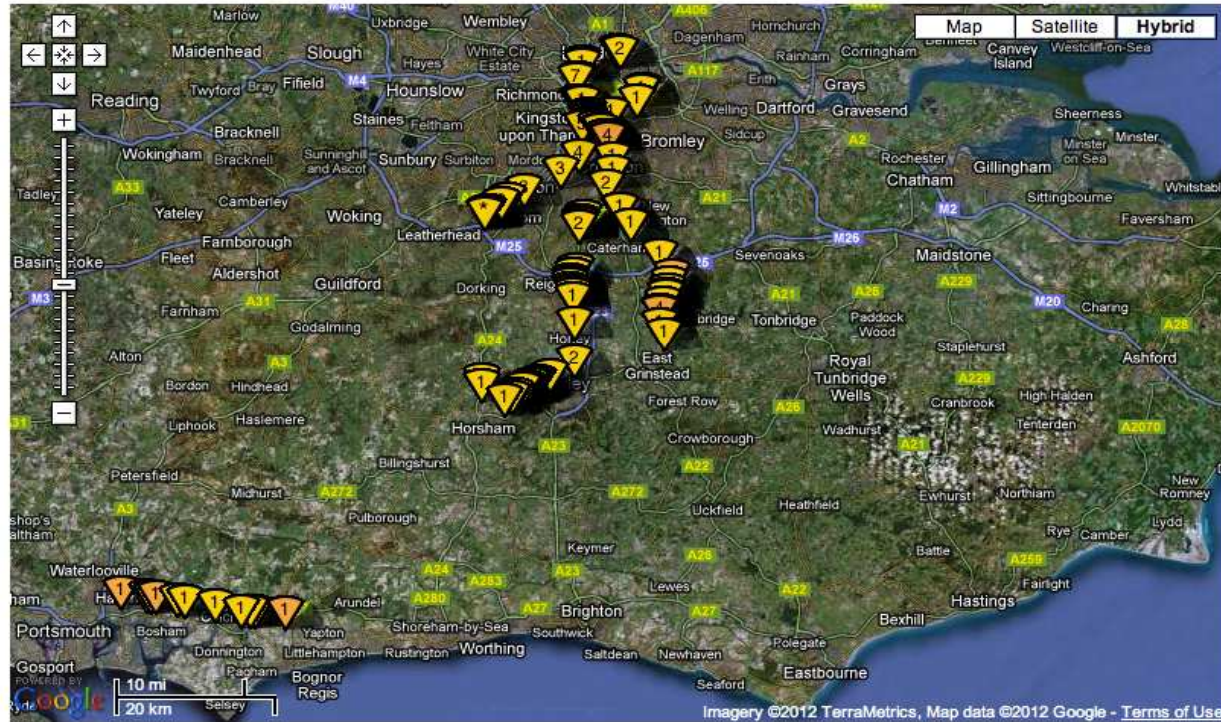
Monitoring of defects

Growth of defects over time



Reporting

Southern Railways Event Data Viewer



Event Selection

Start Date (Inclusive)

<< < February, 2012 > >>

Mon	Tue	Wed	Thu	Fri	Sat	Sun
30	31	1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	1	2	3	4
5	6	7	8	9	10	11

End Date (Exclusive)

<< < February, 2012 > >>

Mon	Tue	Wed	Thu	Fri	Sat	Sun
30	31	1	2	3	4	5
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13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	1	2	3	4
5	6	7	8	9	10	11

Available Events

Cluster event type	Cluster average severity	Cluster size
Shoe high	moderate	1
Shoe high	moderate	1
Shoe high	moderate	1
Shoe high	moderate	1
Shoe high	moderate	1
Shoe high	moderate	1
Shoe high	moderate	1
Shoe high	moderate	1
Shoe high	moderate	1
Shoe high	moderate	1
Shoe high	moderate	1
Shoe high	moderate	1
Shoe high	moderate	1

Export Event Clusters

To export a summary of the clusters selected (or all available clusters if none selected) please click the button below.

Export Selected Event Clusters

Laser One



Laser Two



Speed



Conclusions (Switch inspection)

- An approach to understanding inspection requirements has been developed
- A number of switch inspection innovations have been developed from first principles or further developed during the project
- Key demonstrations have taken place in the UK, Germany and Sweden
- Work will be taken forward by IMs

Conclusions (Track monitoring)

- The concept of continuous track monitoring has been developed, and the key technical challenges (compare with inspection) have been identified
- New software processes have been developed and have (or will be validated)
- The development of early decision support solutions now exist

In-service monitoring and inspection

Part two

Applicability of the SIM (Switch Inspection and Measurement)

Agenda

- Train-borne switch inspection
- Benefits explained
- Conformity
- Demonstrator results
- Future developments
- Lessons learned
- Concluding remarks

SIM characteristics

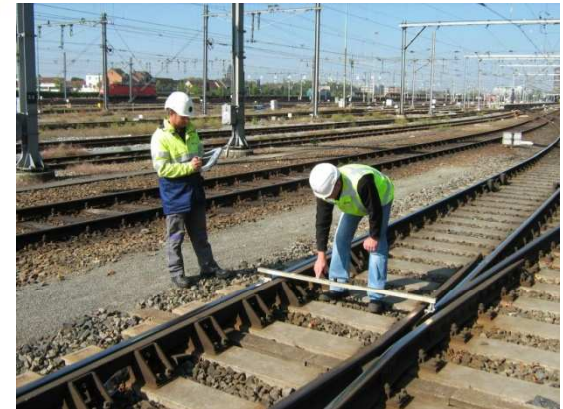
- Loaded measurement
- One cross section every 20 mm, up to 40 km/h
- Analyzing cross section; gauge and gap computation
- Geometry: alignment, level, cross level, twist
- Rail profile and wear
- Video survey front/back and track structure
- Pulled or pushed service
- In service usage
- Mobile unit



Benefits explained: Safety

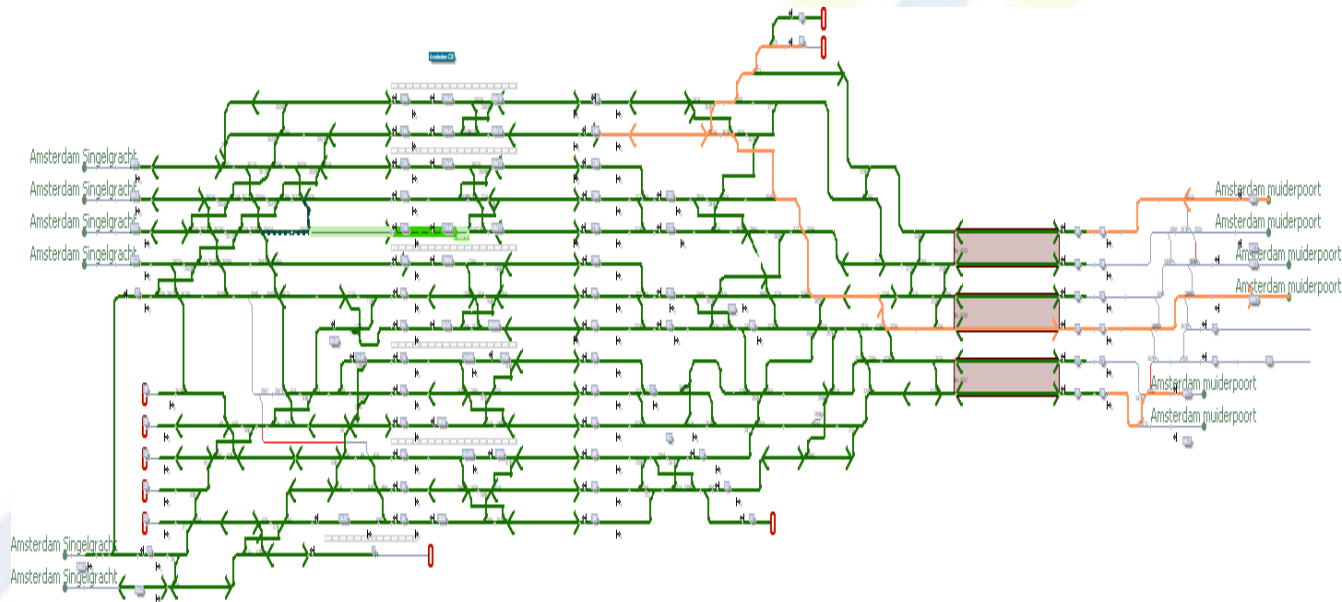
Imagine measuring 100 switches in a yard

↪ *night shift in limited time and area* 



↪ *day time, in regular service*

Benefits explained: Productivity



- SIM:
 - 106 switches in 6 hour shift ~ 18 S/h
 - survey only: 212 switches in 6 hour shift ~ 35 S/h
- Manual: 10 min / switch ~ 6 S/h

Benefits explained: Cost

- From a track owner perspective:
 - Considering Asset Management goals:
lower TCO due to higher availability
- From a Service provider perspective:
 - Lower costs in high density area's such as a yard due to full switch inspection & measurement in one pass

Conformity

Sim Benefits

Safety

Productivity

Cost

Automain Primary Goals

Less staff on/near running lines

Reducing possession time

Increase network capacity

Automated inspection S&C

How does it work?



Demonstrator results

- 100 to 150 switches in 7 hour shift at Nurnberg and Rosenheim: ~14-21 S/h
- In service screenplay
- Increase in number of detected defects per shift; past 2-3 repairs -> SIM 30-40 repairs



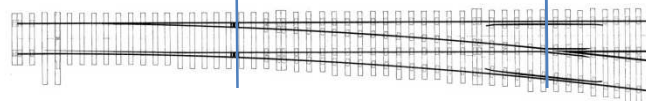
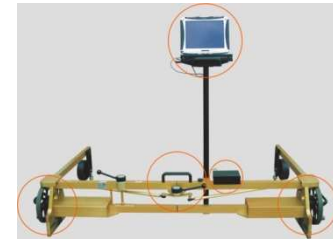
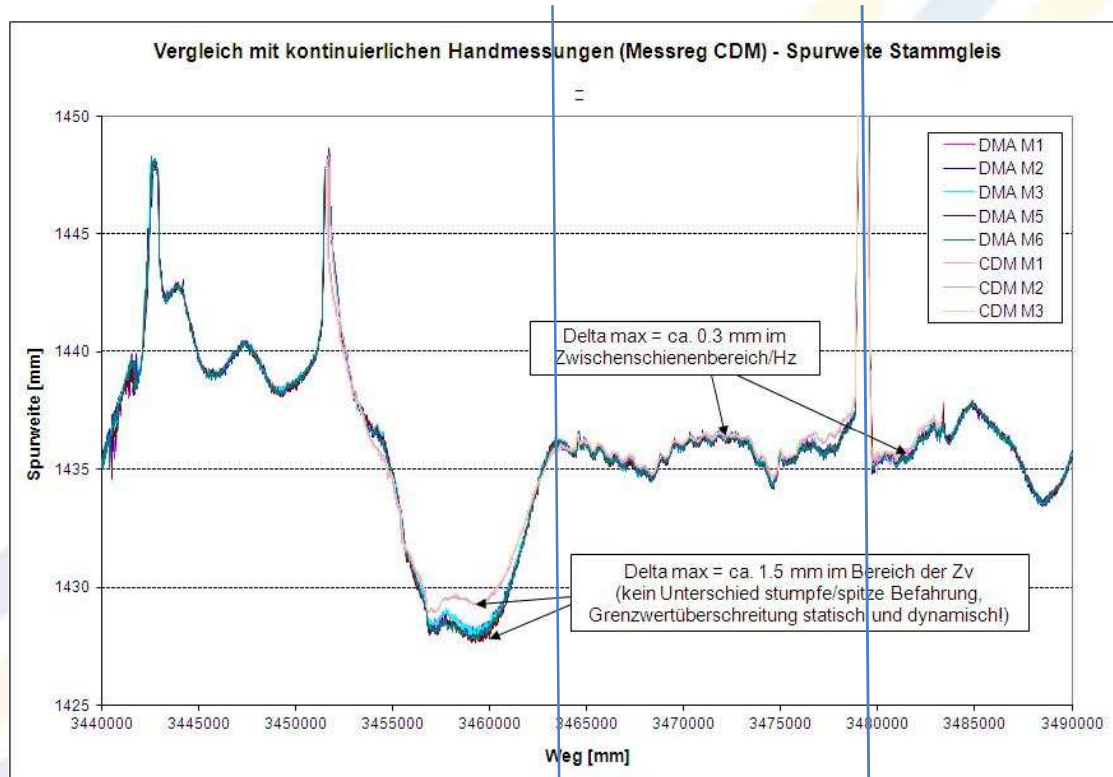
Demonstrator results

Localization tests:

- Geo referencing by GPS unsuitable
- Map-mapping supported by GPS after the runs
- RFID tags on each frog online during measurement



Demonstrator results



Difference continue trolley measurement and SIM

Lessons learned

From the SP Strukton Rail perspective:

- Working together in European context offers new solutions to common problems
- Third party (DB) confirmation applicability
SIM



Future developments

- Higher speed usage makes plain-lines assessable
- Unattended SIM;
SIM is handled/processed as a container wagon



Concluding remarks

- SIM is a high performance tool which enables:
 - Track owners (Infra provider)
 - Higher track availability
 - Lower TCO
 - Service Providers
 - Safer working conditions
 - Less possession (competitive advantage)
 - Lower costs
- EU projects enable new solutions