Measuring and Inspecting Switches & Crossings with the "SICS Approach"

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Corporate Product Line Manager
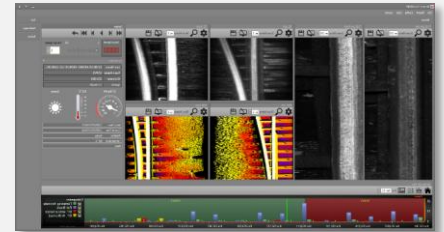*Railway Infrastructure Measuring Trains and Systems*

About MERMEC

**MER MEC main goal is to supply integrated solutions for
railways infrastructure high-speed inspection, measuring and monitoring**

MEASURING VEHICLES AND TRAINS

MEASURING SYSTEMS

DECISION SUPPORT SOFTWARE SYSTEM

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Introduction

The device of the railway superstructure, allowing trains to change from one track to another one is called **SWITCH**. The device allowing trains to cross tracks is called **CROSSING**.

Switches and crossings (S&C) are devices with moving parts, subjected during their life cycle to high and repetitive **forces and vibrations** (e.g., in Italy max load up to 25 tons per axle and train speeds up to 330 Km/h are used).
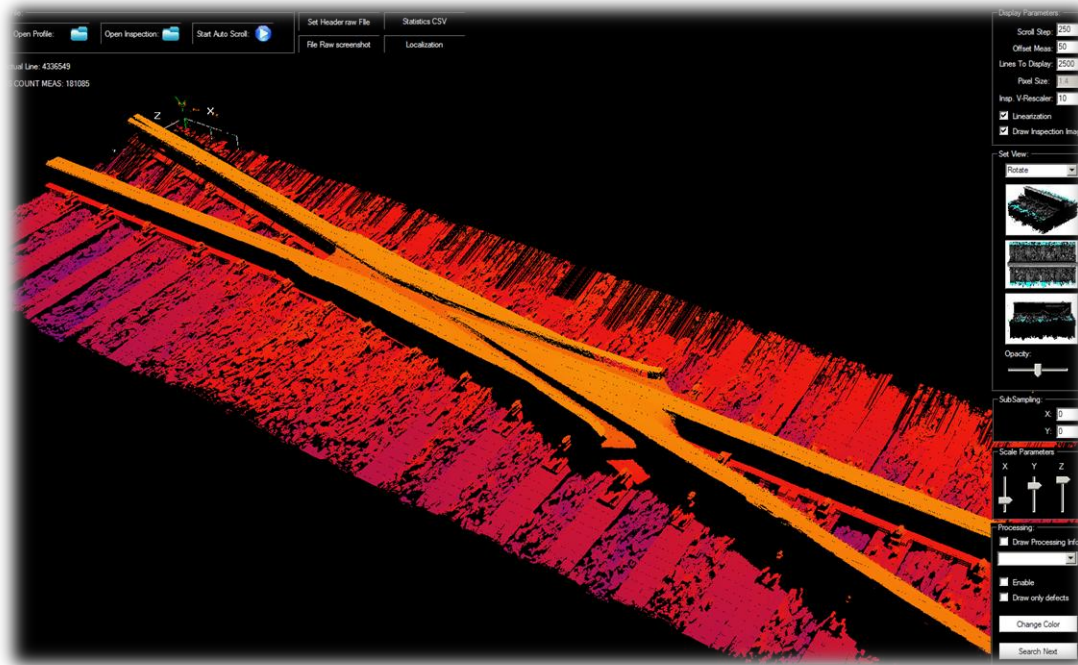
Consequently the different parts of the S&C are subject to wear and defects, and the geometry will deteriorate over time, up to a certain limit that must be detected by means of regular inspections.

To avoid either traffic interruptions or even accidents measurements, maintenance and renewal actions are regularly required, **including the periodical measuring and monitoring of S&C**

S&C degradation

Today more than **100 different wears, defects and degradation phenomena** of the S&C are known.
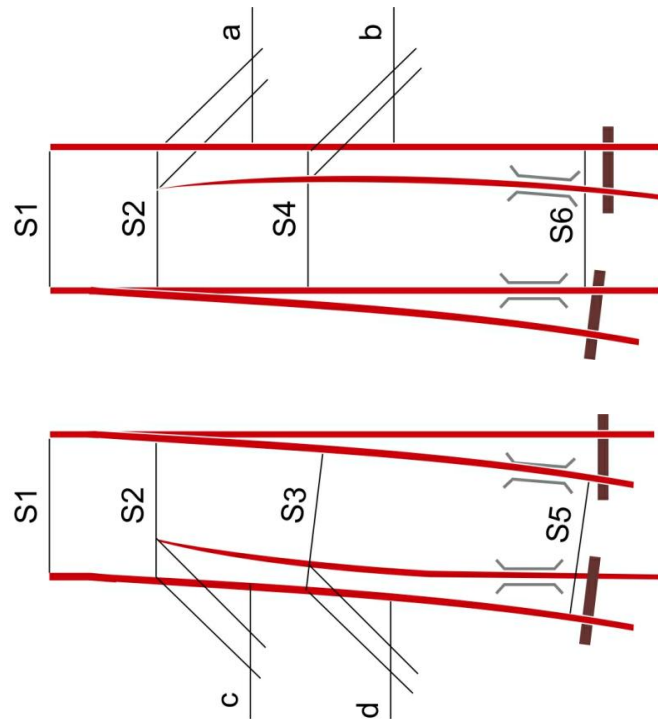
They goes from the degradation of the geometric characteristics to wear of the material, to cracks, to electric faults, etc.
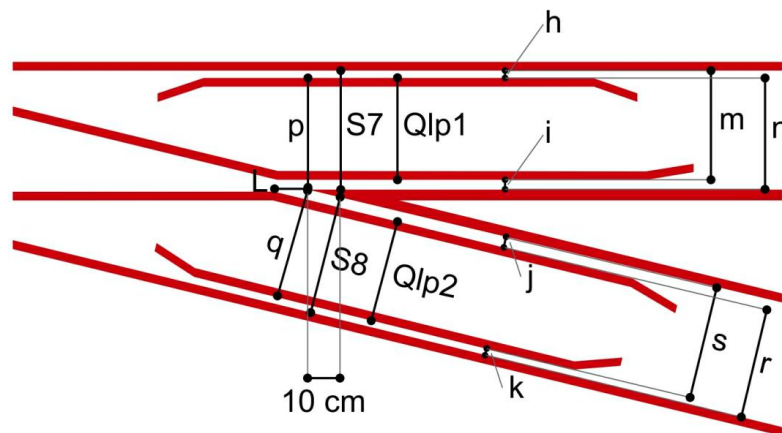
S&C geometric parameters: a look to the RFI case

In Italy there is a RFI National Standard that officially define 14 main geometric parameters for switches (in the tables, in Italian language)

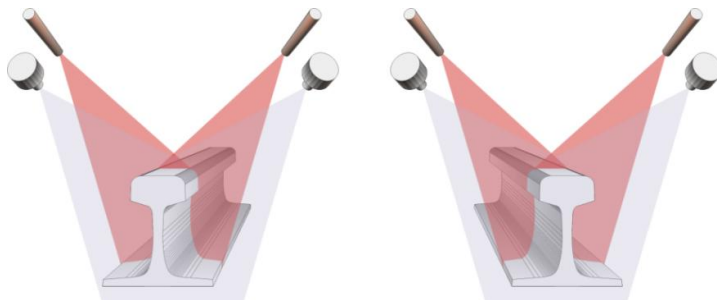| ID	PAR.	DESCRIPTION
1	a	Apertura dell'ago sinistro misurata sull'asse del tirante dell'attuatore
2	b	Apertura dell'ago destro misurata sull'asse del tirante dell'attuatore
3	c	Apertura dell'ago sinistro misurata nel punto più stretto
4	d	Apertura dell'ago destro misurata nel punto più stretto
5	S1	Scartamento misurato in corrispondenza della punta reale del deviatoio
6	S2	Scartamento misurato al contatto funghi rotaie
7	S3	Scartamento misurato al contatto funghi rotaie, ago sinistro accosto
8	S4	Scartamento misurato al contatto funghi rotaie, ago destro accosto. La misura va fatta sotto carico.
9	S5	Scartamento misurato in corrispondenza della prima piastra fissa degli aghi dopo la cerniera elastica, in deviata
10	S6	Scartamento misurato in corrispondenza della prima piastra fissa degli aghi dopo la cerniera elastica, su corretto tracciato

S&C geometric parameters: a look to the RFI case

ID	PAR.	DESCRIPTION
11	S7	Scartamento misurato quando lo spessore della punta del cuore è di 22 mm, su corretto tracciato
12	S8	Scartamento misurato quando lo spessore della punta del cuore è di 22 mm, in deviata
13	p	Quota di protezione della punta, su corretto tracciato
14	q	Quota di protezione della punta, in deviata

S&C geometric parameters: a look to the RFI case

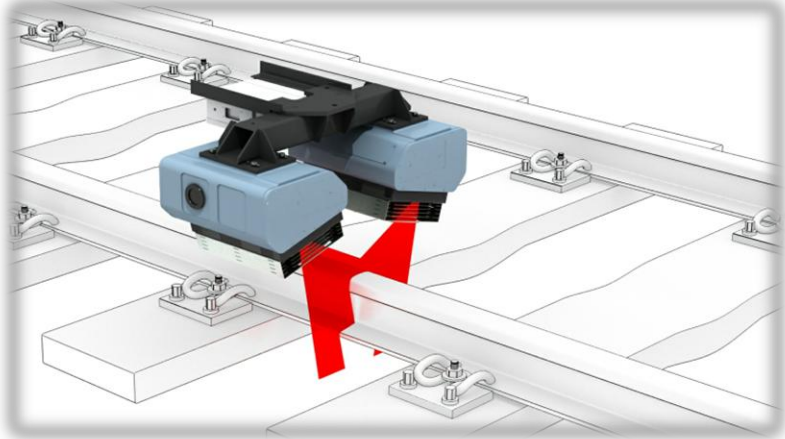In RFI other S&C parameters are measured: for example parameters concerning the switch rail profile

ID	PARAMETER
1	Rail type
2	Rail cant
3	Vertical wear
4	Horizontal wear
5	Area wear
6	Switch Blade wear
7	Switch Counterblade wear

S&C Inspection and measurement

The last generation MER MEC S&C Automatic Inspection and Measurement System, called **Dr. Switch**, is realized trough a combination of:
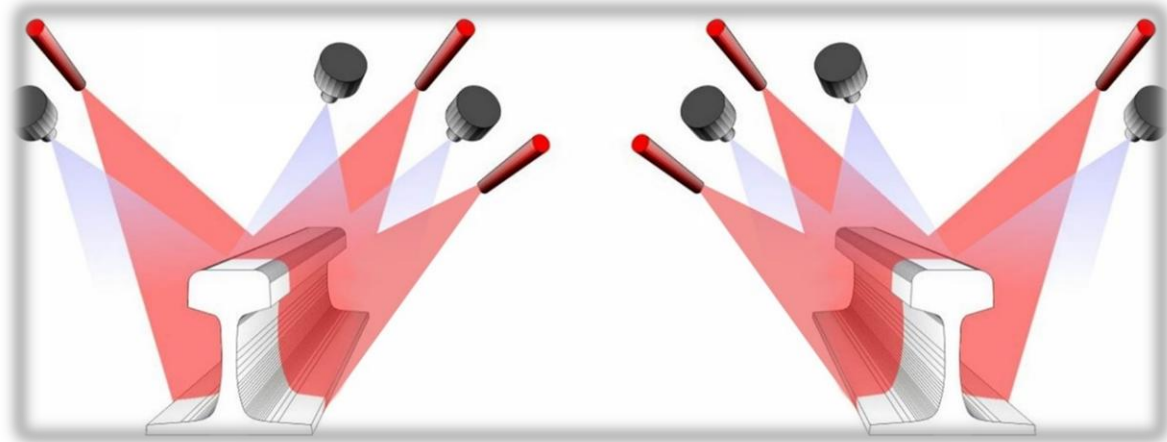
❑ One **No Contact Optical Measuring System**

❑ And one **Track Machine Vision System** called **V-CUBE**

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No Contact Optical Measuring System
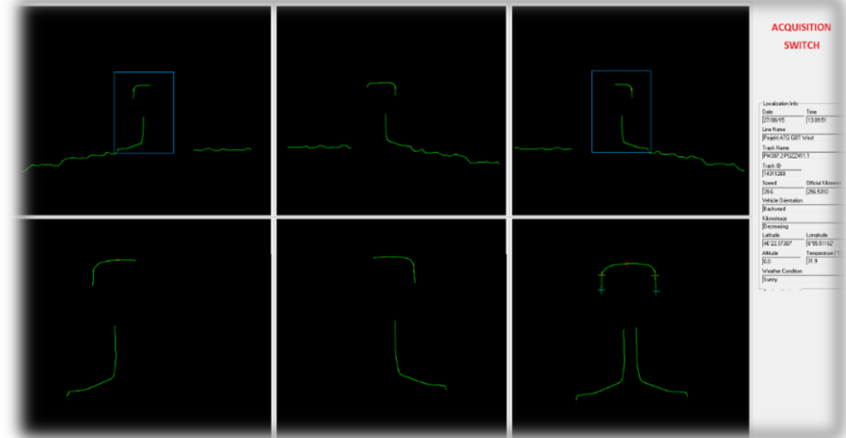
The No Contact Optical Measuring System is based on:

❑ N. 6 lasers and N. 6 high resolution/high speed cameras (3 + 3 for each rail), for the acquisition of the full rail profile in S&C

❑ Fast acquisition and processing unit, for S&C real time parameters calculation

No contact optical measuring system

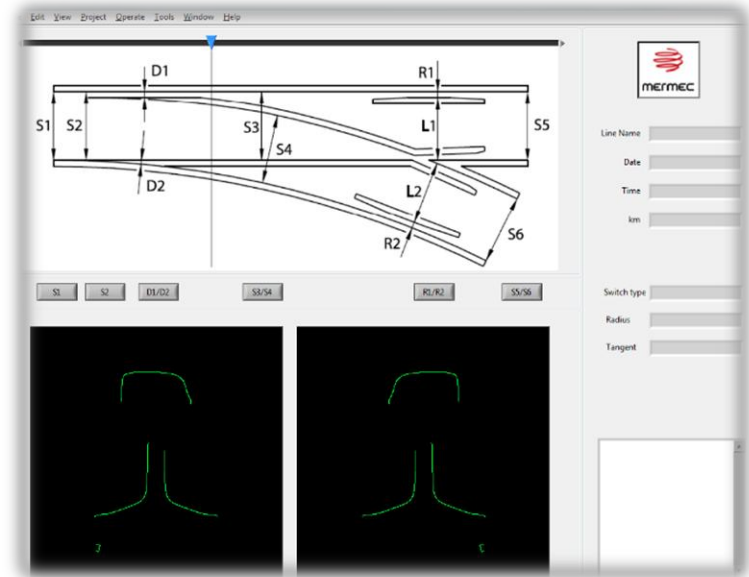The no contact optical measuring system is provided with the following functionality:

❑ Displaying of the three profiles acquired by the three cameras

❑ Merge of the linearized internal and external profile

❑ Displaying of the camera images in dedicated windows

❑ Displaying of the information coming from the localization system

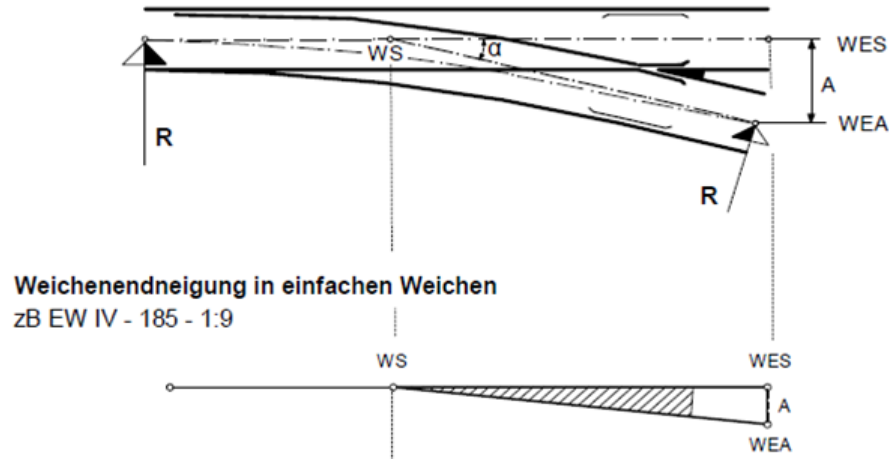❑ Storage of data

No contact optical measuring system

The processing unit is dedicated:

- ❑ To merge the cameras profile
- ❑ To automatic recognize blade and frog of the switches
- ❑ To recognize the running direction of switch
- ❑ To displaying the switch information
- ❑ To calculate the geometry and the wears of the switch
- ❑ To calculate the parameters for building the 3D model
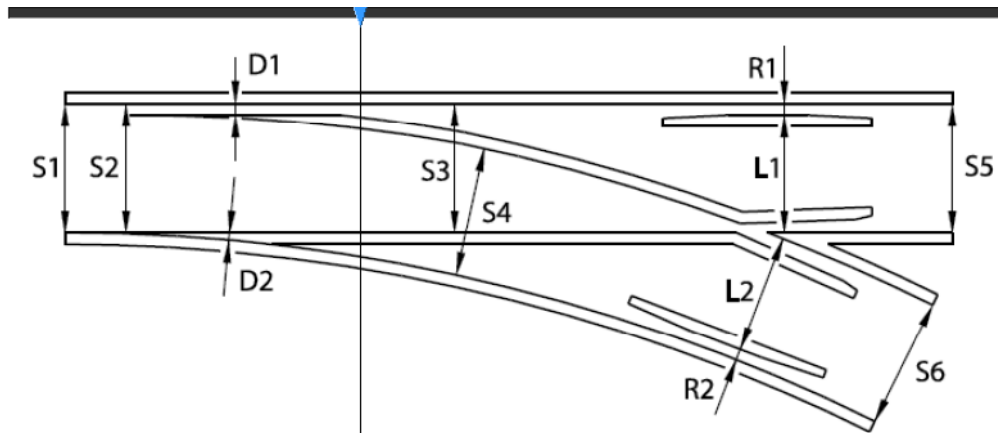- ❑ To store the results and to generate reports

Automatic Detection of Switch Information

❑ Switch type

❑ Rail type

❑ Radius

❑ Tangent of the α angle

❑ Curvature (in case of switch in curve)

Weichenendneigung in einfachen Weichen
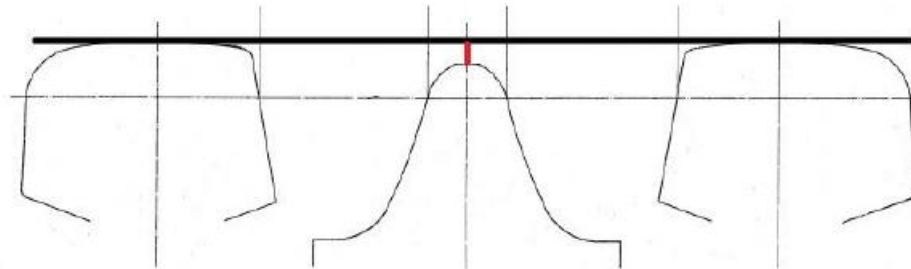zB EW IV - 185 - 1:9

Automatic S&C Characteristic Point Calculation
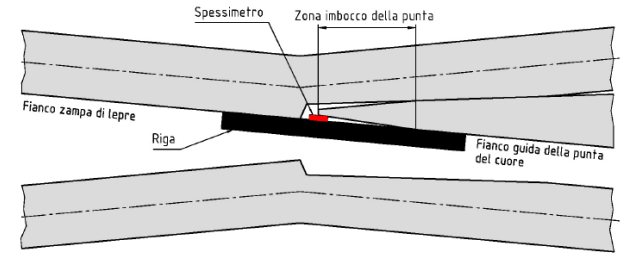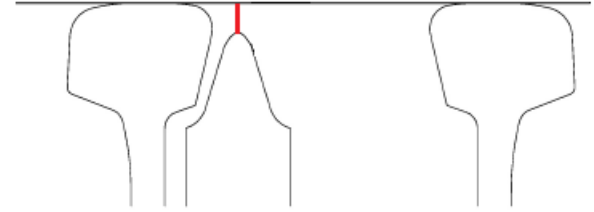
❑ S1: beginning of the switch (junction point)
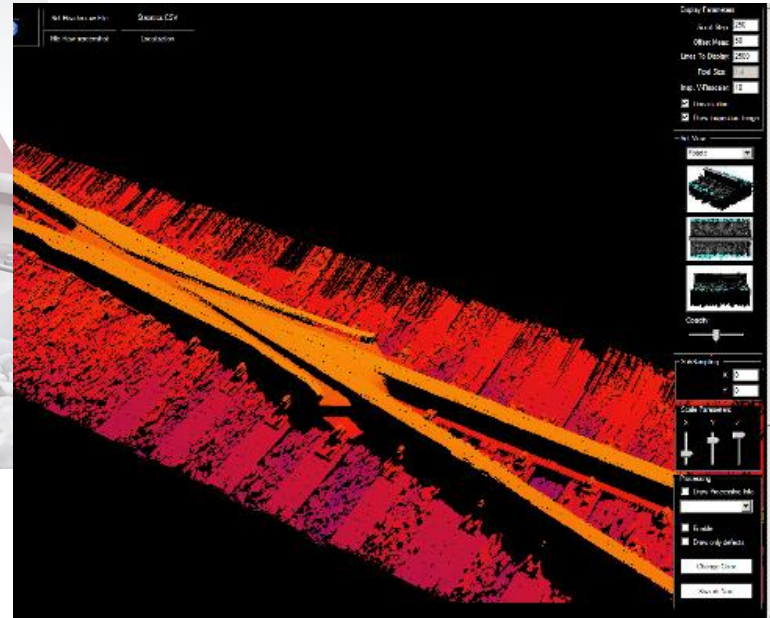
❑ S2: beginning of the blade

❑ End of the blade

❑ D1/D2: section with minimum distance between the open blade and stock rail

❑ S3/S4: Middle point between beginning of blade and point of the frog

❑ Point of the frog

❑ L1/L2, R1/R2: passage widths 300 mm after the point of the frog

❑ S5/S6: end of the switch (junction point)

Automatic S&C Checks

❑ Check of the position of the tip of the blade

❑ Check of the stock rail wear reserve

❑ Check of inclination of the blade

❑ Check of mobile frogs (position and height)

❑ Check of the height of fixed frogs

❑ Check of the notch of the switch blade

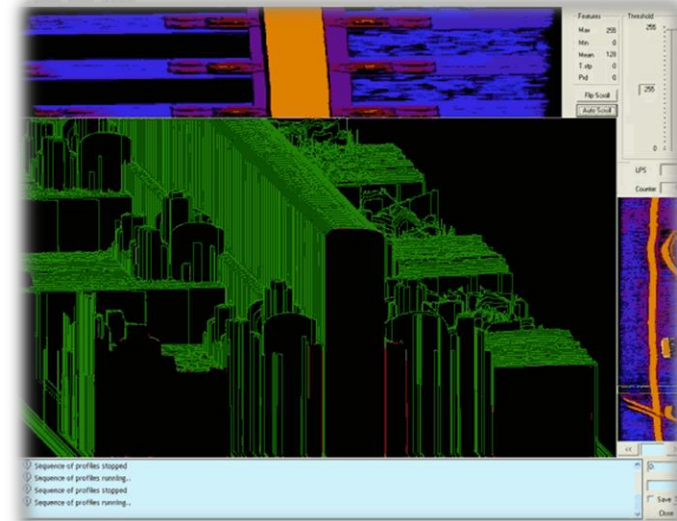❑ Collection of data for building the 3D model of switch

Spessimetro   Zona imbocco della punta

Fianco zampa di lepre
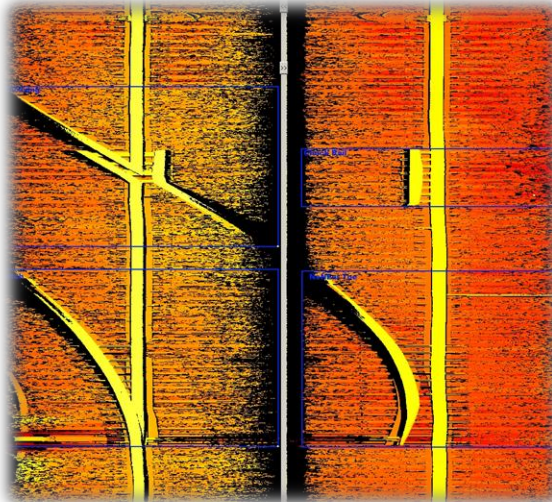
Riga

Fianco guida della punta del cuore

Track Machine Vision System for S&C: V-CUBE

V-CUBE Outputs and Results: special checks

Thanks to V-CUBE, special checks for S&C are possible:

- ❑ Automatic recognition of switches and check rail
- ❑ Rail surface defects
- ❑ Detection of defects on fastening and sleeper
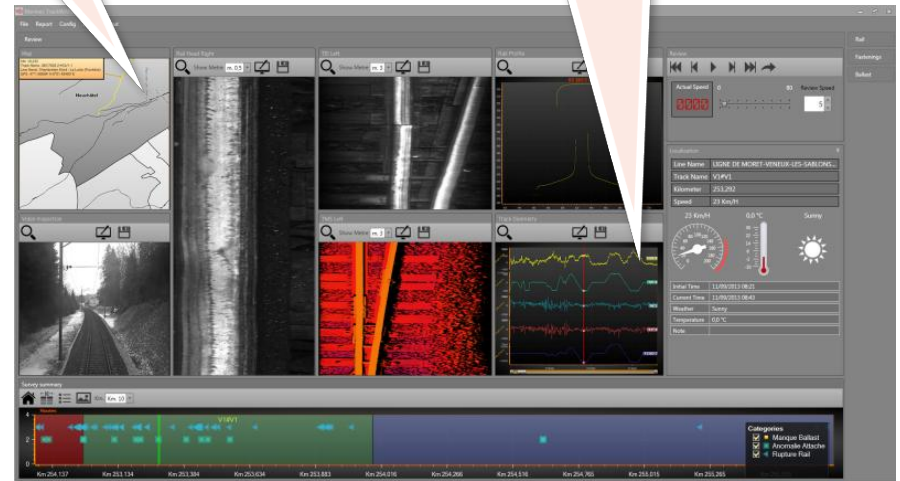- ❑ Detection of foreign objects and debris

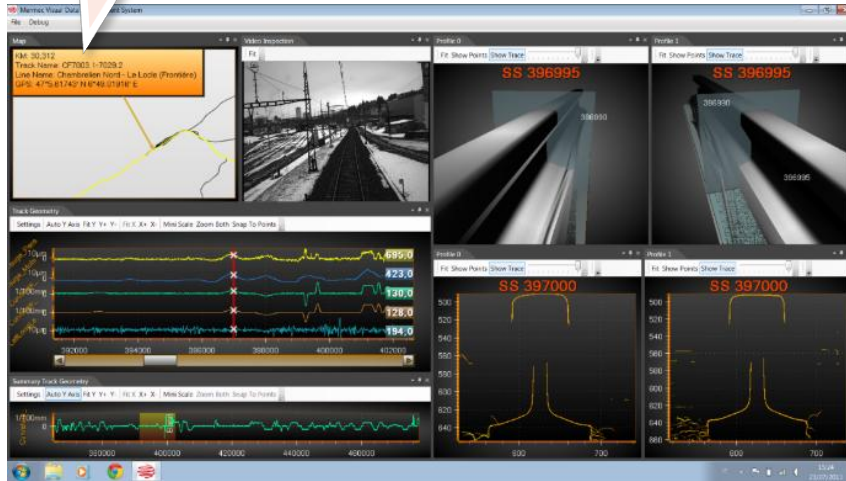# S&C Inspection & Measurement Data Review

GIS, Linear and Video Correlation

Geographic Representation of S&C

Track Geometric Parameters for S&C area

All data acquired by **Doctor Switch** are **fully integrated and synchronized** and are presented to the user by means of an integrated "Graphic User Interface", showing all types of data, like GIS, linear, video and even their correlations

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The MER MEC "SICS" approach

The traditional approach, based on Measuring Vehicles having installed on board isolated S&C inspection systems and just flowing condition data in database, is gradually being replaced by a more comprehensive and advanced approach, proposed by MER MEC, that can be defined as "**SICS approach**".

The MER MEC "SICS" approach

"SICS" means:

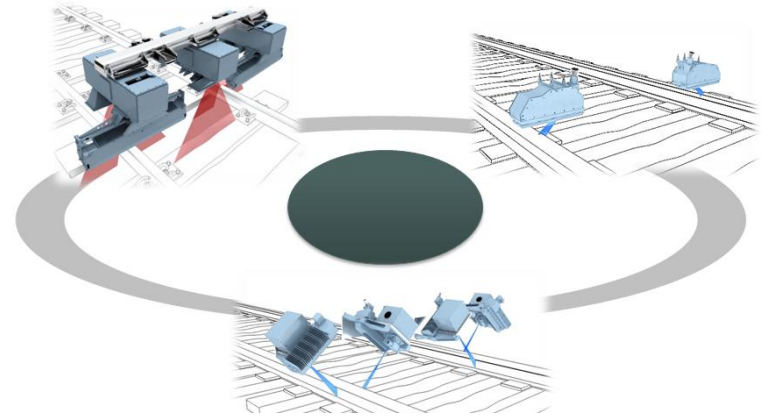- ❑ Synchronization / Integration of measured data
- ❑ Correlation for measures and defects
- ❑ Statistics on "Big Data"

"SICS" is an integrated and holistic approach overcoming all the limitations of the traditional approach and giving the high advantage to support the implementation of International Standards and to increase up to the top the safety of the Railway Infrastructure

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Synchronization / Integration of measured data

Generally speaking about measurement of the Railway Infrastructure, it's essential to emphasize that the integration and the synchronization of all the main measuring systems among them and with the rolling stock, the software and the decision support systems is today an essential requirement to perform complete, exhaustive, accurate and reliable measurement of the railway infrastructure.

Correlation for measures and defects

Having multiple sets of exhaustive, integrated, validated and synchronized data, including S&C measurements gives the possibility to perform a full data analysis.

Today only the highest level of **cross correlation between measured parameters** can give reliable and effective indications on the real state of the high speed infrastructure; single, isolated measurement can be useless and even meaningless.

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Statistics on "Big Data"

The progressive implementation of the "Big Data Technologies" in the Railway Infrastructure measurement and monitoring allows the performing of completely new type of analysis, first of all the predictive analysis. Further more statistics on "Big Data" open new possibilities, like for example:

❑ The definition of the optimal frequency of measurement.

❑ A reliable and systematic trend analysis for defects.

❑ The GIS mapping, including the geo-referencing of the various railway "object" for mapping projection.

….and, not less important, a maintenance costs (and savings !) accurate calculation.

Conclusions

❑ S&C measurement made in full automatic way is today possible

❑ S&C Data Management and Decision Support Systems are today ready to support the measurements

❑ International Standards can supply guidelines for S&C automatic full inspection and quality index calculation

❑ Technology is now ready to support in the most effect way the needs of the Railway Administrations, thanks to the **SICS approach**, an integrated and holistic approach overcoming all the limitations of the traditional approach and giving the high advantage to turn **DATA** into **INFORMATION**

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Thanks for your attention

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