

Introduction

Application Groups - focus engineering surveying

- Linear Objects
 - Roads
 - Railways
 - Pipelines
 - Power lines
 - Harbor and river engineering objects scanned from the water side
- Construction work - buildings
- Industry

Other

- Forensic
- Cultural heritage
- Mining



Terrestrial Laserscanning / MLS

Wide range of use – lack of standardization for the methodology and the final products

- Depending of demand for projects
- Several manufacturers of Laser Scanner are on the market
- Different ranges and measuring rates
 - High speed low range
 - Low speed high range



Hardware - Laserscanner technical data (old/new)

	Z+F		Leica		Riegl	
Scanner	5006	5010	Scanstation2	C10	VZ-400	VZ-1000
Range	80m	180m	300m	300m	500m	1400m
Rate	up to 500.000 p/sec	up to 1.000.000 p/sec	up to 50.000 p/sec		up to 125.000 p/sec	up to 122.000 p/sec
Field	310 x 360	320 x 360	270 x 360		100 x 360	
Security	3R	1	3R	3R	1	1



The Applications defines the main functionality , requirements
For the results and also the processing steps in the software

- Criteria for measuring method like static, stop & go or kinematic
- Planning a project
- Completeness vs. Accuracy
- Measuring
- Registration of Scans or Synchronization of the scan lines
- Analyzing and evaluating the Scans patches
- Presentation of the results
 - Different applications – leads to different software, cost intensive
 - At least 2 sof. packages for a single project – in average




Laserscanning

Measuring methods


360° scans - profile scans

- Static
 - Scans from different station points **360° mode**
- Stop and go
 - Scans from moveable platforms with total station support **360° mode**
- Kinematic
 - Profile scans from a platform in motion, with DGPS and real time or post processing step for georeferencing **profile mode**




Measuring method

- Static
- Stop & go
- Kinematic



The slide features a header with the TECHNET logo (technet-rail 2010 GmbH) and a blurred image of a train. Below this, the text 'Measuring method' is followed by a bulleted list: 'Static', 'Stop & go', and 'Kinematic'. To the right is a 3D point cloud visualization of a railway track, with two parallel yellow lines overlaid on the track bed to indicate the rail positions.



Laserscanning

Laserscan data – software needs and modules

- Analyzing software /pre process - provided by the manufacturers
- Project management - external providers
- Database
- Special graphics engine – the CAD plug in's are not efficient enough
- Detect geometry objects / extracting features – just primitives if special requirements - third party specialized software
- Standard output formats (dxf, dgn, 3ds, geotiff, ecw, bmp, avi)
- The market is still creative regarding creation of new formats!

The slide features a header with the TECHNET logo (technet-rail 2010 GmbH) and a blurred image of a train. Below this, the word 'Laserscanning' is written in a red box. The main content is a section titled 'Laserscan data – software needs and modules' followed by a bulleted list of seven items related to software requirements for laser scanning data.

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Laserscanning

Laser scan data – software structure

The image displays two screenshots of a software interface for laser scanning data processing. The top screenshot shows a menu bar with options: Camera, Cutting, Create/Modify, 2D Selection, Fitting, Regression, Measure, Sections, Ortho, Import, Export, Action, Color, Other. Below the menu bar are several tool icons and labels: Change Current View, Magnifier, Snap Size, Focus at Object Position, Shift View Position, Deactivate Move/Rotate Mode, Save/Load View Points, Fullscreen View, Reset Change Navigation Center, Select Type Of Navigation Relating To Translation/Rotation, and Show/Hide Coordinate Axis At Center Of View. The bottom screenshot shows a similar menu bar with options: Camera, Cutting, Create/Modify, 2D Selection, Fitting, Regression, Measure, Sections, Ortho, Import, Export, Action, Color, Other. Below the menu bar are tool icons and labels: Load/Save 3D-Cutting Form, Detection of Linear Objects, Erase All Points, List Of 3D Cutting Forms, Erase Last Point Of Polygonal Cutting Form, 3D-Cutting Forms (Cube, Cuboid, Cylinder, Polygonal Cylinder and Cuboid Prisms and Line Based, polygonal Cuboid), Color Based Selection, Delete/Active Cutting Form, and Action With Selected Region: Cut/Format/Duplicate/Erase.


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Products based on the customer requirements

Building & Architecture


- Documentation as build - actual state
- Getting plans
- Sections
- Orthophotos
- Mapping „hand photos“


The image shows two architectural renderings. The left rendering is a perspective view of a large, vaulted interior space, likely a church or cathedral, featuring a central staircase and multiple levels. The right rendering is a detailed view of a building's exterior facade, showing a prominent tower with a gabled roof and arched windows.

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Building & Architecture

- Documentation as build
- Getting plans
- Sections
- Orthophotos
- Mapping „hand photos“




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Building & Architecture

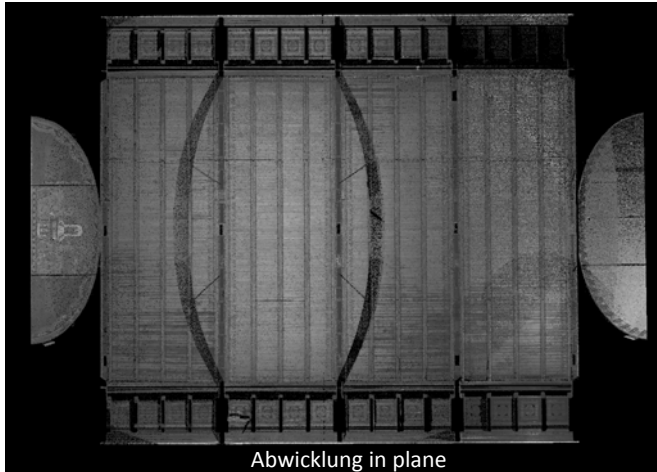
- Documentation as build
- Getting plans
- Sections
- Orthophotos
- Mapping „hand photos“




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Building & Architecture

- Documentation as build
- Getting plans
- Sections
- Orthophotos
- Mapping „hand photos“





Abwicklung in plane

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Building & Architecture

- Documentation of actual state
- Getting plans
- Sections
- Orthophotos
- Mapping „hand photos“





Detailed modeling

Interpolation Functions

- Spline Definition
 - for surfaces & volume calculation
 - gives the parameter of the surface
- TIN models
 - increases the data volume

base $g : I \rightarrow \mathbb{R}$

$$\partial^{#j} L_k(u_j) = \delta_{jk}, \quad j = 1 : m \quad (3)$$

$$|L_k(t)| \leq \alpha \exp(-\beta|t - u_k|), \quad (1)$$


$$f = \sum_j L_j g_j \quad (2)$$



Spline

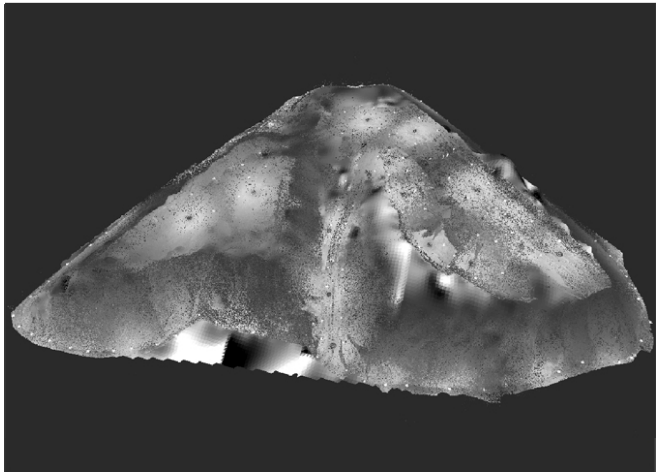
- Data reduction
- Increasing surface accuracy



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Spline/TIN
models

- Volume calculation




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Linear Objects - Infrastructure

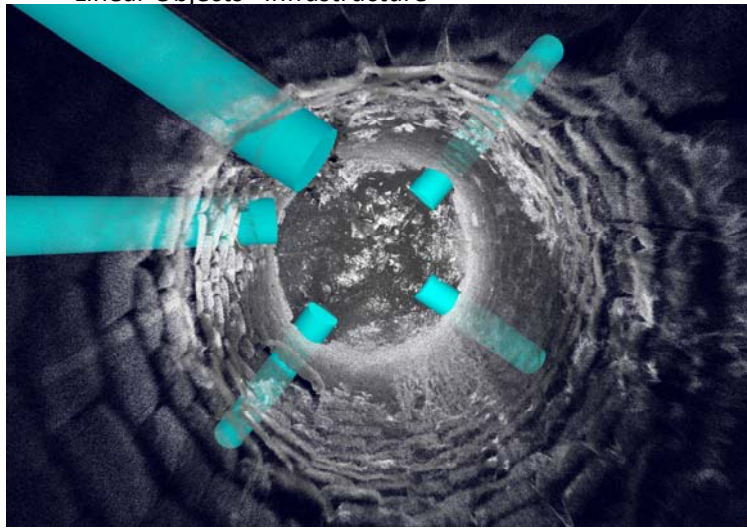


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Linear Objects Infrastructure

Parameter calculation



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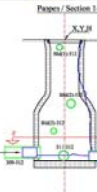


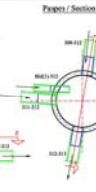
Linear Objects Infrastructure

ОБЪЕКТ / PROJECT:
 МОДЕРНИЗАЦИЯ ИЛИ ВОССТАНОВЛЕНИЕ РАЙОНА/РАЙОНОВ НАСЕЛЕННЫХ ПУНКТОВ НА ЖЕЛЕЗНОДОРОЖНОМ ТРАНСПОРТЕ

ОБЪЕКТЫ:
 Проектирование и строительство объектов инфраструктуры железнодорожного транспорта в составе реконструкции и модернизации инфраструктуры для обслуживания существующих и проектируемых пассажирских станций и станций для обслуживания грузовых поездов

Тема / Volume 2: Переход на SRS / Stage of DSS
 СХЕМА ИЛИ ПЛАН ОТВОДА / SCHEME OF DSS DRAFT

Планы / Section 1-1


Планы / Section 2-2


Канал / Branch: 4.00
 Шхота / Shaft
 400 WW 4.00.312
 (WW3K7)

Местонахождение на плане / Shaft location:
 ОН, Административный округ

Геодезические координаты / Geodetic measurements

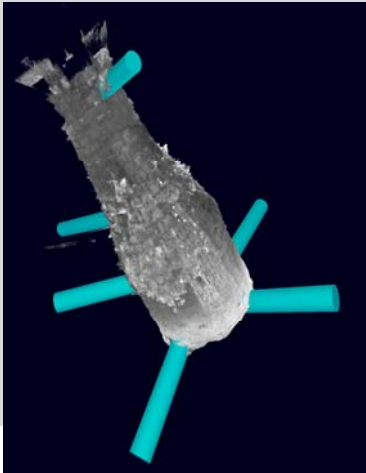
Композит	Содержит	Канал / Elevation M [m]	Диаметр / Diameter	Панель / Panel
X(m)	Y(m)	Канал / Elevation	Диаметр / Diameter	Панель / Panel
4000643.030	6168812.004	718.38	713.79	3.05 1.10


Таблица / Table: 0-0-0-0

Тип / Type	Имя / Name	Материал / Material	Диаметр / Diameter (D [mm])	Высота / Elevation
Шхота / Shaft <td>400 WW 4.00.311 (WW3K9)</td> <td>бет / concrete</td> <td>200</td> <td>713.80</td>	400 WW 4.00.311 (WW3K9)	бет / concrete	200	713.80
Шхота / Shaft <td>300-312</td> <td>бет / concrete</td> <td>300</td> <td>714.00</td>	300-312	бет / concrete	300	714.00
Шхота / Shaft <td>400 WW 4.00.309 (WW3K8)</td> <td>бет / concrete</td> <td>200</td> <td>713.87</td>	400 WW 4.00.309 (WW3K8)	бет / concrete	200	713.87
Шхота / Shaft <td>300-311</td> <td>бет / concrete</td> <td>300</td> <td>714.00</td>	300-311	бет / concrete	300	714.00
Шхота / Shaft <td>400 WW 4.00.312 (WW3K7)</td> <td>бет / concrete</td> <td>200</td> <td>713.79</td>	400 WW 4.00.312 (WW3K7)	бет / concrete	200	713.79

Описание на плане / Shaft description

Элемент / Element	Содержит / Content	Материал / Material
Канал / Channel	бет / concrete	бет / concrete
Канал / Channel	бет / concrete	бет / concrete
Тело / Body	бет / concrete	бет / concrete
Содержит / Content	бет / concrete	бет / concrete
Дно / Bottom	бет / concrete	бет / concrete
Имя / Name	ОН / ON	

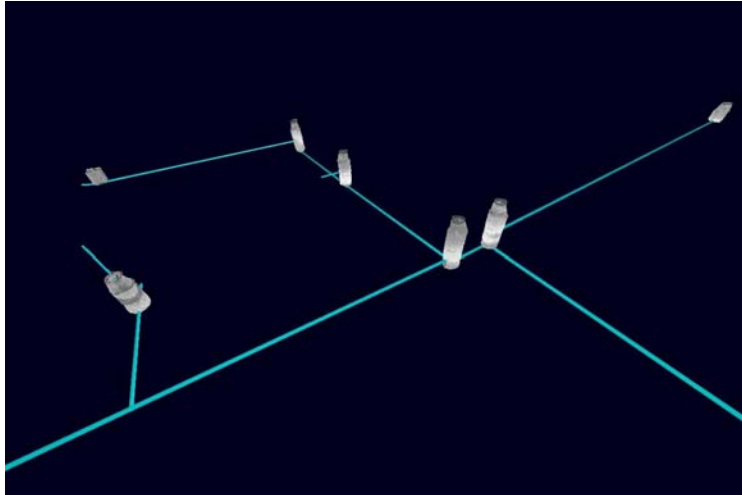


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Linear Objects Infrastructure

Parameter calculation

Slopes of the pipes



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Kinematic system

- Low cost
- Scanner + GNSS + MEM'S
- ~ 100 000 EUR



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Kinematic system MLS VMX-450

- High end

The diagram illustrates the components of the Kinematic system MLS VMX-450. It includes a laser scanner (RIEGL logo), a mounting platform, an IMU (Inertial Measurement Unit), a GNSS receiver, and a wheel. A photograph of the VMX-450 unit is also shown.

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Kinematic system MLS

First Prototype of an Mobile Street Acquisition System (MoSES)


- High end
- ~ 400 000 EUR


The photograph shows a yellow van equipped with the Kinematic system MLS (MoSES) on its roof. The system components are highlighted with red and green boxes. The van has a license plate that reads "3D MAPPING".

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Lynx Mobile Mapper system MLS

- High end




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Application for the data synchronization - road

Kinematic system

- Roads



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Classic methods

Repeat the measurements on the selected points is in fact not repeatable there are not fixed

Области измерений

ПК 0+00

ПК 1+00

Контролируемые точки

Контролируемая точка

Место измерений

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Classic methods

Using this profile type for control and also the selected areas (area 3000m² each) do not give any representative information about the thickness and the homogeneous distribution of the asphalt thickness

места вырубок

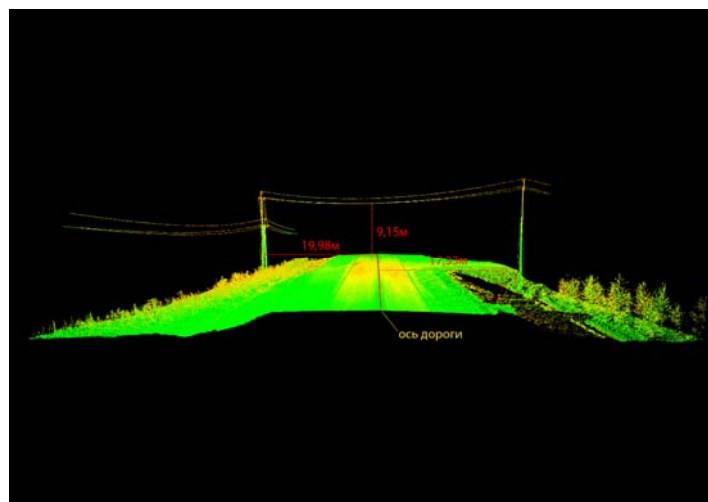


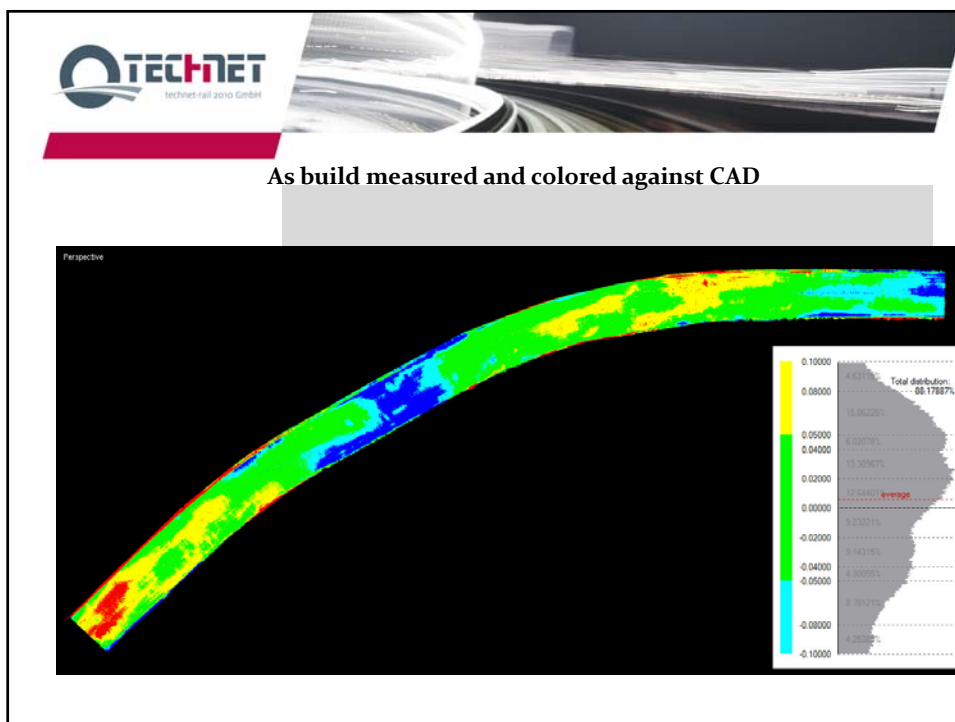
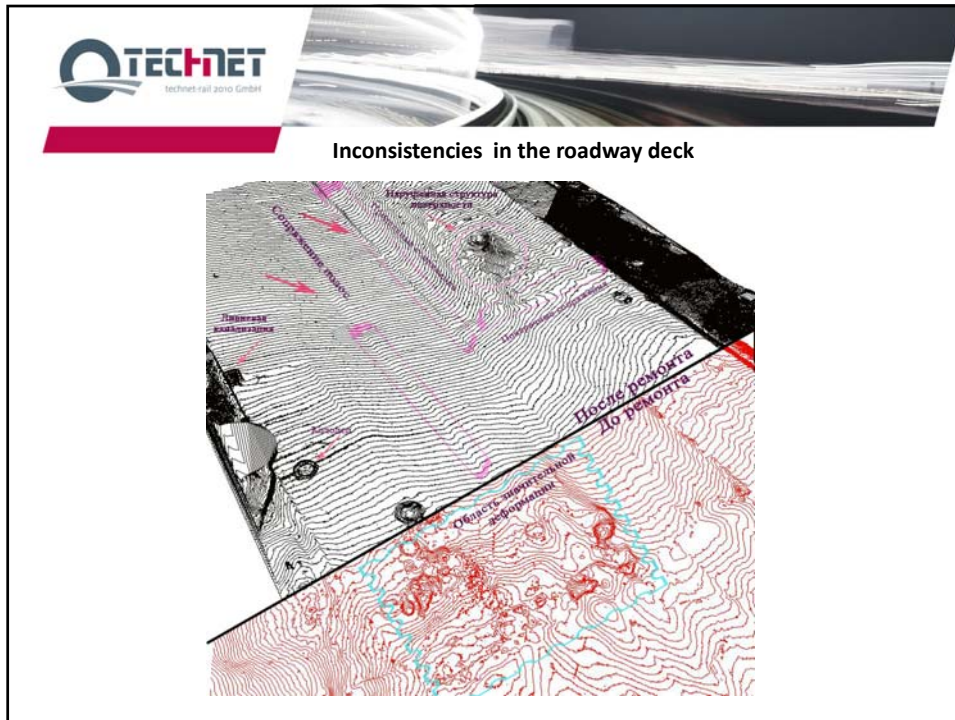
This causes that the process of geodetic works do not allow to get an objective picture and information about the current state of the roadway as continuous engineering object. Most important is the fact to not be able to control the construction or rehabilitation work.

In this situation the contractor is not able to prove his construction results and the employer is permanent in right



Clarence





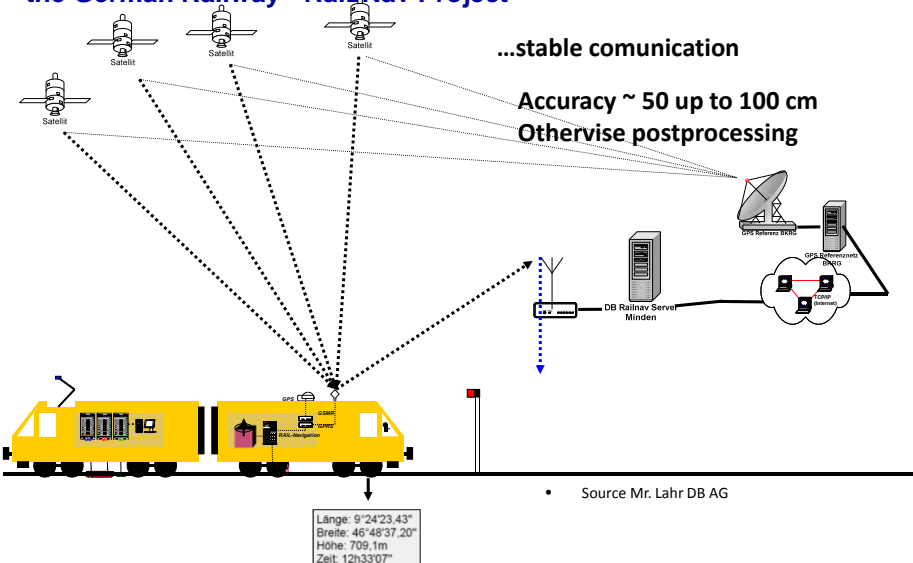


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Kinematic system MLS - Rail

- Low cost

EUPOS/SARPOS-based Vehicle Scheduling and Control System by the German Railway - Rail_Nav Project



...stable communication

Accuracy ~ 50 up to 100 cm
Otherwise postprocessing

DB Railnav Server
Minden

DB Netz

DB Fernverkehr

DB Schenker

DB Arriva

DB Cargo

DB Fernverkehr

DB Schenker

DB Arriva

DB Cargo

Länge: 9°24'23,43"
Breite: 46°48'37,20"
Höhe: 709,1m
Zeit: 12h33'07"

- Source Mr. Lahr DB AG



Kinematic system MLS - Rail



Kinematic system MLS - Rail



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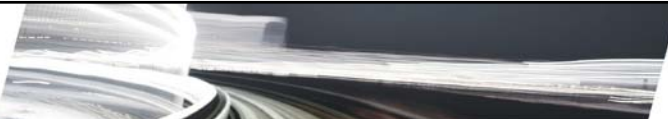
Kinematic system MLS - Rail

Kinematic systems







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3D clearance measuring train


Fraunhofer Institute Freiburg

- Metronom GmbH Mainz
- INS System
- Video system
- 20 HZ GNSS receiver
- 2 High speed laser scanner

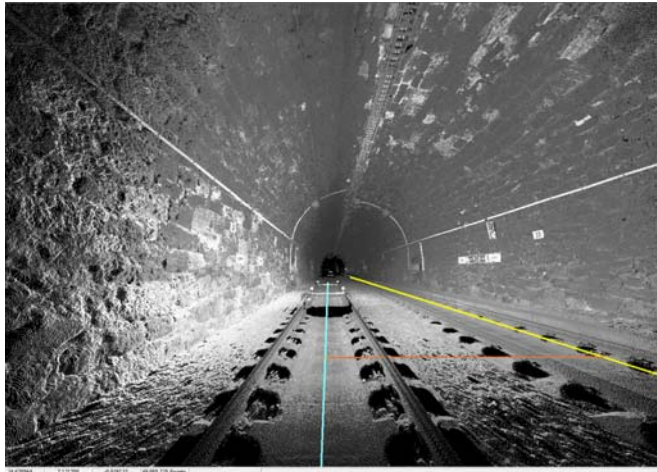



Highest data acquisition rates 300, 500, 1000Hz depends of the scanner type
Up to 80 km/h for the measurement ride

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Kinematic systems

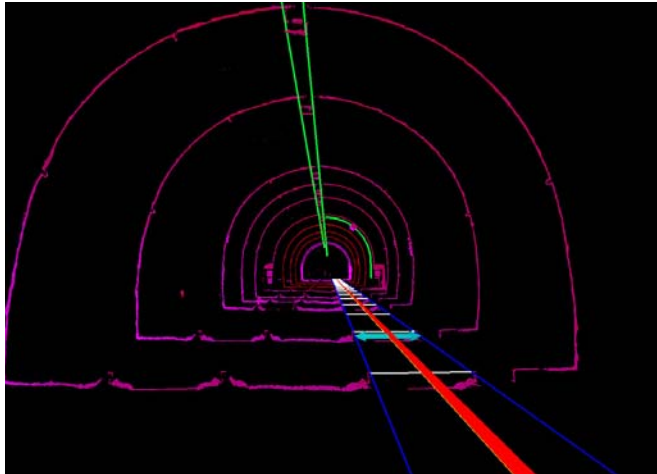
- Tunnel shape - clearance
- Distance to neighbour track



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Kinematic systems

- Rail geometry
- Electricity wiers
- Batch Sections functionality




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Kinematic systems

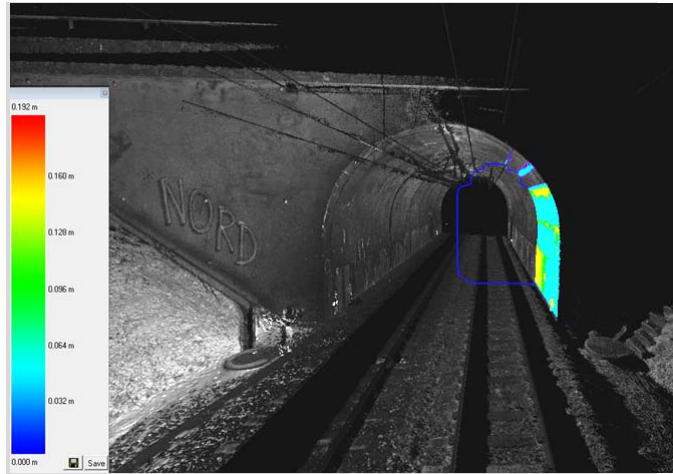
- Rail geometry
- Electricity
- Batch Sections





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Kinematic systems


- Rail geometry
- Electricity
- Batch Sections
- Collision detection

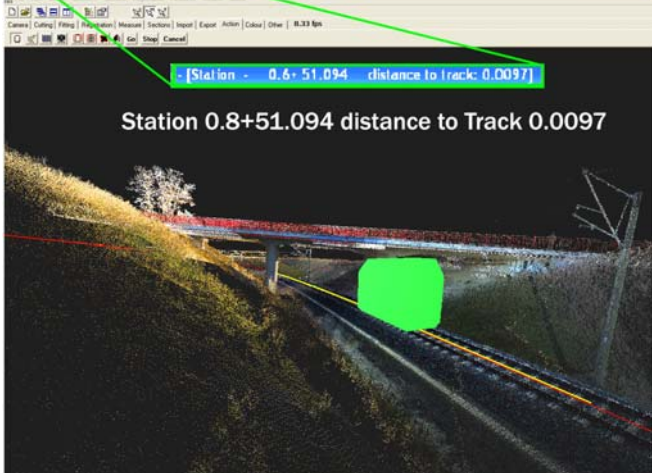




Kinematic system

- Maintenance purposes





Station 0.8+51.094 distance to Track 0.0097





Kinematic system

- Variance comparison

16:01:23[Stats]: neubeern> Station -	0.6+ 24.260	distance to track: 0.0140
16:01:24[Stats]: neubeern> Station -	0.6+ 23.919	distance to track: 0.0136
16:01:24[Stats]: neubeern> Station -	0.6+ 23.573	distance to track: 0.0130
16:01:24[Stats]: neubeern> Station -	0.6+ 23.223	distance to track: 0.0121
16:01:25[Stats]: neubeern> Station -	0.6+ 22.973	distance to track: 0.0111
16:01:25[Stats]: neubeern> Station -	0.6+ 22.526	distance to track: 0.0099
16:01:25[Stats]: neubeern> Station -	0.6+ 22.187	distance to track: 0.0089
16:01:26[Stats]: neubeern> Station -	0.6+ 21.860	distance to track: 0.0079
16:01:26[Stats]: neubeern> Station -	0.6+ 21.543	distance to track: 0.0073
16:01:26[Stats]: neubeern> Station -	0.6+ 21.233	distance to track: 0.0068
16:01:27[Stats]: neubeern> Station -	0.6+ 20.925	distance to track: 0.0066
16:01:27[Stats]: neubeern> Station -	0.6+ 20.615	distance to track: 0.0066
16:01:27[Stats]: neubeern> Station -	0.6+ 20.301	distance to track: 0.0068
16:01:28[Stats]: neubeern> Station -	0.6+ 19.985	distance to track: 0.0073
16:01:28[Stats]: neubeern> Station -	0.6+ 19.668	distance to track: 0.0077
16:01:28[Stats]: neubeern> Station -	0.6+ 19.351	distance to track: 0.0083
16:01:29[Stats]: neubeern> Station -	0.6+ 19.034	distance to track: 0.0088
16:01:29[Stats]: neubeern> Station -	0.6+ 18.717	distance to track: 0.0094
16:01:29[Stats]: neubeern> Station -	0.6+ 18.399	distance to track: 0.0099
16:01:30[Stats]: neubeern> Station -	0.6+ 18.082	distance to track: 0.0104
16:01:30[Stats]: neubeern> Station -	0.6+ 17.766	distance to track: 0.0110
16:01:30[Stats]: neubeern> Station -	0.6+ 17.452	distance to track: 0.0116
16:01:31[Stats]: neubeern> Station -	0.6+ 17.138	distance to track: 0.0122
16:01:31[Stats]: neubeern> Station -	0.6+ 16.822	distance to track: 0.0126
16:01:31[Stats]: neubeern> Station -	0.6+ 16.503	distance to track: 0.0127
16:01:32[Stats]: neubeern> Station -	0.6+ 16.180	distance to track: 0.0125
16:01:32[Stats]: neubeern> Station -	0.6+ 15.849	distance to track: 0.0118

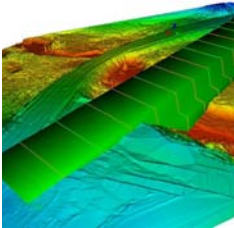
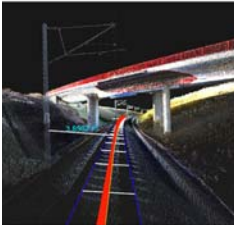

16:01:24[Stats]: neubeern> Station -	0.6+ 23.573	distance to track: 0.0130
16:01:24[Stats]: neubeern> Station -	0.6+ 23.223	distance to track: 0.0121
16:01:25[Stats]: neubeern> Station -	0.6+ 22.873	distance to track: 0.0111
16:01:25[Stats]: neubeern> Station -	0.6+ 22.526	distance to track: 0.0099
16:01:25[Stats]: neubeern> Station -	0.6+ 22.187	distance to track: 0.0089
16:01:26[Stats]: neubeern> Station -	0.6+ 21.860	distance to track: 0.0079



Rail and Road

Getting all the information you need

- Documentation „As-Built“
- Quality control
- Useful calculation base for driving dynamics
- Maintenance purposes and helps make future decision

Conclusions

Hardware

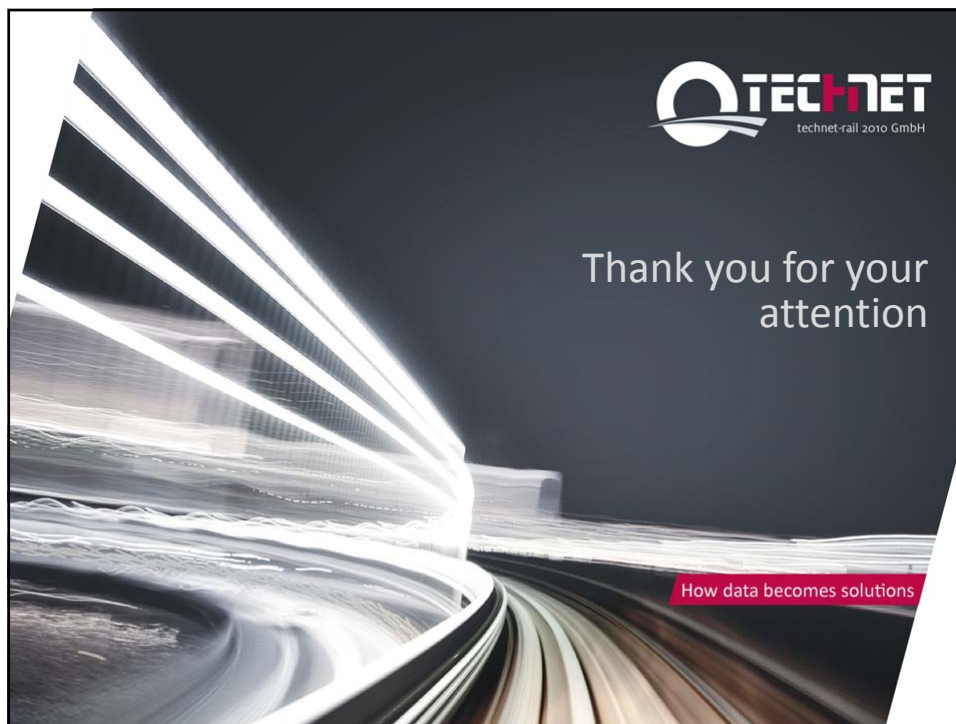
- The hardware is working stable, reliable and accurate
- Increasing the scanning speed

Software

- Increase the degree of automatization for feature extraction
- Automated registration
- Change the proportion between the data acquisition and office processing

Technology

- Automatization of the data processing
- Future development of scanning complexes
- Integration of additional sensors – MEM's; low cost IMU; ...
- We have to calculate engineering parameters
- Modeling and coloring is not the main target in the engineering surveying
- If you try to sell this as final product you will fail



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International federation of geodesists
Agencies of Republic Kazakhstan on management of land resources
D. Serikbaev East Kazakhstan state technical university
Siberian State Academy of Geodesy
Regional Scientific and Technological Park "Abai"

FIG Commissions 5, 6 Workshop

**INNOVATIVE TECHNOLOGIES FOR AN EFFICIENT
DISPATIAL MANAGEMENT OF EARTH RESOURCES**

TECHNICAL PROGRAMME

September, 3-7

Organizers:
FIG, IAGLR, IAGU, IAGTC, IAGUO, IAGUW, IAGUW-2, IAGUW-3, IAGUW-4, IAGUW-5, IAGUW-6, IAGUW-7, IAGUW-8, IAGUW-9, IAGUW-10, IAGUW-11, IAGUW-12, IAGUW-13, IAGUW-14, IAGUW-15, IAGUW-16, IAGUW-17, IAGUW-18, IAGUW-19, IAGUW-20, IAGUW-21, IAGUW-22, IAGUW-23, IAGUW-24, IAGUW-25, IAGUW-26, IAGUW-27, IAGUW-28, IAGUW-29, IAGUW-30, IAGUW-31, IAGUW-32, IAGUW-33, IAGUW-34, IAGUW-35, IAGUW-36, IAGUW-37, IAGUW-38, IAGUW-39, IAGUW-40, IAGUW-41, IAGUW-42, IAGUW-43, IAGUW-44, IAGUW-45, IAGUW-46, IAGUW-47, IAGUW-48, IAGUW-49, IAGUW-50, IAGUW-51, IAGUW-52, IAGUW-53, IAGUW-54, IAGUW-55, IAGUW-56, IAGUW-57, IAGUW-58, IAGUW-59, IAGUW-60, IAGUW-61, IAGUW-62, IAGUW-63, IAGUW-64, IAGUW-65, IAGUW-66, IAGUW-67, IAGUW-68, IAGUW-69, IAGUW-70, IAGUW-71, IAGUW-72, IAGUW-73, IAGUW-74, IAGUW-75, IAGUW-76, IAGUW-77, IAGUW-78, IAGUW-79, IAGUW-80, IAGUW-81, IAGUW-82, IAGUW-83, IAGUW-84, IAGUW-85, IAGUW-86, IAGUW-87, IAGUW-88, IAGUW-89, IAGUW-90, IAGUW-91, IAGUW-92, IAGUW-93, IAGUW-94, IAGUW-95, IAGUW-96, IAGUW-97, IAGUW-98, IAGUW-99, IAGUW-100

General sponsor:
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