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塑造智慧变革

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Scanning in deformation monitoring
扫描变形监测

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5年的经验- 徕卡 GeoMoS 扫描变形监测
5 years of experience - Leica GeoMoS scanning for deformation monitoring

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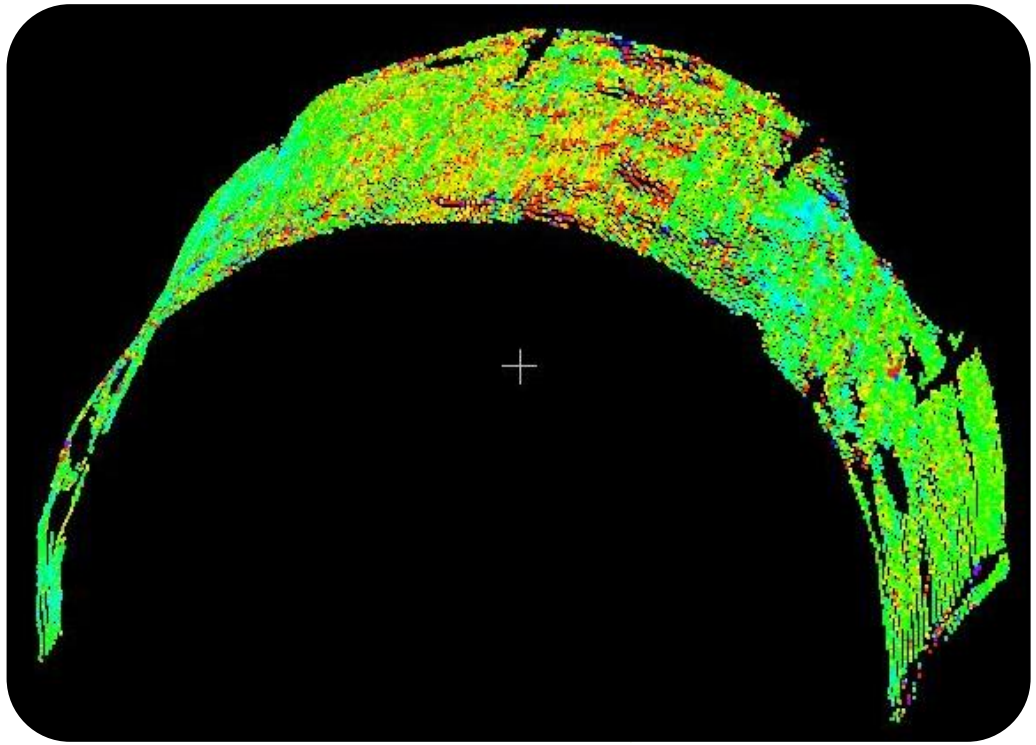

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徕卡GeoMoS自动扫描概述

Overview automatic scanning with Leica GeoMoS

- 通过现场的传感器

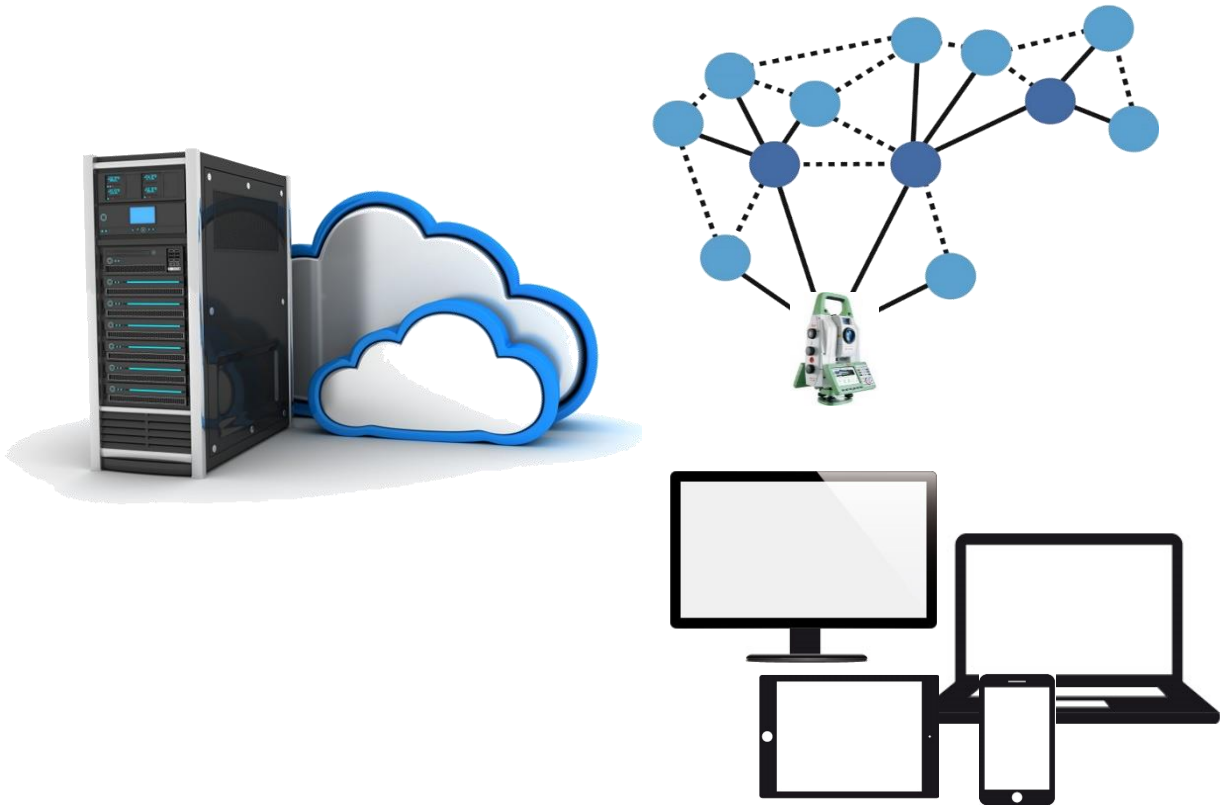
Sensors – in the field

- GeoMoS核心——云处理能力

GeoMoS core – with cloud processing capability

- 通过浏览器，在任何设备上获得可视化结果

Browser – visualize results on any device



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徕卡MS60全站扫描仪

Leica Nova MS60 MultiStation

- 三维棱镜测量-ATRplus长测程

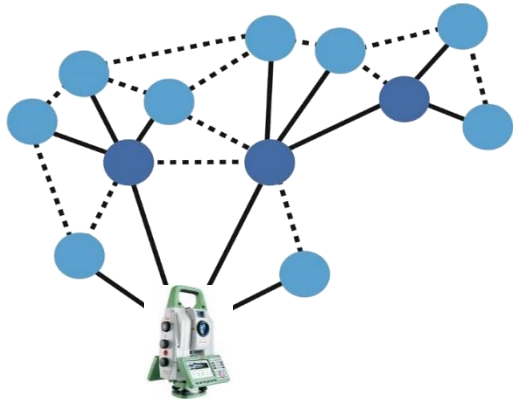
  3D prism measurement – ATRplus long range

- 扫描-通过点云数据

  Scanning – geo-references point cloud

- 成像-高分辨率，双相机图像系统

  Imaging – high resolution dual camera image system



Leica Nova MS60

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徕卡GeoMoS自动扫描概述

Overview automatic scanning with Leica GeoMoS

- 徕卡MS60的数据采集

Data acquisition from Leica MS60

- 高级云处理

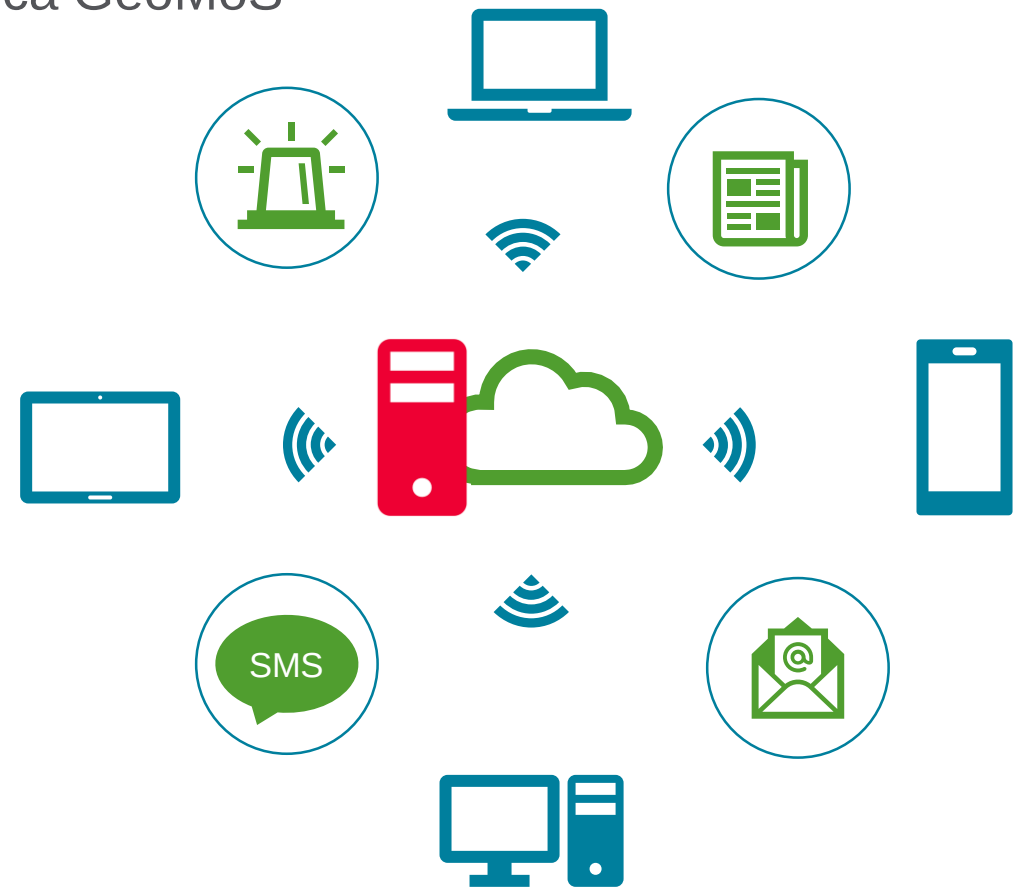
Advanced cloud processing

- 变形检测

Detect deformation

通知（电子邮件，SMS）

- Inform (E-Mail, SMS)



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徕卡GeoMoS自动扫描概述 Overview automatic scanning with Leica GeoMoS

- 徕卡Leica MS60
- GeoMoS扫描选项

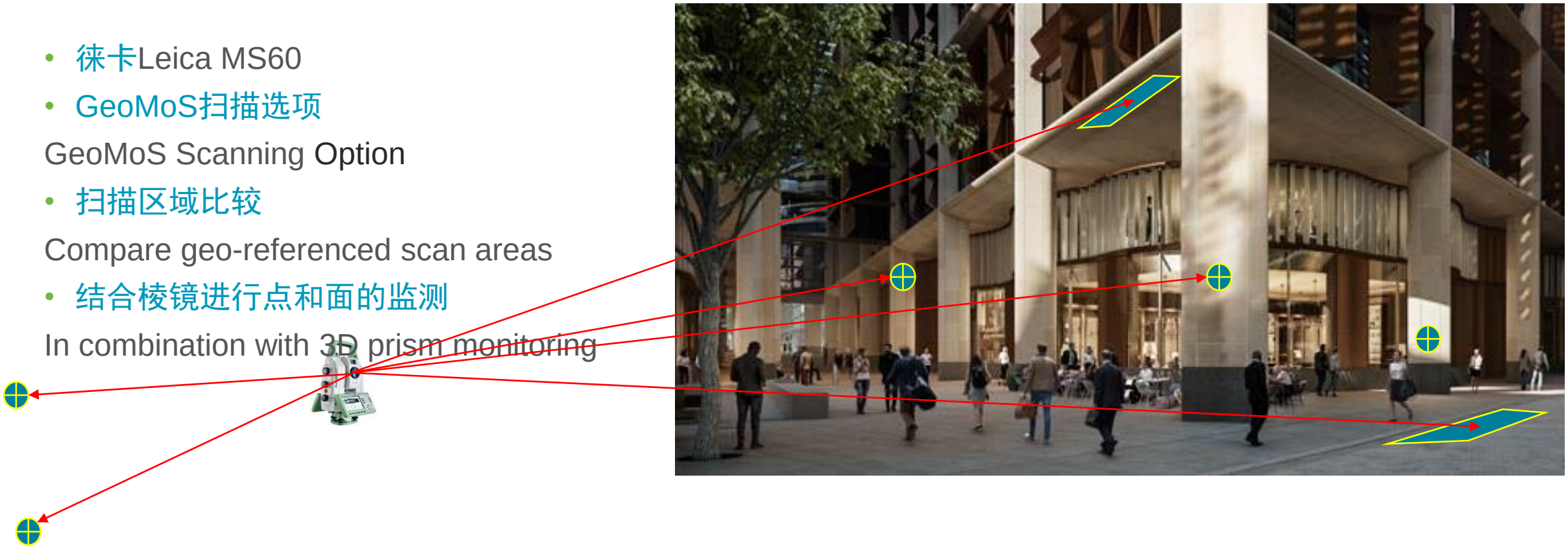
GeoMoS Scanning Option

- 扫描区域比较

Compare geo-referenced scan areas

- 结合棱镜进行点和面的监测

In combination with 3D prism monitoring



MS60

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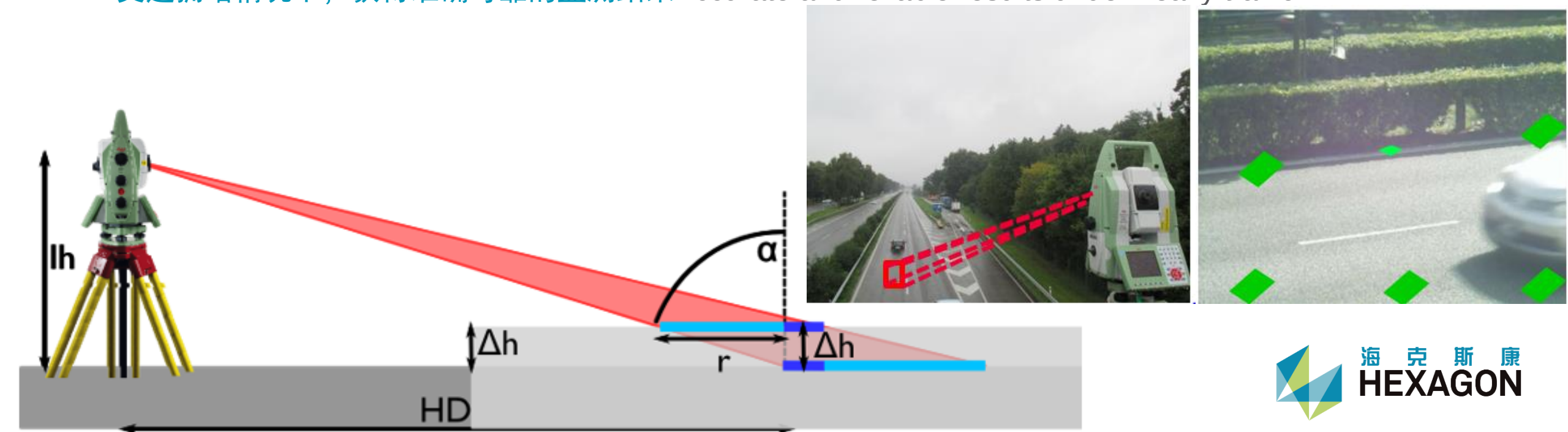
应用案例和项目——公路表面扫描 Use cases and projects – Scanning of highway surface

- 不能安装棱镜的情况 Prism mounting not possible
- 定义多个扫描区域（在路面上坐标方格）Define multiple scan areas (grid on road surface)
- TBM在公路下推进 TBM excavation below highway
- 交通拥堵情况下，获得准确可靠的监测结果Accurate and reliable results under heavy traffic



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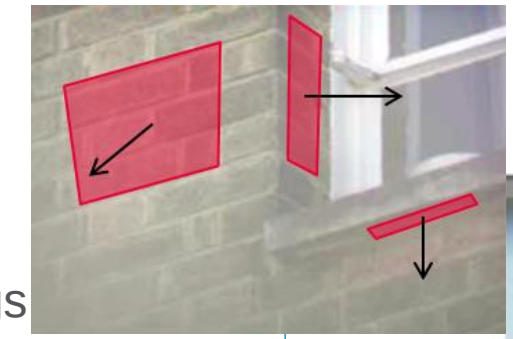
案例-建筑扫描

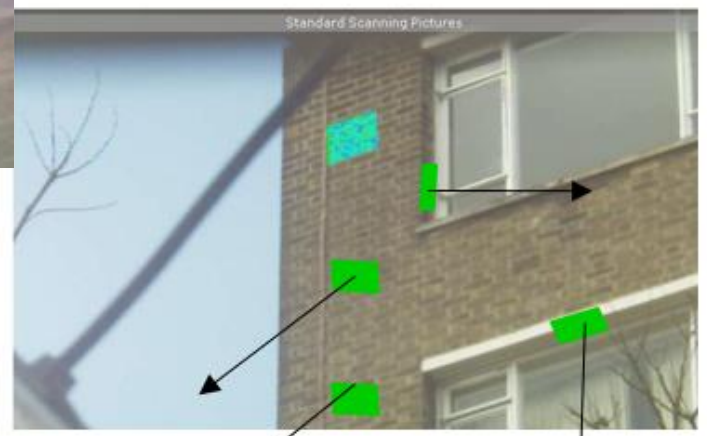
Use case – Scanning of parts of buildings

- 建筑附近挖掘施工Excavation under or nearby buildings
- 不能安装棱镜的情况Prism mounting partly not possible
- 与棱镜点监测结合Mostly combined with 3D prism monitoring
- 一维高程监测The result is 1D deformation
- 在互相垂直的表面附近，扫描3个区域

Use 3 areas nearby on perpendicular surfaces

  - 3 x 1D
- 通过扫描水平面进行沉降观测Settlement can only be measured on overhang





Facade

Overhang

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Confidential

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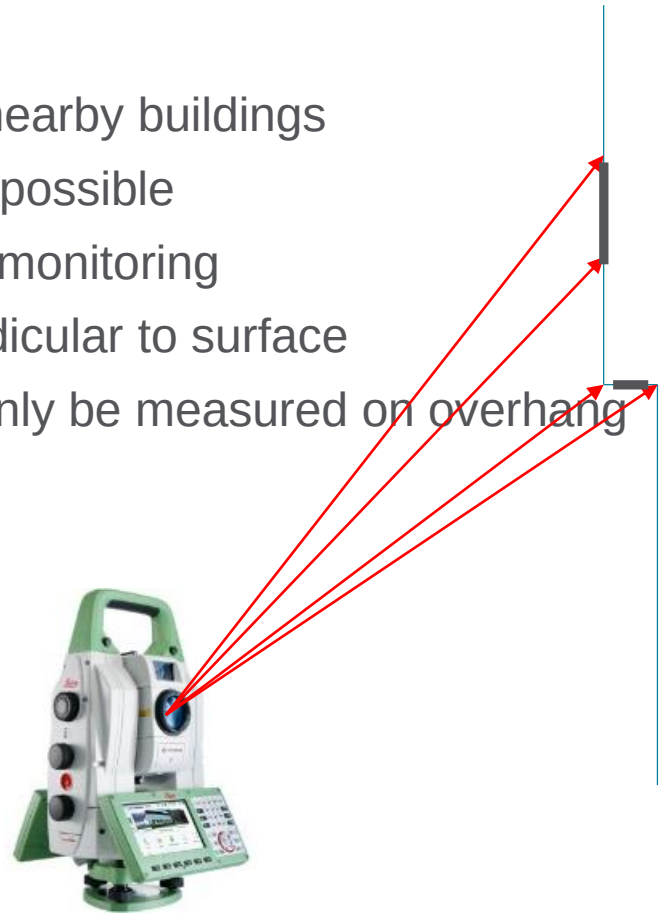
案例-人工难以到达的结构扫描监测

Use case – Scanning of parts of structures – difficult to access

- 建筑物地下或附近有开挖Excavation under or nearby buildings
- 不能安装棱镜的情况Prism mounting partly not possible
- 与棱镜点监测结合Mostly combined with prism monitoring
- 垂直于表面的变形Precise deformation perpendicular to surface
- 通过扫描水平面进行沉降观测Settlement can only be measured on overhang



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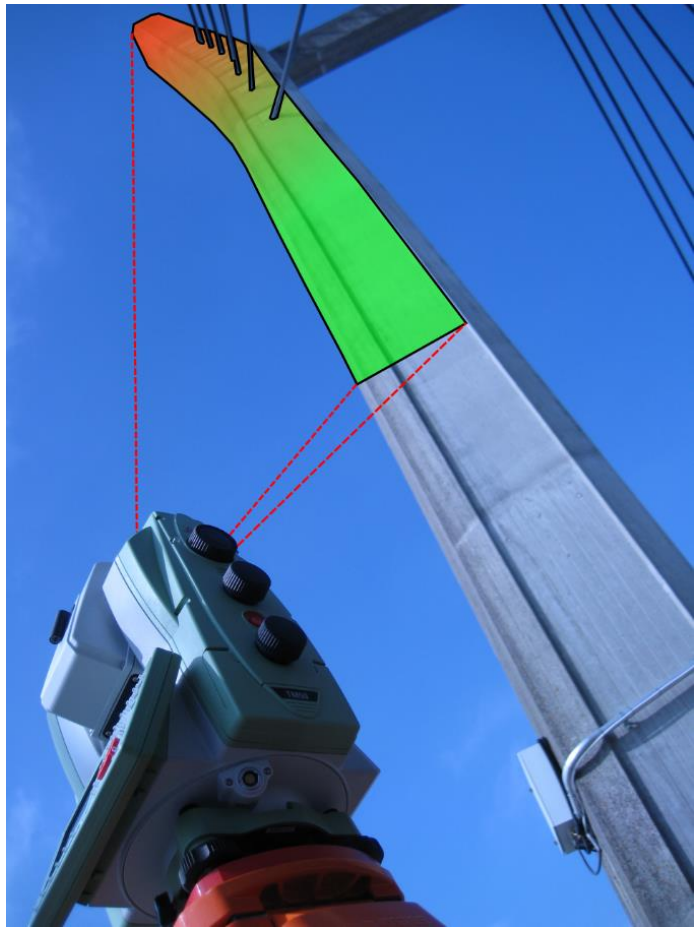

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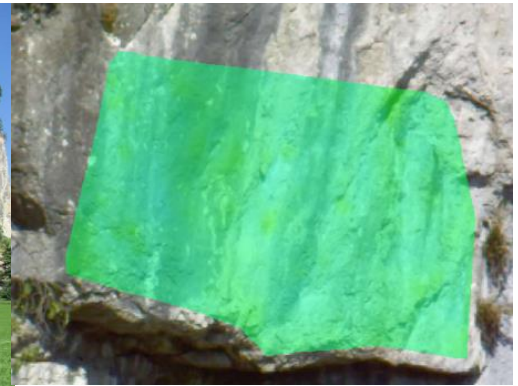
使用案例-扫描岩土断层采矿/落石Use case – Scanning geotechnical fault mining/rockfall

- 范围高达300米（取决于反射率）Range up to 300 m (depends on reflectivity)
- 高精度（取决于表面平整度）High accurate (depends from the flatness of the surface)
- 与棱镜点监测相结合Mostly combined with prism monitoring
- 与图像（望远镜相机）相结合Mostly combined with imaging (Telescope camera)
- 检测垂直于表面的变形

Detects deformation perpendicular to the surface



MS60

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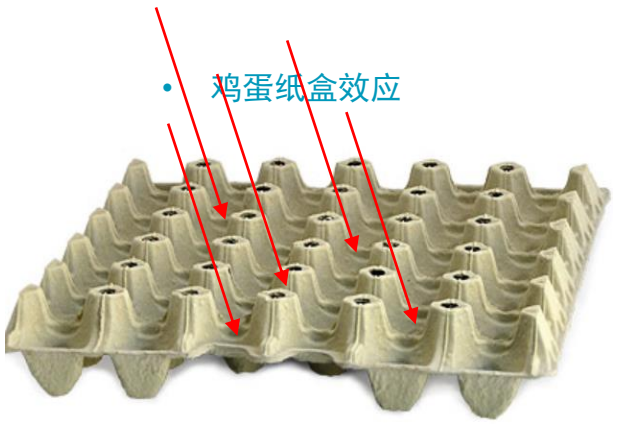
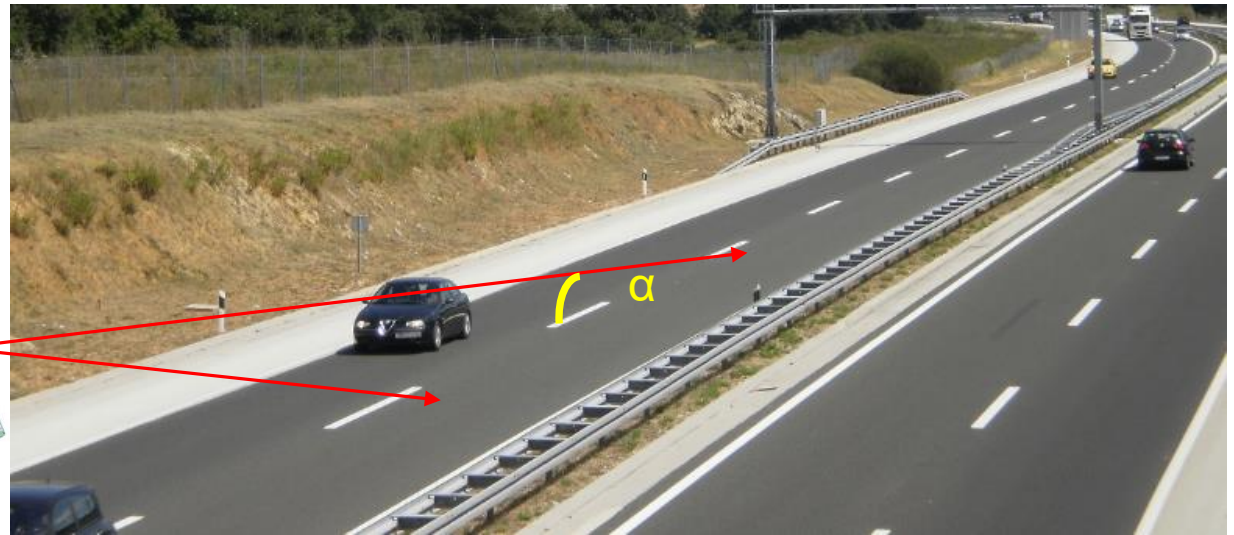
- 自动扫描-需要注意的重点Automatic scanning – what is important?

  - 入射最小角度＞10°（高度8m，距离50m）Minimum angle of impact > 10° (height 8m, distance 50m)
  - 物体最远扫描距离Distance to the object
  - 扫描区域的大小（在多个较小区域中分割）Size of a scan area (split in multiple smaller areas)
  - 期望最大运动（重叠！）Expected max. movements (overlap!)
  - 移动互联网上的数据传输量（每次扫描2到4兆字节）Data volume over mobile Internet (2 - 4 MB per scan)
  - 表面平整度关系到提高精度Flatness of surfaces for deliver higher accuracy



Egg-carton-effect!



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Leica n.Vec Technology

计算变形-对移动障碍物过滤

Compute deformation – Filter moving obstacles

- 滤除原始测量中的车辆影响

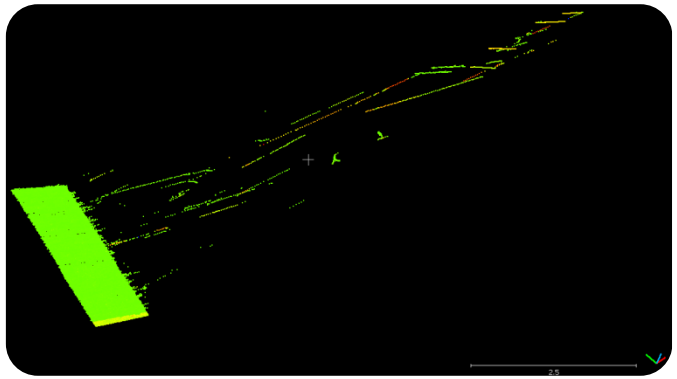
Filter out the impact of the traffic in raw measurements

- 各种障碍线

Lines caused by passing obstacles

- 移除单个噪点（飞点）

Remove single outliers in relation to their neighbors



滤波前Before filter

消除交通噪声Traffic noise eliminated

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计算变形，与扫描参考数据的比较 Compute deformation – compare with reference scan

- 对于每个扫描点，我们计算基于扫描面片的法向量。

For each scan point we compute a normal vector based on scan patches

- 对扫描数据进行面片建模

Modelling reference scan into patches

- 法向向量与扫描数据

Local normal vector intersection with reference scan

- 从参考面片返回到起点的法线向量

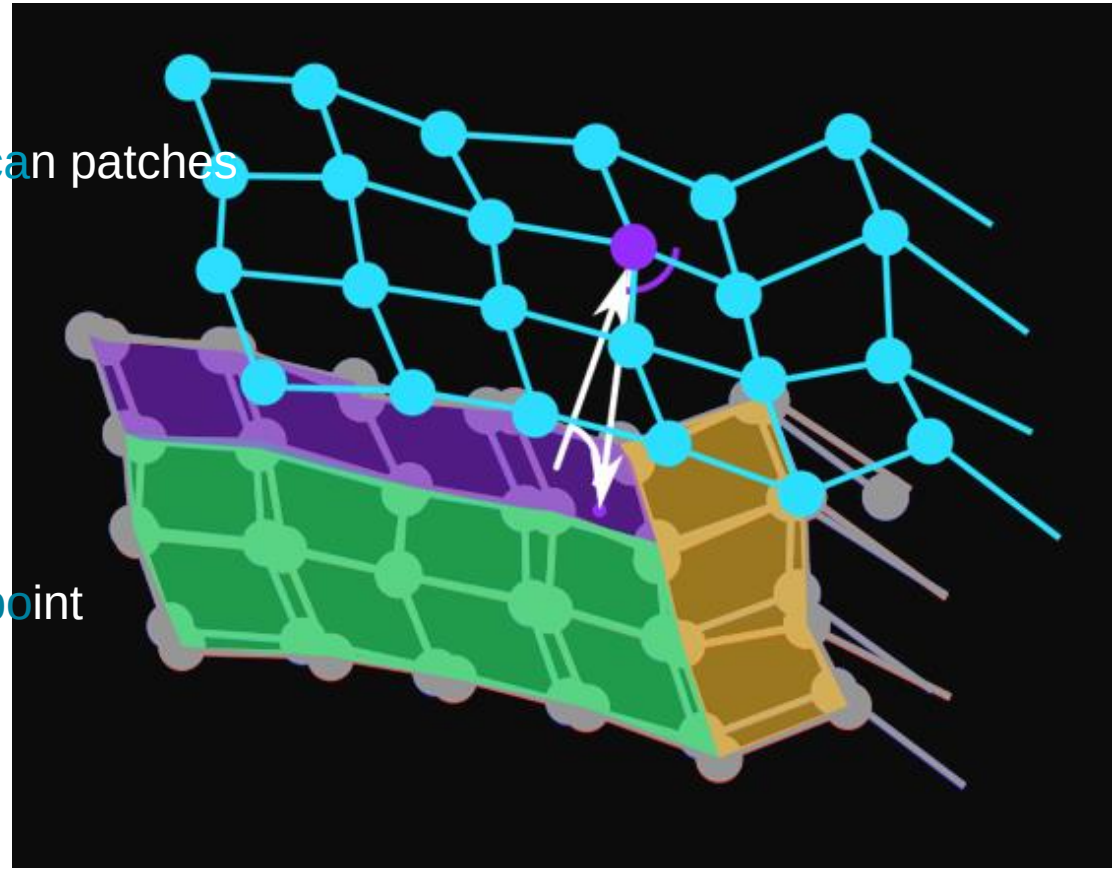
Find normal vector from reference patch back to the starting point

- 变形-矢量长度的绝对值

Deformation – absolute value of the vector length

- **面片边缘自动检测，比经典的三角模型方法更精确。**

Edges will be detected automatically and more precise than classical triangulation models



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计算变形——自动稳健分析

Compute deformation – automated robust analyses

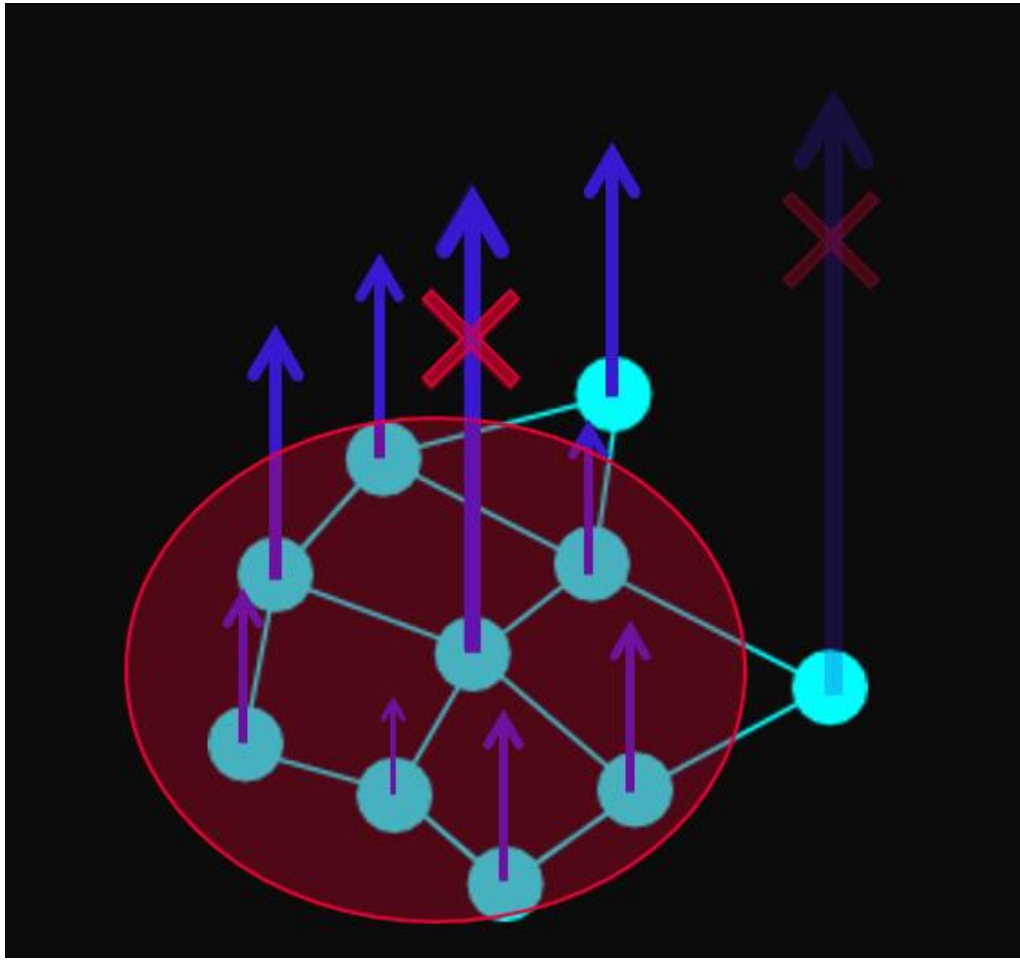
- 自动过滤粗差（定义阈值）

Automated filtering of blunders (defined threshold)

- 邻域真实性检查 Plausibility check regarding neighborhood
- 邻域相似变形Similar deformation expected in the neighborhood
- 移除与邻域相关的单个噪点

Remove single outliers in relation to their neighbors

- 变形中位数Median deformation



Leica n.Vec Technology

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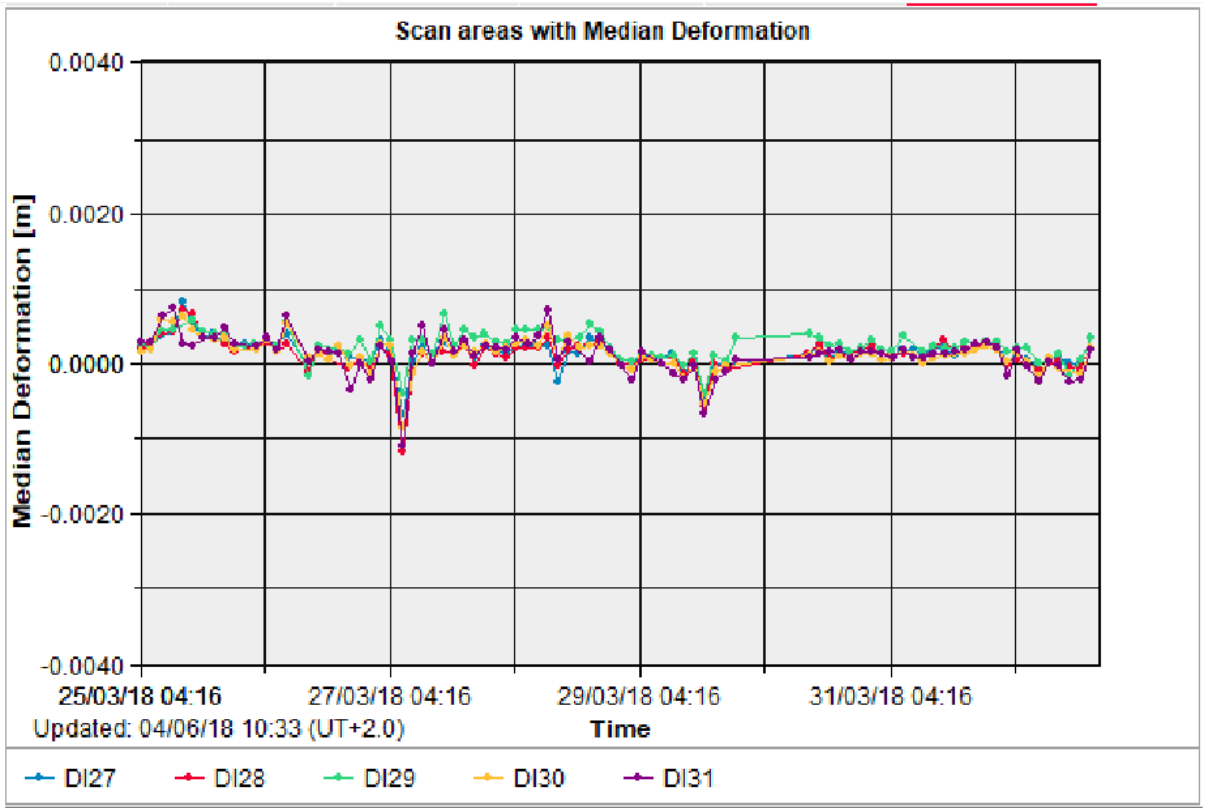
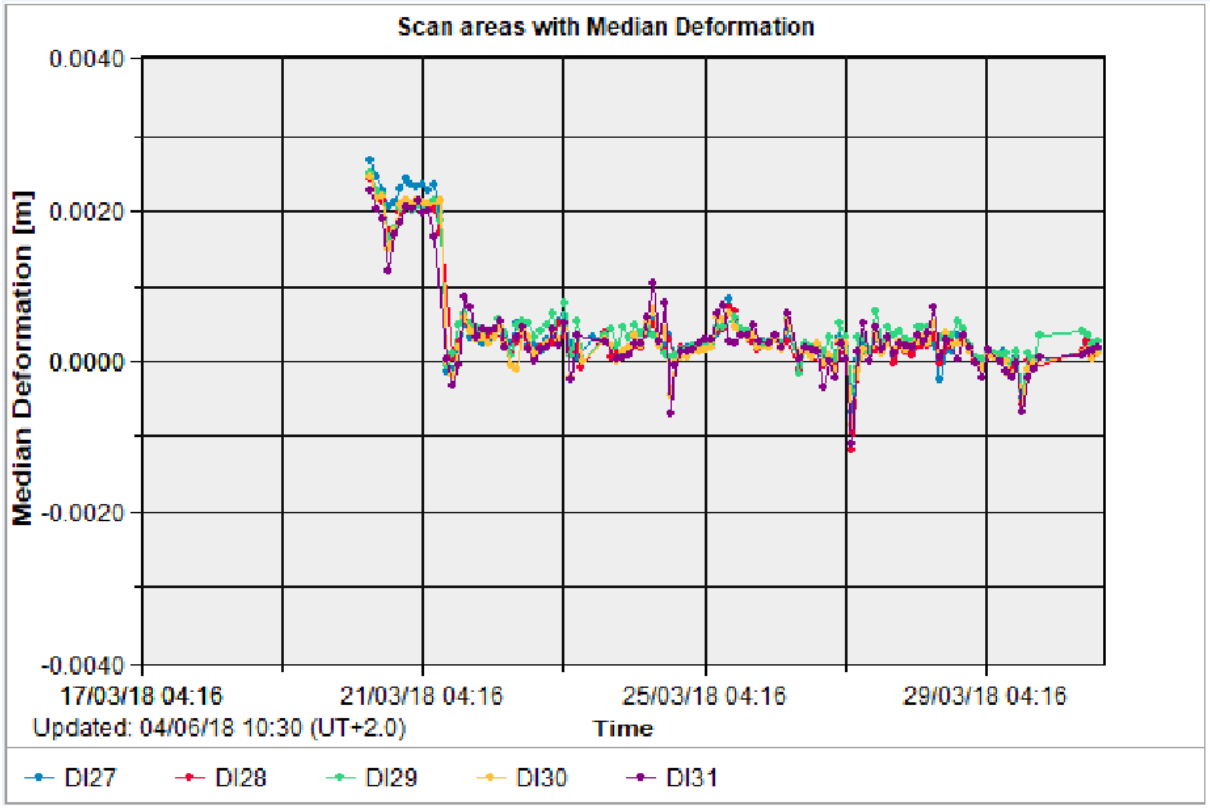
- 真实数据报告-毫米精度 Presentation of real data – mm accuracy



1周路面数据 1 week data road surface



3个月地面数据 3 month data road surface

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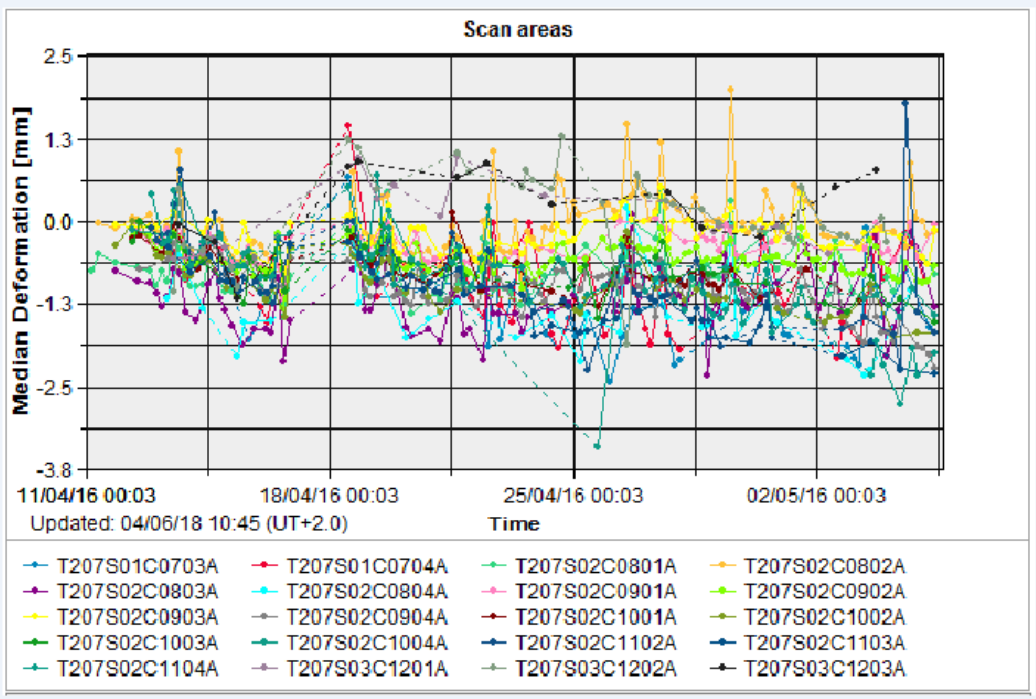
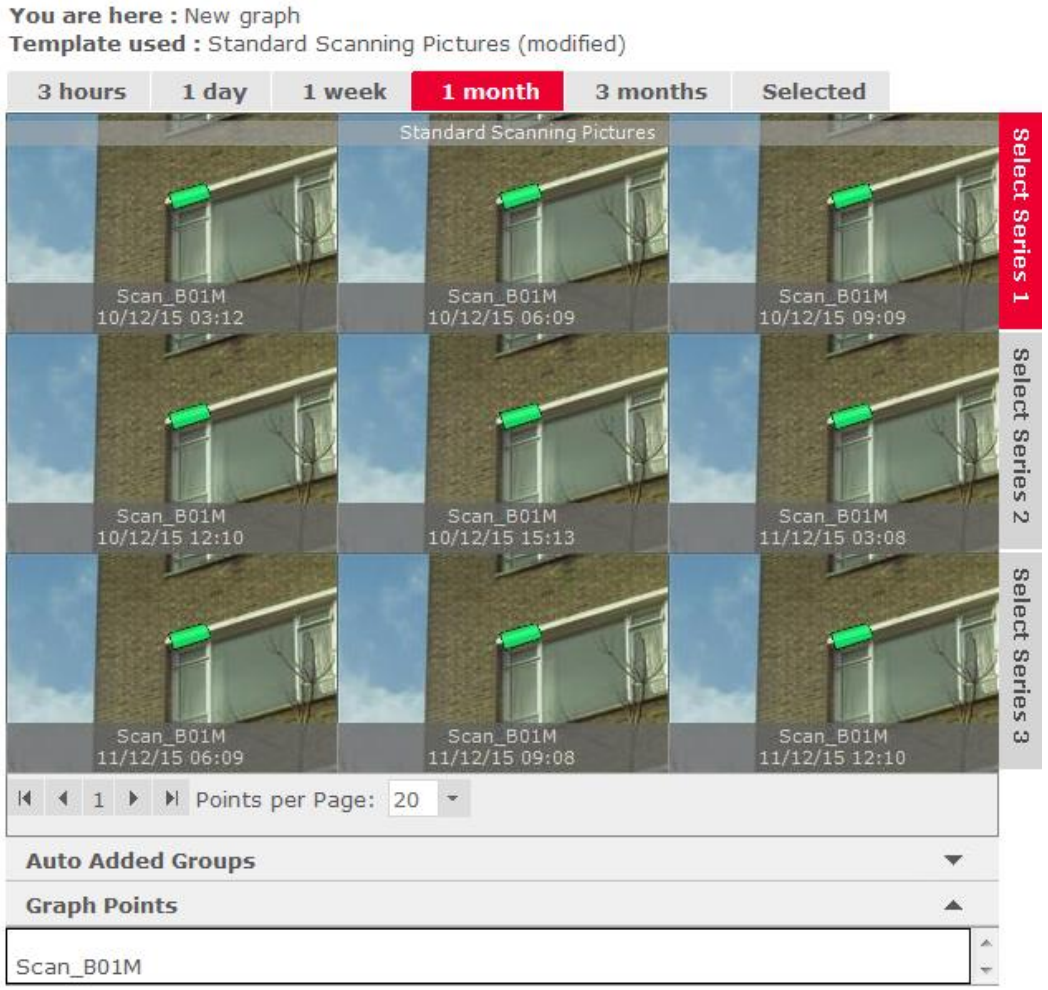
- 真实数据报告 Presentation of real data
  - GeoMoS Now!扫描和图像

  GeoMoS Now! Scanning and Imaging



1个月的建筑数据 1 month of building data



GeoMoS Now!

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- 来自项目现场的实际应用 Projects – from the field …




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发展前瞻 Future possibilities

- 支持扫描仪

Support real scanner – geo-referencing

  - 高数据量传输 transfer high data volumes
  - 高处理能力 high processing power
  - 高级滤波器 Advanced filters
- 结合影像和雷达传感器

Sensor Fusion with imaging and radar

  - 数字图像-亚像素

  Digital image correlation – sub pixel
  - 雷达进行远程无振动监测

  Remote less vibration monitoring with radar

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结论 Conclusion

- 毫米精度（表面平整度）mm accuracy (flatness of the surfaces)
- 可靠的中位数结果 Reliable median results – robust and reliable median results
- 减少棱镜安装（例如，悬垂，良好的反射表面）Reduce prism mounting depending on the structure (e.g. overhangs, good reflecting surfaces)
- 在道路拥堵情况下监测公路Monitor highway settlements – under high traffic load
- 多个小的扫描区域-坚实可靠Multiple small scan areas – robust and reliable versus
- 单次大面积扫描 Singe large scan area – limited performance because unexpected effects

谢 谢