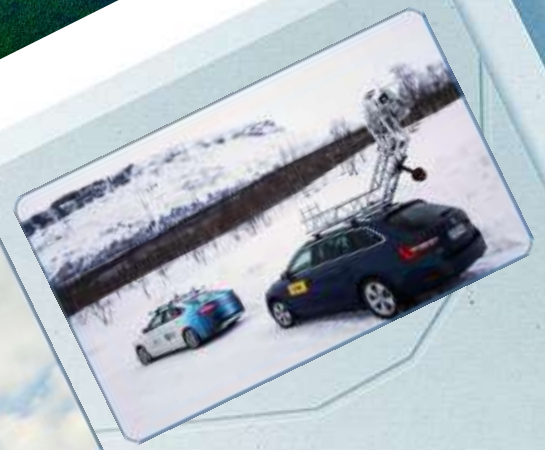
NLS
FINNISH GEOSPATIAL RESEARCH INSTITUTE
FGI

Academy of Finland:
flagship UNITE 2020-2024

Centre of Excellence
in Laser Scanning Research

Laser scanning research generates benefits for society in Finland

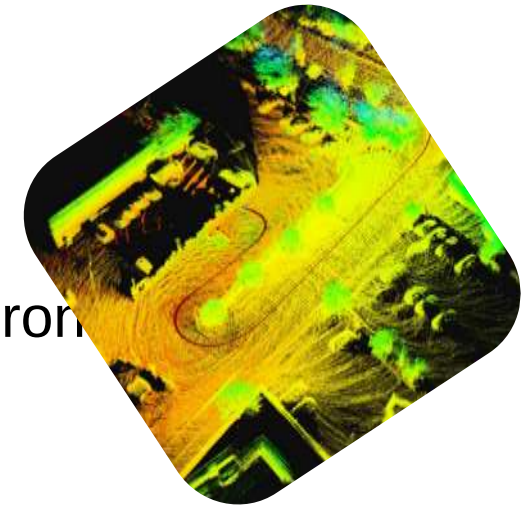


Outline

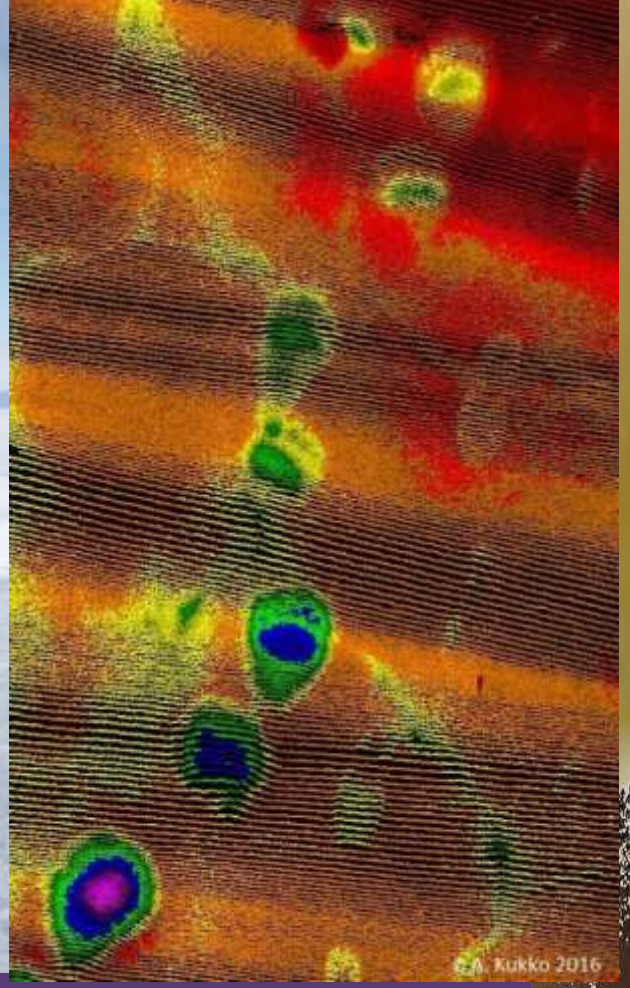
- What is FGI?
- Example problems we aim to solve
- How we do it?
- Forests
- Corridors
- Autonomous big data
- Summary of some selected benefits

What is FGI ?

- Research Organisation belonging to the National Land Survey of Finland
- Academy of Finland (corresponds to NSF in US), state of Finnish research, 2018 and 2021: FGI is the highest quality research organisation in Finland, Drone and laser scanning research among best 24 research areas in Finland, out of 1000+ analysed
- FGI has 4 Departments – Remote Sensing and Photogrammetry
- Academy of Finland funding is considered as one quality indicator
  - Department has numerous running Academy of Finland projects
  - Academy flagship (7th flagship granted Nov 2020, ranked as “Game Changer”)
  - Centre of Excellence 2014-2019
  - Academy SRC 2015-2021
  - Most of projects combine top science and impact
- 4 research groups, mixing Autonomous Mapping, surveying, robotics, dron image data and point cloud

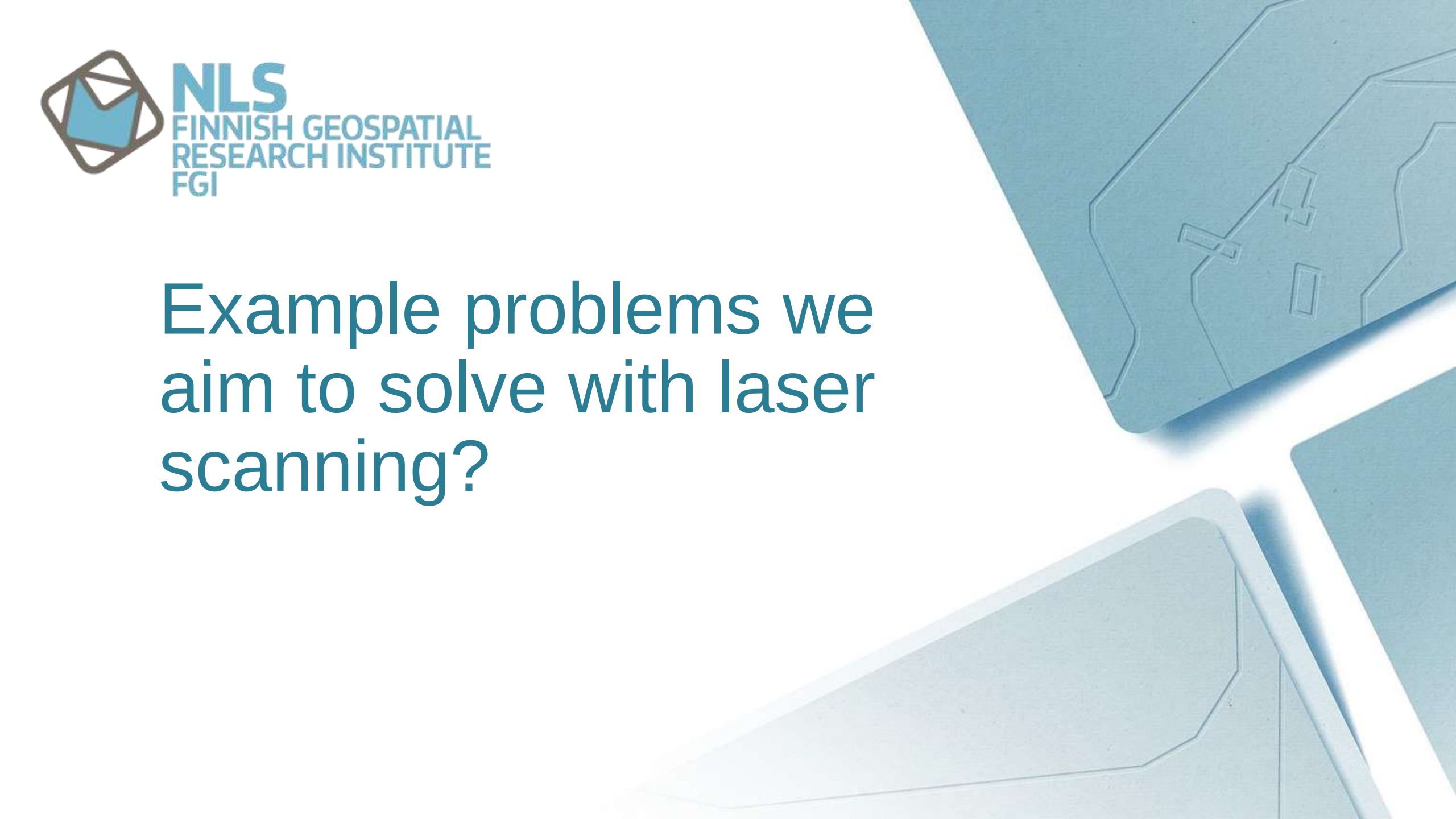


Everywhere – in any airspace/ground



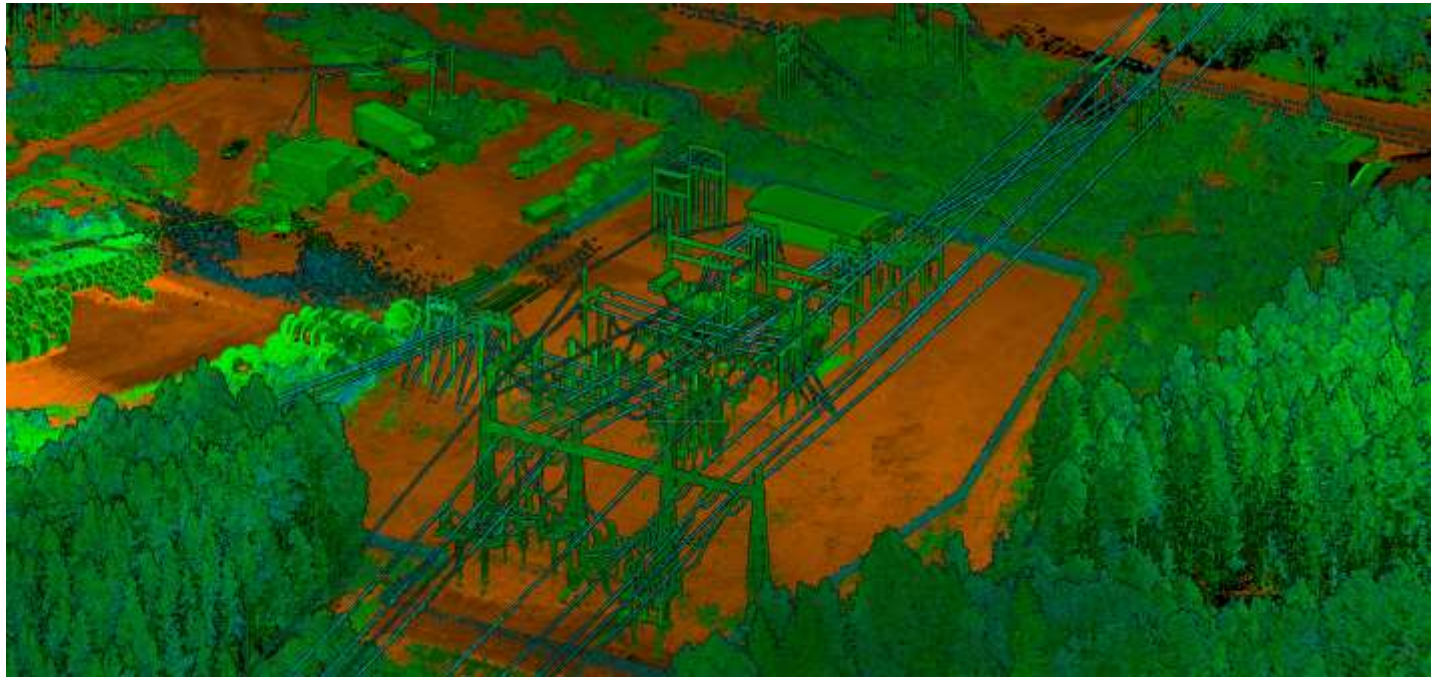
NLS
FINNISH GEOSPATIAL
RESEARCH INSTITUTE
FGI

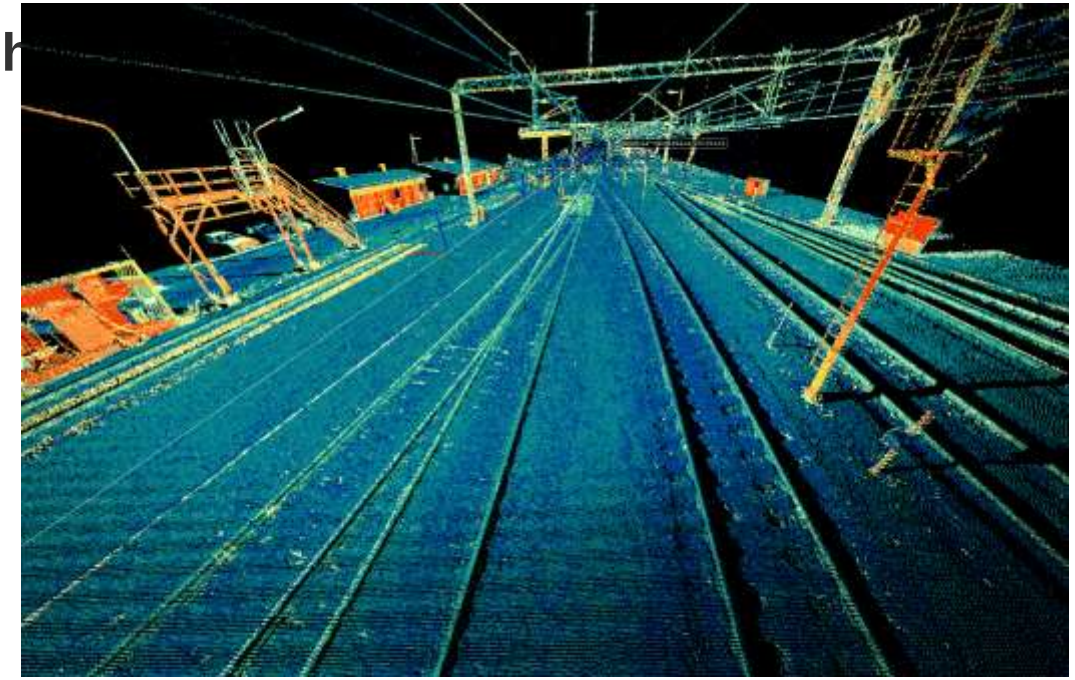
Example problems we aim to solve with laser scanning?



The problems we are solving - corridors

- Finland has 400 000 km of roads. Finnish roads, railways and other moving networks are lacking 2.5 billion € for maintenance. New debt is obtained 0.1 B€ annually.
- Proper, timely and selective road maintenance thus becomes an important principle which lengthens the life of the pavement and also reduces the cost of maintenance. The savings in Finland could be several tens of million of € in optimized maintenance.





The problems we are solving – improved positioning

- The best localization techniques for autonomous driving are strongly based on the concept of a high-resolution probabilistic map, i.e, a HD map created with Lidar data.
- In 2019, the global HD Map market size was USD 589.5 million and it is expected to reach USD 23280 million by the end of 2026, with a compound annual growth rate (CAGR) of 68.3% during 2021-2026. There are 64.3 million road kilometres in the world, out of which 5 million km in Europe, and 225 million km of streets.
- HD maps could provide a new way for indoor positioning and modelling.
- Autonomous driving + drone could automize cadastre mapping for future

Therefore, we are developing HD mapping techniques for autonomous car, indoor and other application area positioning as well as autonomous big data applications

The problems we are solving - forests

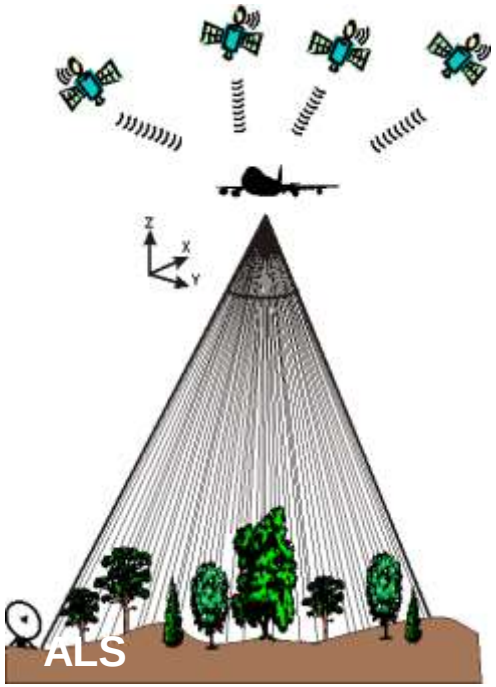
- Finland has more than 600000 forest owners with 2 B€ gross stumpage earnings, several thousands of harvesting companies, 1000+ transportation companies with hundreds of millions euro transportation costs and more than 1000 industrial companies with around 20 B€ total direct turnover. Forest sector employs 140,000 people and produces € 4 billion in taxes annually.
- According to Kangas et al. (2019), even current raster maps carried out every 5 years could provide added value with a level of 56€ /ha in well-informed decisions to owners and all parties involved in the wood trade. However, according to Kangas et al. (2019), improving the RMSE of stem volume estimates by 1 percent unit would benefit the forest owner by 4€ /ha (corresponding to 80M€ for whole Finland).
- It is estimated that Finland released in 2020 the total of 48.3 Mtons of greenhouse gasesannually out of which about 20.4 Mtons was mitigated by the land use, land use change and forestry sector.
- Alone efficiency increase of >10% due to improved positioning in harvesting business having 450M€ costs means 45M€ annual savings in Finland.

We are, thus, improving forest maps, improved carbon sink estimates, and positioning inside forests

NLS
FINNISH GEOSPATIAL
RESEARCH INSTITUTE
FGI

How we do it?

Same Sensors/Technologies in different platforms



Airborne Laser Scanning

Mobile Laser Scanning

We study whether the problem can be solved by

- National laser scanning data
- High-density airborne data
- Mobile laser scanning
- Drone laser scanning
- Autonomous big data

Same Sensor = close to same technology

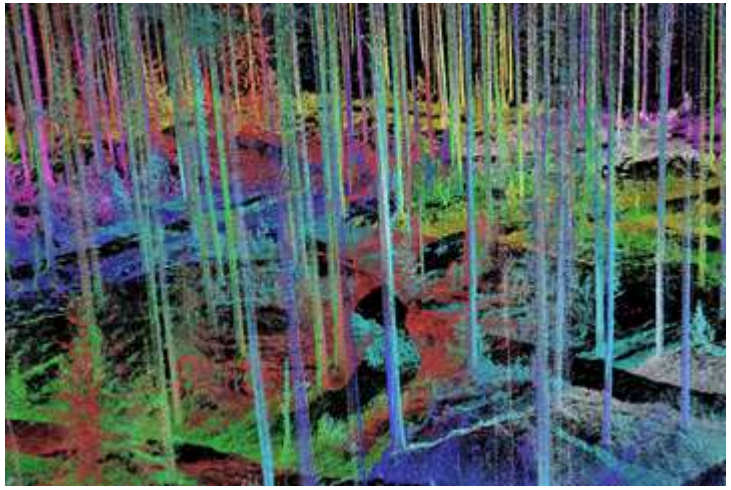
Centre of Excellence in (Mobile) Laser Scanning Research

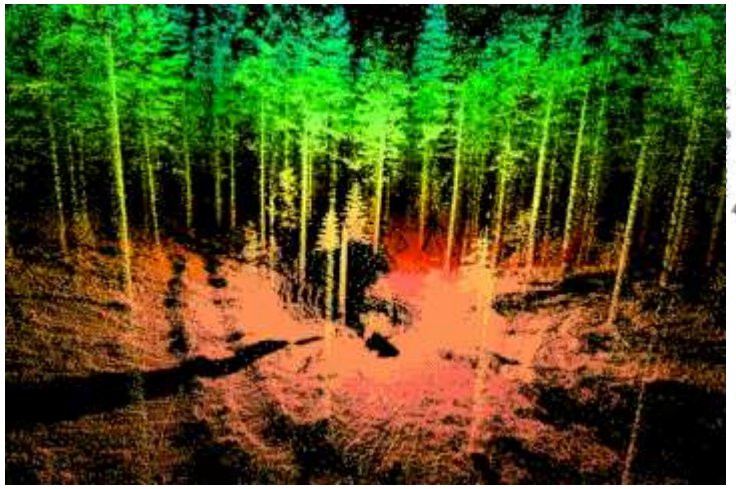
NLS
FINNISH GEOSPATIAL
RESEARCH INSTITUTE
FGI

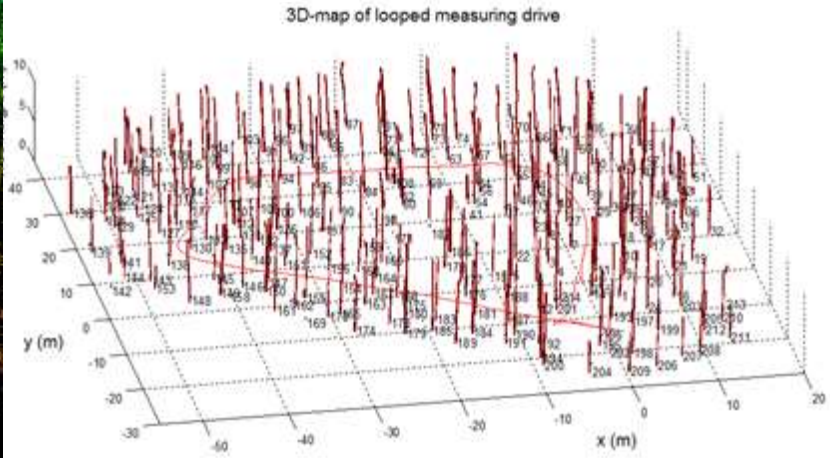
Forests

Quality derived for all trees in Finland

POMSE

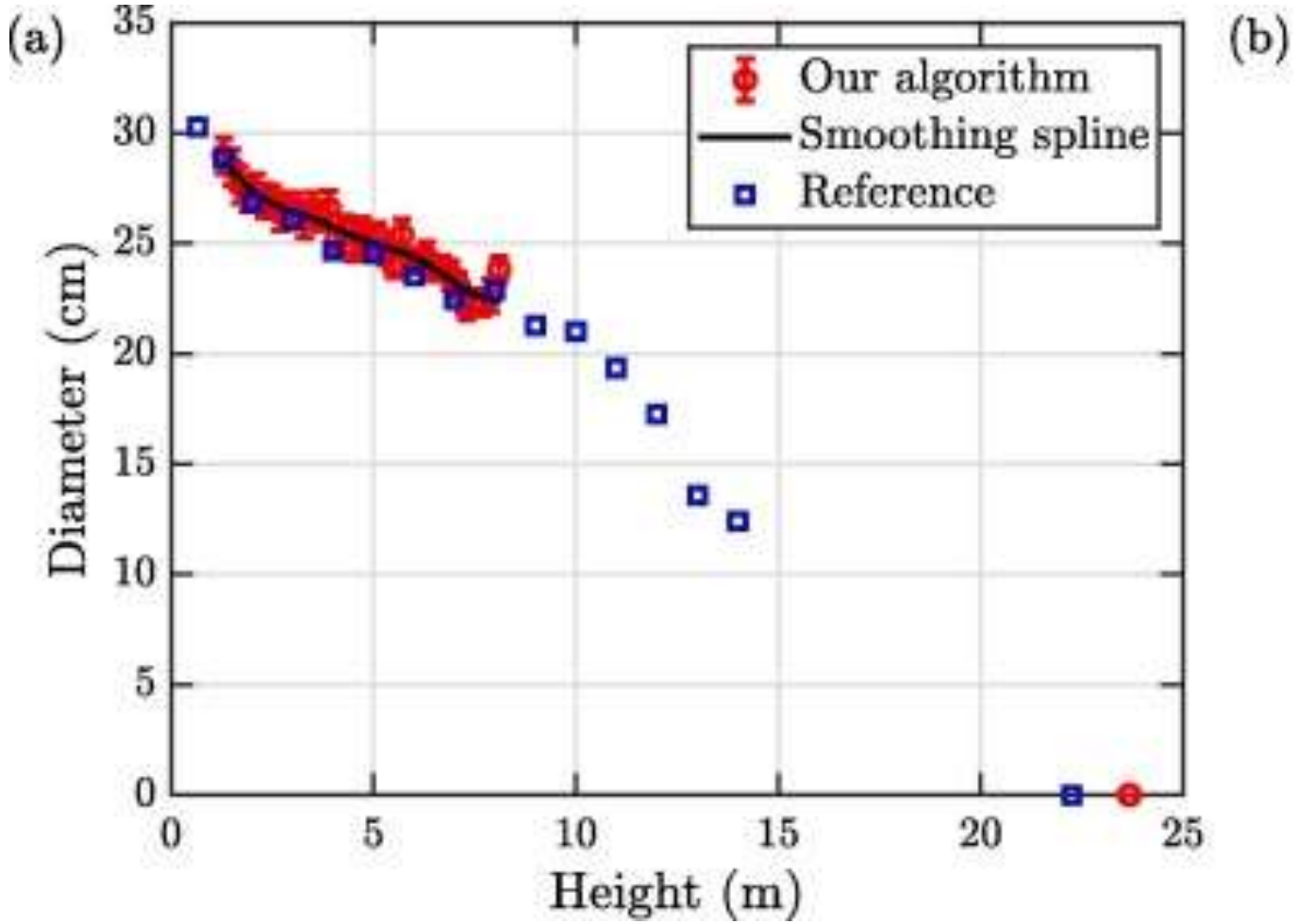




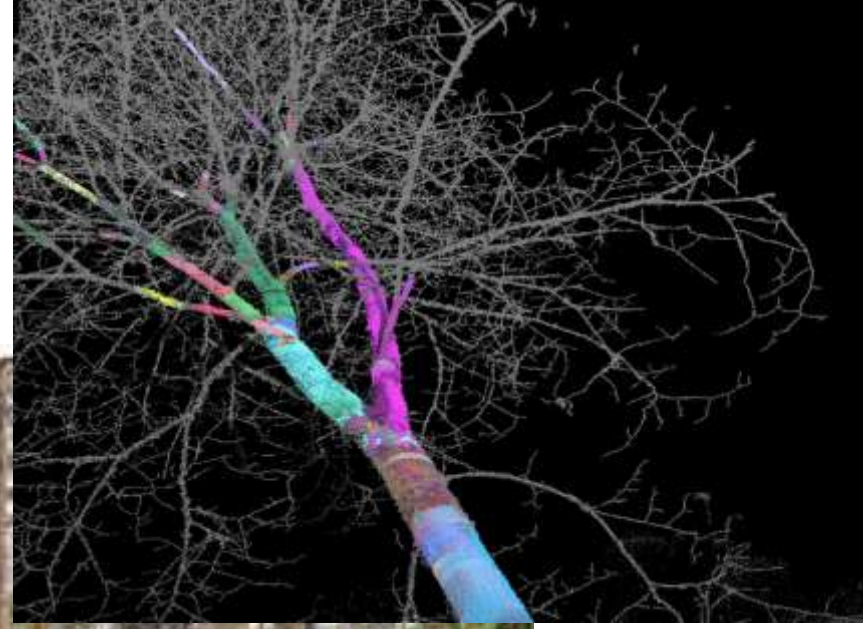

3D-map of looped measuring drive
y (m)
x (m)

Hyyppä, E., Hyyppä, J., Hakala, T., Kukko, A., Wulder, M.A., White, J.C., Pyörälä, J., Yu, X., Wang, Y., Virtanen and Pohjavirta, O., 2020. **Under-canopy UAV laser scanning** for accurate forest field measurements. ISPRS

Automatically high-quality reference



(b)

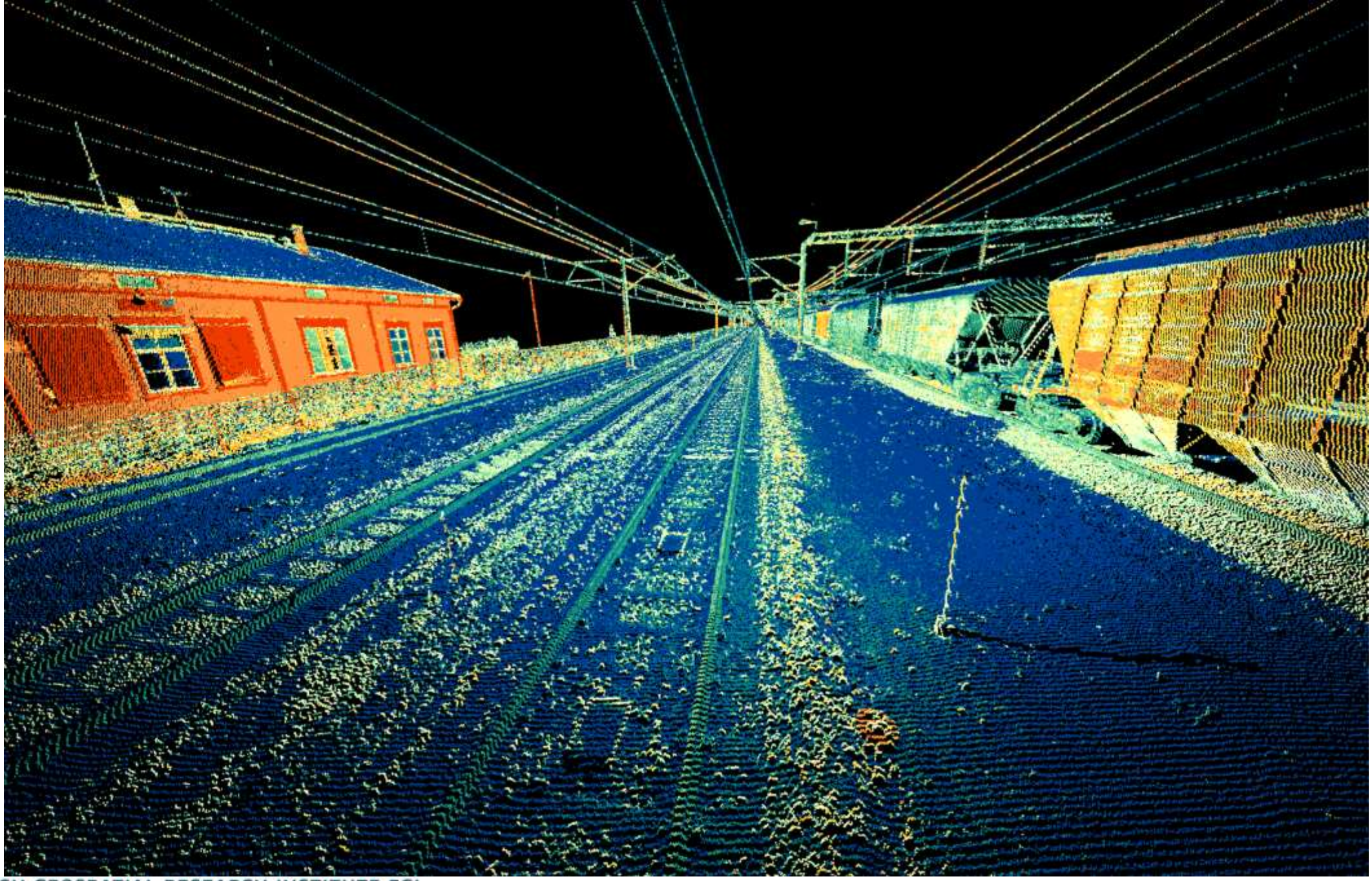


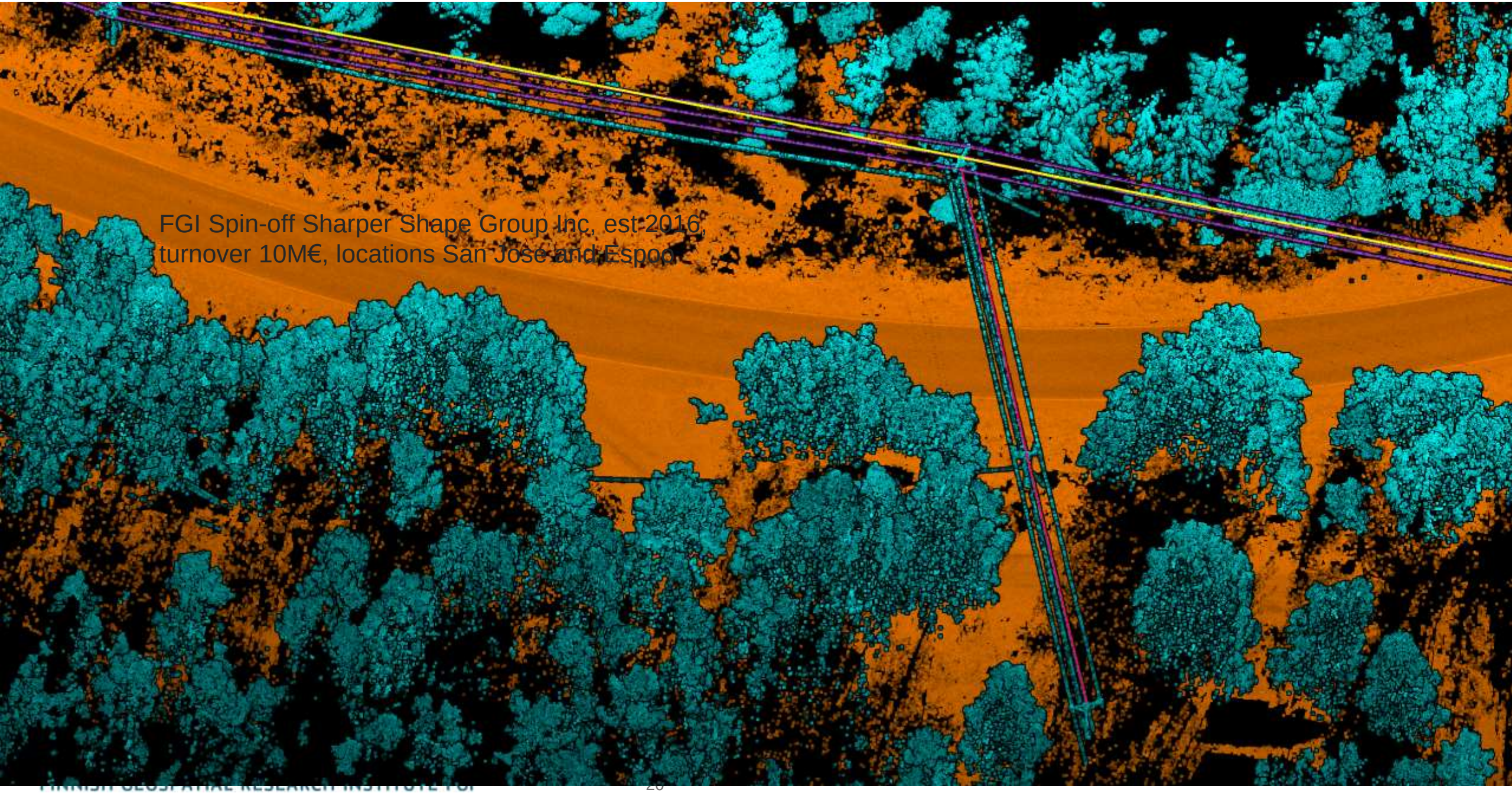
NLS
FINNISH GEOSPATIAL
RESEARCH INSTITUTE
FGI

Corridors

Road Distress Mapping

El Issaoui, A., Feng, Z., Lehtomäki, M., Hyyppä, E., Hyyppä, H., Kaartinen, H., Kukko, A. and Hyyppä, J., 2021. Feasibility of mobile laser scanning towards operational accurate road rut depth measurements. *Sensors*, *21*(4), p.1180.




FGI Spin-off Sharper Shape Group Inc, est 2016,
turnover 10M€, locations San José and Espoo

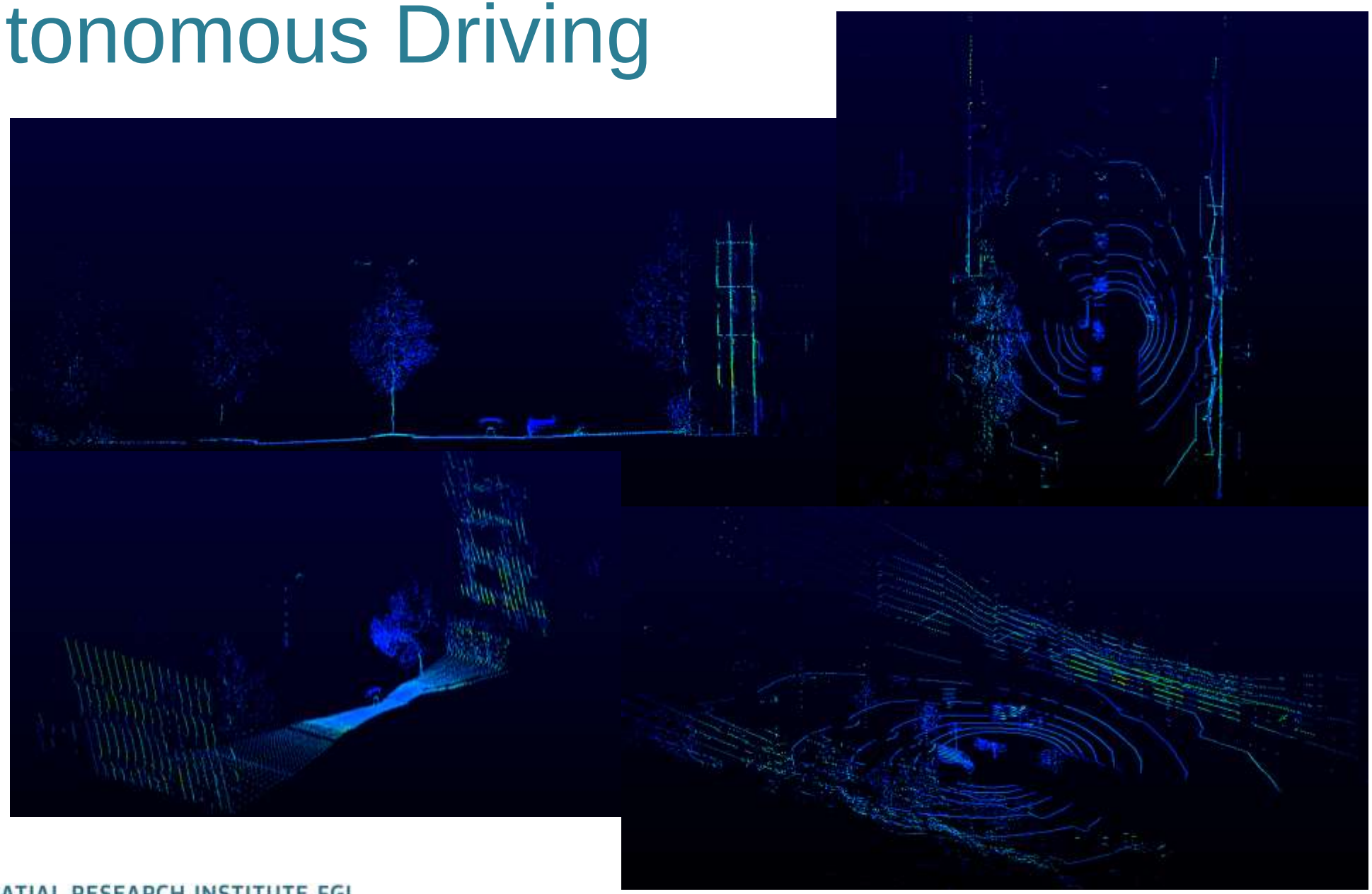
NLS
FINNISH GEOSPATIAL
RESEARCH INSTITUTE
FGI

Autonomous Big Data and HD maps

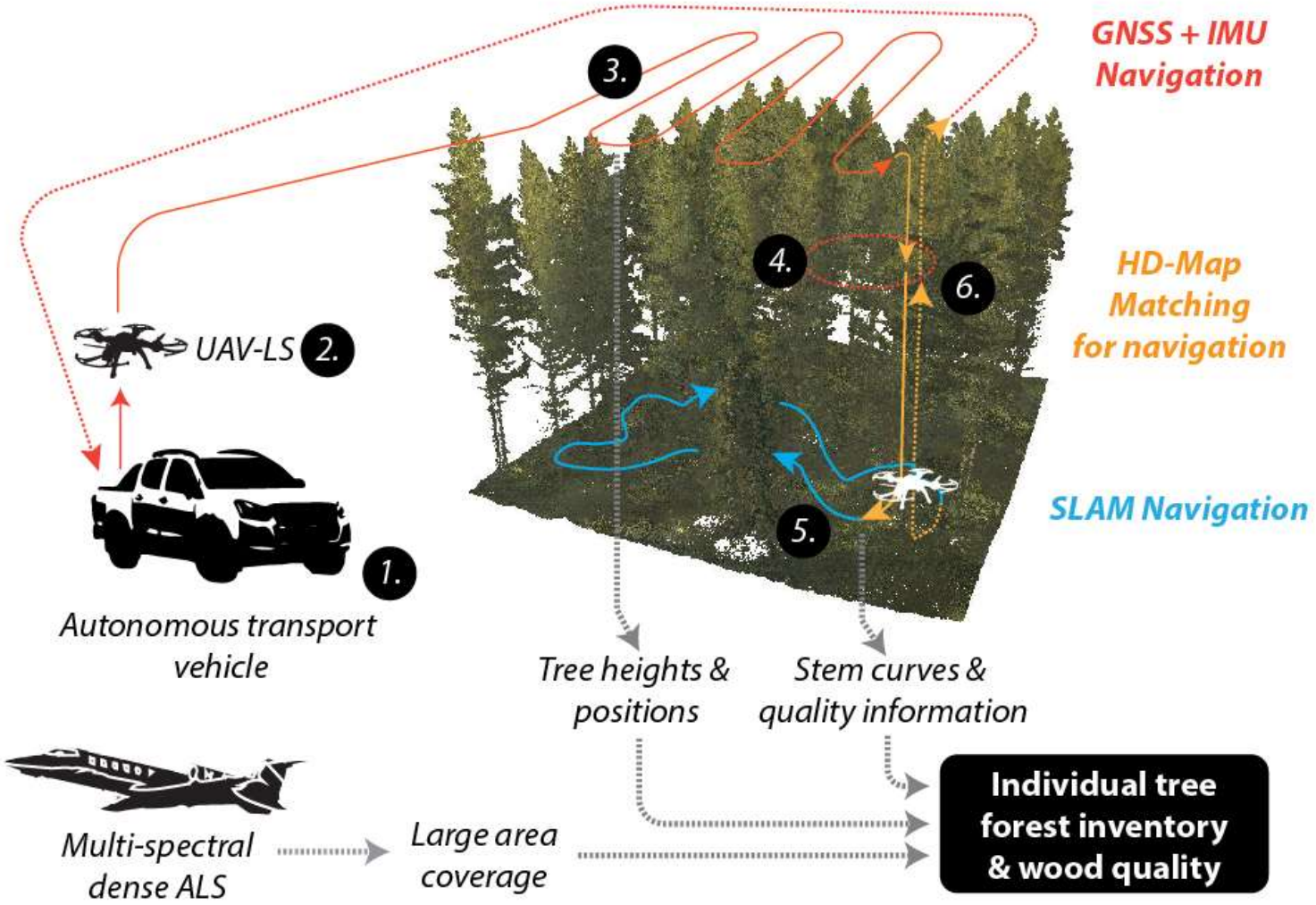
Autonomous driving in all conditions

Maanpää, J., Taher, J., Manninen, P., Pakola, L., Melekhov, I. and Hyyppä, J., 2020. Multimodal End-to-End Learning for Autonomous Steering in Adverse Road and Weather Conditions. *arXiv preprint arXiv:2010.14924*.

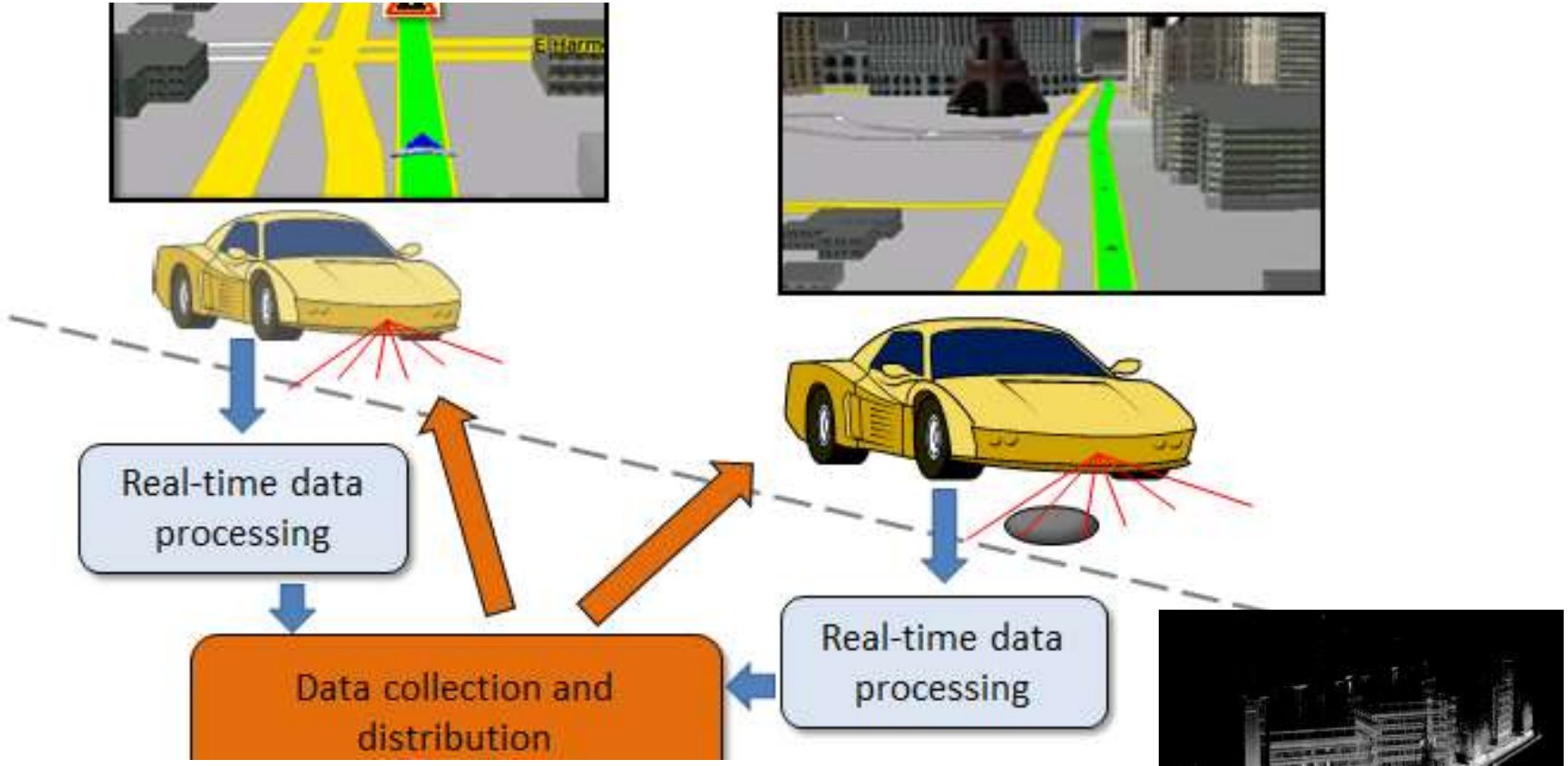
Autonomous Driving



Same technology for cadastre surveys



Coming Big Data



Summary of some selected benefits

20 M€ annually as savings to Finnish goverment

Several M€ annual savings in DEM

National laser scanning is open data, thousands of users

100-200+ M€ annual savings coming in forestry in improved data and logistics (including efficiency using improved positioning)

Multiple use of road MLS data in future, including HD maps and autonomous big data

10 spin-offs created during CoE, e.g. FGI Spin-off Sharper Shape Group Inc, est. 2016, turnover 10M€, locations San Jose and Espoo

We have educated 30+ profs to 12 Universities and research organizations