

# Influence of Mining Innovation on other Sectors



Engineering

**En**

Performance

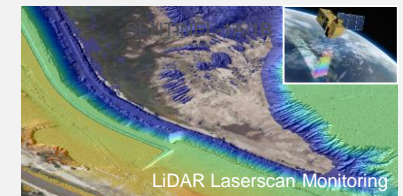
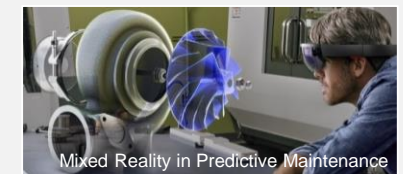
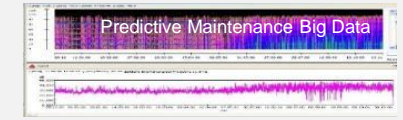
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# Key Innovations in Mining Technology



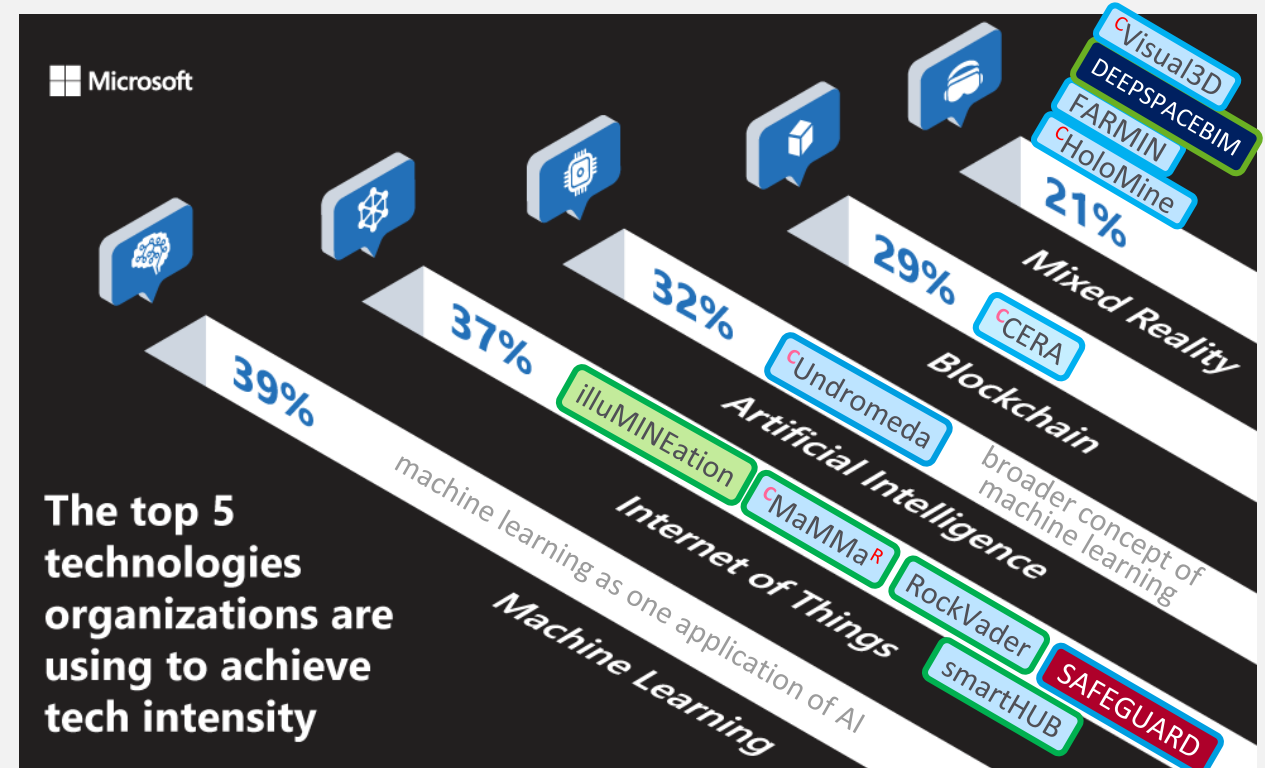
- **Unmanned autonomous mining** → haulage systems (e.g. Caterpillar, Komatsu)
- **Big Data Analytics & Predictive Maintenance** → big data (5G) compilation and real-time analysis of operational machine data for enhanced efficiency and cost reduction in (predictive) maintenance cycles → growing demand for IT security for IoT systems.
- **(Holo)Graphic Dashboard Visualization for Mixed Reality Mine Inspection & Quality Controlled Mining** → dashboard holographic visualization of mine infrastructure and ore grade data.
- **Tailings & Landslide Monitoring** → automated deformation monitoring for improved early warning systems for tailings failure.
- **Mine Waste Recycling** → Sensor-based automated mine waste (radionuclide) classification, sorting and automated recycling of (phosphogypsum) for reprocessing into raw material ( $^{226}\text{Ra}$ ) pharmaceutical cancer medication.
- **EU Principles for Sustainable Raw Materials** → Industry shift towards sustainable value chain for mineral resources. European screening of auditable sustainability schemes and certification standards.



- Digitalisation
- Construction & Natural Hazard Monitoring
- Medical & Pharmaceutical Industry
- Hydrogen
- Sustainability

# Digitalization Next Level

- Digitalization remains **denominator of technological innovation in raw materials sector**.
- Explosive growth of data, and emergence of powerful AI & machine learning tools will **unlock insights in data to drive new values and opportunities** → primary catalyst for progress and disruption in the 2020-2030s.
- **Digitalization Next Level: TechIntensity** i.e. organization's rate of technology adaption along with its ability to build its own digital capabilities → **TechIntensity** will determine an organization's future.



SOURCE: MICROSOFT, The State of Tech Intensity 2019 Study, by YouGov, % represent organisations surveyed (Volkswagen, Airbus, Novartis, Unilever, Waalgreens)

## IMPORTANT UNDERSTANDING

**Artificial Intelligence** is the broader concept of machines to carry out tasks in a way that we would consider “smart”.

**Machine Learning** is a current application of AI based around the idea that we give machines access to data and let them learn for themselves.

# Actual Benefits of Digitalisation



- **Amazon Robotics** (Boston, MA) – IoT enabled KIVA robots to improve warehouse efficiency
  - OPEX reduction **-20%**
- **Harley Davidson** (York, PA) - IoT enabled tracked production & real-time performance management
  - Production cost reduction **-7%**
  - Employee production **+2.4%**
  - Increased net margin **+19%**
- **Komatsu Mining Corp.** (Milwaukee, WIS) – Innovative autonomous 200t haulage LTE vehicle (IAHV)
  - Increase in mine safety, efficiency, and productivity **>20%**
  - Optimized maintenance cycles
  - Reduced fuel consumption & emissions



SOURCES: [www.forbes.com](http://www.forbes.com), [www.techinsider.com](http://www.techinsider.com); accessed 22.8.2019, and Komatsu Mining Corp, Innovative Autonomous Haulage LTE Vehicle (IAHV), 200t, accessed 22.8.2019

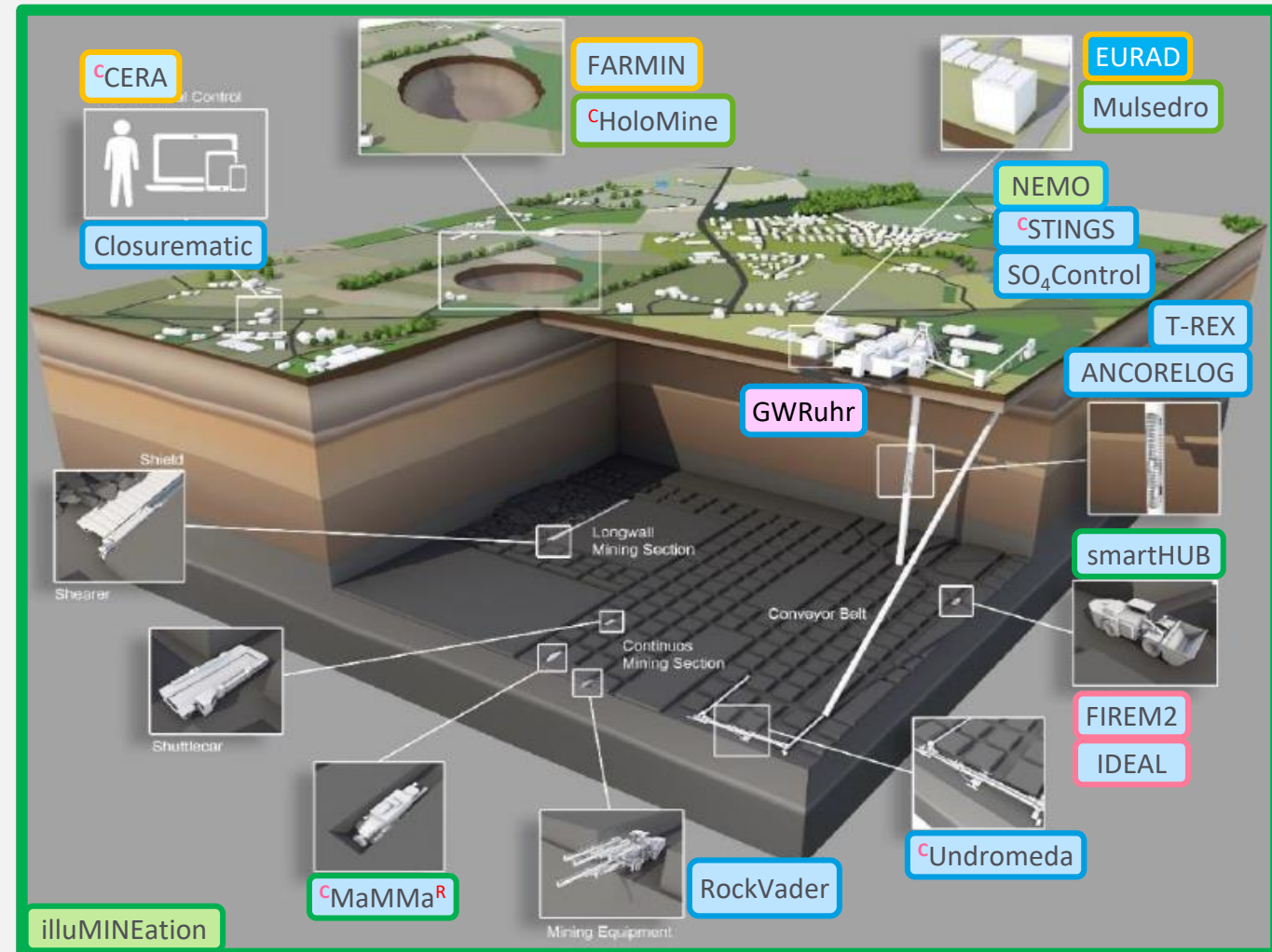
# Industry Needs & Priorities for Digitalisation

in the Raw Materials Sector



## The Digital Mine

- Unmanned Mining for max. safety and enhanced productivity
- Automated – Remote Controlled – Autonomous
- Material-Tracking-Systems for mine waste and tailings materials, monitoring and re-processing
- Optimized Predictive Maintenance – safer, faster, more cost-saving
- Mixed Reality as high-tech communication tool
- IoT based real-time processing



# Selected Research and Development Projects



## DEMO of a digital mine IoT system prototype

### illuMINEation

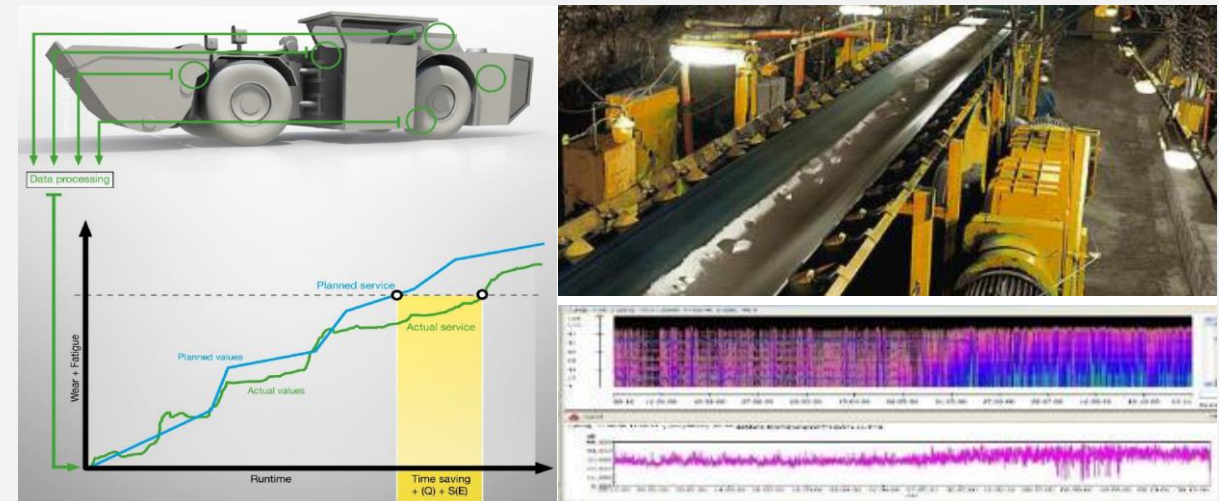


### Product

- IoT-platform for automated condition monitoring of mining machines with visual dashboard for real-time condition monitoring of mining machinery underground and open-pit.
- Improved algorithms and novel user interfaces for condition monitoring of analysis while drilling, rock bolt status monitoring, tailings storage monitoring, predictive maintenance of 3D printed machine replacement parts.

### Result – 5 Use Cases

- Fluorite mine Lujar, Minera de Orgiva, Spain
- Magnesite mine Breitenau, RH Magnesita, Austria
- Tailings storage Zelazny Most, KGHM Polska Miedz, Poland
- Underground Zn-Cu-Au Boliden, Sweden
- Mining equipment, Epiroc Rock Drills

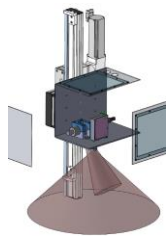


# Selected Research and Development Projects



## Automated Drill Core Scanning and Analysis

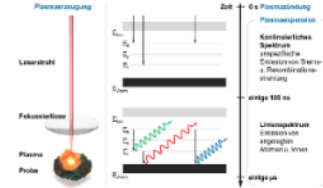
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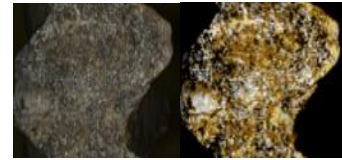
XRF



RAMAN



LIBS



Hyperspectral Imaging

### Product

- Mobile drill core logging system that measures chemical, mineralogical, and textural rock properties with high accuracy (XRF, LIBS, VIS-SWIR, RAMAN).
- Smart classification algorithms convert measured properties ("big data") into geological domains ("intelligent data") on-site in real time into classification models.

### Result

- Output: Classified Drill Core.
- Digital drill core library (database) compatible with 3D modeling, on-line data accessibility.

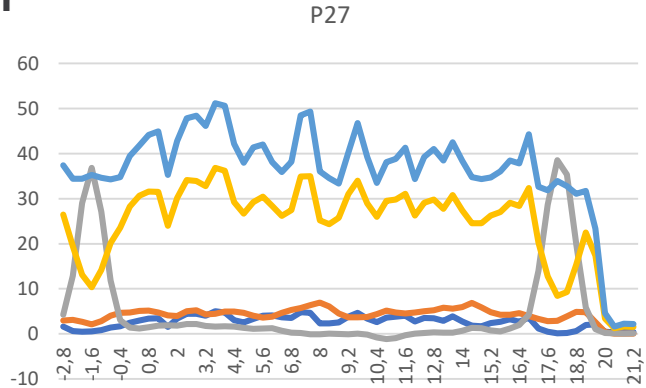
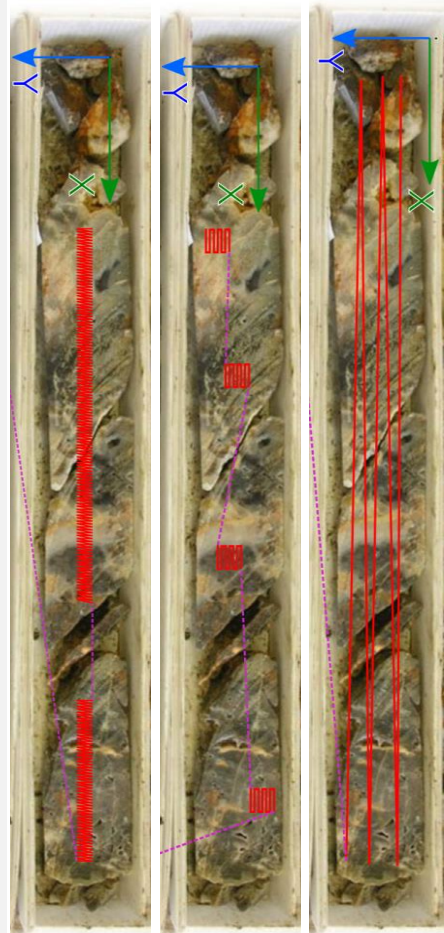




# Selected Research and Development Projects



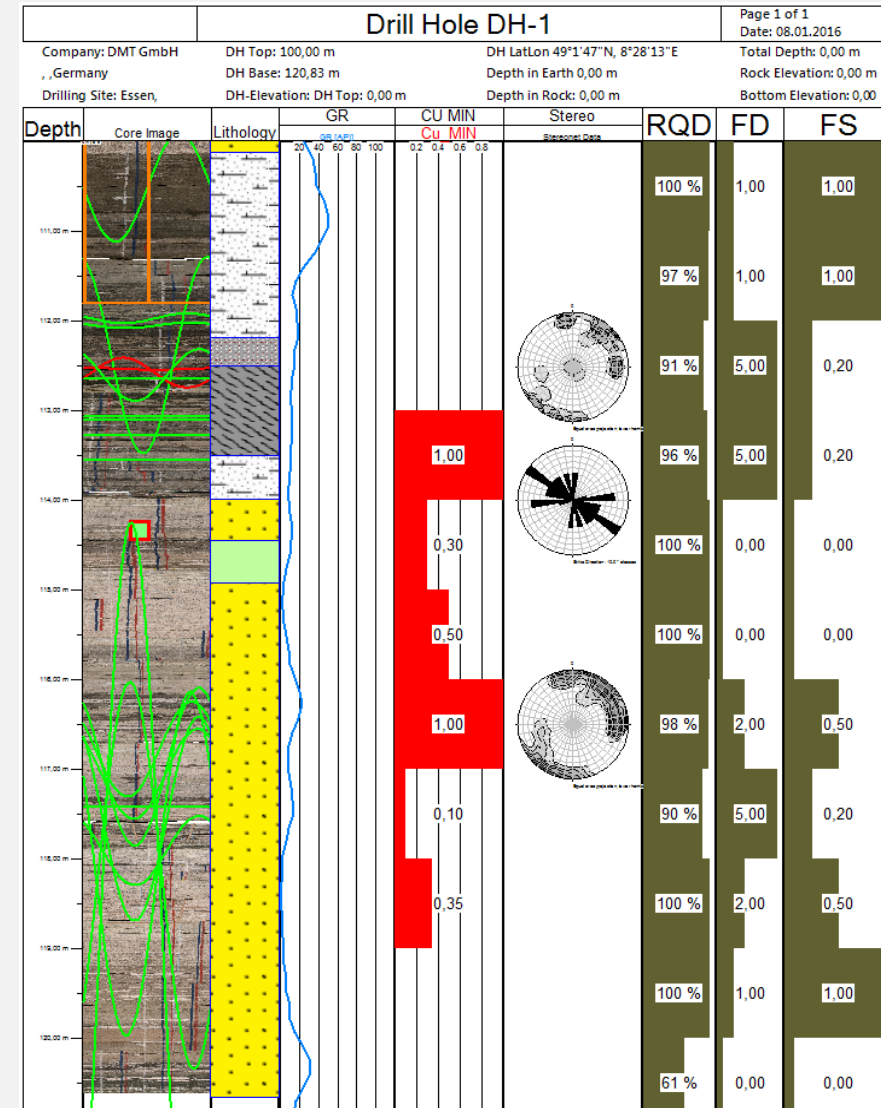
## Example: XRF sensor



— Copper (%)    — Zinc (%)    — Lead (%)  
— Iron (%)    — Sulphur (%)



- Continuous profile measurement width 5 mm.
- Scan speed and measurement integration time case specific / adjustable.
- Integration time 5-120 sec.
- Site-specific sensor calibration with reference measurements (e.g. bulk chemistry) on representative samples.



# Selected Research and Development Projects



## Digital Construction Assistant

### DeepSpaceBIM



#### Product

- DMT **Pilot3D BIM** for construction monitoring via LiDAR laserscan integration service.
- Digital construction assistant for alignment of planned geodata with actual surveyed construction progress.
- Construction progress monitoring via LiDAR-scanning and augmented reality visualisation for the BIM construction industry.



#### Result

- Mobile LiDAR monitoring of construction progress.
- LiDAR point-cloud data converted into 3D model for comparison with planned geodata.

Commercial Support Partner: Microsoft HoloLens



3D matching of planned and actual construction



Pilot3D for georeferenced positioning

# Selected Research and Development Projects



## Digital Construction Assistant

### DeepSpaceBIM



Bundesministerium  
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digitale Infrastruktur

**mFUND**

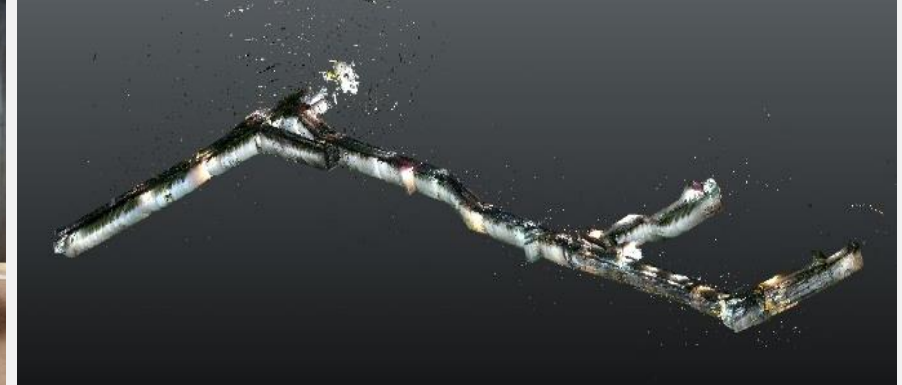
TRL 7

### DMT Pilot3D BIM

- All-in-One system: 2 solid-state LiDAR sensors, display, stereo tracking camera and RGB camera for 6DOF real-time navigation data, positioning and trajectory, timestamp, CPS, RAM, 2 LEDs, battery pack.
- Pilot 3D accuracy improvement from 10cm to 1cm.

### Applications

- Cloud data connection for AR solutions, IFC/BIM data, GIS models, SiGeko training simulation.



# Selected Research and Development Projects



## Integrated Mine Impact Monitoring

### i<sup>2</sup>MON



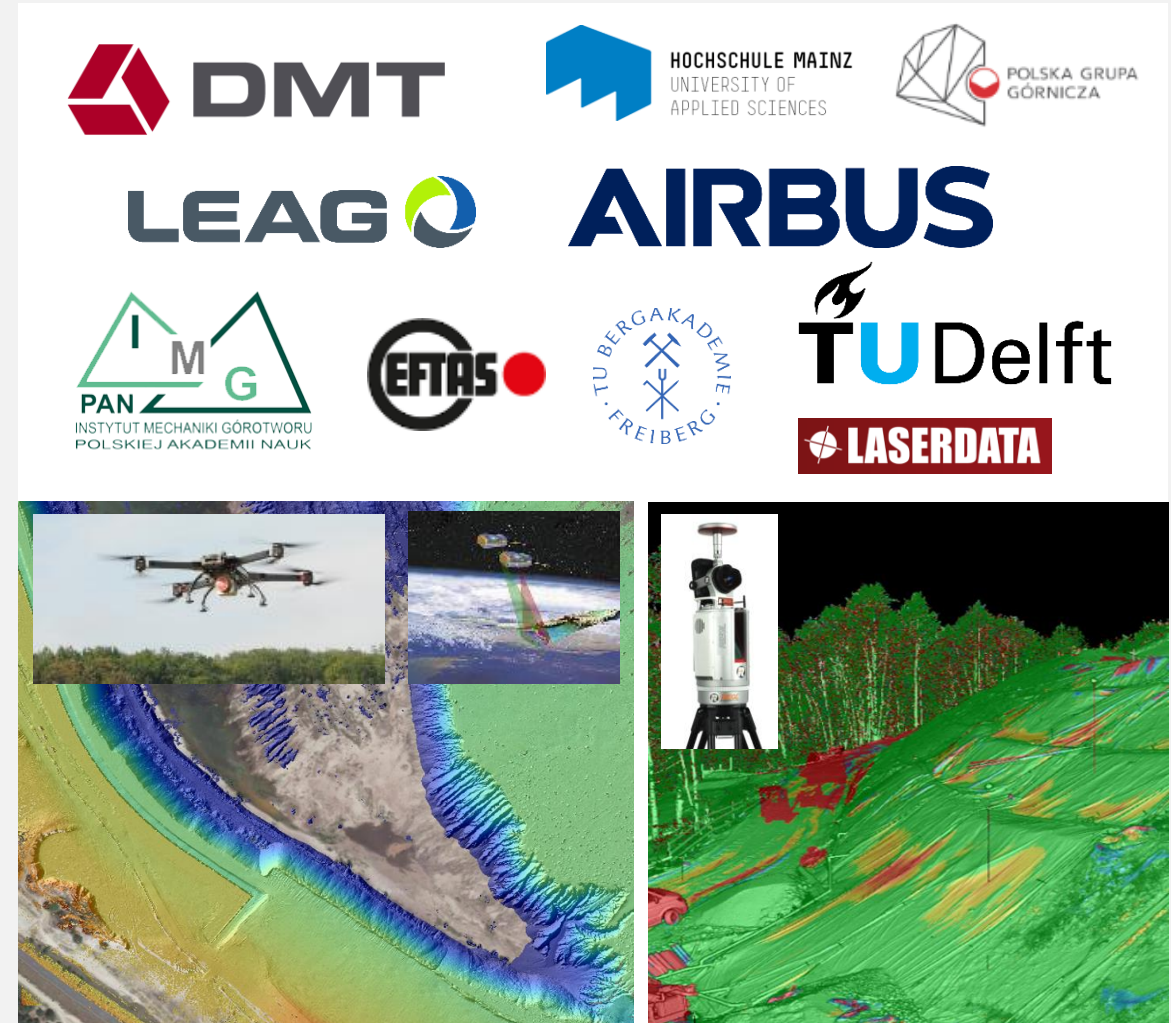
TRL 8

#### Product:

- **Development of innovative monitoring tools for enhanced ground and slope deformation monitoring** using laser scanning, space borne (Sentinel, TerraSAR-X PSI) and airborne (UAV) technology
- **Identification of physical processes** and development and implementation of suitable modelling methods
- **Development of the integrated monitoring platform**, including data ports, database, analysis and visualization functionalities

#### Result:

- Implementation of a complete integrated monitoring and analysis service regarding ground and slope deformation for the coal mining community.



# Medical & Pharmaceutical Industry Applications



- Covid-19 pandemic **testing of medical equipment.**
- **Toxicological assessment** of coal dust on human health (ROCD).
- Examples of mineral raw materials ingredients contained in selected drugs:
  - **Lopinavir** (HIV and HPV anti-viral) contains mineral based silica, talc, titanium, and iron,
  - **Remdesivir** (Ebola anti-viral) contains phosphate, calcium, silica, magnesium, titanium,
  - **Xofigo** contains  $^{223}\text{Ra}$  (raPHOSafe  $^{226}\text{Ra}$  →  $^{223}\text{Ra}$  from phosphogypsum tailings processing).



# Selected Research and Development Projects



## Reducing risks from Occupational exposure to Coal Dust

# ROCD



TRL 7

### Product:

- DMT Dust Monitoring Instrument (DMI) solves 3 critical issues related to dusts in underground mines:
  1. Market demand for ATEX certified, calibrated continuous dust concentration monitoring systems
  2. Quantitative physical-chemical assessment protocols for mine dusts and predictive tools to assess dust hazards in different mining scenarios
  3. Improving risk management and operational efficiency, by optimizing dust mitigation and suppression measures

### Result:

- Collection of separated dust fractions for toxicological assessment
- Online counting of dust fractions
- Enables control of counter measures (e.g. spraying, ventilation)
- Assures compliance with Health & Safety Regulations



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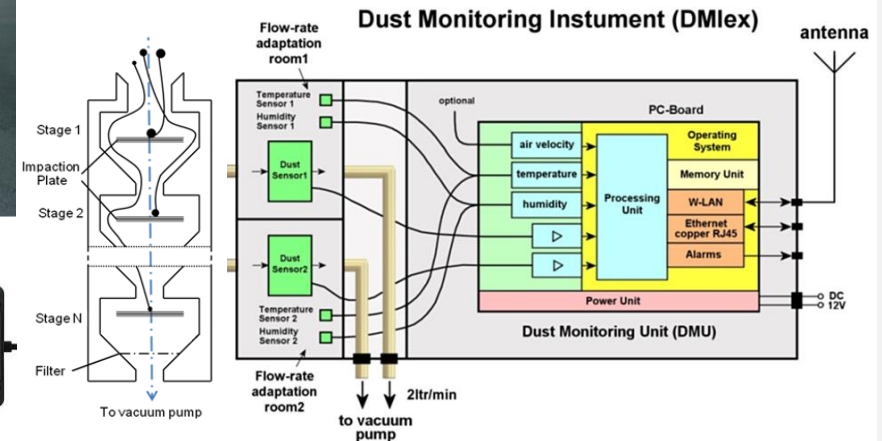
CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS



Łukasiewicz  
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LUBELSKI WĘGIEL  
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# Selected Research and Development Projects



## Radionuclide Classification & Automated Sorting for Phosphogypsum (PG) Materials Recycling

**raPHOSafe**



TRL 7

### Product:

- Construction and calibration of Nukem/DMT patented automated conveyor belt classification system.

### Result:

- Legal EU-radiation compliant classification (1Bq/g) and automated sorting of  $^{226}\text{Ra}$ -rich PG tailings material.
- Cost-saving process for radionuclide remediation of PG tailings by minimising PG material due for radiochemical remediation.
- Near-zero-waste recycling of gypsum material for the construction industry.
- Extraction of  $^{226}\text{Ra}$  for further processing to  $^{223}\text{RaCl}_2$  as sought-after raw material for treatment of bone metastasis of prostate cancer medication (6 cycles, treatment cost ca. 63 T€).
- Potential for global application for radionuclide-bearing materials disposal with target capacity: >8 t/hr.



# Hydrogen Initiative



- 169 Industry partners, 78 research partners, 23 associations.
- Currently 244 funded R&D projects (893 million €) related to H2 since 2014.
- Annual R&D calls for H2 funding: FCH JU total: 1.33 billion €





# Hydrogen Sector Applications

## DMT Carbon Management Initiative

- Member of national and international H2 expert networks.
- Develops solutions for H2 readiness and monitoring of European H2/NG transmission and distribution grids.
- Focus on:
  - Testing and monitoring of metal-based transmission and distribution pipelines for structural (physical) **material integrity** (e.g. growth of micro-fractures, H2 embrittlement etc.).
  - Development of **sensor technologies for H2 and H2/NG leak detection** (e.g. online and mobile solutions).



Bundesministerium  
für Wirtschaft  
und Energie



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digitale Infrastruktur

# Sustainability of Raw Materials

European Commission about to publish **EU Principles for Sustainability of Raw Materials** (est. June 2021).

- Existing & upcoming sustainability schemes & certification standards to meet EU Principles.
- **Ongoing screening** of auditable sustainability schemes and certification standards for EU sustainability of raw materials.
- Increasing mining activity expected (on short-intermediate term) to supply technologies for (renewable) green energy & mobility goals (e.g. Li, Co, Ni, Cu, graphite, REE [Nd-Dy-Tb-Pr]) to meet EU Principles.
- **Competition** in leadership over sustainability of raw materials: Increasing competition for THE standard for sustainability of raw materials.
- UNECE concerned about potential green-washing of raw materials supply by unchecked sustainability standards.



# Thank you for your attention !



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**Many R&D projects across business units covering all digitalisation technologies**

**Millions EUR of public funding for growth in innovation & digitalisation – every year**

**Sought-after expert contributor in high-level innovation & digitalisation events around the world**

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**Placement of DMT innovation and digitalisation activities at highest international expert levels and European Parliament advisory boards**

**Award-winning Research**



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Engineering	Performance
<b>En</b>	<b>Pe</b>