

UNEXMIN

AN AUTONOMOUS UNDERWATER EXPLORER FOR FLOODED MINES

UNEXMIN PROJECT: AN UNDERWATER EXPLORER FOR FLOODED MINES

LUÍS LOPES & UNEXMIN CONSORTIUM

USE OF ROBOTICS AND AUTOMATION FOR MINERAL PROSPECTING AND EXTRACTION

BLED, SLOVENIA

30 JANUARY, 2018



LPRC

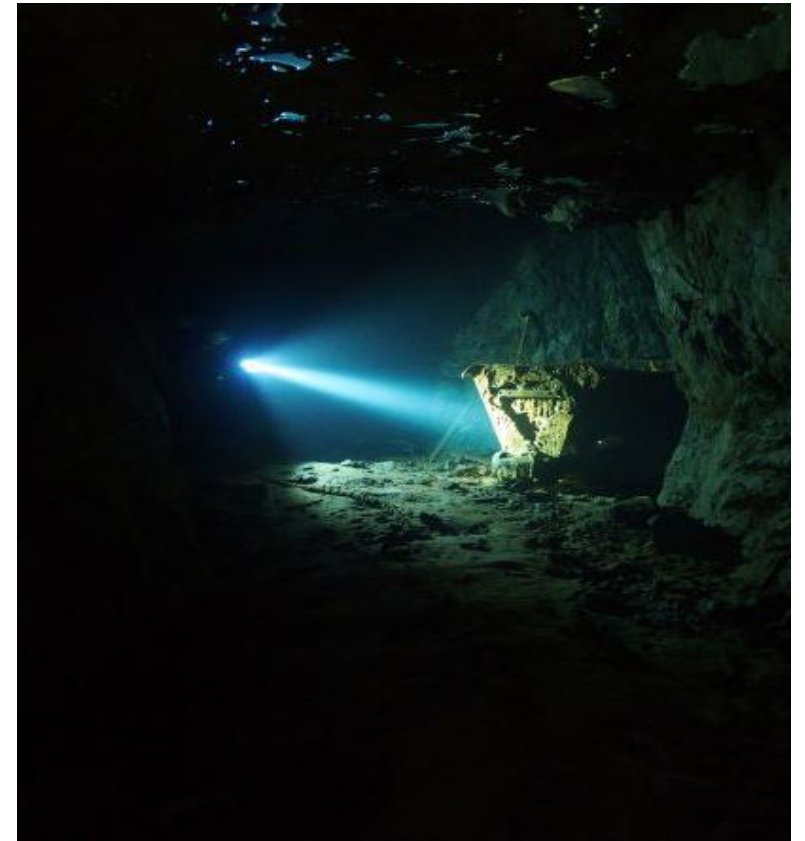
LA PALMA
RESEARCH
CENTRE

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 690008.



KEY FACTS

- EU funded Horizon 2020 project (RIA: Research and Innovation Action)
- 13 partners / 7 countries
- 45 month duration (February 2016 – October 2019)
- Funding: 4.87 million Euros
- Final outcomes:
 - Three prototype robots
 - Company offering the technology to market



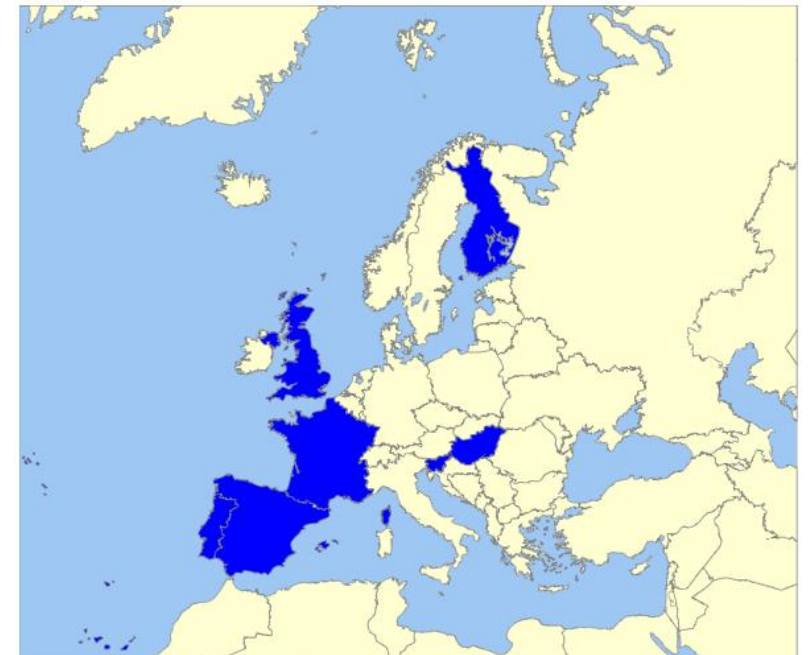
CONSORTIUM

- University of Miskolc
 - Tampere University of Technology, Department of Mechanical Engineering Systems
 - Universidad Politécnica de Madrid, Centre for Robotics and Automation
 - INESC Tec – Instituto de Engenharia de Sistemas e Computadores, Tecnologia e Ciência
-
- Resources Computing International Ltd
 - La Palma Research Centre for Future Studies
 - Geological Survey of Slovenia
 - Geoplano Consultores SA
 - European Federation of Geologists
 - Geo-Montan Kft
-
- Empresa de Desenvolvimento Mineiro
 - Ecton Mine Educational Trust
 - Center za Upravljanje z Dediscino Zivega Srebra Idrija

*Technology
developers*

*Technology
exploitation*

Stakeholders



CONCEPT AND APPROACH

Dependence on import of raw materials



30,000 closed mine sites in Europe



Abandoned deep underground mines become interesting



Most of them are now flooded



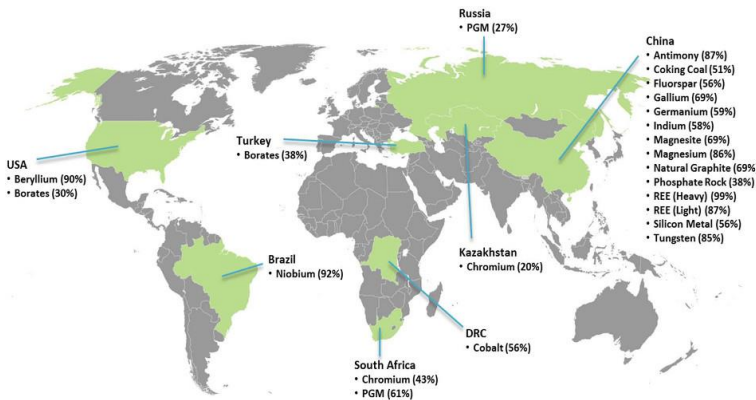
Lack of information on status and layout



PROBLEM!

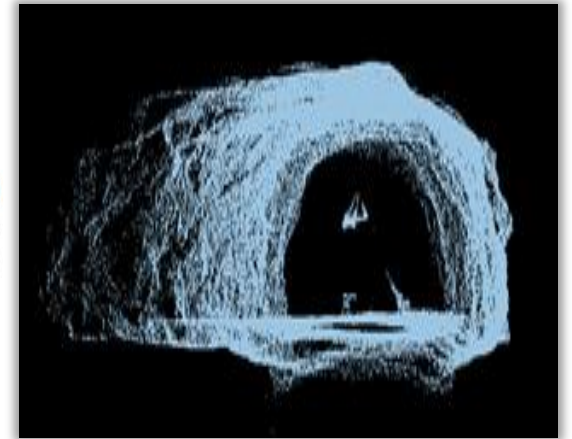
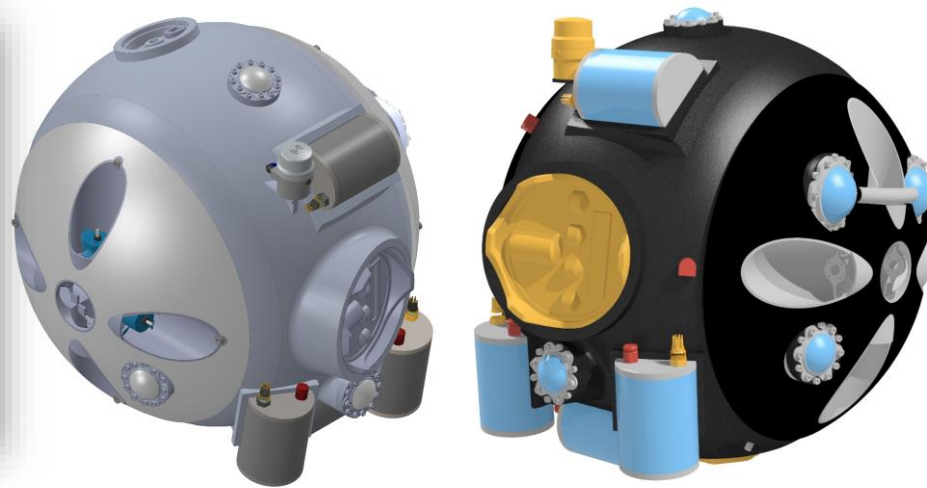


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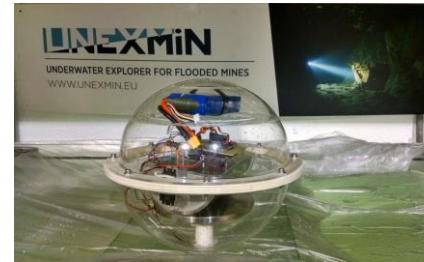
GOALS

UNEXMIN develops a novel robotic system – 3 robots - for the **autonomous exploration and mapping** of flooded underground mines using **non-invasive methods** to gather **geological and spatial data**.

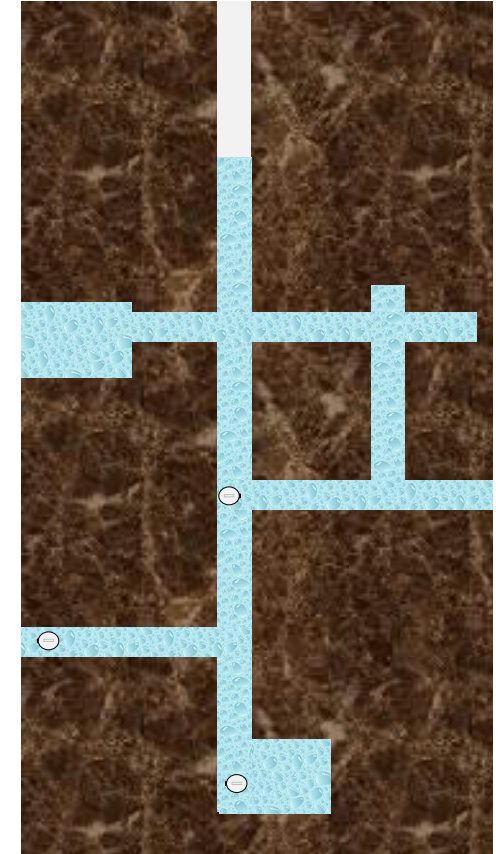


UX-1 ROBOT CHARACTERISTICS

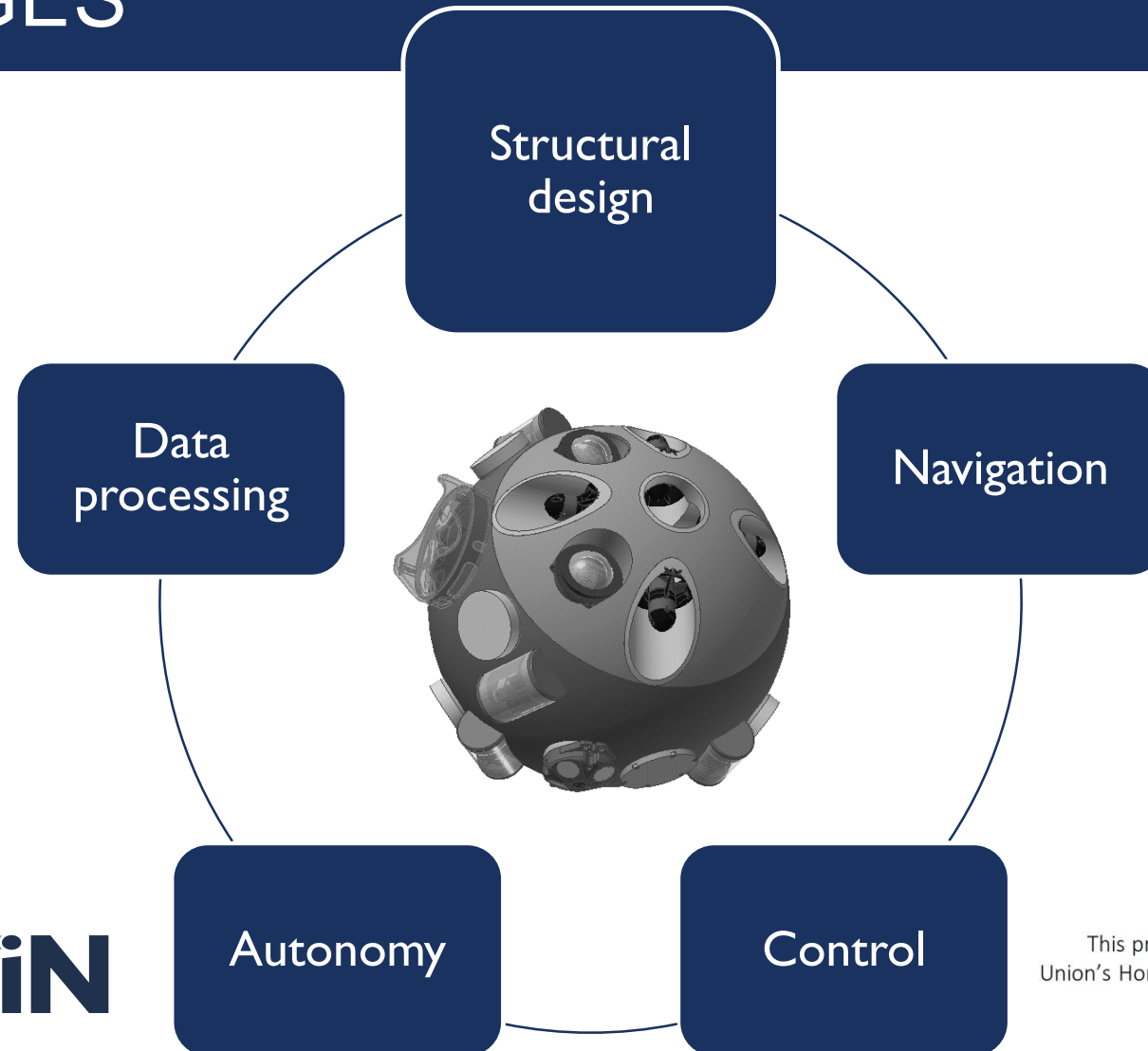
- Shape: spherical
- Size: ~ 0.6 m diameter
- Expected weight: 112 Kg
- Neutral buoyancy
- Max operational depth: ~500m
- Max speed: 1–2 Km/h
- Autonomy: up to 5 hours
- Power consumption: 150-300W
- Thrusters power: 2-5 Kgf



End-user requirements



CHALLENGES

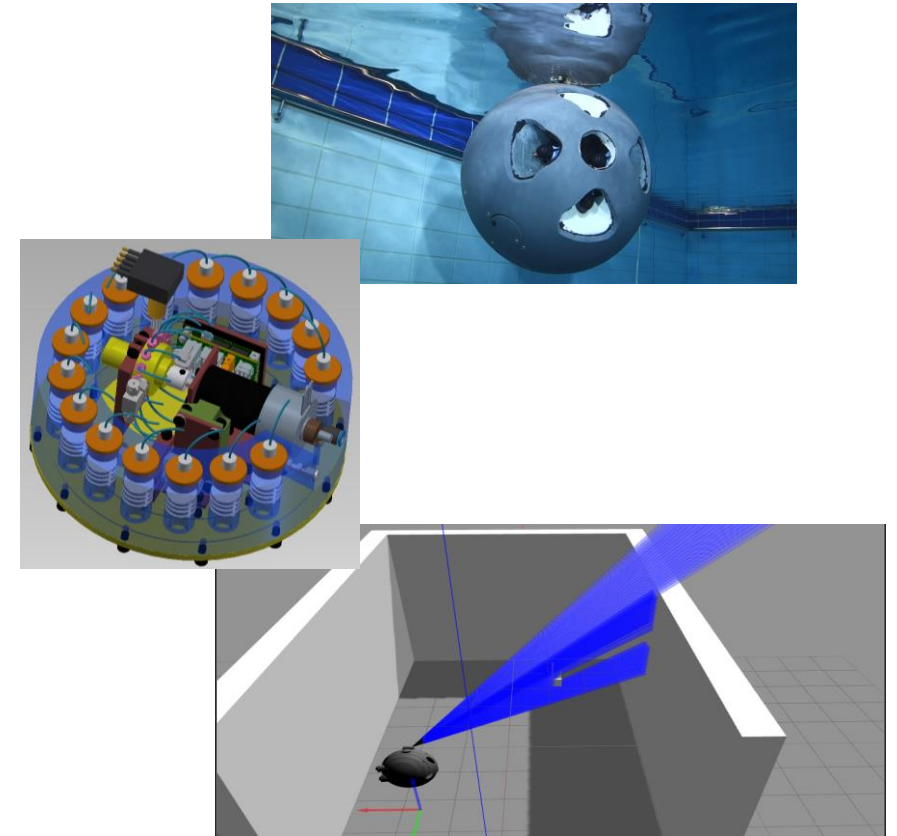


“It would be easier to perform the same task on the surface of the Moon or a planet like Mars.” - Dr. Norbert Zajzon



WORK DEVELOPED & IN DEVELOPMENT

- Validation and simulation of robotic functions
- Designing, testing and adaptation of scientific instruments
- Mine Perception, Navigation and 3D mapping
- Development of post-processing and data analysis tools
- Construction of first fully-operable UX-1 prototype



UX-1 BASIC INSTRUMENTATION

- Acoustic cameras
- Thrusters
- DVL (Doppler Velocity Log)
- Inertial navigation system
- Laser scanner
- Computer
- Batteries
- Integrated pressure hull

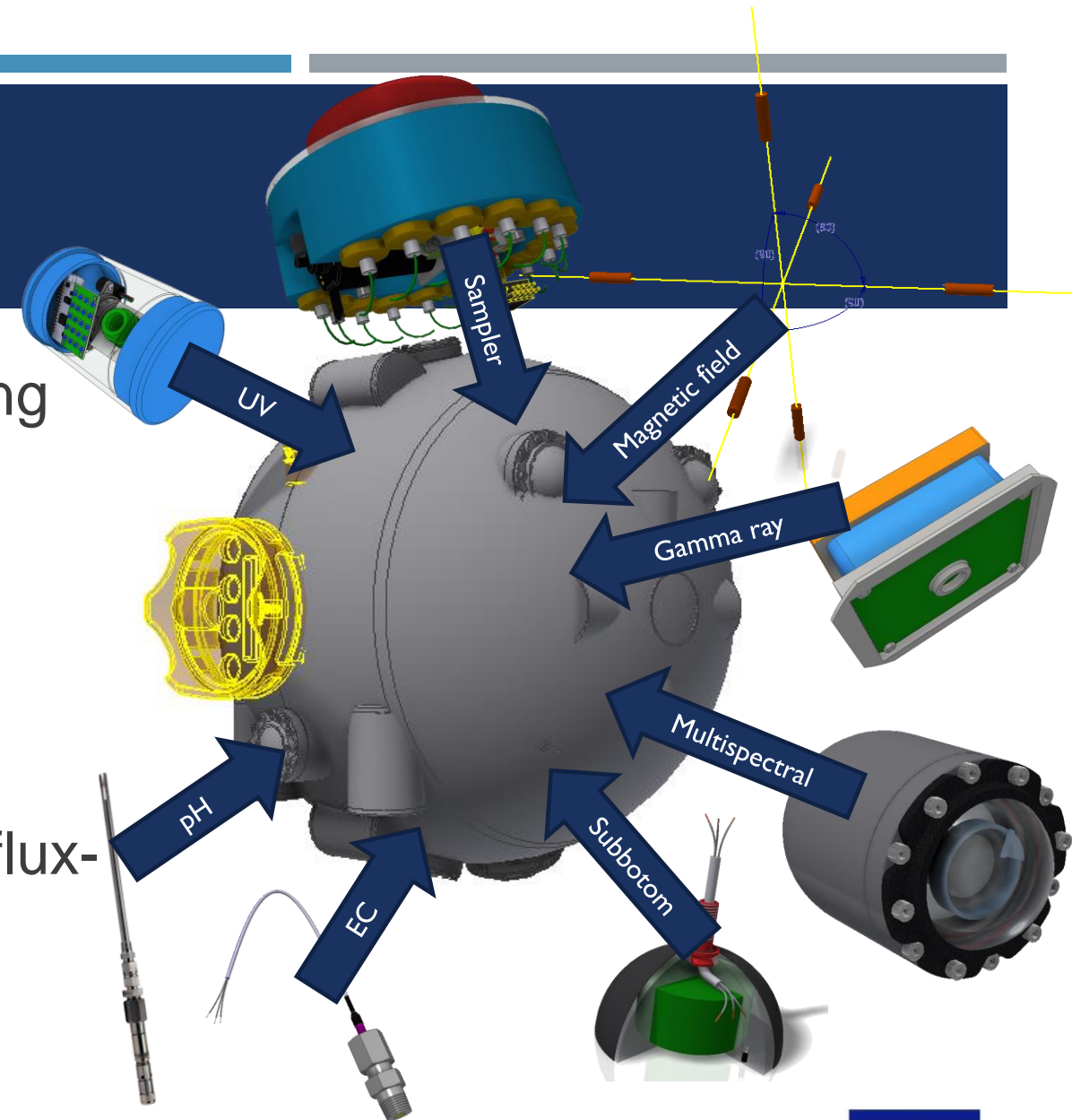


Navigation
Control
Autonomy
Mapping
Interpretation
Evaluation



UX-1 SCIENTIFIC INSTRUMENTATION

- pH and electrical conductivity measuring units
- Water sampler unit
- Sub-bottom sonar
- Natural (integral) gamma ray activity measuring unit
- Magnetic field measuring unit (3 axes flux-gate sensors)
- UV fluorescence imaging unit
- Multi-spectral unit

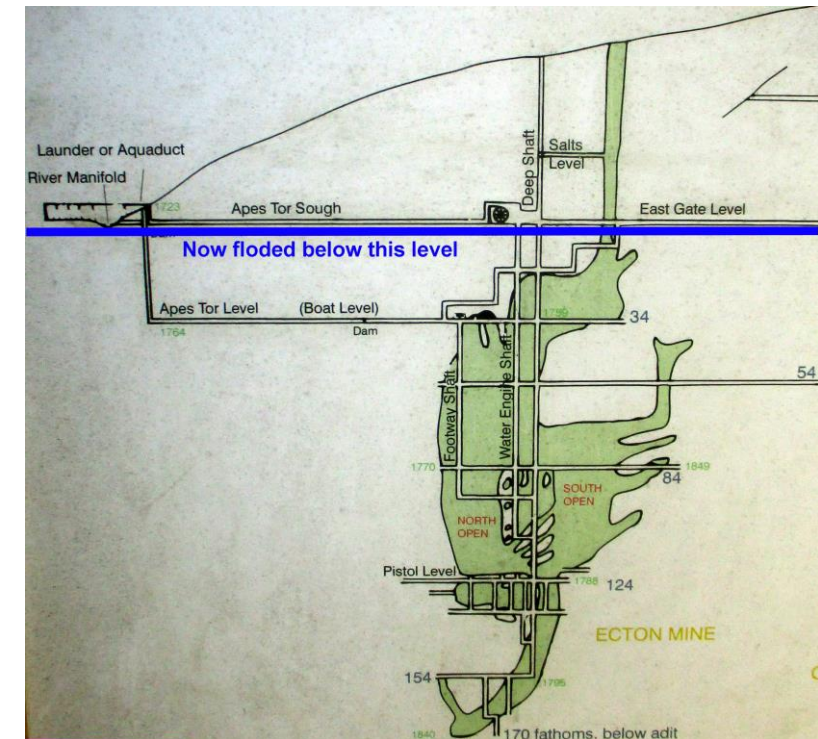


DEMONSTRATION, PILOTS

- **Kaatiala, Finland (June 2018; first prototype)**
 - Pegmatite mine
 - Open-pit and small underground part
 - Robot recoverable by divers
- **Idrija, Slovenia (September 2018)**
 - Mercury mine
 - UNESCO World Heritage site
- **Urgeiriça, Portugal (early-2019; second prototype)**
 - Uranium mine
 - It is completely flooded
 - Water level 12–20 m below surface
- **Ecton, UK (mid-2019; multi-robotic platform)**
 - Cu – (Zn-Pb) mine (MVT)
 - National monument site

Increasing
difficulty in:
mine layout
geometry
topology

Nobody has seen for 160 years!



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APPLICABILITY

- **Raw materials exploration**
 - Early stage of exploration (after sampling; before drilling)
 - Create and/or update new geological models
- Water reservoirs
- Cavity measurement
- Cultural heritage sites
- Risk assessment
- Environmental monitoring
- Cave exploration
- Etc...



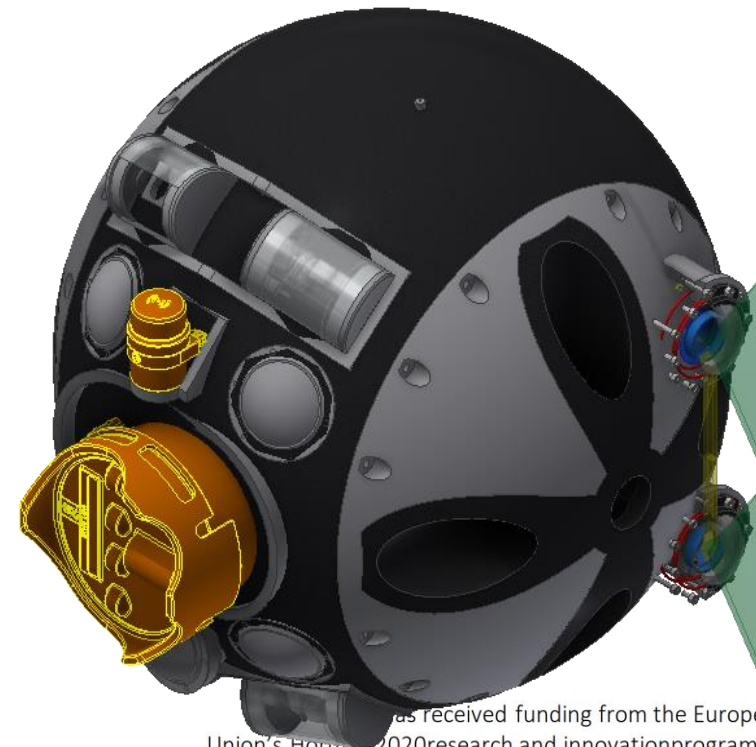
PLANS FOR THE FUTURE

Offering service with the developed equipment

- Further develop the existing instruments/sensors
- Develop new instruments
- Modification of the UX-1 series
 - Long-range version
 - Smaller version for confined spaces
 - Ect...
- UX-2 series: sampling / drilling



RESEARCH ROADMAPPING



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BE PART OF UNEXMIN – STAKEHOLDER MOBILISATION

- Collection and analysis of requirements to create initial UX-1 specifications
- Creation of detailed stakeholder database as well as a database of flooded mines
- Adaptation of the robot design to Stakeholder needs



THANK YOU!



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