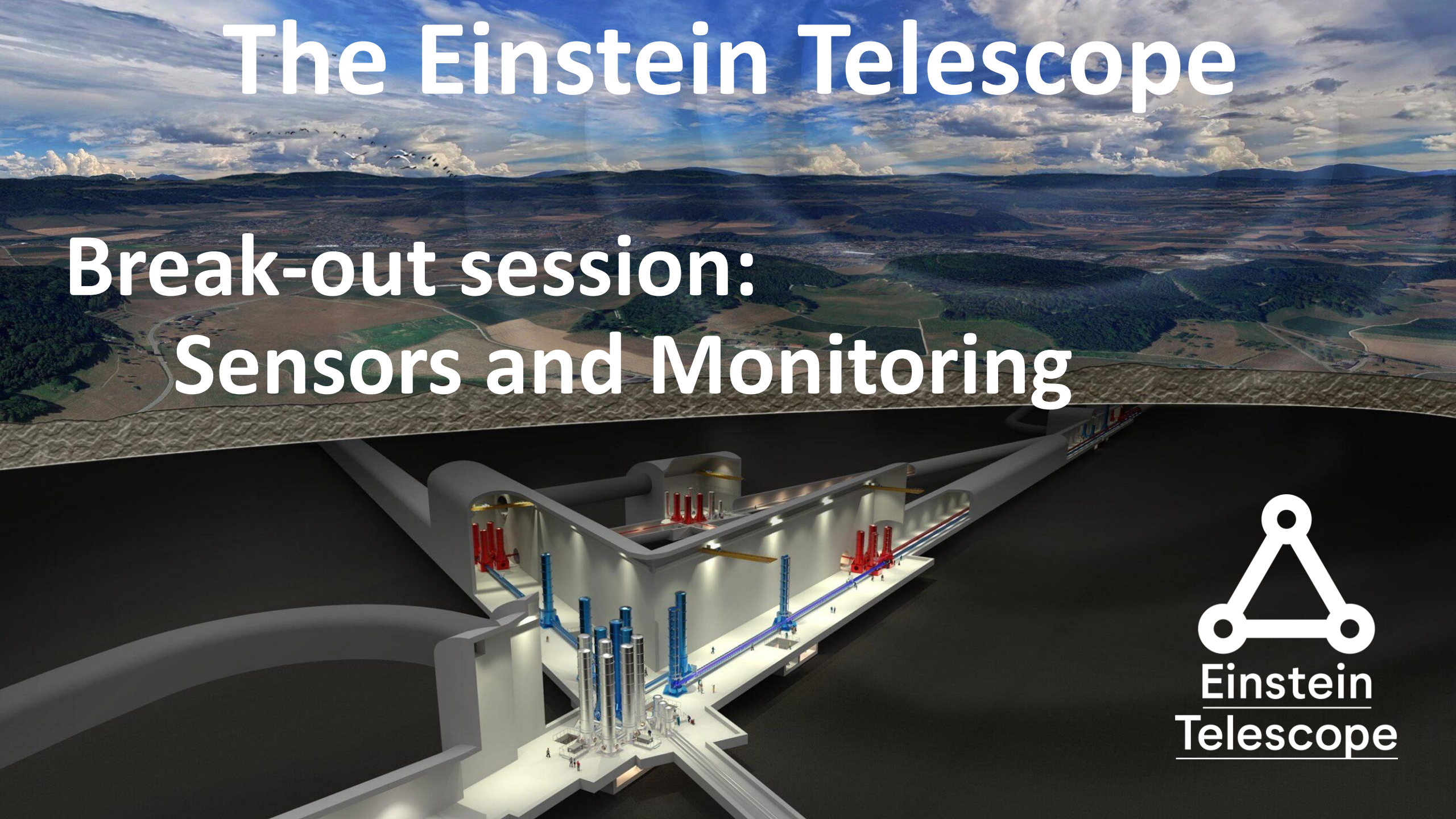
The Einstein Telescope

Break-out session:
Sensors and Monitoring



Einstein Telescope

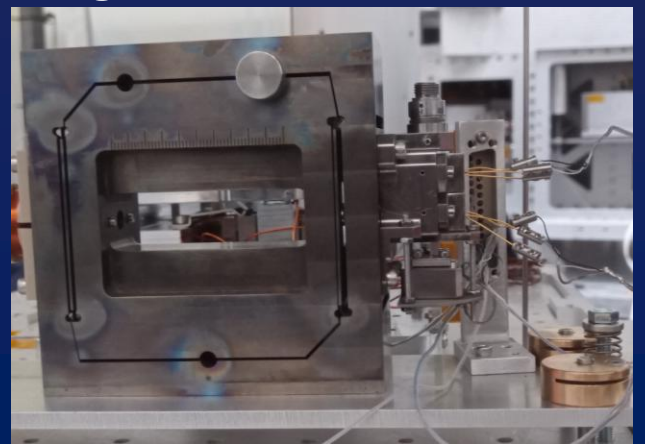
Who-is-Who

Problem Statement

Surface and subsurface sensors (what are we missing?)

- Enviromental
  - Lightning sensors, weather stations
  - Thermo-hygrometers, barometers
  - Geophones, seismometers ...
- Instrumental
  - (Partial) pressure
  - 6 DoF motion sensors
  - Tower control systems
  - Voltage and current sensors

- Tunnels and caverns
  - Acoustic and infrasound sensors
  - Deformation sensors in the walls
  - Thermo-hygrometers
  - Seismometers
  - Magnetometers
  - Gamma-ray detectors
  - Battery leakage detectors
  - Water flow measurements
  - Ingress detection



Problem statement

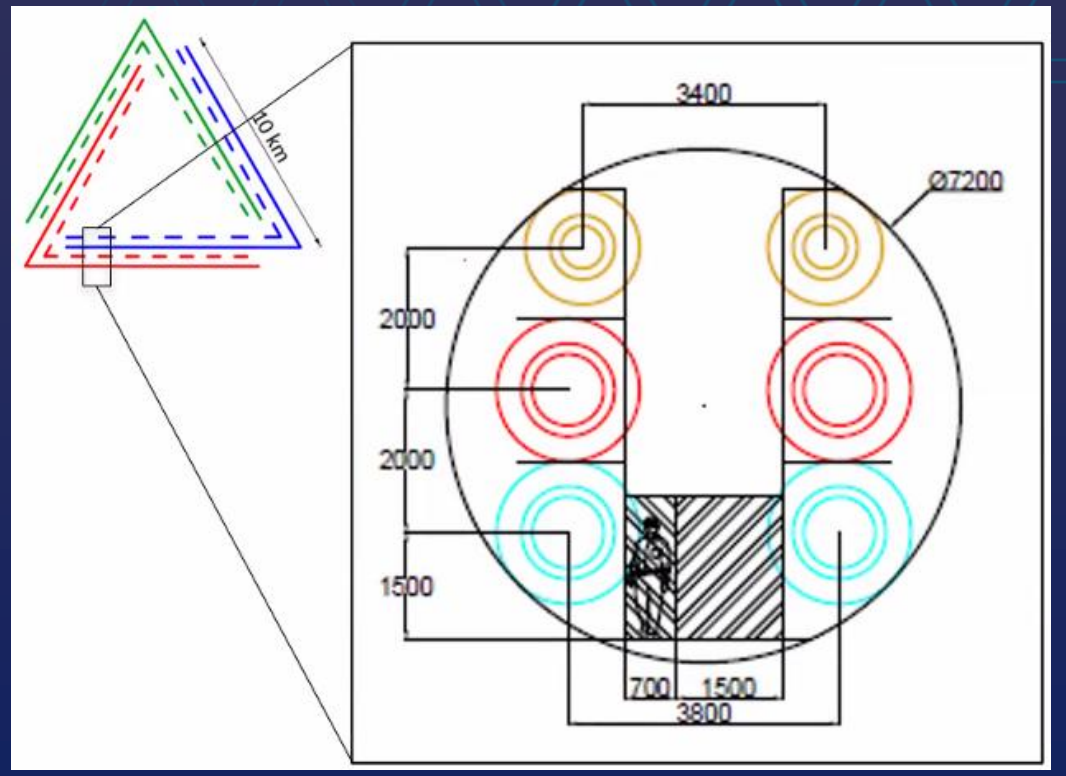
- Subsurface communication is still a grey zone
  - RF communication is difficult (5 to 10 km underground small pipes)
  - RF communication is unwanted (voice coil interference)
  - ➔ Fiber power fed sensors?
  - ➔ Light grid communications?
  - ➔ What does already exist?

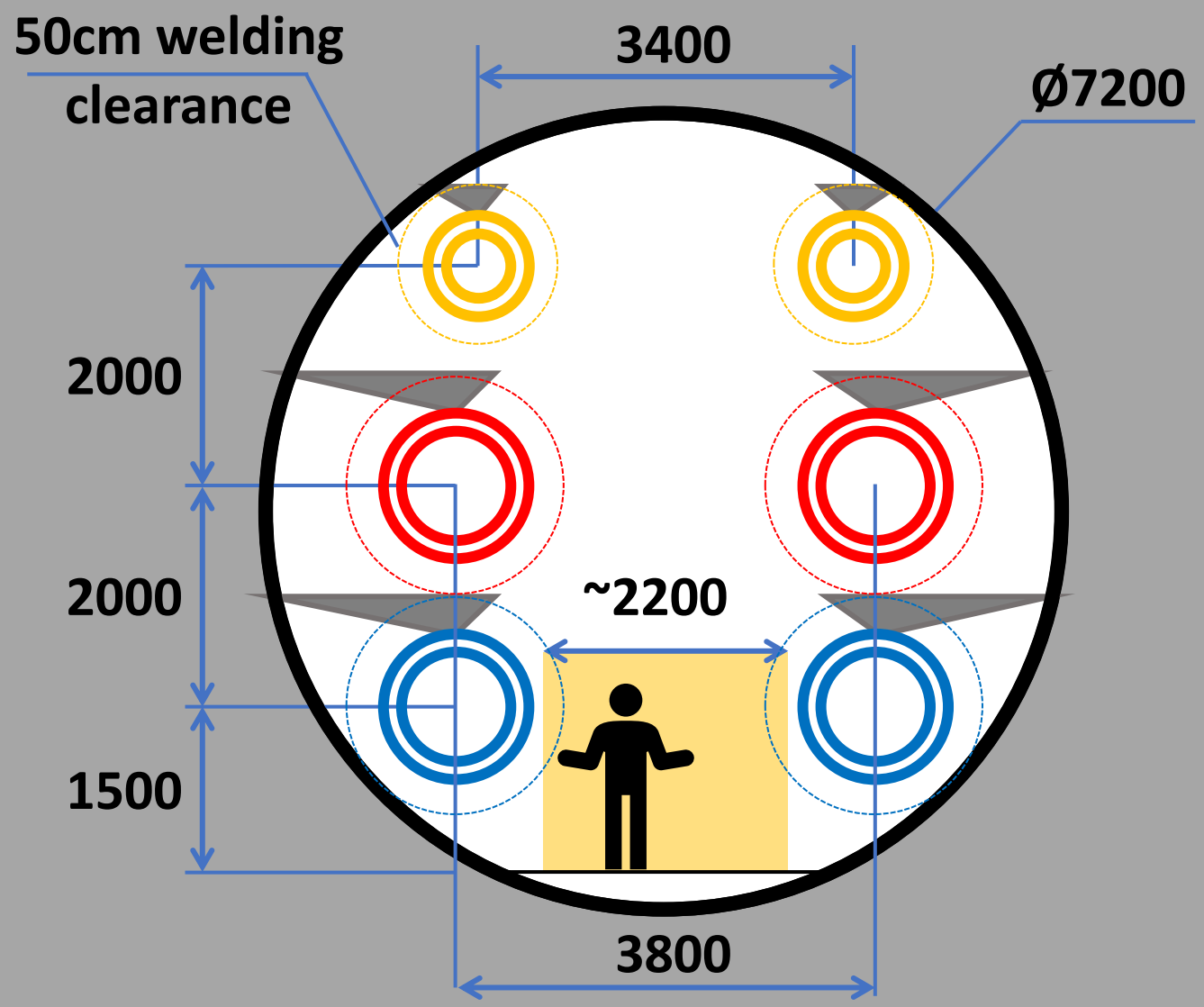
- Precise parameter values still largely unknown
  - What needs to be measured exactly?
  - Locations and distances
  - What precision (#bits)? Bandwidth / frequency? What sensitivity?

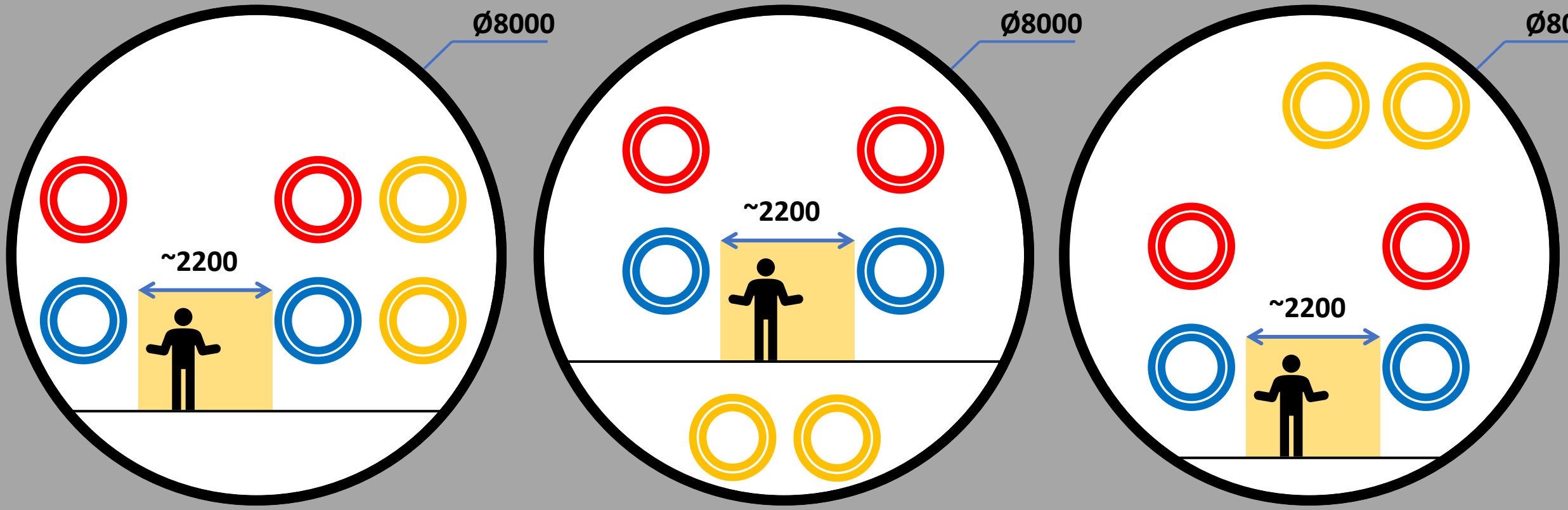
Use Cases

Use Case: Health Monitoring & Inspection

- Problem statement
  - Difficult access to the instrument
  - Means of transport still unknown (assuming 25km/h monorail)
  - Known issues with animals and pests (rats)
- Use Case: monitoring of tunnels and caverns
  - E.g. corrosion of underground structures
  - E.g. pests and anomalies in the tunnels
  - → air based and ground based drones possible?
  - → what do you expect we must monitor?

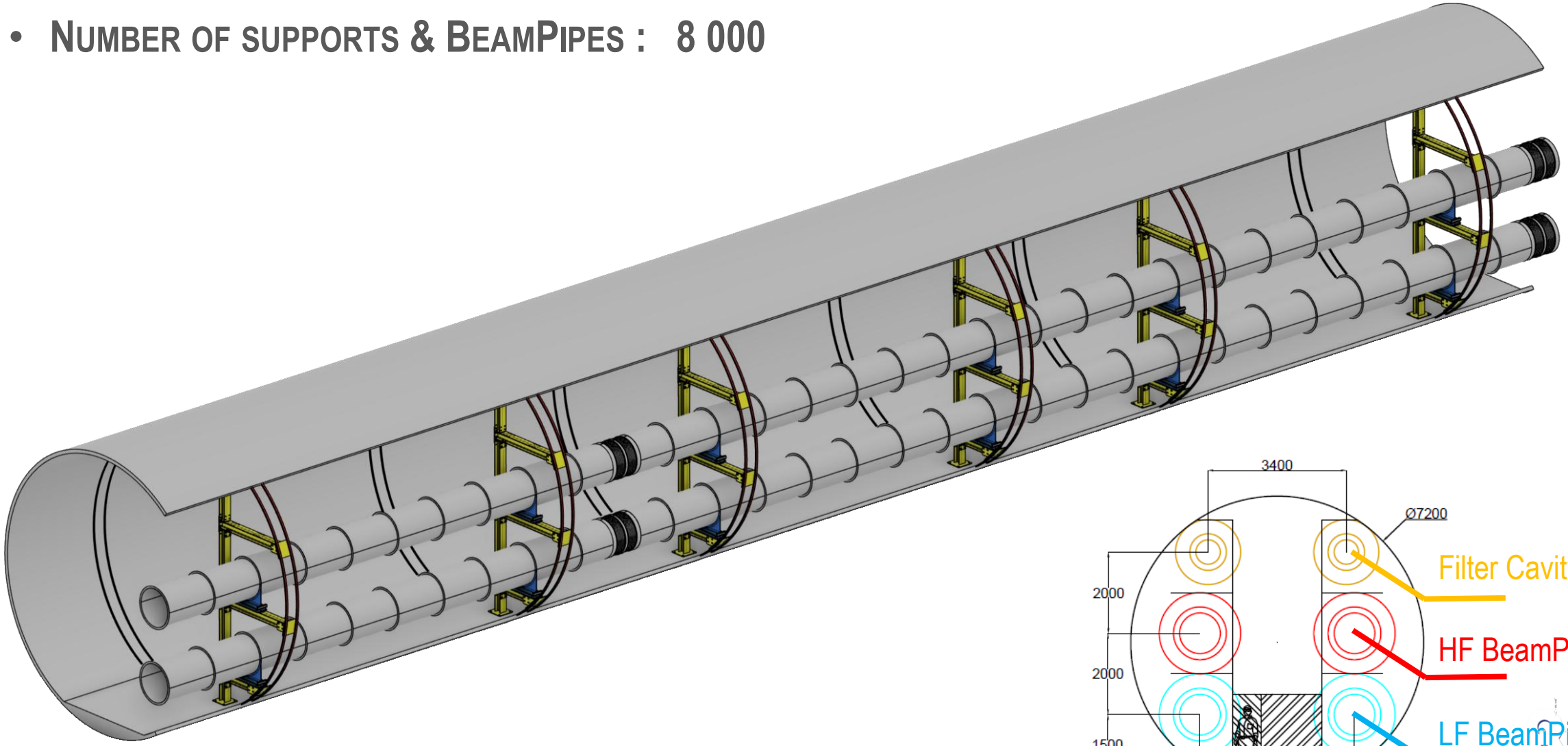


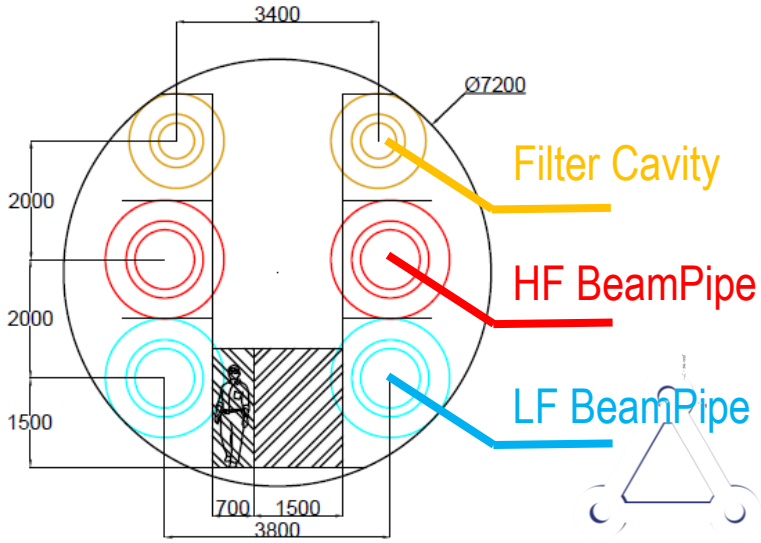

50cm welding
clearance
3400
Ø7200
2000
2000
1500
~2200
3800

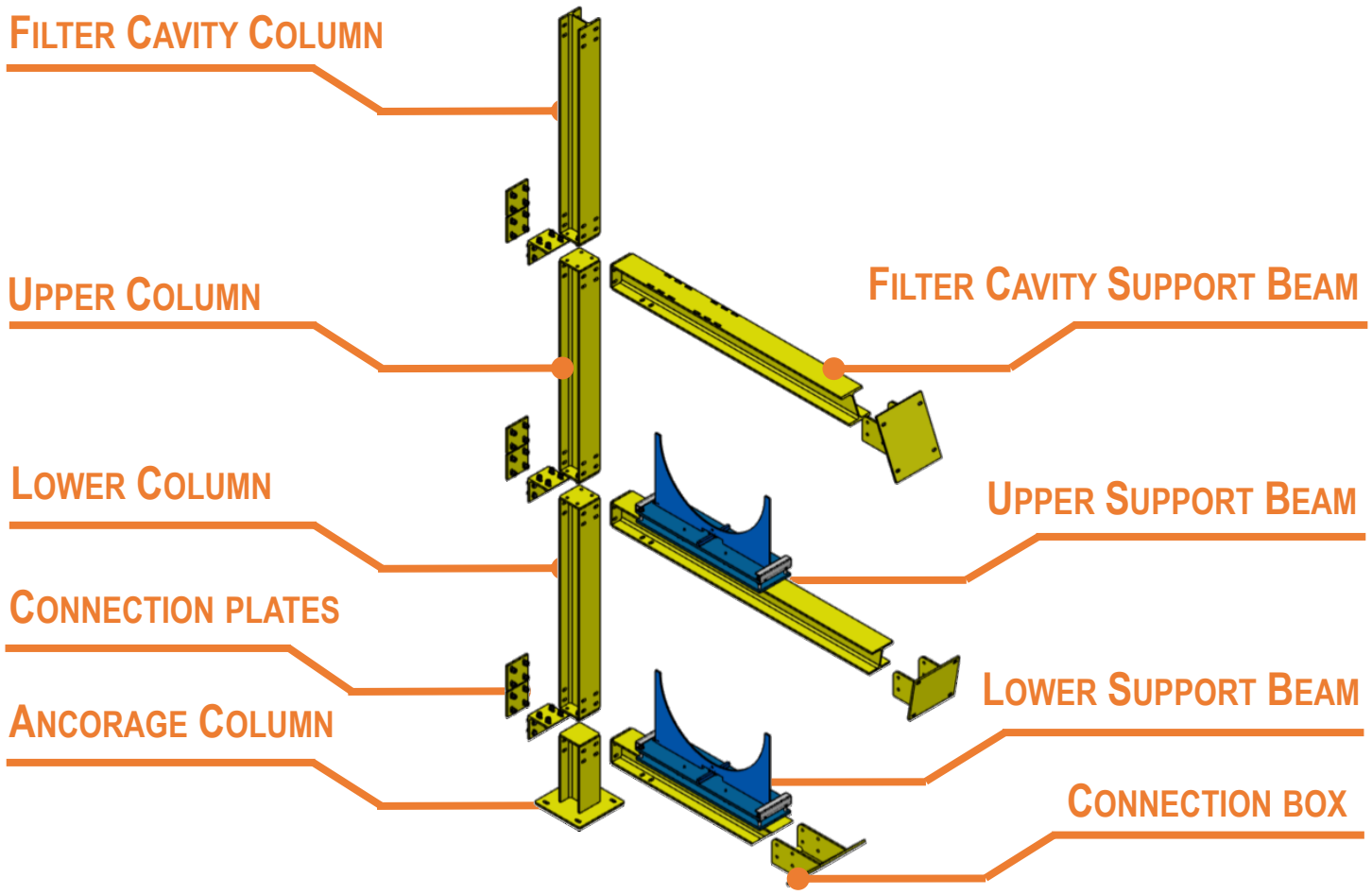


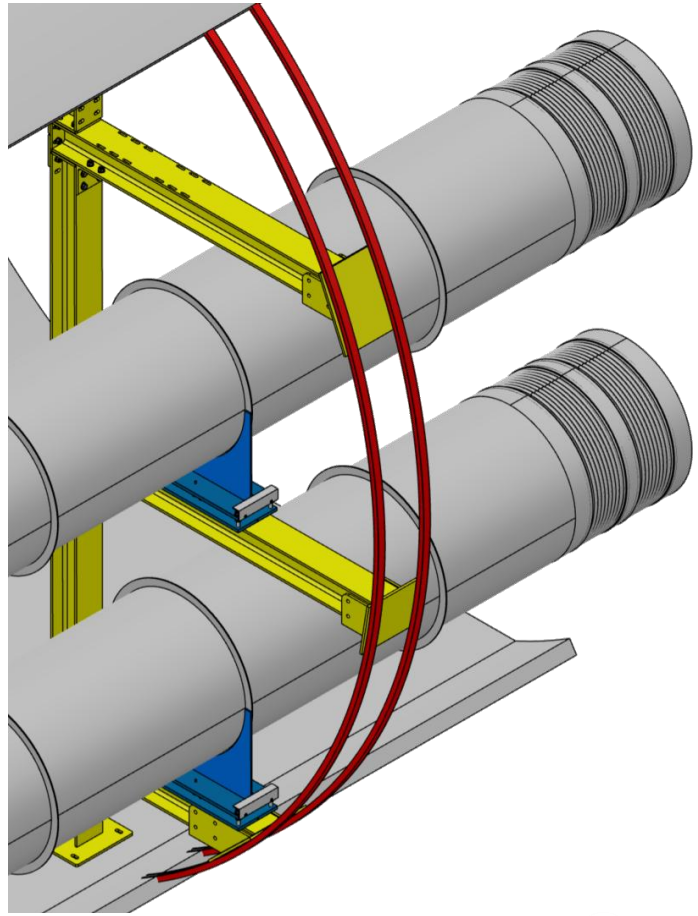
Alternative setups (Ø8000 or Ø8400 tunnel diameter)

- **TOTAL LENGTH OF HF & LF BEAMPIPE : 120 KM**
- **NUMBER OF SUPPORTS & BEAMPIPES : 8 000**

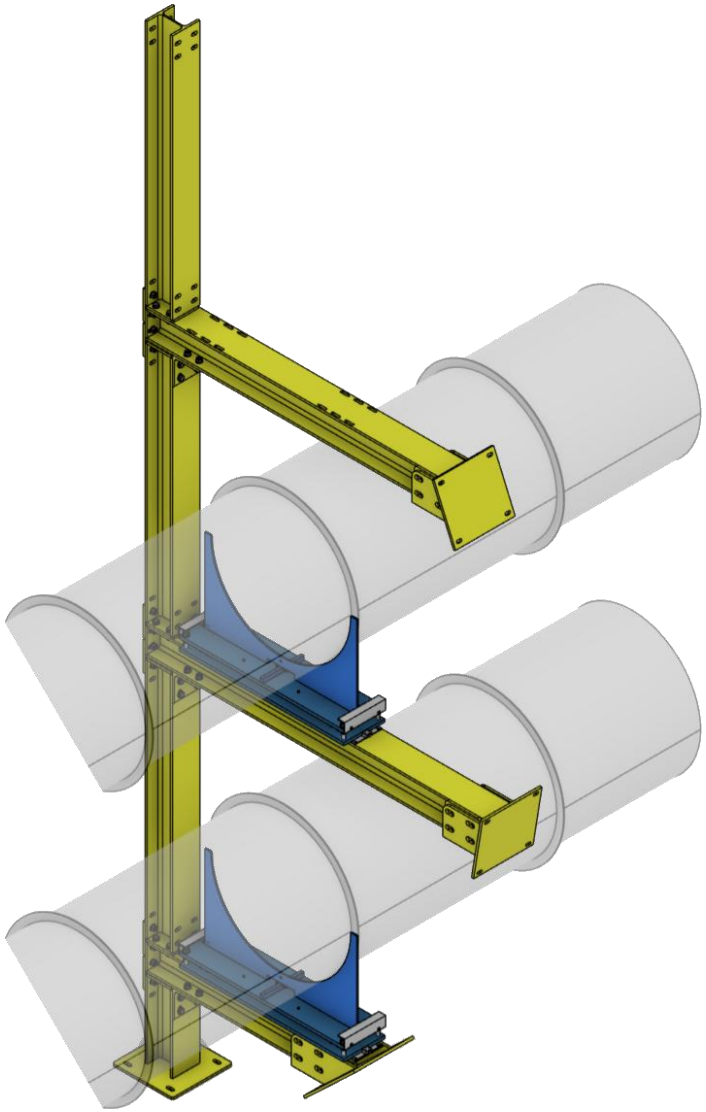


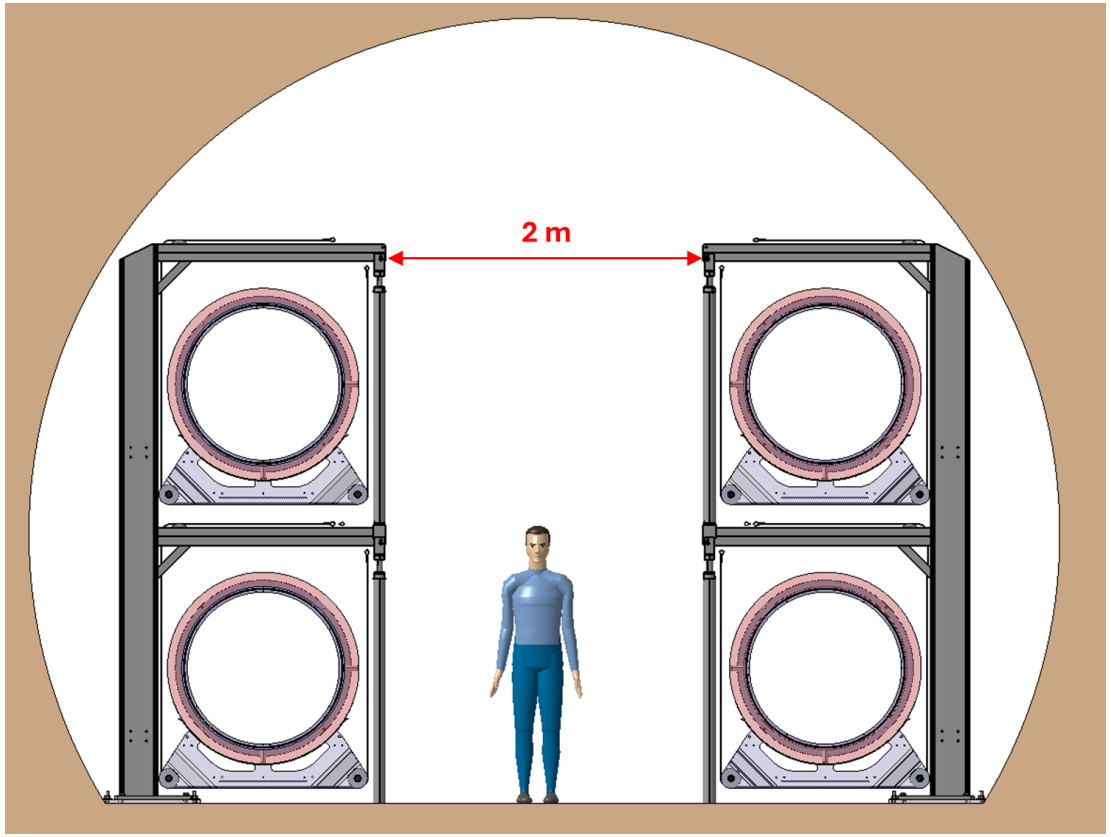



FILTER CAVITY COLUMN
UPPER COLUMN
LOWER COLUMN
CONNECTION PLATES
ANCORAGE COLUMN
FILTER CAVITY SUPPORT BEAM
UPPER SUPPORT BEAM
LOWER SUPPORT BEAM
CONNECTION BOX



TWO ALTERNATIVES PROPOSED





Use Case: Sensors for remote maintenance

- Problem statement: even Virgo is still analysing what sensors are needed
  - Question: is there interest in collaborating or proposing your research (e.g. ICON)?
- Use case: questions
  - Distributed sensing vs. point measurements
  - Are sensor assemblies readily available?
  - How can we measure at lowest cost?
  - What data networks to use?
  - What are we forgetting / missing?
  - Other sensors available on the market (or ready for design)?

Use Case: Optical Fiber

- Problem statement: monitoring in the tunnels what sensors are needed
  - Buildwise already has experience
- Use case: monitoring with Optical Fiber