

Energy Sector
Applications of
Cosmic Ray
Muons

September 2024



Company Introduction



- UK based company specialising in **cosmic ray muon imaging and sensing**
- University spinout since 2020



The University Of Sheffield.



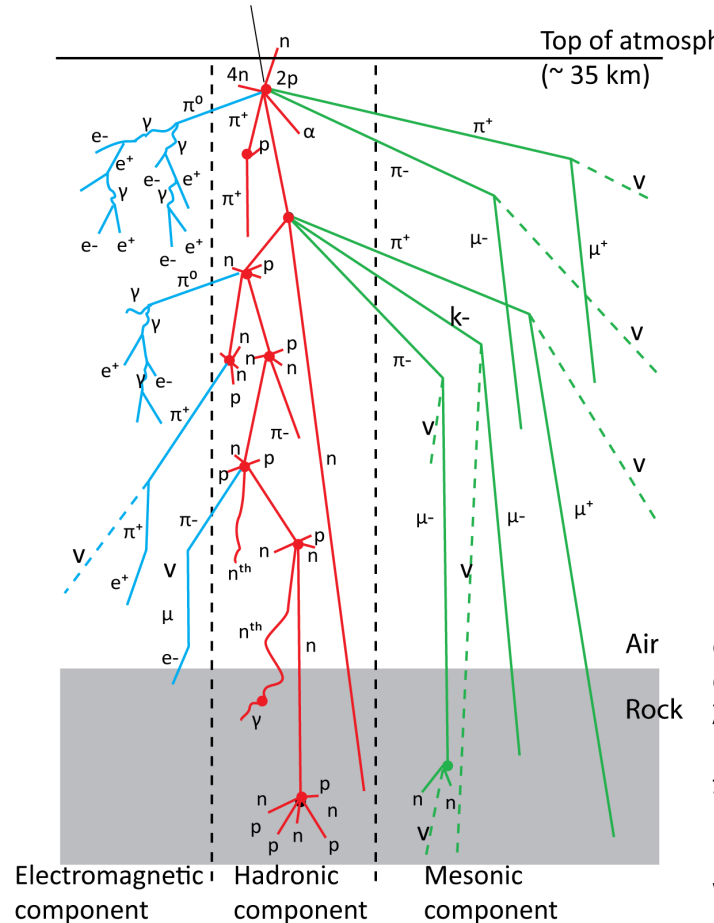
- Non-invasive and continuous imaging technology aimed at subsurface energy measurement challenges

- Many types of subatomic particles produced
- Muons dominate at Earth's surface
- Approximately 10,000 muons/m²/minute
- Continuous and non-invasive



Cosmic Rays Source

Secondary particle production in atmosphere and rock
After Gosse and Phillips, 2001





- *Cosmic ray muons are highly penetrating, making the subsurface transparent*



Offshore wind pre-construction seabed investigations

Floating wind anchor positioning monitoring

TRL3



CO2 Storage Site Monitoring

Geothermal shallow exploration

TRL7



Subsurface sensors for risk management

Tunnel sensing for transportation networks

TRL9



- **Provision of instrumentation and technical services to engineering projects**
 - Well-suited to imaging large man-made or natural structures



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Offshore wind pre-construction seabed investigations

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TRL3



CO2 Storage Site Monitoring

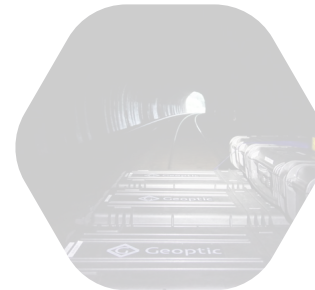
TRL7



Subsurface sensors for risk management

Tunnel sensing for transportation networks

TRL9

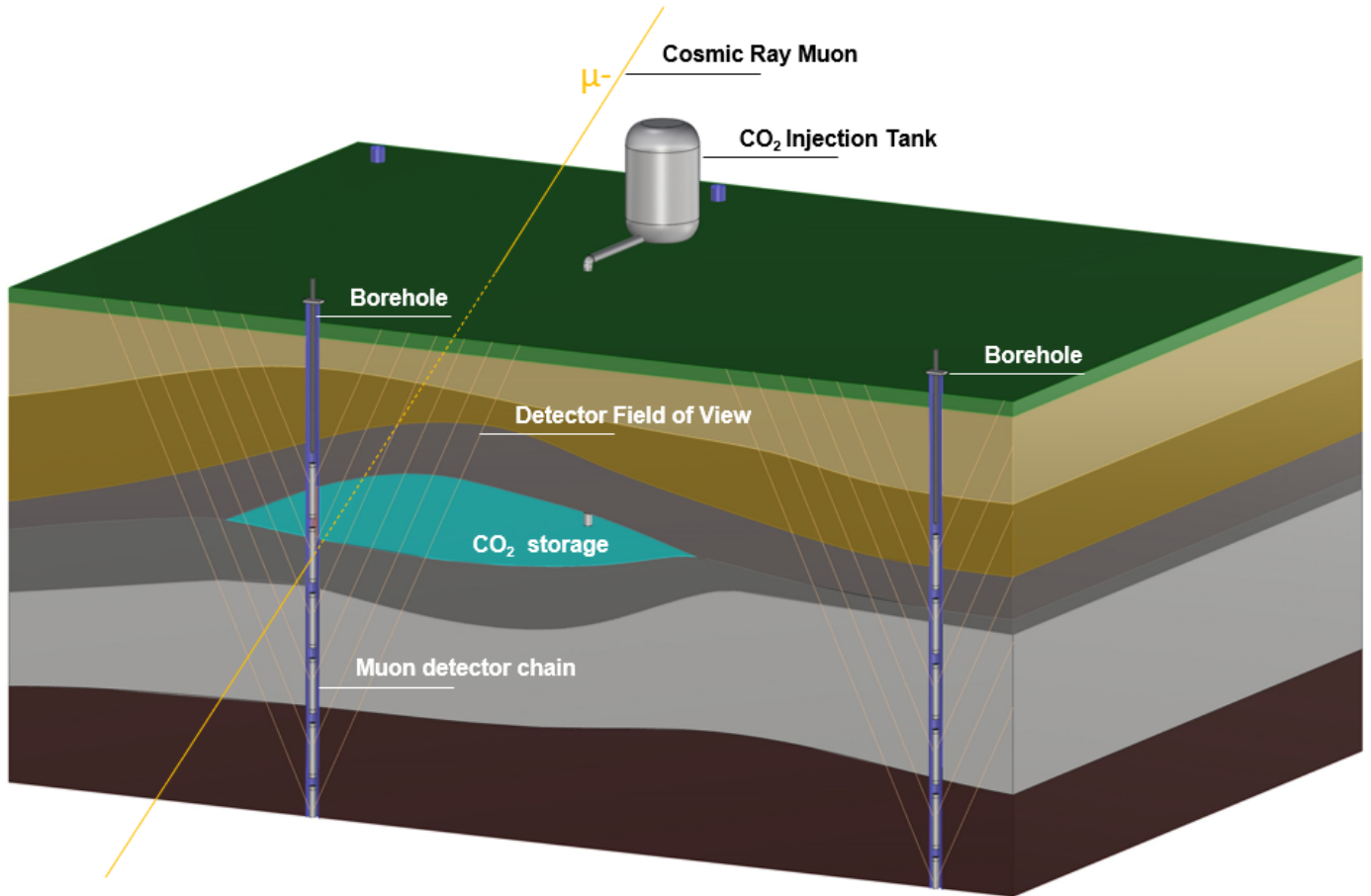


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Geoptic

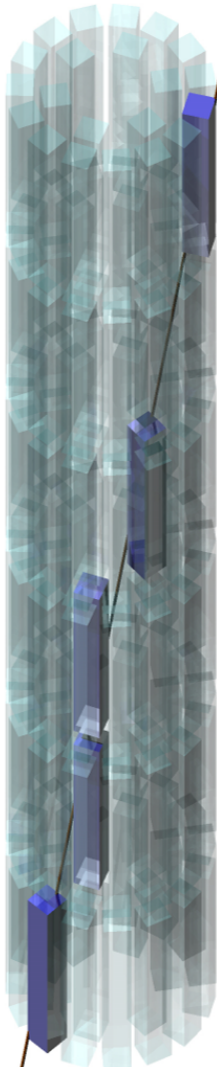
Stored CO₂ Monitoring with Muons





Geoptic

Borehole Muon Detector

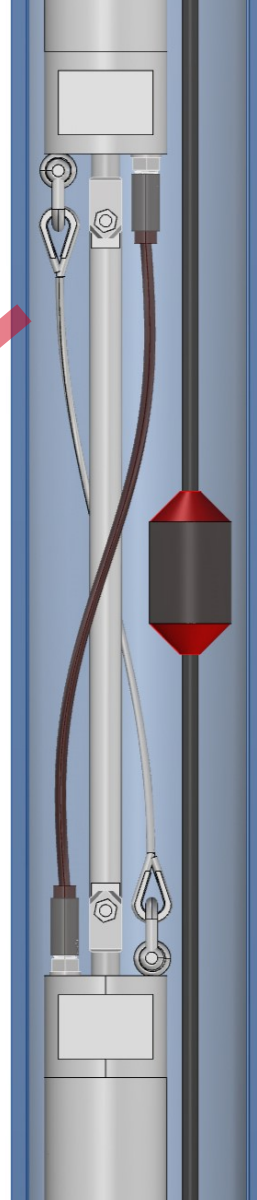


- Muons are detected within scintillator
 - Muon deposits energy in scintillator
 - Converted to a pulse of light photons
 - Photosensors produce electrical pulse
- Detector Characteristics
 - 60mm diameter
 - 1.5m sensitive length (2.2m total)
 - Deployed as a string
 - 5W in sustained operation
 - 15kg (without interconnections)
- Online dashboard of health and rate measurements





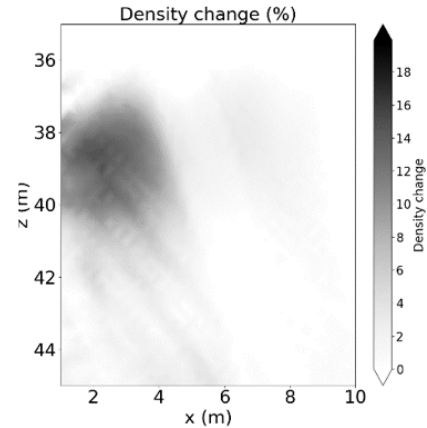
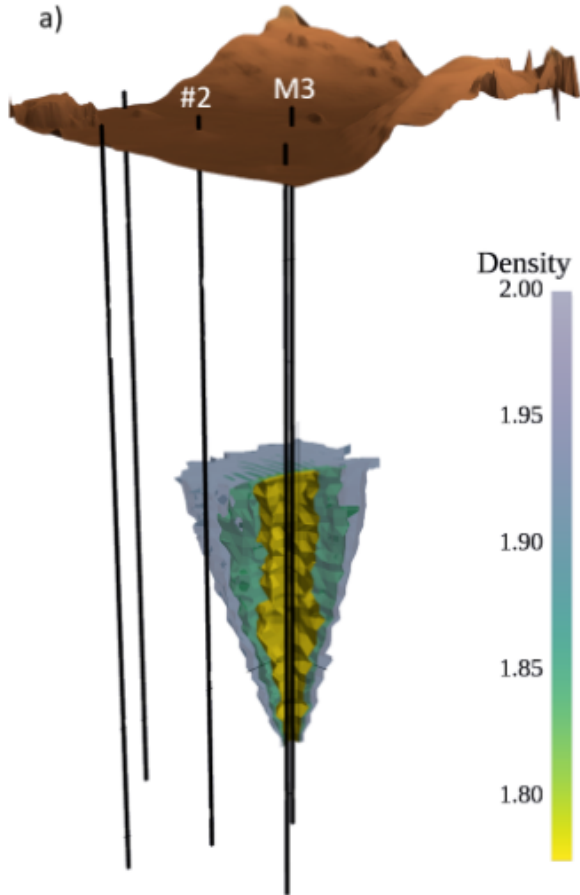
Geoptic Case Study : Site Overview







- Injection of 3.2t of CO₂ and imaging measurement over 29 days



- 3D tomographic density reconstruction (left) shows a clear 5m wide plume around M3
- Validated by seismic analysis also exhibiting a plume 5m wide

- Cosmic ray muons are naturally-occurring and highly-penetrating
- Able to provide 3D tomographic density mapping of subsurface (c.f. medical computed tomography)
- Relevant wind, CO2 monitoring and geothermal applications



Gateshead Mine Water Heating Scheme

Photo: The Coal Authority



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Any questions?