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AusIMM

New Zealand Branch Conference
Christchurch, 20-22 Aug 2023
Rydges Latimer Christchurch

Underground Networking & Automation

Macraes Mine

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COST EFFECTIVE PACKET SWITCHED NETWORKING UNDERGROUND

Network Overview

Why have an IP Network?

- Communication
- Remote monitoring and control
- Data integration
- Safety and emergency response
- Scalability and flexibility
- Path redundancy

Key Network Features:

- Single mode fibre
  - 10Gb backbone & Low latency
- Passive ethernet repeaters
  - 100m – 1.5km distance
- Access point per port
- Commercial off the shelf (COTS)

Golden Point Underground, Macraes

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Commercial off the shelf (COTS)

Benefits of COTS

- Availability – Covid supply constraints.
- General-purpose functionality
- Simplified maintenance & troubleshooting
- Ongoing technological advancements
- Cost

Our approach

- To adopt COTS products for underground operations, allowing for increased coverage & improved throughput at a lower cost.

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COTS vs Mining Specific Equipment

CURRENT COTS SYSTEM – COST COMPARISON

- 56 WIFI 5/6 APs – 802.11AC/AX
- 344 1Gbps ACCESS PORTS @ $90 PER PORT
- 10 Gbps SPATIALLY DIVERSE BACK HAUL
- MULTIPLE FIELD BUS BRANCHES INCL. MODBUS OVER LEAKY RF

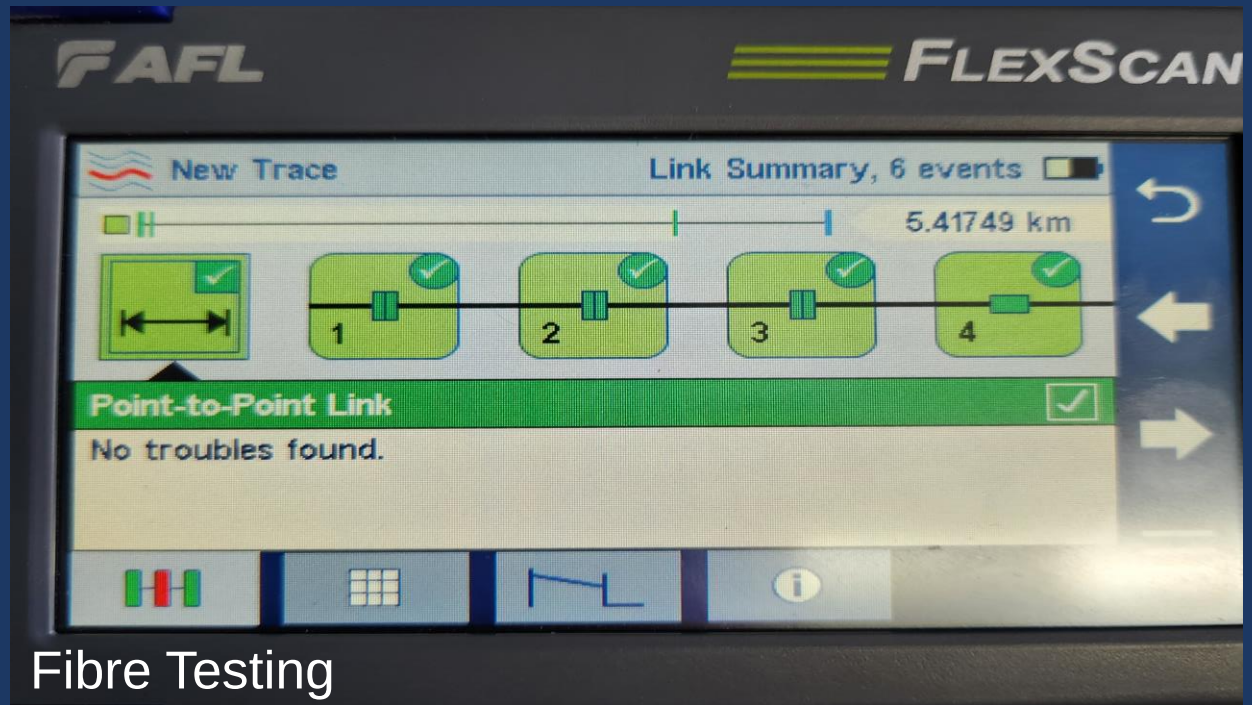
	Cost
COTS Solution (Deployed System)	$42,000
Industry Specific (AP Capacity Only)	$138,000 ≈ 3x
Industry Specific (Port Capacity)	$915,000 ≈ 21x

- Industry specific niche solution equates to $2400 per 1Gbps access port
- Industry specific niche AP provides Wi-Fi 4 (802.11n) performance
- Industry specific niche switch is limited to 1 Gbps back haul
- Excludes cable. Based on COTS RRP/Niche Indicative pricing

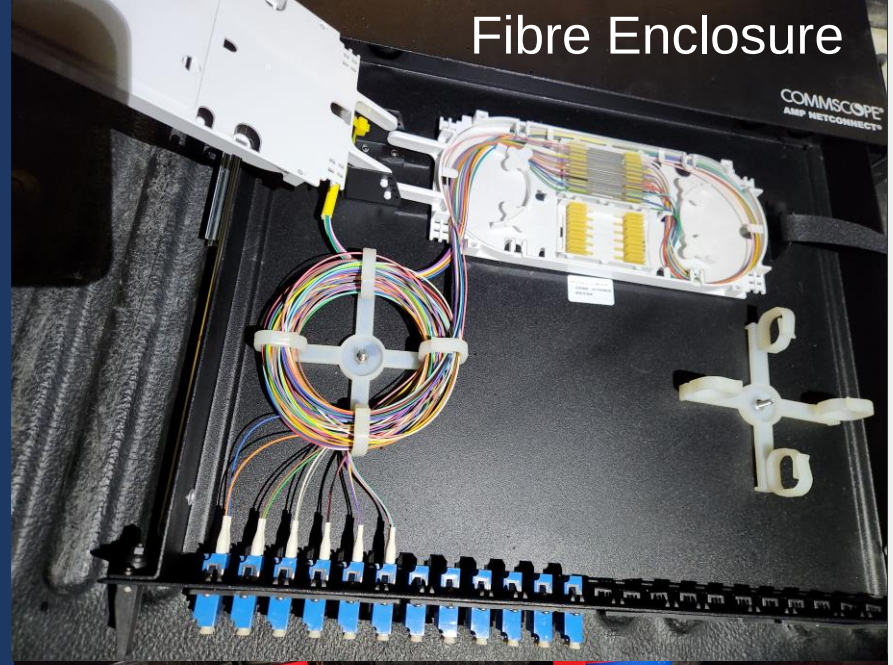
Capability Development

Fibre Splicing

- Reduced contractor reliance & expense
- Faster troubleshooting & repairs
- Efficient install timeframes



Fibre Testing



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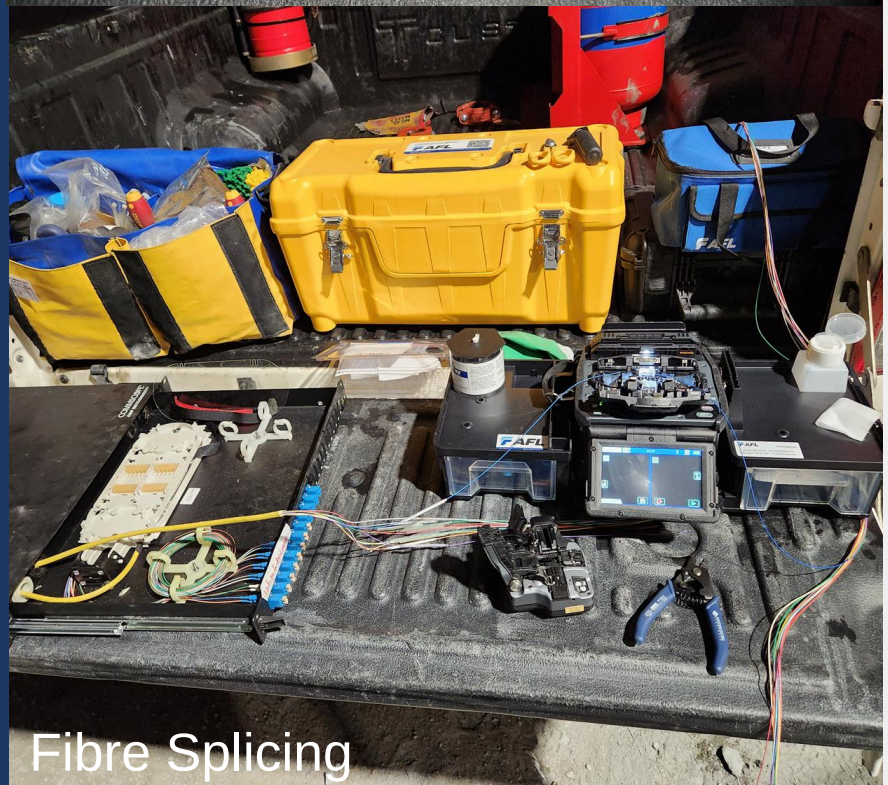
Fibre Splicing

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Future capabilities

- Wireless connectivity
  - Wi-Fi 6E & 7
- Industrial internet of things (IIoT)
- Automation and autonomous systems
- Augmented reality (AR) & virtual reality (VR)
  - Immersive training
  - Remote assistance
  - Visualisation of underground structures

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Key Points

- Network best practices have been applied in addition to hardware being adapted for the underground environment
- COTS hardware is utilised to improve capability while reducing cost
- Improved productivity
  - Automation
  - Network widely accessible underground
- Improved safety
  - Real time monitoring (Cameras & telemetry)
  - Path redundancy

Surface remote hut

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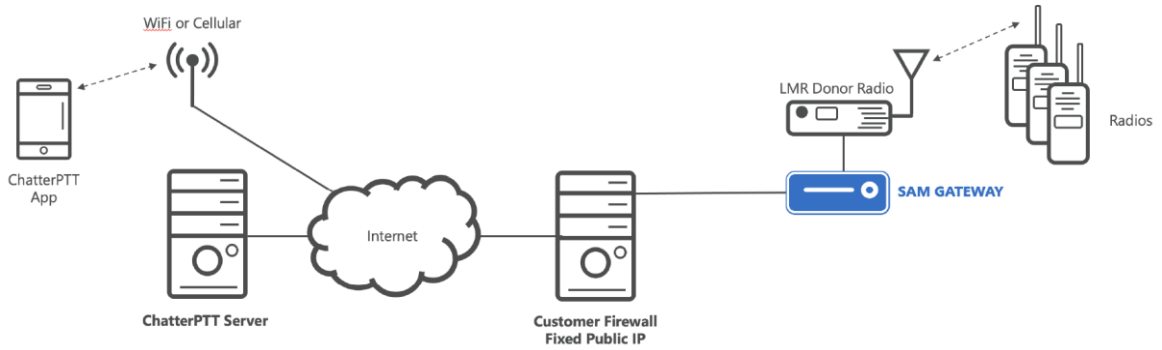
WHAT CAN WE DO WITH INCREASED NETWORK COVERAGE?

POTENTIAL OF INCREASED COVERAGE

- COMMUNICATIONS
  - RFoF, RoIP, WiFi Calling, PTToC, Integrated Mass Notification Systems
- DATA EXCHANGE
- CONTROL
  - VoD, SCADA
- PRODUCTION
  - Task Tracking
  - Plant and Equipment Location
  - Autonomous Fleet Operations
- EMERGENCY MANAGEMENT



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AUTONOMOUS FLEET OPERATION

- AUTONOMOUS/SEMI AUTONOMOUS LOADING
  - Increased bogging rates – larger loaders and faster tramming
  - Better material accounting potential
  - Reduced exposure to time dependent stope failure
  - Reduced damage

- AUTONOMOUS HAULAGE
  - Improved traffic management and route efficiency
  - Haulage unit to loading unit optimisation
  - Higher haul speeds

- AUTONOMOUS DRILLING
  - Lets talk about this

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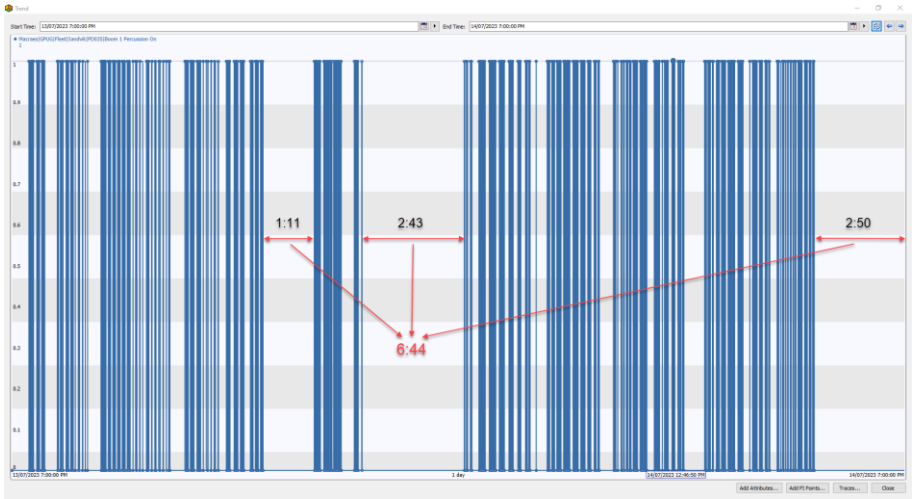
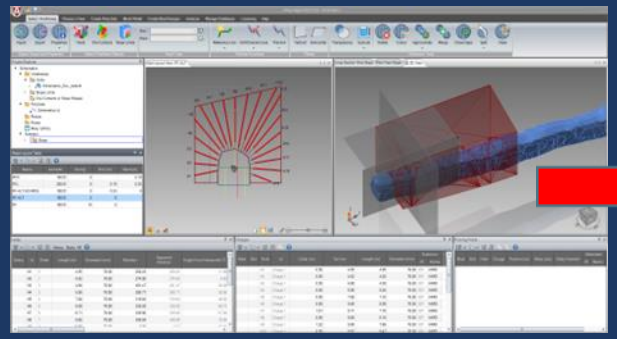
PRODUCTION DRILL AUTOMATION – THE OBVIOUS

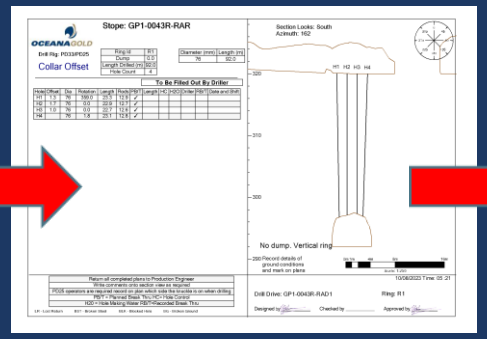
- MORE EFFICIENT UTILISATION
  - Single Hole Automation
  - Single Fan Automation
- UTILISING PREVIOUSLY UNAVAILABLE TIME
  - WiFi Tele-remote Drilling
  - Tram on power pack
- OPERATIONAL IMPROVEMENTS
  - Reduction in damage
  - Reduced consumable consumption
  - Faster Fault Resolution

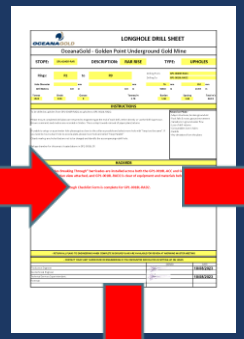


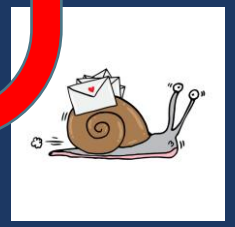
1. TELE-REMOTE OPERATION 400i CLASS - LONGHOLE DRILLS

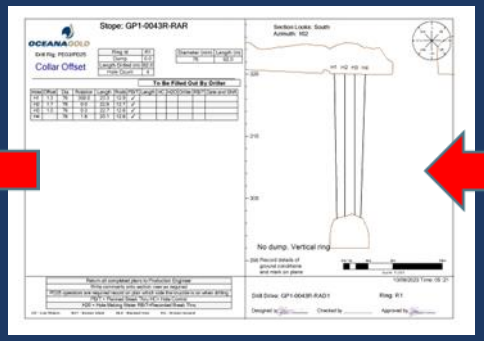
PRODUCTION DRILL WORKFLOW – LESS OBVIOUS

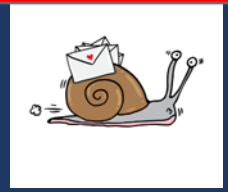












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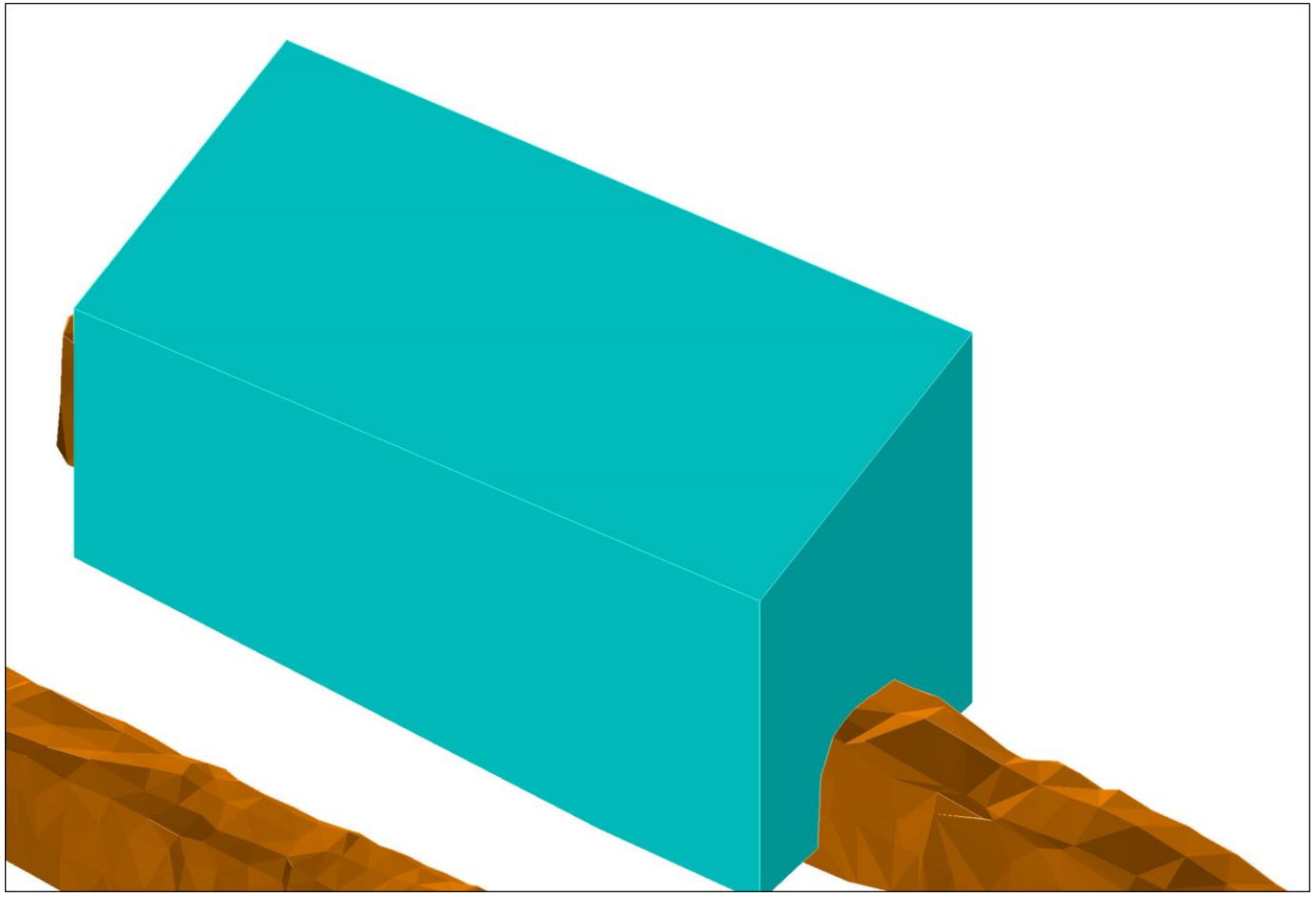
SPATIAL NAVIGATION IS THE DETERMINANT

- HOW DOES A TRADITIONAL RIG NAVIGATE SPACE



- Example Stope

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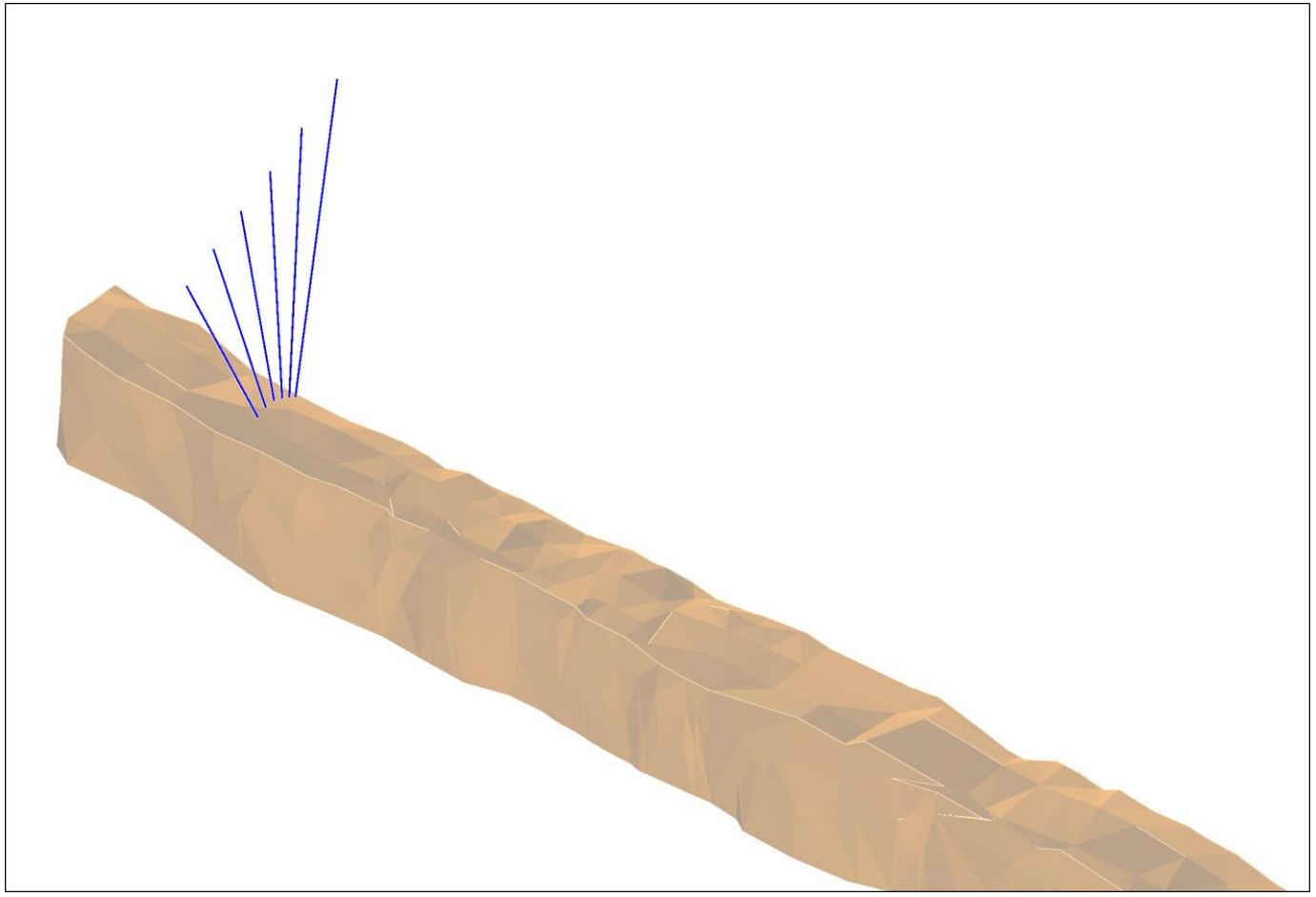

- Example Stope
- Single plane of up-holes dumped at 10˚

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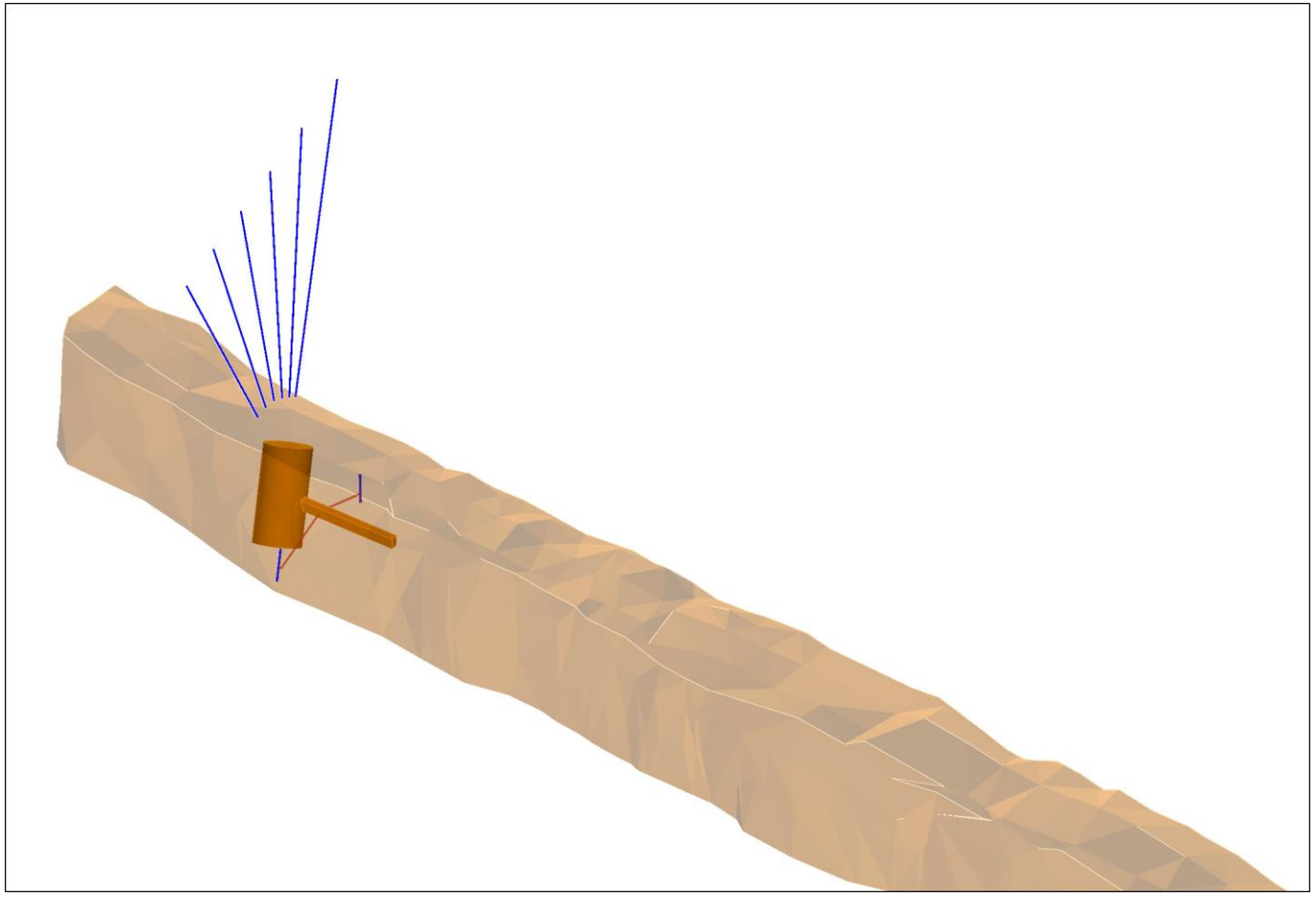

- Example Stope
- Single plane of up-holes dumped at 10˚
- Markup laser reference lines to provide azimuth
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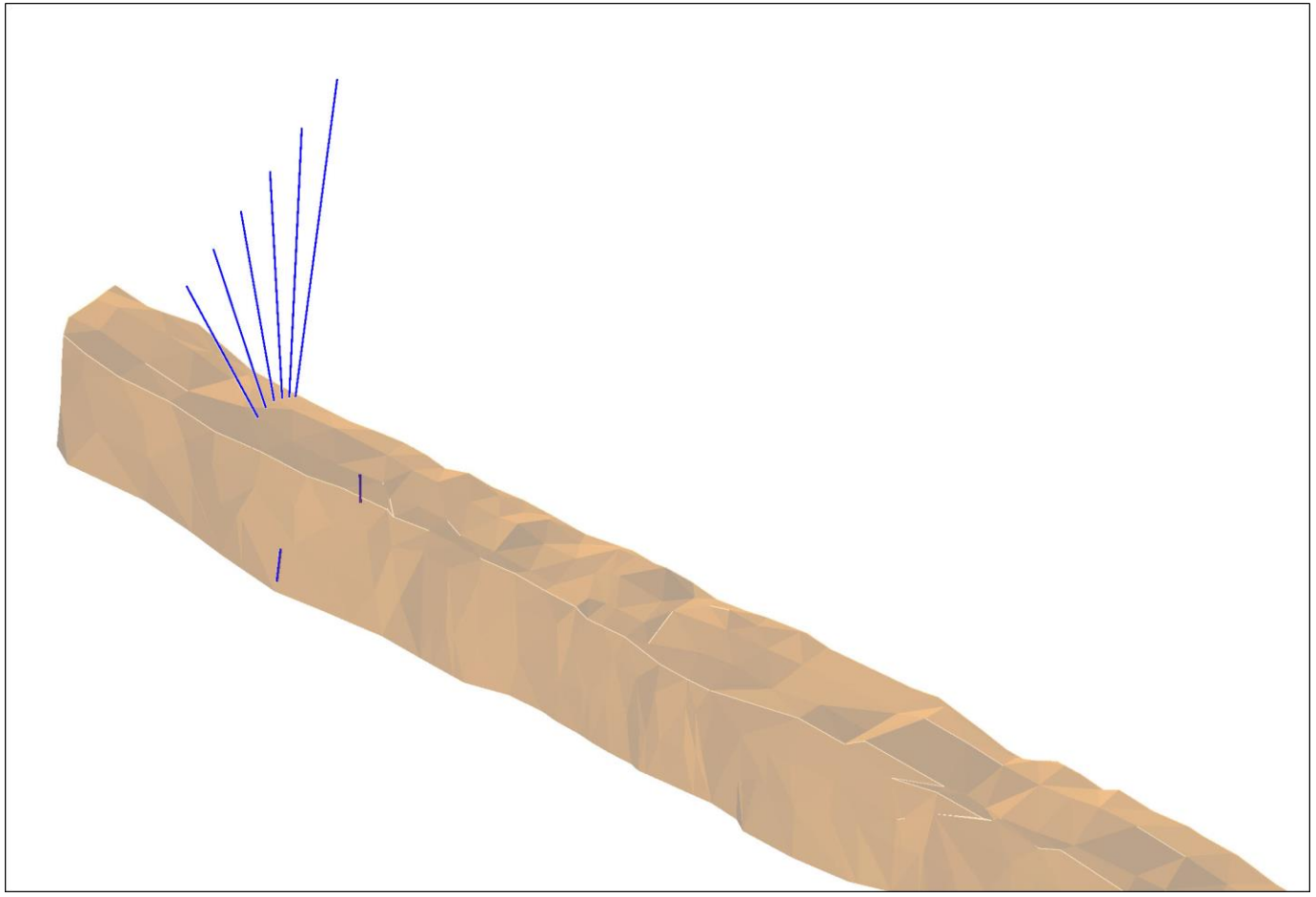

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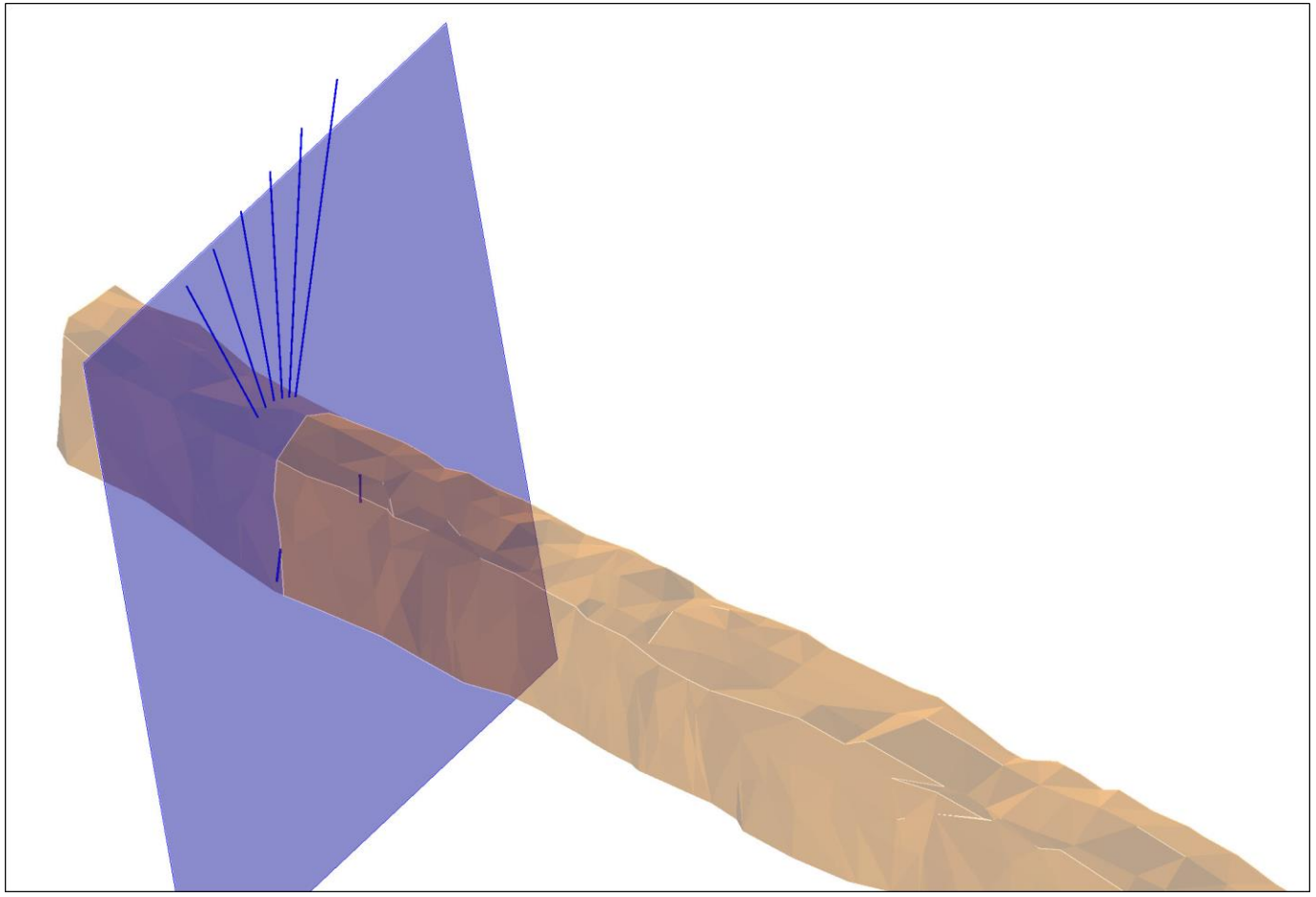

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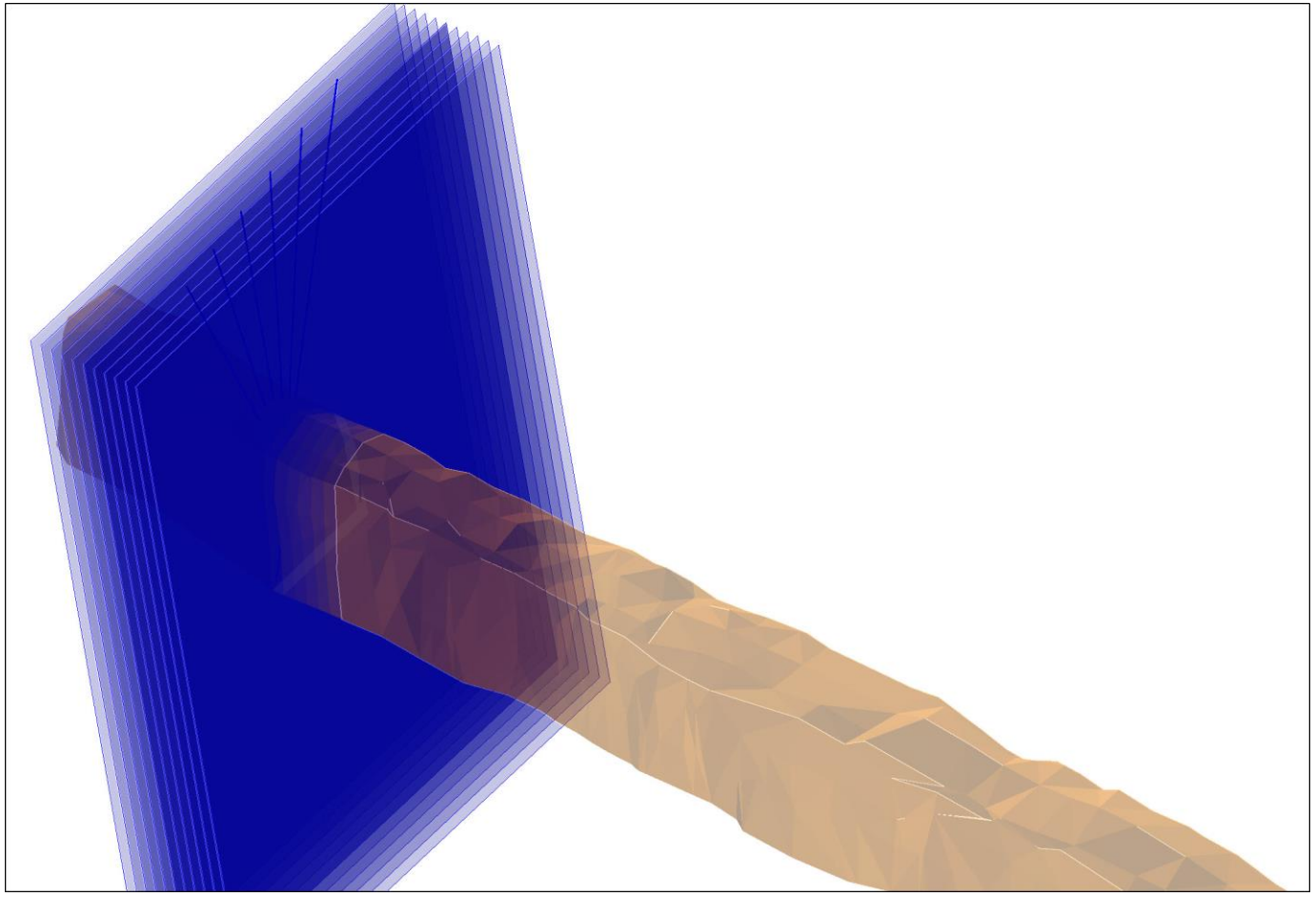

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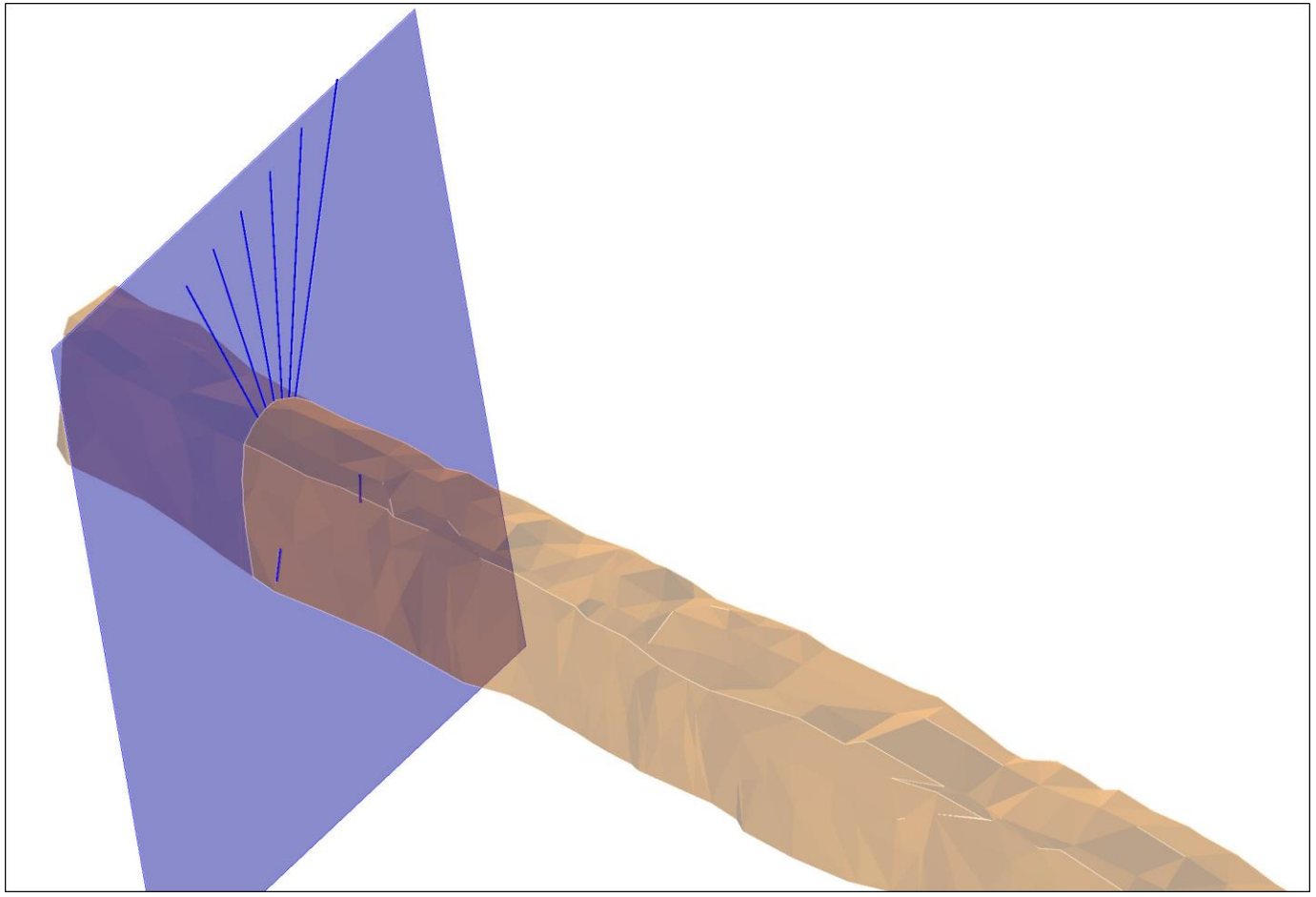

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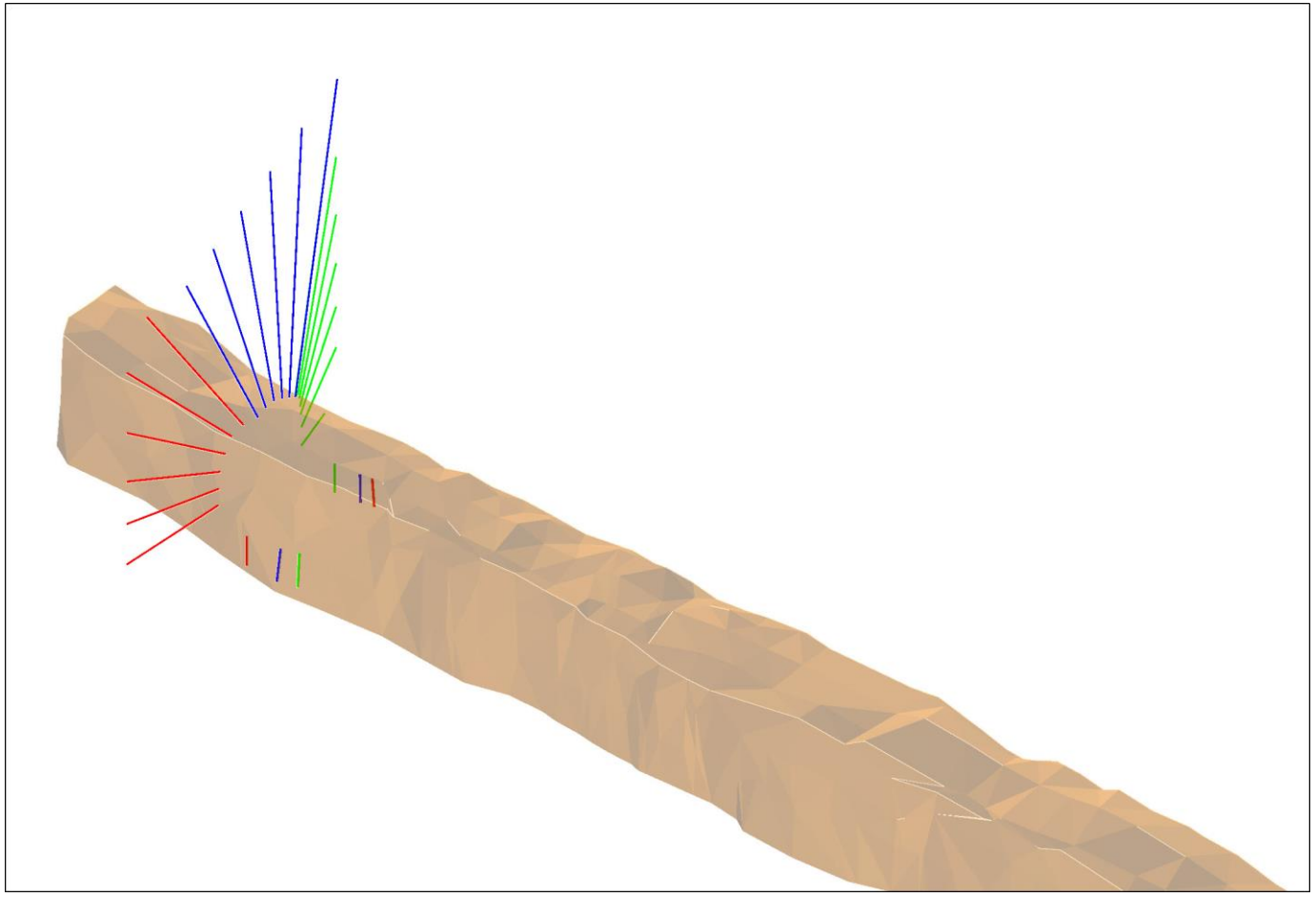

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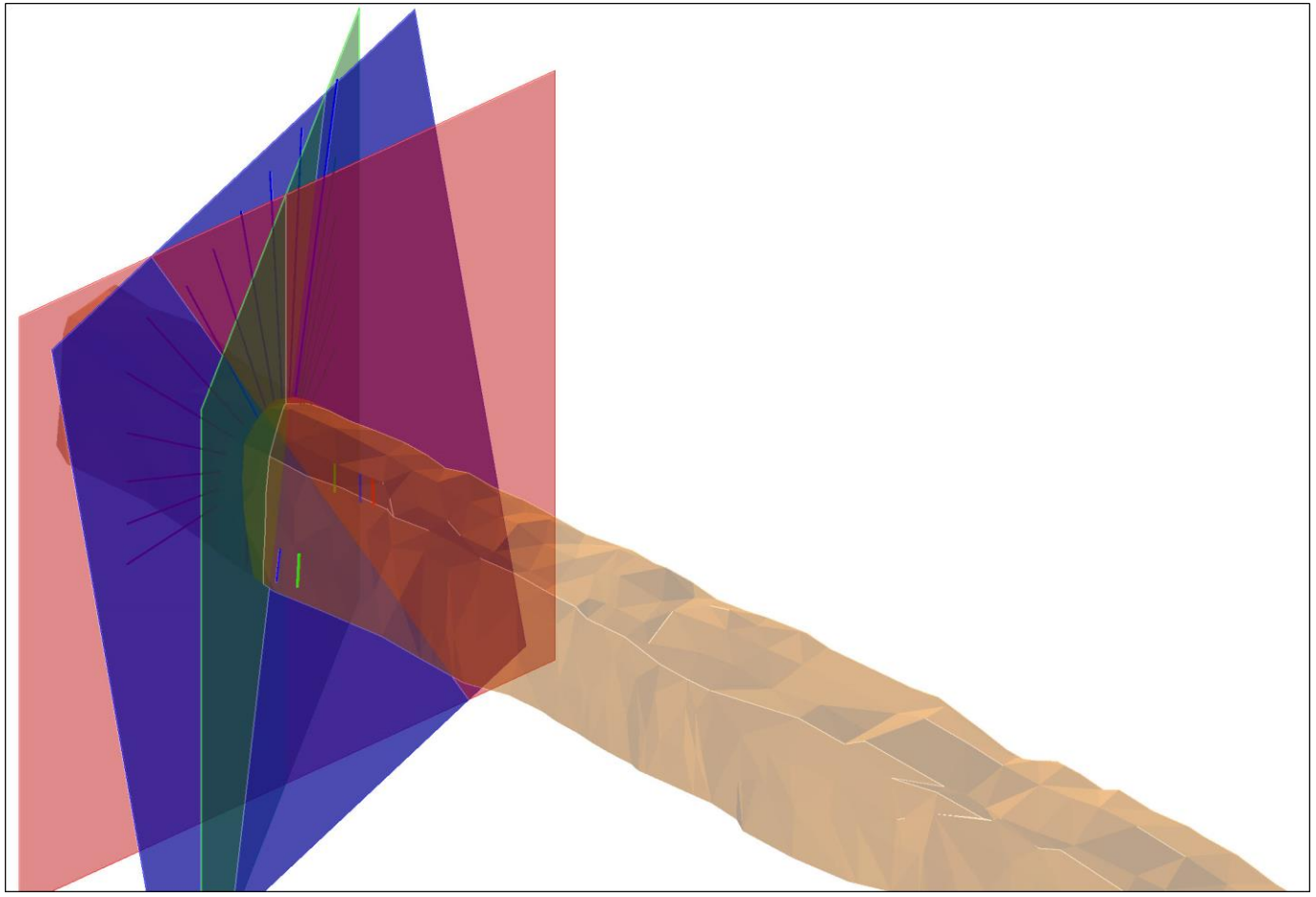

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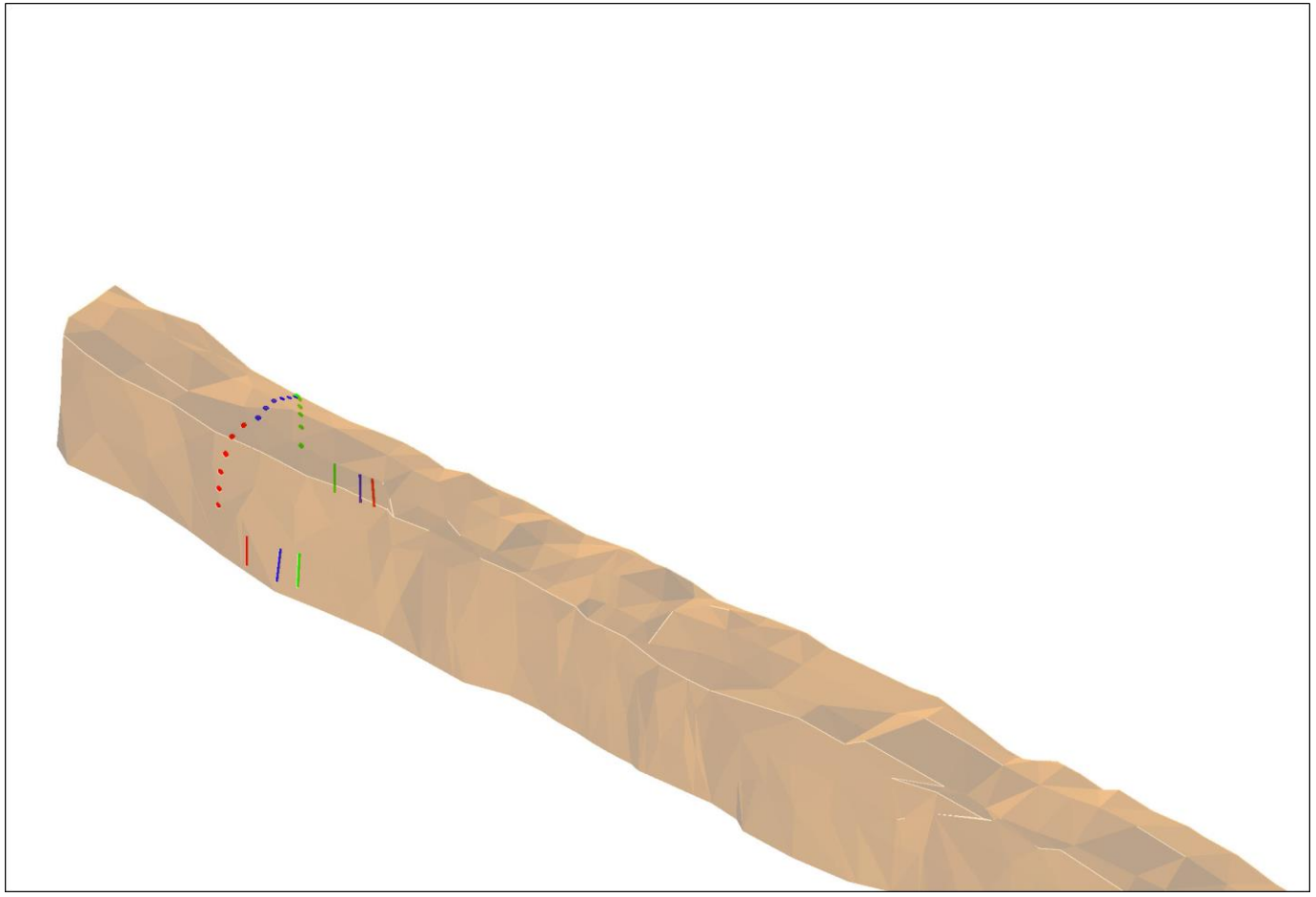
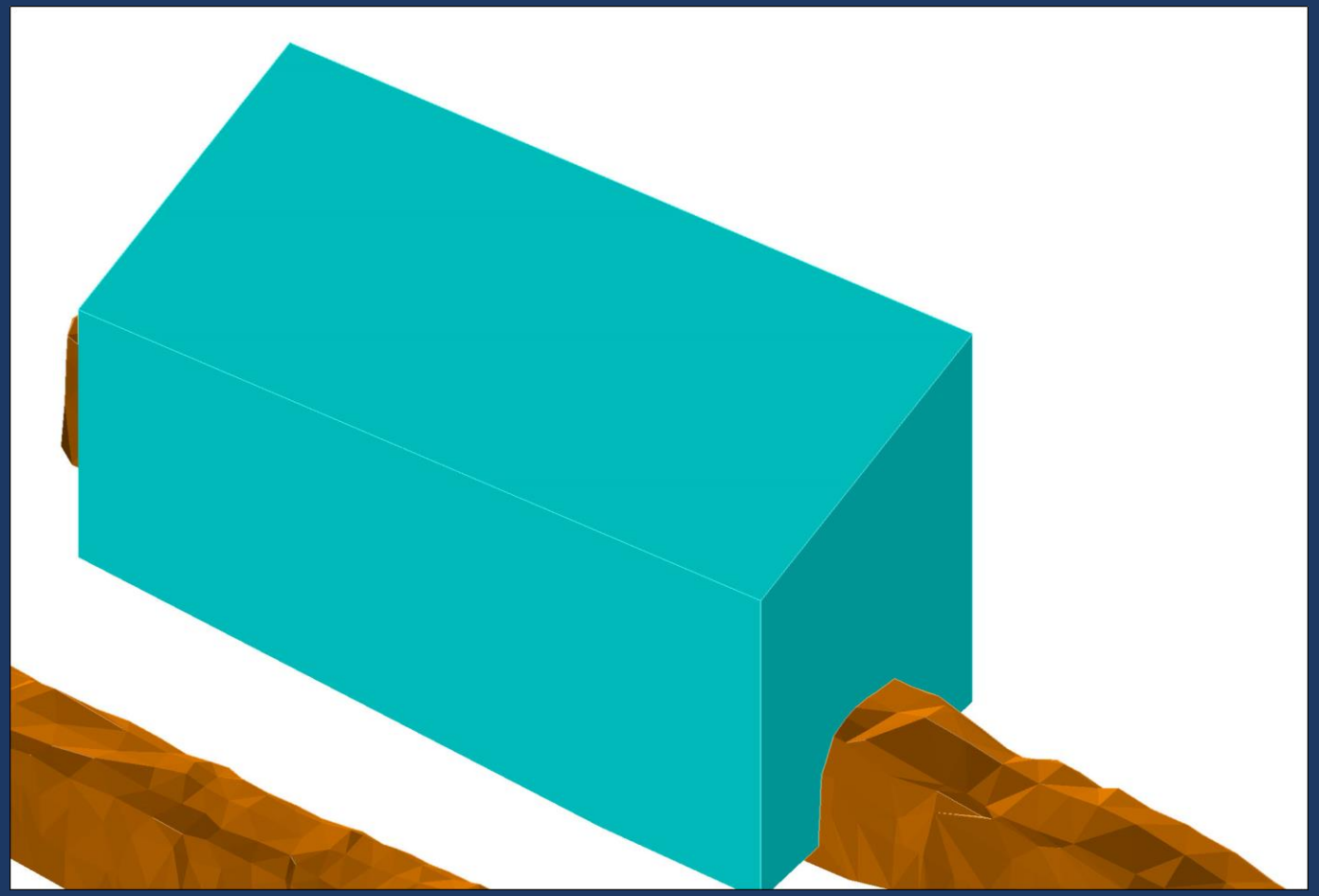


- Adding additional holes in different planes such as fly holes
- Each plane requires its own reference markup and the rig to be separately initialised
- To drill a ring pseudo conical holes we must define and provide markup for three rings
- We require a substantial amount of markup for a comparatively small amount of drilling
- Most importantly to define all holes in space we must provide markup specific to each individual hole, or rely on relatively inaccurate operator set out relative to some reference line – mesh grid counting for instance
- As a result design must precede survey markup

SPATIAL NAVIGATION IS THE DETERMINANT

- HOW DOES THE DL432i NAVIGATE BY COMPARISON

- Example Stope Again



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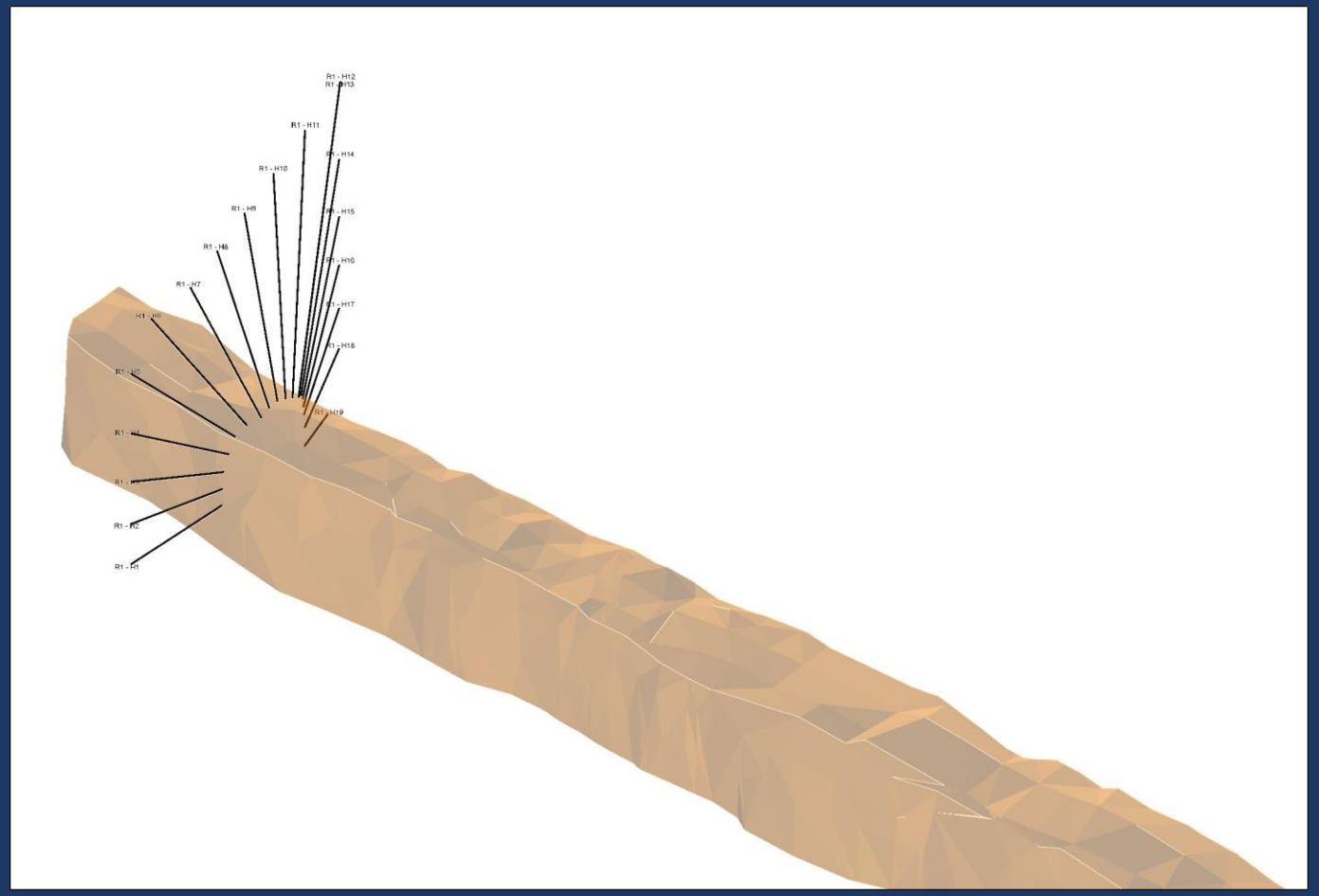

- Example Stope Again
- Looking at the entire multiplanar ring set from before

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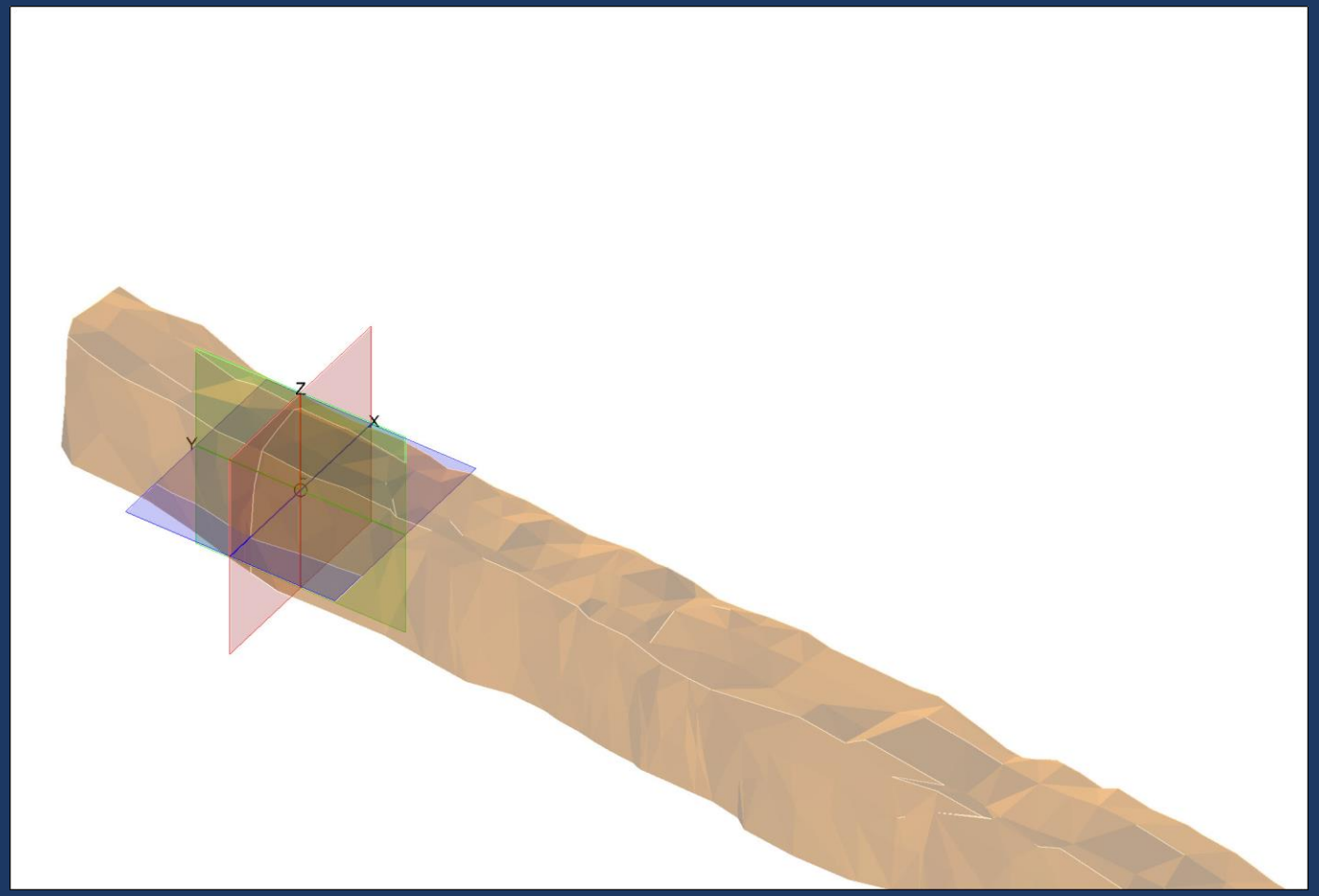

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- The DL432i navigates in a relative cartesian coordinate system

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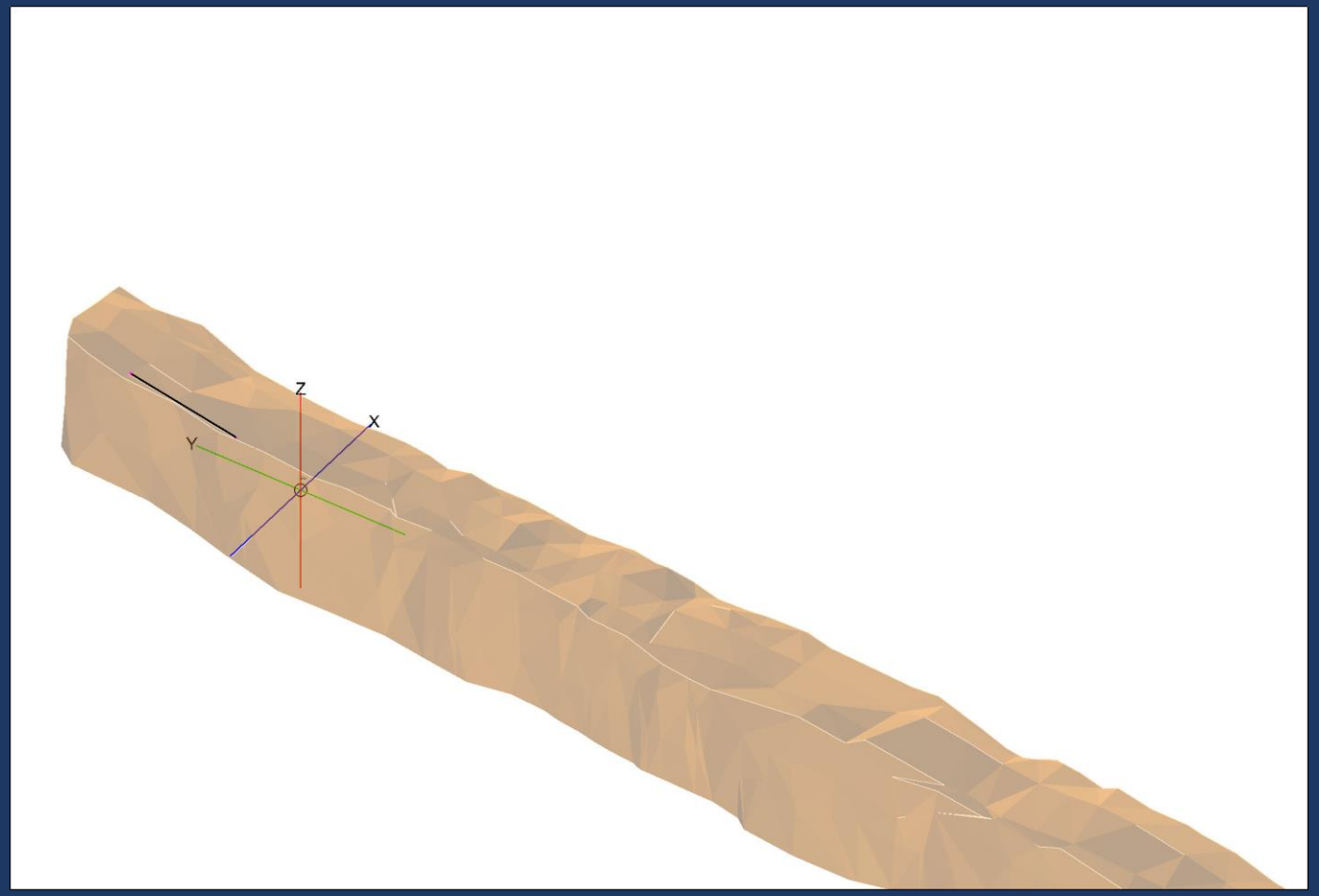

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- Individual holes are defined within this relative 3D space

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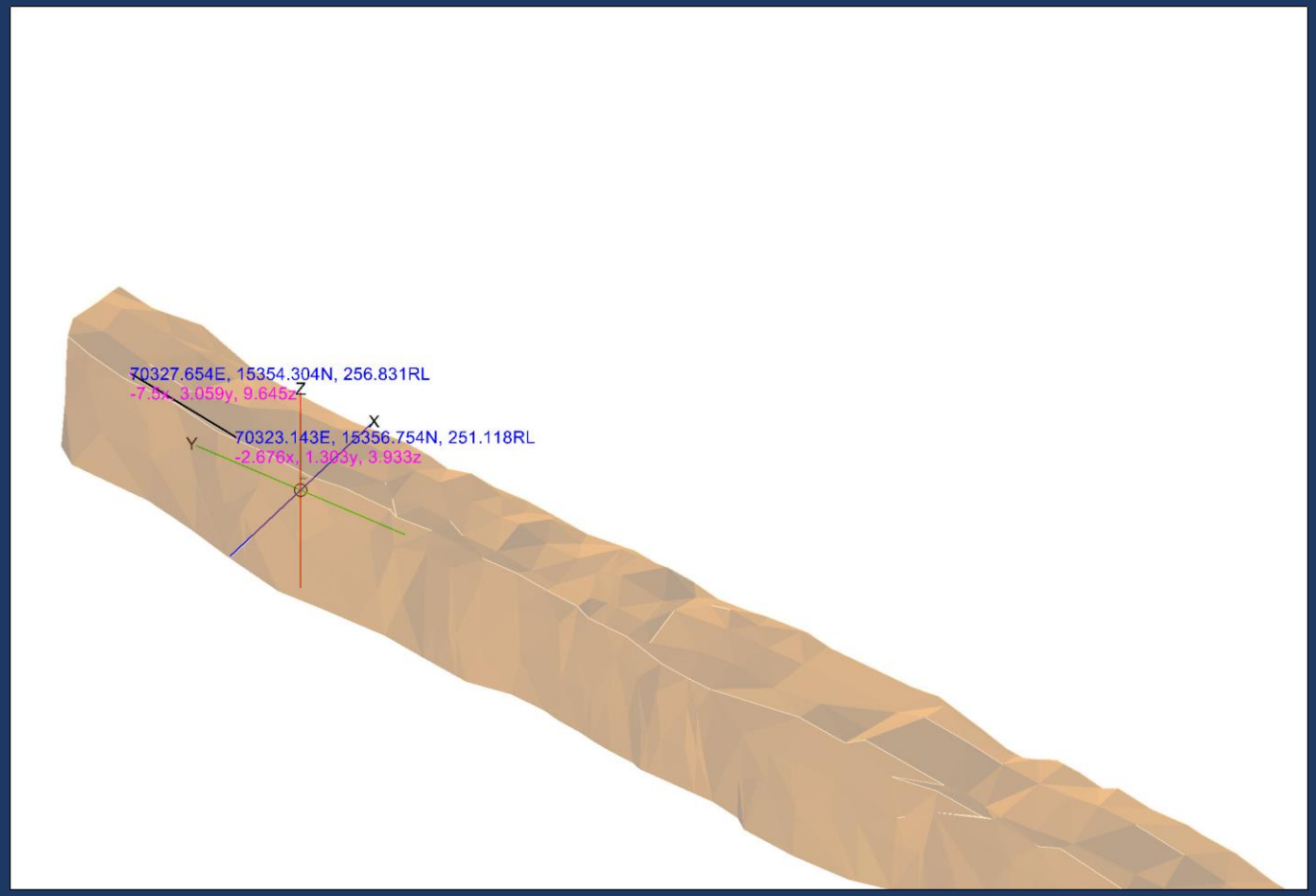

- Example Stope Again
- Looking at the entire multiplanar ring set from before
- The DL432i navigates in a relative cartesian coordinate system
- Individual holes are defined within this relative 3D space
- Each hole is defined by a collar and toe point in relative space rather than as a ray on a loosely specified plane
- In order to drill a hole the rig need only know the relative position of the coordinate system to itself and no longer requires any markup for the hole

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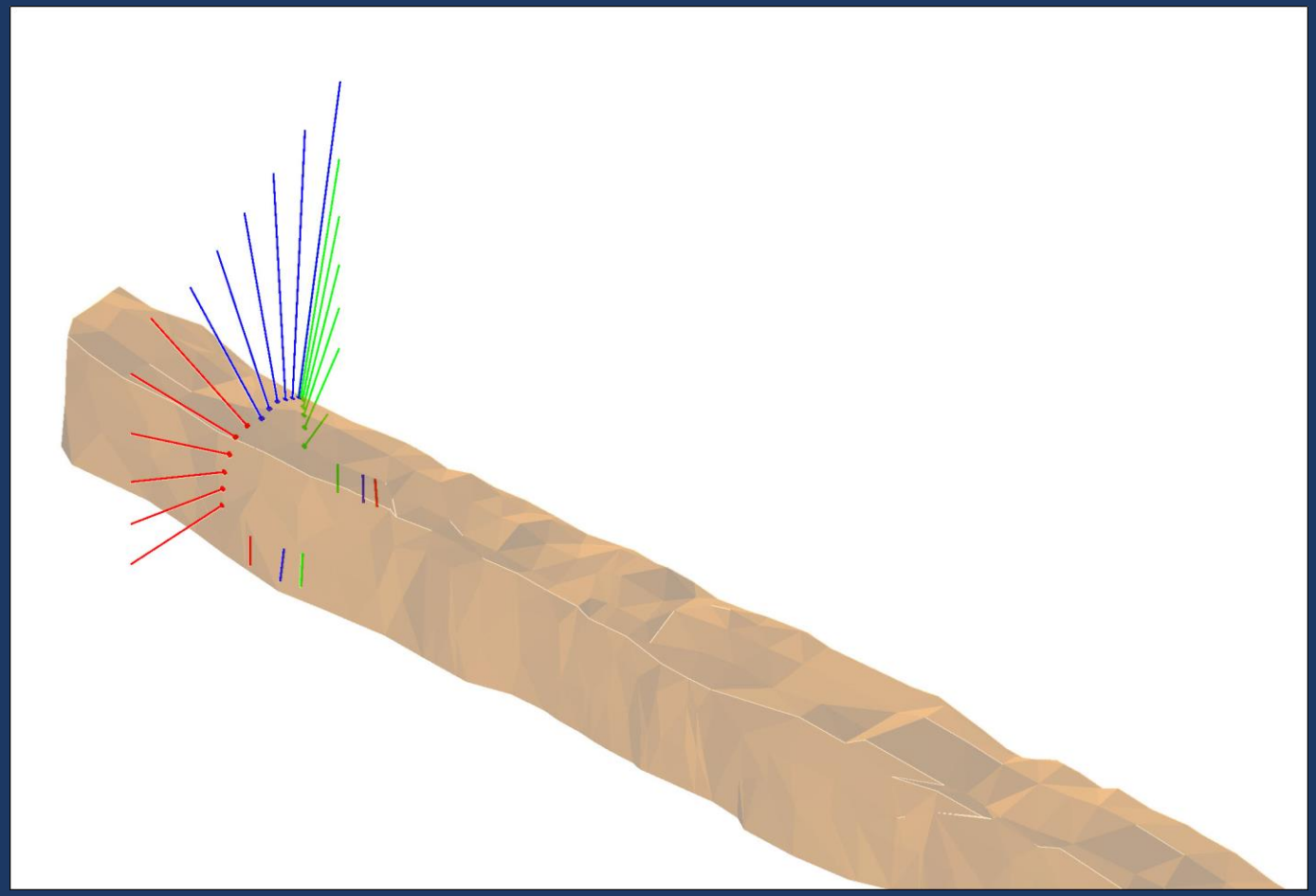

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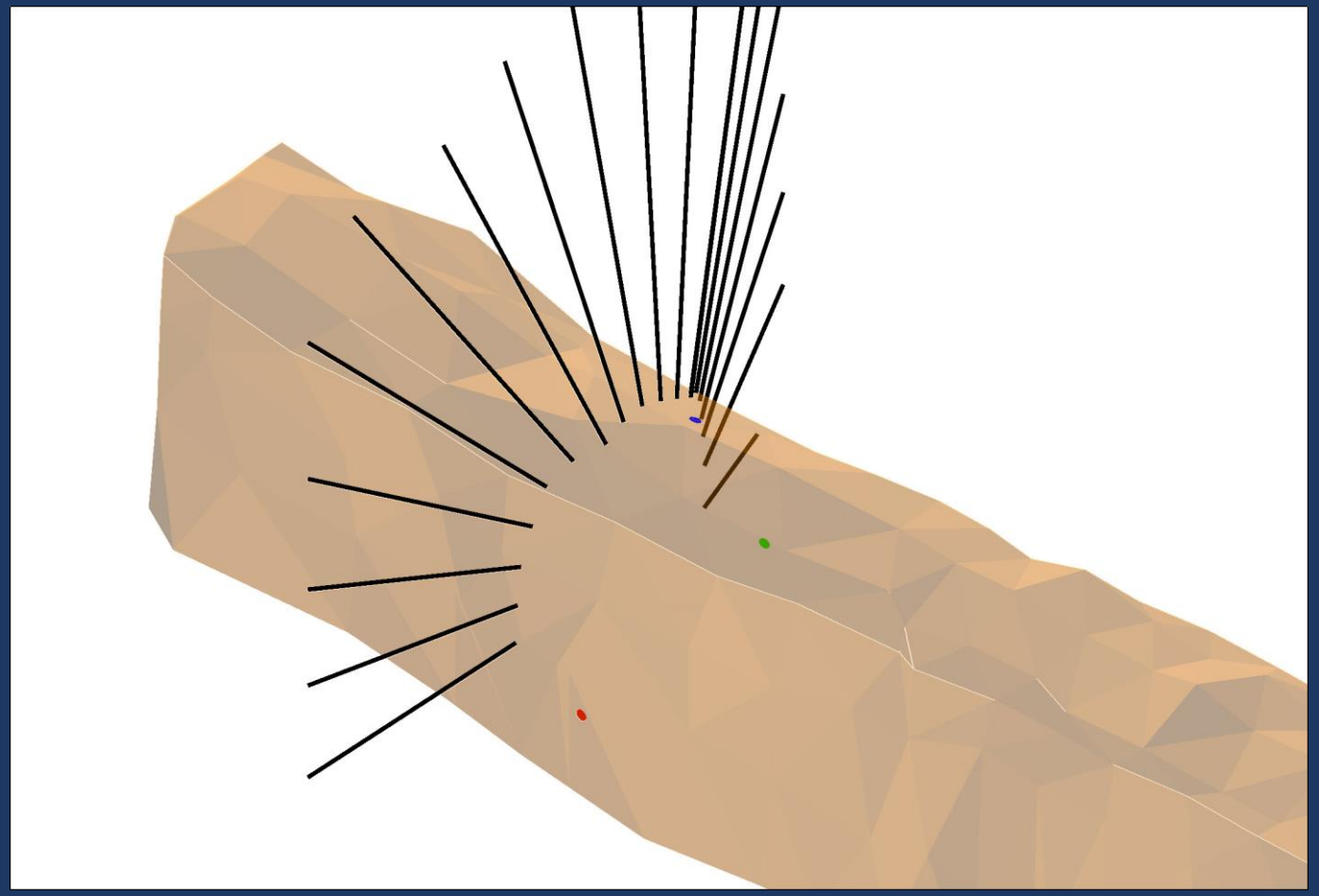

- Looking at our multi planar holes again, it is clear all holes can be defined equally well in a single coordinate system
- As such we can do away with laser lines for each plane, and collar points for each hole. Instead relying only on three reference points
- The two lateral points define the azimuth of the X axis and the zero crossing on the Z axis
- The reference point in the backs defines the zero crossing of the Y axis
- The relationship between each hole and the reference system in which it is defined is now somewhat arbitrary

ADDITIONAL CAPABILITY


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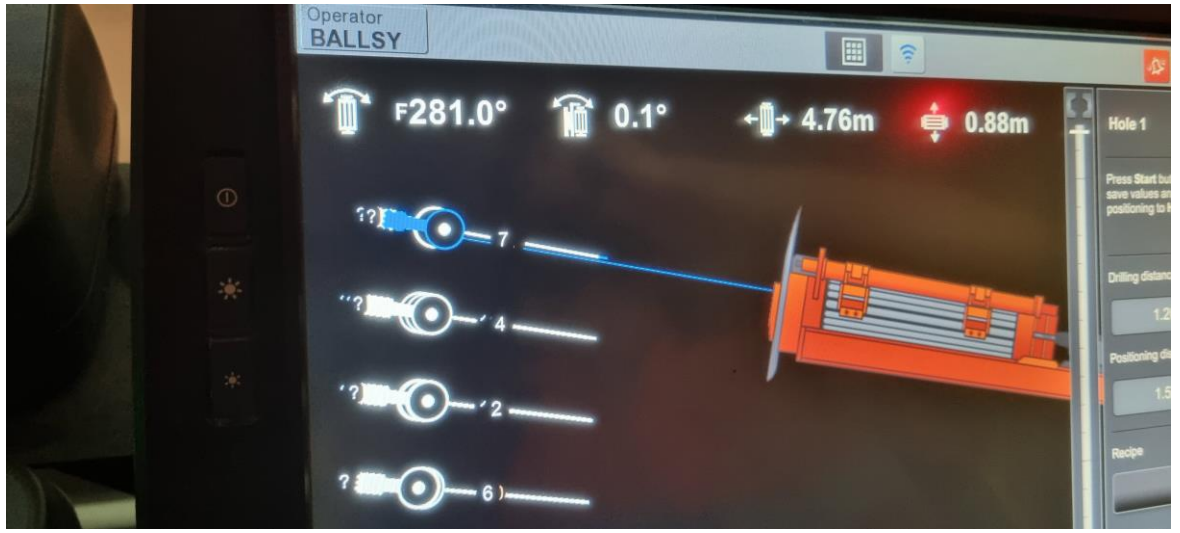
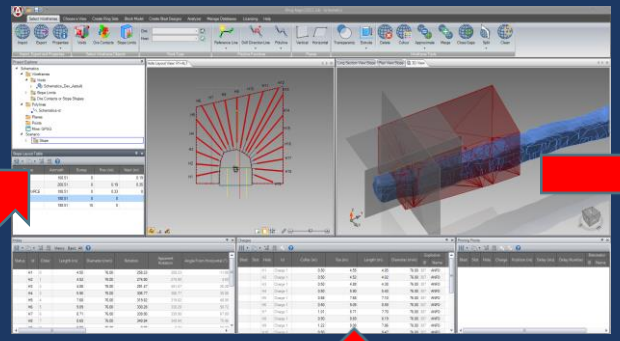
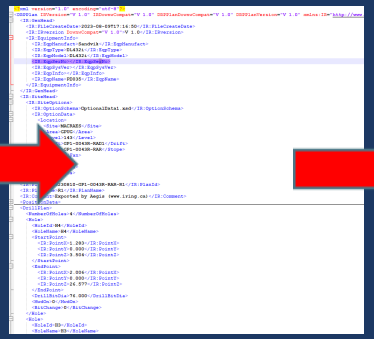
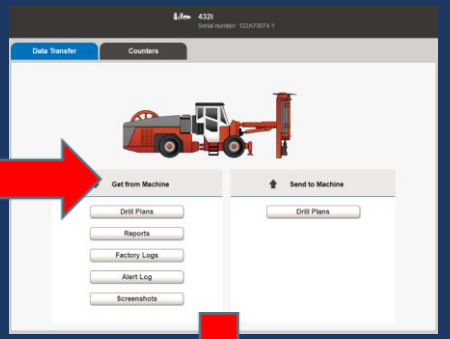
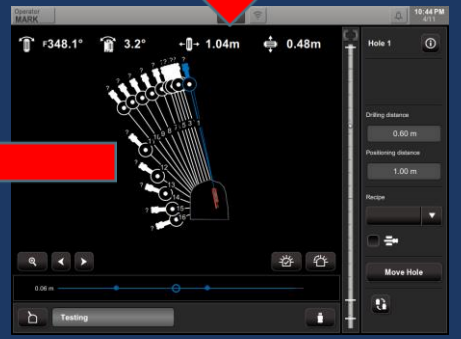


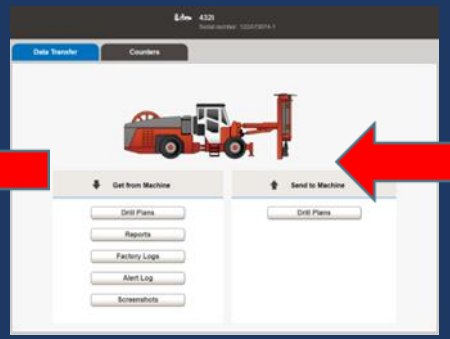
A NEW PRODUCTION DRILL WORKFLOW









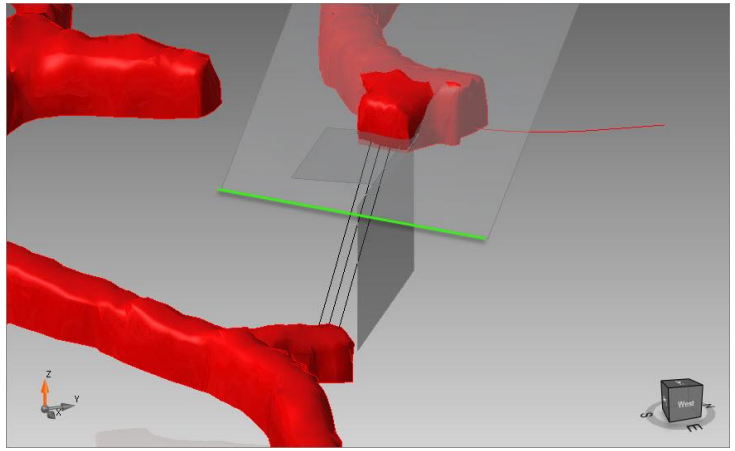


MINING GOLD FOR A BETTER FUTURE

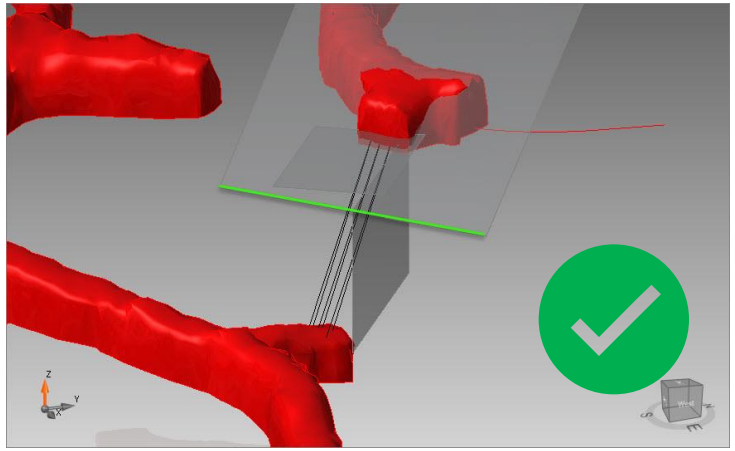
OCEANAGOLD

PRODUCTION DRILL COMPARATIVE SCENARIO

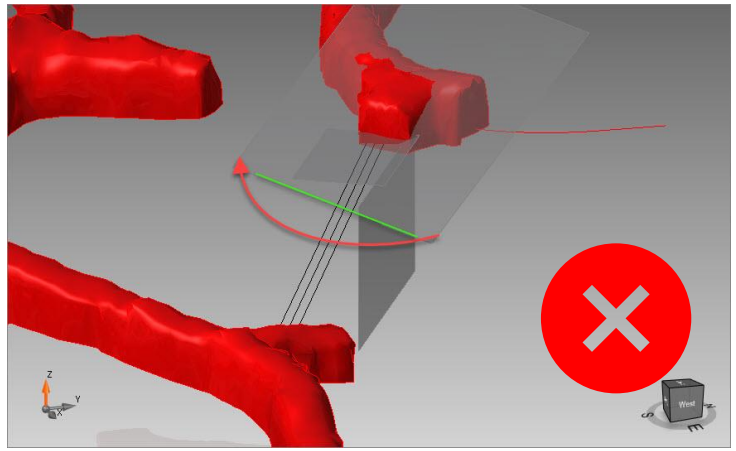
- DRILLING A SERVICE HOLE – FAILURE TO BREAK THROUGH
- QUESTIONS ABOUT SETUP VS CERTAINTY
- 1-2 DAY RESOLUTION CYCLE VS MINUTES



Original design



Multiple adjusted dump options – 15 minutes



Adjusted azimuth – new reference system - >1 day

PRODUCTION DRILL BENEFITS SUMMARY

- IMPROVED EFFECTIVE UTILISATION
- INCREASED DRILL DESIGN FLEXIBILITY AND RESPONSIVENESS
- IMPROVED OVERALL DRILL ACCURACY
- REDUCED CONSUMABLE & OPERATING COSTS
- REDUCED RIG DAMAGE & FASTER FAULT IDENTIFICATION

THE TAKEAWAYS

- MINING PACKET SWITCHED NETWORKS NEED NOT BE EXPENSIVE
- THE ABILITY TO LEVERAGE BENEFITS SCALES EXPONENTIALLY WITH COVERAGE AND CONNECTED SYSTEM COUNT
- COVERAGE IS THE KEY TO LEVERAGING AUTOMATION BEYOND THE BASE CASE
- TO GET THE MOST FROM AUTOMATION RE-EVALUATE YOUR WORKFLOWS AND LOOK PAST WHAT THE CURRENT PROCESS DICTATES
- ASK WHY, WHAT IF, HOW & ENGAGE WITH THE OEM
- USE TECHNOLOGY TO AUGMENT PEOPLE

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