

Longwall remote operation

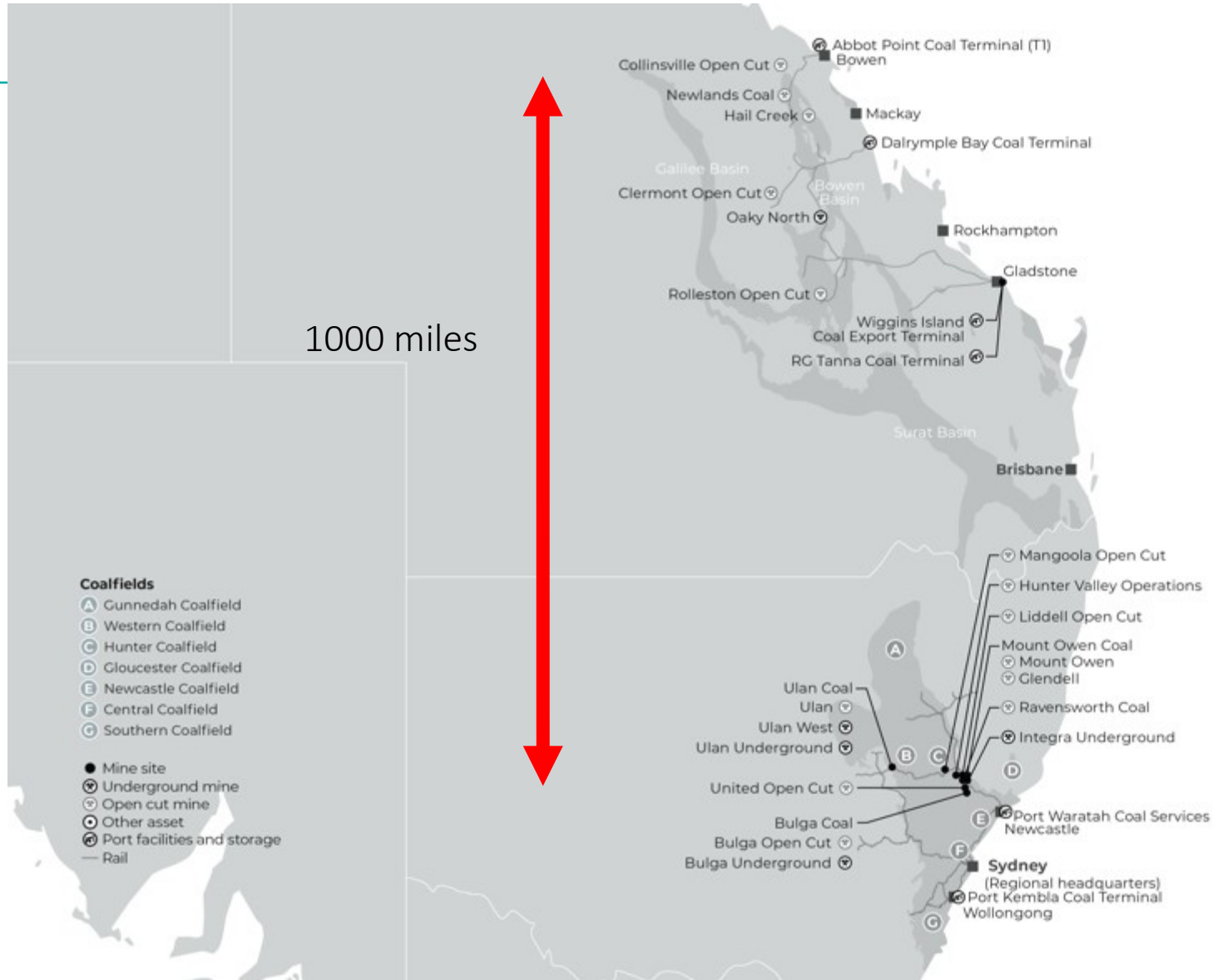
Peter Henderson

May 2019



- We are Glencore, one of the world's largest globally diversified natural resource companies.
- Divisions
 - Energy Products
 - Metals and Minerals
 - Agriculture
 - Marketing
- 2018 figures
 - 50 Countries
 - 158,000 Employees and FTE's
 - EBITDA \$15.8B







Mine	Face W	Face H	Shearer	AFC	Supports
Oaky Nth	350m (1150')	2.6m (100")	Eickhoff SL750	KMC TTT	Cat & KMC
Integra	250m (820')	2.6m (100")	Cat EL2000 (Eickhoff SL750)	Cat CST	Cat PMC-R
Ulan 3	400m (1310')	2.8m (110")	Eickhoff SL750	KMC TTT	KMC RS20s+
Ulan West	400m (1310')	2.8m (110")	KMC 7LS6	KMC TTT (11kV)	KMC RS20s+

Recently Closed (exhausted resource)

- Bulga- 2018
- West Wallsend- 2015
- Ravensworth – Care & Maintenance
- Newlands- 2016
- Oaky #1- 2017

Recently Divested

- Tahmoor- 2018



During 2017 one of the Glencore longwalls in Australia was faced with a tough situation. An excessively high concentration of carbon dioxide was found in a section of the current longwall block. This concentration was so high that the risk of injury due to coal outburst was intolerable. The area of high risk was approx. 200m of retreat. Two options were considered to deal with this area, move the longwall around the high risk area, or mine through the area with no people on the longwall face. The later option was selected based on shearer floor steering using LASC enhanced horizon control protocols. As many functions as possible were transferred to a room on the surface that became known as “the Bunker”. Not only did this method of mining successfully mine through the high risk zone but the mine continued to use this method even when people were allowed back on the longwall face. This paper discusses the positives and negatives from this experience and other initiatives Glencore has undertaken since.

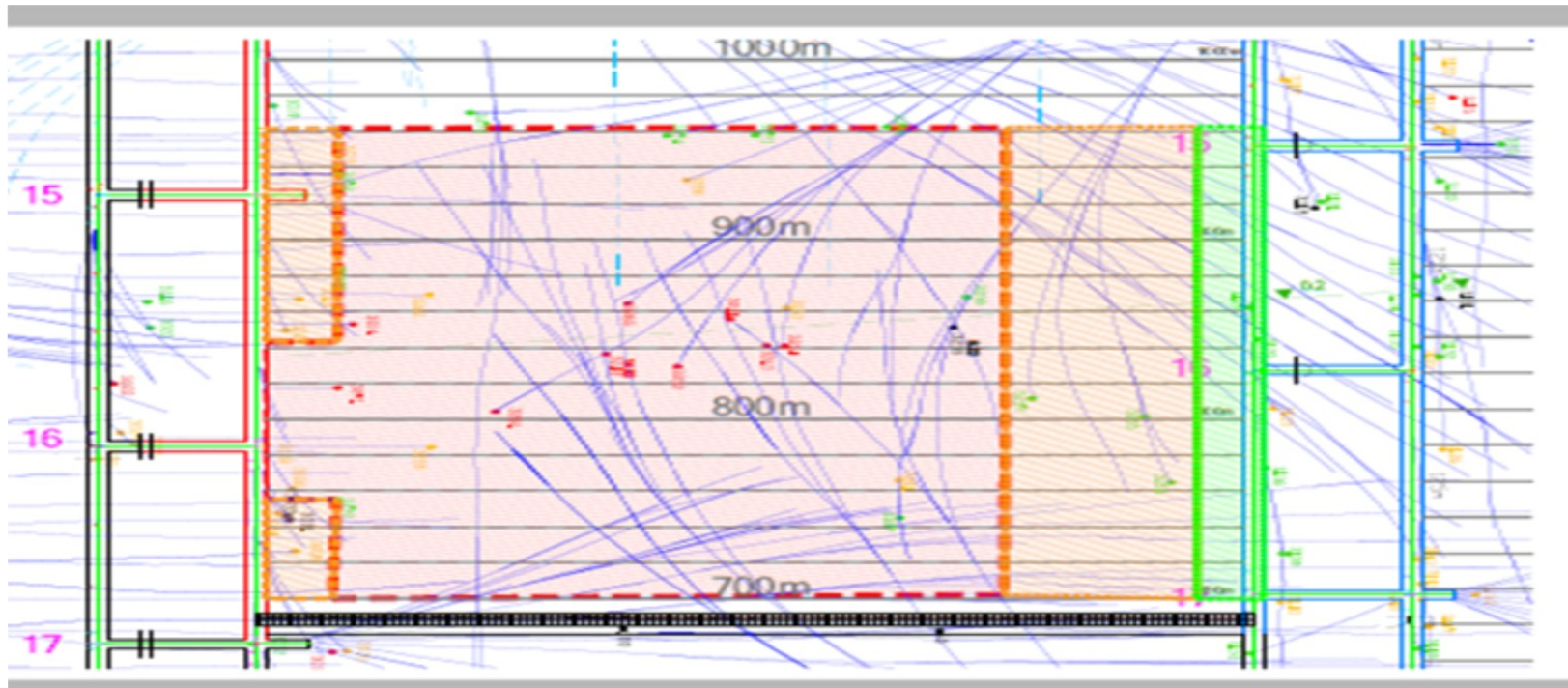




- In 4 weeks the law is changing and no people can be on the LW face when the shearer is cutting.
- What are you going to do?
- Do you really need people next to the shearer?
- Do those people need to interact with the shearer in real time?



- High CO2 gas levels in longwall panel
- Risk of outburst of coal into walkway was intolerable
- Self imposed exclusion of people from the LW face while cutting and for 20mins after cutting stops



- Relatively old longwall – 260m (853')
- Extraction height 2.2m (86")
- Roof supports - Caterpillar (DBT) with PM4 control system
- Shearer - Eickhoff SL300 with latest controls including LASC SPMS
- Rockwell PLC in power center
- Fiber based Ethernet from surface to Main Gate power center
- Power line modems to shearer
- No Cameras on the face
- No WiFi on the face



- From the time the high risk zone was defined only 4 weeks of production before restricted mining was in place.
- There was no time to make big software changes.
- Had to use what was available.
- Both Caterpillar and Eickhoff were helpful but in the limited time they could not develop anything new.



System	Feature available	In Use
Shields	PM4- SRB, Gate end shield automation	✓
Face Alignment	LASC Automatic Face alignment based on inertial navigation	✓
Shearer sequence	State based (EControl)	✓
AFC to Shearer	Pause command	
Shearer Horizon Control	Remote control via camera???? Floor steering????	?

- All shearers have the ability to be “paused”.
- When the AFC stops a command is sent to the shearer to pause.
- Haulage stops.
- Cutters continue to run.
- When the AFC starts another command is sent to the shearer to “un pause” and shearer resume production.
- Rockwell PLC in power center managed the pause.



EIP Command
PAUSE

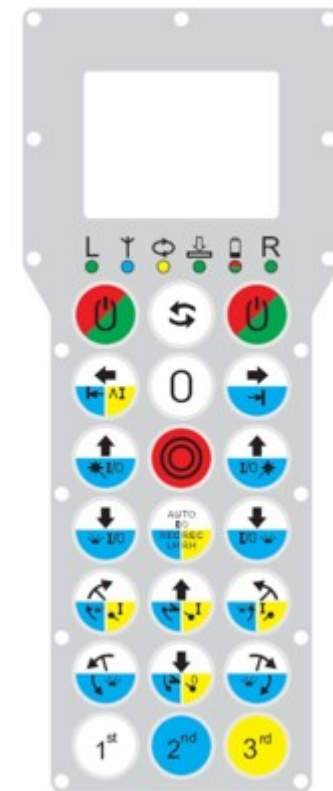
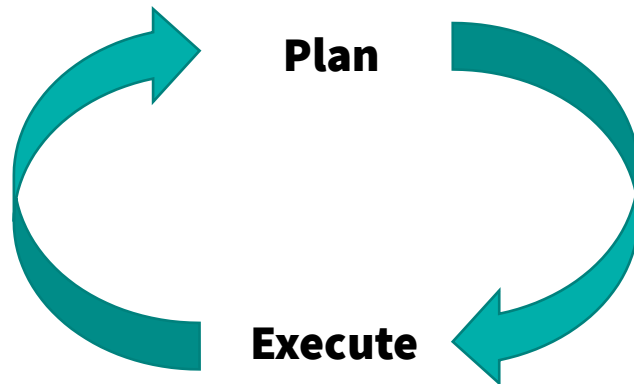


- Remote Control of Ranging arms – valid strategy

Longwall Command Center



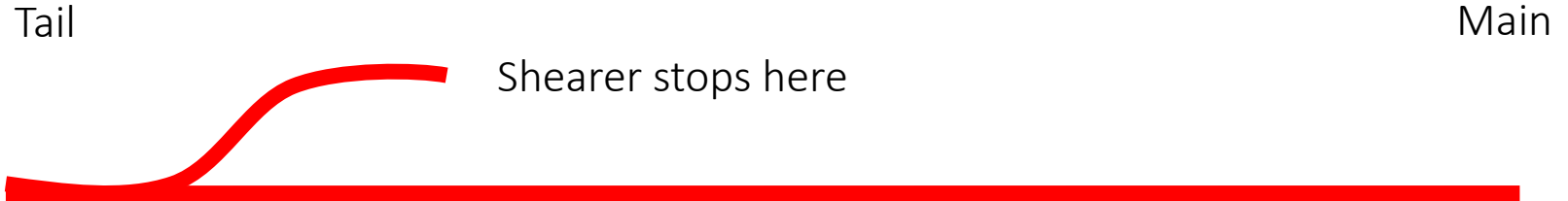
- **Planning**
 - Observe the longwall face
 - Determine corrections for the floor
 - Load the corrections into the shearer
-
- **Execution**
 - Let the shearer execute the plan with no human intervention
-
- The shearer remote handset is NOT used.



- Shearer becomes a plow
- Floor corrections become the tilt rams

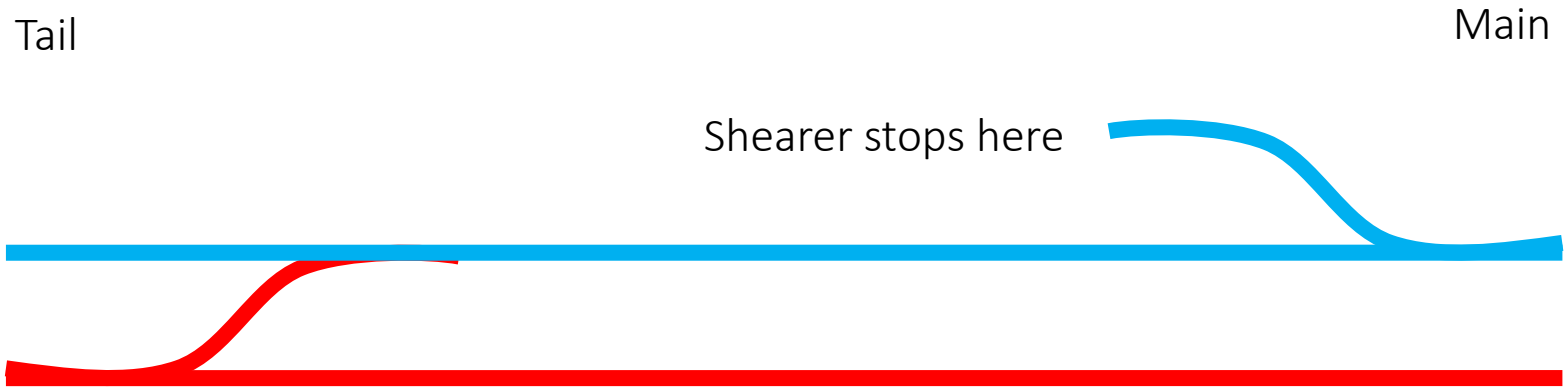


-
- Using State based automation the shearer was programmed to follow a set BiDi sequence.
 - Leave the main gate cut to tail gate
 - Leave the tail cut to the turn around



Wait 20 minutes

Walk the face to observe noting corrections required



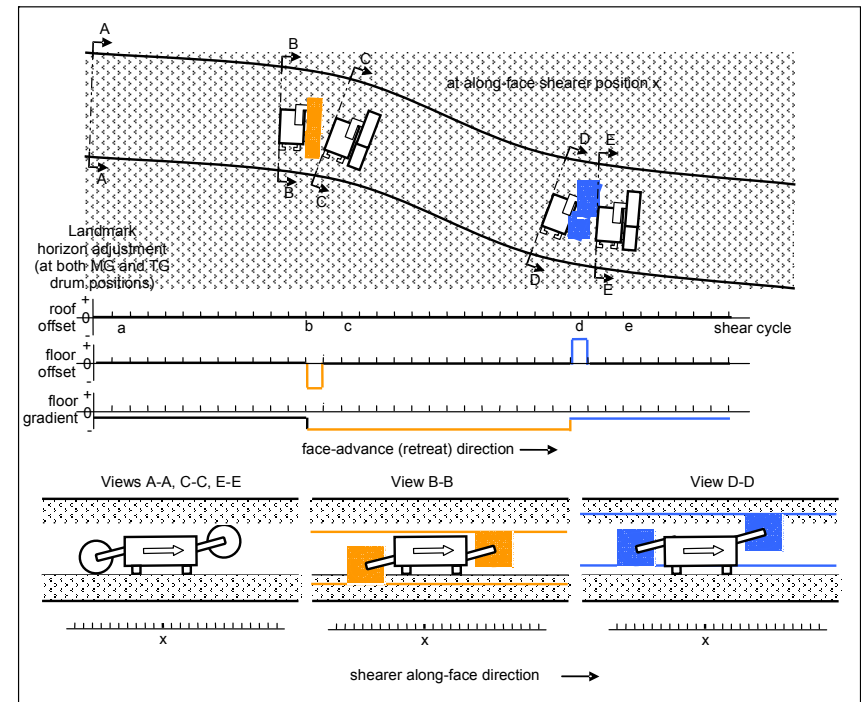
Wait 20 minutes
Walk the face to observe noting corrections required

- Corrections
- LASC defined Enhanced Horizon Control (EHC) in 2005
- All major shearers support EHC protocol – you just have to turn it on
- <http://lascautomation.org/docs/HorizonControlSpecificationV2.36.pdf>

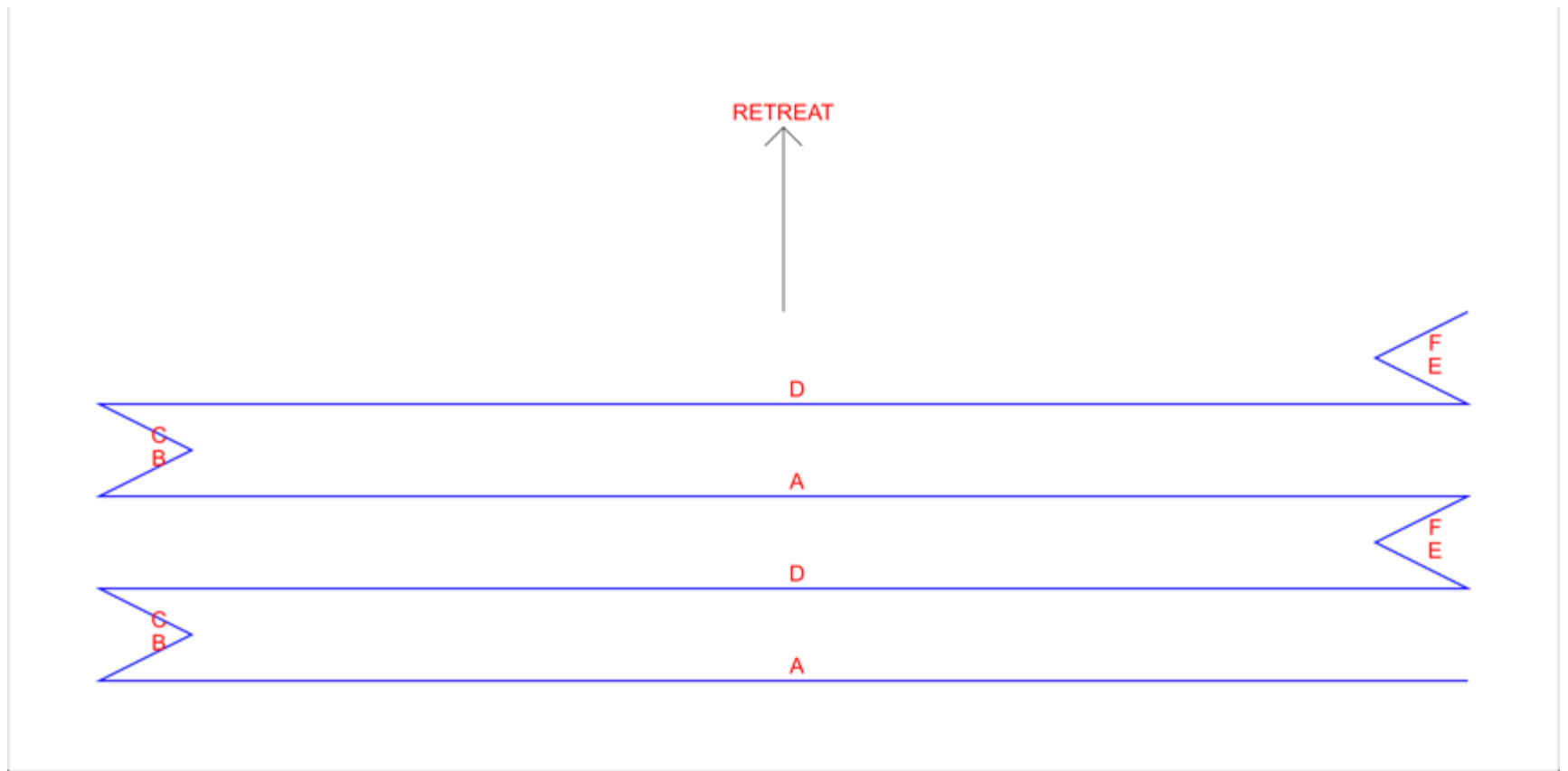
Version 2.36

CSIRO Exploration & Mining Report P2004/6

Interconnection of Landmark Compliant Longwall Mining Equipment – Shearer Communication and Functional Specification for Enhanced Horizon Control

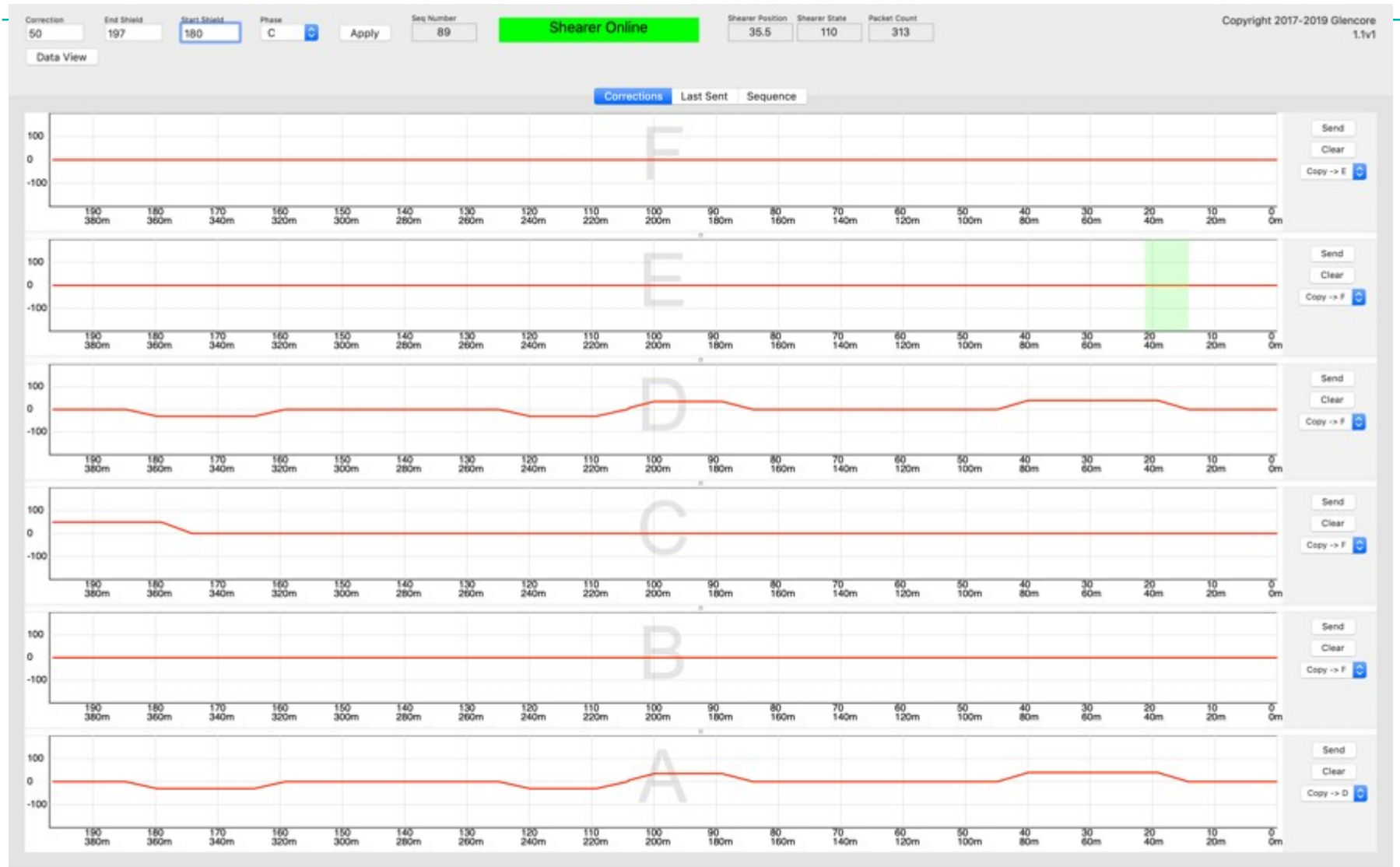


Phases of a bi-di cutting sequence



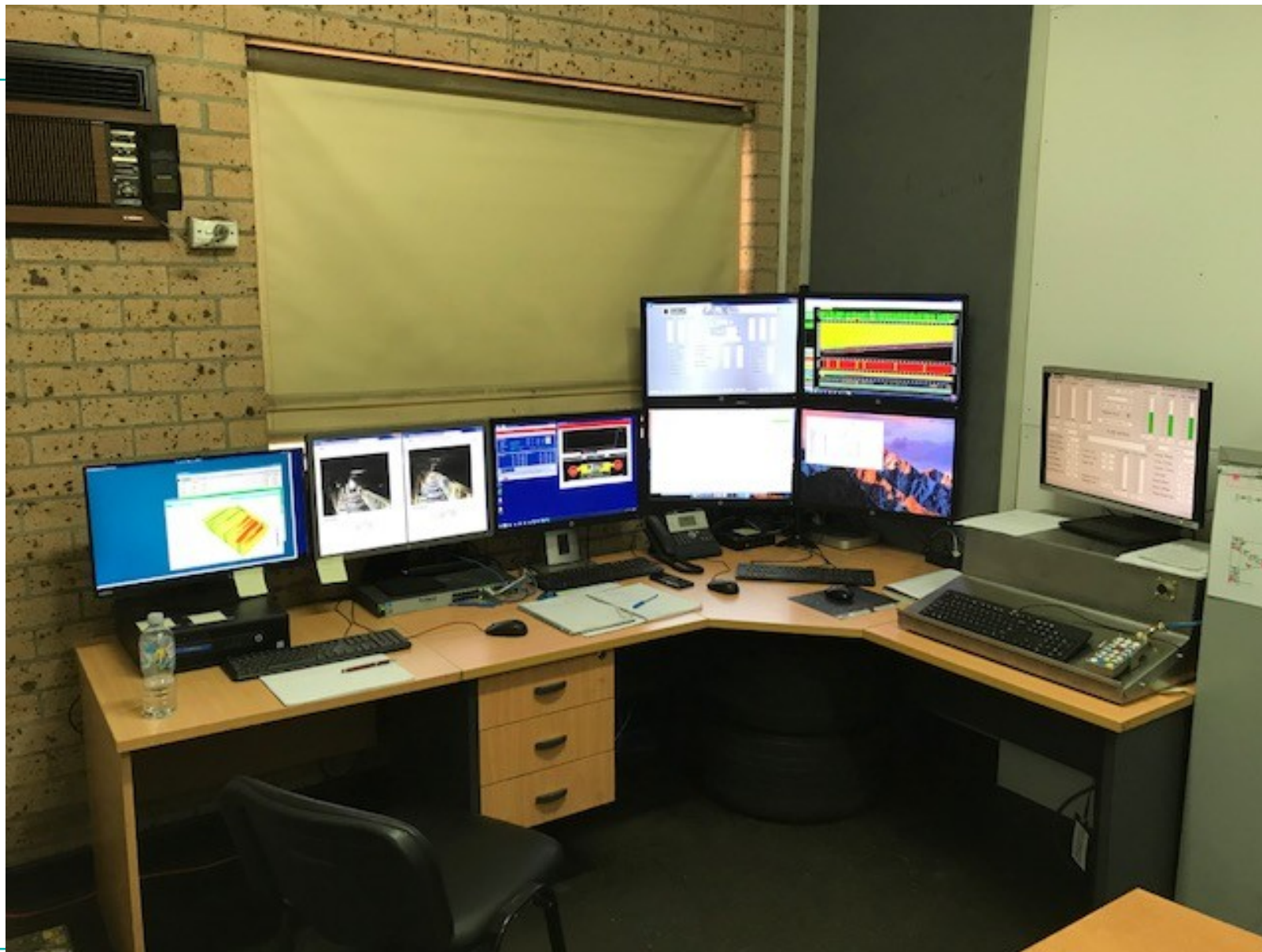
Floor Steering – corrections app

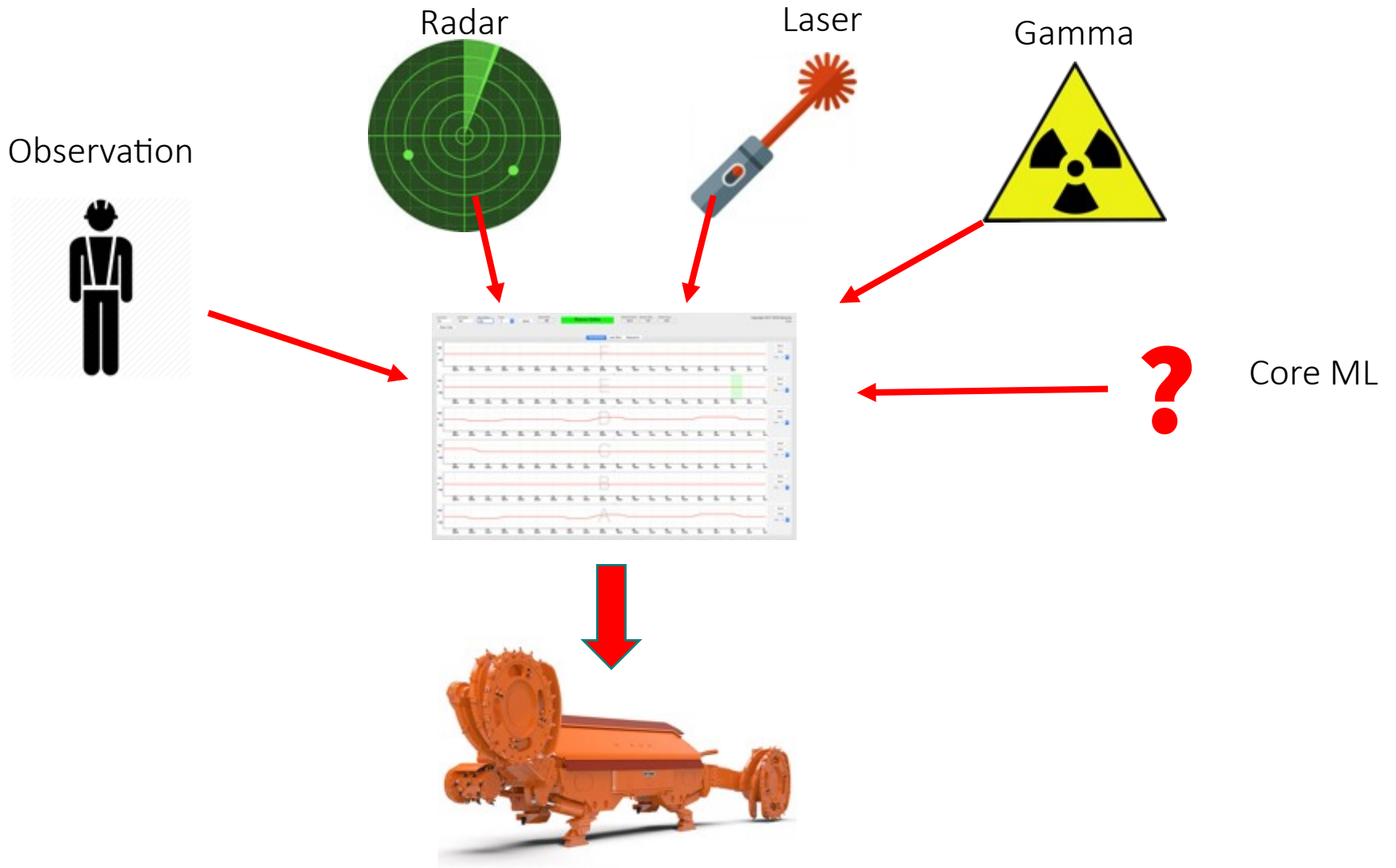
Glencore engineering



- Steer the pans correctly and the the roof will follow.
- Program a fixed profile into the shearer
- Must be managed daily
- Gate end heights require shear by shear monitoring
- Shearer becomes a programmable plow











Floor Steering Results

Heatmap of height

Tail Gate

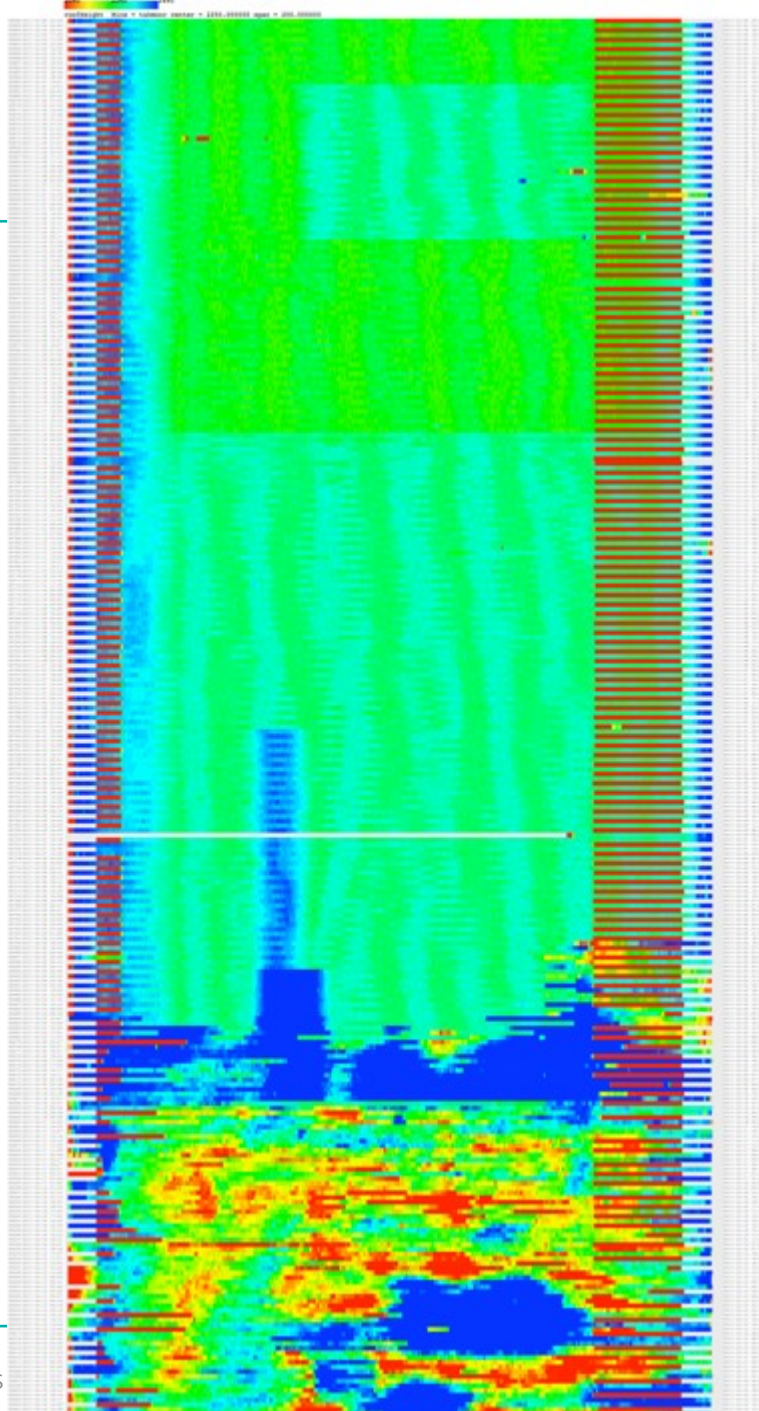
Main Gate

Floor Steer

Transition

Roof Steer

Retreat



- **Positives**

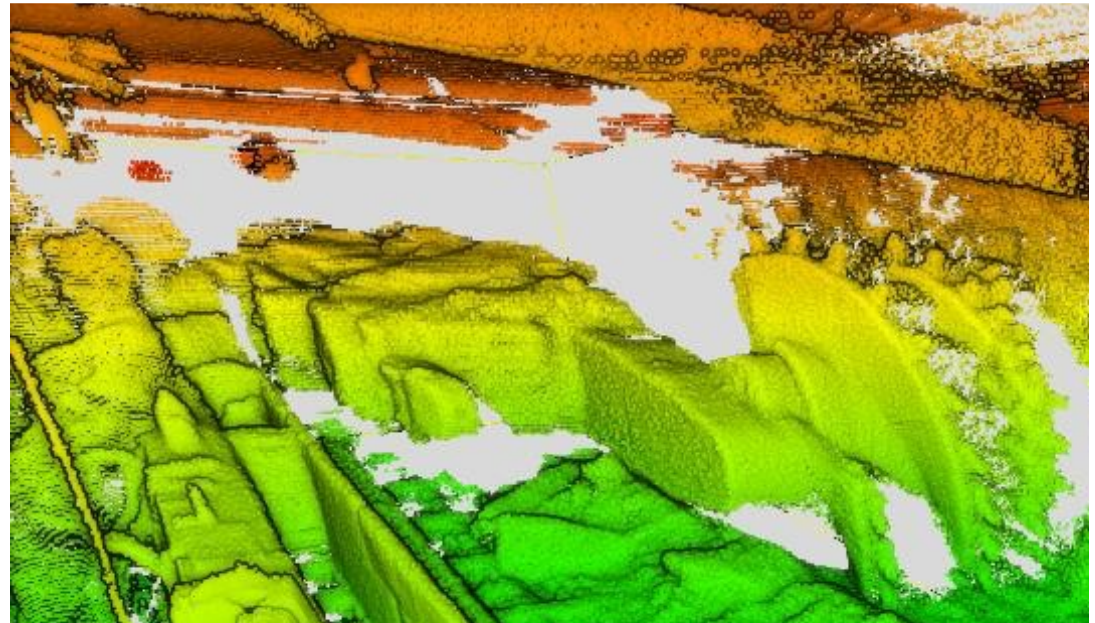
- The process does work – 4 months of continuous operation
- The conditions underground improved significantly
- Boil overs reduced
- Shield advance was more consistent

- **Negatives**

- The mechanical reliability of the roof supports caused lots of delays
- No remote control of PM4
- A person on the surface was an extra cost

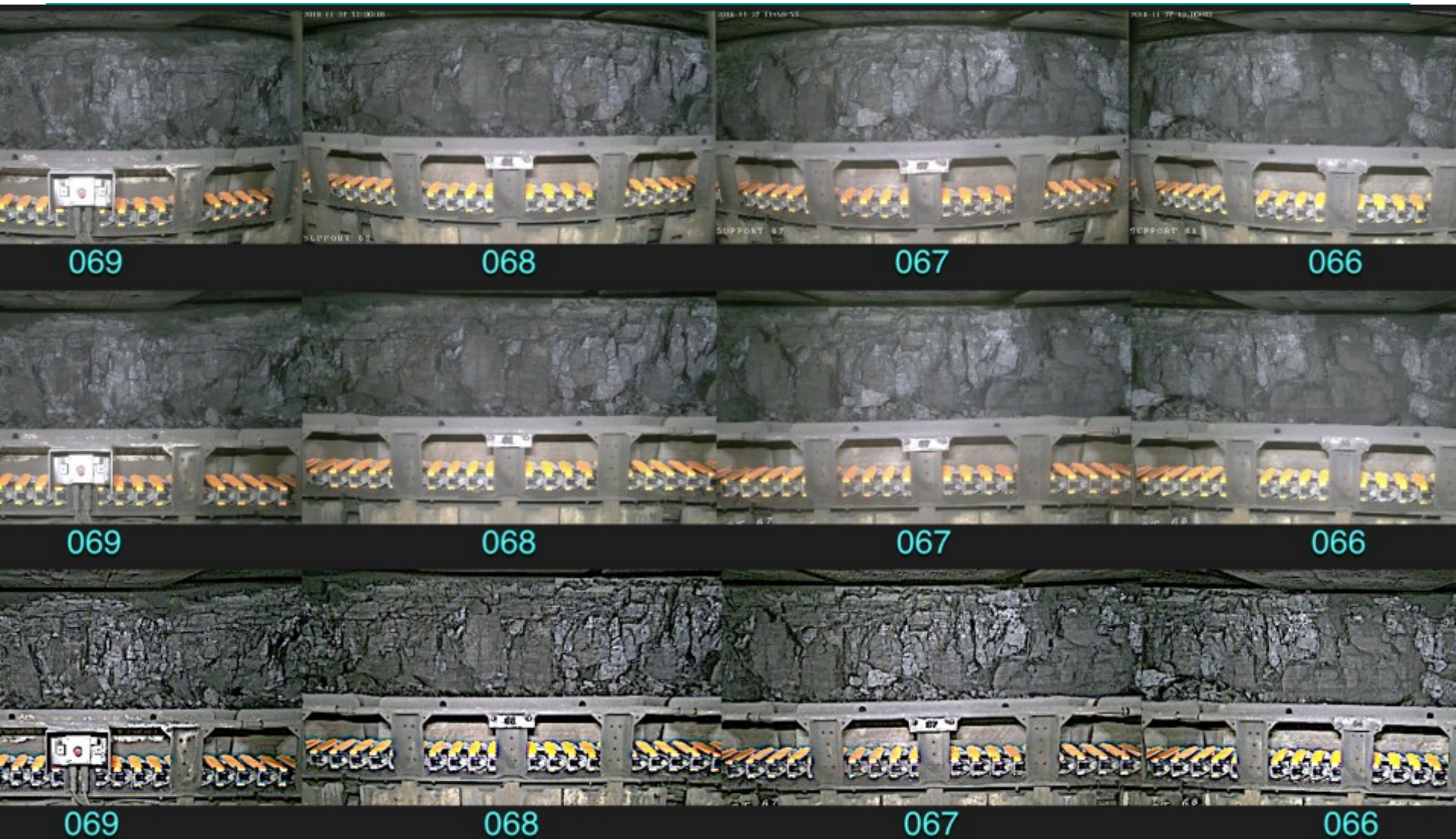


- **Oaky North Mine**
- Floor steering implemented with surface bunker
 - Face conditions significantly improved (best conditions ever)
 - Production is 30% above budget
 - Product yield improved by 3%
 - Pick usage halved
 - Delays more than halved
- **Installing**
 - 3D laser scanners
 - Inclinometers on shields
 - Inclinometers on AFC pans
 - Cameras at Gates
 - Personnel Prox



- **Ulan West Mine**
- Currently running KMC “Pitch Steer”
 - Face conditions significantly improved
 - Investigating the move to full floor steer
- Installing
 - Inclinometers on shields
 - Camera on every shield (197)
 - Personnel Prox

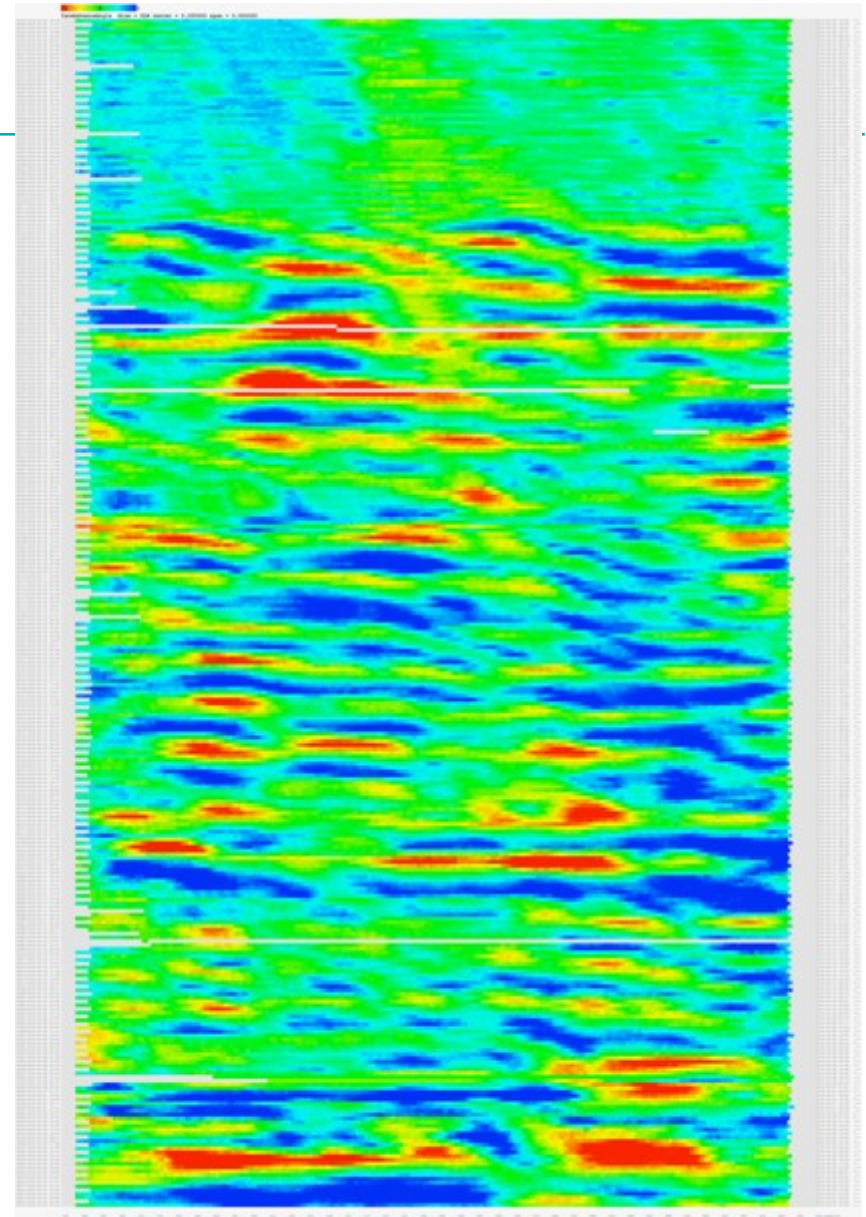






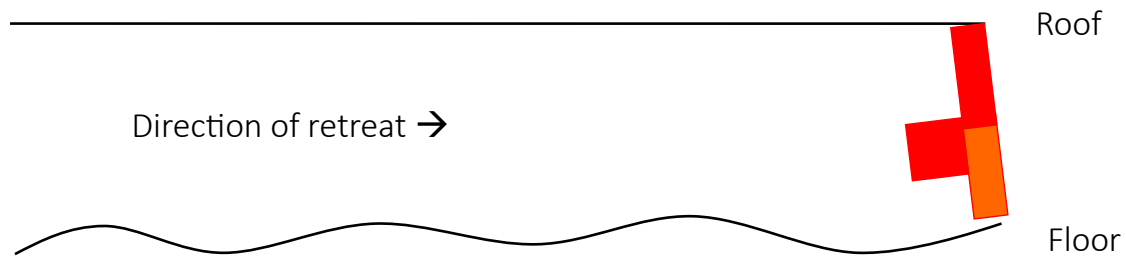
Roof Steering – what is the problem

- FX2 (extract to current)
- Fundamentally unstable
- Oscillations occur
- Moguls in the floor



Factor in poor accuracy of ranging arm automation
Control system overshoot

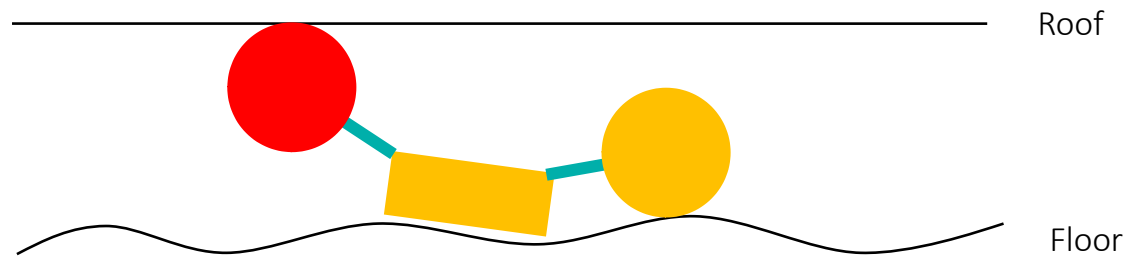
Operator steering to the roof = nice flat roof



Extract to current (auto) cutting the floor = oscillations
Ranging arm errors must go into the floor
Bumpless limit on Extract to current makes this worse

Factor in poor accuracy of ranging arm automation
Control system overshoot

Operator steering to the roof = nice flat roof



The absolute altitude of the shearer body is oscillating
The shearer records the relative height of the lead drum to the lead shoe
Shearer mode “extract to current” generates oscillations along the face

-
- In 4 weeks the law is changing and no people can be on the LW face when the shearer is cutting.
 - What are you going to do?
 - Manless operation is possible with today's technology
 - Don't wait
 - Set a deadline
 - Make it happen

