Innovative blasting to improve mining processes at Middlemount Coal

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The Middlemount project is a joint development between Peabody Energy Australia PCI Pty Ltd and Yancoal Australia Ltd.

Objectives

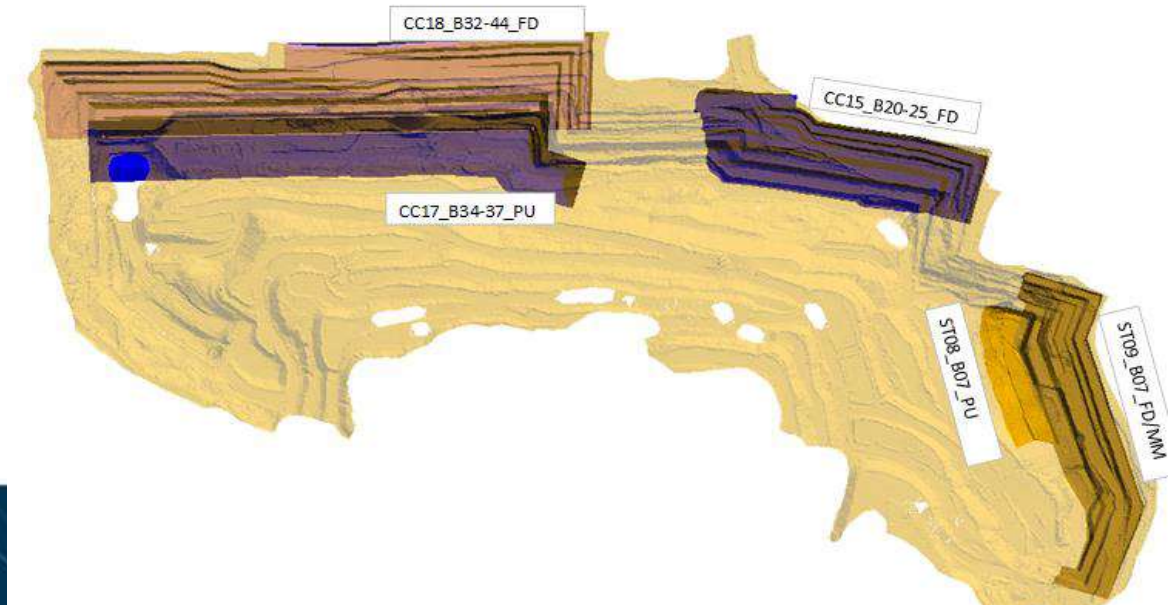
- Middlemount Coal (MPCL) embarked on a ‘process improvement’ project early on this year
- Objective was to holistically approach all aspects of mining operation
- Mend each underperforming process to improve overall efficiency of the mine operation

About Middlemount operation

- Very efficient and cost effective operation
- Highly motivated FIFO work force
- Produce about 5 MT of ROM and remove 60 Mbcm OB
- Mine machines:
  - EX1900, 3600, 5500, 5600,
  - D11 fleet
  - Atlas Copco drill 270/251 mm dia
  - Trucks CAT785, 789,793, EH3500 &
  - Single stage two product coal handling and preparation plant

Geometry

- Free dig prestrip, 30-35 m
- Middlemount (MM) OB, - 70-90 m
- Pisces (PU) OB, 35 to 50 m
- Coal seams gently dip from 3^0 to 15^0
- Fluctuations in dip & geology influence:
  - OB height
  - Stripping ratio & selective mining
- Current areas of operation



Issues

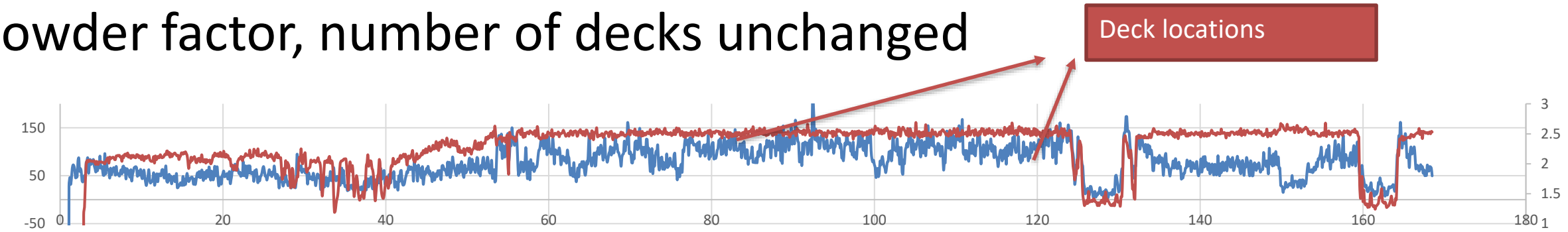
- Highwall stability
- Low machines productivity:
  - Increasing cast % and doze volume
  - Muckpile shaping & loosening
  - Excavators dig rates (pinch points)
- Cost down projects
  - Through seam and Double cast blasting
  - Combined through seam and Double cast blasting
  - Coal recovery

Highwall stability

- Highwalls appeared to be performing reasonably well. Some barrels were clearly identifiable
- A number of blasts were scheduled to be fired through failures
- Current practice couldn’t be measured & modelled
- Team agreed for reverse engineering
- Changes were made based on:
  - Sonic logs - mostly competent rock
  - MIC - 16t
  - Pre vs Mid-split

Highwall stability

- Powder factor, number of decks unchanged



- Endwall split to separate blast block
- Midsplit fired S-N and multipoint initiation more favourable due to:
  - Predominantly competent rock and
  - Dip of J1 & J2 joints - $80^0/096^0$ - > 40^0 to strike
- Established presence of unstable structures causing failures

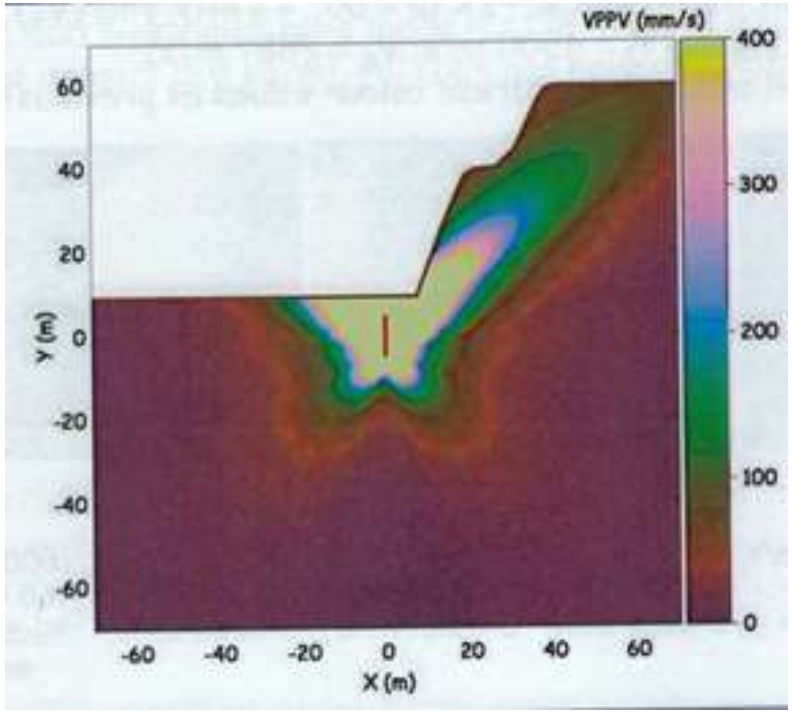
Highwall stability

- Summary of design changes to minimise vibration on highwalls
  - Up to 30 holes/cluster
  - Used up to 40 ms delay
  - Endwall split
  - Unidirectional S-N
  - Multipoint initiation

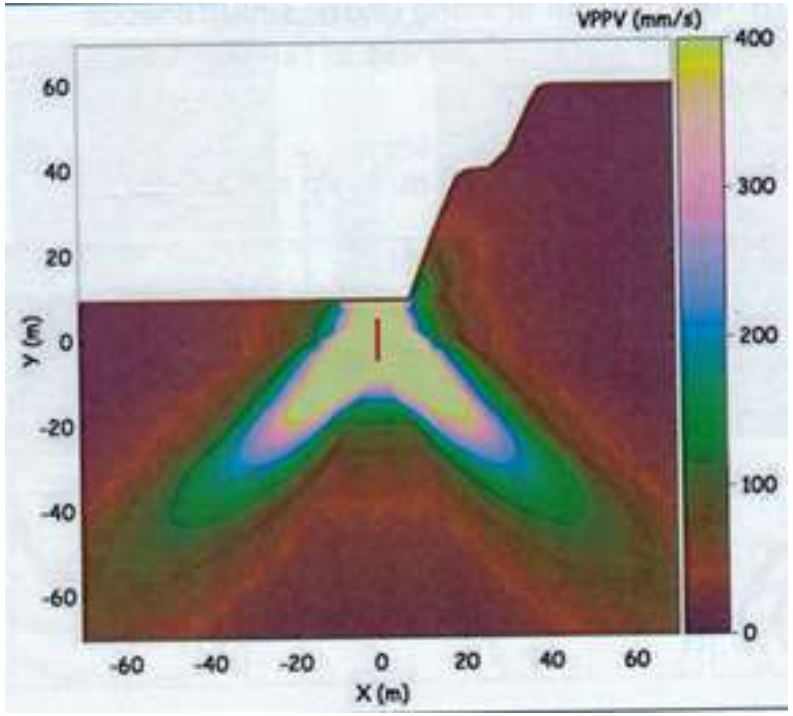
- Another important change
  - Top vs bottom priming

Bottom vs top priming

Bottom priming radiating energy towards highwall



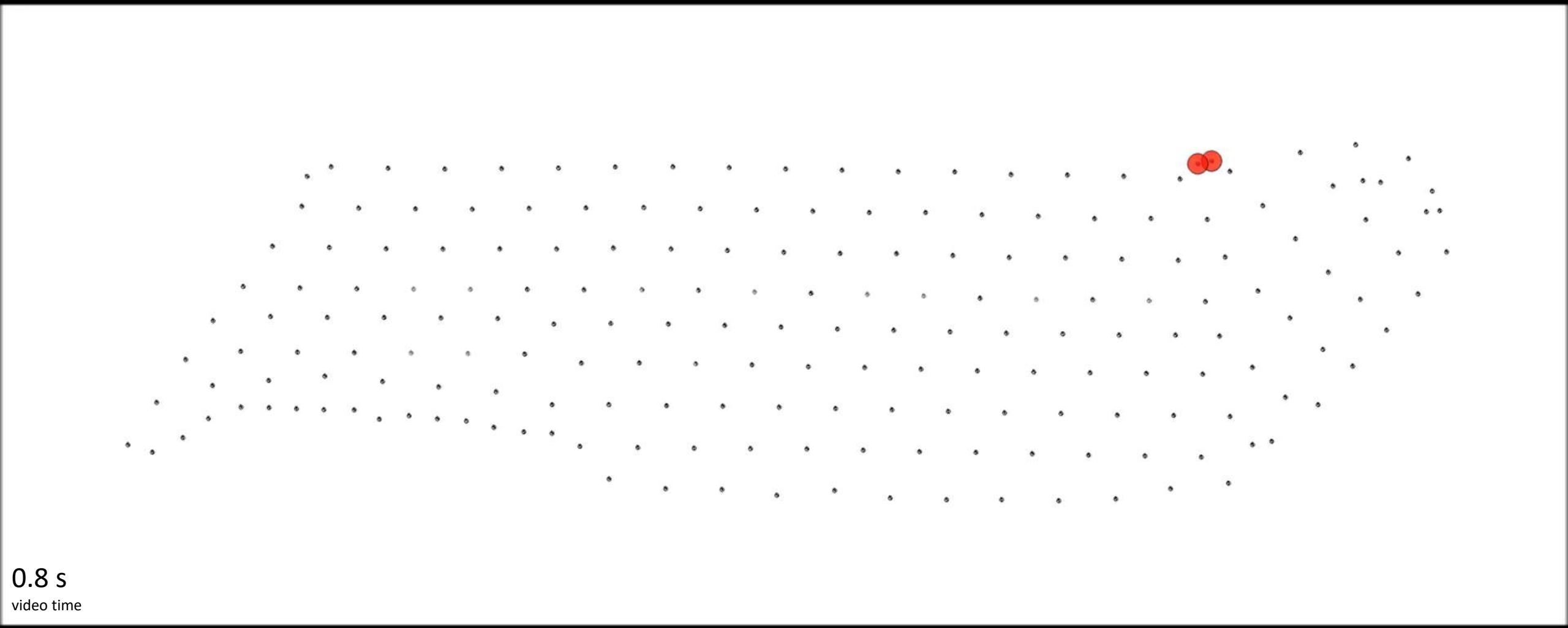
Top priming radiating energy away from highwall



Acknowledgement - Dr Dane Blair, Blasting Geomechanics Pty Ltd

Highwall stability

- Measured 3 blasts fired together, lasting 20 sec
  - Used high resolution accelerometers used (0.5 Hz to 10kHz)
  - Monitored at safe location (>100 m) along the strike and behind blast



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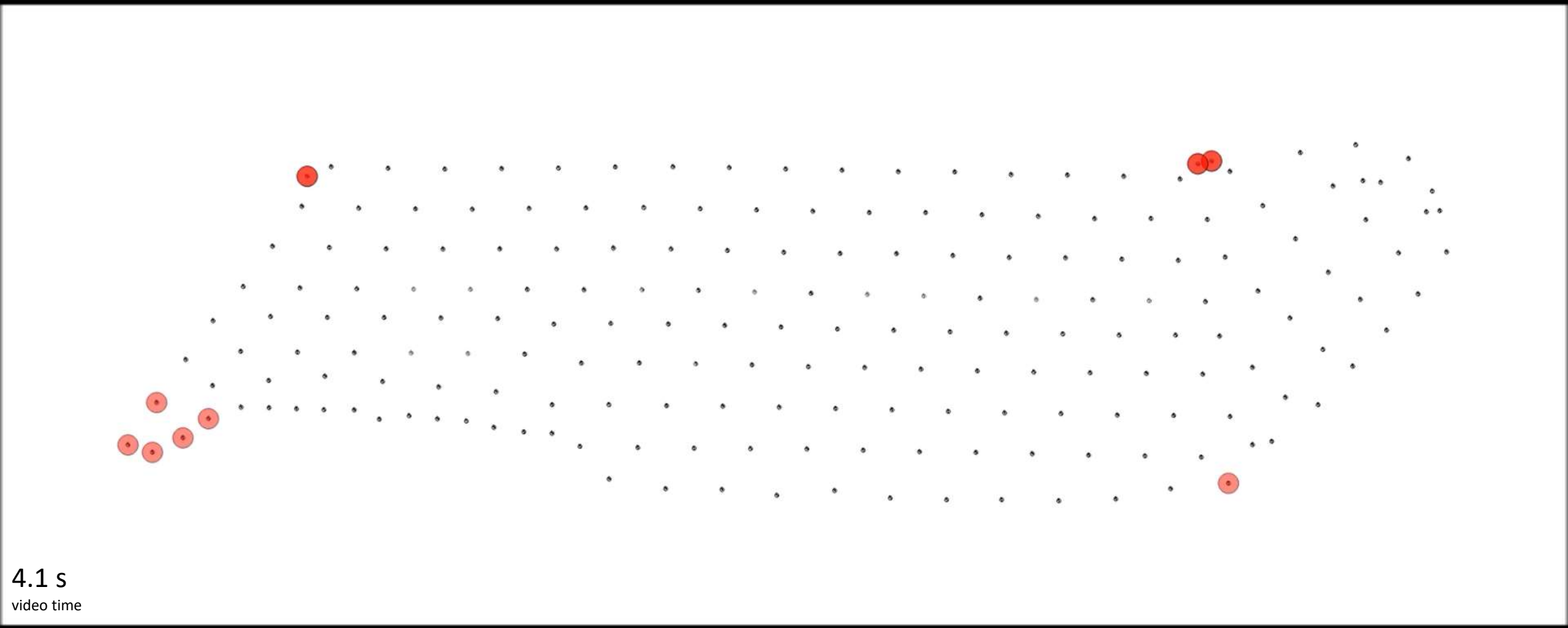
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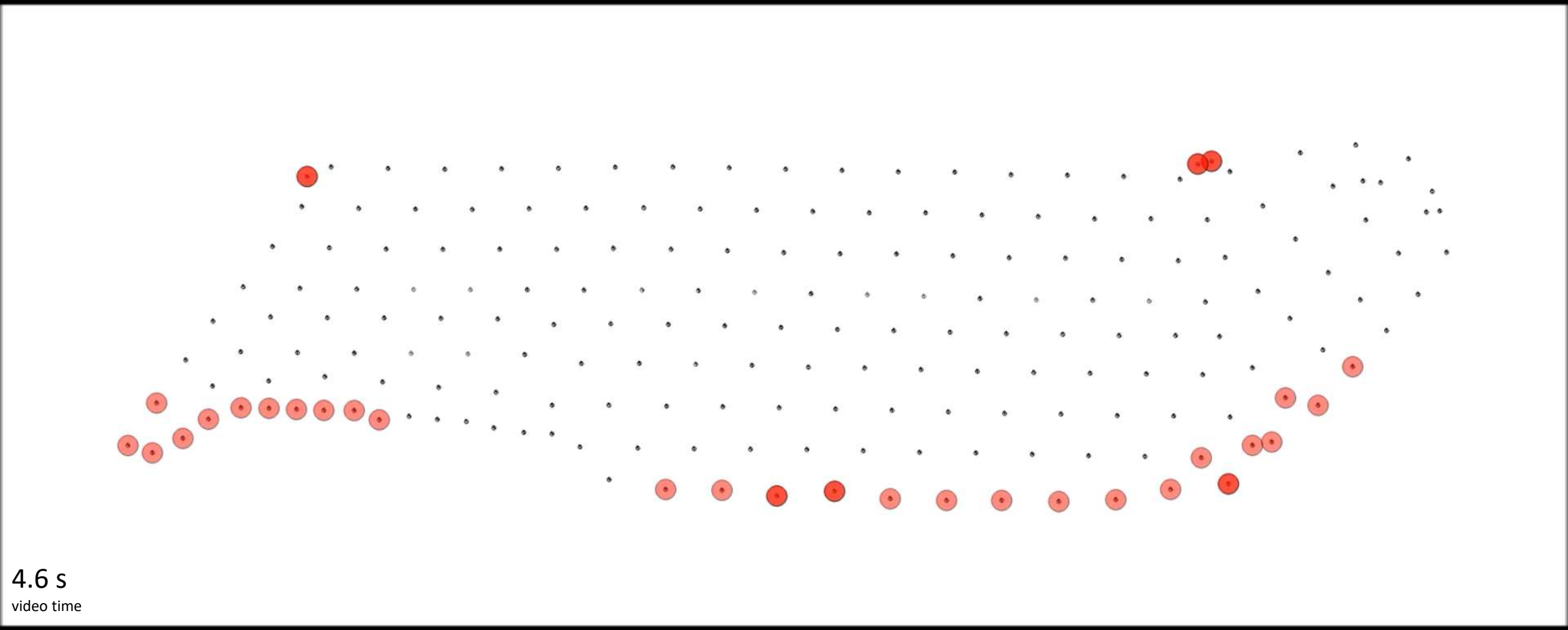
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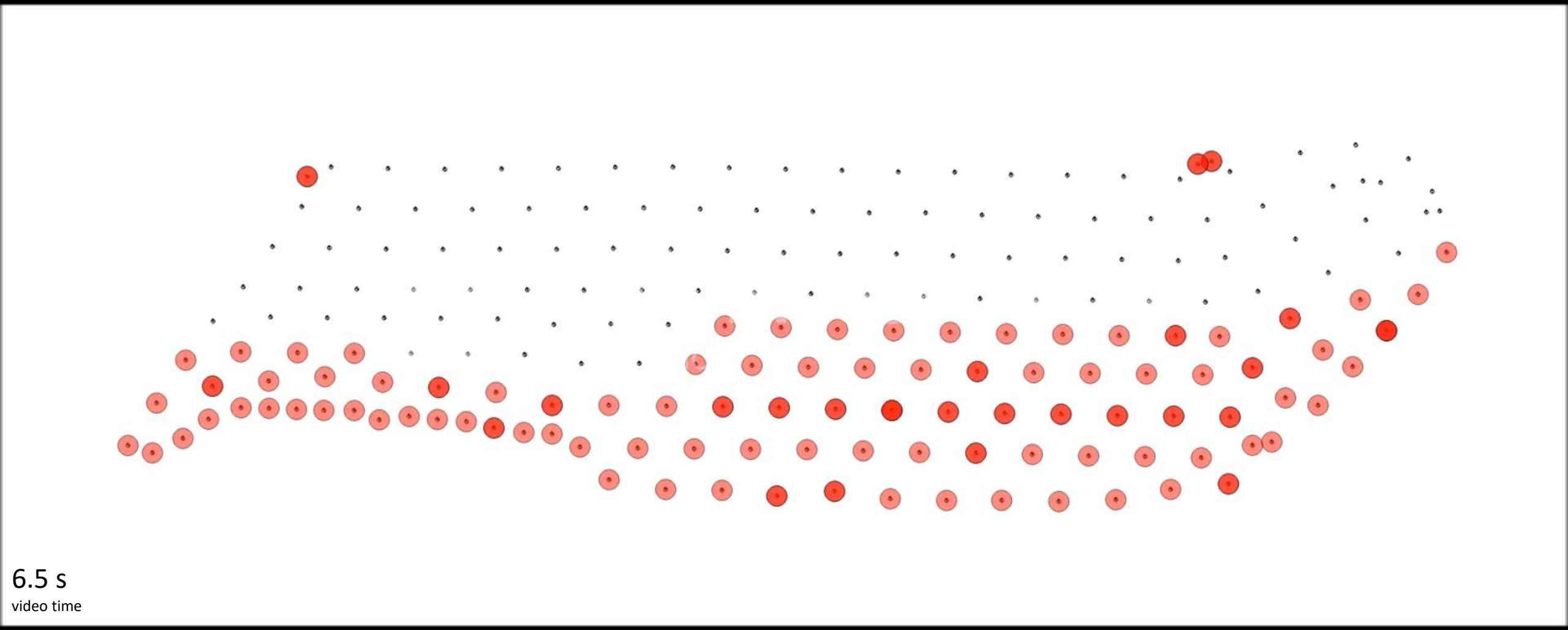
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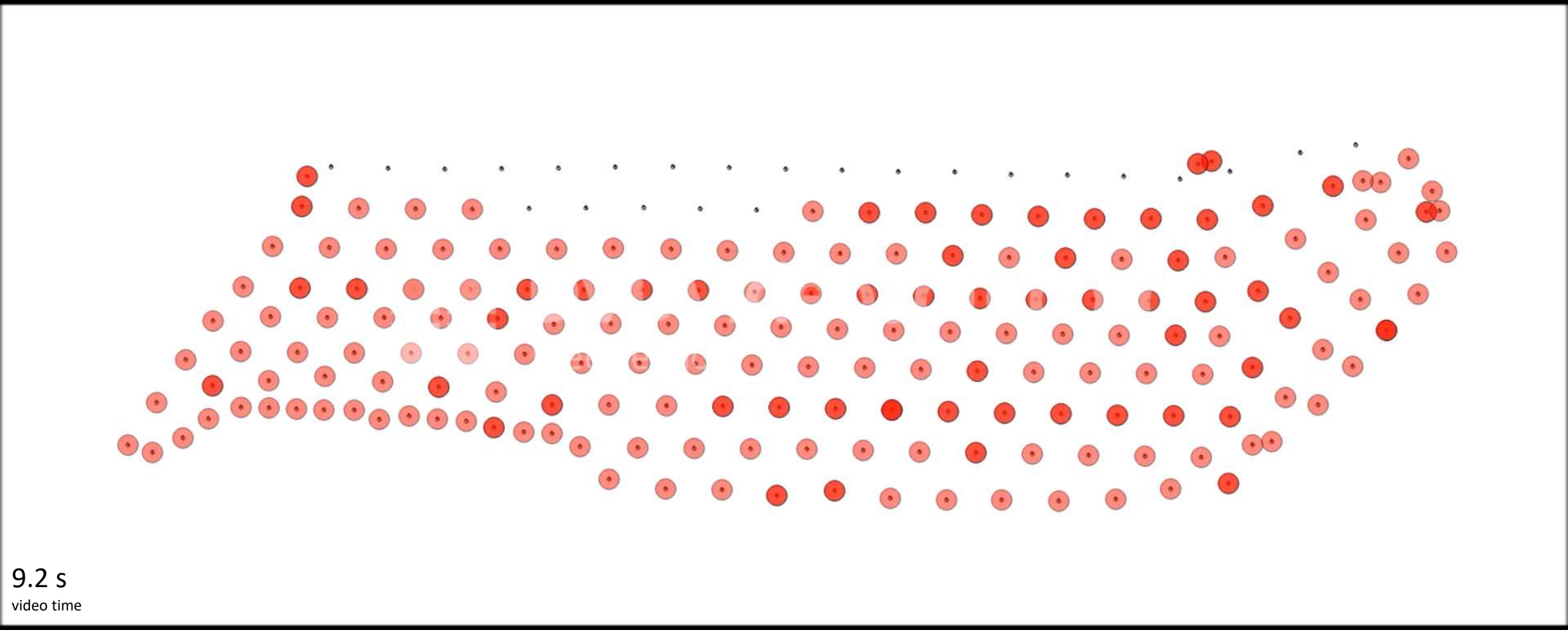
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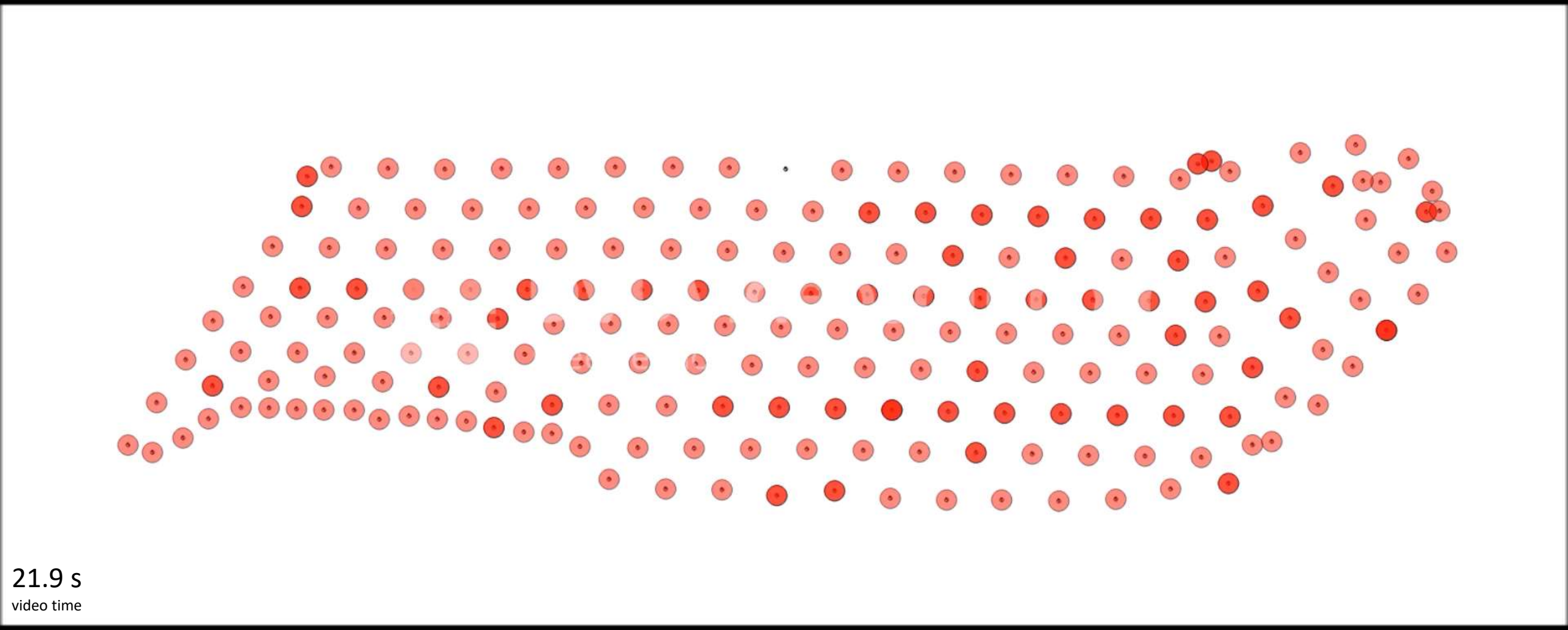
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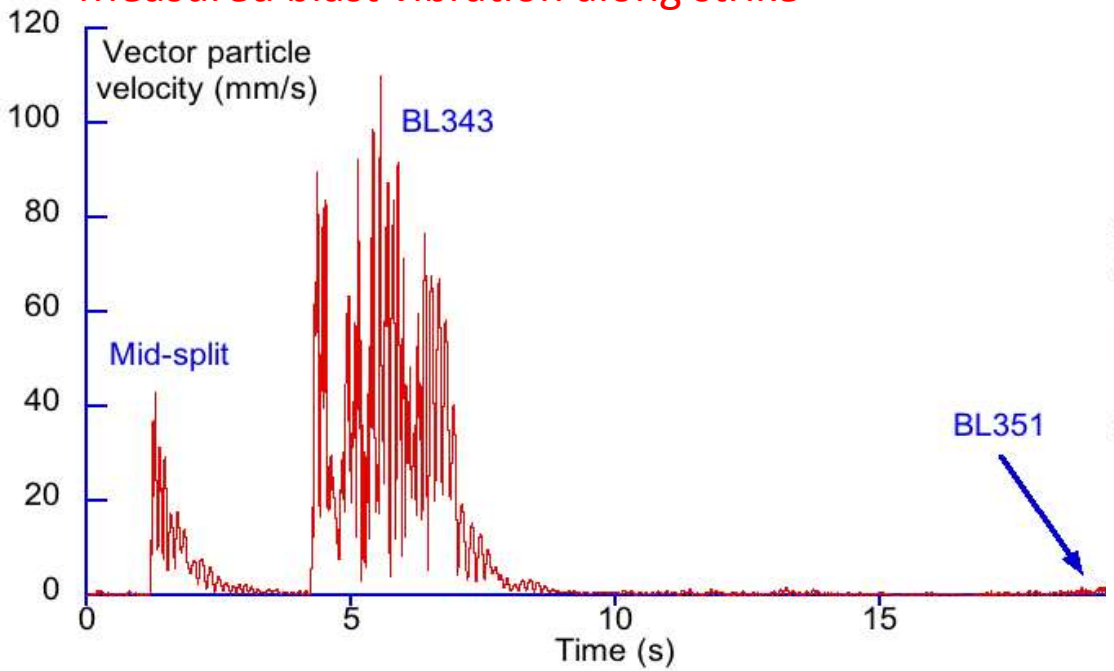
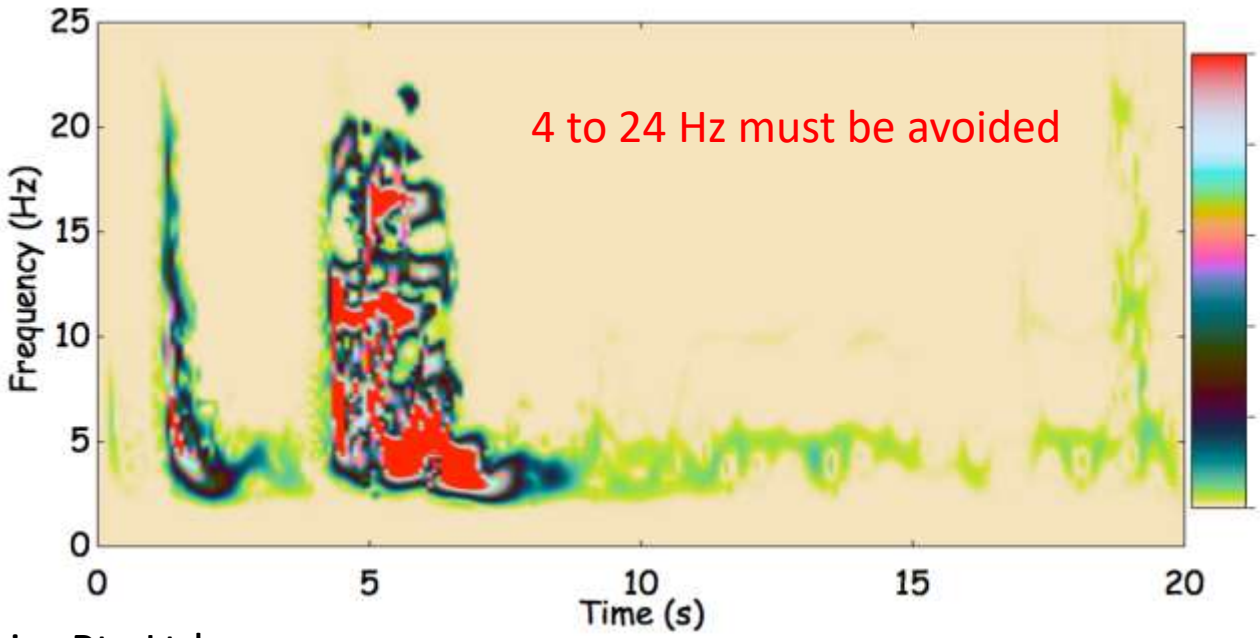
Vibration measurement

- Vibration acceptable but frequency require further attention - 4 to 24 Hz must be avoided
- Several blasts were measured and modelled

Measured blast vibration along strike



Measured blast vibration frequency along strike



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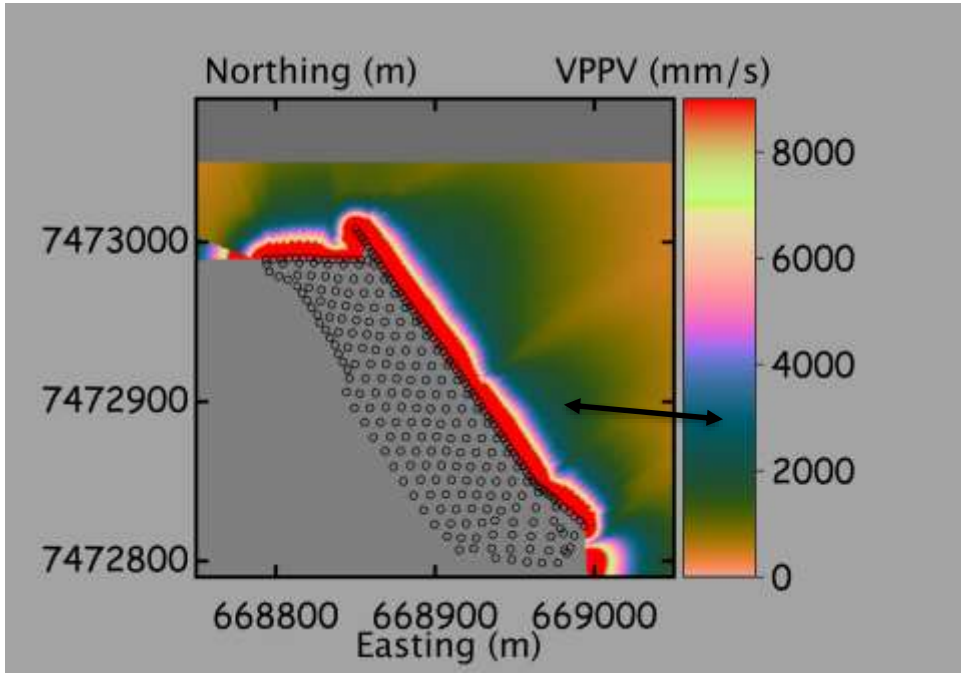
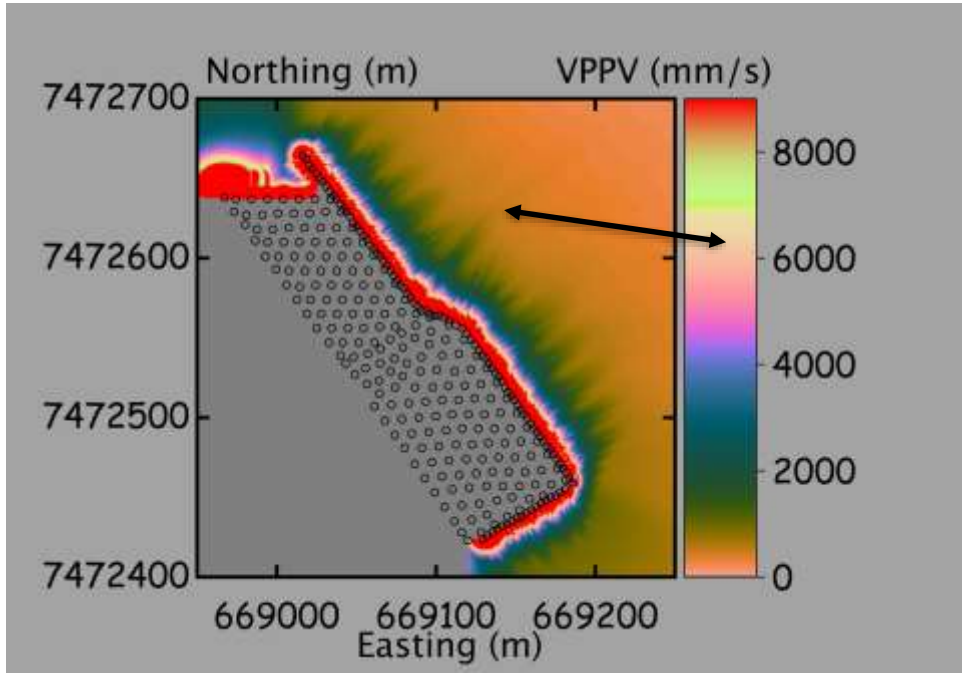
Modelling

Measured levels and modelling proved new design is putting less energy through the highwall

New design with endsplit



Old design without endsplit



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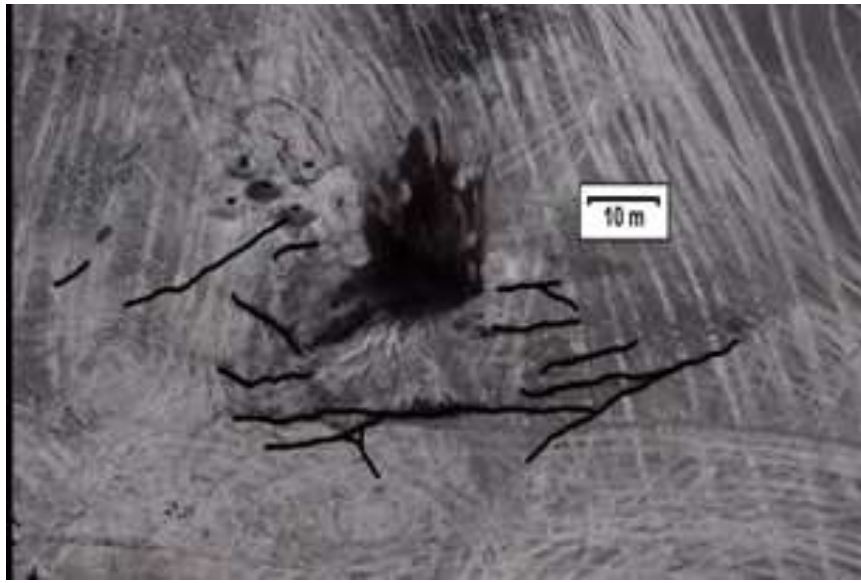
Summary of highwall stability project

- Changed practice significantly reduced vibration on the highwall
- Half barrel factor calculated to be around 90%
- Unfortunately geotechnical failures continued
- Future work:
  - Measure gas pressure at 1B (burden), 2B and 3B distances behind midsplit line
    - Dilation or contraction (positive or negative gas pressure)
    - Implement blast induced (controlled) failures around fault to make operation further safe

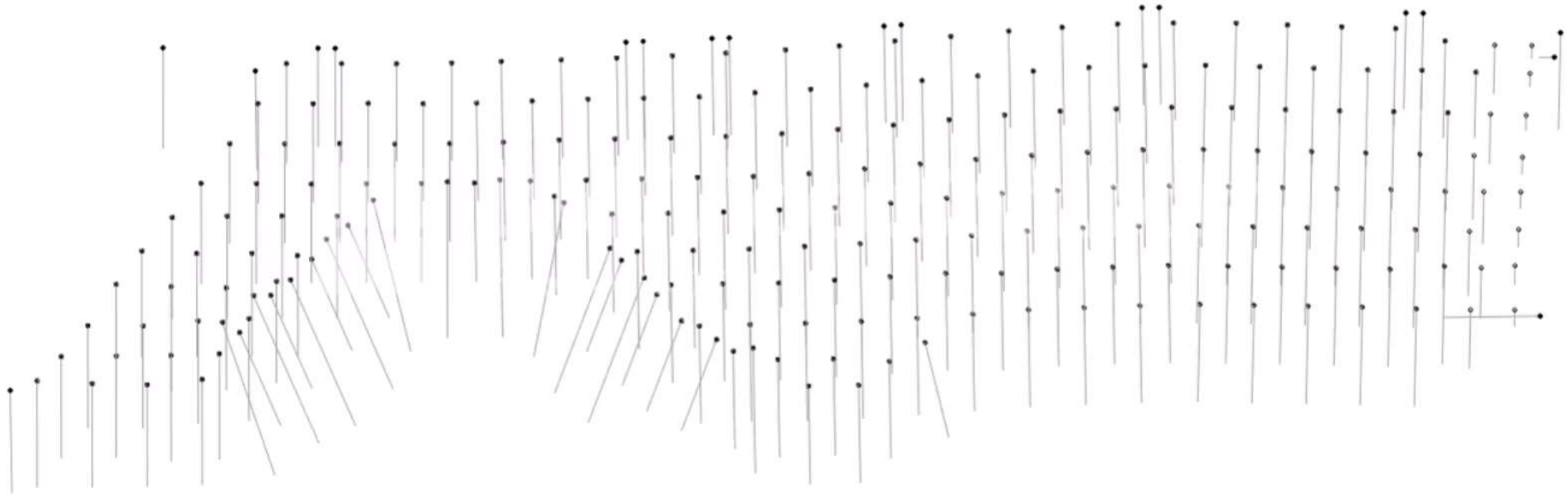


Uplifting machines productivity

- Wherever possible cast % was increased by:
  - Adjusting burdens
    - Front three row burdens increased
    - Rear three row burdens decreased
  - Changed over to gravel from drill cuttings after measuring VOD
  - Timing design
    - Increased between row timing
    - Decreased between spacing timing
    - Multiple point initiation
  - Achieved higher power trough

Uplifting machines productivity

- Muckpile shaping was achieved by:
  - Closely working with schedulers - dig direction agreed
  - Machines digging in the direction of firing (following timing contours) always dig better
- Multi-point initiation:
  - By combining of row-by-row, stand-up, ‘V’ firing, ‘centre zip’ within a blast
  - Cast and stand-up as required achieved
- Up to 41% cast achieved



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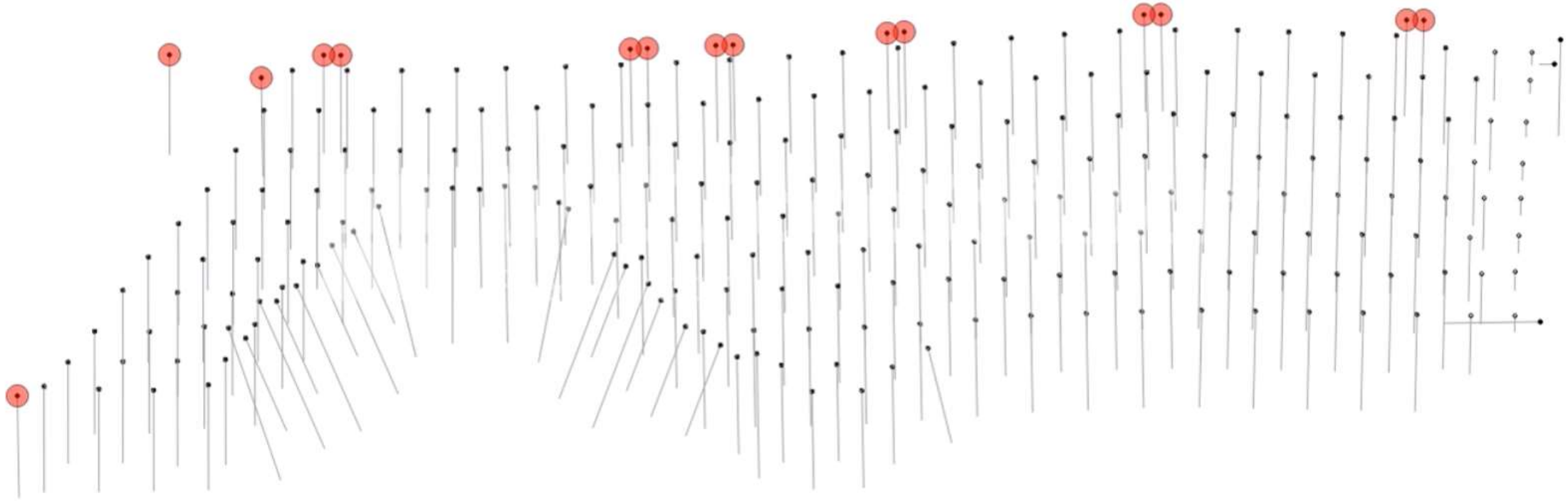

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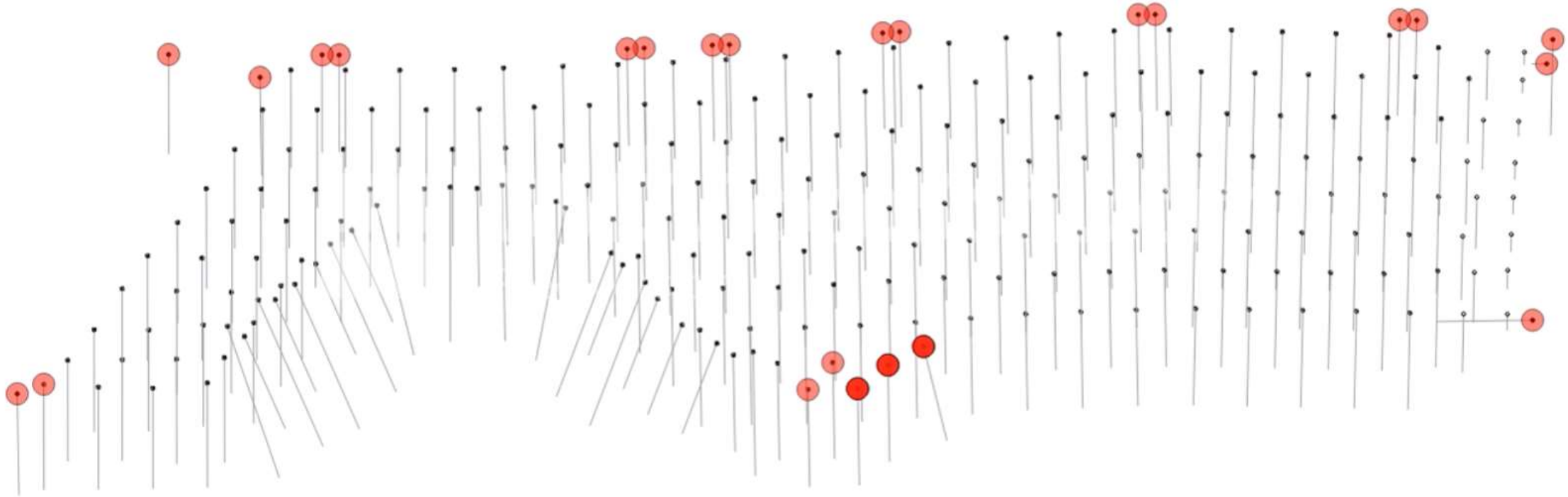

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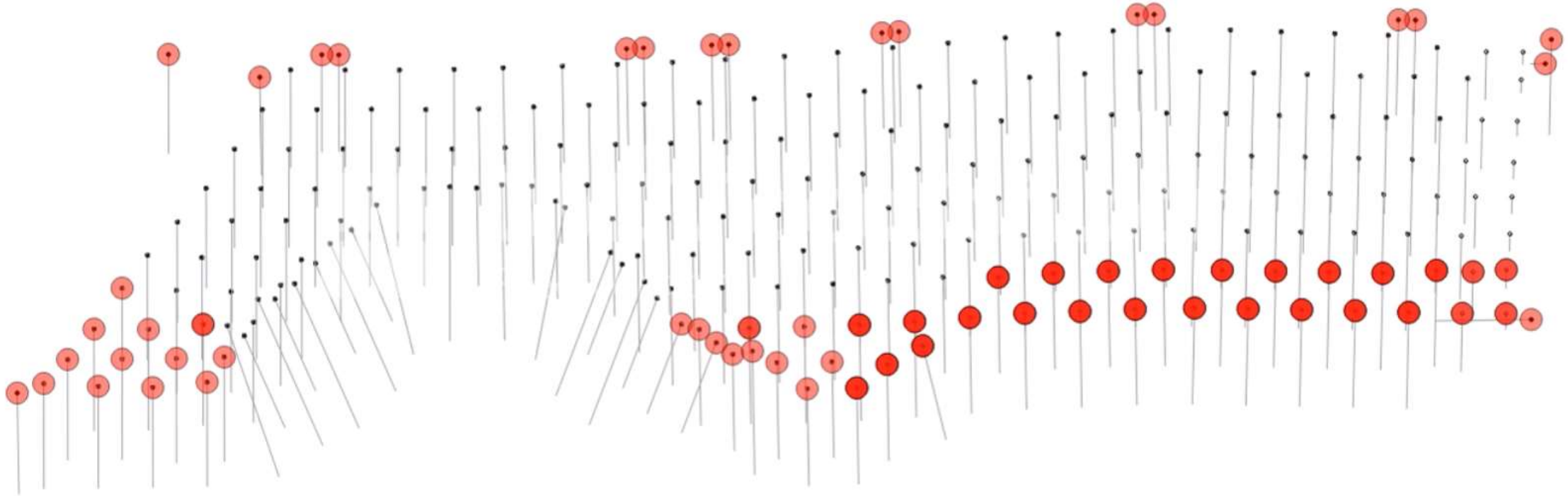

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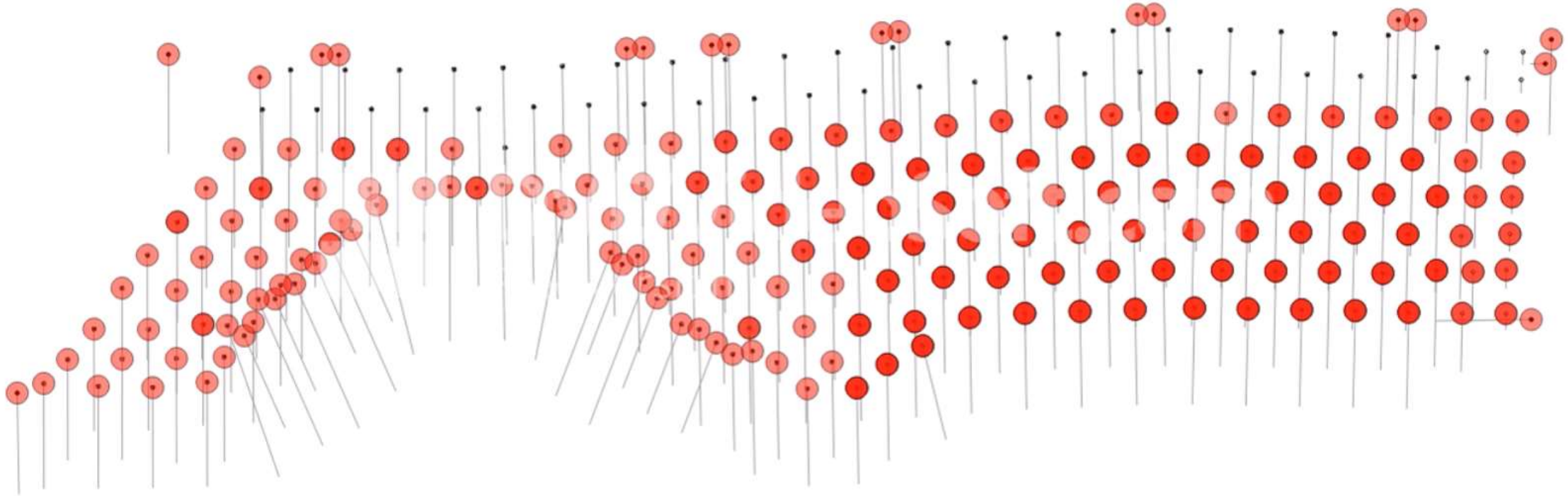

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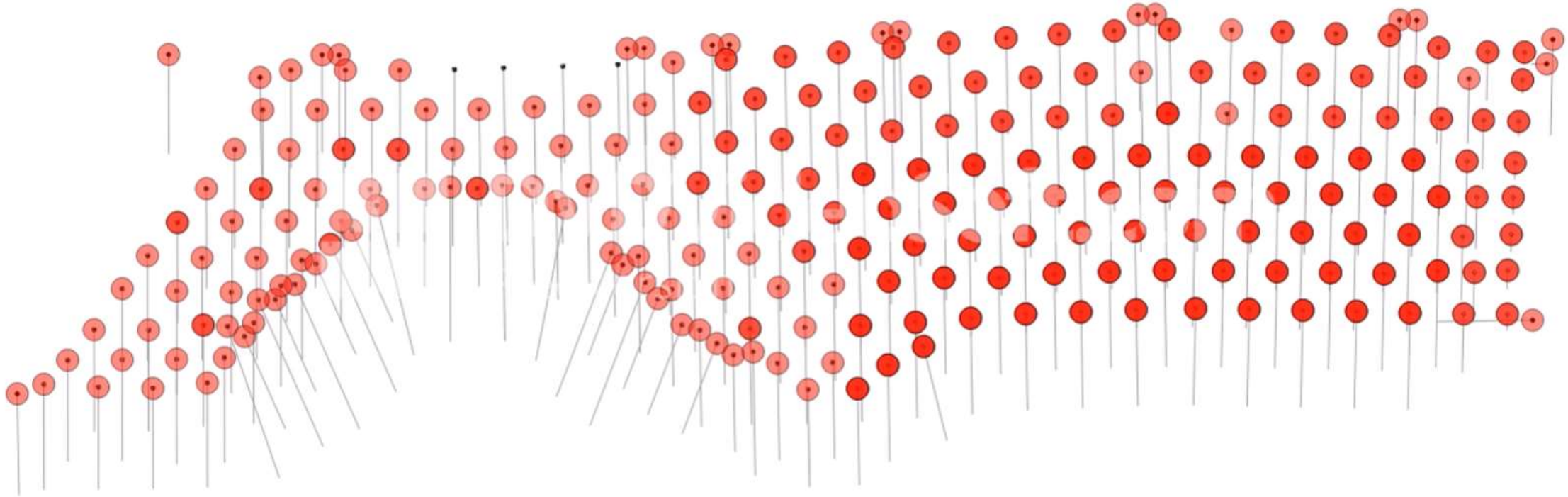

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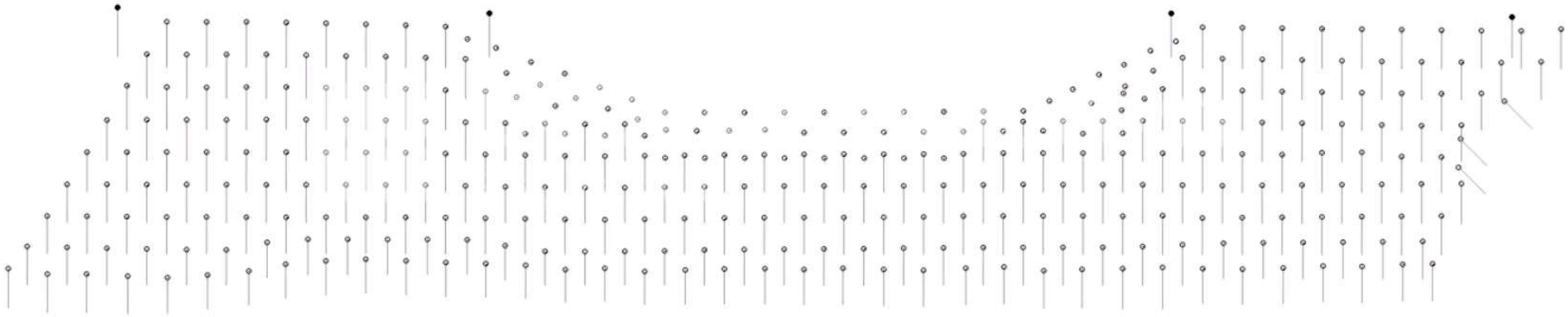

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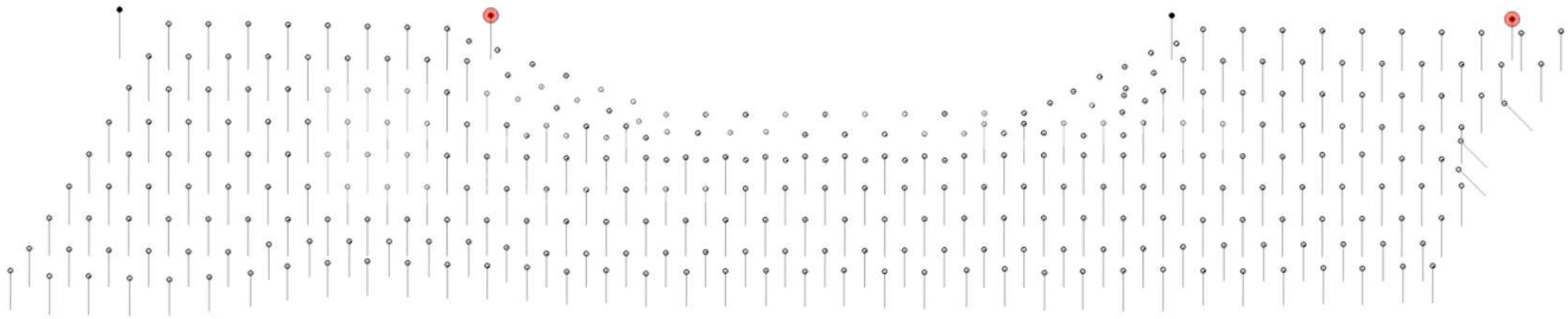

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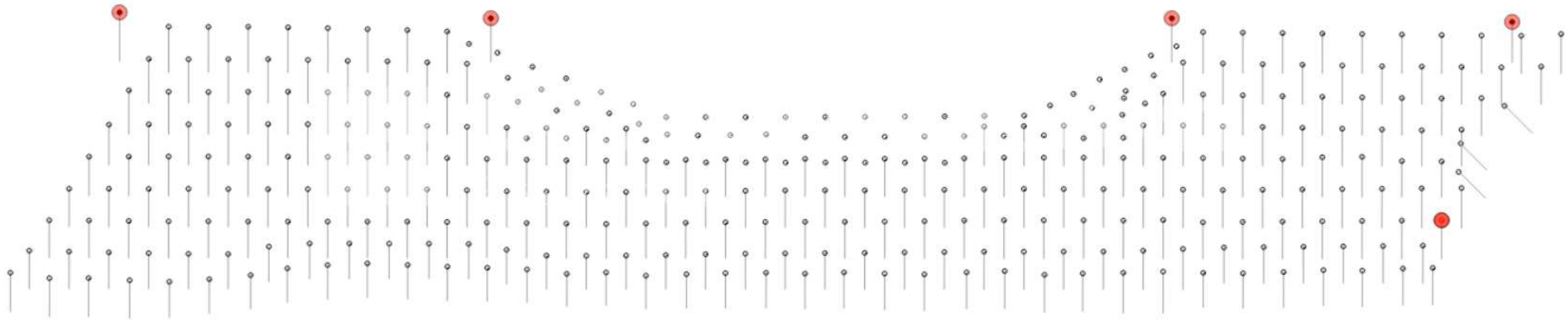

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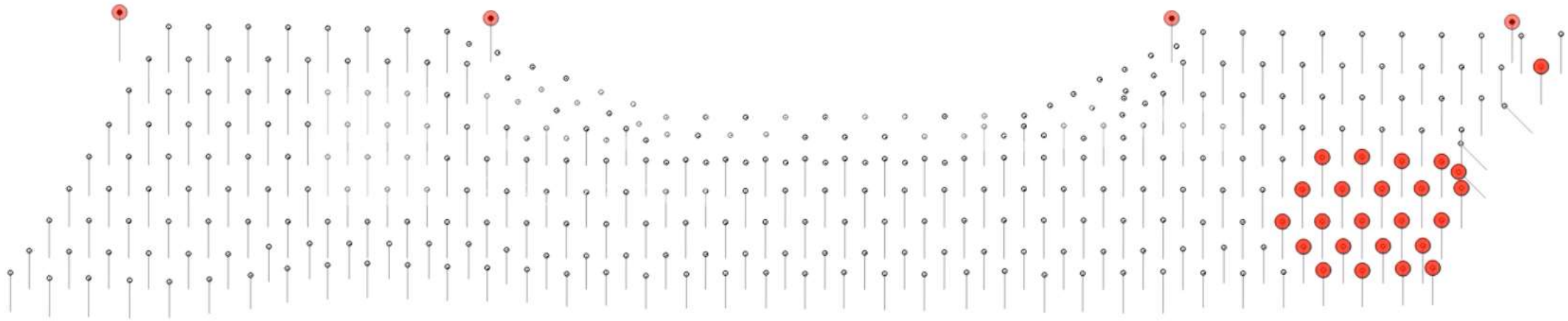

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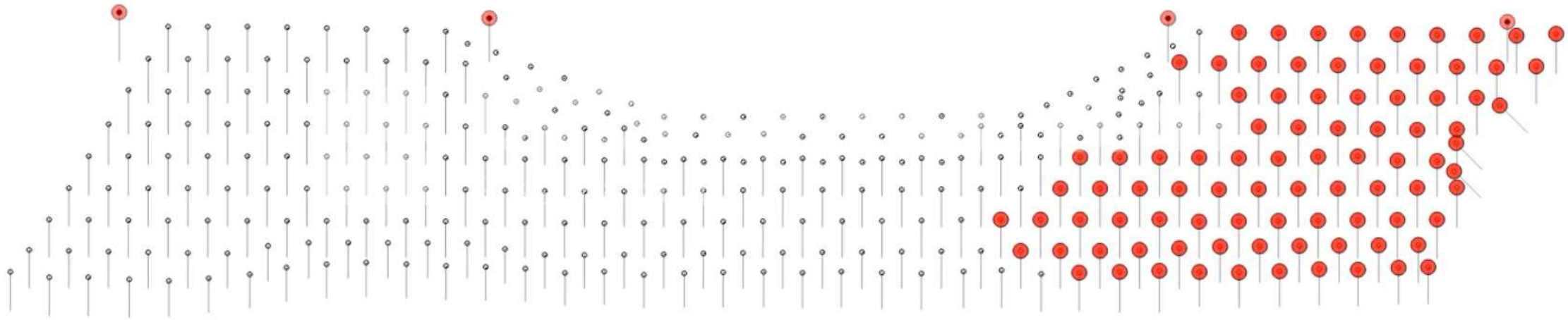

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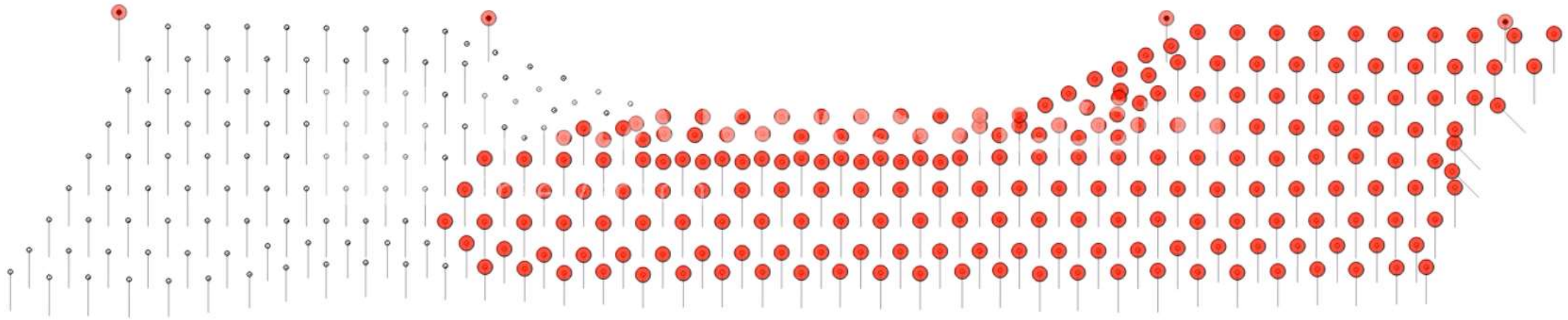

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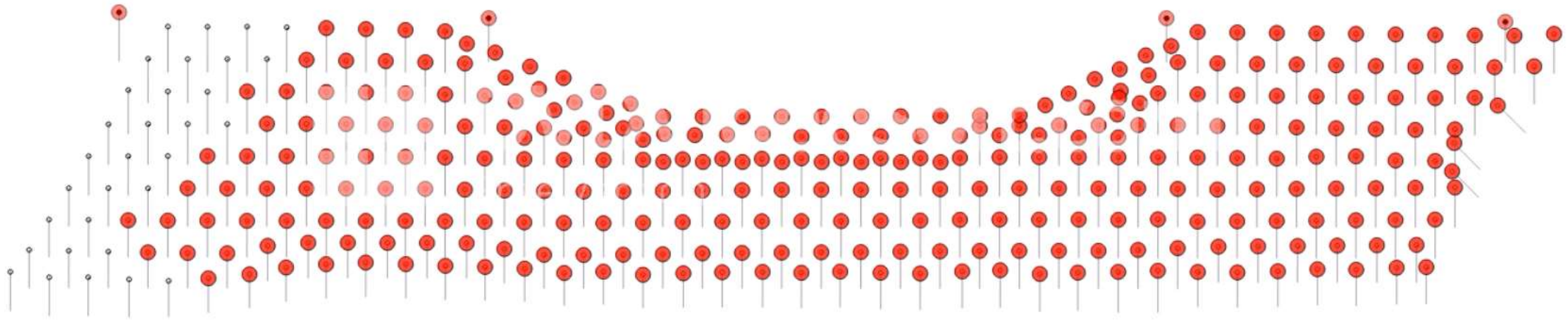

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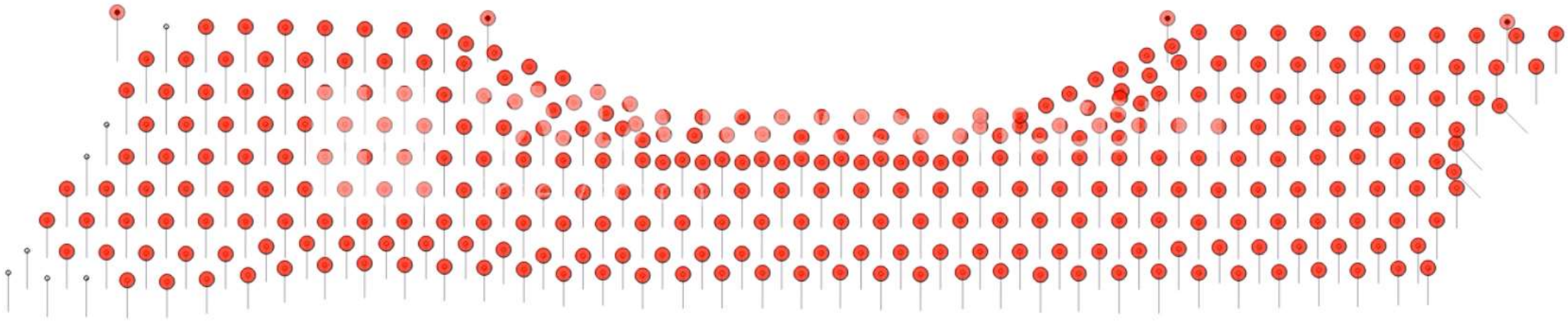

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Multi-point initiation - example

- Use of multiple ‘zip’ timing
- Combined ‘V’, row-by-row and stand-up firing


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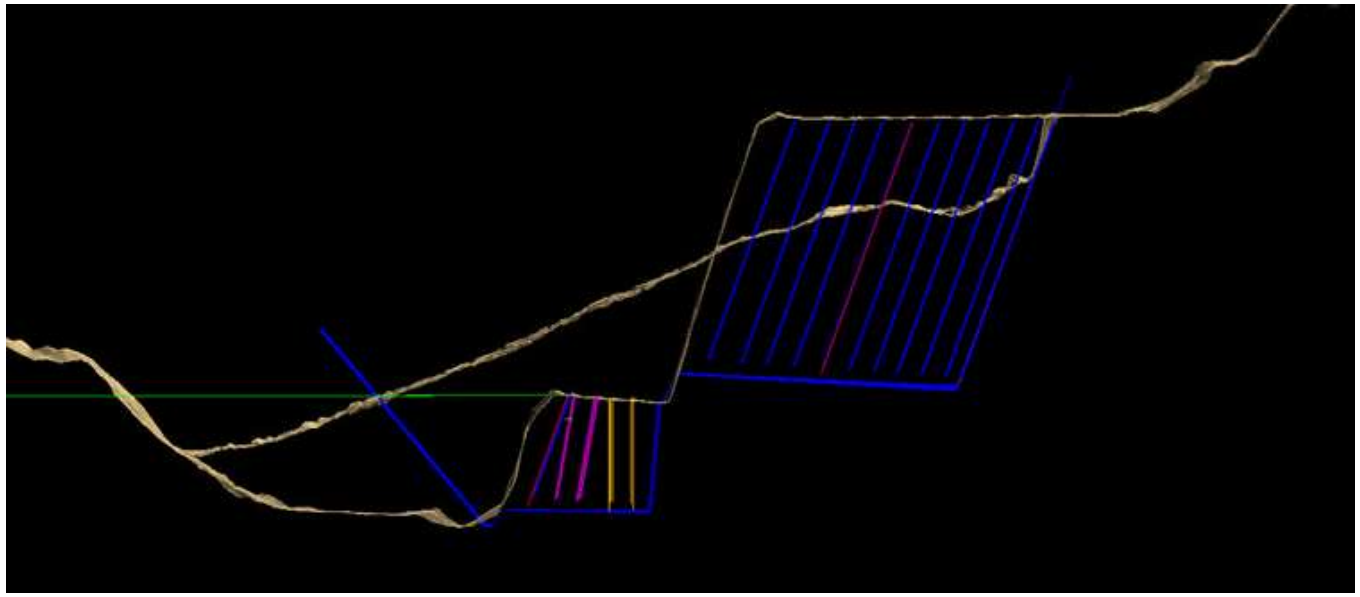
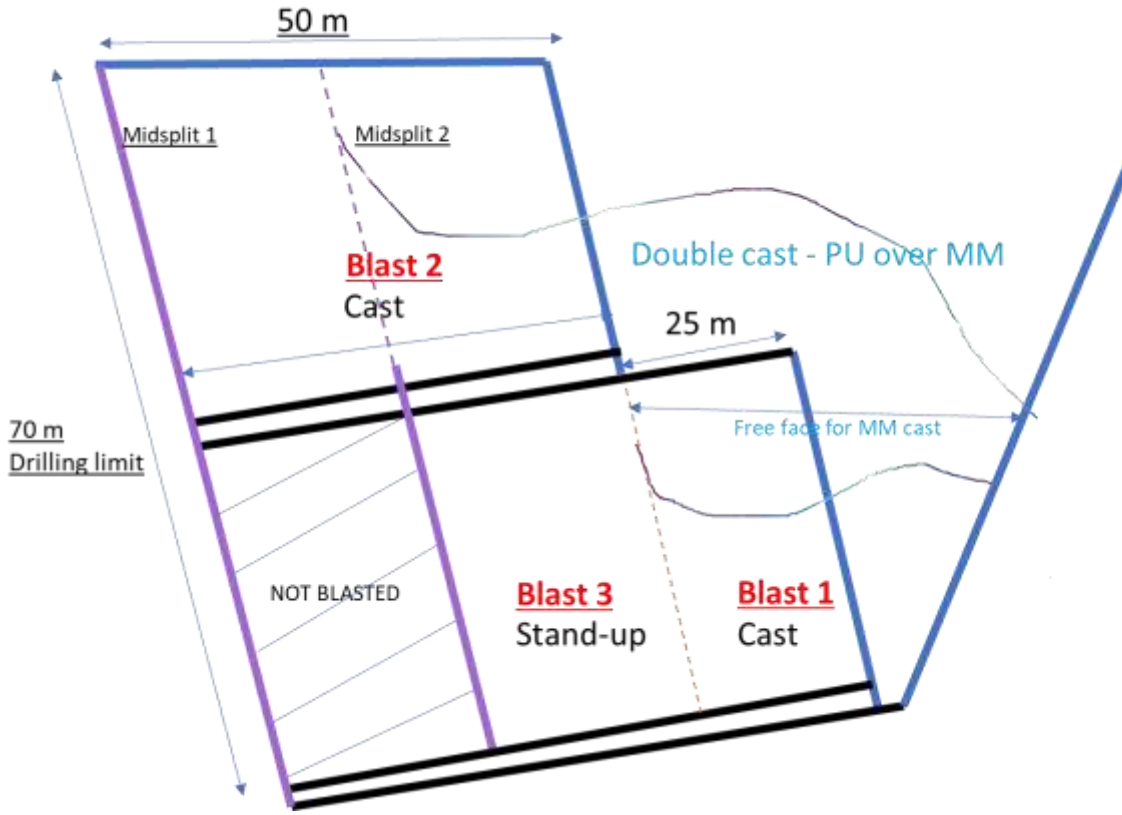
Cost down projects

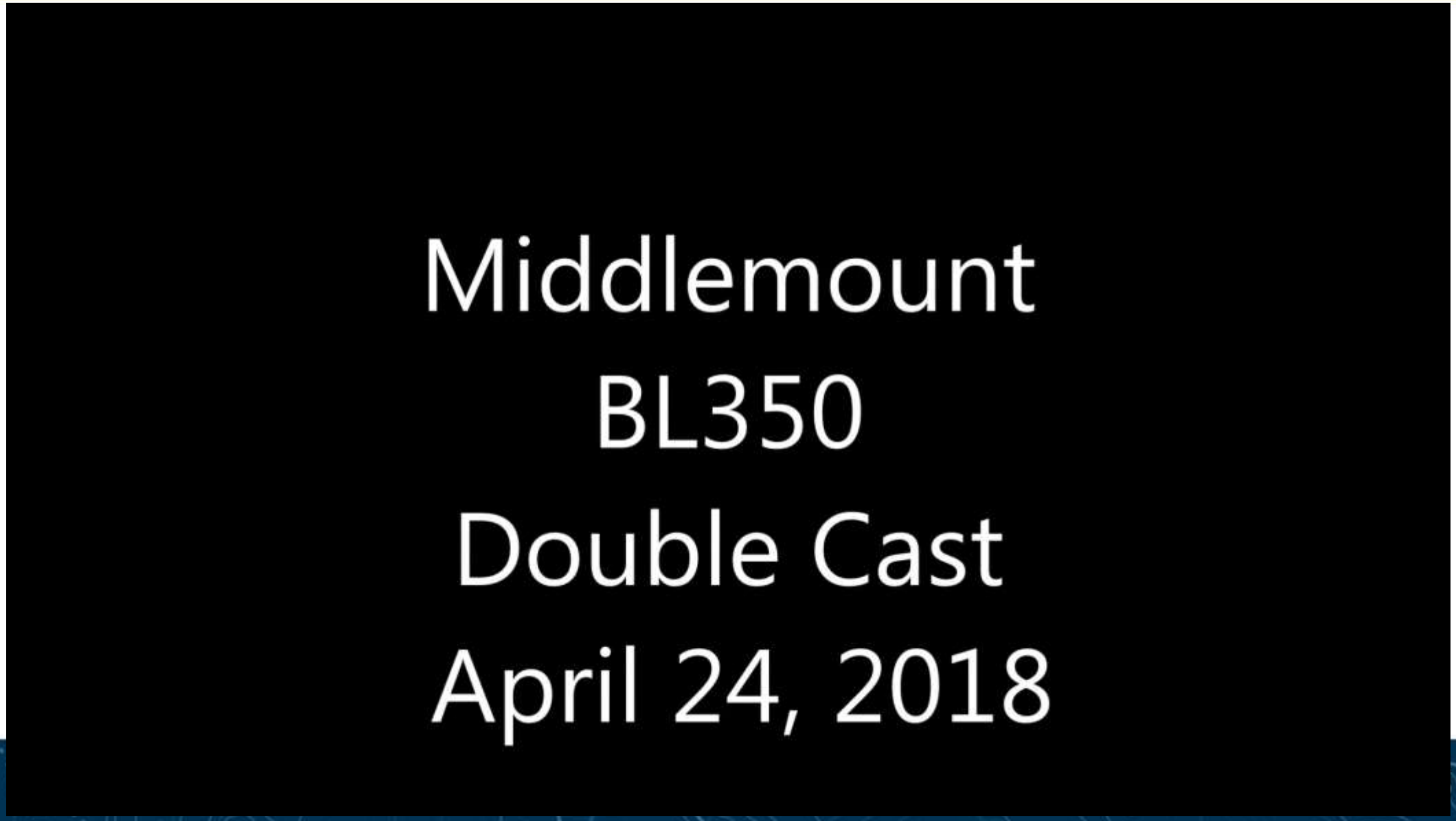
- Mining to a RL will significantly reduce cost of operation:
  - Through-seam (TS) blasting
  - Double cast blasting
  - Combined TS & Double Cast



Concept



Double cast blast



Double cast blast

Double cast blast

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Double cast blast

Cost down projects

- Double cast – mixed success:
  - Only 14% cast
  - High dozer push and dig rates achieved
  - No coal damage/loss
  - High washery yield
- More work required
  - Rock property assessment
  - Displacement modelling (JK Blast model)

Cost down projects

- Coal damage/loss (future projects)
  - Identify susceptible coal blocks where damage/loss usually occurs
  - Understand mechanism
  - Gamma log (density & natural)
  - Understand coal roof and floor
  - Manipulate stand-off distances to minimise edge loss, coal roof damage and dilution
- Ultimate aim is to maximise coal recovery per block, produce clean coal and maximise washing yield

Conclusions

- Significant number of projects delivered in a short five months
- Site personnel concentrate on ‘keeping up with the schedule’
- In my experience site driven ‘Process Improvement’ projects always results savings - MCPL is a classic example where as a team worked together to deliver projects of value

Acknowledgements

- MCPL
  - Allowing me to work as part of a dynamic team and publish this work
- Action Drill & Blast
  - Accurately and painstakingly implementing D&B designs
- Dyno
  - Implementing timing designs, running simulations and supplying full proof & event free products
- Orica
- ISEE