Large-scale explosion propagation testing of treated and non-treated rock dust

Eranda Perera, PhD

Explosions Team Project Lead

Pittsburgh Mining Research Division,

National Institute for Occupational Safety and Health

Problem

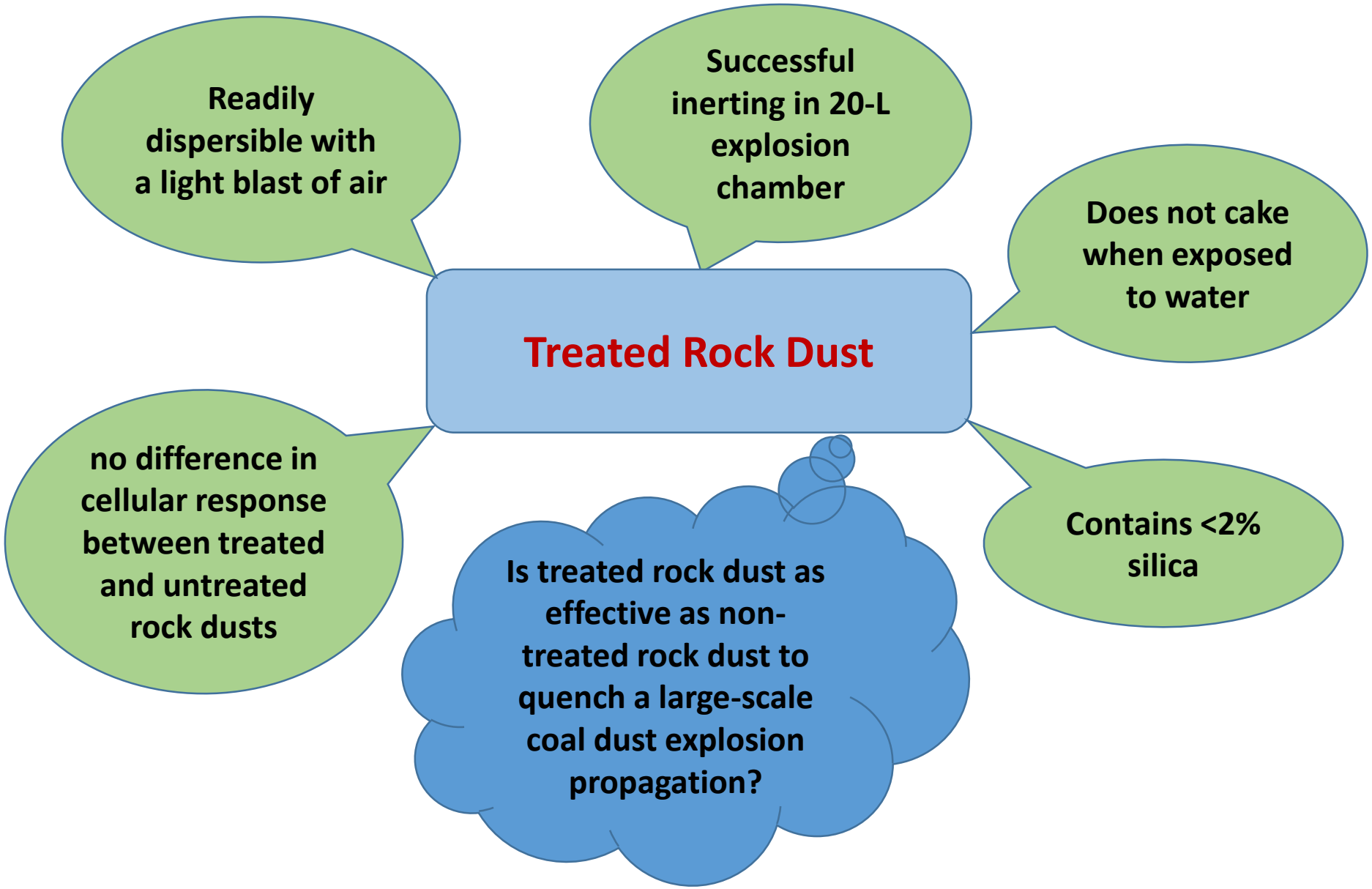
Caked rock dust cannot disperse and inert coal dust. Rock dust is effective only if sufficient quantities of properly-sized particles are dispersed

Dry untreated rock dust

Untreated rock dust (After moisture exposure)

Coal dust on top of untreated rock dust (Exposed to water and dried)

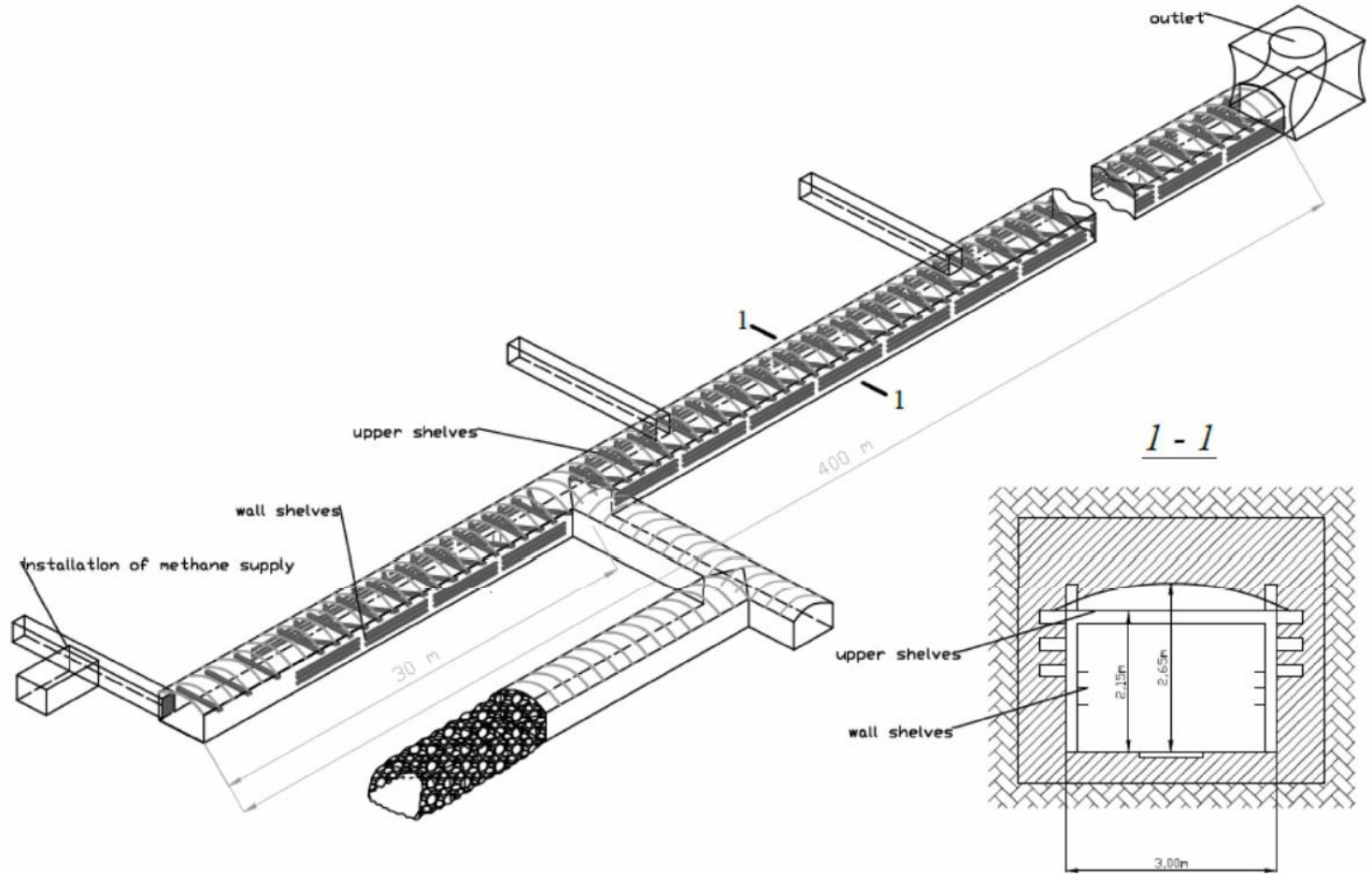
Treated Rock Dust Attributes



Testing at Central Mining Institute - Poland

- Rich history of collaboration between the Bureau of Mines/NIOSH and Central Mining Institute scientists
- Very little variability in interior surface temperatures of underground galleries
- Similar sized stearate treated and untreated rock dust readily available at Poland
- Barbara coal dust is similar to Pittsburgh medium coal dust (volatility and heating value)

Large – scale explosion test gallery (400 m)



Harris et al. Society For Mining Metallurgy and Exploration Conference, Denver, CO, USA, 24 - 27 Feb ,2019

Tests Conducted

1. Homogenized CD/RD mixtures

- Tests were conducted on a comparative basis
- d38 coal dust ≈ Pittsburgh medium coal dust
- Polish rock dust ≈ Reference rock dust
- Polish treated dust

2. Coal dust layer on top of rock dust

- Tests were conducted on a comparative basis
- Polish coal dust minus 200 mesh (float coal dust)
- Polish rock dust ≈ Reference rock dust
- Polish treated dust

Cashdollar et al., Recommendations for a New Rock Dusting Standard to Prevent Coal Dust Explosions in Intake Airways, RI 9679, 2010.

Homogenized CD/RD mixtures

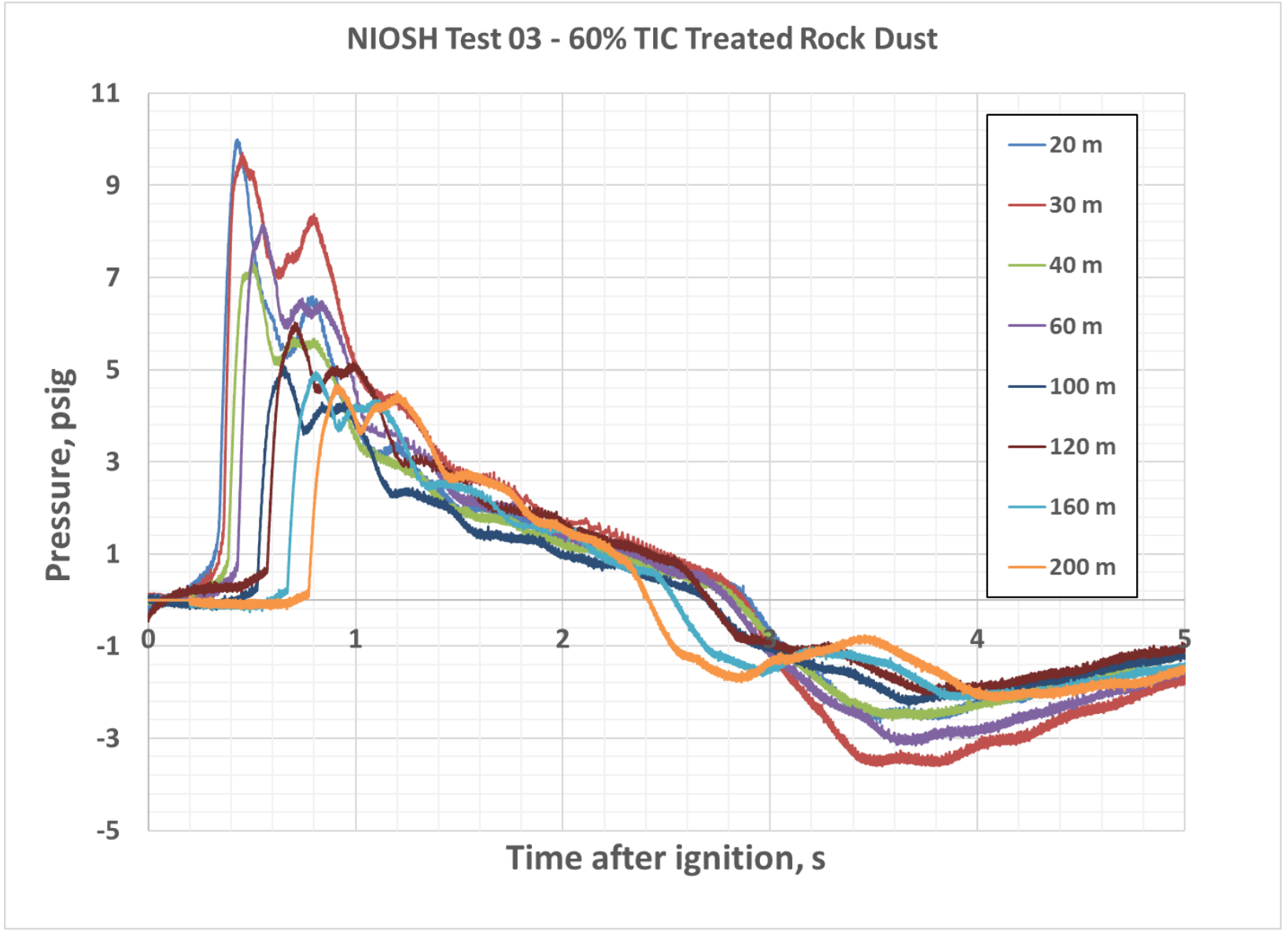
The Polish coal dust and the Pittsburgh coal have similar properties

	Pittsburgh medium Coal	Polish d38
Moisture, %	1.7	2.9
Volatility,%	36.5	36.7
Ash, %	6.2	7.9

The Polish treated and untreated rock dusts perform similar to the Reference rock dust in the 20-L chamber

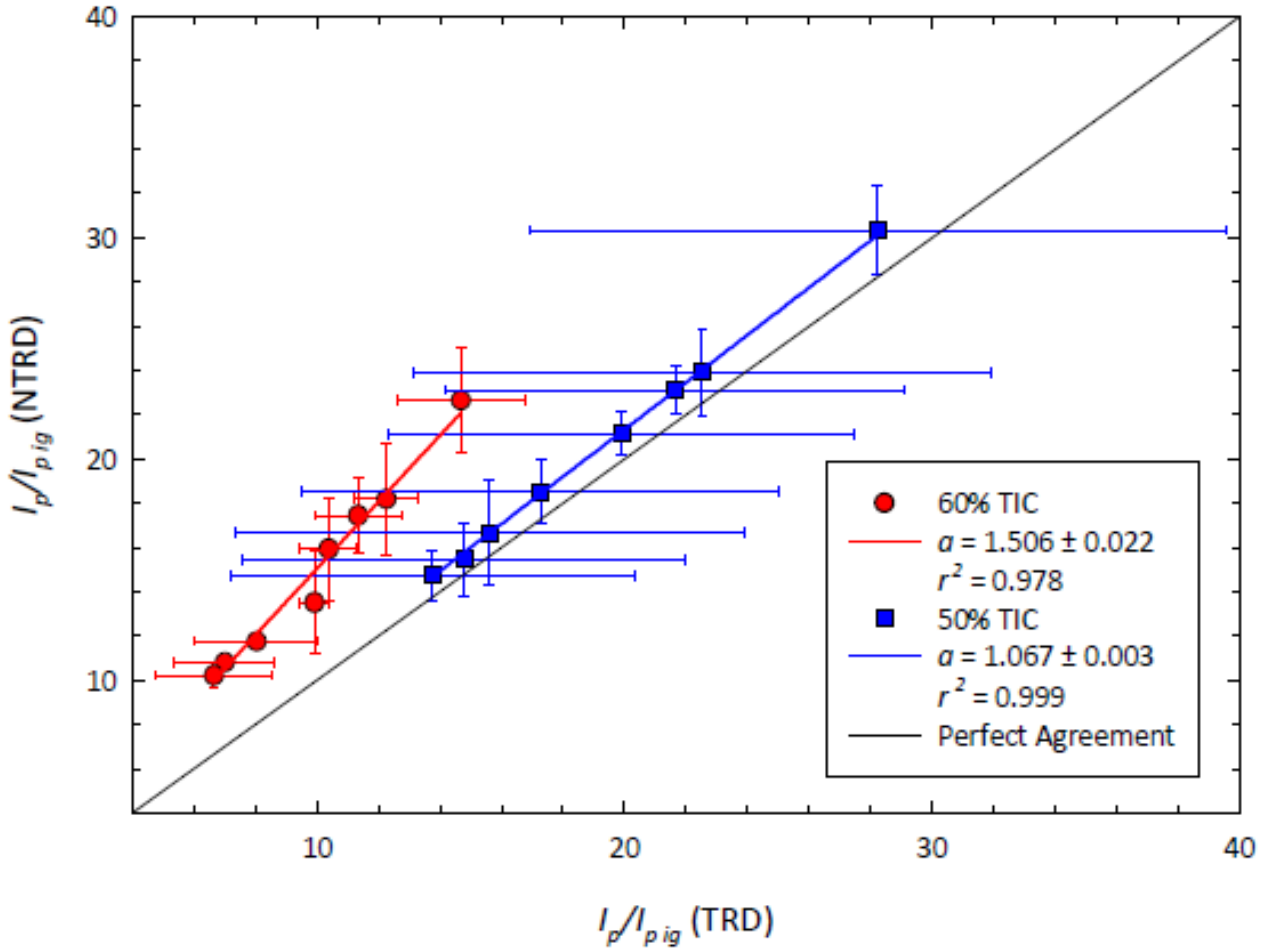
Rock Dust	Coal Dust	% Rock Dust Inerting
Reference	d38 Polish	60
Polish untreated	d38 Polish	60
Polish treated	d38 Polish	60

Explosion Pressure Time Histories (Homogenized testing)

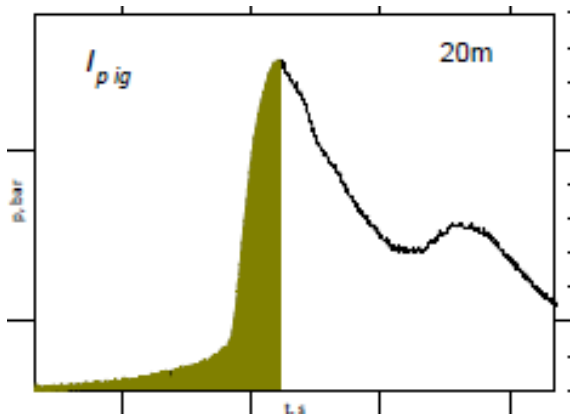


Harris et al. Society For Mining Metallurgy and Exploration Conference, Denver, CO, USA, 24 - 27 Feb ,2019

Explosion Intensity (Homogenized testing)



Pressure Impulse

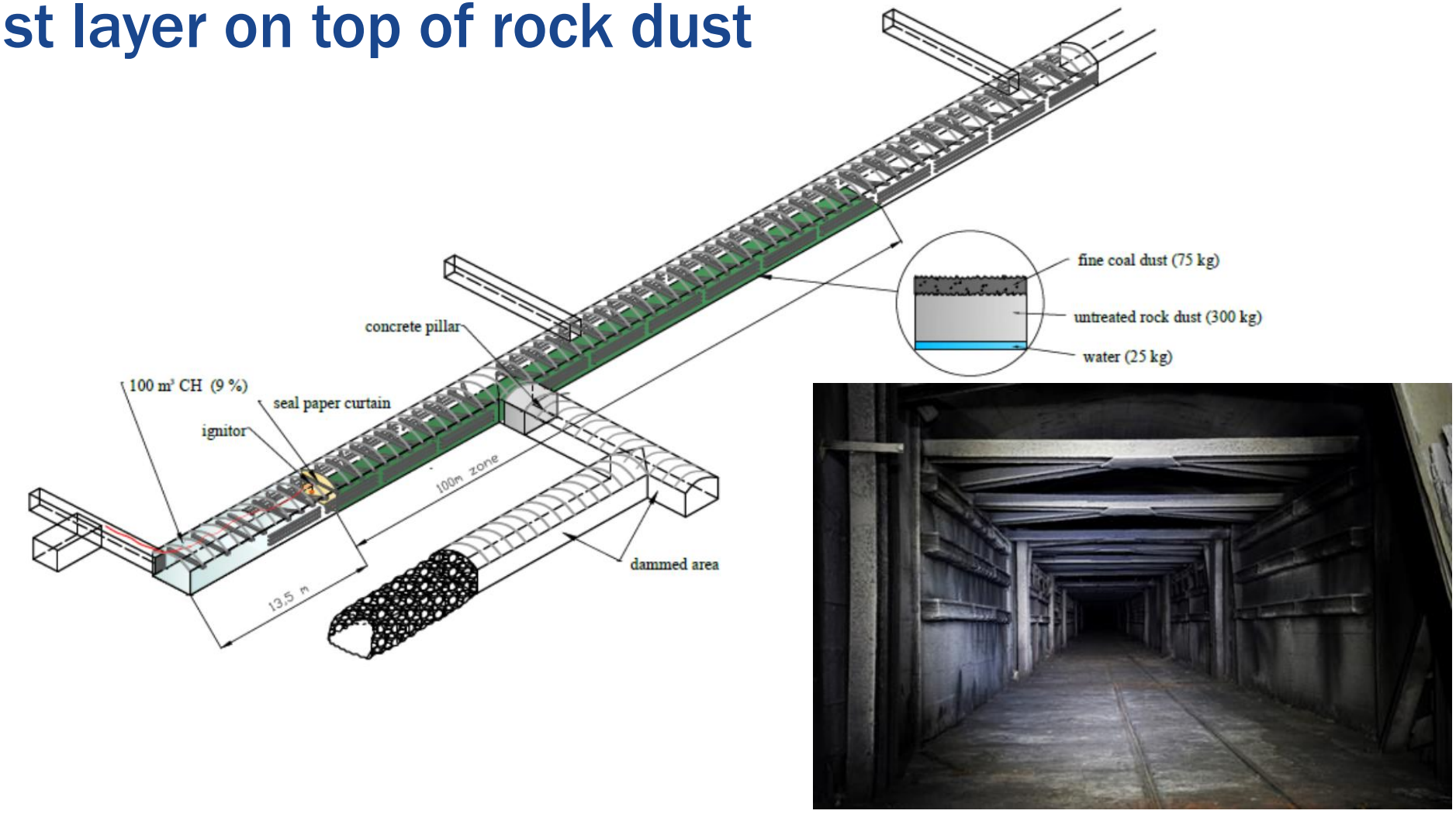


Nominal TIC	Average Impulse at 100 m ($I_p/I_{p\,ig}$)
60% TRD	7.7
60% NTRD	11.8
50% TRD	15.6
50% NTRD	16.7

- Inerting properties of the treated rock dust (TRD) are at least as good as those of the non-treated rock dust (NTRD)
- Experimental results suggest better performance of the treated rock dust at TIC values larger than 50%

Harris et al. Society For Mining Metallurgy and Exploration Conference, Denver, CO, USA, 24 - 27 Feb ,2019

Coal dust layer on top of rock dust



The 400-m experimental gallery

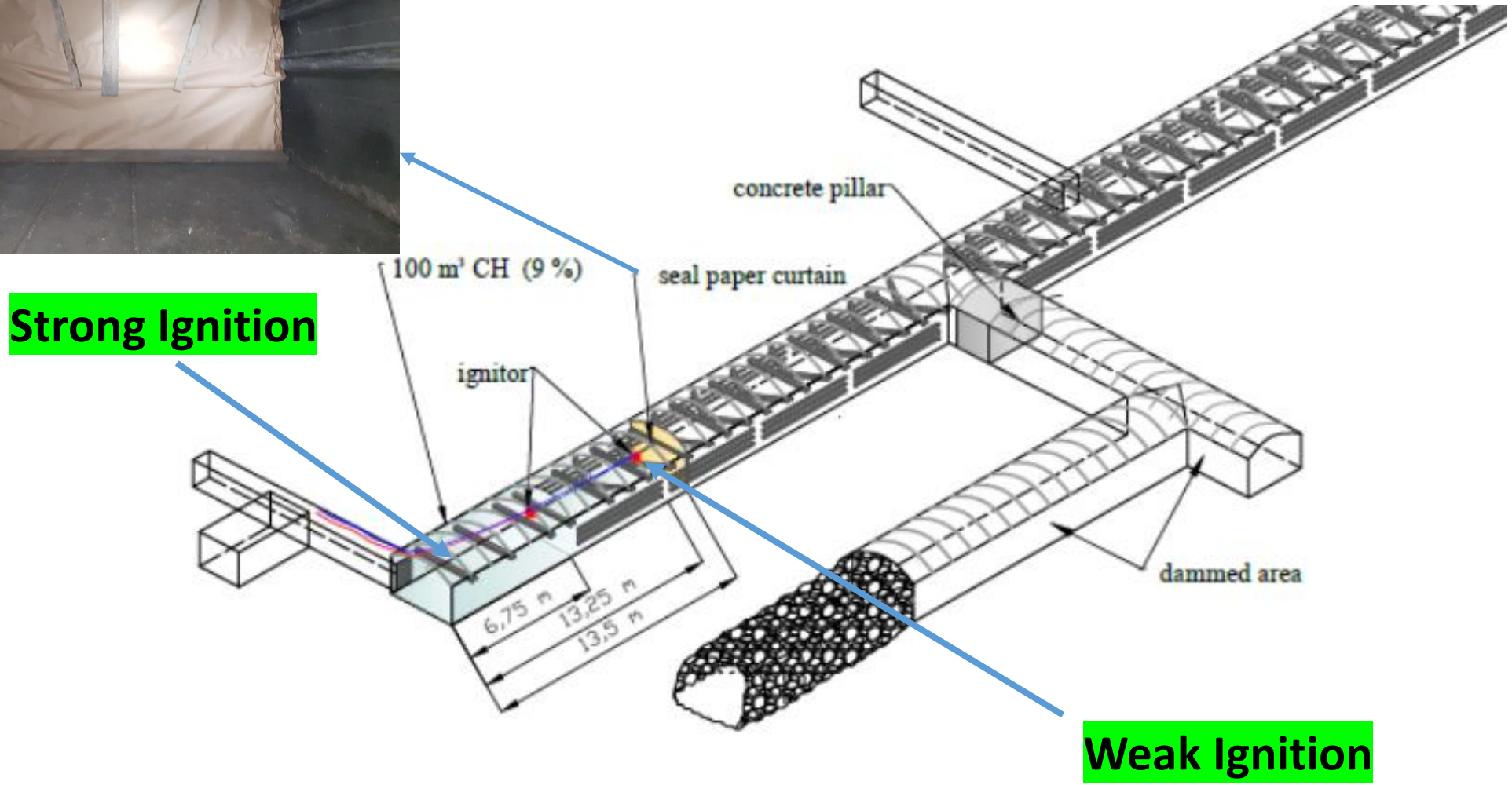
- Two commonly used rock dusts in Polish coal mines were used in this study:
  a non-treated rock dust (NTRD) and
  an anti-caking treated rock dust (TRD)

Test Preparation (Layered dust testing)

Layering 300 kg of rock dust

Applying 75 kg of coal dust on top of rock dust

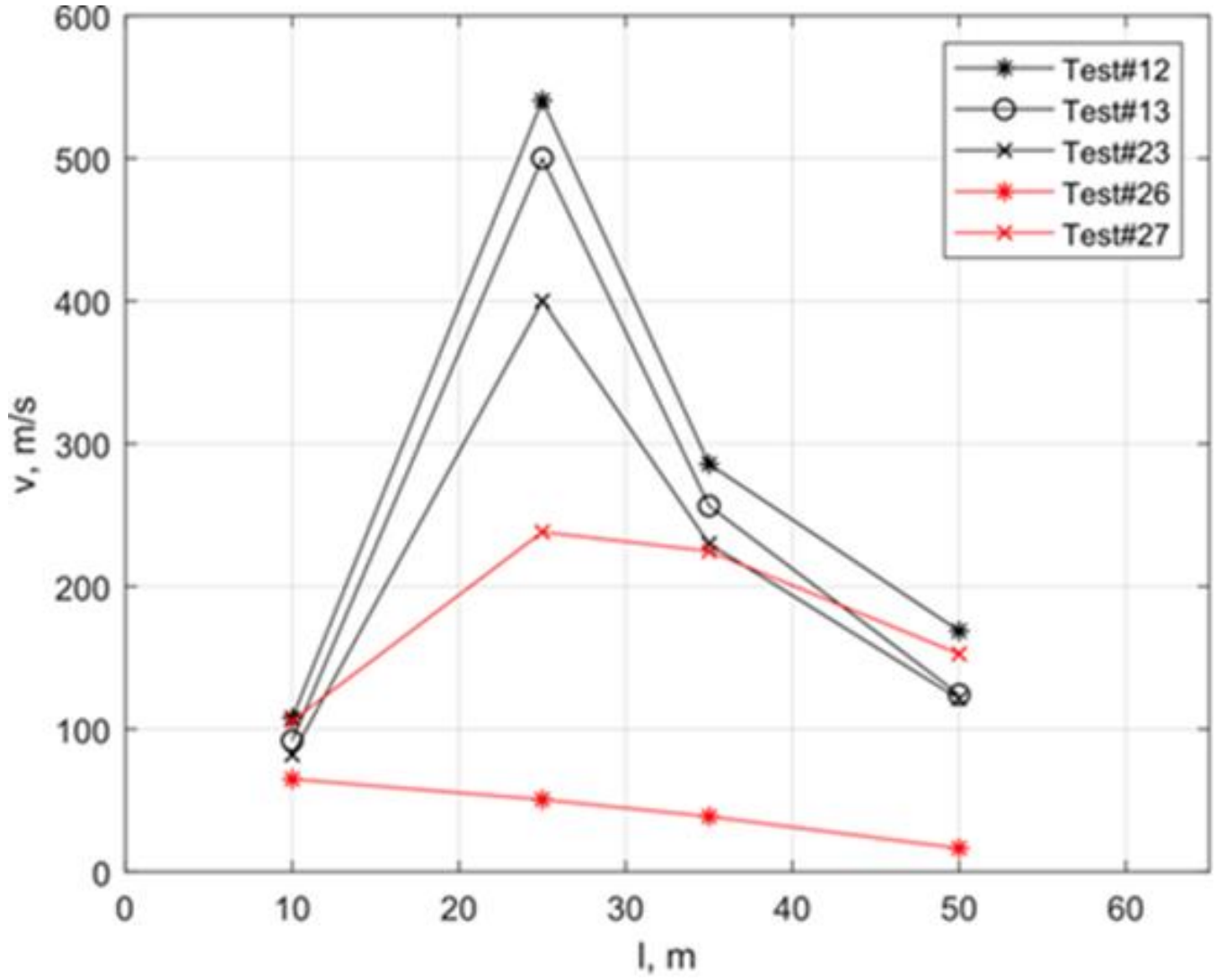
Ignition Source (Layered dust testing)



Strong Ignition

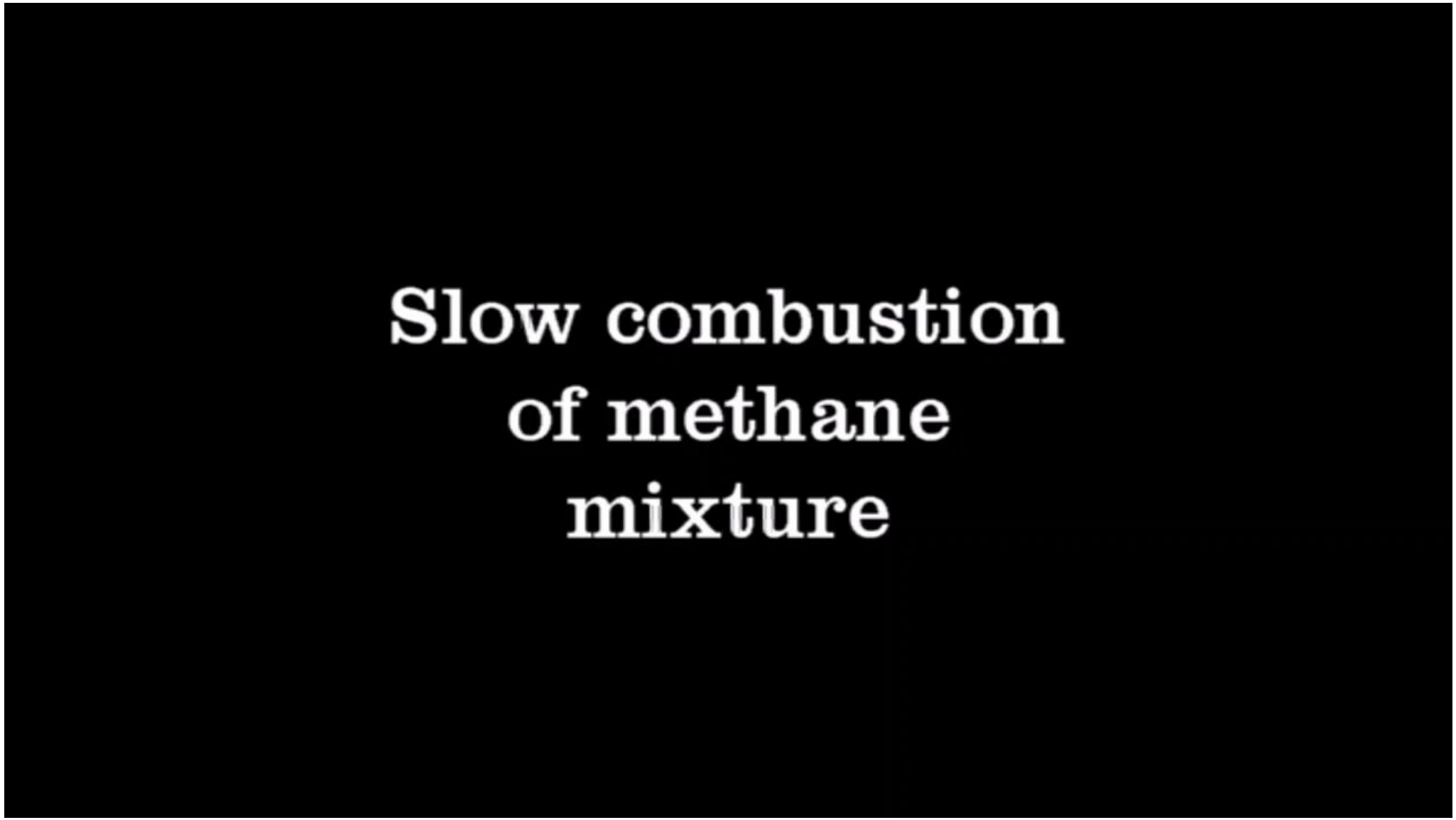
Weak Ignition

Ignition Source (Layered dust testing)



Perera et al. Society For Mining Metallurgy and Exploration Conference, Phoenix, AZ, USA, 23 - 26 Feb ,2020

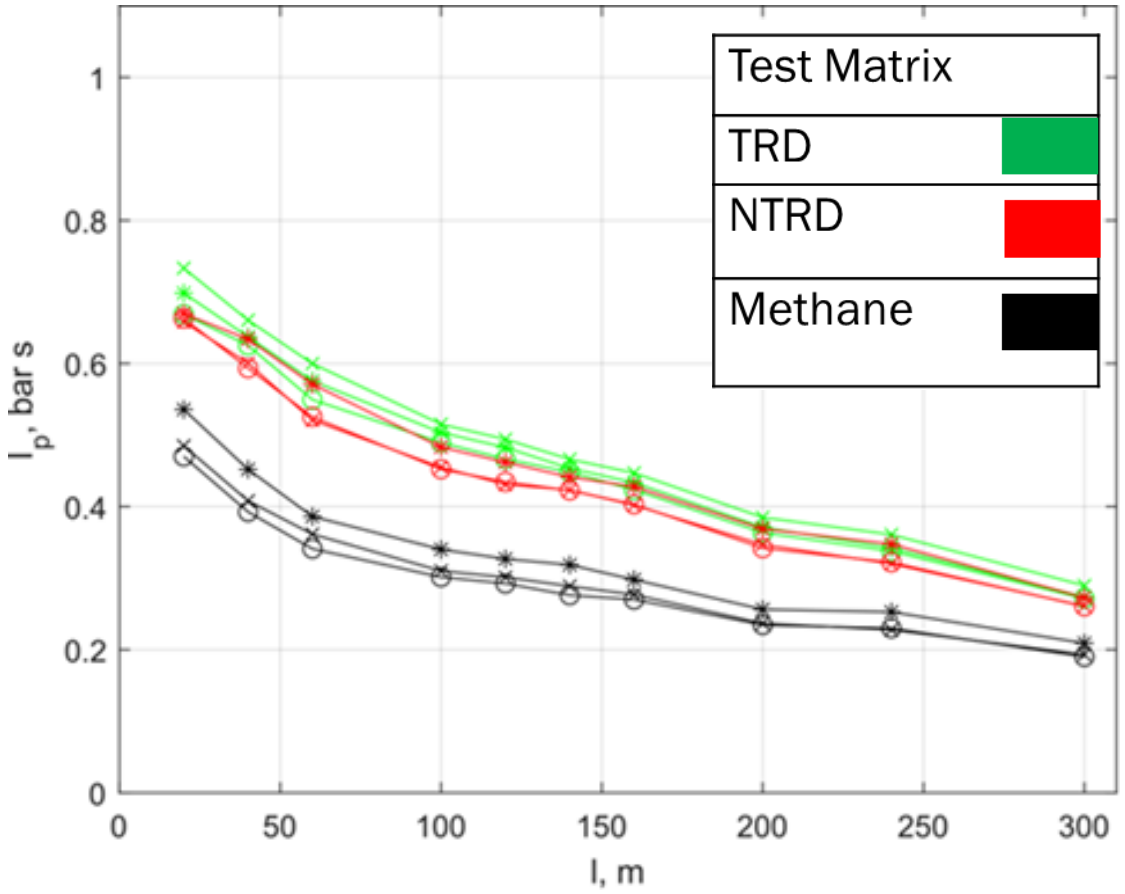
A Methane explosion



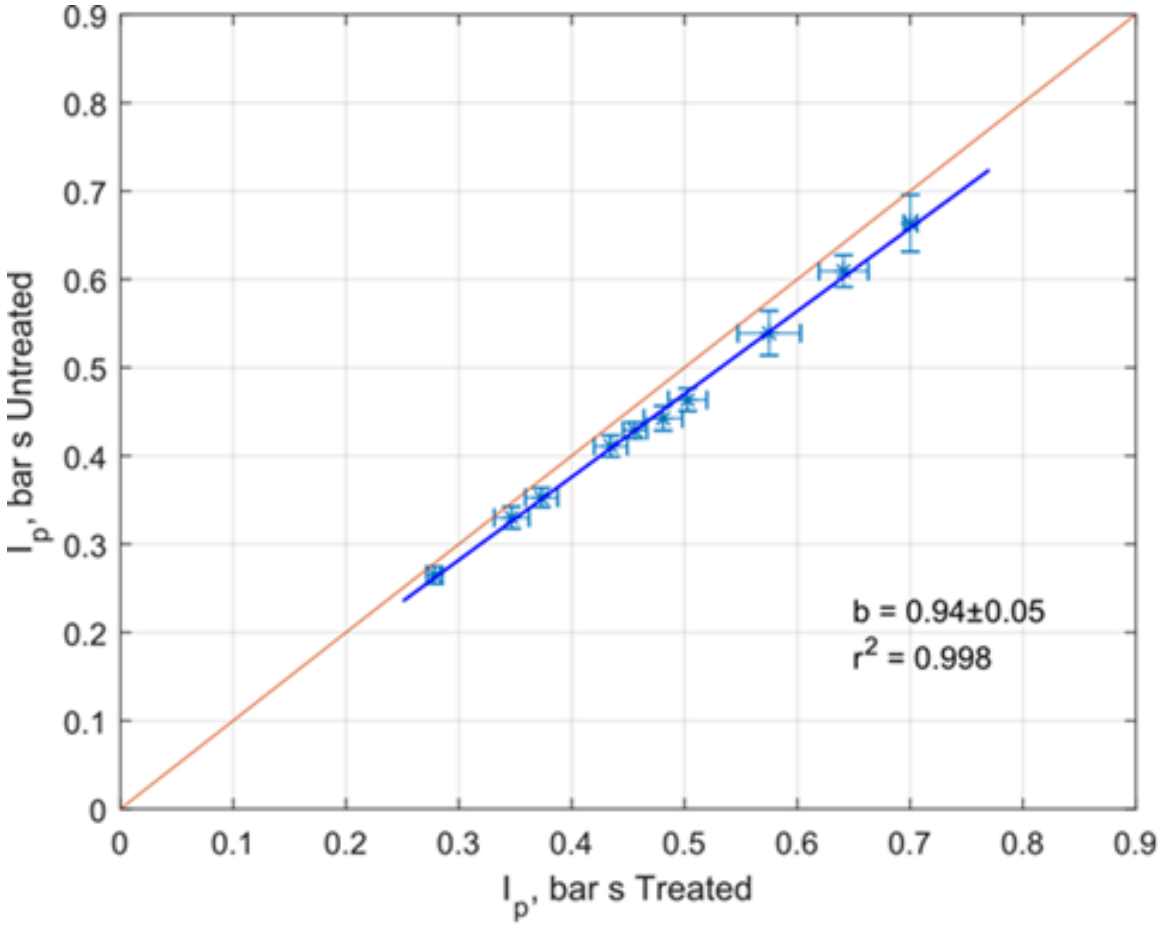
Ignition Strengths (Layered dust testing)

	Dry Rock Dust Tests		Wet Rock Dust Tests	
Explosion Type	TRD	NTRD	TRD	NTRD
Strong				
Weak	NA	NA		

No difference between dry TRD and NTRD with strong ignition



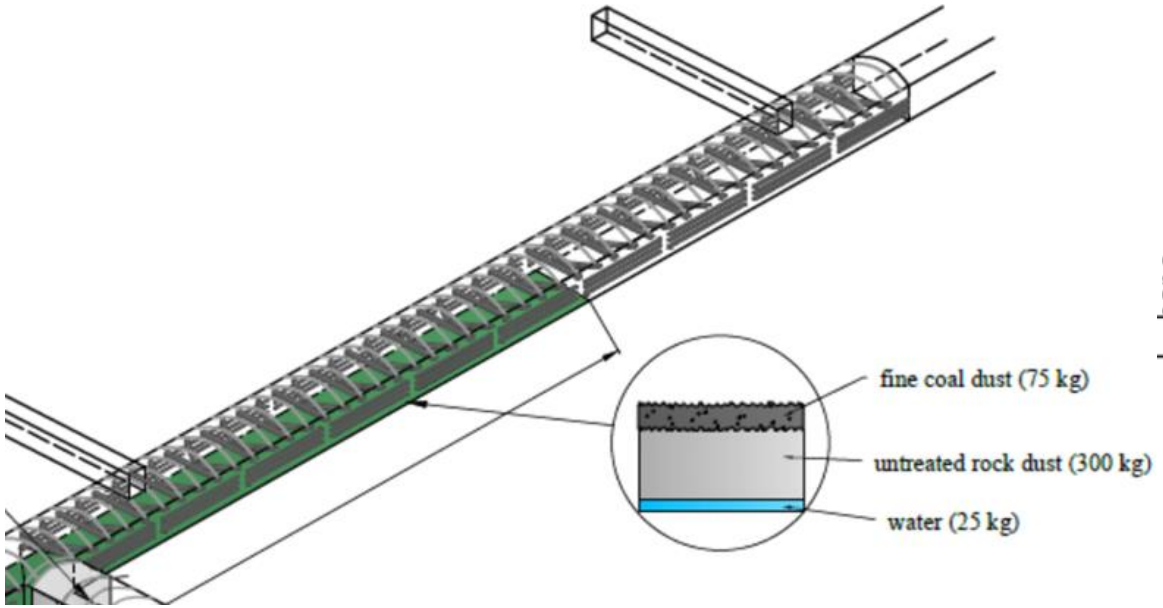
Pressure impulses at different locations along the gallery

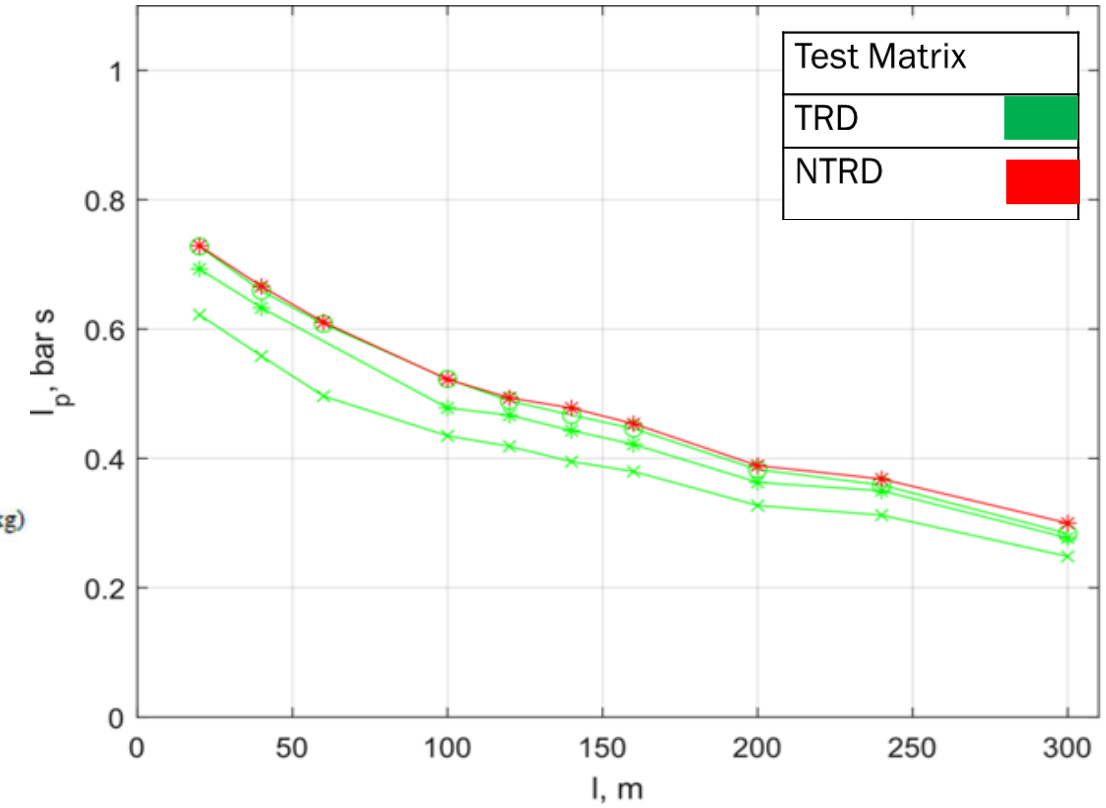


Direct comparison of average pressure impulses

Perera et al. Society For Mining Metallurgy and Exploration Conference, Phoenix, AZ, USA, 23 - 26 Feb ,2020

No difference between wetted TRD and NTRD with strong ignition

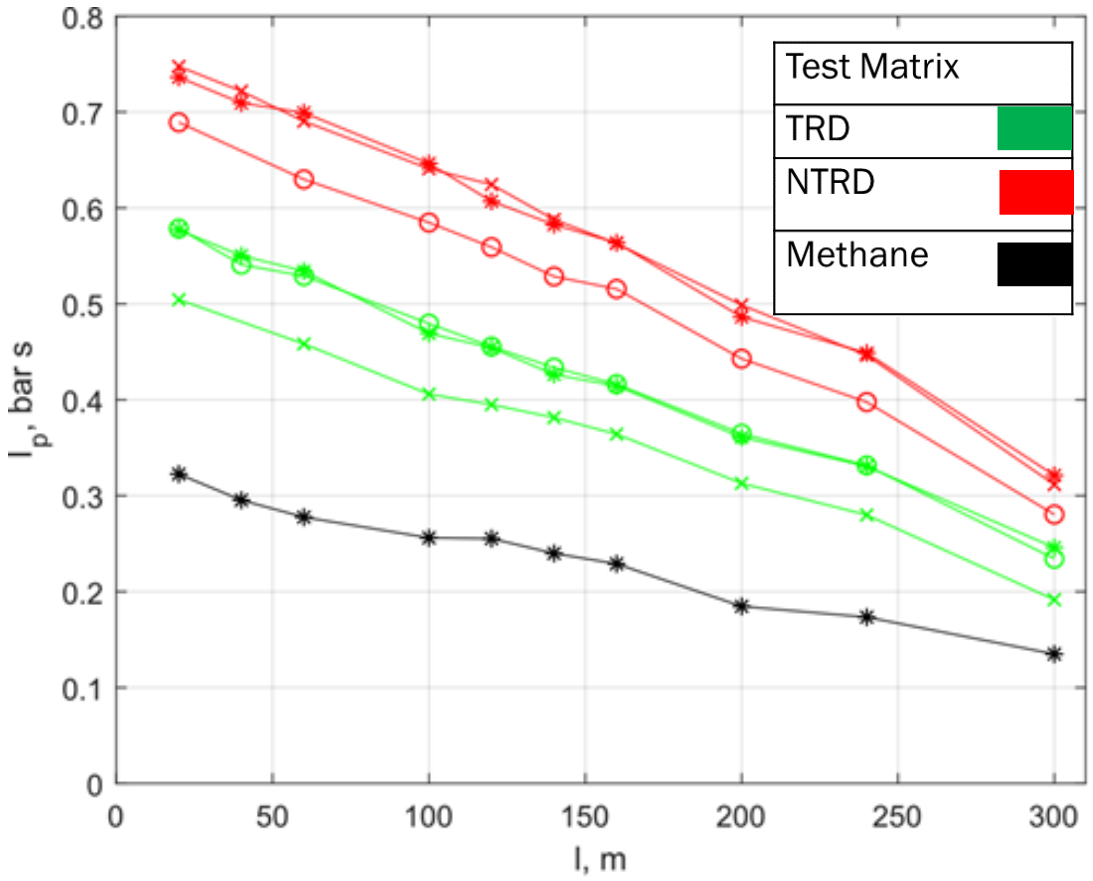




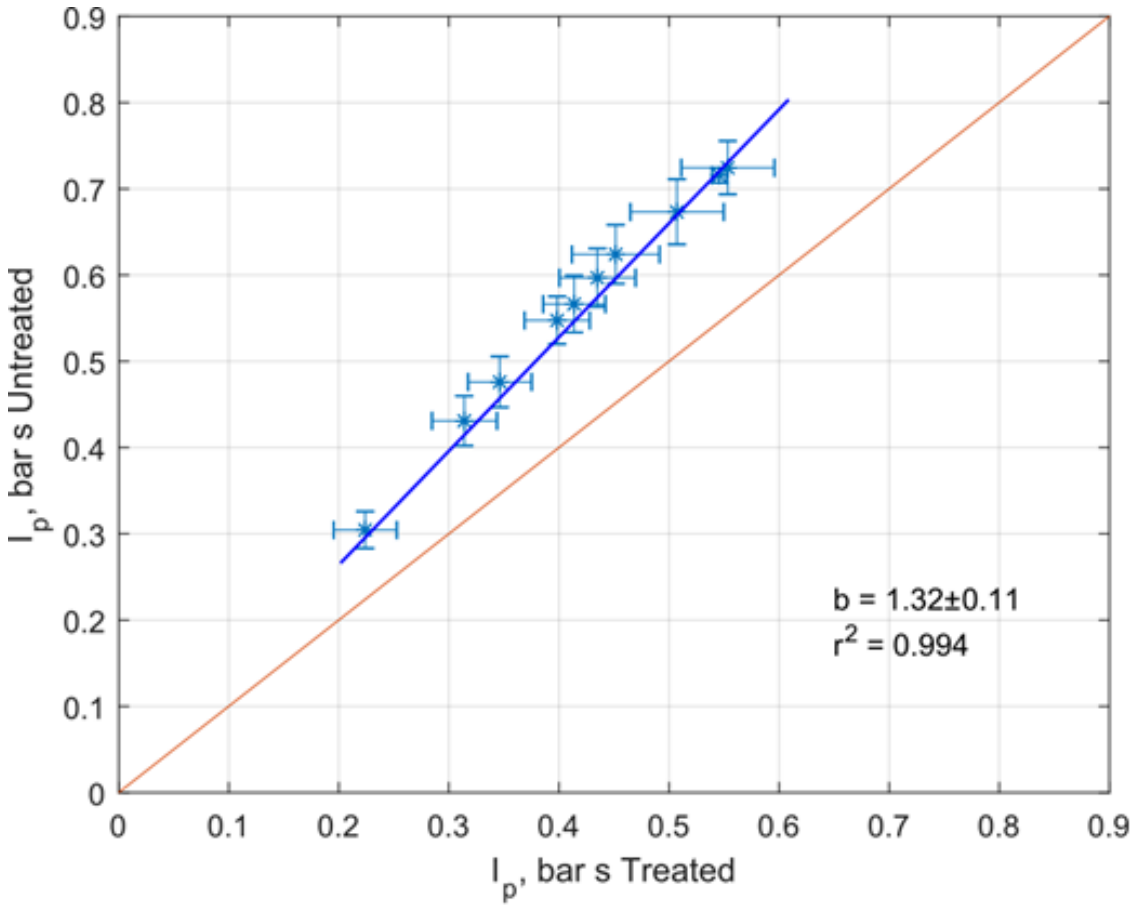
Pressure impulses at different locations along the gallery

Perera et al. Society For Mining Metallurgy and Exploration Conference, Phoenix, AZ, USA, 23 - 26 Feb ,2020

Difference observed between wetted TRD and NTRD with weak ignition



Pressure impulses at different locations along the gallery



Direct comparison of average pressure impulses

Perera et al. Society For Mining Metallurgy and Exploration Conference, Phoenix, AZ, USA, 23 - 26 Feb ,2020

Summary of Large-Scale Explosion Tests

Homogenized testing:

- Inerting properties of the treated rock is better than non-treated rock dust, especially under wet conditions.

- For TIC > 50%, the experimental results suggest better performance of the treated rock dust than non-treated RD.

Layered dust testing:

- The explosion tests were initiated using a thin layer of standard Barbara coal dust on top of a layer of limestone rock dust and the explosion severities were assessed in terms of flame travel and pressure impulse.

- The experimental results gathered using a strong ignition source indicated that the suppression properties of the treated rock dust (TRD) were as good as those of the non-treated rock dust (NTRD).

- In high moisture conditions and using a weaker ignition source, the treated rock dust performed better than the non-treated rock dust.

Thank you

Questions?

Eranda Perera

eperera@cdc.gov