Rock Dust Extinguishing of Coal Dust Explosions

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Purpose

- Dry Dust
  - Respirable Dust Problems
- Wet Dust
  - Caking Problems
- Proprietary Dust
  - 2 Types
- Newly Developed Dust
  - Hydrophobic

- Research Funded by Kentucky Department for Energy Development and Independence (DEDI)

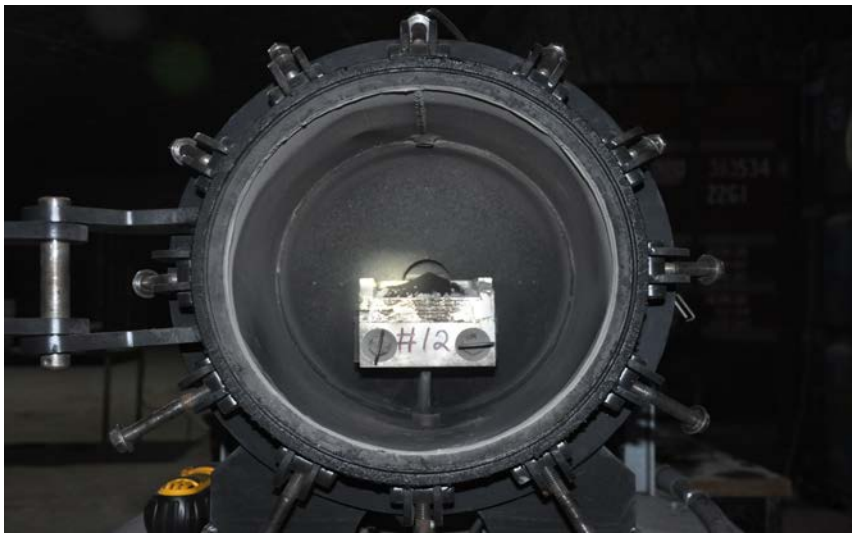
This Presentation

- I am going to talk about
  - Coal Dust Explosion Extinguishment Characteristics
  - Rock Dust Lift
  - Comparison between:
    - Dry Rock Dust
    - Wet Rock Dust
    - Hydrophobic Rock Dust
  - The proprietary ones are sensitive at this time and will be published at a later date.

Explosion Chamber

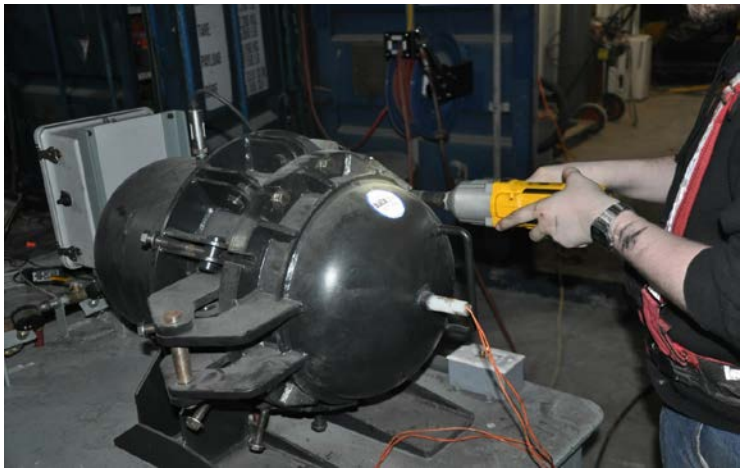
Procedure

- Sample prep
  - 80% incombustible (rock dust)
  - 20% combustible (coal dust)
    - Placed on top of rock dust to simulate float dust
  - Weigh
- Place in chamber
- Place Igniter
- Close and fasten
- Draw Vacuum ~ 2 psia

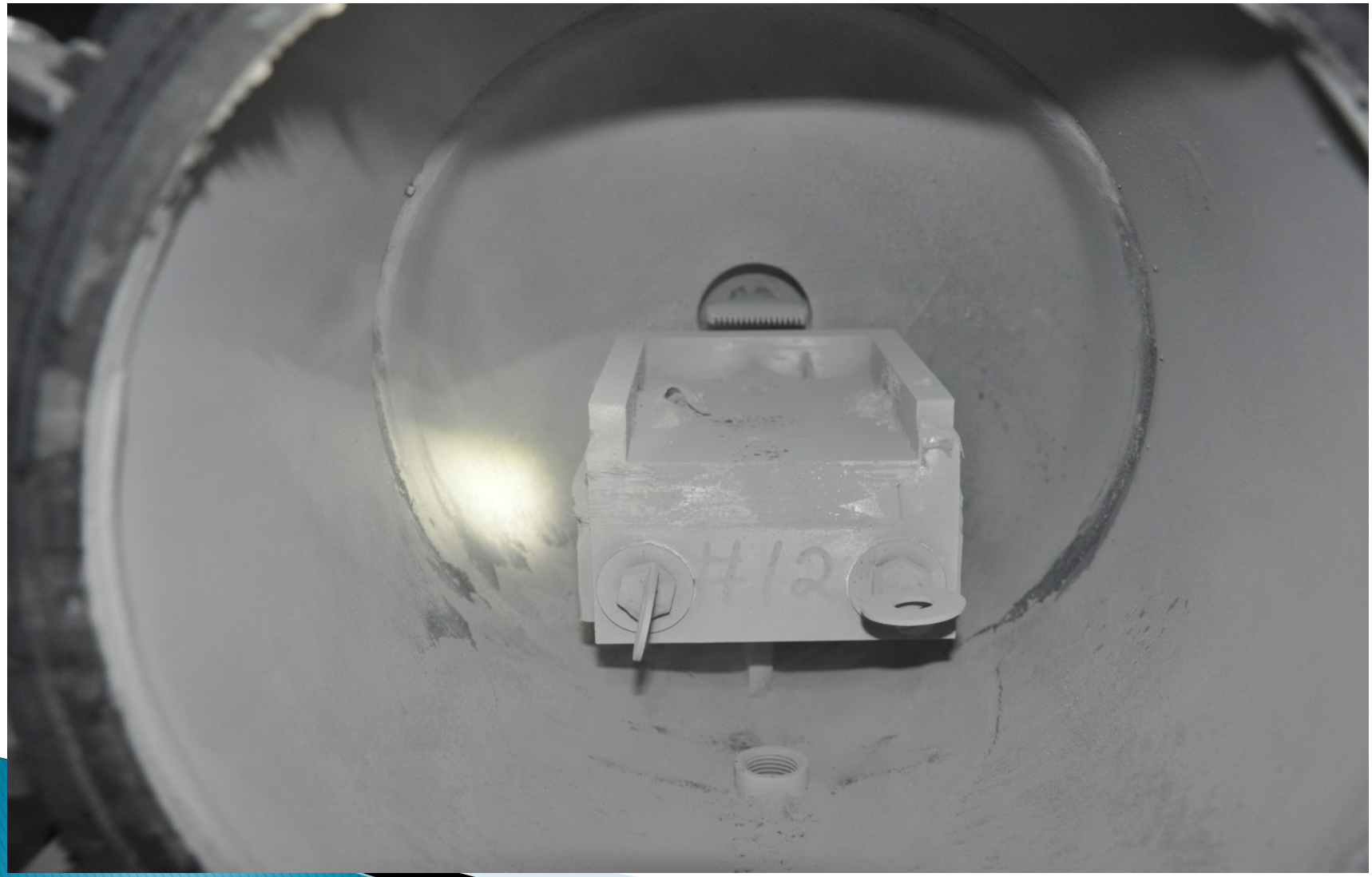


More procedure

- Inject breathable air mixture to disperse mixture and bring to atmospheric ~ 14.7 psia
- Ignite – measure pressure
- Weigh sample tray to determine amount dispersed
- Clean
- Repeat… over and over and over



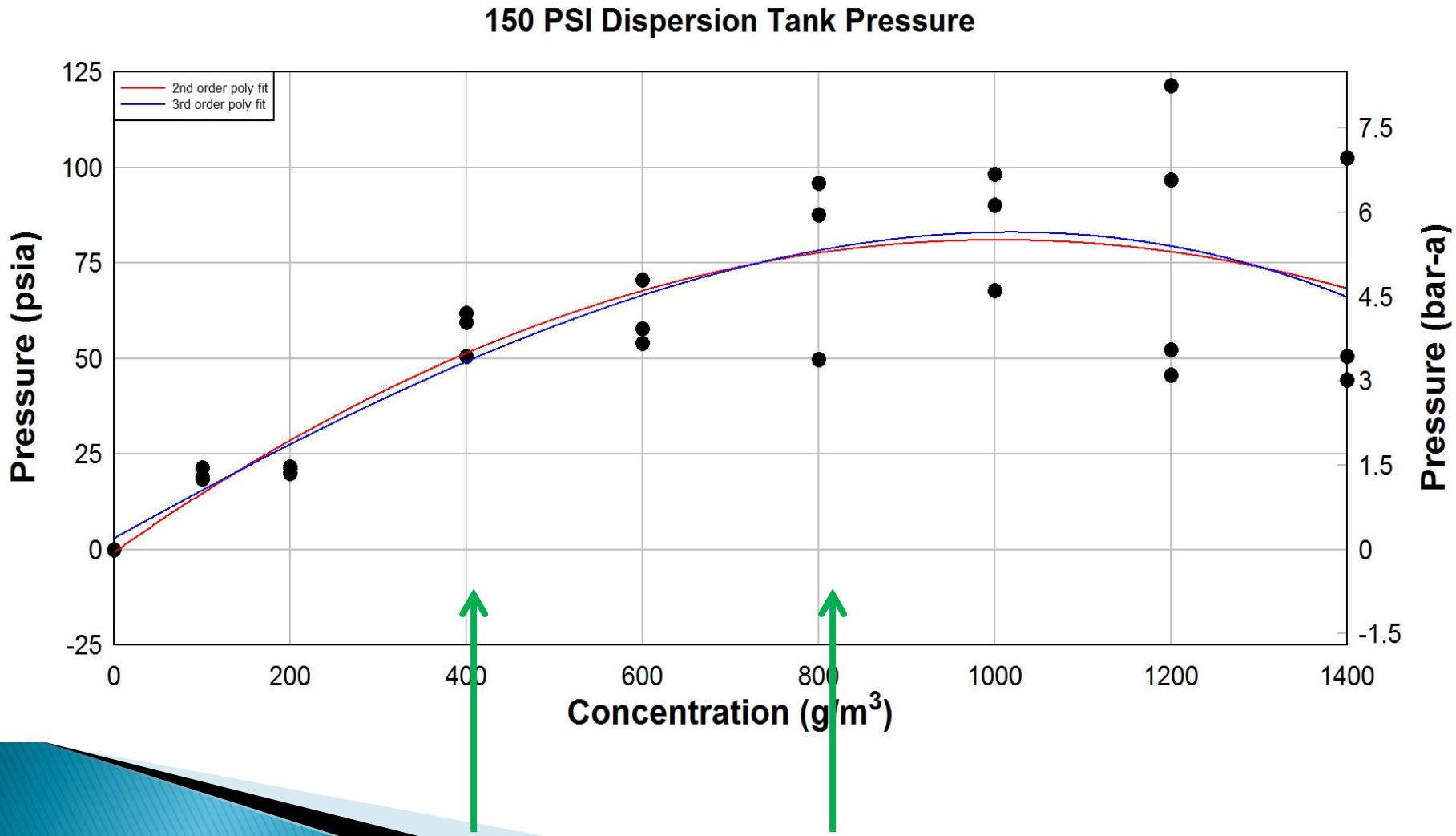
After a test



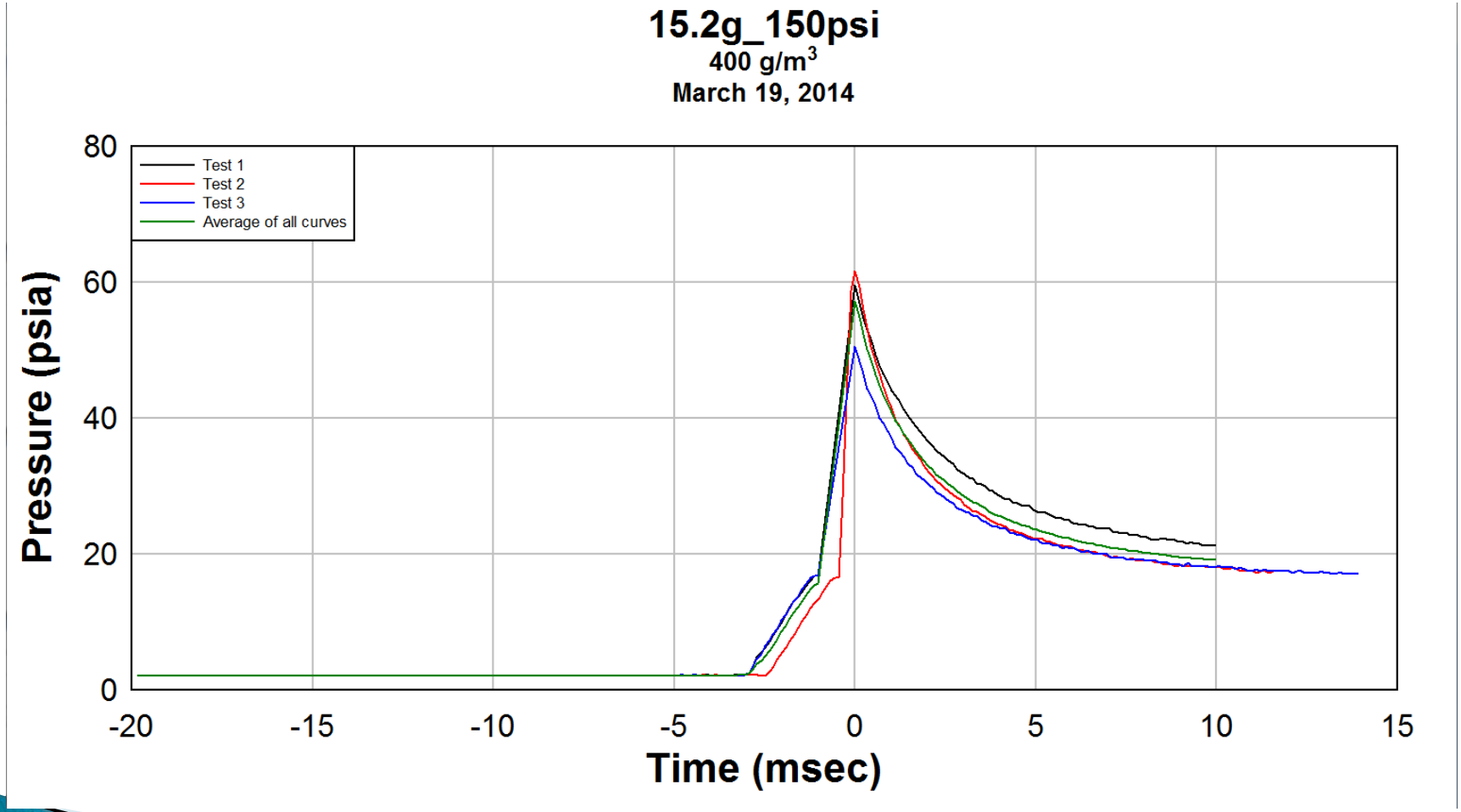
Establish Baseline

- Need something to compare the effects of rock dust to
- Coal Dust only trials
- Varied coal dust concentrations to 1400 g/m^3 in 200 g/m^3 increments
  - This is grams of coal dust per volume of chamber

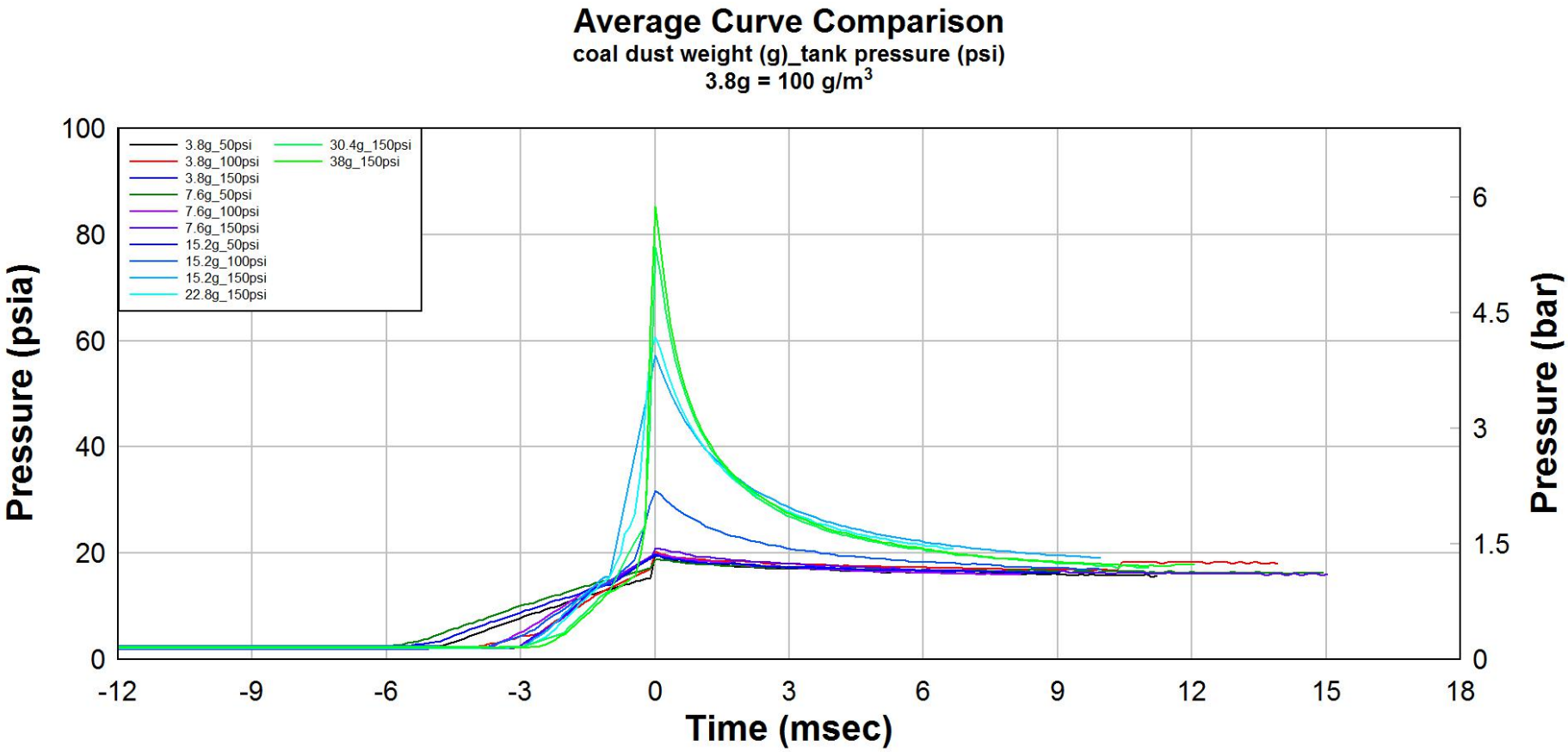
What we generated



Example Series



All Coal Dust Series

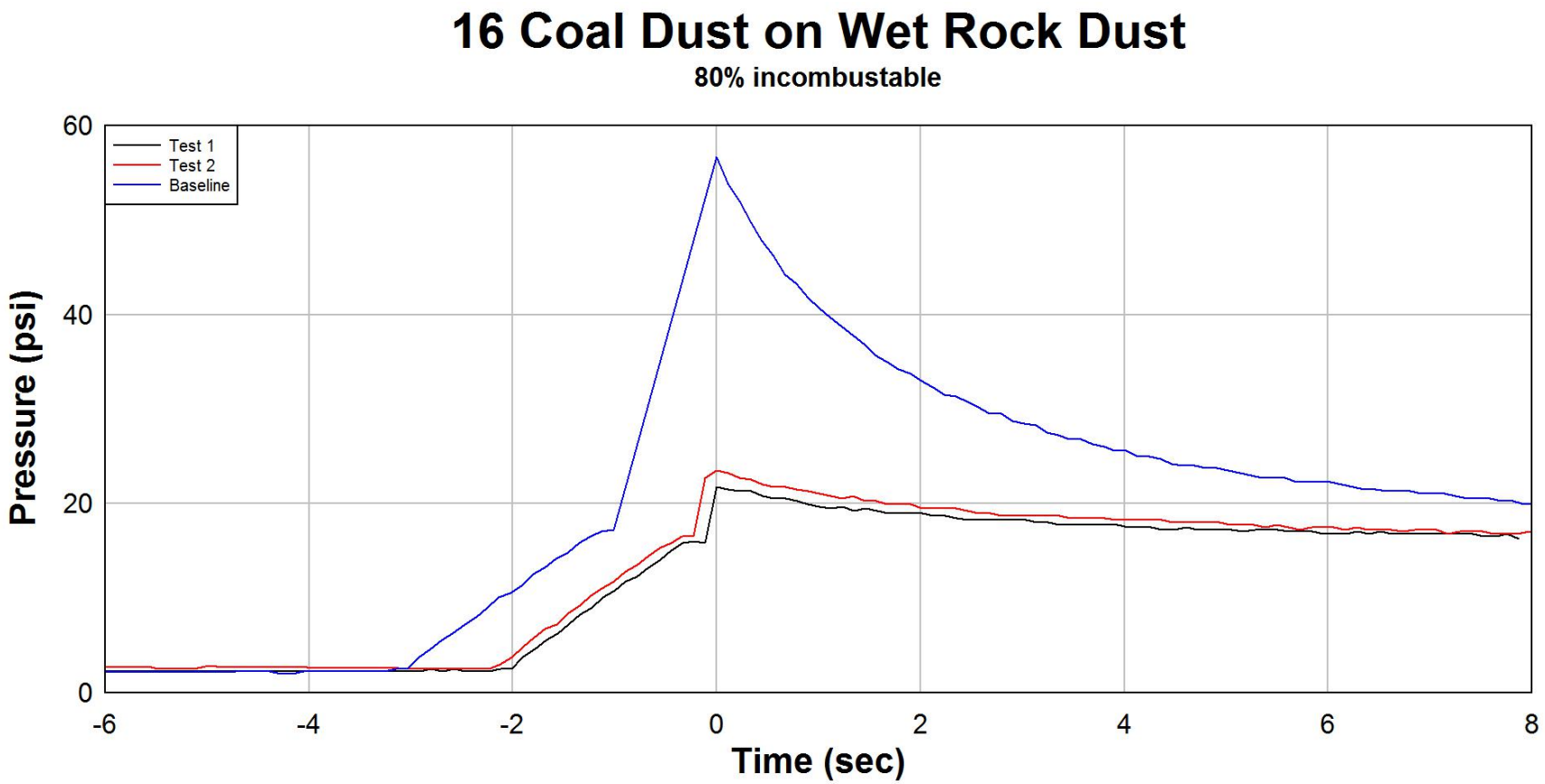


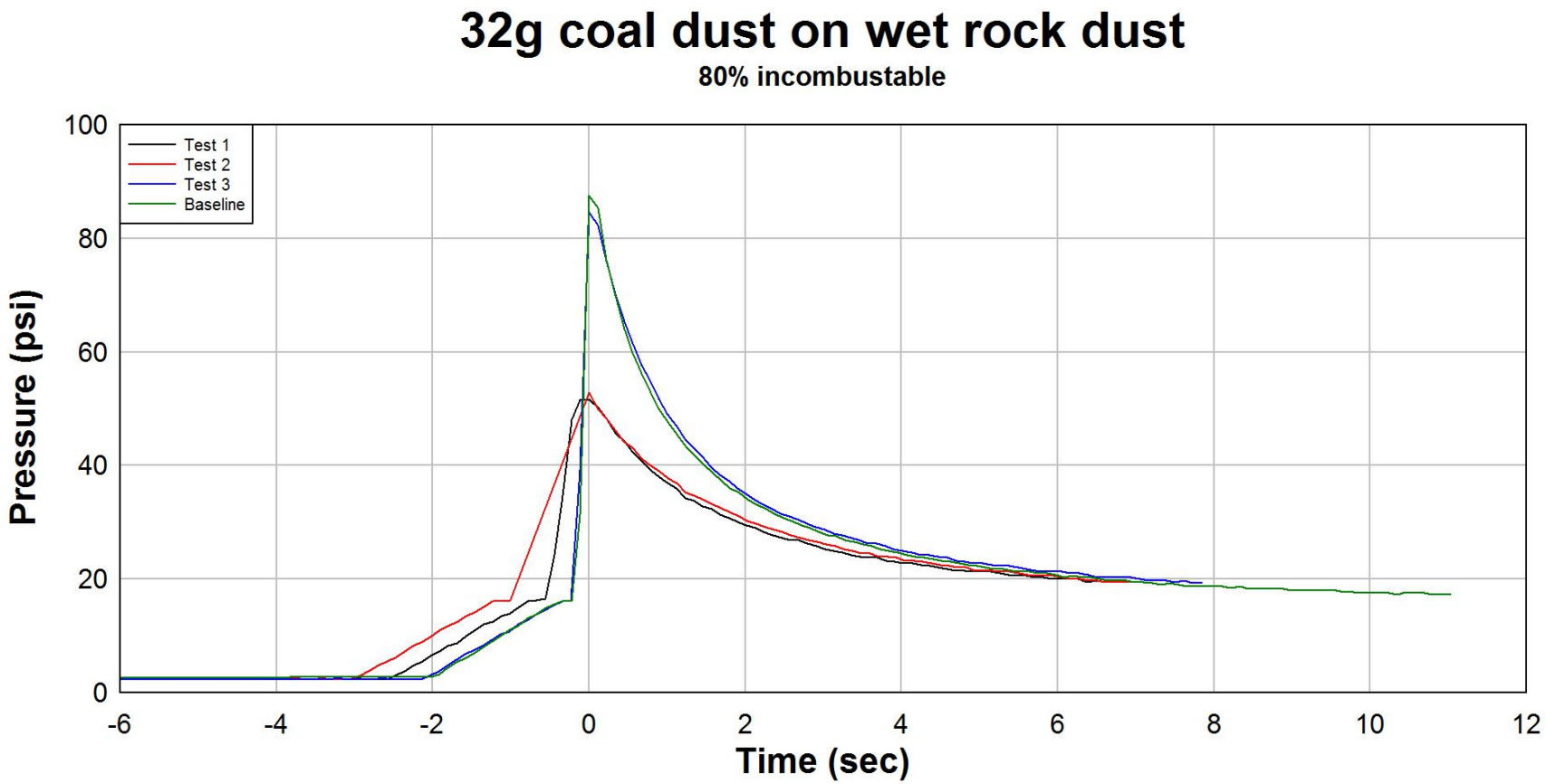
Set 2 standards

- 412 g/m^3 to compare with a previous NIOSH study
- 824 g/m^3
  - Doubles initial standard
  - Begin seeing the data separate at that point where some samples detonated while other deflagrated

Results

- Dry dust functioned as designed for both coal dust ‘standards’
  - Max pressure seen inside chamber was about 22 psi which does not suggest detonation of the mixture
- Wet dust functioned as designed for the 412 g/m^3 concentration ‘standard’, but not consistently for 824 g/m^3


16 Coal Dust on Wet Rock Dust
80% incombustable
Test 1
Test 2
Baseline
Pressure (psi)
60
40
20
0
-6
-4
-2
0
2
4
6
8
Time (sec)


32g coal dust on wet rock dust
80% incombustable
Test 1
Test 2
Test 3
Baseline
Pressure (psi)
100
80
60
40
20
0
-6
-4
-2
0
2
4
6
8
10
12
Time (sec)

Results – Wet rock dust

- Of the 11 trials run at the smaller standard, only 1 could be considered as a detonation
  - ~ 42 psia
- Of the six trials run at the larger standard, only 1 did not detonate
  - max ~ 85 psia

What does this mean

- The weight of mixture dispersed varied greatly
  - Dependent on tray type (slim or deep)
  - Curing location
  - 0.9% to 53.5% with mean of ~ 20%

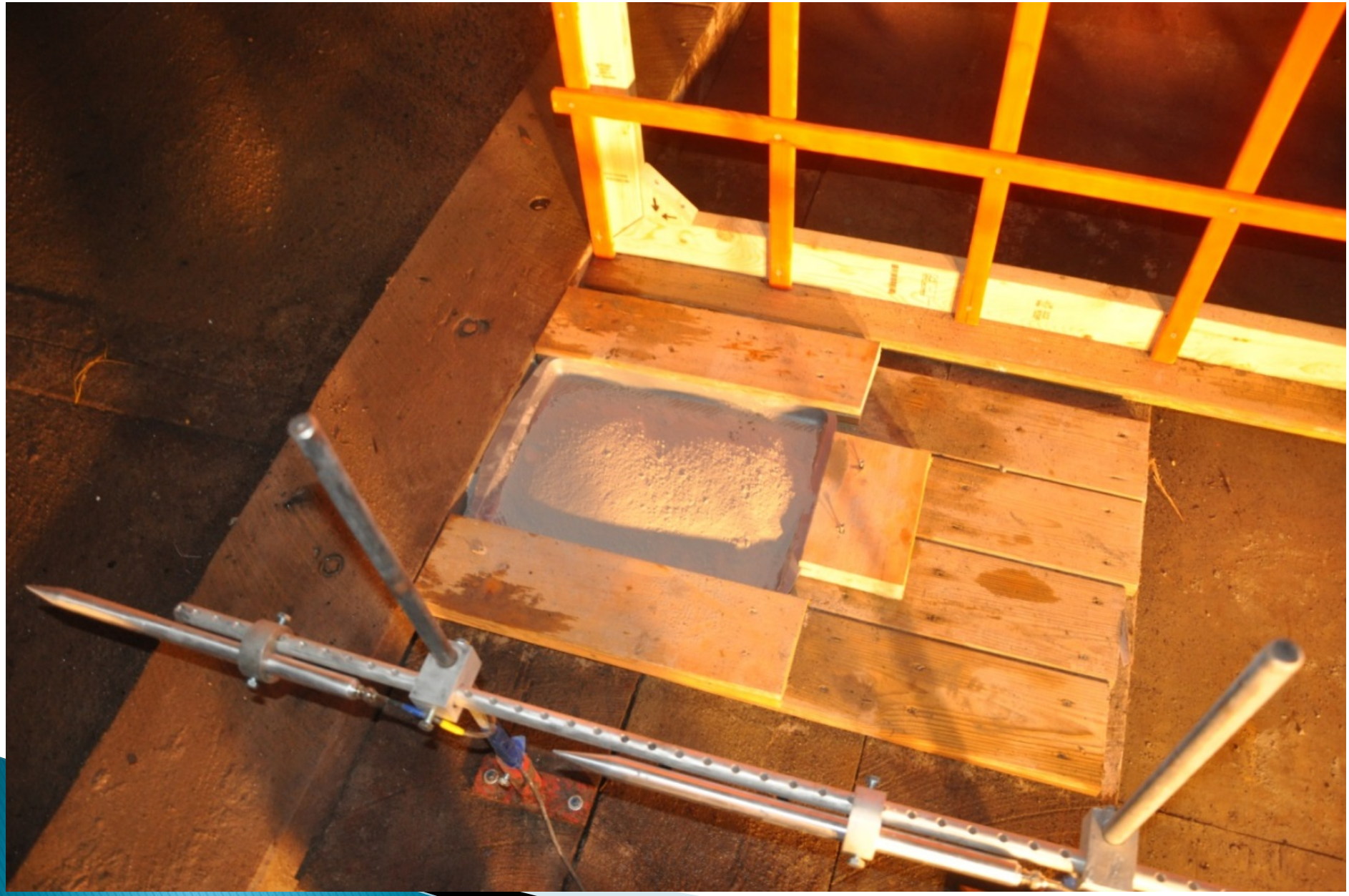
- We found that the “caked” rock dust was not easily dispersed, especially for the larger ‘standard’ that we used

Results – Hydrophobic Dust

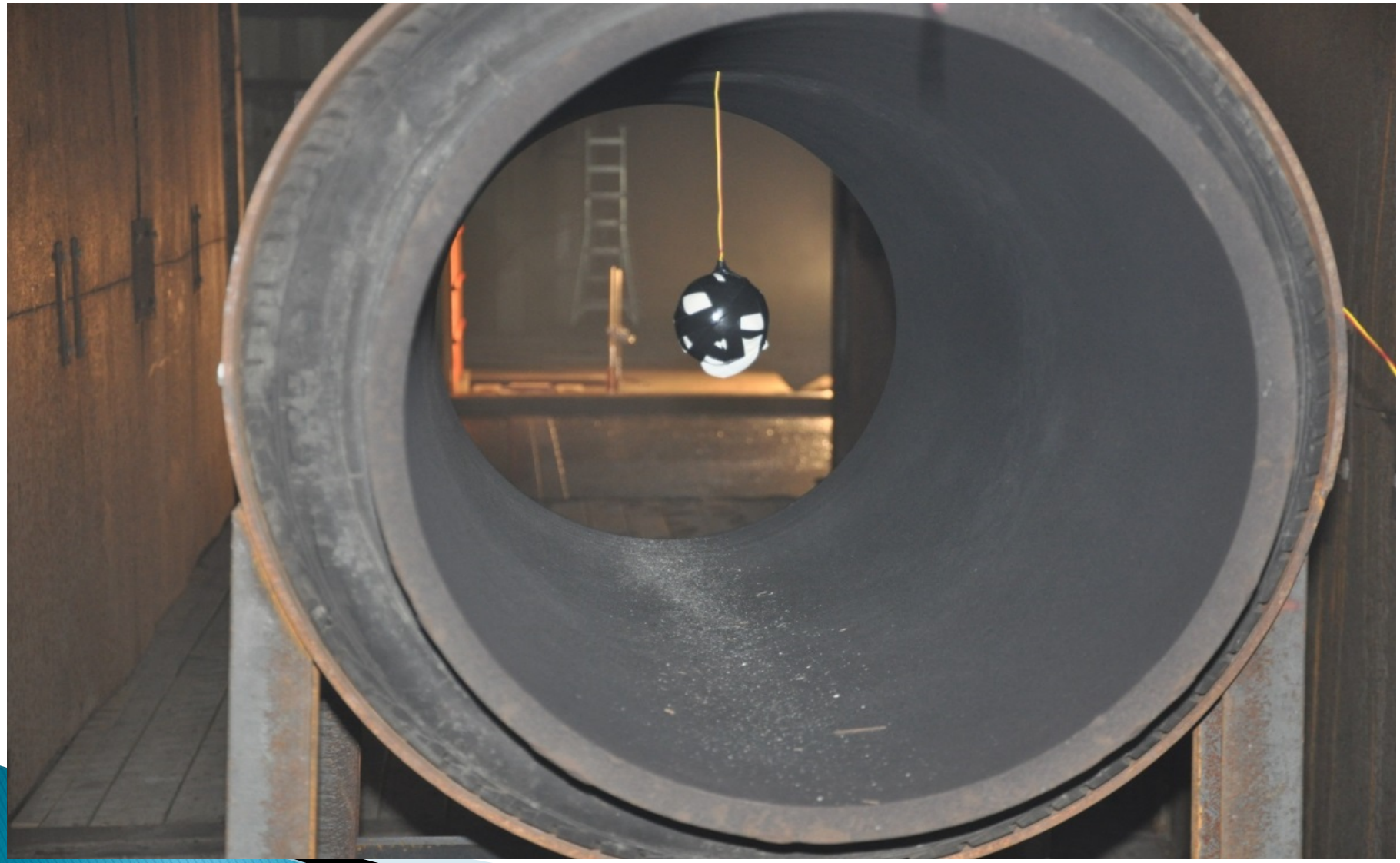
- The rock dust was treated with a surface coating to make the dust particles resist adsorption of water
- Was mixed like a wet dust and cured the same way
- Results similar to that of dry dust
- Only 1 of 14 samples ‘detonated’

Angle of Ejection

- Trays of dust types placed at end of shock-tube
- Explosives detonated within tube
- Shock front passes over trays of dust
- Pressure sensors to determine shock front speed
- High speed video to capture angle of ejection
- Weighed before and after to see amount dispersed



C-4 Charge

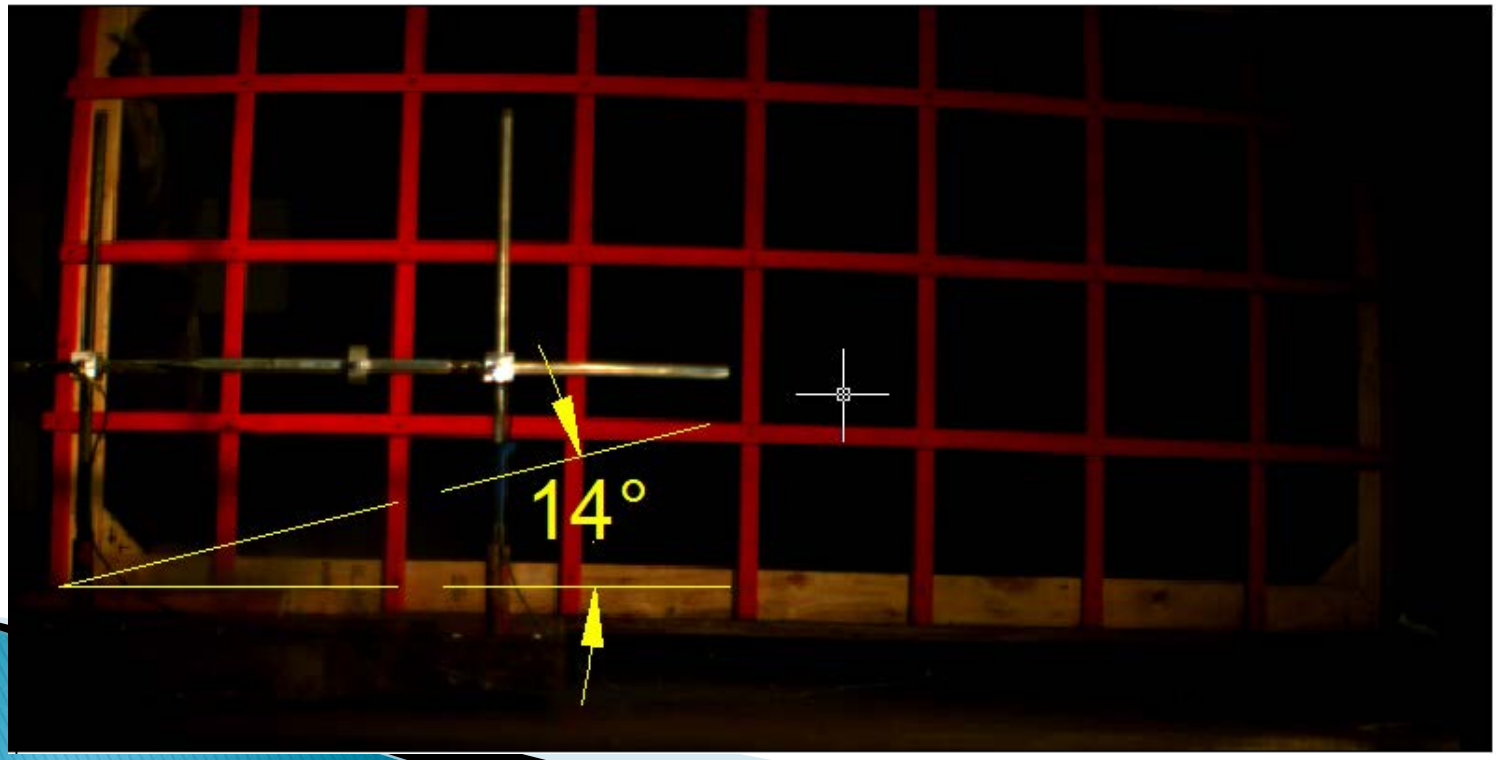


Dry Dust

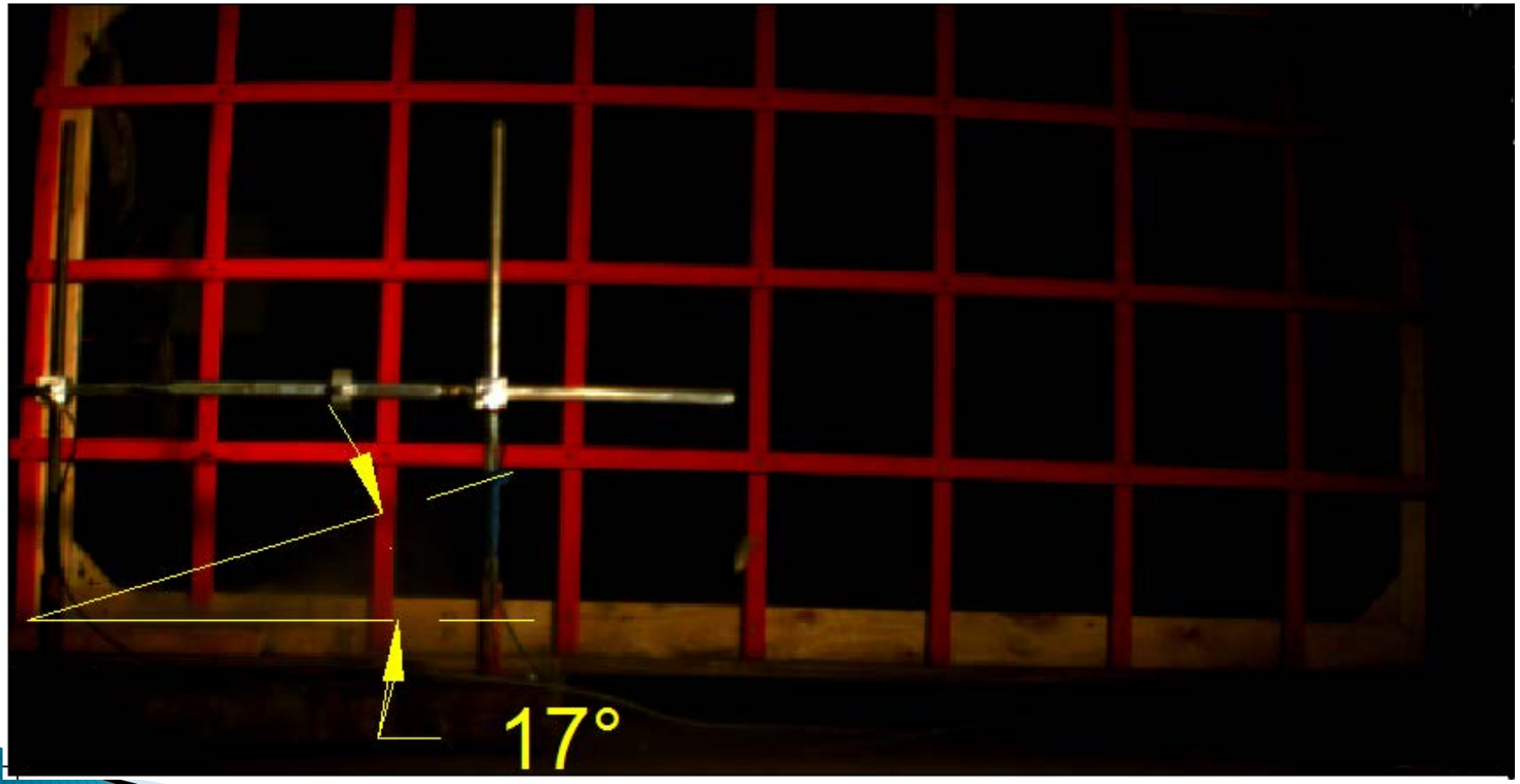
- ~ 2% by weight (average) of dust dispersed

Wet Dust

- 5% dispersed
  - Large clods of caked dust may account for increase
  - Would not be effective in extinguishing flame front of coal dust explosion



Hydrophobic Dust



Summary

- Dry dust does the job
  - But can't dust on the intake on-shift due to respirable dust concerns
- Wet dust does the job sometimes, but sometimes not
  - Caking is a significant problem that academia and industry are addressing
- Hydrophobic Dust lies somewhere in the middle
  - Advantage of "wet" application
  - More reliable than wet dust from initial results

Conclusion

- This type of research will be beneficial to industry
  - Produce reports and publications to aid in MSHA's acceptance of new methods/types of rock dusting
  - Need to prove that the "new" products are better than wet dusting results, but is nearly as effective as dry dusting
- We are on the right path, but further testing is necessary…. and planned.

- Thank you