Pressure measurement for reduction of back-break

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QMR Blasting Analysis

Pressure measurement for reduction of back-break

- Description of Back Break
- Description of the Sensor
- Description of sensor calibration
- Description of the Logger
- Results
- Future Work

Back break

Back Break is rock broken beyond the limits of the blast.

Detonion Sensor

The aim is to (with a single sensor):

- Measure the VOD of many holes
- Measure the density of the explosive in the hole.
- Measure the blast induced pressure in the rock mass from detonation of surrounding holes.
- Measure the detonation pressure in the hole.

Detonation measurement

How does it work?

- Detonation is a high energy chemical reaction that produces electromagnetic pulses (EMP) that travel at the speed of light.
- The sensors detects these emissions
- The sensor also contains a pressure transducer

Sensor calibration for high pressure using Pentolite, TNT and ANFO

TNT - note low VOD,

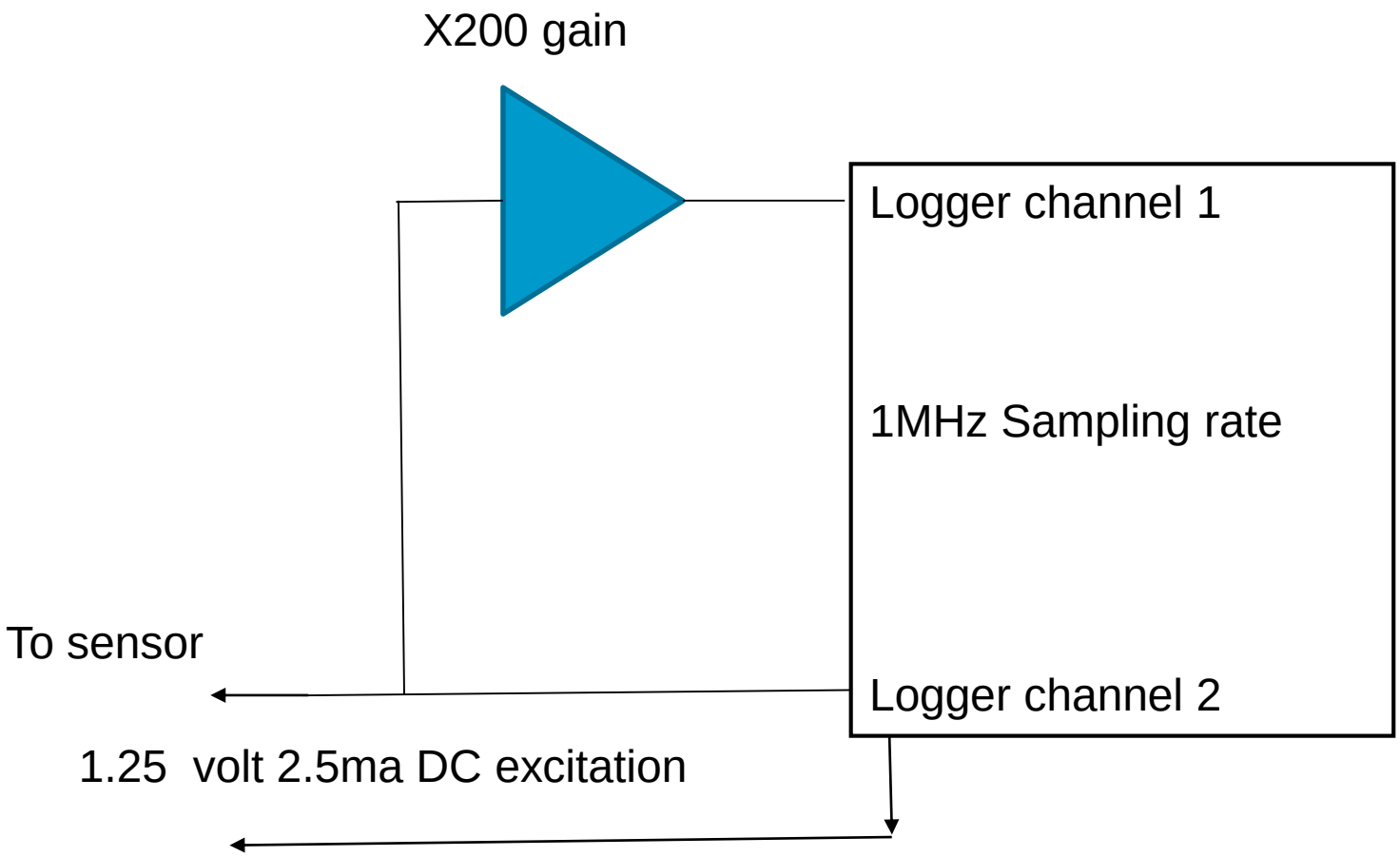
Sensor calibration for high pressure using Pentolite, TNT and ANFO

Pentolite - note high VOD and not as much throw as TNT.

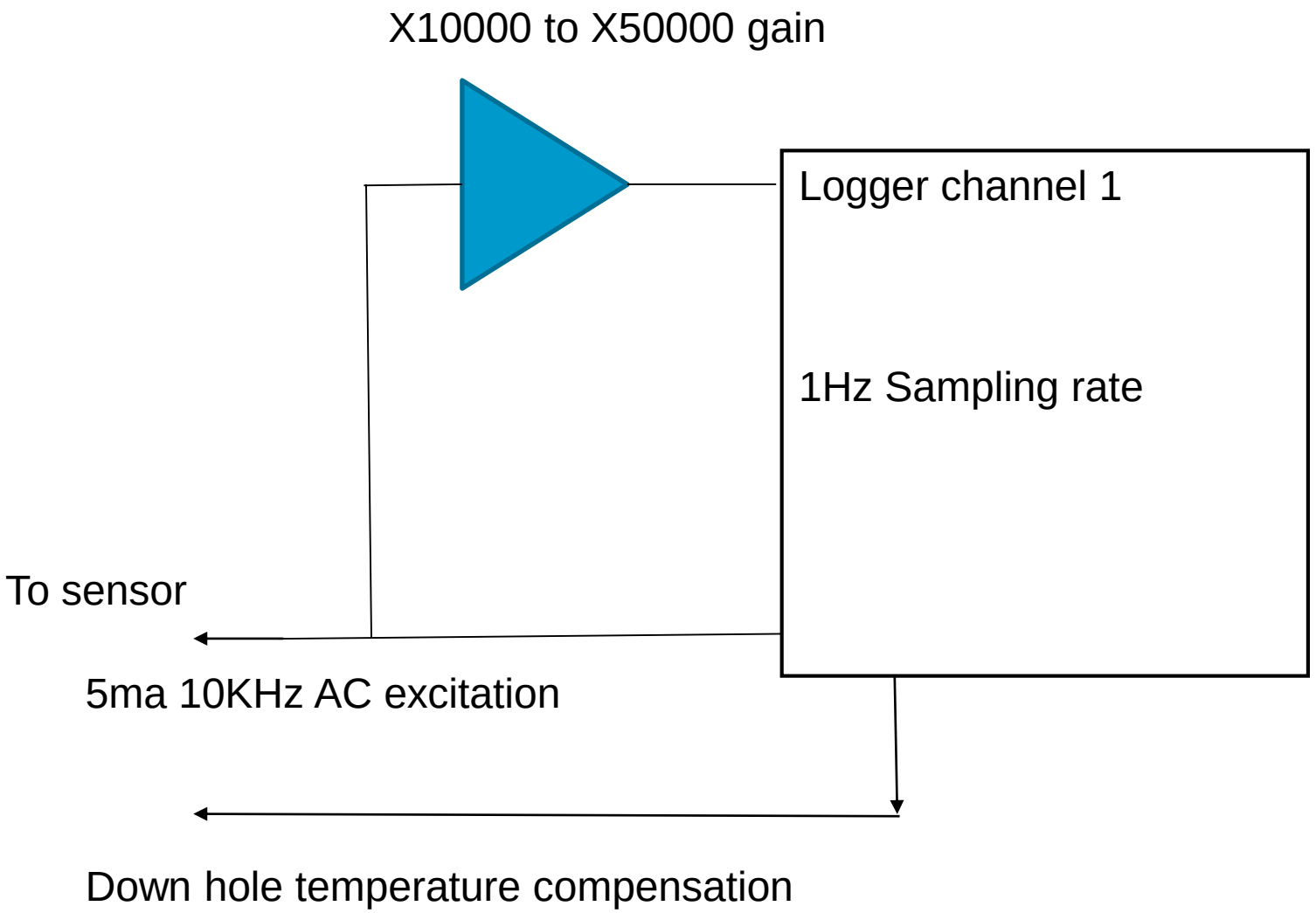
Sensor calibration for low pressure

- Used a pressure vessel filled with water.

Logger used during detonation



Logger used to measure product density – Note - still in R&D stage.



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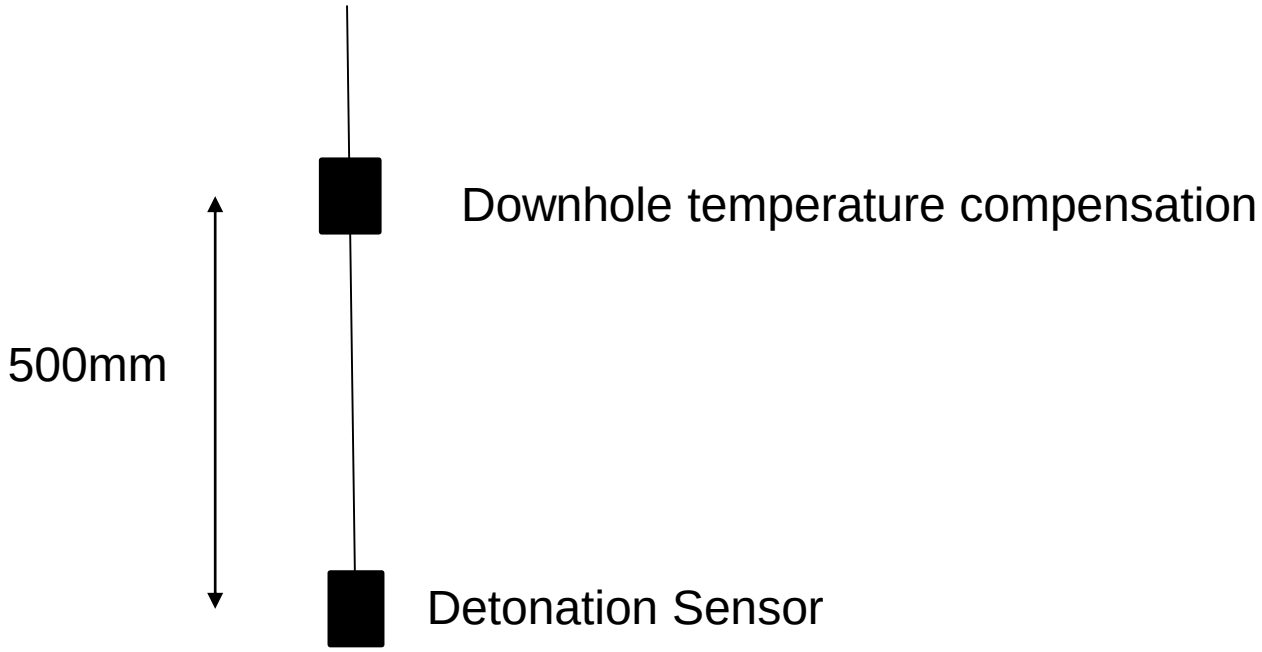
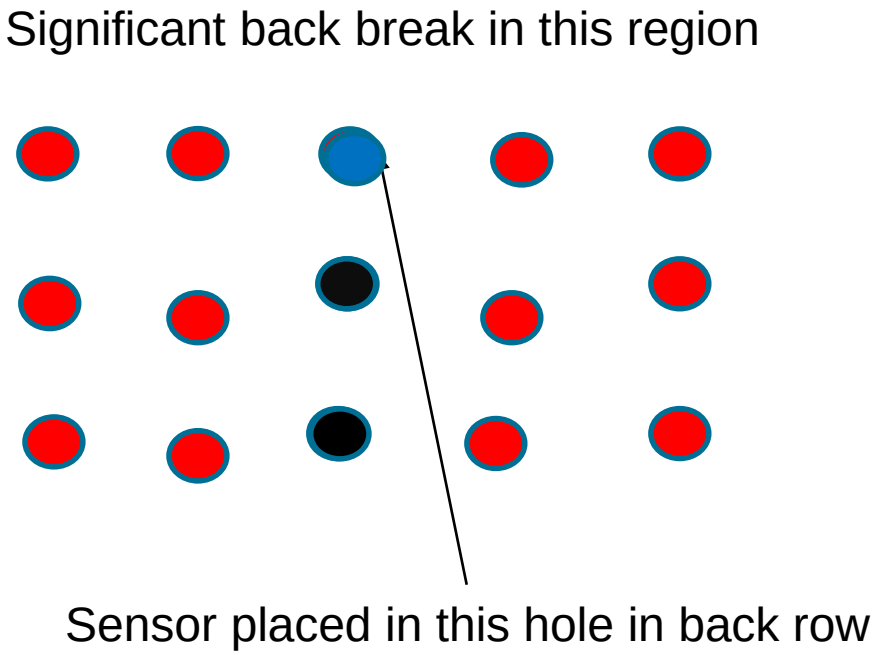
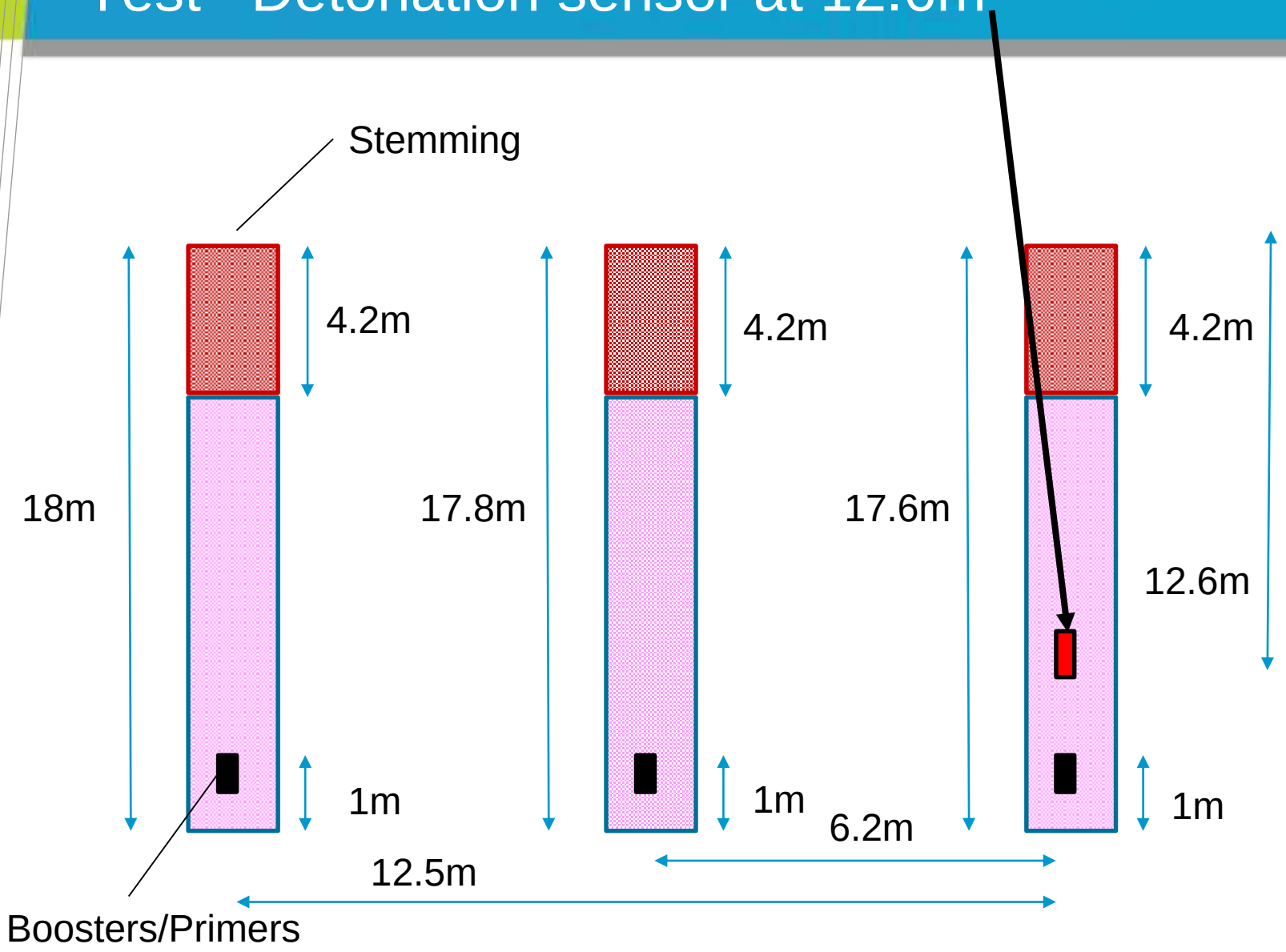


Can use the two sensors to do a point to point VOD

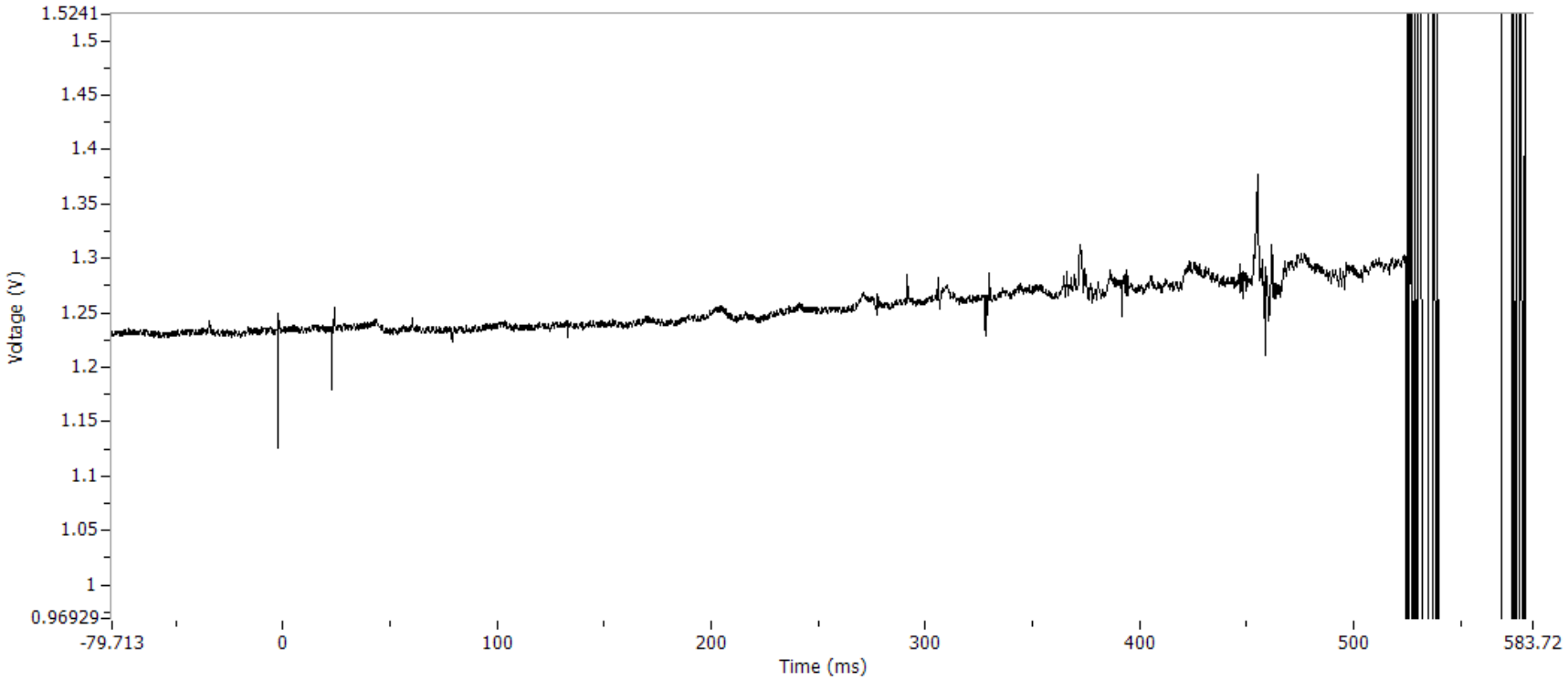
Approx. 600 holes- sensor in a hole at back



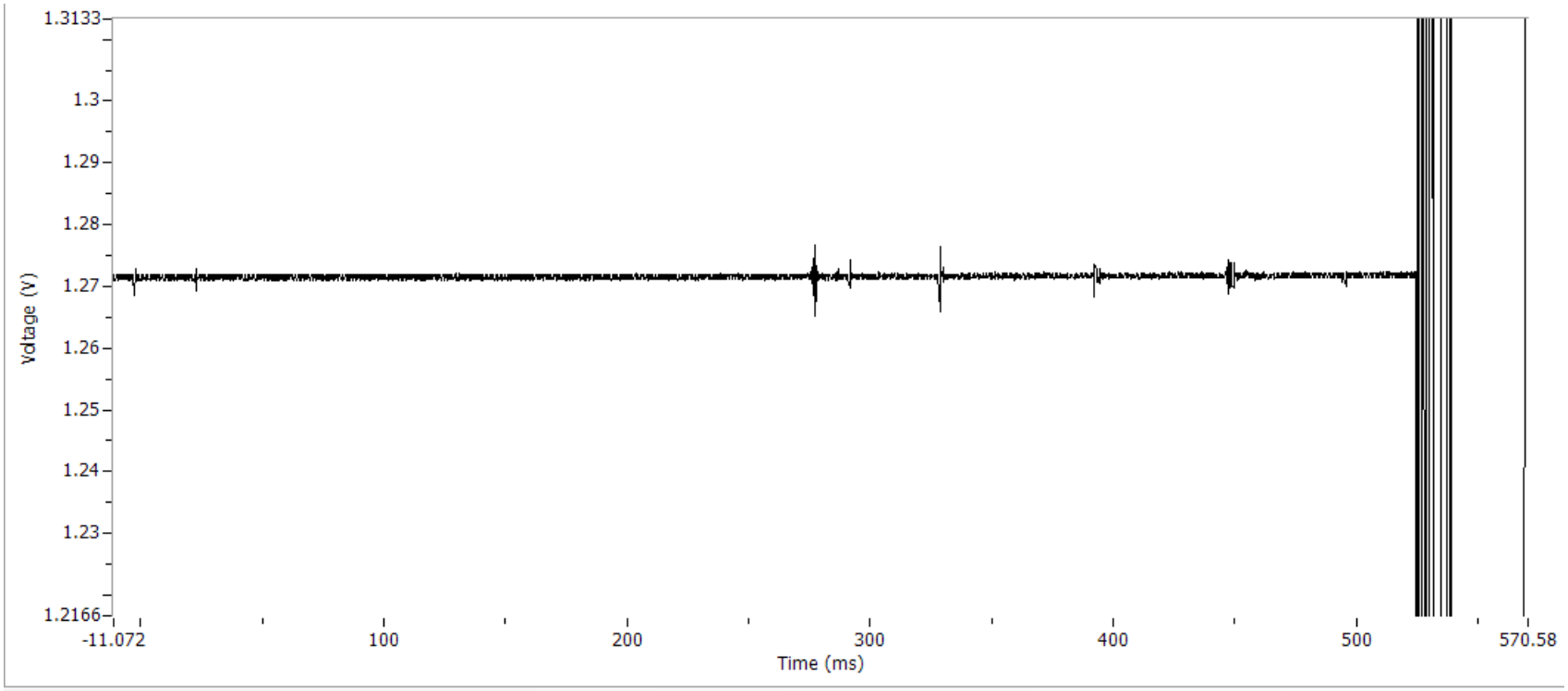
Test –Detonation sensor at 12.6m



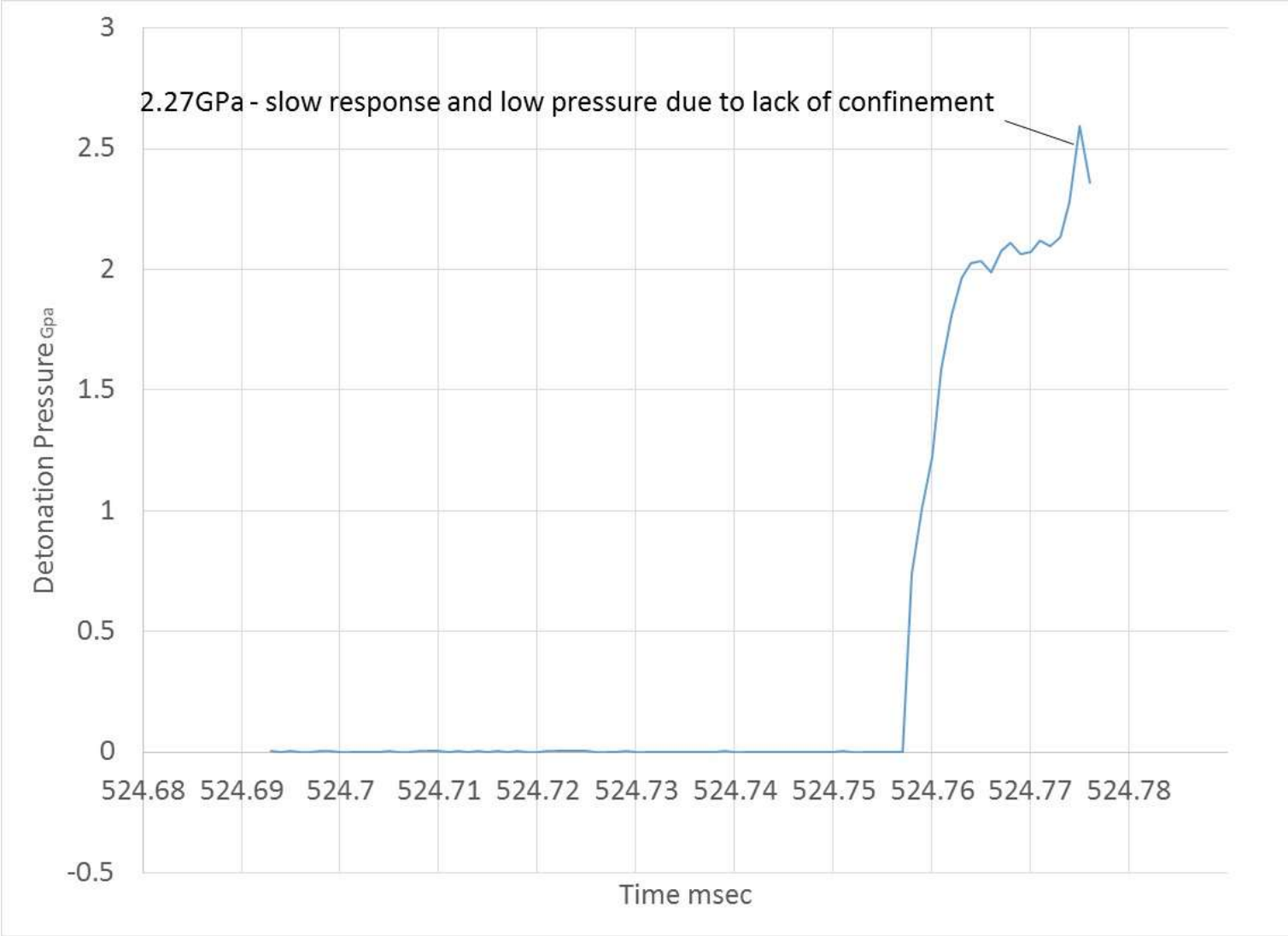
Signals recorded from sensor channel 1



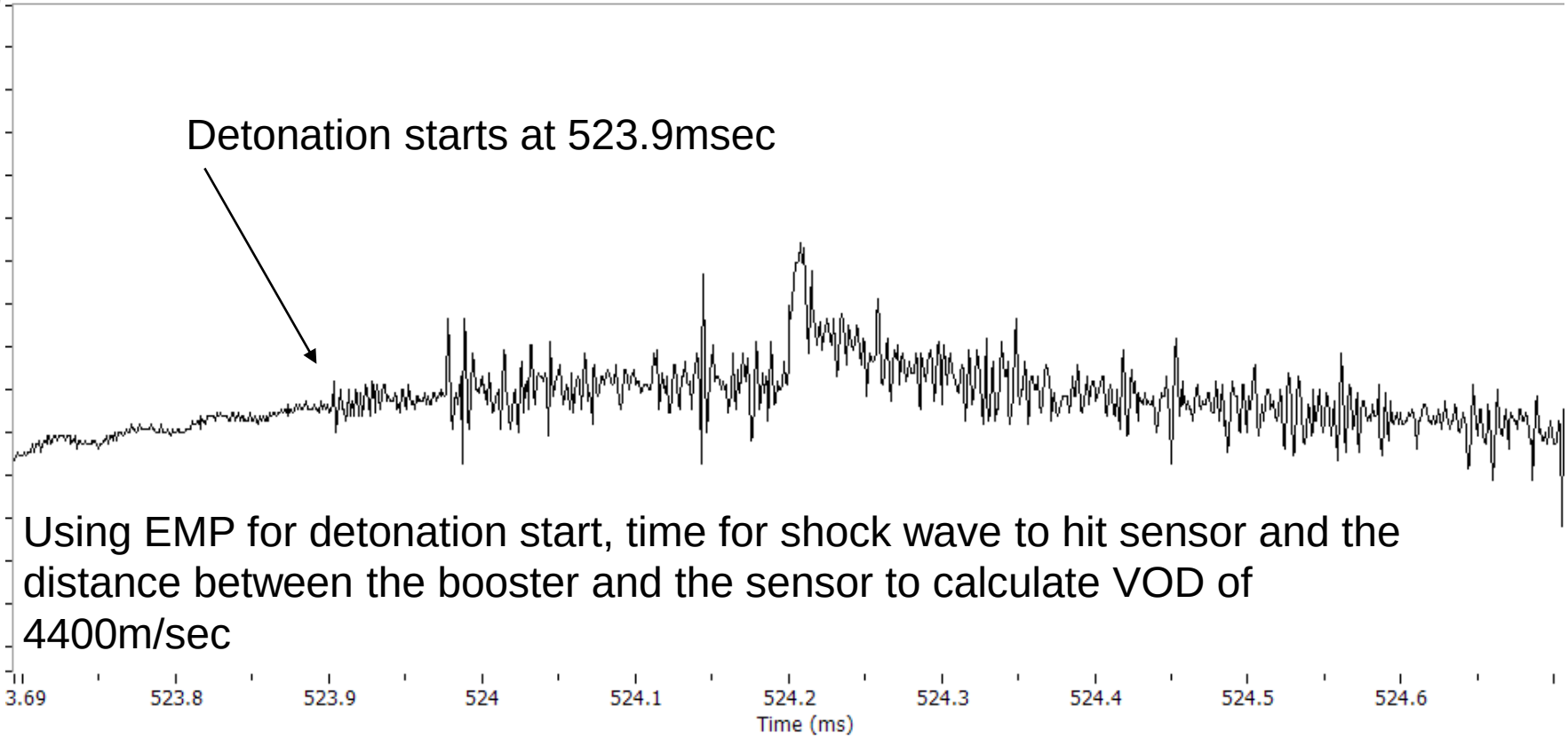
Signals recorded from sensor channel 2



Detonation Pressure (hole containing sensor)

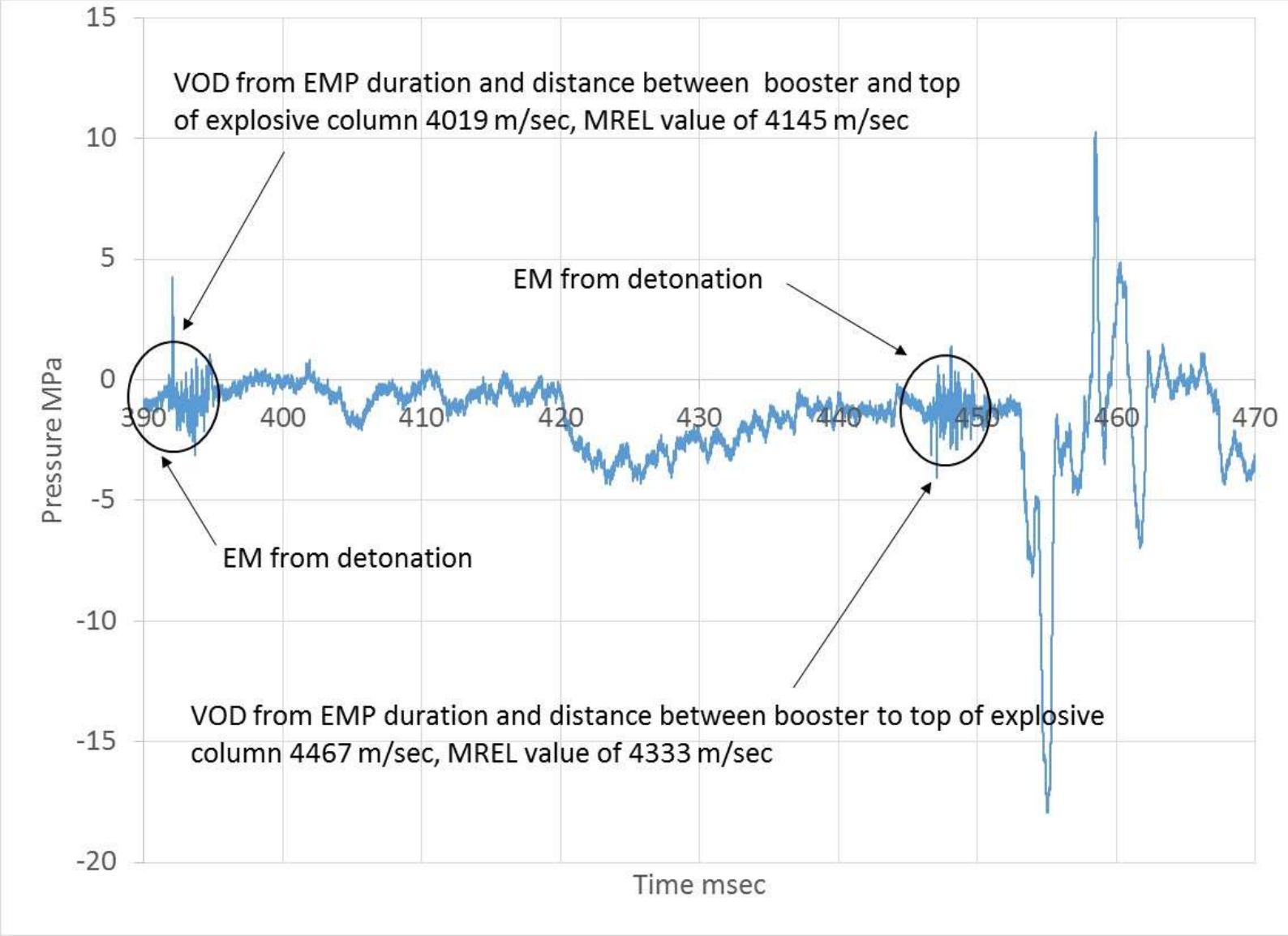


EMP (hole containing sensor)

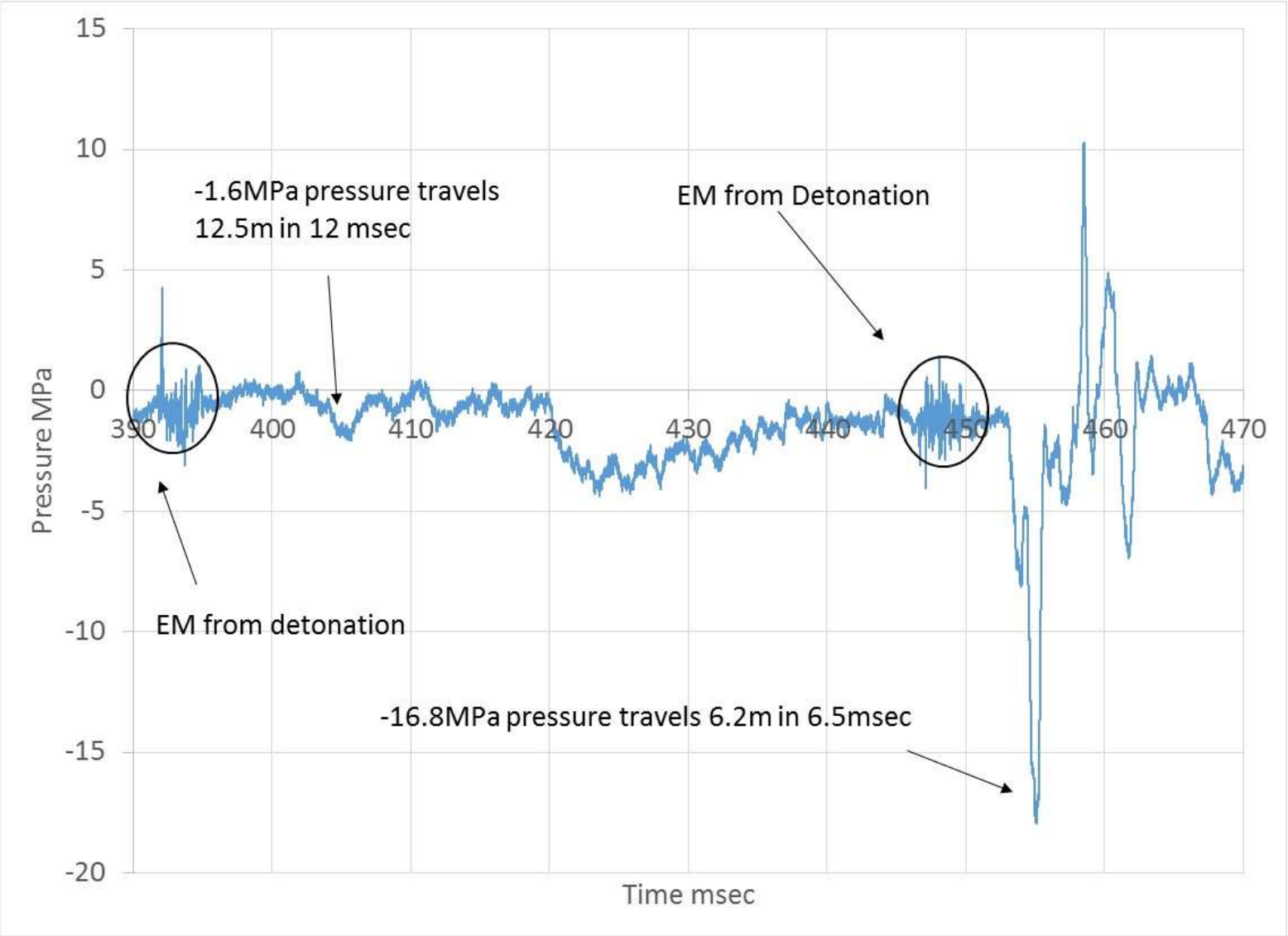


Using EMP for detonation start, time for shock wave to hit sensor and the distance between the booster and the sensor to calculate VOD of 4400m/sec

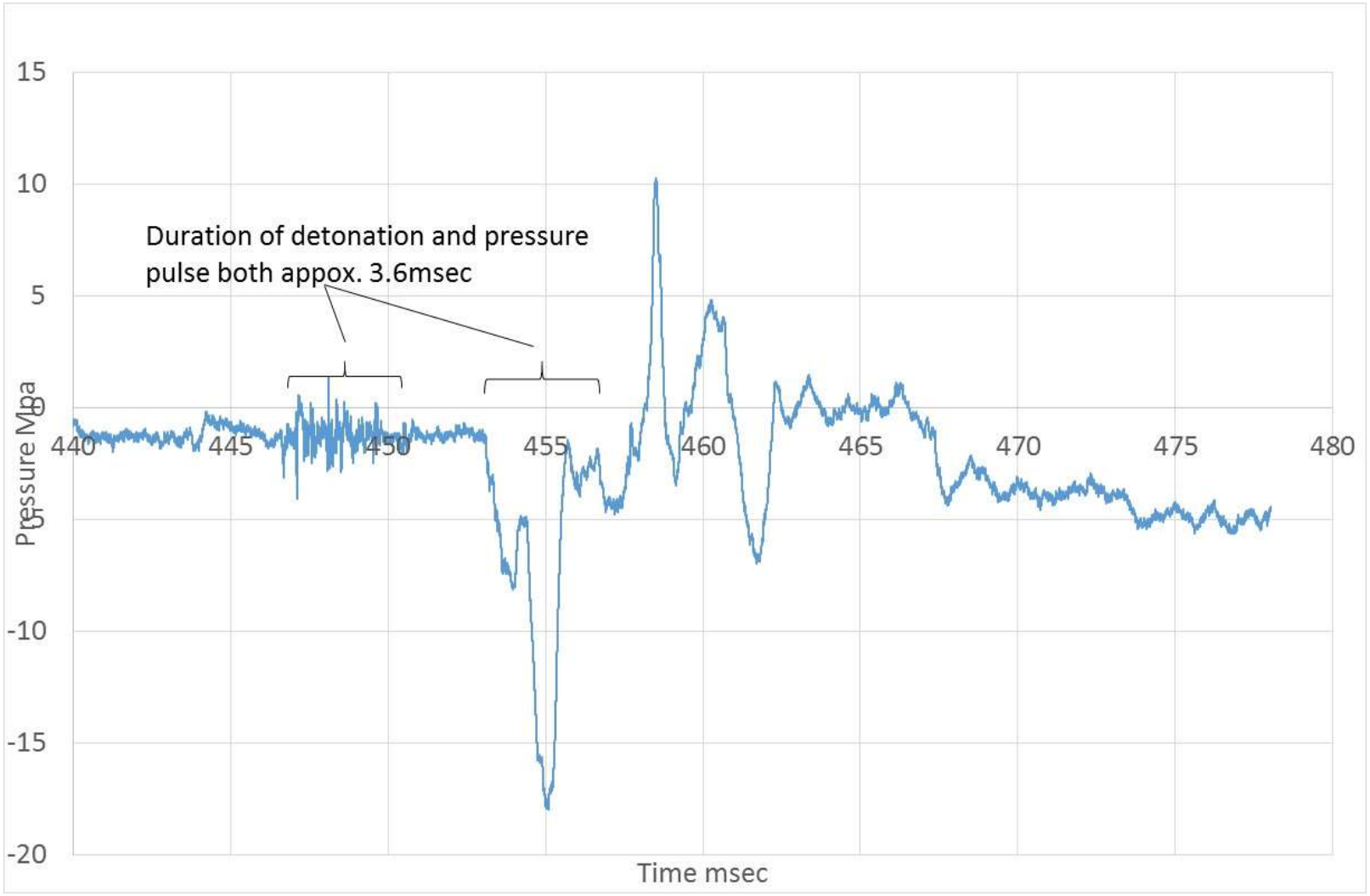
Signals detected from adjacent holes - VOD



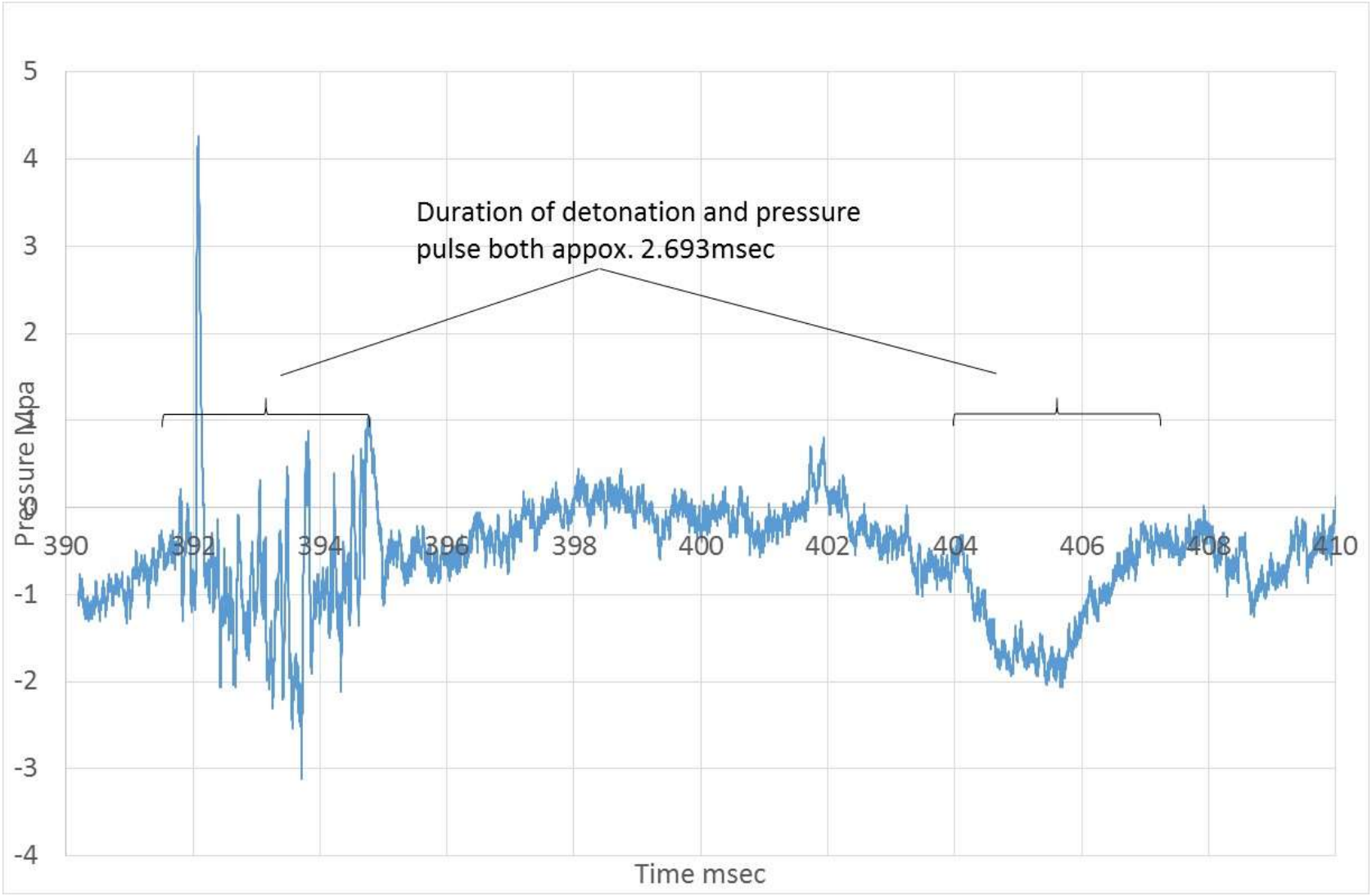
Signals detected from adjacent holes – pressure induced from adjacent holes



Signal from hole at 6.2m

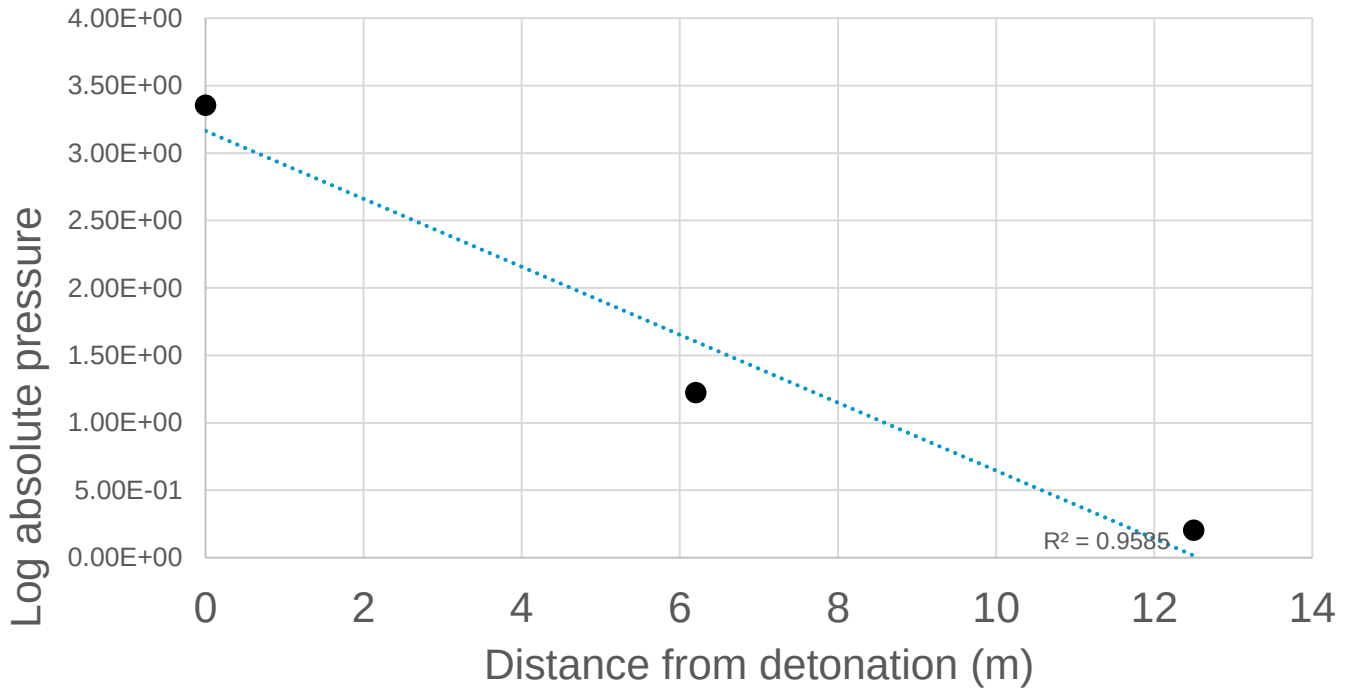


Signal from hole at 12.5m

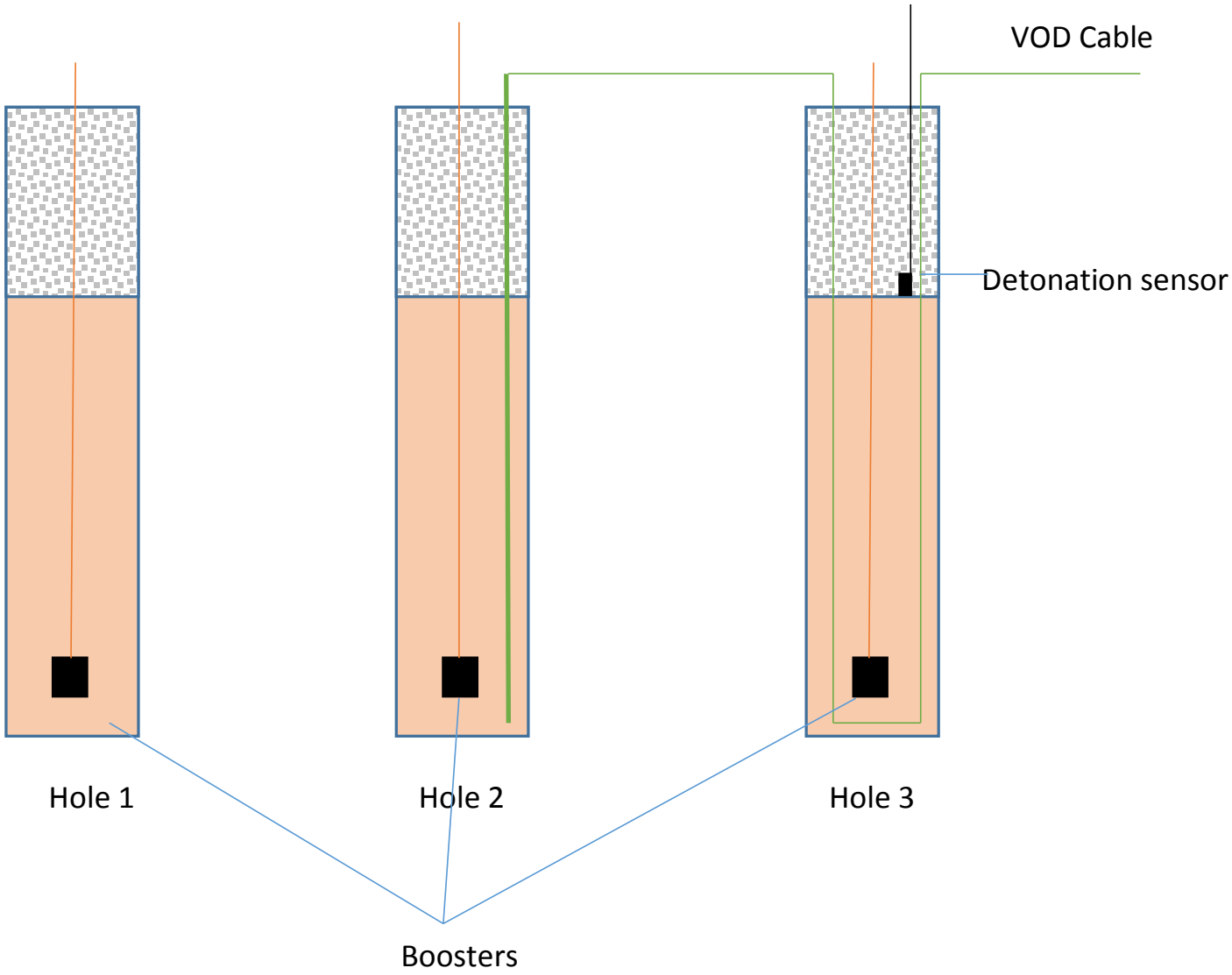


Propagation of pressure (from this test)

- The pressure travels at approx. 1000m/sec
- The equation is:
- Abs(Log(pressure))= Log(Det Press) – 2.7xLog(metres)
  and the period is 2 x detonation time.



Test Equation on another blast in soft ground with same order of velocity of propagation



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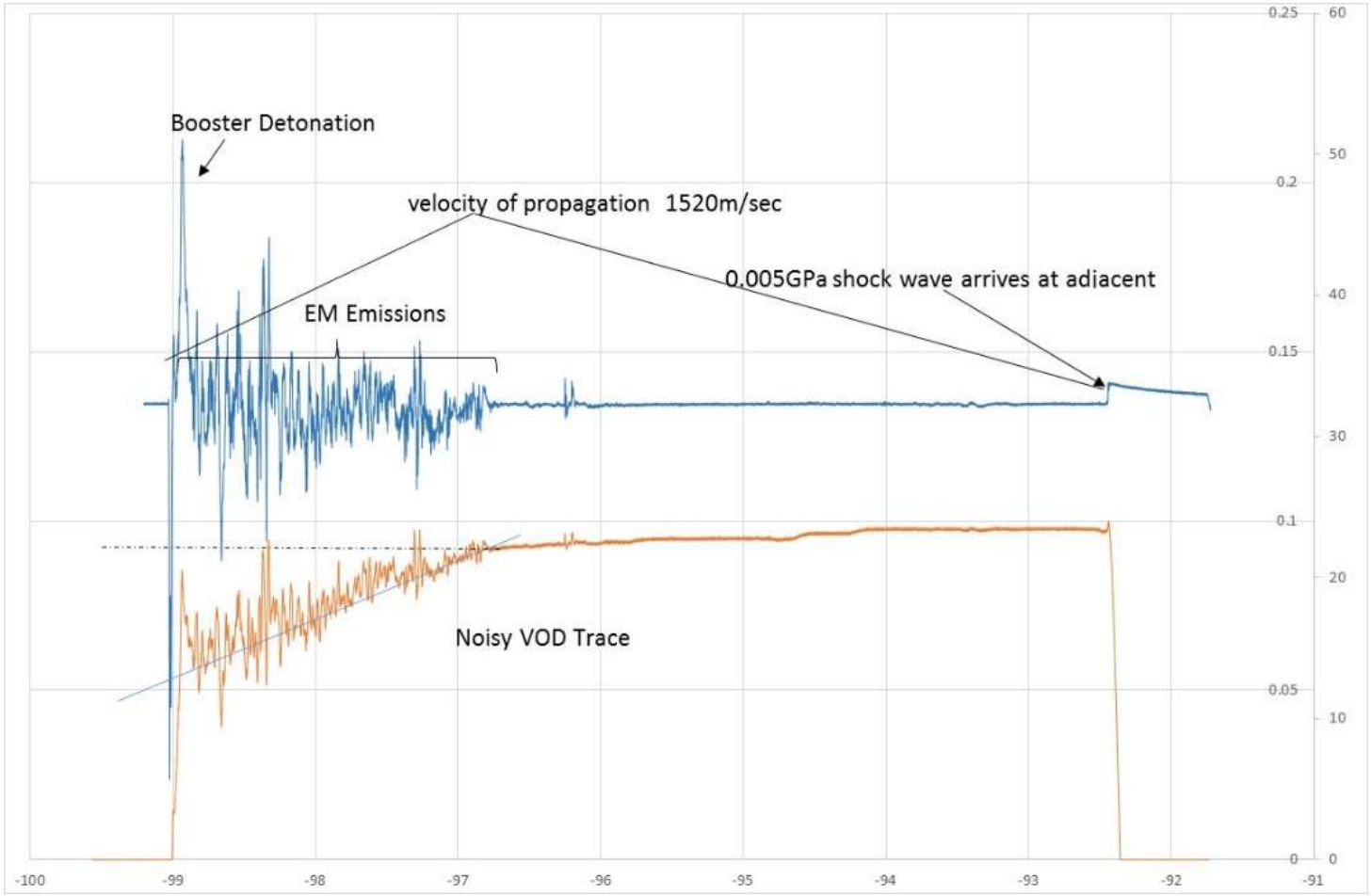


Calculated pressure

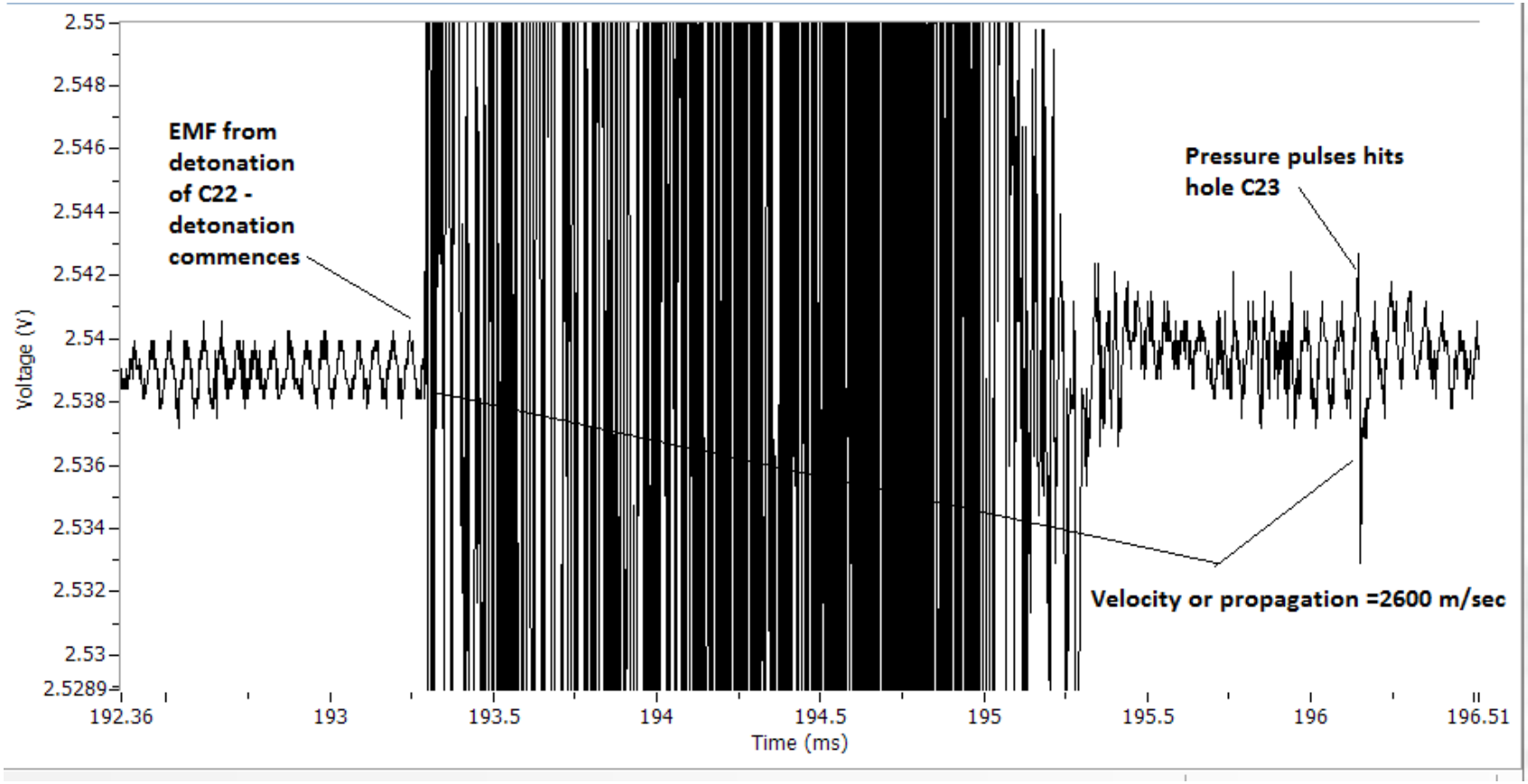
- Measured detonation pressure 1.6GPA
- Pressure measured at 10m 0.005GPa

Calculated pressure= log(1.6)- (2.7x log(10))

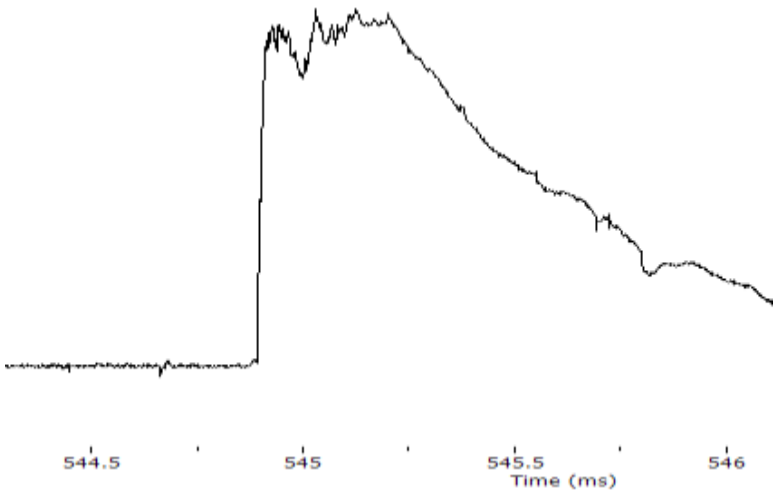
==0.0033GPa

Could not measure the duration due to lack of an amplifier

Does not work in competent ground with higher velocity of propagation- equation needs a velocity term?

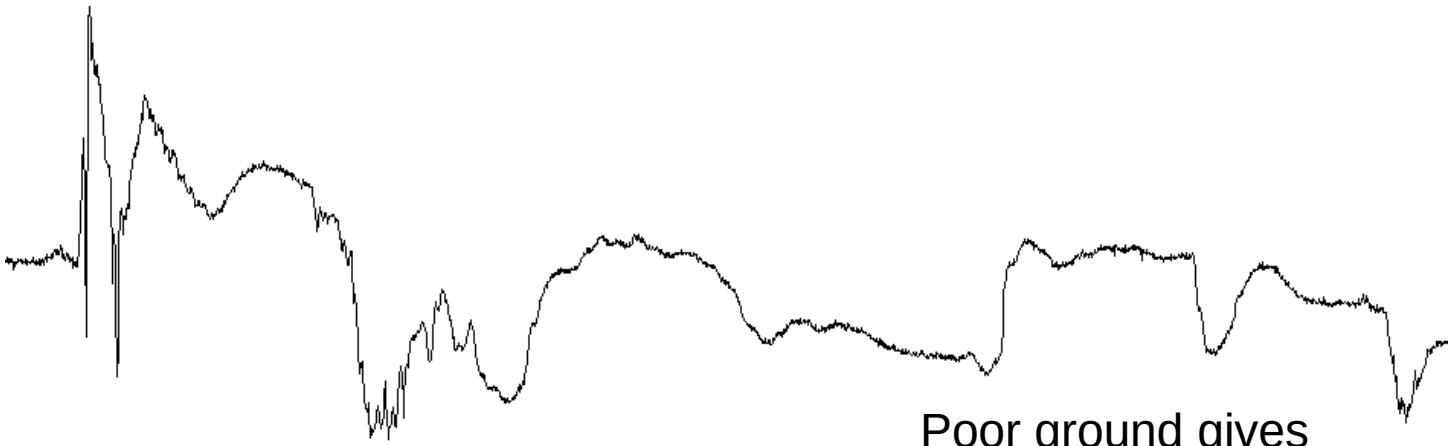


Pressure <1m from the blast and directly coupled in competent ground



Competent ground holds- approx.max 100MPa

Pressure <1m from the blast and directly coupled in not competent ground – is this the source of the stress wave that cause back break



Poor ground gives negative pressure due to ground failure – approx. max 50MPa

Future work

- Ground breaks more easily in tension:

  a tensional force of 20MPa can be equivalent to

  a compressional force of >>100MPa.

- Is negative pressure a factor that induces back break?

- Can the negative pressure be illuminated by lower VOD, lower energy or appropriate timing to prevent back break?

- Need to measure the pressure amplitude and velocity

Look at impedance matching (Persson, et al.,1994)?

PeCd =Zr PrCp

Where: Pe = explosive density; Cd = VOD of explosive; Pr = rock density; Cp= P-wave velocity; and Zr = impedance ratio.

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Thank you