Drag Loading in Vented Gas Explosions

2017 UK Explosion Liaison Group Meeting at Spadeadam

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Test Requirements

- Commissioned for a gas explosion test
  - Jacketing PFP Product
  - Offshore new build
- Required blast properties
  - 2 bar overpressure
  - 0.5 bar drag loading

Image: Jacket for an Acoustic Solution. Unknown Manufacturer

Standard Blast Testing

- Spadeadam Explosion Chamber
  - 4.5 m x 4.5 m x 9 m
- Typical Requirements
  - 0.2 to 4 bar overpressure
- Drag requirements are complicated
  - Experimental configuration requires input from CFD
- Cannot measure drag directly

Drag

What is meant by drag

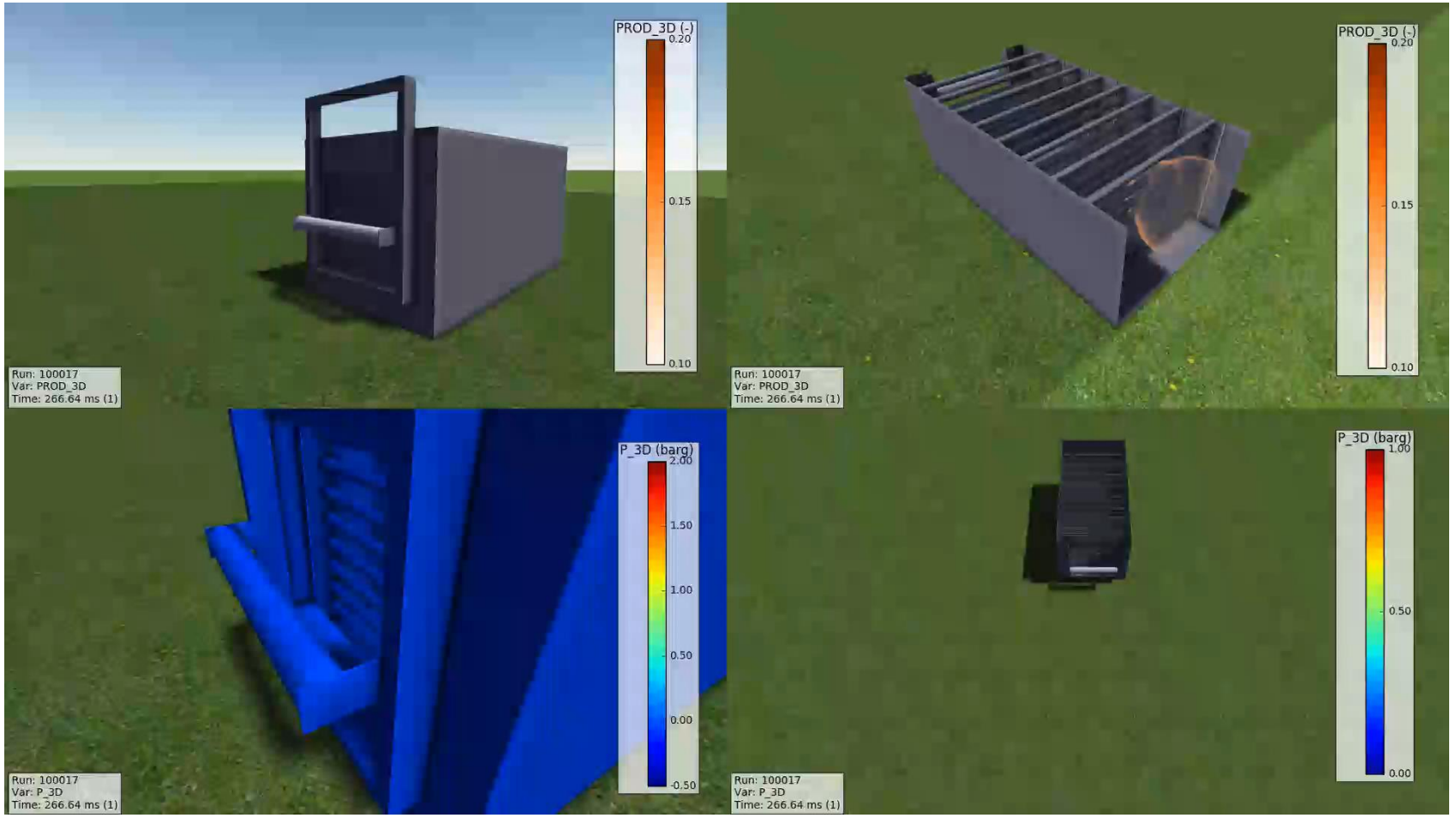
- Drag requirements come from explosion CFD studies
- FLACS provides 'Drag' as a parameter which is a property of the flow
- Not a drag load onto any particular item

Experimental requirements

- Need to generate high flow speeds
    - In vicinity of explosion chamber vent
- Presence of test specimen alters flow field
- No reliable way of measuring drag and/or flow velocity

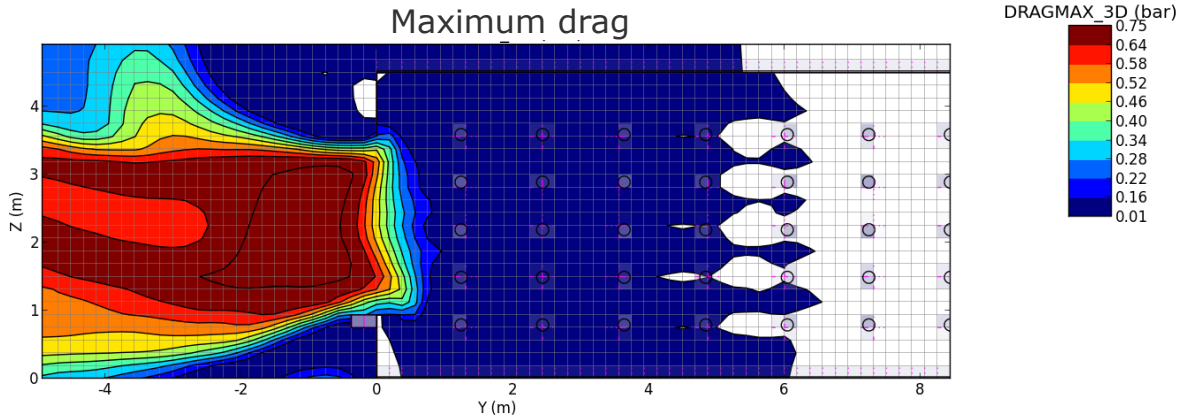
Modelling Gas Explosion in FLACS

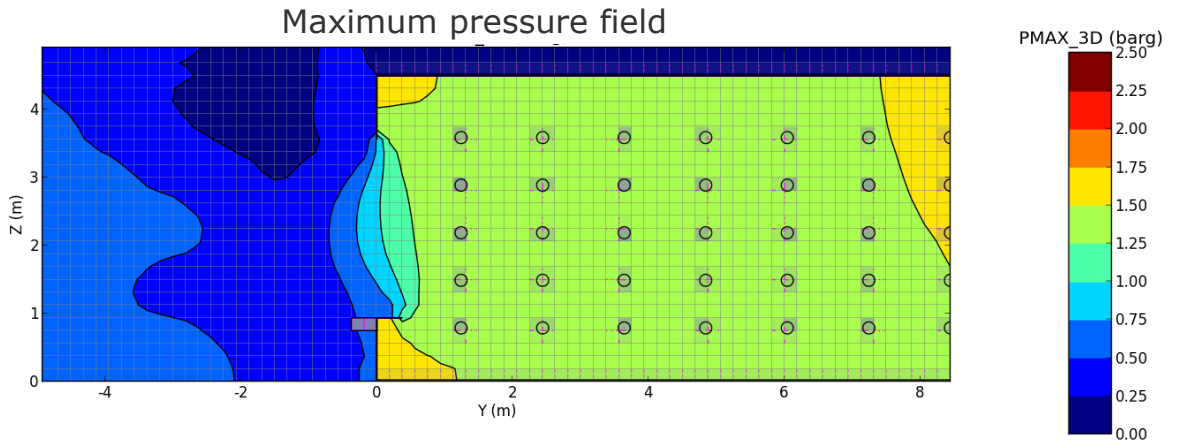
- Design experimental configuration in FLACS
  - Measure overpressure
  - Assume drag property fulfilled if predicted & measured pressures were similar
- Experimentally viable variables
  - Fuel-air ratio & ignition position
  - Amount of congestion inside the chamber
  - Size of vent opening
  - Position of test specimen relative to the vent



Drag and Pressure

- Predictions show that:
  - High drag forms at location outside the explosion chamber
  - High pressure forms at locations inside the explosion chamber
  - Rapidly changing velocity field in the locality of the vent
- Ideal sample location:
  - Outside chamber for high drag
  - Inside chamber for high pressure



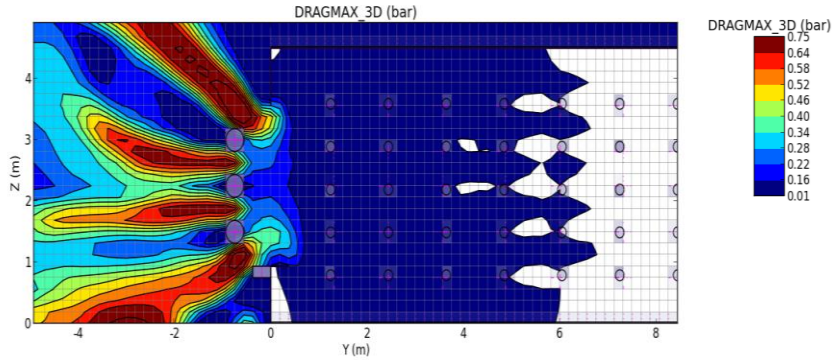


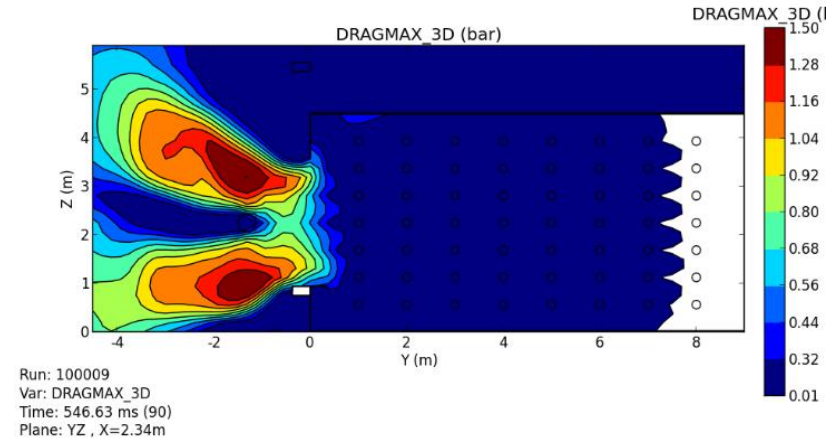
Vent coefficient Ka = 2.9. No. pipes = 35

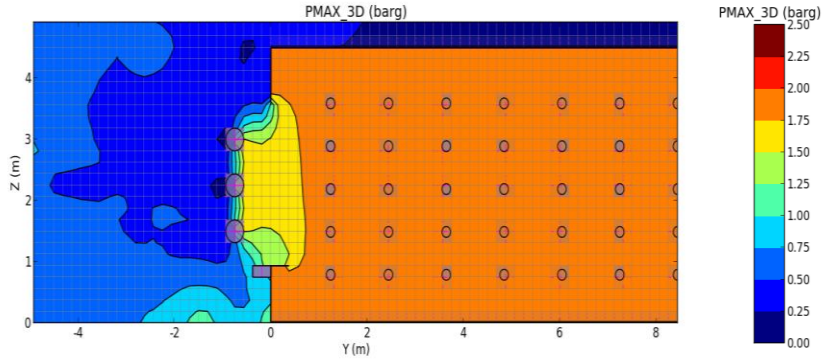
Number of Samples and Location in Vent

- Number of samples in vent
  - 2 or 3 samples in vent prevent formation of sufficient velocity field
- Location of sample in front of vent
  - Inside vent prevents formation of velocity field
  - Inadequate pressure on pipe 1.5 m outside vent
  - 1.0 m from vent is a good compromise

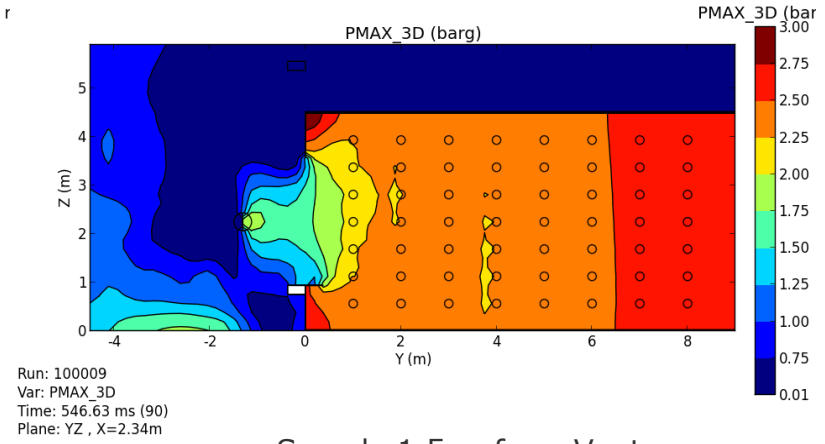
Drag & Pressure Field – Sample at 1.5 m and 3 samples at 1.0 m







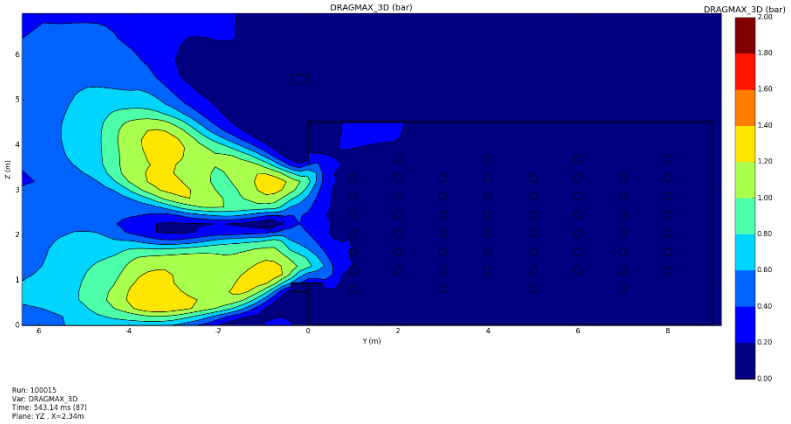
3 Samples in Vent

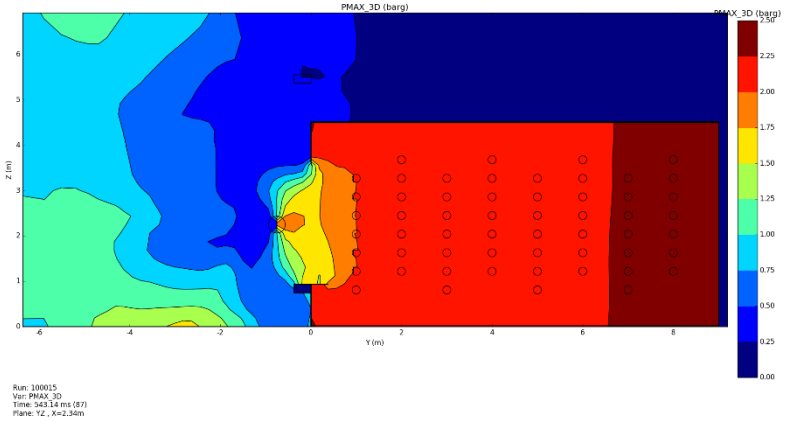


Sample 1.5 m from Vent

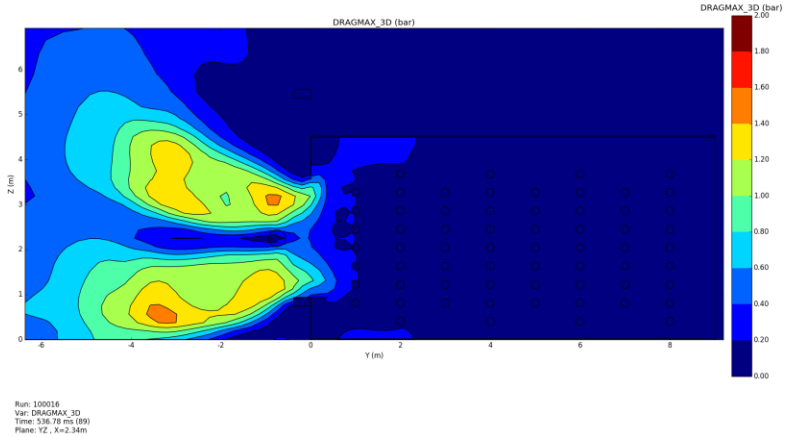
Final Configurations

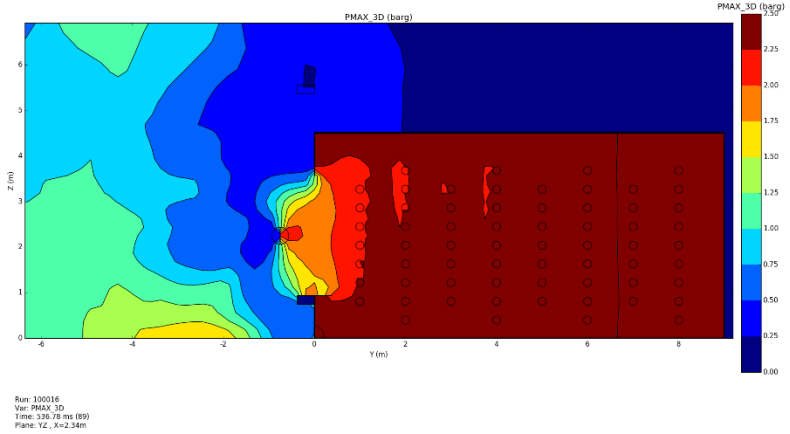
56 Pipe Predictions



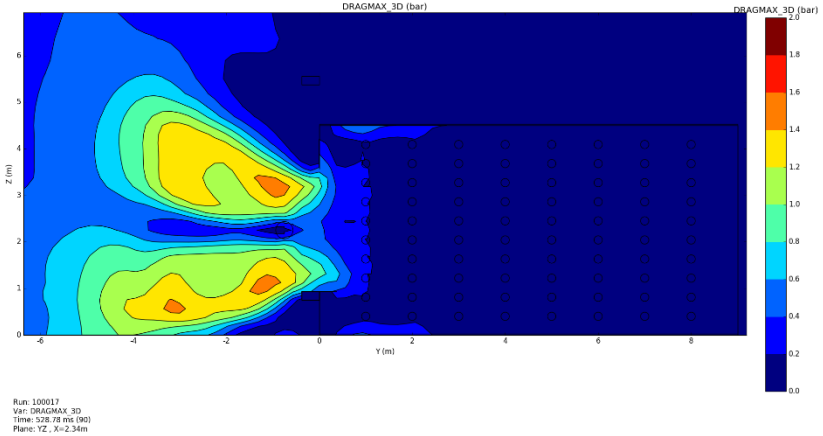


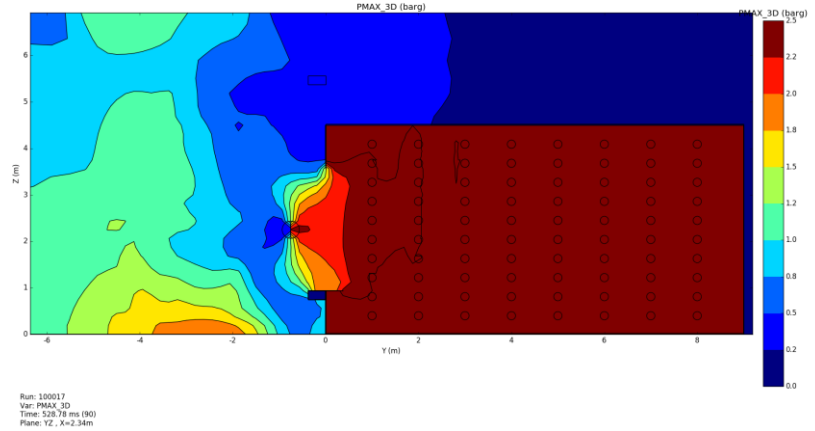
64 Pipe Predictions





80 Pipe Predictions

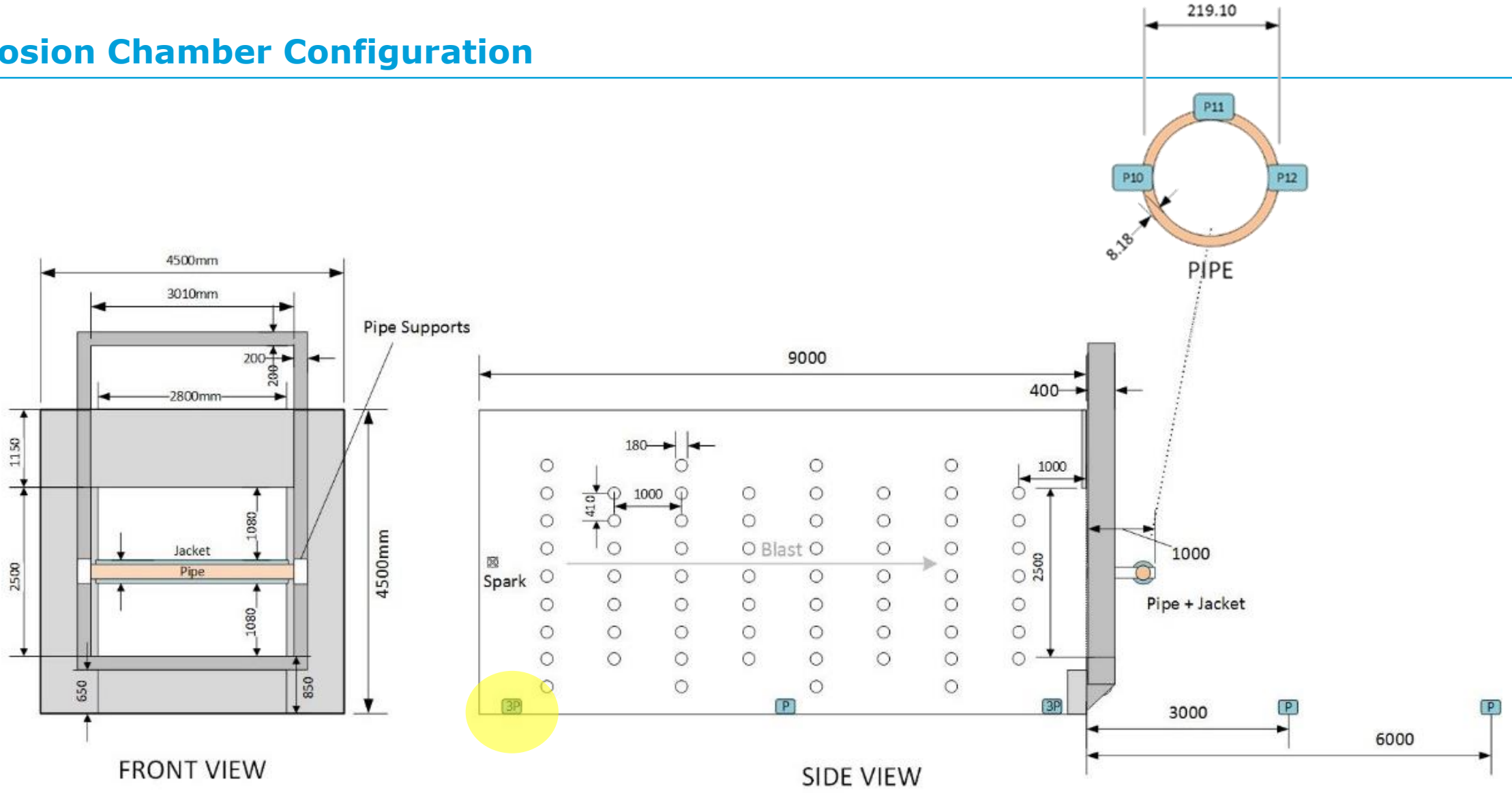




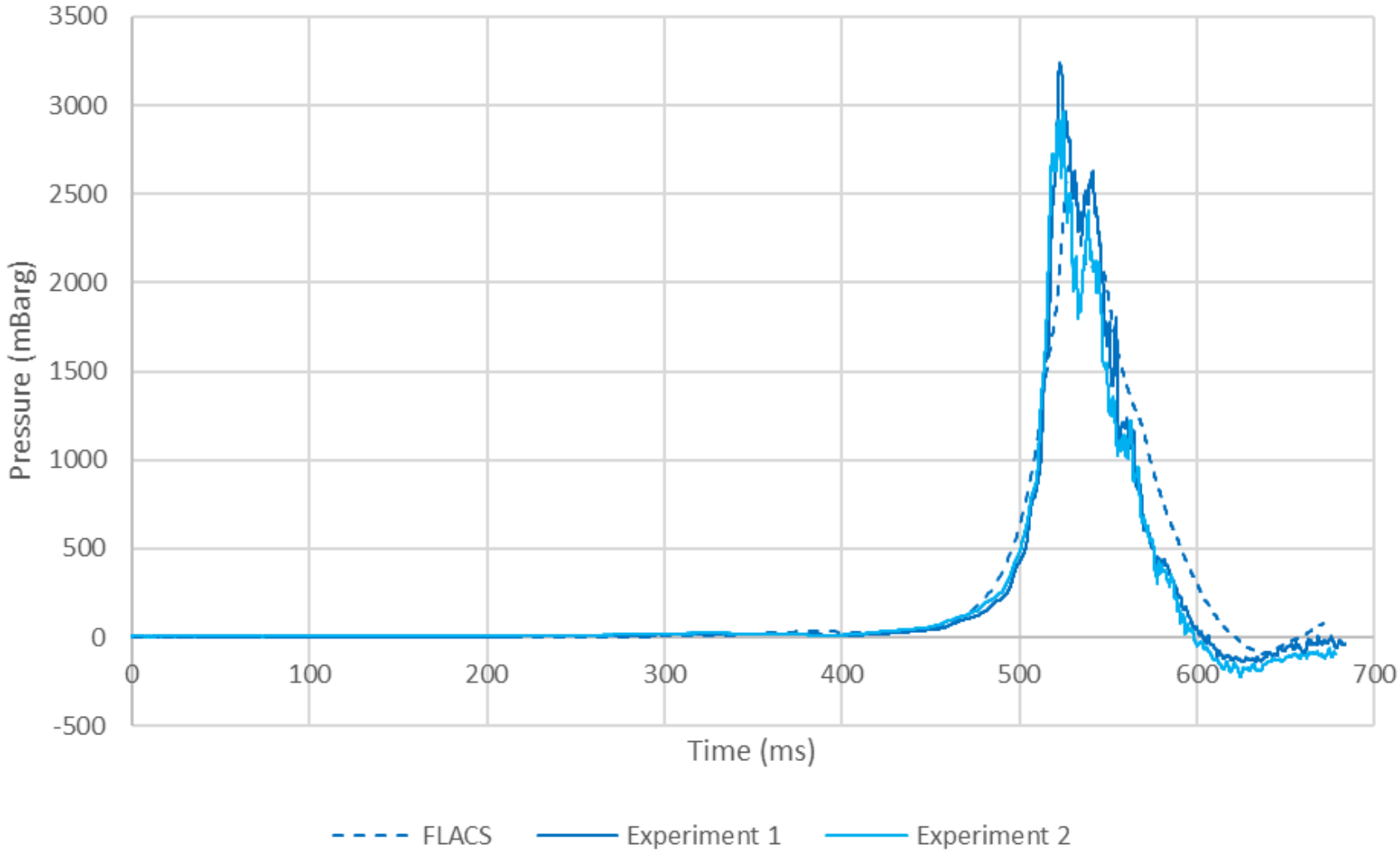
Example Video # 1

Example Video # 2

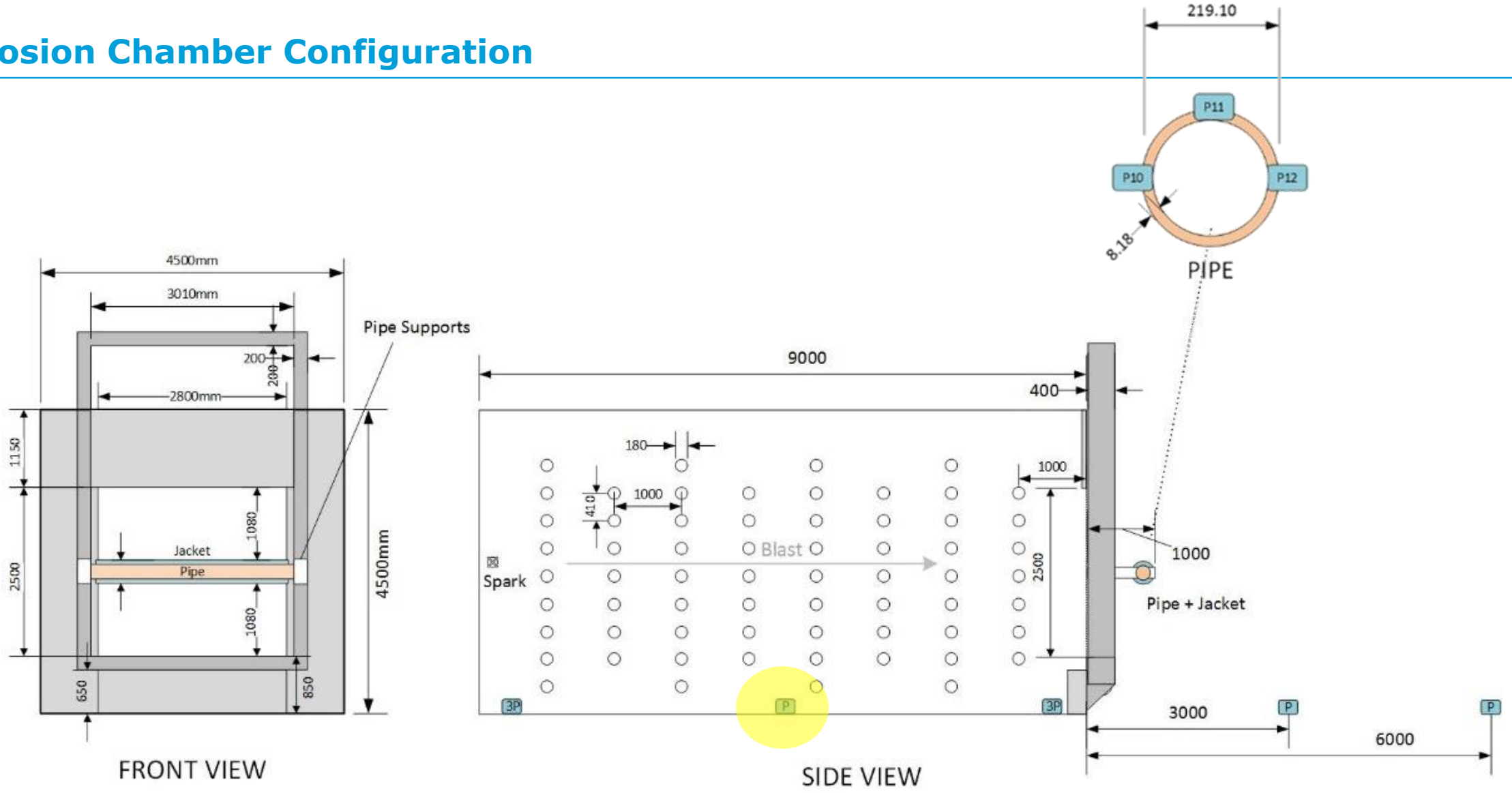
Explosion Chamber Configuration



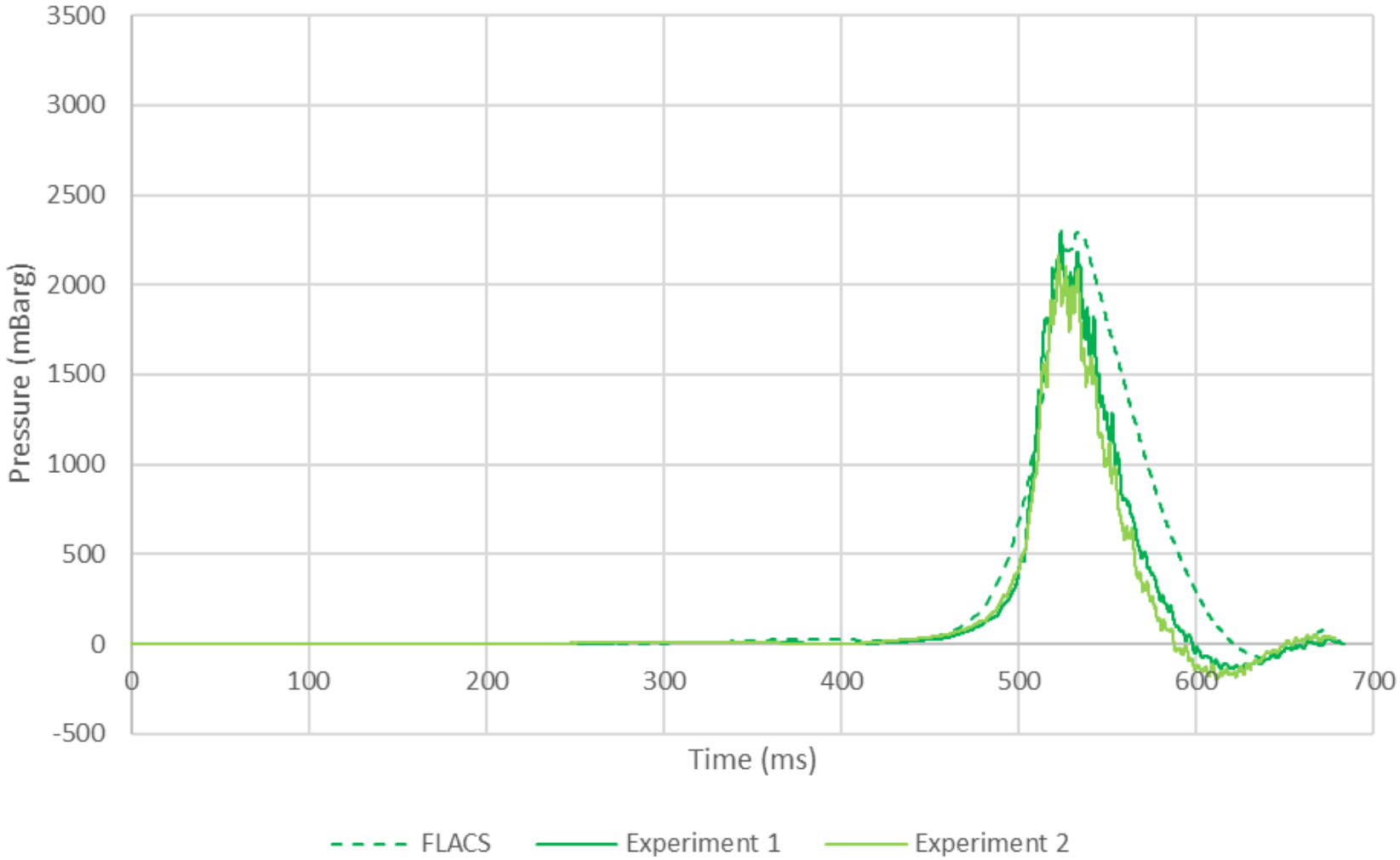
Model Prediction vs Experimental Measurement – Rear of Chamber



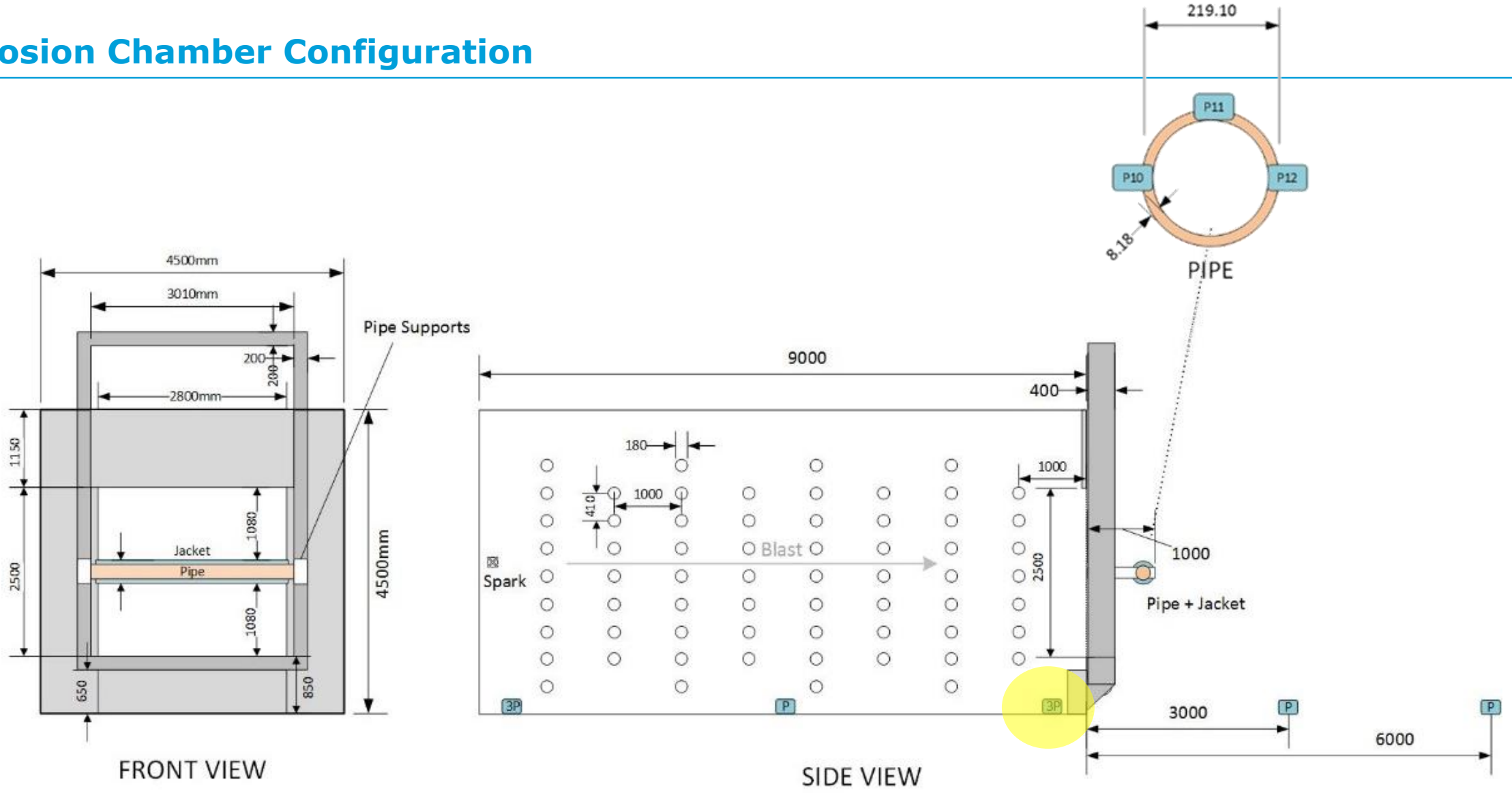
Explosion Chamber Configuration



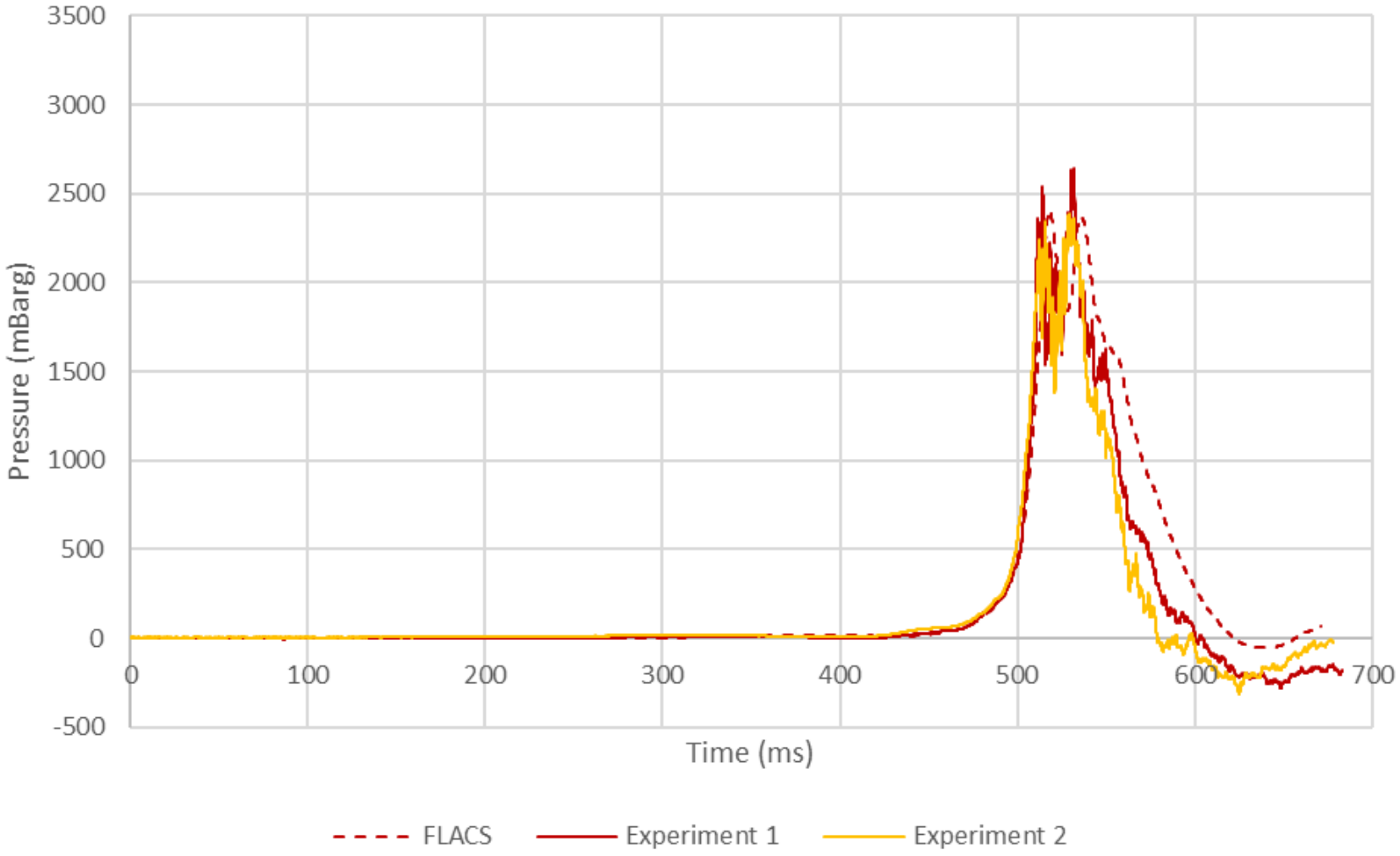
Model Prediction vs Experimental Measurement – Middle of Chamber



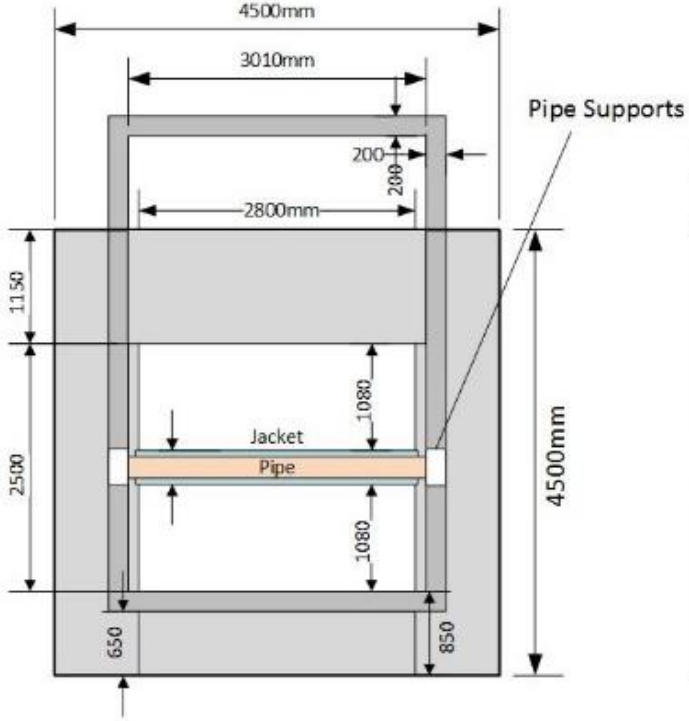
Explosion Chamber Configuration



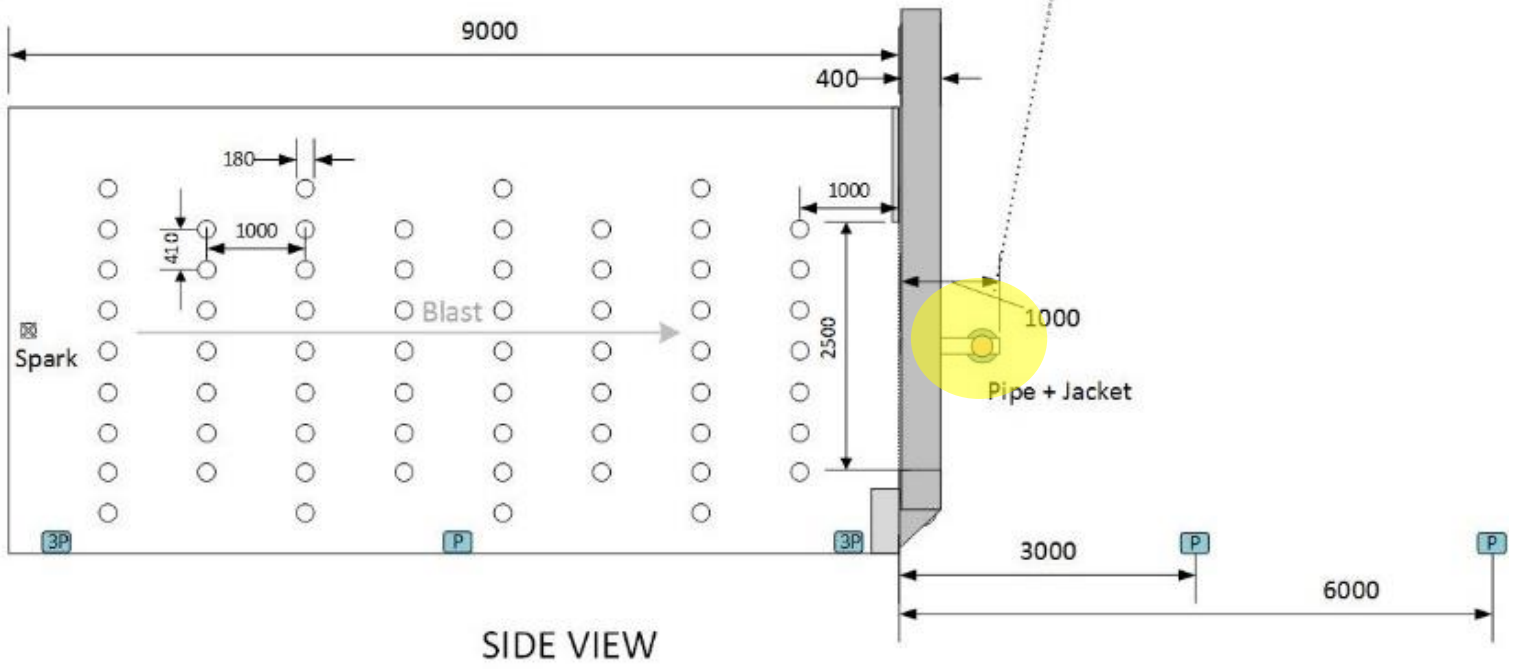
Model Prediction vs Experimental Measurement – Front of Chamber



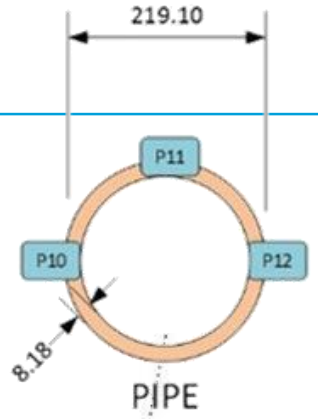
Explosion Chamber Configuration



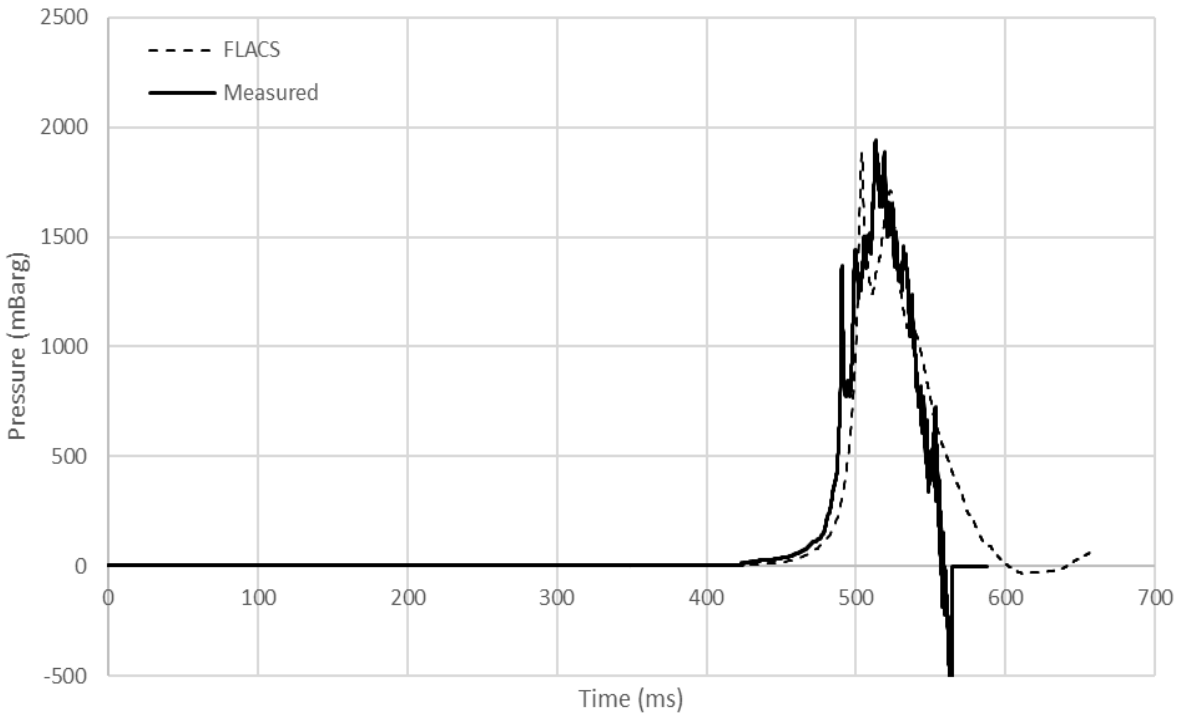
FRONT VIEW

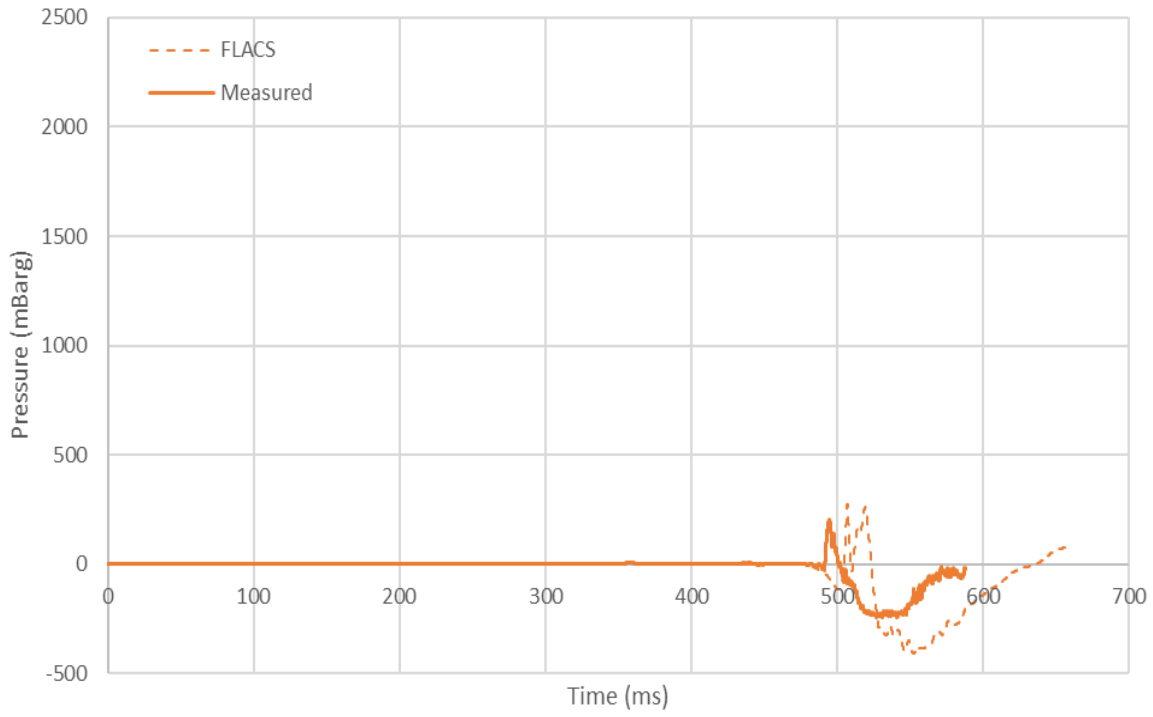


SIDE VIEW

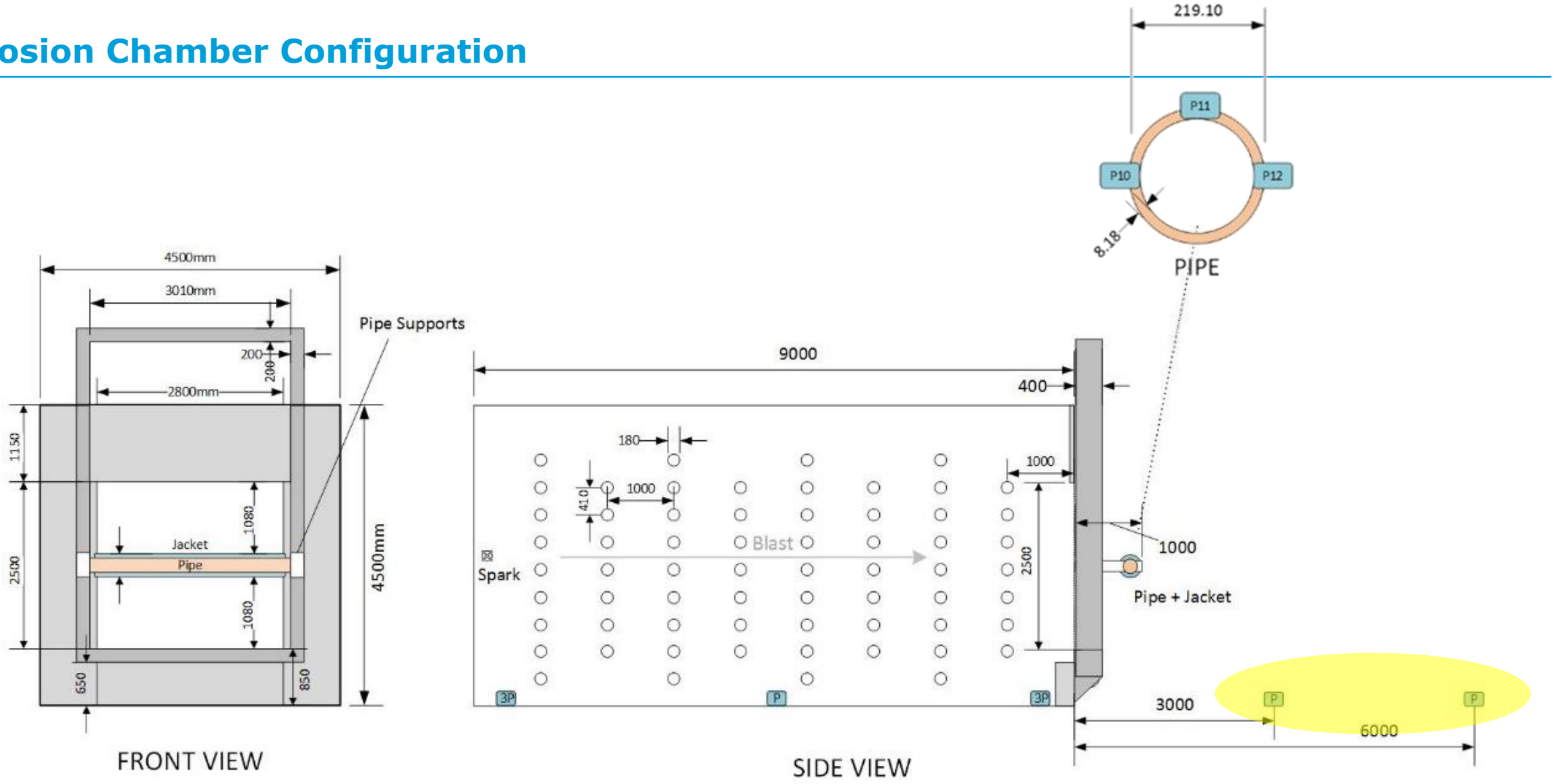


Model Prediction vs Experimental Measurement – Front and Back of Pipe

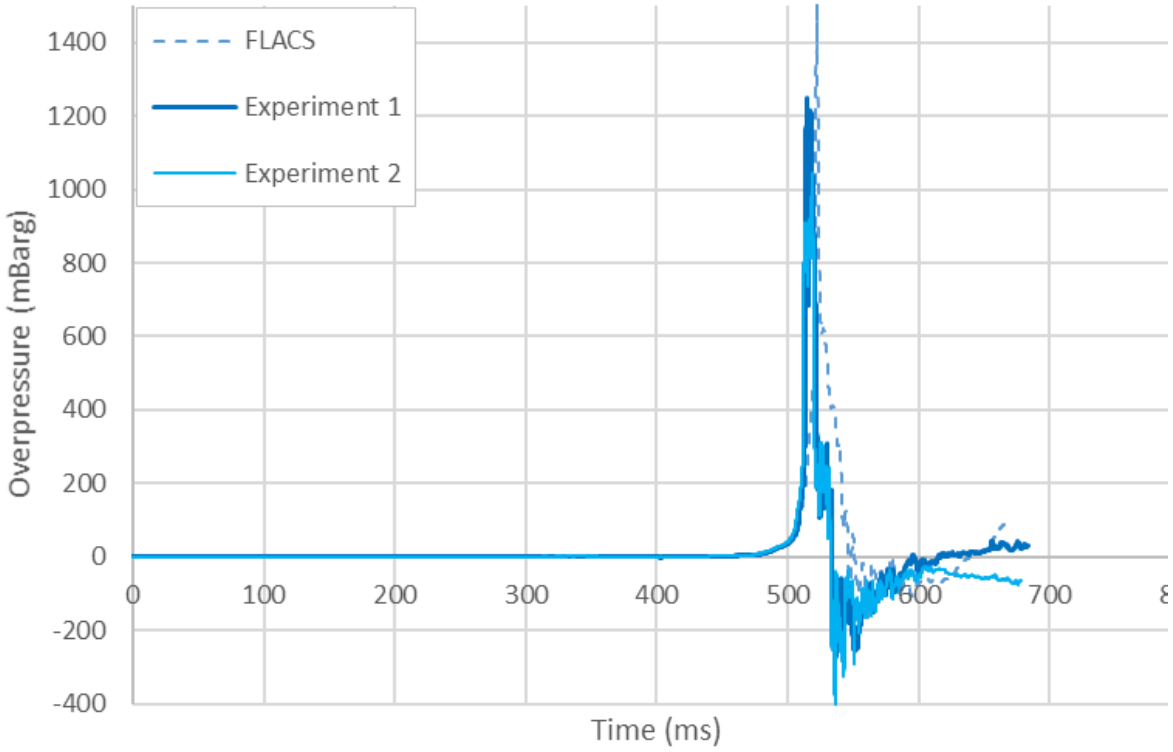


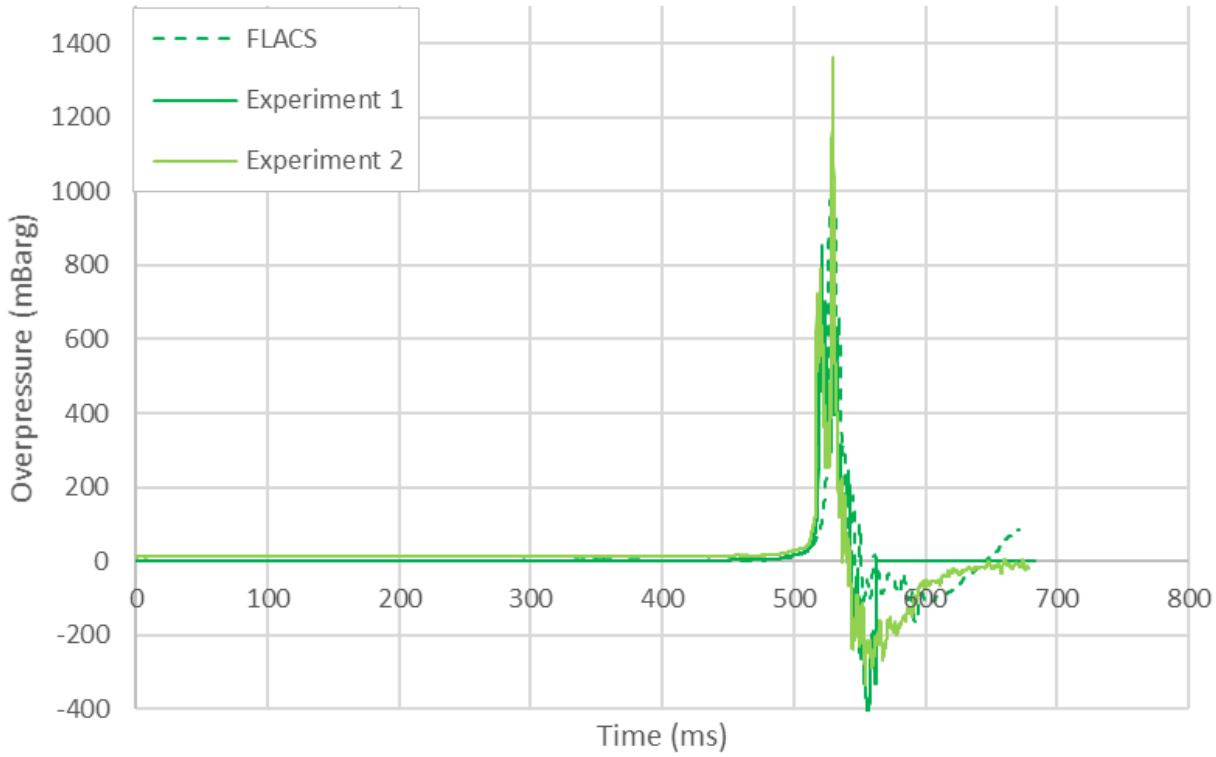


Explosion Chamber Configuration

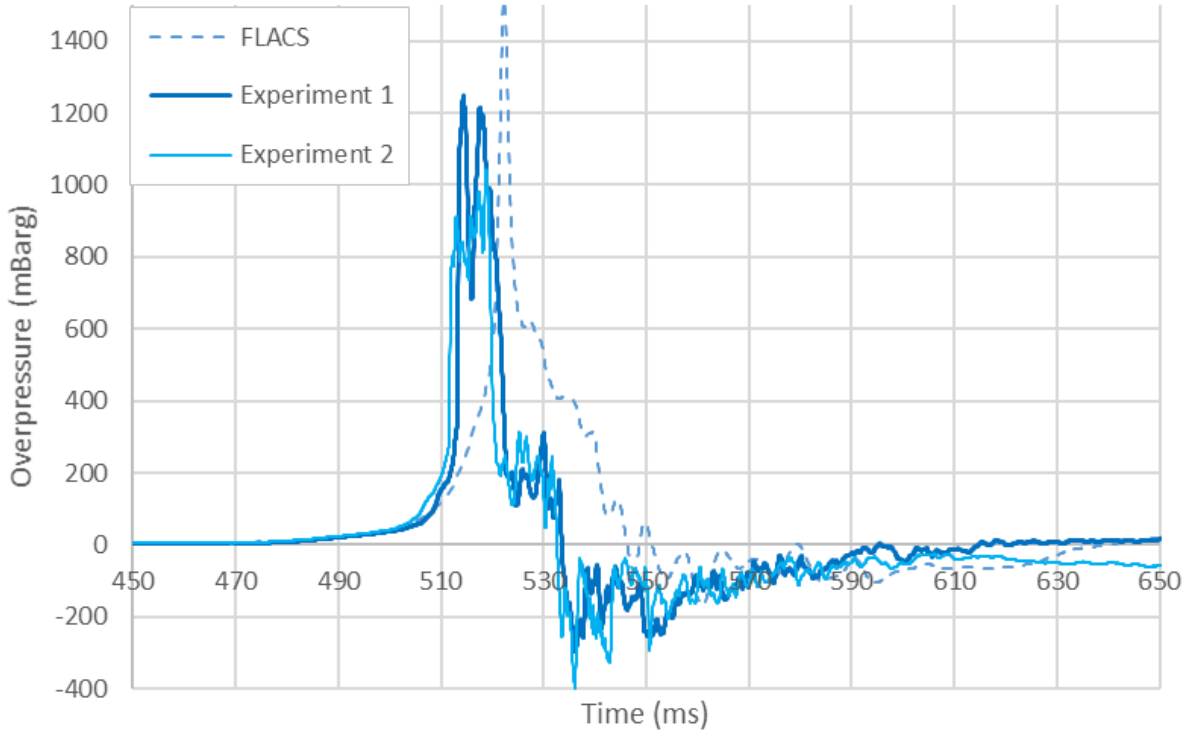


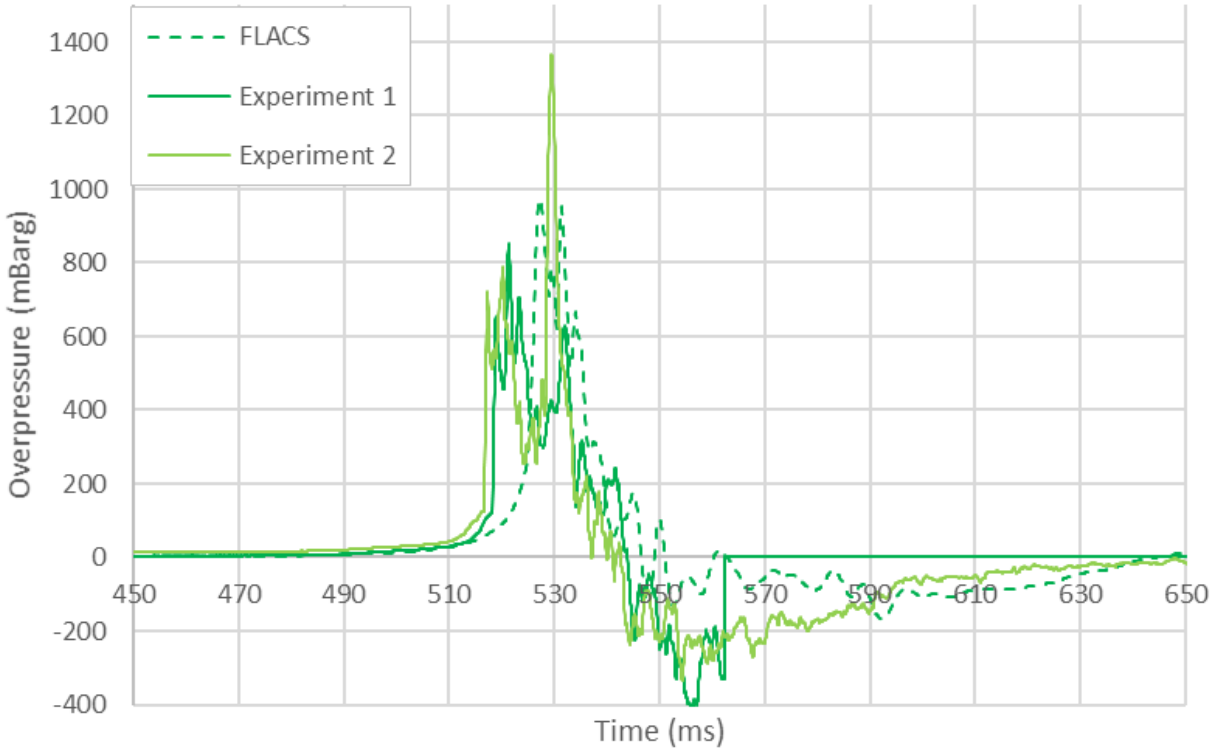
Model Prediction vs Experimental Measurement – Outside Explosion Chamber





Model Prediction vs Experimental Measurement – Outside Explosion Chamber





The End

Any Questions?

CFD Predictions – Test Configuration