TES Technical Enabling Services

The Use of Numerical Simulation in the Defence Ordnance Safety Group

Dr Ian Barnes

Head Ordnance Risk Assessment (DOSGST2)

dosgst2@dpa.mod.uk

DOSG DEFENCE ORDNANCE SAFETY GROUP

DPA DLO Working together to deliver capability

AIM

To give an overview of the use of numerical simulation in the MoD explosives risk and effects community

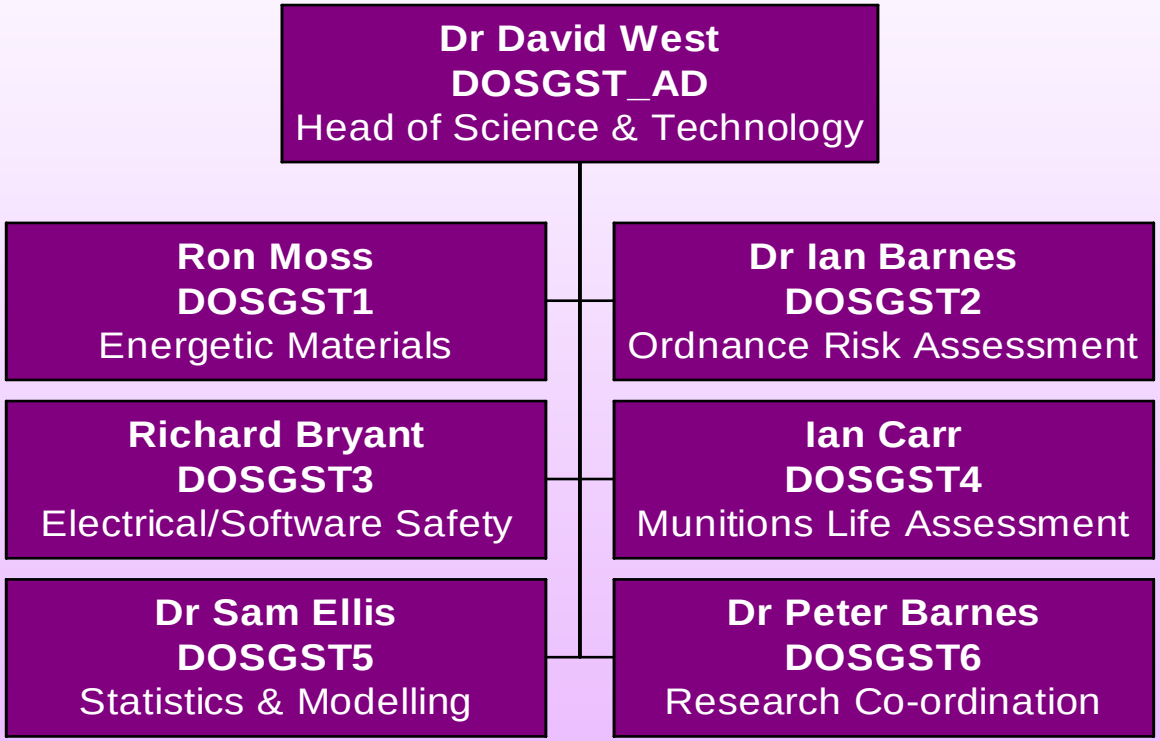
DOSG MISSION

To be the Department's focal point for Ordnance, Munitions and Explosives (OME) Safety, providing policy, advice and regulatory functions on behalf of Secretary of State and to monitor Departmental performance to provide assurance on OME safety to the Secretary of State

MAIN DOSG ROLES

- OME safety Policy and Standards
- Advise Duty Holders on the OME Safety Management System and on the Safety and Suitability for Service of weapons and explosives
- Advise on matters affecting the safe use of weapons, explosives and other hazardous stores in training or operations
- Regulate and advise on safe storage, handling and transportation of explosives

SCIENCE AND TECHNOLOGY



SCIENCE AND TECHNOLOGY

DOSGST2

9 Posts.

Provide advice and technical support on safety cases, risk assessment, risk management tools.

Expertise in risk reduction measures e.g. mitigation techniques.

DOSGST5

5 Posts.

Provide advice on mathematics, statistics, ballistics, numerical modelling and explosives trials.

NUMERICAL SIMULATION

Philosophy

To improve our understanding of the physics and chemistry of explosives events in order to;

a) better predict the likelihood and consequences of accidents

b) inform development of policy and regulation

c) advise on possible solutions to safety concerns

NUMERICAL SIMULATION

Strategy

Limited In-House Capability - Intelligent Customer

Contract Support from Modelling Community

Work Areas

Physics of Explosions

Human Vulnerability

Structures Vulnerability

Prediction Tools

Risk Tools

Risk Analysis Support

Explosives Mitigation

PHYSICS OF EXPLOSION

e.g.

Physics and Chemistry of Detonation

Primary Weapon Fragmentation

Blast Shock

Combined Energy Partition (fragmentation/blast)

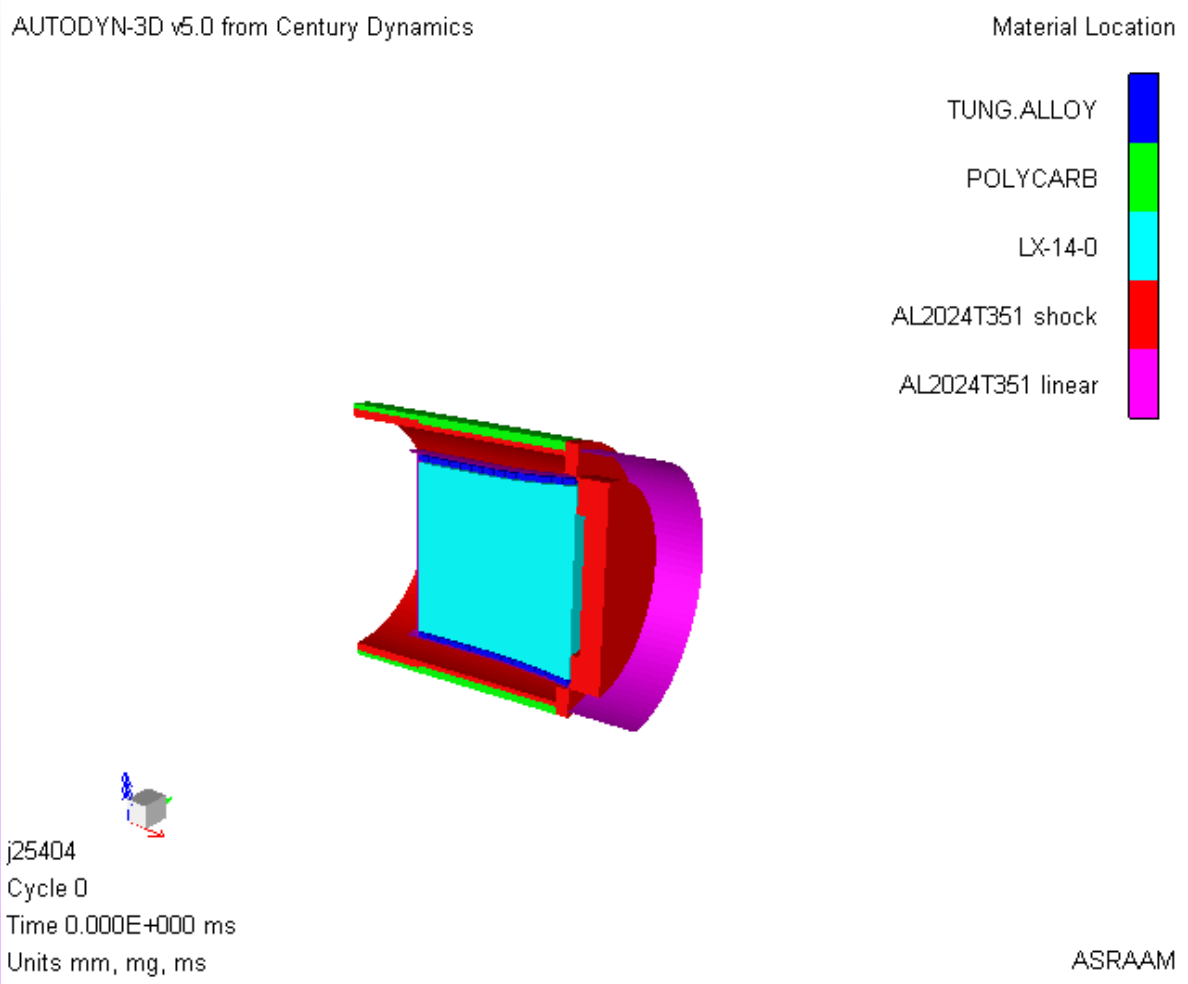
Secondary Fragmentation - Packaging/racking

Energy Partition for Stacks of Munitions (e.g. pallet of shells)

Shaped Charges

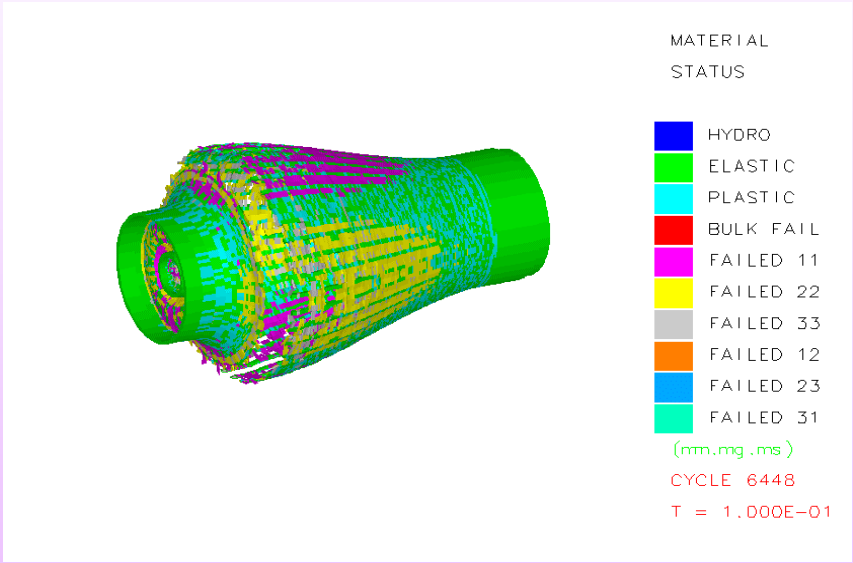
Thermal Effects

PHYSICS OF EXPLOSION

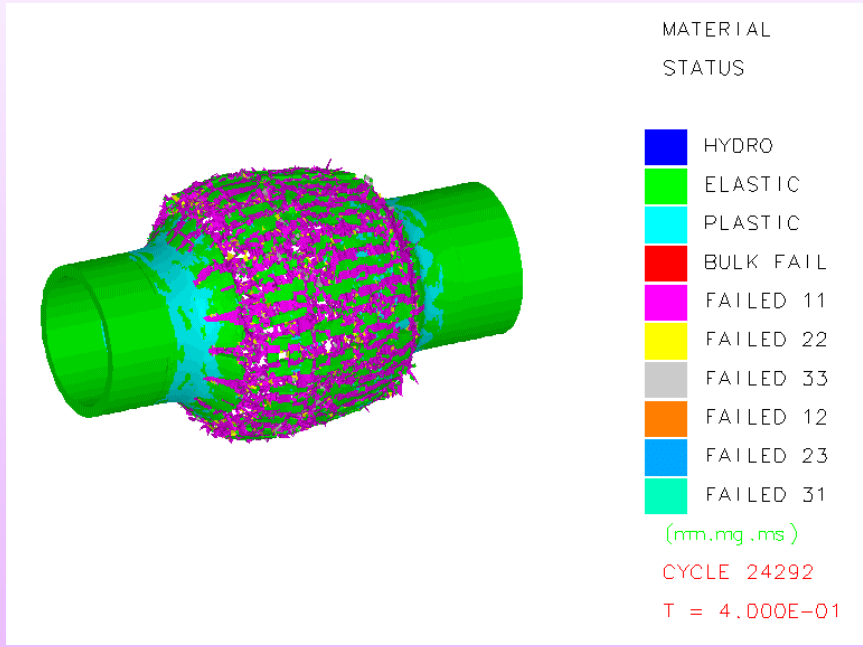


Pre-formed fragmentation Warhead

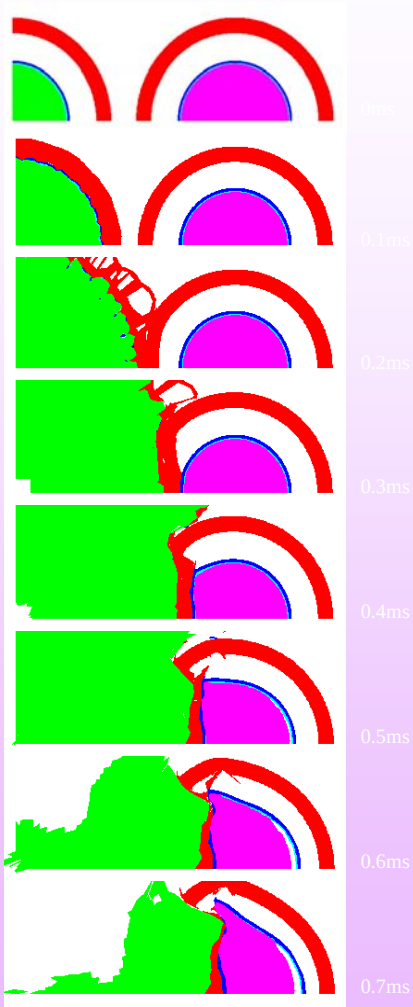
PHYSICS OF EXPLOSION

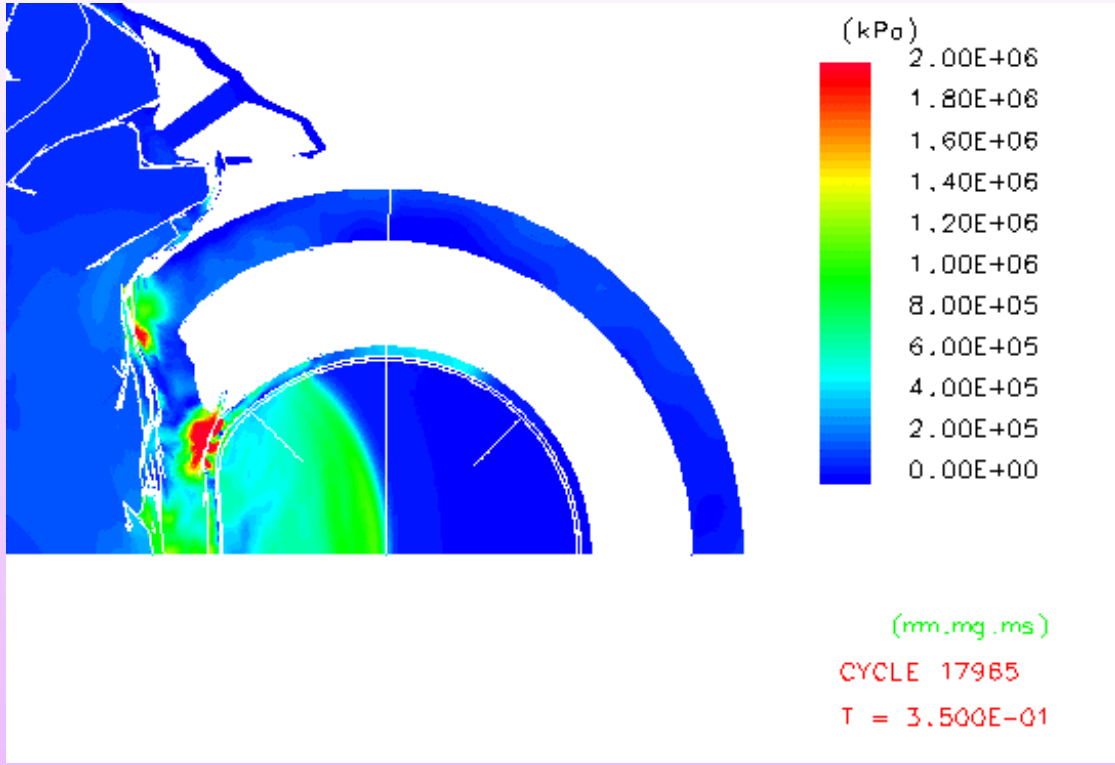


Naturally Fragmenting Casing



Stack Effects





Adjacent Fragmenting Warheads

Stack Effects

Adjacent Expanding Rings
(60% dia separation)

Stack of 5 Shells
(60% dia separation)

Effects in Stack
(60% dia separation)

Dutch 8" Shell Stacks

Horizontal Stack - Material Plot

Horizontal Stack - Pressure Plot

Vertical Stack - Material Plot

Vertical Stack - Pressure Plot

STRUCTURES VULNERABILITY

STRUCTURES VULNERABILITY

e.g.
Blast Loading
Quasi-Static Pressure
Secondary Combustion Effects
Primary Fragmentation Effects
Combined Energy Partition (fragmentation/blast)
Secondary Fragmentation - Packaging/racking
Structural Break-Up
Debris Throw
Debris Penetration Through Targets

27 TONNE TRIAL - AUTODYN

Initial Explosion - Pressure Contours.gif

Step 1 - Shell Detonation

Dutch shell w-o floor.gif

Step 2 - Effect of Stack Constraints and Crater Formation

Combined.gif

Step 3 - Combined Blast and Frag Effects on Wall to Side of Edge of Stack

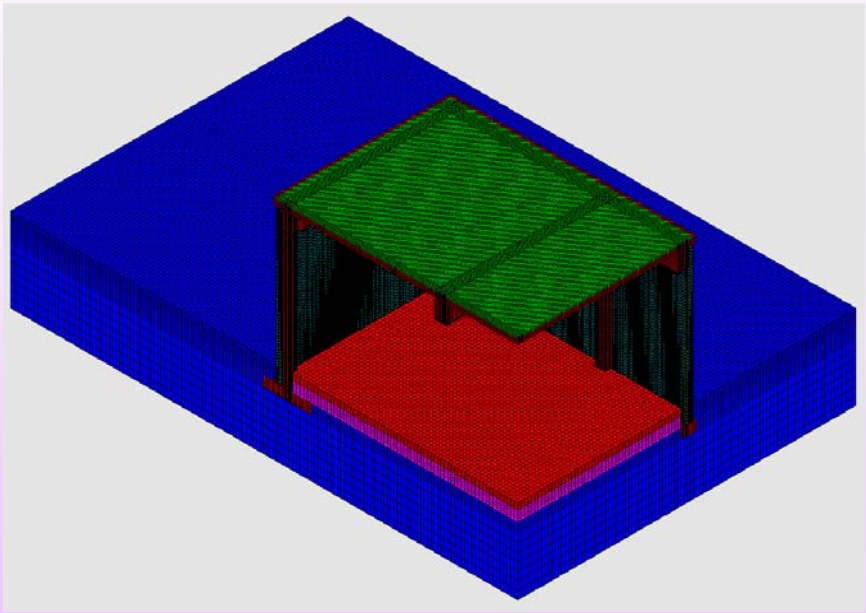
NEQ+fragattack.gif

Step 4 - Complex Loading on Storehouse

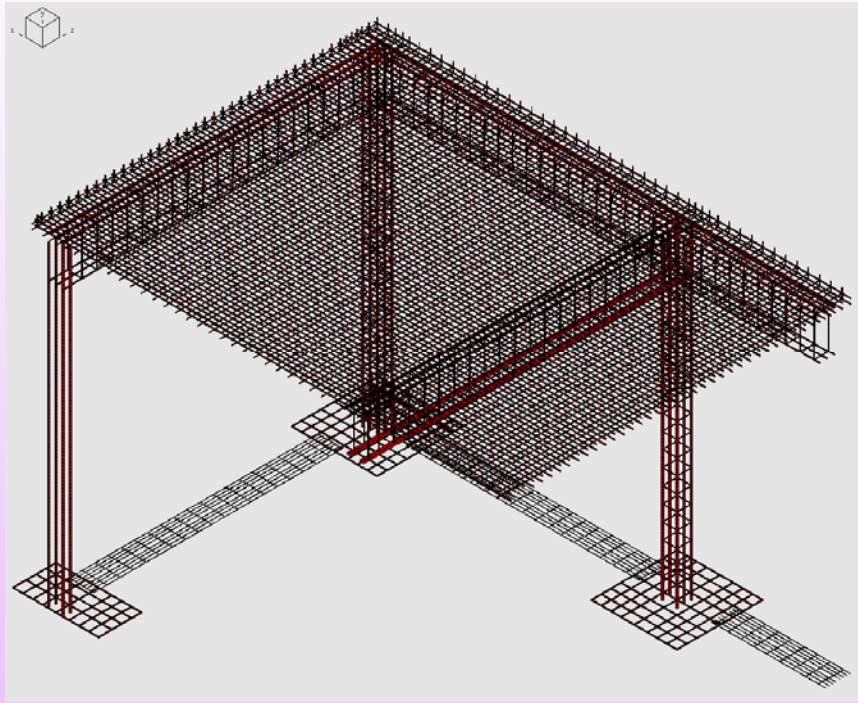
With crater.gif

Step 5 - Effect of Crater Volume on QSP

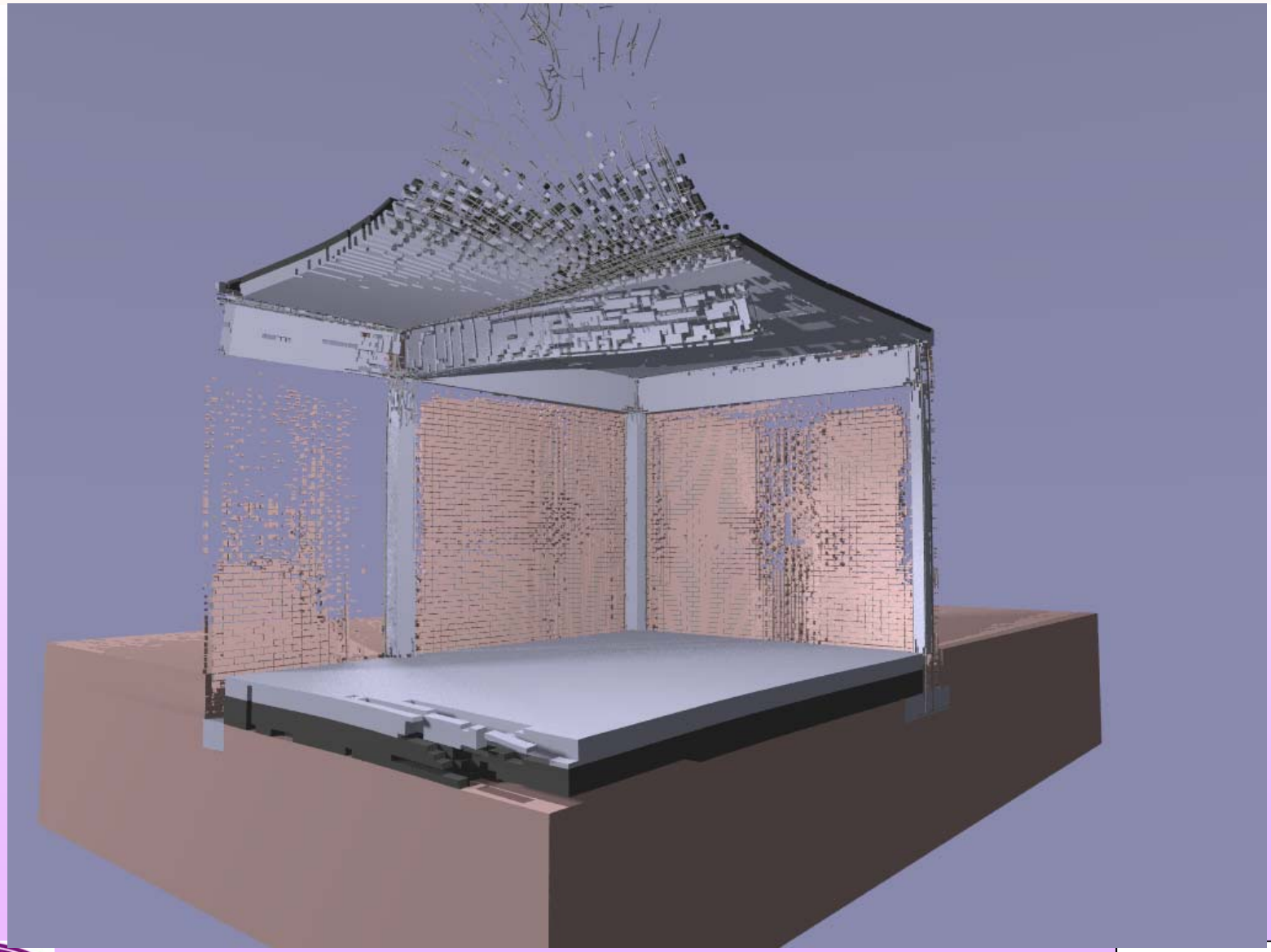
27 TONNE TRIAL - FE MODELLING

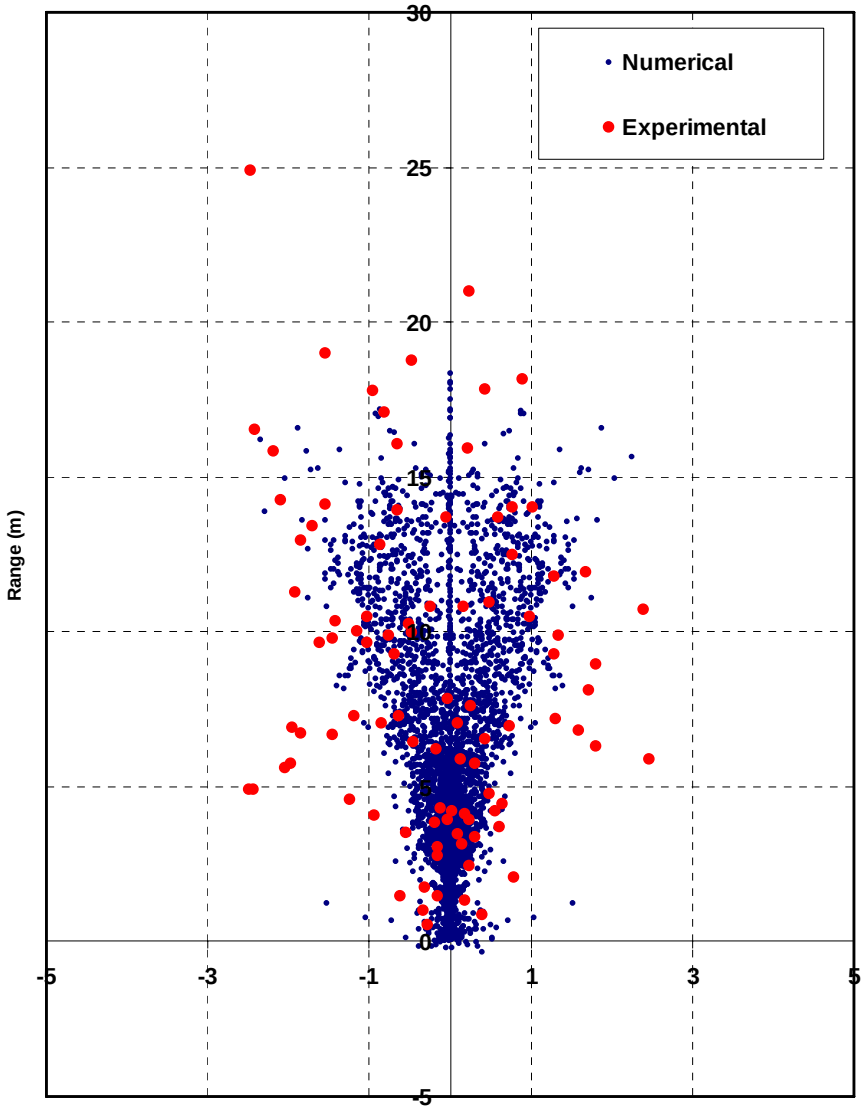


FLEX FE Mesh of 1/4 Woomera donor building



FLEX FE Mesh of 1/4 Woomera donor building showing internal re-bar



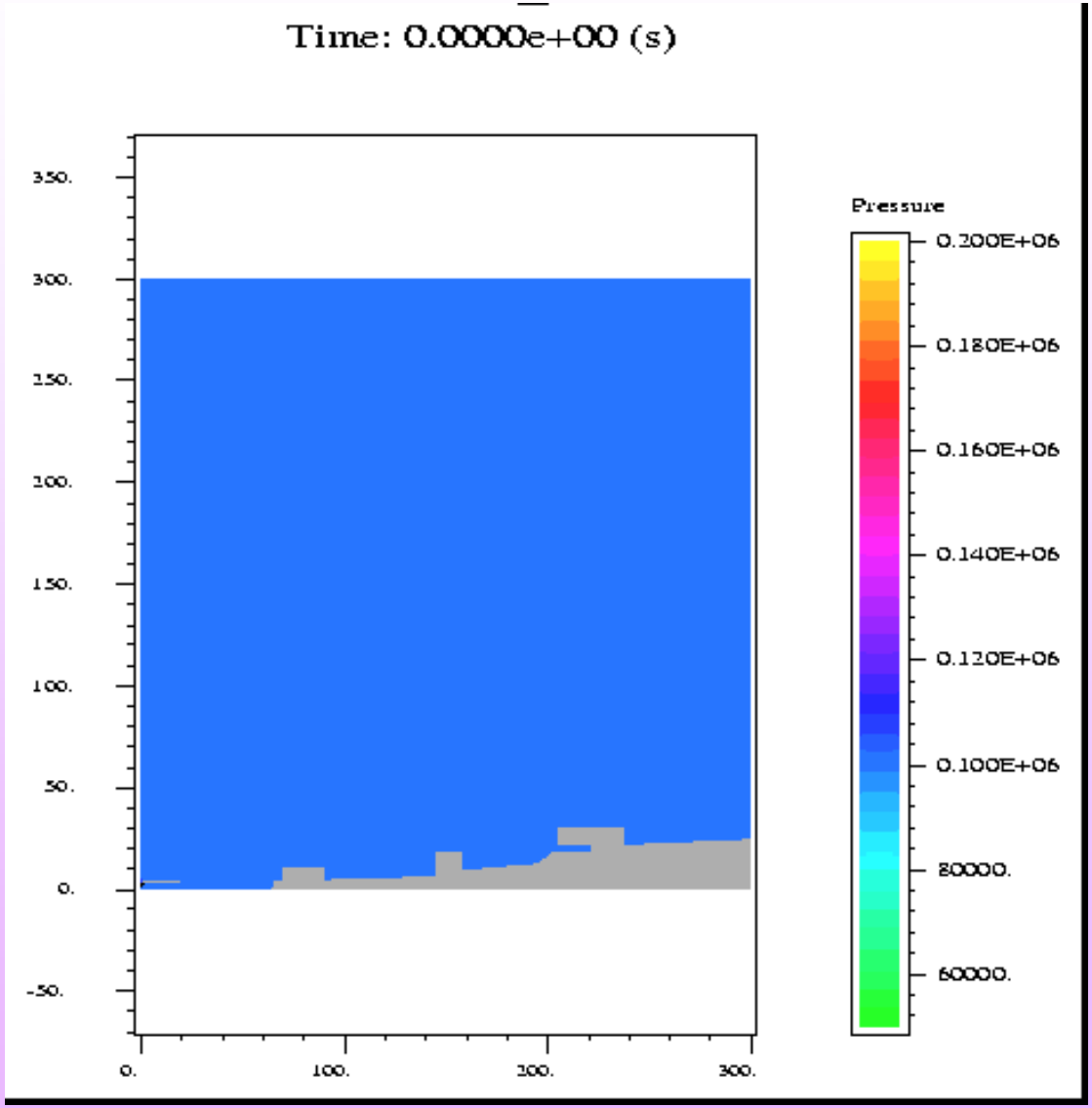

Numerical
Experimental
Range (m)
Range (m)
30
25
20
15
10
5
0
-5
-5
-3
-1
1
3
5

RISK ASSESSMENT SUPPORT

Munition, Platform or Site Safety Specific Safety Issues

e.g. To assess the explosives hazard to a Naval Accommodation Block from ammunitioned warships.

RISK ASSESSMENT SUPPORT


Time: 0.0000e+00 (s)
350.
300.
250.
200.
150.
100.
50.
0.
-50.
0.
100.
200.
300.
Pressure
0.200E+06
0.180E+06
0.160E+06
0.140E+06
0.120E+06
0.100E+06
80000.
60000.

EXPLOSIVES MITIGATION

Block shown 1000mm x 750mm x 500mm (other sizes available)

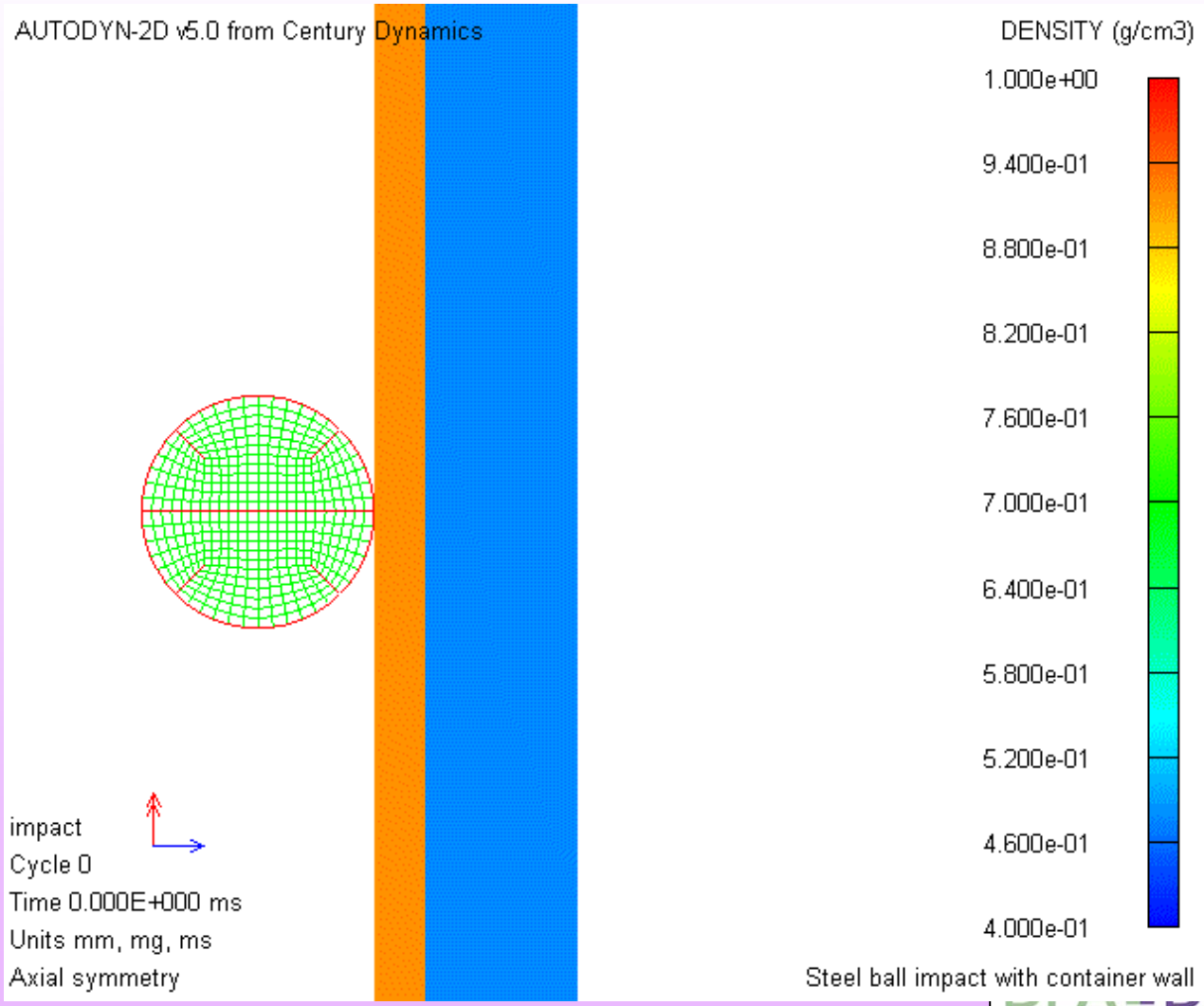
- **5mm polyethylene outer skin**
- **16mm closed-cell foamed polyethylene inner - gives structural rigidity**

NUMERICAL SIMULATION – TANK WALL

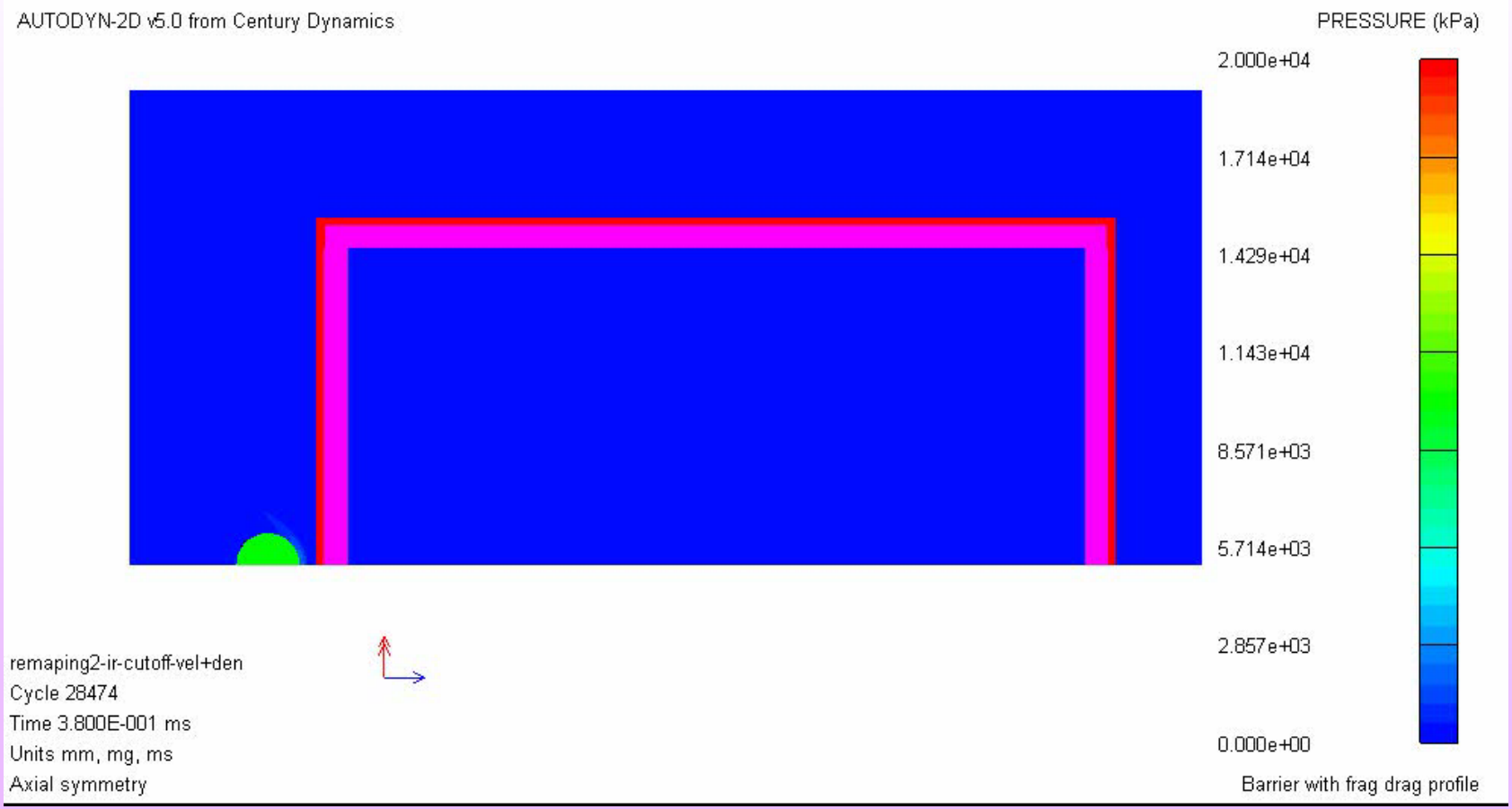
Ø 24mm 50g steel sphere

Entry speed 1500ms^{-1}

Predicted speed reduction 47ms^{-1}



NUMERICAL SIMULATION - 2D



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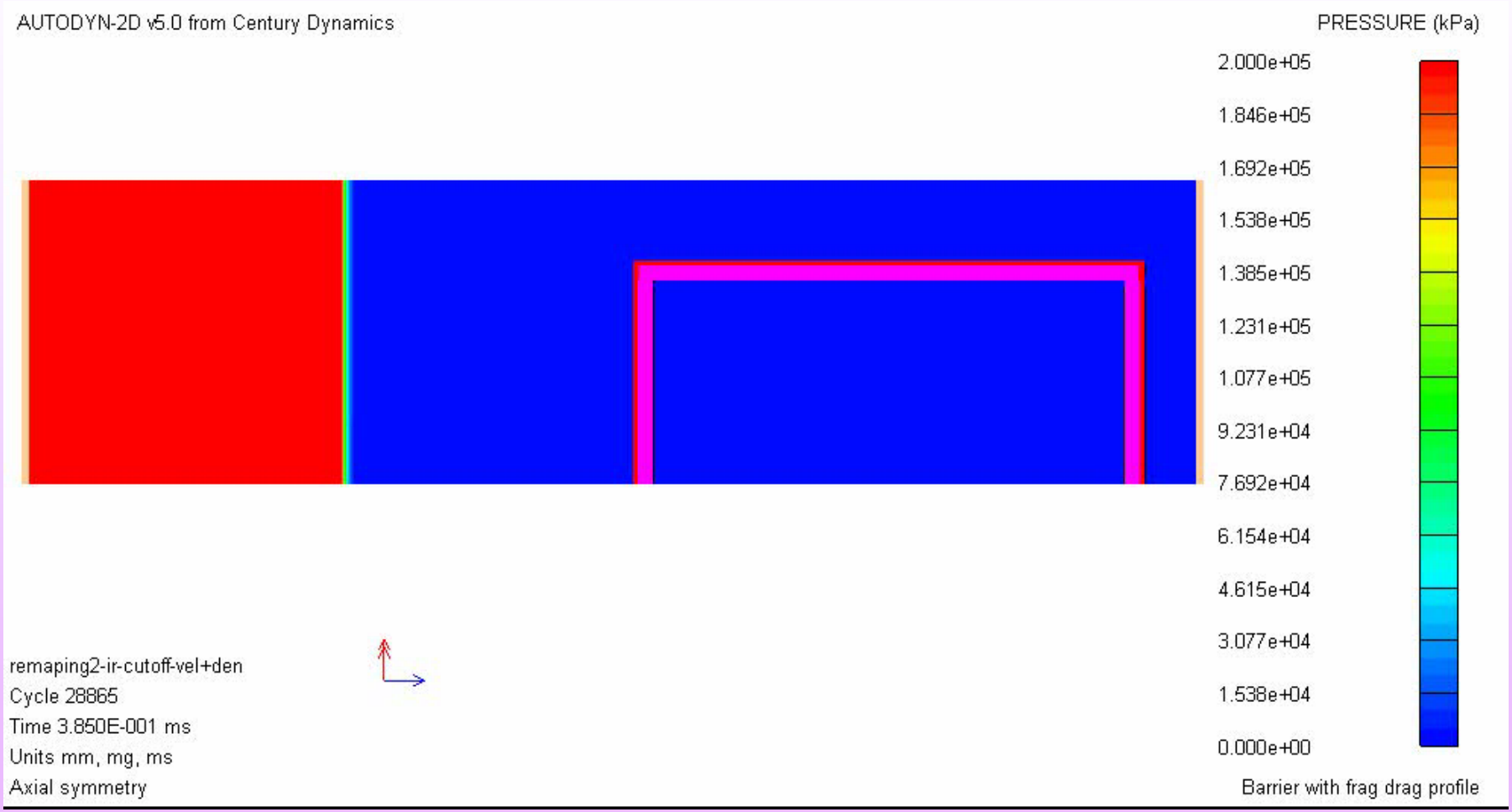

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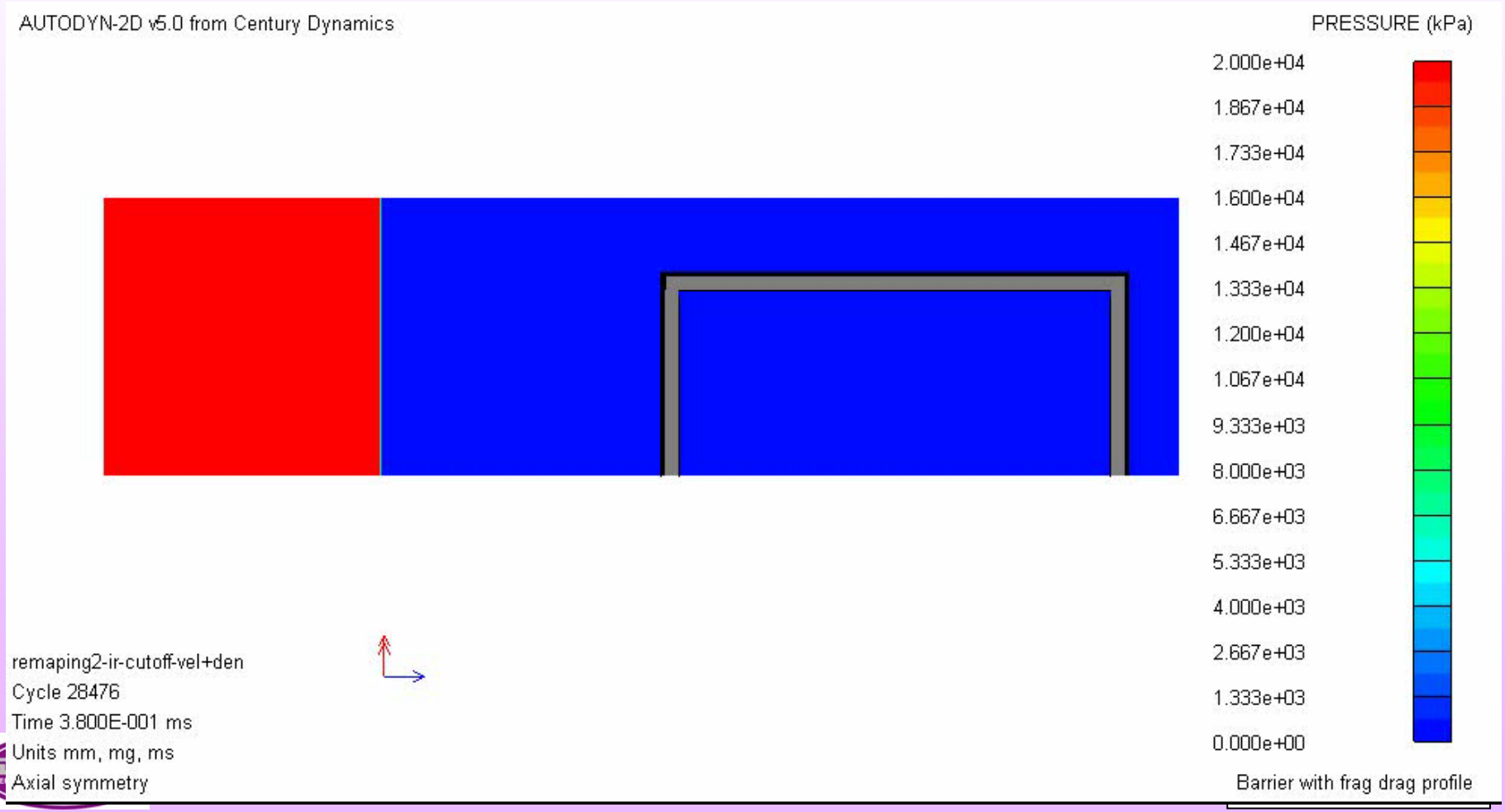
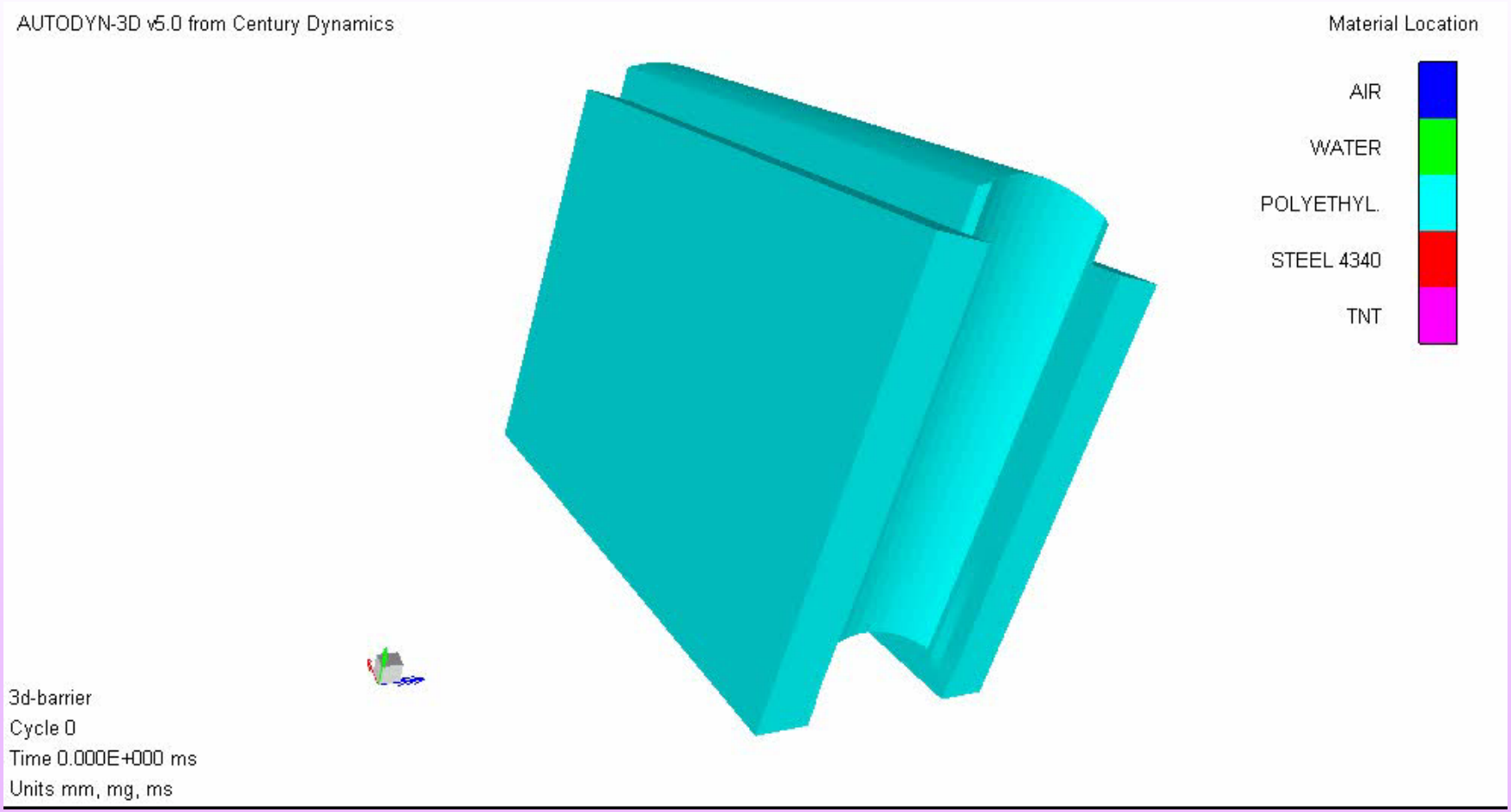


NUMERICAL SIMULATION - 3D



THANK YOU