MUNITION FRAGMENT IMPACT TESTING

- ITS USE IN THE UK IN IM ASSESSMENT AND TO EVALUATE RISK

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INTRODUCTION

Aim of this presentation is to:

- Give an overview of UK munition related fragment attack work
- Identify some issues for future work

BACKGROUND

Three UK programmes of work are currently ongoing which are directed to:

- Support **IM Assessment** through development of the underlying science and generation of data for read-across to AUR configurations
- **Address Platform Vulnerability**, through work assessing and mitigating the risk to naval platforms
- Develop **Specific Mitigation Solutions** to tackle in-service high risk situations (be they high consequence or high probability or both).

MUNITION FRAGMENT IMPACT TESTING AREAS

IM Assessment

Assessing Risk & Platform Vulnerability

Develop Specific Mitigation Solutions

IM ASSESSMENT

- IMAP assessment methodology has evolved towards a ‘whole body of evidence approach’ and includes assessment of data under the following areas:
  - Assessment of the energetic materials
  - Analysis of the weapon system design
  - Analysis of the role of packaging
  - AUR testing

THE BODY OF EVIDENCE

- Laboratory scale tests
- Component level tests
- Munition level tests
- Read across from similar formulations or munition designs
- Modelling and simulation
- Expert judgement

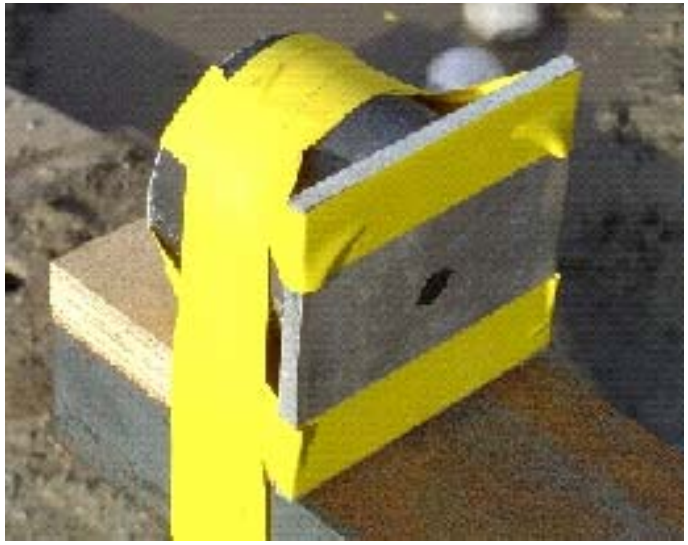
ASSESSMENT OF ENERGETIC MATERIALS

Effort directed towards characterising response mechanisms

- Fragment Impact (FI)
  - **the principal reaction mechanism we need to assess is whether prompt shock initiation (shock to detonation transition, SDT) occurs due to fragment impact.**
  - **If the item does not SDT then an understanding of burn to violent reaction (or deflagration to detonation transition, DDT) as a function of mechanical damage becomes important.**
- Sympathetic Reaction
  - **This is a similar situat**

The two reaction mechanisms that IMAP focuses upon are:
SDT and DDT

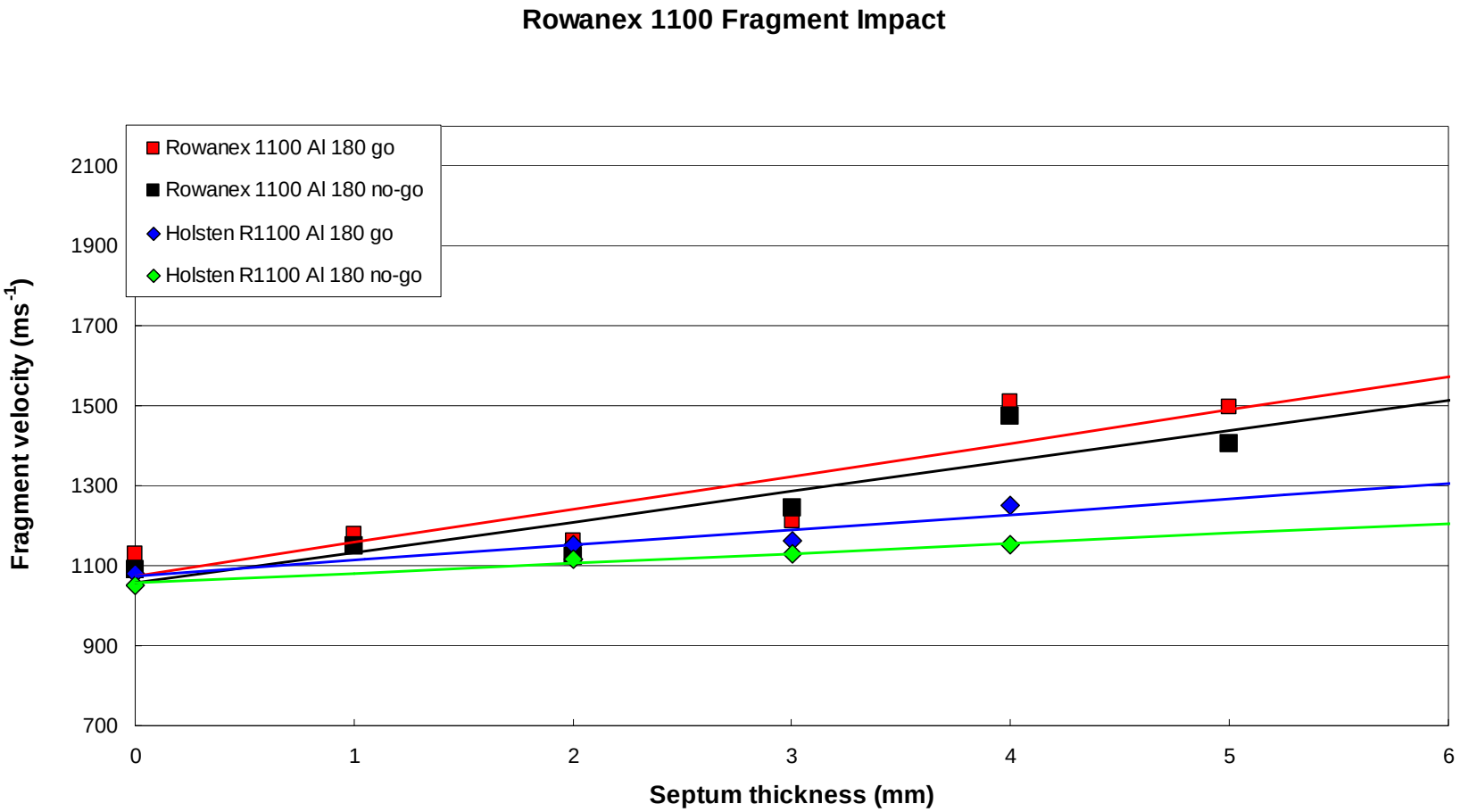
SMALL SCALE FRAGMENT ATTACK TEST



Fragment Impact Test Set-up

Fragment Impact Target

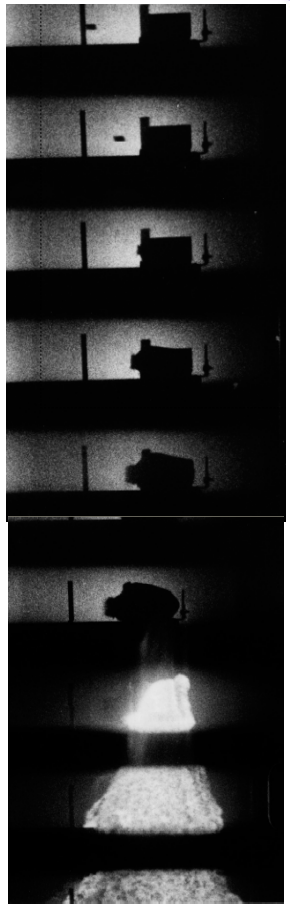
TYPICAL RESULTS - RS-RDX



IM ASSESSMENT LIMITATIONS

Limitations of the assessment process and deficiencies in our understanding of response mechanisms have been identified and include:

- XDT – Unknown to detonation transition. Of particular interest in sub-SDT mechanical impact and when significant damage is effected in the energetic materials



XDT as a consequence of a Fragment impact

IM ASSESSMENT LIMITATIONS

- Modelling – currently, modelling is only of limited use to IMAP because models are insufficiently mature.
- Packaging – there is a need to better understand the effectiveness of materials and design solutions.
- Gun and Rocket Propellants – we lack the ability to screen out unsuitable materials by using small scale tests.
- DDT – We need to develop a means to rank the bulk burning properties of energetic materials and generate better quantitative data.
- There is a need to better understand the probability of initiation and to inform risk assessments

AUR TESTING - PGB

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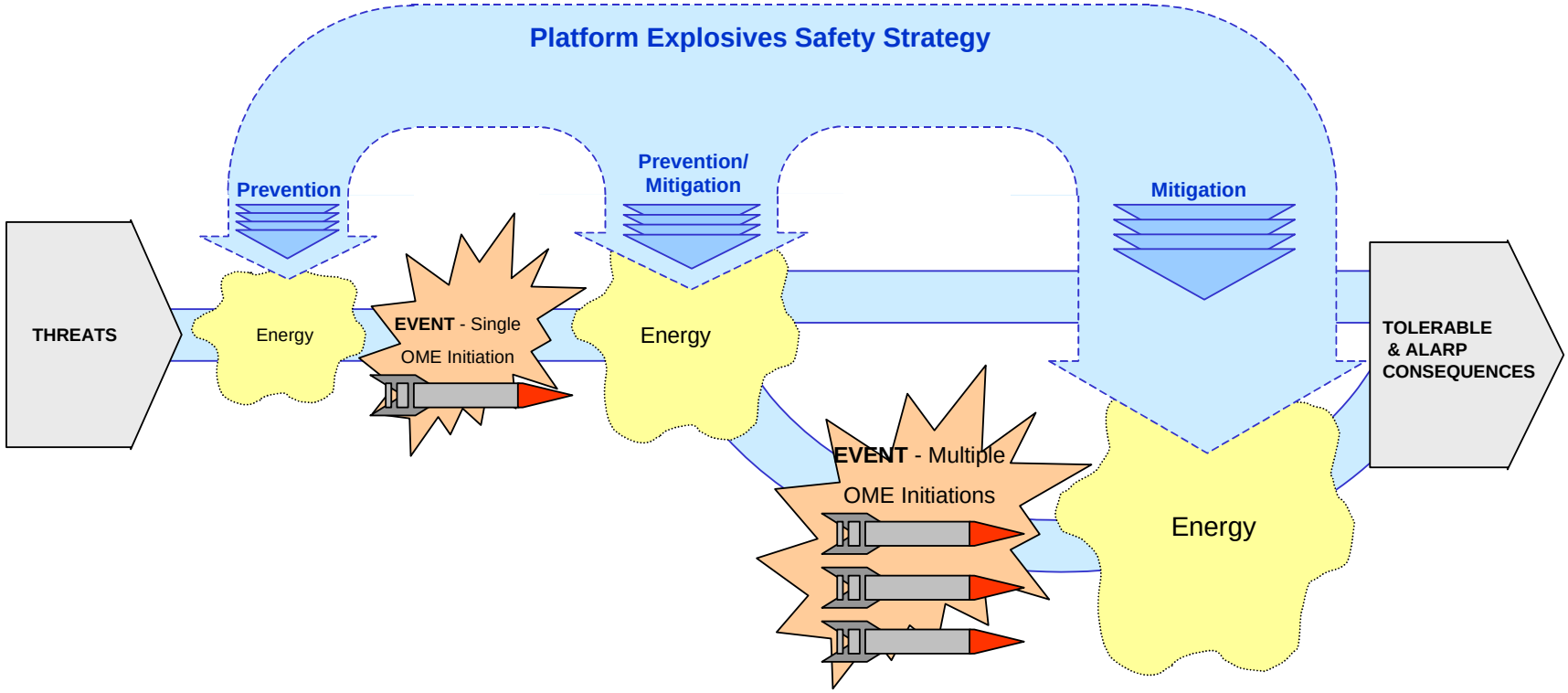
EVALUATION OF PLATFORM RISK

- Platform IPT are required to conduct risk assessment on the use of ordnance, munitions and explosives (OME)
  - This is of particular importance to navy platforms where management of munition risk by separation at appropriate distances is not an option
    - Fragment threat is an important threat – originating from enemy attack or as a consequence of own munitions reacting

PLATFORM EXPLOSIVES SAFETY STRATEGY



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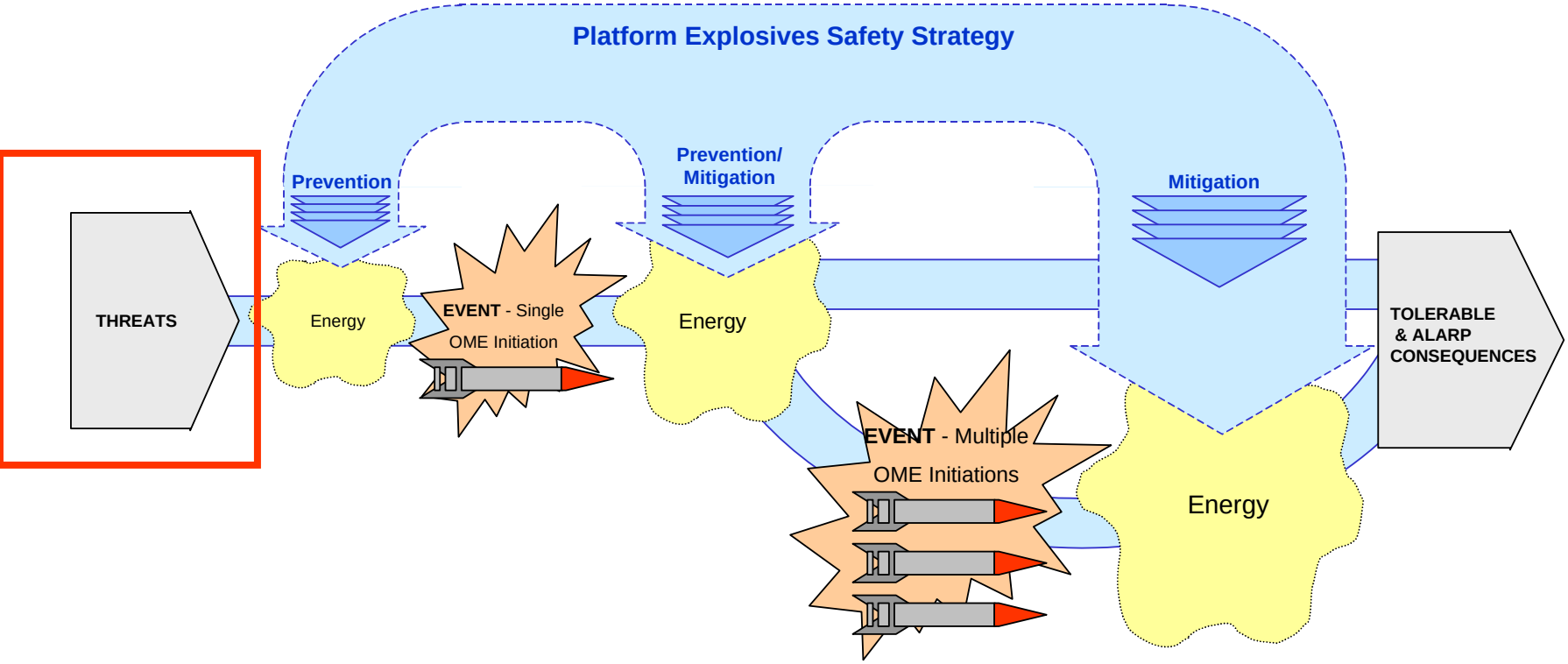
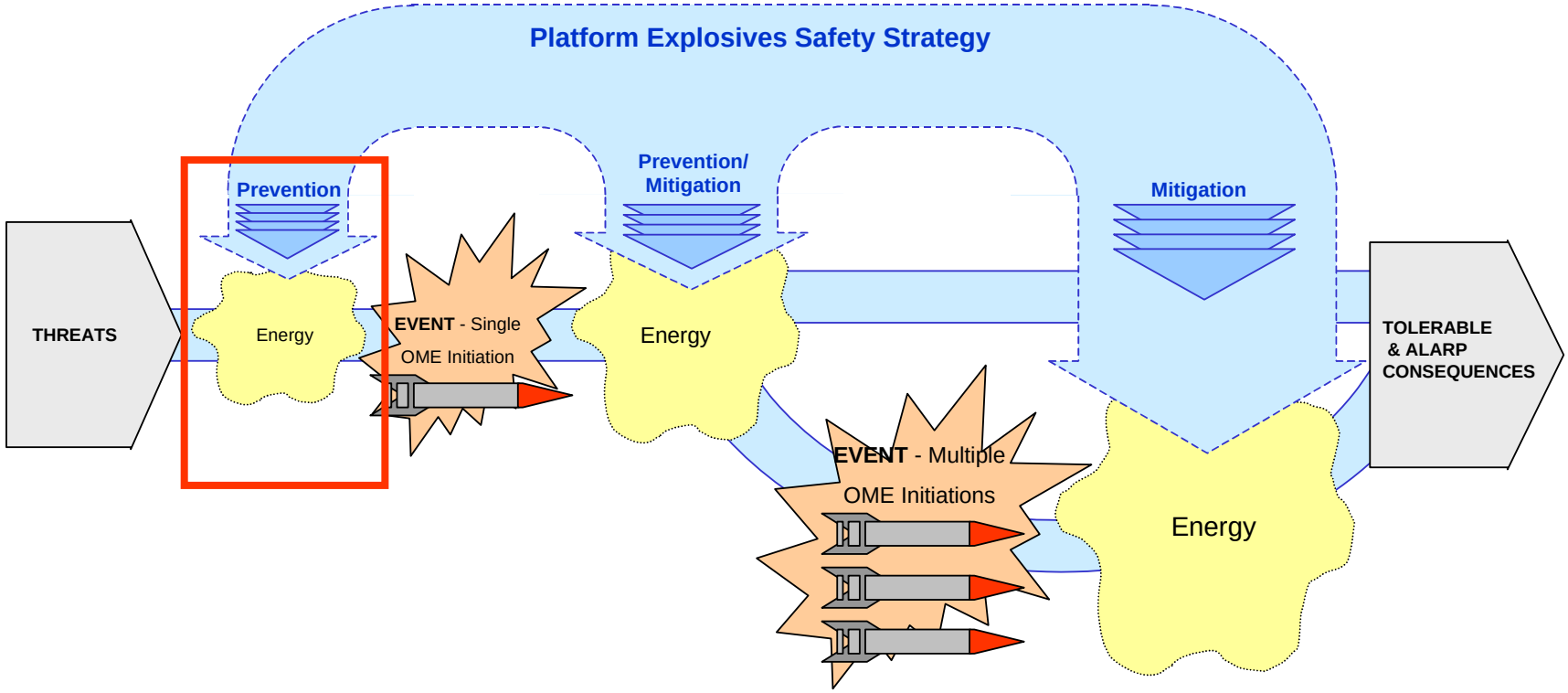


FRAGMENT SIMULATING PROJECTILES

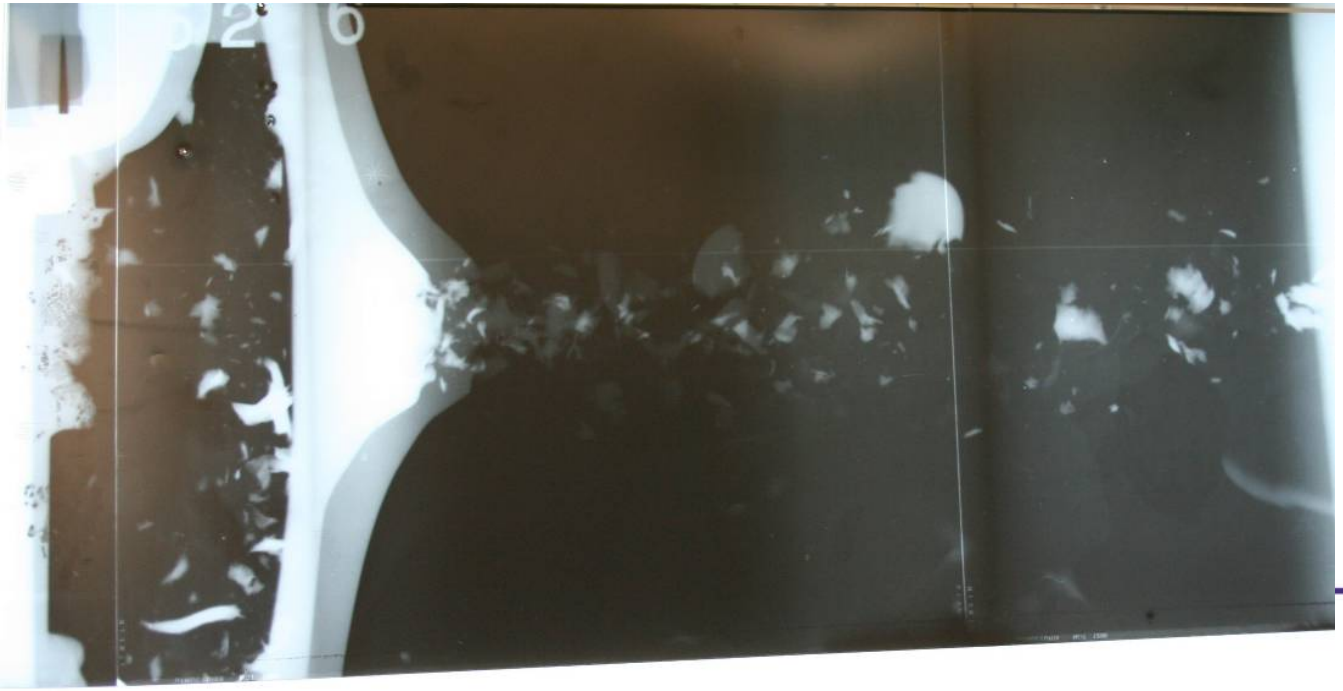
Designation	Mass	Velocity
UK Small	~3.5 g	1500ms^{-1}
UK Medium	~50g	1700 ms^{-1}
UK Heavy	~200 g	2200 ms^{-1}
STANAG 4496	18.6 g	2530ms^{-1} / 1830 ms^{-1}
French light	20 g	< 2000 ms^{-1}
French Heavy	250 g	< 1650ms^{-1}

PLATFORM EXPLOSIVES SAFETY STRATEGY



BEHIND ARMOUR EFFECTS

- Flash X-Ray trace recording residual velocity and distribution of behind armour effects.



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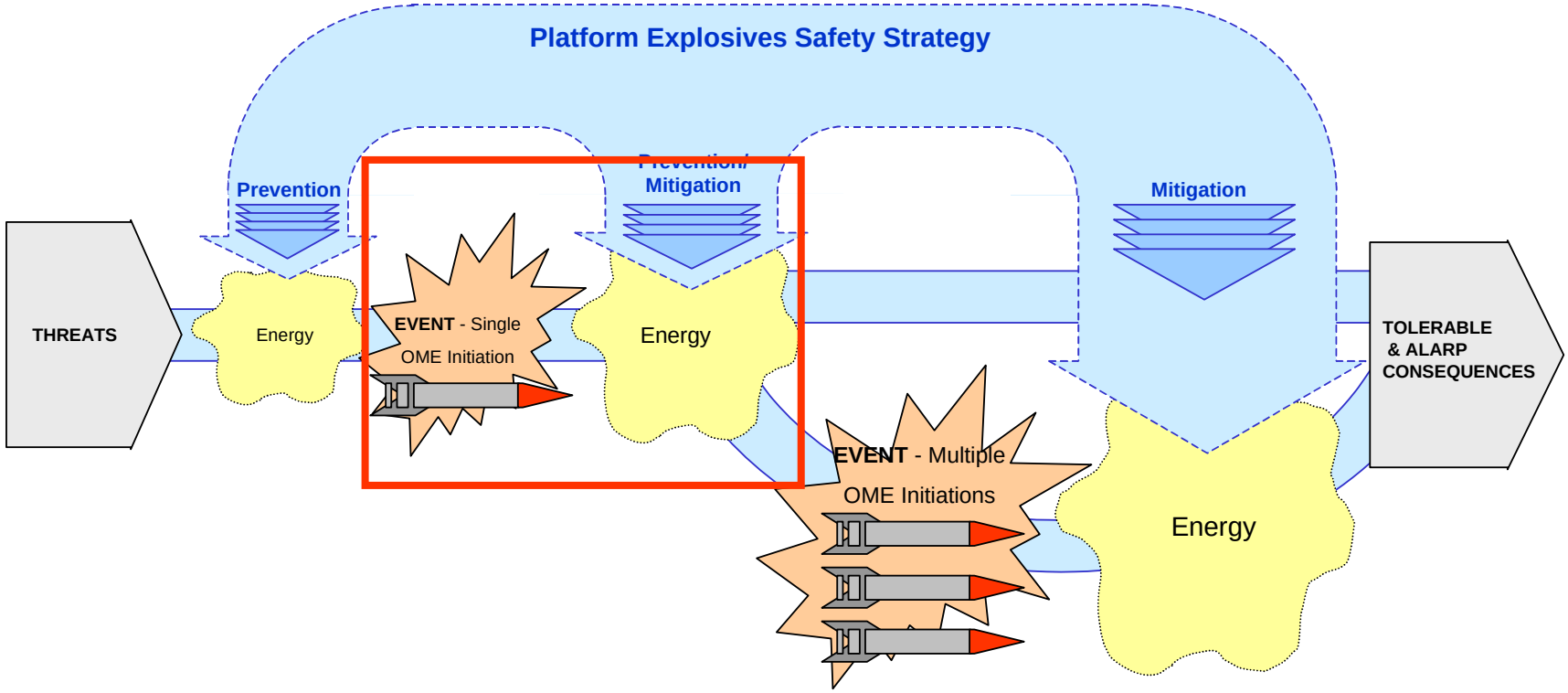
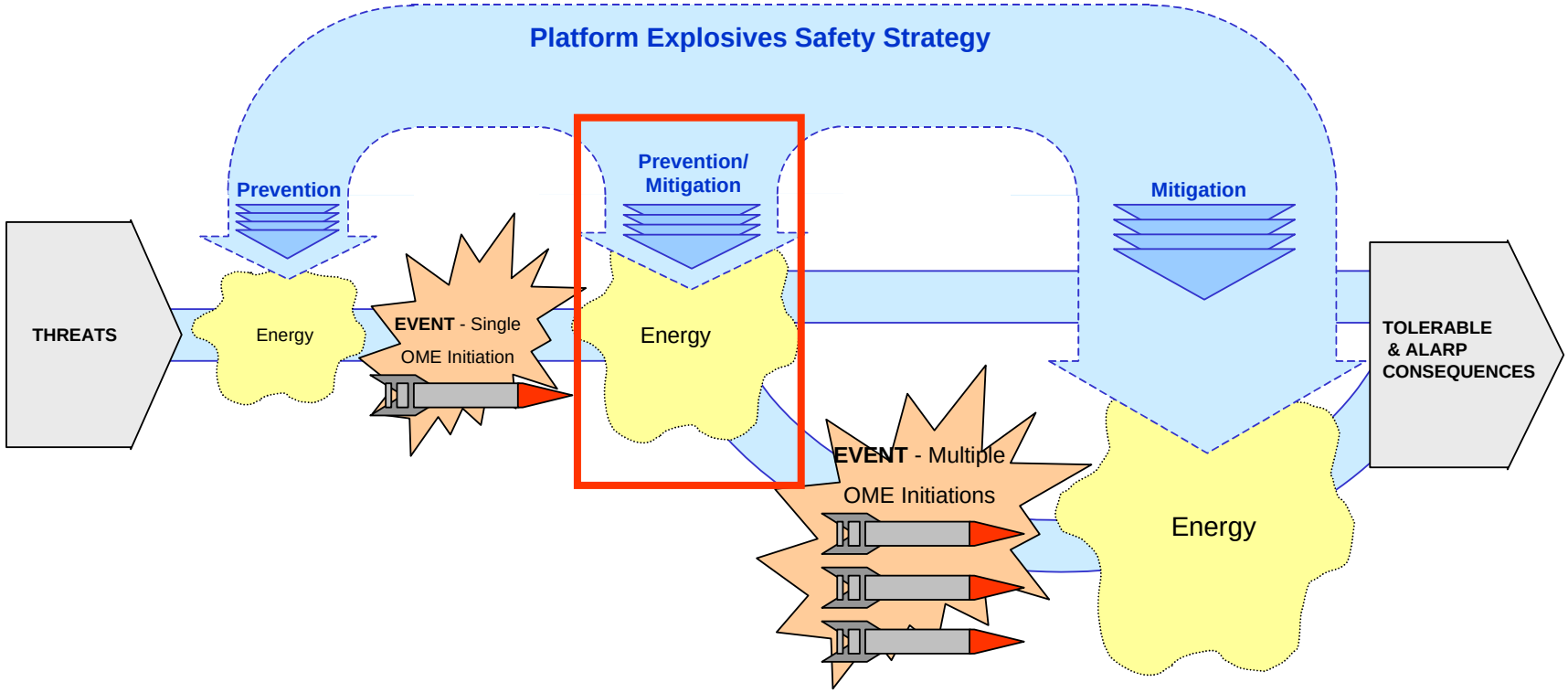


ROLE OF FRAGMENT ATTACK DATA

- IM assessment
  - Data often used directly to inform of consequences
- Small scale fragment attack data
  - Used to improve predictive capability for a range of threat stimuli and where AUR IM tests results are not available

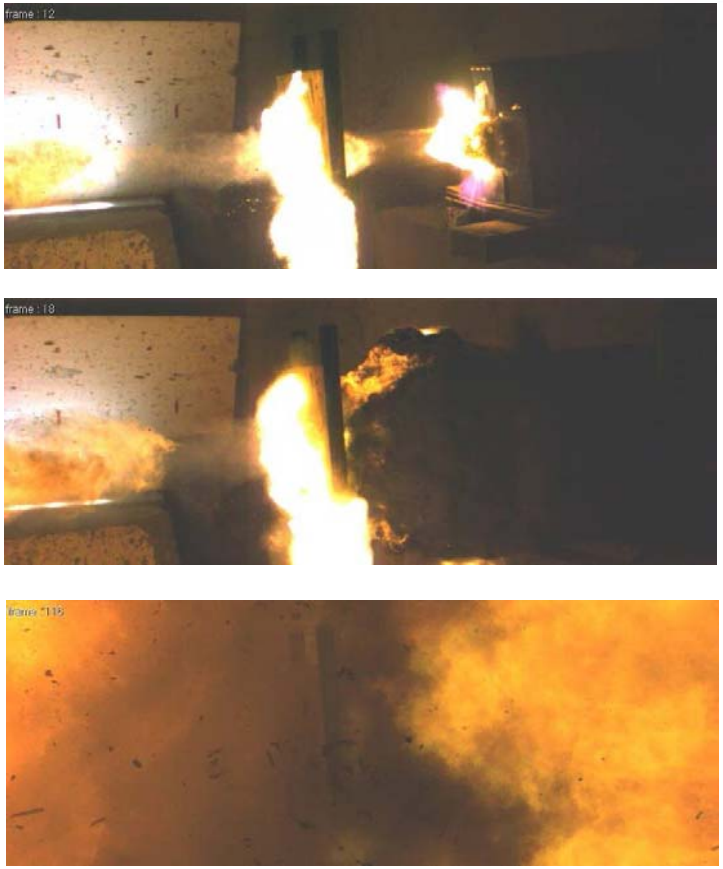
PLATFORM EXPLOSIVES SAFETY STRATEGY



UNITISATION

Shielding vulnerable munitions using less vulnerable natures and barriers

- Reduces risk by unitising NEQ to tolerable damage levels



HD 1.4s Being impacted by a heavy impact

MUNITION FRAGMENT IMPACT TESTING AREAS

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DEVELOPMENT OF MITIGATION SOLUTIONS

- Where there is a requirement to reduce the Maximum Credible Event (MCE) mitigation solutions have been specifically developed
  - bulk storage of conventional munitions in land based magazines
  - bulk movement of munitions in built up environments
  - prevention of communication of explosive events between adjacent armed aircraft, and in process rooms during maintenance and testing

APPROACH

- Assessment of the fragmentation threat
  - Arena trials data mass distribution and velocity data profile
  - Determine the maximum Kinetic Energy (KE) fragment as a function of mass and velocity
- Develop Barriers to achieve required level of mitigation against this threat
- Conduct AUR SR trials

SUCCESS STORY

Success Story
RAF apply UK developed Barriers in Kandahar

US Deploy same barriers on operations

CONCLUSIONS

- Fragment impact testing plays a key role in the assessment of munition vulnerability
- UK modelling capability is not being exploited in this area. There is also a need for better empirical or semi empirical tools that can be applied on an ad hoc basis (MSIAC TEMPER will be explored).
- Effort should be directed towards reducing the testing burden and towards determining more quantitative information to support risk assessment. An obvious route to achieving the latter is to better quantify explosive effects when conducting IM testing.
- The science underlying the work reported is the same and coordination will maximise the potential of this already successful area of research

QUESTIONS?