# EUROPEAN FLY BAGS FOR IEDs

2015 Aviation Security Forum, Washington DC

D'APPOLONIA
consulting, design, operation & maintenance engineering

# The Terrorist Threat to Commercial Aviation

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- **Commercial aviation** is constantly under **threat of terrorist attacks**


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UK

**Ryanair plane grounded in Poland after bomb threat 'hoax'**

25 June 2015 | UK


**United flight bound for DC is diverted to Ohio after female passenger 'makes threatening comments about a bomb'**

- United Express Flight 3342 departed from Missouri at 8.50am Thursday
- Aircraft diverted to Ohio after female flier 'made threatening comments'
- Passengers told Daily Mail Online the woman made threat about a bomb
- She was 'in her fifties' and 'acting recklessly and looking around oddly'
- Flight was met on tarmac at Port Columbus Airport by emergency crews
- Passengers were evacuated; 'disruptive' woman was detained by police

By SOPHIE JANE EVANS FOR DAILYMAIL.COM

PUBLISHED: 18:17 GMT, 2 July 2015 | UPDATED: 20:10 GMT, 2 July 2015


THE CHRISTMAS DAY PLOT THAT CAME SO CLOSE


Cargo plane bomb plot: Key developments

# Effect of Explosion in a Cargo Hold Aircraft

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## Explosions in aircraft cargo holds

**PROTECTION MEASURES ARE NEEDED**

# Blast Containment on Cargo Hold - HULDs: Past Attempts

- Since the Lockerbie disaster in 1988, development of HULDs for cargo holds:
  - Never gained wide market acceptance:
  - Too heavy
  - Too bulky
  - Too expensive
  - Easily damaged during use and/or by environment
- Only for wide bodies!

# Blast Containment on Passenger Compartment – Past Attempts

- Aviation regulations mandates that a **Least Risk Bomb Location (LRBL)** is identified on each aircraft
- Existing solutions for blast containment are based on:
  - phase-changing materials
  - thick reinforced plates
- Drawbacks:
  - Weight
  - Cost
  - bulkiness
  - Explicit presence of a blast disposal container onboard can give rise to panic

# FLY-BAG2 Project

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## *FLY-BAG2: Advanced Technologies for Bomb-Proof Cargo Containers and Blast Containment Units for the Retrofitting of Passenger Airplanes*

**Project Type**: Collaborative project
**Call**: FP7-AAT-2012-RTD-1
**Topic**: AAT.2012.5.1-1. Aerostructures
**Start date:** August 2012
**End date:** July 2015
**Coordinator**: Alessandro Bozzolo, D'Appolonia S.p.A. (RINA Group)

# FLY-BAG2 Partners

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D'APPOLONIA
consulting, design, operation & maintenance engineering

ZIPLAST
The essence of quality

DeltaSch
AIR CARGO EQUIPMENT & REPAIR

University of Patras

AERnnova

APC Composite

CARGO NETWORK

easc European Aviation Security Center e.V.

Blastech

CETMA

Maintenance Meridiana

stfi

INASCO
INTEGRATED AEROSPACE SCIENCES CORPORATION

# Introduction: from FLY-BAG1 to FLY-BAG2

# FLY-BAG2: follow-up of FLY-BAG1 Project

- **FLY-BAG2** is a **follow-up of the previous FP7 Research Project FLY-BAG** (GA No. ACP7-GA-2008-213577)
- FLY-BAG developed and successfully tested a **blast-resistant flexible composite luggage container** for the protection of aircrafts from on-board explosions from explosives hidden in luggage in the **cargo hold**

# FLY-BAG1 Demonstrator


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JEC COMPOSITES FINALIST OF 2011 INNOVATION AWARD

WINNER techtextil innovationprize.2011 SAFETY+PROTECTION CATEGORY

M DESIGN+ TECHNOLOGY AWARD MATERIALICA 2011

EARTO IMPACT DELIVERED

PREMIO NAZIONALE PER L'INNOVAZIONE

# FLY-BAG1: Installation trials into Meridiana Airbus A319

TRANSPORT SECURITY EXPO
2 - 3 DECEMBER 2014 | OLYMPIA LONDON

# Blast Event

Four possible causes of damage:

- High speed fragments ejection
- Shock peak pressure (duration: few ms)
- Quasi static pressure (duration: few s)
- Fire/heat

# Blast Test of a LD3-45 ULD



## WOULD MOST LIKELY LEAD TO FUSELAGE COLLAPSE

# Final Blast Test on FLY-BAG1

TRANSPORT SECURITY EXPO
2 - 3 DECEMBER 2014 | OLYMPIA LONDON

**FLY-BAG blast test with the same explosive charge that destroyed the ULD**


**THE FLY-BAG SURVIVES SUBSTANTIALLY INTACT!**

# FLY-BAG1 – Key Issues

- Lightweight (65 kg) ≤ standard Al LD3-45 ULD (85 kg)
- Blast resistant
- Developed with focus on narrow bodies
- It stays inside the cargo hold of the airplane (no-ULD version)
- Easy to install and use
- Slim – payload is unaffected when in use, when folded it fits in a 30x40x80 cm case
- FLY-BAG1 Patented (EP 2492217 A1)

# FLY-BAG2 Project

# Why FLY-BAG2?

- FLY-BAG1 has demonstrated the feasibility of a textile-based blast resistant container, but:
  - For a **specific configuration** (narrow-body, the container stays in the cargo hold)
    - **No use for wide-body aircrafts**
    - **No use against suicide bombers**
  - FLY-BAG1 was only **blast-tested in open air**
  - The **interaction with airframe** was only known from **simulations**, not tested

# FLY-BAG2 Objectives

- FLY-BAG2 aims at developing two entirely new classes of bomb-proof devices, namely:
  - **cabin device**, meeting the *Least Risk Bomb Location* (LRBL) requirements
  - **cargo device,** for cargo holds of narrow body and wide body aircrafts
- **Full scale blast tests** on disused aircrafts are being performed

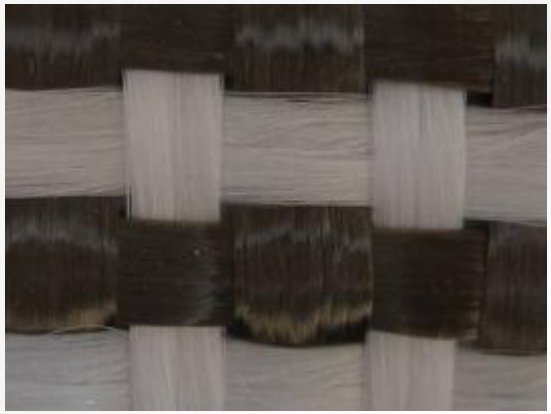
# Material Selection

# Blast Events

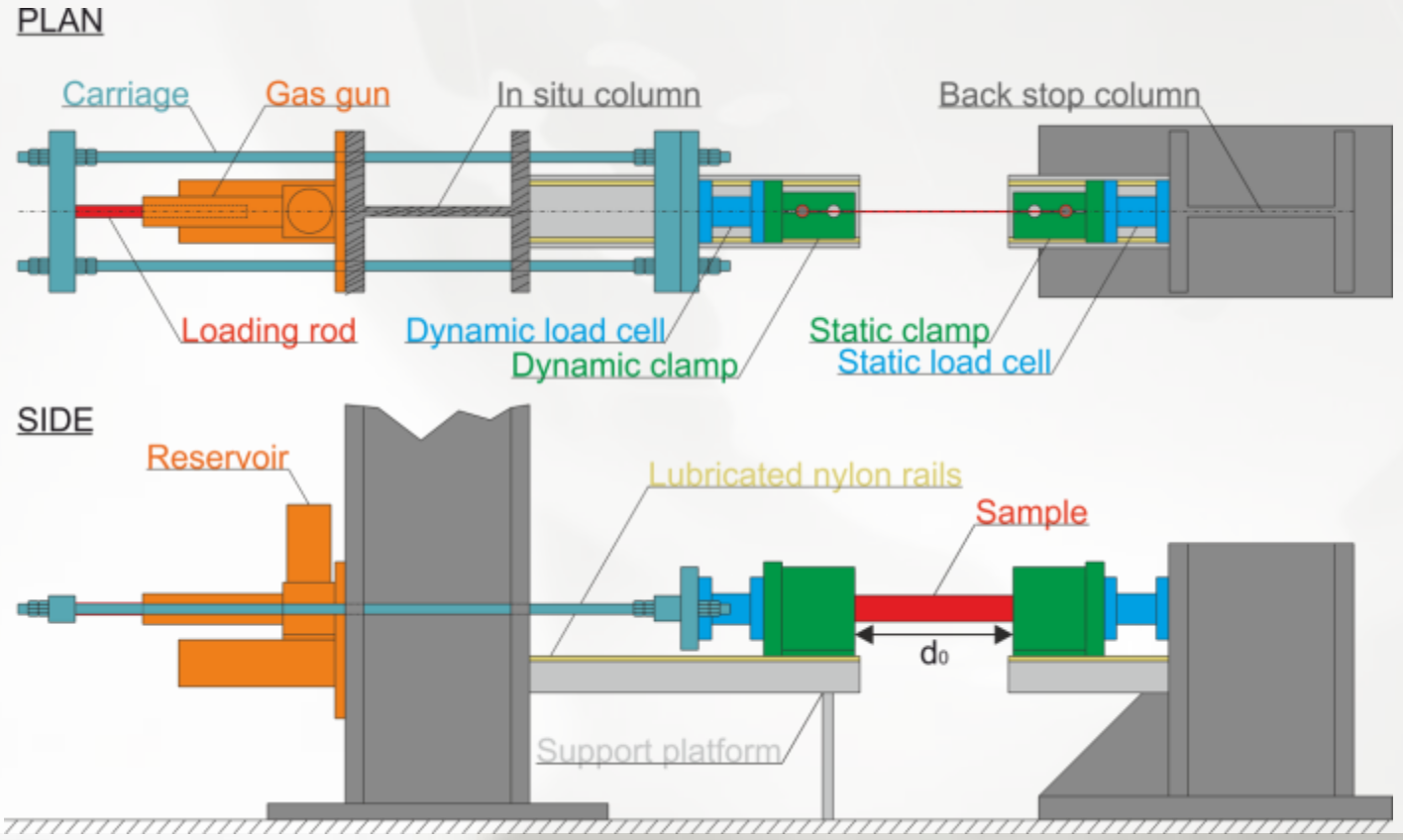
- Four possible causes of damage:
  - High speed fragments ejection
  - Shock peak pressure (duration: few ms)
  - Quasi static pressure (duration: few s)
  - Fire/heat

**MULTILAYER CONFIGURATION**

# Selection of Advanced Materials (Fabrics, Composite & Zip)

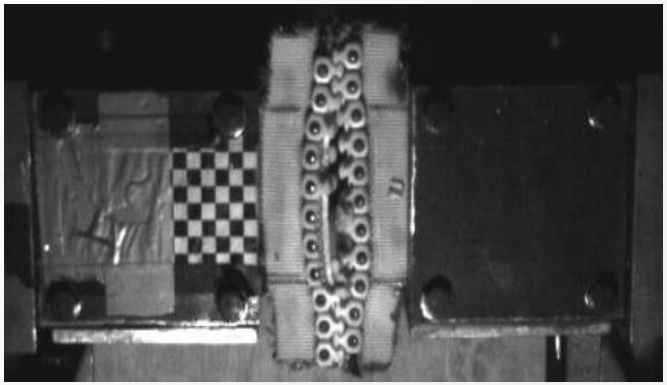



# Dynamic Tests on Fabrics

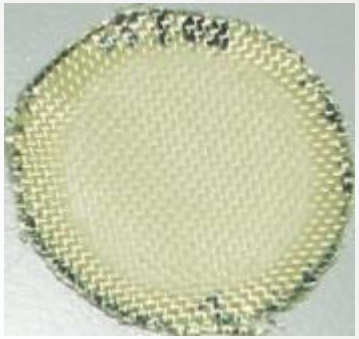


# Dynamic Tests on Fabrics / Zips

- Test program: >50 tests conducted in total
- All samples 5cm wide by 40cm long
- Strain rates ~2-20 strain/second



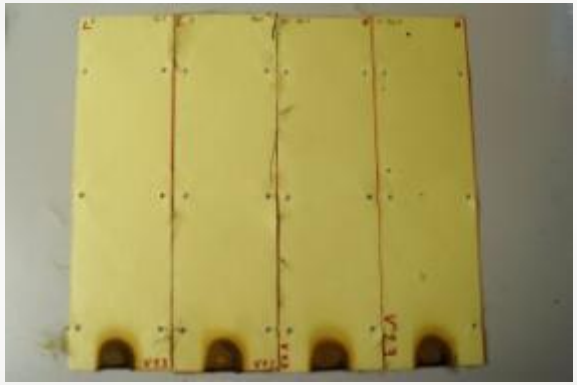
# Mechanical, Flame & Burning Tests on Fabrics

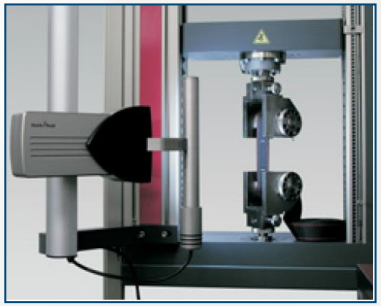


Abrasion resistance tests

Burning Tests

Wheatering Tests





# High Velocity Impact Tests on Composites

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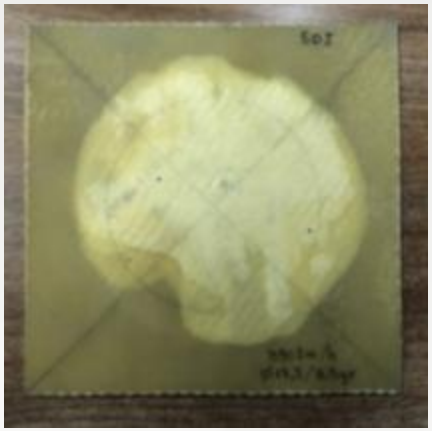
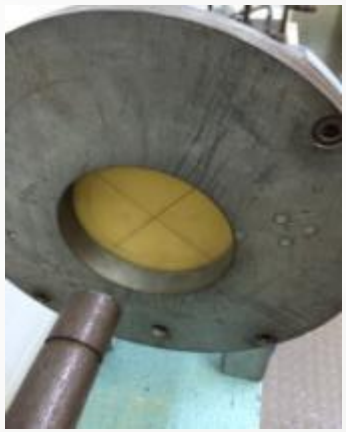
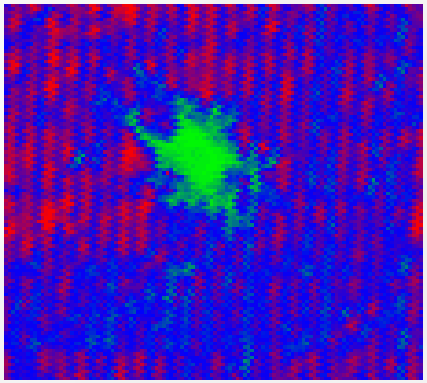
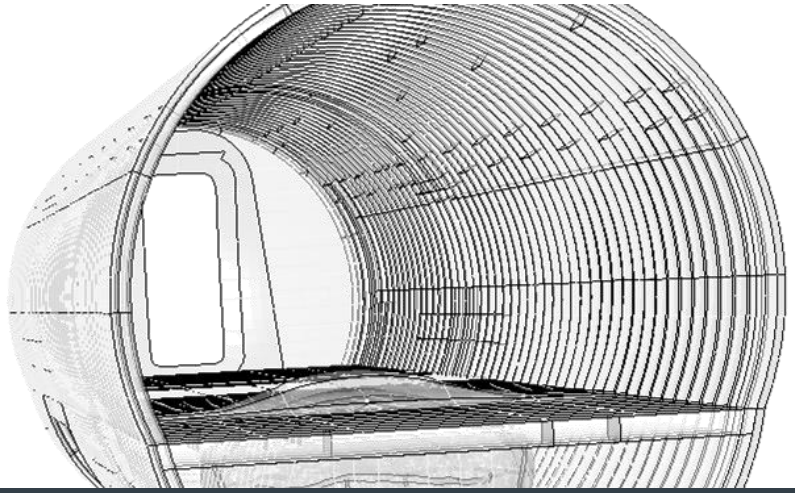
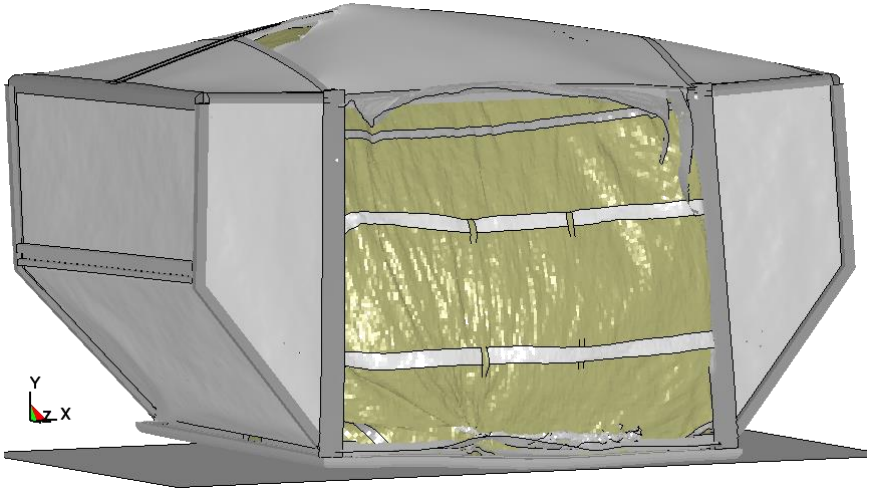


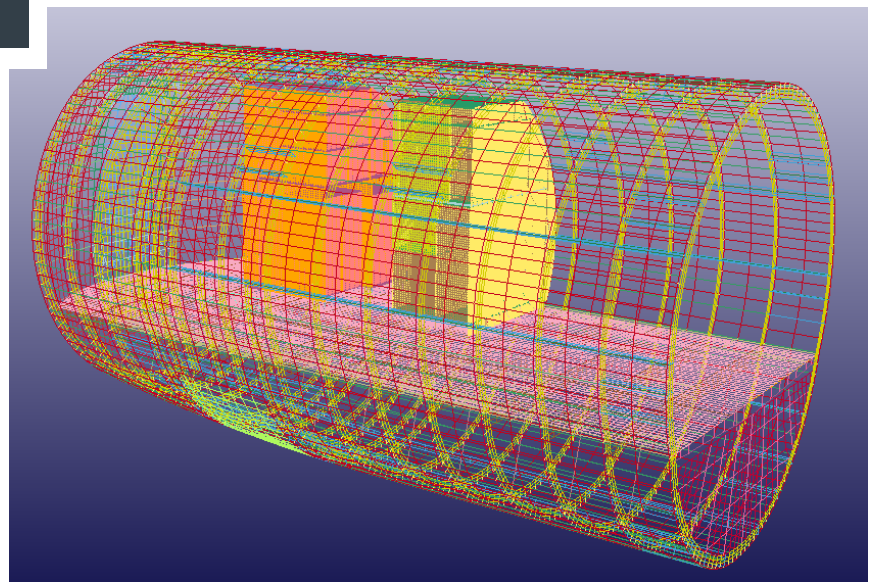






# FLY-BAG2 Blast Containment Units: Design & Prototyping



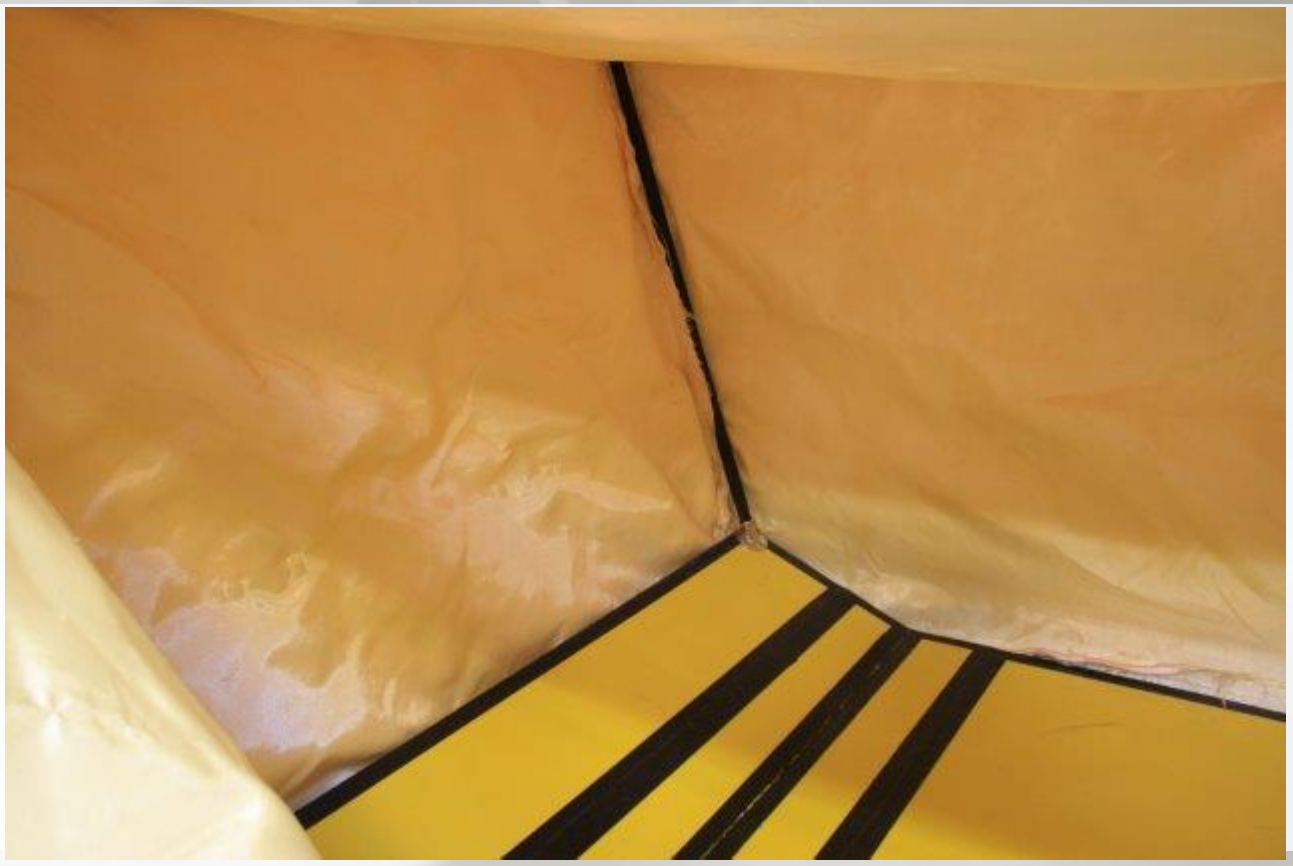
# FLY-BAG2 Products

| FB2 Products | Type of aircraft | |
|---|---|---|
| | Narrow body | Wide Body |
| FB2 cabin version | X | X |
| FB2 cargo version (see FB1) | X | - |
| FB2 AKE version (ULD) | - | X |
| FB2 PMC-pallet (ULD) | - | X |
| FB2 Hardened composite panels (for LRBL) | X | X |

# FLY-BAG2 Cargo Version (for A320)

# FLY-BAG2 Cargo Version (for A320)

# FLY-BAG2 Cargo Version (for A320) – Composite Floor



# FLY-BAG2 Cargo Version (for A320) – Zip

# FLY-BAG2 AKE Version

# FLY-BAG2 AKE Version – Composite Parts

# FLY-BAG2 AKE Version – Blast Tests

- Open air blast tests conducted in UK (Buxton)
- Full-Scale Blast Tests conducted in UK (Cotswold airfield) (Nov. 2014)
- The tests were conducted in the forward luggage hold of a decommissioned Boeing 747 aircraft

# FLY-BAG2 AKE Version – Open Air Blast Test

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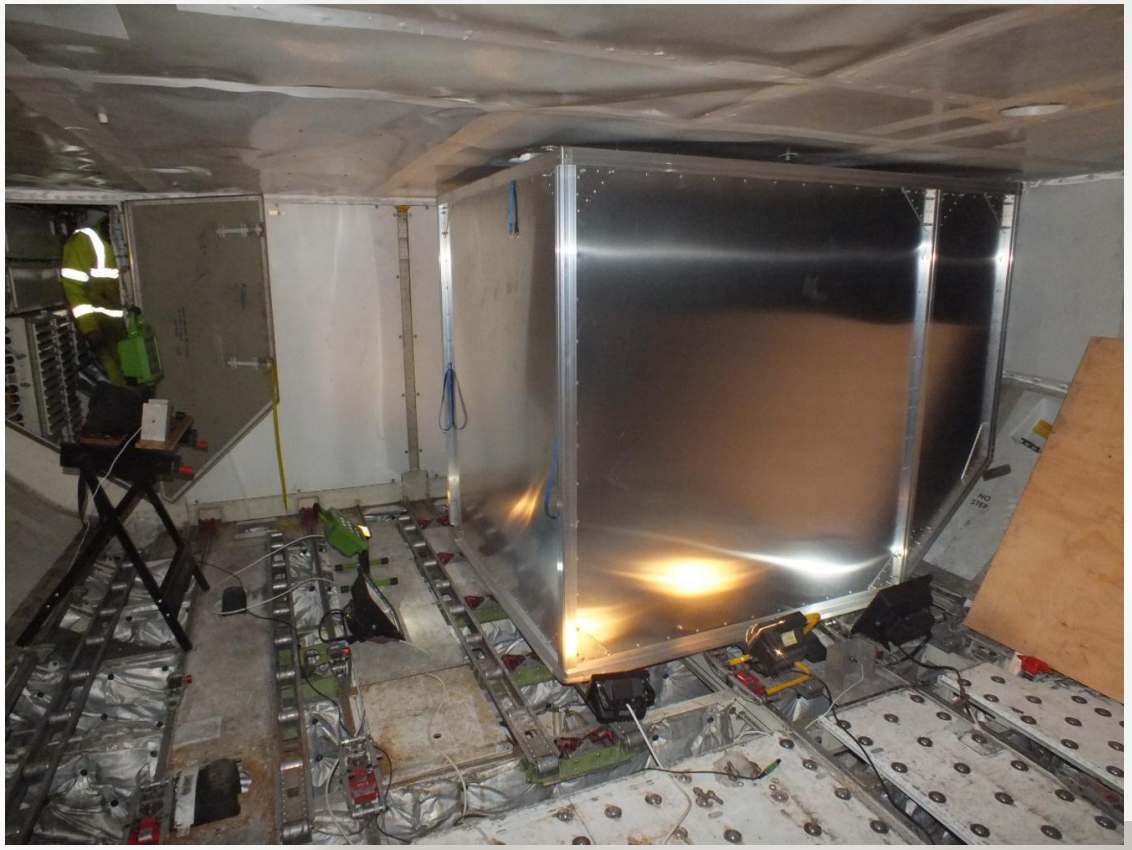
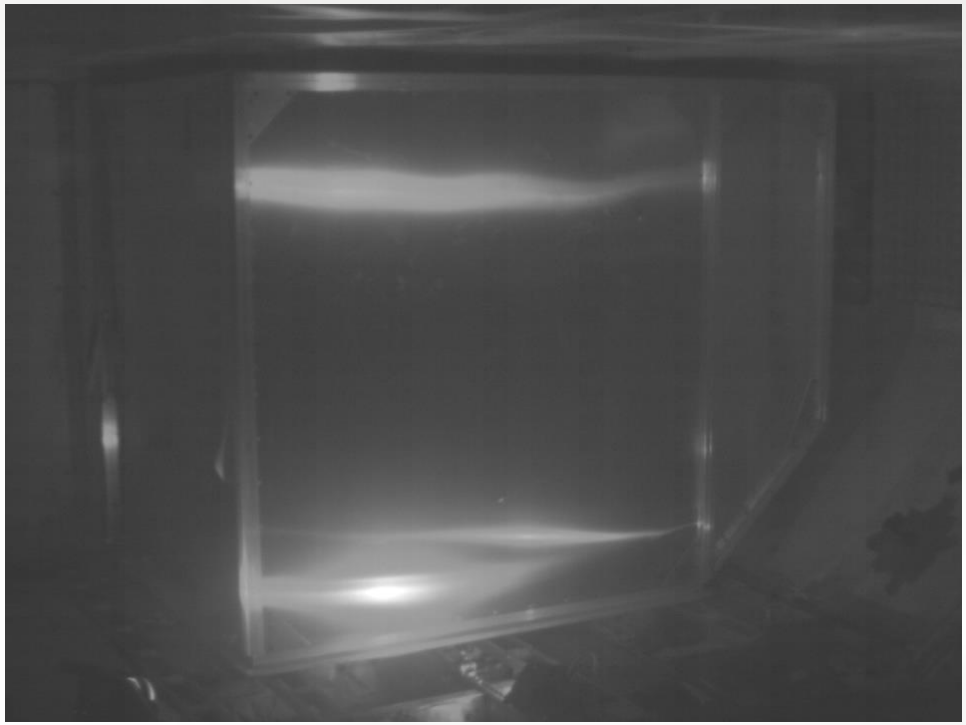
**NO DAMAGE OF THE FLY-BAG2 – BLAST TEST IN OPEN AIR**

# FLY-BAG2 AKE positioned in Forward Cargo-Hold of B747



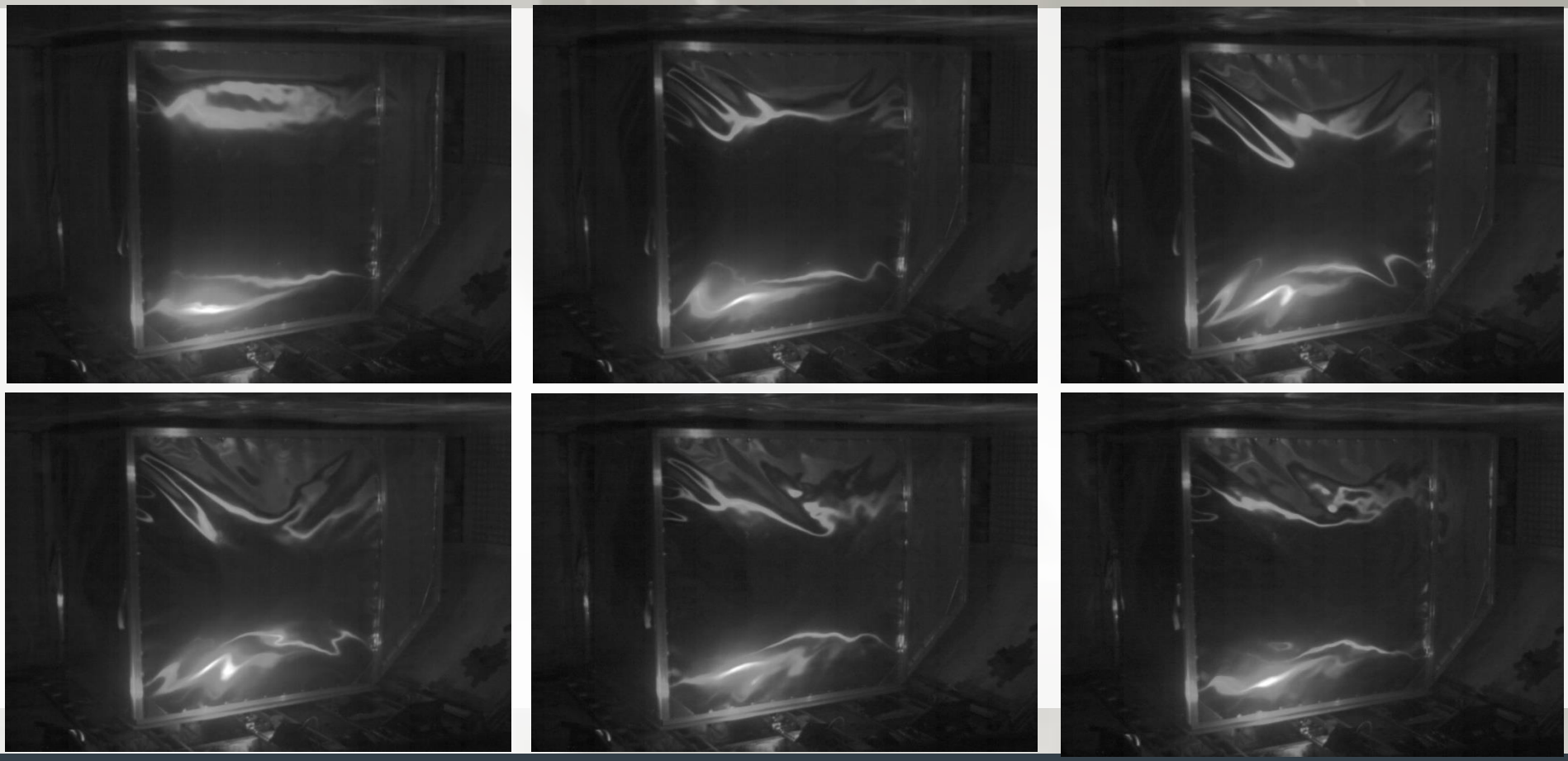
# Hybrid III Anthropomorphic Dummy – Blast Test on B747

# FLY-BAG2 AKE Version – Blast test on Boeing747



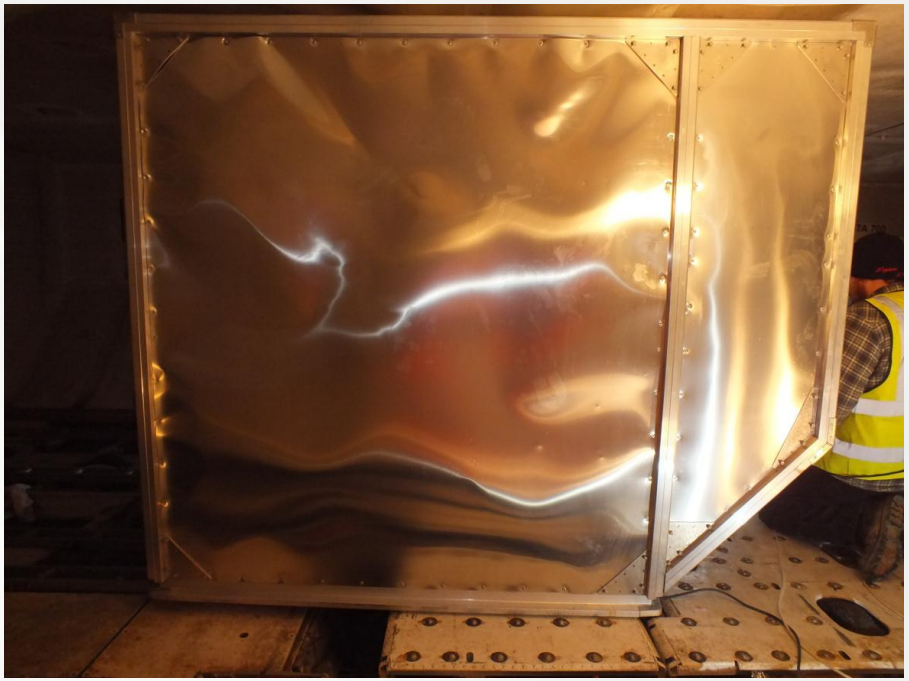
**NO DAMAGE OF THE FLY-BAG2 – BLAST TEST INSIDE A BOEING747**

# FLY-BAG2 AKE Version – Blast test inside a Boeing747



# Post-Test Internal View of FLY-BAG

# Post-Test External View of AKE



# FLY-BAG2 AKE – Results of Full Scale Blast Tests

- **FLY-BAG2 prototypes** are capable of containing the effects of the detonation of an explosive charge of mass **3.0W TNTeq**
- **non-structural damage to the aircraft**
- **no** significant, measurable **egress of blast pressure** in the hold
- no significant impact loading transmitted into the passenger compartment immediately above the location of the detonation.

# FLY-BAG2 Cabin Version

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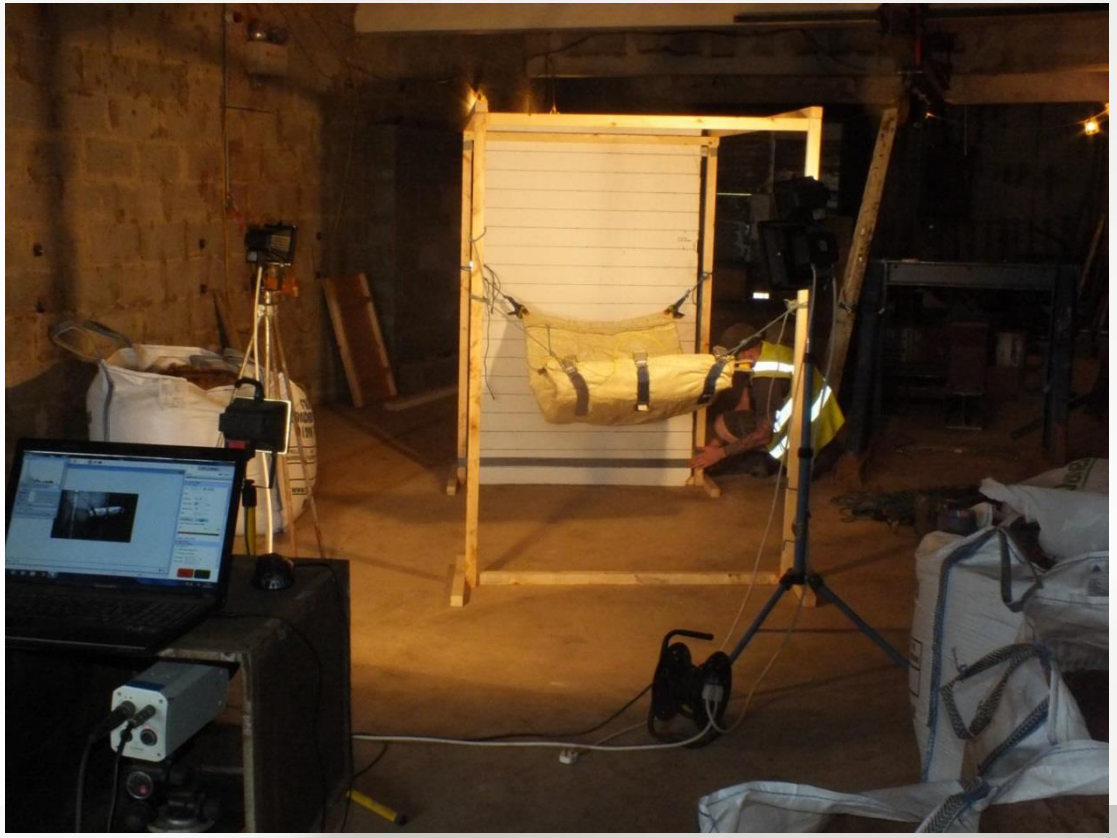
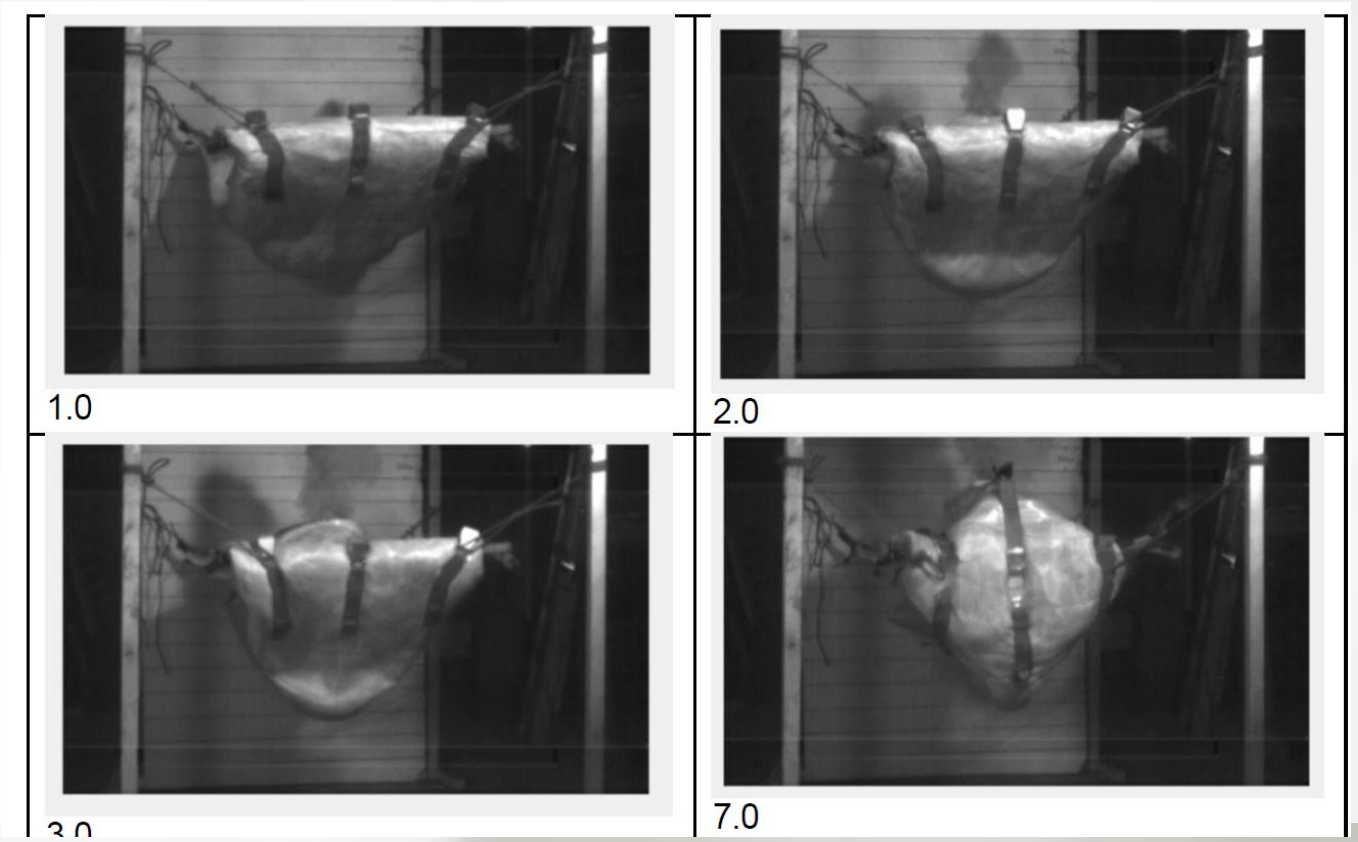
# FLY-BAG2 Cabin Version

- Preliminary tests were performed at lab scale
- Full-scale blast tests conducted inside a Boeing 747 (UK, Cotswold – Nov. 14)

# FLY-BAG2 Cabin Version



# FLY-BAG2 Cabin Version



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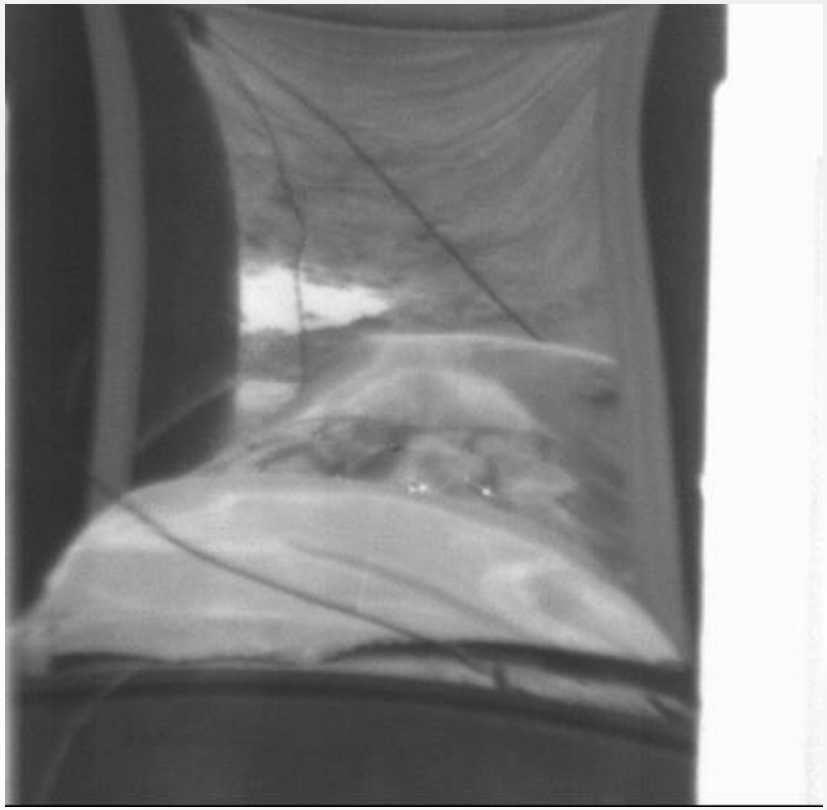

# FLY-BAG2 Cabin Version

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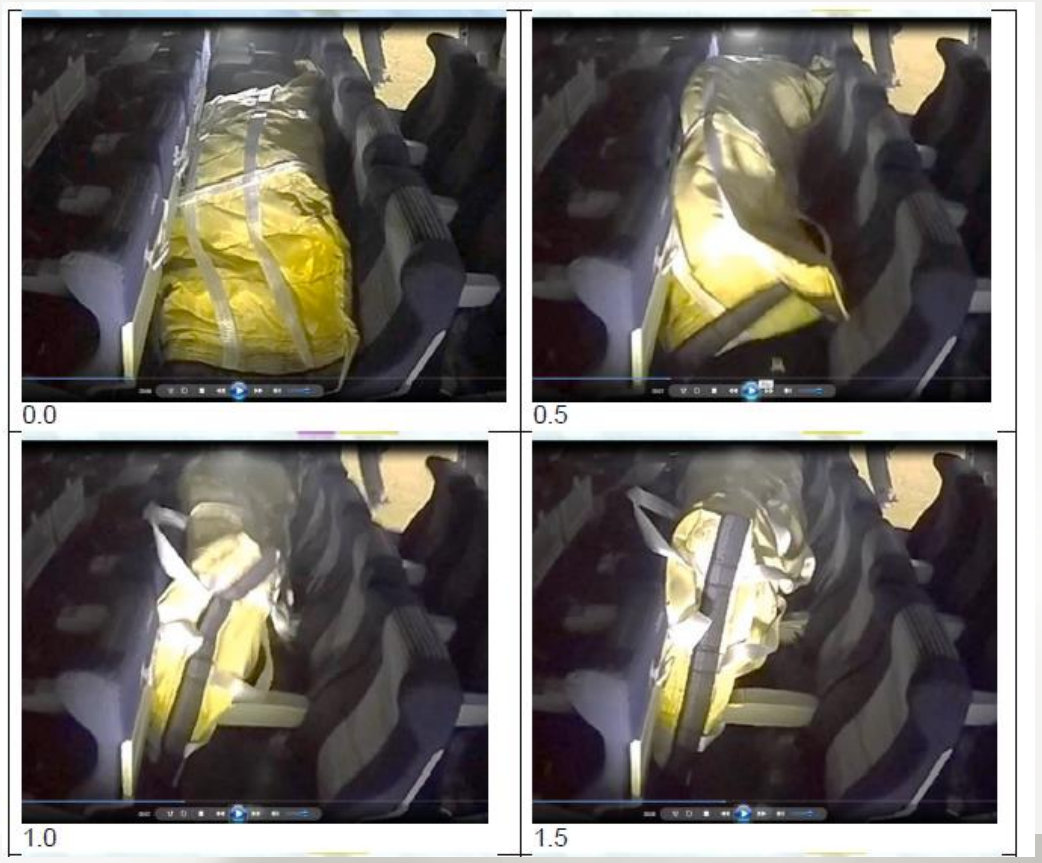

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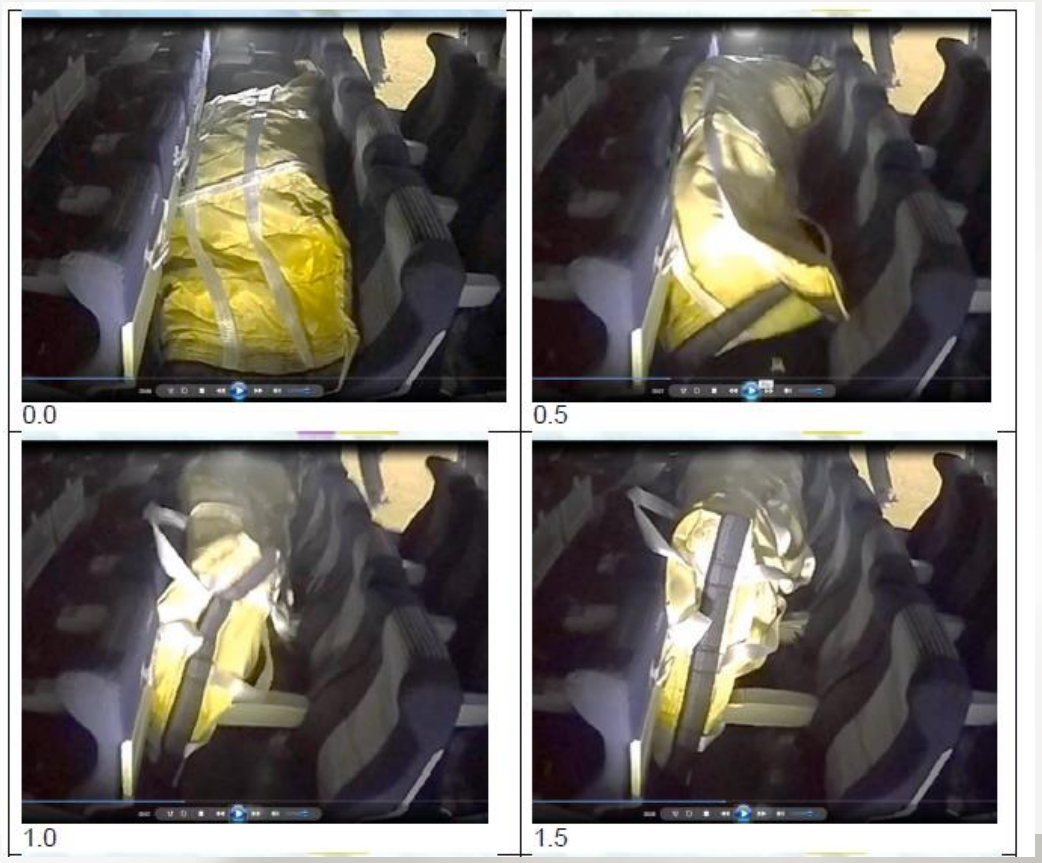
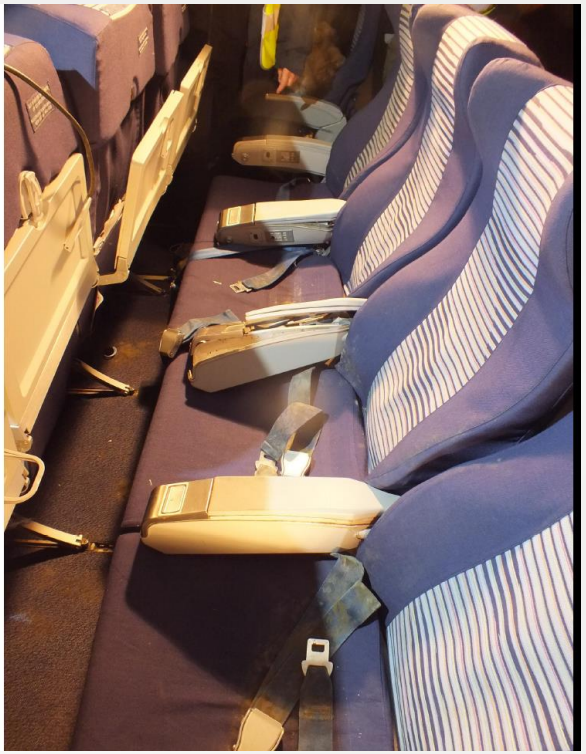


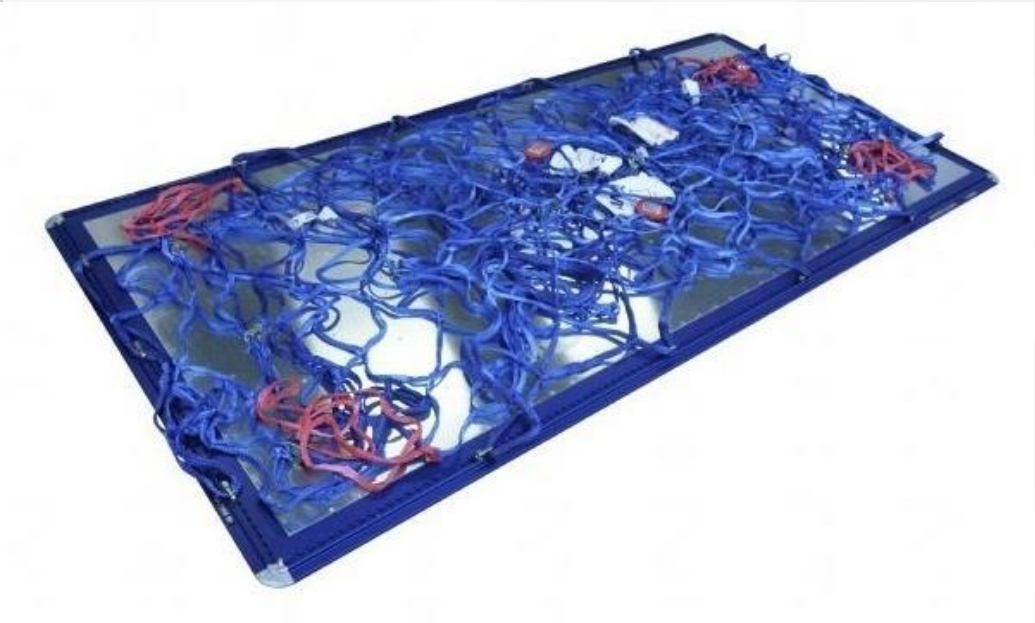
# FLY-BAG2 Cabin Version

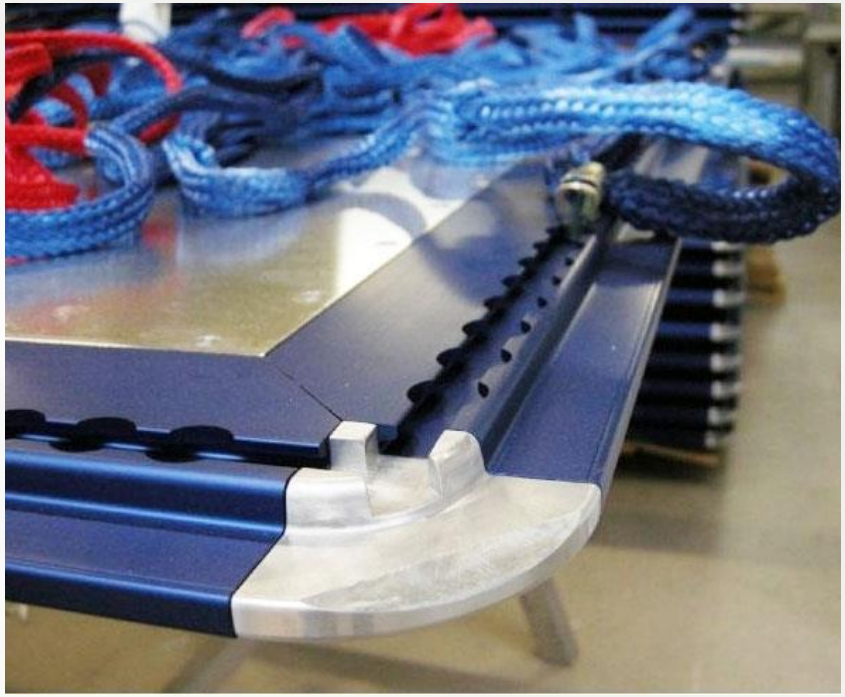



# FLY-BAG2 Cabin Version

- FLY-BAG cabin variant prototypes are capable of containing the effects of the detonation of an explosive charge of mass up to 1.5W TNTeq, without the failure of the outer envelopes of the protection system, or significant egress of blast pressure
- Tests conducted inside the aircraft indicate that the detonation of an explosive charge of mass up to at least 1.0W TNTeq, can be contained by the Fly-Bag cabin variant prototypes placed over passenger seats, with only localised and non-structural damage to seat-back tray tables and arm rests

# PMC P6P Pallet





# FLY-BAG2 PMC Pallet

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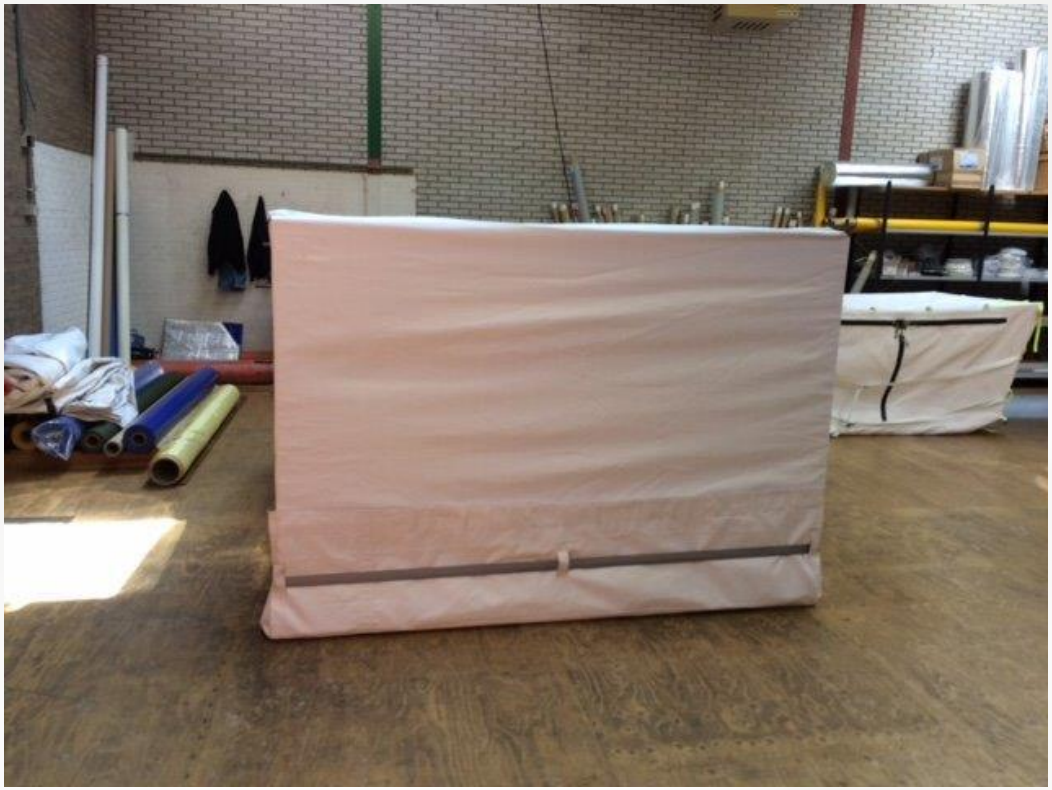

# FLY-BAG2 PMC Pallet

# FLY-BAG2 PMC Pallet – Stabilizer Rack

# FLY-BAG2 Cabin Version – Blast Test on Boeing747

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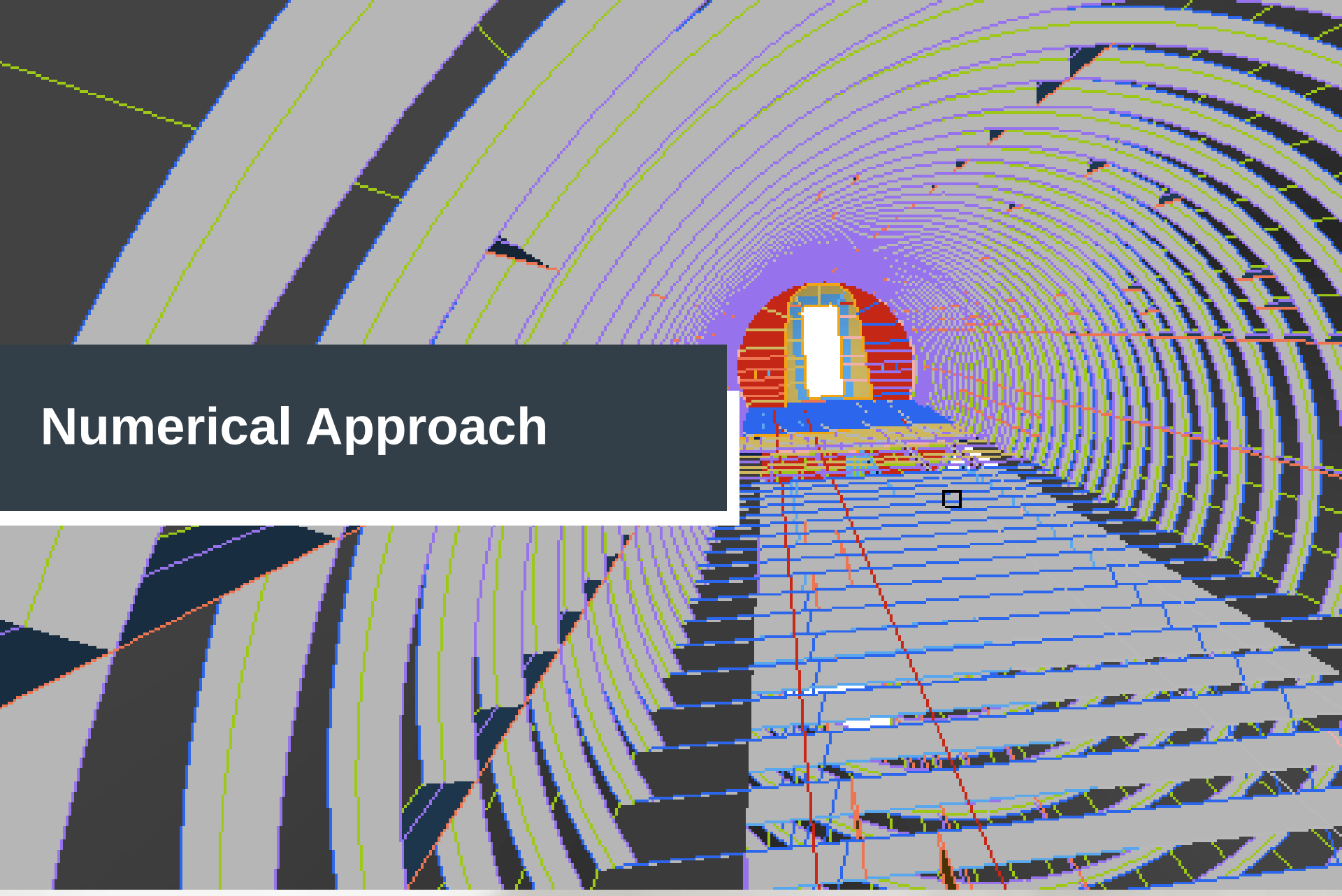
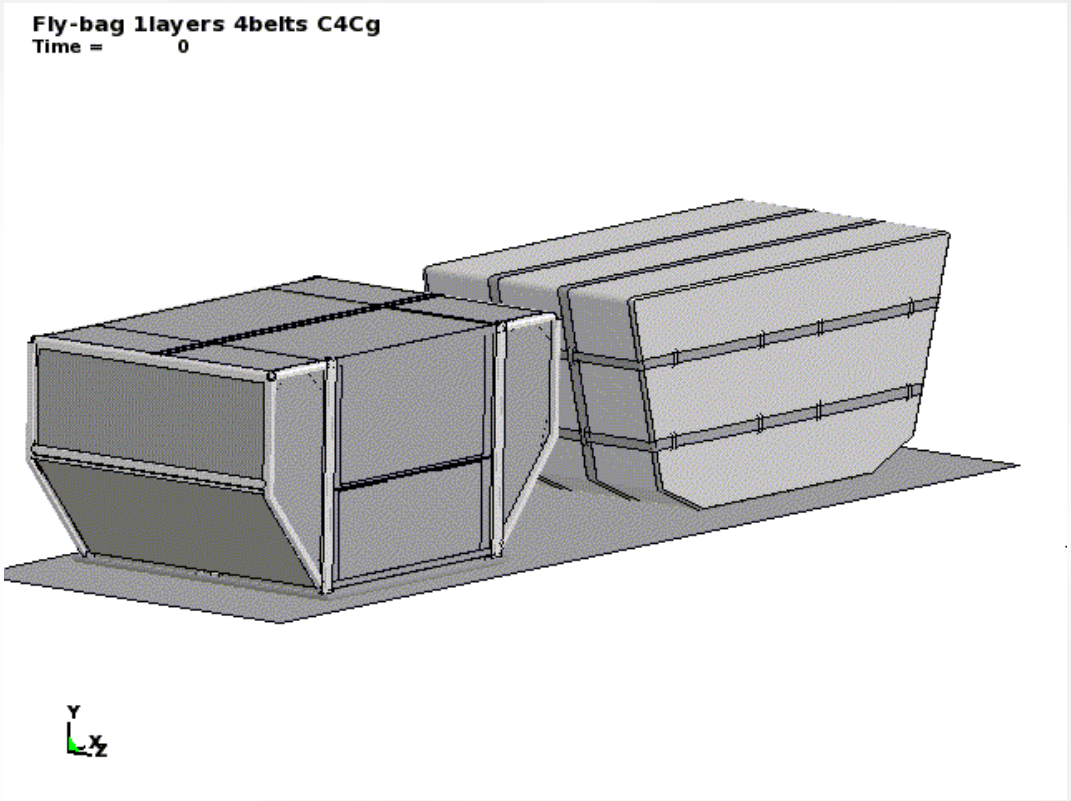
LINK TO VIDEO

**NO DAMAGE OF THE FLY-BAG2 – BLAST TEST INSIDE A BOEING747**

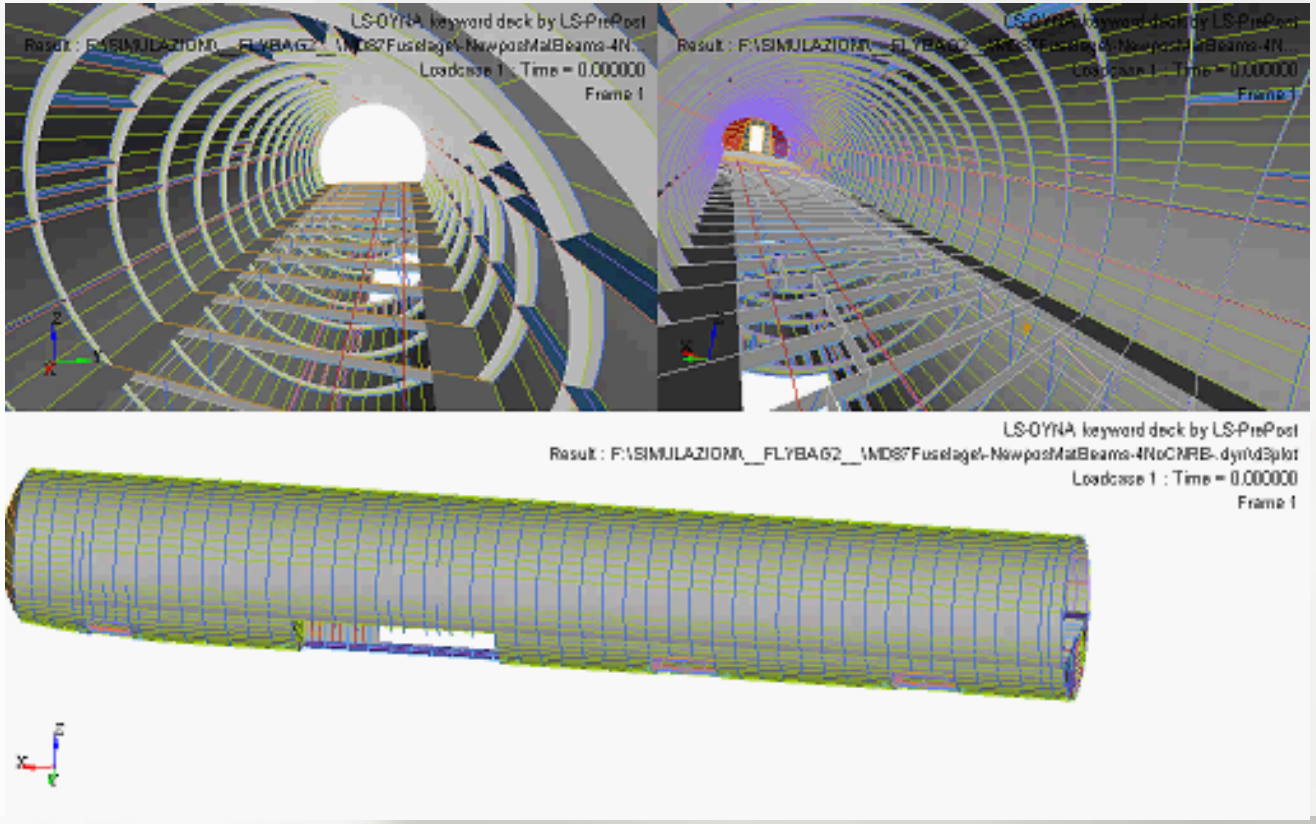
# Numerical Approach



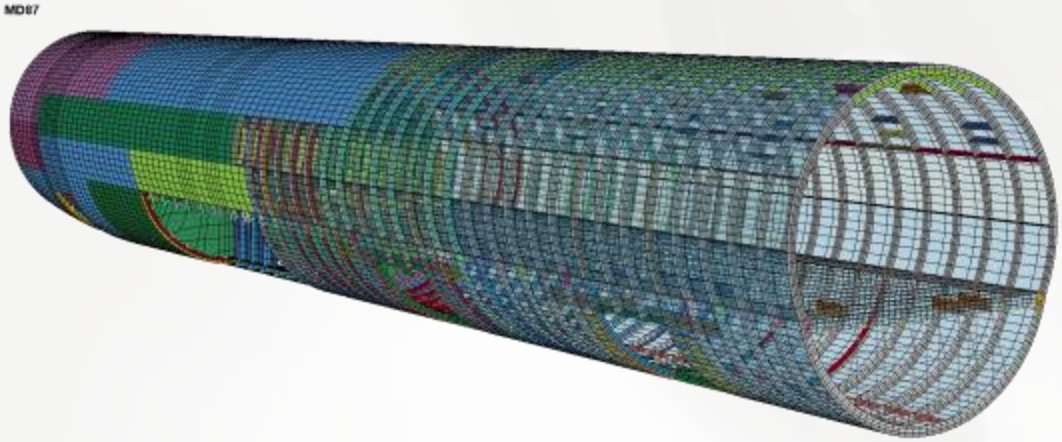
# FE Model of FLY-BAG

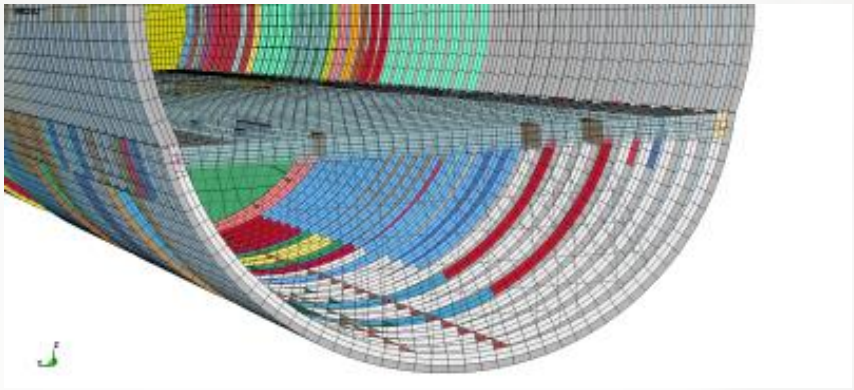


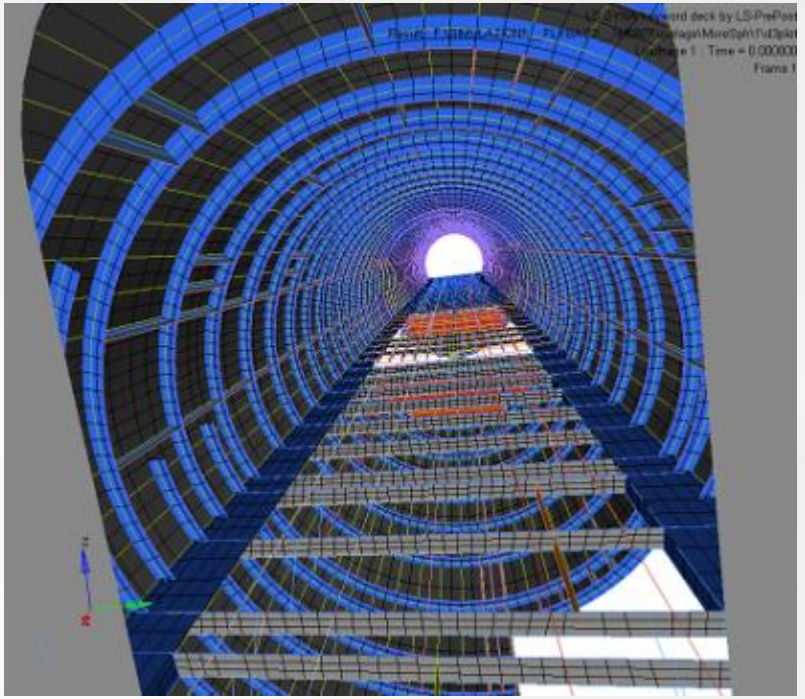
# FE Model of FLY-BAG



# FE Model of the MD80-87 Fuselage



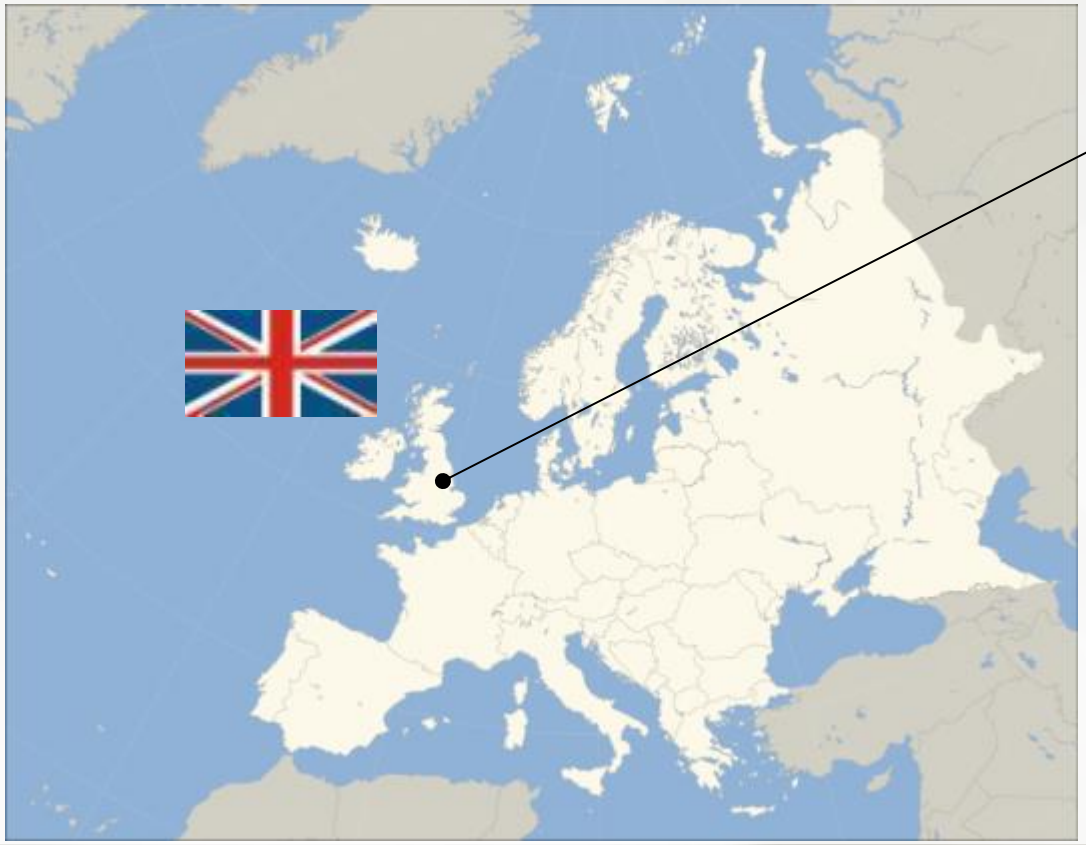


# Blast tests

# Full Scale Blast Tests

- Illustrate efficacy of FLY-BAG2 in wide and narrow body aircrafts
- Determine structural interactions between hold bag / cabin bag and aircraft
- Measure any physiological effects on passengers caused by event in hold / cabin contained within bag

# Full scale blast tests



UK, Cotswold Airport
Wide body aircraft - (Boeing 747) & Narrow body aircraft (Airbus A320) – Tests on Cabin Bag, AKE, PMC Pallet and Cargo Bag (A320) prototypes (20-21 July 2015)

# Results of Blast Tests on Boeing747

- A first set of full scale blast tests was carried out on a retired Boeing747 on November 2014
- Both FLY-BAG2 cabin and cargo prototypes were tested
- No damage after blast tests at the designed charge

# Conclusions

- Final full scale blast tests to test FLY-BAGs on narrow/wide body aircrafts (Boeing747, Airbus A320) are being performed in these days (from 20 to 31st July in Cotswold airport, UK)
- Patented technology
- No certification is needed for cabin bag, AKEs and PMC Pallet prototypes. Certification of FLY-BAG for A320 is on-going
- FLY-BAG cabin prototype is shown at **ASF Exhibition Stand**
- The project team is **looking for commercial exploitation** – contact us for more information!


Contact

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