BaToLUS

European programme for including increased battle damage resistance technology in UAV design and development.

Funded by EDA/FMV

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PROGRAMME PARTNERS

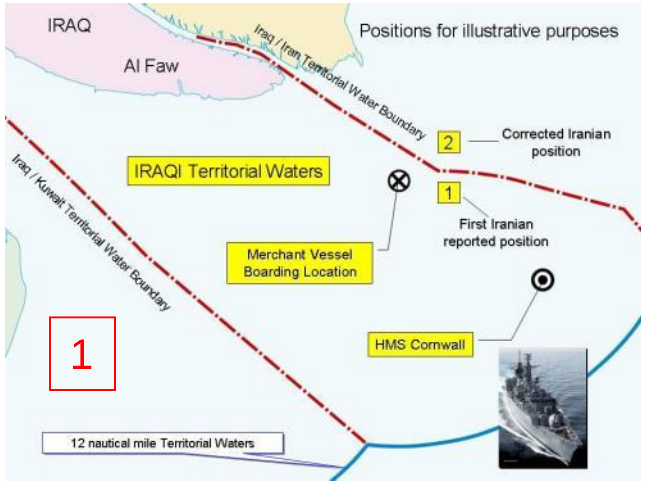
- 12 partners from 4 nations
  - Germany: Airbus DS, IABG, EMI, WIWEB
  - France: AGI, DGA-AS, CEA Gramat, ONERA
  - Sweden: SAAB, Dynamec
  - UK: BAES, DSTL
- Coordinated by Airbus DS
- 40 month project
- Funded by EDA

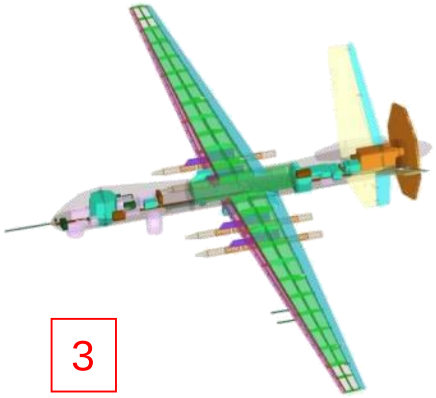
PROGRAMME OBJECTIVES

- Definition of a UAV design and development process for vulnerability improvement which can be integrated within a UAV design process.
- Demonstrate improvement of the current UAV modelling, simulation and design capabilities.
- Provide a guideline on the costs associated with the development of a vulnerability-improved UAV.

MISSION SCENARIOS

- Selected mission scenarios
    1. Land or maritime surveillance over a wide area for long periods of time
    2. Precision target location and identification.
    3. Hunter-killer strike.





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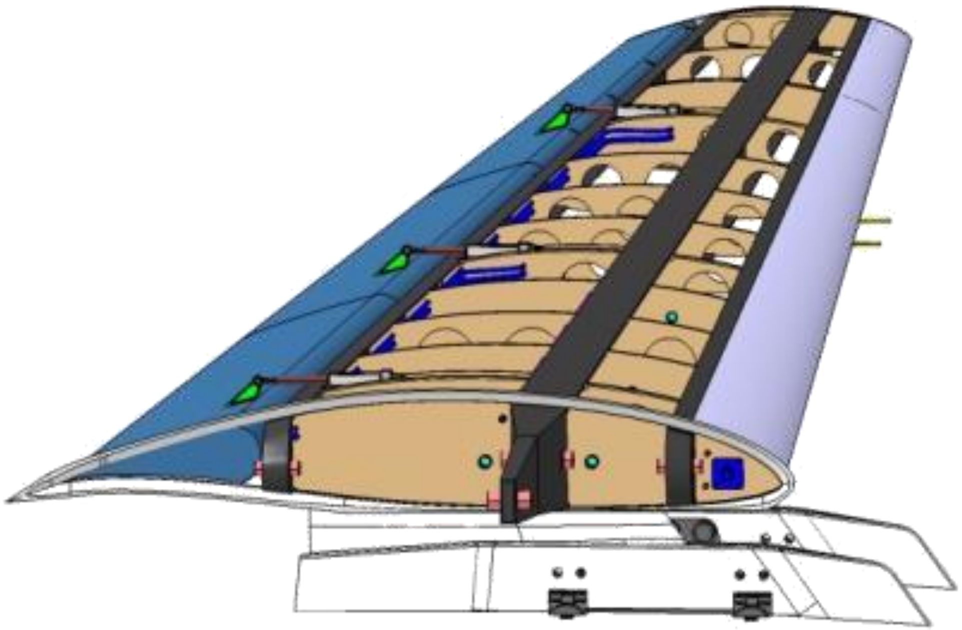
THREAT WEAPONS

Selected prioritised threats

- Surface-to-Air threats:
  - 7.62 mm rifle
  - 12.7 mm gun
  - 14.5 mm gun
  - MANPADS
  - 23 mm HEI projectile with impact fuze
  - 40 mm HE projectile with time/proximity fuze
  - Large SAM
- Air-to-Air threats:
  - Aircraft 30 mm gun
  - Light AA missile
  - Heavy AA missile

BASELINE AIRCRAFT STRUCTURE

- Conventional aircraft structure
- Light-weight
- Carbon fiber composite
- Application: MALE UAV (Medium Altitude Long Endurance Unmanned Aerial Vehicle)

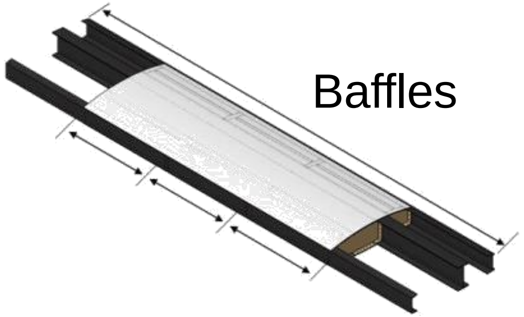


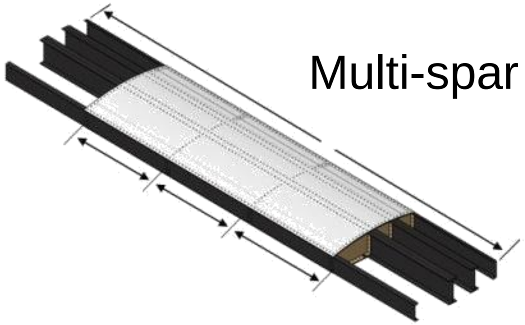
DAMAGE EFFECTS

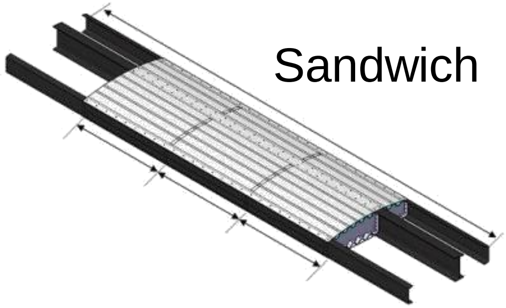
- Damage effects from conventional anti-aircraft weapon on a fuel filled wing structure
- Penetration
- Reduced structural strength
- Hydraulic ram
  - Over-pressure
  - Momentum

CANDIDATES FOR IMPROVED DESIGN

- 20+ candidates were proposed and evaluated
- 4 downselected candidates were evaluated in more detail
- The pressure vessel design was selected for demonstrator based on
  - performance (mass and endurance)
  - Hydrodynamic RAM performance
  - wing manufacturing recurring and non-recurring costs
  - novelty (BaToLUS is seen as an opportunity to validate new concepts, not slight modifications of proven designs)

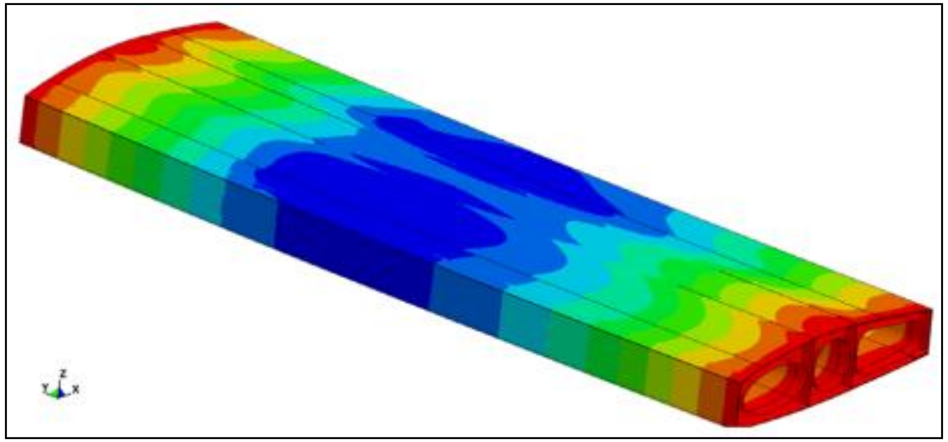


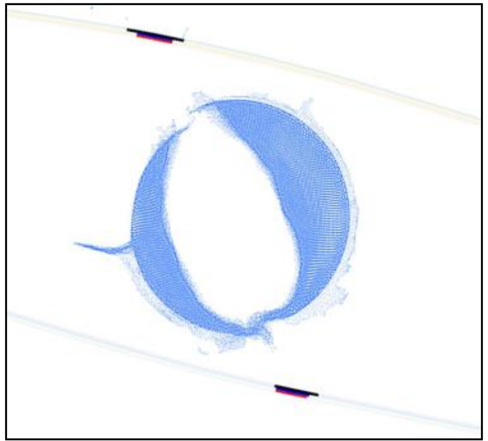




FEM ANALYSIS

- Static sizing of demonstrator before manufacturing
- Ballistic impact simulation with / without pre-loading including planned test parameters
- Ballistic impact simulation with / without pre-loading including actual test parameters
- Parametric study





- The simulations showed no critical or even catastrophic failure.

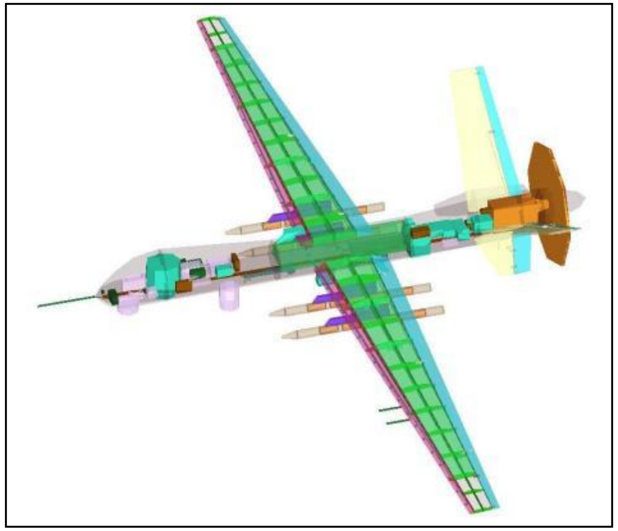
DEMONSTRATOR TESTS

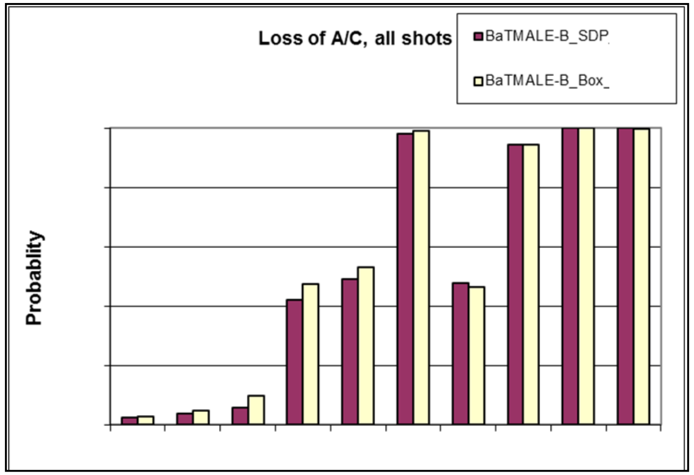
- Pre-loading during impact test (representative structural load during a flight maneuver = limit load)
- High velocity impact with a steel sphere
- Tanks completely filled with water
- Data acquisition
- Applying of post-load up to ultimate load
- Data acquisition
- No catastrophic failure
- Damages in test less than in simulation predicted

VULNERABILITY ANALYSIS

- The vulnerability analysis were carried out with AVAL and INTAVAL. The simulations were performed for the baseline and the improved design including a comparison.

- The comparison showed an improvement of the structural behaviour regarding vulnerability. The overall results may not increase too much as the main reason for failure are the components (systems).





CONCLUSIONS

- New rapid prototype modelling capabilities have been developed
- A generic design process, which includes high-fidelity simulation methods have been successfully demonstrated
- A large number of structural concepts for vulnerability-reductions have been identified, and one of them implemented and tested successfully
- Impact on weight and tank volume capabilities has been identified, individual optimisation is required
- The comparison between test and simulation showed a good match for both demonstrators. Only the damage prediction for the tube in the wing demonstrator was more conservative in the simulation compared to the test results

THANK YOU!