OHB System AG
Gerrit Proffe
25.10.2017, Clean Space Industrial Days 2017, ESTEC

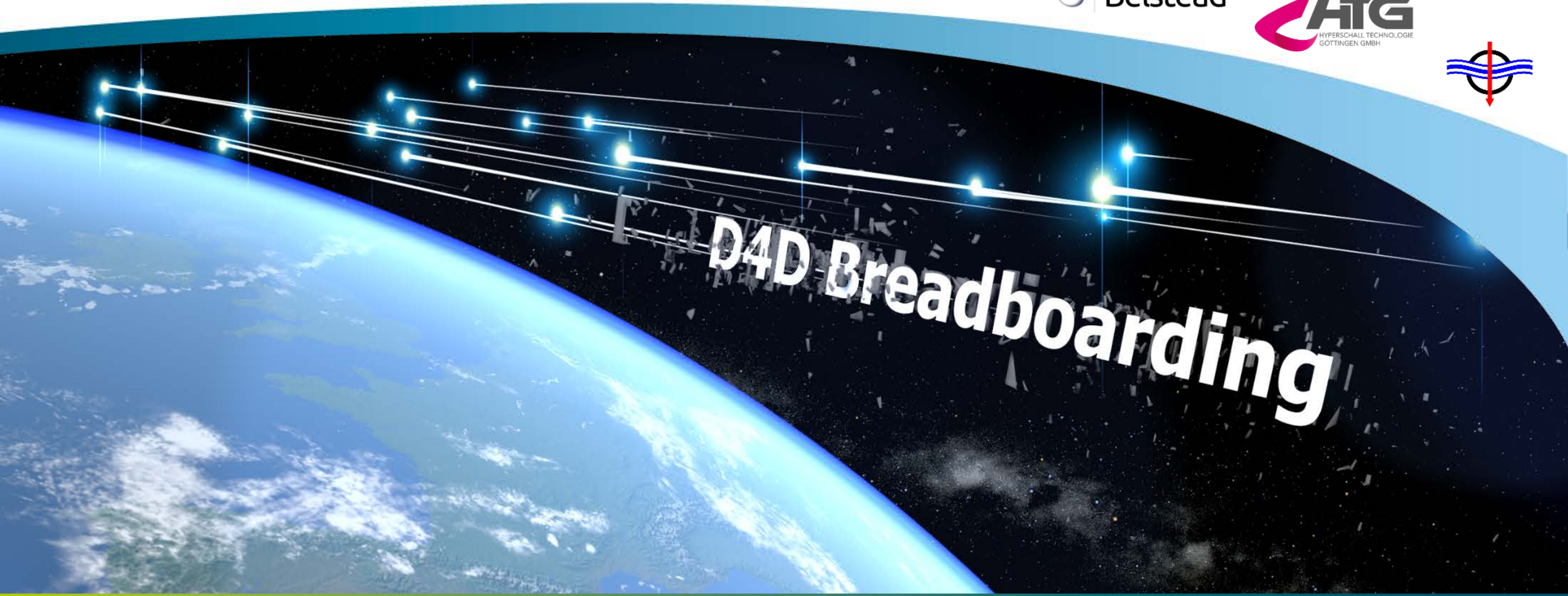
OHB

DLR Institute of Aerodynamics and Flow Technology

INVENT

Belstead

HTG HYPERSCHALL TECHNOLOGIE GÖTTINGEN GMBH



SPACE SYSTEMS

Multi-Disciplinary Design and Breadboarding of Technologies for Early Break-up of S/C during Re-entry

We. Create. Space.

Agenda

- Objectives
- Study Overview
- What has been done so far?
- Actual Status
- Next Steps

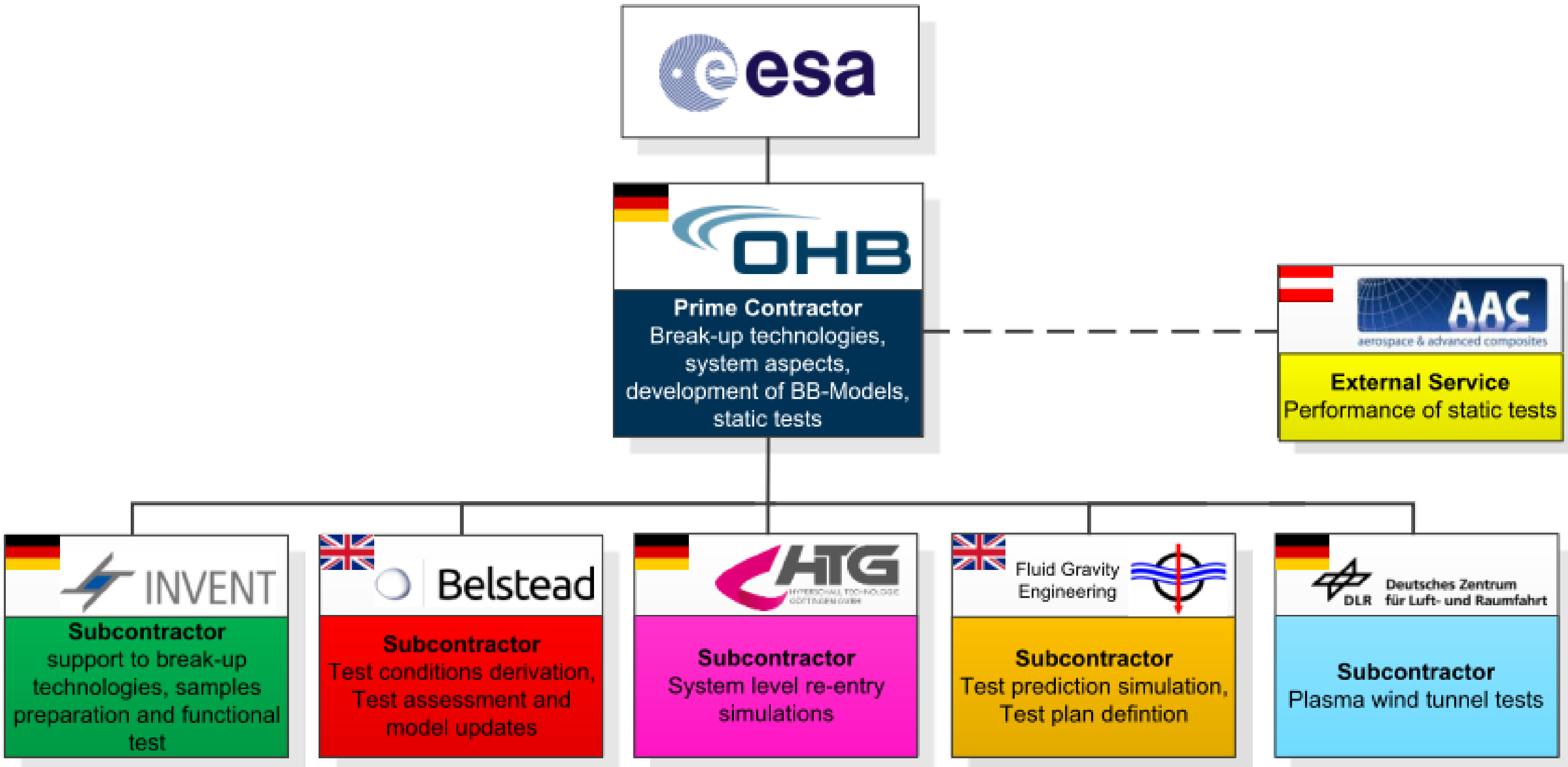
Objectives of the Study

The objectives of the activity are

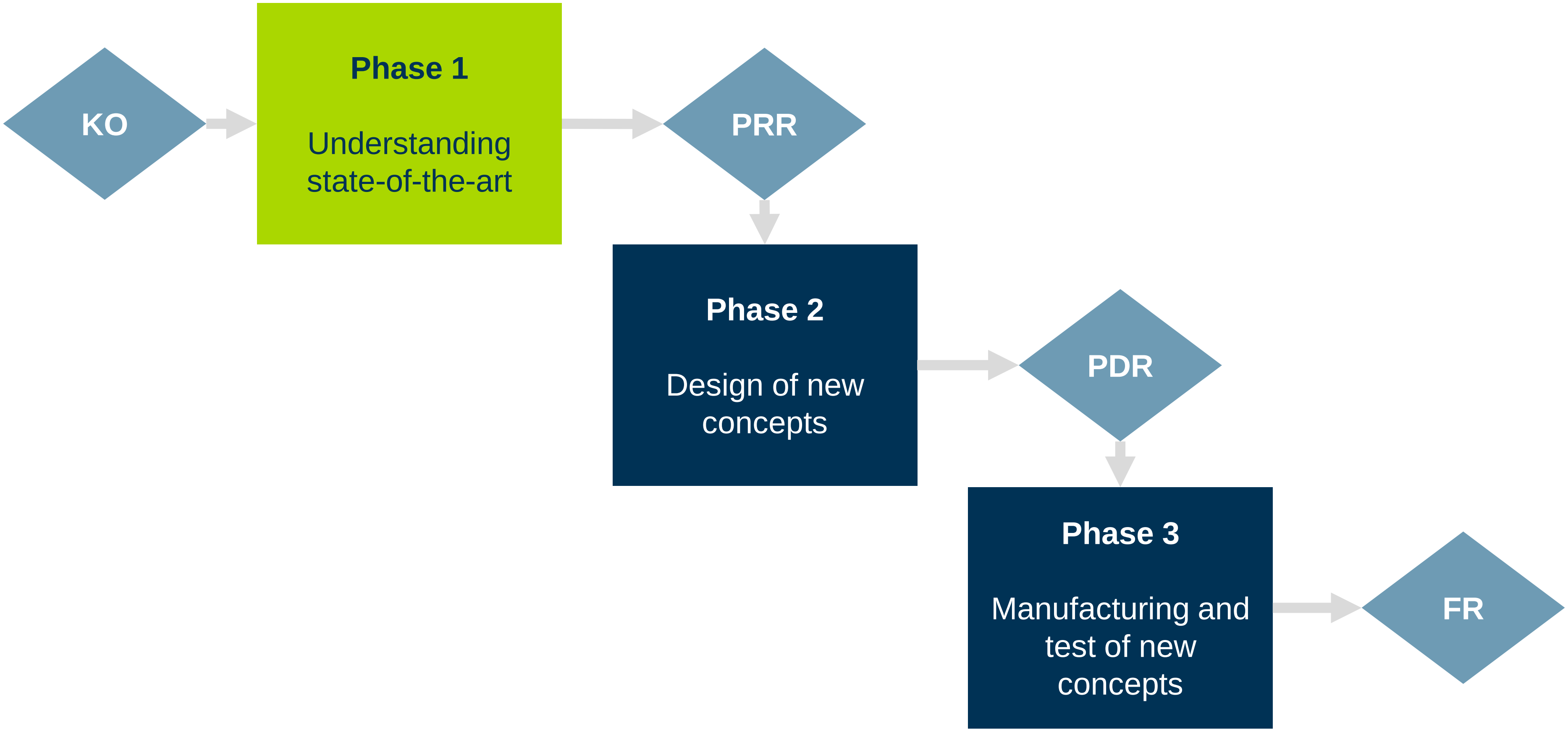
- To define feasible design concepts to achieve a spacecraft structure break-up or structure opening at an altitude above ist natural break-up altitude and
- To demonstrate the feasibility of selected technologies by breadboard development and testing.

- Focus is set on technologies to open and/or release external structural elements and spacecraft modules (e.g. payloads and large appendages) to increase the overall spacecraft demisability

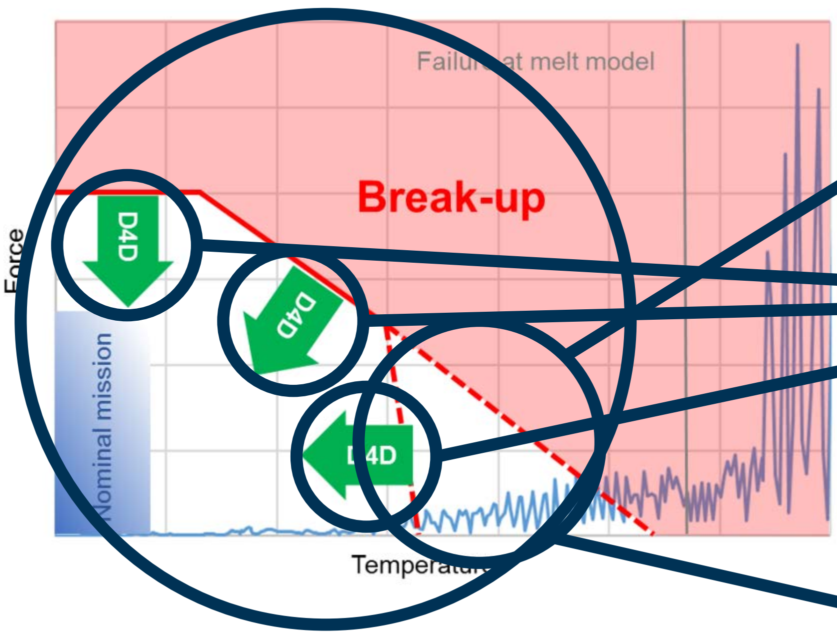
The team to bring D4D to breadboard level



Study Overview



Technologies to increase a satellite‘s break-up altitude



Phase 1

Understanding state-of-the-art

Phase 2

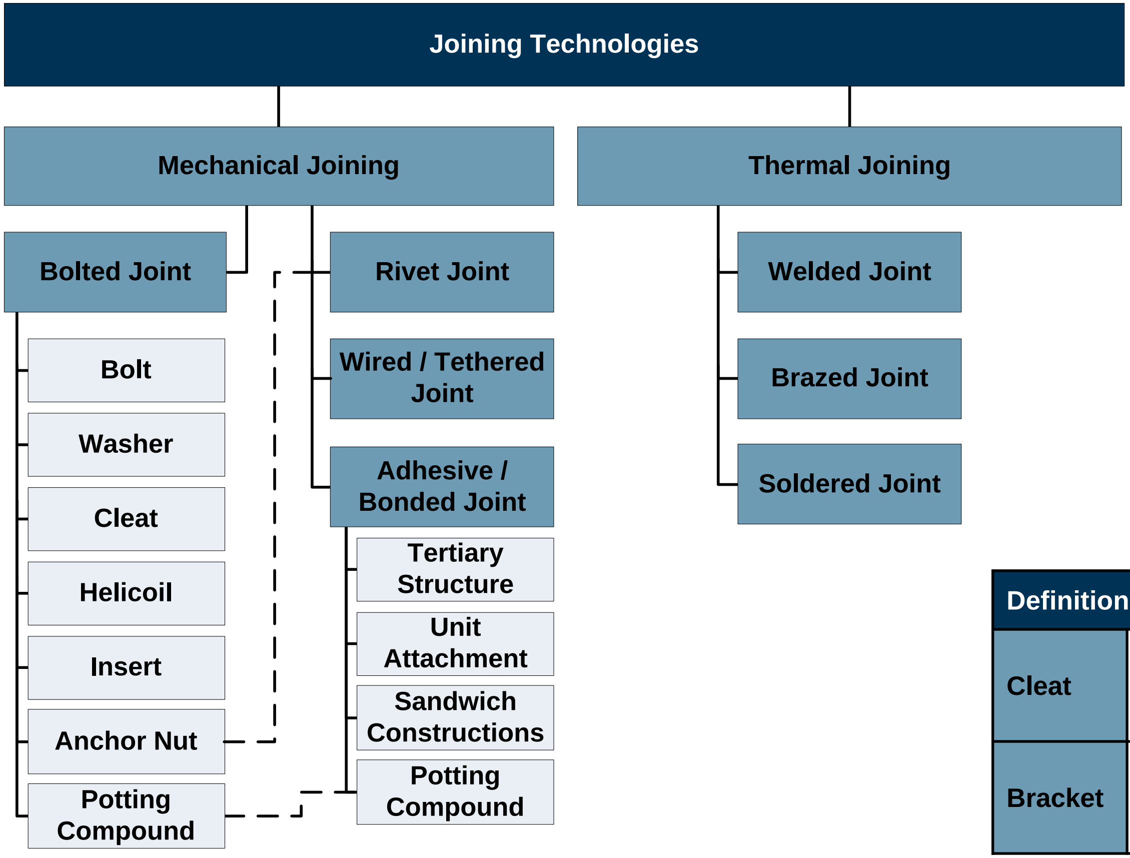
Design of new concepts

Phase 3

Manufacturing and test of new concepts

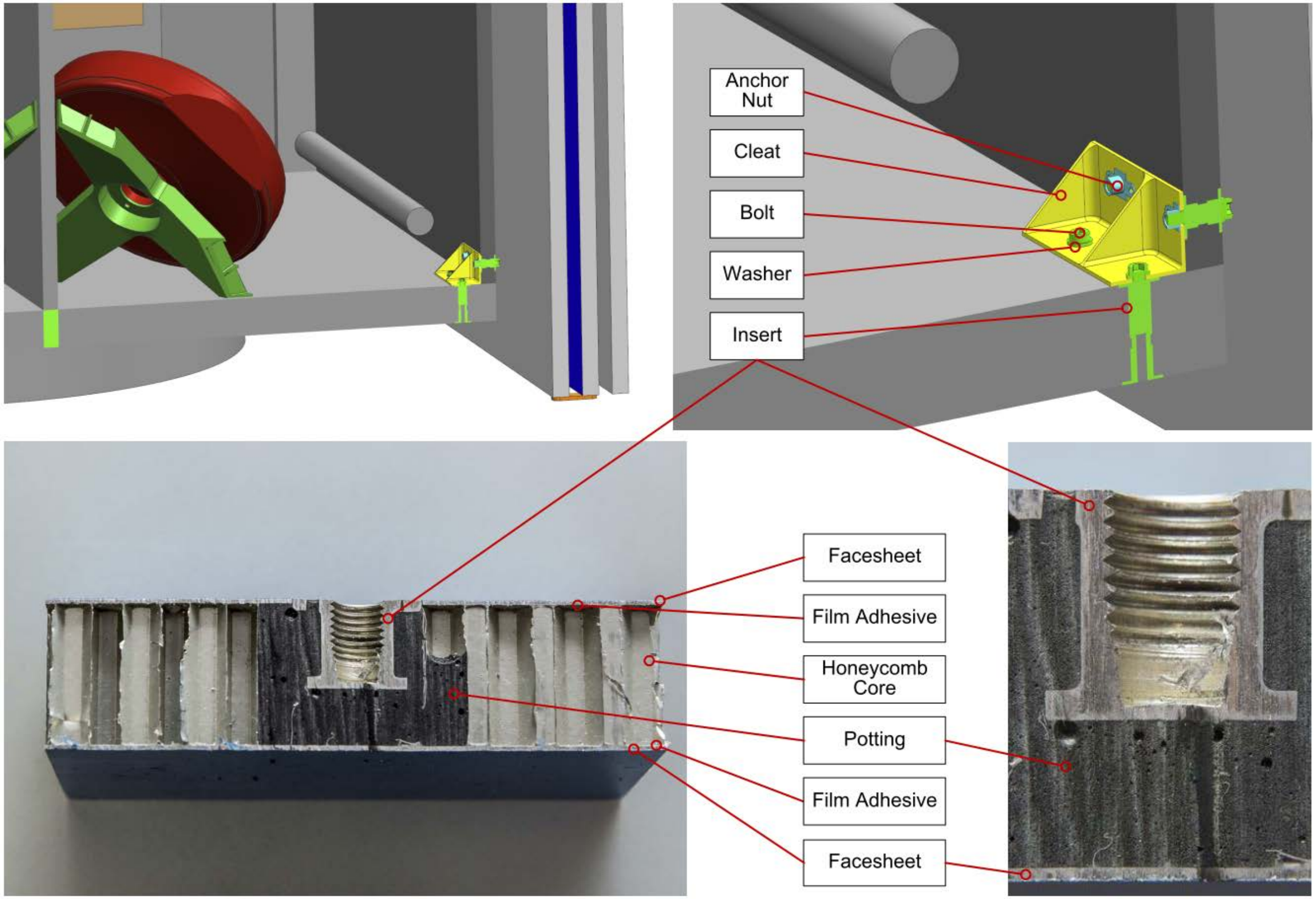
Identification of existing Joining Technologies

"Joining technologies are components, parts or materials which connect structural elements or equipment of the spacecraft."

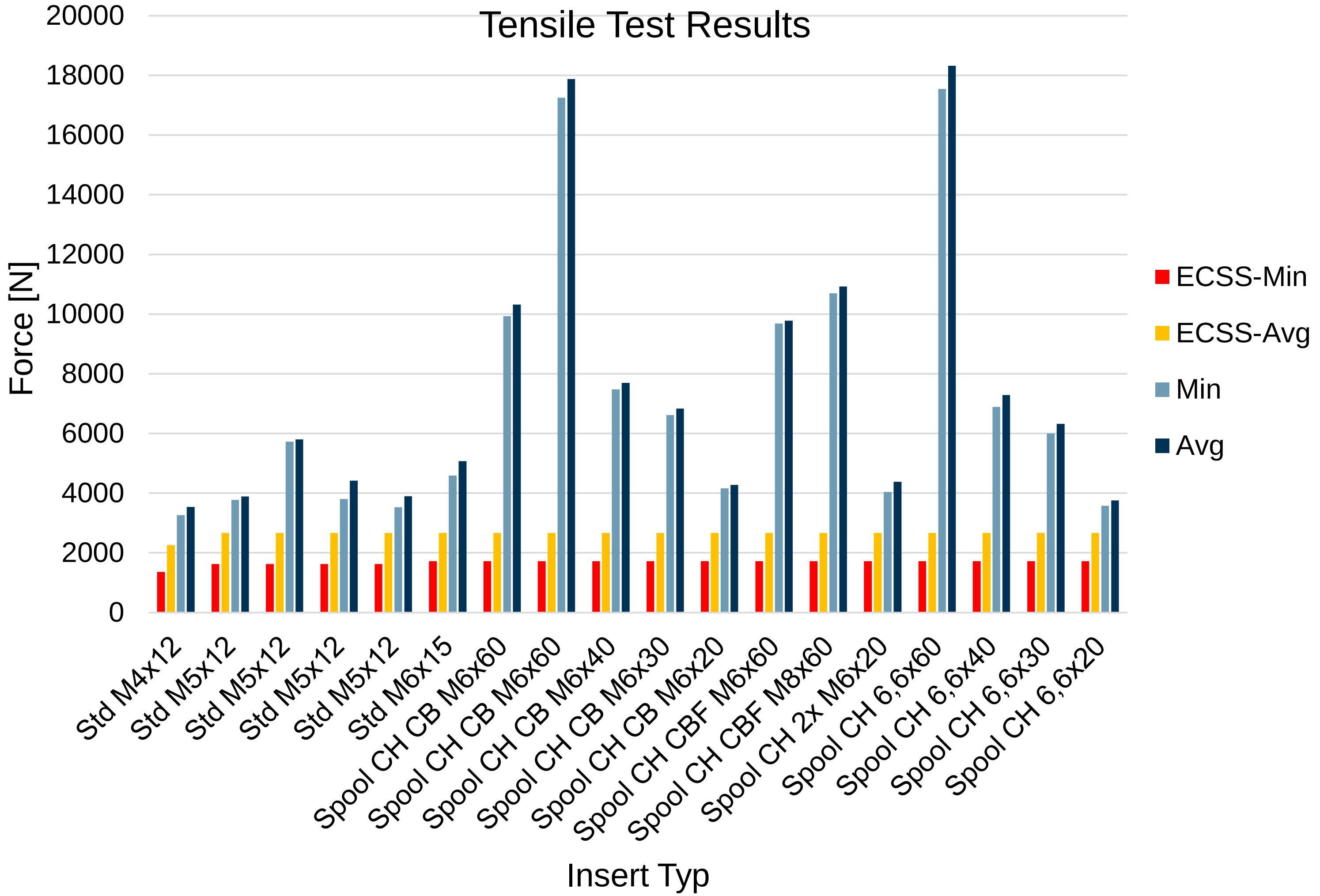


Definitions	
Cleat	A joint that is used to connect the panels of a spacecraft.
Bracket	A joint that is used to mount units and electronic boxes onto the panel.

Relevant Joining Technologies for D4D Breadboarding

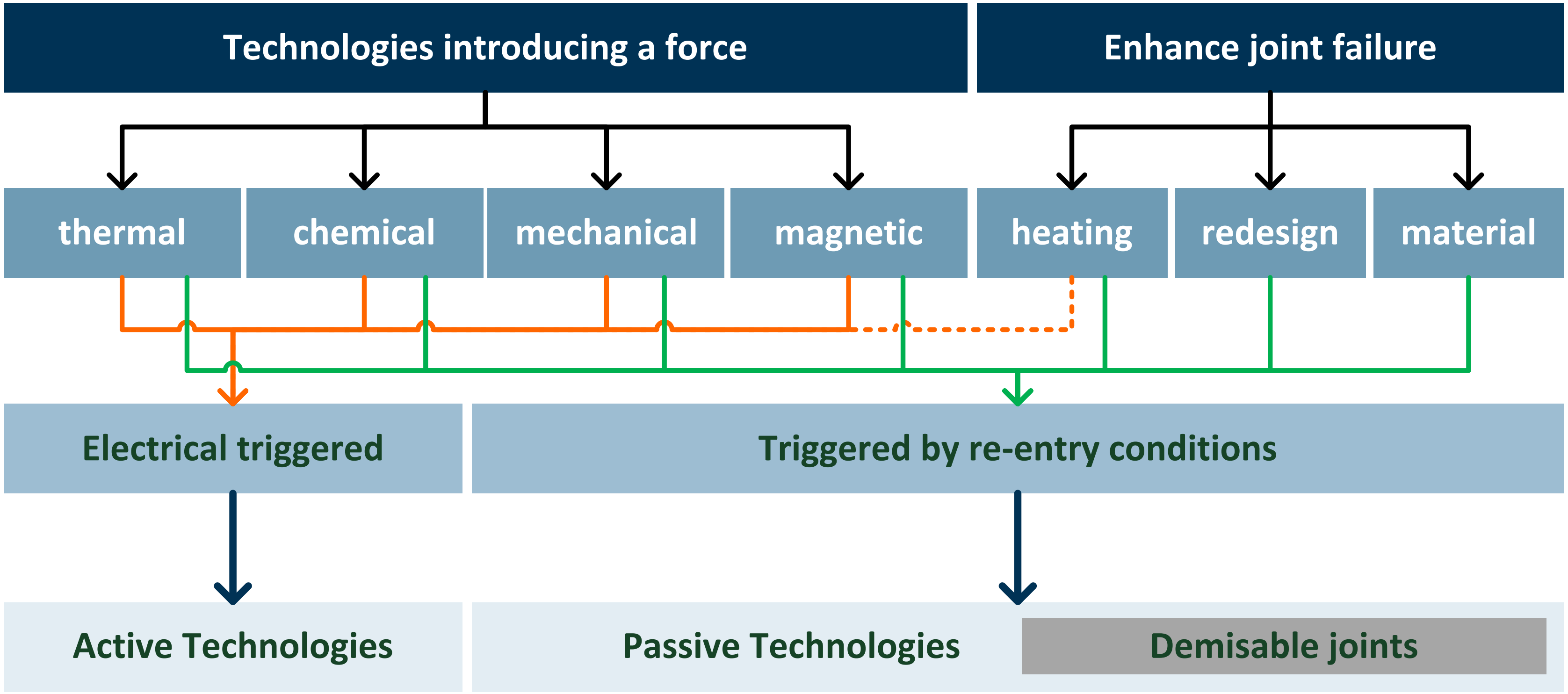


Load Capacity of Structural Joining Technologies



Identification of active and passive technologies

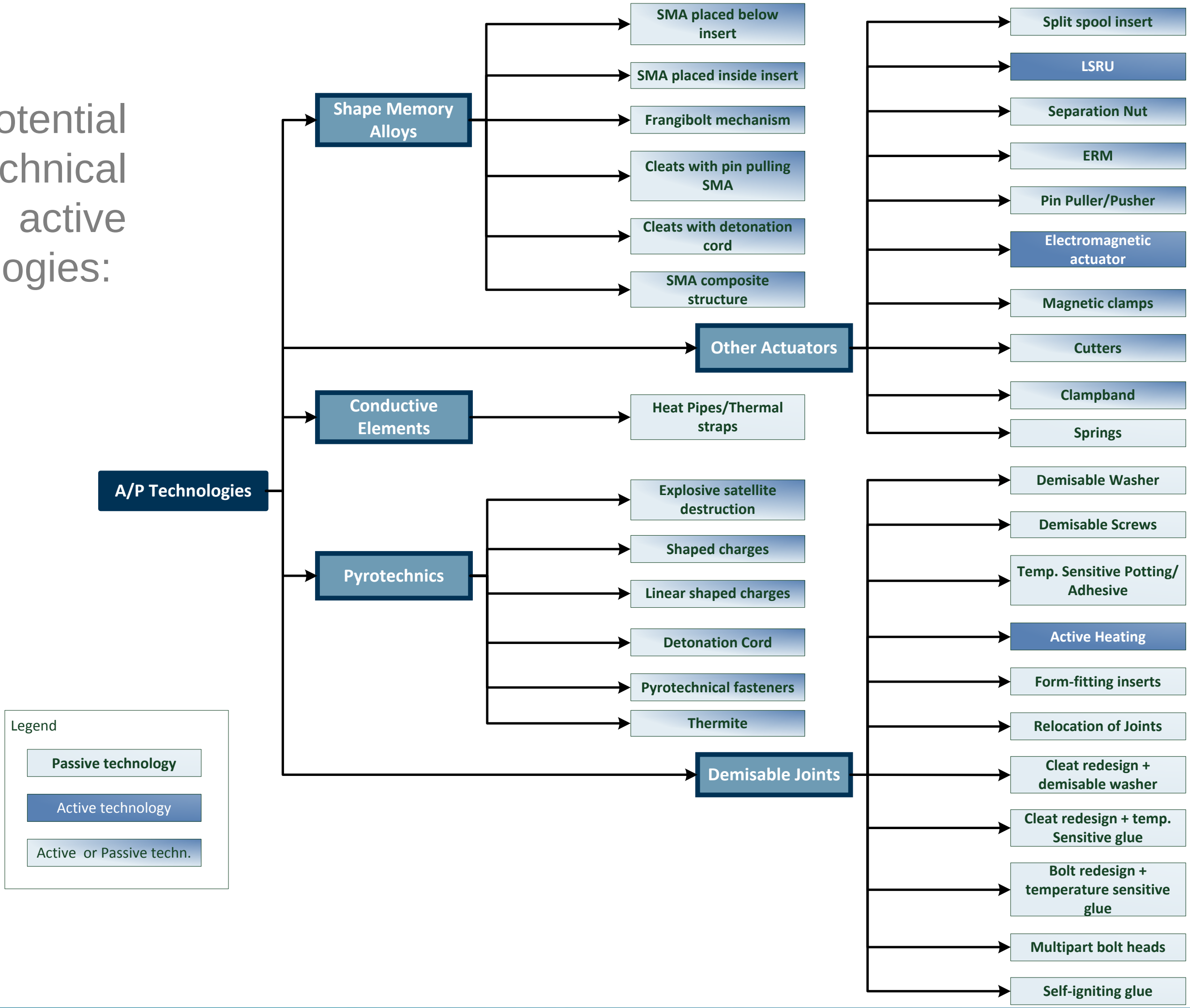
- Where to start? What kind of technologies can be used?



Identification of active and passive technologies

- Total number of potential concepts for technical implementation of active and passive technologies:

31



Analysis of environmental loads, derivation of test conditions and test plan

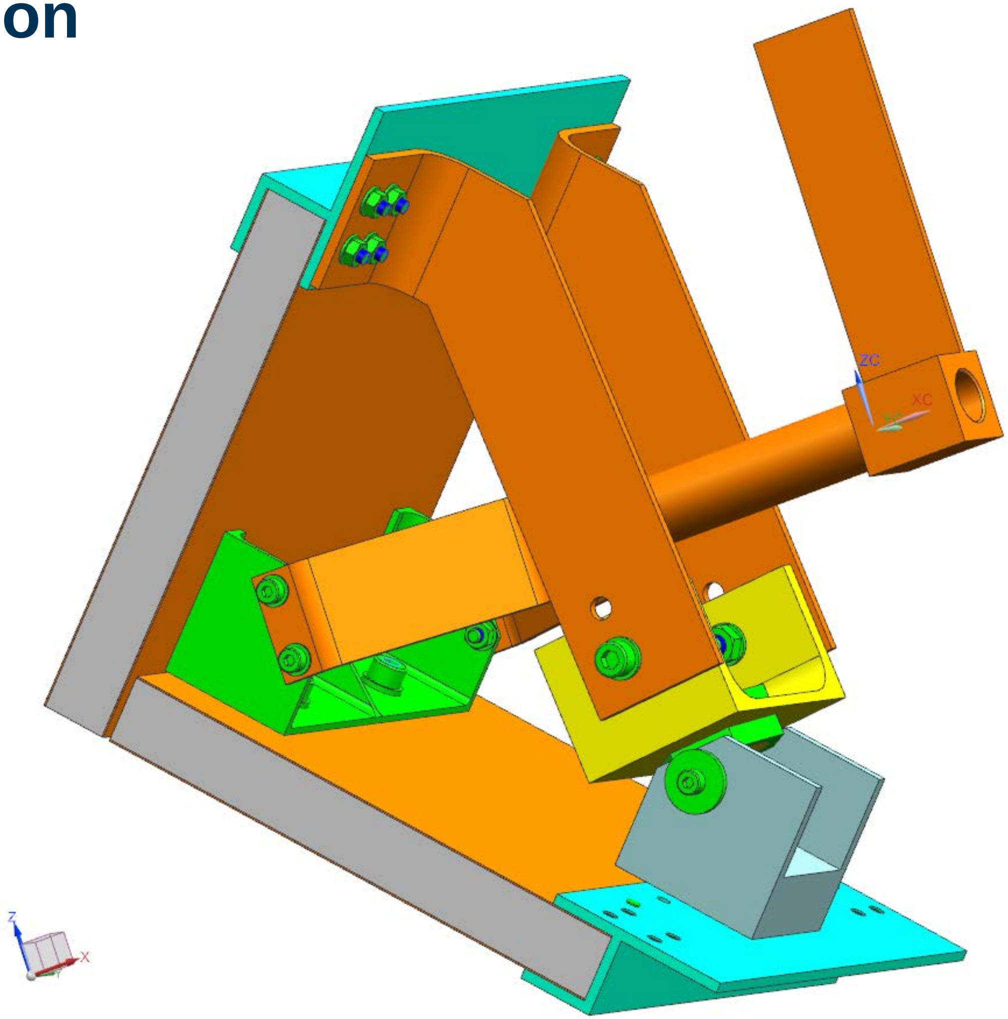
- Representative Flight Conditions Established
  - External environmental conditions
  - Expected thermal response of materials
  - Expected stress response of materials
- Derivation of Test Conditions
  - Representative trajectory may be important for heat soak
  - Constant flux tests for read across to wind tunnel
- Derivation of Test Plan
  - Many parameters to influence the test results (list on the right)
  - **A full factorial test would require >70 Million tests !**
  - Reduction of varied parameters is based on engineering judgement
  - General approach:
    - One baseline test configuration
    - Variation of individual single parameters from the baseline
      - Variation of multiple parameters where coupling effects are expected

Heat flux
Stagnation point pressure
Trajectory type
Flow direction
Mechanical load
Load type
Connection type
Facesheet material
Facesheet thickness
Core material
Core thickness
Core cell dimensions
Core cell wall thickness
Insert type external
Insert type internal
Insert material
Potting type
Potting system
Facesheet glue
Insert size

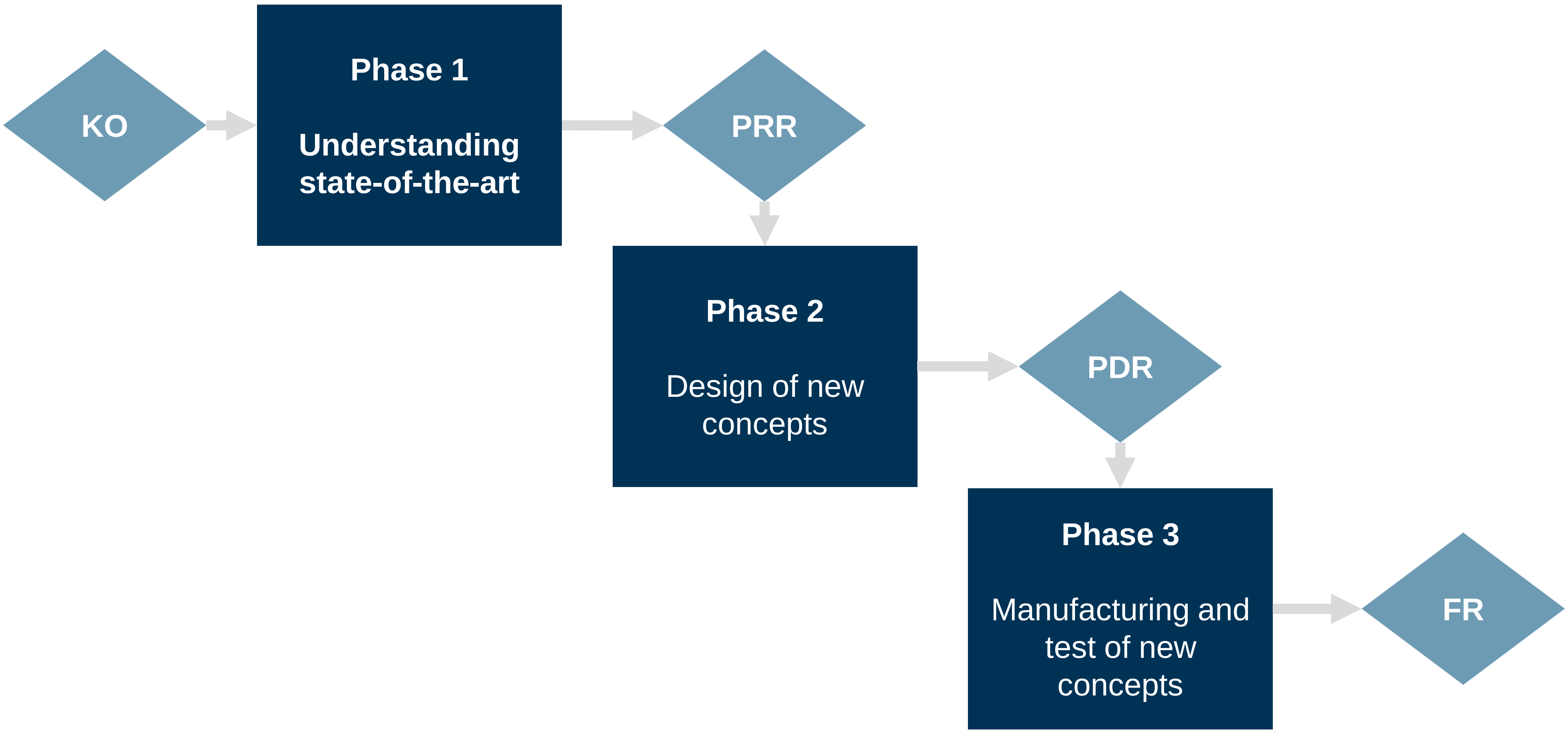
Preparartion of test prediction simulations

- CFD – to support prediction of wind tunnel forces expeted on surface of test articles
  - given sample dimensions and test conditions aerodynamic forces upon surface can be estimated
- Thermal Modelling – representative of test articles (applicable to both facilities)
  - Static facility
    - Given radiative heat flux – thermal analysis of model can be undertaken
    - Geometry likely to be simplified/broken-up for analysis and developed/combined with time
  - Wind tunnel
    - Convective heat flux upon surface more difficult to estimate
    - Geometry again simplified at first

Test and sample preparation



Next Steps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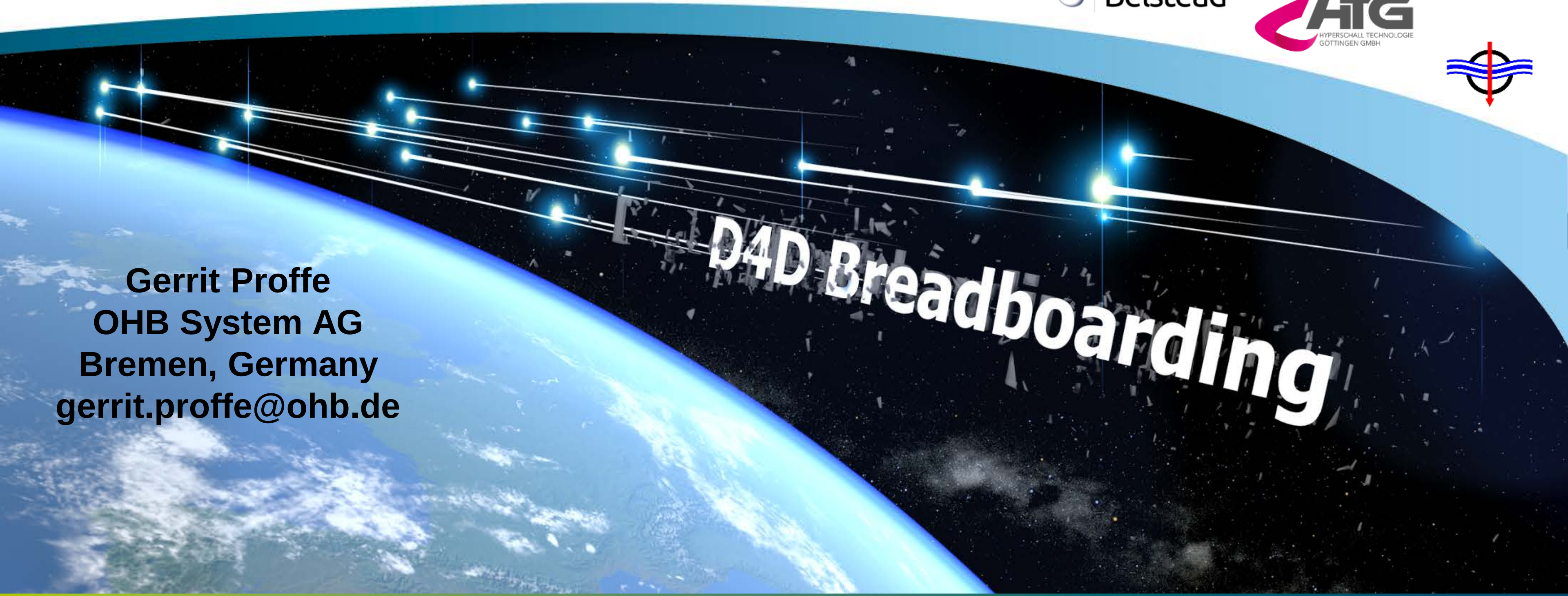

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