Ceramic Matrix Composite Airframe

MBDA Systems Technology Challenge

Last Updated – 21 October 2021

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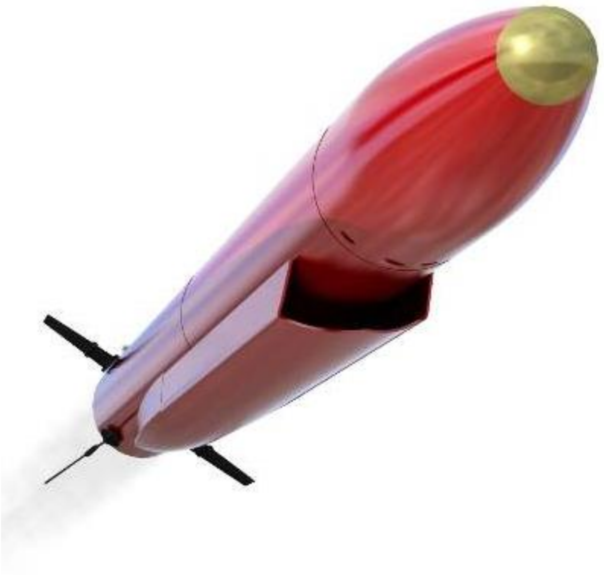
Reference : mbda-systems.com/newsroom

The Need for Ceramic Matrix Composites



- Ceramic Matrix Composites (CMCs) are a novel class of materials that can provide good structural properties at elevated temperatures for sustained durations of heating.
- The airframe structure for high speed vehicles needs to operate in a high temperature environment due to kinetic heating.
  - CMC airframe structures provide a step change in operating temperature, and could enable higher speed systems that can fly for longer durations
  - The aim is to provide an alternative to a conventional metallic airframe (aluminum, steel or titanium), that can operate at elevated temperatures.
- Other applications for CMC of interest to MBDA include:
  - Propulsion systems (including air inlets)
  - Control surfaces with high temperature leading edges
  - RF transparent seeker radomes
- This challenge aims to identify novel CMC materials and manufacturing methods for MBDA to support the development of for the next generation of high speed systems

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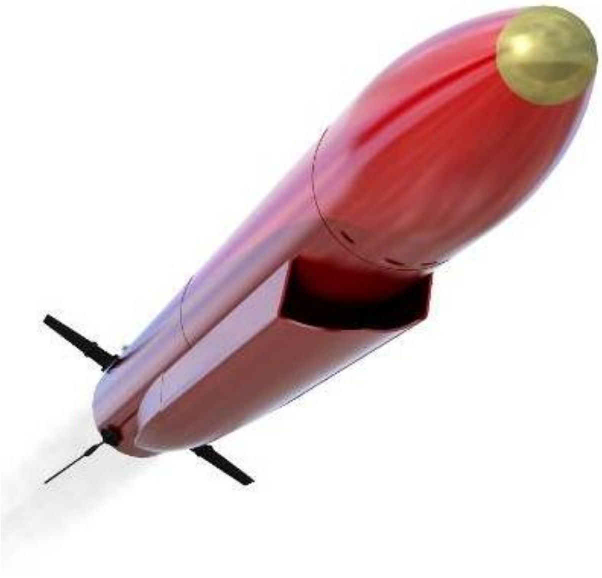

Challenge Question

What materials and associated manufacturing processes are available to develop a temperature resilient airframe forebody?

Reference : mbda-systems.com/newsroom

Challenge Process

Reference : mbda-systems.com/newsroom

- The non-negotiable Challenge T&C's and NDA should be returned signed with the proposal. Any proposals received without the signed NDA or T&C's will be discounted.
- Companies / universities provide a short proposal on how they would manufacture the forebody geometry, using the provided template.
  - Proposal template available
  - MBDA engineers will answer any technical queries as required to support the applications
  - **Proposals to be submitted to MBDA ftn.innovation.gateway@mbda.co.uk by 17 December 2021**
- MBDA UK review proposals and down-select projects of interest for further development
  - Those proposals down-selected will be provided up to £17.5k to provide a detailed overview of how the part could be manufactured, and invited to present to an MBDA panel
- If a viable method of manufacturing the part is identified MBDA will fund the manufacture of a demonstrator component in 2022.

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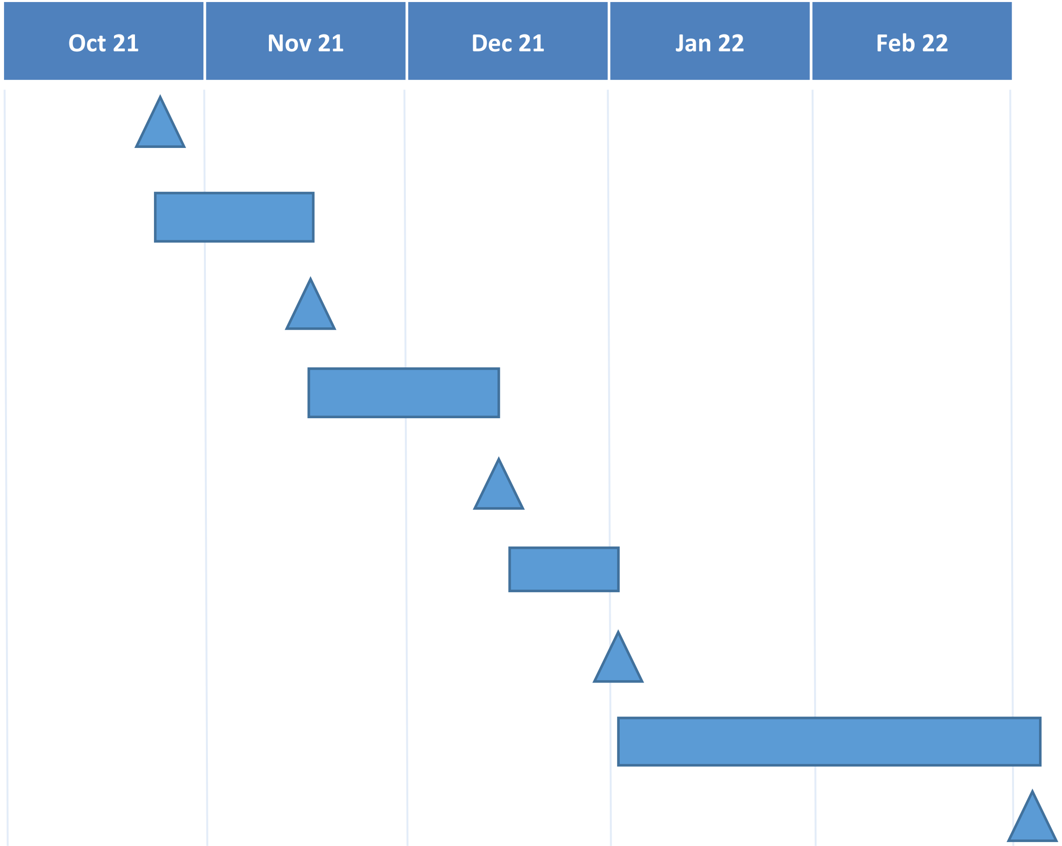
MBDA Ceramic Matrix Composites Airframe Technology Challenge 2021

Covid-19 : MBDA will continually monitor the situation and keep participants informed of any changes to the schedule via the NCC website

MBDA challenge goes live on NCC website & Press release	25 Oct
Companies/academia preparation time	4 weeks
Launch event – Webinar and Q&A	23 Nov
Companies/academia prepare submissions	4 weeks
Proposal submission deadline	17 Dec
MBDA reviews submissions (inc. 2 week winter break)	1 week
MBDA selects successful submissions by	4 Jan 22
Successful submissions carry out paid Proof of Concept study	10 weeks
Proof of Concept review panel (virtual/face to face)	~12 Mar 22



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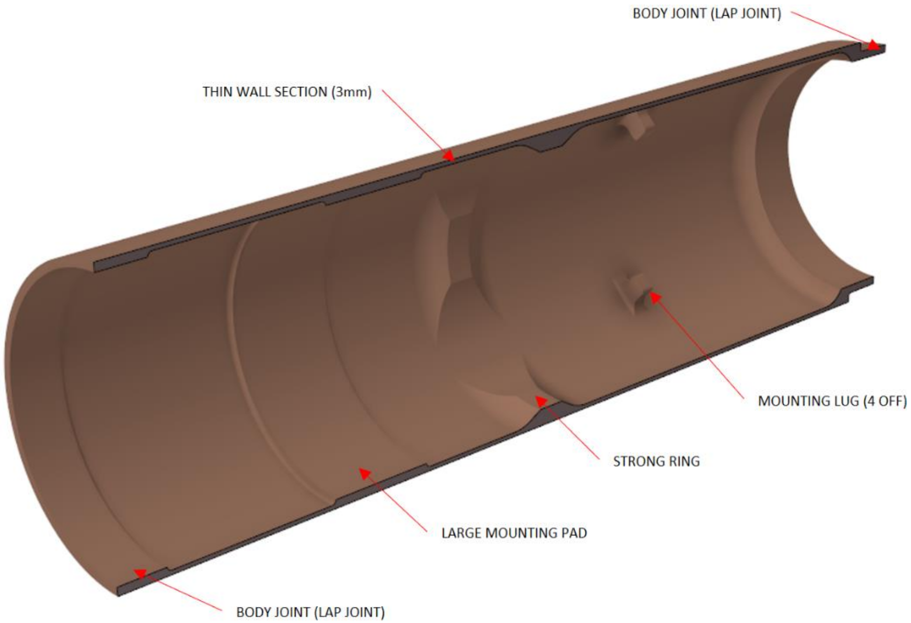
Generic Forebody Geometry (1/2)

- Demonstrator part is a de-featured generic forebody
  - MCAD Forebody Tube : 12301774684 rev 1.1 (available as STEP file)
- Generic forebody tube for a 8” calibre airframe
  - Calibre : 203mm
  - Length : 700mm
  - General tolerances : ISO 2768-m
  - Surface roughness : Ra 3.2
  - Cylindricity : 0.2mm
  - Straightness : 0.25mm
- Cut-outs, holes, fillets, chamfers, precision tolerances, and geometric tolerances have been omitted
- **Features, shape and dimensions are tradeable to suit manufacturing process**
  - Example 1, mounting lugs could be metal, but method for attaching them to the CMC forebody must be presented
  - Example 2, geometry of mounting lugs could be changed to enable them to be manufactured as one CMC part
  - Tolerances can be relaxed to suit manufacturing process



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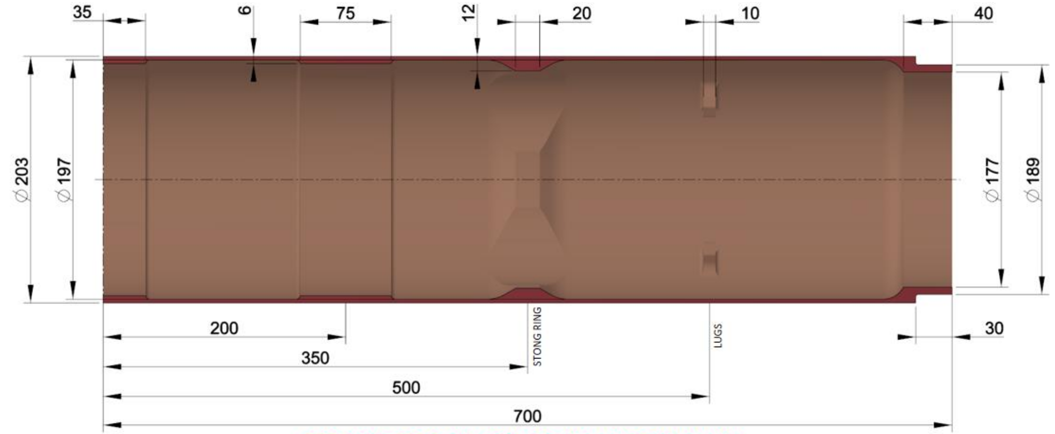
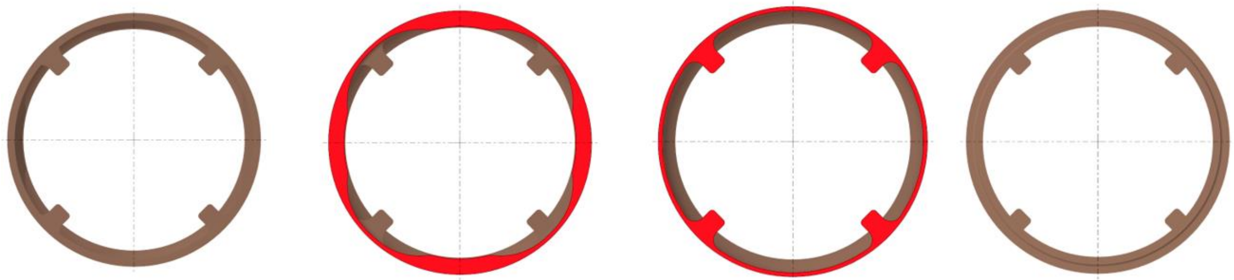
Generic Forebody Geometry (2/2)



SEE CAD FOR DIMENSIONS NOT SHOWN



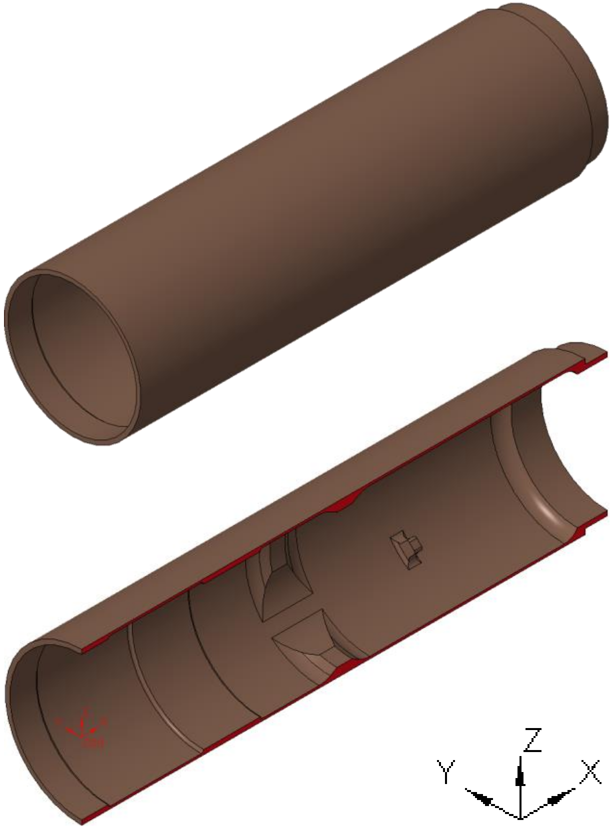
VIEW ON FRONT

SECTION THRU STRONG RING

SECTION THRU LUGS

VIEW ON AFT

Structural Requirements



- Mass
  - Shall be <14kg
  - Should be <10kg
- Temperature (soak)
  - Shall operate at > 1000°C for < 300 s (e.g. oxide based CMCs)
  - Should operate at > 1200°C for < 300 s (e.g. non-oxide based CMCs)
- Quasi-Isotropic material stiffness (Young's Modulus)
  - $E_{xx} \approx E_{yy} \approx E_{zz}$
  - E_{xx} > 60 GPa (at ambient)
  - E_{xx} > 20 GPa (at 1000°C)
- Further material properties (at ambient)
  - Fracture Toughness $K_{Ic} > 5\ MPa.m^{1/2}$
  - Tensile Strength $UTS > 180\ MPa$

Design considerations of high interest to MBDA (1/2)

Reference : mbda-systems.com/newsroom

- Proposed material and associated manufacturing methods for forebody
  - Identify any partner companies if capability is not available in house (e.g. material suppliers including source location)
  - Development / manufacturing lead times of parts
  - Material properties (structural and thermal) and associated standards / testing data
  - Limitations of manufacturing method (e.g. ply orientations / stacks)
  - Estimated cost for 1-2 components and batch production of 1000 forebodies
- Maturity of technology
  - Technology Readiness Level (TRL) of any materials and Manufacturing Readiness Level (MRL) of any manufacturing processes
  - Development roadmap and dates as to when commercially available
  - Ideally (but not essential) avoid sources which may apply restrictions on military use of technology (e.g. ITAR and EAR)
- Modifications to baseline geometry to enable manufacture
- Surface finish restrictions (typically airframes would be painted)

Design considerations of high interest to MBDA (2/2)

Reference : mbda-systems.com/newsroom

- Options (e.g. additives) to increase forebody functionality
  - Electrical conductivity
  - Thermal conductivity
  - Lightning protection
  - Thermal protection
  - EM attenuation
  - RF Transparency (vs temperature)
  - Functionally graded materials (inclusion of small RF transparent patch)

Scoring Criteria

Reference : mbda-systems.com/newsroom

- Proposals will be scored and selected based on the following criteria (all criteria are equally weighted)
  - Production cost of airframe
  - Availability of materials and manufacturing process to MBDA in 2025+
    - Expected Technology / Manufacturing Readiness Level in 2025+
    - Including availability of the technology to MBDA without restrictions (e.g ITAR, EAR)
    - Comply to legislation and appropriate standards (e.g. REACH, ISO9001, ROHS)
  - Survivability of the forebody at elevated temperatures
    - At what temperatures can it operate and for how long?
  - Structural properties (mass, stiffness, strength, etc.) at elevated temperature
    - Does the proposal meet (or exceed) the requirements in Slide 7
  - Geometric properties being met by manufacturing methods (Slide 5)
    - Impact of manufacturing method on forebody geometry
    - Changes wont be viewed negatively if they don't impact the assembly of components to forebody
    - Repeatable performance in manufacture
  - Additional functionality material can provide to airframe (Slide 9)

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Contacts

Reference : mbda-systems.com/newsroom

- Contacts / Support
  - NCC
    - Nicci McCambridge (NCC Events Lead)
  - MBDA
    - Simon Wadey (SME Development Manager / Challenge Lead)
    - Dr Daniel Underhill (Materials and Processes Group – non-metallic materials)
    - Dr David Hayes (Mechanical Technology Development Lead)
- National Composites Centre (NCC)
  - Email : events@nccuk.com
- MBDA (for technical queries and submissions)
  - Email : ftn.innovation.gateway@mbda.co.uk

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