ALFA Seal

NATEP: Helping SMEs Innovate in Aerospace

May 2021 – Oct 2022

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NATEP

design engineering expo

AEROSPACE TECHNOLOGY INSTITUTE

Department for Business, Energy & Industrial Strategy

ALFA Seal - **A**dvanced **L**aminar **F**low sn**A**p-fit Seal

Lead Partner

Jigsaw Structures
SUSTAINABLE • RENEWABLE • ENGINEERING

- Bristol – UK based R&D SME
- 30 years in the Aerospace Industry
- Structures / Design / Certification / Testing - Stress Consultancy
- Laminar Flow Enabling Technologies - 10 years involvement in Low Drag Aircraft, ALFET Project (TSB-IUK) with Airbus, GKN, NCC, MTC, City University of London, Imperial College London
- Snap Fit Seal Technology (granted IP)

Research Partner

CITY UNIVERSITY OF LONDON EST 1894

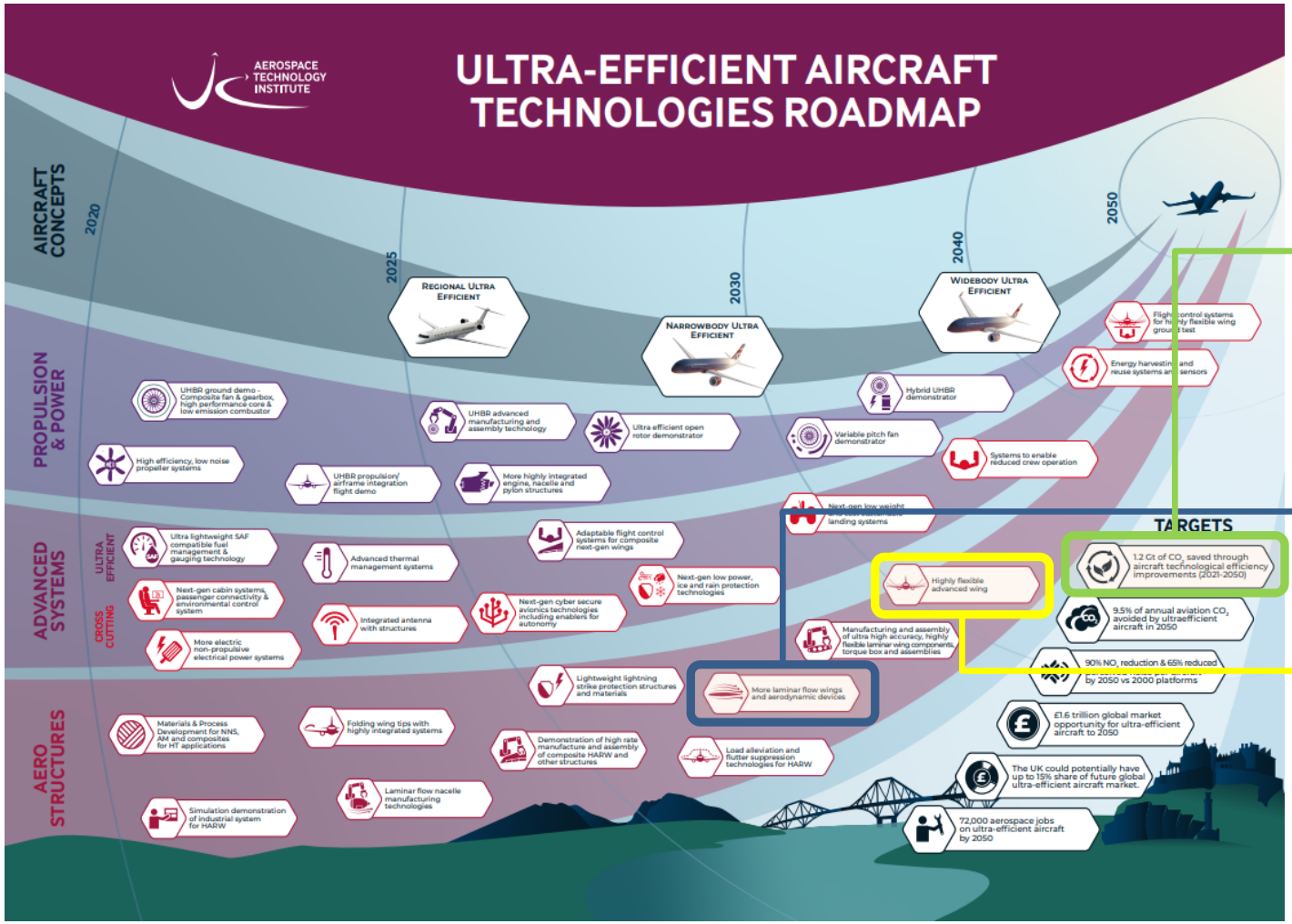
Transonic Wind Tunnel Facility, part of the UK National Wind Tunnel Facility (NWTF)

Industrial Partners

AIRBUS — Early End User Engagement

MEGGITT — Aerospace Seal Manufacturer

ATI Destination Zero Strategy: 2050



Target

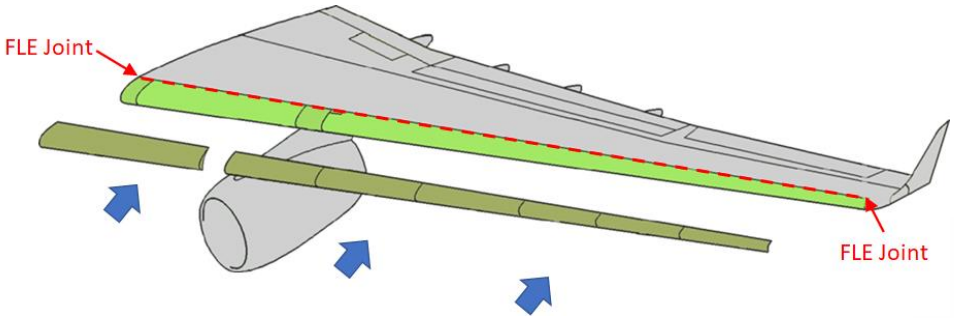
1.2 Gt of CO_2 saved through aircraft technological efficiency improvements (2021-2050)

Technology Enablers

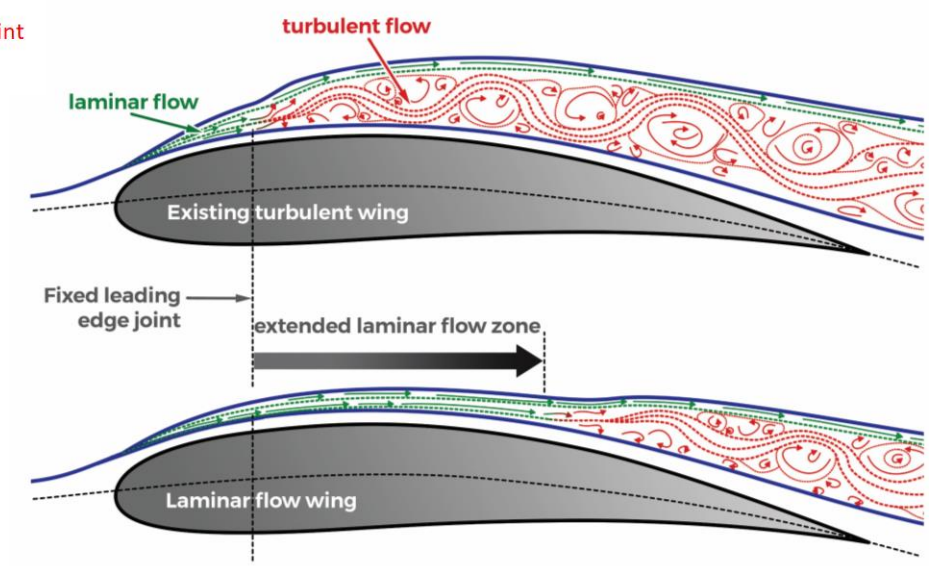
More laminar flow wings and aerodynamic devices

Highly flexible advanced wing

Project Objectives - NLF/HLF Enablers



The Fixed Leading Edge (**FLE**) joint (as a flow disturbance) is a significant threat to maintaining laminar flow across the rest of the wing chord

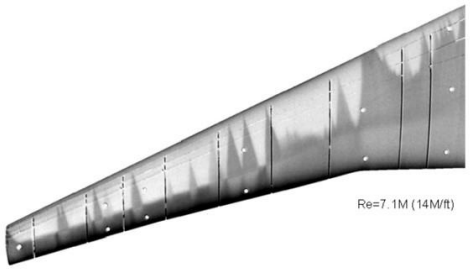


- Progress the Snap-Fit Seal system from TRL 2/3 to TRL 4
- Contribute a technology enabler for *7%* drag reduction (versus a turbulent winged aircraft), equating to a potential *5%* fuel saving (Airbus UK)
- Traditional sealant not compatible with Laminar Flow ambitions/Advanced High-Flexure wing structures
- Non-funded project partners – **Airbus UK** & **Meggitt Seals**

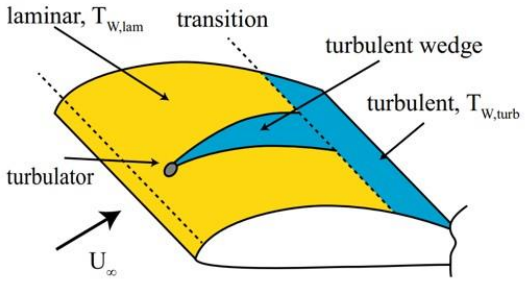
A laminar-flow-friendly FLE joint is a key technology enabler for drag reduction

Challenge - Enabling Laminar Flow across joints

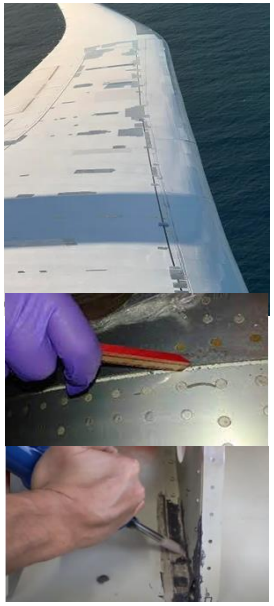
Advanced Wings



- **More aerodynamic/efficient, Laminar Flow enabled**
  - Managing steps & gaps at joints
- **Highly Flexible to accommodate**
  - dry wings
  - next generation propulsion



Sealant



- Swelling
- Dishing
- Peeling

Poor Aerodynamic performance of aging sealant

- ➢ Costly maintenance & repairs
- ➢ Low tolerance to high wing flexure/compliance with joined parts

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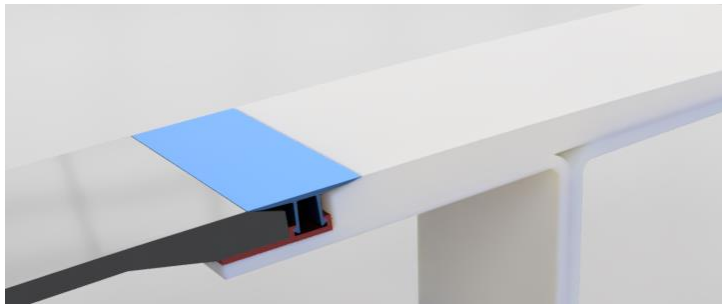
Patented Technology - GB2545153

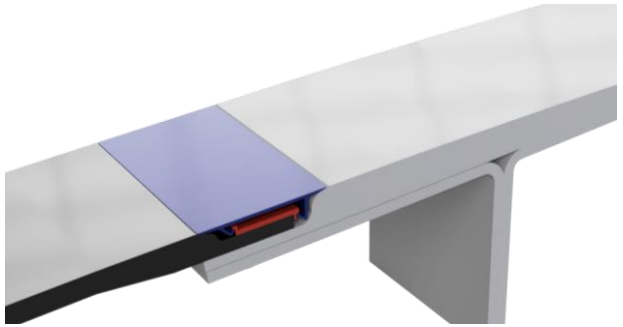
- Laminar Flow Compatible (step & gaps aero requirements)
- Accommodates high wing flexure by design

Wing Integration

Gap Bridging



Fastener Concealment



Materials & Manufacturing

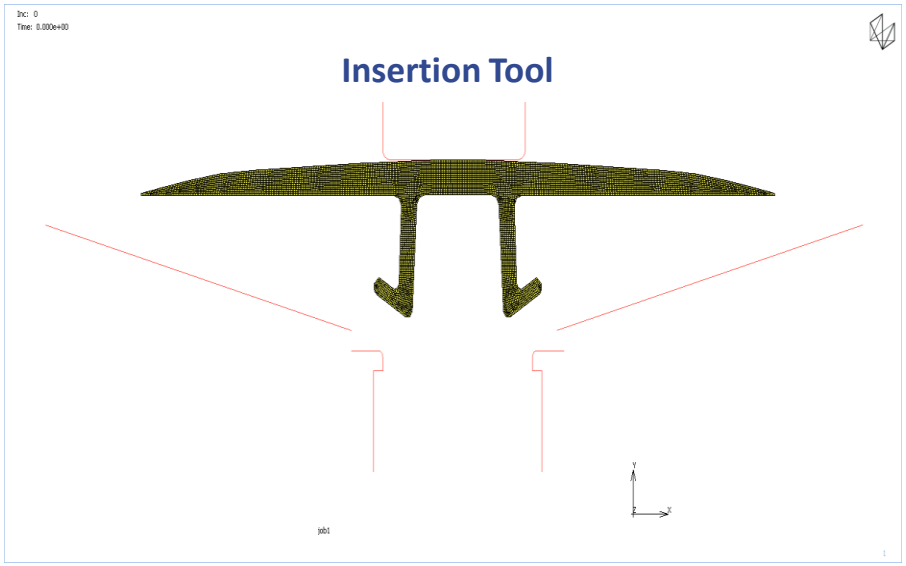
- **Insert**
  - Plastic (PEEK)
  - Continuous Compression Molding
- **Receptacle**
  - Metallic/Plastic
  - Extrusion

Key Features

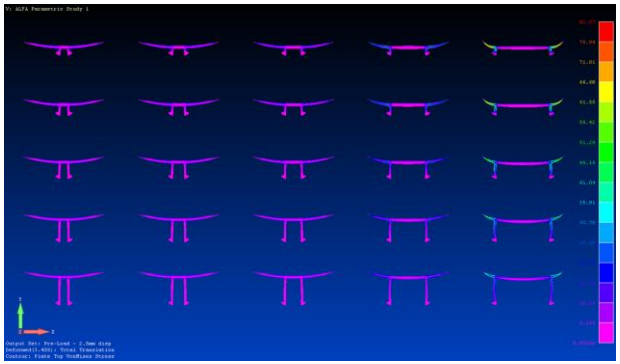
- Removeable/replaceable insert (operability)
- Pre-cambered design (flat when installed & pre-loaded)
- Receptacle is located via:
  - Fastener positions
  - Single panel landing “A” surface
- Insert flexibility & pre-load accommodates:
  - Tolerances: manufacturing, assembly
  - Operational conditions - pressure, temperature, wing bending strains & deflections

Jigsaw - Seal Mechanical Analysis & Simulation

Snap-fit Non-Linear Finite Element Analysis



- End-user requirements (NLF/HLF laminar flow)
  - aero (step heights/waviness)
  - structural (pressures/thermal/wing-bend)
  - manufacturing (tolerances/roughness)
  - materials
- Insert pre-load:
  - Seal strength & stiffness
  - Sealing performance
- Moisture ingress management



Insert

Recep*

Insert

	Manufacturing Process	Tensile Strength (MPa)	Tensile Modulus (GPa)	Flexural Strength (MPa)	Flexural Modulus (GPa)	Glass Transition (degC)	Max Op temp (deg.C)	Density (g/cm3)
VICTREX™ PEEK 450G	Injection Molding	98	4.0	125	3.8	143		1.3
TECAPEEK	CNC	96	3.6	191	6.6		250	1.4
TECAPEEK CF30	CNC	208	13.0	318	13.0		250	1.5
AlSi10Mg Aluminium	3D Printing	345	70.0	345	70.0		350	2.7
Ceramic-Like	3D Printing	70	10.0	70	10.0			1.6
ABS Carbon - RPU 70	3D Printing	40	1.7	55	1.5			1.1
Nylon PA12 40% GF	3D Printing	30	2.9	30	2.9			1.3
Nylon PA12	3D Printing	50	2.0	50	2.0			1.0
Nylon Tecamid GF30	Injection Molding	90	5.5	135	4.7		110	1.3
Nylon Zytel 70G33HS1L	Injection Molding	200	9.0	275	9.0			1.4

* Aluminium available for CNC

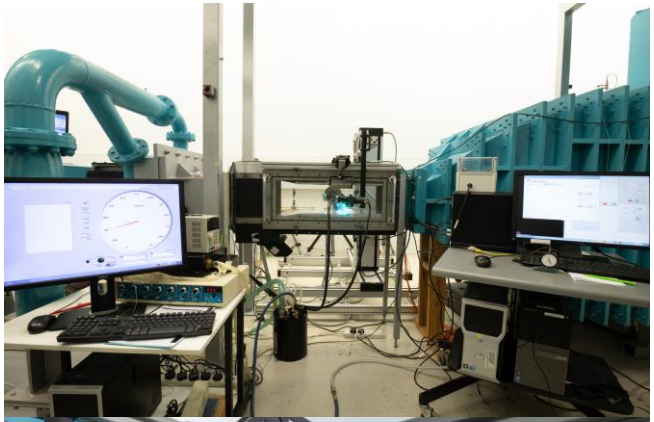
City, University of London – Wind Tunnel & Mechanical Testing

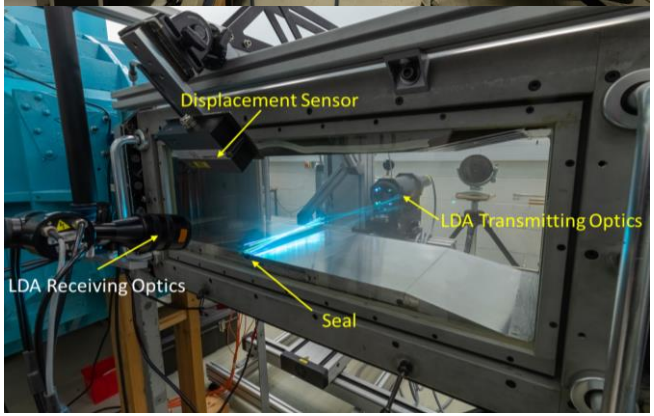
Seal Pre-load Characteristics

Aerodynamic & Sealing Performance

Bespoke Test Setup:

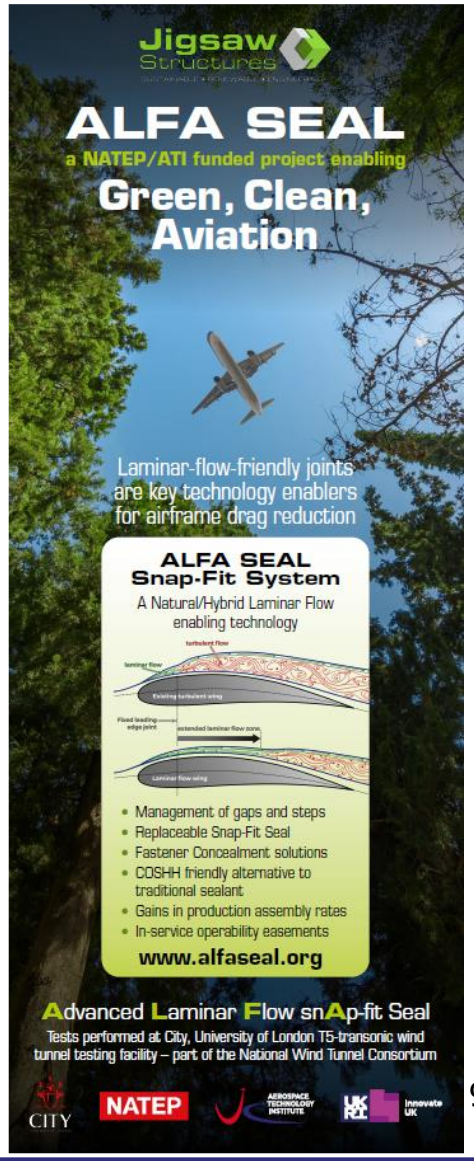
- T5 Transonic Wind Tunnel (NWTF)
- Ultimate & Cruise pressure differential
- Controlled seal pre-load
- Seal seating adjustability





Exploitation & Dissemination

- Jigsaw and City, University of London continue to work closely with our primary ALFA Seal project end users – Airbus UK & Meggitt Seals
- ALFA Seal exhibited at the FAC Annual Conference in November
- The ALFA Seal project will be represented at the Farnborough International Airshow 2022 as part of City's/FAC's exhibition space
- The Jigsaw snap-fit seal system has been granted patent status (GB2545153, April 2020) and as such, associated use cases can be readily exploited and are free from competitor restrictions
- Contact: www.alfaseal.org



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Thank you

(Images courtesy of Airbus Media)