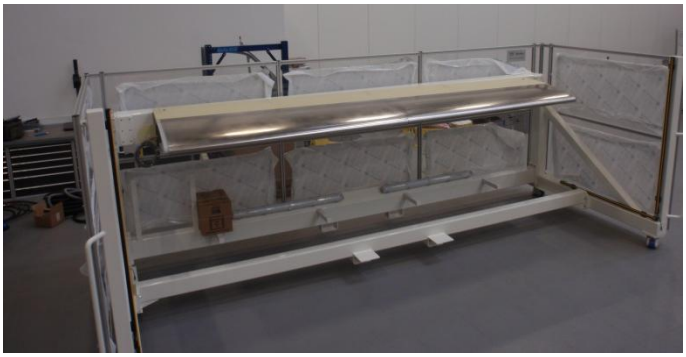
The Natural Laminar Flow Ground Based Demonstrator

The Ground Based Demonstrator (GBD) project was a collaboration between Airbus and GKN funded by European Clean Sky 1.

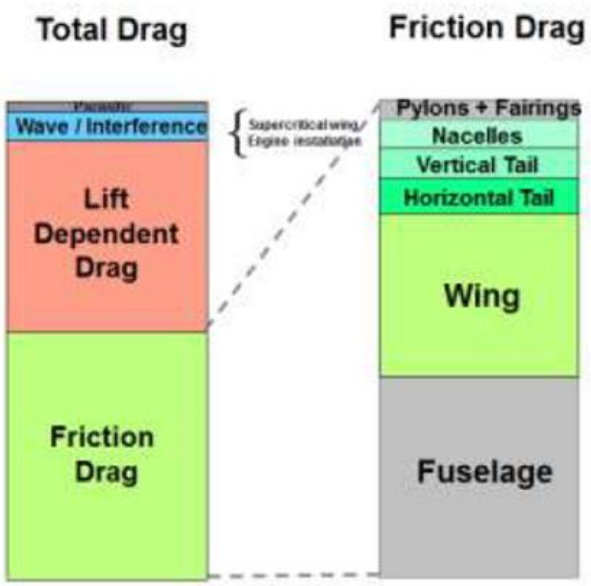
The GBD is a full scale partial wingbox demonstration of the structure and systems needed to produce a leading edge solution to meet the strict requirements to achieve Natural Laminar Flow (NLF).



Why do you want Natural Laminar Flow?

An NLF wing aims to improve aerodynamic performance through a reduction in drag compared to a conventional turbulent wing. Achieving these performance improvements will play a part in achieving ACARE goals for 2020 such as a 50% reduction in carbon dioxide emissions.

- Friction Drag contributes to circa **50%** of total aircraft drag
- Circa **40%** of friction drag comes from wing drag.
- High drag reduction potential due to laminar flow can reduce aircraft drag by up to **8%**
- Natural Laminar Flow requires **no additional systems for suction**
- Reducing aircraft drag **increases efficiency** which equates to **less fuel** being used and therefore a **cleaner aircraft**.
- This is **better for the environment**
- …and depending on the cruise speed of the aircraft, **savings of up to 2.2% of the cash operating cost** could be made by operators of single aisle aircraft with NLF capability.



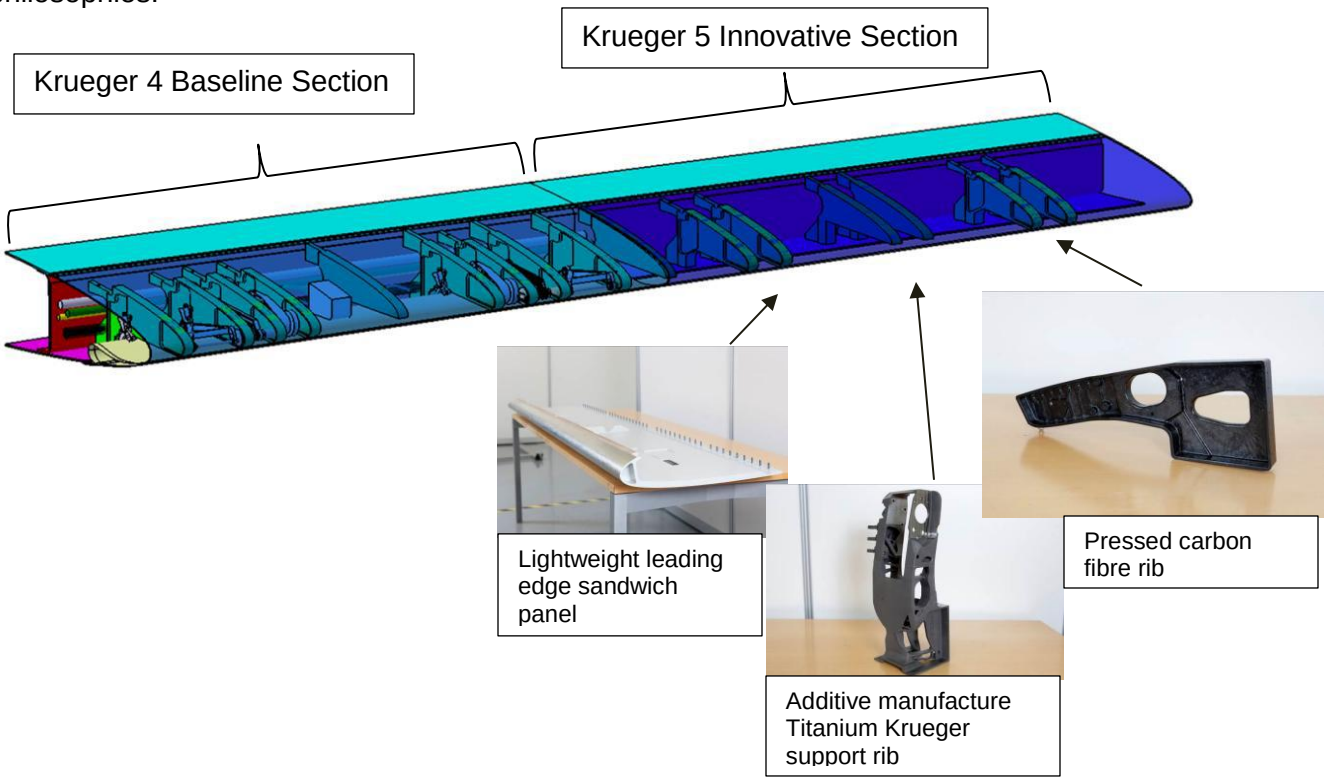
How do you achieve Natural Laminar Flow?

Natural Laminar Flow requires the aerodynamic surface to be extremely smooth i.e. fee of defects, damage and contamination. Achieving NLF puts very demanding constraints on the structure and systems of the wing. In order to demonstrate the novel technologies being proposed for an NLF aircraft the GBD was designed to include a number of key features required to meet the constraints set out by NLF. These technologies are focused on two key areas of the wing:

1. The Leading Edge structure
2. The High Lift system

Leading Edge Structure:

The GBD is a 4.5m long by 1m wide section of flight-representative wing leading edge attached to a partial wing box assembly. The leading edge accommodates a Krueger flap in two sections. This split has allowed GKN Aerospace engineers to investigate two very different design philosophies.



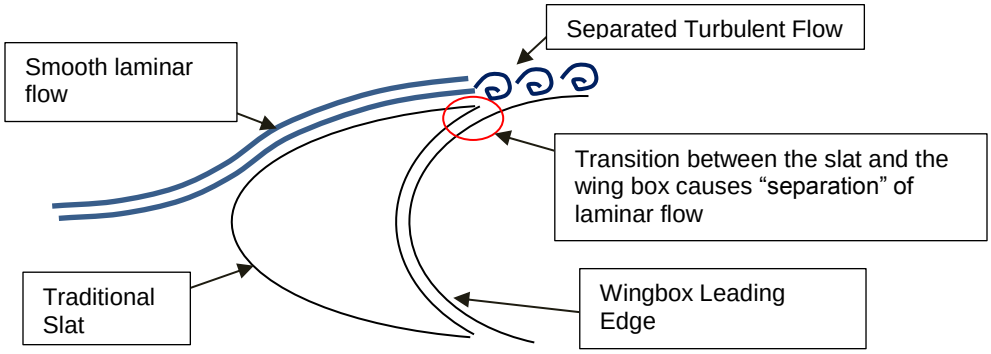
- The ‘baseline’ section applies a monolithic composite skin to the traditional rib design seen on the majority of metallic leading edges today.
- The ‘innovative’ section has applied a more radical design to address issues experienced meeting NLF tolerances with the baseline design.
- This section comprises a lightweight leading edge sandwich panel incorporating
    - Electro-thermal wing ice protection technology with an integrated erosion shield and fastener-free outer surface.
    - Additive manufacturing processes have been used to create a novel support structure for the Krueger mechanism, replacing the aluminium ribs in the baseline design.

    - This allows the leading edge panel to be supported by just three composite ribs: a single composite central rib and two closing ribs.
- These maintain the correct leading edge aerodynamic profile over the complete range of operating temperatures.
- This innovative section has a lower component and fastener count, is significantly lighter and has a greatly improved performance predictions compared to the baseline section.

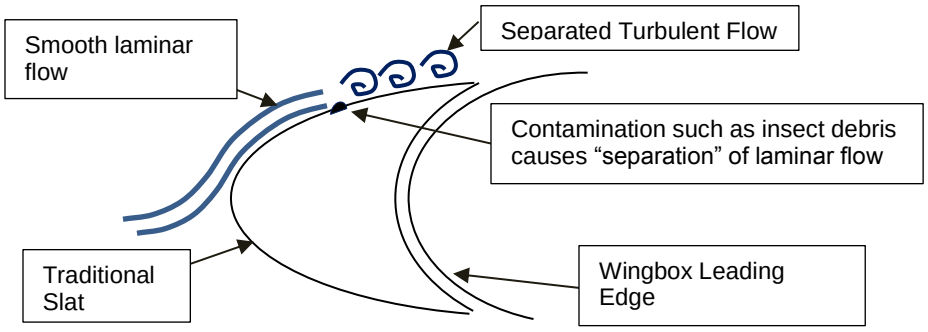
The project is a collaboration between GKN Aerospace's technology centres in the UK including teams at the UK's National Composite Centre, GKN Aerospace in Luton and the GKN Aerospace additive manufacturing centre (AMC) in Bristol.

High Lift System:

- The more continuous the flow across the wing, the lower the drag will be.
- Even minute irregularities in the surface can cause laminar flow to fail.
    - Such as the transition from a traditional slat to the wing:

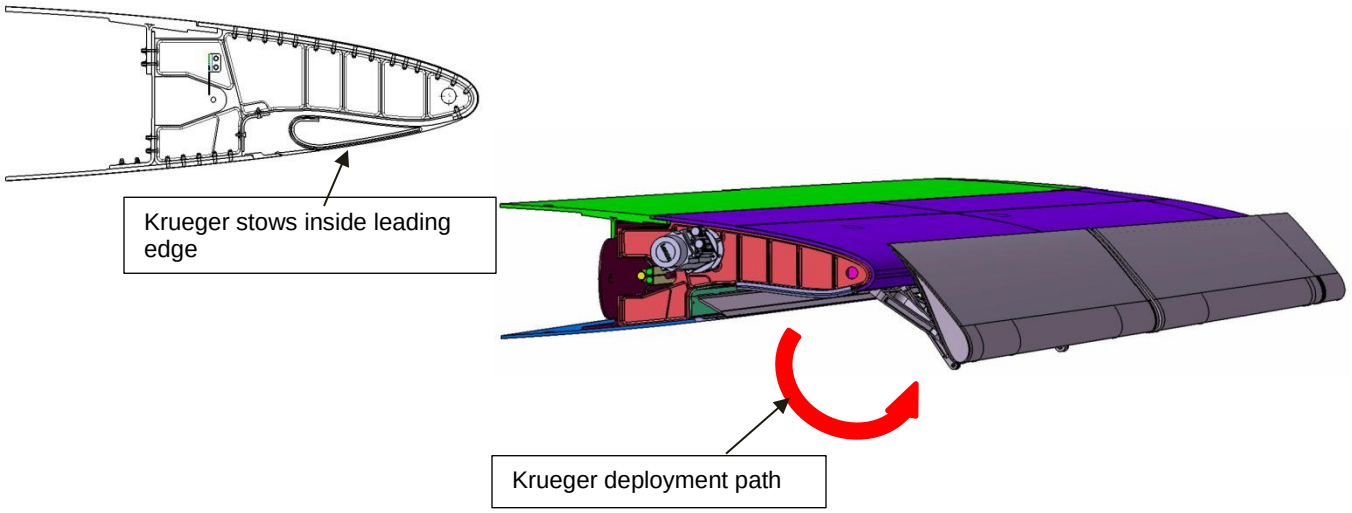


    - Or contamination of the surface, due to insect debris for example.

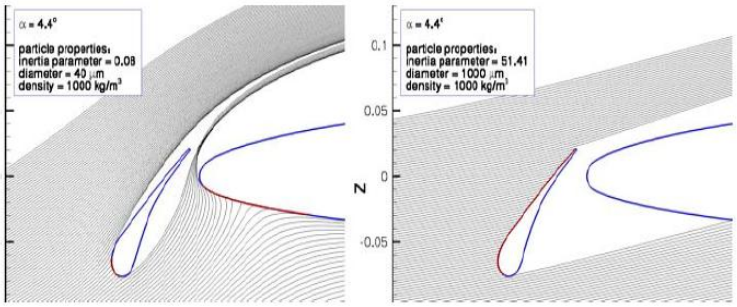


- To overcome these problems the GBD makes use of a Krueger flap to generate high lift

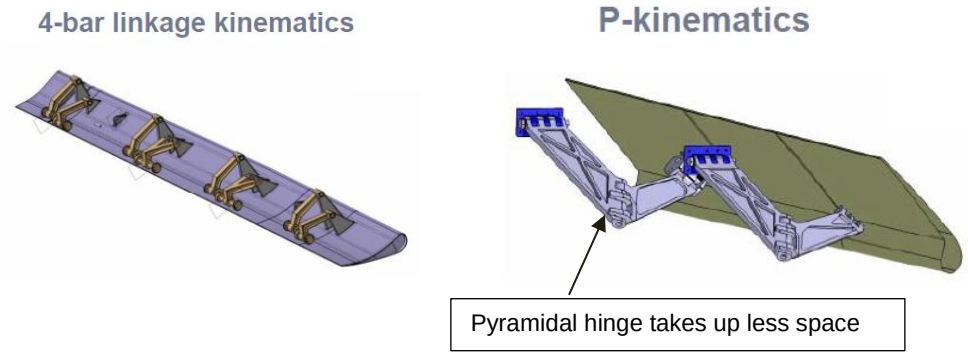
- A Krueger slat stows in the underside of the leading edge therefore eliminating the transition caused be a traditional slat.



- … and as the Krueger is stowed away out of the airflow it can also be used for shielding the leading edge from contamination.



- In order to deploy and stow the Krueger two types of kinematic system have been developed
    - A four-bar linkage is used inboard where space allocation allows
    - A pyramidal hinge is used in the outboard regions where space allocation is at a premium.



Manufacture and Integration of the Krueger flaps and deployment mechanism was managed by Airbus in Germany.

Clean Sky Clean Sky is the most ambitious aeronautical research programme ever launched in Europe. Its mission is to develop breakthrough technologies to significantly increase the environmental performances of airplanes and air transport, resulting in less noisy and more fuel efficient aircraft, hence bringing a key contribution in achieving the Single European Sky environmental objectives.

The Clean Sky JTI (Joint Technology Initiative) was born in 2008 and represents a unique Public-Private Partnership between the European Commission and the industry. It is managed by the Clean Sky Joint Undertaking (CSJU) until 31 December 2017.

Airbus – a division of Airbus Group – is a world leader in commercial aircraft design and manufacture. It has a comprehensive product line comprising highly-successful families of aircraft ranging from 100 to more than 500 seats: the single-aisle A320 Family (including A320neo, the best-selling aircraft in aviation history); the widebody, long-range A330 Family (including the A330-200 Freighter, plus the recently-launched A330-800neo and -900neo); the new-generation A350 XWB Family; and the flagship A380.

GKN plc is a global engineering group. It has four divisions; GKN Aerospace, GKN Driveline, GKN Powder Metallurgy and GKN Land Systems, which operate in the aerospace, automotive and land systems markets. Over 50,000 people work in GKN companies and joint ventures in more than 30 countries. GKN is listed on the London Stock Exchange (LSE: GKN) and recorded sales of GBP7.5 billion in the year to 31 December 2014