Accelerating the future of aerospace

Innovation in Avionics Systems

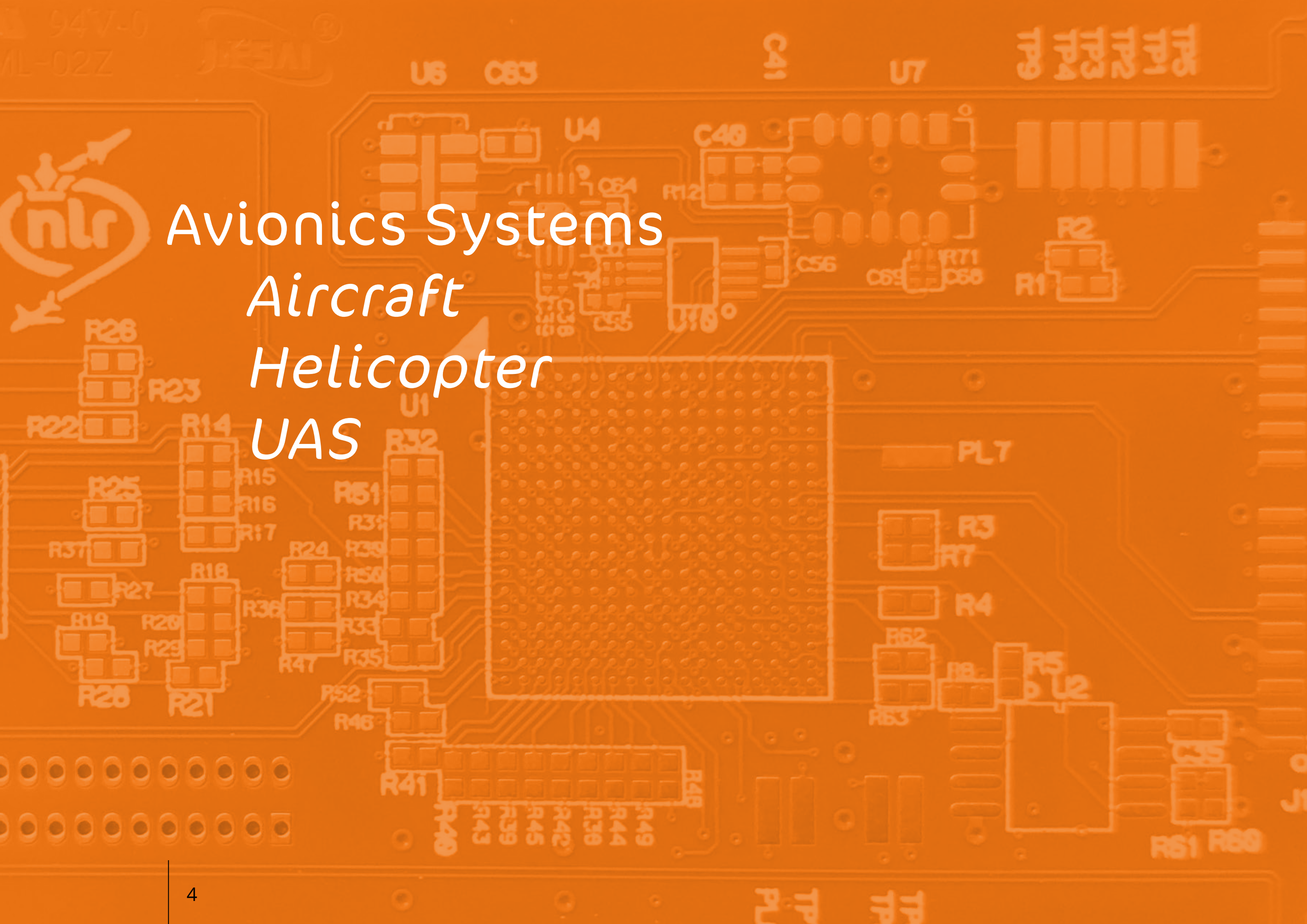
Royal NLR - Netherlands Aerospace Centre

From innovation to industrialisation

Dedicated, high-end and reliable

A key objective for more efficient and sustainable aircraft is to make lightweight, durable and affordable components which are designed for ease of operations and maintenance. NLR provides high-quality and innovative avionics systems and maintenance techniques for civil and military platforms in the aerospace industry. The products and services are characterized by their applications in innovative and special research and test programs.

Through intensive and strategic partnerships with other national and international partners as well as end users of our products and services, we want to continue to develop and innovate with a strong focus on the usability and feasibility of our technologies



Avionics Systems

Aircraft

Helicopter

UAS

Design, Development & Qualification

Cockpit/Mission avionics units

UAS Detect & Avoid

Data Processing Unit

Compact data acquisition & control

Contactless Rotating Power & data transfer

CONSTANCE:

Flight-critical wireless slip ring for a civil tiltrotor

WHY?

Slip rings for transferring power and data commonly form the interface between a rotating environment and a stationary domain. For aerospace applications, currently only conventional slip rings, with brushes, are on the market. The technique is proven, fairly reliable and robust, but there are clear drawbacks: wear, size and compromised signal integrity due to electrical noise.

Flight-critical applications in harsh environments – such as in the rotor assembly of a tiltrotor aircraft – require a fault-tolerant design. The need for qualification has to be taken into account from the start of the development.

HOW?

For the development of Constance, NLR combines our tiltrotor experience from the FP5 TILTAERO and FP7 NICETRIP programs with our patented wireless slip ring design and knowledge from the Contra-Rotating Open Rotor (CROR) project of the Clean Sky 2 Smart Fixed Wing Aircraft (SFWA) program. The distinguishing feature of the Constance slip ring is the specific orientation of the rotor and stator parts of the contactless slip ring which makes the design mechanically robust, safe and fault tolerant up to high rotational speeds.

For the extension towards the flight-critical application on the tiltrotor the expertise of DDC Electronics Ltd. on power converters will be fully incorporated into the proven technology.

Photo: Leonardo (AugustaWestand)

WHAT?

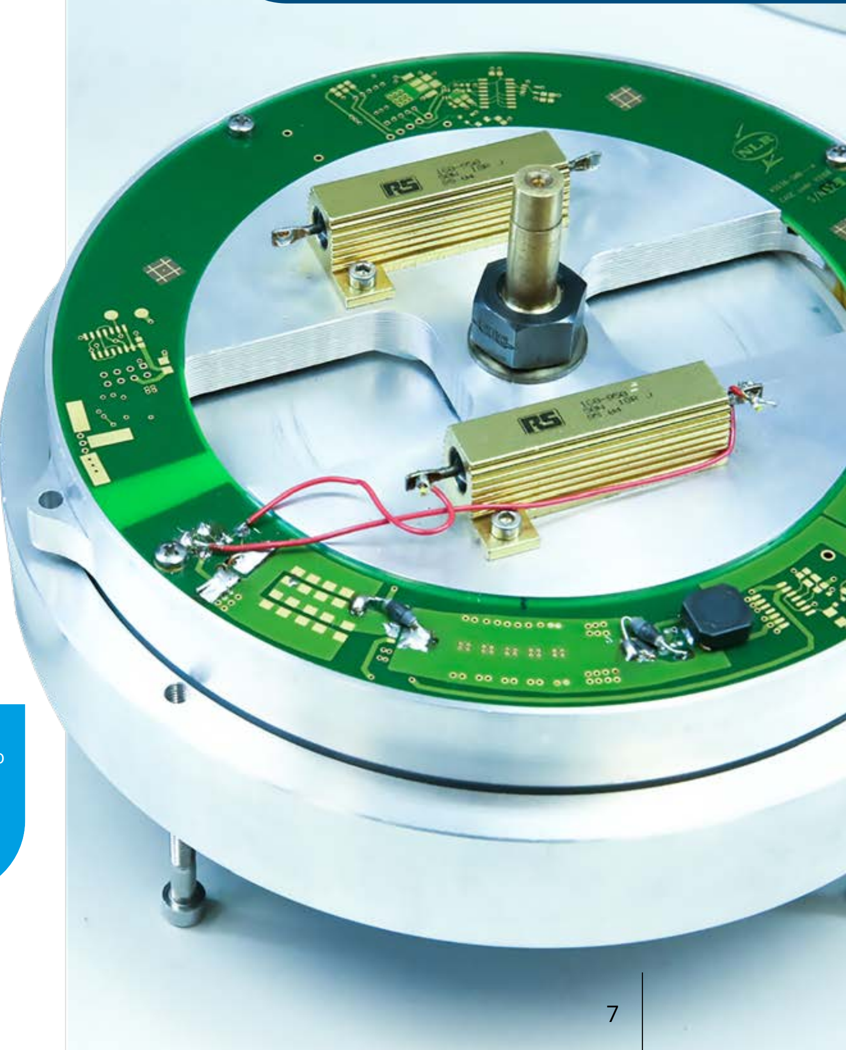
Compared to traditional slip rings the technology used for the Constance slip ring will have the following advantages:

- Operational from non-rotating to high-speed rotation
- Scalable and modular, easily tailored to the desired application environment (size, weight and power/data optimization)
- Eliminates friction or heating between rotating and stationary components
- Wear-resistant in non-rotating operations (maintenance-free)
- Available for high-speed data (up to 100 Mbit/s)
- High level of data integrity and reliability (low error rate)

Project partners

Industry (EU)	: A DDC Electronics ltd , Leonardo
Research organisations	: NLR
Start	: September 2017
Duration	: 5 years

CONSTANCE is a EU funded project. This message doesn't necessarily reflect the views of the EU.



1NTEGRATE: an integrated Structural Health Monitoring system for stationary and rotating aircraft components, based on fibre optic sensing

WHY?

The sustainment costs of military aircraft make up a substantial part of the total life cycle costs. An important world-wide trend in this respect is the transition from corrective and preventative maintenance to predictive maintenance, which is expected to lead to large cost savings and availability improvements. For predictive maintenance it is essential that the actual system condition can be measured. Much research effort is currently being put in the development of technologies that enable predictive maintenance, among which Structural Health Monitoring (SHM). However, the transition of these technologies into service is very slow. One reason for this is the lack of standardization and the poor integration of the new technologies with existing data acquisition systems.

HOW?

The project partners aim to integrate three key data acquisition technologies into one comprehensive Structural Health Monitoring system for stationary and rotating aircraft components, based on fibre optic sensing: an existing modular data acquisition unit, a patented contactless power and data transfer module and a miniaturized fibre optic interrogator based on ASPIC technology (application specific photonic integrated circuits).

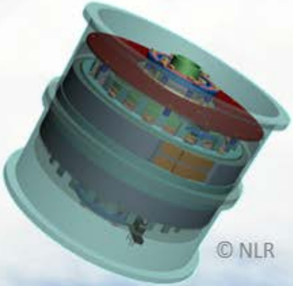
The loads and damage data collected with the SHM system will be fully synchronized with data from other sources, such as flight and usage parameters. The fibre optic sensors in the form of Fibre Bragg Gratings (FBG) that are incorporated in the SHM system will offer many significant advantages over conventional strain gauges.

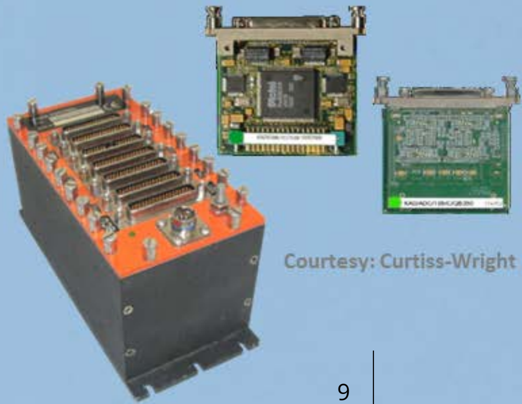
WHAT?

The SHM system will enable loads & usage monitoring to be performed much more efficiently in comparison with currently available technology. Moreover, it will combine functionalities that could not be combined before, viz. simultaneous loads monitoring, mechanical impact event detection and damage detection/localization, both in stationary and in rotating aircraft components. The following examples serve to show the relevance and potential use of the developed SHM technology

- Loads monitoring of landing gears (hard landings, remaining useful life)
- SHM of medium-sized and large UAVs
- Enhanced rotor balancing of helicopters

Project partners:
Industry: Technobis Fibre Technologies, ACQ International, Curtiss-Wright Avionics & Electronics
Research organisation: NLR





Project partners
Customer: European Space Agency
SME (EU): Orange Aircraft (NL) and Barnard Microsystems Ltd. (UK)
Research organisations: Netherlands Aerospace Centre (NL)

Start: March 2018
Duration: 1.5 years

Integrated Steerable Antenna for Beyond Line-of-sight L-band data Exchange (ISABELLE)

WHY?

Unmanned Aerial Vehicles (UAVs) are used for applications such as infrastructure survey, pipeline inspection, surveying of crops, maritime surveillance and communication relay. A recurring obstacle is the accommodation of satellite antennas into small sized UAVs.

HOW?

Available surfaces such as the wing and tail can be used to integrate antenna arrays. The objective of the ISABELLE project is to demonstrate by design, manufacture and testing the viability of an embedded antenna array with real time adaptive beam forming where the antenna is integrated in the wing structure of the UAV.

WHAT?

The main R&D activities of the project are:

- Development of a structurally integrated L-band phased array antenna in the wings of a mid-size UAVs
- Development of an electronic beam steering unit, to be placed in the fuselage or wing of the UAV.
- Development and manufacturing of breadboards in L-band for testing in laboratory and flight;
- Breadboards for critical hardware are L-band antenna tile, wing structures for structural embedding of the L-band antenna tile, beam steering unit and tracking/pointing system unit.
- Demonstration in flight of wing integrated L-and antenna tiles, with beam forming and tracking-and-pointing system, communication with Inmarsat BGAN satellites.

ISABELLE is co-funded by the European Union. This message doesn't necessarily reflect the views of the EU.

Scale Model Aircraft Research & Development (SMARD)

Testing aircraft designs with full-scale prototypes involves risks. A possible alternative is to develop scale models for these tests, in the form of drones with the aerodynamic and aeroelastic properties of a full-sized aircraft. Within the SMARD project, NLR is accumulating knowledge for the development of such scale models. Testing with scale models is an additional step between wind tunnel tests and tests with full-scale prototypes, and can even replace them in some cases. They allow radically new aircraft configurations, such as aircraft with hybrid or fully electric propulsion, to be tested more easily.

NLR is currently conducting research in two programmes: SCALAIR and NOVAIR. These are feasibility studies for the development and testing of new concepts. In addition, NLR has built a so-called scaled flight demonstrator. This is a scale model of an existing commercial aircraft with state-of-the-art instruments on board. By comparing the results of flight tests with the scale model with flight test data from the full-size aircraft, NLR can determine how representative the scale model is. In the next step, NLR will equip a scaled-down aircraft with fully electric propulsion. This will facilitate research into innovative aircraft configurations. This could include tailless aircraft and aircraft with active boundary layer injection or blended-wing bodies.

WHERE DO WE CURRENTLY STAND?

- In collaboration with aircraft manufacturer Airbus, NLR is creating a scale model of an existing aircraft.
- This scale model will be tested in a wind tunnel and then in the air.
- If the measurement data prove reliable, new advanced aircraft configurations can be tested at model scale.

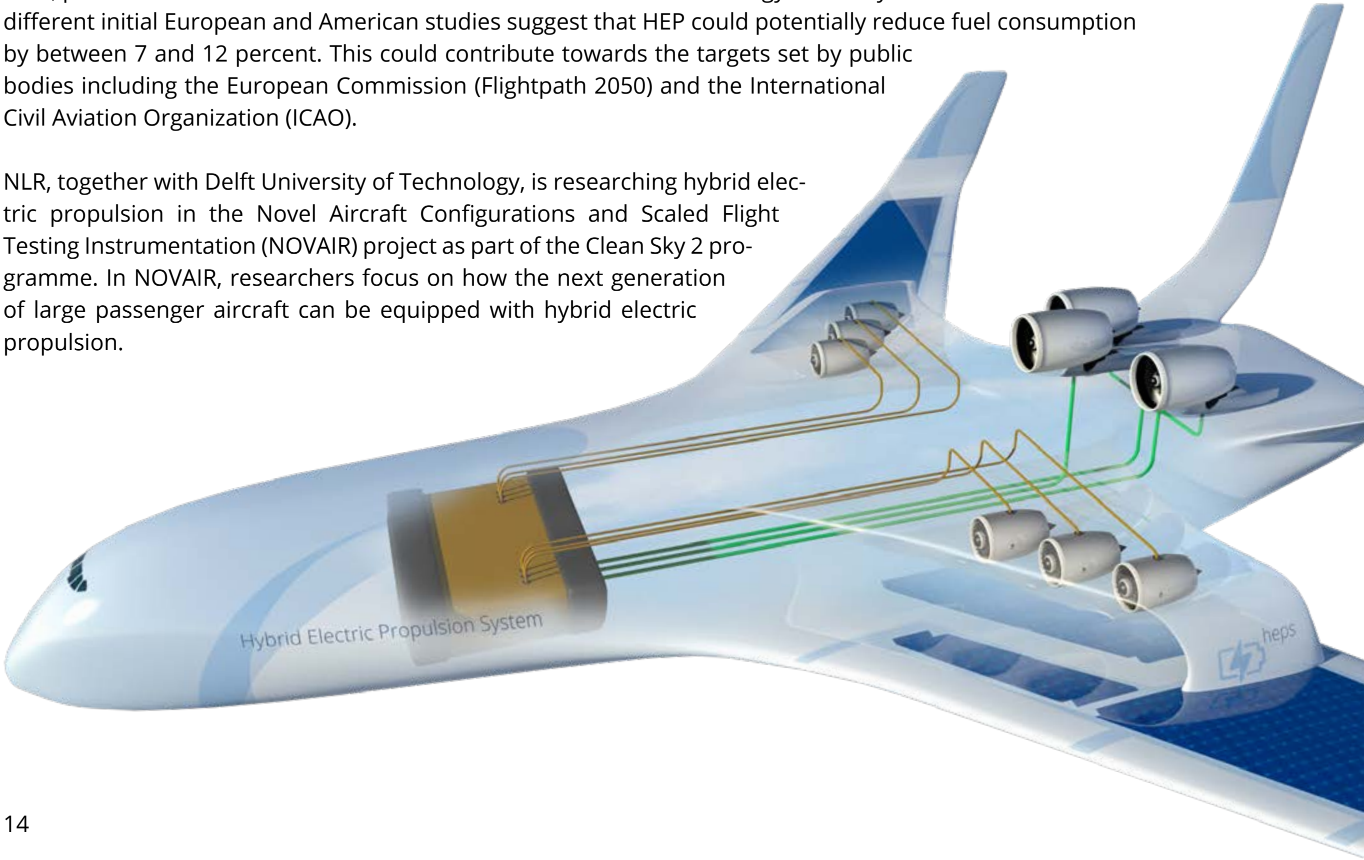
This project has received funding from the Clean Sky 2 Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 717183 and 945583.


AIRBUS
ONERA
CIRA
OrangeAerospace

NOVAIR: in pursuit of flying electric

Hybrid Electric Propulsion (HEP) can become an important step in the development of large passenger aircraft, provided it is shown to be achievable and leads to the desired energy economy. Recent estimates from different initial European and American studies suggest that HEP could potentially reduce fuel consumption by between 7 and 12 percent. This could contribute towards the targets set by public bodies including the European Commission (Flightpath 2050) and the International Civil Aviation Organization (ICAO).

NLR, together with Delft University of Technology, is researching hybrid electric propulsion in the Novel Aircraft Configurations and Scaled Flight Testing Instrumentation (NOVAIR) project as part of the Clean Sky 2 programme. In NOVAIR, researchers focus on how the next generation of large passenger aircraft can be equipped with hybrid electric propulsion.



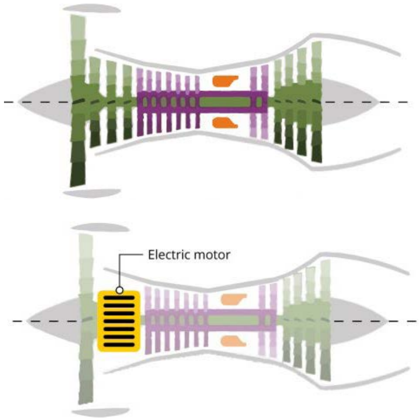
Future HEP enablers

The NOVAIR project was kicked off in December 2016 and will run for six years in total. Most of the research has therefore yet to take place. Here below are some of the possible solutions. They are focused predominantly on leveraging three key advantages that HEP propulsion will enable. There are still many challenges ahead for the project as a whole. It is too early to say anything about which way things will go. The advantages of distributed propulsion and boundary layer ingestion are potentially greater propulsive efficiency, less drag, better lift, improved control over the aircraft, less noise, enablement of different (potentially modular) designs, and energy regeneration. Therefore, detailed studies of subsystems for HEP will first need to be conducted, after which there could be a clear path for these propulsion systems to be implemented.

This project has received funding from the Clean Sky 2 Joint Undertaking under the European Union's Horizon 2020 research and innovation programme

A: Combination of jet engine and electric engine

A relatively simple form of HEP drive that NLR's NOVAIR researchers are working on is a combination of a jet engine with a fan, with an electric engine built into that same engine. An advantage of such an HEP system is that a relatively small, and therefore lighter, jet engine would be required for the intended mission. This jet engine would be able to operate slightly more efficiently, especially in the relatively long cruise phase of the mission.



Detect and Avoid development

2012 2013 2014 2015 2016 2017 2018 2019 2020 2021

Explorer
System Development & Testing

AIRICA
Interface design with RPAS BVLOS without visual observers
Flown with manned aircraft to evaluate Detect And Avoid measures

B-VLOS
BVLOS flights planned to gather experience, support rule-making in the Netherlands and develop the market potential.

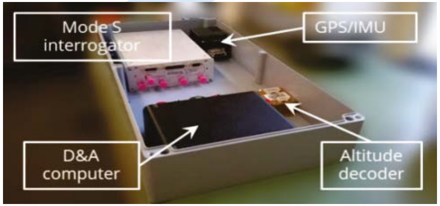
AIRPASS
Feasibility study of required (on-board) equipment for integration in u-space

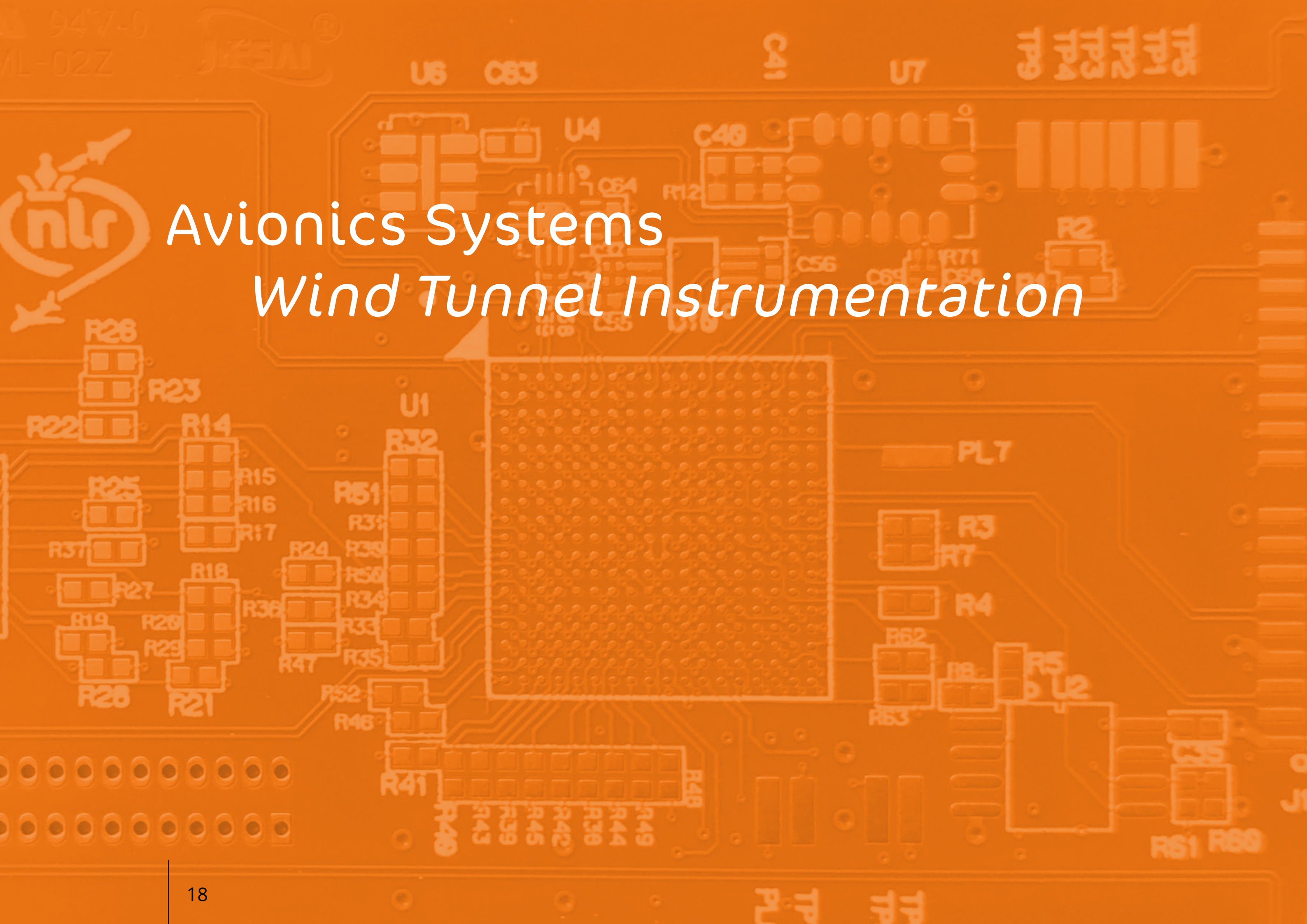
PODIUM
Demonstrate U-space services with today's technology in 'unexpected' situations (incl. BVLOS flights)

VUTURA
Validation of U-Space by Tests in Urban and Rural Areas. Combination of different U-Space systems

DAA Miniaturization

Fuel cell Drone





Avionics Systems

Wind Tunnel Instrumentation

Design & Development

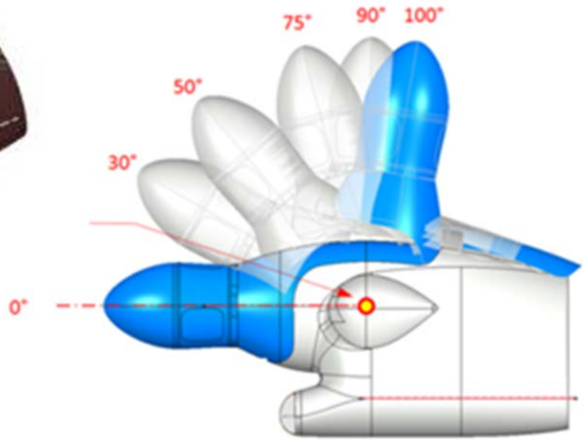
Compact data acquisition & control

- Rotating
- In model
- In flow
- Wind Tunnel

Contactless Rotating Power & data transfer

Real-time Data Processing

Wind Tunnel Facility Management



Project partners
Industry (EU): SZEL-TECH, P.W. METROL
Research organisations: NLR (coordinator), ILOT

Start: November 2019
Duration: 3 years

HIGHTRIP is a EU funded project. This message doesn't necessarily reflect the views of the EU.

HIGHTRIP:
HIGH speed civil Tilt Rotor wind tunnel Project

WHY?

The aerodynamic configuration of the Next Generation Civil Tilt Rotor (NGCTR) needs to be characterized at high speed by a dedicated wind tunnel test campaign. Within the EU CleanSky 2 program new T- and V-tail empennages were designed and fabricated in the NEXTTRIP project, envisaging use for higher speeds. In order to fully exploit this research, HIGHTRIP will design a new model based on NEXTTRIP design philosophy and scale, re-using the new (instrumented) NEXTTRIP empennages. If complete re-use is not feasible, basic design, balances and remote controls will be re-used to limit the costs. Consequently, the exact model scale will result from sizing NEXTTRIP empennage to the NGCTR Technology Demonstrator geometry.

HOW?

The partners will work together to design and manufacture new fuselage and new wing in the HIGHTRIP model, based on the NEXTTRIP tails and NICETRIP parts. NLR will coordinate the HIGHTRIP project and will perform wing design and manufacture. The Polisch partners will focus on the design and manufacturing of the new fuselage. NLR will subcontract the non-powered high speed wind tunnel test to ONERA-S1MA, resulting in a data package (on model scale) corrected for wind tunnel effects. To provide full scale Reynolds number data and perform aerodynamic characteristics analysis at high speeds and full scale conditions, extrapolation to full scale Reynolds numbers will be done by CFD.

WHAT?

The Next Generation Civil Tilt Rotor fast rotorcraft concept aims to deliver superior vehicle productivity and performance. The aerodynamic configuration definition of the novel tilt rotor NGCTR Technology Demonstrator needs to be validated further at high speeds. By exploiting outcomes and facilities of NICETRIP (FP6) and NEXTTRIP (CleanSky 2) projects and providing a full scale high speed database of different empennage configurations, HIGHTRIP provides a vital contribution for the validation of an innovative tilt rotor concept, the configuration of which will go beyond current architectures of this type of aircraft.

Project partners
Royal NLR

Start:	September 2018
Duration:	2 years

Composite blades for wind tunnel models: design and manufacturing

WHY?

Composite materials have proven to be ideal for wind tunnel model blades. It allows to mitigate potential fatigue loading problems and enables extensive instrumentation. Furthermore, composite materials offer the possibility for aero-elastic tailoring, i.e. the structural design can be optimized in such a way that for example blade deformation and blade frequencies are tuned as desired. For rotating systems, it is essential that this aero-elastic behaviour is well understood prior to wind tunnel entry. Advanced FEM models of composite wind tunnel model blades and a good understanding of the complete manufacture process is important in this. How accurate can blade deformation and blade frequencies be predicted? To what extent is the extensive instrumentation influencing the aero-elastic behavior?

HOW?

Further insight in design and manufacture of composite wind tunnel model blades is developed via NLR and European funded research projects. Material and coupon tests are being performed to validate the basic material properties for the specific manufacturing process used to manufacture the final blades.

Coupon tests are also used to validate the modeling method and material models in an early stage of the design process. In parallel, prototype composite wind tunnel model blades are made with extensive instrumentation included.

WHAT?

The test elements and prototypes are subjected to a variety of inspections and typically these inspections are tailored for wind tunnel blades. Geometry inspection, frequency measurement, deformation measurement and structural integrity check are standard procedure. This research will improve accuracy of the predicted aero-elastic behaviour and improves quality of the manufactured composite blades. More extensive instrumentation can be integrated in the blades, like:

- Integrated strain gauges, especially for load monitoring
- Flush mounted embedded pressure sensors, for aerodynamic and acoustic measurements
- Flush mounted LED’s, for blade deformation measurement during rotation
- Integrated heating system, for laminar-turbulent flow transition measurement

Research infrastructure

With our wide range of test facilities we can simulate your environmental testing requirements for your spacecraft or aircraft equipment, meeting international, military, aircraft and commercial standards. Regardless of the environment that has to be simulated, NLR is the ‘one stop shop’ for all your testing needs.

We conduct environmental tests for climatic, thermal vacuum, mechanical, electric, radiation and acoustics properties using our specialised knowledge, experience and over 20 different facilities for environmental testing.

We can advise and support you throughout the entire testing process from establishing test requirements and test definition, to test set-up and execution. We can also assist you in validating your own models of your test subject.

NLR Environmental test facilities

- **Climatic**
  - Temperature
  - Humidity
  - Salt Spray
  - UV Light
  - Fluid Susceptibility
  - Altitude, Decompression & Overpressure
  - Waterproofness
  - Icing
  - Tear Down
  - Thermal Vacuum
  - Fungus
  - Sand & Dust
- **Mechanical**
  - Vibration
  - Shock
  - Acceleration
  - Static Load
  - Bending Resistibility
  - Pull Force
- **Electric**
  - EMI/EMC
  - ESD
  - HIRF
  - Lightning
- **Radiation**
  - Total Dose
  - Proton
  - Heavy Ion
  - Californium Cf-252
- **Acoustics**
  - Acoustic Noise
  - Transmission Loss

Tests performed externally under NLR responsibility

EMC facility

The EMC facility carries out testing and analysis concerning Electromagnetic Compatibility (EMC) and Electromagnetic Interference (EMI) of electrical and electronic equipment. Testing can be done in accordance with most applicable aerospace standards. Other standards and dedicated test procedures can also be supported.

Vibration and Shock Facility

The Vibration and Shock Testing (VST) facility subjects sensitive equipment used in the aerospace industry to shock and vibration tests. It fulfils an essential role in the certification process for precision instruments and electronic equipment on board aircraft and spacecraft. Vibration and shock testing is part of NLR's full range of solutions for Electromagnetic Characteristics (EMC) testing and environmental testing (e.g., temperature and altitude tests).

NLR in brief

One-stop-shop	Global player with Dutch roots	100+ Since 1919	Amsterdam, Marknesse Rotterdam, Noordwijk, Brussel
Innovative, involved and practical	For industry and governmental	For civil and defence	800+ staff
€ 127 M turnover	78% Dutch, 19% EU and 3% worldwide	Active in 24 countries	Very high customer satisfaction

About NLR

Royal NLR - Netherlands Aerospace Centre

NLR is a leading international research centre for aerospace. Its mission is to make air transport safer, more efficient, more effective and more sustainable. Bolstered by its multidisciplinary expertise and unrivalled research facilities, NLR provides innovative and comprehensive solutions to the complex challenges of the aerospace sector.

NLR's activities span the full spectrum of Research, Development, Testing & Evaluation (RDT & E). Given NLR's specialist knowledge and state-of-the-art facilities, companies turn to NLR for validation, verification, qualification, simulation and evaluation. They also turn to NLR because of its deep engagement with the challenges facing our clients. In this way, NLR bridges the gap between research and practical applications, while working for both government and industry at home and abroad.

NLR stands for practical and innovative solutions, technical expertise and a long-term design vision, regarding their fixed wing aircraft, helicopter, drones and space exploration projects. This allows NLR’s cutting-edge technology to find its way also into successful aerospace programmes of OEMs like Airbus, Boeing and Embraer.

NLR research aircraft 1919 - now

Hybrid electric propulsion (HEP) study model

Cessna 550 Citation II

Pipistrel Electric plane


Fairchild Swearingen
SA226-TC Metro II
Hawker Hunter T.7
Fokker F.VIIa PH-NLL
Queen Air
Fokker S.14.1 Machtrainer
Fokker F.II PH-RSL
PH-NLL
PH-RSL

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