European Commission

FUTURE SKY SAFETY

The 8th Triennial International Fire & Cabin Safety Research Conference
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Future Sky Safety – P7: Study of temperature and fire exposure effects on Carbon Fibre Reinforced Plastic mechanical behaviour and chemical degradation

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Content

- Future Sky Safety
- P7 Mitigate risks of fire smoke & fumes
- WP71 - Improve understanding – T700/M21 material
- WP72 – New material solutions
- WP73 – On board air quality
- Conclusions & Outlooks

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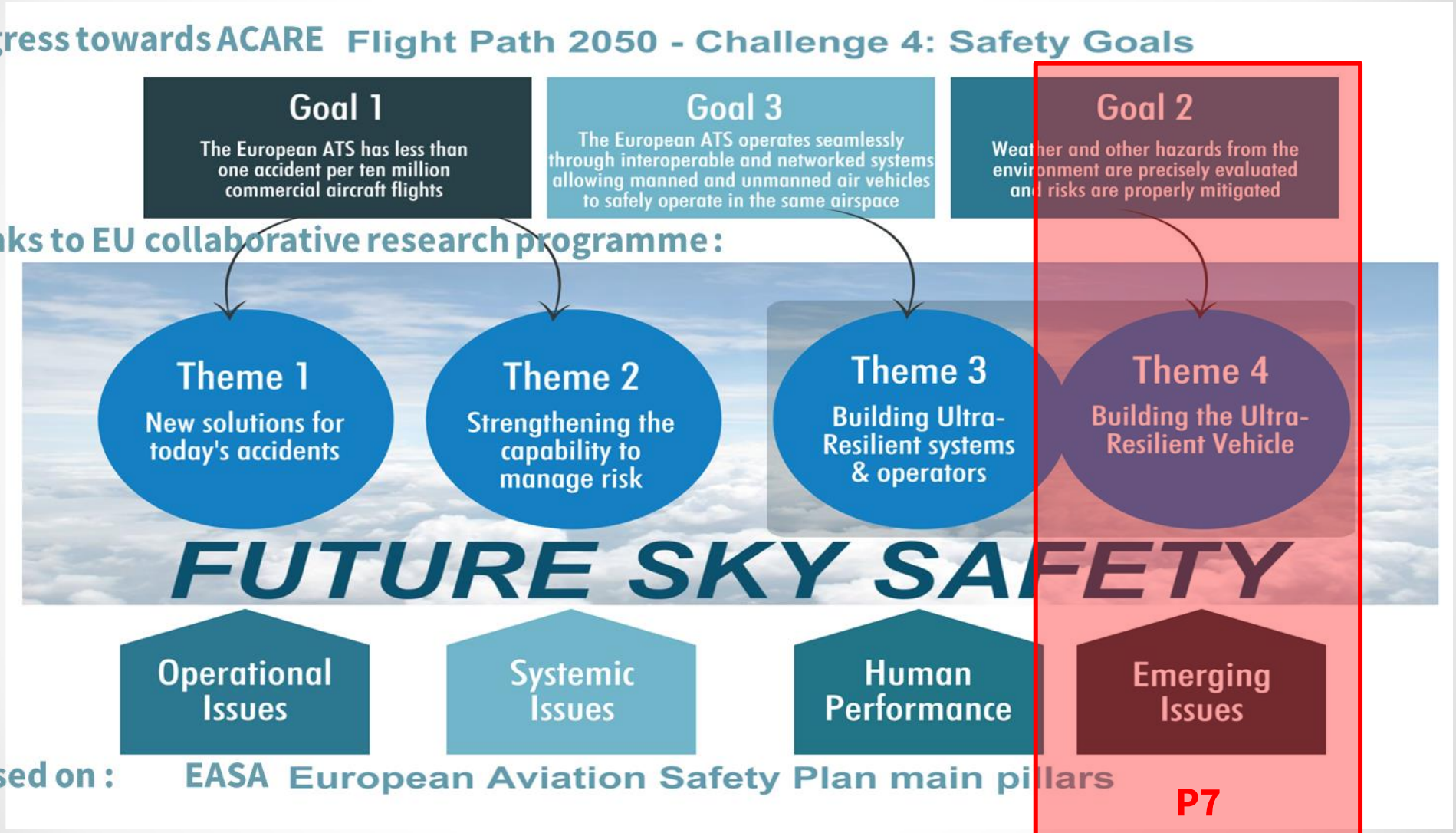
FSS - The Concept



SAFETY | FUTURE SKY

FSS Objectives

- *To coordinate institutional safety research programmes (P1)**
- *To perform dissemination, exploitation & communication (P2)*
- *To perform collaborative safety research on safety risk priority areas (P3-P7)*

- Projects in FSS Phase 1 (2015-2018):
  - *Solutions for runway excursions (P3)*
  - *Total system risk assessment (P4)*
  - *Resolving the organizational accident (P5)*
  - *Human Performance Envelope (P6)*
  - ***Mitigating risk of fire, smoke and fumes (P7)***

**in regard with safety priorities in the ACARE SRIA on Safety and Security*

More details in appendices.

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Technical / scientific objectives

To increase safety by …

O1 : Improving knowledge concerning OMC materials and structures behaviours vs fire

O2 : Assessing mechanical properties of heating/burning/degraded materials

O3 : Evaluating the fire consequences (incl. toxicity, smoke), proposing solutions to mitigate them

O4 : Sharing database for future modelling purposes (expensive tests)

O5 : Establishing/giving design recommendations

P7 – Mitigate risks of fire, smoke & fumes

- 3 years research project, 10 EU partners (F, G, NL, 2 UK, 2 PT, CZ, I, S)
- WP7.1 (101 MM): Understanding and characterizing the fire behavior of primary structure composite materials (epoxy resins, standard CFRP)
- WP7.2 (111.5 MM): Improving material solutions to mitigate fire, smoke and fumes in cabin environment (plus toxicity)
- WP7.3 (72 MM): Effects of new materials, technology and fuel systems on the on-board air quality

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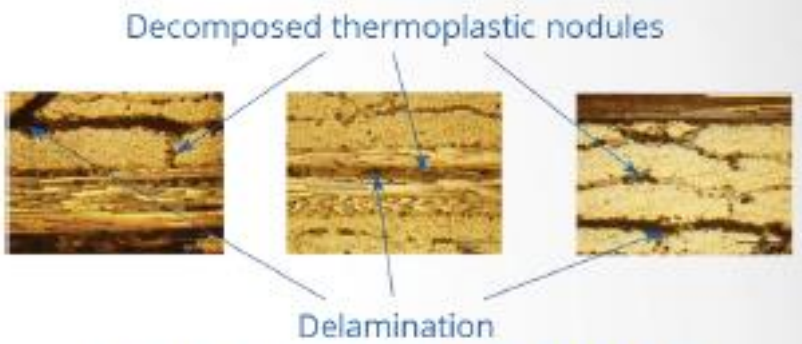


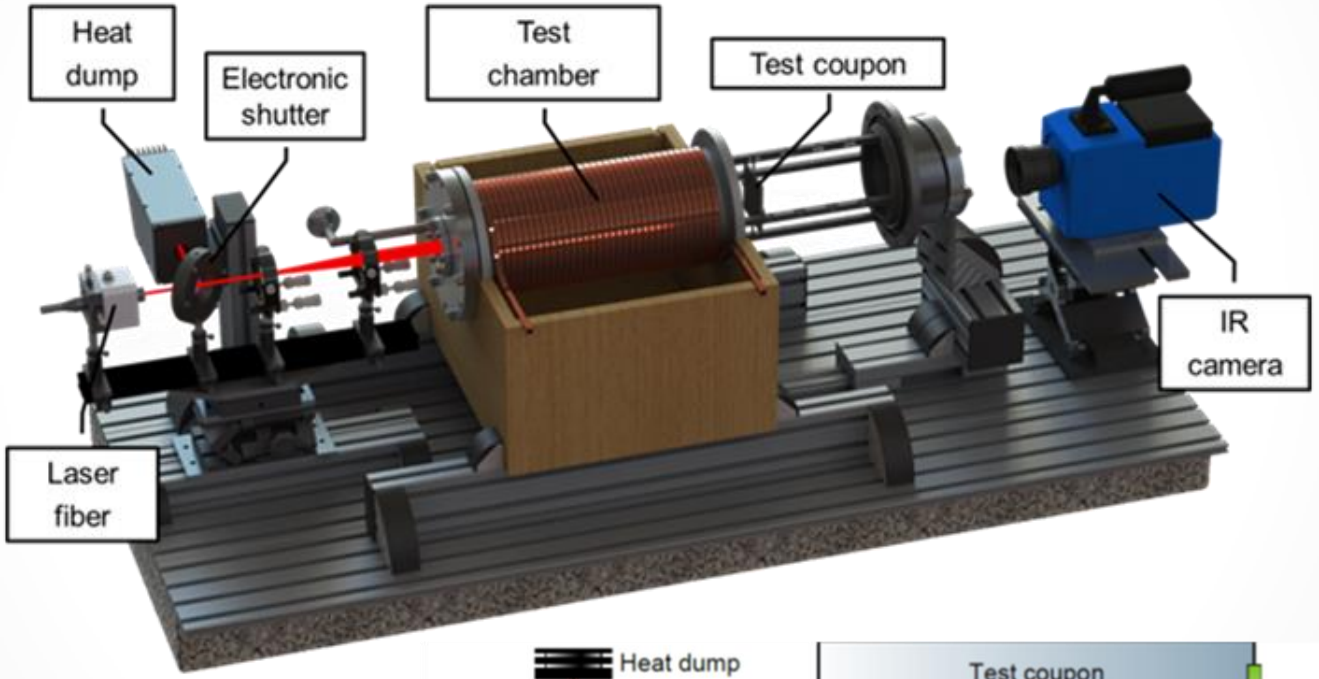
Nodules decomposition effect on interface damage

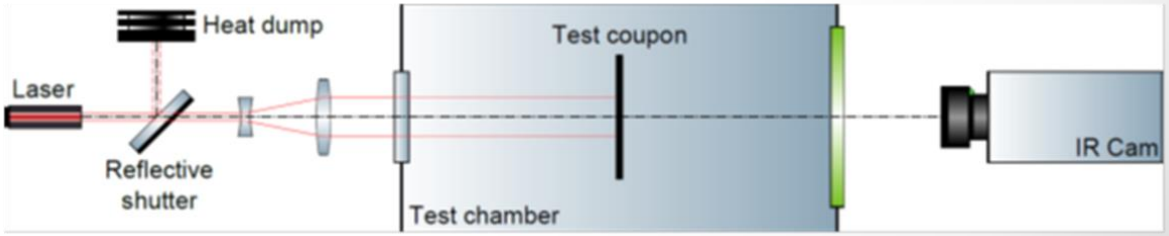
Research Test Device (BLADE)

e.g. T700/M21 thermal conductivity tensor (& heat capacity)

Thermo-physical characterization by controlled (T° & T° rate) laser-induced Heating and decomposition of materials

ONERA Blade facility

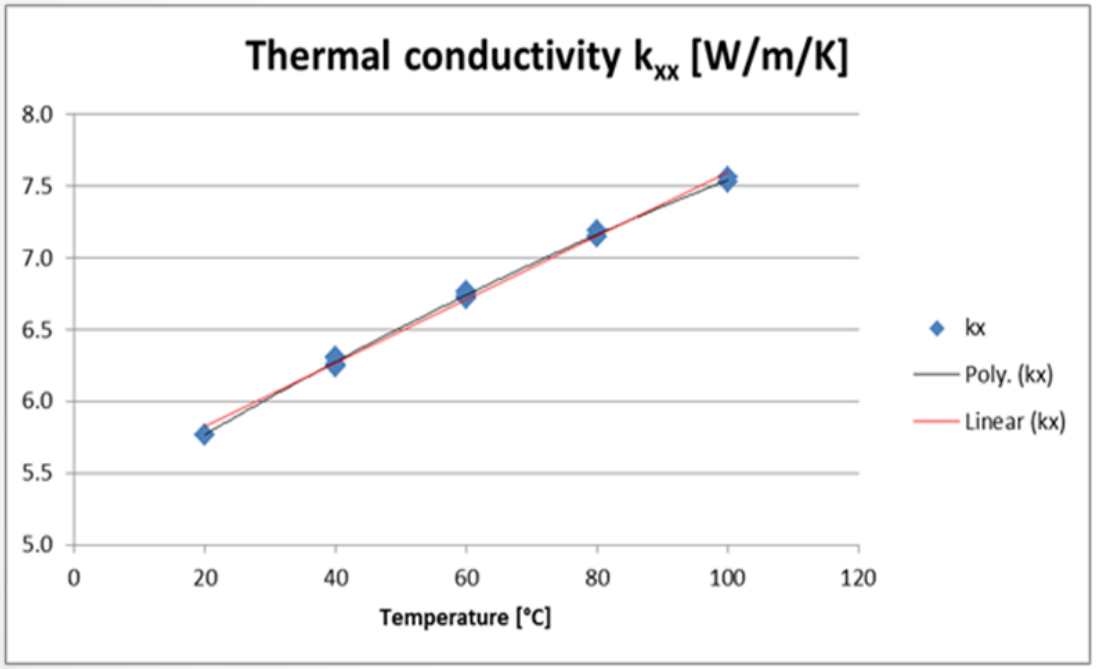




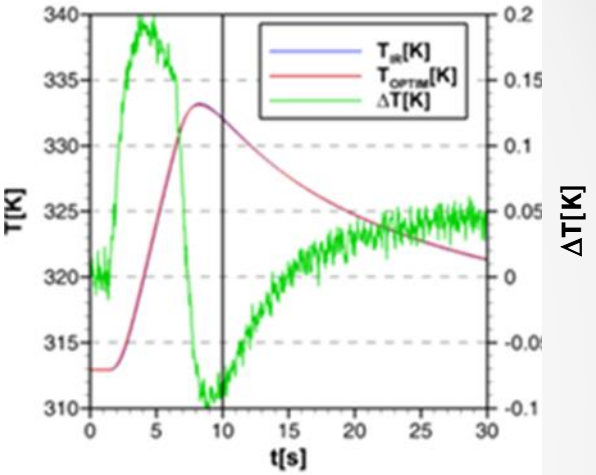
Experimental Results / Data

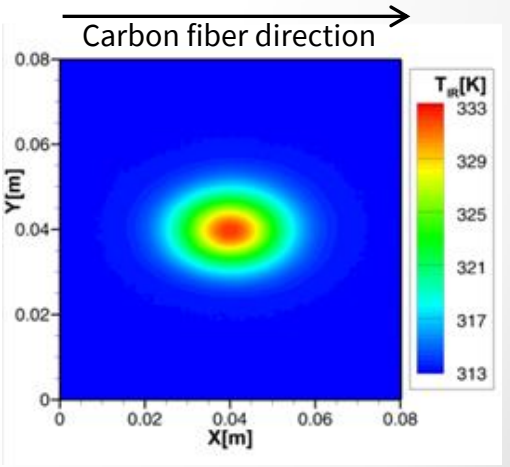
Basic research for accurate modelling

Example of identification of the thermal conductivity k_{xx} for the T700GC-M21-UD8 composite laminate:



Thermal response of T700/M21 UD

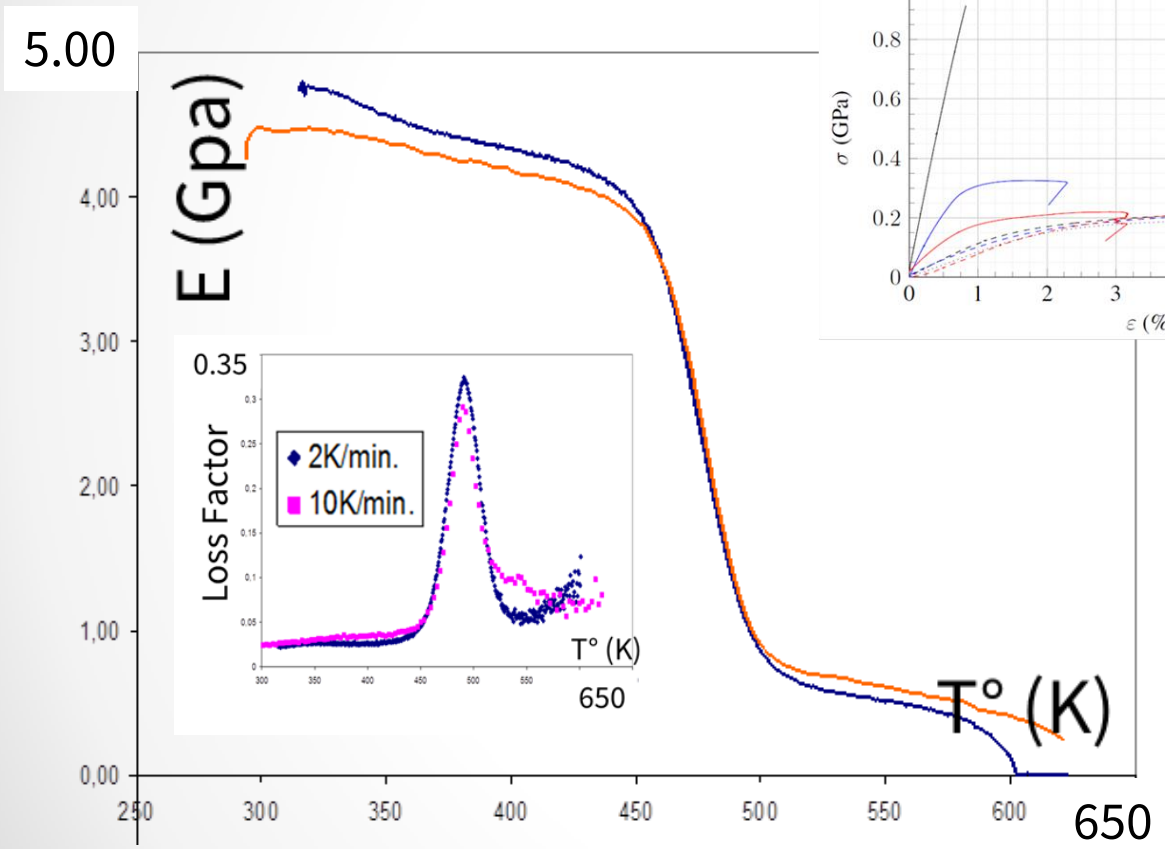




Experimental Data

T700/M21 thermo-mechanical properties

DMA tests on 90° laminates



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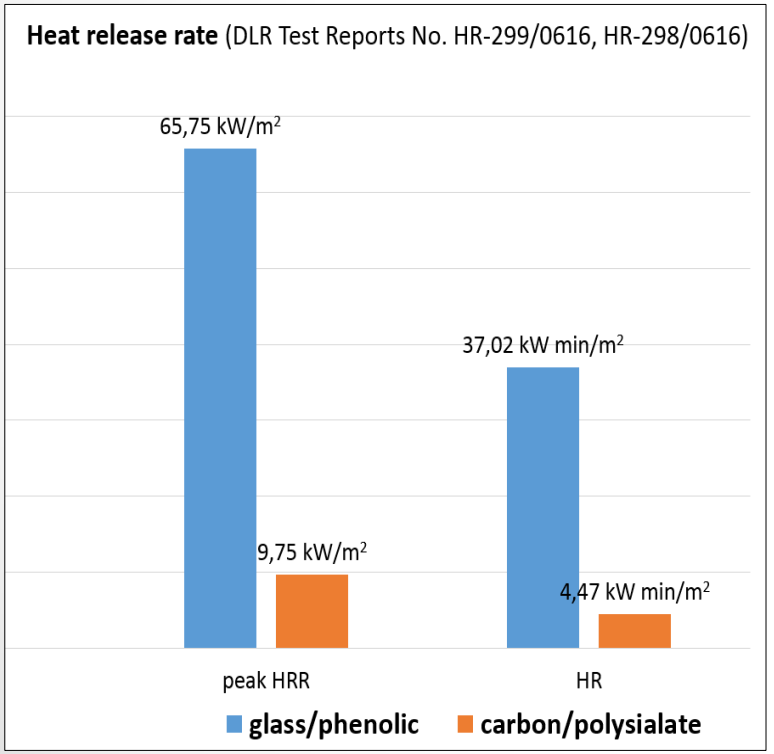
Polysialates (Geopolymers)

- Anorganic polysialate (geopolymer) matrix can withstand temperatures in excess of 1000°C, producing almost zero toxic products or smoke
- The material can be worked up with carbon fibers like common organic resins by low temperature/low pressure processes
- CFRGP Mechanical properties & density are comparable to glass/phenolic prepreg



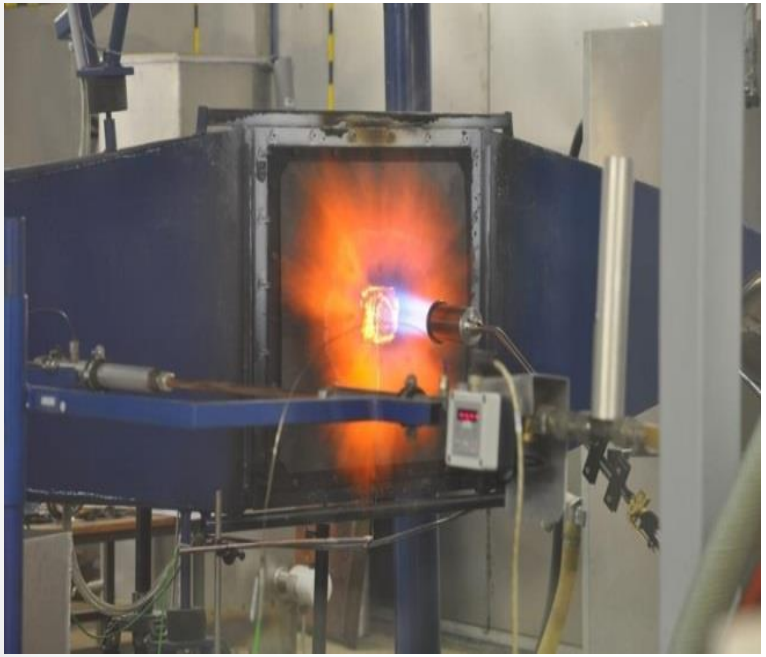
Test of resistance to fire in designated fire zones per ISO 2685 (1200oC/JET A-1 fuel)

Glass/Phenolic

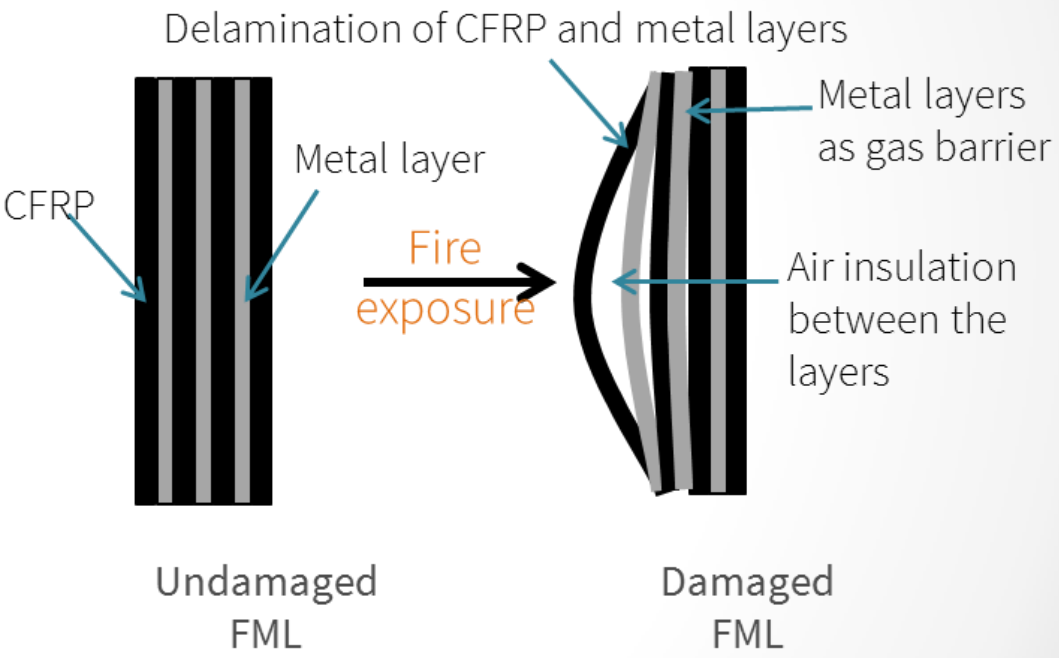
Carbon/Polysialate

Fibre Metal Laminates (FML)

- Tests demonstrate improved FML behaviour under Fire exposure



Flame exposure Test (5min)



Phenomenology leading to improvement : gas produced by heat caught between delaminated plies

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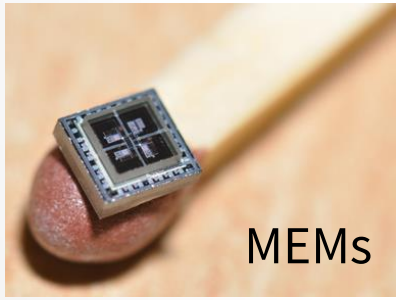
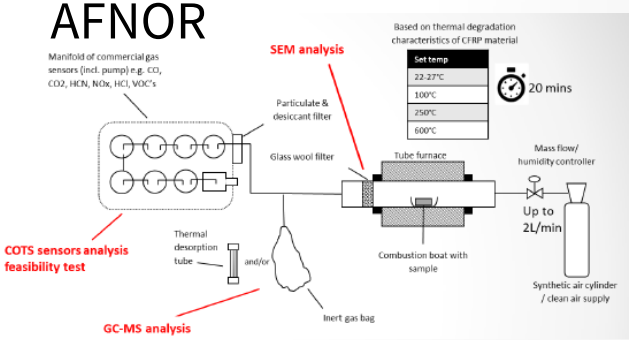
Literature review & methodological survey

- Addressing comfort & health considerations
- Understanding possible new emissions "sources" from recent A/C developments
- Investigating opportunities offered by modern sensing technologies to study air quality



Low cost Techs

AFNOR



- Discussing possible industrial framework to monitor air quality

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Conclusions & outlooks

- Primary structure & cabin materials are investigated
- Test specimens have been manufactured for WP71 & WP72, and tests are in progress
- General survey and first proposal for OBAQ framework is being discussed with the industry partners
- New test protocols (from existing standards) have been proposed in WP71 & WP73 and will be assessed
- Evaluation of state of the art models will start soon

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THANK YOU FOR YOUR ATTENTION ! ANY QUESTION ?

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Consortium

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Office national d'études et de recherches aérospatiales
Centro para a Excelência e Inovação na Indústria Automóvel
Centro Italiano Ricerche Aerospaziali
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Instituto Nacional de Técnica Aeroespacial
Výzkumný a zkušební letecký ústav, a.s.
Totalförsvarets FOrskningsInstitut
European Organisation for the Safety of Air Navigation
Civil Aviation Authority UK
Airbus SAS
Airbus Operations SAS
Airbus Defence and Space
Thales Avionics SAS
Thales Air Systems SA
Deep Blue SRL
Technische Universität München
Deutsche Lufthansa Aktiengesellschaft
Service Technique de l'Aviation Civile
Embraer Portugal Estruturas em Compositos SA
Russian Central Aerohydrodynamic Institute TsAGI
Ente Nazionale di Assistenza al Volo Spa
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Sistemi Innovativi per il Controllo del Traffico Aereo

http://www.futuresky.eu/projects/safety

Future Sky Safety has received funding from the European Union's Horizon 2020 research and innovation programme, under Grant Agreement No 640597.
This presentation only reflects the author's view; the European Commission is not responsible for any use that may be made of the information it contains.

Detailed FSS objectives

- *To coordinate institutional safety research programmes (P1),* and connect and drive institutionally funded safety research by EREA to safety priorities in the ACARE SRIA on Safety and Security.
- *To perform dissemination, exploitation & communication (P2),* and maximize the impact of results.
- To perform collaborative safety research on safety risk priority areas. The associated objectives are:
  - *Solutions for runway excursions (P3)*. Perform breakthrough safety research, in accordance with EAPPRE priorities, to enable a significant reduction of runway excursion risk.
  - *Total system risk assessment (P4)*. Develop a prototype risk observatory to assess and monitor safety risks throughout the total aviation system and allow frequent update of risk assessments.
  - *Resolving the organizational accident (P5)*. Reduce the likelihood of organizational accidents in aviation via development and implementation of a Safe Performance System.
  - *Human Performance Envelope (P6)*. Define and apply the Human Performance Envelope for cockpit operations and design, and determine methods to recover crew's performance to the center of the envelope, and consequently to augment this envelope, through Human Machine Interface principles, procedures or training.
  - *Mitigating risk of fire, smoke and fumes (P7)*. Develop solutions to mitigate fire, smoke and fumes related (fatal) accidents.

Why is P7 relevant for A/C safety

Almost 50% fatalities in case of accidents are fire caused/related. About 300 fatalities/year could be saved if fire fatalities were suppressed.

Emerging - New trends / new risks :

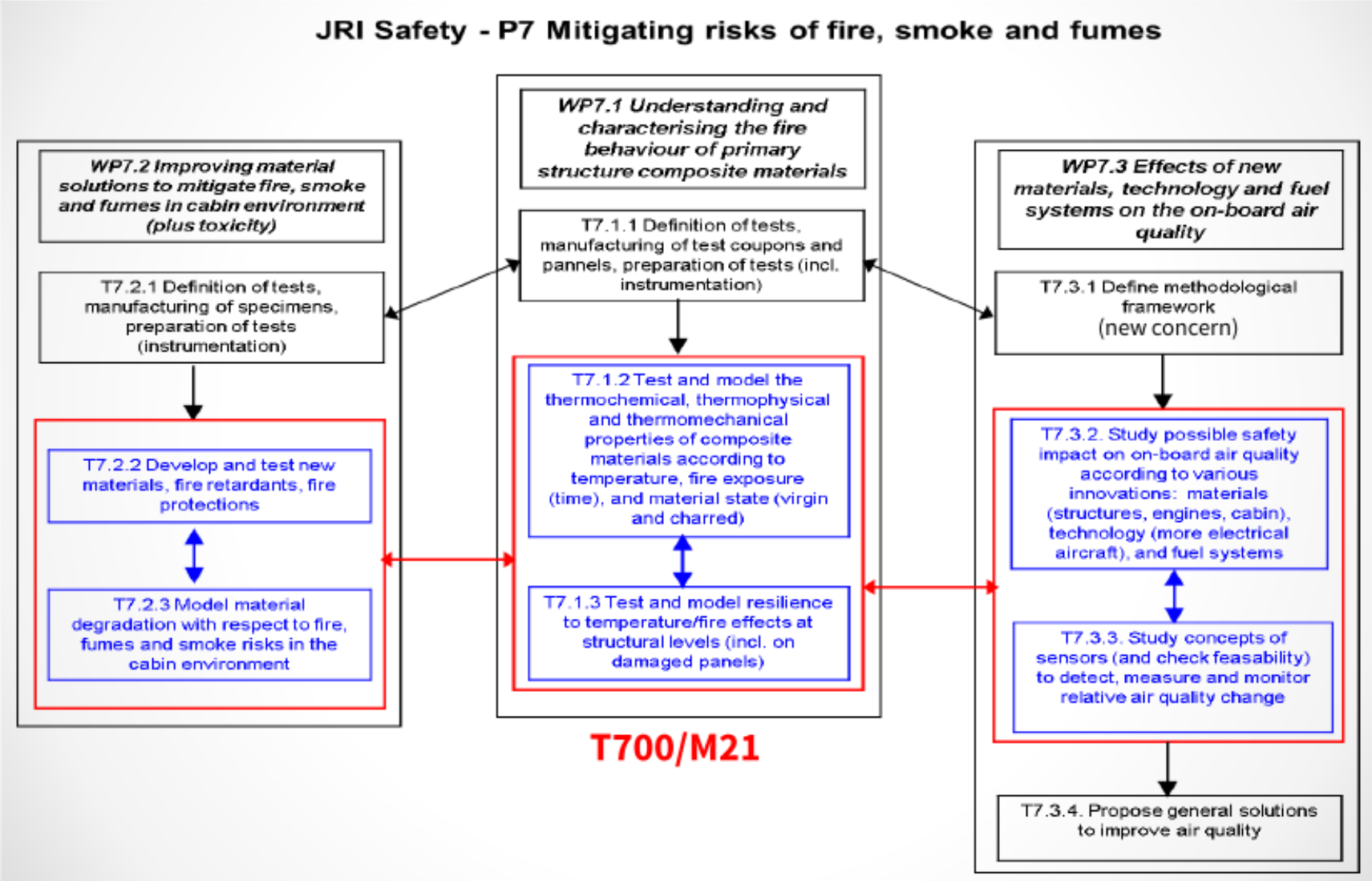
- More electric aircraft maybe increases risks of in-flight fires,
- More organic composites in A/C design with very different behavior compared to metalic materials,
- Limited knowledge wrt fire & heat behavior of composites materials.

CMO composites claimed to bring better burnthrough protection !
What about mechanical stiffness/strength **under compression** above 200°C (glassy transition) for structural integrity during evacuation ?
What about heat, toxic fumes and smoke ?

Few EU research on Composite Aircraft fire related safety : see Aircraft Fire Project.

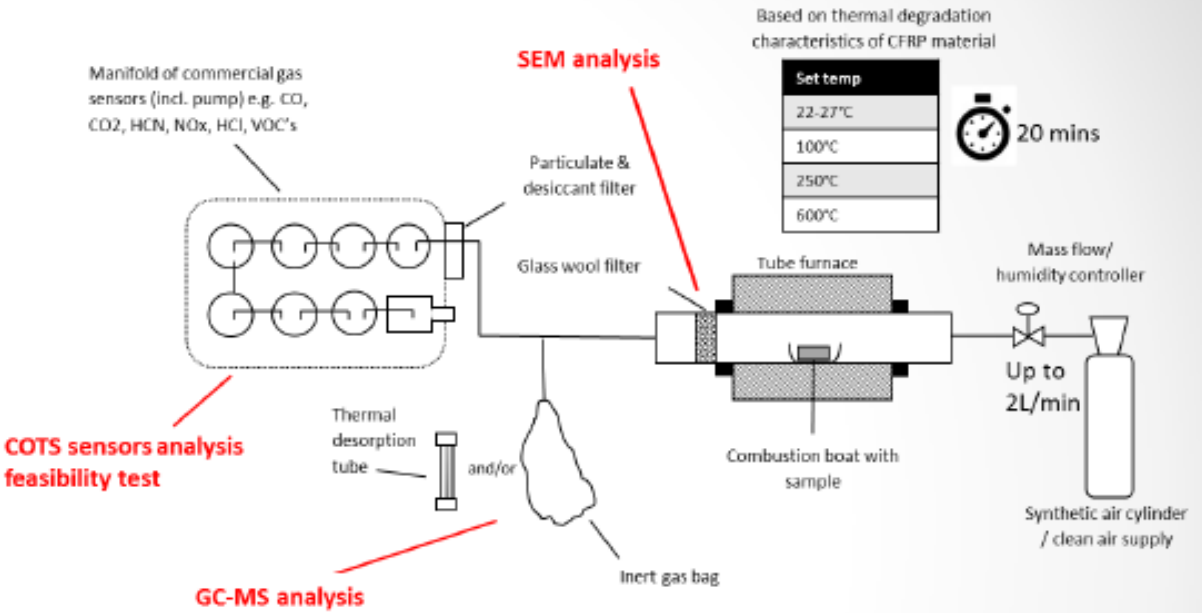
Few test results available (plus industry tests are often confidential), expensive.

Scientific Approach



Results (2015) – Testing Capabilities & Scope :

- Air quality test procedure for composite materials (based on AFNOR standard)
- Feasibility of monitoring system of low cost sensors



GC-MS analysis – To identify volatiles esp. epoxy resin derived e.g. phenols
SEM analysis – Analyse the char for particle sizing, potential for CNT's
COTS analysis – Comparison with GC-MS results as part of feasibility test

- Industrial framework for monitoring of air quality
- Literature study addressing substances in on-board air
  - amid confusing terminology
  - highly incomplete knowledge

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