RoCS
Certification by Simulation

Agenda

01. Objectives
02. Approach
03. Challenges and potential gains
04. Predictive fidelity
05. Perceptual Fidelity
06. Impact
07. Planned disseminations
08. Closing remarks

Main goal

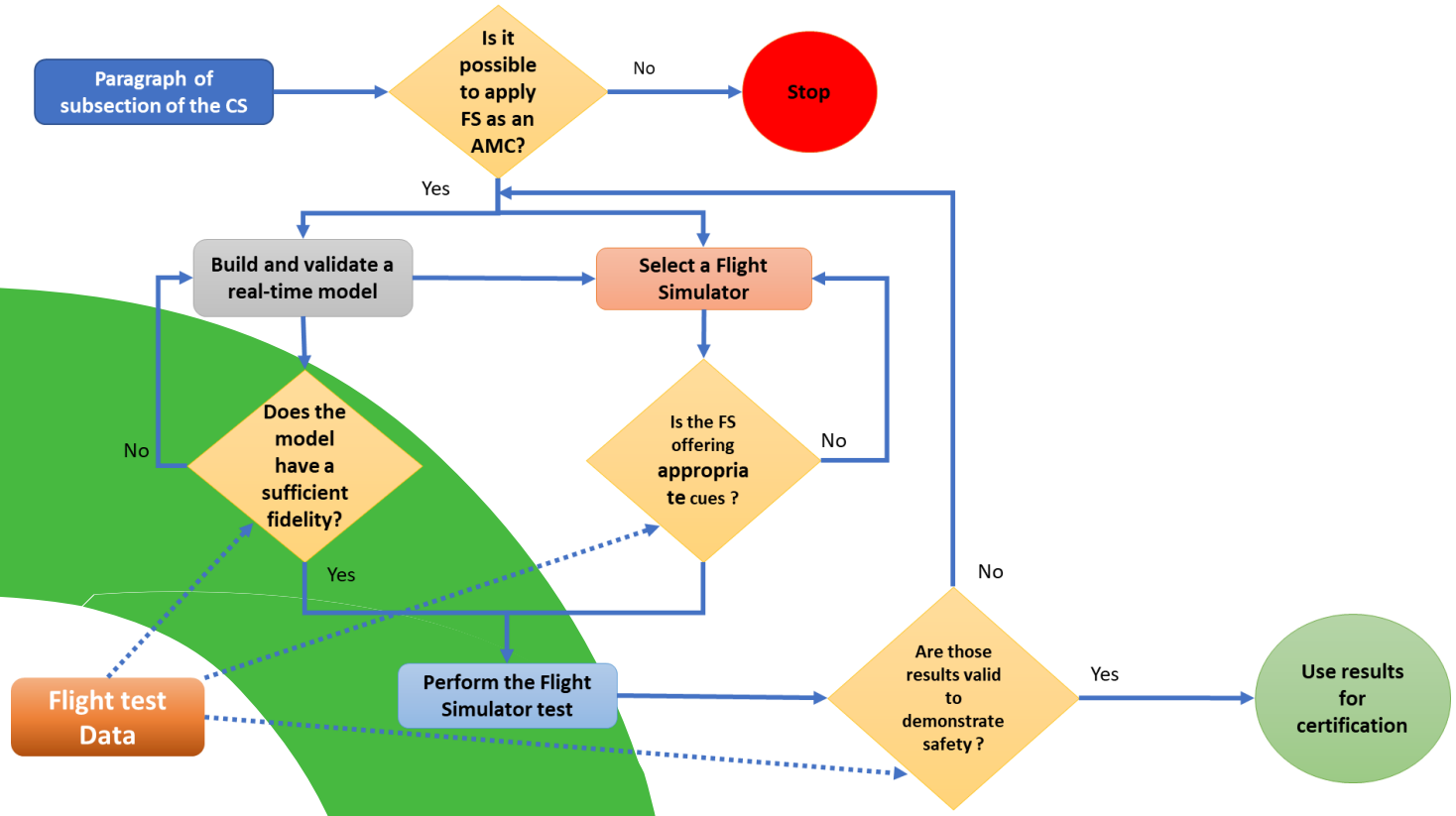
Produce a consolidated set of guidelines, agreed with the certification authority, and applicable to helicopters and tiltrotors, to extend and facilitate standardized application of flight simulation in the future certification of rotorcraft in Europe. The goal is to opt for simulation as a mean of compliance based on an equivalent level of risk wrt usage of flight tests.

Risk = probability of failure of correct compliance demonstration x consequences of failure

> The level of substantiation of the simulator to flight correlation should be commensurate with the level of compliance (i.e., the closer the case is to being non-compliant, the higher the required fidelity of the simulation).

FAA AC25-7D

Approach



Decide the criteria to choose simulation or FT

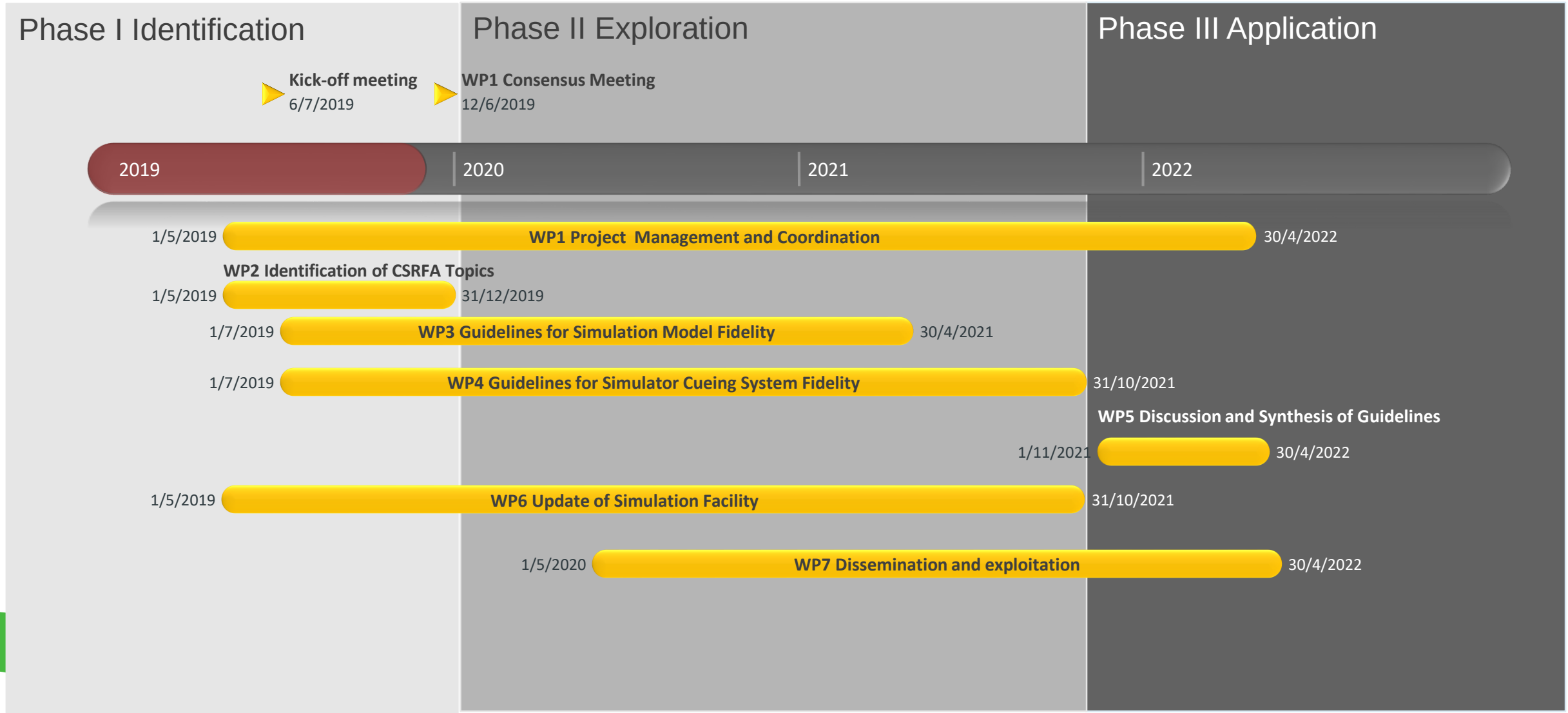
What metrics to use to measure fidelity

What level of model fidelity should be required

What perceptual fidelity should be required in the sim

How to manage the sim test (Virtual Testing Protocols)

WPs and Schedule



Phases

Phase I

the industry and certification authority are engaged to define the list of certification topics.

Phase II

starts with the definition of the related simulation fidelity metrics with input from industry and the certification authority. Identification of the capability gaps, improvements to the flight simulation models and simulator cueing environment using consortium simulation facilities

Phase III

will see the consolidation of the final set of guidelines and application to the updated LH AWARE simulation facility.

Current Use of Simulation

1. Flight demonstration is too risky
2. Required environmental condition are too difficult to attain
3. Used to demonstrate reputability, or demonstrate a specific scenario with a range of pilots

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Extend the usage of simulation

Safety

Increase of safety thanks to the possibility to demonstrate the flight conditions with highest associated risk

Anticipate, reduce and prevent risks

Economy

through reduction of costs associated with flight testing. Flight tests are expensive, require a lot of personnel. No risk to damage aircraft, less personnel involved

Duration

Tests in a simulator can be completed in a fraction of the time required by a full flight test. Environmental condition easily adjustable

Effectiveness

The possibility to test numerous different configurations with only a slight increase in costs and time. Possibility of repetition

Challenges

> The simulation should be suitably validated by flight test data for the conditions of interest. This does not mean that there must be flight test data at the exact conditions of interest

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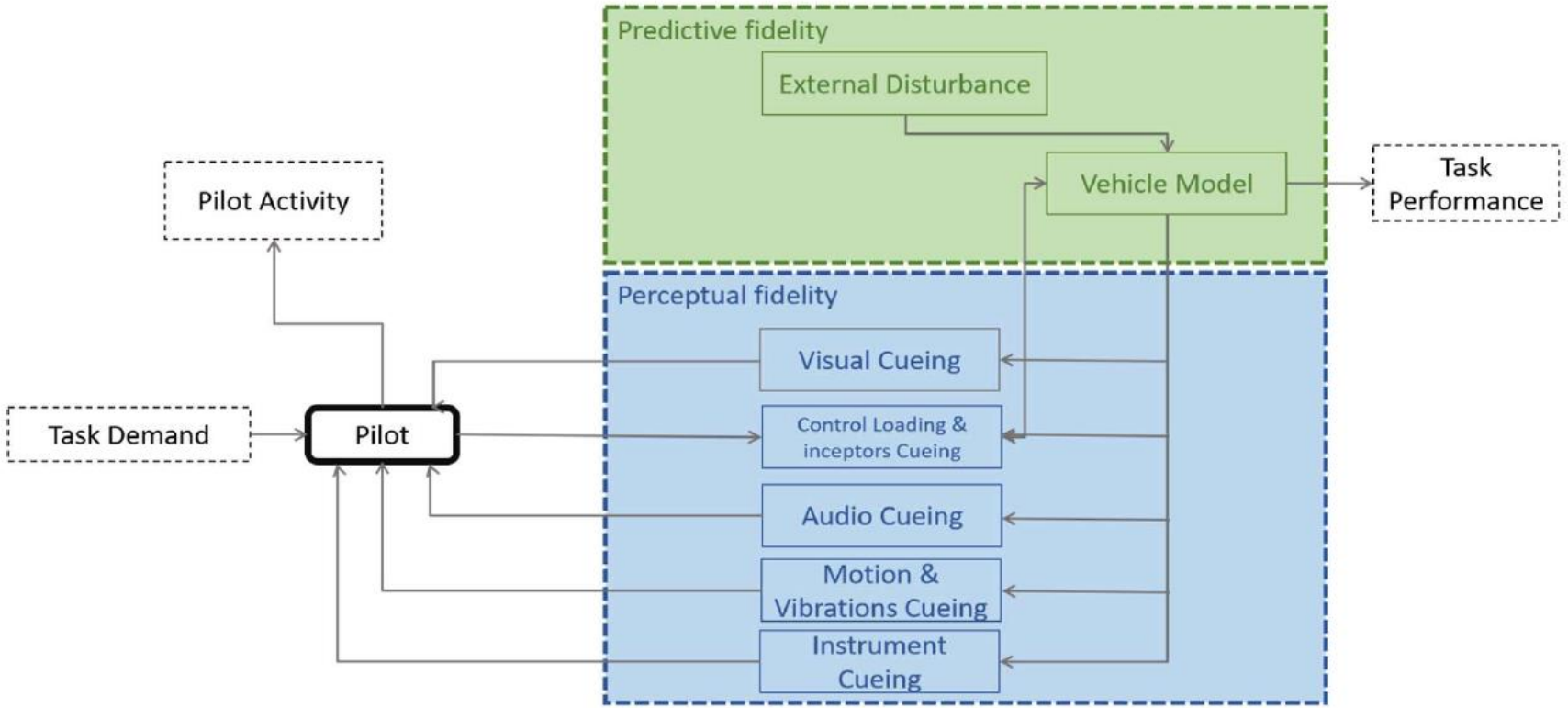
Credibility

Reach a level where the users can say “I believe the simulation is credible and I am comfortable taking the needed decision”



Elements of a simulation

Vehicle Model	WP3
Flight Simulator Cues/Hardware	WP4/WP5

Models for Simulator

Simulators already accepted for rotorcraft training, and cueing standards are defined to ensure that these devices are “fit-for-purpose”

Goal within RoCS – Define first standardized requirements for simulation cueing fidelity

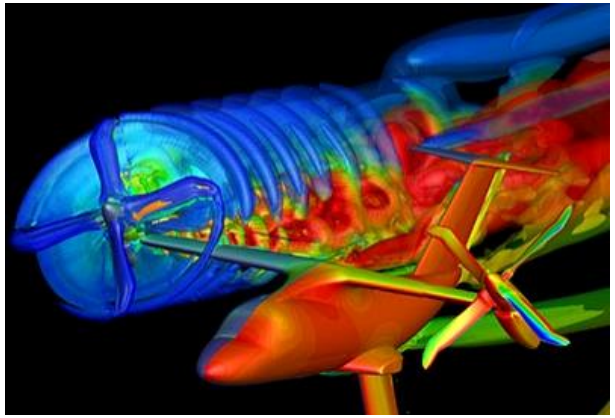
Goals of Activities

1. Define simulation cueing fidelity metrics and determine their use to evaluate simulation facilities for certification topics

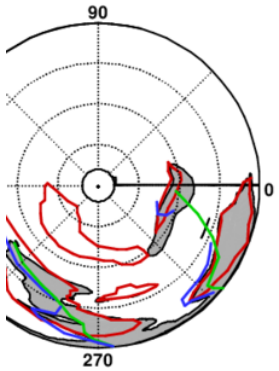
2. Provide guidelines for upgrades to existing simulation facilities and the design of new tiltrotor simulation device.

3. Draft preliminary guidelines regarding the simulation cueing fidelity requirements for the acceptance of simulation as a means of compliance.

WP3 Identify the gaps of modelling



Interference



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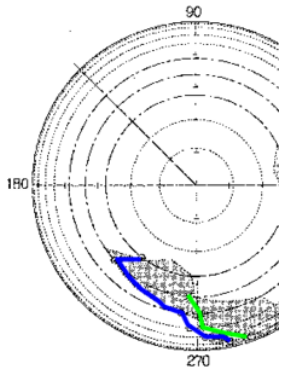


FLIGHT TEST [35]

High speed dynamic stall

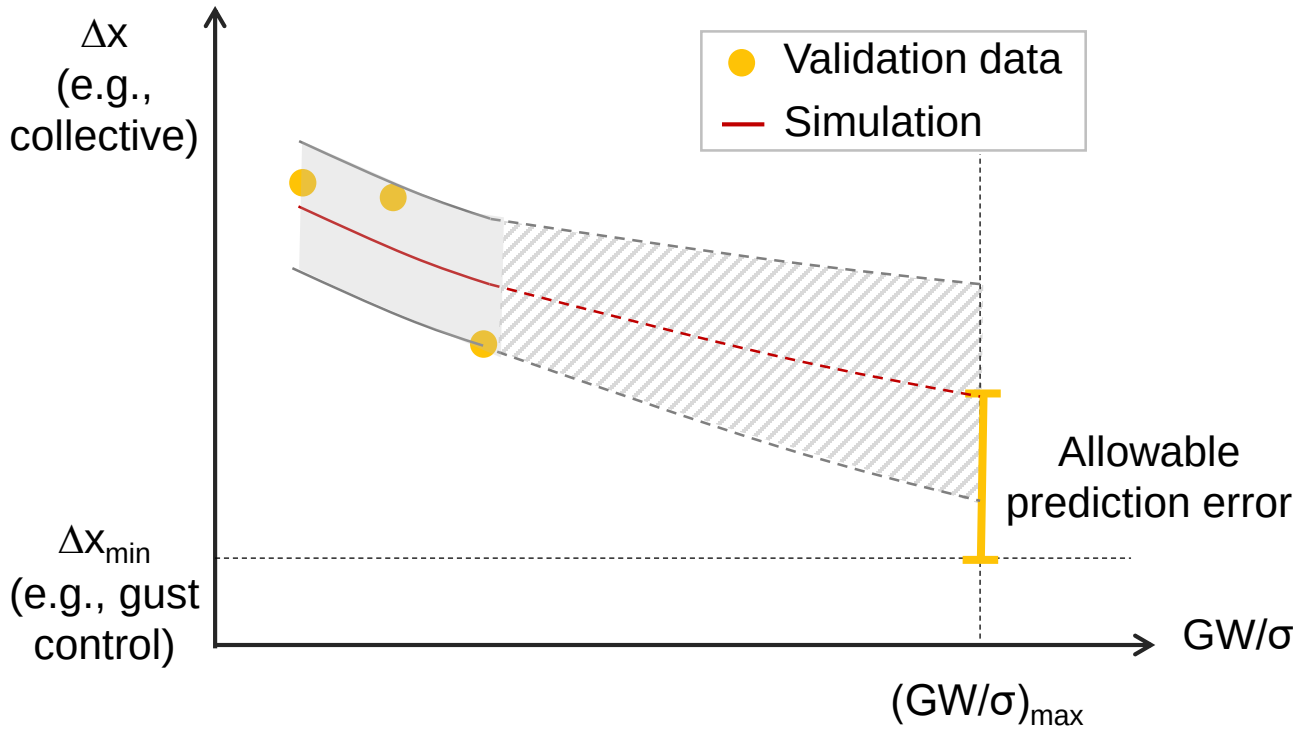
blade flexibility

Predictive Fidelity

Prediction: use of the model under non-validated conditions

Predictive Fidelity: strength of inferences made with the model

Uncertainty quantification and sensitivities could be used to infr the predictive fidelity



Simulator Cueing Environment

AVES Simulator at DLR – one of partner facilities available during project

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Simulation Facilities

Development of Test Procedures

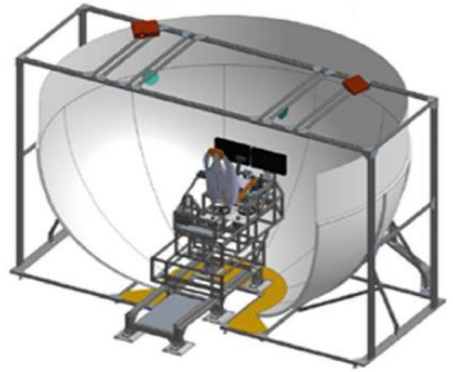
- Use of partner simulation facilities to develop mission tasks and scenarios to simulate certification aspects

Use and Development of Cueing Metrics

- Conduct investigations to select suitable metrics for assessing simulation cue fidelity
- Use of metrics both in terms of subjective and objective measures
- Development of novel metrics to ascertain fidelity (pilot adaptation metrics)

Certification Tests in Leonardo Simulator

- Tests conducted to justify the use of simulator at Leonardo Helicopter facilities to conduct certification tests
- Feedback from pilots and engineers regarding applicability of methodologies



What are the Requirements? Examples

Motion Systems?

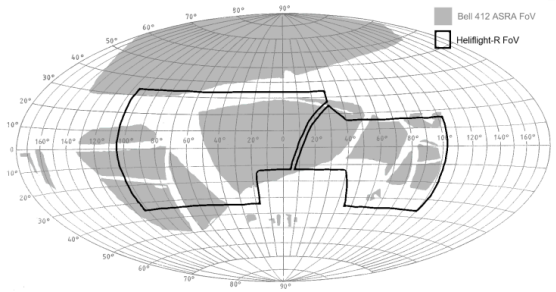
- When is motion required?
- What level of motion feedback is necessary for certification tasks
- Are defined metrics and hardware capabilities for training simulators acceptable?

Visual Cueing? Replication of Instruments?

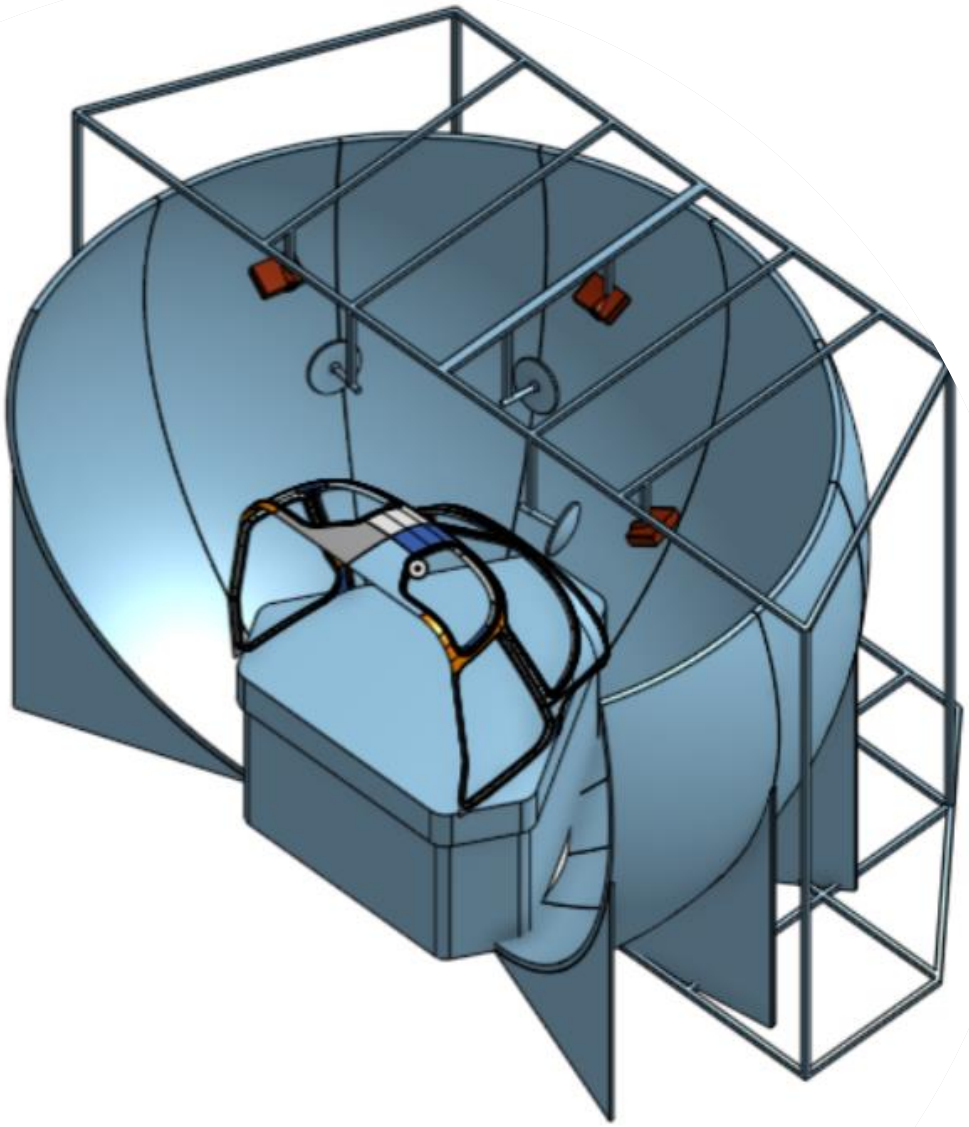
- How is the relationship between visual field and view and cockpit requirements?
- Is it possible to conduct certification pilot-in-the-loop testing with AR/VR
- Which aspects does this support

Desktop Training and Assessment?

- Can the certification activity be conducted using “desktop simulation”?
- Could activities be supported through desktop/tablet or do we require full aircraft cockpit



Certification Simulators



- the models should limit as much as possible non-physics-based tuning
- models should be developed while the FE is opened
- they can be used often in extrapolation to investigate the behavior close to the boundaries of FE and even outside the standard FE
- Lower relevance to subjective pilots' evaluation
- necessity to be easily reconfigurable
- Simulation cues should be there to create the correct environment for the pilot

Scenarios to be analyzed

1. Cat A 29.53(a)
2. Low speed Controllability 29.143(c-d)
3. Dynamic Stability 29.181 and App. B Par VI

4. Tiltrotor: Power off landing AFCS failures – 29.672(b)

Impact

Decrease the risks associated with rotorcraft certification compliance demonstration.

Promote a better industry and authority understanding of the rotorcraft characteristics by increasing flight test effectiveness in terms of data gathered and number of configurations evaluated. Increase safety of rotorcraft flight (connection with EASA Safety Roadmap)

Reduce cost of rotorcraft certification (about 88% reduction for each test performed via simulation).

Reduce the time required to complete rotorcraft certification, and so the time-to-market of new products. (could be potentially extremely interesting for new product like tiltrotor/eVTOL)

Dissemination

A final **showcase workshop** will be organised to demonstrate the use of guidelines to a select group of stakeholders, primarily certification authorities, rotorcraft manufactures and test pilots. The workshop will begin with presentations of the activities performed in RoCS and it will continue with a **demo of a test by simulation** using the flight simulator of one of the partners

www.rocs-project.org

RoCS
ROTORCRAFT CERTIFICATION BY SIMULATION

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