Clean Sky 2
Call for Partners 06

Fast Rotorcraft IADP
NextGenCTR

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Clean Sky 2

CS2 Fast Rotorcraft NGCTR Objectives

The main objectives for the Clean Sky 2 NextGenCTR Programme (Next Generation Civil Tiltrotor - NGCTR) are the following:

- Validation of **key tiltrotor technologies** for rotors, drivetrain, wing, empennage, engine installation and Flight Control System (FCS)
- Validation from **test data** (lab, ground and flight test) of **numerical and experimental predictions** of component, system and vehicle **performance**
- Validation of **predictive models** for environmental impact of production vehicle (**noise and emissions**)

NGCTR key technology drivers

- **Key objectives of NextGenCTR**:
  - CO_2 and Noise Footprint reduction
  - Reduced cost of ownership (operating & MRO)
  - High Efficiency, High Productivity
  - Fast Forward Speed

- **A set of key enabling technologies** have been identified for maturation and demonstration under CS2 program.

CS2 CfP06 – NGCTR Topics

Clean Sky 2

CS2 CfP06 – NGCTR Topics List

Identification Code	Title	WP	Indicative Start Date of activities	Indicative Duration (in months)	Indicative Value (funding in M€)	Type of Action
JTI-CS2-2017-CfP06-FRC-01-13	Low-speed Air Data Sensor for Tilt-rotor Control	WP 1.2	Q1 2018	72	0.75	IA
JTI-CS2-2017-CfP06-FRC-01-14	Contactless measurement system for real time monitoring of proprotor flapping angle	WP 1.2	Q1 2018	72	1.00	IA
JTI-CS2-2017-CfP06-FRC-01-15	Interactional aerodynamic assessment of advanced Tilt Rotor configuration	WP 1.4	Q1 2018	30	2.20	RIA

Low-speed Air Data Sensor for Tilt-rotor Control

CfP Header

6th Call for Proposals (CFP06)

Type of action (RIA or IA)	IA		
Programme Area	FRC		
Joint Technical Programme (JTP) Ref. (ref. to Work Package)	IADP – NextGenCTR Demonstrator Tiltrotor WP 1.2		
Indicative Funding Topic Value (in k€)	750 k€		
Duration of the action (in Months)	72 months	Indicative Start Date*	01-2018

Identification	Title
JTI-CS2-2017-CFP06-FRC-01-01	Low-speed Air Data Sensor for Tilt-rotor Control
Short description (3 lines)	
Improvements in tiltrotor control and performance in the low speed (0-50 knots) regime requires the availability of high fidelity air data. Pneumatic-based air data systems cannot provide this, whereas state of the art laser or microwave systems could. The present activity involves the integration of a proven (min TRL-7) low speed air data system with the flight control system to provide the innovative tiltrotor control in the low-speed regime.	

Scope of work

- Application of a state-of-the-art **low-speed air data system** (L-ADS) to **tiltrotor control**.
  The focus of the innovation is in the application of the sensor to tiltrotor control, **rather than the sensor itself**.
- The partner must be able to demonstrate that the L-ADS is a **flight validated system** by CDR (T0+22).
- Demonstration of sensor measurement accuracy, integrity and continuity in **all weather conditions**.
- The **measurement volume** shall be located in an area remote from the sensor, **unaffected by the air vehicle aerodynamics**. No local airflow analysis at sensor/probe for calibration shall be necessary as for a conventional air data system.

Air data parameters to be measured

- The system shall provide (as a minimum) the following air data parameters in all flight conditions, from hover at 0 knots to forward flight at 300+ knots:

Parameter	Range/units	Accuracy
True Air Speed	0 .. 400 knots	± 1 knot
TAS relative direction at speeds < 50 knots	-180 .. 180° with respect to longitudinal aircraft axis	± 1°
Angle of Sideslip	-90 .. 90 degrees	± 0.5°
Angle of Attack	-90 .. 90 degrees	± 0.5°
Pressure Altitude	As per SAE AS8002A	
Altitude Rate (Vertical Speed)	As per SAE AS8002A, with an accuracy of at least 100 ft/min for the low-speed domain (< 50knots).	

Project Implementation

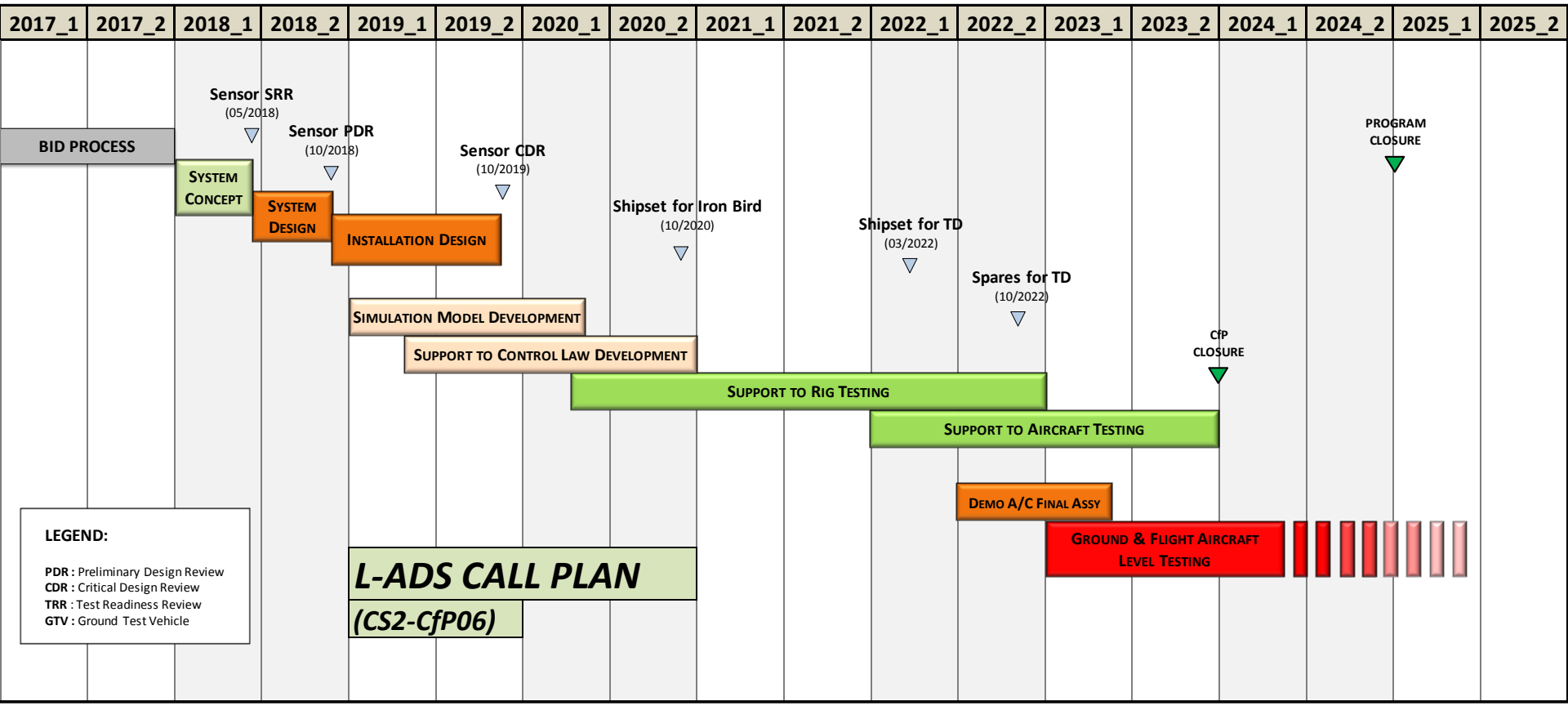
Tasks		
Ref. No.	Title - Description	Due Date
1	System Concept	T0 + 5
2	System Design	T0 + 10
3	Installation Design	T0 + 22
4	Simulation Model Development	T0 + 28
5	Support to Control Law Development	T0 + 36
6	Support to Rig Testing	T0 + 60
7	Support to Aircraft Testing	T0 + 72

Milestones			
Ref. No.	Title - Description	Type	Due Date
M1	System Requirements Review	RM	T0 + 5
M2	Preliminary Design Review	RM	T0 + 10
M3	Critical Design Review	RM	T0 + 22

Deliverables			
Ref. No.	Title - Description	Type	Due Date [T0+mm]
D.1	System Requirements Specification	R	T0 + 5
D.2	Equipment Specifications	R	T0 + 5
D.3	System Design Description	R	T0 + 10
D.4	Equipment Interface Control Documents	R	T0 + 10
D.5	Installation Design Description	R	T0 + 22
D.6	Equipment Qualification Evidence	R	T0 + 22
D.7	L-ADS Simulation Model for Pilot-in-the-loop simulator	D	T0 + 16
D.8	L-ADS Emulation Model for Iron-bird.	D	T0 + 28
D.9	Shipset for Iron bird	D	T0 + 34
D.10	Acceptance Test Procedure.	R	T0 + 51
D.11	Shipset for Technology Demonstrator	D	T0 + 51
D.12	Spares for Technology Demonstrator	D	T0 + 58

See CfP document for items description

Master Plan



Applicant requirements

The Applicant shall have proven capabilities and skills in each of the specific areas of this Call, in particular:

- Aeronautic rules, certification processes and quality requirements.
- Design, validation, manufacturing and environmental/functional qualification of avionic systems, according to RTCA-DO-160, RTCA-DO-178 and RTCA-DO-254 for safety critical equipment.
- EMI compatibility issues: capacity to design complex electronic HW in compliance with EMC guidelines, and experience in performing EMC justification analyses and experimental assessments (RTCA-D0-160, EUROCAE ED-107/ARP-5583, ED-81/ARP-5413 and ED-84/ARP-5412).
- Engineering and quality procedures capable to produce the necessary documentation and means of compliance to achieve the “Safety of Flight” with the applicable Airworthiness Authorities (FAA, EASA, etc.).
- Safety assessment process according to SAE-ARP-4754 and SAE-ARP-4761.

Contactless measurement system for real time monitoring of proprotor flapping angle

CfP Header

6th Call for Proposals (CFP06)

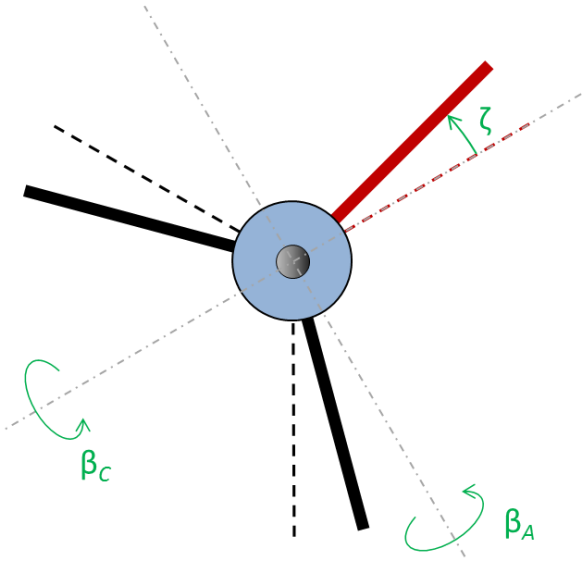
Type of action (RIA or IA)	IA		
Programme Area (ref. to SPD)	FRC		
Joint Technical Programme (JTP) Ref. (ref. to Work Package)	IADP – NextGenCTR Demonstrator Tiltrotor WP 1.2		
Indicative Funding Topic Value (in k€)	1000		
Duration of the action (in months)	72 months	**Indicative Start Date**[1]	Q1-2018

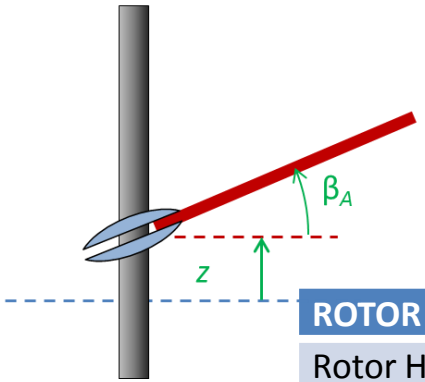
Identification	**Title**
JTI-CS2-2017-CFP06-FRC-01-02	**Contactless measurement system for real time monitoring of proprotor flapping angle**
Short description (3 lines)	
Improvements in tiltrotor performance can be reached with a reliable real-time monitoring of proprotor flapping angle. To overcome reliability and durability limitations due to the challenging operating environment, especially in terms of vibrations, the present topic relates to the provision of a contactless measurement system to be integrated in the proprotor assembly. It shall preferably be based on laser or vision sensor(s), and capable of communicating with the NGCTR avionic system and Flight Test Instrumentation providing actual flap motion. This includes also support to flight test activity.	

Scope of work

- **Design, develop and manufacture** a new compact, low weight, accurate, reliable and power efficient system capable of **real-time monitoring of the proprotor hub flapping angle**, for the NextGenCTR tiltrotor demonstrator.
- **Integrate** the sensor system into the NextGenCTR Technology Demonstrator and **test it in flight**.
- **The proposed equipment does not need to be flight qualified at program start**, but the Partner shall provide all the required documentation to **support an Experimental Flight Approval (EFA)** release in accordance to the plan (T0+31).
- Support the Tiltrotor manufacturer during the **ground and flight test campaign**.

Quantities to be measured





Rotor shaft

Rotor hub

Rotor blade

R. blade in original position

Rotor blade (measurement target)

Flapping axis

β_A Flap motion

β_C Cross-axis flap motion

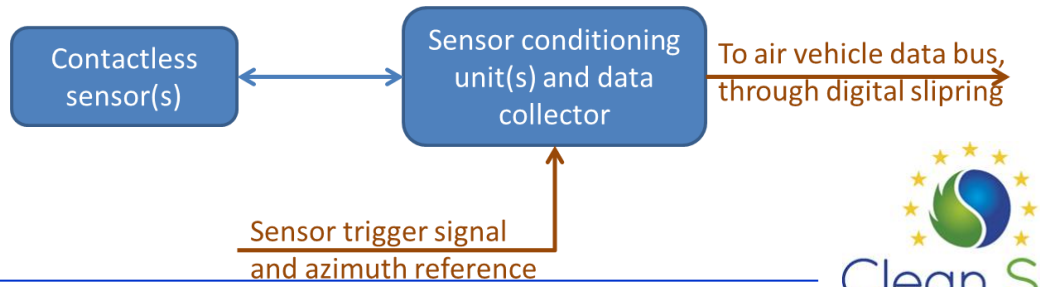
z Hub vertical displacement

ζ Lag motion

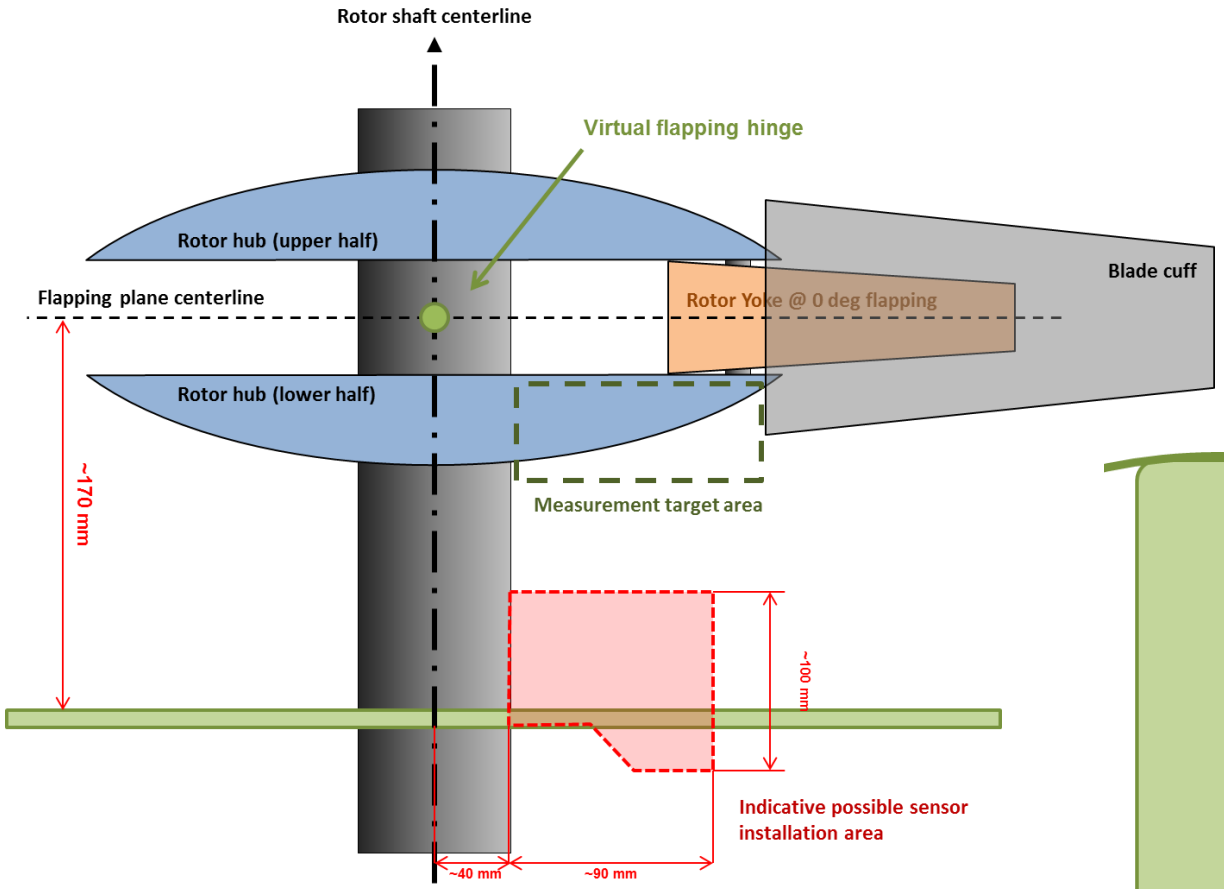
ROTOR HUB ANGLE/DISPLACEMENT	Mandatory / Desirable
Rotor Hub Flapping (β_A)	Mandatory
Rotor Hub Cross-Axis Flapping (β_C)	Mandatory
Rotor Hub Lag (ζ)	Desirable
Rotor Hub Axial Displacement (z)	Desirable

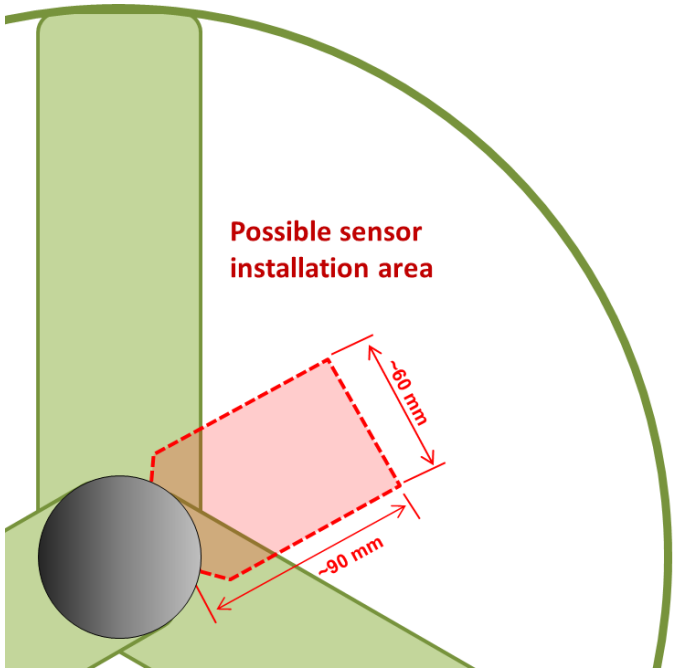
System description

- **Contactless sensors** measuring the **rotor hub flap angle**
- **Sensor conditioning unit**, aimed at
  - Receiving a trigger digital signal;
  - Receiving an azimuth reference;
  - Driving the sensors acquisition simultaneously with the trigger signal;
  - Receive the measurement data from the sensors;
  - Provide the air vehicle data bus with the rotor hub measured data (one data packet per each sensor), through the slipring.
- I/O interfaces with the tiltrotor avionic system: **digital databus**
- **Redundancy** to meet the failure probability requirements of a **hazardous event**



Installation schematic





Characteristic	Requirement
Voltage supply	28 VDC
Power requirement	< 100 W per rotor
Accuracy Objective	0.5 deg (mandatory), 0.1 deg (desired)
Weight Objective	< 0.5 kg per rotor
Samples per rotor revolution	>= 24 per rotor

Project Implementation

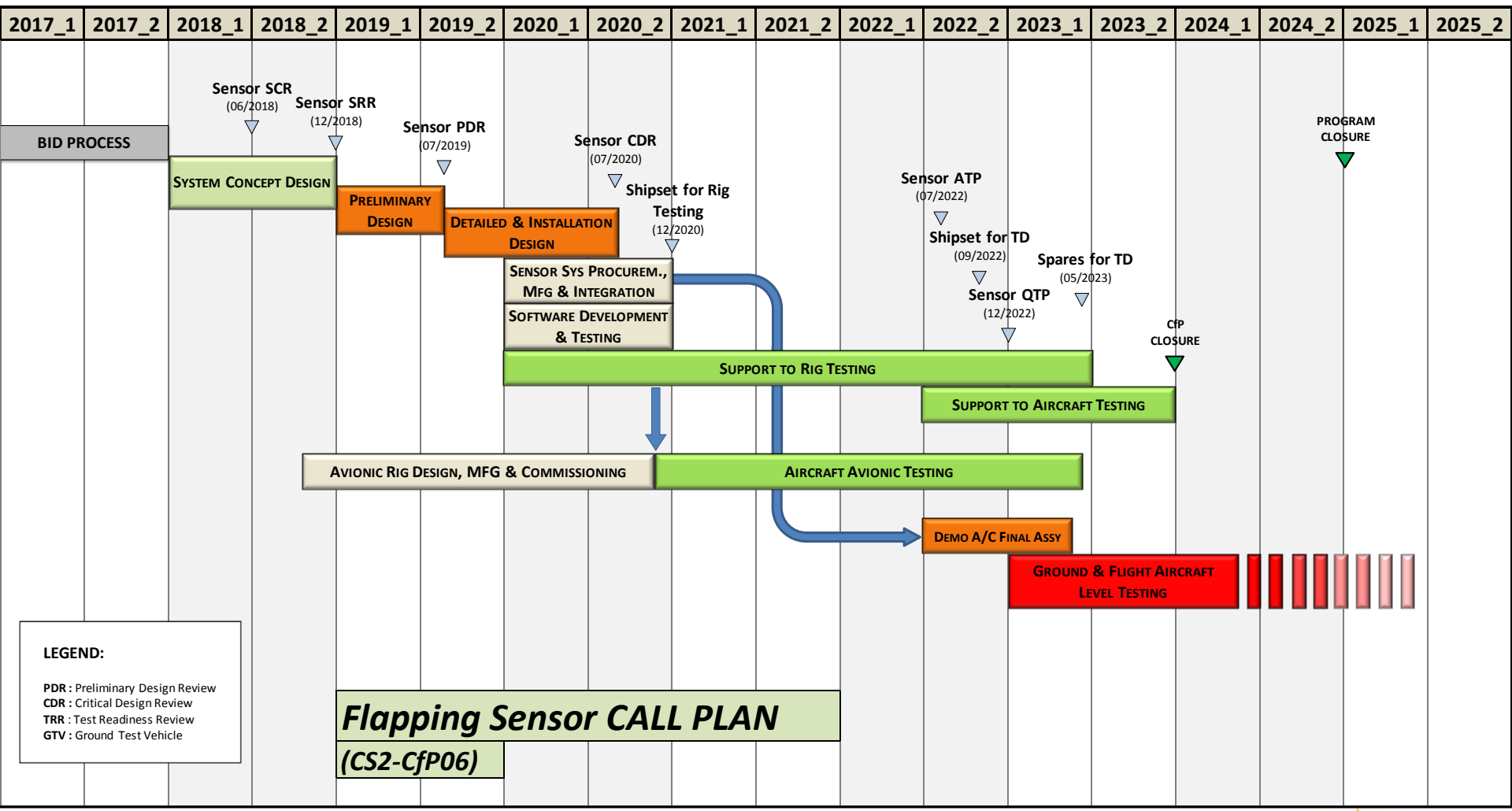
Tasks		
Ref. No.	Title - Description	Due Date
1	System Concept	T0 + 12
2	System Design	T0 + 19
3	Installation Design	T0 + 31
4	Support to Rig Testing	T0 + 66
5	Support to Aircraft Testing	T0 + 72

Milestones			
Ref. No.	Title - Description	Type	Due Date
M1	System Concept Review	RM	T0+6
M2	System Requirements Review	RM	T0 + 12
M3	Preliminary Design Review	RM	T0 + 19
M4	Critical Design Review	RM	T0 + 31

Deliverables			
Ref. No.	Title - Description	Type	Due Date [T0+mm]
D.1	System Requirements Specification	R	T0 + 12
D.2	Equipment Specifications	R	T0 + 12
D.3	System Design Description	R	T0 + 19
D.4	Equipment Interface Control Documents	R	T0 + 19
D.5	Installation Design Description	R	T0 + 31
D.6	Equipment Qualification Evidence	R	T0 + 31
D.7	Shipset for rig testing	D	T0 + 36
D.8	Acceptance Test Procedure	R	T0 + 55
D.9	Shipset for Technology Demonstrator	D	T0 + 58
D.10	Qualification Test Procedure	R	T0 + 60
D.11	Spares for technology demonstrator	D	T0 + 65

See CfP document for items description

Master Plan



Applicant requirements

The Applicant shall propose a consortium with the following skills, experiences and capabilities:

- Capability of adapting/customizing the sensor (if required)
- Aeronautic rules, certification processes and quality requirements.
- Design, validation, manufacturing and environmental/functional qualification of avionic systems, according to RTCA-DO-160, RTCA-DO-178 and RTCA-DO-254 for safety critical equipment.
- EMI compatibility issues: capacity to design complex electronic HW in compliance with EMC guidelines, and experience in performing EMC justification analyses and experimental assessments (RTCA-D0-160, EUROCAE ED-107/ARP-5583, ED-81/ARP-5413 and ED-84/ARP-5412).
- Engineering and quality procedures capable to produce the necessary documentation and means of compliance to achieve the “Safety of Flight” with the applicable Airworthiness Authorities (FAA, EASA, etc.).
- Safety assessment process according to SAE-ARP-4754 and SAE-ARP-4761.

Interactional aerodynamic assessment of advanced Tilt Rotor configuration

CfP Header

Clean Sky 2

6th Call for Proposals (CFP06)

Type of action (RIA or IA)	RIA		
Programme Area	FRC		
Joint Technical Programme (JTP) Ref. (ref. to Work Package)	IADP – NextGenCTR Demonstrator Tiltrotor WP 1.4		
Indicative Funding Topic Value (in k€)	2200 k€		
Duration of the action (in Months)	30 months	Indicative Start Date*	01-2018

Identification	Title
JTI-CS2-2017-CFP06-FRC-01-03	Interactional aerodynamic assessment of advanced Tilt Rotor configuration
Short description (3 lines)	
The Topic is aimed to investigate, through a modified existing powered wind tunnel model, the fundamental interactional aerodynamic aspects in the tail region of a tilt rotor. The activity will be accomplished by providing a clear understanding of the efficiency (in terms of aircraft static stability) of different empennage configurations when embedded in the rotor inflows.	

Scope of work

- **Interactional Aerodynamics evaluation of proprotor inflow effect on empennage**:
  - Basic understanding of the NGCTR layout with two different empennage configurations
  - Modification of the existing Nicetrip 1/5th powered model to host the two proposed empennage configurations
  - Determination of impact of proprotor wake on empennage efficiency and loads, using the modified Nicetrip 1/5th model
  - Assessment of the basic NGCTR empennage configuration based on the results of the modified Nicetrip 1/5th model tests

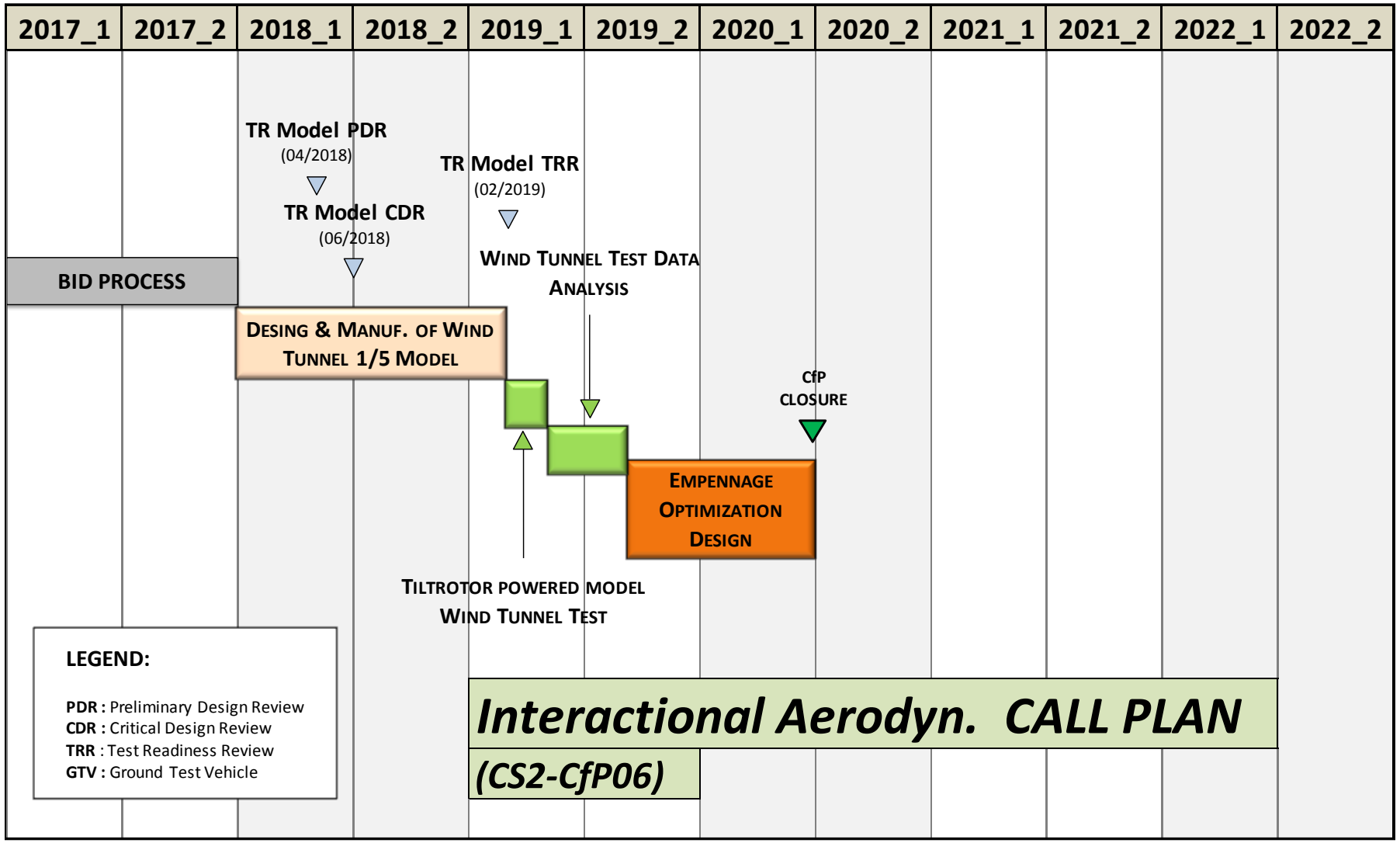
Project Implementation

Tasks		
Ref. No.	Title - Description	Due Date
1	Design and manufacturing of the modified powered model (Nicetrip 1/5th) components	T0 + 14
2	Wind tunnel tests of the modified full span powered model (Nicetrip 1/5th)	T0 + 16
3	Wind tunnel data analysis	T0 + 20
4	Empennage optimization proposals suitable for NGCTR	T0 + 30

Milestones (when appropriate)			
Ref. No.	Title - Description	Type	Due Date
M1	Tiltrotor Powered Model PDR	RM	T0 + 4
M2	Tiltrotor Powered Model CDR	RM	T0 + 6
M3	Tiltrotor Powered Model Test Readiness Review	RM	T0 + 14
M4	Tiltrotor Powered Model Wind Tunnel Entry	RM	T0 + 16

Deliverables			
Ref. No.	Title - Description	Type	Due Date [T0+mm]
D.1	Tiltrotor Powered Model Trade off studies	RM	T0 + 2
D.2	Tiltrotor Powered Model acceptance	R/D	T0 + 12
D.3	Test matrix	R	T0 + 14
D.4	Raw data from Wind Tunnel Test	R	T0 + 16
D.5	Force and moments report	R	T0 + 18
D.6	Analysis of the stability report	R	T0 + 20
D.7	Surface pressure report	R	T0 + 20
D.8	Empennage optimization proposal report	R	T0 + 30

Master Plan



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