



Clean Sky programme

SAGE ITD overview

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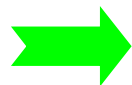
Project Officer Systems for Green Operations (SGO)

**CLEAN SKY Info Day
September 12-13, Warsaw, Poland**

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SAGE ITD – Contribution to environmental targets

Reduced fuel
consumption (CO₂ &
NO_x reduction)



➤ Engines

- Loads & flow control
- New Aircraft Configurations
- Low weight
- Aircraft Energy Management
- Mission & Trajectory Management

CO₂ up to 20%
NO_x up to 60%

External noise
reduction



➤ Engines

- Mission & Trajectory Management
- Configuration
- Rotorcraft noise reduction

Noise up to 7 dB

« Ecolonomic »
life cycle

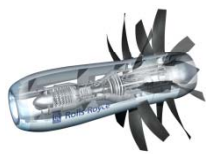


- Aircraft Life Cycle

SAGE ITD – Objectives and content

To develop and validate technologies

- ❖ Contributing to the environmental targets
- ❖ On **5 complementary demonstrator** engines for regional, narrow body, wide body & rotorcraft applications
- ❖ Raising the Technology Readiness Levels to TRL 6



Contra-rotating open rotor (CROR) propulsion systems, demonstrating

- Feasibility of geared power transmission
- Ability to control contra-rotating propeller blade pitch
- Ability to control system noise levels equal to or better than current engines

Lightweight Low Pressure (LP) systems for large turbofans, including

- Composite fan blades & fancase
- Lightweight structures
- High efficiency low pressure turbine

Advance engine externals & installations including novel noise attenuation

For advanced geared fan engine concepts

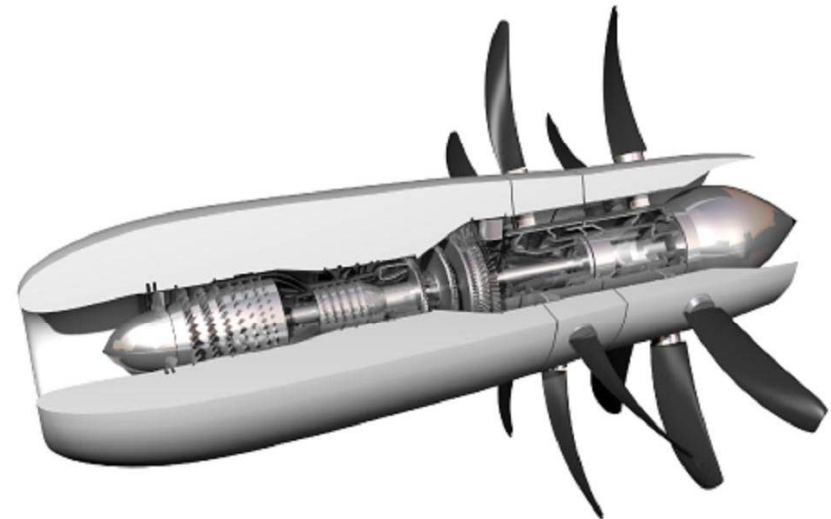
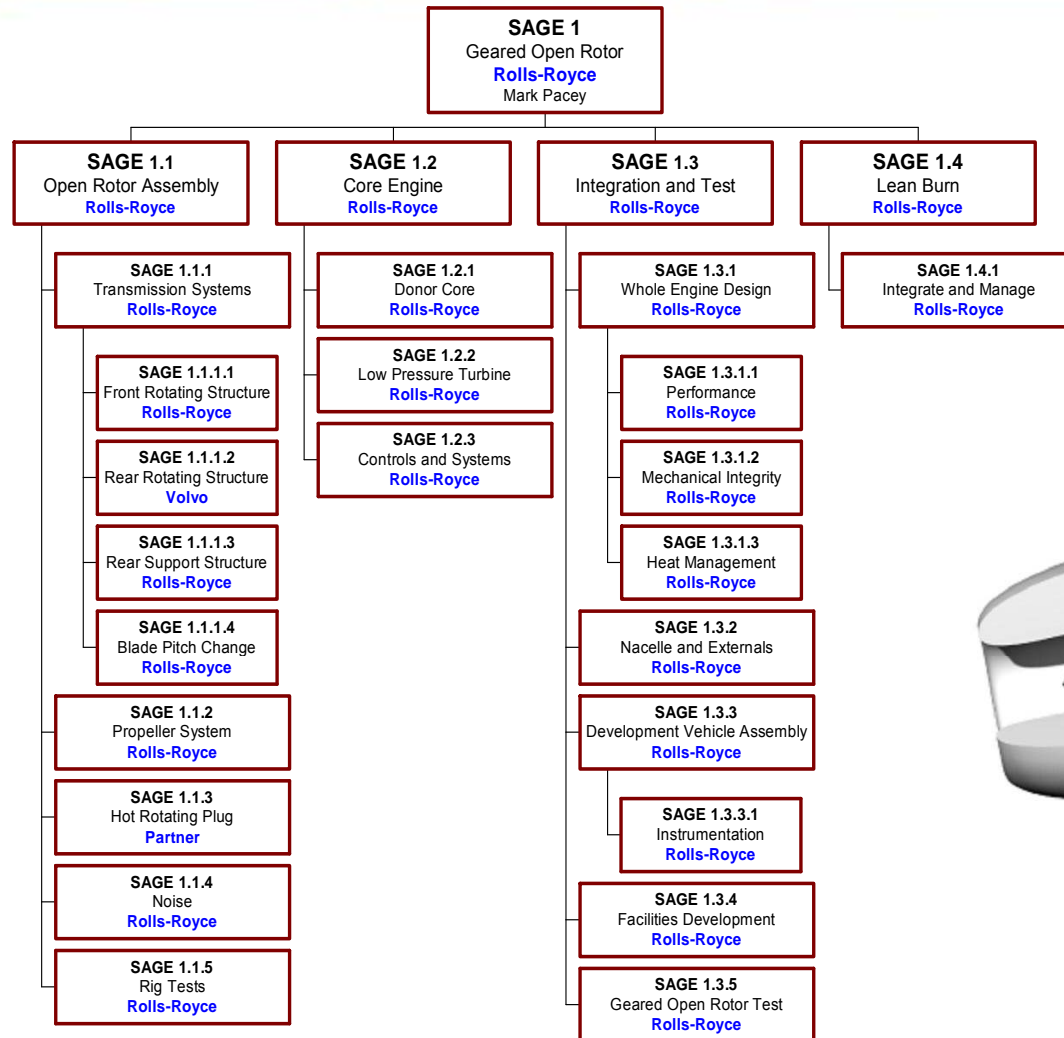
- High efficiency LP spool technology
- High speed LP turbine design
- Aggressive mid turbine interduct

For next generation rotorcraft engine

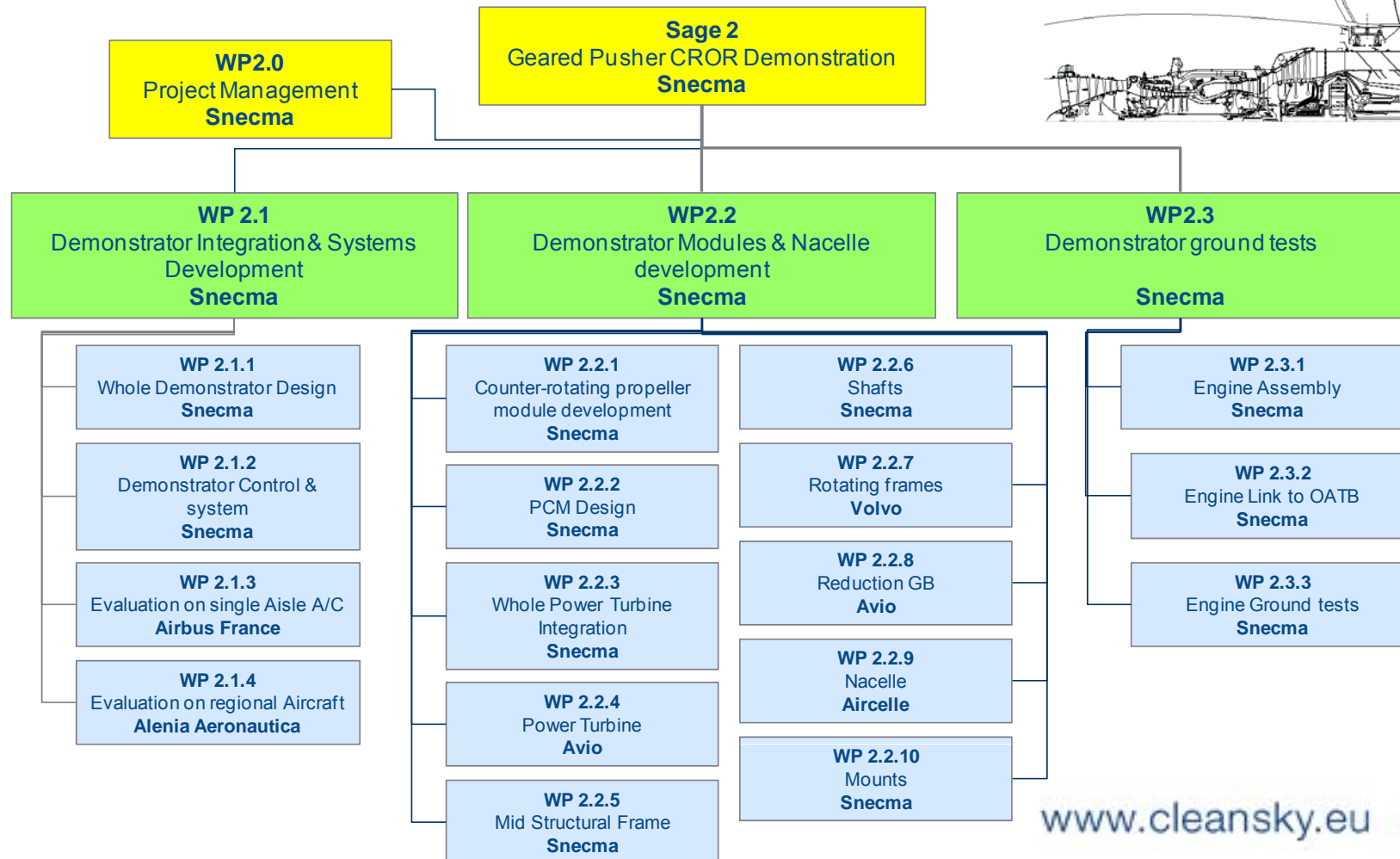
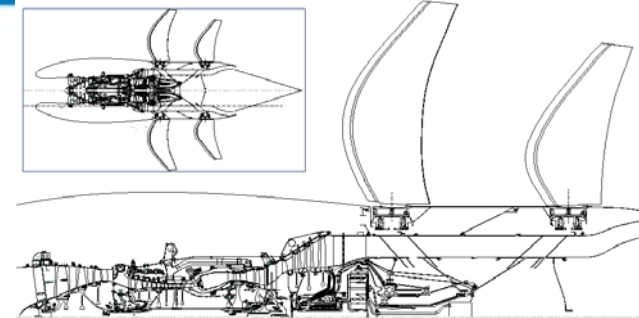
- High efficiency & lightweight compressor
- High efficiency & lightweight turbine
- Low emission combustion chamber



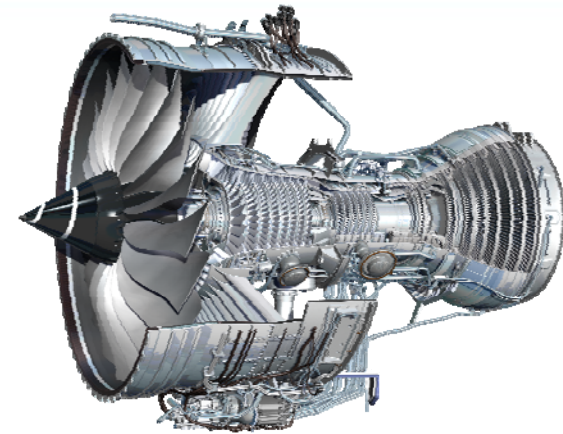
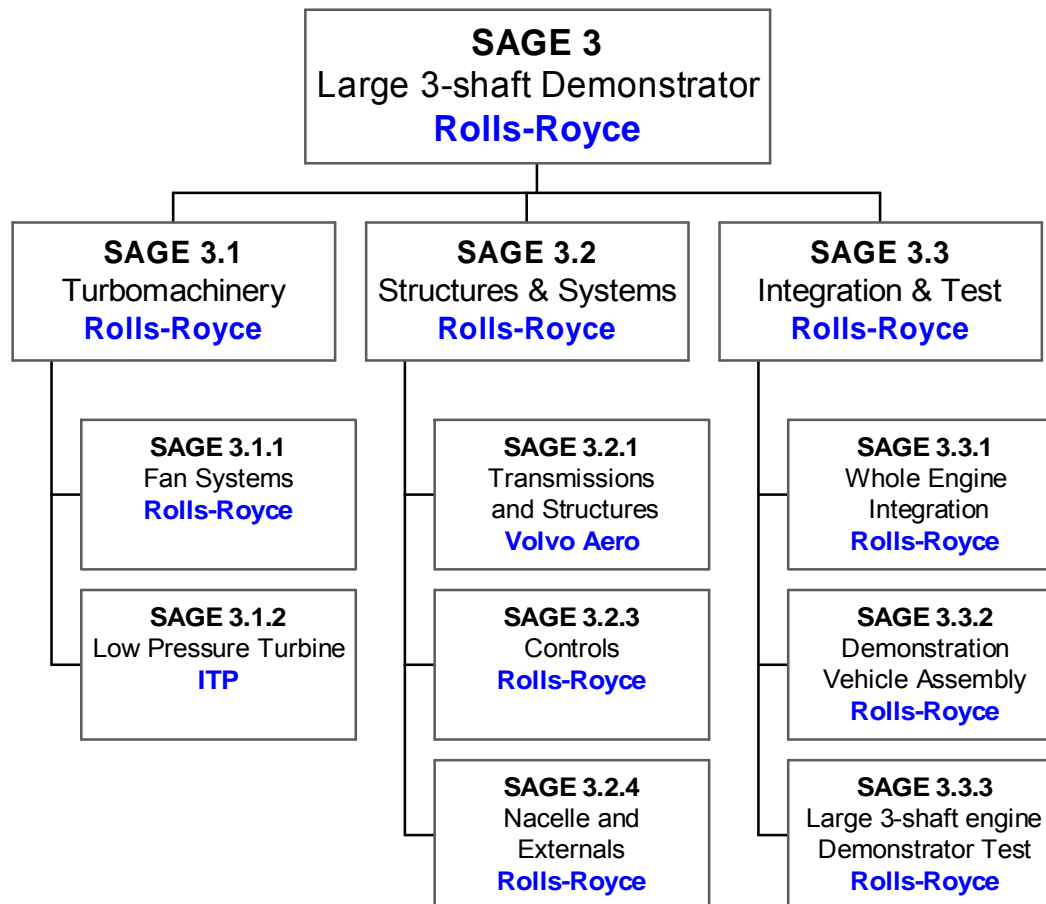
SAGE 1



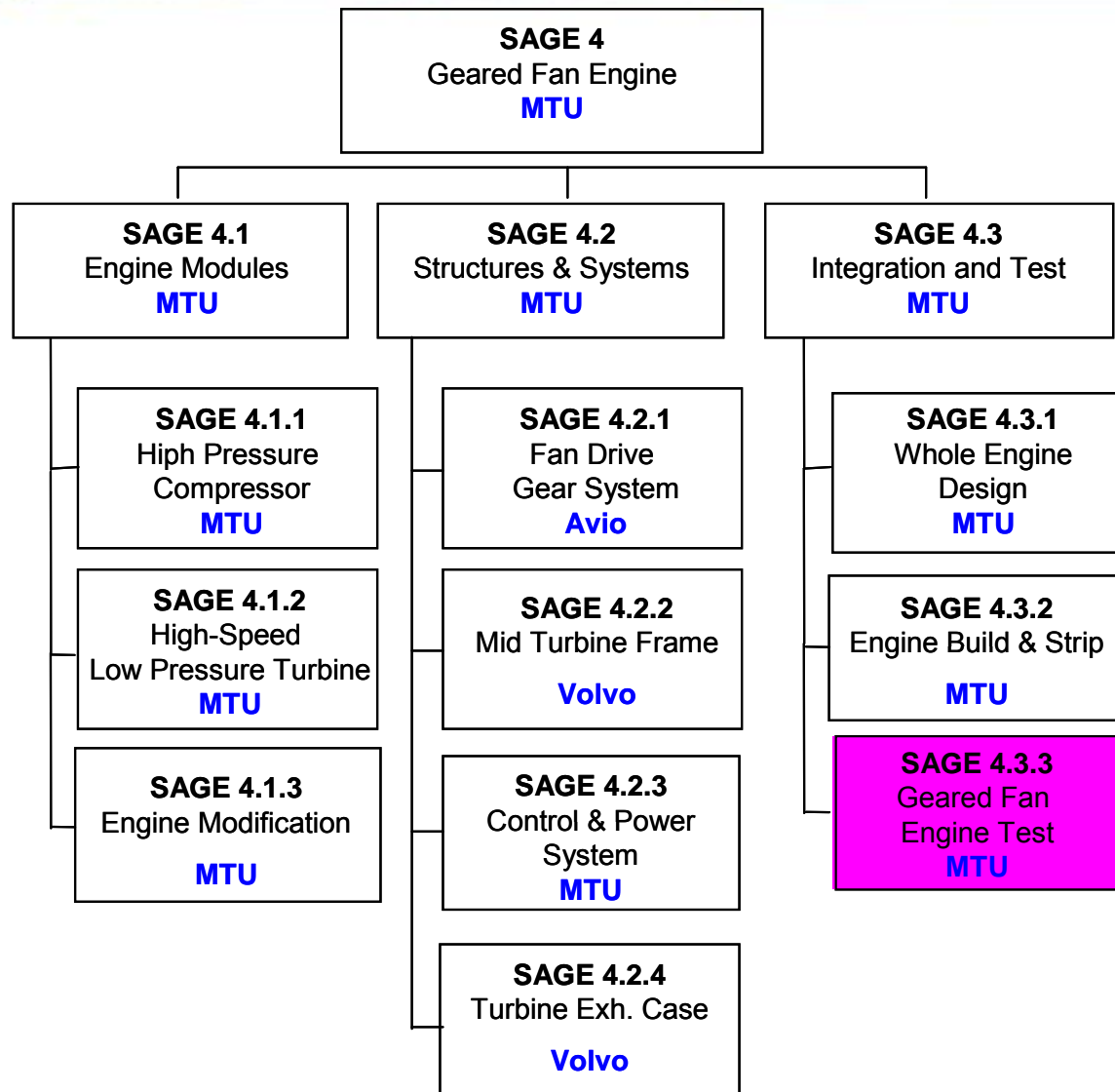
SAGE 2



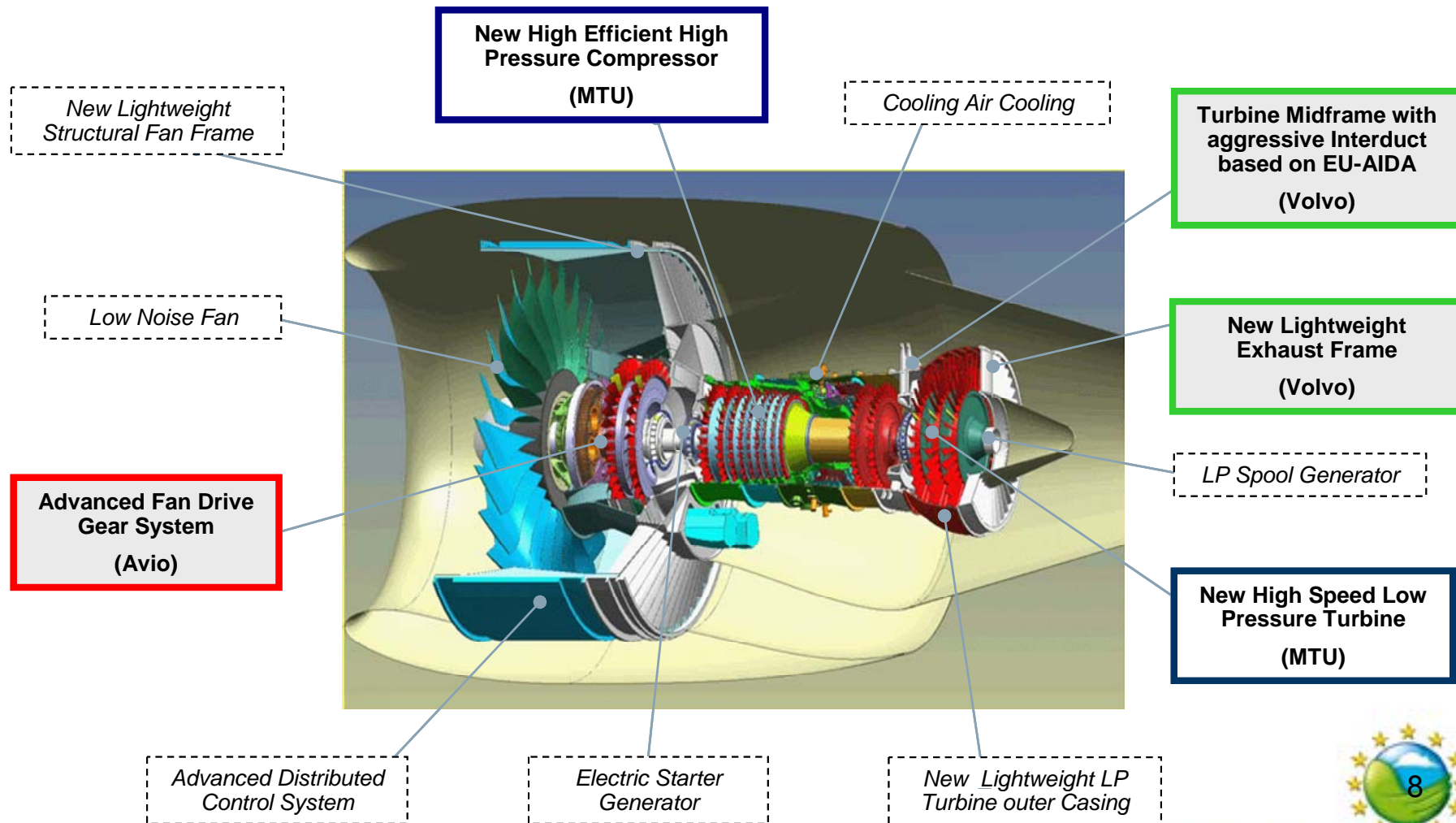
SAGE 3



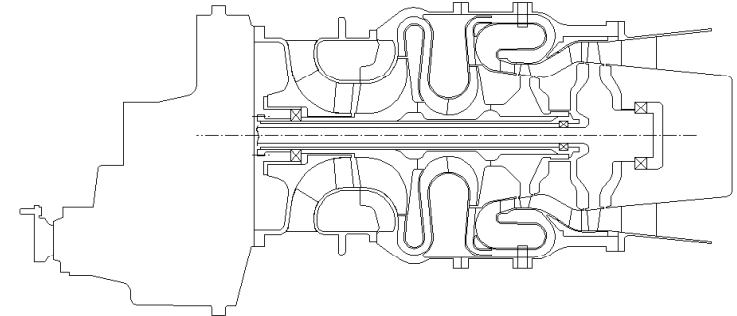
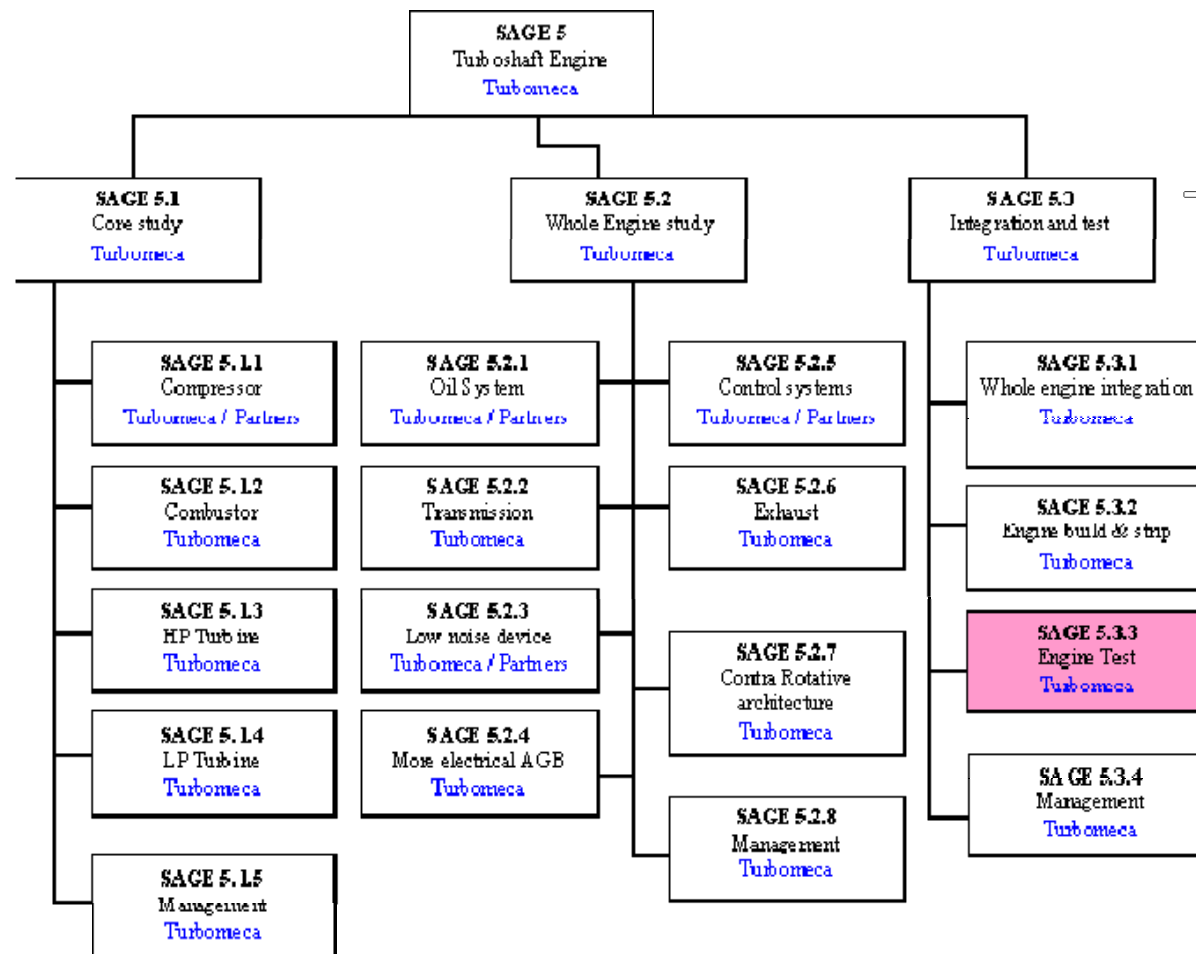
SAGE 4



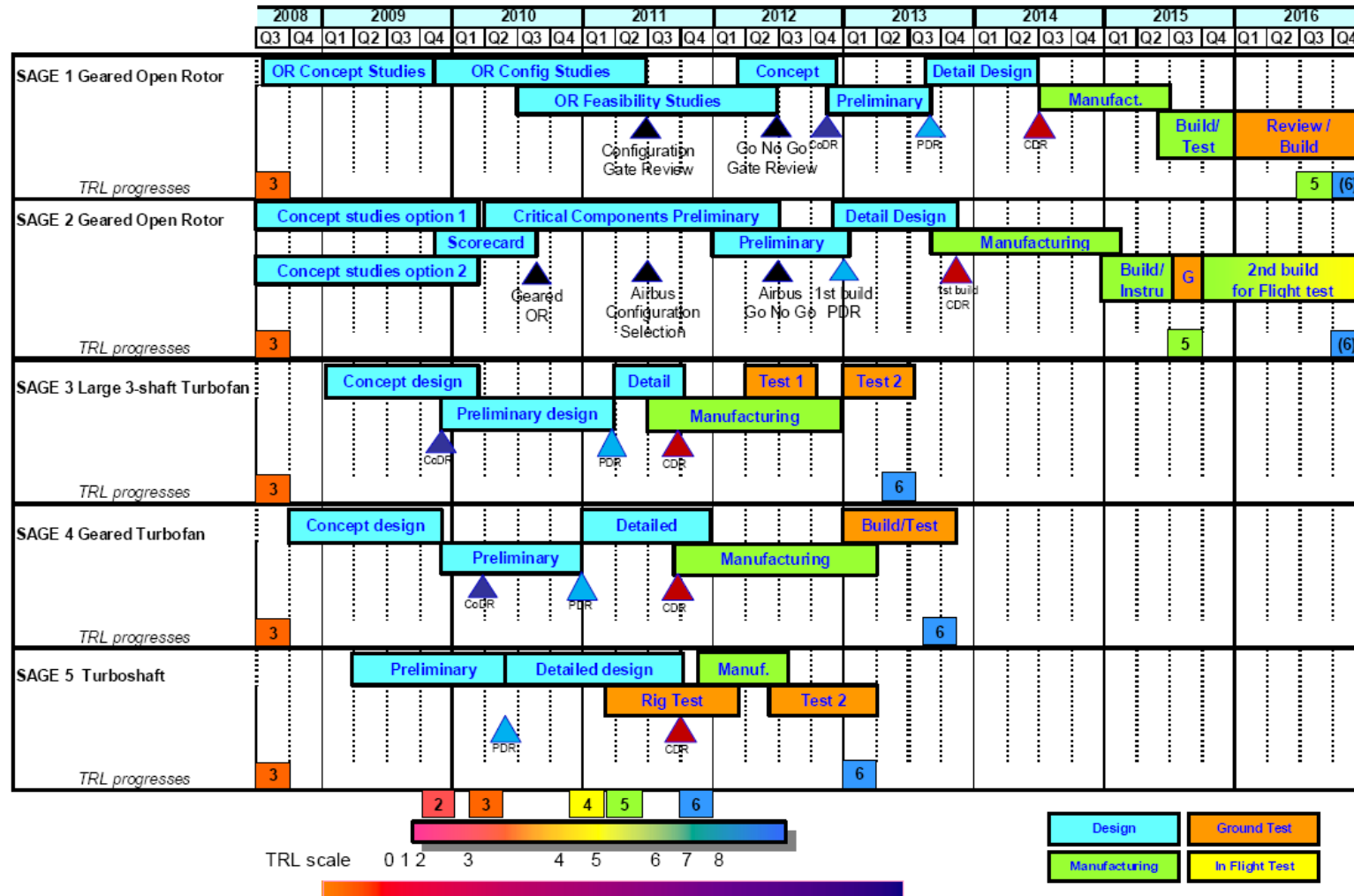
SAGE 4



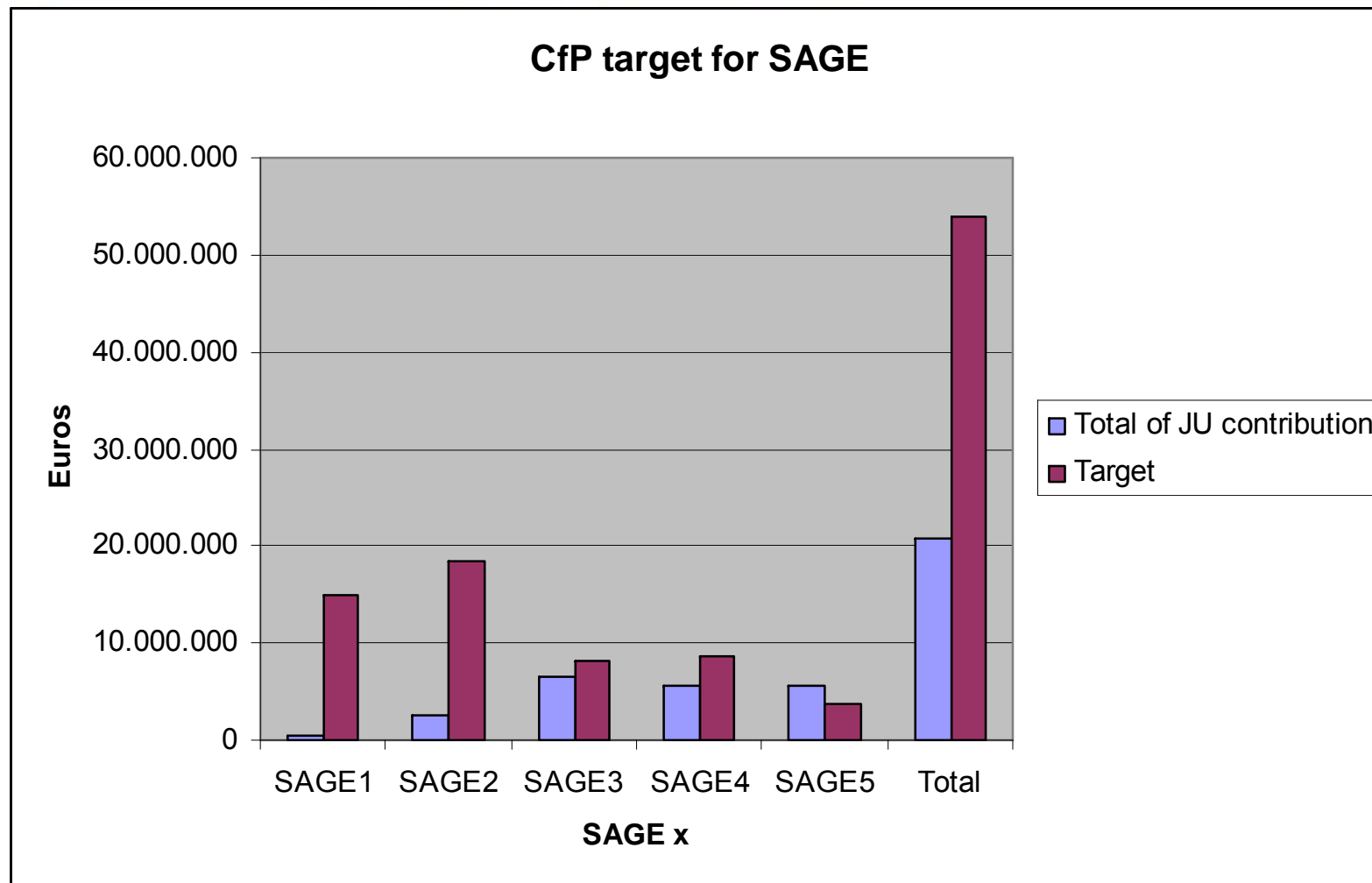
SAGE 5



SAGE ITD - Master Plan



CfP status



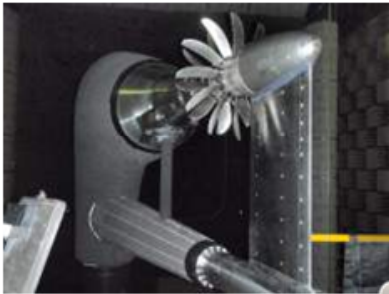
Objective: 25% of budget allocated to CfP

Links with other ITDs

- SFWA
- GRA
- GRC
- TE

SFWA- ITD integration of the CROR engine concept

CROR Aero -Acoustic experimental characterization

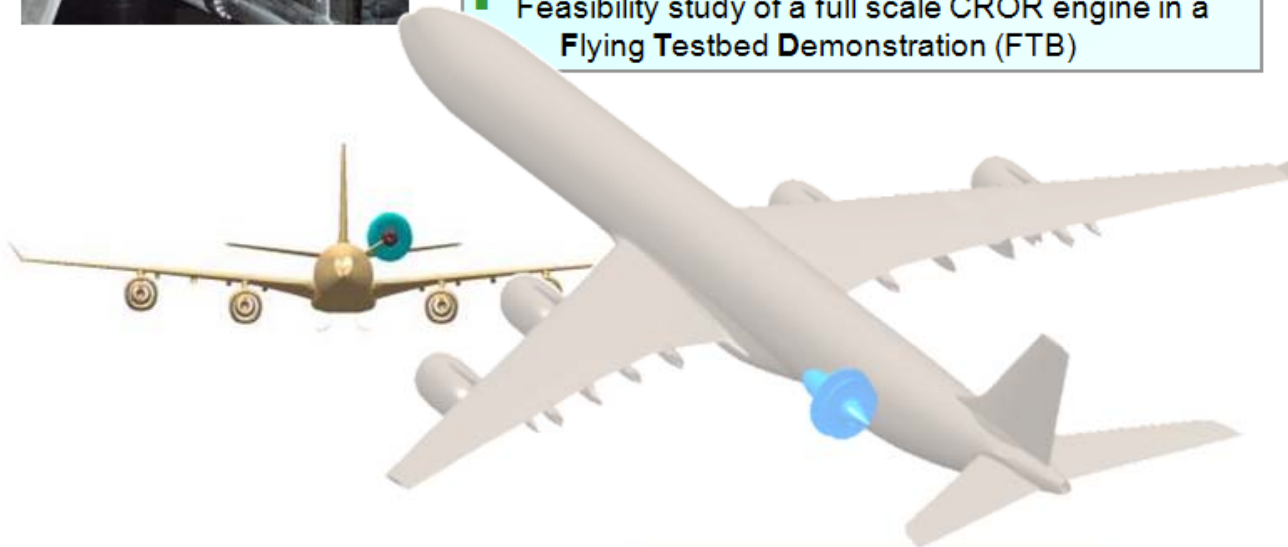


Innovative Power-Plant Integration

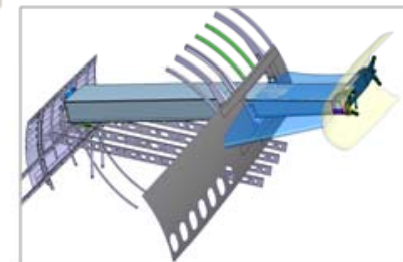
- Design of innovative CROR blades and pylon
- CROR installation effects: aero, noise, vibrations, handling qualities
- CROR propeller kinematics, study of fragment impact depending on size and propeller and fuselage materials
- Structural technologies for armour and shielding
- Feasibility study of a full scale CROR engine in a Flying Testbed Demonstration (FTB)



CROR design study: interference with HTP

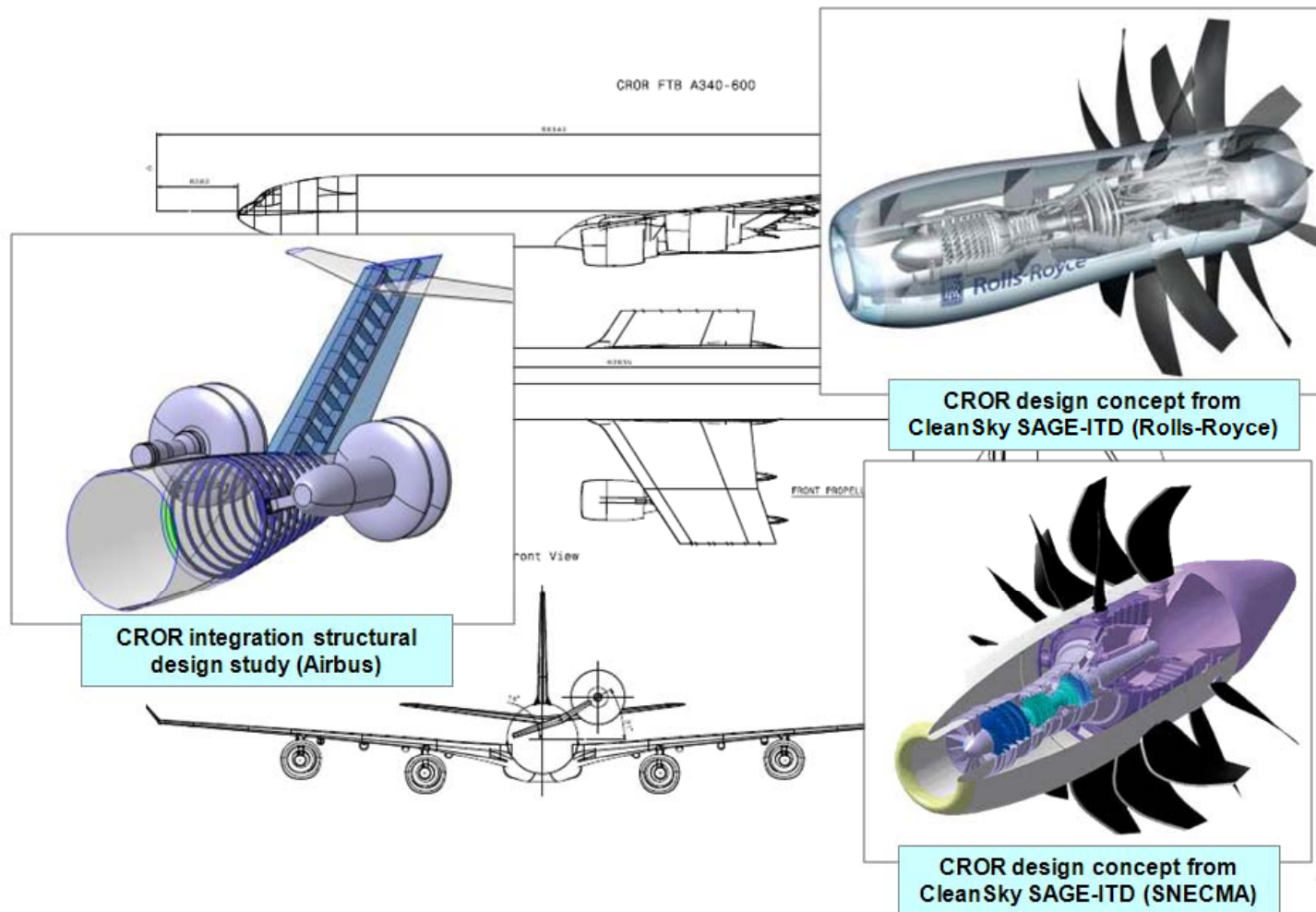


Airbus A340-600 Flying Test Bed with CROR engine



CROR structural integration concept

CROR engine integration concepts



GRA link



GEARED TURBOFAN

PUSHER OPEN ROTOR



LOW SPEED TURBOPROP



ADVANCED TURBOFAN



Loop 2

- ☐ Rear engine installation
- ☐ Under wing engine installation
- ☐ Engine data updating (AEA hypothesis)
- ☐ All Electric Aircraft and More Electric Aircraft Systems architectures trade-off studies
- ☐ Aerodynamic Improvement (Wing design and HLD studies)
- ☐ New materials improvement & Preliminary Structural layout definition
- ☐ Under wing engine installation
- ☐ Rear & Under wing engine installation

Loop 3

- ☐ Engine data updating (AEA or MEA hypothesis)
- ☐ Feasibility studies under Structural and Systems points of view
- ☐ Best configuration choice for WTT

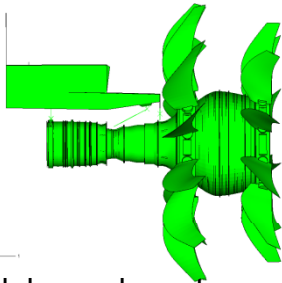




CfP call 10 example

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SAGE2 Objectives



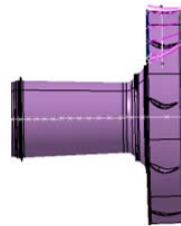
Modules, sub-systems, nacelle items
Design integration, assembly
Test Programme



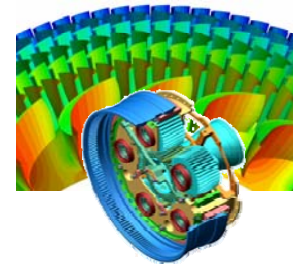
Airframer requirements
and installations



VOLVO AERO



Rotating structure
Shafts



Power Turbine items
PGB for alternate
architecture



Nacelle items



Pitch Change
Mechanism



PGB
Bearings

Interim Review
Nov. 2009

Prelim. DR
Dec 2012

Project completion
2016

Open rotor technology development → full-scale engine demonstration

Concept studies
Demo spec.

Prelim. design
Partner selection

Detail design
Manufacture

Build and
test

Project launch
1 June 2008

Choice Configuration
Sept. 2010

Critical DR
Dec. 2013



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SAGE2 Research Topic (I/II): CROR Propeller blades

- **Topic Objectives**
 - Provide a CROR Blade definition compliant with SAGE2 Demo engine requirements for ground and flight tests
 - Verify compliance of the definition with SAGE 2 requirements (by experience, analysis and/or tests)
- **Skills expected from the applicants**
 - Professional experience in propeller blade design and manufacturing
 - Capability to manage full scale blade manufacturing
 - Experience in impact testing on propeller blade
- **Expected outcome**
 - Blade concept validation, definition and manufacturing
 - Blade qualification by testing

SAGE2 Research Topic (II/II):

CROR Propeller Rotating Aero Ducts

- Topic Objectives
 - Provide a CROR rotating aero ducts definition compliant with SAGE2 Demo engine requirements for ground and flight tests
 - Verify compliance of the rotating aero ducts definition with SAGE 2 requirements (including certification requirements for rotating parts, by experience, analysis and/or tests)
 - Deliver the parts for the SAGE2 demonstrator
- Skills expected from the applicants
 - Professional experience in sheet metal parts design and manufacturing
 - Capability to manage full scale part manufacturing
 - Experience in rotating parts design
- Expected outcome
 - Rotating aero ducts design and manufacturing for the SAGE2 demonstrator



Q & A

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