



Rolls-Royce

DREAM – valiDation of Radical Engine Architecture systeMs

- Level 2 Project for the 1st Call of the 7th EU Framework
- Coordinator: Rolls-Royce plc

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DREAM - Aims

The main aims for this project are to:-

1. Integrate and validate engine technologies, components and structures in an engine architecture aimed at minimising the operating costs of propulsion systems in a new carbon trading world.
2. Develop, where applicable, these technologies through to component and system level and verified by the use of rig component and/or system demonstrators.
3. Include, where necessary, the latest advances in whole engine integration, validation and modelling.



DREAM – Themes

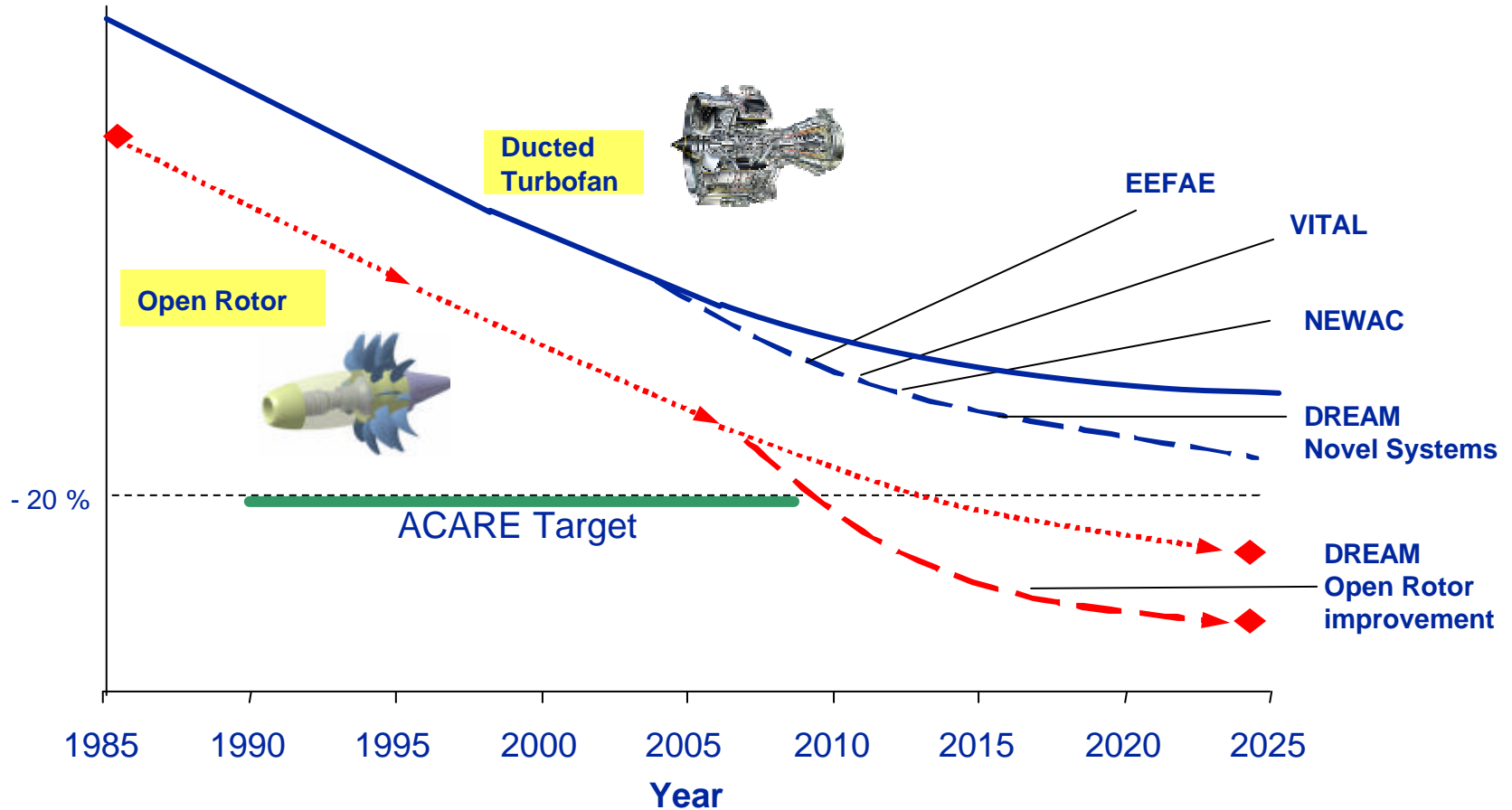
The project technology themes include advanced technologies mainly devoted to fuel consumption / CO₂ reduction pollution reduction, whilst retaining acceptable noise levels

The main themes of this project are to:-

1. Develop contra-rotating open rotors with variable pitch blades which are known to provide 10 to 15% fuel burn reduction but are noisier than high bypass turbofans. Recent progress in aero-acoustic modelling and design allow this architecture to be reconsidered for short / medium haul aircraft
2. Develop and validate novel engine systems providing potential advances for traditional turbofan engines and open rotor engines. This will include new hot and cold structures with additional functionality, and active solutions for turbines such as adaptive capacity, smart active clearance control and active boundary layer control
3. Test alternative fuels with thermo-chemical characteristics acceptable for aeronautics such synthetic kerosene from Fischer-Tropsch process and selected biofuels



Impact of Engine Architectures on Efficiency

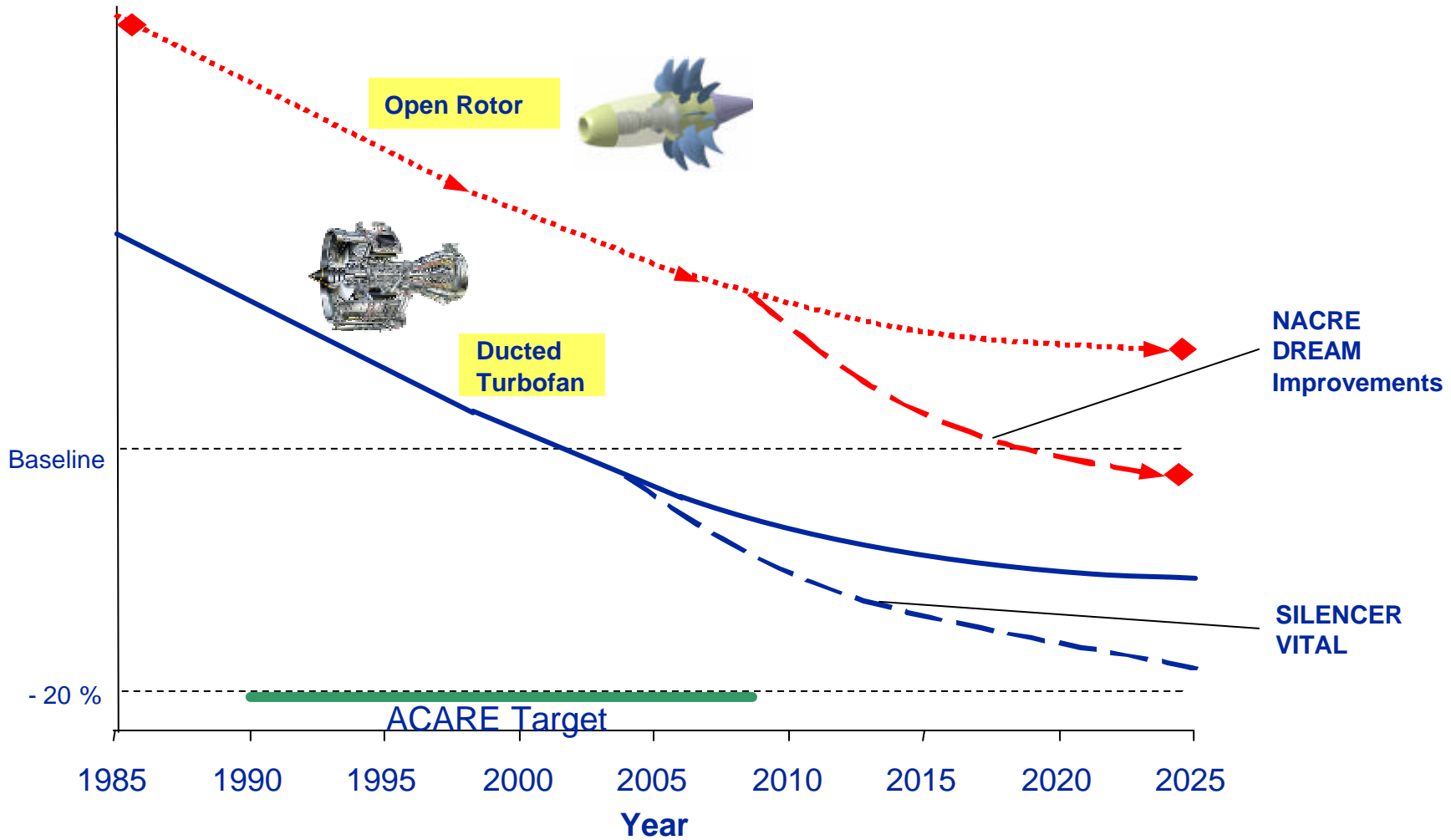


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Impact of Engine Architectures on Noise



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DREAM – Overview

- **Budget:** **Approx €40m**
- **Project Term:** **3 Years**
- **No of Partners:** **20-30**
- **Project Start:** **First quarter 2008**
- **Proposal Delivery:** **3 May 2007**
- **The larger EU Aero Engine manufacturers are already included in the project**
- **A number of SMEs and Academic Institutions have already been identified as potential partners (mainly as a result of partnerships on existing projects)**



DREAM – Proposal Timescales

January

Step 1: Close core group agreement on:-

1. Scope of the project
2. WPs title and scope
3. Budget
4. Project synopsis
5. Proposed partners

**February
March**

Step 2: Consortium building & WP definition

1. Produce initial WP definition
2. Select partners
3. Agree on WP definition and partners
4. MoU / letter of commitment with partners

**March
April**

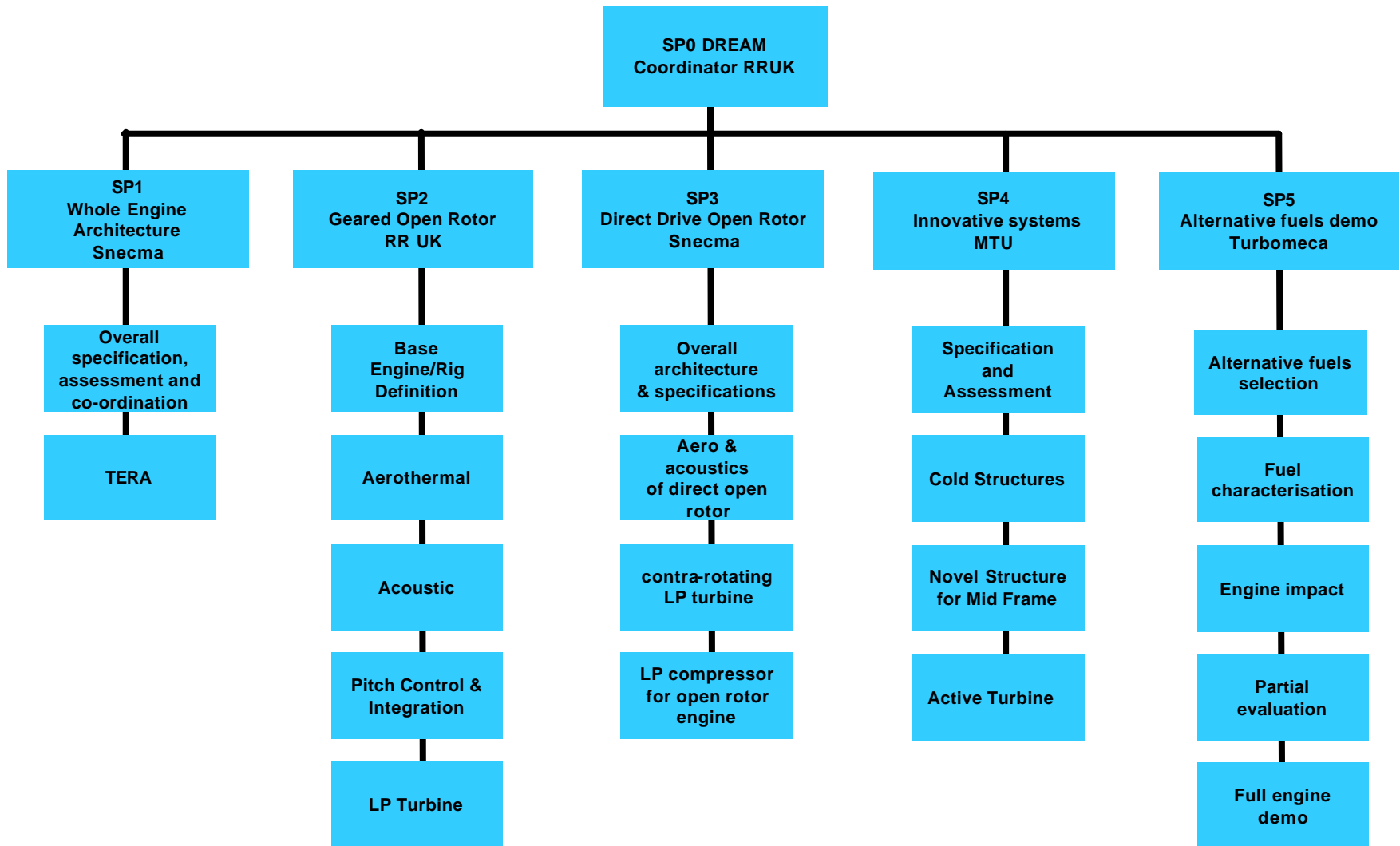
Step 3:

1. Proposal writing

May 3rd: Submission



DREAM – Project Structure



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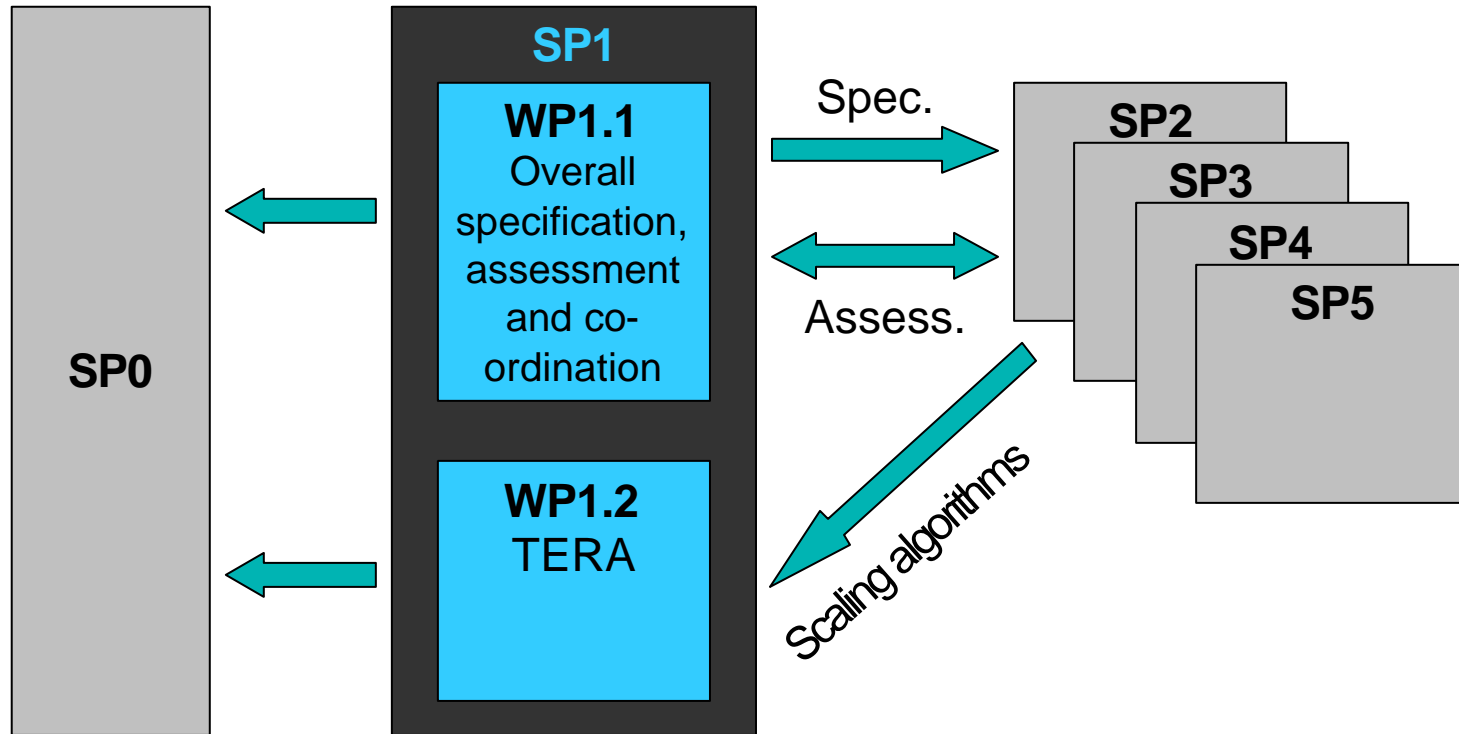
SP 1 Whole Engine Integration

Whole engine integration ensures the overall consistency of the DREAM results and provides an assessment of the DREAM engine technologies, both technically and economically

- Define and provide requirements for DREAM module and engine technologies
- Ensure suitable integration of module characteristics
- Compare, assess and rank the benefits of the advanced concepts and technologies investigated in DREAM
- Use a software tool to compare the environmental and economic impact
- Assess the outstanding technical risk at the end of DREAM project
- Identify technology routes to environmental and economic propulsion solutions



SP 1 Whole Engine Integration



SP2 – Geared Open Rotor

An open rotor engine has been shown to produce significant benefits in terms of a fuel burn reduction. The aim of this sub project is to demonstrate this benefit whilst maintaining acceptable noise levels (better than ICAO Stage 4 regulation).

A candidate architecture for this engine type is a geared open rotor, which allows greater control of tip speed whilst using more conventional and proven turbine technology. This sub project aims to show the benefits of this concept via:-

Aero and Acoustic

- The development of a preliminary design for the optimisation of aerodynamic and noise characteristics
- Experimental parametric studies conducted following the refurbishment and re-specification of an existing contra-rotating rig .
- Final testing (following data appraisal) focusing on a narrower range of parameters.



SP2 – Geared Open Rotor (cont')

Pitch Control and System Integration

- A range of mechanical design options for variable pitch open rotors and its integration into the control mechanism of the system will be studied.

LP Turbine

- A number of designs will be considered followed by a cascade test of the selected variant.

Active Control Technologies

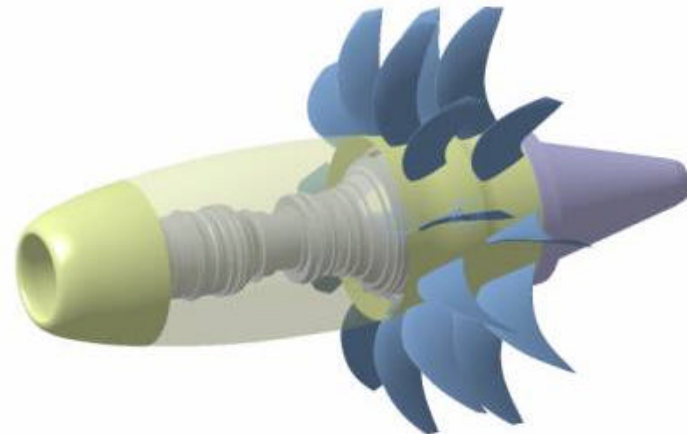
- WEM optimisation of geared open rotor architecture.
- Aero/Mechanical/Services optimisation of the rear frame.
- Definition of new requirements for forming, welding and machining techniques.
- Subcomponent manufacturing trials and mechanical testing.



SP3 – Direct Drive Open Rotor

Open Rotor engine brings significant fuel burn and CO₂ reduction. The challenge is to reach a noise level better than ICAO Stage 4 regulation, and in any case as quiet as nowadays turbofans. Important progress in aerodynamic and acoustic modelling done since the earlier 1990's should allow us to achieve this goal.

Direct Drive Contra Rotating Open Rotor is the candidate architecture for SP3



SP3 – Direct Drive Open Rotor (cont’)

The objective of SP3 is to address the main challenges of this concept by:

Aero/noise

- Making an advanced design of the direct drive contra rotating open rotor
- Validating its acoustic and aero behaviour by wind tunnel model tests

Contra-rotating turbines

- Making an advanced design of the specific low pressure turbine fitted to this concept
- Checking critical issues through dedicated mechanical and material tests

Low Pressure Compressor

- Investigating the low pressure compressor fitted to this concept (including advanced aero devices focused to efficiency improvement)
- Validating concept by a single stage aero rig test

Reducing the cost and complexity of the variable pitch system



SP4 - Novel Systems

The aim of Sub Project 4 is to develop and validate novel systems providing potential benefits for traditional turbofan engines and open rotor engines.

Innovative Turbine Mid Structure with engine mounts

- Develop novel configuration of mid structure and engine mounts including assessment of aerodynamics, structural design, heat transfer, cooling and sealing strategies due to increased mechanical and thermal loads
- Review enabling technologies such as active damping using piezoelectric elements on metallic and composite/hybrid materials to reduce vibration on structures. These technologies can then also be applied to mounts, shafts and casings
- New design solutions will be validated with aerodynamic tests to demonstrate reduction of total pressure loss of the component while minimizing the upstream and downstream influence
- Thermal behavior will be validated with thermal and mechanical subcomponent test



SP4 - Novel Structures(cont')

Integrated Acoustic Liners

- Several alternative design concepts will be developed based on aerodynamic and noise optimization, structural and manufacturing aspects
- Sub-component tests to validate concepts.

Turbine Active Control

To improve the efficiency of the low pressure turbine the component has to be adapted in a close loop system during the whole life of a engine

Different active solutions will be investigated like adaptive capacity, smart active clearance control or active boundary layer control

The most promising solution will be validated with model test to prove that new elements work reliable for the full life.



SP5 : Alternative fuels demonstration

Global objectives

- Ensure alternatives to actual kerosenes
- Reduce pollutants emissions
- Reduce CO₂ emissions

Project objectives

- select best candidates for aero engines (gas to liquid {GTL}, coal to liquid {CTL}, biomass to liquid {BTL} or blended mixtures)
- demonstrate capability of aero engines to use alternative fuels
- demonstrate pollution reduction by using alternative fuels



SP5 : Alternative fuels demonstration (cont')

Alternative fuels selection

- Objectives definition
- Grid criteria definition
- Selection of several candidates

Fuel characterisation

- density, viscosity
- lubrication behaviour

Engine impact

- Functional impact (ignition, flight envelope, transient conditions ...)
- Mechanical impact (parts in contact with alternative fuels)
- Impact on technologies



SP5 : Alternative fuels demonstration (cont')

Partial evaluation

- Fuel system tests
- Combustion capacity - Full annular test

Full Engine Demo

- Altitude test rig
- AMT test
- Performances, emissions, life duration



DREAM : Overall Summary

- **DREAM is a project aimed at evaluating and validating radical engine concepts**
- **Significant improvements to the efficiency of the next generation of aero engines is the priority**
- **A major theme is the demonstration of a gas turbine engine operating using alternative fuels**
- **The project will be a partnership between the major European engine manufacturers and a number of SMEs, research and academic institutions**
- **The project has very challenging timescales to enable the validated results to be integrated into future level 2 demonstrator projects in later calls of Framework 7 or a potential level 3 engine system demonstrator project in Framework 8**

