DEVELOPMENT OF ULTRA HIGH TEMPERATURE MULTI-HOLE PROBES

Guillaume BIDAN
Safran Tech
Magny les Hameaux

Jean-Louis CHAMPION
Safran Tech
Bordes

ABSTRACT

SAFRAN TECH is developing a specific kind of multi-hole probe adapted to high temperatures measurements in turbomachinery. The probes are designed to be inserted in the inter-grid space of a helicopter engine high pressure core. In this severe environment, metallic probes rapidly become unsuited due to elevated temperatures, high aerodynamic drag and limited available space. The proposed probe design is of a hybrid kind including a ceramic measurement head and a high strength metal body. The current paper proposes insights in the design process including 1-dimensional and 3-dimensional computations used for probe sizing. Steps of the development process are also discussed, including maturation of the production of the ceramic head, preliminary design, materials and assembly choices. The design, production and testing of the first complete prototype are also discussed.

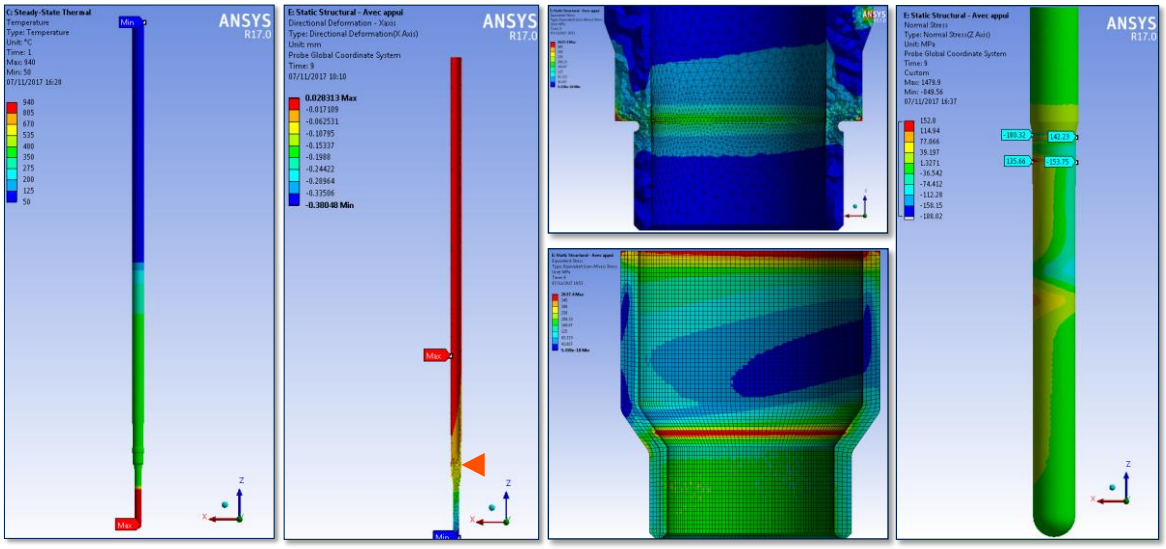

Figure 1 Tuning of the metallization process

INTRODUCTION

Obtaining aerothermal data inside a realistic aero-engine is one of the primary objectives of the BEARCAT (Banc d'Essai Avancé pour la Recherche en Combustion et en Aerothermique dans les Turbomachines) project underway at SAFRAN TECH. BEARCAT is based on a MAKILA engine, a turboshaft developed by Safran Helicopter Engines and powering H215 and H225 Airbus Helicopters. BEARCAT allows both steady and unsteady flow measurements (velocity, static or dynamic pressure, temperature, chemical species…) coupled with mass temperature or local stress. A classical metrology allows the determination of detailed engine performances as well as the knowledge of the average experimental conditions generating investigated flows. Moreover, in order to characterize the turbulence, a specific attention is given to unsteady measurements such as, 2D/2C velocity measurements with LDA (Laser Doppler Anemometry), local temperature measurements by means of fine unsheathed thermocouples, pressure measurements with dynamic transducers, flame light intensity in the primary zone. These time-resolved measurements can be completed with time averaged measurements performed with multi-hole probes. Both types of data will be used to calibrate advanced CFD Models. BEARCAT will be operated in BORDES (Safran Helicopter Engines plant) with a dedicated team. First tests are scheduled mid of 2019. The

current paper discusses the development of high temperature multi-hole probes necessary for those measurement campaigns.

RESULTS AND DISCUSSION

The development process has been carried out in several steps. First, the probes were modeled using a 1-dimensional finite element code in order to evaluate probes cross-sections and corresponding deflections when submitted to temperature and aerodynamic drag at an early stage of the engine development process. Once the conceptual feasibility was ascertained, the different technological features were matured through various proof of concepts including development of the ceramic head production process, development of the brazing process though choices of metallization materials and processes, assembly of sub-models, mechanical and thermal testing. 3-diemnsional computations were used to refine the design and probe dimensions (presented in Figure 1). The final step consists in the production of a full scale prototype to be tested in realistic, engine-like conditions.