FROM RESEARCH TO INDUSTRY

cea

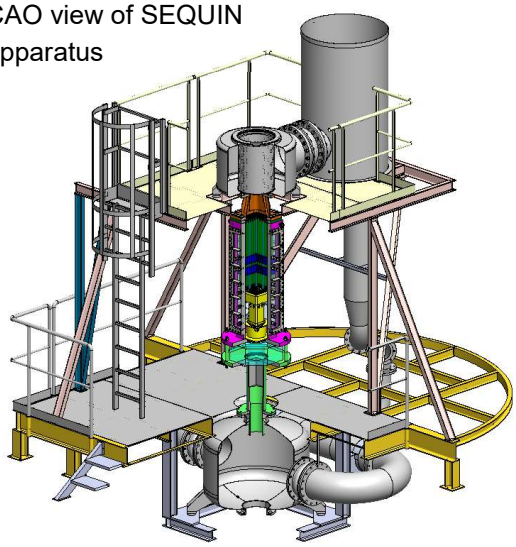
Proposition for a post-doctorate position

«Experimental benchmark for optical measurements in complex turbulent flows»

Context

The project described here is part of the work carried out by the CEA concerning the design and qualification tests on nuclear reactor components (fuel assemblies, circuit elements, safeguard devices, etc.). It is part of the R&D activities conducted by the CEA in terms of knowledge of the hydro-mechanical and thermo-hydraulic behavior for PWR fuel assemblies, as well as the qualification of assemblies for industrialists. A panel of experimental facilities ranging for moderate size analytical rigs to industrial scale facilities permits to pursue these R&D activities.

CAO view of SEQUIN apparatus



Project description

In such a context, the CEA Cadarache is developing a new CFD grade experiments, called SEQUIN (see figure). This setup is mainly dedicated to the detailed studies of the turbulent flow at the entrance of full fuel nuclear assembly. Such flow exhibits a complex pattern imposed by the different obstacles before entering the rods bundle maintained by grids [1].

SEQUIN is a “fully transparent” industrial mockup that allows optical measurements of the structure (streamlines, pressure patterns, etc.) and velocities flows. Moreover, due to the materials used, SEQUIN allows refractive index adjustments adapted to optical measurements in complex geometries.

The main objective of this post-doctoral work is the preparation of the experiments that will be carried out on SEQUIN. One of the major issues concerns the effect of refractive index adjustment. One hypothesis made here is that it is unlikely that we will be able to get a perfect index matching as in SEQUIN the fluid should be non-expensive (large volume) and non-dangerous both for humans and the experimental facility.

To assess the influence of this parameter on SEQUIN experiments, different optical methods will be evaluated considering imperfect index matching, e.g.: PIV (classic and possibly tomographic) [2], Particle Tracking (low and high density) [3] and digital in-line Holography [4]. For this purpose, the post-doctorate will:

i. Contribute to the development of an experimental benchmark. In this benchmark, the complexity of the optical pattern will be modified to mimic some elements of SEQUIN using specific and standardized shape for academic purposes.
ii. Evaluate the performances and the accuracy of the different optical measurement techniques.
iii. Propose the most suitable optical diagnostic for SEQUIN experiments and perform first optical measurements using SEQUIN (second year).

Experiments will be performed in different places, mainly Cadarache and Marcoule CEA centers and will involve several teams. Therefore, the transportability (compactness, modularity) and reproducibility of the benchmark are important.

Profile sought

PhD in science or doctor-engineer, in the field of experimental fluid mechanics. The applicant must have a solid background in physics (optics) and in instrumentation, and master the main optical technics (PIV, PTV, ect.). Ideally, more specific knowledge in computational fluid dynamics will be appreciated, but is not indispensable. Good communication skills are required in order to add value to the work via participation in international congresses and in publications.

Host team

The host laboratory is the **L**aboratoire d'essais de **T**hermo-hydraulique et d'**H**ydromécanique analytique du **C**œur et des circuits (Core and Circuit Analytical Thermohydraulics and Hydromechanics Test Laboratory) of the CEA Cadarache (LTHC). The mission of this Laboratory is to study the hydro-mechanical behaviour of components and the thermos-hydraulics of industrial and experimental water reactors. Its experimental research rely on reduced-scale experiments (analytical and integral) possibly using simulant fluid when needed. The quality of the various rigs permits to support the implementation and developments of both system codes and CFD codes. These codes being developed either by the LTHC or other CEA labs or academic and industrial partners.

Duration:

12 months (renewable once)

Availability: April 2021

Remuneration:

Environ 2100-2300€

Contacts

Lionel Rossi (CEA/DES/IRESNE/DTN/STCP)
CEA / Cadarache 13108 St Paul lez durance Cedex Tel : +(33) 4 42253251 email: lionel.rossi@cea.fr

Initial bibliography

[1] N.Turankok et al., "Unsteady pressure and velocity measurements in 5 × 5 rods bundle using grids with and without mixing vanes", Nuclear Engineering and Design, volume 364 (2020)

[2] GE Elsinga, F. Scarano, B. Wieneke, BW van Oudheusden, *"Tomographic particle image velocimetry. Experiments in Fluids*", volume 41 (2006)

[3] D. Schanz, S. Gesemann & A. Schröder, *"Shake-The-Box: Lagrangian particle tracking at high particle image densities"*, Experiments in Fluids, volume 57 (2016)

[4] S. Grare et al., *"Dual wavelength digital holography for 3D particle image velocimetry",* Journal of the European Optical Society Rapid Publications, volume 10 (2015).