# 2-year post-doctoral position available at CEA-Leti and CEA-Irig in Grenoble

## “Deep learning approaches for fast and low-dose spectroscopic electron tomography of nanomaterials”

Within the framework of DIADEM Exploratory Research Programme and Equipment (PEPR), we are looking for a candidate for a 2-year postdoctoral position, on the topic of spectroscopic electron tomography using a state-of-the-art STEM microscope and deep learning tools. The starting date will ideally be October 2024.

**Research topic:**

Electron tomography (ET) is an established technique in materials science, where HAADF-STEM mode is commonly used for the 3D morphological studies, while 3D elemental and chemical information can be obtained using STEM-EELS and STEM-EDX modes. Compared to HAADF-STEM mode, STEM-EELS and STEM-EDX require high electron doses and acquisition times, making spectroscopic ET only suitable for the study of beam-resistant samples, with a resolution of a few nanometers.

In this project, we aim to (1) extend the applicability of spectroscopic ET to a wider range of samples and (2) improve its resolution.

Recent advances in hardware enable considerable improvements in acquisition time and spectrum quality. In particular, direct electron detectors (DeD) and EDX detectors with large solid angles greatly reduce the constraints with respect to acquisition speed and electron dose, without compromising spectral sensitivity and spatial resolution. At the same time, deep learning (DL) approaches have recently been shown to greatly improve 3D reconstruction quality and correct artefacts associated with high noise level, limited tilt range (missing wedge) and large tilt increments. DL approaches are based on either pre-trained deep neural networks, which requires high-quality training datasets, or self-supervised training of the said deep neural networks. In this project, the candidate will compare the performance of various models on simulated data and apply them to the 3D chemical analysis of two selected samples: (1) sub-10nm bimetallic nanoparticles (provided by PEPR Diadem NACRE project partners) and (2) ultra-scaled (sub-18nm) phase-change memory devices (provided by CEA-Leti partners).

A probe-corrected Cold-FEG NeoARM TEM (60kV-200kV) will be used for the tomographic data acquisition. It is equipped with two large solid angle SSD detectors (JEOL Centurio), a CEOS Energy-Filtering and Imaging Device (CEFID) and a Timepix3 direct electron camera. The TEM is also equipped with dedicated

tomography holders for TEM grids and needle-shaped samples. Depending on the candidate's interests and expertise, data acquisition will be performed by himself/herself or by the project PI.

The candidate will have access to in-house Python codes and open source libraries, as well as to the computing resources needed to carry out the comparative study of the selected DL models.

The candidate will also interact closely with other members of the DIADEM projects (METSA-Setdia and NACRE), and will be expected to communicate results effectively in the form of oral presentations in national/international conferences and articles in peer-reviewed journals.

**Research field:** deep learning, electron tomography, EELS, EDX, direct electron detectors.

**Profile:** Eligible qualifications for this position include:
- PhD in Physics/Materials Science with a strong background in image analysis and/or electron microscopy;
- Proficiency in Python;
- Experience in deep learning frameworks such as Keras, Tensorflow, Jax, and/or Pytorch;
- Excellent written and verbal communication skills in English.

**Applications deadline:** July 20th, 2024. Please send a CV, a short cover letter and the contact details of two referees to: Zineb Saghi (zineb.saghi@cea.fr), Nicola Vigano (nicola.vigano@cea.fr) and Pascale Bayle-Guillemaud (pascale.bayle-guillemaud@cea.fr).