3D Imaging with X-ray backscattering and fluorescence for applications in additive manufacturing

Imagerie 3D par rétrodiffusé et fluorescence RX pour applications en fabrication additive

The department of imaging and simulation for non-destructive testing (DISC) at CEA Tech develops advanced inspection methods through specific algorithms used with commercial or in-house devices. The three main techniques employed are ultrasound, eddy current and X-ray imaging.

In the framework of an inter-laboratory project, we aim to develop a 3D imaging system of industrial metallic samples using backscattering and X-ray fluorescence techniques. The system will be dedicated to the detection of surface and sub-surface defaults (cracks, porosity, etc.) inside very attenuating or complex geometry parts that cannot be controlled by using standard transmission X-ray imaging.

We propose a post-doctoral position of one year to work on this project, to prepare and integrate the system which will target a prototype level. This includes several aspects, from design of the system, instrumentation to signal and image processing. The design and implementation of the 3D imaging system will require simulation, experimentation and programming. The prototype will consist of an X-ray generator, a bi-dimensional spectral camera and a mechanical device to perform surface scans over areas of few tens of square centimetres. The main work will focus on the method comprising signal and image processing aspects in order to generate a 3D cartography of the inspected area of a sample.

A dedicated CALISTE micro-camera developed in the IRFU institute of the CEA will be specially designed for the project. This new micro-camera will have to be qualified before its integration into the device. With the help of simulation tools, the optimal characteristics will be defined and for the integrated system a special collimator will have to be designed and fabricated. The micro-camera will have to be interfaced with the mechanical system performing the scan and with the signal processing functions.

Activities for the post-doc candidate:

- Design and implementation of the 3D imaging device
  - Qualification of the dedicated CALISTE micro-camera and interface for data processing
  - Design of collimators
  - Control and interface of the mechanical device
  - Development of an algorithm to extract a 3D cartography of the scanned area
- Management
  - Technical management and presentation of the results to project partners
- Publications / dissemination
  - Paper or presentation of results at international conferences
  - Patent(s)

Expected skills:
- Theoretical background in the field of X-rays physics
- Programming skills: python, C/C++, Java, etc.
- Practical experience with X-ray devices is highly appreciated
- Skills in Monte Carlo numerical simulation tools MCNP/Geant4/Penelope will be appreciated

Keywords: X-ray imaging, NDT/NDE, X-ray fluorescence, backscattering, Monte Carlo simulation, image processing.
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