Multi-architecture programming for high performance reconstruction in passive tomography

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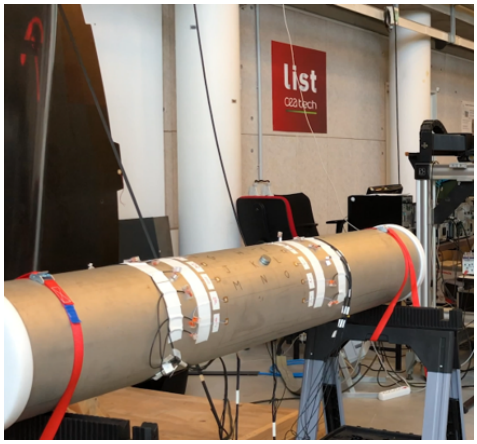
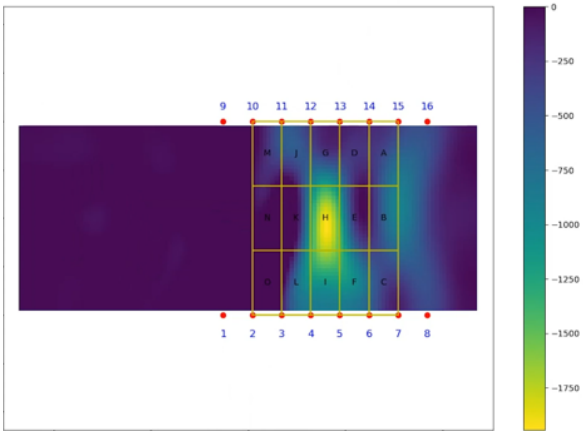
Structural Health Monitoring (SHM) is an approach to non-destructive testing that aims to integrate inspection tools directly into the targeted structures to facilitate data acquisition and avoid the regular mobilization of inspection resources (human, material) the immobilization of equipment. As part of this approach, passive ultrasonic tomography exploits the structural noise of waveguide-like parts to monitor variations in their thickness, to detect the appearance of corrosion or erosion defects. This process involves using several signal processing algorithms applied to large amounts of data and integrated into an embedded system.



(a) Passive tomography using structural noise on a pipe



(b) Thickness values over the inspected area

PhD Goal. Intending to integrate SHM controls in compact and energy-efficient equipment, this PhD thesis aims at developing an embedded signal processing chain that meets the needs of passive tomography. Therefore, it will be necessary to determine the most suitable hardware architectures and realize highly-optimized implementations of the algorithms involved in the processing chain by making them evolve according to the performance needs. To this end, different hardware architectures (GPU, low power GPU, FPGA) will be studied during the thesis by comparing generic programming approaches (Sycl) and implementations dedicated to each architecture.