PhD in Metrology

Research Title:
3D Random-Distributed Force Measurements

Funded by	INRiM/Ateneo fondi CRT

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Context of the research activity	Many industrial sectors, such as the automotive, aerospace, offshore energy, healthcare, and construction sectors, as well as research, rely on material and mechanical tests to ensure the safety and quality of their products. In these applications, force measurements are most often carried out in continuous and dynamic conditions with single-axis force transducers. Furthermore, recent developments in the industrial and healthcare sector (e.g. Industry 4.0, IoT and robotics) also require simultaneous measurements of forces and moments along the three axes. At present, the traceability to national primary standards is ensured with static calibration methods (ISO 376) on a single axis. In this context, INRiM is developing and testing calibration methods for continuous, dynamic and multicomponent force transducers, in the Meganewton range, and is performing comparisons between these methods. In this context, recently, INRiM has recently developed

	two 400 kN and 5 MN hexapod-shaped multicomponent force transducers, consisting of six uniaxial force transducers. The proposed activity will focus on the characterization of multicomponent transducers, their use in different test machines for simultaneous measurements of 3D forces and moments, on the investigation of transfer standards and their interaction with the test machines, on the evaluation of parasitic influences, and on the development of a test procedure for force measurements in static, continuous and dynamic conditions with single-axis and multicomponent transducers, in industrial applications. The proposal is framed in the context of a recently funded European project, EMPIR ComTraForce (https://www.euramet.org/research-innovation/search-research-projects/details/project/comprehensive-traceability-for-force-metrology-services/?L=0&cHash=6dcf75f72771f916f4a696b40809d1c1). The project is in collaboration with other national metrology institutes, universities and European industries and involves an exchange of knowledge, samples, and researchers within the partners.

Objectives	• Implementation of new improved methods for static, continuous and dynamic force calibrations in a force range up to 1 MN, with analysis of parasitic components; • Development of advanced models that accurately describe the influences in force measuring devices including the development of digital twins of force measuring devices according to the future requirements for digitisation and industry 4.0; • Evaluation and development of calibration procedures for multicomponent transfer standards and for multicomponent testing machines selected from industrial applications (e.g. spring testing machines, seismic dampers testing machines, etc); • Development of an uncertainty estimation model for multicomponent force and moment measurements in industrial applications (e.g. spring testing machine, robotics, dampers testing, etc).

Skills and competencies for the development of the activity	Master degree in Physics or Mechanical Engineering. Skills on mechanical measurements, measurement uncertainty assessment, Finite Element Method (FEM) programs, Matlab and LabVIEW development environment are appreciated, but not mandatory.