Course unit English denomination	Advanced instrumentation for the study of nuclear structure and reaction dynamics
Teacher in charge (if defined)	Daniele Mengoni, Francesco Recchia, Kseniia Rezynkina
Teaching Hours	24
Number of ECTS credits allocated	3
Course period	02/2025 - 06/2025
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (50% minimum of presence) ☐ No
Course unit contents	**Radiation interaction with matter:** ● Detectors for charged particles. Use of semiconductors to build spectrometers, spectrum characterization, and effects on energy resolution; ● Neutron detection; shielding based on energy spectrum. Production of neutron beams and their use in experimental physics; ● Detection of gamma and X-rays. Use of hyperpure germanium, efficiency, resolution, resolving power; ● Measurement systems for complete spectroscopy. Recoil-decay correlation method. **Advanced measurement systems for studying nuclear systems:** ● Possible configurations for hyperpure germanium detectors. Position-sensitive germanium detectors. Discussion of Doppler correction capability. Segmented germanium detectors: pulse shape analysis, gamma tracking, and performance. ● Detectors for light charged particles: TPC, solenoids, and highly segmented silicon detectors. Description of properties and discussion of sensitivity of different approaches and possible combined use. **Exploration of the nuclide chart for the study of nuclear structure:** ● Ion sources and types of accelerators, from electrostatic machines to synchrotrons; ● Use of few and many nucleon transfer reactions for the study of nuclear structure and experimental setups. Hands-on practical session for calculating cross sections; ● Production of radioactive beams with ISOL techniques and experimental setups; ● Production of radioactive beams through fragmentation and experimental setups.
Learning goals	In-depth understanding of the physical principles behind the operation of radiation detectors used in nuclear physics experiments. Understanding the performance and use of these detectors. Ability to choose the type of detector and configuration for the design of nuclear physics experiments.

Teaching methods	Lectures with possible adjustments to the program and the depth of the different topics based on the participants' interests and student feedback
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	Physics laboratory courses commonly offered in master's degree programs in physics.
Examination methods (in applicable)	In-depth study of one of the course topics using scientific literature that illustrates the state of the art in the field. Discussion of the chosen topic within the broader context of all the topics covered in the course.
Suggested readings	Scientific articles and material provided by the instructor. *Radiation Detection and Measurement*, Glenn F. Knoll, Wiley editions; fourth edition (August 16, 2010).
Additional information	