Description of two Hands-on Experiments for the EPS' TIG event @CERN on October 13-15th, 2023

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Introduction:

The two experiments described here shall be performed by a mixed group of international students, invited to the three day event @CERN by EPS. This event is the fourth of its kind (2X CERN in 2019 and 2022 and 1x In Montenegro, July-2023). The ideas for this years' experiments come from Richard Zeltner and Stefan Kubsky, implementation and tests are performed by the SOLEIL-team from the Materials' Laboratory at Synchrotron Soleil (France) and support from HORIBA (Saclay, France).

Experiment 1:

Doppler measurements with light

The Doppler effect is the change in frequency of a wave when either is emitter or receiver are moving relative to each other. Measurements based on the doppler effect are widely used in medicine, astronomy and radar. In this experiment students will build a simple laser doppler measurement and measure the speed of a moving target.

The setup to be created by the students works with a red laser and splits the output light into reference and "measurement" paths, respectively. Interference between these is to be detected in order to measure the speed of the target object, a mirror moving on a translation stage. The students work together on optics, opto-mechanics, detection-electronics, data recording, analysis and finally presentation of results and limits. A more detailed material list will appear soon. Apart from a low-power red laser, there will be a beam-splitter, a motion stage, photodiode with transimpedance amplifier and a digital oscilloscope.

Experiment 2:

nm-precise piezo-actuation and sensing via a new, compact superresolution sensor

The session begins with a comprehensive introduction (20-30 min) about the state of the art in nm-positioning explaining the experimental challenge for the students. An experimental setup including a simple but nm-precise piezo-actuator will be created by the students. It will be powered by simple electronics and its movements monitored by an integrated strain gauge, a miniature Wheatstone bridge. In collaboration with HORIBA, a new optical sensor (OXYO, 2+1axes, nm-resolution), based on superresolution image-treatment will be assembled and operated in parallel. Apart from the piezo-actuator and the OXYO-sensor, a PC with adapted

software, powersupplies, multimeters, some optical elements, mechanics and an oscilloscope are part of the setup.

Results of the measurements will be recorded, compared and presented by the students.

Take a comprehensive peek into one of the basics of nano-science: To see where you are on a nm-level!

Proposed Laser Safety protection and procedure:

The first experiment features a HeNe ~1mW Laser. This Laser will be used in conjunction with an optical cage system (40mm from Thorlabs) in order to properly guide the light paths and detect the interferences. Our (SOLEIL) personnel absolved a Laser safety training. An adapted, optically opaque cloth (from Thorlabs) will cover the experiment when running. A sufficient number of Laser-protection glasses v(>=OD4) will be supplied. The most important point is: The laser will be kept off during most of the experimental time. Only the trained personnel has the physical possibility to switch the Laser on.

During the setup phase of the experiment, trained personnel constantly verifies the proper construction of the experimental setup by the students' teams.

There are no other dangerous substances or instruments foreseen.