School on time metrology in experiments

Report of Contributions

https://indico.cern.ch/e/klfamo22

Contribution ID: **1** Type: **not specified**

Introduction to time and frequency metrology - SA.COK

Thursday 24 November 2022 12:35 (1h 15m)

Time and frequency metrology is the basis for the functioning of the modern world and sets a new frontiers of knowledge in science. SI second is the most accurate realized fundamental unit of physical quantity. It requires the complex sophisticated time keeping system and analysis of the atomic clocks and primary frequency standard behaviour in short and long-term. In the lecture the international system of time keeping will be presented, including a basic concepts, assumptions and tools applied to validate the quality of atomic clocks, timescales, or time transfer links. The future redefinition of SI second, i.e. conversion into the optical definition, and possible options of its realization will be discussed.

Presenter: CZUBLA, Albin (Cental Office of Measures, Poland)

Contribution ID: **2** Type: **not specified**

Welcome and introduction - S.26

Thursday 24 November 2022 12:20 (15 minutes)

Presenter: ZAWADA, Michal Jerzy (Nicolaus Copernicus University (PL))

Contribution ID: **3** Type: **not specified**

Optical atomic clocks - SA.COK

Thursday 24 November 2022 14:10 (1h 30m)

Optical lattice clocks are the most precise device ever developed and are at the forefront of frequency metrology. Nowadays, the systematic uncertainty and stability of optical clocks are 2 orders of magnitude better than cesium microwave fountains currently realizing the SI second, with applications in fundamental physics, astronomy and geoscience. In the near future, a re-definition of the SI second is expected, once optical clocks are proven to be as reliable and reproducible as their microwave counterparts. In this talk we discuss the science foundations of optical lattice clocks, their state of the art, current limitations and possible applications in science and industry.

Presenter: BILICKI, Sławomir (KL FAMO, Institute of Phyics UMK)

Contribution ID: **4** Type: **not specified**

Time and timing in experiments with antimatter at CERN - SA.COK

Thursday 24 November 2022 16:00 (1h 30m)

According to current understanding of natural laws the same amount of matter and antimatter was created in the beginning of the Universe. We observe, in high energy experiments done at the Large Hadron Collider at CERN (European Organization for Nuclear Research) in Geneva, that matter and antimatter are produced in equal amounts and only small differences have been found in rare decays, which are not sufficient to explain the current imbalance and almost nonexistence of antimatter. To address this fundamental problem a dedicated facility has been built at CERN called Antiproton Decelerator. Its mission is to provide slow antiprotons to experiments which are probing the fundamental properties of antimatter. The research is focused on three main pillars: the confirmation of the Weak Equivalence Principle (measurement of the gravitational constant g) for antimatter, precision spectroscopy of antihydrogen and its ions and the exploration of the properties and transitions of exotic atoms containing antimatter like positronium –a bound state of an electron and positron, protonium –a bound state of a proton and an antiproton and other heavier antiprotonic atoms where one of the electrons is replaced by a 2000 times heavier antiproton.

In this contribution I will introduce to the ongoing experimental activities and future developments as well as the challenges of working with antimatter.

Presenter: KORNAKOV, Georgy (Warsaw University of Technology (PL))

Contribution ID: **5** Type: **not specified**

Ultra-stable optical cavities - SA.COK

Friday 25 November 2022 09:30 (1h 15m)

Ultra-stable optical cavity is an essential element of all the best optical atomic clocks serving as a fly wheel keeping stable optical frequency on time scales up to a few hundreds of seconds. The idea of such a cavity is very simple, keep stable distance between two mirrors and use it to stabilize frequency of a laser. Stability of the best lasers is of order of 10^-17 which corresponds to a distance stability of much less than a diameter of a proton. During this lecture construction of a such ultra-stable laser will be presented.

Presenter: BOBER, Marcin (KL FAMO, Institute of Phyics UMK)

Contribution ID: **6** Type: **not specified**

Fibre links for time and frequency transfer - SA.COK

Friday 25 November 2022 11:05 (1h 15m)

In recent years a rapid development of time and frequency transfer based on optical fiber is being observed. In the lecture the specific challenges and limitations related to fiber-based T&F transfer will be discussed, and various solution will be presented and characterized, both for optical frequency transfer, radio-frequency transfer and time transfer. The European initiatives towards building wide range networks for T&F transfer will be briefly mentioned.

Presenter: KREHLIK, Przemysław (AGH University of Science and Technology)

Contribution ID: **7** Type: **not specified**

Voluntary exam - SA.COK

Friday 25 November 2022 12:20 (30 minutes)

For those that needs it for your local ECTS points.
Please note, that you have to arrange it by yourself either with the dean or with the director of the doctorate school.
We can only provide you a certificate of the attendance with the score from the exam.