



## Particle physics education in Hungary

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### Abstract

In recent years various educational activities have been pursued in Hungary with the aim to raise the interest of high school students in natural sciences, and especially in physics. This brief summary will present some of the key projects of broader interest for the scientific community.

*Keywords:* CERN; national teachers programme; moving exhibiton; virtual visits

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### 1. Introduction

In recent years various educational activities have been pursued in Hungary with the aim to raise the interest of high school students in natural sciences, and especially in physics. This brief summary will present some of the key projects of broader interest for the scientific community.

### 2. Hungarian Teachers' Programme

Hungary was the first to respond to the CERN announcement of the National Teachers' Programme, and we organized the first programme of this kind in 2006, which since then expanded to many countries. Every year 40+ Hungarian physics teachers participate in a one-week activity at CERN. These weeks are

preceded by a meeting in Budapest where the participants get acquainted with each other and with the expected CERN activity and we give them some general information. They spend 5 days at CERN, lectures in the mornings, visiting experimental areas, doing their own experiments and solving exercises in the afternoons and evenings. The teachers' experiments are quite manifold: e.g. measuring radon concentration, radioactivity and air pressure at various places on the way to Geneva and back and at CERN and also build cloud chambers. The lectures were originally predefined by CERN Education in 2006 and we developed and added to them: they are about particle physics and cosmology, accelerators and detectors, data handling and computing, and also medical applications. The lectures are given in Hungarian by physicists involved in CERN experiments. The detailed

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programmes, lecture notes and video recording of the lectures are stored at the [Education pages](#) of CERN. Each lecture, visit and activity is evaluated and marked by the participants.

We organize a follow-up meeting at the end of the year, where the participants report on the results of the teachers experiments and we analyse the evaluation sheets of the individual lectures, visits and teachers' experiments made at CERN and during the travel. That post-meeting is attended by all the teachers and most of the lecturers, by the representatives of CERN and of the sponsors, the Director General of Wigner RCP, the Secretary of the Hungarian CERN Committee and the Chairperson and Secretary General of the Hungarian Physical Society. This programme is quite popular and heavily oversubscribed, and the involved teachers organize student visits to CERN regularly.



Fig. 1. Participants of the Hungarian Teachers' Program

### 3. Masterclasses



Fig. 2. Students participate in the Masterclass

From the very beginning in 2005 Hungary participates in the annual events of the International Masterclass program. They are organized at 3 institutions in Hungary:

at Wigner RCP, Budapest, at University of Debrecen and at Óbuda University, Székesfehérvár. These masterclasses are very popular, students come to them from all over

Hungary and more and more teachers come together with them. During the past ten years about 700 high-school students and 100 of their teachers have visited these daylong programmes. The day starts with an introductory lecture to particle physics and to the experiment events of which the students will analyze. The groups visit experimental facilities of the institute and after lunch perform an actual analysis of real CMS high-energy events in groups of two on computers searching for  $W/Z$  leptonic decays. The analyses are combined and the results discussed in a videoconference organized by CERN, where the institutes in different countries compare and discuss their results. The afternoon is closed by a quiz. The Budapest masterclass is so popular that since many years we have to organize an additional one after the official CERN masterclass: we have the same lectures and same analysis job for the students, but instead of the joint video session we make virtual visits to Hungarian groups at CERN.

### 4. Virtual Visits to CERN

In these visits, developed on the request of Hungarian physics teachers, the schools' workstations have a 3-way audio-visual connection to the control room of an experiment and to a mobile unit. First the convenor in the control room introduces the experiment, then the mobile unit shows various places of the experiment, some of which are even off-limits for visitors. These visits make it possible to visit experimental areas at CERN for whole classes in their class room, without having to travel to



Fig. 3. Secondary school pupils in a CERN Virtual Visit

Geneva. Virtual visits should help CERN to solve the problem of the very crowded visitors' schedule at certain experimental areas (like the LHC caves).

### 5. Student projects in the Gaseous Detector Laboratory

Involvement of secondary school students in contemporary particle research projects is a

challenging task – which, however, if successful, boosts motivation and skills. Examples of two such high profile projects are presented below, both completed in a full semester, 4 hours a week by 3-5 students.

#### *High sensitivity current meter*

Precision current measurement of the HV supply line, in the range of 1-100 nA, is a key diagnostic test for gaseous detectors used in HEP applications. With the help of expert scientists from Wigner RCP the students designed, built and tested such devices. The ammeters reached sensitivity below 1 nA and were certified for operation at 6 kV.

#### *Multi-wire proportional chamber for cosmic muon detection*

The classical and much appreciated MWPC has served generations of HEP experiments, and won the Nobel Prize for its inventor, *G. Charpak*. The students have built such detectors of 20 cm by 20 cm size.

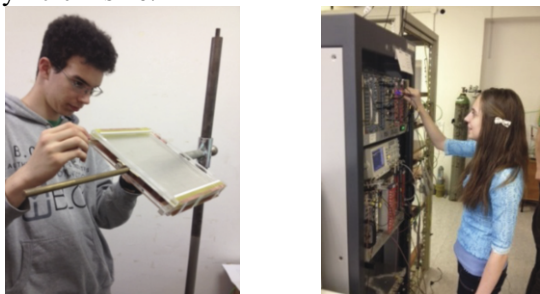


Fig. 4. Secondary school pupils in the Gaseous Detector Laboratory

Wire stretching (Fig. 4. left) was the most interesting step to build the two complete chambers. Stable operation with clear signals (Fig.4 right) was achieved. The project participants are students from the Mechatronika secondary school (Budapest) and from the Teleki Blanka school (Székesfehérvár) together with physics teacher *Ms. Éva Oláh*.

#### 6. Open Days

Atomki and Wigner RCP organizes Open Days, the last ones were devoted to particle physics. Wigner RCP's last one coincided with CERN's Open Day and this year it will be devoted to CERN's 60<sup>th</sup> anniversary.



Fig.5.Visitors at Open Day

We present posters on particle physics activity in Hungary with explanations by local physicists. During Open Days Atomki opens her laboratories where atomic, nuclear and environmental physics experiments are performed (Fig. 5.). Wigner RCP shows her detector laboratory and the new LHC Data Centre (Tier-0) where the raw LHC data will be first analysed before sending them to the primary storage centres all over the world from Chicago to Taipei.

#### 7. Visitors' Centre

Atomki prepared a special exhibition room for visitors where it shows the various research activities of the institute, including particle and astro-particle physics. It will have a special CMS corner in which actual data quality monitoring can be done and also demonstrated to visitors „*All Colors of Physics*” bus. Wigner RCP is preparing a moving exhibition of solid-state and particle physics. It will visit high schools all over Hungary and together with popular lectures hopefully raise the interest of the students in physics. The solid state physics part, called *nanobus* has been used already, the particle physics part will be a *boson bus*. The exhibition includes posters on CERN and particle physics. Together with the bus visit CERN physicists will present lectures about particle physics and solid-state physicists will show small experiments to high-school students. It was opened 27 May 2014 by *Prof. Rolf-Dieter Heuer*, Director-General of CERN.

#### 8. From Atoms to Stars

The highly popular bi-weekly lecture series at Eötvös University, "*From Atoms to Stars*" (AtomCsill), attracts students since already 9 years. Frontline scientists discuss hot topics or their own research in an understandable but scientifically rigorous way. The presentations are followed by vivid discussions and experimental demonstrations.