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## **The physics frontline and innovative science experimentation for school Education projects by Erik Johansson**

To make students and school children feel the excitement of today's science research, Erik Johansson has for many years devoted time and effort to promote science, particularly particle physics, at school. The best known education initiatives and innovative projects are:

- Hands on CERN
- Stockholm Science Laboratory
- Stockholm House of Science
- ATLAS experiment Education and Outreach project

Several of these education projects have become models for how modern physics and science experiments can complement the physics taught at school and how research experiments and results can be implemented in the school education in a new and innovative way.

### **1. Hands on CERN**

With the Hands on CERN project ([www.hands-on-cern.physto.se](http://www.hands-on-cern.physto.se)) students can approach the physics frontline in the classroom. They can interactively explore the building blocks of nature and the fundamental forces in nature using real data from the DELPHI experiment at CERN, the European particle physics laboratory, and get close to a modern scientific experiment using the same scientific information as the scientists.

When the Hands on CERN web education project was launched it was not obvious that particle collision data from a real particle physics experiment at CERN could be made available to schools via the web. After half a year the feasibility was demonstrated and the first version of Hands on CERN was developed and used for many years. After important revisions and improvements, including also the Greek interactive "Fireworks of particle physics", Hands on CERN has become a European-wide used education project. Hands on CERN has been translated to 15 European languages including the two original languages (Swedish and English). These translations were to a large extent done by scientists and teachers who wanted to use the education project in their classes or courses in the many different European countries.

### **Masterclasses 2005 and 2006**

Close to 60 European particle physics institutes and altogether 6000 students from 18 countries participated in the very successful European Masterclasses 2005 and 2006 directed by Michael Kobel from Dresden University. The majority of the participating groups used Hands on CERN to explore the fundamental particles and processes of microcosm. This was a genuine European-wide physics education event, in which also the European Particle Physics Outreach Group (EPPOG, <http://cern.ch/eppog/>), chaired by Erik Johansson, played an important role.

### **International attention**

The hands on CERN project demonstrates a new and innovative way of introducing the physics frontline in the classroom as the students interactively explore the building blocks of nature and the fundamental forces in nature using experimental data from the DELPHI experiment at CERN, the European particle physics laboratory. The project has received a lot of international attention and Hands on CERN was selected a winner of the Scientific American Science and Technology Web award in 2004. In 2005 Erik Johansson received the

prestigious Webby Award in the Science category in New York. The Hands on CERN project has been described in seminars, at conferences and in science publications (see Appendix).



The Webby award in June 2005, Broadway, New York

## **2. Stockholm Science Laboratory**

The Stockholm Science Laboratory was built at Fysikum, Stockholm University. The novel feature was that it was complete devoted to schools. The new concept of receiving school classes for a few hours up to a whole day, was immediately very well received. Many physicists gave presentations in the laboratory, emphasizing the connection with the physics frontline and the physics department. After six years of successful operation, the laboratory developed into Stockholm House of Science.

## **3. Stockholm House of Science**

The concept of House of Science ([www.houseofscience.se](http://www.houseofscience.se)) is built on the very successful concept of Science Laboratory. The laboratories were enlarged and extended to astronomy, biotechnology and physics. The great success of the concept has led to the present implementation of chemistry. As initiator of Stockholm House of Science and its first Director, Erik Johansson has created a very successful and ambitious platform for interesting and advanced experiments in a university environment, entirely dedicated to school. Each year between 10 000 and 15 000 students and teachers make experiments in astronomy, biotechnology and physics in House of Science. The laboratories are also visited by teachers from other European countries. The Stockholm European Masterclasses 2005 and 2006 took place in House of Science.

## **4. ATLAS E&O project**

Since eight years the ATLAS world-wide collaboration and particle physics experiment ([atlas.ch](http://atlas.ch)) at CERN has had an active Education and Outreach project directed by Michael Barnett and Erik Johansson. A large number of innovative information material has been produced for teachers and schools. The ATLAS Student Event Challenge is a future education project based on the ideas of Hands on CERN and the American Quarknet project.

## **5. The science frontline**

Erik Johansson has made part of the physics frontline available in the class room with Hands on CERN, the ATLAS education and outreach project, and with Stockholm Science Laboratory and House of Science modern science experimentation in astronomy, biotechnology, physics, and recently also chemistry, has been introduced in the schools. Several of the experiments are close to the science frontline, engaging both students and their

teachers. The numerous seminars, conferences, and publications (listed in the appendix) demonstrate the European and international recognition of Erik Johansson's innovative projects on the European arena promoting physics and science in society.

## **6. Evolution**

The education projects started already ten years ago with the feasibility verification of the ideas and concepts. They were confirmed and the first very well received versions were produced. Particularly during the last five years have the ideas and concepts been further confirmed through interactions with numerous students and teachers, very often in organised workshops. The projects were extended and tested particularly on the European arena resulting in many national activities and the translation to 15 languages. The European Masterclasses of 2005 and 2006 will continue 2007. The idea and concept of the Hands on CERN education project will be implemented also at future particle physics experiments at CERN, like the ATLAS experiment ([atlas.ch](http://atlas.ch)). These ideas and innovations have a promising future.

## Appendix

**During the last years Hands on CERN and its initiator and project leader Erik Johansson have received international attention in CERN Courier, Science, Scientific American.com and as Webby award winner and a recognition of the innovative nature of the education ideas and projects.**

### 1. Hands-on particles appeal to students, CERN Courier March 2002

### 2. CERN courier December 2004-12-14

#### **Scientific American accolade for Hands-on-CERN website**

"2004 will go down in history as the year the rovers *Spirit* and *Opportunity* landed on Mars, the year the Cassini-Huygens spacecraft entered Saturn's orbit, the election year in which the issue of stem-cell research loomed large, and the year predicted to contain the costliest hurricane season ever recorded in the US", reads the website that describes *Scientific American's* Science & Technology Web Awards 2004.

So it is a pleasure to find that Hands-on-CERN (<http://hands-on-cern.physto.se>) is among the 50 sites honoured this year. Developed by Stockholm's Erik Johansson, it uses events from the DELPHI experiment at CERN's Large Electron Positron collider to explore the smallest components of matter ([CERN Courier March 2002 p18](#)).



[Website](#)

According to the citation, "the site does a brave job of making the business of elementary particles, accelerators, detectors and collision exercises comprehensible to a general audience. The crowning jewel of the site is WIRED, or World Wide Web Interactive Remote Event Display, where students can study actual particle collisions... The site represents quite a feat in ultimately making this branch of physics more accessible for all."

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### 3. Take the Collider for a Spin, Science magazine vol 303 February 2004

#### **Take the Collider for a Spin**

Get a crash course in particle physics and deciphering the structure of matter at Hands-on-CERN, a tutorial that explains the workings of the famous atom smasher near Geneva. Physicist Erik Johansson of Stockholm University and colleagues are still polishing up the English version, but the site provides high school students with

plenty of background on the quarks, gluons, and other particles that form matter and carry forces. Visitors can take a virtual trip more than 100 meters below ground to learn how the accelerators at CERN push electrons and positrons to nearly the speed of light. Animations help explain how detectors register the products of high-energy collisions. After studying a primer on the tracks that these different particles leave behind, students can analyze results from CERN experiments (above).  
hands-on-cern.physto.se

# NETWATCH

edited by Mitch Leslie

## 4. Scientific American.com award 2004



**Hands on CERN (hands-on-cern.physto.se) has been selected a WINNER of the Scientific American Science and Technology Web Awards 2004**

## 5. The Webby Award 2005

Hands on CERN website was awarded the 2005 Webby award in Science. The award was received by Erik Johansson in New York on 6<sup>th</sup> June 2005.

More about Webby awards and the Nominees:

<http://www.webbyawards.com/index.php>

Said about Webby awards:

“Hailed as the "Oscars of the Internet" by the New York Times, the Webby Awards is the leading international award honoring excellence in Web design, creativity, usability and functionality. Established in 1996, the 9th Annual Webby Awards received over 4,000 entries from all 50 states and over 40 countries worldwide. The Webby Awards are presented by The International Academy of Digital Arts and Sciences.”

**List of some education publications and conference presentations**

1. *Hands on CERN: an education project on Internet using real high energy particle collisions*, Erik Johansson and Tord Malmgren, **Physics Education** 34/5(1999)286
2. *Stockholm Science Laboratory for Schools*, Erik Johansson and Christer Nilsson, **Physics Education** 34/6 (1999)345
3. *Science Bringing Students Together*, J. Engstedt, R.Jacobsson, K.E.Johansson, Marshall and M.Mulligan, **Physics Education** 35/2 (2000)86
4. *Experiments in Modern Physics for the General Public*, Erik Johansson and Christer Nilsson, **Physics Education** 35/4 (2000)256
5. *Astronomy and particle physics research classes for secondary school students*, K.E.Johansson, Ch. Nilsson, J. Engstedt and Aa. Sandqvist, **American Journal of Physics** 69(5) 2001 p.576.
6. *The physics of 'Copenhagen' for students and the General Public*, L. Bergström, K.E. Johansson and Ch. Nilsson, *Physics Education*. **Physics Education** 36/5 (2001)388
7. *Quarks, Leptons and Galaxies for Students*, Erik Johansson, Proceedings of the International Europhysics Conference on High Energy Physics, Budapest, Hungary, 12-18 July 2001; **Journal of High Energy Physics**, PRHEP-hep2001/282
8. School Projects at the Physics Frontline, invited talk at the European **Conference on Trends in Physics, EPS-12**, Budapest, Hungary, 25-30 August 2002.
9. *Frontline Physics for Teachers and Students* , K. E. Johansson **Europhysics News** 34 (2003) 110-111, May/June 2003
10. School Projects at the Physics Frontline, invited talk at the European **Conference on Trends in Physics, EPS-12**, Budapest, Hungary, 25-30 August 2002.
11. *House of Science: a university laboratory for schools*, K. Erik Johansson, **Physics Education** 39 (2004) 342-345
12. Hands on CERN – a well-used physics education project, K.E. Johansson, **Physics Education** 41 (2006) 250-254.
13. Einstein for schools and the general public, K.E. Johansson, C. Kozma and Ch. Nilsson, **Physics Education** 41 (2006) 328-333

14. The Education and Outreach Project of ATLAS – a new participant in physics education, R.M. Barnett and K.E. Johansson, **SN-ATLAS-2006-055, Physics Education** 41 (2006) 432-436
15. An educational PET camera model, K.E. Johansson, Ch. Nilsson and P. E. Tegner, **Physics Education** 41 (2006) 437-439
16. Observing the Solar Spectrum at House of Science, K.E. Johansson, C. Kozma and Ch. Nilsson, **Physics Education** 42 (2007) 41-44
17. Hands on Physics and Biology in House of Science, L. Gumaelius and K.E. Johansson  
Plenary presentation by E. Johansson at the **Third Hands on Science International Conference**, Braga 3-9 September 2006, conference proceedings page 11.
18. Particle Physics goes to School, Plenary presentation by E. Johansson at the **Third Hands on Science International Conference**, Braga 3-9 September 2006, conference proceedings page 254.