HiSPARC

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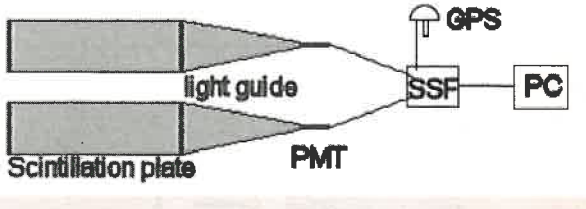
Science education is of great cultural and economic importance for modern societies. It is also of great importance to science itself, as scientific continuity depends on our success in educating and training the next generation of scientists and science teachers. To be successful, science education must challenge the intellect and captivate the mind of young people, and acquaint them with the joy of discovery and understanding.

There is no better way to achieve this than by involving students in research as early as possible. This is the main aim of the High-School Project on Astrophyics Research with Cosmics (HiSPARC) [1]. Following the example set by others elsewhere [2] and initiated in the Netherlands by Charles Timmermans and Sijbrand de Jong in Nijmegen [3], HiSPARC members have built a network of cosmic-ray detectors based on high-school infrastructure, involving students and teachers in an essential way by making them collaborators in the research.

A cosmic ray is observed through the shower of secondary particles it creates when entering the atmosphere of the earth. The larger the area the shower covers when reaching the surface, the larger the primary energy of the cosmic particle. Such showers are reconstructed through coincidence measurements between detectors. These detectors are placed on the roof of the participating schools, creating city-centered regional clusters of detectors. The average distance between the schools guarantees a sufficient number of coincidences, allowing students to get meaningful measurements within a period of a few months. Internet connections, available at all schools in the Netherlands, allow the transfer and central collection of data. Subsequently data and suitable analysis tools are made available to all participants. At the same time, the involvement of enough schools provides an opportunity to hunt for Ultra-High Energy Cosmic Rays (UHECRs). In this way the project can contribute to solving the puzzles surrounding the origin and nature of these cosmic particles with energies above 10^{20} eV.

At the initiative of Bob van Eijk, Henk-Jan Bulten and the present authors the project is now run at a national level. It is co-ordinated by NIKHEF, the Dutch research institute for subatomic physics in Amsterdam. The importance of the project was recognized by the Foundation for Fundamental Research of Matter (FOM), a national physics funding agency, which has appointed Ilka Tanczos as full-time national project co-ordinator.



▲ Fig. 1: Indicated are schematically the scintillation plates, light guides, the Photo Multilier Tubes (PMTs), the Scintillator Signal Follower (SSF), the Global Positioning System (GPS) antenna to provide a time-stamp and the PC for data acquisition.

▲ Fig. 2: Ski box containing one unit of the detector.

Recently HiSPARC also received a strong boost when it was awarded the prestigious european 2004 Altran Prize for Innovation [4]. The Altran Foundation will provide a full year of technical support and assist in the development of a professional organization. Nationwide the project now has five active detector clusters in Amsterdam, Groningen, Leiden, Nijmegen and Utrecht.

An important part of the fun is that high-school students of each participating school get to build, calibrate and maintain their own detector. This includes wrapping the scintillator plate and light guide in reflecting aluminum foil to minimize the loss of photons produced in the scintillator by charged particles that are part of a cosmic air shower, and covering the plates with light-tight plastic foil to keep out light from other sources. The students then have to glue the scintillator plate, light-guide and photo multiplier tube (PMT) together and calibrate the final detector. In this way they learn to work in a team, they find out that doing research involves learning from failure and mistakes, and they get to know the excitement that goes with potential discoveries. Indeed, a very stimulating factor for them is the anticipation that this project may provide new scientific results, even if this requires many years of data taking.

Each detector station consists of two scintillator plates, placed several meters apart in ski boxes to keep them safe and dry. A GPS antenna provides a time stamp for registered events. Only events producing a signal in both detectors within a couple of microseconds are stored on a central computer (presently there are two, one in Nijmegen and one in Amsterdam). High-school students and teachers have access to these data. The data can be analysed for coincidences between schools in the same area, or for correlations with atmospheric conditions, but one can also search for clustering of different events over a larger area. Starting only this summer the Nijmegen cluster has already observed quite a number of triple coincidences. Such measurements allow by triangulation the determination of the direction of the primary cosmic particle creating the airshower.

An interesting aspect of the set-up in Leiden is that the HiSPARC detector recently installed at the university is also intended to function as a veto for excitations in the miniGRAIL gravitational wave detector [5] simultaneous with the arrival of a cosmic air shower. Clearly HiSPARC is a near unlimited source of research projects, which are a compulsory part of high-school science education in the Netherlands.

HiSPARC is still young, but it has already built up considerable momentum. It should run for at least ten years, and a considerable effort is going into the development of educational packages,

mostly by teachers of the participating schools. Several of them receive funding to allow their schools to temporarily free them for work on HiSPARC, typically for one day per week. All this helps in fulfilling the goals of science education: stimulate teachers and students to enjoy science in a active way, and bring scientific thinking and scientific culture into the schools.

References

[1] The national HiSPARC webpage: www.hisparc.nl

[2] The NALTA webpage: csr.phys.ualberta.ca/nalta/

[3] The Nijmegen HiSPARC webpage: www.hef.kun.nl/nahsa/

[4] The Altran Foundation webpage: fonda.netarchitects-europe.com/

[5] Poster presented at the 19th Cosmic Ray Symposium in Florence: www.lorentz.leidenuniv.nl/vanbaal/HiSPARC-MiniGRAIL.pdf (2.3 Mb); The MiniGRAIL wepage: www.minigrail.nl

▲ **Fig. 3:** Typical arrangement of the detector on the roof of a school.