

Data Life Cycle Based Outreach Activities in Astroparticle Physics at the Karlsruhe Institute of Technology *

Katrin Link^[0000-0002-5179-9743]

Institute for Nuclear Physics, KIT - Karlsruhe Institute of Technology, Karlsruhe, Germany

Abstract. With various outreach activities KIT aims to make astroparticle physics more accessible for everyone, not only high-school students and their teachers but also a broader public. A wide range of activities, from public lectures, internships and practical activities for students to art meets science projects are therefore part of our repertory. Partly, these activities are also embedded in the programs of national and global initiatives. There are also close links at European level with the APPEC (Astroparticle Physics European Consortium) Functional Centre for Outreach being located at KIT. A catchy outreach program requires the access to real scientific data and therefore a close connection to the data life cycle of the research field. Here we present an overview of our current outreach program.

Keywords: outreach activities · KCETA · astroparticle physics.

1 Introduction

At discussions on data centres or the organization and maintaining of data life cycles in astroparticle physics one also needs to keep in mind to make data available not only for scientist but also to pupils, students and the broader public, who could profit from an easy access to data. Especially, since many experiments are supported by public money, we should give back our knowledge and attract young people to science. Data centres can and should integrate a section for outreach activities. Especially the concept of Masterclasses suits to be part of a public data centre. The idea of a Masterclass is to bring real data from experiments to classrooms, either virtually or during a hands-on-lecture given by PhD students. Already during the design of data centers one should

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keep in mind to provide easy accessible data, a basic analysis concept and an easy understandable documentation and manual. This is mandatory to base any outreach and education activities on such a data center. In addition, also scientists will profit a lot by such a concept.

Of course, there are also many other ways to attract the next generation of students to astroparticle physics and to show a broader public this fascinating research. In the following we will present an overview of astroparticle physics related outreach activities at the Karlsruhe Institute of Technology, in particular of the KIT Center Elementary Particle and Astroparticle Physics (KCETA) [1].

2 Outreach for high-school students

For high-school students we offer a wide range of activities for both, individuals but also groups or the whole class.

Masterclass In the context of Netzwerk Teilchenwelt, see section 6.1, we offer schools to take part in one of our Masterclasses, the Auger Masterclass [2] or the IceCube Masterclass on measuring cosmic rays [3]. These are the two main astroparticle experiments where KIT is part of the collaboration. We want to give the students a better understanding of the detector, the measurement principles, the analysis and the way how physicists work in international collaborations. After an introduction the students are provided with real data from the experiment which they use to make their own analyses.

International Cosmic Day At the International Cosmic Day (ICD) [4] questions like "What are cosmic particles?", "Where do they come from?" and "How can they be measured?" are addressed. After an introduction to cosmic rays and air-shower experiments the students measure the zenith dependence of cosmic muons with scintillator detectors. The analysis of the data is then presented in an international video call with other participants and finally presented in a booklet. This allows students to work like a real scientist in an international collaboration for one day. The ICD is organized by DESY, Germany together with Netzwerk Teilchenwelt, IPPOG, QuarkNet and Fermilab and takes place once per year. In 2018, KIT took part for the first time.

Girls' Day On the Girls' Day [5], companies, businesses and universities throughout Germany open their doors to female pupils to learn about apprenticeships and courses of study in IT, crafts, natural sciences and technology, in which women have so far been rather rarely represented. We offer the girls the opportunity to get to know the work of an astroparticle physicist and to meet women working in the respective field.

Cooperation with local school Since 2013 exists an official cooperation between KCETA and a school close to Campus North, the Thomas-Mann-Gymnasium Stutensee (TMG) [6]. This includes not only astroparticle physics

but the whole spectrum of science at KCETA. In the field of astroparticle physics we offer within this cooperation not only lectures but also excursions to the Campus North of KIT as well as practical exercises or internships in our working groups.

Internships Students from Baden-Württemberg must complete a two-week compulsory internship for career orientation. For this purpose, a program has been developed in which students get to know the different aspects of the work of an astroparticle scientist and also get an insight into other professions, such as electronic technicians or engineers, with whom we work together.

Additionally we offer individual internships in our working groups which are organised according to length and knowledge of each student. This can range from a few days up to several weeks or month and the content and complexity of the projects varies accordingly.

Education section KCDC The KASCADE Cosmic ray Data Center [7] provides a dedicated education section for teachers and pupils [8]. This compilation of interesting lessons within the vast field of cosmic radiation should illustrate the processes within and outside of our atmosphere by means of the data sets of the KASCADE experiment. Currently two lessons are available, both for higher level education. Prior knowledge in programming and cosmic radiation and air showers is required. We invite all users of KCDC to help in adding more and appropriate examples into KCDC or to translate the existing examples in more languages.

3 Outreach for the general public

The following activities are not restricted to students but in principle available for everybody, though the main audience is still interested in science. All these events are not explicitly for astroparticle physics but deal with the science at KIT in general. However, we only show astroparticle contributions here.

Wissensdurst As part of the EFFEKTE 2019 science festival, the event Wissensdurst (Thirst for Knowledge) [9] took place, a pub crawl in which scientists talk about their work in a relaxed and sociable atmosphere. Dr. Andreas Haungs, KCETA scientist, talked about the "Digital (R)Evolution of the High Energy Universe" and explained why free access to data is so important especially in astroparticle physics.

KIT im Rathaus Once a semester, one of the KIT centers has the opportunity to present in the town hall its research to the public [10]. The aim of the event is to create a connection between scientists and citizens and to intensify the exchange between science and the city of Karlsruhe. In 2019, KCETA presented itself under the motto "Research at Super Accelerators" with lectures and an exhibition [11]. Prof. Dr. Ralph Engel reported about

”Cosmic particle accelerators of superlatives”.

Open Day Usually every two years, an open day takes place on one of the KIT campuses, usually integrated into the science festival EFFEKTE. Every KIT-center has the option to present itself and its research. Of course, this is also a good opportunity for astroparticle physics to share the fascination of this discipline with the broad public, which is always welcome. Last year, visitors to the KCETA tent were able to experience astroparticle physics not only with informative posters, but also with a cloud chamber and a KATRIN model and engage in personal exchange with the scientists [12].



Fig. 1. Wissensdurst - Public talk in a beer garden, Credits: Bernhard Haungs



Fig. 2. Impressions during KIT Open Day 2019, Credits: Beatrix von Puttkamer, KIT

4 Art Project Cosmic Revelation

As a collaboration by the KASCADE experiment and Tim Otto Roth (imachination project [13]), Cosmic Revelation [14–16] is a minimalist light art project and a scientific experiment as well. Already in 2008 the first public presentation took place within the KASCADE Detector Array. The 16 Cosmic Mirrors, flashing light sculptures, made the cosmic rays that continuously strike our Earth and which were measured by KASCADE visible as light signals. Since then Cosmic Revelation has been presented again in different configurations and at different locations. Different detectors served as signal generators and the Cosmic Mirrors were sometimes enhanced with laser light or with sound, like in 2016 at the SV SparkassenVersicherung headquarter in Stuttgart or 2019 at the exhibition "From the Rocket to the Moon" shown in the gallery Parrotta Contemporary Art [17] in Bonn.



Fig. 3. Cosmic Revelation inside the KASCADE array 2008 (left, Credits: Markus Breig, KIT), in Stuttgart 2016 (middle, Credits: Tim Otto Roth, imachination project) and a Cosmic Mirror at Burg Lede in Bonn 2019 (right, Credits: Tim Otto Roth, imachination project)

5 Show Case Experiments

An important tool, especially when working with pupils, are small hands-on experiments which allow pupils to measure by their own and thus experience physics more directly. At KIT we can provide several detectors which can be used for such purposes.

CosMO The Cosmic Muon Observer (CosMO) [18], was build and developed at DESY for the outreach network Netzwerk Teilchenwelt. Consisting of scintillator panels and a SiPM, read out using a picoscope and dedicated software, students can measure cosmic muons and some of their characteristics, like the distribution of arrival direction or the muon lifetime. The experiment is built with components that are also used in a large scale experiment, but still kept simple, so the setup allows the students to do the measurements themselves and gives insight into the scientific work of experimental astroparticle

physics.

DETECTORS The Demonstration Experiment with ThErMal Cans To measure cOsmic Ray air Showers (DETECTORS) was build and developed at KIT. Like the CosMO detectors it is possible to measure cosmic muons, but the detection is based on a different principle: Muons produce Cherenkov light in the water filled thermal cans, this light is read out using a photomultiplier tube (PMT) and simple data acquisition boxes. This allows to not only measure muons and their characteristics but also to compare the measurements with pure noise measurement by removing the water. Currently a new version is being developed using a state-of-the-art SiPM sensor instead of a PMT.

Cloud Chamber The cloud chamber is used to make the actually invisible particles visible and can be used at various occasions, e.g. pupil events or Open Days. The cloud chamber was the first particle detector to make traces of elementary particles visible. A mobile version of such a cloud chamber is regularly used at events of various kinds, as it allows astroparticle physics to be demonstrated and made visible with simple means.

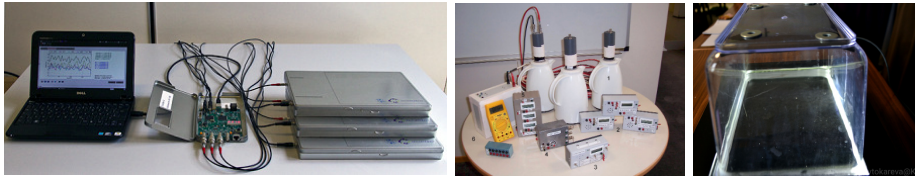


Fig. 4. Show Case Experiments: CosMO Detector (left, Credits: DESY), DETECTORS (middle, Credits: KIT), Cloud Chamber (right, Credits: Victoria Tokareva, KIT)

6 National and international Networks

In order to support each other in the field of outreach, to exchange ideas and to implement projects together, networks have developed at both national and international level. Some of the activities presented here were also developed within and are supported by these networks, e.g. the Masterclasses or the CosMO detectors. The outreach network on national level in Germany is "Netzwerk Teilchenwelt" and on international level the International Particle Physics Outreach Group (IPPOG). Due to a big overlap in science and institutions both networks deal with particle physics and astroparticle physics. In order to strengthen astroparticle physics, also on a European level, a closer cooperation between APPEC, the Astroparticle Physics European Consortium, and IPPOG is aimed at.

6.1 Netzwerk Teilchenwelt

Netzwerk Teilchenwelt (NTW) [19] is a network of scientists from 30 research institutes throughout Germany. The aim is to make latest topics in astroparticle and particle physics accessible to young people and teachers. With real data from research at CERN and astroparticle physics experiments the fascinating world of the smallest particles and big questions should be answered in schools. NTW works with a so-called step-by-step program, both for teachers and students. From the first level "Experience", it goes through the 2nd level "Mediate" to the last level "Explore". For high-school students level 1 includes participation in masterclasses or similar, in level 2 active participation is required, for example helping to organize and conduct masterclasses or presenting one's own experiences at school, and the third stage requires the preparation of an own research project. In order to stay in contact with interested students after the end of the step-by-step program, a fellow program was developed. Since 2019 NTW has been integrated into the "KONTAKT" project, which has not only high-school students but also the broader public, students, scientists and journalists as its target group.

6.2 IPPOG

IPPOG [20] is a network of scientists, science educators and communication specialists who want to bring the fascination of particle physics closer to the public worldwide. IPPOG has more than 30 members, which are countries, experiments and CERN as an international laboratory. The collaboration forum meets twice a year to provide a platform for the development and sharing of ideas and best practices and coordination of the programs. IPPOG provides a resource database and organizes international masterclasses [21]. The IPPOG Global Cosmics group is particularly dealing with outreach activities in the field of cosmic rays and organizes in cooperation with other organizations the International Cosmic Day and other events.

6.3 APPEC

APPEC [22] is a consortium of funding agencies, national government institutions, and institutes from 17 European countries, responsible for coordinating and funding national research efforts in astroparticle physics. The APPEC General Assembly gathers heads of agencies around Europe and observers from international organizations such as CERN, the European Southern Observatory (ESO), Astronet, the European Committee for Future Accelerators (ECFA) and the Nuclear Physics European Collaboration Committee (NuPECC), to coordinate a collective European strategy for astroparticle physics, execute the recommendations of the roadmap and to create a forum where future actions are discussed and common endeavours emerge.

The General Assembly (GA) is assisted by the Scientific Advisory Committee (SAC), the advisory body formed by leading scientists from various disciplines,

and the Joint Secretariat (JS), the executive body. The JS is organized in several Functional Centers, one of them located at KIT. The functional centre in Karlsruhe is responsible for Outreach and Communication. In this respect, we are also responsible for the bi-monthly newsletter of APPEC.

7 Summary

In the context of astroparticle physics KIT, in particular the KIT Center Elementary Particle and Astroparticle Physics, provides a broad range of activities targeting different audiences, from high-school students to the broader public [23]. With this presentation we hope to have made suggestions to make the exciting field of astroparticle physics accessible to a wider audience in other cities and countries. On the other hand, our activities can also be further expanded and new concepts and ideas are always welcome.

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