



# Netzwerk Teilchenwelt

Particle Physics Education and Outreach  
in Germany

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QuarkNet UPRM



# 1. Our Concept



# 2. Activities for students ...



# 3. ... and teachers / educators



# 4. Community



# Netzwerk Teilchenwelt

- Multi-level program for
  - high school students, aged 15-19
  - teachers/trainers
- at schools, school labs, science centers...
  - 170 – 200 events p.a.
- 26 research labs + CERN
- central organization: TU Dresden
- Project team: experts from science, didactics, science communication, teachers





# Our Concept

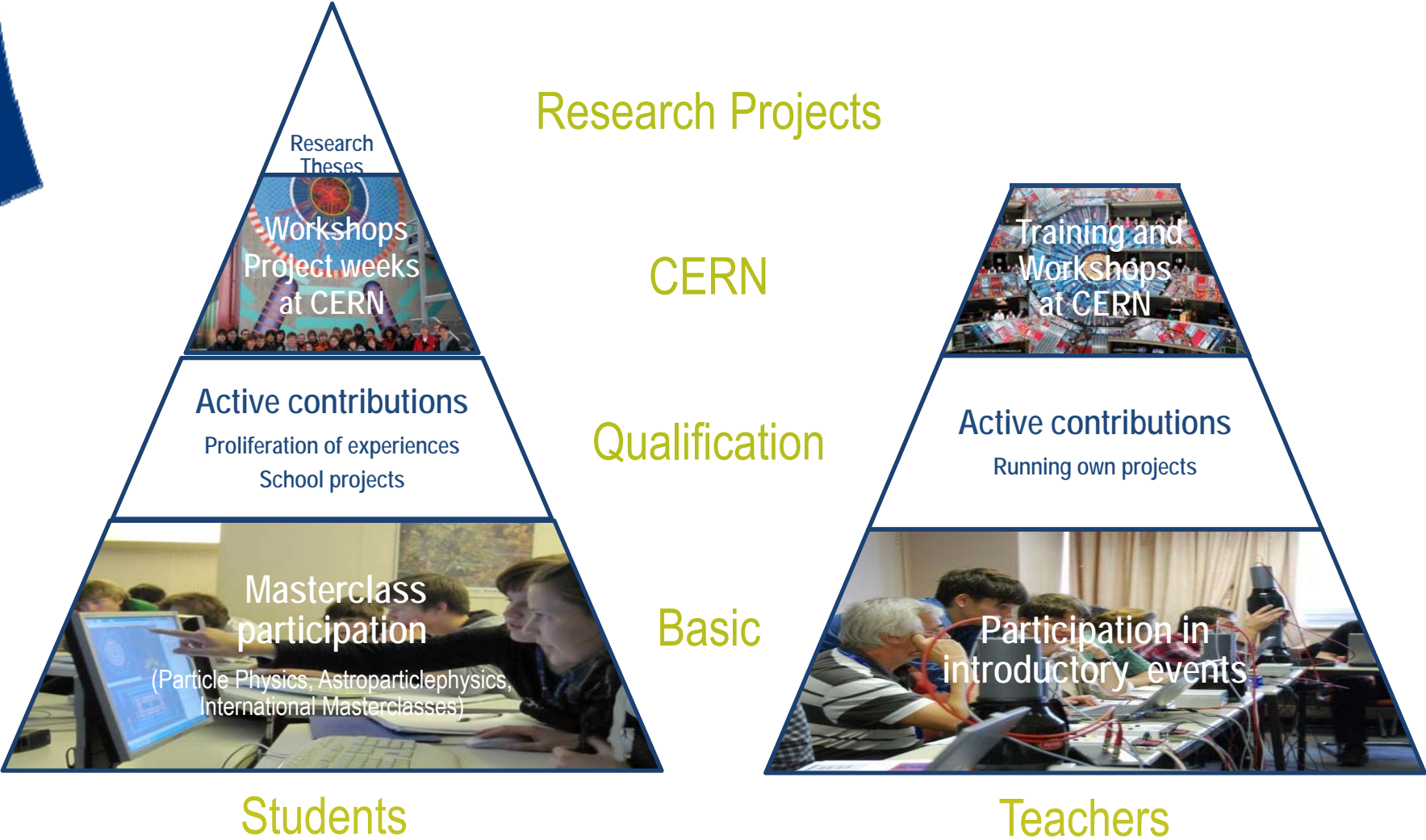
High school students and teachers are „scientists for one day“

- as close as possible to current research
  - experience how scientists explore nature
- own „hands-on“ activities
  - hear → forget // see → remember // do → understand

Get insight into scientific research process

- use the same tools and methods like scientists
  - theory  $\leftrightarrow$  experiment
  - direct contact with (young) physicists
- 
- stimulate students' interest in physics
  - raise fascination for particle physics
  - understand fundamental research as fundamental knowledge for society

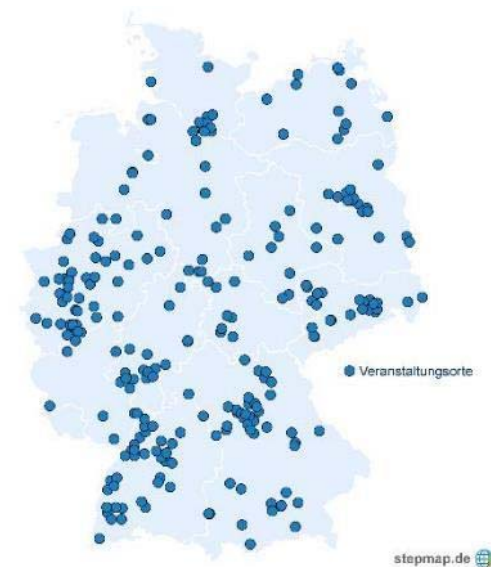
# Four Levels of Activities





# Particle physics Masterclasses

- 1 day in schools, also school labs, exhibitions (~100 p.a.)
- facilitators = PhD students
- agenda:
  - introductory talk (standard model, accelerators, detectors)
  - measurement with LHC data using event displays (ATLAS, CMS, ALICE, LHCb)
- tasks: identify events, create histograms, data quality investigation
- Possibly also for teachers





# Astroparticle Projects

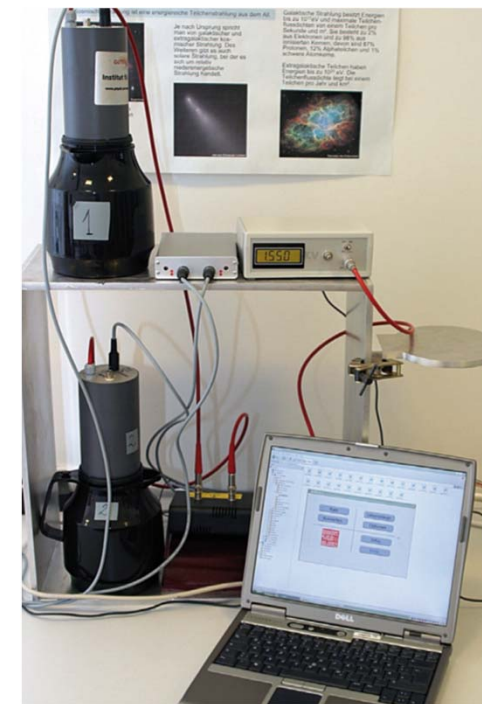
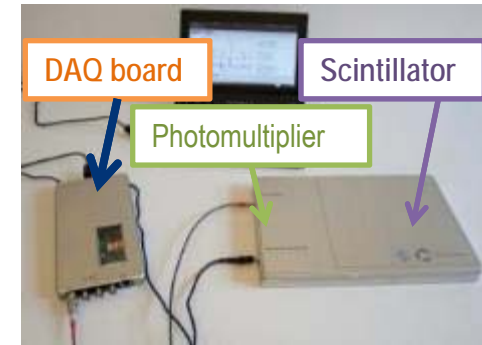
Scintillator experiment „CosMo“ and „Kamiokanne“

- loan to schools (after teachers training)
- Variety of measurements:
  - angular distribution
  - coincidence
  - muon lifetime (2 signals within 20  $\mu$ s)
  - study particle showers

Cloud chamber sets

Web experiments (Pierre Auger data)

International Cosmic Day





# Workshops + Project Weeks at CERN

## Students:

- 60 s. in two annual workshops (3 days)
- 10 s. in project weeks
  - own research projects, e.g. Medipix detector, CLOUD, ATLAS trigger system, lifetime of the B-meson

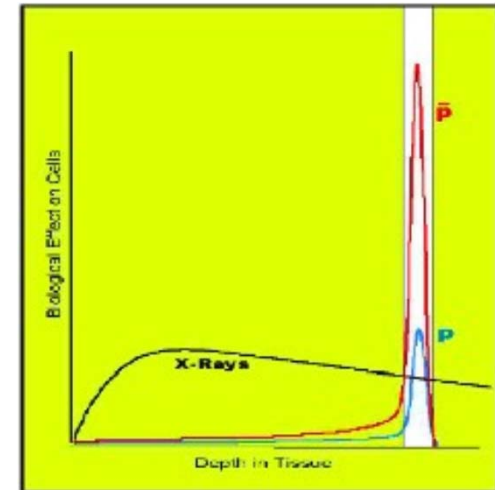
## Teachers:

- 60 t. in two annual workshops (5 days)
  - big motivation for activities
  - very effective training for teachers in modern physics



# Research Projects

- research projects for 3 -10 months
- often part of final school examinations
- work on own measurements, possible continuation at project week
- tutors: PhD students/ physicists at universities and teachers
- Several awards:
  - „Jugend forscht“
  - Dr. Hans Riegel-Fachpreis
  - Von Ardenne Physikpreis



# Material development

- Supporting material for facilitators and teachers
- Particle Profiles
- Background information and worksheets
- Freely available as
  - Printed versions
  - Download as pdf

[www.teilchenwelt.de/material](http://www.teilchenwelt.de/material)



**ANWENDUNGEN DER TEILCHENPHYSIK  
MEDIZIN**

**Positronen-Emissions-Tomographie (PET)**  
Die PET ist eine Diagnosemethode, mit der sich unter anderem Tumore sichtbar machen lassen. Hierbei wird dem Patienten eine Flüssigkeit gespritzt, die Positronen ausstrahlt (ein Beta-Plus-Strahler). Dabei handelt es sich meist um eine spezielle Zuckersubstanz, in der Fluor-Atome durch das radioaktive Isotop  $^{18}\text{F}$  ersetzt wurden (Fluor-Desoxyglucose). Da Tumorzellen mehr Zucker verbrauchen als gesunde Zellen, sammelt er sich insbesondere in Tumorgewebe.

**Tumortherapie mit Hadronen**  
Heute werden hauptsächlich drei Methoden verwendet, um Krebs zu behandeln: Operation, Chemotherapie und Strahlentherapie. Bei der hadronischen Strahlentherapie werden Tumore mit hochenergetischen Protonen oder Ionen bestrahlt. Diese ionisieren auf ihrem Weg durch den Körper Moleküle in den Zellen, was wiederum chemische Reaktionen auslöst, welche die Zellen abtöten oder sie an der Teilung hindern. Obwohl die Strahlung möglichst stark auf den Tumor fokussiert wird, schlägt die Behandlung auch gesunde Zellen – insbesondere, wenn der Tumor tief unter der Haut liegt. Eine neuartige Form der Strahlentherapie, die am GSI Helmholtzzentrum für Schwerionenforschung GmbH in Darmstadt entwickelt wurde, verwendet Hadronen (Protonen oder andere Ionen). Hierbei lässt sich gezielt einstellen, wie tief die Teilchen ins Gewebe eindringen sollen, bevor sie das Großteil ihrer Energie abgeben. So kann gesundes Gewebe geschont werden.

**Detektoren** **Signalverarbeitung**

**Beta-Plus-Strahler** **Bildrekonstruktion**

Abb. 1: Positronen-Emissions-Tomographie (PET)

**NETZWERK  
TEILCHENWELT**

**DER ATLAS-DETEKTOR  
ARBEITBLATT 1: ZUSAMMENFASSUNG**

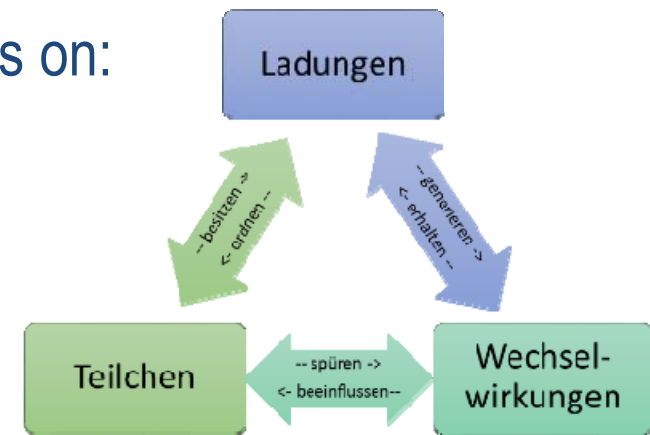
<p><b>1a. Hadronische Spurendetektor</b></p> <p>No Signalname Detektor</p> <p>Physikalische Größe:</p> <p>Beschreibung des Phänomens:</p>	<p><b>1b. Übergangstrahlungsdetektor</b></p> <p>No Signalname Detektor</p> <p>Physikalische Größe:</p> <p>Beschreibung des Phänomens:</p>
<p><b>2a. Stoßionisationskammer Kalorimeter</b></p> <p>No Signalname Detektor</p> <p>Physikalische Größe:</p> <p>Beschreibung des Phänomens:</p>	<p><b>2b. Hadronisches Kalorimeter</b></p> <p>No Signalname Detektor</p> <p>Physikalische Größe:</p> <p>Beschreibung des Phänomens:</p>



# Teaching Material



- particle physics for schools, comprising 300 pages of texts, exercises and work sheets on:
  - Interactions, charges and particles
  - Research methods in HEP
  - Cosmic rays
  - Micro courses
  
- Establishing a standardized terminology
- Finalized few weeks ago, will be printed and distributed to teachers
- Training for teachers planned



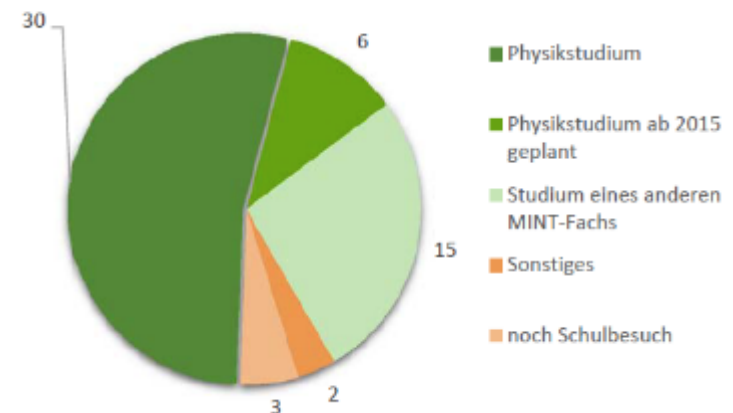


# Student Alumni

- > 100 participants of CERN Workshop
- own activities
- Yearly meeting
- Evaluation in July 2014:
  - Consolidating decision to study physics: *„NTW helped me a lot in deciding to study physics. I learned how exciting physics can be, outside of school.“*
  - 2/3 studying physics



Wie ist Deine derzeitige Ausbildungssituation?



# Training for facilitators

PhD students, Diploma and Master students

- facilitate Masterclasses and Cosmic Projects in schools

2,5 days workshops

- exchange of experience
- training in didactics + science communication

→ improve their soft skills

→ commitment is acknowledged with certificates (and fee)



# Network Community

**Scientists:**  
> 100 (young) scientists

- activities
- experiments
- scientists' perspectives

**Students:**  
4000 involved in activities per year  
330 qualification level or higher

**Staff:**  
6 staff

- management
- coordination
- communication

**Teachers:**  
400 involved in activities per year  
130 qualification level of higher

**Alumni:**  
40 active alumni

- studying physics (and other)
- bring in own activities

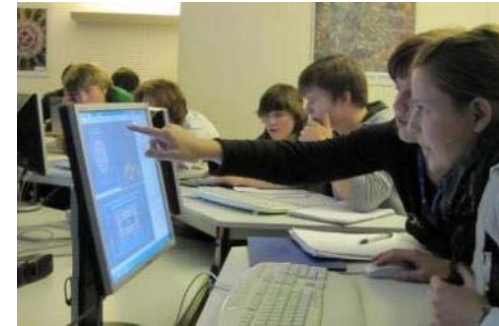
# Benefits for all stakeholders

## Students

- Inspired and fascinated by doing own measurements/research
- Meeting scientists (role model)
- Direct contact to research labs
- Alumni organisation

## Teachers

- Training
- Exchange with colleagues and scientists
- Encouragement to include particle physics in school
- Material for lessons



# Benefits for all stakeholders

## Facilitators

- See the relevance of their work to society
- Soft skills: science communication, didactics
- Training provided (2.5 d workshop)
- Broader view: (particle – astro, theory – experiment)

## Research labs

- Increased public appreciation and visibility
- Contact to future students
- Support (experiments, material, organisation, ...)







More information:  
[www.teilchenwelt.de](http://www.teilchenwelt.de)  
[www.facebook.com/teilchenwelt](https://www.facebook.com/teilchenwelt)

ORIGINALSCHAUPLATZ



SCHIRMHERRSCHAFT



PROJEKTLEITUNG



GEFÖRDERT VOM



Bundesministerium  
für Bildung  
und Forschung

