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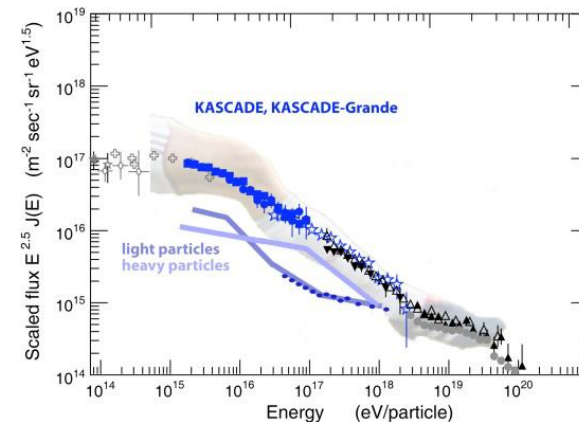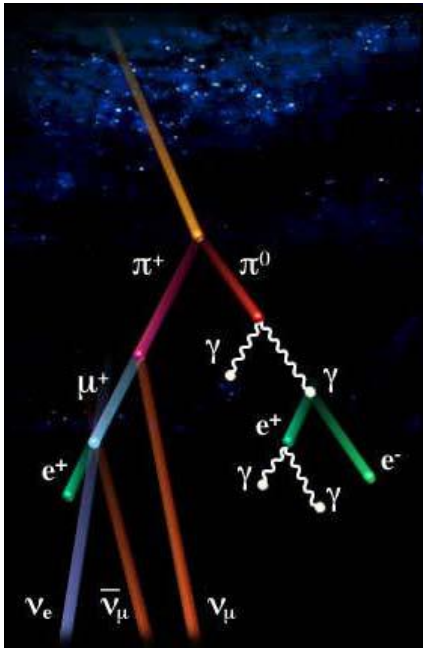
KASCADE

KArlsruhe **S**hower **C**ore and **A**rray **DE**tector

**High energy cosmic ray measurements
by detection of air showers**

physics topics under investigation

− **sources, acceleration mechanisms and
  propagation of cosmic rays**
− **knee structure of the energy spectrum**
− **search for anisotropy in the incident direction**
− **hadronic interactions in the atmosphere**
-- **and more…..**

KCDC in a nutshell

- providing open access to astroparticle physics research data as required by funding agencies
now: $1.6 \cdot 10^8$ EAS events of first data release are available

- ## data provider
    - free, unlimited, open access to KASCADE cosmic ray data
    - selection of fully calibrated quantities
    - reliable data source
    - guaranteed data quality

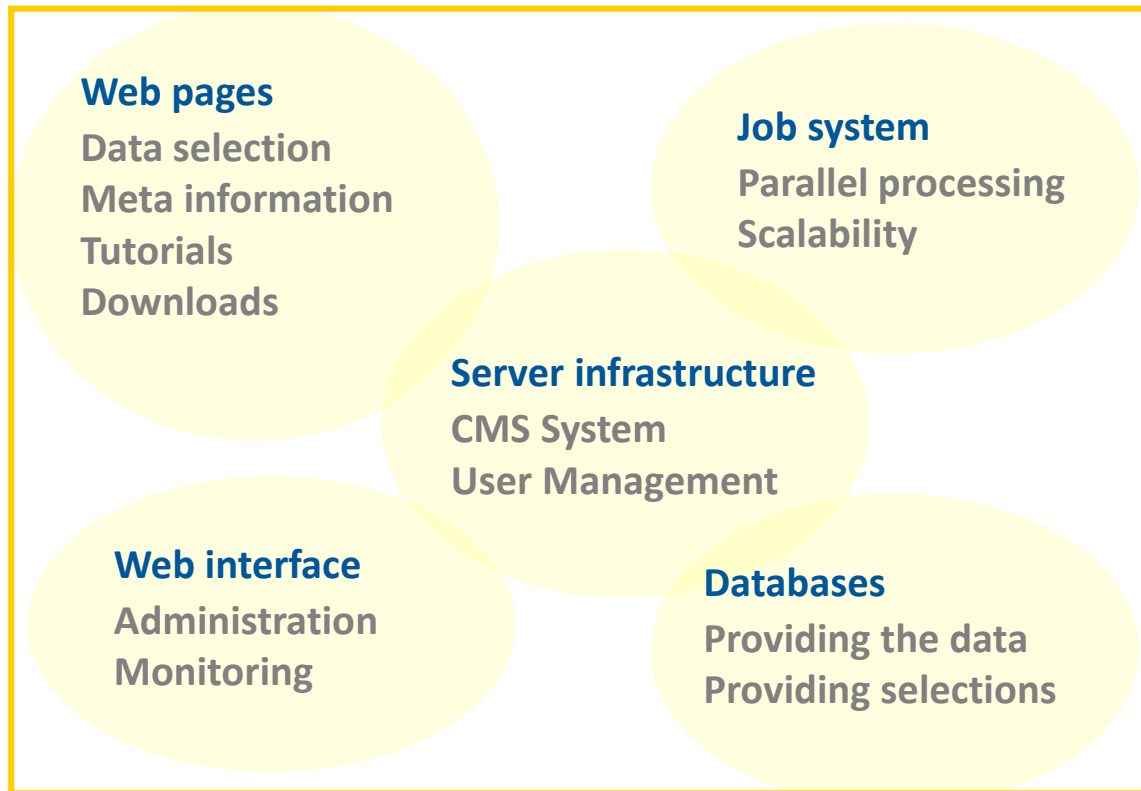- ## information platform
    - experiment description
    - meta information for data analysis
    - physics background
    - tutorials (focused on teachers and pupils)

- ## as long-term digital data archive
    - archive of software and data
    - for the collaboration
    - for the public

The Web Portal

- **open data publication**
  - **follows the "Berlin Declaration on Open Data and Open Access"**
  - **explicitly requests the use of web technologies**

- **free unlimited access for everyone**
  - **scientific and non-scientific audience in focus, requires extensive documentation**

- **modern technologies**
  - **internet access & interactive data selections**

Web pages
Data selection
Meta information
Tutorials
Downloads

Job system
Parallel processing
Scalability

Server infrastructure
CMS System
User Management

Web interface
Administration
Monitoring

Databases
Providing the data
Providing selections

KCDC impressions

KCDC impressions

KCDC impressions

KCDC impressions

KCDC impressions

Output:

zip-archive with data, metadata, and the EULA (end user licence agreement)

Data as ASCII file

Commented header give information about the content

In future:
options for different formats of the output: ASCII, ROOT and HDF5 files

Law and Order

open data publication

no ready available open data licence
free access to data and web portal
good scientific practice for work with data
citation of collaboration, KIT, and the web portal mandatory
free redistribution of data "as is"

KCDC approach

licence based on EULA model (as usually for software)
licence details: following the industry
flexible and adaptable to our needs
signed during registration & shipped with each data package

[*haungs*] | HOME | KIT | IKP | IMPRESSUM | ADMIN | LOGOUT

KIT
Karlsruhe Institute of Technology

KASCADE Cosmic Ray Data Centre (KCDC) / *Open β*

KCDC

KCDC Homepage

KCDC Motivation

Regulations

Information

Announcements

FAQs

DATA Shop

Regulations - Legal Aspects of KCDC

End User Licence Agreement for using the KCDC webportal and the KCDC data (EULA)

This EULA provides the rights and duties of the usage of the KASCADE Cosmic Ray Data Centre (KCDC) webportal (hereinafter called WEBPORTAL) as well as the corresponding scientific KCDC data (hereinafter called DATA).
The Karlsruhe Institute of Technology (KIT) is the owner of the WEBPORTAL which contains DATA, as well as printable materials about KCDC and online or electronic documentation about KCDC (hereinafter called DOCUMENTS), and related modules (hereinafter called SERVICES) of KCDC.

Please read this EULA carefully. By using the WEBPORTAL or by using any SERVICES or by downloading DATA, You (You, as the licencee, are hereinafter called YOU) agree that this EULA is enforceable like any written contract signed by YOU. If YOU do not agree to all of the terms of this EULA, click on the button that indicates that YOU do not agree to accept the terms of this EULA (if applicable) and do not continue the use of the WEBPORTAL, the provided DATA or the

KCDC, the software

providing a modern software solution
for publishing KASCADE data for a general audience

In a second step: release the software as Open Source for free use

- **Publication foreseen under Open Source License**

- **Following the concept of open access to research data**

- **Simple configuration via web interface**

- **Based solely on Open Source Software**
  (Python, Django, HTML/Javascript and CSSdata provider)

Frontend	Portal	Admin	Monitor
Server	Web Framework *DJANGO*		FTP
Communication	Messaging *RabbitMQ*		
Data Processing	Task Queue *Celery*		
Storage	DATA		
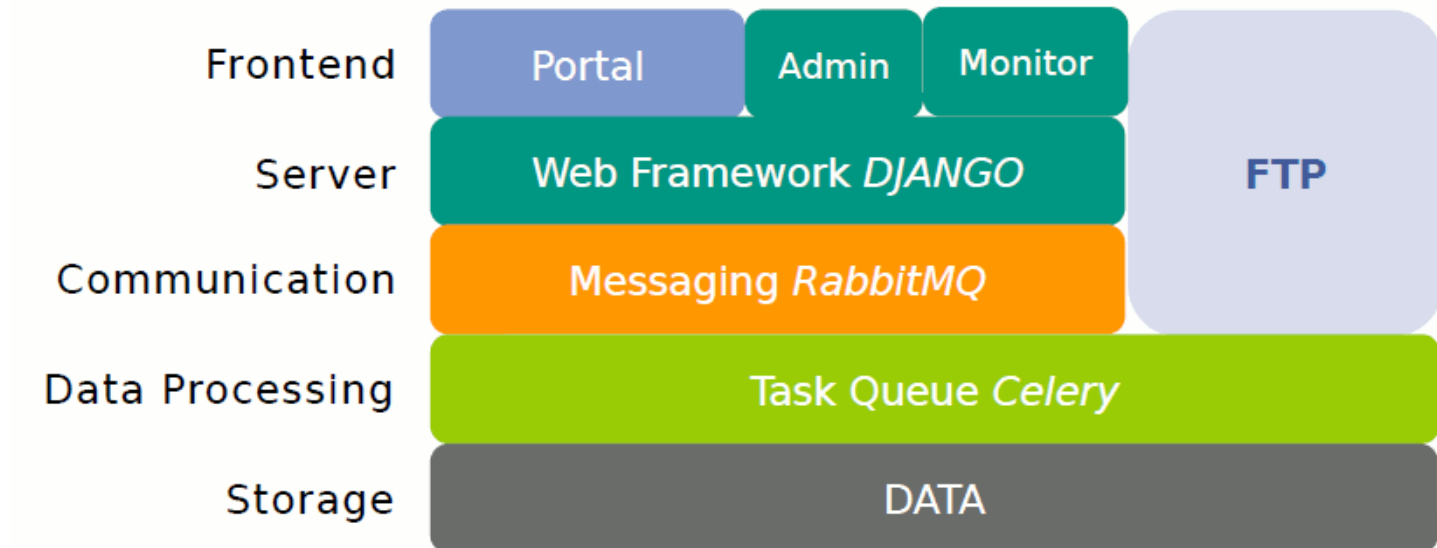
Tutorials and Teaching

- **The goal: Providing the data to a general public**

- **Education portal (in development)**

  - **first tutorial is up**
    (only in German at the moment)

  - **knowledge database on KASCADE,**
    astrophysics and related topics

  - **step by step tutorials of**
    simple data analyses

  - **including a modern programming**
    language code example

  - **interpretation and discussion**
    of the outcome

  - **cooperation with local**
    teachers and pupils

  - **later offering to teachers dedicated**
    lessons for high schools

- **introduction**
- **physics background**
- **step-by-step analysis**
- **source code example**
- **discussion**
- **interpretation**
- **pdf download of all**

Physics with KCDC

$1.6 \cdot 10^8$ KASCADE EAS events of first data release are available

This is the data set for analysis works like

- ➢ **Astroparticle Physics 19 (2003) 703-714**

    Measurement of Attenuation and Absorption Lengths with the KASCADE Experiment

- ➢ **The Astrophysical Journal 608 (2004) 865-871**

    Search for Cosmic-Ray Point Sources with KASCADE

- ➢ **Astroparticle Physics 24 (2005) 1-25**

    KASCADE Measurements of energy spectra for elemental groups of cosmic rays: Results and open problems

- ➢ **etc…..**
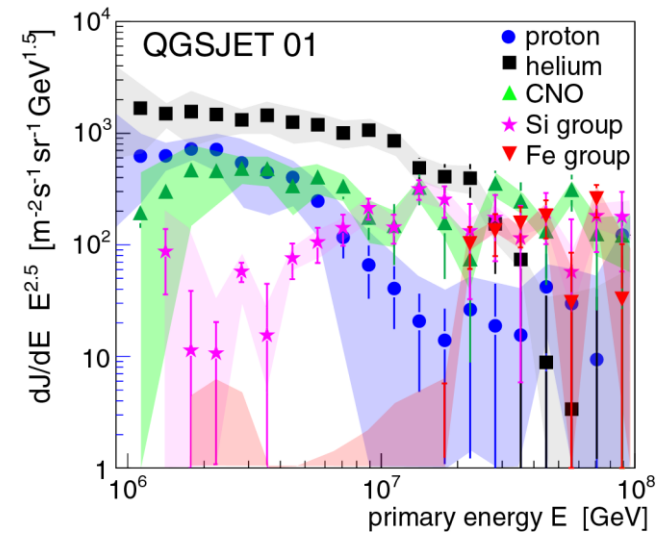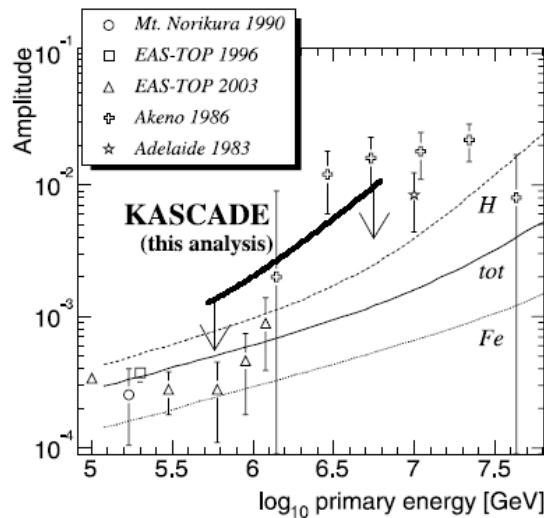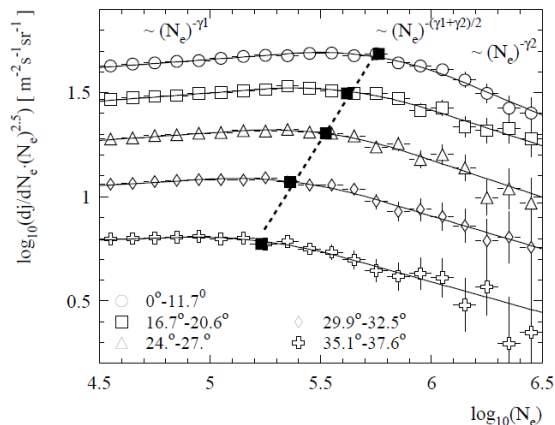
Future

The KASCADE Cosmic ray Data Center

- since November 2013
- KCDC open beta release to public
- More than 160 million events of the KASCADE experiment with 15 parameters per event

- Next steps
- Extending the educational portal
- Improving data selection process
- Adding more data of KASCADE

- future
- Adding data of other experiments
- Publication of the software
- Inclusion in long-term data archive networks
  e.g. Re3data, repository for scientific data http://www.re3data.org/

KASCADE(-Grande): Mission Accomplished !!

1996

2013

open access to research data
https://kcdc.ikp.kit.edu

2014

https://kcdc.ikp.kit.edu

Thanks the support of the KASCADE Collaboration
Thank you!

Exercise with KCDC

Determination of the Attenuation Length of the Electron Component in extensive air-showers

Attenuation Length Λ_e : describes the average decrease of the electron number N_e with increasing atmospheric depth X (at fixed primary energy)

$$\langle N_e(X) \rangle \propto \exp\left(-X/\Lambda_{N_e}\right)$$

Why of interest?
➜ *Understanding of shower development*
➜ *Test of hadronic interaction models*
➜ *Composition measurements*

You need:
➜ *KASCADE EAS-data from KCDC*
➜ *Read/Analysis/fitting/plotting tools*
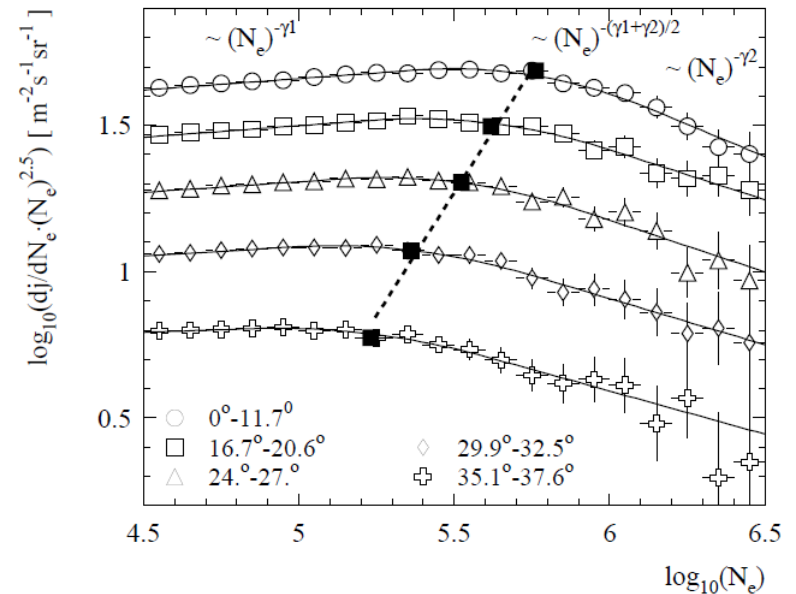
Exercise with KCDC

Determination of the Attenuation Length of the Electron Component in extensive air-showers (2)

Steps to do:

- **Differential shower size spectra for different zenith angular ranges**
    by KASCADE-data from KCDC

- **Select a fixed primary energy**
    by taking a structure of the primary energy spectrum: the knee

- **Plot dependence of shower size with zenith angle**
    using

$$\langle N_e(\Theta) \rangle \propto \exp\left(-\frac{X_0}{\Lambda_{N_e}}(\sec\Theta - 1)\right).$$

Based on: Astroparticle Physics 19 (2003) 703-714

Measurement of Attenuation and Absorption Lengths with the KASCADE Experiment

Exercise with KCDC

Determination of the Attenuation Length of the Electron Component in extensive air-showers (3)

Details:

- **KCDC:**
  get data: N_e and Θ and micro time for all events with cuts
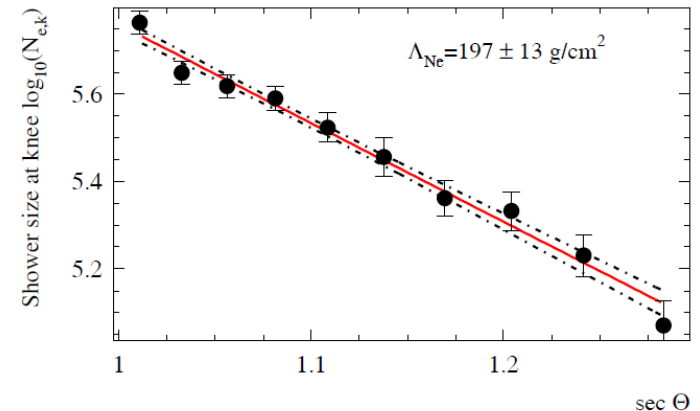 - Ne>4.5, E and Nmu-cut, area<90m radius, zenith<40degree

  https://kcdc.ikp.kit.edu

- **Create spectra:**
  - spectra for angular ranges of same solid angle
    e.g.: 5 ranges: -16.7; -24; -29.9; -35.1
  - estimate normalization factors:
    area, steradian, time
    (The entire sphere has a solid angle of 4πsr)
    (total time via the time difference between two events
  - multiply by 2.7 in Ne (don't forget to divide by bin size)

$$\log_{10}(dj/dN_e \cdot (N_e)^{2.5})\ [\ m^{-2}s^{-1}sr^{-1}\ ]$$

- **Estimate knee positions (take care: threshold…)**
  - either by fitting the spectra
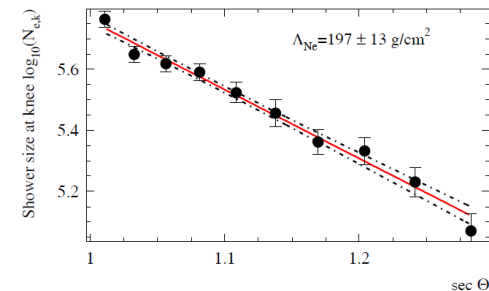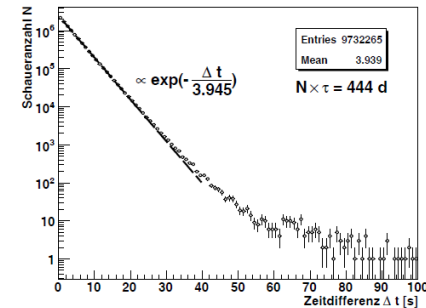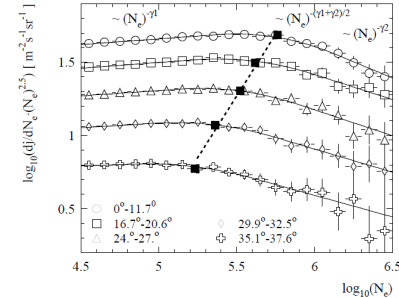   (Ne instead of E)
  - or by hand….

$$I(E) = I_0 \cdot \left(\frac{E}{E_{\text{knee}}}\right)^{-\gamma_1} \cdot \left(1 + \left(\frac{E}{E_{\text{knee}}}\right)^{\varepsilon}\right)^{\frac{\gamma_1 - \gamma_2}{\varepsilon}}$$

- **Plot shower size at knee vs. Sec zenith angle**
  - fit it and determine the attenuation length
  - ….be happy!

$$\langle N_e(\Theta)\rangle \propto \exp\left(-\frac{X_0}{\Lambda_{N_e}}(\sec\Theta - 1)\right).$$

Based on: Astroparticle Physics 19 (2003) 703-714

Measurement of Attenuation and Absorption Lengths with the KASCADE Experiment

Exercise with KCDC

Determination of the Attenuation Length of the Electron Component in extensive air-showers (4)

Room for Improvement:

- **At the spectra**

    more zenith angular ranges
    fit the spectra
    interpolate knee position

- **Attenuation curve**

    apply constant intensity cut top select same energy
        (same intensity = same energy) you need integral spectra

- **Determine attenuation length for different primaries**

    select „light" and „heavy" EAS (via muon/electron ratio)

....

Based on: Astroparticle Physics 19 (2003) 703-714
Measurement of Attenuation and Absorption Lengths with the KASCADE Experiment