Online Masterclass built on the KASCADE Cosmic ray Data Centre

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Educational Goals

- Understand the physics of cosmic rays
- Learn about the air shower experiment KASCADE-Grande[1] and the data portal KCDC[2]
- Comprehend the reconstruction of primary particle properties using simulations
- Be aware of the principles of open data
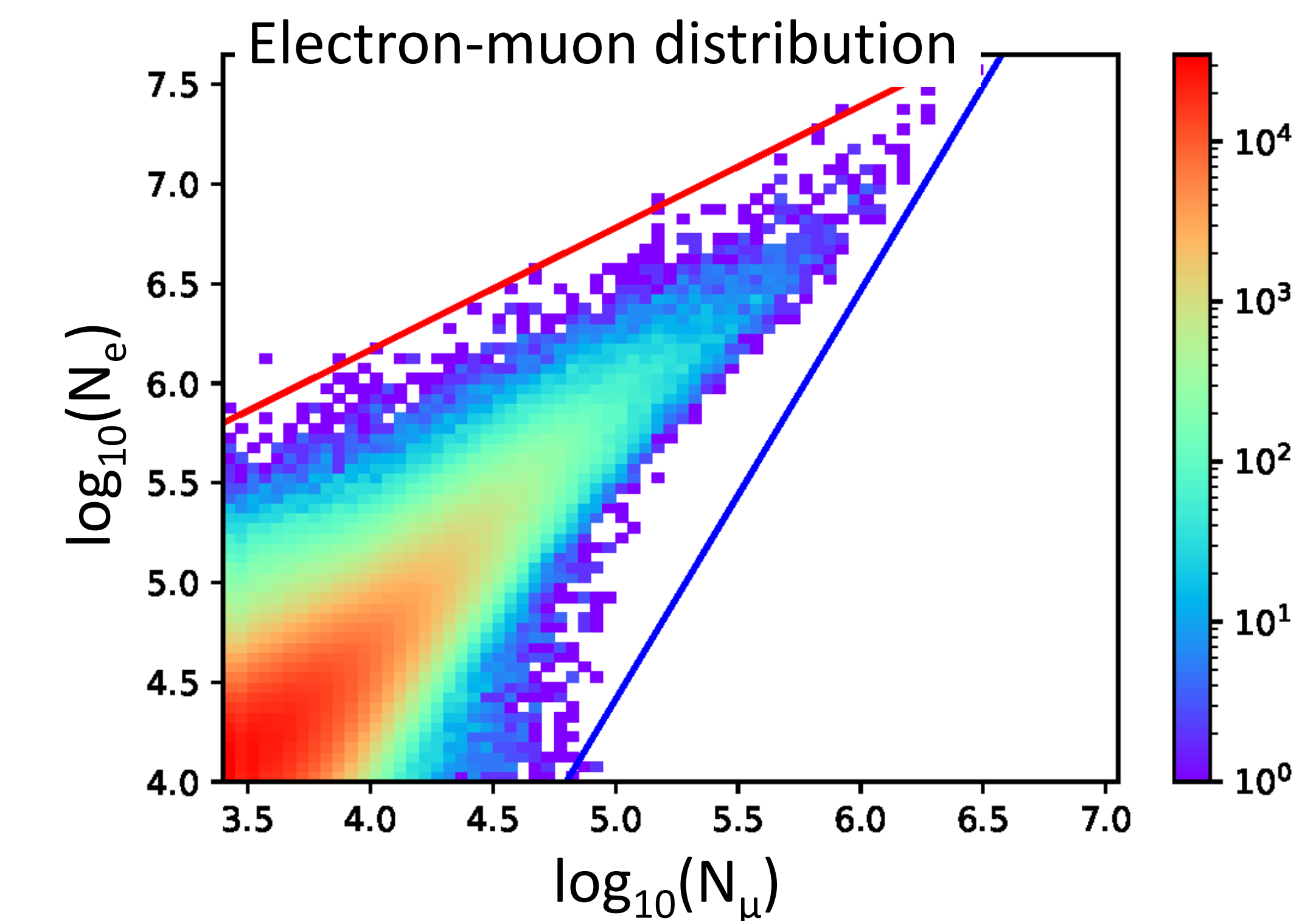- Discover how scientist analyze large amount of data

Technical Requirements

- Identical workspace for all participants
- Easy and fast installation and setup of the working environment
- Fast processing of large amount of data
- Use well-known data format
- Interactivity
- Minimal programming knowledge required

Implementation

- Jupyter Notebooks with Python3 kernel in JupyterHub environment
- Popular libraries pandas and matplotlib
- Well-known data format as .txt and .cvs
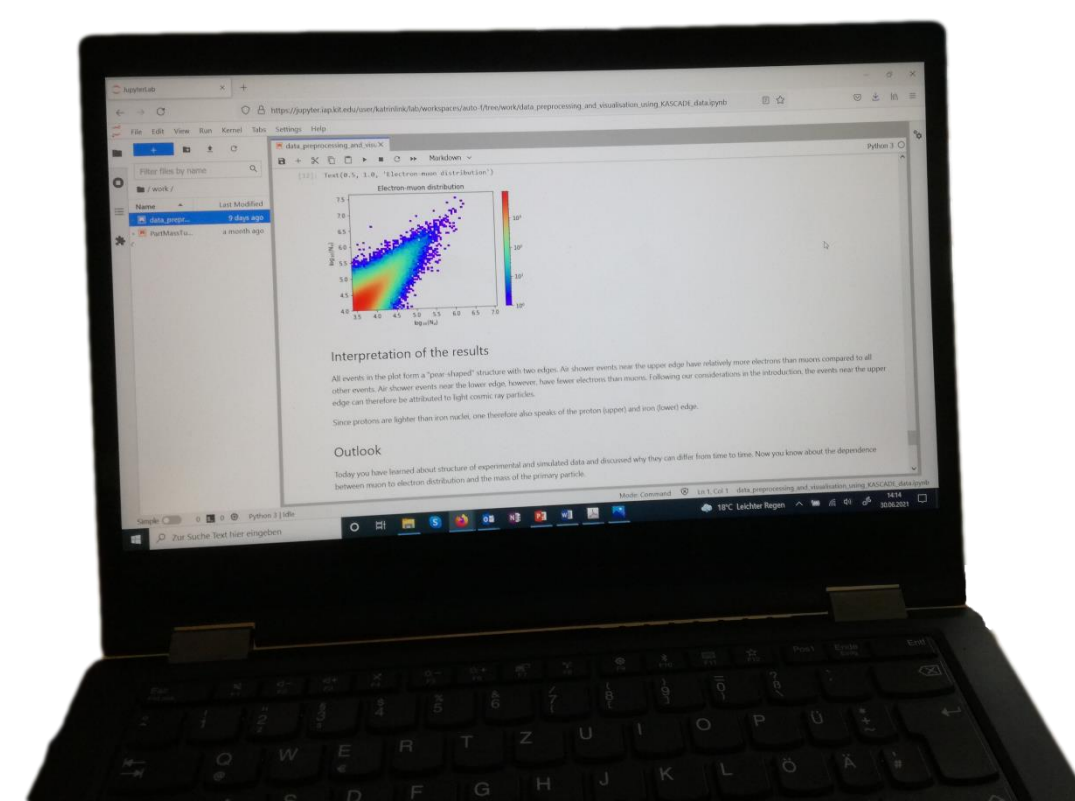
Data analysis tutorials

Two different tutorials for different levels of prior experience were developed. By completing exercises in the tutorials, the students have learned to...

- pre-process and plot large amount of data
- interpret the data and draw conclusions
- compare experimental data and simulations
- derive the primary mass from the muon to electron ratio of an air shower

Electron-muon distribution

First event using the KCDC Masterclass

- Embedded in International Cosmic Day[3] and Woche der Teilchenwelt[4]
- Online event for pupils from an Austrian school
- Introductory talks on Astroparticle physics, air shower reconstruction, basics of programming and the KASCADE-Grande experiment
- Data analysis in breakout sessions, each guided by one tutor
- Final discussion on results

→ Positive feedback from the participants

Summary

An online Masterclass was developed in November 2020 using real data from the KASCADE-Grande experiment. This Masterclass allows students to learn about the physics of Cosmic Rays and they learn how scientists handle a large amount of data.

In the workshop we used the KCDC to access open data of KASCADE experiment as well as JupyterNotebooks with python3 kernels for data analysis. For simultaneous handling of multiple JupyterNotebooks we used JupyterHub

The Masterclass tutorials and the Jupyter environment will be available from the KCDC web portal https://kcdc.iap.kit.edu.

1 Apel, et al. The KASCADE-Grande experiment. NIM A 620(2-3):202–216, 2010
2 Haungs, et al. Status and future prospects of the KASCADE Cosmic-ray Data Centre KCDC PoS (ICRC2021) 422
3 icd.desy.de
4 www.teilchenwelt.de