Karlsruhe Institute of Technology

New PhD student

Nice to meet you all!

Max Büsken, Supervisors: Ralph Engel, Tim Huege
HIRSAP Workshop 2020

PhD with Auger/Cosmic Rays

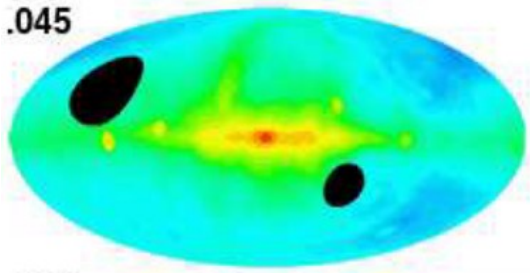
- Radio Upgrade of the Pierre Auger Observatory

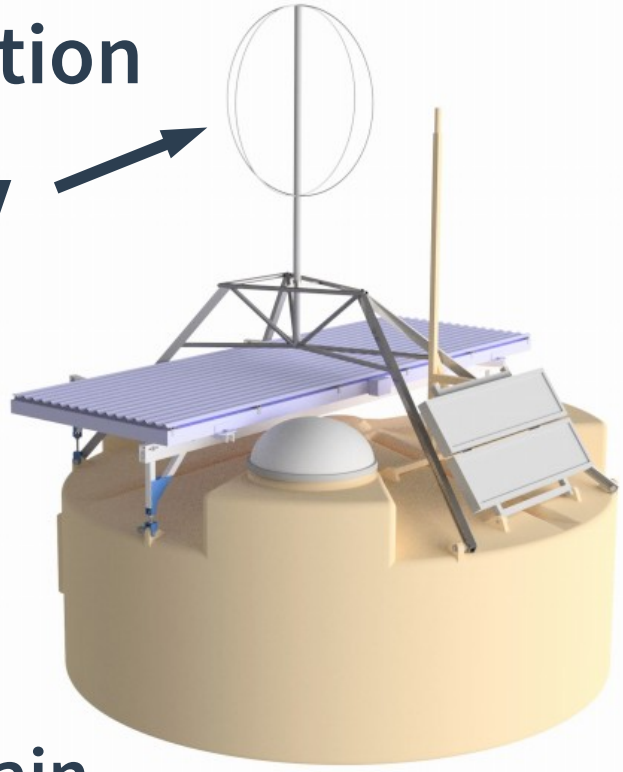
1) Absolute calibration of the new antennas
2) New electric field mills for thundercloud monitoring
3) Muon number measurements with RD + particle detectors

- Exciting topics of physics ahead
- Plus: Joining the HIRSAP community

Absolute Calibration of the Antennas

- New radio antennas on each SD station
- Calibrate them relatively and **absolutely**
  → **absolute:** Use Galactic radio emission (strongest background)

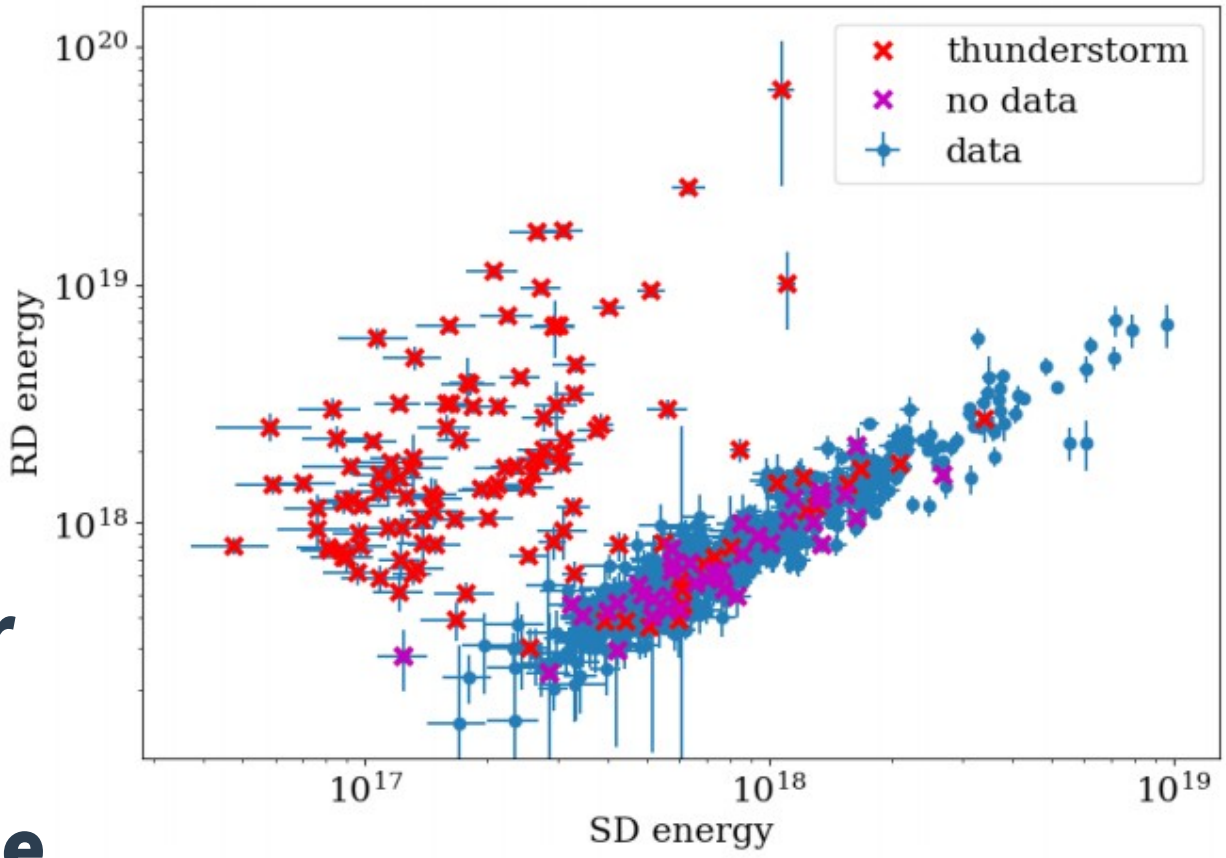




- Propagate sky models through signal chain
- Compare with measured noise traces → cal. constants $C(\nu)$

Electric Field Monitoring

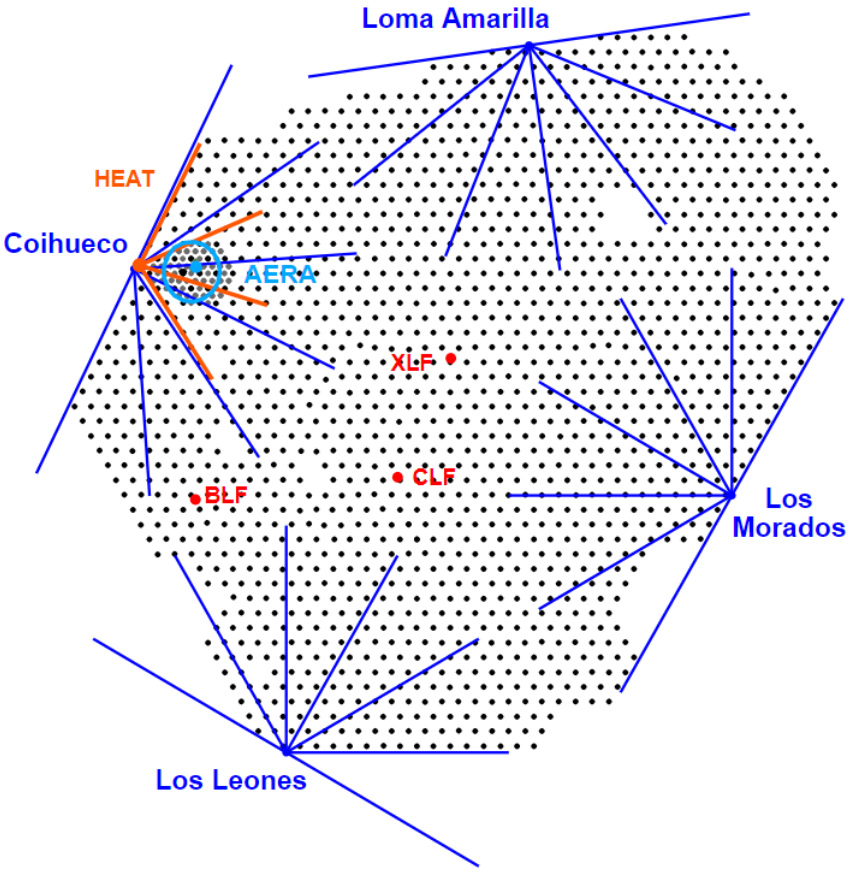
- Thundercloud conditions have significant influence on radio signals



→ Need to monitor to see, if radio signals are reliable

Electric Field Mills

- Two stations in the AERA array with **E-field mills**
- Qualitative thunderstorm flagging → can do more?

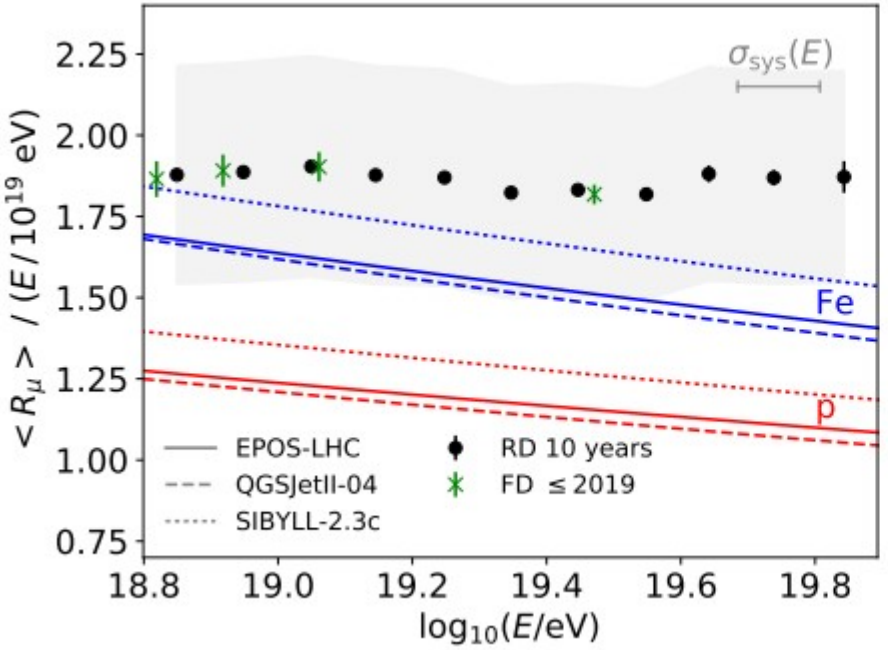


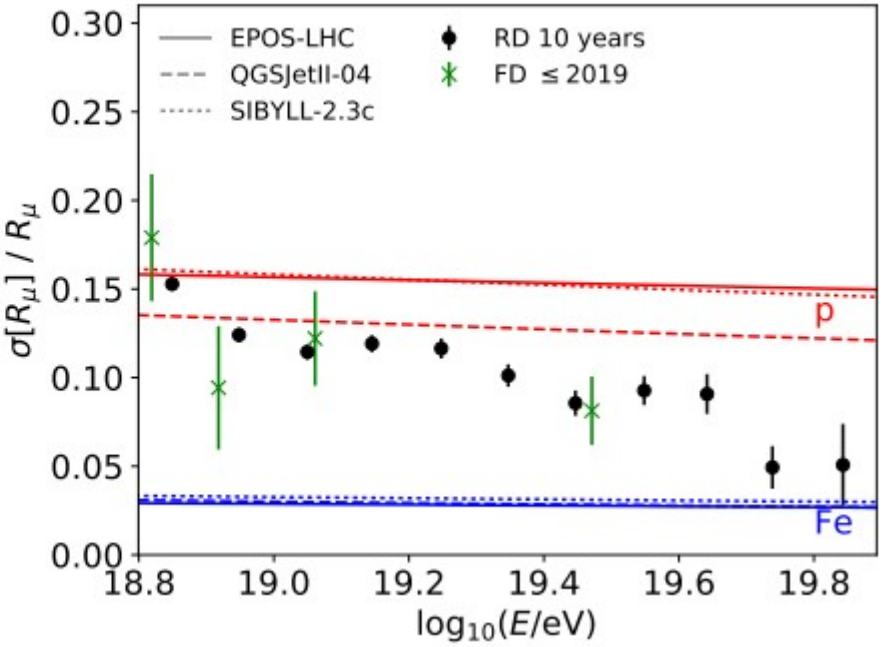
- Plan: set up 5 new stations
- 4 at the FD sites
- 1 central station

} Study best setup

Later: Muon number measurements

- Observe highly inclined air showers with new RD
- Determine muon number and spread from combined WCD + RD measurements

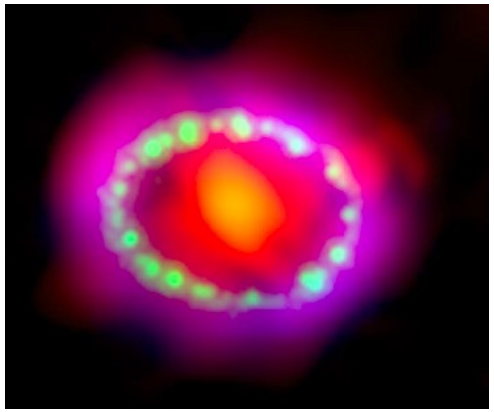




Thanks!

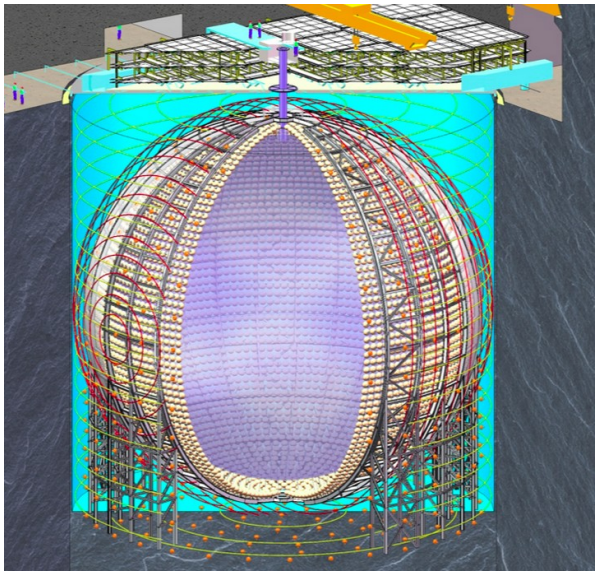
Before my PhD at KIT

- Neutrino group at RWTH Aachen
- JUNO experiment
- Supernova neutrino studies



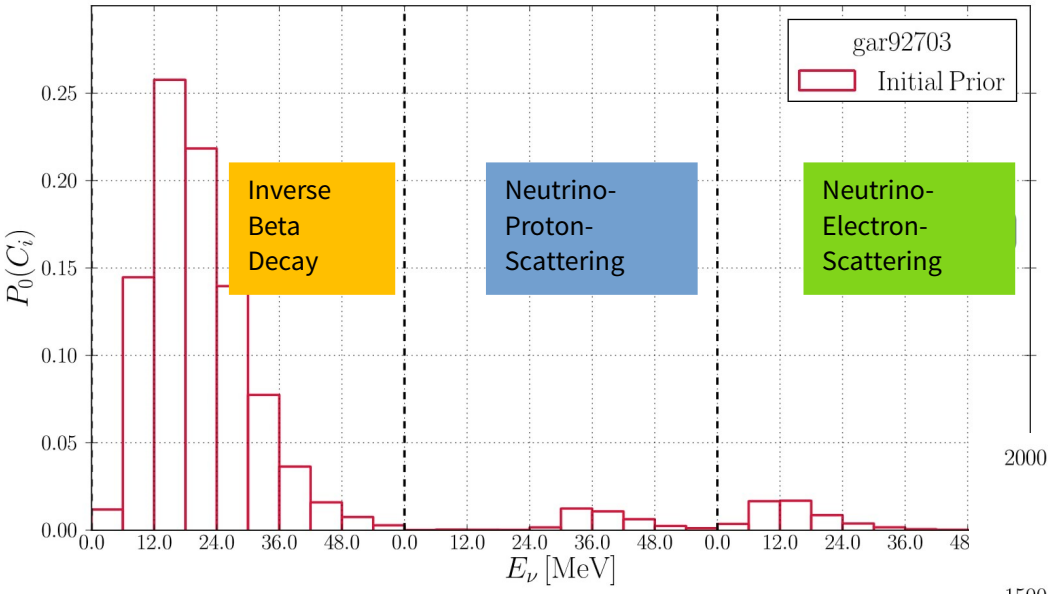
ν_e, ν_μ, ν_τ

+ antiparticles



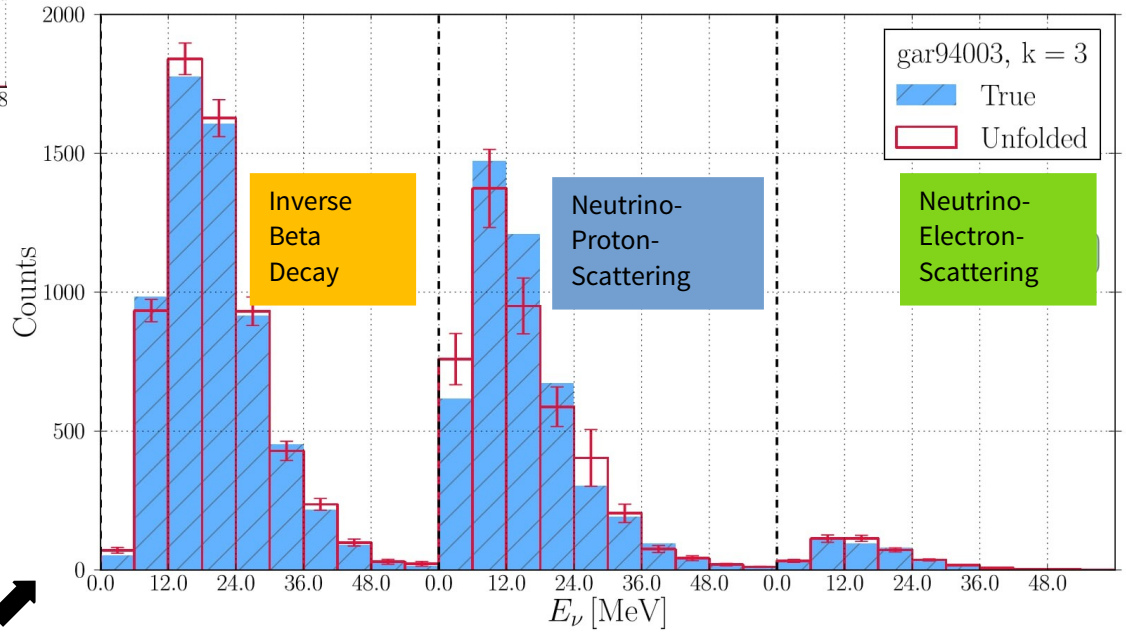
20 kt Liquid Scintillator

Master thesis: Spectrum Unfolding



Iterative Bayesian Unfolding

Measured energy spectrum per interaction channel

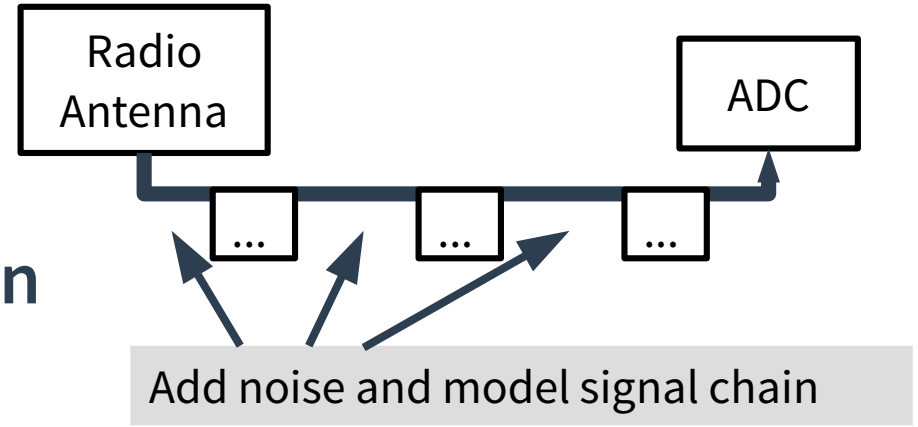


Unfolded spectrum vs. MC truth

Absolute Calibration of the Antennas

- **Process galactic emission through antenna signal chain**
- **Add noise contributions at given steps and propagate as well**
  - Antenna model itself
  - Low-noise amplifier
  - (Coaxial cable)
  - Receiver Unit: bandpass filter + ADC noise

⇒ Simulation of expected background + noise



Absolute Calibration of the Antennas

- **Result: Modeled background signal**

$$P_{\mathrm{sim}}\left(t_{\mathrm{LST}}, \nu\right) = P_{sim}\left(t_{\mathrm{LST}}, \nu; N_{\mathrm{LNA}}, N_{\mathrm{RCU}}, N_{\mathrm{ADC}}, S\right)$$

- **Compare to measured noise traces**

$$P_{\mathrm{meas}}\left(t_{\mathrm{LST}}, \nu\right)$$

- **Minimize difference to solve for noise contributions**
- **Calculate calibration constants** $C\left(\nu\right)$