

## 2018 Helmholtz – OCPC – Program for the involvement of postdocs in bilateral collaboration projects

### PART A

**Title of the project:** Radio and Particle Detection of Cosmic Rays of Highest Energies

**Helmholtz Centre and institute:** Karlsruhe Institute of Technology, Institute for Nuclear Physics (IKP)

**Project leader:** Dr. Frank Schröder, Dr. Andreas Haungs

**Web-address:** <http://www.ikp.kit.edu/english/index.php> <https://www.auger.org/>

**Description of the project (max. 1 page):**

Radio detection is a new and promising technique for cosmic-ray air showers initiated by cosmic particles of highest energies. These particles have energies up to several  $10^{20}$  eV, which is orders of magnitude beyond the reach of human-made accelerator, such as LHC at CERN. In combination with the measurement of muons, radio antennas can boost the accuracy for the energy and mass of the primary cosmic particles. This increased measurement accuracy will help to understand the still unknown origin of the primary cosmic ray particles.

The Pierre Auger Observatory in Argentina is the world-leading and largest experiment for cosmic rays of highest energies. Its main detector is a 3000 km<sup>2</sup> large array of 1660 water-Cherenkov detectors for air-shower particles. These detectors can be enhanced by radio antennas to increase the total measurement accuracy for air showers of less than 30° elevation. This enables to study the recently discovered anisotropy of cosmic rays at highest energy [*Science* 357 (2017) 1266 – *Top 10 physics breakthrough of the year 2017*] in more detail, e.g., by separating the anisotropy in cosmic-ray components of light and heavy mass.

The project is about the development and setup of radio antennas on a large scale at the Pierre Auger Observatory, and the subsequent data analysis. While an engineering radio array already consists, there are ideas to equip each individual water-Cherenkov detector with a radio antenna in the next years. The necessary hardware development, simulation studies and analyses will be done together with colleagues at KIT as well as with international collaborators of the Pierre Auger Collaboration.

Finally, the successful installation of a large-scale radio extension of the Pierre Auger Observatory will also be a pathfinder for next-generation projects, especially the Giant Radio Array for Neutrino Detection (GRAND) to be deployed and operated in China in the next decades. GRAND will be a huge antenna array based on the radio detection of inclined showers. Build up step-by-step, around 2025 GRAND will exceed the size of the Pierre Auger Observatory and become the leading experiment for cosmic particles of highest energies.

**Description of existing or sought Chinese collaboration partner institute (max. half page):**

There is an existing cooperation between KIT and Shanghai Jiao Tong University (SJTU) in the fields of particle and astroparticle physics, which can be fostered by this project. Nevertheless, applicants from other institutions are welcome, too. Moreover, a few members of KIT are co-authors of the GRAND White Paper currently being finalized, which among others is also co-authored by Chinese scientists from institutions in Beijing, Urumqi, and Shanghai. The first prototype of GRAND will start operation in China this year, and later phases of GRAND will start 2020. Thus, the proposed project using the radio technique at the Pierre Auger Observatory in the same way as planned for GRAND can be the basis for a long-term strategic partnership in astroparticle physics.

**Required qualification of the post-doc:**

- PhD in Astroparticle Physics, Astrophysics, Particle Physics or related fields
- Experience with Radio or Particle Detectors and / or with Data Analysis;  
Ideally experienced with collaborative work in international groups
- Additional skills in Software Programming (C++, Python, Linux, ROOT)

**PART B**

**Documents to be provided by the post-doc, necessary for an application to OCPC via a postdoc-station in China, which is affiliated to a research institution like a university:**

- Detailed description of the interest in joining the project (motivation letter)
- Curriculum vitae, copies of degrees
- List of publications
- 2 letters of recommendation
- Proof of command of English language

**PART C**

**Additional requirements to be fulfilled by the post-doc:**

- Max. age of 35 years
- PhD degree not older than 5 years
- Very good command of the English language
- Strong ability to work independently and in a team