The topic of scientific work

1. Analysis of satellite data concerning the concentration of aerosols in the area of the Pierre Auger Observatory.

In the Pierre Auger Observatory we investigate on extensive air showers: cascades of secondary particles induced by cosmic rays of the highest energies known: 10^20 eV. This is many millions more than the energies achievable in the man-made accelerators. The nature of these extremely energetic particles is unknown – help us to solve the puzzle waiting for an answer since more than 50 years. Your work will help to understand the impact of aerosols present in the Earth atmosphere on the interpretation of the extensive air shower data.

2. Influence of the inhomogeneities in the aerosol concentration over the Pierre Auger Observatory on reconstruction of extensive air showers as a way to explore exotic physics effects.

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3.Probing New Physics trough (non)observation of extensive air showers induced by large cascades of photons.

In the Pierre Auger Observatory we investigate on extensive air showers: cascades of secondary particles induced by cosmic rays of the highest energies known: 10^20 eV. This is many millions more than the energies achievable in the man-made accelerators. Extensive air showers could be initiated also by ensembles of particles: cascades of photons and electrons originated above the atmosphere, possibly due to non-standard electromagnetic processes. Identification of such cascades might be possible with the analysis of non-standard air shower properties. Look beyond the paradigm and visit the scientific terra incognita.

4. Influence of the geomagnetic field on the properties of extensive air showers initiated by super-preshowers.

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5. Simulation of electromagnetic cascading of 10^20 eV photons during their propagation through the Solar System.
In the Pierre Auger Observatory we investigate on extensive air showers: cascades of secondary particles induced by cosmic rays of the highest energies known: 10^20 eV. This is many millions more than the energies achievable in the man-made accelerators. Extensive air showers could be initiated also by ensembles of particles: cascades of photons and electrons originated above the atmosphere, possibly due to the interactions occurring in the not-so-well known regions of the Solar System. If it turns out that such cascades emerge frequently, we would need a fundamental revision of our knowledge about ultra-high energy cosmic rays. You might contribute to such a breakthrough.

6. Numerical analysis of QED equations describing the photon splitting effect in the regime of ultra-high energies.
In the Pierre Auger Observatory we investigate on extensive air showers: cascades of secondary particles induced by cosmic rays of the highest energies known: 10^20 eV. This is many millions more than the energies achievable in the man-made accelerators. Extensive air showers could be initiated also by ensembles of particles: cascades of photons and electrons originated above the atmosphere, possibly due to the splitting of a primary photon of extremely high energy into the secondary photons. The photon splitting effect, although allowed by the standard theories, has not yet been observed in experiments. It seems that it would be possible indirectly in our Observatory. To understand correctly the observations we need precise modelling of the electromagnetic processes at the highest energies, with different theoretical assumptions. It turns out, that numerical processing of the existing equations is highly non-trivial. We need your help.

7. Design and construction of an economical detector of extensive air showers.
Some exotic physical processes might result in emerging of correlated in time but highly spatially spread air showers. Observation of such phenomena might be possible only with a unique infrastructure: a worldwide network of small and economic detectors with well synchronized clocks. The project has just started, you might be one of the pioneers.

8. Design and construction of a distributed and diversified network of economical cosmic-ray detectors.
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9. A study of an air shower detection efficiency in a distributed and diversified network of economical cosmic-ray detectors.
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10. Search for cosmic-ray events clustered in time as a potential signature of New Physics.
Some exotic physical processes might result in emerging of correlated in time but highly spatially spread air showers. Observation of such phenomena might be possible in the Pierre Auger Observatory, the largest cosmic-ray detector in operation. Help us checking this.

11. A study on characteristics of extensive air showers initiated by magnetic monopoles.
Magnetic monopoles are yet not observed but possibly existing particles. Will CREDO help in detecting them?

12. Design and construction of a prototype of an internet system for an exchange of information in a large scientific collaboration.
The long-awaited breakthrough in science might happen within an exceptionally large collaboration, composed of even a million of contributors. An optimum efficiency of such a collaboration will require a complex, multi-function communication system. Something like Facebook but for professionals. Many of them. Work with us in this direction.

13. Search for the New Physics signatures in the data of the experiments recording Cherenkov radiation induced by particles of extremely high energies.
Cherenkov radiation is induced by charged particles moving in a medium at the speed larger than the speed of light in this medium. Cherenkov photons are the signal for gamma astronomers and a background for the cosmic-ray detectors. It is expected that some exotic particle, for instance magnetic monopoles, might induce an emission of Cherenkov light of a non-standard intensity and angular distribution. Such „strange" events are most often rejected in the standard analysis where only the data of a superior quality are taken into account. Help us to find „strange" events in the data taken by the Pierre Auger Observatory as well as in those collected by H.E.S.S. and MAGIC gamma ray telescopes. Let us check together whether they are the New Physics manifestations or not.

Topics of student practice:

1. Testing the efficiency of the particle counters used in the Pierre Auger Observatory
2. Construction of an economic muon counter prototype
3. Design and coding of an internet platform to communicate and exchange information within a large, international scientific collaboration
4. [NEW] Bayesian Analysis of Cosmic Rays data for Earthquake Predictions [Read more]

Mini-jobs

1. Scientific description of the lab exercise „muon life time"
2. Construction of an economic muon counter prototype

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