FCPPL-CSC PhD proposal - 2015

Thesis title: Prototype study for a Giant Radio Array for Neutrino Detection

Type of proposed PhD diploma: French x Chinese □ French & Chinese □ (tick correct answer)

French host laboratory: ***LPNHE IN2P3-UPMC Paris***

Chinese laboratory (if applicable): NAOC Beijing

Thesis advisor(s) and email(s): Olivier Martineau omartino@in2p3.fr, Wu XiangPing wxp@bao.ac.cn

Planned date of start of stay in French lab: September 2015

Planned duration of stay in French lab (months): 3 years

Expected date of thesis defense: September 2018

Detailed description of the thesis subject:

Cosmic neutrinos are very precious messengers of violent phenomena in the Universe. Neutral and interacting through weak interactions only, these particles propagate without interaction nor deflexion on cosmological distances.

If their tiny cross sections make these particles so attractive for the study of the Universe, this property also makes their detection extremely complex. It requests in particular huge detection volumes together with a very strict rejection of background events. The experimental effort carried out since more than 20 years to detect cosmic neutrinos may reach a turning point, with the recent detection of 37 cosmic neutrino candidates by the IceCube collaboration [1]. However, only 2 of those have energies above 250TeV. Much larger detection volumes (typically effective volumes of several hundreds of km^3) would be requested to reach a detection rate of neutrinos above 101(eV large enough to allow for the rise of neutrino astronomy.

Radiodetection of extensive air showers (EAS) may constitute a valid solution to tackle this issue. Cosmic neutrinos could indeed induce air showers for Earth-grazing trajectories. Results obtained these last years by several experiments [2, 3, 4] show that EAS can be detected by radio antennas arrays. Cheap, easily transportable, with a stable response, radio antennas might be the valid technological choice foir a giant telescope.

An international group of particle physicists, radioastronomers, astrohysicists, experimentalists and theoreticians presently think about a project of this type, called GRAND, for *Giant Radio Array for Neutrino Detection*. To validate this hypothesis, the priority is to prove that radio signals generated by EAS can be discriminated from background events with a high confidence level. The TREND collaboration is going to deploy a prototype array in summer 2015 on its experimental site (XinJiang, China) to investigate this issue and provide a quantitative estimation of the background rejection properties of the radio detection technique.

The selected PhD candidate will participate in the deployment and validation of this setup. He will also be involved in the data analysis. This part of the work will request the presence of the PhD candidate for a significant period of time on the experimental site (typically 2 months/year), and will give a strong experimental bias to the PhD work.

The estimation of the sensitivity of a giant radio array to cosmic neutrinos is another important aspect of the proposed PhD subject. This work, based on MC simulations, will be carried out in collaboration with

researchers from the LPC Clermont-Ferrand laboratory, and the Institute of Astrophysics of Paris. This work shall lead to a detailed design proposition for a giant radio telescope dedicated to cosmic neutrino detection, and a precise estimation of the setup capacity to test the existing models for cosmic neutrino production.

The relative weight of these 2 work axis will be discussed with the candidate.

Candidates' requested qualifications:

Solid background in particle physics and astroparticles.

Expertise in computing (Linux) and coding (C++, python)

Publications related to the PhD subject:

- D. Fargion, Astrophys.J.570 (2002) 909-925 arXiv :0002453
- D. Ardouin et al, the TREND collaboration, Astropart.Phys. 34 (2011) 717-731 arXiv:1007.4359