

DESCRIPTION OF A THESIS PROJECT

DOCTORAL SCHOOL “Matter, Molecules, Materials & Geosciences”

Please note that this offer must be written in English for publication on the Euraxess platform (<https://euraxess.ec.europa.eu>).

Once completed, please save the document in a pdf format as following: Name of the Thesis director_Name of the research Unit, prior to submit the proposal on TEBL site.

Title of the thesis: Observation of neutrinos from Supernova with the JUNO experiment
Principal disciplinary field: particle physics Disciplinary field 2: astrophysics
Three keywords: neutrino, supernova, astroparticle
Research unit (specify if the research time is shared between several sites): Nantes Université (SUBATECH) et Université de Bordeaux (LP2I)
Indicate if the thesis will be subjected to a labeling by one of the Graduate Programmes of Nantes University: <input type="checkbox"/> Light, Molecules, Matter (LUMOMAT) <input type="checkbox"/> Earth and Planetary Sciences (EPS) <input type="checkbox"/> Innovative Materials and Energy systems (E-Mat)

FUNDING OF THE THESIS

Origin(s) of the funding: X University <input type="checkbox"/> CNRS <input type="checkbox"/> ANR <input type="checkbox"/> International co-supervision <input type="checkbox"/> other: <i>specify</i>
Funding status: X acquired <input type="checkbox"/> demand in progress (<i>indicate the expected date of answer</i>)
PhD employer: Nantes Université
Gross monthly salary: <i>From 01/01/2024, the minimum gross salary set by the Ministry of Higher Education, Research and Innovation is €2100 per month.</i>
Starting date: <i>Funding for the thesis covers a period of 3 years starting from the date of the first registration.</i>

SCIENTIFIC DESCRIPTION OF THE PROJECT

Context, objectives, methodology (1 page maximum)

JUNO (Jiangmen Underground Neutrino Observatory) is an international multi-purpose project, under construction in Southern China, which aims to determine the mass ordering of neutrinos, perform a precision measurement of the oscillation parameters and detect neutrinos from multiple sources (nuclear reactors, Sun, astrophysical objects, atmosphere, Earth mantle,...). The project is made up of ~700 scientists from ~70 institutes mainly in China and Europe (including LP2i Bordeaux and SUBATECH). Scheduled to start at the end of 2024, it will be the only neutrino detector of this size (20,000 tonnes of liquid scintillator in a 36 m diameter sphere). The detector consists of two photodetection systems, including more than 16700 20-inch PMTs and 25600 3-inch PMTs.

Thanks to its size, JUNO is a unique tool for observing neutrinos from a Core Collapse Supernova — an enormous explosion which marks the end of life of a massive star — in our Galaxy or its proximity. JUNO will detect more about 10,000 neutrinos of all flavors in a few seconds if the explosion occurs in our Galaxy, at a distance of 10 kpc. Participating in the international SNEWS (SuperNova Early Warning System), JUNO will also be able to send an alert to astrophysical observatories around the world, a few hours earlier than the arrival of the electromagnetic signal.

This thesis will focus on the optimization of the algorithms for reconstructing the interaction point of Supernova neutrinos using the energy and time information provided by the two photodetection systems and on the identification of the different neutrino flavors. The precise measurement of the time spectrum and energy spectrum of different neutrino flavors is crucial to discriminate between different explosion models and can provide an independent measurement of the neutrino properties (oscillations and mass). The work will also focus on the fine characterization of the detector response thanks to energy and time calibrations and a comparison to simulations.

Work Context

This thesis will be done in co-supervision between the laboratories LP2i Bordeaux and SUBATECH Nantes, and the student will be based half of the time in each institute.

The Laboratory LP2i Bordeaux (Laboratoire de Physique des deux infinis de Bordeaux) is a Mixed Research Unit (CNRS/Université de Bordeaux) around multiple subjects: astrophysics and particle physics, nuclear physics and health and Environment. The neutrino group has a long experience in neutrino and low background experiments (Double Chooz, JUNO, SuperNemo, DUNE) and in low radioactive background measurements (XXXXX).

The student will also benefit from the expertise of the Astrophysics Laboratory of Bordeaux (LAB) in the massive stars formation mechanism which is essential for the interpretation of the models of a Core Collapse Supernova and the explosion scenarios.

The PhD student will travel in France, Europe and China to participate to the detector installation and data taking shifts and to the collaboration meetings.

Scientific and technical skills required:

The candidate must hold a master's degree in particle, nuclear or astroparticle physics.

Required knowledge :

- good knowledge in particle and experimental
- good knowledge in programming and data analysis

Expected skills:

- Programming in C++ and ROOT and possibly python
- Capability to work in a team and in international projects
- Communication skills (presentation of work to the regular meetings of the JUNO collaboration, participation to national and international conferences, contribute to the writing of articles, ...)
- Fluent in English (written/spoken)

Language requirements:

- English:

N/A Basic Good Excellent Native language

- French:

N/A Basic Good Excellent Native language

 **MANAGEMENT OF THE THESIS PROJECT**

A minimum supervision percentage of 40% must be allocated to the director of the thesis. A minimum supervision percentage of 30% must be allocated to the co-directors and/or co-supervisors. For more information, please consult the internal regulation of the doctoral school.

Name of the home research unit 1 : SUBATECH LP2I	Name of the research team 1 : Neutrino
Name of the research unit director: Gines MARTINEZ	

Director of the thesis

Name, first name: SETTIMO Mariangela

Function: Date of obtaining HDR*: CR, HDR 14/10/2021

Research unit: SUBATECH

Supervision percentage in the project: 40%

Number of current directions, co-directions and co-supervisions: 0

Current total thesis supervisions percentage (directions, co-directions and co-supervisions):

**HDR = French Ability to Supervise a PhD*

Co-director (if applicable)

Name, first name:

Function:

Date of obtaining HDR:

Research unit (or private company):

Supervision percentage in the project:

Number of current directions, co-directions and co-supervisions:

Current total thesis supervisions percentage (directions, co-directions and co-supervisions):

Co-supervisor 1 (if applicable)

Name, first name: Frederic PERROT

Function: MdC

HDR holder: yes no If yes, date of obtaining:

Research unit (or private company): LP2I

Supervision percentage in the project: 30%

Number of current directions, co-directions and co-supervisions: 1

Current total thesis supervisions percentage (directions, co-directions and co-supervisions): 50%

Co-supervisor 2 or co-director (applicable only for inter-doctoral school project)

Name, first name: Sylvain BONTEMPS

Function: DR

HDR holder: yes no If yes, date of obtaining: 2010

Research unit and location (or private company): LAB

Supervision percentage in the project: 30%

Number of current directions, co-directions and co-supervisions in belonging ED: 2

Current total thesis supervisions percentage (directions, co-directions and co-supervisions): 100 %

Private company partner (*if applicable*)

Name of company:

Address: