PhD in Physics and Nanoscience - XXXVI cycle
Second year report

Matteo Rossi

Tutors:

Alessio Caminata
Gemma Testera

Research activity:

My activity is focused on the direct detection of Dark Matter particles and I am working on the design of the neutron veto for the DarkSide-20k Dark Matter experiment. The whole detector consists of a 20 T liquid Argon Time Projection Chamber, surrounded by a neutron veto, with all the system immersed in liquid Argon and closed in a cryostat. The interaction between a candidate for a Dark Matter particle, namely a Weakly Interacting Massive Particle (WIMP) and an atomic nucleus of a scintillator, as liquid Argon, is expected to generate photons, that can be collected using photosensors as cryogenic Silicon PhotoMultipliers. Since the small WIMP-nucleon cross section, it is necessary to identify spurious events that can mimic a Dark Matter particle interaction with Argon atoms. Neutrons are responsible of these events and the role of the veto is to moderate and record the events generated by neutrons; indeed, when the material that constitute the veto itself, that is Gadolinium-loaded plastic, captures a neutron, that results in emitted photons that can be collected in the veto volume as these photons interact in veto liquid Argon.

My contribution is focused on simulating the DarkSide-20k detector exploiting the Geant-4 software, aligning the drawings in Geant-4 with the CAD ones, and analysing the results of several physics simulations in order to understand the best way to construct the detector and find its potentialities and properties. In addition, my work is to find out the best way to place photosensors in the veto, that are arrays of cryogenic Silicon PhotoMultipliers, reaching the highest and most uniform light collection. Recently I also worked to have CAD drawings directly imported into Geant-4, that can be useful to implement complex volumes in the simulations and test several approximations done in the current simulation of the detector.

I am also working on ARTIC (ARgon Test InfrastruCture), which is a cryostat in Genoa which will allow tests in liquid Argon and liquid Nitrogen, useful for DarkSide components. In particular, I am working on the LabVIEW program to control and maintain the cryostat (temperature, pressure, liquid level, ..).

In the last months I also started collaborating in the tests of the new-produced arrays of cryogenic Silicon PhotoMultipliers; on one side, this means to place few photosensors in a dewar and emulate liquid Argon scintillation with a laser, to test their performances and parameters. On the other hand, I am helping in the writing of a LabVIEW software useful for large scale tests. This activity takes place both in Genova and at Laboratori Nazionali del Gran Sasso.

Courses and exams:

Metodi di simulazione applicati alla fisica (F. Parodi) - exam to be done
Computer games (A. De Gloria) - exam to be done

Publications:

M. Rossi on behalf of the DarkSide collaboration, *The veto apparatus of DarkSide-20k: Dark Matter search in a background-free experiment* (10.1393/ncc/i2022-22021-0)

Conferences:

LIDINE 2022, LIght Detection In Noble Elements (Warsaw, 21-23 September 2022)

Conference presentations:

Speaker at June 2022 DarkSide collaboration meeting on behalf of the veto group

Extra:

I helped in writing the Technical Design Report of DarkSide-20k.

For two weeks I received students from high schools for a stage on particle physics, which included both theoretical lessons and hands-on sessions. Their final goal was to build a muon detector and obtain a value for the muon flux at sea level, at different zenith angles.