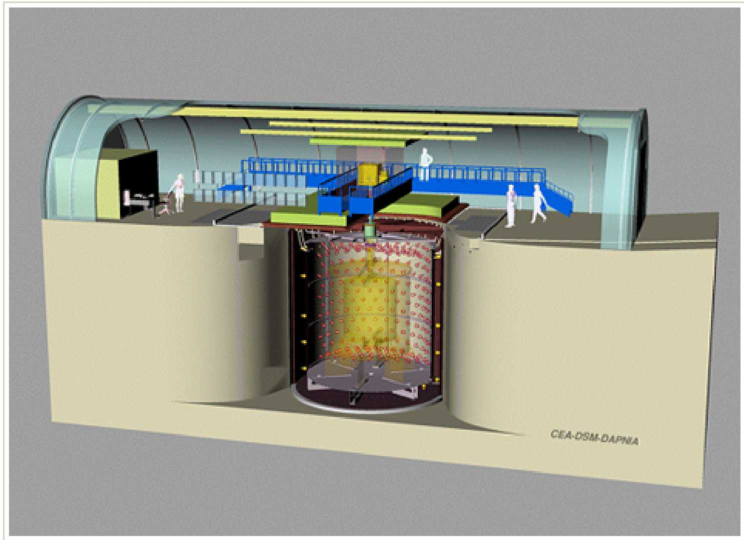
Double-Chooz Detector Filled and Ready to Take Data

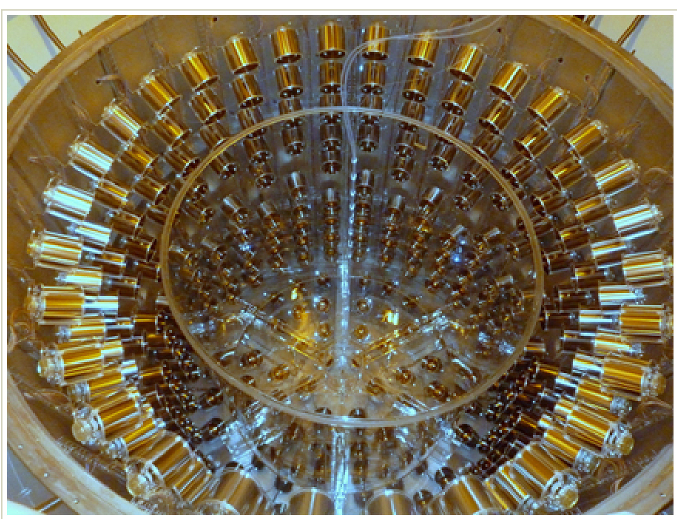
January 4, 2011

The Double Chooz collaboration recently completed its first neutrino detector, which will see anti-neutrinos coming from the Chooz nuclear power plant in the French Ardennes. The experiment is now ready to take data in order to measure fundamental neutrino properties with important consequences for particle and astro-particle physics.



Neutrinos are electrically neutral elementary particles, three of a kind plus their antiparticles. Though already postulated in 1930 their first experimental observation was made in 1956. Because of their weak interaction with other particles, matter is almost completely transparent to neutrinos and large sensitive detectors are needed to capture them.

Neutrino oscillations were a major discovery in the late '90s and the corresponding experiments were therefore honoured in 2002 by the Nobel Prize. Oscillations describe in-flight transformations of different neutrino species into each other and the observation of this effect implies that neutrinos do have mass. The oscillations depend on three mixing parameters, of which two are large and have already been measured. The third one is called theta13 and is known to be smaller with an upper limit coming from a previous experiment at Chooz. The new Double Chooz detector is the first of a new generation of reactor neutrino experiments aiming at measuring this fundamental parameter in neutrino physics, which is a key area of particle physics research. The results will also have important consequences for the feasibility of future neutrino facilities aiming at even more precise measurements.



Double Chooz consists of two identical detectors. The first one at a distance of about 1km from the reactor cores has now been filled and is beginning to take data. The measured number of neutrinos compared to the expected flux from the reactors will allow improving considerably the sensitivity for theta13 already in 2011. The second detector located at a distance of 400 m will start operating in 2012. At this distance no significant transformation into another neutrino species is expected. By comparing the results from both detectors theta13 can be determined with even higher precision.

Both detectors use an organic liquid scintillator, which was developed specifically for this experiment. The neutrino target in the core of the detector consists of 10 m3 of Gadolinium doped scintillator which can to tag neutrons from inverse beta decays which are induced by anti-neutrinos emitted by the reactors. The target is surrounded by three layers of other liquids in order to protect against other particles and to dampen environmental radioactivity. These liquids are contained in very thin vessels, to minimize inactive volumes inside the detector. The target is observed by 390 immersed photomultipliers, which convert the interactions into electronic signals. These signals are processed in a data acquisition system that is ready to take data over the next five years. The new detectors will ensure that neutrino physics will stay one of the most fruitful areas of particle physics, as it has been for the past 50 years.

The Double Chooz collaboration is composed of universities and research institutes from Brazil, England, France, Germany, Japan, Russia, Spain and USA. Fourteen US institutions in the Double Chooz collaboration, with the University of Tennessee among them, are contributing to the detector hardware and software components. These institutions have received support for this work from the National Science Foundation and Department of Energy. UTK Professors Y. Efremenko and Y. Kamyshkov together with a researcher A. Hatzikoutelis and graduate students A. Osborn and B. White are contributing in the commissioning and operation of the photo-detectors in the Double Chooz experiment.

The shiny iron shield covering the Double-Chooz Detector.