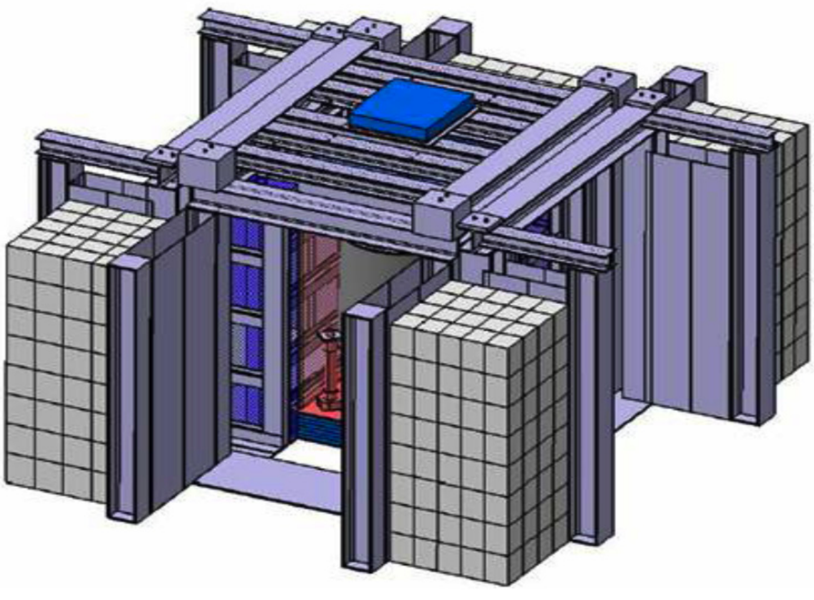
NEXT – Exp-05-2008

Is the neutrino its own antiparticle, as proposed by Majorana? A key question to be answered experimentally.
If this is the case, some nuclei can undergo a rare type of decay called neutrino-less double beta decay, or bb0nu (Panel 1). This decay is characterized by the emission of two electrons, whose energies add up exactly to the available reaction energy of Qbb, with typical values of 2.5 MeV. The lifetime of those processes is many orders of magnitude longer than the lifetime of the universe. Finding them, if they exist, are a major experimental challenge, since one requires simultaneously detectors that are: a) very massive, b) very sensitive to the signature of the process and c) very robust against the copious backgrounds associated with the natural radioactive chains and a rare, but allowed mode called bb2nu, where 2 electrons and two neutrinos are emitted.
Xenon is a noble gas, present in small quantities in the atmosphere, who is exceptionally well suited for this enterprise since it is simultaneously source (10 % of Xenon is ^{136}Xe, who decays bb, see panel II) and detector (one can build a xenon-based apparatus to register the signature of the decay).
NEXT is a proposal to build a gas xenon based TPC. It has been presented to the LSC scientific committee and to the Spanish Consolider Program (for funding). It proposes a five year program, with an initial 3 years R&D followed by the construction of a 100 kg pressurized TPC.
The advantages of a gas Xenon TPC are illustrated in Panel-IV: a) It provides the two-track signature characteristic of a bb event
(two electrons, which are seen in the gas as a “filament” or “spaghetti”, which ends in two ionization blobs when the electron ranges out). b) such signature separates very efficiently the electrons from the main background of gammas arising from natural decay chains (in the panel, separation of the compton electron produced by 2.6 MeV gamma from ^{208}Tl and the region where the signal is expected). and c) energy resolution is expected to be good in gas (1 % FWHM at 2.5 MeV), providing excellent separation between the bb0nu and bb2nu modes (as shown in panel) and also between the two-electrons from bb events and one-electron from gamma scattering or conversion (also shown in panel).
The lifetime of the rare bb0nu mode depends on the absolute neutrino mass. We know today that the mass of the neutrino is smaller than about 1000 mili-eletron Volts (meV). Experimentally, one would like to explore neutrino masses as small as possible. Depending on the neutrino mass pattern, one could find a positive signal if the region up to masses of 20 meV is explored. NEXT expects to be sensitive to lifetimes for the bb0nu mode of 10^{26} years (60 meV) with 100 kg of enriched xenon and to 10^{27} y (20 meV) for 1ton.



The installation in Hall A will start at the end of 2011.