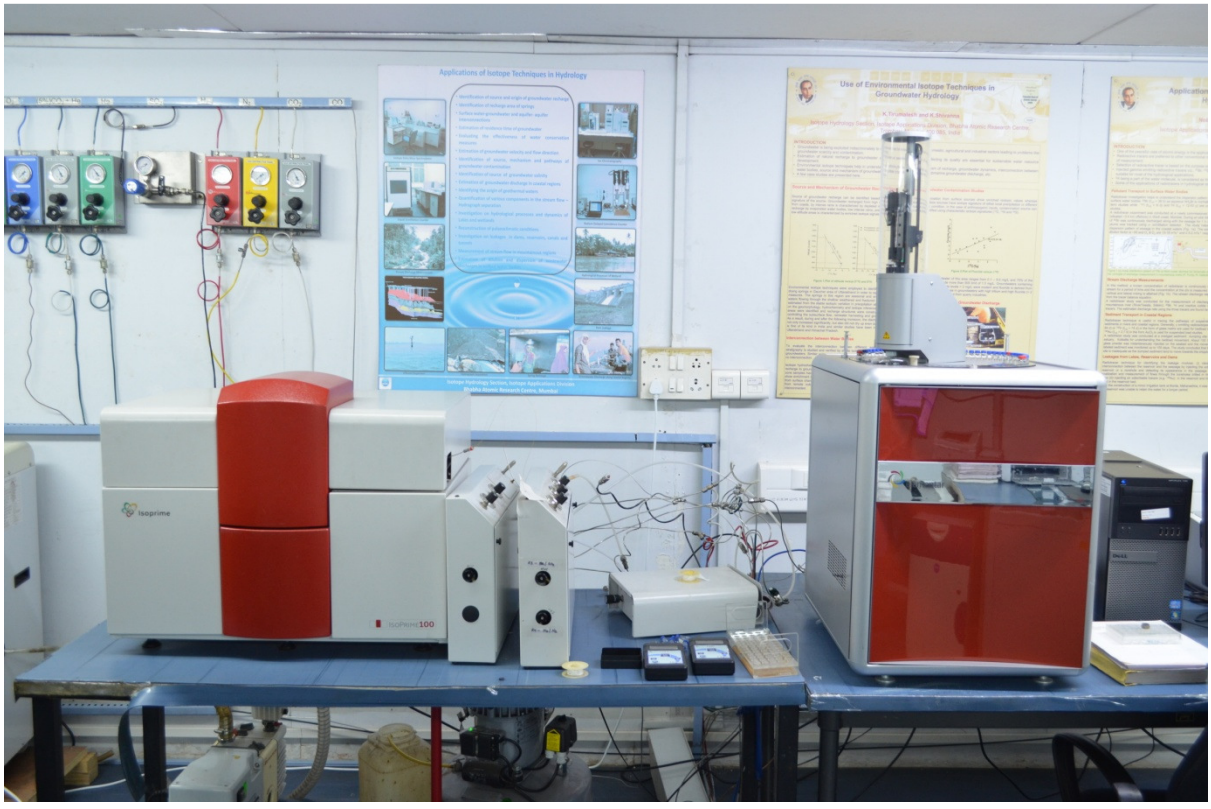
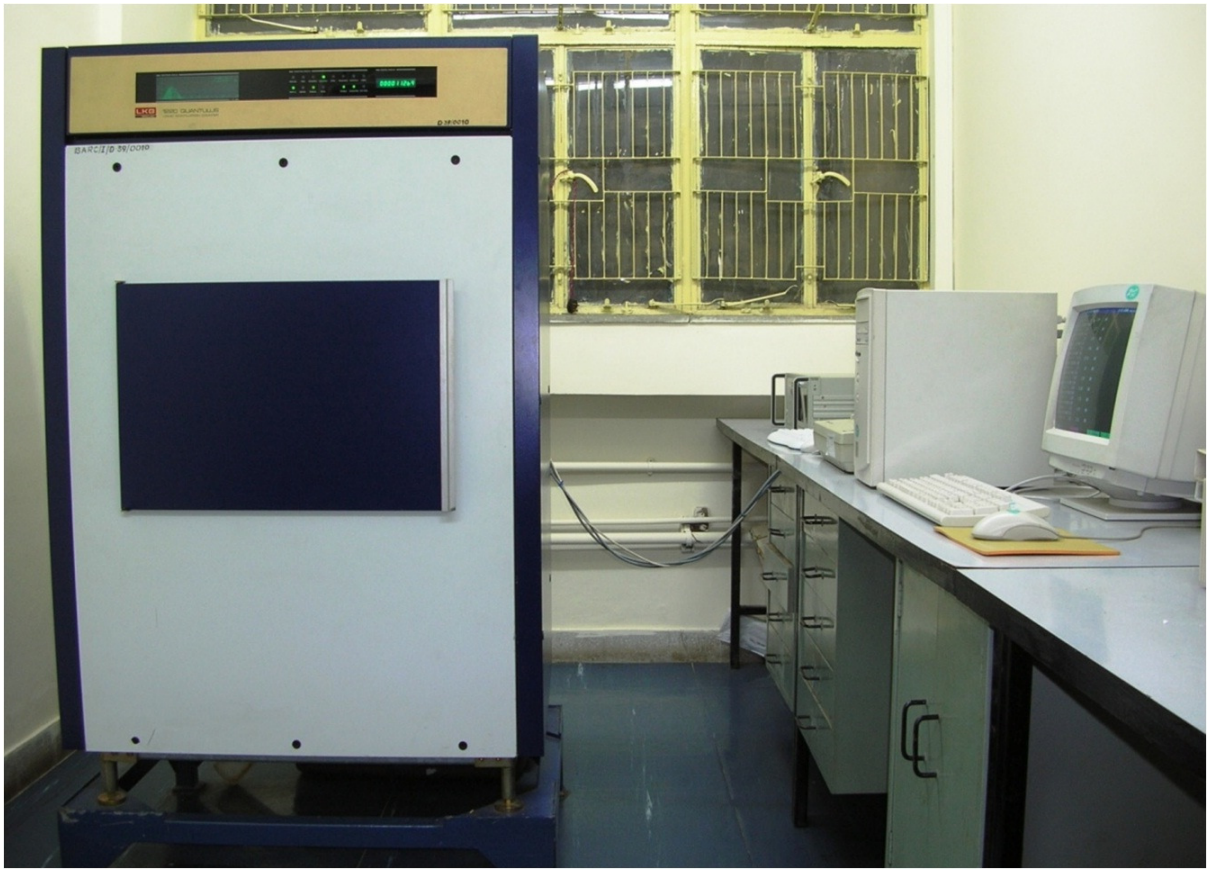
Isotope Ratio Mass Spectrometer (IRMS)



Isotope Ratio Mass Spectrometery is a specialized technique in which relative abundance of isotopes in a given sample is measured. Isotope ratios of elements such as carbon, hydrogen, oxygen, sulfur, and nitrogen can become locally enriched or depleted through a variety of kinetic and thermodynamic factors so measurement of these isotope ratios can be used to differentiate between samples which otherwise share identical chemical compositions. The complete process involves the conversion of the sample into gaseous ions which are then characterized by their mass to charge ratios (m/z) and relative abundances. Isotope Hydrology Section has two IRMS systems. These IRMS systems contain electron impact ionisation source, magnetic sector analyser and Faraday cup detectors. One IRMS instrument is copuled with multiflow and the another IRMS is coupled with Elementar Analyser. IRMS coupled with multiflow system is used to measure $^{18}O/^{16}O$ and $^{2}H/^{1}H$ by water equilibration technique which is very useful in various hydrological studies such as to throw light about the origin and source of groundwater, interconnection between aquifers, surfacewater-groundwater interaction etc. Another IRMS coupled with Elementar Analyser is suitable for measuring $^{2}H/^{1}H$ by pyrolysis technique as well as $^{13}C/^{12}C$, $^{34}S/^{32}S$ and $^{15}N/^{14}N$ by combustion technique. Measurements of the $^{13}C/^{12}C$ helps to identify the source of dissolved inorganic carbon whereas $^{34}S/^{32}S$ and $^{15}N/^{14}N$ are used mainly in tracing the source of pollutant and contaminants.

Liquid Scintillation Counter (Quantallus 1220)



Quantallus 1220 liquid scintillation counter is a low background scintillation counter with active and passive shields i.e. 660kg lead shield and coincidence-anti coincidence system respectively. This brings down the background to about 0.5 cpm. The basic working principle of scintillation detector is that the radiation interacts with scintillation cocktail generating a photon which is converted to signal with the help of PMT. The instrument is used to measure tritium and radiocarbon content which are extremely useful tools in hydrological investigations. Tritium and radiocarbon measurements are mainly used in the determination of residence time of groundwater samples. Tritium and radiocarbon is measured in almost all the projects carried out by Isotope Hydrology Section. It can be used to measure isotopes emitting alpha radiation.

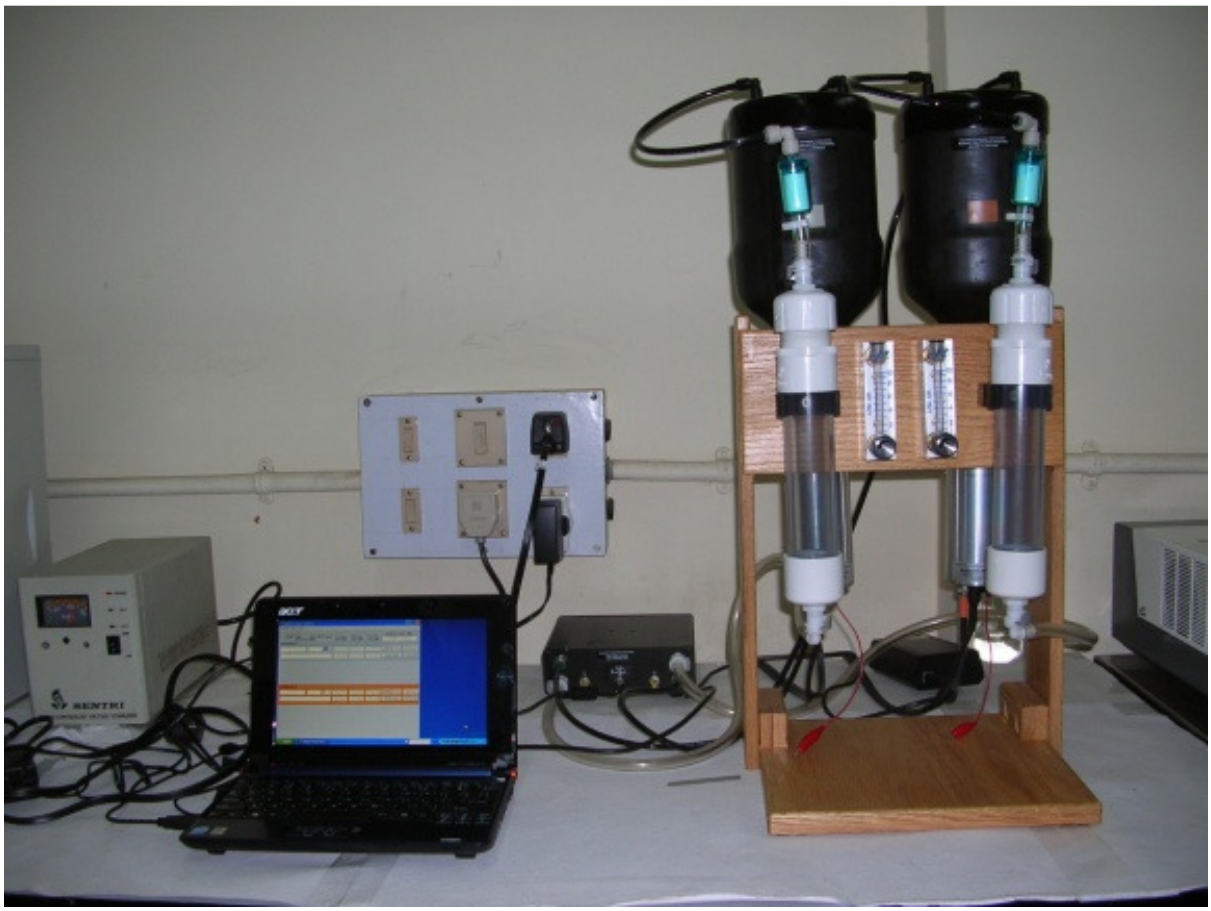
Ion Chromatography system

Ion chromatography is used for water quality analysis. The ion chromatograph is DIONEX 500 system; it is capable of measuring major anions, such as fluoride, chloride, nitrate, nitrite, and sulphate, as well as major cations such as lithium, sodium, ammonium, potassium, calcium, and magnesium in the parts-per-billion (ppb) range with very good resolution and sensitivity. The major ion chemistry complements the isotope data for isotope hydrological studies and is proving to be very useful in different ongoing sectional projects. The Ion chromatograph instrument separates ions based on their affinities towards the ion exchange resin in analytical column. Ionic species separate differently depending on species type and size. Sample solutions pass through a pressurized chromatographic column where ions are absorbed by column constituents. As an ion extraction liquid, known as eluent, runs through the column, the absorbed ions begin separating from the column. Different type of detectors such as: conductivity, spectroscopic or amperometric detectors are used for quantification if the eluted ions.

Alpha Spectrometer

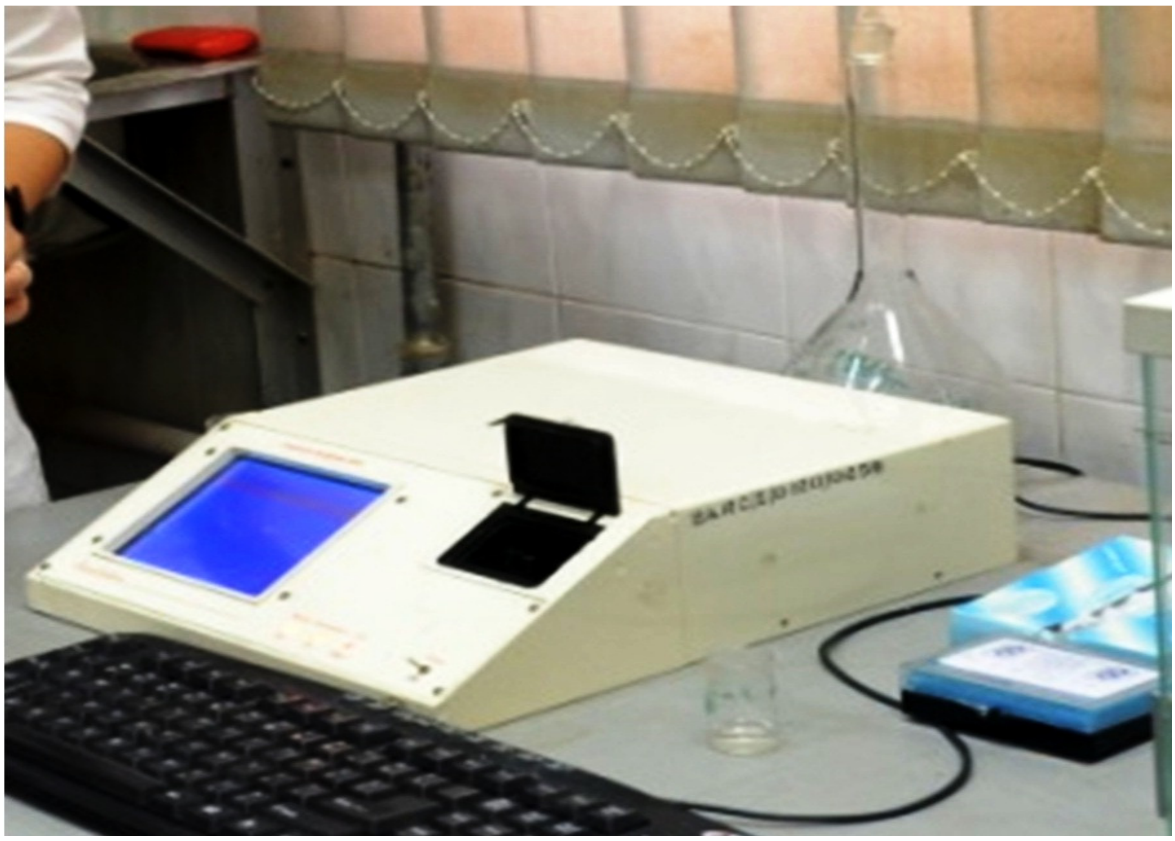
Alpha spectrometer is a passivated ion-implanted planar semiconductor detector (PIPS) with an area of 450mm^2. PIPS detector is made by introducing doping impurities at the surface of the semiconductor by exposing that surface to a beam of ions produced by an accelerator. This method is known as ion implantation and can be used to form n^+ or p^+ layers by hitting the surface with accelerating particles. The advantages of ion-implanted detectors are thinner depletion zone with rugged front contact, better energy resolution and lower electronic noise. The counting is done in a vacuum to reduce attenuation hence increasing the resolution of the system. It is used to measure uranium isotopes. The advantage of measuring uranium isotope for hydrology is that activity ratio ($^{234}U/^{238}U$) of uranium act as a fingerprint to trace water masses under different environmental conditions. This helps us understanding the processes that would have favoured uranium release and the long-term condition of the aquifer.

Radium Delayed Coincidence System (RaDeCC)



It is a ZnS(Ag) scintillation detector. The radiation interacts with the crystal generating electron hole pair which combines to give a photon that is converted to signal using PMT. This instrument works on time delay and measures the coincidence alpha from the daughter nuclei of radon gas. The instrument is used to measure short lived isotopes of radium by measuring the radon gas produced by the decay of radium. In the field of isotope hydrology, the radium isotope is measured to estimate submarine ground water discharge i.e. discharge of fresh groundwater and/or re-circulated seawater into the coastal water. It is important to estimate SGD as it the major component of fresh water that is lost into the sea. SGD estimation helps in better understanding and management of coastal aquifer, nutrient flux determination etc. Variable short lived half-lives of radium are useful for time series analysis of submarine groundwater discharge into estuaries or lagoons where the flushing time is approximately 2-3 days while submarine groundwater discharge into sea or ocean longer lived isotope of radium are used.

Laser Fluorimeter



The LED laser fluorimeter is Quantalase Enterprises Pvt. Ltd. Make. It is very useful for direct measurement of uranium concentration in water samples at ultra-trace levels. Various ongoing sectional projects (uranium contamination in Tummalapalle mining region, Andhra Pradesh and Uranium contamination in groundwater of Punjab region) are related to uranium contamination in groundwater and studying the leaching process of uranium in groundwater, these projects demand high resolution sampling and analysis of groundwater samples for uranium along with isotopes and chemical analysis. The LED laser fluorimeter is very useful in this type of works. The instrument uses laser light source in the near UV region (350-300 nm) to excite U (VI) species. Under UV excitation uranyl salts emit green luminescence, which is detected by a photomultiplier tube (PMT). The fluorescence measurements from excited U (VI) species give uranium concentration with high precision and reproducibility.