1. ACCELERATOR

1.1 OPERATIONAL SUMMARY

S Chopra

The accelerator operation in this year had been smooth with few problems. There were two scheduled tank opening maintenance. The details of this maintenance are mentioned in maintenance section. The operational summary of the accelerator is as follows for period from 1st April 2008 to 31st March 2009.

Total No. of Chain Hours	=	7074 Hours
Total Beam utilization	=	4534 Hours
Machine breakdown	=	0180 Hours
Accelerator Conditioning	=	2056 Hours
Beam Change Time	=	0013 Hours
Tank opening maintenance	=	1615 Hours

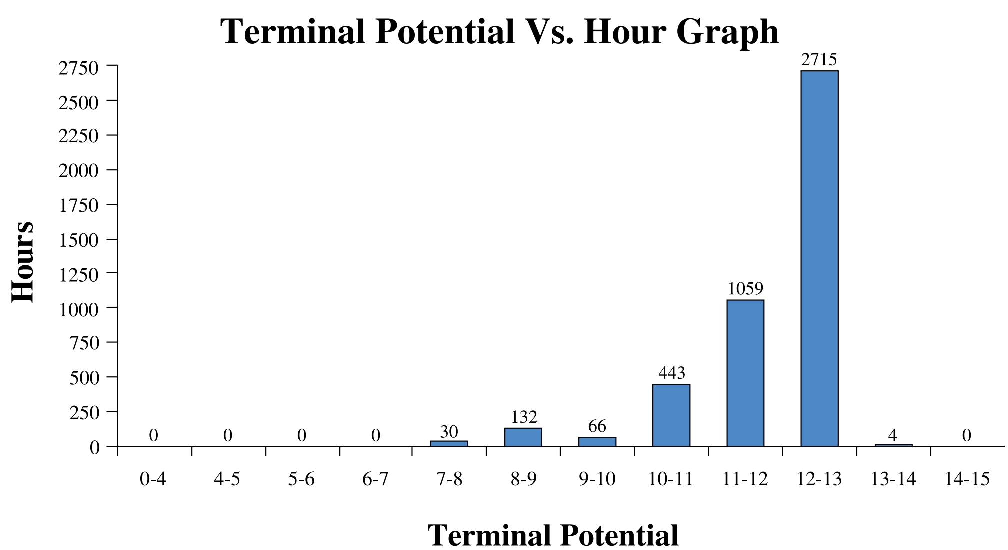

Fig. 1. Terminal Potential vs. hour graph

A total of 884 shifts were used for experiments during the mentioned period. Out of these 884 shifts, 100 shifts were used for pulsed beam users. The machine uptime for this period is 97.46% and the beam utilization is 64.09%. The voltage distribution graph of Terminal Potential used for different experiments during above mentioned period is shown in figure 1. The minimum and maximum terminal voltage at which beam was delivered to users was 7.14 MV and 13.6 MV respectively. Maximum terminal voltage achieved during conditioning in this year was 13.75 MV.

Accelerator performance, in the form of Pi-chart, is shown as below in figure 2.

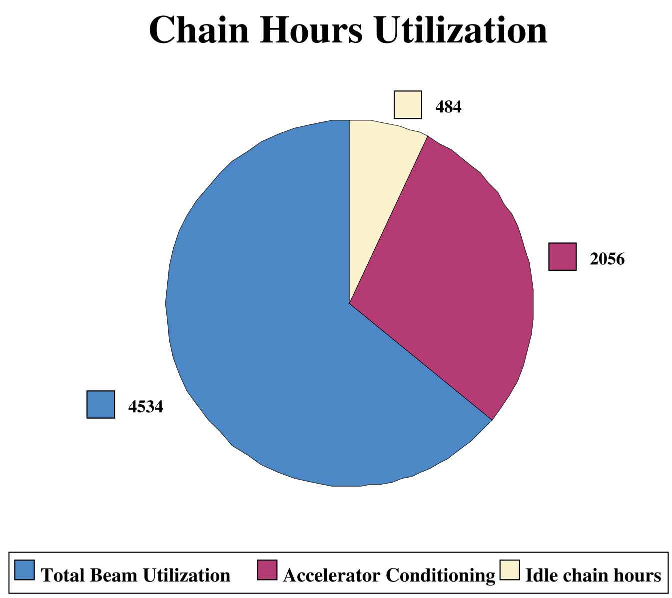

Fig. 2. Chain hours utilization

The total duration of beam run for mentioned period is 4197 hrs. Duration of run time in percentage for different ions is shown in table 1.

Table 1.

Beam delivered	*Utilization (%age of total time)*	*Beam delivered*	*Utilization (%age of total time)*
^{6}Li	2.67%	^{28}Si	14.98%
^{7}Li	5.81%	^{32}S	3.42%
^{10}B	0.31%	^{34}S	1.78%
^{11}B	0.81%	^{35}Cl	3.74%
^{12}C	4.51%	^{40}Ca	0.68%
^{16}O	24.07%	^{56}Fe	0.80%
^{18}O	5.67%	^{58}Ni	8.24%
^{19}F	3.53%	^{107}Ag	9.73%
^{24}Mg	2.35%	^{197}Au	6.20%
^{27}Al	0.68%		

Pi- chart in figure 3 shows the distribution of delivered beam species during beam run from 1st April 2006 to 31st March 2007.

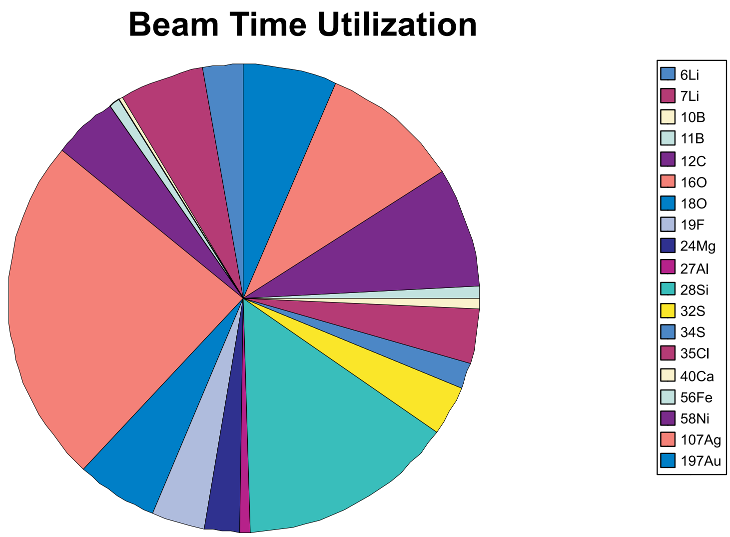

Fig. 3. Beam Time Utilization

1.2 MAINTENANCE AND DEVELOPMENT ACTIVITIES

S Chopra, R Joshi, S Gargari, M Sota, S Ojha, K Devarani, Pankaj Kumar, V P Patel, R P Sharma, J Prasad, R Kumar, M P Singh, N S Panwar, S Mohan, Suraj Kumar, Pranav Singh, P Barua and A Kothari

In this year, there were two scheduled tank openings during which maintenance of Pelletron and associated components were performed. The first schedule maintenance was from 18th July 2008 to 2nd September 2008 and the second one was from 12th March 2009 to 1st April 2009. In these scheduled maintenances, routine maintenance jobs like checking of resistor network inside tank, HV breakdown test of CSP gaps, foil stripper change, maintenance of all ion pumps and sublimator pumps, CAMAC maintenance, ion source routine maintenance etc. were carried out. Apart from this, a few major maintenance works were also performed, which are listed below.

Major maintenance jobs during scheduled tank openings:

The major maintenance jobs carried out are listed below:

Testing and maintenance of earthquake RAM

All RAMs were charged with SF_6 gas up to pressure of ~240 psi. During testing, Earthquake sensor in control room was put in test mode for testing of earthquake RAMs, but earthquake RAMs did not fire. The solenoid valve, which fires the RAM actuators, was jammed mechanically although its coil was fine. This solenoid valve was replaced by a new one to rectify the problem. Retraction of RAMs also had problem and only one RAM got retracted out of four. The compressed air connection to the solenoid valve used to fire RAM actuator for retraction of RAMs was not proper. Proper air connection was made to rectify the problem.

Charging system maintenance

During the normal operation of Pelletron, instability was observed in charging system. Maximum fluctuation of around 8 μA was observed in 20 μA of charging current for charging system #2. Therefore it was decided to check both the charging systems thoroughly during July 2008 maintenance. The high voltage terminal was grounded for this testing. It was observed during testing that there were lots of fluctuations in charging current of chain #2 due to snapping of chain #2. Alignment and bearings of charging system #2 were checked and they were found to be fine. To take care of snapping of chain, a pellet from chain #2 was removed and few counter weights from its see saw mechanism were also removed for proper alignment of chain. Charging current of chain #2 was then checked again and found that the fluctuation in charging current had reduced to very low value. All the mounting bolts of both the charging systems were checked thoroughly and tightened. Performance of chain #1 was also checked which was satisfactory. After repairing of charging system #2, both the chains were kept ON for two days. No idler dust was observed and the alignment of all idler wheels was perfect. The condition of both charging systems was satisfactory.

In March 2009 tank opening maintenance, first observation has shown that the condition of both charging system was extremely good.

Maintenance of Rotating parts inside accelerator tank

Rotating shafts, in Pelletron, are used to drive generators stationed at both dead sections and terminal. These generators generate the power for the controllers of beam line components. Separator boxes are used for mounting of these rotating shafts. It contains bearings and a rubber coupler. In July maintenance lots of metallic dust was found in unit #25 and 26 due to severe damage of separator box in unit #25. This separator box was replaced by a new assembly as it was beyond repair. Apart from this, nine separator boxes were opened and bearings of all of these separator boxes were changed. Out of these nine separator boxes, four boxes were in low energy side and five were in high energy side of machine. Separator box between unit #18 and 19 was replaced by NEC made separator box as its rubber coupler got cracked twice. The performance of both rotating shafts was satisfactory after their maintenance.

Unit repairing

Total number of four CSP gaps was shorted in these two maintenances. Condition of gap #15 in unit #11 was bad as its ceramic part cracked severely. Although this gap was shorted at two different posts in past, it was essential to short gap #15 of unit #11 separately at P-2. This shorting was essential as some field may develop across this gap and will further damage post P-2. For this a 1” Cu braided wire was used and looped around the gap. A single strand Cu wire was soldered to lock the loop. Proper care was taken to avoid any kind of sharp edges on this loop. Similar shorting was done for gap #6 in unit #26 as spark gap of this gap was severely damaged. Apart from these shorting, gaps #2 and 4 of unit #26 were shorted. After shorting the gap the shorting was tested by multimeter. Two CSP resistors were also replaced one in unit #25 and another in unit #26.

Replacement of equipotential rings screws

Sparking was noticed in unit #25 and 26 before March 2009 tank opening maintenance. The cause for this sparking was investigated and found that one resistor broke in unit #25. In unit #26, six equipotential rings came out from their respective mountings and a faulty resistor was also located in this unit. Resistance between hoop screw head and equipotential rings, for unit #25 and 26, was measured. Hoops screws, which had resistance value more than 500 ohms, were replaced in these units.

Corona probe maintenance

Corona probe stopped working before July 2008 tank opening maintenance, so it was tested by simulating all the electronics signal during July 2008 maintenance. All seven needles of corona probe were replaced by new needles.

Stripper foil loading in terminal and High Energy Dead Section (HEDS)

Laser Plasma ablated (LPA) foil strippers were procured from Munich. Thickness of these procured foils was 4 $\mu g / cm^2$. These stripper foils along with IUAC make foils were installed in terminal in July 2008 tank opening. Around 70 stripper foils of IUAC make and remaining stripper foils of Munich (LPA) were loaded in terminal with proper demarcation. This mixed foil loading was done to study the performance of LPA foils in comparison to IUAC foils. Similarly nineteen number of stripper foils whose thickness is >10 $\mu g/cm^2$ and remaining stripper foils are of normal thickness (< 10 $\mu g/cm^{2)}$ were loaded in High Energy Dead Section with proper demarcation.

Maintenance for electronics related problems

During regular operation, just before March 2009 opening, gas stripper valve was not opening. In both INC and DEC mode the valve was closing instead of opening in INC mode and closing in DEC mode. The problem was detected in CAMAC Output register module corresponding to gas stripper valve. Opto coupler of the particular channel was faulty. This opto coupler was replaced to solve the problem.

Maintenance of Vacuum related components

Routine maintenance of all ion pumps and sublimator pumps along with their controller was done. Cooling fans of two of the sublimator pumps were replaced. Ion pump controller of GDA experimental line was also changed.

Turbo pump TP 01-2 installed before injector magnet was replaced by new turbo pump as this turbo pump stopped working.

1.3 ION SOURCE ACTIVITIES

S Chopra, R Joshi, S Gargari, M Sota, S Ojha, K Devarani, Pankaj Kumar, V P Patel, J Prasad, R Kumar, M P Singh, N S Panwar, S Mohan, Suraj Kumar and Pranav Singh

The ion source operation was satisfactory from April 2008 to March 2009. The source was opened twice in this duration for routine maintenance.

Maintenance work

Routine maintenance

Routine maintenance work for ion source was carried out twice in July 2008 and March 2009. All the electrical connections of ion source were removed. The source was removed from line and taken out from deck for maintenance. The source was dismantled and all of its parts were cleaned. After cleaning of all the parts, the source was assembled again and the alignment was done with the help of alignment jig. During both the maintenance, 5 gm. of fresh cesium was also loaded in cesium reservoir. Proper vacuum was first established in the source before loading the cesium. This saves the cesium from getting contaminated, in case of any vacuum problem after maintenance.

Breakdown maintenance

Ionizer problem

During operation it was noticed that focus was not holding potential more than 1.5KV. The ceramic surface resistance of the einzel lens was measured with the help of 5KV Megger. It was showing only resistance of 500 Mohm. Generally the surface resistance of the ceramic should be infinity. So, this einzel lens was replaced by a spare one in July 2008 regular maintenance.

General Purpose Tube (GP tube) conditioning

All five General purpose tubes were cleaned thoroughly with alcohol and then conditioned. During conditioning X-ray activity was monitored as well as electron current was also monitored in FC 01-1. After proper conditioning, now the General purpose tube is holding upto 300 kV.

1.4 BEAM PULSING SYSTEM

R Joshi, S Ojha and A Sarkar

Operation

There were 100 shifts of pulsed beam operation with Pelletron and beam was utilized by the users. The beams which were bunched for these pulsed beam runs were ^{16}O, ^{28}Si, and ^{32}S. Out of these 100 shifts, LINAC group utilized 25 shifts of ^{16}O pulsed beam for testing and 10 shifts of ^{16}O chopped beam at a repetition rate of 4 μs was delivered to HYRA experimental line. 4 MHz. chopper in pre acceleration section was used to eliminate the dark current as the repetition rate required by user was 250 ns. Traveling wave deflector (TWD) was also used, along with chopper and multi harmonic buncher, to get different repetition rates other than 250 ns. Performance of High Energy Sweeper (HES) was also tested during LINAC test runs. All the beam pulsing system worked satisfactorily for all experiments.

Maintenance

The TWD maintenance was carried out once, apart from regular routine maintenance of beam pulsing system.

1.5 DEVELOPMENT ACTIVITIES

S Chopra, R Joshi, S Gargari, M Sota, S Ojha, K Devarani, V P Patel, R.P. Sharma, J Prasad, R Kumar, M P Singh, N S Panwar, S Mohan, Suraj Kumar and Pranav Singh

Few modifications and development work were also carried out in July 2008 scheduled maintenance. Those are mentioned below.

Modification of foil stripper position read back

Position read back system for stripper foils at high energy dead section (FS D2) was modified to read the exact position of stripper foils FS D2.

Installation of new 50 position stripper foil assembly

A 50 position foil stripper assembly was procured from NEC, USA and installed in vault area (after analyzer magnet). Use of this stripper foil assembly is multi purpose. This can be effectively used to reduce ME / Z^2 by increasing the charge state after acceleration. This will help to switch the beam to the beam line where ME / Z^2 is low. The controller for it was developed and fabricated in house which can control the movement of foil strippers either locally or remotely from control room. CAMAC crate in vault area was modified for remote control of this newly installed foil strippers. The foil stripper assembly along with its controller was tested after its installation and it is working fine. These stripper foils were also used in one of the user experiment in GPSC experimental line.

Testing of charging chains

Both the charging system performance was tested before July 2008 tank opening. It was found that performance of charging system #1 was satisfactory but performance of charging system #2 was not up to the mark. Maintenance work of charging system #2 was carried out in July 2008 tank opening. The performance of both charging systems was checked once again just before March 2009 tank opening. For this testing the terminal was shorted to ground with the help of shorting rods. Performance of charging systems was found to be satisfactory and improvement in the performance of charging system #2 was also noticed. Charging efficiency of charging system #2 was much improved as compared to earlier test (before July tank opening).

Phase correction for High Energy Sweeper (HES)

A circuit for the phase correction of HES was developed and tested. This circuit compares beam currents from HES double slit. Change in HES phase results in unbalancing of slit currents. The phase correction circuit will adjust the phase of HES to balance back the slit currents. Beam currents from HES double slit was fed to this circuit. Proper correction of HES phase was observed by this circuit. This phase correction circuit was tested for about a shift. This circuit has to be tested for longer duration.

Ion Source Test Bench facility

Earlier the controls of all the devices in Ion source Test Bench (ISTB) were hard wired individually up to control console. A computerized control system was planned and installed. An in-house developed computer control system was used for this purpose. This system has provision of 64 channels of 12 bit ADC for analog input, 28 channels of 12 bit DAC for analog output, 32 bits digital outputs for Status Control and 32 bits of digital input for Status Read. Presently, all ISTB device parameters, except parameters of devices at HV deck, can be controlled through this computerized control system and it is working fine. Computerized control of all the devices at HV deck, which are controlled using fiber optic cable, is already planned and will be incorporated later on. Beams were delivered to users for irradiation of samples by using this control system.

1.6 ACCELERATOR MASS SPECTROMETRY (AMS)

Pankaj Kumar, Sunil Ojha, A. Jhingan, S. Gargari, R. Joshi and S.Chopra

The AMS facility for ^{10}Be measurements is in operation and in this year, ^{26}Al measurements from standard samples have also been added. A new chemistry laboratory for samples processing is being developed and in future, all the AMS users will be able to process their samples in this laboratory.

1.6.1 New Modifications in the AMS facility

1.6.1.1 Port Aligner installation with the off-set Faraday cup

Pankaj Kumar, Ashok Kothari, P. Barua, S.Ojha, S.Gargari, R. Joshi and S.Chopra

A new port aligner has been installed with Offset Faraday Cup (OFC) present in vault area after the analyzer magnet. The use of port aligner is to provide an angle to the offset faraday cup, while collecting $^{17}O^{5+}$ beam during ^{10}Be AMS experiments. Since $^{17}O^{5+}$ comes out from the analyzer magnet at an angle, it is required to provide a desired angle to the offset faraday cup to collect all the $^{17}O^{5+}$ ions. This angle may vary with a slight variation in the energy in different experiments. Port aligner can provide a continuous range of angles to the offset Faraday cup. Earlier a fixed angle offset faraday cup was being used but now offset faraday cup angle can be changed as per the requirement. The port aligner (Fig1.) can provide

15^0 tilt along X and Y axis independently, but we require tilt only in Y axis so the X plane is kept locked. Port aligner has a micrometer (with least count of 0.01mm) and tilts position lock for each plane and is installed with the Faraday Cup Chamber using a bellow. Testing of OFC has been done with beam to optimize the angle and linear position of the cup for collecting $^{17}O^{5+}$ beam in AMS experiment

Fig.1 Port Aligner (standard Gimbal)

1.6.1.2 Modification of Gas detector and installation of data acquisition system in control room

Pankaj Kumar, Akhil Jhingan, S.Ojha, S. Gargari, R. Joshi and S. Chopra

The old gas detector has been modified and the new modified gas detector is smaller length and has only three anodes. Due to its smaller length, transmission between first anode and SSBD will be more and therefore it will help in increasing the statistics especially in case of ^{10}Be experiments. One new set of electrodes was designed and placed inside the old detector housing. Old electrodes set up are also there and can be used, if required.

Accuracy and reproducibility of AMS measurement is very much dependent on the stability of Accelerator and source parameters. Keeping this point in mind we have installed a new rack in control room having data acquisition system mounted in this rack. It is now very easy to control accelerator parameters according to the requirement of measurement.

1.6.2 ^{26}Al AMS Facility development:

Pankaj Kumar, JK Pattanaik[1], S.Ojha, Akhil Jhingan, S.Gargari, R.Joshi and S.Chopra

[1]Department of Earth Sciences, Pondicherry University, Puducherry

Efforts were made to detect ^{26}Al from standard Al sample procured from University of California, Berkley USA. These samples were originally in HCl solution, which was converted in Al_2O_3 powder in the chemistry laboratory at Pondicherry Central University and mixed with Nb/Ag powder before putting in cathode wheel in Ion source. ^{26}Al AMS measurement is done by sequential injection method by injecting mass 27 amu (^{27}Al) and 26 amu (^{26}Al). ME/q^2 is kept constant during the experiment, while only Injector magnet value and terminal potential is changed to match ME/q^2 for both isotopes. ^{26}Al is detected in the detector and ^{27}Al is collected in Insert-able Faraday cup in the AMS beam line. Isobar (^{26}Mg) of ^{26}Al does not form the negative ion and eliminated at the ion source level itself.

We could detect ^{26}Al from the standard sample using single silicon surface barrier detector (Fig2.1) and there was no signal of ^{26}Al, when blank cathode was chosen in the ion source (Fig 2.2). The other signals in the spectrum could be from nitrogen and boron entering as boron nitride (mass 26) and making through the analyzer magnet by matching the ME/q2 after stripping somewhere in the accelerating tube.

The whole experiment was repeated with two dimensional E-dE detector and we were able to get similar results (Fig 3.1). In this experiment Wien filter was also utilized to throw away the same ME/q2, but different velocity unwanted ions (Fig 3.2)

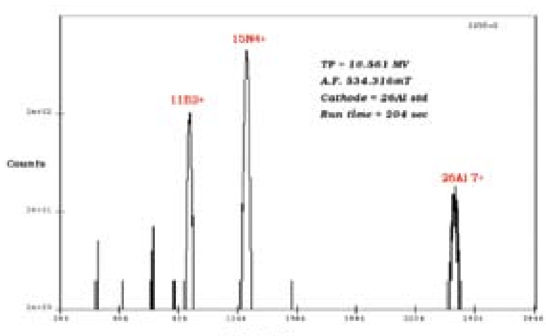

Fig.2.1. One dimensional spectrum from 26Al standard sample, shows 26Al signal

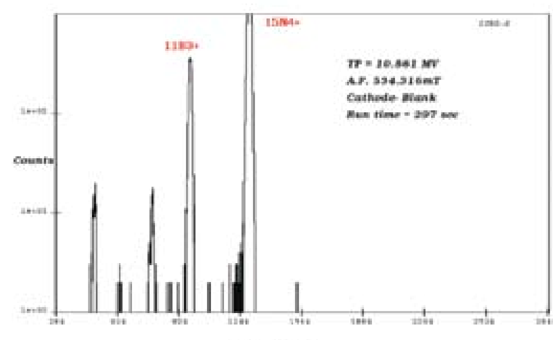

Fig.2.2 One dimensional spectrum from Blank sample, shows no signal at 26Al position

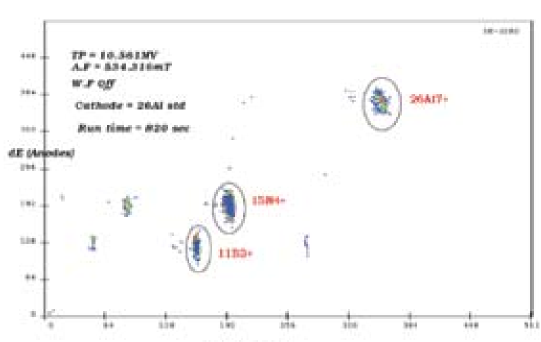

Fig.3.1. Two dimensional spectrum from 26Al standard sample with Wien Filter Off

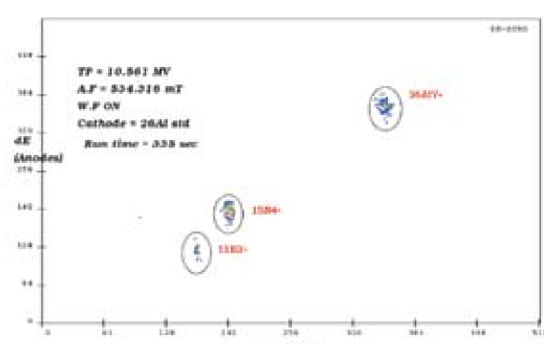

Fig.3.2. Two dimensional spectrum from 26Al Standard sample with Wien Filter ON

1.6.3 Development of ultra-Clean Chemistry lab

Pankaj Kumar, Raj Kumar, Bishamber Kumar, S.Ojha, S.Gargari , Rajan Joshi, and S.Chopra

Chemistry lab is an integral part of AMS. Before the measurement, sample has to be processed in a clean environment to separate out the unwanted species. Development of clean lab at IUAC is in progress. The laboratory will be 10000 class clean room with no outside metal exposure and will be utilized for chemical processing of samples. Wooden work tables will be used for putting laminar flows and other equipments. Laminar Flows will have 100 class air environments and will be utilized for doing the column chemistry, keeping drying station and acid distillation units. Chemistry lab will have its own water and acid purification units. Exhaust fumes and waste water will be treated before going into the environment/ drainage.

1.6.4 Separation of quartz from quartzite samples around Main Central Thrust, Himalaya for *in situ* ^{10}Be and ^{26}Al measurements using AMS

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In situ ^{10}Be and ^{26}Al are produced by cosmic ray spallation with O_2 and Si in the quartz, which is a common mineral found in most of the rock types exposed on the surface. The rate of production of ^{10}Be is ~ 6 atoms g^{-1} y^{-1} and for ^{26}Al it is ~37 atoms g^{-1} y^{-1} in quartz. Measurement of two different nuclides with different decay rates from the same sample will help to more precisely estimate exposure ages and erosional rates at different geomorphically significant locations. This *in situ* method works best over time period from 5 ka to 5 Ma and can measure erosion rates ranging from 0.1 to 10 mm/ka.

As the abundance of these nuclides in rocks is very low, it can be measured precisely by AMS technique. For the preliminary measurement of ^{10}Be and ^{26}Al from the quartz, four quartzite samples have been collected between Joshimath and Nandprayag region across the Main Central Thrust (MCT) of the Himalaya. The samples were cleaned in ultrasonic bath and size was reduced to 60-80 (0.250mm to 0.177mm) ASTM mesh size and is taken for further studies. Heavy minerals are separated by bromoform and other magnetic minerals present in the lighter fraction were separated by Frantz Isodynamic separator at 1.6 to 2.0 Amp current in reverse slope. The final nonmagnetic fractions were leached with 1% HF and 0.5% HNO_3 to remove feldspar and other minerals from the quartz. The cleaned quartz were taken for complete digestion and followed by the ^{10}Be and ^{26}Al separation using anion and cation exchange column chromatography. The procedure for separation of Al is being established at National Facility for Isotope Geochemistry, Pondicherry University, Puducherry.

1.6.5 Separation of ^{10}Be and ^{26}Al from the sediment core samples of the Kaveri delta.

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The deposition of successive layers of sediments in environments such as lakes, deltas and Deep Ocean provides an archive for long lived cosmogenic radionuclides like ^{10}Be with short residence time in atmosphere, to estimate the rate of deposition. Though the concentration of ^{10}Be in continental sediments (~10^7 atoms/g) is lower compared to marine sediments (~10^{10} atoms g^{-1}), it can be measured using AMS. Rate of deposition of sediments depends on the climatic condition and tectonics. During glacial and interglacial period, intensity of physical and chemical weathering and sediment supply markedly differ. In turn the fluctuation in the ^{10}Be concentration in sediment is due to change in global climate and variation in cosmic ray flux which depends on the paleomagnetic intensity. Hence, the study of ^{10}Be in the sediment provide a better understanding about the variation in the sedimentation rate for the past few million years, which could be related to global warming / cooling events.

The Kaveri River basin covers an area of 87900 km^2 and lies between latitude 10° 7'N to 13° 28'N and longitude 75° 28'E and 79° 52'E. The river originates from the Brahmagiri range of the Western Ghats at an elevation of 1345 m above mean sea level and travels ~ 800 km to join the Bay of Bengal. It starts bifurcating at Tiruchirapalli after which it has deposited a thick sequence of deltaic sediment [1]. From the Kaveri delta, four sediment cores have been collected for the study of provenance, tectonic history, and for paleoclimate modeling. Here an attempt has been made to estimate the age and depositional rate from sediment core samples of the Kaveri delta region, by carrying out precise ^{10}Be measurement using AMS facility at IUAC. Initially, for ^{10}Be measurement, eight samples were taken from the sediment core of the Uttrangudi site.

Here, 'Be' was separated from both absorbed and residual phase of the sediments. The procedure described by Pattnaik et.al [2] was followed for separating absorbed phase 'Be' from the sediment. The residual part of the sediment was completely digested with $HF+HNO_3+HCl$ and taken for the Be and Al separation. Digested samples were spiked with ^{9}Be carrier and followed by the anion-cation exchange column chromatography. Separated

Be and Al were converted to hydroxide at 7.8 pH and then it was converted to oxide in quartz vial after step heating upto 900° C.

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