1. ACCELERATOR

1.1 OPERATIONAL SUMMARY

S Chopra

The accelerator operation in this year had been smooth with few problems. There were two scheduled and two unscheduled tank opening maintenance. The details of the work performed maintenance are mentioned in maintenance section. Charging chain #2 of Pelletron accelerator had completed 1,00,000 hours of operation in July 2007. The operational summary of the accelerator is as follows for period from 1st April 2007 to 31st March 2008.

Total No. of Chain Hours	=	7270 Hours
Total Beam utilization	=	4149 Hours
Machine breakdown	=	0298 Hours
Accelerator Conditioning	=	2996 Hours
Beam Change Time	=	0011 Hours
Scheduled maintenance	=	1515 Hours

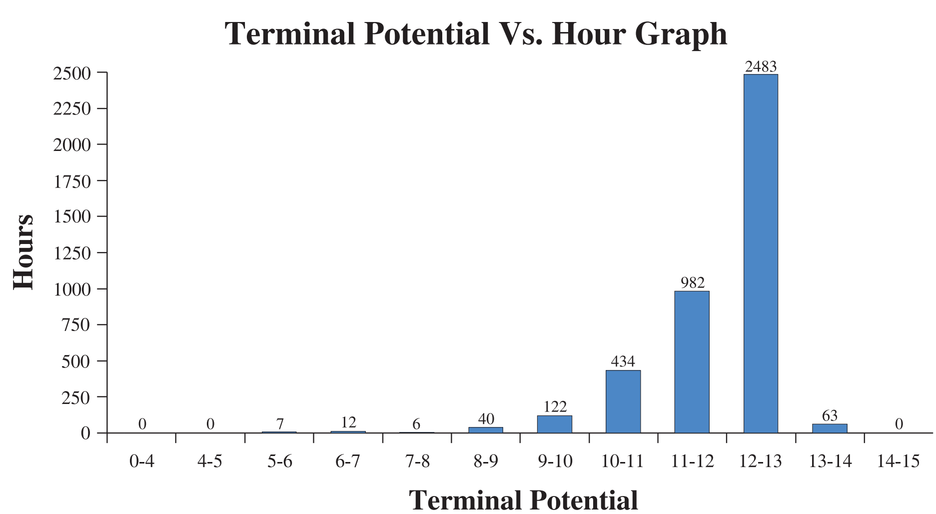

Fig. 1. Terminal potential Vs. Hour graph

Total number of 519 shifts were used for experiments during mentioned period. Out of these 519 shifts, 108 shifts were used for pulsed beam runs inclusive of LINAC runs. The machine uptime for this period is 95.50% and the beam utilization is 57.07%. The voltage distribution graph of Terminal Potential used for different experiments during above mentioned period is shown in figure 1. The maximum terminal voltage (TP) achieved during conditioning in this year was 14.6 MV and maximum TP at which beam was delivered to user was 13.91 MV. In above mentioned beam utilization time, 56 shifts were utilized for INGA runs in HYRA experimental line.

Chain hours utilization, in the form of Pi-chart, is shown as below in figure 2. Most of the idle chain hours are user waiting period and remaining is breakdown period.

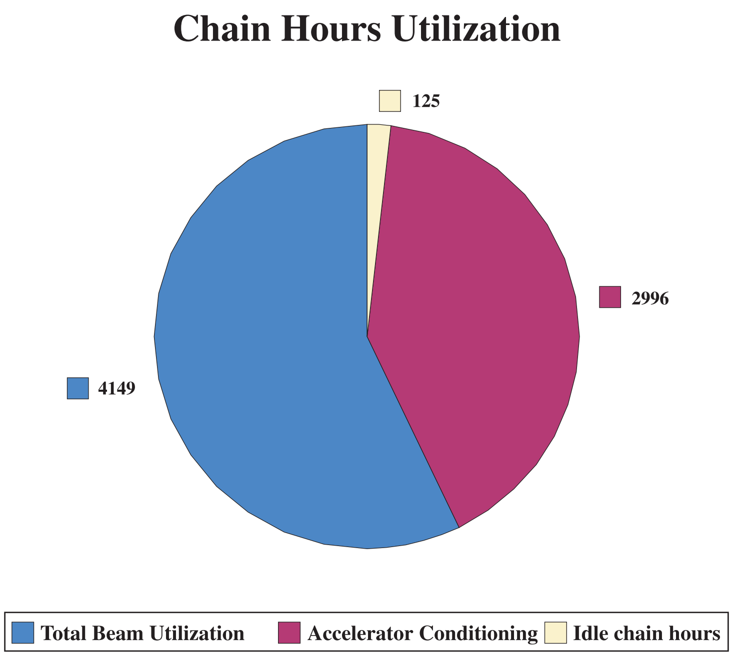

Fig. 2. Chain hours Utilization

The total duration of beam run for mentioned period is 4149 hrs. Duration of beam delivered time in percentage for different ions is shown in table 1 (below).

Beam delivered	***Utilization (%age of total time)***	***Beam delivered***	***Utilization (%age of total time)***
^{7}Li	2.96%	^{35}Cl	0.20%
^{9}Be	0.82%	^{40}Ca	3.86%
^{10}Be	1.15%	^{48}Ti	0.48%
^{10}B	0.51%	^{56}Fe	2.38%
^{11}B	1.27%	^{58}Ni	8.98%
^{12}C	4.19%	^{79}Br	0.10%
^{14}N	1.56%	^{88}Sr	0.82%
^{16}O	24.09%	^{107}Ag	20.84%
^{19}F	3.97%	^{120}Sn	0.19%
^{28}Si	8.34%	^{127}I	1.02%
^{32}S	2.93%	^{197}Au	9.35%

Pi- chart in figure 3 shows the distribution of delivered beam species during beam run from 1st April 2007 to 31st March 2008.

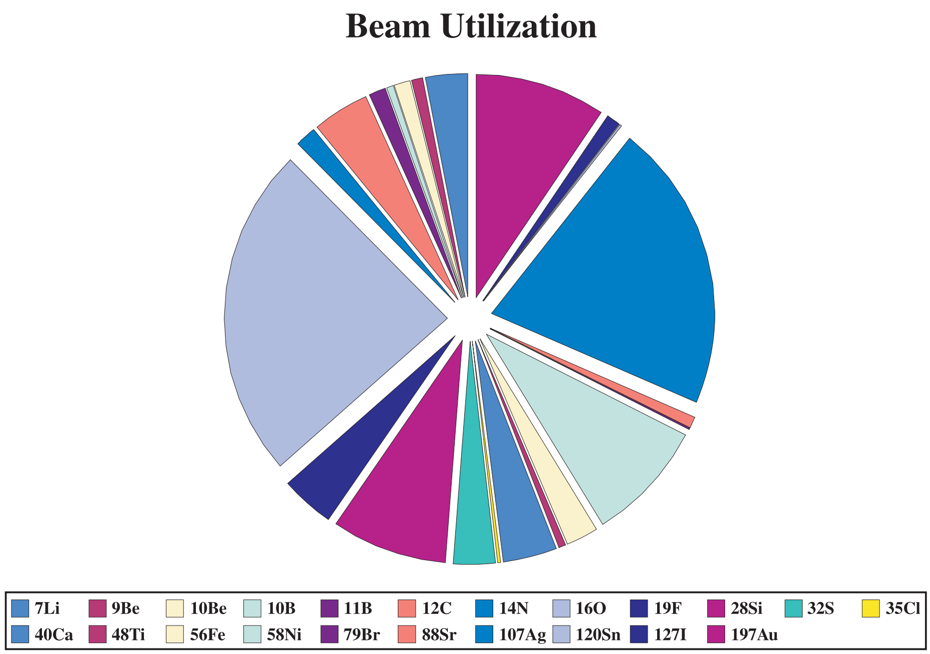

Fig. 3. Beam Utilization

1.2 MAINTENANCE AND 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, Pranav Singh, P Barua and A Kothari

In this year, there were four tank openings during which maintenance of Pelletron and associated components were performed. Out of these four tank openings, two tank openings were scheduled while other two were unscheduled. The first schedule maintenance was from 1st October 2007 to 24th October 2007 and the second one was from 1st January 2008 to 21st January 2008. In these scheduled maintenances, routine maintenances like checking of resistor network inside tank, HV breakdown test of CSP gaps, foil stripper change etc. were carried out. Terminal foil strippers loading was carried out only in January 2008 tank opening. However, the October 2007 maintenance was scheduled for the complete check up of accelerator for forthcoming INGA runs. Few major maintenance works were performed during these scheduled maintenances, which are listed below.

Major Maintenance Jobs During Scheduled Tank Openings:

The major maintenance jobs carried out are listed below:

1. Charging system maintenance

All the mounting bolts of both the charging systems were checked thoroughly & tightened and both the charging systems were operated one by one & thoroughly checked. There was no idler wheel dust from idler wheels. The position and condition of all idler wheels of both of the charging systems was satisfactory. Some charging pulley dust was seen at terminal. Both the pulleys were properly cleaned & oiled to take care of pulley dust problem. Some sticky idler dusts were observed on both charging chains which were thoroughly cleaned. Both the charging systems were kept ON for over night. The condition of both charging systems was satisfactory.

2. Maintenance of Rotating parts inside accelerator tank

Maintenance of the rotating parts of rotating shafts of the accelerator was one of the major maintenance works. Total number of seventeen separator boxes were opened and bearings of all of these separator boxes were changed. Out of these fourteen separator boxes, eight boxes were in low energy side and nine were in high energy side of machine. Rubber coupler of separator box between unit #18 and 19 was also replaced as it got cracked. The performance of both rotating shafts was satisfactory after their maintenance. All five motors (two chain motors, two rotating shaft motors and a blower motor) were also greased.

3. Unit repairing

The resistor value across gap #13 in unit #21 was measured as 600 Mega ohms instead of 6 Gega ohms. This gap was electrically shorted in order to save corresponding post from further damages.

4. Replacement of ion pumps at lower terminal area (IP T-2)

In one of the beam run, IP T-2 stopped working. Condition of this pump was checked with mega ohm meter. Ion pump was showing short at 1 kV. This damaged ion pump was replaced by new ion pump. Performance of this new ion pump was satisfactory.

5. Annular Service Platform (ASP) maintenance

During October 2007 tank opening maintenance, one of the ASP wheel got stuck in view port and consequently a section of plate of ASP got damaged. This resulted in the misalignment of ASP wheel. The damaged portion of ASP plate was welded to the main frame of ASP and the misalignment of wheel was rectified. After this maintenance work, ASP worked satisfactorily.

6. Replacement of equipotential rings screws

Resistance between hoop screw head and equipotential rings, for full accelerator column, was measured. Hoop screws, which had very high resistance value, were replaced in few units.

7. *Gas stripper maintenance*

Turbo pumps (TP T-1), related to gas stripper (GS T-1) in terminal area, were not operating at full speed. The problem was located in the turbo pump controller. Base emitter junction of three transistors (2N 6059), in transistor bank, was showing some leakage resistance. Due to this fault a 1 ohm, 10 W and a 0.5 ohm, 10 W resistor got heated up and damaged. All faulty transistors and resistors were changed. The controller was assembled back and connected inside tank. A pedestal cooling fan was put ON for proper cooling of gas stripper controller (TP controller). Gas stripper was put ON for testing. TP controller worked satisfactorily. TP current went as low as 1.1 A which indicated that both the turbo pumps were operating at full speed. Stripper gas was also injected unto 90 micron of pressure. At this time the vacuum of IP T-2 was 2.7×10^{-7} T. The base vacuum of IP T-2 was 8×10^{-8} T. Gas stripper was tested for ~5 minutes with stripper gas pressure of 90 micron. System ran satisfactorily.

Maintenance jobs during unscheduled tank openings

1) First unscheduled tank opening maintenance took place during May 2007. The reason for this maintenance was the failure of Generating Volt Meter (GVM) motor. During a beam run, there was terminal glitch. Terminal potential went down to 11.3 MV from 12.7 MV. The beam was stopped at FC 02-1 and conditioning of terminal was started. Terminal was not rising and then suddenly terminal dropped down to 0 MV (condition of spark). The charging chains were put ON, after seeing the favorable conditions inside tank. The GVM reading was showing 0.001 MV on DPM as well in control console even at 5kV of CPS. Proper investigation confirms the problem in GVM motor. Accelerator tank was opened after gas handling. It was found that GVM motor was not operating due to bad bearings of motor. New GVM motor was installed to solve the problem. Tank was closed and transfer of SF_6 gas was done. Terminal was charged up and GVM was showing the proper voltage read.
2) Second unscheduled tank opening maintenance took place in July 2007. Problem in gas stripper and poor condition of the foil strippers were the reasons for this maintenance. Gas stripper problem was identified in the gas valve controller. This problem got solved by replacing a relay. New foil strippers were loaded in the terminal area.

Maintenance For Electronics Related Problems

Fluctuation in corona probe current

During regular operation lots of fluctuations in corona probe current were observed. First of all the condition of corona probe was assessed by disconnecting the corona probe from corona probe controller (triode valve) and output of a 0 to 20 kV power supply was connected to the plate of this triode valve. This is done to simulate the corona probe by 0 - 20kV power supply. Terminal was jacked up to 10 MV and TRV 03-1 was set to 10.1 MV. At ~15 kV (output of power supply), Terminal Potential Stabilizing (TPS) started working. This confirms that the condition of corona probe is good. The triode valve plate was disconnected from HV power supply and connected back to corona probe. Now, total TPS system was thoroughly checked. Ripple of ~4.5 V was observed in +15 Vdc supply. Main filter capacitor related to this supply was changed. This improved the ripple and the ripple got reduced to few mv range. TPS system was checked again for TP = 10 MV. The TP was quite stable and corona probe was stable.

Vacuum problem in vault (04) area

Performance of ion pump in vault area (IP 04-1) was not up to the mark. It was showing a vacuum in the order of 10^{-6} T instead of 10^{-8} T. The pump was showing short at 5 kV. Therefore, it was replaced with another recycled pump. Now this pump is pumping the area satisfactorily and vacuum achieved by this pump is in the order of 10^{-8} T.

1.3 ION SOURCE ACTIVITIES

S Chopra, R Joshi, S Gargari, M Sota, S Ojha, K Devarani, 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 2007 to March 2008 having one breakdown. The source was opened three times in this duration. Two times the source was opened for routine maintenance and once for breakdown maintenance.

Maintenance work

Routine maintenance

Routine maintenance work for ion source was carried out twice in July 2007 and October 2007. Apart from regular cleaning of source, einzel lens was also replaced by a spare one in July 2007. This replacement was required as einzel lens was quite dirty and was not holding the required potential. In October 2007, 5 gm. of cesium was loaded in cesium reservoir along with the regular cleaning of source.

Breakdown maintenance

1. Ionizer problem

In December 2007, ionizer was not operating at full power. Therefore, the source assembly was opened and this ionizer assembly was replaced by a new one.

2. *No cathode change*

The cathode position of MC-SNICS cathode wheel could not be changed. The problem was found in index controller of MC-SNICS. One of the NC contact of latch relay (K103) had contact problem. This relay was replaced to solve the problem.

3. *No remote readback of cathode position*

The position readback of cathode in use was not proper. This lead to wrong information about cathode in use which is misleading especially for AMS runs. Problem was investigated and found that a pressure switch (LS2), which gives indexer in position information, got stuck and was not operating properly. This pressure switch was changed and now proper cathode position readback is available at control console.

4. *Other Electronics related problems*

In one of ^{16}O beam run, filament power supply tripped. Problem was traced to an interlock relay. This interlock was provided for old SNICS ion source and now with new MC-SNICS in operation, this interlock is not required. Therefore, this interlock relay was bypassed. Fluctuation in extractor power supply was also noticed due to punctured cable at the output of extractor power supply. This cable was changed for proper operation of einzel lens.

5. *General Purpose Tube (GP tube) conditioning*

Sparking was observed in General Purpose Tubes (GP tubes) due to its de conditioning and was not holding voltage more than 220 kV. All five General purpose tubes were cleaned thoroughly 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, the General purpose tube now has started holding upto 350 kV.

1.4 BEAM PULSING SYSTEM

R Joshi, S Ojha and A Sarkar

Operation

There were 109 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 ^{11}B, ^{12}C, ^{14}N, ^{16}O, ^{19}F, ^{28}Si, ^{40}Ca and ^{58}Ni. Out of these 109 shifts, LINAC utilized 49 shifts. In these 49 shifts, ^{28}Si beam was bunched for 104 hours and used by LINAC group for testing. For the remaining time, ^{16}O beam was bunched and its energy was boosted by LINAC by 20 MeV. This beam was then delivered to users for experiment in GPSC-II experimental area. Multi harmonic buncher is used for all the pulsed beam runs. 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. For LINAC test run using ^{28}Si pulsed beam, high energy sweeper was used, instead of pre acceleration chopper, to get rid of dark current. All components of the beam pulsing system worked satisfactorily for all experiments.

Maintenance

There was no breakdown maintenance in the entire beam pulsing system, although routine maintenance of chopper was carried out.

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, Pranav Singh and Bishamber Kumar

1) Performance of newly installed chiller inside tank

A new chiller was installed outside tank, to regulate accelerator tank temperature, in Year 2007. This new chiller is in operation for around a year and the old chiller, which was inside tank, is inactive since then. Performance of this new chiller is quite satisfactory. It is regulating the tank temperature quite well. The tank temperature is regulated to ~25 degree C during regular operation of accelerator.

2) Installation of new 50 position stripper foil assembly

A new 50 position stripper foil assembly is planned for the installation 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. Example of such beam line is $\pm$ 45 degree beam line where ME / Z^2 of switching magnet is only 135. Another use is for isobar separation in case of beryllium AMS. If ^{10}B and ^{10}Be can be fully stripped, charge state achieved for ^{10}B will be 5^+ whereas for ^{10}Be it will be 4^+. These charge states can be separated out effectively.

The foil stripper assembly has already been procured from NEC, USA. The controller for it has also been developed and fabricated in house. Testing of foil stripper assembly along with its controller is still to be done. This 50 position foil stripper is being planned to be installed in the next tank opening maintenance.

3) Testing of charging chains

There is a program to replace resistors of column support posts and accelerating tube resistance network of accelerator from 3 Gega ohm to 1 Gega ohm value. This replacement work will further improve the stability of accelerator and may also help to boost up the input beam currents to accelerator column. Calculation shows that to accommodate 1 Gega ohm of resistors, total charging current from charging system should be at least 130 micro ampere. As in IUAC accelerator there are two charging chains, charging current from each charging chain should be 65 micro ampere. Both the charging systems were checked separately to asses their performance. First of all the terminal was shorted to ground with the help of shorting rods. Testing of both the charging system shows that charging system #1 is more efficient than charging system #2. At 2kV, CPS average charging currents for both charging chains is in the order of 5 micro ampere but as CPS increases the average charging current of chain #1 is better than chain #2. At CPS of 32kV average charging current of chain #1 is 73 micro ampere. Charging current of chain #2 saturates to average charging current of 33 micro ampere at CPS of 22kV and it did not increase at higher CPS (whereas average charging current of chain #1 is 52 micro ampere at CPS of 22kV). This clearly indicates that performance of charging system #2 has to be improved in order to accommodate resistor network of 1 Gega ohm.

4) Phase correction for High Energy Sweeper (HES)

A circuit for the phase correction of HES is under development. If HES phase is proper, the current induced in both HES slits should be the same and if phase got disturbed one of the slits will have more current compared to another one. Current from the HES slits will be sensed and compared. The difference between these two slits current will give an error signal which then is processed and used for phase correction of HES.

5) Ion Source Test Bench (ISTB) facility

Presently the controls of all the devices in Ion source Test Bench (ISTB) are hard-wired individually upto control console. There is a plan to convert ISTB control system to a computerized control system. For this purpose prototype control system was developed in house. This system has provision 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. The entire prototype CAMAC control system is wired on PCB. This will be converted to modular type later on. All wiring related to this control system is already planned. As this control system will also be used to control the devices on HV deck, therefore wiring of spark protection crate for this purpose is under process. ISTB was also used by user for irradiation of samples and beam used for these irradiation were ^{12}C, ^{63}Cu, ^{74}Ge and ^{107}Ag.

1.6 ACCELERATOR MASS SPECTROMETRY (AMS)

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

AMS facility for ^{10}Be measurements is in operation. Samples are being prepared by different groups. We have performed ^{10}Be measurements with both Lake and Ocean sediment samples. AMS Facility development for ^{26}Al and development of chemistry lab is in progress. ^{26}Al Standards (Al_2O_3) were prepared from standard solution. Progresses in AMS activities are being reported below in detail.

1.6.1 Modifications made in the system

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Last year a slight modification in our detection system was made. In the detection system we are having a Multi Anode Gas Ionization Chamber (MAGIC), which has five spilt anodes, Frisch grid, cathode and one Silicon Surface Barrier Detector (SSBD). In the earlier ^{10}Be detection experiments we have been using it in dE-Eres mode i.e. all anodes shorted to give one dE signal and SSBD as Eres, but because of the small active area of SSBD there was a transmission loss which was responsible for the low count rate and therefore required much more time to get reasonable statistics. This time MAGIC was used in gas–gas mode i.e. anode 1, 2, 3 and 4 all together making dE signal & 5th anode as Eres and this modification increased the ^{10}Be count rate but decreased the resolution. Finally we transferred SSBD closer to the entrance window and without compromising the resolution of the detector, we were able to increase the ^{10}Be count rate. In new configuration Anode1, 2 and 3 altogether gives dE signal and SSBD makes Eres.

1.6.2 ^{10}Be Study of Antarctic Lake and southern ocean sediment samples

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Climate is a dynamic system and has changed in the past considerably. Many tools have been used to decipher the past climatic variation such as Foraminiferal abundances, oxygen and carbon isotopes, paleomagnetic records and Biogeochemical elemental concentration to decipher the past sea surface temperature and salinity variation and solar activity to the earth. Besides these established tools, we have used cosmogenic radio-nuclide ^{10}Be concentration in southern ocean sediments to understand the past climate variability and its possible linkage with solar radiations occurred in the geological past.

As a beginning, ^{10}Be concentration measurement using AMS is attempted in lake sediments collected from the waterbody (Latitude 68^0 37' 26.7" South and longitude 77^0 58' 14.6" East). These sediment samples were chemically processed at the ultra clean chemistry lab of Dept of Earth Science, Pondicherry University and have been analyzed for ^{10}Be concentration measurement at IUAC. Results obtained from AMS measurement are being processed.

1.6.3 Preparation of ^{10}Be and ^{26}Al AMS standards

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Last year we prepared several ^{10}Be and ^{26}Al standard samples of different concentration. SRM 4325 ^{10}Be standard solution ($^{10}Be/^{9}Be$=2.68E-11) were diluted in 5 different concentrations using ^{9}Be dilution solution SRM 3105a. Different concentrated standards are useful to do the system calibration and to perform the AMS measurement of different concentration geological samples. For this required amount of SRM 4325 (Be solution in HCl) was taken and dried and then it was mixed with the required amount of SRM 3105a (^{9}Be solution in HNO_3). This mixture was kept on hot plate again to mix properly and added with few ml. of NH_3 to get the precipitation of $Be(OH)_2$. Then it was put in Centrifuge, and was washed several times with water. The heating of precipitate upto 900^0C gave BeO. Finally Ag/Nb powder was mixed to enhance thermal conductivity in the BeO powder and then this mixture was loaded in cathode capsules. ^{26}Al standard samples of six different concentrations were also prepared with the standard solution procured from University of California, Berkeley. Required amount of standard solution (in HCl) was added with a few ml. of NH3 to get the precipitation of $Al(OH)_3$. This ppt. was centrifuged and washed several times with water and ppt was dried upto 900^0C in steps to get Al_2O_3 powder. Ag/Nb was added in powder and loaded in the cathode tubes.

1.6.4 Determination of Sedimentation Rate using ^{10}Be Studies on Lagoonal Sediments from Kaluveli, Pondicherry

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The adsorbed ^{10}Be have been used to estimate rate of sedimentation in the Kaluveli Lagoon. Lacustrine and alluvial deposits of clayey sediments of 4.3 meters long core sequences from Kaluveli lagoon situated 15 km north of Pondicherry, has been studied for clay minerals and ^{10}Be abundance. This lagoon runs parallel to the east coast adjoining Bay of Bengal.

Absorbed ^{10}Be was leached from nine samples of this core and analyzed using newly developed AMS facility at Inter University Accelerator Center (15 MV Pelletron), New Delhi. This AMS facility has been standardized using NIST ^{10}Be standard (SRM 4325). Chemical separation of 'Be' from sediment sample was done in ultra-clean lab for isotope study at Pondicherry University.

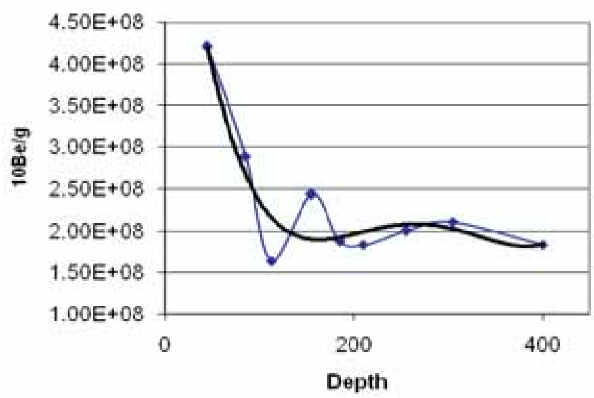

Fig.1. Depth vs ^{10}Be/g (dry sample)

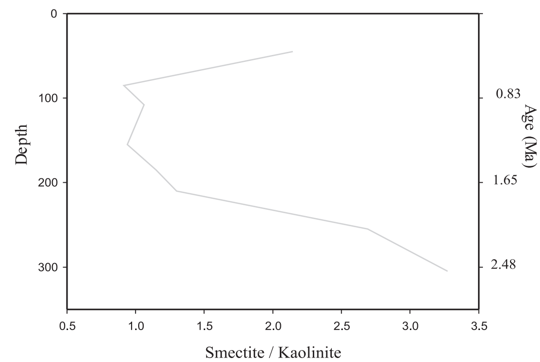

Fig.2. Depth vs Smectite/Kaolinite ratio

Concentration of ^{10}Be varies between 4.2 x 10^8 to 1.8 x 10^8 atom g^{-1} (dry sample) from 45 cm to 400 cm depth (Fig. 1). The average sedimentation rate of 1.1 ± 0.12 x 10^{-3} mm y^{-1} has been calculated using ^{10}Be concentration in the sediments. The depth between 40 to 50 cm and below 220 cm, sediment corresponding to age ~ 0.37 Ma and 1.7 Ma respectively shows dominance of smectite over kaolinite which indicate that semiarid conditions prevailed at the time of their formation . Kaolinite abundance is higher in the sediments found at depth of 80 to 220 cm (~ 0.7 to ~ 1.7 Ma) which were possibly deposited under relatively humid climate (Fig. 2). Further studies are in progress.