**Panjab University and Punjabi University visit lab report :**

We (Sunil Devi and Dr. Raj Kumar Gupta) visited Panjab University and Punjabi University M. Sc. physics labs for upgrading M. Sc. Nuclear Physics lab in School of Physics and Materials Sciences (SPMS), Thapar University. There were two major obervations :

1. Both of these labs have multiple sets of some of the set-ups like Geiger Muller (GM) detector and gamma spectrometer. Both of these set-ups can be used for performing multiple experiments. Therefore, it is important to have more than 1 experimental set-up of above mentioned mentioned but we have 1 of each at present. Punjabi University has 4 GM detector set-ups and 3 gamma spectrometer. Same is the case with Panjab University, they also have multiple set-ups of GM detector set-up and gamma spectrometer.
2. In both of the universities, M. Sc. nuclear labs also have some advanced experiments based on Compton scattering, gamma-gamma coincidence, alpha spectroscopy, beta spectroscopy.

Based on our visit to these labs, the list of suggested experiments to be added in M. Sc. Nuclear physics lab is :

| Sr. No. | Experimental set-up | No. of set-ups suggested | Supplier | Price excluding taxes (in INR) |
|---|---|---|---|---|
| 1. | GM counter set-up and accessories | 3 | Nucleonix | ~ 90,000 each |
| 2. | Gamma spectrometer and accessories | 2 | Nucleonix | ~ 3,50,000 each |
| 3. | Compton scattering and accessories | 1 | Didactic Systems India Pvt. Limited | ~ 12,00,000 |
| 4. | Rutherford scattering and accessories | 1 | Didactic Systems India Pvt. Limited | ~ 5,00,000 |
| 5. | Alpha spectroscopy and accessories (advanced set-up) | 1 | Didactic Systems India Pvt. Limited | ~7,20,000 |
| 6. | Alpha spectroscopy (very basic set-up) | 1 | Cspark Research Pvt. Limited | ~60,000 |

List of the experiments that can be performed with each set-up is :

**1. GM counter set-up :**

(a) Study of the characteristics of a GM tube and determination of its operating voltage, plateau length / slope etc.
(b) Verification of Inverse Square Law for gamma – rays.
(c) Study of nuclear counting statistics.
(d) Estimation of Efficiency of the G.M. detector for (i) Gamma source & (ii) Beta Source
(e) To Study Beta Particle Range, Maximum Energy and Backscattering of Beta particles.
(f) Production and Attenuation of Bremsstrahlung.

**2. Gamma spectrometer :**

(a) Study of energy resolution characteristics of a scintillation spectrometer as a function of applied high voltage and to determine the best operating voltage.
(b) Study of various gamma spectrum and calculation of FWHM & resolution for a given scintillation detector. Energy calibration of Gamma Ray Spectrometer (Study of linearity).
(c) Spectrum analysis of Cs-137 & Co-60 and to explain some of the features of Compton edge and backscatter peak qualitatively.
(d) Unknown energy of a radioactive isotope.
(e) Variation of gamma intensity as a function of distance (Verification of inverse square law).
(f) Activity of a Gamma Source (Relative Method as well as Absolute Method).
(g) Mass Absorption Coefficient.

**3. Compton scattering :**

(a) Quantitative observation of the Compton effect.
(b) Recording and calibrating a gamma spectrum.
(c) Absorption of gamma radiation.
(d) Detecting gamma radiation with a scintillation counter.

**4. Rutherford scattering :**

(a) Measuring the scattering rate as a function of the scattering angle and the atomic number.

**5. Alpha spectroscopy (advanced set-up) :**

(a) Alpha spectroscopy of radioactive samples.
(b) Determining the energy loss of alpha radiation in air.
(c) Determining the energy loss of alpha radiation in aluminum and in gold.
(d) Determining age using a Ra-226 sample.

**5. Alpha spectroscopy (basic set-up) :**

(a) Determining the energy loss of alpha radiation in air.

For details, manuals of all these experimentals provided by the suppliers and quotations are also attached. At present, it is very difficult to enagage 20 students with 2 experimental set-ups. The addition of these experiments will be very important for proper functioning of nuclear physics lab at M. Sc. level. From future perspecttive, if these experimental set-ups are added, the department can start a M. Sc. Physics course with specialization in nuclear physics by adding a few more adavnced experiments.