the L-lines of Cl and K in the X-ray spectra measurements, resulting in a high LD in this region. This new setup is being used for the analysis of archeological pottery artifacts, paintings and biological tissues (teeth and bones), which are not compatible with the high vacuum of the regular PIXE target chamber. In addition most art and archeological objects are too large for the evacuated analysis chamber. Preliminary applications of the new facility will be presented.

[02/09/03 - Poster]

Comparison of absolute NAA by using cadmium ration technique with comparative NAA to determine trace elements in biological samples aiming clinical analysis

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Absolute neutron activation analysis, by using the cadmium ration technique, was compared with conventional neutron activation analysis, using the comparative method, to determine trace elements in medium and small-sized animal bones (Wistar, Poultry and Beagles) aiming clinical evaluation. The cadmium ratio technique was used for the measurement of thermal flux distribution. In this technique, gold foils, both bare and cadmium covered, were irradiated together with the biological sample in the IEA-R1 nuclear reactor at IPEN/SP, and the gamma-ray activities induced in the gold foils by both the thermal and epithermal neutrons were obtained. In the comparative neutron activation analysis, standards prepared by pipeting convenient aliquots of standard solutions (SPEX) onto filter paper were irradiated with the samples. The accuracy and precision of the results obtained were verified by the analysis of certified biological reference materials. Conventional neutron activation analysis is preferred to the absolute method due to avoid the necessity of determining the neutron flux parameters and detector efficiency, as far as samples and standards are submitted to the same conditions. On the other hand, the cadmium ratio technique uses smaller quantities of the samples, allows the simultaneous evaluation of several elements concentrations in the biological samples at once, which is not always possible in the conventional clinical analysis, and eliminates the need to prepare and use standards, what makes analysis more rapid and economic. The advantages and disadvantages of each method are discussed.

[02/09/03 - Poster]

Computed Tomography with High-Energy Proton Beam: Tomographic Image Reconstruction from Computer-Simulated Data

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The use of protons instead of x-rays for computed tomography (CT) studies has potential advantages, especially for medical applications in proton treatment planning. However, the spatial resolution of proton CT is limited by multiple Coulomb scattering (MCS). We used the Monte Carlo simulation tool GEANT4 to study the resolution achievable with different experimental schemes of a proton CT scanner. The passage of a parallel 200MeV proton beam through a virtual cylindrical aluminum phantom with 50mm external diameter was simulated. In our study, the phantom contained a set of cylindrical holes with diameters ranging from 4mm to 0.5mm. The GEANT4 simulation consisted of a series of 180 projections at 2 degree intervals with 350 proton track histories for each projection. The filtered back projection algorithm was used to reconstruct a 2D-tomographic image of the phantom.

An uncritical use of the conventional x-ray CT reconstruction method, i.e., binning the protons into regular spatial intervals according to their exit position and replacing linear photon attenuation with linear integrated stopping power, did not yield a useful CT image. However, when the entrance instead of the final position of the proton was used, the phantom holes 1.5mm and larger in diameter became visible. This means that a moderate spatial resolution can be achieved by using a position-sensitive proton detector in front of the object, and a proton energy detector without position sensitivity behind the object. If both entrance and exit position were taken into account to determine a straight-path approximation, phantom holes with 1mm diameter or larger could clearly be seen in the reconstructed image, and the presence of the 0.75mm and 0.5mm holes could be guessed. Thus, an experimental scheme with two position-sensitive detectors, one situated in the front and the other behind the object, leads to a reasonably high spatial resolution in this case of a high-contrast phantom. Further improvement of the spatial resolution can be expected when using reconstruction techniques that allow incorporation of better models of proton MCS than the straight-line approximation.

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