Originally Developed Method of Quantitative Analysis for PIXE.

－Progress of nation-wide common utilization of PIXE at NMCC in the last 10 years－

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NMCC (Nishina Memorial Cyclotron Center) was established in 1990 by Japan Radioisotope Association (JRIA) for the purpose of PET (Positron Nuclear Medicine) and PIXE (Particle Induced X-ray Emission analysis. The Nationwide-common utilization for PET and PIXE has been carrying out since April 1993, and more than 60000 samples have been analyzed by PIXE. Nearly 200 subjects of PET and 400 subjects of PIXE in total have been pursuing. Especially for PIXE, more than 400 academic papers have already been issued in various research fields.

In recent years, uses of PIXE in the fields of environmental science, dentistry, veterinary medicine, sitiology and pharmacology in addition to clinical and fundamental medicines have gradually increased. Furthermore, those of analytical chemistry, geology and mineralogy, material engineering, wood chemistry, studies for cultural properties protection and archaeology have rapidly increased. In this manner, multipurpose use of a small accelerator in various research fields has been actively carrying out.

The secret of the key to our success is the circumstances of our facility where every researcher, even though he has no knowledge about PIXE, can use our PIXE in a carefree manner. Our catchphrases are; “If you bring your samples to us in the morning, we’ll give you their final results in the evening.” and “We’ll carry out quantitative analysis of all kinds of samples; everything is OK.” In order to declare such catchphrases, we have developed many methods of target preparation, of measurements of x-rays, of spectral analysis, of determining physical quantities, and of quantification of concentration. Especially, “The standard-free method” for quantitative analysis made it possible to perform quantitative analysis of infinitesimal samples, powdered samples and untreated bio samples which could not be well analyzed quantitatively in the past. Moreover, “The powdered-internal-standard method combined with correction for self-absorption of x-rays” is working miracle in analyses of high-Z-matrix-powdered samples such as soil, rock, ash, dust and aerosol.

Last year, a three-detector measuring system making use of a pure-Ge detector combined with two Si(Li) detectors has been developed. The efficiency curve of the pure-Ge detector has been determined easily as relative efficiencies to those of the existing Si(Li) detectors, since this system allows us to analyze a sample with the pure-Ge and the Si(Li) detectors simultaneously under the same irradiating conditions. It is found that detection efficiencies of the pure-Ge detector decrease just above the absorption edge of Ge owing to absorption of X-rays in the dead layer of the detector. Accuracy of the efficiency curve thus obtained was confirmed by analyzing a few samples whose elemental concentrations are known. It is confirmed that a pure-Ge detector can be used in place of a Si(Li) detector for the purpose of analysis of elements $Z \geqq 19$, since its energy resolution is almost equal to that of a high-performance Si(Li) detector and efficiencies at high energies are far better. Moreover, it becomes possible to detect prompt γ-rays and to analyze light elements such as fluorine, which arouses much interest from the point of view of environmental contamination. Detection limit of fluorine is found to be less than 0.1 ppm for water samples. We have also established the method of quantitative analysis of fluorine in environmental samples.