# A μ Ionization Chamber for Synchrotron Radiation Diffraction / Scattering Experiments

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## 1. Introduction

In X-ray diffraction / scattering experiments using synchrotron radiation, the beam intensity before the sample is very important in the implication of presuming scattering intensity and normalizing experiment data by beam intensity.

Since the X-ray collimator which decides the final X-ray intensity is installed as near as possible to the samples, X-ray intensity is needed to be measured in a few tooth spaces of an X-ray collimator and a sample. In addition, place-interference with other measurement apparatus, such as the sample holder and goniometer makes it difficult to install a normal sized ionization chamber, and to measure the X-ray beam intensity before samples [1,2].

In view of such present conditions, a micro ionization chamber for X-ray diffraction / scattering experiments using synchrotron radiation was developed.

## 2. Conceptual Design

The fundamental concept of the micro-ionization chamber is that it should be built to enable the same handling as usual ionization chambers but without special cautions. For example, although the case of the ionization chamber can be formed with an insulator for miniaturization, it is not acceptable since a caution against electric noise generated in surrounding environment is needed. Moreover, although the ionization chamber can also be miniaturized by limiting the filling gas to atmospheric air only, it is not acceptable since it limits the measurement of the X-ray flux.

We designed an ionization chamber so that the normal components such as the two gas connectors, the high voltage connector, signal connector, X-ray inlet and outlet windows are fully equipped, the only difference being that the configuration is far smaller than that of the normal ionization chamber and that it has no special cautions or limitations. And this time, those working on the SPring-8 biological beamlines requested that the length along the beam axis be less than 20 mm, the design was adjusted to comply with this request.

## 3. Electric Field Calculation

Since the most important difference from the usual ionization chambers is the shape of the electric-field in miniaturized configuration, calculations of the electric field were performed with the finite element method. If the typical short-type ionization chamber in SPring-8 beamlines were reduced to one third of the 1/3 size of the current configuration, the distance between the electrodes would also be set to one third, and it would become smaller than twice the range of the photoelectron of 12.4 keV in nitrogen gas which was calculated to be about 6 mm. Since the distance between the electrodes cannot be smaller than twice the photoelectron range to maintain independence to the X-ray incident position in the ionization chamber, that of the micro-ionization chamber was decided to be 12.5 mm, which is smallest among those of standard ionization chambers which have already been used in SPring-8.

The two-dimensional electric-field calculation in the area perpendicular to the X-ray beam axis was performed using an electric-field calculation program R3D [3]. First, the result of the calculation with a high-voltage electrode of 15 mm and a collecting electrode of the same length is shown in Fig. 1. Here, the upper white rectangle is the high voltage electrode and the voltage is 1000 volts in this calculation. The equi-potential lines are drawn for every 20 volts.

Since the distance between the electrode and the case is short at both ends of the high-voltage electrode, the electric-field is very strong and the maximum applied voltage is limited by the discharge there. We need a higher and higher voltage in proportion to the higher and higher incident X-ray intensity of the synchrotron radiation facility to avoid electron-ion recombination problems in the gas [4]. In order to improve the electric-field there, the electrode was shortened to 10 mm as shown in Fig. 2. Consequently, the discharge problem should be greatly reduced.

As mentioned above, the details of the design were decided, and a photograph of the constructed apparatus is shown in Fig. 3.

## 4. Conclusion

A miniaturized ionization chamber of 20 mm along the X-ray beam axis of 20 mm has been developed. It is fully equipped with two gas connectors, a high voltage connector, signal connector, X-ray inlet and outlet windows and the same handling as ionization chambers of standard size with no special cautions. It is being used for actual synchrotron radiation experiments at SPring-8 experiment station BL45XU-PX. In addition to the present model, in another experiment station BL45XU-SAXS, a model arranged so that the gas-shielding characteristics was enhanced and can be inserted into a vacuum pipe in the experiment station. The model reported in this article can be purchased as MIC-20 type ionization chamber from Teikoku Electric Co.. We would like to thank H. Moriyama, Y. Inoko, T. Fujisawa and M. Yamamoto for their helpful discussion.

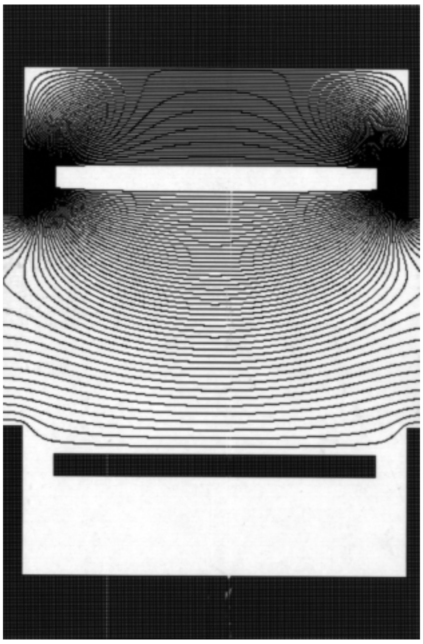

Fig. 1. Before modification.

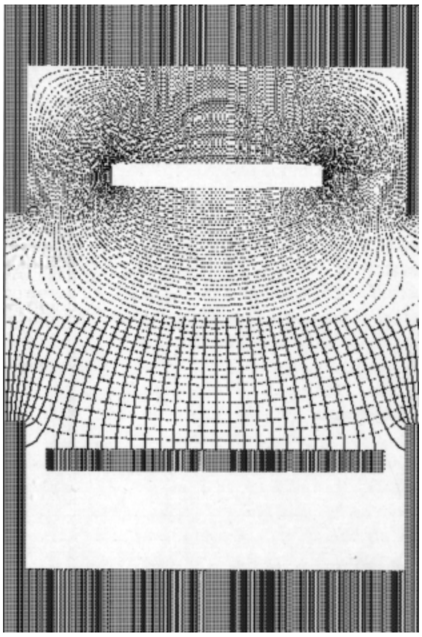

Fig. 2. After modification.

Fig. 3. Photograph of the μ1C.

## References


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