MASTER

BNL 30165

CONF-810750--11

Ion Chambers for Fluorescence and Laboratory EXAFS Detection

E. A. Stern, W. T. Elam, B. A. Bunker, Kun-quan Lu, and S. M. Heald

Form 2075

Ion chambers for fluorescence and laboratory EXAFS detection*

E.A. Stern, W.T. Elam, B.A. Bunker,† and Kun-quan Lu§

Department of Physics, FM-15, University of Washington, Seattle, Washington 98195

and

S.M. Heald††

Brookhaven National Laboratory, Upton, New York 11973

It is possible to design gas ionization chambers with a noise equivalence of 10^3 photons per second for 10 KeV x-radiation. With such a low noise level, ion detectors can be used for laboratory EXAFS facilities and fluorescence detectors at national synchrotron facilities where the detected signal is above 10^3 photons/sec. In such use the ion chambers are limited by statistical noise and produce as good a signal to noise as counting detectors. The advantages of ion chambers are simplicity, high linearity at high counting rates, and large detecting area.

*Research supported by NSF grant PCM7903674.

†Supported by DOE contract DE-AS05-80ER10742.

§Permanent address: Institute of Physics, Academic Sinica, Bejing, People's Republic of China.

††This research was supported in part by the U.S. Department of Energy under Contract No. DE-AC02-76CH00016.

It is possible to design gas ionization chambers with a noise equivalence of 10^3 photons per second for 10 KeV x-radiation.[1] With such a low noise level, ion detectors can be used for laboratory EXAFS facilities and fluorescence detectors at national synchrotron facilities where the detected signal is above 10^3 photons/sec. In such use the ion chambers are limited by statistical noise and produce as good a signal to noise as counting detectors. The advantages of ion chambers are simplicity, high linearity at high counting rates, and large detecting area. The noise limitation in the ion chamber is amplifier noise. In order to attain this limitation it is necessary to design the ion chamber with good electrical insulation and with rigid construction, particularly in the windows and collection plates. At the University of Washington we built a large area fluorescence detector and a laboratory EXAFS detector which meet the low noise criterion mentioned above.

The good electrical insulation was attained by employing Teflon. The windows used in our ionization chambers were thin Kapton or aluminized Mylar. It was found that minute motions of the windows would introduce an output signal by inducing charge on the collector plates. This spurious signal was eliminated by prestretching the Mylar and Kapton before epoxying to the frame.

A schematic drawing of a design for an ionization chamber employed as the I_0 detector in a laboratory EXAFS facility is shown in Fig. 1. The laboratory EXAFS facility uses a fixed anode x-ray tube as a source and typically generates about 10^5-10^6 photons/sec with 5 eV resolution around 10 KeV. By intercepting about 20%-30% of the incident beam the I_0 chamber detects more than 10^4 photons per second and thus is limited by statistical noise.

The small physical length of the I_0 chamber is an advantage in a focusing laboratory EXAFS facility, where the beam diverges after passing through the focus. The sample can be then placed behind the I_0 chamber at a location when the beam has not diverged too much, permitting a small sample. In our laboratory EXAFS setup the divergence is about 1 in 10, so that 1 inch from the focus the beam is about 0.1 inch in width.

The output current from the ion chamber goes directly to a preamplifier, Analogue Devices Model 310, with a 10^{10} ohm feedback resistor giving an output of one volt per 10^{-10} amperes input. The voltage output from the preamplifier is then further amplified as required by a standard voltage amplifier whose output is converted to digital form by a voltage to frequency converter.

A large area ionization chamber is made by placing the collector plates perpendicular to the beam direction, as shown in Fig. 2. The front collectors thus have to be transparent to the x rays. This was accomplished by using aluminized Mylar 0.001 inch thick. Again the Mylar must be prestretched before epoxying to the frame. Electrical contact to the frame was made by use of silver conducting paint. The electronics employed in the large area ionization chamber is the same as in the I_0 chamber above.

The large area ionization chamber was found to be very useful as a fluorescence detector at SSRL when used in conjunction with a filter-soller slit arrangement.[2] The large area enhances the counting rate from the sample, which is important when dilute samples are being measured.

REFERENCES

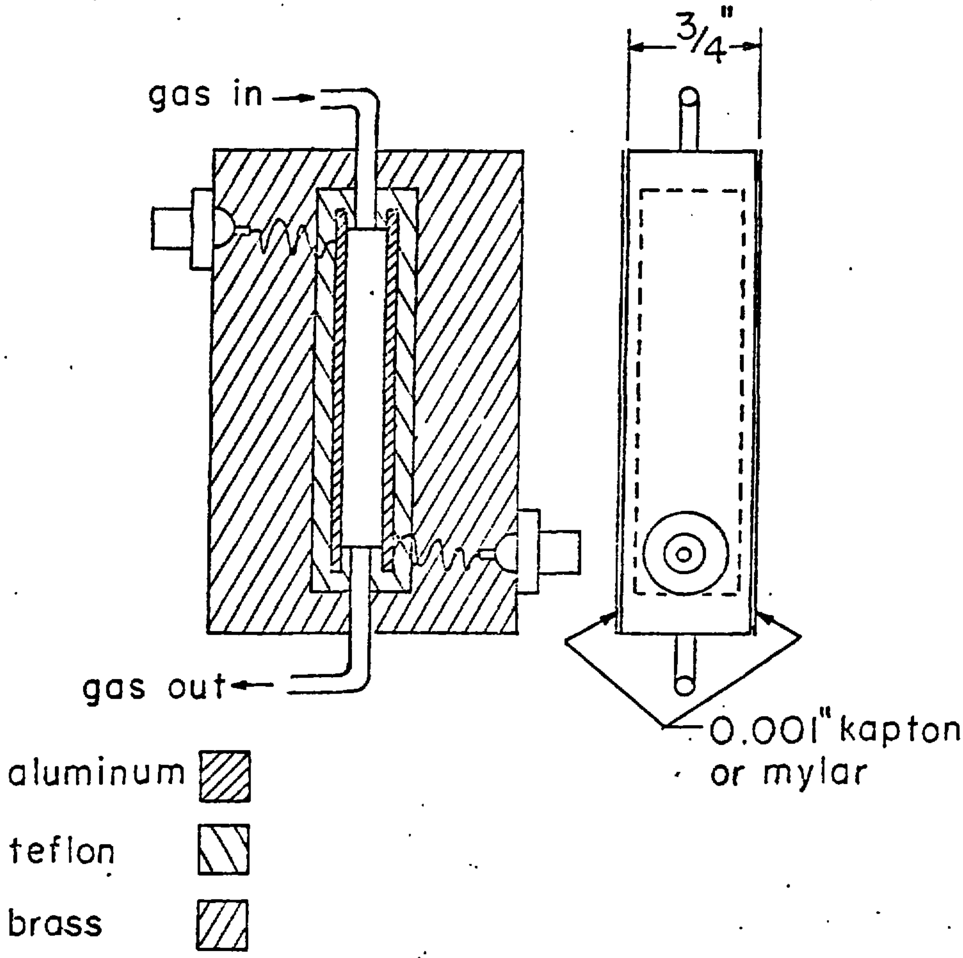
(1) E.A. Stern, AIP Conference Proceedings No. 64 (edited by E.A. Stern), chapter 4, American Institute of Physics, N.Y., 1980.

(2) E.A. Stern and S.M. Heald, Rev. Sci. Instr. 50, 1579 (1979).

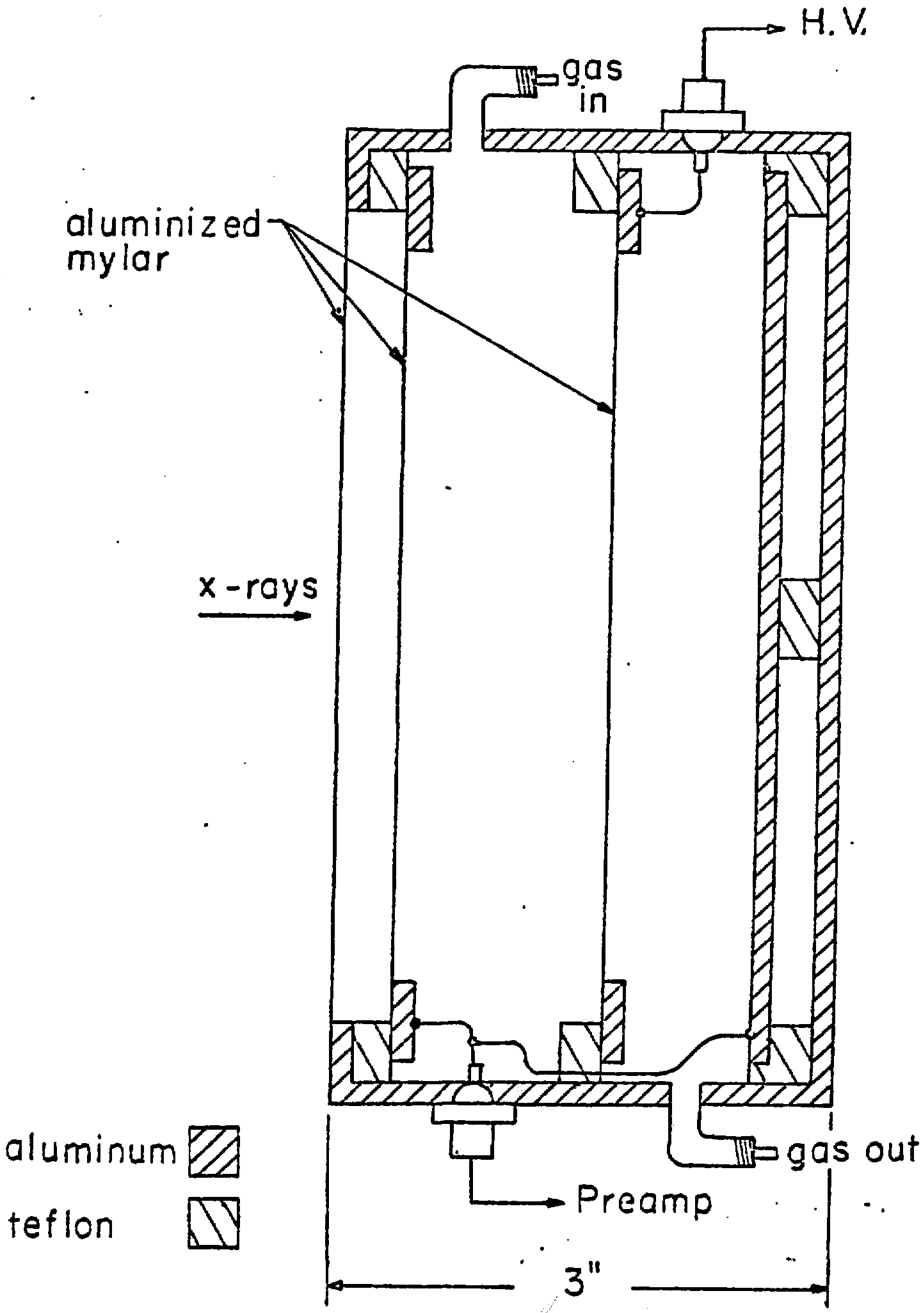
FIGURE CAPTIONS

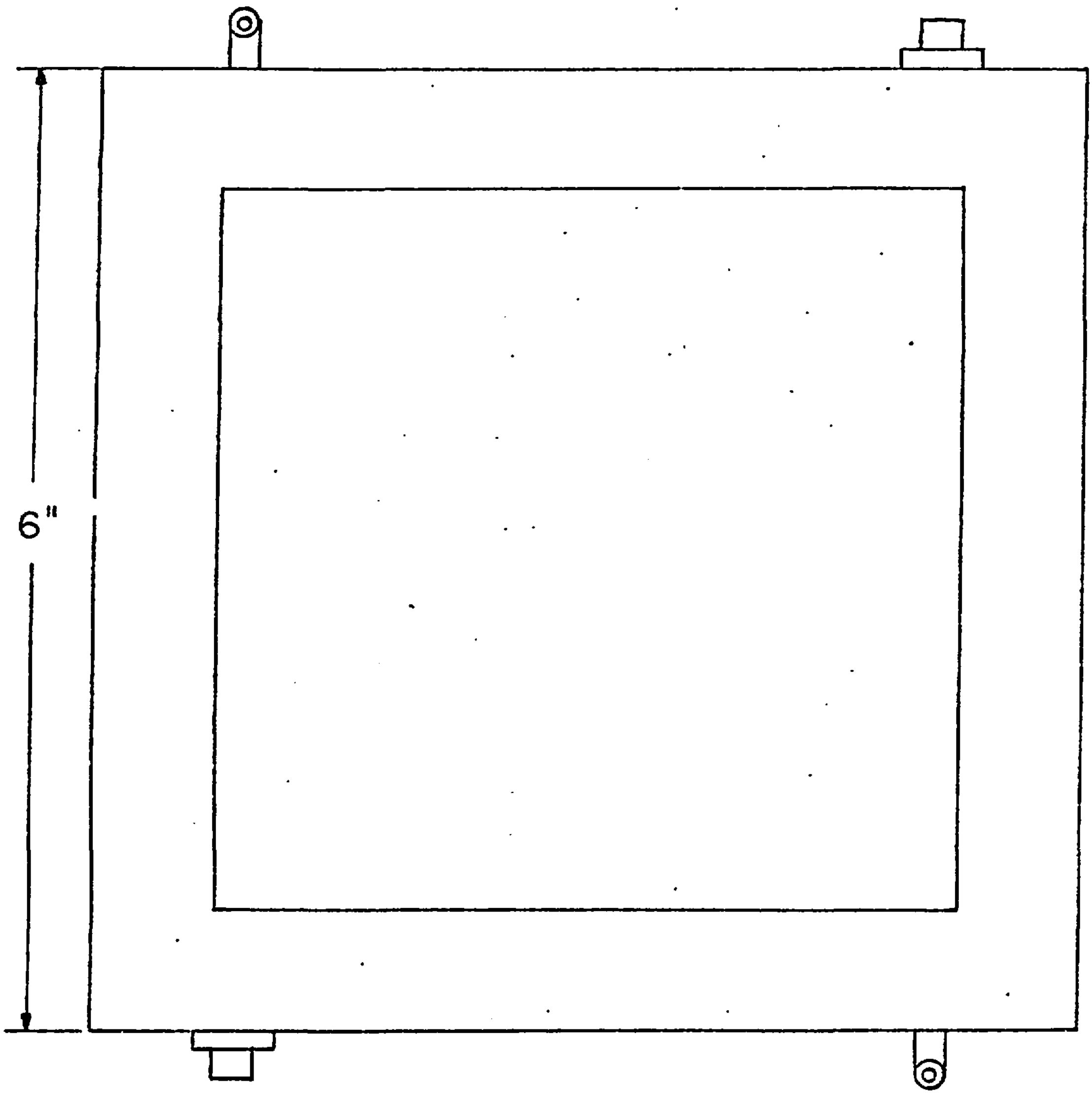
Fig. 1. Drawing of a partially transparent ion chamber for use in the University of Washington laboratory EXAFS facility.

Fig. 2. Drawing of a large area ion chamber suitable for fluorescence measurements at national synchrotron radiation sources.



gas in
gas out
aluminum
teflon
brass
3/4"
0.001" kapton
or mylar


H.V.
gas in
aluminized mylar
x-rays
aluminum
teflon
gas out
Preamp
3"


6"