# Development of MicroStrip Gaseous Chamber for Realtime X-ray Imaging Detector

Atsuhiko OCHI[1], Shunsuke AOKI[1], Tetsuro FUJISAWA[2], Yuji~NISHI[1],
Masayo SUZUKI[3], Toru TANIMORI[1], Hidenori TOYOKAWA[3] and Tatzuo UEKI[2,3]

[1]Department of Physics, Tokyo Institute of Technology, Meguro, Tokyo 152, Japan
[2]The Institute of Physical and Chemical Research (RIKEN), Wako, Saitama 351-01, Japan
[3]Japan Synchrotron Radiation Research Institute (JASRI), Ako-gun, Hyogo 678-12, Japan

## 1. Introduction

The MicroStrip Gaseous Chamber (MSGC) was proposed in 1988 [1] as a new type of proportional gaseous detector providing an excellent position resolution. A very fine pitch (<200$\mu$m) of signal lines, which could be realized by printing several hundred of strips on a substrate using the Multi-Chip Module technology [2, 3],makes possible to satisfy almost all requirements for X-ray position detectors: a good position resolution of a few tens µm, and stable operation under a high luminosity X-ray (>$10^7$cps/mm$^2$). The MSGC is expected, therefore, to one of the next generation X-ray imaging detector for the third generation synchrotron radiation facility.

We developed a new type MSGC system, which has not only anode strips but also back strips in orthogonal to each other on a poly-imide substrate. It is able to produce two-dimensional X-ray images by detecting both of the anode- and back-strip signals, while most of the existent MSGCs could give only one-dimensional position information for the anode-strips. We are also developing a novel high speed readout system based on the CPLD module in order to operate high counting rate events. This new MSGC will be used for small angle x-ray scat-tering (SAXS) experiments at RIKEN beam-line I (SR Structural biology), where the maximum x-ray intensity will be $10^6$ photons/mm$^2$/sec at the detection part.

## 2. Two-Dimensional MSGC

Figure 1 shows the schematic structure of prototype MSGC with a 50 mm × 50 mm detection area [4, 5]. The anodes and cathodes are printed both with a 200 $\mu$m pitch on a poly-imide substrate 20$\mu$m in thickness, and the back-strips in orthogonal to the anode-strips are also printed with the same pitch on the opposite side of the substrate. An electric field is formed by a bias voltage of the anode and cathode strips, and a drift plane which lied 3mm above these strips. Argon and ethane mixture gases are filled between the drift plane and the strips. At the incidence of X-rays, induced charges would be appeared not only at the anode- and cathode-strips, but also at the back-strips. As a result, two-dimensional position information can be obtained by detecting the anode and back-strip signals with coincident.

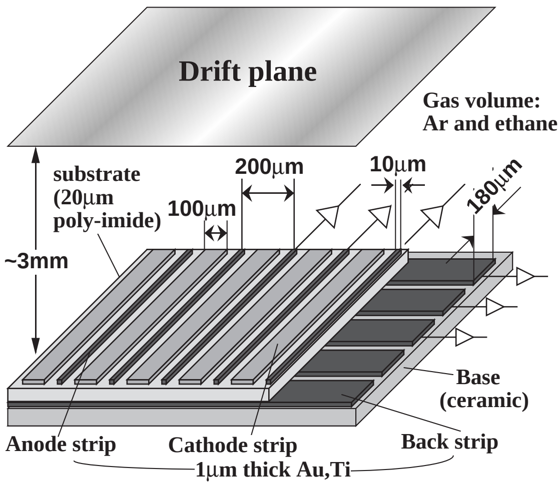


Fig.1: Schematic structure of the two-dimensional MSGC with a 50 mm x 50 mm detection area.

These all anode-strips and back-strips are connected to readout system. For handling these all signals, this detector was mounted on large size LSI package (Figure2). This package have 541 signal pins, and it is easy to mount on test board as well as ordinary electric parts. Figure 3 shows the test board which mounted on a MSGC and a gas pack-age.

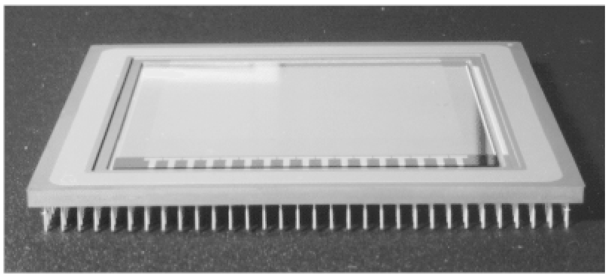

Fig.2: The MSGC package on which a 5cm × 5cm two dimensional MSGC is mounted.

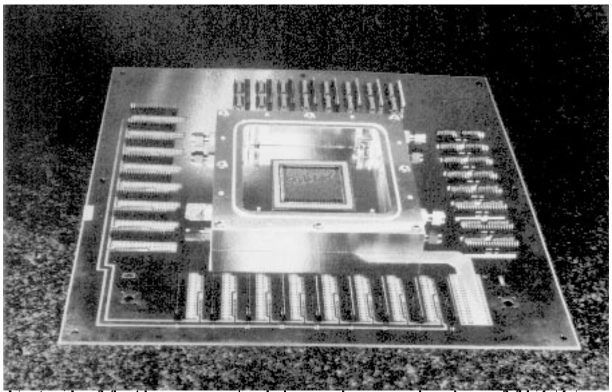

Fig. 3: Mother printed board on which a MSGC is mounted

The prototype readout system consists of preamplifier cards, discriminators, time-digital converters (TDC), and a Unix workstation for an acquisition of data from the CAMAC system. The block diagram of this readout system is shown in Fig. 4. All of anodes and backstrips signals are digitized with the some threshold. The cathode signals are summed up, then used for trigger signals. The analog data from the summed cathode signals can be also measured. The position of each X-rays are obtained by catching the timing of each signaled strips and coinciding with anodes and backstrips. The position resolution is about 60$\mu$m (RMS) with only digital readout form the anodes and back-strips.

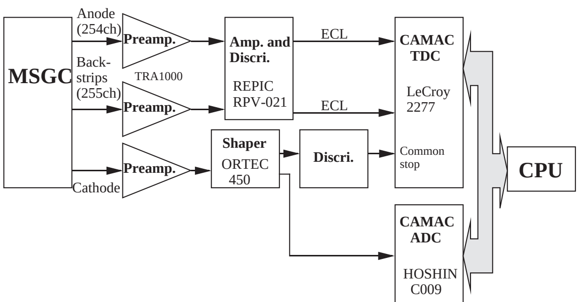


Fig.4: Block diagram of the prototype readout system.

## 3. Imaging performance and result of Beam Test at KEK-PF

Fig. 5(b) shows an example of X-ray transparent image by using a X-ray generator. A printed circuit board was used as sample (Fig. 5(a)), and very fine through-holes with a 300 $\mu$m diameter and a 600 $\mu$m pitch are clearly separated from each other. Furthermore, note that the printed pattern on the circuit board can be clearly seen, which indicates that the digital image of X-rays in MSGC allows us to measure the small variation of material density.

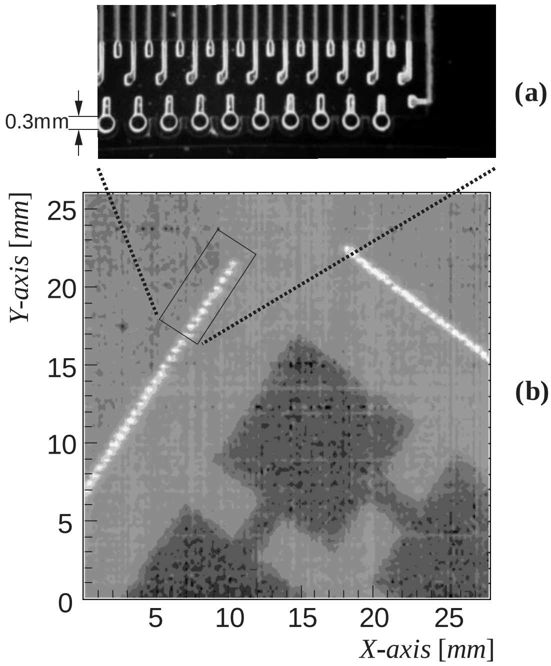


Fig.5: X-ray transparency image of printed circuit board.

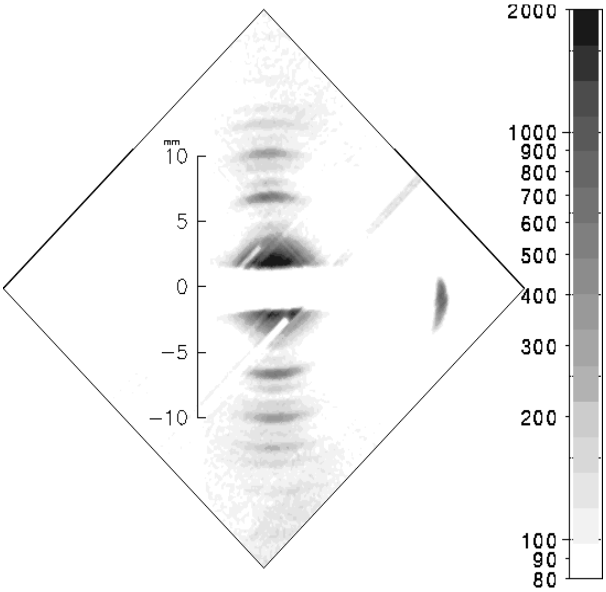


Fig.6: X-ray diffraction image of collagen.

The synchrotron radiation beam test was performed with the prototype detector at KEK-PF for taking reflection image of X-rays. Figure 6 shows the two-dimensional image for SAXS. The collagen of chicken's tendon was used as a sample. The incident beam is 9 keV monochronized X-rays with a spot of 1 mm in diameter. The camera length is 45cm, and a vacuum path is inserted between the sample and the MSGC.

Figure 7 shows the meridial reflection obtained from Figure 6. The peaks of more than 12th order was clearly resolved in this result, and left-right symmetry and flatness is excellent good.

## 4. Next Version

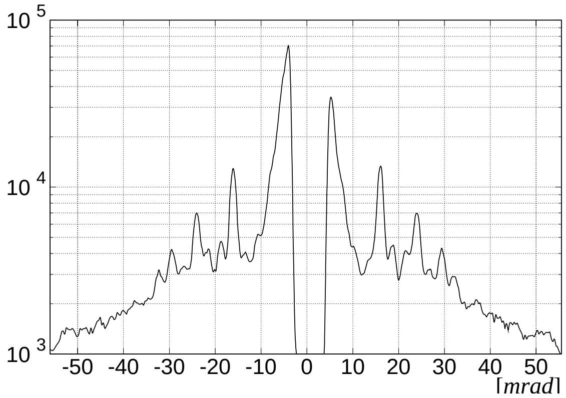


Fig.7 Profile of collagen diffraction image.

The advanced version of MSGC with a 100 mm × 100 mm detection area is under constructing. The high speed readout system by using the CPLD modules is almost available. Signals from the anode- and back-strips can be read out by 16 IC-boards (64 strips/board) with preamplifiers (LeCroy-MQS104) and discriminators (LeCroy-MVL407). Fig.8 shows this preamprefier and discriminator card with 32-channels.

The readout system must process more than 1000 signals (100 mm of one side / 200 $\mu$m pitch × 2 dimension), and encode to position information of each incident X-rays. Fig.9 shows the block diagram of this new data acquisition system. This system can operate at more than $10^6$events/sec rate, and these data can be stored in the memory board (512MB maximum) through the VME-bus. If both anodes and backstrips are hit in same the clock phase, this event is decided as a valid signal by the CPLD logic module. On the other hand, multiple hit data in one clock is rejected.

This system is based on VME standard, and data in memories are accessed directly by a VME based workstation. Figure 10 shows the picture of this data acquisition board. The test running of

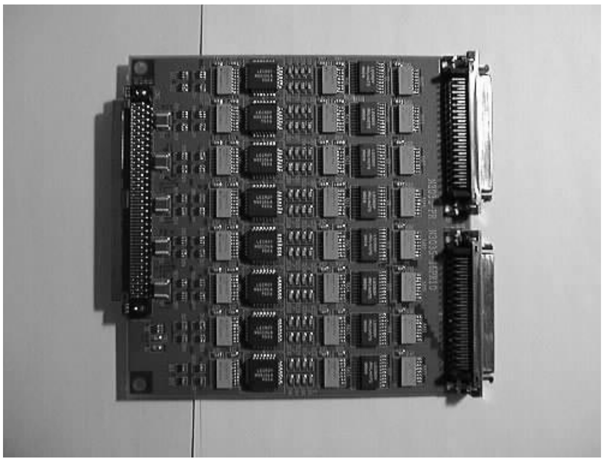

Fig. 8: Premprefier and discriminator board for 10cm × 10cm MSGC.

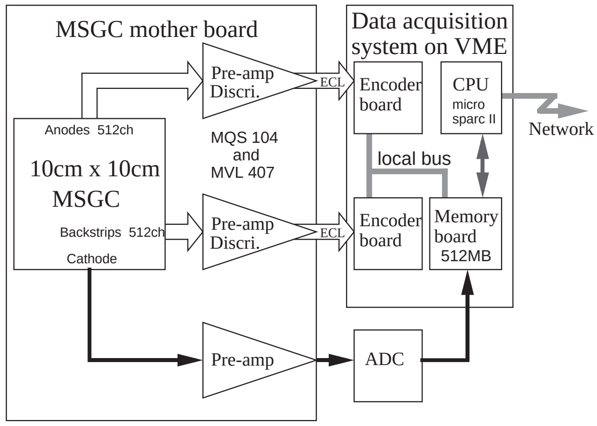


Fig.9 Block diagram of new data taking system.

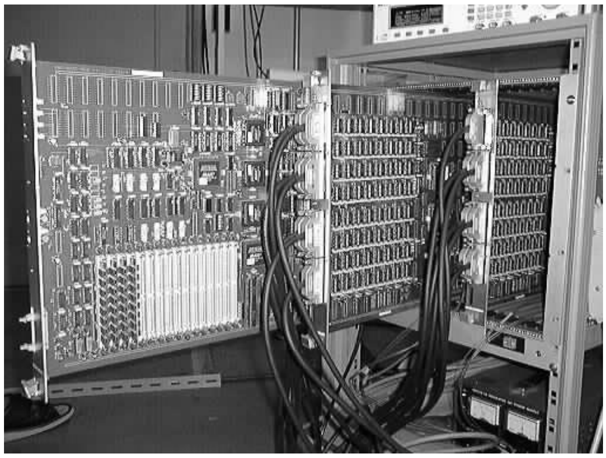

Fig.10 New data acquisition system board.

this system was succeeded. It would be possible to take more than 100 frame in a second (in case of 10k events are needed for building a picture), without loss of timing information of each one of X-ray events.

## References

[1] A. Oed, Nucl. Instr. and Meth. A263 (1988) 351.
[2] T. Nagae et al., Nucl. Instr. and Meth. A323 (1992) 236.
[3] T. Tanimori et al. Proceedings of SPIE, Gamma-ray Detectors, San Diego, (1992) 68.
[4] A.Ochi et al. Proc. Workshop on MSGC, Lyon(1995).
[5] T. Tanimori, A. Ochi, S. Minami and T. Nagae, Nucl. Instr. and Meth. A381 (1996) 280.