The influence of oxygen contamination on the performance of a mini-jet-cell-type drift chamber for JLC-CDC

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Abstract

We have studied performance of mini-jet-cell-type drift chamber filled with a $CO_2 : isoC_4H_{10}$ (90:10) gas mixture using cosmic-ray data and beam test data at the KEK-PS for JLC-CDC. The spatial resolution and wire efficiency are discussed. And O_2 contamination in the chamber gases is also discussed.

1 Introduction

2 Test chamber

2.a Cell structure

In order to test the overall performance, we constructed a test chamber with small jet cells, which is called hereafter a *Baby chamber* of the proposed JLC-CDC. Fig. 1 shows a picture of the Baby chamber, while Fig. 2 shows its cell structure. The cross-sectional size of the Baby chamber is 26cm $\times$ 27cm and the wire length is 40cm. This chamber has three identical jet cells (Cell1 to Cell3), each being 7cm $\times$ 10cm in size and having five sense wires (S1 to S5) and a maximum drift length of 5cm. The sense wire spacing is 1cm. These sense wires are made of Au-plated W and have a diameter of 30μm. Other wires are made of Au-plated Al and are 125μm thick.

2.b H.V. and electric field

Fig. 3 shows the high voltage applied on each wire and equipotential lines in the cell. The high voltage on the sense wire is 2.5kV and the electric field in the drift space is 1.0kV/cm.

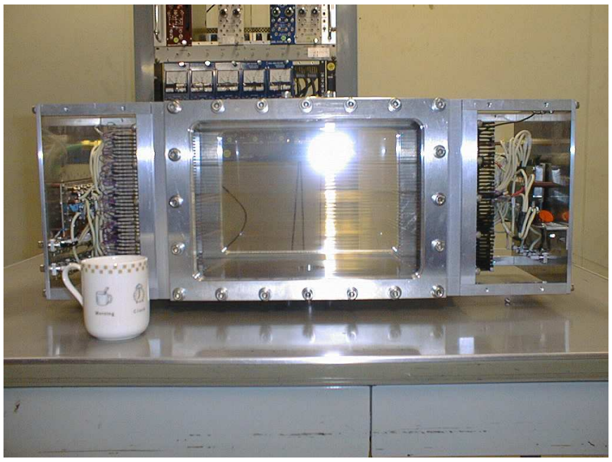

Figure 1: Baby chamber

2.c Gas system

- Fig. 4 shows the gas system.
- The O_2 concentration in the chamber gases is monitored by O_2 monitor.
- We took the data of 120ppm O_2 concentration of in the chamber gases using CO_2 containing O_2 (100ppm).
- We took the data of 20ppm O_2 concentration of in the chamber gases using O_2 filter.

2.d Data acquisition system

Current preamplifiers are mounted on the endplate of the Baby chamber. The signals from the preamplifiers go into flashADCs after passing through post amplifiers. The flashADCs have 8bits and a 500MHz sampling frequency over a 16μsec time window.

3 Experimental setup

3.a Experimental setup for cosmic-ray tests

- Fig. 5 shows the experimental setup.
- Cosmic-ray was triggered by three plastic scintillation counters sandwiching the chamber.
- The size of upper scintillation counter is 10cm $\times$ 20cm.
- The size of lower scintillation counter is 20cm $\times$ 30cm.
- The lower two scintillation counters are piled about 10cm $\times$ 10cm.

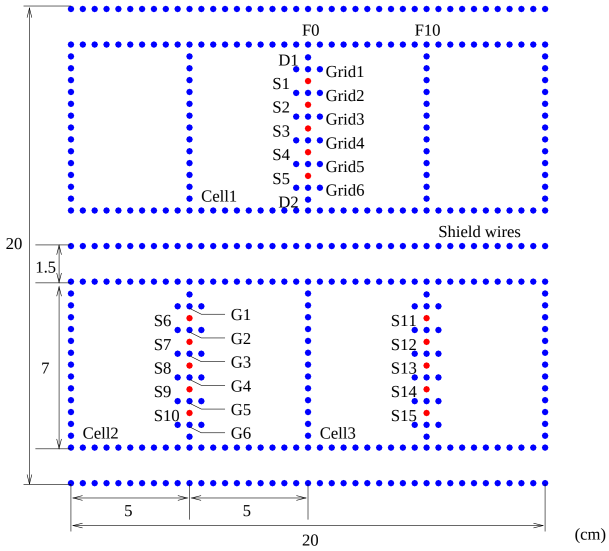

Figure 2: The cell structure of the Baby chamber

3.b Experimental setup for beam test at the KEK-PS

4 Analysis procedure

4.a T_0 determination

The so called T_0 (the signal arrival time for the zero drift length) was determined from the shorter-drift-length edge of the arrival time distribution for each sense wire. The drift time can then be defined as the arrival time measured from T_0.

4.b X-T relation

In order to convert the drift time to the drift length, we used the x-t relation calculated with GARFIELD for each wire (see Fig. 7). The validity of the calculated x-t relation was experimentally confirmed by comparing the drift velocity given by GARFIELD with the independent drift velocity measurements.

4.c Track fitting

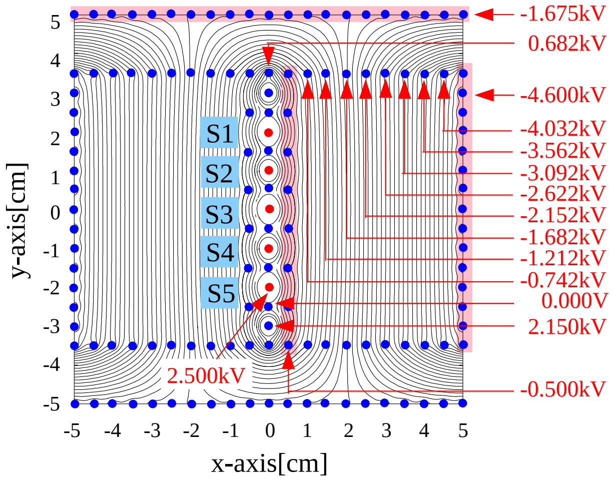

Figure 3: Electric field in the cell

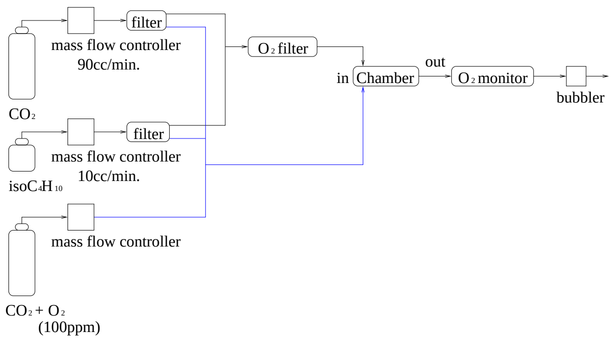

Figure 4: Gas system

5 Results and Discussions

5.a Charge attenuation

5.b Wire efficiency

5.c Spatial resolution

5.d O_2 contamination

6 Conclusions

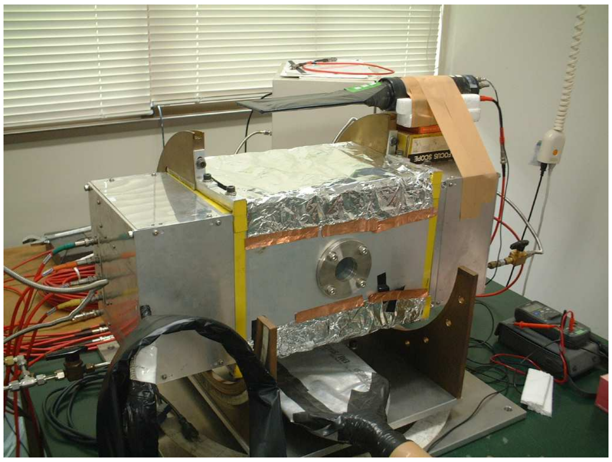

Figure 5: Cosmic-ray test setup

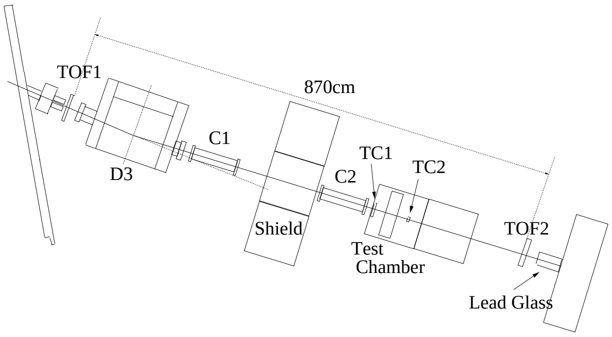

Figure 6: Cosmic-ray test setup

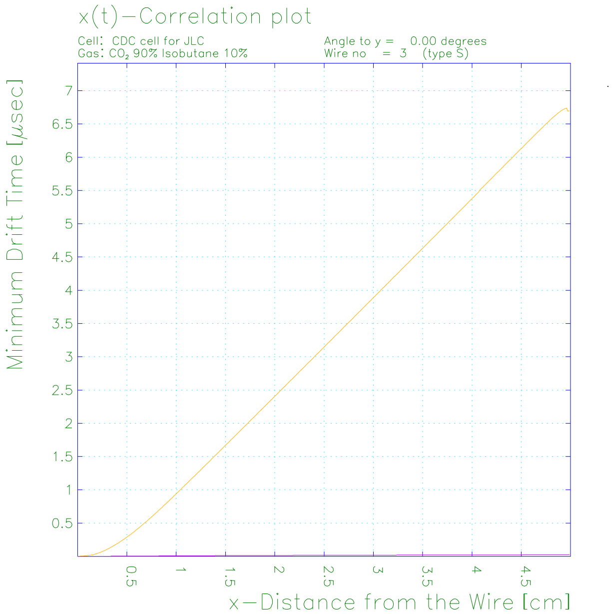

Figure 7: X-T relation by GARFIELD

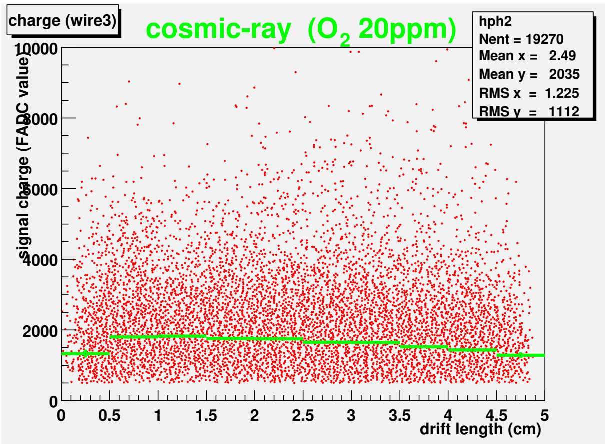

Figure 8: Charge attenuation as a function of drift distance(20ppm)

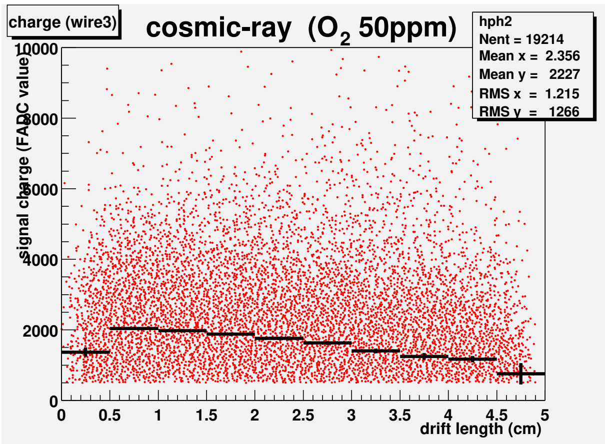

Figure 9: Charge attenuation as a function of drift distance(50ppm)

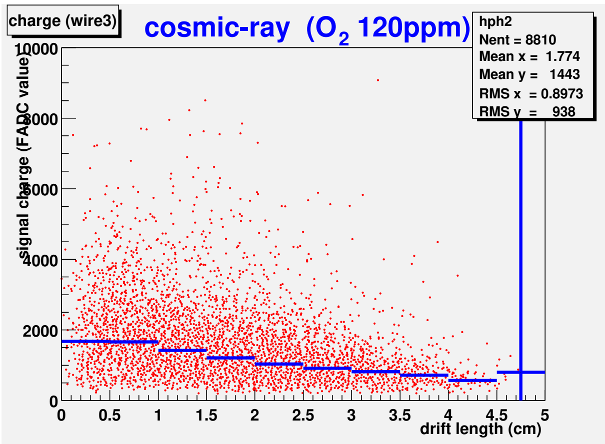

Figure 10: Charge attenuation as a function of drift distance(120ppm)

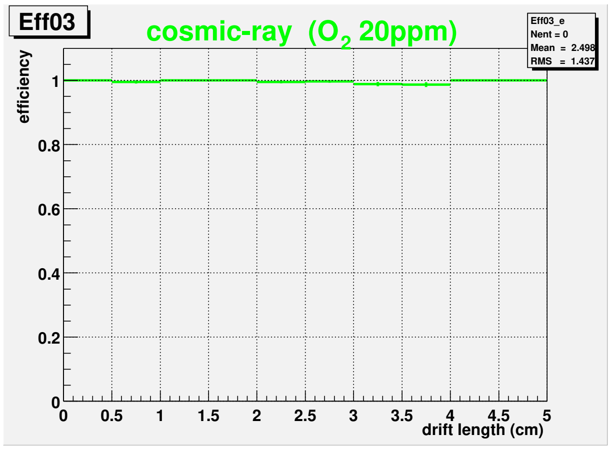

Figure 11: Wire efficiency as a function of drift distance(20ppm)

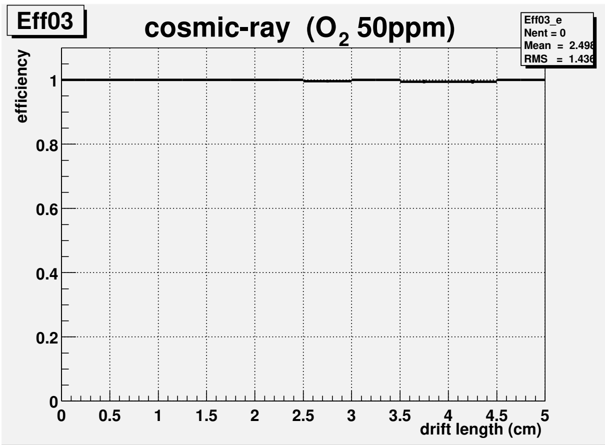

Figure 12: Wire efficiency as a function of drift distance(50ppm)

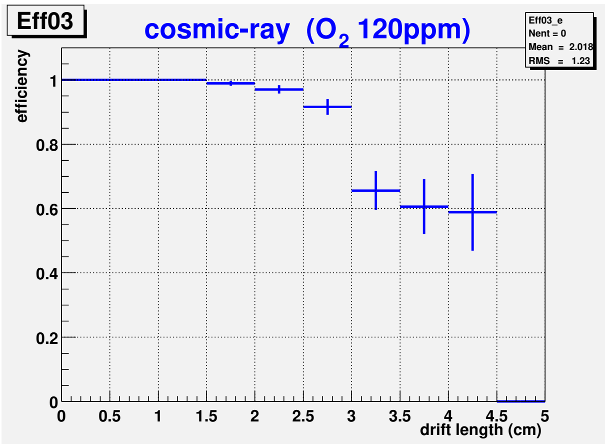

Figure 13: Wire efficiency as a function of drift distance(120ppm)

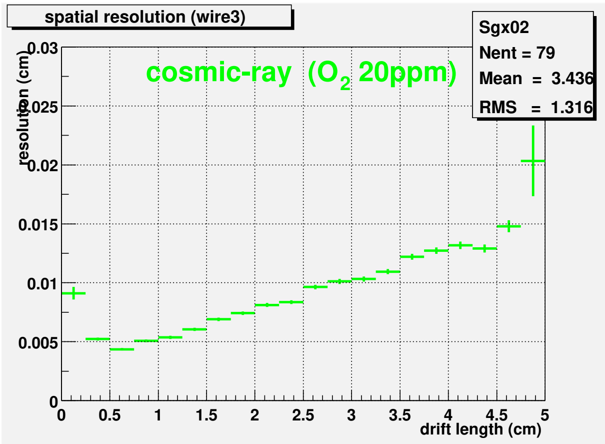

Figure 14: Spatial resolution as a function of drift distance(20ppm)

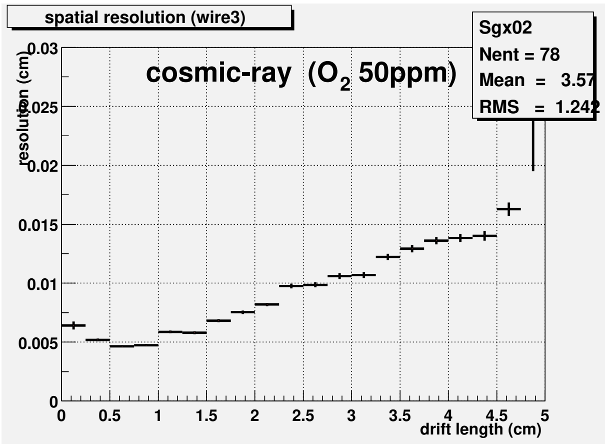

Figure 15: Spatial resolution as a function of drift distance(50ppm)

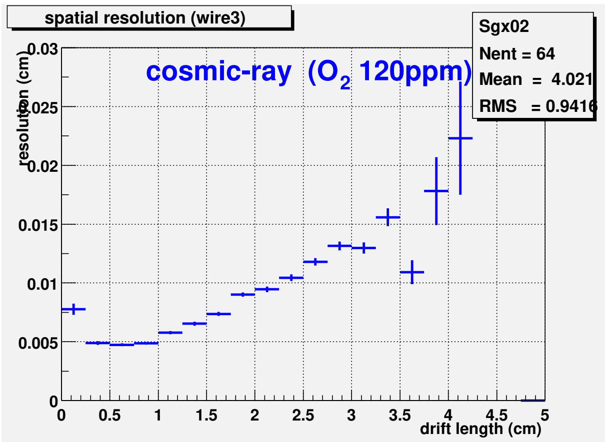

Figure 16: Spatial resolution as a function of drift distance(120ppm)

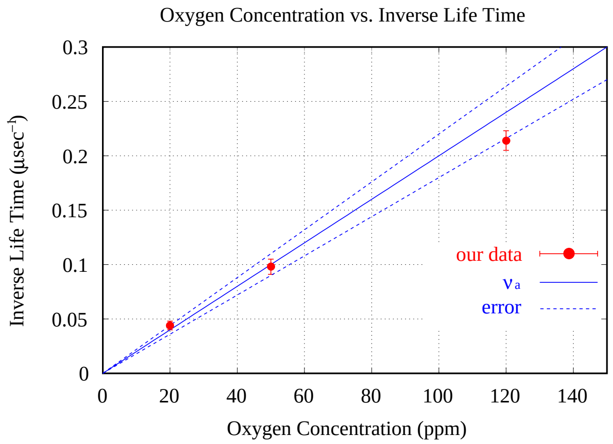

Figure 17: Attachment rate as a function of O_2 concentration