CHAPTER 3

Inner Part of Belle II Central Drift Chamber

The Belle II CDC is designed to reconstruct the tracks of the charged particle precisely, especially, around 1 GeV/c momentum region. It retains the global structure of the Belle CDC, which has worked well throughout the past decade, for the material of the major parts, the superlayer wire configuration, the rectangular cell shape, the wire material, as well as the gas mixture of Helium and Ethane (50 % He – 50 % C_2H_6). However, improvements in the momentum resolution and the particle identification via the energy lost (dE/dx) are achieved by a large outer radius. The outer radius of the Belle II CDC is 1.13 m, which is 25 cm larger than the Belle CDC. In addition, the inner part of the Belle CDC consisting of eight layers with tightly space axial wires are constructed. The inner part had its wires strung separately before installation into the main chamber. Figure 3.1 shows a long section view of the Belle II CDC main structure pattern. In this chapter, the mechanical structure and wire configuration of the inner part are described.

3.1 Core Structure

The CDC with asymmetric shape in the z direction is used to accommodate the fact that the considered particles are boosted because of the asymmetric nature of the collider [6]. Thus, the both endplates of the chamber are designed to match the detector's polar angular acceptance of 17^o–150^o as shown in Figure 3.1.

A thin inner cylinder and two endplates of the inner chamber are made of a thin carbon-fiber reinforced plastic (CFRP) and aluminum, respectively (Figure (3.2)). The aluminum endplates also follow the asymmetric conical shape to match with the both inner detectors (Silicon Vertex Detector; SVD) and the main chamber of CDC. Figure 3.3 indicates the structure of the small cell chamber endplates, which gives the 10 mm drilling depth exactly the same as the whole CDC's endplates.

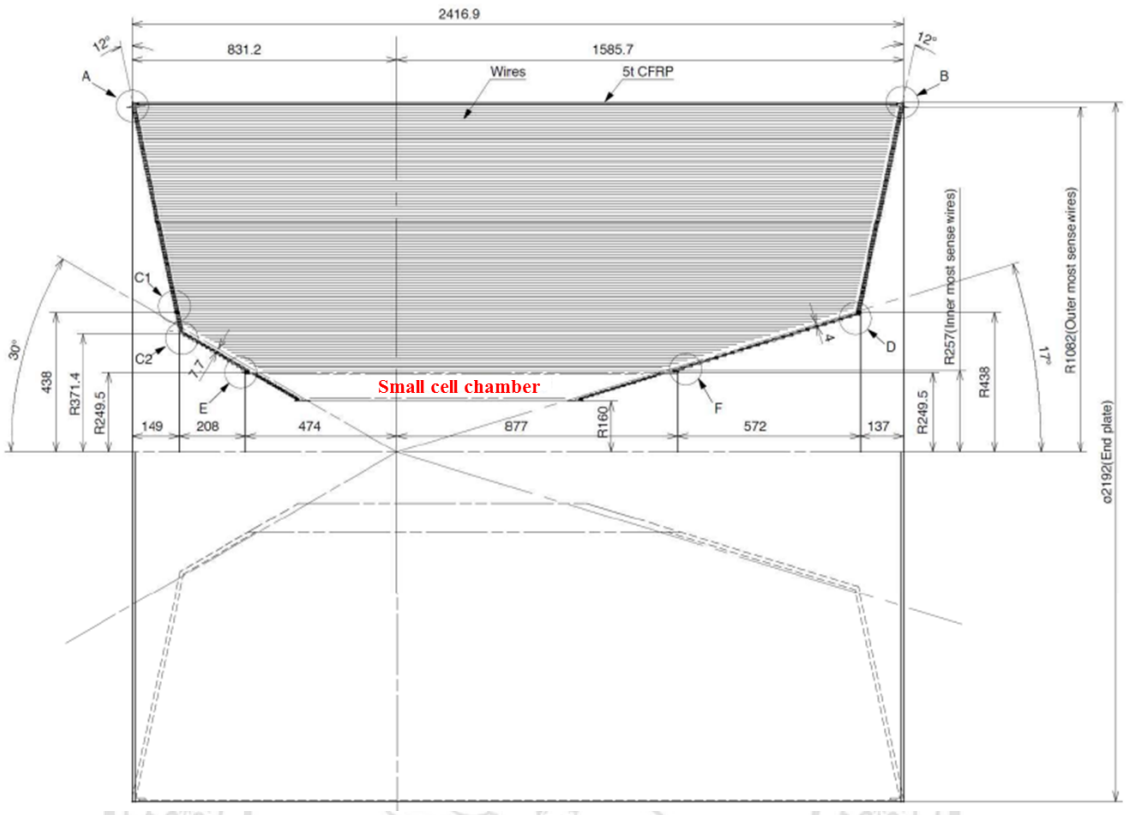

Figure 3.1: Main structure of the Belle II CDC [2].

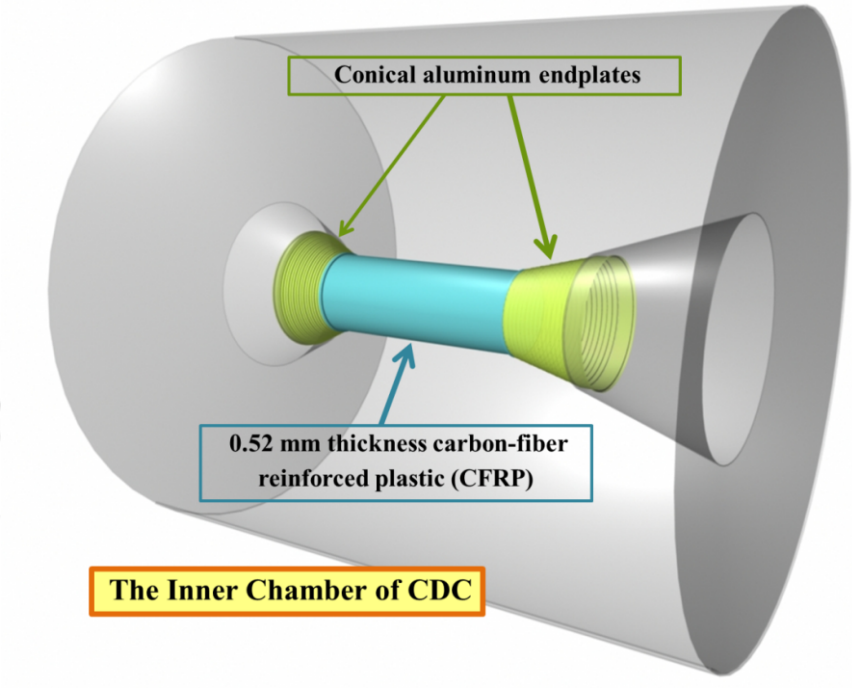

Figure 3.2: Layout of inner chamber of the Belle II CDC.

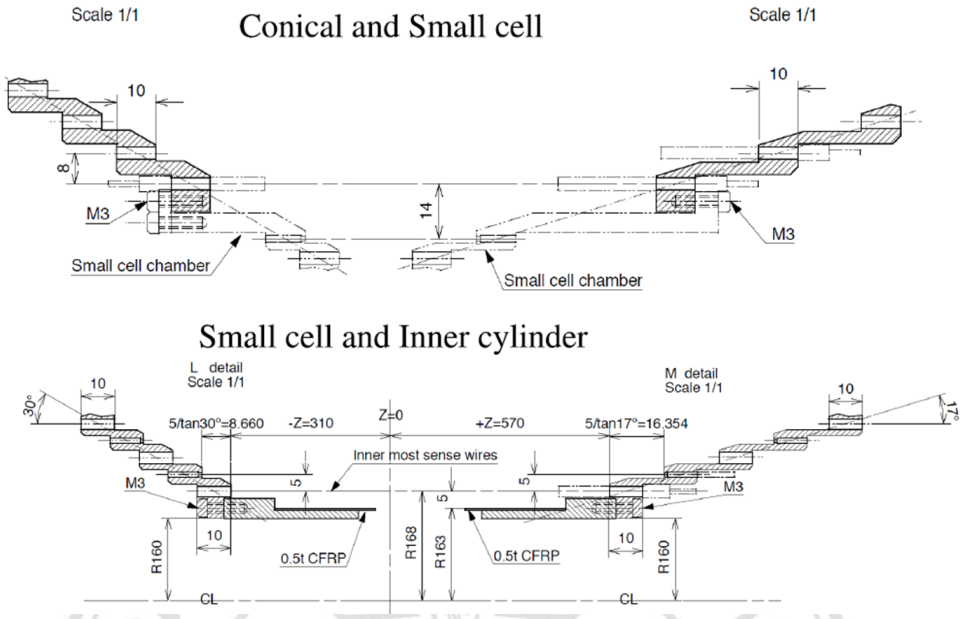

Figure 3.3: Detailed layout of inner chamber [2].

The 0.52 mm thickness of inner cylinder is not only used for minimizing material, but it also supports the whole wire tension for the inner chamber. Moreover, it is thin enough to minimize the background, which is produced by a photon conversion. Thin aluminum films with 0.1 mm thickness are glued on the outer surface of the inner cylinder for electric shielding. Major parameters of the chamber are listed in Table 3.1.

Table 3.1: Major parameters of the Inner Chamber.

Radius of inner cylinder (mm)	160
Radius of innermost sense wire (mm)	168
Radius of outermost sense wire (mm)	238
Number of layers	8
Number of sense wires	1,280
Gas	50 % He – 50 % C_2H_6

3.2 Wire Configuration

The gold plated tungsten wires of 30 μm diameter are used as the sense wires with 50 g tension. The 126 μm diameter aluminum field wires, without plated for avoiding unnecessary material, are used with 80 g tension [2]. In the close up frame in Figure 3.4, the red dots and the blue crosses are represented the field wire and the sense wire, respectively. A “drift cell” is defined from a sense wire arranged among 8 field wires,

which remain the rectangular cell shape. The Belle CDC is presented in Figure 3.4 with the green square. A series of the drift cell that shares the same radius is called a “layer”. The figure also shows the layout of the sense wire configuration of a part of the Belle II drift chamber in cross section view. The group of six layers is called a “superlayer”, which are represented with different colors and the labeled letters A, U and V. The super layer group A consists of a combination of the wires arranged in axial direction, which is parallel to the chamber central axis, and the U and V wires arranged in varying angles called the “stereo wire”(Figure 3.5). These various angles of each superlayer are utilized for considering the incoming particle track in z direction.

The inner chamber has eight cylindrical axial layers consisting of one superlayer and two additional innermost layers, that contain active guard wires. Even though, the high occupancy from the beam backgrounds and the wall effect compromise the performance of these two layers, the remaining six layers ensure that the innermost superlayer performs as well as the others [2]. Each layer contains 160 drift cells with the radial cell size of 10 mm and the minimum azimuthal cell size of only 7 mm. This is the reason why it is called the “Small Cell Chamber”. The inner chamber net length is 1.35 m and it has no outer cylinder. Thus, the wires were strung horizontally from the inside on a table without any special jigs (Figure 3.6).

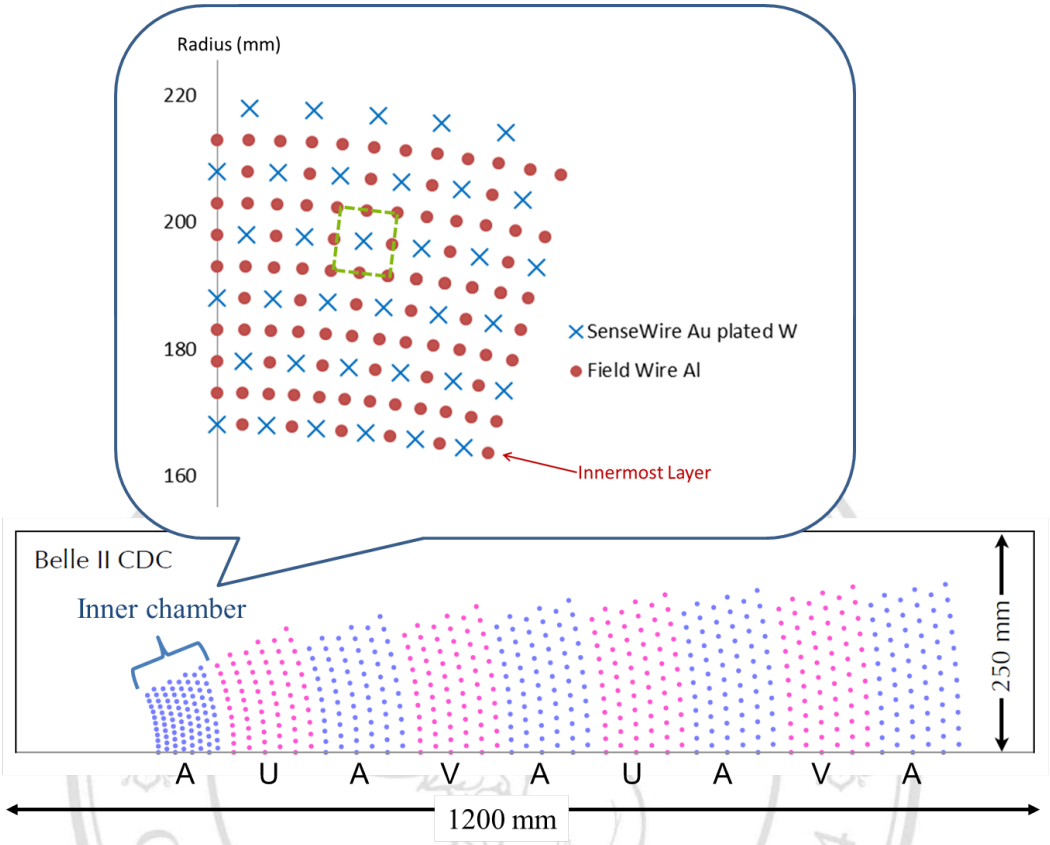

Figure 3.4: Cross section view of the wire configuration of the Belle II drift chamber.

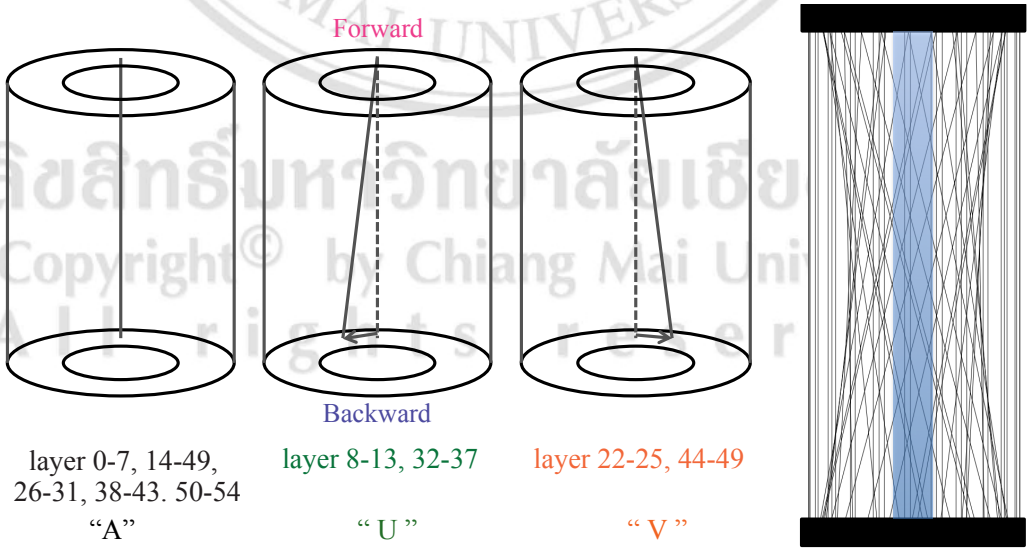

Figure 3.5: The stero wire diagram.

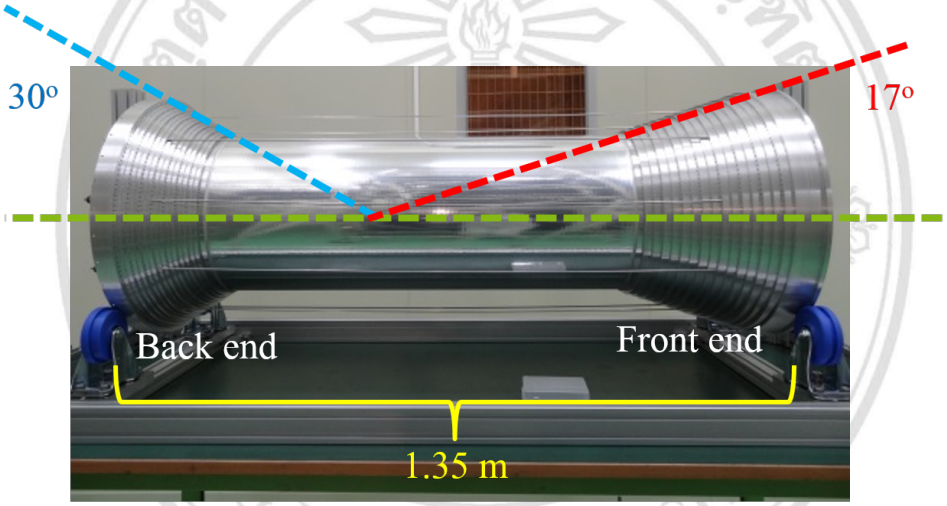

Figure 3.6: Photograph of completely assembled main structure of inner chamber of the Belle II CDC before the wires stringing.