

## BEPCCII INTERACTION REGION DESIGN AND CONSTRUCTION STATUS

Y. Z. Wu<sup>1)</sup>, C. H. Yu, F. S. Chen, J. B. Pang, J. F. Zhang, M. T. Wang, Q. L. Peng, X. W. Dai, Y. Yang, Z. S. Yin, IHEP, Beijing, China

### Abstract

BEPC (Beijing Electron Positron Collider) is now upgrading to a double-ring collider which requires a new storage ring to be built in the existing tunnel. A new and compact interaction region (IR) has been designed to allow a peak luminosity of  $10^{33} \text{cm}^{-2}\text{s}^{-1}$  from an equal beam energy of 1.89 GeV, a crossing angle, 93 bunches with maximum beam current of 0.91 A.

The multi-purpose superconducting magnets and conventional dual aperture quadrupoles are used as final focusing quadrupole in the interaction region. The two beams collide at the interaction point with a crossing angle of  $\pm 11$  mrad and further beams separation is enhanced with the help of a septum bending magnet which locates just beyond the superconducting magnet and acts on the outgoing beam lines only. This paper will describe the IR design and the construction status.

### INTRODUCTION

The circumference of BEPCII storage ring is 238m and the length of IR is only about  $\pm 14$  m around the interaction point (IP). Since about 20 main magnets and other equipments must be installed into the IR, the space is very tight.

The construction of the BEPCII program is now underway and will be completed in 2006. At present, all the components of the IR are under fabrication. The coils winding of the first superconducting magnet have been completed and the cold testing in the vertical dewar are underway. The prototype of Q1a, Q1b and ISPB magnets have been successful built and their field quality meet the requirements of the beam dynamics. The studies on the fabrication techniques for special vacuum chambers have been completed and fabrications are underway.

### INTERFACE BETWEEN DETECTOR AND ACCELERATOR

The interface between detector (BESIII) and accelerator is shown in Fig 1.

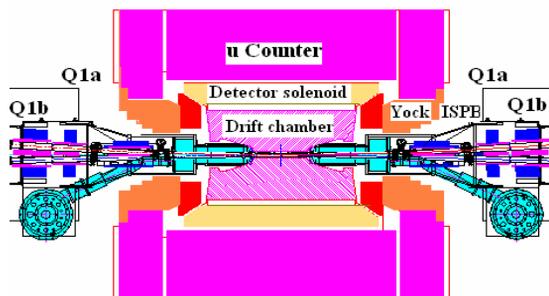


Figure 1: Interface between the BESIII and accelerator

The central part of BESIII detector is cylindrical drift chamber surrounded by an electromagnetic calorimeter, which is immersed in a superconducting solenoid field with a length of 3.6m and strength of 1.0T.

The geometry of the drift chamber has a direct bearing on the IR design. It requires the accelerator components inside the detector must fit within a conical space with an opening angle of  $21.5^\circ$ . The first accelerator element can only approach to 0.55m on each side of the IP.

### BEAM-LINE LAYOUT IN THE IR

The beam line layout<sup>[1]</sup> in the central part of the IR is shown in Fig. 2. On each side of the IP, a doublet of quadrupole is used to provide the focusing optics at the IP. The first vertical focusing quadrupole is a superconducting magnet, which is shared by both beams. Two beams collide with a horizontal crossing angle of 22 mrad at the IP. A horizontal bending magnet labelled ISPB<sup>[2]</sup>, which is located just beyond the superconducting magnet will enhance the separation between electron beam and positron beam. ISPB is a septum magnet with a narrow septum coil. It is 2.3m away from the IP with the length of 0.6m and the field strength of 4kGs. It acts on the outgoing beam-line only.

The second element of the doublet is horizontal focusing quadrupoles Q1a and Q1b.

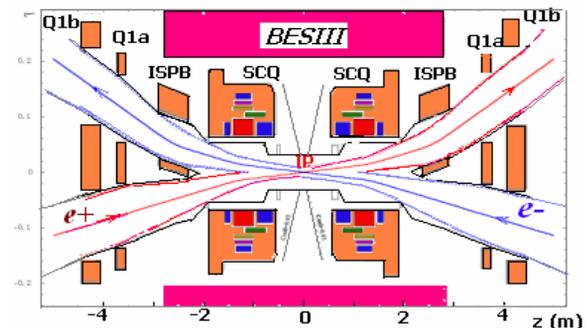


Figure 2: Layout of the interaction region

In order to achieve the aims of keeping the symmetrical structure of two rings and saving space, the quadrupoles Q1a and Q1b are designed as a two-in-one type in which the two separate beam channels for the incoming and outgoing beams have same field strength.

The separation between two beams is about 185 mm at the inboard face of Q1a and 231 mm for Q1b while the beam stay clear (BSC) is 95mm and 102mm respectively, so the space for the design of septum is limited. The following accelerator elements are quadrupoles Q2, Q3 and Q4 where the separation of two beams is large enough to allow them to be installed side by side into the two rings.

With this IR layout the vertical beta function at the IP could be 1.5cm., as well as 1.0m horizontally. The first parasitic crossing is 1.2 m away from the IP where the separation of two beams is about  $40\sigma$ .

### SUPERCONDUCTING MAGNETS

The superconducting magnet<sup>[3]</sup> has a multi-function coil pack. As shown in Fig. 3, it consists of independent quadrupole (SCQ), horizontal dipole (SCB), vertical dipole (VDC), skew quadrupole (SKQ) and three part anti-solenoid (AS1-3) windings. The cryostat has a warm bore with an inner diameter of  $\phi 132\text{mm}$  and outer diameter of  $\phi 326\text{mm}$ . The endcan of cryostat has an outer diameter of  $\phi 640\text{mm}$ .

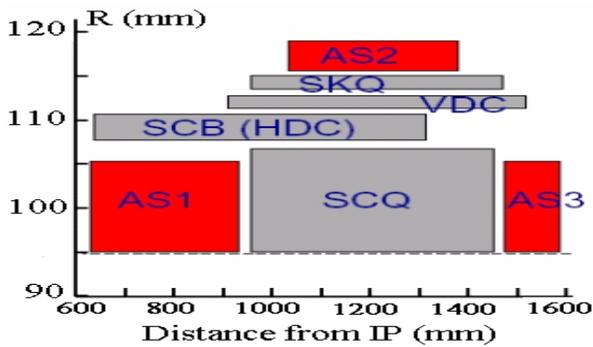


Figure 3: Coils layout of the SC magnet

The design and fabrication of the superconducting magnet are being carried out at BNL. The coils winding of the first superconducting magnet have been completed and the cold testing in a vertical dewar are underway.

### TWO-IN-ONE QUADRUPOLE Q1A

The first Q1a magnet<sup>[4]</sup> has been successfully fabricated in the factory of IHEP. Fig. 4 displays the shape of Q1a. The excitation test was succeeded up to an enough current of 1550A. The average temperature rise of the magnet is  $20^\circ\text{C}$  degree at the current of 1550A when the flow rate of water was 5.0 L/min. The coil protection systems such as thermal relay, water flow relay, and fast voltage search device have been used on the magnet.

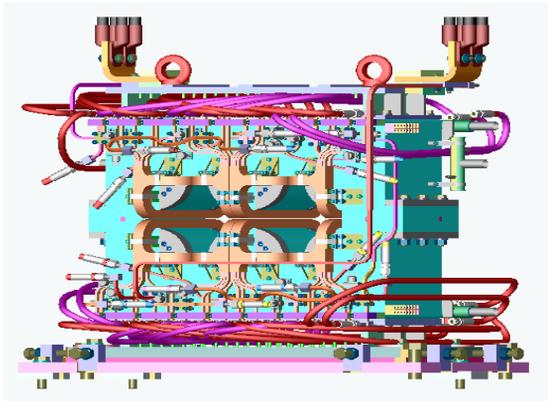


Figure 4: The shape of the Q1a magnet

The magnet is shimmed with iron sheets to achieve multipole components below  $3.5 \times 10^{-4}$  at reference radius of 53.45mm ( $14\sigma$ ) with a pole end chamfers ( $7 \times 57$ ).

### COMPENSATION OF THE DETECTOR SOLENOID FIELD

The BESIII detector solenoid has the maximum field strength of 1.0T over an effective length  $\pm 1.8\text{m}$  around the IP. This longitudinal field inside the beam pipe should be compensated to avoid strong coupling of the betatron oscillation.

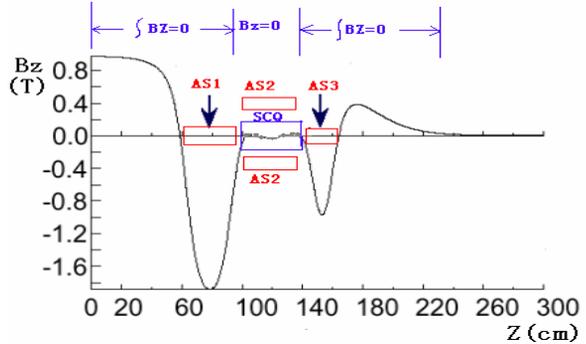


Figure 5: Distribution of the axial field  $B_z$  of the IR

Three anti-solenoids AS1, AS2 and AS3 will be used to compensate the detector solenoid fields along the detector axis. The AS1 will balance the integral longitudinal field from the IP to the SCQ, AS2 approximately null the field over the active of SCQ and AS3 to balance the integral field in the fringe region beyond where the cold mass end. A skew quadrupole included in the SC magnet package will be used for fine tuning. Fig.5 shows the distribution of the axial field  $B_z$  of the IR.

### IR VACUUM CHAMBER

To ensure adequate quantum lifetime, the chambers are designed to accommodate at least  $14\sigma + 2\text{mm}$  in the IR region. The majority of the IR chamber<sup>[5]</sup> is made of oxygen-free copper. The central part of the beam pipe is a double-wall beryllium structure with 0.8mm gap as a cooling channel. It is  $\pm 0.15\text{m}$  long around the IP with inner diameter of 63 mm. The inside wall of Be pipe will be coated by gold. The Be pipe is welded to a copper cylinder with the length of 0.55m, which is connected to SC magnet chamber through special CF63 bellows. The profile of the IP vacuum chamber is shown in Fig. 6.

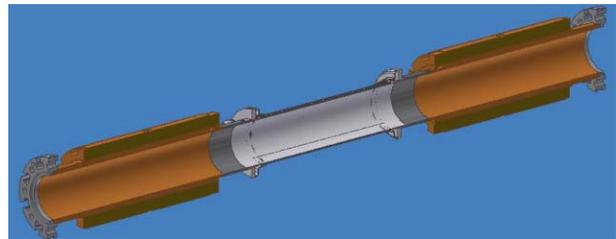


Figure 6: The profile of IP vacuum chamber.

