Table 5.5: Cost Estimate for the PHENIX MVD

W B S	Description	Amounts in FY93 k$ Total	M&S	EDIA	Labor	Cont%	Cont(k$)
5. 2. 1	**Silicon Detectors**	**1536**	**1125**	**206**	**202**	**24**	**374**
5. 2. 1. 0	EDIA	313	104	206	3	20	63
5. 2. 1. 2	Fabrication	1106	1021	0	84	25	276
5. 2. 1. 3	Test/Assembly	118	0	0	115	30	35

for the MVD is consderably lower than expected by SSC experiments.

5.6 Cost

The cost estimate for the silicon detector subsystem is presented in Table 5.5. In this table the silicon detector hardware (WBS 5.2.1) and its FEE (WBS 5.8.1.2.1) have been combined under 5.2.1. Also Testing (WBS 5.2.1.3) and Installation (WBS 5.2.1.4) have been combined under 5.2.1.3. These differences relative to other cost estimates in this document are a consequence of the way the costs were estimated for the MVD. The full detailed cost estimate is available in the PHENIX WBS document.

5.7 Schedule

The proposed schedule for the silicon system is shown in Fig. 5.17. This is the time required for engineering, design, prototyping, procurement and fabrication, and assembly and testing.

5.8 Beam-beam Counter Overview

The PHENIX beam-beam counter (BB) provides the time of the beam-beam interaction and its position along the beam axis by the difference of the time-of-flight of prompt particles on the two sides. This information must be available at the trigger level to aid in correlation of tracks in various detector elements. For reliable particle identification of the interaction products by time-of-flight measurements, both the BB and the TOF detectors, which provide the stop time, should have comparable timing resolution. To achieve time-of-flight measurements with 100 ps resolution, the intrinsic timing resolution of each detector system must be better than 70 ps ($100\text{ps}/\sqrt{2}$).

There is a BB counter upstream and downstream of the beam crossing point, each consisting of an array of counter elements. These elements are Cherenkov counters with solid radiators and photomultiplier tube readout clustered around the beam pipe outside the central magnet poles. BB intercepts particles at large rapidities. The elements will see fast

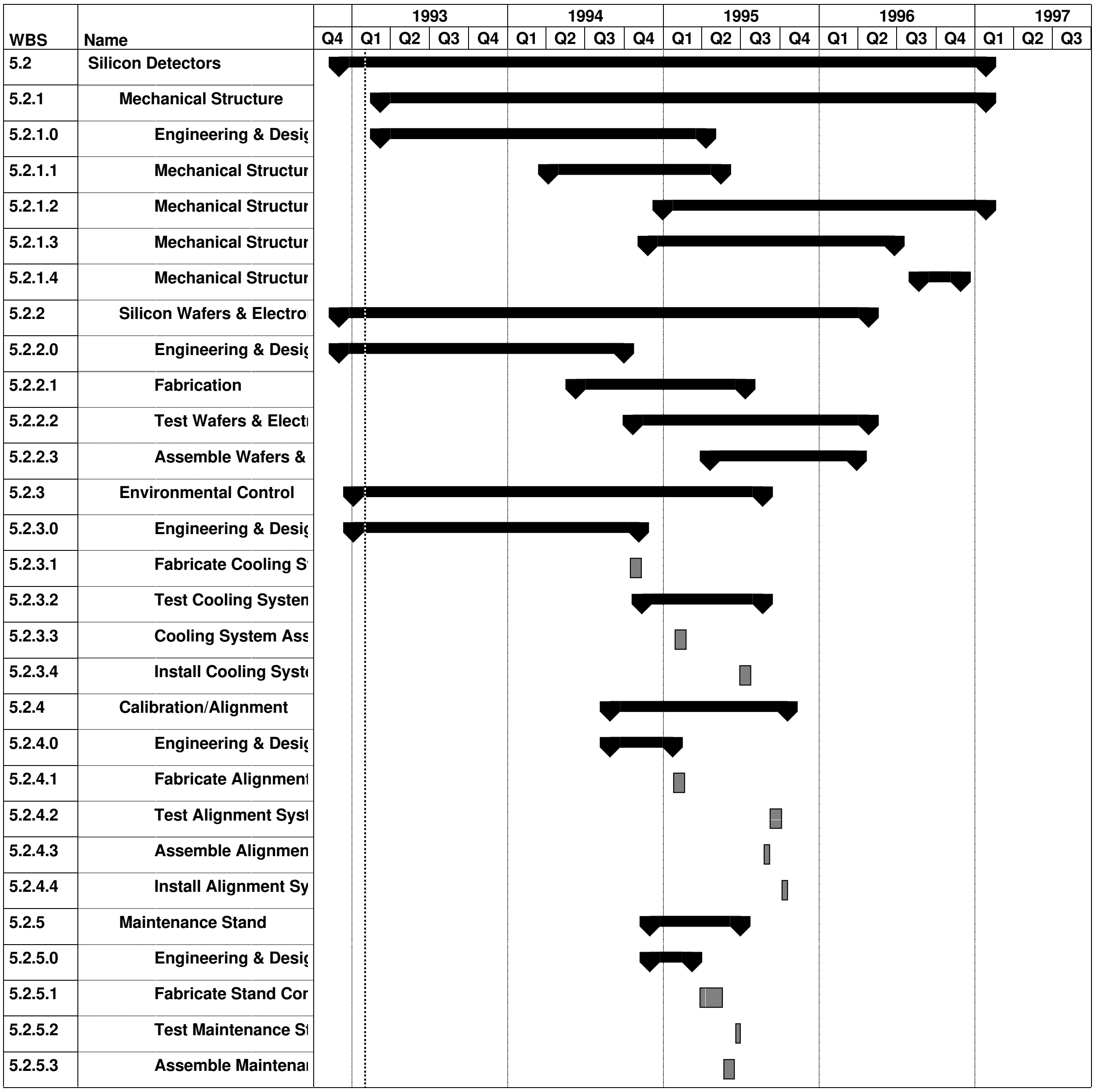

Figure 5.17: Overall schedule for the PHENIX MVD.

leading particles with the velocity of light from the interaction. However, some counter elements will also see slow particles from the interaction or background particles scattered from the central magnet or hadron absorbers.

Because they provide the start time of the time-of-flight measurement, the BB subsystem will share many readout electronics elements with the TOF subsystem.

5.9 Beam-beam Counter Layout

5.9.1 Detector Elements

The following points constrain the design of the counter elements:

1. The counter element should have an intrinsic timing resolution of 50 ps, after slewing corrections, for single minimum ionizing particles.

2. The counter elements should have adequate dynamic range to accept multiple particle hits (up to 10 in central Au + Au).

3. There must be no problems arising from any magnetic field at the location of the beam-beam counter.

4. The counter element should be compact so that an appropriate number of counter elements can be packed densely in the space allocated for the beam-beam counter. This is driven both by the need for good coverage for low multiplicity events, and mechanical constraints on the muon arm side of PHENIX.

5. The insensitive area of counter elements should be minimized.

6. The counter element must be adequately radiation resistant.

Each element of the beam-beam counter is a flashlight-type Cherenkov counter as shown in Fig. 5.18. A UV-transparent solid material is mounted directly on a mesh-dynode photomultiplier with a UV-transparent window.

The mesh-dynode photomultiplier is a 1-in. tube made by Hamamatsu (Hamamatsu H5082) with a UV-transparent window. The mesh-dynode photomultiplier can be used without a magnetic shield in the magnetic field environment at the BB location. Minimizing the outer dimensions of the counter element decreases the dead space between the counter elements and may improve the timing resolution with a smaller radiator size. In the current design the outer diameter of each counter element is 28 mm. These elements have been studied in a beam test at KEK, and an intrinsic timing resolution of 44 ps was achieved for single 1.6 GeV/c pions. Detailed test results are presented in Appendix B.

The radiator is fused quartz glued to the window of each photomultiplier. The material tested was Suprasif P-20, which gave satisfactory results and is the material of choice for the counter elements. The shape of the radiator will be fixed later; one option is the hexagonal cylinder tested. Another option is a round cylinder, which would introduce insensitive gaps between the counters, but may improve the timing resolution.

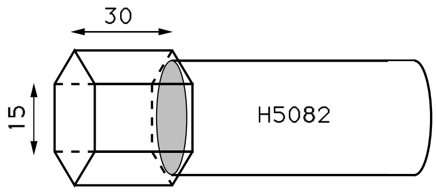

Figure 5.18: A prototype counter element of the beam-beam counter array, built for a test at KEK, Japan in December 1992.

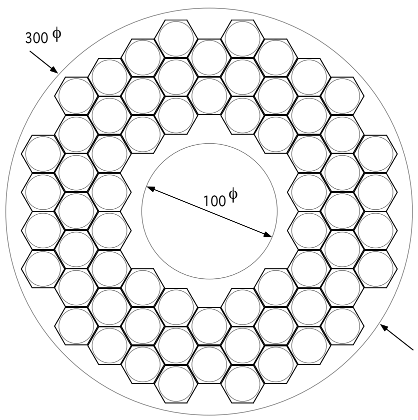

Figure 5.19: Front view of the beam-beam counter array.

5.9.2 Layout

The BB array on each side of the crossing point consists of 66 identical counter elements, arranged as shown in Fig. 5.19.

The elements are closely packed into a ring around the beam pipe. The minimum inner bore radius and the maximum outer radius are designed to be 50 mm and 150 mm, respectively.

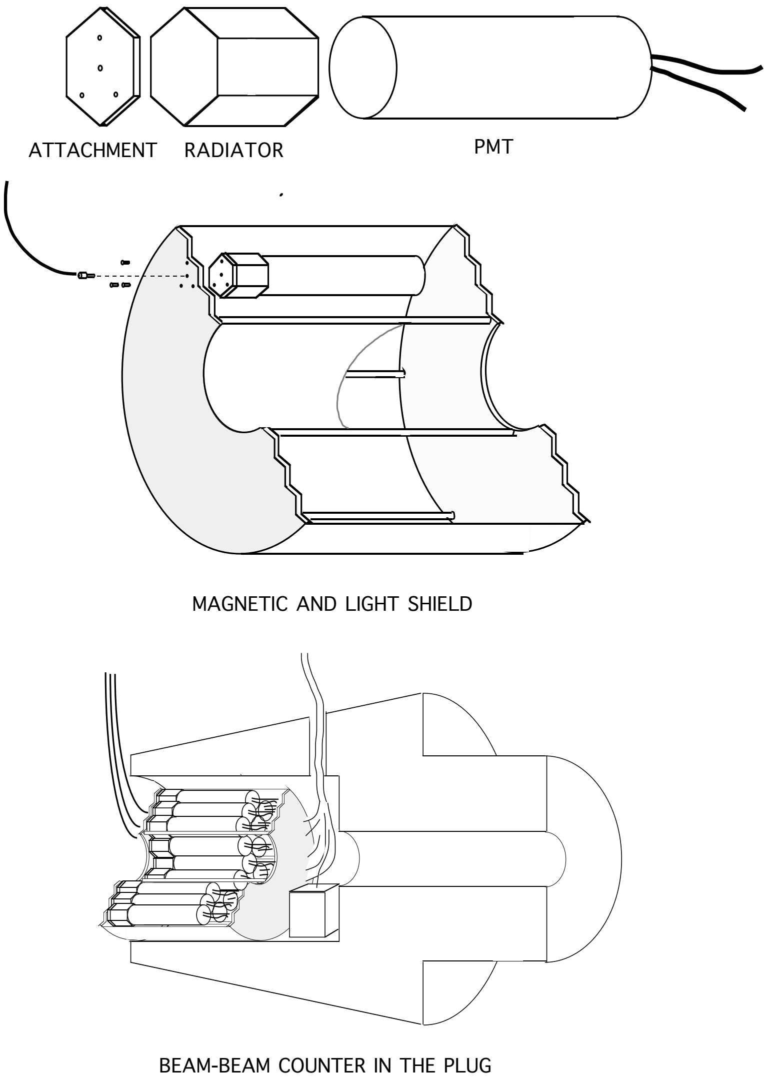

Figure 5.20: Top: A single element of the BB. Middle: The assembly on the muon spectrometer side. Bottom: Positioning of the assembly in the iron plug on the muon side.

5.10 Mechanical

The assembly of a single counter element is depicted in the top section of Fig. 5.20.

The quartz Cherenkov radiator block is glued directly onto the surface of a photomultiplier with optical cement. The mesh-dynode photomultipier of 1 in. diameter is used without