The CDF MiniPlugs

Proposed Forward Calorimeters for CDF-II

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A program of hard diffraction and very forward physics proposed for CDF in Run II requires the employment of two forward 'MiniPlug' calorimeters in the pseudorapidity region $3.5 < |\eta| < 5.5$ designed to measure the energy and lateral position of both EM and hadronic showers. The MiniPlugs are based on lead/liquid-scintillator layers read out by wavelength shifting fibers arranged in a pixel-type geometry suitable for 'calorimetric tracking'. Test beam results are presented, obtained with a 28 radiation length prototype of one radiation length granularity and an effective tower size of 2×2 cm^2. For positrons in the range 5-120 GeV, the energy resolution was measured to be $\sigma/E = 18.1\%/\sqrt{E} + 0.6\%$ and the position resolution 9.2 mm$/\sqrt{E}$; for charged pions in the range 10-230 GeV, a position resolution of 23.8 mm$/\sqrt{E}$ was obtained.

A program proposed for studies of hard diffraction and very forward physics with CDF in Run 2 requires adding to CDF three detector components (see Fig. 1): A **Roman Pot Spectrometer** to detect leading antiprotons, a set of **Beam Shower Counters (BSC)** positioned around the beam pipe at four (three) locations along the $\bar{p}$ (p) beam direction to tag rapidity gaps within $5.5 < |\eta| < 7.5$, and two **MiniPlug** calorimeters covering the pseudorapidity region $3.5 < |\eta| < 5.5$ to detect particles and jets and measure their lateral position and energy.

The MiniPlugs, to be placed within the holes of the muon toroids of CDF, will consist of 36 layers of 3/16″ lead plates (laminated with reflective 0.5 mm thick aluminum) immersed in mineral oil liquid scintillator (Fig. 2). The signal is guided by 1 mm dia. WLS fibers strung through holes in the plates, as shown, to be read out by multi-cannel photomultipliers. The "tower" structure, defined by the grouping of the fibers to be read out, is shown in Fig. 3. Test beam results obtained with a 28 rl MiniPlug prototype using high energy muon, electron and pion beams have been reported in two *Nucl. Instr. Methods* articles [1,2]. A fully assembled Miniplug consisting of 36 lead plates ready to be "fibered" is shown in Fig. 4.

References

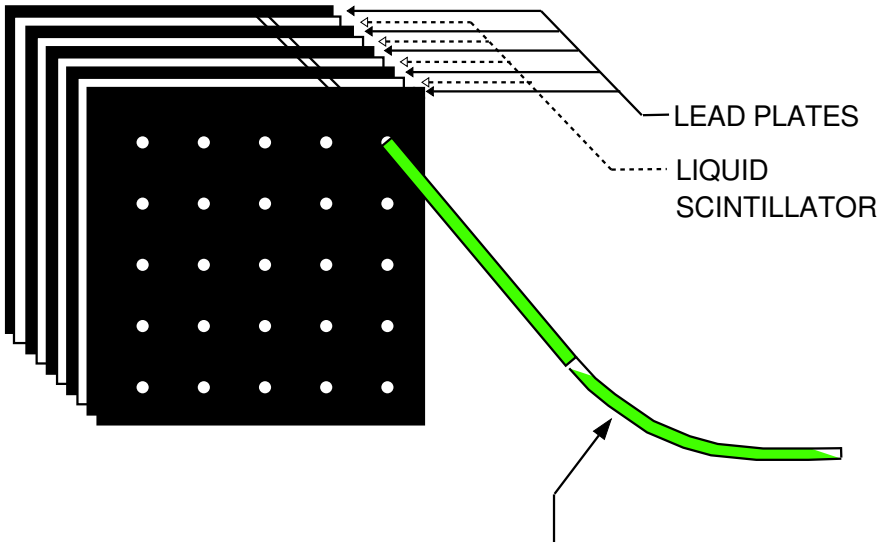
[1] S. Bagdasarov, K. Goulianos, A. Maghakian and Q. Wang, Nucl. Instrum. Meth. **A 372** (1995) 117-124.

[2] K. Goulianos and S. Lami, Nucl. Instrum. Meth. **A 430** (1999) 34-47.

The MiniPlug Calorimeter

proposed for CDF in Run II

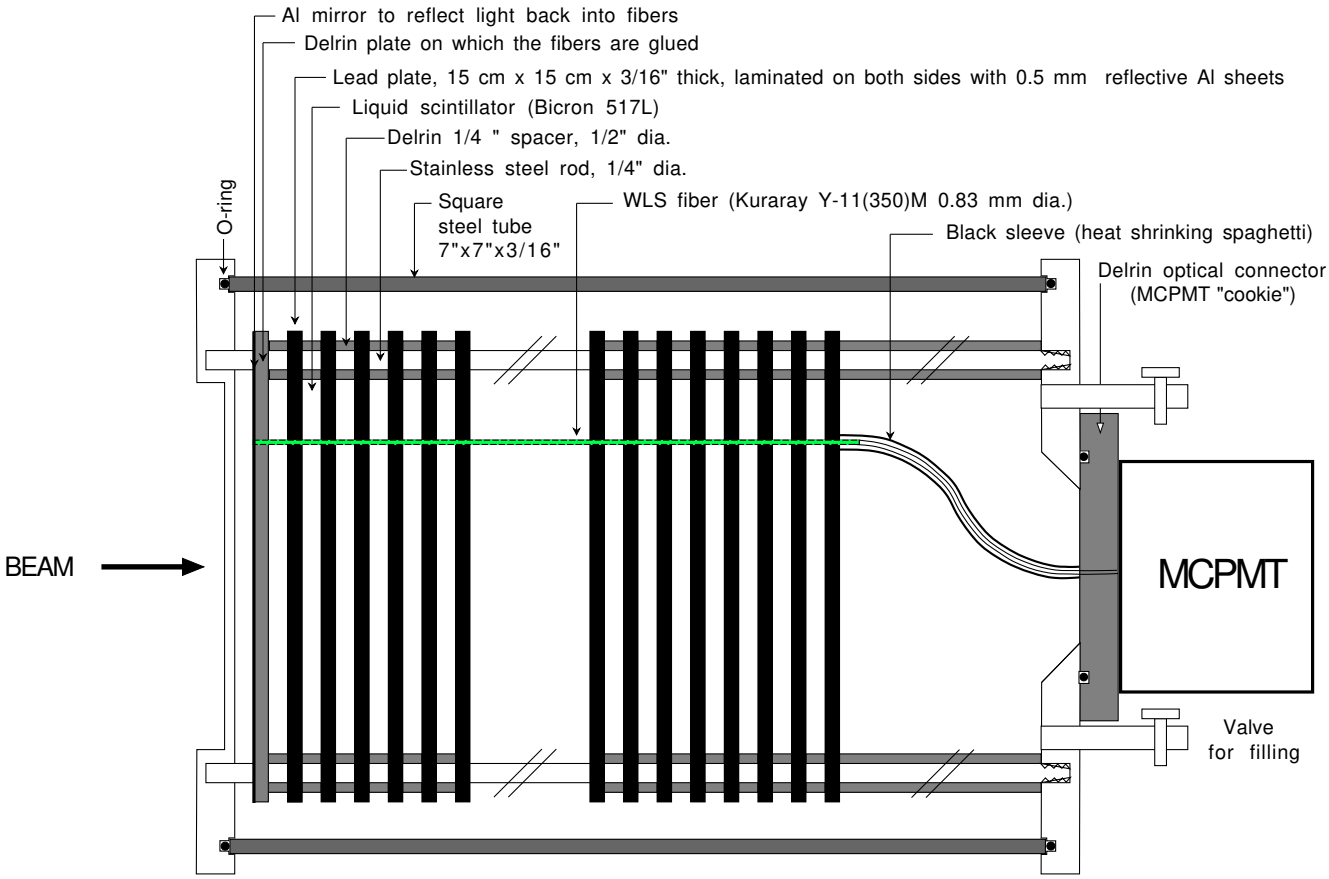
Conceptual Design

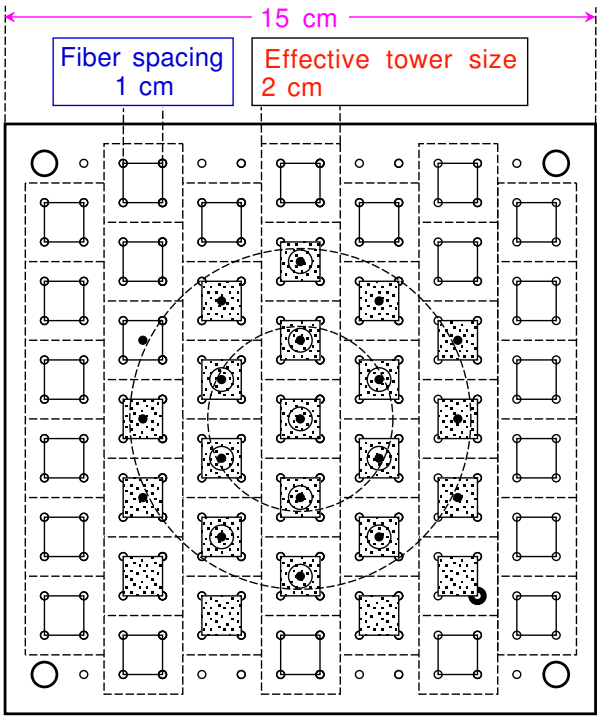


The MiniPlug consists of a set of parallel lead plates immersed in liquid scintillator. The scintillation light is wavelength shifted and guided to MCPMT's.

Calorimeter "towers" are formed by combining the desired number of fibers to be viewed by a single MCPMT pixel.

Schematic side view of the MiniPlug prototype

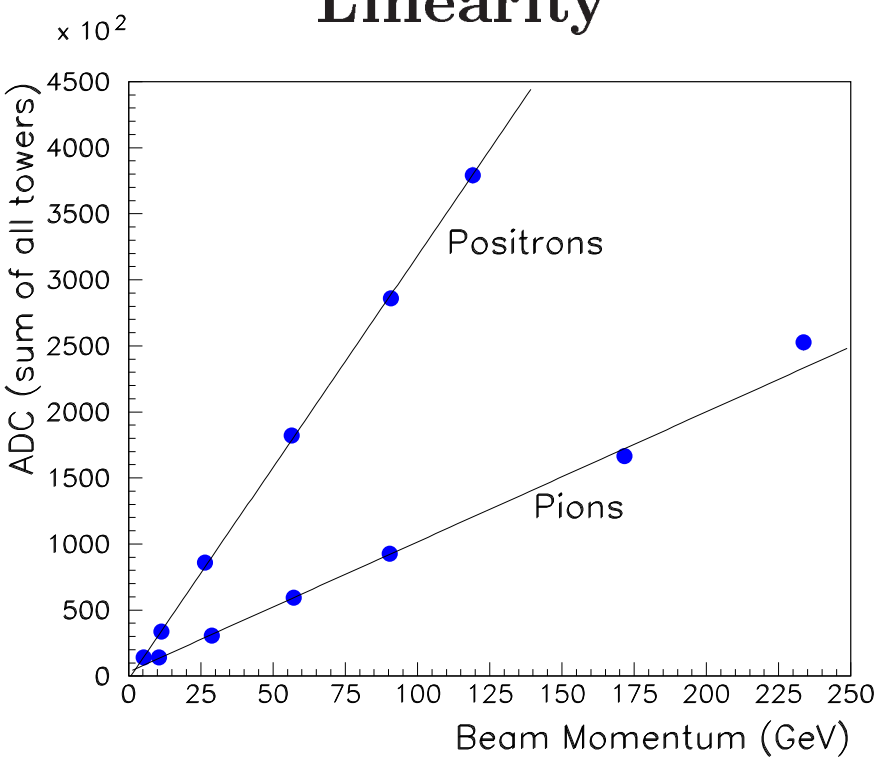




Front view of the MiniPlug prototype. Each group of four fibers in a square is read by the same MCPMT channel. Only the shaded squares and encircled single fibers were instrumented for the test beam results presented here. The beam was directed into the "tower" at the center.

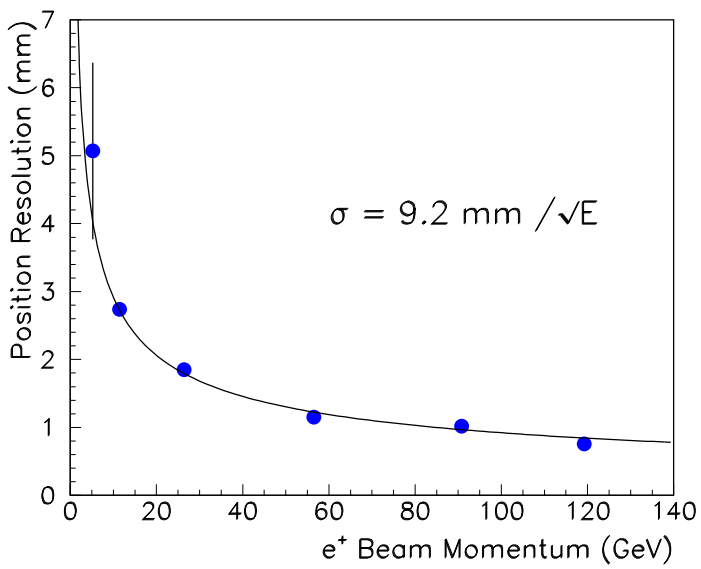
Results from the MiniPlug Prototype

Linearity

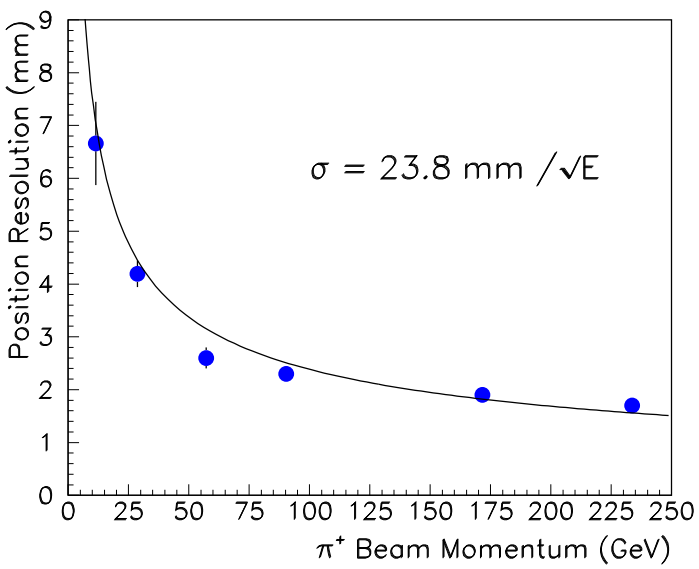


Position Resolution

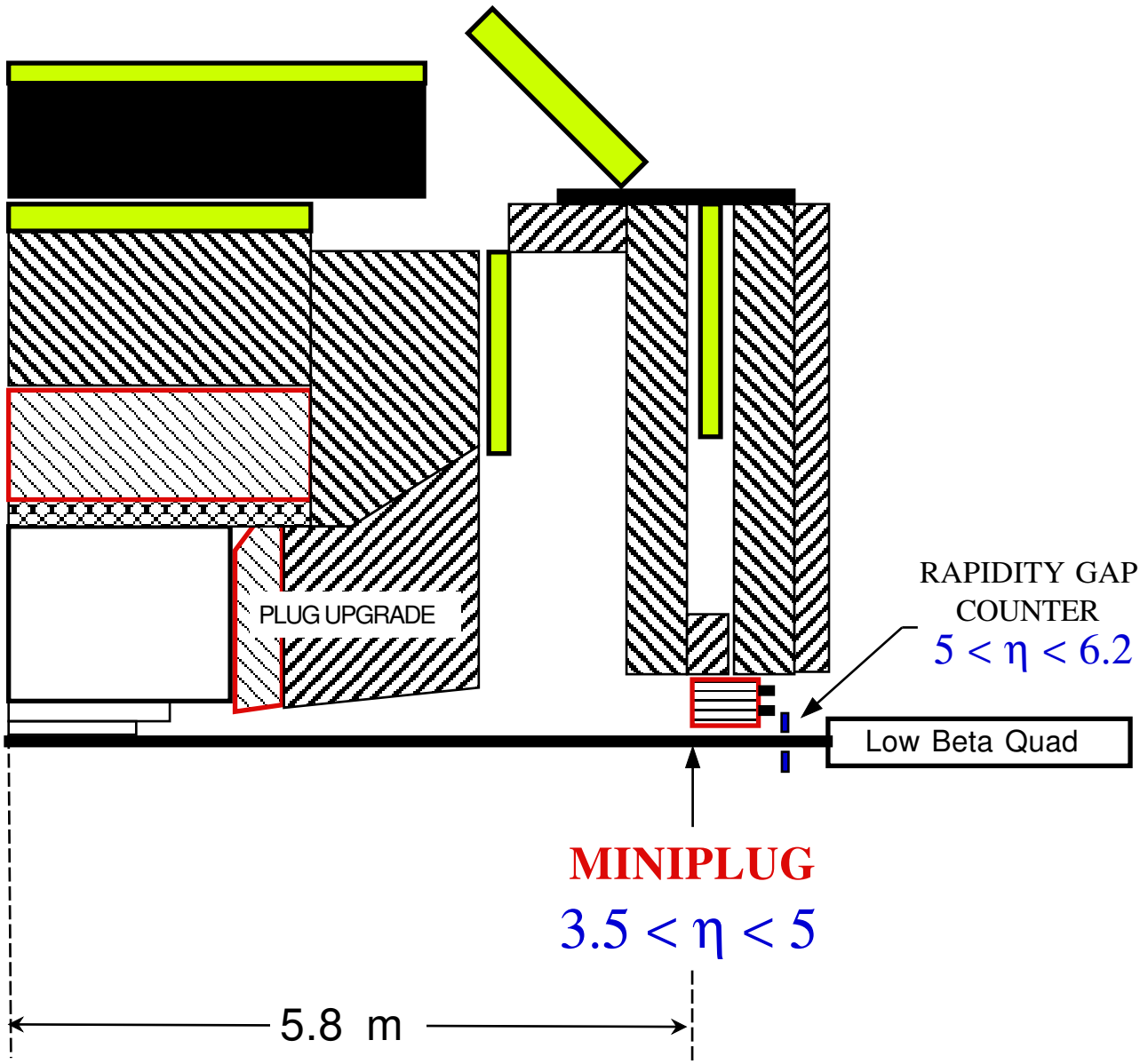
Electrons



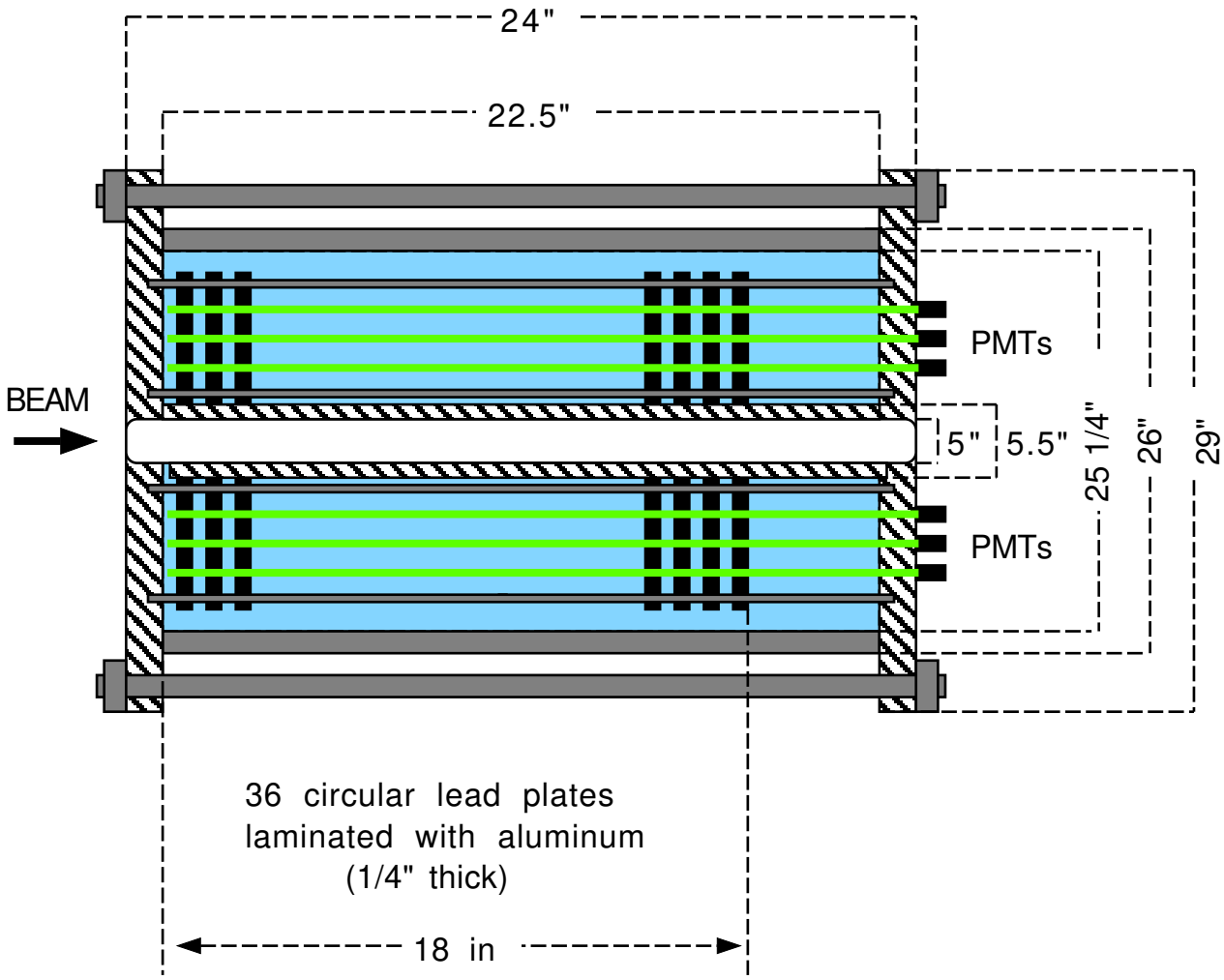
Pions



MINIPLUG IN CDF-II



MINIPLUG SIDE VIEW
(not to scale)



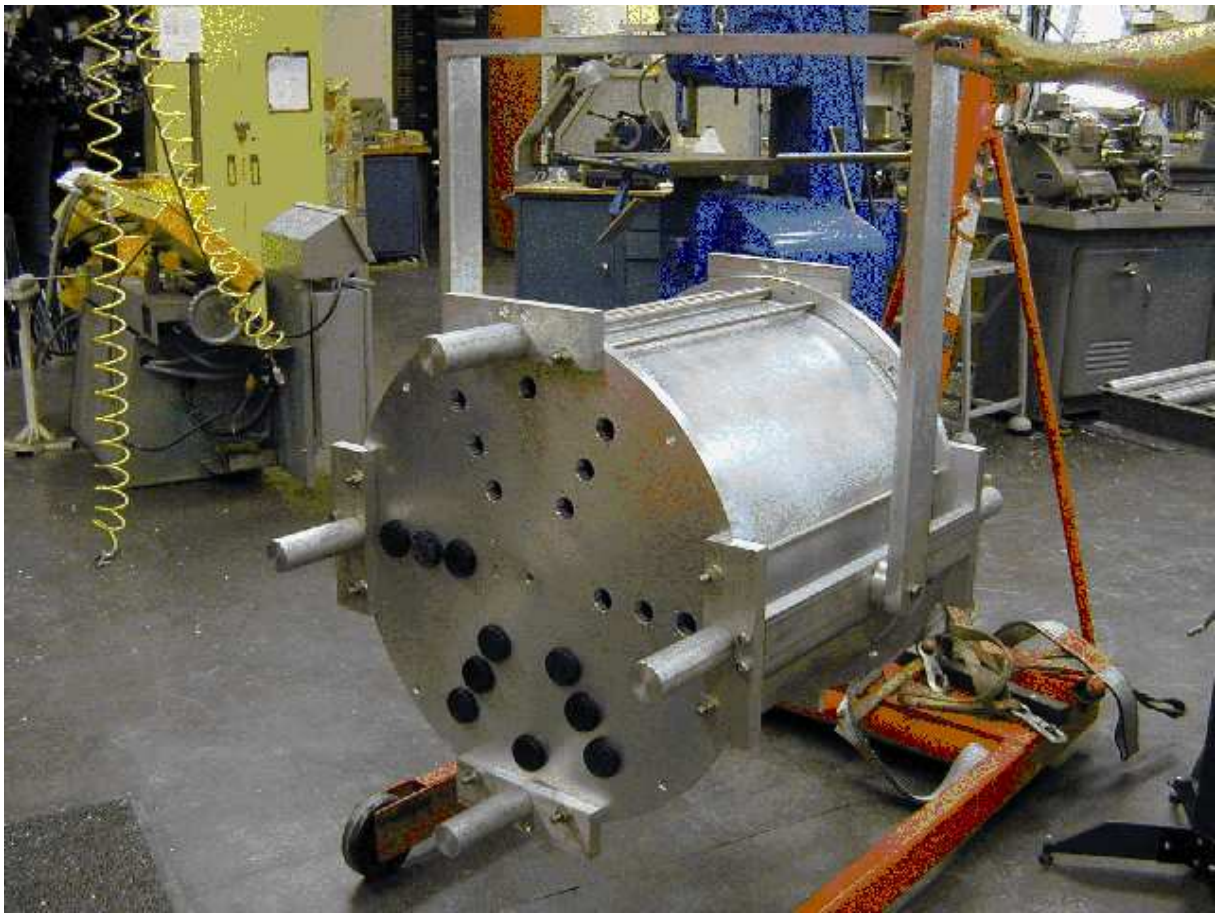
PLATES: 25 " dia, 1/4"thick (3/16 " Pb + 2x0.5 mm Al + epoxy)

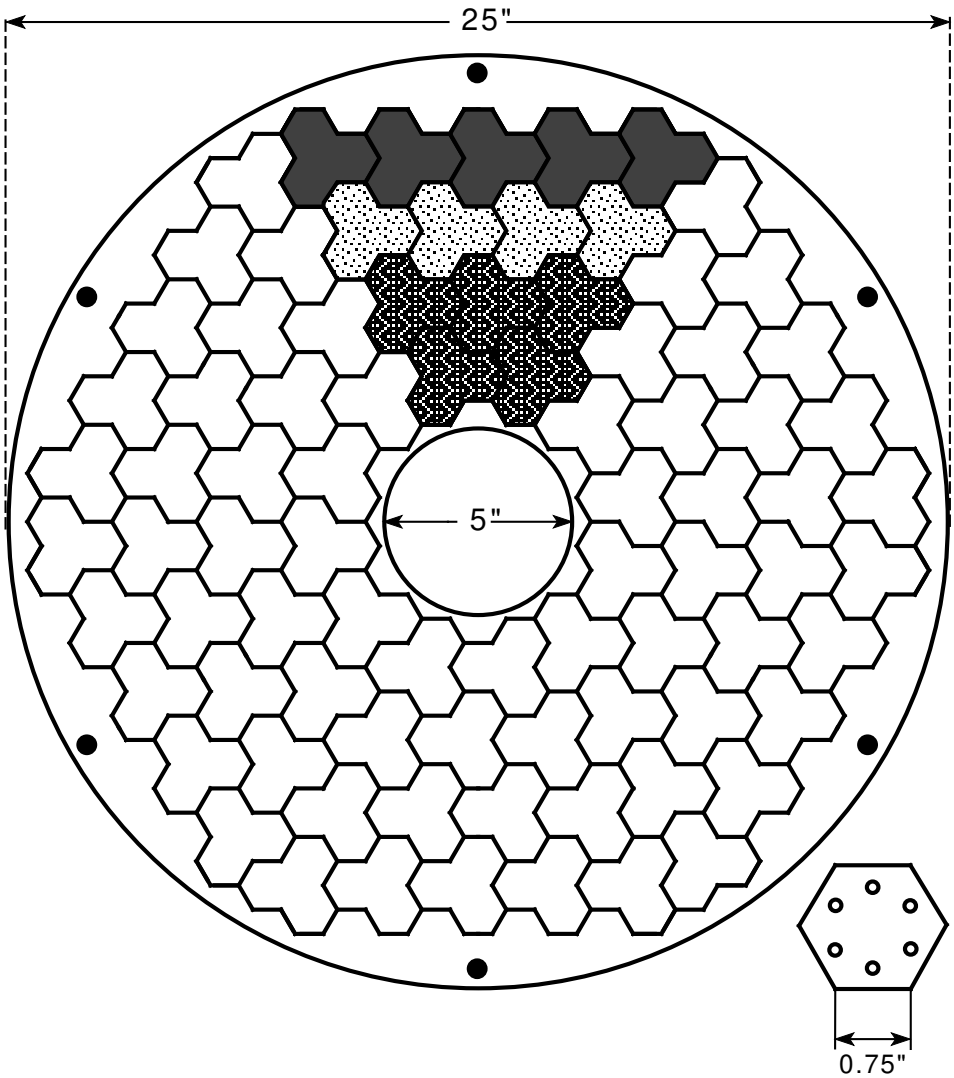
ALUMINUM

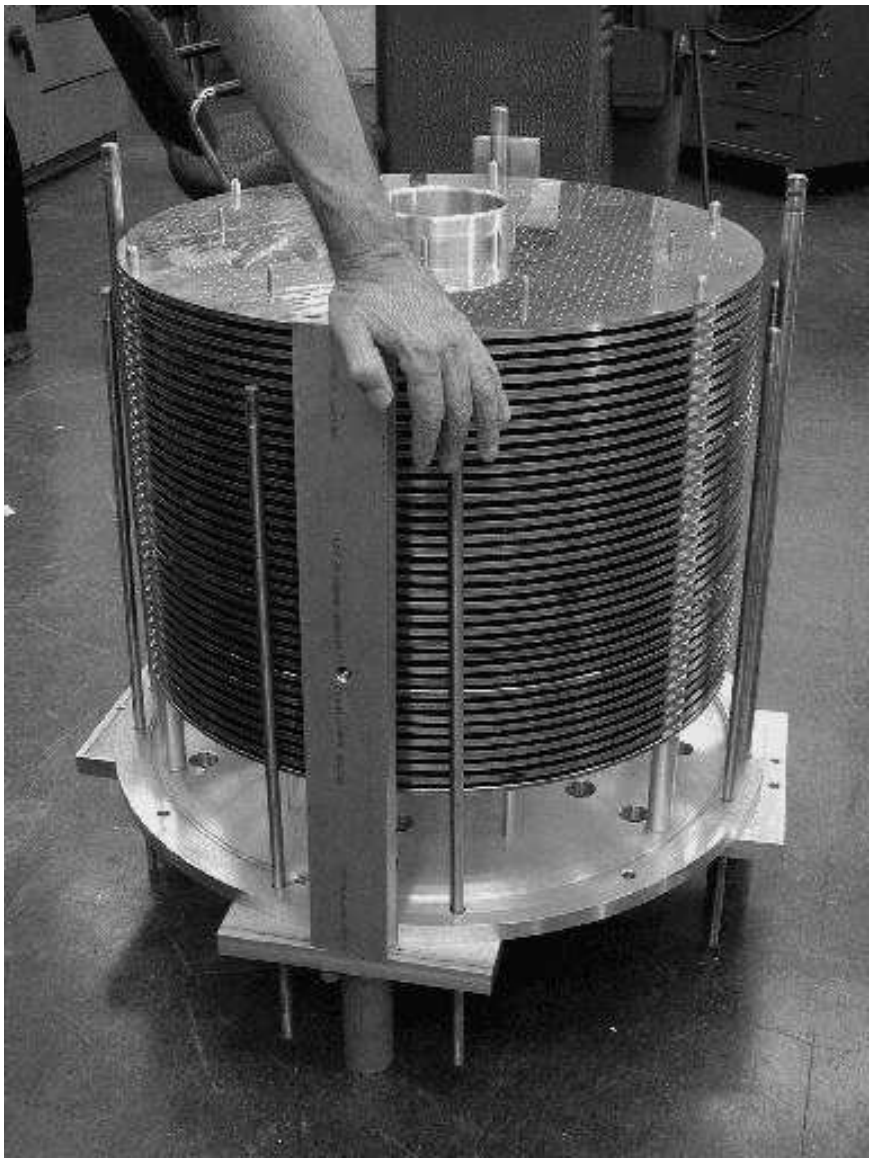
STAINLESS STEEL

LIQUID SCINTILLATOR

MiniPlug Vessel





MiniPlug lead plate. The design is based on a hexagon geometry. Each hexagon has six holes, with a WLS fiber inserted in each hole. The six fibers of a hexagon are grouped together and viewed by one MCPMT channel.
There are 252 hexagons in each MiniPlug viewed by 18 16-channel MCPMTs. The MCPMT outputs are added in groups of 3 to form 84 calorimeter "towers". The shaded areas represent tower groups viewed by a single MCPMT.

MiniPlug with all plates assembled