MUON DETECTORS AFTER THE 25-FOOT CHAMBER

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DISTINCTION BETWEEN HADRONS AND MUONS

The interaction length in liquid D_2 is 200 cm, in neon 80 cm. The number of interaction lengths presented by a 25-foot chamber, filled half by deuterium and half by Ne is relatively small, about 5, giving $e^{-5} = 1/150 = 0.7\%$ confusion between pions and muons. 2 BeV/c particles being trapped by the field can be distinguished of course!

It is thus suggested that an additional 10 interaction lengths or so be deployed at the end of the chamber with a suitable detector to tag non-interacting particles. We here describe a minimal system of Pb absorber and proportional wire chambers. In view of the very large fringe field of the 25-foot chamber (see Fig. 1) any ferromagnetic material is ruled out, i.e. no iron! We decided on Pb although concrete is not ruled out.

Shape

In the plane perpendicular to the magnetic field the dominant factor is the net bending of the particle by the bubble-chamber field itself; a 10-GeV particle starting from the center of the chamber parallel with the beam axis will suffer a 30° bend. It appears that something close to 2π azimuthal coverage is necessary in order to be able to provide π-μ discrimination down to 5 GeV/c. In the vertical plane, however, it seems that about 15 feet will suffice. The overall tonnage of such a "chastity belt" of Pb is 1000 tons (area = 90 m^2). Note: the equivalent concrete wall should be ~5 times as thick (Fig. 2).

Detector

The boundary conditions were 20 μsec spill (or longer), the detector size about 6 ×6 inches.

Plastic scintillators, Cerenkov counters, and ordinary spark chambers were considered. The first two are ruled out on the basis of large cost and the rather difficult task of shielding the photomultipliers from the fringe field. The third, spark chambers, seem okay except that 20 μsec sensitive time appears to be uncomfortably long.

Proportional wire chambers with 1-2 cm wire spacing appear to be best suited to this purpose. With modular units of 8 × 8 feet, a total of 24 such units could do the job.

Rough Cost Estimate

1.	Pb wall: 1000 tons @ $1,200/ton*	$1200 K
2.	Support structure for the wall	150 K
3.	24 wire-chamber units @ $5,500/unit	130 K
4.	Wire readout system total of 32 × 500 wires/chamber ≈ 15,000 wires @ $3.00/wire	45 K
5.	Computer-buffer for wire readout	150 K
6.	HV system	50 K
7.	Gas system	20 K
	Total	$1745 K

The Pb being the dominant cost, concrete is the obvious choice, with the understanding that 15-foot thickness gives rather uncomfortable bulk and a corresponding loss in the useful area if the detector size is kept the same.

Conclusion

Granted that 2π coverage is desired in the horizontal plane, perhaps the construction of the bubble-chamber pit can be so modified to allow the wall of the pit to serve the purpose of the absorber. Such a construction will present $1-1.5 M savings over the Pb "chastity belt" configuration (Fig. 3).

*The cost of Pb is delivered market cost. However, T. Toohig informs us that Pb can be obtained essentially free in which case this major item cost will go down to, say, $200 K.

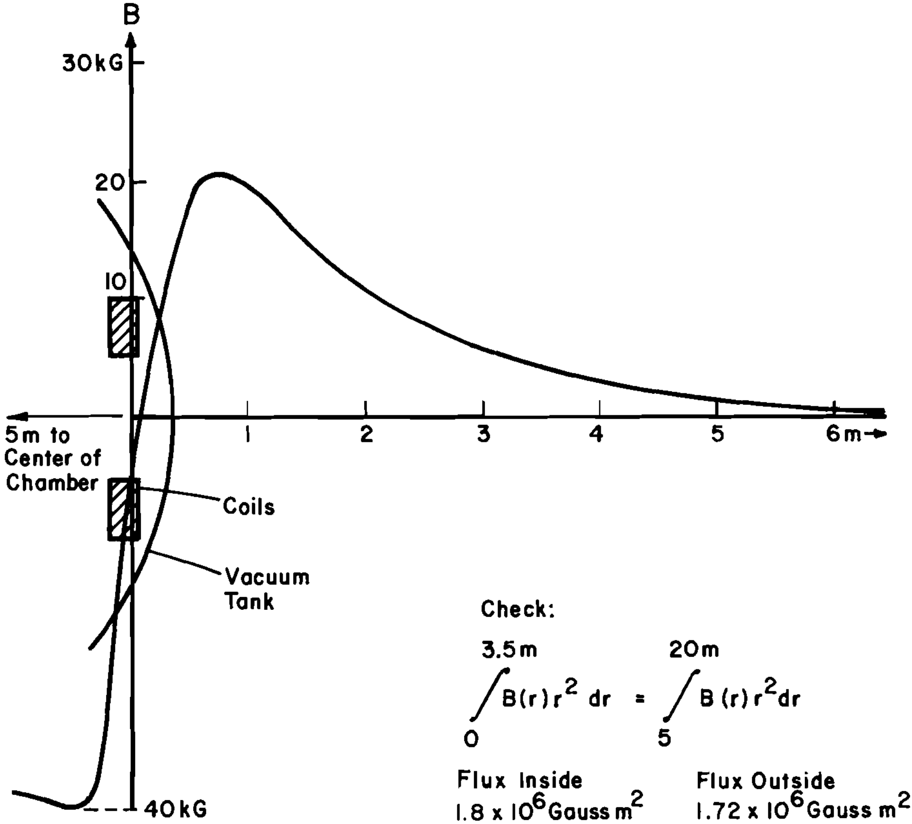

Fig. 1. Calculated fringe field of the bubble chamber.

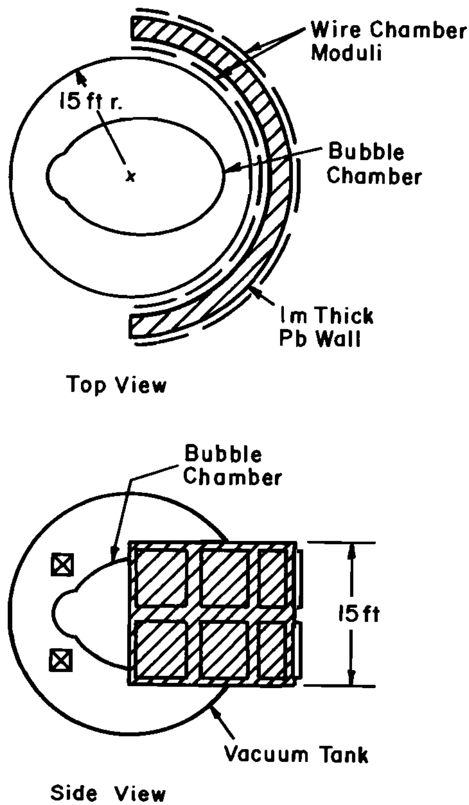

Fig. 2. Addition of a downstream muon detector to the bubble chamber.

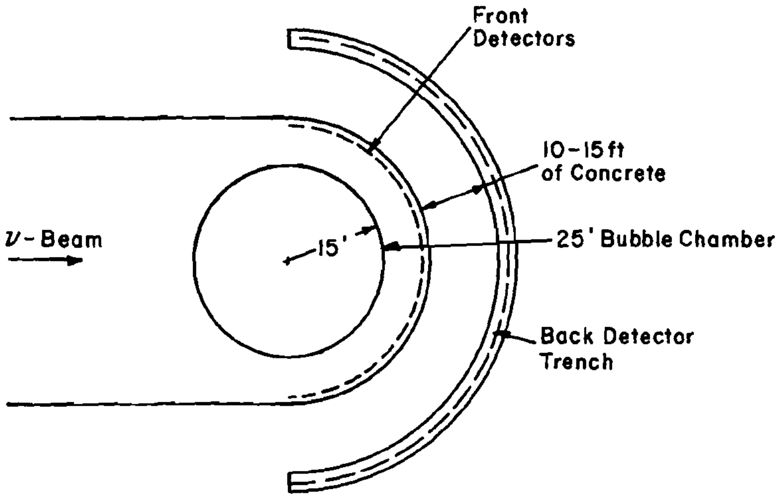

Fig. 3. Alternative muon detection system.