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M E M O R A N D U M

To. ISRC

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Subject:

STATUS OF R608 AND REQUEST TO ADD EQUIPMENT AT 90°

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This memo gives the first status report from R608 and contains a request to add a modest detector at 90° using a magnet and some wire chambers which already exist. As requested by the ISRC in ISRC/80-1 (20/3/80), we have waited to make this more detailed request until the R608 forward spectrometer is operational. As stated in our memo ISRC/80-10 (14/3/80), the group from Clermont-Ferrand has joined the collaboration for the purpose of participating in this work. This group is waiting to start construction of the necessary new equipment (and, in fact, has already started working on the existing chambers) and should not be further delayed.

Although we might otherwise have waited a bit longer so as to have more results from our August 1980 run to show to the ISRC, what we already have obtained shows definitely that the forward spectrometer is working and should be ready for physics when the ISR starts up in November. It is important to note that none of the people working on the forward detector will be involved in the 90° apparatus discussed below until the first phase physics program of R608 is well underway. We propose that the 90° detector referred to in the original R608 proposal can now be implimented by an additional group that is only involved in that detector; the intensity of work on the forward spectrometer is therefore not diminished.

STATUS OF R608

Installation work proceeded smoothly during the first half of this year. During August 1980, the first test data were recorded with 9 out of the 10 chamber packs and the rear Freon-114 gas Cerenkov counters installed. The readout of the 40-crate time-digitizer system functioned well (approx. 2/3 of the full complement of 514 32-channel TDC modules were plugged into the crates).

Figure 1 (appended) shows the horizontal projection of a typical 3-track event in the bottom spectrometer with the field off (we also have field-on data which is currently being analyzed). Each of the 5 chamber packs has 2 vertical wire planes with 3 mm. wire spacing (x and x', 1.5 mm. displaced), 1 horizontal wire plane (y) and 1 slanted wire plane (u). Thus, in the event shown, the x and x' planes are seen in each of the 5 chamber packs.

The 32-channel ECL 10000 amplifier cards have a gain of 1500 and yield clean 1.2 volt differential logic signals at the ends of 70 m. flat polyethylene cables. These plug into the TDC modules. The start pulse (or level-1 trigger) for the TDC's is derived from scintillation counters in front of the spectrometer. The digitization in the ECL 10000 TDC circuits occurs rapidly by means of latching 4 grey-code clock lines when the wire signals arrive. With a least count of 5 nsec ($\sigma \sim 1.5$ nsec), the TDC's count up to 80 ns, appropriate for our 30 ns maximum drift time. Figure 2 contains a histogram from our August run of drift time for plane 1x and shows that the time distribution is approximately flat within statistics and rather clean. At least part of the tail on the high side is presumably due to particles with $\beta < 1$, whose $t = 0$ point on the plot occurs later than that for the $\beta = 1$ particles.

If a level-2 trigger logic signal is obtained (from the various other scintillation counters in the experiment, discussed below), a central control and memory crate strobes out the TDC information from the 40 crates in parallel. This proceeds at the rate of 60 ns per hit. Thus, for example, an 8-track event which has, on the average, 4 hits in the upper chambers and 4 hits in the lower chambers takes only 4 x 60 = 240 ns (+ 120 ns overhead time) to be transferred to the RAM (memory). In the process of being read into the memory modules, the hits are counted and compared with lower and upper limits which had been down-loaded from the PDP-11 before the run. Majority logic is performed on this information and, if successful, provides our level-3 trigger which is the computer interrupt to read out the event. If either the level-2 or level-3 decisions are unsuccessful, the system is rapidly reset and available for the next event.

During the August run, we brought up the high-mass diffractive trigger with which we will search for the associated-charm production reaction:

$$pp \rightarrow p + (\Lambda_c^+ D^o) \qquad (1)$$

The scintillation counter part of this trigger consists of vetoing the entire solid angle outside the forward spectrometer except for a recoil proton collinear with the total momentum in the spectrometer (collinearity checked off-line). To accomplish this, we have veto counters in the central region, lead veto counters in the arm opposite the spectrometer and small-angle hodoscope counters for the recoil proton (the latter 2 sets of counters were used in R603). Under construction are lead veto counters to cover the solid angle outside the spectrometer in the spectrometer arm.

The level-2 trigger rate of $\sim$2000/sec (for luminosity $\sim 10^{31}$) was found to be reduced to $\sim$20/sec using the above-mentioned multiplicity trigger. With a possible data acquisition rate of more than 100/sec, the dead time is small. What can we therefore expect for Reaction 1 ? This trigger rate corresponds to a $20/10^{31}$ = 2 μb cross section. We do not know the cross section for Reaction 1, although we think that the total charmed-particle cross section at the ISR is large. If $\Lambda_c D$ diffractive production in Reaction 1 were 100 times smaller than the corresponding cross section for $\Lambda^o K^+$ of $\sim$2 μb measured in R603, there is 1 example of Reaction 1 entering the spectrometer every 5 sec, or 1 event out of 100 on tape. In fact, the signal may well be better than this because (a) we did not have the large angle veto counters installed in the spectrometer arm in August, and (b) $\Lambda_c D/\Lambda K^+$ is probably larger that 1/100 at ISR energies.

In the August run, we broke wires in 2 planes because of a simple mechanical problem (now repaired). The 10^{th} chamber is now being equipped with cards, we are finalizing the chamber alignment system and repairing defective channels in the 16,448 wire system. After recording some initial calibration data in November when the ISR starts up, we shall use our high mass diffractive trigger and attempt to observe Reaction (1). Also being readied for installation towards the end of this year, but not essential for the first charmed-particle runs are the CO_2 Cerenkov counters and the large γ-detector, which is positioned at the rear of the spectrometer.

REQUEST TO ADD EQUIPMENT AT 90°

The 90° equipment would be installed as shown in Figure 3. It consists of:

(a) Magnet

We ask CERN to supply us with the existing 1 m. magnet, MEP17 (this magnet is available - G. Petrucci, private communication). We will use it in an orientation with horizontal field and a gap enlarged from 300 mm to 400 mm. This modification is straight-forward and inexpensive. The present magnet characteristics and the ones which we desire are as follows:

	Present charac.	Desired charac.
overall length	1550 mm	
overall width	2270 mm	
overall height	1540 mm	
gap	300 mm	400 mm
useful aperture	1000 x 300 mm	1000 x 400 mm
power consumption	93 Kw (max)	70 Kw
field	0.98 T (max)	0.55 T
bending power	0.88 Tm. (max)	0.50 Tm.

(b) Wire chambers

The drift chambers have the dimensions

CH1	22 x 40 cm
CH2	37 x 40 cm
CH3	52 x 40 cm
CH4	100 x 100 cm
CH5	100 x 100 cm

Chambers 1, 2 and 3 (3 planes, xyu, in each) will be constructed by the Clermont-Ferrand group. They will have drift cells of $\pm$ 25 mm and have double sense wires to resolve the left-right ambiguities. Chambers 4 & 5 have already been constructed by the UCLA group. They have drift cells of the same size and also have double sense wires, but have a thin printed-circuit delay line positioned between the double sense wires to furnish a course measurement ($\sigma \sim 3$ mm) of the longitudinal position of the hit along the sense wire.

The spatial resolution of the chambers (0.2 mm), multiple coulomb scattering, the length of the lever arms (70 cm) and bending power of the magnet yield a momentum resolution of $\delta p/p \sim 0.01p$,

(c) Aerogel Cerenkov Counters

The Saclay group will construct two ensembles of silica-aerogel Cerenkov counters shown as C_1 and C_2 in Figure 3. Each ensemble has transverse dimensions 105 x 50 cm and consists of 7 horizontal cells, each 15 cm high by 50 cm long. The respective indicies of refraction, of n = 1.03 and n = 1.11 will permit the identification of each type of particle in the following ranges of momentum:

pions:	0.3 to 2.0 Gev/c
kaons:	1.05 to 2.0 Gev/c
protons:	1.05 to 3.8 Gev/c

Thus, there is a total separation between 1 and 2 Gev/c

(d) Gas Cerenkov Counter

This counter is optional. It contains Freon 114 (π threshold $\sim$2.5 Gev/c) at atmosphereic pressure and would be added at a later date if sufficient interest is found to extend the particle identification to higher momentum (pions up to 8 Gev/c and kaons up to 3.8 Gev/c). The counter is small (50 x 100 cm) and contains 3 cells, thus presenting no problems to construct.

RATES:

With an expected $p\bar{p}$ luminosity of about 12 x 10^{28}, we find the following counting rates for P_t= 1 and 2 Gev/c,

	π	K	P
P_t = 1	1500	150	240
P_t = 2	15	5	7

Rates per hour per Δp = 100 Mev/c for each charge

TIME SCALE

The apparatus will be progressively installed between February and October 1981

COSTS

We estimate the new equipment costs as:

chambers and electronics	175 KFF	Clermont-F[d].
chamber hodoscope (50 wire chamber for triggering)	15 KFF	
scintillator, power, cables & fast electronics	150 KFF	
Aerogel Cerenkov counters	250 KFF	Saclay

In addition to the magnet requested of CERN, we also request apparatus supports and 3 Lecroy TDC modules (about 15,000 dollars). No additional computer time should be needed, beyond the normal R608 allotment.

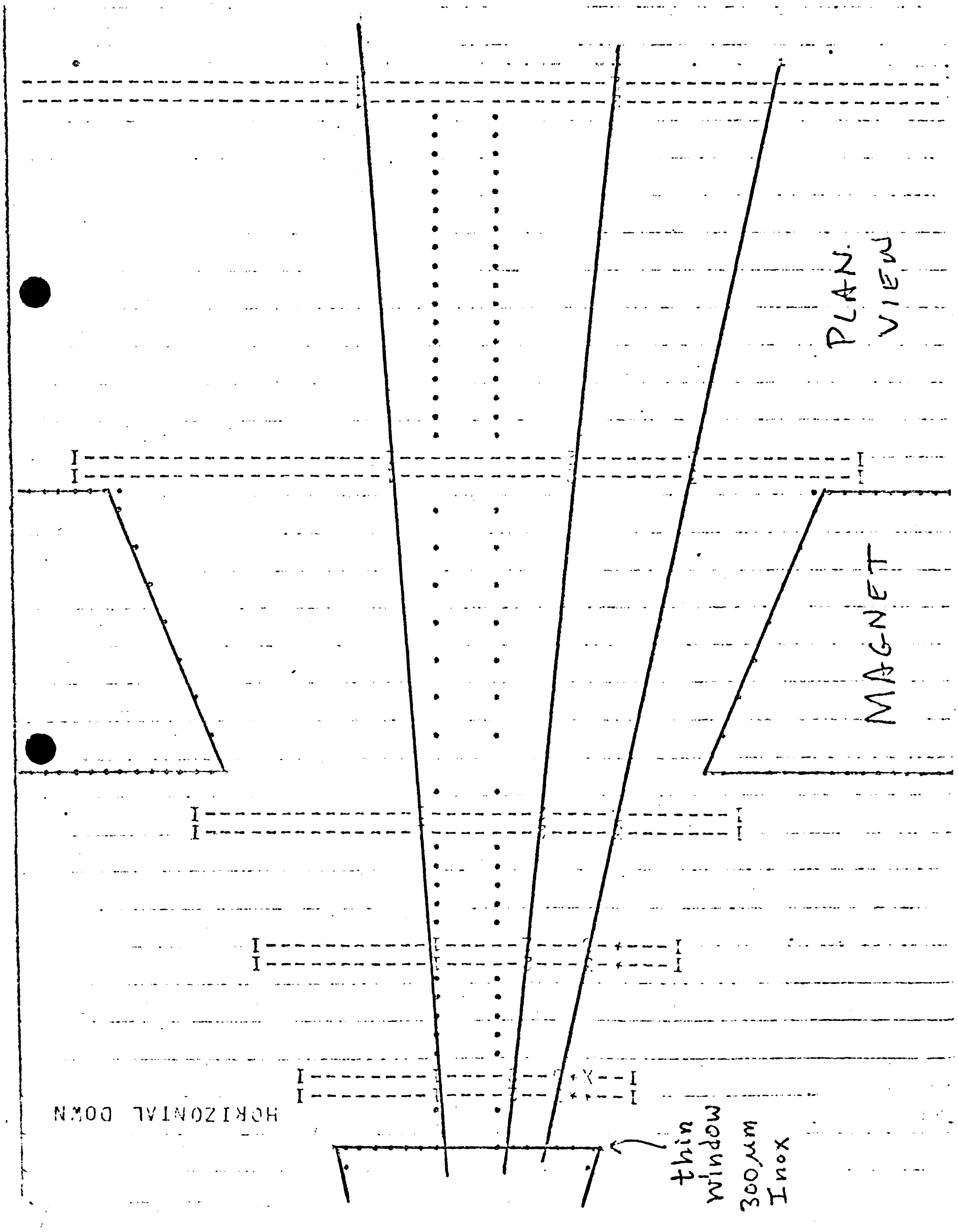
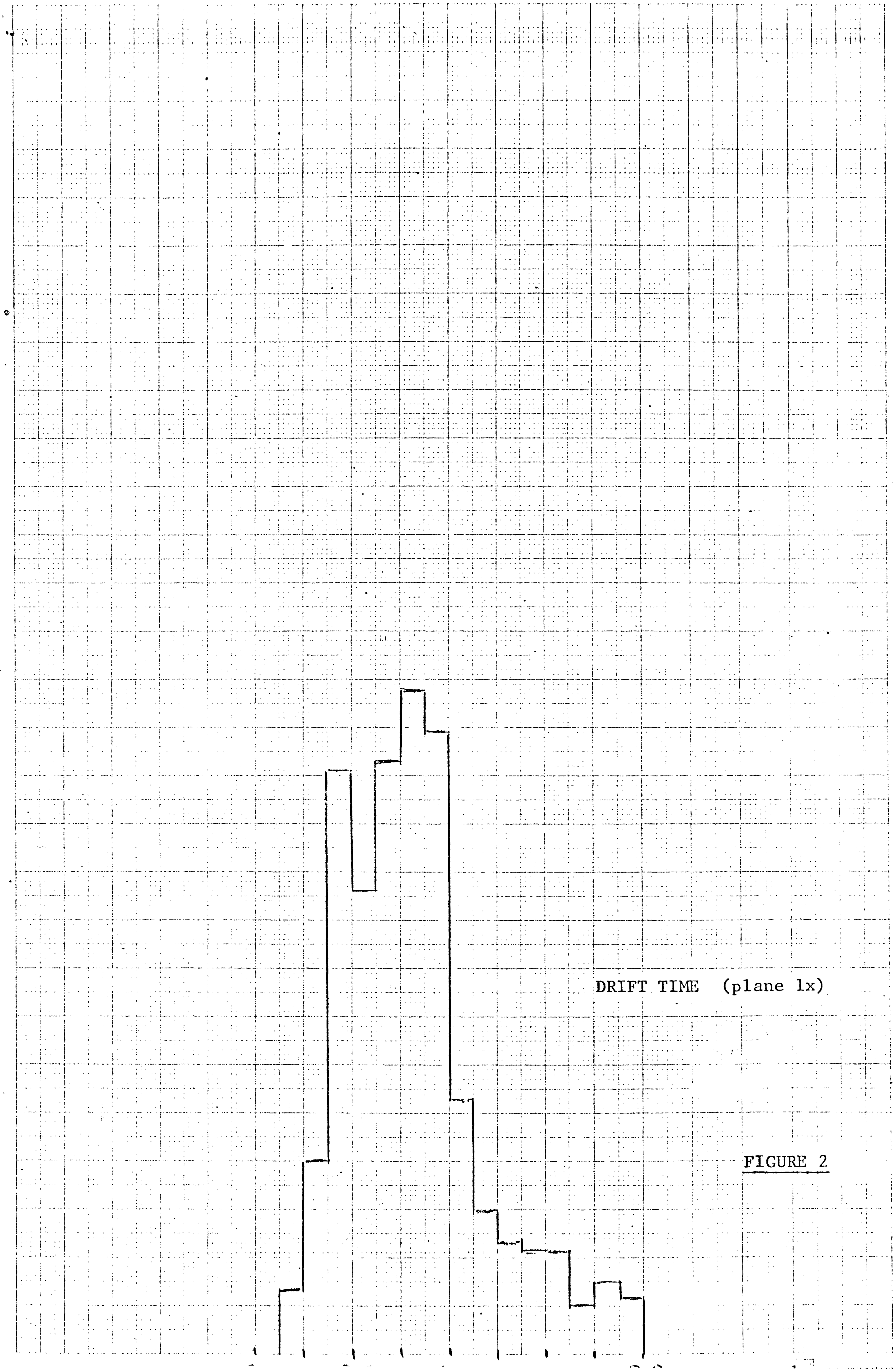
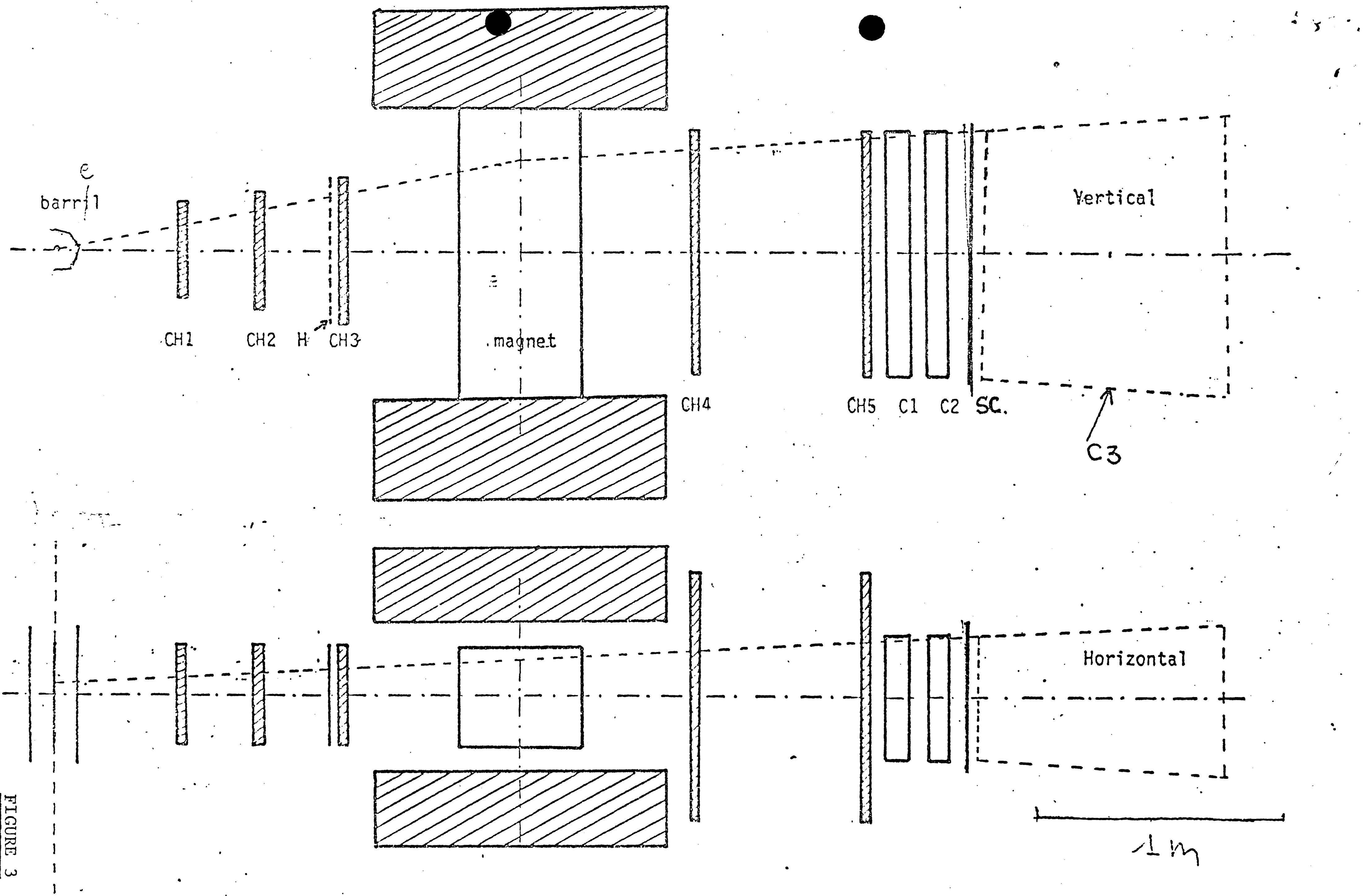


FIGURE 1



DRIFT TIME (plane 1x)

FIGURE 2



Layout of proposed 90° spectrometer

FIGURE 3