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ADDENTUM 2 TO

REVISED PROPOSAL FOR A SEARCH FOR MULTIGAMMA EVENTS AT THE ISR

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A MODIFICATION OF THE DETECTOR SYSTEM

We are presenting here a modified detector system design with considerably less complexity and reduced cost at approximately one-third the price of the equipment in our previous design. This has been made feasible due primarily to the knowledge as well as the experience gained from the results recently analysed from our exploratory experiment The main important conclusions drawn from these results are as follows:

1) In the 90° region of the colliding beam interaction zone, there appears to be present a very large number of high-multiplicity neutral or possibly γ events, which is higher by several orders of magnitude than the theoretically expected γ multiplicity in the uncorrelated π^0 production process in this region. This is true in spite of the fact that the resolution in solid angle in the γ multiplicity measurement of the present detector system is rather poor, i.e. $\sim$ 1/16 sr.

2) Most of these high multiplicity neutral or γ events possess comparatively low energies of $\sim$ 50 to a few hundred MeV. Such energies were measured adequately, in a large number of cases by depositing sufficient energy in a 3-radiation-length thick lead-glass detector.

3) A clear demonstration of the feasibility of operating the MWPC (multiwire proportional chamber) satisfactorily with eight wire groupings at the ISR.

4) The multiplicity triggering system based on a fairly high threshold energy value introduces a bias condition which is clearly undesirable.

By making use of the above-mentioned conclusions, we can modify our earlier design to follow the revised criteria listed below:

a) A single layer of 3-radiation-length thick lead-glass detectors would be sufficient to give a rough energy measurement over all the solid angles covered by the detector system, with the additional provision that in a preselected angular region a special sectional detector unit is placed which is capable of not only measuring the γ-ray energies accurately but also of obtaining an increased space resolution measurement by a factor of $\sim$ 64. This special unit can be interchanged with one of the other units and be placed at a different angular region to obtain a corresponding precise measurement of the γ-ray energies and angular and multiplicity distributions in this newly selected angular region. Correlation of these measurements can be achieved by comparing the results of those events which have similar multiplicity and angular distribution registered by the other segments of the detector system.

b) The detector design makes use of the improved design of the MWPC developed by the Charpak group, so that one edge of the detector segment can be placed very close to the beam pipe without losing more than one centimetre dead-space Thus one can get as close as ever possible to the forward directions of the interacting beams.

c) With the modified design of the detector elements it is possible to re-employ the whole detector system such that the new arrangement covers close to 85% of the total solid angle instead of the 70% in the previous design. Furthermore, with only one-third of the cost of the earlier version, and with considerable simplification, the whole system can be installed all in one step instead of the two-step installation planned for a two-year period. Thus one can immediately obtain correlation effects in our results, if present.

d) Triggering can be achieved by the selected multiplicity only without any bias effect due to energy threshold. However, energy threshold can be added in the triggering if so desired.

There are six separate detector units, five of which, namely F_1, F_2, U_1, U_2, and S, are similar in design but different in size Basically each unit consists of two MWPC, each with three signal wire planes at 3 mm wire spacing and with a layer of 3-radiation-length thick (7.5 cm) of lead-glass blocks ($10 \times 7.5 \times \ell$ cm) sandwiched in between them, where ℓ varies from 30 cm to 50 cm, respectively.

Figure 1 shows the plan view of the detector arrangement. F_1 and F_2 are (1×1) m^2 in size and are placed immediately on the top and bottom of the interaction region. U_1 and U_2 are of the size (0.3×1) m^2 with U_1 placed on the top of one beam pipe in the forward direction, slightly tilted as shown in the side view (Fig. 2) U_2 is placed on the bottom of the opposite beam pipe also in the forward direction, and tilted

S is $(0.6 \times 1)\ m^2$ in size and is placed on the inside of the colliding beam in the 90° region. SP is the special detector unit with the front MWPC consisting of five signal wire planes and two HV signal planes. The second MWPC behind the 3-radiation-length lead-glass elements consists of three signal wire planes. However, none of the wires in these two chambers is grouped together; thus each wire represents a signal channel, whereas in the other MWPC the wires are in groups of eight. Behind the second MWPC there are 66 lead-glass blocks, each 14-radiation-length thick (10 × 10 × 35 cm), which enable the accurate measurement of the total energy of the gammas.

At a later stage of the experiment, an additional sandwich layer of 20 lead-glass blocks (7.5 × 10 × 30 cm) and a MWPC $(0.3 \times 1)\ m^2$ in size could be inserted in the SP detector segment to further ensure the identification of the extremely rare events, should they exist

REVISED EQUIPMENT COST

	Estimated cost in $
1) Multiwire proportional chambers (MWPC)	
4 (1 × 1) m^2 MWPC (using existing MWPC with modif.)	4,000
4 (0.3 × 1) m^2 MWPC	9,300
3 (0.6 × 1) m^2 MWPC	10,000
1 (0.6 × 1) m^2, 5 signal planes +2 HV sig. planes	
Total	23,300
2) Electronics for MWPC	
2800 signal channels (+ 336 existing channels) (a) $ 23	64,400
60 signal cables (a) $ 2.3/ft at 65 m	5,600
Total	70,000
3) Lead-glass blocks	
40 pcs 7.5 × 10 × 50 cm (for F_1 and F_2)	17,500
20 pcs 7.5 × 10 × 30 cm (for U_1 and U_2)	5,300
20 pcs 7.5 × 10 × 30 cm (for S)	5,300
20 pcs 7 5 × 10 × 30 cm (for SP)	5,300
66 pcs 10 × 10 × 35 cm (for SP)	26,900
Total	60,300
4) Miscellaneous parts	
166 RCA 4517 phototubes (a) $ 40	6,640
166 Tube bases for above (a) $ 40	6,640
30 Scintillators (3 mm × 1 m × 20 cm) + phototubes and bases (a) $ 200	6,000
30 Plastic strips (3 mm × 1 m × 20 cm) + phototubes and bases (a) $ 150	4,500
3 HV supplies for phototubes + distrib.	4,500
3 HV supplies for MWPC	3,000
166 ADC (minus 48 in existence) (a) $ 120	14,400
166 Calibrating sources ^{24}Am in NaI (a) $ 70	11,620
	57,300

	Estimated cost in $
	57,300
166 Calibrating diodes (a) $ 10	1,700
166 Linear fan-out (minus 36 in existence) (a) $ 34	4,600
- Cables (HV + signal coax.) cable connections, space lead-glass blocks	24,000
- Gas supplies for MWPC for 6 months' running	4,000
Total	91,600
Grand Total (1 + 2 + 3 + 4)	245,200
15% contingency	36,800
	282,000
(Previous design total cost)	(798,400)
Total Rome contribution	117,000

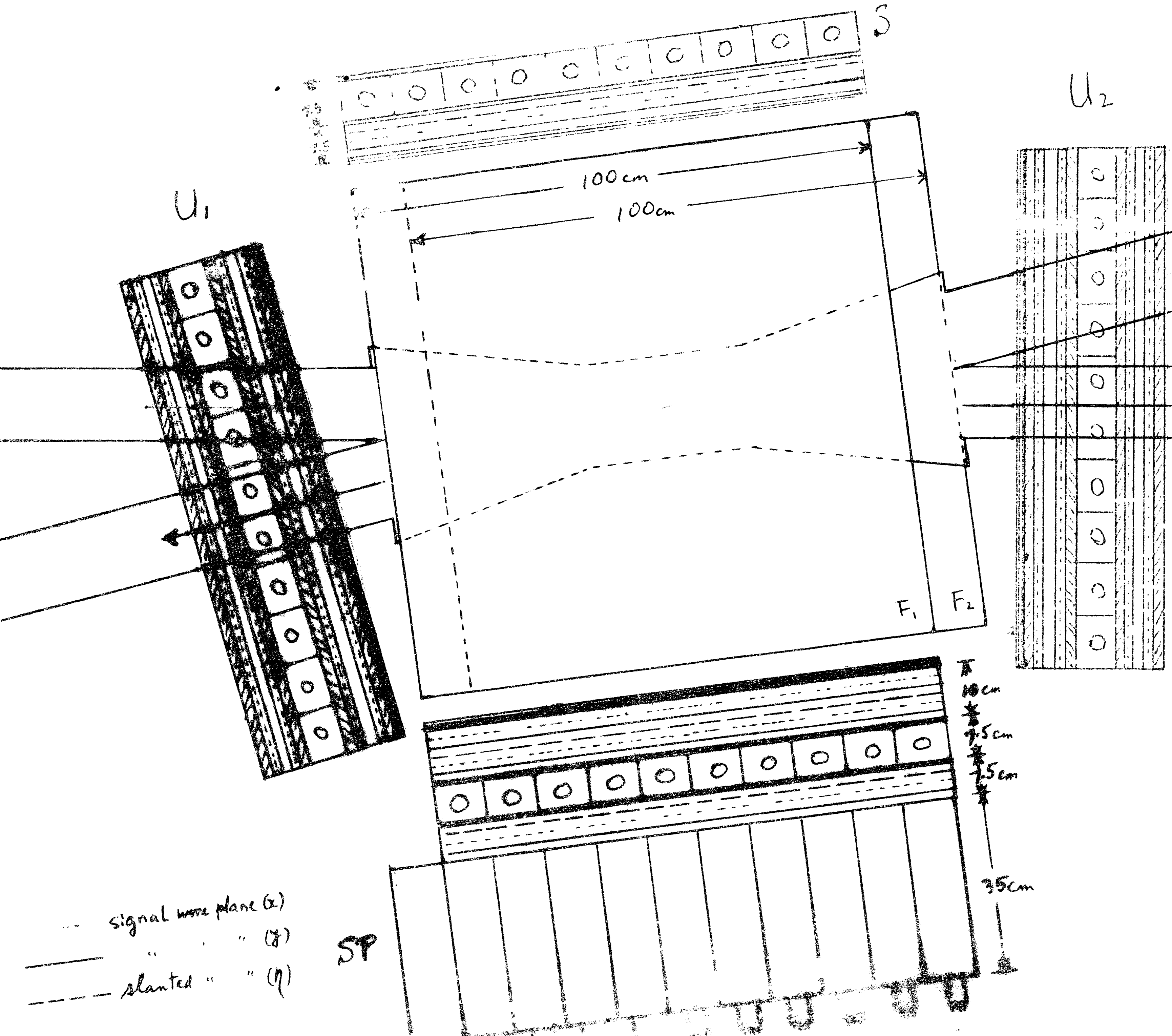
S
U1
U2
100 cm
100cm
F1
F2
10cm
35cm
SP
signal wire plane (x)
" " (y)
slanted " " (η)

Fig 1

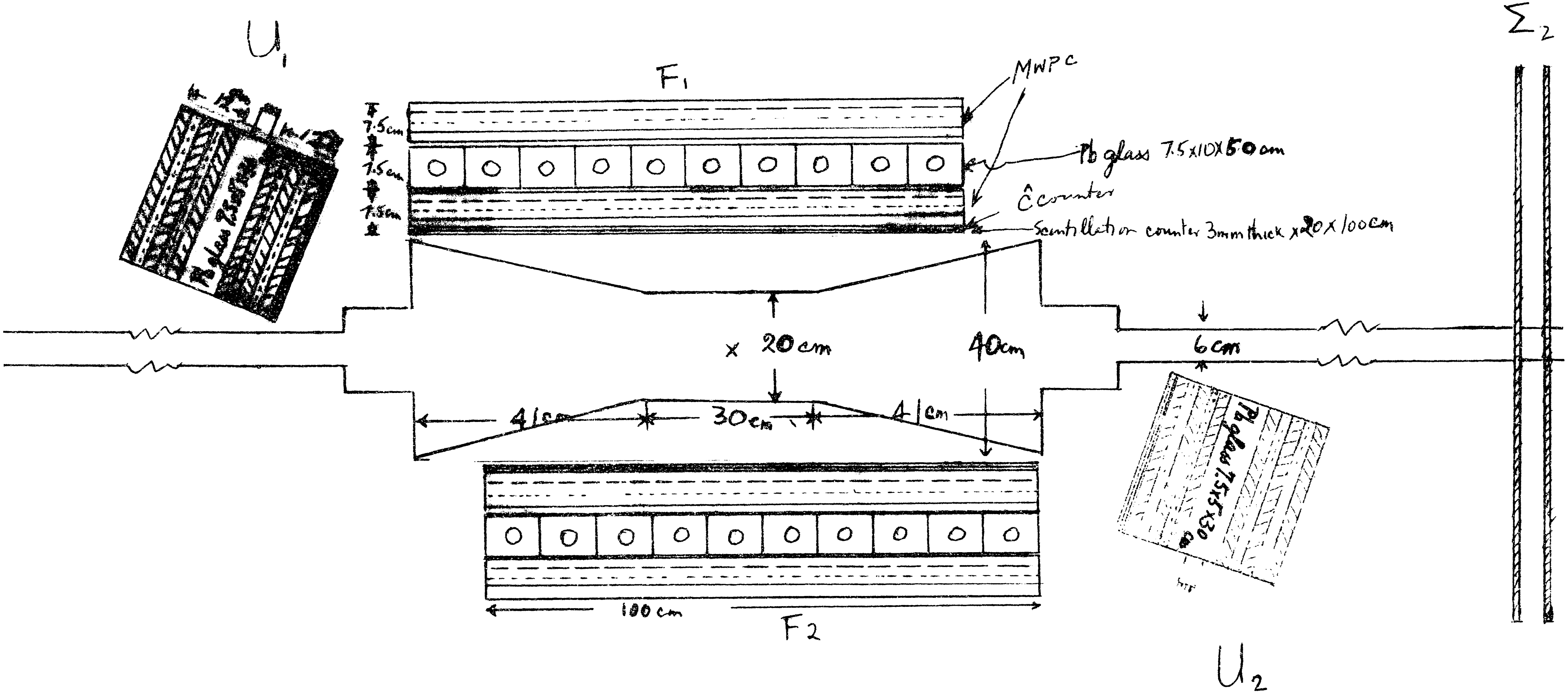
U1
F1
MWPC
Pb glass 7.5x10x50 cm
Ĉ counter
Scintillation counter 3mm thick x20x100cm
7.5cm
7.5cm
7.5cm
20cm
40cm
6cm
41cm
30cm
41cm
100 cm
F2
Pb glass 7.5x5x30 cm
U2
Σ2

Fig 2