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POSSIBLE INSTALLATION OF A THIRD "SPLITTER MAGNET" IN THE LEAR EXPERIMENTAL AREA: STUDIES OF LAYOUT AND OPTICS

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1. Summary

By installing a third splitter magnet in the CØ line of the LEAR beam area the experiments of the lines C1 and C2 could simultaneously be in operation as asked for by some users. The special facility of the C2 line which allows the beam to be energy-degraded as well as polarized at "Foc 1" is suppressed.

In this note a new layout of the C lines' downstream splitter magnet 2 is presented. The end of the beam lines C1 and C2 are not changed significantly. Except for the splitter magnet 3, which is in construction, only existing beam-guiding elements are used. No permanent changes of shielding walls are necessary.

For monitoring the beam some new equipment is needed (multi-wire proportional chambers) as well as vacuum components (pumps, vacuum chambers, etc. ...) to bring the vacuum of the C1 and the C2 lines down to that of LEAR.

The beam should not be split in more than three branches for reasons of $\bar{p}$ losses and tuning time. This means that not more than two splitters should be used simultaneously.

The installation is estimated to take about five weeks and could be finished in about 6 months after the decision has been taken.

The cost of all extra equipment is 100 kSF.

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2. Motivation, design goals and constraints

The idea to install a third splitter magnet in the LEAR experimental area emerges from the pressure for antiproton beams of medium and high momenta. An explicit request to the PSCC (84-23), Ref. 1, and a feasibility study, Ref. 2, were made in March 1984.

The conclusions of this note together with other more or less obvious goals and constraints of such a project can be summarized as follows:

1. Possibility to run experiments in both C1 and C2 lines simultaneously.

2. Maximum beam momentum (p = 2 GeV/c) should be available at the C target positions, except for PS182 in the C1 line.

3. The special layout of the $\bar{C}2$ line can be suppressed (the possibility to degrade the energy of the $\bar{p}$ as well as polarize them).

4. No changes upstream splitter magnet 2.

5. No changes in the experimental area. In particular the target positions should remain the same.

6. The beam quality at the target positions should not get worse.

7. The vacuum of C1 and C2 lines has to be connected to that of LEAR.

8. Only existing beam elements should be used (except for the splitter magnet). Some new beam monitoring equipment and vacuum components will be necessary.

9. No changes of shielding walls.

10. It should be possible to install the layout in the middle of 1985.

3. Discussion of the design

Figure 1 shows the part of the existing layout which has to be modified: A design which fulfils the above points with only minor compromises is shown in Fig. 2. The possible beam distributions at present and after a possible installation of a third splitter are schematically indicated in Fig. 3. The 'sub-cases' of one or no split are, of course, possible in addition.

The position of the third splitter magnet is determined from the direction of the CØ-C1 line, the bending angle of the splitter magnet (120 mrad) and the position of the bending magnet C2-BHN02, hence the direction of the beam line ends are preserved. It turned out to be possible to keep the triplet upstream splitter 3 in its present position and achieve good condition for splitting (beam horizontally focused and vertically parallel) in the full range of splitting ratios.

The vertical beam size can be adjusted, by varying C0-QNN01, from about 3 cm to at least 12 cm with the splitting conditions acceptably fulfilled. The figures on beam sizes quoted in this note are based on the emittances ε_H = 5 π mm.mrad and ε_V = 20 π mm.mrad of the beam from LEAR.

From splitter magnet 3 to the target positions, the beam is controlled with two quadrupole couples in each line, set for intermediate foci. The asymetric emittance of LEAR makes double foci impossible if circular beam spots at target positions and full transmission are wanted. The proposed positions of Multi-Wire Proportional Chambers (MWPC) 12 and 13 are such that a double focus there makes the full beam pass to the targets for all achievable vertical beam sizes in splitter magnet 3.

Using the full emittance also in the C1 and C2 lines the theoretical full beam sizes are the following:

	C1, PS182 ($P \leq 1.5$ GeV/c)	C1, PS170	C2, PS173	C2, PS172
HxV (mmxmm)	0.5 x 0.7	1.0 x 2.0	0.4 x 0.5	0.6 x 1.1

The envelopes (half values) are shown in Figs. 4 and 5.
Six vertical dipoles are planned downstream of the splitter magnet 2: two upstream splitter 3 to vary the splitting ratio and two downstream in each line to correct the off-axis beam after splitting. In the horizontal plane one dipole upstream splitter 3 is used to minimize the losses due to eventual misalignment. For the further corrections in the horizontal plane only one dipole in the beginning of the C1 line is available in addition to the existing dipoles at the beam end and main bending magnet (the two splitters and C2-BHN02).

The available space in the beam transport area and the small bending angle of the splitter magnets put severe constraints on the choice and position of the beam elements. It is, however, possible to combine the existing beam-guiding elements to fulfil all the above design considerations with two exceptions. The beam lines inside the zones have to be modified. First, in the C1 line the last quadrupole, C1-QDN04, of the type QNP is changed to one of the type Q500 and put in the position

C1-QNN02 for reasons of strong space limitations at the latter position. Second, the use of maximum energy beams in the upstream position of the C2 line (PS173) demands an increase of the focusing power of the existing triplet. This can simply be done by removing the first quadrupole in the triplet and moving the second as far upstream as possible. In the proposed layout the triplet is not required anyhow.

To facilitate easy tuning, the beam has to be monitored at least in the proposed position. This means that three new complete multi-wire proportional chambers have to be built.

The beam lines C1 and C2 have at present a separate vacuum system, because the degrader installed at Foc 1 interrupts the C0 line and allows for a moderate vacuum. In the proposed design these lines have to be incorporated in the vacuum system of the LEAR machine. To achieve the necessary high vacuum new pumps and components have to be installed. As a consequence of the disappearance of the windows at Foc 1, the beam quality for the C1 experiments which do not use the degrader would improve (better transmission and smaller spot size).

4. Time and money considerations

It has been estimated that the installation can be made in 5 weeks (no beam in the LEAR experimental area). The necessary equipment can be installed in about 6 months. An installation in the middle of 1985 consequently calls for a decision before the end of 1984.

In the note of L. Hoffmann and D.J. Simon the project costs were estimated to 180 kFr out of which 80 kFr have been allocated for a spare splitter magnet which is now being built. This study has not come up with any reason to change the estimate. Therefore the completion of the project will require another 100 kFr.

We acknowledge the help of Mr. M. Chassard, Mrs. G. Granger and Ms G. Maus in preparation of this note.

5. List of elements

Computer Name	Proposed element	Note
E6 BHS02	Spl. 2	not moved
C0 MWPC09		not moved
DVN01	MNP39	not moved
QNN01	Q251	not moved
QNN02	Q513	not moved
QNN03	Q524	not moved
DHN01		
DVN02	MNPA31	
MWPC10		
BHS03	Spl. 3	in construction
C1 MWPC11		
DVN01	MNP39V	
DHN01		
QNN01	Q253	
QNN02	QNP02	
STP01		
MWPC12		to be constructed
QFN03	QNP01	not moved
QDN04	Q518	
DVN02	MNPA21	not moved
DHN02	MNPA03	not moved
DHN03	MAX88	not moved
C2 MWPC13		to be constructed
DVN01	MNP39V	
QNN01	QNP01	
STP01		
QNN02	Q515	
MWPC14		to be constructed
BHN02	M116	not moved
DVN02	MNPA27 (DVN03)	not moved
QFN03	Q520	
QDN04	Q522	not moved
DHN01		not moved

Figure captions

Fig. 1: The 1984 layout of the LEAR experimental area (2 splitter magnets). The affected region if the third splitter is installed is framed.

Fig. 2: Proposed layout of the CO, C1 and C2 lines in the case of an installation of a third splitter magnet in the LEAR experimental area.

Fig. 3: Schematic drawings of the possibilities to split the LEAR beam in three branches after installation of a third splitter.

Figs. 4 and 5: Optics of the C0, C1 and C2 lines after installation of a third splitter.

References

1) F. Bradamante, University of Trieste, Memorandum to PSCC, CERN/PSCC 84-23, March 1984.

2) L. Hoffmann and D.J. Simon, Splitter magnet for LEAR experimental area, PS/MU/EP/NOTE 84-1, March 1984.

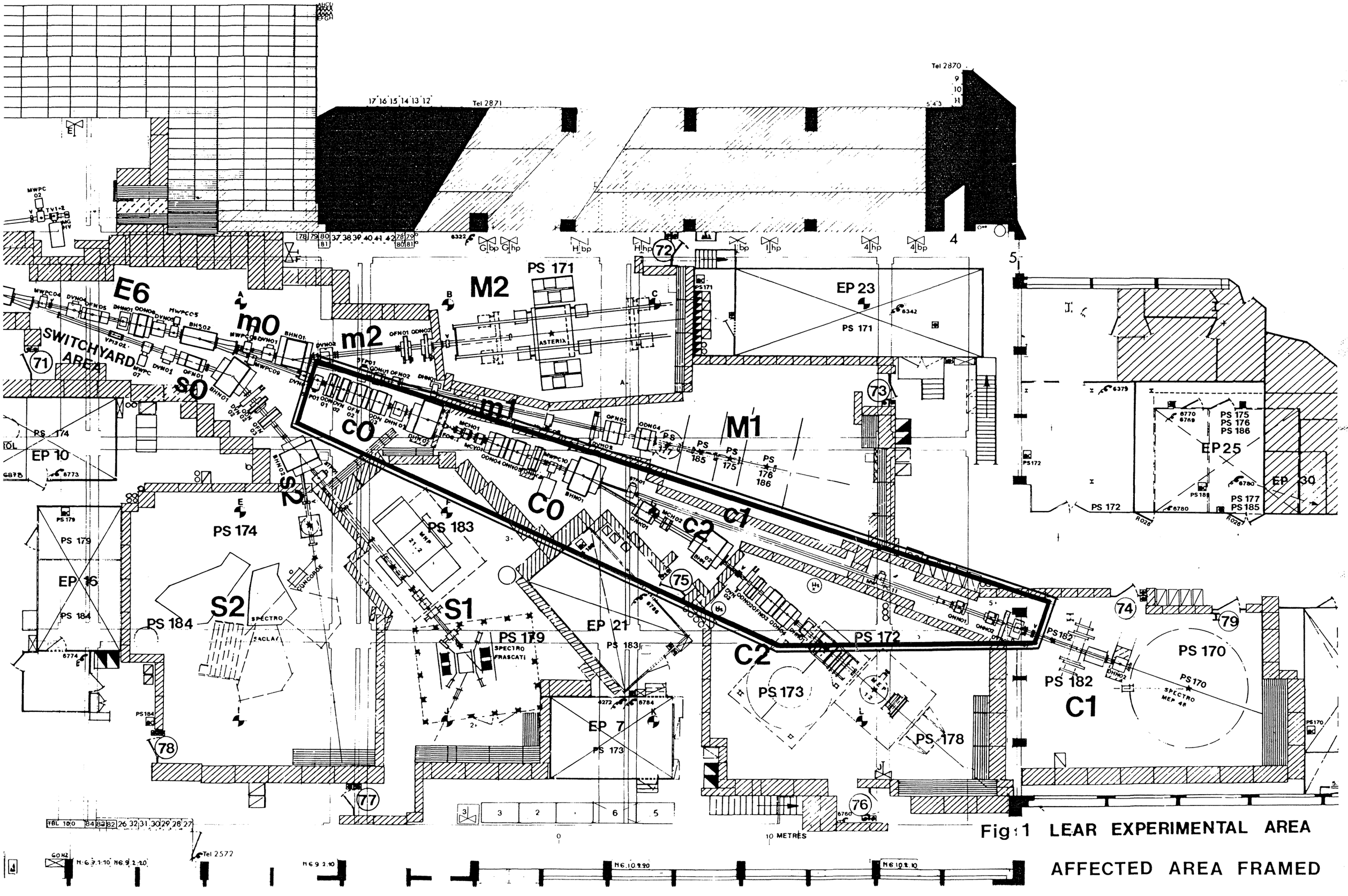
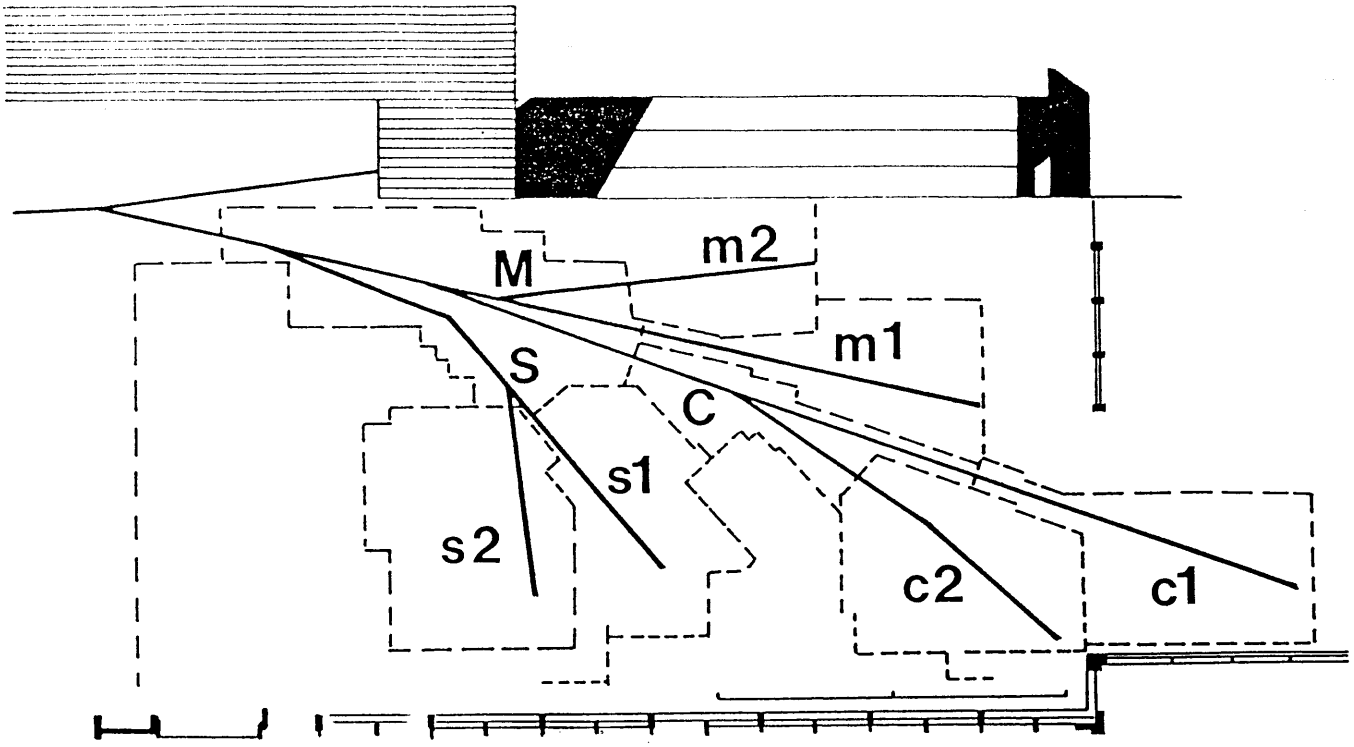


Fig 1 LEAR EXPERIMENTAL AREA

AFFECTED AREA FRAMED



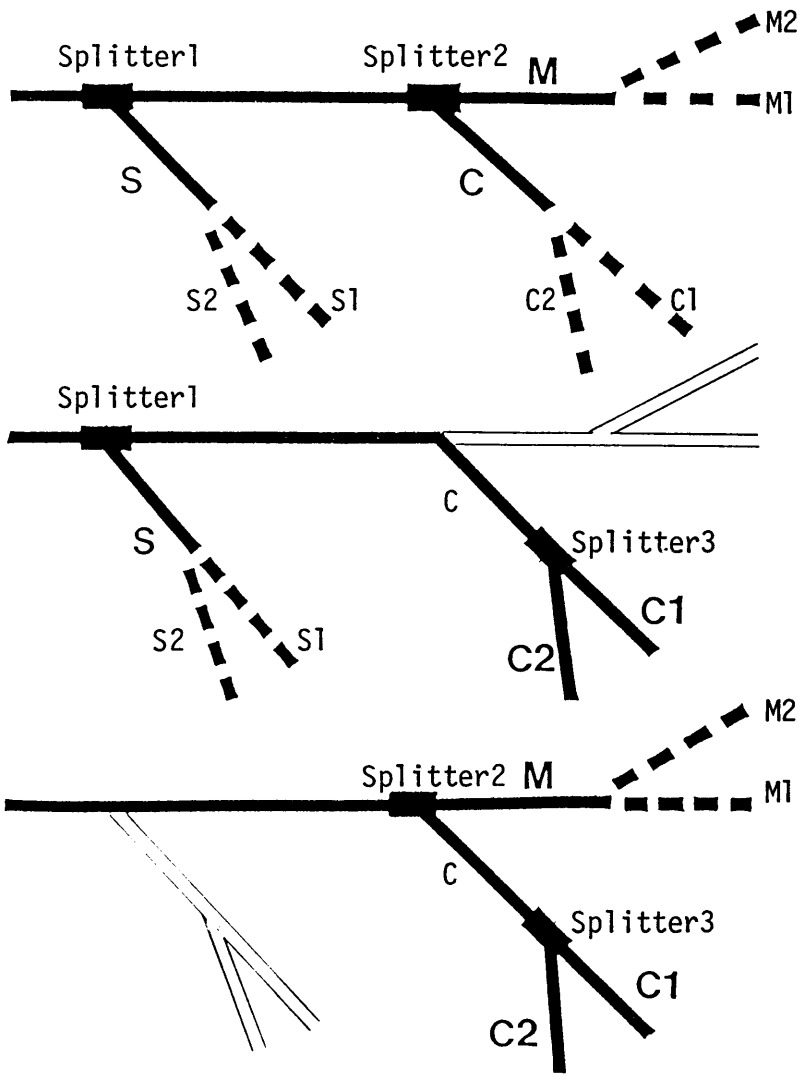


Fig : 3 POSSIBLE CASES OF SPLITTING IN 3 BRANCHES (3 SPLITTER LAYOUT).

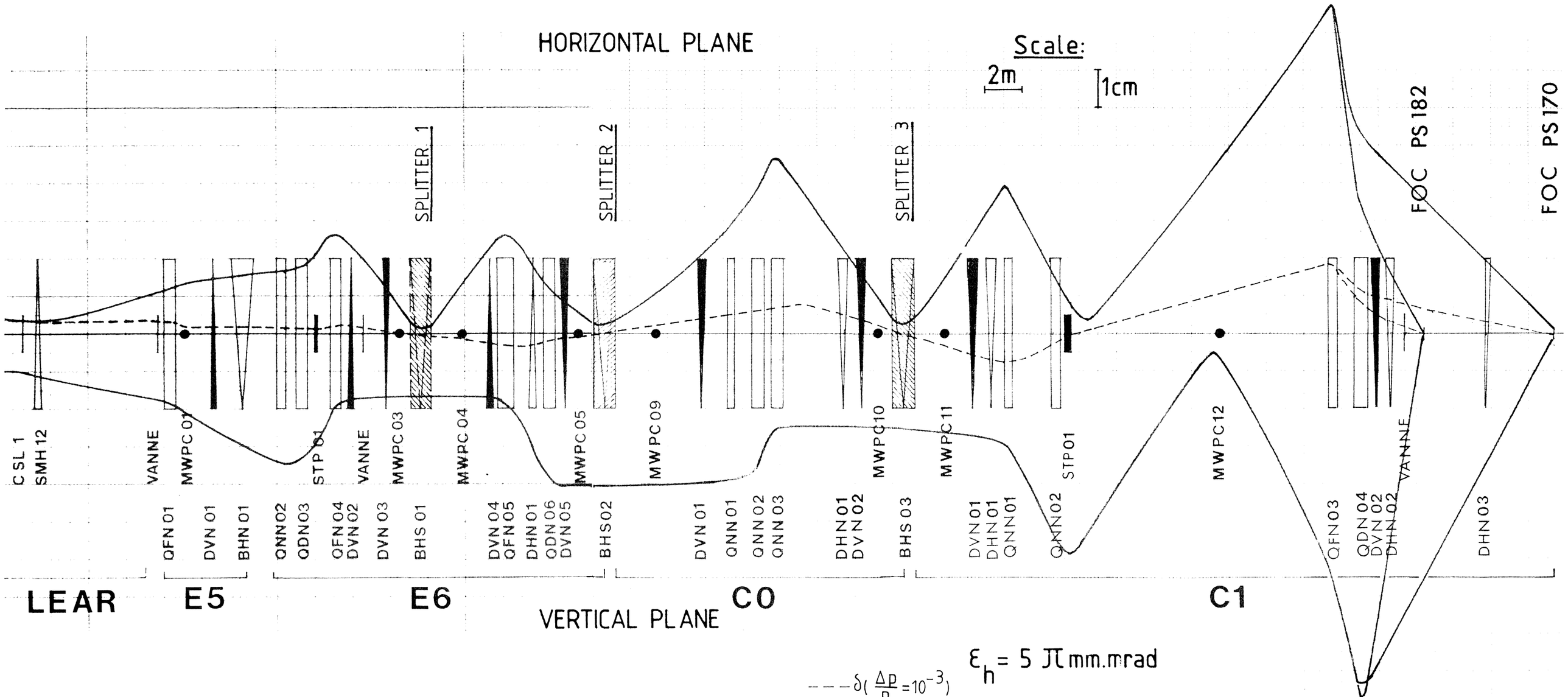


Fig.4_Proposed optics of E6-C0-C1 lines

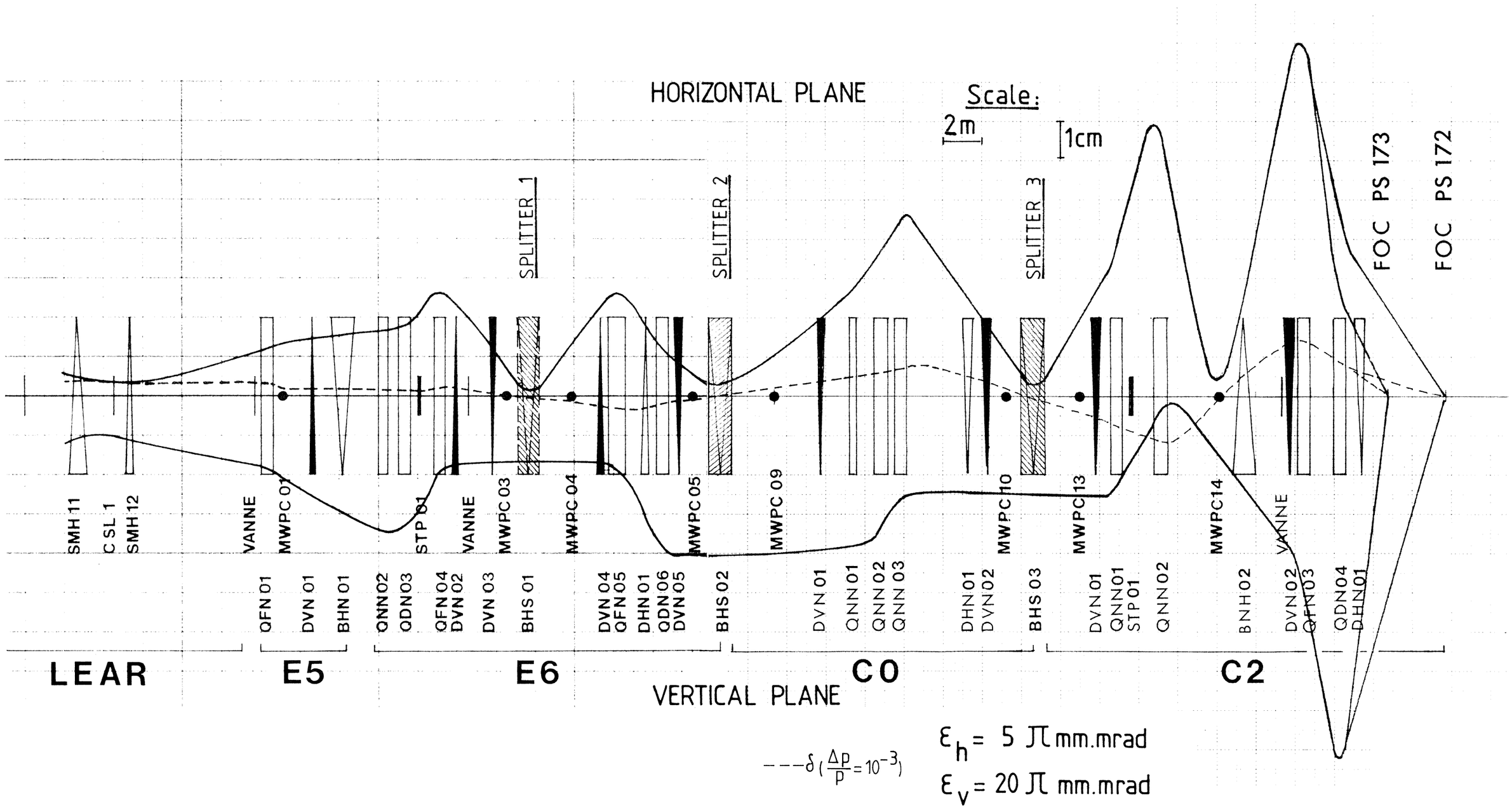


Fig.5_Proposed optics of E6-C0-C2 lines

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