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(SUMMARIES AND CONTRIBUTIONS)

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STATUS OF EPIC

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1 INTRODUCTION

The first tentative designs for EPIC (Electron Positron (or Proton) Intersecting Complex) were developed in 1971[1], inspired by the paper of Pellegrini etal.[2]. Since then, much detailed work has been carried out by the EPIC joint machine study group of the Rutherford and Daresbury Laboratories, and the high energy physics community in Britain has examined the physics potential of the various machine options[3]. A detailed proposal asking for funds to build an electron positron storage ring with 28 GeV centre of mass energy will be submitted to the Science Research Council in October this year. An important feature of the design is the possibility it offers to add a second ring at a later date in which protons could be stored at momenta up to 200 GeV/c.

2 MACHINE PARAMETERS

A detailed description of the present design is given in the design study group paper presented by Rees at the 1974 International Accelerator Conference[4]. A few of the main features are summarised below.

The general layout of EPIC is shown in figure 1. Stage 1 consists of a single electron-positron ring. In stage 2, a proton ring would be mounted above it and the beams bent vertically so as to collide with a 0° crossing-angle in the four interaction regions. Existing buildings and equipment at the Rutherford and Daresbury Laboratories are used to the full, including the NINA and NIMROD linacs, the 5 GeV NINA synchrotron, beam transport equipment for the transfer lines, power supplies and cooling. It is intended to use NINA as a booster for protons as well, provided that problems of the proton beam coupling to the electron radio-frequency cavities can be solved.

Some parameters of the e^+e^- ring are given in Table 1. There are two bunches in each beam, each with 0.8×10^{12} particles. The luminosity of 5×10^{31} cm^{-2} sec^{-1} per interaction region at 14 GeV assumes a tune shift, ΔQ, of .04. It is planned to control the beam size at lower energies by reducing the Q value and by adjusting the radial damping, to produce an E^2 variation of the luminosity. A filling time of 15 minutes and a lifetime in excess of two hours are expected. The cost of the e^+e^- system was estimated, in 1973, to be £19.6 millions. A revised costing at 1974 prices is being made.

Several options for the ep version of EPIC were considered[5] ranging from an 80 GeV/c proton ring with conventional magnets to a full ring of superconducting magnets capable of reaching 200 GeV/c, giving ep collisions at $S = 11{,}200(\mathrm{GeV/c})^2$. The cost of adding the proton ring in the 200 GeV option was estimated (in 1973) to be £36.9 millions, giving a total cost of £56.5 millions. The proton beam would contain eight bunches each with 0.75×10^{12} particles. On the assumption that the machine physics uncertainties involved in the design of high luminosity electron proton rings would be resolved, a luminosity of 5×10^{31} cm^{-2} sec^{-1} per interaction region was estimated.

3 EXPERIMENTAL UTILISATION

In all four interaction regions there is a free space of 17 metres between the high β quadrupoles for experimental equipment. Four experimental halls similar to that shown in figure 2, 20m wide, 34m long will be provided. For the time being we have designated one area to be fully developed for the largest scale apparatus, with 6 metres clearance above and below beam height and having an adjoining assembly bay which can be used while the machine is operating. The least developed would be suitable for "small experiments" - which will of course be quite big - and this will have 3.5m clearance below beam, 6m above and no assembly bay.

Figure 3 is a sketch of a possible large scale detector which was considered during the 1973 summer study[6] before the SPEAR data were available. The main item is a 4m ϕ superconducting solenoid providing a 1 Tesla field over 6m length. Cylindrical wire spark chambers are used to measure charged particle trajectories. Lead-proportional wire chambers, with wires grouped together to give $\sim \pm$ 1cm resolution, are used for photon detection and electron identification. They are

placed outside the 1 radiation length thick coil and cryostat, and the iron return yoke is shaped so that they can be slotted in conveniently. This detector is expected to be useful for e p as well as e^+e^- physics.
It can be seen that there is plenty of room left in the low β insertion for the detection of small angle particles. In particular, it should be possible to install a system to tag "$\gamma\gamma$" events in which one or both final state leptons makes an angle of more than 14m radians with the beam direction.

It is clear that the detector I have described would not be ideal for detecting multitudes of 200 MeV photons. A detector with just enough field integral to measure the charged particles and small enough to consider surrounding with a "4π" lead glass array might cope better with SPEAR-type events extrapolated by a factor of six.[7]

Schemes to exploit the expected antiparallel transverse polarisation of the e± beams are being considered. While the transverse polarisation has its uses, longitudinal is much to be preferred and, most of all, one would like to have longitudinal polarisation that is not equal and opposite for e±. Rotation of transverse to longitudinal polarisation in the interaction regions can in principle be achieved by tilting the beams vertically through between 1° and 3°.(

Unequal polarisations can only be produced if the electrons and positrons pass through different fields. In EPIC, with two bunches of each type of particles stored, there is 1.8 μsec between the passage of a bunch of electrons and one of positrons at a point midway between two interaction regions. Solenoids placed there may be pulsed to act only on selected bunches. It is possible[9] to prevent a bunch becoming polarised by programming the solenoid excitation so that the direction of the field alternates in step with the $\gamma\ (\frac{g-2}{2})$ spin precession frequency (not a multiple of the orbit frequency). Because a resonance method is used only weak fields are needed. A few tens of ampere turns are sufficient to reduce the polarisation by a factor of ten at 14 GeV.

We are all very enthusiastic about the physics we will be able to study with both stages of EPIC, and the design is being pressed forward as fast as possible.

REFERENCES

1 A J Egginton in Proc. Dec 71 Meeting of Daresbury-Rutherford Accelerator Working Party. Rutherford Laboratory Report RHEL R252 (1972) p. 34.
G H Rees, Rutherford Laboratory Internal Note DRAG/SR1 (1972).

2 C Pellegrini etal. Proc. 8th International Conference on High Energy Accelerators. CERN (1971) p.153.

3 G Manning etal. Rutherford Laboratory Report RL74/078 and references therein.

4 EPIC Design Group (presented by G H Rees). Proc. 1974 International Conference on High Energy Accelerators.

5 M R Harold and G H Rees Rutherford Laboratory Internal Report EPIC/MC/12 (1973).

6 P Clee etal Rutherford Laboratory Internal Report EPIC/WP5/P18.

7 W Venus, private communication (1974).

8 F J M Farley Rutherford Laboratory Internal Report EPIC/WP8/P2 (1973).
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9 Report in preparation.

FIGURE CAPTIONS

1 Schematic Diagram of e^+e^- and e p versions of EPIC.

2 Experimental Area Layout.

3 Large Solenoid Detector.

Mean radius (metres)	348.8	
No. of interaction regions	4	
Length of each int. region (metres)	17	
	e-ring	p-ring
Maximum momentum $\hat{p}$ (GeV/c)	14	80
Q-value	19.2	19.3
Peak RF volts (MV)	42.8	3.0
Natural bunch length* (cm)	3.5	35.0
Enhanced H-amp* at X(cm) at $\hat{p}$	0.06	0.102
Enhanced V-amp* at X(cm)	0.016	0.031
For e^--p collisions:		
No. of bunches/beam	8	8
No. of particles/bunch	5×10^{11}	7.5×10^{11}
Luminosity/int. region (cm^{-2} sec^{-1})	$\sim 0.5 \times 10^{32}$	
For e^--e^+ collisions:		
No. of bunches/beam	2	
No. of particles/bunch	8×10^{11}	
Luminosity/int. region (cm^{-2} sec^{-1})	$\sim 0.5 \times 10^{32}$	

Amplitudes marked amp* are 2 times RMS values. X is Interaction Region.

Table 1: EPIC Parameters

(In this option, the proton ring has conventional magnets. The 200 GeV proton ring uses superconducting magnets.)

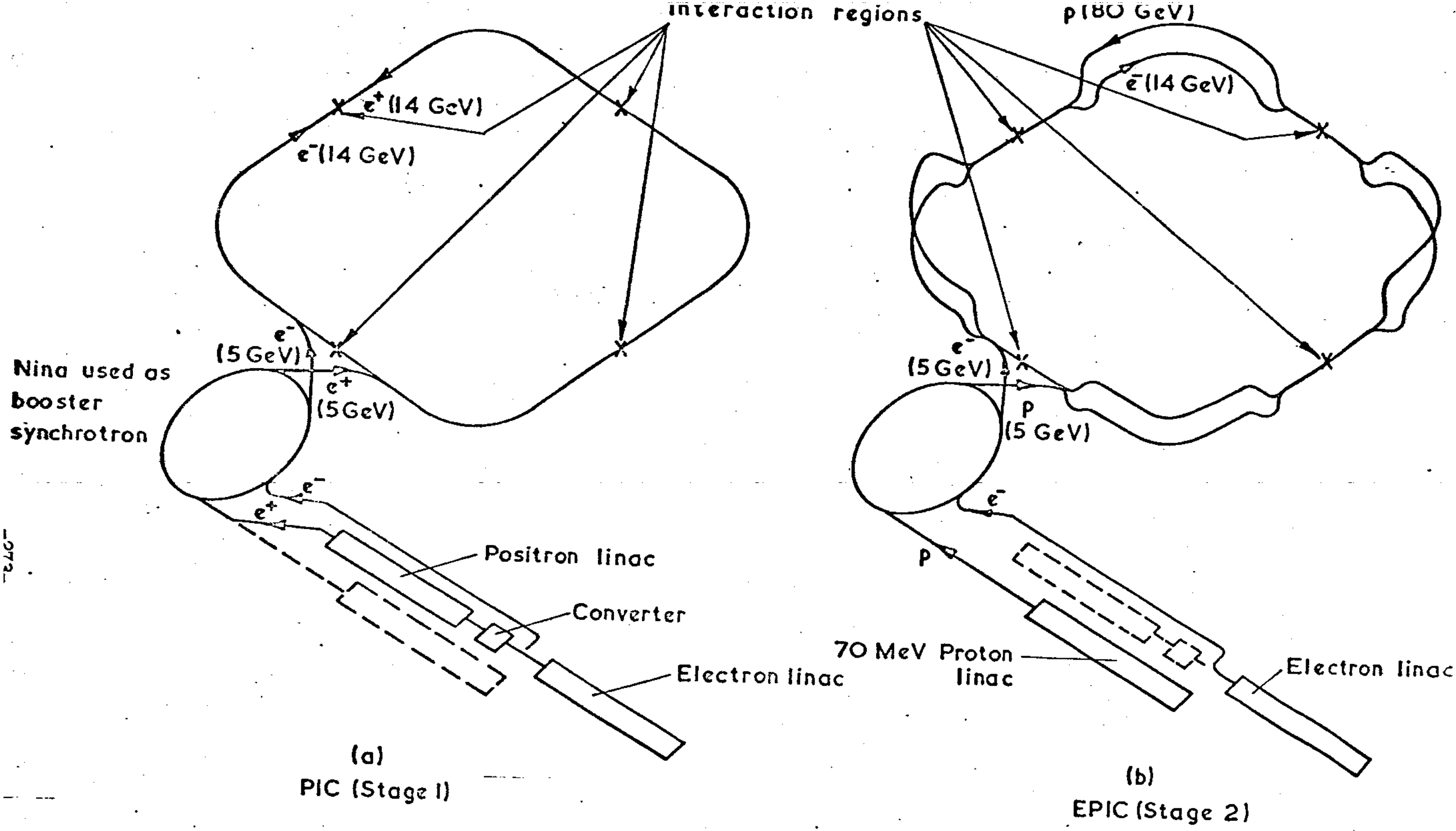
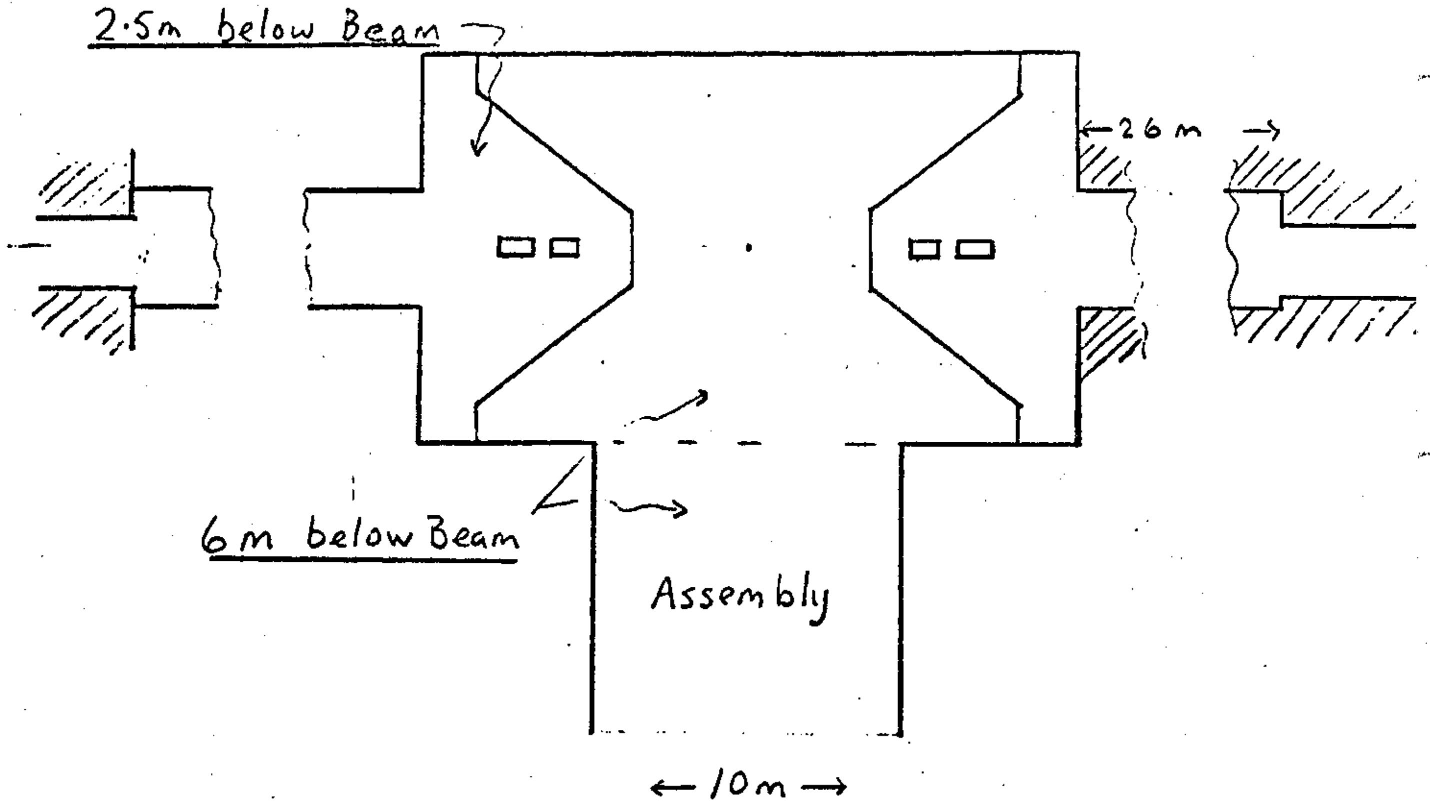
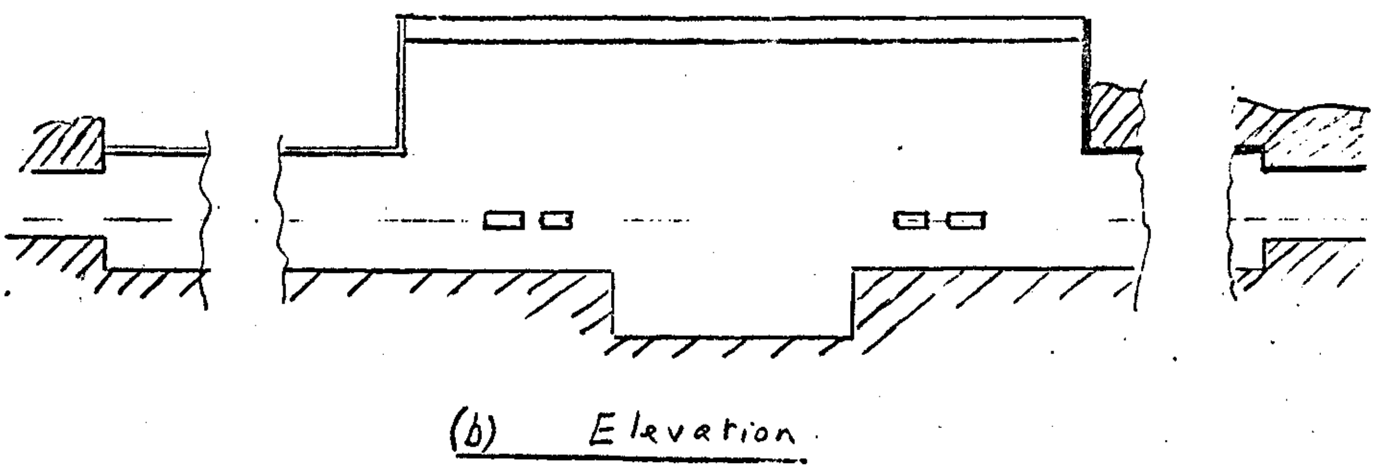


Fig. I. SCHEMATIC DIAGRAM OF EPIC (STAGE I) FOR $e^+ e^-$ COLLISIONS AND EPIC (STAGE 2) FOR $e p$ COLLISIONS.



(a) Plan



(b) Elevation

Figure 2 : Layout of Typical Experimental Area

Fig 3: Side View of Possible Solenoid Detector