REPORT OF THE EXPERIMENTAL AREAS GROUP

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ABSTRACT:

Based on twenty example e^+e^- experimental arrangements considered during the PEP summer study, experimental area configurations and requirements are defined. These include: Easily movable local shielding to permit close access to operating experiments, adjoining set-up areas for either preparation of upcoming experiments or modification of continuing experiments and the provision of modest power and other utilities. Because many experiments require less than the full length of the designed interaction region (± 10 m), it is recommended that initially the free length in half the areas be reduced to ± 5 m and that efforts be made to increase the luminosity by using low β insertions in the beam line.

I. Introduction

The summer study considered e^+e^- physics and the requirements for carrying out e^+e^- colliding beam experiments at PEP. ep physics was not studied and no consideration was given to the requirements of ep experiments. The recommendations that follow are therefore relevant only to experimental areas for e^+e^- physics. It is obvious that if and when a proton ring is added to the e^+e^- system, an ep physics program will require (1) development of the experimental areas in the proton direction for some length beyond the e^+e^- experimental areas recommended here, and (2) additional shielding, particularly on exposed roofs. It seems probable that in other respects the e^+e^- areas will be suitable for ep physics.

The summer study found no reason to recommend a change in the overall scope of the experimental area program described in the PEP proposal of April, 1974. In view of the exciting physics program envisioned for the facility and the wide interest for its use shown by the physics community, we strongly support the concept of six interaction regions. The study recommends changes in detailed execution and specifications for which time limitations did not permit cost estimates. Although we believe that the impact on the overall budget will be small, some important questions related to machine operation have been raised and will need to be answered by others.

II. Experimental Equipment (Size, Weight, etc.)

Table I gives a summary of some of the requirements of experiments considered during the study.

(a) 2L is the length parallel to the beam required for the experiment. Ordinarily this is the minimum possible length of the interaction region (free length between quadrupoles Q_1). In some experiments it is suggested that the apparatus can surround the beam elements. In two examples a minimum distance between quadrupoles is given in brackets. It is not impossible that the intersection region could, for some experiments, be totally immersed in beam elements as well as experimental apparatus.

(b) 2W is the width of the experiment and 2V the height. It is important to note that the distances given in the table do not allow for stands, supports and other crucial appendages.

(c) An estimate is given of the weight of the experiment and of the maximum capacity required for any crane requested for use during the experiment. Where no or little crane capacity is requested, it is assumed that a temporary crane can be used for installation and removal.

(d) The power required for major equipment is given in MW. In all cases additional power will be required for electronics, services and small computers.

(e) The number of counters and wires for multiwire proportional chambers, drift chambers or magnetostrictive wire chamber readout is given as an indication of the scale of the experiments. This can be taken as an indication of the cable requirements to local counting areas. The counting area requirements are discussed below.

(f) Any special requirements are indicated in TABLE I under COMMENTS.

The following general conclusions can be drawn from the table.

(a) Typical experiments have 200 - 400 counters; 10^4 wires for MWPC and drift chambers; weight of 100 - 300 tons; and require a crane of 20 - 40 ton capacity.

(b) Approximately 50% of the experiments can fit within an interaction region of 10 m total length and the rest fit within a length of 20 m.

(c) More than 50% of the experiments fit in an experimental area with a vertical clearance of ± 3 m from the beam. We note, however, that little attention has been given to needs for stands, cranes and supports.

(d) No experiment needs more than 1 MW of power.

III. Area Required for Electronics

Not all groups estimated the area required for electronics, but from those that did an average requirement is:

(a) About 20 m^2 at a distance $\lesssim$ 10 m from equipment.

(b) About 100 m^2 at a distance $\lesssim$ 50 m from equipment.

IV. General Services Required

Generally experiments require all or most of the following:

(a) Provision for the use of flammable and toxic gases.

(b) Some degree of temperature control in the experimental area.

(c) Power for electronics and small computers.

(d) Communication with accelerator control room and other experimental areas, including the possibility of gating off noise from other experiments.

(e) Refrigeration and helium recovery facilities for superconducting systems.

V. Recommendations

(a) Shielding

Local shielding should be provided close to the accelerator to permit use of the assembly areas (see below) and to allow personnel access to some equipment and electronics while the machine is running.

Since thick walls are not required for shielding, this raises the possibility of making the experimental buildings of a light structure with movable shielding provided internally in a way that allows easy readjustment. This pattern easily allows for future modification and extension (for example, the ep option).

(b) Assembly areas for experiments

In the experimental areas shielded space should be provided transverse to the beam for groups to assemble experiments while the machine is running. This will permit experiments to be installed in shorter periods. It will also allow experiments to be withdrawn for modification without complete dismantling.

We believe that the exciting physics prospects of PEP fully justify five active interaction regions, and their effective utilization. We have considered other more elaborate systems for the rapid installation of new experiments or modifications of existing ones. We feel that the proposed scheme is relatively simple and goes a long way toward realizing the desired goal.

(c) Height of interaction region for e^+e^- physics in the tunnel

The e^+e^- machine should be positioned in the median plane of the tunnel. This has the following advantages:

1) More space is available for detectors in the straight section beyond the experimental pits. This may be necessary for tagging, luminosity monitors, measurement of polarization, etc.

2) Experimental equipment will not necessarily have to be moved if the ep option is built.

(d) Lengths of interaction regions

1) Three interaction regions should initially have 20 m total free length and three regions 10 m total free length. One of the 10 m long regions should be region 10.

2) Provision should be made for the length of the interaction regions to be changed depending upon experimental demands closer to operation time, and after. Because many, if not most, experiments would benefit greatly from increased luminosity the full range of possible minimum free lengths should be explored. Symmetry requirements apparently set a 3 and 3 division between long and short regions, with only the assignment of the "machine physics" region 10 as variable. Since luminosity and interaction region length requirements depend strongly on the physics which will be found with PEP, flexibility in the use of mixed lengths and the assignment to a given set of areas is very desirable ("flexibility" here is meant to imply changes within a period of weeks).

(e) Sizes of experimental areas

Based on the experiments and apparatus considered during the summer study, we make the following recommendations concerning the sizes of the experimental areas.

1) Two experimental areas with interaction region lengths of 10 m should have:

a. a vertical depth below the beam of 3-4 m
b. a vertical height above the beam of 5 m
c. a width from +17 m to -7 m (with the beam at the origin)
d. a total length (beam direction) of 20 m centered at the intersection point.

2) Two experimental areas with interaction regions 20 m long should have:

a. a vertical depth below the beam of 4 m

b. a vertical height above the beam of 5 m

c. a width from +17 m (with the beam at the origin) to -7 m

d. a total length (beam direction) of 20 m centered at the intersection point.

3) One experimental area with a 20 m long interaction region should have:

a. a vertical depth below the beam of 5-6 m

b. a vertical height above the beam of 8 m

c. a width of from +20 m to -10 m (with the beam at the origin)

d. a total length (beam direction) of 20 m centered at the intersection point.

4) In order to minimize the installation or improvement time of major apparatus, we recommend that the floor depth below beam be extended to the full width of each area.

Note the following:

1) The recommended areas are asymmetric in width to allow for assembly room and local shielding (see above), and for local counting areas.

2) The vertical asymmetry is to allow for crane handling of experimental equipment. However, we have not included height for the crane itself.

3) The areas as recommended will accommodate all experiments listed in Table I except one. A pit of increased depth would have to be constructed for the "Uranium Ball".

(f) <u>Provision of Services</u>

1) It is recommended that a crane be provided in each area with a capacity of 20 - 60 tons moving perpendicular to the beam with a span of 20 m. It is assumed that the hook will not go closer than $\sim$ 2 m to any wall of the area.

2) One or more temperature controlled electronics rooms should be available in each area for experiments operating and being set-up.

3) Other services as discussed in Section IV should be available.

(g) It is recommended that the tunnel in the machine physics area (region 10) be increased in diameter for a length of 20 m to give the possibility of simple experiments using this area at some time in the future.

VI. Concluding Remarks

Our recommendations for sizes and arrangements of experimental areas, lengths of interaction regions and specification of services were based on the list of experiments and apparatus discussed during the summer study. This seems a reasonable procedure since these experiments and apparatus are "typical". There is clearly no implication that all or any of these designs will in fact be installed and used some day.

When this report was being prepared, no detailed designs for polarization monitors were available to us. Such monitors are needed and their requirements will need to be considered. Although no great difficulty is anticipated we are not certain that the tunnel is big enough to permit installation in a curve section (if that turns out to be needed) and still allow necessary circulation.

We also want to draw attention again to the fact that ep requirements were not considered. As a result we do not request "alcoves". However, the increased flexibility in area arrangements implied in our recommendations may well be as helpful for expansion to a future ep program as it appears to be for initiation of the e^+e^- program.

Finally, it is realized that financial constraints as well as accelerator operating requirements may dicate modification or postponement of some of the recommendations.

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TABLE I. Summary of experimental requirements.

GROUP	EXPT. EQUIP. ±L	EXPT. EQUIP. ±W	EXPT. EQUIP. ±V	WEIGHT TON	CRANE CAPACITY	POWER MW	CABLES Counters	CABLES MWPC	COMMENTS
Strange particles (YAMIN)	5	2	2	200	0	.5	200	5×10^3	1) s/c beampipe 2) reverse e^+e^-
All neutral (DAKIN)	5	2-5	2-5	200	100	.2	1200	?	
Neutral & charged (GALTIERI)	6	3-5	3-5	190	15	.5	10^3	10^4	s/c magnet
New particles non-mag. (CHENG)	2-5	5	3	80	20	.1	100	10^3	
New particles split field (NAUENBERG/LIMON)	5	2	2	40	20	1	200	2×10^4	s/c beampipe
New particles μ-e detector (BERLEY)	4	4	4	250	40	1			
New particles mini mag. (LITKE)	2-5	2	2	120	20	1	10^3	2×10^3	
New particles calorimeter (ROSEN)	3	3	3	35	10	.1	800	100	
High mom. (CRONIN)	6	5	5	300	40	1	600	5×10^4	possible rails for side motion
Low mom. (PEREZ)	5-10	3	3	100	20	1	500	10^4	s/c magnets
Streamer chamber (MEYER)	7-5	2	4	100	20	1	150	10^3	
σ total Time Projection Chamber (NYGREN)	6	4	4	100	20	.5	300	2×10^4	1) s/c mag. 2) luminosity monitor

continued . . .

TABLE I (continued)

GROUP	EXPT. EQUIP. ±L	±W	±V	WEIGHT TON	CRANE CAPACITY	POWER MW	CABLES Counters	MWPC	COMMENTS
σ total 4π calorimeter (FELDMAN/HITLIN)	3	3	3	350	20	0	450	500	Vac < 10^{-9}
σ total "Magic angle" LYNCH/SCHWITTERS)	6	2	2	10	0	0	200	3×10^4	1) good vac 2) tagging system
$e^+e^- \to \mu^+\mu^-$ (WANDERER)	2-5	2	2	70	20	.2	20	100	1) pol^n monitor 2) luminosity monitor
$e^+e^- \to \mu\mu/ee$ (YELLIN)	5	2-5	2-5	150	7	.1	200	3×10^3	1) pol^n monitor 2) luminosity monitor
$e^+e^- \to \mu^+\mu^-$ BUCHHOLZ/ STRAUCH	4	2	2	615	40	.1	200	4×10^3	1) luminosity monitor 2) rails for assembly
$e^+e^- \to \mu^+\mu^-$ Uranium ball (WENZEL)	8 (3)	8	8	13000	30	0	300	10^5	
$e^+e^- \to \mu^+\mu^-$ Iron tear drop (STEVENSON)	4.5-10 (3)	4.5	4.5	3000	40	.5	300	10^4	
2γ tagging (BARBIELLINI)	10	2	2	20	5	.3	400	10^3	collimator before Q2 radius 7 cm
Polarization (RESVANIS)	-	-	-	-	-	-	-	-	