MS 572
5.8
BOX 3 FOLDER 4

[HEPAP] [1972-1974], correspondence, reports, budget

24-40 62

V. F. W.
office

The Support of High Energy Physics in the U.S.A.

The field is in deep trouble.

Facts:

1. The operating budgets have decreased since 1967 in real value by about 12% inspite of the fact that two new large national facilities started operation (SLAC and NAL), that one large facility increased its capacity by an order of magnitude (AGS), and that the other national facilities (Bevatron, ZGS) are still very productive.

2. No new construction was approved since the approval of NAL in 1968. Because of this fact the total yearly expenses for High Energy Physics from FY 1974 on, will be reduced by about 25% from the average value during the previous 6 to 7 years.

3. The funds for H.E.P. expended in Western Europe is steadily increasing. Their expenditure overtook ours last year and rises continuously. During the next years they will spend considerably more money in this field than the U.S.A.

Consequences:

The previously unchallenged leadership, vitality and ingenuity of U. S. High Energy Physics are diminishing and will erode during the coming decade, inspite of the activities at the newly completed NAL. The reasons for this development are:

1. The shrinking scientific manpower in H.E.P. reduced significantly the influx of young researchers who provide most of the vitality.

2. None of the proposed innovative construction programs have been approved, such as the upgrading of SLAC by means of a recycling device (~20M$, 3 years construction time) or colliding beam devices in the 100 GeV region (~100 M$, 5-7 years construction time). Only SLAC was able to squeeze in the construction of a new device (electron-positron storage ring SPEAR) by using operational equipment funds at the expense of reduced running time and other needed improvements. Because of the long time

interval between approval and exploitation, the present indefinite postponements of new construction will prevent the extension of the frontier of H.E.P. in the U.S.A. at the end of this decade. Already today the U.S. is behind in this extension because of the great success of the proton storage ring (ISR) in Geneva.

3. A decreasing total amount of operational money must cover the operation of NAL and the other facilities. This state of affairs hampers the exploitation of the new accelerator at NAL and severely restricts research at the other accelerators. Many excellent research projects are indefinitely postponed or must be carried out with insufficient means. Funds are lacking to introduce the best and most efficient instrumentation. The scope of U.S. High Energy Physics is shrinking and great opportunities for discoveries are left untapped. This can't go on much longer without changing the character of much of the work from pioneering at the most interesting frontline to routine work behind the front. If this happens, the intellectual and financial investment would be wasted to a large extent.

4. Apart from the decreasing amounts of support, the erratic and short-range budget planning interferes severely with efficient management of the facilities. The same amounts of money would be better used if the budgets were known in advance for a longer time interval.

<u>Effects of the Decline of H.E.P. in the U.S.:</u>

H.E.P. represents a vital spearhead of physical science; it is the continuation of a frontier that started with Rutherford's discovery of atomic structure, continued towards the insights into nuclear structure, and is now penetrating into the structure of elementary particles. It always attracted the best and most innovative minds because of its great challenges, in respect to theory, experimentation and instrumentation. One faces problems, technical and theoretical, that go far beyond what has been achieved before. This is why so many innovations have come from H.E.P. that were of use in other fields of science and technology, ranging from high vacuum techniques, sophisticated methods of data analysis, short time measurements, the construction of superconductive magnets, to the concepts of quasi-particles now used in solid state physics. If vitality and forcefulness is drained from this field, the effects will be felt all over. U. S. science would loose one of its main driving powers.

Recommendations:

In planning future budgets for H.E.P.,construction and operation funds should be considered together. The future survival of the field requires that, in the average, about 20% of the expenditures be devoted to construction of new facilities.

The total yearly expenditures in H.E.P. must be higher than the figure reached in FY 1974 when the NAL construction has practically ceased. That figure would represent a reduction of 25% below the average of the last 6 to 7 years. An increase of this figure, allowing some new construction to begin in the near future, is a precondition for a program that may keep the U.S. in the forefront at least in some areas of the field. It is a necessary step for the maintenance of the innovative seminal effect of H.E.P. on the scientific life of the nation.

Memorandum to: G. Stever May 1, 1973

From: S. Drell and V. F. Weisskopf

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ELEMENTARY PARTICLE PHYSICS: PROBLEMS, STATUS, PROSPECTS

I. BASIC PROBLEMS OF ELEMENTARY PARTICLE PHYSICS

What are we made of?

What are the forces? At the frontiers of the submicroscopic unknown are there universal laws? In particular, do our laws of quantum electrodynamics remain valid?

What are the great surprises? Will nature reveal very unexpected new behaviors? Will there be new forces or forms of energy?

II. THE ADVANCING FRONTIERS

Large accelerators, new detectors, and sophisticated data handling with computers have allowed us to compress the scale of dimensions at the frontiers of the search for elementary particles and of the study of fundamental forces by almost seven orders of magnitude in this century from 10^{-8} cm to $\sim 10^{-15}$ cm.

Experimental clues come from two kinds of studies requiring electron (muon), proton (secondary hadron), and neutrino beams that complement and reinforce each other in vital ways:

Knowing the force law, we study scattering patterns à la Rutherford. This we can do with electromagnetic interactions since studies of the past decade confirm universality of quantum electrodynamics to distances $< 10^{-14}$ cm (or over 24 decades of scale out to space probe studies). This is the 20th Century parallel of the Newton-Einstein program establishing universality of gravitational theory. For strong or weak interactions, with force laws still being deciphered, we study debris patterns and identify emerging fragments from protons and other hadrons in search of their constituents.

III. IMPORTANCE OF PROTON, ELECTRON, AND NEUTRINO PROBES

Scattering patterns from electron collisions suggest point-like constituents within the proton (seeds in the raspberry jam) and we begin to explore their characteristics and distributions.

Debris patterns from hadron collisions give us a rich family structure of hadrons (symmetries) and we learn more properties of the strong forces. Important initial weak interaction measurements with neutrinos at NAL will give vital clues about both the constituent structure and the weak forces themselves.

Advances on both the proton and electron frontiers are needed because we cannot identify "debris" with "constituents" when dealing with very strongly bound systems. We are in a very strange new realm with anti-matter prominent and families of particles never expected. Forces lose symmetry properties and new quantum numbers and selection rules take over. (Recall example of stable deuteron of bound proton plus neutron but unstable free neutron.)

IV. MOST RECENT GREAT EXCITEMENT

Growth of hadron cross sections and of large transverse momentum events with energy. This shows we have not come to barren land of asymptopia yet.

Unusually large hadron production in colliding electron-positron beams.

First glimpse of high energy behavior of weak interaction cross sections.

V. BURNING QUESTIONS

Will hadron cross sections continue to grow along with their angle scatterings? Is there ever asymptopia?

Do secondary distributions display strong correlations? How do multiplicities vary with energy in detail?

Does the level density of states continue to grow - perhaps exponentially - and lead to clues about the first boiling few seconds of the universe?

Is there structure to the constituents in the proton (or even meaning to the notion of constituents)?

Is there a fundamental unification of the weak and electromagnetic interactions that is revealed experimentally by behavior of the neutrino cross sections at very high energies?

VI. INSTRUMENTAL POSSIBILITIES TO PUSH FORWARD THE FRONTIERS

Small to big steps:

RLA; Super e^+e^- rings; ERA; Isabelle and PEP.

TABLE I

PLAN FOR A VIABLE AND PRODUCTIVE NATIONAL PROGRAM
WHICH KEEPS ALL ACCELERATORS IN OPERATION

(IN FY 73 DOLLARS)[1/]

	FY 71[2/]	FY 72[2/]	FY 73	FY 74	FY 75	FY 76	FY 77
OPERATING EXPENSES							
Total	130.3	122.2	126.4	143.0	153.0	161.0	165.0
	(118.5)	(116.4)					
NAL	10.1	13.3	19.2	28.0	34.0	40.0	43.0
Base lab Program . .							
Subtotal	92.6	83.9	82.7	87.0	87.0	87.0	87.0
BNL	24.5	23.8	24.7	27.0	27.0	27.0	27.0
SLAC	26.6	25.1	25.2	27.0	27.0	27.0	27.0
ANL	18.4	16.5	15.4	15.5	15.5	15.5	15.5
LBL	18.3	16.3	15.2	15.3	15.3	15.3	15.3
CEA	2.6	2.2	2.2	2.2	2.2	2.2	2.2
PPA	2.2	--	--	--	--	--	--
Universities	27.6	25.0	24.5	28.0	32.0	34.0	35.0
CAPITAL EQUIPMENT-(COSTS)							
Total	17.3	24.4	25.5	35.0	29.0	24.0	24.0
	(15.8)	(23.3)					
NAL	5.3	7.2	8.4	23.0	18.0	14.0	14.0
Other Labs & Universities . . .	12.0	17.2	17.1	12.0	11.0	10.0	10.0
ACCELERATOR IMPROVEMENTS-(COSTS)							
Total	4.0	3.6	2.0	4.0	4.0	5.0	6.0
	(3.4)	(3.4)					
NAL	--	--	--	--	1.0	2.0	3.0
Other Labs	4.0	3.6	2.0	4.0	3.0	3.0	3.0
CONSTRUCTION-(COSTS)							
Total	102.7	53.4	47.5	12.0	6.0	--	--
	(87.7)	(49.3)					
NAL	94.0	50.7	47.0	12.0	6.0	--	--
Other Projects . .	8.7	2.7	0.5	--	--	--	--
Subtotal Present Program	254.3	203.6	201.4	194.0	192.0	190.0	195.0
	(225.6)	(192.4)					
New Projects							
Operating	--	--	--	2.0	3.0	4.0	5.0
Equipment	--	--	--	--	--	1.0	2.0
Construction . . .	--	--	--	6.0	10.0	13.0	10.0
Subtotal New Projects	--	--	--	8.0	13.0	18.0	17.0
PROGRAM TOTAL COSTS	254.3	203.6	201.4	202.0	205.0	208.0	212.0
	(225.6)	(192.4)					

[1/] The projections do not provide for escalation.

[2/] FY 71 and FY 72 are normalized to FY 73 dollars. Parentheses indicate current year

HIGH ENERGY PHYSICS

ACCELERATORS
AND
FUNDING

5/1/73

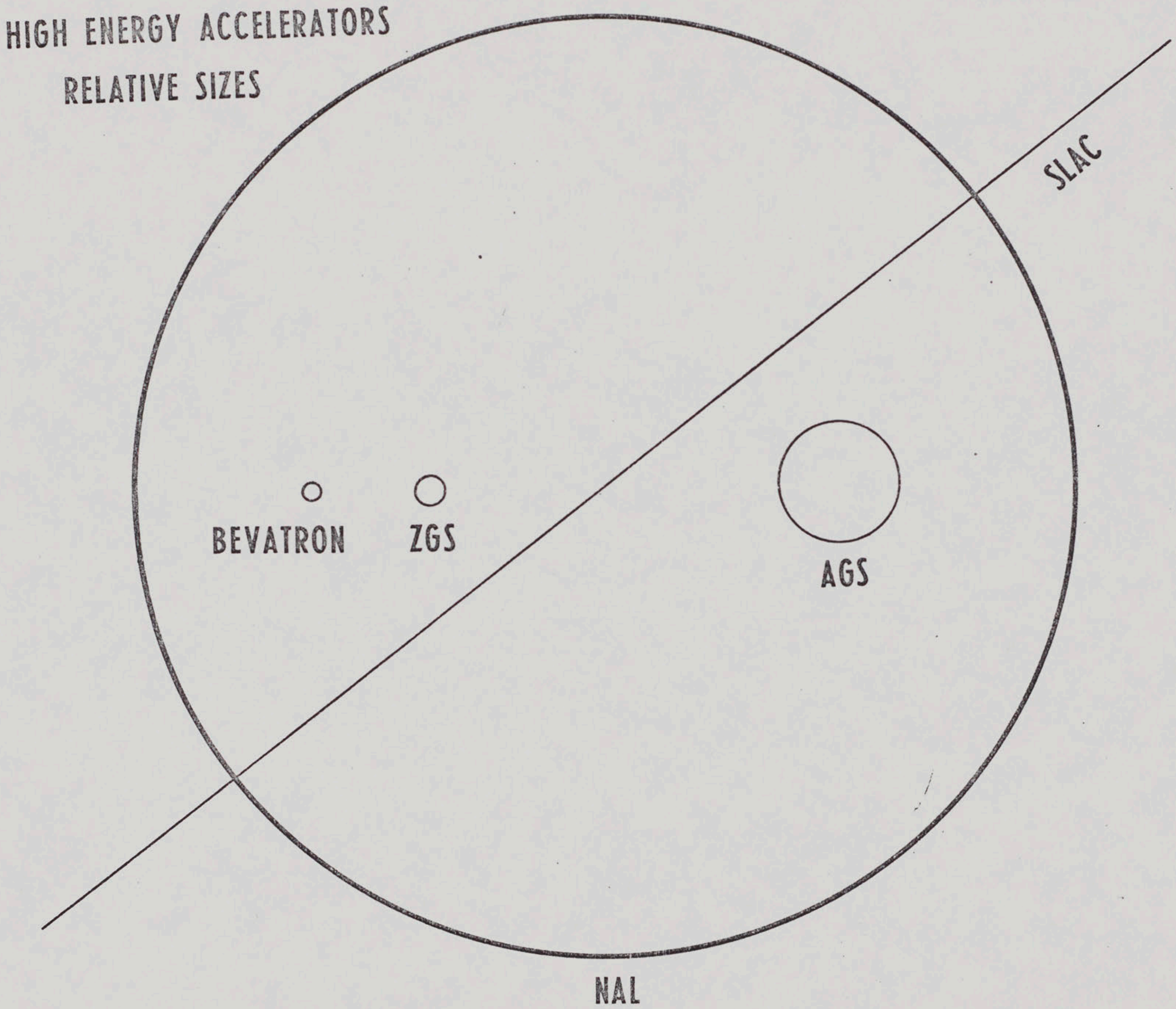

HIGH ENERGY ACCELERATORS
RELATIVE SIZES
SLAC
BEVATRON
ZGS
AGS
NAL

Figure 1

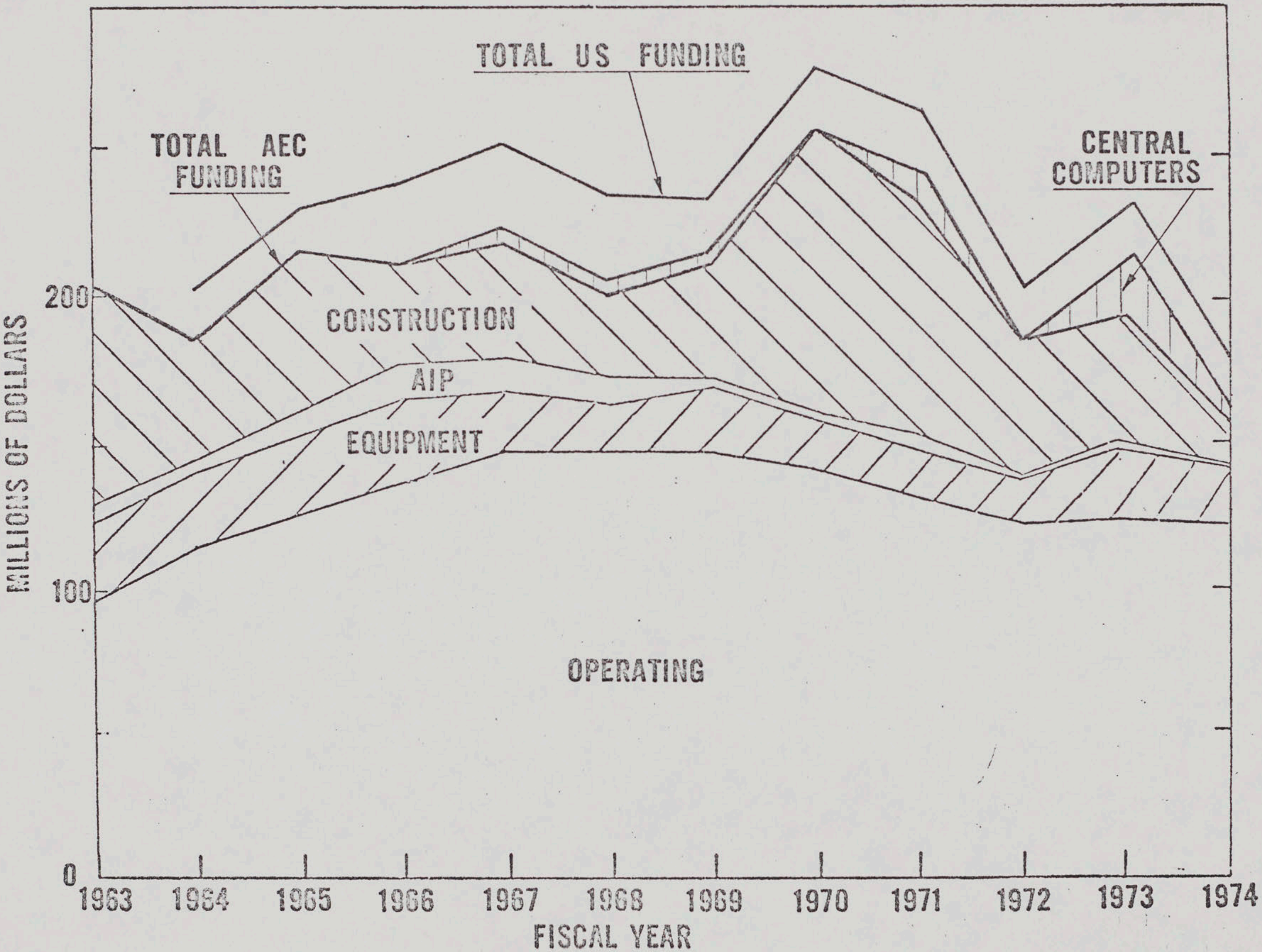
High Energy Accelerators

	United States	Western Europe (and Japan)	USSR
Proton Synchrotrons	LBL, Bevatron* 6.2 BeV ANL, ZGS 12 BeV BNL, AGS 33 BeV NAL 200/400 BeV	Saclay, Saturne 3 BeV RHEL, Nimrod 7 BeV CERN PS 28 BeV CERN II . SPS 400 BeV } under const. Tsukuba (Japan) 10 BeV } under const.	Moscow, ITEP 7.2 BeV Dubna, JINR 10 BeV Serpukhov, IHEP 76 BeV
Electron Accelerators	Cornell 12.5 BeV SLAC 22 BeV	Lund, Sweden 1 BeV Frascatti 1.5 BeV Orsay 2 BeV Bonn 2.3 BeV Daresbury, NINA 5 BeV Hamburg, DESY 7.5 BeV Tokyo 1.3 BeV	Kharkov 1.8 BeV Erevan 6.1 BeV

Colliding Beam Systems

	United States	Western Europe (and Japan)	USSR
Proton Storage Rings		CERN ISR 30 x 30 BeV Proton-Proton	Novosibirsk VAPP 4 25 x 25 BeV Proton/Antiproton (Under const.)
Electron-Positron Storage Rings	CEA 3 x 3 BeV SLAC SPEAR 2.7 x 2.7 BeV	Orsay ACO 0.5 x 0.5 BeV Frascati, ADONE 1.5 x 1.5 BeV Hamburg, DORIS 3.5 x 3.5 BeV } Under const. Orsay 1.5 x 1.5 BeV } Under const.	Novosibirsk VEPP 2M 0.7 x 0.7 BeV Novosibirsk VEPP 3 3.5 x 3.5 BeV } Under const. Novosibirsk VEPP 4 6 x 6 BeV } Under const.

* Also, Heavy Ions (to Neon) to 2.6 BeV/nucleon, and the Bevalac under construction 2.6 BeV/nucleon to Iron.



HIGH ENERGY PHYSICS FUNDING (in FY 1973 dollars)

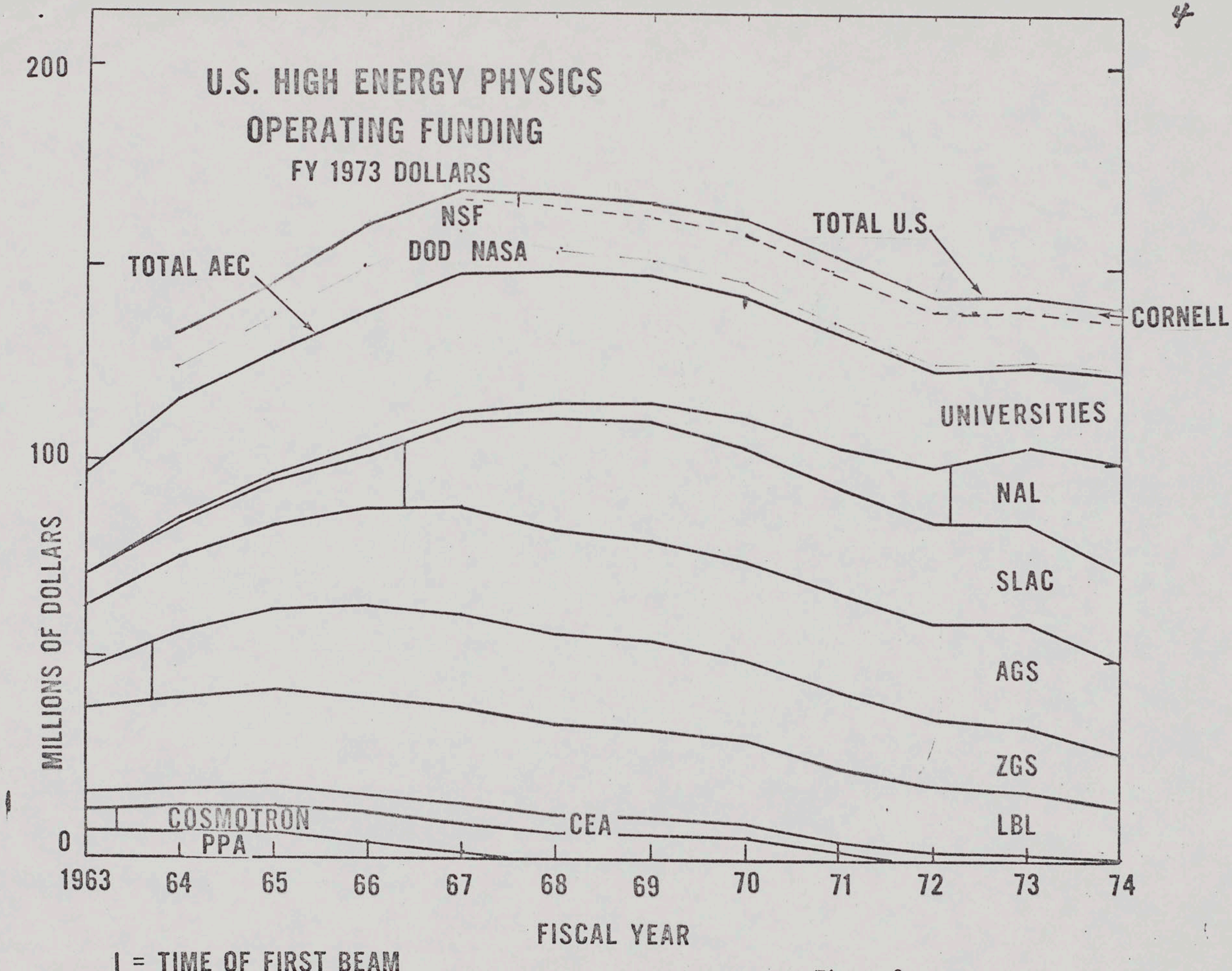
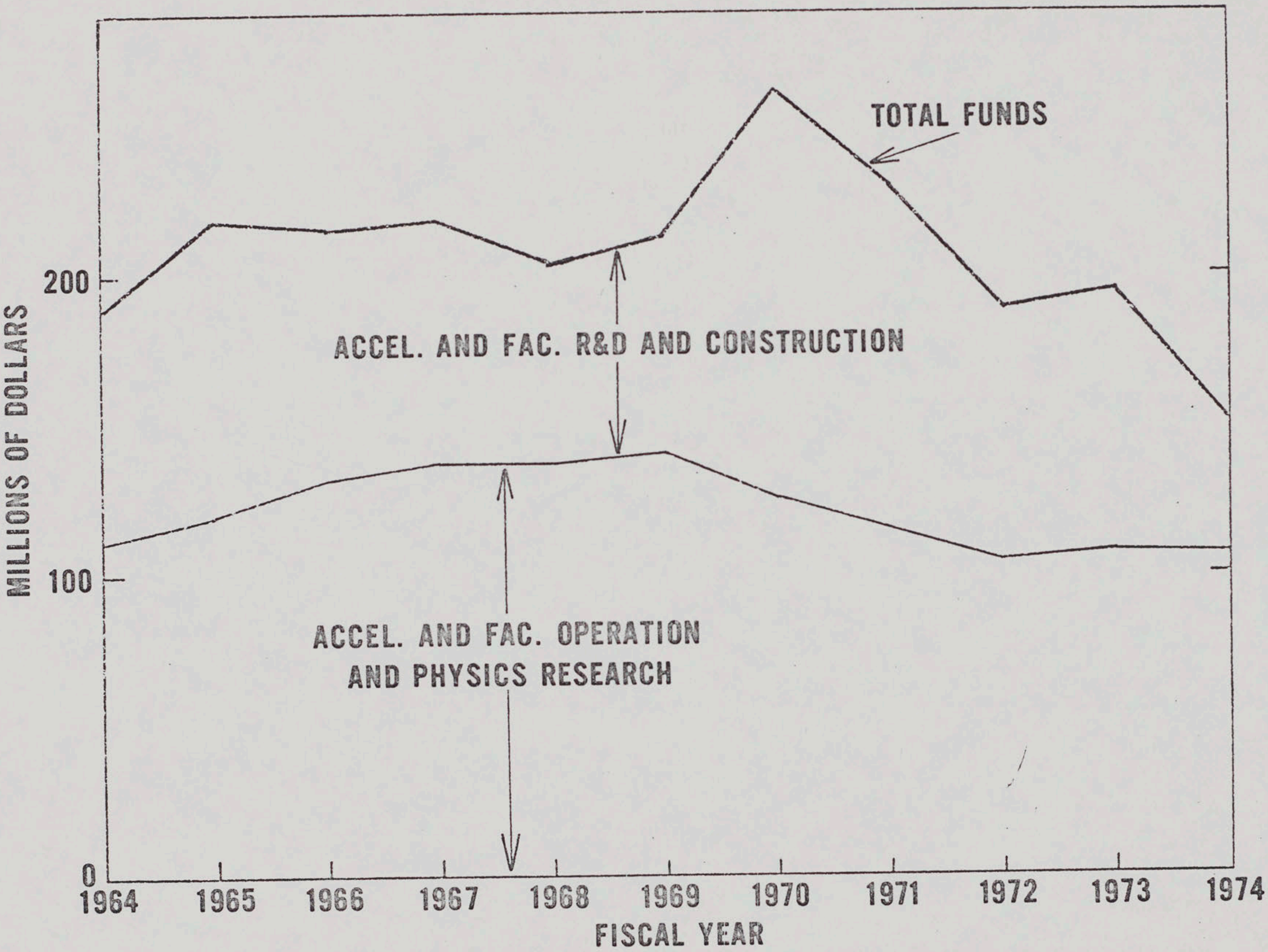
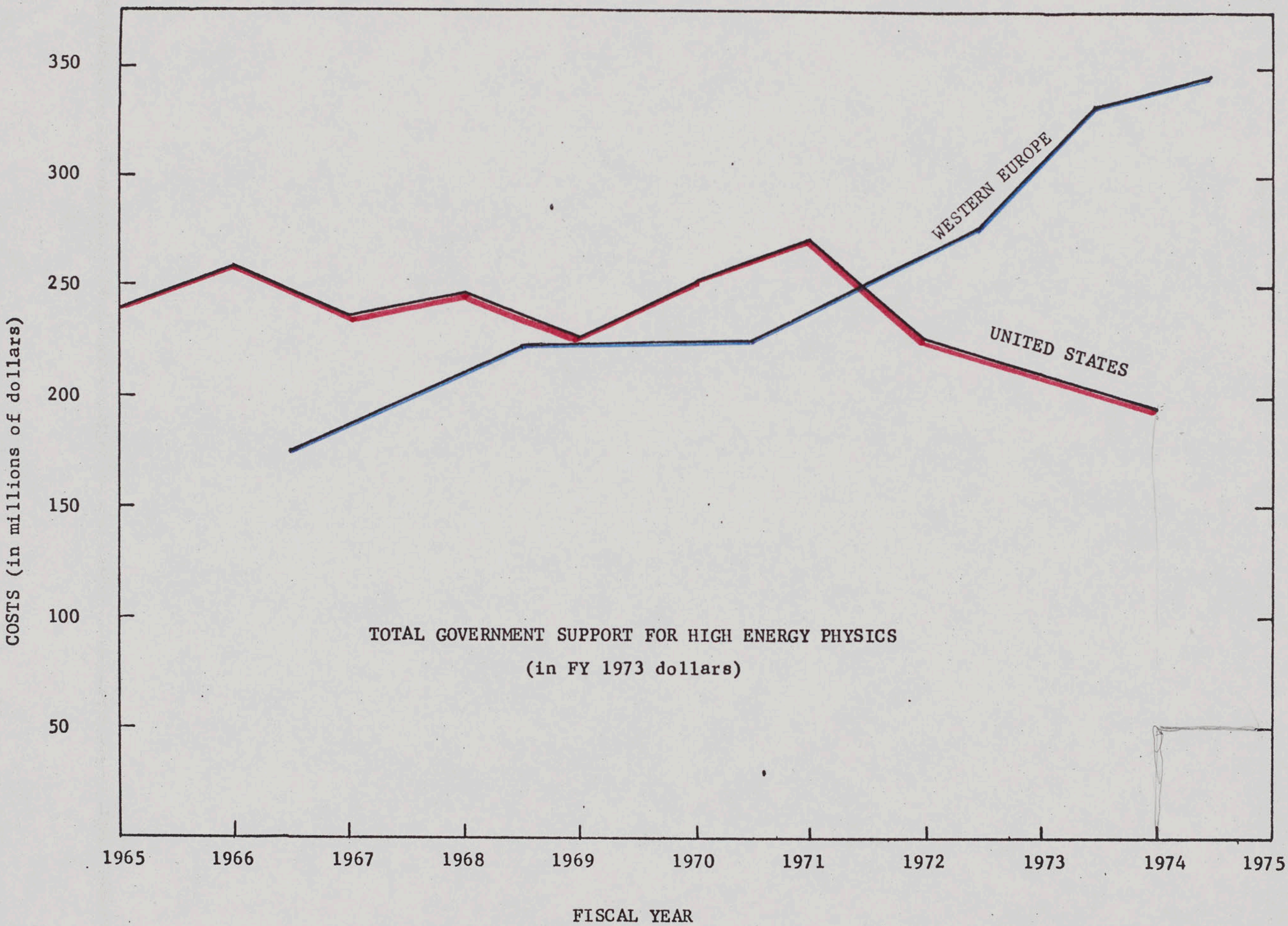

U.S. HIGH ENERGY PHYSICS
OPERATING FUNDING
FY 1973 DOLLARS
200
100
0
MILLIONS OF DOLLARS
TOTAL AEC
NSF
DOD NASA
TOTAL U.S.
CORNELL
UNIVERSITIES
NAL
SLAC
AGS
ZGS
LBL
COSMOTRON
CEA
PPA
1963
64
65
66
67
68
69
70
71
72
73
74
FISCAL YEAR
I = TIME OF FIRST BEAM

Figure 3

5



AEC HIGH ENERGY PHYSICS - TOTAL FUNDS (in FY 1973 dollars)


350
300
250
200
150
100
50
COSTS (in millions of dollars)
WESTERN EUROPE
UNITED STATES
TOTAL GOVERNMENT SUPPORT FOR HIGH ENERGY PHYSICS
(in FY 1973 dollars)
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
FISCAL YEAR

REVISED 4/30/73

AEC HIGH ENERGY PHYSICS PROGRAM MANPOWER
PERSONNEL COUNT* AT END OF FISCAL YEAR

		FY 67	FY 68	FY 69	FY 70	FY 71	FY 72	Est. FY 73	FY 74**
PPA	Total[1]	336	320	295	95	0	0	0	0
	Physicists	7	7	7	4	0	0	0	0
	Other Prof	50	50	50	20	0	0	0	0
CEA	Total[1]	233	230	216	146	126	121	32	0
	Physicists	18	18	18	18	11	10	4	0
	Other Prof	45	45	46	38	37	33	11	0
ANL	Total[1]	1,070	1,000	950	790	732	683	592	540
	Physicists	49	55	64	62	65	62	58	54
	Other Prof	170	165	159	133	110	115	100	90
	Grad Students	31	20	3	4	0	0	0	0
LBL	Total[1]	1,481	1,350	1,291	1,145	1,025	896	879	725
	Physicists	108	105	103	102	100	93	93	90
	Other Prof	204	190	184	170	158	132	131	112
	Grad Students	111	110	104	92	87	60	39	35
BNL	Total[1]	1,250	1,305	1,365	1,276	1,204	1,110	1,171	1,043
	Physicists	100	105	110	103	95	101	93	94
	Other Prof	170	180	187	169	132	121	124	107
SLAC	Total[1]	1,350	1,300	1,397	1,330	1,319	1,310	1,164	1,153
	Physicists	85	90	99	104	110	122	106	113
	Other Prof	215	220	222	223	169	162	160	160
	Grad Students	20	30	38	28	35	31	20	23
Laboratory Subtotal (except NAL)	Total[1]	5,720	5,505	5,514	4,782	4,406	4,120	3,838	3,461
	Physicists	367	380	401	393	381	388	354	351
	Other Prof	854	850	848	753	606	563	526	469
	Grad Students	162	160	145	124	122	91	59	58
University Programs[2]	Total[1]	2,682	2,759	2,606	2,378	2,342	1,904	1,795	1,710
	Physicists	645	659	641	639	673	590	618	610
	Other Prof	190	190	175	145	146	128	133	125
	Grad Students	647	660	626	594	539	400	357	335
Program Subtotal (except NAL)	Total[1]	8,402	8,264	8,120	7,160	6,748	6,024	5,633	5,171
	Physicists	1,012	1,039	1,042	1,032	1,054	978	972	961
	Other Prof	1,044	1,040	1,023	898	752	691	659	594
	Grad Students	809	820	771	718	661	491	416	393
NAL	Total[1]	-	200	410	695	850	920	1,250	1,300
	Physicists	-	15	36	56	74	76	80	85
	Other Prof	-	30	63	93	239	262	320	330
TOTAL PROGRAM	Total[1]	8,402	8,464	8,530	7,855	7,598	6,944	6,883	6,471
	Physicists	1,012	1,054	1,078	1,088	1,128	1,054	1,052	1,046
	Other Prof	1,044	1,070	1,086	991	991	953	979	924
	Grad Students	809	820	771	718	661	491	416	393

*Personnel Count and Man Years Effort are not significantly different except within the University Program.

**Estimated on the basis of the President's FY 74 Budget.

[1] The Total for each laboratory includes, in addition to Physicists, Other Professional, and Graduate Students, all other personnel supported by the program eg. technicians, accelerator operators, scanners, machinists, craftsmen, etc. In accounting parlance there are, in addition to "direct" and "indirect" people, also many "contract" heads included in the count in cases where their numbers are directly affected by the level of HEP program support.

[2] ~ 15% of the support for the research effort carried out by the people listed under University Programs is provided by University contribution. No "indirect" or "contract" type heads are included in the University head count (see footnote 1).

High Energy Physics Funding
(Obligations - AEC + NSF)

	FY 72	FY 73	FY 74 (request)
TOTAL HEP	$ 193.76 M	$ 230.85 M	$ 189.5 M
Operating Expenses	$ 132.7 M	$ 141.4 M	$ 145.8 M
NAL	12.75	19.20	29.00
Base Program Laboratories	83.24	85.65	80.20
AGS	22.65	24.60	24.20
Bevatron	15.58	15.20	13.40
CEA	2.16	2.00	0.60 1/
Cornell	3.00	3.30	3.40 2/
SLAC	24.08	24.95	24.20
ZGS	15.77	15.60	14.40
Universities	36.71	36.55	36.60
AEC	23.41	22.85	22.70
NSF	13.30	13.70	13.90 2/
Capital Obligations	$ 61.06 M	$ 89.45 M	$ 43.71 M
NAL	53.22	59.36	25.20
Base Program Laboratories	7.15	29.19	17.71
AGS	2.16	2.98	11.08 3/
Bevatron	.69	.98	.58
CEA	.28	.13	0
SLAC	2.96	13.70 3/	5.25 4/
ZGS	1.06	11.40 3/	.80
Universities	.69	.90	.80

1/ Closeout costs

2/ NSF apportionment of FY74 request not yet determined

3/ Includes large general-use computer

4/ Includes computer building

STANFORD UNIVERSITY

STANFORD LINEAR ACCELERATOR CENTER

Mail Address
SLAC, P. O. Box 4349
Stanford, California 94305

July 17, 1973

Professor V. F. Weisskopf
c/o Director General
CERN
1211 Geneva 23
Switzerland

Dear Viki:

I am including the letter which I have written to John Teem together with the physics section of the revised design report on RLA. We are all unhappy about the way this whole business has evolved and we sincerely hope that the report of the troika which met here at SLAC will not be given a great deal of weight; it may, of course, be that the final report will in fact be quite favorable to RLA.

According to those present at the SLAC meeting, Dick Wilson was simply unable to focus on anything except how RLA might interact with the appraisal of the ongoing experiment #98 at NAL; this is the muon scattering experiment at NAL which is having a terrible time since the intensity if currently only 10^4 muons/sec with an improvement to 10^5 forecast in the not too distant future. The projected beam in the north hall of CERN II is expected to reach 10^8 muons/sec and its halo should be below 10% as compared to the current 100% at NAL. In any rational world none of this should have anything to do with RLA since Dick's present problems in making his NAL experiment competitive have to do with the comparison between NAL and CERN II and not with RLA. A dispassionate look at this whole business makes it fully clear that RLA offers a great deal more powerful penetration into the high q^2 region and higher precision, while the CERN lepton beam (and hopefully NAL) will reach larger ν and therefore W values. Both need support.

More importantly, I am very critical about the narrow focus and the bureaucratic circumstances of the review and I guess this displeasure has filtered into the Teem letter, although I tried to word it in a moderate way. Under current circumstances it is so difficult to get a "yes" on anything out of the Government and therefore any noise in the system gives an excuse for inaction. Since RLA is now definitely "ripe" I think that a deferral of decision at this point clearly makes no sense.

The real issue therefore is whether the growth of high intensity electron and photon physics should be stopped at the SLAC parameters or whether another substantial step should be taken. Naturally I am prejudiced on this subject and feel that RLA is a bargain.

I feel that HEPAP has a real responsibility in this whole business; the reviews of the previous years were all favorable and, at least thus far, the reopening of the question has not been handled well. It is too bad that the time scale and other circumstances have made it so difficult for HEPAP either to reaffirm last year's position or do what I feel is a responsible job of review.

All this makes the sabbatical more attractive, although it also makes me more worried about being absent during the critical decision making period. On the other hand I am afraid that is the way it will always be.

I am very glad that we have about one month of overlap in Geneva. Any advice you can give me on the RLA business would be greatly appreciated.

With best regards,

Pief

W. K. H. Panofsky
Director

encs.

STANFORD UNIVERSITY

Stanford Linear Accelerator Center

Mail Address
SLAC, P. O. Box 4349
Stanford, California 94305

July 17, 1973

Dr. John Teem
Director, Division of Physical Research
U. S. Atomic Energy Commission
Washington, D. C. 20545

Dear John:

SLAC was host last weekend (July 13 and part of July 14, 1973) to the meeting of the special ad hoc committee which you established under the chairmanship of Jerry Rosen to look into certain questions which were raised covering RLA at the end of the last HEPAP meeting.

Naturally we are grateful to the three individuals on the committee (Rosen, Richard Wilson, Richter) for their willingness to take time to help in answering the questions raised. At the same time I am concerned about the circumstances attending the particular review. For one, the chairman (Rosen) had to go to Europe immediately after the HEPAP subcommittee meeting and the deadline for the report is July 20; thus only the brief meeting at SLAC was possible and barely one week of elapsed time is available for all the tasks and communications of the group. Secondly the group can in no way be described as a subcommittee of HEPAP since its findings cannot be made known to HEPAP in the time slot available, let alone be reviewed by them, and no member of the AEC staff could attend the meeting. Therefore the particular membership available to serve on the committee significantly affects its findings. Third, the primary question into which the committee was to inquire - the overlap between the physics program now envisaged for RLA and that attainable in the post-1977 era by NAL and CERN II through the use of muon, electron and gamma beams - touches on only a particular facet of the RLA program; it is by no means a full technical review.

The case for RLA rests on a much broader basis as follows:

1. The physics program envisaged for RLA and as outlined in the enclosed first chapter of the forthcoming RLA Design Report encompasses not only a substantial advance in the inelastic electron and muon scattering programs, but covers investigations in high energy photoproduction, the use for hadron physics and weak interaction studies of special secondary beams of unique and non-unique characteristics, and other programs depending on SLAC's existing and future complements of beams and equipment.

2. The most important area of activity of a new step in accelerator performance has rarely, if ever, been correctly predicted in the past. E.g. the Cosmotron was justified as a tool for the study of multiple meson processes while its main impact on physics was the discovery of Associated Production of strange particles; the energy of the Bevatron was designed to be above the anti-proton threshold while its greatest contribution was probably the discovery of hadron resonances. To come closer to home: SLAC was proposed mainly to extend the boundaries of quantum electrodynamics (QED) and of elastic electron scattering; in actuality the first pure QED experiment remains yet to be done at SLAC while the most profound impact of SLAC has probably been in the areas of deep inelastic electron scattering, bubble chamber physics with hadron and special γ-beams, K_o weak decay studies and SPEAR.

The basic question is not to delineate a specific field of foreseen productivity in detail but to ask whether or not the general field of physics made accessible by high intensity electron and photon beams should be closed at the present SLAC energies or should be broadened through RLA.

3. RLA is an improvement program to an existing, highly instrumented accelerator. It doubles SLAC's energy and increases its duty cycle at present energy one hundredfold. The cost corresponds to four or five major equipment installations. When discussing the possible overlap between the RLA and the NAL or CERN II programs one must consider the cost* of creating opportunities for such programs. All of SLAC's present major equipment installations (single-arm spectrometers, LASS, the 2 m streamer chamber, the K_o^- spectrometer, the rapid pulsing bubble chambers) can serve RLA. The Improvement Program represented by RLA is a particularly cost-effective way to increase the total research returns of the total capital investment in SLAC.

The purpose of this note is in no way to express objection to the establishment or procedures of the ad hoc committee (although I would appreciate the opportunity to comment on their report), but to put its work into

*The estimated cost of the high intensity muon beam at CERN (10^8 muons/sec) whose authorization is to be decided in September 1973 is 25 Million Swiss Francs. The corresponding NAL beam line currently yields only 10^4 muons/sec with improvement to 10^5 muons/sec planned shortly.

the perspective of the broader framework of the RLA decision. We consider the latter to be a vital question for the future of the electron-photon component of U.S. high energy physics and I fully realize that in the highly competitive circumstances which basic Science faces these days any input, however narrowly circumscribed, can affect a vital decision. I would be happy to discuss these questions further with you or arrange for a presentation before any forum you may wish to designate.

With many thanks for your concern with this difficult problem.

Sincerely,

W. K. H. Panofsky
Director

enc.

cc: Dr. W. A. Wallenmeyer w/enc.

I. HIGH ENERGY PHYSICS OBJECTIVES

A. Introduction and Summary

The potential impact of an increase in energy and duty cycle of the two-mile accelerator can be understood by considering SLAC's research program of the past six years. This program has confirmed that the study of particle physics via electron- and photon-scattering experiments plays an essential and unique role in the investigation of the structure of the hadrons. The importance of such experiments derives from the fact that the electromagnetic interaction is well understood, can be well treated in the formal analyses, and exhibits a local, point-like nature. The known electromagnetic field generated during the electron's scattering or absorption of a photon interacts with the local electromagnetic current of the hadron target and thus can probe the structure of the nucleon at arbitrarily small distances. This is in sharp contrast to hadron-hadron scattering, in which the basic interaction between the target and beam particles is both unknown and diffuse, so that it is difficult to isolate the structure of the target particle.

Since the electron interacts via a known electromagnetic force, its scattering pattern can be interpreted in terms of the structures within the target protons and neutrons from which it scatters. Indeed, the deep inelastic scattering measurements performed at SLAC have given dramatic evidence of a scale-invariant behavior of the nucleons' structure functions which is reminiscent of the original Rutherford atomic scattering patterns and which strongly hints at a rich substructure, perhaps point-like, within the nucleon itself. In a complementary manner the purely hadronic interactions studied at the high-energy proton accelerators reveal regularities and patterns in the distribution of the debris emerging from the collisions. In these two patterns -- electron scattering and debris analysis in hadron collisions -- lie the clues to progress in our understanding of elementary particles. The results of the last few years have emphasized the vital importance of advancing both electron (photon) and proton (meson) scattering frontiers.

With RLA the sensitivity of SLAC experiments to short distance and other physics effects will be significantly increased. The projected increase in energy will greatly extend the kinematic range covered by the SLAC measurements and more than double the energy that can be transferred to the target hadron. The improved duty cycle at 20 GeV will permit multiparticle final state coincidence techniques to be advanced by up to several orders of magnitude.

The key beam parameters of the RLA are summarized in Table 1 (for a more detailed explanation of beam parameters, the reader is referred to Section II of this report). The beam intensity will be of the order of 10^{14} electrons per second. By contrast, the estimated muon flux from the 500 GeV NAL proton beam will be approximately 5×10^6 muons per second at 100 GeV; this limit is set primarily by beam halo. The electron beam attainable from neutral pion decay at NAL is expected to be between 10^7 and 10^8 electrons per second. Thus, for purposes of electromagnetic physics, there is an intensity ratio of at least six orders of magnitude in favor of the recirculating SLAC accelerator so that, although the energy range will be much more limited than at NAL, the momentum-transfer range for electromagnetic scattering can be extended to larger values. Thus while NAL will probe for new threshold effects at higher energies, SLAC-RLA will probe closer and closer to the light cone by studying the high momentum transfer regions.

It will be very important to compare the results from RLA with those from the electron-positron storage ring SPEAR, since SPEAR can probe hadronic properties with time-like photons carrying photon-masses of q^2 up to 81 GeV^2, while RLA will allow the comparable space-like probes to reach values of $q^2 \sim 45$ GeV^2. This will thus permit what can be anticipated to be highly important comparisons for elucidating the structure of hadrons.

The physics possibilities of RLA can be divided into four main categories:

1. Deep inelastic electron scattering
2. Photoproduction and photon scattering processes
3. Secondary beams for hadron and weak interaction physics
4. New particle physics

We summarize below some of the essential physics of these four areas. The latter part of Section I will then discuss the physics program in more detail. A summary of how the capabilities of the existing experimental facilities at SLAC can be extended for use with RLA will also be presented.

1. Deep inelastic electron and muon scattering

Electron or muon scattering experiments can be considered as (virtual) photoproduction experiments in which the photon mass can be controlled by varying the energy and angle of the scattered lepton. This possibility of

TABLE 1

The Principal Design Beam-Parameters For RLA

	High Energy Mode	High Duty Cycle Mode
Output Beam Energy (GeV)	42	17.5
Recirculating Beam Energy (GeV)	17.5	17.5
Peak Output Beam Current (mA)	24	0.2
Average Beam Current (e/sec)	$\sim 10^{14}$	$\sim 10^{14}$
Duty Cycle (%)	.06	7

"tuning" the photon's mass is a unique feature of lepton-induced reactions. In addition, the polarization of the incident photon (real or virtual) may also be controlled experimentally. The scattering experiments performed at SLAC to date are of two general types: (i) Inclusive measurements in which the scattered electron (or muon) is detected and all available hadron channels are summed over; these are in effect total-cross-section measurements in which the virtual photons have a particular mass and polarization. (ii) Semi-inclusive and exclusive experiments in which one or more of the emerging hadrons is detected along with the scattered electron. The projected increase in energy obtained with the RLA will greatly extend the kinematic range covered by these measurements and more than double the energy that can be transferred to the target hadron. In particular, one is anxious to learn if the proton continues to scatter as if individual point-like constituents are contributing incoherently. The high-intensity electron beam will allow detailed and precise measurements of the electroproduction cross sections and will be a necessary complement to the gross measurements possible at NAL at still higher energies. Figures 1, 2, and 3 compare the kinematic ranges and counting rates at SLAC, RLA, and NAL for the inclusive experiments.

The continued observation of scale-invariant behavior of the proton and neutron cross sections in the RLA energy and sensitivity range could imply that we are observing asymptotic features of the proton structure, and would strongly support the main hypothesis of the parton and light-cone models: that the carriers of the electromagnetic current within the hadrons are structureless and light. Observation of scaling breakdown, on the other hand, would imply a new scale for hadronic phenomena, as would be required, e.g., if there are thresholds for parton or quark production, or could reflect the structure of the partons themselves. The experimental support or failure of scaling could represent one of the most significant problems in particle physics.

Further clues to the fundamental substructure of the nucleon must come from the detailed study of the properties of the final state in deep inelastic electron scattering. The increased duty cycle of RLA will greatly enhance SLAC's ability to observe final-state hadrons in electroproduction. As in hadron-hadron experiments, this may be done by identifying all final-state particles (exclusive experiments) or by identifying only a few particles and summing over the rest (inclusive experiments). The detailed information

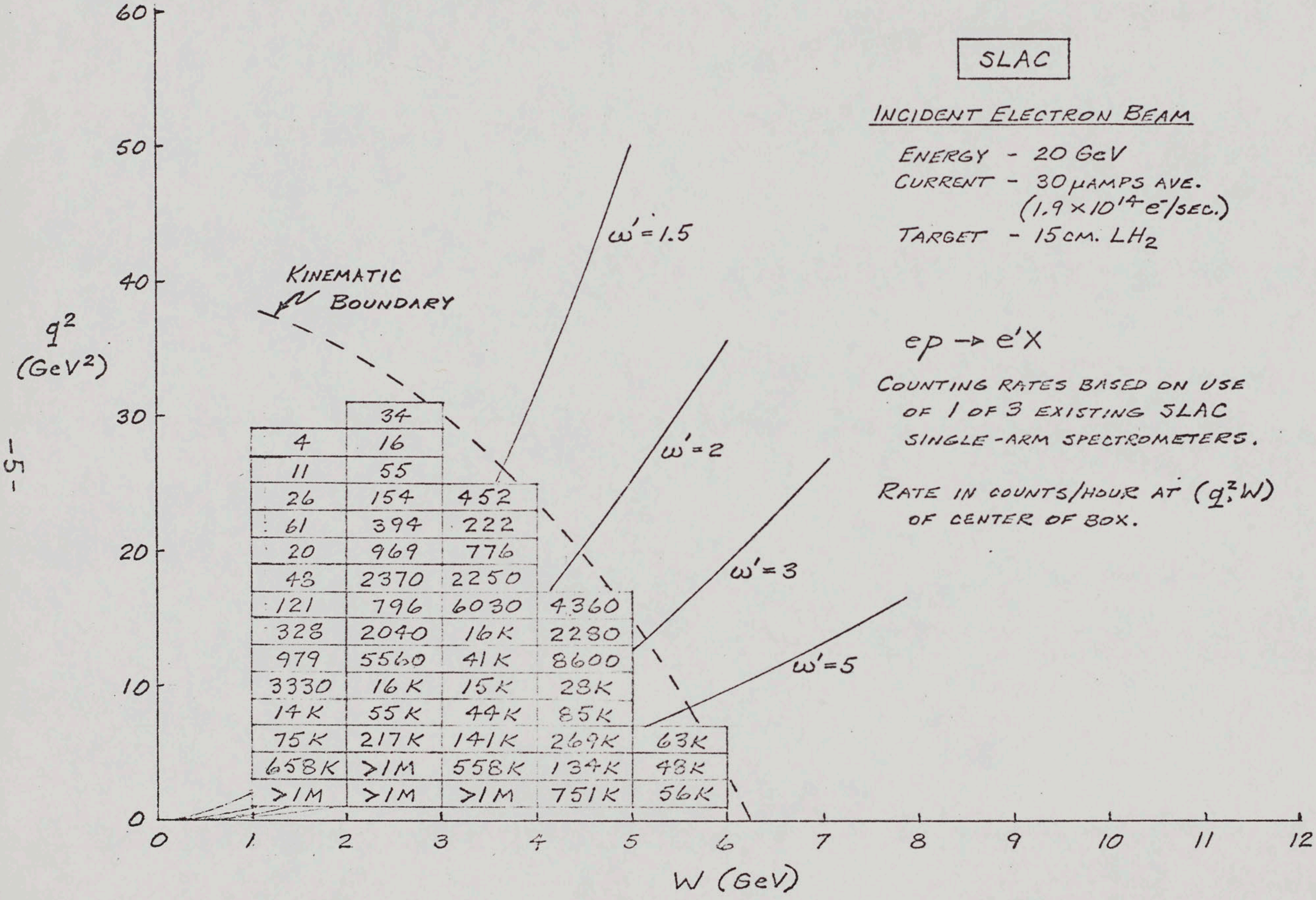


FIG. 1 — THE (q^2, W) REGION THAT HAS BEEN EXPLORED BY THE SLAC ACCELERATOR.

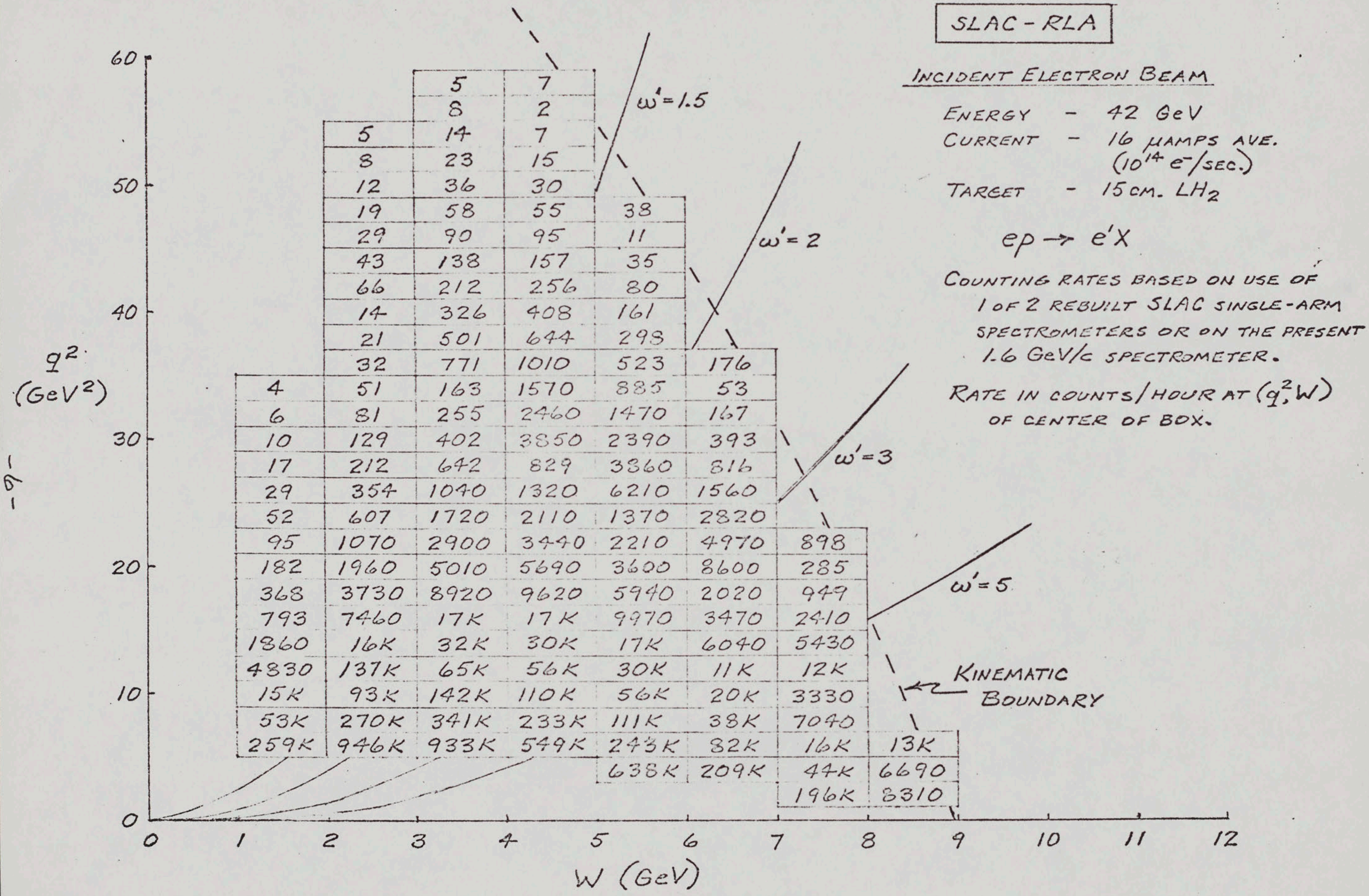


FIG. 2 — THE (q^2, W) REGION THAT COULD BE EXPLORED BY THE SLAC-RLA ACCELERATOR.

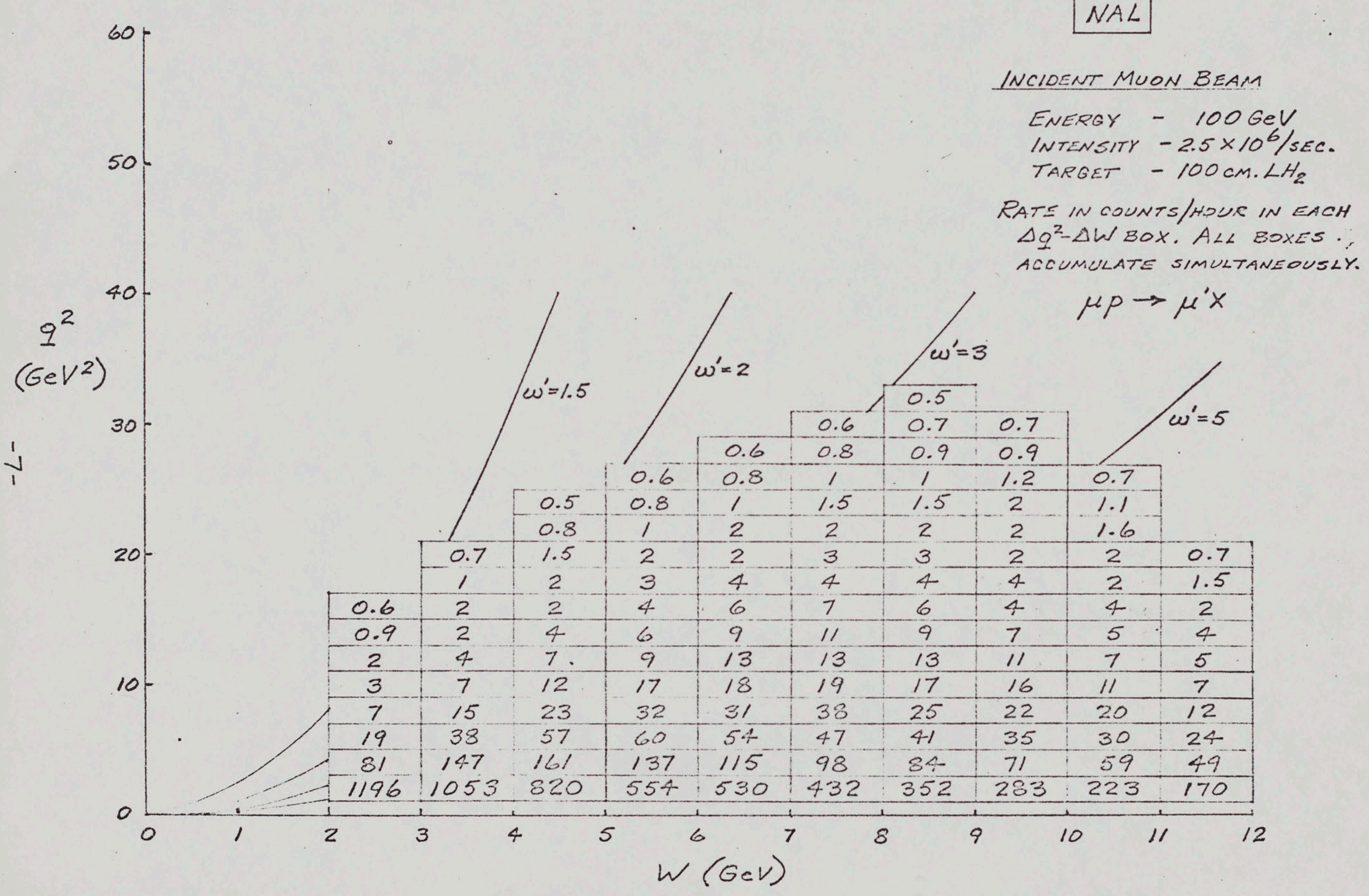


FIG. 3 – THE (q^2, W) REGION THAT CAN BE EXPLORED BY THE NAL ACCELERATOR.

available from these experiments (i.e., multiplicities, momentum distributions, quantum numbers, correlations, etc.) will provide tests of specific predictions of the parton and other models (such as the intimate relations in the parton view between electroproduction, e^+e^- annihilation, and large-angle hadron scattering). Similarly, the photon mass and energy dependence of exclusive channels measurable at RLA will contribute much to our understanding of quasi-two-body production and will test many existing models (such as the quark model) and dynamical production mechanisms. Other general and fundamental features to be studied at large photon masses include the applicability of Regge theory analyses, the validity of sum rules based on current algebra and light-cone analyses, and the "fragmentation" of massive photons into jets of secondary hadrons.

2. Photoproduction and photon scattering processes

The study of reactions in which strongly interacting particles are produced by high-energy gamma rays (photoproduction) has been a major field of research at SLAC. These experiments have contributed directly to our understanding of the dynamics of the strong interaction, both in their own right and because they complement experiments done at other laboratories, such as Brookhaven and CERN, with incident proton and meson beams. The improvements proposed here for the SLAC machine will allow a great extension of this work. An increase in the duty cycle of the accelerator in the 15 to 20 GeV energy region by a factor of about 100 should provide an increase of the same factor of 100 in the amount of data already obtained on multiparticle momentum and angle correlations in photoproduction reactions. Most of the work to date in this multiparticle field has been devoted to the various vector-meson production reactions which have relatively large cross sections. The increase in data rate allowed by the improvement in duty cycle will allow experiments to be done on reactions with smaller cross sections, and hence broaden the spectrum of experiments which complement the work done in the same energy range at Brookhaven and CERN.

Photoproduction data bears directly on the electroproduction work at SLAC by furnishing a reference point at $q^2=0$. An understanding of the transition from photons with $q^2=0$, which exhibit mostly hadronic behavior, to high q^2 photons, where scaling appears to hold, is one of the fundamental challenges in high-energy phenomenology.

There are unique characteristics of the photon-initiated exclusive reactions that can be explored at high energies for uncovering the ways in which a photon is similar to and differs from a hadron. Subtle differences in Regge limiting behavior or the possible appearance of "fixed poles" in photon-induced reactions can be probed. Photon-initiated diffraction-dissociation events viz., γ + target $\rightarrow$ (hadronic system with the photon's quantum numbers) + target, can be probed to higher energies as well as higher massive hadronic states with RLA. To cite one very clear special feature as an example: the mechanism turning a γ into a ϕ is purely diffractive via Pomeron exchange and, with other background contributions absent, the pure diffraction character of the amplitude can be more readily observed. The studies of other "hadronic" features of a photon beam such as the shadowing effects as it traverses nuclear matter can also be explored in detail.

Scatterings with a large transverse momentum transfer correspond to small impact parameter collisions and also probe the short-distance structure of hadrons. Whether the probes are hadrons themselves, as at CERN, Brookhaven and NAL, or photons, as at SLAC, new types of scaling behavior are anticipated based on constituent models of the hadron as developed from the deep inelastic electron scattering results. Thus photoproduction and Compton scattering will be important processes to study -- and it is important to extend the measurements to as large a value of momentum transfer and to as small a value of the cross section as possible. In particular, comparison of exclusive vector-meson photoproduction and elastic Compton scattering in this region will be important for comparing the short-distance behavior of photons and mesons. In this domain all the processes, exclusive and inclusive, initiated by electromagnetic currents will require RLA's high fluxes to allow the measurements to probe to large momentum transfers.

For example, with the full photon flux of SLAC at 7.5 GeV, it has been possible to probe two-body photoproduction cross sections out to the kinematic limit of $\sim 13\ (\mathrm{GeV/c})^2$ for the momentum transfers, corresponding to a minimum cross section value of $\sim 10^{-34}\ \mathrm{cm}^2/\mathrm{GeV}^2$. Since these observations show a cross section falling rapidly with $p_\perp$ (as $p_\perp^{-14}$) the importance of very high photon fluxes for studying such processes is clear.

Another example of high-energy limiting behavior comes from very inelastic photoproduction of massive μ-pairs, which can be studied for scaling laws similar to those found in deep inelastic scattering of electrons by protons. Comparison with the production of massive μ-pairs in proton-proton collisions will provide new information on possible differences of the photon and hadron interactions. Inclusive measurements at large momentum transfer of deep inelastic Compton scattering, $\gamma + p \rightarrow \gamma + X$, and wide-angle bremsstrahlung, $e + p \rightarrow e + \gamma + X$, are also important tests of predictions based on point-like constituents within the hadrons. Furthermore, measurements of the difference between electron and positron wide-angle bremsstrahlung, $e^{\pm} + p \rightarrow e^{\pm} + \gamma + p$, provide a direct determination of the real part of the Compton amplitude, which is a fundamental quantity in particle physics.

In photoproduction the use of a quasi-monochromatic polarized photon beam is important because it provides the only practical boson beam with spin. Consequently, it is a unique tool in the study of the spin dependence of meson processes. SLAC has been very successful in developing such a beam, and experiments with it have shown that ρ^{o}, ω and ϕ photoproduction tends to conserve the s-channel helicity of the photon; i.e., the spin of the vector meson is along its direction of motion. The polarized photon beam also allows a clean separation of the interactions due to exchange of natural and unnatural parity particles or "trajectories"; in this case only one beam is necessary, as opposed to the hadron beam case, where cross sections from different types of reactions are needed to make the separation.

The high-intensity, good-duty-cycle photon beams at RLA will make possible measurements of the η and η' lifetimes by the Primakoff effect, and may permit a more general study of even-charge-conjugation hadronic states in photon-photon collisions. The study of the interference of the electromagnetic and hadronic production amplitudes is also valuable.

3. Secondary beams for hadron and weak interaction physics

RLA will also be a copious and effective source of secondary hadron beams, as shown in Table 2. While the improved duty cycle will allow some experiments with pion beams which cannot be done now, the greatest interest will lie in the 25-45 GeV region. Also, the variety of experiments will be enhanced over the present ones by the introduction of useful K^{-}, $\bar{p}$ and $\bar{n}$ beams. Although the hadron beams at RLA are neither unique nor of exceptionally high flux,

TABLE 2

The Expected Secondary Particle Yields From RLA

Particle	Particles/sec
$\pi^{\pm}$	$\sim 10^6$
K^+	few $\times 10^4$
K^-	$\sim 10^4$
$\bar{p}(\bar{n})$	few $\times 10^3$
p(n)	$\sim 10^4$
K_L^o	few $\times 10^4$

Note: These yields are applicable to beams similar to those now in existence at SLAC.

neutral K^o and $\bar{n}$ beams at SLAC will be clean compared to those at NAL, since they will be relatively free of neutron backgrounds. Reasonable momentum measurements of these neutrals can be made up to energies of 7 GeV by time-of-flight methods based on the intrinsically short rf bunches (10^{-11} sec) in the SLAC pulse.

Some of the interesting processes that RLA can study include:

(a) Determination of the energy dependence of specific processes and tests of duality, factorization, etc.

(b) The isolation of diffraction from exchange processes, and the illumiation of diffractive-dissociation mechanisms.

(c) The search for exotic exchanges.

(d) The search for heavy mesons.

(e) The study of relatively low-cross-section hadron processes induced by pions, such as backward-produced pion resonances, quasi-two-body final states involving high-mass nucleon resonances, etc., will be possible for the first time at SLAC since a large fraction of the full pion intensity in the energy range 10-20 GeV will be utilized.

(f) The study of parton-model scaling laws which predict energy-independent angular distributions at large center-of-mass angles.

(g) K-meson decays, regeneration, and associated weak interaction and CP-violating processes.

The high repetition rate at SLAC allows application of an important new technology in the area of fast-cycling bubble chambers operating in a triggered mode. The large aperture solenoid system (LASS) now being developed at SLAC allows a huge event capability with reasonable acceptance and high mass resolution. These facilities, and others such as the already existing streamer chamber and spectrometer systems, combined with RLA indicate that a strong program in hadron physics will continue at SLAC.

The yields given in Table 2 are for secondary beams of momenta of 10-40 GeV. Despite the fact that these yields are lower than that of NAL (by a factor of 10-100 for an NAL current of 5×10^{12} protons/sec), for reasonable cross sections in which the flux exceeds or matches the capacity of the data-handling system, SLAC will be a valuable complementary facility to NAL, as it now serves to Brookhaven and CERN.

4. New particle physics

Among the great mysteries of particle physics are the role of the muon and the possible existence of new leptons or heavy particles (W's, Z's) which carry the weak current. Since any particle with charge or magnetic moment is pair-produced, there will be great interest in experimental searches for such particles using the high-intensity higher energy electromagnetic beams of RLA. Further channel-by-channel comparisons of muon and electron interactions can be made to search for a possible difference in their interactions with hadrons. Tests of lepton conservation at high momentum transfer can also be done.

B. General Areas of Research - Detailed Discussion

1. Deep inelastic processes

The deep inelastic electron scattering results at SLAC have clearly shown that there are very large reaction rates as well as many contributing channels. To be more specific, consider the process in which an electron scatters inelastically and is detected after transferring energy ν and invariant four-momentum square q^2 to a target nucleon (hadron of mass M). For values of $\nu/M > 1$ and $q^2/M^2 > 1$, i.e., the deep inelastic region, the data indicate cross sections much larger than the partial cross sections to individual nucleon ground and resonance states. In fact, the structure functions for the inelastic cross section are observed to be functions of the dimensionless variable $\omega = 2m\nu/q^2$ and consequently do not fall as q^2 increases. The resonance bumps disappear into the large continuum tail as q^2 rises, and the scattering behaves as if it occurs from point-like constituents (anticipated by Bjorken and called "partons" by Feynman) in the proton, each contributing independently of the others, just as individual electrons add incoherently to make up the atomic cross section for highly inelastic scattering from atoms.

One of the primary questions to be answered by RLA is whether scaling continues to persist in the larger kinematic domain. With the higher energy beam in the 40-50 GeV region, it will be possible to extend greatly the range of ν (from 18 to $\sim$40 GeV) and q^2 (from 20 to 40 GeV^2), as already illustrated in Figures 1 and 2, and to explore further into this deep inelastic scattering range. Whether scaling continues or not will help answer if we are truly probing the elementary, structureless building blocks of the hadrons or if we are uncovering a new layer of structure dominated by another mass scale (i.e., if the hadron constituents possess structure themselves). Also of great imporatnce is the separation of $\sigma_L(\nu, q^2)$ and $\sigma_T(\nu, q^2)$ (the longitudinal and transverse total virtual photon cross sections). This requires large-angle lepton scattering and places severe requirements on the event rate. Thus, whereas NAL will probe to higher values of ν, the separation of σ_L and σ_T requires large-angle scattering and can be performed only with SLAC intensities. Indeed, one of the most interesting results from SLAC to date is the small value (~0.18) of σ_L/σ_T which suggests the dominance of spin-$\frac{1}{2}$ partons.

The state of theory is now such that in deep inelastic lepton scattering experiments, accuracy of measurement is becoming important. Specifically, alternate models differing in their fundamental aspects (such as the "anomalous dimensions" concept of K. Wilson) predict variances only discernible with high energy.

Further clues to the nature of the deep inelastic process, and the unravelling of the properties and interactions of the constituents, requires detailed study of the distribution and multiplicities of secondary particles emerging from the proton, as well as the dominant individual final-state channels, their mass distributions and dependence on momentum transfer. These are the analogues of the richly rewarding studies with incident baryon and pion beams that have paced the understanding of hadron dynamics and are the processes that the recirculating linear accelerator with a higher duty cycle would first open to our view.

The improvement in duty cycle by a factor of 100 or more at present energies provided by RLA means that event rates for these coincidence measurements would be increased by a comparable factor, allowing the determination of detailed effects and the measurements of small cross sections for specific channels.* With good duty cycle in the 15-25 GeV range at SLAC, one can explore this essential physics without expensive and major new detectors in the experimental area. Not only can the photon mass and energy dependence of these channels be mapped out, but also (by correlation with the scattering angle of the electron) the polarization of the incident virtual photon can in principle be controlled. In contrast, the hadron processes only allow variation of the incident energy but not the mass of the incident target.

*Some examples of experiments with RLA using existing SLAC experimental apparatus are discussed in part C of this section.

One such detector that has been successfully used at SLAC energies is an electroproduction apparatus consisting of a hydrogen target followed by a superconducting tube to reduce drastically the background due to Bethe-Heitler processes. The rest of the apparatus is a large magnet followed by wire chambers to detect forward-going hadrons while shower counters detect the scattered electrons. The superconducting tube has allowed electron intensities as high as 10^6/second to be used in this large-solid-angle detector, even with a poor duty cycle. The apparatus is especially suited to studies of electroproduction of ρ^0 and ϕ, and to inclusive studies in inelastic electron-proton interactions.

The coincidence experiments in which outgoing hadrons as well as the scattered electron are detected can provide severe tests of proposed models. For example, one can look for fast pions in the lab which are associated with the break up or "fragmentation" of the virtual photon. Much information about high-energy scattering has been learned from studying hadronic fragmentation. Photon fragmentation should be even more interesting because of the variable-mass q^2. Parton and Regge models of inclusive electroproduction predict that these single-particle distributions will exhibit Feynman-Yang scaling (limiting fragmentation) in addition to overall Bjorken scaling (function of ω rather than ν and q^2 separately). It will also be especially interesting to compare the fragmentation of these space-like virtual photons with the time-like virtual photons from e^+e^- annihilation at SPEAR. The multiplicity and quantum numbers of the fragments will bear directly on the existence and nature of the hypothetical partons. Polarization information can also be obtained from the coincidence experiments, since the polarization of the virtual photon can be controlled to some degree by the scattering kinematics.

It is also particularly interesting to measure the elastic and inelastic electroproduction of hadrons at large transverse momentum relative to the virtual photon direction. Here one probes the short-distance structure of the produced particle as well as the target nucleon, and detailed checks of parton-model predictions can be made. The cross sections for the large-transverse-momentum processes are predicted to be small and will require the high intensity RLA beam.

The ability to vary the photon mass in coincidence measurements also allows a useful probe into the nature of diffractive processes. The measurements of elastic and inelastic electroproduction of the vector meson are essential for answering such questions as the following:

(1) Do these channels contribute to scaling behavior?

(2) Are diffractive effects controlled solely by the minimum momentum transfer to the target?

(3) How does the transition between point-like behavior at large photon mass and hadron-like behavior in real photoproduction occur?

(4) Do virtual photons become more pointlike? Is there a "small photon" effect, which would be reflected in the variation of the diffraction pattern of the electroproduction process with photon mass?

(5) Can the transition region from photoproduction to deep electroproduction shed light on impact-parameter and geometric pictures of hadron interactions?

(6) Are there s-channel helicity conservation laws in the high photon mass regions?

(7) What is the range of validity of vector dominance and generalized vector dominance theories?

(8) What is the interrelation between Feynman-Yang (hadronic) scaling and Bjorken (scale-invariant) scaling?

At low q^2 studies of diffractive processes can of course also be carried out in the NAL lepton beams and can reach higher virtual photon energies.

These same theoretical questions are also confronted in comparing the behavior of virtual photoabsorption cross sections on nuclei with real photoabsorption. Experiments at SLAC and DESY have shown that "shadowing" of photon processes and in hadron-nucleus interactions is absent when the photon has $q^2 > 0.2$ GeV^2. Furthermore, sensitive measurements are needed for understanding this behavior and its dependence on photon mass and energy. Extending the range of these studies to higher energies as well as doing more detailed and accurate experimental studies using the improved RLA duty cycle at present SLAC energies will add importantly -- perhaps crucially -- to our understanding of the transition from real "hadronic" photons to virtual "point-like" ones.

There are higher order electromagnetic processes which will be exciting to measure at RLA. For example, the measurement of the inelastic wide-angle bremsstrahlung process $e + p \rightarrow e + \gamma +$ (anything) not only tests the time-like and space-like electron propagators at large invariant masses, but also gives a measurement of the virtual Compton inelastic amplitude. The interference of the Bethe-Heitler and Compton amplitudes, which is measured in the difference of electron and positron wide-angle inelastic bremsstrahlung, is related to the matrix element of the product of three electromagnetic currents. Measurements of this basic process and confirmation of the scaling laws predicted by the parton model can lead to a determination of parton charge. Measurements of the difference of electron and positron elastic wide-angle bremsstrahlung leads to a determination of the real part of the elastic Compton amplitude. Here one can check the validity of the fundamental Kramers-Kronig dispersion relation. The determination of the photon mass dependence and energy dependence of the virtual Compton amplitude (especially confirmation of energy-independent, and photon-mass independent, terms corresponding to local point-like two-photon interactions) is a critical test of parton and light-cone theories. All of these measurements are extremely difficult with the present SLAC duty cycle because of π^0 backgrounds, but are expected to be feasible with the high duty cycle of RLA.

2. Photon physics

RLA will provide photon beams well suited to a wide variety of experiments. The properties of the photon beams available from the RLA depend on unique features of this particular accelerator, and are not likely to be duplicated elsewhere. The only parameter of interest which will be surpassed at any other accelerator is the photon energy. Although photon beams of considerably higher energy will be available at NAL, the much lower intensity available in these beams, along with their lack of polarization, will limit the work undertaken with them to studies of the unpolarized total cross section and a few of the larger cross section diffractive processes.

A. Photon beams

Before discussing the RLA photon experiments, a brief summary of the various RLA photon beams is in order. These beams are:

(1) Ordinary bremsstrahlung. In the high-energy mode, yields of a few $\times 10^9$ equivalent quanta per pulse (upwards of 10^{12} e.q. per second) are readily available. Presently, beams of this intensity are used only in End Station A at SLAC. The facilities available there, the three large focusing spectrometers and the pair spectrometer, will be adaptable to use with higher energy photon beams with little or no modification. For example, the present 20 GeV spectrometer could readily be adapted for use at 45 GeV by simply re-arranging the existing magnets and some of the shielding. The 1.6 GeV

spectrometer would clearly have the utility it presently has with no modification. Even higher intensity bremsstrahlung beams could be delivered to targets in ESA by bringing the electron beam into the end station, producing the bremsstrahlung there in a thick radiator, and continuing both beams through to Beam Dump East.

An excellent facility for conventional bremsstrahlung beams could be made for use with the high-duty-cycle or high-energy modes of operation. This would be accomplished by mounting a permanent target for bremsstrahlung production in the recirculating beam at all times. Calculations indicate that a target could be made thin enough so that losses to the recirculating beam would be negligible (less than 1%) while providing bremsstrahlung yields on the order of a few $\times 10^{11}$ e.q. per second. Alternatively, bremsstrahlung beams of a few $\times 10^{11}$ e.q. per second could be provided by stripping off a small portion of the recirculating beam on each turn.

(2) Bremsstrahlung polarized by coherent pair production. This technique has recently been developed into a practical facility by a group at SLAC. Basically, one attenuates one linear polarization state of the unpolarized beam more than the other. It is possible to produce a high polarization at the bremsstrahlung tip by this method, and thus to create the highest energy polarized photons of any technique. The beam is most useful with experimental apparatus or techniques which can be made insensitive to the large number of less strongly polarized, lower energy photons. An important point with this beam is that the cross-section difference responsible for the polarization increases linearly with energy. At 40 GeV, a beam of 40% polarization at the bremsstrahlung tip, with an intensity of 10^8 e.q. per pulse could be made with the graphite polarizer now in hand. Because of the attenuation necessary to produce the polarization, successful utilization of this method needs the high intensities available at RLA. This technique offers enough advantages that it will probably replace the use of uncollimated coherent bremsstrahlung for energies greater than about 16 GeV, though detailed studies would have to be undertaken in some specific instances.

(3) Highly collimated coherent bremsstrahlung. By collimation to angles notably smaller than the characteristic angle of m/E, the coherent bremsstrahlung spectrum from crystalline targets is significantly improved in two ways. First, the width of the coherent peak is significantly narrowed, and second, the incoherent bremsstrahlung is greatly reduced. SLAC has recently perfected a technique for producing the very thin (less than 80 microns) diamond targets necessary for this work, and has brought such a beam into experimental use

for the first time. This beam relies on both the high intensity and the excellent phase space of the linac for its performance. In particular the yields are directly related to the electron beam phase space. A helpful factor in going to higher energies is that the coherent cross section increases linearly with energy. Based on the performance of the existing beam, and making reasonable assumptions about the phase space of the 40 GeV RLA beam (see Table 5 in Section III), yields of 6×10^8 quanta per second at 22 GeV (± 5% width, 65% linear polarization) and 1.5×10^8 quanta per second at 30 GeV (± 3.5% width, 39% linear polarization) appear possible.

Furthermore, it may be possible to produce a crystalline radiator thin enough to allow continous placement in the recirculating beam, for high duty-cycle use.

(4) Highly collimated backscattered laser beams. This technique, previously brought to full utilization at SLAC, produces photon beams of very high polarization, with very narrow, background-free spikes as a spectrum. The yields from this process are very low, however, making them suited for use only with large-solid-angle detectors. Again, the yields are directly related to the electron-beam phase space. With the same reasonable assumptions about phase space noted above, it appears that the present ruby laser system could provide enough yield for a bubble chamber exposure. Very rapid advances in the areas of high average power, high repetition rate, and repetitively Q-switched YAG lasers give promise that linearly and circularly polarized photon beams might be practical from these systems at energies between 4 and about 24 GeV, again with yields suited for large-solid-angle detectors.

B. Photon beam experiments

There are a variety of photon-beam experimental problems which could be studied with RLA. (This list is not intended to be exhaustive.)

(1) Bubble chamber survey at 20 GeV. Using the ruby laser beam, an exposure of 10^6 pictures would yield 3×10^4 events, covering all topologies in a reasonably unbiased fashion. Such an exposure would give a good outline of the physics, and would undoubtedly be useful in planning future, more highly selective, experiments.

(2) Pseudoscalar meson photoproduction. In this work, and for vector-meson photoproduction as well, two points are worth stressing. First, due to the steep energy dependence of secondary-particle yields at BNL and CERN, most experiments with boson beams have been done at energies at or below

16 GeV, even though the primary energy at these machines is about 30 GeV. At SLAC, where photon experiments are often done at the maximum machine energy, the experiments are thus a good complement to the higher energy proton machines. Second, since the photon has two spin states, twice as many amplitudes are necessary to describe photoproduction process as would be required if it were produced by spinless bosons. However, since the photon can be polarized, useful information can be obtained which is not readily accessible to measurements of single-boson-induced reactions. For example, forward production of single scalar or pseudoscalar mesons with polarized photons leads directly to a separation of natural and unnatural parity t-channel exchange contributions. Similar separations for production by spinless bosons require the measurement of more than one reaction, with the concommitant systematic errors.

Pseudoscalar meson photoproduction studies have produced a wealth of new information and uncovered a number of still poorly understood phenomena. For example, there is the near constancy of $s^2 d\sigma/dt$, the approximate e^{-3t} falloff away from $t = 0$, and the dominance of natural parity exchange in the t-channel. These properties are common to all the measured reactions. To accommodate these features into contemporary theories or phenomenological models seems to be very difficult.

A study of these reactions at higher energy, especially with polarized photons, will be very interesting. With the new graphite-attenuated beam, it will be possible to study both the polarized photon asymmetry and the differential cross section in the same experiment out to a t of 1.5 $(GeV/c)^2$, at energies between 20 and 40 GeV. Larger momentum transfer studies could be made with unpolarized beams. With this facility it should also be possible to study backward photoproduction, where baryon exchange is presumably dominant, with polarized photons. This will be the first information of this type available.

With the aid of the high-duty-cycle mode of RLA, it will be possible to undertake double-correlation measurements where either one initial and one final spin, or both initial spins, are determined. Measurements of this type will be of considerable aid in studying the amplitudes which contribute to these processes. Present-day models are sophisticated enough to require this sort of information. The combination of high energy and high intensity of RLA in its low-duty-cycle mode makes it possible to pursue studies of very high momentum transfer inclusive photoproduction processes; these have become of great theoretical interest as a result of recent ISR results.

(3) Vector meson photoproduction. The observed vector-meson photoproduction cross sections decrease very slowly with photon energy. Measurements of these cross sections at higher energies, and in nuclei, provide a crucial test of models such as vector dominance.

The search for new vector mesons by their diffractive production by photons can also be extended. Higher energies relieve the complications that arise from minimum momentum transfer effects, which have been a bit troublesome in some of the present experiments. Since many of the final states from these reactions involve a number of particles, these experiments are "naturals" for the large-solid-angle detectors, combined with good duty cycle, sophisticated photon beams. Event rates of several per second seem achievable, and would represent a substantial increase in our knowledge of these particles.

In investigating diffractive problems where spin and helicity rules are of interest, photons play a unique role. In these forward processes, where photons resemble hadrons, they offer an opportunity to investigate polarization effects not accessible in hadron reactions. Thus, for example s-channel helicity conservation has been shown to be a prominent feature of rho, omega and phi photoproduction out to moderate momentum transfers. It will be of great importance to determine how far in t this behavior extends. If the present t dependence is maintained, exploration out to $t = 2\ (\mathrm{GeV}/c)^2$ can be done with RLA photon beams. Photoproduction of ϕ mesons is a unique reaction in which no ordinary Regge poles other than the Pomeron can contribute if exchange degeneracy holds. This reaction may provide interesting information about the Pomeron at low energies.

(4) Compton scattering. Elastic photon scattering experiments test the Regge hypothesis for the couplings to the nucleon and the photon as well as vector dominance. Present experiments at energies up to 18 GeV indicate some disagreement with current models. The real part of the Compton scattering amplitude can be measured by interference with the Bethe-Heitler amplitude. Both these experiments will profit from higher energies, and the high-duty-cycle mode of operation of RLA will allow extension of the angular distribution measurements into the higher momentum transfer region. The possible presence of fixed poles (i.e., amplitudes with energy dependence unrelated to t) in photoproduction and Compton scattering is of great interest. The light-cone and parton models predict fixed-pole behavior in the Compton amplitude but not in photoproduction of any hadron which is composite. For such

investigations one requires both more accurate low-energy data for the evaluation of sum rules and higher energy data to establish the asymptotic behavior. For large angles, parton models predict that the Compton amplitude is energy independent and has form-factor-like dependence on t. No such behavior is expected for large-angle ρ photoproduction. All of these tests are in the natural province of the high-duty-cycle RLA.

(5) Primakoff effect. The cross sections for this process grow with the fourth power of the photon energy. [The Primakoff peak, integrated over the small t range, grows like $\ell n(s)$.] This situation, coupled with the fact that the polarized photon asymmetry for this process is nearly unity, will allow studies to be conducted at RLA.

(6) $q^2 = 0$ point. Measurements of any particular channel in photoproduction are important as a $q^2 = 0$ point for comparison with the electroproduction data for the same channel.

(7) Large-angle photon processes. Photoproduction at large angles can be an important probe of hadron structure at short distances. Parton models predict that the cross section at fixed energy and fixed but large center-of-mass production angle has the form $d\sigma/dt = s^{-N} f(\Theta_{cm})$, that is, a universal angular dependence independent of energy. The s-dependence can be related to the power-law fall-off of the form factors of the target proton and produced hadron. If the parton models are valid, then these large-angle processes obey the impulse approximation and involve a basic interaction at short distances, and the photon can display its point-like scale-invariant coupling. Comparison with large-angle electroproduction will also be of great interest. Since the cross sections for these basic processes fall so rapidly with energy, it is clear that the high-intensity RLA beams are essential.

Very inelastic scattering of real photons will also shed important new light on the constituent structure of both protons and photons. The inelastic photoproduction of hadrons at large transverse momentum is interesting as a test of the short-distance structure of the photon and the produced hadron. In certain parton models, the photon is predicted to behave in a completely point-like fashion, and new types of scaling laws arise. Such processes are also sensitive to the existence of "hard" parton-parton or gluon forces.

The very inelastic Compton effect, $\gamma + p \rightarrow \gamma + X$, at very large transverse momentum transfer may be observable, and its behavior can extend the ideas of the parton model to very virtual parton states in the proton. This will cast light on the validity of the model in this new application. It is predicted to be a large and measurable process at high energies.

(8) Mu-pair experiments. Mu-pair processes are of great interest in different kinematic regions: (a) low-mass muon pairs give information similar to inelastic Compton scattering, (b) experiments in which one energetic muon goes forward are an excellent vehicle for testing electrodynamics involving highly off-shell leptons, and (c) muon-pair experiments can be described as time-like lepton scattering processes similar to the Brookhaven (Lederman) experiments on the production of muon pairs from hadrons.

3. Hadron physics

RLA will also be a copious and effective source of secondary hadron beams, as previously demonstrated in Table 2. These yields are for secondaries in the range 10-40 GeV/c. While the improved duty cycle will allow some experiments with pions which cannot presently be done, the greatest interest will lie in the 25-40 GeV/c region. In this interval the duty cycle and intrinsic rf bunching of the primary electron beam are quite well suited to the use of rf separators for charged beams. Also, the variety of experiments will be extended over the present situation by the introduction of useful K^-, $\bar{p}$, and $\bar{n}$ beams. The neutral K_L^o and $\bar{n}$ beams at SLAC are exceptionally clean compared to those at proton accelerators since electroproduction is relatively free of neutron backgrounds. Reasonable momentum measurements of these neutrals can be made up to momenta of ~ 7 GeV/c by time-of-flight methods based on the intrinsically short rf bunches (10^{-11} sec) in the SLAC pulse.

The momentum interval 25-40 GeV/c is particularly important since it lies beyond the reach of the CERN-PS and the BNL-AGS proton synchrotrons. While the yields cited in Table 2 are lower than those expected at NAL (by a factor of 10-100 for 5×10^{12} protons/sec), the thrust of the NAL effort will rightly be focused on the higher energy phenomena. Furthermore, for reasonable cross sections the fluxes often exceed the capacity of data-handling systems. Recently considerable effort has been made at SLAC to develop very high volume data-acquisition systems (LASS) and the necessary computing facilities for reducing these data. In this area SLAC will be a valuable complementary facility to NAL as it now serves in relation to Brookhaven and CERN.

The interest in hadron beams in the 25-40 GeV/c momentum range is that they will extend our present knowledge of the energy dependence of specific final states, aid in the isolation of diffractive from exchange processes, and facilitate the search for new diffractively produced resonances, for exotic exchanges, and for new heavy mesons. Current theoretical ideas of duality and factorization have predictions in this energy range which will be tested. Furthermore, large center-of-mass angle scattering in two-body and quasi-two-body processes is a measure using hadronic probes of the innermost structure of nucleons. Comparison of the large-angle scattering for various initial and final states as a function of energy provides a useful supplement to the structural information obtained with electromagnetic probes. Other hadron experiments are discussed earlier in this section and in the following description of bubble chamber physics.

As noted above, for processes with reasonable cross sections, wire-chamber spectrometers with huge event-rate capabilities and large acceptances for high-mass resonances can be used quite profitably at SLAC. The large aperture solenoidal spectrometer (LASS) presently being built at SLAC can be used at these higher energies without extensive modification. The conventional dipole portion of this device is capable of measuring fast, forward particles to $\leq 0.5\%$ in momentum, while the solenoidal part measures the angles of all charged particles to high precision and the momenta of particles >3 GeV/c to a percent or two. It has a large acceptance over the full kinematic range of variables and is ideally suited to the study of bosons produced at the upper vertex or baryon resonances produced at the lower vertex. It is most effective for final states which do not involve neutral particles, but used in conjunction with neutron detectors or shower counters, LASS will be an effective tool for other final states as well. Data can be collected at rates up to 100 events/sec.

There are several experiments of an extended nature which require long running times but are nevertheless important. From past experience at proton machines, not many of these are completed per year, and SLAC-RLA could make significant contributions in this field. Examples are: polarization parameters in πp and Kp elastic scattering; detailed examination of multi-neutral final states; and low-cross-section states in πp and Kp interactions in the 5-10 GeV region. Examples of the latter that LASS could measure are backward processes, exotic exchanges, and large t processes. The good duty cycle will allow $\sim 2 \times 10^5$ π/sec intensities to be used so that backward

$\pi p \rightarrow px$ processes which have 1 μb cross sections would yield 2500 events/hour/GeV^2, while large-t events in the same process having cross sections between 0.01 - 0.1 μb would still give 25-250 events/hour/GeV^2.

4. Bubble chamber physics

The high repetition rate of SLAC, its characteristically short pulses, and the availability of pulse-to-pulse beam switching have led to the development of a very productive bubble chamber program at SLAC in both the conventional and hybrid modes. In conventional usage, there have been a great many high statistics experiments, mostly in hadron physics but with a significant series of investigations in photoproduction as well.

In hybrid usage, there have been a number of unique applications developed at SLAC which have broadened the scope of the bubble chamber technique. Hybrid techniques of this sort at the RLA energies will not, for practical purposes, be attainable at other laboratories. In particular these are:

(1) Time-of-flight measurments of the momentum of neutral kaons, neutrons, and anti-neutrons by counters surrounding the chamber. (As mentioned above, these measurements rely on the rf bunching of the electron beam which is unique to SLAC.)

(2) Fast cycling (10-20 pps) of the large hydrogen chambers; the lights are flashed only when a very fast forward particle is observed and its momentum is measured by spark chambers placed behind the bubble chamber. (This and the following application both exploit the high repetition rate of SLAC.)

(3) Rapid-cycling chambers of target size (45-90 pulses per second and 30-60 cm long) with thin beam windows all around. When the lights are triggered by counter-spark chamber arrays, the chamber becomes a visible hydrogen or deuterium target.

Since the chamber has 4π geometry, many biases can be turned off for part of the experiment by running in an untriggered mode. A second feature, peculiar to SLAC, is that when the proposed system operates at 25-40 GeV/c in a hybrid mode, the number of beam particles per pulse acceptable to the bubble chamber (15-20) exceeds the number acceptable to a spark chamber (5-10); thus the bubble chamber as a target is more than matched to its counter-spark-chamber subsystems. As would be expected, most of the benefits to bubble chamber physics from this proposal will accrue at the higher energies.

Keeping these points in mind, one can foresee a large class of experiments in the 25-40 GeV range that can be done at SLAC in a highly competitive and perhaps unique manner. Among these are:

(1) Studies of energy dependence and differential cross sections for highly peripheral quasi-two-body reactions involving backward nucleon resonances. These are excellent experiments for the fast-cycling chambers; one such experiment has already been completed at 14 GeV using the SLAC 40-inch chamber.

(2) Studies similar to (1) except where the final state involves a backward hyperon resonance. These are particularly suited to the rapid cycling target chamber because of the short lifetime involved.

(3) Studies of nucleon-antinucleon resonances such as $R^{+} \rightarrow \bar{n}p$ by triggering on a fast forward $\bar{n}$ in a reaction $\pi^{+}p \rightarrow \bar{n}pp$.

(4) Studies of antilambda-proton elastic scattering by triggering on fast forward protons in $K^{+}X \rightarrow \bar{\Lambda}X'p$ and observing the $\bar{\Lambda}p$ scattering in the chamber.

(5) Studies of exotic exchanges by triggering on fast forward nucleons and looking in the chamber at backward-produced mesons. These studies would be especially effective for backward going K^{0}'s.

Conventional use of a 2-3 meter chamber (with good optics and high resolution) with its small demand (1-2%) on machine intensity, would also be useful for studies of high mass resonances and multiple-particle final states. Neon-hydrogen mixtures will extend these to states with several neutral π's. A chamber of this size with a field of 25-30 kG is quite capable of the resolution needed.

5. Streamer chamber physics

The SLAC streamer chamber has been used in a wide variety of experiments including photon, muon and meson beams. It has several advantages over the bubble chambers: it can be triggered more rapidly, auxiliary detectors can be easily installed around the chamber, and it can be triggered in a wide variety of conditions. In short, it is a very flexible tool for studying many classes of events whose usefulness will increase significantly with RLA.

The data-taking rates for the streamer chamber are generally limited by background because of the relatively long time constant of the chamber compared with the time width of the beam pulse. Lowering the beam intensity will reduce the instantaneous background rates, while increasing the number of pulses will provide higher data-taking rates. Low-energy high-duty-cycle experiments of the following type are possible with RLA:

(1) Interactions from a tagged photon beam or monocrystalline beam. Standard types of experiments will provide 10 to 30 times as much data as presently available from track chambers. Using very selective triggers RLA will provide about 100 times as many "special" events per microbarn as currently obtainable.

(2) The observation of hadron interactions is limited by the background of delta rays unless the target region is outside the chamber. RLA will provide about 50 times improvement in data rates for pion scattering.

(3) Radiative effects and corrections now limit inelastic electron scattering to a kinematic region (q^2, ν) smaller than that possible with muon beams. With the improved duty cycle, rates with electron beams 10-30 times greater than present SLAC muon-beam rates are possible.

The streamer chamber is not limited to low-energy experiments. External wire chambers can be installed around the basic equipment to increase the accuracy of the streamer chamber for high-momentum particles. Typical examples of this are high-energy photoproduction experiments with 10 times the statistics currently available; 30 to 40 GeV/c meson beams; and electron scattering yielding about 30,000 events at small angles but with large energy loss.

6. K^o decay physics

The present advantages of SLAC for K^o physics are the relative absence of neutron background (K^o/n ratio > 1 above 1 GeV) and time-of-flight information (accuracy ± 1/3 nsec, giving useful momentum information up to about 6 or 7 GeV). The present disadvantage is the poor duty cycle, which results in a K^o flux limitation that is considerably below the capability of the machine.

It thus appears that the high-duty-cycle mode of RLA will offer the main advantages for K^o physics. At present, because of the number of sparks in the wire chambers, the flux of K^o's available from the SLAC accelerator is limited to a primary electron current of 3 or 4 milliamps. Even at this low current, the secondary beam has to be attenuated by about 4-5 interaction lengths. (It is preferable for reasons of accelerator operation and K^o/neutron ratio to run relatively high current with a large attenuator rather than low accelerator current and a small attenuator.) With the improved RLA duty cycle, a factor of 6-8 in K^o flux could be obtained by removing some absorber. Another factor of 3 could be obtained by increasing the electron current. Conceivably, another factor of 1.5 to 2 could be obtained by reducing the production angle from the present 3^o to 1.5 or 2^o. Thus the K^o flux could be increased by a factor of about 30. Since the duty cycle would increase by a factor of ≈ 120, the background spark problem would also be considerably reduced. These factors lead to an expected flux of about 5×10^7 accepted K^o decays/day for experiments which use the existing K^o spectrometer with the RLA accelerator running at 180 pps. This flux level, combined with a very large acceptance detection system, would enable one to reach meaningful levels for rare K^o decay modes.

C. Sample Data Rates Using Present SLAC Equipment with RLA

1. Single-arm spectrometers

With some modifications, the three single-arm spectrometers now used at SLAC can achieve the counting rates previously shown in Fig. 2 for inelastic e-p scattering. These spectrometers can remain in their present location in End Station A.

2. Electroproduction apparatus

A relatively simple apparatus using a superconducting flux-exclusion beam pipe, a large analyzing magnet, proportional chambers, hodoscopes and shower counters has been used to measure ρ^o electroproduction and single π inclusive processes at SLAC. A comparison of this experiment with the results that could be expected with RLA is shown below:

	SLAC Experiment	RLA Experiment
Running Time (hours)	200	200
Total No. of Electrons	1.3×10^{14}	1.4×10^{16}
Inclusive Events	200,000	200,000
$q^2 (GeV/c)^2$	0 - 6.0	3.0 - 12.0
$P_\perp^2 (GeV/c)^2$	0 - 1.0	0 - <1.0
Rho Production	3000	10,000
q^2	0 - 4.0	1.5 - 5.0

3. Large-angle solenoid spectrometer (LASS)

This apparatus, now under construction, is described in Report No. SLAC-152. It can be used with either the high-duty-cycle or high-energy mode of RLA and in electron, photon or hadron beams. The following are some counting rates that may be obtained:

(1) Inelastic electron scattering. Assuming 3.6×10^6 e^-/sec (superconducting tube and a one-meter LH_2 target) for the high-energy mode, and 2×10^8 e^-/sec for the low-energy, high-duty-cycle mode, then the rates shown in Table 3 should be achievable.

(2) Photoproduction. Assuming a one-meter LH_2 target and 3.6×10^5 quanta/sec for the high energy mode, and 3.6×10^7 quanta/sec for the low-energy high-duty-cycle mode of RLA, then the following rates should be achievable:

20 GeV (good duty cycle)	100 events/sec/μb
40 GeV (poor duty cycle)	1 event/sec/μb

Since photoproduction total cross sections vary from about 10 μb (ρ^0 production) to ~.01 μb (single inelastic channel at 40 GeV) these rates are quite acceptable.

(3) Hadron interactions. Assuming a one-meter LH_2 target and the fluxes shown below, then the following rates should be achievable:

	π	Event Rate	K	Event Rate
20 GeV (good duty cycle)	2×10^5/sec	1000/sec/mb	2×10^3/sec	10/sec/mb
40 GeV (poor duty cycle)	10^3/sec	5/sec/mb	10^3/sec	5/sec/mb

The data-gathering capacity of LASS should be in the 50 - 100/sec range. For π beams at good duty cycle rates, cross sections as low as a fraction of a microbarn can be investigated.

4. Streamer chamber

The large streamer chamber now in regular operation at SLAC will benefit from the good duty cycle because its dead time of several microseconds (now just about matched to the pulse length of the linear accelerator) is short enough to take full advantage of the factor of ~100 improvement. Thus all present experiments can be run at data rates ~100 times larger. Typical rates expected with streamer chamber experiments at RLA are shown below.

TABLE 3

Inelastic Electron Scattering

Counting rates per hour* for various cuts in q^2, W variables using the LASS wire-chamber spectrometer.

E_e = 20 GeV (good duty cycle)

W ≥	2 GeV	3 GeV	4 GeV
$q^2 > 0.5\ GeV^2$	390 K	230 K	110 K
$q^2 > 1.0\ GeV^2$	160 K	100 K	50 K
$q^2 > 1.5\ GeV^2$	85 K	55 K	30 K
$q^2 > 2.0\ GeV^2$	40 K	35 K	15 K
$q^2 > 2.5\ GeV^2$	30 K	25 K	12 K
$q^2 > 3.0\ GeV^2$	20 K	15 K	10 K
$q^2 > 4.0\ GeV^2$	10 K	10 K	5 K

E_e = 40 GeV (poor duty cycle)

$q^2 > 0.5\ GeV^2$	6 K	4.5 K	3.0 K
$q^2 > 1.0\ GeV^2$	3 K	2.2 K	1.5 K
$q^2 > 1.5\ GeV^2$	1.5 K	1.3 K	900
$q^2 > 2.0\ GeV^2$	1.0 K	900	600
$q^2 > 2.5\ GeV^2$	700	600	400
$q^2 > 3.0\ GeV^2$	500	400	300
$q^2 > 4.0\ GeV^2$	200	300	200

*Counting rates are limited by acceptable background rates, not by the current available.

(1) Hadron interactions. Assuming a 40 cm LH_2 target and the fluxes shown below, the following rates should be achievable:

	π Flux	Event Rate	K Flux	Event Rate
20 GeV (good duty cycle)	3.5×10^5/sec	500/sec/mb	10^4/sec	17/sec/mb
40 GeV (poor duty cycle)	3.5×10^3/sec	5/sec/mb	10^2/sec	0.17/sec/mb

(2) Photoproduction. The memory time of the streamer chamber is ~1.5 μsec. Assuming 15 e.q./1.5 μsec derived from a straight bremsstrahlung beam incident on a 40 cm LH_2 target, the following rates should be achievable:

	γ Flux	Event Rate
20 GeV (good duty cycle)	10^6 e.q./sec	100/sec/μb
40 GeV (poor duty cycle)	10^4 e.q./sec	1/sec/μb

With a tagged γ beam, these rates would be decreased by a factor of ~10.

5. Bubble chambers

SLAC now has a 40-inch and a 15-inch bubble chamber, both capable of having their lights triggered by auxiliary electronic systems. The 40-inch has a potential of 20 expansions/sec, and the 15-inch should go ~60/sec. Both have already operated successfully at half these rates. The chambers will not be able to take advantage of the high-duty-cycle mode of RLA, so the rates shown below are for the high-energy mode of RLA operation.

Using a downstream spectrometer for the momentum measurement of fast tracks, the effective length of the 40-inch chamber becomes 36 inches, while that of the 15-inch chamber is 9 inches. Assuming 15 particles/pulse into the chambers the following rates should be obtainable in the high-energy mode:

Chamber	Flux ($\pi^{\pm}$, $K^{\pm}$, $\bar{p}$, p)	Event Rate
40" (15 exp/sec)	300/sec	0.3/sec/mb
15" (60/sec)	1200/sec	0.3/sec/mb

Note: the 40-inch chamber has a thin exit window only at the downstream side, while the 15-inch chamber has a 360-degree thin beam window.

6. K^o spectrometer

A spectrometer which measures K^o decays in a K^o_L beam has been in operation at SLAC for some time. With RLA, an increase of the presently available flux by a factor of about 30 could be expected. With this enhanced flux (10^{10} K^o_L's per day into the spectrometer), and assuming a detection efficiency of 20%, one would observe a total of 10^7 decays/day. The rates for particular channels of interest are as follows:

$K^o_L \rightarrow 2\pi^o$: 5×10^4/day

$K^o_L \rightarrow$ 4 body: 5×10^3/day (assuming a branching ratio of 10^{-4})

$K^o \rightarrow 2\mu$: 0.3/day (assuming the unitarity value)

Thus the existing K^o spectrometer would be a very effective tool for use with RLA.

7. Improvements in Rates

All the numbers given above pertain to presently existing equipment with little or no modification. Gradual improvements and changes could readily increase these numbers. Eventually some new equipment, such as a 2 - 3 meter fast-cycling bubble chamber, or a new and larger streamer chamber, could improve some of the rates by an order of magnitude, especially at the higher energies.

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DEPARTMENT OF PHYSICS

July 19, 1973

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Gentlemen:

Enclosed is a draft of the report. It includes modifications and additions from all of us. Your revisions arrived simultaneously Wednesday morning, July 18. A few of your revisions were antithetical in nature. I have incorporated them as best as I could. I do not believe the center of gravity of critical opinion is at all shifted, but rather the report evaluations have been sharpened and clarified.

It is not practical to discuss each point in this letter. One important addition proffered by Dick for the conclusion section involved a policy judgement concerning the distribution of monies between E <30 GeV and E >30 GeV. Although I am personally in substantive agreement, I have omitted it, because I believe that it is more properly the purview of the entire HEPAP panel.

We have agreed that our charge is a narrow one -- a physics evaluation under understandably difficult time pressure.

If we are to be of service, our report must be finalized as quickly as possible. I spoke to Bill Wallenmeyer Monday and Tuesday. He intimated that John Teem may already have made a tentative decision. He further intimated that the issue may not be RLA versus some other longer range HEP project, but rather RLA versus a heavy ion machine. Obviously, these factors should not color our hopefully objective appraisals.

Ordinarily, propriety would dictate that we exchange another round of drafts, or better -- meet again (ugh!). I have taken the liberty of forwarding copies to Wallenmeyer and Weisskopf, clearly indicated to be unofficial and unapproved. It is appropriate that they, as HEPAP people, be kept informed. I look forward to hearing from you by telephone concerning your response to this draft.

If you can find it in your hearts to approve this draft in substance, I would then immediately call Wallenmeyer and remove the strictures placed on it. The report will exist in Washington at the same time you receive your copies. Perhaps this is a bit too melodramatic in view of the 2 or 3 days' delay that I am attempting to circumvent. Another possibility is that you approve the report with reservations, reserving your God given right to communicate dissenting additions or disclaimers. In my view, this would considerably reduce the impact of our considerations. I await your reaction and proposals.

In what may be regarded as a bald faced attempt to butter you up, may I say that I have enjoyed serving on this committee with you (so far) and that I feel I have learned something from our exchanges.

Sincerely,

Jerry Rosen

Jerome Rosen
Professor of Physics
Northwestern University

Enclosure

cc: Dr. Richter
Dr.Wilson
Dr. William Wallenmeyer
Prof. Victor Weisskopf

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

12/26/72 19

Memo to Prof. Weisskopf Room Ext.

Viki:

"Another AEC Report" - for your information.

FJE

from Room Ext.

MURAN BOSTON

Laboratory for Nuclear Science
University Mass. Inst. of Technology

Date December 22, 1972

AEC HIGH ENERGY PHYSICS MANPOWER

	FY 1971 (Actual)			FY 1972 (Actual)			FY 1973 (Estimates)		
1) Ph.D. or Equivalent	Heads	MY(U)	MY(C)	Heads	MY(U)	MY(C)	Heads	MY(U)	MY(C)
Experimental	(32)	(4.3)	(16.7)	(35)	(5.0)	(14.5)	(33)	(2.7)	(17.0)
Theoretical	(26)	(1.2)	(5.5)	(24)	(1.3)	(5.5)	(27)	(1.3)	(6.4)
Other	(1)	(--)	(.2)	(1)	(--)	(.1)	(--)	(--)	(--)
Total Ph.D.	59	5.5	22.4	60	6.3	20.1	60	4.0	23.4
2) Other Professional	43	--	33.9	40	--	29.7	40	--	27.1
3) All Other Direct	116	4.9	80.1	100	3.3	59.9	93	--	51.8
4) Indirect	--	--	--	--			--	--	--
5) Graduate Students									
Experimental	(34)	(1.0)	(8.8)	(23)	( )	(7.7)	(21)	(--)	(6.7)
Theoretical	(18)	(--)	(2.5)	(18)	( )	(1.8)	(13)	(--)	(1.3)
Total G.S.	52	1.0	11.3	41	--	9.5	34	--	8.0
6) Total Staff (Sum 1 thru 5)	270	11.4	147.7	241	--	119.2	227	4.0	110.3
7) Guests/Visitors[e]	11			8			8		

a. MY(U) = Man-years involved in the research associated with the contract supported by the University or from other funds.

b. MY(C) = Man-years supported directly by AEC contract funds.

c. If Fiscal Year (FY) is not appropriate to your contract, use Calendar Year or Contract Year and specify corresponding dates.

d. Heads are defined as the number of personnel associated with the total research at the end of the appropriate year interval above.

e. Unpaid participants usually at the PhD level, supported by funds from home institutions, fellowships, etc. There is no meaningful way of measuring impact in terms of man years.

national accelerator laboratory

December 8, 1972

NAL USERS

Dear Colleagues:

My last progress report to you was in February. Since then we reached our design energy of 200 GeV in March and then attained 300 GeV in July. Nearly all of the running for experiments has been at 200 GeV, but we do expect to try to start regular operation at 300 GeV within a few weeks, Commonwealth Edison willing. The main-ring magnet has been ramped without beam to the 400 GeV level; we hope to make occasional forays to that energy in the coming months.

Having now seen 10^{12} protons/pulse, we are beginning to approach the so-called "reduced scope" intensity, which was the original basis for our funding. However, you will remember that somewhat gratuitously, we designed into the accelerator, not only the capability to go to energies higher than 200 GeV, but also to reach an intensity of 5×10^{13} protons per pulse. It is to attain that intensity that we are now giving our greatest effort.

Magnet failures, which once caused us considerable pain, have become less serious. We still lose a magnet from time to time, but since last summer those losses have resulted in total down times of less than one shift per week. Furthermore, the failures are confined to the magnets which were assembled using our earliest procedures. As those magnets are replaced, the time lost should diminish further.

To reach 5×10^{13} protons per pulse, each of the components must come up to its design specification. Let me indicate typical operation of various components at this time. The linac has been giving about 50 mA compared to its design intensity of 70 mA. It has given on occasion more than 100 mA; thus there is a potential factor of two increase in intensity to be gained by tuning up the linac. We can now inject multiple turns into the booster accelerator: our design calls for four turns; two turns is now typical, so another factor of two might be obtained here. After injection, only about one-third of the beam is captured by the r.f. and then accelerated to 8 GeV; a possible factor of three improvement is indicated in this respect.

The difficult problems of synchronizing the radio frequency of the booster to that of the main ring, of having the momentum match perfectly, and then of timing the transfer of the beam from the booster to the main ring so that successive pulses fit head-to-tail, have largely been solved. Seven successive pulses out of a possible thirteen were being injected to attain the 10^{12} protons per pulse beam, so another factor of nearly two should be obtained as we learn how to inject more booster pulses during each cycle of the main ring. Typically there is a loss of a factor of two in getting the beam from the booster and accelerating it to full energy in the main ring.

All of the above conditions, of course, are highly variable from one day to the next. However, multiplying out the various factors cited gives an overall factor of 48, representing a readily identifiable potential for improvement. This is very nearly just the factor needed to raise our 10^{12} to 5×10^{13} protons/pulse.

We see then that all of the component systems are working within a factor of two or three of their design values, so that attaining 5×10^{13} protons/pulse is largely a matter of improving in turn each of these systems - which is what we are doing.

Resonance extraction, using one-half integral resonance, has become a regular thing during the past few months. The present extraction efficiency is about 80 percent with a spill time of a quarter of a second. The r.f. can be turned off on the flat top so that the r.f. structure of the beam can be smoothed out if desired. Improving the extraction efficiency is a matter of major importance in reaching higher beam intensities. There are a number of obvious things yet to be done, such as more accurately lining up the extraction elements.

Let me turn to the present state of the experimental facilities. Our design report indicated that one external beam line leading to one experimental area would be ready by July 1972, with the major part of the experimental facilities not coming on until January 1974. We decided to push forward this construction, and in fact protons have by now been delivered to all of the experimental areas.

The internal target area in straight section C-0 has been in use since the first high energy beam was obtained last February. A USSR-USA collaboration (#36) to measure elastic p-p scattering at small angles is nearly finished and has produced interesting results. Our Russian colleagues constructed a hydrogen gas-jet target in the USSR, brought it over with them, and it has been in operation in the tunnel for the past few months. Three other experiments have produced results using either this gas target or a rotating foil target: Experiments #63 and #120, observing gamma rays, and experiment #67 in which the experimenters are looking for baryon resonances by observing the recoiling proton from inclusive reactions. As these experiments near completion, we have three other approved experiments preparing to go into the same area.

The most extensive running with an external beam of protons has been in the Neutrino Area. This area has been designed for protons of energy up to 500 GeV. It is about one mile long, the bubble chamber at the end of it being some 1.5 miles beyond the point of beam extraction. Although a big bubble chamber was not included as part of our construction project (the Congress had previously added and then subtracted about $25 million for that), we decided that a 15' hydrogen bubble chamber would be an important instrument for research on neutrino interactions, and we found a way to finance the conventional costs of the 15 foot bubble chamber facility out of the $250 million authorization. The superconducting magnet for the 15-foot chamber, built in collaboration with Argonne, is in place and has given 30 KGauss; we are hoping to begin initial testing of the chamber early next year.

Meanwhile, the 30" Argonne bubble chamber has been in operation since July. A separate beam of hadrons is split off at the neutrino target, about one mile upstream, and can be led either to the 15' chamber or to the 30" chamber which is in a nearby building. Last summer we were able to make p-p bombardments in the 30" chamber at 100, 200 and 300 GeV, with between 10,000 and 30,000 pictures taken at each proton energy. At that time, we had to direct the full accelerated beam toward the bubble chamber and to attenuate it severely in order to get no more than the desired half dozen protons per pulse in the 30" chamber. Rather than continuing in this mode, using our accelerated protons very inefficiently, we decided to delay further running of the 30" chamber until a pulsed by-pass magnet could be installed that would take a small bite out of the main proton beam - allowing the remainder to go to the Neutrino target. That pulsed by-pass is now operative and bubble chamber operation has been resumed. The Argonne-NAL (#141) p-p bombardment at 200 GeV has received its 50,000 pictures, and a Michigan-Rochester run (#138A) at 100 GeV is well on its way. There are six more exploratory runs, of some 50,000 pictures each, that are yet to be finished. The hybrid system, experiment #2B, involving the 30" chamber and wide-gap spark chambers, is in initial operation, as is some of the equipment of experiment 154 to tag the particles entering the bubble chamber.

Most of the running so far in the Neutrino Area has been upstream from the bubble chambers in a location where a muon beam is being commissioned for a scattering experiment #26. They have been able to observe several hundred scattering events so far with momentum transfers up to 14 $(GeV/c)^2$ and energy losses up to 80 GeV. The Muon Laboratory building at the end of the muon beam is being enlarged so that two muon-interaction experiments, #26 and #98, can both be in place compatibly. The old Chicago cyclotron magnet, a major element of experiment #98, is now installed in the Muon Laboratory and that group is eager to initiate their experiment.

The neutrino counter experiment #21 shares the same target with Muon #26. Their experiment is located in a "Wonder" building adjacent to the Muon Lab. It gave us all a tremendous boost, recently, when they observed in their apparatus their first muons by neutrinos with an energy of about 35 GeV.

Experiment #1, designed to study neutrino interactions using a broad beam, is located in a building immediately behind the 30" bubble chamber. It is in place and is warming up on the dichromatic beam being used by Experiment #21.

Experiment #14, located in the Neutrino Target Hall, has made some initial studies of inelastic p-p interactions. The physicists of Experiment #95, (gamma and di-gamma production) have been making preliminary measurements to see if they could also work in a parasitic mode in the Neutrino Target Hall.

In September, when protons first to the Meson Area were brought, some nine different groups, mostly from abroad, managed to complete the exposure of some 45 stacks of photographic plates under various conditions. The good-natured collaboration of those concerned made it possible to make all of the exposures in one night and provided for us a heart-warming initiation of research in the Meson Area. Working conditions in that area are still primitive. The main building is as yet unfinished. None-theless, three of the secondary beams are being tuned. Experiment #72, a quark search, is being set up, as is experiment #4 to study neutron scattering. Although designed initially for only 200 GeV, it appears that with only a little difficulty we will be able to harden the Meson Area so as to target 300 GeV protons regularly.

Protons have also been brought into the new Proton Area. Experiment #70 for the exploration of large-angle electron production has been set up for its initial phase in the central beam of the Proton Area. In the East Beam of the Proton Area, Experiment #100, designed to study events at large momentum transfers, is also being assembled and should receive protons before long. The construction of the Proton Area is far from complete. It too is a thoroughly uncomfortable place to work at this stage.

We have recently succeeded in establishing a capability to alternate beam pulses between the various experimental areas, i.e., several pulses to one area, then a sequence of pulses to another area. Some time after the first of the year, we hope to have a "beam splitter" in use so that the Proton Area and the Neutrino Area can share the beam during a single pulse.

Let me say a word about future plans. Although we have now provided for the completion of construction of a facility which should achieve or surpass the scope of the project specified in our Design Report with regard to energy, intensity, and experimental facilities, we have not used all of the construction funds, $250 million, that were authorized for this project. There are still unknowns, and to reach the full intensity and reliability may require all of the remaining funds. We don't know yet, but it appears just possible that some $30 million may be left to improve the facility still further. In my testimony before the Congressional Joint Committee on Atomic Energy, I stated that my interpretation of the Congressional authorization is that it constitutes a challenge to us to provide the highest energy and the most experimental facilities that we can within the $250 million limitation.

One possibility, and a remote one, which I described to them on two successive appearances, is to construct a superconducting magnet ring and install it in the present main-ring tunnel - the so-called energy doubler. It might allow us to save millions of dollars each year on our power bill (operating funds) in the present range of operating energies; it might also enable us to reach 1000 GeV; it could also provide one possible avenue toward a colliding beam facility.

Although the JCAE had asked me to submit a feasibility report to them last spring, I demurred at that time because every person at NAL was required to help bring our accelerator into operation. Indeed I barred any activity in the Laboratory relating to the energy doubler until this past September. Since then a few people have been meeting informally to discuss the feasibility of this rather wild idea.

Right now it makes little sense to say that such a device could be made for less than $50 million. On the other hand, my colleagues here have had a number of very good ideas (one is that our present rather flexible power supply could, without change, be used to power both rings). A few more good ideas plus a miracle or two, e.g., inheriting some cryogenic equipment free, might just bring us within shooting range of being able to realize such a device.

We are starting to build a few short prototype sections of the magnet - maybe one meter in length - and if we can do that successfully, we would then install a 200 foot length of magnet in the old prototype tunnel that is located here in the Village. The development will go one step at a time and should not require a large investment until and unless a several hundred-foot length of prototype magnet has been installed and tested in the main-ring tunnel without interference with the regular operation of the proton synchrotron. The probability of reaching that stage is obviously not high. You can be sure that each step will be discussed in considerable detail before we make final recommendation on the energy doubler to the proper authorities. As a warmup, we have decided to see if we can also construct a number of large-aperture superconducting magnets of similar design to those of the energy doubler in order to improve the intensity of some of our present secondary beam lines - a much less difficult exercise.

Concerning projects for the future that will require new construction funds, we are planning to arrange a summer study at Aspen, Colorado. You will soon receive another letter from me about that.

Our staff size is very close to that anticipated in the Design Report for this date, but not for our advanced stage of operation. It has been obvious for some time that we are seriously undermanned. The accomplishments of my able colleagues have been made at a dear cost to them in sweat and tears - if not blood. We have been adding to our staff and will continue to add to it until we reach the number necessary to operate efficiently - but this will significantly increase operating costs.

This leads to my last point. We are now operating a full-fledged laboratory at energies above 200 GeV. The experiments, as anticipated, tend to be considerably larger and more complicated than those made a lower energies - almost in proportion to the energy. Yet we are doing this with a small operating budget. Unless we can get adequate operating and equipment funds - our projection for this time of the project was for twice as much as we are now getting - the confusion and the frustration and the fatigue that have characterized much of our operation will continue. We need your understanding and we need your support.

Sincerely,

Bob Wilson

R. R. Wilson

New NAL phone numbers:

Main number:	312-840-3000
Directors Office:	312-840-3211
Users Office:	312-840-3291

UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

December 22, 1972

TO : HIGH ENERGY PHYSICS ADVISORY PANEL MEMBERS

B. C. Barish	B. Richter
D. B. Cline	J. L. Rosen
J. W. Cronin	J. R. Sanford
T. H. Fields	G. F. Tape
L. J. Laslett	V. F. Weisskopf, Chairman
F. E. Low	W. A. Wenzel
R. R. Rau	

FROM : Walter D. Wales, Executive Secretary WDW

SUBJECT: MEETING IN GERMANTOWN, MARYLAND, JANUARY 3-4, 1973

It now appears unlikely that I will be able to assemble enough details to permit me to send you a complete agenda in time to guarantee that you will receive it prior to leaving for this meeting. Accordingly, I am writing to summarize the basic arrangements so that you can make appropriate travel plans.

(1) The meeting will be held in Room E-401 at the AEC Headquarters in Germantown. Please enter the building through the South Entrance.

(2) Since the meeting will begin at 9:00 AM on Wednesday, most of you will find it convenient to arrive in the Washington area on Tuesday evening. We have reserved single rooms for all out-of-town members at the Holiday Inn, 2 Montgomery Village Avenue, Gaithersburg, Maryland (301-948-8900), for the evenings of January 2 and 3, 1973.

Most of you will probably find it convenient to get a rental car at the airport and drive to Gaithersburg. However, we will be able to provide some limited assistance if this is not satisfactory. Please call Mrs. Elizabeth R. Burdette (301-973-3367) if you wish assistance with your travel or lodging plans.

(3) The Abashian's have invited HEPAP members and their wives to their home for a buffet dinner on Wednesday evening. We will provide directions during the meeting on Wednesday.

(4) The meeting is scheduled to end by 4:00 PM on Thursday, January 4, 1973. This should permit members to make connections to convenient evening flights.

(5) Please call me if you encounter any serious difficulties in getting here.

Office: 301-973-3368

Home : 301-869-7648

Best wishes for a Merry Christmas and a Happy New Year.

UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

December 15, 1972

TO : HIGH ENERGY PHYSICS ADVISORY PANEL MEMBERS

B. C. Barish	B. Richter
D. B. Cline	J. L. Rosen
J. W. Cronin	J. R. Sanford
T. H. Fields	G. F. Tape
L. J. Laslett	V. F. Weisskopf, Chairman
F. E. Low	W. A. Wenzel
R. R. Rau	

FROM : Walter D. Wales, Executive Secretary WDW

SUBJECT: NEXT HEPAP MEETING - AEC, GERMANTOWN - JANUARY 3 & 4, 1973

The next meeting will be held in Room E-401 at the AEC Headquarters in Germantown, Maryland, on January 3 and 4, 1973. Hotel reservations have been made for out-of-town members for the nights of January 2 and 3 at a closeby Holiday Inn. (Gaithersburg, Md.) Please inform Mrs. Elizabeth R. Burdette (301-973-3367) on any reservation changes. (See note for directions to Holiday Inn.)

I have enclosed for your information a section of the Congressional Record describing the Federal Advisory Committee Act, which becomes effective on January 5, 1973. The Act itself is on Pages 8454, 8455, and 8456. Section 10, which is probably most pertinent to our discussions, is on Page 8455. The remaining material describes the actions of the Conference Committee which resolved differences between the House and Senate versions of the Bill.

A very preliminary agenda for the meeting is outlined below. I expect to send a more explicit agenda to you before the meeting.

Wednesday, January 3, 1973

9:00 AM - Agency Presentations
This will include discussion of the JCAE Report, budgets, international cooperation, and other topics.

12:30 PM - LUNCH

1:30 - Discussion of Role of HEPAP
This discussion should review the role of HEPAP in advising the Division of Physical Research. We should also consider the implications of the Federal Advisory Committee Act.

<u>Wednesday, January 3, 1973</u> - cont.

3:30 - Review of NAL Status

5:00 - End of First Day Session

<u>Thursday, January 4, 1973</u>

9:00 AM - Discussion of Formation of Subpanels (For Future Facilities, Physics Overview)

10:00 - Status of CEA

10:30 - Review of HEP Priorities

12:30 PM - LUNCH

1:30 - General Discussion
This might include reactions to the report of the "Bromley" Panel, and long range plans for existing accelerators.

4:00 - End of Meeting

Note: The Holiday Inn is about 30 miles from Washington National Airport. It can be reached conveniently only by auto.

<u>Directions are as follows</u>:

Follow signs to <u>Washington</u> until you are out of Airport. You will find yourself on a dual highway. You will then follow signs for <u>Parkway</u> or <u>Dulles</u> for next 10 to 15 miles. Critical turns are from right lane. Parkway goes to <u>I-495</u>, where you will follow signs to <u>Maryland</u>. After several miles I-70S branches to <u>left</u> toward Frederick and Rockville. Follow <u>I-70S</u> to <u>Gaithersburg-Darnestown Exits</u>. Leave I-70S at Exit marked <u>Montgomery Village Avenue-Gaithersburg</u>. The Holiday Inn is on the <u>left</u> after the first light.

From Dulles Airport, follow signs to I-495, then take I-495 North to Maryland and then to I-70S as mentioned above.

To reach the AEC from the Holiday Inn, drive back down Montgomery Village Avenue to I-70S, taking the first ramp to the right toward Frederick. Take the second right turn (AEC-Germantown) in the next set of Exits on I-70S to reach the AEC building.

Members are registered at the South Lobby for admittance to the AEC. Please use the South Entrance.

If you need assistance, please call me: AEC - 301-973-3368
Home - 301-869-7648

Enclosure:
Congressional Record excerpt, 9/18/72

CONFERENCE REPORT (H. REPT. NO. 92-1403)

The committee of conference on the disagreeing votes of the two Houses on the amendment of the Senate to the bill (H.R. 4383) to authorize the establishment of a system governing the creation and operation of advisory committees in the executive branch of the Federal Government, and for other purposes, having met, after full and free conference, have agreed to recommend and do recommend to their respective Houses as follows:

That the House recede from its disagreement to the amendment of the Senate to the text of the bill and agree to the same with an amendment as follows: In lieu of the matter proposed to be inserted by the Senate amendment insert the following:

That this Act may be cited as the "Federal Advisory Committee Act".

FINDINGS AND PURPOSES

SEC. 2. (a) The Congress finds that there are numerous committees, boards, commissions, councils, and similar groups which have been established to advise officers and agencies in the executive branch of the Federal Government and that they are frequently a useful and beneficial means of furnishing expert advice, ideas, and diverse opinions to the Federal Government.

(b) The Congress further finds and declares that—

(1) the need for many existing advisory committees has not been adequately reviewed;

(2) new advisory committees should be established only when they are determined to be essential and their number should be kept to the minimum necessary;

(3) advisory committees should be terminated when they are no longer carrying out the purposes for which they were established;

(4) standards and uniform procedures should govern the establishment, operation, administration, and duration of advisory committees;

(5) the Congress and the public should be kept informed with respect to the number, purpose, membership, activities, and cost of advisory committees; and

(6) the function of advisory committees should be advisory only, and that all matters under their consideration should be determined, in accordance with law, by the official, agency, or officer involved.

DEFINITIONS

SEC. 3. For the purposes of this Act—

(1) The term "Director" means the Director of the Office of Management and Budget.

(2) The term "advisory committee" means any committee, board, commission, council, conference, panel, task force, or other similar group, or any subcommittee or other subgroup thereof (hereafter in this paragraph referred to as "committee"), which is—

(A) established by statute or reorganization plan, or

(B) established or utilized by the President, or

(C) established or utilized by one or more agencies, in the interest of obtaining advice or recommendations for the President or one or more agencies or officers of the Federal Government, except that such term excludes (i) the Advisory Commission on Intergovernmental Relations, (ii) the Commission on Government Procurement, and (iii) any committee which is composed wholly of full-time officers or employees of the Federal Government.

(3) The term "agency" has the same meaning as in section 551(1) of title 5, United States Code.

(4) The term "Presidential advisory committee" means an advisory committee which advises the President.

APPLICABILITY

SEC. 4. (a) The provisions of this Act or of any rule, order, or regulation promulgated under this Act shall apply to each advisory committee except to the extent that any Act of Congress establishing any such advisory committee specifically provides otherwise.

(b) Nothing in this Act shall be construed to apply to any advisory committee established or utilized by—

(1) the Central Intelligence Agency; or

(2) the Federal Reserve System.

(c) Nothing in this Act shall be construed to apply to any local civic group whose primary function is that of rendering a public service with respect to a Federal program, or any State or local committee, council, board, commission, or similar group established to advise or make recommendations to State or local officials or agencies.

RESPONSIBILITIES OF CONGRESSIONAL COMMITTEES

SEC. 5. (a) In the exercise of its legislative review function, each standing committee of the Senate and the House of Representatives shall make a continuing review of the activities of each advisory committee under its jurisdiction to determine whether such advisory committee should be abolished or merged with any other advisory committee, whether the responsibilities of such advisory committee should be revised, and whether such advisory committee performs a necessary function not already being performed. Each such standing committee shall take appropriate action to obtain the enactment of legislation necessary to carry out the purpose of this subsection.

(b) In considering legislation establishing, or authorizing the establishment of any advisory committee, each standing committee of the Senate and of the House of Representatives shall determine, and report such determination to the Senate or to the House of Representatives, as the case may be, whether the functions of the proposed advisory committee are being or could be performed by one or more agencies or by an advisory committee already in existence, or by enlarging the mandate of an existing advisory committee. Any such legislation shall—

(1) contain a clearly defined purpose for the advisory committee;

(2) require the membership of the advisory committee to be fairly balanced in terms of the points of view represented and the functions to be performed by the advisory committee;

(3) contain appropriate provisions to assure that the advice and recommendations of the advisory committee will not be inappropriately influenced by the appointing authority or by any special interest, but will instead be the result of the advisory committee's independent judgment;

(4) contain provisions dealing with authorization of appropriations, the date for submission of reports (if any), the duration of the advisory committee, and the publication of reports and other materials, to the extent that the standing committee determines the provisions of section 10 of this Act to be inadequate; and

(5) contain provisions which will assure that the advisory committee will have adequate staff (either supplied by an agency or employed by it), will be provided adequate quarters, and will have funds available to meet its other necessary expenses.

(c) To the extent they are applicable, the guidelines set out in subsection (b) of this section shall be followed by the President, agency heads, or other Federal officials in creating an advisory committee.

RESPONSIBILITIES OF THE PRESIDENT

SEC. 6. (a) The President may delegate responsibility for evaluating and taking action, where appropriate, with respect to all public recommendations made to him by Presidential advisory committees.

(b) Within one year after a Presidential advisory committee has submitted a public report to the President, the President or his delegate shall make a report to the Congress stating either his proposals for action or his reasons for inaction, with respect to the recommendations contained in the public report.

(c) The President shall, not later than March 31 of each calendar year (after the year in which this Act is enacted), make an annual report to the Congress on the activities, status, and changes in the composition of advisory committees in existence during the preceding calendar year. The report shall contain the name of every advisory committee, the date of and authority for its creation, its termination date or the date it is to make a report, its functions, a reference to the reports it has submitted, a statement of whether it is an ad hoc or continuing body, the dates of its meetings, the names and occupations of its current members, and the total estimated annual cost to the United States to fund, service, supply, and maintain such committee. Such report shall include a list of those advisory committees abolished by the President, and in the case of advisory committees established by statute, a list of those advisory committees which the President recommends be abolished together with his reasons therefor. The President shall exclude from this report any information which, in his judgment, should be withheld for reasons of national security, and he shall include in such report a statement that such information is excluded.

RESPONSIBILITIES OF THE DIRECTOR, OFFICE OF MANAGEMENT AND BUDGET

SEC. 7. (a) The Director shall establish and maintain within the Office of Management and Budget a Committee Management Secretariat, which shall be responsible for all matters relating to advisory committees.

(b) The Director shall, immediately after the enactment of this Act, institute a comprehensive review of the activities and responsibilities of each advisory committee to determine—

(1) whether such committee is carrying out its purpose;

(2) whether, consistent with the provisions of applicable statutes, the responsibilities assigned to it should be revised;

(3) whether it should be merged with other advisory committees; or

(4) whether it should be abolished.

The Director may from time to time request such information as he deems necessary to carry out his functions under this subsection. Upon the completion of the Director's review he shall make recommendations to the President and to either the agency head or the Congress with respect to action he believes should be taken. Thereafter, the Director shall carry out a similar review annually. Agency heads shall cooperate with the Director in making the reviews required by this subsection.

(c) The Director shall prescribe administrative guidelines and management controls applicable to advisory committees, and, to the maximum extent feasible, provide advice, assistance, and guidance to advisory committees to improve their performance. In carrying out his functions under this subsection, the Director shall consider the recommendations of each agency head with respect to means of improving the performance of advisory committees whose duties are related to such agency.

(d)(1) The Director, after study and consultation with the Civil Service Commission, shall establish guidelines with respect to uniform fair rates of pay for comparable services of members, staffs, and consultants of advisory committees in a manner which gives appropriate recognition to the responsibilities and qualifications required and other relevant factors. Such regulations shall provide that—

(A) no member of any advisory committee or of the staff of any advisory committee shall receive compensation at a rate in excess of the rate specified for GS-18 of the General Schedule under section 5332 of title 5, United States Code; and

(B) such members, while engaged in the performance of their duties away from their homes or regular places of business, may be allowed travel expenses, including per diem in lieu of subsistence, as authorized by section 5703 of title 5, United States Code, for persons employed intermittently in the Government service.

(2) Nothing in this subsection shall prevent—

(A) an individual who (without regard to his service with an advisory committee) is a full-time employee of the United States, or

(B) an individual who immediately before his service with any advisory committee was such an employee,

from receiving compensation at the rate at which he otherwise would be compensated (or was compensated) as a full-time employee of the United States.

(e) The Director shall include in budget recommendations a summary of the amounts he deems necessary for the expenses of advisory committees, including the expenses for publication of reports where appropriate.

RESPONSIBILITIES OF AGENCY HEADS

SEC. 8. (a) Each agency head shall establish uniform administrative guidelines and management controls for advisory committees established by that agency, which shall be consistent with directives of the Director under section 7 and section 10. Each agency shall maintain systematic information on the nature, functions, and operations of each advisory committee within its jurisdiction.

(b) The head of each agency which has an advisory committee shall designate an Advisory Committee Management Officer who shall—

(1) exercise control and supervision over the establishment, procedures, and accomplishments of advisory committees established by that agency;

(2) assemble and maintain the reports, records, and other papers of any such committee during its existence; and

(3) carry out, on behalf of that agency, the provisions of section 552 of title 5, United States Code, with respect to such reports, records, and other papers.

ESTABLISHMENT AND PURPOSE OF ADVISORY COMMITTEES

SEC. 9. (a) No advisory committee shall be established unless such establishment is—

(1) specifically authorized by statute or by the President; or

(2) determined as a matter of formal record, by the head of the agency involved after consultation with the Director, with timely notice published in the Federal Register, to be in the public interest in connection with the performance of duties imposed on that agency by law.

(b) Unless otherwise specifically provided by statute or Presidential directive, advisory committees shall be utilized solely for advisory functions. Determinations of action to be taken and policy to be expressed with respect to matters upon which an advisory committee reports or makes recommendaitons shall be made solely by the President or an officer of the Federal Government.

(c) No advisory committee shall meet or take any action until an advisory committee charter has been filed with (1) the Director in the case of Presidential advisory committees, or (2) with the head of the agency to whom any advisory committee reports and with the standing committees of the Senate and of the House of Representatives having legislative jurisdiction of such agency. Such charter shall contain the following information:

(A) the committee's official designation;

(B) the committee's objectives and the scope of its activity;

(C) the period of time necessary for the committee to carry out its purposes;

(D) the agency or official to whom the committee reports;

(E) the agency responsible for providing the necessary support for the committee;

(F) a description of the duties for which the committee is responsible, and, if such duties are not solely advisory, a specification of the authority for such functions;

(G) the estimated annual operating costs in dollars and man-years for such committee;

(H) the estimated number and frequency of committee meetings;

(I) the committee's termination date, if less than two years from the date of the committee's establishment; and

(J) the date the charter is filed.

A copy of any such charter shall also be furnished to the Library of Congress.

ADVISORY COMMITTEE PROCEDURES

SEC. 10. (a)(1) Each advisory committee meeting shall be open to the public.

(2) Except when the President determines otherwise for reasons of national security, timely notice of each such meeting shall be published in the Federal Register, and the Director shall prescribe regulations to provide for other types of public notice to insure that all interested persons are notified of such meeting prior thereto.

(3) Interested persons shall be permitted to attend, appear before, or file statements with any advisory committee, subject to such reasonable rules or regulations as the Director may prescribe.

(b) Subject to section 552 of title 5, United States Code, the records, reports, transcripts, minutes, appendixes, working papers, drafts, studies, agenda, or other documents which were made available to or prepared for or by each advisory committee shall be available for public inspection and copying at a single location in the offices of the advisory committee or the agency to which the advisory committee reports until the advisory committee ceases to exist.

(c) Detailed minutes of each meeting of each advisory committee shall be kept and shall contain a record of the persons present, a complete and accurate description of matters discussed and conclusions reached, and copies of all reports received, issued, or approved by the advisory committee. The accuracy of all minutes shall be certified to by the chairman of the advisory committee.

(d) Subsections (a)(1) and (a)(3) of this section shall not apply to any advisory committee meeting which the President, or the head of the agency to which the advisory committee reports, determines is concerned with matters listed in section 552(b) of title 5, United States Code. Any such determination shall be in writing and shall contain the reasons for such determination. If such a determination is made, the advisory committee shall issue a report at least annually setting forth a summary of its activities and such related matters as would be informative to the public consistent with the policy of section 552(b) of title 5, United States Code.

(e) There shall be designated an officer or employee of the Federal Government to chair or attend each meeting of each advisory committee. The officer or employee so designated is authorized, whenever he determines it to be in the public interest, to adjourn any such meeting. No advisory committee shall conduct any meeting in the absence of that officer or employee.

(f) Advisory committees shall not hold any meetings except at the call of, or with the advance approval of, a designated officer or employee of the Federal Government and in the case of advisory committees (other than Presidential advisory committees), with an agenda approved by such officer or employee.

AVAILABILITY OF TRANSCRIPTS

SEC. 11. (a) Except where prohibited by contractual agreements entered into prior to the effective date of this Act, agencies and advisory committees shall make available to any person, at actual cost of duplication, copies of transcripts of agency proceedings or advisory committee meetings.

(b) As used in this section "agency proceeding" means any proceeding as defined in section 551(12) of title 5, United States Code.

FISCAL AND ADMINISTRATIVE PROVISIONS

SEC. 12. (a) Each agency shall keep records as will fully disclose the disposition of any funds which may be at the disposal of its advisory committees and the nature and extent of their activities. The General Services Administration, or such other agency as the President may designate, shall maintain financial records with respect to Presidential advisory committees. The Comptroller General of the United States, or any of his authorized representatives, shall have access, for the purposes of audit and examination, to any such records.

(b) Each agency shall be responsible for providing support services for each advisory committee established by or reporting to it unless the establishing authority provides otherwise. Where any such advisory committee reports to more than one agency, only one agency shall be responsible for support services at any one time. In the case of Presidential advisory committees, such services may be provided by the General Services Administration.

RESPONSIBILITIES OF LIBRARY OF CONGRESS

SEC. 13. Subject to section 552 of title 5, United States Code, the Director shall provide for the filing with the Library of Congress of at least eight copies of each report made by every advisory committee and, where appropriate, background papers prepared by consultants. The Librarian of Congress shall establish a depository for such reports and papers where they shall be available to public inspection and use.

TERMINATION OF ADVISORY COMMITTEES

SEC. 14. (a)(1) Each advisory committee which is in existence on the effective date of this Act shall terminate not later than the expiration of the two-year period following such effective date unless—

(A) in the case of an advisory committee established by the President or an officer of the Federal Government, such advisory committee is renewed by the President or that officer by appropriate action prior to the expiration of such two-year period; or

(B) in the case of an advisory committee established by an Act of Congress, its duration is otherwise provided for by law.

(2) Each advisory committee established after such effective date shall terminate not later than the expiration of the two-year period beginning on the date of its establishment unless—

(A) in the case of an advisory committee established by the President or an officer of the Federal Government such advisory committee is renewed by the President or such officer by appropriate action prior to the end of such period; or

(B) in the case of an advisory committee established by an Act of Congress, its duration is otherwise provided for by law.

(b)(1) Upon the renewal of any advisory committee, such advisory committee shall file a charter in accordance with section 9(c).

(2) Any advisory committee established by an Act of Congress shall file a charter in accordance with such section upon the expiration of each successive two-year period following the date of enactment of the Act establishing such advisory committee.

(3) No advisory committee required under this subsection to file a charter shall take any action (other than preparation and filing of such charter) prior to the date on which such charter is filed.

(c) Any advisory committee which is renewed by the President or any officer of the Federal Government may be continued only for successive two-year periods by appropriate action taken by the President or such officer prior to the date on which such advisory committee would otherwise terminate.

EFFECTIVE DATE

SEC. 15. Except as provided in section 7(b), this Act shall become effective upon the expiration of ninety days following the date of enactment.

And the Senate agree to the same.

CHET HOLIFIELD,
JOHN S. MONAGAN,
DANTE B. FASCELL,
SAM STEIGER,
GARRY BROWN,
Managers on the Part of the House.

EDMUND S. MUSKIE,
HUBERT H. HUMPHREY,
LAWTON CHILES,
LEE METCALF,
CHARLES PERCY,
W. V. ROTH, JR.,
BILL BROCK,
Managers on the Part of the Senate.

JOINT EXPLANATORY STATEMENT OF THE COMMITTEE OF CONFERENCE

The managers on the part of the House and the Senate at the conference on the disagreeing votes of the two Houses on the amendment of the Senate to the bill (H.R. 4383) to authorize the establishment of a system governing the creation and operation of advisory committees in the executive branch of the Federal Government, and for other purposes, submit the following joint statement to the House and the Senate in explanation of the effect of the action agreed upon by the managers and recommended in the accompanying conference report:

1. SHORT TITLE

The Senate amendment changed the short title of the House bill to the "Federal Advisory Committee Act". The conference substitute conforms to the Senate amendment.

2. FINDINGS AND PURPOSES

The Senate amendment contained a more lengthy statement of findings and purposes than did the House bill, but did not differ substantially from the House bill. The conference substitute adopts a compromise between the two provisions.

3. DEFINITIONS

The Senate amendment contained definitions of "agency advisory committee", "Presidential advisory committee", and "advisory committee", while the House bill contained definitions of "advisory committee" and "Presidential advisory committee".

The conference substitute adopts the House definition of "Presidential advisory committee" without any change and adopts the House definition of "advisory committee" with modification.

The conference substitute definition of "advisory committee" includes committees which are established or utilized by the President or by one or more agencies or officers of the Federal Government. The conference substitute excludes from the definition of "advisory committee" the Advisory Commission on Intergovernmental Relations, the Commission on Government Procurement, and any committee which is composed wholly of full-time officers or employees of the Federal Government.

The conference substitute deletes the Senate amendment definitions of "officer" and "employee".

4. APPLICABILITY OF THE PROVISIONS OF THE ACT

The Senate amendment contained a provision setting forth the applicability of provisions of the Act, while the House bill contained no comparable provision. The conference substitute adopts the language of the Senate amendment with modifications. The conference substitute specifically exempts from the applicability of the provisions of the Act any advisory committee established or utilized by the Central Intelligence Agency or by the Federal Reserve System.

The Act does not apply to persons or organizations which have contractual relationships with Federal agencies nor to advisory committees not directly established by or for such agencies.

5. RESPONSIBILITIES OF CONGRESSIONAL COMMITTEES

The Senate amendment and the House bill contained minor differences regarding the legislative review functions of the standing committees of Congress. The conference substitute adopts the language of the Senate amendment.

The Senate amendment and the House bill differed regarding the duties of the standing committees of Congress when considering legislation establishing advisory committees. The conference substitute adopts the House bill with minor modifications.

The House bill provides that when the President, any agency head, or any other Federal official establishes an advisory committee, he shall follow the guidelines which are set forth in the House bill for standing committees of the Congress when they are considering legislation establishing advisory committees. The Senate amendment contained no comparable provision. The conference substitute adopts the House bill.

6. RESPONSIBILITIES OF THE PRESIDENT

The Senate amendment and the House bill differed with respect to the responsibilities of the President. The conference substitute adopts a compromise provision which provides that the President may delegate responsibility for evaluating and taking action with respect to the public recommendations of Presidential advisory committees. The conference substitute further provides that the President or his delegate shall submit a report to Congress stating his proposals for action or his reasons for inaction with respect to such public recommendations.

The House bill required the President to make an annual report to Congress regarding advisory committees. The Senate amendment required the Director of the Office of Management and Budget to make a similar annual report. The conference substitute adopts the House bill with modifications. The modifications include the adoption of a provision similar to a provision contained in the Senate amendment excluding from such annual report information which should be withheld for reasons of national security.

7. RESPONSIBILITIES OF THE DIRECTOR OF THE OFFICE OF MANAGEMENT AND BUDGET

The Senate amendment contained several differences from the House bill with respect to the responsibilities of the Director of the Office of Management and Budget.

As noted above, the Senate amendment required the Director to make an annual report to Congress on advisory committees. The conference substitute provides that the President shall make such annual reports, as did the House bill.

With respect to the other duties of the Director, the conference substitute adopts the language of the Senate amendment with slight modification.

The conference substitute requires the Director to include in budget recommendations a summary of amounts necessary for the expenses of advisory committees.

8. RESPONSIBILITIES OF AGENCY HEADS

The Senate amendment differed from the House bill in that it provided that each agency head should designate an Advisory Committee Management Officer with specified duties, and the House bill contained no comparable provision. The conference substitute adopts the Senate amendment with slight modifications.

9. ESTABLISHMENT AND PURPOSE OF ADVISORY COMMITTEES

The Senate amendment set forth a procedure to be followed when advisory committees are established and provided that advisory committees be utilized solely for advisory functions. The House bill had no comparable provision. The conference substitute adopts the Senate amendment with modifications.

10. ADVISORY COMMITTEE PROCEDURES

With regard to the availability of the records and other papers of advisory committees and public access to their meetings, the Senate amendment differed from the House bill.

The conference substitute provides for publication in the Federal Register of timely notice of advisory committee meetings, except where the President determines otherwise for reasons of national security. The conference substitute further provides for public access to advisory committee meetings subject to restrictions which may be imposed by the President or the head of any agency to which an advisory committee reports. Such restrictions may be imposed after it is determined that an advisory committee meeting is concerned with matters listed in section 552(b) of title 5, United States Code. The conference substitute also provides that subject to section 552 of title 5, United States Code, the records and other papers of advisory committees shall be available for public inspection and copying.

The conference substitute requires that each advisory committee keep detailed minutes of its meetings.

The conference substitute requires that a designated officer or employee of the Government attend each advisory committee meeting. No such meeting may be conducted in his absence or without his approval. Except in the case of Presidential advisory committees the agenda of such meeting must be approved by him.

11. AVAILABILITY OF TRANSCRIPTS

The Senate amendment provided that agencies and advisory committees should make any transcripts of their proceedings or meetings available to the public at actual cost of duplication. The House bill contained no comparable provision. The conference substitute adopts the Senate amendment with modification.

12. COLLECTION OF INFORMATION

The Senate amendment contained a provision relating to procedures followed by the Office of Management and Budget in carrying out its duties under the Federal Reports Act. The House bill contained no such provision.

The conference substitute contains no provision on this subject.

13. FISCAL AND ADMINISTRATIVE PROVISIONS

The Senate amendment and the House bill differ slightly regarding the requirement that records be kept concerning the disposition of funds and the nature and extent of activities of advisory committees. The conference substitute provides that each agency shall keep financial and other records regarding the advisory committees under its jurisdiction and that either the General Services Administration or such agency as the President may designate shall maintain financial records of Presidential advisory committees.

The conference substitute adopts the provision of the Senate amendment concerning support services for advisory committees.

14. RESPONSIBILITIES OF THE LIBRARY OF CONGRESS

The Senate amendment and the House bill differed with respect to the responsibilities of the Library of Congress as a depository of the reports and other materials of advisory committees. The conference substitute adopts the House bill with modifications.

15. TERMINATION OF ADVISORY COMMITTEES

The Senate amendment differed from the House bill in that it provided for the termination of advisory committees created by Act of Congress before the effective date of the bill and further differed in that it provided for the termination of all advisory committees not later than December 31, 1973. The House bill provided for the termination of all advisory committees, other than those created by Act of Congress before the date of enactment of the bill, within two years after the effective date of the bill.

The conference substitute adopts the Senate amendment with modifications. An important modification to the Senate amendment is the substitution of a termination date which occurs two years after the effective date of the bill.

16. EFFECTIVE DATE

The Senate amendment and the House bill differed slightly with respect to effective date. The conference substitute adopts the Senate amendment with modifications.

CHET HOLIFIELD,
JOHN S. MONAGAN,
DANTE B. FASCELL,
SAM STEIGER,
GARRY BROWN,
Managers on the part of the House.

EDMUND S. MUSKIE,
HUBERT H. HUMPHREY,
LAWTON CHILES,
LEE METCALF,
CHARLES PERCY,
W. V. ROTH, JR.,
BILL BROCK,
Managers on the part of the Senate.

Sept 72 draft

Charge to Working Group

The advent of very large bubble chambers makes it timely to re-evaluate the management of bubble chamber facilities, giving special attention to costs, operation, safety, and special gas problems. We would appreciate it if you would serve on an informal working group which would attempt to review the management aspects of bubble chamber operation. We hope the group might collect information on present practices and then work out specific recommendations where appropriate.

Some of the specific items we expect this group to consider include:

(1) Operations with superconducting/high field magnets.

(2) Annual operating costs.

(3) Multiple pulsing and/or rapid cycling.

(4) Whether the current or planned procedures provide assurance of a mechanically safe operation.

(5) Procedures for periodic evaluation of operation.

(6) Operator training.

(7) Sharing/pooling supplies of rare/expensive gases.

(8) Other.

INFORMAL WORKING GROUP MEMBERS

Halsey Allen, NAL

Paul Hernandez, LBL

R. Huson, NAL

Gale Pewitt, ANL

Al Prodell, BNL

Bob Watt, SLAC

J. Hunze, OS, CH-AEC

Arnold Weintraub, OS, AEC HQ

C. Richardson, Div. Phys. Res., AEC HQ

P. McGee, Div. Phys. Res., AEC HQ

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
LABORATORY FOR NUCLEAR SCIENCE
CAMBRIDGE, MASSACHUSETTS 02139
575 Technology Sq., Rm. 408

December 4, 1972

Dear Colleagues:

The enclosed was left out of the correspondence of November 28th.

Sincerely yours,

Irwin

Irwin A. Pless,
for the PHS Consortium

IAP/mk

NOV 24 1972

NATIONAL ACCELERATOR LABORATORY

USERS ORGANIZATION
P.O. BOX 700
BATAVIA, ILLINOIS 60510

Please reply to:

Physics Department
Michigan State University
East Lansing, Michigan 48823

Dr. Robert R. Wilson, Director
National Accelerator Laboratory
P. O. Box 500
Batavia, Illinois 60510

Dear Bob:

In response to the requests of several users, the 30-inch bubble chamber subcommittee of the Executive Committee of the NAL Users' Group met on the evening of November 13 at NAL to discuss the 30-inch bubble chamber program. Those attending on behalf of the Executive Committee were:

G. A. Smith (Chairman and Experiment 2-B, Michigan State)
J. VanderVelde (Experiment 138-II, Michigan)
W. D. Walker (Duke)
E. C. Fowler (Purdue)

Those University Users invited to consult with the subcommittee and attending were:

I. Pless (Experiment 154, MIT)
R. Lander (Experiment 121-A, UC-Davis)
P. Slattery (Experiment 138-I, Rochester)
L. Hyman (Experiment 141-A, Argonne)
R. Strand (Experiment 143, Brookhaven)

Those staff members of NAL invited to consult with the subcommittee and attending (and representing Experiments 37 and 137) were:

W. Fowler
J. Sanford
R. Orr
J. Lach

Experiment 125 (Morrison, CERN) was not represented.

As a result of this meeting, the users drafted a letter to the Executive Committee and requested that it be forwarded to the Director. The Executive Committee considered the letter during its meeting of November 14 and recommended that it be sent to you. A copy of that letter is attached herewith.

Those users present were encouraged that the laboratory is planning to add more technical personnel to the 30-inch project. It is quite apparent that a considerable part of the difficulties related to making the approved

30-inch program go is the current lack of technical manpower. The users were also pleased to hear that the laboratory has decided to schedule runs for longer continuous periods of time. In addition, the users noted that more emphasis must be placed on maintaining continuously reliable electronic monitoring of the hadron beam. Specifically, the proportional chambers installed by NAL for the purpose of tuning and monitoring the beam must be made reliable and readily available to users in Neutrino Lab A as originally planned.

The Executive Committee intends to sponsor similar meetings and mini-study groups more frequently in the future. Our goal will be to have users and NAL staff meet to discuss problems. We feel that it is important that these meetings result in a specific list of problems (if any) and possible solutions.

Sincerely yours,

Gerry

GERALD A. SMITH
Chairman, Executive Committee
of the NAL Users' Group

GAS/tt

Nov. 13 , 1972

Executive Committee, NAL Users' Group
National Accelerator Laboratory
P. O. Box 500
Batavia, Illinois 60510

Dear Executive Committee:

The 30-inch bubble chamber subcommittee met on the evening of November 13 with users and members of the Laboratory. We recommend the following points to the Executive Committee for their consideration as the basis for letter to the Director of NAL:

(1) The 30-inch hadron physics program will be a unique contribution to the High Energy field, especially if it is done early in the life of the accelerator. The work at the ISR cannot compete with this program either in the 4π solid angle nor in the variety of particles that can be used as a projectile. The physics already published on the preliminary runs clearly demonstrates this point. Hence, completing this program with high priority should be a major goal of NAL.

(2) A unique approach to the problem of high energy interactions is the spectrometer elements installed in conjunction with the 30-inch chamber. The utility of this concept should be tested with high priority so as to be able to allow future planning for this program. This testing can be accomplished by running the bare bubble chamber program. It should be noted that the 15-foot chamber cannot do the type of physics that is implied in the addition of a spectrometer to the 30-inch bubble chamber.

In addition to the above comments which are intended to be transmitted to the Director of NAL, it seems that now would be a good time to establish a users committee to study the desirability and feasibility of running both the 15-foot and 30-inch chambers simultaneously.

Sincerely yours,

30-inch Bubble Chamber Users

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
LABORATORY FOR NUCLEAR SCIENCE
CAMBRIDGE, MASSACHUSETTS 02139
575 Technology Sq., Rm. 408

MEMORANDUM

December 4, 1972

TO: PHS CONSORTIUM

FROM: R. K. Yamamoto

SUBJECT: Scheduling for System Operation

Now that the 30" beam line is used steadily for experiments, it is possible to set up a floating schedule for people to serve as system- sitters. I think this chore should be kept independent of system debugging, equipment set up, etc. That is to say, the people responsible for keeping the system in operation during a run should not have to be burdened with drilling holes, soldering wires, etc. and, conversely, people who are drilling holes should not have to worry about re-loading programs, or checking out histograms, etc.

I would like to propose the following schedule:

Run No.	Night shift (8p-8a)	Day shirt (8a-8p)	Run No.	Night shift (8p-8a)	Day Shift (8p-8a)
1	Rut.	Tenn.	6	Yale	Brown
1 a	Yale	Brown	6 a	I.I.T.	Illinois
2	I.I.T.	Illinois	7	Ind.	J.H. Univ.
2 a	Ind.	J.H. Univ.	7	M.I.T.	Rut.
3	M.I.T.	Rut.	8	Tenn.	Yale
3 a	Tenn.	Yale	8 a	Brown	I.I.T.
4	Brown	I.I.T.	9	Ill.	Ind.
4 a	Illinois	Ind.	9 a	J.H. Univ.	M.I.T.
5	J.H. Univ.	M.I.T.			
5 a	Rut.	Tenn.			

The schedule would repeat itself after run 9. I think two people per shift would be nice during the initial training and shakedown period and, perhaps, we could ease back toward a one-man shift after everyone has familiarized himself with the system. For one-man shifts, we could adhere to this schedule using run numbers 1, 1a, 2, 2a, etc.

In the event a particular institution cannot meet their shift assignments due to prior commitments, I think they should take the responsibility of negotiating with other institutions for swapping shifts.

A run is defined as one or more 12-hr. shifts separated by 4 or more 12-hr. shifts of (no-run) before the next run. My feeling is to not try to balance the time put in by each individual group but to bank on the law of averages.

I would appreciate it if you could think about this scheme and, perhaps, we could discuss it during our 16 December meeting.

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