Wilson And Fermilab

L. M. Lederman

I'm terribly sorry that I was introduced by Phil Livdahl. I was expecting an introduction by Norman Ramsey. In that case you know I would have another half hour to prepare my talk. I always find in this place I'm running out of time. Symposia in honor of some great scientist, great heroes, festschrifts, retirement parties, etc., are always nerve wracking enterprises. Speakers are in a delicate situation. They have to praise the hero, they have to list his great accomplishments, his honors, the overwhelming difficulties he surpassed. They have to tell hysterically funny anecdotes about things he did and after a certain amount of this there is always the danger some small kid in the audience will say, "Mom, where's the casket?" and a nervous response, "Shhhh, he's still moving." I want to assure you that this symposium is going to be different. You may hear from the speakers coming after me (I'm not responsible for what they say) some praise for Robert Wilson but you won't hear any praise from me, no sir! If Wilson can't do any better in the next years than he's done in the past he's in plenty of trouble. Now I have to confess to a certain prejudice because for the past twelve years or so he's been my constant nemesis. As a fellow trustee of URA in its formative years he kept making trouble. He was always criticizing, complaining, making outrageous statements about what an accelerator should look like, how long it should take to build, and all sorts of stuff like that. He just never gave us any peace. Somehow he got to be Director in spite of all that, and then he made life miserable for all us trustees, and for me in particular as a user of the Laboratory. He had his priorities all twisted. He seemed more concerned about trees than about having neat, straight beam lines. He seemed to care more about human rights and real affirmative action than about efficiency. He seemed to care more about architectural elegance, style, aesthetics (and leaking roofs) than about pert charts. And to complete this irritating injury to us, the damn crooked beams worked, the affirmative action turned out to be efficient and the pert charts were wrong anyway.

Now some of you know, that a funny thing happened to me on the way to the highrise last summer. I became designated. Since then I've been studying the problem of why I can't trust Wilson. Recently I found a book. It's a Design Report dated 1967. It has all the promises he made to everybody about what a great laboratory this was going to be and I just thought I'd analyze this book very carefully. I had some help from the staff, and I'd like to share with you the promises and the reality. I became thoroughly suspicious about Wilson because there are all sorts of incidents (this is the category of hysterically funny anecdotes) in the archives. There is a story that during the days of considerations of what the accelerator should look like, Wilson happened to be in Paris. When he goes to Paris he has this entree (I don't know how he gets it) to an art studio where he can sketch live models, Parisian models, probably not very well dressed. And there he was, I can see him now, looking at this beautiful Parisian model, you see, there is the model and he looked down at his sketch pad and he saw ..... magnets! Would you trust a man like that? Would you buy a used accelerator from him? So now let's look at this 1967 report. (See Fig. 1.) Promises about the machine, what he promised, and what really happened. I know that there are representatives of the government here and I know it's a very dangerous thing to show all these things. However, I think I should; some of these things are already known.

He promised 200 GeV and what do we get - 400 or 500! There is in fact in this book an estimate of the cost of going to 400 GeV, and the cost estimate based on escalated dollars was $70 million and he didn't spend anything for that; he went to 400 without $70 million. (I don't know where the $70 million is, I'd like to find it.) Now look at the intensity. He promised 5×10^{13}; he only got 3×10^{13}. He failed to meet the cost estimates. He was okay on the groundbreaking but that's easy; all it takes is a shovel. Completion of construction, you see, messed up everything. And then his beam date was supposed to be June '72 and he just eked it out to March for 200 GeV and December for 400 GeV. There was a 42-month interval between groundbreaking and the beam date promised in the proposal. He didn't deliver. He promised 2000 physicists, no, I'm sorry, 2000 people working in the Laboratory, and we only have 1400. He promised an annual budget - well... That's not all, I'm just getting warmed up here.

Talk about the experimental program. (See Fig. 2.) This was called a reduced-scope accelerator. He promised four target stations and in 1974 when the machine really began operating there were eight instead of four, leading to lots of confusion. There were supposed to be ten particle beams; there turned out to be fourteen. There were supposed to be twelve experiments set up, there turned out to be twenty-seven. We were supposed to finish twenty experiments a year; the number was more like thirty. Promises! Then to make matters worse, what about the staff? Well, he expected ninety experimental physicists doing research and there were only fifty. Here he did pretty well: he promised fifteen theorists and we only got eight. Perfect!

There were expected to be 300 non-resident experimenters in this book I'm talking about, and there things went wild; we counted over 600. Now let me talk a little bit about those 600. Wilson apparently let anybody into the Laboratory. They came from something like thirty states and eighty-two

PROMISES ABOUT MACHINE PARAMETERS

	1967 DESIGN	WHAT REALLY HAPPENED
ENERGY	200 BEV*	400/500 GeV*
INTENSITY	5×10^{13} ppm	3×10^{13} ppm
COST	$250 M	$243.5
GND BREAKING	Dec '68	Dec '68
CONSTR. COMPLETE	JUNE '72	JUNE '71
BEAM DATE	JUNE '72	March '72 200 Dec 72 400
INTERVAL: G.B → BEAM DATE	42 Mo.	39 mo.
POPULATION	2000 (1975)	1400 (1979)
ANNUAL BUDGET IN 1975	$130 M (1979 $)	$74 M (1979)

* COST TO GO TO 400 Estimate $70M → 0 (1979)

Figure 1

1967 PROMISE: EXPERIMENTAL PROGRAM

		1974
TARGET STATIONS:	4	8
PARTICLE BEAMS:	10	14
EXPTS SET UP	12	27
EXPERIMENTS/YR	20	~30

1967 PROMISE: POPULATION

RESIDENT EXP'TL PHYSICISTS IN RESEARCH	90	50
THEORISTS	15	8
NON-RESIDENT EXPERIMENTERS	300	600*

* See Details

Figure II

institutions and since there are lots of people here today and they all want to see their own institution I'll give you a list (Chart I a and b). There are places like Hawaii, and Tufts, and Lehigh, and all sorts of places, even Harvard! These are people with approved or recently completed experiments. This is all just to prove that this is indeed a truly national accelerator laboratory. Having done that, what does Wilson do? He let in foreigners! And so there are 101 foreign institutions involved presently at Fermilab from Australia, Canada, China, England, France, etc. (See Chart II.) Each of these institutions is involved in one or more Fermilab experiments.

Now Wilson is very active in the World Laboratory. It's typical of him. He goes around forming committees to make a world laboratory, doesn't even know that he has one right here with more world-wide participation than any other laboratory. Okay, now, in order for these people to do something he promises them experimental areas. Figure 3 is the reduced scope picture out of this book - this book full of promises. What happened in 1973 when the areas were finished? Here is Fig. 4. You see all of these beams and in fact just enormous amount of activity that confused everybody. Some people, a tired user perhaps, would stumble into the wrong portakamp take the wrong data, and go home with it all mixed up.

Okay, now, this is very interesting. I studied this book, the Fermilab Proposal. I know, and everyone knows, that Wilson is a very strong director and nothing gets into this book that he didn't approve. **Everyone** knows that. In the very beginning it addresses the question of why we should build this accelerator. High-energy physics has problems and this accelerator is designed to solve these problems. The Book lists these problems, circa 1967. (See Fig. 5a.). And so now I would like to confront you with the question of how well one did in these twelve years in responding to these questions. I had some theoretical assistance. We took the questions (some of them were awkwardly phrased because the language was changed a bit since those times) rephrased them in more modern language and I will quickly review what happened in the last twelve years between the questions and the facts.

One set of questions is: "Which of the known particles are elementary? What new particles can be made at higher energy? (This was going to be 200 BeV.) Are they particles associated with a weak source? And are there building blocks more fundamental than the protons and neutrons?

This was 1967 and what are the 1979 answers? Well, the first thing that was done at the Lab was a lot of particle searches which didn't find anything. The W boson? We didn't find it. We didn't find free quarks, magnetic monopoles, and stable new particles. Some particles were seen here somehow and a lot of activity went into studying them. The psi was seen and in fact its hadronic character was established by the

CHART I (a)
FERMI NATIONAL ACCELERATOR LABORATORY

Number of Institutions by State with Approved or Completed Physics Experiments - October, 1978

Arizona	1
California	12
Colorado	1
Connecticut	1
District of Columbia	1
Florida	1
Georgia	1
Hawaii	1
Illinois	9
Indiana	3
Iowa	1
Kansas	1
Louisiana	1
Maryland	2
Massachusetts	9
Michigan	2
Minnesota	1
Mississippi	1
New Jersey	4
New Mexico	1
New York	10
North Carolina	2
Ohio	2
Pennsylvania	4
Rhode Island	1
Tennessee	3
Texas	2
Virginia	2
Washington	1
Wisconsin	1
TOTAL	82
States	30

CHART I (b)
INSTITUTIONS WITH APPROVED OR COMPLETED
PHYSICS EXPERIMENTS - OCTOBER, 1978

Arizona

Arizona, Univ. of

California

Cal. Inst. of Tech.
Cal., Univ. of Berkeley
Cal., Univ. of Davis
Univ. of Los Angeles
Cal., Univ. of Riverside
Cal., Univ. of San Diego
Cal., Univ. of Santa Barbara
Cal., Univ. of Santa Cruz
Harvey Mudd College
Lawrence Berkeley Laboratory
Stanford Linear Accel. Center
Stanford Univ.

Colorado

Colorado, Univ. of

Connecticut

Yale Univ.

District of Columbia

National Science Foundation

Florida

Florida State Univ.

Georgia

Georgia Inst. of Tech.

Hawaii

Hawaii, Univ. of

Illinois

Argonne National Laboratory
Chicago, Univ. of
Fermilab
Ill. Inst. of Tech.
Ill., Univ of

Illinois (continued)

Ill., Univ. of, Chicago Circle Campus
North Central College
Northern Illinois Univ.
Northwestern Univ.

Indiana

Indiana Univ.
Notre Dame, Univ. of
Purdue Univ.

Iowa

Iowa State Univ.

Kansas

Kansas, Univ. of

Louisiana

Louisiana State Univ.

Maryland

Johns Hopkins Univ.
Maryland, Univ. of

Massachusetts

AF Cambridge Research Laboratory (CRFC)
Emmanuel College
Harvard Univ.
Mass. Inst. of Tech.
Mass., Univ. of
Northeastern Univ.
Space Physics Div., AF Geophysics Lab., Hanscom Air Base
Suffolk Univ.
Tufts Univ.

Michigan

Michigan State Univ.
Michigan, Univ. of

Minnesota

Minnesota, Univ. of

Mississippi

Mississippi State Univ.

New Jersey

Princeton Univ.
Rutgers Univ.
Stevens Inst. of Tech.
Upsala College

New Mexico

Los Alamos Scientific Lab.

New York

Brookhaven National Lab.
Columbia, Univ. of
Cornell Univ.
General Elec. Co. R & D Center
New York Univ.
State Univ. of Albany
State Univ. of Buffalo
State Univ. of Stony Brook
Rochester, Univ. of
Rockefeller Univ.

North Carolina

Duke Univ.
North Carolina, Univ. of

Ohio

Case Western Reserve Univ.
Ohio State Univ.

Pennsylvania

Carnegie-Mellon Univ.
Lehigh Univ.
Pennsylvania, Univ. of
Pittsburgh, Univ. of

Rhode Island

Brown Univ.

Tennessee

Oak Ridge National Lab.
Tennessee, Univ. of
Vanderbilt Univ.

Texas

Houston, Univ. of
Johnson Space Center, NASA

Virginia

Virg. Polytechnic Inst. & State U.
William and Mary College of

Washington

Washington, Univ. of

Wisconsin

Wisconsin, Univ. of

CHART II
FOREIGN INSTITUTIONS - 101 TOTAL

Australia

Australian National University, Canberra
Melbourne, University of, Parkville
Sydney, University of, Sydney
Tasmania, University of, Hobart

Belgium

Brussels, University of
Universite de L'Etat, Monz

Canada

Canadian Institute of Particle Physics, Montreal
Carleton University
McGill University
Montreal Universite de
Ottawa, Universite de
Quebec, Universite du Cresala, Montreal
Toronto, University of
Western University, London

China

Institute of High Energy Physics, Academia, Sinica, Peking

England

Cavendish Laboratory, Cambridge
Imperial College, London
Liverpool, University of, Liverpool
Open University, the, Bletchley
Oxford University of
Rutherford High Energy Laboratory
University College, London

France

Centre de Recherches Nucleaires de Saclay
Centre de Recherches Nucleaires, Strasbourg
Lab. du Rayonnement Cosmique, Lyon
Laboratoire de L'Accelerateur Lineaire, Orsay
Lyon, Universite de
Nancy, Universite de, Nancy
Paris Vi, U. de., Lab. Physique Generale
Rene Bernas Laboratoire, Orsay
Strasbourg, University of

Germany

Christian-Albrechts Universitat, Kiel
Kiel Universitaet, Inst. Reine Ange. Kernphysik
Max Planck Institute, Munich

Greece

University of Athens

Hungary

Central Research Institute, Budapest

India

Delhi University, Delhi
Jammu University, Jammu-Tawi
Punjab University, Chandiaarh
Ralasthan University, Jaibur
Tata Institute of Fundamental Research, Bombay

Ireland

University College Dublin

Israel

Israel Inst. of Technology, Technion City, Haifa
Tel-Aviv University of, Tel-Aviv
Weizmann Institute of Science, Rehovot

Italy

Bari, Universita di
Bologna, Universita di
Firenze, Universita di
Padova, Universita di
Pavia, Universita di
Rome, Universita di
Torino, Universita di
Trieste, Universitat Degli Sudi Di

Japan

Aichi University of Education, Kariya
Ashikaga Institute of Technology, Ashikaga
Hirosaki University, Hirosaki
Isas, Tokyo University
Kanagawa University, Yokohama
Kinki University, Kobe
Kobe University, Kobe
Konan University, Kobe
Kwansei Gatuin University, Nishinomiya
Nagoya University, Nagoya
Okayama University, Okayama

Osaka University
Saitama University, Urawa
Science Education Insitute of Osaka Prefecture
Shinshu University
Tohoku University
Tokyo, University of, Cosmic Ray Laboratory
Tokyo, University of, INS
Utsunomiya University, Utsunomiya
Wakayama Medical College
Waseda University, Tokyo
Yokohama National University, Yokohama

Korea

Korea University, Seoul

Netherlands

Nijmegen University, Nijmegen

New Zealand

Auckland, University of, Auckland

Poland

High Energy Physics Lab, Warsaw
Institute of Nuclear Physics, Cracow
Institute of Nuclear Research, Warsaw
Warsaw University, INS

Singapore

Singapore, University of

Spain

Barcelona, Universidad Autonoma de
Instituto de Fisica Corpuscular, Valencia
Santander, Universidad de, Santander
Valencia, Universidad de

Sweden

Lund, University of, Lund
Stockholm, University of, Stockholm

Switzerland

CERN
LHE, ETH Honggerberg, Zurich

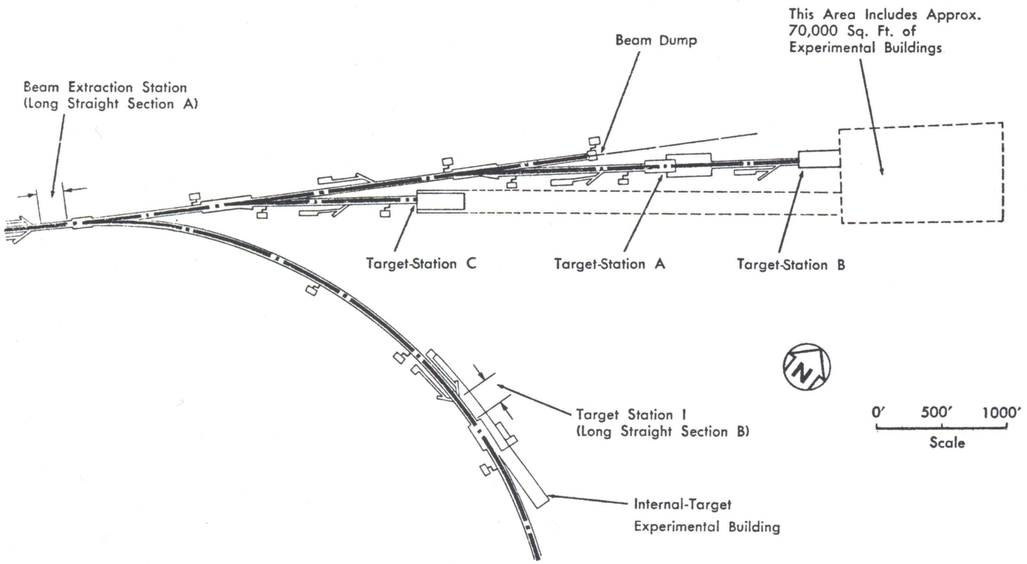
USSR

IHEP, Academy of Sciences of the Kazakh, Alma-Ata
Institute of Theoretical and Experimental Physics, Moscow

Institute of High Energy Physics, Serpukhov
Institute of Nuclear Physics, Novosibirsk
Joint Institute for Nuclear Research, Dubna
Kharkov Physical Technical Institute
Lebedev Physical Institute, Moscow
Leningrad Institute of Nuclear Physics
Moscow University, Moscow
Physical Technical Institute, Tashkent
Tomsk Polytechnic Institite

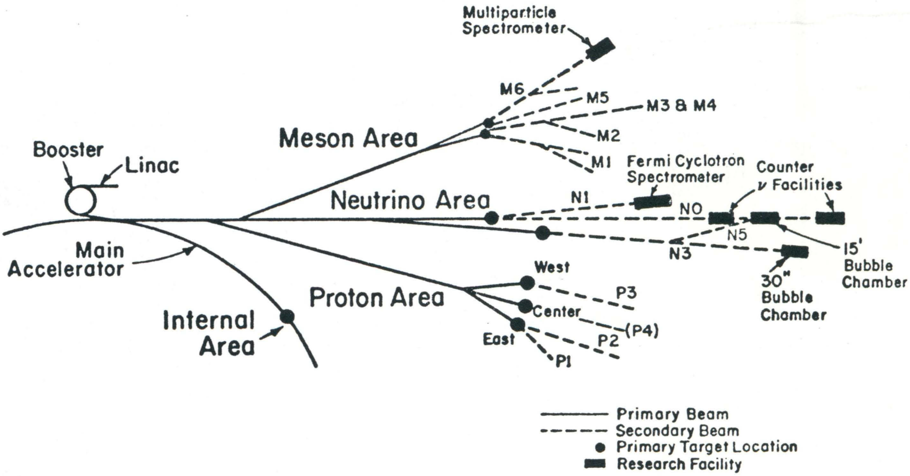
Yugoslavia

Belgrade, University of, Belgrade



EXPERIMENTAL AREAS IN
1967 PROPOSAL "REDUCED SCOPE"

Figure 3



EXPERIMENTAL AREAS FNAL
1973/4 →

Figure 4

PROBLEMS OF HIGH ENERGY PHYSICS
(FROM 1967 "NAL DESIGN REPORT")

QUESTIONS

- WHICH OF THE KNOWN PARTICLES ARE ELEMENTARY?
- WHAT NEW PARTICLES CAN BE MADE AT HIGHER ENERGY?
- ARE THERE PARTICLES ASSOCIATED WITH THE WEAK SOURCE?
- ARE THERE BUILDING BLOCKS MORE FUNDAMENTAL THAN PROTONS + NEUTRONS

ANSWERS

(1) PARTICLE SEARCHES WHICH FAILED

i) W-BOSON
ii) FREE QUARKS
iii) MAGNETIC MONOPOLES
iv) "STABLE" NEW PARTICLES

(2) PARTICLES SEEN AT FNAL

i) PSI (PHOTOPRODUCTION PROOF OF ITS HADRONIC NATURE)
ii) CHARMED MESONS
iii) CHARMED BARYONS
iv) UPSILON FAMILY

Figure 5a

protoproduction process. Charmed mesons were seen, also charmed baryons and something called the upsilon family. And then, to continue answering the question, the quark structure of hadrons was illuminated. There were experiments on the deeply inelastic scattering of muons and of neutrinos. These established structure functions and discovery of scaling violations took place in one of those beam lines. These scaling violations (as we'll see) are also evidence for a field theory of strong interactions; it is called QCD and contains new objects called gluons. (See Fig. 5b.) Measurements of muon pairs established a model in which quarks and antiquarks can annihilate and at the same time gave confidence in the quark structure of hadrons. Jets were seen. These are essentially outgoing quarks arranging themselves. Large transverse momentum experiments gave further evidence for point-like structures.

Then another series of questions: "What symmetry exists at higher energy? Is the Pomeranchuck theorem true?" (It's hard to believe what people were worried about in 1967!) Do total cross sections become constant at higher energies? And Fermilab evidence showed a rise of cross sections from the Serpukhov energies very clearly, and many precise experiments indicated strong support for Regge pole ideas in both inclusive and exclusive reactions. And then, in fact, these high-mass diffractive scattering experiments established the first, as some like to call them, Pomeron beams at Fermilab (Fig. 5c). And another question, "Are short-lived particles different when produced at high energies?" A Fermilab experiment studied the space-time structure of hadrons by looking at the A dependence in hadron nuclear reactions.

"What are the form factors?" Now we talk about quark structure functions. The quantitative photographs of quark structure of nucleons and pions have been taken here in great detail. In another series of questions, "Is there any connection between electromagnetic and strong forces? Is quantum electrodynamics valid? Is there a strong/weak connection? Do weak forces get strong? And the answers in the last twelve years include Fermilab experiments which confirmed and extended the properties of neutral currents. Weak and electromagnetic probes observed one of the more subtle attributes of the quarks, the sea distributions. They turned out to be the same when viewed by the weak and by the electromagnetic probes. There was in fact evidence, not that the weak interactions became strong but that the strong interactions got weak at short distances (Fig. 5d).

Is there a law which predicts the existence and nature of old particles? A nice modest question! Are local field theories valid? What are the relevant fields? Experiments established strong evidence for electro-weak interactions as in the Weinberg-Salam theory but don't forget there is no W or Z^o yet. (One of those promises that are broken.) QCD support in many experiments suggest the fundamental theory of strong forces and so on.

(3) QUARK STRUCTURE OF HADRONS

i) Deep Inelastic μp and νp structure functions: Discovery of Scaling violations as evidence for QCD (i.e. GLUONS)

ii) Measurement of muon pairs as evidence for quark-antiquark annihilation

iii) JETS

iv) Large $P_\perp$ Experiments

QUESTION · What symmetries Exist at higher Energy?
· Is the Pomeranchuk theorem true? Do total cross-sections become constant at higher energies?

Answers: i) FNAL measurements show rise of cross sections from Serpukhov energies

ii) Many precise measurements ⇒ strong support for regge pole ideas in both inclusive and exclusive processes.

Figure 5b

iii) high mass diffractive Scattering
⇒ first "pomeron beams" at FNAL

QUESTION: ARE SHORT LIVED PARTICLES DIFFERENT WHEN PRODUCED AT HIGH ENERGY?

ANSWER THE SPACE-TIME STRUCTURE OF HADRONS IS STUDIED AT FNAL VIA THE A-DEPENDENCE IN HADRON-NUCLEAR REACTIONS

QUESTION: WHAT ARE FORM FACTORS?

ANSWER: WE NOW TALK OF QUARK STRUCTURE FUNCTIONS - THE QUANTITATIVE "PHOTOGRAPHS" OF QUARK STRUCTURE OF NUCLEON AND PION ARE TAKEN HERE.

QUESTIONS:
- IS THERE ANY CONNECTION BETWEEN ELECTROMAGNETIC AND STRONG FORCES?
- IS QED VALID?
- IS THERE A WEAK-STRONG CONNECTION?
- DO WEAK FORCES GET STRONG?

Figure 5c

ANSWERS : i) FINAL EXPTS CONFIRM + EXTEND STUDY OF NEUTRAL CURRENTS

ii) WEAK (ν) and Electromagnetic Probes (μ and $\to\mu\mu$) observe quark, sea, distributions - they are the same. Ditto quark quantum numbers

iii) Evidence here, that STRONG interactions get WEAK at short Distances (asymptotic freedom)

QUESTIONS : • Is there a law which predicts the Existence and Nature of all particles?

• Is local field theory Valid?

• What are the relevant fields?

Answers : i) Strong Evidence for "Electro-weak" Weinberg-Salam model (But no W, Z^0 yet!)

ii) QCD support in many Expt's suggests a fundamental theory of STRONG FORCES

Figure 5d

Another standard cliché in these books that propose new accelerators is, of course, that we don't really know what the real questions are now, they will come out in the future. So another way to summarize discoveries and developments over the last twelve years, not all of which was uniquely Fermilab (See Fig. 6.) We found two new quarks, new particles, the tau lepton and heavy quark bound states. We found neutral currents, as a new process, were able to clarify the structure of weak interactions via a whole new set of reactions, the decay of charmed quarks and hopefully some B quarks. There is a great success of Regge and Regge-Mueller theories for inclusive and exclusive reactions. We already mentioned the success of the quark structure of hadrons and of the gauge theories. Unified weak and electromagnetic theory of Weinberg-Salam, the quark model of strong interactions which we call QCD, and the intense study nowadays of grand unification.

The scope of the effort in this Lab is a little mind boggling and just for fun, out of a standard FNAL publication I've picked out, a set of research results.* You can get this book if you're interested; it's good reading before you go to sleep. These are not the same pages flashed over you. They are different. That's what happens when your budget isn't high enough and you have all these beam lines. This gives you a clue as to what the problems are here. To bring you up-to-date and point to the future just a little bit, what is the basic problem? The basic problem, as perceived here, is that we have a 400-GeV accelerator and we have people who do the same physics in other places and it is a very difficult thing to ask a group of people to spend three years of their life working late at night, going through all the hassles of doing experiments to find out later that someone else can get the same results sooner and with more detail because they have more powerful facilities. And that's a very fundamental question. We find that in Europe, for example, the total expenditures in high-energy physics are about a factor of two more than in the United States and it's a factor of two almost anyway you do it, either by looking at the rate of exchange of the various currencies, or by dividing by the gross national product, or dividing by populations, you always get a number like a factor of two. And if you look in detail at the support 400-GeV physics at Fermilab and CERN, the factor is much worse.

Now Wilson had a solution and the solution was a five-point solution. (See Fig. 7.) It said build an Energy Doubler. Use it to make a Tevatron (which is 1000-GeV protons on fixed target). It's not something that is totally obvious but 1000 GeV is incredibly more powerful than 400. To give an example, there are at least three or four large European experiments that have already expressed some interest in moving their massive and

*A. F. Greene and T. Yamanouchi, *Fermilab Research Program Workbook*, May 1978.

DISCOVERIES AND DEVELOPMENTS

1) NEW PARTICLES

two quarks: c, b

τ lepton

heavy Quark bound states

2) New Processes

neutral currents

3) Clarification of structure of Weak Int

decay of charmed quark

4) <u>Success</u> of Regge + Regge-Mueller theories for exclusive + inclusive hadron reactions

5) <u>Success</u> of Quark structure of Hadrons

6) <u>Success</u> of Gauge Theories

- unified weak + em. - W-S
- quark theory of STRONG - QCD
- intense study of GRAND UNIFICATION of all interactions

Figure 6

PRESENT AND FUTURE

THE BASIC PROBLEM:

EUROPEAN EXPENDITURES IN H.E.P.
(BY LEGAL RATE OF EXCHANGE) $650
U.S. EQUIVALENT $330

RATIO: EUROPE/US : 2.0

(BY GNP) RATIO : 2.2

FERMILAB/CERN FACTOR IS WORSE.

WILSON SOLUTION:

1. BUILD AN ENERGY DOUBLER
2. USE IT TO MAKE A TEVATRON
   1000 GeV PROTONS ON FIXED T
3. USE IT TO MAKE COLLIDER:
   1000 GeV P × 1000 GeV $\bar{P}$
4. COMPLAIN ABOUT FUNDING
5. QUIT!
6. WORK ON S.C. magnets

→ HE IS STILL MOVING! ←

Figure 7

elaborate detectors to Fermilab to get a crack at 1000 GeV; so that turned out to be a very powerful idea: Wilson called it a leap frog. So his plan: i) Build an Energy Doubler, ii) use it to make a Tevatron, iii) use it to make a collider so that one can have 1000-GeV protons against 1000-GeV antiprotons. Once you've got that underway, iv) complain about the funding and v) quit. So what we did is this: we had a little piece of paper he signed as a condition of my taking the job; it was a five-year warranty on the accelerator or 1000 miles whichever comes first. And he's got to work on the superconducting magnets. And he has several other ideas here. So the answer to the little boy is "He's still moving." Thank you.