letters

Funding big science

I read with regret Leon Lederman's reply to the letter by Rustum Roy (September, page 9) regarding US priorities for science-research funding. To respond to Lederman's presumably facetious suggestion that "there is no such person as Rustum Roy and that the letter is a spoof," I must point out that Roy is not only real but a highly respected physicist. I am a materials scientist who does not share Roy's views on funding; I would like to see more money, not less, spent on such "pure" studies as astronomy and elementary-particle physics. But I think it is unfortunate to resort to *ad hominem* arguments of the sort given in Lederman's reply.

The history of cross-fertilization among subfields of physics is rich in this century. Twenty years ago the same people who made progress in nonperturbative problems in condensed-matter physics (BCS theory, polaron problems) found they could contribute to strong-coupling problems in particle physics. More recently, renormalization-group approaches and general ideas about symmetry breaking have transcended the parochialism of physics specialties and have permitted particle physicists and materials scientists to benefit from each other's work. In my department, we materials scientists benefit from the presence of such people as Thomas De Grand, nominally a particle theorist, and James Randa, similarly trained, to help us understand incommensurate lattices.

Perhaps the issue lurking behind Roy's letter is his own reference to "all the 'lesser' breeds of physicists who work with semiconductors, icosahedral metals, photoresists" and so on. I do not find condensed-matter physics to be a lesser breed of anything, nor the scientists working in this field inferior to anyone. I work in condensed-matter because it is beautiful and elegant, and perhaps just plain fun. Probably both Roy and Lederman do their work for the same reasons. By his defensive sarcasm regarding "lesser" breeds of physicists, Roy has revealed somewhat of a professional inferiority complex with regard to less applied physicists, and Lederman has aggravated that situation by suggesting that Roy is fictitious!

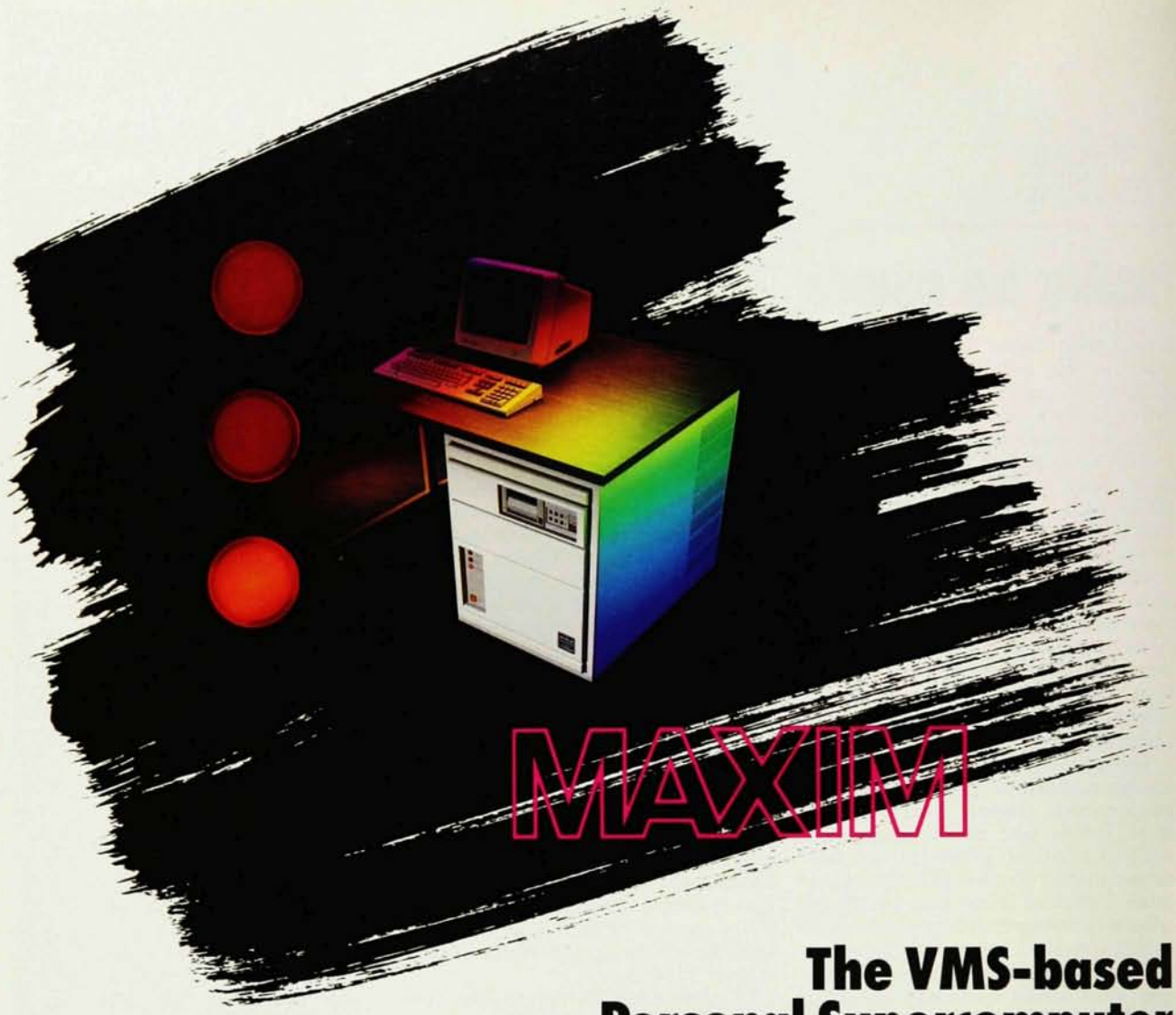
It might be useful for us all to observe that the best materials science in the US gets done at places like Cornell, MIT, Berkeley and Illinois, which also have strong programs in unapplied areas of physics such as elementary-particle studies. It is by no means clear that scientific research is a zero-sum game. As a taxpayer I object to waste in any public expenditure, whether it is bad materials science or bad high-energy physics. But from where I sit, we taxpayers are getting a pretty big bang for our buck. High-energy physics has been damned pretty lately!

JAMES F. SCOTT
University of Colorado
10/85 *Boulder, Colorado*

ROY REPLIES: I am sorry that James Scott missed my intended tongue-in-cheek tone in my reference to "lesser breeds, without the law" (to complete the quotation), because he presents a well-reasoned (indeed the standard) case for retaining the *status quo* in science funding.

Of course high-energy physics "has been damned pretty lately"! So has some radioastronomy, femtosecond spectroscopy and so on. But even in the very language of that phrase a citizen concerned with lack of science teaching for black youth or with aid to dependent children, or a materials physicist observing the flight of middle-tech, high-tech, any-tech industries to the East, might detect a whiff of Marie Antoinette's "let them eat cake."

My proposition to the science and engineering community is simply that the present allocation of resources between big and little science, between science irrelevant to industry and science relevant to it, between esoteric science and basic science, is unbalanced toward the big, irrelevant, esoteric side. I do not propose eliminating or "zeroing out" this major field of science, but asking broader questions about its place in a balanced tax-supported science. And moreover, it is my case that unless we—chemists, physicists, whatever—pay a *great deal* more attention to human societal concerns we will be in trouble. My themes are hardly novel. I quote three recipients of the



The VMS-based Personal Supercomputer

MAXIM brings supercomputer power to the office of the individual scientific researcher. MAXIM is a VMS-based system where a powerful CSPI array processor—either single or double precision—is synergized with Digital Equipment Corporation's MicroVAX II to boost computational speed. The result? Performance up to 50 times faster than a VAX 11/780. Plus total independence for the researcher. FORTRAN compatibility. A VMS-development environment. And economy of space and dollars.

Ask for your free MAXIM brochure today.

MAXIM Action...Here's how to get it.

Call Toll Free 1 800 325-3110
(In Massachusetts call 1 617 272-6020)

cspi
COMPUTATIONAL SPEED FOR SCIENCE AND ENGINEERING

40 Linnell Circle, Billerica, Massachusetts 01821

VMS, MicroVAX II, and VAX 11/780 are trademarks of Digital Equipment Corp. MAXIM is a trademark of CSP Inc.

Circle number 13 on Reader Service Card

letters

Nobel Prize for physics, starting with Albert Einstein:

> Concern for man himself and his fate must always form the chief interest of all technical endeavors, concern for the great unsolved problems of the organization of labor and the distribution of goods—in order that the creations of our minds shall be a blessing and not a curse to mankind. Never forget this in the midst of your diagrams and equations.

If we do not remember this concern, the very same esoteric science so prized by some will suffer an even worse fate. The total scientific-technological system in the US has been weakened to such an extent by the collapse of one component, applied relevant science, that many see sheer technological disaster ahead.

I am afraid that the day is past when appeals to "damned pretty" and basic (old terminology) science were enough. The physics community represents some of the most talented (with respect to a subset of human operations) people on Earth. Can the US in 1986 afford to let an increasing fraction of them "do their thing" with public funds when they might well be doing other, equally interesting physics for the nation? Here is Arno Penzias (Bell Labs) speaking for a new approach (*Science and Government Report*, 15 April 1985):

> What bothers me are those 40 names on each of those papers in *Physical Review Letters*. What else could those people be doing? They are among the brightest human beings in this country today.... I am saying that if we set up a society which says the biggest, the most glamorous, the most high-powered, the most prestigious, the most arcane, the smallest is *the* thing—go after it—and then we find our best people going after it, then we are in trouble, because we don't have a lot of those best people.

In the same interview Penzias also talks of the refuge many take in the term "basic science"—never defined. I have redefined basic science (using the philosophical fallout from the new physics) by starting with the human reference point. Basic science is that science which relates most closely to the human condition. I believe that in the coming era of more democratic control of publicly supported science only such a definition will hold up among philosophers and politicians. On this basis we see that science relevant to agriculture, shelter, health and jobs is really basic, with concentric rings of diminishing "basicity" going outward. This is a "Copernican" revolution advocating an anthropocentric view of science. A major trigger for such a view is to be found in Percy W. Bridgman's work:

> Finally, I come to what it seems to me may well be, from the long-range point of view, the most revolutionary of the insights to be derived from our recent experiences in physics.... This is the insight that it is impossible to transcend the human reference point.... We are now approaching a bound beyond which we are forever estopped from pushing our inquiries, not by the construction of the world but by the construction of ourselves. The world fades out and eludes us because it becomes meaningless.

Mine is not so much a criticism of high-energy physicists' priorities as a St. Paul's Macedonian call "to come on over and help" the US technology-based economy.

RUSTUM ROY
Pennsylvania State University
2/86 *University Park, Pennsylvania*

•

The letter by Rustum Roy and the reply by Leon Lederman gave me a remarkable introduction to the controversial nature of the proposal to build a Superconducting Super Collider. Having previously been only peripherally aware of the proposed machine and naturally captivated by its gargantuan dimensions, I appreciated the food for thought that Roy's letter gave me. Lederman's reply, on the other hand, left me hungry for an equally thoughtful presentation of the opposing view.

The rational debate on SSC that Lederman called for was disappointingly absent from his own letter. He merely encouraged his readers to "react appropriately" to Roy's points and then proceeded to ridicule the person and the points. This tactic is usually a last resort when the weakness of one's position prevents it from standing on its own merits.

The fact that several of Lederman's colleagues joined in the ridicule does not weight my opinion in his favor. I wonder whether there are other colleagues who read the letter and whose knees did not jerk, but who, like myself, were stimulated to ponder broader aspects of the issue than the simple desirability of advancing this one discipline of physics.

The reference to "virtual money" attempted to dismiss Roy's points as figments of the imagination of a nonexistent author. But surely the SSC we are talking about is not just a hypothetical device for performing *gedanken* experiments. Rational science policy dictates that priorities for finite R&D budgets be debated well in ad-

Another high voltage power supply cut in half...

The WH Series...500 watts, 1/2 the space, 1/2 the weight, and we even cut the price!

When Glassman packed 500 Watts @ 80kV into 10½" of rack space a few years ago, it was a pretty impressive feat.

Although that may seem commonplace today, the next step, which we've just taken,isn't. We've packed 500 watts @ up to 75kV in half that space...5¼". The WH Series is one half the size and weight of the PG Series models it replaces. In it, you get more regulated high voltage in less space than any other supply we know of.

To accomplish this, we've developed some new circuitry that we believe has increased the reliability of our already sound, field proven switch-mode technology.

If light weight, compactness, tight regulation, and high reliability are major factors in your high voltage power supply requirements, then call John Belden at 201-534-9007 for complete details on the new WH Series.

Innovations in high voltage power supply technology.

GLASSMAN HIGH VOLTAGE INC.

Route #22 (East), Salem Industrial Park, P.O. Box 551, Whitehouse Station, N.J. 08889
(201) 534-9007 • TWX 710-480-2839

Circle number 15 on Reader Service Card

vance of the appropriations that make the money real.

Lederman's concluding platitudes also do not contribute to a rational dialogue but, it seems to me, seek to isolate particle physics in an ivory-tower bastion surrounded by a world of people beset with overwhelming problems.

JIM STOFFEL(S)
10/85 *Richland, Washington*

•

The nobility in their grand palaces, contemplating "the transcendent beauty and philosophical depth" of their works of art, have heard the cries of the peasants and have told them to eat virtual funding.

JOSEPH F. LOMAX
9/85 *Evanston, Illinois*

•

The reply of Leon M. Lederman to the very reasonable questions on government funding of basic big science asked by Rustum Roy in a PHYSICS TODAY letter is almost its own caricature.

Lederman's beatific extolment of the philosophical and cosmological transcendence of high-energy insights and million-dollar detectors exhibits just the hubris that Roy cites. Of course Lederman is no more an unprejudiced judge of his claim on taxpayers' support than is any other beneficiary of government subsidy. His virtual-money trope is, however, apropos: Lederman's world of virtual particles is paid for by the virtual money that the government has virtually stolen from our savings accounts—by its inflationary monetary and "deficitary" fiscal policies.

A fundamental issue for the economy and also for society is our inability to contain government spending. Although scoffed by Lederman as a virtual issue, the now firmly entrenched and massive Federal deficit spending has priced the US out of world markets by eroding US productivity, discouraged investment, robbed savings and debauched the currency. While a majority of persons wants to reduce government benefits, subsidies and grants, it is only the "unnecessary" ones and the "waste" that are considered dispensable. But what is waste or unnecessary to one person is someone else's bread and butter. Defense-program jobs are no less important to their holders than are the new high-energy detector, space telescope and scholarship grant to their beneficiaries. Trying to reach a consensus on reduction has repeatedly shown itself to be a fruitless hassle. The missing essential ingredient is the willingness of everyone to moderate *his own claim* on government. A slight reduction in every benefit and *every* program would eliminate the deficit. But the necessary and sufficient condition is the willingness of all constituents to accept a little less, not just in someone else's subsidy, but in their own.

In the same issue (September, page 67), PHYSICS TODAY reports and comments on the British Kendrew report, which recommended reduced UK particle-physics expenditures. The column expressed the typical and expected reaction: righteous indignation whenever a reduction or even a nonincrease in some Federal science or educational grant program is proposed. What organization of note will have the courage to say that for the common good it will accept slightly less from the government for its members—or even be willing to resist the lobbying clamor for ever more Federal funds? If the physics establishment cannot exercise this restraint, how can one expect it from the missile makers, the "social securees," the city mayors, the school boards, the teachers' unions and the food-stamp recipients?

WILLIAM MOELLERING
10/85 *Cincinnati, Ohio*

•

I would like to comment on the letter by Rustum Roy and response from Leon M. Lederman concerning the funding of "practical" applied research vs. the funding of particle-accelerator research, or technological fruit feeding basic-research roots vs. research roots bearing technological fruit. Both men are obviously extremely devoted to and knowledgeable in their respective areas of research. Both also have very legitimate concerns for their branches of science. Objective discussions in forums like PHYSICS TODAY have the potential for providing very valuable input concerning the scientific policies of the US. I saw, however, something like disdain for Roy in Lederman's response: Indeed, I was amazed at Lederman's disrespect for Roy in his opening paragraph. Lederman's wording does not give me confidence in his ability to consider objectively the ramifications of a proposal of this nature, even though he may well posess this ability. Roy has a record of being in favor of applied science and has in fact made immense contributions to the field of materials science. His opinions deserve consideration.

Roy's offhand way of describing the costs of "a Bevatron here and the SSC there" would probable raise my hackles if those were *my* babies. I might also take offense at hearing my research gems called a "dead end in spinoff technology and employment." But I hope my initial indignation would simmer down to a skeptical appraisal of

continued on page 81

continued from page 15

the opposition's point. The magnitude of the $5–6 billion price tag for SSC used by Roy is surely appreciated also by SSC proponents. Projects like this inherently require sums of money that appear astounding, even to their supporters. However, at the risk of translating color TVs into meals for starving people, I suggest that SSC promoters remember what such a price tag looks like through the eyes of opponents to SSC: 5000 $1 million research contracts, 50 000 graduate fellowships, much sought-after funding for projects at existing high-energy facilities.

SSC promoters might well have a similar vision of the billions of dollars already designated for SDI. "Big science" is now, and will be in the future, providing valuable information helping to expand technology in this country and in the world, as Lederman has written. However, the concerns of materials scientists, promoters of high-energy research and all groups seeking scientific-support dollars do indeed require "rational" debate in the strictest meaning of the word: objectivity vs. sensitivity.

PAUL CHAYKA
Fiber Materials Inc
10/85 *Diddeford, Maine*

•

In his letter to the editor, Rustum Roy raises several questions dealing with the issue of how (or even whether) public money should be spent on such expensive scientific endeavors as the Superconducting Super Collider and the Very Long Baseline Array. Leon Lederman responded to this criticism in a letter of his own. The tipoff that Lederman's case is a weak one occurs in the first paragraph of his letter, where he chooses to make fun of Roy's name. Indeed, in the entirety of his letter, Lederman did not address a single one of the substantive issues raised by Roy, apparently because he does not understand them, but instead he attempted to wrap the field of particle physics in the mantle of greatness properly worn by Werner Heisenberg, Niels Bohr, Enrico Fermi and others.

A more sensible response would have been to enumerate the specific technological achievements that were spun off from the previous generations of particle accelerators. This approach has been successful for the justification of other expensive research programs, such as the space effort. If no such achievements exist (or if the ones that do exist are 50 years old), then these kinds of research are "vital" for our culture to more or less the same degree as are the arts and humanities, and should be considered on an equal footing therewith.

DAVID L. JOHNSON
Schlumberger-Doll Research
10/85 *Ridgefield, Connecticut*

•

I would like to comment on the recent article by Sheldon L. Glashow and Leon M. Lederman, "The SSC: A machine for the nineties" (March 1985, page 28). Although it is an otherwise interesting article, I found the strange mix of pride and nationalism unfortunate and inconsistent. I am thankful that the authors themselves seem somewhat embarrassed at suggesting pride as one of their four reasons for building the roughly $3 billion machine, and well they should be. When language like this starts being used in articles directed at scientific colleagues (I presume this is why it appears in PHYSICS TODAY), one cannot help but suppose motivations other than scientific in origin—motivations perhaps more appropriate in some emotional experiential forum than in a scientific one. Furthermore, it is inconsistent to list contributions made to society by high-energy physicists—such as Andrei Sakharov or Godfrey Newbold Hounsfield, who invented the CAT scanner, or others—as contributions made by "us," and then to make distinctions based on national boundaries when talking about where SSC should be built. It is especially inconsistent after the authors have just pointed out how the benefits of such activity go beyond such demarcations. Certainly the physics to be done and the knowledge to be gained do not care where SSC is built.

I do not agree that pride, and certainly not pride mixed with the sort of nationalistic language used at times in the article, is an appropriate reason for doing very many things—much less for building SSC. The authors write: "When we were children, America did most things best. So it should again." Firstly, regardless of the truth value of these sentences, it is unnecessary and unfortunate language to many of us, Americans and otherwise. Secondly, if these sentences are meant as "rallying cries," then I suggest that they should rally us not backward to old ways of thinking, but rather forward—forward to the sort of thinking and example setting that are necessary if we are to live together on one planet, thinking of the kind that physicists have traditionally considered themselves capable of.

In hopes of attracting "the best and the brightest" I submit that it has always been the "adventure of ideas," together with the sort of Socratic humility exemplified by physicists such as Albert Einstein, that has been most persuasive. The internationalism of physics, with scientists from East and West meeting and communicating relatively freely with each other, has only added to this. However, pride and nationalism are not friends of truth or ideas in physics or anywhere else, and if they become prime movers in directing physics, I am sure more than a few physicists, present and potential, will either move on or distance themselves from the discipline in other ways.

Why build SSC? There are persuasive economic factors and "spinoffs" that will interest lawmakers, but what moves physicists engaged in pure research toward its construction? To be honest, we cannot promise anything from SSC. We simply do not know what is up there at those high energies. Most likely there are observations of primordial significance to be made, but we cannot make any promises about what they will be.

Why build SSC? Because of the fundamental human desire to understand who, what and where we are, and to find ways of expressing this as cogently and forcefully as possible. This is why we do most of the things we do, and that is what life, and ultimately SSC, is all about. Glashow and Lederman would consider this the "challenge" and "sense of duty" they associate with the whole project. They do not seriously address the very difficult questions of whether this is sufficient justification or is socially responsible in light of the many other ways and places that this huge sum of money could be spent. However, that topic was clearly not the point of their article, and that is fine. It is also beyond the thrust of this letter: Pride cannot and should not play a role in justifying SSC, neither scientifically nor, one would hope, otherwise.

Let us not muddle our justifications for SSC with things like pride and nationalism—at the very least, not among ourselves or in the pages of PHYSICS TODAY.

NORMAN H. BARTH
Albert-Ludwigs Universität
Freiburg
4/85 *Federal Republic of Germany*

•

It is clear from his response to my letter that Leon Lederman, a distinguished leader of a major national facility, still needs help to focus seriously on national science policies. He awaited Glashow's return to be sure I exist. (He obviously needs an increase in his library budget to buy an *American Men and Women of Science*, *Who's Who*, or *Science Citation Index*, as he didn't know how to check on scientists outside his subspecialty.) Because he was unable to reply to the policy questions I framed, he turned those over to the readers; I hope they will help him. He then asked for help in identifying

which committee should decide the spending of public funds. Finally, he needs help in identifying the myriad new technologies of our time that are coming into being daily and providing jobs and economic health without any benefit of the fundamentals of atomic or nuclear physics.

I called for a new *balance* of research support between basic atelestic research (without social purpose) and basic telestic research (linked to societal goals). I aver—and prove beyond any shadow of doubt in my book—that the ratio of atelestic to telestic research is negatively correlated with national technological health. (Just compare Japan, the US and Britain to understand my point.) While my vision of that balance finds plenty of room for the creativity of particle physics, I am willing to bet that the vast, vast majority of even US scientists would find that the existing balance is tilted way over toward particle physics.

Lederman quotes approvingly the bad technological judgment of the *Times* of London. The following technologies—recognizable by all citizens—have had nearly zero, or negative, input from his business: "wonder" drugs, major chemicals, the "Green Revolution" and most of US agriculture and the US airframe industry. It is noteworthy that it is in these areas where US exports are strong.

I am hardly impressed by Lederman's waving the flag of "fundamental [or basic] science," and here find support in the statements by Arno Penzias (who *does* exist and is vice-president of Bell Labs) quoted in *Science and Government Report* (15 April 1985):

> . . . let us not pretend that what we experiment [with in particle physics] is, in fact, going to illuminate what happens in that part of the arena of our knowledge and experience that's useful for us.
>
> And so when you speak about it, we wrap ourselves in the flag of saying, "It is basic." Yes it is "basic." But one of the things you don't get away with. . . at Bell Labs is "it's basic." I don't care if things are "basic" or not; I want them to be interesting.

Lederman seems to have missed my point about private vs. public support. The excellence and creativity in particle physics should indeed compete for private funds with the same qualities in art and music. These are the "consumption goods" of any culture, and the sooner a free-enterprise society grasps that point, the healthier will be its enterprise. It is sheer scientific dishonesty to claim that particle physics is an "investment good."

In a democracy, the committees of

TENNELEC

CP Series
High-Purity Coaxial
Germanium Detector Systems

DESCRIPTION

TENNELEC's high-purity Coaxial Germanium detector systems are designed to provide the nuclear spectroscopist with the performance and reliability required for the detection and analysis of gamma radiation in the range of 40 keV to 10 MeV. These detector systems can be **stored indefinitely at room temperature** but are designed to operate at near liquid nitrogen temperature (77° Kelvin).

Each system consists of a high purity semiconductor germanium detector, vacuum cryostat, liquid-nitrogen dewar, charge-sensitive preamplifier and cable pack.

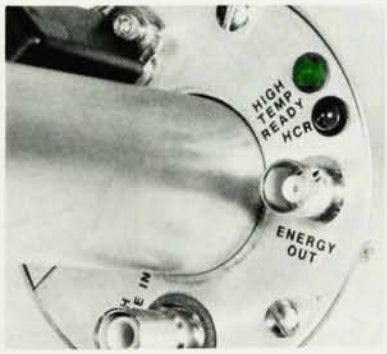
TENNELEC's semiconductor germanium detectors are produced from germanium crystals grown by **TENNELEC** at our Oak Ridge, Tennessee facility. By producing our own crystals, **TENNELEC** has complete control over the quality, reliability and performance of the entire system.

SPECIFICATIONS AND FEATURES

A temperature sensing circuit has been built into the preamplifier electronic package. This circuit is very sensitive to the temperature of the detector element and internally disables the high voltage when the temperature rises to an unsafe level. An LED illuminates red when this disabling circuit is activated. This same LED illuminates green when the system is cold and bias may be applied.

A High Count Rate LED is also provided and illuminates when the count rate of the system exceeds the capability of the preamplifier.

A cable pack is provided with all **TENNELEC** CP Series Systems. Included are a coaxial high voltage cable (SHV female to SHV female, RG-59A/U, 75 ohm) and a preamplifier power cable. The preamplifier power cable contains three (3) RG-174, 50 ohm coaxial cables. When connected to and powered by a **TENNELEC** amplifier, such as the TC 244, one cable carries the signal from the detector preamplifier to the amplifier; the second carries test pulses routed through the amplifier to the preamplifier; and the third is for the Differential input to **TENNELEC** amplifiers.



- **Uniline designed cryostat**
- **Stored indefinitely at room temperature**
- **Unlimited recycles to room temperature**
- **High voltage internally disabled**
- **Charge-sensitive cooled FET preamplifier**
- **High rate LED**
- **"Red" warm, "Green" cold LED**
- **TENNELEC Produced Germanium**

For more information, write or call today.

TENNELEC INC.

601 Oak Ridge Turnpike, P.O. Box 2560
Oak Ridge, Tennessee 37831-2560 USA
Telephone 615-483-8405/TWX 810-572-1018

•

Münchner Strasse 50, D 8025 Unterhaching
West Germany
Telephone 089/611-5060/TLX 841-521 5959 FRIE D

Circle number 24 on Reader Service Card

letters

Congress do, should and will decide which science should be supported. Up to now we in the science community have hornswoggled them by using specious arguments in fuzzy language promising vague goodies to get money for each of our pet "sciences." By the sheer chance event that the engineering feat of constructing a nuclear bomb was credited to "atomic and particle" physics (and many of the very considerable engineering contributions *were* made by the deeply involved and brilliant physicists), particle physics and physics in general have enjoyed a prejudice in the US policy community. Thus this leftover gratitude helps that one community in getting incredibly disproportionate (with respect to its societal value) funds. Other areas of science and technology that deliver the goods that Congress wants, such as all of engineering and polymer synthesis, get shortchanged.

I will continue to work for balanced funding of particle physics, solid-state physics, chemistry, geology and so on. I even offer a quantifiable definition for nationally funded "basic science": It is that which is closest to human needs and which holds out hopes for the greatest effect on the greatest number of the nation's citizenry.

RUSTUM ROY
Pennsylvania State University
10/85 *University Park, Pennsylvania*

LEDERMAN REPLIES: Wow! It would seem as if my letter was not received with universal approbation. Let me apologize to the critics in that the introduction to my response was unnecessarily flippant and plead that Rustum Roy's letter seemed to me outrageously polemical (as Paul Chayka points out) and I rejoiced at the contest of polemics in the great tradition of, alas, a bygone day. It was failed humor, not disrespect.

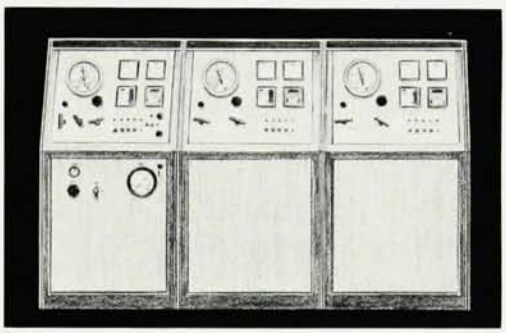
Jim Stoffel's arrows hurt but the article that provoked the letter exchange did present the case (well in advance of appropriation!) for SSC as best we could—as an essential step toward an understanding of all forces and particles. It described the project, its intellectual importance, its technological spinoffs and its potential contributions as a component of our basic-research activity to the nation's cultural and economic well-being. Finally, we expressed our conviction, perhaps a hope, that this would not have a negative impact on other sciences, but that all sciences, good science, would go forward together. The reason is very ably set forth by James Scott—the underlying unity of the subdisciplines should prohibit the advance of one good science at the expense of another good

HIGH PRESSURE SYSTEMS

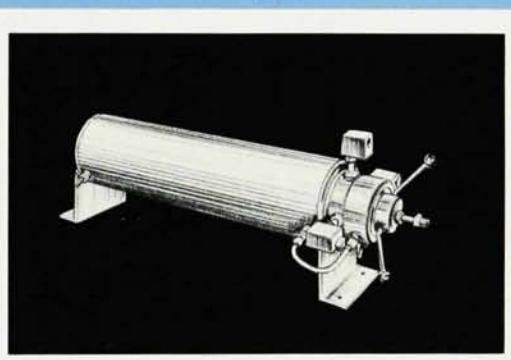
Tem-Pres custom designs for elevated pressure investigation.

50 YEARS OF ADVANCED TECHNOLOGY
LECO 50™ ANNIVERSARY
1936 - 1986

- Properties of Coal
- Solid State Electronics
- Properties of Petroleum
- Oxidation of Silicon Semiconductors
- Corrosion in Nuclear Applications
- Kinetics of Geothermal Systems
- Special Corrosive Applications



Custom system to evaluate corrosion of materials for reactor applications.



Internally heated pressure vessel to study high pressure dry oxidation of silicon for semiconductors.

Coal Research-measures volumetric changes as a function of temperature at elevated pressure.

Tem-Pres designs, tests and fabricates high pressure systems using gaseous, liquid, or solid pressures simultaneously with elevated temperatures. These systems include pressure vessels, pressure intensifiers, furnaces, pumps and associated instrumentation tailored to customer requirements.

To discuss your special requirements, contact:

Bob Shoff

LECO®

Leco Corporation, TEM-PRES Division, Blanchard Street Extension, P.O. Box 390, Bellefonte, PA 16823, Phone: 814-355-7903

Circle number 47 on Reader Service Card

science. My reference to "virtual money," which also excited William Moellering and Joseph Lomax, was an attempt to respond to many of Roy's concerns: Why fund SSC rather than, for example, increase aid to dependent children, cure science illiteracy or make the US a leader in biotechnology?

High-energy physicists wrestled mightily before proposing this giant step. To compare SSC's cost to the cost of more socially relevant alternatives is a prescription for societal as well as scientific stagnation. It is as fruitless as comparing SSC's cost to that of the Sergeant York gun or to the cost of gum chewed in Manhattan. Our society does many things and is far from perfect. We believe we qualify for attention on the basis of the importance of the proposal to science, on the basis of the importance of this science to our culture and on the basis of our skill and track record. As we noted in both article and letter, basic, curiosity-driven research has a good record of returns to society in material as well as cultural blessings.[1]

David Johnson apparently read the letter but not the article. Norman Barth writes from a higher plane of idealism and I would like to know him better. After seven years of trying to organize a World Laboratory as a founding member of the International Committee on Future Accelerators, I found the task too difficult. But "Pride" is an essential fact of scientific life, often a driving force, influencing geniuses, institutions and nations. It by no means excludes collaboration, as we tried to say in our article.

Moellering is concerned about the deficit. He is not alone. In recent months it has become clear that SSC may become a minor casualty of the Gramm–Rudman era—with all of science reverting to the slide experienced in the 1970s. Here we are all at risk but the long-term effect of a setback to basic research would be disastrous to the nation (and the planet, Dr. Barth). I do not accept the notion that science is feeding at the public trough—our problem is to remind the people and their Congress that the long-term well-being of society is intimately dependent upon adequate Federal support of science. I believe that we can easily afford to double the total funding of basic research without significantly adding to the tasks of those who must solve the deficit problem. Basic research, of which SSC is one component, is not a luxury, not an entitlement of fat-cat scientists, but an essential component of a dynamic and modern society.

David Johnson isn't impressed that Niels Bohr and Enrico Fermi are on my side, so perhaps he and Roy would be interested in what three hard-nosed industrial research managers who are also eminent scientists have to say:

▶ George Pake (vice-president, Xerox Corporation):[2]

> Nothing is more pragmatic than the broadest and deepest knowledge base mankind can attain.

▶ Hendrik Casimir (director, retired, Phillips Research Laboratory):[3]

> There are many that hold that programs of scientists should be judged, approved or stopped on the basis of social relevance. The notion strikes me as singularly useless. First of all scientific beauty and philosophical depth are at least as important as practical applicability and that is rarely taken into account. Second, the time lag between scientific progress and practical application makes it impossible to determine

letters

practical social relevance at the time fundamental results are being obtained, and even more impossible to do it before.

▶ Lewis Branscomb (vice-president, IBM):[4]

Microelectronics for computers and the technologies for recombinant DNA were not contained, even implicitly, in the engineering handbooks of their day, nor were they tripped over "by accident" in some laboratory. Indeed, it is hard to think of any technology important to our economic competitiveness or our standard of living that has not been bolstered, directly or indirectly, by exploratory research into fundamental aspects of matter and energy.

Finally, a rereading of Roy's letter convinces me that his is an extremist view. In spite of the mail, this can't be the consensus of PHYSICS TODAY's readers. To use the punch line of my favorite story, "Is there anyone *else* out there?"

References

1. See, for example: L. M. Lederman, Sci. Am. **251,** 40 (1984); J. A. Tay, C. H. Llewellyn-Smith, Fiscal Studies **3,** 15 (1985); M. Bianchi-Streit *et al.*, *Economic Utility Resulting From CERN Contracts*, CERN **84-14** (1984).
2. G. Pake, Mater. Res. Bull., May/June 1985.
3. H. Casimir, *Haphazard Reality*, Harper and Row, New York (1983), p. 312.
4. L. Branscomb, dedication address for the Tevatron, October 1985.

LEON M. LEDERMAN
Batavia, Illinois

2/86

Strategic Defense Initiative

Wolfgang K. H. Panofsky's plea against the Strategic Defense Initiative (June, page 34) overlooks an important fact: the complete inability of technological experts to foresee the state of technology 20 or even 10 years ahead. This was true for the airplane, the machine gun, the tank, radio, radar, the jet engine, television, the atom bomb, the hydrogen bomb, the ICBM, space vehicles, satellites, lasers and electronic computers. In view of this, as a scientist one would say, "Because we are so ignorant, by all means let's go and find out."

The alternative, "We now have secure mutual assured annihilation capacity; for heaven's sake, let's not rock the boat," seems rather unappetizing, in particular because it is permanent. Because we are so much more sensitive about these things than the Russians, does anyone think that they will ever