

Originally Processed With FOIA(s):
2005-0336-F

FOIA Number:
2005-0336-F

FOIA MARKER

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Record Group/Collection: George H.W. Bush Presidential Records
Collection/Office of Origin: Science and Technology Policy, Office of (OSTP)
Series: Bromley, D. Allan, Files
Subseries: General Science Files

OA/ID Number: 62042
Folder ID Number: 62042-001

Folder Title:
Physical Sciences: General (1) [1 of 7] [1992]

Stack:

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Position:

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"Document Control"

TYPE: ACTION DOCUMENT NUMBER: 9203666
ORIGINATOR: 02 STATUS I DIRECTORATE STATUS

FROM: McCRORY, Robert: UNIVERSITY OF ROCHESTER

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 01/05/93

SUBJECT: RE: A CONCEPTUAL DESIGN FOR THE NATIONAL IGNITION
FACILITY.

DIRECTORATE STAFF
ASSIGNED: PHYSICAL SCIENCES ASSIGNED:

ACTION
REQUIRED: AS NECESSARY
STAFF ACTION: *Discussed with DAB 1/6/93 KFE* *DB✓* *Doug Beeson to see & return to PF*

SENDER'S DUE DATE:
OSTP DUE DATE: 01/14/93 STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT: *1/6/93*

COPIES TO: D. Allan Bromley

WHITE HOUSE TRACKING #: CONTACT PERSON:
PHONE: EXT:
REMARKS:

OSTP RECEIVED: 01/05/93
FILE: P-PHYSICAL SCIENCES

DEPT RECEIVED:

CENTRAL FILES:

Fusion



Withdrawal/Redaction Sheet

(George Bush Library)

Document No. and Type	Subject/Title of Document	Date	Restriction	Class.
01a. Letter	To: Allan Bromley From: Robert McCrory Re: Findings of Inertial Confinement Fusion Advisory Committee (1 pp.)	1/5/93	(b)(1)	

Collection:

Record Group: Bush Presidential Records
Office: Science and Technology Policy, Office of (OSTP)
Series: Bromley, D. Allan, Files
Subseries: General Science Files
WHORM Cat.:
File Location: Physical Sciences: General (1) [1 of 7] [1992]

Date Closed:	3/19/2010	OA/ID Number:	62042001
FOIA/SYS Case #:	2005-0336-F	Appeal Case #:	
Re-review Case #:		Appeal Disposition:	
P-2/P-5 Review Case #:		Disposition Date:	
AR Case #:		MR Case #:	
AR Disposition:		MR Disposition:	
AR Disposition Date:		MR Disposition Date:	

RESTRICTION CODES

Presidential Records Act - [44 U.S.C. 2204(a)]

P-1 National Security Classified Information [(a)(1) of the PRA]
P-2 Relating to the appointment to Federal office [(a)(2) of the PRA]
P-3 Release would violate a Federal statute [(a)(3) of the PRA]
P-4 Release would disclose trade secrets or confidential commercial or
financial information [(a)(4) of the PRA]
P-5 Release would disclose confidential advice between the President
and his advisors, or between such advisors [(a)(5) of the PRA]
P-6 Release would constitute a clearly unwarranted invasion of
personal privacy [(a)(6) of the PRA]

C. Closed in accordance with restrictions contained in donor's deed of
gift.

PRM. Removed as a personal record misfile.

Freedom of Information Act - [5 U.S.C. 552(b)]

(b)(1) National security classified information [(b)(1) of the FOIA]
(b)(2) Release would disclose internal personnel rules and practices of an
agency [(b)(2) of the FOIA]
(b)(3) Release would violate a Federal statute [(b)(3) of the FOIA]
(b)(4) Release would disclose trade secrets or confidential or financial
information [(b)(4) of the FOIA]
(b)(6) Release would constitute a clearly unwarranted invasion of
personal privacy [(b)(6) of the FOIA]
(b)(7) Release would disclose information compiled for law enforcement
purposes [(b)(7) of the FOIA]
(b)(8) Release would disclose information concerning the regulation of
financial institutions [(b)(8) of the FOIA]
(b)(9) Release would disclose geological or geophysical information

Withdrawal/Redaction Sheet

(George Bush Library)

Document No. and Type	Subject/Title of Document	Date	Restriction	Class.
01b. Letter	To: Richard Claytor From: Venkatesh Narayanamurti Re: Findings of Inertial Confinement Fusion Advisory Committee (3 pp.)	12/30/92	(b)(1)	

Collection:

Record Group: Bush Presidential Records
Office: Science and Technology Policy, Office of (OSTP)
Series: Bromley, D. Allan, Files
Subseries: General Science Files
WHORM Cat.:
File Location: Physical Sciences: General (1) [1 of 7] [1992]

Date Closed:	3/19/2010	OA/ID Number:	62042001
FOIA/SYS Case #:	2005-0336-F	Appeal Case #:	
Re-review Case #:		Appeal Disposition:	
P-2/P-5 Review Case #:		Disposition Date:	
AR Case #:		MR Case #:	
AR Disposition:		MR Disposition:	
AR Disposition Date:		MR Disposition Date:	

RESTRICTION CODES

Presidential Records Act - [44 U.S.C. 2204(a)]

P-1 National Security Classified Information [(a)(1) of the PRA]
P-2 Relating to the appointment to Federal office [(a)(2) of the PRA]
P-3 Release would violate a Federal statute [(a)(3) of the PRA]
P-4 Release would disclose trade secrets or confidential commercial or
financial information [(a)(4) of the PRA]
P-5 Release would disclose confidential advice between the President
and his advisors, or between such advisors [(a)(5) of the PRA]
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personal privacy [(a)(6) of the PRA]

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(b)(7) Release would disclose information compiled for law enforcement
purposes [(b)(7) of the FOIA]
(b)(8) Release would disclose information concerning the regulation of
financial institutions [(b)(8) of the FOIA]
(b)(9) Release would disclose geological or geophysical information

AGENDA**INERTIAL CONFINEMENT FUSION ADVISORY COMMITTEE/DEFENSE PROGRAMS (ICFAC/DP)****Wednesday, December 16, 1992****Morning Open Session - Room 6A-110**

- 08:00 - 08:30 Convening - Coffee
- 08:30 - 08:45 Administrative Details and Announcements - Robert Jones, DOE
- 08:45 - 08:55 Welcome and Introduction of Chairman - Marshall Sluyter, DOE
- 08:55 - 09:20 Introduction of Committee - Venkatesh Narayanamurti, UCSB
- 09:20 - 09:30 Comments by the Secretary of Energy -
James D. Watkins, Admiral, U.S. Navy (Retired)
- 09:30 - 09:45 Defense Programs Perspective and Charge to the Committee -
Assistant Secretary for Defense Programs Richard Claytor
- 09:45 - 10:00 Energy Research Perspective -
Director, Energy Research, William Happer
- 10:00 - 10:15 Military Application Perspective - W.G. Ellis, RADM, US Navy
- 10:15 - 10:30 Break
- 10:30 - 11:00 DOE Implementation of the Federal Advisory Committee Act -
Office of Organization, Resources and Facilities Management
Director, Howard Raiken
- 11:00 - 12:00 Opportunity for Public Comment
- 12:00 - 12:30 Lunch in Room 4A-104 (Committee Members only)

Afternoon Closed Session - Room 4A-104

- 12:30 - 01:00 Discussion of Conflict of Interest Issues -
MaryAnn Shebek, Office of General Counsel, DOE
- 01:00 - 02:00 The Inertial Confinement Fusion Program -
An Overview by Marshall M. Sluyter, Acting Director, DOE
Office of Inertial Confinement Fusion
- 02:00 - 02:30 Defense Nuclear Agency (DNA) Requirements for Nuclear Weapons
Test and Evaluation - Thomas E. Kennedy, Chief, Test
Requirements Division, DNA
- 02:30 - 02:45 Break
- 02:45 - 04:00 Introduction to Hohlraums - John Lindl, LLNL
- 04:00 - 04:45 The Physics of Hohlraum Asymmetry - Stephen Bodner, NRL
- 04:45 - 05:15 Introduction to LLNL Program - E. Michael Campbell, LLNL
- 05:15 - 06:15 Executive Session

Thursday, December 17, 1992

Morning Closed Session - Room 4A-104

08:00 - 08:30 Convening - Coffee
08:30 - 08:45 Administrative Details and Announcements - Robert Jones, DOE
08:45 - 09:15 Target Design for National Ignition Facility - S. Haan, LLNL
09:15 - 09:55 Laser-Plasma Coupling Issues - William Kruer, LLNL
09:55 - 10:10 Break
10:10 - 11:20 Hohlraum Energetics - M. Rosen & R. Kauffman, LLNL
11:20 - 12:35 Hohlraum Symmetry - L. Suter, LLNL and A. Hauer, LANL

12:35 - 01:35 Lunch in Room 4A-104 (Committee Members only)

Afternoon Closed Session - Room 4A-104

01:35 - 01:55 Hohlraum Modeling - Andrew Schmitt, NRL
01:55 - 02:15 Shell Implosion Modeling - Jill Dahlburg, NRL
02:15 - 02:35 2-D Comparisons with the Shell Model - John Gardner, NRL
02:35 - 03:20 Evaluation of the Ignition Pellet Design - S. Bodnar, NRL
03:20 - 03:35 LANL Program Overview - Stephen Younger, LANL
03:35 - 03:50 Break
03:50 - 04:00 Theory Overview - Roger Kopp, LANL
04:00 - 04:30 Integrated Calculations - Erik Lindman, LANL
04:30 - 05:00 Hohlraum Plasma Dynamics - Juan Fernandez, LANL
05:00 - 05:15 Symmetry Experiments - Allan Hauer, LANL
05:15 - 06:00 Executive Session

07:00 - 07:30 Social Period
07:30 - 09:00 No-Host Dinner

Friday, December 18, 1992

Morning Closed Session - Room 4A-104

08:00 - 08:15 Convening: Administrative Details and Announcements
08:15 - 09:00 Concluding Remarks - Stephen Bodnar, NRL
09:00 - 09:30 Concluding Remarks - Stephen Younger, LANL
09:30 - 10:15 LLNL Experimental Schedule and Plans - Joseph Kilkenny, LLNL
10:15 - 10:30 Summary - E. Michael Campbell, LLNL
10:30 - 11:30 Executive Session
11:30 -----Adjournment



University of Rochester

College of Engineering and Applied Science

Robert I. McGrovy

Director

Laboratory for Laser Energetics

250 East River Road Rochester, New York 14623-1299

TEL 716 275 4973

Laboratory for Laser Energetics**FAX COVER SHEET**Date: 5 January 1993

Automatic Fax No. 716/256-2586

Confirmation No. 716/275-5286

TO: Hon. D. Allan Bromley Phone No.: 202/456-7116Company: White House Science OfficeFax No.: 202/395-3261 Confirmation No.: _____Number of pages (excluding cover sheet): 6From: Prof. R. L. McGrovy Phone No.: 716/275-4973COMMENTS/INSTRUCTIONS:

DEC 29 1992

"Document Control"

TYPE: ACTION DOCUMENT NUMBER: 9203632
ORIGINATOR: 02 STATUS I DIRECTORATE STATUS

FROM: GOODMAN, Charles: INDIANA UNIVERSITY CYCLOTRON FACILITY

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 12/18/92

SUBJECT: HE IS WRITING REGARDING FUNDING OF HIS FACILITY BY
NSF.

DIRECTORATE STAFF
ASSIGNED: PHYSICAL SCIENCES ASSIGNED:

ACTION STAFF
REQUIRED: DRAFT FOR DAB ACTION:

SENDER'S DUE DATE:
OSTP DUE DATE: 01/04/93 STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT: 1/12/93

COPIES TO: D. Allan Bromley

WHITE HOUSE TRACKING #: CONTACT PERSON:
PHONE: EXT:
REMARKS:

Dr. Eke responded.

OSTP RECEIVED: 12/23/92 DEPT RECEIVED:
FILE: P-PHYSICAL SCIENCES

CENTRAL FILES:



EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20506

January 12, 1993

Dear Charlie,

I fully share your frustration with the funding cuts that are projected for nuclear physics research at the National Science Foundation. The IUCF facility has made possible an outstanding research program and it offers much for the future. I truly hope that Indiana and the NSF will find a way to bridge the difficult year ahead.

Allan adds his regards to my own. I look forward to seeing you in the not too distant future.

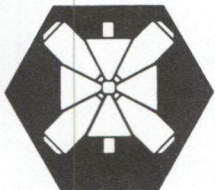
Sincerely,

A handwritten signature in dark ink, appearing to read 'Karl', written over a horizontal line.

Karl A. Erb
Associate Director
for Physical Sciences and Engineering

Dr. Charles D. Goodman
Indiana University Cyclotron Facility
2401 Milo B. Sampson Lane
Bloomington, IN 47408-1398

3632



INDIANA UNIVERSITY CYCLOTRON FACILITY

2401 Milo B. Sampson Lane, Bloomington, Indiana
Telephone: 812-855-9365

47408-1398
FAX: 812-855-6645

December 18, 1992

Dr. D. Allan Bromley
Presidential Science Adviser
The White House
Washington, DC

Dear Al,

I wish I had written to you before the election. Nevertheless, you are a good person for me to sound off to now as well as then, and in a large measure what makes me feel angry and frustrated is not closely coupled to who is in the Whitehouse. Furthermore, you know a hell of a lot more about the politics of science funding than I do, so

What I see from my limited point of view is that within NSF, for budget shortfalls that are infinitesimal on the scale of overall NSF funding, and within DOE for budget shortfalls that are infinitesimal on the scale of overall DOE funding, important research programs that were created painfully over years and are just beginning to come to fruition are being unrecoverably destroyed.

With respect to our work at the Indiana University Cyclotron Facility, our contact man at the NSF has informed us that we should expect a cut in funding of the order of 7-10% for FY 93 and he assembled a committee of physicists to review our lab along with the Michigan State Cyclotron Lab. We have just been through this review, and I think we did rather well in showing the scope and depth of our work. I think the committee was favorably impressed, and I hope that a little bit of the sense of what is really happening gets back to NSF management.

The problem is not with our work, or with the committee, or even, perhaps, with the overall funding level of the NSF, but rather appears to be with Congress and with the internal workings of the NSF. My superficial understanding of the immediate crisis is that NSF has been directed by Congress to provide a substantial increase in funding for LIGO, and to do this they are cutting nuclear physics funds. As I see it, the proposed cut would take us about \$1M below the survival level for our lab. We have already been reduced to the point where there is nothing to cut but people and our running time is below the required time to complete in a reasonable time the graduate student thesis projects that are already underway.

I realize that we are not helped by the political unpopularity of nuclear physics. We are certainly not helped by an article I saw by Representative George Brown blaming the nuclear physicists for the ills of society and suggesting that they be directed to working of social problems. I am cynical enough not to expect NSF to come up with a creative solution, and they are not helped by Barbara Mikulski, who, if I am to believe what I read, is one of the villains in the Senate. A few years ago when funds were very tight, our NSF man wrote a memo to us saying that we should save a little money by paying our graduate students less. It made me think of a cartoon I saw years ago in the New Yorker showing an art museum with a huge canvas suggestive of the Rape of the Sabines. Next to it is a person at an easel copying a tiny dove from the corner of the canvas. Inside NSF there might be a ray of hope with Bob Eisenstein coming on board, but will he get the ear of Massey, and does Massey have any real power.

On the DOE front things are at least as bad if not worse. For a shortfall of about \$10M it is probable that nuclear physics at LAMPF will be shut off forever. This will kill meson physics in the US and, as I heard from Dave Hendrie, the DOE has irrevocably decided not to support KAON, so there will be no meson physics in North America. Killing LAMPF also has a direct effect on us at IUCF in that we have, through a LAMPF-IUCF collaboration built up a very fine time-of-flight facility for making spin observable measurements in (p,n) reactions. We are specifically concerned with understanding delta excitations in nuclei. (In a constituent quark model the delta is just another arrangement of the three quarks in the nucleon.) The facility is unique and it is the only place in the world where these experiments can be done. The program has barely gotten underway, and it is, to use a tired metaphor, nipped in the bud.

To turn from this gloomy note, let me wish you and your children a happy holiday season and let me convey regards from Jody also. I will be interested to know what job position you go to after the Bush administration. I hope it works out well for you.

Best regards,



Charles D. Goodman

"Document Control"

TYPE: ACTION DOCUMENT NUMBER: 9203652
ORIGINATOR: 02 STATUS I DIRECTORATE STATUS

FROM: SADOULET, Bernard and SUNYAEV, Rashid: CENTER FOR PARTICLE
ASTROPHYSICS

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 12/17/92

SUBJECT: THEY ARE WRITING TO SECURE SUPPORT FOR THE RUSSIAN
SPACE AND GROUND BASE ASTROPHYSICS PROGRAM.

DIRECTORATE STAFF
ASSIGNED: PHYSICAL SCIENCES ASSIGNED:

ACTION STAFF
REQUIRED: AS NECESSARY ACTION:

SENDER'S DUE DATE:
OSTP DUE DATE: 01/08/93 STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT:

COPIES TO: D. Allan Bromley
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WHITE HOUSE TRACKING #: CONTACT PERSON:
PHONE: EXT:
REMARKS:

OSTP RECEIVED: 12/28/92 DEPT RECEIVED:
FILE: P-PHYSICAL SCIENCES

CENTRAL FILES:

3652



CENTER FOR
**PARTICLE
ASTROPHYSICS**
NSF SCIENCE & TECHNOLOGY CENTER

17 December 1992

Prof. Allan Bromley
Science Advisor to the President
Director, Office of Science and Technology
Old Executive Office Building
17th Street & Pennsylvania Avenue, NW
Washington, DC 20506

Dear Dr. Bromley:

On December 10, 1992, 40 astrophysicists from the Former Soviet Union and the United States met in Berkeley to discuss their current collaborations and explore what can be done to keep the current projects on schedule, and the directions in which the collaboration can be expanded. They arrived at a common statement that we have been asked to convey to you.

The enclosed statement stresses the importance of the FSU space and ground based astrophysics program in our international effort to understand the universe. It suggests a number of actions to keep this field and science in general alive in the countries of the Former Soviet Union and the former Eastern Bloc and to expand our multilateral collaborations.

The situation is urgent and your office can still have a tremendous influence at a critical moment.

Thank you for your help.

Sincerely yours,

Bernard Sadoulet
Professor of Physics
University of California, Berkeley
Director,
Center for Particle Astrophysics

Rashid Sunyaev
Member of the Russian Academy of Sciences
Foreign Associate of the U.S. National
Academy of Sciences
Head of High Energy Astrophysics
Space Research Institute, Moscow

BS:vm

Enclosure

Executive Summary

On December 10, 1992, 40 astrophysicists from the Former Soviet Union and United States met in Berkeley to discuss their current collaborations and explore what can be done to keep the current projects on schedule and the directions in which the collaboration can be expanded. They arrived at a common statement with the following main points:

- The Former Soviet Union pursues an excellent scientific program in our field of astrophysics and cosmology. Satellites such as RELICT II, Spectrum X-Gamma, RADIOASTRON and Spectrum UV, as well as ground based observation in optical and radio astronomy, and particle astrophysics, promise to break exciting new ground and the theoretical effort is one of the best in the world. Strong collaborations with U.S. scientists already exist and new scientific opportunities for collaborative efforts are emerging.

- We are, however, concerned by the current stress on these scientific enterprises, which may potentially lead to catastrophic delays or cancellations of existing programs and a disastrous brain drain and degradation of facilities. It is more than our collaborations and science which may be at risk, but the world economic order and ultimately its security.

- In the short term, early intervention is needed. We applaud the efforts in that respect of the members of the American Astronomical Society and the American Physical Society, and the recent initiative of George Soros and the International Science Foundation for the Former Soviet Union. We praise the U.S. for passing the Freedom Support Act and creating the AmeRus foundation.

- We also believe it important for the U.S. governmental agencies to take an active role, as in the longer run this is the only way to support ongoing collaborations. International scientific cooperation provides a unique model for international political cooperation. As an example, an international collaboration line item should be established in the NASA budget. We also suggest to consider the conversion of part of the international debt incurred by FSU countries in order to put additional funds at the disposal of their science and education programs.

- Given the serious budgetary stresses in the U.S. scientific funding, a significant intervention will require resources additional to those currently accessible to NSF, NASA and DOE. As the goals are not only scientific but involve important foreign policy issues, we urge that Congress consider budgetary allocations specific to the temporary assistance that should be given to FSU science and the support of the long term collaborations.

At the occasion of the "Texas Symposium on Relativistic Astrophysics" which took place at the University of California at Berkeley, 40 astrophysicists from the Former Soviet Union and United States met on December 10, 1992 to discuss their current collaborations and explore what can be done to keep the current projects on schedule and the directions in which the collaboration can be expanded. The scientific part of this meeting was co-sponsored by the U.S. National Science Foundation and the Russian Academy of Sciences. In addition to its rich scientific agenda, this gathering gave us the opportunity to informally share our concerns about the current situation. This resulted in the following statement, which obviously reflects only the individual responsibility of the undersigned.

We would like to call attention both to the very significant scientific opportunities offered by the astrophysics programs of the Former Soviet Union and the current stress on these scientific enterprises.

Of particular importance is the CIS scientific space program, which we believe will bring critical new data in our field of astrophysics and cosmology. We discussed in detail three programs, RELICT II, Spectrum-X-Gamma and RADIOASTRON, and also received some information about Spectrum UV; they are projects which are widely recognized as excellent by the international scientific community and which promise to expand on the discoveries of recent satellites and complement in essential ways the American, European and Japanese programs.

The ground based program can also play an important role in the scientific advances of the next decade. The radioastronomy projects (RATAN600, the 70m telescope in Uzbekistan, and the Russian VLBI program) provide a valuable base for general astrophysics observations in this wavelength domain. The Baksan Neutrino Observatory represents an impressive asset in the important study of solar neutrinos and search for dark matter. The 6m telescope, properly equipped with modern instruments, could play an important role in cosmology.

The FSU theoretical school is universally recognized to have a profound influence in the field of physics and astrophysics, and should be strongly supported.

Our call for attention is not only motivated by our solidarity and friendship with our FSU colleagues. We already strongly benefit from the collaborations. The field of radioastronomy, in particular very long base line interferometry, is an exemplary case

where the observations from telescopes in the FSU were crucial. A similar instance occurred with the analysis of gamma ray bursts, where the data acquired by Soviet interplanetary probes and American spacecrafts have been critical. Through our relations with Russia we also have access to special materials (e.g., isotopically enriched materials for dark matter searches and solar neutrino research), and the relatively low price of products in the FSU industry represents in some cases significant help to our own scientific program. The intellectual exchanges with the FSU theoretical groups has had great impact on our vision of cosmology. New projects are under way which will benefit U.S. science. For instance, in the field of X-ray astronomy, the collaboration on Spectrum-X-Gamma will give us access to invaluable data and assure the continuity of observation of intrinsically variable objects before AXAF and XMM can be launched. RADIOASTRON also significantly involves American scientists. Moreover, in this meeting we have identified new opportunities for collaboration. In hard X-ray and gamma ray astronomy, for instance, combined analysis of GRANAT and GRO observations are very promising as would be collaborations for long duration balloon flights. The European-U.S. INTEGRAL satellite could be launched by a Russian PROTON rocket. The possibility of an American EUV spectrometer aboard RELICT II was also discussed. New opportunities arise in ground based astronomy: examples include collaboration with the Moscow group on the analysis of variable stars measured in the U.S. and Polish microlensing observations, and the use of FSU isotope enriching capabilities for dark matter, double beta decay and solar neutrino experiments.

Our concern, however, goes beyond the risk faced by our collaborations. Over the years, the Soviet Union has made essential scientific contributions, the most prominent example being the Soviet school of theoretical physics. We are worried by the current difficulties faced by our FSU colleagues (especially the young scientists), and we fear significant scientific losses in the countries of the Former Soviet Union. As science is global and interdependent, such losses would be felt by the worldwide scientific community.

Astrophysics is only one of the scientific fields currently under stress in the Former Soviet Union countries, and the United States should be very concerned about a possible collapse of science in this region. We have already witnessed a large emigration of Russian scientists, and we believe that further erosion of the scientific base could lead to a serious destabilization of the countries of the Former Soviet Union. Such a loss of scientific leaders and technical expertise would be bound to have a large impact on education and on the capability of the nation to solve its problems and compete on the world market. The

disintegration of the scientific infrastructure would also lead to unbearable costs in the future for these countries, when economic needs will require a reconstruction of existing capabilities.

We are also concerned that such a collapse might have a very negative impact on world security. We are thinking here not only of the potential dissemination of sensitive technologies, but of the dangerous reactions that might be provoked by a combination of extreme economic difficulties and the perception of the loss of the past intellectual leadership. The loss of scientific expertise would further isolate these countries, since scientific collaborations remain a very effective way to establish stable links among countries. Special mention should also be made of the difficult problems faced by smaller states of the FSU and the countries of the former Eastern Bloc, where specific cooperation mechanisms should be put in place (e.g., in the form of working groups). Let us note finally that assistance from the United States in this area is a very effective means of maintaining good relationships with countries, which are likely to become important in the future on the international economic scene.

What can be done in practice?

- In the short term, early intervention is needed to prevent potentially catastrophic delays or cancellations of existing programs and a disastrous brain drain and degradation of facilities. The needed scale is often relatively small, with very high leverage because of the different price structure in the FSU and the apparent willingness of the FSU governments to match foreign funds. The most urgent needs involve computing and communication equipment (in particular, terminals for personal electronic mail) and direct support of FSU scientists (e.g., \$1000 per scientist and per year) through research grants. For the time being this intervention has been mainly private, for instance through contributions of members of the American Astronomy Society and the American Physical Society. We are enthusiastic about the recent initiative of George Soros and the International Science Foundation for the Former Soviet Union which will allow a significant expansion of this effort. We also praise the U.S. for passing the Freedom Support Act and urge full endowment of the AmeRus foundation thus created, which will support promising scientific and technology projects between the United States and participating FSU republics. The excellence of the FSU astrophysics makes it a field of choice for these aid programs. In order to maximize its scientific effectiveness, it is essential for this support, whether it is private or public, to be allocated through a mechanism involving a rigorous

peer review. Guarantees should be obtained that transferred equipment and funds will not be subject to taxation and administrative overhead, nor diverted to other goals.

- We believe it is also important for the U.S. governmental agencies to take an active role, as in the longer run this is the only way to support ongoing collaborations. The main agencies involved in the field of astrophysics are NSF, NASA and DOE. Special attention has to be given to keeping present collaborative projects on schedule. New opportunities should also be explored along the lines sketched above. In both cases, the scientific returns are expected to be high for American science, as in many cases this represents a real complementarity to our own program.

- Explicit recognition should be made of the importance of international scientific cooperation among all nations and in particular with the Former Soviet Union and the Former Eastern Bloc. Toward this end, the scope of international programs existing in the funding agencies should be broadened. For example, NASA should have a "line item" in its budget specifically associated with international collaborations, and we urge the inclusion of astrophysics in the agreement on space research collaboration with the Former Soviet Union. The role that the NSF and DOE play in collaborative efforts with the FSU should also be expanded.

- As a complementary mechanism, it may be also interesting to consider the conversion of part of the international debt incurred by FSU countries: an equivalent sum be made available by the countries to their own scientific and education program. Some form of control, e.g., guarantee that this really represents additional resources and American peer review of the proposals (through the NSF, for instance), will have to be established.

- Given the serious budgetary stresses in the American scientific funding, a significant intervention along those lines will require resources additional to those currently accessible to NSF, NASA and DOE. As the goals are not only scientific but involve important foreign policy issues, we urge that Congress consider budgetary allocations specific to the temporary assistance that should be given to FSU science and the long term collaborations.

Signatories

As of December 19, 1992, this statement has been signed by

Carl Akerlof, University of Michigan
Frank T. Avignone, University of South Carolina
John Bahcall, Institute of Advanced Studies, Princeton
Mitchell C. Begelman, University of Colorado, Boulder
Roger Blandford, California Institute of Technology
Thomas J. Bowles, Los Alamos National Laboratory
Vladimir Burdyuzha, Astrospase Center, Lebedev Physical Institute, Moscow
Claude R. Canizares, Director, Center for Space Astrophysics, MIT
Mark Davis, University of California, Berkeley
Marek Demianski, N.Copernicus Astronomical Center, Varsaw
Alexandre Dolgov, ITEP Moscow and University of Michigan
Andrei Doroskevich, Institute of Applied Mathematics, Moscow
John J. Dykla, Loyola University, Chicago
Alex Filippenko, University of California, Berkeley
Peter M. Goorjian, NASA Ames Research Center
Leonid P. Grishchuk, Moscow University
Vladimir Gurzadyan, Yerevan Physics Institute, Armenia
Stephen S. Holt, Director of Space Sciences, Goddard Space Flight Center
Igor Karachentsev, 6m telescope, Special Astrophysics Obervatory, Russia
Nikolai Kardashev, ASC of Lebedev Physical Institute, Moscow
Ken Kellerman, National Radio Astronomy Observatory
Robert Lanou, Brown University
Andrei Linde, Stanford University
Phil Lubin, University of California, Santa Barbara
Christopher McKee, Director Space Science Laboratory, University of California, Berkeley
Richard A. Muller, University of California, Berkeley
Leonid Ozernoy, Goddard Space Flight Center
John Peoples, Director, Fermi National Laboratory
Dmitri Pogosyan, Institute of Astronomy, Cambridge, U.K.
Alexander Pomansky, Institute for Nuclear Research, Baksan Neutrino Observatory
Joel R. Primack, University of California, Santa Cruz
P.Buford Price, University of California, Berkeley

Paul Richards, University of California, Berkeley
Paul M. Ricker, University of Chicago
Ivor Robinson, University of Texas at Dallas
Bernard Sadoulet, Center for Particle Astrophysics, University of California, Berkeley
Michael Salamon, University of Utah
David Schramm, University of Chicago
Thomas Schumman, California state University, San Luis Obispo
Joseph Silk, University of California, Berkeley
George Smoot, Lawrence Berkeley Laboratory
Alexei Starobinsky, Landau Institute for Theoretical Physics, Moscow
Igor Strukov, Space research Institute, Moscow
Rashid Sunyaev, Space Research Institute, Moscow
Virginia Trimble, University of California, Irvine
C.J. Waddington, University of Minnesota, Minneapolis
Joe Weber, University of Maryland
Paul Wiita, Georgia State University
David Wilkinson, Princeton University
Stanley Woosley, University of California, Santa Cruz

TYPE: ACTION DOCUMENT NUMBER: 9203570
ORIGINATOR: 02 STATUS I DIRECTORATE STATUS

FROM: CABIBBO, N.: NATIONAL INSTITUTE OF NUCLEAR PHYSICS

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 12/11/92

SUBJECT: HE IS WRITING REGARDING THE KOAN PROJECT.

DIRECTORATE STAFF
ASSIGNED: PHYSICAL SCIENCES ASSIGNED:

ACTION STAFF
REQUIRED: FOR DAB'S SIGNATURE ACTION:

SENDER'S DUE DATE:
OSTP DUE DATE: 12/28/92 STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT:

COPIES TO:

WHITE HOUSE TRACKING #: CONTACT PERSON:
REMARKS: PHONE: EXT:

OSTP RECEIVED: 12/14/92 DEPT RECEIVED:
FILE: P-PHYSICAL SCIENCES
CENTRAL FILES:



ISTITUTO NAZIONALE DI FISICA NUCLEARE

IL PRESIDENTE

3570
ROMA (Italy) 11th December '92
Piazza dei Caprettari, 70 (00186)
Tel. 68 61 362 - 65 48 081
Telex 61 41 25

Dr. A Bromley
Assistant to the President
for Science and Technology
Director, Office of Science and
Technology Policy
358 Old Executive Office Building
The White House, Washington, D.C.
20500

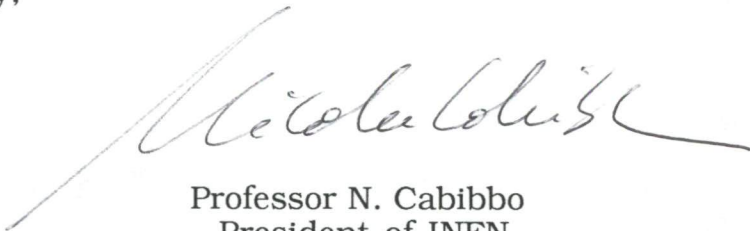
Dear Doctor Bromley,

I understand from our Canadian colleagues at TRIUMF that the KAON project is approaching a final funding decision and construction could start in the new year. I am writing this letter to you - and my other colleagues in the G7 countries who are considering support of KAON - to urge rapid positive action in support of Canada's efforts for KAON and to give my own personal view that the scientific case for KAON remains as strong as ever.

It is my understanding that the Governments of Canada and British Columbia have together committed about two-thirds of the construction funds and that all the normal operating costs will be provided domestically. Therefore, I now urge that this important project can get underway.

I am informed that in the United States a delay occurred this fall in the reconfirmation of U.S. support for KAON, but that you are very actively trying to achieve the desired reconfirmation. I wish you very well in this.

Yours sincerely,



Professor N. Cabibbo
President of INFN

TYPE: ACTION

DOCUMENT NUMBER: 9203570

ORIGINATOR: 02

STATUS I

DIRECTORATE STATUS

FROM: CABIBBO, N.: NATIONAL INSTITUTE OF NUCLEAR PHYSICS

DEC 17 1992

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 12/11/92

SUBJECT: HE IS WRITING REGARDING THE KOAN PROJECT.

DIRECTORATE

STAFF

ASSIGNED: PHYSICAL SCIENCES

ASSIGNED:

ACTION

STAFF

REQUIRED: FOR DAB'S SIGNATURE

ACTION:

SENDER'S DUE DATE:

OSTP DUE DATE: 12/28/92

STAFF DUE DATE

DATE COMPLETED:

DATE COMPLETED/DEPT:

COPIES TO:

WHITE HOUSE TRACKING #:

CONTACT PERSON:

PHONE:

EXT:

REMARKS:

OSTP RECEIVED: 12/14/92

DEPT RECEIVED:

FILE: P-PHYSICAL SCIENCES

CENTRAL FILES:





ISTITUTO NAZIONALE DI FISICA NUCLEARE

IL PRESIDENTE

3570
ROMA (Italy) 11th December '92
Piazza dei Caprettari, 70 (00186)
Tel. 68 61 362 - 65 48 081
Telex 61 41 25

Dr. A Bromley
Assistant to the President
for Science and Technology
Director, Office of Science and
Technology Policy
358 Old Executive Office Building
The White House, Washington, D.C.
20500

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I am informed that in the United States a delay occurred this fall in the reconfirmation of U.S. support for KAON, but that you are very actively trying to achieve the desired reconfirmation. I wish you very well in this.

Yours sincerely,

Professor N. Cabibbo
President of INFN

THE WHITE HOUSE
WASHINGTON

January 12, 1993

Dear Dr. Cabibbo:

Thank you for your letter urging U.S. support for KAON. I fully share your conviction that this important project should go forward and I will continue to work to achieve that end. The support of the other G-7 countries will be an important factor for the Canadians and could also influence the U.S. position.

Sincerely yours,

A handwritten signature in black ink, reading "D. Allan Bromley". The signature is fluid and cursive, with the first name "D. Allan" and the last name "Bromley" clearly distinguishable.

D. Allan Bromley
The Assistant to the President
for
Science and Technology

Professor N. Cabibbo
President
Istituto Nazionale di Fisica Nucleare
Piazza dei Caprettari, 70 (00186)
Roma, ITALY

TYPE: ACTION
ORIGINATOR: 02

STATUS I

DOCUMENT NUMBER: 9203572
DIRECTORATE STATUS

FROM: PIORE, E.R.

DEC 17 1992

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 12/08/92

SUBJECT: HE IS WRITING REGARDING DR. BROMLEY'S ARTICLE
REGARDING THE SCIENCE BUDGET.

DIRECTORATE
ASSIGNED: PHYSICAL SCIENCES

STAFF
ASSIGNED:

ACTION
REQUIRED: AS/IF NECESSARY

STAFF
ACTION:

SENDER'S DUE DATE:
OSTP DUE DATE: 12/28/92

STAFF DUE DATE
DATE COMPLETED/DEPT: 1/12/93

COPIES TO: D. Allan Bromley

WHITE HOUSE TRACKING #:

CONTACT PERSON:
PHONE:

EXT:

REMARKS:

Dr. Ehr drafted letter for DAB

OSTP RECEIVED: 12/14/92
FILE: P-PHYSICAL SCIENCES

DEPT RECEIVED:

CENTRAL FILES:



3572
E. R. Piore
115 Central Park West, New York, N. Y. 10023

December 8, 1992

Dr. D. Allan Bromley
Director
Office of Science & Technology
The White House
Washington, D.C.

Dear Allan,

Your article in the issues "Science, Scientists, and The-
Science Budget" is a first class document.

I have a minor concern-the ten percent on research. The
boundary between research and engineering is not always clear.
Just one example-The Transistor.

The fundamental paper that presented this technology was
published around 1954 or 1955. The authors were physicists:
Bardeen, Shackly, and Brajttan. Putting a limit on "basic research"
does not solve our problems. I hope you do not mind this note.

I hope you will inform all of us where you will be after
the changing of the guard in D.C.

Sincerely,

Mannie

E.R. Piore

May I suggest that the size of basic research does not have an
impact on engineering performance.

THE WHITE HOUSE
WASHINGTON

January 12, 1993

Dear Dr. Piore:

Thank you for your comments on my article on "Science, Scientists, and The Science Budget." I fully agree that distinctions between research in the physical sciences and that in the engineering sciences are arbitrary, at best.

Within the next few days I shall be moving back to Yale University where I hope to see you.

Sincerely yours,

A handwritten signature in dark ink, appearing to read "Allan", with a stylized flourish extending to the right.

D. Allan Bromley
The Assistant to the President
for
Science and Technology

Dr. E.R. Piore
115 Central Park West
New York, NY 10023

"Document Control"

TYPE: INFORMATION

DOCUMENT NUMBER: 9203613

ORIGINATOR: 02

STATUS C

DIRECTORATE STATUS

FROM: DeMARS, B.: UNITED STATES NAVY

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 12/04/92

SUBJECT: HE IS FORWARDING A MEMORANDUM FROM SECRETARY WATKINS
REGARDING THE BETTIS AND KNOLLS LABORATORIES.

DIRECTORATE
ASSIGNED:

STAFF
ASSIGNED:

ACTION
REQUIRED:

STAFF
ACTION:

SENDER'S DUE DATE:

OSTP DUE DATE:
DATE COMPLETED:

STAFF DUE DATE
DATE COMPLETED/DEPT:

COPIES TO: D. Allan Bromley
PHYSICAL SCIENCES

WHITE HOUSE TRACKING #:

CONTACT PERSON:
PHONE:

EXT:

REMARKS:

OSTP RECEIVED: 12/11/92
FILE: P-PHYSICAL SCIENCES

DEPT RECEIVED:

CENTRAL FILES:



3613

NAVAL REACTORS

4 Dec 92

Dear Dr. ~~Bromley~~ ^{Allan},

Attached is Admiral Watkins' decision that the Bettis and Knolls laboratories should not be designated FFRDCs. The reasons are outlined there.

Because of your interest in these matters, I wanted to let you know of Admiral Watkins' decision, and that the National Science Foundation did delete Bettis and KAPL from the newly issued "Master Government List" of FFRDCs.

Sincerely,

B. DeMARS
Admiral, U.S. Navy

Attachment

Dr. D. Allan Bromley
Assistant to the President for Science
and Technology
Old Executive Office Building
17th Street & Pennsylvania Avenue, NW
Washington, DC 20506

Thanks for the nice letter on NR-1
and for your support. Best wishes.

memorandum

ES92-015331

Date: October 27, 1992

Orig. Office: NE-60: B. DeMars

To: The Secretary *11/20/92*

Through: Under Secretary *10-27-92*

Issue: Proposal to Remove Federally Funded Research and Development Center (FFRDC) Designation from the Bettis and Knolls Atomic Power Laboratories

Timing: The National Science Foundation requests a response during October 1992, concerning the "Master Government List" of FFRDCs.

Discussion: The National Science Foundation maintains the Master Government List of FFRDCs, which is updated each October. Now is the time for DOE to request any changes to facility designation.

The Bettis and Knolls laboratories have been on that list, probably inappropriately so, since it was conceived in 1967. Until recently, this was of no great consequence.

In recent years Congress and the Executive branch have increasingly singled out FFRDCs for special controls aimed primarily at avoiding abuse in the assignment of inappropriate work to these facilities.

As you know, the Bettis and Knolls laboratories are unlike the other facilities on the list. These are single purpose laboratories working under contract solely for the Naval Nuclear Propulsion Program; other government offices and agencies cannot assign work there. By Executive Order and Public Law, the Director, Naval Nuclear Propulsion has direct supervisory authority over these laboratories.

In its July 1992 report on FFRDCs (S. PRT. 102-98), the Senate Governmental Affairs Committee suggested the DOE Savannah River and Hanford Engineering Development Laboratories should not be designated FFRDCs, since the majority of their research is tied to improving plant operations. For similar reasons, the Bettis and Knolls laboratories should not be FFRDCs either; their work goes beyond research and development to encompass the whole spectrum of

cm/ 11/36

engineering functions -- including specification, inspection, certification, testing, refueling, operating practices, maintenance, and disposition.

Based on the work they perform, the Bettis and Knolls Atomic Power Laboratories are not FFRDCs and should be deleted from the National Science Foundation's Master Government List of FFRDCs.

Recommendation:

Approve this proposal to request the National Science Foundation delete the Bettis and Knolls laboratories from the Master Government List of FFRDCs.

B. DeMars

B. DeMars
Deputy Assistant Secretary for
Naval Reactors

APPROVED:

DISAPPROVED:

DATE:

cc:

NE-1

This action document does not require the development of a communications plan.

Concur: NE-1
W. K. Young

11/6

"Document Control"

TYPE: ACTION DOCUMENT NUMBER: 9203518
ORIGINATOR: 02 STATUS I DIRECTORATE STATUS

FROM: LEVIN, Craig S.: YALE UNIVERSITY

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 12/02/92

SUBJECT: HE IS FORWARDING A COPY OF A PAPER FOR DR. BROMLEY'S
COMMENTS.

DIRECTORATE STAFF
ASSIGNED: D. Allan Bromley ASSIGNED:

ACTION STAFF
REQUIRED: AS APPROPRIATE ACTION:

SENDER'S DUE DATE:
OSTP DUE DATE: 12/16/92 STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT:

COPIES TO: PHYSICAL SCIENCES

WHITE HOUSE TRACKING #: CONTACT PERSON:
REMARKS: PHONE: EXT:



OSTP RECEIVED: 12/02/92
FILE: P-PHYSICAL SCIENCES

DEPT RECEIVED:

CENTRAL FILES:

THE WHITE HOUSE
WASHINGTON

December 9, 1992

Dear Craig:

Many thanks for sending me a copy of your paper on the Xenon ionization chamber. I have only had an opportunity to read through this very quickly but I was very much impressed by the spectra that you show and congratulate you and your coworkers on what I know has been a long and difficult project.

I look forward to perhaps seeing you before you leave New Haven in mid-January and, in the meantime, all best wishes for the holiday season.

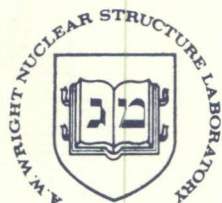
Sincerely yours,



D. Allan Bromley
The Assistant to the President
for
Science and Technology

Dr. Craig S. Levin
A. W. Wright Nuclear Structure Laboratory
Yale University
272 Whitney Avenue
Post Office Box 6666
New Haven, Connecticut 06511

3518



YALE UNIVERSITY

A. W. WRIGHT NUCLEAR STRUCTURE LABORATORY

P.O. Box 6666, 272 Whitney Avenue, New Haven, Connecticut 06511

RECEIVED

DEC 2 4:44

OSTP
MAIL ROOM

Dr. D. Allan Bromley
Executive Office of the President
Office of Science & Technology Policy
Old Executive Office Bldg. - Rm. 360
17th & Pennsylvania Avenue, N.W.
Washington, D.C. 20506

Dear Dr. Bromley:

Greetings!

I just wanted to let you know what became of the W.N.S.L. project to develop an ionization chamber filled with high pressure xenon gas near its critical point (for a ^{136}Xe neutrinoless double beta decay search).

Enclosed is a paper which I have recently submitted to NIM A. Our data suggests that xenon near its critical point is an important addition to the presently available high resolution radiation detector media.

Any questions or comments are welcome. Thank you for your interest and support of this project.

I hope all is going well.

Sincerely,

Craig S. Levin
Craig S. Levin

enc.

CHARGE COLLECTION AND ENERGY RESOLUTION STUDIES IN COMPRESSED XENON GAS NEAR ITS CRITICAL POINT

C. Levin, J. Germani and J. Markey
Yale University

A. W. Wright Nuclear Structure Laboratory
New Haven, CT 06511

We have built a 4.5 liter high purity Xe gas ionization chamber and operated it at pressures of up to 62 atm (1.4 g/cm^3) at room temperature. This thermodynamic regime in pure xenon has not previously been studied. Ionization from a ^{207}Bi internal conversion electron source was drifted over distances of 2.7 and 5.0 cm in two separate gridded ionization chambers within the gas volume. We observed that there was less than 1% difference in the charge collected from these two detectors at the same electric field strength. Energy resolution measurements were performed over the range of xenon densities from 0.49 to 1.40 g/cm^3 at several electric field strengths. An electronic noise subtracted resolution of 16 keV FWHM was measured for the 976 keV ^{207}Bi internal conversion line at an electric field strength of 1.3 kV/cm in compressed xenon gas near its critical density.

1. Introduction

As part of an effort to study $0\nu \beta\beta$ decay of ^{136}Xe , a compressed xenon ionization chamber has been developed. In such a chamber, the ability to drift ionization over large distances without attenuation, stability with time, and excellent energy resolution are essential.

Xenon is an attractive candidate for use as an ionization detection medium. Its large atomic number ($Z=54$) and density (when compressed or condensed) gives it a high stopping power for γ -radiation. The relatively low average energy required to produce an electron-ion pair ($w=21.9$ eV measured for xenon gas, 15.6 eV for liquid)¹ and small Fano factors² allow good energy resolution. For example, in liquid xenon the Fano factor is estimated³ to be $F=0.041$ which translates to a predicted intrinsic energy resolution of 2 keV FWHM at 1 MeV. The measured⁴ Fano factor in gaseous xenon is 0.13 ± 0.01 , which corresponds to an energy resolution of 4 keV FWHM at 1 MeV. Thus, high density xenon spectrometers should have a detection efficiency similar to NaI(Tl) crystals of the same size and an energy resolution comparable in theory to that in Ge(Li) detectors.

Progress toward realization of high resolution liquid xenon devices has been slow. The best energy resolution results⁵ of 34 and 54 keV FWHM for the 570 and 1064 keV photo-peaks of ^{207}Bi , respectively, fall considerably short of the Fano factor prediction. It appears that the resolution is limited by some process other than Poisson fluctuations. Various attempts have been made^{5,6} to explain the discrepancy between measurements in liquid xenon and theory. These authors claim the difference is due to an effect, resulting from the production of low energy delta electrons, that has not been taken into account in the estimation of the Fano factor. In this model, the large statistical fluctuations in the density of ionization along delta electron tracks apparently produces a significant variation in the rate of electron-ion recombination. This, in turn, determines the energy resolution.

In this report we describe results obtained from an ionization chamber filled with purified gaseous xenon operating near the critical point where the density, $\rho_c = 1.09$ g/cm³, approaches that of the liquid phase. If recombination plays a role

in limiting the energy resolution, reducing the density should decrease its effect. Using xenon in its gas phase gives one more freedom to control the density.

2. Apparatus and experimental procedure

2.1. *Thermodynamics of Compressed Xenon*

It is useful to review the thermodynamics of compressed xenon. Figure 1 displays a few isotherms of xenon.⁷ The temperature, pressure and density are intertwined in such a manner as to produce compression near the critical point (57.5 atm, 16.6°C and 1.09 g/ml).⁸ The critical point is indicated in the figure along with the various gas densities studied in this experiment. Also shown is the location on the graph of some other experiments that have been performed in gaseous and liquid xenon.^{4,5,9}

2.2. *The Dual Gridded Ionization Chamber*

The experimental apparatus is shown in Figures 2 and 3. The detector (Fig. 2) is designed as two back to back gridded ionization chambers with a common signal collection anode. All electrodes of the detector are 11.4 cm in diameter. The anode, cathode and grid are circular disks 1.0 mm thick. The field shaping rings are annuli 1.27 cm high and 0.05 mm thick. The grids have a central 10.16 cm diameter aperture with an electroformed nickel mesh¹⁰ spot welded to the side facing the cathode. The mesh has 28.2 μm wire thickness with semi-rounded wires spaced 282 μm between centers (35.5 lines/cm) and is 19.3 μm thick. The anode to grid spacing is 0.64 cm in both detectors. These dimensions result in a grid shielding inefficiency¹¹ of 0.8%. The two detector volumes configured inside the chamber have different values for the cathode to grid spacing, 2.69 and 4.97 cm.

Charge collection characteristics in xenon were studied using ^{207}Bi internal conversion electron sources. The sources were electroplated on the center of each cathode in a less than 2 mm diameter spot with an activity of approximately 1 and 2 nC for the smaller (D1) and the bigger (D2) detector, respectively, as shown in Fig. 2. Drifting ionization from the ^{207}Bi radiation over two different distances within the same chamber allowed the direct measurement of charge attenuation due to the presence of electronegative impurities.

The detectors are contained in a cylindrical 304 stainless steel vessel of approximately 4.5 liters which has copper gasket seals.¹² The top flanges of the chamber are each 6.35 cm thick and are bolted together with grade 8 strength bolts. These precautions were necessary to avoid any buckling of the flange under pressure which would produce a leak by allowing the gasket to separate from the knife-edge seal. Custom-made aluminous ceramic electrical feedthroughs¹³ are mounted on the top flange of the chamber for the electrical connections and mechanical supports (via spot welds) for the electrodes. The detector vessel is connected with 316 stainless steel tubing to the vacuum and xenon gas purification and handling systems (Fig. 3). The entire system was assembled either by welding or by the use of high vacuum fittings, and only all metal bellows valves¹⁴ are utilized. The result is an apparatus made of only high vacuum components. The entire set-up rests on a spring table for vibrational suppression.

2.3. System Preparation

The system is simultaneously evacuated and baked at $\geq 300^\circ\text{C}$ for three days prior to use. The vacuum system comprises sorption pumps for roughing and a triode-ion pump to achieve less than 10^{-10} torr in the vessel and gas-handling system. The measured outgassing rate, using these preparations, was $< 10^{-12}$ torr-liter/sec.

Research grade xenon is then purified using two large volume, low-flow-rate, hot metal getters¹⁵ operating at $> 500^{\circ}\text{C}$. The detector is filled by cooling the vessel with a dry ice and ethanol bath ($\sim -63^{\circ}\text{C}$), thereby condensing the xenon into it. The vapor pressure of xenon at this transfer temperature was approximately 7.5 atm. The chamber is then allowed to warm to room temperature prior to a run. The working volume and density of the xenon are held fixed. The pressure, determined by the ambient temperature,⁷ was measured using a stainless steel transducer with a piezoelectric sensor.¹⁶ The operating pressure for many of the measurements made was 62.2 ± 0.2 atm at $19.0 \pm 0.4^{\circ}\text{C}$.

2.4. Electronics

Negative high voltage for the cathodes, rings and grids of both detectors was supplied from a single power supply (Spellman-RHR40N60 or VK-5900) through an external resistive divider chain originating on the feedthroughs connected to the cathode. A low-pass filtering network was incorporated before the cathode and a bank of capacitors was put in parallel with the resistors on the divider chain. A copper shell, 1/16" thick, shielded the entire electrical feedthrough configuration (top of the chamber) from noise. All detector electronics were grounded to a single copper bar that was bolted to the steel vessel. The anode current resulting from the motion of ionization electrons was integrated using a charge sensitive pre-amplifier with a long fall-time constant (modified ORTEC Model 120). It was mounted directly on the chamber and was at room temperature.

The pre-amp pulses were shaped and amplified using a spectroscopy amplifier (ORTEC Model 572). The shaped pulses were then fed into a multi-channel analyzer (Canberra S-100), and the spectra were stored in a computer for charge collection and energy resolution measurements. The shaping time of the amplifier was set at 10 μs since the signals out of the pre-amplifier had rise times

of 4-6 μ s. The calibration of the whole readout chain was made with a high stability test pulse generator coupled with a 1 pf capacitor to the gate of the first stage FET of the pre-amp. During most of the experiments, the measured electronic noise was 19.5 and 18.5 keV FWHM for D1 and D2, respectively, at room temperature. The intrinsic resolution of the pulser was less than 2 keV. The pre-amp input capacitance was approximately 93 pf for both detectors.

It should be emphasized that in order to make an accurate comparison of the two detectors, the same electronics were used for D1 and D2 (which were within the same chamber with a common signal collection anode); measurements in the detectors were performed by simply applying high voltage to the cathode of either detector; only one detector at a time was operated. At the relatively low applied voltages used in this experiment both detectors operated in the ionization mode without amplification.

2.5. The Source

^{207}Bi is an electron capture source decaying to ^{207}Pb with a half-life of 30 yrs.¹⁷ The dominant γ -ray transitions are at energies of 569.6 and 1063.4 keV. (there is also a much weaker line at 1770.2 keV). The corresponding K-shell internal conversion electron lines are at energies of 481.6 and 975.6 keV, respectively. From Monte Carlo studies in xenon at the densities we are considering, a 1 MeV electron has a range of a few millimeters. The internal conversion electrons will thus be completely absorbed in the region between the cathode and the grid (the active or sensitive volume) in both detectors considered in this experiment. A 1.0 (0.6) MeV gamma ray has an attenuation length of approximately 12 (9) cm in 1.4 g/cm³ of xenon. Therefore, in relatively small detector volumes, the lines in the pulse height spectra are mostly due to K-shell

internal conversion electrons or their summing with the K-fluorescence x-rays or Auger electrons accompanying this nuclear decay process.

3. Data and Analysis

3.1. Pulse Height Spectra, Energy Calibration and Resolution

Typical spectra measured in high pressure (62 atm) gaseous xenon at a density of $1.40 \pm 0.04 \text{ g/cm}^3$ are shown in Figure 4 for the two detectors. The running times were 20 and 10 hours for D1 and D2, respectively, because of their differing source strengths. The peak due to test signals from the electronic pulser is at the far right and measures the noise due to electronics. Two pairs of ^{207}Bi lines are seen in each spectrum. The peak seen on the left of each pair corresponds to the K-internal conversion electron (482 and 976 keV); the peak on the right of each pair results either from the detection of the full energy of the γ -ray from the nuclear transition, or from the summing within the sensitive region of the detector of the energy from the conversion electron and the Pb x-ray or Auger electron produced by the filling of the K-shell vacancy. D2 is seen to have a higher γ -ray efficiency than D1 since it has twice the active detector volume. The peaks corresponding to the full nuclear transition are asymmetrical with a low energy tail. This is due to the detection of the L-conversion electron (which has a reduced intensity¹⁷) and/or incomplete charge collection from a γ -event.

In order to precisely determine the peak position and energy resolution for a given line, a least squares fitting routine¹⁸ was applied that took into consideration the skewed shape of the full nuclear transition lines at 570 and 1063 keV. Only fits with a χ^2 per degree of freedom between 0.95 and 1.1 were accepted. Figure 5 shows a typical fit to the data for the 976 and 1063 keV lines. The residual

between the fit and the spectrum (shown at bottom) is small and corresponds to a reduced χ^2 value of 1.02.

We chose the 976 keV conversion electron line for our charge collection and energy resolution studies. Calibration of the energy deposited in the xenon is accomplished using the known energy of the lines of ^{207}Bi and the corresponding peak positions in the pulse height spectra. The dispersion in Fig. 4 is approximately 0.6 keV/ch. Figure 6 shows the relation between the pulse height and the energy of the line for the spectrum measured in D1; it is linear to less than 1%.

For now, the energy resolution of the 976 keV electron line for a given detector is obtained by subtracting in quadrature the contribution of the electronic noise (FWHM) from the width of the peak in the spectrum. Other factors may contribute to the broadening of the pulse heights and will be discussed later. A major goal of this work is to measure the fluctuation in the number of electrons liberated from the ionization process.

4. Results

4.1. Charge Collection and Energy Resolution

The transparency of the grids in the present chamber to the drifting ionization electrons is calculated using Buneman's criteria.¹⁰ For the detector geometries used in this experiment the transparency is 100% when the collection electric field (E_c) between the anode and grid is at least 1.92 times stronger than the drift field (E_d) between the grid and the cathode. However, Buneman's formula applies to grids of wires of circular cross-sections not to the electroformed meshes used in this experiment.

In order to determine the correct field ratio to be used, we first measured the saturation characteristics of the pulse height and energy resolution versus the ratio E_c/E_d . E_d was fixed at 1.3 kV/cm for this purpose. Figure 7 shows these curves for D1 measured for 62.3 atm (1.4 g/cm³) xenon at 19.2°C using the 976 keV peak. The normalization in Fig. 7a will be described later in this section. There was only a 1% increase in charge collection over the field ratios studied. Fig. 7b displays the improvement in electronic noise subtracted energy resolution (FWHM) with increasing field ratio for D1. We see that there was a significant improvement in energy resolution but not charge collection. The errors bars are due to statistical uncertainties of the fit and systematic uncertainties in the applied electric field ratios. We chose an operating field ratio of 3.5 for our further studies.

Figure 8a displays the dependence of the pulse height of the 976 keV electron peak on E_d for a field ratio of 3.5 in the two detectors. The ordinate is the ratio of the collected charge, Q , to the net charge, Q_0 , obtained using 21.9 eV as the w -value in gaseous xenon and an absolute charge calibration that was performed. The value of Q/Q_0 is approximately 98% at $E_d=1.5$ kV/cm where the curve has sufficiently saturated. This fraction is consistent with complete charge collection since the overall systematic uncertainty in the absolute charge calibration is 4% (not shown in the figures).

Figure 8b shows the electronic noise subtracted energy resolution (FWHM) vs. E_d for the two detectors. We see that the charge collection and energy resolution improves with increasing field in approximately the same manner for D1 and D2. At about 1.3 kV/cm the energy resolution has a value of $2.0 \pm 0.1\%$ and $2.1 \pm 0.1\%$ FWHM in D1 and D2, respectively, which corresponds to 19.5 ± 1.0 keV and 20.5 ± 1.0 keV FWHM for the 976 keV peak for 1.4 g/cm³ of xenon. These values are seen to improve slightly at higher electric fields. The errors bars are due to statistical uncertainties in the fit and systematic uncertainties in the

applied electric fields (possibly causing different operating conditions for D1 and D2). The data points for the two detectors agree within the statistical and systematic errors for all electric field values.

Figure 9 shows the relation between the FWHM electronic noise subtracted energy resolution for the K-conversion electron peaks and their energy. The linearity and the fact that it passes through the origin indicates that the energy resolution scales as $1/E^{1/2}$ to other energies. The extrapolated energy resolution at 2480 keV, the endpoint of ^{136}Xe $\beta\beta$ decay, is slightly over 1%.

4.2. Stability

Measurements were conducted over a 7 month period using D1 as the monitor. In this time there were many successive purifications of the xenon and several exposures of the detector to the atmosphere. The longest running time without repurifying or opening the chamber was approximately 5 months. In this entire seven month period, no change in collected charge was observed to within 0.1%. The variation in the energy resolution was less than 1 keV. These values are consistent with the overall uncertainties of 0.1% in the position of the centroid and 1.0 keV in the FWHM of the 976 keV peak as extracted by the fitting routine due to the statistical uncertainties in the data. These facts indicate a very clean chamber with low residual outgassing rate and an efficient and reliable xenon purification system.

4.3. Previous Results

Similar results were obtained in a significantly different detector. In Fig. 10 we show a ^{207}Bi spectrum taken in 0.9 g/cm³ (58 atm) xenon in a small gridded ionization chamber prototype that was previously developed. The grid-anode and grid-cathode spacings were 0.5 and 1.3 cm, respectively. The cathode and grid

were disks 6.4 cm in diameter. The anode was a disk 2.5 cm in diameter. The grid had an aperture of 2.0 cm over which 63.5 μm diameter wires spaced 635 μm apart were spot welded. Because the grid was made with wires of circular cross-section, a field ratio of 2.0 was sufficient for this detector geometry.

The electronic noise, obtained from the width of the pulser peak, was approximately 6 keV FWHM and characterized the low input capacitance (~ 20 pf) of this system. The low energy "bumps" on the full nuclear transition peaks are due to the L-internal conversion electron lines of ^{207}Bi and can be clearly seen because of the lower electronic noise of this system (compare with Fig.4). The electronic noise subtracted energy resolution (FWHM) measured for the 976 keV peak of ^{207}Bi in this spectrum was 16.6 ± 1.0 keV (1.7%) at an applied drift electric field of 3.0 kV/cm. This value for the energy resolution is consistent with that obtained at 1.3 kV/cm in our present dual-gridded ionization chamber operating at 1.0 g/cm³ (see Fig. 11a). The stability of the prototype chamber was also excellent.

5. Discussion

5.1. Attachment to Electronegative Impurities

If there was a significant loss of ionization electrons due to scavenging by electronegative impurities, then there should be a detectable difference in the charge collected and energy resolution in detectors with different drift distances. At 1.5 kV/cm there is less than a 0.1% difference in the collected charge, and less than a 0.4 keV difference in the FWHM energy resolution (electronic noise subtracted) of the 976 keV peak between D1 and D2 (see Fig. 8). These values are well within the quoted errors. We thus conclude that there is no evidence of attachment to electronegative impurities in our experiment.

5.2. Intrinsic Energy Resolution

In order to determine the spread in energy of the 976 keV peak purely due to the fluctuation in ionization, we must measure and/or estimate the contribution of all other peak broadening effects. By far the largest contribution was due to the noise of the electronics, measured to be roughly 19 keV in both detectors. This number could be reduced by decreasing the capacitive load of the preamplifier (93 pf in the present experiment). This could be accomplished simply by reducing the size of the anode or by segmenting it and by utilizing physically smaller, lower capacitance electrical feedthroughs connected to the anode. For example, the electrical noise was only 6 keV in the smaller prototype described in section 4.3, as a result of the smaller input capacitance (~ 20 pf) in that chamber.

Other factors that might contribute to the broadening in energy were examined. The conversion electron lines from the ^{207}Bi sources were examined using a cooled Si(Li) electron detector. The inherent width of the peaks from the sources, including any backscattering in the source material, was less than 2 keV, a negligible effect.

The effect of the variation in the rise time of individual preamplifier pulses is determined by the drift time of the ionization electrons relative to the shaping constants of the amplifier. At a xenon density of 1.4 g/cm^3 , the rise times of the pre-amp signals were 4-6 μs . We observed no detectable change in the energy resolution for shaping times $\geq 10 \mu\text{s}$.

As we saw from Figure 7b, for a fixed drift electric field, there was no significant improvement in energy resolution in either detector once we were at a field ratio of 3.5. Thus, the effect of the trapping of drifting ionization electrons on the grid was also negligible.

Thus, the measured intrinsic energy resolution in our xenon ionization chamber will be defined as that obtained by subtracting in quadrature only the electronic noise from the measured width of the peak in the pulse height spectrum.

5.3. *Recombination*

Maintaining the field ratio at a value of 3.5 keeps the grid losses small and constant. By varying the drift electric field, we can then examine the effects on the energy resolution due solely to recombination effects. As seen in Figure 8b, the energy resolution was still improving slightly at the highest drift electric fields we utilized. However, in previous studies done in a smaller prototype (see section 4.3), we were able to reach drift electric fields of > 3.0 kV/cm. There was only a slight improvement in energy resolution above 1.3 kV/cm in that chamber.

Another approach to studying the effects of recombination on the energy resolution is to lower the density of the xenon gas. The resolution should improve as the density is lowered, due to reduced geminate or columnar recombination effects. This specific type of investigation has not been performed using liquid xenon. The gas density was gradually lowered in 9 steps from 1.40 to 0.49 g/cm³. At each step the intrinsic energy resolution and charge collection were measured at a field ratio of 3.5 and a drift field of 1.3 kV/cm. The results are presented in Figure 11 for D1.

From Fig. 11a, we see that at a density of 0.49 g/cm³ the intrinsic energy resolution has improved to $1.2 \pm 0.1\%$ FWHM for the 976 keV conversion electron peak. However, there was no indication of an increase in collected charge, as seen in Fig. 11b.

If the amount of electron-ion recombination were decreasing with lower density, we would expect an improvement in energy resolution to be accompanied by a measurable increase in the amount of charge collected from the ionization

process. This does not appear to be the case in Fig. 11b. We searched for systematic effects that might cancel this expected enhancement but found none (rise time and other electronic effects were negligible). Clearly the intrinsic resolution in our chamber is not solely determined by simple Poisson statistics.

We thus conclude that the resolution improved by nearly a factor of 2 as the density was lowered without a statistically significant increase in the average amount of charge collected. This fact further demonstrates that attachment to electronegative impurities is undetectable in our detector. If scavenging did occur, it should diminish as the density was lowered while the amount of charge collected from a given ionization process would increase.

6. Conclusions

29/0 We have demonstrated the ability to drift ionization electrons over large distances in highly compressed xenon at room temperature. The intrinsic energy resolution of the 976 keV K-conversion electron peak of ^{207}Bi was measured to be 20 keV FWHM in 1.4 g/cm^3 (62 atm) of xenon, independent of the distance over which the charge drifts. No change in charge collection or energy resolution could be detected during the entire 7 month running period. These results show that the chamber construction and the purification system utilized were more than adequate to eliminate the problem of attachment to electronegative impurities which has plagued the stability of liquid xenon detectors of the past.^{5,9,20-22} In addition, the chosen grid design, electric field assignments, geometries and pulse shaping parameters made most charge loss mechanisms and width broadening effects negligible.

An additional effect was observed as the density of the xenon was lowered. We found that reducing the density of the xenon gas from 1.4 to 0.5 g/cm^3 improved the energy resolution without an increase in the average charge collected.

This fact contradicts both intuition and previous assumptions of the effects of recombination. The best intrinsic energy resolution obtained for the 976 keV K-conversion electron peak of ^{207}Bi in this work was 11.7 ± 1.0 keV (1.2%) FWHM in xenon gas at a density of 0.5 g/cm^3 (52 atm). While still a factor of 3 worse than the Fano limit, this result is the best reported thus far in xenon by nearly a factor of 5.

Acknowledgments

This work was performed at the Yale University A. W. Wright Nuclear Structure Laboratory and supported by USDOE Grant No. DE-FGO2-91ER-40609. We acknowledge Professors D. Allan Bromley and Peter Parker and the staff of W.N.S.L. for their interest in and support of this project.

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Figure Captions

Fig. 1. Some isotherms of xenon and the location on the graph of this and some other xenon experiments.

Fig. 2. Schematic of the dual-gridded ionization chamber developed for the high pressure xenon gas experiments. The two drift distances are 2.7 and 5.0 cm; the distance between the grid and anode is 6.4 mm in both detectors and the diameter of the electrodes is 11.4 cm.

Fig. 3. Schematic of the xenon gas handling and purification system developed.

Fig. 4. ^{207}Bi pulse height spectrum in 62 atm (1.4 g/cm^3) of xenon gas for two different drift distances at $E_d=1.3 \text{ kV/cm}$. The full nuclear transition lines are at 570 and 1063 keV. The electronic noise subtracted energy resolution is 20 keV FWHM for the 976 keV internal conversion electron peak in both detectors. The FWHM of the test pulse peak (far right) is 19.5 (18.5) keV for the 2.7 (5.0) cm drift distance.

Fig. 5. A typical fit to the data for the 1 MeV region of a ^{207}Bi pulse height spectrum. The solid line is the best fit to the data. The residual of the fit is shown at the bottom. The reduced χ^2 value for the fit is 1.02.

Fig. 6. The energy calibration of the 62 atm xenon gas chamber.

Fig. 7. a) Fraction of collected charge expected and b) electronic noise subtracted energy resolution (FWHM) as a function of electric field ratio for 976 keV electrons in D1 (2.7cm drift distance). There is an overall systematic uncertainty in the absolute charge calibration of 4%, not shown.

Fig. 8. a) Fraction of collected charge expected and b) electronic noise subtracted energy resolution (FWHM) as a function of applied electric field between the cathode and the grid for 976 keV electrons in both detectors. The vertical error bars are due to the statistical errors in the fits; in a) these error bars are roughly the size of the data points. There is an overall systematic uncertainty in the absolute charge calibration of 4%, not shown.

Fig. 9. Relation between the electronic noise subtracted % energy resolution (FWHM) of the conversion electron peaks of ^{207}Bi and their energy in 1.4 g/cm^3 of xenon gas. The linearity indicates that the energy resolution scales as $1/E^{1/2}$ to other energies.

Fig. 10. ^{207}Bi pulse height spectrum in 58 atm of xenon gas at 3.0 kV/cm for a small prototype previously developed (see section 4.3). The noise subtracted energy resolution of the 976 keV electron peak is 17 keV FWHM. The FWHM of the test pulse peak is 6 keV.

Fig. 11. a) Electronic noise subtracted energy resolution and b) collected charge as a function of the xenon gas density at $E_d = 1.3 \text{ kV/cm}$ for the 976 electron peak. The energy resolution improves from 2.0 to 1.2% FWHM without a statistically significant increase in the measured charge collected.

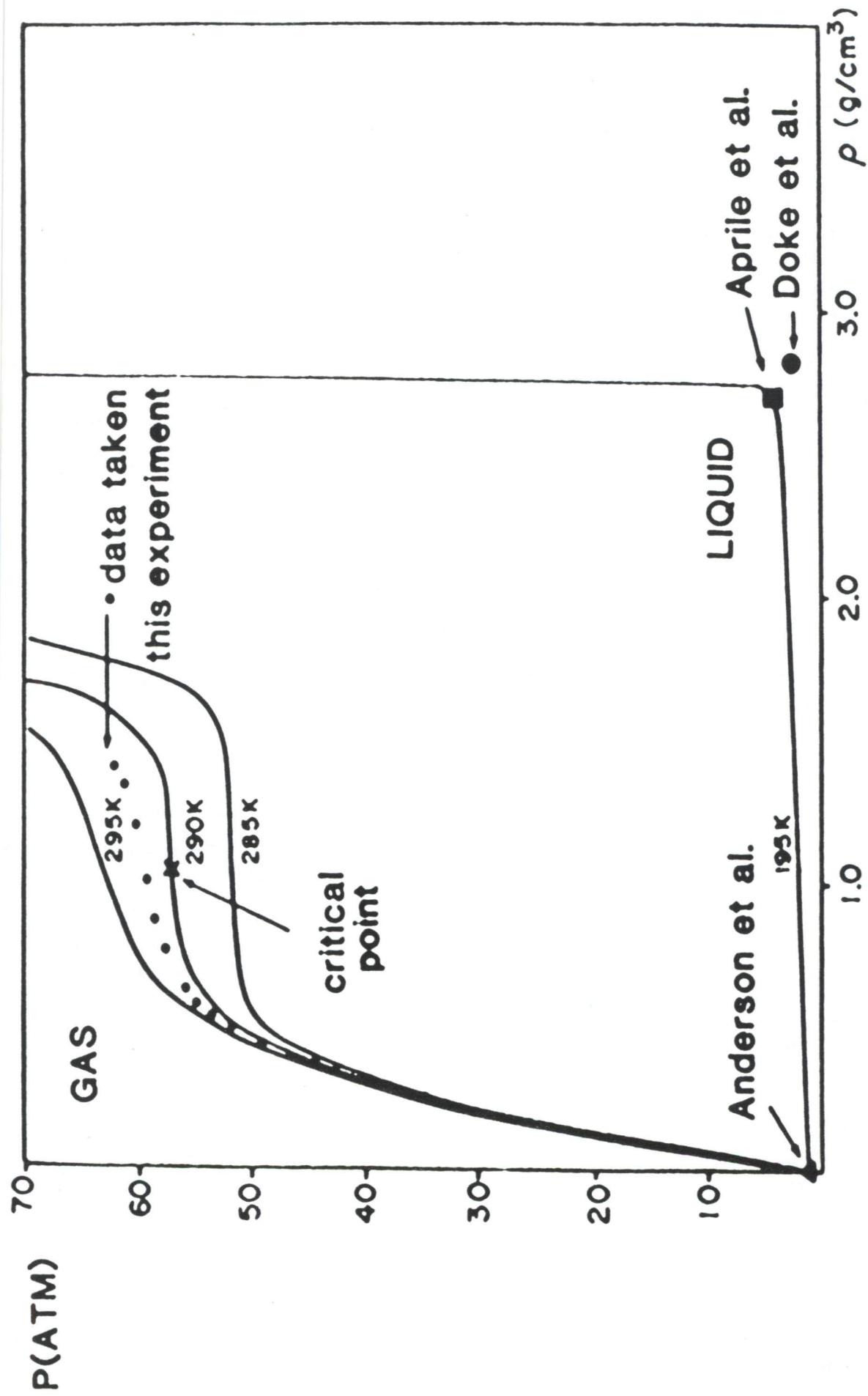


Fig. 1.

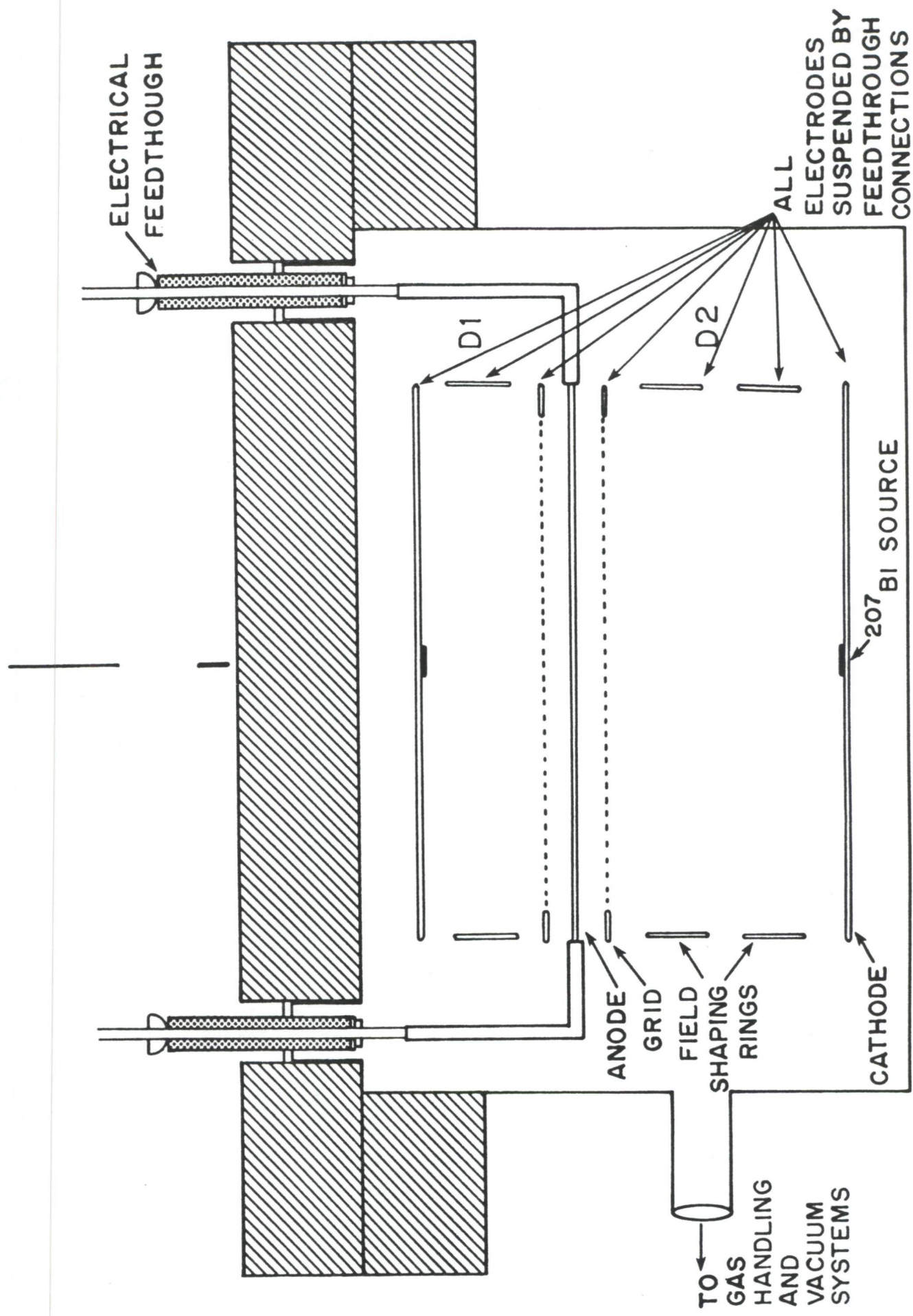


Fig. 2.

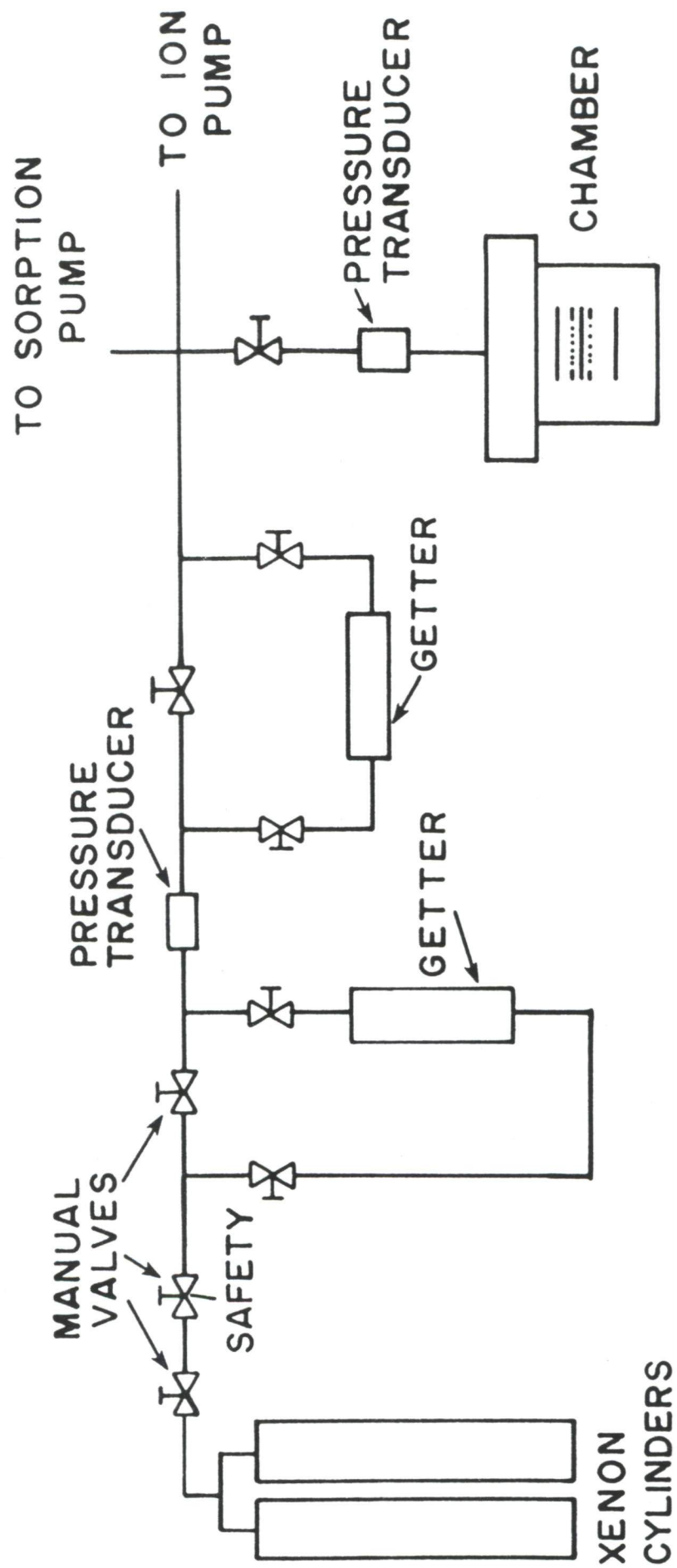


Fig. 3.

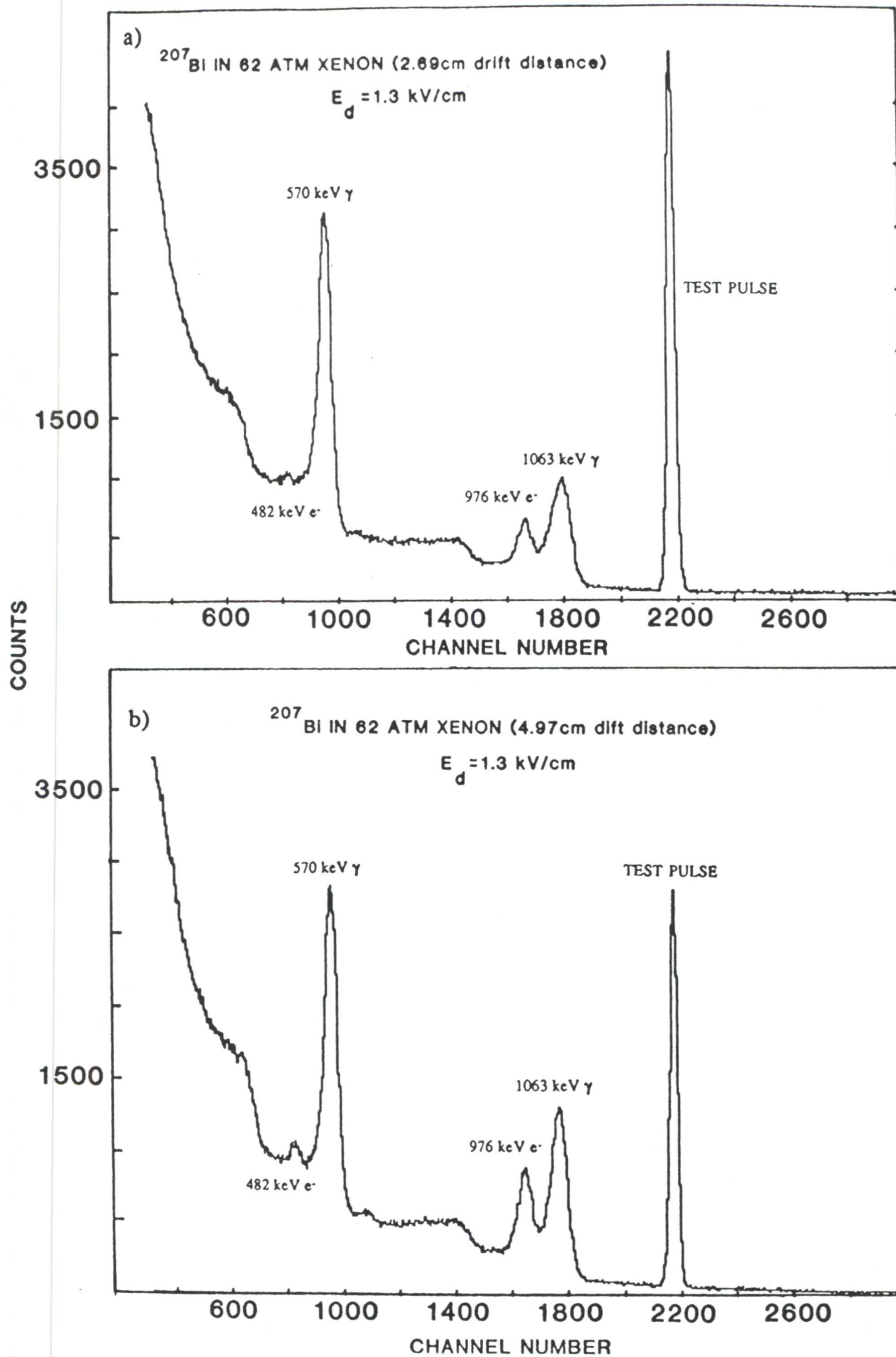


Fig. 4.

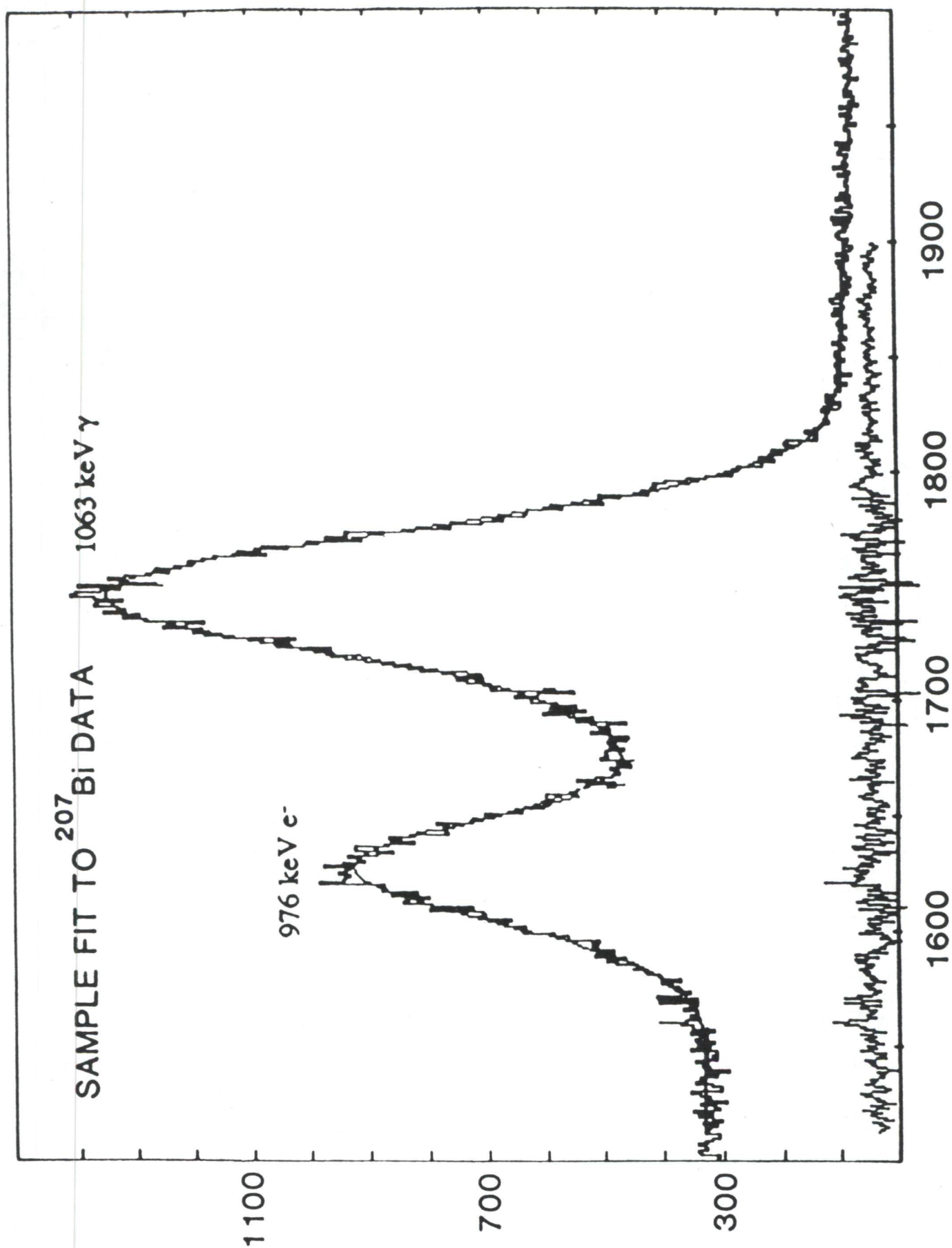


Fig. 5.

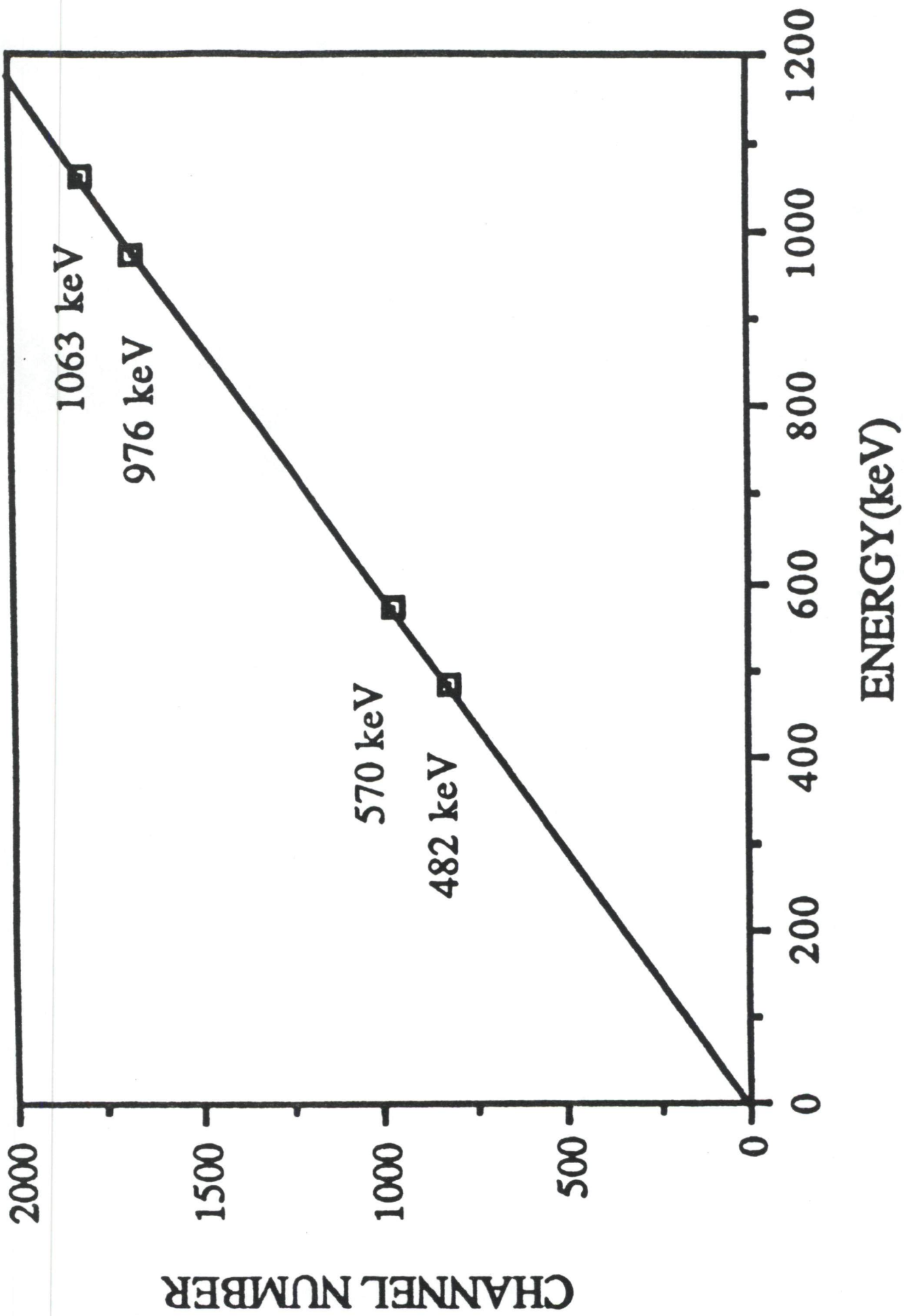
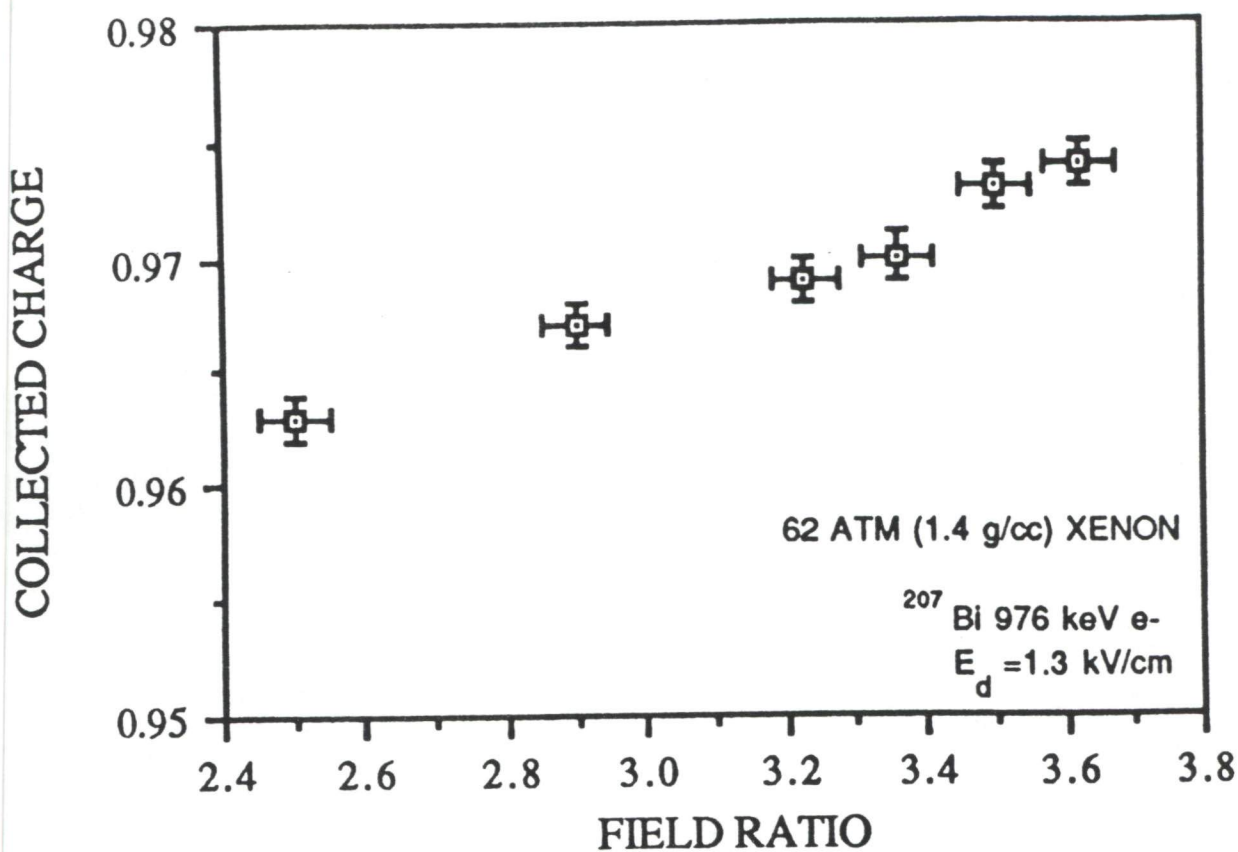


Fig. 6.

a)



b)

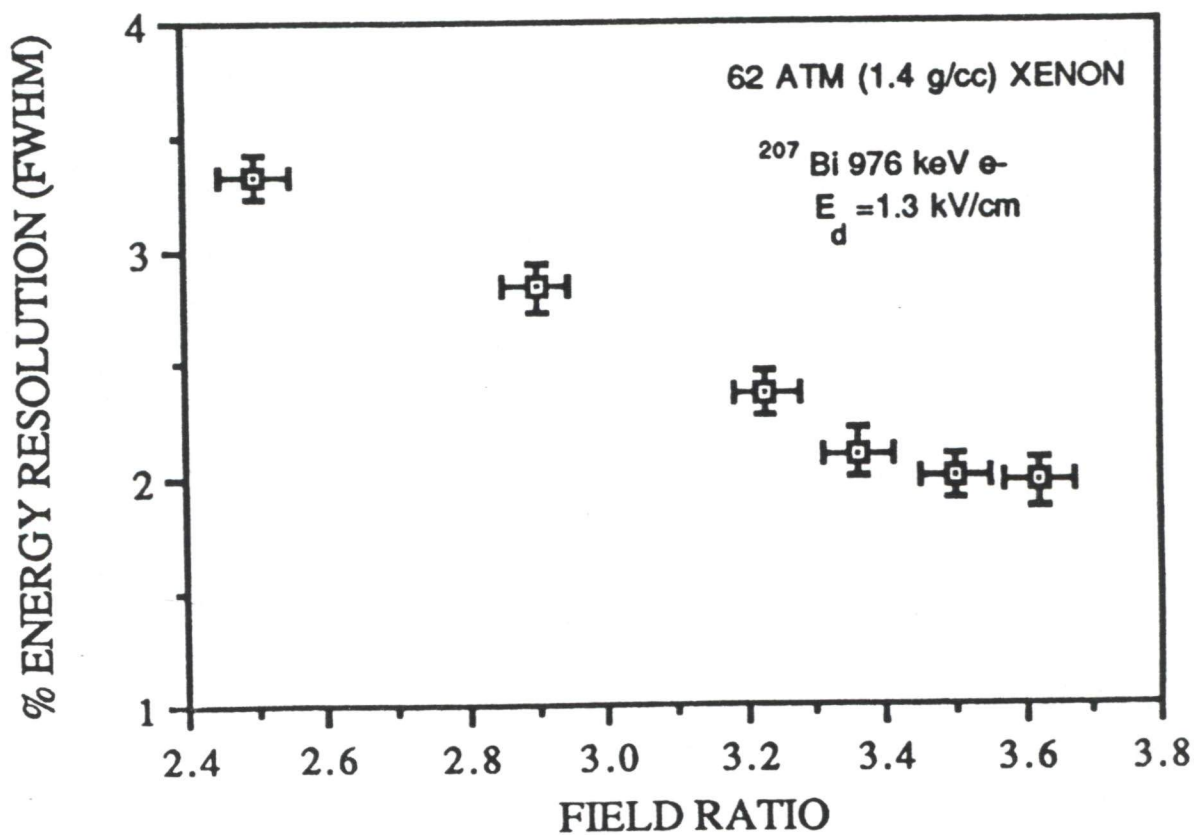
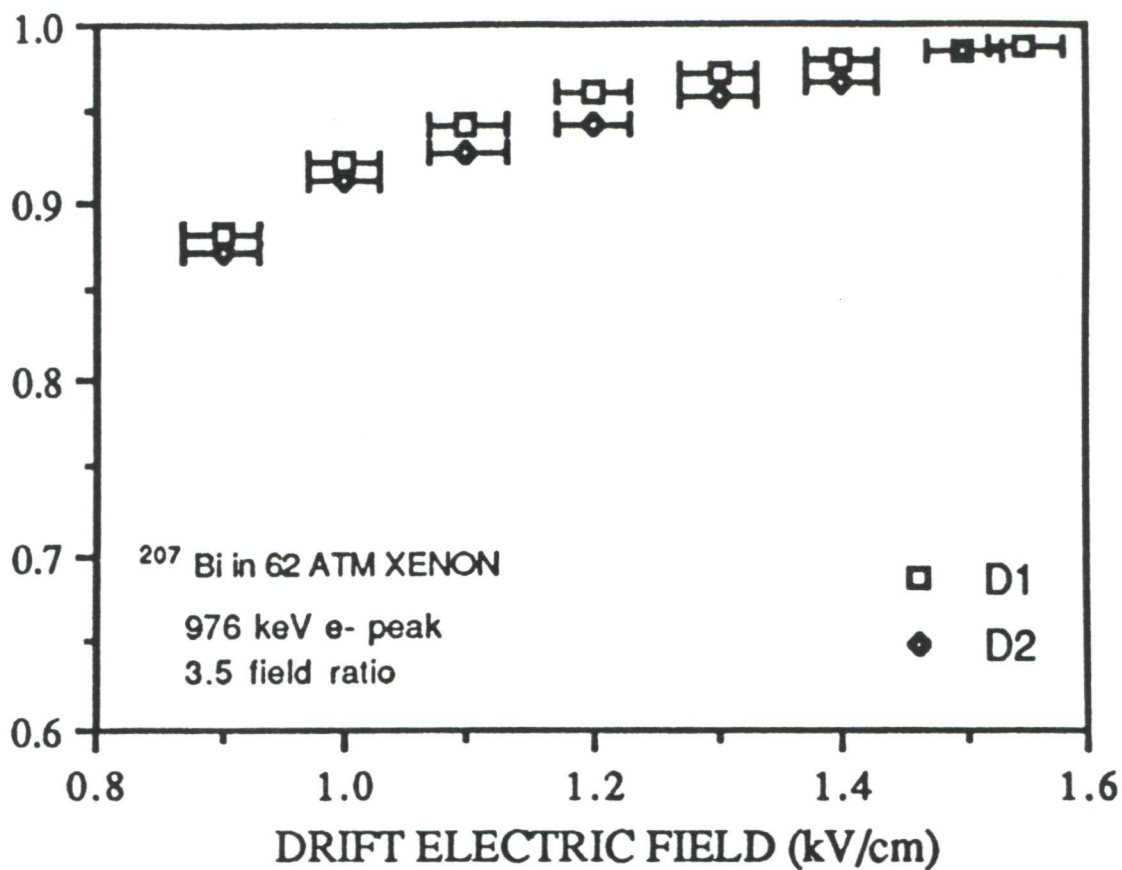


Fig. 7.

a)

COLLECTED CHARGE



b)

% ENERGY RESOLUTION (FWHM)

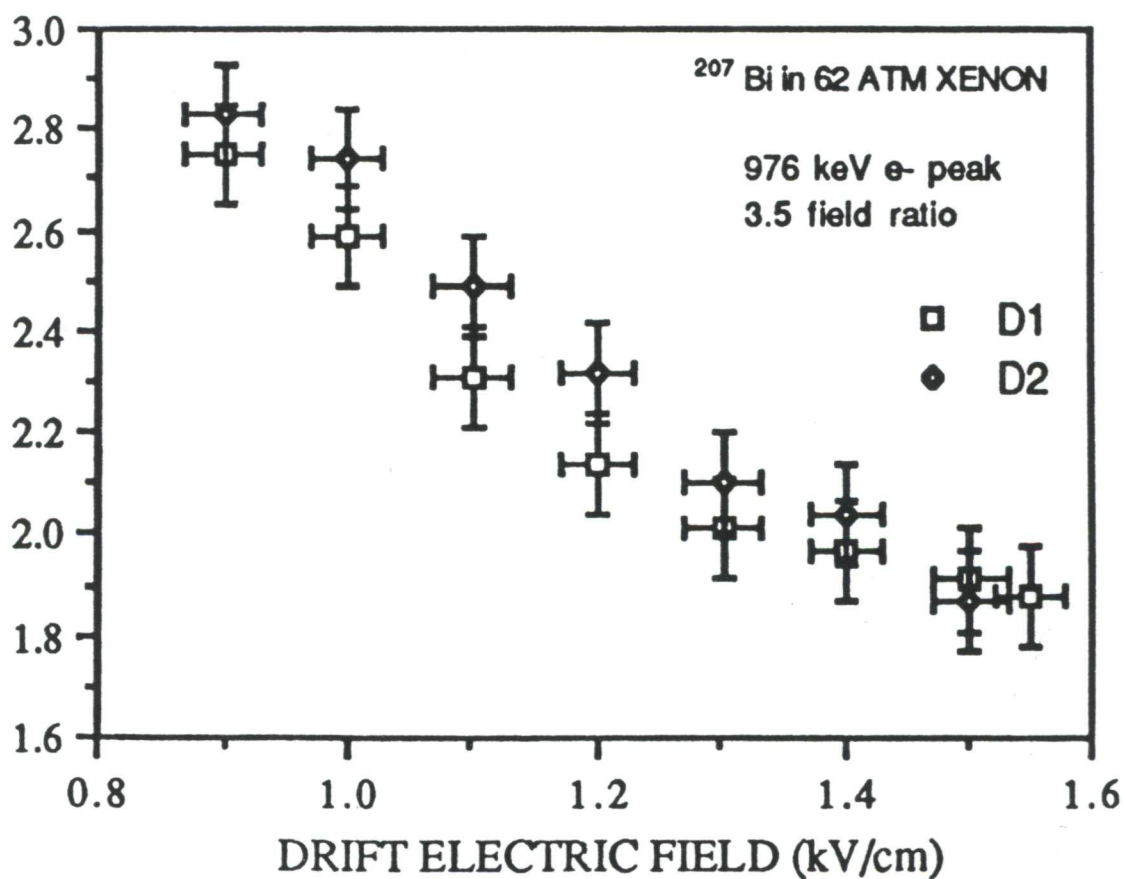
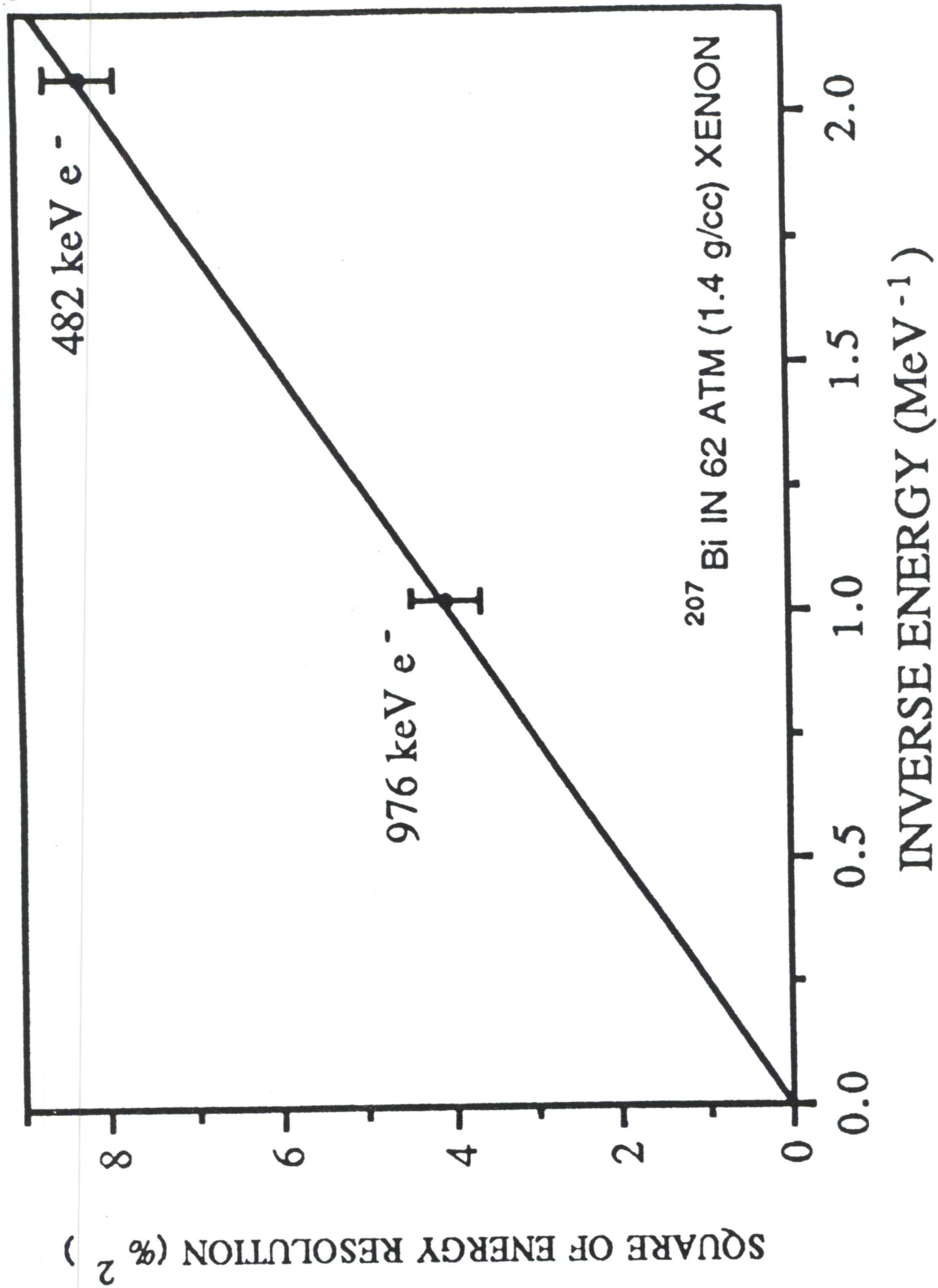


Fig. 8.



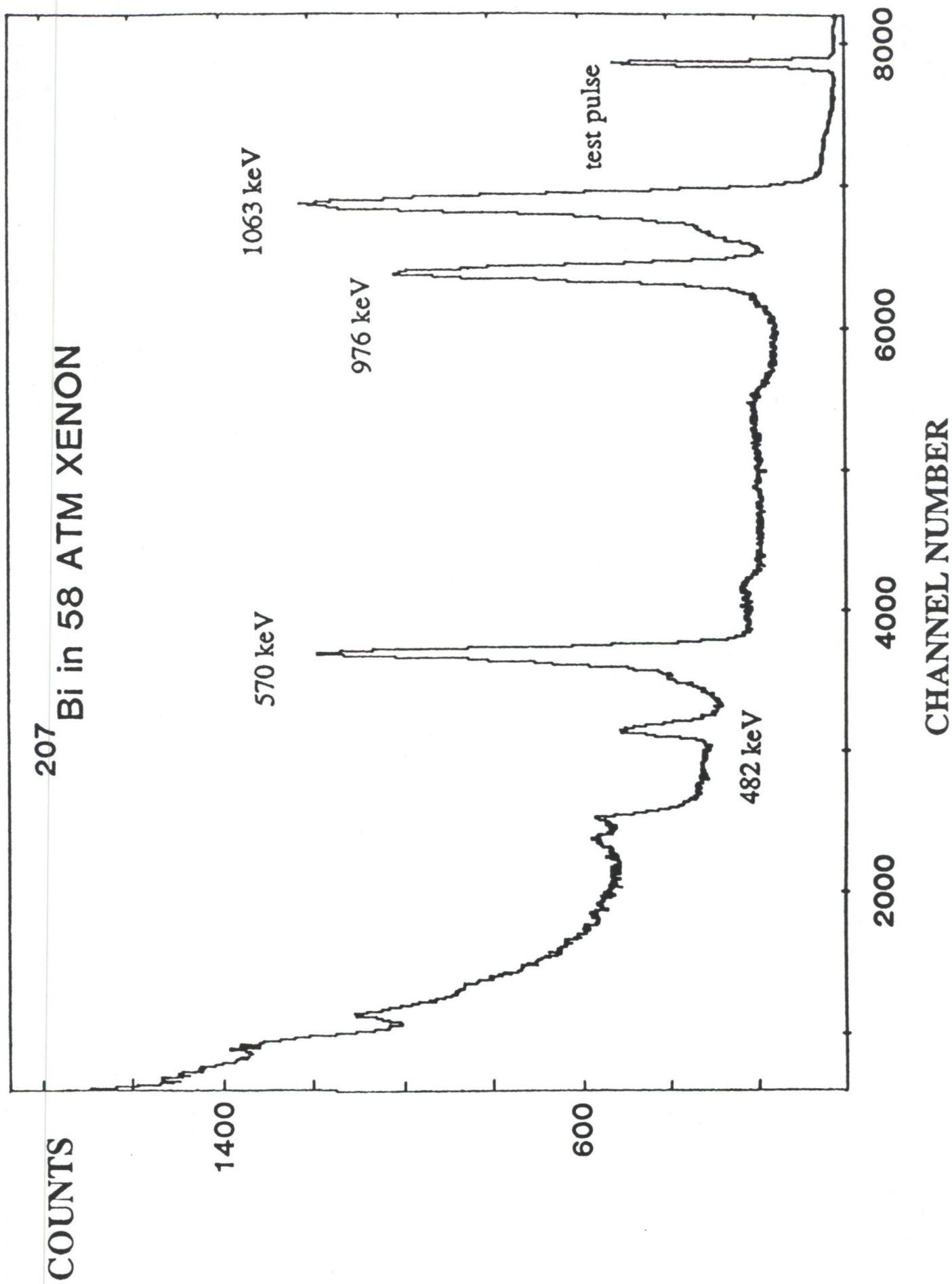
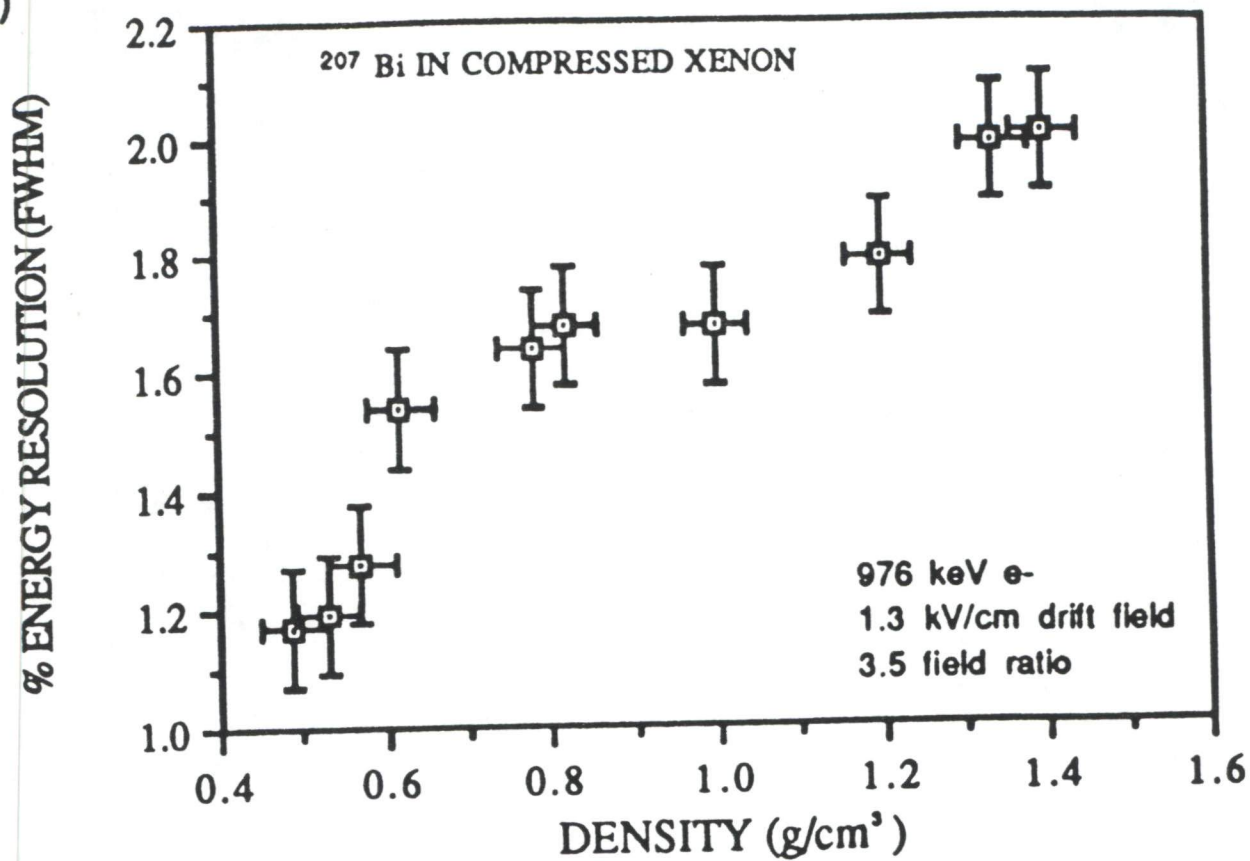


Fig. 10.

a)



b)

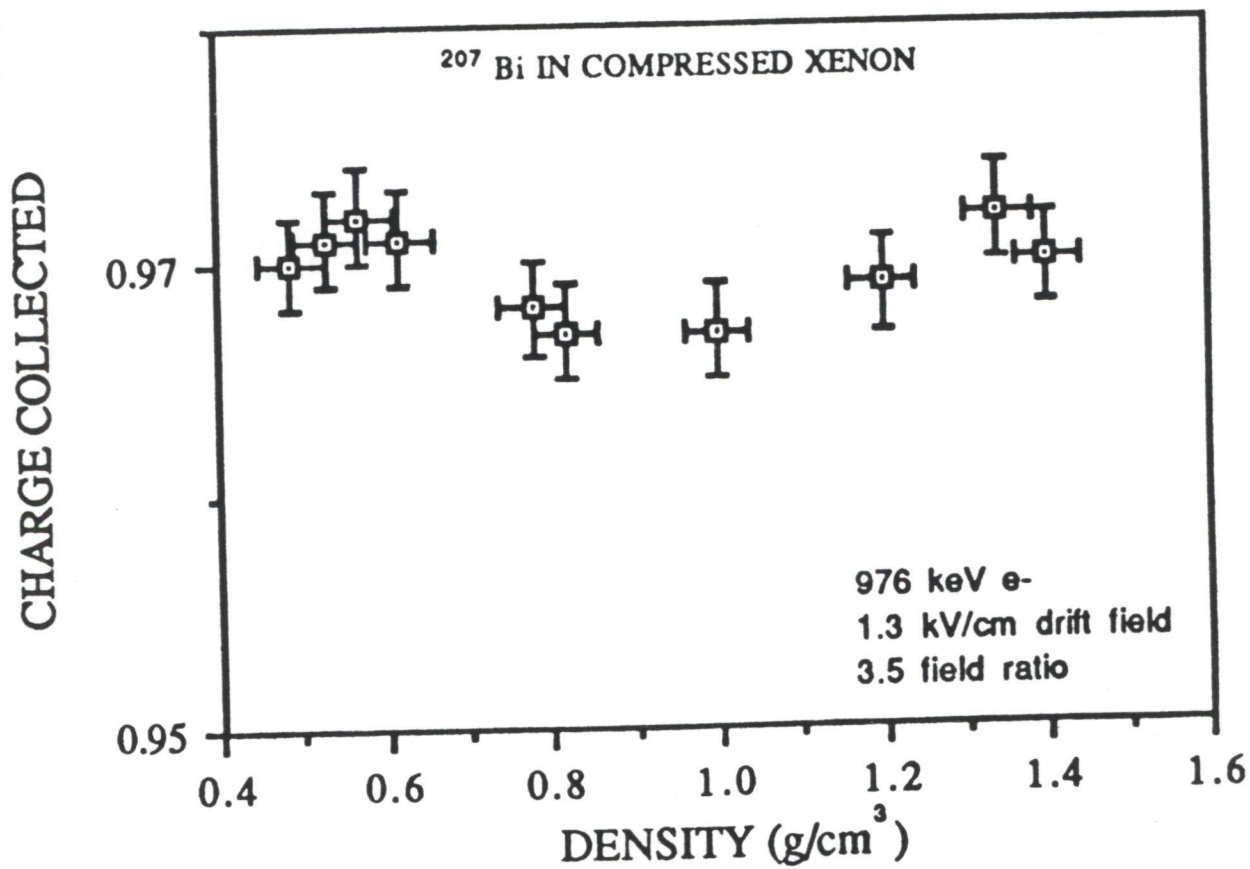


Fig. 11.

DEC 7 1992

"Document Control"

TYPE: ACTION DOCUMENT NUMBER: 9203517
ORIGINATOR: 02 STATUS I DIRECTORATE STATUS

FROM: FESBACH, Herman: MIT

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 12/01/92

SUBJECT: HE IS ASKING FOR A LIST OF THE COUNTRIES TO BE
INVITED TO INTERNATIONAL CONFERENCE ON THE FUTURE OF
NUCLEAR SCIENCE.

DIRECTORATE STAFF
ASSIGNED: PHYSICAL SCIENCES ASSIGNED:

ACTION STAFF
REQUIRED: FOR DAB'S SIGNATURE ACTION:

SENDER'S DUE DATE:
OSTP DUE DATE: 12/16/92 STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT: 12/31/92

COPIES TO: D. Allan Bromley

WHITE HOUSE TRACKING #: CONTACT PERSON:
PHONE: EXT:

REMARKS: Dr. E. drafted letter for DAB.

OSTP RECEIVED: 12/03/92 DEPT RECEIVED:
FILE: P-PHYSICAL SCIENCES

CENTRAL FILES:



OFFICE OF SCIENCE AND TECHNOLOGY POLICY

STAFFING SHEET

SUBJECT: Ltr. to H. Freshback

ORIGINATOR: K. ERB

PHONE: ✓ 13 0

DATE ORIGINATED: 12/31 DATE DUE: ASAP CORR TRACKING NO: 9203517

EXTERNAL COORDINATION:

	COMMENTS	DATE
DIRECTOR		
GENERAL COUNSEL		
SPECIAL ASST.		

ACTION REQUESTED:

[illegible]

THE WHITE HOUSE
WASHINGTON

December 31, 1992

Dear Herman,

Attached is a list of countries that Lee Schroeder, Karl Erb, and I suggest be included in the International Conference on the Future of Nuclear Science. (I have not bothered to repeat the ICHIA member countries, but assume they will be represented.)

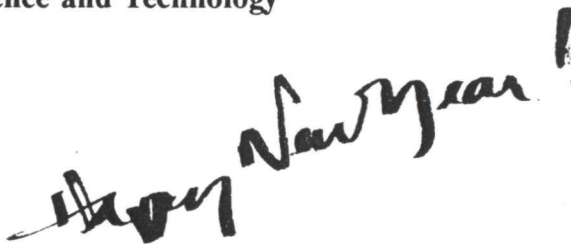
With the change in Administration, OSTP will not be able to send a representative to the January 15th organizational meeting. Karl sends his regrets.

We wish you every success with this new initiative.

Sincerely yours,



D. Allan Bromley
The Assistant to the President
for
Science and Technology



Enclosure

Dr. Herman Feshbach
Department of Physics
Massachusetts Institute of Technology
Cambridge, MA 02139

Europe/Scandinavia: Belgium, Netherlands, Denmark, Finland, Norway

South America: Argentina, Brazil

Australia

Israel

Asia: China, India, South Korea

South Africa

FSU countries and former partners

Mexico

3517

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
DEPARTMENT OF PHYSICS
CAMBRIDGE, MASSACHUSETTS 02139
Center for Theoretical Physics, Room 6-307
(617) 253-4821 — Blnet: HERMAN@MITLNS — FAX: (617) 253-8674

December 1, 1992

Dr. Allan Bromley
Old Executive Office Bldg.
Room 360
Washington, DC 20506

Dear Allan:

Just a note to thank you for your hospitality, the lunch, and the cufflinks and tiepin. It really was a pleasure to talk with you as in the good old days. The topics have changed somewhat but the spirit remains the same. I have written to Dr. Mori as you suggested: I enclose the letter.

I would appreciate it if Karl and you would list the countries to be invited to the International Conference on the Future of Nuclear Science as you suggested.

Do you have anything on applications of nuclear physics?

All the best!

Sincerely,



Herman Feshbach

Enclosures

/hg

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

DEPARTMENT OF PHYSICS

CAMBRIDGE, MASSACHUSETTS 02139

Center for Theoretical Physics

(617) 253- — Bitnet: — FAX: (617) 253-8674

December 1, 1992

Dr. Wataru Mori
Council for Science and Technology
Prime Minister's Office
2-2-1 Kasumigaseki
Chiyoda-Ku
Tokyo

Dear Dr. Mori:

At the suggestion of Dr. D. Allan Bromley, Science Advisor to the President of the United States, and of President Charles Vest of the Massachusetts Institute of Technology, I am writing to you regarding a proposal being brought forward by a committee of the Commission C12 (Nuclear Physics) of the International Union of Pure and Applied Physics (IUPAP). That committee, the International Committee on High Intensity Accelerators (ICHIA), which I chair, has the charge to develop a more effective use of the resources available to the world-wide nuclear physics community. In order to enhance and stimulate mutually beneficial cooperation the ICHIA proposal calls for an International Conference on the Future of Nuclear Science in which the scientific opportunities, the apparatus and manpower required to exploit these, and the consequent costs would be the principal topics. Note that no commitments by the participating countries are to be sought.

One novel feature of the proposal should be emphasized. It is our experience that the funding agencies need to be involved in such a meeting in order for it to be effective. It legitimizes the meeting and provides it with a credibility which is otherwise lacking. Therefore we shall be asking the appropriate national authorities responsible for science and technology to set the conference agenda and to choose a delegation with bureaucratic and scientific components. I enclose a copy of the proposal together with a list of the members of ICHIA.

A preliminary meeting (1 day) of the representatives of the countries leading in nuclear physics to develop an agenda for the international conference is being held in Bonn, Germany on January 15, 1993. The ministers of science and technology Germany, France, Italy, the European Community, and the U.S. are sending designates. It is essential that there be a corresponding Japanese delegate present. It is for this reason that I am writing to you to invite you to come to this meeting or to select a representative if you cannot. The other delegations generally consist of a representative of the minister of science and technology and an expert in nuclear science.

Dr. Wataru Mori

-2-

December 1, 1992

I apologize for inviting you with such short notice but it was not until I talked with Dr. Bromley that I learned that you were the appropriate person to invite.

I would appreciate a response at your earliest convenience. My FAX number is (617)253-8674. My electronic mail address is HERMAN@MITLNS.

Sincerely yours,

A handwritten signature in cursive script, reading "Herman Feshbach".

Herman Feshbach
Institute Professor Emeritus

Enclosures

/hg

Proposal
for
An International Conference on the Future of Nuclear Physics

The International Committee on High Intensity Accelerators (ICHIA) is a committee of the Commission on Nuclear Science C12 of IUPAP. ICHIA is charged with developing a more effective use of the resources available to the world-wide nuclear physics community. As the expenditures required to construct and exploit forefront nuclear physics facilities grow, worldwide cooperation becomes a necessity. It is in order to enhance and stimulate such mutually beneficial arrangements that ICHIA proposes an International Conference on the Future of Nuclear Physics. The conference would

- 1 Outline the scientific opportunities in the field of nuclear physics;
- 2 Describe the needed equipment, the accelerators and detectors, the manpower, etc., as well as the timing which would respond in a productive way to these opportunities;
- 3 Estimate the consequent costs.
- 4 The appropriate government agencies should set the agenda and choose the delegates to the meeting. These should include those who can discuss authoritatively the present plans of each government and who can assess the costs of the equipment which the conference will consider.
- 5 Discuss the need for institutional arrangements which would further international cooperation.
- 6 Develop a conference report which responds to (1)-(5).
- 7 Invite representatives of NUPCC and NSAC to attend the conference.

it would be up to each government and the national nuclear physics community to use the conference document as they see fit. We expect that the conference report will describe a worldwide rational and coherent approach to providing support for nuclear physics. Opportunities for international cooperation will naturally present themselves, but detailed commitments will not be proposed at this meeting. Rather the meeting will provide a forum in which cooperative initiatives can be discussed.

MEMBERS OF ICHIA

Robert Adair (USA)

G. T. Garvey (USA)

P. J. Twin (UK)

A. Molinari* (Italy)

E. Vogt (Canada)

B. Povh (Germany)

A. K. Kerman (USA)

T. Yamazaki (Japan)

H. Grunder (USA)

R. Bock* (Germany)

G. Voss (Germany)

Bernard Frois* (France)

T. Ericson (CERN)

I. Sick* (Switzerland)

V. Lobashev (USSR)

H. Feshbach (USA) Chair

A. Arima (Japan) *ex officio*

*To be confirmed

"Document Control"

TYPE: INFORMATION

DOCUMENT NUMBER: 9203615

ORIGINATOR: 02

STATUS C

DIRECTORATE STATUS

FROM: SCALISE, George M.: SIA

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 12/01/92

SUBJECT: HE IS FORWARDING A COPY OF THE AMERICAN APPRAISAL
STUDY ON THE DEPRICIABLE LIFE OF SEMICONDUCTOR
EQUIPMENT.

DIRECTORATE STAFF
ASSIGNED: ASSIGNED:

ACTION STAFF
REQUIRED: ACTION:

SENDER'S DUE DATE:
OSTP DUE DATE: STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT:

COPIES TO: D. Allan Bromley
PHYSICAL SCIENCES

WHITE HOUSE TRACKING #: CONTACT PERSON:
REMARKS: PHONE: EXT:

OSTP RECEIVED: 12/07/92
FILE: P-PHYSICAL SCIENCES

DEPT RECEIVED:

CENTRAL FILES:



SEMICONDUCTOR INDUSTRY ASSOCIATION

4300 Stevens Creek Boulevard • Suite 271
San Jose • CA 95129 • (408) 246-2711

3615

FAX (408) 246-2830

December 1, 1992

Mr. Allan Bromley
Assistant to the President
for Science and Technology
358 Old Executive Office Building
Washington, D.C. 20500

Dear Allan:

As we discussed today, attached is the American Appraisal study on the depreciable life of semiconductor manufacturing equipment. The study concludes that the depreciable life of the equipment is 3.75 years.

Thank you for taking the time to meet with me. Please let me know if you need any further information.

Sincerely,

A handwritten signature in blue ink that reads "George Scalise" with a stylized flourish at the end.

George M. Scalise
Chairman, SIA Public Policy
Committee, and Senior Vice
President, National Semiconductor

Enclosure

DEPRECIATION RATE REPORT

Semiconductor Industry Association

San Jose, California

Semiconductor Equipment and Materials International

Mountain View, California



American Appraisal Associates

"Document Control"

TYPE: INFORMATION

DOCUMENT NUMBER: 9203602

ORIGINATOR: 02

STATUS C

DIRECTORATE STATUS

FROM: BABCOCK, Horace W.: THE OBSERVATORIES

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 11/30/92

SUBJECT: HE IS FORWARDING A COPY OF HIS LETTER TO DR. JAMES
BELETIC REGARDING AN ADVANCED CAMERA.

DIRECTORATE STAFF
ASSIGNED: ASSIGNED:

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PHYSICAL SCIENCES

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FILE: P-PHYSICAL SCIENCES

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THE OBSERVATORIES

OF THE CARNEGIE INSTITUTION OF WASHINGTON

30 November 1992

Dr. James W. Beletic
Electro-optics and Physical Sciences Laboratory
925 Dalney Street
Georgia Institute of Technology
Atlanta, Georgia 30332-0800

FAX 404-894-6285

Dear Dr. Beletic,

I am responding to your letter of November 19 in which you state that you are a member of a Space Telescope Science Institute panel that is helping to define the Announcement of Opportunity for an advanced camera (1999 installation) which would extend and improve the measurements taken by the WF/PC II camera of the Hubble Space Telescope.

As one aspect of the justification for an advanced camera, you propose a comparison between (a) the predicted performance of the HST with the projected new camera and (b) the expected capabilities of ground-based astronomical telescopes equipped with adaptive optics. You write that the panel's initial review of the field of adaptive optics has generated a "straw man prognosis" for this new technology, and you have provided me with a copy, as well as a request for some specific and detailed forecasts for the 1999 time frame. (I must point out that, for me, your questions 1--6 are not relevant, as I have no R and D project.)

Predicting in 1939 the course of development of microwave radar for the following six years would have been easier, even though, in that year, much of the basic technology remained to be invented. Microwave radar had tremendous organizational and operational advantages: the wartime work was concentrated in two large, well staffed laboratories: the Radiation Lab at MIT and in its counterpart in Britain. Financial support was commensurate with the needs. Such a well-planned situation does not exist today for adaptive optics in the United States.

Adaptive optics is still in its infancy, but it is alive and well. Rapid progress is occurring at many research centers and industrial laboratories that are rather widely dispersed. Groups in Europe, especially at the European Southern Observatory, have been among the leaders. International conferences dealing with adaptive optics and sponsored by the ESO (Garching bei Munich) have been of great value.

Until 1991, developments in AO were carried out along two separate but parallel tracks, one dealing with applications in astronomy as described in the open literature, the other with

military research and applications involving lasers. The latter were largely classified. The international Laser Guide Star Adaptive Optics Workshop (March 10-12, 1992) held at the Phillips Laboratory, Kirtland AFB, Albuquerque N.M., was valuable in bringing together researchers from the diverse and independent groups that seemingly have been operating with few visible administrative connections and too often with catch-as-catch-can funding. All of this suggests that, as for research and development of adaptive optics in the United States, improved coordination of effort and a better balance of support are much to be desired.

In the present situation, I suggest that, rather than attempt to provide highly specific technical forecasts for AO six years ahead, it is desirable to become well acquainted with the present position and with the rate at which advances are now being brought about.

It is fortunate that Jacques Beckers, certainly one of the foremost contributors to the growth of AO, has recently completed a review article that will appear next year in Volume 31 of Annual Reviews of Astronomy and Astrophysics. As Beckers states, adaptive optics is undergoing a rapid evolution which is expected to lead within the foreseeable future to its full implementation on astronomical telescopes. It promises to change radically the face of ground-based optical astronomy in the 21st century. Preprints of Beckers' review may be requested from him at the European Southern Observatory [Scientific Preprint No. 877], or if you need a copy quickly, let me know and I'll be glad to send you one.

I strongly recommend that you review Beckers' article, especially Section 8, where he discusses applications of AO to astronomy. The research possibilities that will be opened to ground-based astronomers are enormous. Beckers' comments on the present position and future prospects of AO are much to the point.

I believe it is rewarding to review briefly developments in European astronomy over the past 40 years. In 1953, Walter Baade, originally from Germany, was a senior astronomer here on the staff of the Mount Wilson and Palomar Observatories. Jan Oort (1900-92) of the Netherlands, "dean" of European astronomers, was in Pasadena on one of his many visits to the Observatories. An historic discussion took place between the two in Baade's tiny office here at Santa Barbara Street. They agreed that:

(1) The Southern Hemisphere lacked large modern telescopes, yet many of the more interesting and challenging objects for study were south of the equator.

(2) The U.S. had a preponderance of good observational facilities (including the 5-meter Hale Telescope), while such

were lacking for European countries, largely because of poor observing conditions. European astronomers, however, had a long history of outstanding theoretical contributions.

(3) It was essential for several of the European countries to join forces for the long term in organizing, financing, designing, constructing and operating a major astronomical observatory in the Southern Hemisphere, thereby gaining much-needed facilities for the conduct of research.

(4) The purpose of the European Southern Observatory would be to advance the science of astronomy, with opportunities to be allotted to astronomers of the member nations in proportion to budgetary contributions.

ESO was organized within a few years, and an excellent mountain site (La Silla) near the coast of Chile was acquired under the direction of Otto Heckmann in 1963; European headquarters were established near Munich. ESO has never looked back. The organization is admirably constituted and administered; its goals are well defined; its governing councils are composed of astronomers, and it has dependable financial support. A number of American astronomers, perhaps sensing greater opportunities, have left the U.S. to join the staff of ESO. It has been announced that Riccardo Giacconi, for several years director of the Space Telescope Science Institute in Baltimore, will assume the directorship of ESO in January 1993.

With numerous telescopes already operating in Chile, ESO has been planning since 1985 to construct an array of four 8-meter telescopes, all to be equipped with adaptive optics. Design is well advanced, and the 8-m disks have been cast for the primary mirrors. The first is being optically figured in France. The four 8-m telescopes of the Very Large Telescope Array are designed so that they can be used interferometrically. Each will be equipped with adaptive optics, which will enhance performance by a large factor, thus yielding extremely high optical resolution. As reference to Beckers' (1992) review paper will show, ESO astronomers and engineers have been at the forefront of design, testing and proving of AO systems, first in France and then on the 3.6-m New Technology Telescope in Chile. In general, European astronomers have led in the application of adaptive optics to astronomy, with the exception of laser hardware. In the U.S., laser applications to AO are being actively pursued by the Phillips Laboratories at the Starfire Optical Range, near Albuquerque, by the Lincoln Laboratory (MIT), and by the Lawrence Livermore Laboratory.

I am adding a few brief technical comments.

One forecast that can be made with some confidence is that valuable experience will be gained by fitting the design

parameters of AO systems to actual atmospheric conditions at outstanding observatory sites, especially those with low wind speed. Of course, astronomers at ESO (La Silla) are already doing this, and their progress has been reported. (See, e.g., the continuing series of the bi-monthly ESO Messenger.) Improved use of existing telescopic facilities in the U.S. could be made.

A solution to the tilt determination problem when laser guide stars are used has been proposed by Rigaut and Gendron, who show that dual AO will give nearly full sky coverage even at visible wavelengths without limitation of accuracy by tilt residuals. I have suggested in a paper submitted to JOSA-A that a single AO system, multiplexed by optically switching between the target and the tilt-reference star, can be used to achieve the huge gains in sky coverage predicted by Rigaut and Gendron, but without the need for duplication of system components.

It has been predicted that focus anisoplanatism can be removed by use of multiple (3 to 4) laser guide stars, with "stitching" of the wave fronts. Experiments have been reported by Murphy (1991, 1992); others are working on this problem. There have also been several proposals to increase the isoplanatic patch size by multi-conjugate AO.

Use of laser guide stars can be restricted to a zone within about 40° of the zenith. This will suit requirements for minimal atmospheric distortion and refraction. It should also ease regulatory approval.

Finally, if a comparison of the future of the improved HST with the future of ground-based adaptive optics is to be attempted, it seems to me that it should involve an objective assessment of cost effectiveness, convenience, and flexibility. This may become a major issue, but I have no problem with it if the goal is advancement of the science of astronomy.

With good wishes,

Sincerely,



Horace W. Babcock

"Document Control"

TYPE: INFORMATION

DOCUMENT NUMBER: 9203618

ORIGINATOR: 02

STATUS C

DIRECTORATE STATUS

FROM: MASSEY, Walter: NATIONAL SCIENCE FOUNDATION

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 11/20/92

SUBJECT: HE IS FORWARDING A COPY OF THE REPORT OF THE NSB
COMMISSION ON THE FUTURE OF THE NSF.

DIRECTORATE STAFF
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ACTION STAFF
REQUIRED: ACTION:

SENDER'S DUE DATE:
OSTP DUE DATE: STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT:

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3618

NATIONAL SCIENCE FOUNDATION

1800 G STREET, N.W.
WASHINGTON, D.C. 20550



OFFICE OF THE
DIRECTOR

November 20, 1992

Honorable D. Allan Bromley
Assistant to the President
for Science & Technology
OEOB Room 358
Washington, DC 20506

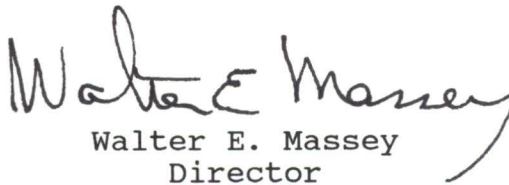
Dear Allan:

The NSB Commission on the Future of NSF has submitted its report to the National Science Board. I am pleased to enclose for your information a copy of the report, and my perspective on the process and the recommendation. This package is being provided to a large number of interested individuals and groups, and particularly to the approximately 1,000 individuals who responded to our request for suggestions.

The NSB plans to spend the next month or so reviewing the report, and then continue a dialogue on the future of NSF with interested publics across the country.

The work of the NSB Commission has been both interesting and rewarding. I am especially pleased that some of the Nation's busiest and most able individuals were willing to devote so many hours to the future of this agency. I look forward to discussing the report with you and other interested parties in the near future.

Sincerely,


Walter E. Massey
Director

Enclosure

Statement of
Dr. Walter E. Massey
Director
National Science Foundation
on the
Report of the Commission on the
Future of the National Science Foundation
November 20, 1992

I thank the Commission for completing a very challenging task in a very short time. I appreciate their diligence and commitment to this responsibility. This will be an invaluable contribution to the planning for the future of the Foundation.

The report confirms my original view that the environment for science and engineering is changing in many ways. These changes require that NSF and the National Science Board re-examine their roles in the support of research and education.

The Commission has provided a significant input to the Foundation in our efforts to build on our strengths and pursue new and challenging opportunities. I am gratified that they have endorsed the importance of fundamental and strategic research and of NSF's role in math, science, and engineering education. Their recommendations are far-reaching and outline strategies to help all citizens benefit from the excellence of the nation's research and education enterprise.

There appears to be a dominant theme that stands out from what I have heard thus far. It is the recognition of the need for greater linkages and integration in all facets of what NSF does:

- a greater integration of science and engineering research into society, and the public's increasing expectations for the results of this research,
- support for research that crosses traditional disciplinary boundaries and links science and technology,
- more active use of partnerships, especially with industry and other government agencies in strategic research areas, and
- integration of science and technology into our educational curriculum at all levels and for all students.

Another extremely gratifying aspect of this process has been the overwhelming interest of the research and education community, notably through the hundreds of letters we have received. Many novel ideas were presented in these letters, and we will continue to draw upon them as the process continues.

I look forward to working with the Board and my colleagues in government, the academic community, and private industry about continuing a dialogue on these issues.

PREPUBLICATION COPY

A Foundation for the 21st Century

**A Progressive Framework
for the
National Science Foundation**

**A Report of the National Science Board
Commission on the Future of the
National Science Foundation**

November 20, 1992

**William H. Danforth
Washington University**

Co-chairpersons

**Robert Galvin
Motorola, Inc.**

**National Science Board
Commission on the Future of
the National Science Foundation**

William H. Danforth, Co-Chair, Chancellor,
Washington University in St. Louis

Robert Galvin, Co-Chair, Chairman
Executive Committee, Motorola

John A. Armstrong, Vice President for
Science and Technology, IBM

Lindy Boggs, Former Congresswoman,
New Orleans, LA

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California Institute of Technology

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Earl Richardson, President,
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Ian M. Ross, President-Emeritus,
AT&T Bell Labs, Inc.

William J. Rutter, Chairman
of the Board, Chiron Corporation

Donna Shalala, Chancellor,
University of Wisconsin in Madison

Letter of Transmittal

Dr. James J. Duderstadt
Chairman, National Science Board

Dear Dr. Duderstadt:

On behalf of the Commission on the Future of the National Science Foundation, we are pleased to present the attached report.

We call the attention of the Board to the extraordinary outpouring of very thoughtful letters from individual scientists and from institutions large and small elicited by its charge to this Commission. Many of these letters are the result of serious drafting by very well informed people. The Board should not only study this material but should be mindful of the opportunities in the future to use this method for an extended dialogue on matters of great moment to the nation.

We are also grateful to those who have spoken with us formally and informally. The report could not have been completed in a timely manner without the support of you, Dr. Walter E. Massey, Dr. Charles Brownstein, and many others on the staff of the Foundation.

We hope that our recommendations may lead to a better understanding of the role of science and engineering in meeting national goals and a better linking of scientific results with those goals.

We are honored to have been given this responsibility and to have worked with the distinguished members of the Commission.

William H. Danforth
Washington University

Co-chairpersons

Robert Galvin
Motorola, Inc.

November 20, 1992

BACKGROUND

The United States is preeminent in science thanks to public support for patient and judicious investment, private as well as public, since World War II. As a result of the government's reliance on universities for much of the nation's basic research, American graduate education in the sciences and engineering leads the world.

The National Science Board (NSB) and the Director of the National Science Foundation (NSF), in a spirit of self examination, have asked this Commission to stimulate thinking on long range strategies for the Foundation.

The task is important:

despite having only about three percent of the total federal R&D budget, the NSF has for over 40 years played an essential role in the scientific primacy of the United States;

the NSF serves as a major source of new scientific and engineering ideas and skilled people underpinning broad sectors of our economy and our society.

And timely:

expectations for benefits from scientific and engineering research, including economic growth, are growing and changing;

the U.S. is competing in an expanding global market place;

there is realization that scientific leadership does not translate automatically into economic success for American industry;

corporate research is becoming more sharply focussed on market-related issues, with fewer companies supporting long term research;

there are calls for greater accountability.

Key to the success of the National Science Foundation in building American science has been:

its broad mandate to strengthen American science and engineering;

a partnership of trust built with America's scientists, engineers, and academic institutions;

investigator initiated proposals and selection of the best of these proposals on the basis of merit;

strong educational programs;
the flexibility to pursue new ideas.

Today, America's hopes for benefits from science focus additionally on:

greater economic success;
better health and less expensive health care;
protection of the environment;
continuing military security in a changing world;
other improvements in the quality of life, including communications, transportation, housing, efficient use of resources, and better education of young people.

With shifts in emphasis from defense to civilian concerns the private sector is an increasingly important consumer of new scientific knowledge. Changes in American businesses and universities hold promise of a more receptive adoption and practical application of the knowledge born of research and advanced education. These include:

more progressive quality processes, and operations standards and systems;
a realization that longer term versus shorter term thinking and planning is necessary;
an increase in shared funding of research and engineering by industry and state and local governments;
academic scientists working more closely with industry.

An important national priority is to improve the relative industrial strength of the United States. The National Science Foundation can make contributions to economic success, but developing a plan to do so must begin with an understanding of the system and of the reasons for failure of some industries in world markets.

Failures in the market place have not been the result of slow transfer of academic science to industry. In fact, American firms have been the first to commercialize virtually all innovative products, but have lost market share to competitors with

shorter product cycles, lower costs, and superior quality. All manner of other more prominent factors, including the stewardship by American business, far outweigh whatever could be traced to the technology itself or the technologists.

Success requires: an enlightened federal science and technology policy that touches all relevant agencies, a determination by industry to reach out for talent and knowledge, and the development of appropriate links. The universities and the NSF should complement rather than replace the roles of those engaged in technology development. Redirecting the NSF's activities from research and education would have little or no effect on the U.S. competitive position in the near term, but would severely restrict prospects for the long term. Research and education activities offer ample opportunity to increase the potential contribution of scientists and engineers to society.

We therefore commend to the National Science Board the following recommendations.

FINDINGS AND RECOMMENDATIONS

Change is part of the national agenda. NSF, and the colleges and universities it supports, are in a position to help create a new vision of and value from the role of science and engineering for society.

To realize these benefits more fully, the Commission commends to the National Science Board and the broader scientific community these:

General Recommendations

1. The United States should have a stronger and more coherent policy wherein science and engineering can contribute more fully to America's strength.

The Board is encouraged to work with the President to assess the health of science and engineering broadly and to generate a stronger policy into which the NSF mission fits. This thesis is amplified in the conclusion of the report.

2. Society's voice is welcome and needed.

Society's support for the NSF and for university research is based on the confident expectation that the generation of new knowledge, and the education of a skilled workforce are necessary (though not sufficient) investments to achieve our national goals of a high quality of life in a productive and growing economy. In accepting society's support, the scientific community naturally assumes an obligation to be both responsive to national needs voiced by society as well as the intellectual priorities solely initiated by the scientist or engineer.

Concern over technology application and competitiveness sometimes conjures a choice that budgeting is decided on either the criteria to please the scientists or to serve the public need. In reality these criteria and interests are congruent.

The history of science and its uses suggests that the NSF should have two goals in the allocation of its resources. One is to support first-rate research at many points on the frontiers of knowledge, identified and defined by the best researchers. The second goal is a balanced allocation of resources in strategic research areas in response to scientific opportunities to meet national goals.

It is in the national interest to pursue both goals with vigor and in a balanced way. The allocation of resources should be reviewed regularly with these two goals in mind. Positive responses to both will enhance the standing of science.

3. The Commission strongly supports the initiation of proposals by investigators and selection of those to be funded by merit review carried out by experts. This method has proved to be the best way of tapping into the creativity of research scientists and engineers. Periodic examination of how to improve the functioning of the system is in order. The system, of course, must assure the selection of work of the highest quality and promise.
4. The NSB, the NSF, and the science and engineering community must better come to grips with the reality that many fields not covered by traditional disciplines offer challenges for new knowledge and opportunities for creative, investigative research worthy of the most gifted scholar. These fields should be valid candidates for support and may both yield key knowledge and enable timely response to national goals.
5. Since the private sector plays the major role in the translation of knowledge into new products and services, and since the speed and efficiency of this process is an important factor in a productive and growing economy, it is appropriate that the NSB involve the private sector more fully than heretofore in the decisions which affect the classes of research allocation as well as some evaluation of the effectiveness of the expenditures. It is more than incidentally significant that scientific advances are as likely to be driven by advances in technology as the reverse and the interplay between parties who are conversant in both fields holds promise of synergy.

Research Recommendations

1. The Board and Foundation's key role in the support of research in science and engineering should be strongly reaffirmed.
2. The NSB and the NSF should encourage interdisciplinary work and cooperation among sectors. Nature knows nothing about disciplinary boundaries.
3. There is a convergence between science and technology arising from technology today having a stronger basis in theory and data, which creates increased demand for research at every stage of the innovation process. Goals for science are, for the most part, necessarily long-term. However, new knowledge from fundamental research is important early-on, to the technical community, as a guide for anticipating future progress in technology and in the selection of strategies for future developments.

Technology is to a significant degree the result of the work of the NSF. NSF and its research and education programs do have much to do with making possible new technologies.

4. It is urged that the size of NSF grants be examined. Many believe that on average, NSF individual research grants are too small. Examination of separate fields and wide consultation within the community would help in understanding the issues. We favor research grants sufficient to do the work for which the grant is awarded.
5. The management of NSF should from time to time review the make up and combinations of Directorates to maintain the most effective focus and management of the selection process, taking into account the evaluation of research, the desirability of interdisciplinary research, the needs of different types of research and efficiency of operation.
6. The diffusion and dissemination of the knowledge and skills derivable from scientific and engineering discoveries is important. Although complex, the system is working better than many presume. It works particularly well when university trained researchers and professionals move from position to position in academia or in industry.

Dissemination is improvable by:

- a) further encouragement of cross-disciplinary collaboration;
- b) facilitating exchanges of people between universities, industry, and government;
- c) utilizing the collective advice of the scientists and engineers in industry, universities, and government agencies;
- d) support of research with active industrial participation;
- e) more effective circulation of scientific discoveries through publications, conferences and networking;
- f) continuing funding for the maintenance of and access to large scale data bases;
- g) development of information infrastructure, such as NSFNET, to facilitate communications, research collaboration, and remote access to shared resources and facilities.

7. The Foundation should more aggressively lead in communicating the "case" for science and engineering, which deserve a high priority in the mind of public officials and citizens alike.

There is a widespread lack of appreciation of the complex interconnected processes by which new knowledge eventually leads to societal benefits. This exists in the university and scientific communities as well as in the halls of government. The NSF should take the lead in interpreting this process to all of its publics.

8. The NSF should both set an example and work with others in fostering international cooperation and agreements for the most effective exchange of research results and for research collaboration. To do so is beneficial to all parties, as important discoveries can be made anywhere.
9. Undergraduate education is enriched by faculty participating in research. Research is essential to preparing graduate students for scientific careers in academia, government, and industry.

We endorse graduate fellowships and traineeships. Students are quite responsive to perceived national needs in their selection of fields of research. The involvement of underrepresented groups should continue to be vigorously encouraged.

10. Successful research requires increasingly sophisticated instrumentation and facilities. We urge the NSB to maintain surveillance over the state of these national resources and to work for a national plan to keep them adequate for the conduct of pioneering science and engineering.

Education Recommendations

1. A major priority for the NSB and the NSF should continue to be education in science and engineering.

NSF's support of education has a cascading influence. The Foundation should be at the leading edge of ever-emerging improvements in curricula, and methodologies of teaching and training for research.

2. The NSF should encourage further development of joint science, engineering, and management education programs.

This recommendation complements our previous research recommendations, which call for recognizing the importance and equivalence of scholarly research in a broader range of fields.

3. The Foundation is chartered to support improved education in mathematics and science throughout all the school years, from kindergarten through graduate and post doctoral studies. The two most critical areas needing improvement are K-12 education and undergraduate education.

K-12 education, which prepares both the workforce and pre-professional students, must continue to receive the Foundation's serious attention and be pursued in collaboration with the Department of Education and other involved parties.

The Commission urges the NSF to persuade the scientific community to expand its commitments to improving the quality of undergraduate education in mathematics, science, and engineering. Introductory courses, especially, need improvement.

We take note of the fact that the system has no one single weakness. No single grade or class can be neglected, for students fall away from science at all stages of the educational process. As we work any stage of the system, we must appreciate consequences throughout the system.

Structural Recommendations

1. Measurement of systems generates improved quality of operations. We speak here of something more than accounting and accountability. All reasonable measurements of the quality of the output of research, the quality of research allocation and the other principal functions of the Foundation should be subject to rigorous and common sense metrics for the evaluation and increase in the quality of its activities.

Enlightened universities are beginning to teach and apply such measurement systems and both of these should be encouraged openly by the Board of the Foundation.

2. NSF should continue to support shared, common use facilities that cannot be built and maintained by individual institutions. Such facilities make economic sense and are an essential part of the research infrastructure for many individual investigators.

THE STRONGER NATIONAL POLICY

The Commission urges that the role of the NSF be further clarified within an overall national policy, the goal of which should be to maintain the premier position of U.S. science and engineering while regaining America's lead in the commercialization of technology.

The first general recommendation reads: "The United States should have a stronger and more coherent policy wherein science and engineering can contribute more fully to America's strength." A call of this nature is not new. The strategy has been voiced in many terms--national science policy, national technology policy, and others. We do not emphasize a title. But, we do advocate a broad national policy going beyond science and engineering and including technology and its applications. The policy should be responsive to the voice and needs of society. NSF with its emphasis on research in science and engineering, and its complementary emphasis on education for science and engineering will play a major, direct, and cascading role in fulfilling the overall policy.

The NSB, in helping to develop a national science and technology policy, should move quickly to propose a role for the NSF based on its past mission and a vision of what is needed today. In this plan the NSF should build on its accomplishments and strengths, specifically its partnership with the scientists and engineers of the nation's colleges and universities in developing outstanding research and strong science education; its partnership with the Department of Education and state and local governments working to strengthen science education in grades K-12; and its role in maintaining the nation's scientific infrastructure. The plan should include a response to the recommendations of this Commission in order to strengthen and make more effective the work of the NSF in meeting national goals.

We urge that the Board and those involved in the planning resist any pressures to strip the NSF of its full spectrum of research goals and linkage mechanisms, from engineering research centers, to computer networks, to pure science and mathematics. The great strength of American science and of American universities is the absence of rigid cultural barriers between science and engineering and between pure research and its applications.

Throughout the report we have identified new challenges, evolving research fields, interdisciplinary opportunities, increasing dependencies among stages in technology development, grant size, student support, improved science education, knowledge diffusion and facility needs. The NSF will find it difficult to respond to these new challenges without an increase in resources, for the budget of the NSF already is inadequate to support its present responsibilities and programs.

Nevertheless, each recommendation is soberly, seriously and confidently proposed as being in the nation's best interest.

We are not unmindful that adoption of most of our individual proposals will increase the funds needed by NSF. We are equally mindful that controlled growth in federal funding and even deceleration of federal expenditures are options that must be considered by governmental officials and that policies to control spending need the support of the citizenry.

Yet, we do not equivocate in recommending each and the aggregate to the Board and through the Board to Congress, to scientists, to business constituencies, and to the broader public. Our recommendations are made in the spirit of continual improvement of a fine existing system.

Moreover, we are aware that the value of the output of the system can be multiplied within a "system of the whole" which would better make the essential linkages of education--discovery--development--application--competitiveness--quality of life.

To address this issue we urge that the NSF's responsibilities, as spelled out in its mission statement, and its budgetary needs be examined in the context of a newly conceived federal R&D budget that supports the stronger, broader policy. Reallocation of funds could achieve an energizing result that stimulates academic scientists and engineers, government officials, and people from industry to serve better the U.S. public. For we are convinced that ever improving universities and colleges and an ever more quality minded private sector working together can,

lower the cost of improving the quality of life;

add value throughout our society;

create true wealth and opportunity for the country.

The hidden costs of not doing so may never be accounted for but would swamp the apparent cost of what is an energizing investment. So, we must get on with it.

However, all roads need not lead just to the public treasury. We have one additional suggestion--expanded contributions by business to complement public funding for selected science, engineering and technology programs.

It has been noted in other public documents that industry's basic research spending has lessened. Yet industry's spending for what is generally called R&D is substantial. Further, industry is moving to more affiliations--alliances, joint ventures, and consortia. Led and attracted by the visibility of a better integrated and more adequately funded government-university partnership, we see promise of a more willing contributing

partner from among the progressive businesses of all sizes, including the smaller, higher growth companies where shared cost in programs with reasonable potential of eventual use would be welcomed.

Finally, the Commission returns to the role of the Board in influencing a stronger science and engineering and technology policy for the Nation. The Board and the National Science Foundation are today the lead organizations representing the interests of broad science and engineering in the United States. The Board must work with its peers in the private and public sectors so that the nation might formulate a much needed science and technology roadmap. We are convinced that students, scientists, engineers, industry, and the public would join together to build and build on that roadway.

It is a journey we must begin.