

C-AD Accelerator Physics Seminar

*“Proton Radiography at the AGS -
Technical, Political and Ethical Issues”*

Dr. Alan Carroll, BNL

Friday, August 25, 2000

1:30 pm - 3:00 pm

Building 911, SNYDER SEMINAR ROOM

Schedule is available on the following web page:

<http://www.jgsrhome.bnl.gov/AP/APseminar.html>

OPENING REMARKS

- **Start of discussion/debate on whether dynamic Proton Radiography should be carried out at BNL. Dr. John Marburger will be making an initial decision this Fall.**
- **Keep any presentations short (£ 35 minutes)**
- **I have been a member of North Shore United Methodist Church for 30 years.**
- **Questions –**
All but shortest questions to be written on board for answering afterwards in coherent manner. Answer them more or less in order with some preference for Director, DD, ALD's, Dept. Chair.
- **Letter from Dr. John Marburger, Director**

Agree w/ Speaker

Disagree w/ Speaker

OUTLINE

I. Opening Remarks

II. Technical

Description of Nuclear Weapons

Proton Radiography (pRad) technique

Safety/Environmental/Security/Programmatic Issues

III. Personal Views

IV. Political (Brookhaven Lab)

Consequences of doing or not doing pRad at AGS

My Conclusions

V. Ethical – Some true life parallels

Andrei Sakharov

Vikings

Martin Luther King, Jr.

VI. What Next?

Conference of all sides

VII. Concluding Parable

TECHNICAL

SLAC Beam Line

Spring 2000

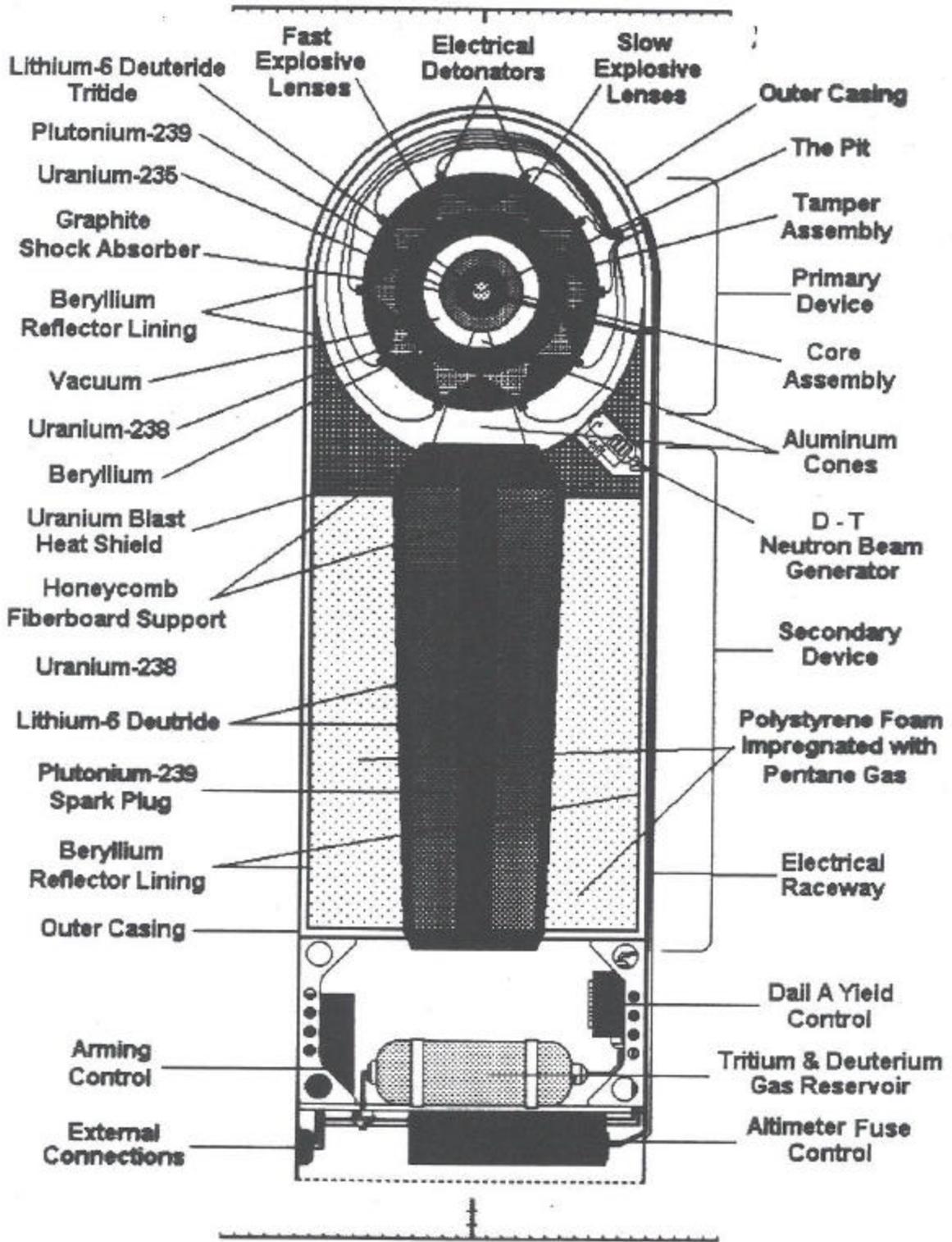
Proton Radiography

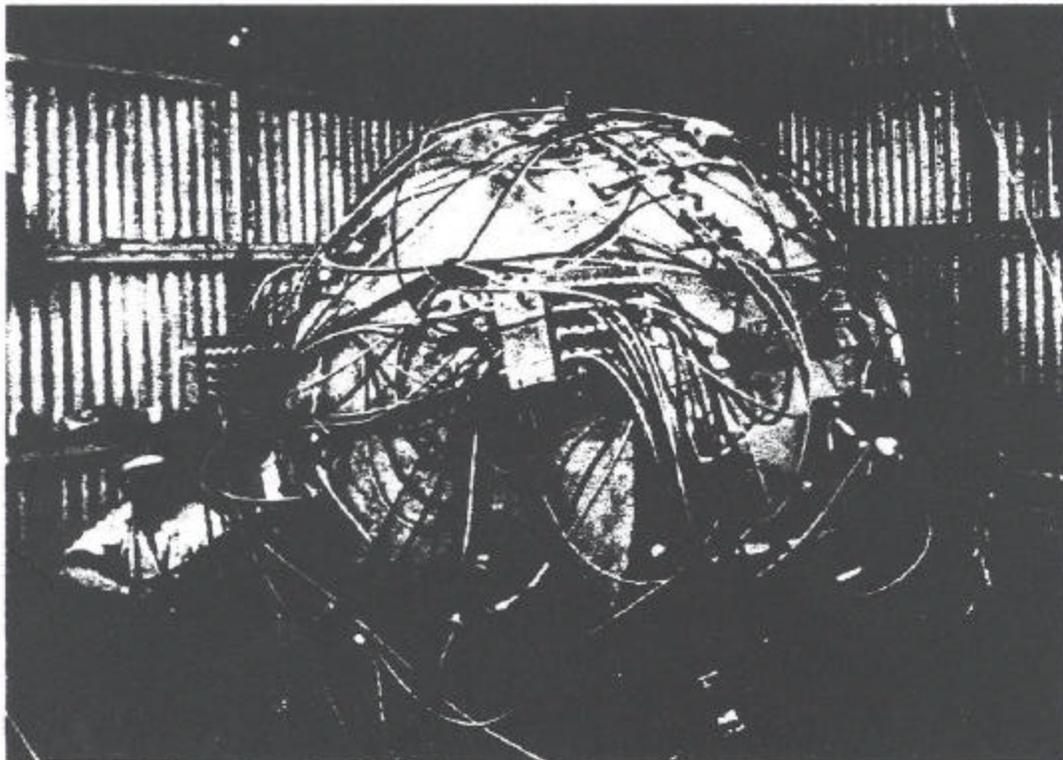
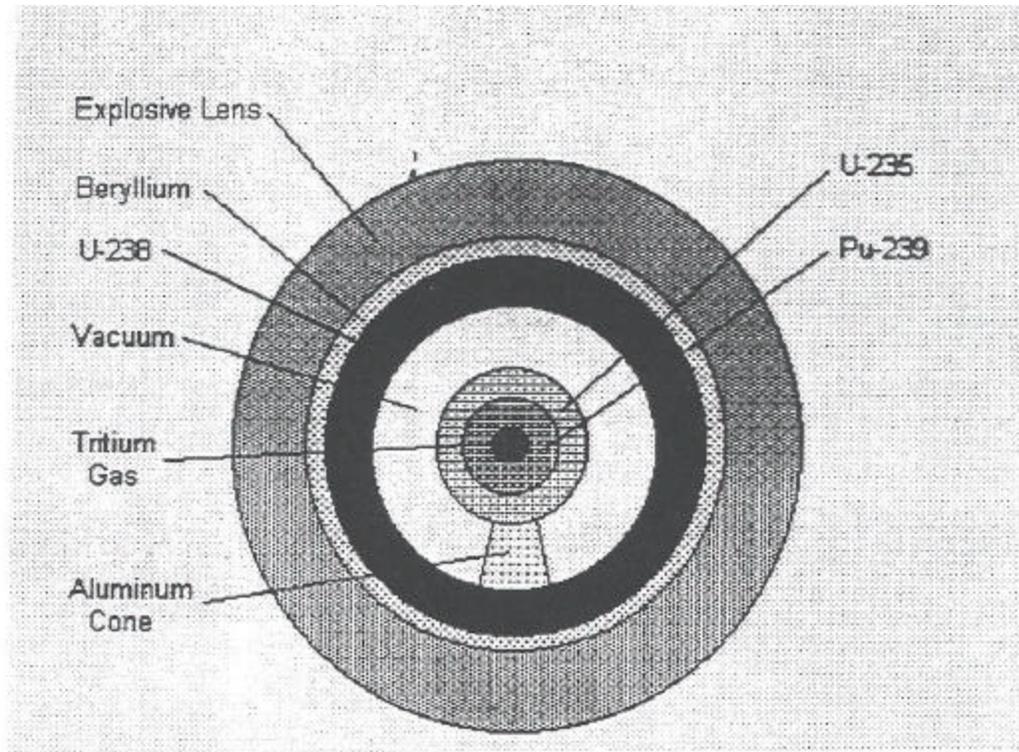
By: Edward P. Hartouni and Christopher L. Morris

BOOM! As beam arrives to your experiment the target is reduced to a twisted pile of rubble in an impressively energetic explosion, this after months of planning and hard work.

- **Description Nuclear Weapons – Implosion type**
- **Proton Radiography (pRad) technique – Distant imaging vs x-rays**
- **Comment of Chris Morris**
- **Comment of Ed Hartouni**
- **Safety/Environmental/Security/Programmatic**
 - **Possible accidents/releases**
 - **Effects on RHIC/AGS Program**

Richard K. Brown





Proton Radiography Overview

John B. McClelland
LANL Project Leader for Proton Radiography
Deputy Division Director for Physics

July 28, 2000

Unclassified

— **Proton Radiography** —
Science Based Stockpile Stewardship

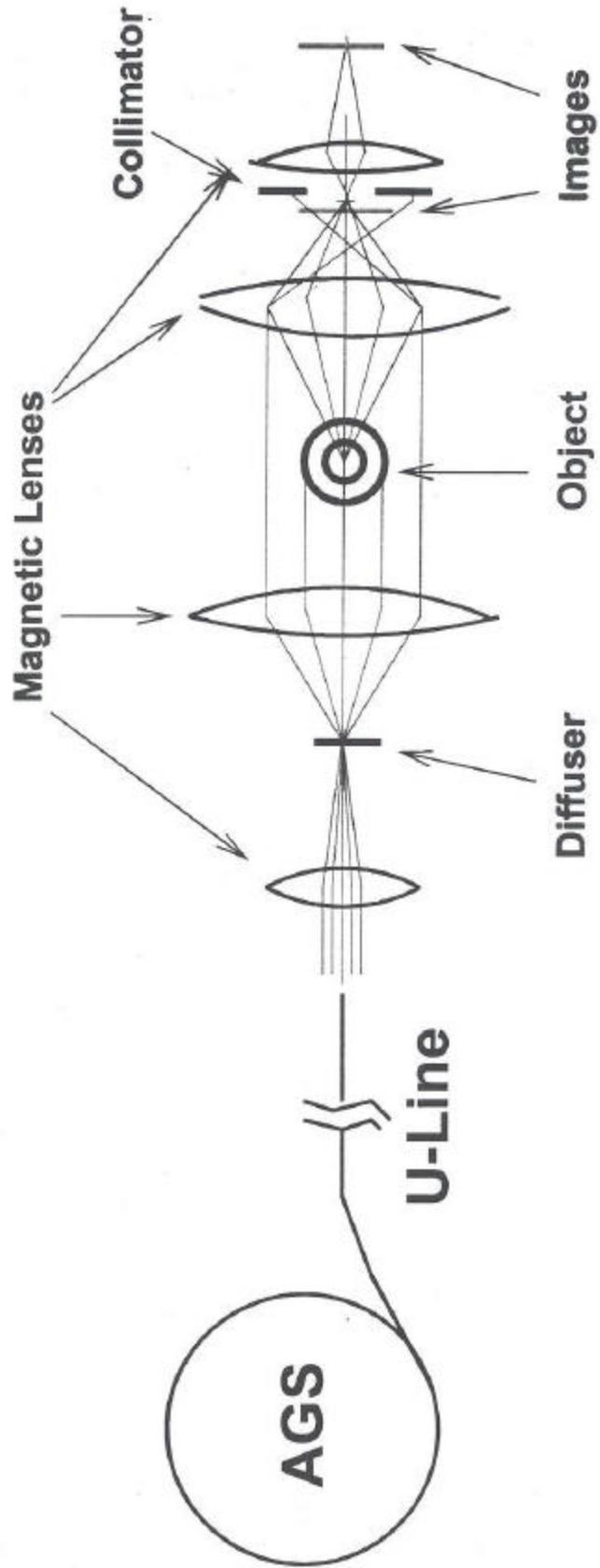
Proton Radiography Overview

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Proton Radiography
Science Based Stockpile Stewardship



Proton Radiography Concept

Protons interact differently than X-rays

Beam in $\{N_0, p\}$

L

β, L_R

Transmitted Beam $\{N\}$

θ_0

Beam is attenuated by nuclear interactions given by:

$$N = N_0 e^{-\frac{L}{\lambda}}$$

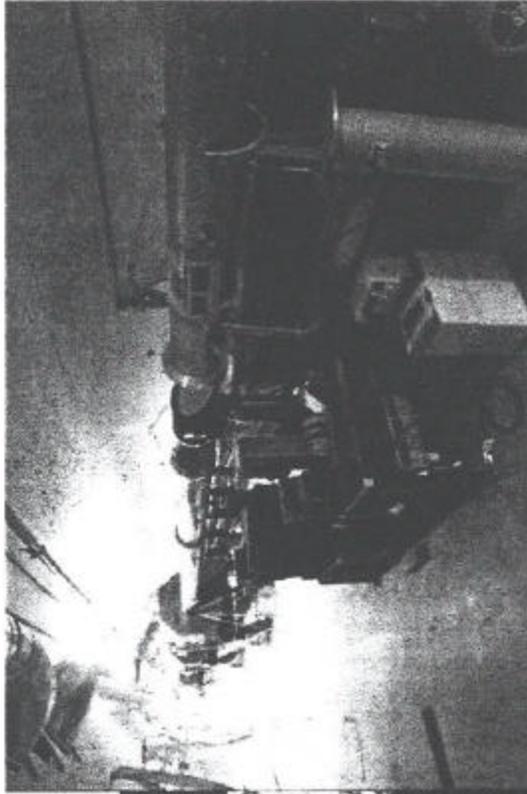
Beam is also scattered at small angles due to Multiple Coulomb Scattering (MCS) given by:

$$\theta_0 \approx \frac{14.1 \text{ MeV}/c}{p\beta} \sqrt{\frac{L}{L_R}}$$

Total Attenuation: $N = N_0 e^{-\frac{L}{\lambda}} \left(1 - e^{-\frac{\theta^2}{2\theta_0^2}} \right)$

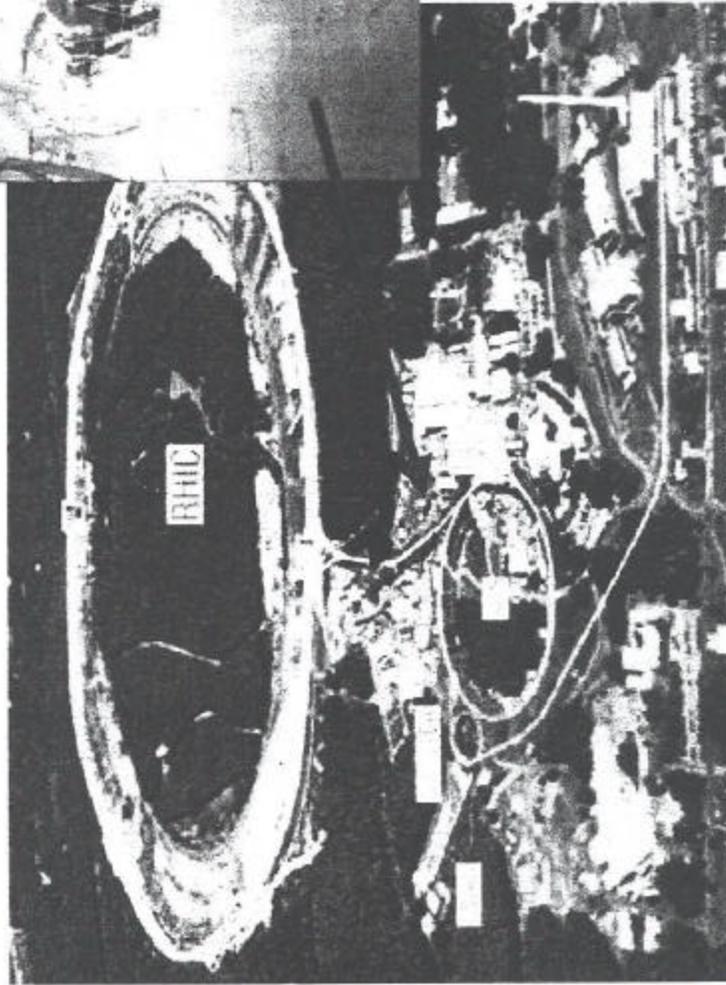
AGS Proton Radiographic Facility

U Line Proton Radiography Facility



•24 GeV/c

- “Flash Radiography” on static objects
- Classified and unclassified objects
- Multiple lens for material sensitivity



Proton Radiography
Science Based Stockpile Stewardship

Advantages of Protons for Advanced Hydrotesting

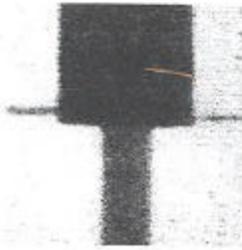
X-Rays

- ◆ 10^5 to 10^6 attenuations in object
- ◆ Scattered background difficult to eliminate
- ◆ Density measurement only
- ◆ Multiple-time difficult due to vaporization of conversion target
 - four will be implemented on DARHT-2
 - more is very hard
- ◆ Accelerator technology at limits of dose and resolution

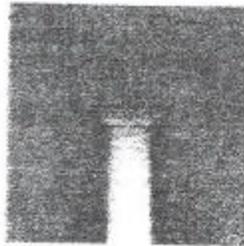
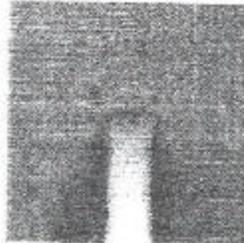
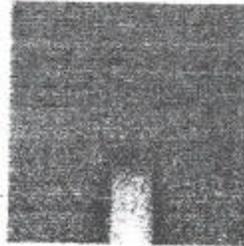
Protons

- ◆ Attenuation lengths well-matched to objects
- ◆ Virtually no background
- ◆ Density and material identification
- ◆ Multiple-time capability easily accomplished with present accelerator technology
- ◆ Proton accelerator technology exceeds requirements
 - flexibility and expandability

Time



High Explosives



Hydrodynamic Tests

- ◆ Use full weapons geometry
- ◆ The fissile material inside the weapon is replaced with another material
 - U²³⁸, Ta, W, Pb, Cu, Fe, Au
- ◆ Used to measure material motions and compressions
- ◆ Supplemented with static, dynamic, or high-explosive experiments
- ◆ Information obtained from hydrotests is then used to develop calculations to predict the safety, performance, or reliability of the weapons device
- ◆ At the AGS, we would not use any special nuclear material (SNM), believe we can avoid RCRA materials, but would have hazardous materials such as HE

Proton Radiography
Science Based Stockpile Stewardship

SAFETY/ENVIRONMENTAL/PROGRAMMATIC ISSUES

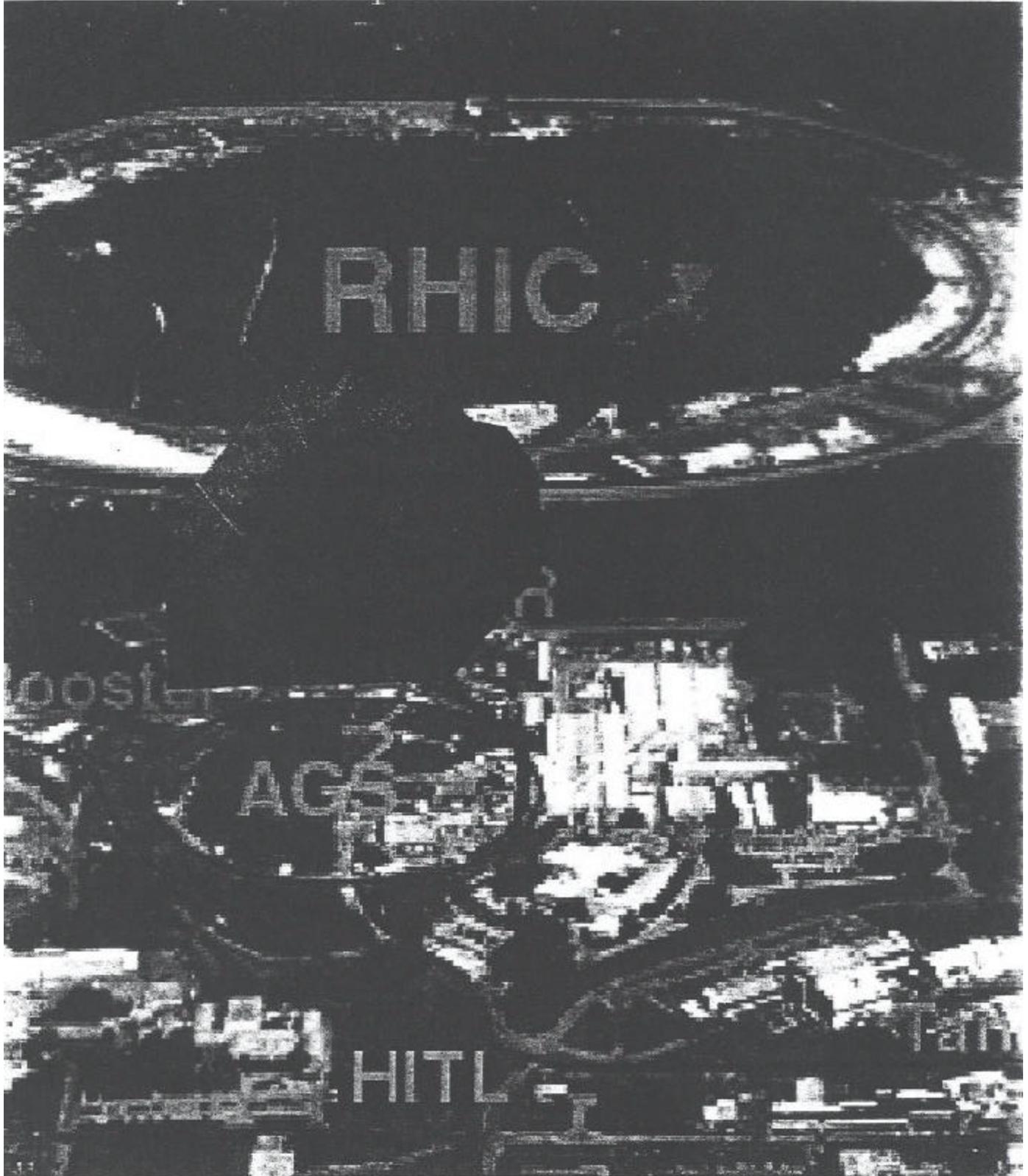
Regarding use of high explosives in the 6' diameter containment sphere

- ~ 50% Some release of gases from ~ 20kg of high explosives**
- ~ 5% Probability of projectile fragments penetrating containment sphere, principally from their entrance and exit window**
- ~ 10^{-4} ? Accidental detonation outside containment sphere. 10 feet lethal radius from H.E., much larger from fragments.**

$\ll 10^{-5}$ Confusion as to cores

RHIC/AGS program will stop during 1-2 weeks of tests.

2.2×10^{-9} Tech confuses heavy metal cores



-----Original Message-----

From: Sakitt, Mark
Sent: Tuesday, August 22, 2000 11:05 AM
To: Carroll, Alan S
Subject: FYI NW article in Albq. journal

Tuesday, August 15, 2000

Low-Yield Nuke Bombs Endorsed

By Ian Hoffman
Journal Staff Writer

New and precise, low-yield nuclear weapons - perhaps built on designs so simple and rugged they don't require testing - could aid the United States in attacking a range of modern targets, a U.S. weapons executive says.

Los Alamos' chief weaponeer, Stephen M. Younger, envisions a flexible U.S. strategic arsenal of conventional and nuclear weapons of low and high yields. He suggests in a recent paper that accurate, low-yield nuclear weapons could be better suited to attacking buried, concrete bunkers and mobile missiles than today's U.S. arsenal of silo-busting weapons.

A rogue nation threatening biological or chemical attack against the United States or its allies might view a massive, ballistic missile attack "as overkill and hence not a realistic threat."

"Such a reliance on high-yield strategic weapons could lead to 'self-deterrence,' a limitation on strategic options and consequently a lessening of the stabilizing effect of nuclear weapons," Younger writes in "Nuclear Weapons in the 21st Century," a paper invited by the Pentagon's ranking defense scientist.

Critics say Younger's proposals are the latest in a persistent lobbying campaign by some nuclear weaponeers for work on new bombs and warheads, theoretically made usable by limited damage and radioactive fallout.

"This is all premised on the notion that you can cross the nuclear threshold if you don't make too much of a mess," said physicist Frank von Hippel, a Princeton University professor of public and international affairs.

"This isn't deterrence," von Hippel said. "This is trying to use these things."

That alarms disarmament advocates.

PERSONAL VIEWS

- **Feel safer in year 2000 than in year 1980**
- **Proton radiography is not just a “technically sweet” academic exercise, but has real consequences.**
- **We owe future generations every effort to bring nuclear weapons under control.**
- **Brookhaven National Laboratory has advertised itself as a non-weapon laboratory.**
- **Why me? R2A2**
- **Polite letter writing has not been fruitful.**

Hydrodynamic Tests

- ◆ Use full weapons geometry
- ◆ The fissile material inside the weapon is replaced with another material
 - U^{238} , Ta, W, Pb, Cu, Fe, Au
- ◆ Used to measure material motions and compressions
- ◆ Supplemented with static, dynamic, or high-explosive experiments
- ◆ Information obtained from hydrotests is then used to develop calculations to predict the safety, performance, or reliability of the weapons device
- ◆ At the AGS, we would not use any special nuclear material (SNM), believe we can avoid RCRA materials, but would have hazardous materials such as HE

Proton Radiography
Science Based Stockpile Stewardship

R2A2

Name: Alan S. Carroll
Life No.: 09331
Job Title: Deputy Head AGS Experimental Planning and Support Division (Physicist)

Role: Maintain, develop, and allocate Division resources in support of AGS and RHIC experimental programs for both outside and BNL research groups.

Responsibilities:

- Provide state-of-the-art beam lines and facilities in response to the needs of RHIC and AGS experiments.
- Support the development and construction of new RHIC and AGS experiments and upgrades to existing experiments.
- Support the construction of RHIC experiments through allocation of Division engineering, scientific and technical resources.
- Ensure safe and efficient operation of the RHIC and AGS experimental areas and beam lines with full respect for the environment and for the health and safety of all.



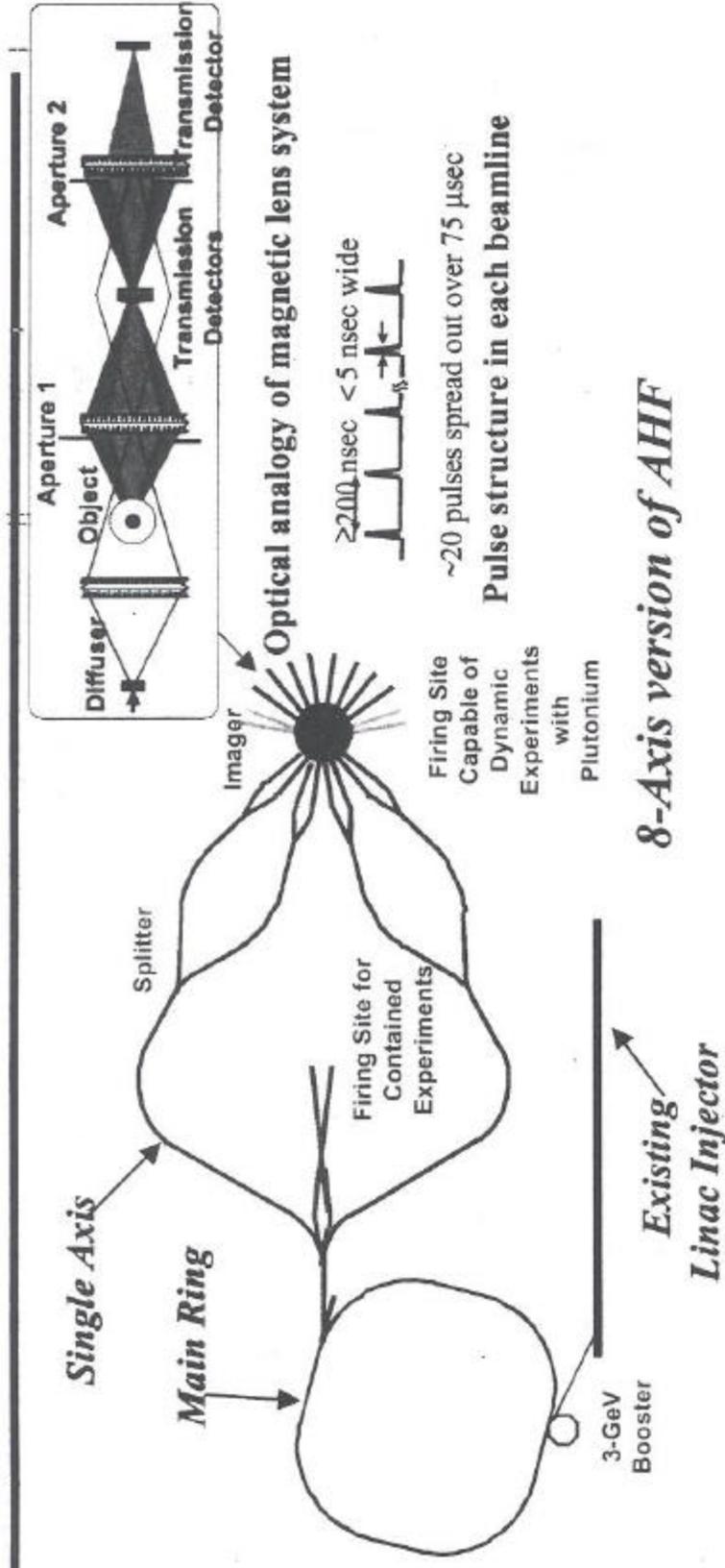
Challenge incorrect statements or incorrect conclusions where I come across them.
Challenge instructions and plans that I review as detrimental to the Laboratory or public.
Adhere to the generally recognized code of ethics and challenge instructions which disagree with this code.

Employee's Signature Alan S. Carroll Date: 3/31/00
Supervisor's Signature [Signature] Date: 3/31/00

Scope of Activities

- ◆ Goal is 2-3 hydros to confirm reproducibility as a technology demonstration for AHF
- ◆ Final selection of experiments would be done through discussions with LANL/LLNL/DOE
- ◆ A series of smaller shots would be required in advance of full scale experiments for system checks
- ◆ Earliest start date is FY01
- ◆ Duration is 2-4 years
 - depending on things like
 - » AGS schedule
 - » funding
 - » actual AHF schedule
 - » hydro schedule

pRAD is the leading candidate for an Advanced Hydrotest Facility (AHF)



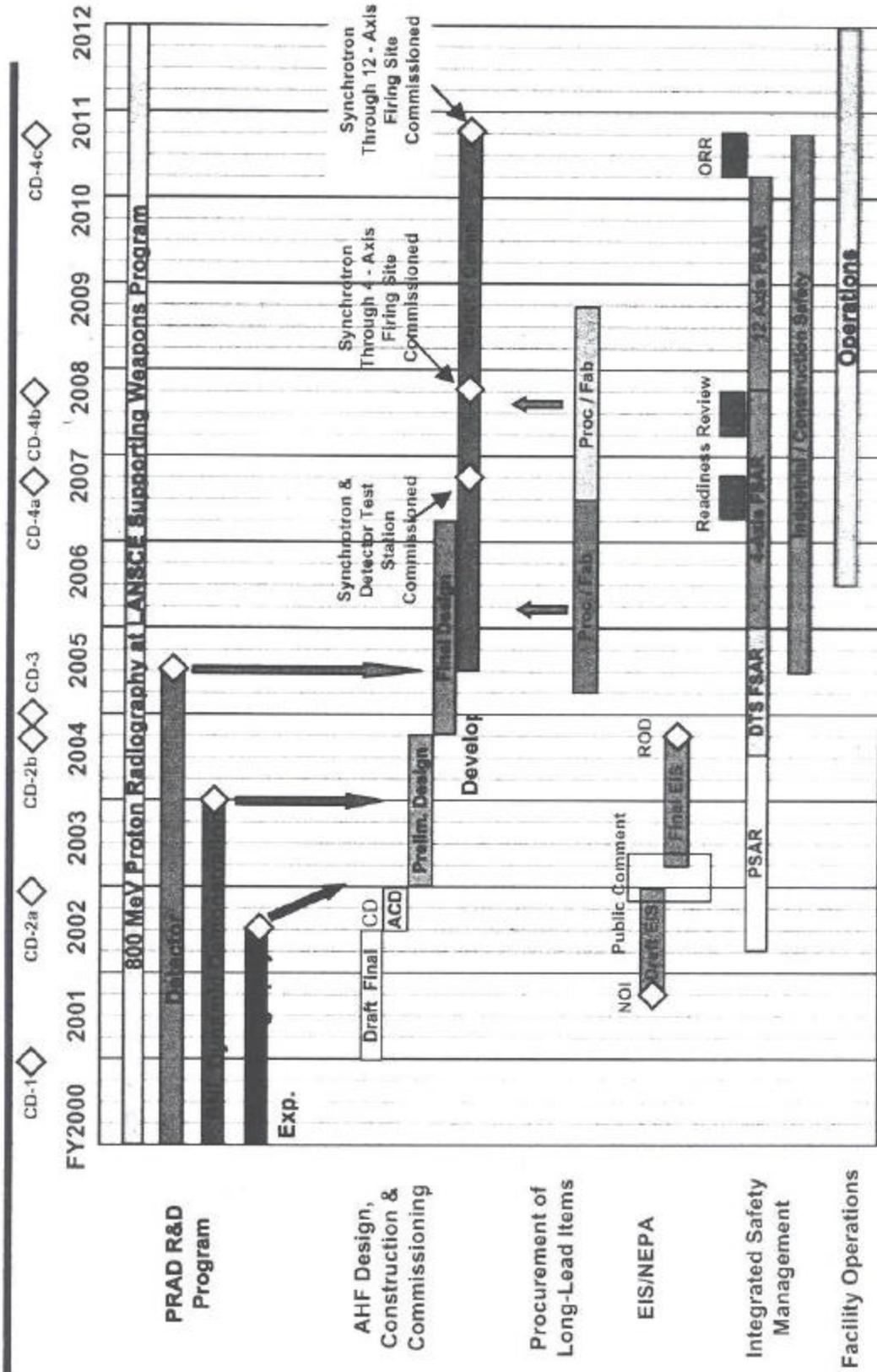
8-Axis version of AHF

- ◆ 50 GeV proton beam, 1 - 2 axis, ~ 20 pulses, non-nuclear materials firing site, operational in 2007
- ◆ 3 GeV booster synchrotron, transport line to firing site capable of dynamic experiments with plutonium, initially operational with 4 axes in 2008 - 2009
- ◆ Expand number of axes to 8 - 12, operational 2010 - 2011

Proton Radiography

Science Based Stockpile Stewardship

Integrated Proton Radiography Program and AHF Project Schedules Based on FY2001 Conceptual Design Funding



Proton Radiography
Science Based Stockpile Stewardship

POLITICAL

- **Consequences of doing pRad at the AGS**

- Tests almost certainly will be successful
- There will be about a decade of explosions at AGS while real accelerator is being built with all of the complications of safety, environmental and spy hysteria.

PRad originally was not to go beyond static tests. Pu 239 at AGS???

- Like the tritium scenario – there is the potential for a real public relations problem. Particularly with East Hampton folks.

- **Consequences of not doing pRad at the AGS**

- pRad may not succeed in competition with x-rays
- Military say they need “Full weapon geometry” task before funding a “dedicated” 50GeV accelerator
- Will cause weapons portion of DOE to be annoyed with BNL – change funding levels?
- Will eliminate possible public relations problem with community stake holders.

MY CONCLUSION

We should just say NO, now!!

- **Avoid confrontations with political and environmental activists.**
- **RHIC/AGS program is very strong and visible. NSF is planning to fund a major portion of the AGS program.**
- **Collider-Accelerator Department has successfully undergone a ISO 14001 certification as environmentally sound**
- **This is in line with the original mission of Brookhaven Laboratory and the current Laboratory statements on weapons research.**

From: Robert Crease [SMTP:crease@exchange02.bnl.gov]

To: Alan Carroll

Cc:

Subject: Re: BNL's original charter

Sent: 8/22/00 12:05 PM

Dear Alan:

Well, there are hundreds of documents relating to the founding of BNL, of course. In the lab's first press conference (28 Feb. 1947), Edward Reynolds, President of AUI, said that "I want to make it completely clear, though, that in undertaking to establish and operate Brookhaven National Laboratory under contract with the Atomic Energy Commission, we are seeking the peacetime uses of atomic energy which will prolong life and raise the standard of living of mankind. The program of the Laboratory includes no military applications." That last sentence, though, would turn out to be a little misleading, because from time to time BNL scientists would be recruited for projects which had military implications -- cross-section research, etc.

7. What kind of weapons-related work and classified research does the Lab do?

BNL does not design, build, or test weapons and has not done so in the past.

The major focus of our weapons-related work is to prevent the theft and diversion of weapons material. We also participate in programs to halt the production and spread of nuclear weapons (called nonproliferation), and we work on techniques to verify that weapons have been dismantled. These techniques are also finding valuable use in detecting possible chemical or biological weapons as demonstrated recently in New York City.

Moreover, we have been providing technical advice to the U.S. Department of Energy as to whether tritium to refresh existing weapons can be produced in a more cost-effective manner in an accelerator rather than in a reactor.

We have also assisted other laboratories in testing the feasibility of imaging techniques that might be used to analyze the safety and reliability of the U.S. weapons stockpile, without actually testing a weapon.

For more on BNL national security research, click here.

[back to top](#)

Subject: Important Message from Kirk re foreign visitors

Date: Thu, 3 Aug 2000 19:34:50 -0400 (EDT)

From: Wit Busza <busza@MIT.EDU>

To: phobos@MIT.EDU

----- Forwarded message -----

Date: Thu, 03 Aug 2000 15:27:26 -0400

From: tom kirk <tkirk@bnl.gov>

To: "Busza, Wit" <busza@mit.edu>, "Harris, John" <John.Harris@yale.edu>, "Videbaek, Flemming" <videbaek@bnl.gov>, "Zajc, Bill" <zajc@columbia.edu>, "Guryn, Wlodek" <guryn@bnl.gov>

Cc: "White DePace, Susan" <swd@bnl.gov>, "Ludlam, Tom" <ludlam@bnl.gov>, "Lowenstein, Derek" <lowenstein@bnl.gov>, "Murtagh, Michael" <murtaghm@bnl.gov>, "Paul, Peter" <ppaul@bnl.gov>, "Marburger, John H." <marburge@bnl.gov>, "Ozaki, Satoshi" <ozakil@bnl.gov>, "Zukowski, Elaine" <zukowski@bnl.gov>, "Kirk, Tom" <tkirk@bnl.gov>, usercenter@bnl.gov

Subject: Important Message to Spokespersons

August 3, 2000

THIS IS AN IMPORTANT MESSAGE FOR YOUR COLLABORATION!

Dear RHIC Spokespersons:

Below, I provide an important message for foreign visitors to BNL. It is likely to impact members and associates of your collaboration. Please read this message carefully and, by carrying out my requested action, help us both ensure the least disruptive results possible for associates of your group.

Because I do not have sufficient information to ensure that this message reaches all the relevant members of your collaboration, I earnestly request that you, as spokesperson, assume the responsibility to pass along this message to the appropriate persons in your collaboration.

The specific subject of this message concerns the notification of Brookhaven National Laboratory, 30 days ahead of time, about prospective visits by non-US persons associated with your collaboration, using the IA-473 Information Form. Information about this form is provided in the message.

I believe that many of your groups are already quite efficient at getting the DOE-required IA-473 information supplied to BNL prior to arrival of non-US persons at the Lab but we are under pressure to get our compliance percentages up.

If for any reason, you cannot carry out the dissemination of the message below to your collaboration, please inform me as soon as possible.

Many thanks,
Tom Kirk, ALD-HENP

***** Statement on BNL Visits *****

BNL Policy on Visits by Foreign Nationals
August 3, 2000

*reminded Henry
White Dandel
re Sunday eve*

The US Department of Energy has demanded that Brookhaven National Laboratory become more effective at enforcing the DOE policy on access of foreign nationals to this (and the other) DOE laboratories. In particular, the Foreign Visits and Assignments Program, which includes the IA-473 forms and indices checks, must improve its compliance record for these visitors. Most of our foreign visitors are users of BNL facilities such as RHIC and AGS. This Statement has as its purpose to reach our users from abroad with the necessary message.

In order to meet the requirements of DOE Order 142.1, IA-473s must be submitted at least 30 days in advance of a foreign national's visit to Brookhaven. For some sensitive-country foreign nationals, the lead time can be as much as 90 days in advance of arrival at Brookhaven.

At present, despite this requirement, about half of the foreign nationals arriving at the Users Center complete their IA-473 only upon arrival, rather than the prescribed 30 (90) days in advance. If we cannot markedly improve this record, the Laboratory is likely to face tighter policy demands from DOE, resulting in persons getting turned away at the Laboratory gate. None of us want this sanction to be tightened.

To improve our BNL record, I am sending this message to the RHIC and AGS Collaboration Spokespersons for re-circulation to their collaboration's user groups and related associates from foreign countries. I must count on the spokespersons to inform their colleagues who intend to visit BNL that they must provide, IN ADVANCE OF THEIR VISIT, the necessary IA-473 information to the RHIC-AGS Users Office by email [userscenter@bnl.gov] or fax [631 344 8686] (or via a web entry when this mode becomes established). For reference, the Users Center phone number is 631 344 5975.

We intend to get the IA-473 information prior to the 30 or 90 day notification limit in as many cases as possible. The information needed to greatly improve Brookhaven compliance with the DOE Order is minimal and shouldn't cause difficulties for our visitors.

The RHIC-AGS Users Center has identified 380 individuals (about 1/3 of the active unpaid visitor population) who have active user appointments but do not have an IA-473 on file. Notification has been sent to those individuals to obtain information to complete their IA-473s. If these users do not respond to this request, a second attempt to reach them will be made. If this is also unsuccessful, their BNL user appointment will be inactivated. The user appointment will only be re-activated upon completion of the IA-473.

The Users Center will continue to work on improving our RHIC-AGS user compliance record with respect to on-time IA-473 completions. We can only succeed if spokespersons and group members also support this effort. The Center is working on a newsletter and a web page that will address this issue. BNL is in the final stages of completing a lab-wide database for guests (formerly named the Guest Information System). This is a web-based registration system which will simplify obtaining the information necessary for meeting IA-473 requirements.

ETHICAL – Some True Life Parables

- **Andrei Sakharov – Inventor of Soviet Hydrogen Bomb**
 - **An insider protesting against the government**
 - **Stopped atmospheric testing**
 - **Won Nobel Peace prize**

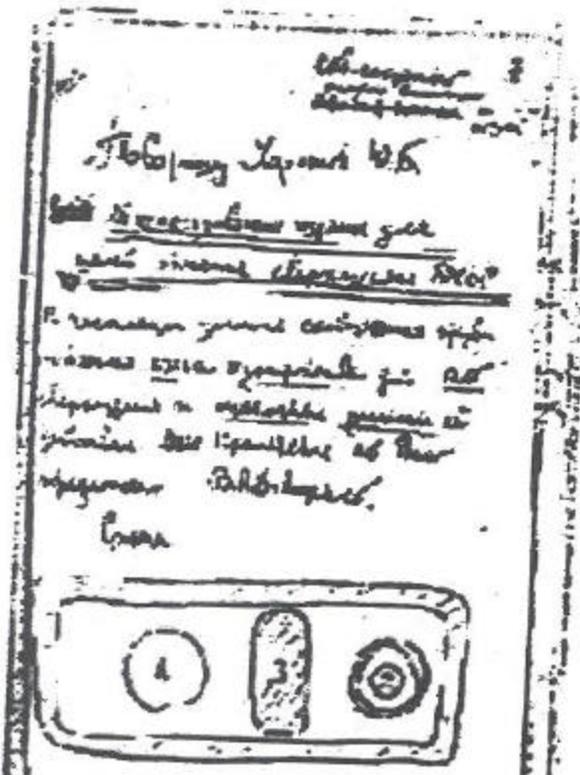
- **The rise and fall of the Vikings**
 - **Christianity has an impact**

- **Martin Luther King, Jr.**
 - **Letter from a Birmingham jail**

Andrei Sakharov is often called the “father of the Soviet hydrogen bomb,” but most people know him as one of the twentieth century’s most ardent and unrelenting champions of human rights and freedoms. It was for his work as an outspoken dissident to the Soviet regime that the Nobel Committee awarded him the Peace Prize in 1975.



The citation called him “the conscience of mankind” saying that he “has fought not only against the abuse of power and violations of human dignity in all its forms, but has in equal vigor fought for the ideal of a state founded on the principle of justice for all.” The Soviet authorities denied him permission to go to Norway to receive his award.



En route from the Sloyka design to a fully functional H-bomb. The first page of a memo by Zeldovich and Sakharov of 14 January 1954, describing the idea of AO - ?Atomnoe Obzhatie? (atomic compression).

The Reverend Dr. Martin Luther King, Jr. at Oberlin



Letter from Birmingham Jail

You may well ask: “Why direct action? Why sit-ins, marches and so forth? Isn’t negotiation a better path?” You are quite right in calling for negotiation. Indeed, this is the very purpose of direct action. Nonviolent direct action seeks to create such a crisis and foster such a tension that a community which has constantly refused to negotiate is forced to confront the issue. It seeks so to dramatize the issue that it can no longer be ignored. My citing the creation of tension as part of the work of the nonviolent-resister may sound rather shocking. But I must confess that I am not afraid of the word “tension”. I have earnestly opposed violent tension, but there is a type of constructive, nonviolent tension which is necessary for growth. Just as Socrates felt that it was necessary to create a tension in the mind so that individuals could rise from the bondage of myths and half-truths to the unfettered realm of creative analysis and objective appraisal, so must we see the need for nonviolent gadflies to create the kind of tension in society that will help men rise from the dark depths of hatred and militarism to the majestic heights of peace and brotherhood.

WHAT NEXT???

My suggestion after discussions with Jim Thompson (RHIC/AGS User's Chair) and Ed Hartouni:

- **Day long discussions/debate/workshop before decision by Brookhaven administration on whether pRad is appropriate at the AGS**
 - **Organized by representatives of all sides**
 - **People on all sides of the question**
 - ❑ **BNL employees**
 - ❑ **Community stakeholders**
 - ❑ **Los Alamos and Livermore pRad people**
 - ❑ **DOE weapons people**
 - ❑ **Pentagon military management**

CONCLUDING PARABLE

**Martin Luther: 31 October 1517 - Door of the church in Wittenberg
“The 95 Theses”.**

**“Out of love for the truth and from desire to elucidate it, The Reverened Father
Martin Luther, Master of Arts and Sacred Theology, and ordinary lecturer
therein at Wittenberg, intends to defend the following statements and to dispute
on them in that place. Therefore he asks that those who cannot be present and
dispute with him orally shall do so in their absence by letter.”**

Amen

Thesis No.

1.

⋮

**26. The pope does very well when he grants remission to souls in purgatory,
not by the power of the keys, which he does not have, but by way of
intercession for them.**

**27. They preach only human doctrines who say that as soon as the money
clinks into the money chest, the soul flies out of purgatory.**

**28. It is certain that when money clinks in the money chest, greed and
avarice can be increased; but when the church intercedes, the result is
in the hands of God alone.**

⋮

95.

Acknowledgements

I have spoken as an individual Brookhaven employee, today, and on previous occasions, but I would like to recognize my support and help along the way.

- All the people I have talked with here at Brookhaven; both those who supported my positions and those who disagreed with me.
- My friends and pastors at North Shore United Methodist Church. Particularly the Outreach Committee.
- Phil Pile, my patient division head, and former nuclear weapons maintenance person for advice: "Read the directions carefully!"
- Derek Lowenstein: The best C-A Department Chair, ever. Going a few rounds with Derek check's out one's resolve.
- Mark Sakitt: clarification of many details, especially what is "fissile"
- Mei Bai and Steve Peggs: for helping organize today's seminar. I owe Mei a whole bunch of quarters.
- Penny LoPresti: help in preparing most of the transparencies.
- John Shanklin: It isn't just physicists that care.
- Roy Rubinstein: "Alan, a little diplomacy will go a long way"
- Yousef Makdisi, Gerry Bunce, Jerry Hastings for their friendly criticism
- Thomas Roser: a quiet voice of reason
- Bob Crease and Judy Liu: Help with early BNL history
- Chris Morris, Ed Hartouni, Matthew Murray for sharing their views
- Jack Marburger: for allowing this dialogue to begin
- Polly: for putting up with the restless nights and baking all of those delicious cookies!!

MY 3 THESES

- 1. As the dominant military power in the world, the United States has a sufficient nuclear arsenal to protect its interests.**
- 2. Brookhaven National Laboratory is in grave danger of repeating the tritium debacle if it accepts Dynamic Proton Radiography.**
- 3. The Brookhaven administration with the backing of the Brookhaven employees should just say **NO** to the DOE weapons establishment.**