The National Lab Perspective: A Tale of Two National User Facilities

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National Institute of Standards and Technology
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Gaithersburg, MD USA

The High Flux Beam Reactor (HFBR)
at Brookhaven National Laboratory

The NIST Center for Neutron Research (NCNR)
at the National Institute of Standards and Technology

Overview

Some Statistics …

My Story – Getting from Here to There

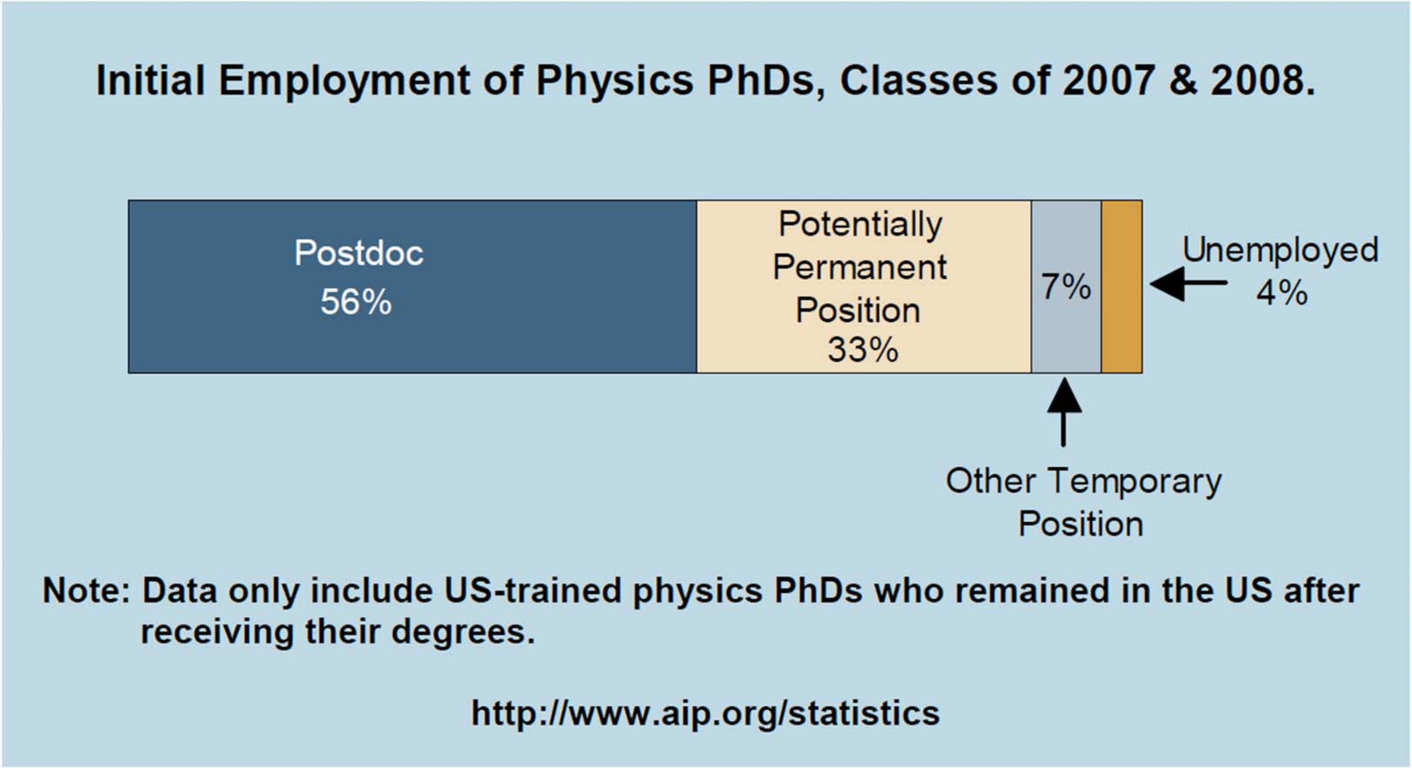
National Laboratories – Pros and Cons

What Staff Scientists Do – Neutron Scattering

Classic Examples of Neutron Science

Some Tips …

Some Statistics …

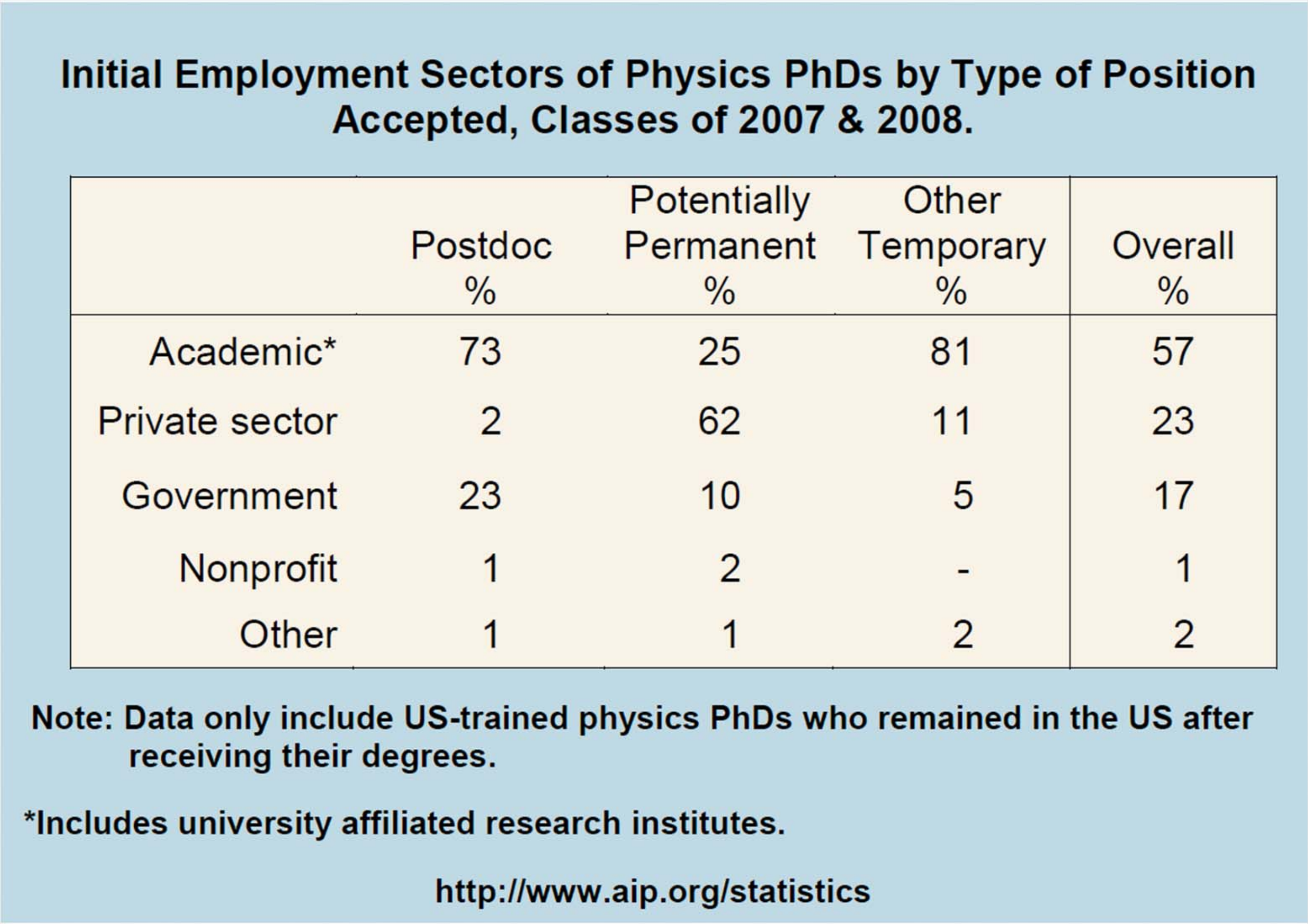


Initial Employment of Physics PhDs, Classes of 2007 & 2008.

Note: Data only include US-trained physics PhDs who remained in the US after receiving their degrees.

http://www.aip.org/statistics

Some Statistics …



Initial Employment Sectors of Physics PhDs by Type of Position Accepted, Classes of 2007 & 2008.

	Postdoc %	Potentially Permanent %	Other Temporary %	Overall %
Academic*	73	25	81	57
Private sector	2	62	11	23
Government	23	10	5	17
Nonprofit	1	2	-	1
Other	1	1	2	2

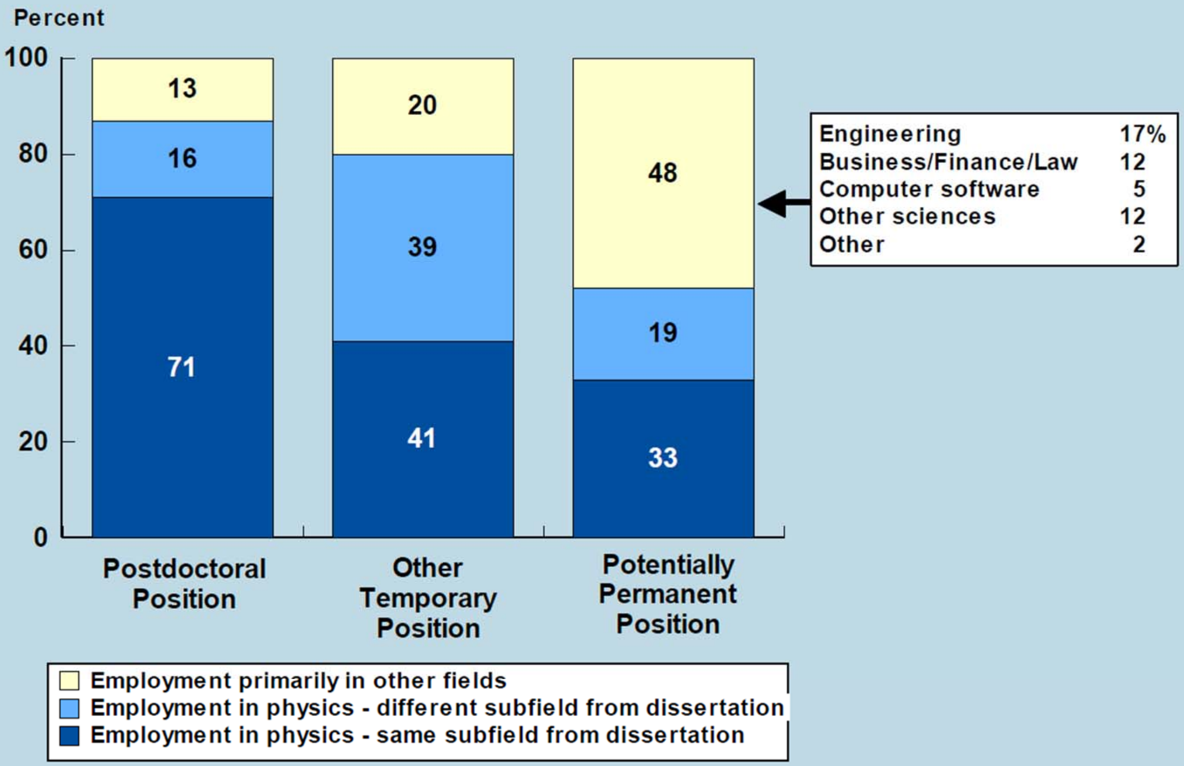
Note: Data only include US-trained physics PhDs who remained in the US after receiving their degrees.

***Includes university affiliated research institutes.**

http://www.aip.org/statistics

Some Statistics …

Initial Employment of Physics PhDs, Classes of 2007 & 2008.

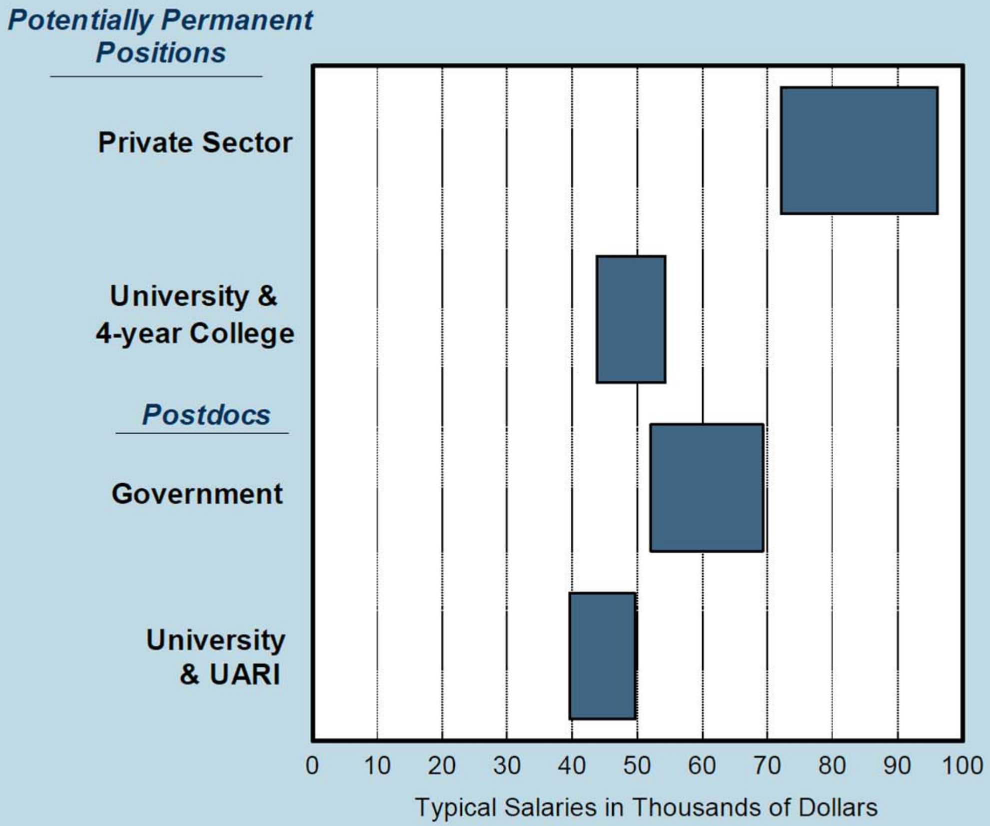


Note: Employment in physics means an individual's primary or secondary employment field was in physics. Data only include US-trained PhDs who remained in the US after receiving their degrees.

http://www.aip.org/statistics

Some Statistics …

PhD Starting Salaries, Classes of 2007 & 2008.



Note: Typical salaries are the middle 50%, i.e. between the 25th and 75th percentiles. Government includes Federally Funded Research and Development Centers, e.g. Los Alamos. UARI: University Affiliated Research Institute. Data only include US-trained PhDs who remained in the US after receiving their degrees.

http://www.aip.org/statistics

Getting from Here to There

Statistically, I was in the largest category – postdoc.

To be honest, I was utterly naïve and uncertain about what I wanted.

A year before graduating I had two awkward industry interviews.

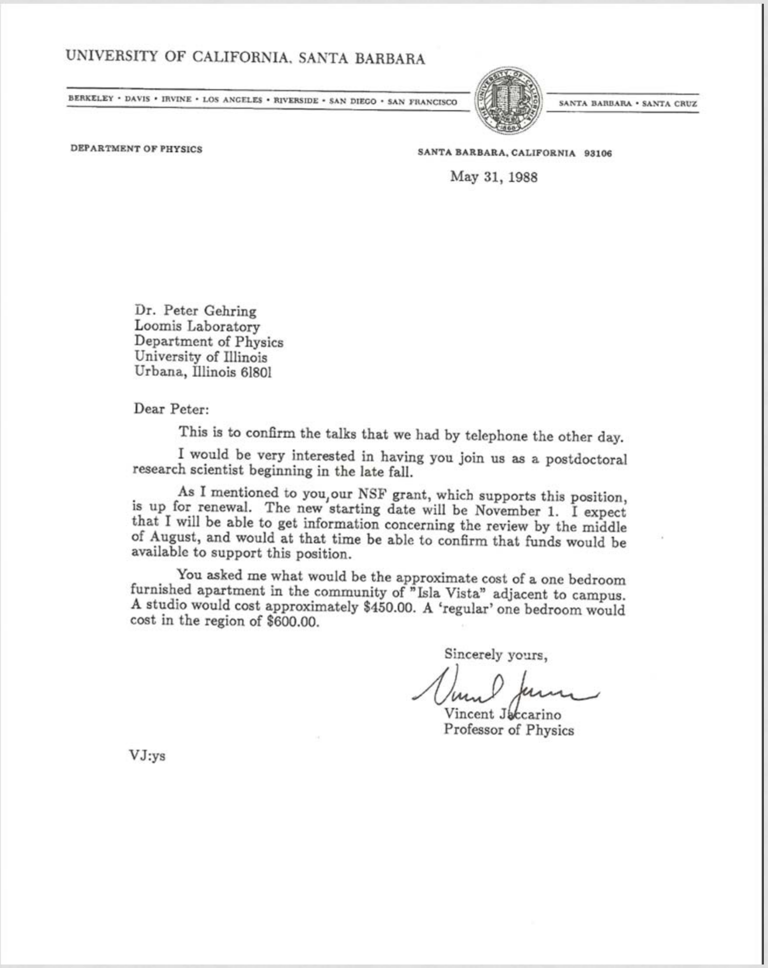
Buckshot approach – I sent out a large number
of letters inquiring about postdoctoral positions.

I was lucky: postdoctoral positions
were relatively plentiful that year.

I interviewed at two places:
UC Santa Barbara and Brookhaven National Lab

Getting from Here to There

Both interviews went well ....



UNIVERSITY OF CALIFORNIA, SANTA BARBARA

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DEPARTMENT OF PHYSICS

SANTA BARBARA, CALIFORNIA 93106

May 31, 1988

Dr. Peter Gehring
Loomis Laboratory
Department of Physics
University of Illinois
Urbana, Illinois 61801

Dear Peter:

This is to confirm the talks that we had by telephone the other day.

I would be very interested in having you join us as a postdoctoral research scientist beginning in the late fall.

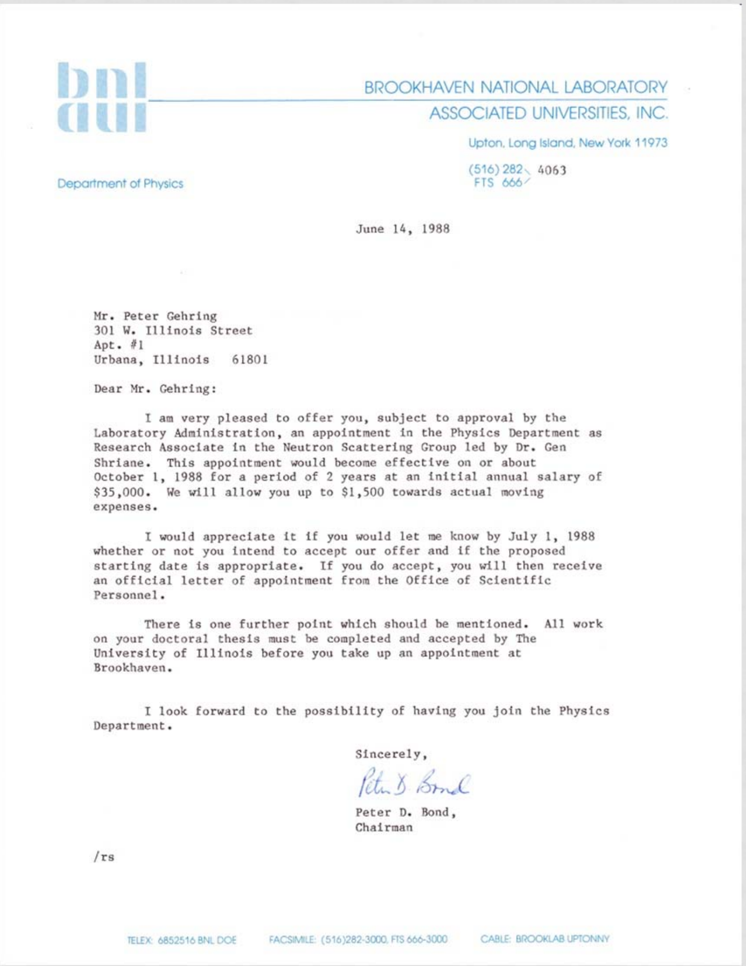
As I mentioned to you, our NSF grant, which supports this position, is up for renewal. The new starting date will be November 1. I expect that I will be able to get information concerning the review by the middle of August, and would at that time be able to confirm that funds would be available to support this position.

You asked me what would be the approximate cost of a one bedroom furnished apartment in the community of "Isla Vista" adjacent to campus. A studio would cost approximately $450.00. A 'regular' one bedroom would cost in the region of $600.00.

Sincerely yours,

Vincent Jaccarino
Professor of Physics

VJ:ys



bnl
aui

BROOKHAVEN NATIONAL LABORATORY
ASSOCIATED UNIVERSITIES, INC.

Upton, Long Island, New York 11973

(516) 282 \ 4063
FTS 666 /

Department of Physics

June 14, 1988

Mr. Peter Gehring
301 W. Illinois Street
Apt. #1
Urbana, Illinois 61801

Dear Mr. Gehring:

I am very pleased to offer you, subject to approval by the Laboratory Administration, an appointment in the Physics Department as Research Associate in the Neutron Scattering Group led by Dr. Gen Shriane. This appointment would become effective on or about October 1, 1988 for a period of 2 years at an initial annual salary of $35,000. We will allow you up to $1,500 towards actual moving expenses.

I would appreciate it if you would let me know by July 1, 1988 whether or not you intend to accept our offer and if the proposed starting date is appropriate. If you do accept, you will then receive an official letter of appointment from the Office of Scientific Personnel.

There is one further point which should be mentioned. All work on your doctoral thesis must be completed and accepted by The University of Illinois before you take up an appointment at Brookhaven.

I look forward to the possibility of having you join the Physics Department.

Sincerely,

Peter D. Bond

Peter D. Bond,
Chairman

/rs

TELEX: 6852516 BNL DOE FACSIMILE: (516)282-3000, FTS 666-3000 CABLE: BROOKLAB UPTONNY

Getting from Here to There

Pros and Cons:

UC Santa Barbara:	Brookhaven National Lab:
● Great scientist (Vincent Jaccarino)	● Great scientist (Gen Shirane)
● Used many techniques	X Used one technique (neutron scattering)
X Studied mainly $Mn_{1-x}Zn_xF_2$	● Studied many systems
● Gorgeous location	X OK location
X Salary - $25K/year	● Salary - $35K/year

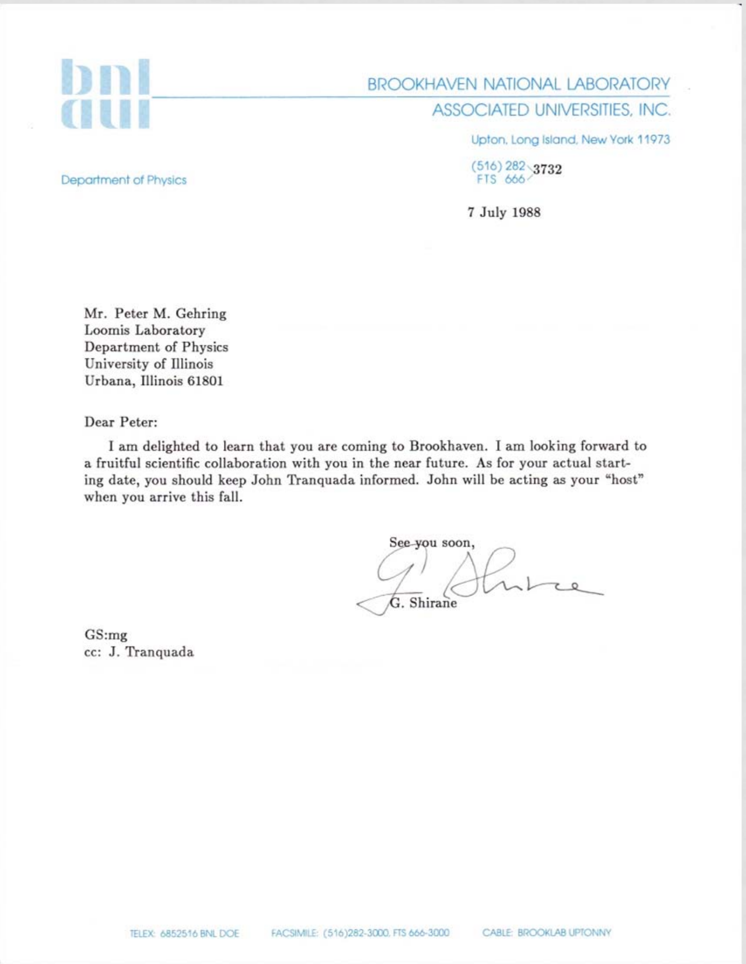
Had a very hard time deciding
(I waited until the last day).

Getting from Here to There

I made my decision.

The High Flux Beam Reactor (HFBR)
at Brookhaven National Laboratory

Letter from Gen Shirane ...



BROOKHAVEN NATIONAL LABORATORY
ASSOCIATED UNIVERSITIES, INC.
Upton, Long Island, New York 11973
(516) 282 3732
FTS 666
Department of Physics

7 July 1988

Mr. Peter M. Gehring
Loomis Laboratory
Department of Physics
University of Illinois
Urbana, Illinois 61801

Dear Peter:

I am delighted to learn that you are coming to Brookhaven. I am looking forward to a fruitful scientific collaboration with you in the near future. As for your actual starting date, you should keep John Tranquada informed. John will be acting as your "host" when you arrive this fall.

See you soon,

G. Shirane

G. Shirane

GS:mg
cc: J. Tranquada

TELEX: 6852516 BNL DOE FACSIMILE: (516)282-3000, FTS 666-3000 CABLE: BROOKLAB UPTONNY

Getting from Here to There

The rest, as they say, is history ...

I have worked (happily) at national labs ever since.

I spent almost four years at Brookhaven National Lab before accepting an offer at NIST to work as an instrument scientist.

Come September I will have finished 20 years at NIST.

Time flies! (This is not an empty cliché.)

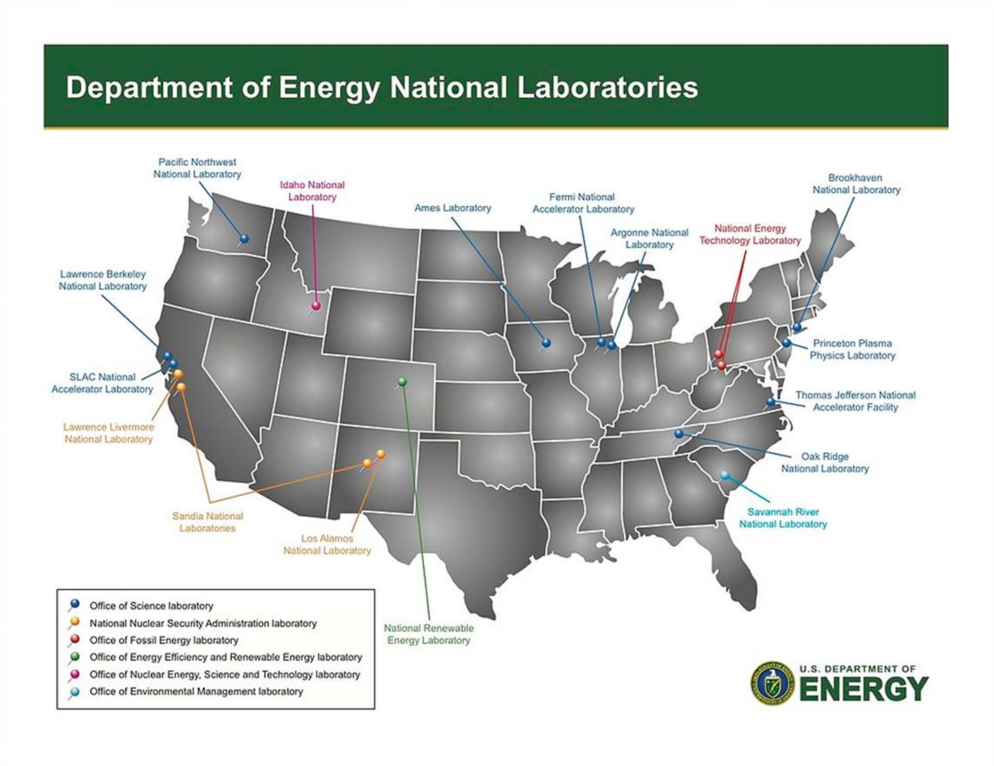
National Laboratories – Pros and Cons

Not all national laboratories are the same.

Federally Operated Labs (incomplete)

- AFRL (Air Force)
- ARL (Army)
- NASA (US Gov)
- NIH (DHHS)
- NIST (DoC)
- NRL (Navy)
- USGS (US Gov)

Contractor Operated Labs (mainly DoE)



National Laboratories – Pros and Cons

★ Many support large, national, user facilities, which attract leading scientists world wide and provide unique research opportunities. ★

One of the best examples is Brookhaven National Lab

AGS and RHIC

NSLS

HFBR

AGS researchers won three Nobel Prizes in Physics:
1976: Ting for the *J* part of the *J*/ψ and charm quark.
1980: Cronin and Fitch for CP violation.
1988: Lederman, Schwartz, and Steinberger for the muon neutrino.

NSLS researchers won one Nobel Prize in Chemistry:
2009: Ramakrishnan and Steitz for ribosome.

HFBR researchers won two APS Buckley Prizes:
1973: Shirane for studies of soft modes.
1987: Birgeneau for low-dimensional magnetism.

National Laboratories – Pros and Cons

Exposure to a broad variety of interesting science.

Do not have to write grant proposals for funding (federal labs).

No teaching requirements and comparatively few committee requirements.

You can get more research done, and it is often of higher impact.

Freer evenings compared to academics .

It is illegal to ask or pressure someone to retire at a federal lab.

NIST staff possess tremendous expertise about physics and measurement science – if you have a question, it's likely that someone at NIST can answer it.

People freely share thoughts when you're thinking of trying a new experiment. They offer suggestions on how to measure it better and warnings about what you might find difficult.

National Laboratories – Pros and Cons

Slightly less job security than for a tenured professor.
(But much better than the private sector/industry.)

Needless bureaucracy.

Tend to have a focused “mission.” Your work needs to be “relevant.”

NIST is a very applied place, and we sometimes have to educate management about how the work we do fits within the NIST mission.

No teaching requirements. (For those who enjoy teaching …)

You won’t be able to “build an empire;” get two or three postdocs at most.

Slightly less autonomy than in academia, but more than in industry.

NIST Center for Neutron Research (NCNR)

25 beam facilities

What Staff Scientists Do

What Staff Scientists Do

They get to interact/collaborate with many world-class scientists.

They are reasonably well-paid.

They publish papers and are well-positioned to strike first on hot-topics in science, e.g. iron-based, high-T_c superconductors.

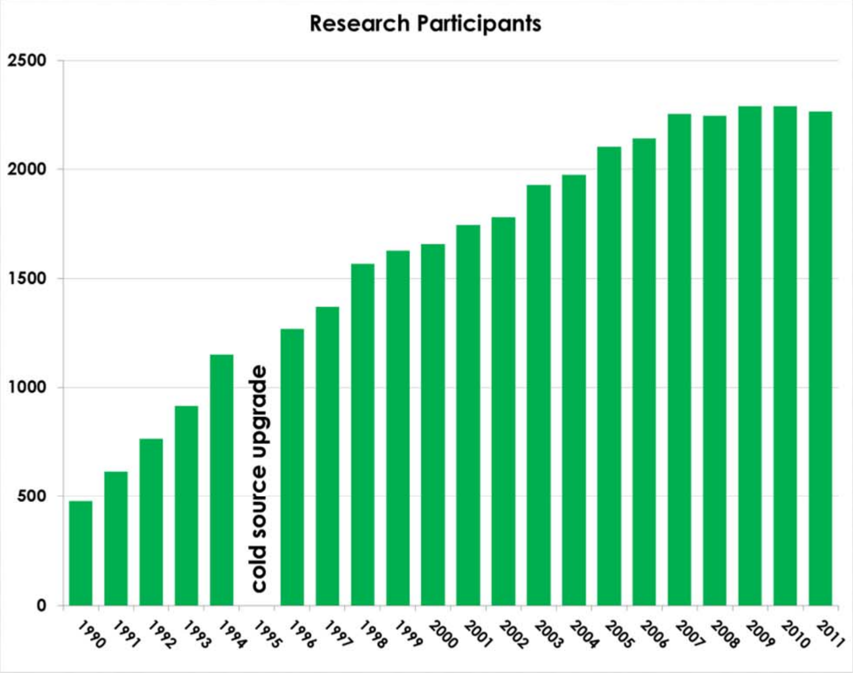
They don’t have to write grant proposals (a few exceptions).

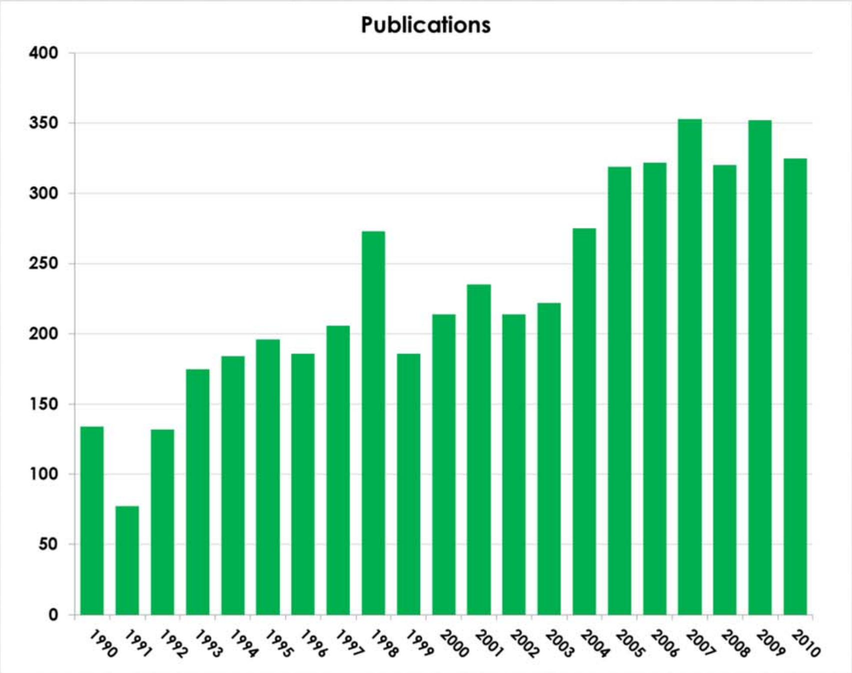
They serve as local contacts for external users who run experiments on a variety of different neutron instruments.

They get to “teach” external users (mainly graduate students and postdocs).

They often have to work long hours/nights/weekends.
(Industrial researchers typically work 9-5.)

What Staff Scientists Do





Different Career Paths

Sample Environment Team

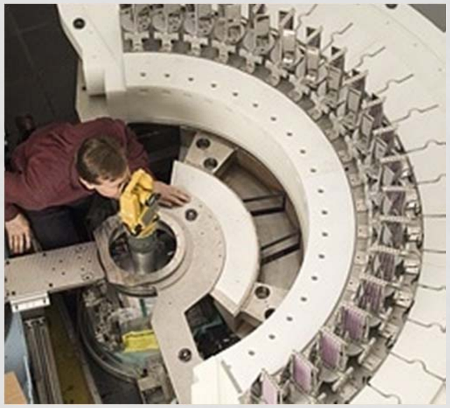
Data Acquisition Team

Management

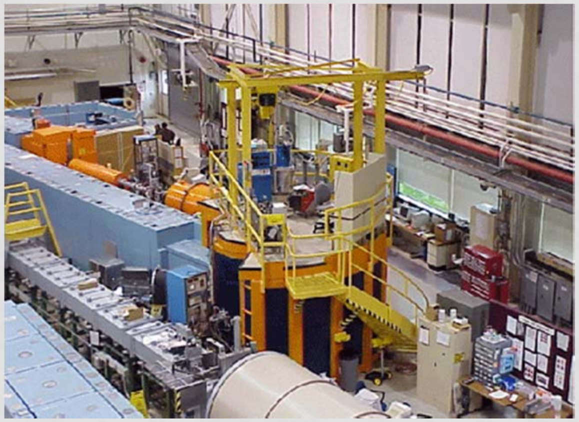
IT Support

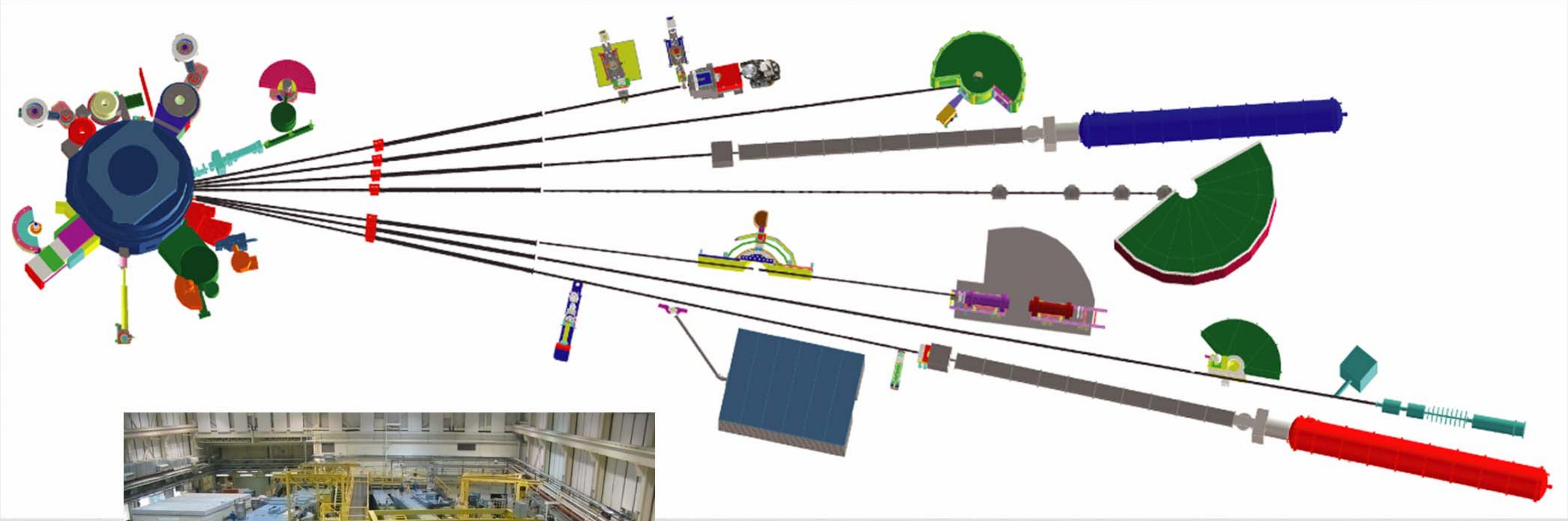
Univ. of Illinois PhDs

Instrument Scientist



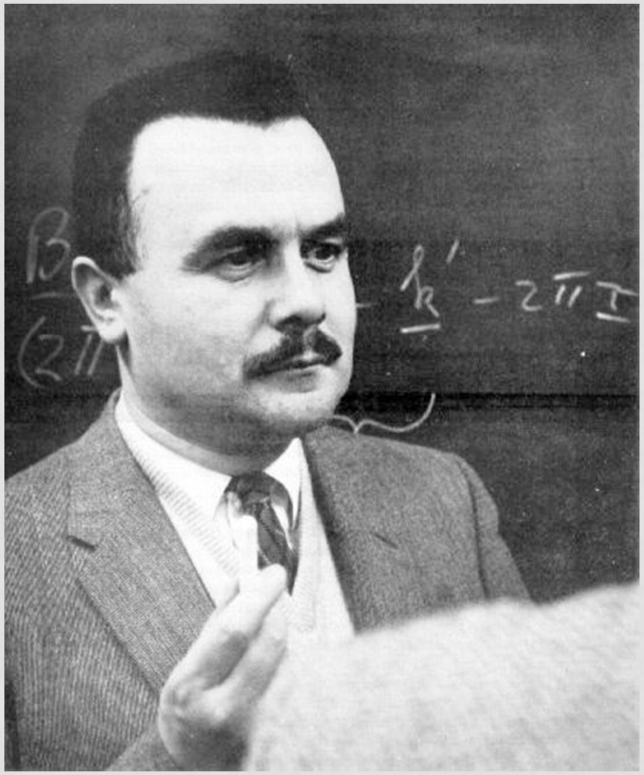
What Staff Scientists Do





Primarily, they schedule and run experiments on, as well as maintain our many neutron scattering instruments.

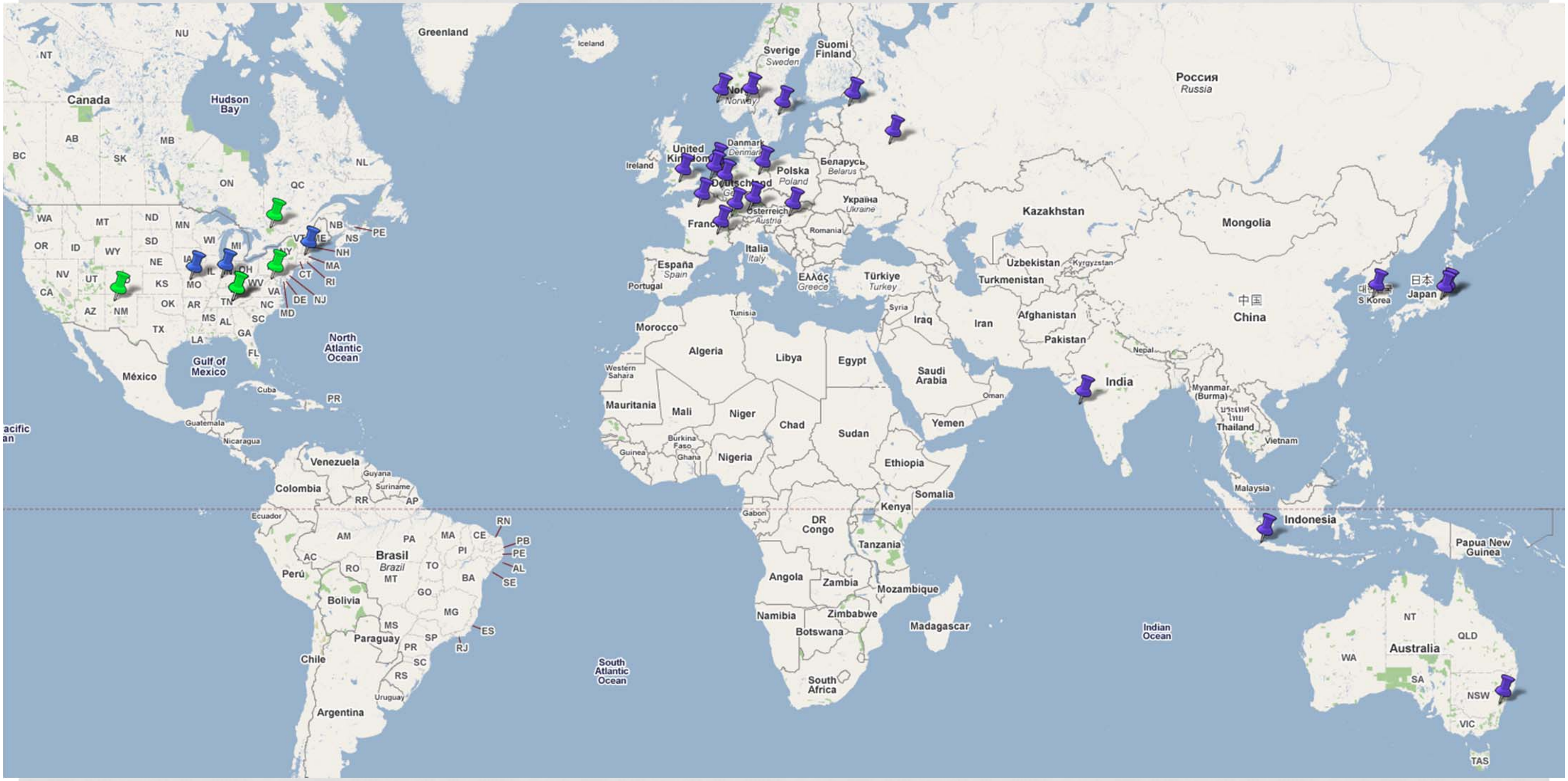
So let's discuss neutron scattering a bit …



“If the neutron did not exist, it would need to be invented.”

Bertram Brockhouse –
1994 Nobel Laureate in Physics

Neutron Scattering in the World

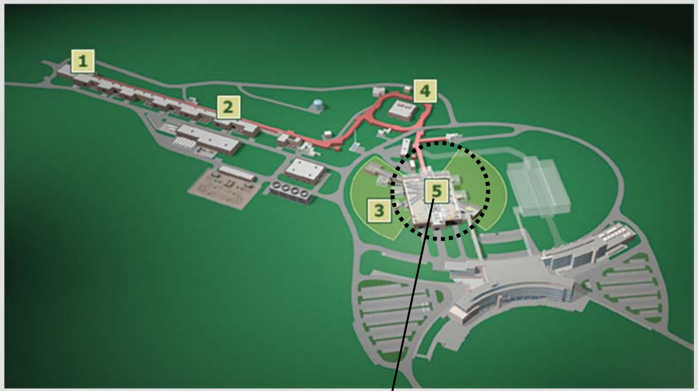


Western Europe dominates in terms of…

- number of users
- capacity/throughput
- scientific productivity

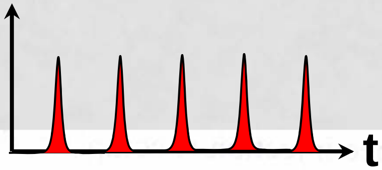
Neutron Production by Spallation

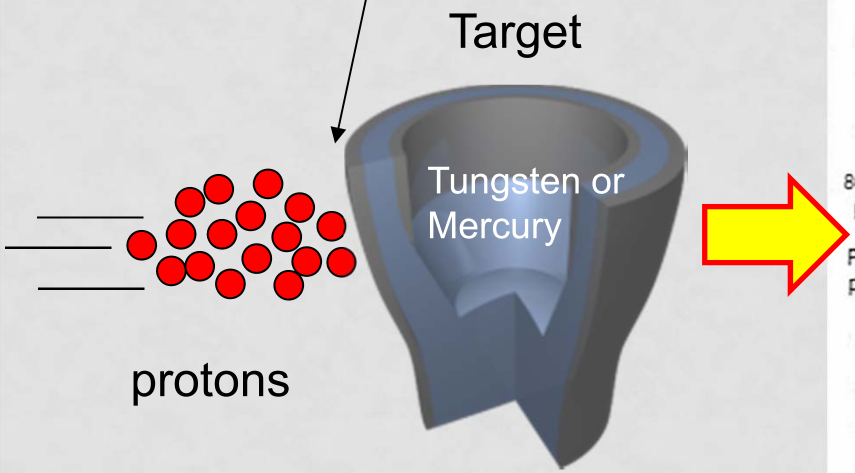
New Spallation Neutron Source (SNS) located in Oak Ridge Nat. Lab, USA.

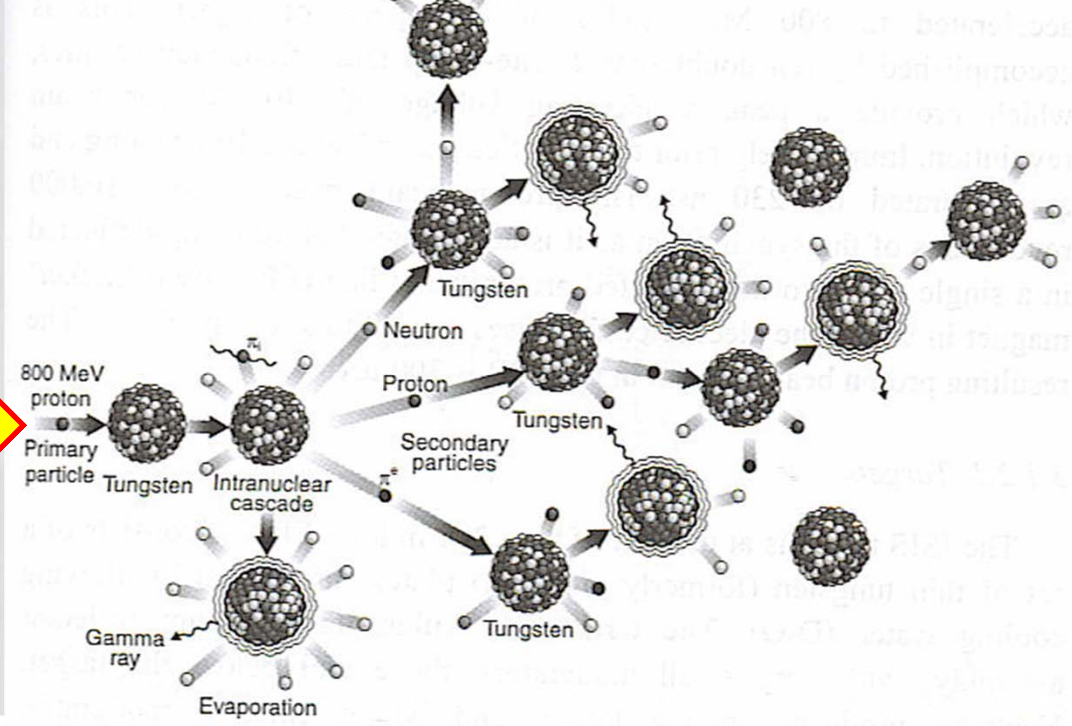


Uses a cascade effect that results from the collision of a proton on a heavy target nucleus

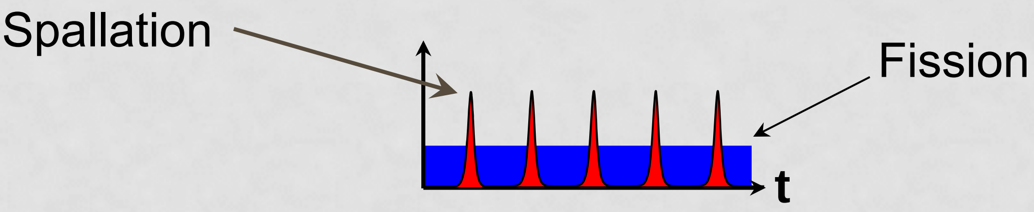
Delivers an intense beam of neutrons with a pulsed time structure





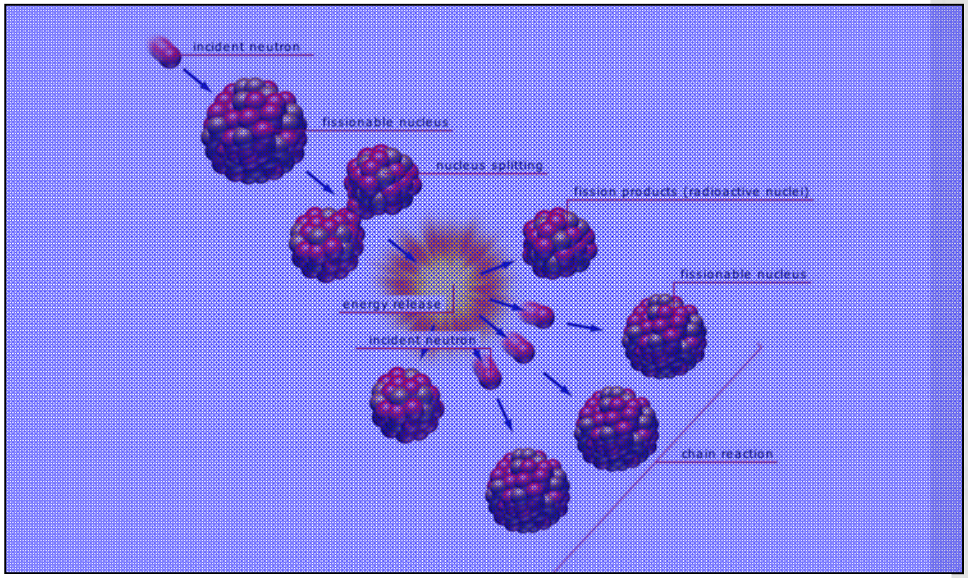


Neutron Production by Fission

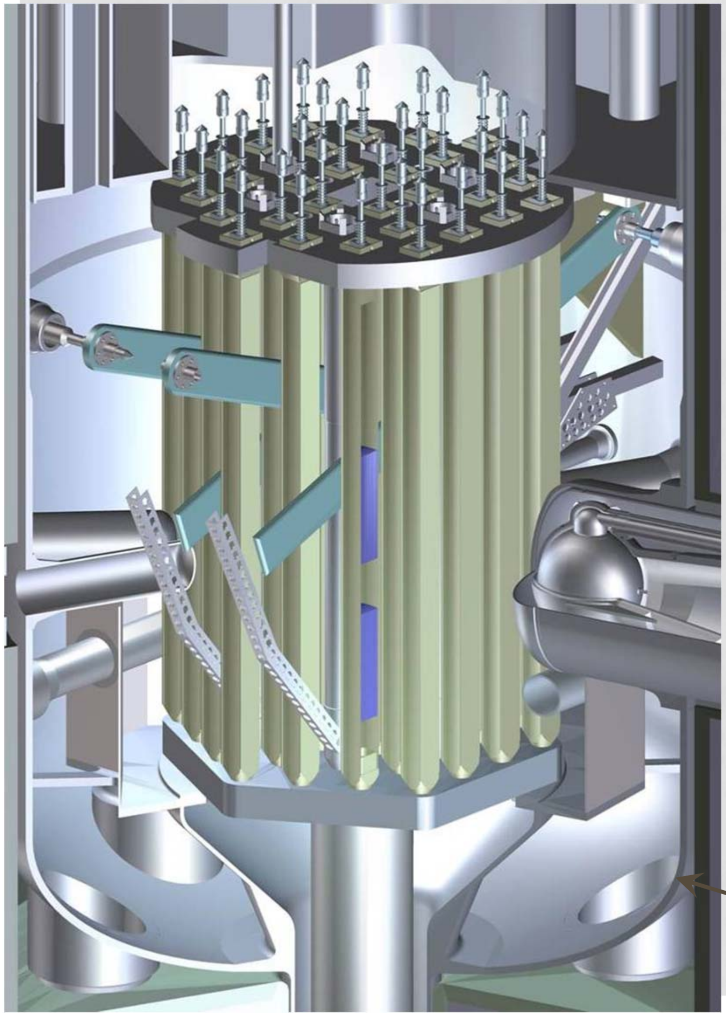


Nuclear fission is used in power and research reactors.

$${}^{235}_{92}U_{143} + n \rightarrow \left[{}^{236}_{92}U_{144}\right]^{*} \rightarrow X + Y + 2.44n$$



A liquid medium (D_2O, or heavy water) is used to moderate the fast fission neutrons to room temperature (2 MeV → 50 meV).

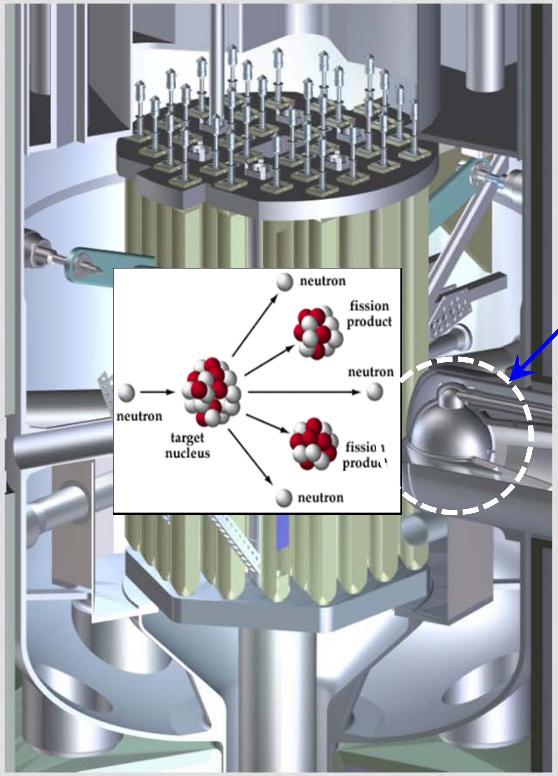


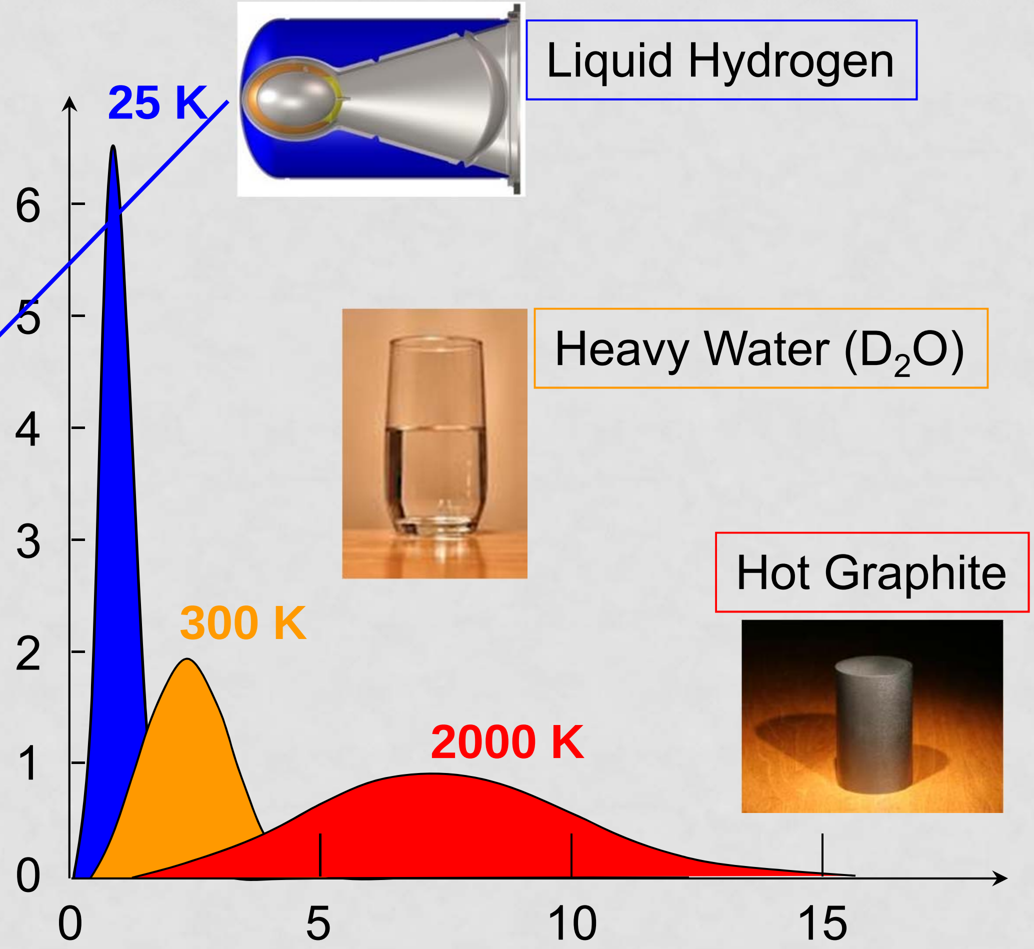
The fission process and moderator are confined by a large containment vessel.

Neutron Moderation

Maxwellian Distribution

$$\Phi \sim v^3 e^{(-mv^2/2k_BT)}$$



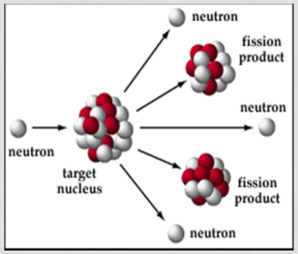


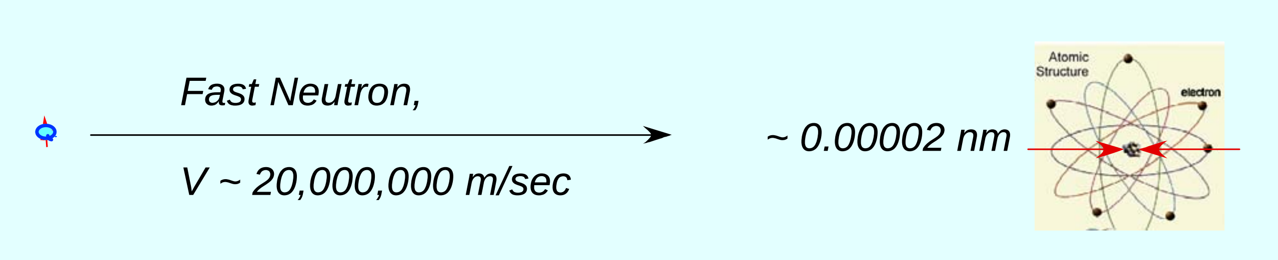
“Fast” neutrons: v = 20,000 km/sec

Neutron velocity *v* (km/sec)

Wave - Particle Duality

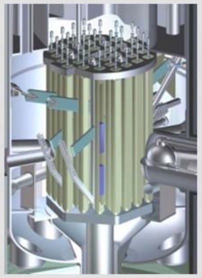
de Broglie Relation $\lambda = h/m_n v$

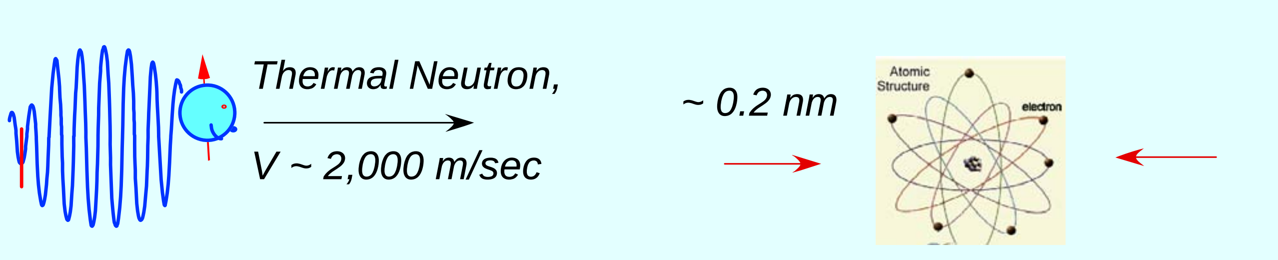



Fast Neutron,

V ~ 20,000,000 m/sec

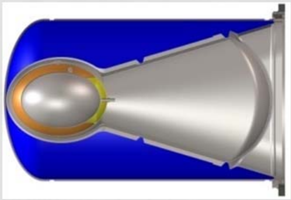
~ 0.00002 nm

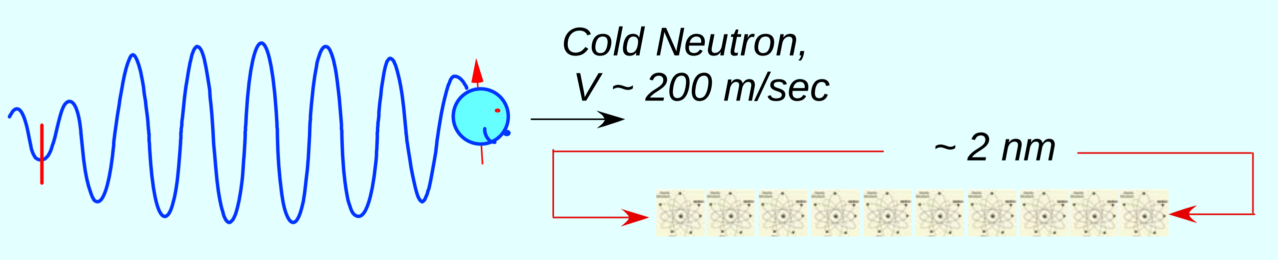



Thermal Neutron,

V ~ 2,000 m/sec

~ 0.2 nm




Cold Neutron,

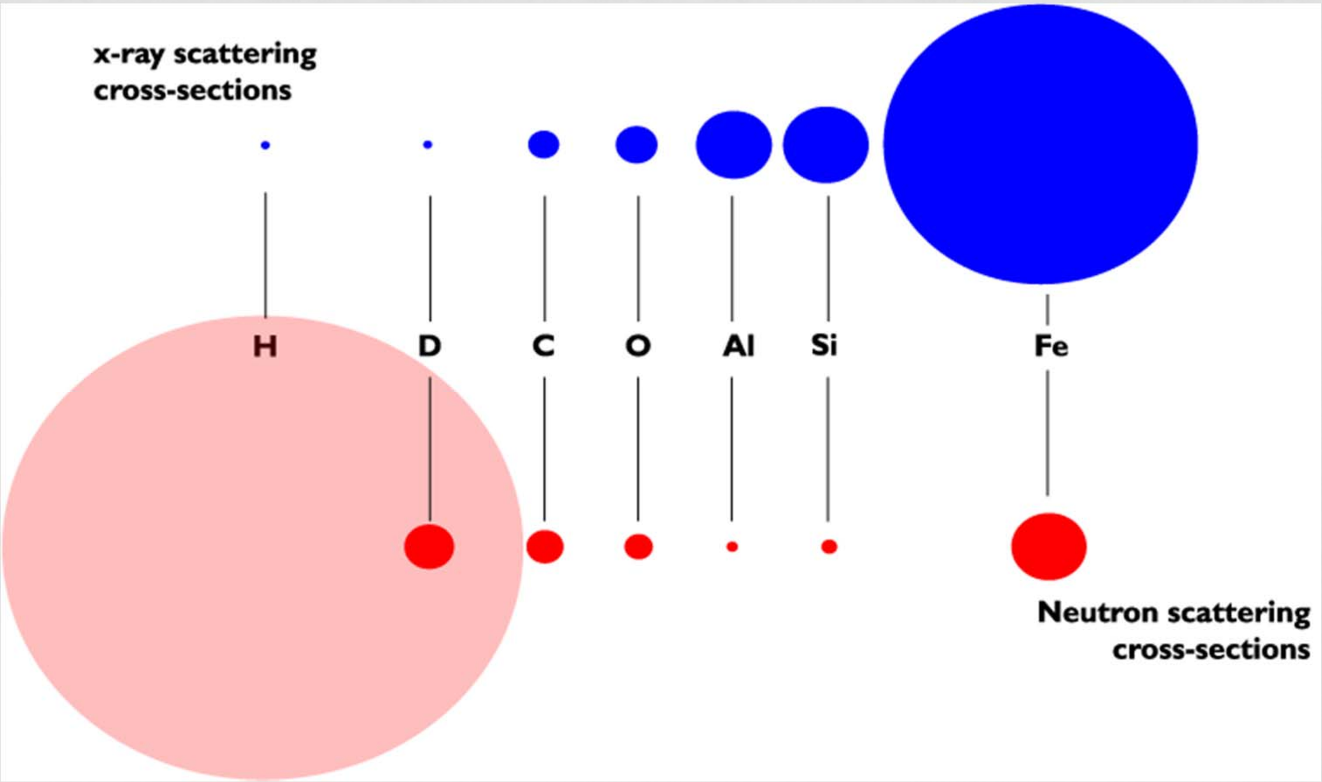
V ~ 200 m/sec

~ 2 nm

Nuclear Interaction

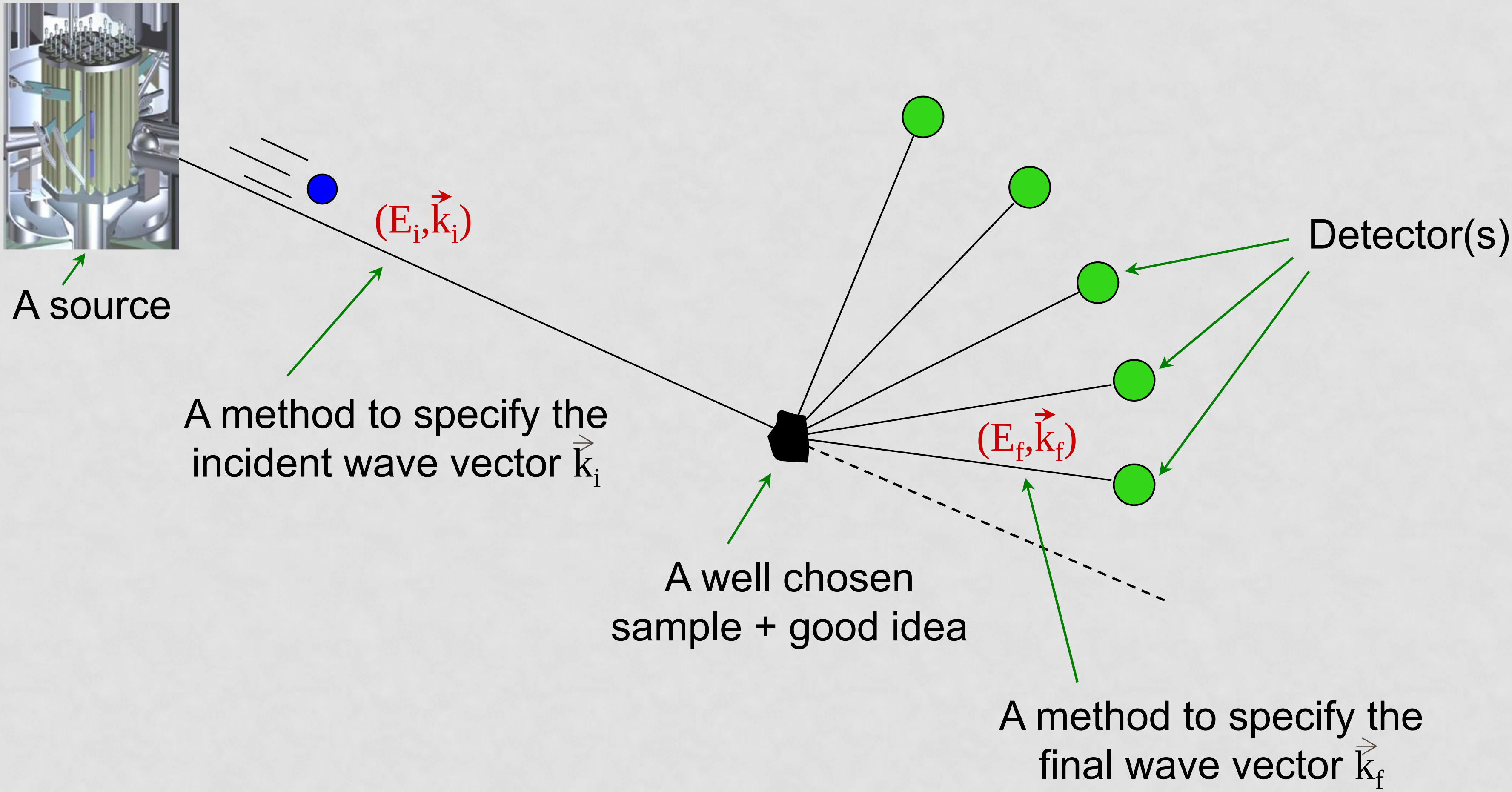
$$V_{nuc}(\vec{r}) = \sum_j \frac{2\pi\hbar^2}{m} b_j \, \delta(\vec{r} - \vec{r}_j)$$

- strong but short-ranged (s-wave scattering)
- varies from isotope to isotope ("isotopic labeling")
- light elements and heavy elements comparable
- nuclear spin-dependent (coherent and incoherent scattering)



Basics of Neutron Scattering Methods

Elements of all scattering experiments



A source

$(E_i,\vec{k}_i)$

A method to specify the incident wave vector $\vec{k}_i$

A well chosen sample + good idea

$(E_f,\vec{k}_f)$

Detector(s)

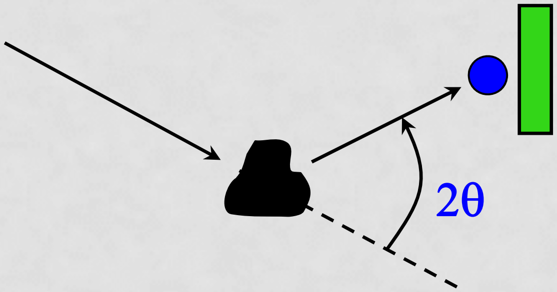
A method to specify the final wave vector $\vec{k}_f$

Basics of Neutron Scattering

(1) Neutron scattering experiments measure the flux of neutrons scattered by a sample into a detector as a function of the change in neutron wave vector ($\vec{Q}$) and energy ($\hbar\omega$).

Momentum	Energy
$\hbar k_n = \hbar(2\pi/\lambda_n)$	$\hbar\omega_n = \hbar^2 k_n^2/2m$
$\hbar\vec{Q} = \hbar\vec{k}_i - \hbar\vec{k}_f$	$\hbar\omega = \hbar\omega_i - \hbar\omega_f$

$\Phi(Q,\hbar\omega) = \frac{\text{neutrons}}{\text{sec–cm}^2}$



(2) The expressions for the scattered neutron flux Φ involve the positions and motions of atomic nuclei or unpaired electron spins.

$$\boxed{\Phi = F\{\vec{r}_i(t), \vec{r}_j(t), \vec{S}_i(t), \vec{S}_j(t)\}} \Rightarrow$$

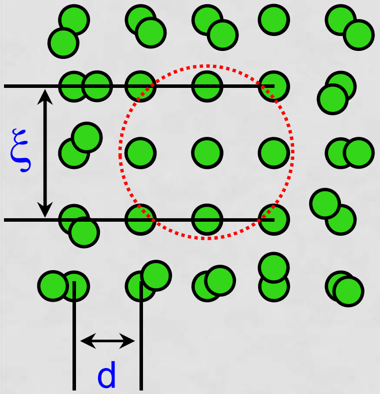
Φ provides information about all of these quantities!

The Neutron Scattering Cross Section

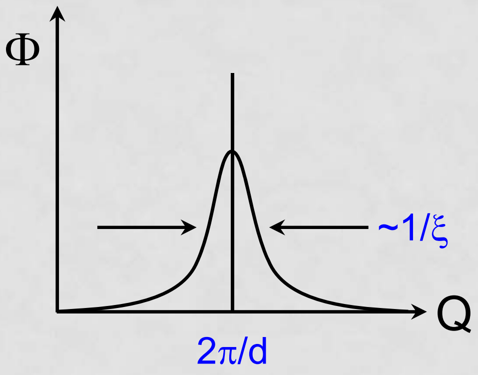
(3) The scattered neutron flux $\Phi(\vec{Q},\hbar\omega)$ is proportional to the space ($\vec{r}$) and time (t) Fourier transform of the probability $G(\vec{r},t)$ of finding one or two atoms separated by a particular distance at a particular time.

$$\Phi \propto \frac{\partial^2\sigma}{\partial\Omega\partial\omega} \propto \iint e^{i(\vec{Q}\cdot\vec{r}-\omega t)}G(\vec{r},t)\,d^3\vec{r}\,dt$$

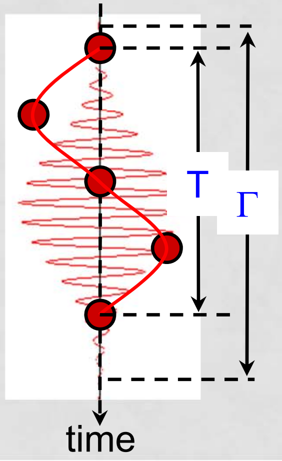
Real space



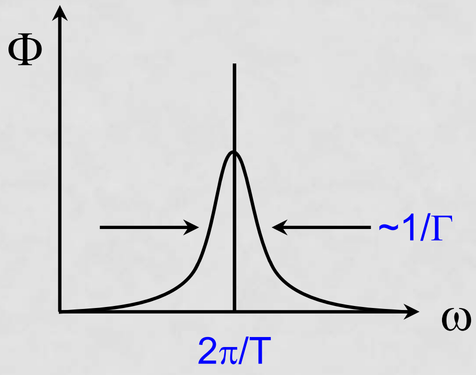
Q-space



Time space



ω-space

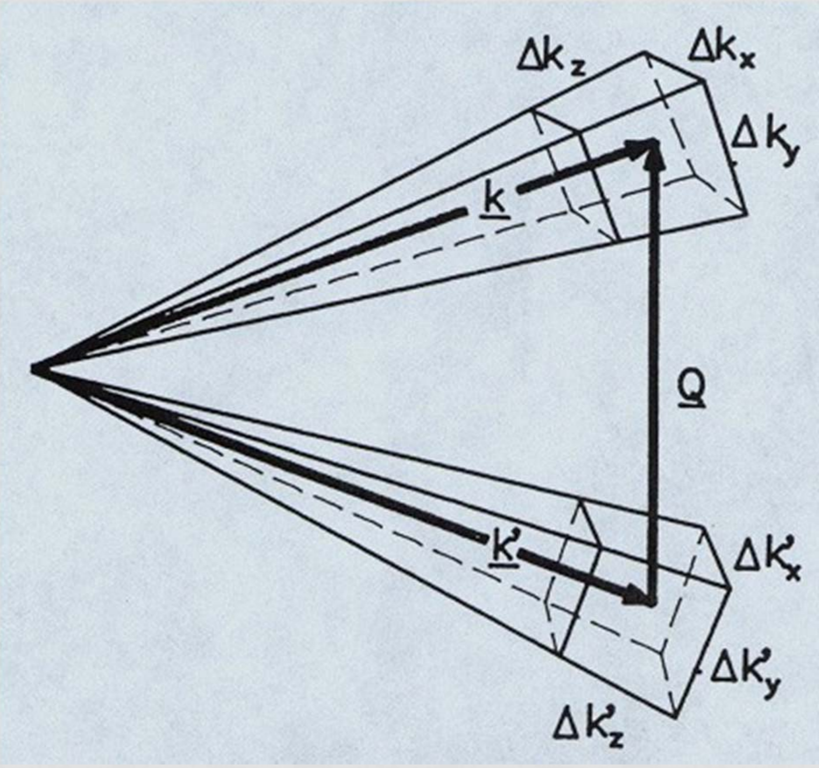


Why so Many Different Spectrometers?

Because neutron scattering is an intensity-limited technique. Thus detector coverage and resolution MUST be tailored to the science.

Uncertainties in the neutron wavelength and direction imply **Q** and $\hbar\omega$ can only be defined with a finite precision.

The total signal in a scattering experiment is proportional to the resolution volume → better resolution leads to lower count rates! *Choose carefully* …

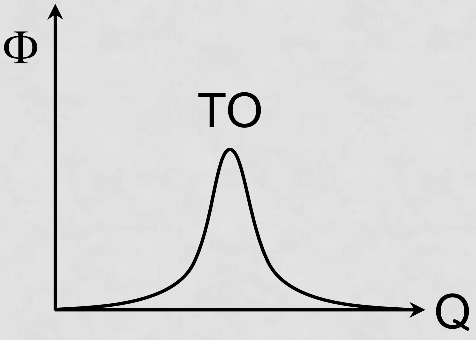


Courtesy of R. Pynn

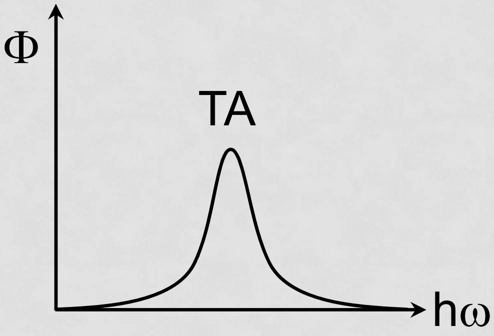
Phonon and Magnon Dispersions

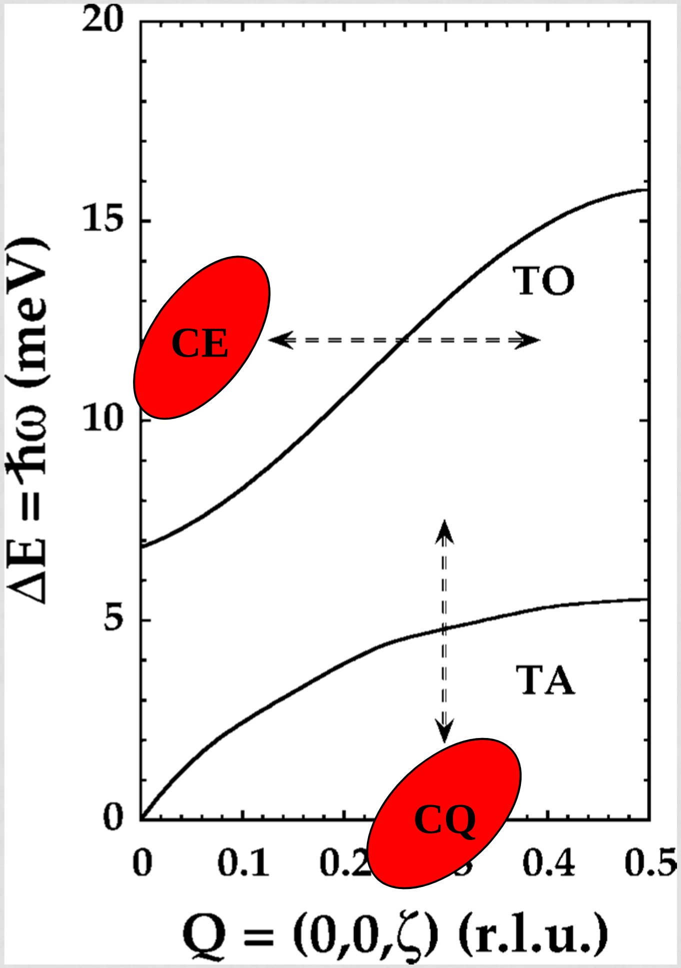
There are two main ways of measuring the neutron scattering cross section S(Q,ω).

Constant-E scans: vary Q at fixed hω.



Constant-Q scans: vary hω at fixed Q.





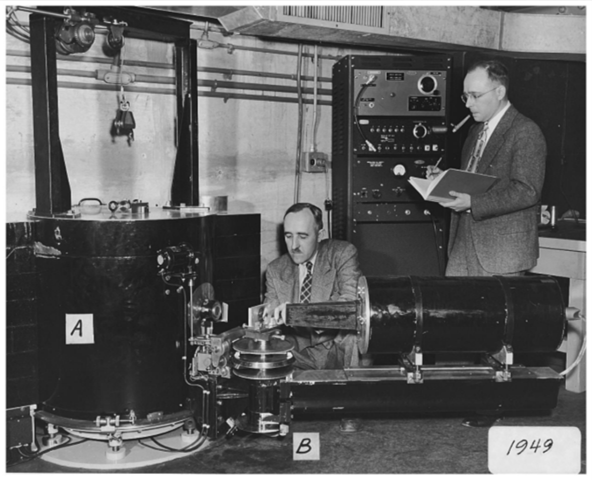
Nobel Prize
in Physics
1994

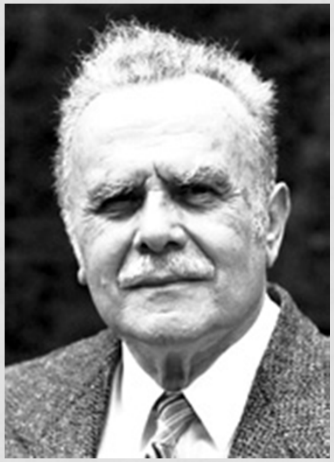
The Fathers of Neutron Scattering

"For pioneering contributions to the development of neutron scattering techniques for studies of condensed matter"

"For the development of the neutron diffraction technique"

"For the development of neutron spectroscopy"





Clifford G Shull
MIT, USA
(1915 – 2001)

Ernest O Wollan
ORNL, USA
(1910 – 1984)

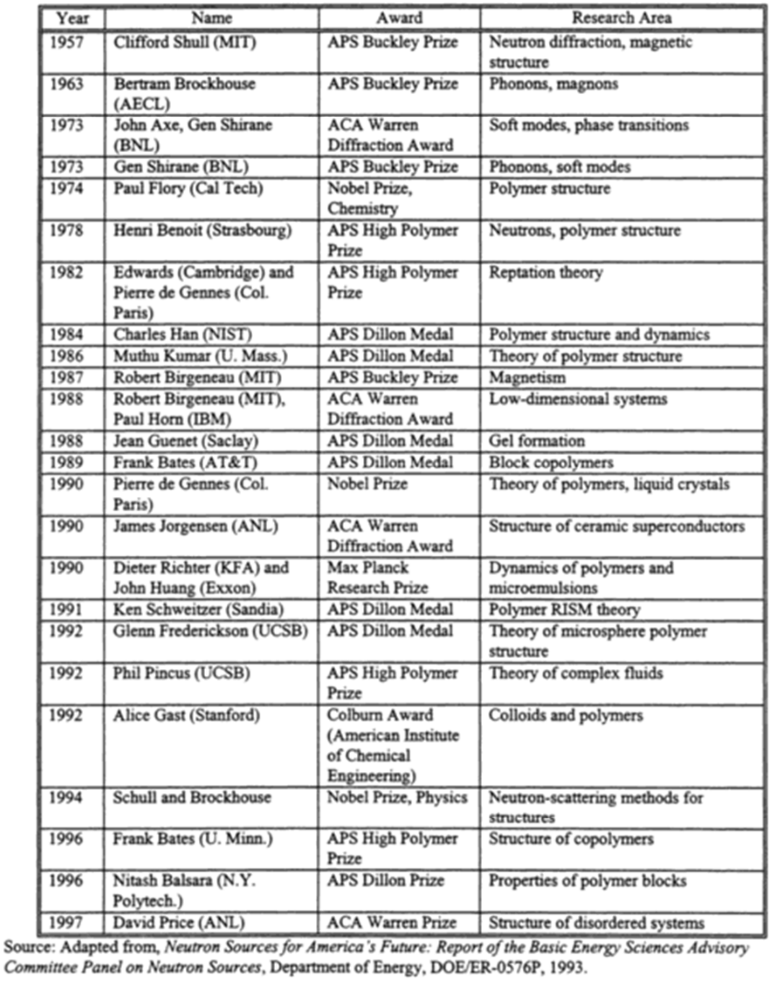
Bertram N Brockhouse
McMaster University, Canada
(1918 – 2003)

Showed us where the atoms are …

Did first neutron diffraction expts …

Showed us how the atoms move …

Awards for or Influenced by Neutrons



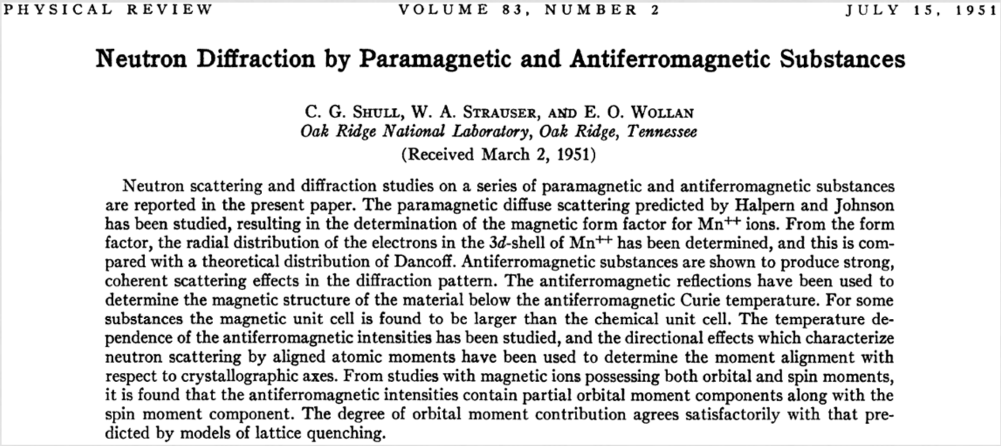
Year	Name	Award	Research Area
1957	Clifford Shull (MIT)	APS Buckley Prize	Neutron diffraction, magnetic structure
1963	Bertram Brockhouse (AECL)	APS Buckley Prize	Phonons, magnons
1973	John Axe, Gen Shirane (BNL)	ACA Warren Diffraction Award	Soft modes, phase transitions
1973	Gen Shirane (BNL)	APS Buckley Prize	Phonons, soft modes
1974	Paul Flory (Cal Tech)	Nobel Prize, Chemistry	Polymer structure
1978	Henri Benoit (Strasbourg)	APS High Polymer Prize	Neutrons, polymer structure
1982	Edwards (Cambridge) and Pierre de Gennes (Col. Paris)	APS High Polymer Prize	Reptation theory
1984	Charles Han (NIST)	APS Dillon Medal	Polymer structure and dynamics
1986	Muthu Kumar (U. Mass.)	APS Dillon Medal	Theory of polymer structure
1987	Robert Birgeneau (MIT)	APS Buckley Prize	Magnetism
1988	Robert Birgeneau (MIT), Paul Horn (IBM)	ACA Warren Diffraction Award	Low-dimensional systems
1988	Jean Guenet (Saclay)	APS Dillon Medal	Gel formation
1989	Frank Bates (AT&T)	APS Dillon Medal	Block copolymers
1990	Pierre de Gennes (Col. Paris)	Nobel Prize	Theory of polymers, liquid crystals
1990	James Jorgensen (ANL)	ACA Warren Diffraction Award	Structure of ceramic superconductors
1990	Dieter Richter (KFA) and John Huang (Exxon)	Max Planck Research Prize	Dynamics of polymers and microemulsions
1991	Ken Schweitzer (Sandia)	APS Dillon Medal	Polymer RISM theory
1992	Glenn Frederickson (UCSB)	APS Dillon Medal	Theory of microsphere polymer structure
1992	Phil Pincus (UCSB)	APS High Polymer Prize	Theory of complex fluids
1992	Alice Gast (Stanford)	Colburn Award (American Institute of Chemical Engineering)	Colloids and polymers
1994	Schull and Brockhouse	Nobel Prize, Physics	Neutron-scattering methods for structures
1996	Frank Bates (U. Minn.)	APS High Polymer Prize	Structure of copolymers
1996	Nitash Balsara (N.Y. Polytech.)	APS Dillon Prize	Properties of polymer blocks
1997	David Price (ANL)	ACA Warren Prize	Structure of disordered systems

Source: Adapted from, *Neutron Sources for America's Future: Report of the Basic Energy Sciences Advisory Committee Panel on Neutron Sources*, Department of Energy, DOE/ER-0576P, 1993.

Classic Examples of Neutron Science

Antiferromagnetism

Confirmed magnetic sublattice model of Louis Neel (Nobel – 1970)



PHYSICAL REVIEW VOLUME 83, NUMBER 2 JULY 15, 1951

Neutron Diffraction by Paramagnetic and Antiferromagnetic Substances

C. G. SHULL, W. A. STRAUSER, AND E. O. WOLLAN
Oak Ridge National Laboratory, Oak Ridge, Tennessee
(Received March 2, 1951)

Neutron scattering and diffraction studies on a series of paramagnetic and antiferromagnetic substances are reported in the present paper. The paramagnetic diffuse scattering predicted by Halpern and Johnson has been studied, resulting in the determination of the magnetic form factor for Mn^{++} ions. From the form factor, the radial distribution of the electrons in the 3*d*-shell of Mn^{++} has been determined, and this is compared with a theoretical distribution of Dancoff. Antiferromagnetic substances are shown to produce strong, coherent scattering effects in the diffraction pattern. The antiferromagnetic reflections have been used to determine the magnetic structure of the material below the antiferromagnetic Curie temperature. For some substances the magnetic unit cell is found to be larger than the chemical unit cell. The temperature dependence of the antiferromagnetic intensities has been studied, and the directional effects which characterize neutron scattering by aligned atomic moments have been used to determine the moment alignment with respect to crystallographic axes. From studies with magnetic ions possessing both orbital and spin moments, it is found that the antiferromagnetic intensities contain partial orbital moment components along with the spin moment component. The degree of orbital moment contribution agrees satisfactorily with that predicted by models of lattice quenching.

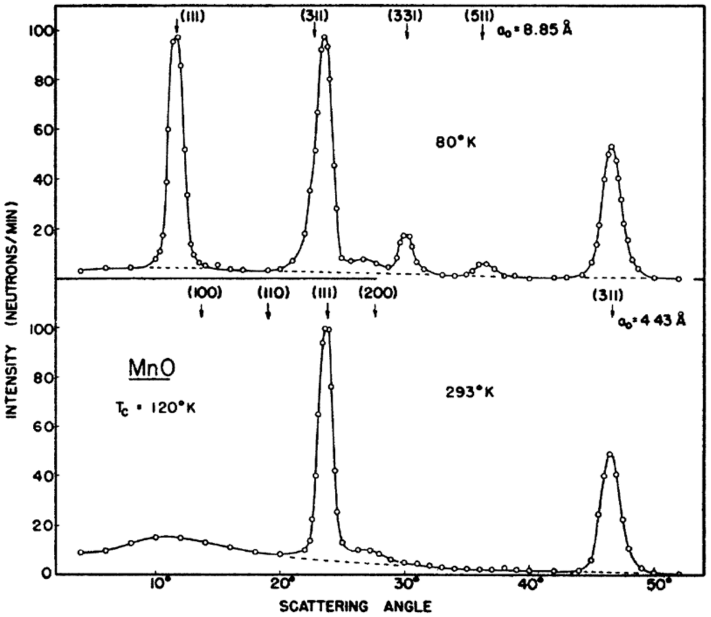


FIG. 4. Neutron diffraction patterns for MnO taken at liquid nitrogen and room temperatures. The patterns have been corrected for the various forms of extraneous, diffuse scattering mentioned in the text. Four extra antiferromagnetic reflections are to be noticed in the low temperature pattern.

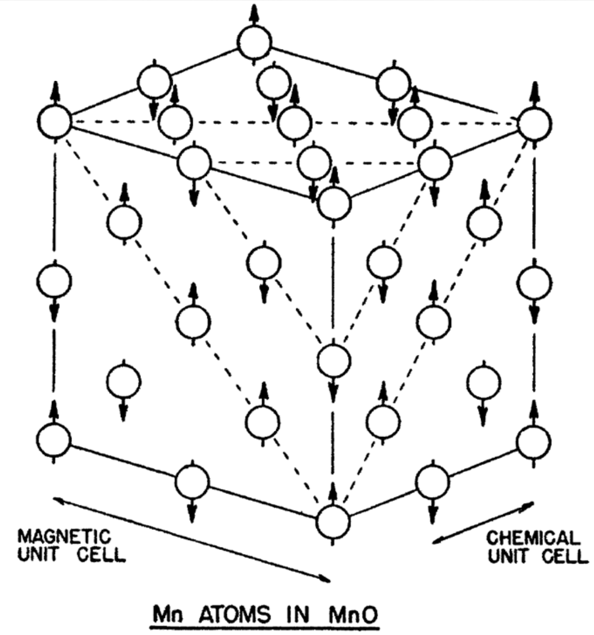
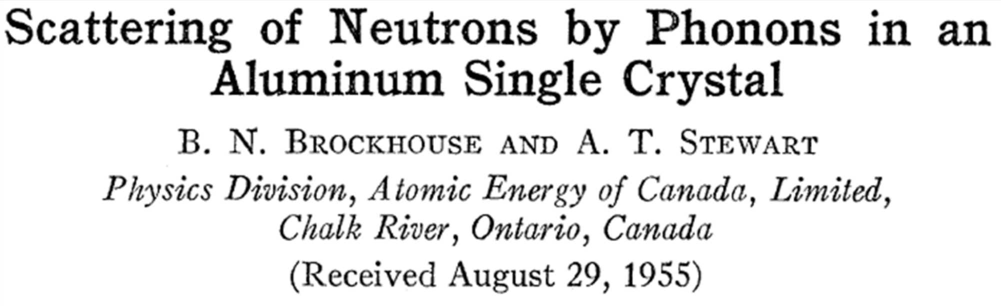


FIG. 5. Antiferromagnetic structure existing in MnO below its Curie temperature of 120°K. The magnetic unit cell has twice the linear dimensions of the chemical unit cell. Only Mn ions are shown in the diagram.

Phonons and Magnons



Scattering of Neutrons by Phonons in an Aluminum Single Crystal

B. N. Brockhouse and A. T. Stewart
Physics Division, Atomic Energy of Canada, Limited, Chalk River, Ontario, Canada

(Received August 29, 1955)

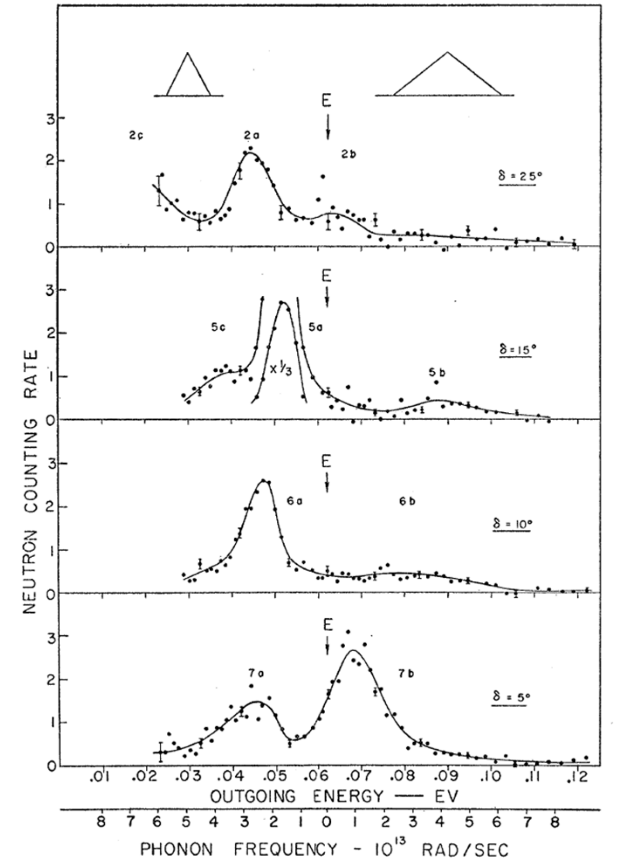


Fig. 1. Typical energy distributions of neutrons inelastically scattered by an aluminum single crystal and approximate resolution functions. The incident neutron energy *E* is indicated by the arrows.

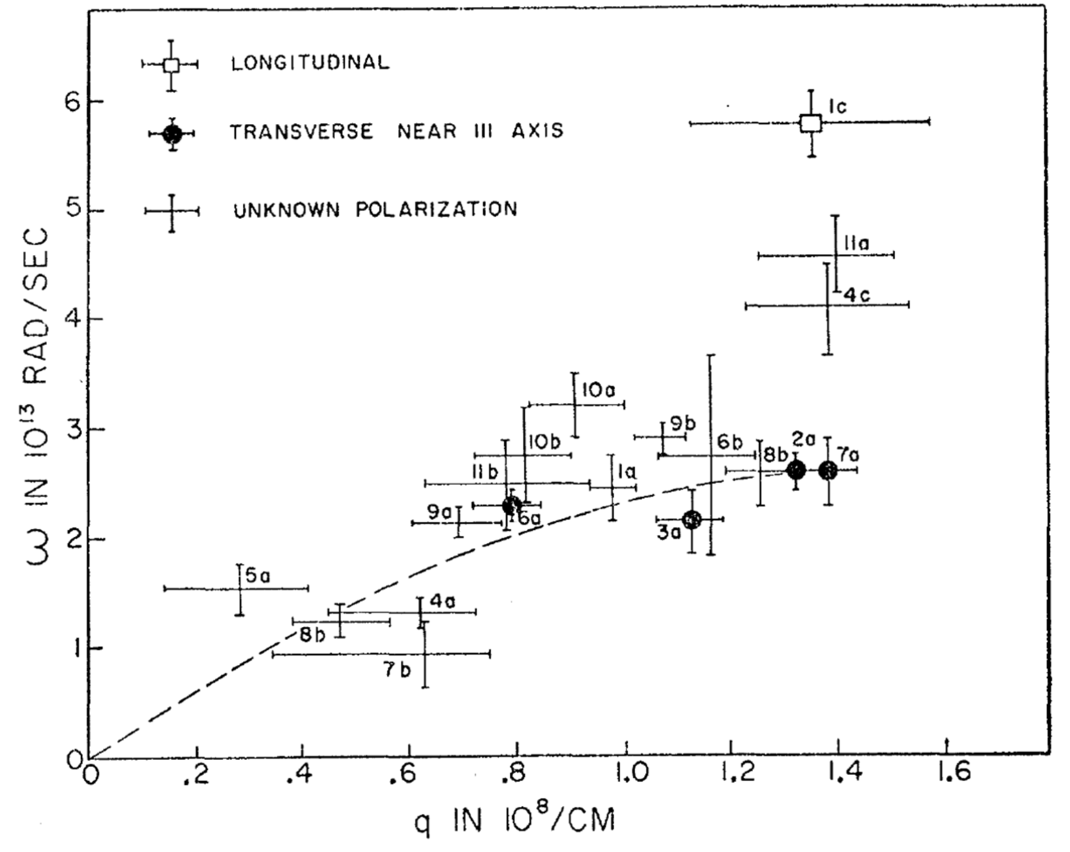
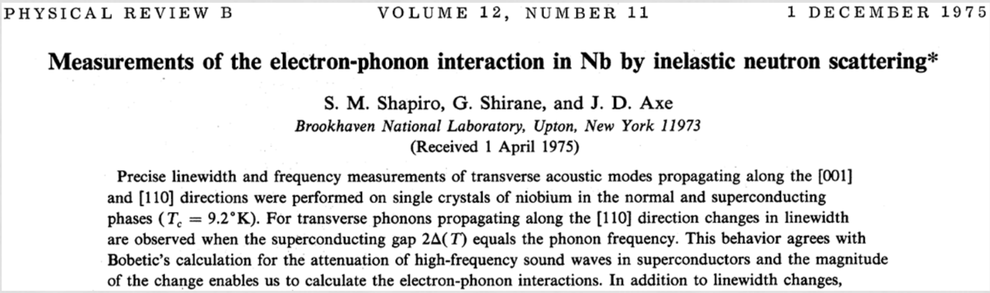


Fig. 3. Relation between ω and q for observed phonon groups, with estimated errors.

Superconductivity

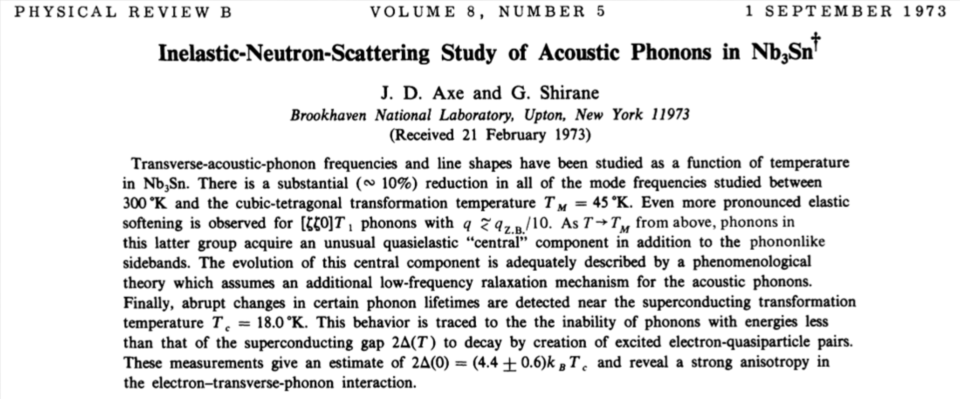


PHYSICAL REVIEW B VOLUME 12, NUMBER 11 1 DECEMBER 1975

Measurements of the electron-phonon interaction in Nb by inelastic neutron scattering*

S. M. Shapiro, G. Shirane, and J. D. Axe
Brookhaven National Laboratory, Upton, New York 11973
(Received 1 April 1975)

Precise linewidth and frequency measurements of transverse acoustic modes propagating along the [001] and [110] directions were performed on single crystals of niobium in the normal and superconducting phases ($T_c = 9.2$°K). For transverse phonons propagating along the [110] direction changes in linewidth are observed when the superconducting gap $2\Delta(T)$ equals the phonon frequency. This behavior agrees with Bobetic's calculation for the attenuation of high-frequency sound waves in superconductors and the magnitude of the change enables us to calculate the electron-phonon interactions. In addition to linewidth changes,



PHYSICAL REVIEW B VOLUME 8, NUMBER 5 1 SEPTEMBER 1973

Inelastic-Neutron-Scattering Study of Acoustic Phonons in $Nb_3Sn^{\dagger}$

J. D. Axe and G. Shirane
Brookhaven National Laboratory, Upton, New York 11973
(Received 21 February 1973)

Transverse-acoustic-phonon frequencies and line shapes have been studied as a function of temperature in Nb_3Sn. There is a substantial (∼ 10%) reduction in all of the mode frequencies studied between 300°K and the cubic-tetragonal transformation temperature $T_M = 45$°K. Even more pronounced elastic softening is observed for $[\zeta\zeta 0]T_1$ phonons with $q \gtrsim q_{\text{Z.B.}}/10$. As $T \to T_M$ from above, phonons in this latter group acquire an unusual quasielastic "central" component in addition to the phononlike sidebands. The evolution of this central component is adequately described by a phenomenological theory which assumes an additional low-frequency ralaxation mechanism for the acoustic phonons. Finally, abrupt changes in certain phonon lifetimes are detected near the superconducting transformation temperature $T_c = 18.0$°K. This behavior is traced to the the inability of phonons with energies less than that of the superconducting gap $2\Delta(T)$ to decay by creation of excited electron-quasiparticle pairs. These measurements give an estimate of $2\Delta(0) = (4.4 \pm 0.6)k_B T_c$ and reveal a strong anisotropy in the electron–transverse-phonon interaction.

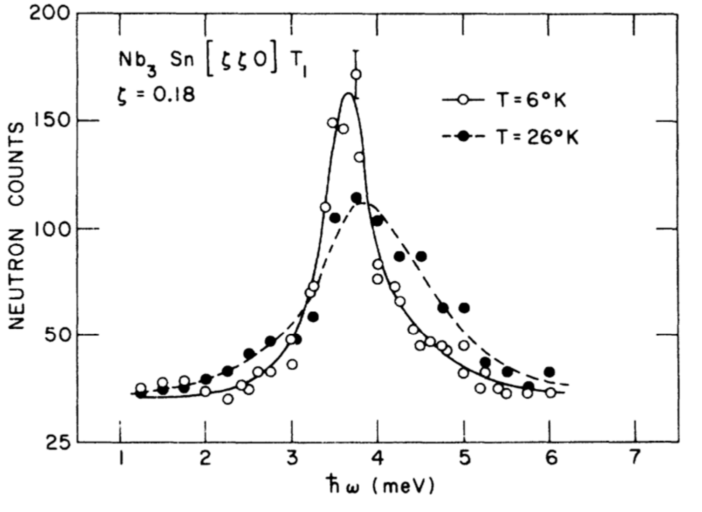


FIG. 13. Widths of low energy $[\zeta\zeta 0]T_1$ acoustic phonons broaden appreciably at temperatures near T_c, the superconducting transformation temperature. This figure shows the same phonon profile above and below $T_c = 18.0$ °K.

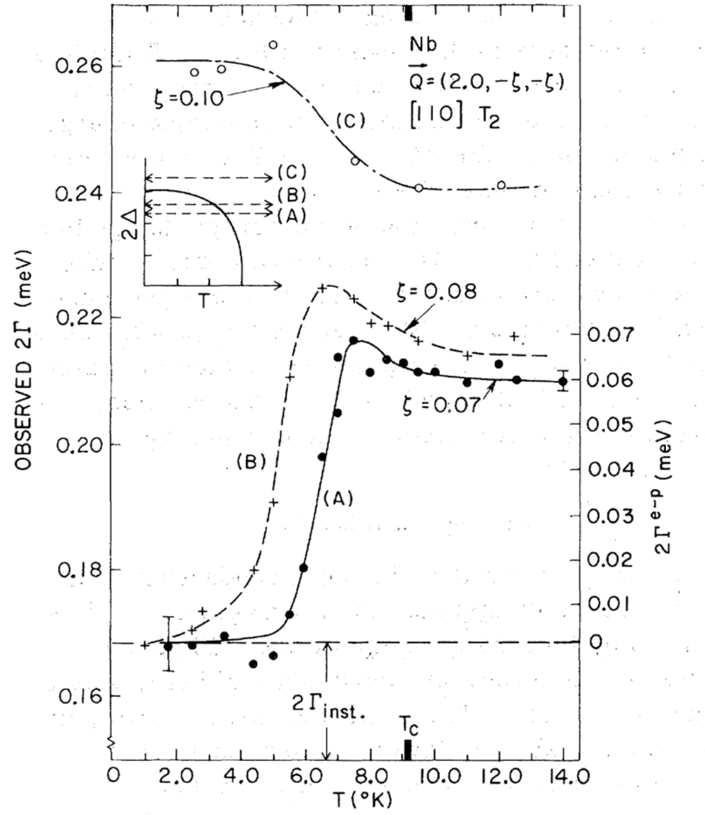


FIG. 3. Temperature dependence of several $[\zeta\,\zeta\,0]T_2$ phonons in Nb showing the change in width due to the superconducting gap. Curves A and B have $h\omega_p < 2\Delta(0)$ and for curve C, $h\omega_p > 2\Delta(0)$.

Polymers

Confirmed De Gennes' model
of polymer reptation

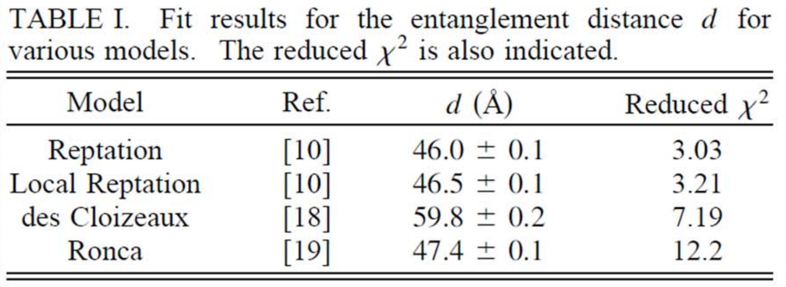
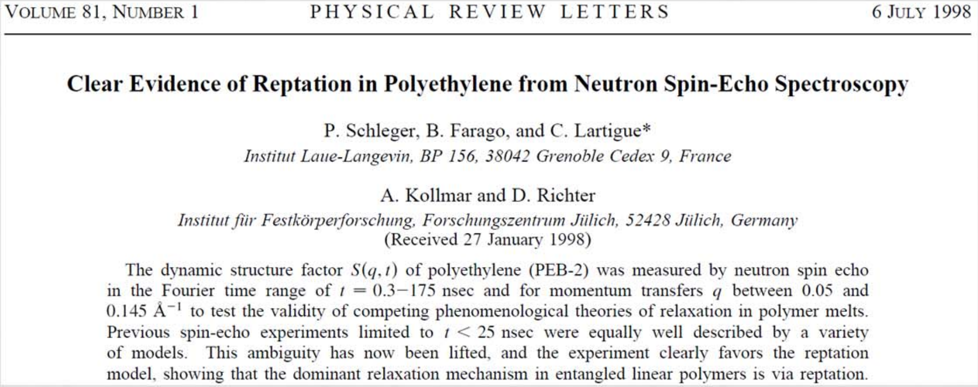


TABLE I. Fit results for the entanglement distance d for various models. The reduced χ^2 is also indicated.

Model	Ref.	d (Å)	Reduced χ^2
Reptation	[10]	46.0 ± 0.1	3.03
Local Reptation	[10]	46.5 ± 0.1	3.21
des Cloizeaux	[18]	59.8 ± 0.2	7.19
Ronca	[19]	47.4 ± 0.1	12.2



VOLUME 81, NUMBER 1 PHYSICAL REVIEW LETTERS 6 JULY 1998

Clear Evidence of Reptation in Polyethylene from Neutron Spin-Echo Spectroscopy

P. Schleger, B. Farago, and C. Lartigue*
Institut Laue-Langevin, BP 156, 38042 Grenoble Cedex 9, France

A. Kollmar and D. Richter
Institut für Festkörperforschung, Forschungszentrum Jülich, 52428 Jülich, Germany

(Received 27 January 1998)

The dynamic structure factor $S(q, t)$ of polyethylene (PEB-2) was measured by neutron spin echo in the Fourier time range of $t = 0.3-175$ nsec and for momentum transfers q between 0.05 and 0.145 Å^{-1} to test the validity of competing phenomenological theories of relaxation in polymer melts. Previous spin-echo experiments limited to $t < 25$ nsec were equally well described by a variety of models. This ambiguity has now been lifted, and the experiment clearly favors the reptation model, showing that the dominant relaxation mechanism in entangled linear polymers is via reptation.

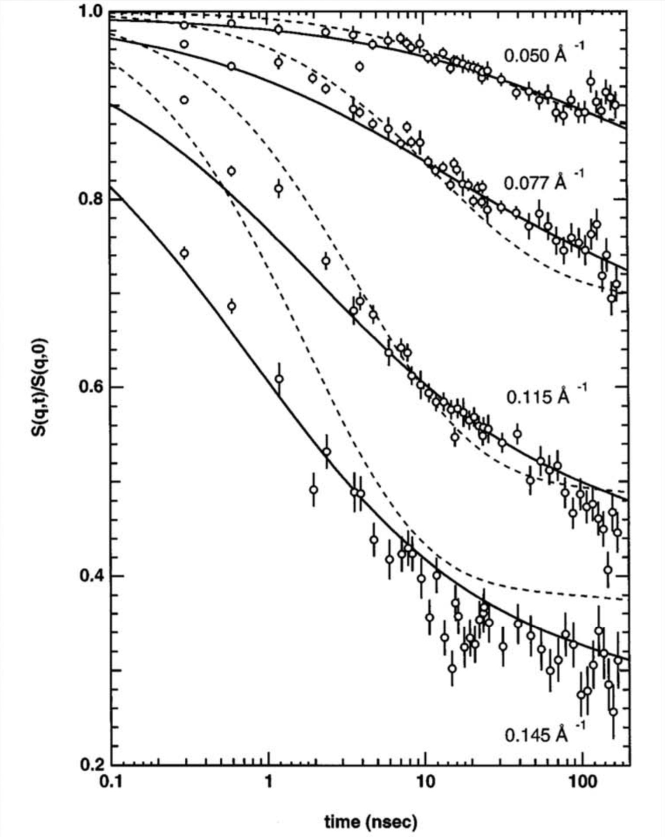


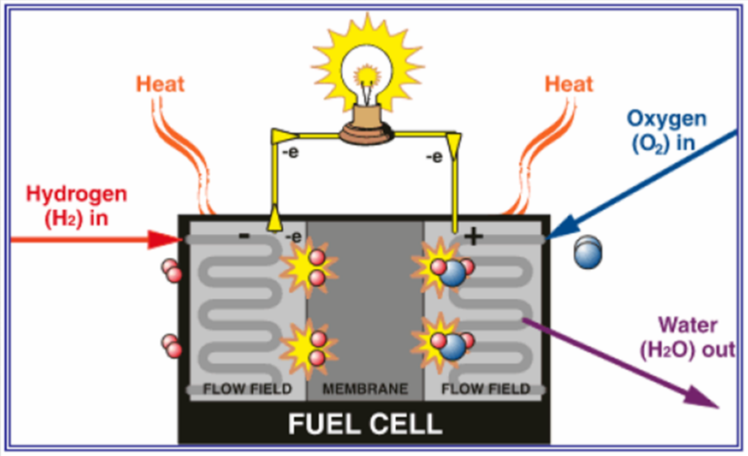
FIG. 3. Semilog plot of $S(q, t)$ vs t for various q. The solid lines are the fit of the reptation model [Eq. (1)]. The dashed lines are a fit using the model of des Cloizeaux [Eq. (27) of Ref. [18]].

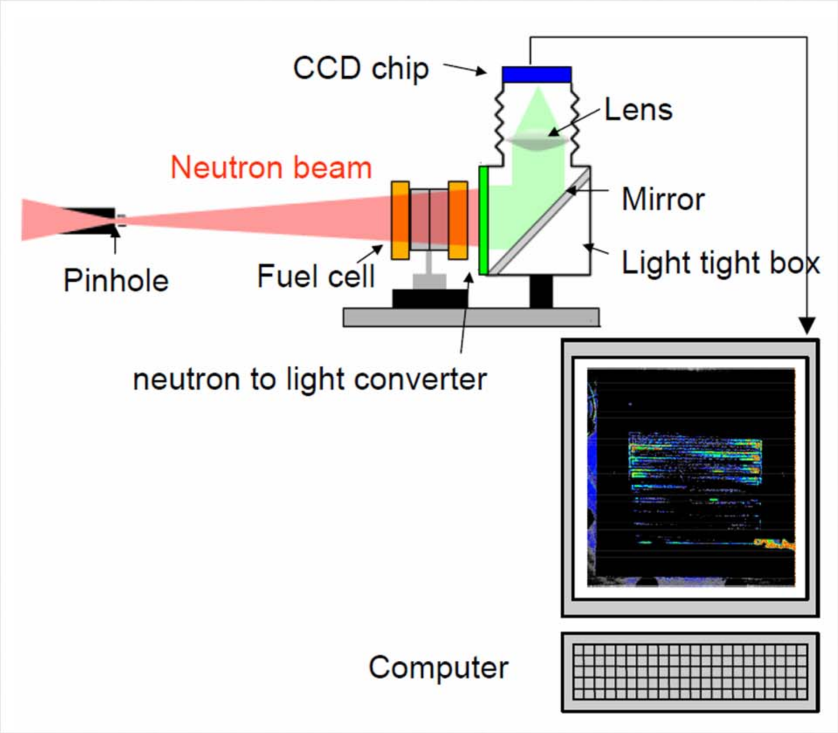
Neutron Imaging

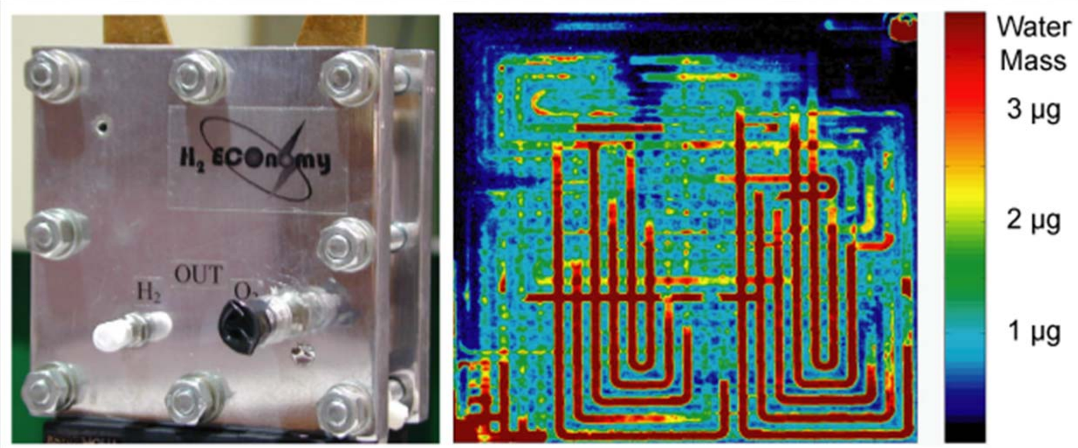
Viewing Operational Fuel Cells in Real-Time

Problem: Water management in fuel cell; metal cell components; scattering from hydrogen

Solution: Neutron imaging







Biology

Insights into Viral Assembly: Conformational Changes of HIV-1 Gag on the Membrane

H. Nanda[1], F. Heinrich[2], S. Datta[3], A. Rein[3], S. Krueger[1] (NCNR)

Formation of HIV-1 is mediated by the viral Gag polyprotein. Expressed in the cellular cytoplasm, Gag eventually targets the inner surface of the cellular membrane of the infected host cell where viral assembly occurs. Molecular insight from early cryo-electron microscopy data showed Gag in the immature spherical virus as elongated rods radiating from the membrane with one end tightly bound to the viral genome [1]. However, in a recent study using small angle neutron scattering as well as other techniques, it was found that the properties of monomeric Gag in solution are incompatible with an extended structure [2]. Rather, Gag likely exists in several compact conformations in solution, most likely due to the presence of several unstructured, flexible domains in the protein. These results imply that the protein must undergo a large conformational change when it assembles into a virus particle. Understanding the mechanism of this conformational change would give important insights into retroviral assembly.

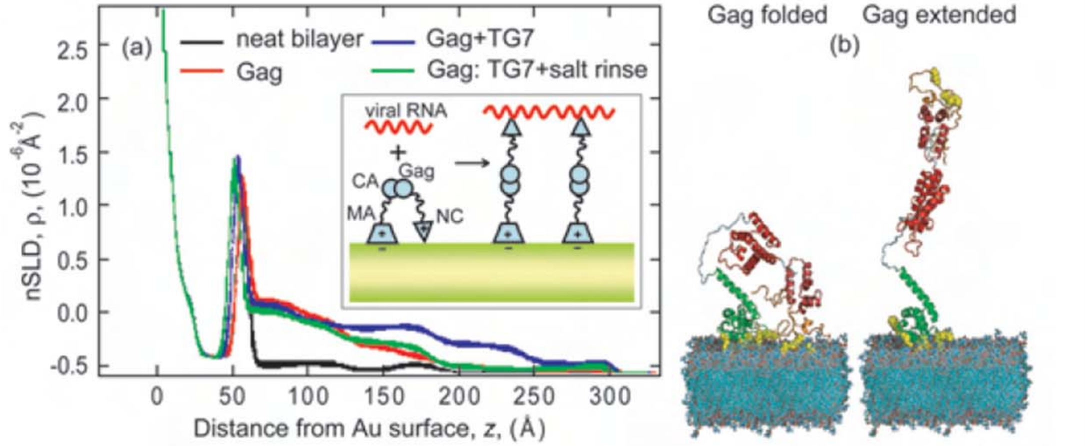
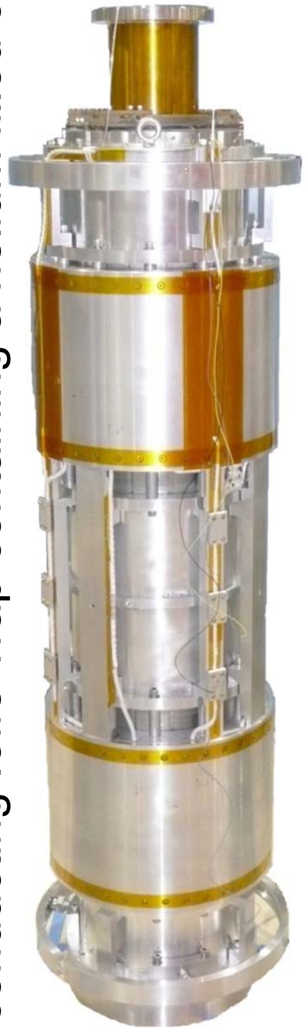


FIGURE 3: (a) nSLD profile of full-length HIV-1 Gag protein on a tBLM. Neat lipid bilayer (black), bound Gag protein (red), Gag + TGx7 DNA strand (blue), Gag:TGx7 500 mmol/L NaCl salt rinse (green). The inset cartoon illustrates how the charged ends of the Gag cause it to fold toward the surface, and then how the viral strands attach to NC, extending and crosslinking the Gag molecules. (b) Illustrative models of folded and extended conformations of Gag on a membrane surface.

Real-Time Observation of Decay Curve

Superconducting Ioffe Trap containing a helium filled cell



3.1 Tesla trap depth
~9 Liter volume

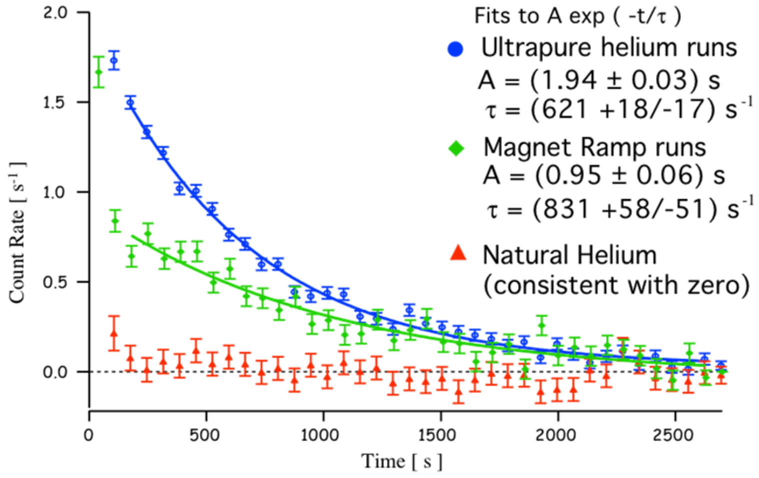
Magnetic Trapping of Neutrons

Neutrons lose energy in liquid Helium

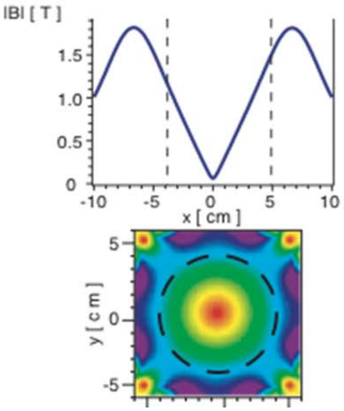
Electrons from decay excite Helium

Dexcited helium gives off photons

Light is detected by outside PMTs



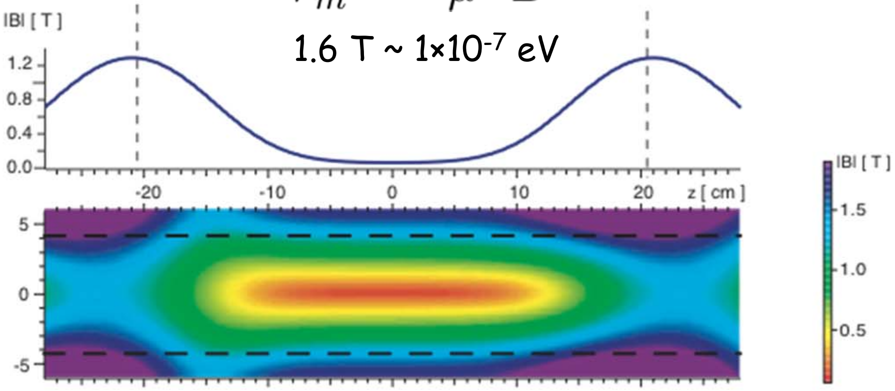
Radial Confinement



Axial Confinement

$$V_m = -\vec{\mu} \cdot \vec{B}$$

1.6 T ~ 1×10^{-7} eV



Expected Sensitivity : 2 s

Some Tips

Things to consider the following when choosing your next job …

- Do you like research?
- Do you like to teach?
- Career path potential
- Quality of management
- Location (US or abroad?)
- Your boss
- Salary/benefits
- Stability
- Tenure
- Retirement

- Personality matters.
- Communication skills matter.
- Writing skills matter.

More Tips

Many federal labs offer NRC postdoc positions.

RAP/NRC Postdocs earn $65K at NIST.

Many open only to US Citizens …

BEFORE you apply, contact a mentor.

They can help you to write a solid proposal.

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Find your program coordinator here

2012 May Review

Application period opens March 1
Submission deadline is May 1
(5:00 PM EST)
Support document deadline is May 15
(5:00 PM EST)

If a deadline falls on a weekend, it changes to the next business day.

Research Associateship Programs

The mission of the NRC Research Associateship Programs (RAP) is to promote excellence in scientific and technological research conducted by the U. S. government through the administration of programs offering graduate, postdoctoral, and senior level research opportunities at sponsoring federal laboratories and affiliated institutions.

In these programs, prospective applicants select a research project or projects from among the large group of opportunities listed on this website. Prior to completing an application, prospective applicants should contact the proposed Research Adviser to assure that funding will be available if their application is recommended by NRC panels. Once mutual interest is established between a prospective applicant and a Research Adviser, an application is submitted through the NRC WebRap system. Reviews are conducted four times each year and review results are available approximately 6-8 weeks following the application deadline.

Prospective applicants should read carefully the details of the program to which they are applying. In particular, note eligibility details. Some laboratories have citizenship restrictions (open only to U.S. citizens and permanent residents) and some laboratories have research opportunities that are not open to senior applicants (more than 5 years beyond the PhD). When searching for research opportunities you may limit your search to only those laboratories which match your eligibility criteria. In addition, note the application deadlines, as not all laboratories participate in all reviews.

Interested in the Research Associateship Programs? Check out the list of...

PARTICIPATING AGENCIES

RAP Spotlights

2012 POSTDOC CONFERENCE & CAREER FAIR
The Annual Postdoc Conference and Career Fair will take place on July 12, 2012 at the Bethesda North Marriott. This conference and career fair is for current postdoctoral fellows working in Washington, D.C. area federal labs and universities, and for companies recruiting high-level S.T.E.M. (Science, Technology, Engineering and Mathematics) professionals. It exposes area postdoctoral fellows in the S.T.E.M. fields to the many career options (e.g., government, private sector, entrepreneurship) that are available to them. The career fair portion also connects local job-seeking postdocs with companies seeking that level of talent. Please visit this page for more information: http://postdocconference.org/.

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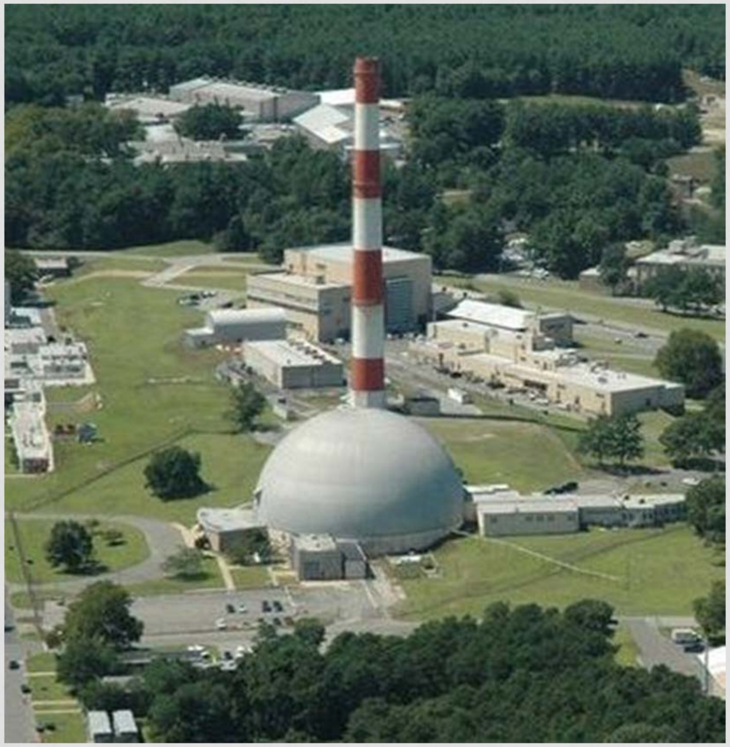
http://sites.nationalacademies.org/PGA/RAP/index.htm

A Tale of Two National User Facilities

In 1996, the routine maintenance of the reactor was being conducted when tests indicated a slightly increased level of tritium in ground water monitoring wells on the perimeter of the reactor. A thorough inspection of the reactor found no leaks in the reactor itself but a small leak in the water system of a pool where spent fuel was being stored. This turned out to be the only source of the tritium and was easily fixed. Unfortunately, the disclosure of the tritium leak lead to a political effort that would prevent the reactor from reopening. Scientists and laboratory personnel fought to keep the reactor alive for the next three years, but in 1999, the Secretary of Energy Bill Richardson ordered that the reactor be decommissioned.

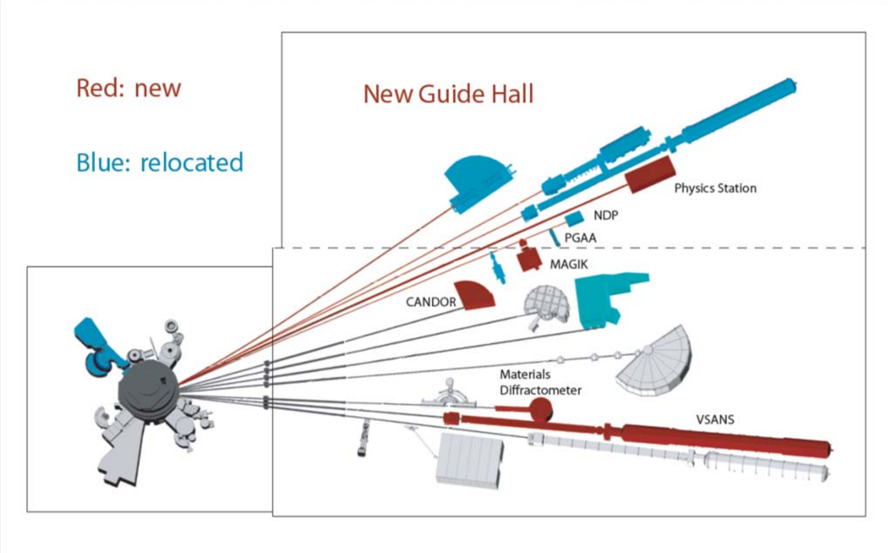


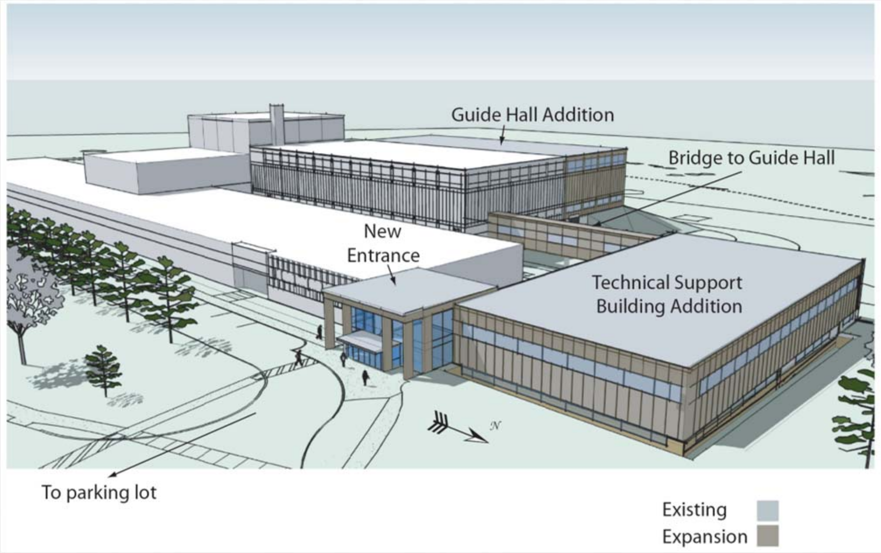
The NCNR Expansion Project

Part of the America Competes Act

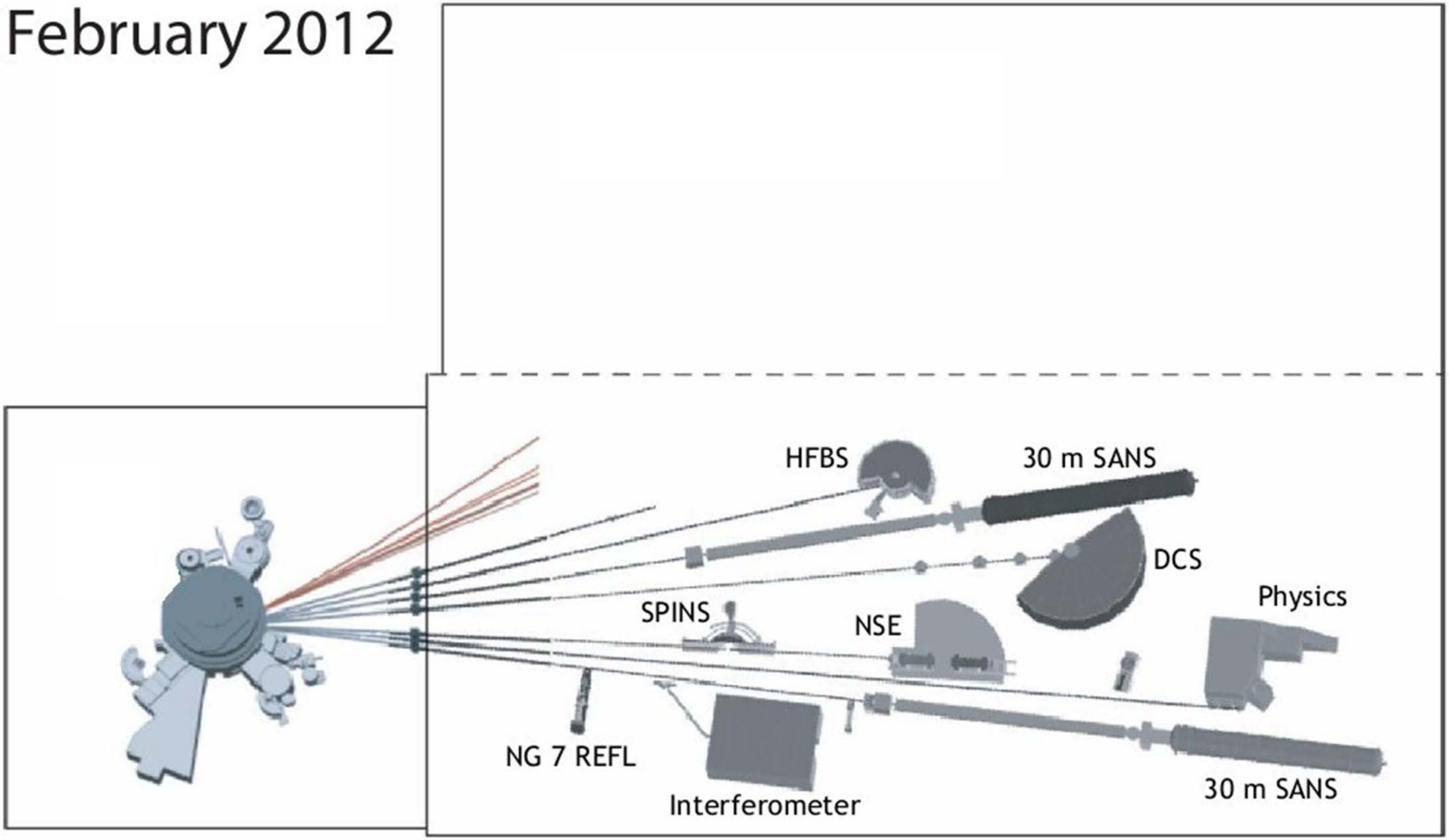
A multi-year plan to meet strong U.S. demand for cold neutron measurement capability by creating new beamlines and instruments at the NCNR.

- Five-year project (started in 2007)
- Four new state-of-the-art neutron guides
- Five new cold neutron instruments
- 500 additional research participants/year

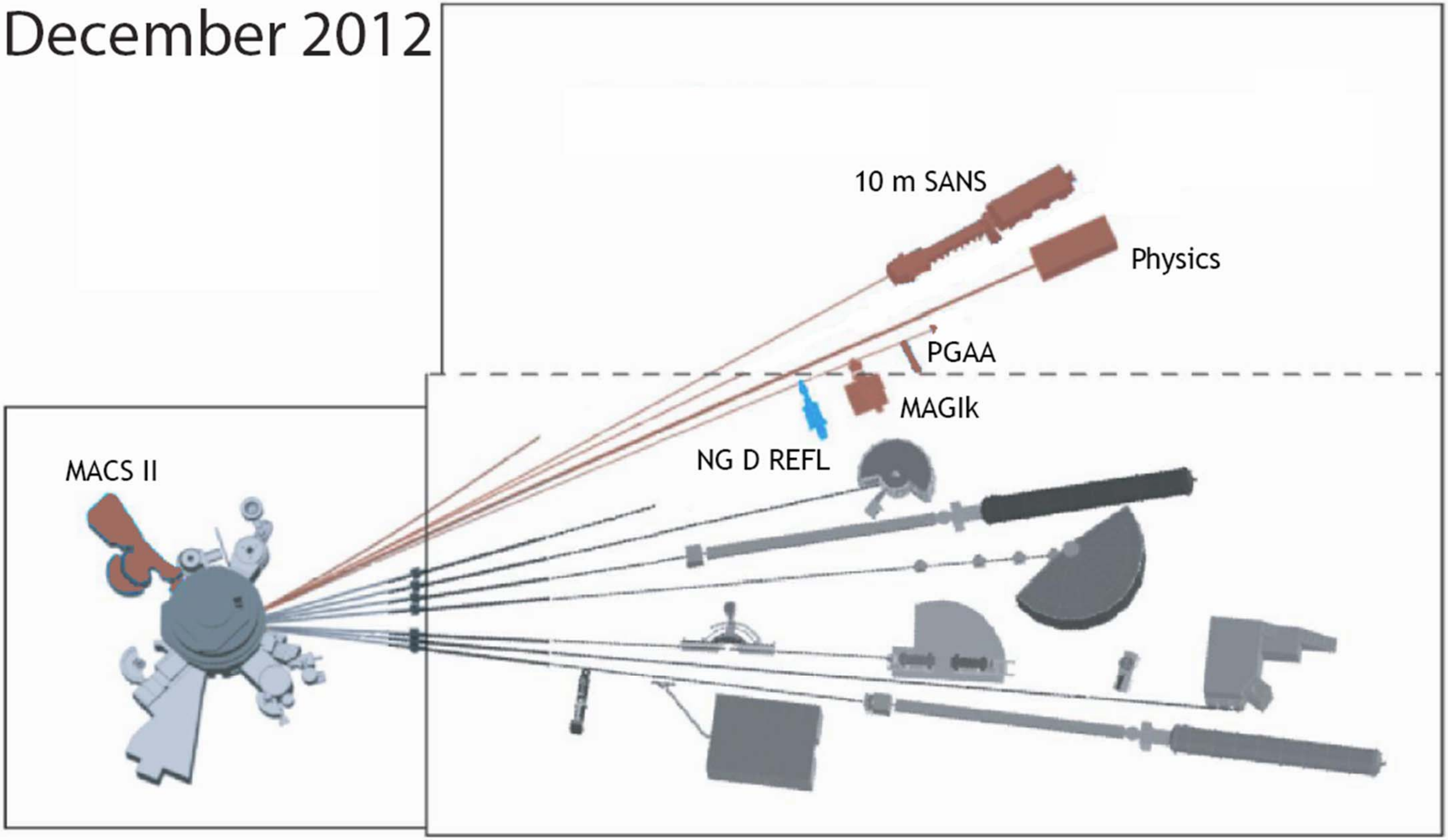




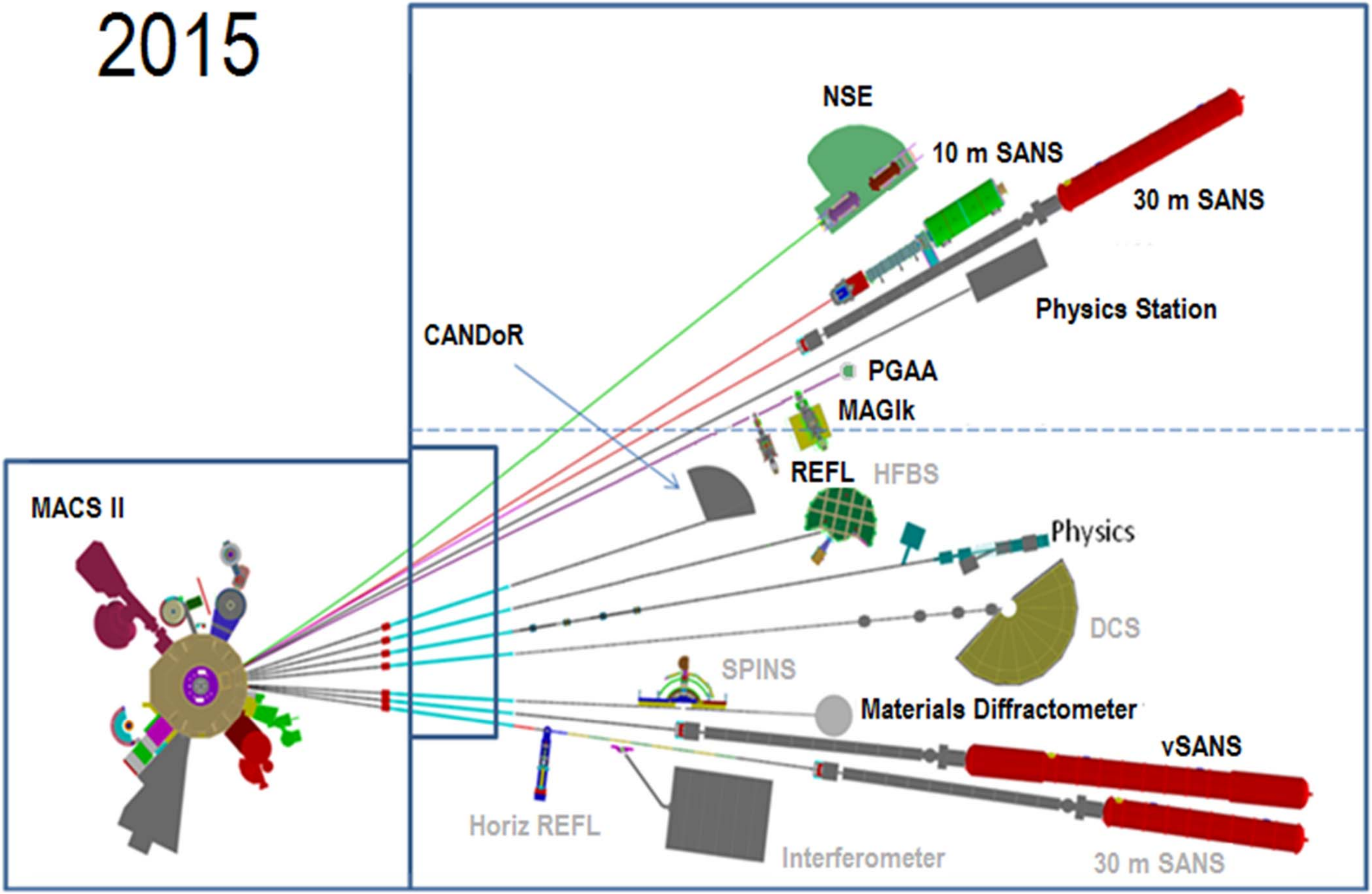
February 2012



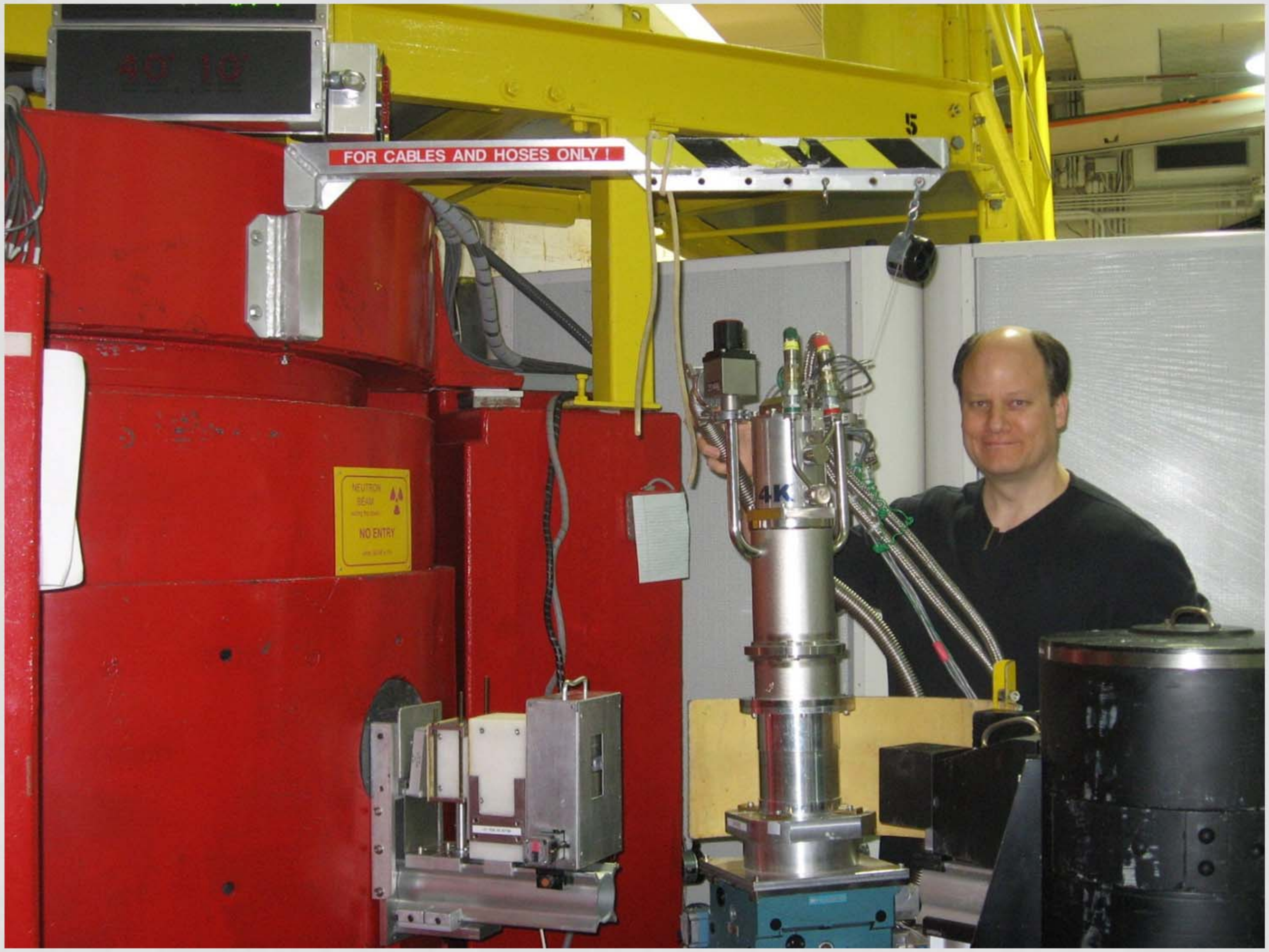
December 2012



2015


NSE
10 m SANS
30 m SANS
Physics Station
CANDoR
PGAA
MAGIk
REFL
HFBS
MACS II
Physics
DCS
SPINS
Materials Diffractometer
vSANS
Horiz REFL
Interferometer
30 m SANS

Thank-You!



Questions?