Early Oak Ridge Team

Mike Wilkinson
Ernie Wollan
Wally Koehler
Cliff Shull
Inveterate Committee Member

- By a rough count, I have served on over 50 in the last 30 years, excluding workshops, Temple and Lehman reviews
- Many for existing neutron sources – IPNS, LANSCE, HFIR, SNS, RRR
- Some unfortunately less successful – ANS, HFBR, INER
- Contrary to abstract, last mention…
Neutrons reveal structure and dynamics

Neutrons show where atoms are
- Neutrons bounce against atomic nuclei. They also react to the magnetism of the atoms.

Neutrons show what atoms do
- Neutrons can be scattered by atoms, which changes the direction and energy of the neutron.

Neutrons reveal inner stresses
- Neutrons can reveal the internal stresses in materials, which can provide information about the structure of the material.

Neutrons see more than X-rays
- Neutrons can penetrate materials that X-rays cannot, which allows for the examination of internal structures and materials.

How it worked
- Brodhouse and Shell made their pioneering contributions at the first nuclear reactors in the USA and Canada back in the 1940s and 1950s. They were the first to use neutron scattering to study the structure of materials.

Further reading
- Information about the Nobel Prize in Physics 1994 (preseved), The Royal Swedish Academy of Sciences.
B. N. Brockhouse & 3-Axis
1962-1966

• One of Bertram Brockhouse’s first three PhD students along with Eric Svensson and Sow Hsin Chen

• PhD Theses were simpler then
  – Design and construction of 3-axis spectrometer
  – Measure lattice dynamics of a metal – β-Sn
Inelastic Scattering 1962
McMaster 2 and 3-axis
1960’s Automation!
Lattice Dynamics of $\beta$-Sn
Argonne National Laboratory

• Post doctoral appointment in 1966, after meeting Jack Rush & Don Connor at HFBR criticality meeting
  – My first cold source (operate, not design), D₂O ice
  – First TOF spectrometer (4 chopper system)
  – David Price joined ANL, and we began a series of measurements on α-Sn, InSb & CdTe at HFIR, working with Harold Smith and Bob Nicklow
Argonne National Laboratory II

- David, Bob Kleb, George Ostrowski, & I built TNTOFS (LRMECS flight path) as part of CP-5 complex with Selmer Peterson & Jack Williams

- Lot’s of fun with science
  - Liquid Ar (Kurt Sköld, Pete Randolph at MTR)
  - Many molecular reorientations with Jack Rush
  - Hydrides (Pd, Nb, Ta…)
  - Cyanides (Susman, Hinks KCN, NaCN)
  - Aneesur Rahman
Assorted Results

FIG. 2. Dispersion relations for $\alpha$-Sn (solid lines), InSb (dashed lines), and CdTe (chain lines) derived from shell-model calculations using the parameters of Table III.

Inelastic Neutron Scattering from a Liquid $^3$He-$^4$He Mixture

J. M. Rowe

and

D. L. Price and G. E. Ostrowski
Solid State Science Division, Argonne National Laboratory, Argonne, Illinois 60439
(Received 18 June 1973)
Serendipity & Liquids

• Kurt Sköld was post-doc
  – Liquid argon Coherent & Incoherent (MTR)
• Aneesur Rahman
  – “RAD Terminal” across from my office
  – Anees & I got to know each other
  – Liquid Rb MD & Experiment (John Copley)
    • MD predicted collective excitations at low Q
    • We measured them at TNTOFS (after I left)
Liquids
ZING-P Building
PULSED NEUTRON SOURCE SYSTEM

ZING-P'

CRYSTAL ANALYZER SPECTROMETER
INSTRUMENT SCIENTIST R.K. Crawford

HIGH RESOLUTION POWDER DIFFRACTOMETER
INSTRUMENT SCIENTIST J.D. Ferguson

CHOPPER SPECTROMETER
INSTRUMENT SCIENTIST C.A. Pelizzari
NBS 1973-1979

• Came to NBS in 1973, with promise from Jack Rush – **NO MANAGEMENT**

• Began design of BT-4 triple-axis with Jack Rush, Sam Trevino and Hank Prask in 1972

• Decided on Ames design, went to inspect, and met Nancy Chesser (m 1/1/75)

• Bought drum from Ames, and installed at NBSR 1973-1975
BT-4 Triple Axis
NBS 1973-1979

- Mostly science after BT-4
  - Structure and dynamics KCN, NaCN, RbCN, CsCN
    - Soft TA mode
    - Quadrupolar, dipolar phase transitions
    - Steric hindrance, strain scattering
    - Mixed alkali halide/alkali cyanides, quadrupole glass state
  - Metal hydrides
    - PdH, PdD, PdT dynamics (old high $T_c$ days)
    - Ta, Nb, CeD$_{2.12}$, trapping, storage hydrides…
Science Results

PdD_{0.6}

PdT_{0.6}
NBS 1980-87

- First NBS “Competence Project” in 1979
  - Built 8m SANS (Charlie Glinka on staff)
  - Started our first real visualization effort & first fast network (Norm Berk, “Roger Ramjet”)
- IMSE crosscut circa 1983, CNRF proposal
- Seitz-Eastman 1984
- First $1.5 M in FY1985
- D$_2$O ice cold source installed 1987
- Construction funding FY1987
Original Estimate

- 3K/m² - LAN
- Building, pavement, safety analysis, neutron guide, $15.0
- New cold source plug
- Instruments (initial complement), upgraded $8.00
- Contingency

Total: $26.01
Management Days 1987-2004

• Began construction of guide hall in fall of 1987
  – Ivan Schroder & I became construction managers
• Dedicated guide hall January 1989
• CHRNS partnership with NSF started 1989
  – Originally 30m SANS, ½ SPINS
  – Now includes 7 instruments in shared program
Management Days 1987-2004

• All planned instruments operating, time to start recycling, replacing…

• Installed 2\textsuperscript{nd} Generation hydrogen source in 2000 (Bob Williams and Paul Kopetka were my partners in both sources)
  – Factor of two gain for most wavelengths
  – 100% reliability last year

• Submitted license renewal application 4/9/2004

• Division Chief 1989; Center Director 1997; Retired March 2004
Three Who Made it Possible

Bob Carter

Carl Muehlhause

Harry Landon
Cliff Visits the NCNR
Triple Axis Developments
Lessons?

• Be lucky!
  – Thesis advisor (the world came to BNB)
  – Room assignment (A. Rahman)
  – Choose instruments well (meet spouse)
  – Work with outstanding people at great places (far too many to mention)

• All decisions are temporary (“no management”)
Conclusions?

• Bert always said that an experimentalist has to get the data right, and should err in interpretation if anywhere.

• Therefore, I want to spend a little time on my thoughts and predictions for the future.

• These are personal, and subject to Bert’s dictum.
Trends

• In my 42 years, sources only increased in flux by approximately $x10$ (NRU to HFBR, HFR, HFIR)

• Capabilities increased by $x100$ to $x1000$
  – Detectors (number, solid angle)
  – Instrument designs (Spin echo, HFBS…)
  – Monochromator design (PG, bent crystals, horizontal and vertical focussing)
  – Neutron guides (regular, $^{58}\text{Ni}$, supermirror, ballistic…)
  – Sample Environment (Stress, P,T,H…)

• Pulsed sources (ZING-P → IPNS → ISIS → SNS)
  – $\approx 3x10^4$ allowing *qualitative* changes in techniques

• Facility use evolved from 95% professional NS → 20%; community has grown
Gen Shirane 80 Birthday
July 15, 2004
Source Development

Future

• Techniques will continue to improve.
  – Existing sources not fully exploited
  – SNS opens new opportunities

• IT will transform the user experience
  – Facilities world-wide will agree on standard user interfaces
  – Data analysis will be real time (models, simulations…), allowing science to be the focus
  – Remote access will grow, in spite of firewalls and other security issues
Future II

• Budget situation in US is tight, and will get worse; it will then get better!
• Science drives everything
  – Funding of current sources (including SNS) depends on scientific and engineering output
  – Current users must help make case
  – Any new source will only be considered when the science REQUIRES it
• Personally, I intend to participate, because it will be fun.