# Neutrons at NIST

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NIST

*Promoting U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life.*

# NIST LABORATORIES

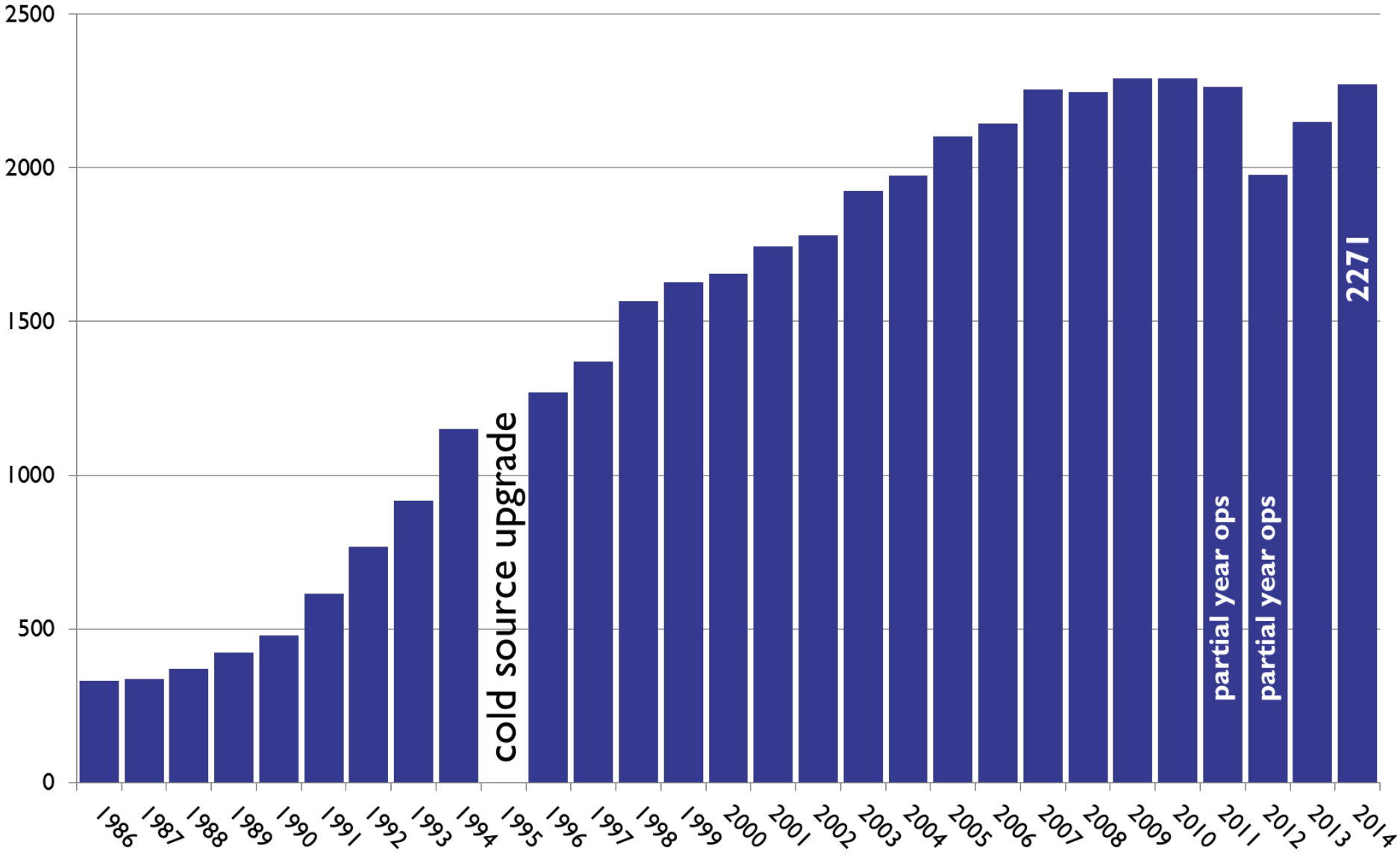
- Physical Measurements Laboratory
- Material Measurements Laboratory
- Engineering Laboratory
- Information Technology Laboratory
- Communication Technology Laboratory
- Center for Nanoscale Science and Technology
- NCNR

MEASUREMENT LABORATORIES

TECHNOLOGY LABORATORIES

USER FACILITIES

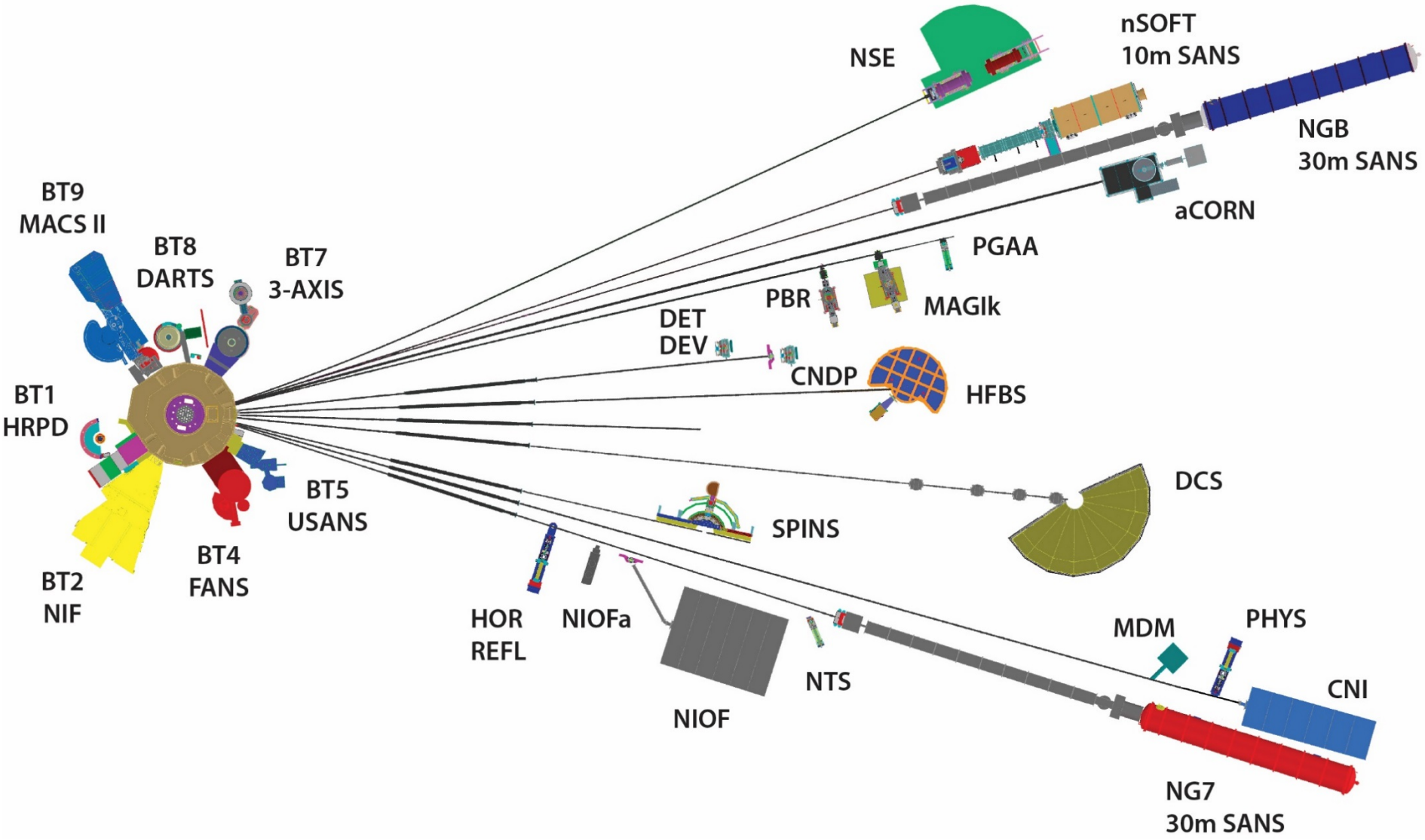
# NCNR Research Participants



**28** instruments

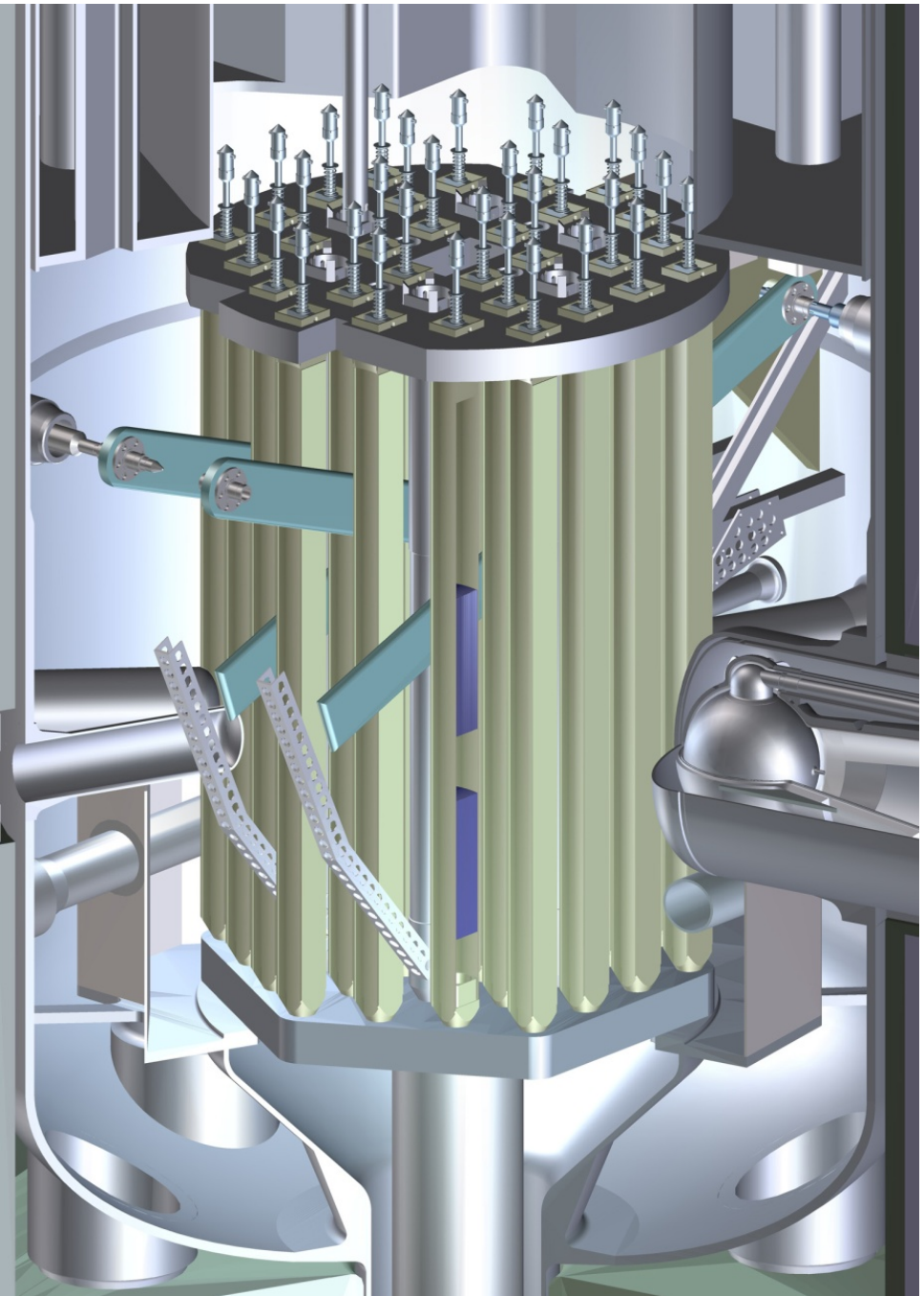
**250** operating days

**2** proposal calls/year



Unique instruments to address the needs of the scientific community

# NEUTRON PRODUCTION



20 MW
$D_2O$ moderated
30 fuel elements

$$\Phi = 1.5 \times 10^{14}\ \mathrm{n/cm^2/s}$$

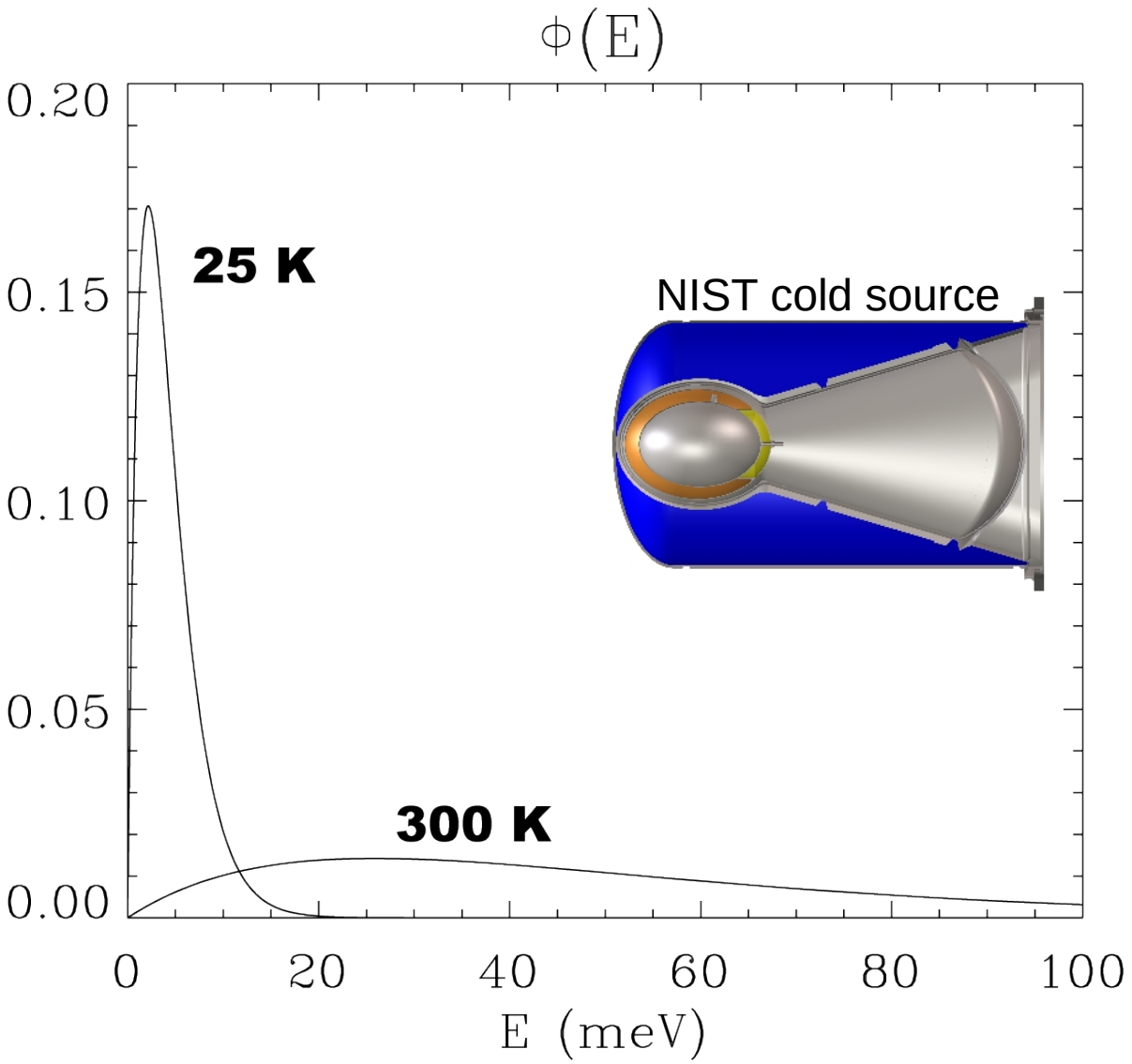
at mid-plane
(un-fueled region)

7 cycles/year
38 day cycles
~250 days/year

Licensed through

2029

# COLD NEUTRON PRODUCTION



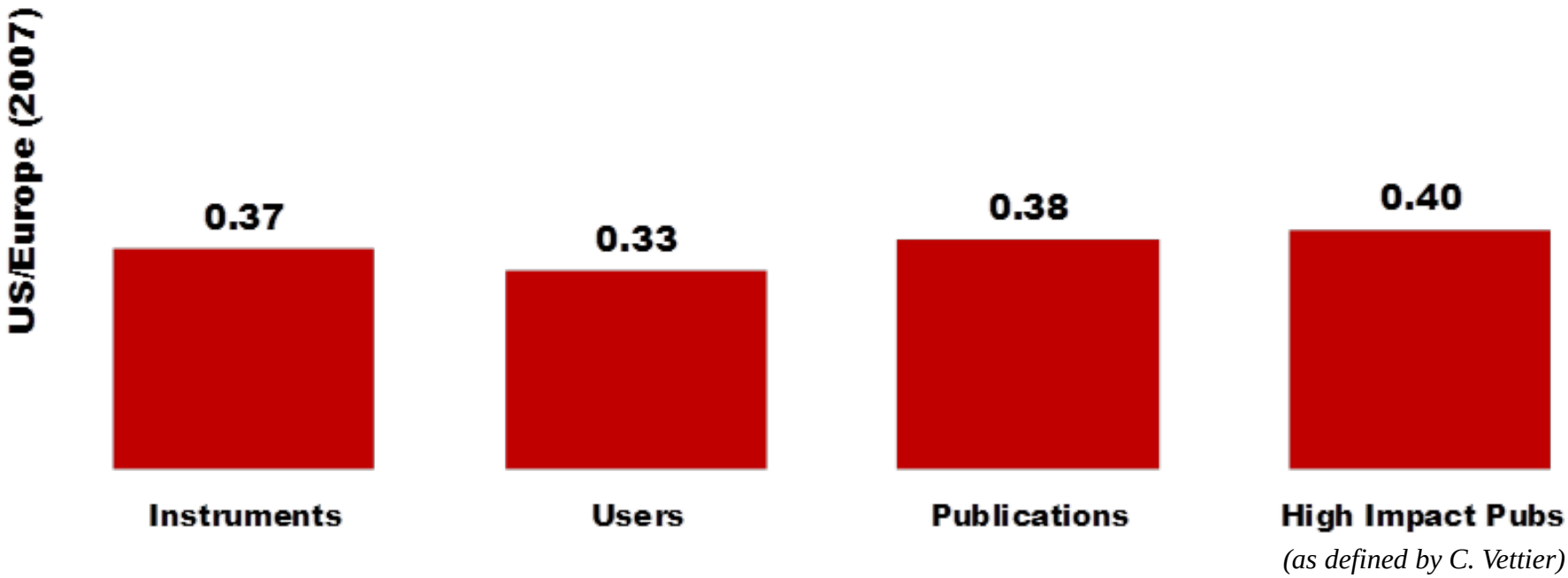

Cold neutrons (long λ, small E) are well-suited for probing structure and dynamics of soft matter such as polymers and biomolecules.

Unit 2 CS serves 12 guides

Pee-wee CS serves MACS

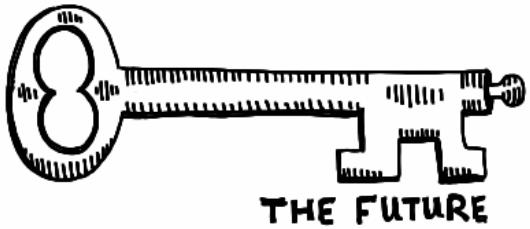
# NEUTRON USER FACILITIES

The US neutron scattering community is ~35% of that in Europe




*(as defined by C. Vettier)*

The US scientific community would produce more high quality science if it had *more good neutron scattering instruments*.




## Safe, reliable, good source of thermal & cold neutrons

Replaced secondary cooling system
Added capacity via new cooling tower cell
Installed new electrical substation
Upgraded thermal shield cooling system
Instrumentation and control upgrades
Replaced primary storage tank pumps
Installed new cold source for MACS
Spent fuel pool liner upgraded
New emergency backup power systems installed
Control rod supply ("shim arms")

Liquid $D_2$ cold source
Secure $D_2O$ supply
HEU to LEU conversion

<u>Age management</u>
Control room modernization program
Plant instrumentation
Replace primary pumps
New de-min water supply
Maintenance of all systems, etc…

## Good neutron scattering capabilities

VSANS, CANDoR, cold neutron imaging, engineering diffractometer
Instrument development workshop in August 2014
Sample environment
Polarized neutron beam production/analysis

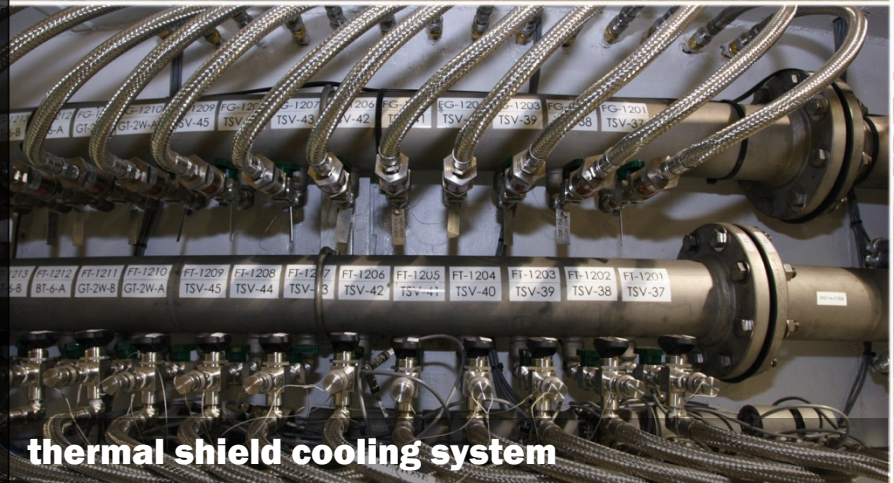
# MAJOR REACTOR PROJECTS

secondary cooling pump building

pool liner

electrical substation

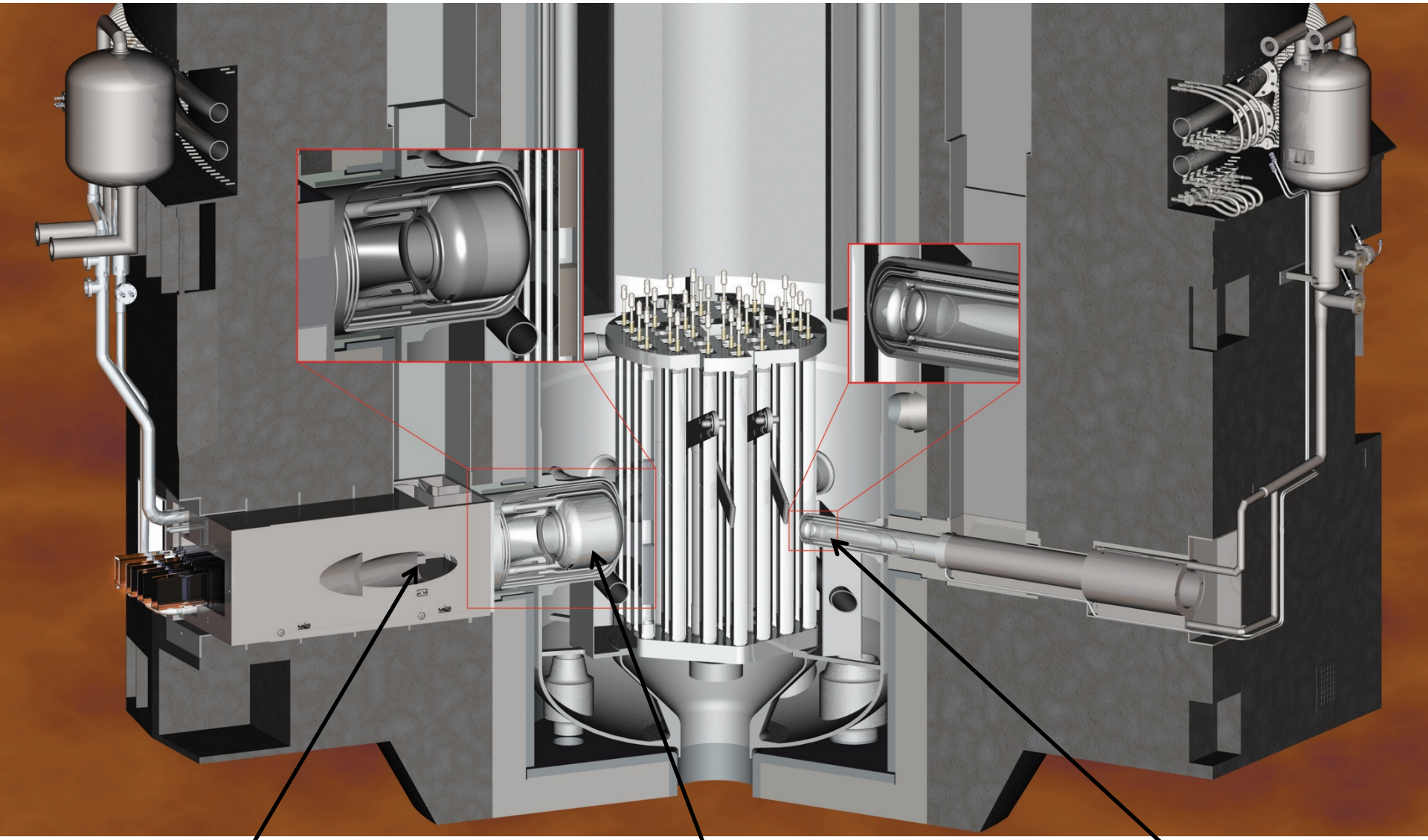
cooling tower cell



thermal shield cooling system

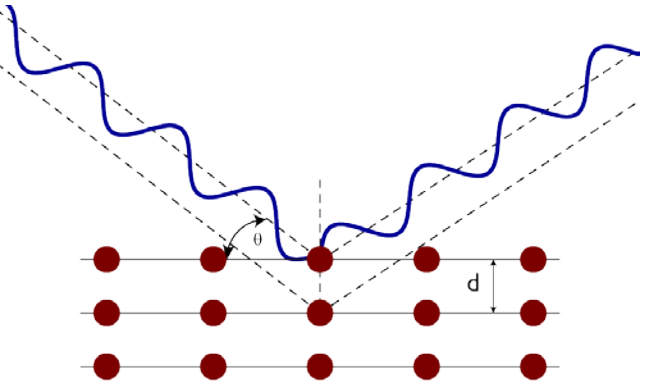
Reactor control room modernization

# Future Cold Source Layout

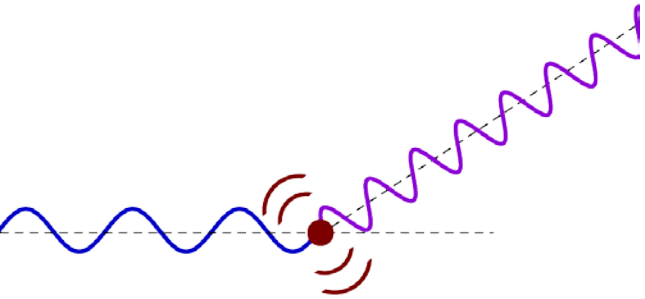


# WHY NEUTRON SCATTERING?

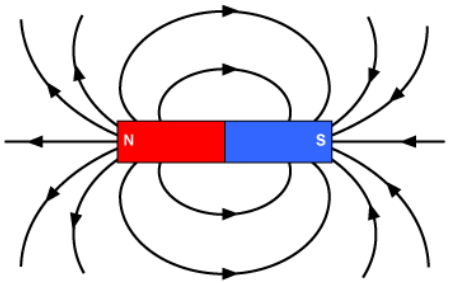
λ ~ interatomic spacing



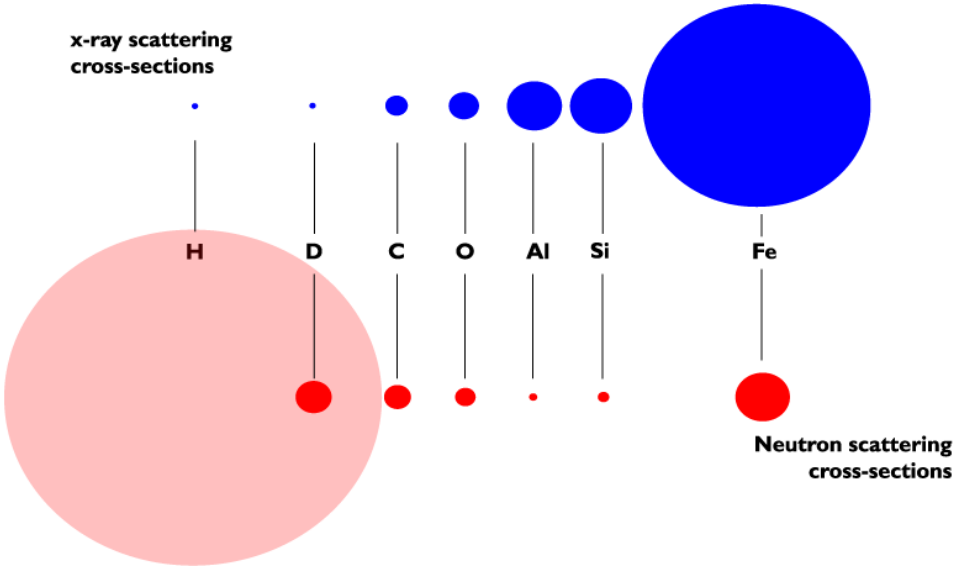

E ~ atomic motion



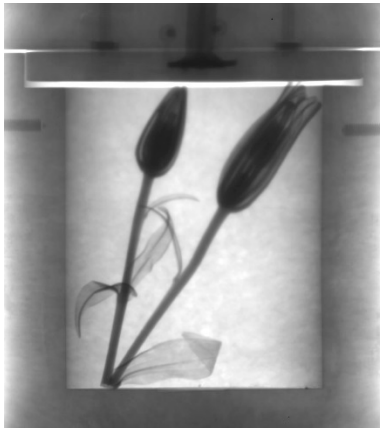
Magnetic

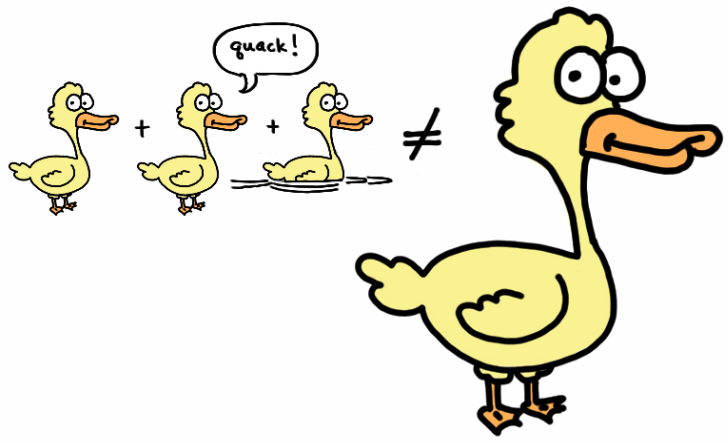



Scattering power varies randomly across the periodic table and from isotope to isotope

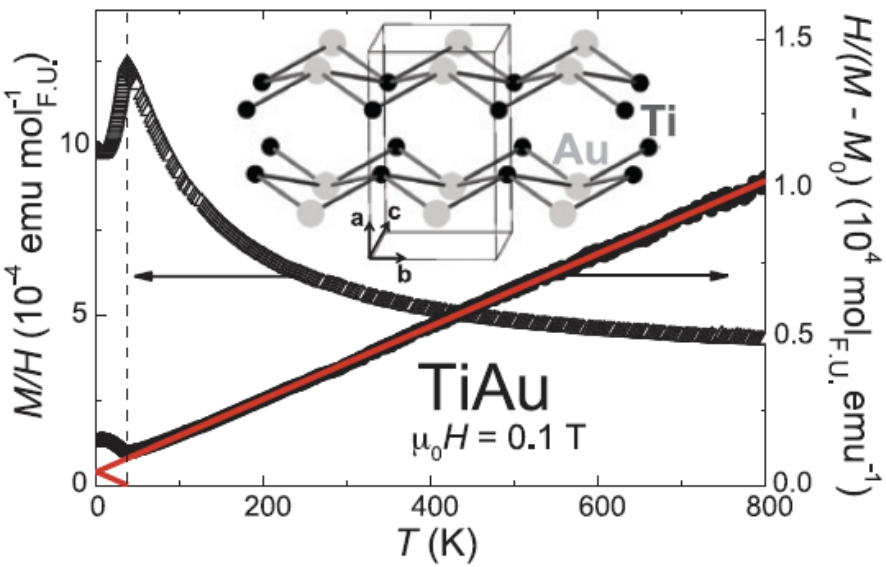


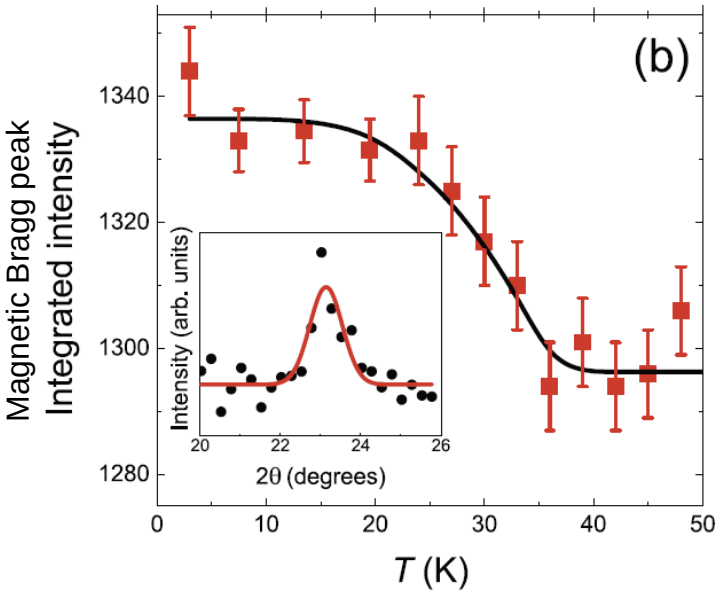

Penetrating




quack!
+
+
≠

# TiAu: a magnetic system with no magnetic elements?




AFM order for T < 36 K

E. Svanidze *et. al.*, submitted.

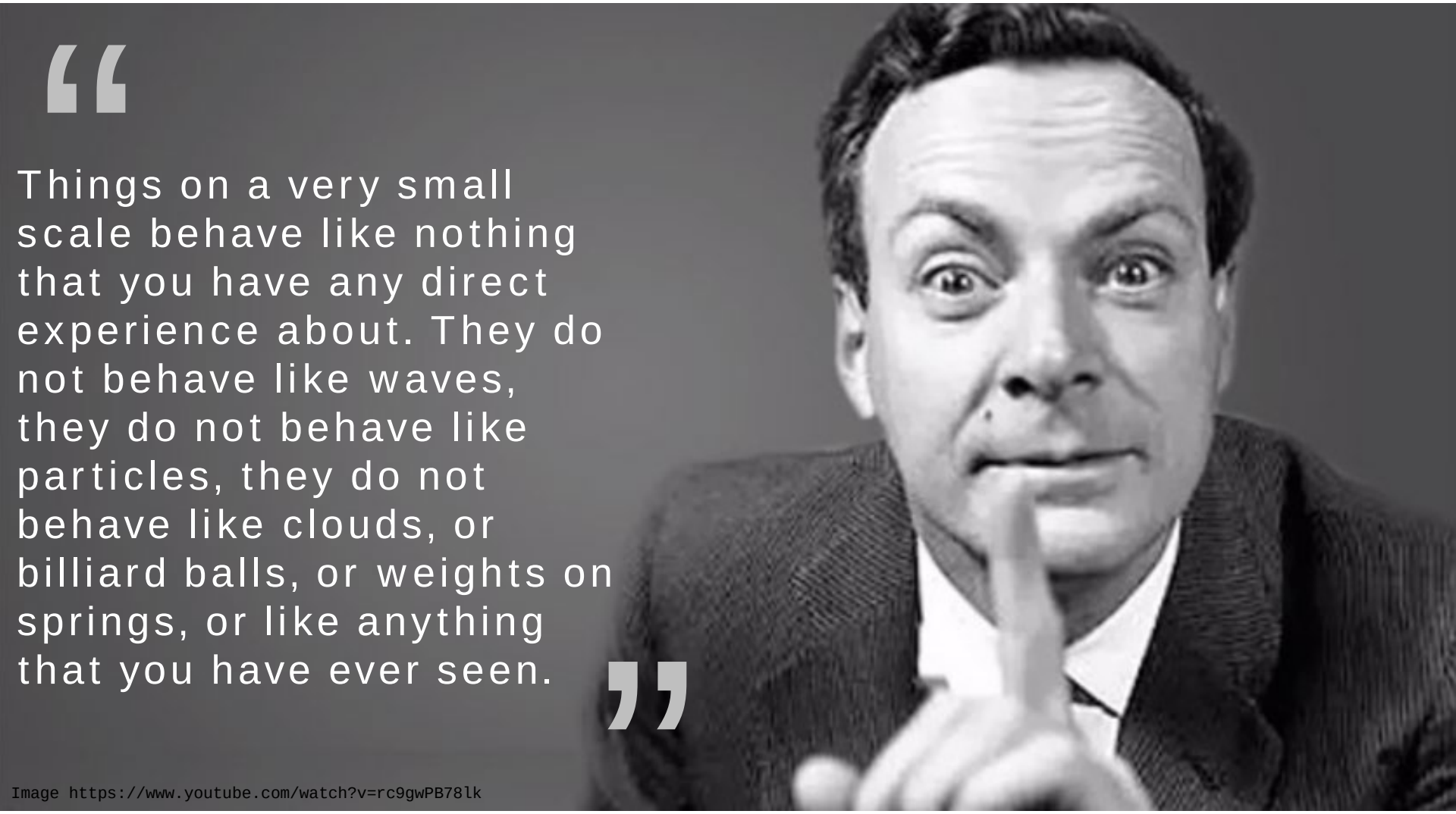
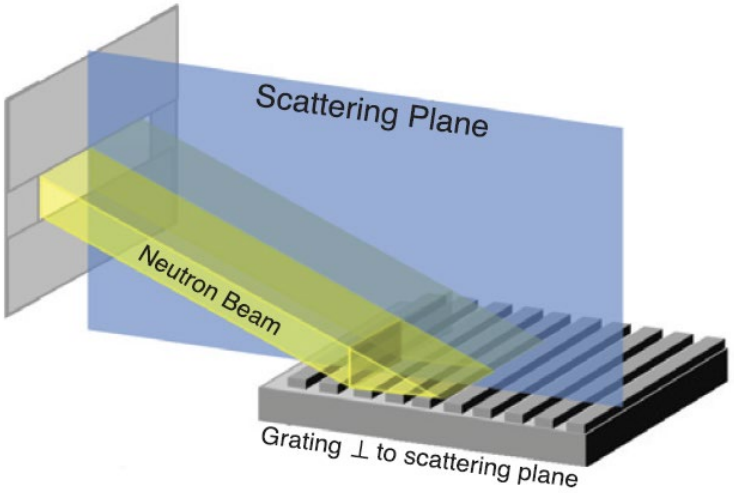


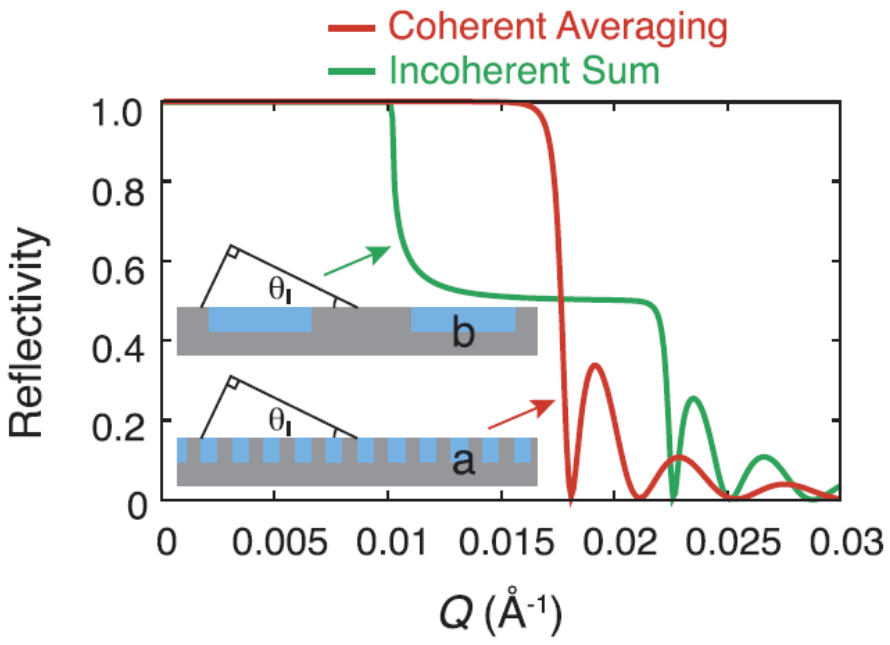

Image https://www.youtube.com/watch?v=rc9gwPB78lk

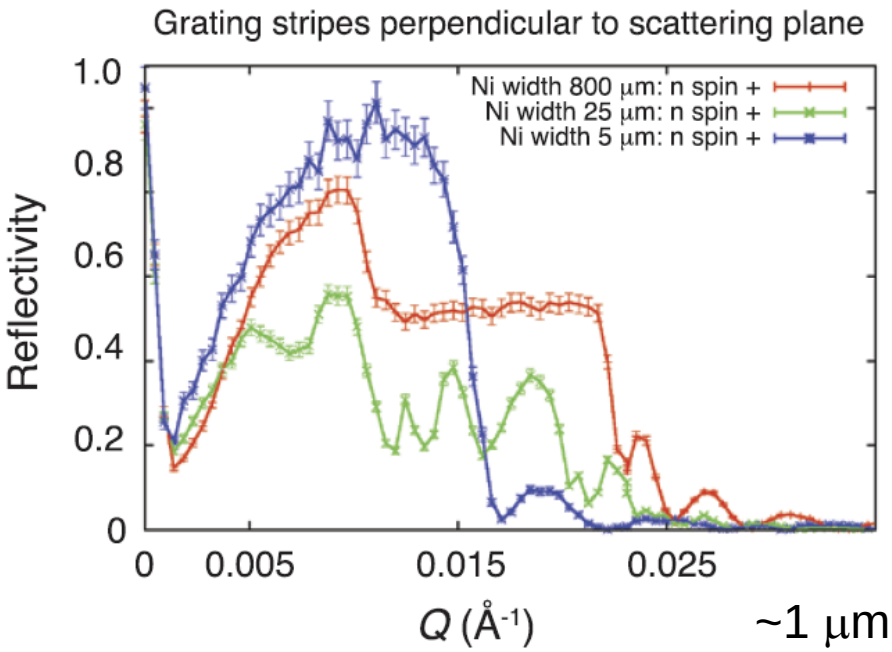
R.P. Feynman, The Feynman Lectures on Physics Volume III, p. 1-1, Basic Books (2010).

# Determining the effective transverse coherence of a neutron wave packet

C.F. Majkrzak, C. Metting, B.M. Maranville, J.A. Dura, S. Satija, T. Udovic, N.F. Berk, Phys. Rev. A **89**, 033851 (2014)




~1 μm