A world-class Neutron Spin Echo Spectrometer for the Nation

- *Dynamic* structure-function measurements are at the frontier of research in soft matter, biology, & nanomaterials.
- **N**eutron **S**pin **E**cho (NSE) measurements cover a unique range of energies and length scales that are especially valuable to US science & engineering.

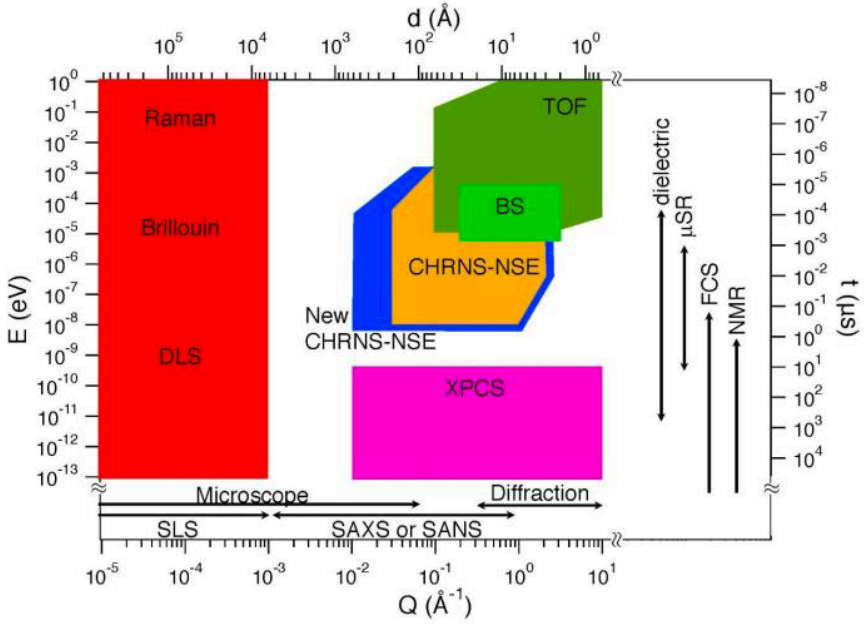

Diagram showing time and length scales investigated by experimental techniques. The blue region shows the significant improvement in time and length scales to be accessible with the upgraded instrument.

Scientific & Societal Value of NSE

NSE measurements enable unparalleled measurements of molecular and nanoscale dynamics on length and time scales critical for the functioning of biological membranes, proteins, and soft materials including nanocomposites and separation membranes.

- Understanding *dynamic* structure-function at the nanoscale is necessary to realize the promise of nanotechnology through rational engineering of nanocomposites at the nanoscale.
- The frontier of engineering dynamics at the nanoscale promises materials with superior and unique properties, such as for more efficient water purification as well as more more powerful and long-lived batteries.
- NSE measurements provide unique information that can be used to greatly improve the production and delivery of biopharmaceuticals with sales of over $100 billion in the US annually.

NSE Status & Need

- US scientists and engineers are *hindered* by lack of access to and the capabilities of neutron spin echo instruments in the US (and western hemisphere more broadly)
- NSE enables *unique* measurement capabilities, that when combined with isotope labeling, yields measurements with unparalleled scientific value
- US scientific community *consensus* identifies this instrument as a high priority for soft matter, biology, and nanocomposite research
- The Center for High Resolution Neutron Scattering (CHRNS) –NSE, an NSF funded center, is one of the most *oversubscribed* neutron instruments in the nation
- Upgrading the CHRNS-NSE at the NCNR will bring the US (and western hemisphere) to be *competitive* with the world-class instruments IN15 at ILL, France & J-NSE-Phoenix at MLZ, Germany, enabling new US science and engineering

NSE – a unique and powerful "microscope" to quantify nanoscale dynamics

- NSE is unique in probing energy and time scales critically relevant for soft matter and biology,
- Proposed instrument will enable science not currently possible in the US, such as:
  - Quantifying biomembrane fluctuations governing intercellular transport essential for life
  - Measuring hierarchical protein domain dynamics of critical importance to understanding protein function and biopharmaceutical stability and function.
  - Quantifying *dynamic* structure-function in nanoscomposites relevant for emergent properties, e.g. for separations, energy storage, photonics, and materials with unique toughness, strength, optical, and thermal properties

Proposed NSE Upgrade

- Superconducting magnets and associated hardware will dramatically improve the range of energy and momentum accessible to US scientists at the NSF supported CHRNS-NSE at NIST
- Critical components have already been designed and proven out at J-NSE-Phoenix at MLZ, Germany, and are known to be procurable, - very low risk
- Experienced NIST Center for Neutron Research scientists and engineers will manage and lead project
- Sustainable operation is assured with the instrument accessible vis NIST and NSF CHRNS