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Overview of the SNS Second Target Station
- preparing for instrument selection

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Instrument Systems

Oak Ridge, Tennessee
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U.S. DEPARTMENT OF ENERGY

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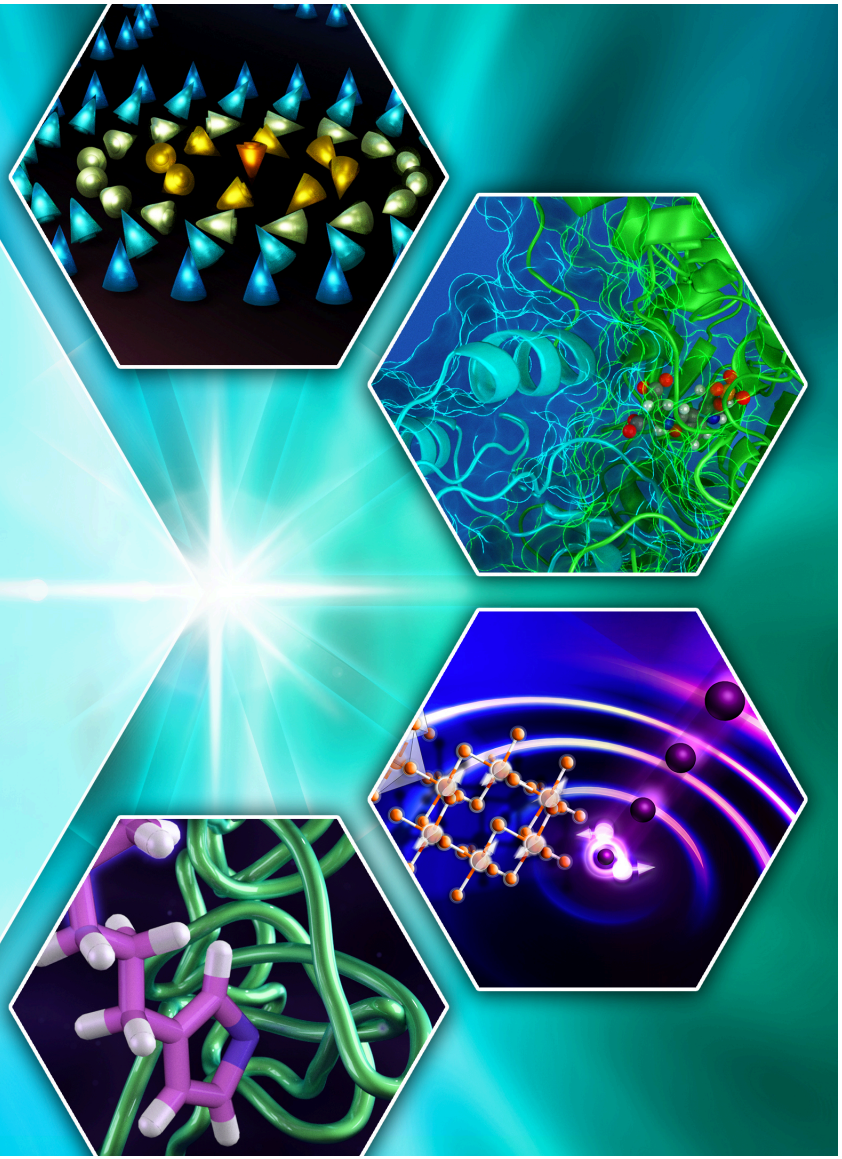
Science at the Second Target Station Workshop

Exploring transformative capabilities for discovery science

December 9–10, 2019



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SNS and HFIR provide unparalleled neutron scattering capabilities for DOE missions and science

Pulsed accelerator sources	→ Highest peak neutron brightness	→ Superior for studying phenomena across broad spatial and temporal regions		SNS is the world's most powerful accelerator-based neutron scattering source
Steady-state reactors	→ Highest steady-state neutron brightness	→ Superior for studying phenomena at specific length and time scales		HFIR is the world's most powerful reactor-based neutron scattering source

SNS upgrades will accelerate scientific progress and deliver wholly new capabilities

PPU project: Double the power of the existing accelerator structure

- First Target Station (FTS) is optimized for thermal neutrons
- Increases the brightness of beams of pulsed neutrons
- Provides new science capabilities for atomic resolution and fast dynamics
- Provides a platform for STS

STS project: Build the second target station with initial suite of beam lines

- Optimized for cold neutrons
- World-leading peak brightness
- Provides new science capabilities for measurements across broader ranges of temporal and length scales, real-time, and smaller samples

High-level status of SNS upgrade projects

Proton Power Upgrade (PPU)

- Critical Decision (CD)-0, CD-1 and CD-3a approved by DOE
- Partner Labs selected – FNAL, LBNL and J-Lab.
- Successful CD-3b review in June 2019
- Ready for CD-2 review at end of 2019
- Early power ramp-up to 1.7 MW proposed for 2022 with start of ramp-up to 2 MW in 2024
- Early project completion in 2024
- Most construction activities occur during regular scheduled maintenance periods

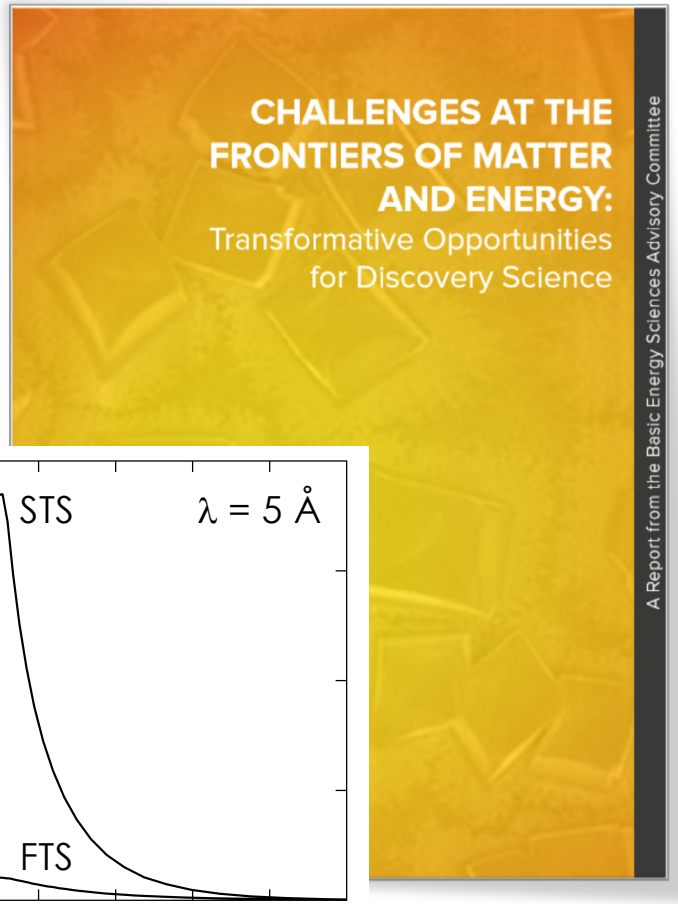
Second Target Station (STS)

- CD-0 approved by DOE
- Design and implementation plan finalized following detailed studies and review panel evaluation in 2017
- Conceptual design packages completed
- Bottom-up cost-estimate by end of August 2019
- Preparing for CD-1 readiness review
- Early project completion in 2028
- Federal Project Director appointed, interim Director appointed, and active search for Director
- Construction has minimal impact on FTS operations

STS will bridge the gap for a high peak brightness pulsed source for cold neutrons

Beams of cold neutrons with higher peak brightness and broader ranges of neutron energies are needed to meet challenges at the frontiers of matter and energy:

- Simultaneous measurement of hierarchical architectures across unprecedented ranges of length scales
- Time-resolved measurements of kinetic processes and beyond-equilibrium matter
- Characterization of smaller samples and matter under more extreme conditions
- Applications for developing next-generation materials for energy, security, and industrial applications



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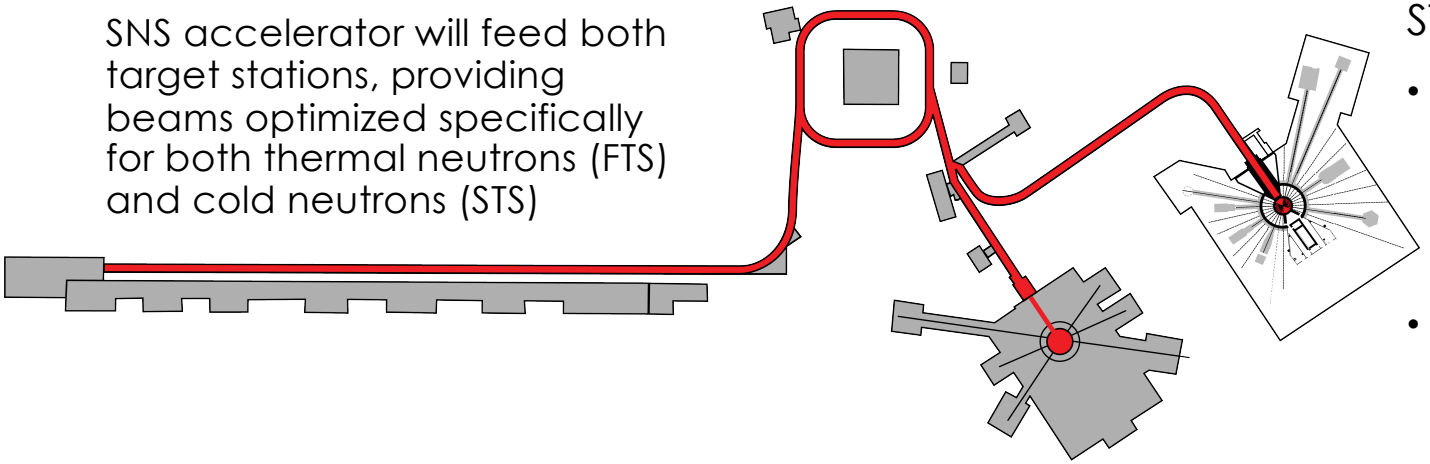
Addition of STS to FTS will enable new science to complement FTS and HFIR

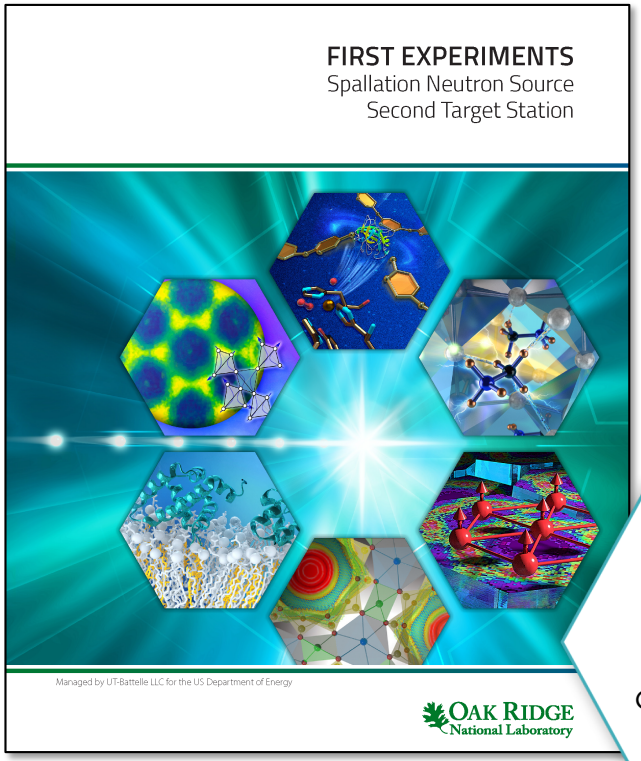
SNS accelerator will feed both target stations, providing beams optimized specifically for both thermal neutrons (FTS) and cold neutrons (STS)



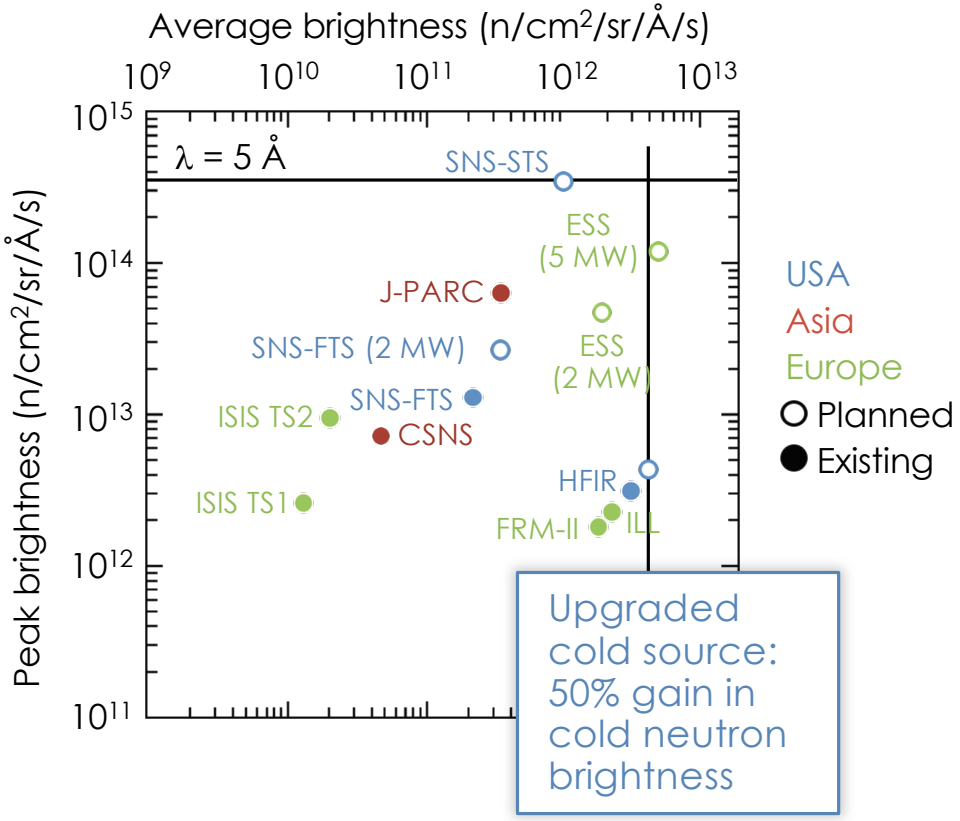
STS: Designed to deliver

- Cold (long-wavelength) neutrons of unparalleled peak brightness (1.5×10^{15} n/s/cm^2/Å/ster at λ = 3 Å)
- Short pulses containing neutrons with broad ranges of usable wavelength or energy ($\Delta\lambda$ = 13.2 Å at 15 Hz at 20 m distance from source)

STS will help establish US leadership in pulsed cold neutrons



>175 researchers from 64 institutions contributed to the report



Upgraded cold source: 50% gain in cold neutron brightness

We are planning a second webinar to highlight science opportunities identified in the First Experiments document as background for the Dec. 9-10 workshop

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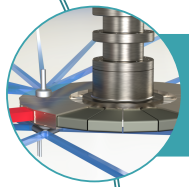
Our goal is to complete 8 world-class instruments ready to begin commissioning with neutron beam (22 total beam lines)

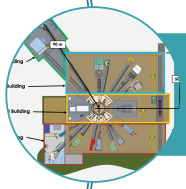
Accelerator

- Independent operation of FTS and STS
- Transport protons to second target station



Target

- Solid rotating tungsten target
- 2 high brightness moderators



Instruments

- 22 beam lines
- 8 initial instruments

Selection of STS project-built instruments has not occurred

Civil Construction

- 10 new buildings
- 40 m, 50 m, and 90 m instrument halls

Integrated controls

- Control systems and computing infrastructure for all STS technical systems
- Instrument data acquisition

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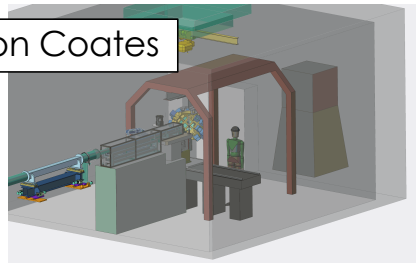
8 notional instrument concepts have been developed to support project planning for a CD-1 readiness review

- Instruments were prioritized by the research community through workshops and advisory boards
- Instrument concepts represent range of types and physical/technical requirements
  - 3 diffractometers, 2 spectrometers, 1 reflectometer, 1 small-angle neutron scattering and 1 small-/wide-angle neutron scattering instrument
  - Instrument lengths of 18 to 90 m
  - Guide and mirror optics concepts
  - Range of detector requirements and types
- Instrument Systems will present these 8 notional instruments as placeholders (*but not as final selection*) for the CD-1 readiness review (early-2020)
  - Conceptual Design Report includes instrument specific science case, technical concept, and initial performance estimates (key elements of an instrument proposal)

We are planning a third webinar to highlight the science capabilities of these 8 notional instruments as background for the Dec. 9-10 workshop

8 notional instrument concepts have been developed

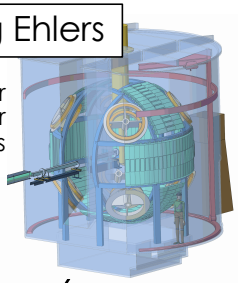
Leighton Coates



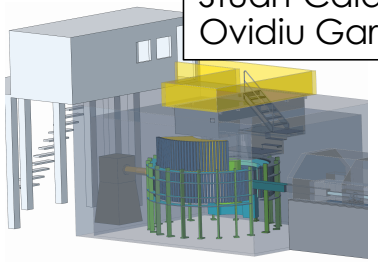
EWALD – Enhanced Wide-Angle Laue Diffractometer

Georg Ehlers

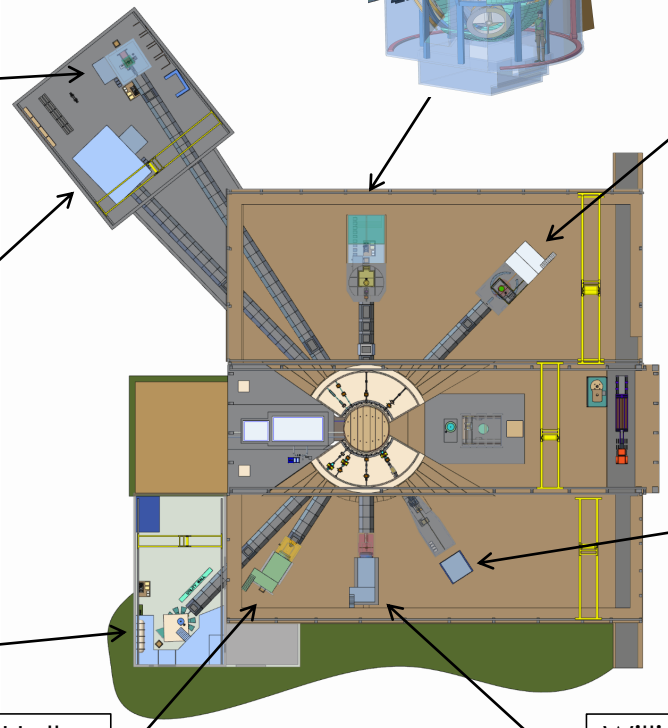
CHESS – Chopper Spectrometer for Small Samples



Stuart Calder
Ovidiu Garlea



VERDI – Versatile Diffractometer



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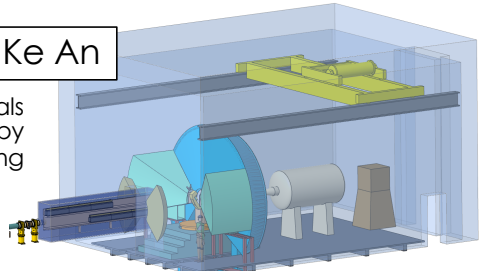
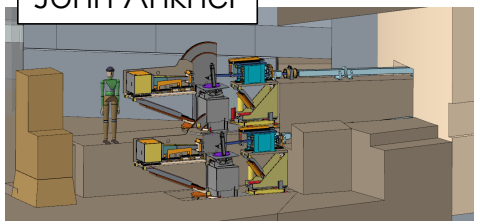
MENUS – Materials Engineering by Neutron Scattering

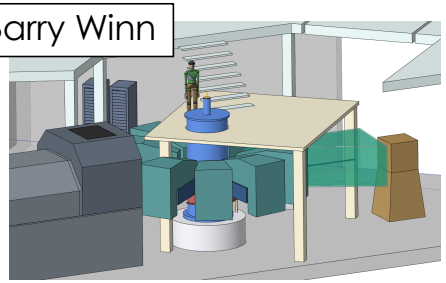


John Ankner



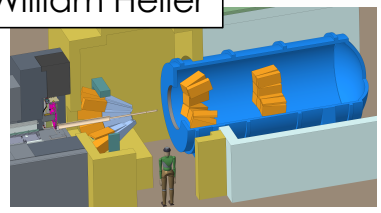
QIKR – Quite Intense Kinetics Reflectometer

Barry Winn



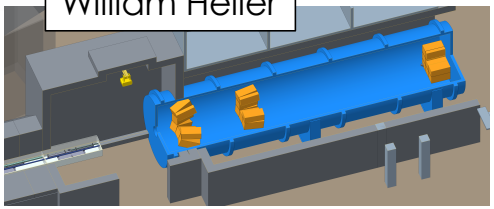
ZEEMANS – High Magnetic Field Instrument

William Heller



CYGNUS – SANS/WANS

William Heller



SANS1

Principles for STS instrument selection process

- Engage the research community to identify the best science that can be addressed at STS
- Engage instrument designers and experts to develop the best instrument technical concepts
- Is communicative, open, transparent and fair
- Is integrated with relevant project milestone dates and critical decision points
- Establish a STS-Science Advisory Board to advise project management on STS scientific directions and recommend prioritization for instrument construction
- Final decisions will be made by STS-project and NScD management

Engagement with the research community is essential to maximize the science impact of STS

Focused science-themed workshops

- Workshop on neutrino and fundamental neutron physics (July 26-27, 2019)
- Workshop on neutron scattering in complex biological and environmental system science (August 28-29, 2019)
- Propose to continue these throughout the STS project (~2/year)

Science at the STS Workshop

- December 9-10, 2019
- Initiate instrument selection process
- Goals
  - Explore new science frontiers opened by STS
  - Build on Early Science document
  - Identify STS science opportunities
  - Identify science champions to develop instrument science cases
- Support moderated, remote participation

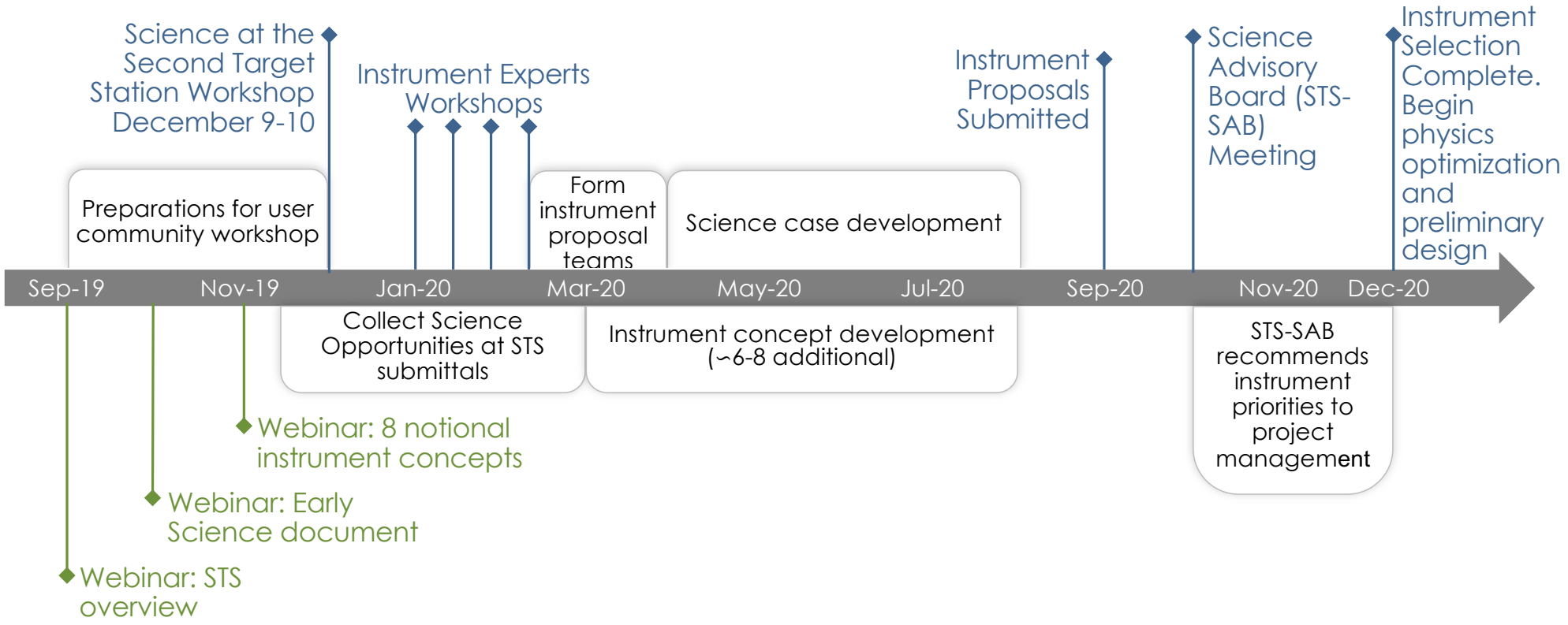
Other opportunities for communication and input

- Webinars
- Presentations/booths at local and national science conferences
  - Intrinsically disordered proteins (September 10-11, 2019)
  - ICANS XXIII (October 13-19, 2019)
  - Pittsburgh Diffraction Conference (October 24-26, 2019)
  - 2019 MRS Fall Meeting (December 1-6, 2019)
- American Conference on Neutron Scattering – 2020

Instrument selection criteria will guide prioritization for instrument construction

- Scientific importance and impact
  - Will the proposed instrument advance the frontiers of knowledge?
  - What are the broad society impacts of the proposed science case?
  - Does the science case reflect identified grand challenges?
- Strength of the relevant user community
  - What is the predicted demand?
  - Will inclusion of this instrument maintain a balanced science portfolio across the ORNL neutron sources?
- Uniqueness of STS capabilities
  - Does this instrument take maximal benefit of STS unique source capabilities?
  - Would the capabilities of this instrument be better enabled at another of the ORNL neutron sources?
- Quality of the proposed instrument (world-leading, competitive, other)
- Feasibility, need for R&D, match to project resources and schedule

Timeline for instrument selection begins now



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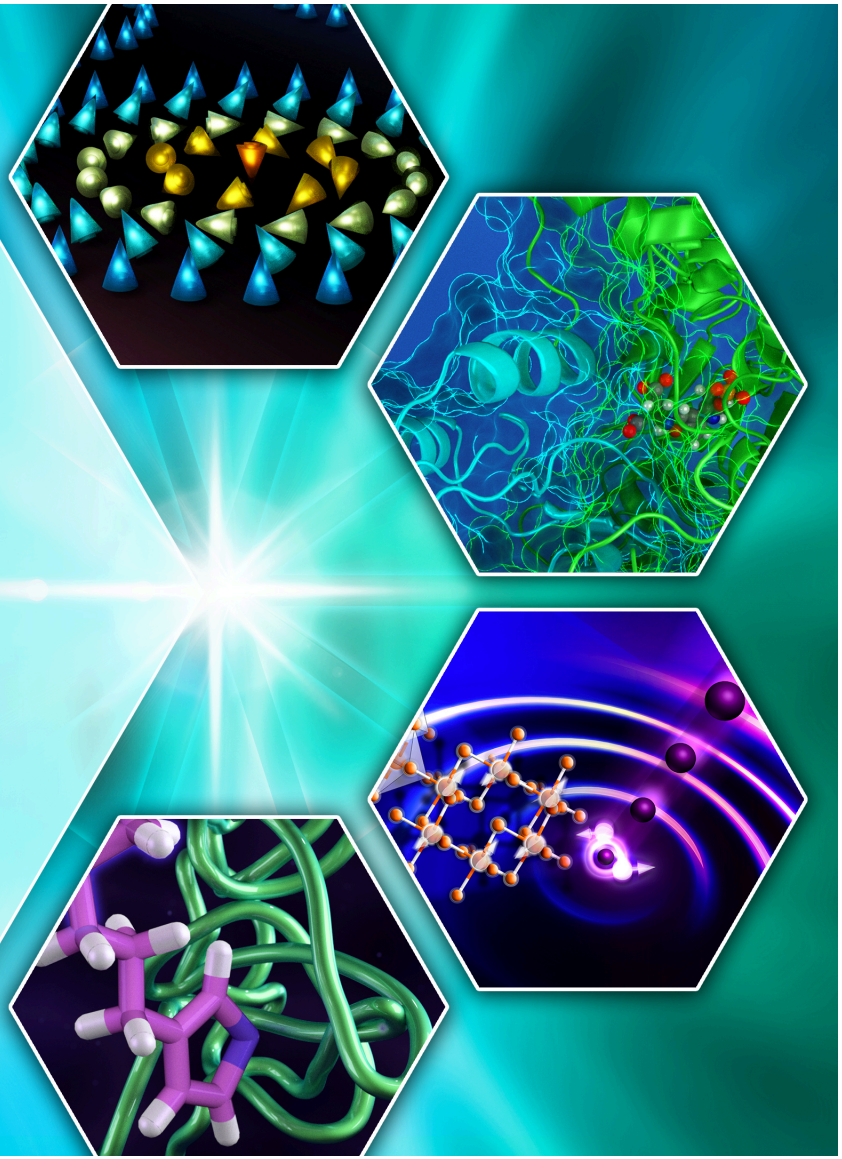

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Questions