Planning for a Second Target Station at SNS

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ICNS-2009

Town Hall Meeting

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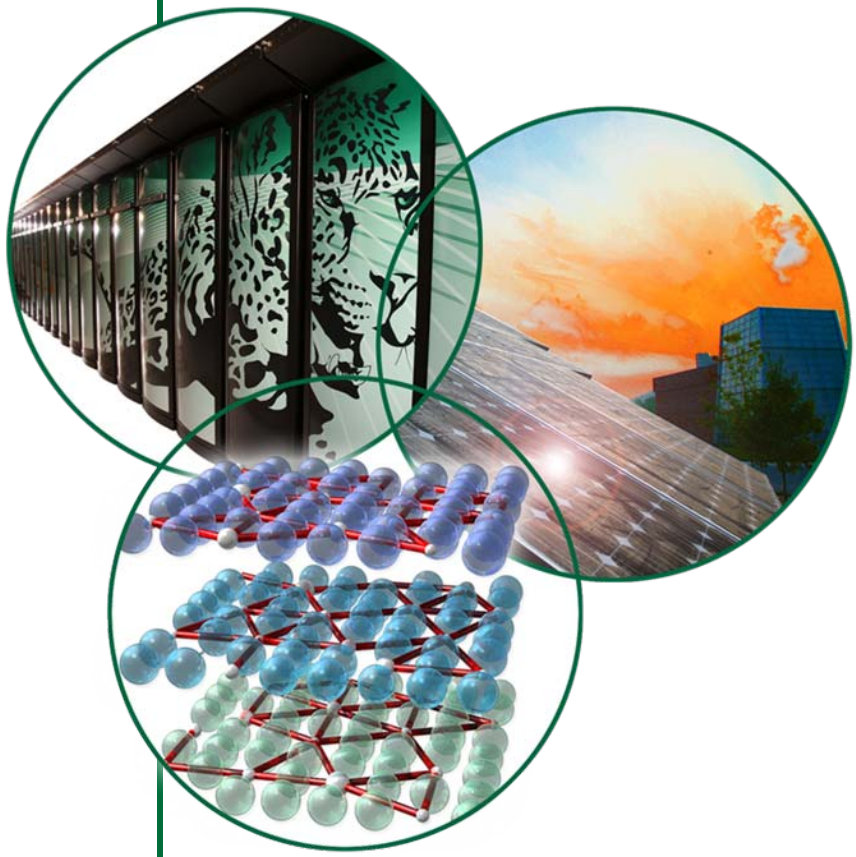

U.S. DEPARTMENT OF ENERGY

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Overview

- **Background**
- **Process**
- **Reference concept**
- **Performance summary**
- **Technical choices**
- **Next steps**
- **Summary**

Background

- **The Spallation Neutron Source (SNS) is a 60 Hz short-pulse neutron source designed to operate at 1.4 MW and to be upgradeable to at least 2 MW. SNS construction was completed in June, 2006.**
- **The inclusion of a second target station at SNS has been part of the Department of Energy (DOE) long-range plans.**
- **The current planning for a second target station (STS) began in Summer, 2006, shortly after SNS completion.**
- **A Reference Concept for the STS was produced and documented in an internal "white paper" in 2007.**
- **DOE has now authorized SNS to proceed to a full conceptual design for the STS.**

Development of STS Reference Concept

- **Science drivers and other requirements**
  - Support the SNS Mission of excellence in science
  - Complementary to SNS First Target Station and to HFIR
  - Extend limits beyond present capabilities
  - High reliability

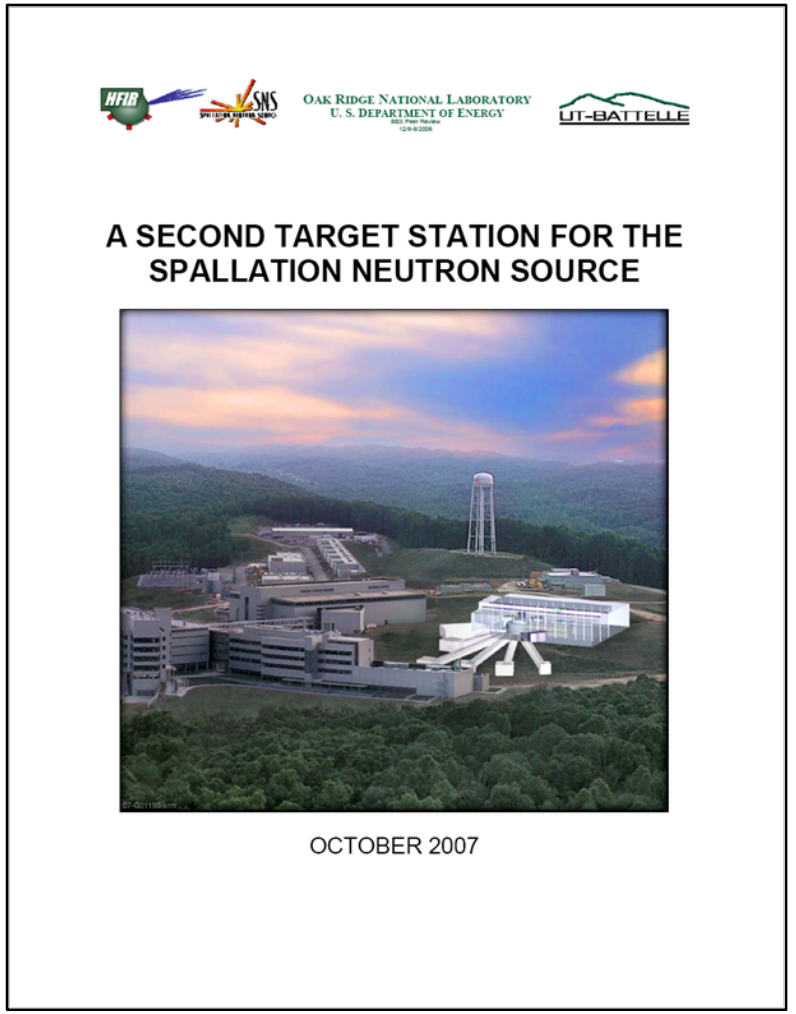
- **Scoping workshop (local and international experts), August 2006**
  - Recommend focus on producing a high flux of cold neutrons

- **Neutronics workshop (local and international experts), December 2006**

- **Instrumentation workshop (local and international experts), February 2007**
  - Concepts for instruments (short and long pulse)

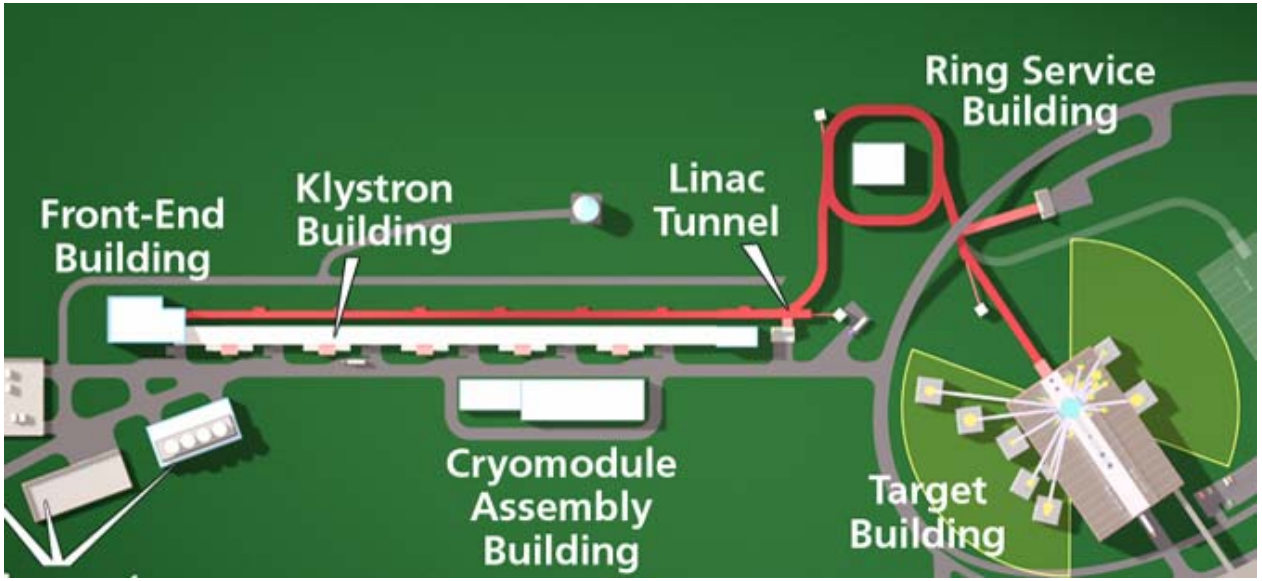
Development of STS Reference Concept –cont'd

- **Working group**
  - Refined these ideas to produce the Reference Concept and evaluate its performance for science
  - Documented in a White Paper, October 2007
  - Submitted to DOE and externally reviewed



REFERENCE CONCEPT

Present SNS Accelerator Systems



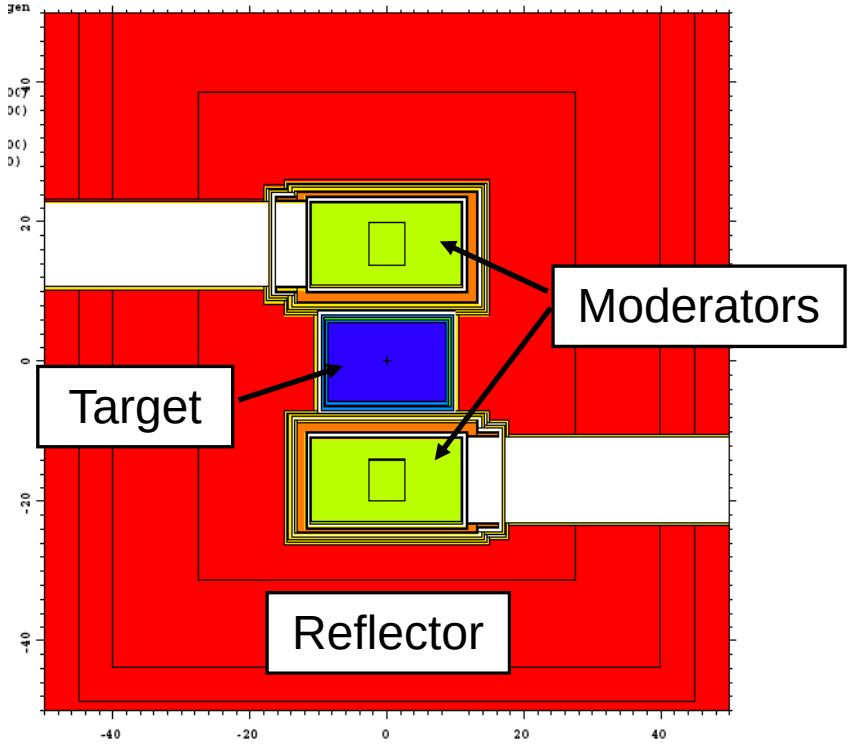
- **SNS linac accelerates the beam to full-energy**
  - Present installation designed for 1.4 MW at 1 GeV
  - Upgrade underway to increase this to > 2 MW at 1.3 GeV
  - Operates at 60 Hz with 1 ms macro-pulse length

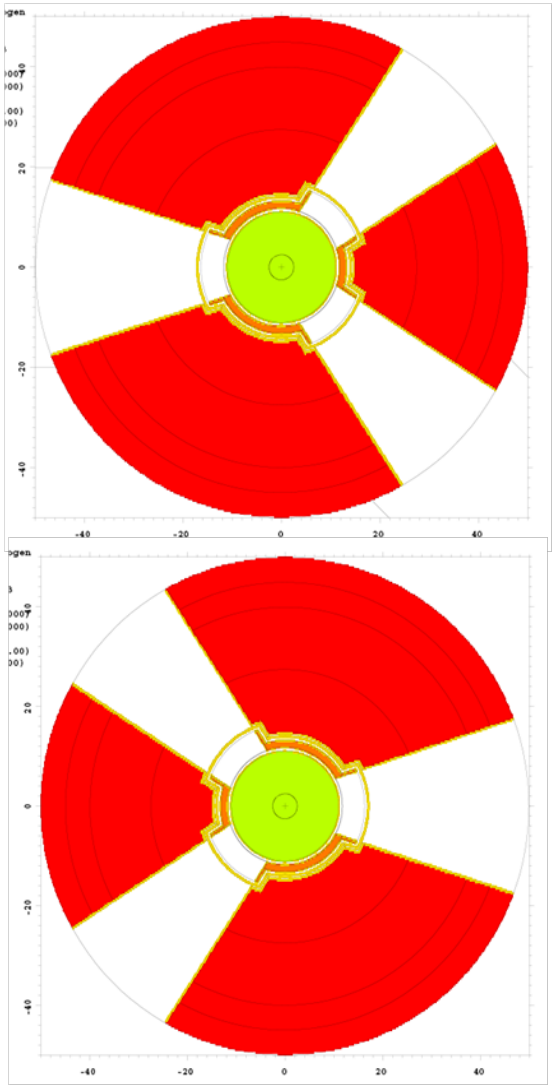
- **Accumulator ring compresses pulse length to ~ 1 μs**
  - Requires chopping segments out of the linac macro-pulse

STS Reference Concept - Accelerator

- **“Pulse stealing mode” for second target station**
  - Second target station takes every third pulse to operate at 20 Hz (50 ms intervals)
  - First target station operates at “pseudo 60 Hz” (40 pulses/ second with alternating intervals of 16.7 ms and 33.3 ms)
- **“Long-pulse mode” with unchopped (and uncompressed) 1 ms linac beam pulse used for STS**
  - Eliminating chopping provides 50% more power for the same linac peak current
  - 1 ms pulse length
- **Power to first target station 1.33 MW (33 kJ/pulse)**
- **Power to second target station 1.00 MW (50 kJ/pulse)**

STS Reference Concept – Neutronic Model





Top

Bottom

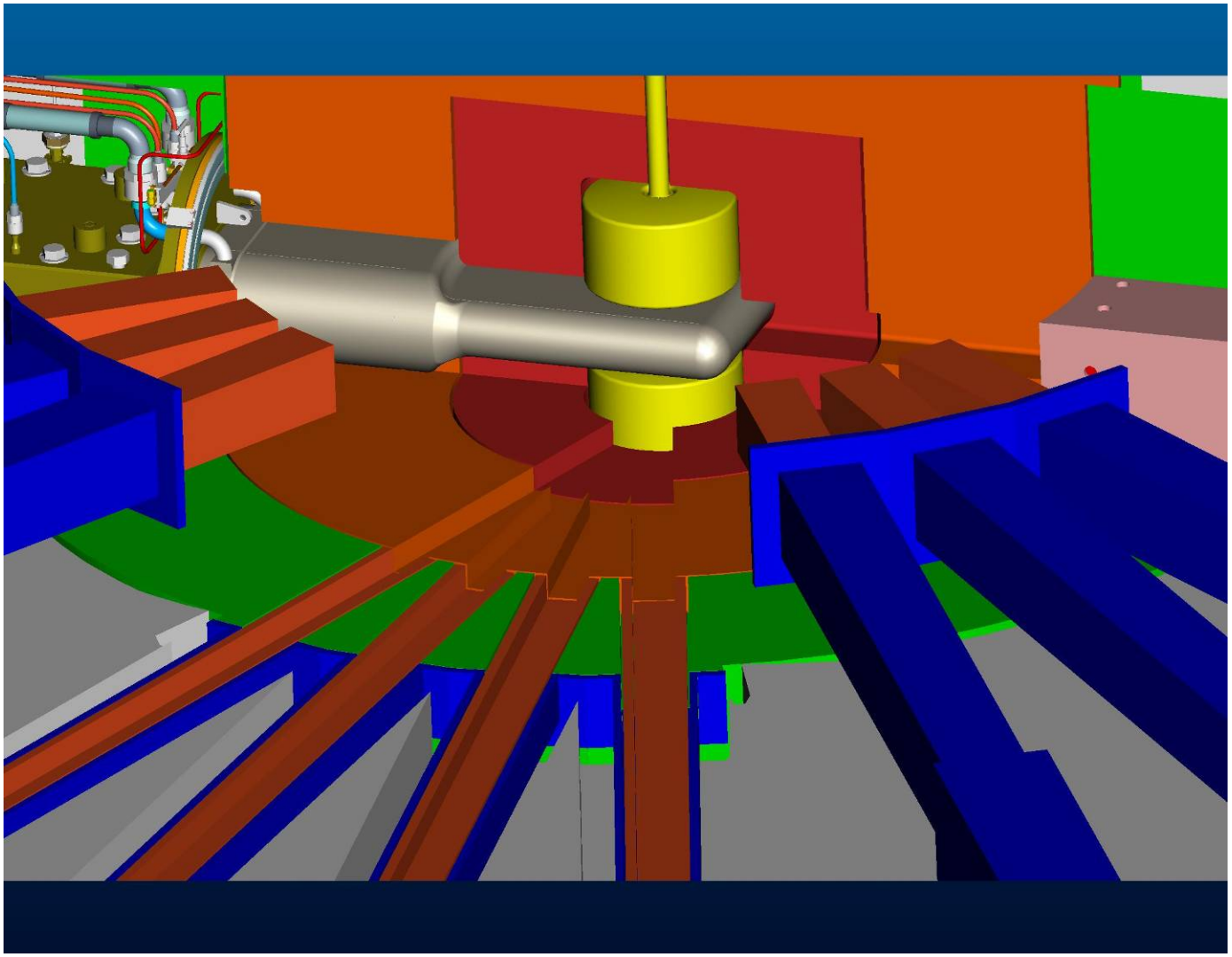
Moderators – parahydrogen
22 cm dia; ~14 cm high

Reflector – beryllium

Target – mercury

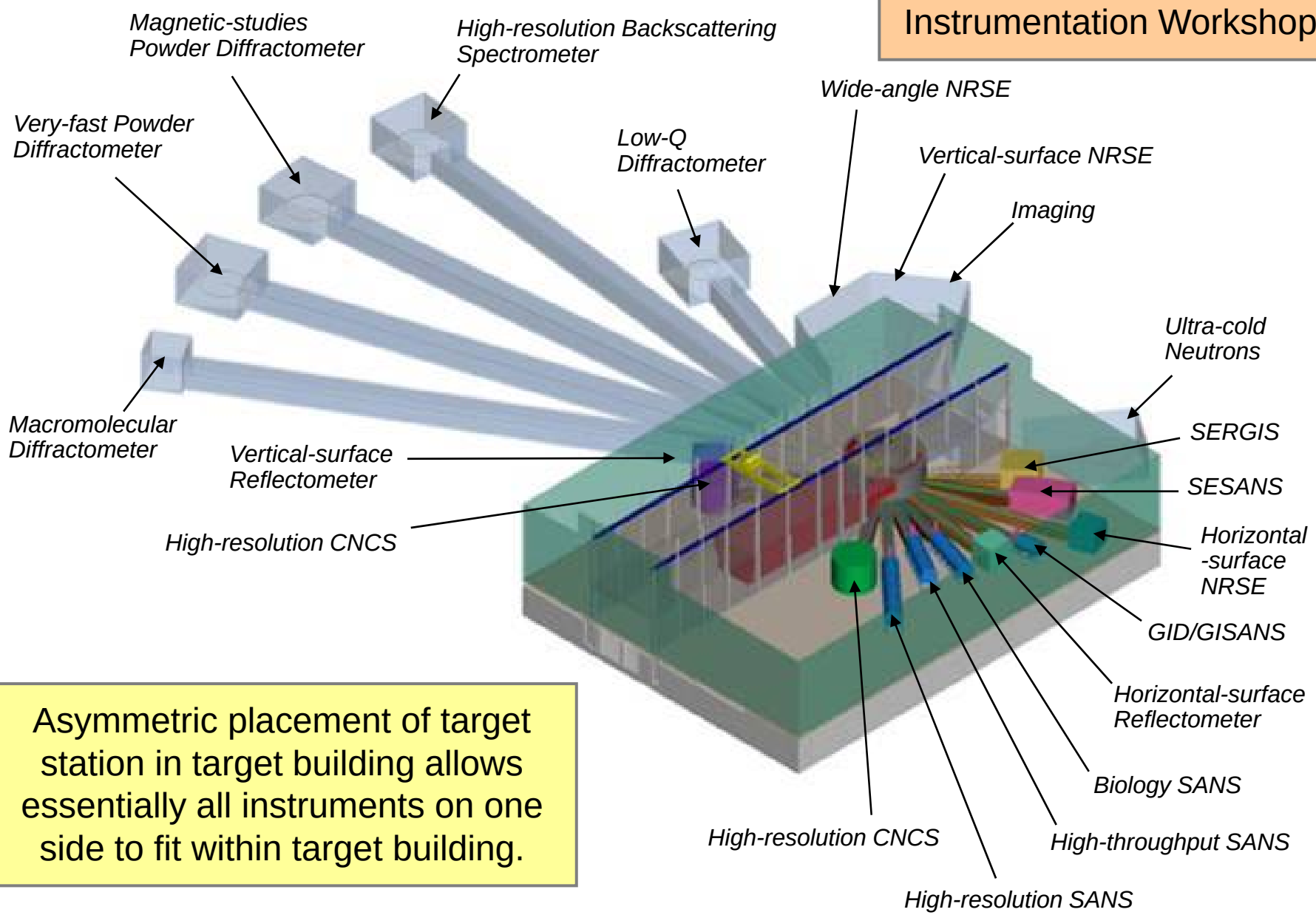
Neutron beams – 20

STS Reference Concept – Target and Moderators



STS Reference Target Building and Instrument Suite

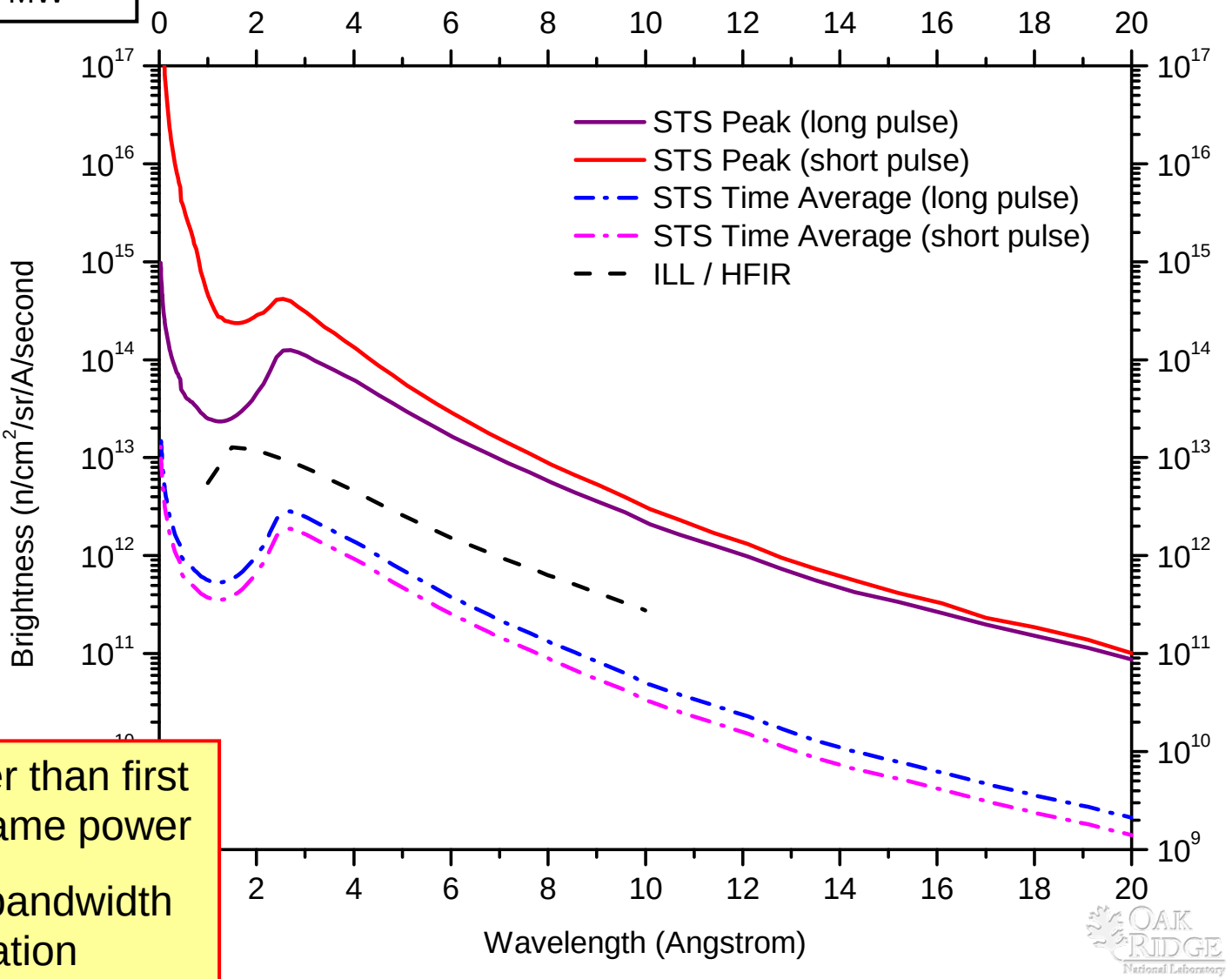
Instrument concepts proposed at the STS Instrumentation Workshop.



Asymmetric placement of target station in target building allows essentially all instruments on one side to fit within target building.

Performance for Science – Short vs Long Pulse

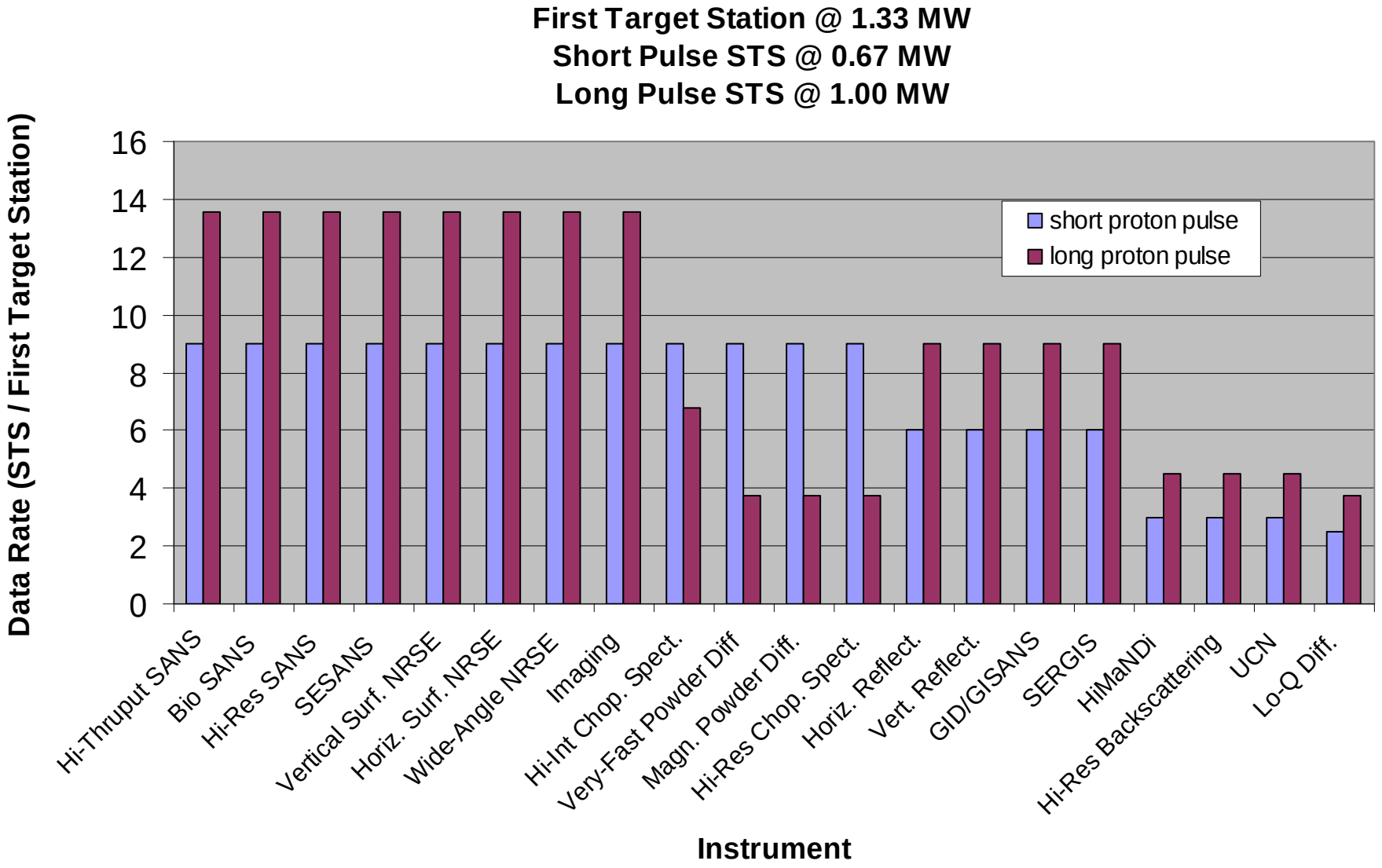
First Target Station @ 1.33 MW
Short Pulse STS @ 0.67 MW
Long Pulse STS @ 1.00 MW



Factor of 6 brighter than first target station at same power

Factor of 3 more bandwidth than first target station

Performance for Science with Reference Instrument Suite – Short vs Long Pulse



Performance for Science – Reference Instrument Suite

Reference instrument suite provides:

- **More than an order of magnitude improvement in performance for broad areas of forefront science (relative to the present target station)**
  - Opens up totally new areas to exploration
- **Complementary to the first target station and to HFIR**
- **Provides opportunity to re-optimize moderators and instruments at the first target station**

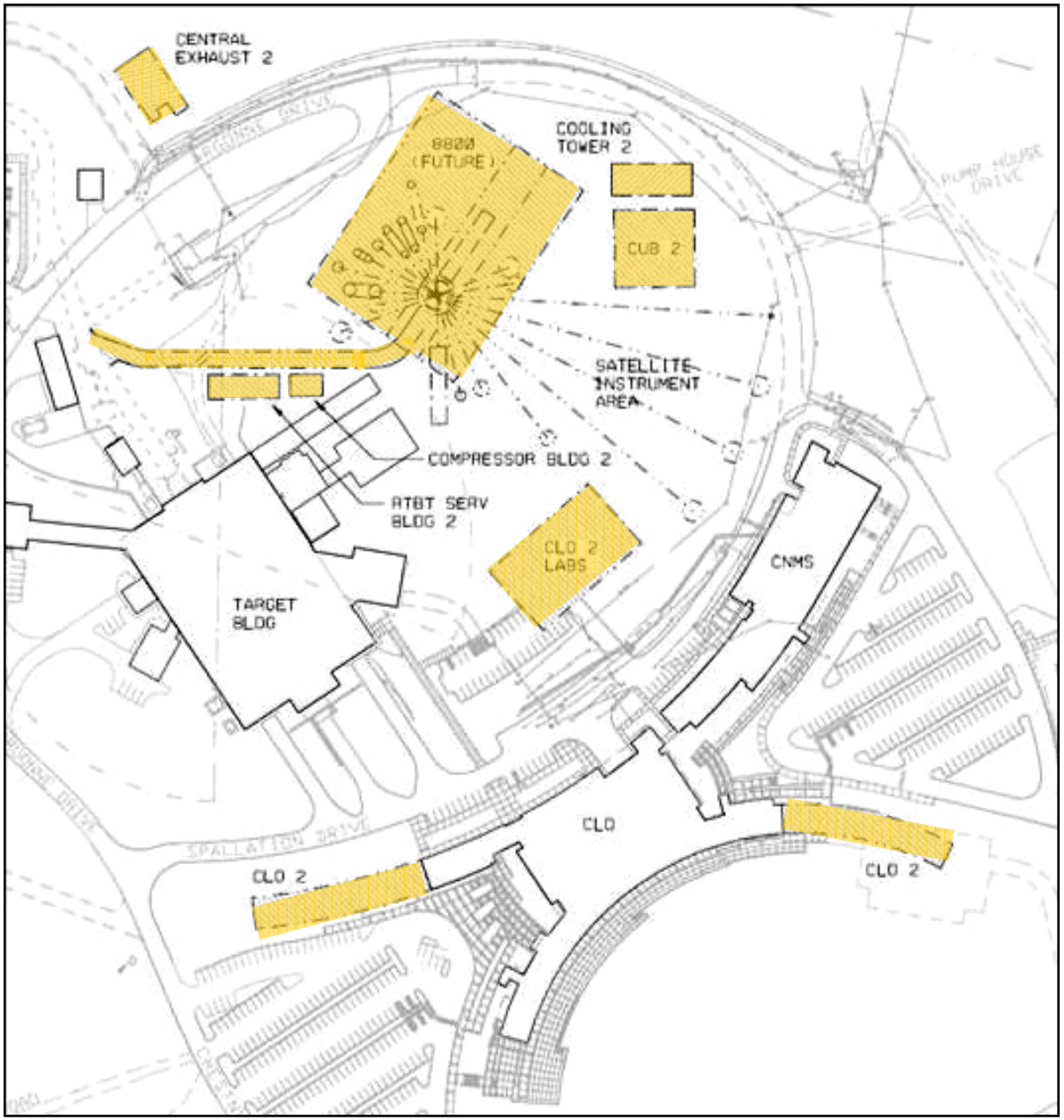
Performance for Science - Potential

An order of magnitude in performance gain offers the opportunity for new developments to extend the experimental range.

Some possible examples include:

- **Slow dynamics at length scales up to 1 micron**
- **Focused 10 micron beams**
- **Lateral surface structures at 10 to 1000 nanometers**
- **Full dynamical range from picoseconds to minutes**

Reference Concept – Conventional Facilities



Reference Concept – General Layout

Major Choices

- **Optimization for intense cold neutron beams**
  - Strong recommendation from 2006 scoping workshop.
  - Cold neutrons important for current and future science
  - More intense beams would enable new capabilities
  - First target station is optimized for very short pulses to provide timing resolution → cold neutron intensity compromised
  - STS optimization for intensity provides a much higher intensity even with its lower repetition rate → order of magnitude increase in useful neutrons on sample

- **Pulse stealing vs pulse interleaving**
  - Pulse interleaving technically challenging, would require major overhaul of the linac → too expensive
  - Pulse stealing at 20 Hz still leaves high power for the first target station

Major Choices – cont'd

- **20 Hz repetition rate**
  - Allows increased bandwidth, even for longer flight paths
  - Minimizes impact on first target station

- **Long-proton-pulse vs short-proton-pulse**
  - Neutronic response to a short proton pulse is a long neutron pulse (~300 μs) in the cold-neutron regime
  - Using the full 1 ms pulse directly from the linac is not a big timing penalty
  - 50% more power → more neutrons
  - Already have short-pulse station, and can re-optimize the mix of moderators and instruments between the two stations
  - Technically much simpler operation → higher reliability
  - Provides opportunity for new types of instrumentation to enable new science

Activities to Prepare for Critical Decision 1

- **Finalize major design choices**
  - Short vs long pulses
  - Site for target station
  - Target type
  - Moderator types and geometry
- **Develop conceptual design**
  - Accelerator systems modifications
  - Target station
  - Initial instruments
  - New buildings, utilities, and site layout
- **Document**
  - Write Conceptual Design Report
  - Prepare realistic and defensible preliminary cost and schedule estimates
  - Develop other CD-1 documents

Summary

- **A reference concept for a second target station (STS) at SNS has been developed and evaluated.**
  - Intense cold neutron beams
  - 1 MW at 20 Hz
  - Long-pulse operation (1 ms)
- **Such an STS at SNS would provide exciting new scientific capabilities.**
  - Order-of-magnitude increase in useful cold flux compared to first target station
  - Qualitatively new scientific capabilities
- **DOE has recently authorized SNS to develop a full conceptual design for the STS.**
- **We would like your feedback on what we are doing ! (crawfordrk@ornl.gov)**