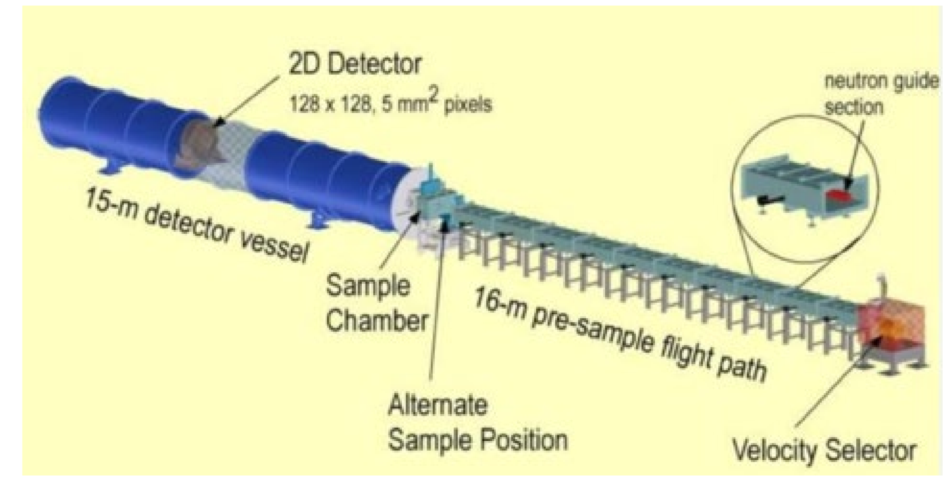
National Institute of Standards and Technology

Syracuse University College of Engineering & Computer Science

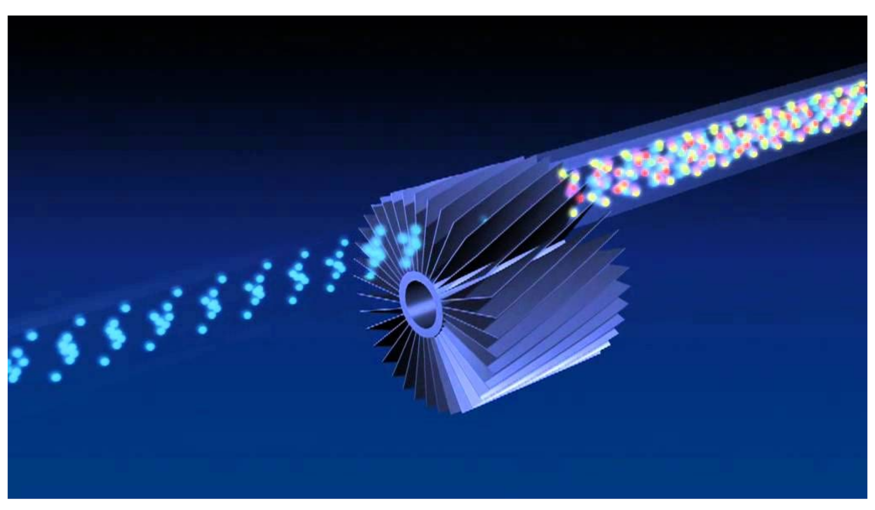
Neutron Velocity Selector Test Base and Cover

The National Institute of Standards and Technology (NIST) was founded in 1901 and is now part of the U.S. Department of Commerce. NIST is one of the nation's oldest physical science laboratories. Today, NIST measurements support the smallest of technologies to the largest and most complex of human-made creations — from nanoscale devices so tiny that tens of thousands can fit on the end of a single human hair up to earthquake-resistant skyscrapers and global communication networks.



Project Description:

NIST consists of a number of beamlines allowing scientists and engineers to do cutting edge neutron research. Each beamline consists of multiple components, one of which is the Neutron Velocity Selector (NVS). The NVS is designed to efficiently transmit the primary wavelength neutrons while suppressing second order, third order, etc., neutrons so that the incident beam from the PG or Cu crystals onto the sample is monochromatic. The NVS spin at incredibly fast speeds and could pose a danger to the machine operators if they were to break apart during the testing phase. Working with NIST, our team will design a permanently mounted base with an attached protective cover to house all models of NVS during the testing phase and ensure the safety of all test participants in the event of a worst-case scenario.



Neutrons that are faster or slower than those "allowed" for a given selector rotation speed are absorbed on the blade surfaces while traveling through the selector. The number of blades and their spacing determine the spread of velocities (wavelengths) around the mean velocity achieved. This "wavelength spread" is typically of the order of 9%.
Lowering the speed of the velocity selector favours the passage of slower neutrons (here shown for 20Å wavelength, marked in blue) The velocity selector thus acts as a monochromator.
Source: Institut Laue Langevin

Neutron Velocity Selector

Design Requirements:

Permanently Mounted Base:

- Must be able to attach all sizes of velocity selector models to the base
- Attachment method to the base must guarantee the NVS to be steady in place in the event of a worst-case scenario.

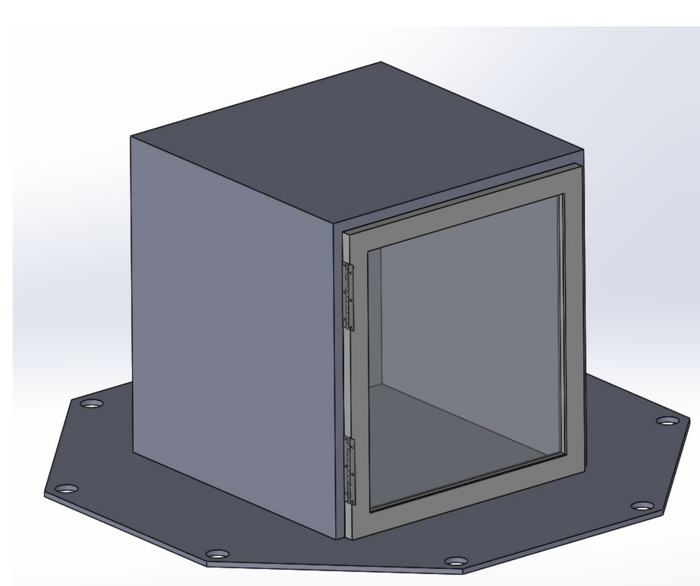
Cover:

- Cover must guarantee the safety of all in the event of worst-case scenario.
- Must have an FEA justification that the cover will not fail.
- Cover must allow for the attachment of all cabling and water-cooling lines to the NVS .
- Cover must include a door to allow easy and convenient access to the NVS between tests.

Design Option	PROs	CONs
Hexagon Dome	Easy to calculate the forces Easy to replace each plate and reuse the structure	Difficult to manufacture and mount plate together Fastener points become the main area of issues
Hexagon Side Box	Easy manufacture Durable structure Allows for hydraulic lock to be used	A door on the top of the box could cause issues Hard to reach/work on the NVS
Sliding Door Box	Combination of efficiency and durability from other ideas	Sliding door may be difficult to manufacture
Cube Box	Maintains wanted aspects from other ideas while simplifying points	Could be considered too simple if not built properly to withstand an accident

Deliverables:

- Design package, including cover and base
- Calculation and simulation analysis
- Minimum safety factor of 4.0



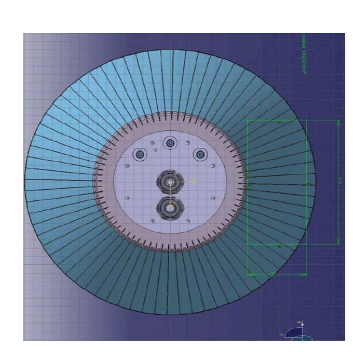
Cube Box

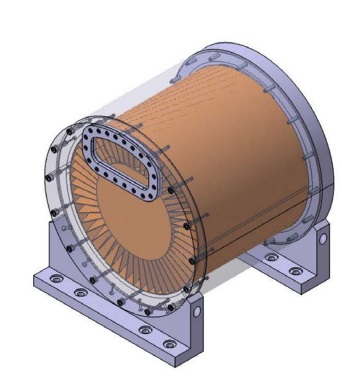
After several design iterations (i.e., hexagon dome, hexagon side, sliding door and cube box) we are narrowed down our design to cube box. The team will focus on material selection, weight, ease of manufacturing, load concentration, different failure modes, meeting applicable standards, cost, schedule etc .

Example NVS:

BT-7 Velocity Selector (Astrium)

- Rotor length, L = 250 mm
- Rotor outer radius, r_2 = 145 mm
- Blade height 75 mm (rotor inner radius, r_1= 70 mm)
- Number of blades, N = 72 (center –center separation 5º, t = 0.4 mm thick)
- Screw angle, 11.7º. $\Delta\lambda/\lambda \approx 40\%$
- The velocity selector is designed for the unrestricted wavelength range between 1.2Å and 3.1 Å.
- Ei= 8.5 meV ▯60 meV (26,000 rpm); Energy range around 5 meV as well.





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