Neutron Velocity Selector

Research with Neutrons
Neutron – Velocity Selector

Neutron Velocity Selector

Converter
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Neutron Velocity Selector

Application
Generation of a monochromatic beam of low-velocity neutrons

Type
Blade rotor developed by Dornier / GKSS* / PTB*

Neutron characteristics for a Selector with standard design data
Standard design data: 72 blades, α = 48.3° (screw angle of the blades), length (0.25 m)
Transmission in maximum T and resolution R are dependent upon neutron beam divergence α, beam height h and tilt angle ξ between beam and rotor axis.

a) Standard operation (ξ = 0, h = 55 mm), wavelength λ 0.45 to 4.2 nm (4.5 to 42 Å), 72 blades, α= 48.3° (screw angle of the blades)

<table>
<thead>
<tr>
<th>α fwhm triangular</th>
<th>Transmission</th>
<th>Resolution fwhm</th>
</tr>
</thead>
<tbody>
<tr>
<td>('')</td>
<td>(%)</td>
<td>(%)</td>
</tr>
<tr>
<td>0</td>
<td>94.5</td>
<td>9.8</td>
</tr>
<tr>
<td>30</td>
<td>87.0</td>
<td>10.6</td>
</tr>
<tr>
<td>60</td>
<td>79.4</td>
<td>11.4</td>
</tr>
</tbody>
</table>

Calculated by *

* P. Wille, GKSS, Geesthacht, H. Friedrich, V. Wagner, PTB, Braunschweig
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b) Beam height $h$ influence @ $\xi = 0$, $\alpha = 30^\circ$: negligible

c) Tilt angle $\xi$ influence for wavelength extension and/or change in resolution $R$.
   $\alpha = 30^\circ$, $h = 20$ mm:

<table>
<thead>
<tr>
<th>$\xi$ ($^\circ$)</th>
<th>$\lambda$ at max. speed (nm)</th>
<th>$T$ (%)</th>
<th>$R$ (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-10</td>
<td>0.252</td>
<td>77</td>
<td>20.6</td>
</tr>
<tr>
<td>-5</td>
<td>0.353</td>
<td>84</td>
<td>13.9</td>
</tr>
<tr>
<td>0</td>
<td>0.450</td>
<td>88</td>
<td>10.5</td>
</tr>
<tr>
<td>10</td>
<td>0.637</td>
<td>77</td>
<td>8.2</td>
</tr>
</tbody>
</table>

For greater beam heights $h$, the Transmission and Resolution values become less favorable @ $\xi \neq 0$

d) Application with external magnetic field and polarized neutrons is successfully tested

e) Transmission of thermal neutrons $< 5 \times 10^{-4}$ with an absorber coating of 35 g per sqm of blade material
# Neutron Velocity Selector

**Mechanical characteristics (standard selector)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotor diameter</td>
<td>mm</td>
<td>290</td>
</tr>
<tr>
<td>Rotor length</td>
<td>mm</td>
<td>250</td>
</tr>
<tr>
<td>Angle of selector screw</td>
<td>°</td>
<td>48.3 (selectable)</td>
</tr>
<tr>
<td>Speed range</td>
<td>rpm</td>
<td>3,000 - 28,300</td>
</tr>
<tr>
<td>Speed constancy</td>
<td>%</td>
<td>0.2</td>
</tr>
</tbody>
</table>

**Blade**
- Number: 72
- Material: carbon fiber in epoxy
- Thickness: 0.4 mm
- Height: 60 mm from r = 85 to r = 145
- Absorber coating: 35g 10B per sqm of blade surface

**Window**
- Material: aluminum foil
- Thickness: < 0.5 mm
- Width (max.): 150 mm
- Height (max.): 65 mm
- Position: can be staggered in increments of 22.5° as required

**Case**
- Material: aluminum
- Length: 306 mm, without connections for power supply, cooling water
- Overall length: approx. 330 mm
- Diameter: 340 mm, without base, base removable

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Based on the fundamental design of the selector, variations are possible according to the specific needs of the customer.
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e.g. divergence before selector ± 0.5°

wavelength resolution after selector

NVS example simulated with McStas V1.12
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Neutron Velocity Selector

Peak-transmission @ resolution 0.01

Transmission $\approx 81\%$

$\lambda = 4.5\ \text{Å} \ (\pm 0.01^\circ) - n= 214723 \text{ before selector}$

$\lambda = 4.5\ \text{Å} \ (\pm 0.01^\circ) - n= 173439 \text{ after selector}$

NVS example simulated with McStas V1.12
Control-System (baseline)

The Neutron Velocity Selector (NVS) can be controlled by:
- Converter – buttons (only simple speed controlled mode)
- Local computer – Graphical User Interface (GUI)
- Remote computer – TCP/IP via the local computer

The converter and the local computer are parts of the baseline delivery of the NVS

Functions of the control program:
- speed/wavelength control
- slip monitoring
- current monitoring
- power loss monitoring (switchable)
- prevent the NVS of operating in critical speed ranges

<- GUI of the control- and monitoring program* and the tilt-table* control.

* options
The monitoring system takes over various safety and process analysis tasks to prevent the NVS from damage. In addition to the NVS baseline control functions, the monitoring system can take over various safety and process analysis tasks. For this purpose the following process parameters are monitored and compared with stored limit values:

- vibrations
- BCU value
- rotor temperature
- cooling water inlet temperature
- cooling water outlet temperature
- cooling water flow rate
- operating vacuum
- sensor defect of the measuring tube (operating vacuum)
- position of the vacuum valve (open / closed)

The system above is a normal configuration, which can be reduced or extended on customer needs.
Tilt–Table (option)

The tilt-table completes the NVS with the following additional functions:

- extending the wavelength range for faster neutrons
- reducing of the wavelength resolution
- reducing of the neutron transmission

As one part of the tilt-table option all control components are installed in a 19"-rack

The control of the tilt-table is integrated in the NVS Control-GUI. Therefore a safe tilt-table operation can be ensured (only when the speed of the NVS = 0 rpm).
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