Neutron detection in the new STT configuration

L. Di Noto, F. Ferraro, P. Sala
Geometry

OLD

NEW

6 blocks, each composed of one module with graphite target followed by 12 standard CH2 modules with target slab and radiator
Geometry – zoom

OLD

NEW
Geometry – zoom again
Neutron spectrum at vertex

We should better compare this spectrum with the one used in GEANT

Details on interactions on H and C in the following slide
Neutron spectrum at vertex
interactions on H and C

We should better compare these spectra with the ones used in GEANT
Disclaimer on the efficiency

• When we say “w/o endcaps” we do not consider at all the neutrons causing hits in the endcaps (as if they were not even generated)
• The endcaps are not yet completely simulated (homogeneous material)
• We can certainly study the efficiency without a time cut, but it has to be considered in the real experiment
• In this comparison we are not considering the time resolution (we are considering the MC truth)
Effect of the 50 ns time cut – old geometry

The time cut is prevalently affecting low-momentum neutrons from interactions on C

Detected at larger time!
Detection efficiency
w/o endcaps
w/o 50 ns time cut

OLD

NEW

<table>
<thead>
<tr>
<th>Component</th>
<th>OLD</th>
<th>NEW</th>
</tr>
</thead>
<tbody>
<tr>
<td>total</td>
<td>59.7%</td>
<td>37.9%</td>
</tr>
<tr>
<td>barrel</td>
<td>47.4%</td>
<td>30.5%</td>
</tr>
<tr>
<td>slit</td>
<td>21.5%</td>
<td>12.0%</td>
</tr>
</tbody>
</table>
Detection efficiency
w/o endcaps
w/ 50 ns time cut

OLD

NEW

- total: 36.2%
- barrel: 29.9%
- stt: 10.4%

- total: 32.2%
- barrel: 24.3%
- stt: 11.9%
Detection efficiency
w/ endcaps
w/o 50 ns time cut

OLD

NEW

![Graph of detection efficiency](image_url)
Detection efficiency

w/ endcaps
w/ 50 ns time cut

OLD

NEW

52.3%  52.3%
32.2%  32.2%
21.4%  21.4%
14.6%  14.6%
47.4%  47.4%
28.5%  28.5%
17.0%  17.0%
13.0%  13.0%
Energy reconstruction
w/o endcaps
w/o 50 ns time cut
Energy reconstruction (w/i 30% from true value)
w/o endcaps
w/o 50 ns time cut

OLD

NEW

3255/9173 \approx 35.5% 

4093/12318 \approx 33.2% 

Of detected events
Energy reconstruction
w/o endcaps
w/o 50 ns time cut

OLD

NEW

3255/9173 \approx 35.5%  

4093/12318 \approx 33.2%

Of detected events
Multiplicity
w/o endcap
w/o 50 ns time cut

OLD

NEW
Monochromatic neutrons toward barrel or endcap
Efficiency plot for monochromatic neutrons towards barrel or endcap in new and old geometry

Barrel and endcap are very different...
The new geo works better at higher neutron energy
New geometry - low density test (LDT)
upward neutron beam (towards barrel)
Comparison – old, new and new-LDT
(no beam towards the endcaps in new-LDT)

Lower density => lower endcap eff., higher barrel and stt eff.

No time cut

Barrel and endcap are very different...
The new geo works better at higher neutron energy
Neutrons detected at higher times

12% of detected neutrons are detected at t>500 ns from vertex time
with old STT the fraction was 27%

For those neutron detected at t>500 ns:
32% interact outside the detector and the daughter are seen
The rest 68% at lower energy does many interactions inside the detector
For 68% of neutrons detected at time $>500$ ns and interacting inside SAND, the neutrons trajectory was studied.

The time of last interaction of a primary neutron is quite similar to its time of detection except for those (about 40% of this group) where the primary neutron interacts early, emitting secondary neutrons which wanders around interacting later.
Summary

We looked at the new STT configuration, in particular:

• Interacting nuclei
• neutron detection efficiency, where we found some differences that should be investigated further
• Energy reconstruction
• Neutron multiplicity
• Some tests to address the “efficiency issue”

We looked at the behavior of the neutrons detected at very late times:

• some neutrons are going outside and/or wandering a lot before they are detected