First investigations of possibilities for a through-going UCN tube at the ESS

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First investigations of possibilities for a through-going UCN tube at the ESS

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UCN @ ESS

The European Spallation Source (ESS), presently starting construction in Lund, Sweden, will be the most intense source of spallation neutrons ever built[1]. Protons from a 5MW, 2.5GeV linear accelerator will impact a rotating tungsten target in 14, 2.86ms long pulses every second. The spallation neutrons hereby created are thermalized in water and some of them are further cooled in liquid para-hydrogen before extracted through individual beam-lines serving 22 cold/thermal instruments.

In the present study, we investigate the possibilities of installing a through-going beam-tube for in-pile ultra cold neutron (UCN) extraction at the ESS. The study is guided by the requirement that the performance of the existing 22 cold/thermal beamlines cannot be seriously affected – i.e. the cold/thermal neutron flux at the instruments must be unaffected by the introduction of a tube. Please refer to [2] for a more detailed information.

Punching a hole in the ESS Target monolith

- 25cm x 25cm through-going beamtube placed perpendicular to the proton beam)
- The beam-tube height is varied between:
  - Upmost position $y = -33.5$cm (central in the tube)
  - Lowest position $y = -50.0$cm (central in the tube)
- Impact: Detectors placed at the monolith boundary (beam extraction), and measure time-averaged cold/thermal flux relative to baseline design

Impact on cold/thermal beamlines

- Cold spectrum: baseline vs beam-tube.
  - Differences are minor.
  - Inserts show the difference (upper) and ratio (lower) between the two spectra
- Average cold/thermal (0-100meV) flux reduction (relative to baseline) in the lower beam-lines as a function of vertical position of the through-going tube.
  - The upper beam-lines are unaffected.

Cold/thermal flux available for UCN moderator

- Flux profile centrally under the lower cold para-H moderator

Heat-load

- To estimate heat-load a dummy para-H moderator (16cm x 16cm x 16cm) is placed centrally in the through-going tube.

Conclusions & prospects

- Depending on tube position, flux of up to $2 \times 10^{13}$ n/s/cm$^2$ can be achieved (central in tube)
- Flux-impact on lower instruments $\leq 5\%$ (0-100meV)
- Spectra at beam-ports (i.e. non-UCN instruments) ~unaltered
- The heat-load range: 0.06 – 0.20 W/cm$^3$ (measured in paraH)

Future:

- Test various moderator concepts, including cooling considerations
- Look into UCN time structure. Exploitable..?