



## 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.



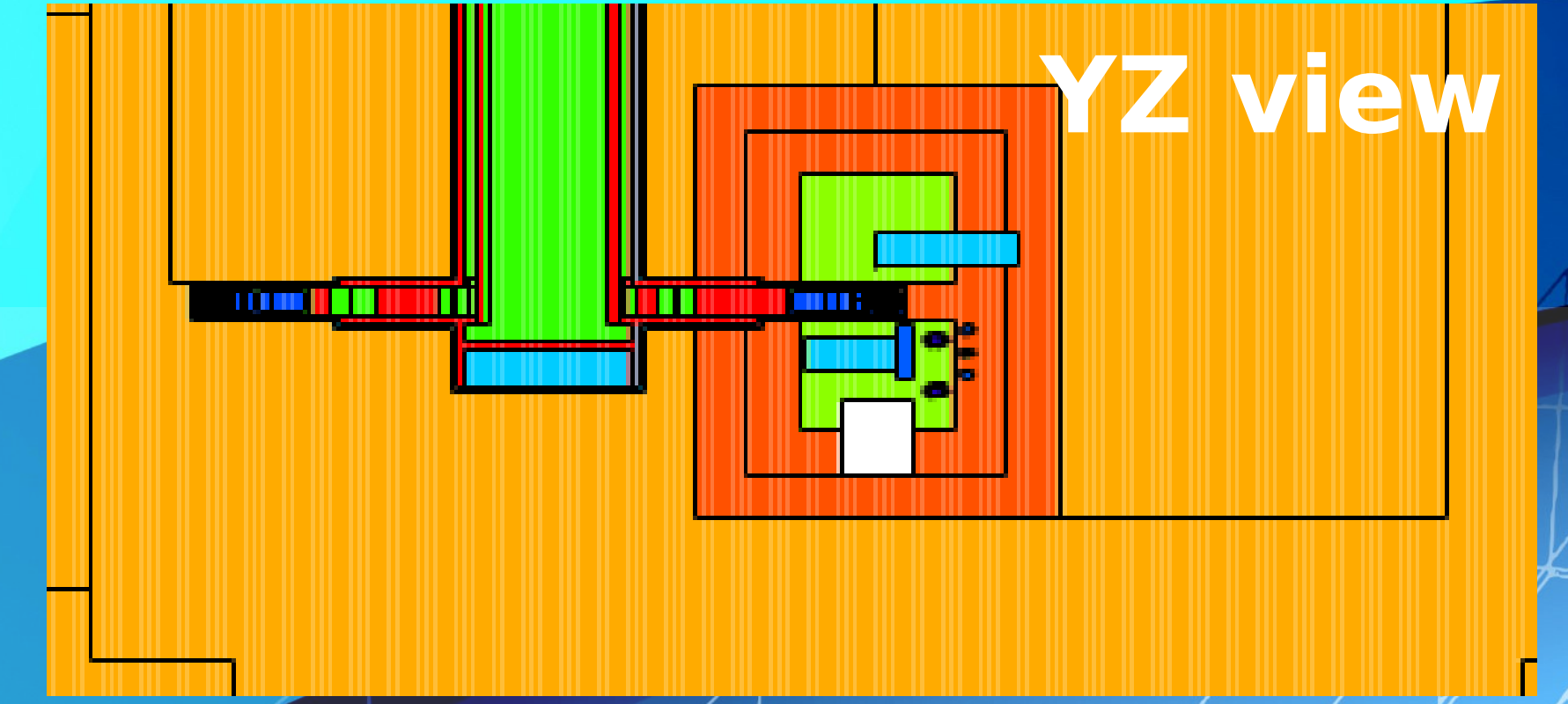
In the present study, we investigate the possibilities of installing a through-going beam-tube for in-pile ultra cold neutron (UCN) extraction at the ESS. The study is guided by the requirement that the performance of the existing 22 cold/thermal beamlines cannot be seriously affected - i.e. the cold/thermal 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

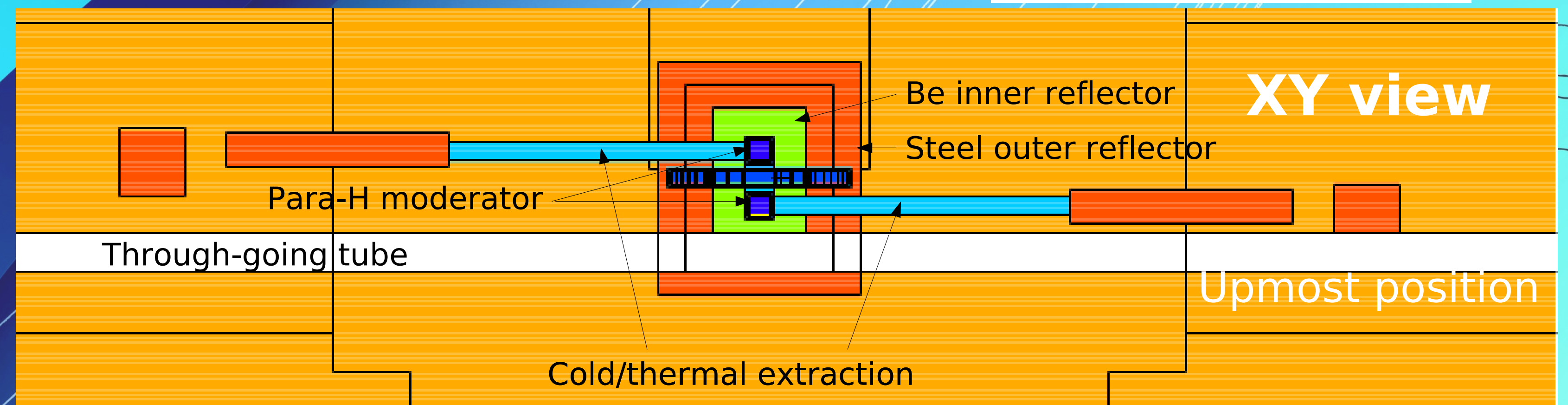
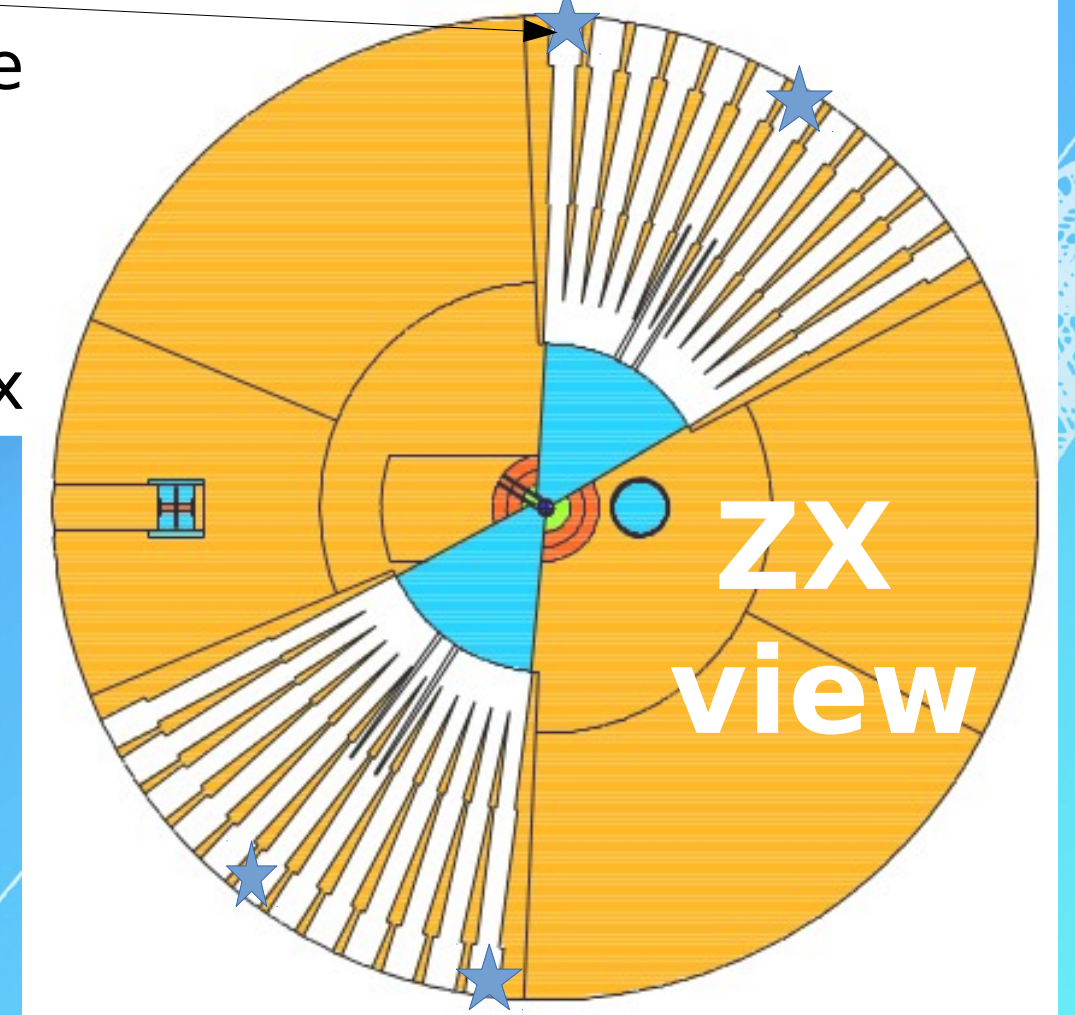
- > 25cm x 25cm through-going beamtube placed perpendicular to the proton beam)
- > The beam-tube height is varied between:

- Upmost position  $y=-33.5\text{cm}$  (central in the tube)
- Lowest position  $y=-50.0\text{cm}$  (central in the tube)

> **Impact:** Detectors placed at the monolith boundary (beam extraction), and measure time-averaged cold+thermal flux relative to baseline design

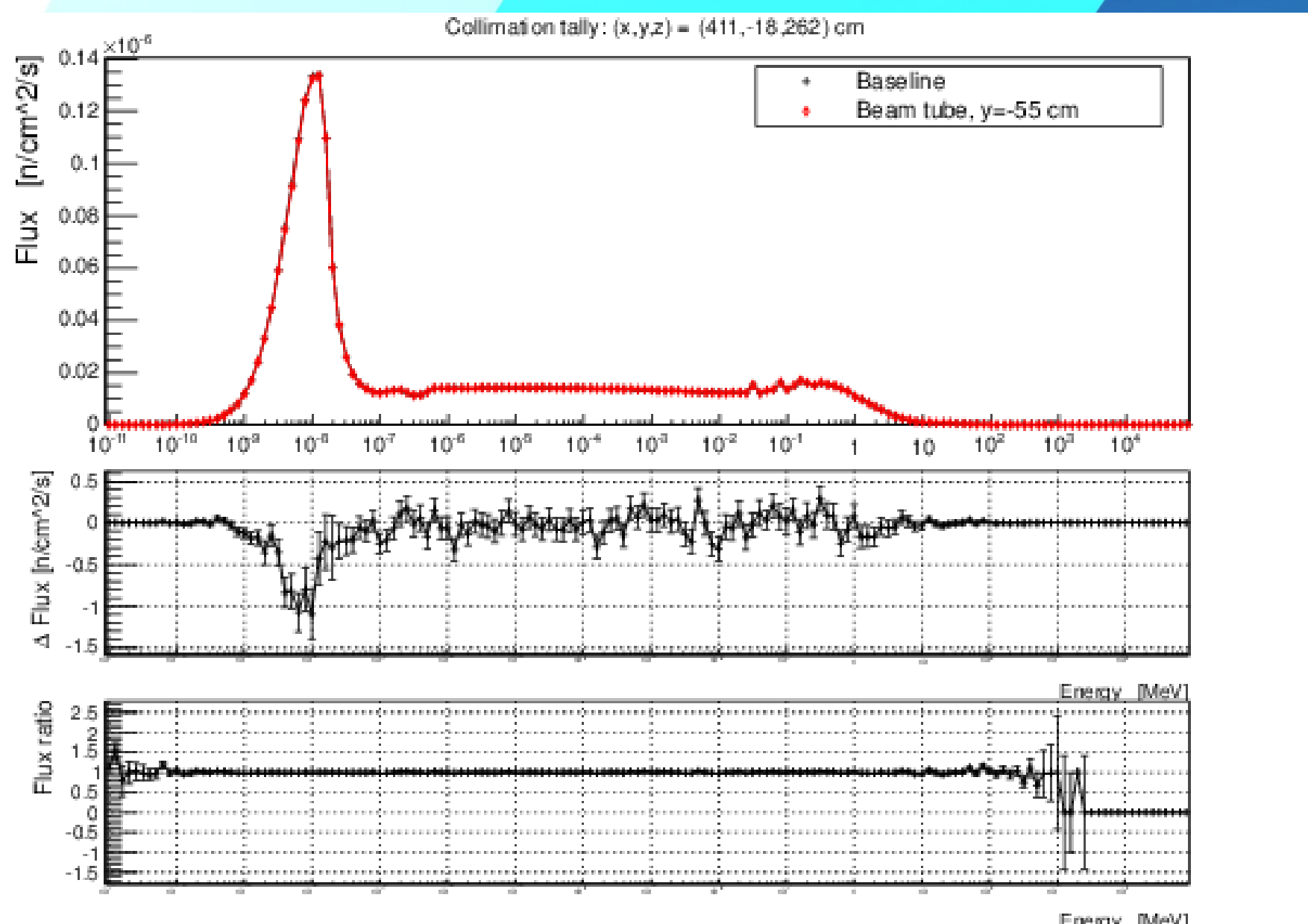


★ = approximate position of detectors measuring cold/thermal flux

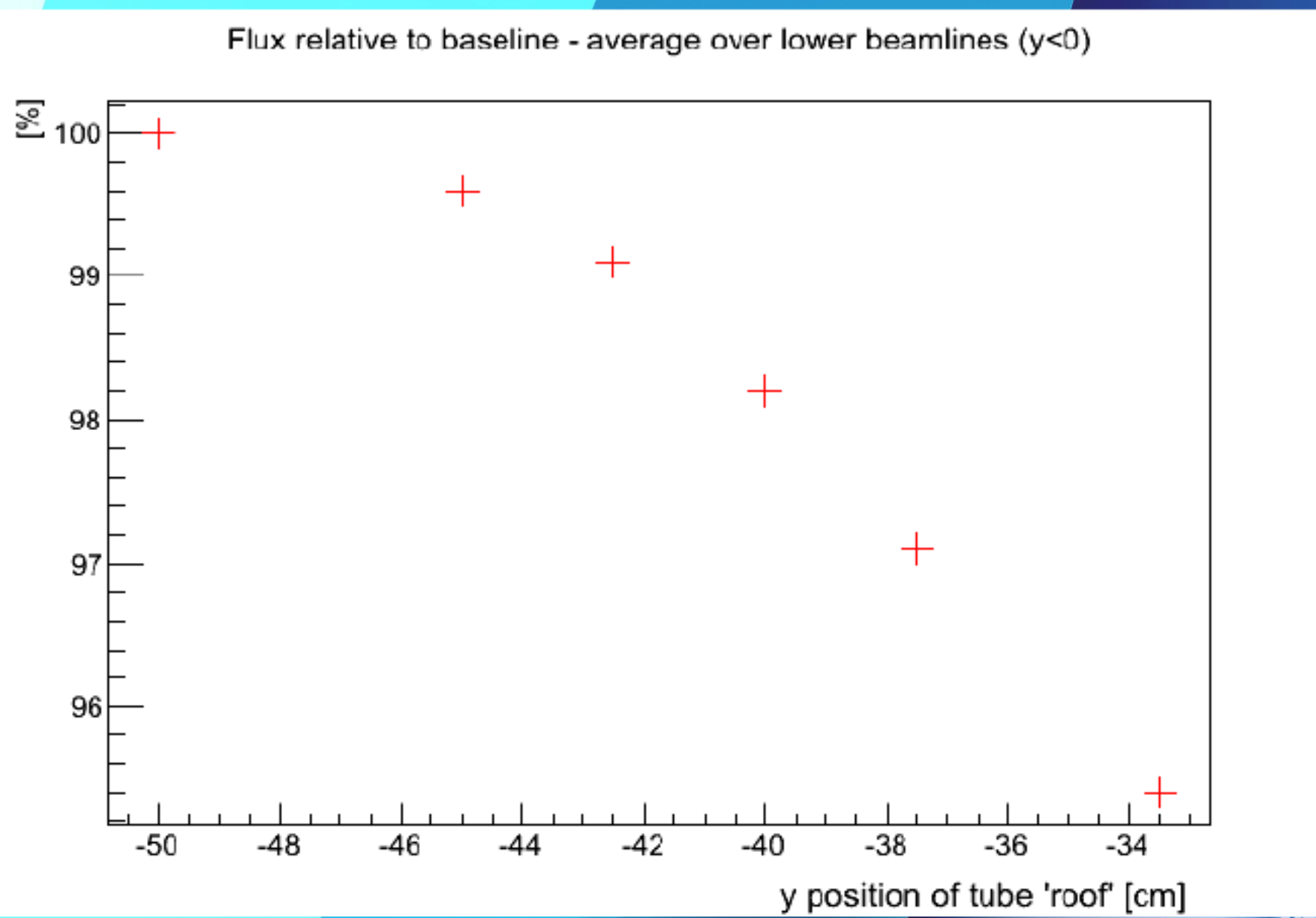


Through-going beam-tube introduced in the Baseline ESS target monolith geometry [1]

### Impact on cold/thermal beamlines

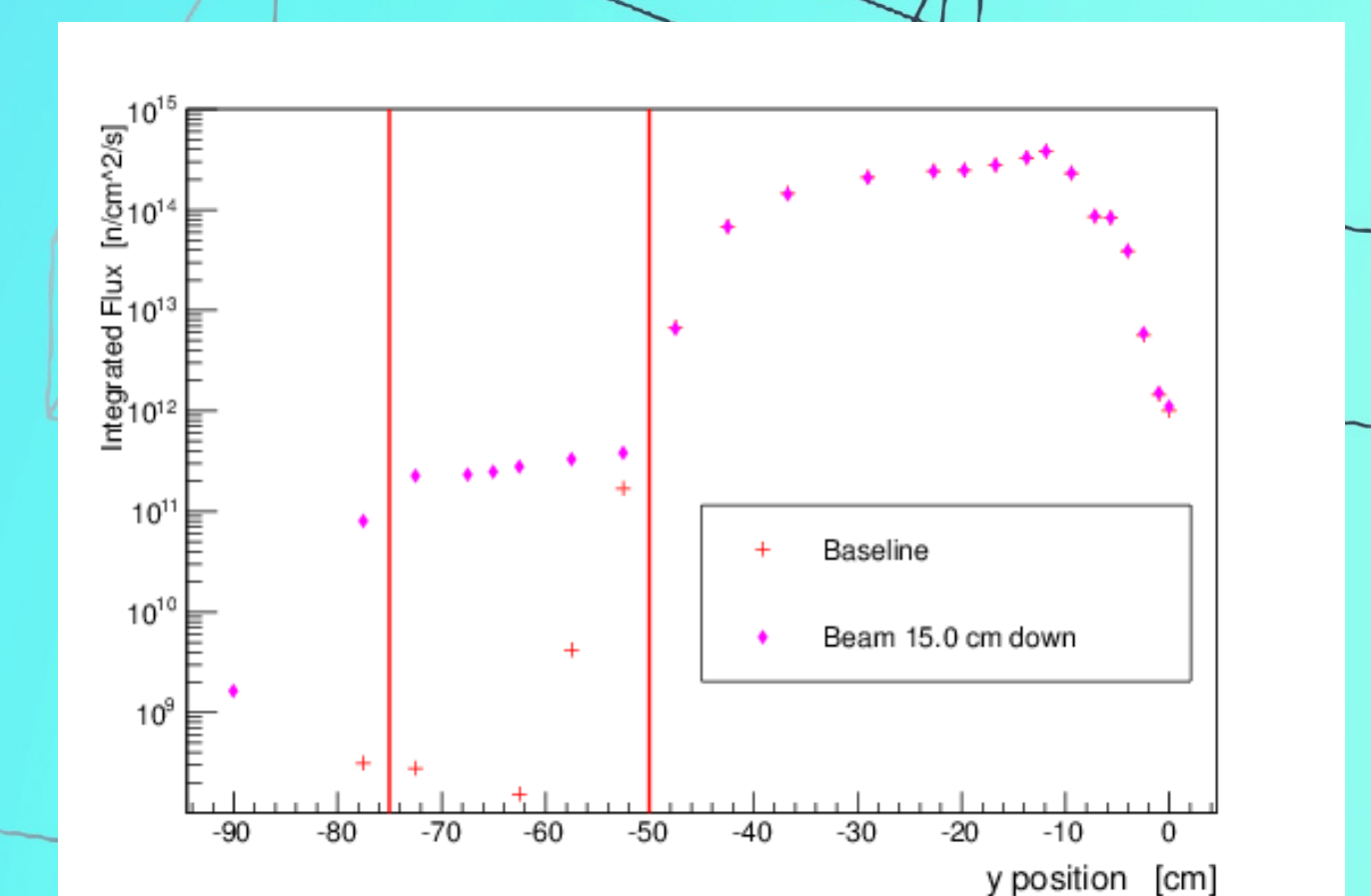
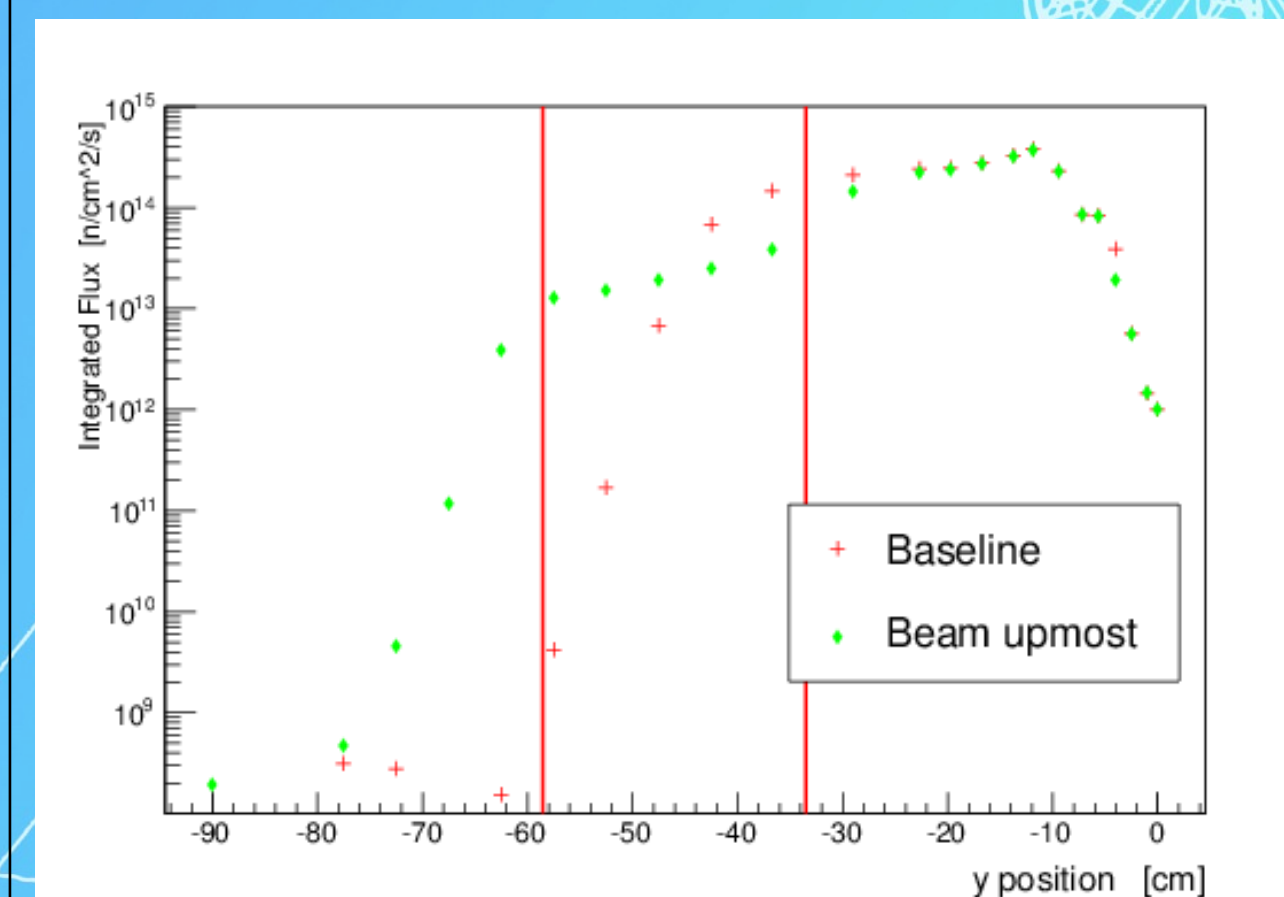


- > Cold spectrum: **baseline vs beam-tube.**
- Differences are minor.
  - Inserts show the difference (upper) and ratio (lower) between the two spectra

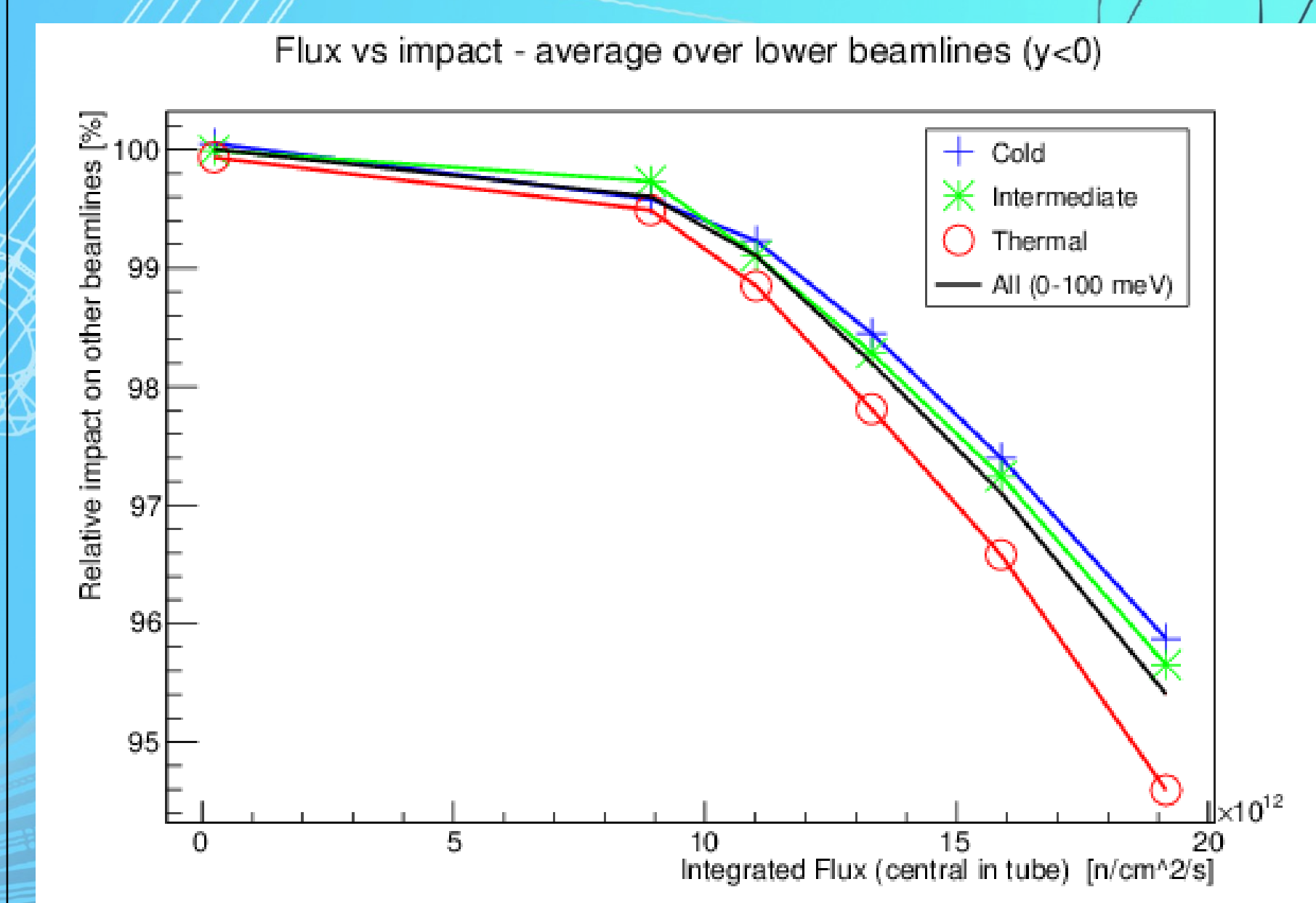


- > Average cold/thermal (0-100meV) flux reduction (relative to baseline) in the lower beam-lines as a function of vertical position of the through-going tube.
- > The upper beam-lines are unaffected.

### Cold/thermal flux available for UCN moderator

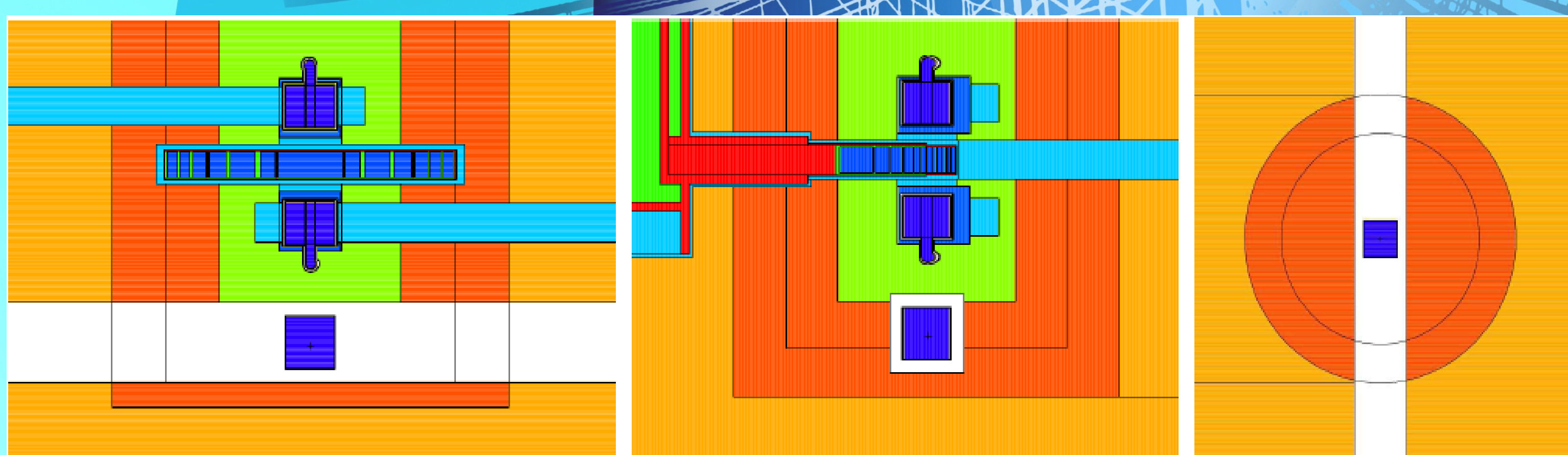


> Flux profile centrally under the lower cold para-H moderator



- > Cold (0-5meV), Intermediate (5-20meV) and thermal (20-100meV) flux reduction (relative to baseline) in the lower beam-lines as a function of integrated cold/thermal flux available for UCN moderation
- > The upper beam-lines are unaffected.

### Heat-load



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

y position [cm]	Flux [n/s/cm²]	Heat-load [W/cm³]
-47.5	$2.4 \times 10^{13}$	0.20
-55.0	$1.3 \times 10^{13}$	0.11
-62.5	$2.9 \times 10^{12}$	0.06

### Conclusions & prospects

- > Depending on tube position, flux of up to  $2 \times 10^{13}$  n/s/cm² 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/cm³ (measured in paraH)
- > Future:
  - > Test various moderator concepts, including cooling considerations
  - > Look into UCN time structure. Exploitable..?