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Moderator engineering realities

The impact of engineering design realities on ESS moderator performance revealed an about 25 % loss of neutronic performance (brightness → neutron flux on sample) and somewhat larger dependence of one moderator performance on the design / existence of the second moderator.

Top moderator: 3 cm butterfly, bottom moderator: 6 cm butterfly	Cold neutrons	Thermal neutrons
Case #1: two moderator baseline, reflector design for optimizing both moderator neutronic performance.		
top moderator (by definition)	1.00	1.00
bottom moderator	0.64	0.70
Case #2: Bottom reflector modified to reduce loss in top moderato performance: top moderator	1.07	1.05
bottom moderator	0.54	0.61
Case #3: Bottom moderator replaced by fast neutron reflector:		
top moderator	1.17	1.15
Average flux on sample [1] for the 5 instruments of 24 identified in [2] for the bottom moderator in case #1		
compared to top mod. in Case #1	1.11	1.12
compared to top mod. in Case #2	0.94	0.97
compared to top mod. in Case #3	0.95	0.97
Average flux on sample for 24 instruments identified in [2]:		
Case #1 (by definition)	**1.00**	**1.00**
Case #2	**1.02**	**1.01**
Case #3	**1.15**	**1.12**

Observations:

- The two now planned moderators perform very similarly, they offer little flexibility
- Replacing the bottom moderator by a small fast neutron reflector (Ni, Pb or W), the average performance of the facility increases by 14 %. This replacement means about 1 M€ saving in construction and >1.5 M€ savings per year in operation (less Be material costs and labor at moderator changes and ~2 MW lower power consumption)
- The installation of the little different bottom moderator now would block / make expensive (20 – 40 M€ in repositioning / replacement of bottom moderator instruments) the life cycle flexibility of ESS in advancing moderator performance when a new design / concept emerges that offers significantly improved special capabilities compared to the work horse top moderator (e.g. very cold neutrons, maximum brightness moderator for small phase space instruments, more directional moderator…)

[1] Ken Andersen, report at SAC12, Oct. 2014
[2] Ken Andersen, Moderator report V4, 27/1/2015