JÜLICH
FORSCHUNGSZENTRUM

Status of Activities at FZJ-JCNS

31.10.2017 | Tsitohaina Randriamalala | FZJ GmbH, Jülich Center for Neutron Science

Timeline Overview

Preparation for the simulations

- Generic beamline (DREAM,TREX,SKADI) implementation in CL
- PHITS benchmarking

5.2017

Shielding workshop at FZJ

Preparation for the simulations

- Setup of new clusters: 4 nodes, 24 cores each
- Neutron source term: TREX and SKADI (DREAM from V. Santoro)

Timeline Overview (2)

- Preparation access on JSC
- Application for computing time on JSC
  - submitted on 15.08.2017
  - approved on 23.08.2017: 1.3 mio core-h (~ 68 % of requested)
- Preliminary studies for the heavy shutter

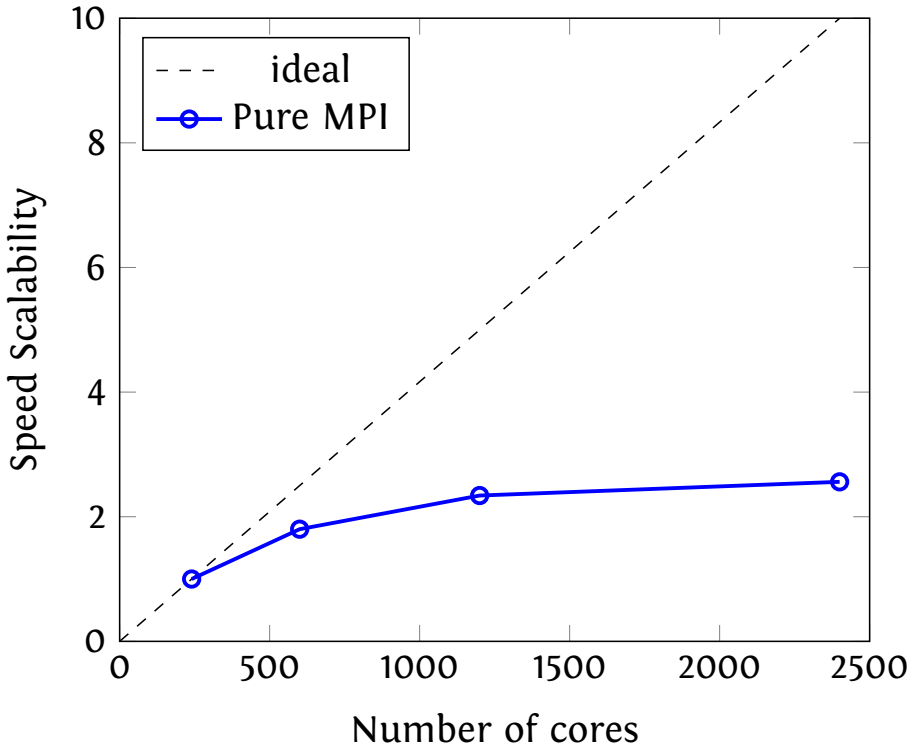
11.2017 Start on JSC

- Heavy shutter (until 12.2017)
- Beamline shielding

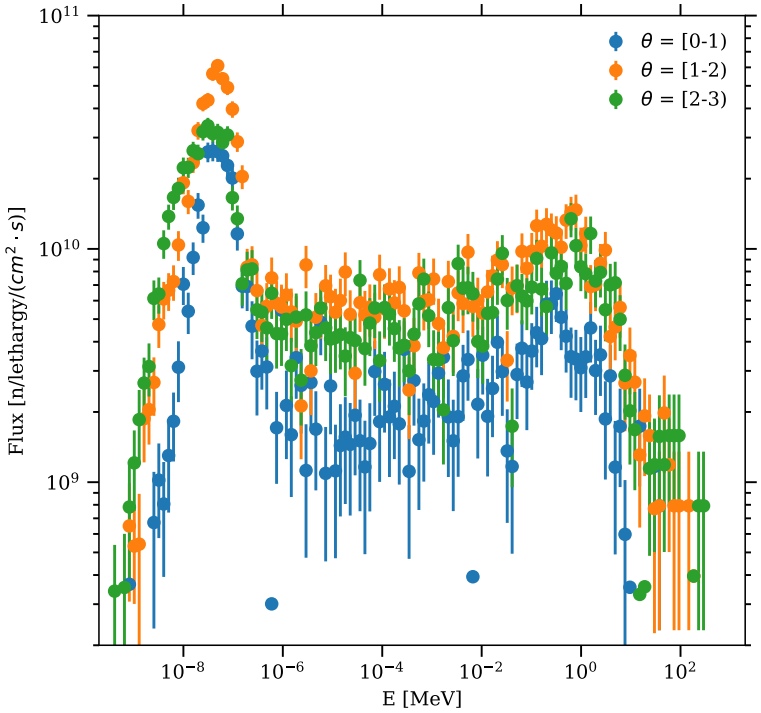
10.2018 End on JSC

Timeline Overview (2)

PHITS scalabilty on Supercomputer (JSC)



Source Term



Source term for W7 (TREX) after 17280 core-h computing time

Surface tally specificities:

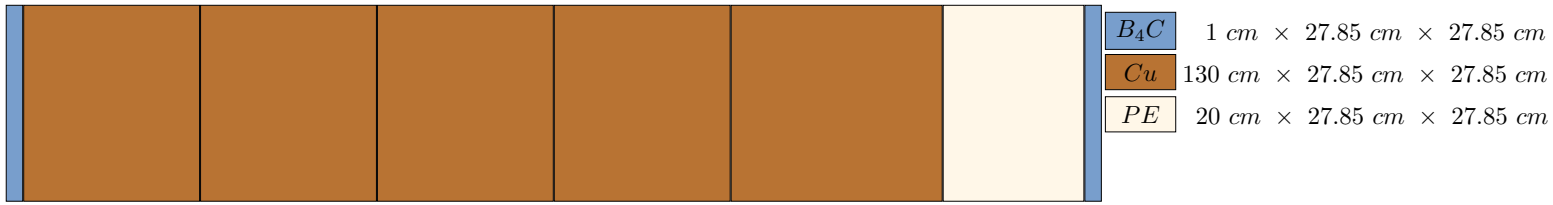
- surf. area: 9 cm $\times$ 3 cm
- position: $\sim$ 201 cm from IP
- 11 angular bins

- Good spectrum demands more computational resource
- alternative to source term: dump source in PHITS

Heavy Shutter Optimization

Heavy Shutter Layout

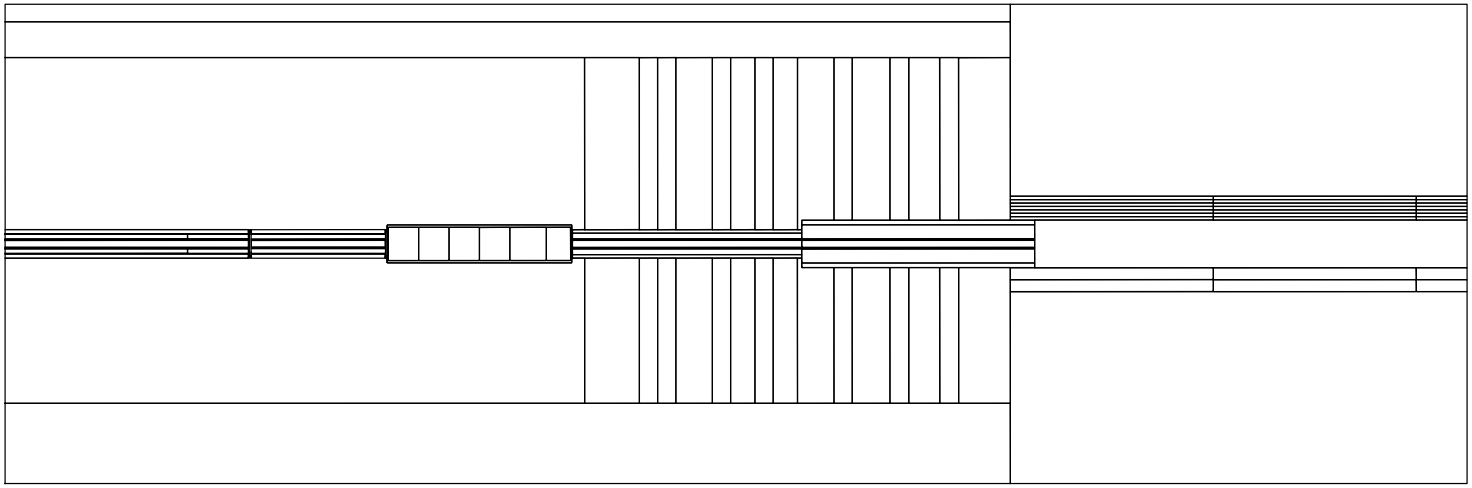
- V. Santoro layout for the Test Beam (c.f. IKON13) adapted for DREAM (config.1)



- Optimization:
  - Reduction of the total thickness
  - Reduction of the residual activity: activation of *Cu* (first layer) might be a problem

Heavy Shutter Optimization (2)

Fast Simulation Setup



- Put the heavy shutter (HS)

Heavy Shutter Optimization (2)

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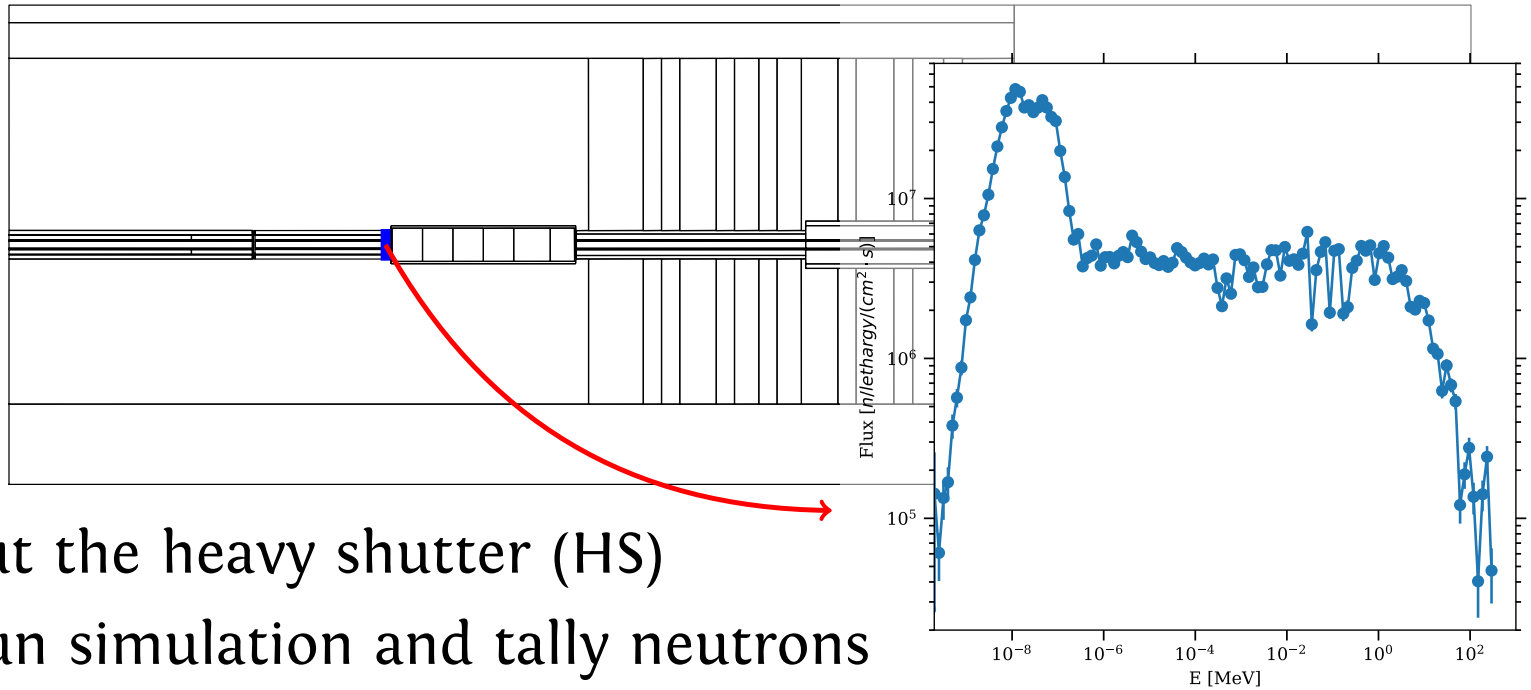
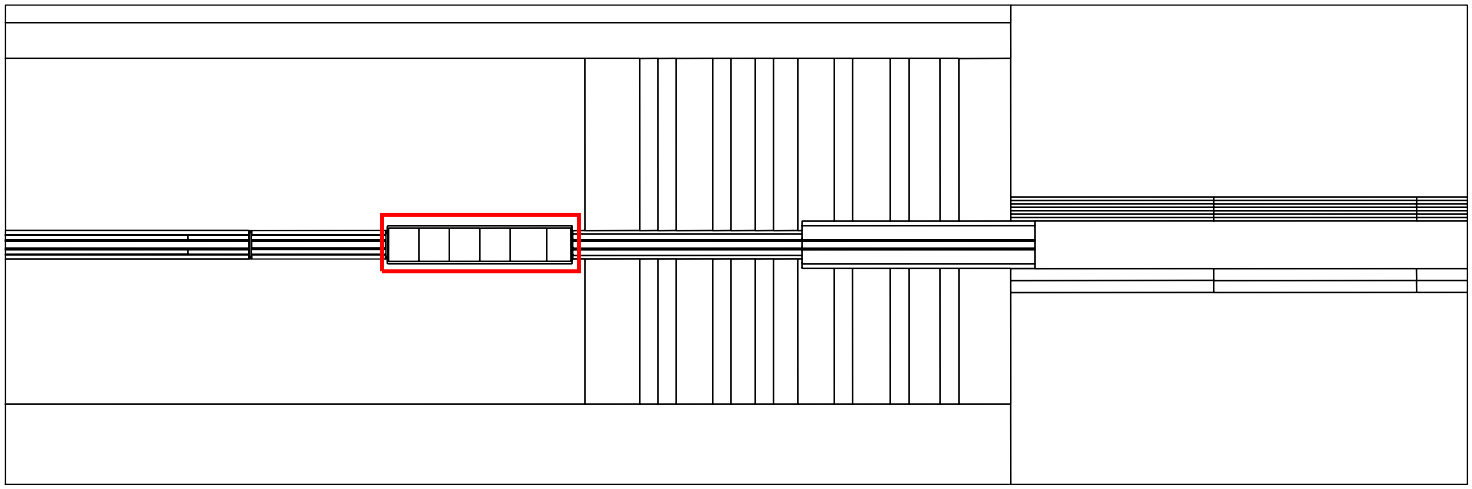


- Put the heavy shutter (HS)
- Run simulation and tally neutrons at the upstream beam side of the HS

Heavy Shutter Optimization (2)

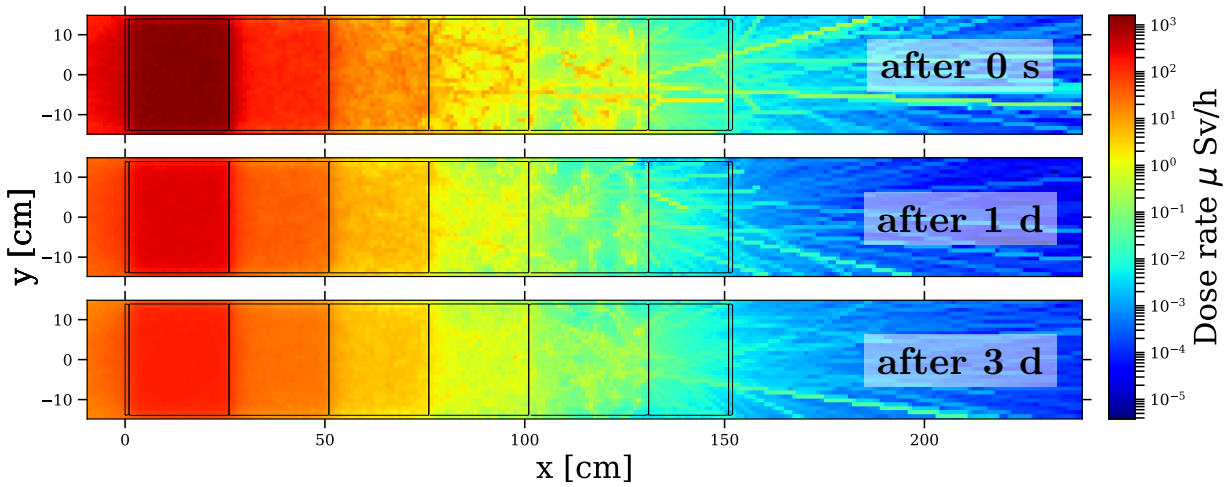
Fast Simulation Setup



- Put the heavy shutter (HS)
- Run simulation and tally neutrons at the upstream beam side of the HS
- Use tallied neutrons as source for separate HS simulations

Heavy Shutter Optimization (3)

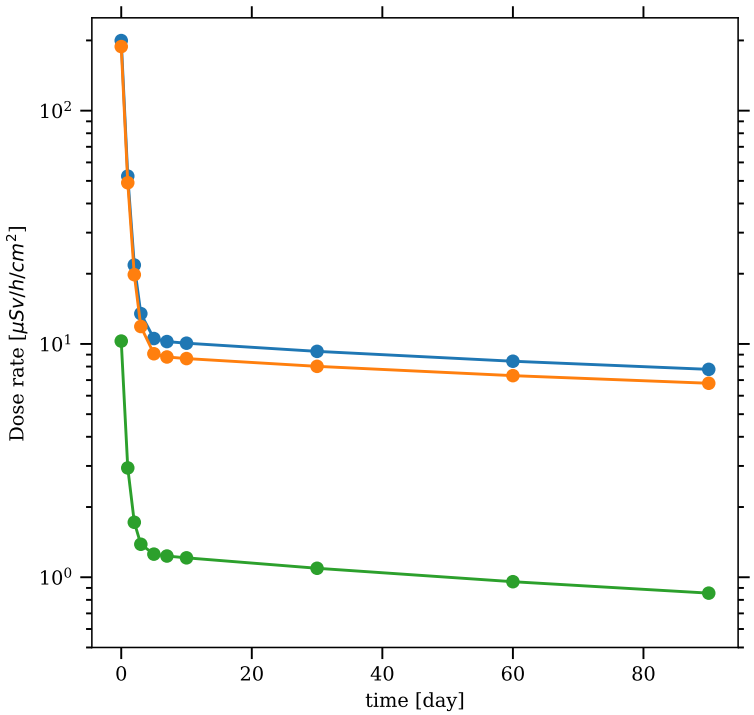
Decay of the Dose Rate



Dose rate map of the config. 1 HS volume after 10 years of neutron irradiation

Heavy Shutter Optimization (3)

Decay of the Dose Rate



Dose rate variation after 10 years irradiation (blue: total, orange: first layer, green: second layer)

- Total dose rate dominated by the first *Cu* layer
- Dose rate decreases slowly after 5 days

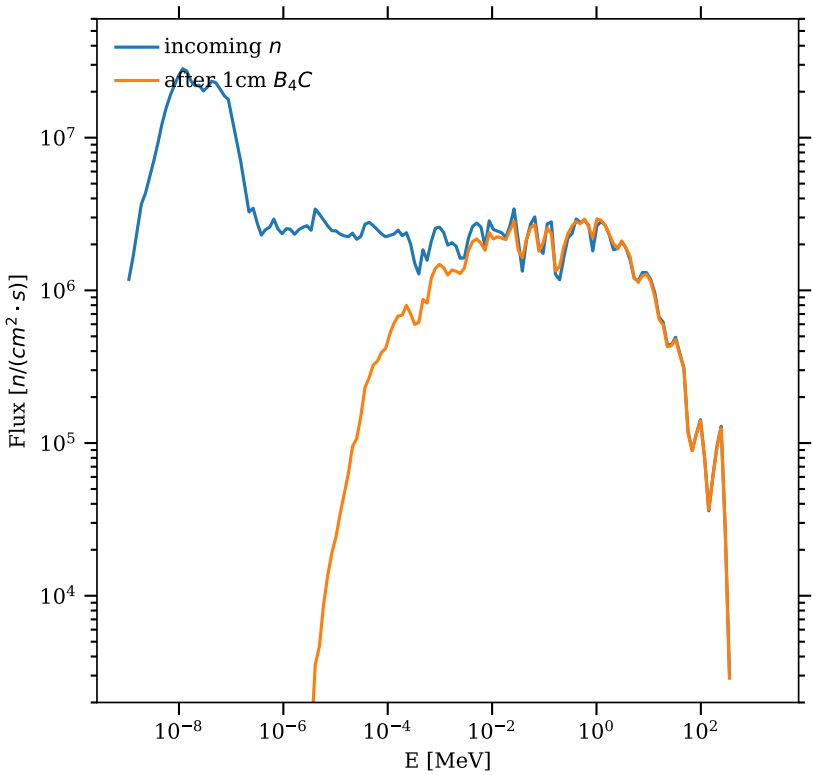
Heavy Shutter Optimization (4)

Activation Analysis

Cool. day	Co-60 Dose rate [$\mu Sv/h/cm^2$]	Co-60 [%]	Co-58 Dose rate [$\mu Sv/h/cm^2$]	Co-58 [%]
0	5.1075E+00	2.71	2.7145E+00	1.44
1	5.1056E+00	10.40	2.6941E+00	5.49
2	5.1038E+00	25.76	26688E+00	13.47
3	5.1020E+00	42.95	2.6430E+00	22.25
5	5.0983E+00	56.16	2.5918E+00	28.55
7	5.0946E+00	57.94	2.5416E+00	28.91
10	5.0891E+00	58.79	2.4680E+00	28.51
30	5.0526E+00	63.02	2.0293E+00	25.31
60	4.9983E+00	68.34	1.5129E+00	20.69
90	4.9946E+00	72.89	1.1280E+00	16.63

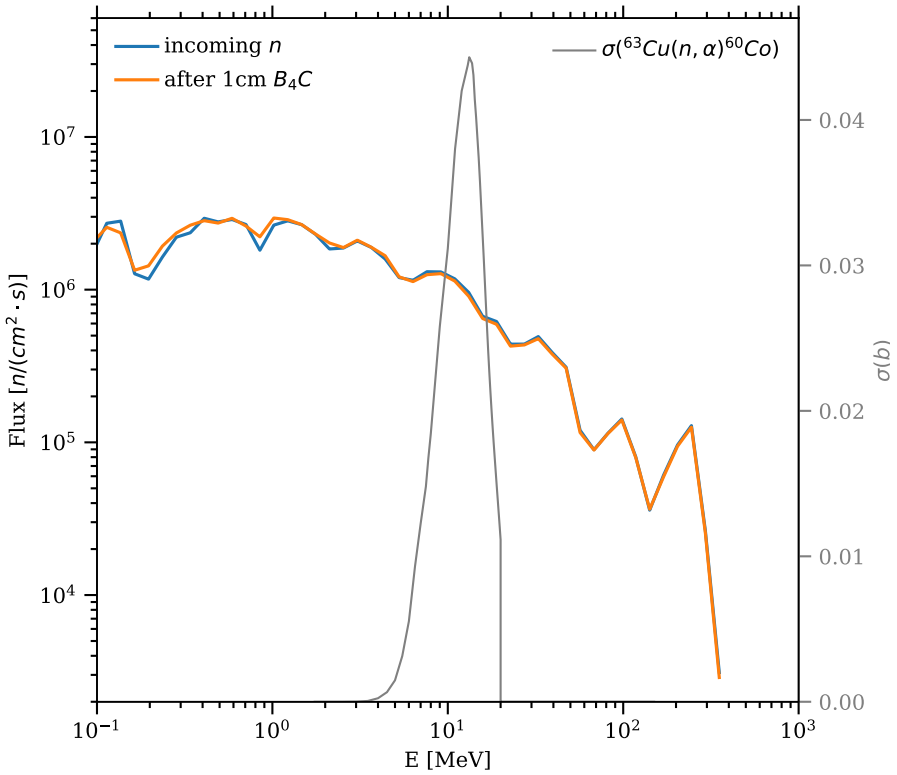
Heavy Shutter Optimization (4)

Reduction of Co-60 Production



Heavy Shutter Optimization (4)

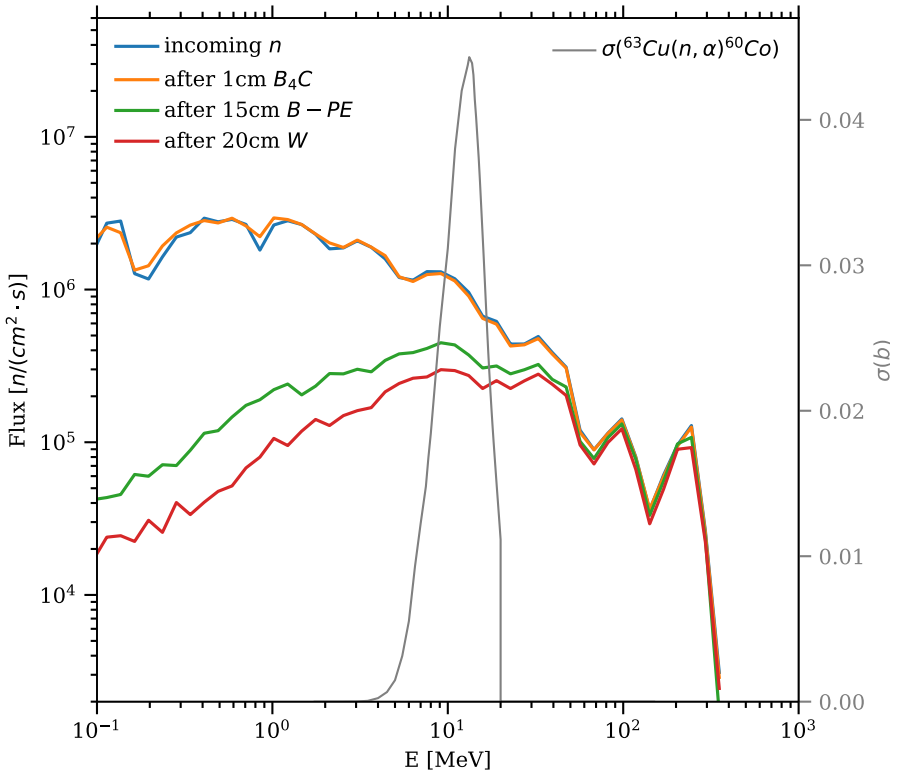
Reduction of Co-60 Production



- B_4C layer is transparent for neutron with $E > 1.74MeV$

Heavy Shutter Optimization (4)

Reduction of Co-60 Production

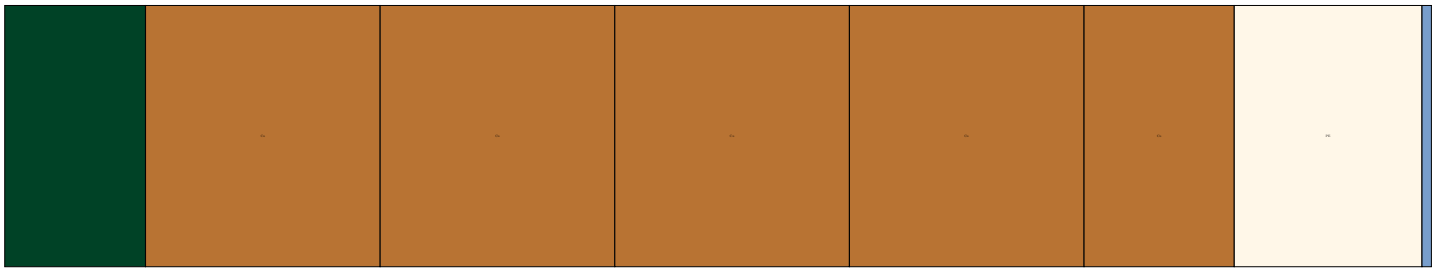


- B_4C layer is transparent for neutron with $E > 1.74MeV$
- Use thicker *BPE* or *W* to reduce the Co-60 production

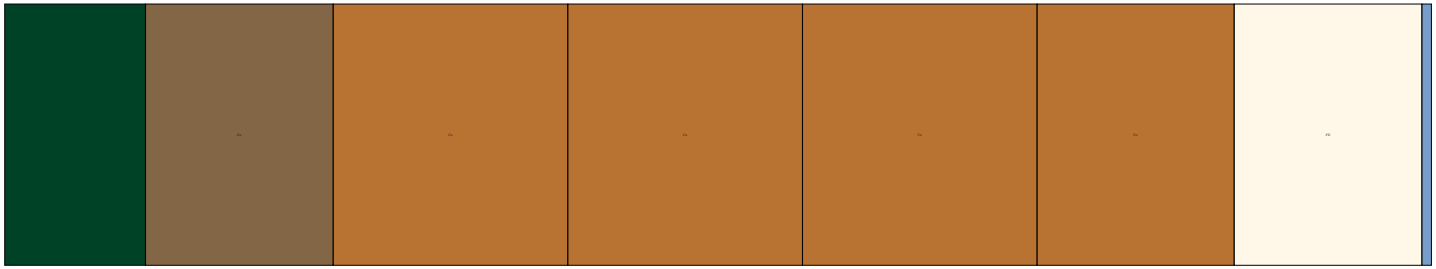
Alternative Layouts

Alternative configuration for HS with a same total thickness as config.1 :

- layer 1: 15 cm 5B-PE (config. 2)

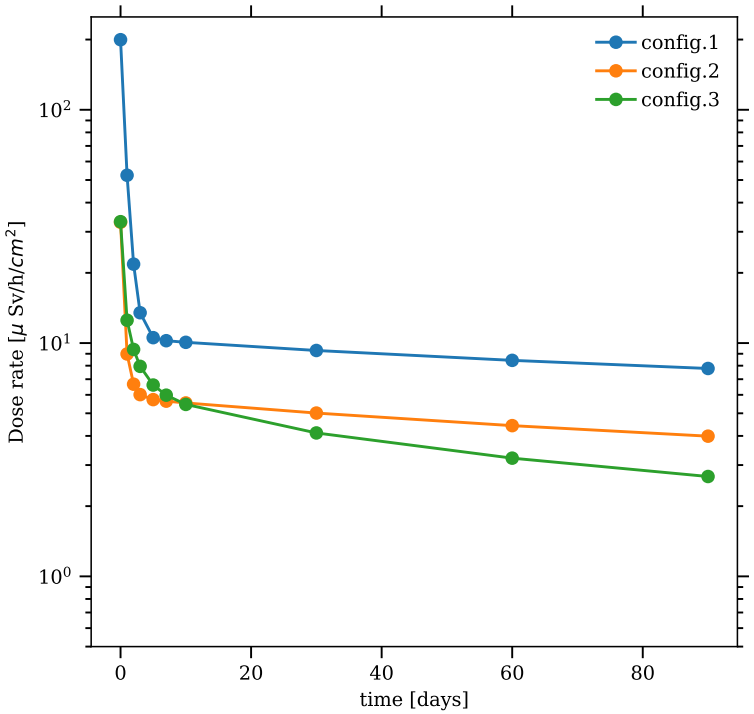


- layer 1: 15 cm 5B-PE, layer 2: 20 cm W (config. 3)



Alternative Layouts (2)

Decay of the Dose Rate Comparison



- config.2 dose rate still dominated by the Co-60 activities, but a factor 2 less than config.1
- config.3 dose rate dominated by Ta-182:
  - $^{182}W(n,p)^{182}Ta$ ($E_{th} \simeq 10.5\ MeV$)
  - $\tau_{^{182}Ta} = 114.43$ days

Possible final layout of HS : (B_4C, W, BPE)-Cu-PE-B_4C