

Optimized thermal moderators for HBS-type neutron sources

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Duties of thermal moderator

- Neutron energy MeV $\rightarrow$ 100 meV
- Confinement of high-density neutron cloud
- Feed cold source with thermal neutrons
- „Recycling“ of unused neutrons
- Pulse shaping (in time)

Interactions

Scattering:

- Energy transfer
 - $\rightarrow$ Depletion of higher energy levels
 - $\rightarrow$ Reduction of velocity
- Randomize flight direction
 - $\rightarrow$ Confinement
 - $\rightarrow$ Diffusive motion after first scattering

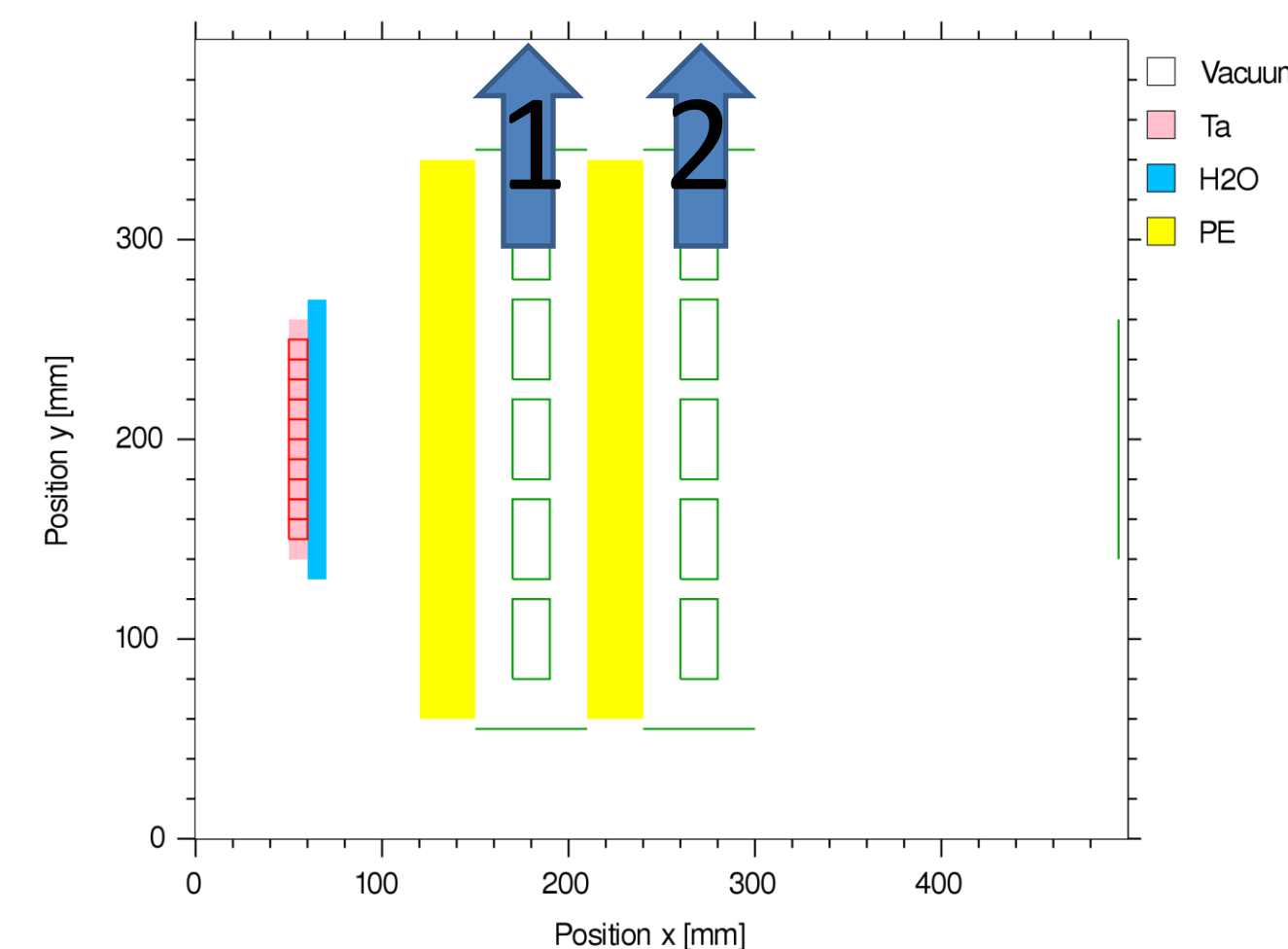
Absorption:

- Decrease of intensity with time

Undisturbed Motion:

- Dilute neutron cloud
- Remove neutrons from the system

Model structures



Neutron source:

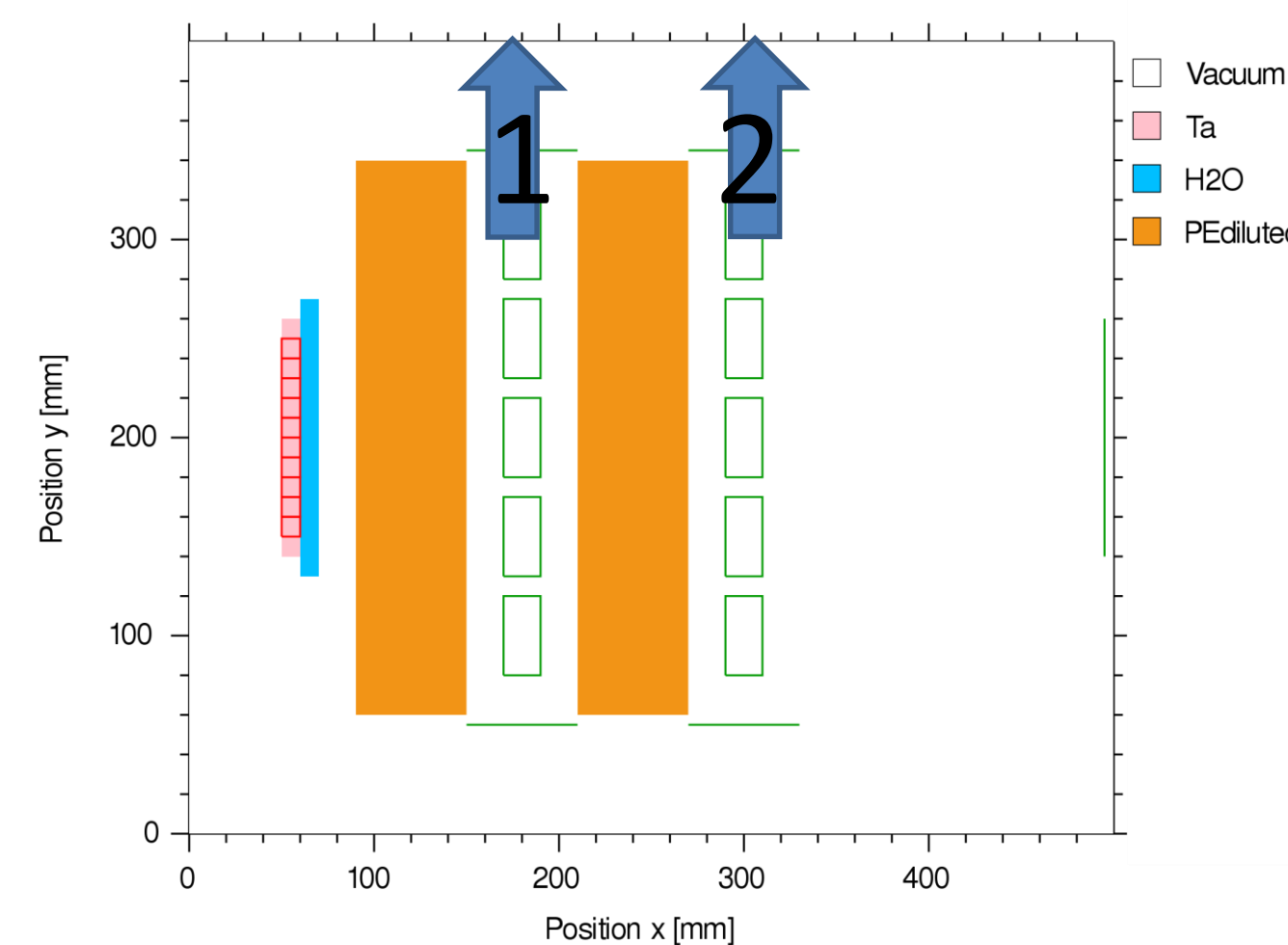
Ta target, 70 MeV protons
1 cm H₂O beamstop at the target

Thermal moderator:

2 PE plates, each 3 cm thick

Extraction beamlines:

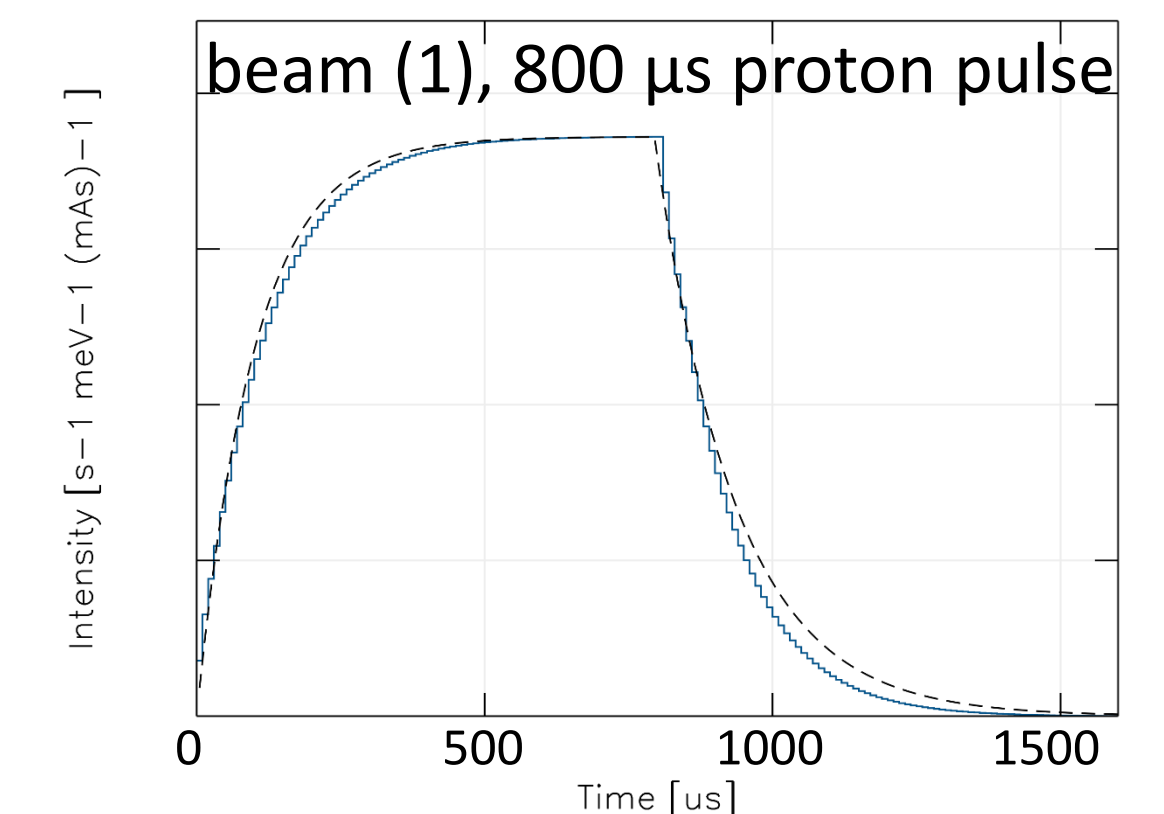
- (1) between the plates
- (2) after the second plate



Thermal moderator:

2 plates of diluted PE (50% density),
each 6 cm thick

$\rightarrow$ same amount of scattering, moderation
almost same amount of confinement,
half of absorption



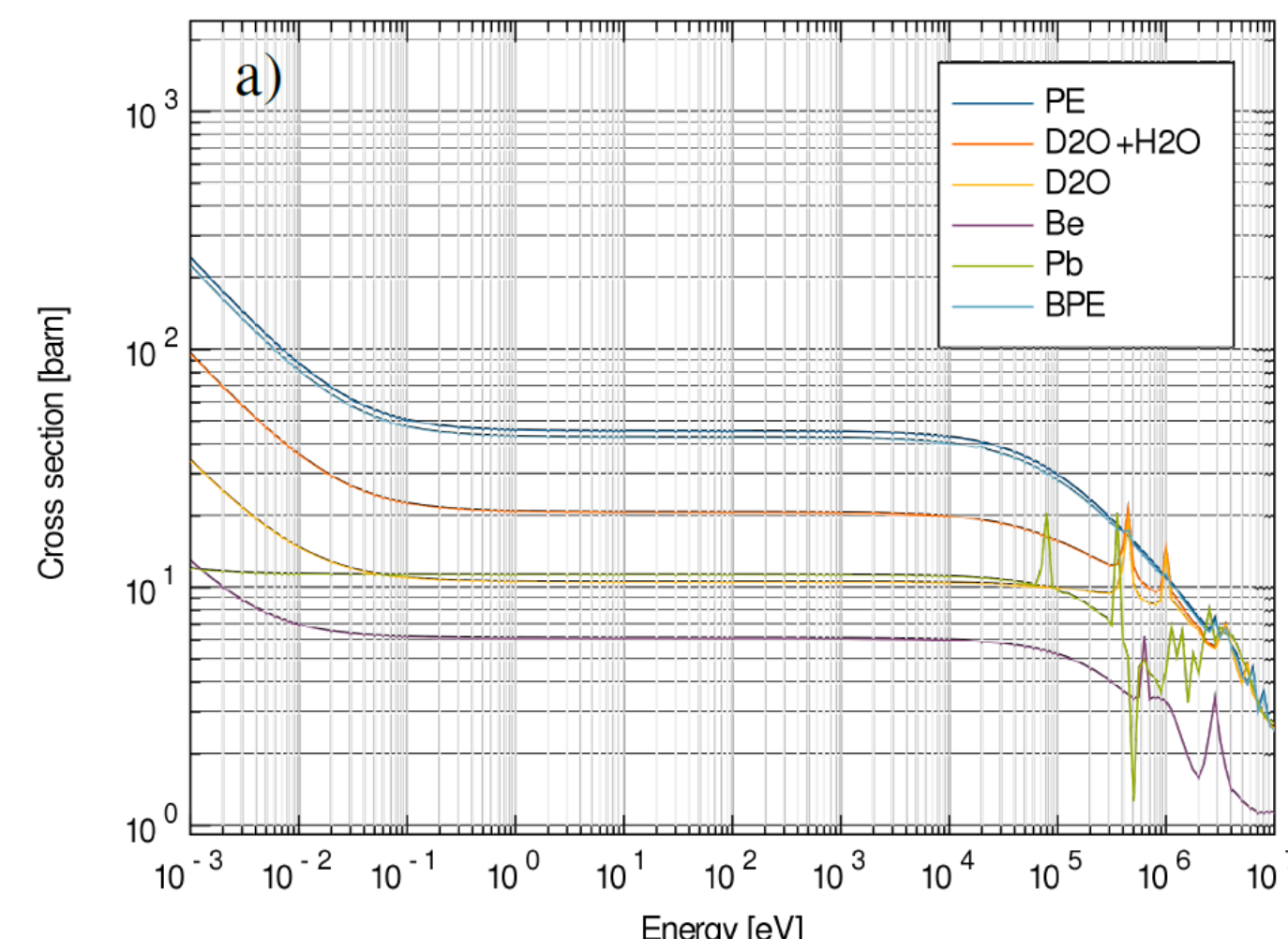
Pulse length [μ s]	Intensity (1)	Intensity (2)
50	5.10	1.17
100	8.44	1.81
800	14.88	2.88

Decay time	140 μ s	100 μ s
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Pulse length [μ s]	Intensity (1)	Intensity (2)
50	1.38	0.41
100	2.11	0.60
800	4.18	0.66

Decay time	154 μ s	118 μ s
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Materials



H-rich, H₂O, PE:

- Strong scattering (not at MeV energies!)
- Perfect moderator
- High Absorption

D₂O, Be:

- Weak scattering
- Reasonable moderator
- Low Absorption

Pb:

- Strong scattering for MeV neutrons
- No moderation
- Low Absorption

Results

- Confinement allows to increase intensity
- Reduced absorption increases pulse length
- Choice of suitable reflector materials can increase intensity and/or pulse length