



FLAT MODERATORS AND BEYOND CURRENT STATUS OF NEUTRONIC WORK

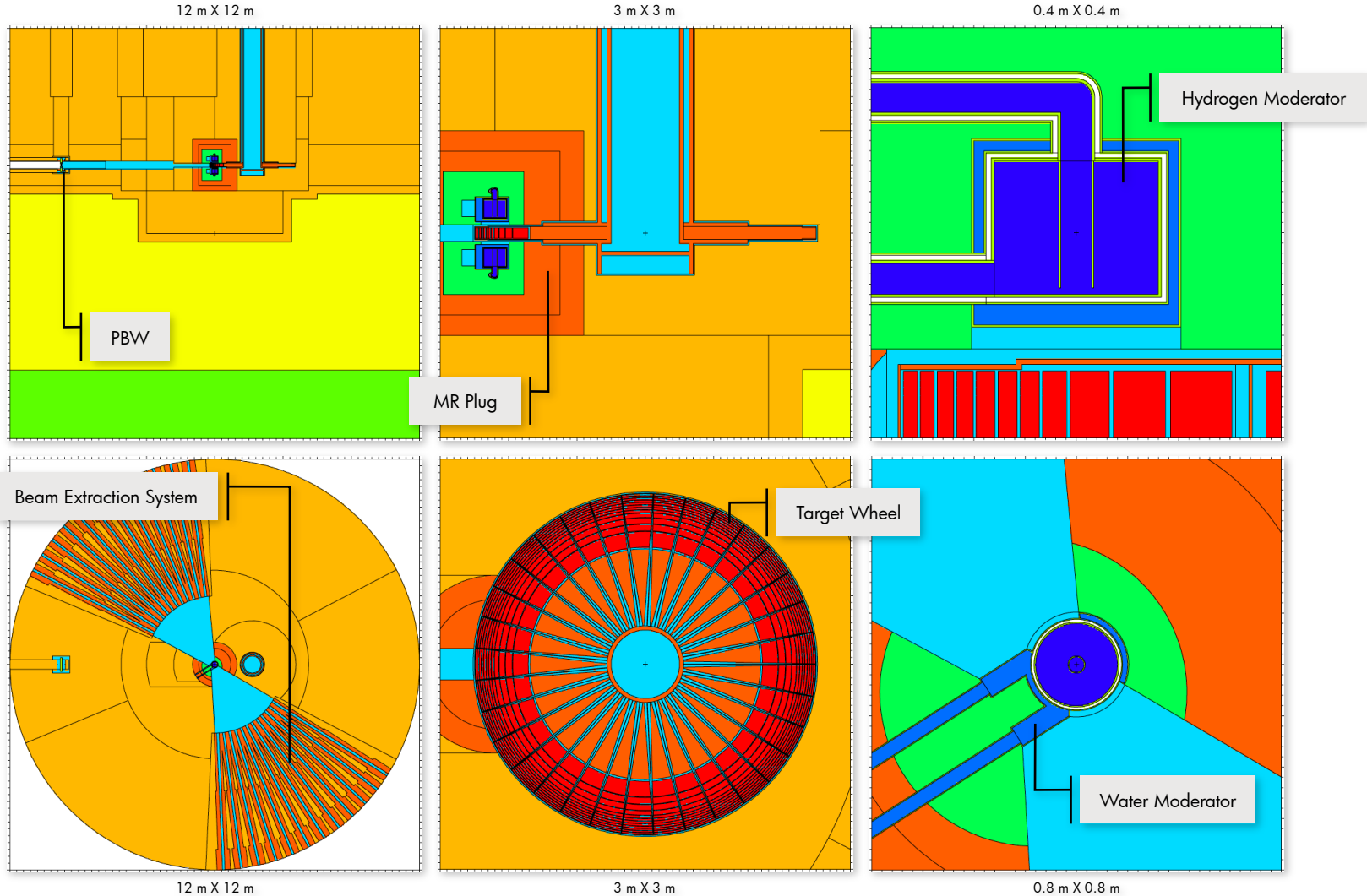
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European Spallation Source ESS AB
2014-02-12



PART 01
TDR BASELINE

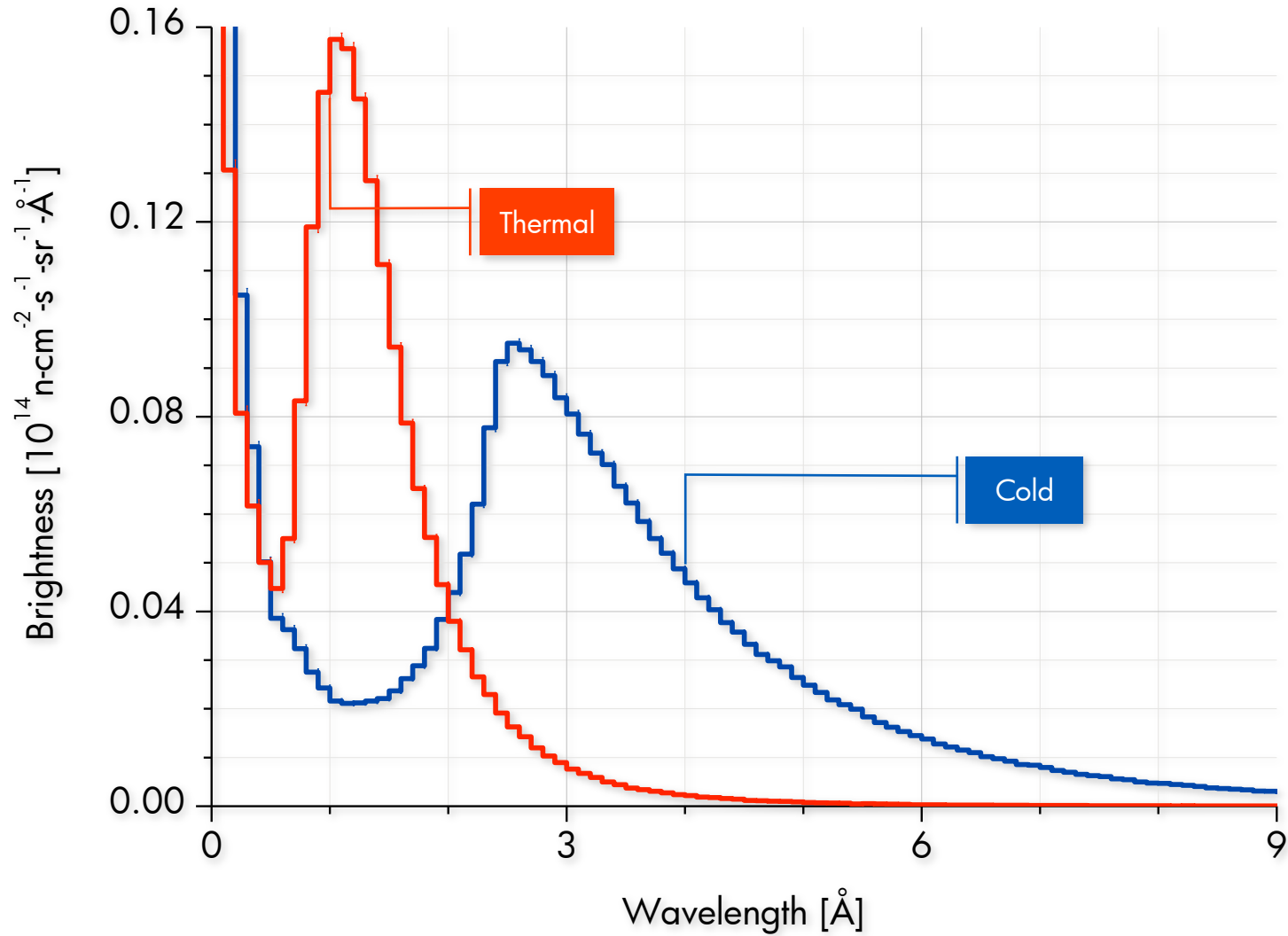
TARGET STATION MONOLITH

MCNP/PHITS neutronic model 2013-03-18



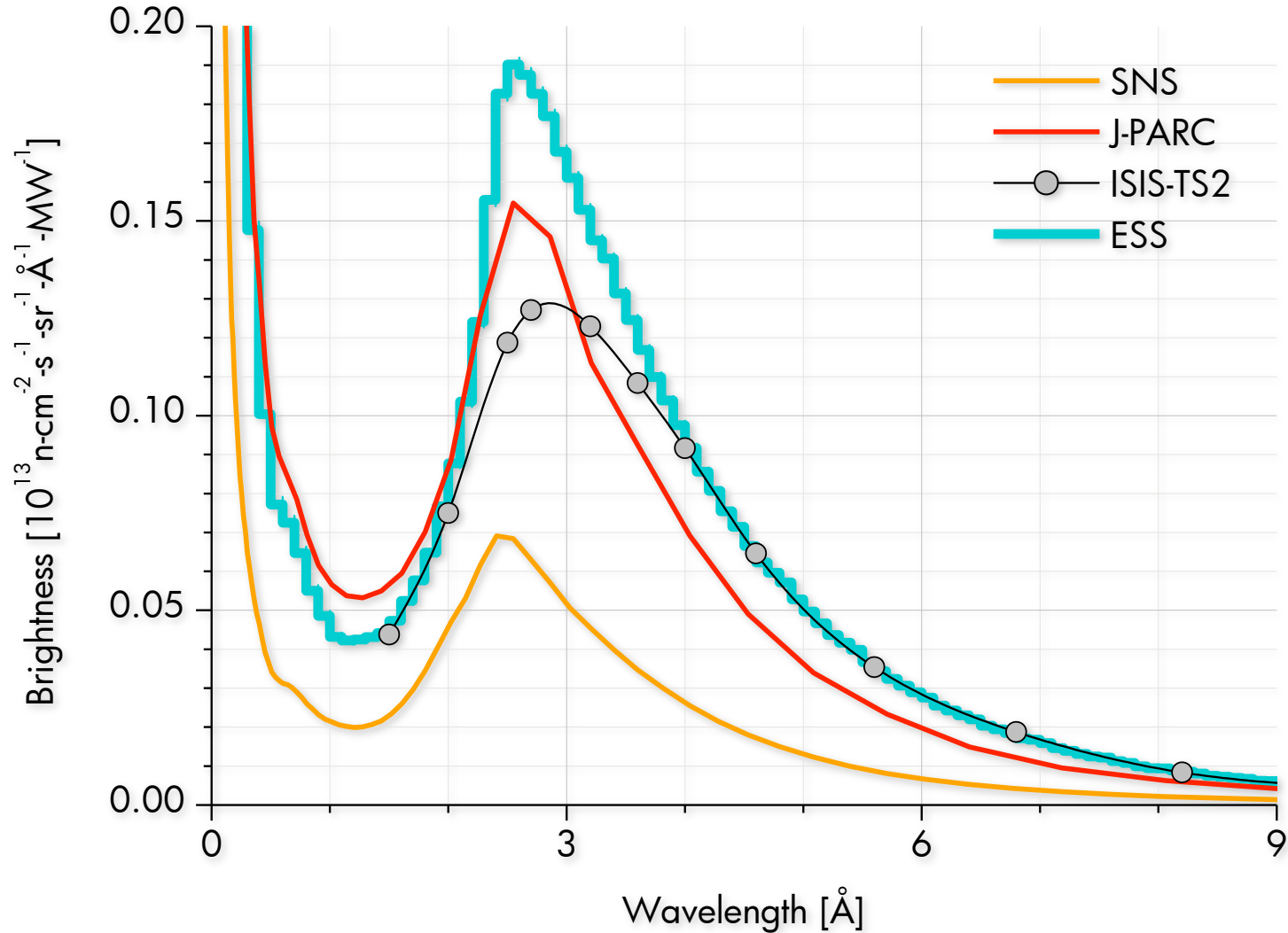
SPECTRAL BRIGHTNESS

Time-average brightness vs wavelength



COLD COUPLED H₂ MODERATORS

Time-average brightness per unit power vs wavelength



TDR BASELINE REFERENCE

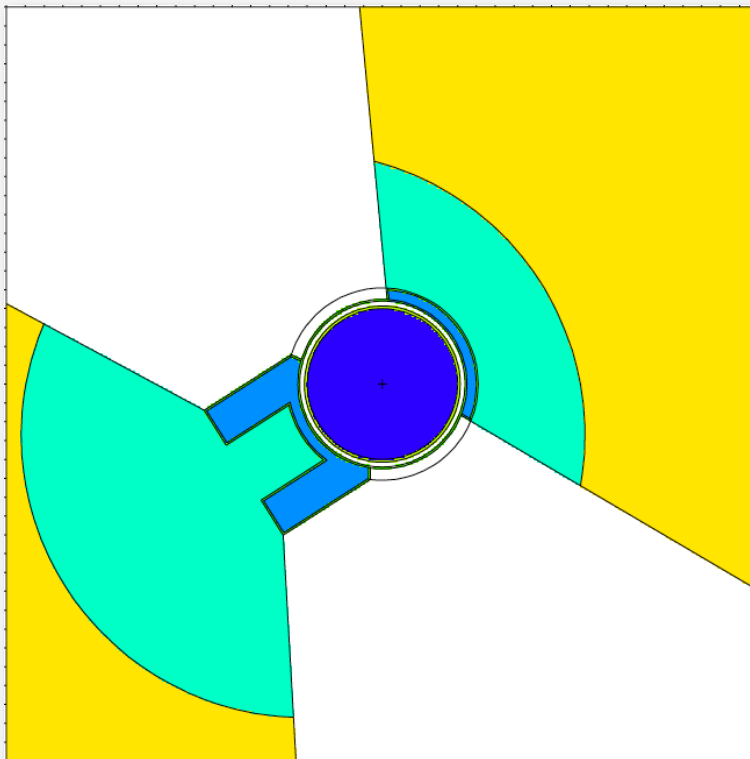
$$1 \text{ PDU} = 1.75 \times 10^{12} \text{ n-cm}^{-2}\text{-s}^{-1}\text{-sr}^{-1}\text{-MW}^{-1}$$

Cold brightness 0-5 meV from para-H₂ cylinder:

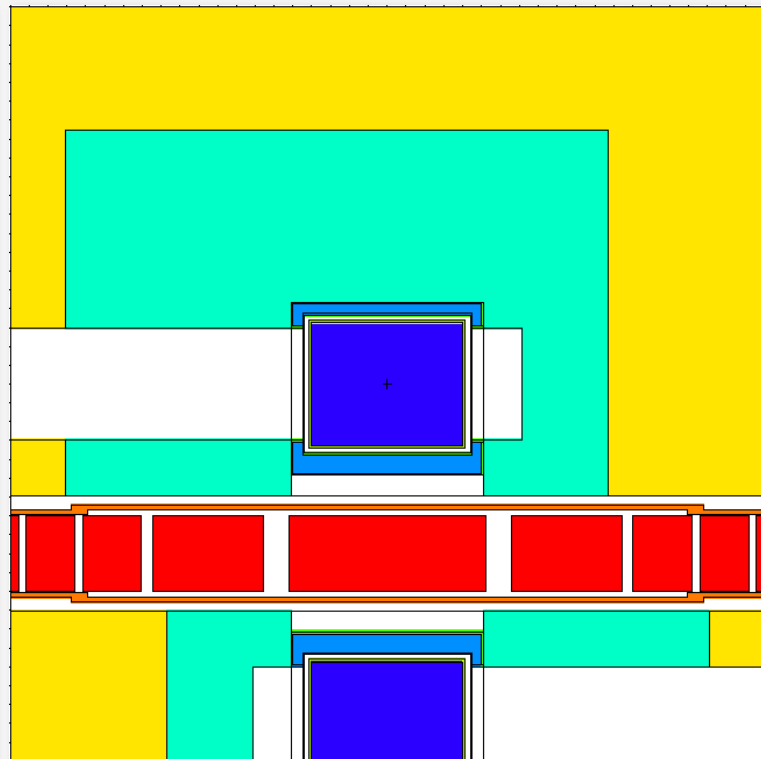
1.0 PDU

Thermal brightness 20-100 meV from water wings:

1.5 PDU



View from above
Proton beam comes from the left



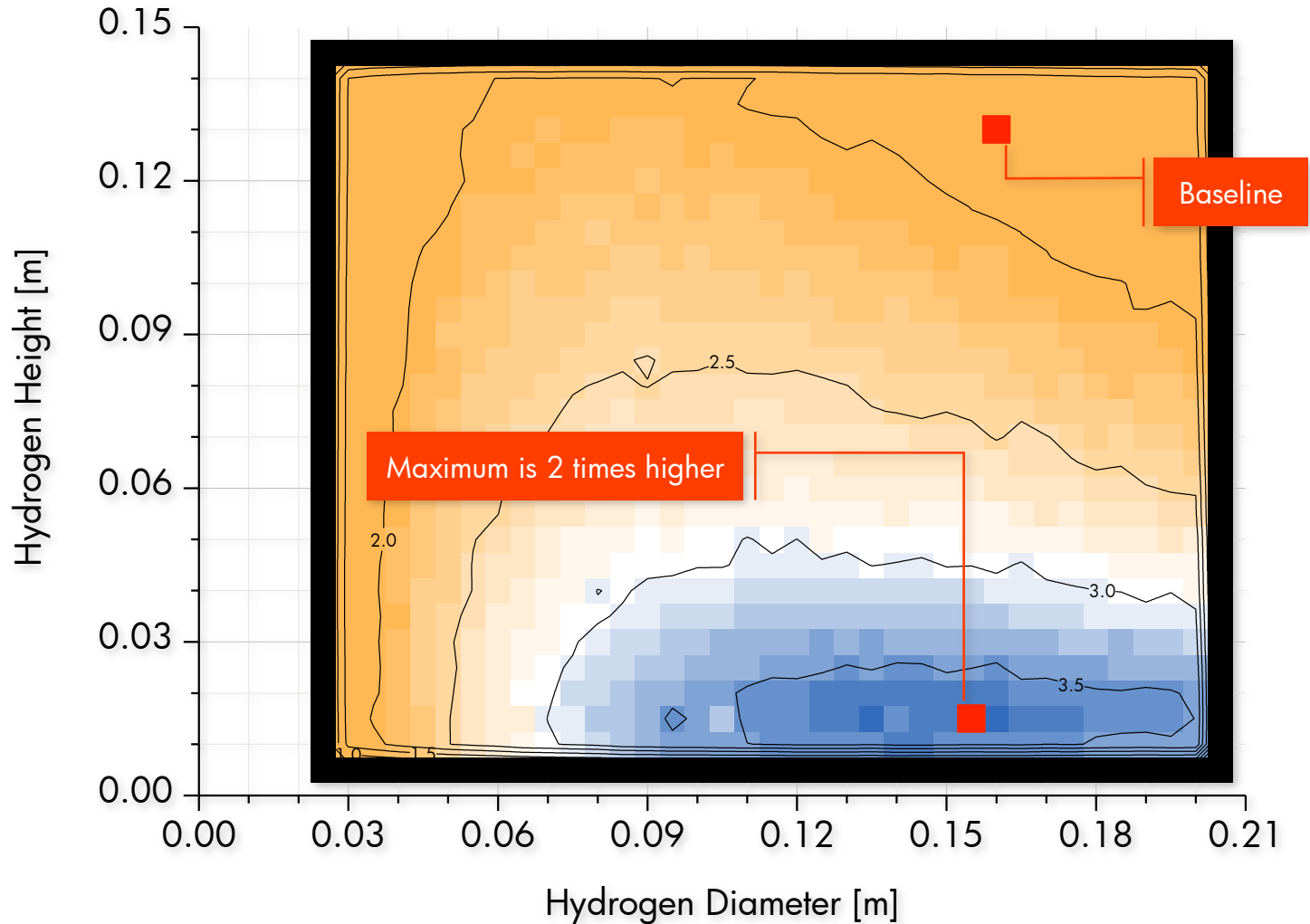
View in proton beam direction
Proton beam comes from behind



PART 02
FLAT MODERATOR

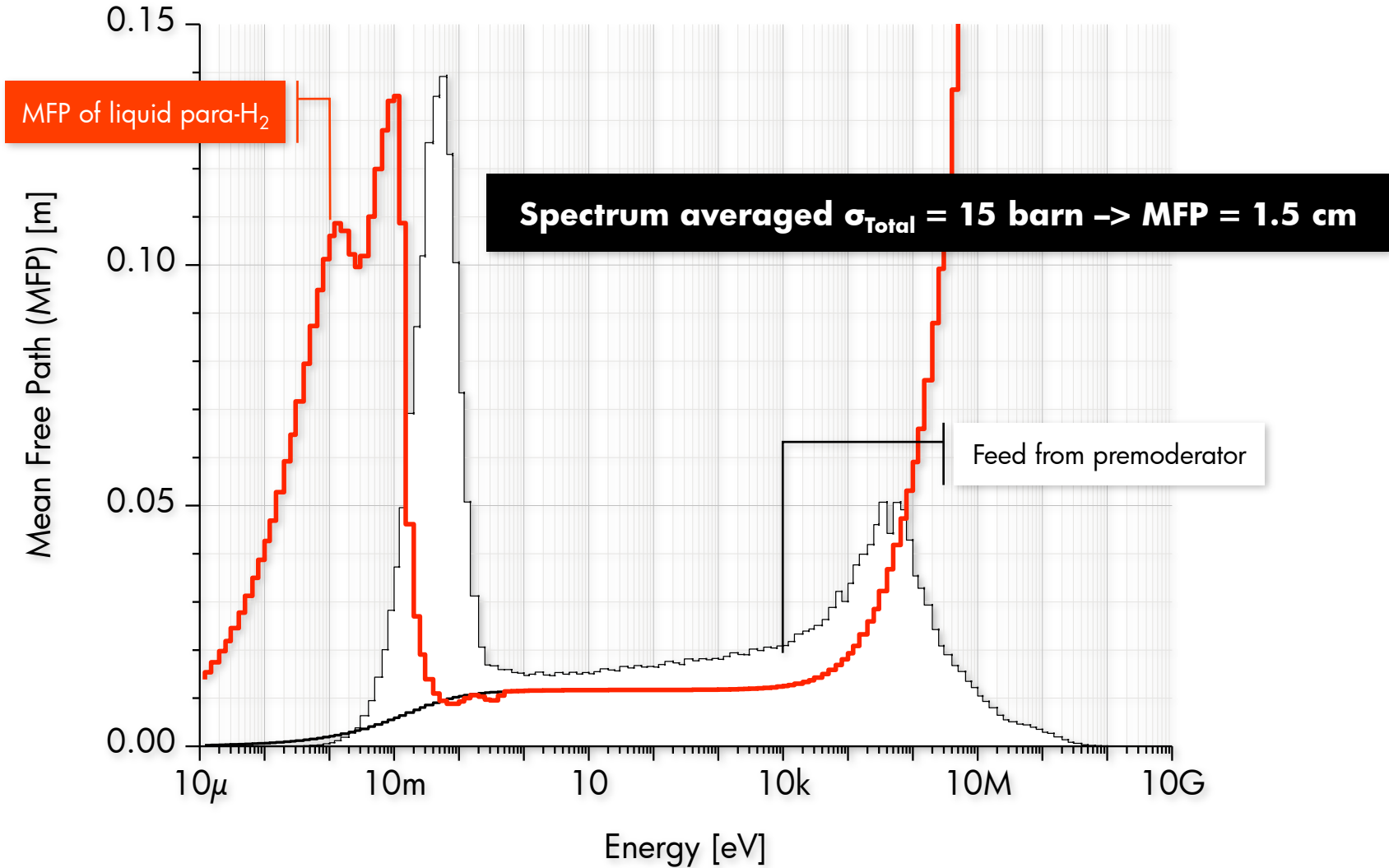
UNPERTURBED BRIGHTNESS

Map of cold brightness 0-5 meV | Ref.: NIMA 729 (2013) 500-505



WHY FLAT MODERATOR WORKS

1.5 cm of liquid para-H₂ is enough to moderate neutrons



FLAT MODERATOR REFERENCE

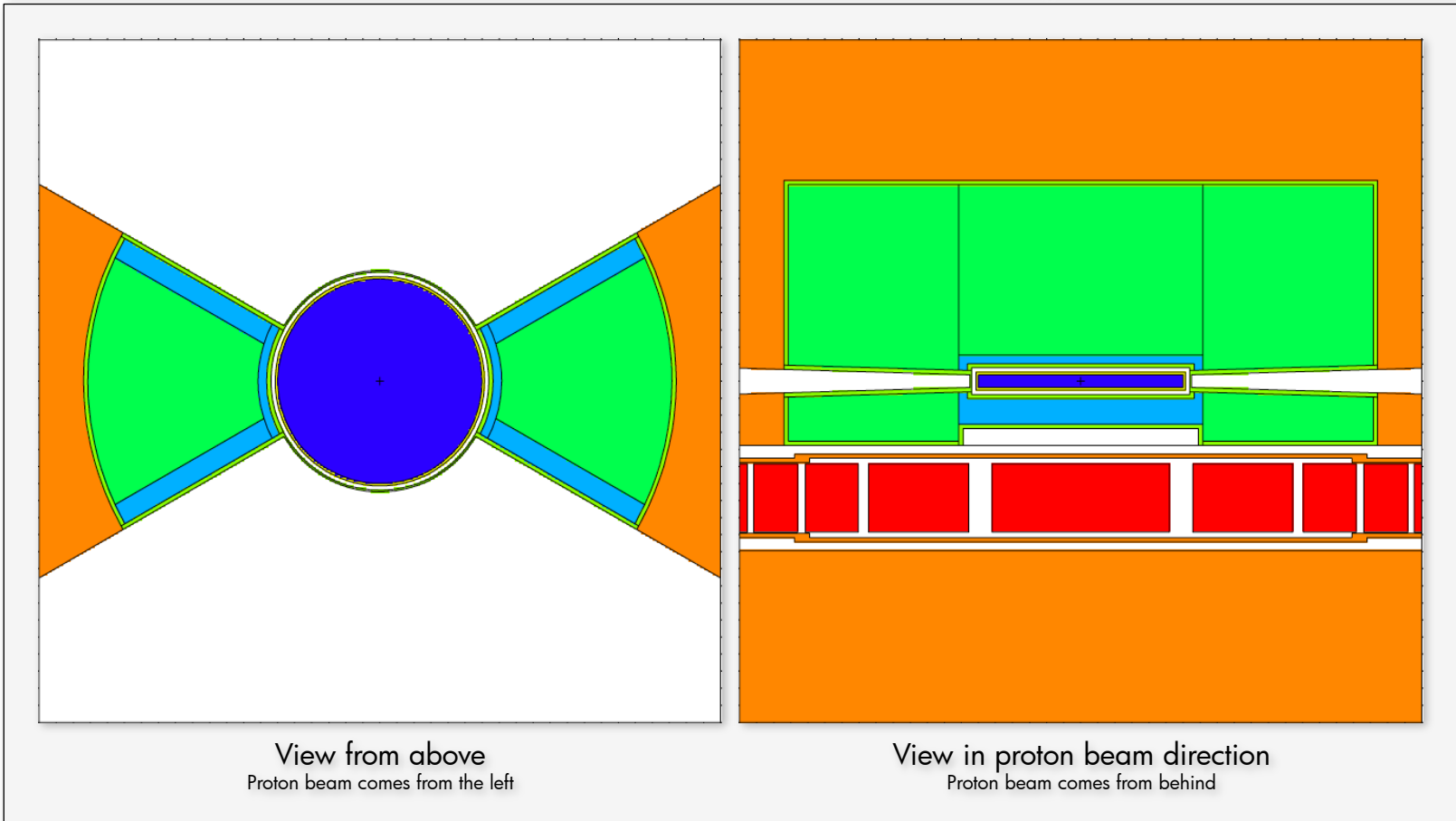
Para-H₂ moderator: 1.5 cm height X 24 cm diameter | Emission surface: 1.5 cm height X 27 cm arcwidth

Cold brightness 0-5 meV from para-H₂ disc:

3.4 PDU

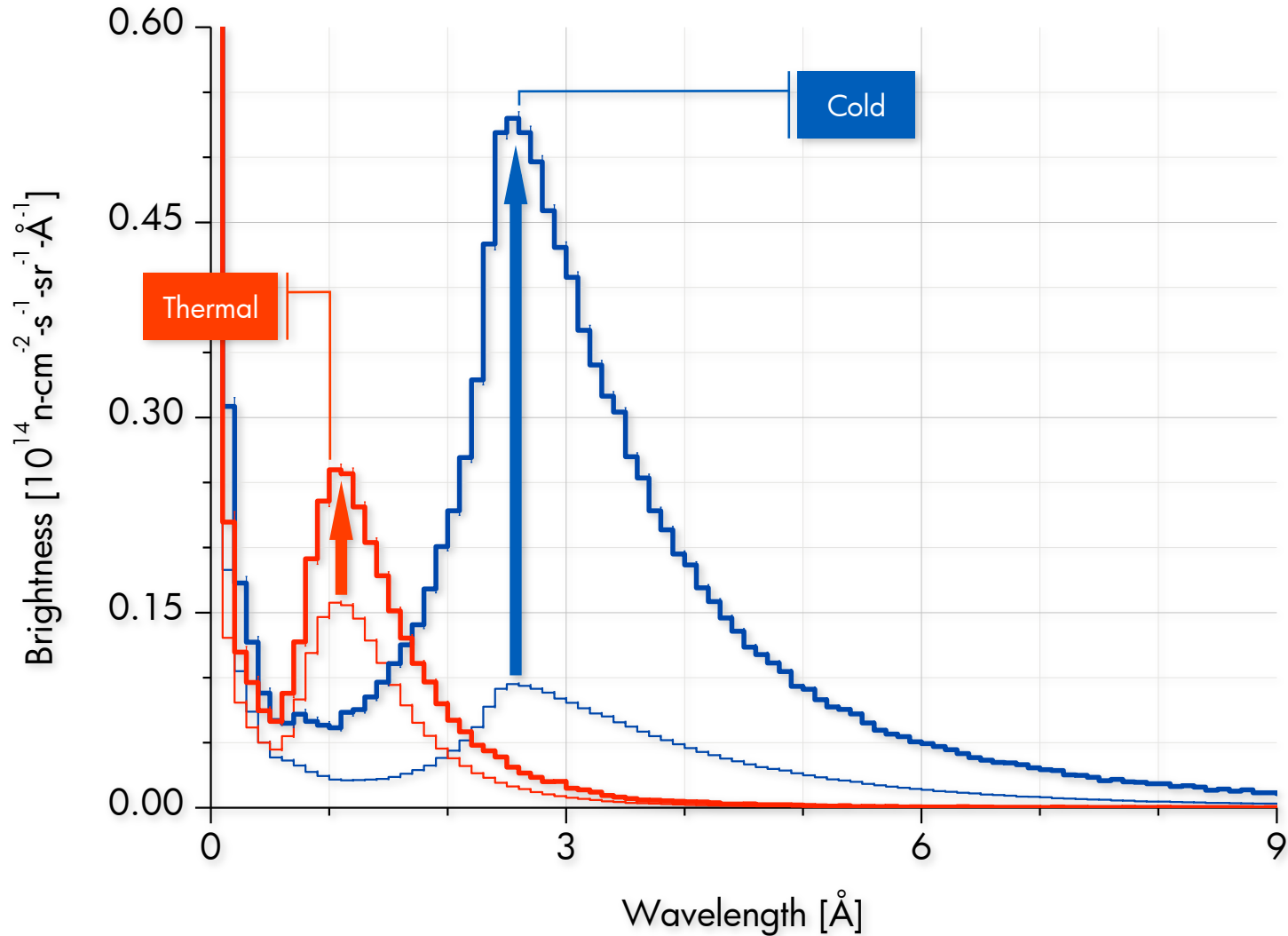
Thermal brightness 20-100 meV from water extensions:

2.3 PDU



SPECTRAL BRIGHTNESS

Time-average brightness vs wavelength

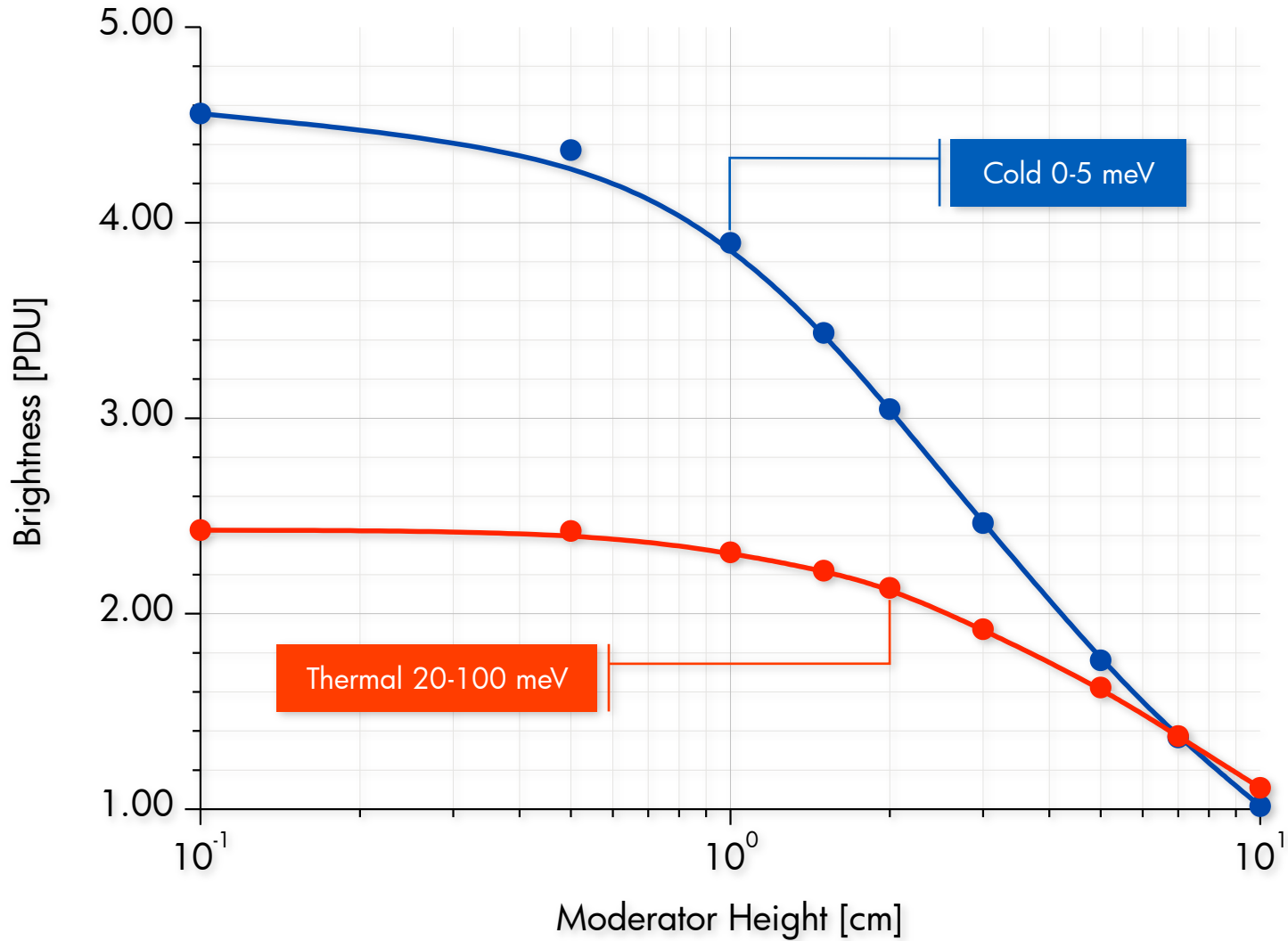




PART 03
VARIABLE HEIGHT MODERATOR

MODERATOR HEIGHT

Brightness vs moderator height



EXAMPLE OF VARIABLE HEIGHT MODERATOR

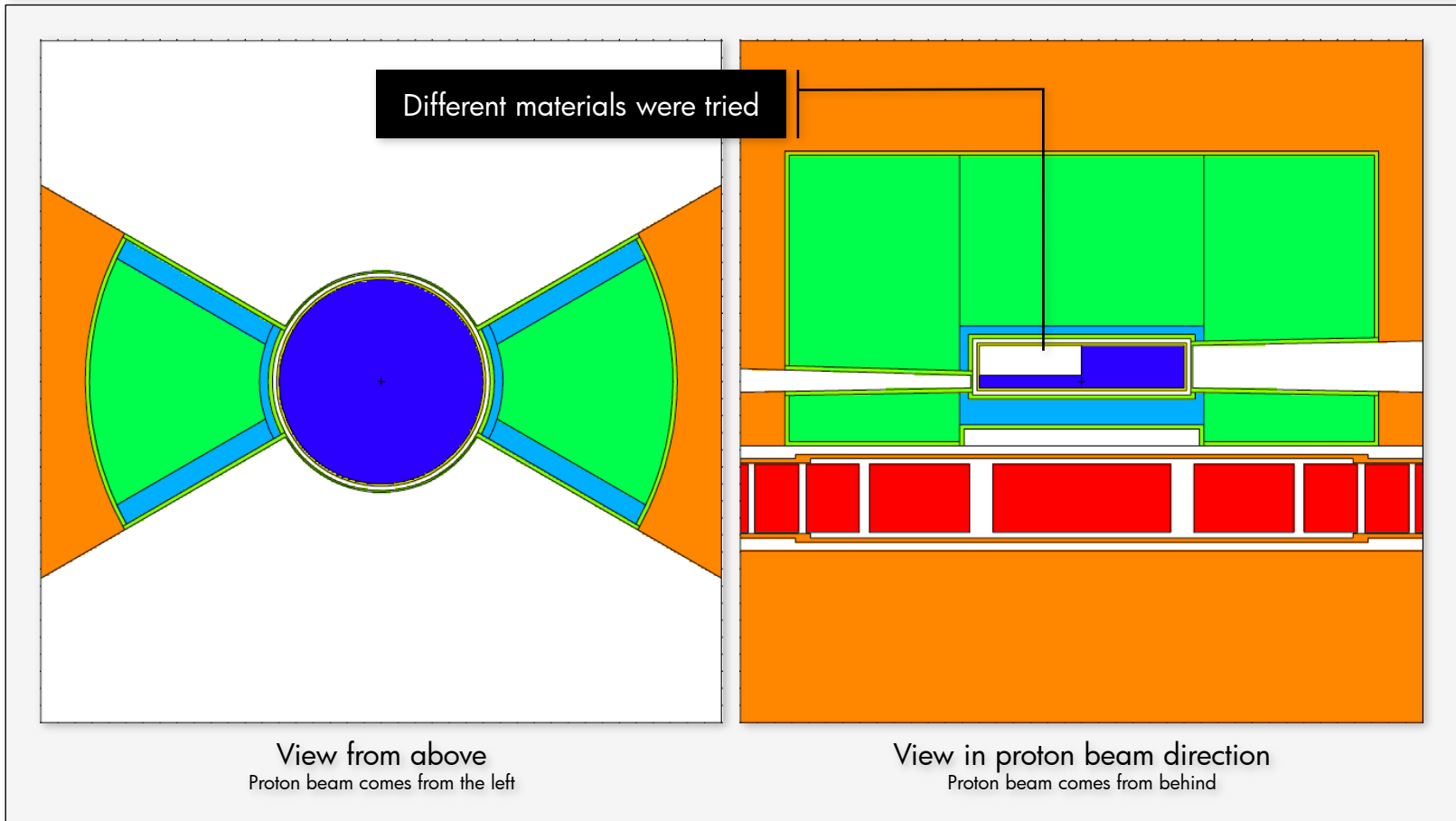
5.0 cm tall + 1.5 cm flat combination

Cold brightness 0-5 meV from 5.0 cm side:

1.7-1.9 PDU – The same!

Cold brightness 0-5 meV from 1.5 cm side:

2.3-3.0 PDU – down by 15-35%

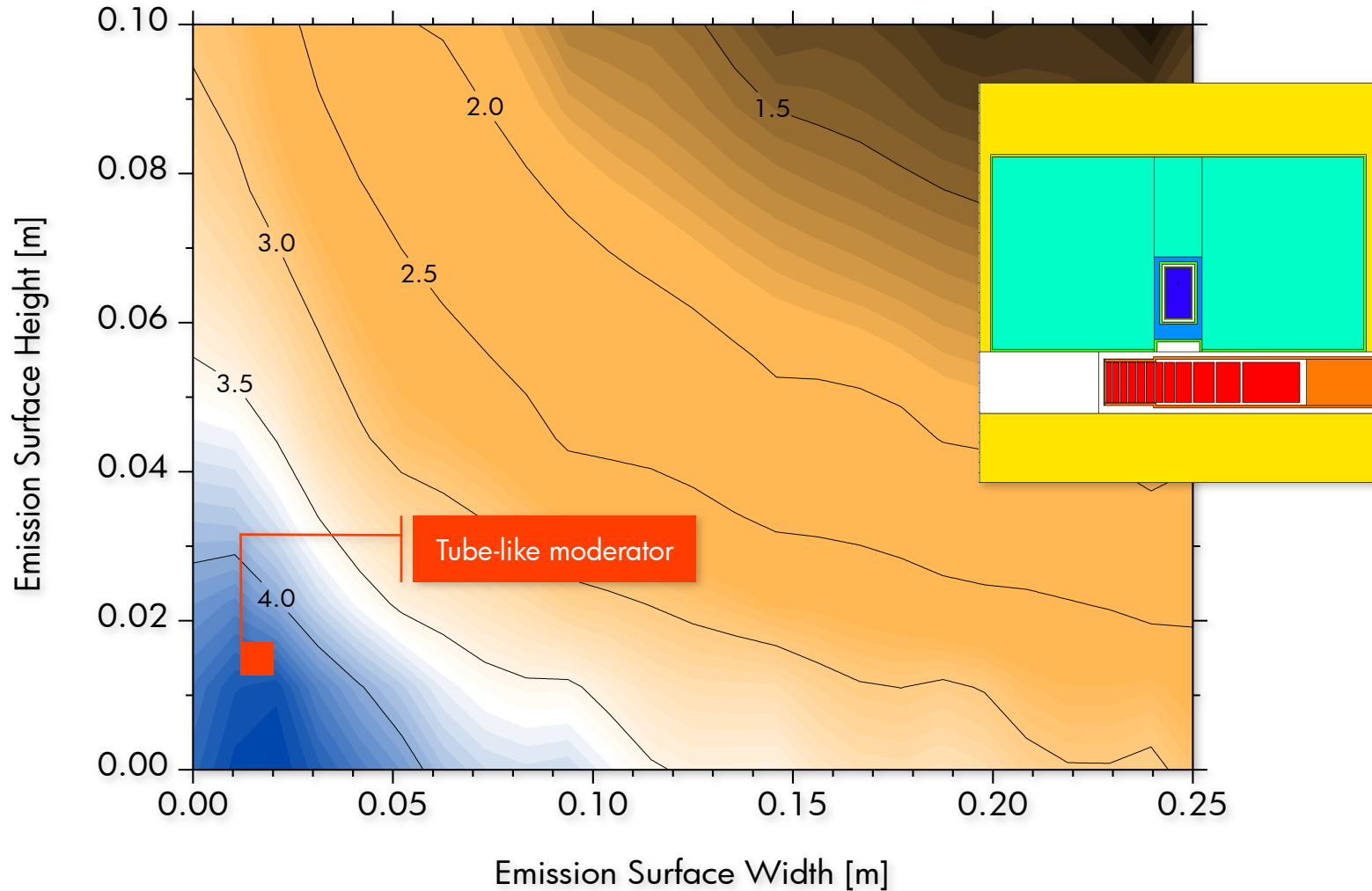




PART 04
STARFISH

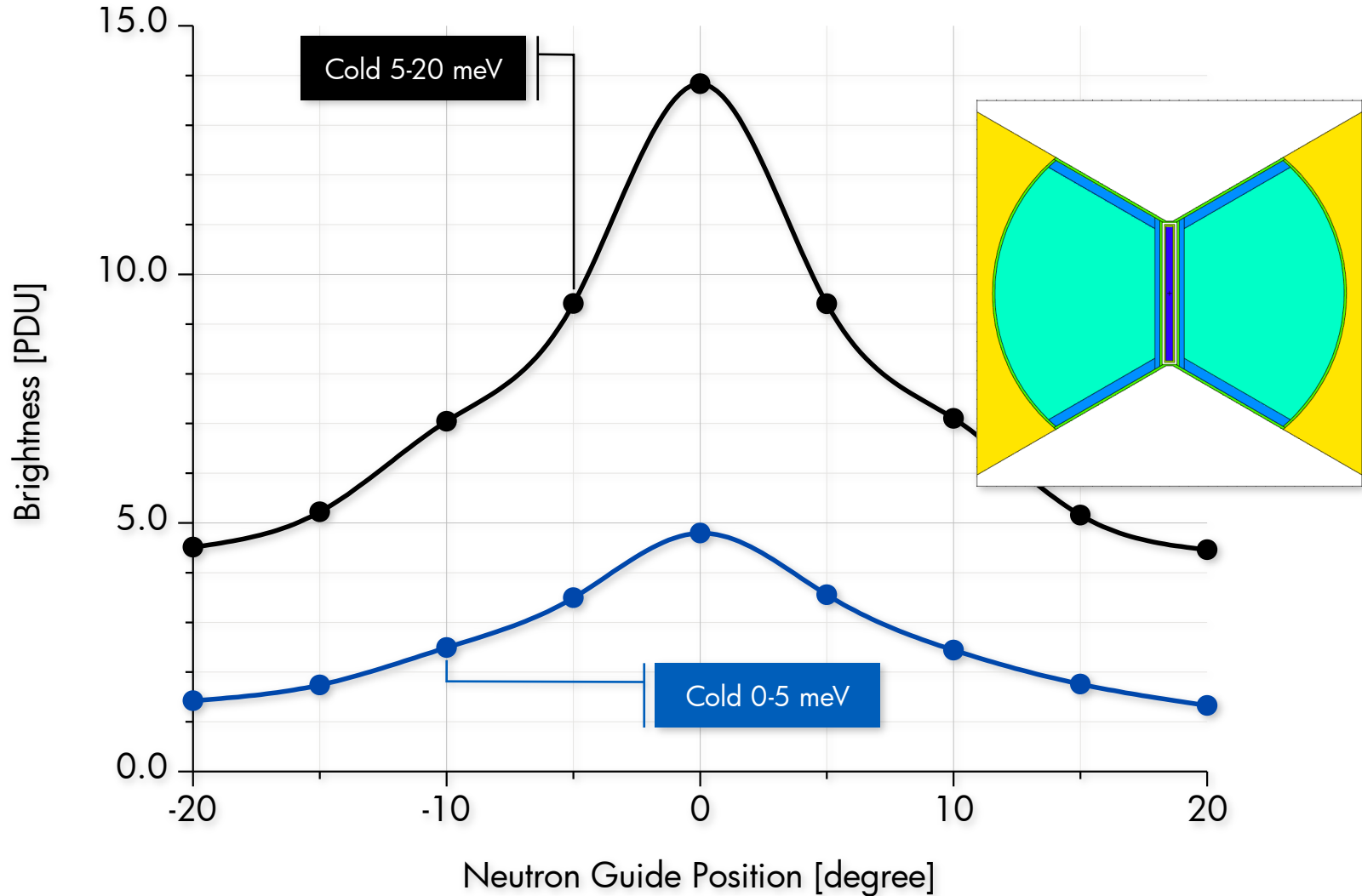
RECTANGULAR MODERATOR

Map of cold brightness 0-5 meV



TUBE MODERATOR

Tube moderator is highly directional and can serve no more than 3-4 beamlines



STARFISH

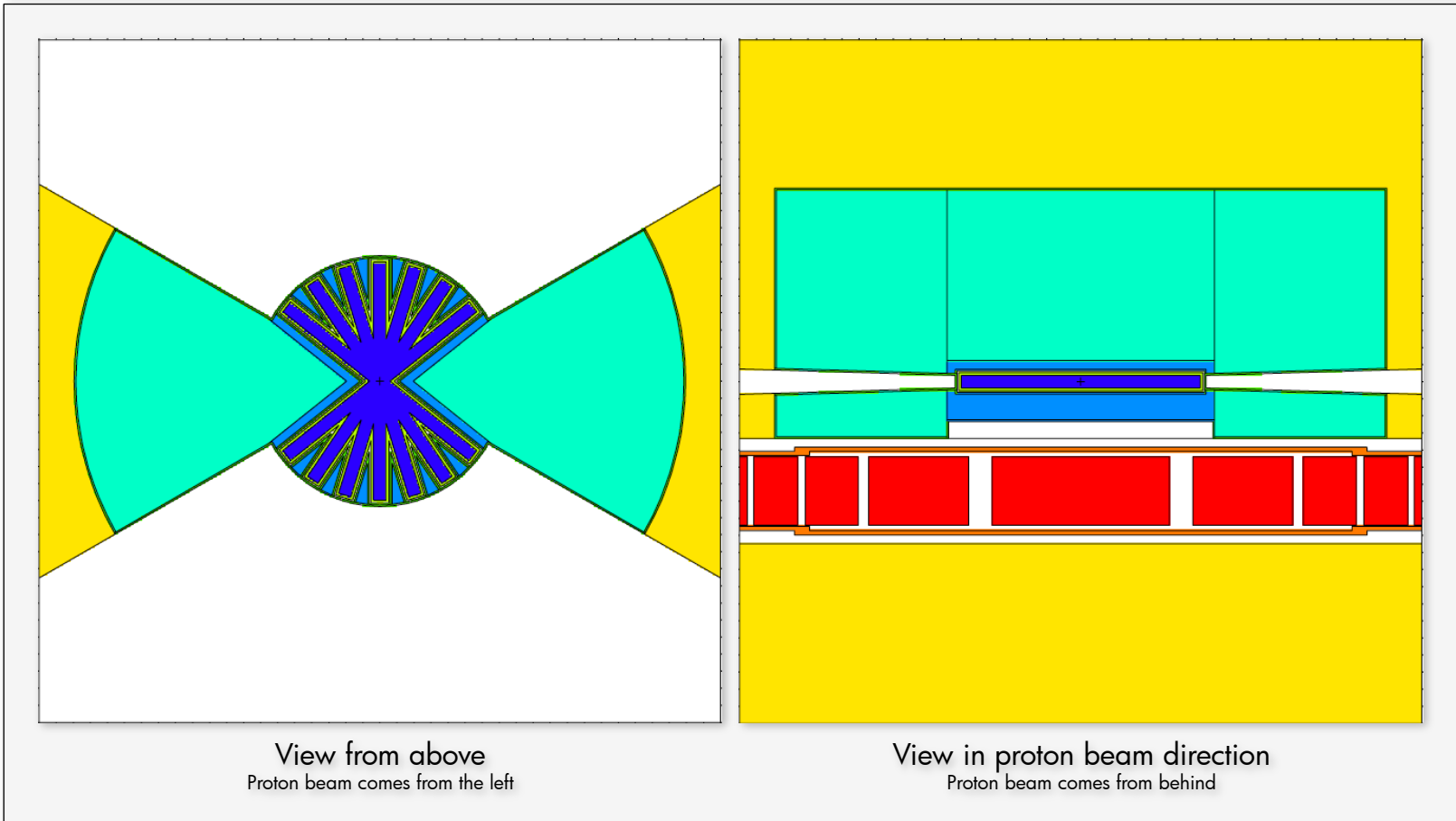
Para-H₂ tube: 1.5 cm height X 1.5 cm width X 28 cm length

Cold brightness 0-5 meV from para-H₂ tubes:

4.3 PDU

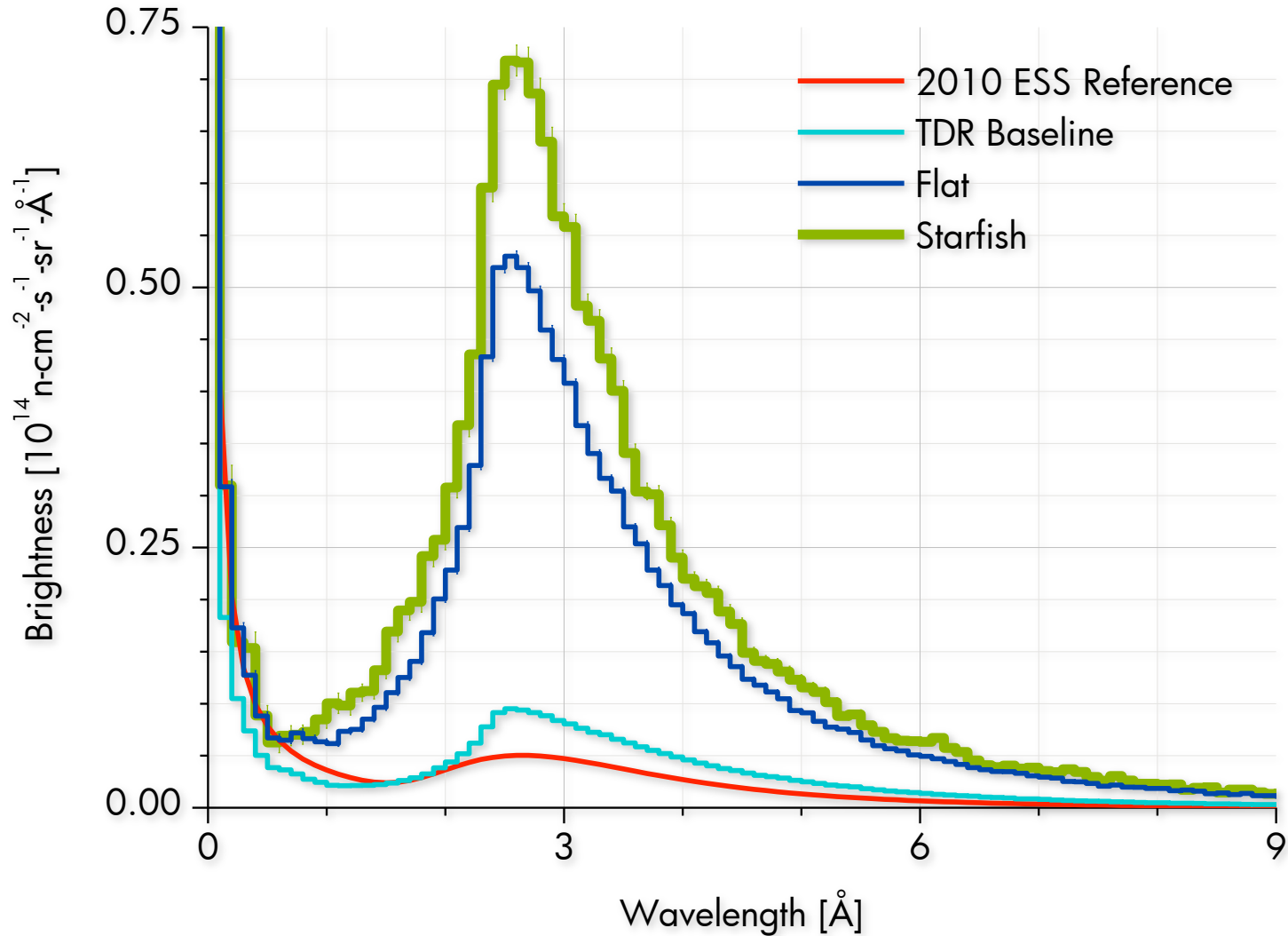
Thermal brightness 20-100 meV from water wedges:

3.2 PDU



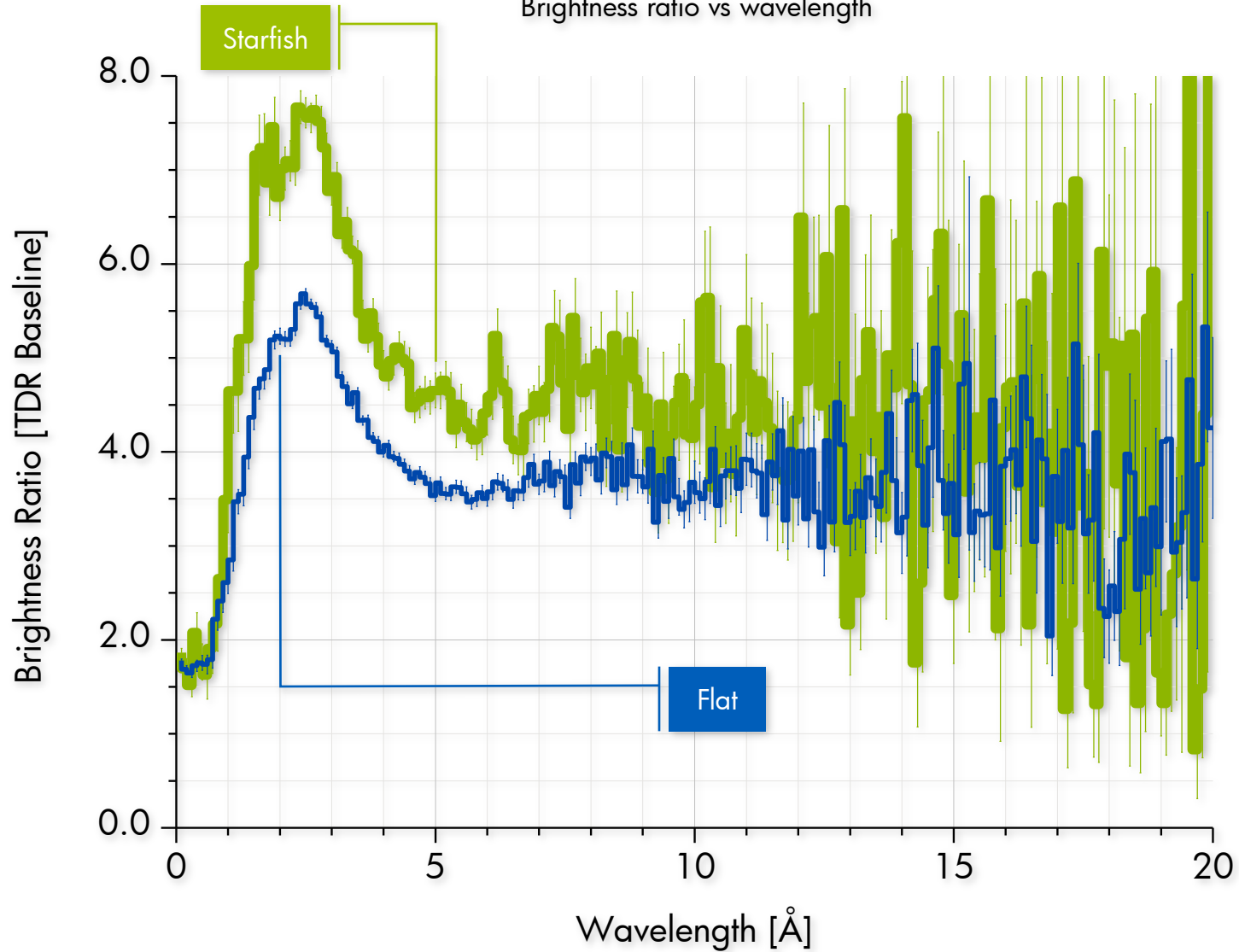
SPECTRAL BRIGHTNESS

Time-average brightness vs wavelength



BRIGHTNESS GAIN

Brightness ratio vs wavelength





BRIGHTNESS DATA COMPILATION

$$1 \text{ PDU} = 1.75 \times 10^{12} \text{ n-cm}^{-2}\text{-s}^{-1}\text{-sr}^{-1}\text{-MW}^{-1}$$

Model	Cold 0-5 meV [PDU]	Thermal 20-100 meV [PDU]
TDR Baseline	1.0	1.5
Flat Moderator	3.4	2.3
Flat Moderator + Lead Reflector	3.9	2.7
Variable Height Moderator (5.0 cm Tall + 1.5 cm Flat)	1.7-1.9 + 2.3-3.0	-
Tube Moderator	4.8	-
Starfish	4.3	3.2