Characterization of neutron fields at Cernavoda NPP

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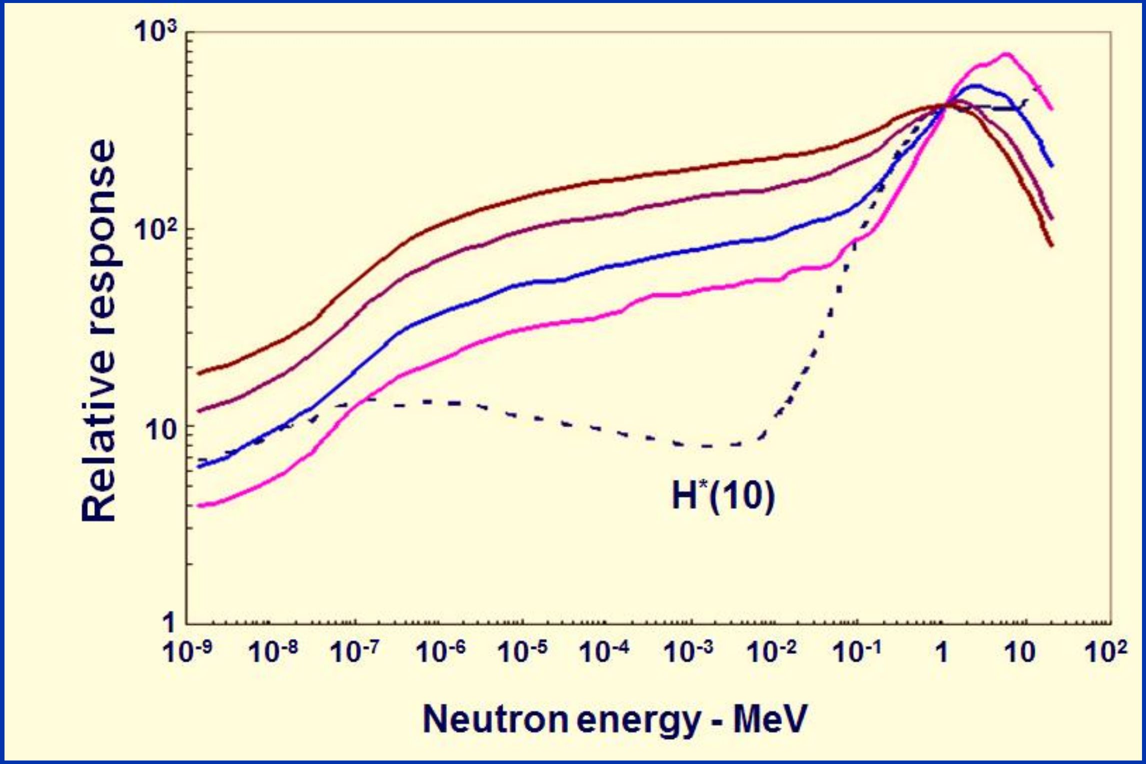
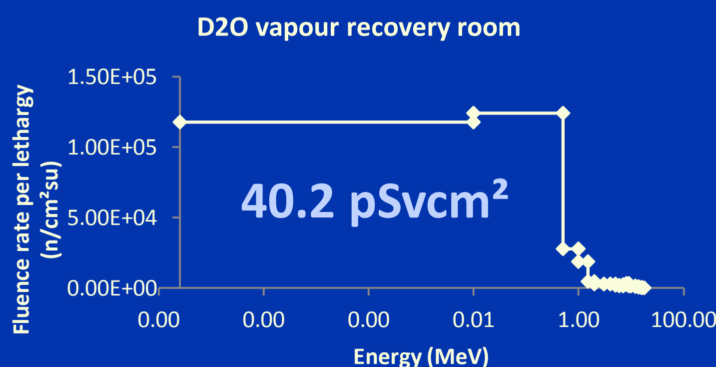
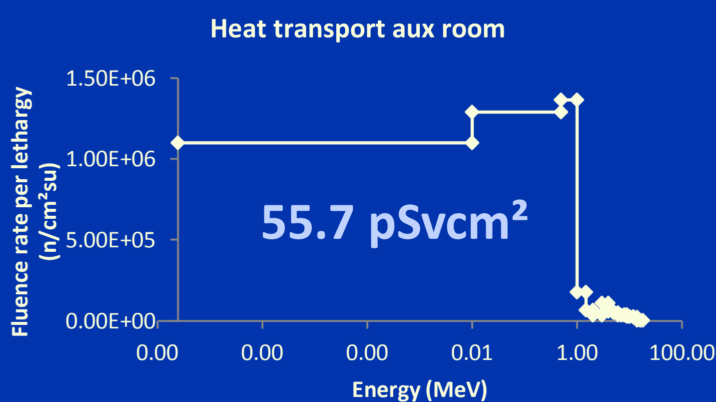
Neutron fluence to ambient dose conversion coefficients are strongly energy dependent

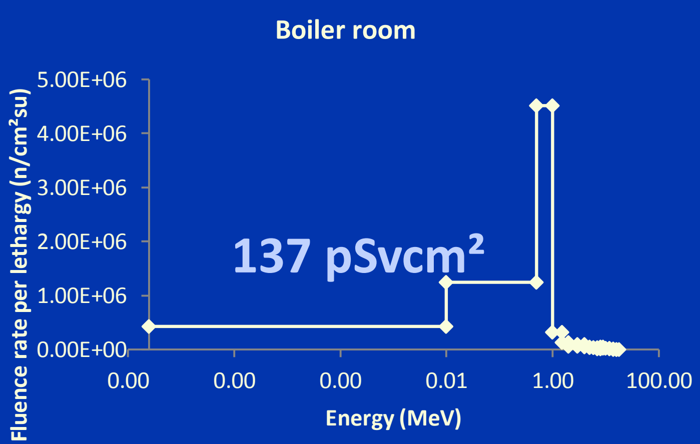


Energy distribution



Nprobe (BTI)





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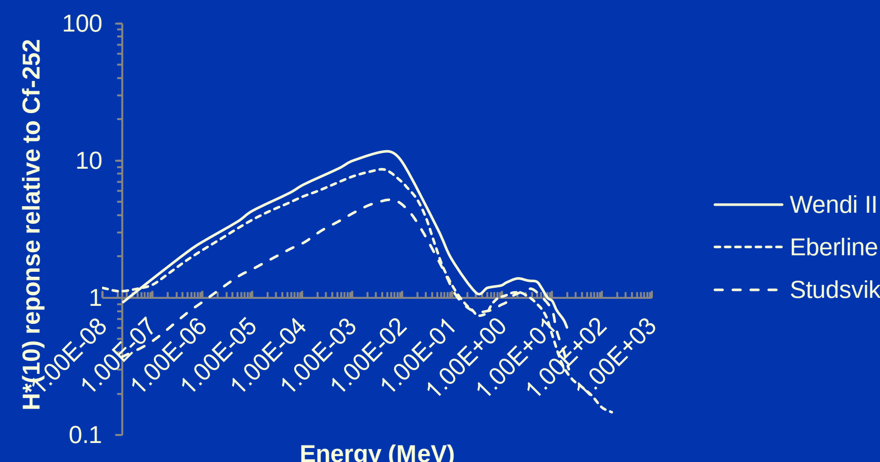
Fluence estimation

Ambient monitors

$$\frac{\mathrm{d}\Phi}{\mathrm{d}t} = \frac{\mathrm{d}H*(10)/\mathrm{d}t}{< h*(10) >}$$



Ambient monitors

	dH*(10)/dt (µSv/h)	<h*(10)> (µSvcm²)	dΦ/dt (n/cm²h)
D_2O vapour recovery room	16 ± 2	$4.02\ 10^{-5}$	$(4.0 \pm 0.4)\ 10^{5}$
Heat transport aux room	97 ± 9	$5.57\ 10^{-5}$	$(1.7 \pm 0.2)\ 10^{6}$
Boiler room	92 ± 9	$1.37\ 10^{-4}$	$(6.8 \pm 0.7)\ 10^{5}$

Directional distribution

- What if we assume the fluence is unidirectional?

	dΦ/dt (n/cm²h)	Hp(10) (µSv/h)
D_2O vapour recovery room	(4.0 ± 0.4) 10^5	17 ± 1.7
Heat transport aux room	(1.7 ± 0.2) 10^6	101 ± 9
Boiler room	(6.8 ± 0.7) 10^5	95 ± 10

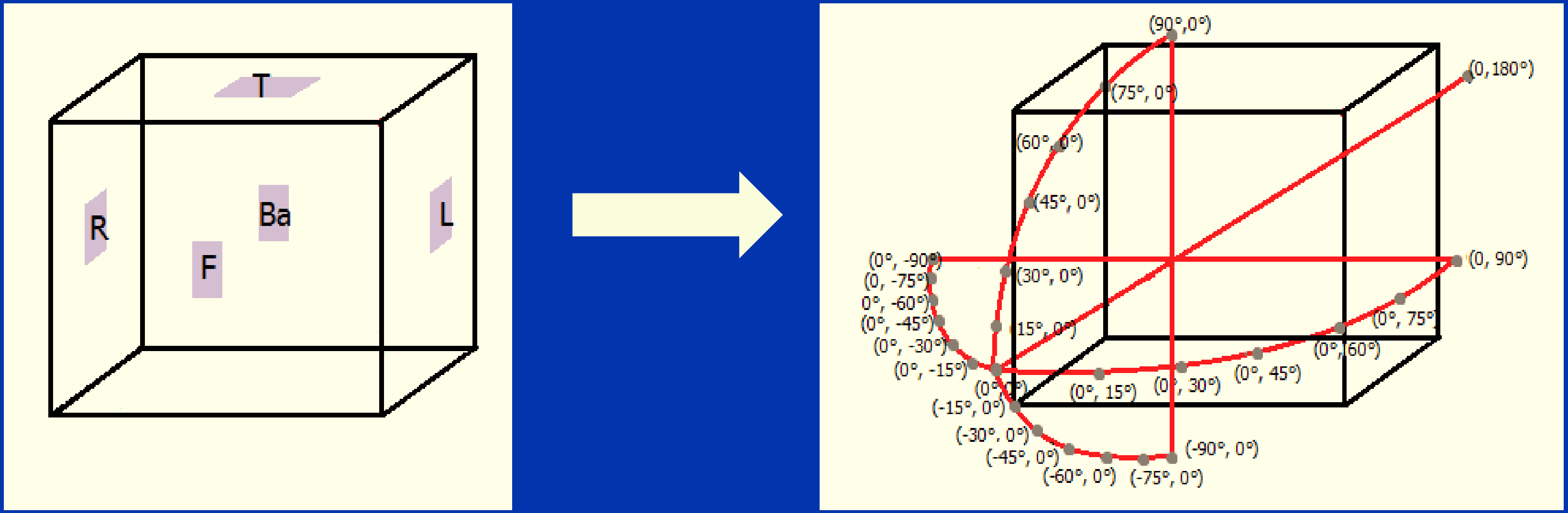
Directional distribution

- What if we assume the fluence is isotropic?

	$d\Phi/dt$ (n/cm²h)	Hp(10) (µSv/h)
D_2O vapour recovery room	(4.0 ± 0.4) 10^5	9.9 ± 1.2
Heat transport aux room	(1.7 ± 0.2) 10^6	54 ± 11
Boiler room	(6.8 ± 0.7) 10^5	52 ± 9

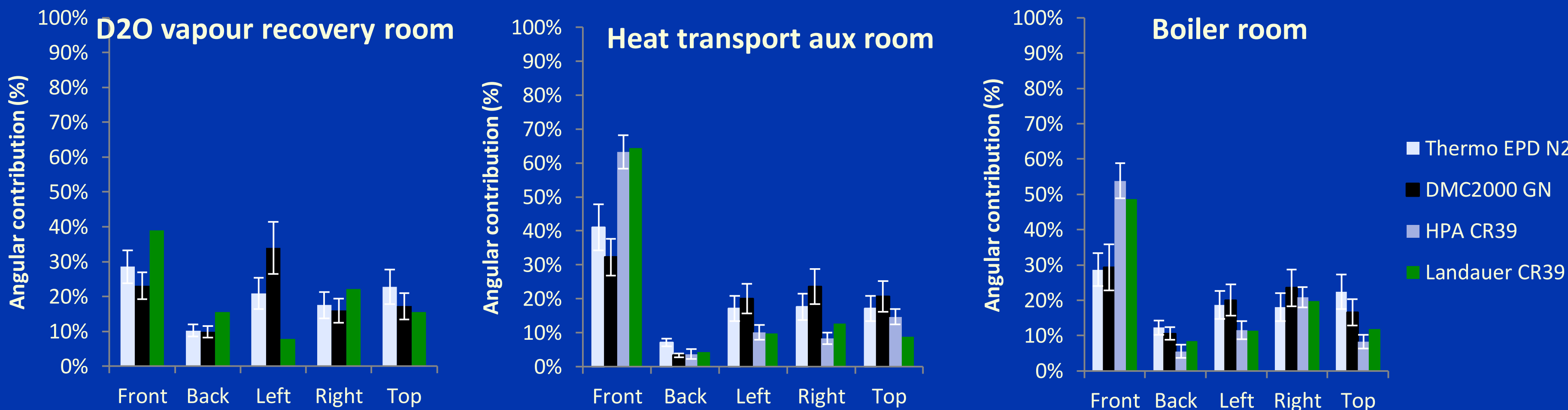
Directional distribution

- Directional distribution estimation



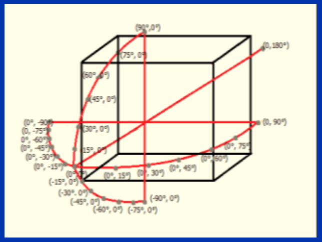
Directional distribution

- Directional distribution estimation



Directional distribution

- Directional distribution estimation



		Unidirectional	Isotropic	Directional distribution
	dΦ/dt (n/cm²h)	Hp(10) (µSv/h)	Hp(10) (µSv/h)	Hp(10) (µSv/h)
D_2O vapour recovery room	(4.0 ± 0.4) 10^5	17 ± 1.7	9.9 ± 1.2	11.3 ± 1.2
Heat transport aux room	(1.7 ± 0.2) 10^6	101 ± 9	54 ± 11	73 ± 11
Boiler room	(6.8 ± 0.7) 10^5	95 ± 10	52 ± 9	65 ± 9

- What did the personal dosemeters say?

	D_2O vapour recovery room	Heat transport aux room	Boiler room
	$H_p(10)$ (µSv/h)	$H_p(10)$ (µSv/h)	$H_p(10)$ (µSv/h)
Reference	11.3 ± 1.2	73 ± 11	65 ± 9
Thermo EPD N2 - Front	77 ± 11	383 ± 54	127 ± 18
DMC 2000 GN - Front	46 ± 6	251 ± 36	135 ± 20
Bubble - Front	41.7 ± 2.2	219 ± 11	
Albedo - Front	24.2 ± 2.8	514 ± 72	140 ± 20
HPA CR 39 - Front	10.5 ± 2.0	76 ± 4	44 ± 3
Landauer CR 39 - Front	13.1	133	80
Landauer FNTD - Front	11.3 ± 1.4	40 ± 5	17 ± 2

Conclusion

- Neutron dosimetry is not straightforward due to the strong energy and angular dependency of the neutron personal dose equivalent
- Neutron field characterization is therefore indespensable, allowing knowledge of the energy spectrum and directional distribution
- The energy spectrum was recorded using an Nprobe
- The directional distribution was estimated by placing several personal dosemeters on a slab phantom
- Comparison between different approaches shows the big importance of taking this directional distribution into account.
- Moreover the measured value of the personal dosemeters must be evaluated with great care and compared with the calculated reference value