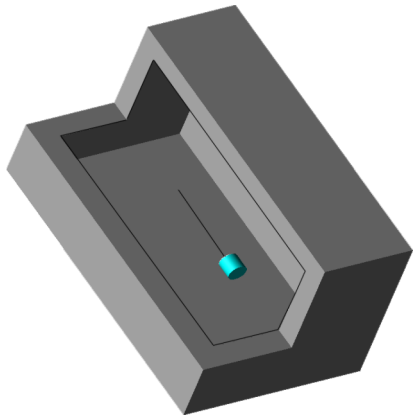
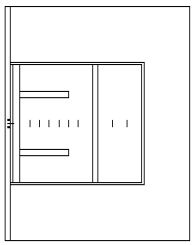
Uncertainty in Monte Carlo simulation: the case of single moderator spectrometers

1) CYSP: cylindrical spectrometer

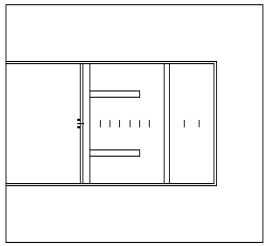
2) SP^2: spherical spectrometer

1) CYSP: cylindrical spectrometer

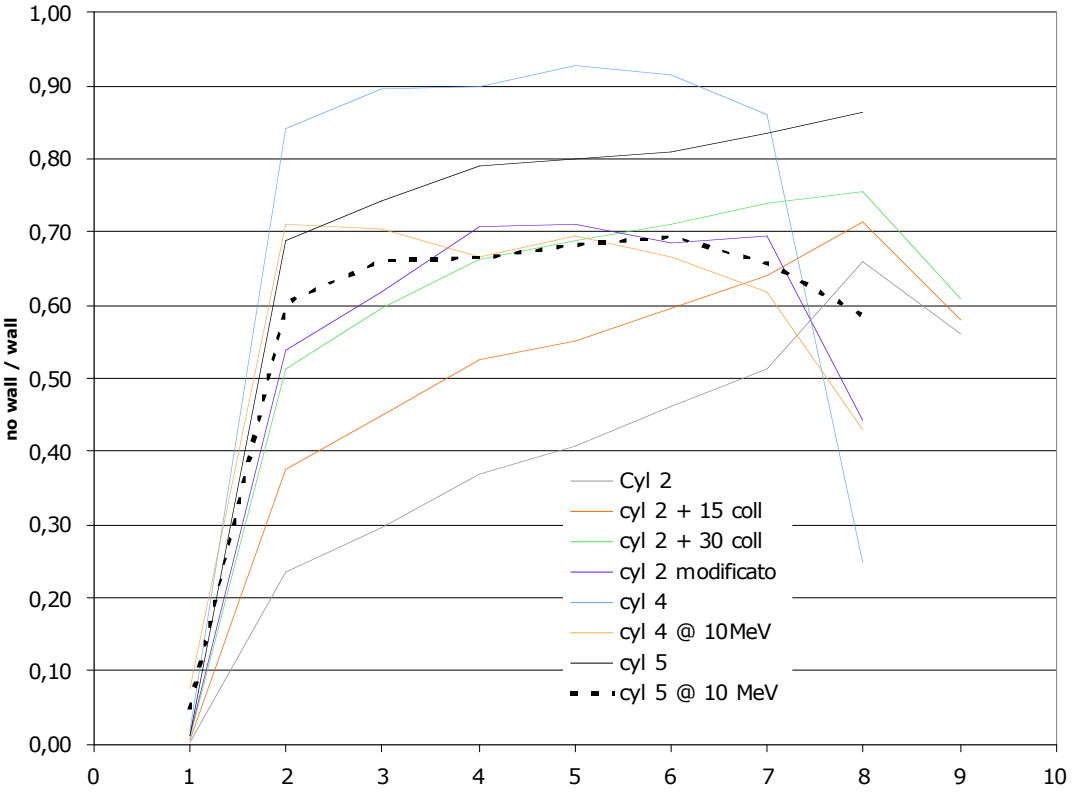


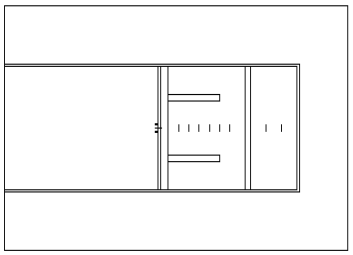


Cyl 2

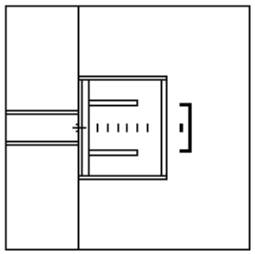


Cyl 2 + 15 cm coll.

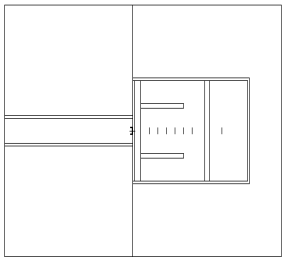




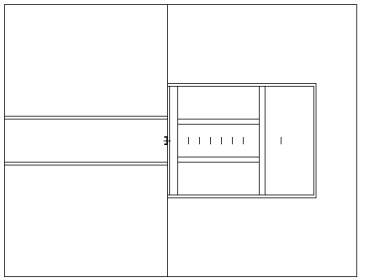
Cyl 2 + 30 cm coll.



Cyl 2 mod.

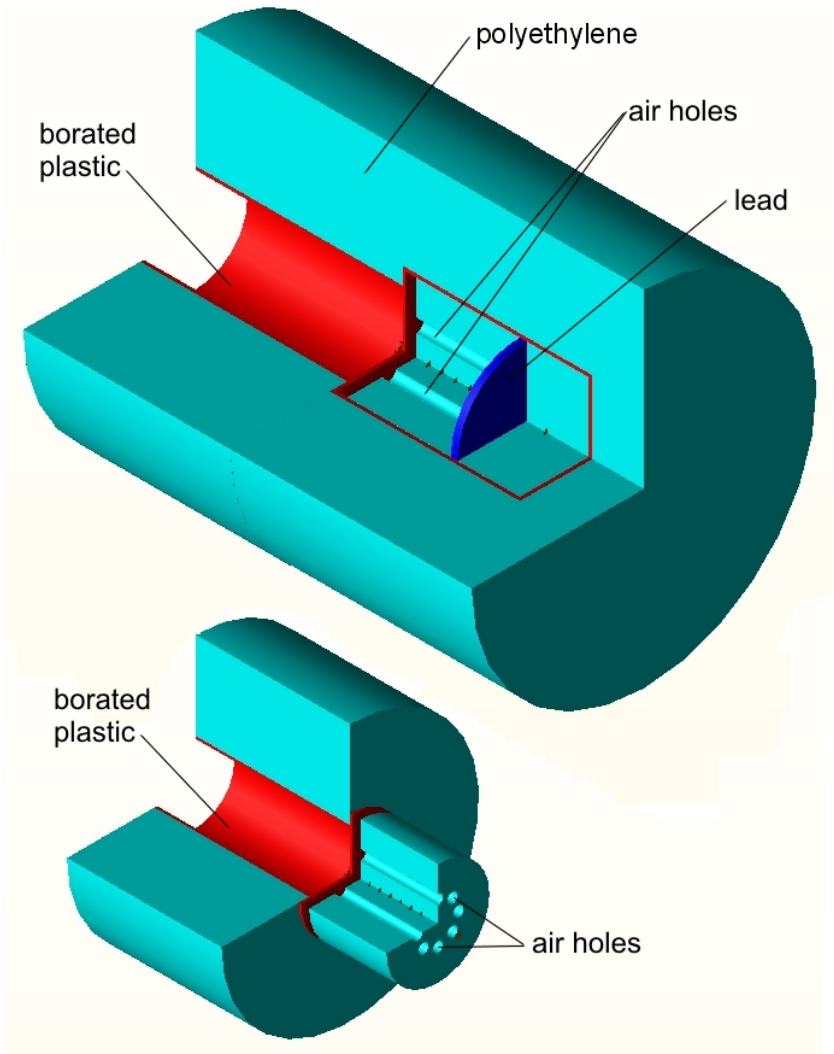


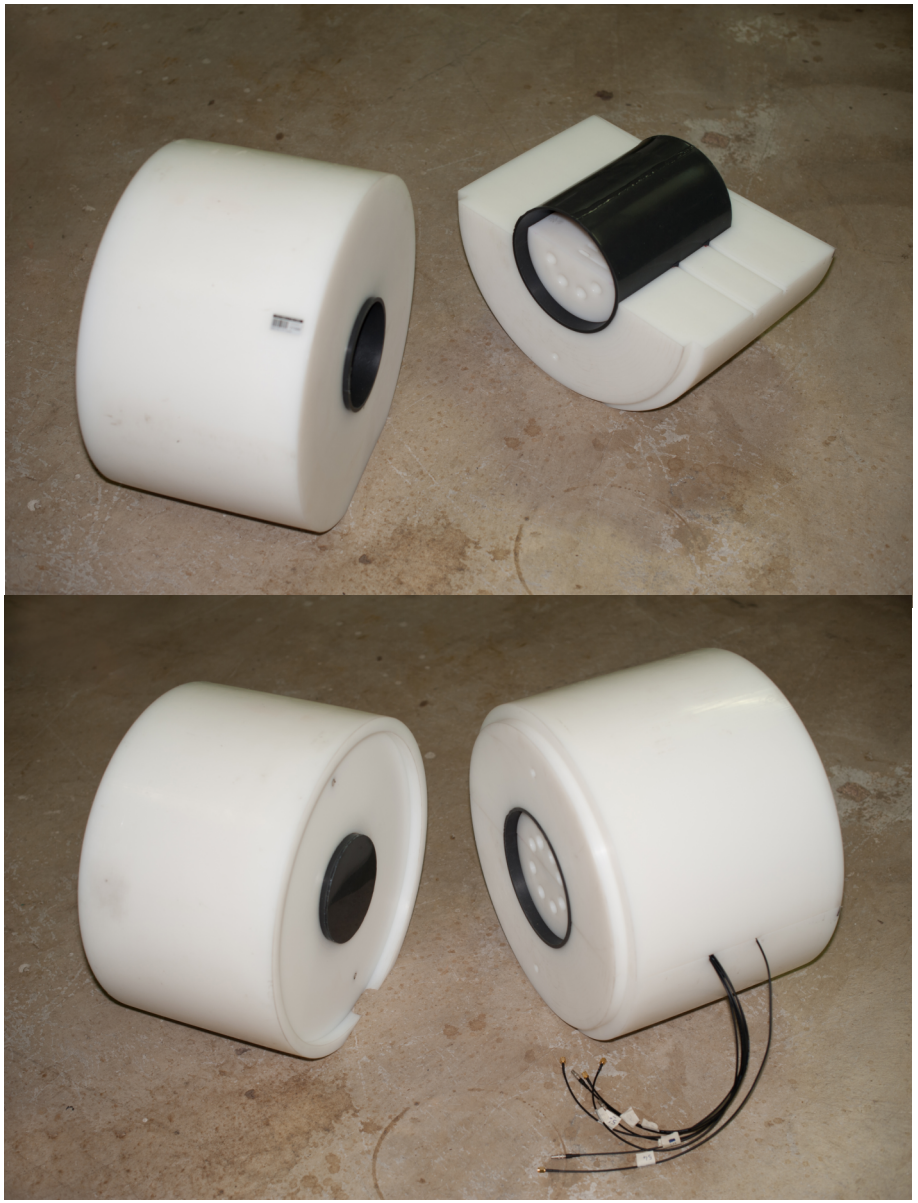
Cyl 4



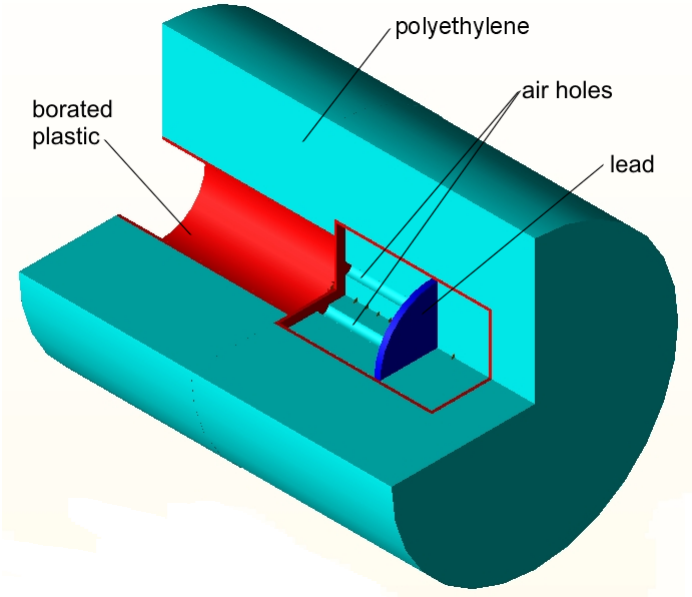
Cyl 5

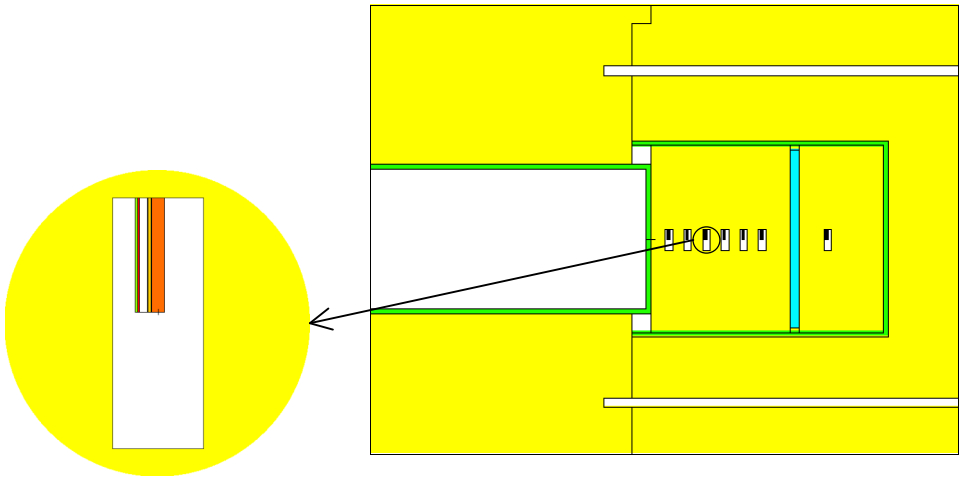
1) CYSP: cylindrical spectrometer





1) CYSP: cylindrical spectrometer





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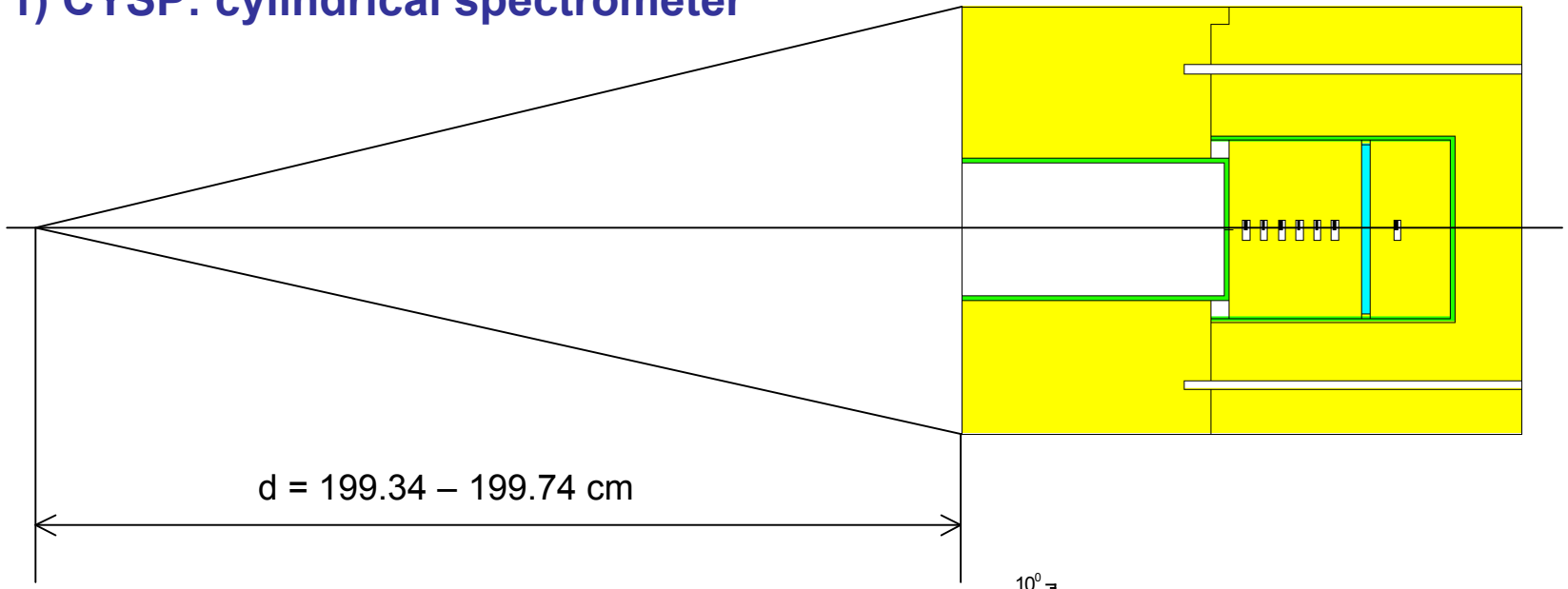
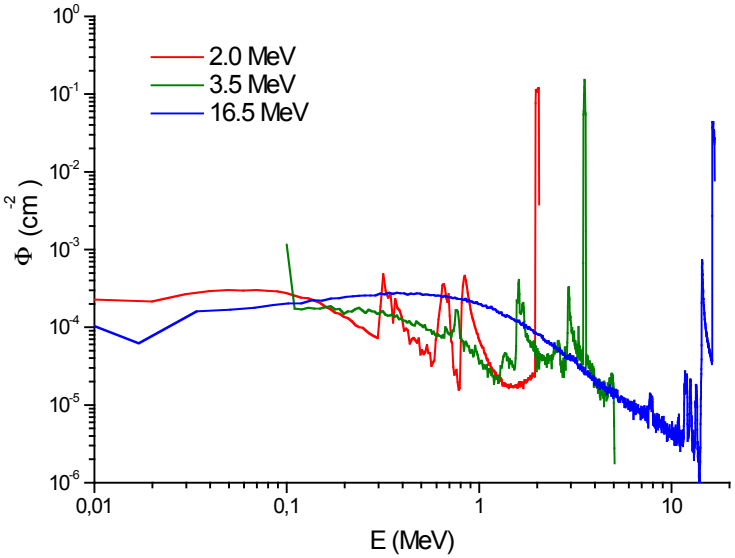


- Simulation of irradiation of CYSP with 0.144, 0.565, 2.0, 3.5, 5.0 and 16.5 MeV monoenergetic neutrons and ^{252}Cf source at NPL.
- Experimental response per unit fluence, $(R/\Phi)_{EXP}$, compared with simulated response, $(R/\Phi)_{SIM}$, to adjust polyethylene density.
- Corrected using the target-scatter percentage of the total fluence.



1) CYSP: cylindrical spectrometer

Energy (keV)	Shadow cone	Spectrum used in simulation	Target-scatter correction (% total fluence)
144.4	Yes	Monoenergetic	0.9%
565.1	Yes	Monoenergetic	0.6%
2000.2	Yes	Detailed	1.9%
3493	No	Detailed	3.5%
5000	Yes	Monoenergetic	0.8%
16500	Yes	Detailed	3.0%
^{252}Cf	Yes	ISO	-

1) CYSP: cylindrical spectrometer

- Comparison results for irradiation with 2.0 MeV neutrons.
- The best agreement is consistently obtained assuming 0.95 g/cm^3 for polyethylene density in all the cases (144 keV, 565 keV, 2 MeV, 3.5 MeV, 5 MeV, 16.5 MeV and ^{252}Cf .

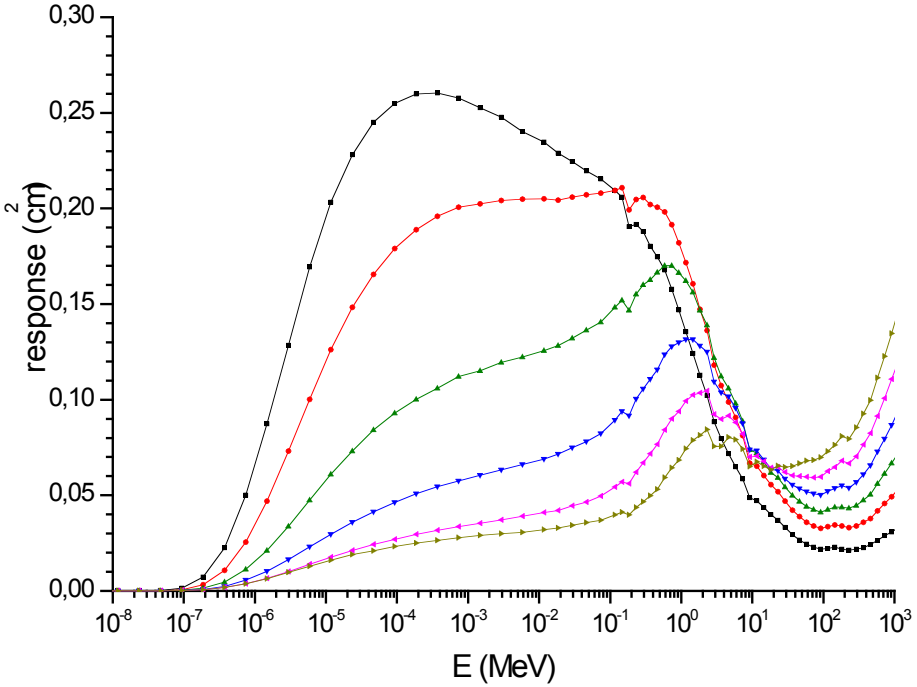
detector	$(R/\Phi)_{EXP}$	$(R/\Phi)_{EXP}$ / $(R/\Phi)_{SIM}$						
		ρ_{PE}=0.91	ρ_{PE}=0.92	ρ_{PE}=0.93	ρ_{PE}=0.94	ρ_{PE}=0.95	ρ_{PE}=0.95	ρ_{PE}=0.95
		monoenergetic spectrum					full spectrum	sc correction
1	0.0182	2.15E-01	2.11E-01	2.11E-01	2.08E-01	2.06E-01	2.01E-01	2.04E-01
2	0.0248	2.21E-01	2.16E-01	2.15E-01	2.10E-01	2.11E-01	2.09E-01	2.13E-01
3	0.0236	2.04E-01	2.03E-01	2.02E-01	2.00E-01	1.98E-01	1.99E-01	2.03E-01
4	0.0209	2.05E-01	2.02E-01	2.02E-01	2.01E-01	2.00E-01	2.02E-01	2.06E-01
5	0.0168	1.98E-01	2.01E-01	2.01E-01	2.00E-01	2.00E-01	2.00E-01	2.04E-01
6	0.0140	2.04E-01	2.05E-01	2.07E-01	2.07E-01	2.09E-01	2.10E-01	2.14E-01
7	0.0067	2.00E-01	2.04E-01	2.08E-01	2.10E-01	2.14E-01	2.10E-01	2.14E-01
		3.9%	2.7%	2.6%	2.3%	3.1%	2.4%	2.4%
		0.207	0.206	0.207	0.205	0.205	0.204	0.208

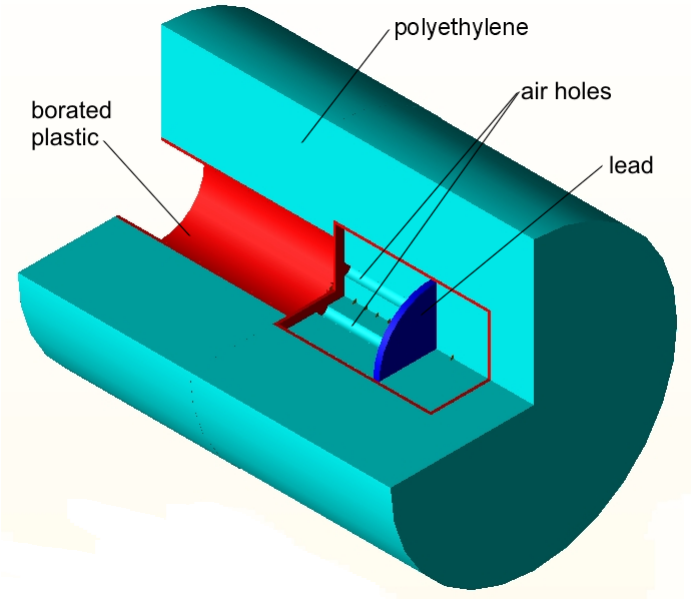
1) CYSP: cylindrical spectrometer

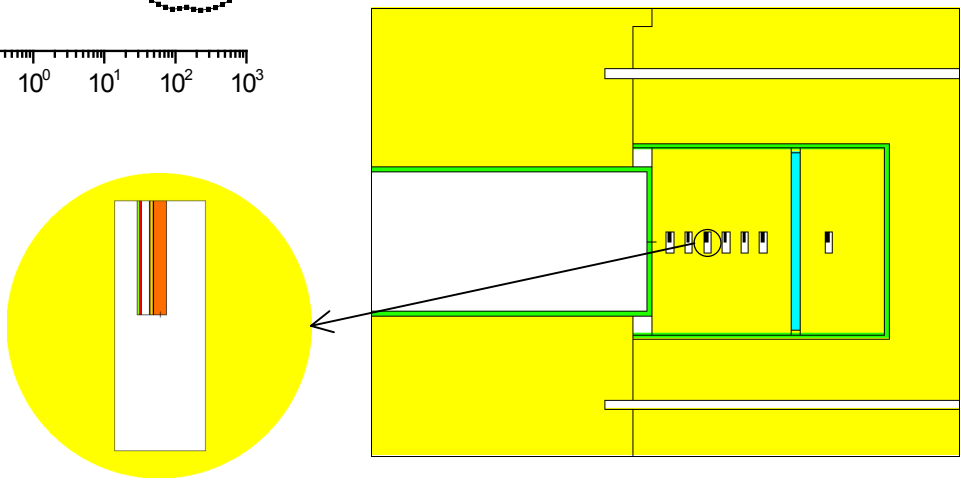
- Summary of results for the six energies and ^{252}Cf source, assuming 0.95 g/cm^3 for polyethylene density in all the cases.

detector	144 keV	565 keV	2.002 MeV	3.493 MeV	5 MeV	16.5 MeV	all energies	^{252}Cf
1	1.95E-01	2.00E-01	2.04E-01	1.96E-01	2.02E-01	2.14E-01		2.01E-01
2	1.98E-01	2.02E-01	2.13E-01	2.01E-01	2.06E-01	2.05E-01		2.06E-01
3	1.94E-01	1.96E-01	2.03E-01	1.93E-01	1.93E-01	1.94E-01		1.95E-01
4	1.91E-01	2.01E-01	2.06E-01	1.88E-01	1.99E-01	1.93E-01		1.97E-01
5	1.89E-01	1.99E-01	2.04E-01	1.84E-01	1.94E-01	1.90E-01		1.96E-01
6	2.01E-01	2.03E-01	2.14E-01	1.90E-01	1.99E-01	2.03E-01		2.02E-01
7	1.82E-01	2.10E-01	2.14E-01	1.99E-01	1.99E-01	2.04E-01		2.07E-01
	0.193	0.202	0.208	0.193	0.199	0.200	**0.199**	0.201
	3.2%	2.2%	2.4%	3.2%	2.3%	4.2%	**3.9%**	2.3%

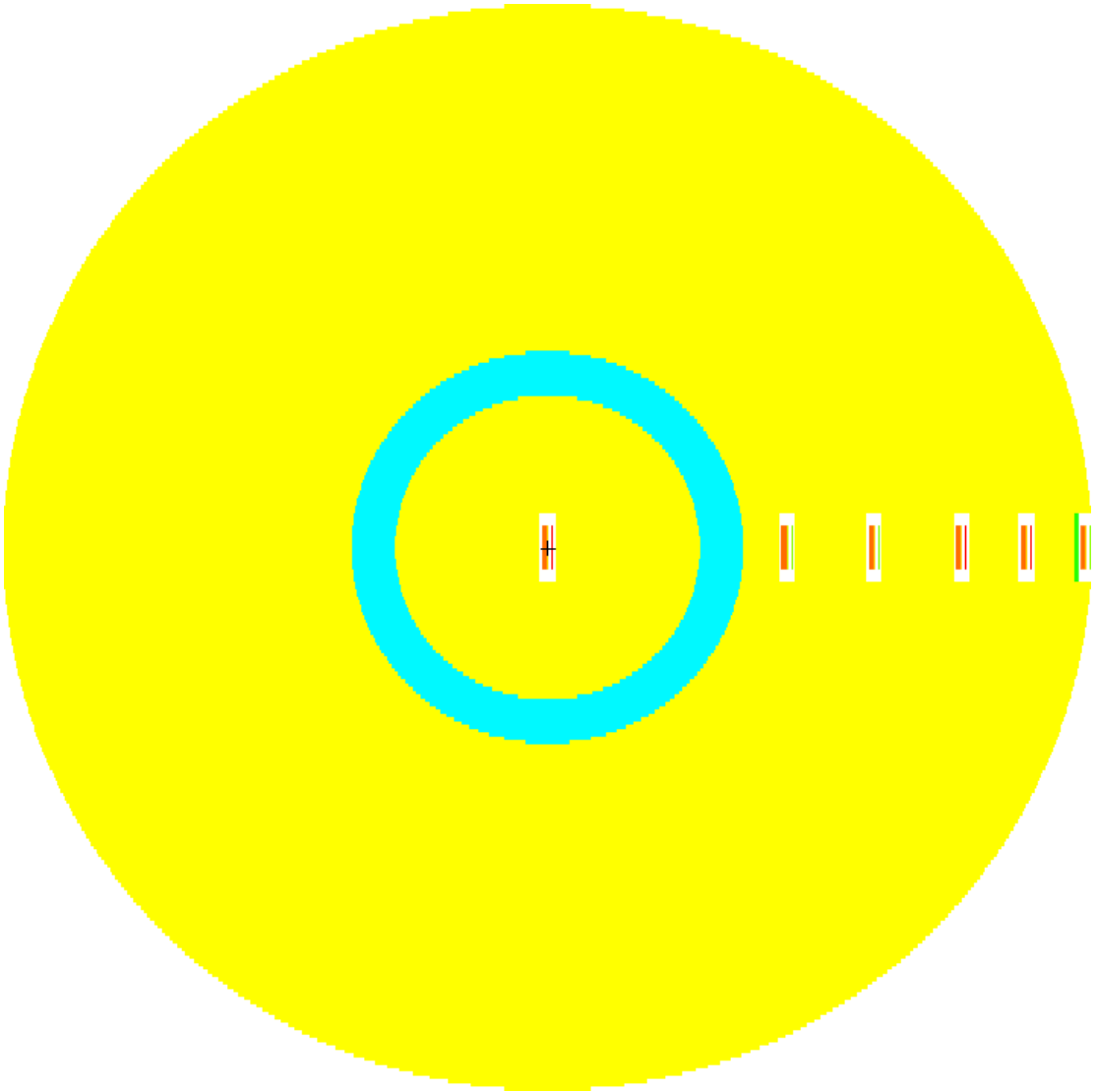
1) CYSP: cylindrical spectrometer





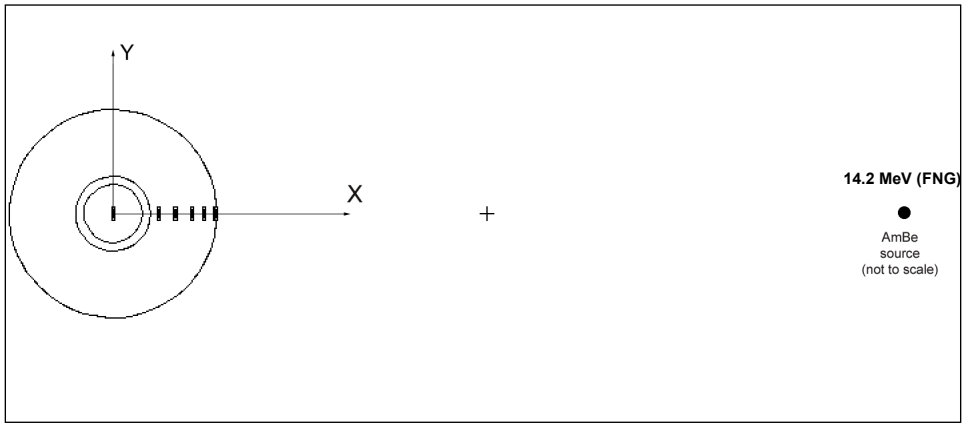


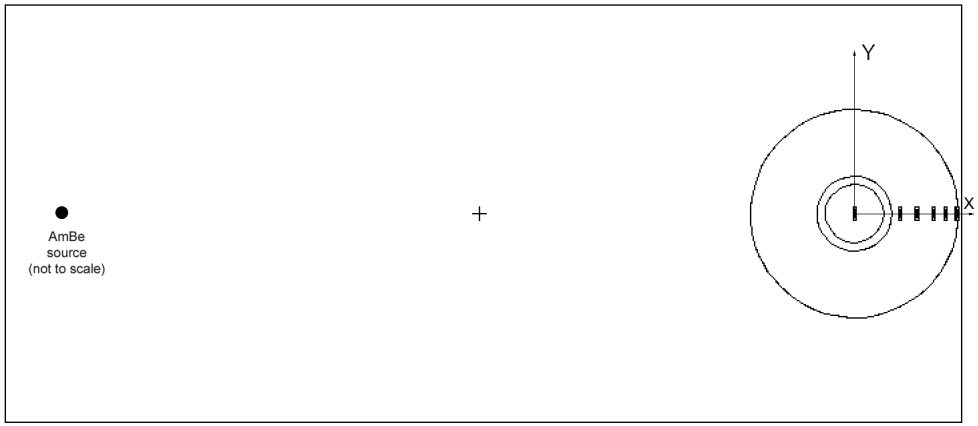
2) SP²: spherical spectrometer

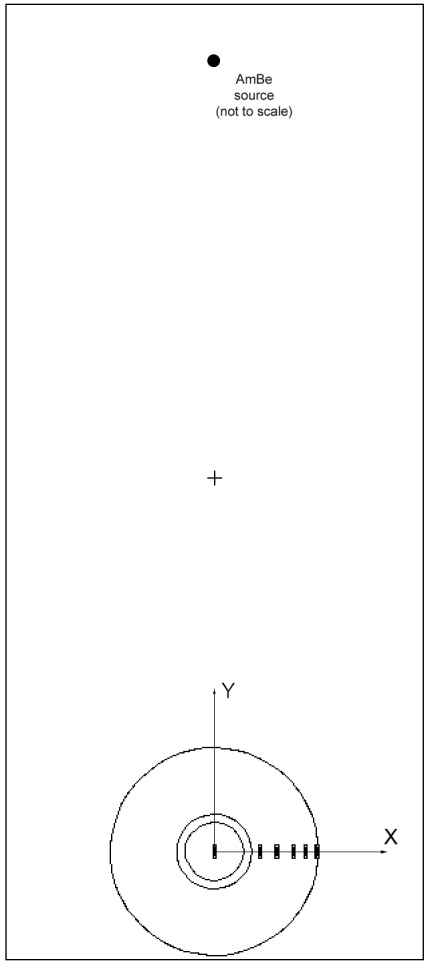


2) SP²: spherical spectrometer

- Irradiation test with an AmBe source.
- Irradiation test with quasi-monoenergetic 14.2 MeV neutrons (FNG).







3) Recently published papers

1) R. Bedogni, J.M.Gómez-Ros, A.Pola, M.V.Introini, D.Bortot, A.Gentile A.Esposito, G. Mazzitelli, B.Buonomo, L.Quintieri, L.Foggetta. *Testing a newly developed single-sphere neutron spectrometer in reference monochromatic fields from 147 keV to 14.8 MeV*. Nucl. Inst. Meth. A 714, 110-114 (2013)

2) R. Bedogni, J.M. Gómez-Ros, D. Bortot, A. Pola, M.V. Introini, A. Esposito, G. Mazzitelli, B. Buonomo, M. Moraleda. *Development of single-exposure, multi-detector neutron spectrometers: the NESCOFI@BTF project*. Radiat. Prot. Dosim. (2014) doi: 10.1093/rpd/nct286

3) R. Bedogni, D. Bortot, A. Pola, M.V. Introini, A. Gentile, A. Esposito, J.M. Gómez-Ros, M. Palomba, A. Grossi. *A new active thermal neutron detector*. Radiat. Prot. Dosim. (2014) doi:10.1093/rpd/nct319

4) A. Pola, D. Bortot, M.V. Introini, R. Bedogni, A. Gentile, A. Esposito, J.M. Gómez-Ros, E. Passoth, A. Prokofiev. *Compact thermal neutron sensors for moderator-based neutron spectrometers*. Radiat. Prot. Dosim. (2014) doi:10.1093/rpd/nct298