Detector simulation within GEANT4 framework

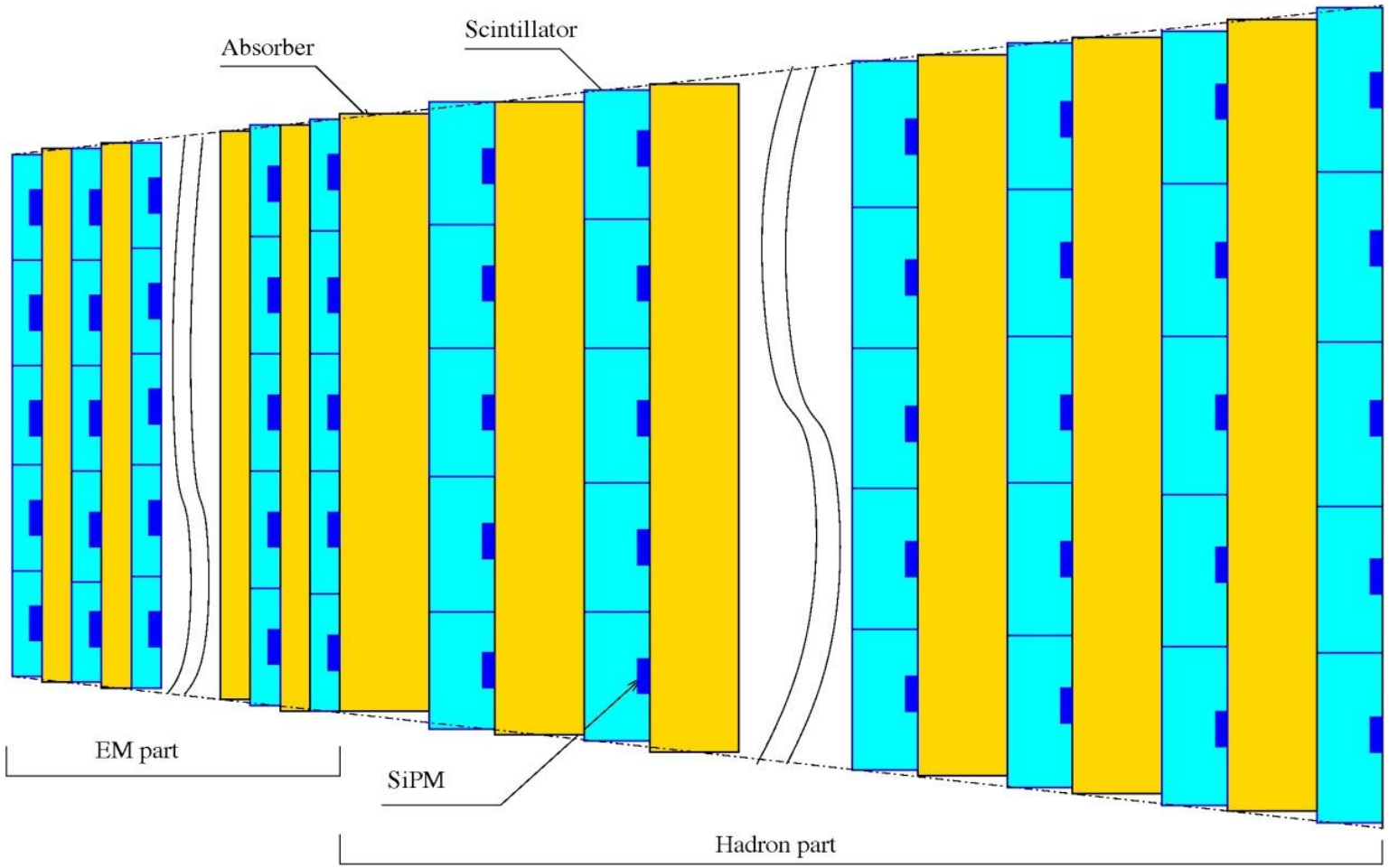
D.Kirin,A.S.

Optimization goals:

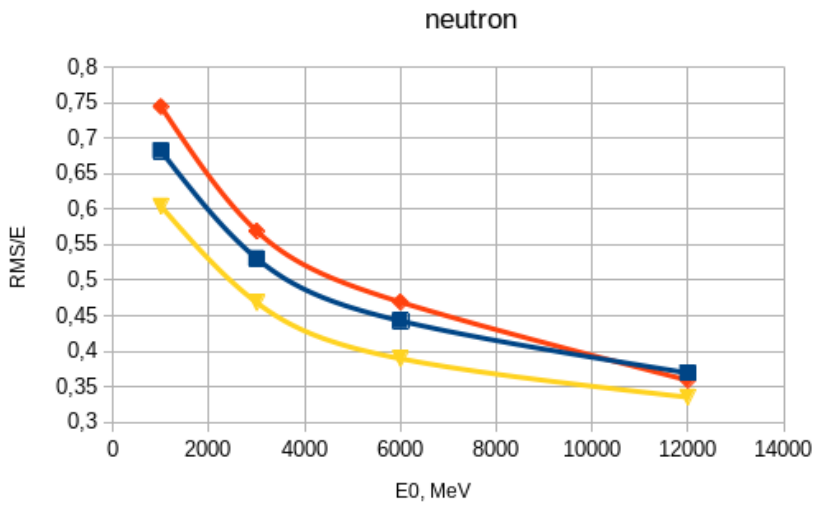
1)Energy resolution for neutrons 50-60%/$\sqrt{E}$ +8-10% within 1-12 GeV energy range;
2)Neutron entry point geometry resolution 10 mm;
3)n-ɣ separation

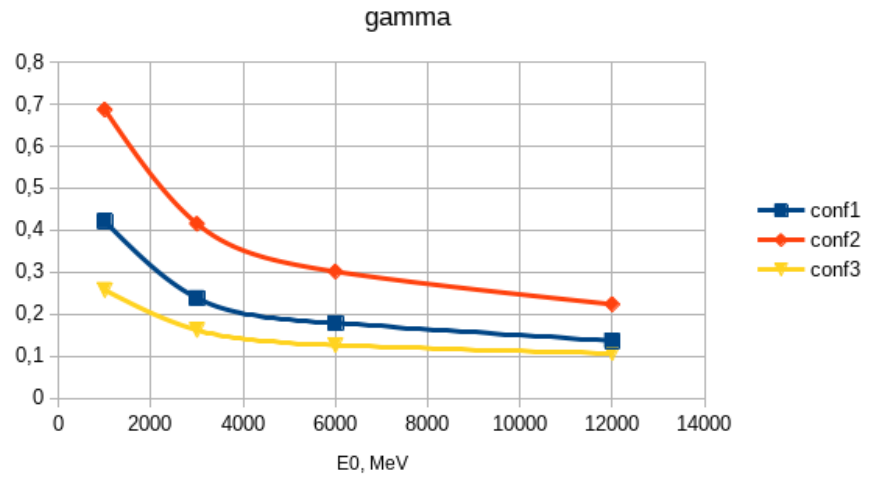
At the first stage of the experiment ZDC size is limited to 88x88 mm^2 at front side and 140x140 mm^2 at rear side. The length is limited to 650 mm.

Neutrons and photons of different energies (1, 3, 6 and 12 GeV) are created by a box generator. The particle momentum is parallel to the longitudinal axis of the calorimeter. The interaction point distribution in the frontal transverse plane of the detector is uniform.

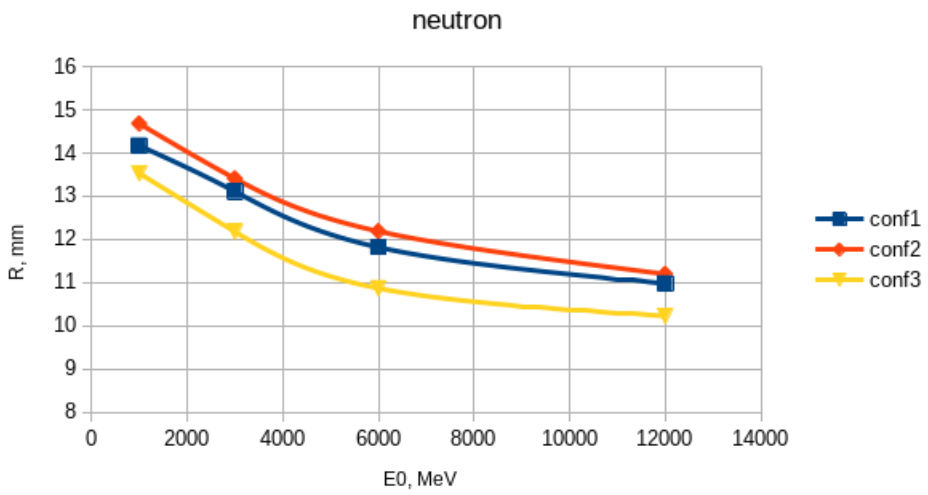


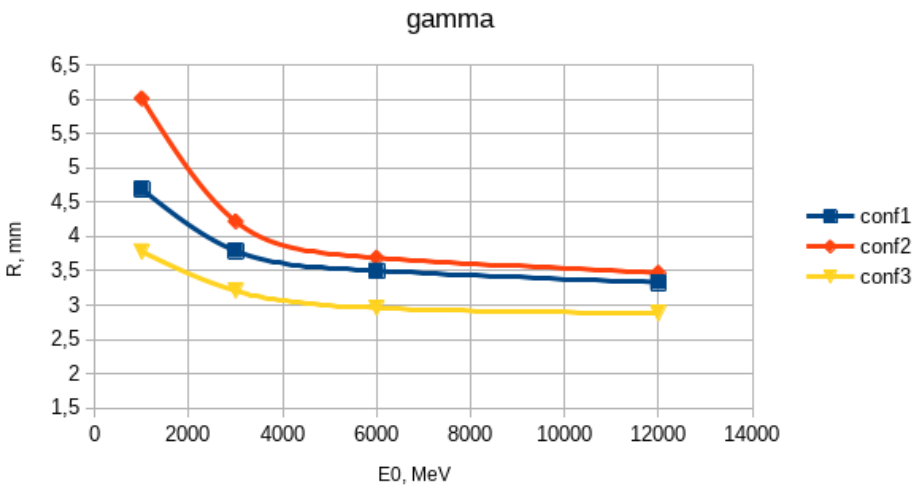
Each scintillator layer has 25 tiles arranged in 5x5 grid with tile size growing from 17x17 mm^2 for the first layer to 28x28 mm^2 at the last layer.

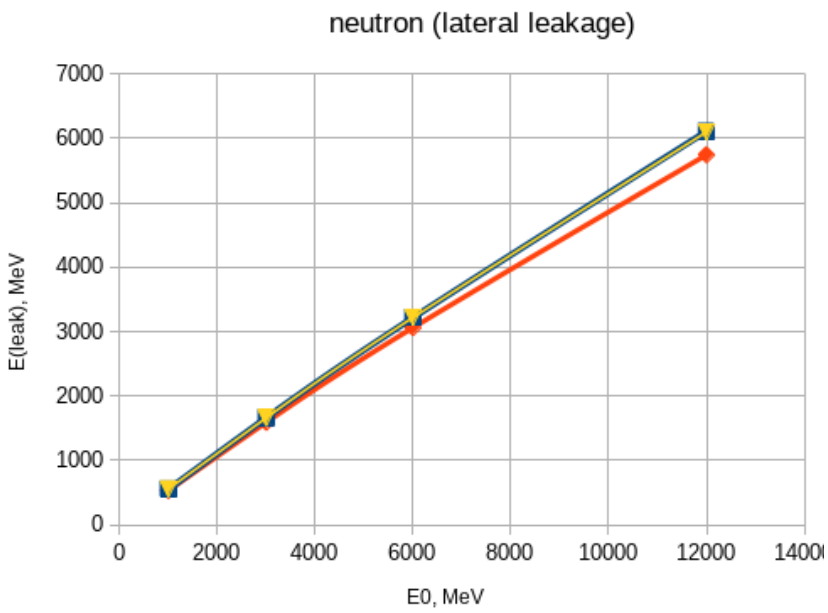


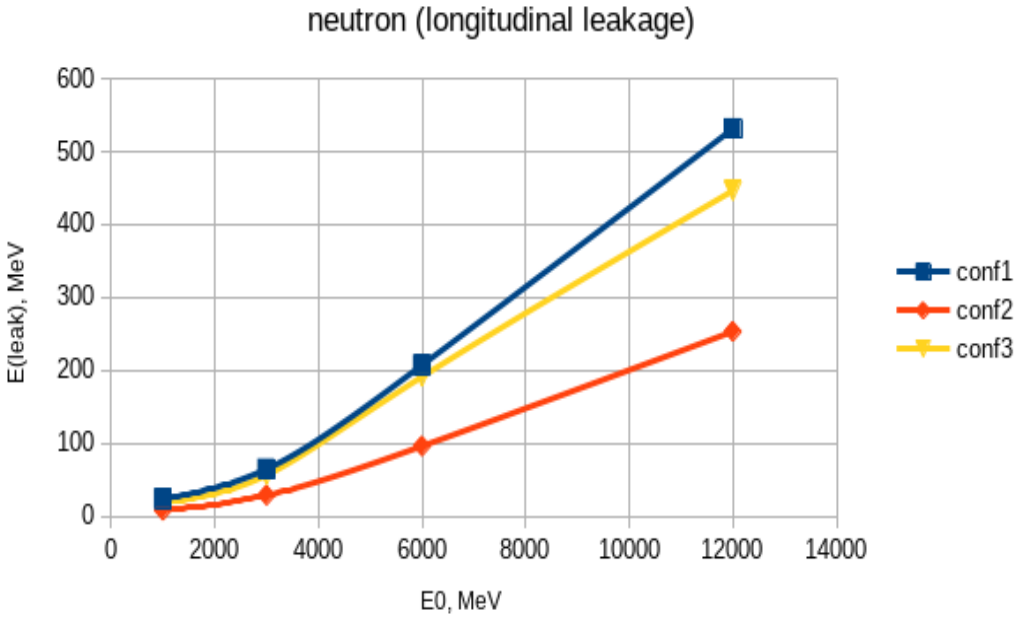


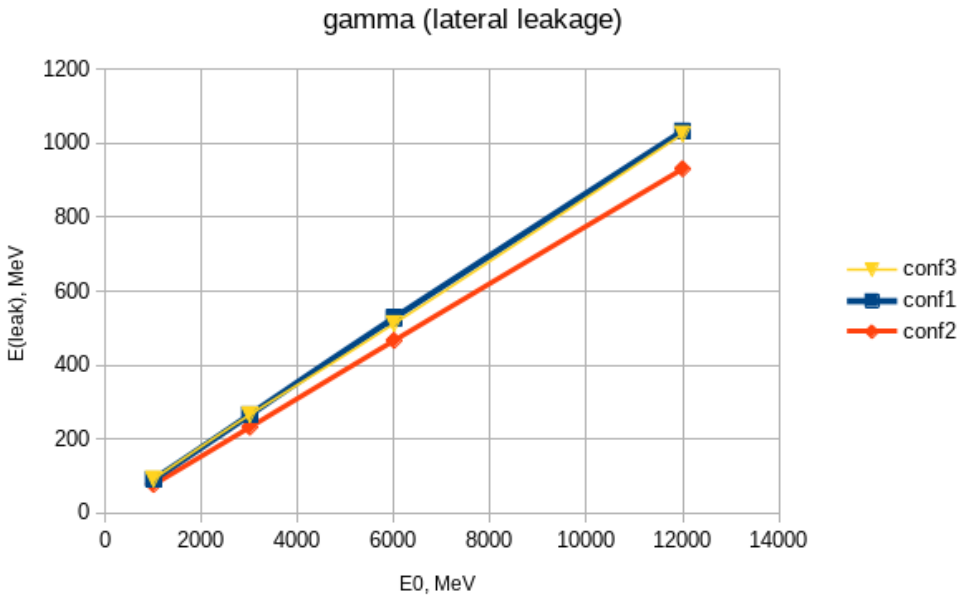
Conf. 1	(Sci(20mm)+W(20mm))x16 active slices	Nucl.int.length 3.4
Conf. 2	(Sci(15mm)+W(30mm))x15 active slices	Nucl.int.length 4.8
Conf. 3	(Sci(10mm)+W(10mm))x33 active slices	Nucl.int.length 3.6

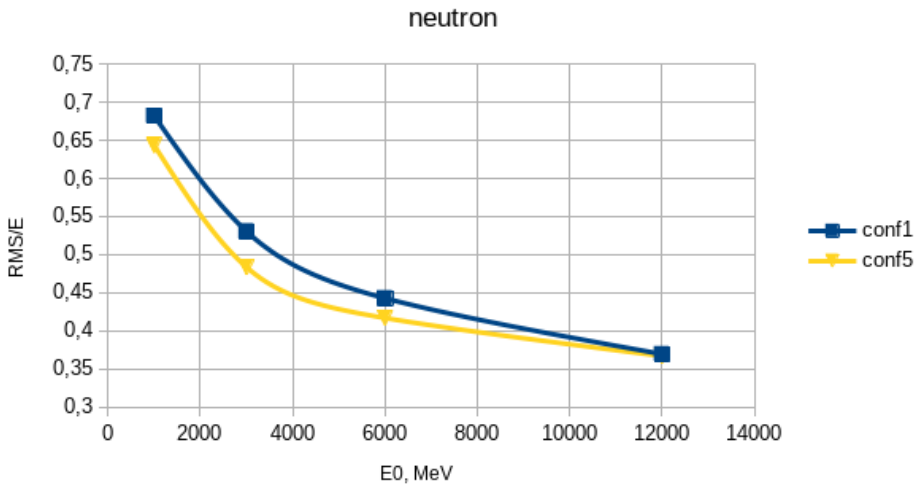


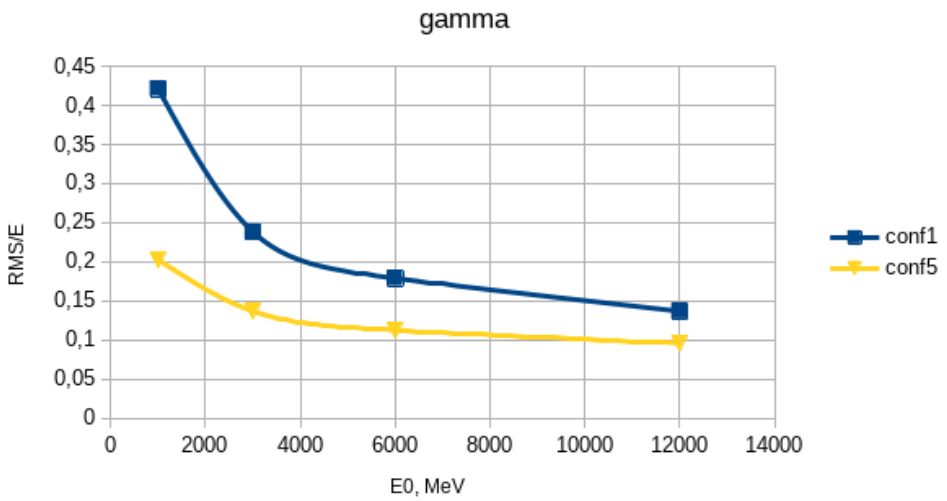



neutron (lateral leakage)
E(leak), MeV
E0, MeV
0
1000
2000
3000
4000
5000
6000
7000
0
2000
4000
6000
8000
10000
12000
14000

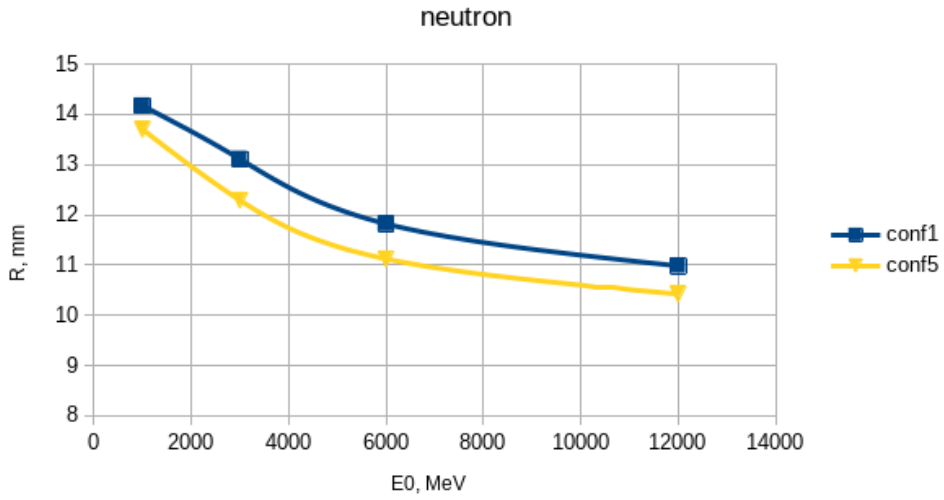

neutron (longitudinal leakage)
E(leak), MeV
E0, MeV
0
100
200
300
400
500
600
0
2000
4000
6000
8000
10000
12000
14000
conf1
conf2
conf3

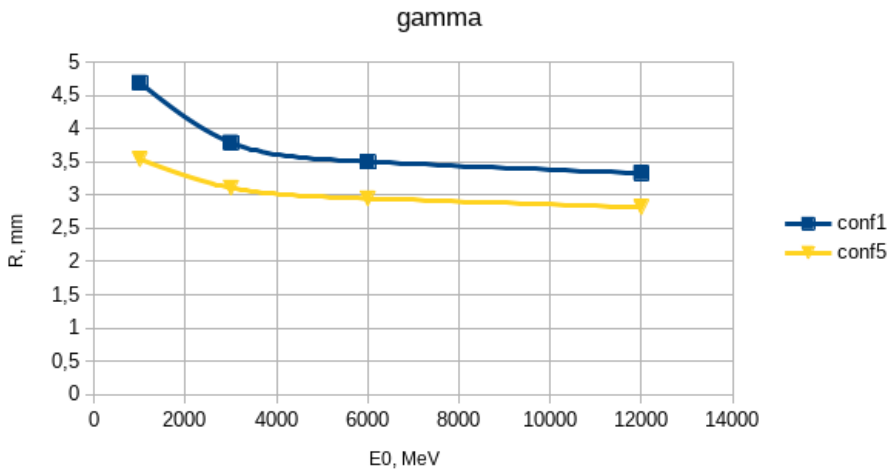

gamma (lateral leakage)
E(leak), MeV
E0, MeV
0
200
400
600
800
1000
1200
0
2000
4000
6000
8000
10000
12000
14000
conf3
conf1
conf2

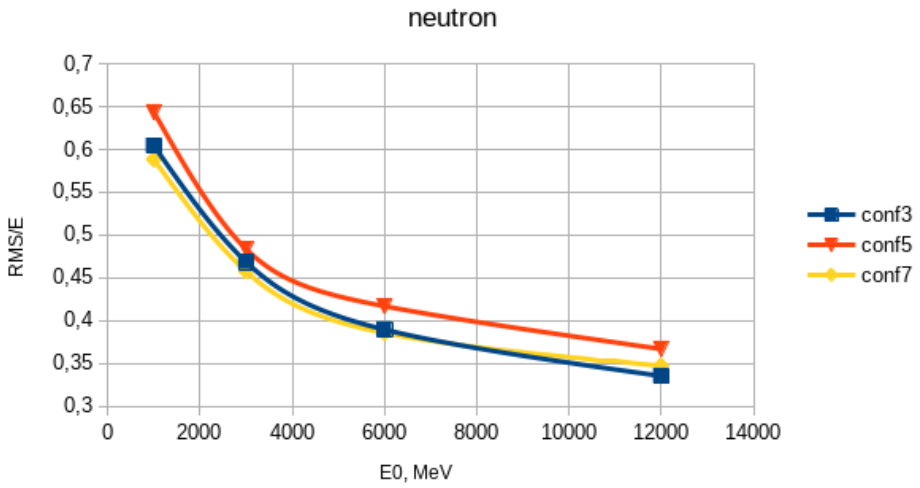


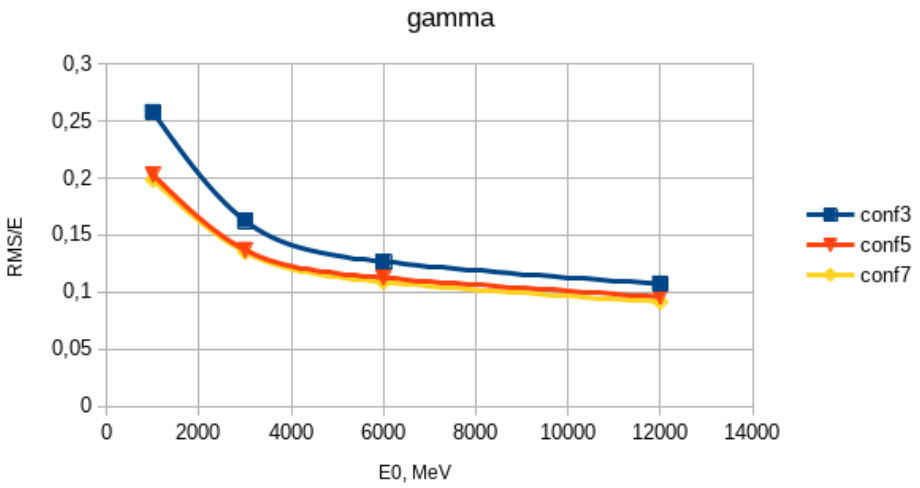


No	Configuration	nucl.int.len.
1	(Sci(20mm)+W(20mm))x16 slices	3.4
5	(Sci(5mm)+W(5mm))x10 slices+(Sci(20mm)+W(20mm))x13 slices	3.3

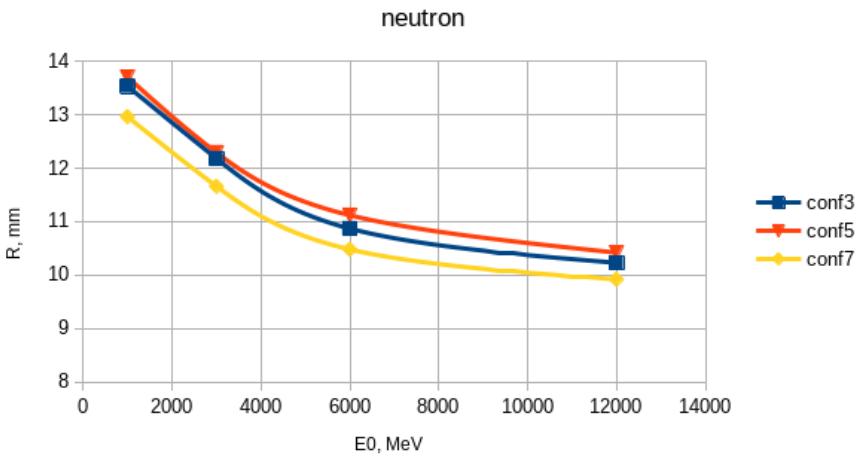


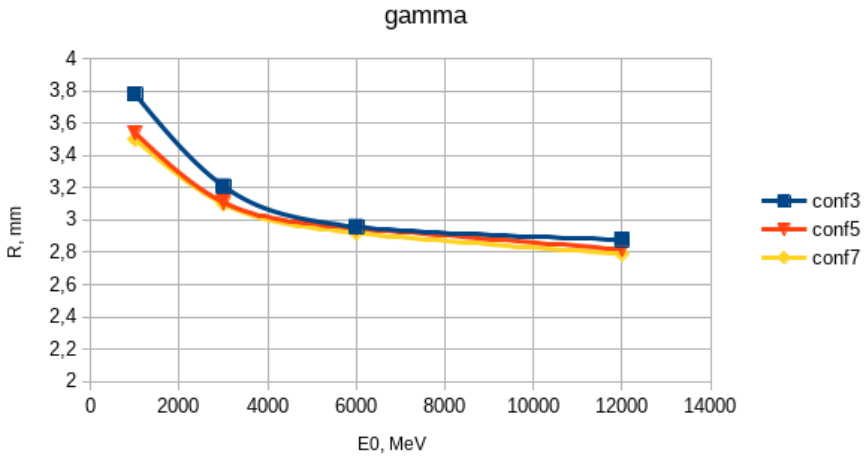


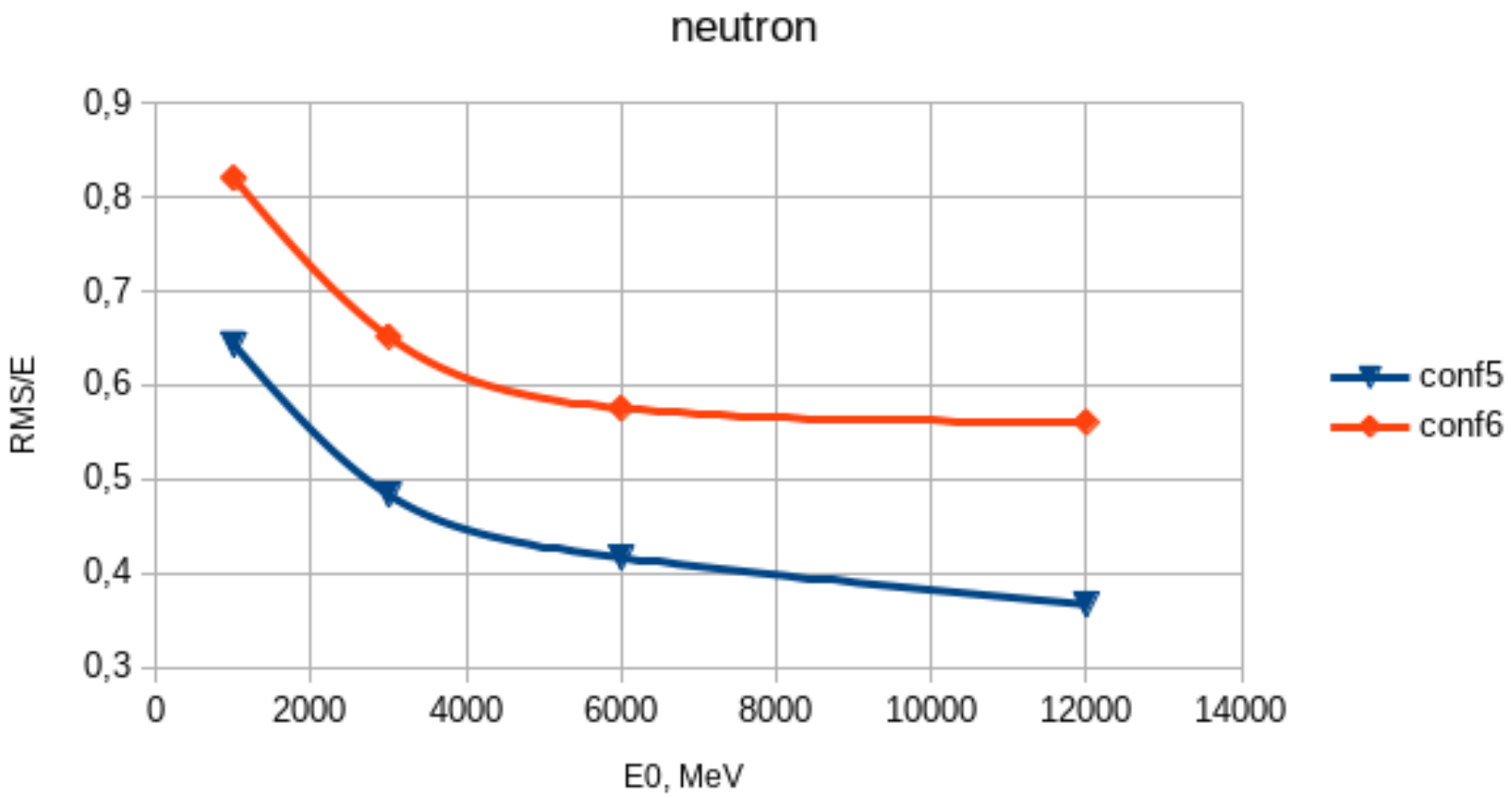




No	•Configuration	nucl.int.len.
3	(Sci(10mm)+W(10mm))x33 slices	3.6
5	(Sci(5mm)+W(5mm))x10 slices+(Sci(20mm)+W(20mm))x13 slices	3.3
7	(Sci(5mm)+W(5mm))x10 slices+(Sci(10mm)+W(10mm))x26 slices	3.4

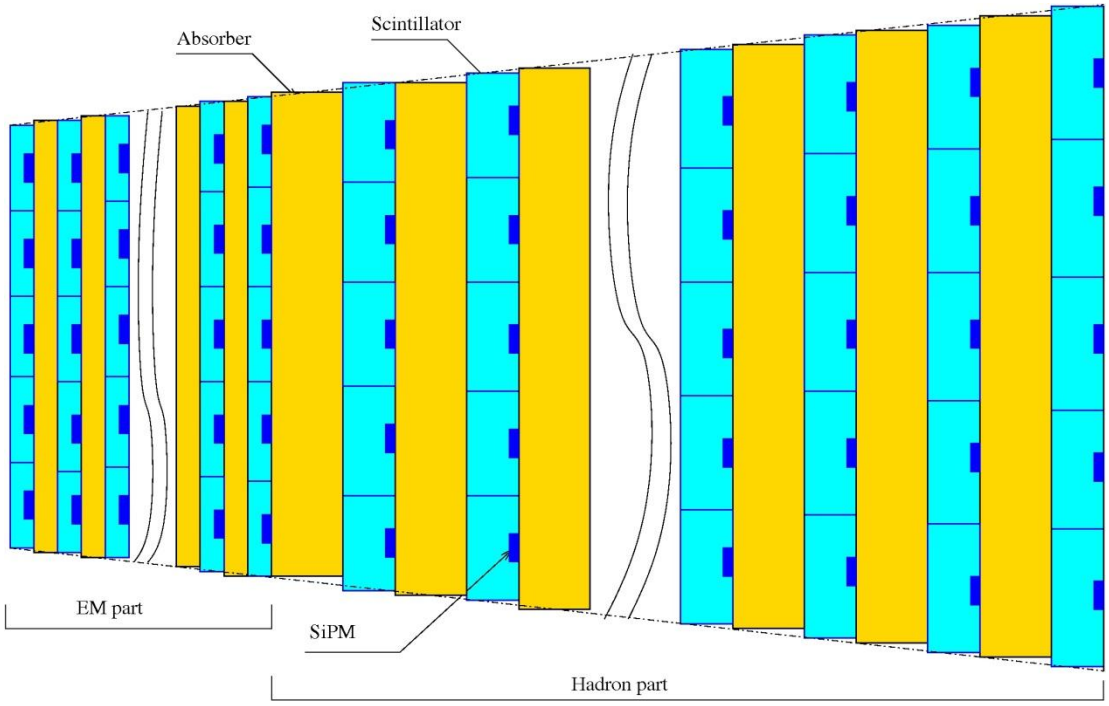






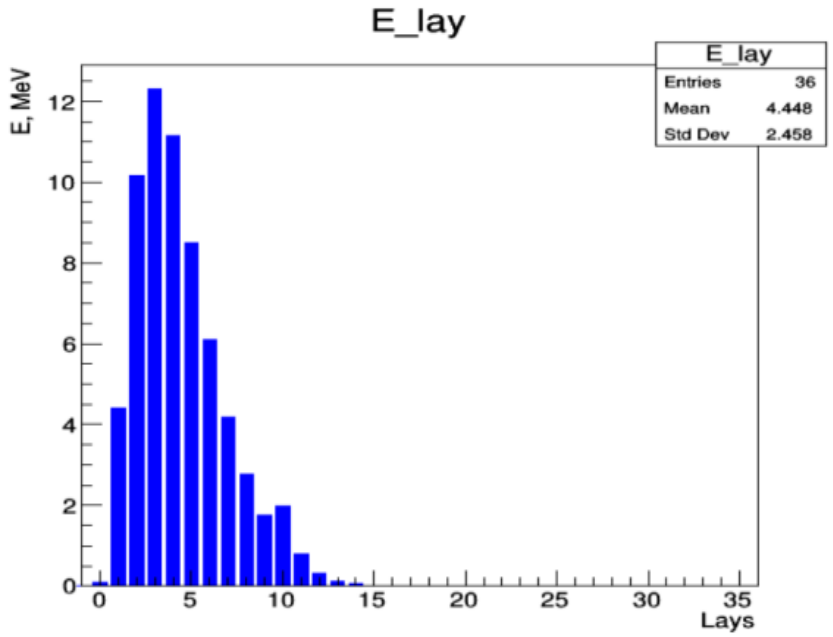
No	Configuration	nucl.int.len.
5	(Sci(5mm)+W(5mm))x10 slices+(Sci(20mm)+W(20mm))x13 slices	3.3
6	(Sci(5mm)+Cu(5mm))x10 slices+(Sci(20mm)+Cu(20mm))x13 slices	2.0

No	Configuration	nucl.int.len.
7	(Sci(5mm)+W(5mm))x10 slices+(Sci(10mm)+W(10mm))x26 slices	3.4

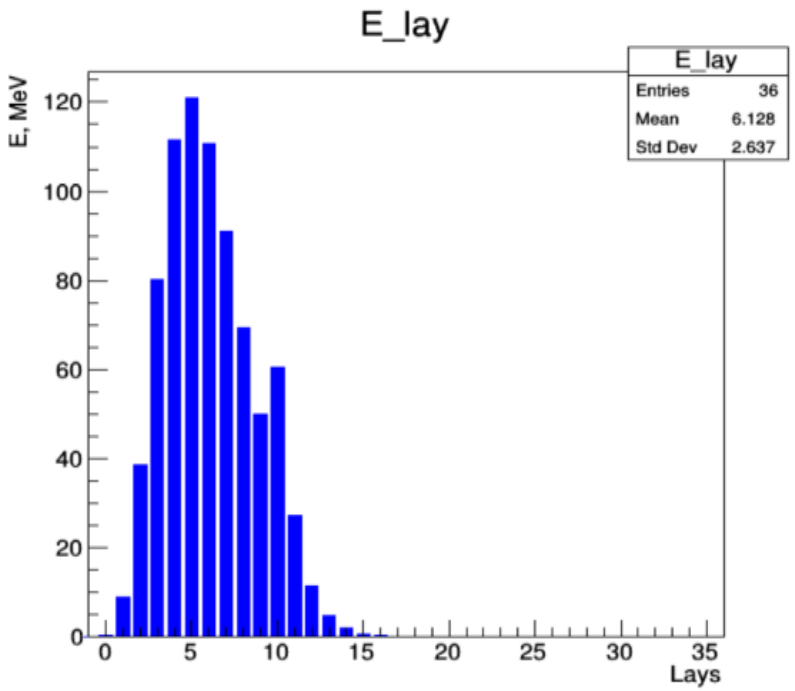


configuration 7 is the best one within available space. For this configuration energy resolution for neutrons is about 50%/√E+30%. (For E<2GeV ~ 60%/√E+10%.)
Energy resolution for photons is about 20%/√E+9%.

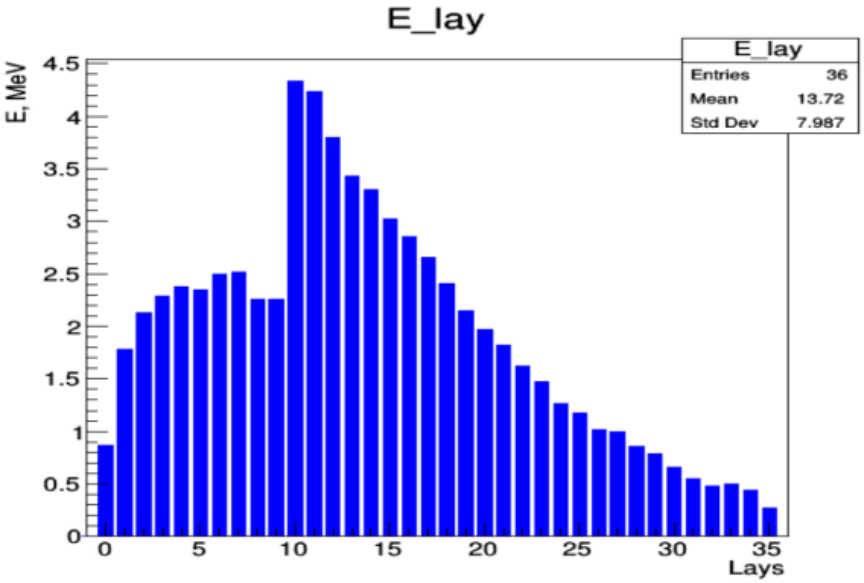
Gamma 1GeV Conf.7



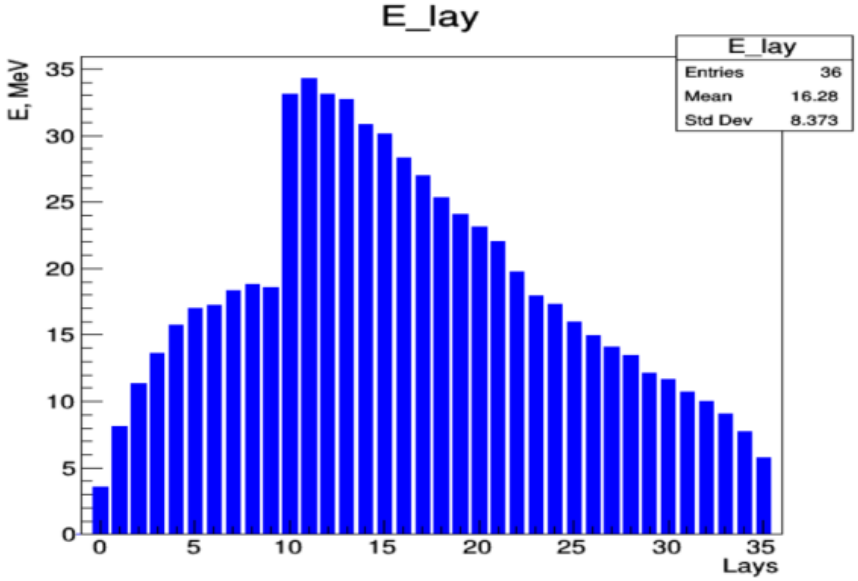
Gamma 12GeV Conf.7

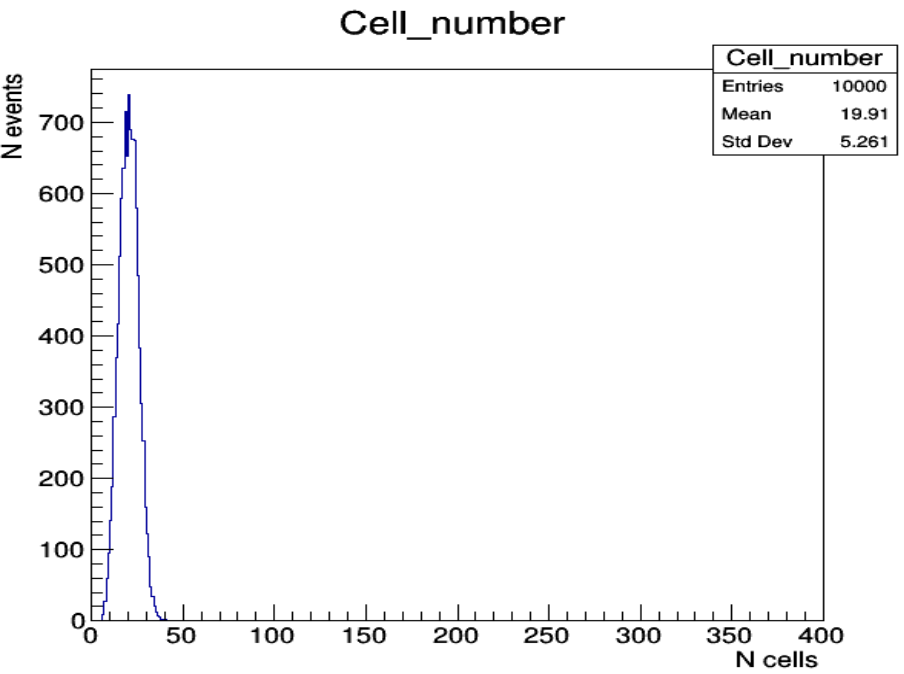


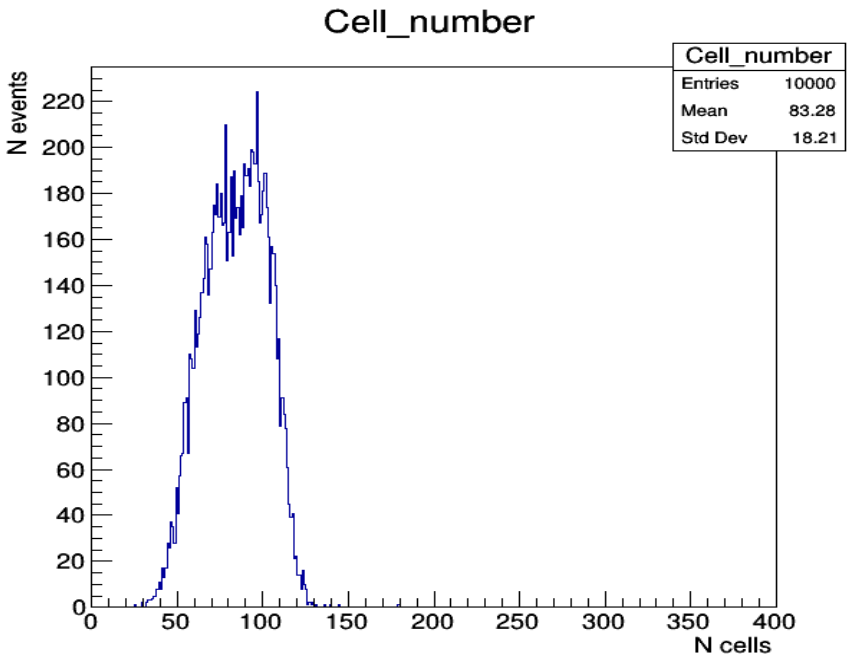
Neutron 1GeV Conf.7



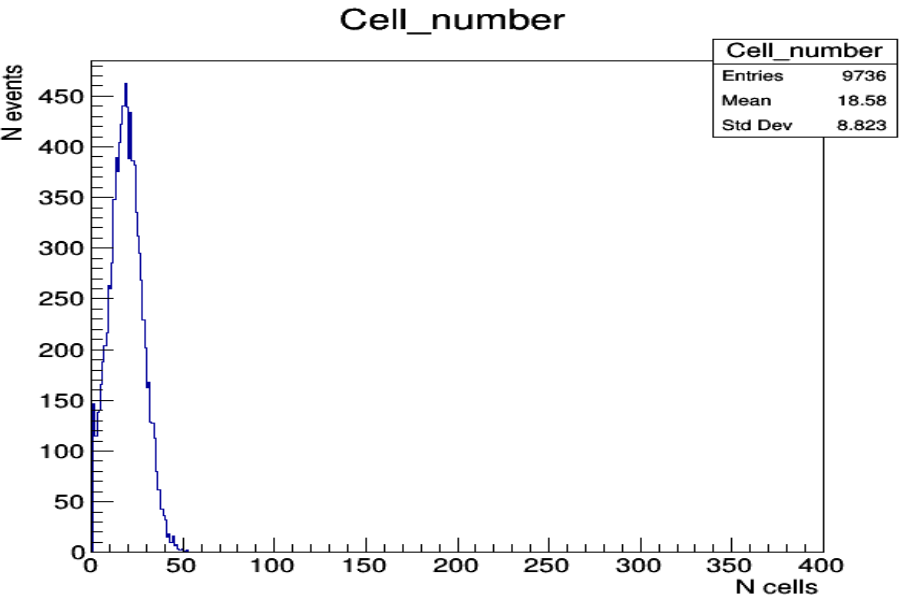
Neutron 12GeVConf.7

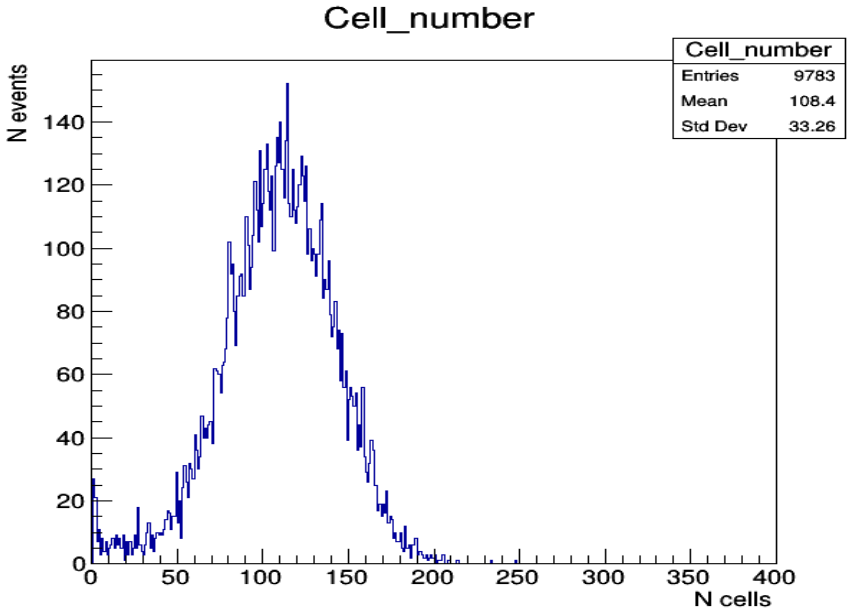


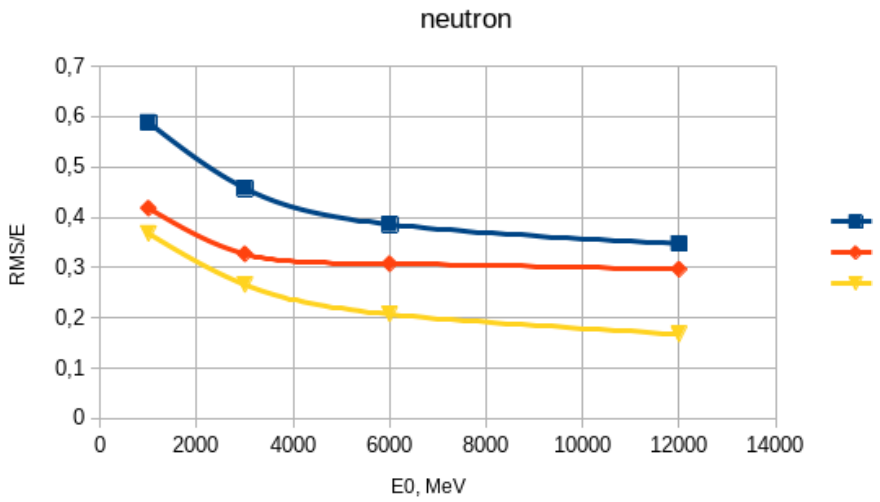


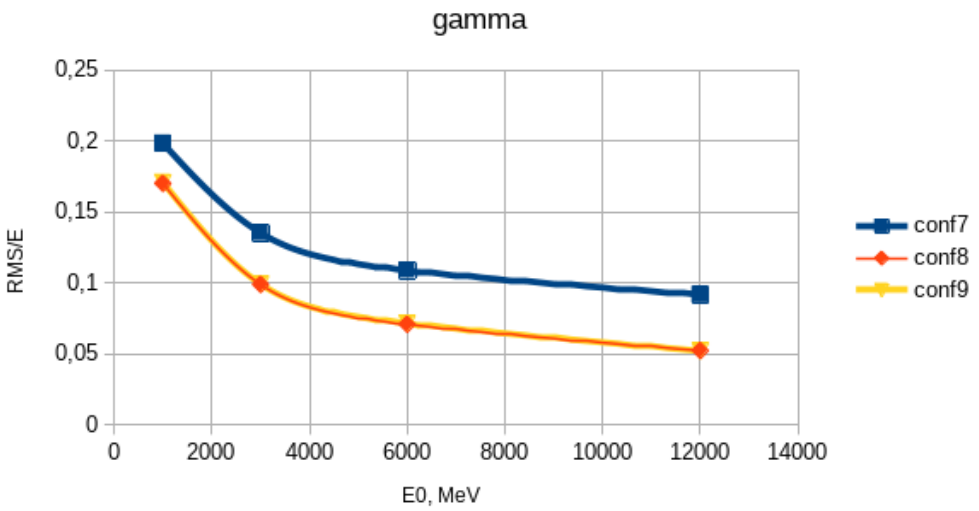


Number of hit cells distributions for photons(up) and neutron (down) for different particle energy(1 GeV-left and 12 GeV-right, all for configuration 7). Energy threshold for single cell is 0.2MeV.





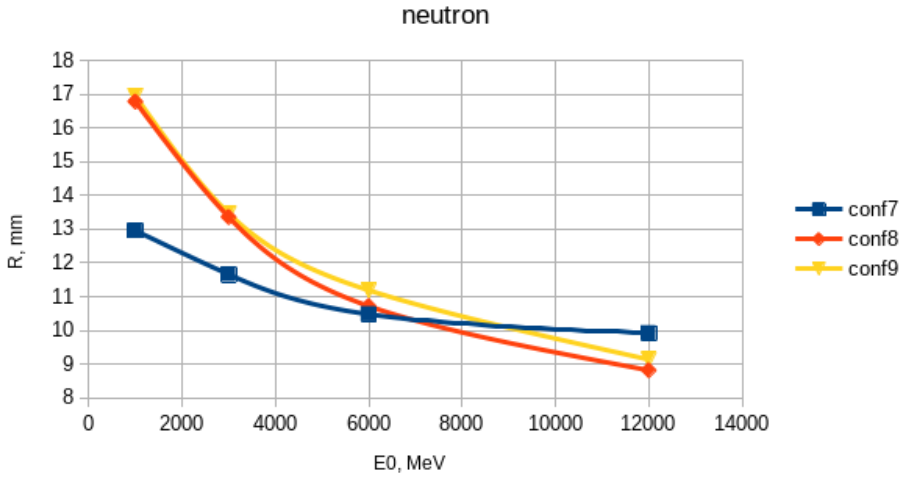


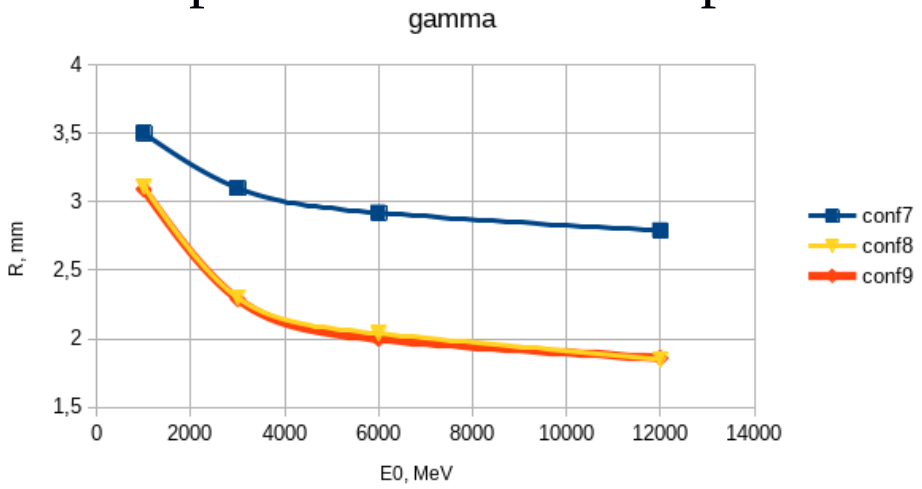


Configuration 9 for neutrons:36%/√E+12%.)

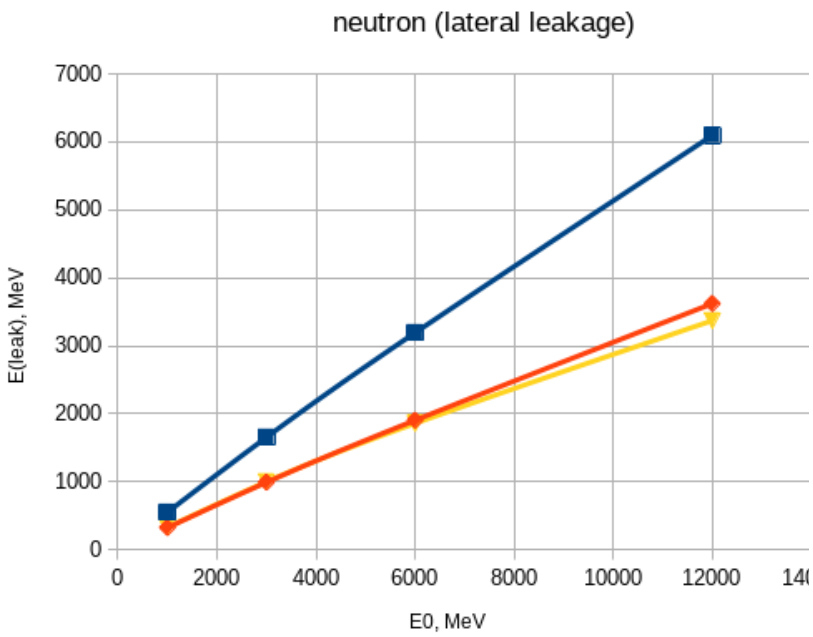
No	Configuration	nucl. int.
7	(Sci(5mm)+W(5mm))x10 slices+(Sci(10mm)+W(10mm))x26 slices	3.4
8	(Sci(5mm)+W(5mm))x10 slices+(Sci(10mm)+W(10mm))x26 slices (14x14; each 18x18mm^2	3.4
9	(Sci(5mm)+W(5mm))x10 slices+(Sci(10mm)+W(10mm))x46 slices (14x14; each 18x18mm^2) **250x250x1010mm^3 total volume**	5.4

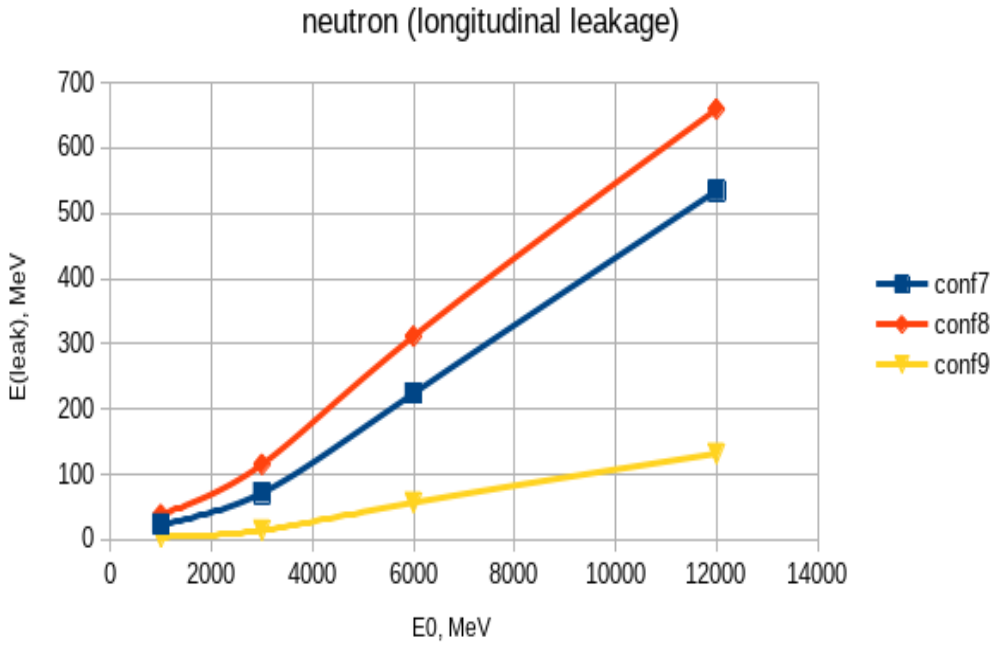
Expansion in both transverse and longitudinal directions is important for neutrons. For photons the longitudinal expansion is not so important.

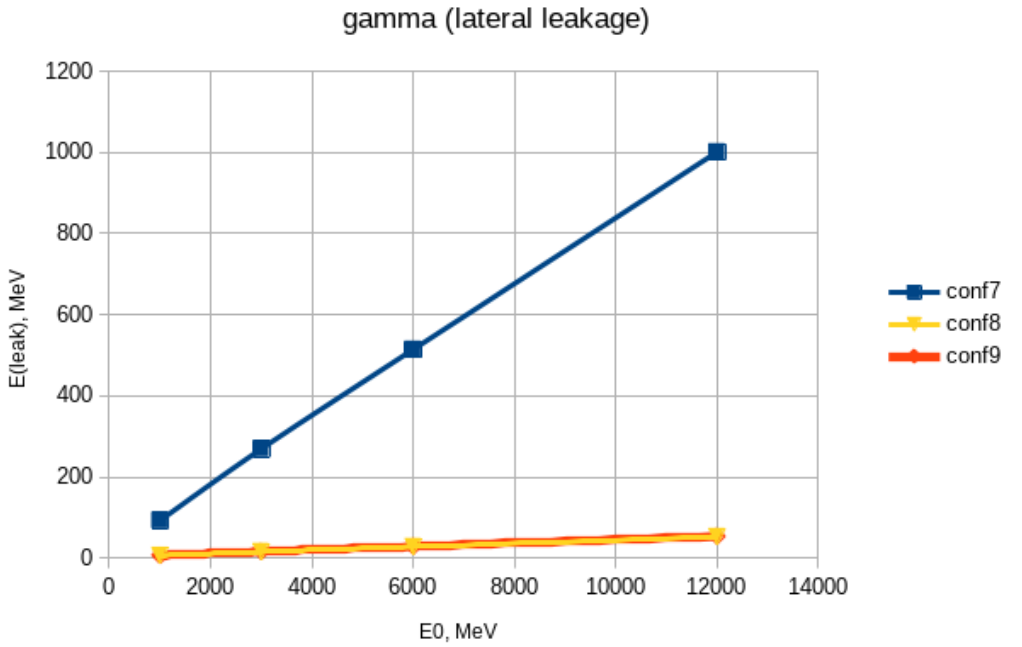




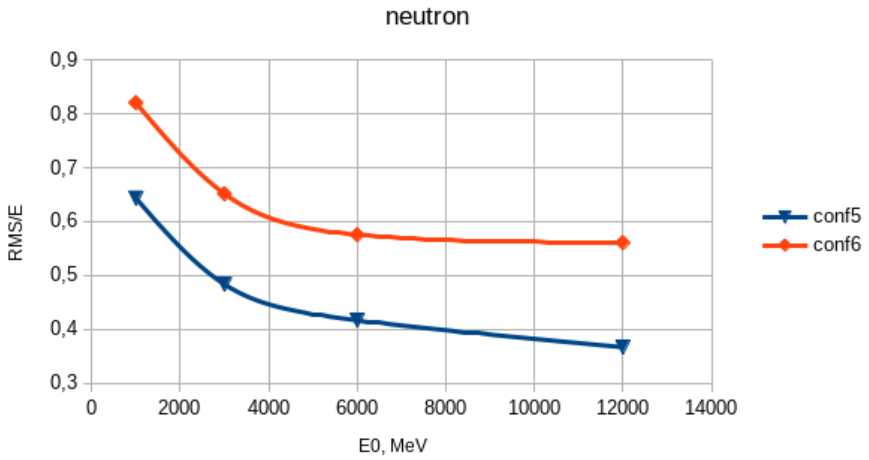
Thanks for the attention!

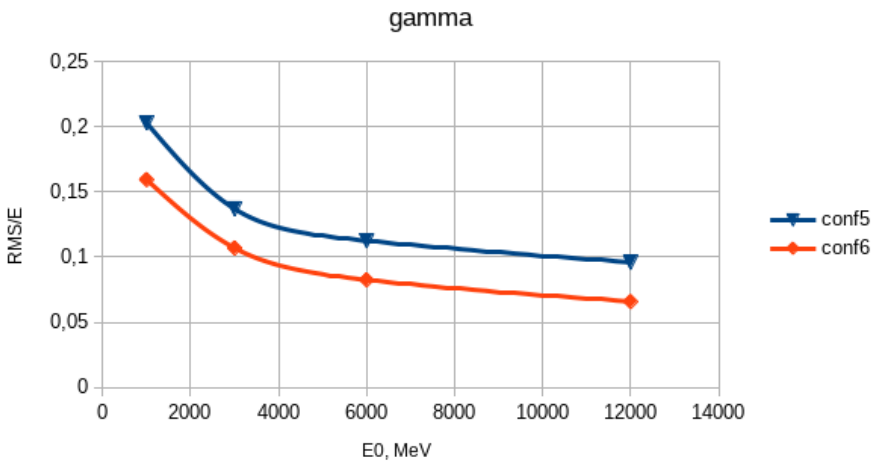

neutron (lateral leakage)
E(leak), MeV
E0, MeV
0
1000
2000
3000
4000
5000
6000
7000
0
2000
4000
6000
8000
10000
12000


neutron (longitudinal leakage)
E(leak), MeV
E0, MeV
0
100
200
300
400
500
600
700
0
2000
4000
6000
8000
10000
12000
14000
conf7
conf8
conf9


gamma (lateral leakage)
E(leak), MeV
E0, MeV
0
200
400
600
800
1000
1200
0
2000
4000
6000
8000
10000
12000
14000
conf7
conf8
conf9

No	•Configuration	nucl.int.len.
1	(Sci(20mm)+W(20mm))x16 slices	3.4
2	(Sci(15mm)+W(30mm))x15 slices	4.8
3	(Sci(10mm)+W(10mm))x33 slices	3.6
4	(Sci(5mm)+W(5mm))x6 slices+(Sci(20mm)+W(20mm))x14 slices	3.3
5	(Sci(5mm)+W(5mm))x10 slices+(Sci(20mm)+W(20mm))x13 slices	3.3
6	(Sci(5mm)+Cu(5mm))x10 slices+(Sci(20mm)+Cu(20mm))x13 slices	2.0
7	(Sci(5mm)+W(5mm))x10 slices+(Sci(10mm)+W(10mm))x26 slices	3.4
8	(Sci(5mm)+W(5mm))x10 slices+(Sci(10mm)+W(10mm))x26 slices (14x14)	3.4
9	(Sci(5mm)+W(5mm))x10 slices+(Sci(10mm)+W(10mm))x46 slices (14x14)	5.4





No	Configuration	nucl.int.len.
5	(Sci(5mm)+W(5mm))x10 slices+(Sci(20mm)+W(20mm))x13 slices	3.3
6	(Sci(5mm)+Cu(5mm))x10 slices+(Sci(20mm)+Cu(20mm))x13 slices	2.0