In the present report we describe the method used to calculate the cost for shielding and its materials of T-REX. For materials we used the ESS value of 1500 €/t for steel and 800€/m^3 for concrete. Other materials are costed according to price information from German companies/market.

T-REX beamline shielding

The shielding materials for T-REX have been costed according to the 'ESS process for shielding cost'. Here we summarize the chosen thickness along the beamline.

	Steel (m)	Concrete (m)
< 28 m	Inside bunker (see below dedicated section)	
28 m < L < 45 m	0.35	0.3
45m < L < 50 m	0.25	0.3
50 m < L < 162 m	between 0.18 and 0.28, according to m-index	0.6
162 m < L < 172 m	Experimental Cave (see below dedicated section)	

The basic parameters for calculation are: inner dimensions of the cave (the so-called optical cave) is assumed 0.5 m with square section; floor height according to the ESS plan from CF. From the calculation one gets a total of 1355 t of concrete and 712 t of steel, for a total cost of 1,520,000€.

T-REX Experimental Cave

The cave is expected to be made with concrete, reinforced with 100 kg/m^3 of steel. The calculation of the required thickness is based on the calculation method used for POWTEX (MLZ) and used also for the DREAM instrument. It has been already presented in several occasions with no criticism. It is based on the assumption that the neutron intensity (10^9 n/s) is converted into gammas by a sample made of 50% Cd and 50% Fe, which is considered the worst case scenario for neutrons to gammas conversion. The distance between sample and wall is given by instrument parameters and requirements: 5.4 m in each direction. The thickness is chosen such that the attenuation power of concrete walls reduces the calculated dose level down to 1μ Sv/h.

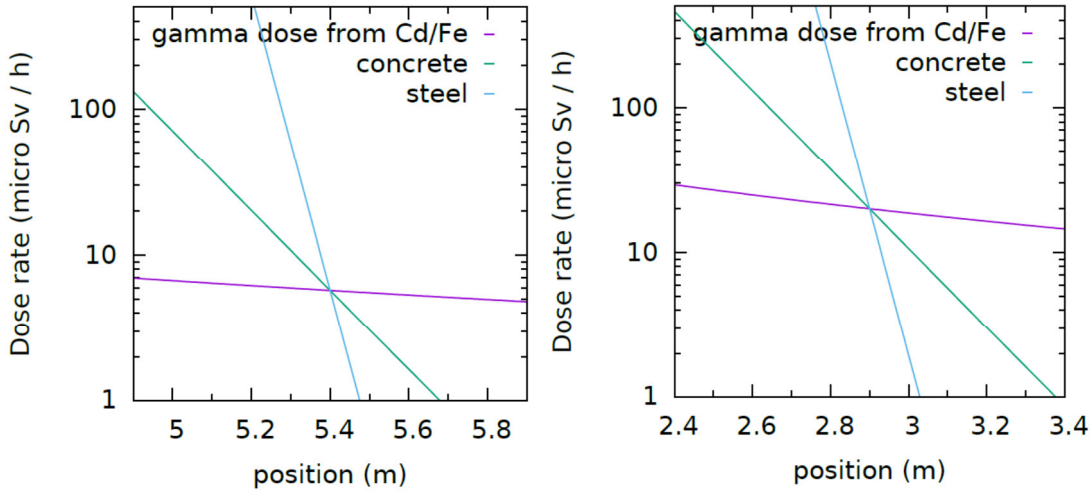
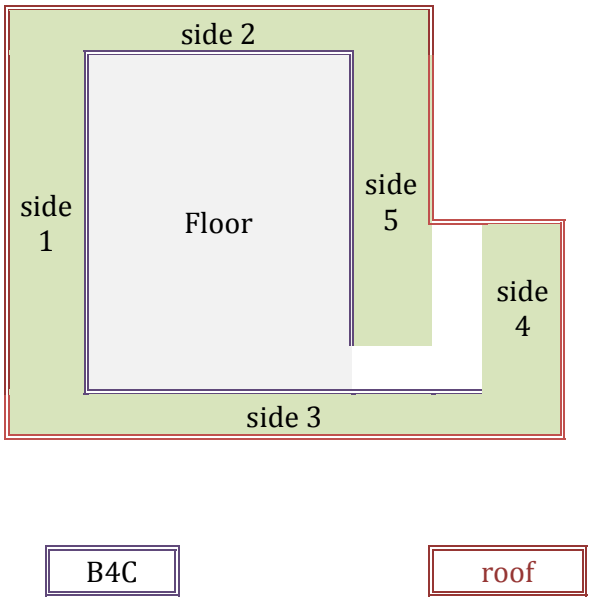


Figure 1. Attenuation of gamma dose rate at the cave wall (left) and roof (right).

As it can be seen nearly 30 cm of concrete are necessary for the walls and 50 cm for the roof, because it's closer (2.9 m from sample). As a comparison it is shown that 7 cm and 12 cm steel would work as well, for the walls and roof, respectively. As described in the picture it has been assumed that the inner side of the cave is lined with B4C sheets of 5mm, costed 500 €/m^2.

Moreover it has been assumed that the floor will be raised by 90 cm over the floor of Hall 3, to adjust the height of instrument components to the beam height, which is 3.14 m over floor in Hall 3.



	(m)
thickness	0.3
wall height	6
side 1	11.4
side 2	11.4
side 3	14.4
side 4	5
side 5	9
floor height	0.9

Table 1 Cave dimensions

Figure 2. Schematic depiction of the cave.

Therefore the T-REX cave will require approximatively 267 m^3 of Concrete, 27 t of steel and 327 m^2 of B_4C. Total estimated cost is nearly 418000€, construction work and logistics excluded.

component	concrete (m^3)	steel content (t) assuming 100kg/m^3	B4C (m^2)	cost (€)
roof	72	7	117	127176
walls	90	9	210	190620
floor	105	10		99727
TOTAL	**267**	**27**	**327**	**417523**

Table 2 Cost calculation

Load

ESS requirement for Maximum load on ground is 20 T/m^2.

✓ load on ground

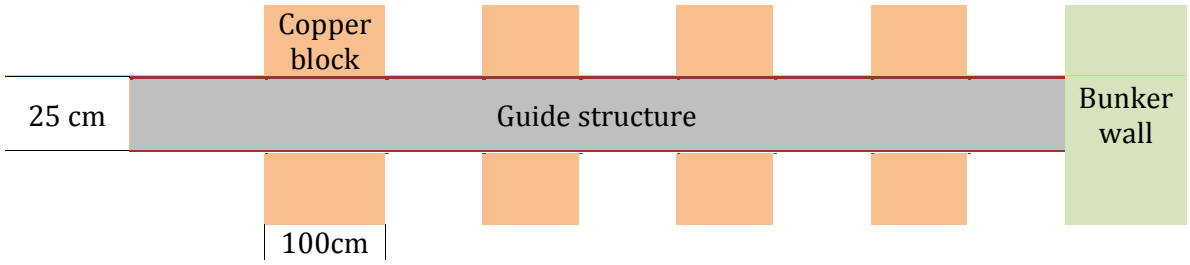
concrete (267 m^3 x 2.4 t/ m^3 = 641 t) + reinforcement steel (27 t)
lying on nearly 150 m^2
hence nearly 4.5 T/m^2

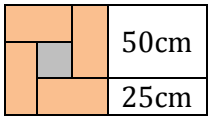
In-bunker shielding

We calculated the cost for lining the guide structure with B4C sheets of 5mm, costed 500 €/m^2 and for additional copper collimators inside the bunker, as suggested by NOSG at the last IKON.

1 copper collimator is: 50 cm x 25 cm x 100 cm, 4 collimators are assembled around the guide structure to make a collar, 4 collars inside the bunker. So the volume is:

4 x 4 x (0.5 x 0.25 x 1) m^3 = 2 m^3





Copper is costed 4170 €/t (37196 €/ m^3), so that the cost is:

2 m^3 x 37196 €/ m^3 = 74393 €

The guide structure, which is 25 cm in size, is lined with 5 mm B4C sheets on the 4 walls, over the entire guide length (22 m) so that one gets:

0.25 m x 4 x 22 m = 22 m^2

The cost is: 22 m^2 x 500 €/m^2 = 11000 €