The background of steel cryostat with copper shielding

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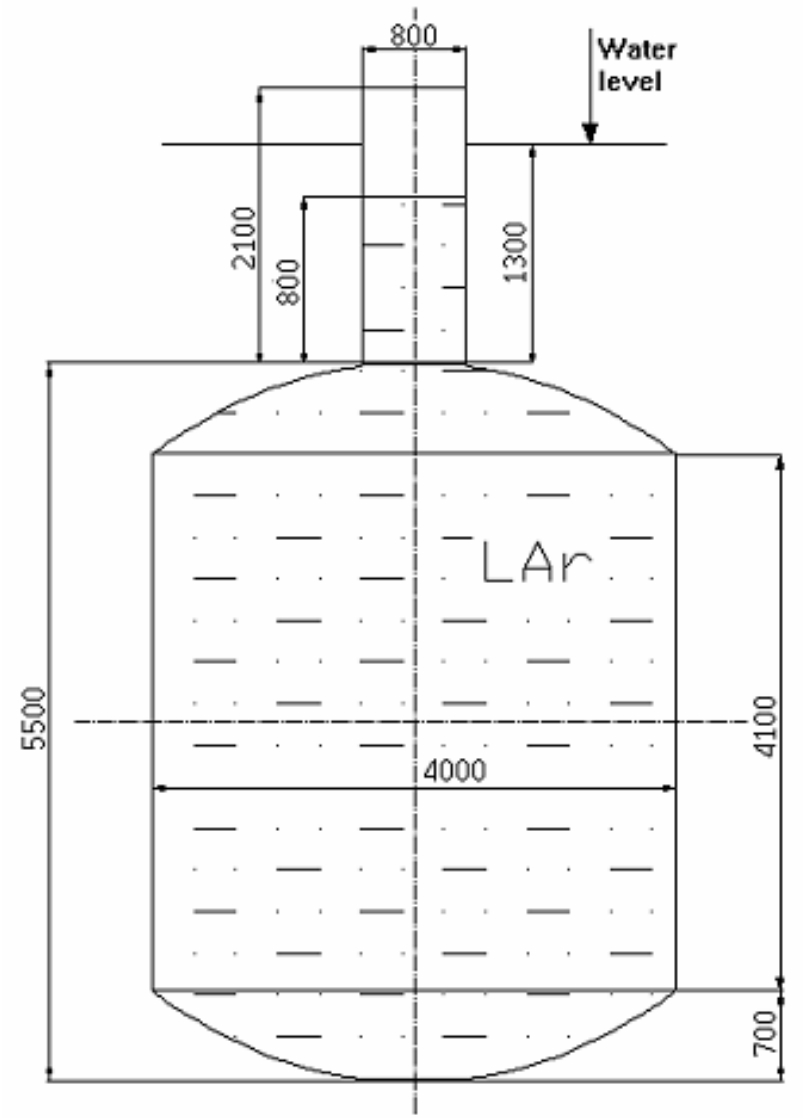
Units of the background index :

10^{-4}/keV.year.kg =1 gbu (Gerda background units)

The dimensions of the cylinder:
The internal diameter is 4 m;
The length of cylinder is 4.1 m;
The thickness of the steel is
3 cm (two walls)



The initial data:

1. The background index for the cylinder with liquid Ar for 9 crystals in the center is **2.2 gbu for steel Th-232 activity of 1 mBq/kg**

The anticoincidences are taken into account. They suppress the background ~30%.

The number has been obtained by two methods:

- direct gamma transport
- Geant 4.

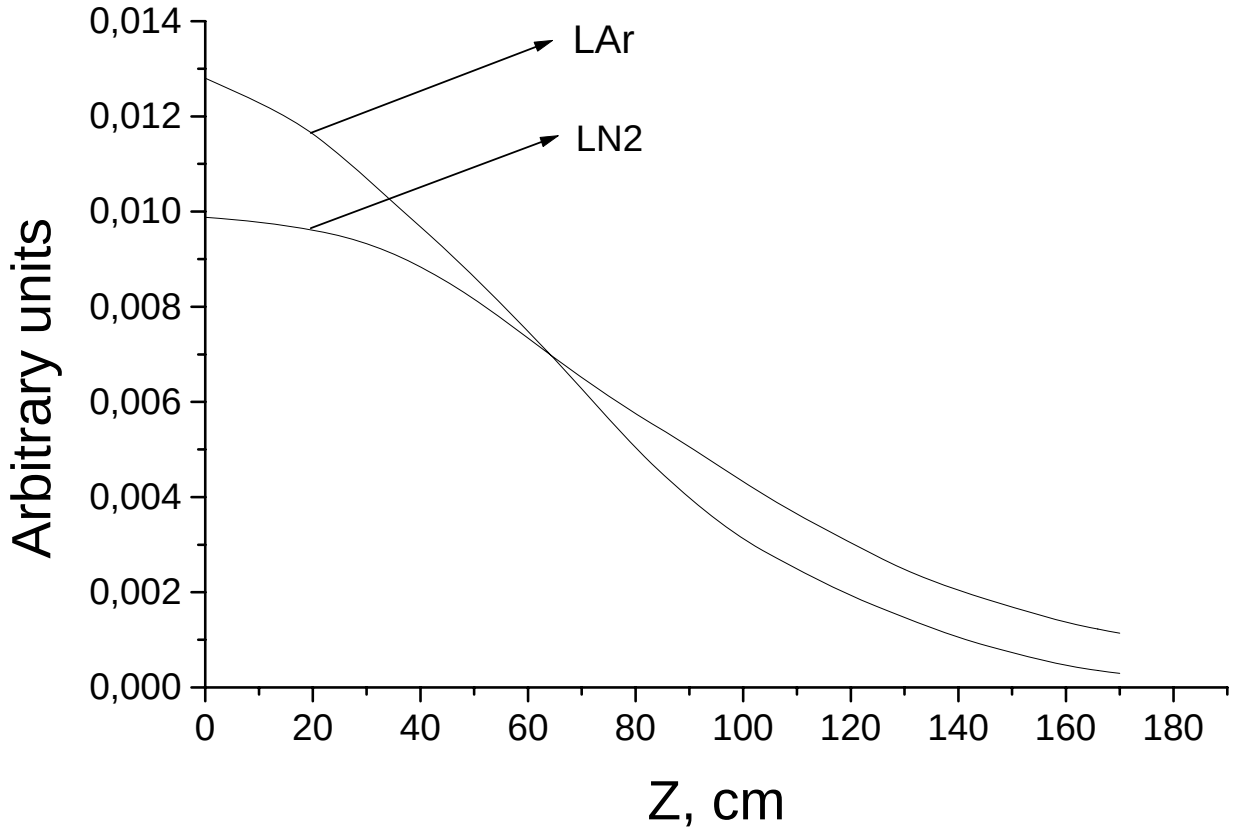
Results are in good agreement (better than 10%.)

	Cylindrical part	**Upper cover**	**Bottom**	**Total**
BG index (gbu)	**2.2**	**0.026**	**0.025**	**2.25**

Remark: **This background index corresponds to the background index of the copper cryostat considered earlier**

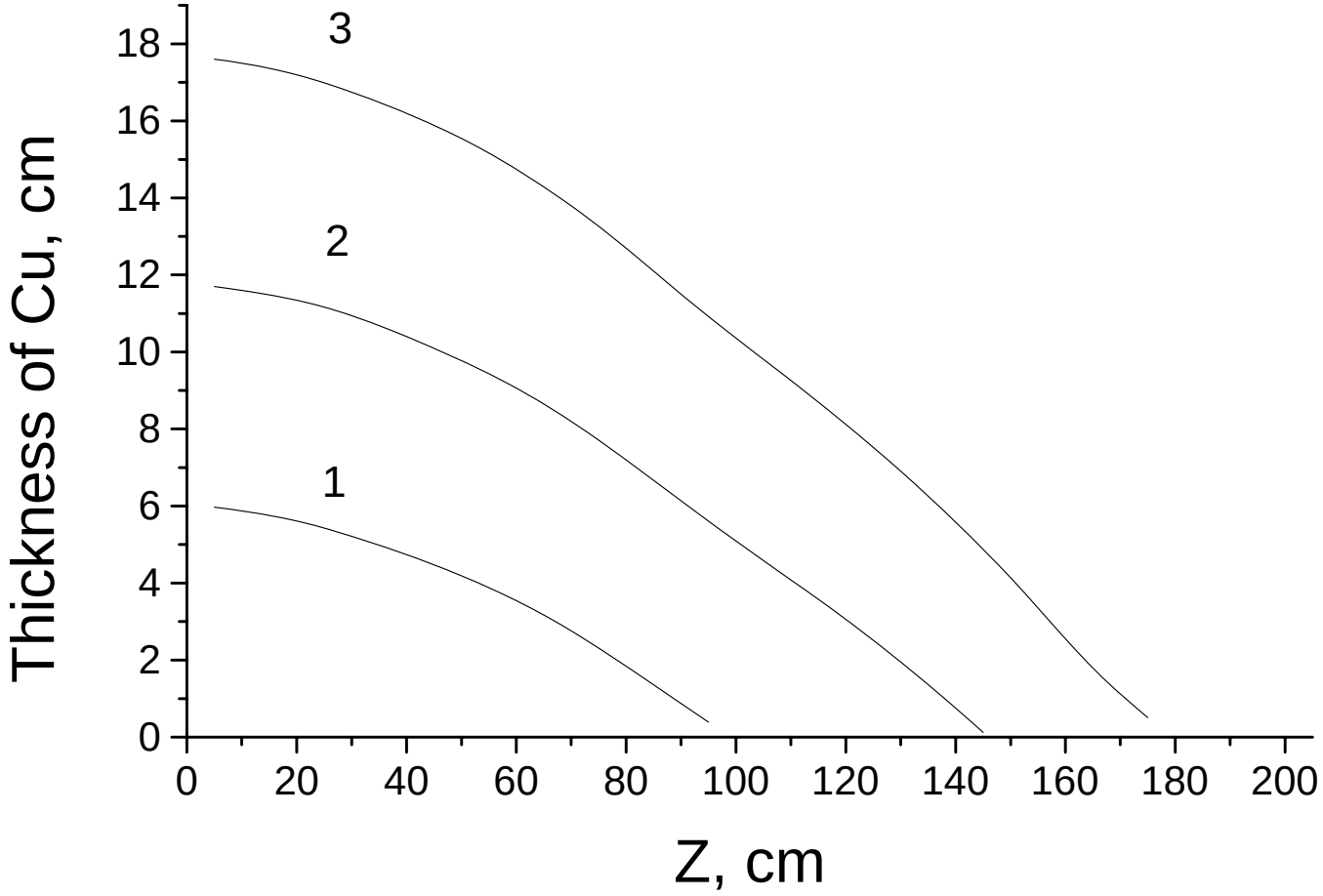
2. **The dependence of contribution to the background from different parts of the cylinder on the distance from the center (z). The dependence is obtained by M-K method taking into account the finite thickness of the steel.**

2. The dependence of contribution to the BG from different parts of the cylinder on the distance from the center (z). The dependence is obtained by M-K method taking into account the finite thickness of the steel. The detector is 9 crystals with 2 kg mass. The curves are normalized to the 1.



- **On the basis of this dependence the additional copper shielding profile is obtained for Th-232 activity - 10 mBq/kg, 3 mBq/kg and 1 mBq/kg from conditions:**
- **the final BG index is 1 gbu.**
- **The length of absorption for Cu and Ar was taken by 15% larger in comparing with table numbers.**

Cu profile for Th-232 activity 10 mBq/kg (3), 3 mBq/kg (2) and 1 mBq/kg (1)



The copper mass for different Th-232 activity and BG index in the gbu units **(1** gbu **=10^{-4} /keV.year. kg.)**

activity	**BG index without Cu shielding**	**Cu mass for BG index 1 gbu**	**BG index withCu shielding (M.-K. simulation)**
10 mB/kg	**22gbu**	**41 t**	**(0.74_+0.16) gbu**
3 mB/kg	**6.6 gbu**	**23 t**	**(0.84_+0.12) gbu**
1 mB/kg	**2.2 gbu**	**8.4 t**	**(1.17_+0.10) gbu**

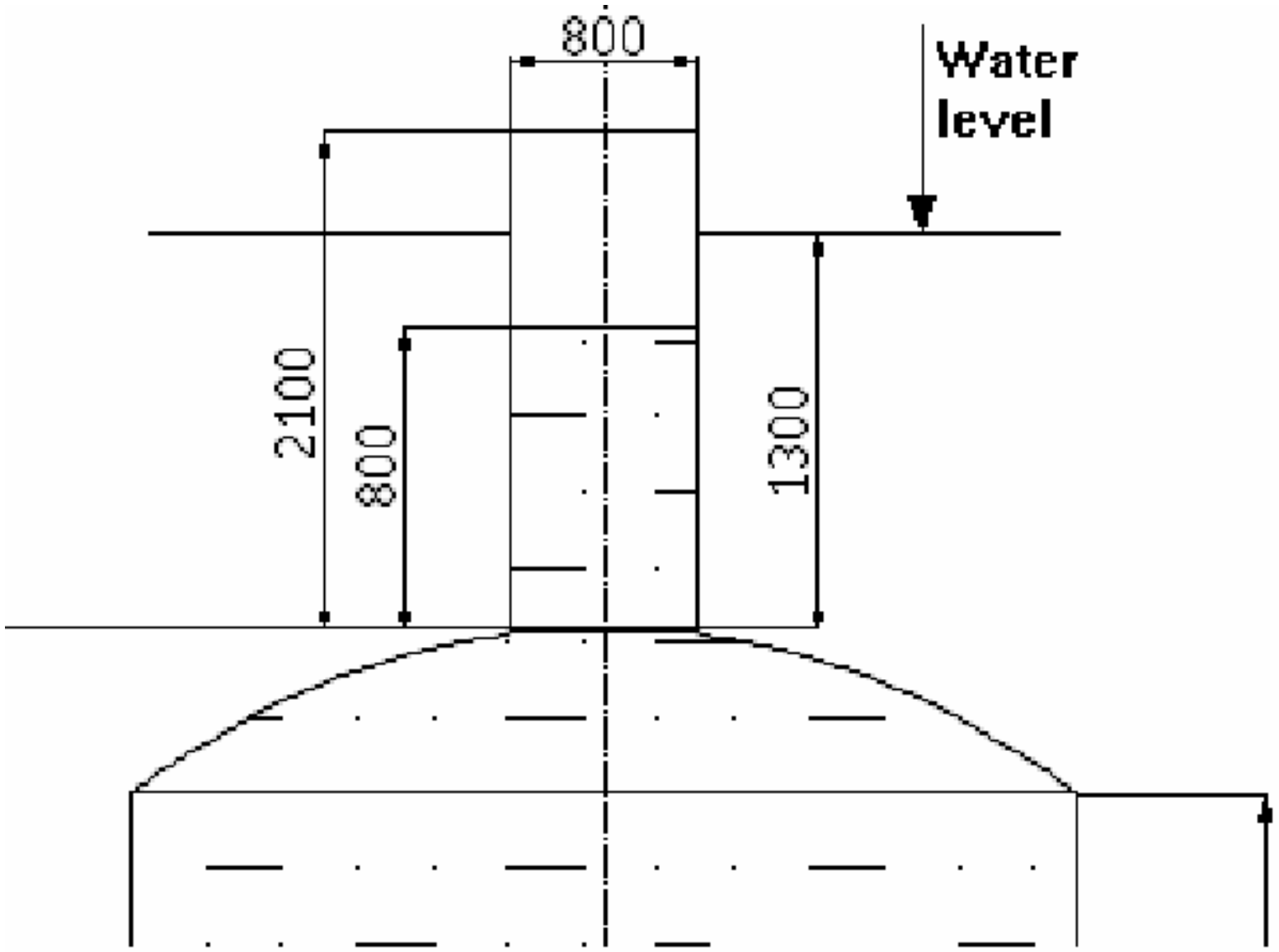
The acceptable level for Th-232 activity of superisolation for steel activity 1 mBk/kg.

If the mass of a superisolation is ~1% of the cryostat (~150 kg) and its contribution to the detector background is ¼ cryostat background (0.5 gbu)

The Th-232 activity of superisolation must be <25 mBk/kg

- Estimation of background from external (rock) gammas with water shielding ~3 m
- The intensity of the 2.615 MeV gamma line is 0.031 /cm^2.c with isotropic distribution.
- **The background index <0.05 gbu**

Background from external (rock) gammas through open neck.



- **Background from external (rock) gammas through open neck.**
- **The intensity of the 2.615 MeV gamma line is 0.031 /cm2.c with isotropic distribution.**
- **The background index ~0.06 gbu**

The preliminary data for steel cryostat with nitrogen for 1 mBq/kg activity of the steel.

	Cylinder	Upper + Bottom cover
9 crystals	**38 gbu**	**1.2 gbu**

With 46 t of Cu shielding of the cylindrical part the background index is 5 gbu.

The copper activity must <10 μBq/kg, otherwise it will be the main source of background .

Summary:

1. The background index for the steel cryostat with liquid Ar for 9 crystals in the center is 2.2 gbu for steel Th-232 activity of 1 mBq/kg.

2. The copper shielding with weight of ~8 t (1/3 of the cryostat weight) gives possibility to lower BG index to 1 gbu.

3. The problems with superisolation, gammas from rock, open neck are essentially easier if exist at all.

4. The best BG index for the steel cryostat with liquid nitrogen, that can be achieved, is ~10 gbu. It requires ~40 t of copper with activity <10 μBq/kg.