

Passive shielding calculation report

This report and the in here described calculation is solely applicable for the below mentioned project and is based on the customer's situation and requirements as provided by the Philips representative with the service request form and summarized below.

1. Project and report data

Hospital Name: Hospital Universitario de Fuenlabrada

City & country: Madrid, Spain

Room ID: TC

Corresponding Drawing number: ESP220129

Philips representative (*the requestor*): R. Marchante

Report history:

Rev	Date	Description
0	13 May 2022	Initial calculation

2. Magnet description

Magnet type: Ingenia Ambition

Magnet field strength(s): 1.5T

Magnet angled? ☐ -

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3. Customer's shielding requirements *(summary from service request)*

Wall/Floor/Ceiling <i>(seen from the front of the magnet)</i>		Field strength <i>(to be reduced)</i>	Shielding location <i>(in/out side room)</i>	Max allowed field line protrusion <i>(position calculated field line with shielding measured from the shielding plate outward)</i>
Rear	<input checked="" type="checkbox"/>	0.5mT / 0.2mT / 0.1 mT	In <input checked="" type="checkbox"/> Out <input type="checkbox"/>	300 mm / Minimal
Left	<input type="checkbox"/>		In <input type="checkbox"/> Out <input type="checkbox"/>	
Right	<input type="checkbox"/>		In <input type="checkbox"/> Out <input type="checkbox"/>	
Front	<input type="checkbox"/>		In <input type="checkbox"/> Out <input type="checkbox"/>	
Top (ceiling)	<input type="checkbox"/>		In <input type="checkbox"/> Out <input type="checkbox"/>	
Bottom (floor)	<input type="checkbox"/>		In <input type="checkbox"/> Out <input type="checkbox"/>	

Details/Additional requirements:

4. Shielding design solution

Steel quality used for this calculation:

Non grain oriented electrical low carbon (< 0.006%) silicon iron, B/H Hc 90A/m

Design concept:

Rear with toe and partly top

Remarks:

The 0.5mT field protrusion from the rear passive shielding plate is approx. 160 mm where 300 mm can be allowed.

The 0.5mT field can be fully contained within the back wall.

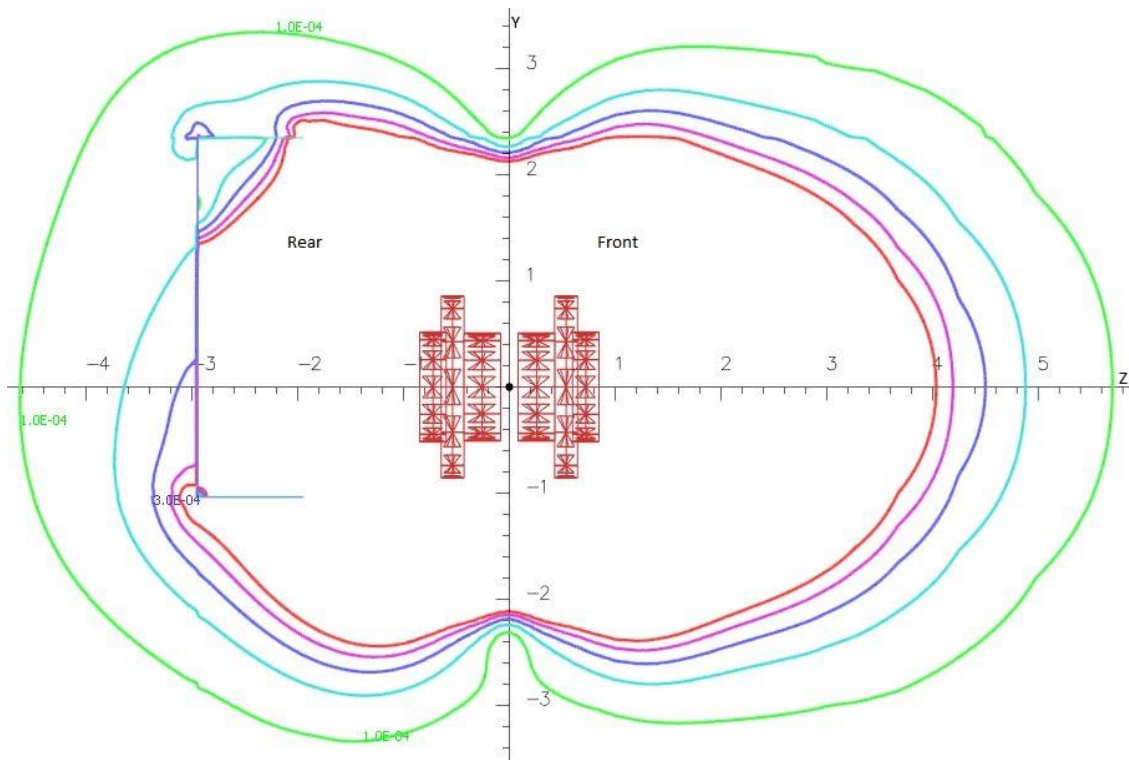
In the future, behind the MR room, will be a CT room planned.

The 0.1mT field will reach until 4630 mm from the magnets iso center.

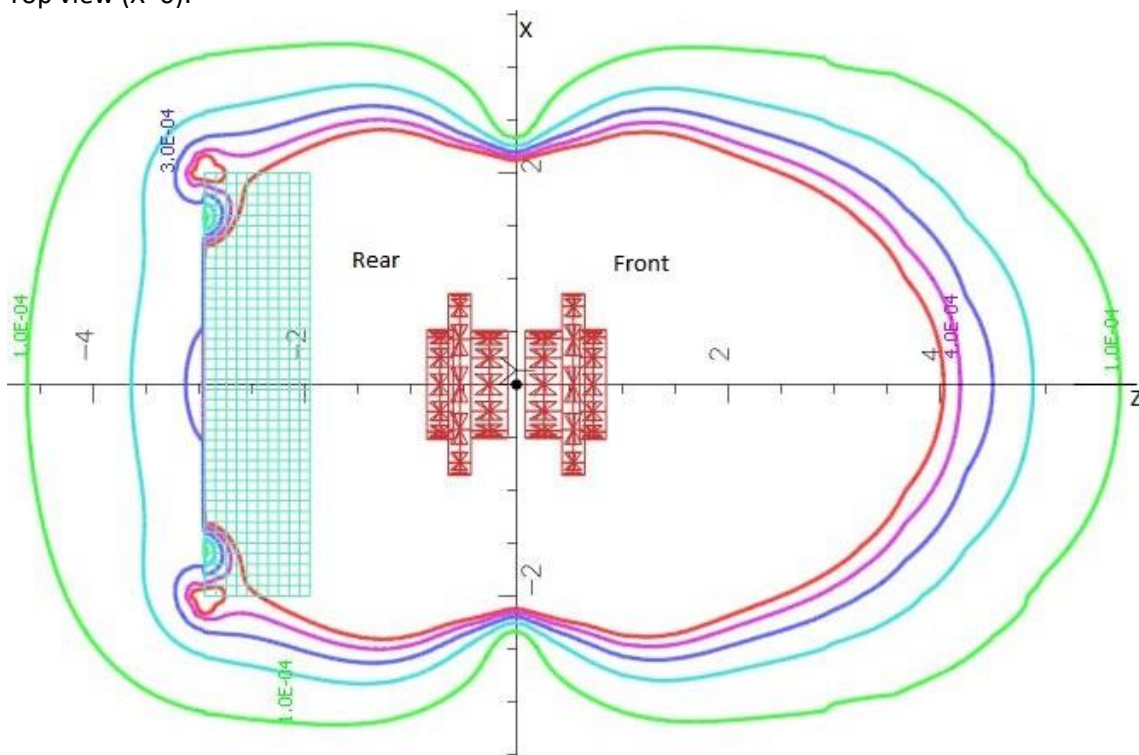
The 0.2mT field will reach until 3750 mm from the magnets iso center. (Relevant for a Philips CT.)

5. Calculation result

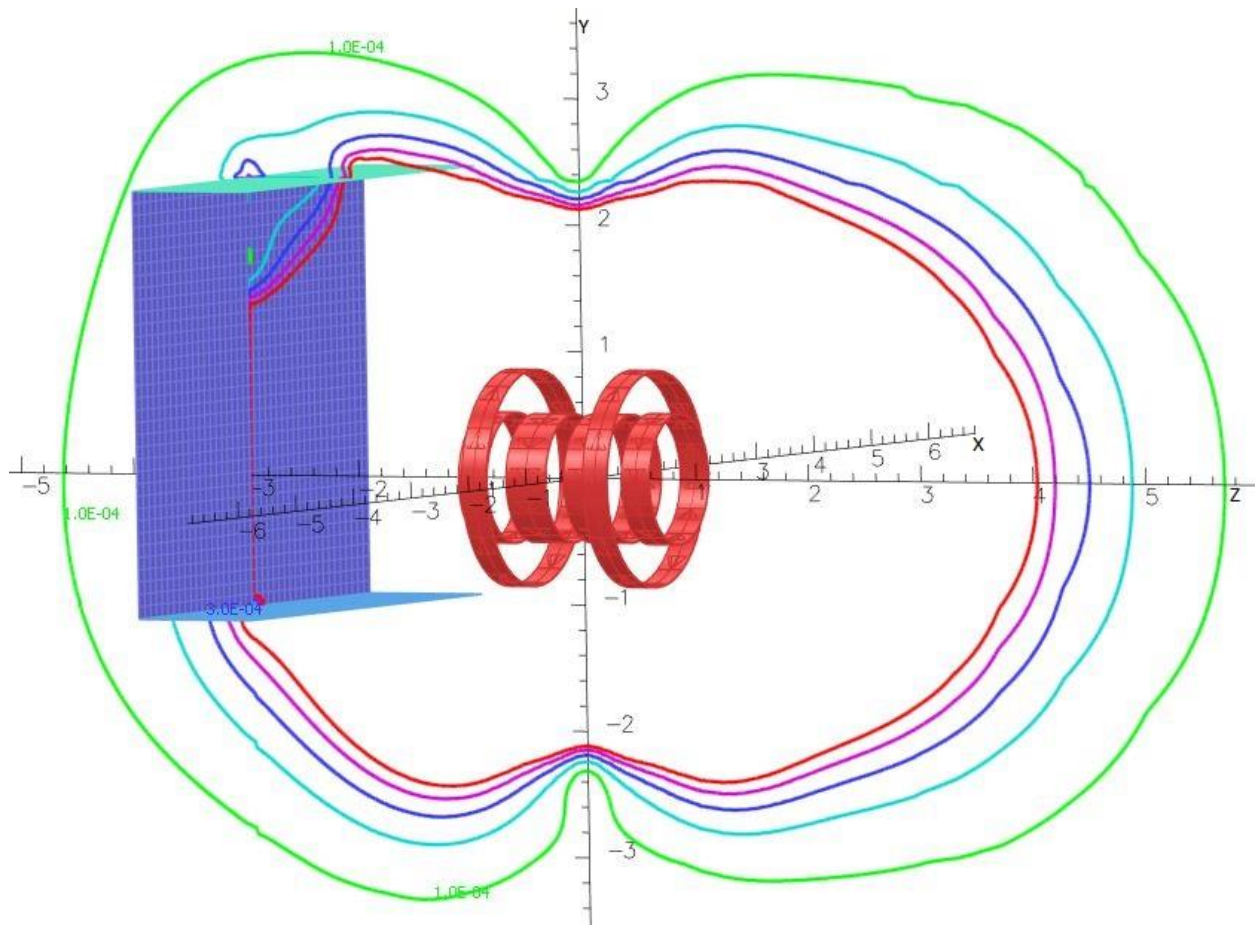
Side view ($Y=0$): (Green = 0.1mT, Light blue = 0.2 mT, red = 0.5 mT)



Top view ($X=0$):



Perspective view:



6. Shielding design details

Rear plate	
Location:	Z = -2.95 m.
Height	3.39 m. Plate starts at X = -1.04 m.
Width	4 m. Plate starts at Y = -2 m.
Thickness	6 mm.
Weight	639 kg
Attraction force	< 10 N
Toe	
Width	See rear plate
Length	1 m
Thickness	See rear plate
Weight	189 kg
Attraction force	< 64 N

Top plate	
Location:	X = +2.35 m.
Length	1 m. Plate starts at Z = -2.95 m.
Width	4 m. Plate starts at Y = -2 m.
Thickness	2 mm.
Weight	63 kg
Attraction force	< 1 N

7. Shielding material & Installation

Steel quality:

The steel used for the passive shielding must have the right magnetic properties.

Non grain oriented electrical low carbon (< 0.006%) silicon iron

B/H Hc 90A/m or less (less = better)

The calculation in this report is based on the minimum quality unless specified differently in chapter 4.

Examples of steel types that meet the criteria:

- AISI M36 or better e.g. M19. (Supplier: AK steel)
- DIN 46400 V350-50A or better e.g. V310-50A (Supplier: ThyssenKrup Electrical steel)
- EN 10106 M350-50A or better e.g. M310-50A (Supplier: ThyssenKrup Electrical steel)

Steel certificate:

The design is valid only if the supplier and installer of the magnetic shielding includes a certification to prove that a sample of the material used has been tested, and meets the requirements also after installation.

Weight of passive shielding steel:

The weight of passive shielding material to be used is approximately 7850 kg / m³, excluding the mounting frame.

Attraction forces:

Inform the installer of the magnetic shield that the plate will encounter attraction forces due to the magnet. The magnetic shielding plate must be fixated to handle the attraction forces and to reduce possible deflection due to magnetic forces. The force is not evenly distributed over the entire plate. A large portion is present near the magnet. However due to requirements on vibrations of the plates and to reduce possible deflection due to magnetic forces, the mechanical fixation of the plates must be made with the assumption that every m² will encounter / feel the force mentioned.

The attraction forces on every m² to be anticipated are mentioned in chapter 6 if relevant.

8. Shielding conditions and remarks

The following points must be read and understood well. Please contact Philips in case of questions or issues during installation.

- Definition of the axes:
Z: length axis (bore)
X: height
Y: width (left to right)
- Calculation tolerances:
0.5mT +/- 10cm
0.3mT +/- 20cm
0.1mT +/- 50cm (Indication only)
- As the shield is magnetized a measurement within 10cm from the plate can give higher readings.
- Due to the local ferromagnetic objects, the earth magnetic field and unavoidable local and unpredictable circumstances, the actual measured fringe field may differ from the calculated field plots. For this reason, Philips Healthcare cannot be held responsible for the performance of the actual fringe field when the shielding has been installed.
- In our calculation we see the shielding plates as massive made out of one piece.
In reality those plates are composed of multiple layers of thinner steel plates. Maximum 2mm seams are allowed between adjacent plates.
- For single and dual layered shielding: To cover a seam, a patch can be used. Minimum width of the patch must be 20 times the width of the seam and with the same thickness as calculated in the shielding calculation.
- Triple or more layered /thickness shielding: the seams must be overlapped with minimum 66% thickness as given in the passive shielding design. This can be achieved with a 3 layered thick shield.
- In corners no seams are allowed, a corner piece patch can be used. The angle piece must have the same thickness as given in the passive shielding design.
- Thickness specified is minimum needed with the magnetic steel quality mentioned.
If the steel quality described below is not available, then a recalculation is required based on the available steel quality.
- This report is based on the drawing number, revision number and drawing date stated above.
- Make sure fringe field measurements are performed after the MR is energized to investigate if the location of the fringe field due to the installation of the passive shielding is acceptable.

Magnet vibration pad replacement:

If the magnet is moved / translocated: Make sure new vibration pads are used.

Do not use old/already used vibration pads.