Jornadas do LIP 2012

Reassessment of structural shielding design and material characterization in radiology installations

Participants

Jorge Miguel Sampaio (CFA/FCUL);

Mª Conceição Abreu (LIP);

Patrick de Sousa (LIP);

Luís Peralta (LIP/FCUL);

Patrícia Enes de Lima (ESSUAlg);

Sónia Dias (Master student/FCUL)

Current shielding guidelines

Are based in international recommendations:

- The NCRP Rep. 49 (1976) is still used in many countries since its adopted as legally binding methodology (DL180/2002);

Workloads and transmission curves are outdated!

Current shielding guidelines

The Decree-Law 180/2002 establishes the Portuguese framework for shielding design of radiological installations:

- HVLs are only provided down to 50 kV;
- Lower operating potentials are obtained by pure exponential extrapolation;
- Thickness equivalence between materials is outdated;
- Workloads need to be revised.

Current shielding guidelines

The NCRP Rep. 147 (2004) revises and updates the shielding design methodology of X-ray imaging installations, including:

- New transmission curves based on the Archer and Simpkin model and data;
- Revised workloads;
- Specificity of new equipments.

Mammography installations

Mammography is performed at low potentials: 25 – 35 kV.

The shielding requirements can be ambiguous

(NCRP Rep. 147, pag. 13):

"Permanent mammography installations may not require protection other than that provided by typical gypsum wallboard construction. […] Although the walls of mammography facility may not require lead shielding, a qualified expert shall be consulted..."

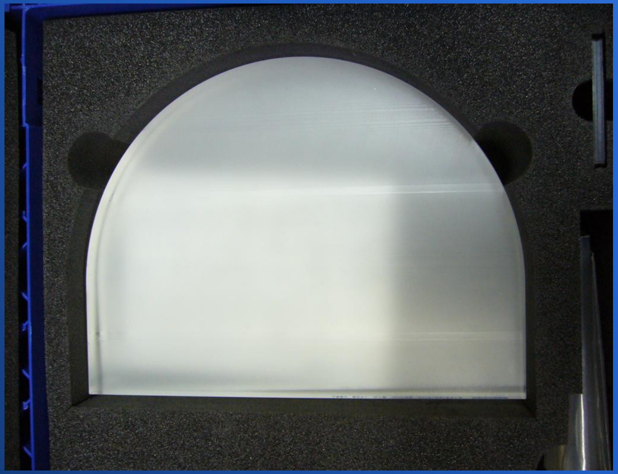
Mammography installations

In same cases, designers and regulators can be confronted with different shielding requirements that have significant cost differences.

Goals of the project

- Map stray radiation dose rates in radiology installations (including a phantom of the patient);
- Evaluate absorption and scattering effects of the patient on unshielded dose rates;
- Support these measurements with generalized MC calculations;
- Revise shielding calculations with new design parameters;
- Assess properties of shielding materials produced by national industries.

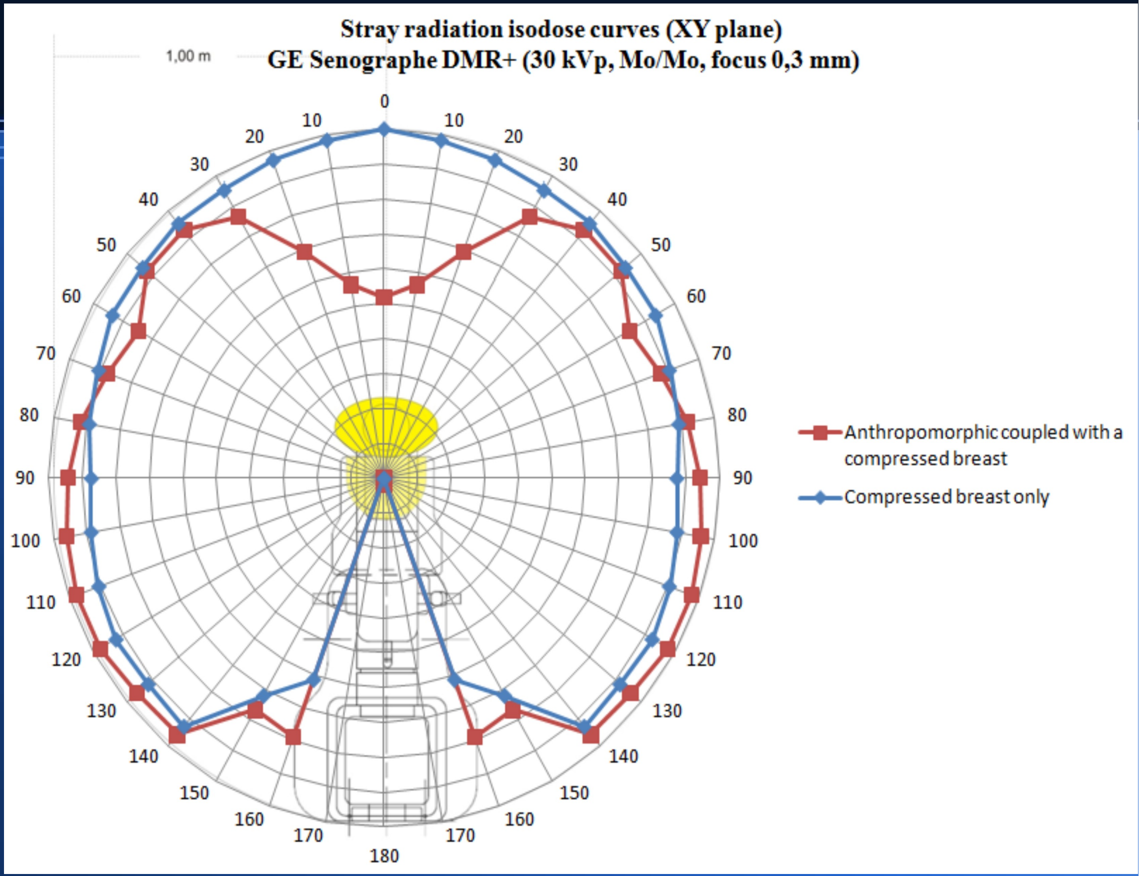
Mammography measurements



- Equipment: *GE SENOGRAPHE DMR+*;
- Phantom: Anthropomorphic coupled with a compressed breast (5 cm thickness);
- Detection system: *Unifors Xi Survey detector* (solid state sensor) + *Base Unit*.

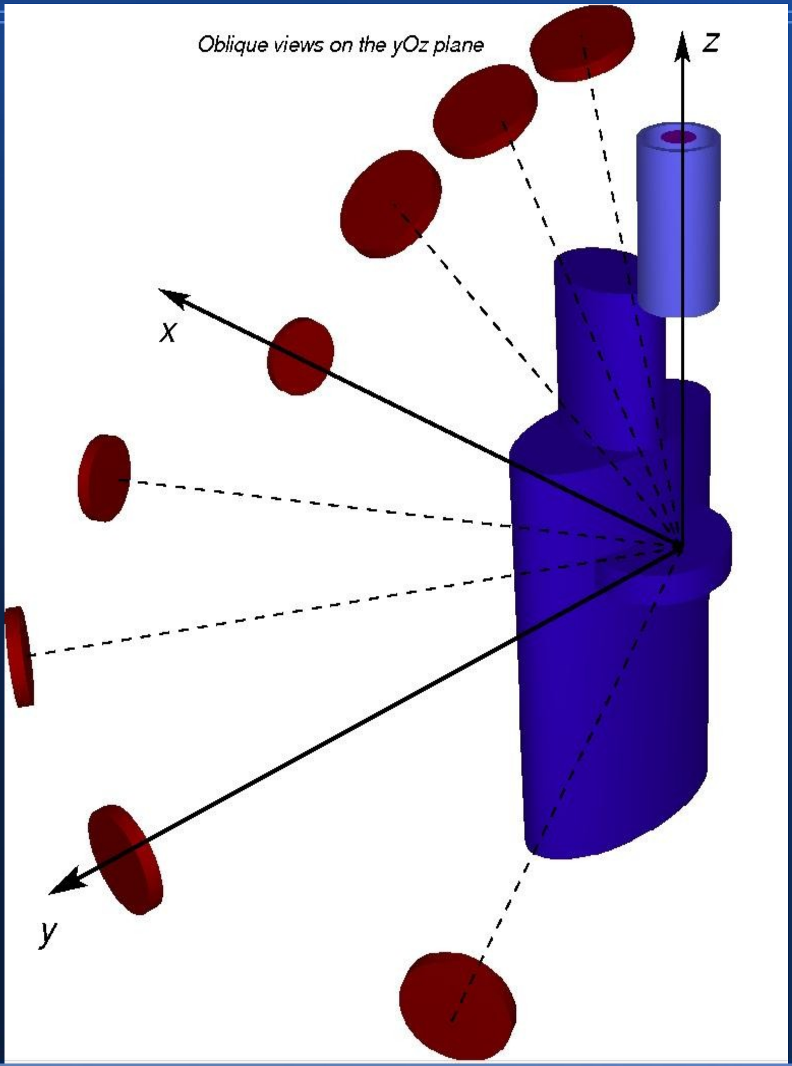
Results

- Between 20º and 0º, absorption by the phantom coupled accounts for more than 50 % reduction relative to the compressed breast only configuration;



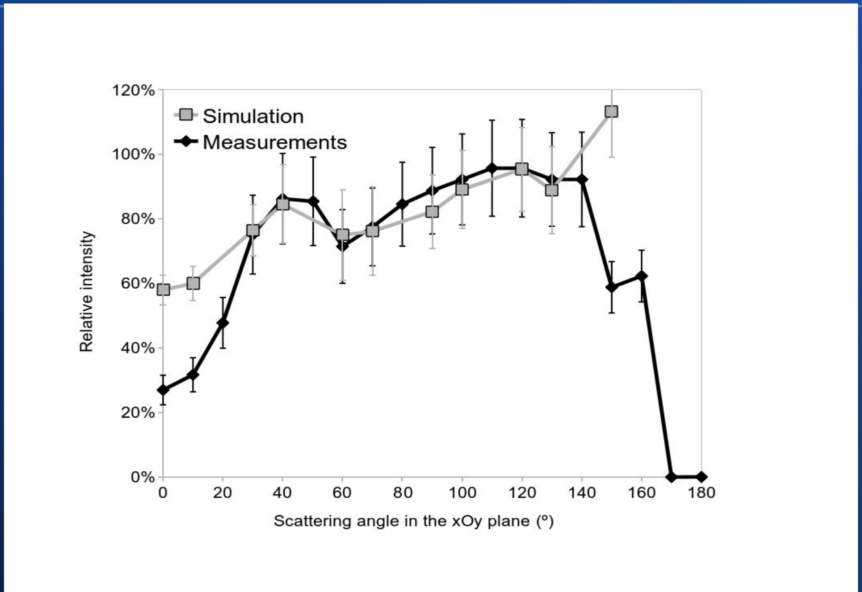
- Between 80º and 140º there is an increase in dose rates due to scattering effects on the anthropomorphic phantom.

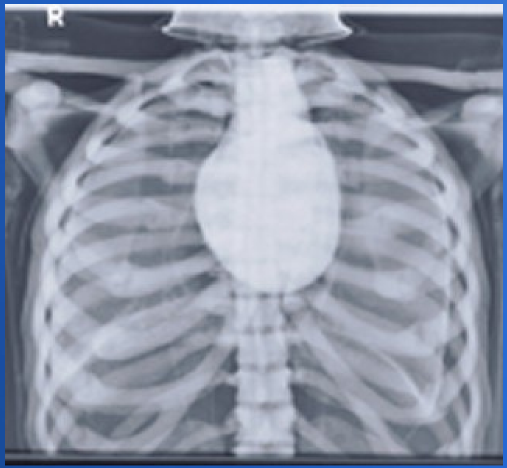
MC simulations



- Code: PENELOPE (2011);
- X-ray source: IPEM database;
- Cut-offs: 1 keV;
- Primaries: 10^9 photons;
- Speed: >1000 photons/second;
- Computing: LIP Farm.

MC simulations



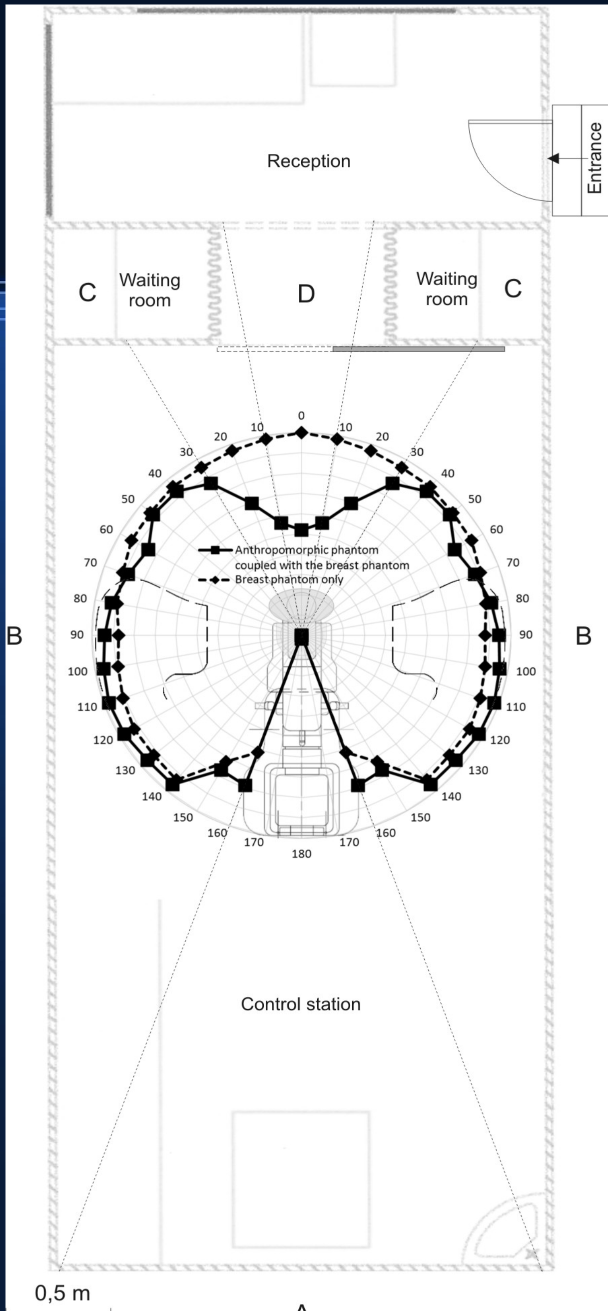


Not included!

Agreement with measurements, except for 0º:

- Overestimation of stray radiation (no shielding of the tube included) and/or;
- Sub-estimation of absorption by internal organs.

Mobile installations



Non-profit organizations use mammography units mounted in caravans for free breast-screenings of the population. **The shielding of these caravans implies significant extra costs**

Mobile installations

NCRP Rep. 147 (2004) methodology;

Material: wood.

	Wall (A)	Wall (B)	Wall (C)	Wall (D)
x (mm) without "patient absorption"	**0.0**	**25.4**	**4.1**	**52.5**
x (mm) with "patient absorption"	**0.0**	**25.4**	**0.0**	**26.6**

Rad. Prot. Dosim, submitted (2012).

Material characterization

Collaboration with a small Portuguese company of building materials.

Wants to develop materials for radiological protection.

Need to know:

- Mass-attenuation coefficients;
- HVLs and lead equivalence.

FICHA TÉCNICA

SEPOR® BARITA

Reboco de protecção radiológica. Substituto de placas de chumbo em áreas de radiação ionizante.

PRODUTO

Argamassa à base de sulfato de bário, inertes seleccionados, ligantes hidráulicos e aditivos.

APLICAÇÃO

Argamassa de revestimento interior de paredes para protecção radiológica em salas de radiologia, radioterapia, consultórios dentários, bem como todos os ambientes onde se exige o isolamento de radiações.

SUPORTES

Suportes convencionais de tijolo, bloco de betão ou betão. Os suportes devem ser salpicados com argamassa de chapisco (**SEPOR M2**) antes de aplicar **SEPOR BARITA.**

MODO DE EMPREGO

1- A superfície (paredes verticais ou tectos) onde vai ser aplicado o reboco baratido deve ser chapiscada para permitir criar pontos de aderência e após chapisco este deve secar pelo menos um dia.
2- A Argamassa **SEPOR BARITA** é uma argamassa pré-doseada, pronta a aplicar, bastando apenas adicionara quantidade de água indicada (cerca de 18%).
3- Consultar no projecto de radioprotecção as espessuras correctas a aplicar em cada parede. É fundamental o cumprimento das espessuras correctas indicadas no projecto.
4- Para espessuras até 2,5 cm a aplicação é feita numa única camada. Para espessuras superiores a outra camada só é aplicada quando a anterior estiver suficientemente firme.

SEPOR®
BARITA
Reboco Radiológico
Protecção Radiológica
± 25Kg

CARACTERÍSTICAS DO PRODUTO

Reacção ao fogo:	A1
Resistência à compressão:	CS III
Densidade da Pasta:	2,2Kg/dm
Consumo teórico:	21 $kg/m^2/cm$
Coef. Atenuação Mássico (g/cm^2): (fonte com feixe de 120 kVp)	1,6 ± 11%

Mixture with $BaSO_4$

Material characterization

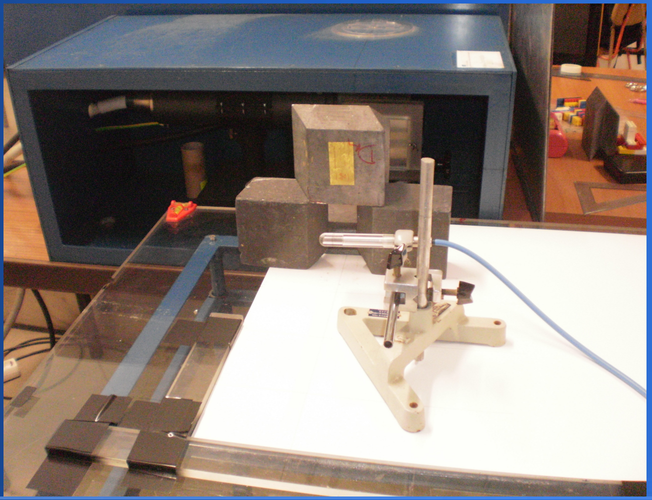
Master thesis (Sónia Dias)

Cs-137 source (662 keV);

X-ray installation (20-100 kV)

Major issue:

- Minimize scattering effects.



$(\mu/\rho)_{sepor}$ (cm^2/g)	$(\mu/\rho)_{NIST}$ (cm^2/g)
$(7.293 \pm 0.583) X 10^{-2}$	**$7.747 X 10^{-2}$**

Future work

- Extend measurements and MC simulations to dental and veterinary radiological installations;
- Address the influence of field inhomogeneities;
- Improve MC simulations including a more realistic geometry;
- Optimize composition of building materials

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Thank you!