Forward-scattered radiation from the compression paddle should be considered when average (or mean) glandular dose is estimated

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Introduction

- From major protocols on dosimetry in mammography there is no doubt that the incident air kerma should be evaluated without backscattered (BS) radiation to the dosemeter. However, forward-scatter (FS) from the compression paddle is neglected.
- This has resulted in confusion and unnecessary differences in dosimetry methods and results.
- A recent thesis [1] and paper [2] made it clear that <u>FS should be included</u> as for an ionisation chamber in contact with the compression paddle and the contribution reported to the incident air kerma was a factor of 1.06 and 1/0.929=1.076, respectively.
- It is suggested that this factor should be called forward-scatter factor (FSF) [1]; cf. backscatter factor (BSF).

1. Hemdal B, PhD Thesis Lund University, Malmö (2009)
2. Dance D R *et al*. Phys Med Biol **54** 4361-4372 (2009)

The purpose of this work is to …

- … further investigate the contribution from FS for typical incident air kerma measurements.
- … compare with backscatter data.
- … discuss some practical consequences that should be considered in dose protocols.

Materials and Methods 1 (2)

- Measurements of forward-scatter were performed with
  - a plane-parallel ionisation chamber (PTW) with volume 0.2 cm^3, diameter 13 mm and depth 1.5 mm at a 60 mm distance from the breast support edge to its center.
- Four mammography units were used, each one with a compression paddle selected based on clinical relevance.
  - A = Senographe Essential (GE)
    - 19x23, flex, high edge, 5144833
  - B = Mammomat Inspiration (Siemens)
    - 24x30, no flex, low edge, 10139964
  - C = DM 1000 (Agfa), which is based on Lorad M-IV (Hologic)
    - 18x24, flex, high edge, FAB-00207
  - D = Mammomat Novation (Siemens)
    - 18x24, no flex, high edge, 10048515

Materials and Methods 2 (2)

Estimation of forward scatter factors (FSF) for an ionisation chamber from air kerma (K) measurements, as $FSF = K_a / K_b$

K_a

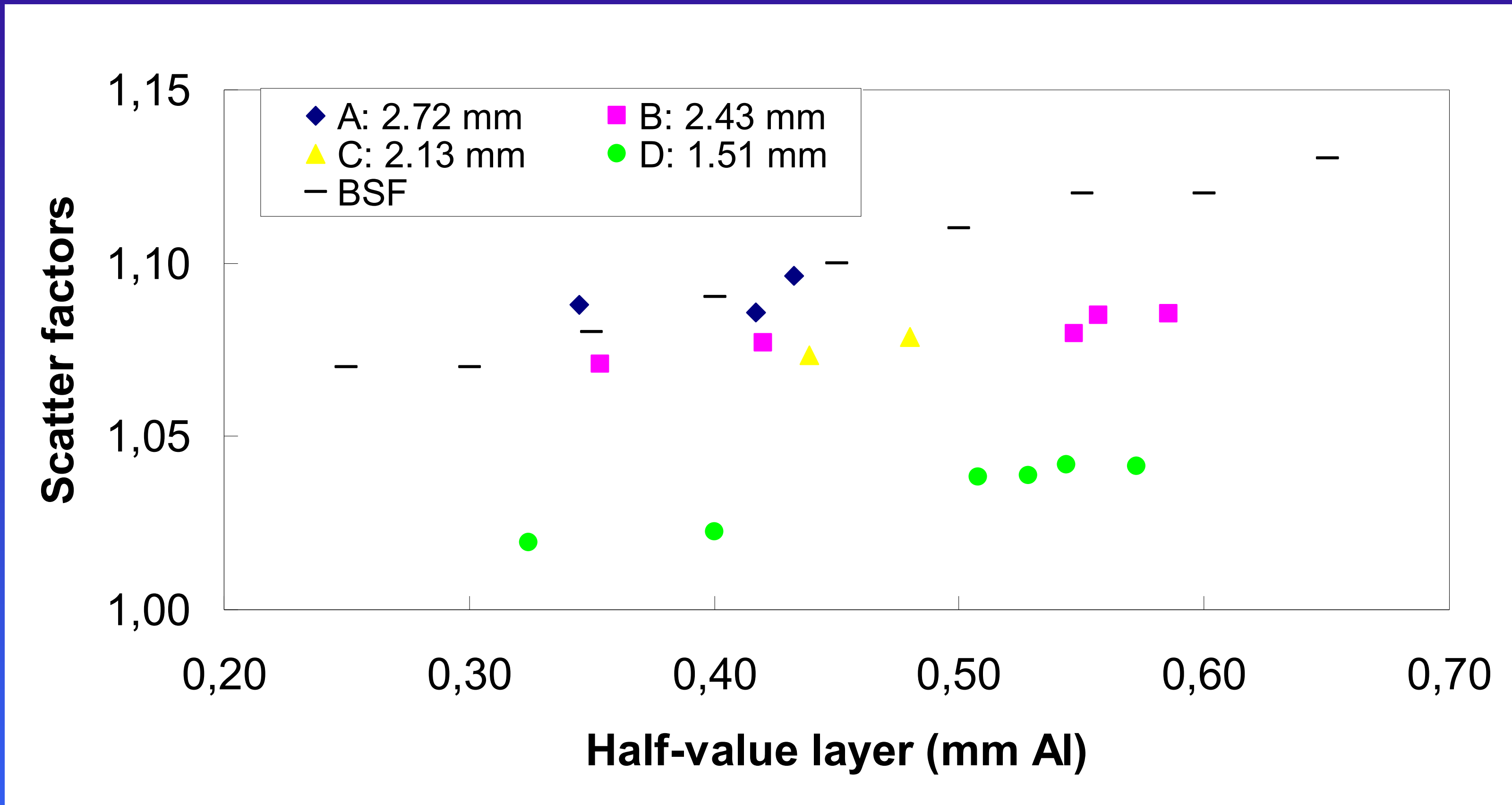
Compression paddle in contact with the chamber

K_b

Compression paddle up, beam well collimated

Note: The figures only shows the principle, not one of the units in this work.

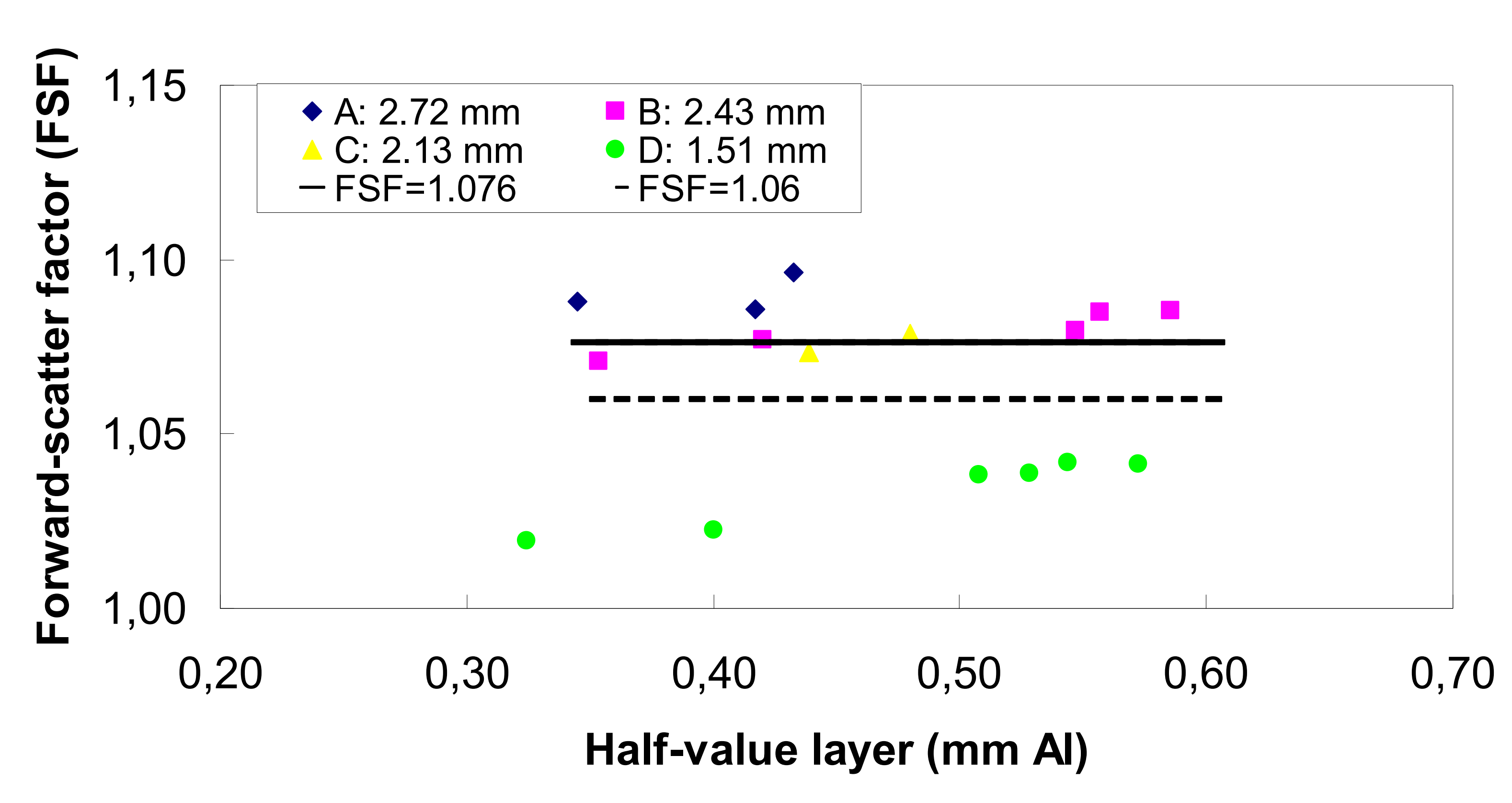
Results 1 (2)



Measured FSF values for mammography units A-D. The measured compression paddle thickness (mm) is indicated in each case, A-D. BSF values from the European dose protocol [3] are also presented.

3. Zoetelief J *et al*. EUR 16263 (1996)

Results 2 (2)



FSF results in the present work compared to literature data

— FSF=1.076 from Monte Carlo calculations, 2.4 mm compression paddle [2].

- - FSF=1.06 from a 6 cm^3 6M chamber (RADCAL), MDM unit (Sectra), 2.6 mm compression paddle ~40 cm up (no collimation) compared to close contact in an experimental setup [4].

4. Hemdal B *et al*. Radiat Prot Dosim **114** (1-3), 436-443 (2005)

Discussion 1 (2)

- The FSF was here found to be 1.02-1.10 and increased with compression paddle thickness, but also with HVL.
- The FSF could have the same value as the BSF and is consequently as relevant to consider in dose protocols.
- FSF=1.076 [2] is an example and not a standard value; this Monte Carlo calculated value is in reasonable accordance with the present experimental results.
- FSF=1.06 [1] is also an example and probably an under-estimation as no collimator was used (experimental setup); the purpose was not to determine FSF [4].
- Based on the results in this work, FSF=1.06 happens to be the best choice of a standard FSF, with a maximum error of about 4%.

Discussion 2 (2)

- Some practical consequences for output measurements.
  - Dosemeters with high FS sensitivity, e.g. ionisation chambers, which for a long time has been the standard dosemeter for output and HVL measurements in mammography.
    - The compression paddle should be in contact with the chamber. *Note*: For a well collimated beam (slide 5, K_b), a FSF must be used.
  - Dosemeters with low FS sensitivity, e.g. dosemeters based on well-collimated semiconductors, which are increasingly used and now are dominating the usage in e.g. Sweden.
    - FSF must be used. FS contribution is small regardless of geometry and can be minimized with a high position of the compression paddle; collimation should not be necessary.
  - Suggested strategies to determine the FSF to be used
    - Compare with an ionisation chamber or
    - use a FSF that depend on paddle thickness and possibly HVL, etc or
    - use a standard FSF, e.g. 1.06.

Conclusions

- It can be as important to consider FS as BS radiation.
- Neglection of FS can underestimate AGD/MGD by 10%.
- Procedures for output measurements in evaluation of incident air kerma
  - Ionisation chambers in contact with the compression paddle and no FSF is then needed.
  - Dosemeters with low FS sensitivity; correct with a FSF.
- Based on the results in this work, FSF=1.06 will lead to a maximum error of about 4% and might be a suitable standard FSF.