

Background

The use of X-rays in medicine is a useful because it allows us to quickly observe a patient's internal state non-invasively. While, there is a risk of radiation exposure. When the X-rays hit the patient's body, some of them change direction and are scattered in various directions. This is called "scattered radiation," and medical staff may be exposed to scattered radiation.



Fig. 1 X-ray fluoroscopy procedure

Purpose

This study aims to collect data on the distribution of scattered radiation during X-ray radiography using a small, lightweight semiconductor radiation visualization camera.

SDGs 3 Good Health and Well-being

3 GOOD HEALTH AND WELL-BEING



Of the 17 SDGs, this research applies to goal 3. Anyone can undergo X-ray fluoroscopy. A test cannot be considered safe unless radiation protection is implemented for everyone involved in the test, including patients and medical staff. In this respect, this research can contribute to the realization of the SDGs with the aim of implementing safe testing for everyone.

Materials

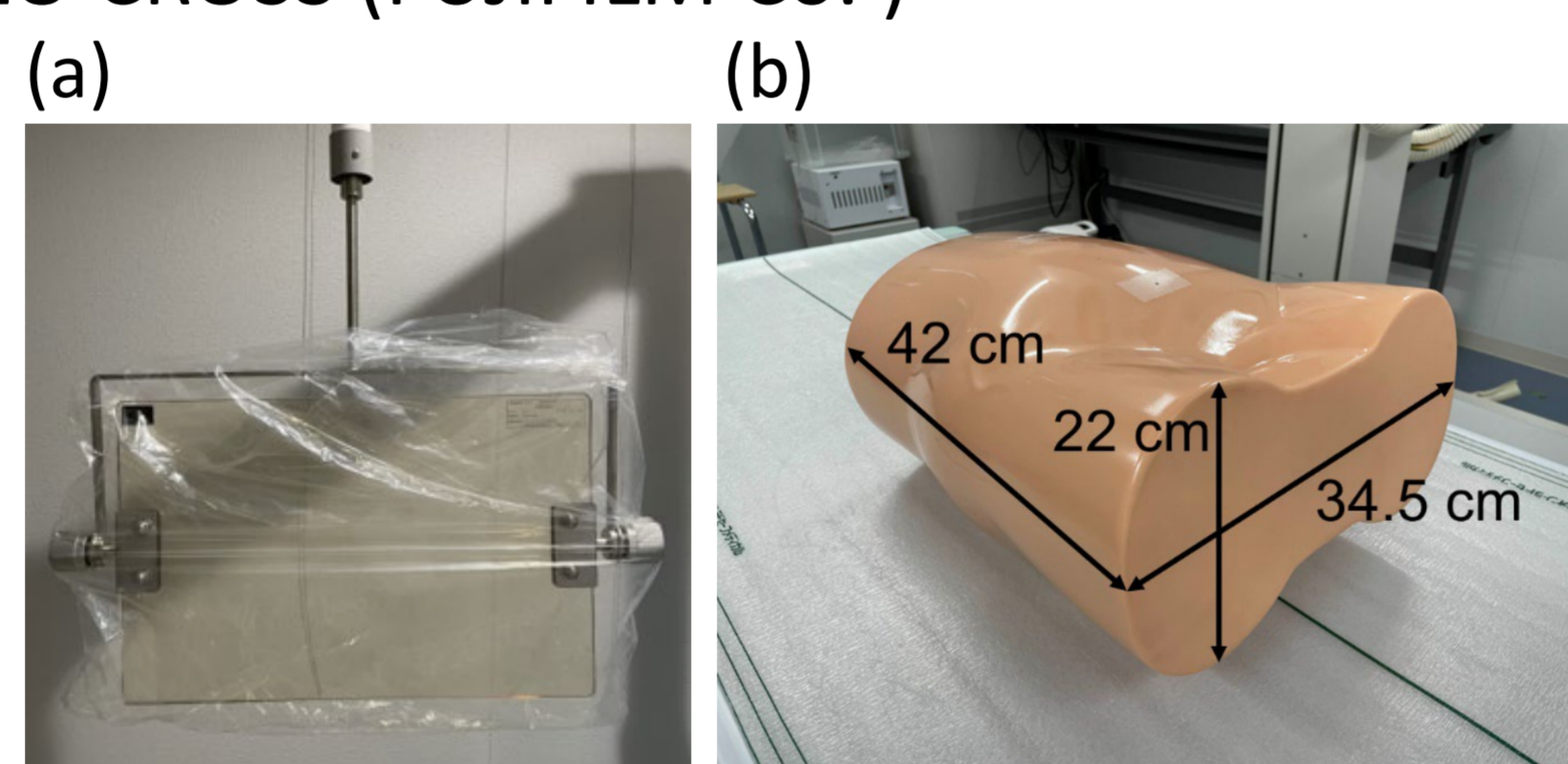
- Semiconductor camera: MiniPIX EDU (Advacam Co.)
- Weight: 30 g
- Thickness of silicon sensor: 300 μm (Surface area: 14 mm \times 14 mm)
- Pixel size: 256 \times 256



Fig. 2 MiniPIX EDU

- RGB camera: RealSense™ Depth Camera D435 (intel Co.)
- C-arm X-ray machine: DR CALNEO CROSS (FUJIFILM Co.)
- Acrylic protective board
- Pelvic phantom: No.41926-080 (Kyoto Kagaku Co.)
- ImageJ ver. 1.53k

Fig. 3 (a) Acrylic protective board (b) Pelvic phantom



Methods

- Basic irradiation condition

Table. 1 Basic irradiation condition

Tube voltage	70 kV
Tube current	25 mA
Irradiation time	1.0 s
Number of exposure	10 times
Sensor to pinhole	1.7 cm
Viewing angle	61°
Irradiation field size (focus to FPD: 105 cm)	Max: 53 cm \times 52 cm
Direction	AP

- Comparison condition
- Basic irradiation condition
- With the acrylic protective board (0, 5cm shown the Fig. 4)
- Irradiation size = 10 \times 10 cm²

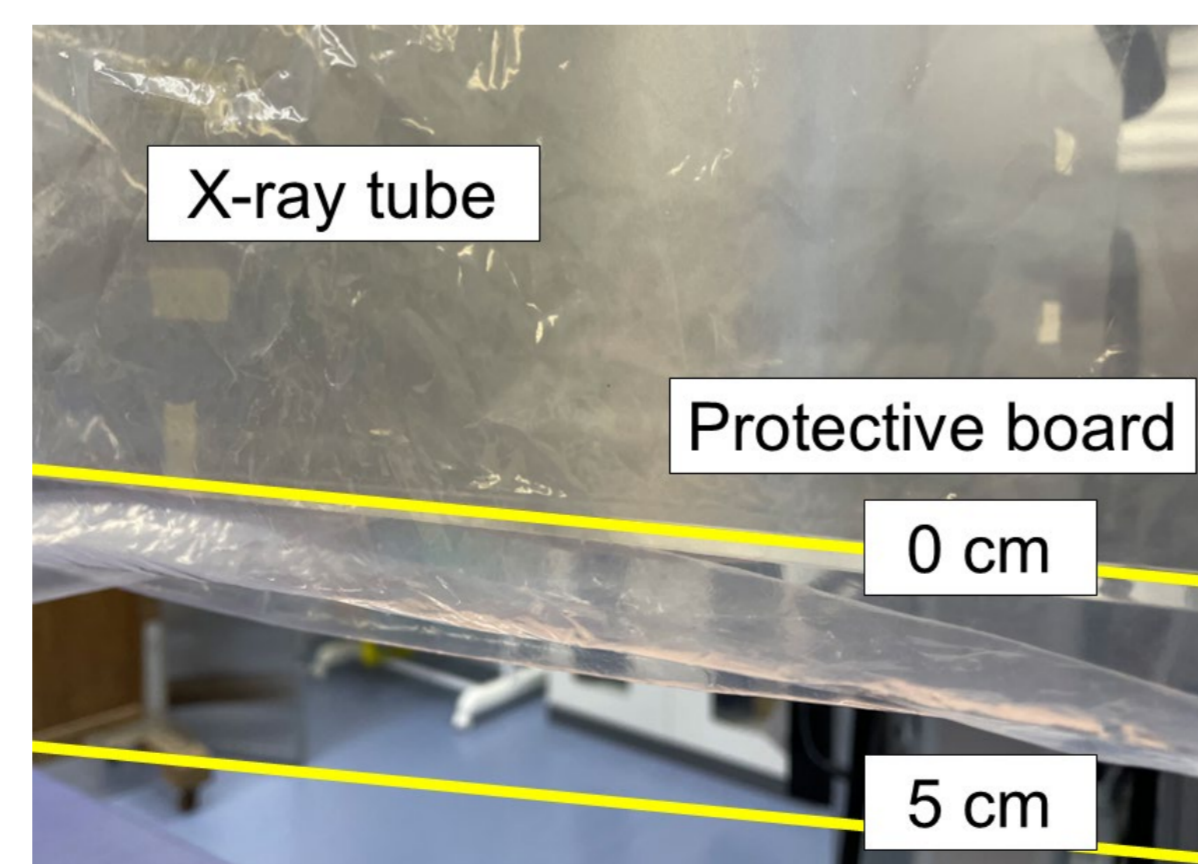


Fig. 4. Heights of the protective board

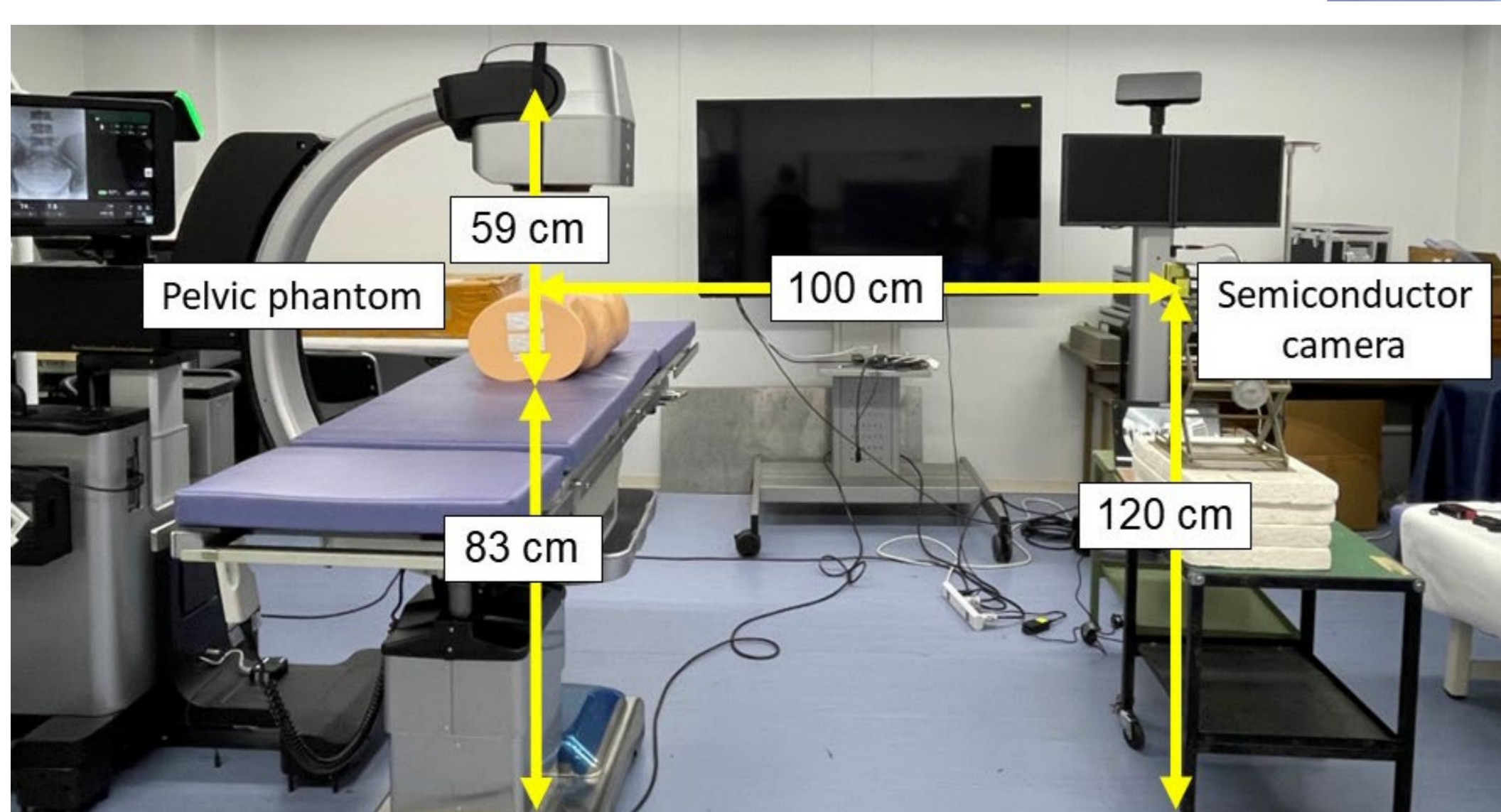


Fig. 5 Geometrical arrangement of each device

Results

- Images and profiles of changes of irradiation conditions

As illustrated in Fig. 6 (a), the collimator, window, and surface of the phantom was identified as the main sources of scattered radiation. The peaks corresponding to them are shown in Fig. 6 (b).

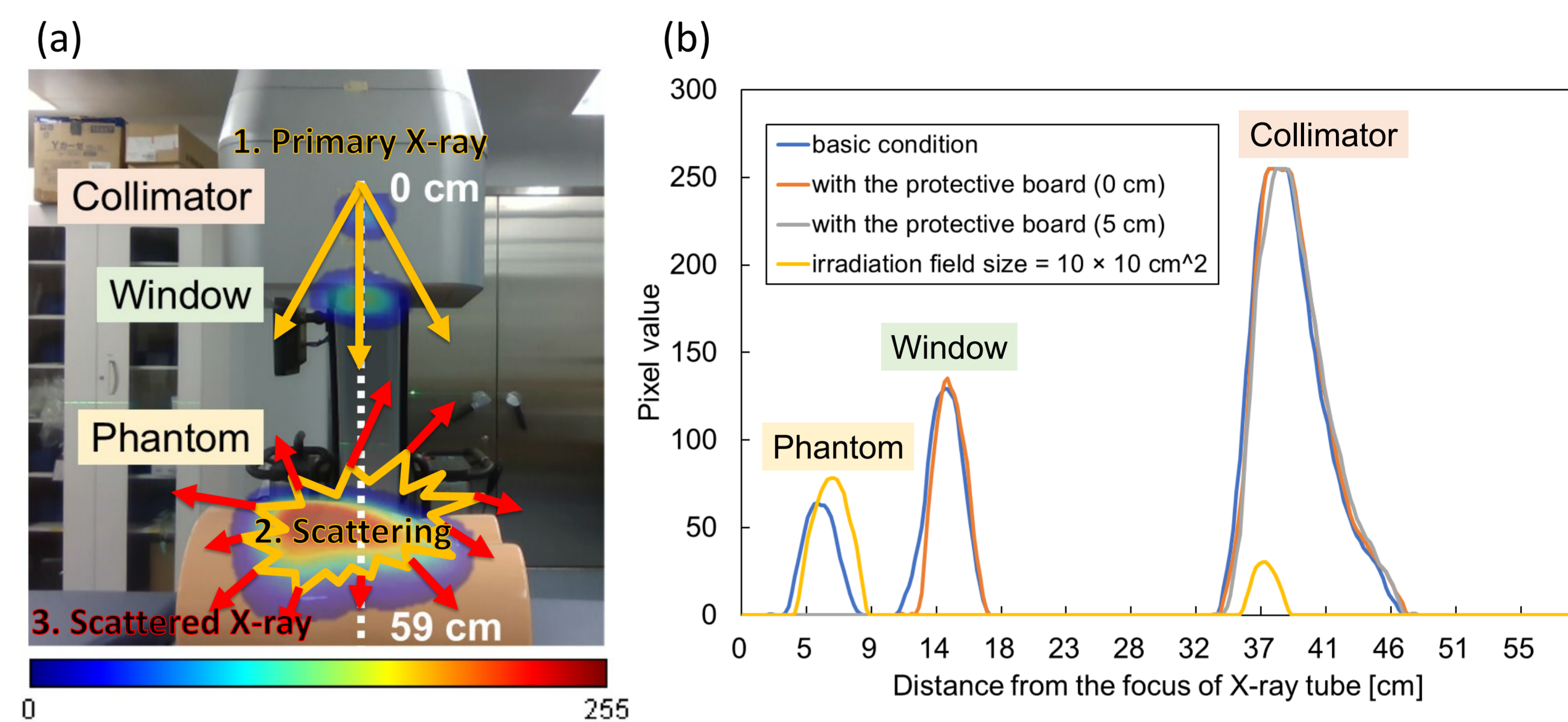


Fig. 6 Basic condition (a) Distribution of scattered radiation (b) Plot of the white dotted line in (a) and under each condition

It can be seen that scattered radiation shielding effect was higher when the protective board height was 5 cm than when it was placed at 0 cm (Fig. 7).

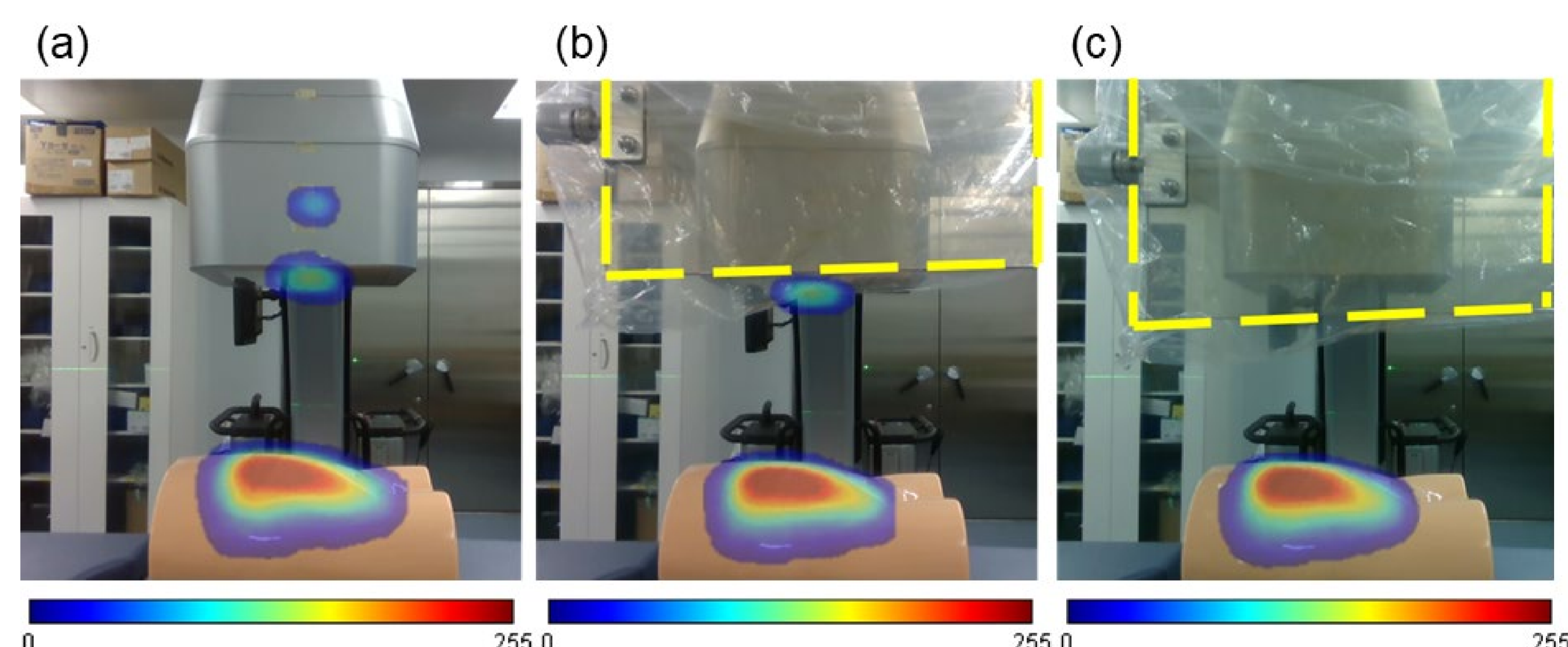


Fig. 7 (a) no protective board (b) 0 cm (c) 5 cm

Fig. 8 shows a decrease in scattered radiation from the window and phantom under the narrow irradiation field size, but that from the collimator increased.

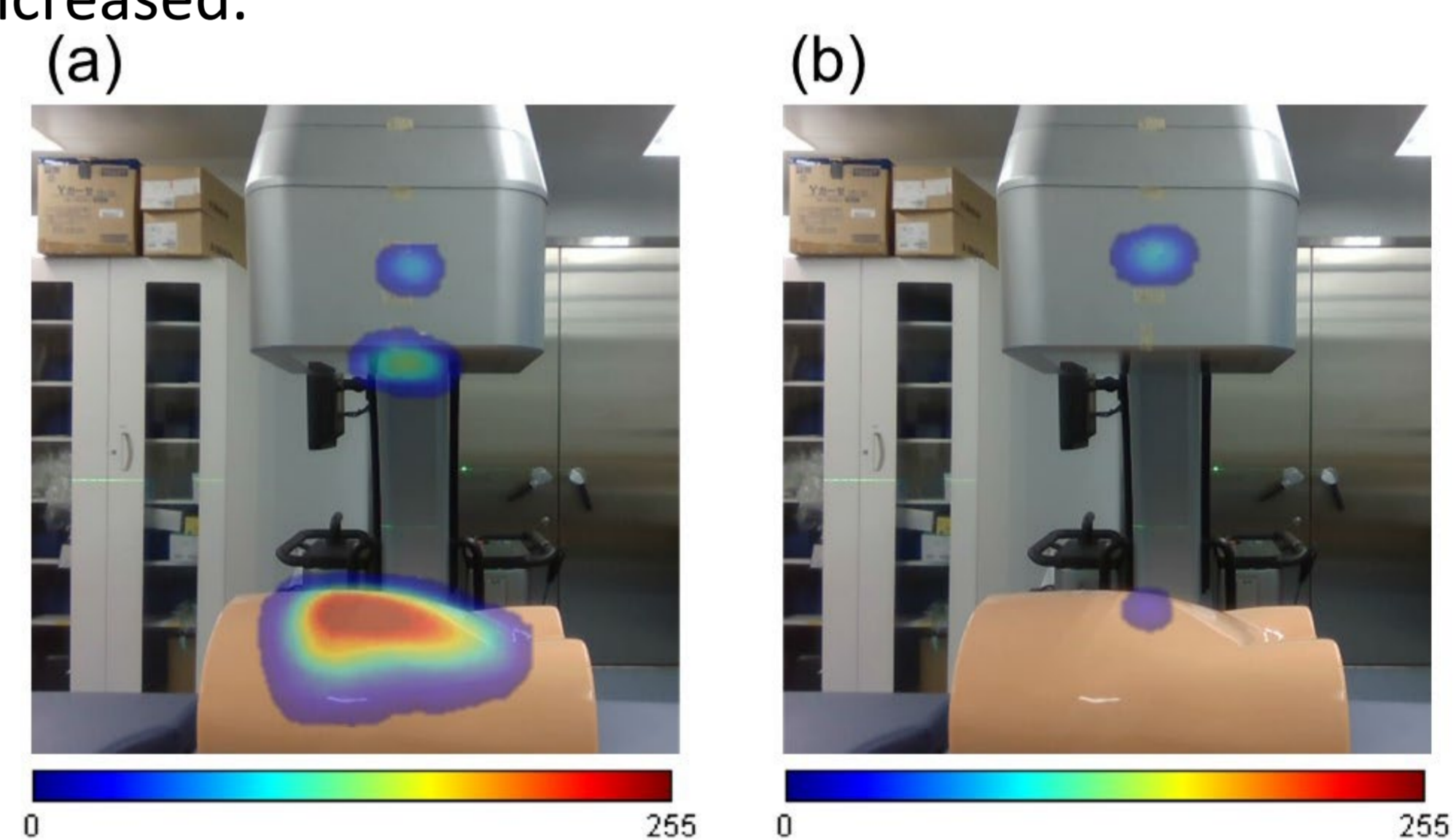


Fig. 8 Irradiation field size (a) 53 cm \times 52 cm (2,756 cm²) (b) 10 cm \times 10 cm (100 cm²)

Discussion

The shielding effect of the protective board was confirmed for the scattered radiation from inside X-ray tube. A reduction in the field size confirmed a reduction in scattered radiation from the phantom and an increase in that from the collimator. This increase was likely due to the greater interaction between the edges of the reduced irradiation field and the primary X-rays.

Conclusion

We verified that the distribution of scattered radiation source in X-ray radiography can be visualized using a semiconductor camera with a pinhole. It can be used to consider methods for protecting the surgeon from scattered radiation.

Reference

- [1] Cosette MS, Quinn CM, Michael PA, et al. Radiation Risk to the Fluoroscopy Operator and Staff. AJR Am J Roentgenol. 2016; 207(4): 737-744