NEW RADIATION PROTECTION CALIBRATION FACILITY AT CERN

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A new RP calibration facility for CERN

The CERN Radiation Protection (RP) group has designed a new state-of-the art low-scattering calibration laboratory to replace the present facility, which is > 20 years old [1, 2].

Main features of the new facility:

- ✓ four types of radiation fields available: neutrons, gamma, X-rays and beta;
- ✓ low-scattering facility;
- ✓ simultaneous gamma/neutron irradiation;
- ✓ monoenergetic neutrons from D-D/D-T neutron generator (under investigation);
- ✓ not influenced by external neutron sources, e.g. particle accelerators [3].

Figure 1. Worksite status in November 2013.

Figure 2. Worksite status in June 2014.

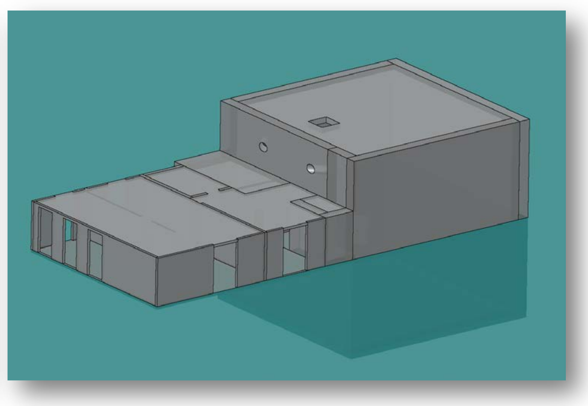


Figure 3. 3D cross section of the laboratory (simulated geometry).

The facility will be used for the calibration, evaluation and test of:

- dosimeters (Fig. 4);
- fixed RP instrumentation;
- handheld radiation detectors (Figs. 5 and 6);
- new commercial products;
- CERN research detectors;
- new accelerator instrumentation.

Figure 4. CERN dosimeters.

Figure 5. The WENDI-2 neutron rem counter.

Figure 6. AD 6 detector.

Radiation sources and irradiators

- ▪ **Main calibration hall**:
  - ✓ neutron panoramic irradiator (Fig. 8): ^{241}Am-Be (888 GBq – 100 MBq);
  - ✓ gamma irradiator (30° irradiation angle, Fig. 9): ^{137}Cs (3 TBq – 300 MBq), ^{60}Co (5 GBq);
  - ✓ X-ray generator (Fig. 10): 320 kV, Tungsten anode;
  - ✓ beta irradiator (Fig. 11): ^{90}Sr (1.85 GBq) and ^{85}Kr (4 GBq).
- ▪ **Irradiation room 1**: ^{60}Co (10 TBq) for qualification of electronic components and systems.
- ▪ **Irradiation room 2**: dosimeter calibration.

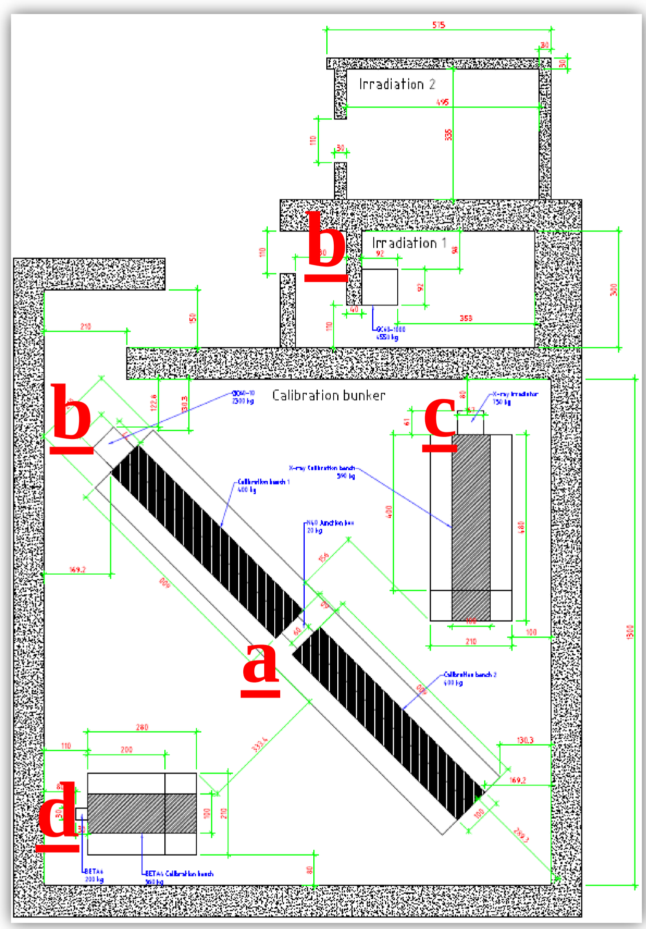


Figure 7. Top view of three irradiation rooms.

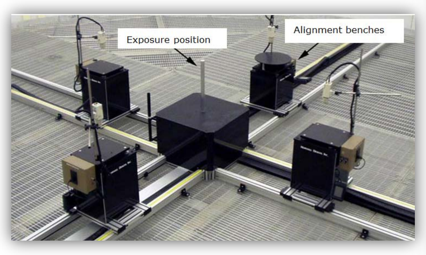


Figure 8. (a) Neutron irradiator.

Figure 9. (b) Gamma irradiator.

Figure 10. (c) X-ray generator.

Figure 11. (d) Beta irradiator.

Monte Carlo simulations for Radiation Protection

The FLUKA code [4, 5] was used to study and optimize the:

- radiation shielding (Figs. 12, 14 and 15);
- skyshine effect (Figs. 12 and 13);
- air activation;
- ozone production.

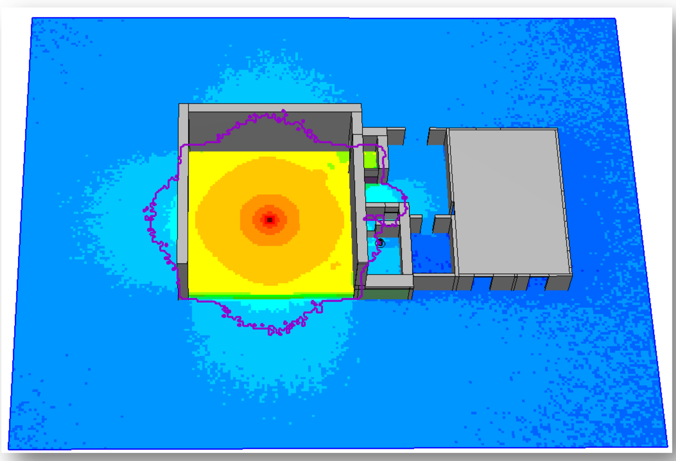


Figure 12. H*(10) from the AmBe. With skyshine.

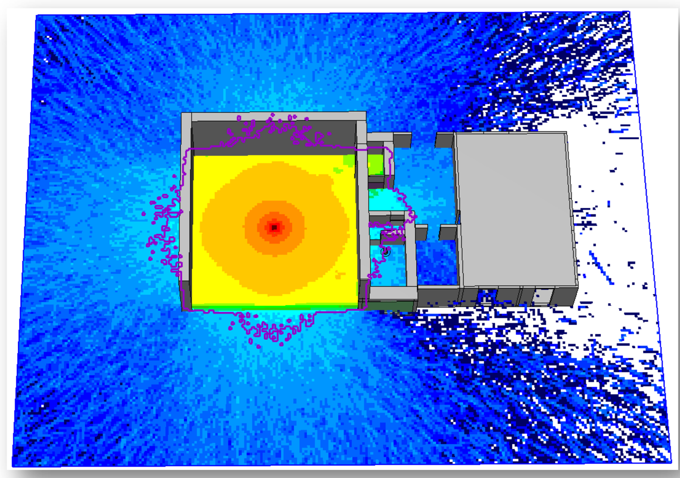


Figure 13. H*(10) from the AmBe. Without skyshine.

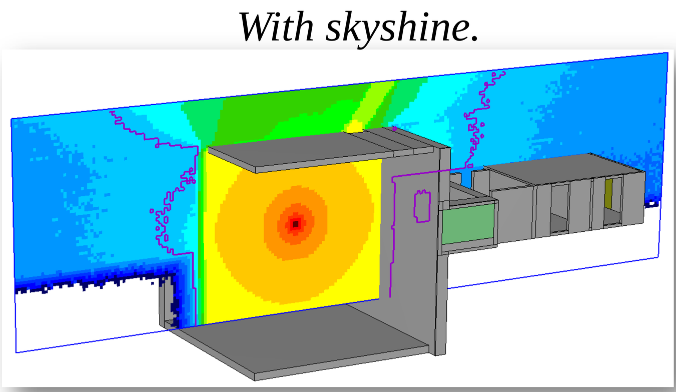


Figure 14. H*(10) from the AmBe.

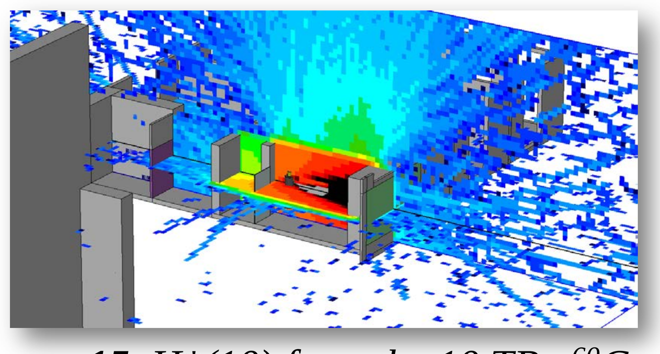
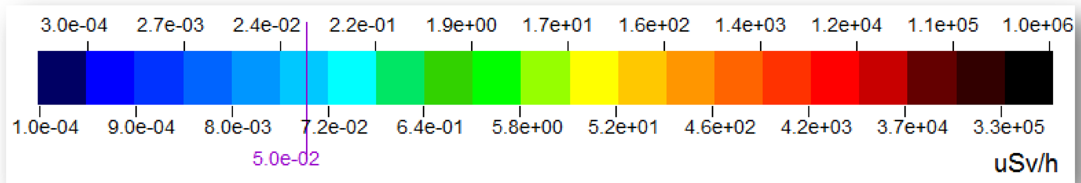
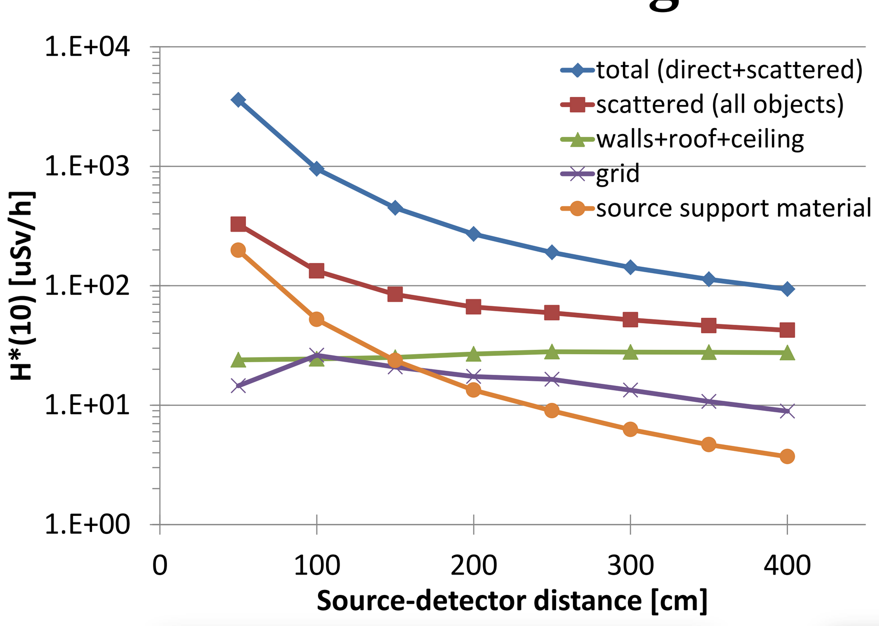


Figure 15. H*(10) from the 10 TBq ^{60}Co.

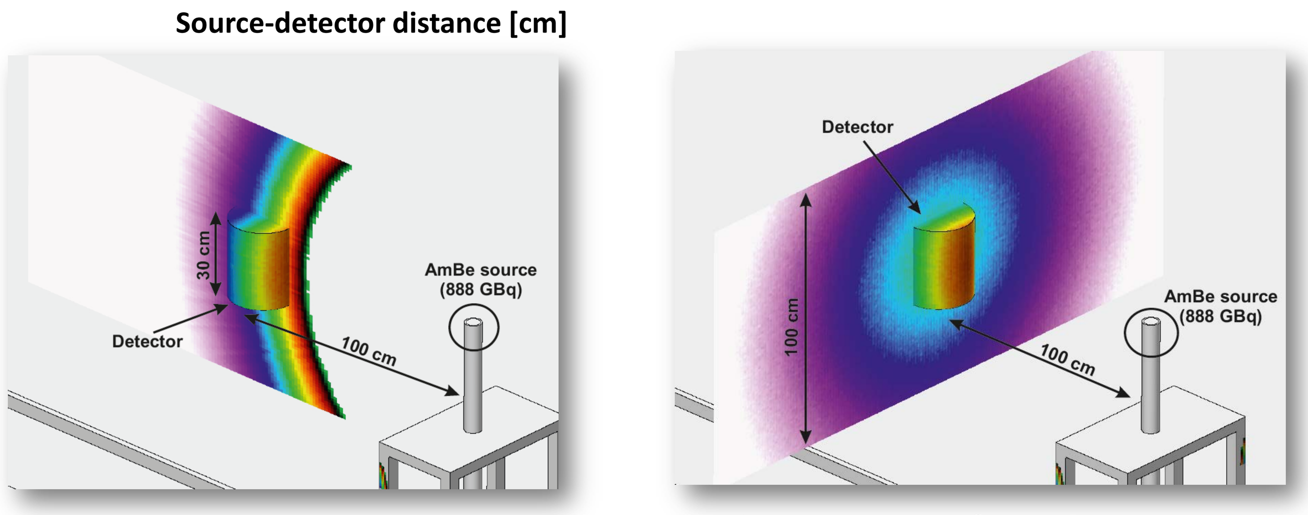


Neutron scattering and field homogeneity studies



Scattered neutrons (at 200 cm):

- •walls+roof+ceiling = 40%
- •grid = 26 %
- •source support materials = 20 %
- •air, irradiators, pillars and positioning systems = 14 %



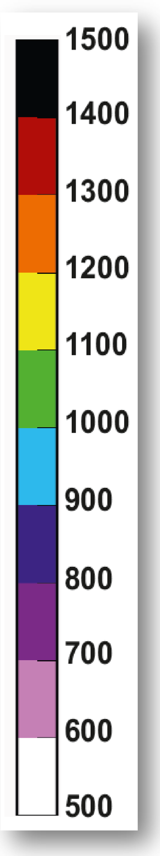


Figure 16. 3D cross sections showing the H*(10) map at 1 m from the AmBe source. The legend is in uSv/h (normalized to the source activity of 888 GBq).

Current RP studies

1. Feasibility study for the installation of a neutron generator (Fig. 17) to provide monoenergetic neutron beams (2.5 and 14 MeV).

Figure 17. NSD-35 Neutron Generator by Gradel s.a.r.l.

2. Investigation of the TIMEPIX detector as reference detector for the gamma/X-rays field characterization (Fig. 18).

Figure 18. TIMEPIX detectors.

3. Development of a set of shadow cones via FLUKA simulations for accurate neutron calibrations (Fig. 19).

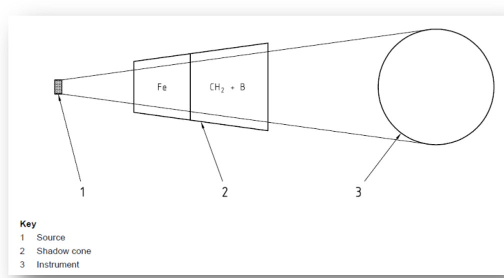


Figure 19. Schematic diagram of a neutron source, shadow cone and spherical instrument [6].

References

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