Supplementary Material

1 TLD READOUT PROCEDURE

The TLD annealing and readout procedure was performed, according to the manufacturer indications, with a pre-heating, acquisition, annealing and cooling segment, with a Harshaw 6600 PLUS reader. The preheating phase is applied to minimize the fading effect by excluding the light produced by the low energy traps and consists in a 10 s heating cycle at $160°$C. The dosimetric data are collected during the acquisition segment where the TLD pellets are heated up to a temperature of $260°$C with a heating rate of $15°$C s^{-1}. The readout procedure is concluded with an annealing phase where the residual signal on the TLD is removed by keeping the pellet at a constant temperature of $260°$C for additional 10 seconds. Before the readout procedure, all dosimeters undergo a pre-heating step consisting in heating up all the dosimeters in a dedicated oven for 30 minutes at a temperature of $100°$C. Readout and annealing procedures were performed also prior to the irradiation in order to eliminate eventual noise and background signal recorded on the cards.

2 GSI BALLS CALIBRATION RESULTS

2.1 TLD crystals calibration with ^{137}Cs gamma source

All the TLD crystals (four per TLD card) used in the present work have been calibrated, in terms of dose, with gamma radiation from a ^{137}Cs source, GSI with a nominal activity of 364 MBq, available at GSI. The obtained responses R_γ are shown in figure S1A for TLD600H andfig:1B TLD700H in the top and bottom panel respectively. For each card the value of the two different crystals are reported separately.

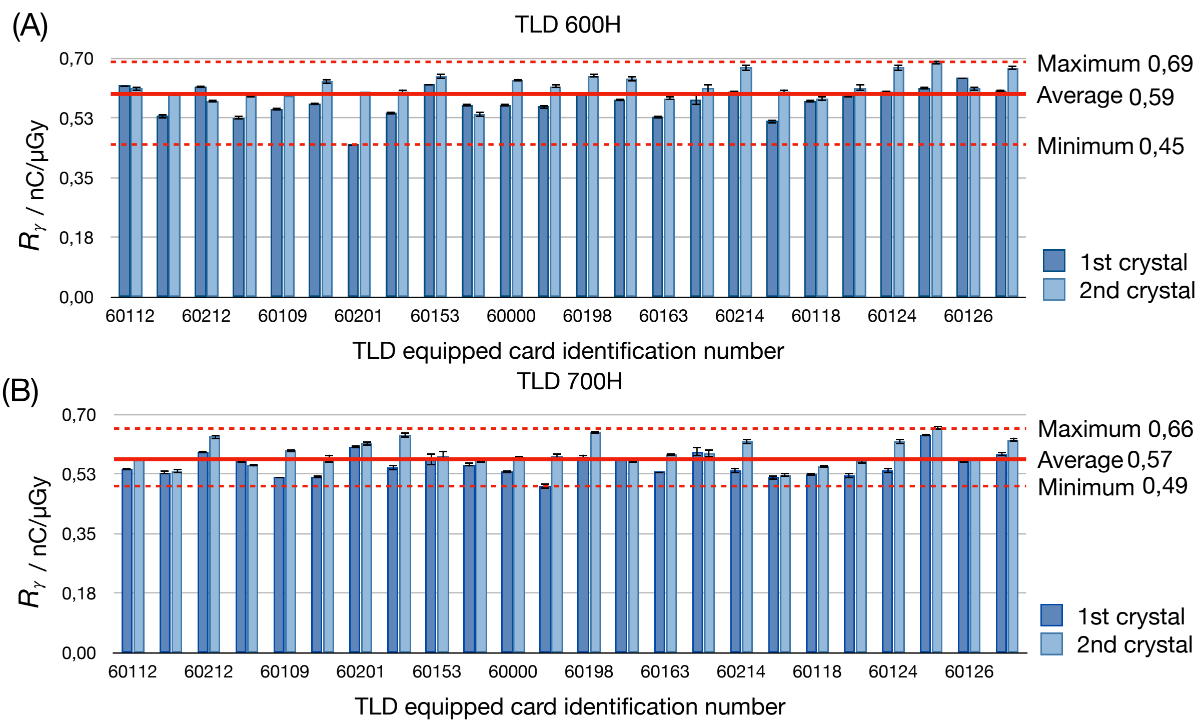

Figure S1. Single response obtained trough ^{137}Cs irradiation for TLD600H (top panel) and TLD700H (bottom panel).

2.2 GSI Balls neutron calibration with ^{241}Am-Be(α,n) source

All the dosimeter configurations used during the experimental campaign have been calibrated in terms of neutron ambient dose equivalent by exposing the GSI Balls to the neutron field generated by a ^{241}Am-Be(α,n) source available at GSI, nominal activity 370 GBq. The neutron ambient dose equivalent response, R_{n}, for all dosimeters used during the experiment is shown for two independent irradiations in figure S2. For all the detectors, an average R_{n} of 0.97 μGy μSv^{-1} (minimum of 0.89 μGy μSv^{-1} and maximum of 1.07 μGy μSv^{-1}) has been found. For the new GSI ball prototype (the one at 15, 40 and 130 degrees) containing three TLD cards, the reported response is obtained by averaging over the signal measured by the three TLD cards, in this way it is possible to exclude any possible dependency on the relative position of each card respect to the neutron source.
Additionally, one new GSI Ball containing three TLD cards has been calibrated in the PTB neutron reference field of ^{241}Am-Be(α,n) radionuclide source. The contribution of back-scattered neutrons was corrected by means of the shadow-cone method. Averaging between the neutron doses measured by the three card in the GSI ball a mean of R_{n} (0.82 ± 0.05) μGy μSv^{-1} has been found. This value is 1.2 times lower than mean the R_{n} measured at GSI (obtained by averaging over the responses of all the dosimeters used during the experiment). The individual ball responses measured at GSI have been then, accordingly, reduced by 20%.

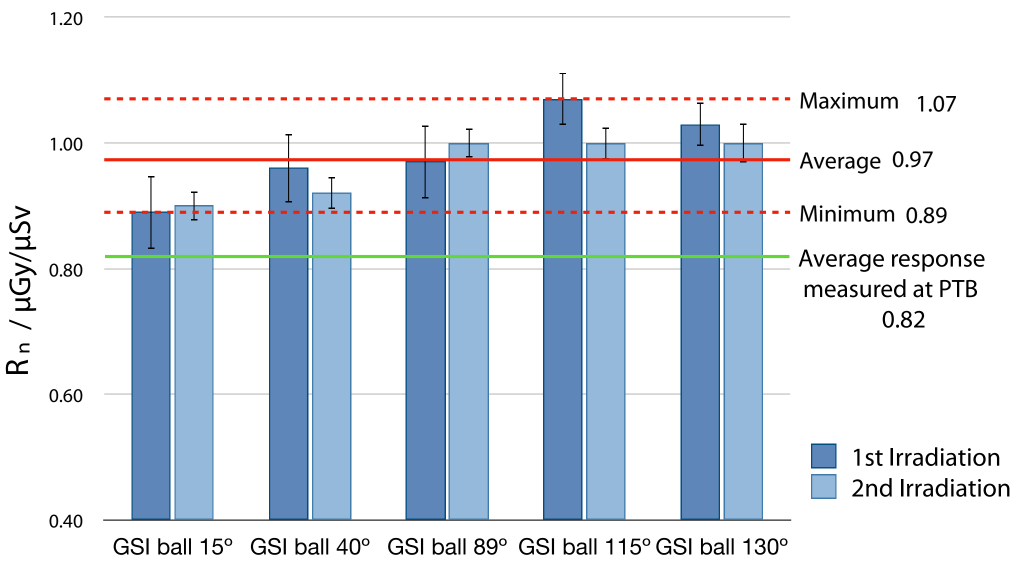

Figure S2. GSI ball response, in terms of neutron ambient dose equivalent, obtained by irradiating all the all the dosimeter used during the experiment with an ^{241}Am-Be(α,n) available at GSI. For the balls containing three TLD cards ((the one at 15, 40 and 130 degrees) the calibration factor was obtained by averaging the neutron dose measured by the three different cards.The values were corrected by using a correction factor obtained by a comparison with the values determined at PTB (green line).