The Radionuclide ^{63}Ni - a Fluence Monitor for Fast Neutrons in Hiroshima and Nagasaki

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The results of the Life Span Study (LSS) [1] on the survivors of the atomic bomb explosions in Hiroshima and Nagasaki are the major basis for risk estimates of radiation exposure. The survivors were exposed to a mixed γ– and neutron–radiation field with, according to DS86, the γ–field being the major component. The contribution of neutrons to the doses, however, is still in question. Measurements in Hiroshima have shown that DS86 may underestimate *thermal* neutron fluences at large distances (>1000 m) from the hypocenter[1] (see for example [3]). This discrepancy casts doubts on neutron doses estimated for the survivors, though neutron doses are mainly governed by *fast* neutrons. The existing measurements on fast neutrons, i.e. the measurement of ^{32}P produced by fast neutrons via the reaction ^{32}S(n,p)^{32}P are not meaningfull at large distances [2,4], due to large measurement uncertainties. To determine fast neutron fluences in Hiroshima and Nagasaki retrospectively, the reaction ^{63}Cu(n,p)^{63}Ni can be used if adequate copper samples are available [6,7]. Since the half life of ^{63}Ni is (101.4±1.4) a [8] about 70% of ^{63}Ni produced by the atomic bomb exists in copper samples more than 50 a after the explosion. By means of AMS with the gas–filled–magnet GAMS we are now able to determine concentrations as low as 10^4 at/g Cu which are typical for distant samples. The method is described in detail in [4,5,9,10,11].

In the year 2000 we performed a systematic search for potential copper samples in Hiroshima and Nagasaki, and a few of unknown new samples could be identified. For some of these first concentration measurements have been made, see table 1 [4,5]. In addition, samples were identified to measure the natural background of ^{63}Ni in copper. One sample was from a copper roof of the church tower in Thannhausen, Germany, 550 m above sea level. The copper was exposed to cosmic rays almost 100 a, another sample under investigation is a brass key from a meteorological station at the Sonnblick mountain, Austria, 3 100 m above sea level. In order to quantify the production of ^{63}Ni due to fast and stopped muons, copper samples irradiated with fast muons at CERN and irradiated with stopped muons at PSI [12] will be analysed for ^{63}Ni.

Copper Samples	gr [m]	mea.
Hiroshima		
Bank of Japan	367	*
Sanin Godo Bank	621	*
Soy Sauce Brewery	948	*
City Hall	1 014	*
H. University Primary School	1 304	*
H. University Radioisotope Building	1 461	*
Sumitomo Bank	1 880	
Ohban Shrine	3 392	
Kusatsu-Hachiman Shrine	5 062	
Kamasaki Shrine	7 500	
Nagasaki		
Yanabashi	300	
Ohbashi	500	
Mitsubishi Arms Factory	1 400	

Table 1: Copper samples which were probably exposed to atomic bomb neutrons; gr denotes the ground range (the distance from the hypocenter to the point of interest). Some of the samples (*) have already been measured [4,5].

References

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[1] Hypocenter is defined as the vertical projection of the point of explosion to the ground. The distance from a point to the hypocenter is the ground range.