In order to estimate the lifetime of quadrupole magnets in the High-Luminosity (HL) LHC accelerator during operation up to 3000 fb^{-1}, a precise knowledge of the potential damage on the superconductors caused by the simultaneous action of several high energy irradiation sources is needed. After introducing a W shield, the radiation load by multiple energy sources on the innermost windings of the HL-LHC quadrupoles has been calculated and a total displacement per atom value *dpa* of 1.8×10^{-4} has been found [1]. In order to predict the irradiation effects the same Ta and Ti added multifilamentary Nb_3Sn wires were irradiated with high energy protons (65 MeV and 24 GeV, up to 1.4×10^{21} p/m^2) and neutrons (1 MeV, up to 1.8×10^{22} n/m^2). Within these fluences, T_c exhibited a slight, linear decrease and B_{c2} increased by ~5 and 3 %, respectively. J_c showed a strong increase by a factor of 2 and 1.5, respectively, reaching the remarkably high values of the order of 11×10^3 A/mm^2 at 4.2 K/10 T. This enhancement is the result of a strong enhancement of the point pinning contribution, and was satisfactorily described by a quantitative two-force model [2]. The variation of T_c in Nb_3Sn wires as a function of the *dpa* value (determined using the FLUKA code) for both, proton and neutron irradiation in the *dpa* range between 1×10^{-4} and 1.4×10^{-3} was found to fall almost on the same curve. The variation of J_c vs. *dpa* shows some similarities between proton and neutron irradiation, too, but the problem is more complex: the correlation T_c vs. *dpa* is governed by the change in atomic ordering, while J_c vs. *dpa* depends on the enhanced point pinning correlated with the radiation induced defect clusters. With the new relationship between T_c and *dpa* for both, protons and neutrons, the decrease of T_c in the quadrupoles at the maximum luminosity can now be estimated to ~ 0.3 K. Finally, to completely study the radiation damage problem in HL-LHC quadrupoles the effects induced on the A15 structure by the Bragg peak were studied. After 10 MeV proton irradiations of Nb_3Sn platelets up to fluences of 1.0×10^{22} p/m^2, changes in the crystallographic parameters are observed by means of Synchrotron measurements: both the microstrains and the lattice constant increase while the Bragg Williams LRO parameter, S, decreases. It was shown that the effects of proton irradiations are considerably more pronounced in the platelets where the Bragg peak occurs reflecting the higher damage induced by protons in this region.

1) A. Lechner et al., CERN, 2015, unpublished
2) T. Spina et al. Published in IEEE Trans. Applied Supercond., 2015, Vol. 25