Critical current density of Nb$_3$Sn wires after irradiation with 65MeV and 24GeV protons

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Abstract - Industrial Nb$_3$Sn wires with Ti and Ta additives (RRP process) and with Ta additives (PIT process) with a diameter of 1 mm have been irradiated at room temperature with protons of 65 MeV and of 24 GeV at various fluences up to $1\times10^{21}$ p/m$^2$. A steady increase of $J_c$ vs. fluence was observed for all the wires up to the highest fluence. The observed increase of $J_c$ at 4.2K in all wires was quite similar in spite of the very different proton energies. With increasing fluence, the radiation induced pinning force was found to increase, the enhancement $J_c/J_{co}$ after $5.04\times10^{20}$ p/m$^2$ reaching 1.4 for Ta and 1.8 for Ti alloyed wires at 10T. The present results were quantitatively analysed by assuming a radiation induced point pinning mechanism in addition to grain boundary pinning. The results are compared with those of an ongoing neutron irradiation study undertaken on the same Nb$_3$Sn wires in collaboration with the Atominstitut Vienna. Proton irradiation was found to produce considerably higher damage than neutron irradiation.

Keywords - PIT Nb$_3$Sn wires, proton irradiation, flux pinning, critical currents, HL-LHC