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Preliminary investigations of Rutherford cable splicing techniques for high field accelerator magnets

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High field accelerators magnets will require coil grading, and thus low resistance joints (splices), in order to increase the magnetic field and decrease magnet cost. These joints must have low resistance (<1 nΩ) and reasonably good mechanical strength. Three techniques have been initially considered by the Applied Superconductivity group of the Swiss Plasma Center for the preparation of joints between Nb3Sn Rutherford cable: 1) Soldering (PbSn or SnAg alloys) 2) Diffusion bonding and 3) Diffusion bonding between electroplated cables (in order to fill up gaps between strands). Many test joints were prepared using these methods. Initial investigations included examinations of cross sections (cut by electro-erosion) and measurements of resistance up to 1 kA at 4.2 K in 15 T background. These investigations allowed selecting the most promising techniques for further developments and tests at higher currents. All soldered joints had resistance lower than 2 nΩ; diffusion bonding technique gives the lowest resistance (<1 nΩ) only if the applied pressure is sufficiently high and these samples showed also very good reproducibility. The use of Cu foils in between the cables also improves the bond strength, without increasing the joint resistance. The most promising joints were later tested in the SULTAN facility up to 20 kA at 5 K and in 10.8 T background field.

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