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Numerical simulation of cold helium safety discharges into a long recovery line

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Helium cryogenics is currently the most developed technology for the thermal conditioning of large superconducting particle accelerators. The extremely elongated structures of these accelerators require long-distance transport of cold helium from the helium refrigeration units to the users of cryogenic cooling powers (mainly magnet cryostats and cavity cryomodules). The design and operation of the superconducting accelerators must fulfill requirements of high reliability and operating cost minimization. These strongly influence the baseline design choices for cryogenic gas management and pressure equipment safety strategies. As helium accidental discharges from the cryostats and cryomodules cannot be excluded, some possibilities of recovering helium releases from safety devices are taken into consideration. Collecting of discharged helium and transferring it back to the cryoplant via a long recovery line is an option. However, rapid and fast discharges of cold helium into warm recovery lines can result in significantly unsteady, compressible and thermal flows. Therefore the proper designing and sizing of the recovery lines have to be supported by detailed analyses of all expected fluid dynamics and thermodynamics phenomena.

This paper describes the numerical simulations of cold helium discharges into a long warm recovery line that have been used for sizing the recovery line of the ESS linac cryogenic system. The paper discusses the model assumptions and presents some exemplary results.

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