Uppsala activities within CLIC collaboration 2021/2022

Uppsala activities were mainly focused on the cryogenic DC spark system in Uppsala built in collaboration with CERN. The setup is used to investigate field emission and vacuum arcs, which limit the accelerating gradient of normal conducting and superconducting accelerating cavities. The system can be operated at ambient to cryogenic temperatures measuring conditioning data, breakdown threshold and field emissions.

The system was upgraded in 2022 to lower the achievable temperature below 10 K. This was successful and the first copper electrodes were tested at 4 K. With this milestone behind the setup is ready for measurements of niobium electrodes from room temperature through the superconducting transition. Further goal is to measure electrodes, both normal and superconducting, which have been prepared using superconducting cavity preparation protocols.

Unique features were identified on the surface of the cryo-conditioned electrodes using microscopy done after field exposure (shape changes from circular craters to star-like formations). The features are common for the surfaces tested at cryogenic temperature and very rare for the electrodes after the test at room temperature. The investigation into the origin of the features are proceeding with the help from material science experts from the Hebrew University of Jerusalem.

Uppsala also recently joined the ongoing study at CERN, of the effects of H- irradiation on different materials to providing data on the field reached during conditioning for irradiated and non-irradiated electrodes in cryogenic conditioning. One pair of partly irradiated electrodes is currently being tested in Uppsala.

A new PhD student started the work on the cryo-DC setup with the main aim to measure changes in the resistivity before and after conditioning process as a way to quantify movement of dislocations. This study could shed light on the question if movement of dislocations in the crystal structure is indeed the underlying mechanism for breakdown phenomenon. The plan is to use the electrode system as a resonance cavity and induce a high frequency (GHz) current in the electrodes that will only flow near the surface exposed to high fields and affected by dislocations. Huge advantage of our system is the cryogenic environment since resistivity at low temperature is due only to dislocations, vacancies, impurities and all possible material defects. With this we hope to extend the understanding of high-field physics and material science to low temperatures and make also new and potentially important connections between the high-gradient normal-conducting and superconducting fields.