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# Realization of a Digital twin of the KARA accelerators at KIT in a real-time simulation environment: the ACCESS Project

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Particle accelerators are complex and energy-intensive facilities that require extensive and inter-twined connections with the public electrical grid. Furthermore, accelerator facilities are well known for their low power demand flexibility, which depends only on experimental operations, and it must be accommodated independently from the grid. So, it is necessary to develop, and test new energy solutions for an energy-efficient and stable operation of particle accelerators. However, validating novel solutions at a research facility is difficult because technical problems can disrupt the research process.

In the ACCESS (Accelerator Energy System Stability) Project, a digital twin of the accelerator KARA will be realized at Energy Lab 2.0 in a real-time simulation environment. The goal is to validate any energy solutions that can be applied to accelerators in a safe and flexible environment (simulation) without interfering with KARA experiments, while retaining high accuracy (digital twinning).

As the first step, the electrical system of KARA will be modeled. A real-time communication infrastructure between KARA and Energy Lab 2.0 will be installed in order to transfer measurement data in real time from the accelerator to the simulated environment. Once initial communication is established between the two labs, voltage and current sensors are placed at specific strategic points on the KARA to capture the state of the system with high time resolution. Voltage and current curves are saved in local data memory together with the experiment sequence and sent to the digital real-time system OPAL-RT available in Energy Lab 2.0 via a fiber optic backbone at full sampling rates.

This work will provide a look at the first results of the ACCESS project and will highlight the need for fast measurement systems in particle accelerators

## Speed Talks

Normal

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