

## Master's Thesis Electrical Engineering at Energy Lab

### Analyzing Energy Consumption and Lifetime Energy Costs for Karlsruhe Research Accelerator (KARA)

#### Thesis Description:

Particle accelerators consist of complex, energy-intensive components with different power demands and operating schedules. Annually, these facilities can consume hundreds of GWh of electricity, leading to significant operational costs. To accurately evaluate these costs over an accelerator's lifetime, this thesis will analyze the energy consumption of individual components under different conditions, including temperature, humidity, operational modes, seasons, and electricity price fluctuations. The research will further assess lifetime costs by considering component degradation, maintenance needs, and projected energy price trends. These studies will help enhance the sustainability of accelerator operations across Europe's research infrastructure.

#### Milestones:

- **Energy Consumption Analysis:** Collect and preprocess data on power usage across different operating conditions. Use Exploratory Data Analysis (EDA) techniques to visualize trends in power consumption as affected by temperature, humidity, and operation modes.
- **Statistical Analysis:** Apply methods such as ANOVA, correlation tests, and regression analysis to quantify the effects of external factors (e.g., temperature, humidity, operation modes) on energy consumption.
- **Lifetime Energy Cost Modeling:** Develop models to assess how component degradation and replacement cycles impact energy consumption over time. Factor in maintenance schedules, component upgrades, and electricity price trends to create a comprehensive cost model.
- **Visualization and Reporting:** Create clear visualizations (e.g., energy trends, cost breakdowns, scenario comparisons) to present your findings. Validate your models by comparing the results with historical data from existing accelerators.

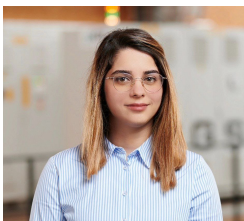
#### Your Profile:

- Strong analytical and Statistical skills with MATLAB or **Python** for data analysis.
- Basic knowledge of particle accelerators (preferred but not mandatory).
- Language: English

#### You will learn:

- Advanced data analysis techniques for energy systems, including statistical modeling and scenario simulations.
- Lifetime cost analysis for complex systems
- Particle accelerator operations

#### Contact:



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