Hackathonino – Case Study / Challenge # 2

IUPAP-WG14 @ IPAC2026

Title & Contact

Title: Electrical Power Capacity Estimation for an ESS Accelerator Component Test Facility
Proposer: (Conceptual exercise – based on ESS-like infrastructure)
Contact: infrastructure & accelerator systems design study

Context & Objectives

Modern high-power proton accelerator facilities such as the European Spallation Source require significant electrical infrastructure to support RF systems, cryogenics, magnets, beam operation, and supporting utilities.

This exercise focuses on a **conceptual electrical load assessment** for a dedicated accelerator component test facility hosting:

- RFQ and DTL RF systems
- Cryomodule test stands
- Ion source and LEBT systems
- Magnet and beam diagnostic systems

Objective:
Estimate the **total installed and operational electrical power requirements**, distinguishing between:

- Peak installed power
- Average operational power
- Major subsystem contributions

Data & Task Description

Data Inputs (assumed / reference-based):

- RF system specifications (RFQ, DTL, cryomodules)
- Typical efficiencies (RF chain, cryoplant, power converters)
- Magnet and beamline electrical consumption benchmarks
- Infrastructure loads (cooling, vacuum, controls, HVAC)

Task:

- Build a **power budget model** for the facility
- Decompose electrical demand by subsystem:
    - RF systems (dominant load)

- Cryogenics plant
- Magnet systems
- Beam instrumentation and controls
- Infrastructure utilities

Expected Outputs:

- Total installed electrical capacity (MW)
- Average operational power consumption (MW)
- Subsystem-level breakdown (stacked contribution model)

Success Criteria:

- Physically consistent power budget (energy conservation valid)
- Realistic scaling with ESS-class accelerator parameters
- Clear identification of dominant power consumers
- Transparency of assumptions and efficiency factors

Impact & Follow-up

- Provides early-stage **infrastructure sizing input for facility design**
- Supports feasibility studies for ESS-like test facilities
- Identifies **dominant cost drivers (RF and cryogenics)**
- Enables comparison with SNS / CERN-scale installations
- Can be extended into a full techno-economic model (CAPEX/OPEX)

Proposer Support & Consent

- Conceptual guidance on accelerator subsystem power scaling
- Reference values for ESS-class RF and cryogenic systems
- Support for interpretation of results
- Consent for use of benchmark assumptions in design studies

Subsystem(s) concerned

☐ Beam dynamics / collective effects ☐ RF / LLRF ☐ Magnets / power converters
☐ Diagnostics ☐ Vacuum ☐ Controls / operations