Hackathonino – Case Study / Challenge # 4

IUPAP-WG14 @ IPAC2026

Title & Contact

Title: Utilities and Infrastructure Sizing for High-Power Accelerator Component Test Facility
Proposer: (Conceptual exercise – ESS/SNS/CERN-class infrastructure)
Contact: accelerator infrastructure & facility systems study

Context & Objectives

High-power accelerator facilities such as the European Spallation Source require extensive supporting infrastructure beyond accelerator systems, including cooling, vacuum, gas systems, and electrical distribution.
This exercise focuses on estimating the **non-accelerator utilities required** for a dedicated test facility hosting RF, cryogenic, beam, and magnet systems.
Objective:
Determine the required **industrial utilities footprint**, including:

- Cooling water systems
- Vacuum pumping infrastructure
- Industrial gas consumption
- Electrical auxiliary systems
- HVAC and environmental systems

Data & Task Description

Data Inputs (assumed / reference-based):

- Heat loads from RF, cryogenics, and magnets
- Vacuum pressure requirements per subsystem
- Beamline length and pumping section distribution
- Gas usage for ion source and cryogenic systems
- Control system and electronics power demand

Task:

- Build a **facility utility model** including:
  - Cooling water flow and thermal load (MWth)
  - Vacuum pumping speed and system topology
  - Gas consumption rates (H_2, He, N_2)
  - Electrical auxiliary loads (controls, IT, safety systems)
- Define redundancy and reliability strategy (N+1 design)

Expected Outputs:

- Cooling water demand (MWth and flow rates)

- Total vacuum pumping capacity (l/s and pump distribution)
- Gas consumption estimates (Nm^3/year or equivalent)
- Auxiliary electrical load estimate (MW)
- Utility redundancy architecture

Success Criteria:

- Consistency with accelerator heat load budget
- Realistic industrial utility scaling
- Clear separation of beam-related vs infrastructure loads
- Robust redundancy and safety assumptions

Impact & Follow-up

- Provides critical input for **civil engineering and facility design**
- Enables realistic planning of ESS-class test infrastructures
- Identifies utility bottlenecks (cooling, vacuum, gas logistics)
- Supports lifecycle cost (OPEX) estimation
- Forms basis for **integrated facility digital twin models**

Proposer Support & Consent

- 🎬 Reference benchmarks from ESS/SNS/CERN infrastructure systems
- 🎬 Guidance on utility scaling and engineering assumptions
- 🎬 Support for interpretation and validation of estimates
- 🎬 Consent for use in conceptual design studies

Subsystem(s) concerned

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