The European Spallation Source Control System

Garry Trahern,
Head of Integrated Control Systems
The ESS site is in Sweden!

Sweden, Denmark & Norway cover 50% of cost

The other 14 member states covers the rest, with the European Investment Bank
Evolution of neutron sources

Effective thermal neutron flux n/cm²-s


Berkeley 37-inch cyclotron
350 mCi Ra-Be source
Chadwick
Effective thermal neutron flux n/cm²-s

10^5 10^10 10^15 10^20

Steady State Sources
Pulsed Sources

[Graph showing the evolution of neutron sources from 1930 to 2020, with various sources labeled along the timeline, such as Berkeley 37-inch cyclotron, FRM-II, SNS, J-PARC, etc.]

Neutrons in 2019!

- 5 MW beam power
- 2.5 GeV protons (H+)
- 2.9 ms pulses
- 14 Hz rep rate
- 50 mA pulse current
- 704 MHz RF frequency
- < 1 W/m beam losses
- 7.5 MW upgradability?

No H- injection,
No accumulator/compressor ring!

Green field site
**Scope of integrated control system**

*Everything* from source to target, cryogenics & conventional facilities

- Good for long-term maintainability
- Get everybody on board at the beginning (when it is not ‘so hard’)
- Organizational challenges are faced head-on
## ESS Master Programme Schedule

### ESS Program Phases, Gates and Milestones

<table>
<thead>
<tr>
<th>Year</th>
<th>Program Initiations</th>
<th>Program Set-up</th>
<th>Delivery of Construction phase</th>
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### Program level

- **Pre-construction phase**
- **Construction**
- **Design Update**
- **Prepare to Build**
- **Installation**
- **Conception**
- **Site preparation**
- **Ground Break**
- **First Building**
- **Full beam power on target**
- **Operations**
- **Design and Manufacturing 22 instruments**
- **Installation 1-22**

### Accelerator

- **Design Update**
- **Prepare to Build**
- **Installation**
- **Construction**

### Target

- **Design Update**
- **Prepare to Build**
- **Installation**
- **Construction**

### Instruments

- **Conceptional Design**
- **List**
- **Design and Manufacturing 22 instruments**

### Conventional Facilities

- **Design Update**
- **Site preparation**
- **First Building**
- **Construction**
Current activities

Prepare-to-Build (P2B) provides 1) Prototyping & 2) Engineering Design Reports, in smooth transition from design to construction.
Projects to model on in terms of controls

• SNS
  • Similar in functionality to ESS
  • Real-life experience from SNS control system

• ITER
  • multi-lab and multi-nation project just like the ESS
  • A very large EPICS installation
  • ITER timeframe
    - First subsystems integrated: 2013
    - Commissioning: 2018
    - Operation: 2019
Some architectural, design and organizational decisions

• ESS will use the EPICS control system.

• Linux will be the operating system in the ESS controls service tier.

• Provide a standardized “Control Box” platform to ESS partner institutions, with first prototype delivery in the design phase.
  • Release Control Box software and hardware in (approximately) yearly cycles
Control System Architecture – Control Box

Control Box
- Provide a standardized solution before teams develop their own
- A cornerstone in the 3 year design update phase

Benefits
- Encourage consistency between sub-systems
  - including target, experimental stations, cryogenics & CF
- Enable factory acceptance testing of subsystems through control system,
- Validate technology decisions,
- Minimize throw-away hardware and software development
Control Box consists of
• Hardware
• Software (IOC, OPI)
• Procedures

Provides a clear split of responsibility among
• Control system developers
• Subsystem integrators
Beam line elements database (BLED)

- Automatically generate as much of the control system's components as possible
- Principal input: a high-level description of the system (e.g., the accelerator's lattice)

- Use of system engineering tools and model-driven architecture
- The database(s) contain:
  - inventory information (equipment and its location, reference to manuals, reference to purchasing information, …)
  - cabling, connectivity and topology information
  - control system process variables, processing rules, …
Hardware platform selection

• How to select the hardware platform, main criteria
  • Usability
  • Longevity
  • NOT “top performance” or coolness factor
  Acceptance by majority in the industry.

• Selection process:
  • Stakeholders: controls, beam instrumentation, RF, …
  • First prototype decision on October 3: cPCI
  • Decision revised through prototyping and comparing notes
    • Early prototype – learn from mistakes
    • Different groups – different experiences

• Objective approach: unified table for all platforms, arguments agreed upon by all groups
Current status

• Development environment
  • ITER’s CODAC is taken as basis
  • 8 service servers hosting bug tracking, version control, continuous integration …
  • Scientific Linux user development virtual machines
    • Cross platform: Windows, Mac OS, Linux
• Timing, MPS: gathering requirements
  • Single source clock will be used
• Naming convention finalized
• End of 2012: First major deliverables
  • Technical Design Report
  • Vertical prototype with Control Box (and manual)
… complement each other.
The European Spallation Source will be built in Lund.
• The design of the CS should ensure a long life with many upgrades.
• The accelerator design, prototyping & construction is being performed in a collaboration.

Use code and best practices from similar projects as much as possible
• Collaboration with SNS and ITER

Provide a working control system from the onset
• Control Box, released in yearly cycles