

# Status of the European Spallation Source Control System

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# The European Spallation Source ERIC



- An accelerator-based neutron source to be built in Lund, southern Sweden
  - Material and life sciences research
- A collaboration of 17 European nations (as of now)
  - Construction budget about 1860 million Euro (2013 level)
  - An ERIC (European Research Infrastructure Consortium) since October 1<sup>st</sup>, 2015
- Targeted to be the world's most powerful neutron source
  - 5 MW beam power, 2.5 GeV proton energy, 14 Hz repetition rate, 2.86 ms pulse@50 mA beam current
  - Superconducting linac, rotating tungsten target
  - 22 neutron instruments in construction budget
- Aim to produce first neutrons by 2019

# The European Spallation Source ERIC



## The European Commission decision to set up the European Spallation Source ERIC

A screenshot of a web browser displaying the official text of a Commission Implementing Decision. The browser's address bar shows the URL 'eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L\_.2015.225.01.0016.01.ENG'. The browser's navigation bar includes various utility icons and links such as 'Intranet', 'ESS Public Web', 'ICS Home', 'JIRA-ESS', 'ESS Bitbucket', 'CHESS', 'DOORS', 'Primavera P6', 'ess Staff Handbook', 'PICMG', 'TODO list', and 'ESSnow Service P...'. The document content is displayed in a structured layout with a header, title, date, and main body text. The header includes the date '28.8.2015', a language selector 'EN', and the text 'Official Journal of the European Union' followed by 'L 225/16'. The title is 'COMMISSION IMPLEMENTING DECISION (EU) 2015/1478 of 19 August 2015 on setting up the European Spallation Source as a European Research Infrastructure Consortium (European Spallation Source ERIC) (Text with EEA relevance)'. The main body text begins with 'THE EUROPEAN COMMISSION, Having regard to the Treaty on the Functioning of the European Union, Having regard to Council Regulation (EC) No 723/2009 of 25 June 2009 on the Community legal framework for a European Research Infrastructure Consortium (ERIC) (1), and in particular point (a) of Article 6(1) thereof, Whereas:'. This is followed by a numbered list of four points detailing the request from various member states, the Commission's assessment, the agreement on the Host Member State, and the final decision. The text concludes with 'HAS ADOPTED THIS DECISION:'.

28.8.2015    EN    Official Journal of the European Union    L 225/16

**COMMISSION IMPLEMENTING DECISION (EU) 2015/1478**

**of 19 August 2015**

**on setting up the European Spallation Source as a European Research Infrastructure Consortium (European Spallation Source ERIC)**

**(Text with EEA relevance)**

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union,

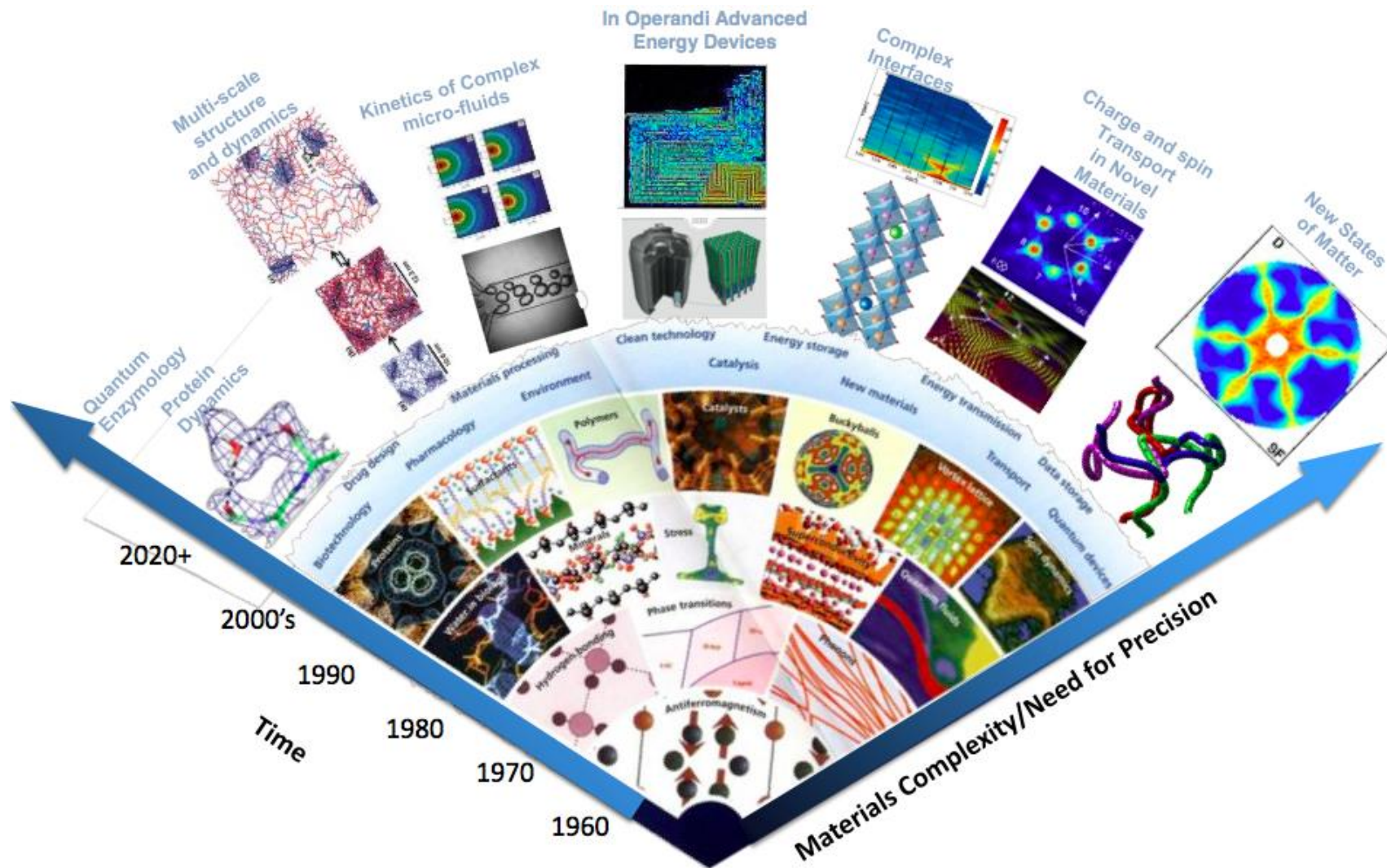
Having regard to Council Regulation (EC) No 723/2009 of 25 June 2009 on the Community legal framework for a European Research Infrastructure Consortium (ERIC) <sup>(1)</sup>, and in particular point (a) of Article 6(1) thereof,

Whereas:

- (1) Czech Republic, the Kingdom of Denmark, the Federal Republic of Germany, the Republic of Estonia, the French Republic, the Italian Republic, Hungary, the Kingdom of Norway, the Republic of Poland, the Kingdom of Sweden and the Swiss Confederation requested the Commission to set up the European Spallation Source as a European Research Infrastructure Consortium (hereinafter 'European Spallation Source ERIC'). The Kingdom of Belgium, the Kingdom of Spain, the Kingdom of the Netherlands and the United Kingdom of Great Britain and Northern Ireland have made known their decision to participate in the European Spallation Source ERIC initially as Observers.
- (2) The Commission has, in accordance with Article 5(2) of Regulation (EC) No 723/2009, assessed the application and concluded that it meets the requirements set out in that Regulation.
- (3) Czech Republic, the Kingdom of Denmark, the Federal Republic of Germany, the Republic of Estonia, the French Republic, the Italian Republic, Hungary, the Kingdom of Norway, the Republic of Poland, the Kingdom of Sweden and the Swiss Confederation have agreed that the Kingdom of Sweden will be the Host Member State of the European Spallation Source ERIC.
- (4) The measures provided for in this Decision are in accordance with the opinion of the Committee established by Article 20 of Regulation (EC) No 723/2009,

HAS ADOPTED THIS DECISION:

# Science at ESS



Addressing (among others) the so called Grand Challenges of neutron and muon research  
: **Energy, Health and Life Science, Information Technology, Nanoscience and Nanotechnology, Environment and Earth Sciences, Heritage Science**

Several instruments with techniques to address these challenges have been selected :

**Small-Angle Neutron Scattering** : LOKI, SKADI

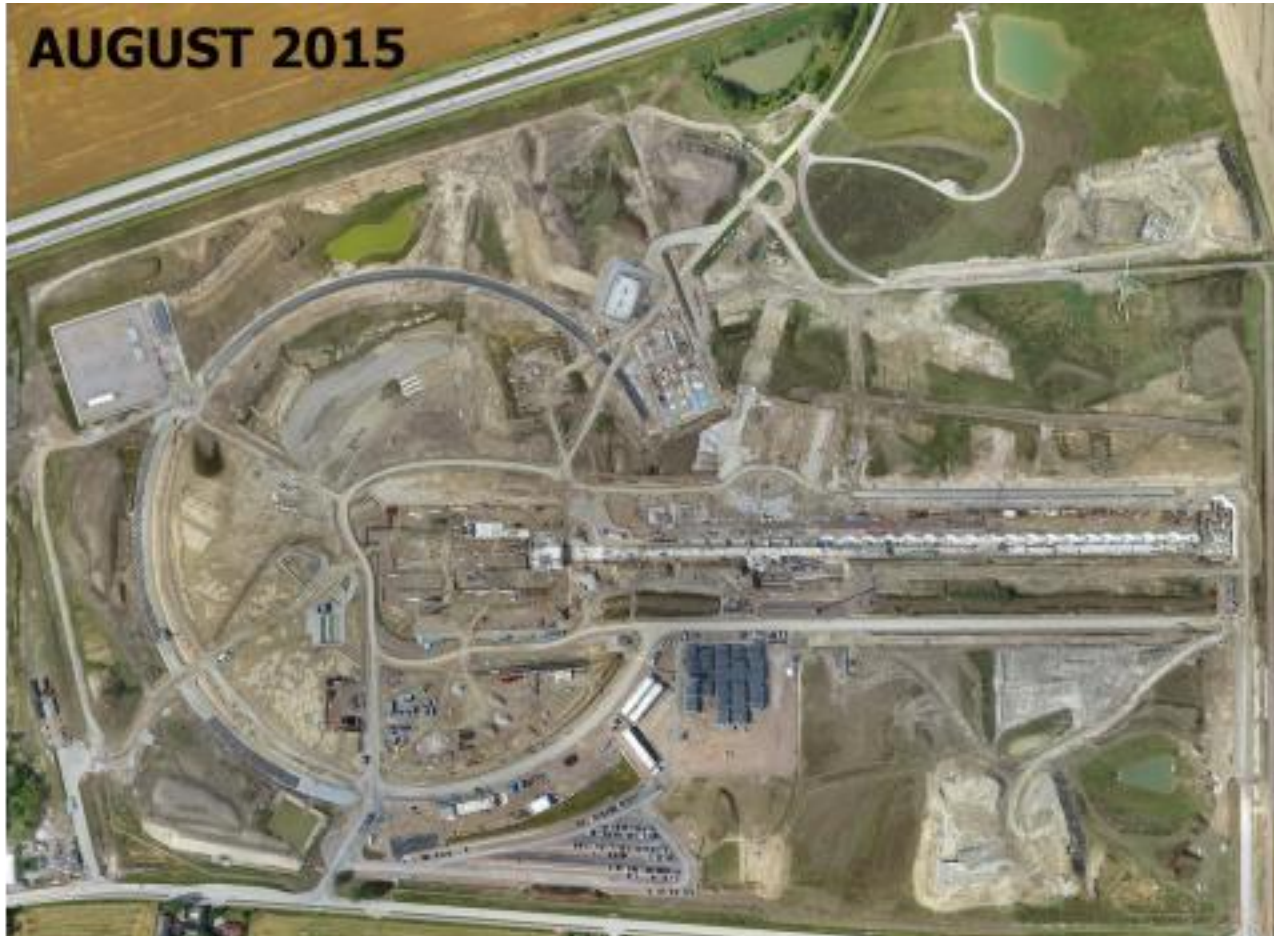
**Diffraction methods**: NMX, BEER, DREAM, HEIMDAL

**Direct/Indirect Geometry spectroscopy**: C-SPEC, VOR, BIFROST

**Reflectometry**: FREIA, ESTIA

**Neutron imaging**: ODIN

# ESS facility



# ESS facility



# ESS facility





# ESS facility



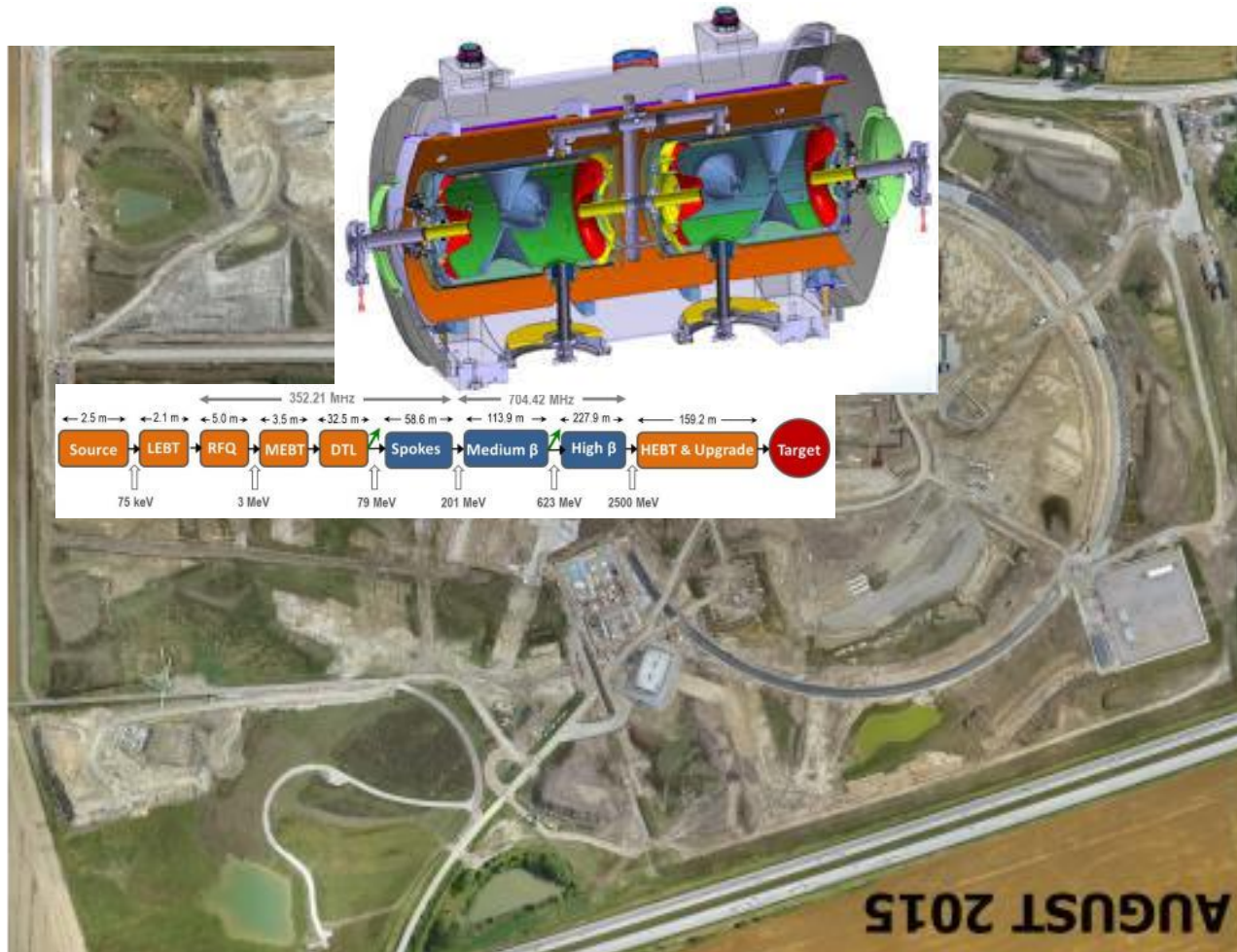
# ESS facility



# ESS facility



# ESS facility



AUGUST 2015

# ESS facility



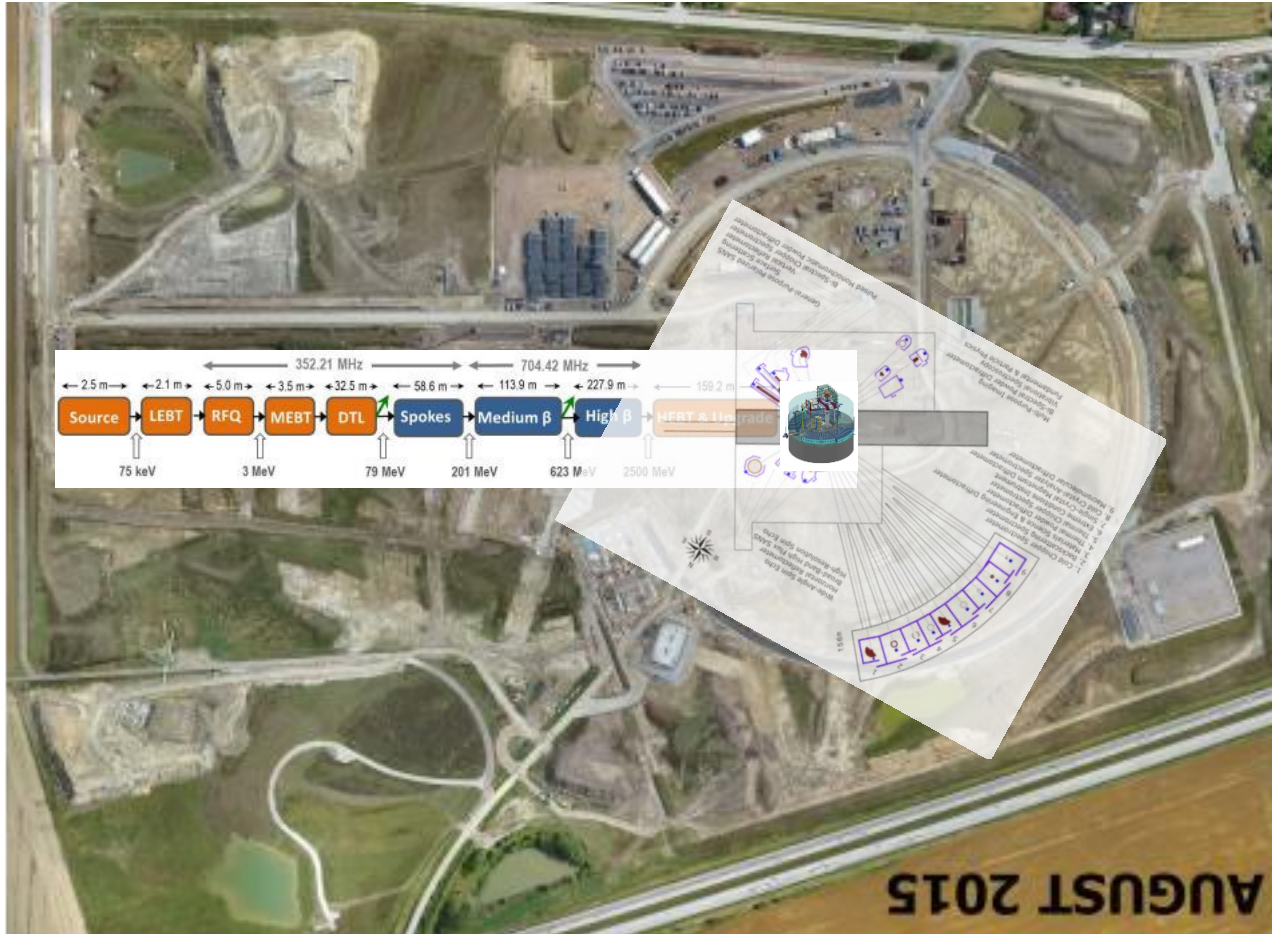
# ESS facility



# ESS facility



# ESS facility





# The Integrated Control System (ICS)

- Integrated Control System Division (ICS) Scope
  - Conventional facilities control integration
    - Site infrastructure: cooling water, power distribution, etc.
  - the accelerator control system
  - the neutron target control system
  - EPICS layer for the neutron instruments (in cooperation with the colleagues from science directorate)
  - Global systems (next slide)
- Combination of
  - On-site developments
  - in-kind contributions (up to 40% of total value)
    - e.g., proton source and LEBT controls by CEA,Saclay (France)

- Control system networks and servers
  - Thursday talk (**THHD3002**)
- Global timing system for site-wide synchronization
  - Synchronisation of devices
  - Distribution of time, time stamping
  - Operation sequencing
  - Using MRF event system, latest generation (see timing workshop)
- Protection systems
  - Machine protection (TUC3003, MOPGF126, MOPGF138)
    - High demands for reliability and speed
  - Personnel protection
    - Designed according to IEC61508 standard, safety-credited

- Threefold structure for generic I/O:
  - Fast real-time processing, FPGAs
    - MTCA.4
    - Use only where needed (high cost, specialization)
    - Extensively use FMC (Vita-57) mezzanine cards
  - Real-time industrial-type I/O
    - EtherCAT, on IOC, or on Beckhoff TwinCAT
    - Low cost, distributed, good real-time performance
    - Moderate speed (e.g. up to 100 kSPS A/D conversion)
  - Process I/O with no tight synchronisation requirements
    - PLCs (Siemens)
  - In addition, prepare integration of off-the-shelf devices
    - Serial and LAN interfaces

# Hardware Strategy

- I/O Controller variants
  - MTCA.4 processors
  - Industrial PCs where appropriate
  - Virtualized IOCs running on server infrastructure
    - No tight real-time requirements or pulse-to-pulse data
    - Site infrastructure systems, cryogenics, vacuum
    - Redundant fail-over clusters
    - Typically interfacing PLC-based systems
  - possible mini-IOC
    - Concept study ongoing
    - Integrated timing and processing unit

- EPICS as the system backbone, for all controls I/O
  - Use **exclusively** EPICS 4
  - Model for distributed development (next slide)
- Services based on Web/RESTful interfaces
  - Configuration data management
    - Controls Configuration Database (CCDB)
  - Cable Database
  - Naming service
- IOC Factory for IOC management
  - Create, maintain, audit IOCs
- Calibration, etc. utility databases being planned

# Distributed development

- Issue: support of off-site developers



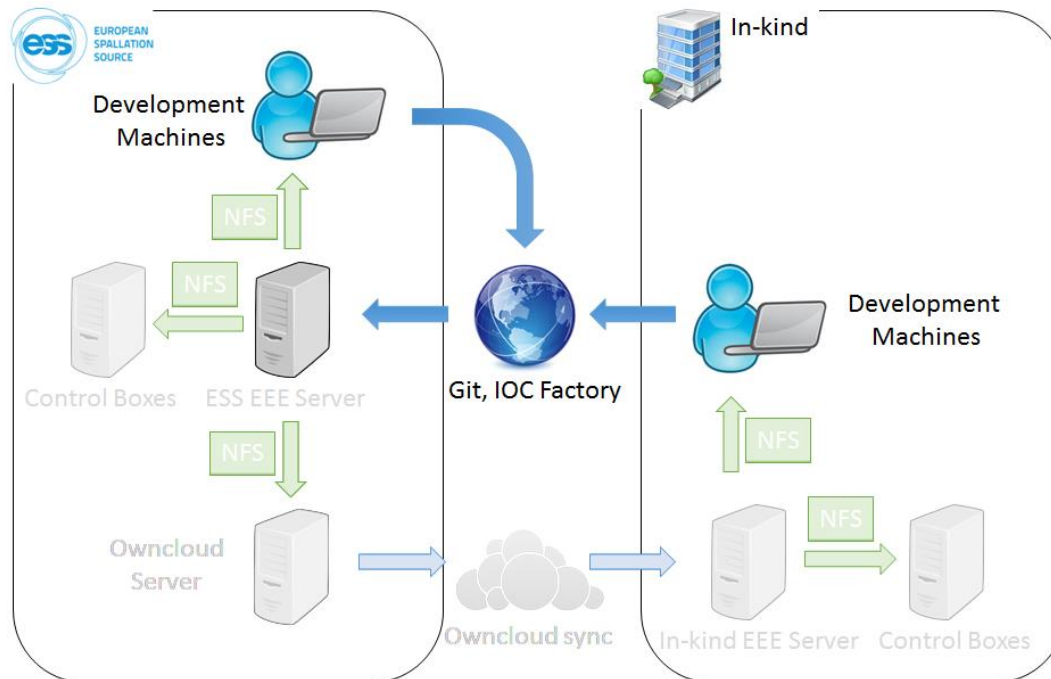
- An (incomplete) map of collaborating institutes
- Potentially any/all of these could be developing or integrating control system components for ESS
- Development and testing happens at the institutes
- Finally all of this has to be integrated into ESS in Lund
- How to manage that?
- We cannot afford long release cycles

# Distributed development (2)

- ICS provides a development environment consisting of
- Web-based infrastructure tools
  - Naming, configuration, cabling, IOC configuration
    - Databases hosted in Lund
  - Collaborative tools (Atlassian JIRA, Confluence, Bitbucket)
  - “IOC Factory” tool to manage IOC configuration (set-up, deployment, audit)
- Network-synchronised development cycle
  - Ansible playbooks for development (virtual, real) machine configuration
  - Pre-built, loadable EPICS modules (concept courtesy of Dirk Zimoch, PSI)
  - EPICS tools and libraries on network drives (next slide)

# Distributed development (3)

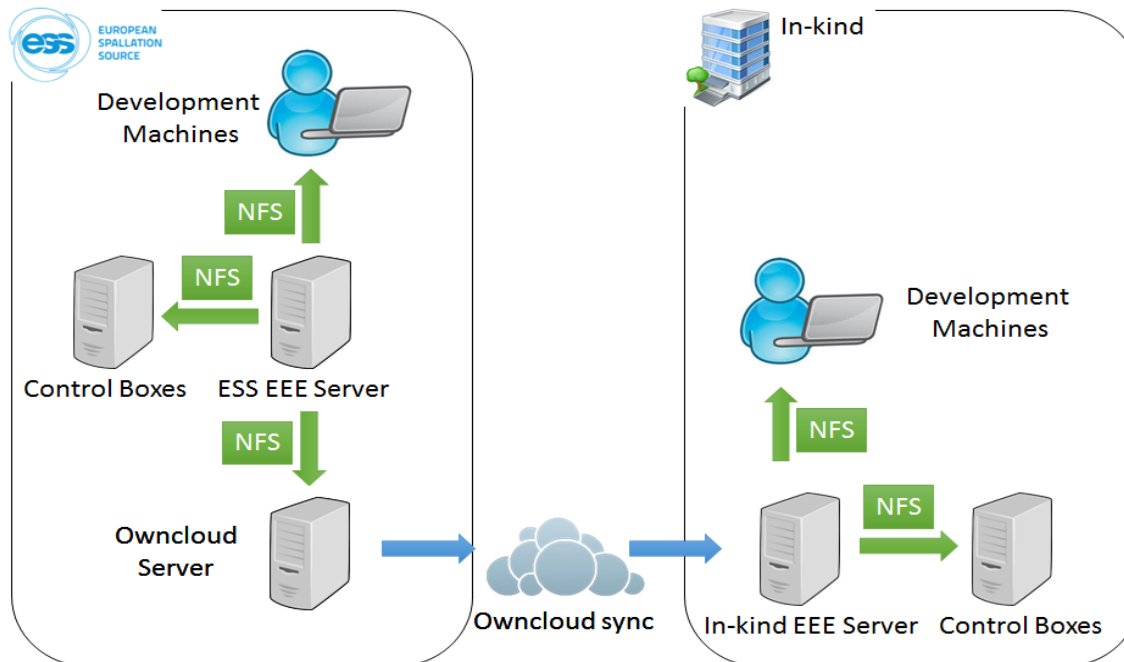
- All software hosted in a central repository
- Full cycle can be reproduced at Lund anytime
- All developers work with exactly the same versions of tools
- Deployed, first user feedback is very positive (still needs work, though)





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# Machine Operation

- Machine sequencing
  - Repetition rate, beam current, pulse length: power envelope
    - Careful coordination with machine protection
- Measurements
  - Beam-synchronous data acquisition
    - Neutron instruments need pulse-to-pulse beam data
- Machine modeling
  - Online model for beam commissioning applications
- Machine protection
  - Post-mortem analysis an essential tool

- Construction has started
  - On and off Lund site
  - Controls support needed **now**
- Try to use the best from the community
  - Borrow & contribute
  - Invent ourselves things to cover the special needs
- Project management is a challenge
  - Standardization should help
- More to come – in the next conferences!