



EUROPEAN  
SPALLATION  
SOURCE



# Technology transfer

AI, Control Systems & Data Acquisition, Big Data

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# Integrated control system



The ESS facility is a large and complex machine with very much and diverse equipment that needs to work in synchronization and with well-known configurations

The Integrated Control System Division (ICS division) is responsible for the control systems within the ESS facility including controls for

- **Accelerator**
- **Target**
- **Neutron Scattering Systems**
- **Conventional Facilities**

In addition, ICS will implement

- **Machine Protection System**
- **Personnel Safety System**

To build a distributed control system of this size is a major undertaking



# The ESS integrated control system



The ESS control system complexity is very high

- About 1 600 000 “process values”
- About 100 000 connected “devices”
- Ambitious approach to automation of control system configuration



Facility availability goals are very high

- ICS plays a key role for the availability of the facility
- High performance and availability requirements on equipment used



Some new approaches will be implemented at ESS/ICS

- Full scale deployment of EPICS 7
  - ESS is committed to contributing to the EPICS community
- Full scale deployment of MicroTCA.4
  - ESS is involved in a public procurement for innovation initiative
- Machine learning/Artificial intelligence assisted control system
  - Project started to explore how machine learning technologies can be applied



# EPICS - a capable DCS



Data centre



IOC

Control room



IOC

## RELIABILITY and ROBUSTNESS

Hundreds of millions of run-hours in mission critical, very complex contexts  
30+ years of continuous development with consistent community on the leading edge  
Data centre virtualisation reduces downtime vulnerabilities

## EFFICIENCY

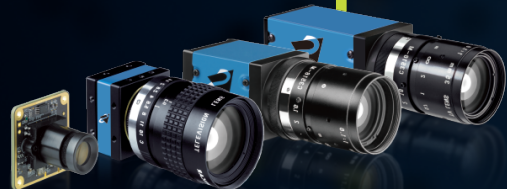
Efficient configuration through centralised/distributed approach and architecture  
High engineering efficiency due to unified IOC concept with modular drivers  
Ready-made modules for many, many devices/manufacturers/systems

## SCALABILITY and FLEXIBILITY

Extremely scalable due to distributed architecture and virtualisation techniques  
From 5000 - 20 000 000+ live process values in a unified system  
Many API:s and other interfaces available - migration to web/mobile clients  
Excellent data management facilities built on requirements from scientific data analyses

## COMMUNITY DYNAMICS

Open source and free with a "generous" license  
Very dynamic and supportive community  
Many, many ongoing extension projects



Vision systems



PLC



High speed DAQ



High-end PLC



PLC

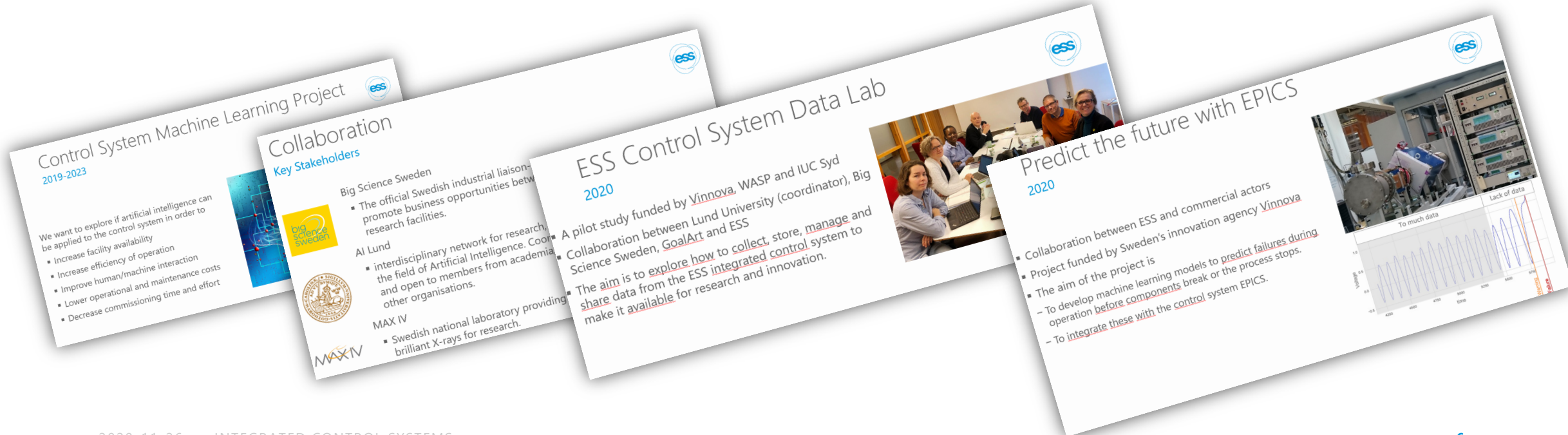


Sensors

# Control system machine learning

A project is ongoing at ESS to explore if modern AI/Machine learning technologies can be used to augment complex control systems

- Decrease commissioning time and effort
- Increased facility availability (95% goal)
- Increased efficiency of operation
- Improved human/machine interaction
- Lowered operational and maintenance costs



**Control System Machine Learning Project**  
2019-2023

We want to explore if artificial intelligence can be applied to the control system in order to

- Increase facility availability
- Increase efficiency of operation
- Improve human/machine interaction
- Lower operational and maintenance costs
- Decrease commissioning time and effort

**Collaboration**  
Key Stakeholders

Big Science Sweden

- The official Swedish industrial liaison - promote business opportunities between research facilities.

AI Lund

- interdisciplinary network for research, the field of Artificial Intelligence. Coordinate and open to members from academia and other organisations.

MAX IV

- Swedish national laboratory providing brilliant X-rays for research.

**ESS Control System Data Lab**  
2020

A pilot study funded by Vinnova, WASP and IUC Syd

- Collaboration between Lund University (coordinator), Big Science Sweden, GoalArt and ESS
- The aim is to explore how to collect, store, manage and share data from the ESS integrated control system to make it available for research and innovation.

**Predict the future with EPICS**  
2020

- Collaboration between ESS and commercial actors
- Project funded by Sweden's innovation agency Vinnova
- The aim of the project is
  - To develop machine learning models to predict failures during operation before components break or the process stops.
  - To integrate these with the control system EPICS.

*Visuals on slides include: a network diagram, logos for Big Science Sweden and MAX IV, a group photo of the Data Lab team, and a graph showing 'To much data' vs 'Lack of data'.*

Thank you

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