

The European Spallation Source (ESS) is a research facility being built in Lund, Sweden. The Integrated Control System (ICS) division at ESS is responsible for defining and providing a control system for all the ESS facility. ICS decided to establish open-source EtherCAT systems for mid-performance data acquisition and motion control for accelerator applications. For instance, EtherCAT will be used when the I/O system needs to be beam-synchronous; it needs to acquire signals in the kHz range; or needs to be spread across locations that are far from each other and would need cumbersome cabling, but still, belong to one system.

## ECMC EtherCAT Motion Controller

ECMC is based on EtherCAT (Ethernet for Control Automation Technology) developed by Beckhoff. EtherCAT is a real-time Ethernet-based open Fieldbus that relies on conventional Ethernet frames to communicate with multiple devices in a synchronized way. ECMC is an open-source motion control and mid-range Generic IO controller module integrated into the ESS EPICS Environment (E3). The ECMC communicates and configures the EtherCAT terminals through the EtherCAT protocol thanks to the tools provided by the open-source IgH EtherCAT Master

## ECMC Architecture

The communication between EPICS records and ECMC is performed using AsynPortDriver. The different interfaces of the AsynPortDriver have been implemented allowing transfer of data of both scalar and array types in an efficient way.

The Real Time Thread handles all the real time task within ECMC Memory. It communicates with the EtherCAT process memory keeping up to date the communication (read/write) with the EtherCAT slaves, provided by etherlab master. The Thread then executes motion control, general I/O control, plc objects, data storage, etc.

## ECMC Features

ECMC has embedded into one system the motion control and data acquisition at ESS, and integrated them into EPICS.

- Motor record support
  - Absolute positioning
  - Relative positioning
  - Constant velocity
  - Evaluation of limit and reference switches
  - Homing sequence
  - Interlock support
- Real and virtual axis support
- Synchronization
- Data Acquisition
  - Up to 100kHz analog and 1Mhz digital (oversampling slaves)
- PLC objects in Real Time
- Hardware support:
  - Drives: stepper, servo, pulse direction and analog
  - I/O: Several analog and digital terminals
  - Other: bus-couplers, system terminals

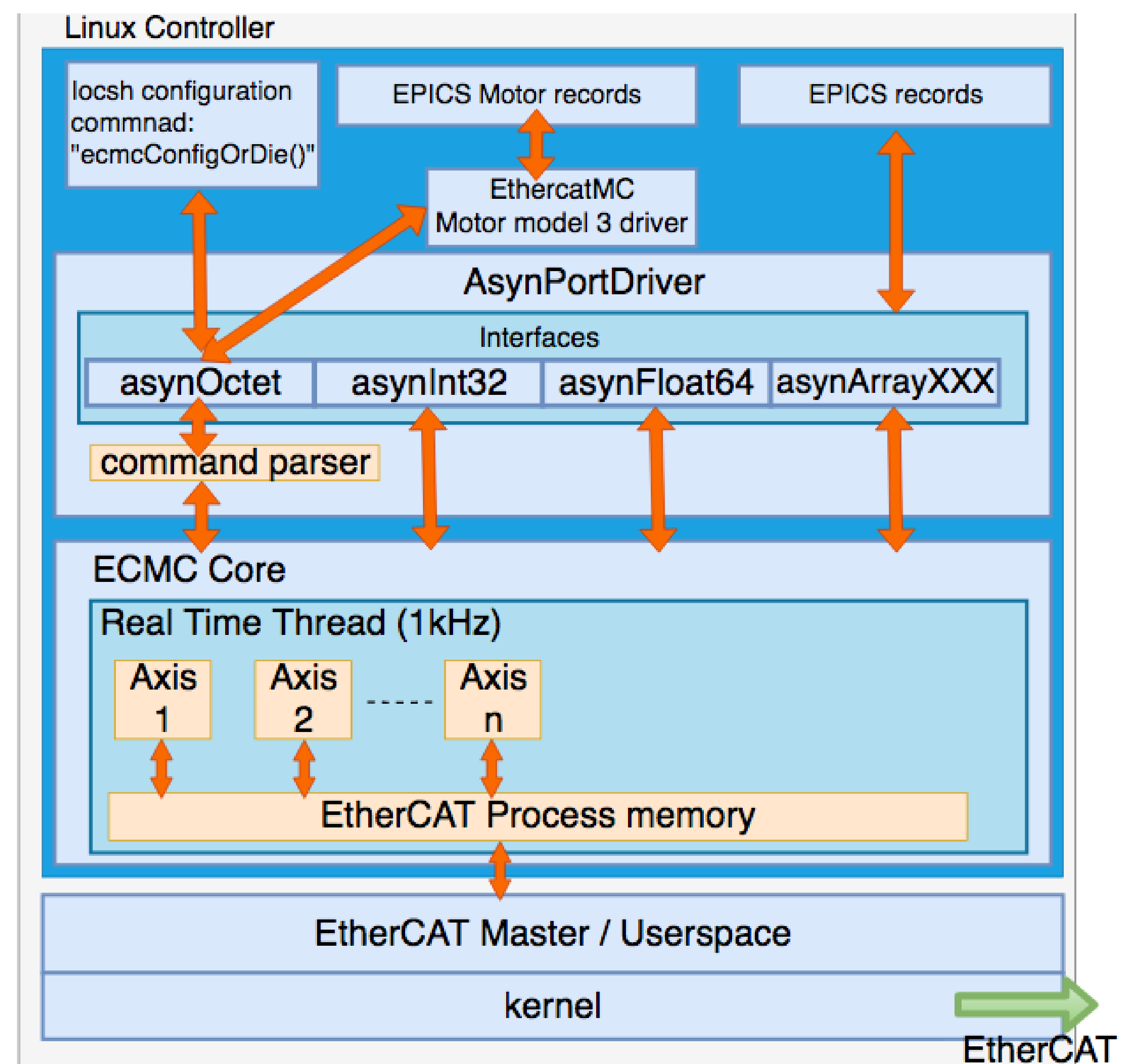


Figure 1: ECMC Architecture

## EtherCAT based control applications within ESS accelerator

### IonSrc & LEBT

The Ion Source and the Low Energy Beam Transfer (ISrc & LEBT) line is installed and is being commissioned at ESS, Lund, Sweden.

- IRIS
- Faraday Cup
- Emittance Measurement Unit
- Doppler
- Non-Invasive Profile monitor

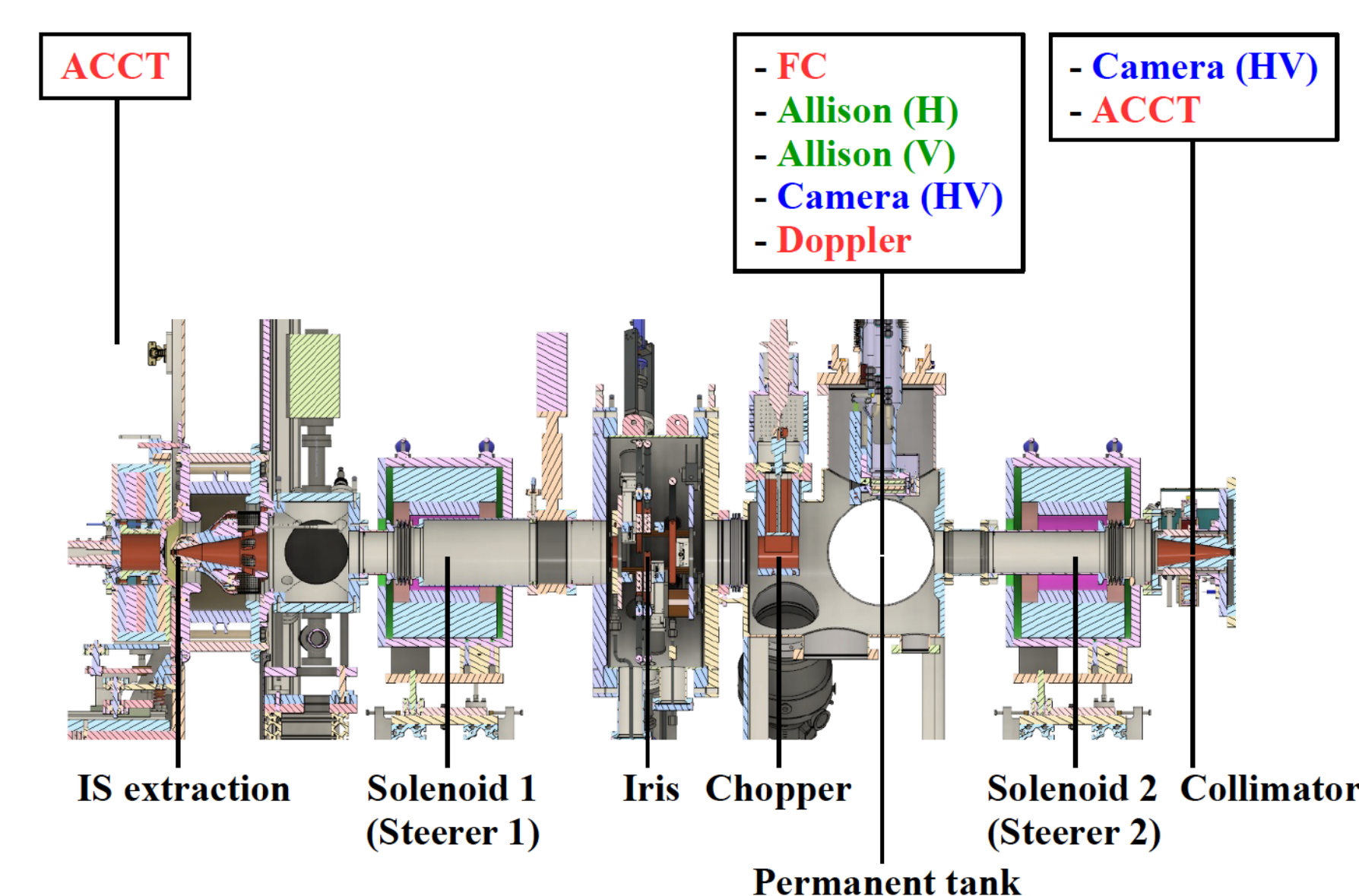


Figure 2: IonSrc & LEBT layout

### APTM & GRID

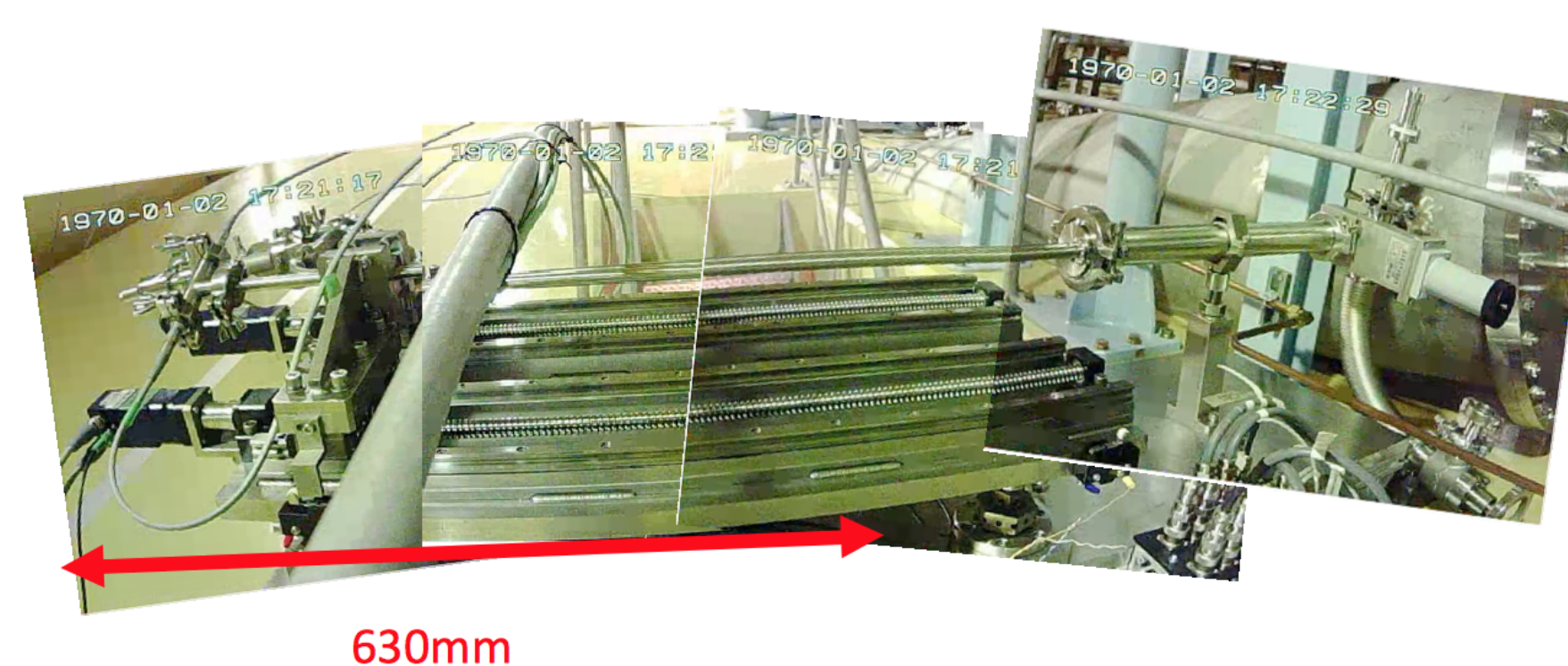


Figure 3: APTM & GRID.

### Gamma Blocker

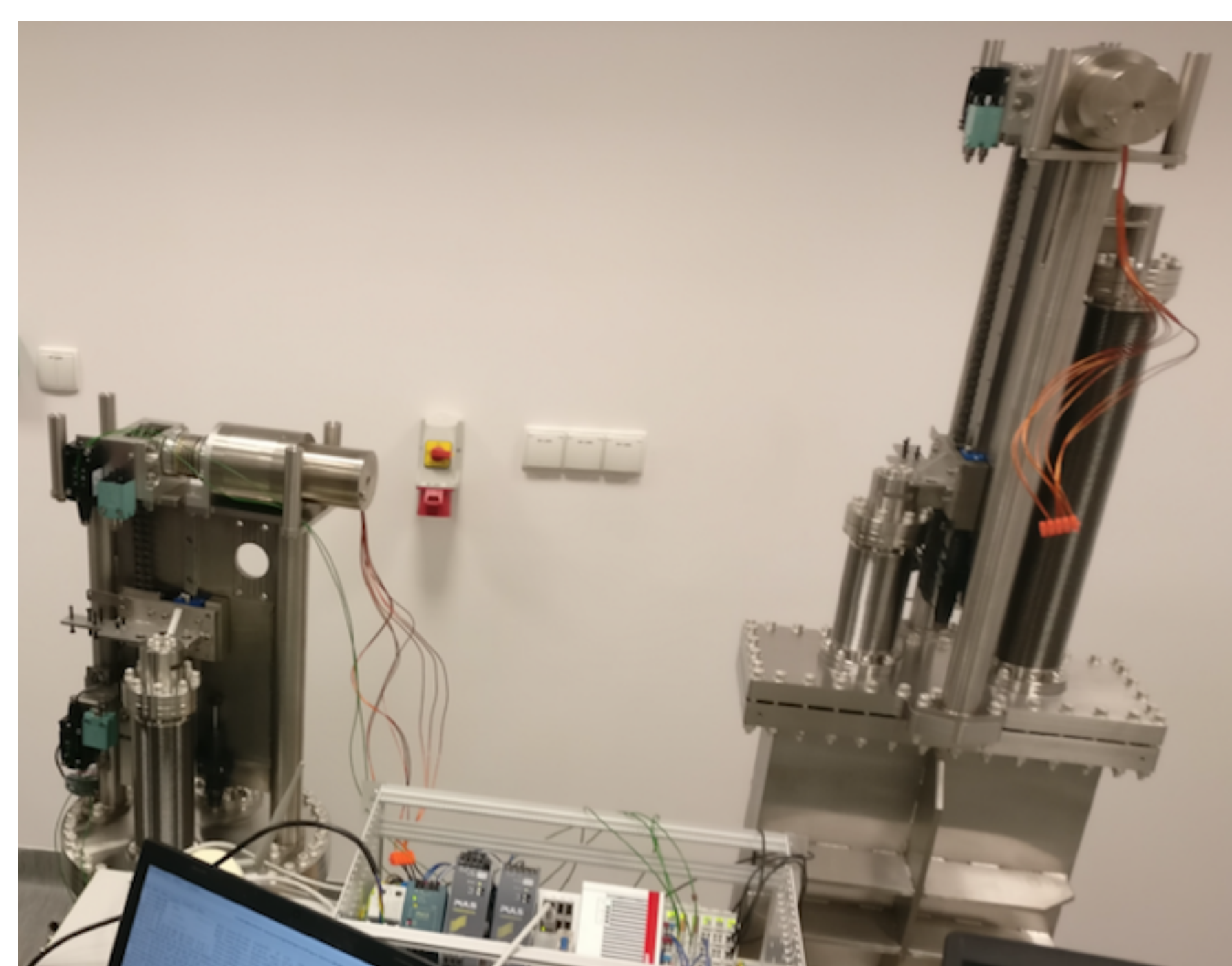


Figure 4: Gamma Blocker.

### IRIS

Left blade  
 $ax1.traj.setpos := ax7.traj.setpos - (ax8.traj.setpos / 2)$   
Right blade  
 $ax2.traj.setpos := ax7.traj.setpos + (ax8.traj.setpos / 2)$   
center  
 $ax7.enc.actpos := (ax2.enc.actpos - (ax8.enc.actpos) / 2)$   
gap  
 $ax8.enc.actpos := ax2.enc.actpos - (ax1.enc.actpos)$

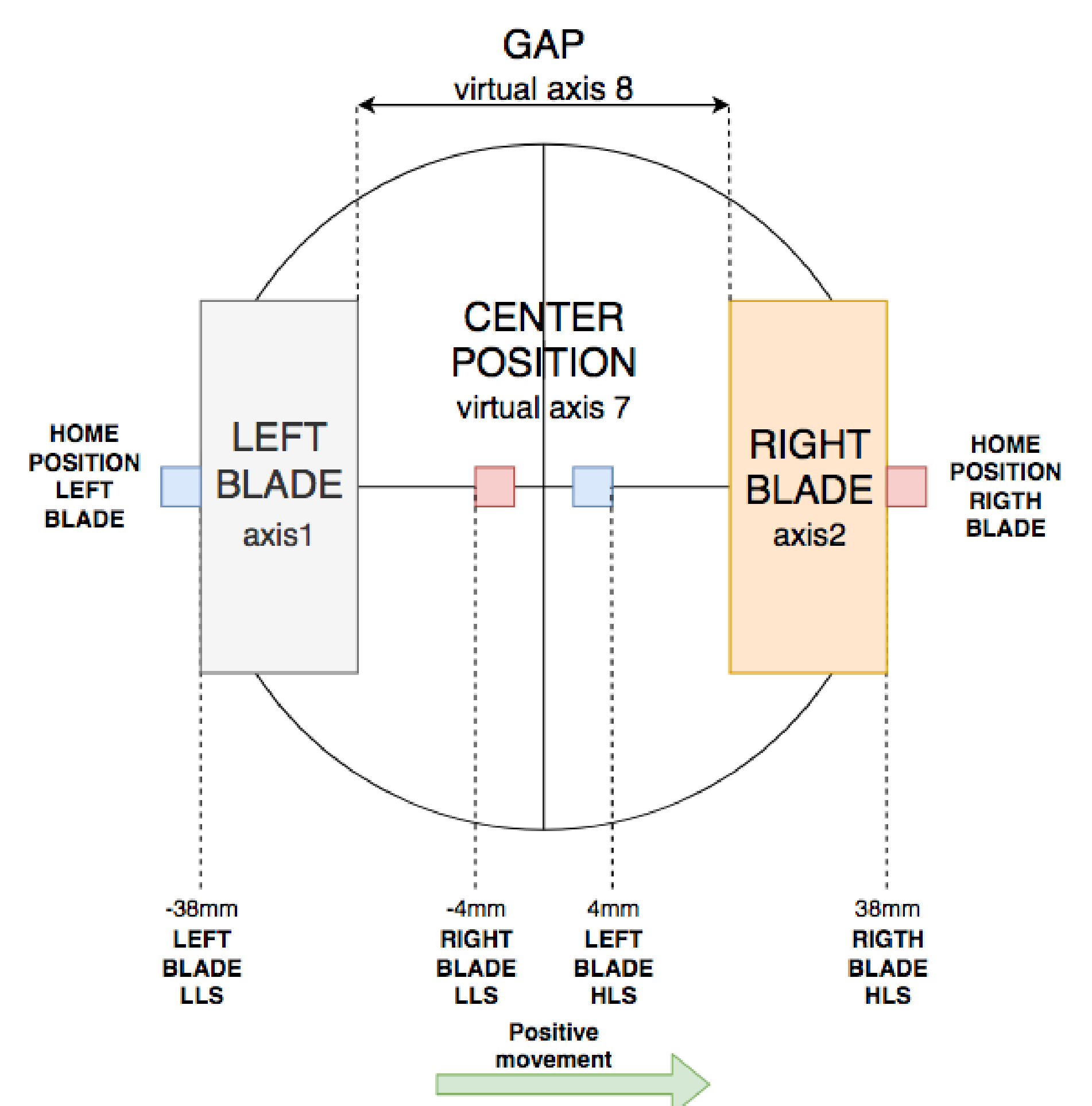


Figure 5: IRIS synchronization.