

Safety in Focus: Exploring Safety Interlock Systems at EPAC's Laser Facility

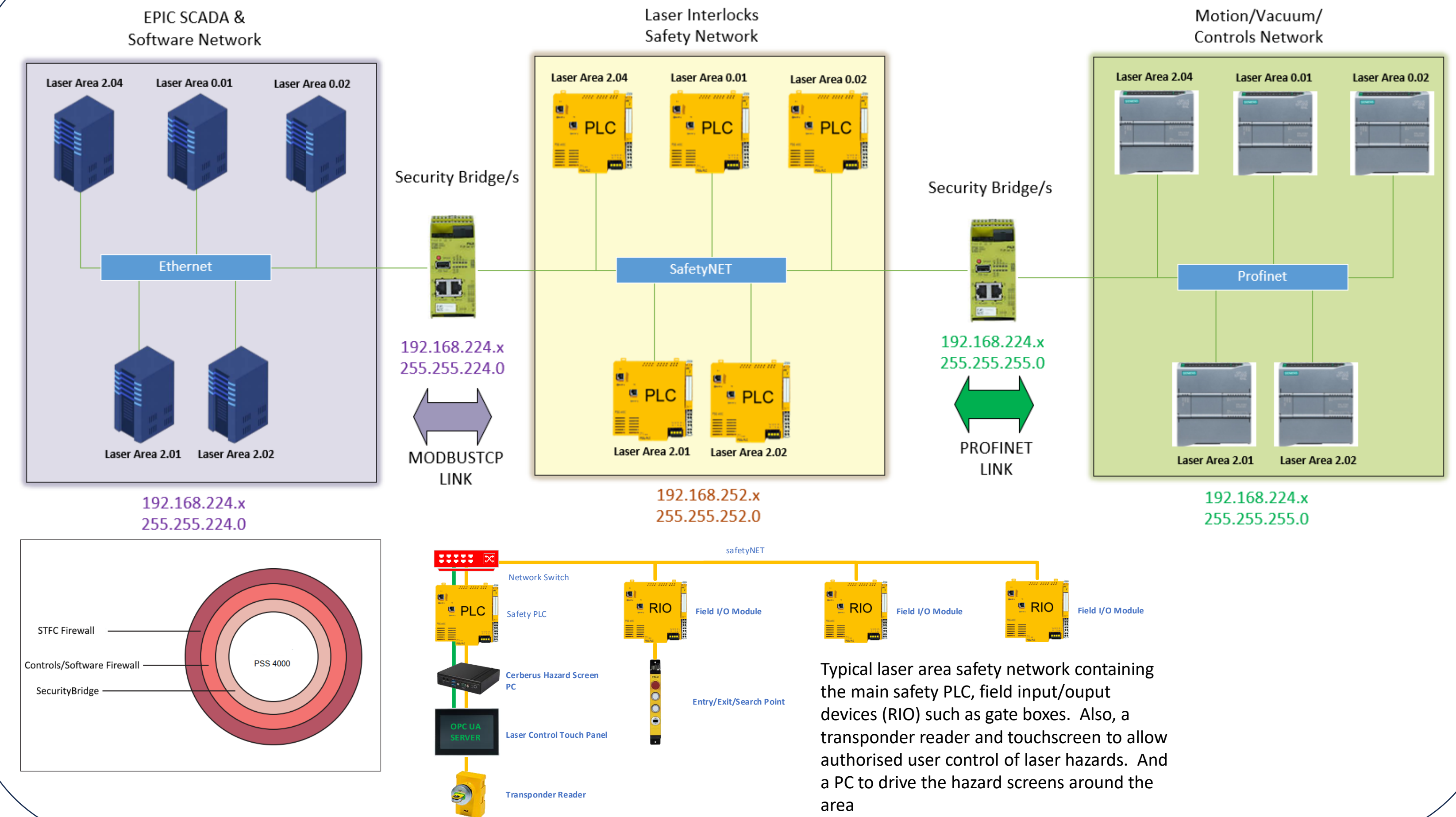
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Introduction

- Fail-safe laser safety interlocks systems installed in EPAC **promote the safe use of research lasers** by automatically detecting and preventing hazardous conditions or deviations from established safety protocols, thereby safeguarding personnel and equipment while maintaining operational integrity.
- Common **safety functions** found in all interlock systems include:
 - Door Interlocks that shut down unenclosed laser hazards
 - Enclosure Interlocks that shut down enclosed laser hazards
 - Emergency Laser Off Buttons that shut down all laser hazards
 - Authorised key control system that restricts the bringing-on of laser hazards and opening of inter-room safety shutters.
- Each laser area is monitored by its own **independent safety interlock system** ensuring maintenance or modifications in other parts of the facility do not affect local operations.
- Safety interlock systems share safety-related data with each of the other areas through the independent **facility-wide safety network** (safetyNET). This allows the amalgamation of safety data making it possible to integrate all safety systems into one unified facility.
- CLF-designed **inter-room safety shutters** give authorised operators with the highest level of permissions, the ability to propagate laser beams between laser areas, under safe conditions.
- The safety network contains Security Bridges used as part of a security design concept known as Defence in Depth to protect against cyber-attacks whilst **allowing controlled and secure access** from other trusted facility networks to safety network status information. This allows control and monitoring collaboration between the safety interlocks, vacuum, motion control, EPICS, and software systems.

Laser Safety Interlocks Network Philosophy



Engineering measures to reduce risk from exposure to hazardous lasers

LED warning lamps

- "Laser Hazard" - above each door to a laser area
- "Hazardous" - inside of each laser area (monitored)
- Red/Orange/Green beacon stacks throughout the laser area

Hazard Displays

- Red/Green indicating hazard/safe
- Hazard list highlighting laser/power/wavelength
- Information about the status of all laser areas in the facility

Guard Sensors

- RFID Unique Coded dual guard access door position sensors
- Electro-magnetic door lock with integrated dual guard door position sensors

Access Control & Hazard Authorisation

- RFID Unique Coded transponder keys
- Ensure access to hazardous areas is only to authorised staff
- Allow permissions to be set for laser and shutter control

Safety shutters

- Inter-room
- Enclosure
- Beam stops

Emergency laser off buttons

- On main interlock control panel and in the field

Maintenance Key

- Ensure no lasers can be brought on when in maintenance mode

Interlocked enclosures

- Light tight, robust laser containment
- High integrity position sensors
- Exit shutters designed in house

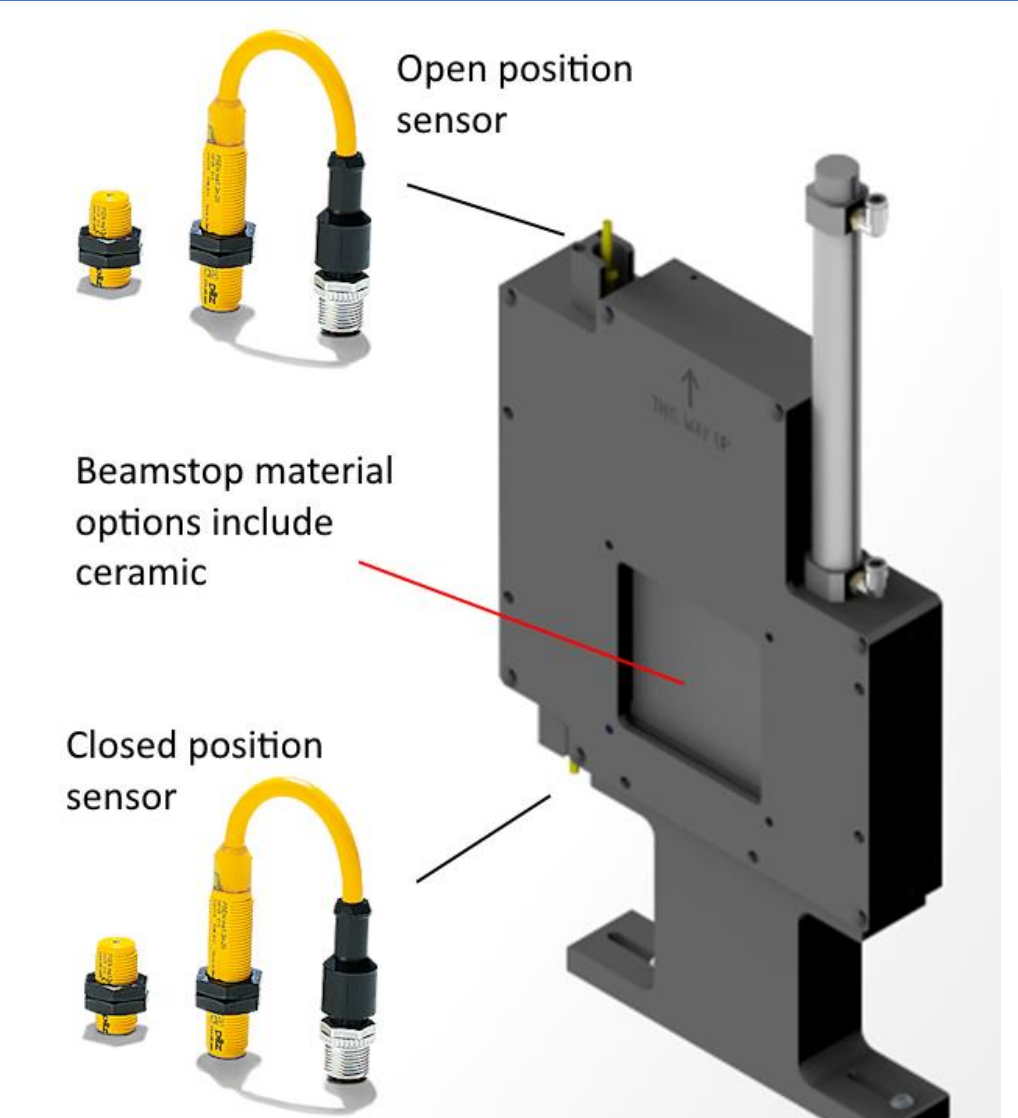
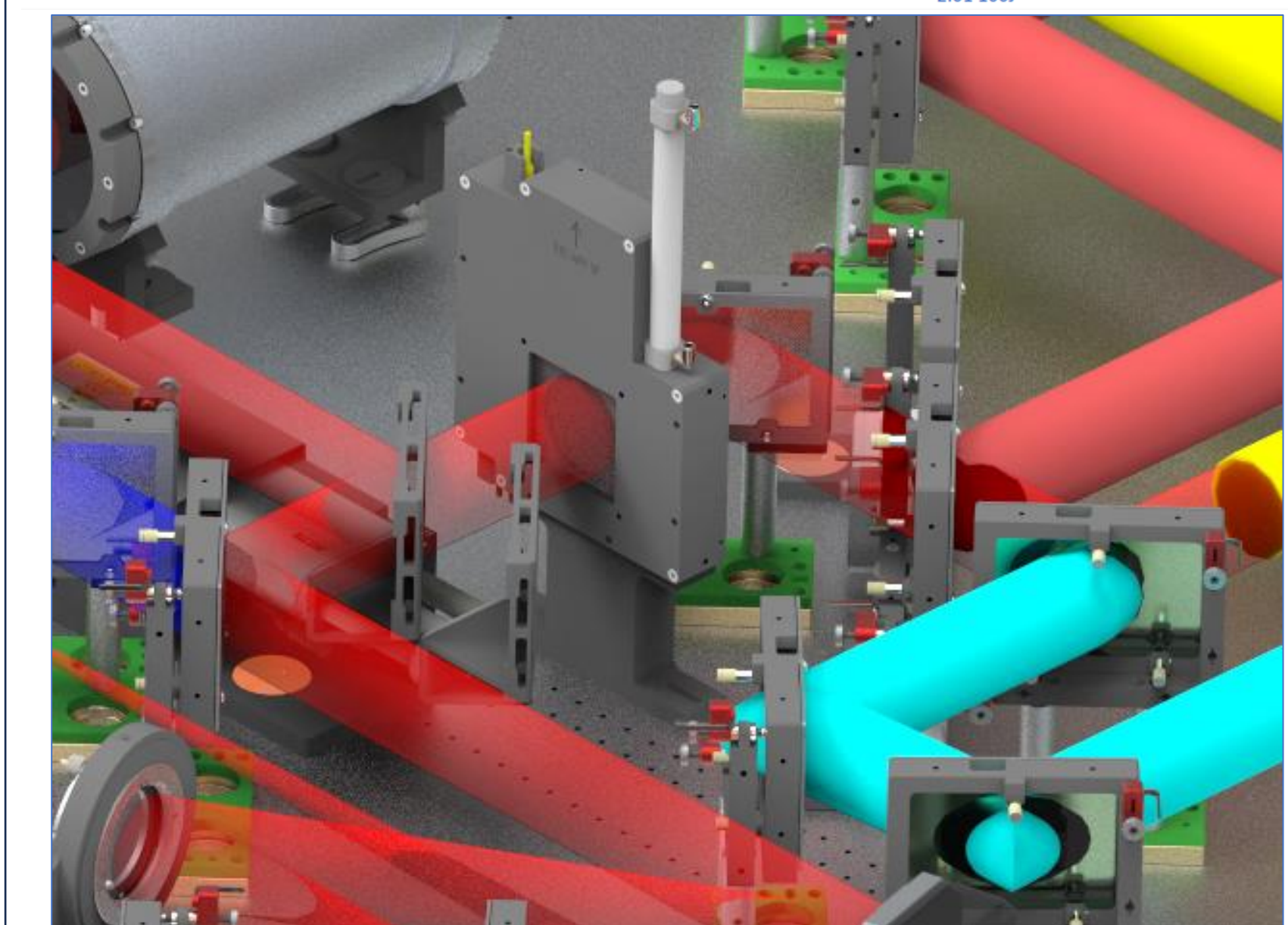
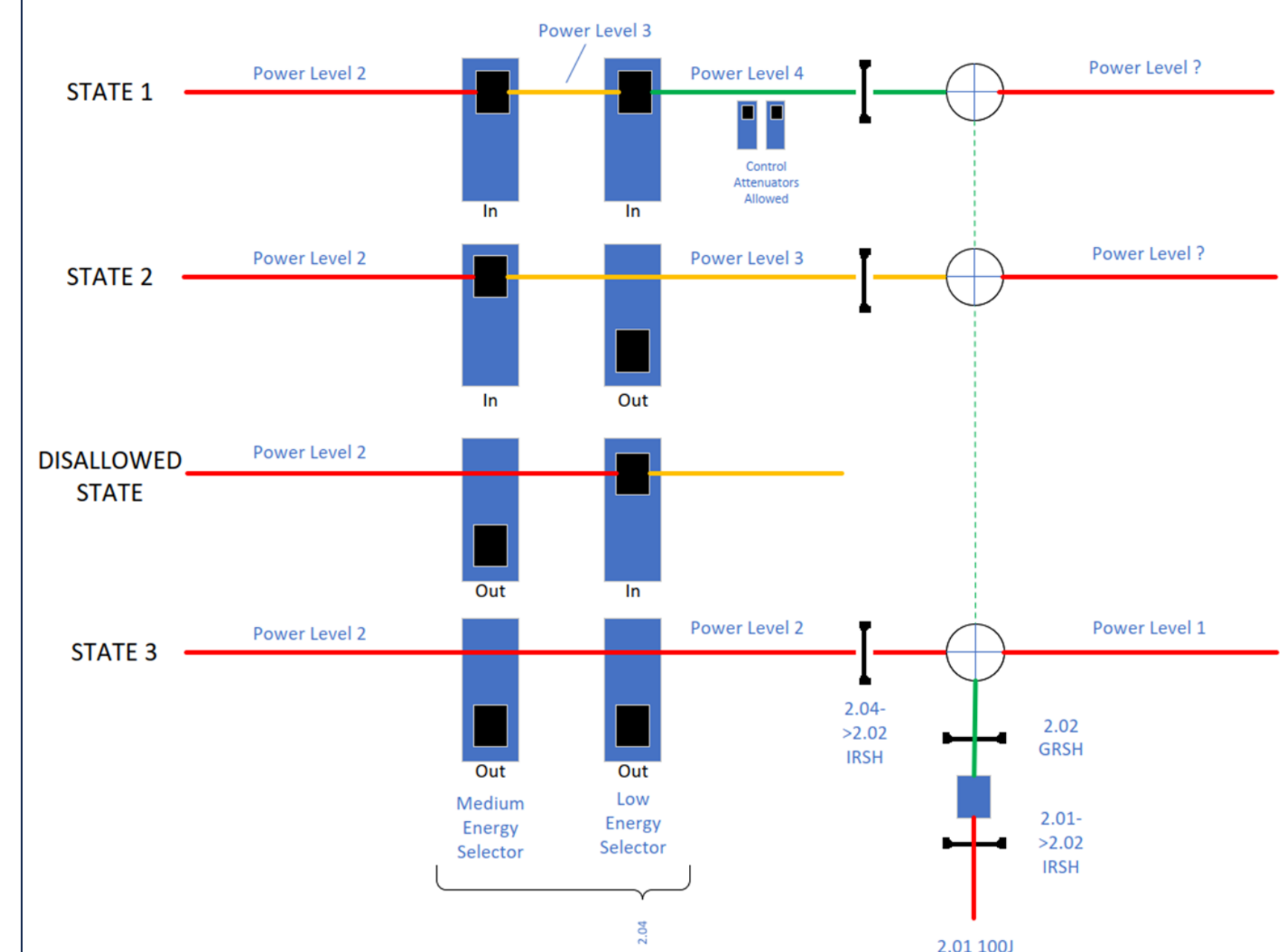
Interlocked roller blinds

- Control is disabled when area is operational

FE (2.04) Interlocks Development Energy Slides



- Energy mode slides (Medium & Low)
- Driven and monitored by the interlock system.
 - Status data is shared with the controls and software networks.
 - The resultant power mode in 2.02 is a function of the 100J pump beam, the FE NS laser, and the state of the associated safety shutters.



Low average power beam stops, enclosure exit shutters and inter-room shutters designed and used in CLF.

Integrating the 2nd Floor Laser Area Interlock Systems – Beam Energy Safety Assessment and Control Measures

