EUROPEAN SPALLATION SOURCE

Using virtual axes for a slit system

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TwinCAT Workshop

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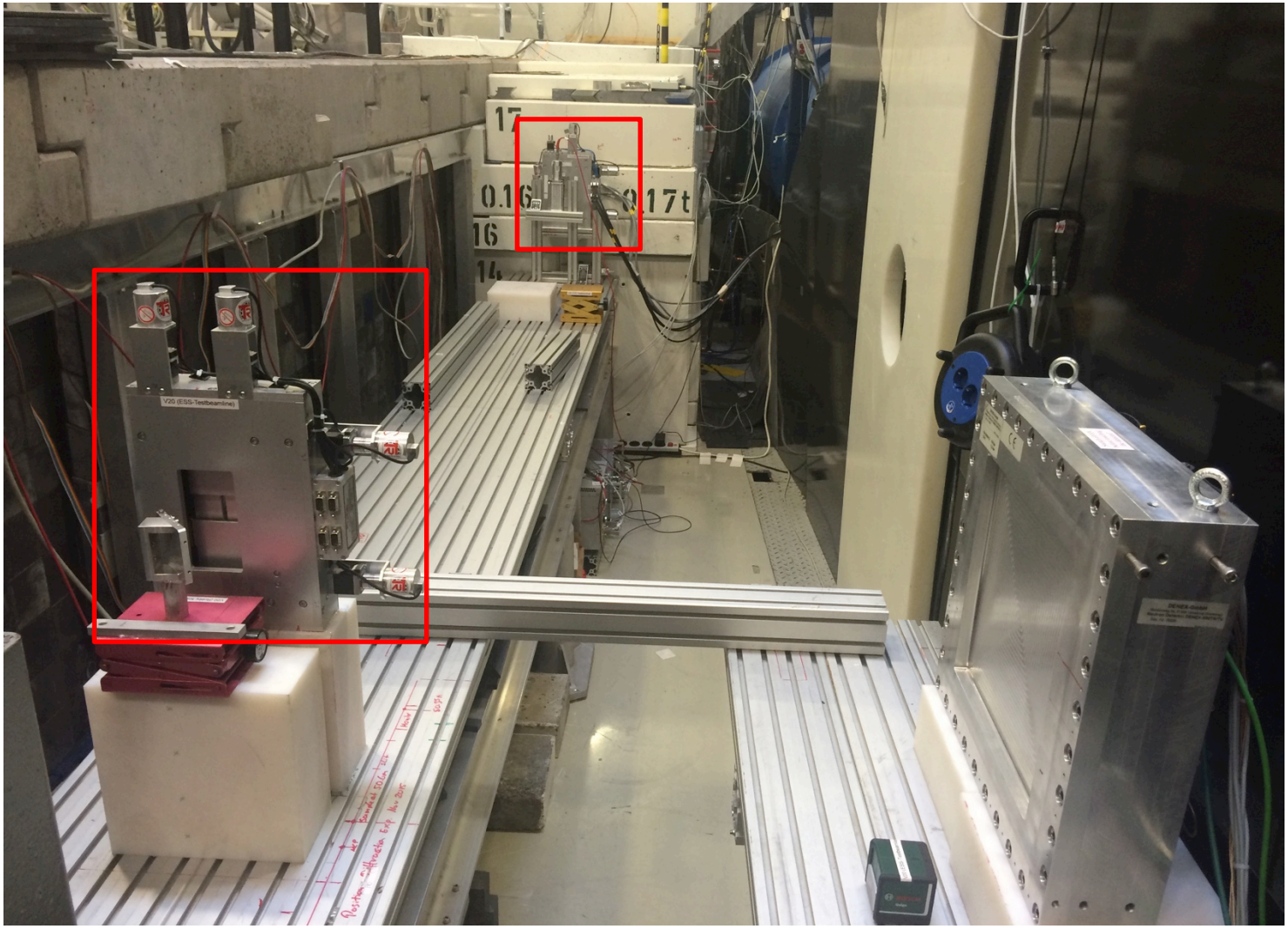
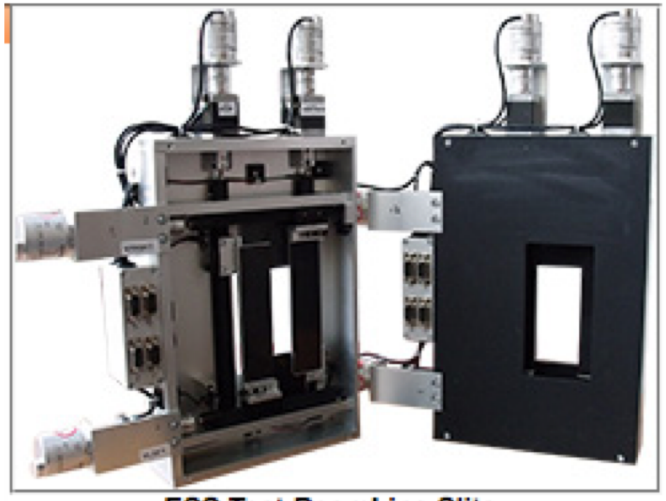
Slit Hardware



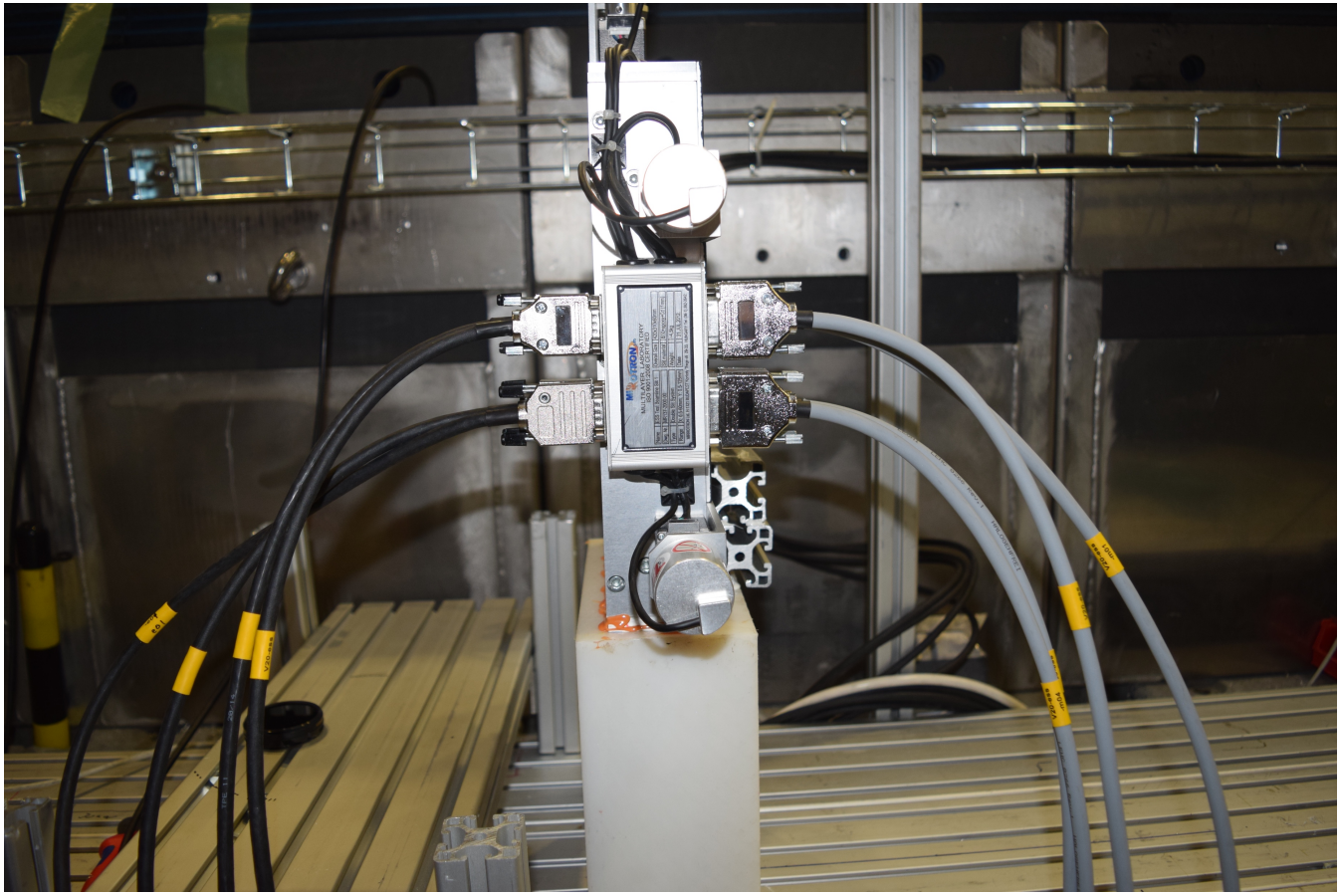
Mirrotron slit system



ESS Test BeamLine Slits
HZB

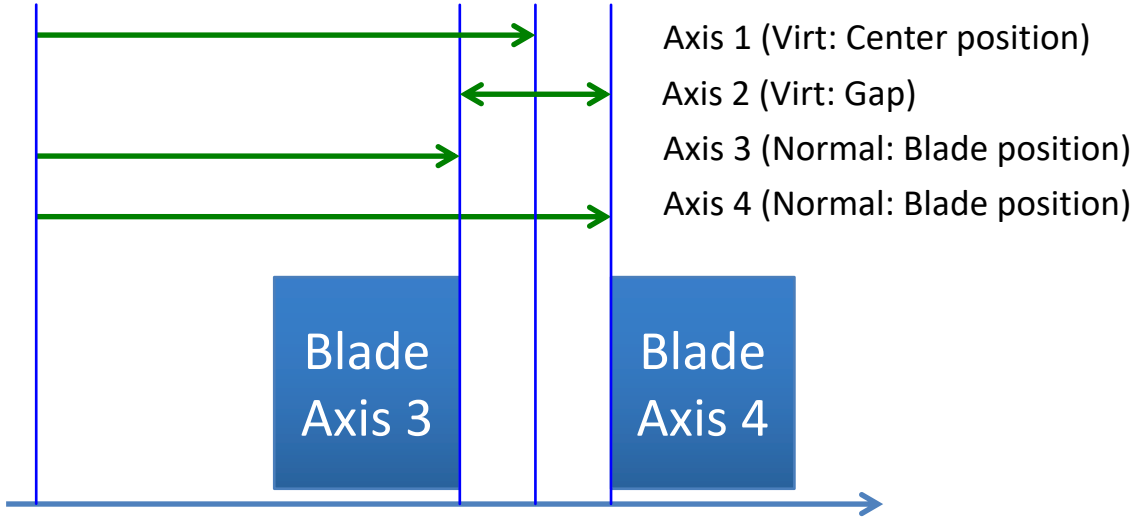
MIRROTRON LTD
Neutron Optics & Instruments

Slit Hardware



Non-standard Slit Axes

- Slit axes are are non standard since the blades can collide -> machine protection.
- Scientists prefer to specify gap and gap centre using virtual axes which feeds into our requirements. This is often done in higher levels.

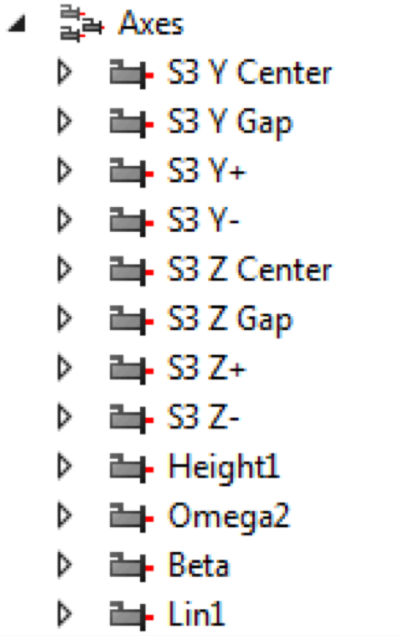


Slit Requirements

- The control software shall:
  - Be controlled by two virtual axes: one for gap and one for the centre of the gap.
  - **Prevent collision of the blades.**
  - Show accurate limit values for the virtual axes which is dependant on the other slit.
  - Show correct axis data in EPICS for gap/centre for example: read back values for position and status bits.
  - Able to recover from an error without requiring specialist intervention.
- The control software should:
  - Able to drive physical axes independently from EPICS without requiring user intervention such as homing/toggling a bit.

Implementation of Slits (TwinCAT)

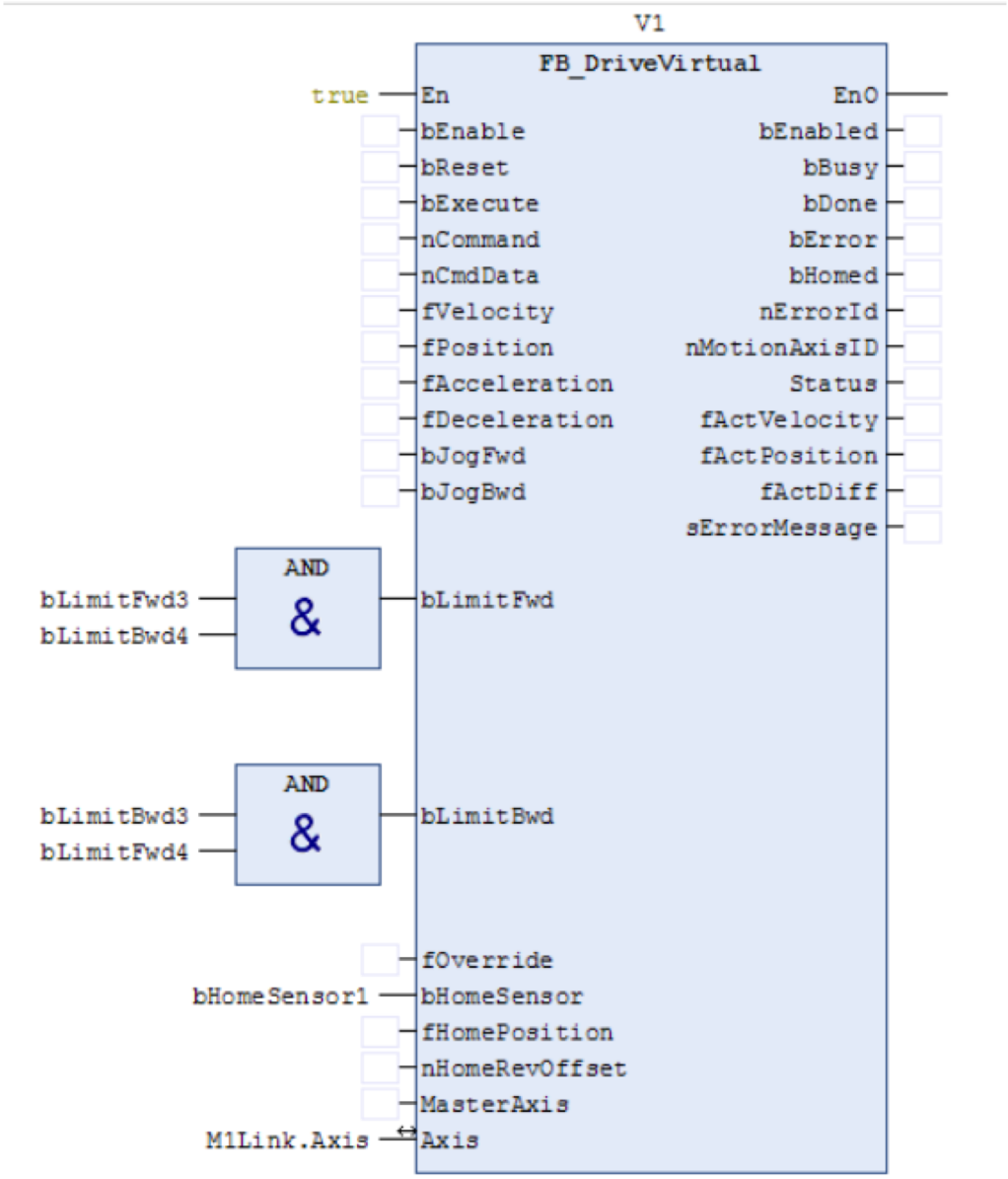
- Four TwinCAT axes per slit pair: two virtual and two physical. Convention as follows:
  - V1-Center (virtual)
  - V2-Gap (virtual)
  - M3-Positive Blade (physical)
  - M4-Negative Blade (physical)



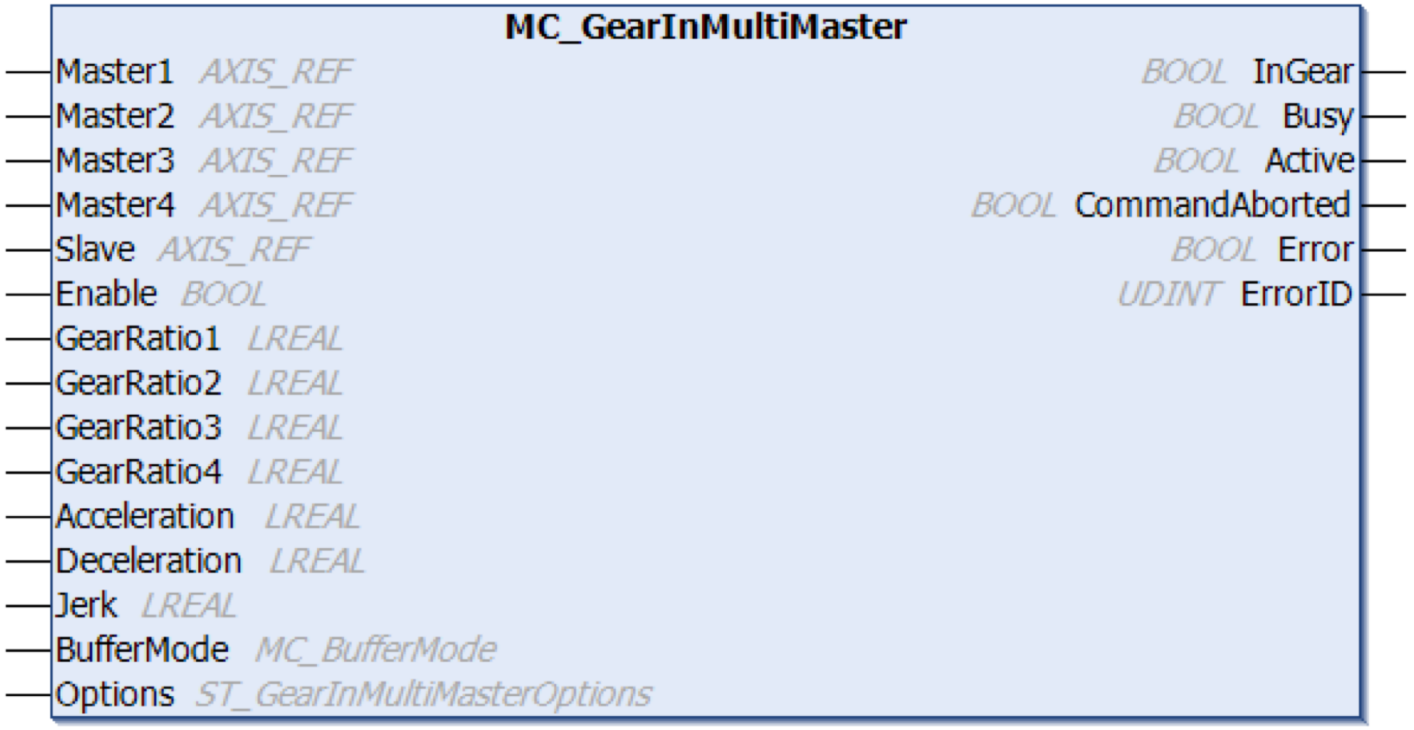
Implementation of Slits (TwinCAT)

- Beckhoff function block (GearInMultiMaster): two master axes (virtual) driving the slave axes (physical).
- Master/slave relationship only enabled when a command is received on a virtual axes; otherwise physical axes free to move independently.
- A set position command is constantly being calculated when axes are not geared.
- Special slit function block to co-ordinate slit control. Checks to prevent the blades colliding with each other and reduce the speed as the blades approach each other.

Standard Axes (FB_DriveVirtual)

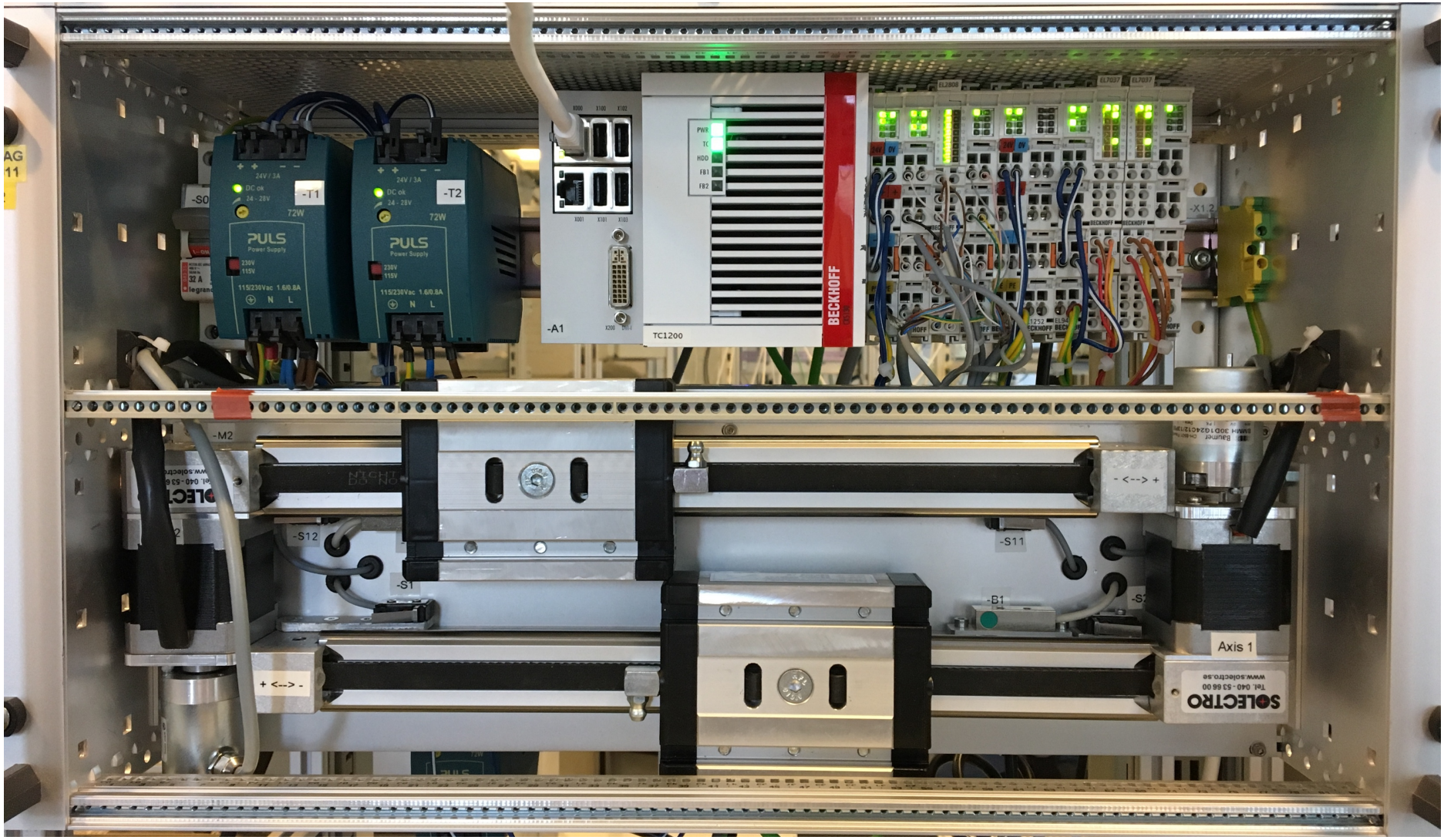


GearInMultiMaster Function Block




```
289
290  fbGearInMultiMaster_1(
291      Master1:= CenterAxis,
292      Master2:= GapAxis,
293      Master3:= EmptyAxis1,
294      Master4:= EmptyAxis2,
295      Slave:= Axis1,
296      Enable:= bEnableGearing,
297      GearRatio1:= 1,
298      GearRatio2:= 0.5,
299      GearRatio3:= ,
300      GearRatio4:= ,
301      Acceleration:= ,
302      Deceleration:= ,
303      Jerk:= ,
304      BufferMode:= ,
305      Options:= ,
306      InGear=> ,
307      Busy=> ,
308      Active=> ,
309      CommandAborted=> ,
310      Error=> ,
311      ErrorID=> );
312
```

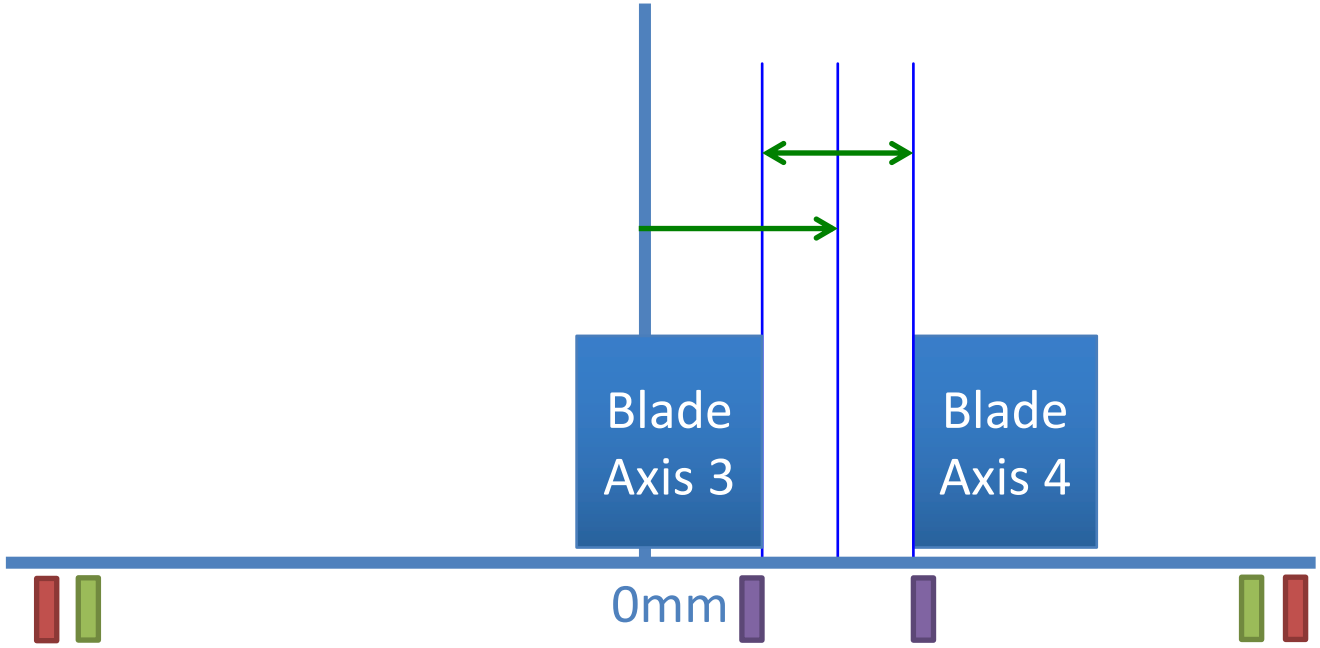
Implementation of Slits (Testing)



Implementation of Slits (EPICS & NICOS)

- A soft slit object was implemented in the EPICS layer with dynamic soft limits to further avoid collision of the slit blades.
- NICOS has existing functionality to convert virtual axes positions into physical axes positions.
- The slit system is able to be controlled using centre and gap virtual axes at all three software layers.
- TwinCAT: not all axes parameters are calculated correctly for virtual axes, some are only ideal and not actual.

Implementation of Slits (Limits)



Physical
Limits Switches

TwinCAT
Soft Limits

EPICS Dynamic
Soft Limits

Beckhoff Libraries and Licenses

- TF5410 | TC3 Motion Collision Avoidance could have done the job but was deemed overkill.