High-Integrity Laser Safety Shutters for personnel interlocks.

The Requirement

During the development and expansion of the Artemis lab it was identified that several new beam shutters were needed.

These safety shutters are required to be to control beams passing between adjacent rooms (wall-mounted) and on optical tables (table/enclosure mounted).

A study of existing shutters at the CLF highlighted an opportunity to design new ones during the Artemis move to R92. New, small, and light interlock switches had become available, replacing heavy, or outdated Burgess micro-switches incompatible with our software.

Specification

After compiling a specification for the new shutters, it became clear that no commercially available options suited our needs.

The designed shutters include the following features:

- Fail-safe design
- 50mm beam aperture
- Pneumatic operation
- Adjustable closing speed, targeting around 0.25 seconds
- Latest Pilz dual channel magnetic safety switches (to be compatible with our high-integrity laser interlock safety system) to detect with a high level of reliability, the open and closed state of the shutter
- Vibration and shock free operation
- Beam wall or table-mounted, height adjustable
- No moving parts except those attached to the pneumatic piston
- Friction-free operation without guides
- Slim side profile to be fit between table enclosures
- Compatibility with Thorlabs lens tubing

The Design

The design centres around a 75mm single-action, spring-return pneumatic cylinder with a keyed piston shaft to prevent rotation. An 80mm cylinder replaced the initial 75mm model due to pandemic-related unavailability. A black anodized aluminium shutter blade is attached to the piston shaft with switches mounted directly to the blade and enclosed in a CNC-machine aluminium alloy housing.

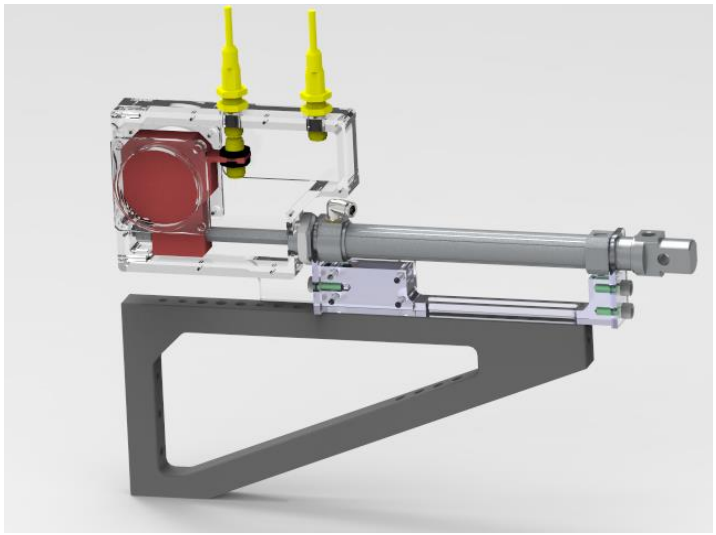

Table shutter

Wall shutter

Robustness Testing

A series of tests on a wall shutter assessed the reliability and suitability for use on EPAC. Repeated opening and closing of the shutter evaluated its durability and ability to maintain functionality over extended use. The test method and criteria are documented in a report, with a summary table shown below.

Success Results

596893	165	42	58	1	0	0	0	1	1	1	1	PASS	6753
596894	165	42	59	0	1	1	1	0	0	0	0	PASS	6754
596895	165	43	0	1	0	0	0	1	1	1	1	PASS	6755
596896	165	43	1	0	1	1	1	0	0	0	0	PASS	6756
596897	165	43	2	1	0	0	0	1	1	1	1	PASS	6757
596898	165	43	3	0	1	1	1	0	0	0	0	PASS	6758
596899	165	43	4	1	0	0	0	1	1	1	1	PASS	6759
596900	165	43	5	0	1	1	1	0	0	0	0	PASS	6760
596901	165	43	6	1	0	0	0	1	1	1	1	PASS	6761
596902	165	43	7	0	1	1	1	0	0	0	0	PASS	6762
596903	165	43	8	1	0	0	0	1	1	1	1	PASS	6763

TESTV27 | TESTV28 | TESTV29 | **TESTV213** | Sheet1

ASSUMPTION: Total Open and Close Signals per day = 8

Total operating days a week = 5

Number of weeks per year = 52

Therefore, the test run of **596,902 Pass** operations simulated about **287 years of maintenance free** successful operations