

UPGRADING THE IRRAD CONTROL SYSTEM GUIs USING OPEN-LICENSE AND CROSS-PLATFORM TECHNOLOGIES

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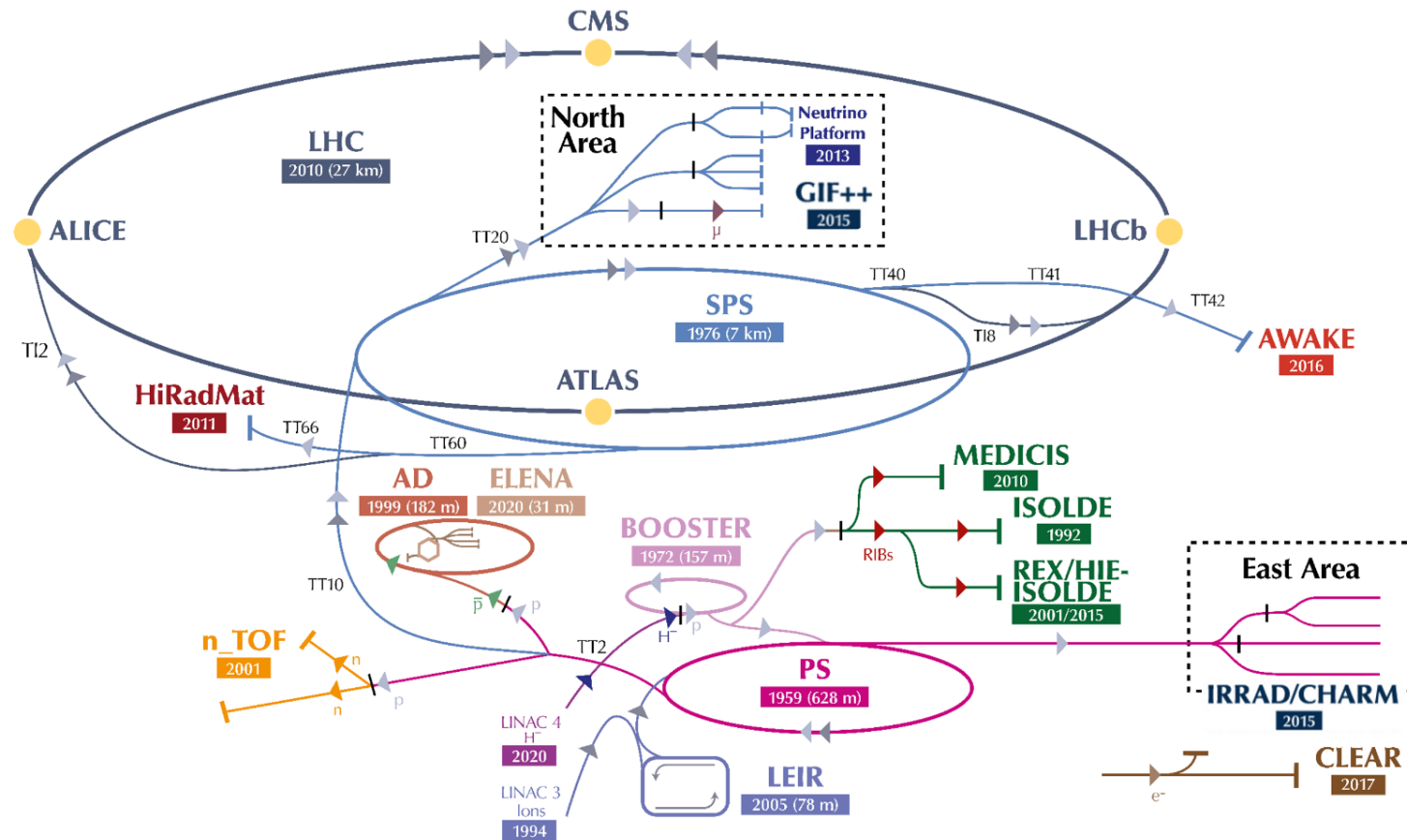
Outline

- CERN Accelerator Complex
- CERN Proton Irradiation Facility (IRRAD)
- IRRAD Control System Upgrades
 - IRRAD Tables
 - Shuttle
- Lessons Learned
- Future Work
- Summary

Outline

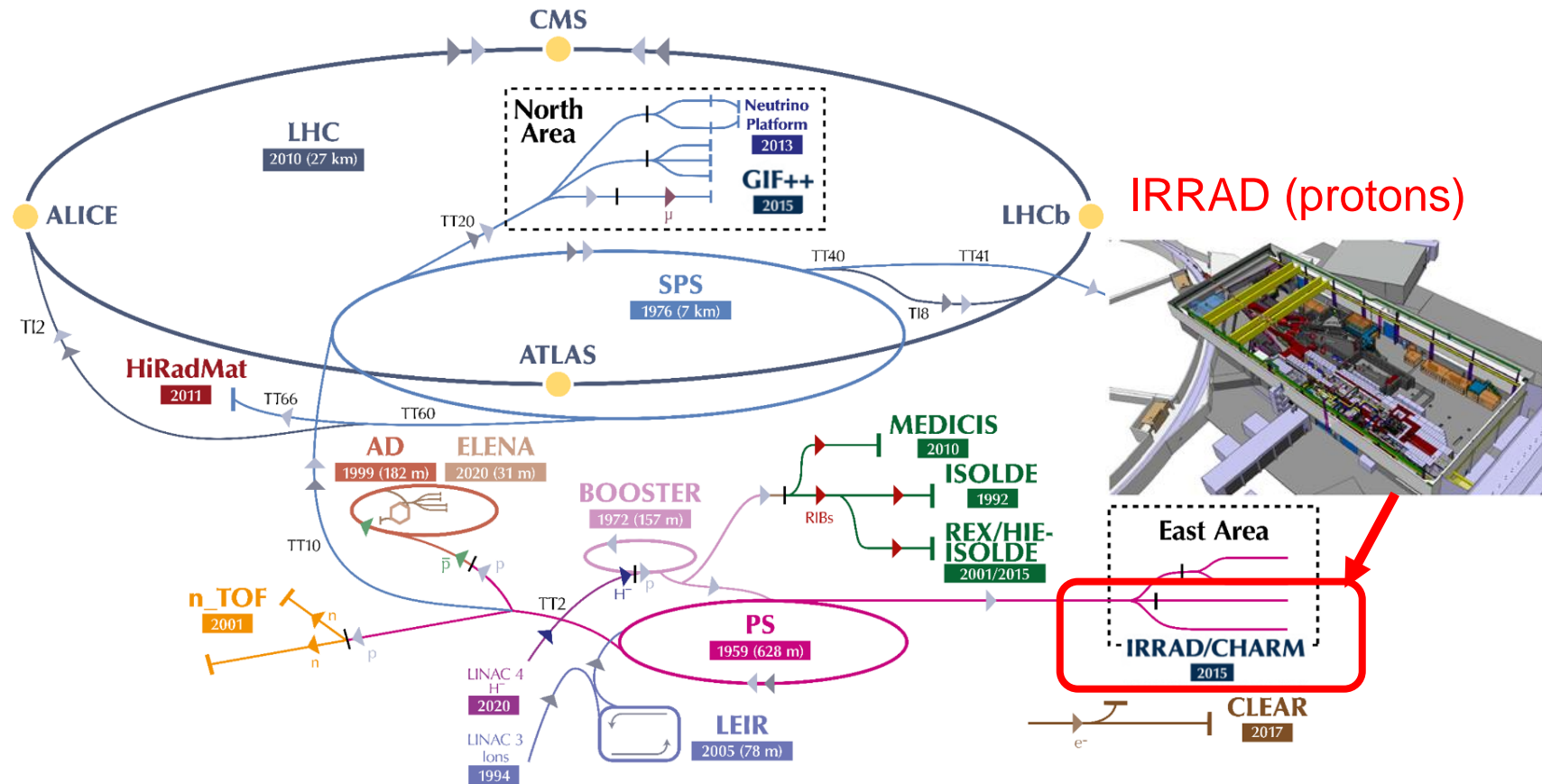
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CERN Accelerator Complex



▶ H^- (hydrogen anions) ▶ p (protons) ▶ ions ▶ RIBs (Radioactive Ion Beams) ▶ n (neutrons) ▶ \bar{p} (antiprotons) ▶ e^- (electrons) ▶ μ (muons)

CERN Accelerator Complex

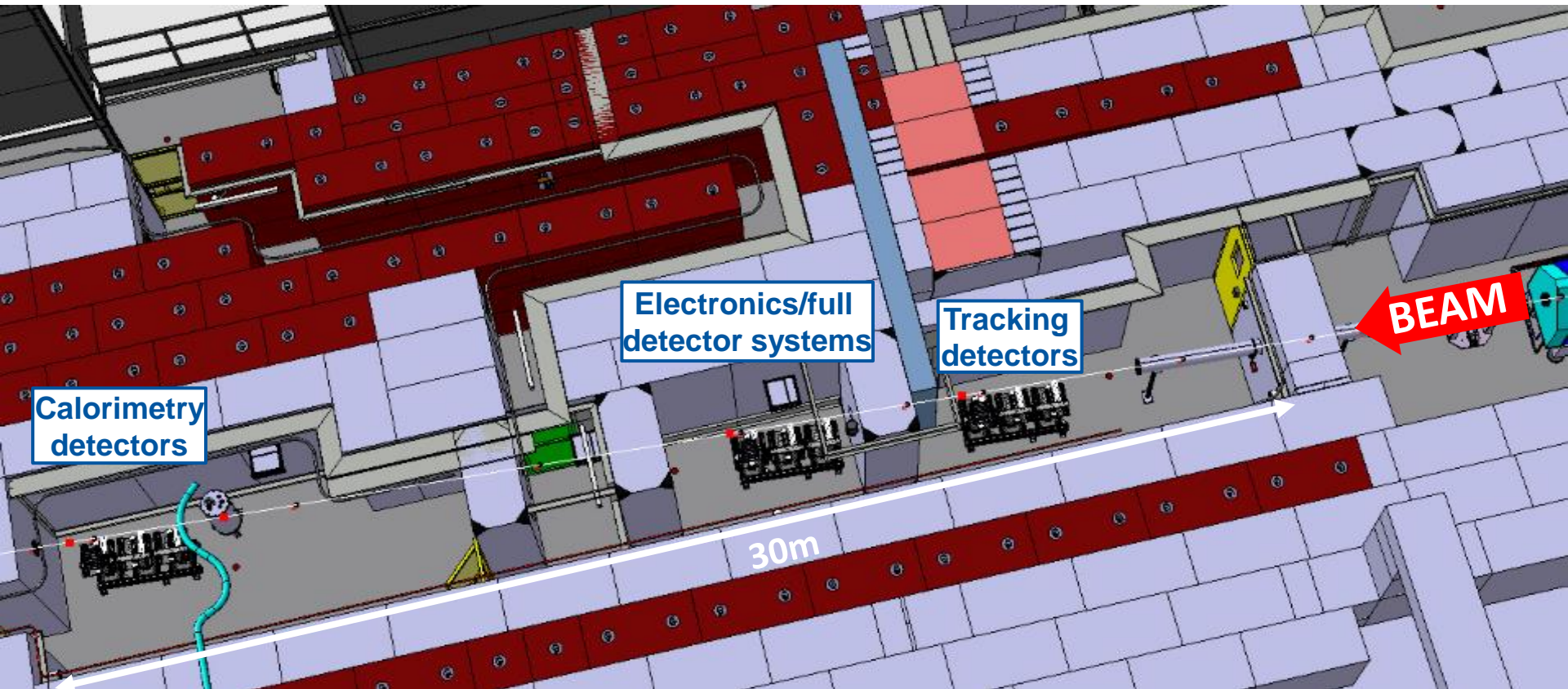


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CERN Proton Irradiation Facility (IRRAD)

- Testing components of HEP experiments
- 24 GeV/c, Gaussian 12×12 mm² FWHM
- Spills of 400 ms every ~10 s
- Fluence of 1×10^{16} p/cm² in ~14 days

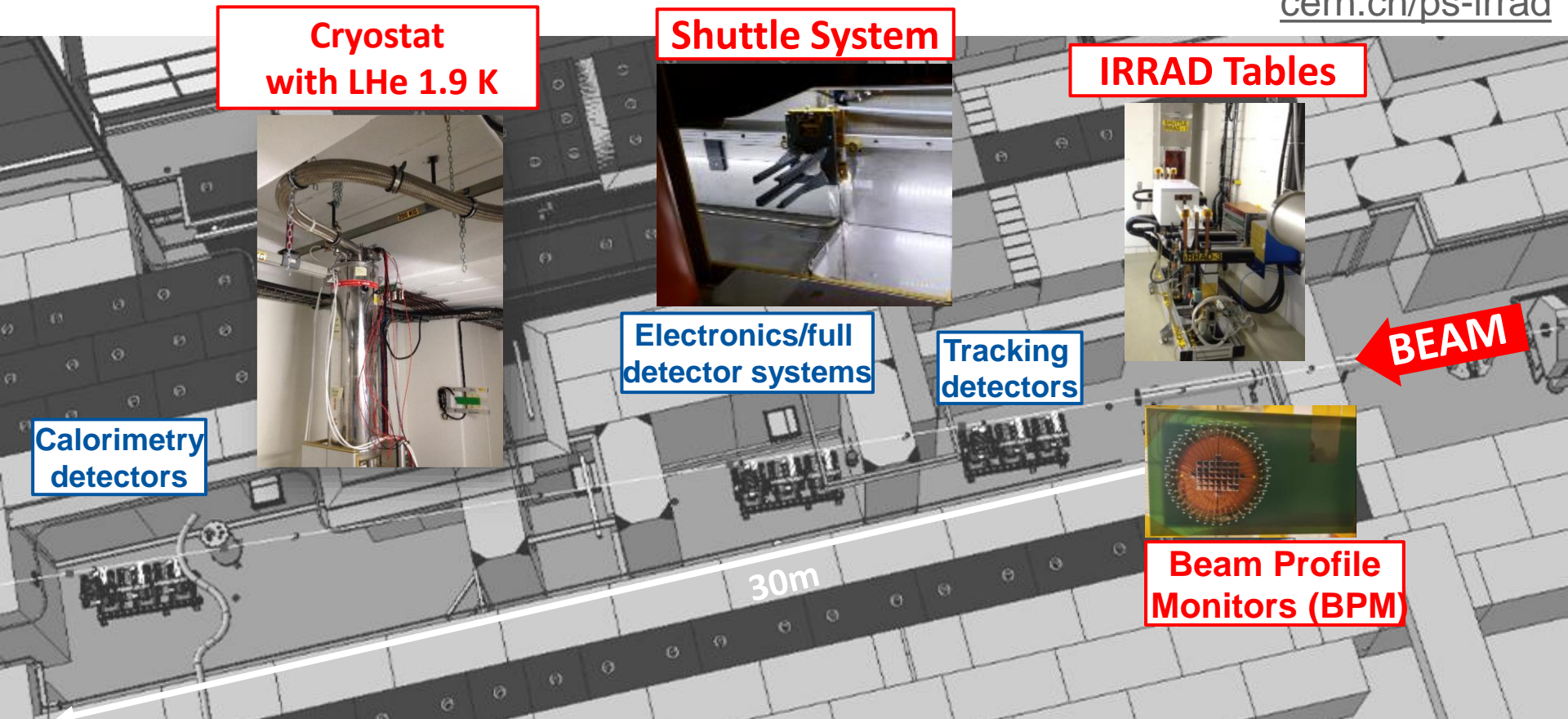
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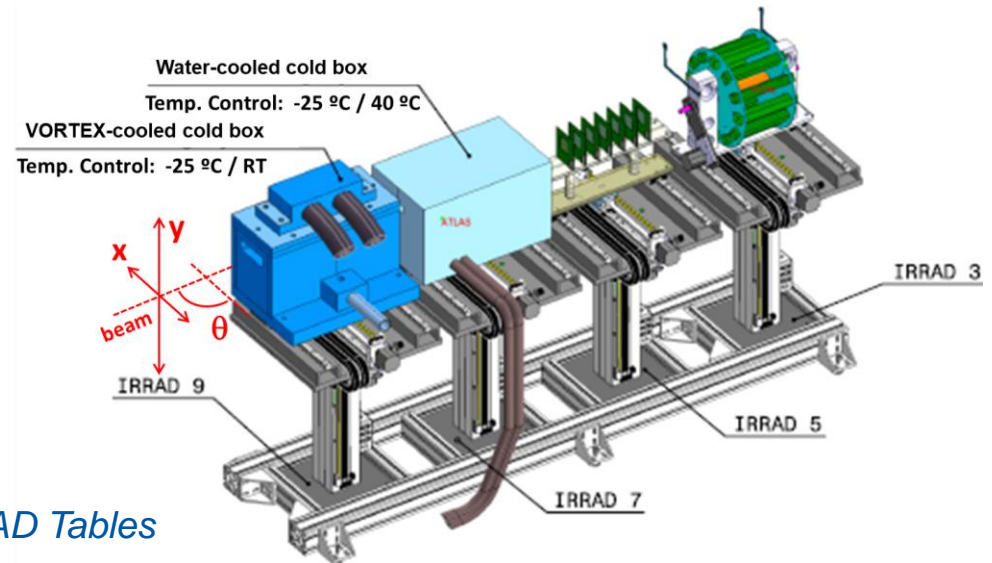
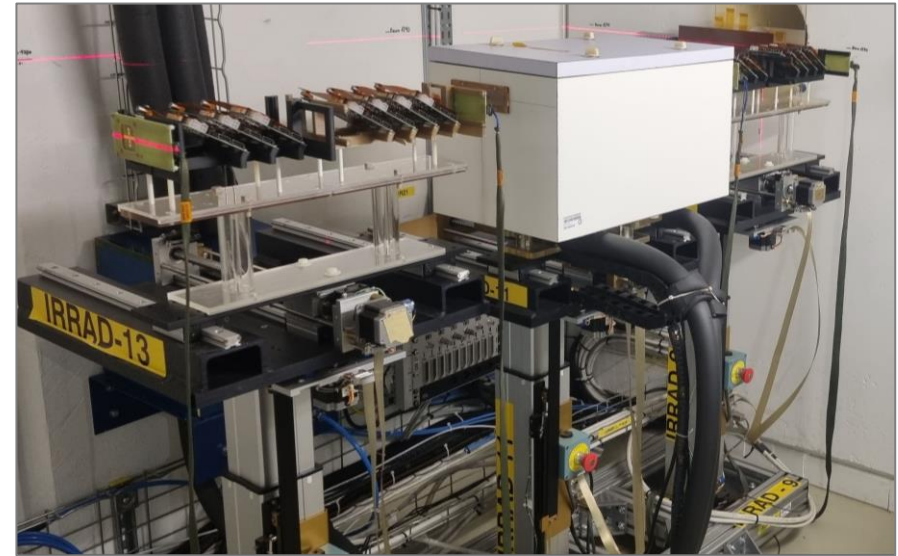
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IRRAD Tables

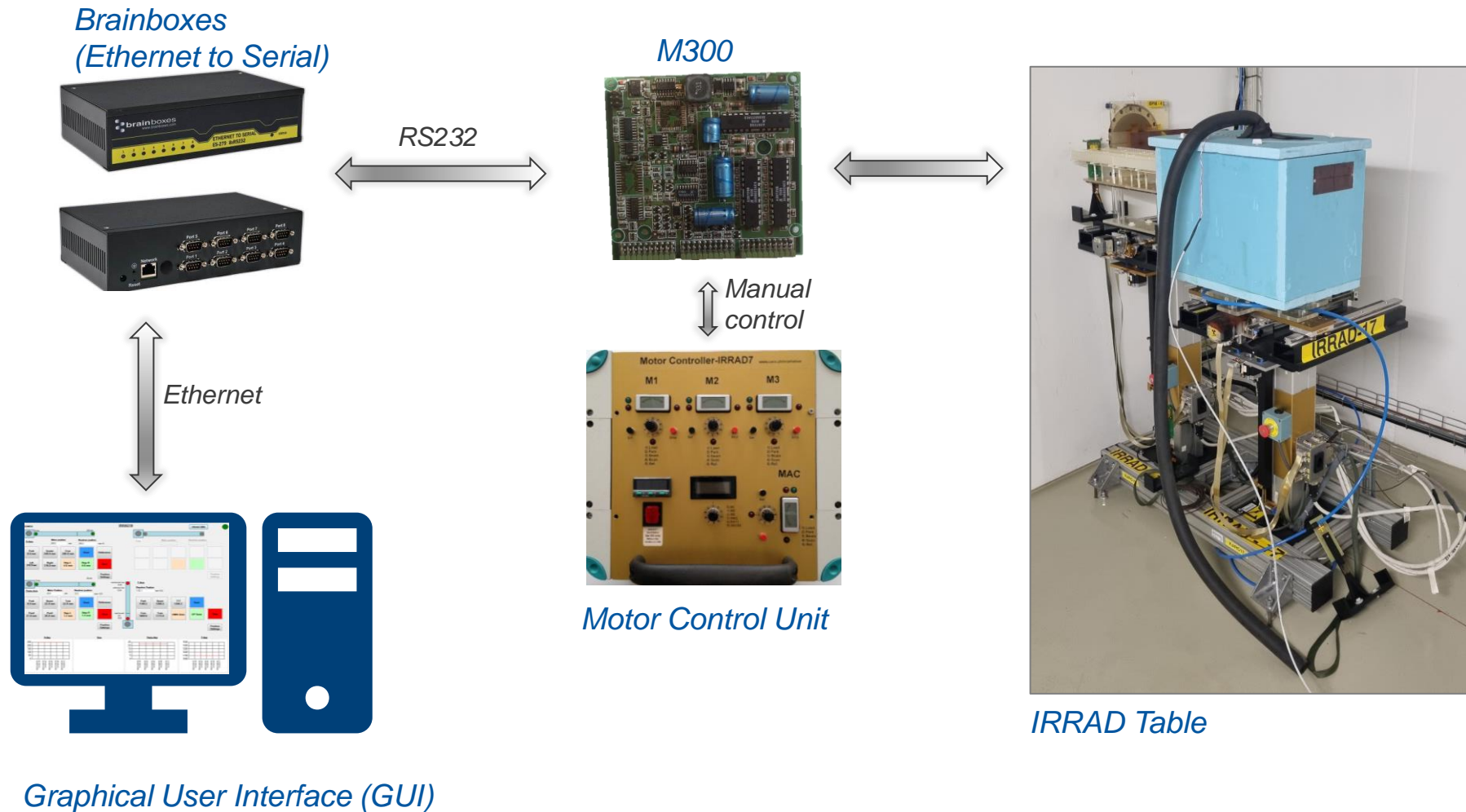
Remotely controlled moveable stages

- 2 stepper motors for horizontal move and rotation
- 1 AC motor for vertical move
- 9 IRRAD Tables in total
 - 6x at room temperature
 - $V_{\max} = 20 \times 20 \times 50 \text{ cm}^3$
 - Scan over 10-20 cm (X-axis)
 - 2x with cold boxes (-25°C)
 - $V_{\max} = 12 \times 4 \times 38 \text{ cm}^3$
 - 1x cryogenic setup (1.9K)
 - $V_{\max} = 5 \times 5 \times 20 \text{ cm}^3$



IRRAD Tables

IRRAD Tables Control System: Hardware Components & Communication



Software Technologies

Old GUIs:

- Limited to specific operating system;
- Proprietary software;
- Additional functionalities required (no database in the backend)

→ Need for free, open-license cross-platform technologies and implementation of additional functionalities

Development



Serial Communication



Data Storage



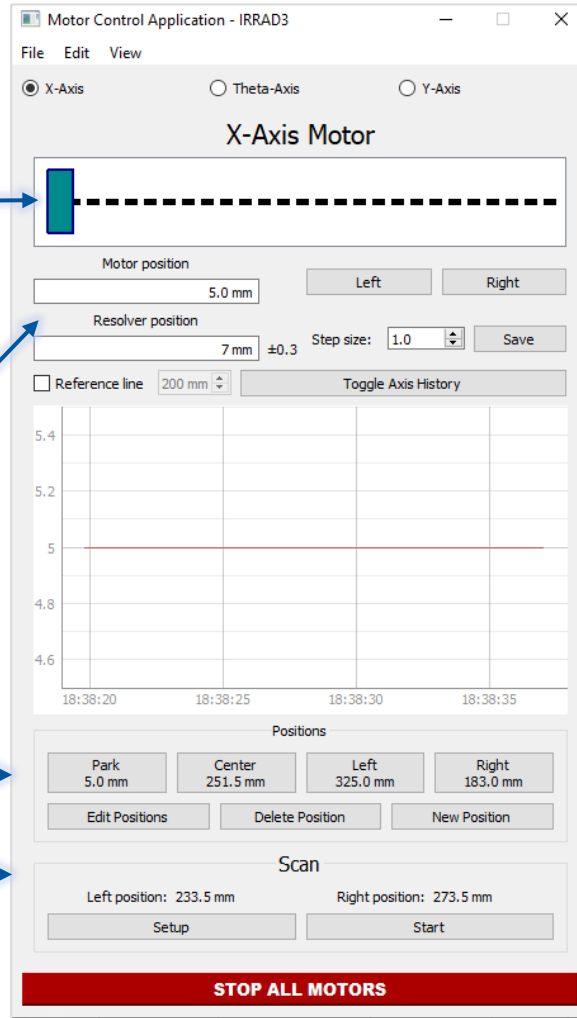
IRRAD Tables Control System: GUIs and Functionalities

Position visualisation

Indication from position sensors

Fixed buttons

Scanning setting



Movement in steps

Movement in time

Additional custom positions

Emergency stop

IRRAD Tables Control System: GUI Full View

The screenshot displays the 'MainWindow' of the IRRAD Tables Control System, divided into three main motor control sections: X-Axis Motor, Theta-Axis Motor, and Y-Axis Motor. Each section includes a visual representation of the motor's position, numerical readouts for motor and resolver positions, control buttons (Left, Right, Up, Down), and a 'Scan' section for setting positions.

X-Axis Motor

Motor position: 240.0 mm
Resolver position: 282 mm ±0.3
Step size: 0.0

Reference line: 200 mm

Positions: Park (4.0 mm), Left (205.0 mm), Center (240.0 mm), Right (244.8 mm)

Theta-Axis Motor

Motor position: 24.34 mm
Resolver position: -102 mm ±0.3
Step size: 0.0

Reference line: 10 mm

Positions: Park (2.93 mm), Left (13.34 mm), Center (24.34 mm), Right (0.0 mm)

Y-Axis Motor

Motor position: 953.30 mm ±0.3
Step size: 1 mm

Reference line: 1000 mm

Positions: Park (952.02 mm), Left (1044.08 mm), Center (1002.97 mm), Right (1044.08 mm)

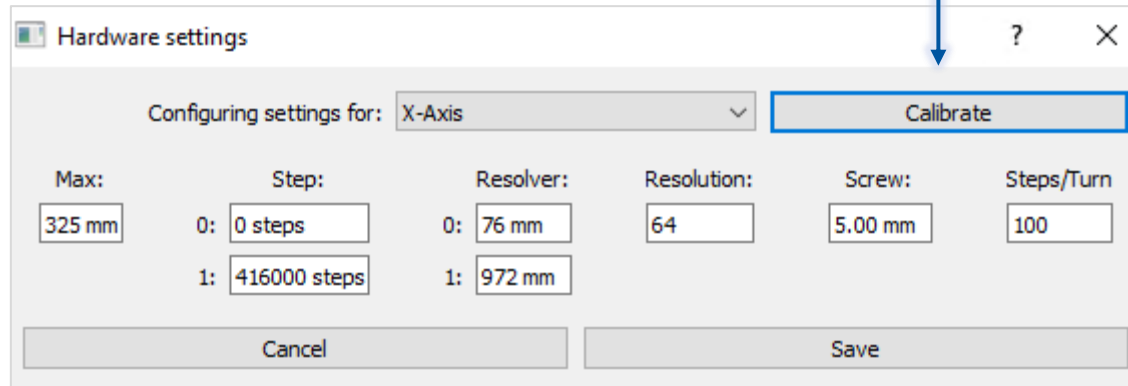
STOP ALL MOTORS

IRRAD Tables Control System: Database Data and Hardware Settings

Data stored in the database:

- Stepper-motor hardware settings
- AC motor hardware settings
- Motor
- Movements
- Custom positions

Automated
calibration process



The screenshot shows a 'Hardware settings' dialog box for the X-Axis. The 'Configuring settings for:' dropdown is set to 'X-Axis'. A 'Calibrate' button is highlighted with a blue border and a blue arrow pointing to it from the text 'Automated calibration process'. The dialog contains several input fields for motor parameters:

Max:	Step:	Resolver:	Resolution:	Screw:	Steps/Turn
325 mm	0: 0 steps	0: 76 mm	64	5.00 mm	100
	1: 416000 steps	1: 972 mm			

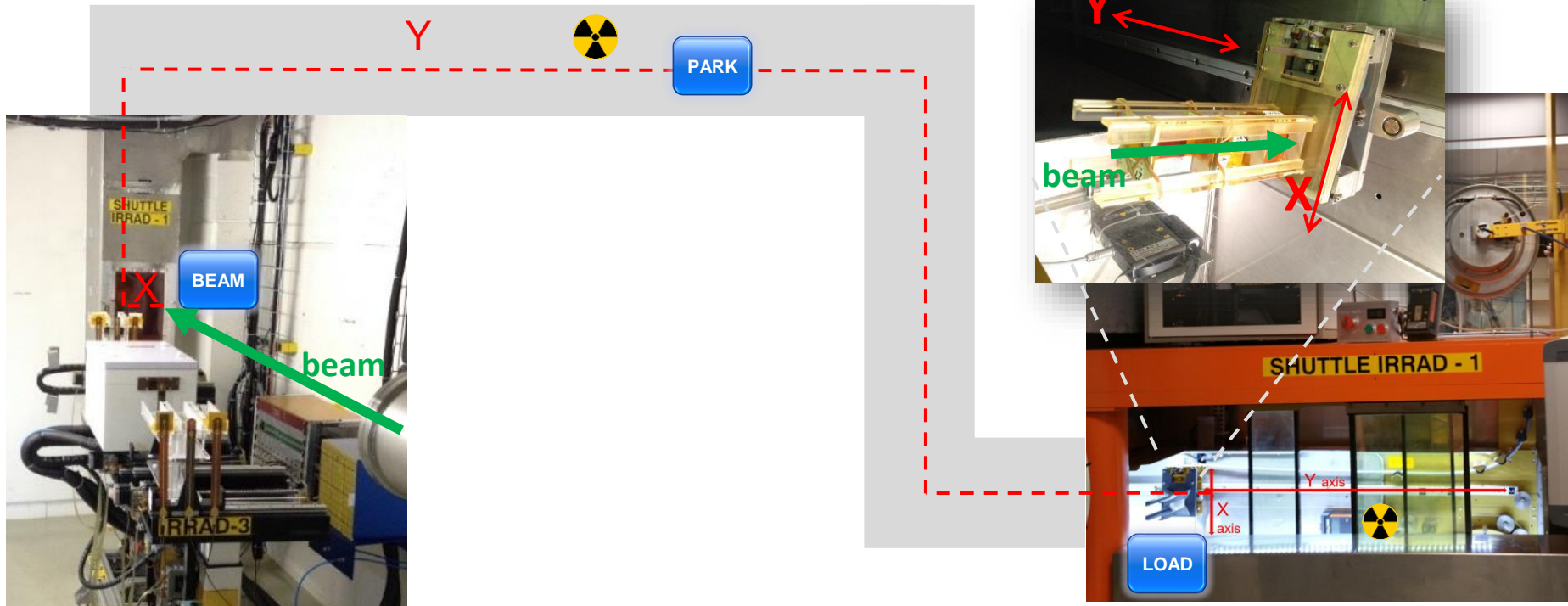
At the bottom of the dialog are 'Cancel' and 'Save' buttons.

Outline

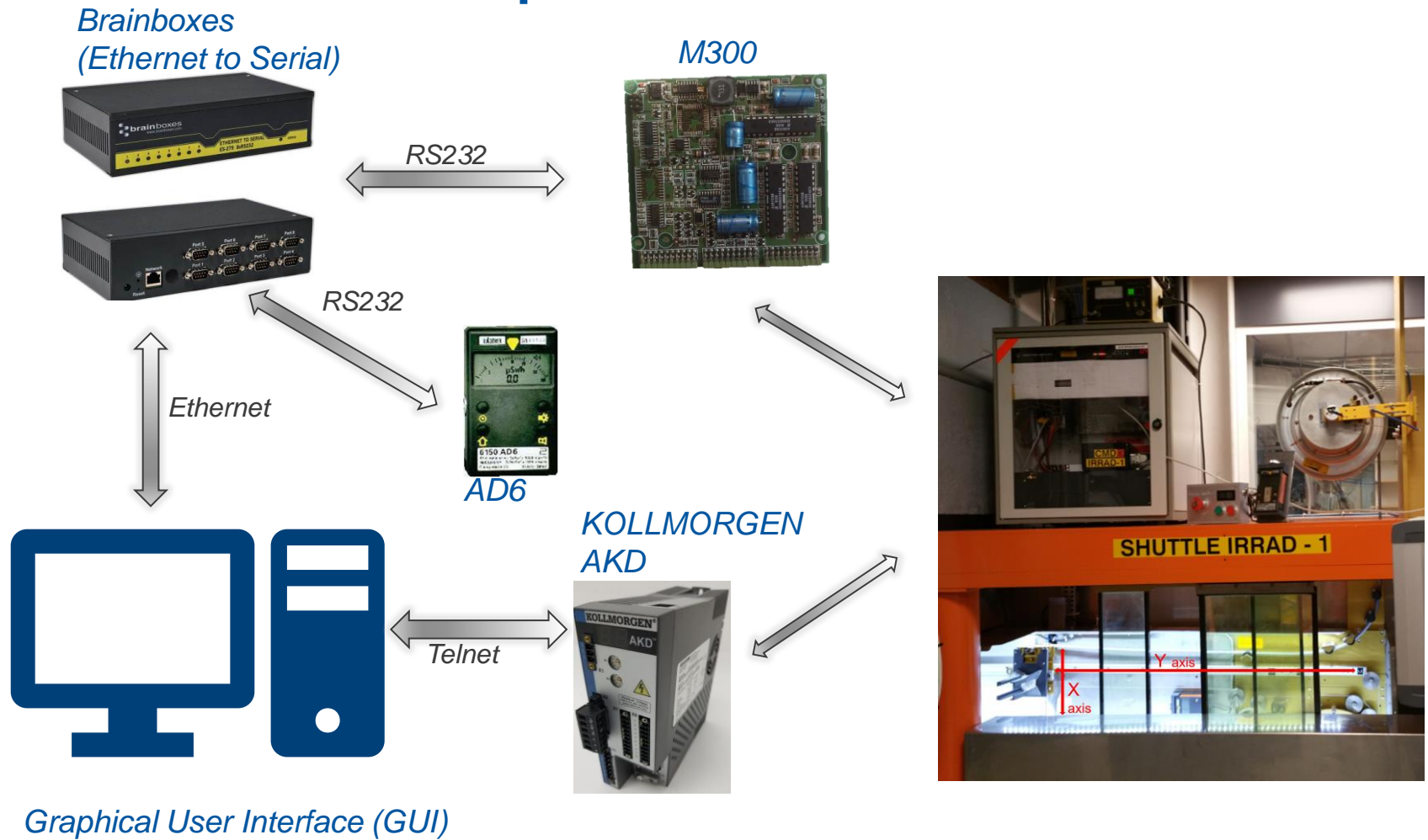
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IRRAD Shuttle Control System

- Movements between irradiation zone and out
- 2 movements:
 - Y axis 9-m-long path
 - X axis 63 mm
- Irradiations room temperature
 - $V_{\max} = 5 \times 5 \times 15 \text{ cm}^3$
 - mainly passive samples
- Radiation levels monitored



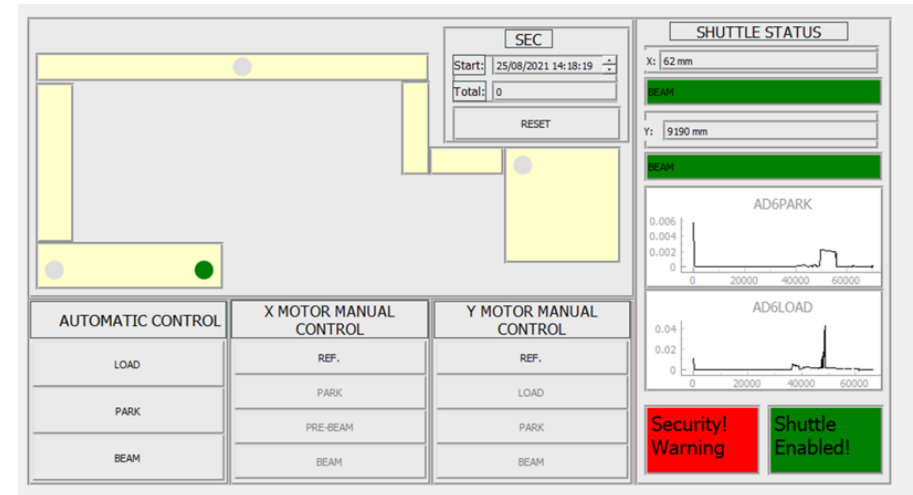
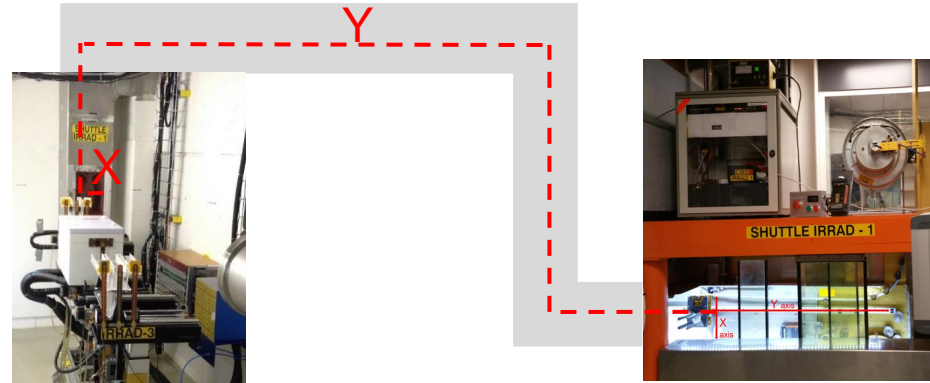
IRRAD Shuttle Control System: Hardware Components & Communication



IRRAD Shuttle Control System: GUIs and functionalities

Same software technologies as
IRRAD Table Control System GUIs

- Moving positions Load, Park, Beam
- Monitoring and visualising activity
- Software interlocks
- Position visualisation
- Cumulated proton intensity monitored when shuttle in beam



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Lessons Learned

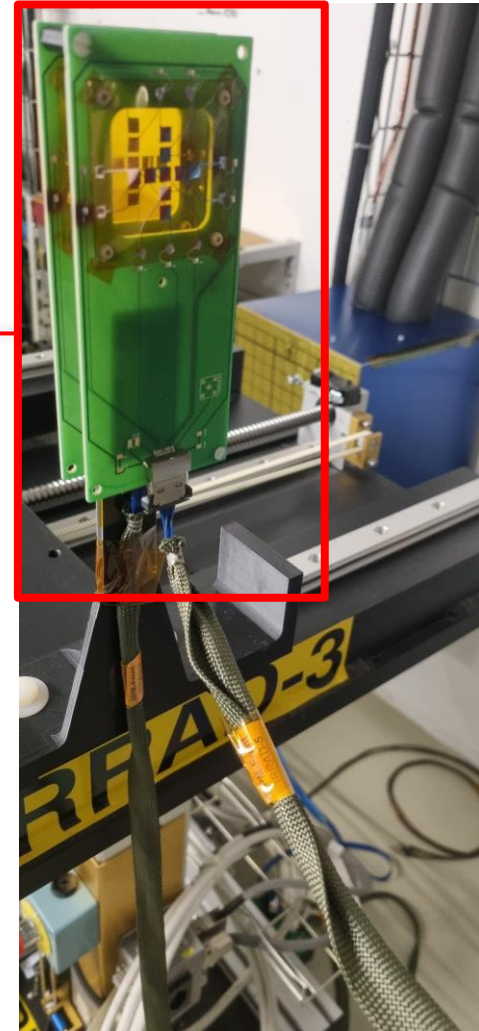
- **Common programming languages like Python** can improve:
 - ✓ **scalability**
 - ✓ **maintainability**for a small-scale infrastructure
- **Open-source and free-license** software:
 - ✓ can **save development time** in the future
 - ✓ find **easily solutions** from **documentation** and large-scale **community**
- **Cross-platform** technologies:
 - ✓ can improve **portability**
 - ✓ **Remove constraints on operating system**

Future Work

1. Beam Position Monitors (BPM) positioned on IRRAD table → Automatic movement of tables in and out of beam

2. Web interfaces for the software control system

BPM



Summary

- IRRAD Control systems overview
- IRRAD Control System GUIs upgraded:
 - Open-license and cross-platform technologies used
 - New functionalities
- This upgrade improved:
 - Scalability
 - Maintainability
 - Portability
- Future Work:
 - New developments (BPMs) can be integrated
 - Web interfaces under discussed