

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

Blerina Gkotse^{1,2}, A. Abdulhalim¹, Pierre Jouvelot², Alexander Smith Mølholm¹, Federico Ravotti¹

¹ CERN EP-DT

² Mines Paris, PSL University



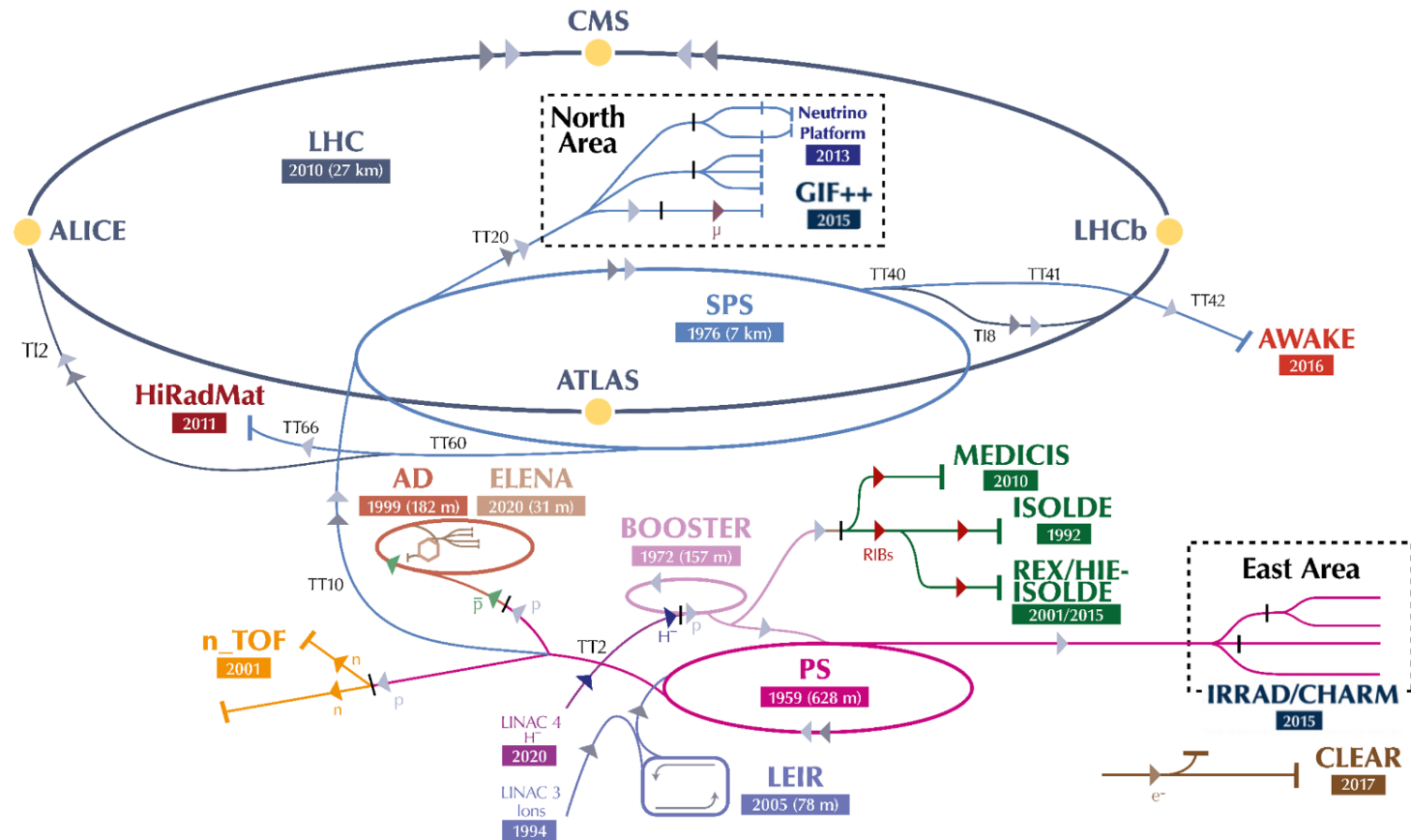
Outline

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

Outline

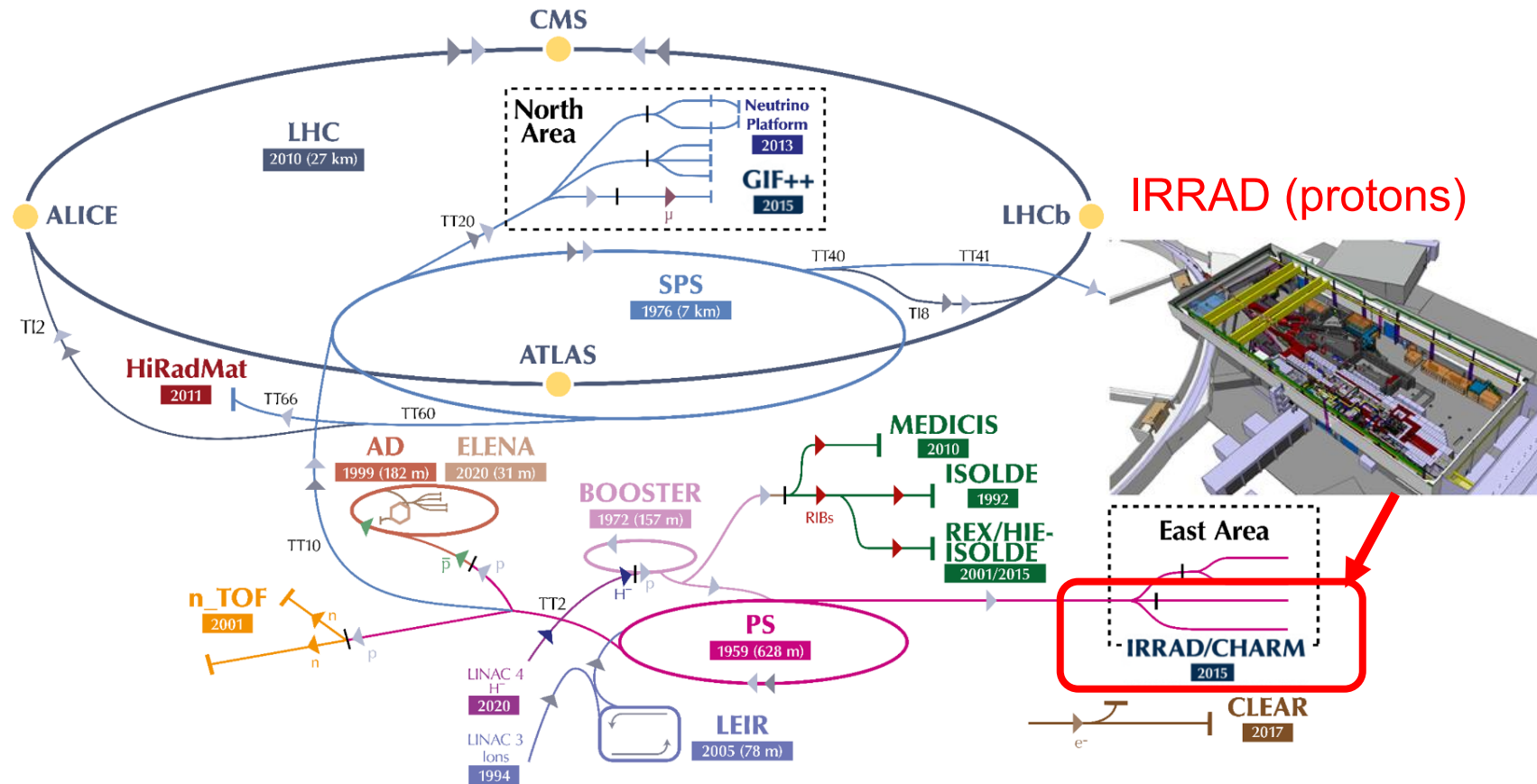
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CERN Accelerator Complex



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

CERN Accelerator Complex

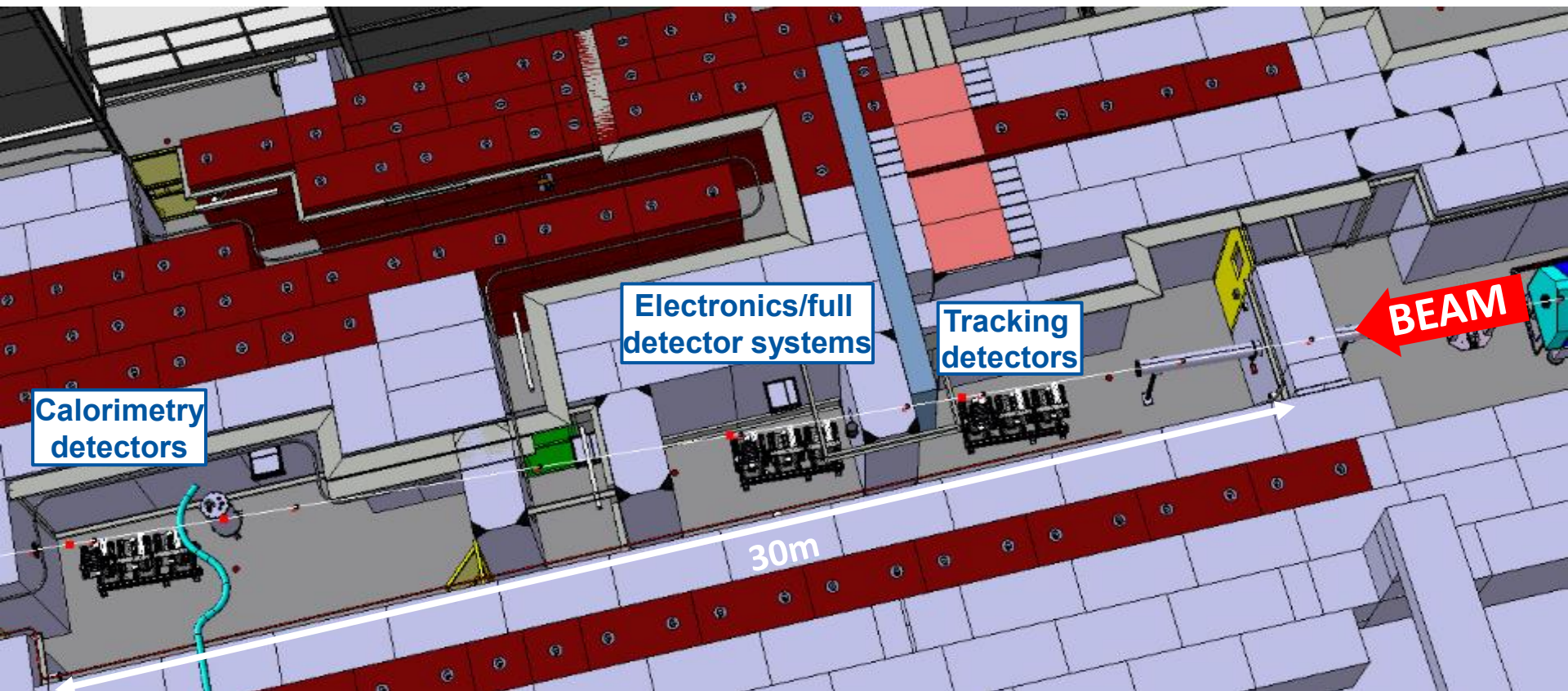


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CERN Proton Irradiation Facility (IRRAD)

- 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

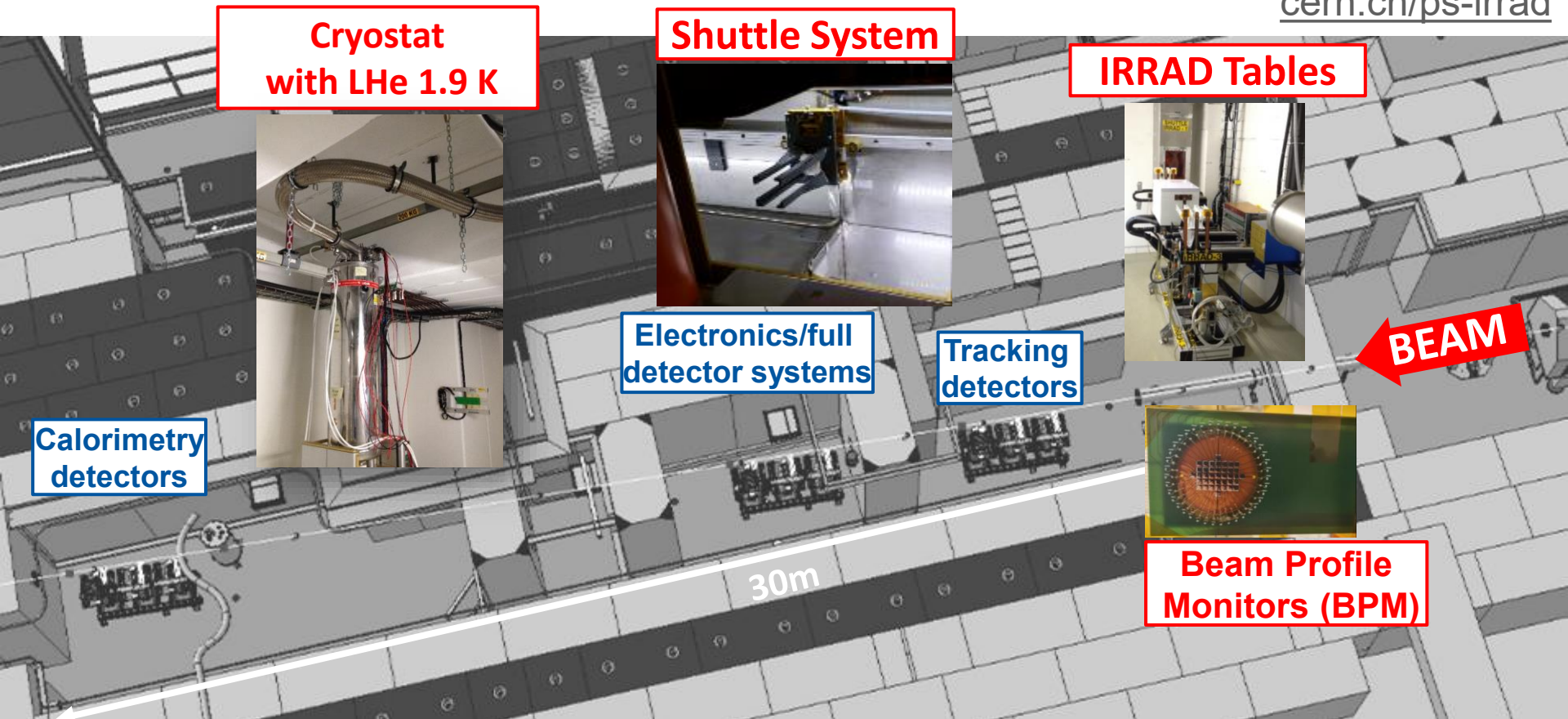
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CERN Proton Irradiation Facility (IRRAD)

- Testing components of HEP experiments
- 24 GeV/c, Gaussian $12 \times 12 \text{ mm}^2$ FWHM
- Spills of 400 ms every $\sim 10 \text{ s}$
- Fluence of $1 \times 10^{16} \text{ p/cm}^2$ in ~ 14 days

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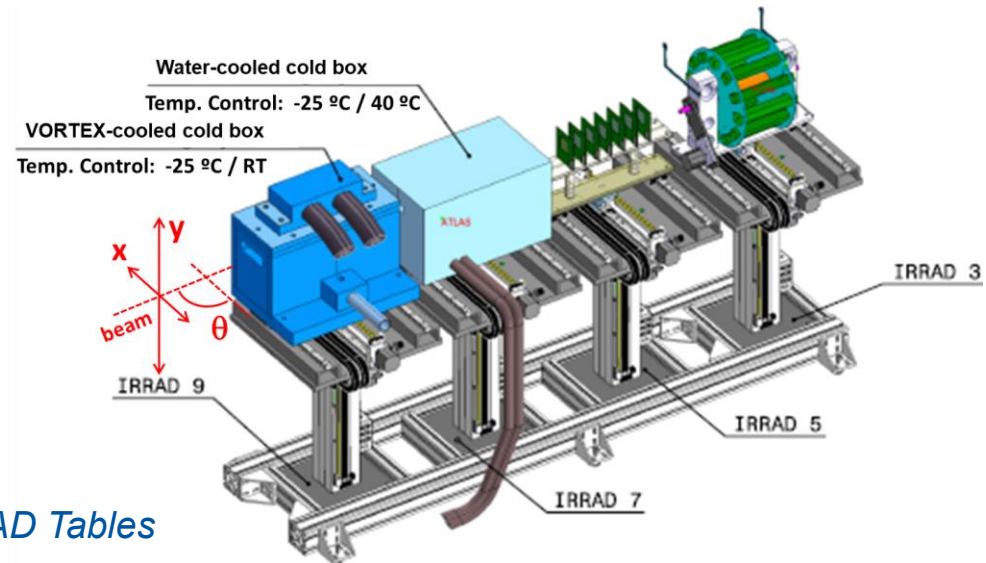
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IRRAD Tables

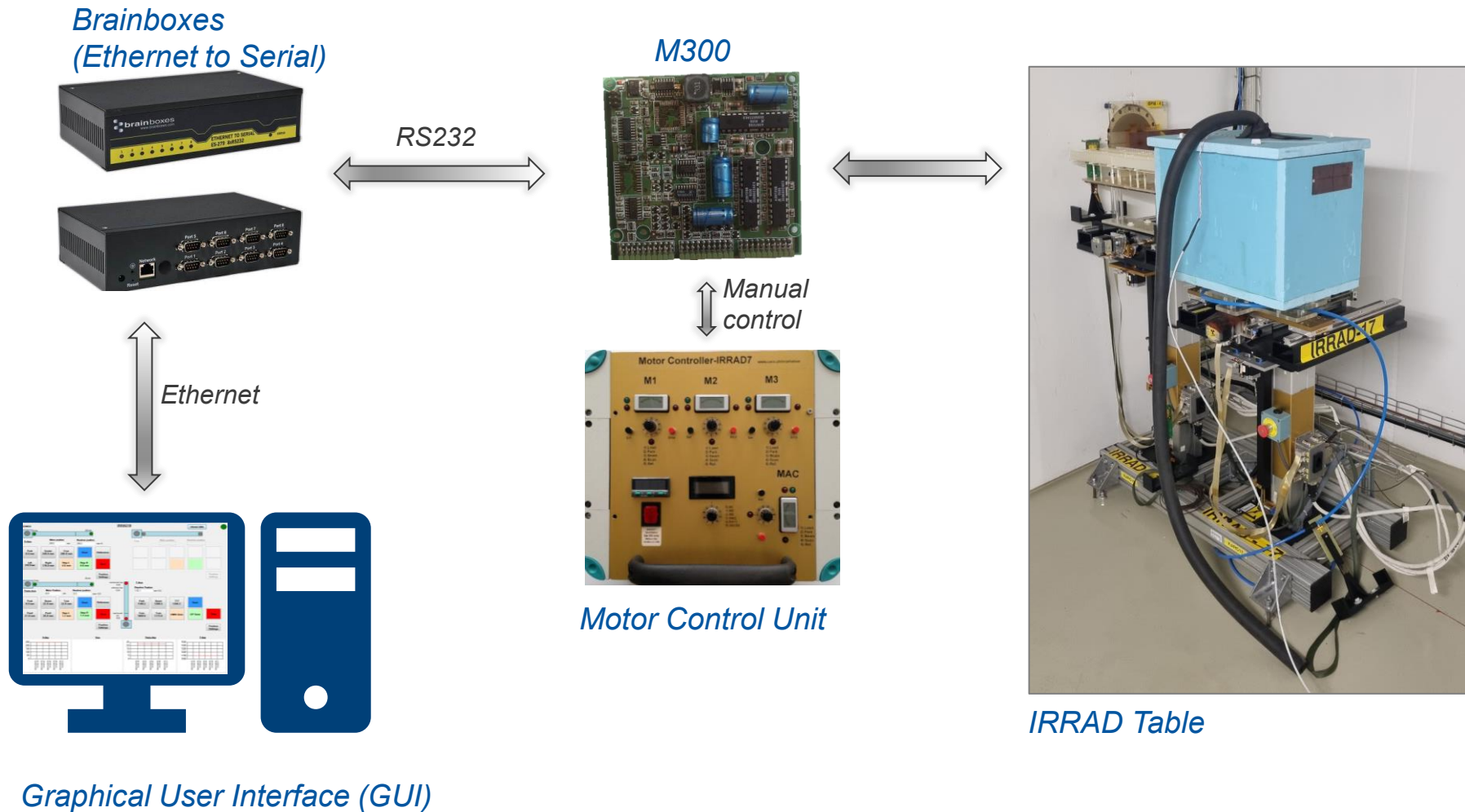
Remotely controlled moveable stages

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



IRRAD Tables

IRRAD Tables Control System: Hardware Components & Communication



Software Technologies

Old GUIs:

- Limited to specific operating system;
- Proprietary software;
- Missing functionalities (e.g. 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

The screenshot shows the 'Motor Control Application - IRRAD3' window. It features a menu bar (File, Edit, View) and three radio buttons for axis selection: X-Axis (selected), Theta-Axis, and Y-Axis. The main section is titled 'X-Axis Motor'. It includes a position visualisation bar with a green indicator, a 'Motor position' field set to 5.0 mm with 'Left' and 'Right' buttons, and a 'Resolver position' field set to 7 mm with a ± 0.3 tolerance and a 'Step size' of 1.0. A 'Reference line' is set to 200 mm, and there is a 'Toggle Axis History' button. Below this is a graph showing position over time, with a red horizontal line at 5.0 mm. The x-axis of the graph shows timestamps from 18:38:20 to 18:38:35. At the bottom, there are 'Positions' buttons (Park 5.0 mm, Center 251.5 mm, Left 325.0 mm, Right 183.0 mm), 'Edit Positions', 'Delete Position', and 'New Position' buttons. A 'Scan' section shows 'Left position: 233.5 mm' and 'Right position: 273.5 mm' with 'Setup' and 'Start' buttons. A large red button at the very bottom reads 'STOP ALL MOTORS'.

Position visualisation

Indication from position sensors

Fixed buttons

Scanning setting

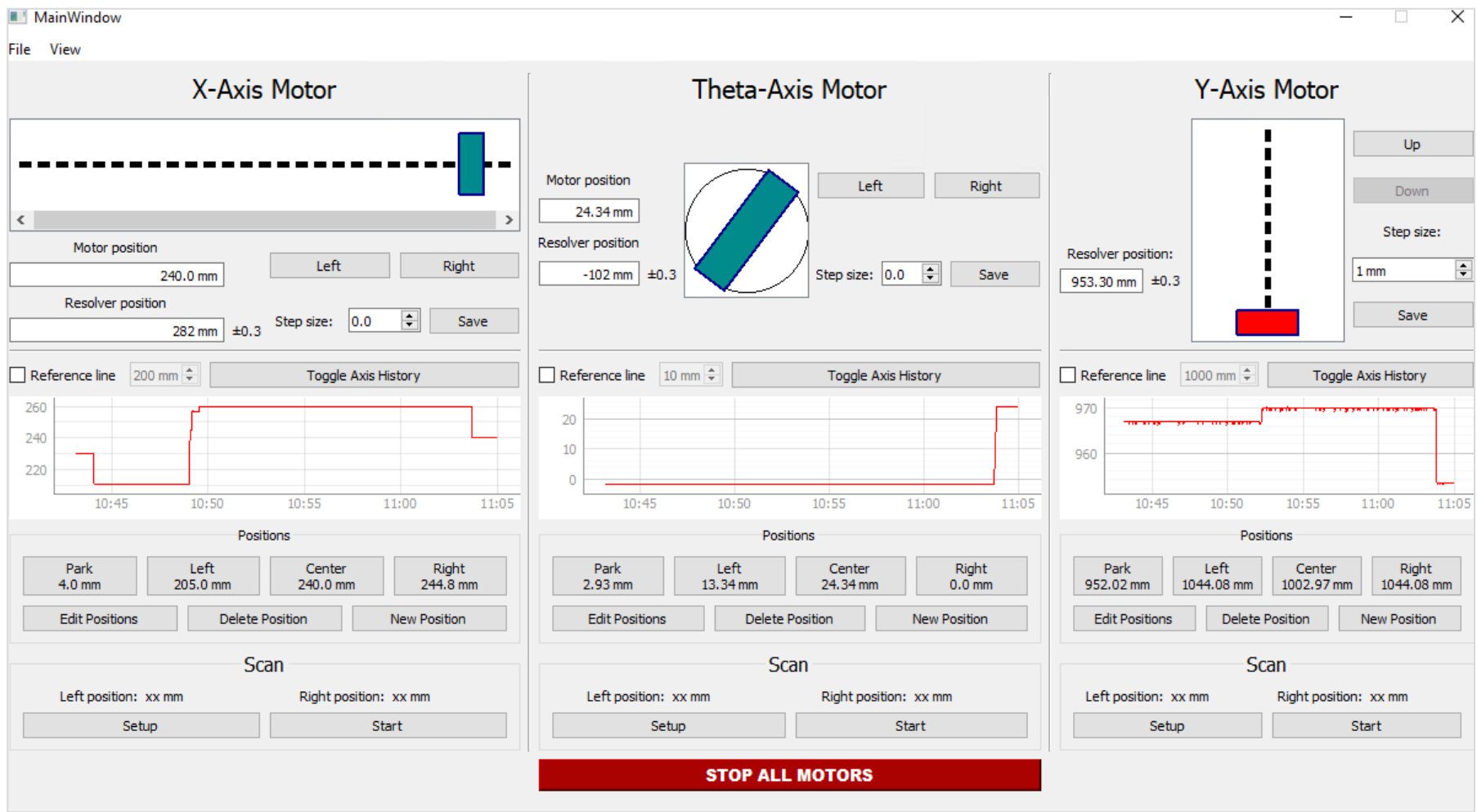
Movement in steps

Movement in time

Additional custom positions

Emergency stop

IRRAD Tables Control System: GUI Full View



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

Hardware settings

Configuring settings for: X-Axis

Calibrate

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			

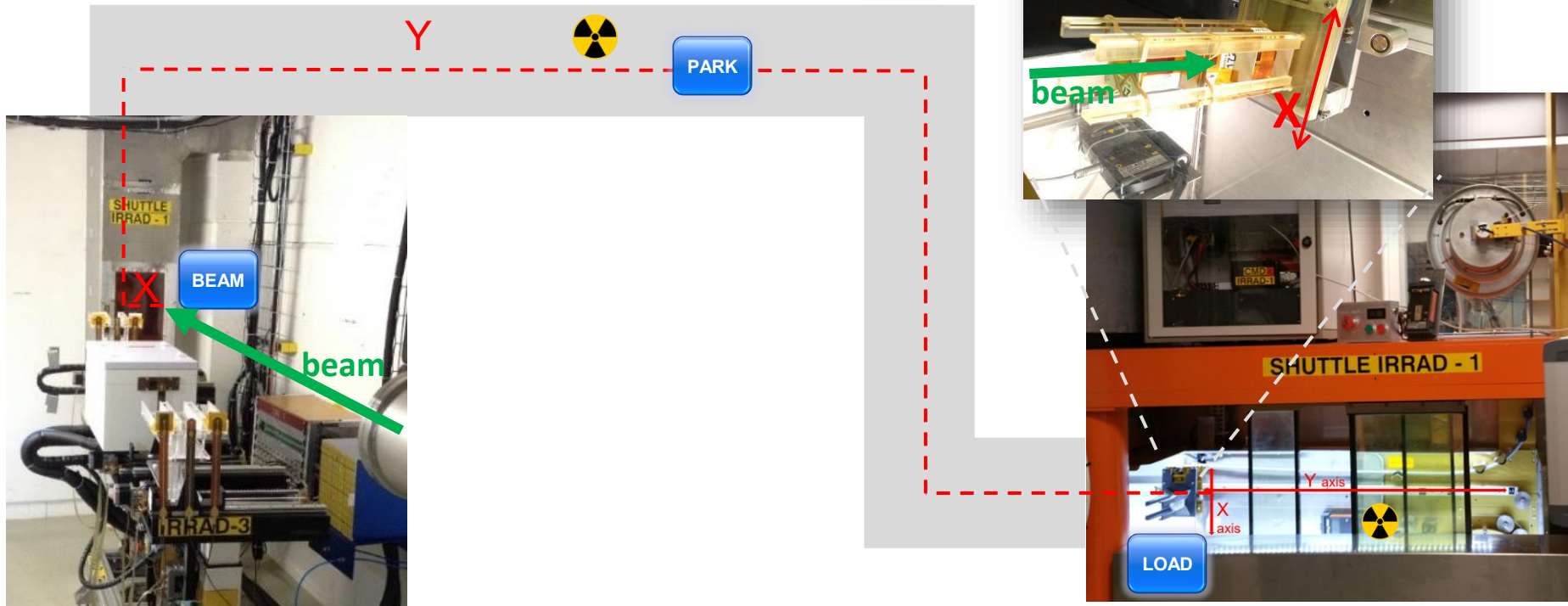
Cancel Save

Outline

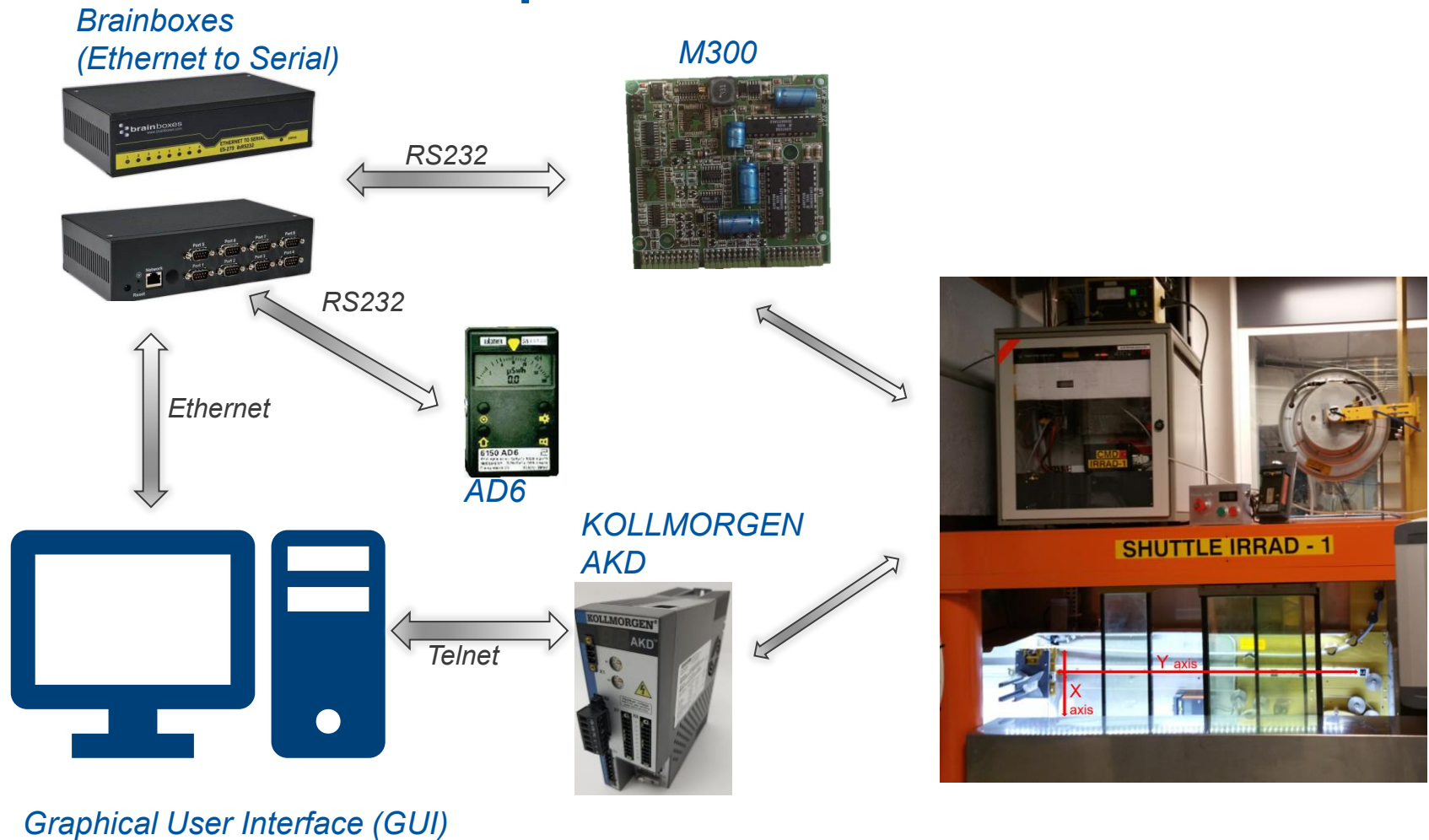
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IRRAD Shuttle Control System

- 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



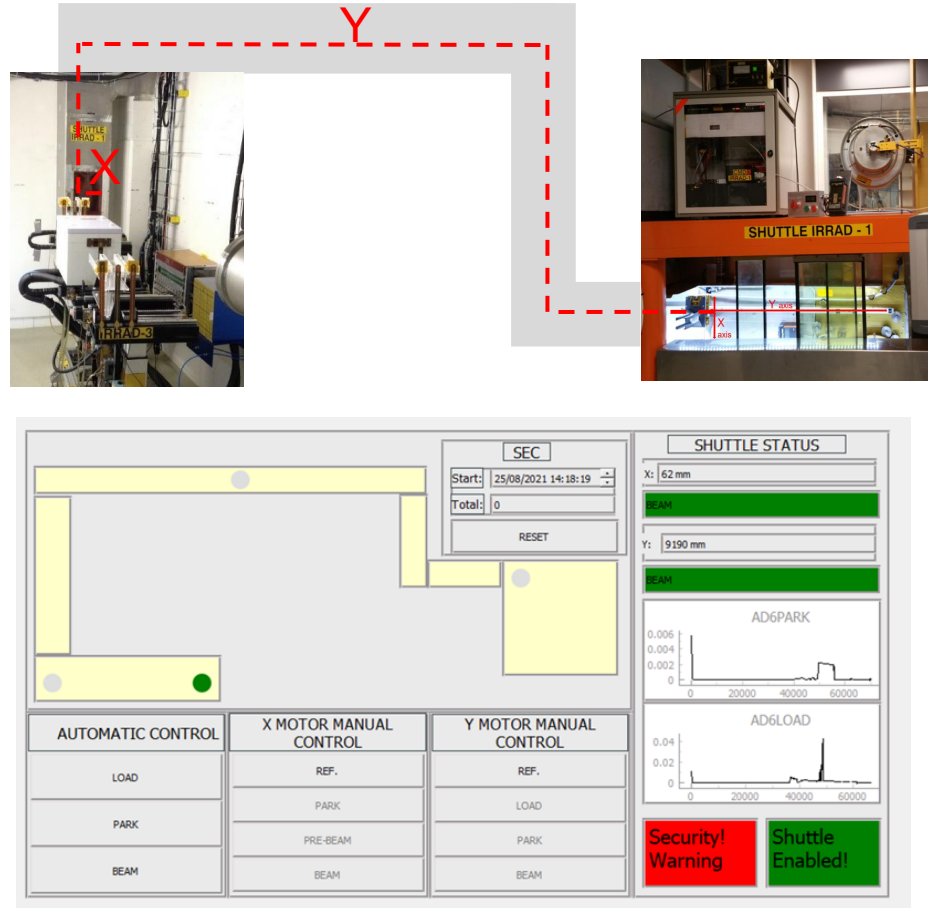
IRRAD Shuttle Control System: Hardware Components & Communication



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

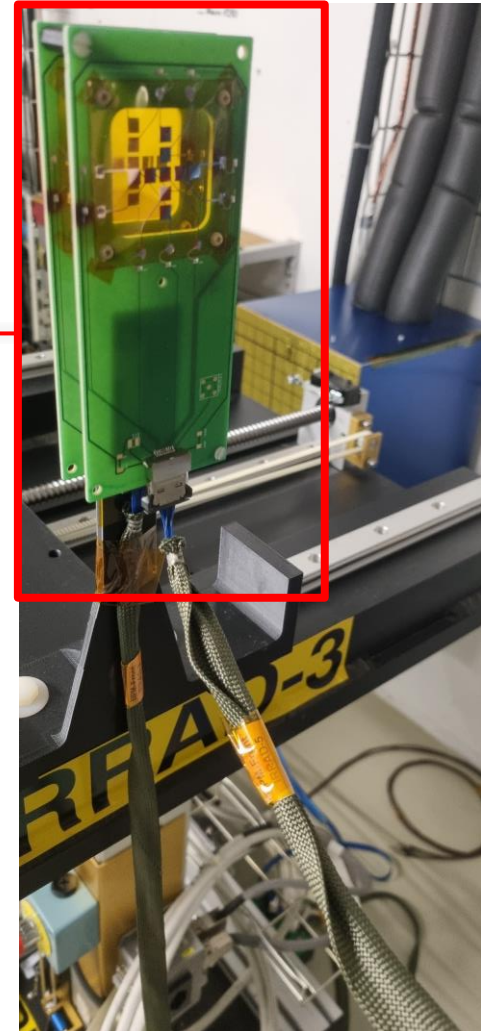
- **Common programming languages** like **Python** can improve:
 - ✓ **scalability**
 - ✓ **maintainability**for a small-scale infrastructure
- **Open-source** and **free-license** software:
 - ✓ can **save development time** in the future
 - ✓ find **easily solutions** from **documentation** and large-scale **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