Task 4.4: Service Improvements to Research Infrastructures for Detectors

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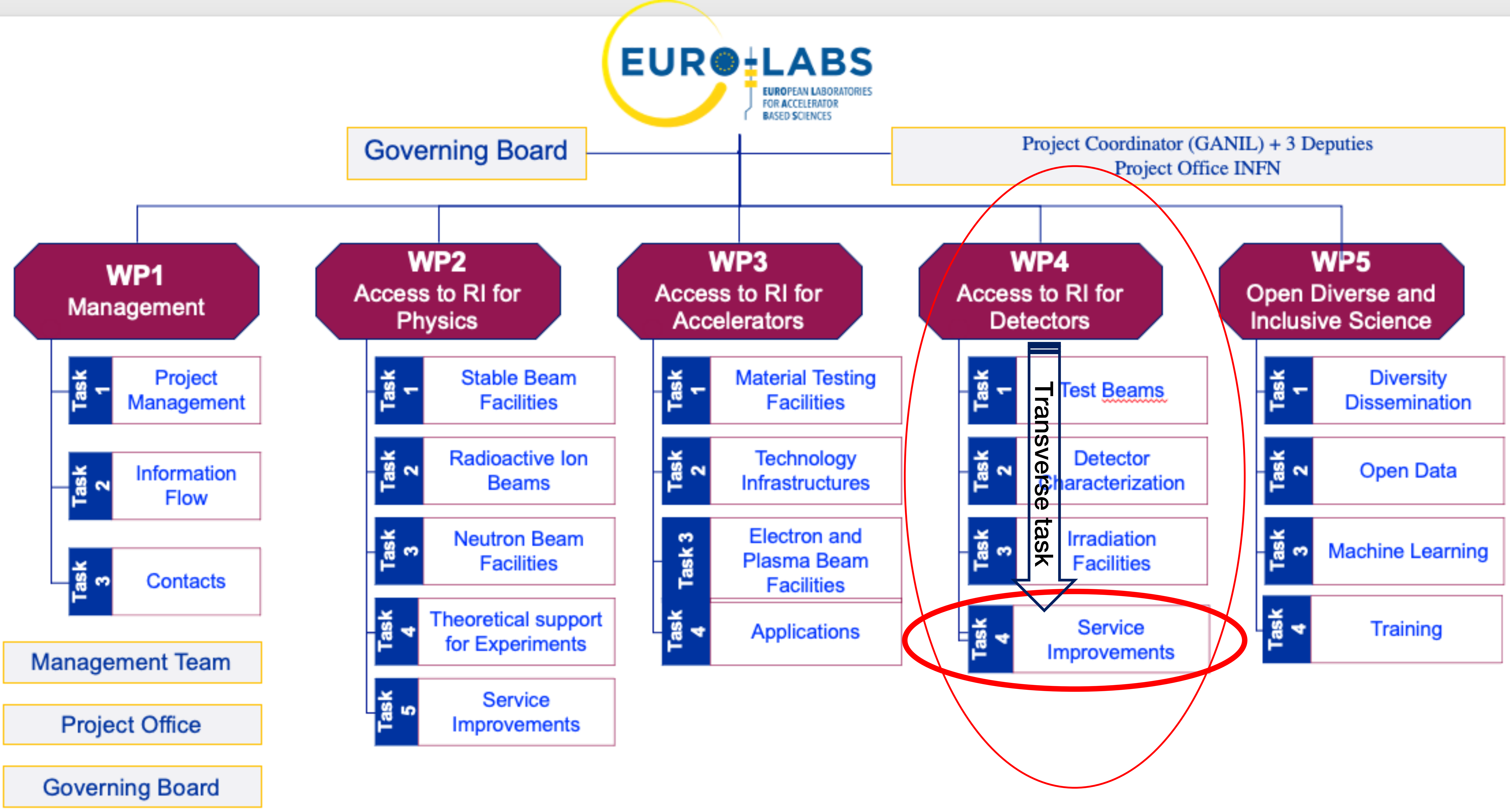
Task 4.4:Service Improvements to RIs in WP4



Task 4.4: Service Improvements

- Aimed at improving access to WP4 RIs for EURO-LABS
  - Each RI proposed improvements with maximum impact on user access
  - Improvements have to be ready in **Y2** of the project
  - EC contributions are matched by RI's own funding, typically exceeding EC
  - Supplemented by WP4 (!) of AIDAinnova

CERN TB, IRRAD & GIF++	Data base handling of beam time and irradiation requests
DESY Test Beams	Precision motion stages for large detector setups
PSI Test Beams	Beam monitor
RBI-AF	Ion beam focusing lens
ITAINNOVA	Cooling System and Graphical User Interface for EMC test station
CERN IRRAD	Beam profile monitor
JSI TRIGA	Cadmium shielding in the tangential channel
IFJ PAN AIC-144	2-D scanning table for irradiation
UCL CRC	Test chamber for the heavy ion irradiation facility
UoB MC40	Scanning system upgrade for high fluence delivery

Task 4.4: Milestones

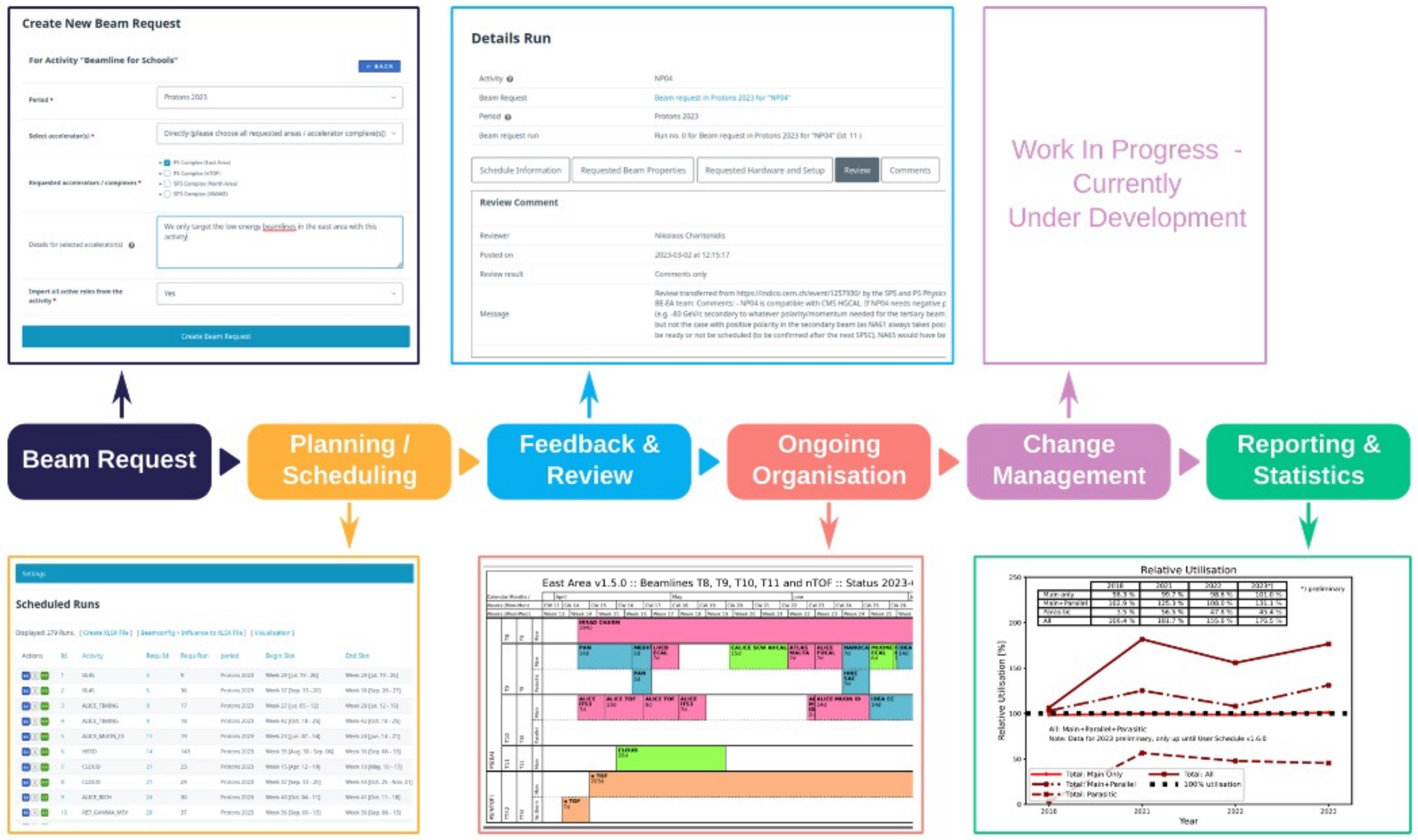
Improvements have to be ready in Y2 of the project

- All milestones in P1 and P2

MS24	4.4.1	Development and test of the first prototype of the system	31 Aug 2023	JSI	Report on prototype functionality
MS25	4.4.3	Prototype and software ready for lab tests	31 Oct 2023	JSI	Documentation on software and prototype
MS26	4.4.4	Electrostatic Microprobe Quadrupole Quadruplet Lens Assembly installed and tested	31 Dec 2023	JSI	Installation report
MS27	4.4.5	Cooling system developed	29 Feb 2024	JSI	Documentation on cooling system
MS28	4.4.6	Upgrade BPM DAQ	31 Aug 2023	JSI	Demonstration of BPM DAQ
MS29	4.4.6	ML-based classification and evaluation of the beam profile patterns	31 Aug 2024	JSI	Report on ML classification results
MS30	4.4.7	Design of the shielding system including safety related aspects	31 Oct 2023	JSI	Design and safety documentation
MS31	4.4.8	Design of the XY table and purchase of materials and equipment for the device	29 Feb 2024	JSI	Design documentation
MS32	4.4.9	Design and commissioning of the beam line (vacuum and test chamber)	31 Aug 2023	JSI	Report on design and commissioning
MS33	4.4.10	Mechanics of the setup adapted to fit into the experimental area	31 Aug 2024	JSI	Design documentation

4.4.1 Data Base Handling of Beam Time and Irradiation Requests

- CERN: PS&SPS, IRRAD and GIF++ (WP4.1.1, 4.3.1 & 4.3.2)



Objective:
Design, develop & deploy a data base driven tool to improve the handling of beam time requests and management of user schedules

Significant activities and achievements:

- Implementation of first version completed, beam requests & user schedules for 2023 and PS & SPS testbeam users at CERN already handled using new tool
- Modular design; first module allowing reuse in existing software tools for Irradiation requests developed & tested
- Milestone report MS 2.4 submitted in time (August 31st 2023) => all objectives for first 12 months achieved ahead of time, ongoing developments reported.

Next Steps, Ongoing Developments:

- Update data model using the lessons learned during 2023
- Preparation for PS & SPS beam requests 2024
- Explore potential for code sharing & reuse with other tools
- Work towards feature completeness

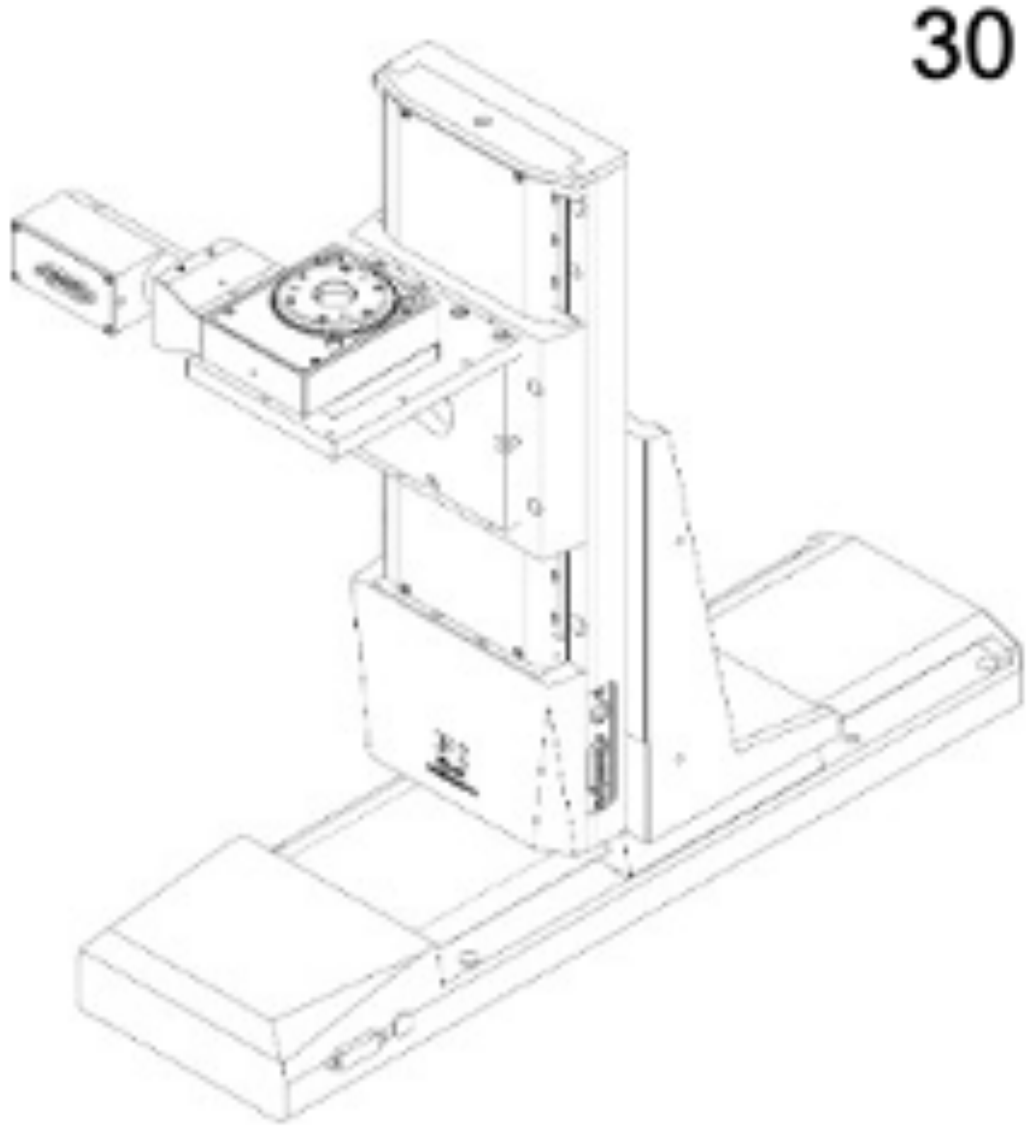
4.4.2 Longer-range motion stages

- Used for mounting DUTs in beam telescope setup
- DESY: WP4.1.2

.Our standard setup:

.Combination of two PI linear stages for movements in x and y

- Max. specified load: 8 kg
- Accuracy: < 1 um
- Travel ranges:
- 10 (M-511) or 20 cm (M-521)



.Need for larger range of motion for scans of large-scale DUTs (e.g. strip petals) in telescope setup expressed by several groups

.Our standard model is also available with 30 cm range (M-531)

- Already replaced a broken one with an M-531

The second stage arrived in October

➢ 13 months lead time !

- Installation and commissioning on the way

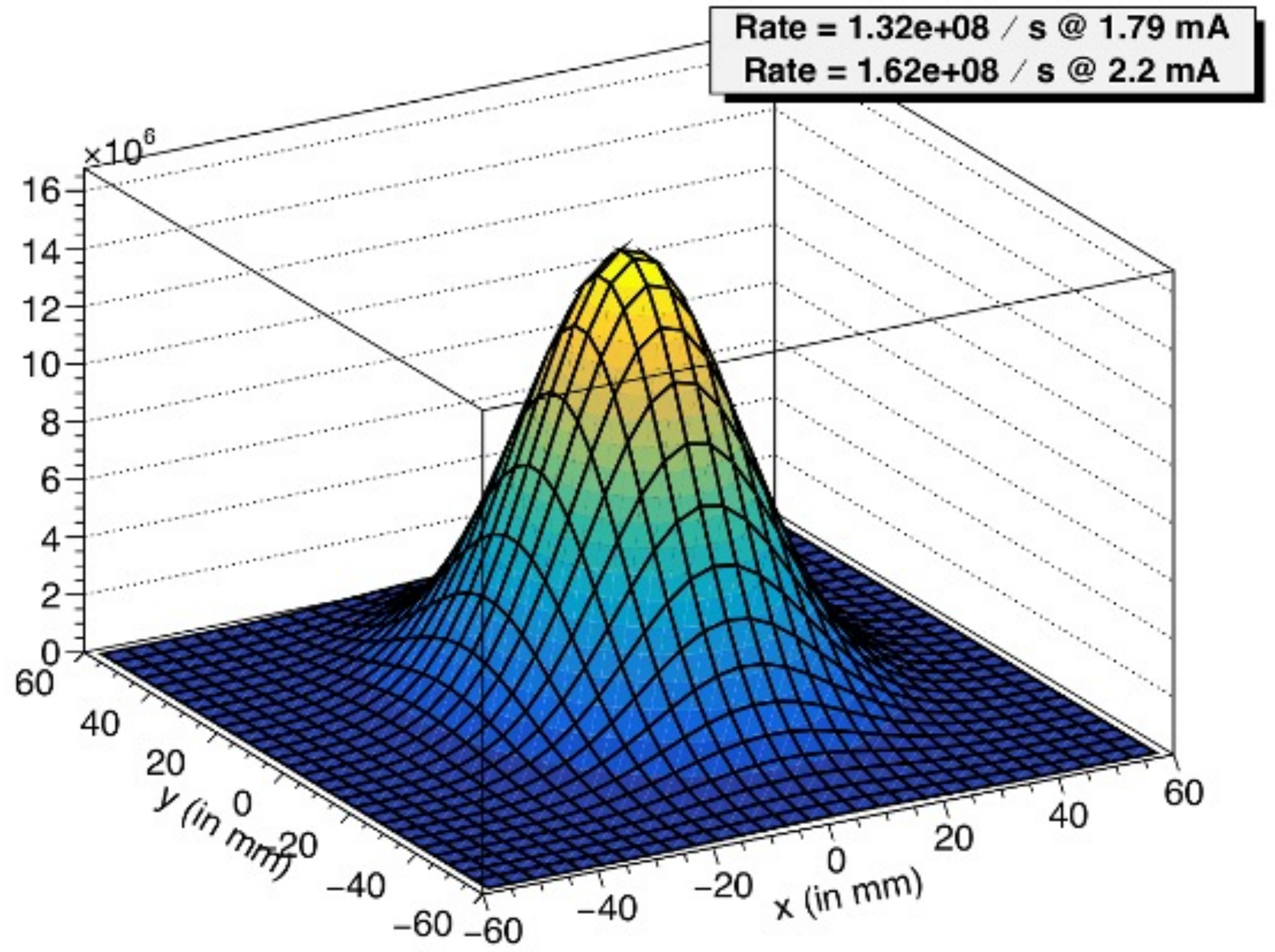
✓ SI finished well before M24

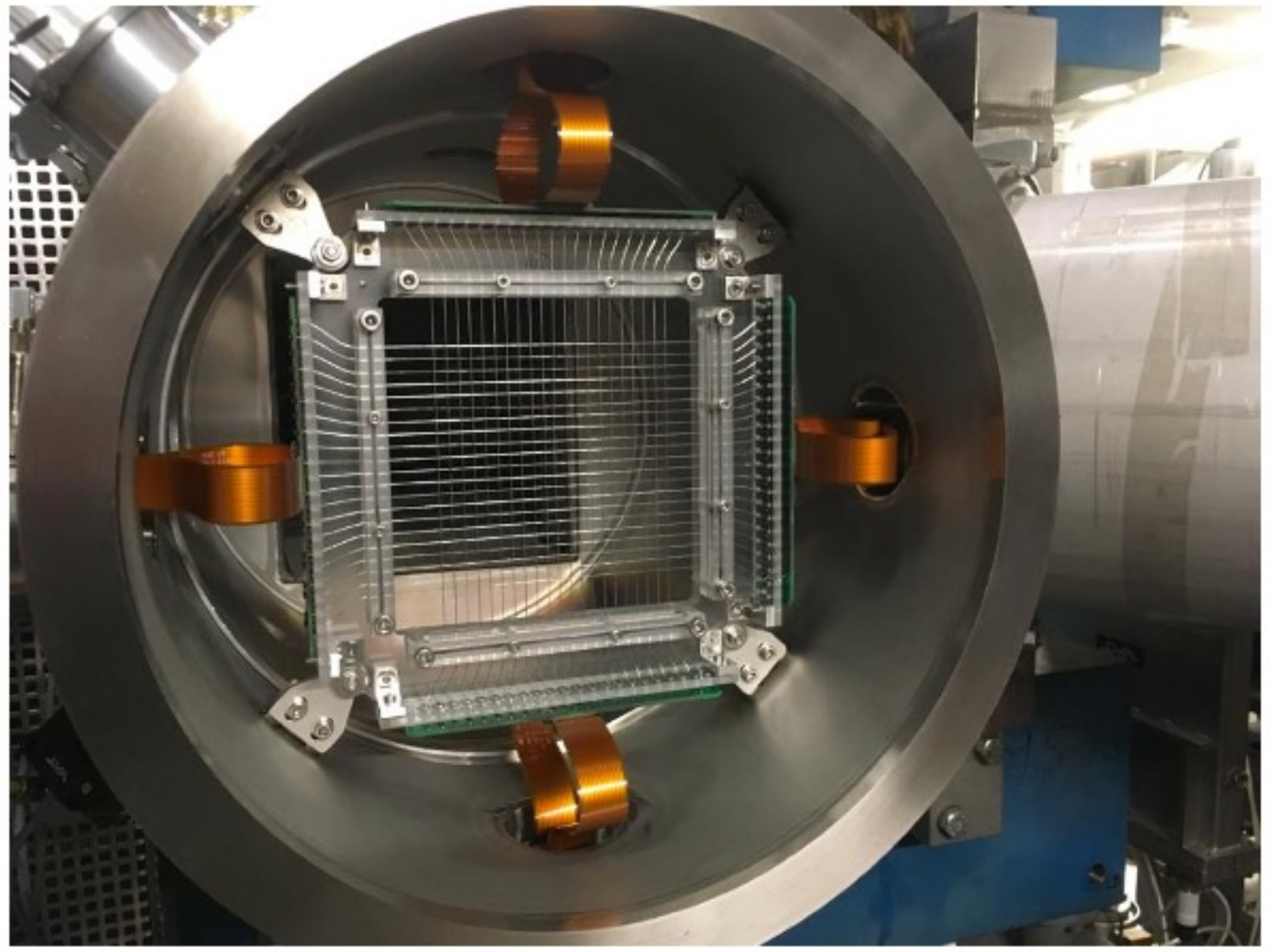
4.4.3: Scintillating Fiber Beam Profile Monitor

• PSI: WP4.1.3

PSI – PiM1 – ScFi-Beam Monitor

- Monitor for beam diagnostics
  - Profile
  - Rate
  - Composition
    - Low energy particles («surface muons»): dE/dx
    - High (decay in flight): TOF
- 2 Layers of 21 fibres (X,Y)pitch 5mm, length 200mm
- Fibres: Saint Gobain Double cladding square 500 um
- Photosensors: Hamamatsu MPPC S13360-1350CS
- DAQ + TRG: Wavedream + “OR” of all “AND” from SiPM on the same fibre
- Status:
  - 1st prototype tested in air (PiM5, 28 MeV/c positive Muons)
  - 2nd prototype for operation in Vacuum in construction
  - Final system on movable stage in design process



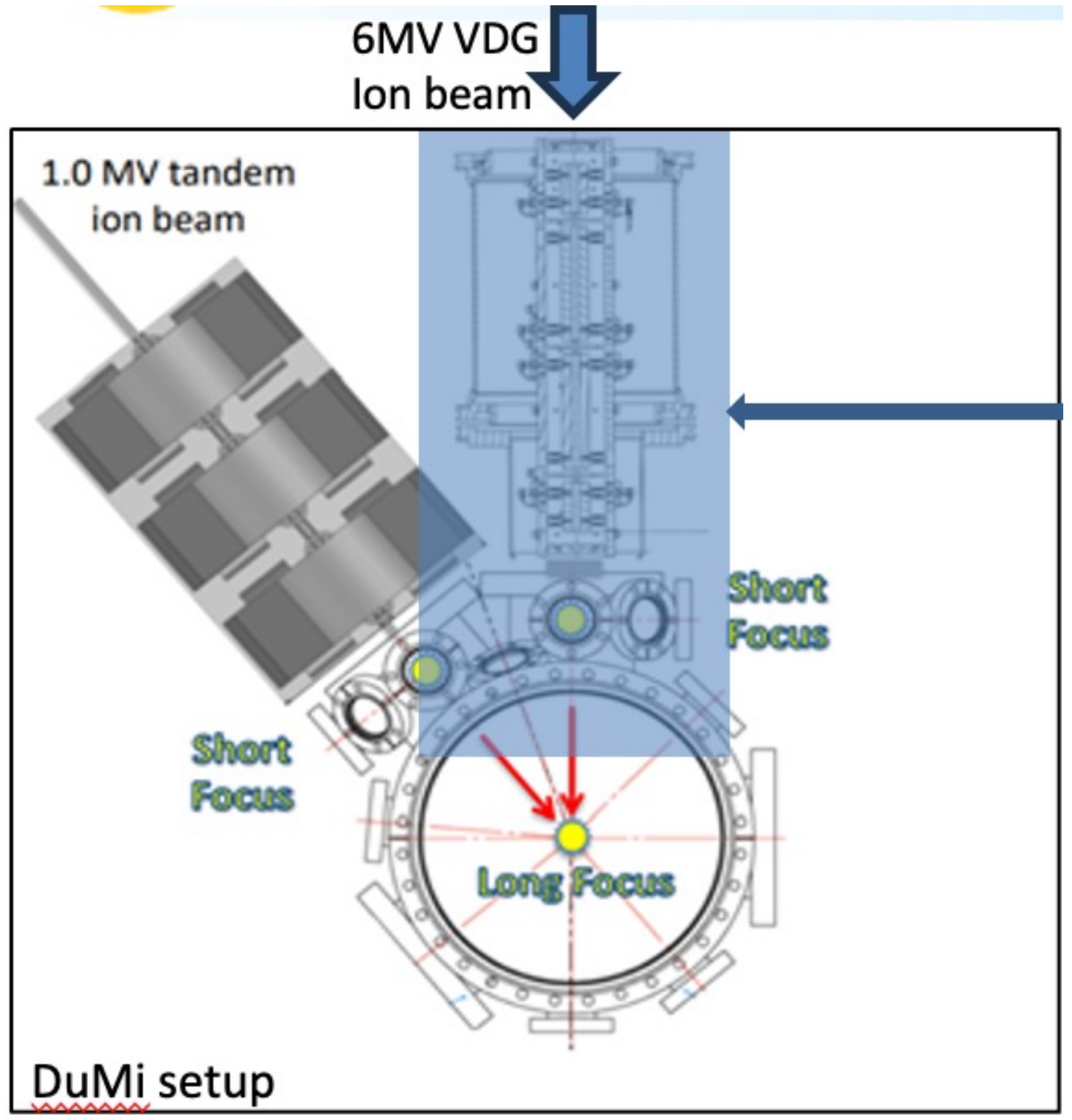


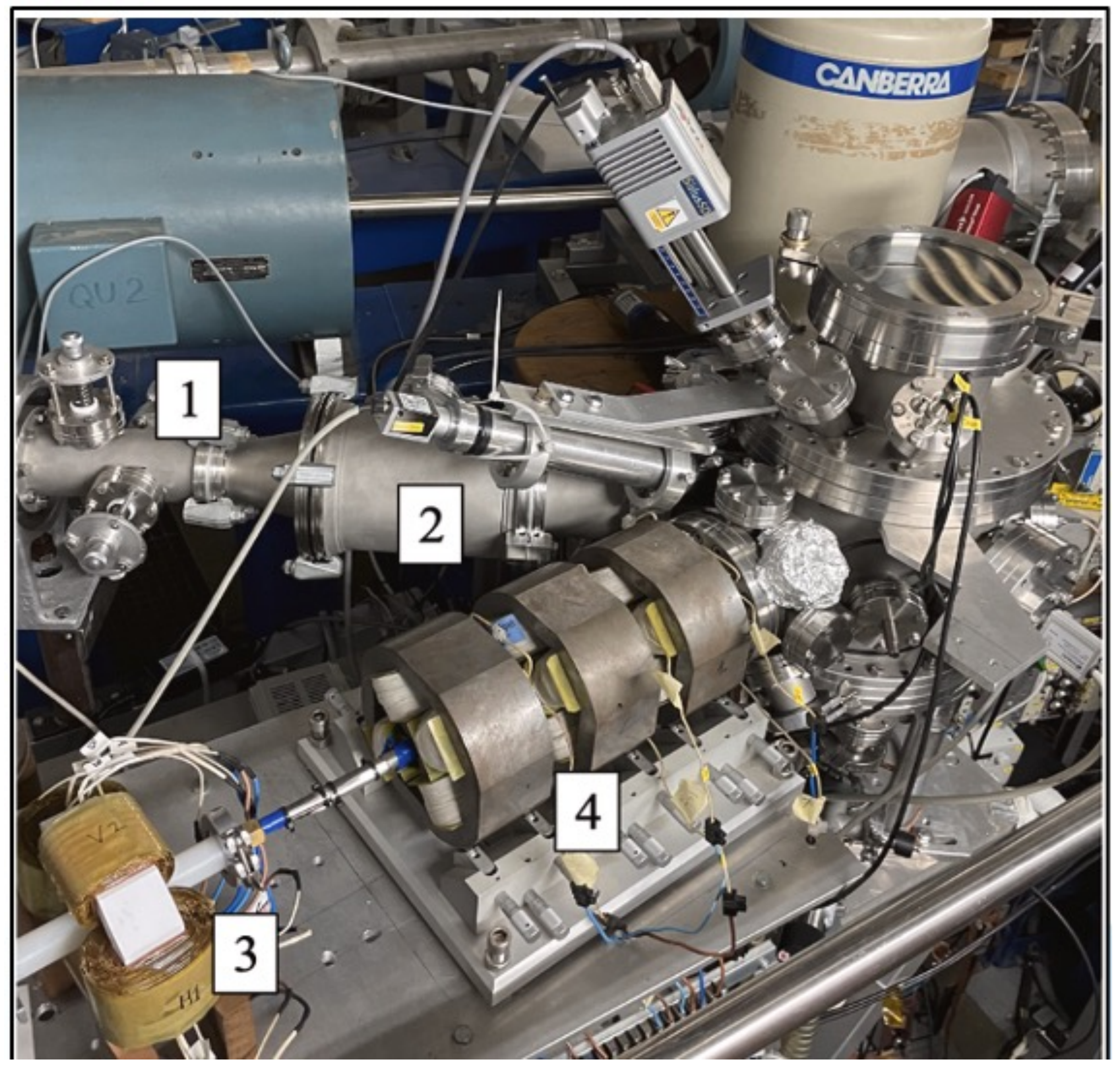
MS25 due end October!

4.4.4: Improvements of the dual microbeam (DuMi)

- Detector testing at RBI: WP4.2.2

- <u>Objective:</u> To enable ion beam focusing with light and heavy ions from the second beam-line at the RBI-AF dual microprobe end-station.
- <u>Significant activities and achievements:</u>
- - The Electrostatic Lens Assembly purchased just before the project start have been installed, alinged and tested. The beam resolution of 7.4 and 15 mm was obtained for low/high beam currents.
- - Related electrostatic beam deflector/scanner has been developed and installed. The scanner control is incorporated in the local SPECTOR data acquisition sofware. First tests have been carried out with 2 MeV proton beam. Tests with heavy ions will follow.
- - Milstone report MS26 '*Electrostatic Microprobe Quadrupole Quadruplet Lens Assembly installed and tested*' will be delivered as planned, i.e. By 31st December 2023.

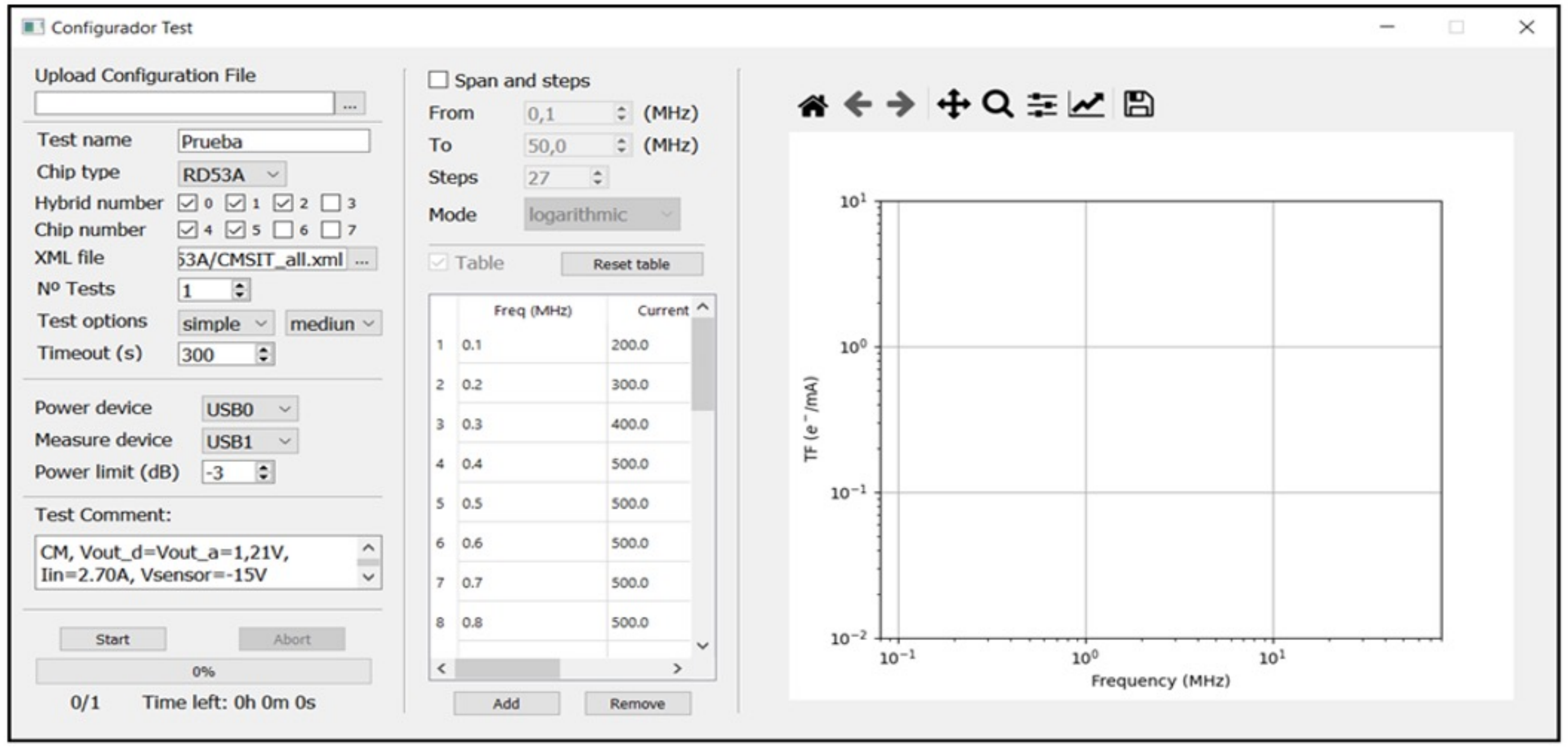




4.4.5: Cooling System and GUI for EMC test station

ITAINNOVa: WP4.2.1

- Two activities focused on the improvement of the TF measurement system have been planned for the project
  - ➢ The development of user-friendly graphical user interface (GUI) to configure, run tests, and visualize results efficiently
  - ➢ To Implement a cooling system with detailed temperature control
- During the first year of the project the activity has focused on the development of Graphical User Interface.
  - ➢ GUI is completed and totally operational.
- Now the activity has start to focused on the cooling system development.



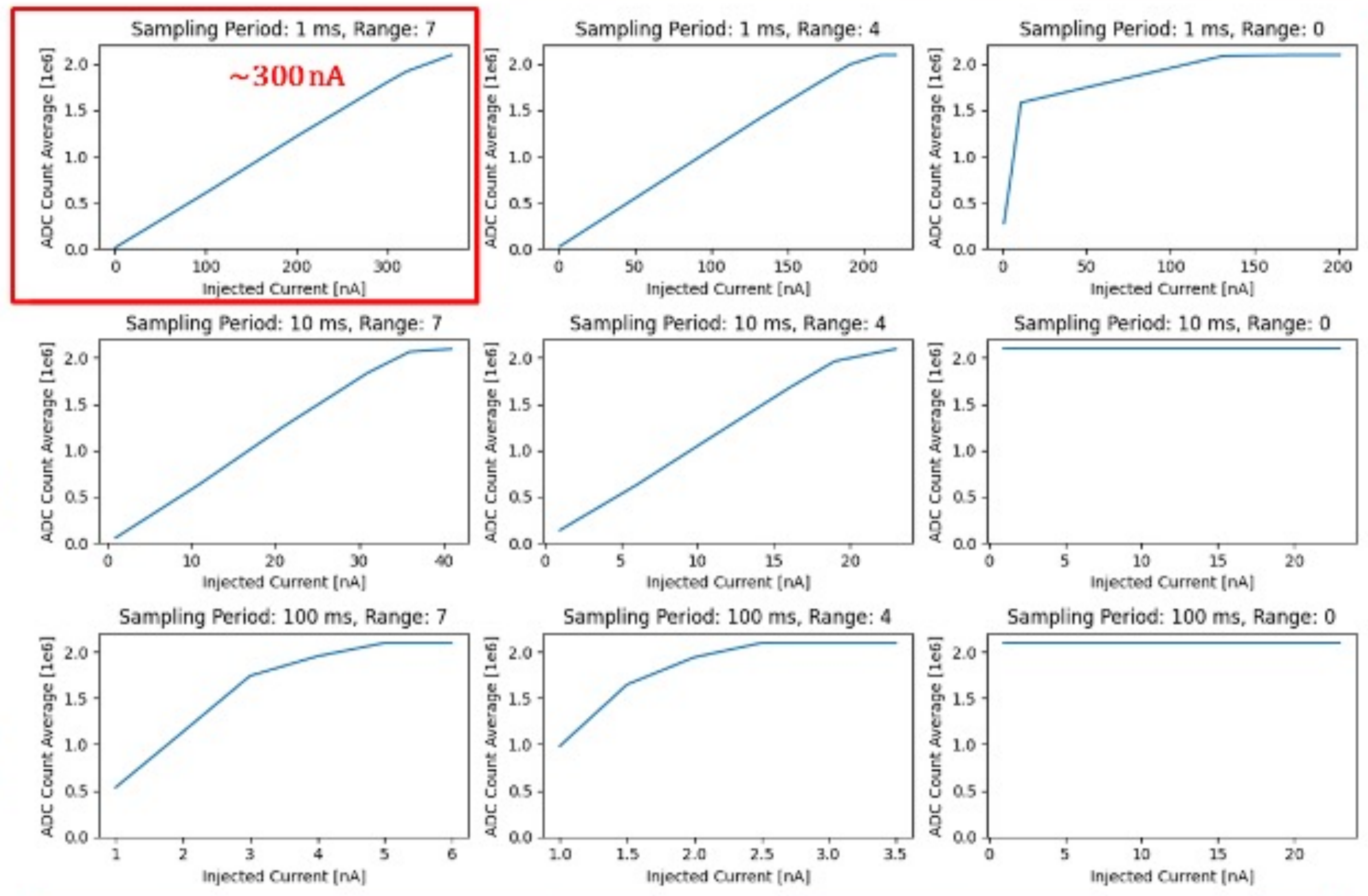
- The GUI consists of two main areas: test parameter configuration and result display.
  - ➢ The configuration area streamlines test setup by allowing the loading of existing configuration files or parameter definition
  - ➢ The results display area features a graph showcasing the TF of selected test, offering tools for customization and data export

WP4.4.6: IRRAD Beam Profile Monitor Improvement

• CERN IRRAD: WP4.3.1

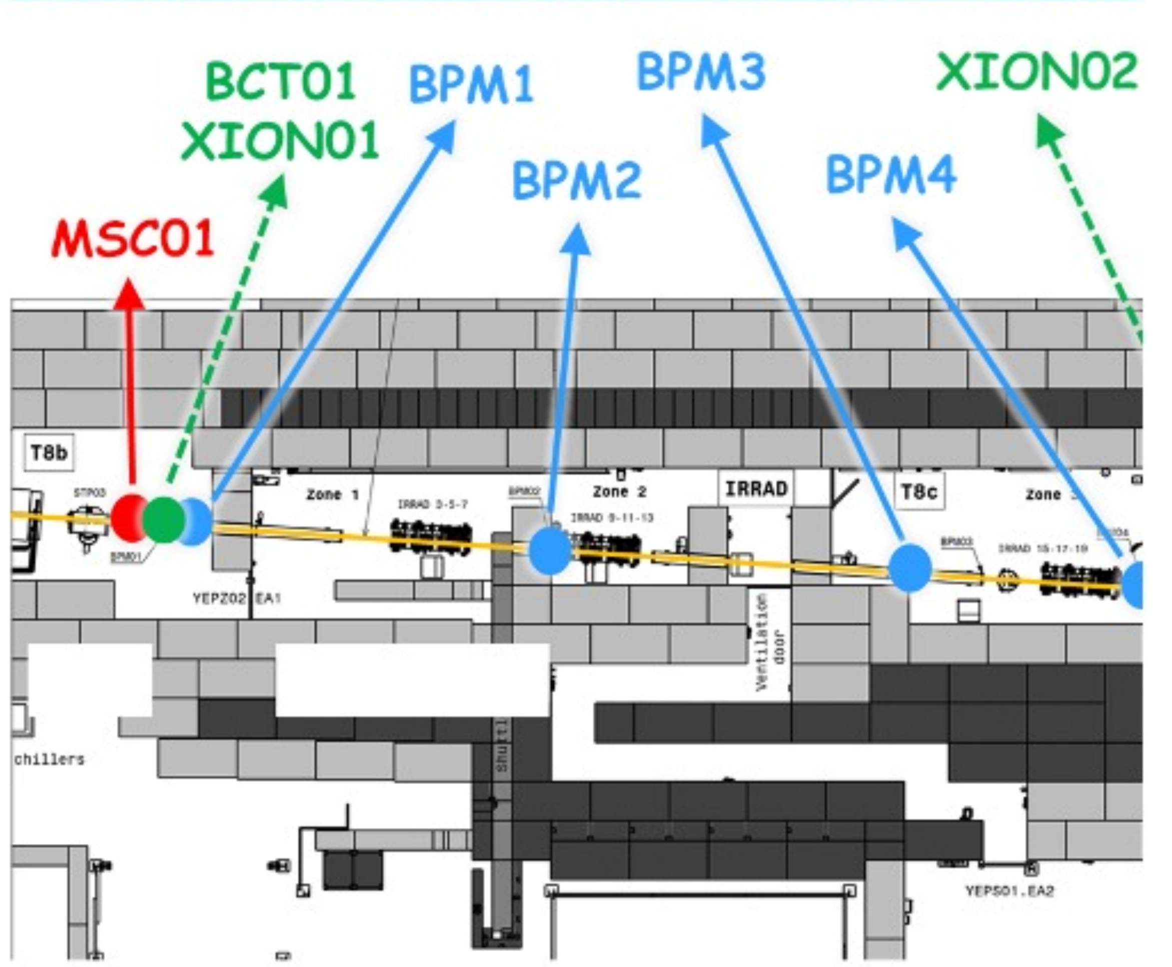
- **IRRAD-BPM sensors improved:**
  - 4 large- & several small-pattern sensors used for beam quality check (blue location in the picture)
  - Manufacturing technology: nano-layers microfabrication
    - ✓ Less invasive, higher radiation hardness, etc.
- **Now improving DAQ & data analysis:**
  - Present DAQ has several limitations:
    - ✓ 20ms sampling-time
    - ✓ limited number of channels and dynamic range
    - ✓ longitudinal profile available for one channel only
    - ✓ etc.
  - To cope with new operational requirements: ~<1ms sampling-time, new sensor technology (larger dynamic-range), more scalable (data bus), suitable for proton & ion beams, etc.
- **Development of new DAQ prototype:**
  - Evolve into full instrument (IRRAD & EU-facilities): MS28 ACHIEVED!
  - Improve data analysis & display (ML-techniques): MS29 ONGOING [M24]

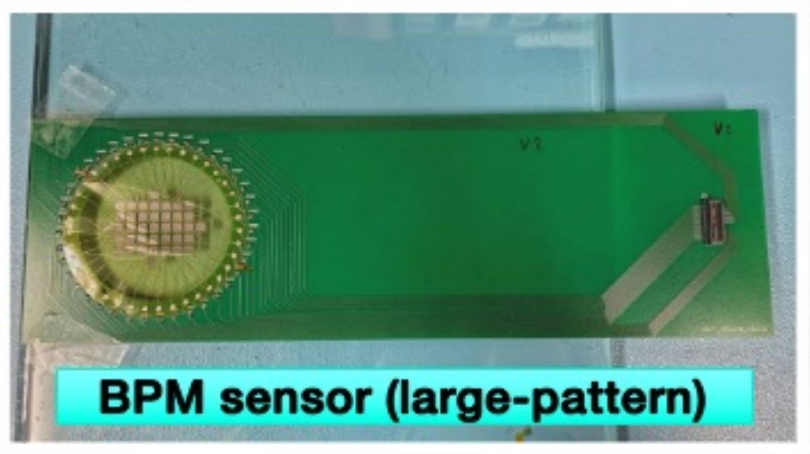
S. Maiorano, MSc Thesis, https://cds.cern.ch/record/2867817, 2023.



DAQ system linearity & dynamic range (measurements)

Location of the BPM sensors in the IRRAD Facility





BPM sensor (large-pattern)


EURO-LABS

Grant Agreement No: 101057511

EURO-LABS

EURopean Laboratories for Accelerator Based Science

MILESTONE REPORT

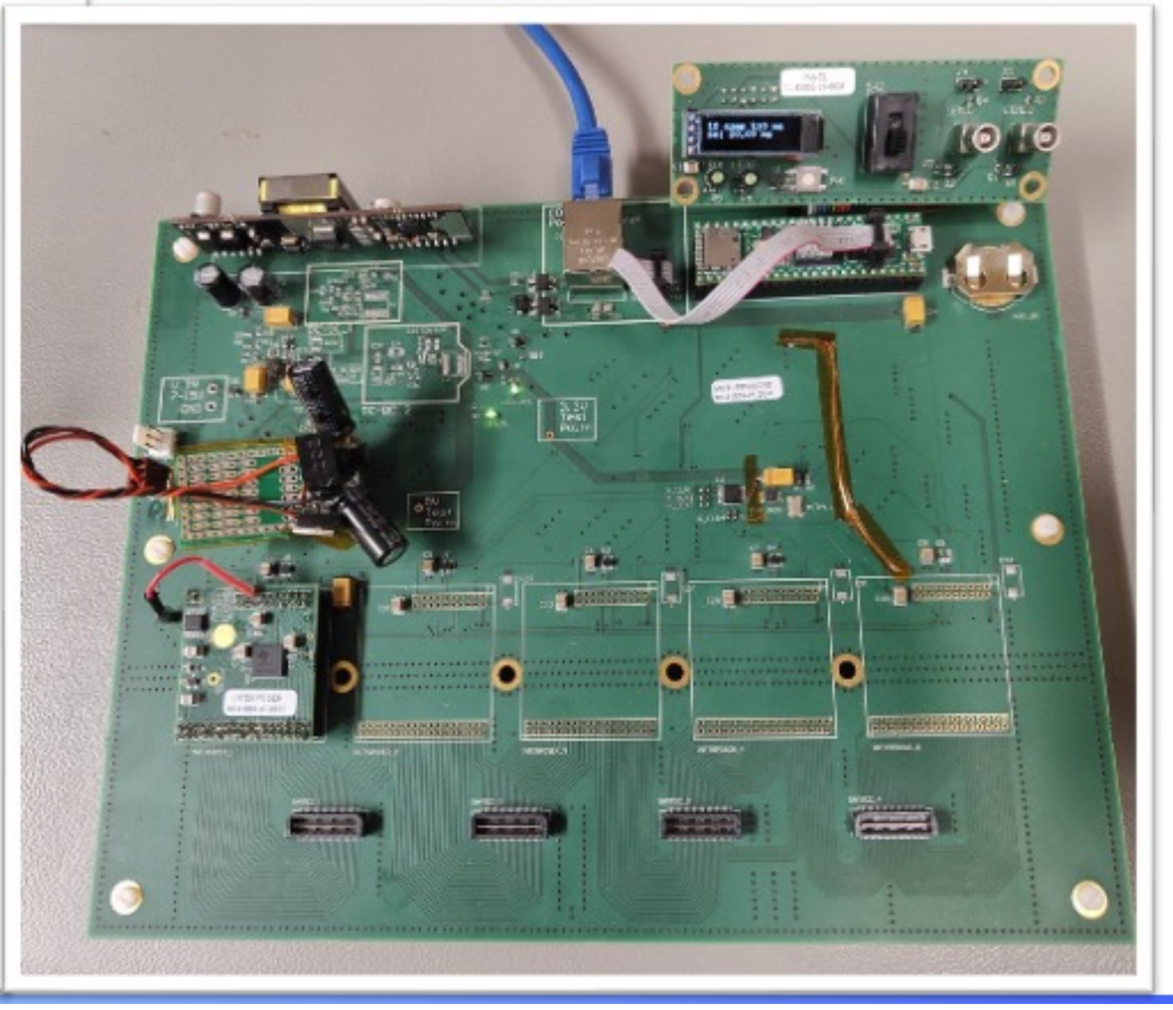
UPGRADE OF IRRAD BPM DAQ

MILESTONE: MS28

Document identifier:	EURO-LABS MS28 BPM electronics final.docx
Due date of milestone:	End of Month 12 (August 2023)
Report release date:	24/08/2023
Work package:	WP4 [Access to Research Infrastructures for Detectors]
Lead beneficiary:	JSI
Document status:	Final

Abstract:

Full integrated DAQ system (160ch)

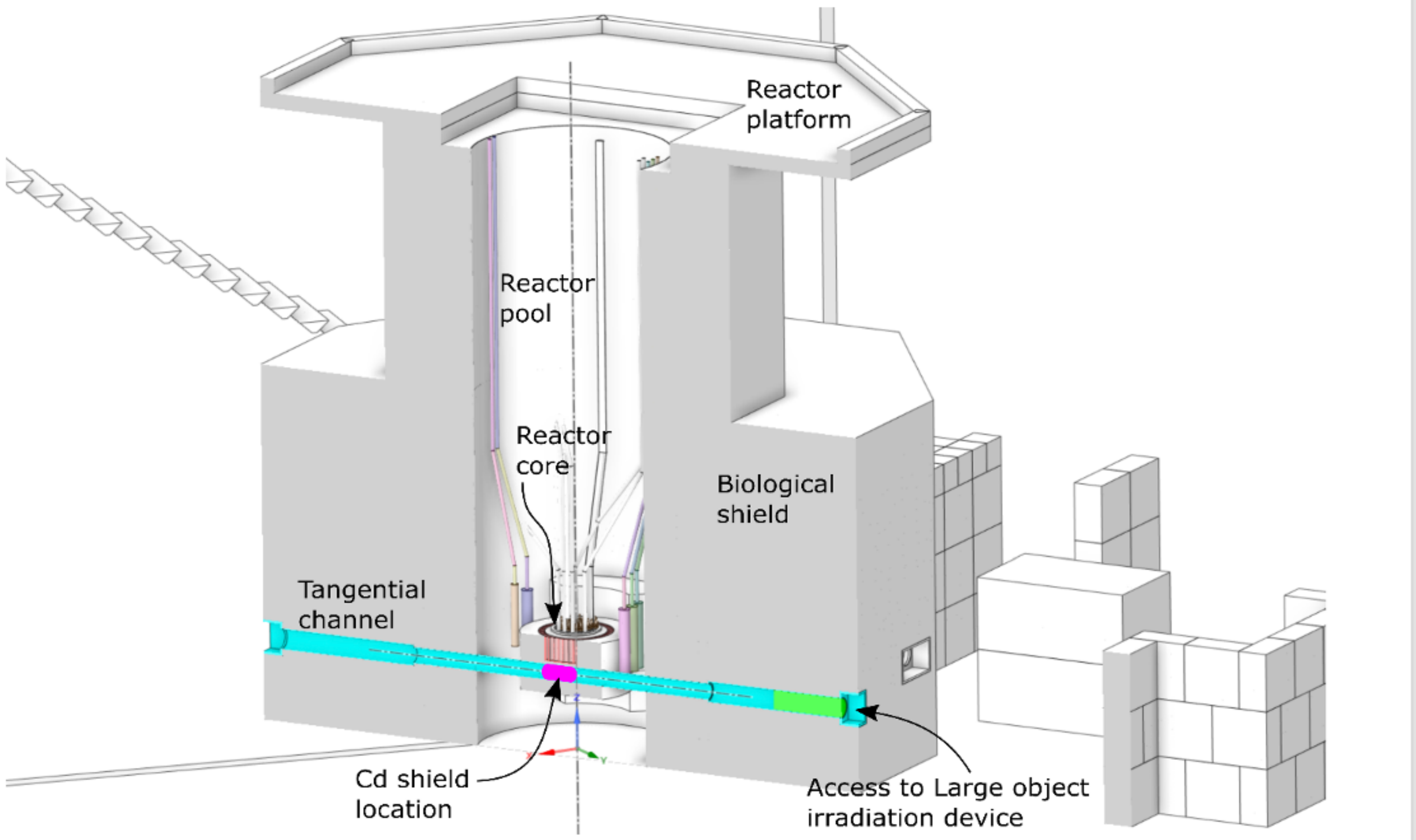


4.4.7: Cd Shielding in the Tangential Channel

JSI: WP4.3.3

Requirements

- Reduction of thermal neutron flux (sample material activation), low effect on epithermal and fast neutron flux (radiation damage)
- Low impact on normal reactor operation (reactivity, dose rates)



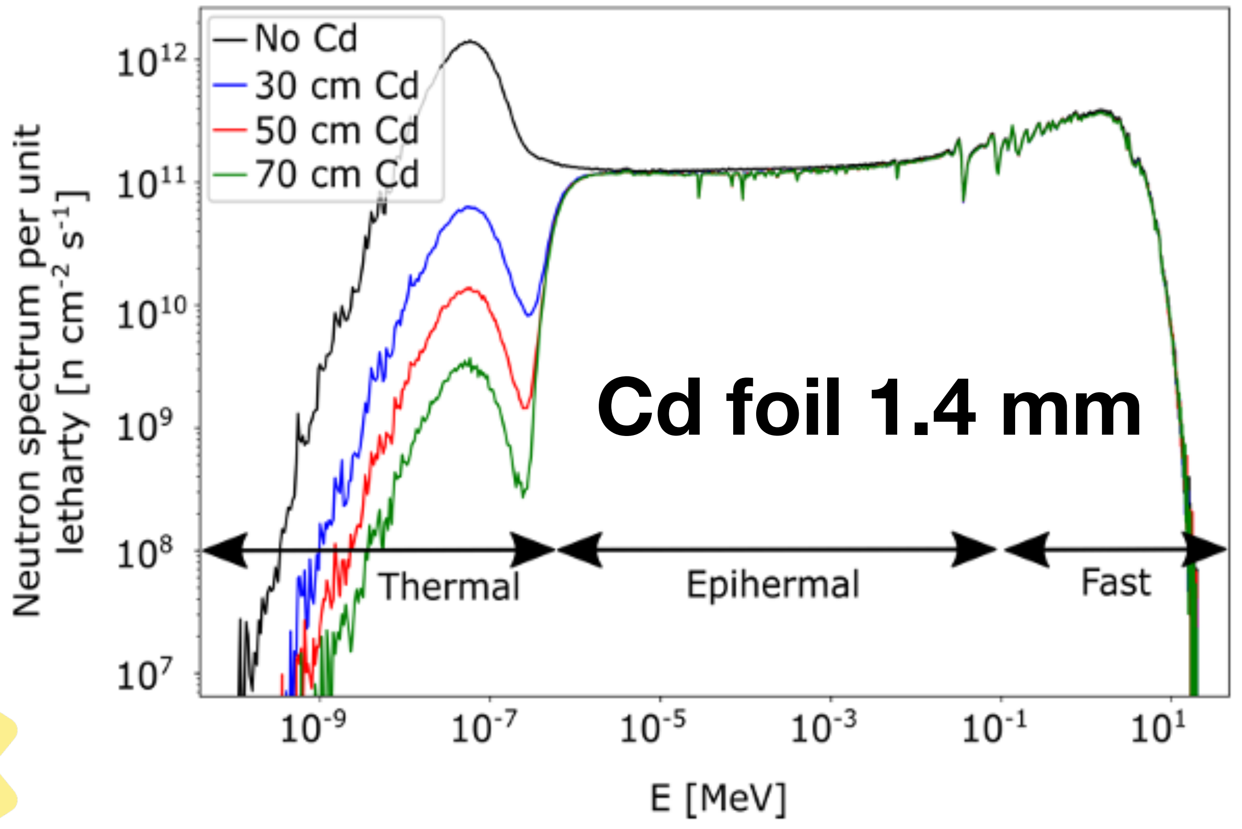
Monte Carlo calculations

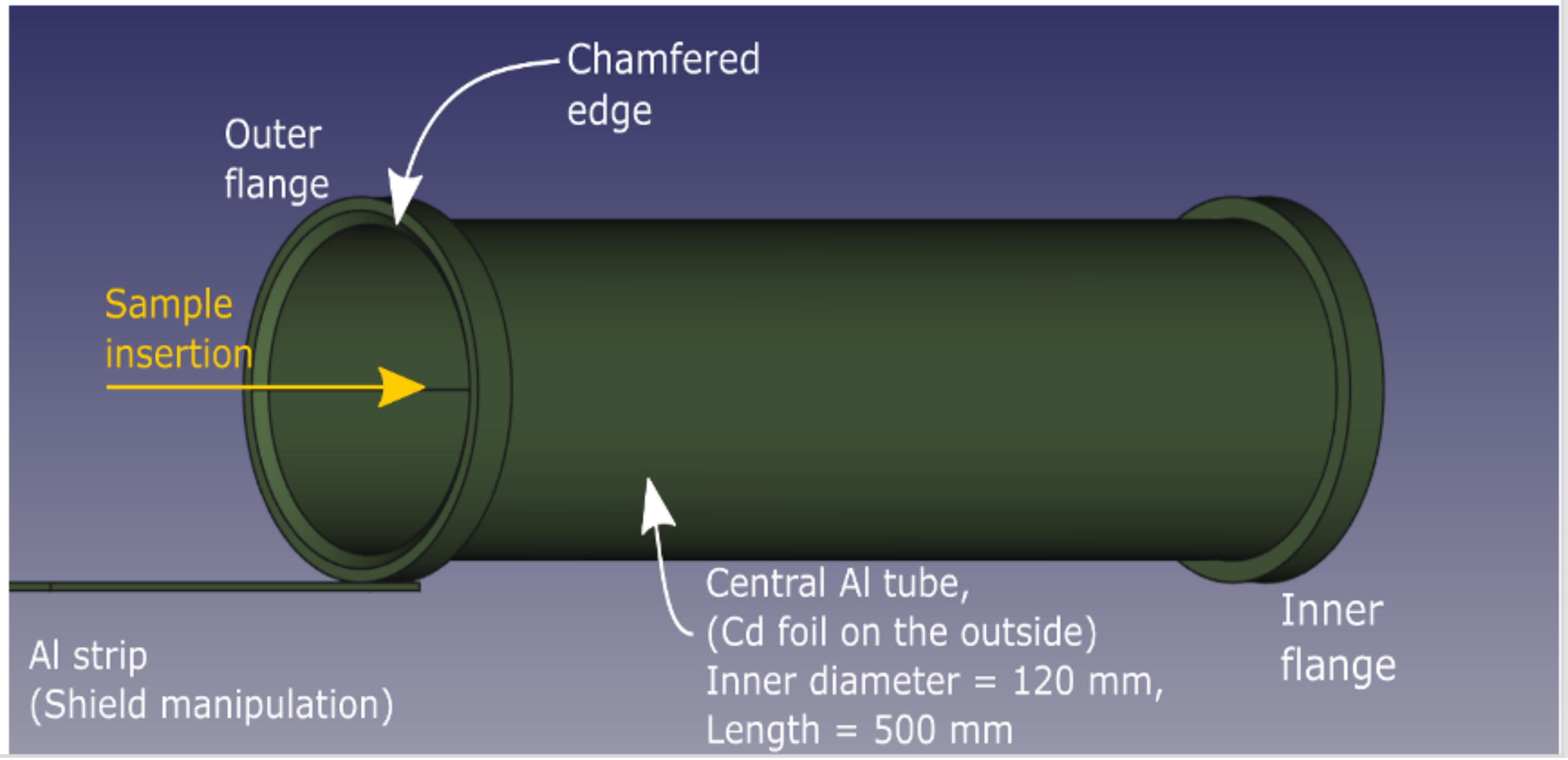
- Flux levels and spectra
- Reactivity effect
- Cd shield activation

Shield design

- Al open tube, Cd foil on the outside
- Length = 50 cm, interior diameter = 12 cm
- Two shield positions
  - Centered on core (in use)
  - Partially withdrawn (cooling)

MS30 due end October!



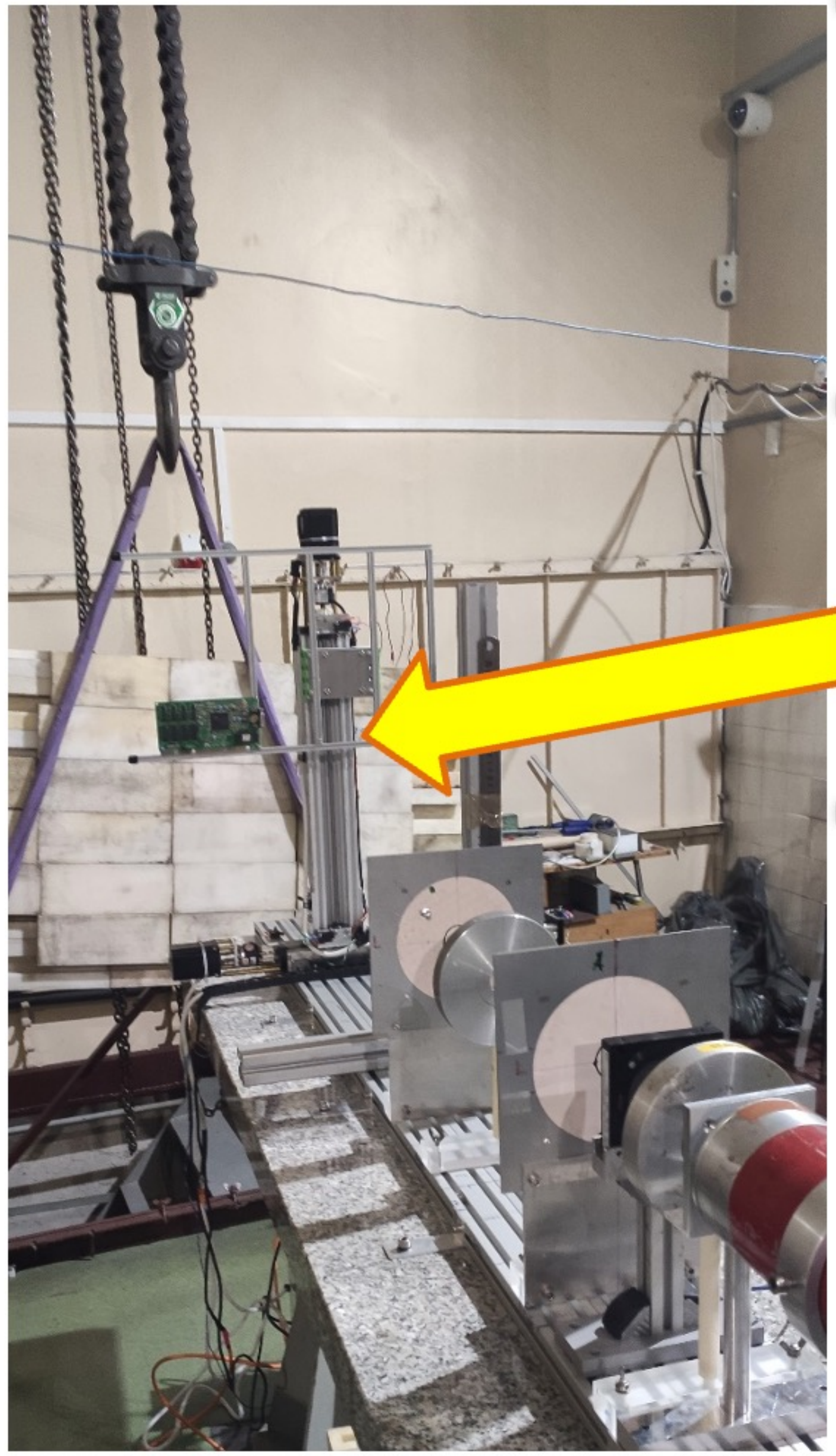


4.4.8: Improvements of the irradiation line at AIC-144

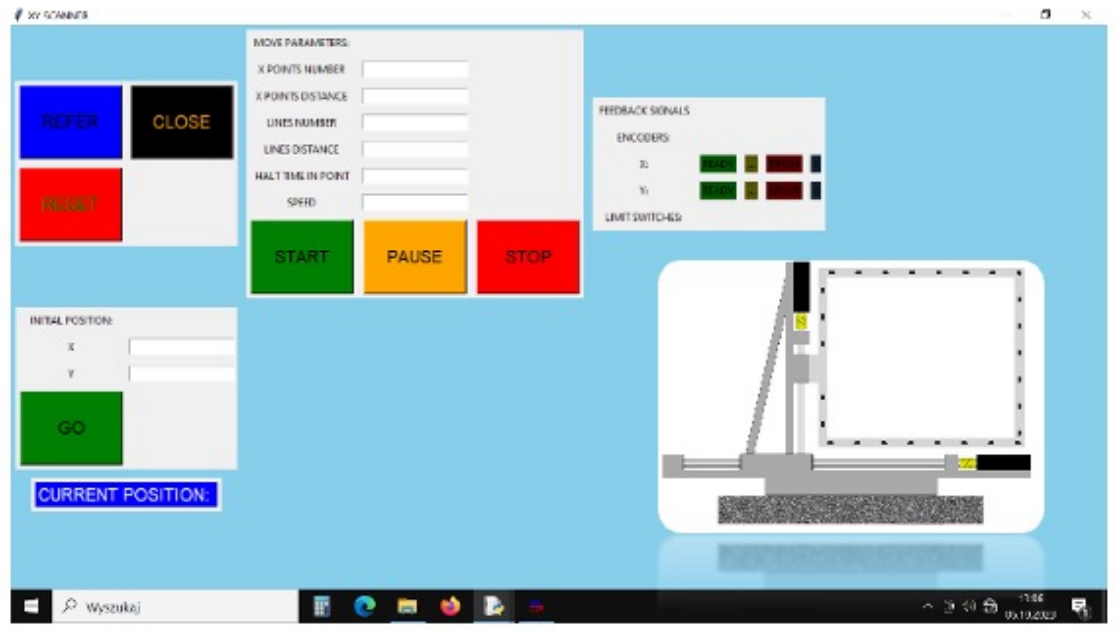
• IFJ-PAN: WP4.3.4

The automatic, remote controlled 2D moving table will be constructed to enable moving the probes perpendicular to beam's axis.

has been !

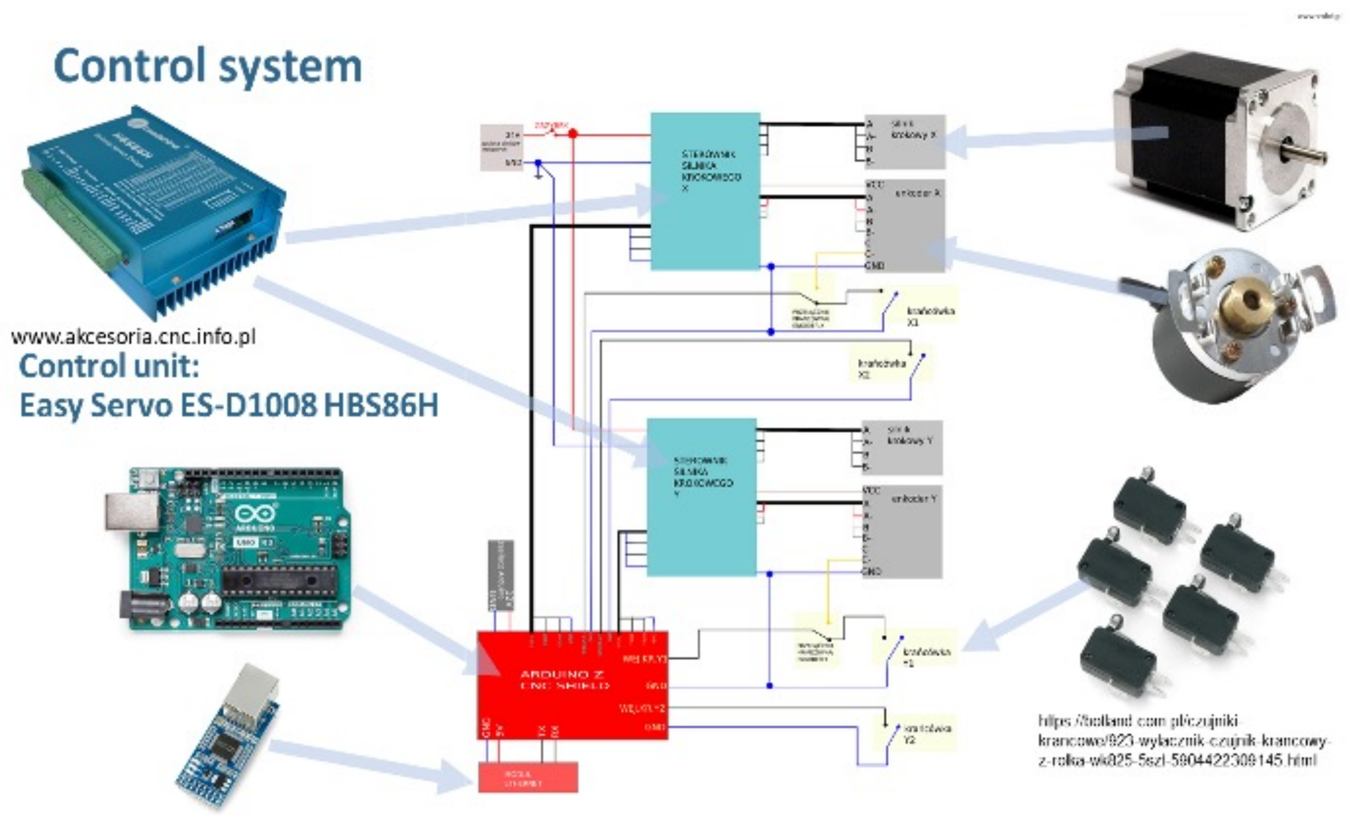


The user interface has been made in Python

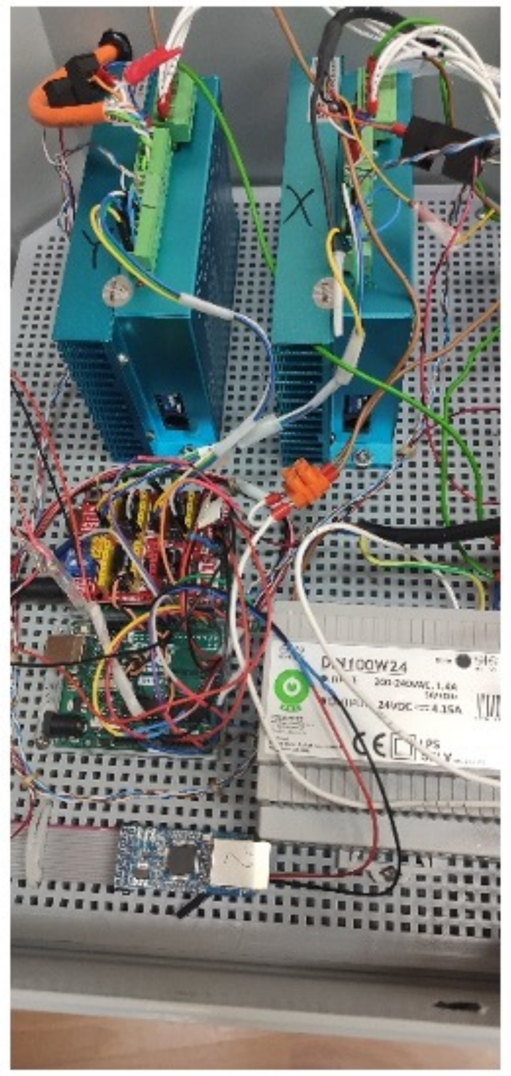


2D moving table control system

Control system

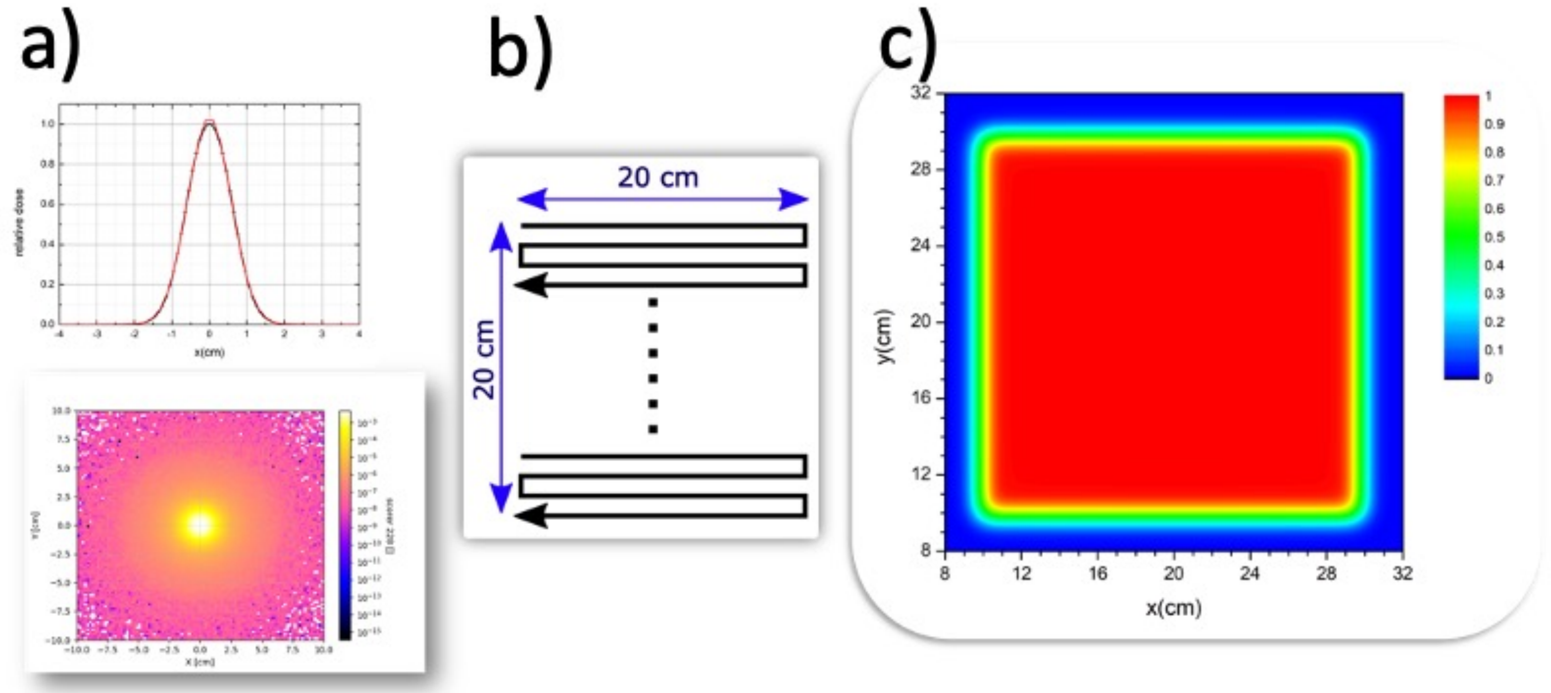


www.akcesoria.cnc.info.pl
Control unit:
Easy Servo ES-D1008 HBS86H



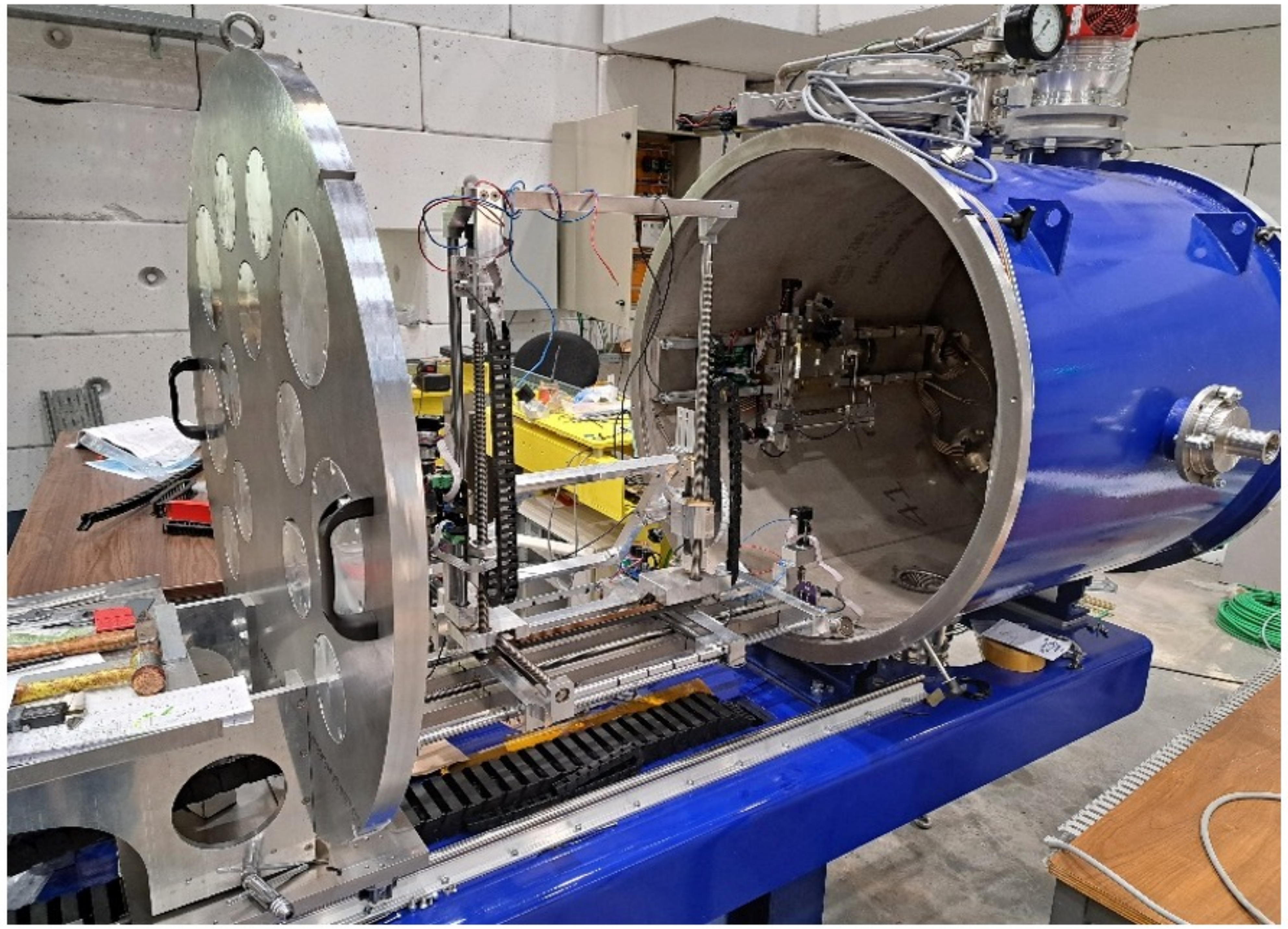
Simulation of radiation field with moving table:

a) 2D single beam dose distribution,
b) example of moving table scanning trajectory,
c) simulation of dose distribution with moving table



4.4.9: New test chamber for CRC-HIF

• CRC - Louvain-la-Neuve: WP4.3.5



- Feedtrhoughs
  - ✓ New SUB-D-25 for control installed: motors, cameras,...)
  - ✓ Large variety of connectors available (from old HIF)
  - ✓ New flanges to host new connectors available

✓ Beam transfer line from the cyclotron has been fully refurbished

✓ Vaccumm chamber and DUT positioning system installed

✓ New DAQ and control system (LabVIEW based) has been acquired and installed

✓ New vaccum system installed: pumps, sensors and control.

- Dosimetry:
  - ✓ New PPAC in beam installed.
  - ✓ PIPS detectors: flux measurement @DUT
  - ✗ End of line scintillators, ordered.

✗ Commissioning

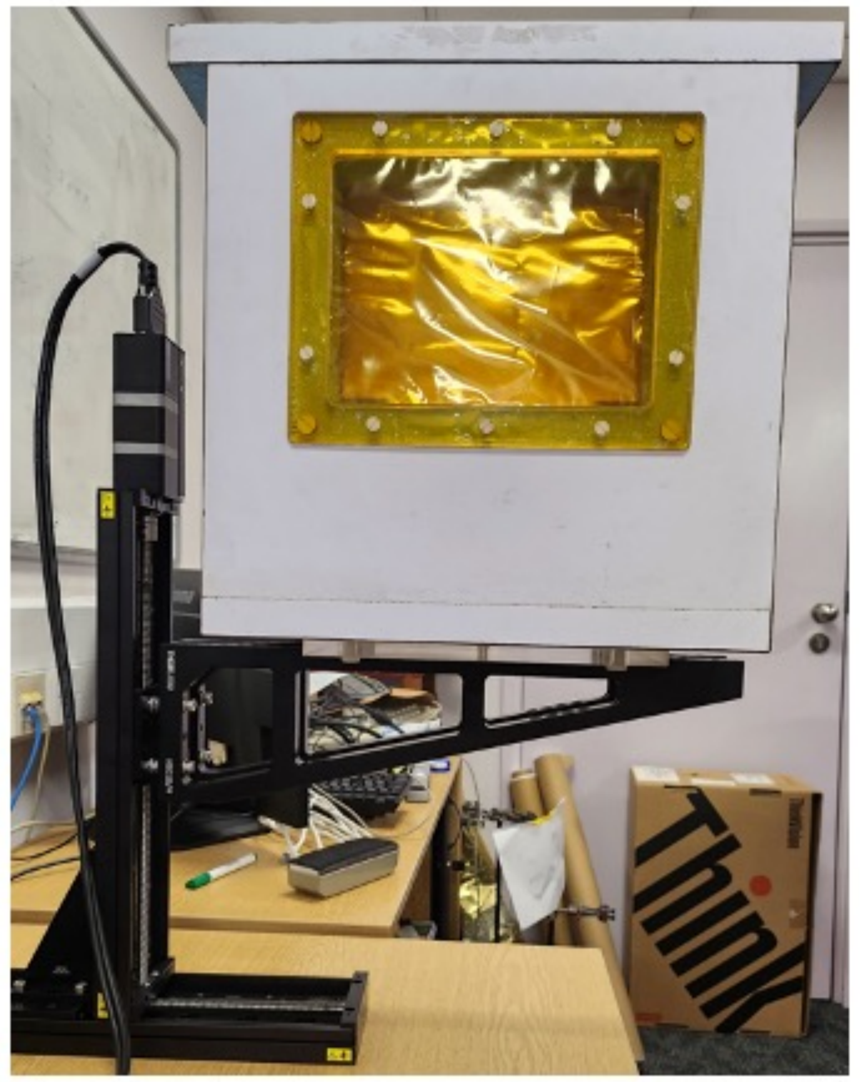
MS32 achieved in time !

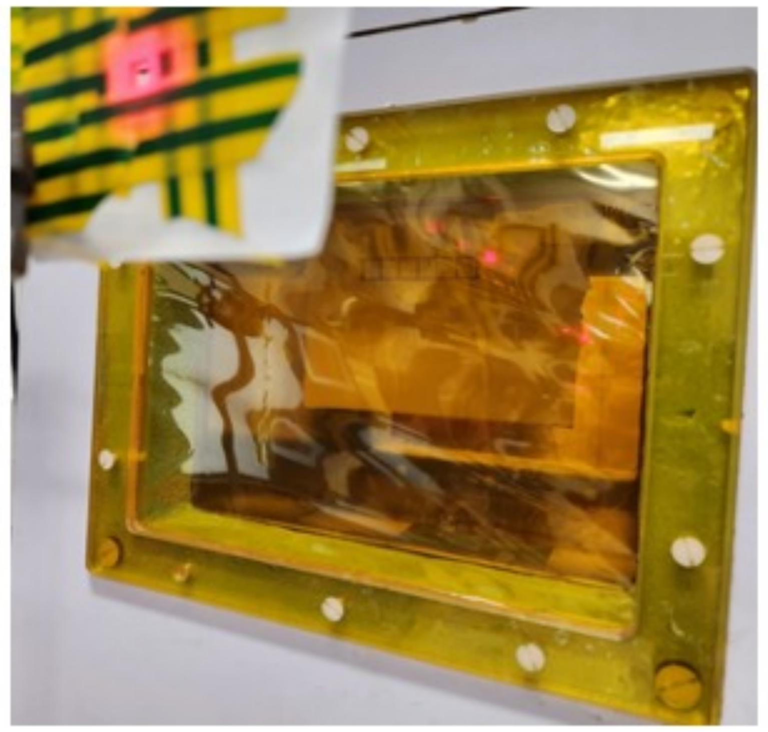
4.4.10: Scanning system upgrade for high fluence delivery

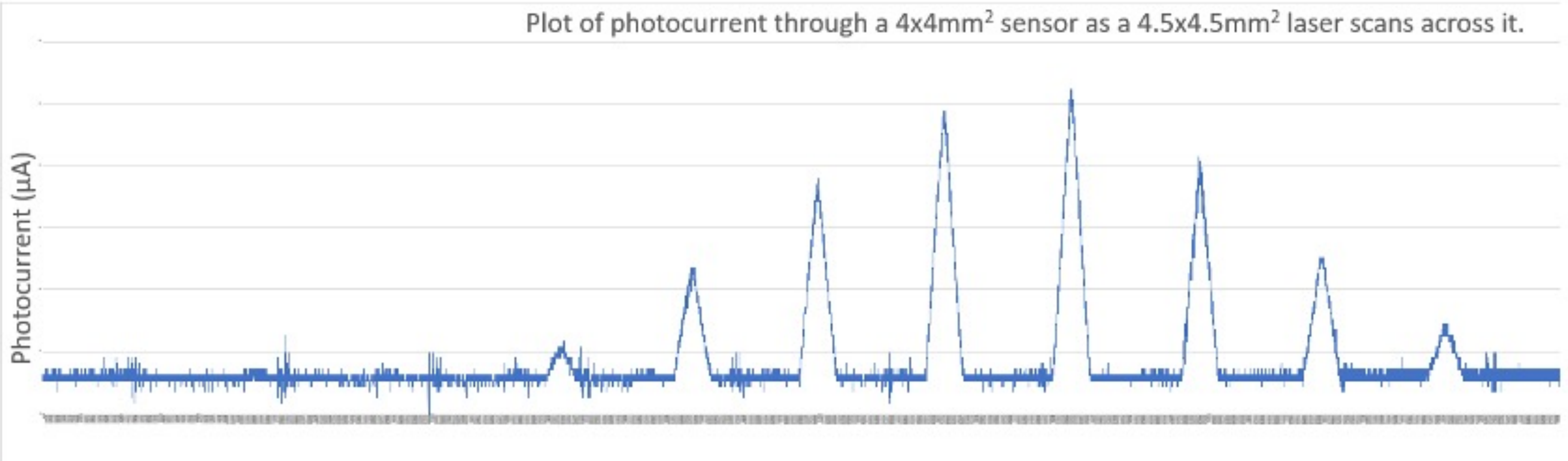
- UoB MC40: WP4.3.4

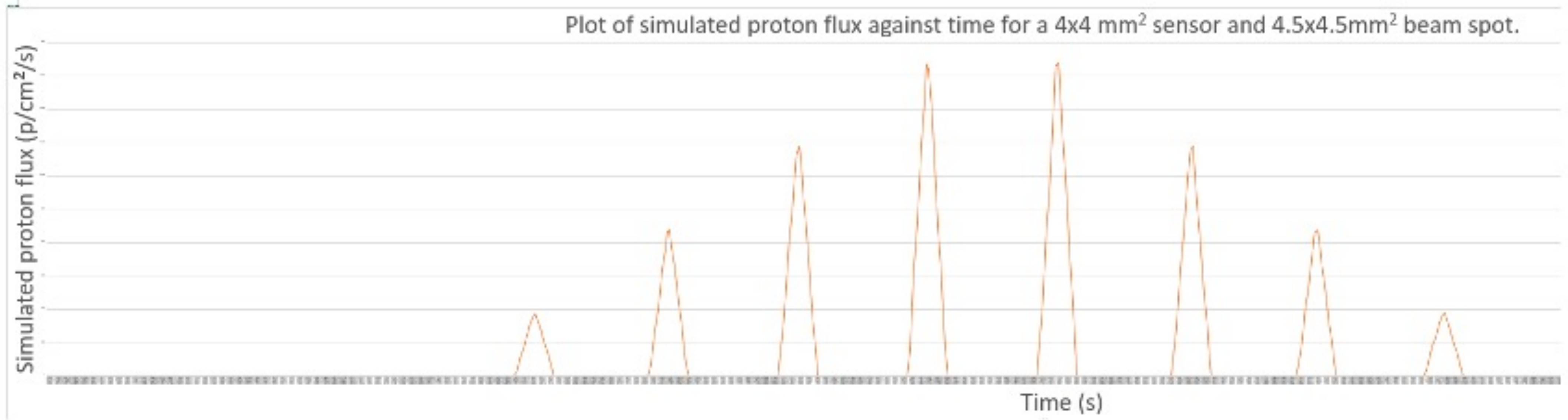
- Service improvements planned to reach higher fluences
  - Higher scanning speed, improved cooling to fully exploit beam current capability (~1uA).
  - Aim to have upgrade completed at M24.

- Status
  - New scanning stages purchased; steering software implemented
  - System functionality tested in the lab with laser beam and a photodiode
  - Next: commissioning and testing in beam line









Task 4.4 Summary

- Service Improvements targeted at improved performance of RIs for EURO-LABS users and beyond
  - All RI's of WP4 except GIF++ (still benefits from improved CERN database)
- Many of the improvements planned before, but EURO-LABS funds enabled kick-starting the projects
  - Remember: RI contribution ≥ EURO-LABS contribution
- Task follow-up: ~1 Milestone per SI, common report as Deliverable

	Year 1												Year 2												Year 3												Year 4													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
4.4 Service improvements												MS24 MS28 MS32		MS25 MS30		MS26		MS27 MS31						MS29 MS33																						D4.1 D4.2 D4.4				

- All 3 Milestones in P1 achieved in time, 3 more to deliver in 2023
- P2 is a (very) busy year for WP4.4 as all Service Improvements are planned to be operational by M24 of EURO-LABS