HiRadMat: a high power targetry facility at CERN

N. Charitonidis, A. Goillot, A. Ebn Rahmoun, P. Alexaki

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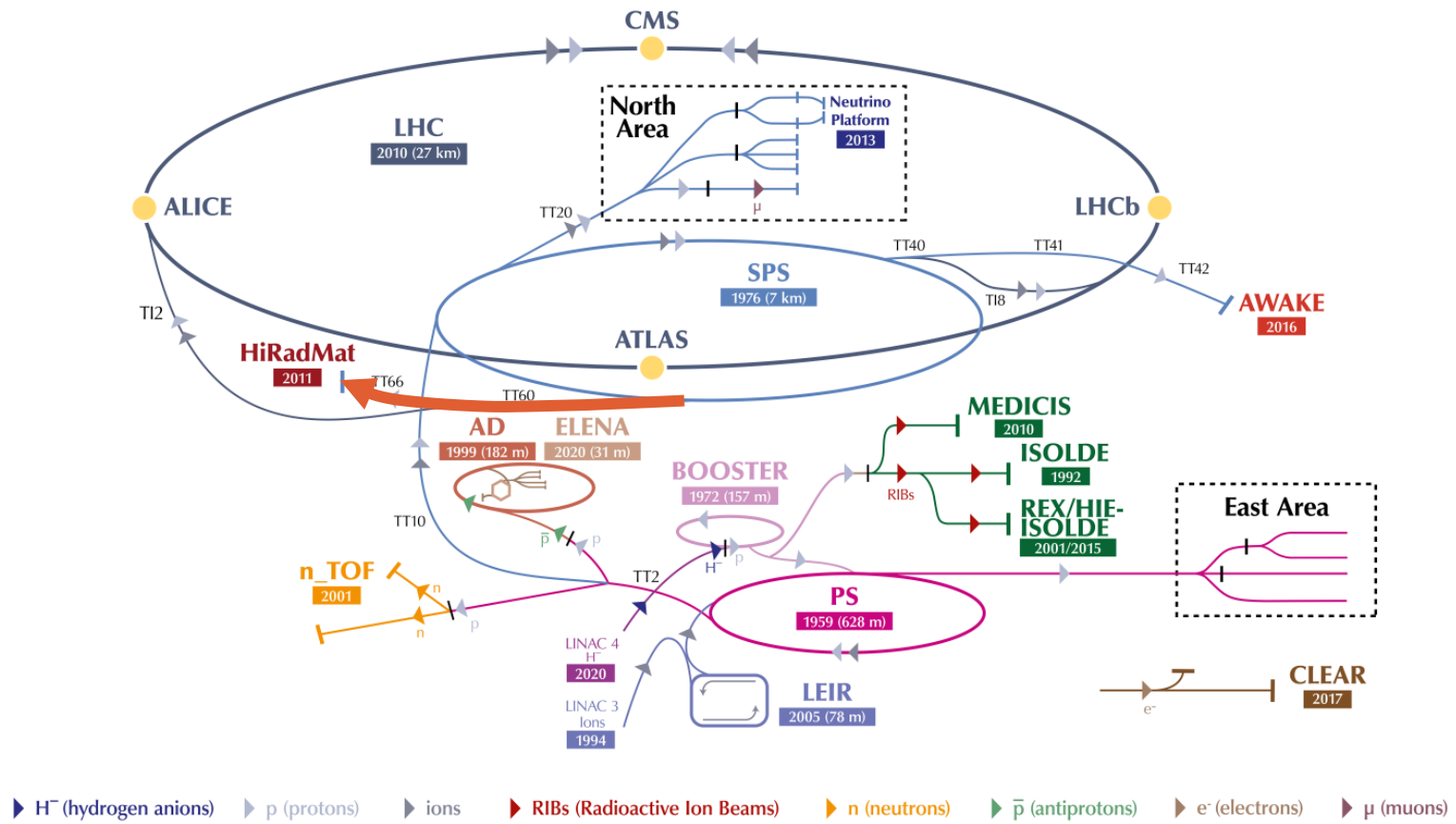
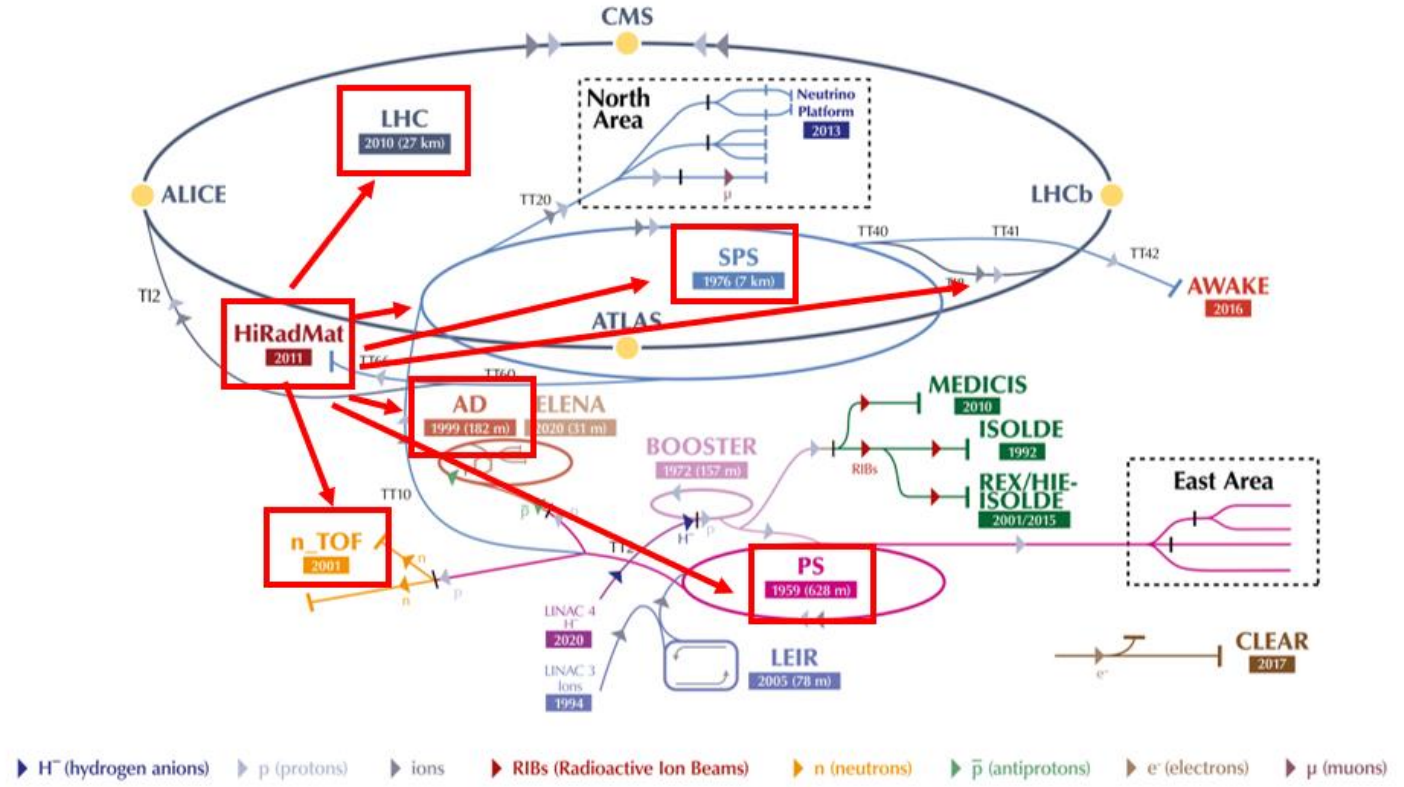
Beam Testing facilities at CERN



The CERN accelerator complex, layout in 2022. © CERN

Courtesy of S. Gilardoni (SY-STI)

On which HIRADMAT has/will have an impact@CERN?



HiRadMat Facility

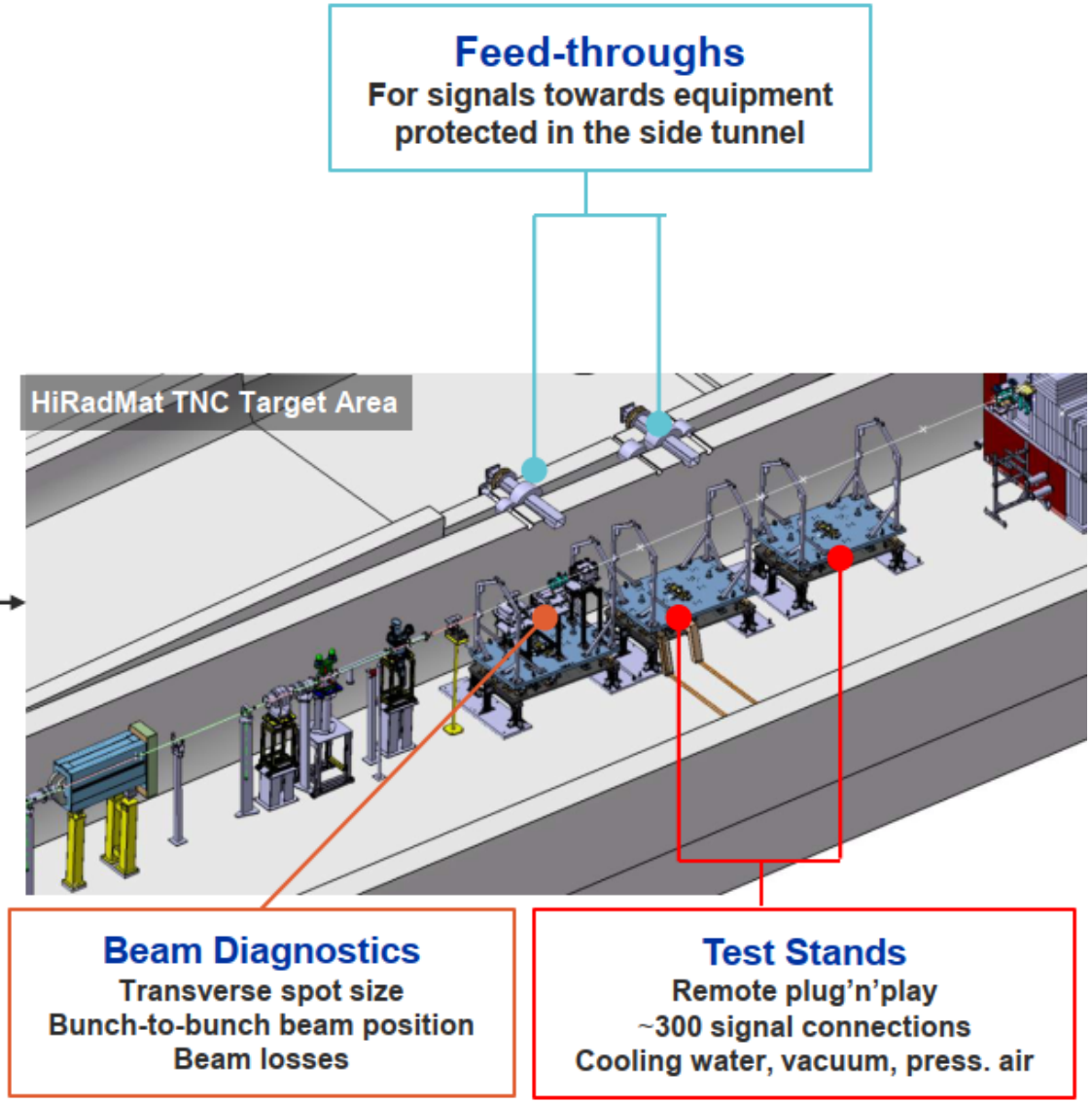
Short-pulse high-energy proton irradiation facility

LHC-like Beam Parameters
Up to 288 bunches, **≤2.3×10^{11} protons per bunch**
≤6.6×10^{13} protons per pulse at **440 GeV/c**
~1.5 ns long bunches, 25 ns bunch spacing
Beam size at target: **flexible between 0.1 - 4 mm** (1 σ)

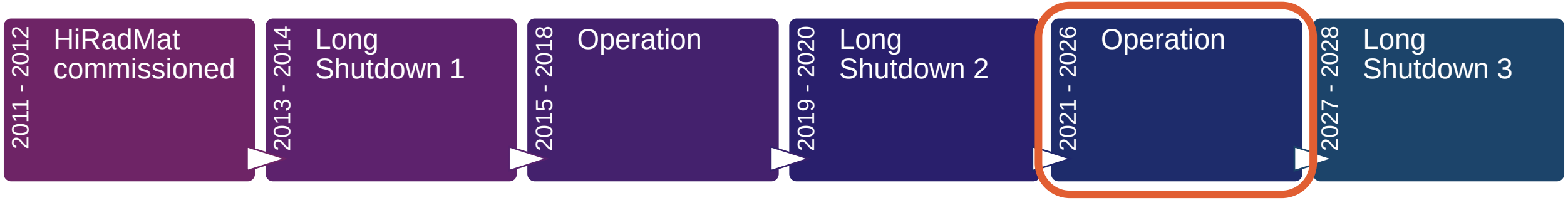
- **Maximum flexibility to accommodate most of the requests**

P[J/pulse] = 440 GeV x 1.6x10^{10} J/p x 288 p/b x 2.3x10^{11} ppb = 4.7 MJ/pulse

- **Ions also available – However never extracted to the facility. A test is planned for 2025/6 to validate this.**



Operation schedule



Experiments

- 18 Materials R&D
- 11 Accelerator component prototyping
- 6 Targetry R&D
- 9 Beam diagnostics
- 2 Particle detectors
- 3 Plasma Physics

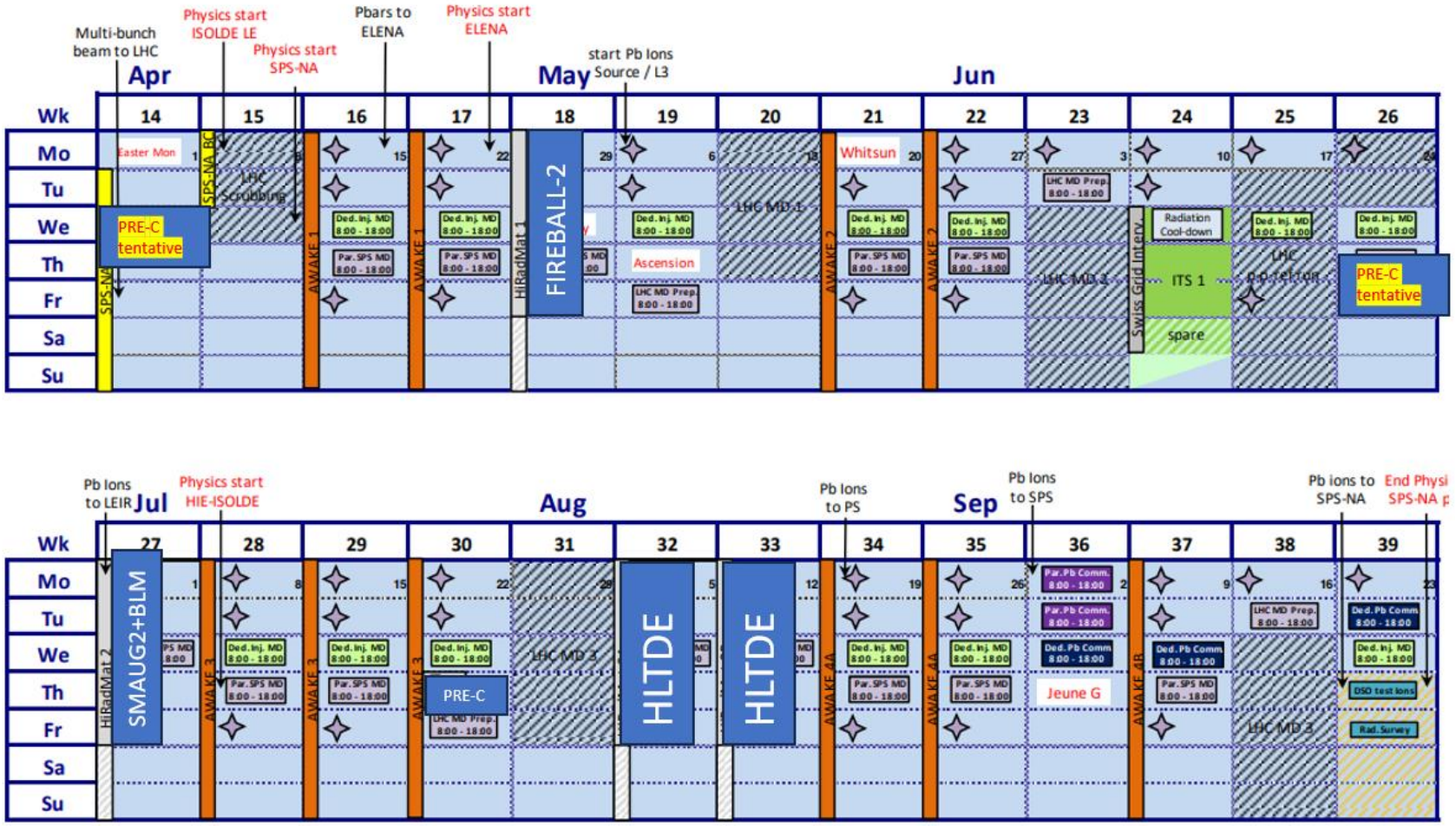
60 publications

Future experiments

- Beam diagnostic devices
- Material for nuclear reactor
- Superconducting material damage mechanisms
- Muon collider (and other) windows
- DPA theory research
- Plasma physics for astrophysics phenomena

- Also look for more

2024 summary

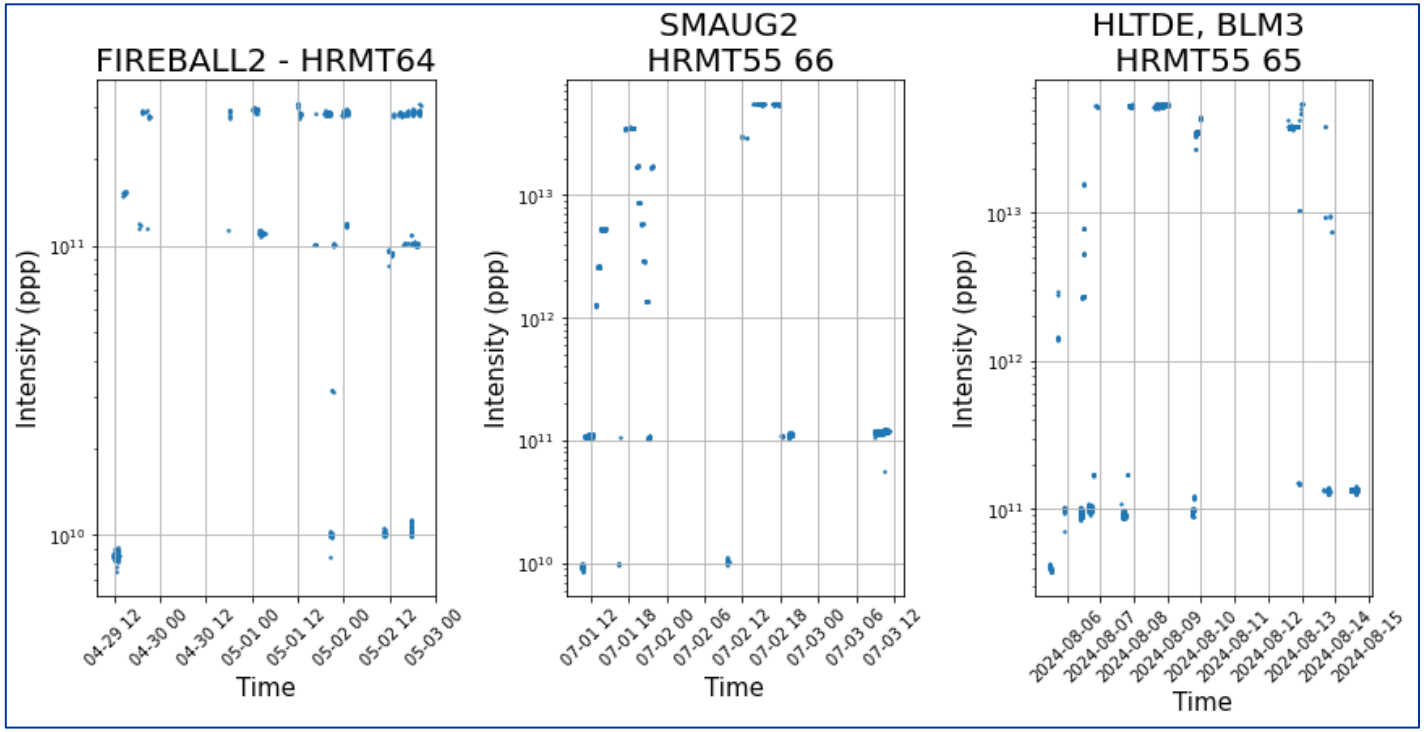


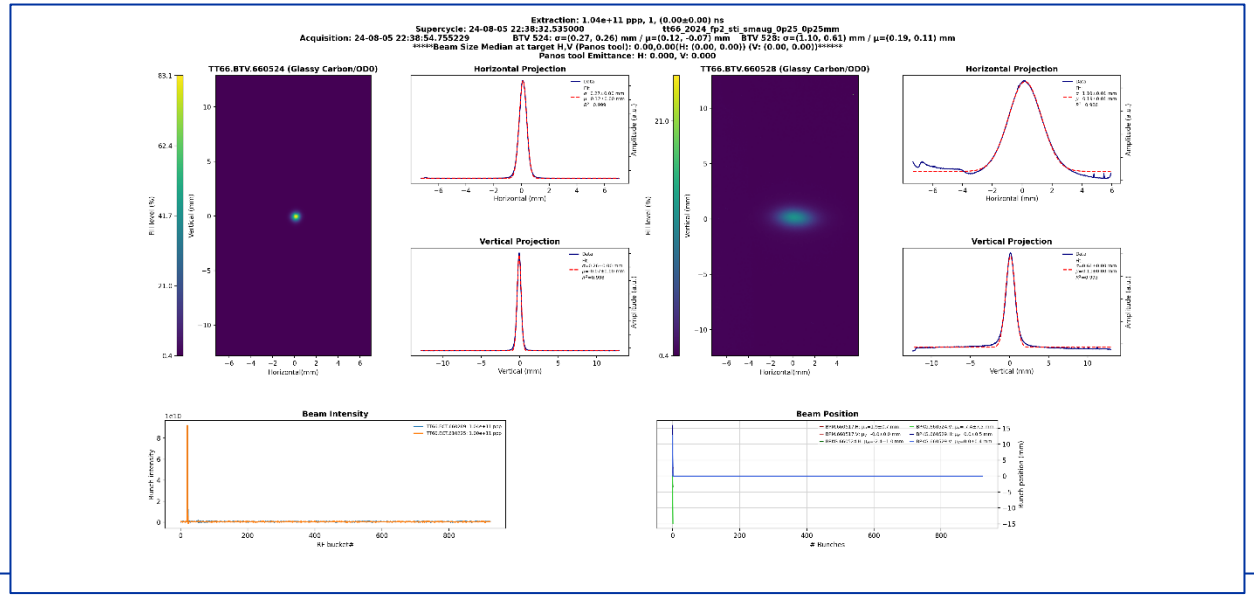
Overall run feedback

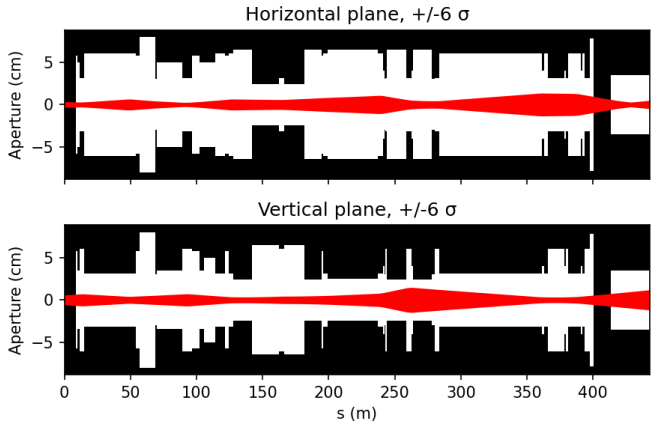
1500 extractions including
→ **475 with 288 bunches**
→ **950 with 1 bunch**

Precommissioning helped to be **more efficient during data taking**

- New version of our **vistar and logbook**
- **Scripts** for the experiment controls and data taking
- **Beam size** computing new tool the at the experiment live (input: emittance in SPS, dispersion estimation, beam shape, size at BTV)







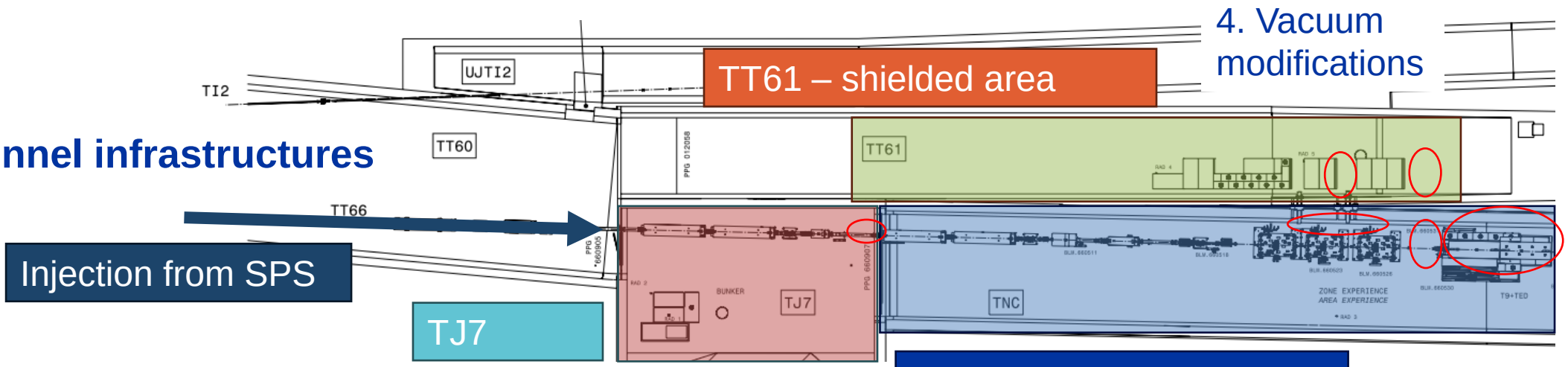
23/24 (last) YETS upgrade

Please see last year presentation for details (https://indico.cern.ch/event/1321764/)

1. Dump upgrade [SY-STI]
2. Downstream experiment OTR BTV [SY-BI, BE-EA]
3. Partition of TT66 Vacuum Sector [TE-VSC]
4. Vacuum upgrade [TE-VSC & BE-CEM]

Dump did not reach critical temperature
None of the windows (dump, BTV, beam line) failed
Implementation (mechanical and controls) was a success
BTV study ongoing, will likely change the tank material

Tunnel infrastructures



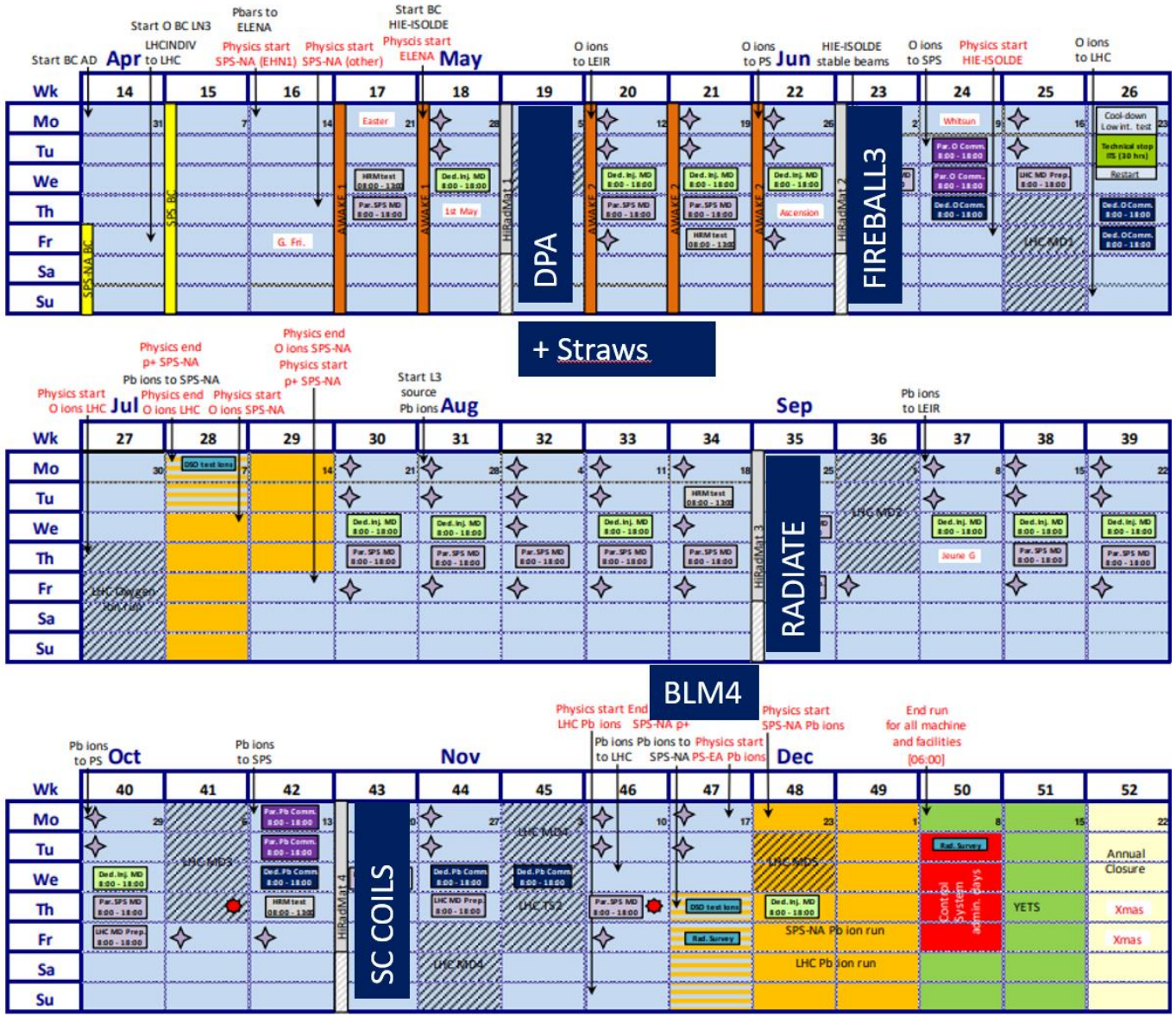
HiRadMat Outlook for 2025+

- ▪ **4 [+1 tentative] experiments being planned for 2025**
- **HRMT-63 DPA**
  - Measurement of displacement cross-sections
- **HRMT-68 Fireball-III**
  - Follow-up of measured instability with further improved setup
- **Radiate-II**
  - Test of various materials for future target systems
- **SCcoils-II**
  - Study of damage limit in SC coils for HL-LHG magnets
- **BLM-IV**
  - Test and validate multiple types and production runs of Beam Loss Monitors (BLMs)

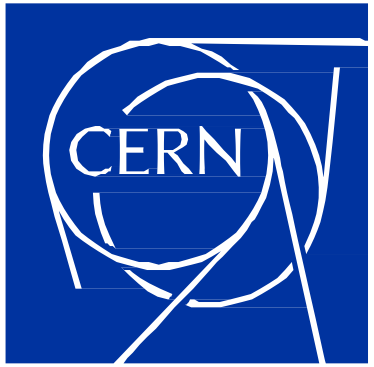
ENLARGE THE POSSIBILITIES

- Ions beams
- Lower momentum (<440 GeV)
- Improve the softwares

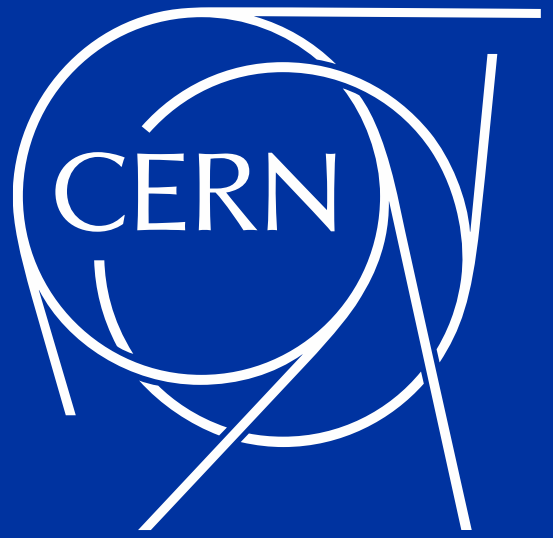
2025 schedule



A big thank you to the members of the working group and also everyone else along the ATS sector for their dedication and help in the operation of HiRadMat facility since 2011!



SY-STI EN-MME SY-BI BE-ASR TE-MPE BE-GM BE-CEM HSE-RP SY-ABT BE-OP EN-HE BE-EA


CERN

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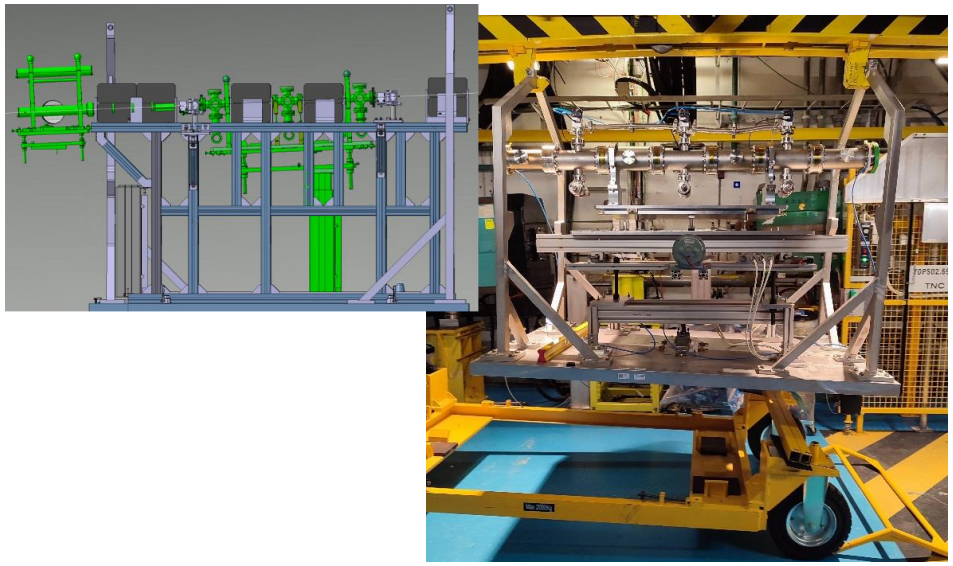
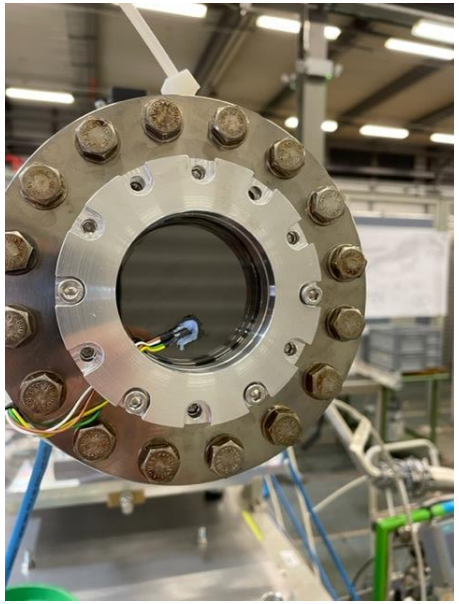
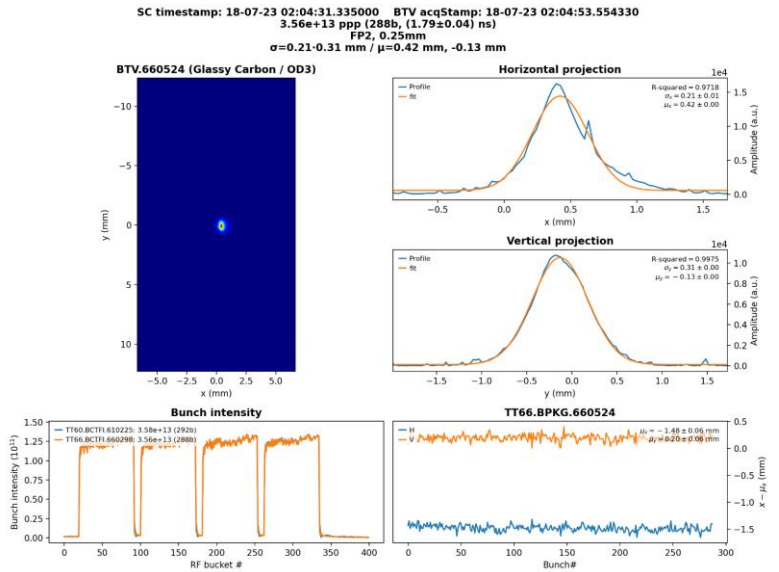
Expertise provided to users







Experiment preparation

3D integration & mechanical studies

Installation & survey

Transport and handling

On-line diagnostic equipment and expertise

Sensors, Cameras & LED

Movable stages (H&V)

Remote control of the equipment

Beam diagnostics

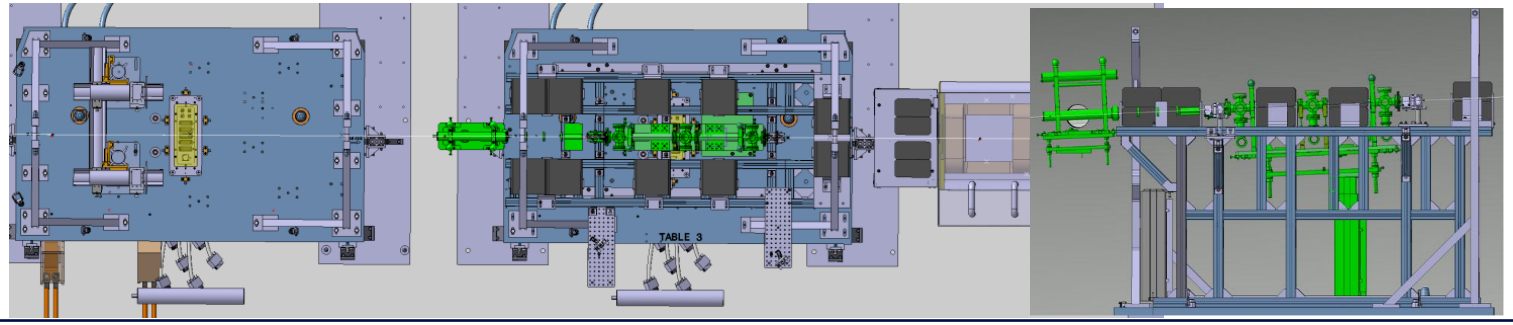
Beam parameters

Automatic parameter display

Auto-logging in CERN infrastructure

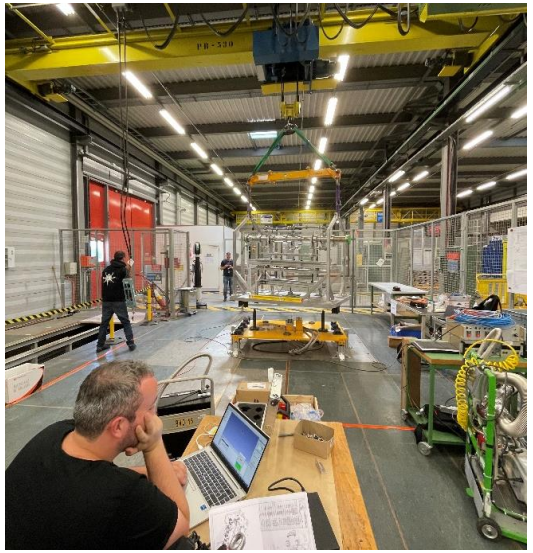
Experiment preparation

- Integration in 3D layout
- Mechanical evaluation

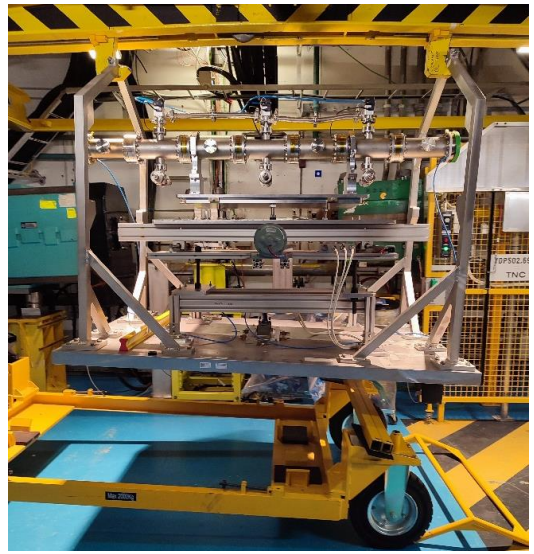


- Assembly
- Installation

- Survey (alignment precision < 1 mm)

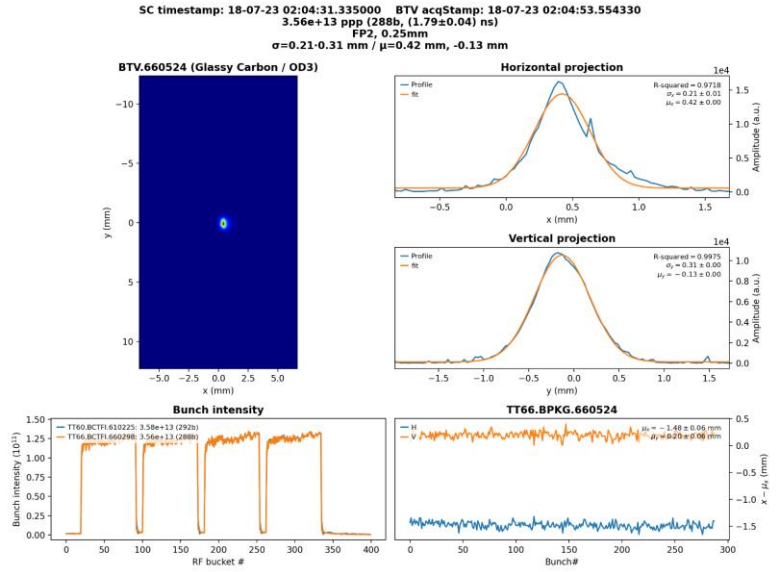


- Handling and transport
- Disassembling

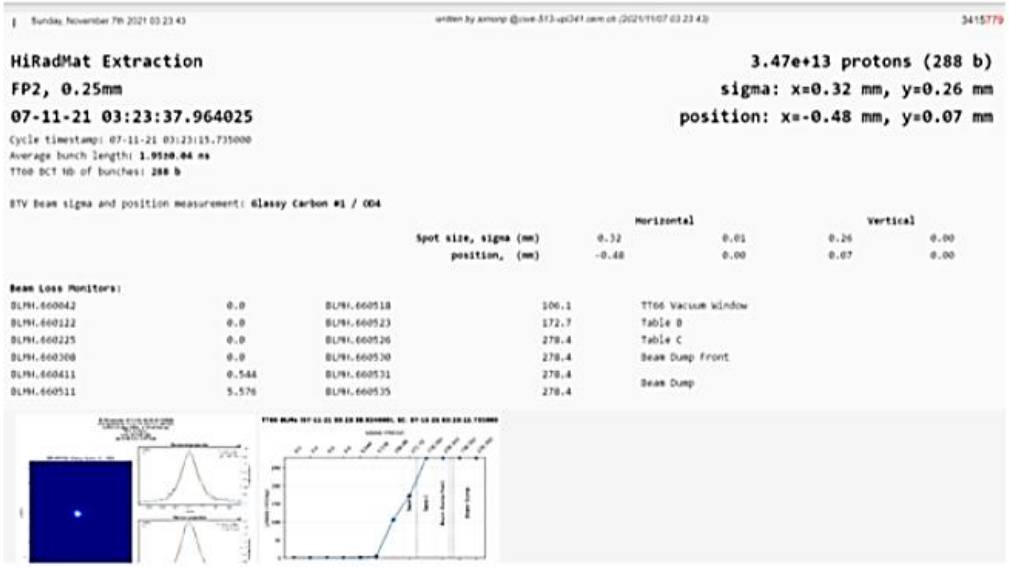


Beam diagnostics

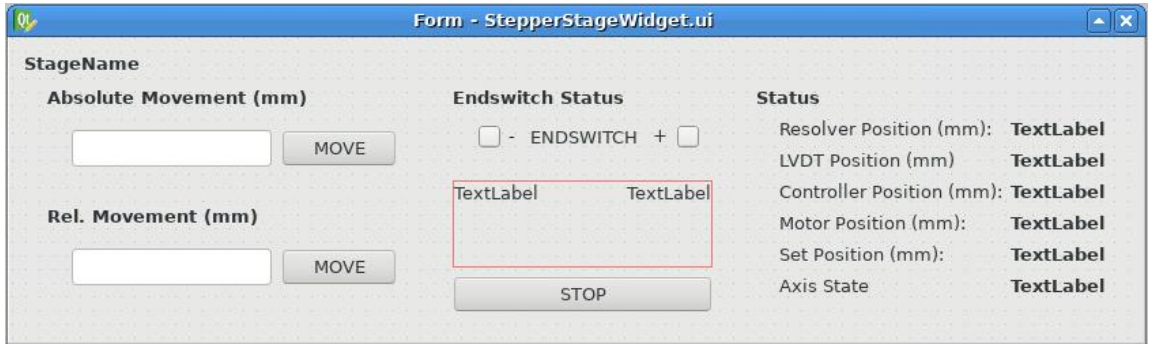
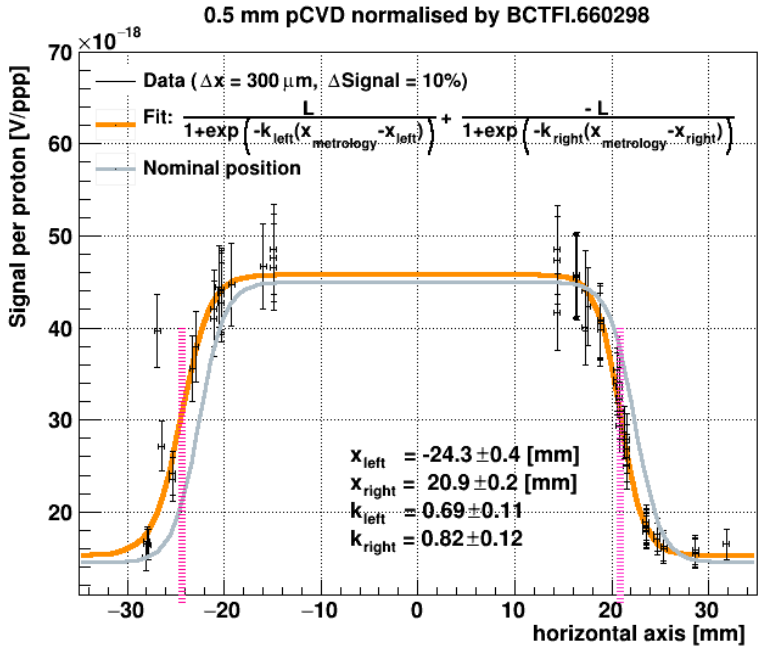
- **Beam TeleVision**
- **Beam Current Transformer**
- **Beam Position Monitor**
- **Bean Loss Monitor**
- **Vistar and logging automatisation for each shot**



HiRadMat vistar



HiRadMat auto e-logbook

Flexible software for users

- **Interface for motor stage control:**
  - DC stage
  - Step-motor stage
- **Beam based alignment automatisation**
- **Data acquisitions (temperature, cameras, pressure…)**