

Commissioning of Timepix3 Based Beam Gas Ionisation Profile Monitors for the CERN Proton Synchrotron

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<https://bgi.web.cern.ch>

Outline

- Beam Gas Ionisation (BGI) Profile Monitor in a nutshell
- From prototype to operational
- Timepix3 detector setup and testing
- First beam measurements
- Examples of operational measurements
- Summary

From prototype to operational

Horizontal prototype
2017-2018



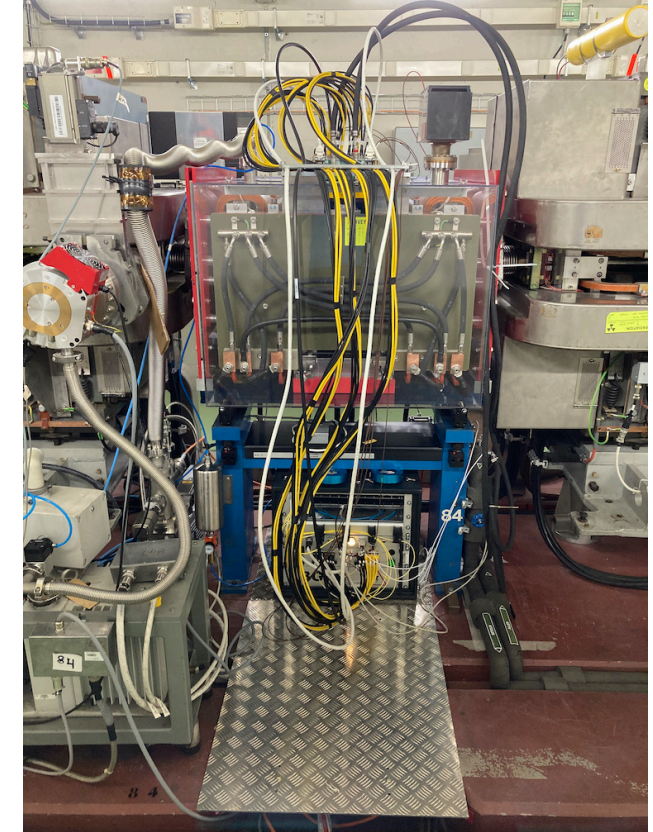
- Proved feasibility
- 1st generation detector assembly

Horizontal operational
2021

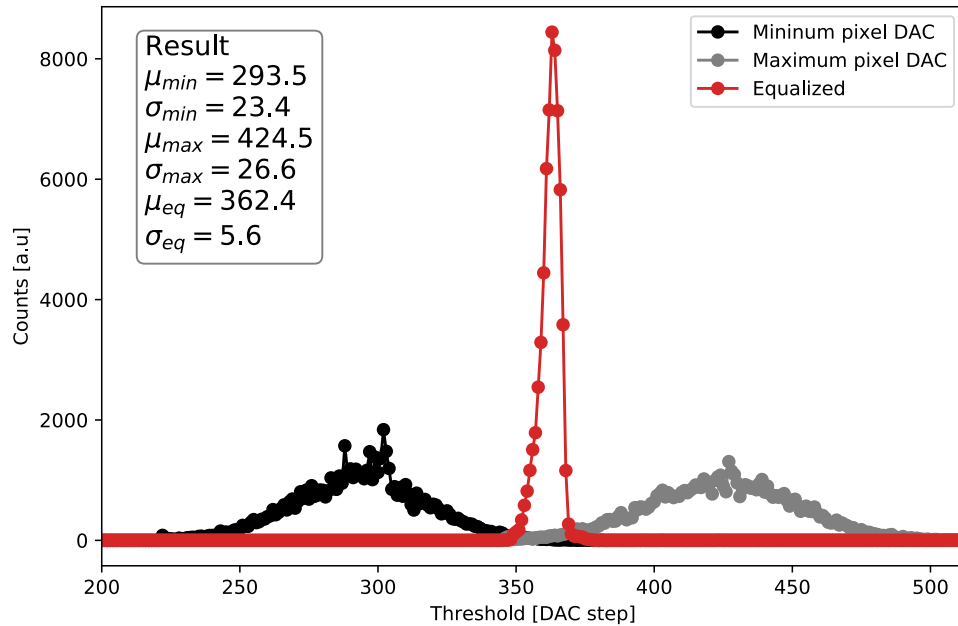


- New in-vacuum electronics and Timepix3 detectors.
- New installation of vertical vacuum chamber and magnet.
- Gas injection on both instruments.

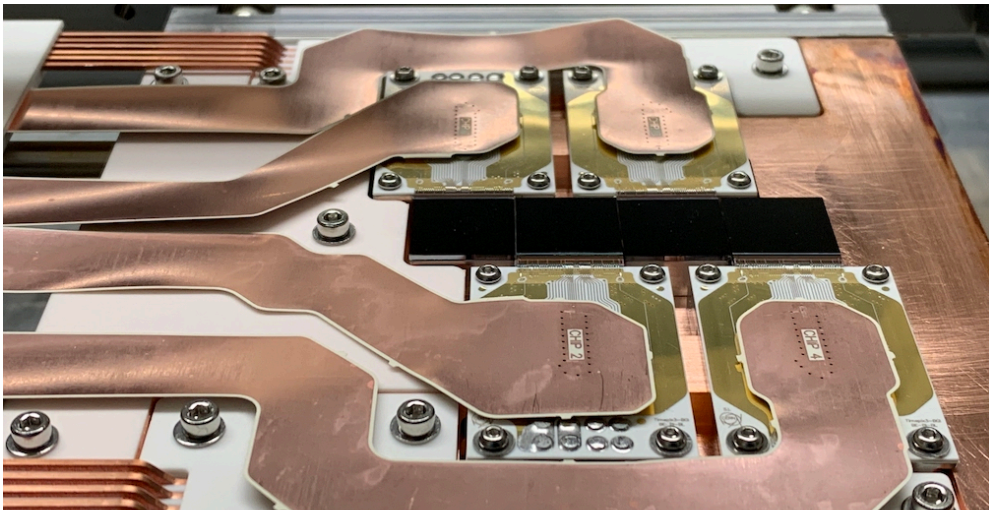
Vertical operational
2021



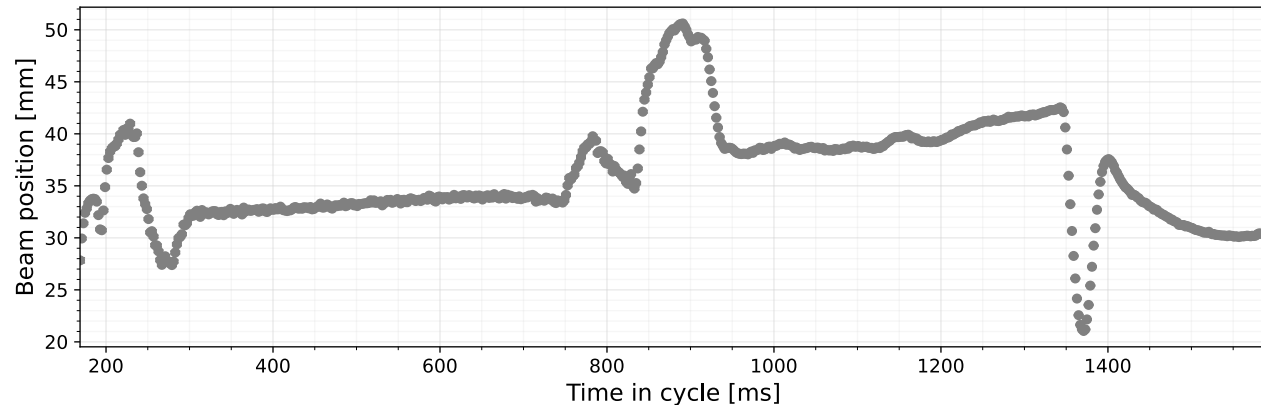
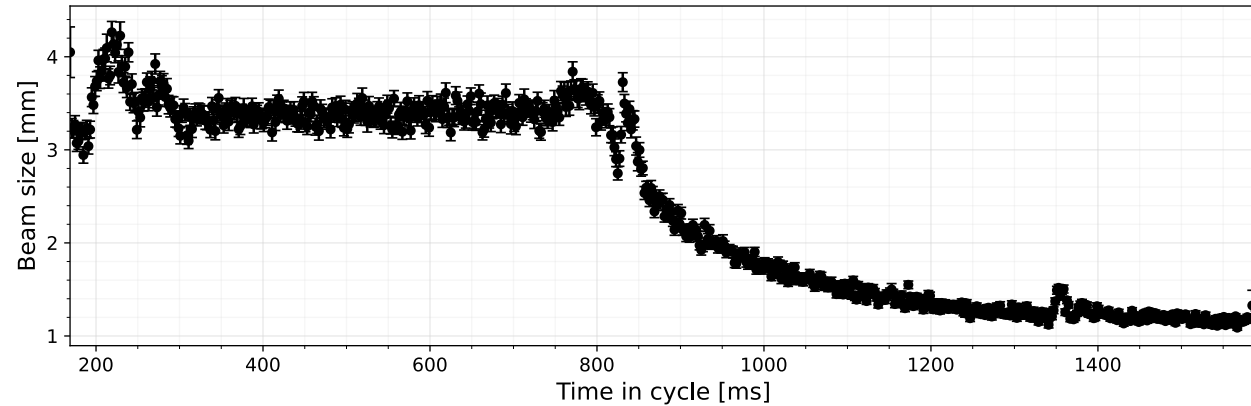
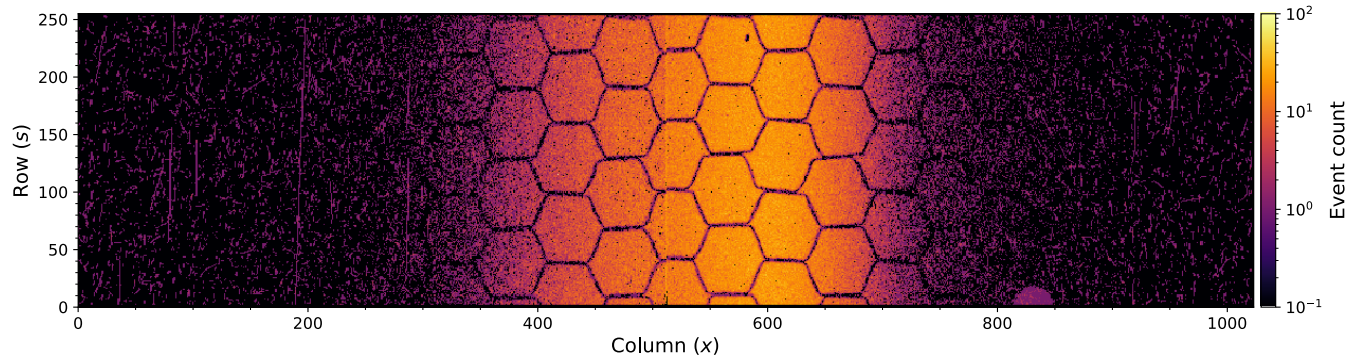
Timepix3 detector setup and testing



- Four Timepix3 detectors per BGI instrument.
- All Timepix3 detectors tested in the lab before installation in the vacuum.
- Power consumption, sensor bias current, DAC scan, equalization, threshold tuning, ionizing radiation etc.
- Tests are run before and after installation in CPS.
- No significant difference indicate that the detectors are ready for operational use.



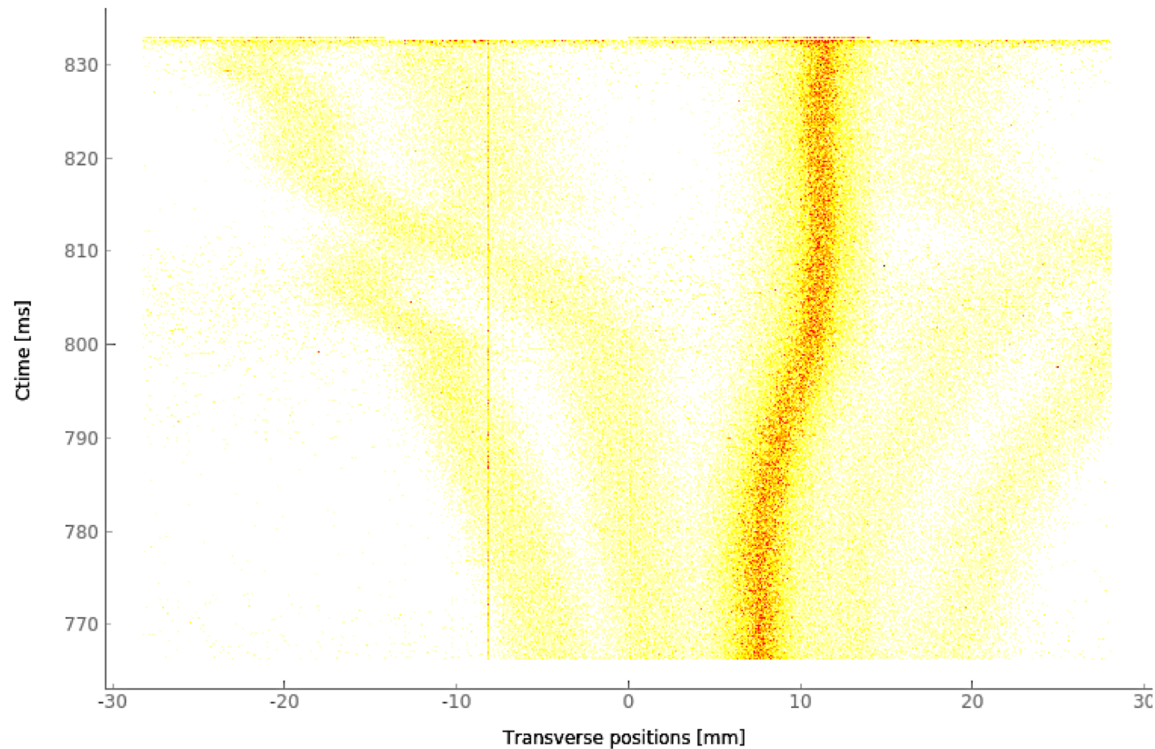
First beam measurements



- Single bunch beam recorded on the first week of beam commissioning.
- Pixel image is full 1.2 s beam cycle.
- Correction for honeycomb shadow.
- Integration window set to 2 ms.
- 600 beam profiles measured.
 - Up to 1024 profiles per cycle.
- Fit each profile with a Gaussian.
- Evolution of beam size and position throughout the cycle.

Examples of operational measurements

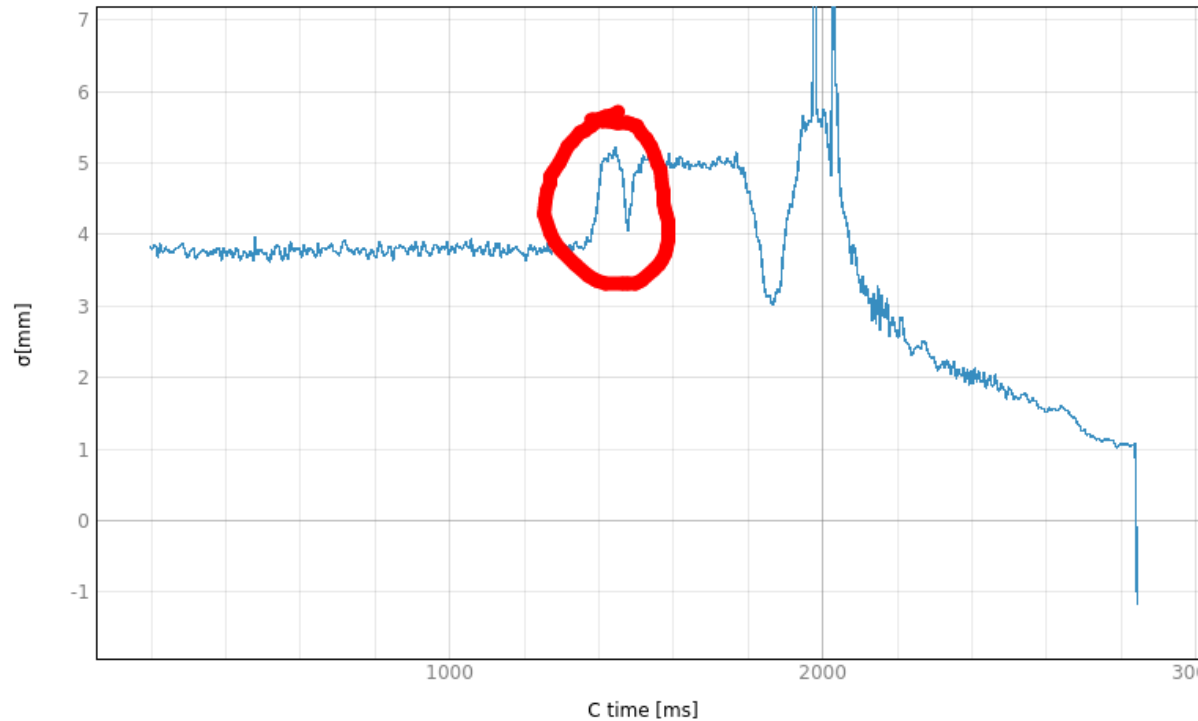
Beamlets in multi-turn extraction beam



- Beam is split into several beamlets in the transverse planes.
- Each beamlet is extracted one by one, turn by turn.
- Continuous measurements with BGI shows how the beamlets behave throughout the beam cycle.
- One beamlet (the core) has higher intensity and can be distinguished in the BGI data.

Examples of operational measurements

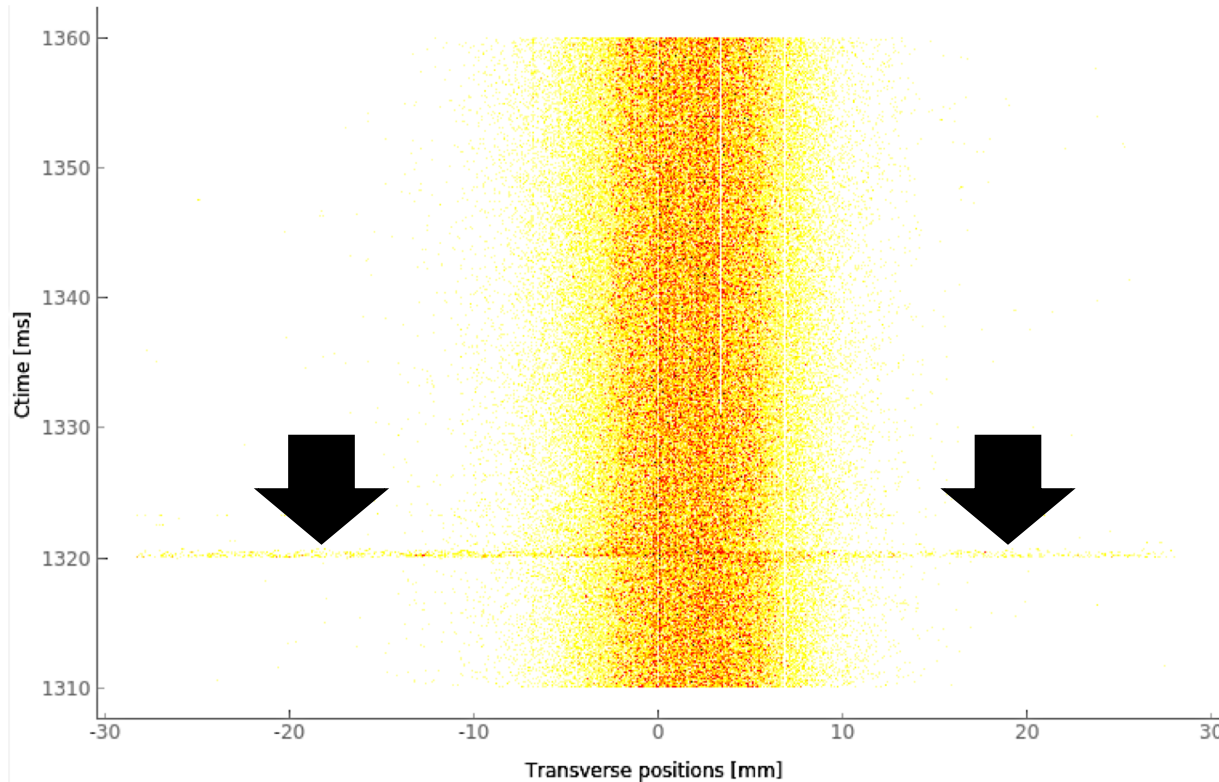
Intermediate plateau beam size squeeze



- Horizontal beam size evolution in the cycle is shown.
- At 1450 ms there is a sudden dip in the beam size.
- Corresponds to the time in the cycle where the particles are accelerated a bit before the next injection (intermediate plateau).
- Longitudinal momentum spread is increasing and decreasing at the same time.
- Couples to the transverse horizontal plane through dispersion.

Examples of operational measurements

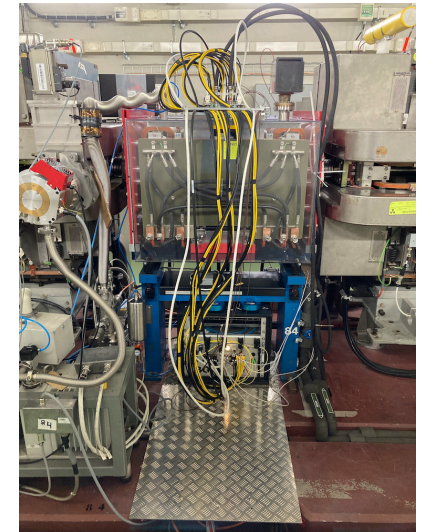
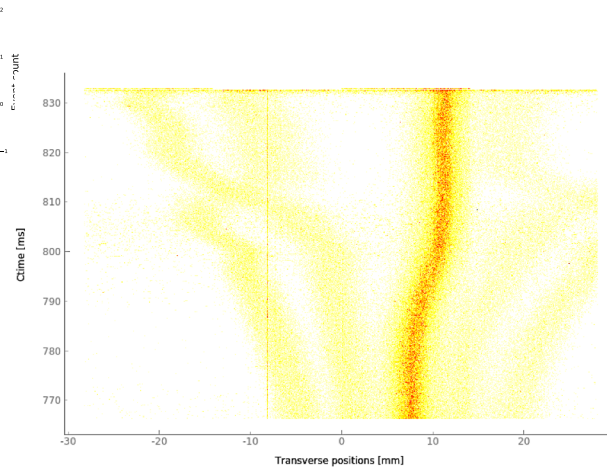
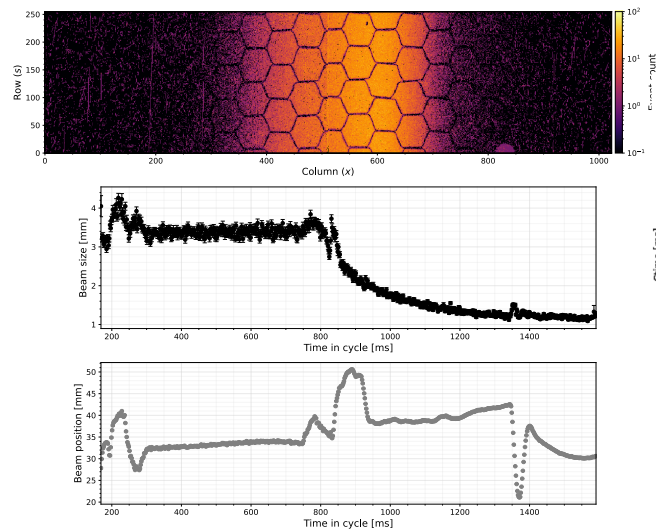
Second injection beam losses



- Part of the cycle with a stable transverse beam size
- “Glitch” visible at 1320 ms in the cycle
- Timepix3 detectors are also sensitive to beam loss
 - Normally filtered out since we are only interested in the ionisation electron signal
- Indicates something is disturbing the beam
- In this case the injection kicker magnet is active at this point (but nothing is injected)
- These losses were not visible on nearby beam loss monitors

Summary

- Two operational beam gas ionisation profile monitors have been installed in the CERN PS.
- Measures in the transverse horizontal and vertical planes in a continuous and non-invasive way.
- Instruments were commissioned and measured the first beam in March, 2021.
- Operational use of the instrument demonstrate various use cases.
- Measurements are still in progress for injection mismatch studies, beam time structure and comparison against other profile monitors.



Thank you for your attention!

