SPS BGI MDs

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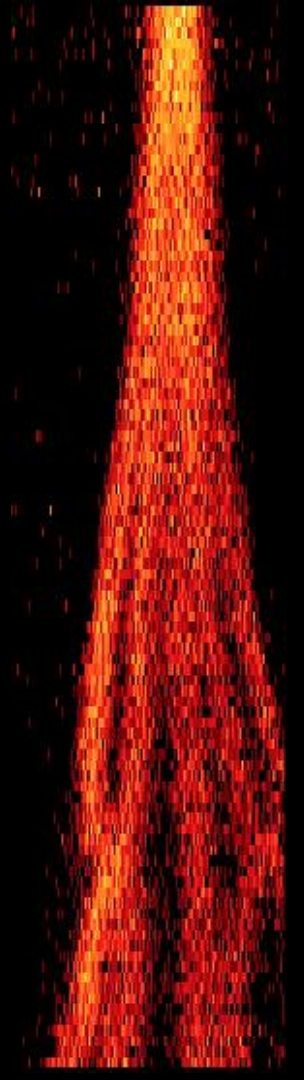
on behalf of the BGI team

4th February 2025

Injectors Performance Panel MD days 2025

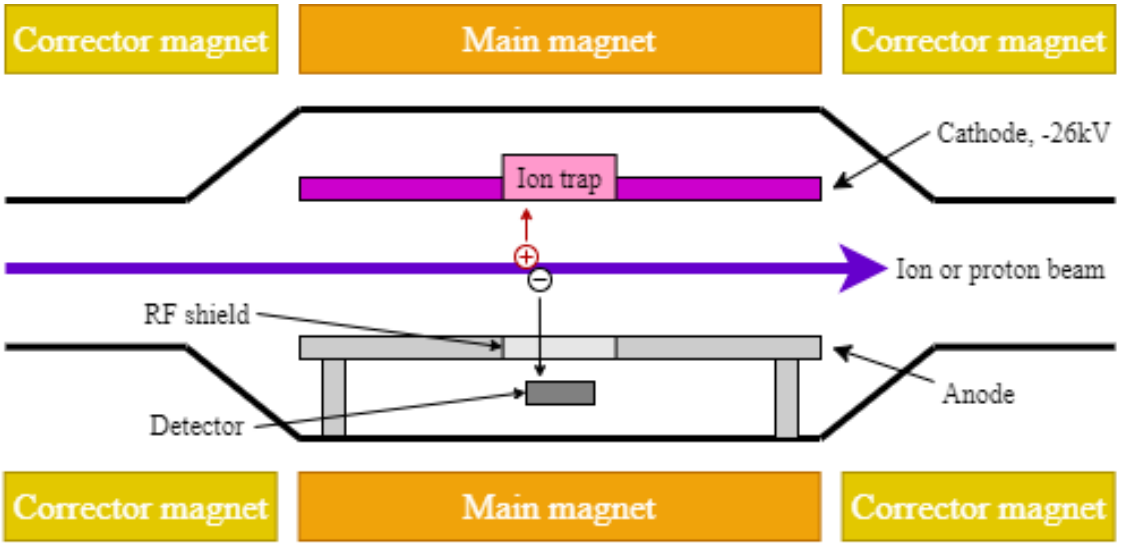


The BGI in Brief

The **Beam Gas Ionisation Monitor** (**BGI)** is an Ionisation Profile Monitor (IPM) using **Timepix3** detectors, designed for **transverse profile measurements**.

BGI Features

- **Non-destructive** measurement
- Beam profile is measured by counting individual ionisation electrons
- Regular operating mode with ≥ 100 ns integration time, integrating over all bunches
- Monitor **beam evolution** throughout the cycle with up to 1024 profiles / cycle



Installation status

- YETS 2023/24: Horizontal BGI installed
- TS June 2024: Horizontal BGI moved to the vertical position, new improved instrument installed in the Horizontal position
- Both instruments show promise but are severely affected by the AWAKE and LHC25NS beams

Nature of the problem

- The Timepix3 chips communicate with the Front-End Readout Box via many LVDS pairs inside RJ45 cables.
- Certain beams cause this communication to be temporarily disrupted, and often crash the Timepix chips, requiring a reset and re-configuration cycle before they will work again.
- We also saw evidence of corruption of the settings inside the Timepix3
- The re-configuration takes several seconds and effectively renders the instrument useless for at least the interfering beam and the subsequent beam.

MDs performed

- The focus of the MDs was to determine what features of the beam caused the interference with the BGI
- We demonstrated a clear link with peak intensity
- A single very short (rotated) bunch was enough to cause the problem, e.g. AWAKE, where the interference came only after the bunch rotation
- Multiple intense bunches also caused it (LHC25NS)

Other work

- Using the SY EMC lab we made some investigations into possible mechanisms of EMC interference between the beam and the BGI electronics.
- We attempted to create interference with a simulated beam, but we did not have an RF amplifier with the necessary power and frequency range to do this.
- We did show clear evidence that EMI to the instrument's communication cables could cause a similar problem, and that the HV cable picks up a strong signal from the beam.

Next steps

- During the current YETS we have installed a new Vertical instrument with extra internal shielding.
- We have also installed new HV, power and communication cables with improved shielding.
- We await the returning beam with fingers crossed!

Thank you

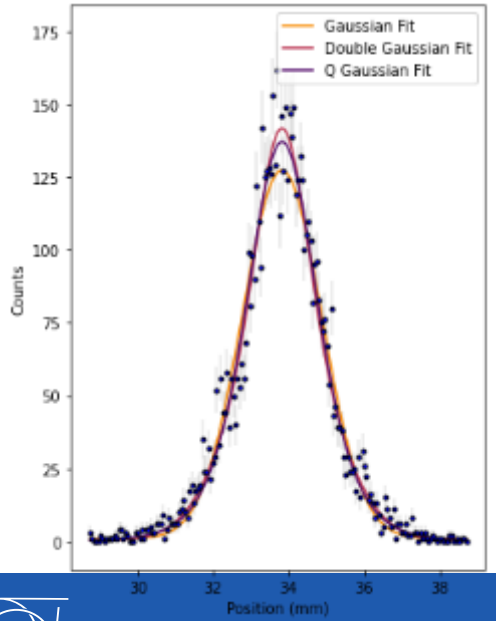
- Thank you for the MD slots, and also for facilitating access several times during the year to make modifications to the instruments.

Backup slides

PS BGI Profile Examples

The following profiles are taken with a 36-bunch LHC-type beam at flat-top, with a 1.9 ms integration time, without gas injection.

BGIH Profile



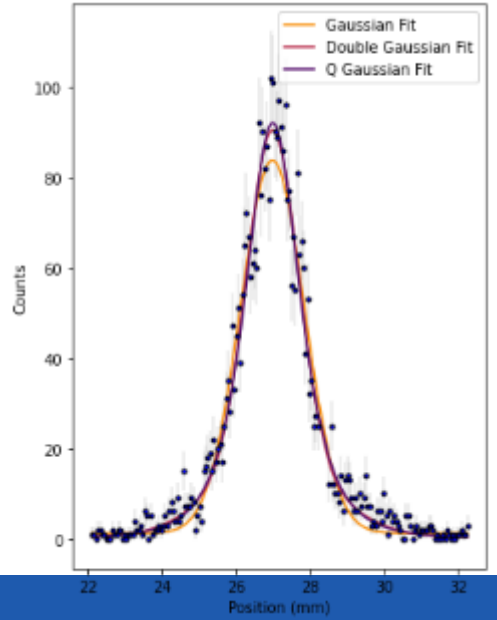
Total Counts:
6603 counts

σ:
0.90 ± 0.03 mm

Background:
0.0 ± 0.3 counts

q:
1.27 ± 0.05

BGIV Profile



Total Counts:
3703 counts

σ:
0.67 ± 0.03 mm

Background:
0.0 ± 0.3 counts

q:
1.51 ± 0.05

SPS BGIs

Based on the PS BGI design.

Same FESA class, ExpertGUI & OP-GUI (dev. by Marcel Coly).

Main differences to **improve reliability** and **simplify setup**:

- Improved **radiation tolerant readout electronics** (also deployed in the PS).
- **New silicon pixel detector sensor** optimised for ionisation electron detection & **increased cathode operating voltage,** which should:
  - **Minimise “noisy” pixels;**
  - **Reduced chip-to-chip gain variation;**
  - **Improve electron detection efficiency.**
- New Timepix3 detector layout to **reduce readout satutation** & to **facilitate chip-to-chip gain equalisation.**