Development of an RPC-based photo-detector with picosecond resolution

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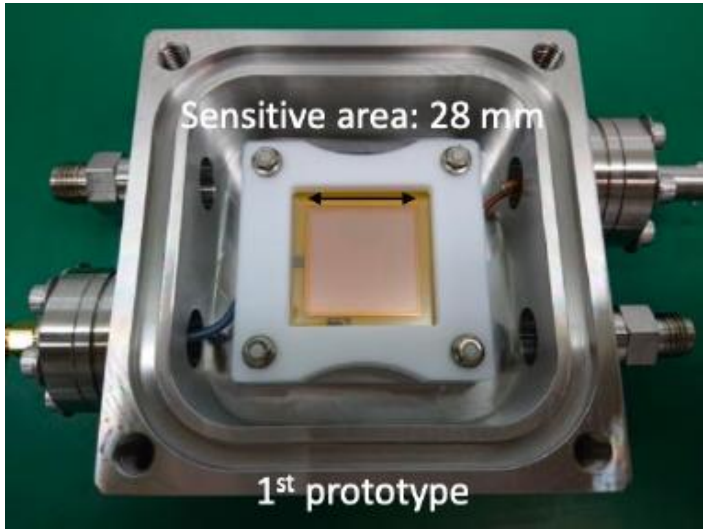
Outline

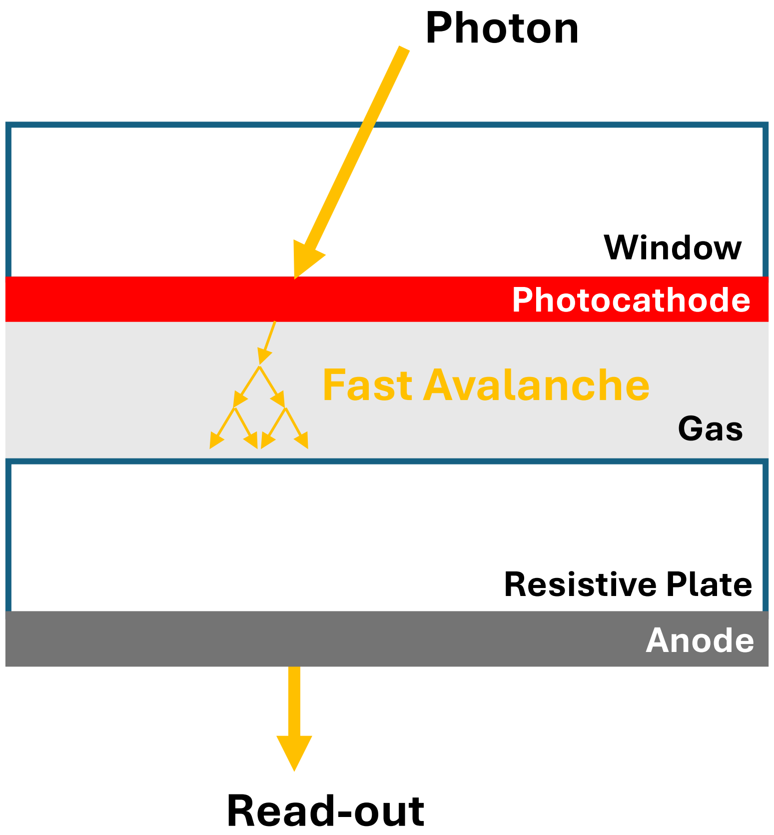
- GasPM
- Test beam
  - MPPC analysis
  - Photon feedback study
- LaB6 photocathode

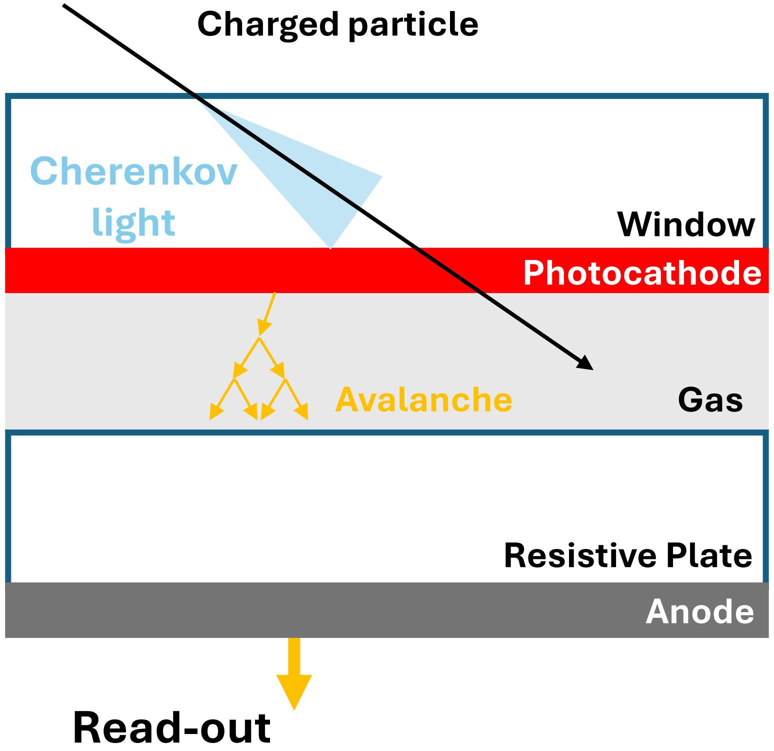
Gaseous Photomultiplier (GasPM)

- **Belle II upgrade – veto beam background on ECL**
- **Excellent time resolution, large photocoverage, low cost**
  - ➢ Fast avalanche multiplication process in gas
  - ➢ High electric field in the narrow gap without electric breakdown thanks to resistive plate
  - ➢ Cheap components
  - ➢ Assembled on a table



- Self-produced at KEK
- Gas mixture: 90% R134a + 10% SF_6
- E_{gap} = 2.8 kV / 150 μm
- CsI photocathode





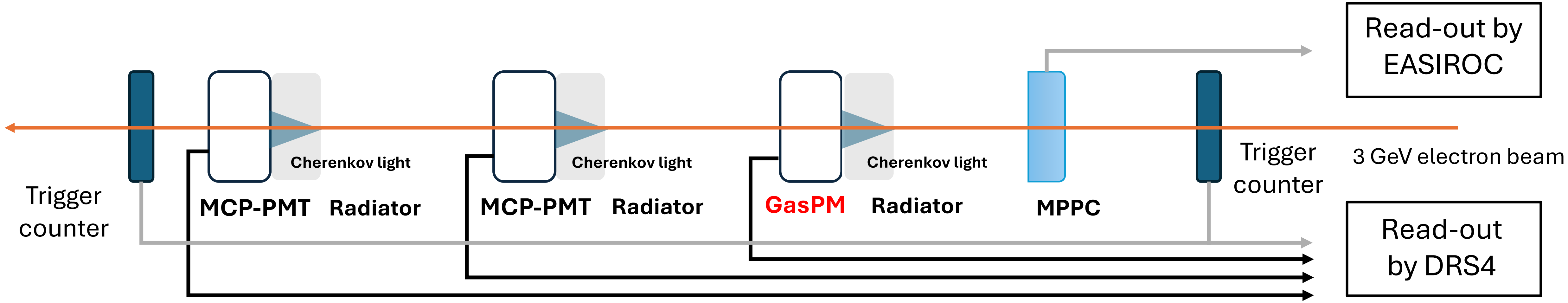
Test beam

Goal

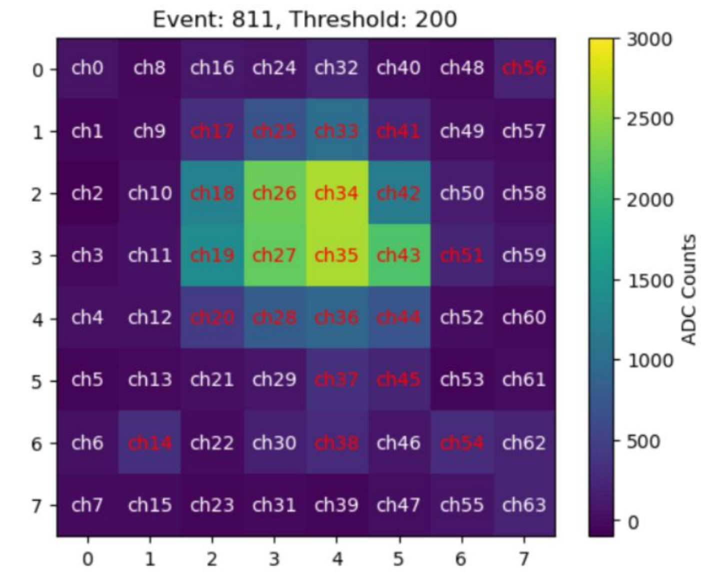
- Demonstrate the Cherenkov timing detection using GasPM
- Time resolution measurement of GasPM
- Improve time resolution obtained last test beam (~ 60 ps)

How

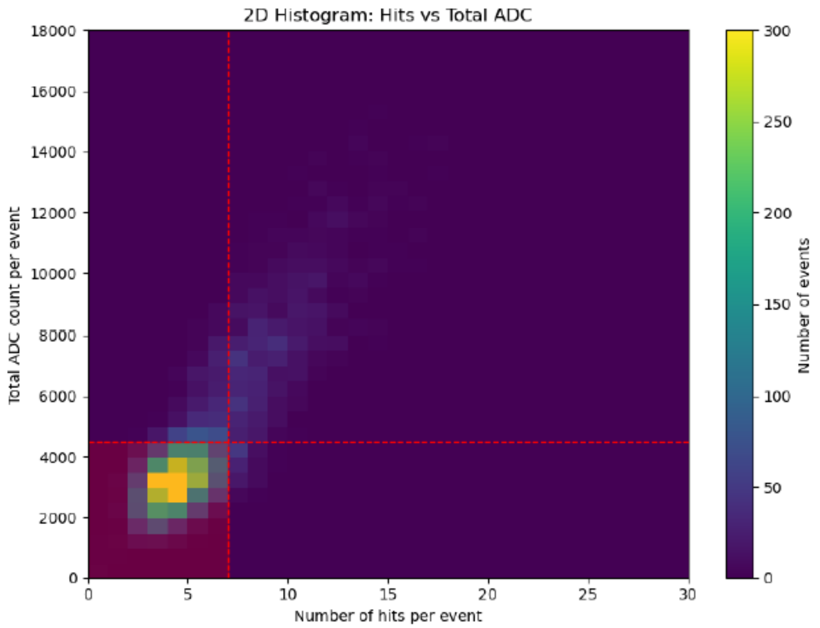
- Increased electric field
- Identify photon feedback peaks
  - Higher acquisition frequency digitiser (10GHz)
- Select only single electron events
  - Multi-pixel photon-counter

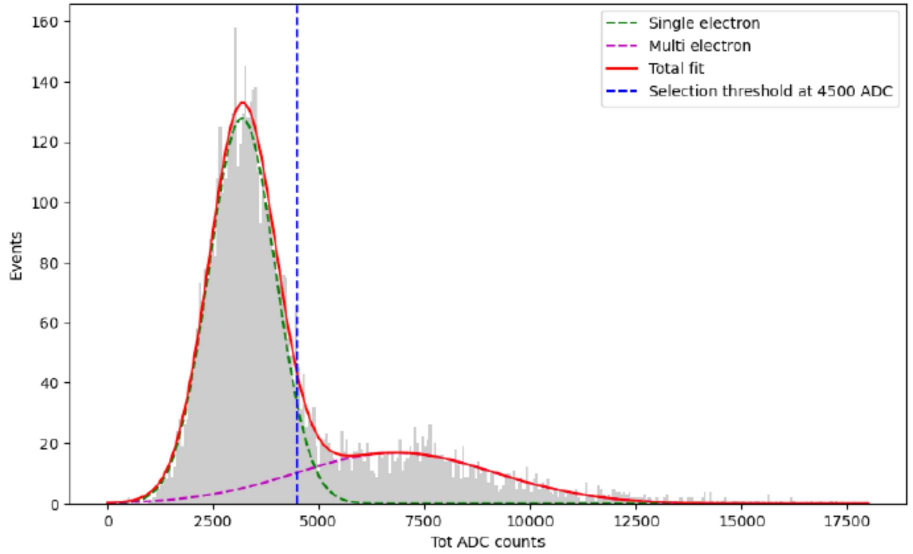


Single-electron events selection



- 64-channel MPPC arranged in an 8×8 matrix
- Applied ADC threshold to identify photon hits
- Performed cuts on total ADC and number of hits per event
- Achieved 95% efficiency for single-electron detection
- Rejected 84% of multiple-electron events

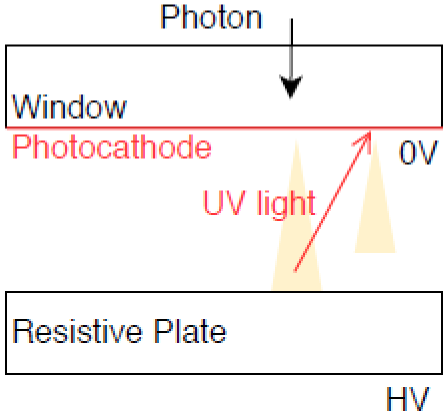




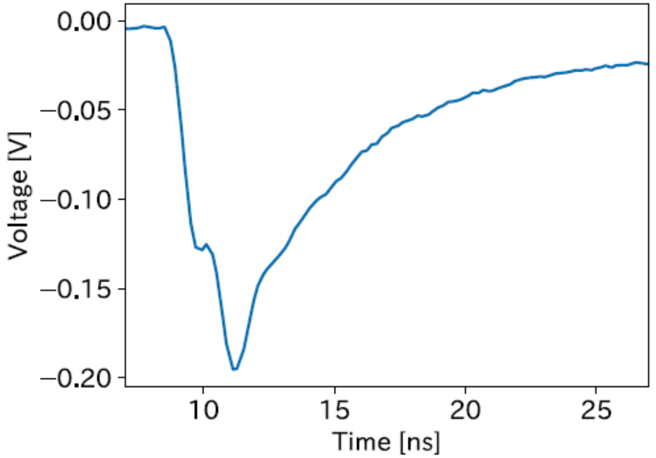
NALU digitiser

High frequency acquisition of 10 GHz → allows to better discriminate secondary peaks due to photon feedback

PHOTON FEEDBACK: UV photons emitted during gas excitation and de-excitation trigger secondary electron avalanches in the gas gap.



R.Okubo, PD24



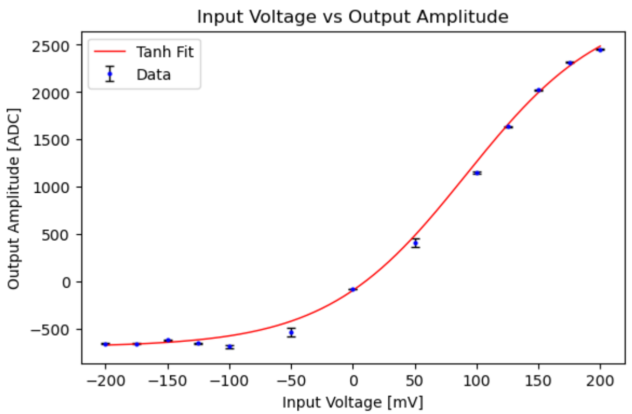
R.Okubo, PD24

Test beam data are now under study

Digitiser calibration:

- Voltage calibration
- Time calibration

After calibration I obtained 7.23 ps resolution



LaB_6 photocathode characterisation

Previous Issue

- CsI photocathode was highly sensitive to radiation damage
- **Ion feedback:** avalanche ions drift back and degrade the photocathode over time

Goal

- Measure quantum efficiency (QE) of the new photocathode
- Asses its resistance to ion-induced damage

Cosmic ray test is ongoing:

- Streamer discharges observed
- Actions taken:
  - Increased quenching gas ratio
  - Reduced electric field strength
- Current result: only **ionization signals** observed (RPC-like behaviour)