Development of Fast Timing Silicon Pixel Sensors for Positron Emission Tomography

Daiki Hayakawa (Daiki.Hayakawa@unige.ch, University of Geneva) on behalf of TT-PET collaboration

Introduction

- **PET** is a nuclear medicine method used to observe the metabolic processes in the body, by detecting pairs of back to back gamma-rays produced by the annihilation of positrons emitted by a beta plus tracer
- **Thin TOF-PET project** is developing a PET based on silicon sensors with very high time resolution (30 ps) for small animal and meant to be inserted in existing MRI (PET-MRI).

16 cells and 60 layers
Inner radius: 2.02 cm

Fulfill 4 important keys of PET-MRI
1. Time of Flight (TOF)
2. Depth of Interaction (DOI)
3. Thin
4. Not affected by the magnetic field

First measurement of timing resolution

**Beam test with minimum ionizing particle (MIP)**

M. Benoit et al., 100 ps time resolution with thin silicon pixel detectors and a SiGe HBT amplifier, JINST 2016

Corresponds to 24 ps with 511 keV photons

ASIC Development

Sensor layout of Monolithic Prototype (September 2016)

- Low noise and fast amplifier based on SiGe HBT transistors
- Low power consumption

Apply 20, 40, 60, 80, 100 V to First GR

Succeeded to control the breakdown voltage by applying voltage to first guard ring

Sensor layout of Monolithic Prototype (April 2017)

- Pixel Matrix with guard ring
- Special guard ring test structures
- Full read-out chain, amplifier, discriminator and TDC