

## **R&D**

### **Development of microstrip sapphire sensor prototypes for Gamma Beam Profiler LUXE (GBP LUXE).**

#### **Aim**

The investigation is aimed to development of physical and technological bases of radiation hard microstrip single crystal sapphire sensors.

#### **Application**

The sensors as part of microstrip detector provides control of high-energy gamma-quanta beam profile, which is spatial distribution of gamma-quanta intensity over beam cross section with accuracy of few micrometers.

#### **Objectives**

1. Development of criteria and appropriate non-destructive methods for characterization and selection of sapphire wafers that is acceptable for microstrip sensor fabrication
  - 1.1 Photocurrent ( $I_{ph}$ ) mapping over area of the wafers having of 50 mm diameter or sizes of 60 mm × 48 mm and thickness within range of 100-150 microns.
  - 1.2. THz irradiation absorption mapping.
2. Development of method for estimation of electron mobility×lifetime value  $(\mu \times \tau)_n$ .
  - 2.1. Measurement of charge collection efficiency (CCE) dependence on bias of pad sensors (single sensors with sizes of 3 mm × 3 mm and i.e.) under irradiation with alpha - or beta - particles
  - 2.2 Measurement of photocurrent ( $I_{ph}$ ) dependence on bias of pad sensors (single sensors with sizes of 3 mm × 3 mm and i.e.) under irradiation with X-ray or electron beam.
- 3 Investigation of radiation hardness of sapphire sensors to irradiation of high energy beta-particles with energy of 0.5 MeV and dose up to 10 MGy.
4. Simulation of collected charge per strip and spatial resolution of sapphire microstrip sensor
  - 4.1 Simulation of dose and energy deposition distribution into volume of the sensor
  - 4.2 Simulation of 2D electric field distribution into volume of the sensor
  - 4.3 Simulation of 2D CCE distribution into volume of the sensor.
  - 4.4 Simulation of collected charge per strip.
5. Development and validation of microstrip detector prototypes
  - 5.1 4 channels prototypes (6 items)
  - 5.2 Full-size (192 channels) prototypes (6 items).
6. Testing of microstrip detector prototypes under X-ray or/and beta-particle irradiation
  - 6.1 Sensitivity
  - 6.2. Dynamic range
  - 6.3 Spatial resolution
  - 6.4 Radiation hardness

#### **Results**

1. Verification of compliance of microstrip sapphire sensor characteristics with the GBP LUXE requirements.
2. Criteria for selection of sapphire wafers that are optimal for GBP LUXE
3. Non-destructive methods for characterization of sapphire wafers
4. Technology of radiation hard microstrip sapphire sensors