Defect Engineering and Pad Detector Characterization

Defect engineering:

Search for hydrogen enrichment in silicon is still ongoing but takes time

- High energy H-implantation into the Cz-substrate of EPI-sensors with an energy of 5.5 MeV (range ≈ 300 µm, still inside the substrate).
  Problems:
  Damage at the end of the proton range too high
  High damaged region acts as a stopper for H diffusion into the EPI-layer
  High concentration of defects observed inside the EPI-layer already before any thermal treatment
- Search for enrichment by remote plasma treatment at elevated temperatures is ongoing

Pad Detector Characterization:

- Effects of mixed irradiation in FZ and MCz (n- and p-type, thickness 300 μm)
  - Damage additive with respect to leakage current
  - Damage effect on Vdep additive for n- and p-type FZ, p-type MCZ but not n-type MCz;
    FZ and p-type MCz damage dominated by acceptor creation,
    n-type MCz donor introduction by charged hadrons (dominant) partly compensated by neutron induced creation of acceptors
- Trapping, de-trapping
  - Electric field dependence
    Trapping time constant depends on electric field; effect seen in highly irradiated detectors but before onset of charge multiplication, physics behind still open question (trap assisted tunneling?)
  - Charge multiplication
    CM occurs after high damage and local high electric fields → CCE>1
    CM visible in I-V
    Correlation between CM and defects → model developed by Eremin
    Special strip test-sensors devoted for CM effects are under investigation

- CMS HPK campaign:
  - find optimal material and sensor thickness for CMS tracker upgrade
    Silicon material: FZ, MCz, EPI ; n- and p-type
    Thicknesses: 300, 200, 120 µm for FZ and MCz; 50, 75, 100 µm EPI

  - Process technology (HPK specific)
    fisrt batches: deep diffusion for 120, 200 µm sensors
    p-stop, p-spray for p-type sensors

  - Sensor design
    specific HPK design concerning guardring, cut edge,

  - First results before and after irradiation presented today

  - Systematic radiation damage studies on all materials
    neutrons, protons, mixed irradiation
    macroscopic and microscopic effects