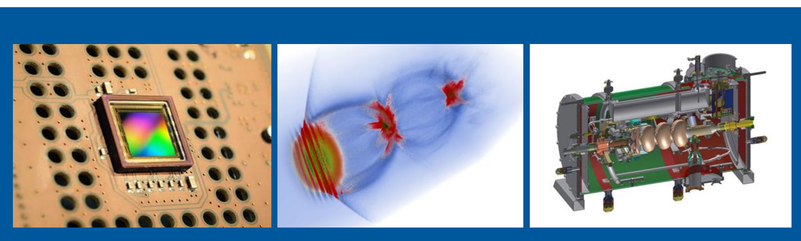
Programme Matter and Technologies

# Diamond Sensors for Particle Detection



Characterization and Application of Diamond Sensors

Maria Hempel

## Unique Features of Diamond Sensors

- *radiation hardness* → usage in high radiation fields
- *low permittivity* → low noise
- *high charge carrier mobility* → excellent time resolution
- *low leakage current* → low noise
- *Large band gap* → no cooling needed

## Sensor Development

Production of diamond sensors:

- *wafers by chemical vapor deposition (CVD)*
- *cutting and polishing*
- *metallization using lithography*

Different crystal structures:

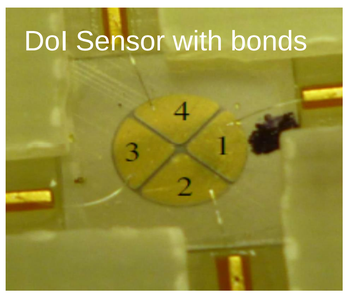
- *single crystal diamond sCVD*
- *poly-crystalline diamond pCVD*
- *diamond on Iridium DoI,*

Cooperation with different institutes/companies:

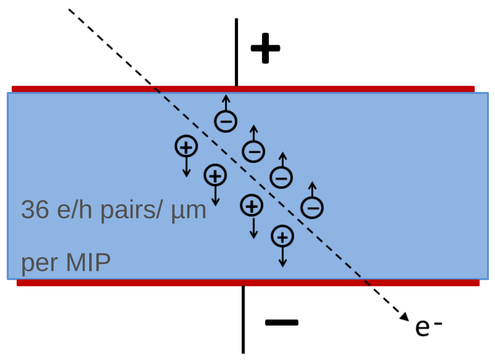
- *GSI Helmholtzzentrum für Schwerionenforschung*
- *Frauenhofer Institute IAF (pCVD)*
- *Element 6 (sCVD and pCVD)*
- *Augsburg University (DoI)*

## Sensor Qualification

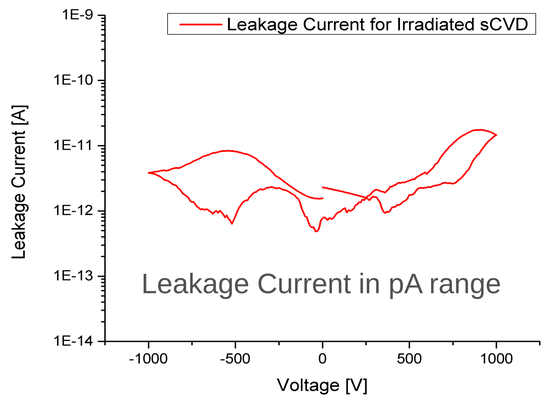
### Signal Generation



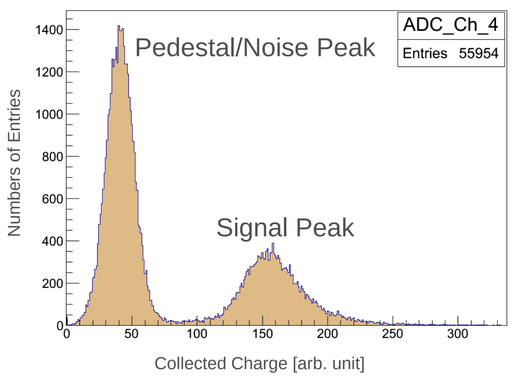

Ionization produces e/h pairs




### Leakage Current




### Signal Spectrum




Very good signal-to-noise ratio with dedicated front-end ASIC

### Charge Collection Efficiency (CCE)

- 100% CCE for sCVD
  → 75% CCE (irradiated)
- 60% CCE for pCVD
  → 45% CCE (irradiated)
- 55% CCE for DoI

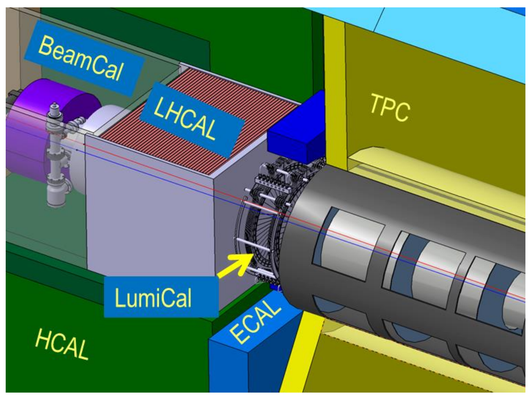


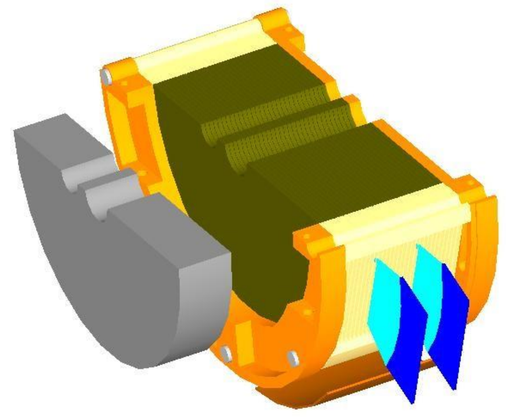

Irradiation of fluence 8.78x10$^{13}cm^{-2}$ (25GeV protons) after 30$fb^{-1}$ at LHC

## Sensor Application

### Future Application for ILC

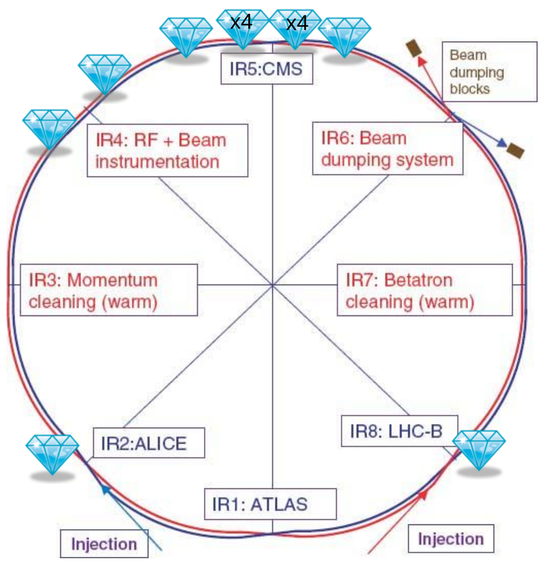
- instrumentation of the very forward region (Beamstrahlung of 1MGy per year)
- option for the BeamCal at ILC
- assist beam tuning and
- high energy electrons detection

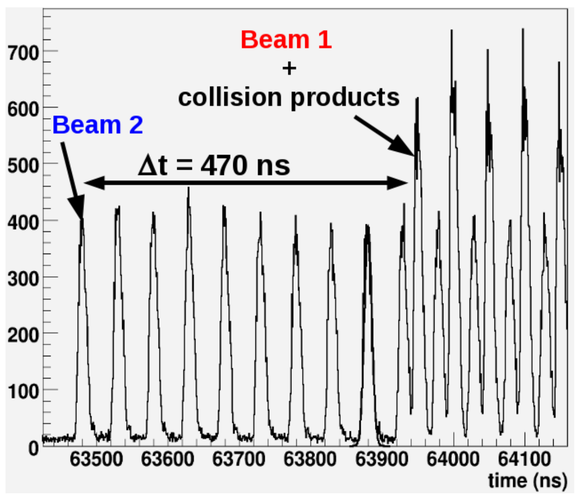


### Beam Condition Monitoring in CMS

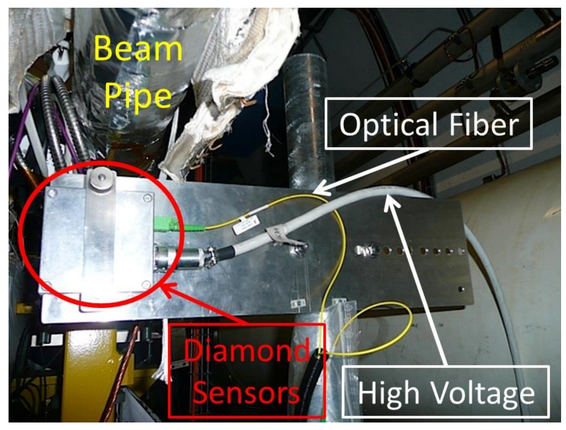
- 4 sCVD on each side of the CMS interaction point
- measurements of collision rates and beam background
- No other detector would show such a great performance under these conditions




### Diamond Sensors in LHC

- sCVD and pCVD sensors are positioned around the LHC
- measurements of beam losses on a bunch by bunch basis

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