

# Test beam results of MCz-Si detectors

P. Luukka

On behalf of the CMS SiBT group

(<http://www.hip.fi/research/cms/tracker/SiBT/php/home.php>)

# Beam studies

- Summer 2007
  - Commissioning of the upgraded SiBT (converted CMS long-term test system) at CERN H2 beam line.
  - N-type MCz-sensors (non-irradiated and two irradiated sensors)
  - 10-20 Hz DAQ rate
- Summer 2008
  - New n-type MCz sensors
  - FZ sensors (wafers from RD50 common order with Topsil)
  - Data acquisition rate increased to 100 Hz
  - Cold box temperature lowered
  - Introduction of a separate “cold finger” for CID studies
- Summer 2009
  - p-type MCz in addition to new n-type MCz and FZ sensors
  - Biasing range extended from 600 to 1000 V

# Test beam setup

- CERN North area SPS H2 beamline

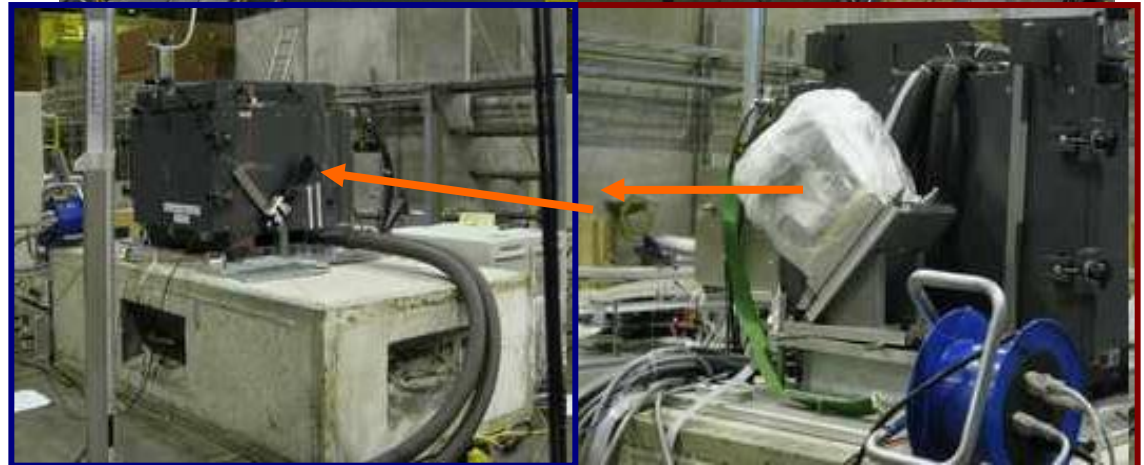
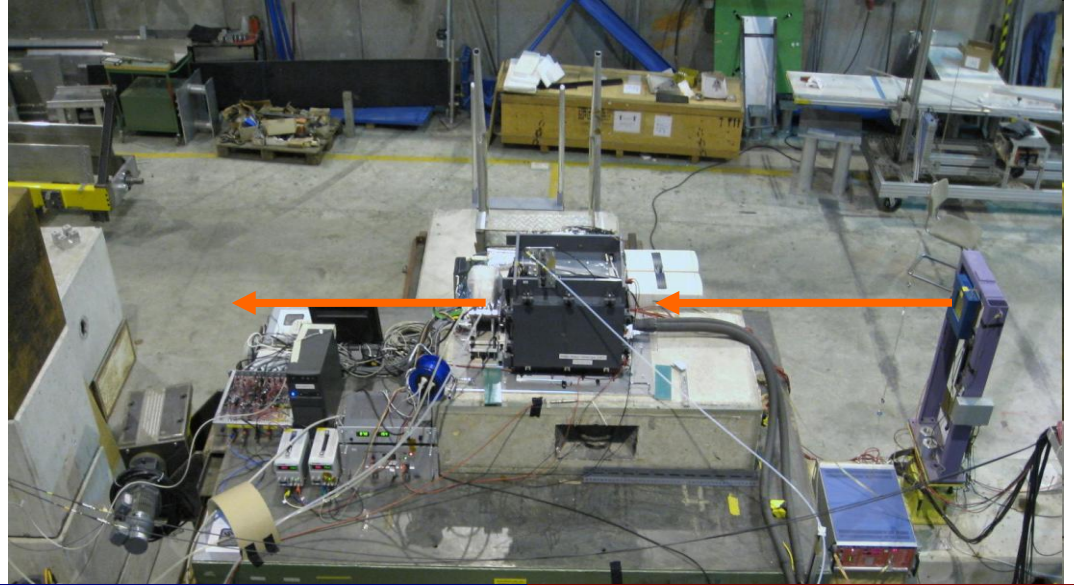
- 225 GeV muon, pion, and mixed beams

- 10 slot beam telescope based on CMS module test station

- 8 reference modules and 1-2 DUTs in central slots

- CMS DAQ electronics with early version of the Tracker SW

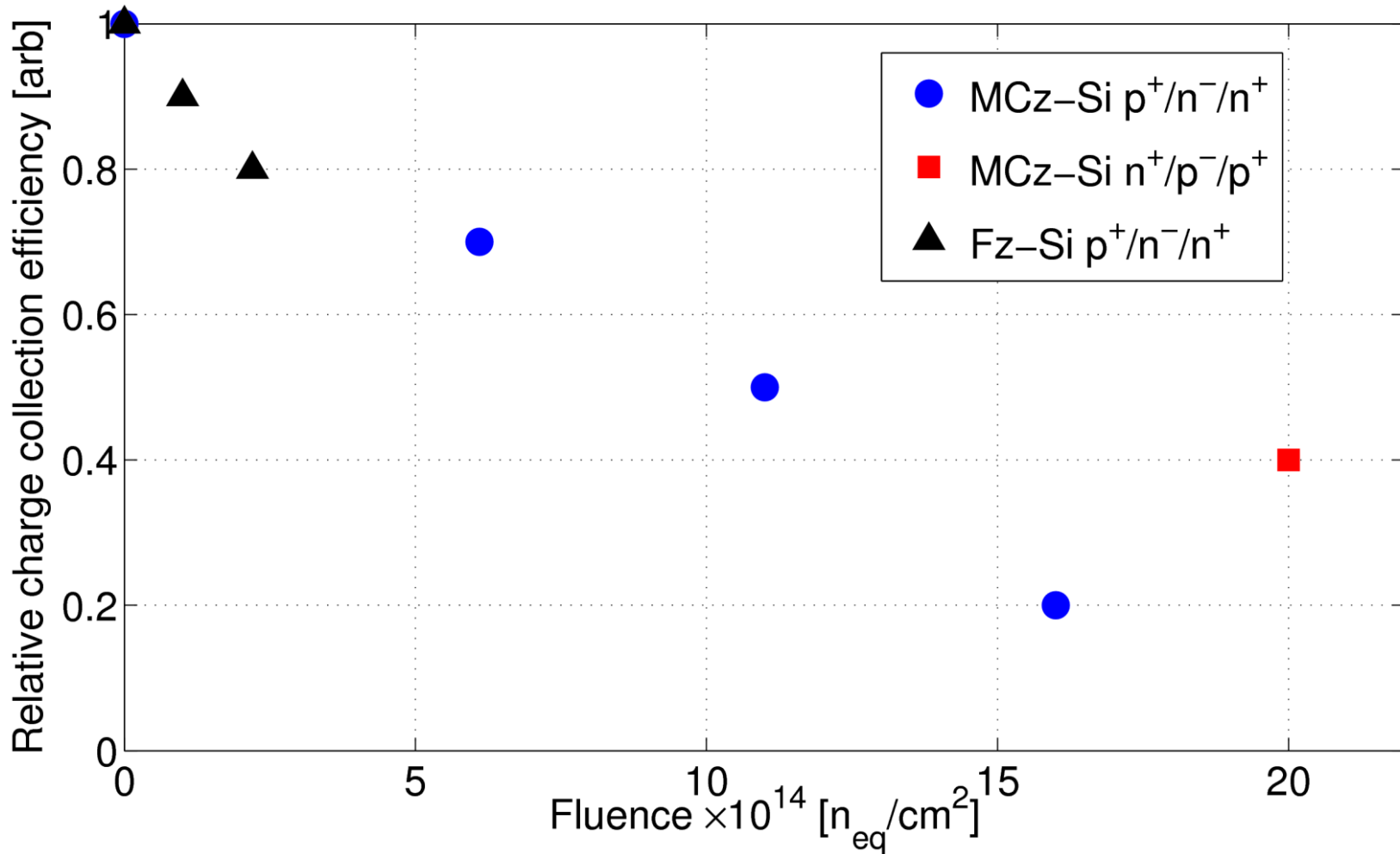
- CMSSW framework used for track reconstruction



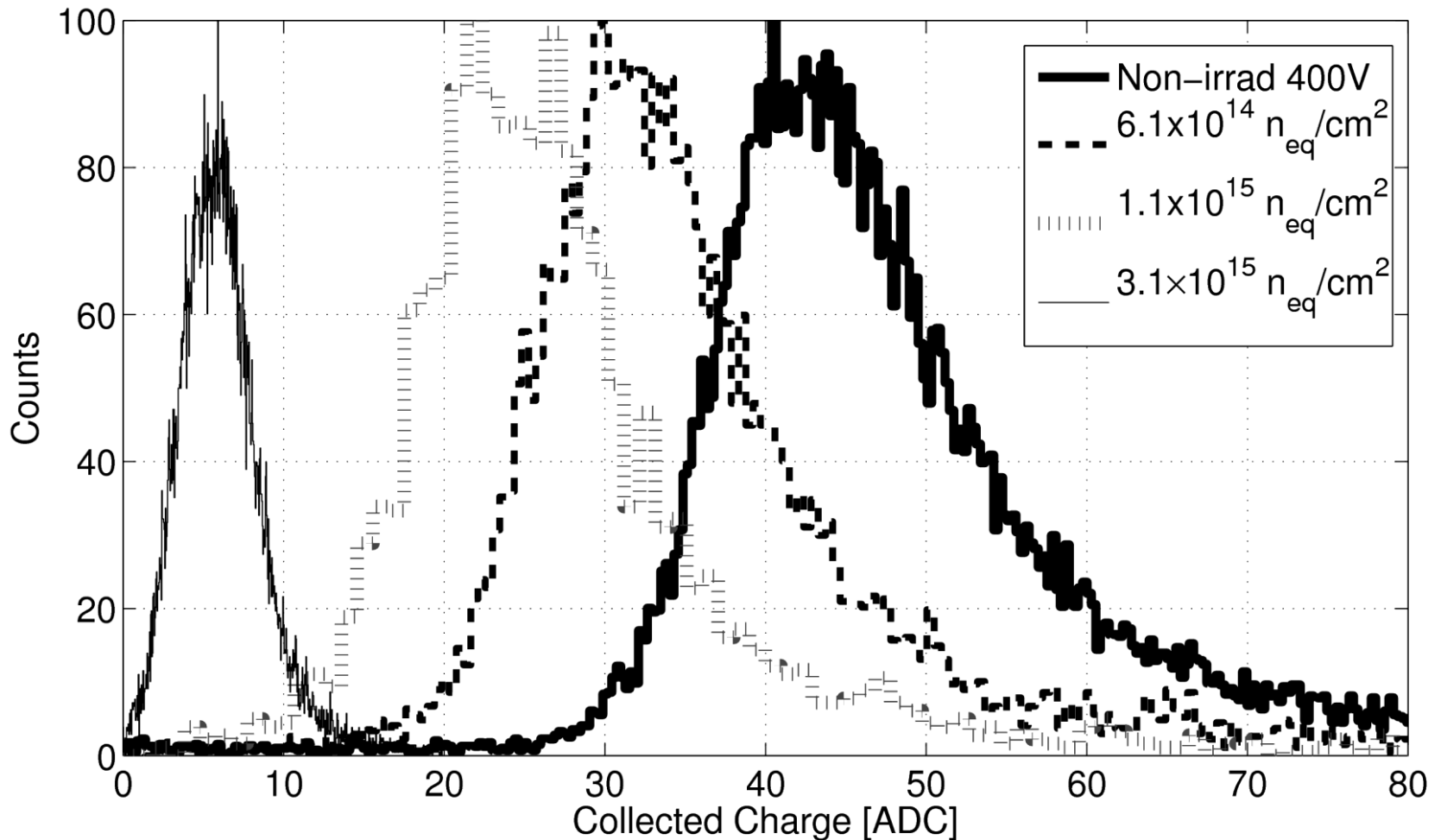
# Sensors

- N- and p-type MCz, FZ and CID sensors:
  - Processed at Helsinki University of Technology
  - Micronova Centre for Micro and Nanotechnology
  - 4" silicon wafers from Okmetic and Topsil
  - Two 4 cm x 4 cm detectors from one wafer
  - 50  $\mu\text{m}$  pitch
  - 768 strips per detector
- Telescope reference sensors:
  - Provided by the D0 collaboration from unused Run IIb stock
  - Hamamatsu FZ
  - 4 cm x 10 cm
  - 60  $\mu\text{m}$  pitch with intermediate strips
  - 639 strips per detector

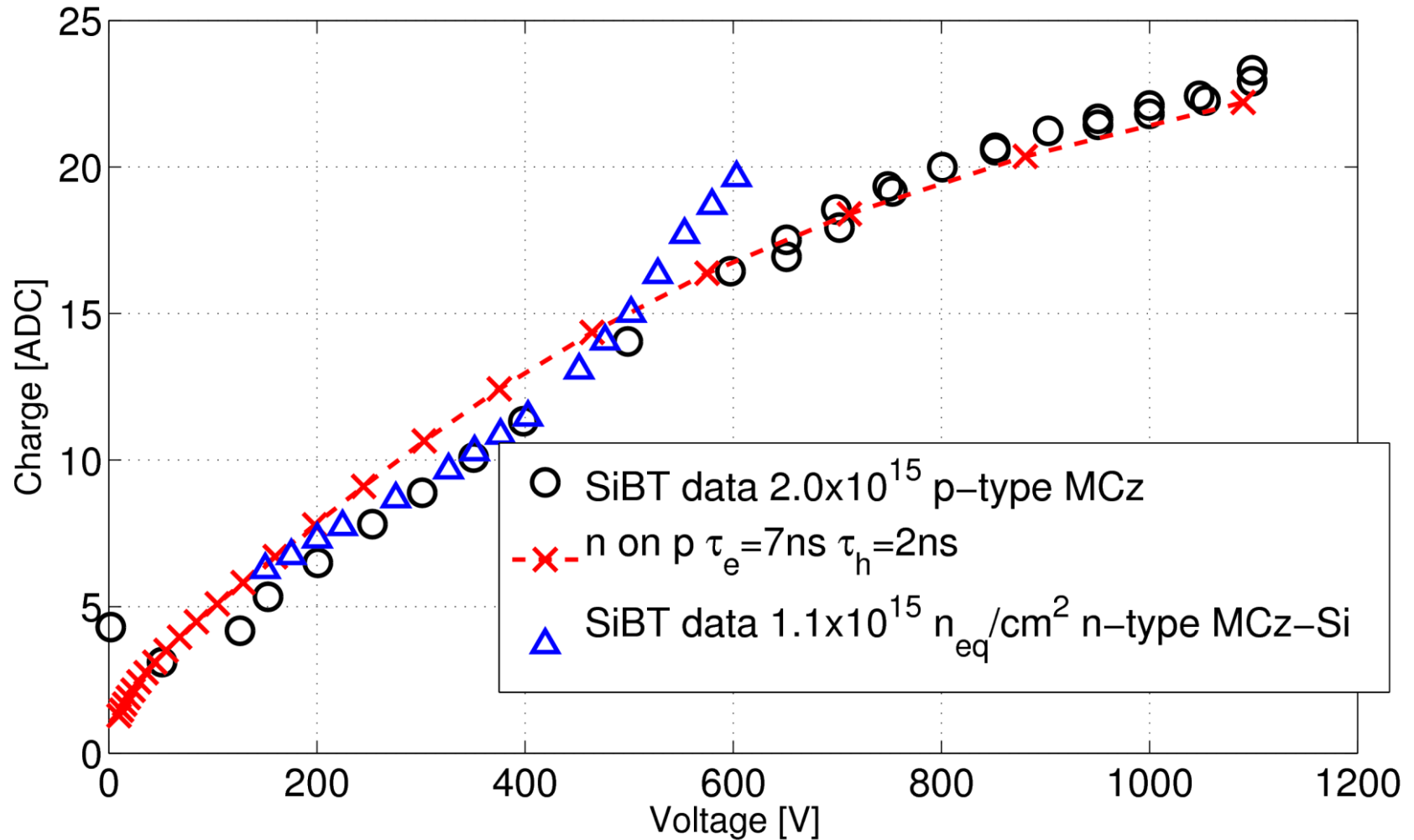
# Relative CCE as a function of fluence



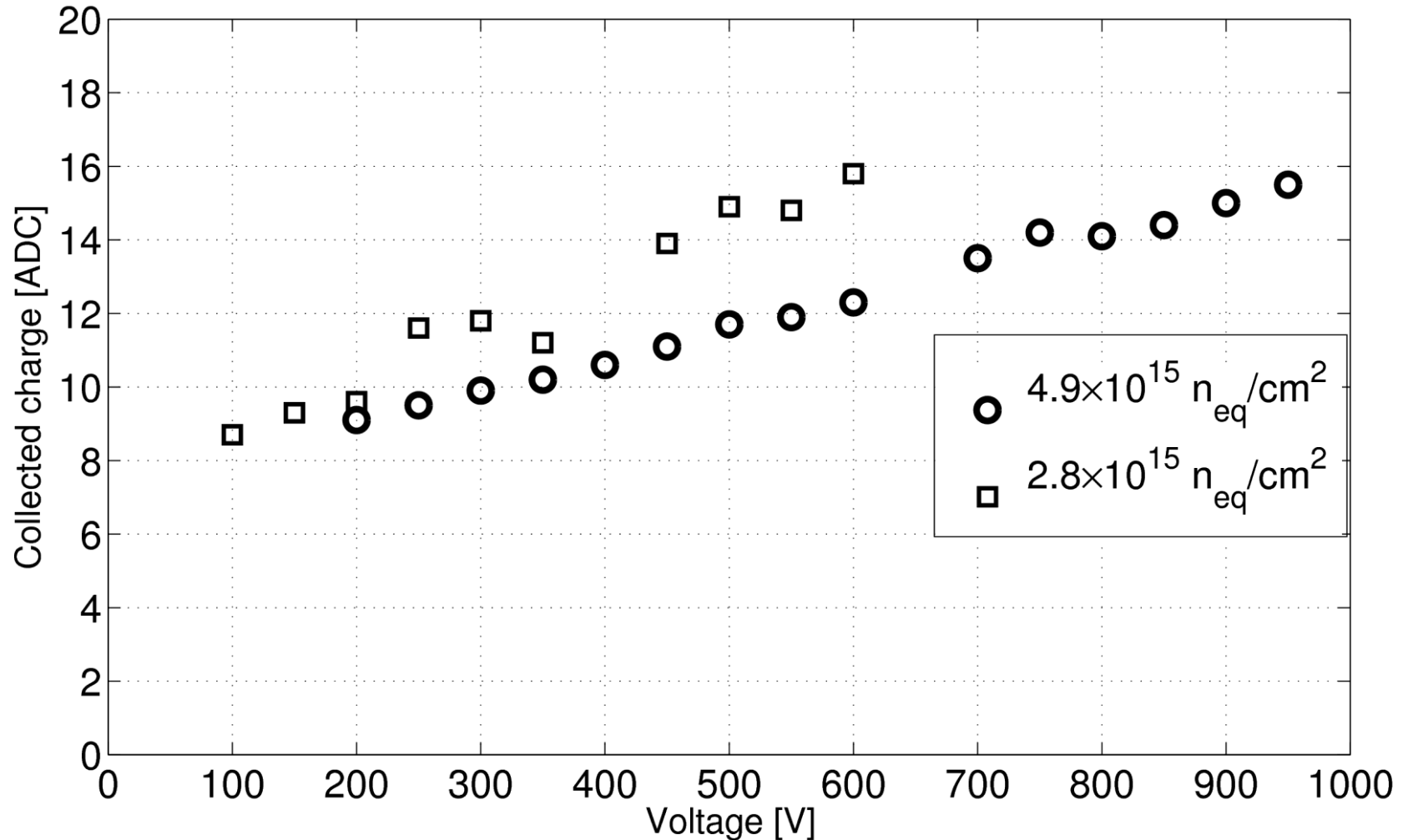
# Landau distributions of n-type MCz-Si sensors



# Collected Charge - n and p-type Mcz-Si sensors



# CCE of Charge Injected Detectors (operating at $-50^{\circ}\text{C}$ , RD39)





# Summary and conclusions

- ✓ n-type MCz-Si operational after  $1 \cdot 10^{15} n_{eq}/\text{cm}^2$ , i.e. feasible for S-LHC strip layers.
- ✓ p-type MCz-Si 40% CCE @ 600V and 55% CCE @ 1100V after  $2 \cdot 10^{15} n_{eq}/\text{cm}^2$ .
- ✓ Performance on p-type similar to n-type after 2 times higher fluence
- ✓ No avalanche multiplication observed up to 1100V