EXPERTISE IN TECHNOLOGY AND ECONOMICS

LAPPEENRANTA
UNIVERSITY OF TECHNOLOGY

P.O. Box 20, FIN-53851 Lappeenranta, FINLAND | Skinnarilankatu 34, 53850 Lappeenranta, FINLAND
Tel. +358 5 62 111 **Fax** +358 5 621 2350

www.lut.fi

2D simulation of n-on-p strip detectors with different p-stop and p-spray structures

Tanja Palviainen
Lappeenranta University of Technology
Laboratory of Microelectronics

in collaboration with

Helsinki Institute of Physics, CERN, Geneva, Switzerland
Ioffe Physico-Technical Institute of Russian Academy of Sciences, St.Petersburg, Russia
Brookhaven National Laboratory, Upton, NY, USA

Outline

- Motivation
- Benefits of n-on-p strip detector structure
- The Layout of the n+/p-/p+ strip detector
- Problems of the p-type detectors
- P-spray and p-stop implant
- Simulations done by Silvaco VWF
- Simulation of n-on-p strip detector
- Simulation problems to overcome
- Summary and future work

Motivation

- It has been shown that the charge collection in silicon strip detectors is effected by the properties of the surface in the inter-strip gap [*V. Eremin et al., NIM, A500, (2003) 121*].
- For device and material characterization and development of radiation hard detectors it is essential to investigate some special constructions of detectors for evaluating or even eliminating this effect.
- One of the constructions is an n-on-p strip detector.

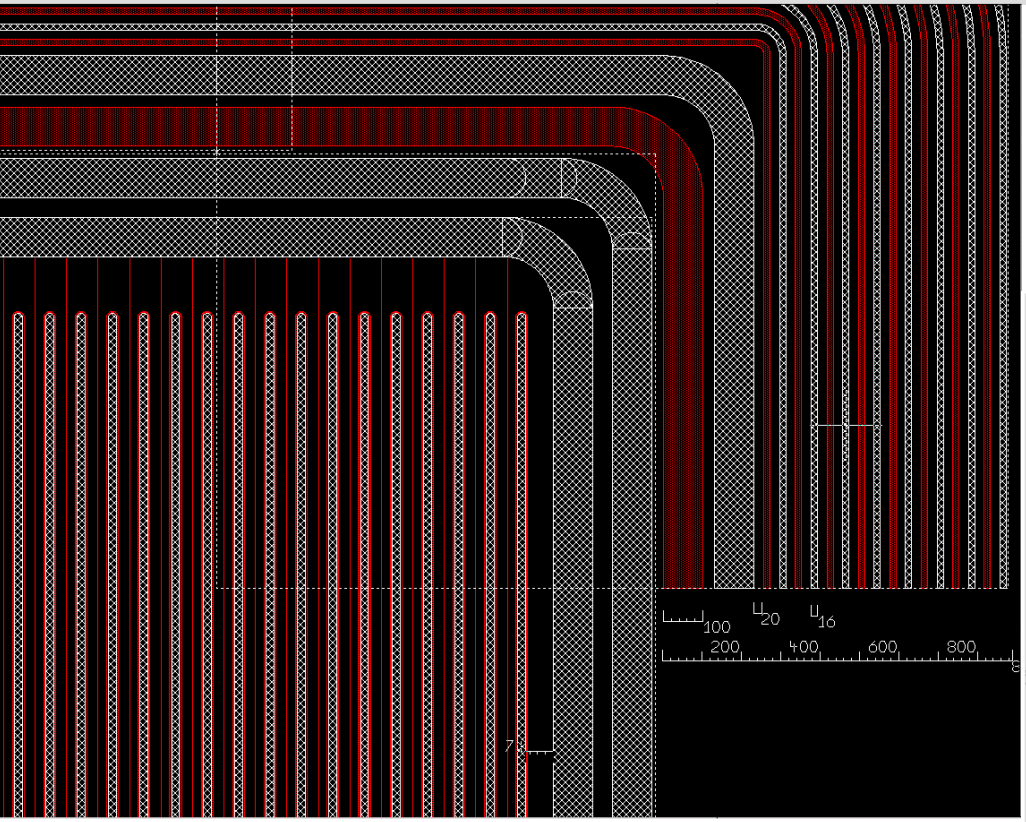
Benefits of n-on-p strip detector structure

- The strips collect electrons

  → the charge loss problem is less effected because electron mobility is three times that of holes

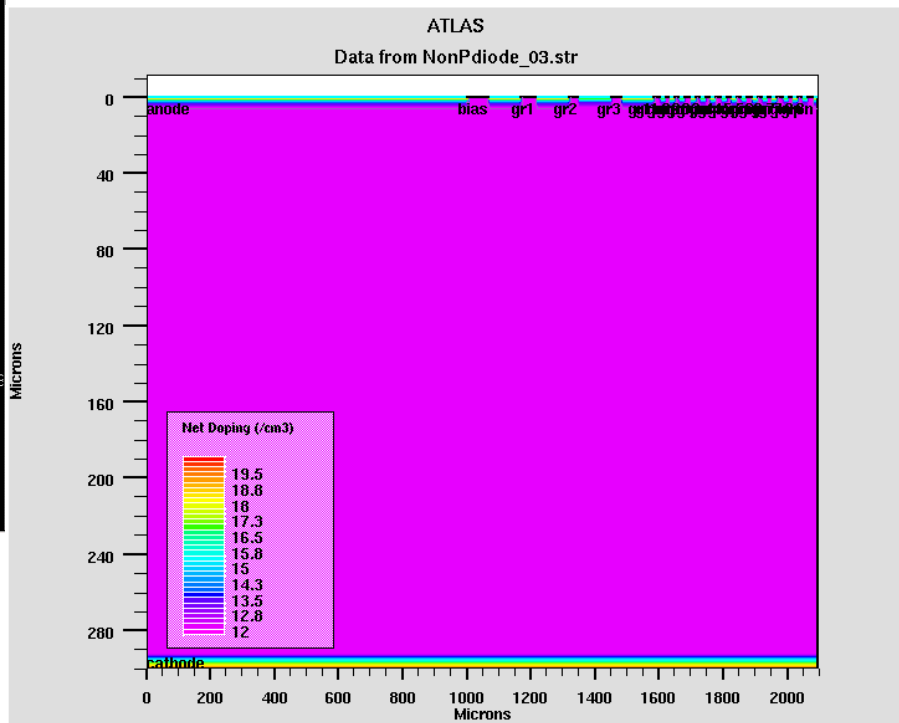
  → trapping drops to one third

The layout of the n+/p-/p+ strip detector



The layout: Jaakko Härkönen, HIP

white = Phosphorus
red = Boron



LAPPEENRANTA
UNIVERSITY OF TECHNOLOGY

Problems of the p-type detectors

- Larger leakage current
- Surface inversion

  → Reducing surface inversion can be done with two methods: using **p-spray** implant, or using **p-stop** implant

P-spray and p-stop implant

- In case of p-spray implant: the whole wafer surface is doped with a small amount of boron
- In case of p-stop implant: the big dose of boron is doped to the area separated by mask level.
- In this design of n-on-p strip detector the combined p-stop structure [*Unno Y. et al. IEEE Transactions on Nuclear Science, vol. 45, no. 3, June 1998*] is used where each n-strip region is splitted into a cell with a narrow p-implant line and placed the individual p-stop frame within the cell.

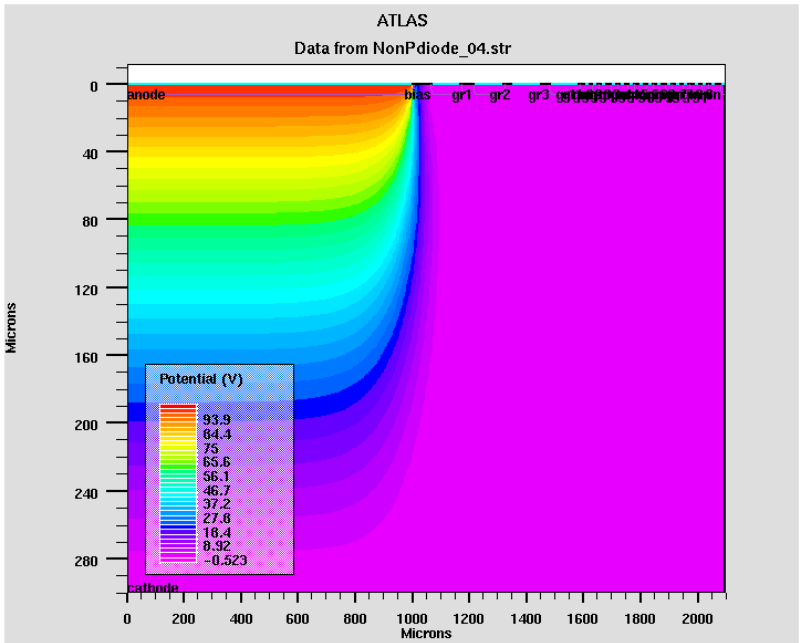
Simulations done by Silvaco VWF

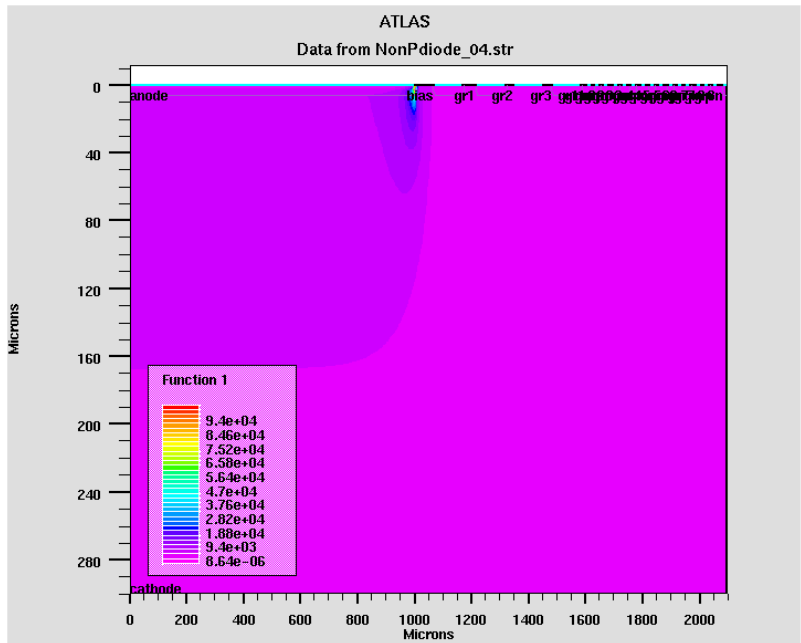
- The computer simulations of the n-on-p strip detector are done using Silvaco Virtual Wafer Fab (VWF) software.
- VWF software is a simulation tool for electronic design.
- It includes different kind of tools for device and process simulation (atlas and athena).
- Silvaco is a physically based simulator, which predicts the electrical characteristics associated with specified physical structures and conditions.

Simulation of n-on-p strip detector

- n-on-p strip detector structure is under simulation

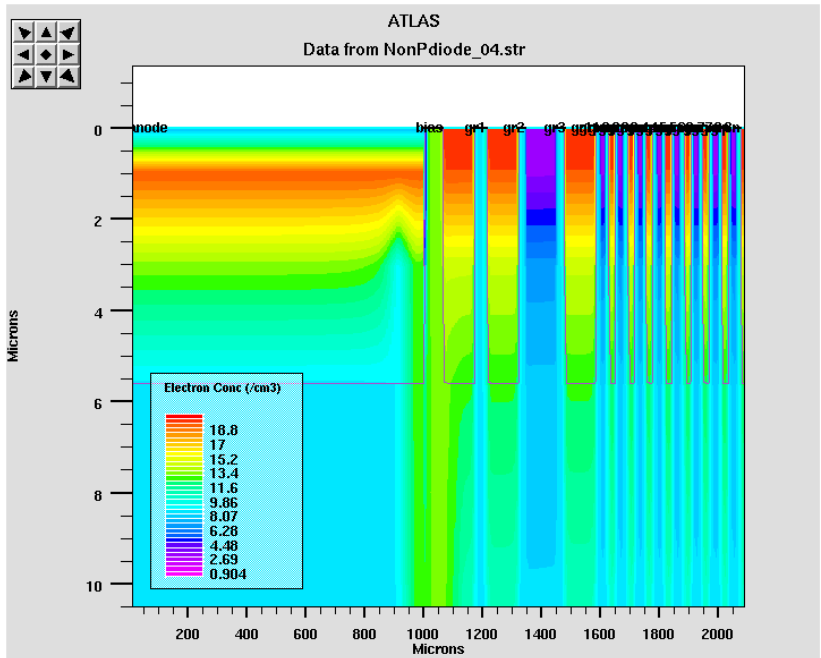
  → these results are the first ones and not correct!





LAPPEENRANTA
UNIVERSITY OF TECHNOLOGY

Simulation of n-on-p strip detector



MORE DETAILED ANALYSIS IS NEEDED!

LAPPEENRANTA
UNIVERSITY OF TECHNOLOGY

Simulation problems to overcome

- Include parameters for trap states
- Define oxide charge
- Investigate if the simulation of dynamical response is possible

Summary and future work

- Simulations are in process
  → big amount of work still to be done

- Develope structure model for simulation
- Include parameters
- Confirm results with measurements

LAPPEENRANTA
UNIVERSITY OF TECHNOLOGY

Thank you for your attention!

LAPPEENRANTA
UNIVERSITY OF TECHNOLOGY