Institute of Physics
University of Freiburg

Current activity status at Freiburg

Beta source measures on irradiated 3D-STC after annealing

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Outline

-3D-STC sensors and setup description

-CCE results after irradiation and annealing

-On going work on 3D-DDTC

-Conclusions

Detectors characteristics and setup

3D-STC microstrip sensors: 80um pitch X and Y, 230 columns per strip, 64 strips.

2 devices under test: FZ and CZ p-type substrate, p-spray isolation,
525um and 300um thick respectively.

SETUP

Sr90 Beta source, 2 triggers in coincidence

ATLAS SCT binary readout, 20ns shaping time

The whole system is cooled down to -10° C

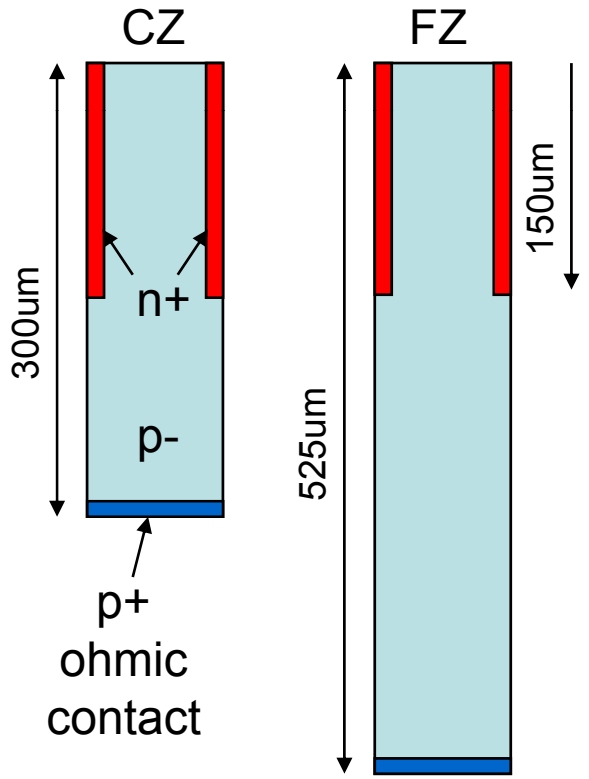
Irradiation

24MeV protons in Karlsruhe, 9.81x 10^{14} Neq/cm^2

Annealing:

CZ at 60°C, 80min

FZ at 80°C, 60min



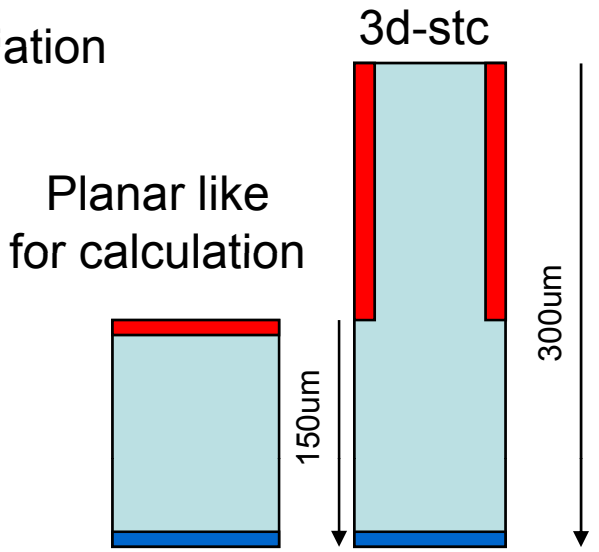
CCE on CZ, 300um thick

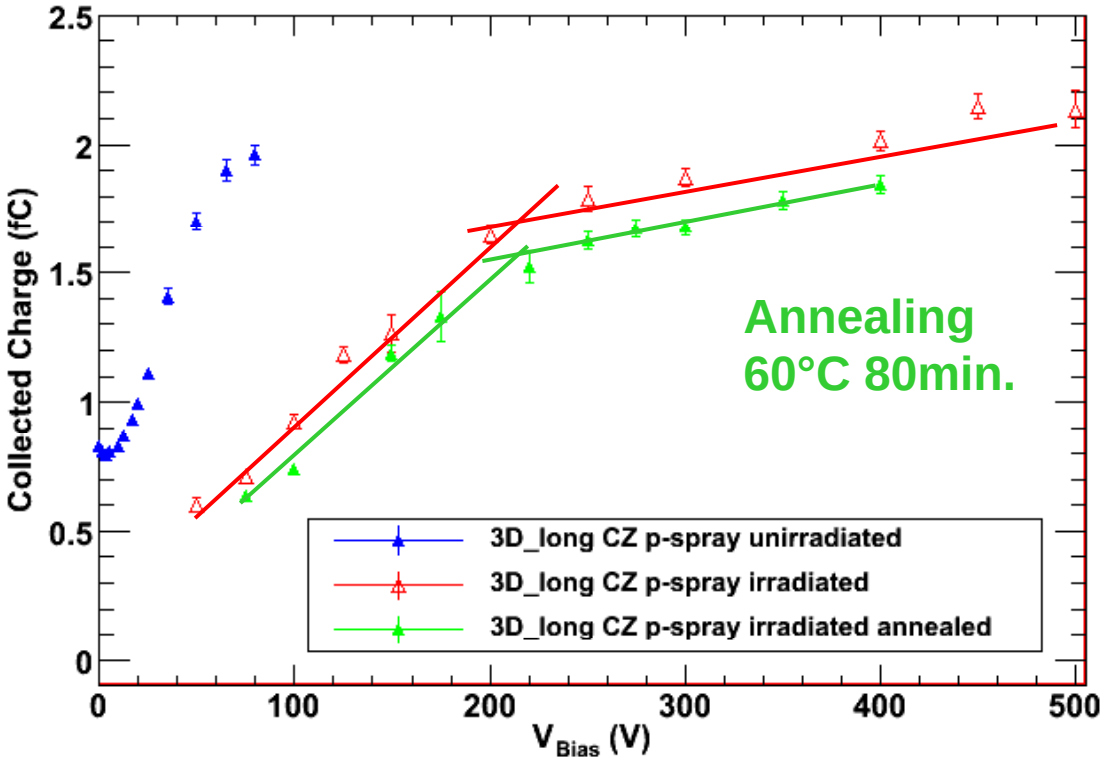
Neff= g_C x Φ_{EQ} +N_0 = 1.33x10^{13}cm^{-3} expected after irradiation

N_0= 3.5x10^{12} cm^{-3} g_C=0.01cm^{-1}

$$V_{DEP} = \frac{W^2 \cdot q \cdot N_{eff}}{2\varepsilon_{Si}\varepsilon_0}$$

Expected V_{LAT} = 33V
Expected V_{FD} = 230V





Full depletion voltage well predicted by g_C CZ p-type. (see Cindro's talk)

Low CCE after irradiation could be explained by holes trapping, that gets even worse after annealing

Trapping of holes estimation with Ramo's theorem

Has the trapping any influence in 3D_STC CCE?

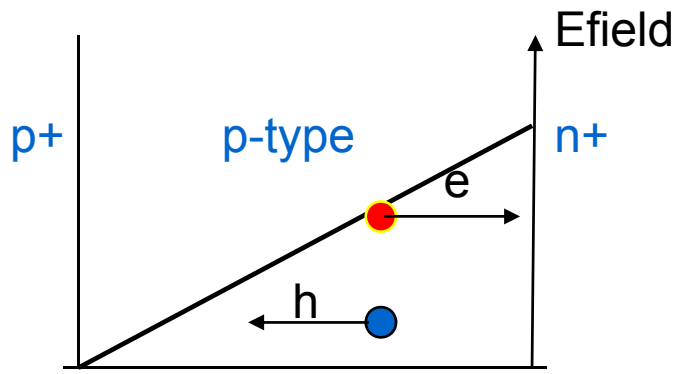
$1/T_{EFF}$ (hole) 30% higher after annealing
$1/T_{EFF}$ (el) 15% lower after annealing

$$1/T_{EFF} = \beta * \Phi eq$$

$\beta h = 5.7x\ 10^{-16} cm^2/ns$

$\beta e = 3.7x\ 10^{-16} cm^2/ns$

Ramo's theorem and collected charge:
the increase of 1/ Teff after annealing lowers CCE by only ~ 0.05fC.



Hole trapping is critical between columns where holes are diffusing toward the back side

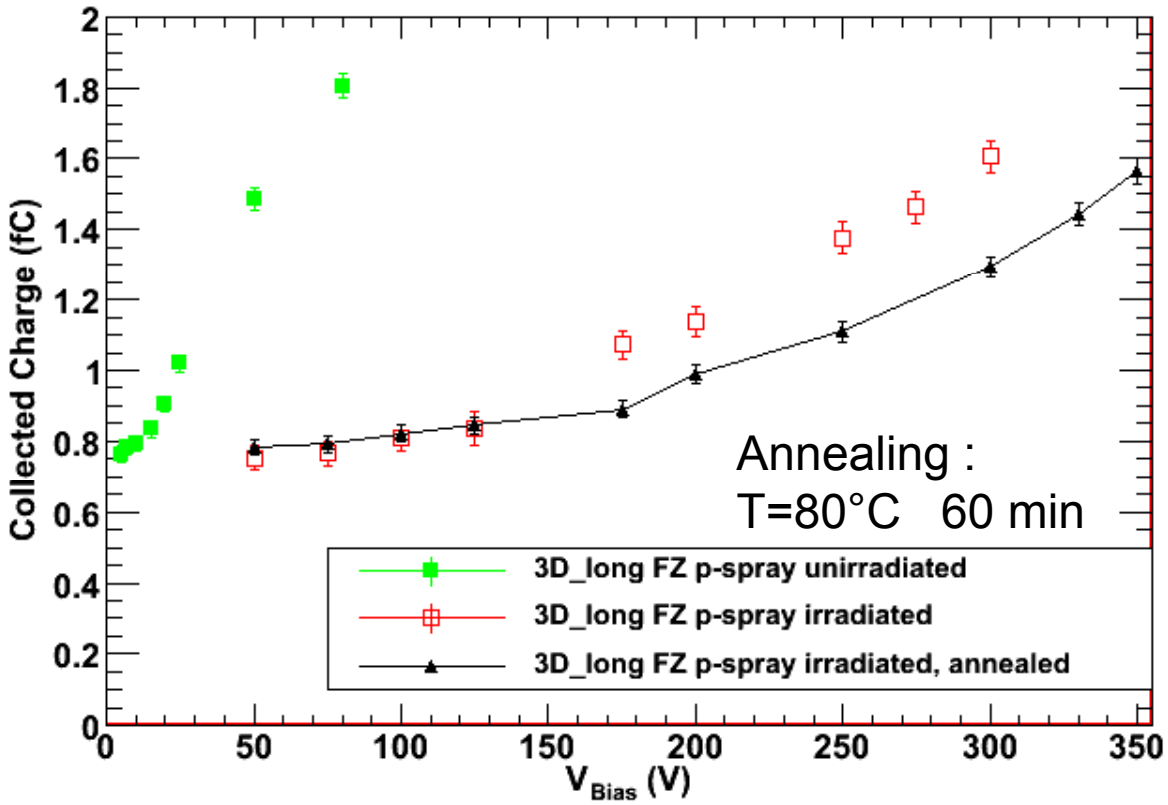
Kramberger et. al., NIMA 571 (2007),pp 608-611

	Pre Annealing	Annealing FZ 80°C 60min	Annealing CZ 60°C 80min
Teff (hole) Leff	**1.93 ns 108 um**	**1.48 ns 83 um**	**1.84 ns 103 um**
Teff (electrons) Leff	2.97 ns 286 um	3.49 ns 337 um	3.13 ns 301 um

CCE on FZ, 525um thick

After irradiation lateral depletion increases from 10V to 33V, total depletion unreachable due to onset of microdischarges.

Due to reverse annealing Neff increase -> less charge after annealing due to smaller depleted volume underneath the columns.



On going work at freiburg, DDTC n-type

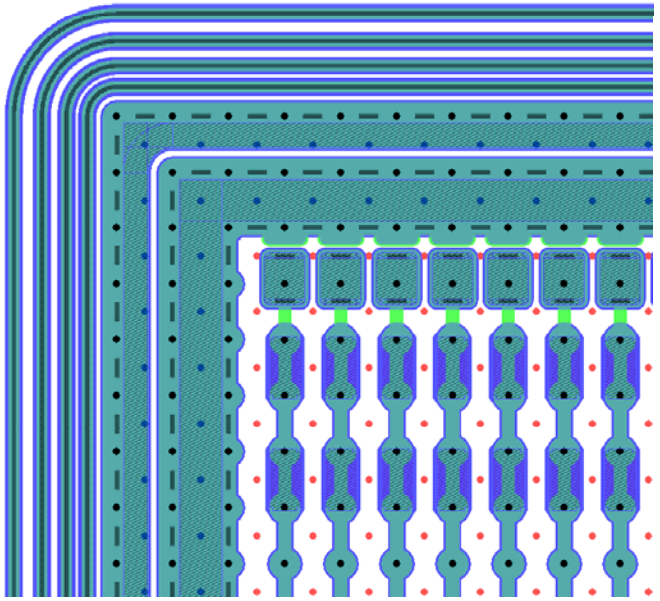
4 DDTC p-on-n strip sensors are at freiburg.
300um thick, 190um column depth

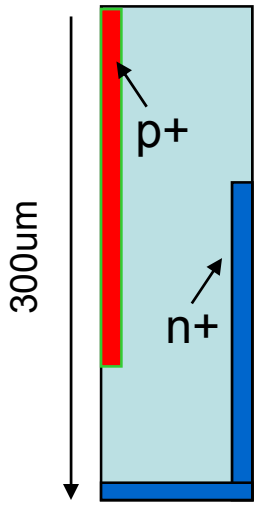
1cm x 1cm area, 80um inter/intra column pitch,
102 strips and 102 col/strip.

AC coupled, bias by punch-through from BL.

The sensors were just glued on the module
and will be tested both with IR pulsed laser
and beta source setup.

ATLAS readout , 20ns shaping time





Conclusions

- 3D_STC after irradiation are still working

- The annealing has affected the CCE:
  - on CZ probably due to trapping of holes between columns
  - on FZ mostly because the annealing was too long and Neff has increased significantly

- 3D_DDTC ready to be tested in Freiburg,
  the new geometry is an important step as for CCE and radiation hardness.

Thank you