# Characterization of silicon diodes

## pion and proton irradiated n-MCz and n-Fz diodes
## proton irradiated p-Epi (50µm & 75µm)

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**CERN PH-DT**

# Material and irradiation

2.5 x 2.5mm, 300 µm, HIP

**MCz-n**: 1kΩcm => depletion voltage 300V

**Fz-n**: 15 kΩcm => depletion voltage 20V

**protons:**

CERN PS, 24 GeV/c

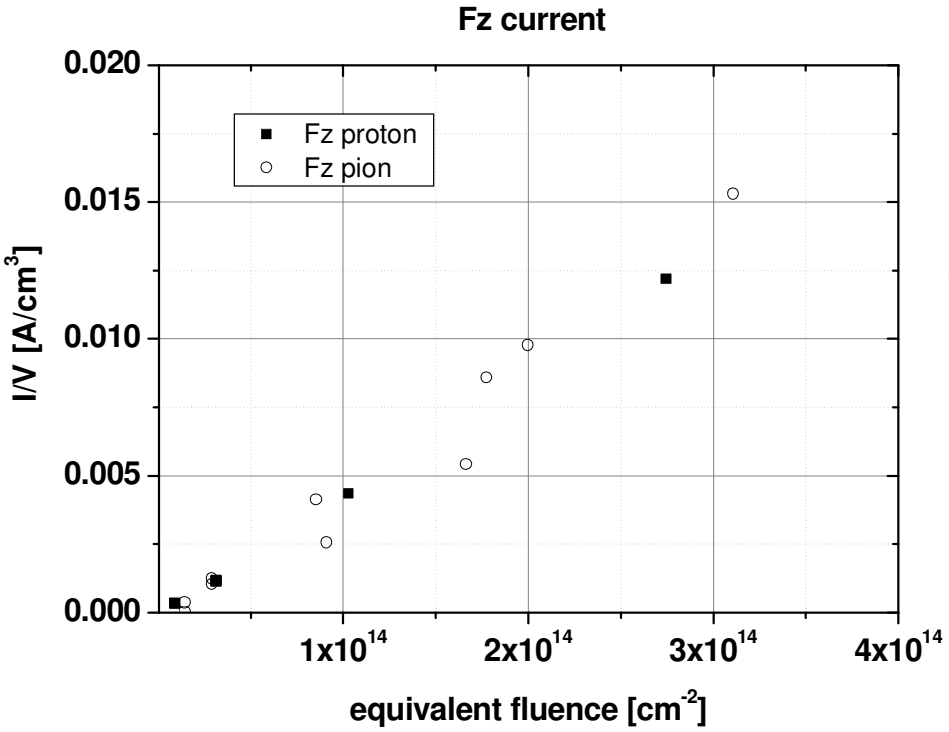
Hardness factor: 0.62, 7-8% fluence uncertainty

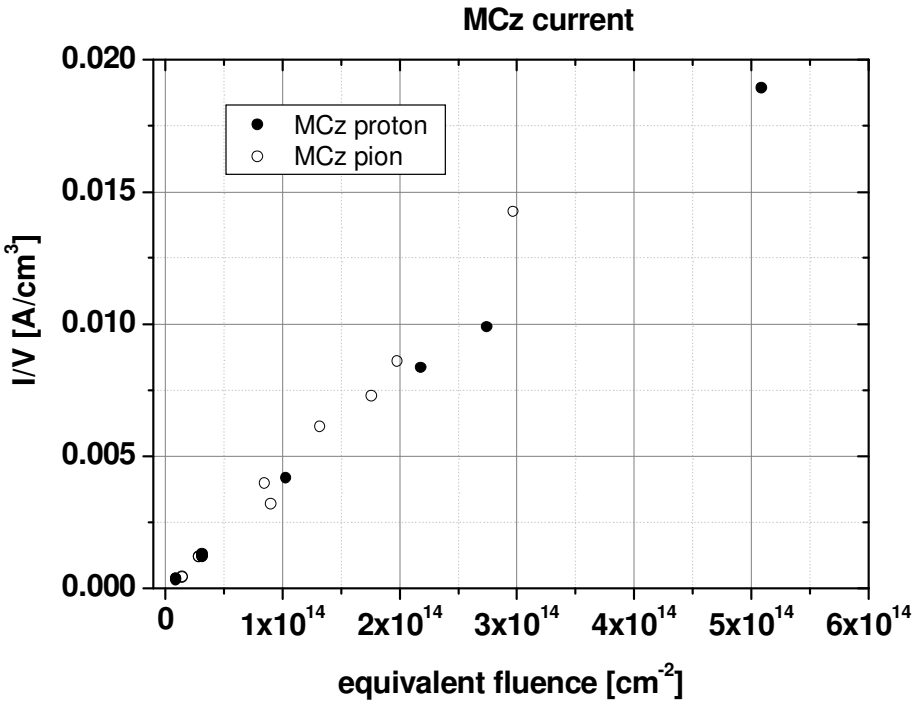
**pions:**

PSI, 300 MeV

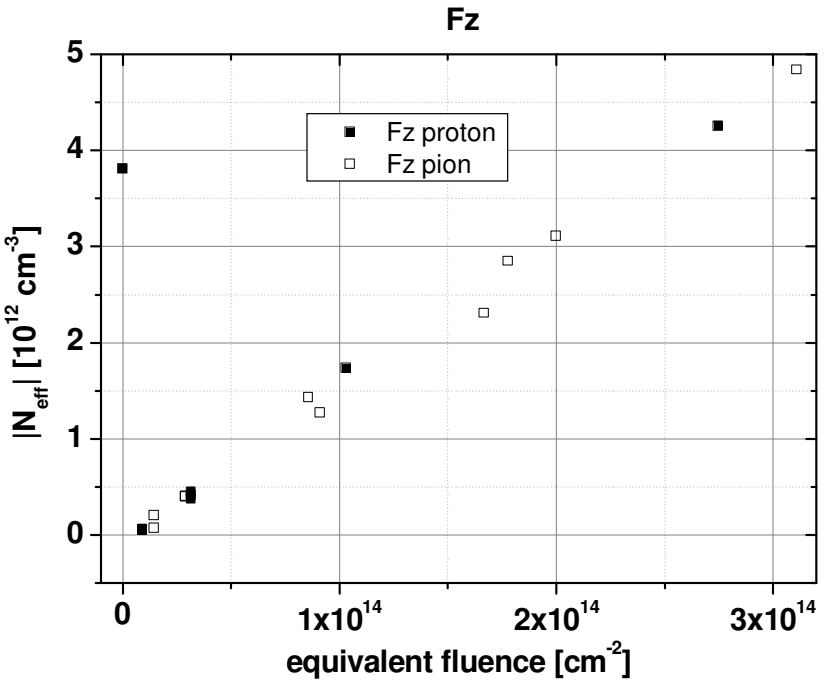
Hardness factor for pions 1.11 used => **20%** uncertainty in fluence

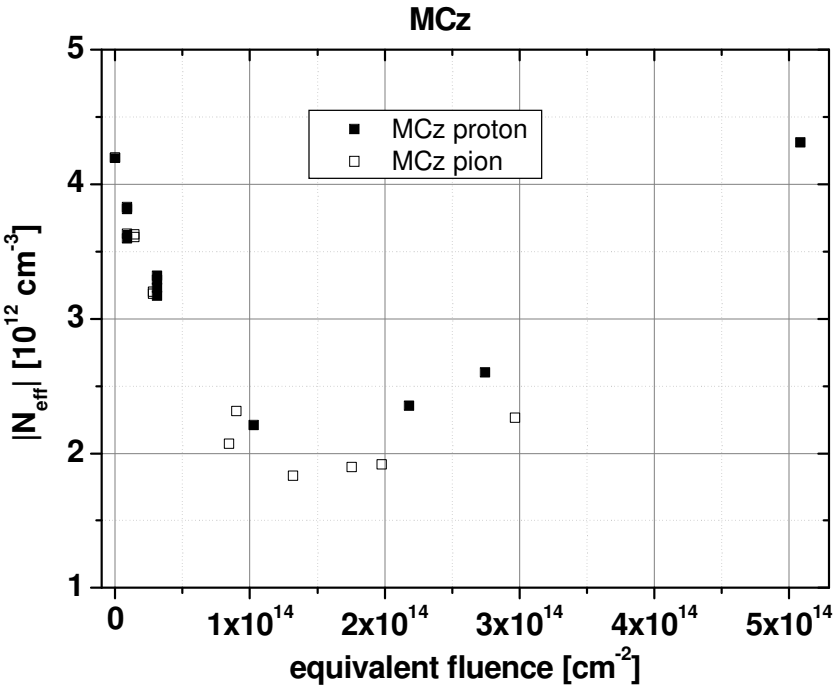
# Current comparison



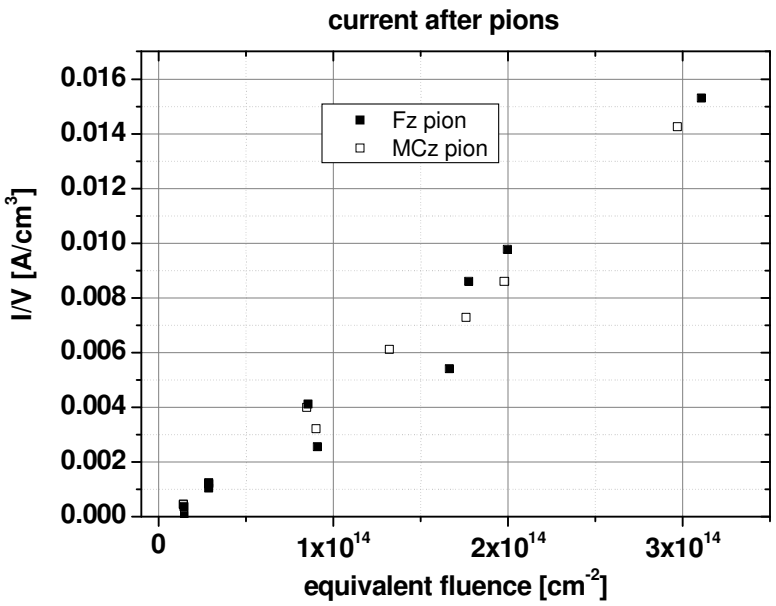



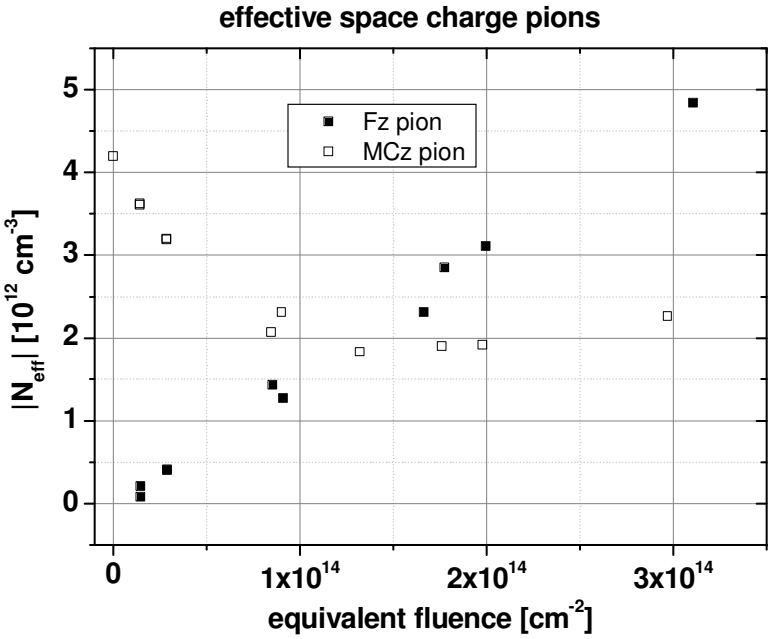
# Depletion voltage



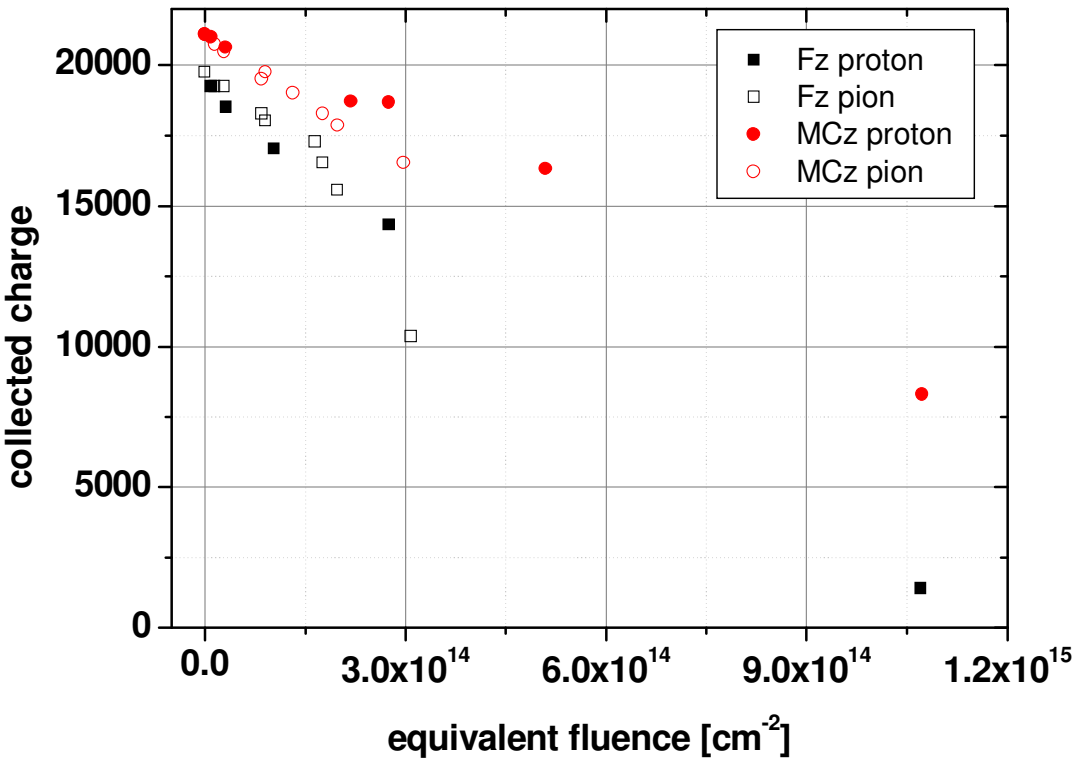
# Material comparison



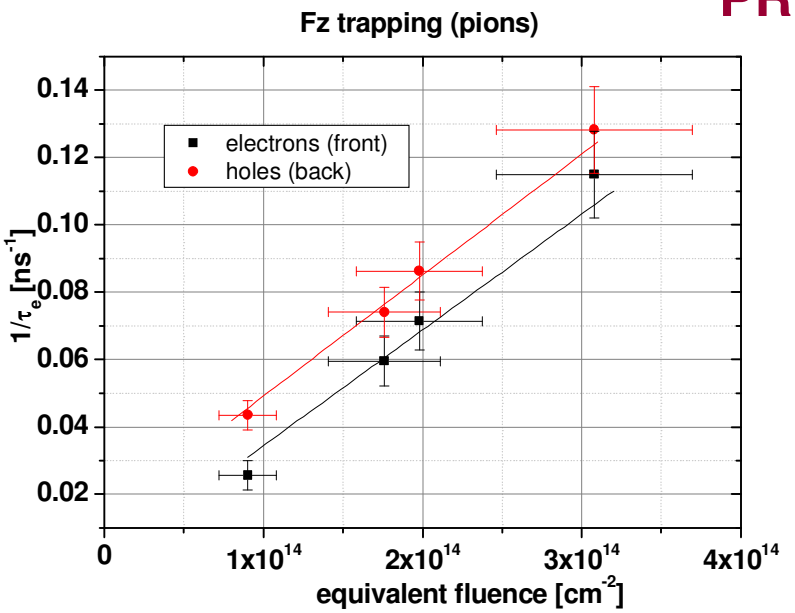
# Collected charge

## Collected charge at 300 V



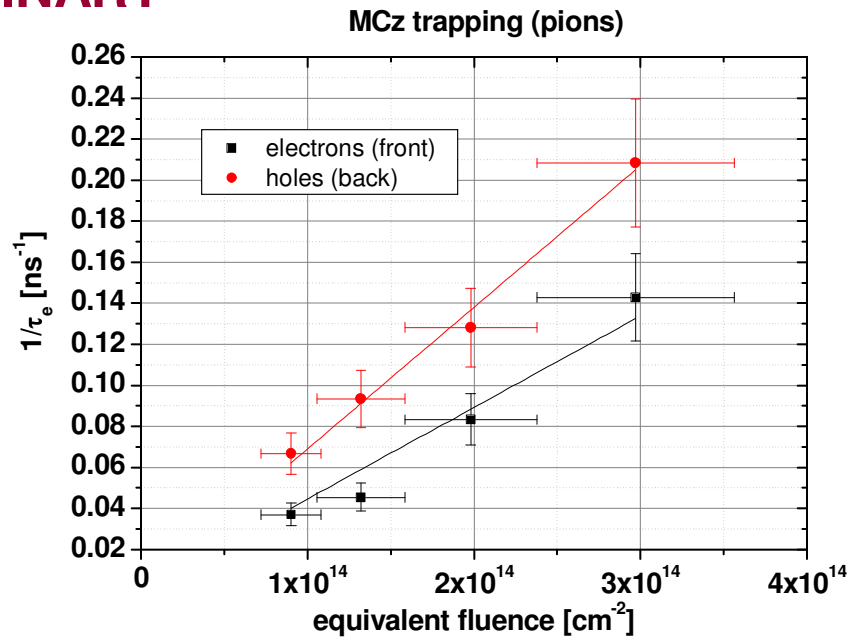
# Trapping

## PRELIMINARY




electrons 3.43 x $10^{-16}$ cm$^{-2}$/ns
holes 4.37 x $10^{-16}$ cm$^{-2}$/ns

Trapping after proton irradiation
electrons 6.2 x $10^{-16}$ cm$^{-2}$/ns
holes 6.4 x $10^{-16}$ cm$^{-2}$/ns



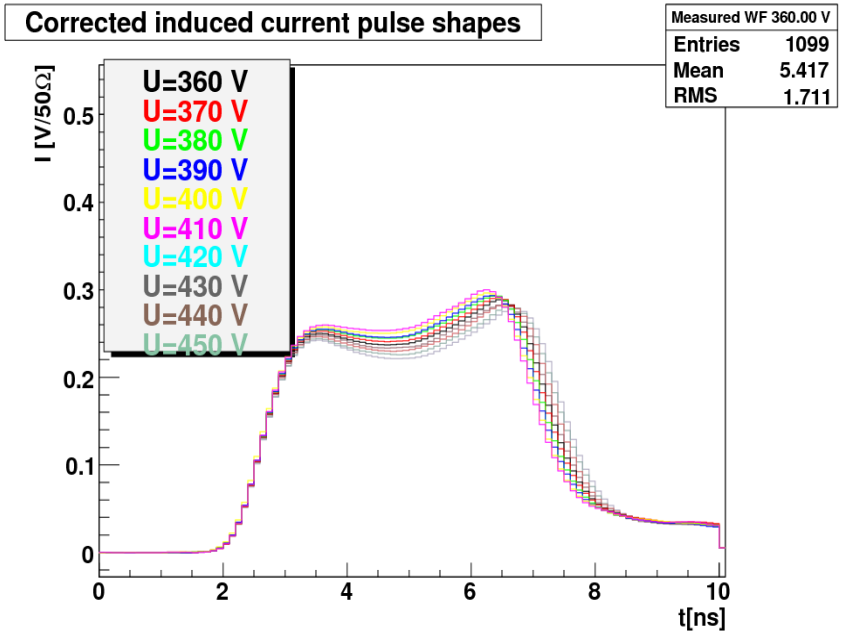

electrons: 4.5 x $10^{-16}$ cm$^{-2}$/ns
holes: 6.9 x $10^{-16}$ cm$^{-2}$/ns

Trapping after proton irradiation
electrons: 7.0 x $10^{-16}$ cm$^{-2}$/ns
holes: 6.8 x $10^{-16}$ cm$^{-2}$/ns

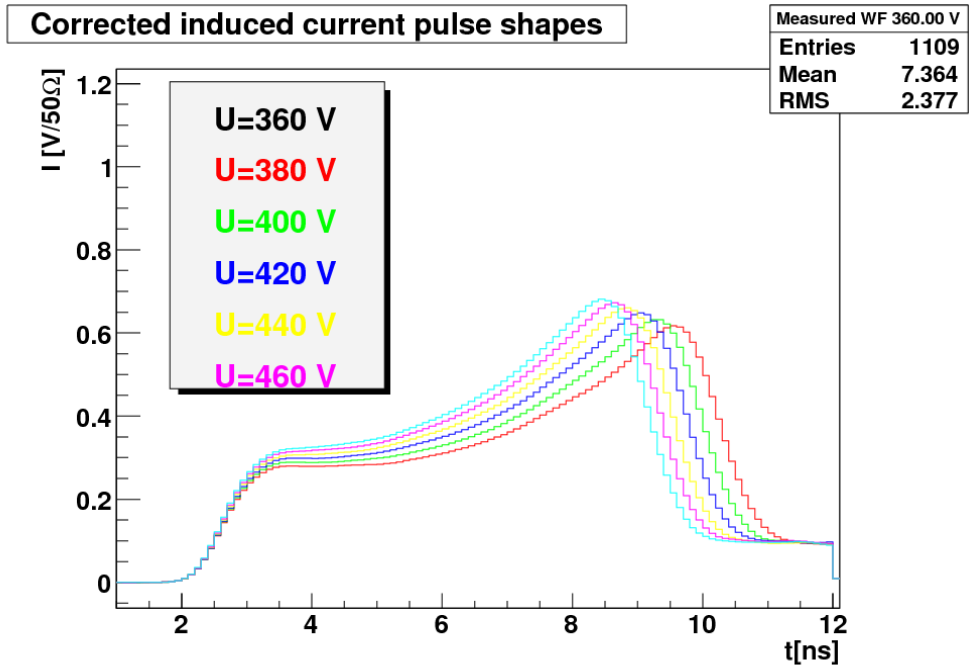
# Corrected TCT curves

## MCz

PRELIMINARY




Front illumination, trapping time 7ns




back illumination, trapping time 4.8ns

**=> Inconclusive =>equal double junction?**

N. Pacifico et al. doi:10.1016/j.nima.20
Z. Li et. al. doi:10.1016/j.nima.2009.08.082

# Thin Epi-p

**Material:**

**150 µm:** 5x5mm, 1 kΩcm => depletion voltage 220V (CNM)

**75 µm:** 2.5x2.5mm, 350 Ωcm => depletion voltage 180V (CiS)

**50 µm:** 2.5x2.5mm, 220 Ωcm => depletion voltage 120V (CiS)

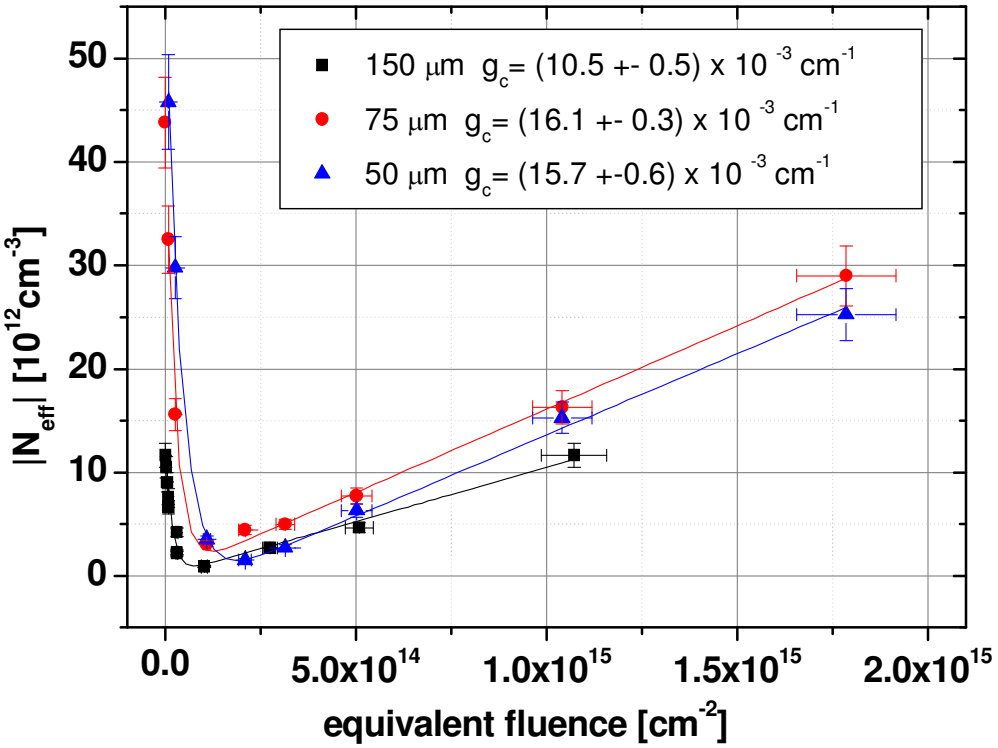
**Irradiation:**

24 GeV/c protons, CERN PS

**Epi-n** => $g_c$ varies with layer thickness after proton irradiation
positive space charge for all thicknesses after proton irradiation

**Epi-p** => variation?
150 µm: positive space charge after proton irradiation
75 µm, 50 µm: ?

# Depletion voltage




$g_c$ 150 µm slightly lower, but 75 µm and 50 µm very similar

Comment: Significantly less variation than seen in Epi-n after proton irradiation

For comparison: Epi-n as measured by the Hamburg group

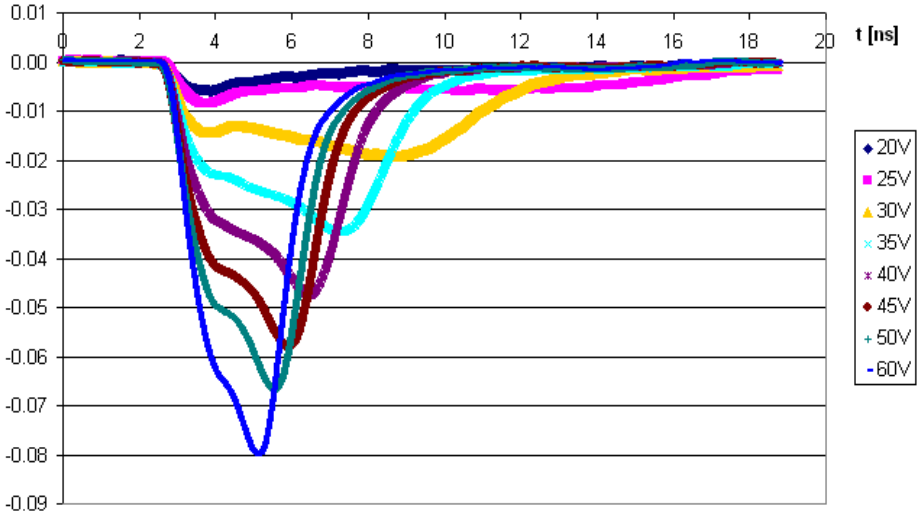
| thickness [µm] | 50 | 75 | 100 | 150 |
|---|---|---|---|---|
| $g_c$ [$10^{-3}$ $cm^{-1}$] | -23 | -12 | -6 | -6 |

see also V. Khomenkov's talk yesterday

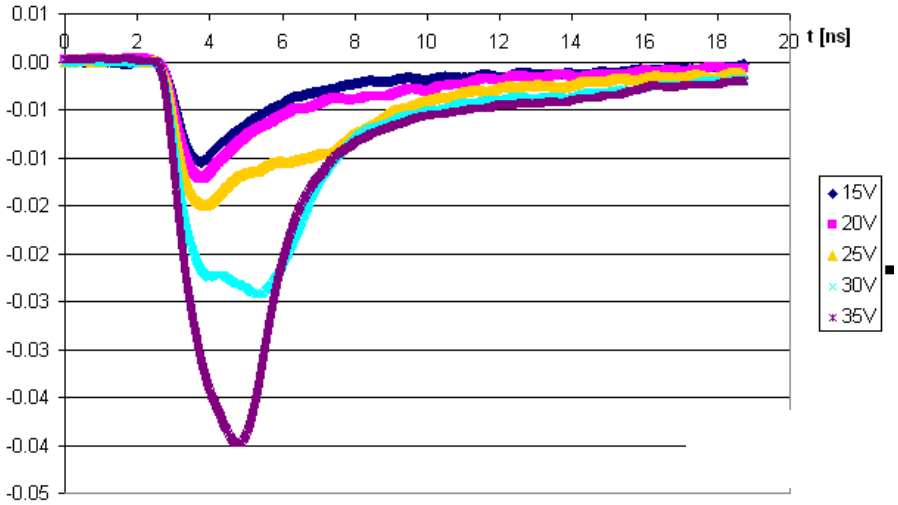
# TCT results

Not corrected for trapping!

75 µm, 5 x $10^{14}$ p/cm$^{-2}$




50 µm, 1.66 x $10^{15}$ p/cm$^{-2}$




=> positive space charge after irradiation (type inversion)

# Summary

- Depletion voltage and leakage current in Fz very similar after proton and pion irradiation
- Slight variations in MCz in leakage current and depletion voltage after proton and pion irradiation+
- Collected charge in MCz higher than in Fz
- Collected charge slightly less after pion irradition compared to proton irradiation in both materials
- Preliminary: trapping probability lower after pion irradiation, hole trapping different for Fz and MCz

- $g_c$ doesn't strongly depend on layer thickness in Epi-p
- Type inversion after proton irradiation in Epi-p of all investigated thicknesses (150µm, 75µm, 50µm)

**THANK YOU**