

# 10<sup>th</sup> RD50 Workshop

## PDC discussion

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## 24 GeV proton irradiated samples

	MCz-n Cz-n	MCz-p	Epi-n	STFZ-n STFZ-p	DOFZ-n DOFZ-p
$\beta_{eq}$ [10 <sup>-3</sup> cm <sup>-1</sup> ]	-4.2 to -6.5 [1,2,7] -5.4 [3]	3  to  7.5  [1,4]	-3 to -10 [6] ****	24 [5] 4[7]	6-7 [5] 4[7]
$g_Y$ [10 <sup>-2</sup> cm <sup>-1</sup> ]	3.8 [2] * 4 [3]	>3 [1,4]***	2.9 [6] (first component)	4.8	2.3*
$\tau_{ra}$	~80 min@80C (1 <sup>st</sup> component)	>100 min@80C	~120min@80C	~50 min@80C	~200min@80C



Negative space charge



Positive space charge

- [1] N. Manna, 8<sup>th</sup> RD50 workshop
- [2] A.G. Bates and M. Moll, *Nucl. Instr. and Meth. A555* (2005) 113.
- [3] E. Fretwurst, 3<sup>rd</sup> RD50 workshop
- [4] H. HödelMoser, RESMDD06
- [5] Rose RD48 status report
- [6] G.Lindström, NIMA ()
- [7] G. Pellegrini et al., NIM A552 (2005) 27.
- [8] N. Manna, 7<sup>th</sup> RD50 workshop
- [9] Lozano et al, NIMA A 552 (2005) 27–33.
- [10] V Cindro, 8<sup>th</sup> RD50 Workshop

- \*saturation at  $\Phi_{eq} > 5 \cdot 10^{14} \text{ cm}^{-2}$
- \*\*\*annealing not fully completed
- \*\*\*\* depends on thickness

## Neutron irradiated samples

MCz-p,n ; DOFZ-n ; STFZ-n type:

- $\beta_{eq} \sim g_c \sim 20 \cdot 10^{-3} \text{ cm}^{-1}$  [5,8,10]
- $g_Y = 4 \cdot 10^{-2} \text{ cm}^{-1}$
- $\tau_{ra} = \sim 80 \text{ min@80C}$

Epi-Si:

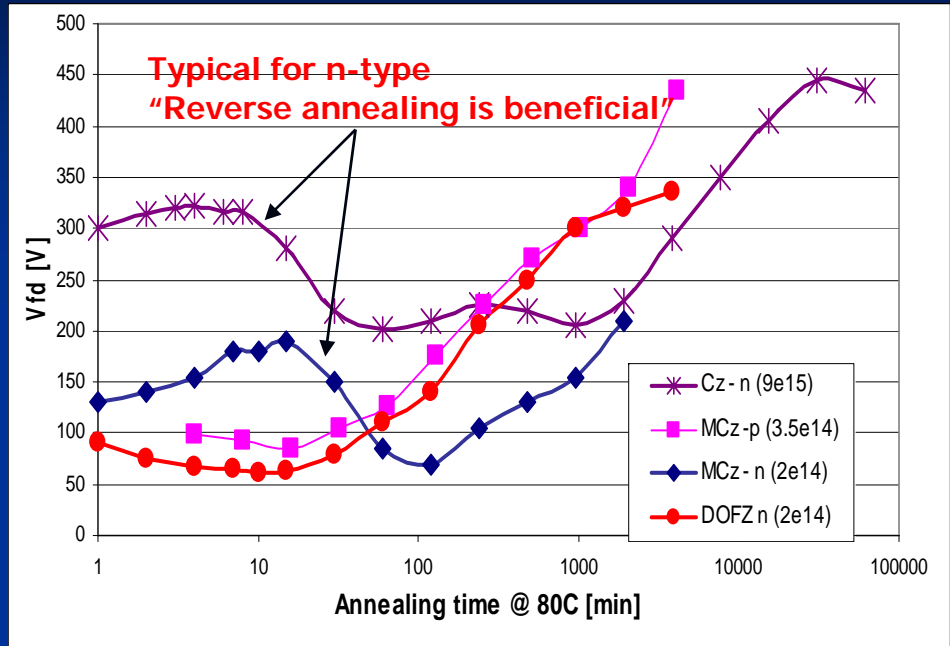
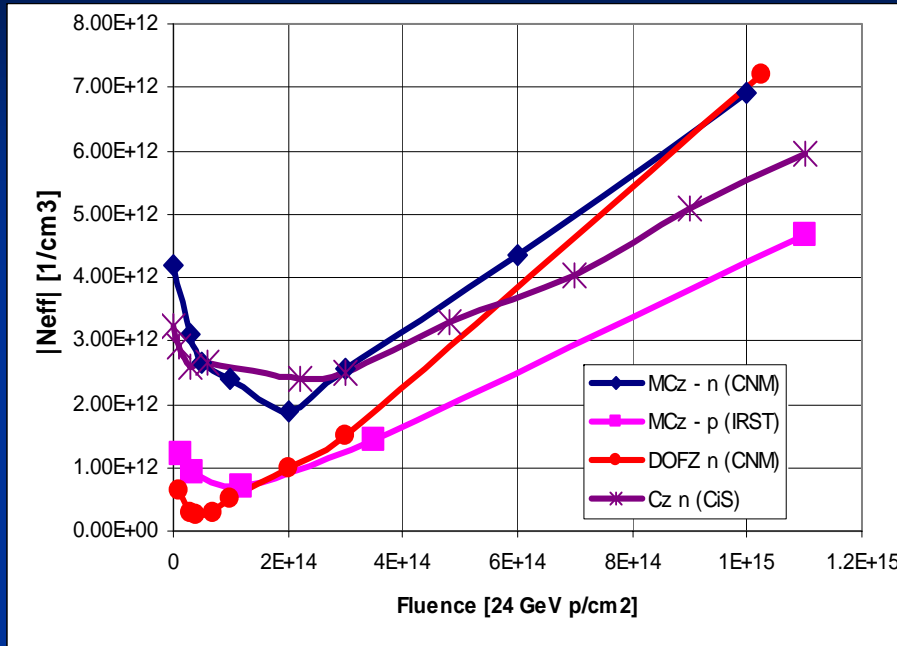
- $\rho > 150 \text{ } \Omega\text{cm}$  (75 and 150  $\mu\text{m}$  samples)
  - $g_c \sim 5 \cdot 10^{-3} \text{ cm}^{-1}$  [8,11]
- $\rho = 50 \text{ } \Omega\text{cm}$  (75 and 150  $\mu\text{m}$  samples)
  - $g_c \sim -5 \cdot 10^{-3} \text{ cm}^{-1}$  [8,11]

- [1] N. Manna, 8<sup>th</sup> RD50 workshop
- [2] A.G. Bates and M. Moll, *Nucl. Instr. and Meth. A555* (2005) 113.
- [3] E. Fretwurst, 3<sup>rd</sup> RD50 workshop
- [4] H. HödelMoser, RESMDD06
- [5] Rose RD48 status report
- [6] G.Lindström, NIM A .
- [7] G. Pellegrini et al., NIM A552 (2005) 27.
- [8] N. Manna, 7<sup>th</sup> RD50 workshop
- [9] Lozano et al, NIMA A 552 (2005) 27–33.
- [10] V Cindro, 8<sup>th</sup> RD50 Workshop
- [11] G. Kramberger, 8<sup>th</sup> RD50 Workshop

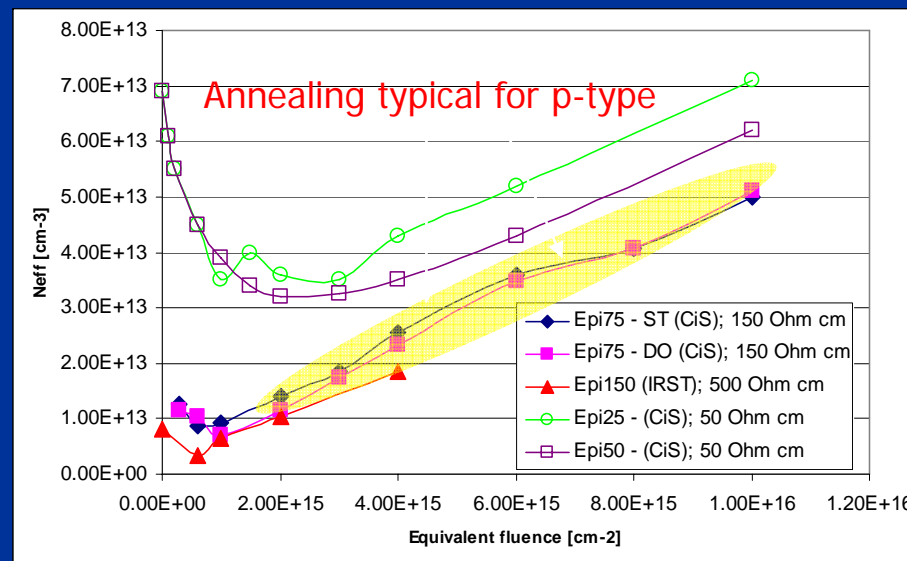
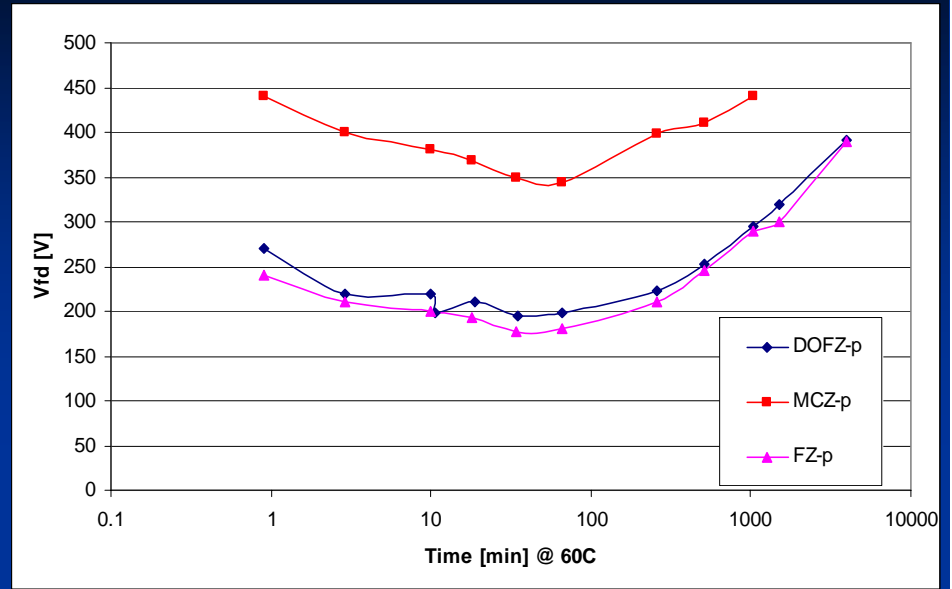
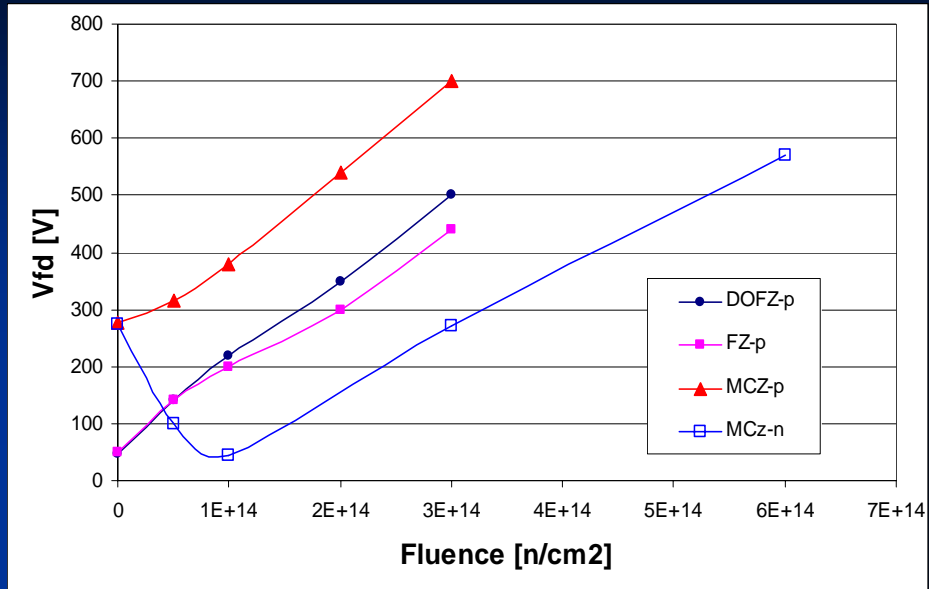
## 26 MeV proton irradiated samples

Type inversion is observed for all materials (SMART, HH)!  
How does that fit to our picture?

# 24 GeV proton irradiated samples



# Neutron irradiated samples



# *Probing of material type*

- Probing material type

- TCT

- Annealing curve shape

- Neutrons introduce negative space charge, so adding them to

- p-type material ->  $V_{fd}$  increases

- n-type material ->  $V_{fd}$  decreases

We also need to do some mixed irradiations to check for any surprises and simulate SLHC detector!  
(are there any fully annealed MCz-p type that you can miss?)

# To do

- Mixed irradiations (list of samples)
- Isochronal annealing (60,80,100,120,140 °C...) measurement of trapping !
- Conversion list pad detector -> different segmented devices (shaping times of amplifiers)
- Bistability with  $^{90}\text{Sr}$
- C(V) Neff profile
- Irradiation under bias?
- H in Si (ongoing deuterium implantation)
- $\tau_r$  during 9 MeV p irr.!

# MCz p,n puzzle with 24 GeV p

- [C] [O]= $3.8 \times 10^{17} \text{ cm}^{-3}$  in MCz-Okmetic?
  - Sumitomo [O]= $1 \times 10^{18}$ ;
- Free carriers during irr.
- Other impurities in MCz-(p,n) Fe?
- Campaign with MCz n,p
- Epi-p evaluation and comparison



# 26 MeV protons

- Question about irr. T (8 min @ 80C)

# Irradiations

6/13/2007

Gregor Kramberger, 9th RD50  
Workshop - PDC discussion

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