Carrier lifetime variations during irradiation
by 3 - 8 MeV protons @ 40-300 K in MCZ Si

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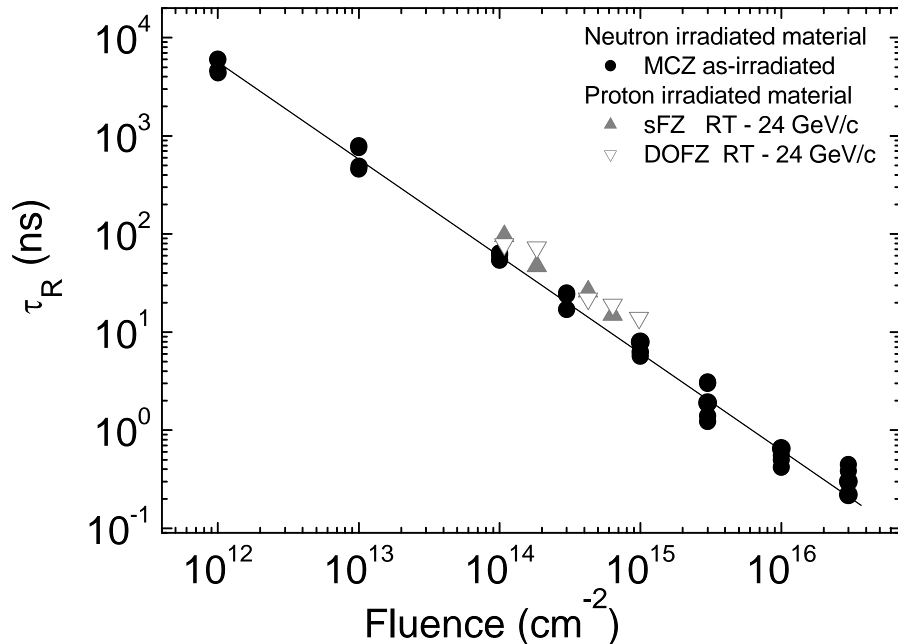
Outline

- HUAL & VU instrumentation for lifetime measurement during proton irradiation, in-situ positioning and control
- Lifetime-temperature characteristics for initial MCz material and during irradiation with stopped and penetrative protons at different temperatures
- Summary

Motivavtion



The dependence of the lifetime on the fluence in the neutron and proton irradiated Si.

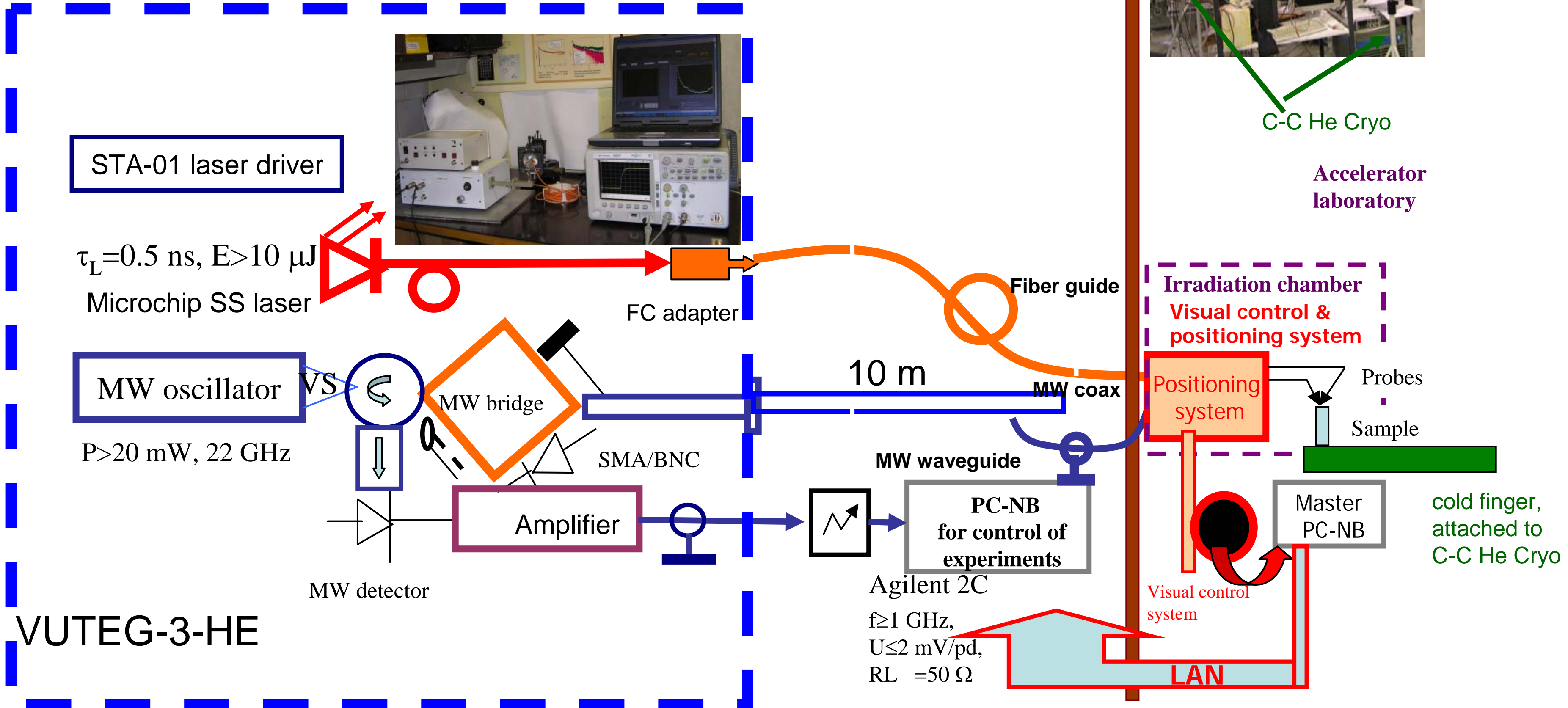
It is interesting to understand:

if this linear dependence is a result of irradiation

or

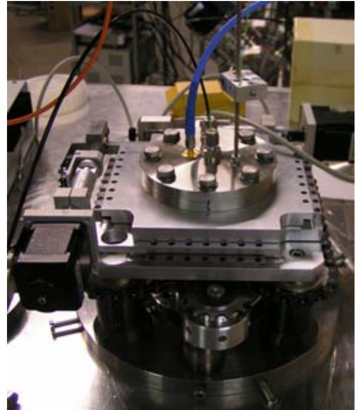
it is a consequence of irradiation and migration of defects to form other type of defects

Scheme of the installed instrumentation



The microwave probed photoconductivity (MW-PC) modules for the direct measurements of the carrier decay transients by employing MW absorption are assembled. VUTEG-3HE, master PC-NB, antenna/excitation fiber modules, positioning and visual control modules are installed within irradiation chamber containing a cold finger for cooling of a sample by using closed-cycle He cryostat. Delivering of signals to destination outside running irradiation area are implemented by using LAN.

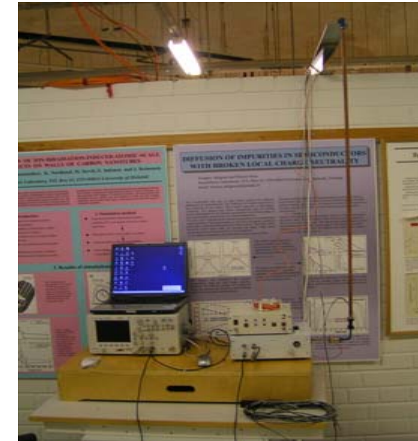
Assembled instrumentation for τ-exposure-T measurements



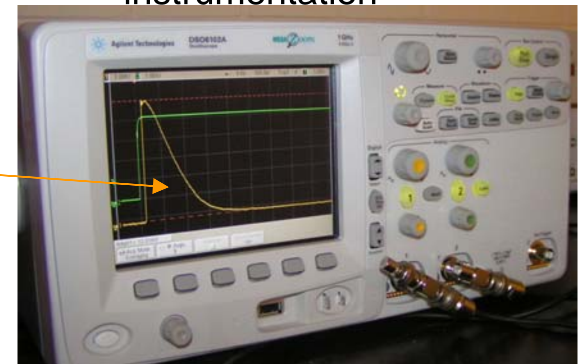
3D positioning & inputs

Drivers & and remote control instrumentation

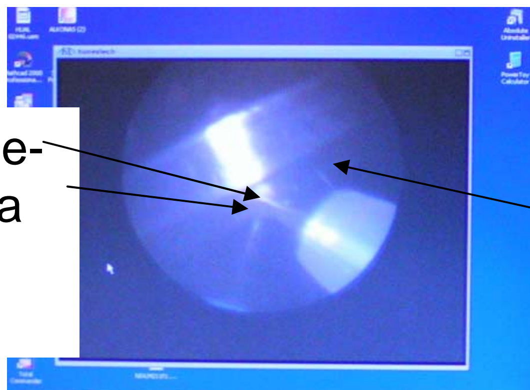
Distant transfer lines



Beyond-radiation area & Measurement and operating instrumentation



MW-PC signal



MW needle-tip antenna and fiber probes

Sample side for cross-sectional scan

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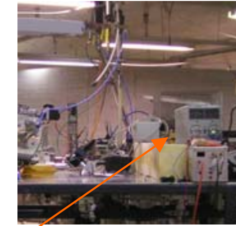
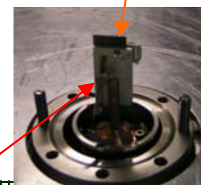
τ-T measurements after irradiations



HUAL in-chamber temperature control system



Thermo-couple

τ-exposure at various T characteristics during irradiation with penetrative protons probes are located at half-width of wafer thickness

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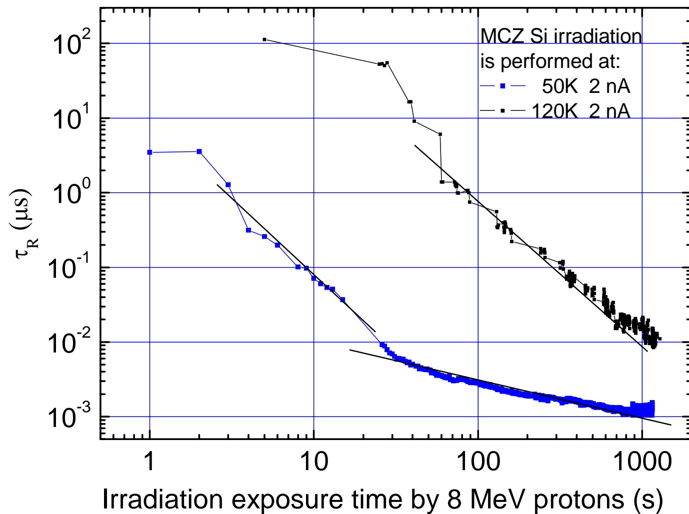
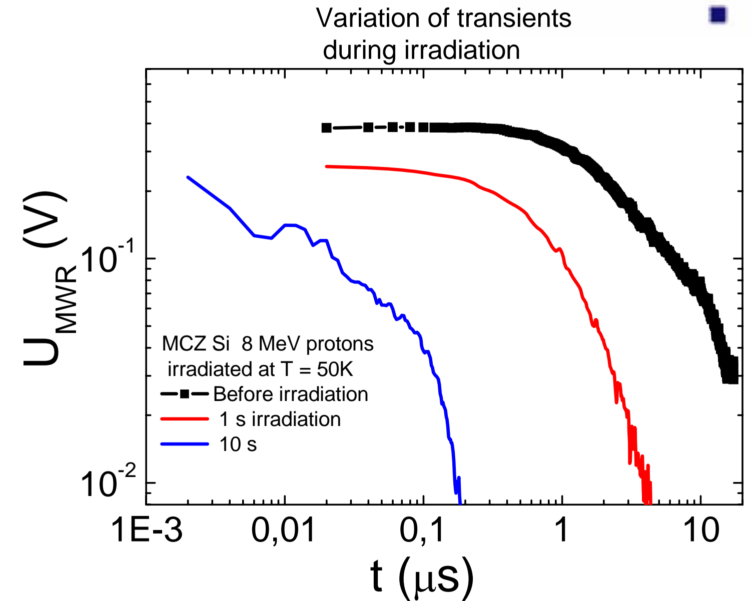
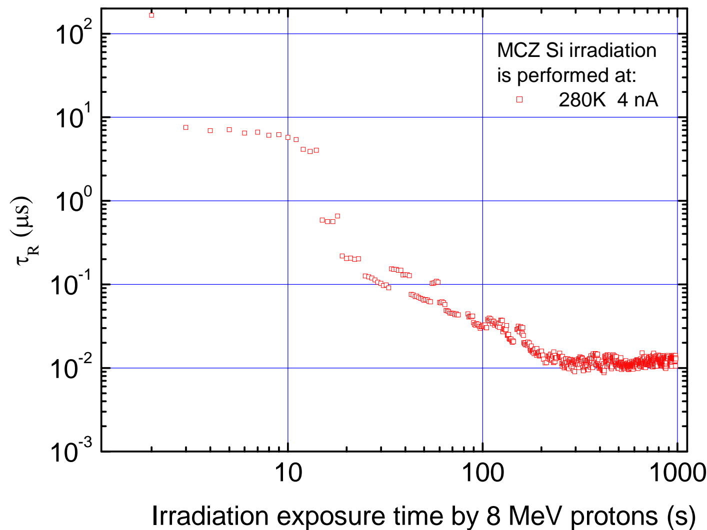
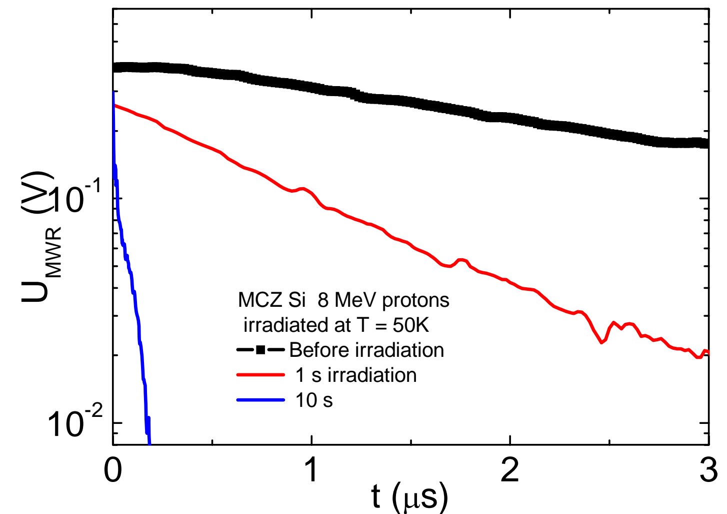
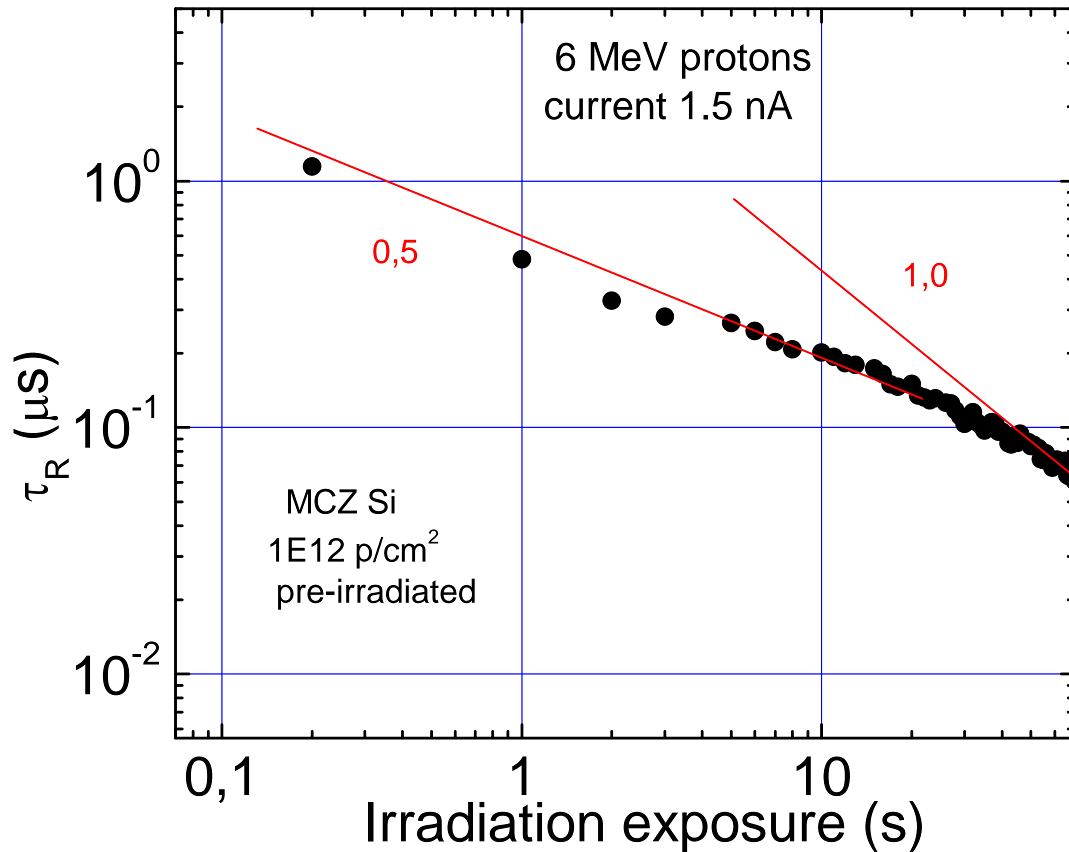


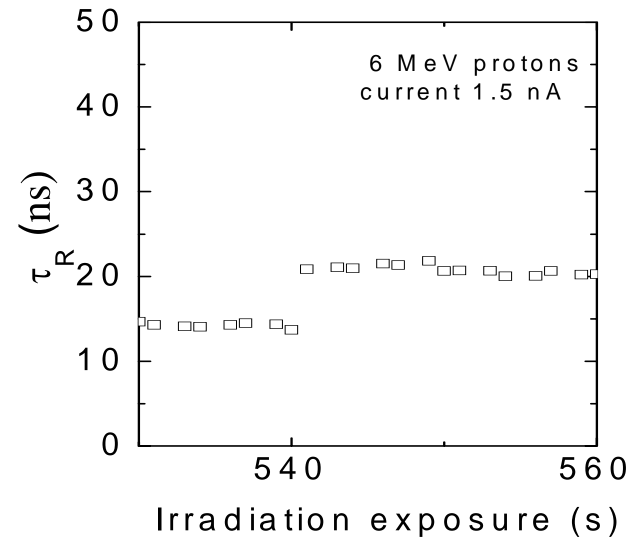




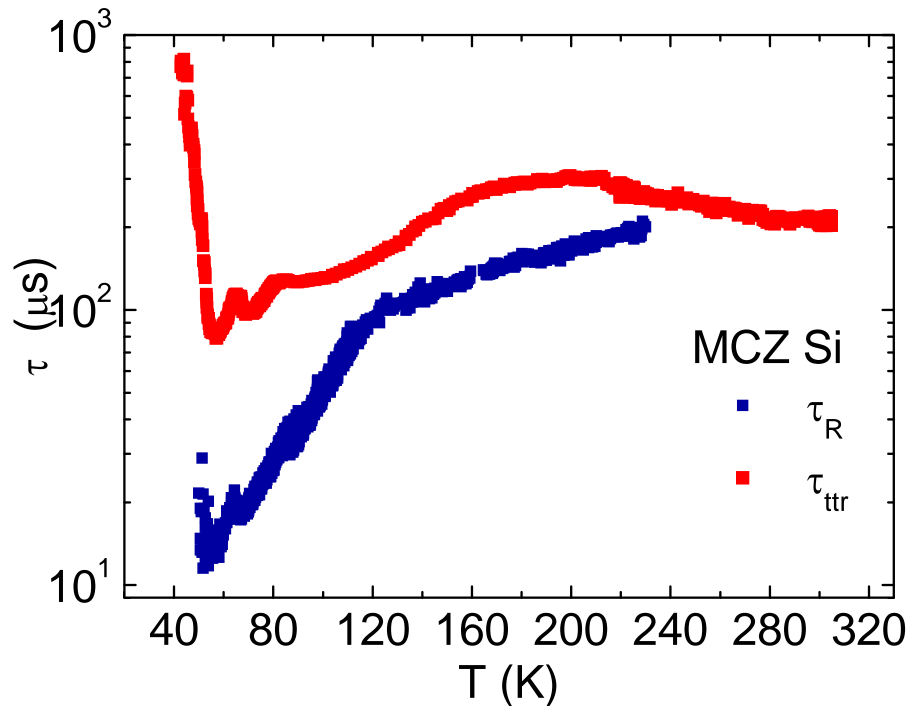


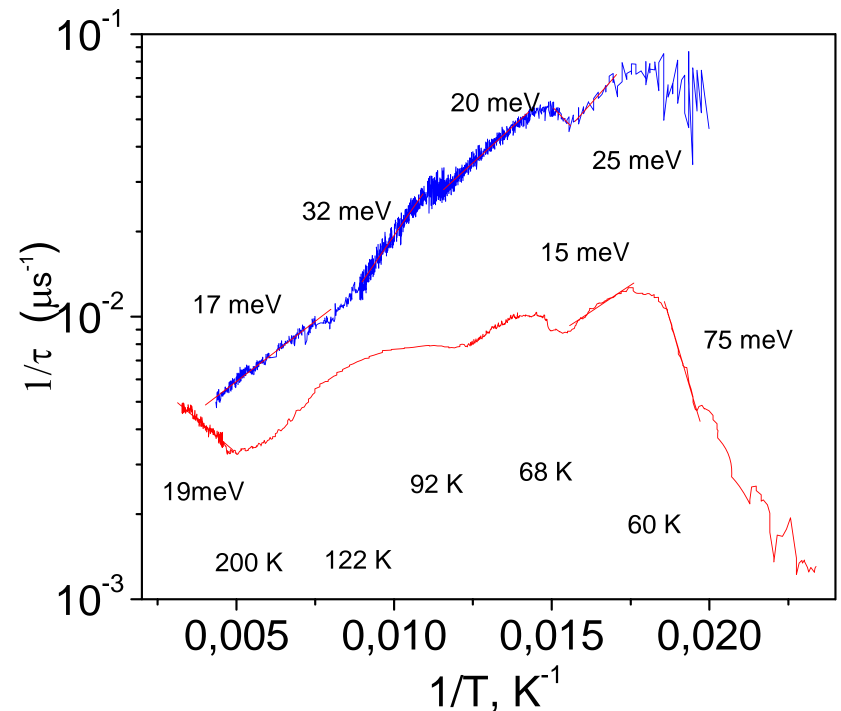
Irradiation of pre-irradiated Si





τ-T results for initial material before irradiation



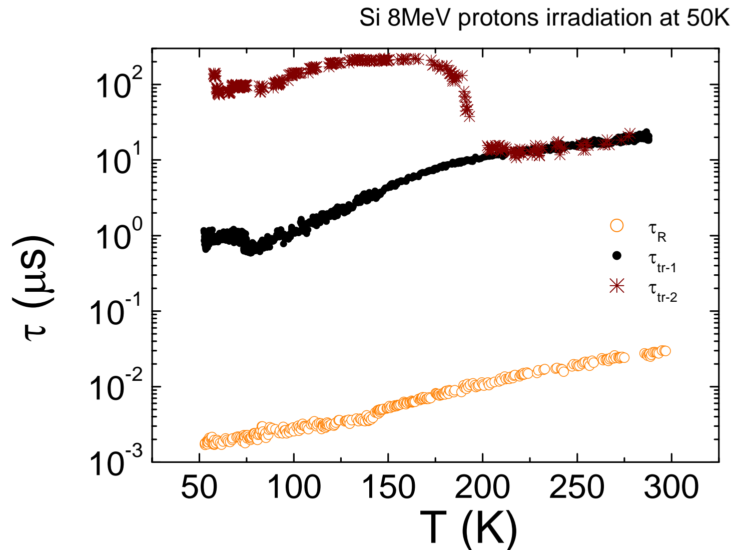


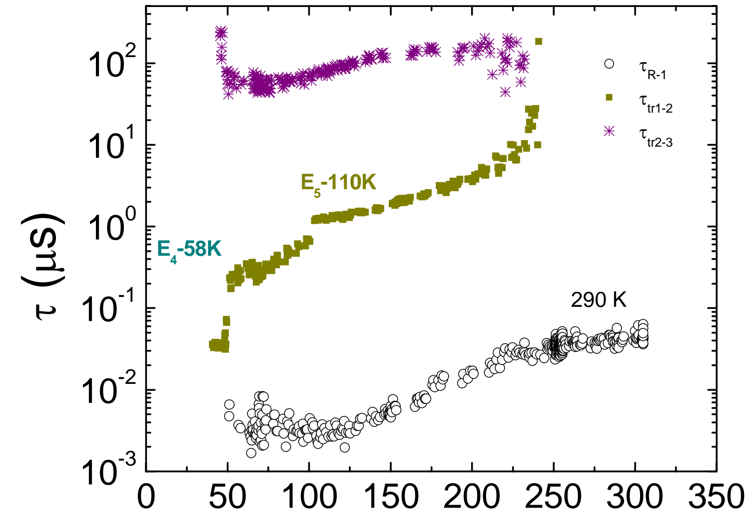
Two-componential decay in the initial MCZ material wafers, ascribed to carrier recombination (τ_R) and trapping (τ_{ttr}), is observed, and these decay constituents show different temperature characteristics.

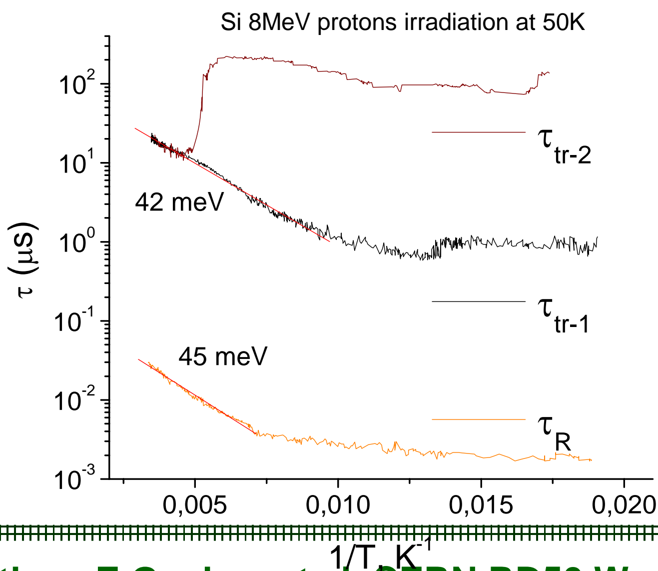
For trapping constituent, a few peaks was be observed.

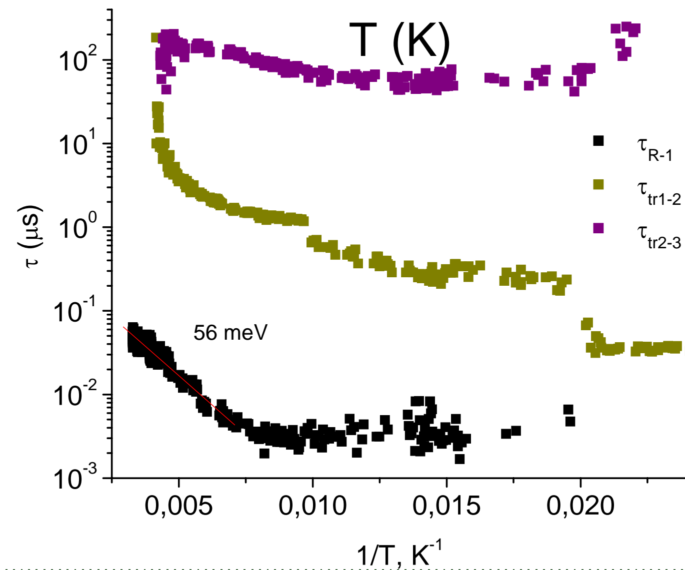
τ-T characteristics in the 8 MeV proton post-irradiated material

Several carrier trapping components appear in τ-T characteristics after irradiation.



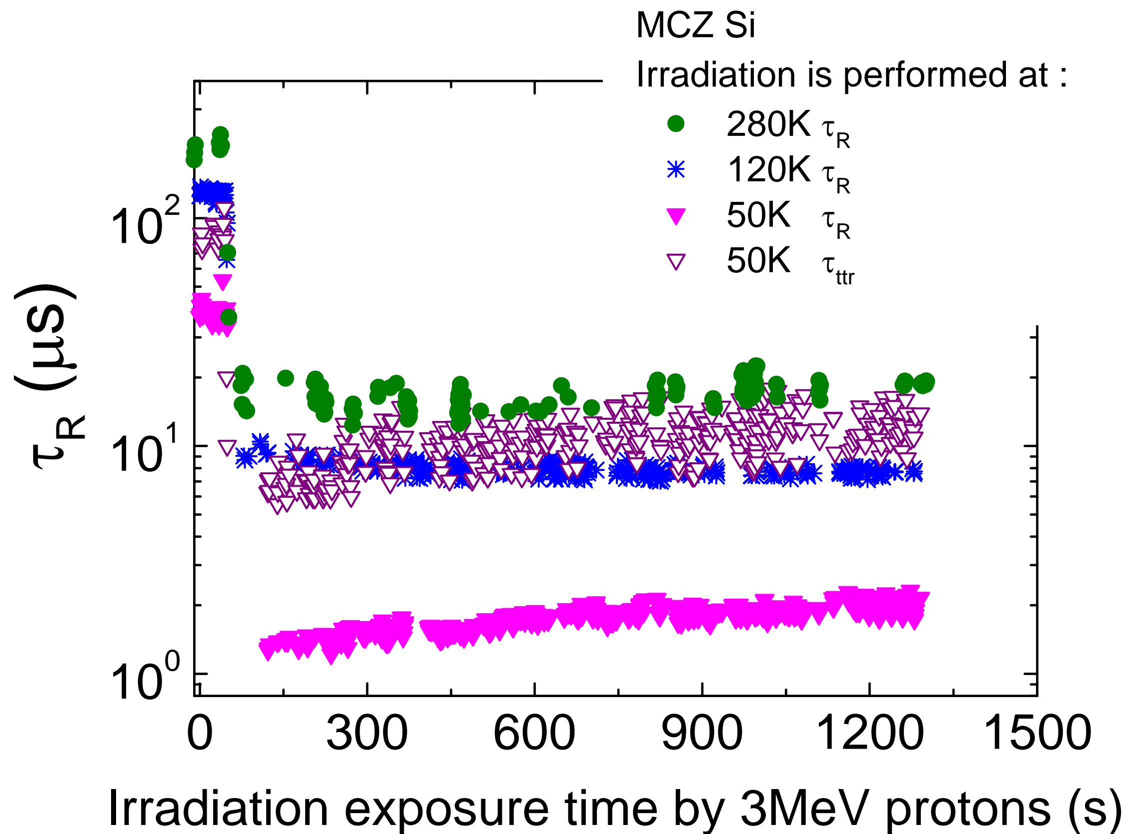






τ-exposure dependence during implantation of 3 MeV protons

Microwave probe and optical fiber are located at ~ 80 μm distance from the irradiation (beam side) face-surface of wafer



Summary

- The dependence of lifetime on fluence during irradiation by protons shows a dependence of defects generation rate on the temperature and of irradiation, i.e., irradiation itself induces the defect reactions in the sample.
- The pre-irradiation also creates the different conditions for defect reactions.

(The increase of statistics is necessary)

- Two-componential decay in the initial MCZ material wafers, ascribed to carrier recombination (τ_R) and trapping (τ_{ttr}), is observed, and these decay constituents show different temperature characteristics.
- Several carrier trapping components appear in τ-T characteristics after irradiation by penetrative protons.

Thank You for attention!

and

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