CARBON BEAM AT I3 INJECTOR FOR SEMICONDUCTOR IMPLANTATION

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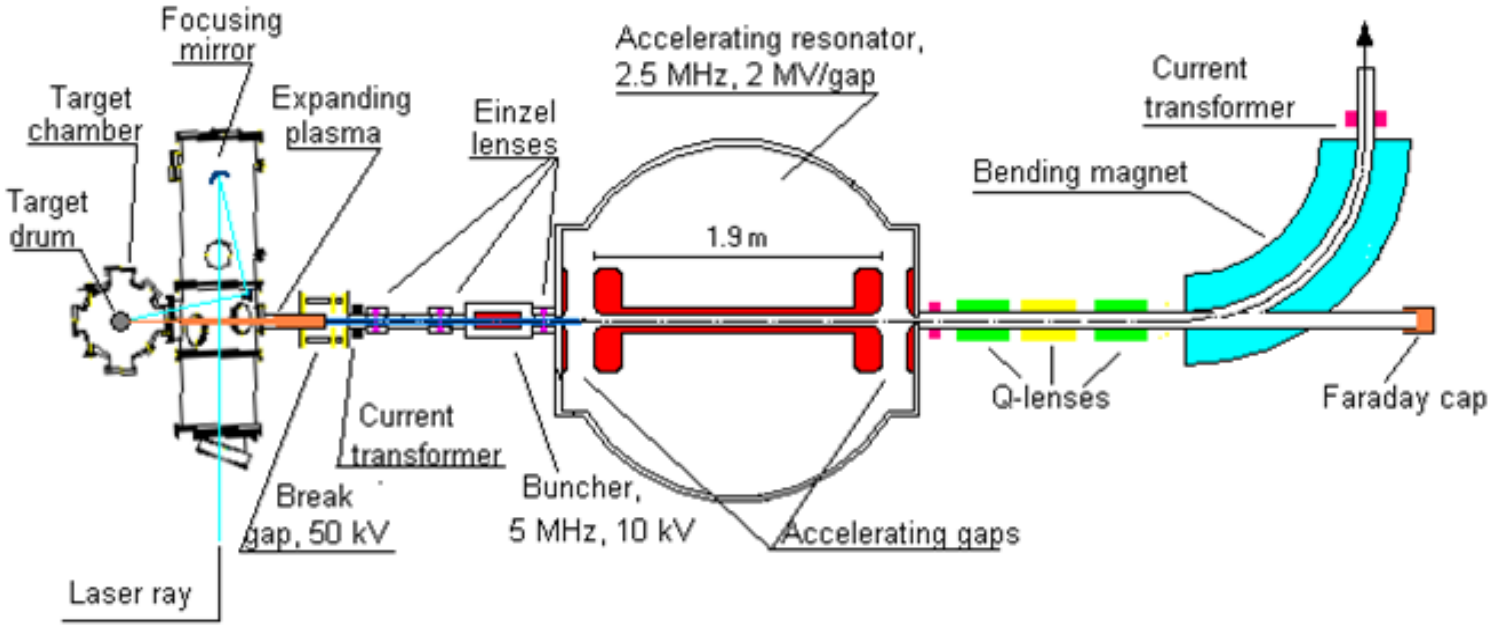
IPAC 21, May 24–28th, 2021

Introduction

- The purpose is to investigate the possibility to obtain low switch time for reference diode by carbon implantation
- The most widely utilized method is treatment by accelerated electrons, protons or He^+ ions
- Electron irradiation requires high fluence and irradiation time
- Proton irradiation leads to doping by small donors
- Carbon ions have large range at relatively low energy
- Carbon is present in silicon crystal, i.e.contamination with foreign impurities is minimal

Setup layout



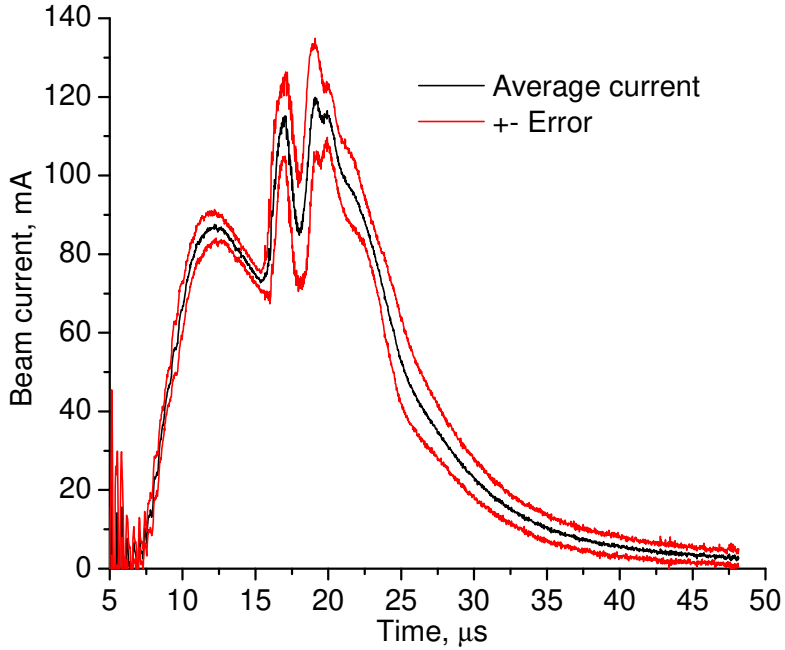
- Carbon ion beam generated by laser plasma ion source
- Two gap RF resonator, up to 2 MV per gap, transverse acceptance 2000 π mm mrad, Z/A range 0.2–0.5
- 90° bending magnet for ion selection

Laser plasma ion source

Based on a pulsed CO_2 laser:

- pulse energy about 6 J
- peak power 60-70 MW
- FWHM duration - 30 ns
- radiation flux density 10^{11} W/cm^2 at carbon target

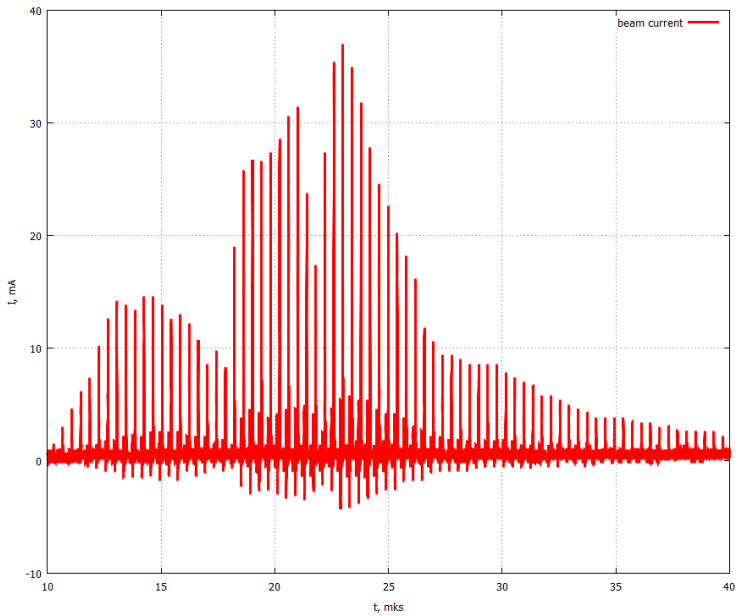
Generates carbon ion beam with up to 120 mA amplitude



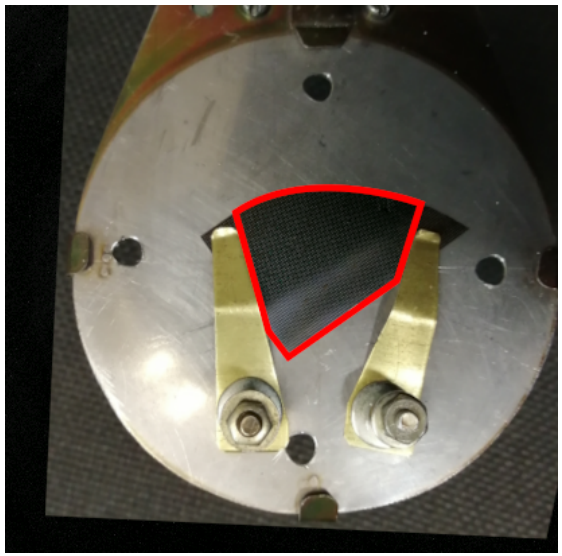
Ion source output current

Irradiation conditions

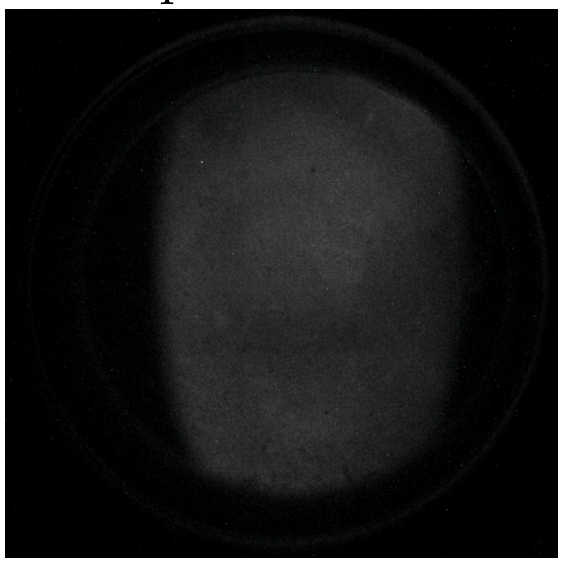
Fluence was calculated by integration of ion beam current signal at target holder.
Irradiation uniformity of sample area (red polygon) was measured using scintillator images.



C^{3+} beam current measured at target holder



Sample in a holder



Accelerated carbon beam profile image

Results

Experimental reference diode structures were obtained by forming a $3\mu m$ junction in $10\mu m$ epitaxial n-type layers, followed by vacuum deposition of the $1\mu m$ anode Al-contact.

- The best "reverse recovery time / leakage currents" ratio is achieved at an energy of 8.7 MeV and a fluence of $2 \cdot 10^{12}\text{cm}^{-2}$
- Carbon-irradiated diodes have better direct voltage drop characteristics compared to electron-irradiated diodes at close switching times and leakage currents