Contribution ID: **27** Type: **Poster Presentation**

# Experimental plan for displacement damage cross sections using 120-GeV protons at FNAL

*Thursday, 26 November 2020 16:58 (1h 52m)*

To predict the operating lifetime of materials in high-energy radiation environments at accelerator facilities, Monte Carlo codes such as PHITS, MARS, and FLUKA are used to calculate the number of displacements per atom (dpa) related to the number of Frenkel pairs. The Norgertt–Robinson–Torrens (NRT) model has been widely used to predict the number of "initial"Frenkel pairs (NRT-dpa). For more accurate estimation of the actual damage production, athermal-recombination-corrected displacement damage (arc-dpa) was proposed, recently. For the validation of codes, it is necessary to measure displacement cross-sections of metals in relation to changes in electrical resistivity at cryogenic temperature (around 4 K) where the recombination of Frenkel pairs by thermal motion is well suppressed. The comparison between the experimental data and calculated results for proton irradiation with energies from 0.1 to 30 GeV indicates that the arc-dpa results are good agreements with the experimental data and the NRT-dpa results are larger than the data by a factor of around three.

In this presentation, we introduce our experimental plan for displacement cross sections with 120-GeV protons at Fermilab Test Beam Facility (FTBF) in Fermi National Accelerator Laboratory (FNAL). Experiments will be performed at the M03 beam line high rate tracking area in FTBF for the US fiscal year 2022 (October 2021 –September 2022). For the preparation of experiments, we developed the sample assembly with four wire sample of Al, Cu, Nb and W with 250-$\mu$m diameter and 4-cm length. Annealing under vacuum condition (~$10^{-4}$ Pa) was performed by heating an Al sample at 840 K for 30 minutes, a Cu sample at 1289 K for 30 minutes, a Nb sample at 1923 K for 15 minutes, and a W sample at 2473 K for 15 minutes, respectively. The sample assembly will be maintained at around 4 K by using a Gifford–McMahon (GM) cryocooler in a vacuum chamber. Then, changes in the electrical resistivity of samples will be obtained under 120-GeV proton irradiation. Recovery of the accumulated defects through isochronal annealing, which is related to the defect concentration in the sample, will also be measured after the cryogenic irradiation.

This work was supported by JSPS KAKENHI Grant Number JP19H02652.

**Primary authors:** Dr IWAMOTO, Yosuke (Nuclear Science and Engineering Center, Japan Atomic Energy Agency (JAEA) ); Dr YOSHIDA , Makoto (J-PARC Center, High Energy Accelerator Research Organization (KEK) / 高エネルギー加速器研究機構 J-PARC センター); Dr MEIGO , Shin-ichiro (J-PARC Center, Japan Atomic Energy Agency (JAEA) / 日本原子力研究開発機構 J-PARC センター); Dr NAKANO, Keita (J-PARC Center, Japan Atomic Energy Agency (JAEA) / J-PARC Center, Japan Atomic Energy Agency (JAEA) / 日本原子力研究開発機構 J-PARC センター); Dr ABE, Shin-ichiro (Nuclear Science and Engineering Center, Japan Atomic Energy Agency (JAEA) / 日本原子力研究開発機構原子力基礎工学研究センター); Prof. ISHIDA, Taku (J-PARC Center, High Energy Accelerator Research Organization (KEK) / 高エネルギー加速器研究機構 J-PARC センター); Prof. YABUUCHI, Atsushi (Institute for Integrated Radiation and Nuclear Science, Kyoto University / 京都大学複合原子力科学研究所); Prof. KINOMURA, Atsushi (Institute for Integrated Radiation and Nuclear Science, Kyoto University / 京都大学複合原子力科学研究所); Prof. YOSHIIE, Toshimasa (Institute for Integrated Radiation and Nuclear Science, Kyoto University / 京都大学複合原子力科学研究所); Dr YONEHARA, Katsuya (Fermi National Accelerator Laboratory (FNAL) / 米国フェルミ国立加速器研究所); Dr SPINA, T. (Fermi National Accelerator Laboratory (FNAL) / 米国フェルミ国立加速器研究所); Dr AMMIGAN, K. (Fermi National Accelerator Laboratory (FNAL) / 米国フェルミ国立加速器研究所); Dr MOKHOV, N. (Fermi National Accelerator Laboratory (FNAL) / 米国フェルミ国立加速器研究所)

**Presenter:** Dr IWAMOTO, Yosuke (Nuclear Science and Engineering Center, Japan Atomic Energy Agency (JAEA) )

**Session Classification:** Poster