In case of proton irradiation test chips, the ionizing doses were obtained from fluences using the formula:

\[
\text{Dose} = \text{Fluence} \times \text{Energy to Dose Conversion Factor}
\]

While the polysilicon is a ubiquitous semiconductor material, the radiation damage and temperature dependence of its resistance is not easily predictable, especially for the tracking detector with the operational temperature significantly below the values typical for commercial microelectronics. Dependence of the radiation damage on the polysilicon bias resistance on temperature, as well as on the total delivered fluence and ionizing dose, was studied, both before and after irradiation by protons, neutrons, and gammas to the maximal expected fluence of \(10^3\) 1-MeV n$_{eq}$/cm$^2$ and ionizing dose of 0.66 Mrad.

The resulting bias resistance value for each temperature is calculated from the slope of measured test voltage vs test current (Test I) as

\[
R_{bias} = \frac{\text{Slope}}{\text{Current}}
\]

• The measurement was performed on special structures called Test Chips, in temperature range between \(-50^\circ\text{C}\) and \(+25^\circ\text{C}\).

• The bias resistance is measured by setting pad 1 to ground and performing a test voltage sweep on pads 2 to 7 while measuring the test current.

The R$_{bias}$ dependence on temperature was fitted using the exponential function:

\[
R_{bias}(T) = \alpha \exp\left(\frac{T - T_0}{k}\right)
\]

where \(k\) is the Boltzmann constant.

It has been shown that the general function describing the development of R$_{bias}$ with temperature has the form:

\[
R(T) = \alpha \exp\left(\frac{T - T_0}{b}\right)
\]

Let us assume that \(b\) is a material constant that has the same value for all samples.

For one chosen sample we take R$_{bias}$ = R$_{bias}$ at a temperature T$_{test}$

Then from eq. (1) we get:

\[
\alpha = \frac{R_{bias}}{\exp\left(\frac{T_{test} - T_0}{b}\right)}
\]

By inserting eq. (2) into eq. (1), we can write for all other samples:

\[
R(T_{test}; R_{bias}) = \frac{R_{bias}}{\exp\left(\frac{T_{test} - T_0}{b}\right)} = R_{bias_{test}} \cdot \exp\left(\frac{T_{test} - T_0}{b}\right)
\]

\[
(3)
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