Determination of Si wafer resistivity distributions by C-V measurements

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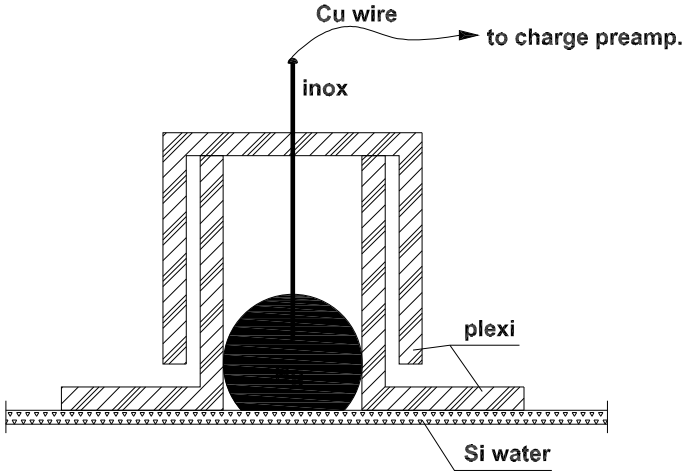
Motivation

Uniformity resistance of silicon wafers is essential for proper working of silicon detectors. It is especially important for the Pulse Shape Discrimination Technique, where the single detector signalis used for charge and mass identification. For these reasons we have elaborated a new method of evaluation of silicon wafer resistivity distribution basing on the C-V measurements. Measured silicon resistivity distribution gives possibility for:

- Selection of silicon wafers parts with constant resistivity (useful for detector production).
- Correction of the silicon wafer resistivity distribution, using the Selective Transsmutation Doping.

The method

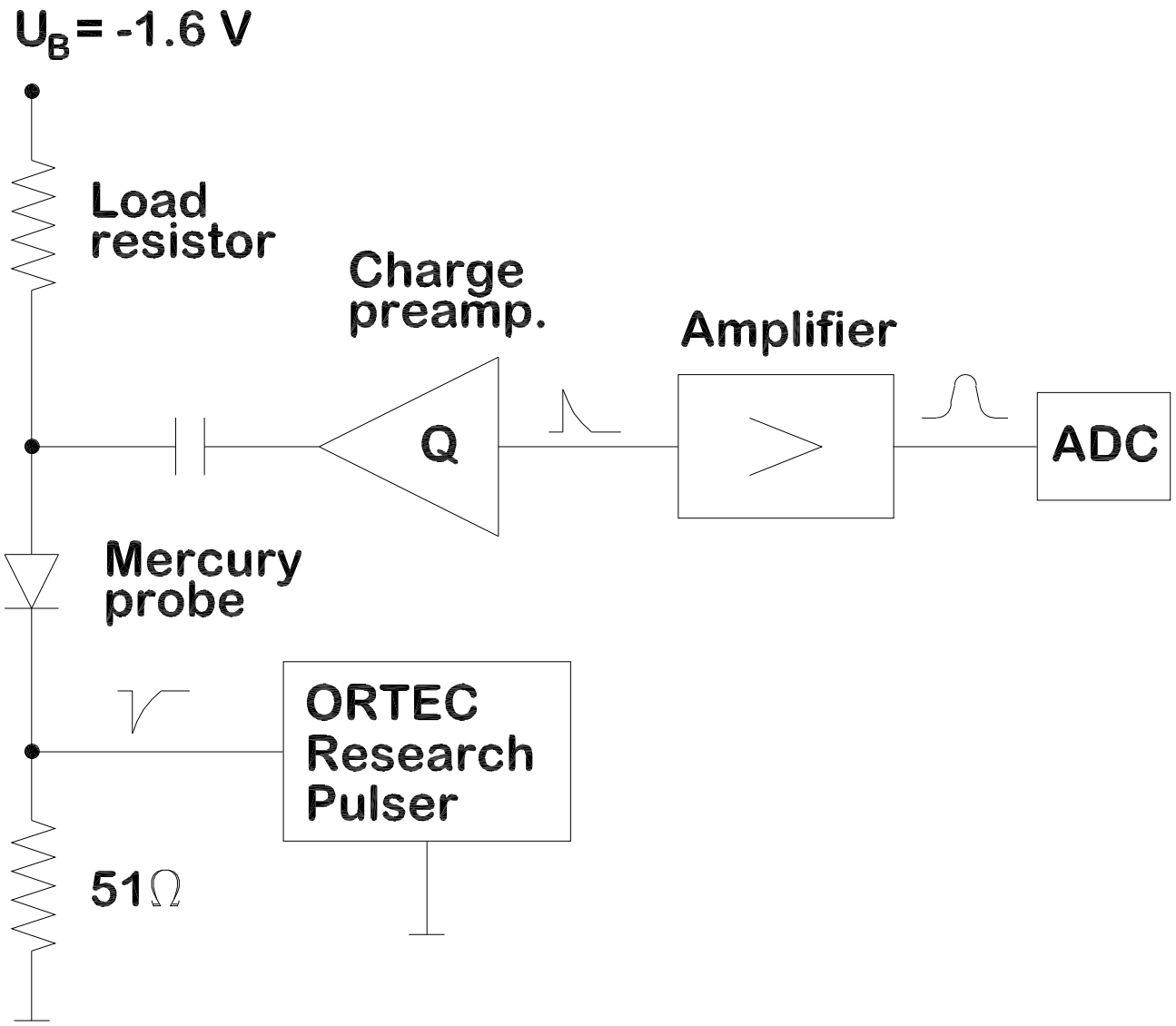
For capacitance measurement of Shotky Junction a mercury probe was used. For this purpose a mercury drop was gravitationally pressed to the Si wafer and moved along Si wafer surface with one (or two) mm steps by the computer system.



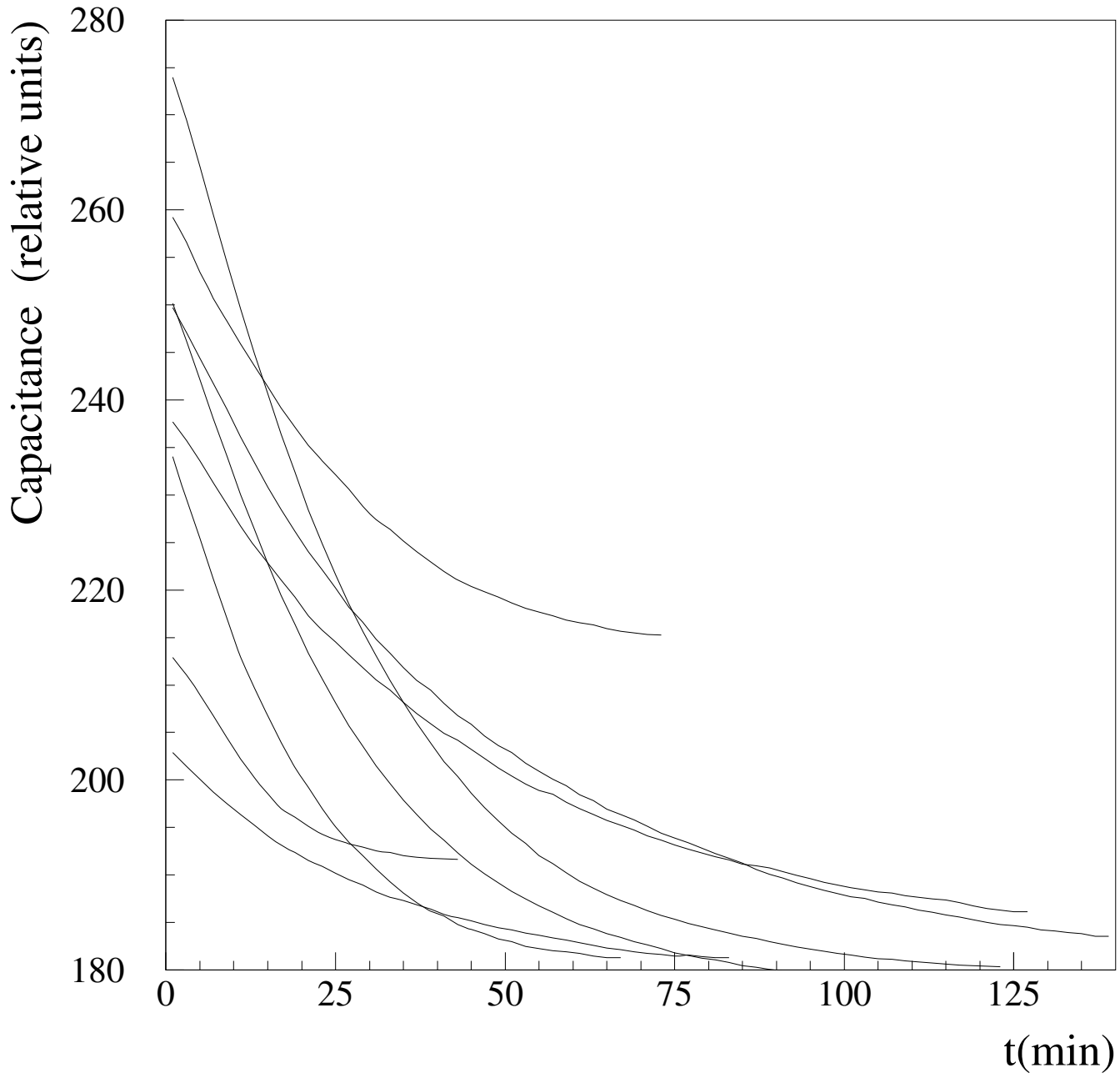
Mercury probe

The silicon resistivity $\rho[\Omega \cdot cm]$ is calculeted from junction depletion depth:
$d[cm] = 5.3 \cdot 10^{-3}\sqrt{(}\rho(V_\circ + V))$ and junction capacitance: $C = 1.17/d[pF/cm^2]$.

The capacitance is evaluated by measuring the charge injected into the charge preamplifier followed by the amplifier, ADC and aquisition system.

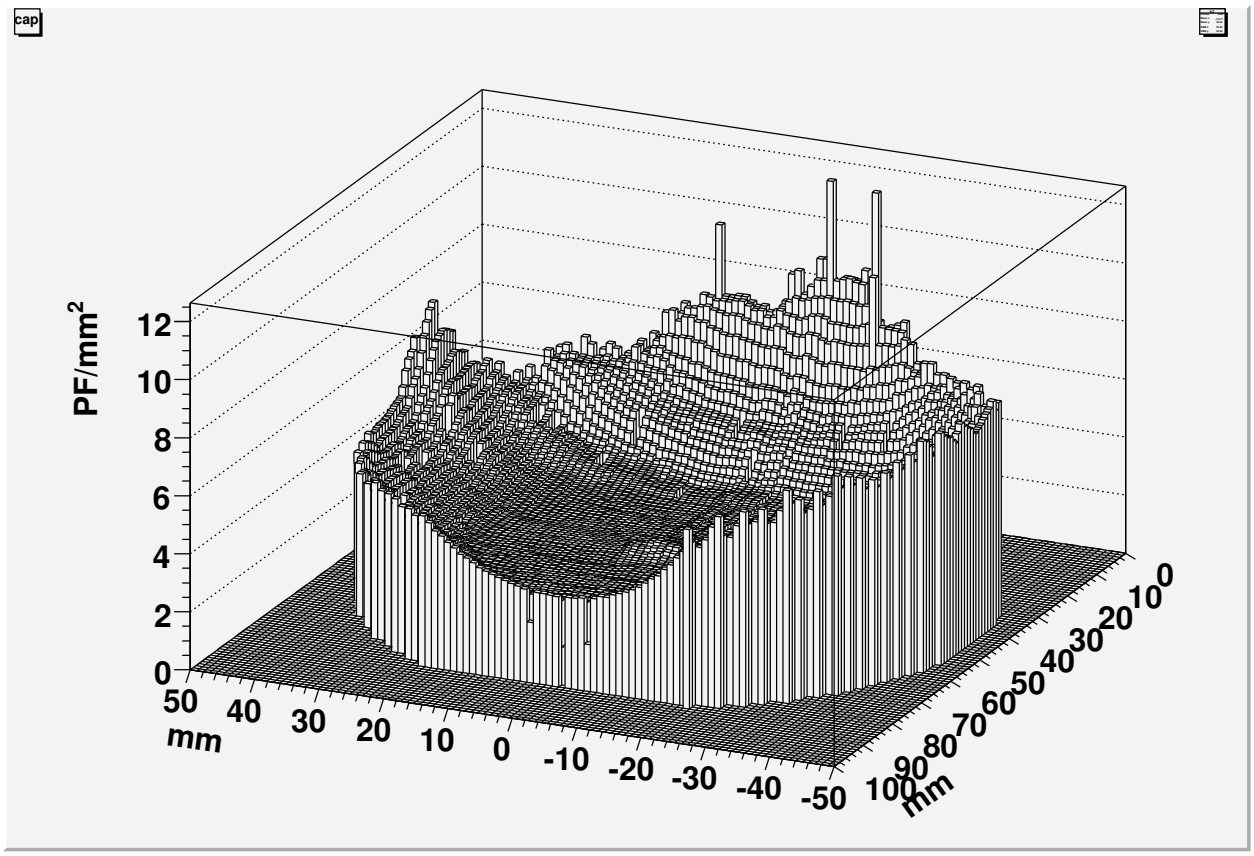


Decreasing of capacitance as a function of time. Measurement of capacitance at the beginning of time.

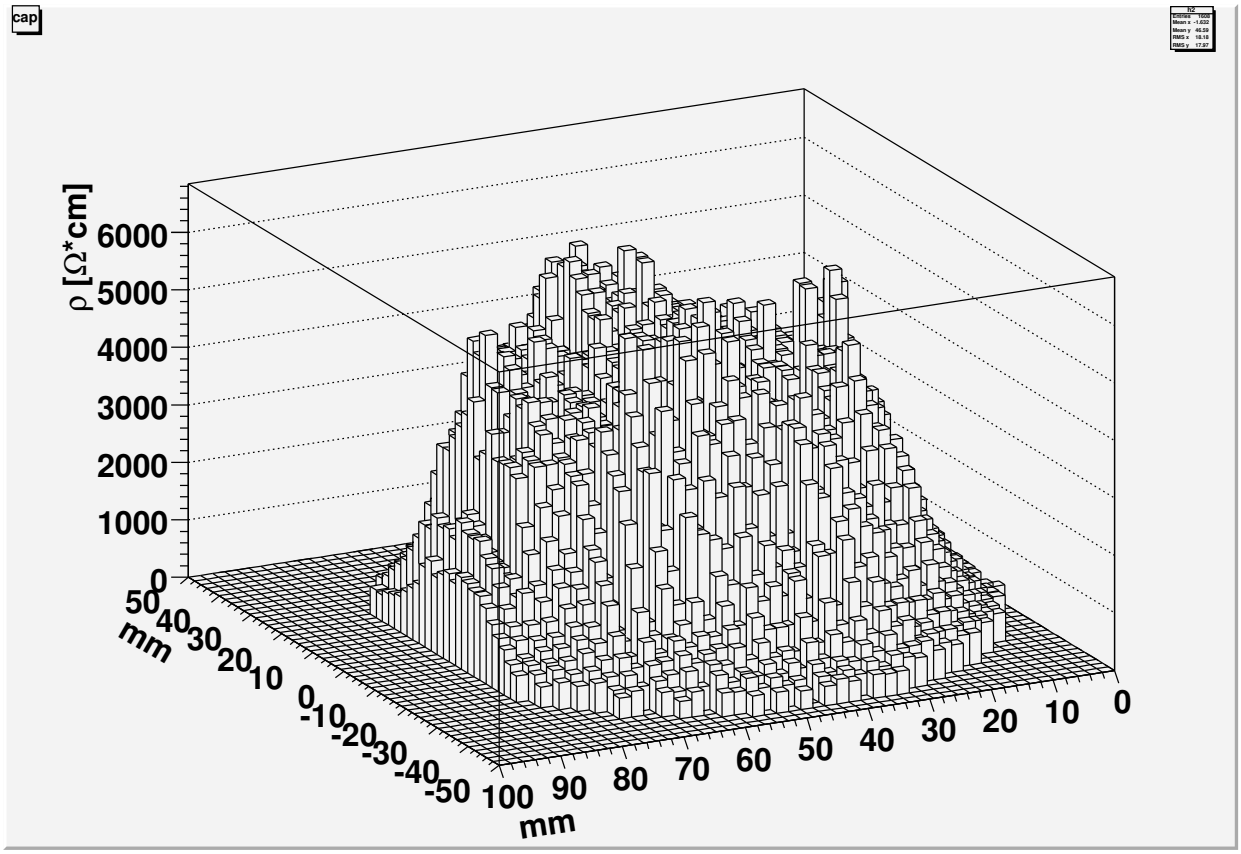


Results.

High resistivity, 4 inches, epitaxial N/N^+ structure of 118 μm thickness. produced in the Institute of Electronic Materials Technology, Warsaw, Poland.

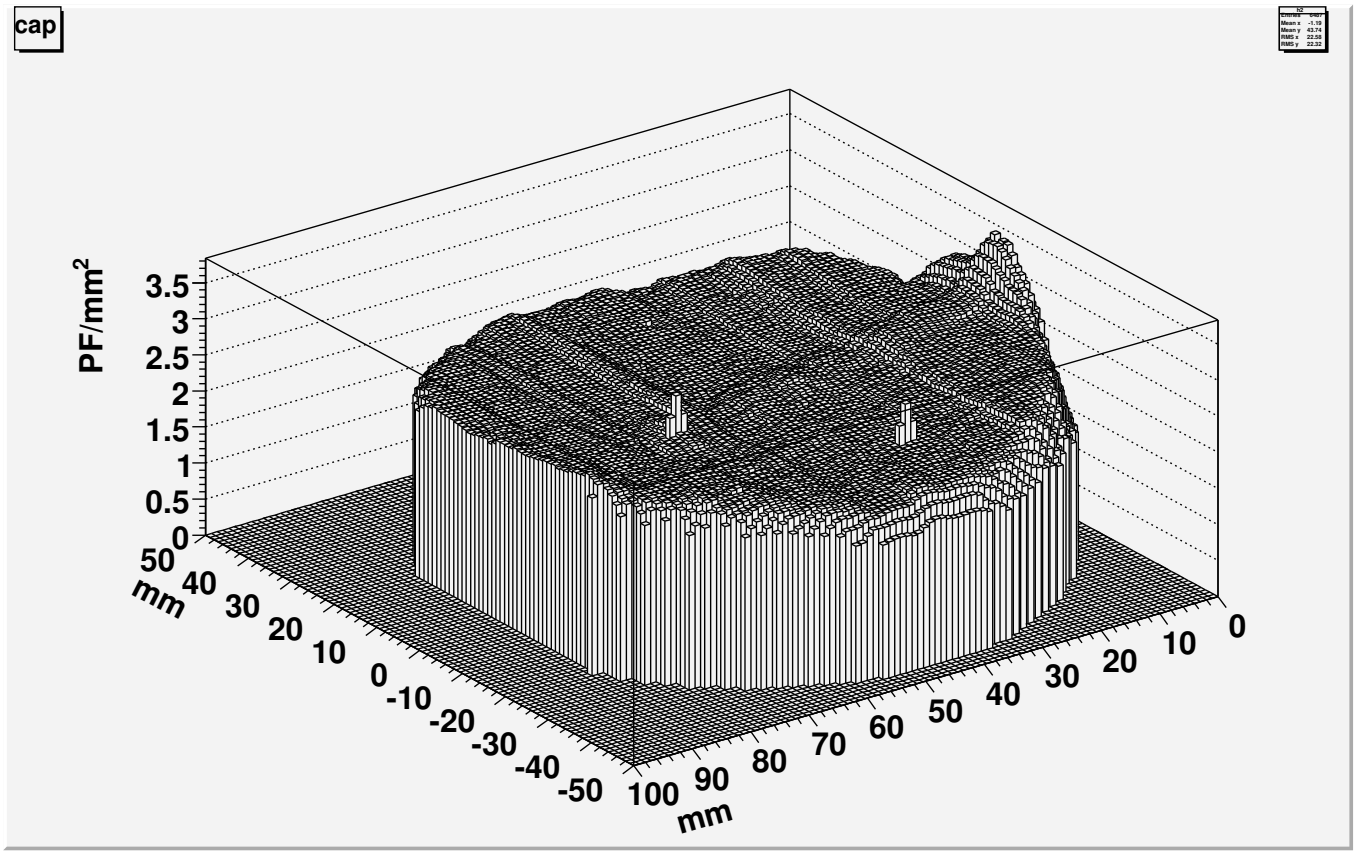


Capacitance [C] distribution.
<C> = 2.8 pF/mm^2, FWHM = 3.4 pF/mm^2.

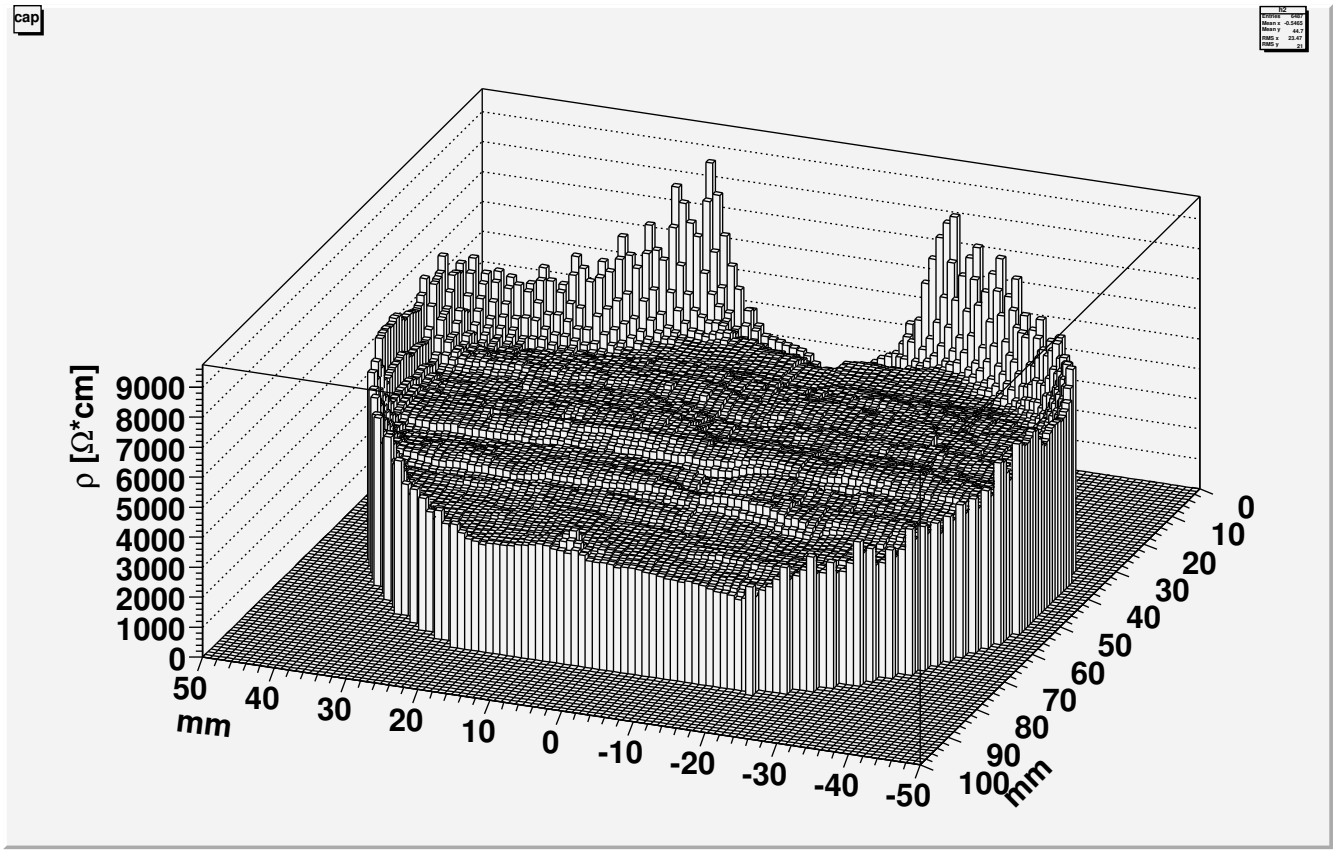


Resistivity [ρ] distribution (2 mm steps).
$<\rho>$ = 3.9 k$\Omega\bullet$cm, FWHM = 5.5 k$\Omega\bullet$cm.

Topsil wafer No:. 5139, of 4 inches diameter and resistivity ρ = 2 - 3 kΩ•cm. Series resistance of the back contact is about 100 kΩ.

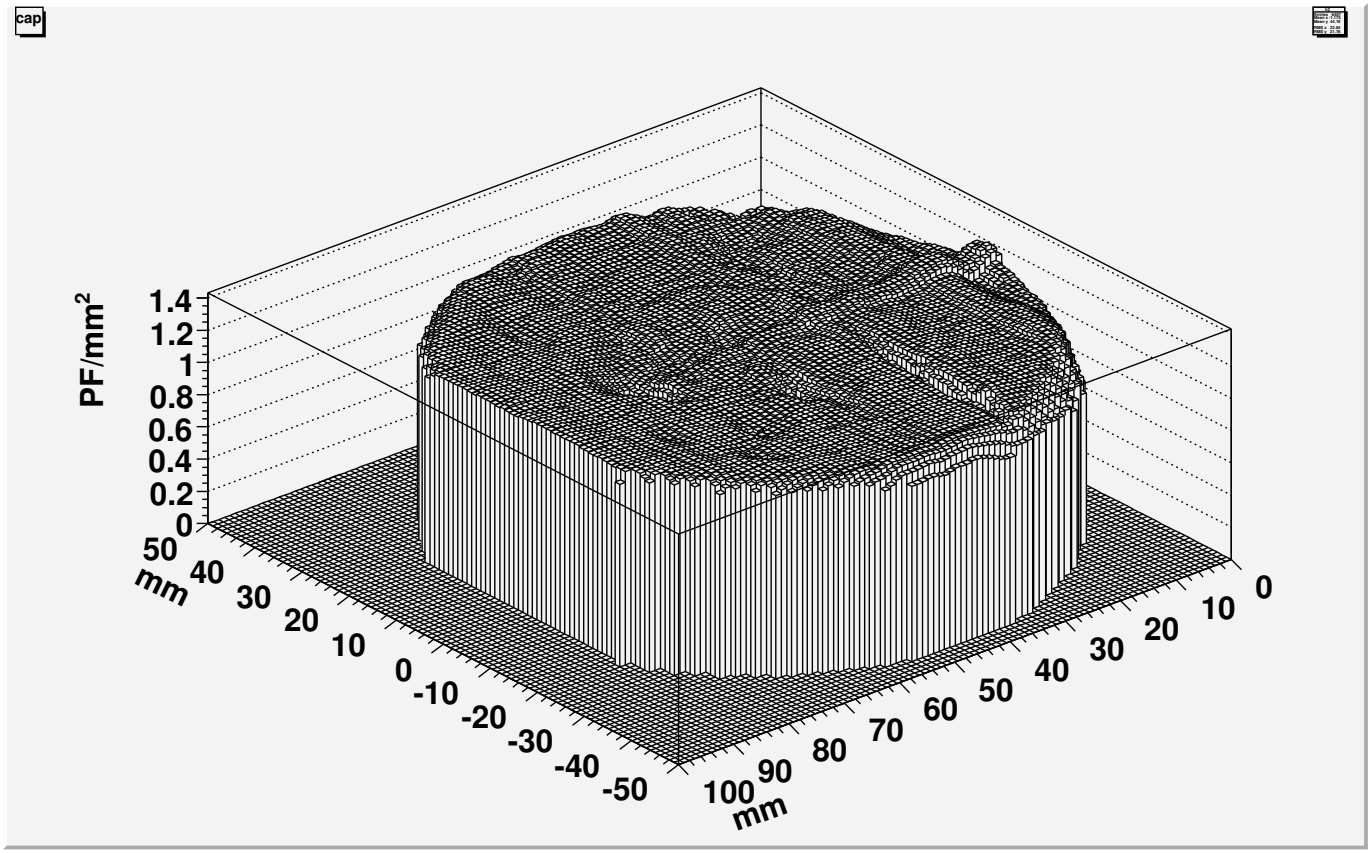


Capacitance [C] distribution.
<C> = 2.3 pF/mm^2, FWHM = 0.8 pF/mm^2.

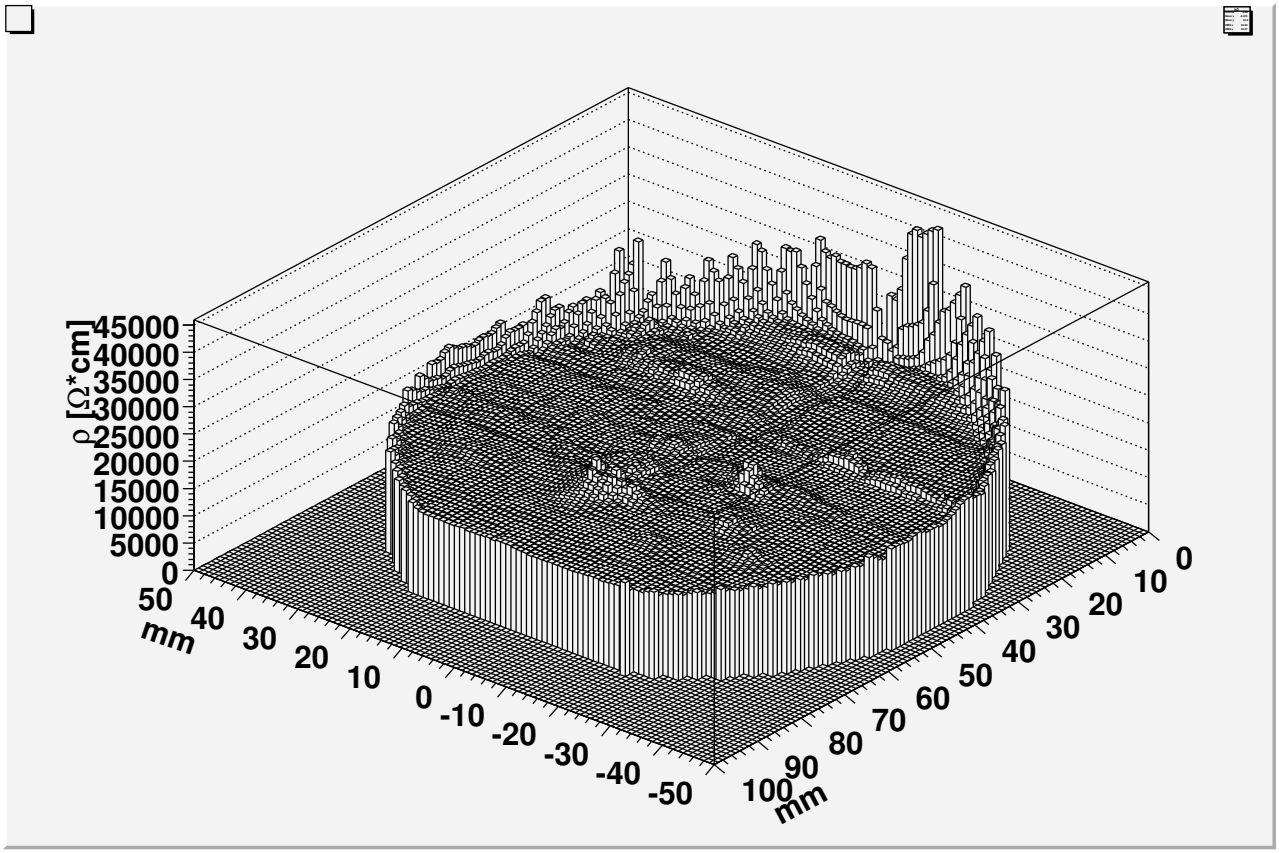


Resistivity [ρ] distribution. $<\rho>$ = 4 k$\Omega\bullet$cm, FWHM = 1.8 k$\Omega\bullet$cm.

Topsil wafer of 4 inches diameter and resistivity ρ = 14 - 27 kΩ•cm. Series resistance of the back contact is about 130 kΩ.



Capacitance [C] distribution.
<C> = 1.1 pF/mm^2, FWHM = 0.34 pF/mm^2.



Resistivity [ρ] distribution. $<\rho>$ = 16 k$\Omega\bullet$cm, FWHM = 6.3 k$\Omega\bullet$cm.