A basic problem in elaborating ionospheric vertical sounding data is the fact that it is not the true height of the layer from which the electromagnetic wave is reflected that is measured but only the time lag between the received pulse and the transmitted pulse. This lag is ascribed a so-called virtual height which is the height at which the electromagnetic wave would be reflected on the assumption of constant velocity equal to the velocity of light c. Many papers have been devoted to the method of calculating the true heights from the measured virtual heights. The aim of the present communication is to give information on the method used in the Geophysical Institute of the Czechoslovak Academy of Sciences in elaborating data obtained at the Průhonice observatory and on some of the details of calculation.

As has already been stated, it is actually the time of propagation of the wave packet (pulsed radio signal with carrier frequency f) in the direction of the z axis that is measured. The right-handed Cartesian coordinate system has its origin in the observation point, the x axis points to the south and the z axis is vertical. The time in which the pulse reaches the reflection point is thus given by the relation

\[ \frac{1}{2} T = \int_0^{z_0} (dz/v') \]

on the assumption of validity of the theorem of reciprocity (i.e. the propagation of energy upwards and downwards takes the same time). \( z_0 \) is the height for which \( \mu = \text{Re}\{n\} = 0 \), \( n \) is the refractive index and \( v' \) the group velocity. The virtual height \( h \) is introduced by the relation

\[ h = c \int_0^{z_0} (dz/v') = \int_0^{z_0} \mu'\,dz \]

where \( \mu' \) is the group refractive index (its real part).

The problem now is to find the dependence \( z_0 = z_0(f) \) from the measured dependence \( h = h(f) \) taking into consideration that \( \mu' = \mu'(f, z) \). Under very simplifying assumptions (neglection of influence of magnetic field, monotonous form of \( z_0(f) \)) this equation can be solved exactly but if the anisotropy of the medium is taken into consideration the possibility of an explicit solution is lost and approximate methods must be used. We chose the method given in [1] which consists in resolving the
integral in (2) into a sum, expressing this sum by a multiple of the matrix with a sequence of the true heights and finally solving this formal record by inversion of the auxiliary matrix.

**DESCRIPTION OF METHOD USED**

Equation (2) must first be rewritten in a form suitable for the above-mentioned operations. Since the integral in (2) is divergent as a result of the integrand (for \(z \to z_0, \mu' \to \infty\)), we exchange the variable

\[
h = \int_{0}^{f_0} \mu'(f, f_0) \left(\frac{dz}{df}\right) df,
\]

where \(f_0\) is the plasma frequency at a height \(z_0\). After introducing the parameter \(\phi\) by the relation \(f = f_0 \sin \phi\) we obtain

\[
h = f_0 \int_{0}^{\pi/2} \mu'(f_0, f_0 \sin \phi) \left[\frac{dz}{d(f_0 \sin \phi)}\right] \cos \phi \, d\phi.
\]

This integral is now resolved into the sum of the integrals with equidistant distances of their limits equal to \(\Delta f\) (with regard to the possible accuracy in reading from the ionograms we choose 0.1 MHz), i.e. \(f = k \cdot \Delta f, f_0 = k \cdot \Delta f\) and, on the assumption that in each partial interval we can write \(\frac{dz}{d(f_0 \sin \phi)} = \frac{\Delta z}{\Delta f} = \text{const.}\) we obtain

\[
h = \sum_{k=1}^{l} M_{1,k}(z_k - z_{k-1}),
\]

\[
M_{1,k} = l \int_{\arcsin((k-1)/l)}^{\arcsin(k/l)} \mu'(f_0, f_0 \sin \phi) \cos \phi \, d\phi.
\]

Equation (5) can be expressed in the matrix form \([h] = [M] \cdot [z]\) where

\[
[M] = \begin{bmatrix}
M_{1,1} & 0 & 0 & \ldots & 0 \\
M_{2,1} - M_{2,2} & M_{2,2} & 0 & \ldots & 0 \\
M_{3,1} - M_{3,2} & M_{3,2} - M_{3,3} & M_{3,3} & \ldots & 0 \\
\vdots & \vdots & \vdots & \ddots & \vdots \\
M_{l,1} - M_{l,2} & \ldots & \ldots & \ldots & M_{l,l}
\end{bmatrix}
\]

and then \([z] = [M]^{-1} \cdot [h]\), where \([M]^{-1}\) is the matrix inverse to \([M]\). In this way it is thus possible to calculate the heights \(z_i\) corresponding to the frequencies \(f_i (i = 1, 2, 3, \ldots, l)\) if the sequence \(h_i(f_i)\) is given and if the matrix \([M]^{-1}\) is known. In the final operation the terms \(i = 1, \ldots, 9\) are combined since the sequence \(h_i\) is measured from a frequency of 1 MHz. A substantial part of the work is the calculation of the matrix \([M]\). The individual terms \(M_{i,k}\) are given by relation (6) where