

3.5. COMPUTED TOMOGRAPHY (CT) SYSTEM FOR AUTOMATIC ANALYSIS OF ICE CORES

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An automated analysis of ice cores from various depths in antarctic glaciers allows conclusions about climatic changes during the past millenia. Cores with a length of 1 m and with a diameter of 10 cm of firm and porous ice have to be scanned and reconstructed in their full size in order to analyze the mean porosity of the ice core and porosity distribution in the case of bubble ice.

The complete cores of firm ice are measured by means of a Helical-CT in a low spatial resolution. Using a quantitative calibration measurement of a phantom without any porosity, the mean density and hence the mean porosity of the firm core can be measured.

For an analysis of the porous ice in an adequate precision, a reconstruction of the complete volume in a high spatial resolution (12.5 μm) is essential. Because of the huge object size and the stringent requirements on spatial resolution, an immense amount of data arises during the measurement and the reconstruction. In this context challenges considering the CT setup and the automatic image analysis arise.

For high precise determination of the volume distribution of the bubbles a high magnification is needed. In spite of the big active area of the X-ray detector (8000×4000 , 32 Mpixels) used in the setup, the needed magnification cannot be reached with the full width of the core. The object will be inspected with a Helical-CT in its full size. At the maximum magnification only the inner part of the ice core can be displayed on the detector. A multiscan procedure makes measurements of the object in various magnifications and reconstructs the inner part of the ice core in a high spatial resolution. The whole diameter of the object can only be displayed with a low spatial resolution and is used as artefact reducing additional information for the back projection algorithm (MRA-ROI-CT). As an alternative missing data are resumed in a single scan procedure, which leads to a reconstruction afflicted with artefacts (truncated projections). Finally there is the option of a reconstruction by means of a gradient method (lamda reconstruction), which exclusively reconstructs the bounding surfaces between air and ice. Anyway, only the inner part of the object can be reconstructed in an adequate precision.

The high resolution measurement enables us to make precise conclusions about the physical volume of single pores and furthermore allows calculations of a statistic distribution of the pore volumes in the inner part of the core. Using the knowledge of the number of pores and their local distribution the results of the high resolution measurement will be transferred to the entire ice core in order to make conclusions about the mean porosity and the porosity distribution. The setup of the CT-system, implemented methods for data acquisition and analysis and results will be presented.