Detector System of the Focal Plane Detector of KATRIN

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The Karlsruhe Tritium Neutrino Experiment (KATRIN) is designed to measure the mass of the electron neutrino directly with a sensitivity of $m_{\bar{\nu}_e} \geq 0.2$ eV (90 percent C.L.). It is a next generation tritium beta-decay experiment scaling up the size and precision of previous experiments by an order of magnitude. The energy of electrons from the tritium β^-decay ($E_{max} = 18.6$ keV) is analyzed with an electrostatic retarding spectrometer with an energy resolution of 0.9 eV. The spectrometer is followed by the Focal Plane Detector System which counts the electrons passing the spectrometer.

The 500μm thick Si pin-diode[1] detector has an active area of 80 cm^2 and is subdivided on the junction side into 148 pixels of an equal area to allow a spatial resolution of a few millimeters and an energy resolution in the range of 600 eV FWHM. This energy resolution is necessary to identify the intrinsic background level caused by detector materials and reduce this background to $B \leq 10^{-3}$ Hz. To reach the over all background level of $B \leq 10^{-2}$ Hz the detector is surrounded by inert shielding and active veto counter. The selection of the materials surrounding the detector was optimized with Monte Carlo calculations and radio-assay of construction materials. Since the detector operates in ultra-high vacuum, attention must be paid to the mounting and signal connection techniques. Operating the preamplifiers in a confined space, under high vacuum, in fields of up to 6 Tesla provided additional design challenges.

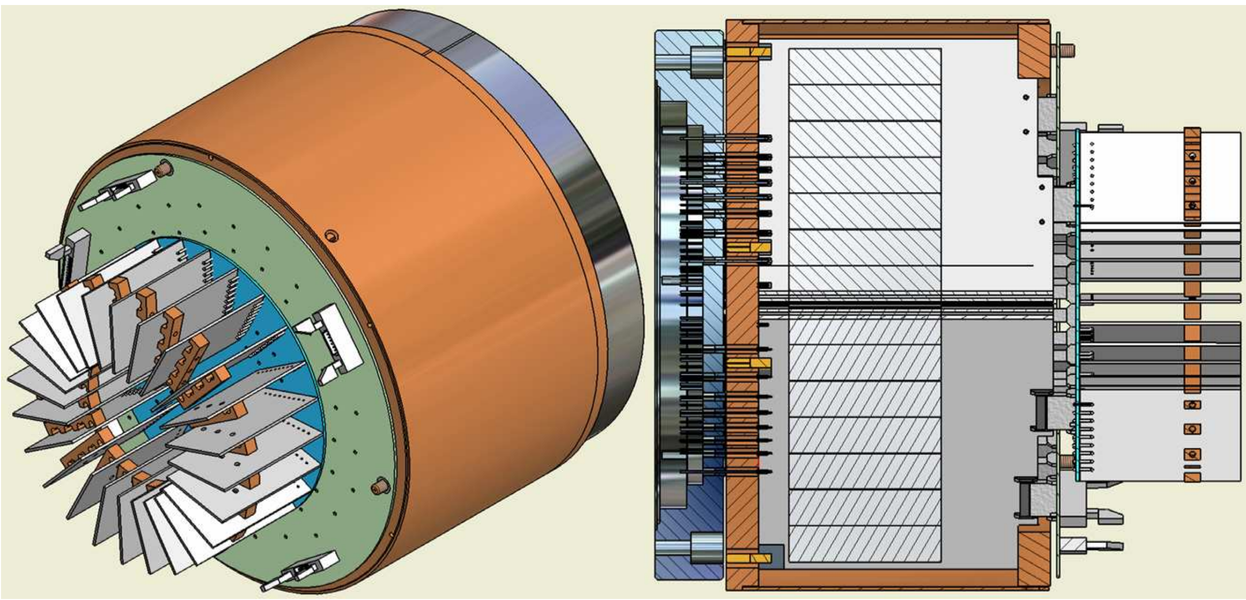

Figure 1: **Focal Plane Detector System** On the left side is an isometric view of the complete assembly as it will be installed. On the right side is a section through this assembly showing the individual components in more detail.

The detector is read out by charge sensitive preamplifiers, which, for reasons of heat dissipation and radioactivity, are built on ceramic boards using RUBALIT 710 S[2]. The preamplifiers offer a resolution in the range of 600eV FWHM. All 148 channels of preamplifiers will be installed as a carousel of 24 boards with 6 or 7 channels per board. The temperature of each module and the leakage current of each channel is monitored and a test pulse is supplied to each channel. Detector signals pass from the ultra high vacuum via a custom feed-through using niobium pins in sapphire insulators. The preamplifiers are housed in an OFHC copper enclosure which provides both shielding and improved cooling. Connections to the preamplifiers use distribution boards and cable boards made from REXOLITE[3] which has approximately 10^3 less radioactivity than typical PCB materials.

Results obtained with the final version of the preamplifiers concerning noise analysis and resolution measurements will be expected by the end of July followed by the integration into the detector system at the University of Washington, Seattle at the end of September.

The construction of the electronic system and results obtained with prototypes will be described.

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