Purpose: To design, fabricate and test the data acquisition timing control, precision rotary stage control, and an analog data multiplexer unit for a prototype megavoltage computed tomography (MVCT) detector. To measure the basic detector characteristics such as linearity with dose rate, the pre-sampled modulation transfer function (MTF), the noise power spectrum (NPS) and the detective quantum efficiency (DQE).

Method and Materials: The 80-element prototype detector array is made with $\text{CdWO}_4$ (element size 0.275 x 0.8 x 1 cm$^3$) scintillators and photodiodes placed on an arc with a radius of 110 cm. In addition to designing and fabricating an in-house data acquisition system (front-end integrators, data multiplexer unit, and timing control), a precision rotary stage and its control are added to create a third generation MVCT scanner. The data acquisition is synchronized with radiation pulses from a linear accelerator. The response of the detector as a function of dose rate was studied by varying the source to detector distance. A narrow slit beam, at five locations, was used to measure the pre-sampled MTF. The detector signal in open beam was measured for a number of radiation pulses to use the periodogram method for NPS estimation. Using the measured MTF, NPS, and the photon fluence impinging on the detector, the DQE was calculated.

Results: Detector response is linear as a function of dose rate, however, shows a non-linear component while measuring the attenuation by solid water due to the poly-energetic spectrum. Therefore, beam-hardening correction is necessary before MVCT image reconstruction. The MTF at the Nyquist frequency (0.16 mm$^{-1}$) is approximately 0.48. The zero-frequency DQE in 6 MV beam at 21% is higher than any experimental MVCT detector.

Conclusions: The basic performance of the prototype detector was found to be satisfactory for producing reasonable low contrast resolution in MVCT images with low dose.