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## Design of a scientific CCD camera with a large focal plane of 4k x 4k pixels

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A scientific CCD camera with 4k by 4k pixels and compact size is designed which can be used for astrophysics, Particle Physics, biology, medicine and material Science. This camera uses a CCD detector with model CCD230-84 from Teledyne e2v (UK) Ltd. The detector is a back illuminated detector with QE higher than 90% at 500nm to 650nm wavelength, which has split readout registers at both top and bottom with charge detection amplifiers at both ends. The pixel size is 15  $\mu\text{m}$  square. The image area has four separately connected sections to allow full-frame, frame transfer, split full frame or split frame-transfer modes. Depending on the mode, the readout can be through 1, 2 or 4 of the output circuits.

The hardware structure of the camera system includes three parts: vacuum head, CCD controller, and power and temperature controller unit (PTC). The vacuum head and the CCD controller constitute the main body of the camera named "camera head". In the vacuum head, a thermoelectric cooler (TEC) is used to refrigerate the detector for lower readout noise and dark current noise. Both air cooling or water cooling could be used for the system heat dissipation. The CCD could be refrigerated to -60 degree centigrade with water cooling mode or be refrigerated to 50 degree centigrade below ambient temperature when using air cooling. The vacuum is vacuum sealed with vacuum clamping technology. The signals of the CCD detector and the TEC connect to the CCD controller through four 26 pins vacuum feedthrough connectors. The CCD controller provides interfaces with the host computer and the PTC unit, drive biases and clocks for the detector, and four readout channels with ACDS sampling technology and maximum readout speed of 500kpixels/channel/s. The PTC takes 24V as the input power and generates multiple voltages for the controller. Meanwhile the PTC implements the high precision temperature feedback control for the TEC with a STM32 microcontroller. A 19 pins cable is used for connecting the PTC and the CCD controller.

The whole size of camera head is just  $\varnothing 165\text{mm} \times 300\text{mm}$ , and the size of the PTC is  $183\text{mm} \times 55\text{mm} \times 95\text{mm}$ . So the camera is very compact and easy to be assembled. The camera has been tested for the imaging function, gain, dark current and readout noise. The readout noise is measured as 9.3 electrons (rms) with 500 KHz readout speed.

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