# MCCD

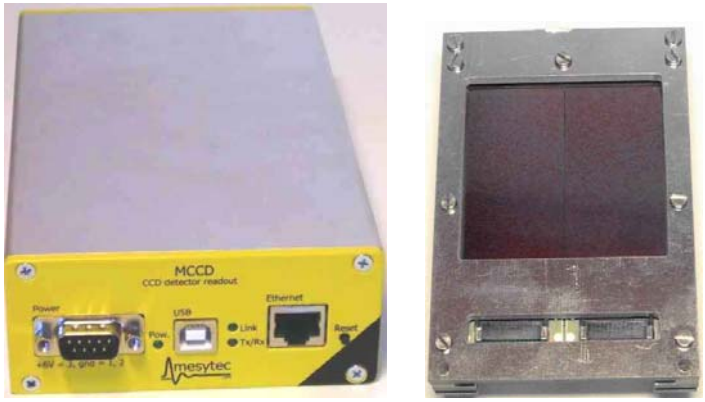
*datasheet V1.0, preliminary*

Large Area CCD for particle detection with readout electronics and software

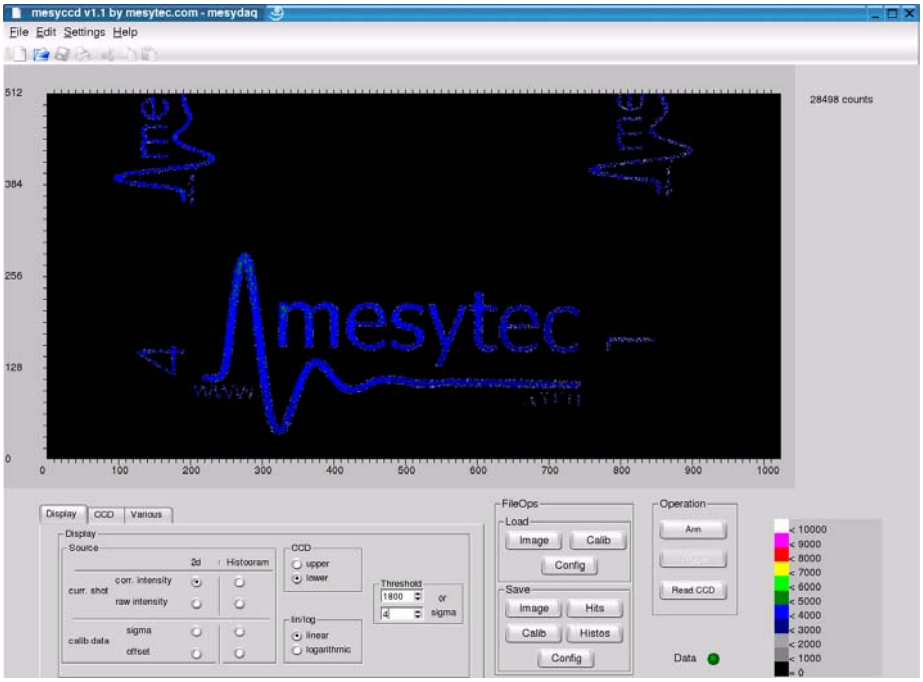
mesytec MCCD is a large area CCD detector with high speed and high resolution readout electronics. It is designed for in vacuum operation to allow charged particle detection.
CCD data are transmitted via 100 Mbit ethernet to a PC. Software for calibration, visualization and particle detection is included. Maximum frame rate including transmission is 1 frame per second.

**Features:**

- 14 bit digitization
- Data interfaces: USB2.0 and 100Mbit Ethernet
- 50 x 50 $mm^2$ active CCD area
- 48 x 48 um pixel size
- 1M pixels
- Vacuum feedthrough and cables are included
- Software for visualization and particle detection (for ethernet connection only)
- gain 1 and gain 10 remote switchable to extend range




*Sequencer module MCCD and the large area CCD*




*mesyccd: data acquisition and control software for the ethernet interface*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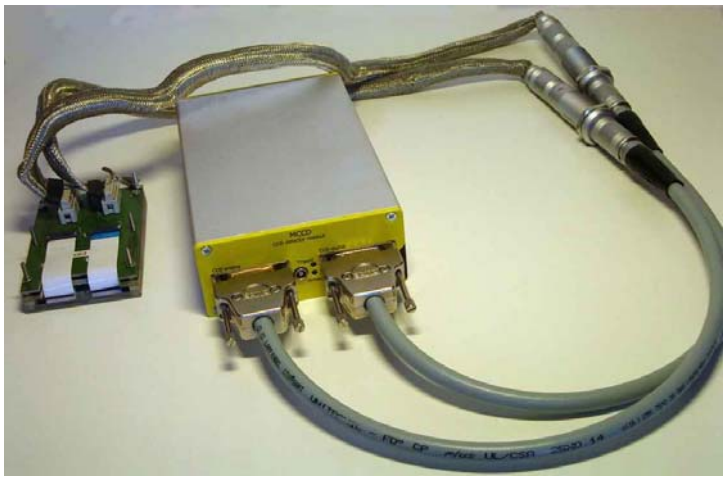
## Setup, overview



# Technical Data:

### CCD:

**Power dissipation in vacuum:**
280 mW

**noise / detection level**
gain = 1 :
80 e- per bin

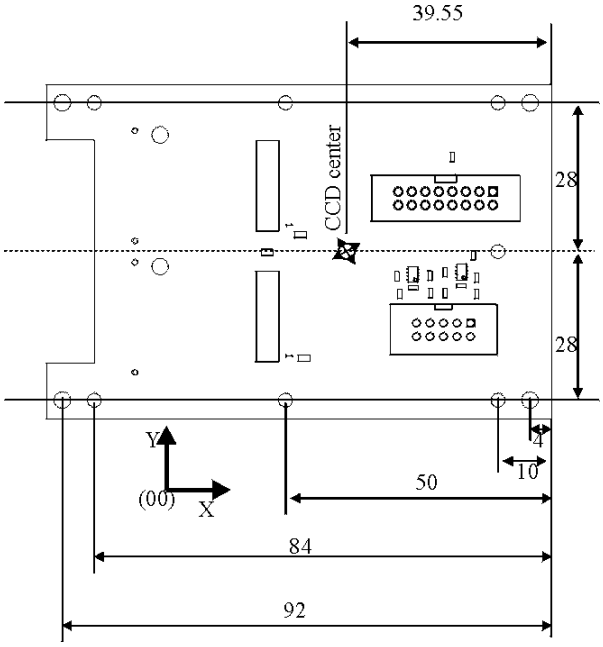
gain = 10:
8 e- per bin
Typical noise is 250 e- rms

**Sensitivity for particle detection:**

for particle detection a threshold of typical 500 e-, which corresponds to 1.8 keV energy deposition in the 2.2 um active layer, is possible.
(Typical $E_{loss}$ of 1MeV protons in the active layer: dE = 80 keV)

- maximum charge is $2*10^6$ e- or 7.2 MeV at low gain or 700 keV at high gain.
- active layer thickness about 2.2um
- light sensitive: for particle detection vacuum vessel illumination, also by light emitting vacuum sensors, must be avoided.
- 2 CCD sensors are used to cover the area of 50 x 50 $mm^2$. The non sensitive gap between the 2 CCD sensors is about 150 um.

**Mechanical outlines, CCD position and orientation**




*CCD Module seen from rear side. The CCD coordinate system is shown.*

## Vacuum Feedthrough

A vacuum feedthrough system is provided with the CCD module. It consists of two vacuum suitable cables, two feedthroughs (18 and 10 pole) and two cables to connect to the MCCD box.

## MCCD: Sequencer / Digitizer

- gain factor switchable 1 and 10
- 14 bit digitization (16k)
- external or internal (software) triggering
- trigger input/output (TTL)
- USB 2.0 (FTDI-driver for all operating systems)
- 100 Mbit Ethernet
- mesyccd operating and evaluating software (Ethernet only)

## Mechanical outlines

- Size:
  Length: 173 mm
  Width: 105 mm
  Height: 46 mm
  weight:

- Inputs, outputs:


*Front view of MCCD sequencer box: left the power input connector, middle the USB port and right side the Ethernet connector*


*Rear side oft the MCCD sequencer box: left and right connectors interface the CCD module. In the middle the Lemo 00 series connector can be used for external triggering of CCD sequence start or for output of internal trigger signal.*

- Trigger input/output: if connected to an input, operates as TTL trigger output (a 470 Ohm resistor is switched to +5V during high period). If external trigger is applied: works as trigger input. Positive edge triggers delay start, exposure and readout.

- Power consumption:
  +6V, 400mA (500mA including CCD)

**Readout Sequence:**

1. Arm (enables trigger input)
2. Trigger (external via positive TTL trigger input or by software from PC), starts delay time.
3. Delay time can be set from 0us to 65ms. The CCD is insensitive in this time. After delay time the exposure time is started.
4. Exposure time. Can be set from 0 to 64ms in steps of 1us. During this time the particles or light dispose charge in the CCD pixels.
5. After Exposure the CCD is read out. **No light or particle flow is allowed in this time!!** Readout lasts for 410ms
6. After readout the data are in the MCCD memory an can be transferred to the PC (500ms)

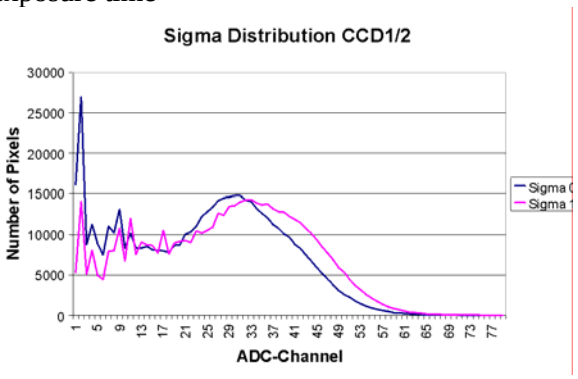
Typical operation in experiment

1. Power up for at least 30 minutes to ensure thermal equilibration.
2. Set delay, exposure time and gain (typical 10).
3. Run calibration (20 frames are read out, offsets and noise are calculated for each pixel).
4. Arm and trigger to get a dark frame.
5. Adjust threshold and sigma (typical 30, 2) to get no hits.
6. Start experiment:
7. Arm and wait for external experiment trigger.
8. Get CCD-Data
9. Export hit coordinates and evaluate data.

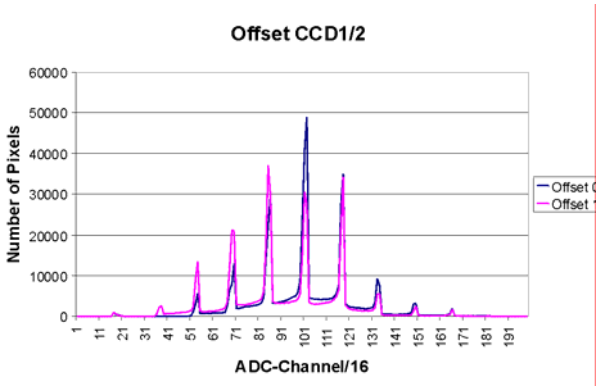
## Measured data:

### Calibration Data

Noise distribution for 20 samples: gain=10, 1ms exposure time

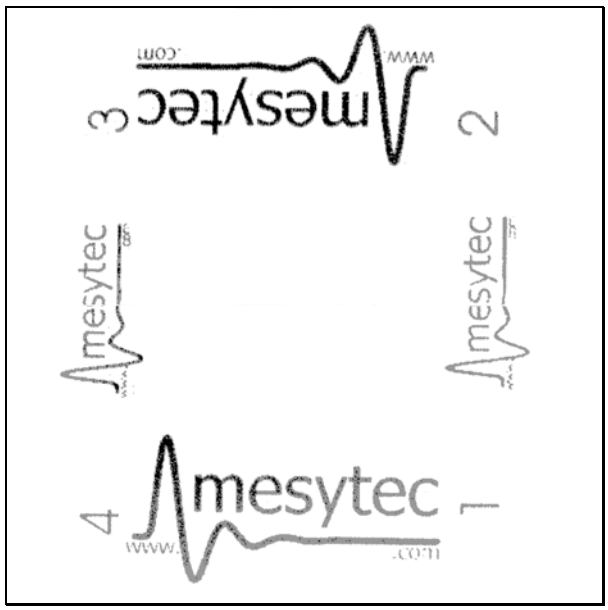



Offset distribution: gain = 10, 1ms exposure time



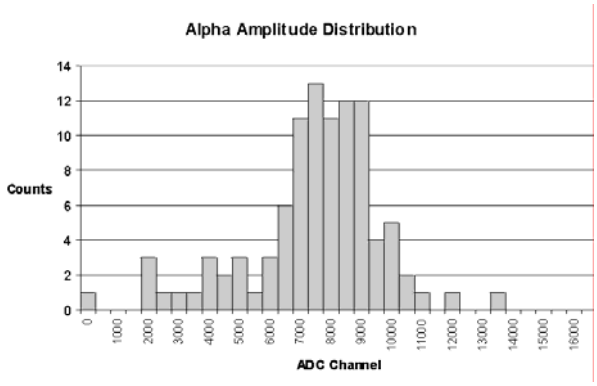

### Light detection

The large area CCD is a light sensitive device. A green LED was mounted in 25 cm distance to the CCD. An image was printed on a light transparent foil and mounted in a distance of 5 mm in front of the CCD. Within the exposure time a current of 20 mA was sent through the LED. The next figure shows the image after subtraction of the dark image offset (calibration data set) and with a threshold value of 100 ADC histogram bins.



### Particle detection

A 241Am alpha source with 5 kBq activity and 5.5 MeV Alpha energy was situated in a distance of 3 cm before the CCD. A calibration run was initiated with removed source.
Then a readout sequence was started. With an average threshold of 100 and a sigma of 2 only pixels which were hit by an alpha particle were discriminated from background. After extraction of the alpha hits the data file was analysed:




7% of alpha particles distribute their charge to two pixels.
Disposed charge (channel 8000) is about 320 keV which corresponds to 2.2 um of active silicon layer.
In comparison: a proton with 1 MeV of energy will dispose about 80 keV (= channel 2000) in a pixel. So a clear identification of protons is possible.

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