WHAT IS CLAIMED IS:

1. A detector for a charged particle apparatus comprising:

a plurality of sensor elements, each of the sensor elements having a corresponding first circuit configured to detect and digitally count a number of electron events based on a current pulse generated by the corresponding sensor element in response to an electron impacting the corresponding sensor element, each of the sensor elements including a diode that is configured to operate in a linear mode; and

a second circuit configured to digitally sum counts of multiple sensor elements of the plurality of sensor elements during a predetermined period of time.

2. The detector of claim 1, wherein the diode is a PIN diode or an avalanche diode operating in a linear mode.

3. The detector of claim 2, wherein the avalanche diode operating in the linear mode is a low gain avalanche diode.

4. The detector of claim 1, wherein the diode being configured to operate in a linear mode includes the diode being configured to avoid operation in a Geiger mode or in a photon counting mode.

5. The detector of claim 1, wherein the diode being configured to operate in a linear mode includes the diode being configured to generate the current pulse with a magnitude distribution that is substantially proportional to a kinetic energy of the impacting electron when the impacting electron enters the diode.

6. The detector of claim 1, wherein said corresponding first circuit includes circuitry to determine a first characteristic of the current pulse, and to determine a second characteristic of the electron based on the first characteristic.

7. The detector of claim 6, wherein the first characteristic is a magnitude of the current pulse and the second characteristic is a determination that the electron is any one of a secondary electron, a backscattered electron, or an electron from a noise source.

8. The detector of claim 7, wherein the determination that the electron is from a noise source is based on the magnitude of the current pulse being below a first threshold, wherein the determination that the electron is a secondary electron is based on the magnitude of the current pulse being above the first threshold and below a second threshold, and wherein the determination that the electron is a backscattered electron is based on the magnitude of the current pulse being above the second threshold.

9. The detector of claim 6, wherein the second characteristic is a determination that the electron event corresponding to the electron is one of multiple electron events resulting from multiple electrons impacting said corresponding sensor element during the predetermined period of time.

10. The detector of claim 9, wherein the current pulse generated by said corresponding sensor element is in response to the multiple electrons impacting said corresponding sensor element.

11. A method of operating a detector for a charged particle apparatus that comprises a plurality of sensor elements, each of the sensor elements having a corresponding first circuit configured to detect and digitally count a number of electron events based on a current pulse generated by the corresponding sensor element in response to an electron impacting the corresponding sensor element, each of the sensor elements including a diode that is configured to operate in a linear mode; and a second circuit configured to digitally sum counts of multiple sensor elements of the plurality of sensor elements during a predetermined period of time, the method comprising:

counting a number of charged particles incident on a sensor element of the plurality of sensor elements; and

summing counts of the multiple sensor elements of the plurality of sensor elements,

wherein an area of the sensor element is configured to receive no more than a predetermined number of charged particles per sampling period.

12. The method of claim 11, wherein the sampling period is less than a dead time of the sensor element.

13. The method of claim 11, wherein the area is configured so that the sampling period is a factor of average charged particle separation time, the factor being 0.1 or less,

wherein the average charged particle separation time is based on beam current of a beam of charged particles incident on the detector and a position of the detector elements relative to a geometric spread of the charged particles incident on the detector.