

BURLE Glossary of Terms (Dec. 2003)

Analog

An output signal that is a continuously variable quantity and proportionate to input; as with a meter or linear amplifier. The analog mode may also be referred to as the current measurement mode.

Anode

The collector electrode of a CEM or MCP detector. The anode is the most positive electrode in the detector circuit.

Bakeable

The ability of a detector to withstand a vacuum bake procedure. Most detectors used in mass spectrometry are capable of being baked (with no voltage applied) at 350° C unless otherwise specified.

Bias Angle

The angle of the individual channels in a MCP relative to a perpendicular to the surface. Typical bias angles are 5, 8, and 12 degrees.

Bias Current

The DC current flowing in the walls of the CEM or MCP (microchannel plate) as a result of differing voltages applied to the input and output. Bias Current was formerly called Strip Current.

Burn-in

The operation of CEM and MCP detectors prior to their ultimate application in order to stabilize their characteristics and identify premature failures. Burn-ins is sometimes also referred to as “preconditioning” or “scrubbing”.

CEM (Channel Electron Multiplier) (SCEM)

Channeltron®, a single channel electron multiplier

CEMA (Channel Electron Multiplier Array)

A MCP detector that utilizes a single MCP used for analog measurements and is used when gains less than 10^4 are sufficient. May have a metal anode or phosphor screen collector

Center Tab

A contact electrode positioned between MCPs in a Chevron or Z-stack configuration to equalize detector voltage across MCPs that are mismatched in resistance and bias current. Refer to Matched Set.

Center to Center (c-c) Spacing

Refer to Pitch

Chevron™

A MCP detector containing two microchannel plates with the bias angles aligned 180° opposite. Detector output may be to a metal anode, phosphor screen or RAE (resistive anode encoder)

Collection Efficiency

A measure of the ability of a detector to collect the total available signal. It is the ratio of collected signal to the total available signal.

CEM: Collection efficiency is a function of such parameters as CEM cone geometry, and the presence and potential of nearby electrodes.

MCP: Collection efficiency is a function of the MCP diameter and the OAR (open area ratio) of the MCP. Collection efficiency should not be confused with detection efficiency.

Conditioning

See burn-in

Conversion Dynode

An electrode (usually metal) used for accelerating ions exiting a mass analyzer to a high velocity in order to enhance detection efficiency. This is accomplished by holding the conversion dynode at a high potential opposite to the charge of the incoming particle. Typical conversion dynode potentials range from $\pm 3\text{kv}$ to $\pm 10\text{kv}$. Ions striking the conversion dynode produce many secondary particles which are in turn detected by the CEM.

Count Rate

A measure of the rate of input signal events. For Channeltrons®, this is typically defined as counts/second (cts/sec) and for MCPs as counts/second/square centimeter (cts/sec/cm^2)

Dark Count Rate

The output count rate that occurs in the absence of input events for a CEM or MCP detector. Dark count rate is a pulse counting measurement and is usually given in counts per second (cps).

Dark Current

Output current that occurs in the absence of an input event for a CEM or CEMA. Dark current is an analog measurement and may be affected by elements outside the detector proper, such as leakage current in the collector assembly.

Detection Efficiency

A measure of the ability of an incident particle to induce secondary electrons in a CEM or MCP detector. The detection efficiency is strongly dependent upon parameters such as the mass-to-charge ratio velocity, and momentum of incident particles. Detection efficiency should not be confused with Collection Efficiency. It is the ratio of Detected input events compared to total input events under a given set of operating conditions.

Detection Quality MCP

Detection quality MCPs are used for a wide range of signal detection applications and offer the best value for non-imaging applications. Detection Quality MCPs are typically used in Time of Flight (TOF) Spectrometry, Residual Gas Analysis (RGA) and Point Source Detectors.

Dynamic Range

The ratio of maximum to minimum detectable linear signals. For analog CEMs or CEMAs, dynamic range is a function of dark current and maximum linear output current. For pulse counting CEMs Chevron and Z-stack MCP detectors, dynamic range is a function of dark count rate and maximum output count rate capability.

Electrode Penetration

Electrode Penetration is the depth that surface metallization is deposited into the channels. This is typically defined as the number of channel diameters. Typical values range between 0.3 and 3.0 channel diameters.

Electron Generator Array (EGA)

ELECTROGEN™ Electron Generator Arrays (EGAs) consist of millions of precision glass tubes fused together to produce a uniform and mechanically rigid structure. When a voltage is applied across the thickness, each pore produces a beam of electrons. With each of the millions of pores producing electrons, the resultant electron flux is extremely uniform and dense.

End Spoiling

Another term for electrode penetration; refer to Electrode Penetration

Emission Current

A measure of the output current emitted from an EGA

Enhancement Coatings

Coatings applied to the input surface of a Channeltron or MCP detector to improve the detection efficiency for a particular input event type. Examples are: MgO, KBr, MgF₂, Au, CsI, CuI and others.

Extended Dynamic Range™ (EDR)

Provides a linear output range for a CEM or MCP that is up to 100 times that of a standard CEM or MCP.

Full-Width at Half-Maximum (FWHM)

A figure of merit for the output pulse height distribution (PHD) of CEMs and MCP detectors operated in the pulse counting mode. The FWHM is a measure of the narrowness of the quasi-Gaussian PHD produced by the saturated detector output pulses. It is usually expressed as a percent and calculated by dividing the peak or modal gain value by the gain range at half the peak height, and multiplying the result by 100%.

Fixed Pattern Noise (FPN)

A feature observed in an image that is independent of input signal and attributed to non-uniformity of MCP or phosphor screen response.

Funneling

A special feature that may be added during the MCP manufacturing procedure to increase the entrance diameter of the pores of the MCP. Funneling increases the effective OAR of the MCP to improve collection efficiency.

Gain

The ratio of the amplitude of the output signal to the amplitude of the input signal. Analog and pulse counting gain measurements are made via different procedures, however, the result can still be considered the ratio of output to input signals.

Gating

The process of turning a detector on and off at precise intervals by changing the input or output applied voltages.

Grid

A wire mesh placed in front of the entrance of a Channeltron or MCP detector, typically containing 50X50 or 70X70 wires per inch. Ion or electron transmission through the grid is approximately 90%. Grids are used to create a uniform field across the detector entrance or to apply accelerating or retarding voltages.

Image Quality MCPs

Designed for use in applications where image quality or position sensing is required. When used with appropriate readout devices, these MCPs provide an intensified high resolution image.

Interplate Biasing

A MCP detector biasing scheme that permits independent biasing of the input and output voltages applied to each MCP in a Chevron. This is particularly useful in applications that require gating of the MCP

L/D

The ratio of the channel length to the pore diameter for a MCP. Typical values are 40:1, 60:1 and 80:1. L/D affects gain, timing, PHD and determines maximum operating voltage.

Lifetime

The limit beyond which useful signal can no longer be obtained at the maximum recommended detector operating voltage. Lifetime can be expressed either as a measure of total accumulated output charge or in hours of operation under stated conditions of pressure, gain, and input. Lifetime is very dependent on ambient conditions during operation.

Linearity

The ability of a detector to produce an output current which varies directly and linearly (in a straight line function) with respect to the input. Most analog detectors will produce linear output currents of up to 10-12% of the bias current.

Mass Discrimination

The property of a CEM or MCP detector by which the gain varies as a function of the mass of the incident ions. In general, the higher the mass, the lower the gain (detection efficiency) for constant energy ions.

Matched Set

MCPs that have been matched to within 10% of their measured bias current. Matched set MCPs are self biasing when assembled into a detector and do not require the use of a Center Tab. Matched set MCPs are indirectly matched in resistance by Ohm's Law.

$$E=IR \quad \text{Voltage}=\text{Current} \times \text{Resistance}$$

Matched Resistance

Refer to Matched Set

Maximum Operating Temperature

A specified value provided in the product specification that defines the maximum temperature at which the detector may be operated or have applied voltage.

Maximum Vacuum Bake Temperature

A specified value provided in the product specification that defines the maximum temperature that may be used to vacuum bake MCPs, Channeltrons or detector assemblies. This is not an operating temperature.

Refer to Maximum Operating Temperature

MCP

A microchannel plate that is not assembled into a detector

Mesh

Refer to Grid

Metal Anode

An anode for a MCP detector that collects output signal. Spatial relationship of input events is not maintained. See Anode.

Microphonics

The noise signal induced in the output (or collector) circuit of a detector by coupling due to mechanical vibration of nearby circuit elements or sources.

Multi-anode

A MCP detector anode design that provides spatial resolution by creating an array of independent anodes. Some typical arrangements include quadrants or strips.

Open Area Ratio (OAR)

The area percentage of an MCP surface that is comprised of channels.

Pitch

The distance between the center points of two adjacent channels in a MCP. This is another term for center to center (c-c) spacing. Pitch determines the limiting spatial resolution of a MCP.

Plateau

Plateau is the portion of the count rate versus voltage plot over which the count rate is substantially independent of the applied voltage.

Phosphor Screen

A position sensing output for a MCP detector created by a fused fiber-optic or glass substrate coated on one surface with phosphor. Output signal from the MCP detector is converted to an image that retains spatial information from the input events.

Premium Quality MCP

Designed for use in precision imaging applications requiring superior image quality. Premium quality MCPs are manufactured to the highest quality specifications achievable. Premium Quality MCPs are found in applications such as High Speed Photography, Third Generation Image Intensifiers and other electronic imaging applications. Premium Quality MCPs are the preferred choice for space applications where reliability and performance are critical.

Pulse Counting

A CEM and MCP detector operational mode for which all output pulses are nearly the same amplitude due to space charge saturation. Pulse counting is used in digital systems and when detecting extremely low level input signals.

Pulse Height Distribution (PHD)

The distribution of the amplitude of output pulses for a detector at a given applied voltage. Pulse counting CEMs, MCP Chevrons and Z-stacks produce a quasi-Gaussian PHD when operated at sufficient gain. The PHD of analog CEMs and single MCPs (CEMAs) is essentially a negative exponential.

Resistive Anode Encoder (RAE)

A position sensing anode for MCP detectors that provides position information in one or two dimensions.

Rise Time

The time interval for the leading edge of a CEM or MCP detector output pulse to move from 10% to 90% of its peak amplitude. The rise time for typical CEM output pulse is about 3-5ns. MCP Chevron detector rise times are typically less than 700ps and may be as fast as 200ps. MCP rise times are determined by MCP pore size and thickness (L/D). SCEM see CEM

Scintillator

A material that interacts with charged particles, x-rays and other radiation to produce light.

Signal-to-Noise Ratio (S/N)

The ratio of the values for the signal amplitude to that of that of detector noise. S/N is a measure of the noise added by the detector.

Shelf Life

The interval of time that a detector may be stored before usage. Shelf life is very dependent upon the environmental conditions during storage. The recommended storage conditions are in an oil-free vacuum or nitrogen purged dry box.

Strip Current

Refer to Bias Current

Torr (Tor)

A unit of pressure equal to 1mm of mercury or 1/760 atmospheric pressure or 1.33 millibar.

Vacuum Storage

The optimum means to store MCPs and Channeltrons®. Vacuum should be oil-free and better than 1×10^{-3} Torr

V-Stack

Another term for ChevronTM

Wedge and Strip

A position sensing anode for MCP detectors

Z-Stack

A MCP detector assembly containing three or more MCPs. Detector output may be to a metal anode, phosphor screen or RAE (resistive anode encoder)