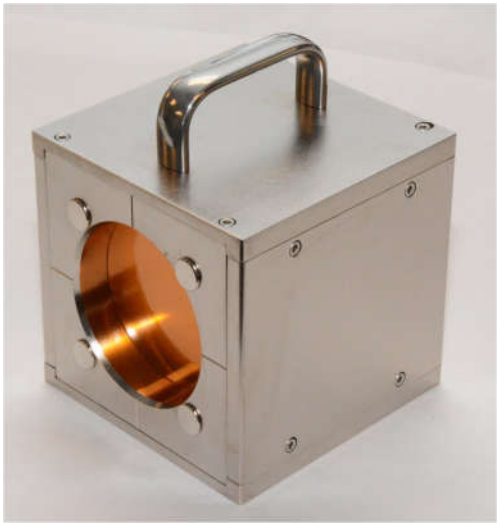
Datasheet **MLFC-128**

Multilayer Faraday Collector for Proton Energies 50 to 250 MeV

Features

- Independent and absolute beam energy measurement
- Total beam current measurement
- Proton energies from 50 to 250 MeV
- Compact, fully-screened design
- 128 high-precision pure copper beam collection plates
- 72 mm diameter sensitive area
- No vacuum system or HV bias required
- Compatible with I128 and I6400 readout electronics
- Each unit individually calibrated based on measured plate areas and weights
- Optional integrated Microhex filter for improved low energy resolution



Applications	• Particle therapy pencil beam quality assurance • Accelerator development • Particle therapy system commissioning • General high energy ion beam diagnostics

Specifications

Beam compatibility	
Species	Protons
Energy range	50 MeV to 250 MeV (Microhex filter recommended for improved resolution below 100 MeV)
Beam current density range	Up to 50 nA cm^{-2} (particle current)

Sensor	
Type	128-layer Faraday collector
Collector plates	Pure copper 0.508 mm thickness insulated by 50 µm Kapton™ and air interlayers.
Sensitive area	72 mm nominal diameter, suitable for protons beams with Gaussian lateral distribution sigma up to 10-12 mm.

Mechanical	
Insertion length	120 mm
Overall size	120 mm by 120 mm by 145 mm approx including handle (see figures)
Weight	5.6 kg (12.2 lb) .
Operating environment	Clean and dust-free, 0 to 35 C (15 to 25 C recommended , < 70% humidity, non-condensing, vibration < 0.1g all axes (1 to 50 Hz)
Shipping and storage environment	-10 to 50 C, < 80% humidity, non-condensing, vibration < 2g all axes, 1 to 100 Hz

Readout	
Compatible electronics	I128S (standard) 128-channel electrometer (one required), or I128 128-channel electrometer (one required) or I6400S 64-channel electrometer (two required).
Cable adaptation	Adaptors available from 68-way VHDCI-terminated cables to 44-way HD44-terminated cables (ADAP-VH68-2HD44M, ADAP-2VH68-4HD44M).
Software	Beam analyser host software application for Microsoft Windows included with MLFC-128 system packages providing direct readout of beam energy, energy spread and total current using unit-specific calibration tables. Trend analysis and historical results database. Pre-configured laptop computer available as option.

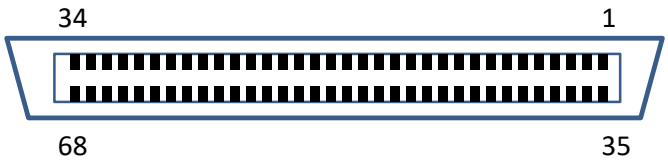
Connectors

Strip readout

Two Centronics VHDCI 68 way receptacle (SCPI-style). Gold-plated contacts. Mating connector Molex VHDCI 0.8MM plug.

VHDCI # 1 Plates 1 to 64

Top row				Bottom row			
1	Chassis	18	Plate 16	35	Chassis	52	Plate 48
2	Plate 32	19	Plate 15	36	Plate 64	53	Plate 46
3	Plate 31	20	Plate 14	37	Plate 63	54	Plate 46
4	Plate 30	21	Plate 13	38	Plate 62	55	Plate 45
5	Plate 29	22	Plate 12	39	Plate 61	56	Plate 44
6	Plate 28	23	Plate 11	40	Plate 60	57	Plate 43
7	Plate 27	24	Plate 10	41	Plate 59	58	Plate 42
8	Plate 26	25	Plate 09	42	Plate 58	59	Plate 41
9	Plate 25	26	Plate 08	43	Plate 57	60	Plate 40
10	Plate 24	27	Plate 07	44	Plate 56	61	Plate 39
11	Plate 23	28	Plate 06	45	Plate 55	62	Plate 38
12	Plate 22	29	Plate 05	46	Plate 54	63	Plate 37
13	Plate 21	30	Plate 04	47	Plate 53	64	Plate 36
14	Plate 20	31	Plate 03	48	Plate 52	65	Plate 35
15	Plate 19	32	Plate 02	49	Plate 51	66	Plate 34
16	Plate 18	33	Plate 01	50	Plate 50	67	Plate 33
17	Plate 17	34	Chassis	51	Plate 49	68	Chassis



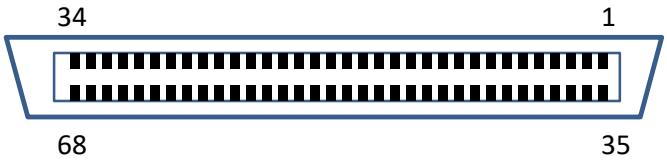
Pins connected to chassis do so via 0R resistors.
Connector shell is common with MLFC body.

Connectors (continued)

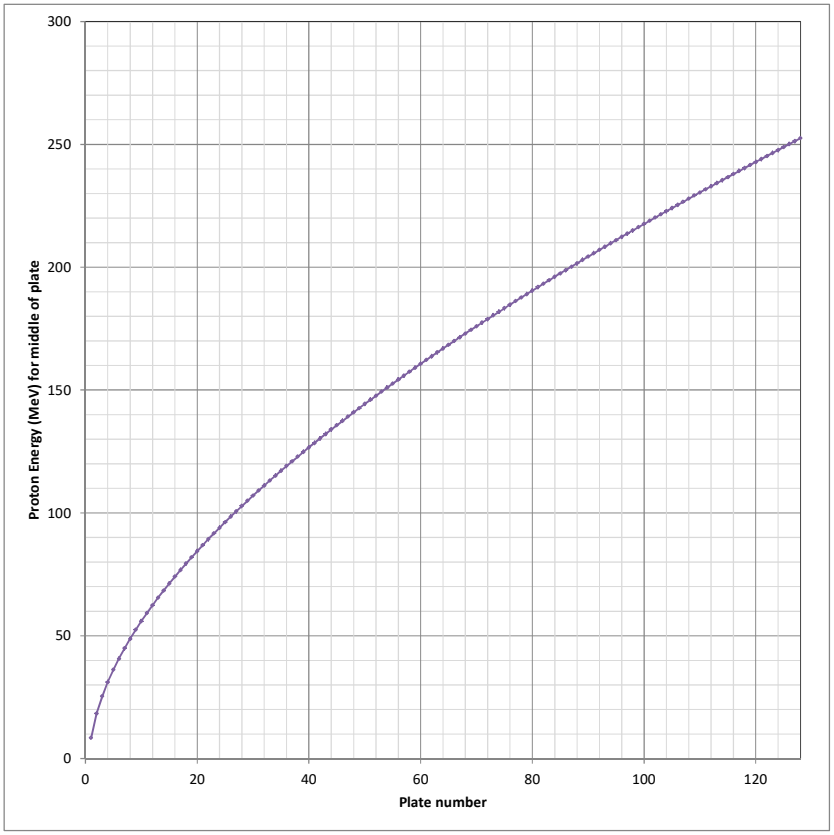
Pixel readout (cont)

VHDCI # 2 Plates 65 to 128

Top row				Bottom row			
1	Chassis	18	Plate 80	35	Chassis	52	Plate 112
2	Plate 96	19	Plate 79	36	Plate 128	53	Plate 111
3	Plate 95	20	Plate 78	37	Plate 127	54	Plate 110
4	Plate 94	21	Plate 77	38	Plate 126	55	Plate 109
5	Plate 93	22	Plate 76	39	Plate 125	56	Plate 108
6	Plate 92	23	Plate 75	40	Plate 124	57	Plate 107
7	Plate 91	24	Plate 74	41	Plate 123	58	Plate 106
8	Plate 90	25	Plate 73	42	Plate 122	59	Plate 105
9	Plate 89	26	Plate 72	43	Plate 121	60	Plate 104
10	Plate 88	27	Plate 71	44	Plate 120	61	Plate 103
11	Plate 87	28	Plate 70	45	Plate 119	62	Plate 102
12	Plate 86	29	Plate 69	46	Plate 118	63	Plate 101
13	Plate 85	30	Plate 68	47	Plate 117	64	Plate 100
14	Plate 84	31	Plate 67	48	Plate 116	65	Plate 99
15	Plate 83	32	Plate 66	49	Plate 115	66	Plate 98
16	Plate 82	33	Plate 65	50	Plate 114	67	Plate 97
17	Plate 81	34	Chassis	51	Plate 113	68	Chassis



Pins connected to chassis do so via 0R resistors.
Connector shell is common with MLFC body.

Calibration	
Energy calibration	Each MLFC-128 is individually characterised for protons at time of manufacture based on the weights and areas of its plates plus the insulators to yield a calibration table of plate number against proton energy. The value assigned to a plate is the energy at which the mean range is halfway through the plate thickness. Intermediate energies are calculated by interpolation of the table values using a longitudinal position obtained by fitting a curve to the distribution of measured currents in the plates. The typical shape of the calibration is as shown:  Range spread and thus energy spread is obtained by de-convolution of the known range straggling of mono-energetic protons in copper from the measured spread in range using the known range straggling of mono-energetic protons in copper. $\sigma_{beam} = \sqrt{(\sigma_{meas}^2 - \sigma_{mono}^2)}$ **Note:** All critical dosimetry measurements must be referenced to traceable external standards, and regularly validated.

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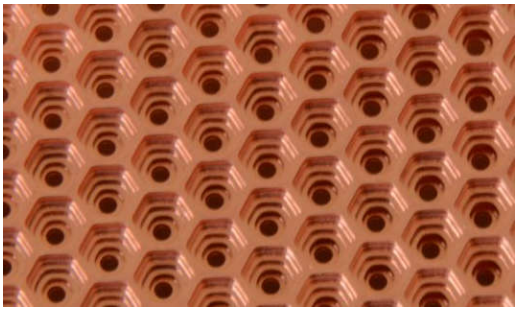
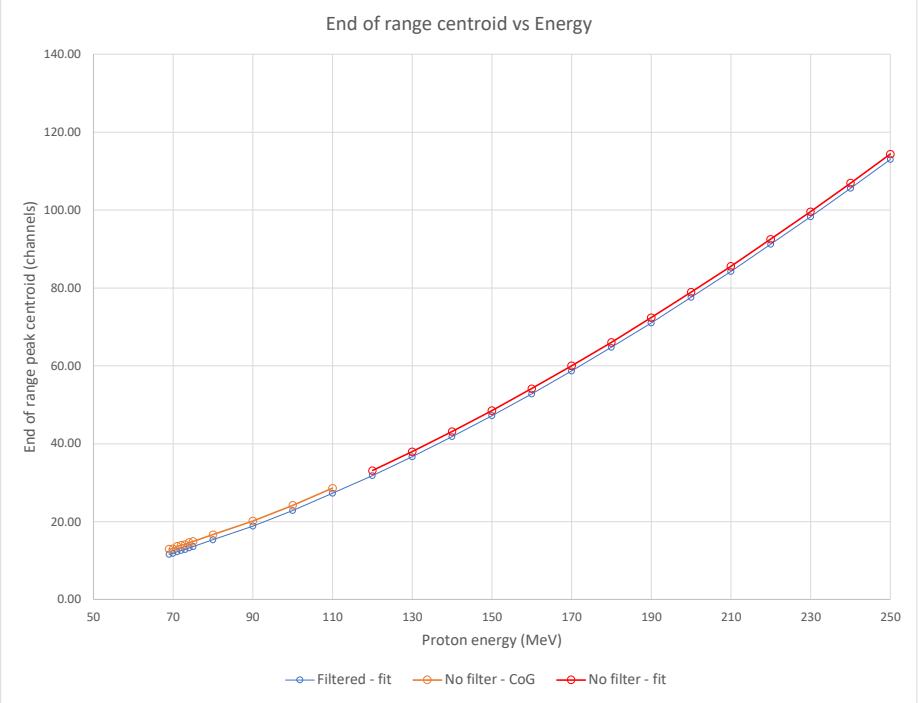
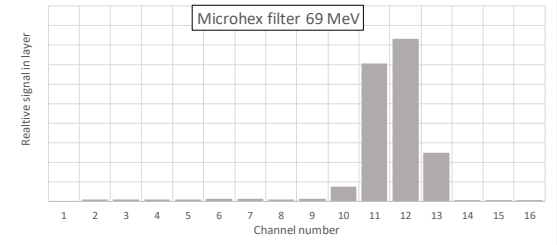
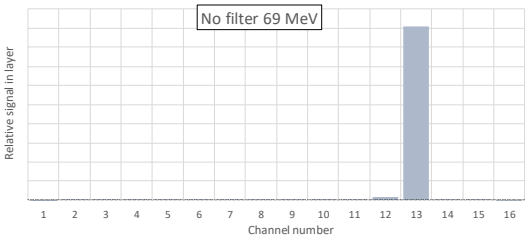
Microhex filter option

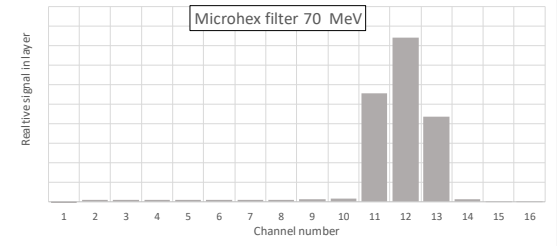
Purpose	The MLFC128-250 measures proton beam energy by measuring the range in copper. Curve fitting to the end of range peak allows resolution to 0.1 layers typically. At low energies, the end of range peak becomes very narrow, and curve fitting is no longer possible. The energy resolution is therefore reduced. The Microhex filter is an optional built-in copper filter layer that adds a known and stable spread to the range and thus allows curve fitting down to below 70 MeV. The added spread is negligible at high energies where normal range straggling is dominant.
Structure	Five copper layers, total thickness 1.275 mm, with tapered hole pattern positioned at the front of the MLFC layers. 
Effect on low energy measurements	Effect on overall calibration curve. Curve fitting not possible below 110 MeV without filter (orange portion of unfiltered curve) - centre of mass calculation only: 

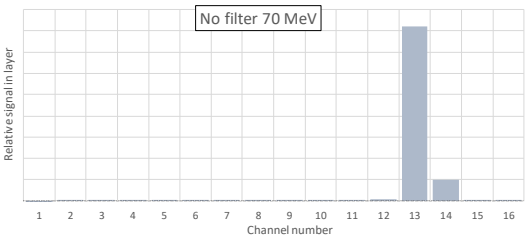
Microhex filter option (continued)

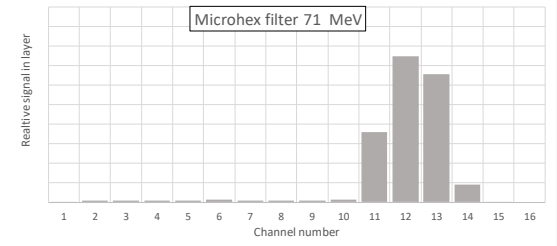
Effect on end of range peak at low energy

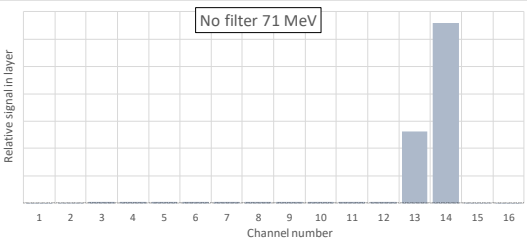




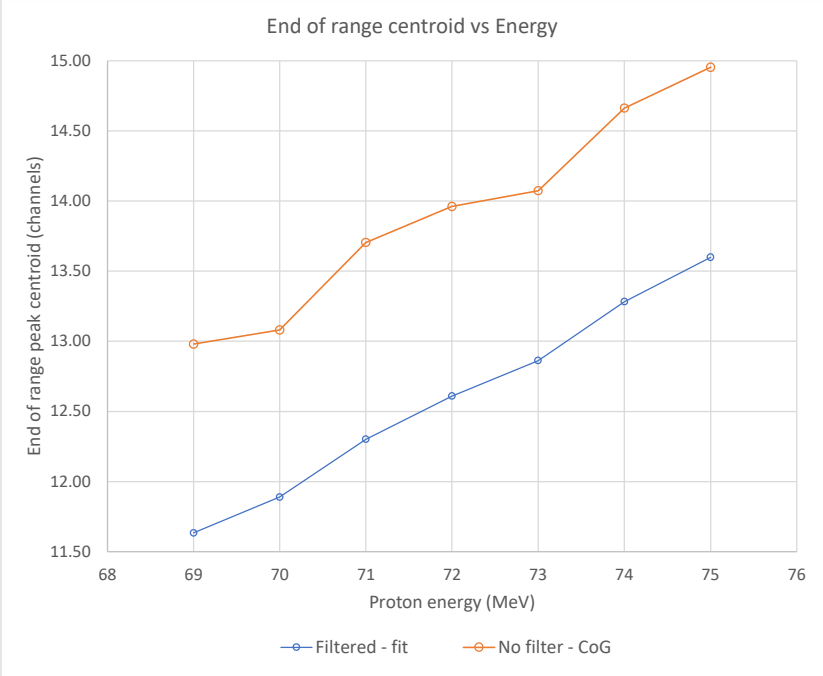


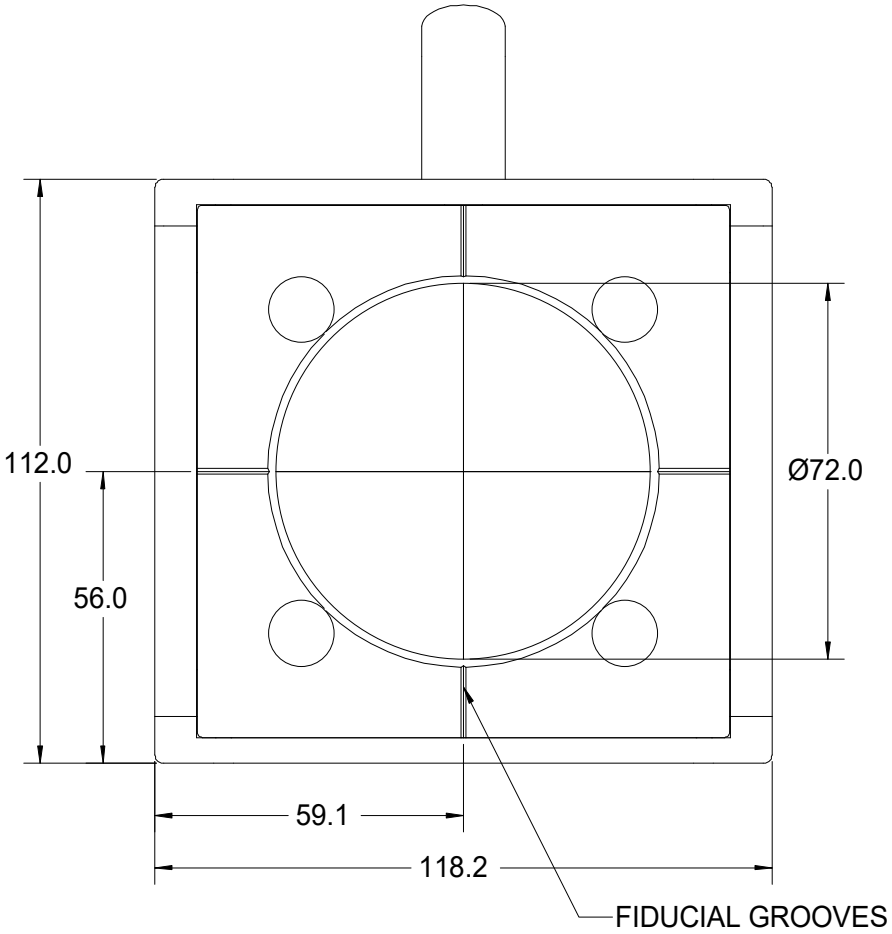






Effect on response function linearity at low energy

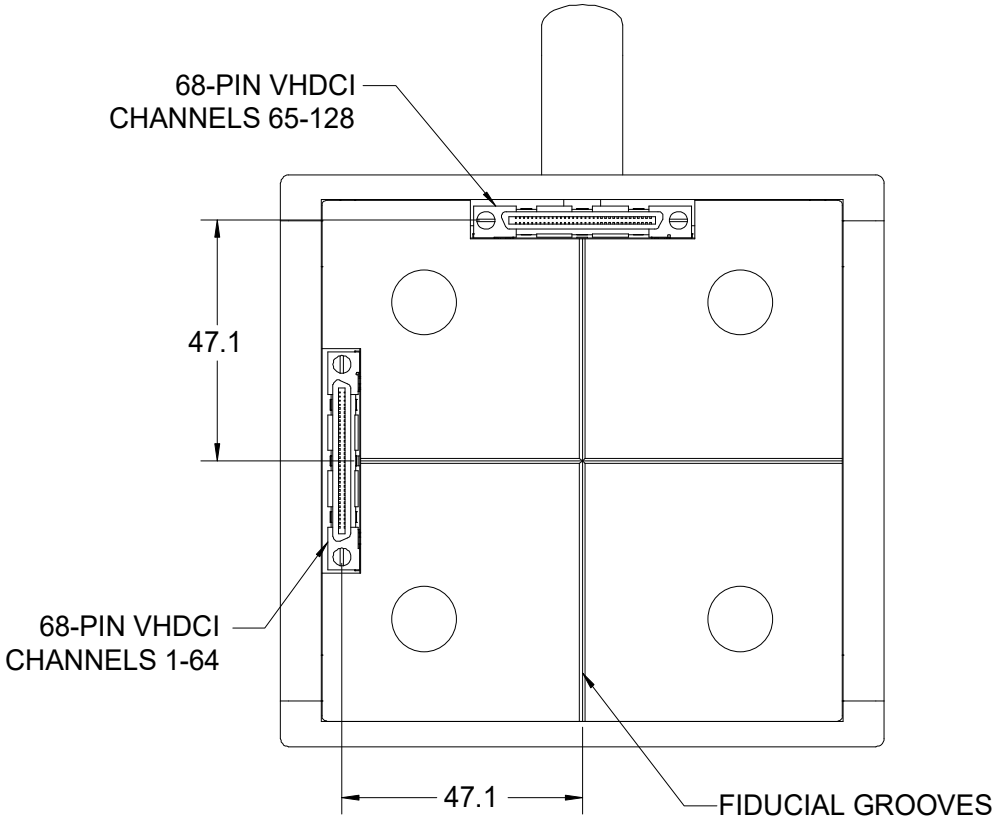




BEAM ENTRY END

Dims mm

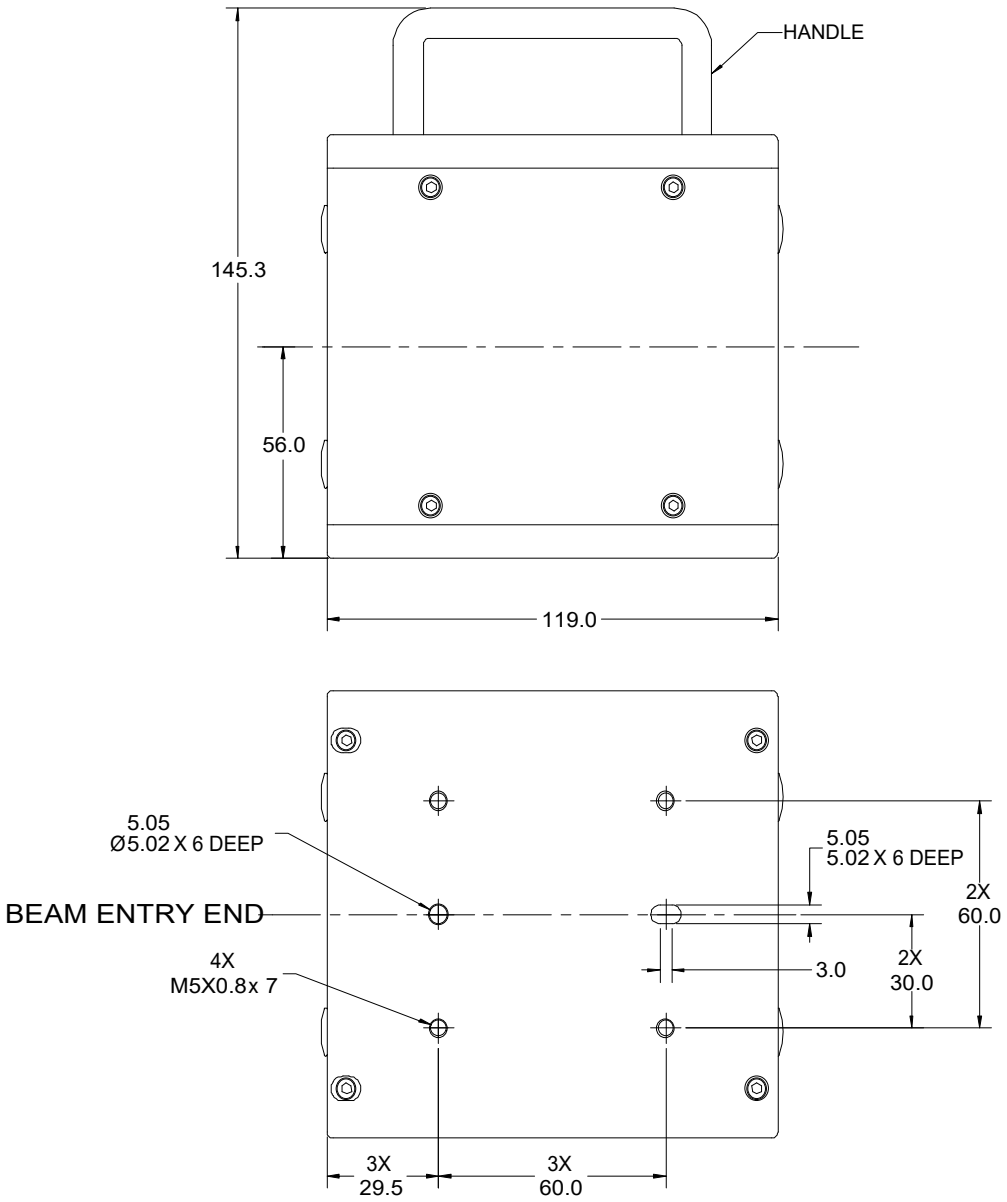
CAUTION: The MLFC-128 will become activated due to exposure to high energy proton beams. This does not affect performance, and will decay over time, but the device must be radiation surveyed by an authorized person and suitably packaged before moving it out of a controlled area.



REAR VIEW

Ordering information

MLFC128-250	Multilayer Faraday Collector with 128 equal thickness copper strips. Energy calibration for protons included.
-MHX1	Microhex filter type 1 for improved resolution at low energy
-SYS	MLFC system including MLFC128-250, I128S 128-channel electrometer, two VHDCI cables, beam analyser software for Windows. Options include pre-configured laptop, Microhex filter, bespoke Monte-Carlo energy calibration.
ADAP-2VH68-4HD44M	Adaptor, two 68-way VHDCI to four HD44 male to enable use of I6400 or standard I128 electrometers.



Dims mm

Pyramid Technical Consultants, Inc.,
135 Beaver Street Suite 102
Waltham MA 02452 USA
Tel: +1 781 402 1700 (USA),
+44 1273 492002(UK)

Email: support@ptcusa.com **www.ptcusa.com**

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