Dosimetry and Position Sensing Ionization Chamber for Ion Beam Tracking

Features

- 16 cm x 16 cm sensitive area
- Ionization chamber with dual integral plane readout for dosimetry and 64 by 64 strip readout for position and shape tracking
- Minimum scattering due to thin films of low-Z material
- Small insertion length (44 mm)
- Kapton(™) film electrode substrates for radiation hardness and high geometric precision
- Operable with atmospheric pressure air chamber gas or flow-through gas
- Integrated temperature, pressure and humidity sensing
- Integrated desiccant for fill gas
- High voltage sense loopback

Applications	• Particle therapy scanned beam tracking and dosimetry • Pencil beam scanning control • General high energy ion beam diagnostics
Options	• Enquire about other electrode gap options.

Specifications

Beam compatibility	
Species	Protons, deuterons, fully-stripped carbon
Energy range	30 MeV/nucleon to 500 MeV / nucleon
Beam current density range	Up to 20 nA cm^{-2} (particle current)

Sensor	
Type	Parallel plate dual ionization chamber with multistrip cathodes and independent integral plane cathodes
High voltage	2000 V nominal, maximum 3000 V
Sensitive area	160 mm by 160 mm

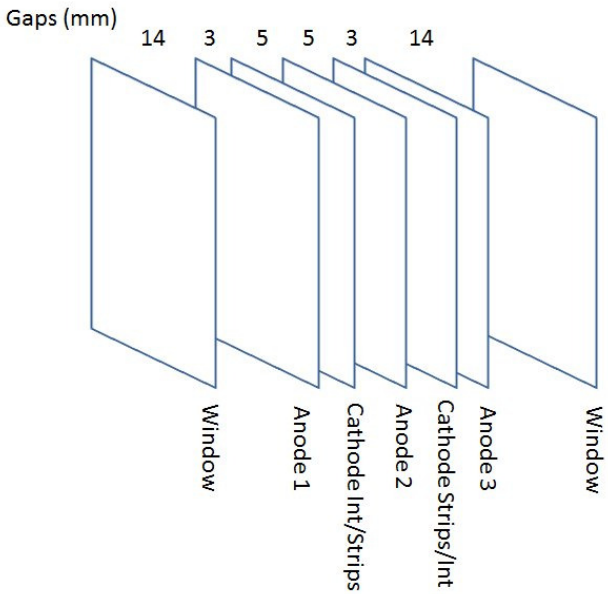
Sensor (cont)	
Sensitive volume	Active volume 1: Anode 1 to integral cathode 1. 3mm. Active volume 2: Strip cathode 1 to anode 2. 5mm. Active volume 3: Anode 2 to strip cathode 2. 5mm. Active volume 4: Integral cathode 2 to anode 3. 3mm.
Strip geometry	64 strips 2.50 mm pitch (50 µm inter-strip gaps typical)
Gain uniformity	Better than +/-2% for beams within the sensitive area.
Position accuracy	Integral linearity better than 60 µm maximum deviation relative over the sensitive area.
Position resolution	Depends on signal to noise ratio; 10's of µm achievable.
Fiducials	Electrode strips tolerance buildup relative to fiducial features on body +/- 0.3 mm nominal, < +/- 0.1 mm typical .

Chamber gas	
Operating gas	Dry atmospheric air, or flow of any clean ionization chamber gas (Ar/CO2 etc)
Flow gas connections	To suit 1/8" tube push fit
Desiccant	For use when chamber is closed to atmosphere. Silca gel sachets (3). Sachets can be changed with chamber in situ.

Mechanical	
Insertion length	44 mm window to window, 50.4 mm housing face to face.
Overall size	330 mm by 330 mm by 78 mm approx (see figures)
Weight	3.8 kg (8 lb) excluding any added mounting brackets.
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) Temperature and pressure compensation of chamber gain must be performed.
Shipping and storage environment	-10 to 50 C, < 80% humidity, non-condensing, vibration < 1g all axes, 1 to 20 Hz

Beam scattering	
Layers in beam path	

1	12.5 µm	Polyimide foil aluminized both sides 0.1 µm (window)
2	14 mm	Fill gas
3	12.5 µm	Polyimide foil aluminized both sides 0.1 µm (anode 1)
4	3 mm	Fill gas (active gap)
5a	0.1 µm	Aluminization (integral plane cathode)
5b	25 µm	Polyimide foil
5c	0.1 µm	Aluminization (strip cathode)
6	5 mm	Fill gas (active gap)
7	12.5 µm	Polyimide foil aluminized both sides 0.1 µm (anode 2)
8	5 mm	Fill gas (active gap)
9a	0.1 µm	Aluminization (strip cathode)
9b	25 µm	Polyimide foil
9c	0.1 µm	Aluminization (integral plane cathode)
10	3 mm	Fill gas (active gap)
11	12.5 µm	Polyimide foil aluminized both sides 0.1 µm (anode 3)
12	14 mm	Fill gas
13	12.5 µm	Polyimide foil aluminized both sides 0.1 µm (window)



Total effective thickness < 250 µm water equivalent.

Connectors

Strip readout

High density DSub male 44 pin.

Four connectors (two per axis for strips 1-32, 33-64)

1	I_28	16	I_30	31	I_31
2	I_27	17	I_29	32	Shield 2
3	I_25	18	I_26	33	KGnd
4	I_23	19	I_24	34	KGnd
5	I_21	20	I_22	35	KGnd
6	I_19	21	I_20	36	KGnd
7	I_17	22	I_18	37	KGnd
8	I_15	23	I_16	38	KGnd
9	I_13	24	I_14	39	KGnd
10	I_11	25	I_12	40	KGnd
11	I_09	26	I_10	41	KGnd
12	I_07	27	I_08	42	KGnd
13	I_05	28	I_06	43	Shield 2
14	I_03	29	I_04	44	I_02
15	I_01	30	I_00		

The table shows the connections for the first bank of 32 signals for either axis (connector J1). The same connection pattern is repeated for the second connector on each axis:

J2: Strips 33 to 64 (I_33 to I_63)

Connector shell is common with shield 1.

Integral plane readouts

Lemo 0B four pin female.

Two identical connectors (one per integral plane)

1	Signal current	4	Shield 1
2	AGnd	3	Aux signal current

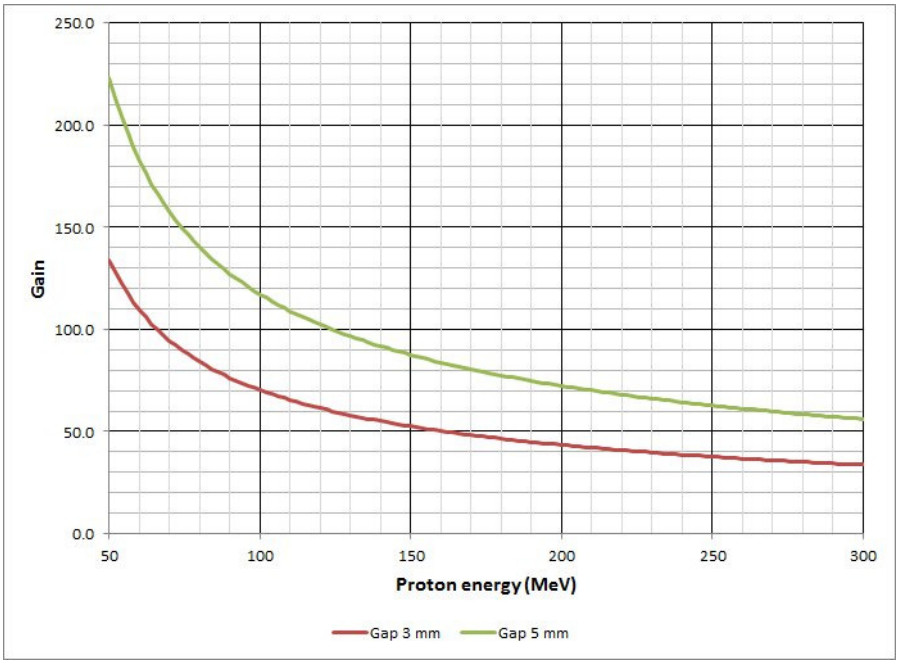
1 and 3 are connected internally

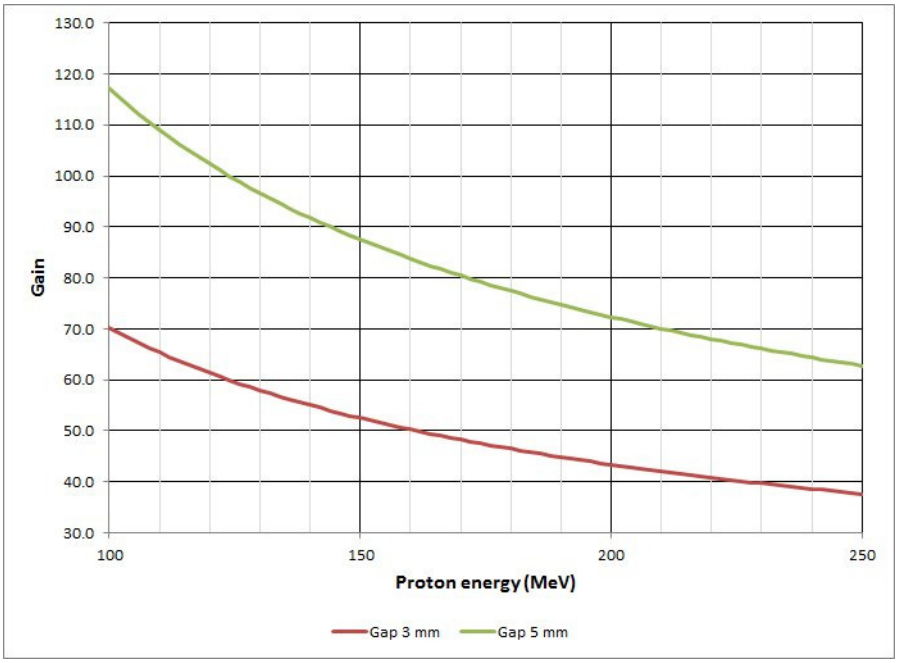
CAUTION

Do not expose the device to ionizing radiation beams unless all connections to readout electronics and bias supplies are made, or otherwise grounded. Charge build-up and subsequent arcing damage can occur.

Connectors (cont)	
HV in / out	SHV Two pairs of connectors for anode voltages - One pair (HV in and HV sense out - allocation is arbitrary) for strip readout sections and first integral plane section. - One pair (HV in and HV sense out—allocation is arbitrary) for second integral plane section
Monitor	DSub male 9-pin Two identical connectors with duplicate functions on two redundant identical sets of sensors. Electrically independent of electrode readouts. 1 Chassis — 6 Analog out + 2 Analog out - — 7 Signal select bit 0 3 Signal select bit 1 — 8 Device ID2 4 Device ID1 — 9 +5V in 5 DGnd Device ID for the I64-16 is 2 (ID2 set).
Grounding	Multiple ground options that may be connected or isolated, depending on whether control and readout electronics (integral plane readout, strip readout, environmental sensor control and readout, high voltage bias) are integrated or independent. **AGnd** is the primary signal reference ground. The guard areas on the integral and strip electrode planes are connected to AGnd. **KGnd** is an auxiliary signal ground for strip readout electronics. Used if the strip readout electronics are independent. Optional connection to AGnd via IC64-16 internal 0 ohm resistor R4. **Shield 1** is the integral plane cable screen (pin 4 on Lemo connectors). Optional connection to the IC64-16 body via internal 0 ohm resistor R7. Optional connection to the HV connector screens via internal 0 ohm resistor R6. **Shield 2** is a special ground associated with the I128 readout electronics. May be ignored for other readout electronics. Optional connection to shield 1 via IC64-16 internal 0 ohm resistors R3, R4. **DGnd** is the reference ground for the environmental sensors control and readout.

Calibration	
Gain curves	Approximate gain curves at standard temperature and pressure for protons, 3mm integral plane gaps and 5 mm strip readout gaps.





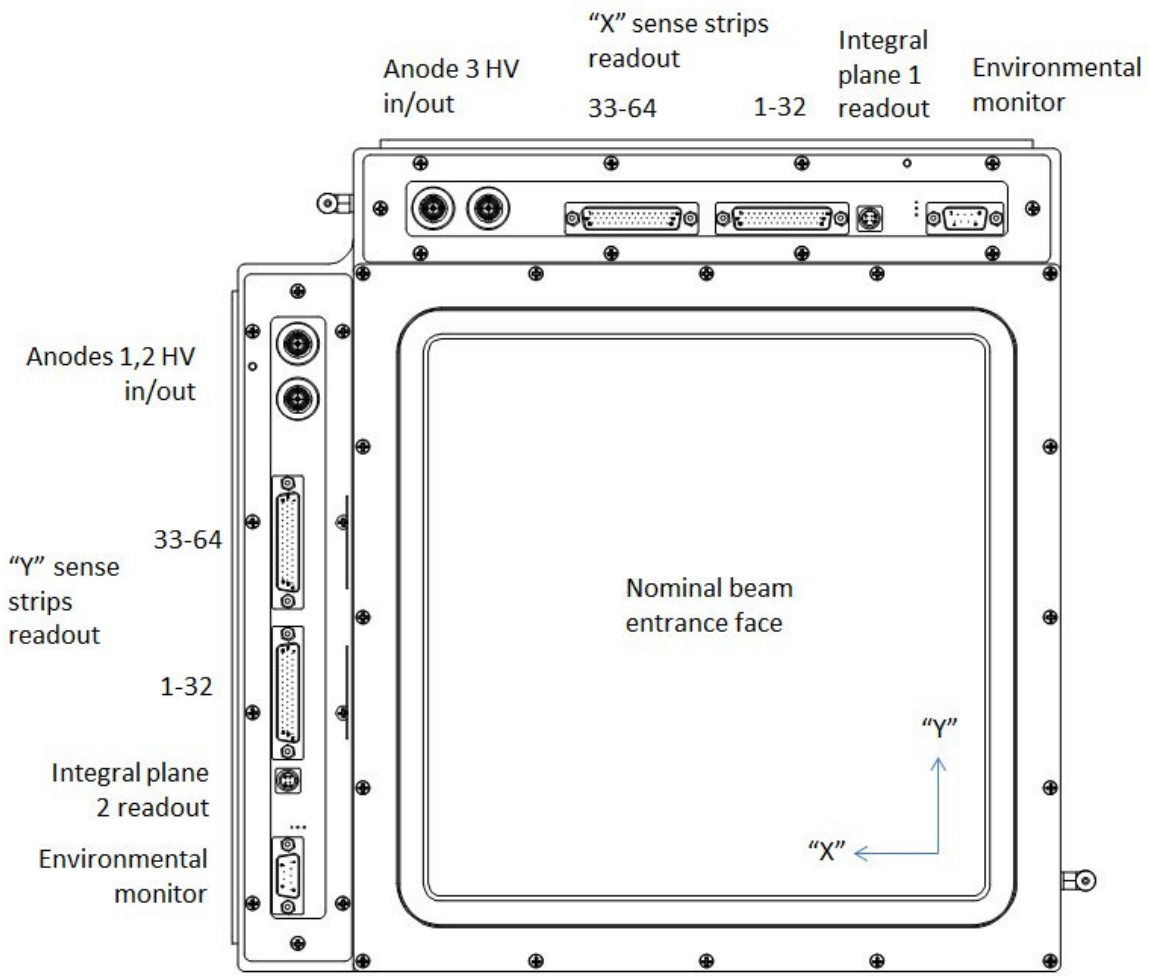
Note: Critical dosimetry measurements must use accurate gain values referenced to traceable standards, and regularly validated.

<table>
<tr><td>Calibration (cont)</td><td></td></tr>
<tr><td>Readout MUX</td><td>Digital bit pattern (TTL levels(to select analog sensor voltage that is switched to pins 6, 2 of monitor connector.
<table>
<tr><th>Bit 1</th><th>Bit 0</th><th>Selected sensor</th></tr>
<tr><td>0</td><td>0</td><td>Temperature (V_{measT})</td></tr>
<tr><td>0</td><td>1</td><td>Pressure (V_{measP})</td></tr>
<tr><td>1</td><td>0</td><td>Relative humidity (V_{measH})</td></tr>
<tr><td>1</td><td>1</td><td>Reference voltage (V_{ref})</td></tr>
</table></td></tr>
<tr><td>Temperature</td><td>Temperature(centigrade) = 100*V_{measT}
Temperature(Kelvin) = Temperature(centigrade) + 273.2</td></tr>
<tr><td>Pressure</td><td>Pressure(psi) = 18.75 * (V_{measP} / V_{ref} - 0.1)
Pressure(mbar) = Pressure(psi) * 68.95
Pressure(Pa) = Pressure(psi) * 6895</td></tr>
<tr><td>Humidity</td><td>Relative humidity (%) = 157 * (V_{measH} / V_{ref}) - 23.8</td></tr>
<tr><td>Gain correction</td><td>Nominal gain at standard ambient temperature and pressure (Temperature$_{SATP}$ = 298.15 K, Pressure$_{SATP}$ = 100000 Pa), must be corrected for measured temperature and pressure:

Gain = 1/ [Gain$_{SATP}$ * (Pressure$_{SATP}$ / Pressure(Pa)) * (Temperature (Kelvin) / Temperature$_{SATP}$)]

For nominal gains established at other reference temperature and pressure, substitute the appropriate reference values in the equation.</td></tr>
</table>

Layout

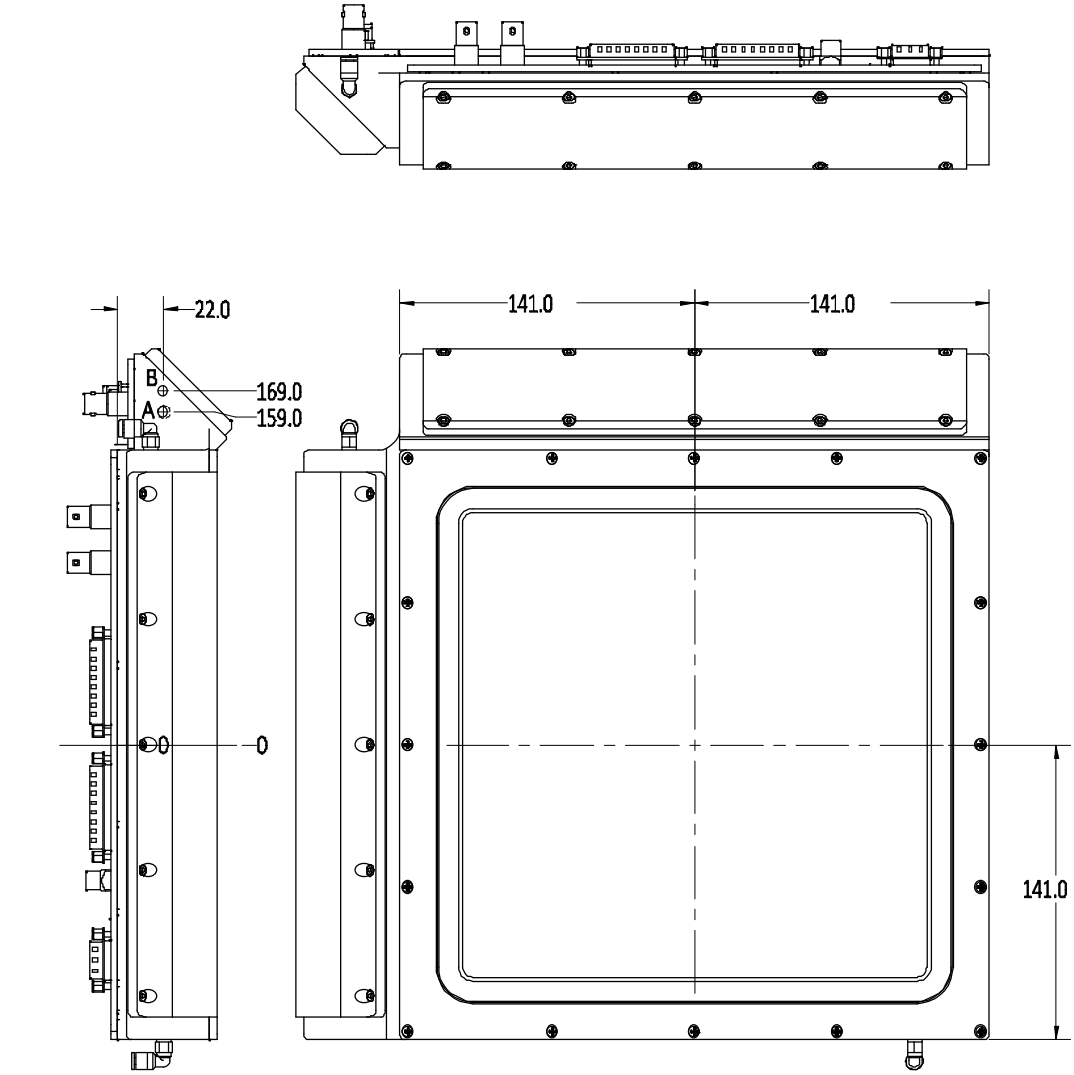


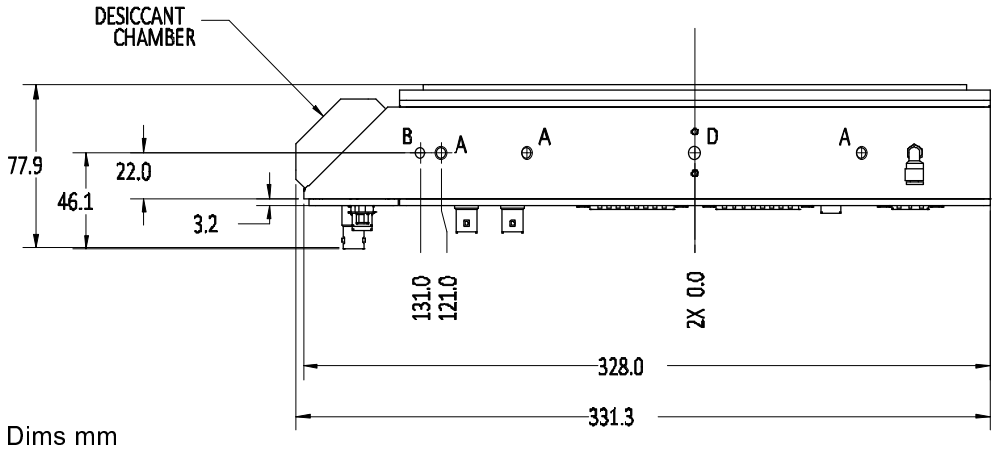
Designation of axes as X /Y, or horizontal / vertical is arbitrary, as it depends upon the orientation of the IC with respect to the beamline. Beam may enter from either direction, entrance face shown is arbitrary, but allows cables to be routed back along beamline.

Strips are numbered sequentially from the lower right corner in the view shown, both axes.

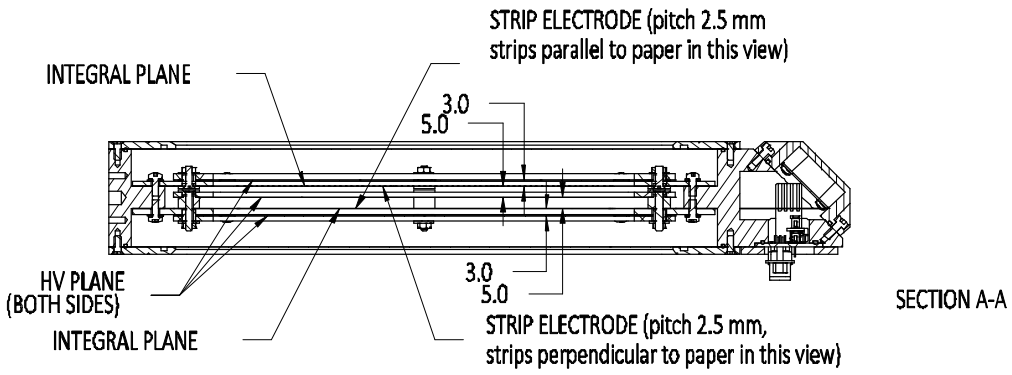
A beam entering through this face passes through integral plane 1 gap, the X sensing gap, the Y sensing gap, integral plane 2 gap in that order.

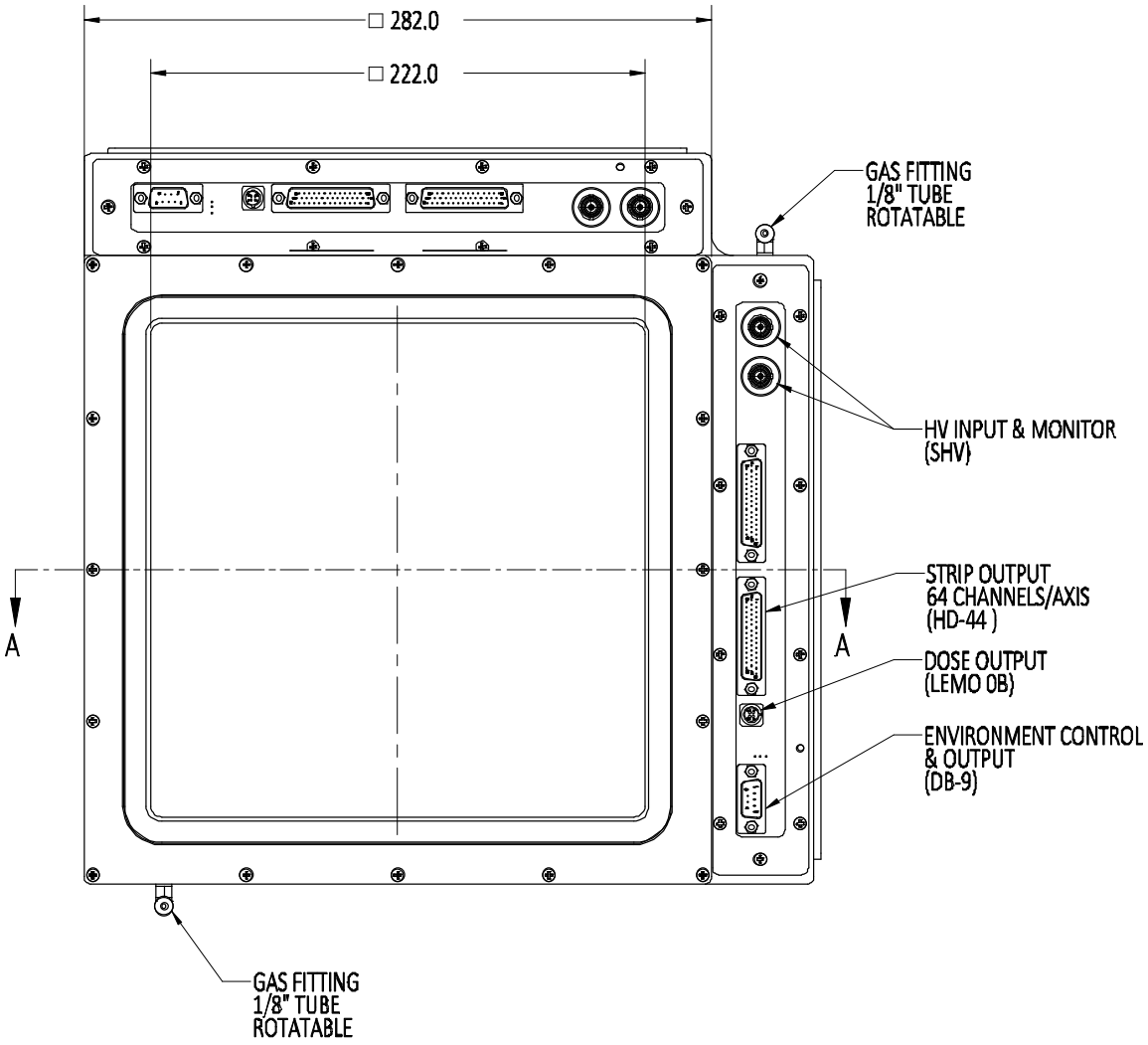
Anodes 1 & 2 bias integral plane 1, X and Y strips. Anode 3 biases integral plane 2.

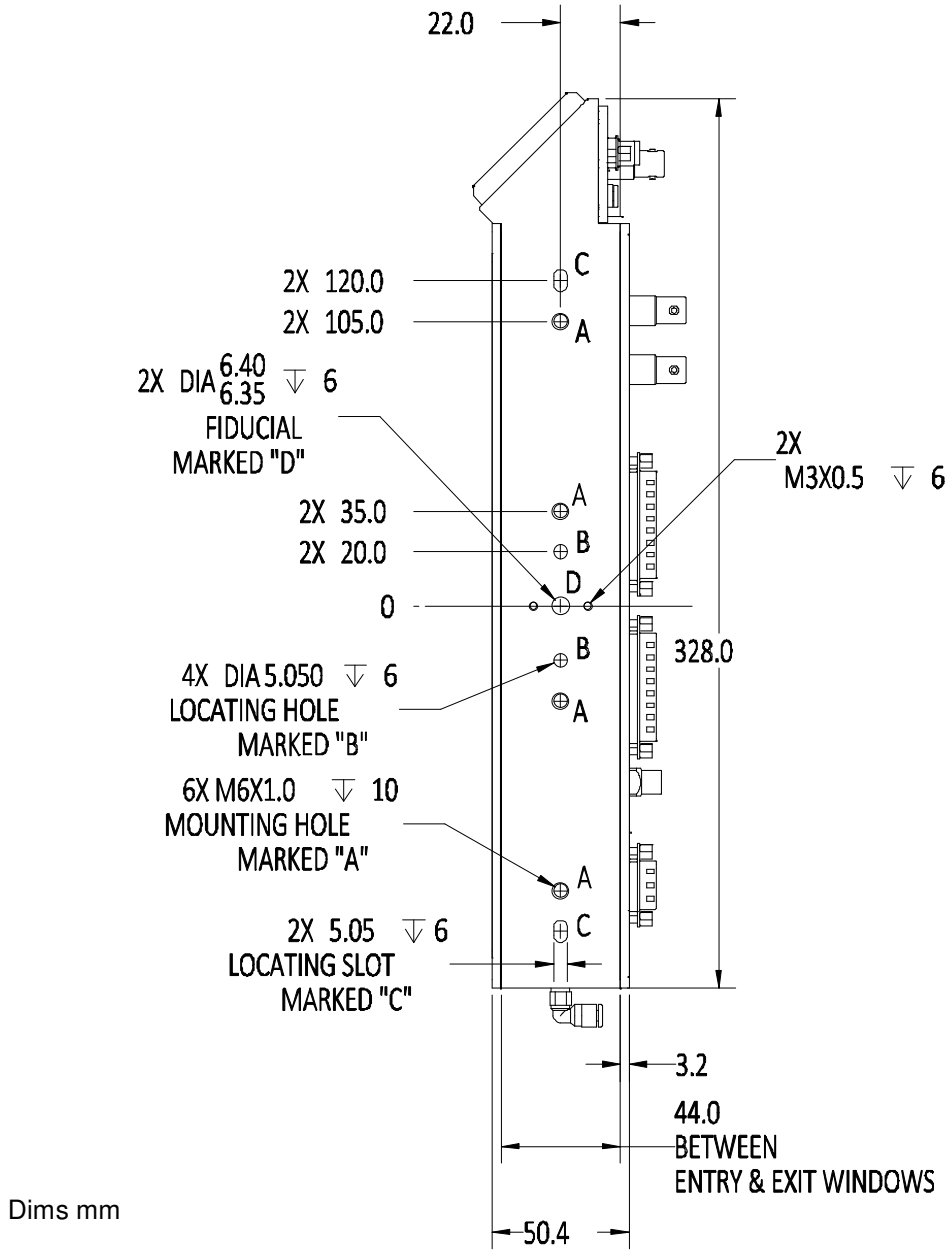

22.0
141.0
141.0
B
A
169.0
159.0
0
0
141.0


DESICCANT
CHAMBER
77.9
22.0
46.1
3.2
B
A
A
D
A
131.0
121.0
2X 0.0
328.0
331.3

Dims mm


STRIP ELECTRODE (pitch 2.5 mm
strips parallel to paper in this view)
INTEGRAL PLANE
3.0
5.0
3.0
5.0
HV PLANE
(BOTH SIDES)
INTEGRAL PLANE
STRIP ELECTRODE (pitch 2.5 mm,
strips perpendicular to paper in this view)
SECTION A-A


□ 282.0
□ 222.0
GAS FITTING
1/8" TUBE
ROTATABLE
HV INPUT & MONITOR
(SHV)
STRIP OUTPUT
64 CHANNELS/AXIS
(HD-44)
DOSE OUTPUT
(LEMO 0B)
ENVIRONMENT CONTROL
& OUTPUT
(DB-9)
A
A
GAS FITTING
1/8" TUBE
ROTATABLE



Dims mm

Ordering information

IC64-16	Ionization chamber with 16 by 16 cm sensitive area, 64 by 64 strip cathode readout and dual redundant integral plane dose readout.

Pyramid Technical Consultants, Inc.,
1050 Waltham Street Suite 200
Lexington MA 02421 USA
Tel: +1 781 402 1700 (USA),
+44 1273 492001(UK)

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

IC64-16_DS_150507