

## Compact High-Resolution Position Sensing Transmission Ionization Chamber

**Features**

- 64 mm x 64 mm sensitive area
- Ionization chamber with 32 by 32 strip readout for position and shape monitoring
- Minimum scattering due to thin films of low-Z material
- Small beamline length (32 mm)
- Small electrode gaps for low recombination
- Polyimide film electrode substrates for radiation hardness
- Gold coated strip electrodes as standard for enhanced long-term reliability (revision B onwards)
- Electrode patterns laser-cut for 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
- HV loopback
- Compatible with I3200 or I6400 readout electronics



<b>Applications</b>	<ul style="list-style-type: none"> <li>• Particle therapy beam monitoring</li> <li>• On-line beam trajectory monitoring</li> <li>• General high energy ion beam diagnostics</li> </ul>
<b>Options</b>	<ul style="list-style-type: none"> <li>• Non-muxed environmental sensor readout</li> </ul>

<b>Specifications</b>	
<b>Beam compatibility</b>	
Species	Protons, deuterons, fully-stripped carbon
Energy range	30 MeV/nucleon to 500 MeV / nucleon
Beam current density range	Up to 20 nA cm <sup>-2</sup> (particle current)
<b>Sensor</b>	
Type	Parallel plate dual ionization chamber with multi-strip cathodes
High voltage	500-1000 V nominal (1660 to 3330 V cm <sup>-1</sup> ); maximum 1500 V
Sensitive area	64 mm by 64 mm



**Datasheet****IC32-6**

<b>Sensor (cont)</b>	
Sensitive volume	Active volume 1: Strip electrode 1 to HV electrode. 3mm spacing. Active volume 2: HV electrode to strip electrode 2. 3mm spacing.
Strip geometry	32 strips 2.00 mm pitch (50 $\mu$ m inter-strip gaps typical)
Gain uniformity	Better than +/-2% for beams within the sensitive area.
Position accuracy	Integral linearity better than 50 $\mu$ m maximum deviation relative over the sensitive area.
Position resolution	Depends on signal to noise ratio; 10's of $\mu$ m achievable provided beam covers more than one strip.
Fiducials	Electrode strips tolerance build-up relative to fiducial features on body +/- 0.3 mm nominal, < +/- 0.1 mm typical .

<b>Chamber gas</b>	
Operating gas	Dry atmospheric air, or flow of any clean ionization chamber gas (Ar/CO <sub>2</sub> , N <sub>2</sub> etc)
Flow gas connections	To suit 1/8" tube push fit
Desiccant	For use when chamber is closed to atmosphere. Desiccant sachet. Sachet can be changed with chamber in situ.

<b>Mechanical</b>	
Insertion length	32 mm window to window, 37 mm housing face to face.
Overall size	190 mm by 190 mm by 37 mm approx (see figures)
Weight	1.3 kg ( 2.8 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

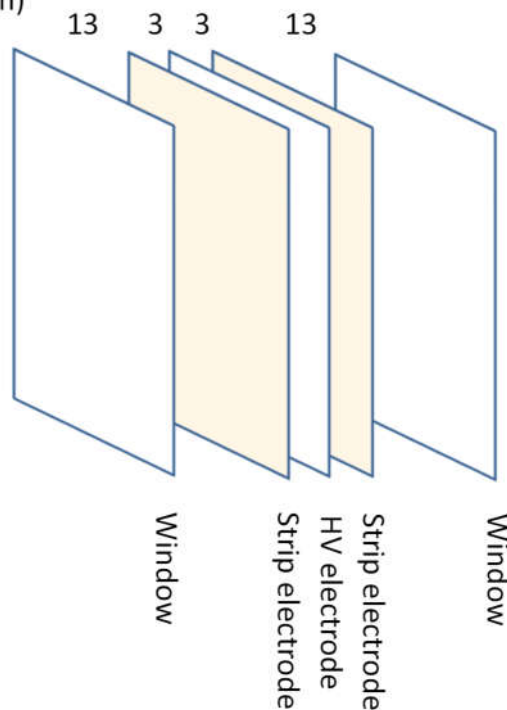


**Beam scattering**

Layers in beam path

1	12.5 $\mu\text{m}$	Polyimide foil aluminized both sides 0.1 $\mu\text{m}$ (window)
2	13 mm	Fill gas (non-active gap)
3a	0.03 $\mu\text{m}$	Gold plating (ground plane)
3b	25 $\mu\text{m}$	Polyimide foil
3c	0.03 $\mu\text{m}$	Gold plating (strip electrode)
4	3 mm	Fill gas (active gap)
5	12.5 $\mu\text{m}$	Polyimide foil aluminized both sides 0.1 $\mu\text{m}$ (HV electrode)
6	3 mm	Fill gas (active gap)
7a	0.03 $\mu\text{m}$	Gold plating (strip cathode)
7b	25 $\mu\text{m}$	Polyimide foil
7c	0.03 $\mu\text{m}$	Gold plating (ground plane)
8	13 mm	Fill gas (non-active gap)
9	12.5 $\mu\text{m}$	Polyimide foil aluminized both sides 0.1 $\mu\text{m}$ (window)

Gaps (mm)



Total effective thickness < 150  $\mu\text{m}$  water equivalent including air filling.

**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**

Strip readout

DSub male high density 44 pin.  
Two identical connectors (one per axis, 32 strips per axis)

1	Strip 29	16	Strip 31	31	Strip 32
2	Strip 28	17	Strip 30	32	Screen
3	Strip 26	18	Strip 27	33	AGnd / KGnd
4	Strip 24	19	Strip 25	34	AGnd / KGnd
5	Strip 22	20	Strip 23	35	AGnd / KGnd
6	Strip 20	21	Strip 21	36	AGnd / KGnd
7	Strip 18	22	Strip 19	37	AGnd / KGnd
8	Strip 16	23	Strip 17	38	AGnd / KGnd
9	Strip 14	24	Strip 15	39	AGnd / KGnd
10	Strip 12	25	Strip 13	40	AGnd / KGnd
11	Strip 10	26	Strip 11	41	AGnd / KGnd
12	Strip 8	27	Strip 9	42	AGnd / KGnd
13	Strip 6	28	Strip 7	43	Screen
14	Strip 4	29	Strip 5	44	Strip 3
15	Strip 2	30	Strip 1	-	-

Connector shell is common with cable screen 1.

The pin arrangement is compatible with a pin to pin (M-F) 44-way cable connection to an I6400 electrometer. One axis will read out on I6400 channels 1-32, the other on channels 33-64.

HV in

SHV

HV out

SHV

Monitor  
(default option)

DSub male 9-pin

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		

DGnd is isolated from AGnd.

AGnd and KGnd are equivalent (the I6400 and I3200 electronics use the name AGnd, the I128 electronics uses KGnd)



**Calibration (cont)**

Readout MUX

Digital bit pattern (TTL levels) to select analog sensor voltage that is switched to pins 6, 2 of monitor connector.

Bit 1	Bit 0	Selected sensor
0	0	Temperature ( $V_{measT}$ )
0	1	Pressure ( $V_{measP}$ )
1	0	Relative humidity ( $V_{measH}$ )
1	1	Reference voltage ( $V_{ref}$ )

Monitor (-NMX option)

DSub male 9-pin

1	Chassis	6	Relative humidity ( $V_{measH}$ )
2	Pressure ( $V_{measP}$ )	7	+5 V in
3	Temperature ( $V_{measT}$ )	8	Device ID2
4	Device ID1	9	+5 V in
5	DGnd		

-NMX purchase option; direct signals, no multiplex

Temperature

Temperature(centigrade) =  $100 * V_{measT}$   
 Temperature(Kelvin) = Temperature(centigrade) + 273.2

Pressure

Pressure(psi) =  $18.75 * (V_{measP} / V_{ref} - 0.1)$   
 Pressure(mbar) = Pressure(psi) \* 68.95  
 Pressure(Pa) = Pressure(psi) \* 6895

Humidity

Relative humidity (%) =  $157 * (V_{measH} / V_{ref}) - 23.8$

Gain correction

Nominal gain at standard ambient temperature and pressure (Temperature<sub>SATP</sub> = 298.15 K, Pressure<sub>SATP</sub> = 100000 Pa), must be corrected for measured temperature and pressure:

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

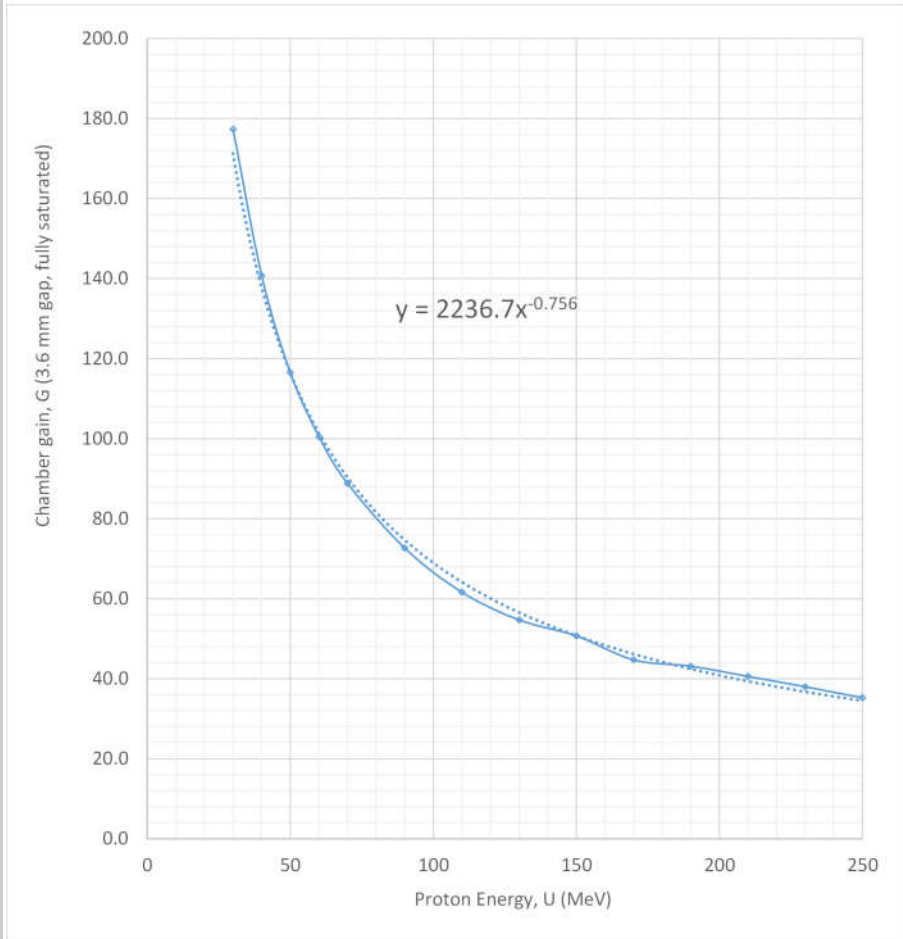
For nominal gains established at other reference temperature and pressure, substitute the appropriate reference values in the equation.



Calibration

Gain curves

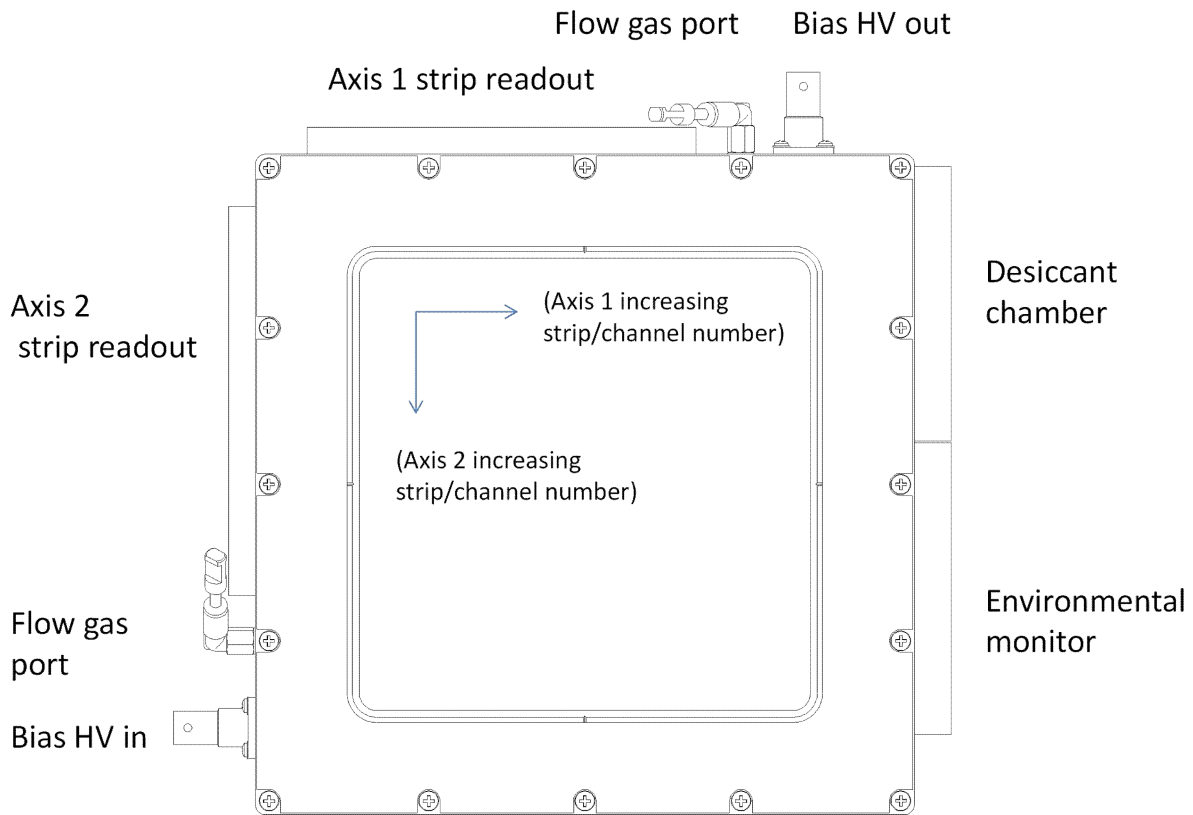
Approximate gain curves for air at standard ambient temperature and pressure for protons calculated by Geant4. The fitting curve is approximate.



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



Layout

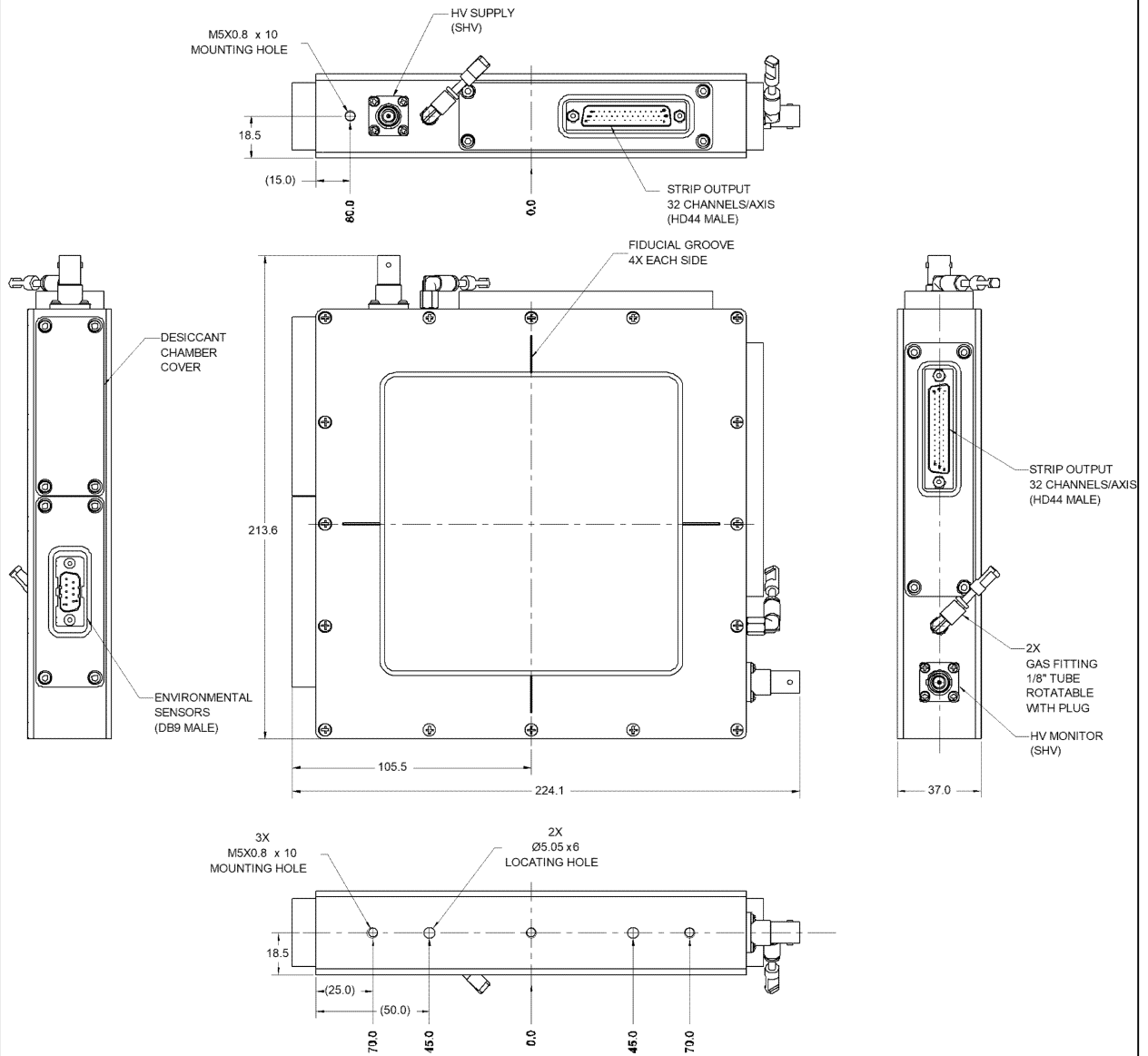


The IC32-6 has no preferred beam entrance side—it is symmetric along the beam path. Designation of axes as X /Y, or horizontal / vertical is arbitrary, as it depends upon the orientation of the IC with respect to the beamline, and of the beamline relative to any other reference coordinate system.

Strips/channel numbering is shown assuming that the axes are connected to I6400 readout electronics with pin to pin cables.

Assuming that the chamber is standing vertically on the mounting face as shown, a beam entering into the page on the figure passes first through the horizontal sensing gap (axis 1, strips running up and down the page), and second through the vertical sensing gap (axis 2, strips running across the page).

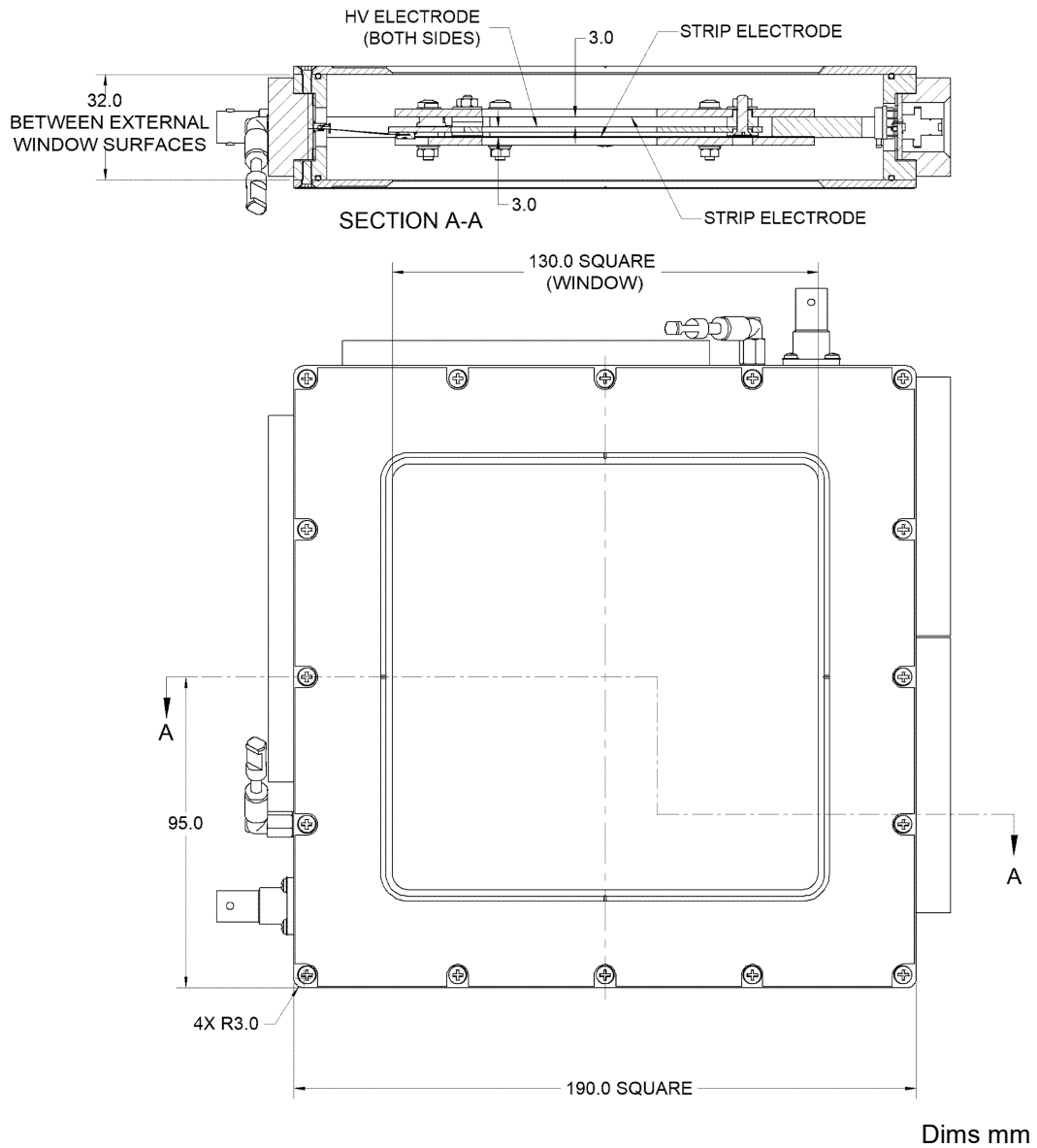




Dims mm







**Ordering information**

IC32-6	Thin film ionization chamber with 6.4 by 6.4 cm sensitive area, 32 by 32 strip, gold readout electrodes.
- NMX	Option—environmental sensor signals not multiplexed (default is multiplexed signals)

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The information herein is believed accurate at time of publication, but no specific warranty is given regarding its use. All specifications are subject to change.

All trademarks and names acknowledged.

IC32-6\_DS\_190625

