Datasheet **PX3**

Pixelated 2D-Sensing Thin-film Ionization Chamber

Features

- Choice of readout electrode pattern area: 42 mm diameter with 3.8 mm pixel pitch, 28 mm diameter with 2.5 mm pixel pitch
- Low insertion length: 20 mm face to face
- Ionization chamber with 120 pixel readout for position and shape monitoring
- Ultra-thin film windows and electrodes permit “always in beam” applications with minimal beam scattering
- HV loopback for bias voltage validation
- Operable with atmospheric air or flow-through gas mixture
- Integrated environmental sensors
- Integrated replaceable desiccant
- Compatible with I128, I128S and I6400 readout electronics

Applications

- Particle therapy on-line beam diagnostics
- Beam shape, position and trajectory monitoring upstream of scan magnets
- General high energy ion beam diagnostics

Specifications

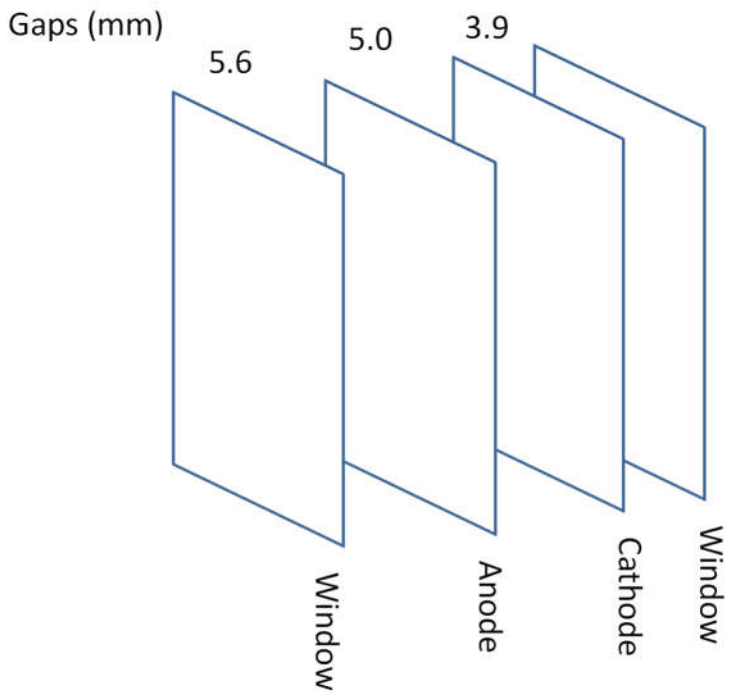
Beam compatibility	
Species	Protons, deuterons, fully-stripped carbon
Energy range	30 MeV/nucleon to 500 MeV / nucleon
Beam current density range	Up to 20 nA cm^{-2} (particle current)

Sensor	
Type	Parallel plate single-gap ionization chamber with pixelated readout electrode
High voltage	500-1000 V nominal (1000 to 2000 V cm^{-1}); maximum 1500 V
Sensitive area	PX3-3.8: 42 mm nominal diameter PX3-2.5: 28 mm nominal diameter

Sensor (continued)	
Sensitive volume	Active volume: Pixelated cathode to anode. 5.0 mm spacing.
Pixel geometry	PX3-3.8 120 pixels 3.80 mm pitch PX3-2.5 120 pixels 2.50 mm pitch 50 µm inter-pixel gaps typical)
Gain uniformity	Better than +/-2% for beams within the sensitive area.
Position accuracy	Integral linearity better than 50 µm maximum deviation relative over the sensitive area using fitted Gaussian beam shape.
Position resolution	Depends on signal to noise ratio; 10's of µm achievable provided beam covers sufficient pixels to permit peak fitting.
Fiducials	Electrode pixel location tolerance build-up relative to fiducial features on body +/- 0.3 mm nominal, < +/- 0.1 mm typical .
Chamber gas	
Operating gas	Dry atmospheric air (hermetically-sealed volume) or flow-through gas mixture
Desiccant	Chamber containing replaceable desiccant cartridge
Sensors	Built-in sensors for temperature, pressure and humidity.
Mechanical	
Insertion length	14.6 mm window to window, 20 mm housing face to face.
Overall size	195 mm by 220 mm by 20 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 as low as possible in 1 to 200 Hz range. Audio noise should be minimised (< 50 dBA recommended) in 20 to 200 Hz
Shipping and storage environment	-10 to 50 C, < 50% humidity, non-condensing. Vibration < 0.5g all axes, 1 to 100 Hz If stored for a long period, internal humidity must be checked before use.
Readout	
Compatible electronics	I128-XP10, I128-XP20, I128S-XP10, I128S-XP20, I6400-XP10, I6400-XP20
Cable adaptation	Adaptors available from 68-way VHDCI-terminated cables to 44-way HD44-terminated cables (ADAP-VH68-2HD44M, ADAP-2VH68-4HD44M).

Beam scattering	
Layers in beam path	

1	12.5 µm	Polyimide foil aluminized both sides 0.1 µm (window)
2	5.6 mm	Air (non-active gap)
3	12.5 µm	Polyimide foil with 0.1 µm aluminization both sides (anode)
4	5.0 mm	Air (active gap)
5	25 µm	Polyimide foil with 0.1 µm aluminization both sides (cathode)
6	3.9 mm	Air (non-active gap)
7	12.5 µm	Polyimide foil aluminized both sides 0.1 µm (window)

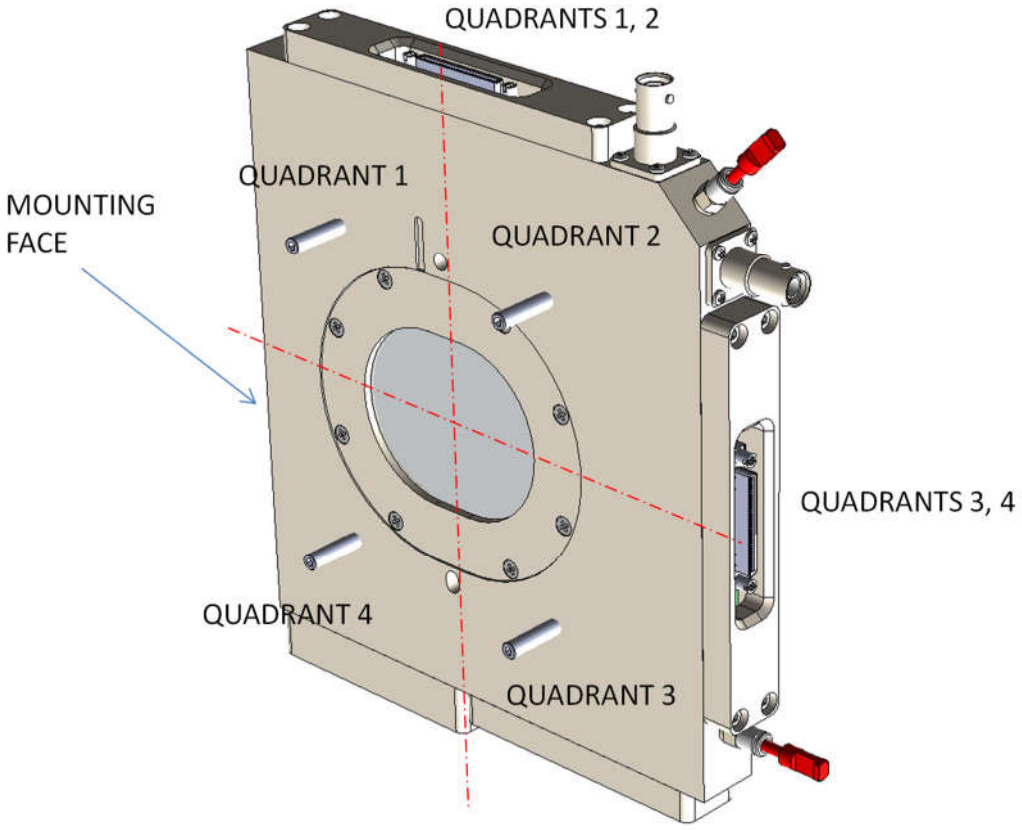


The sequence of layers corresponds to the illustration on the following page. Beam direction is arbitrary.

Total effective thickness 100 µm water equivalent.

Cathode pixel pattern faces the anode.

Orientation and pixel pattern



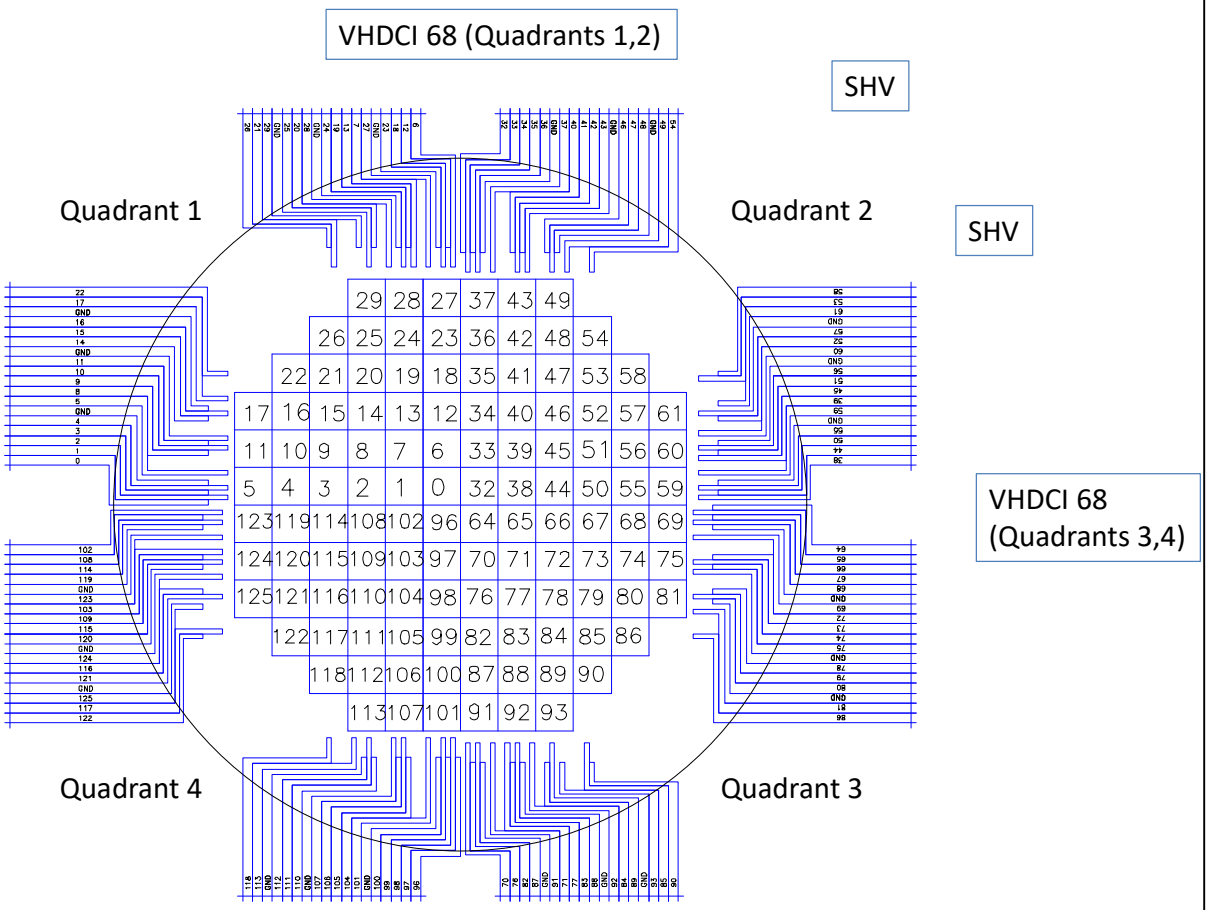
A beam entering the face shown passes through the anode then the cathode. The view of the cathode pixel pattern on the next page is looking through the face shown and through the anode.

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.

Orientation and pixel pattern

View along the direction indicated in the previous figure.

Note: there are 120 pixels, numbered from 0 upwards. Some numbers (30, 31, 62, 63, 94, 95) are absent.



Pixel pattern scale options

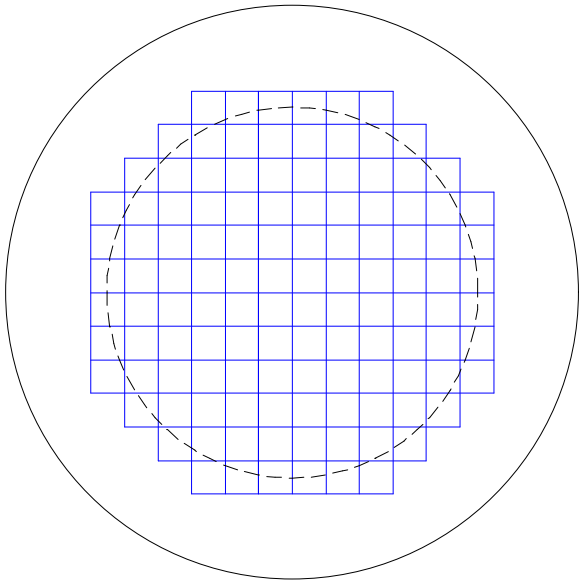
Build-time option for pixel pitch and sensitive area. Charge outside the pixel pattern is returned to ground.

Patterns shown relative to the 65 mm diameter beam window (outer circle).

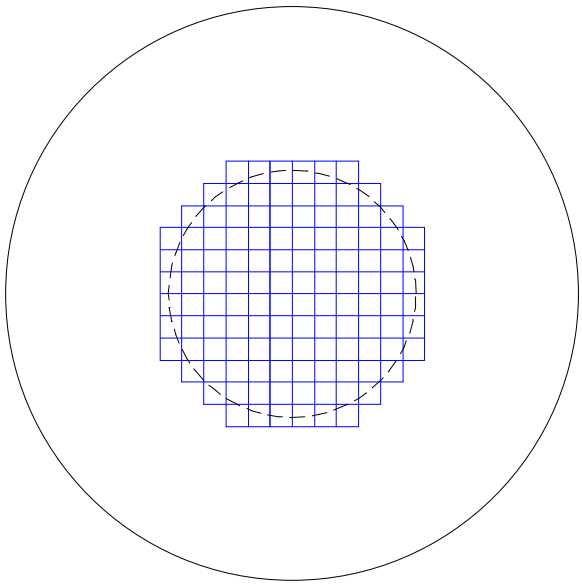
Inner dashed circle is the nominal sensor diameter:

Top:	PX3-3.8	42 mm nominal sensor diameter
Bottom:	PX3-2.5	28 mm nominal sensor diameter

PX3-3.8



PX3-2.5



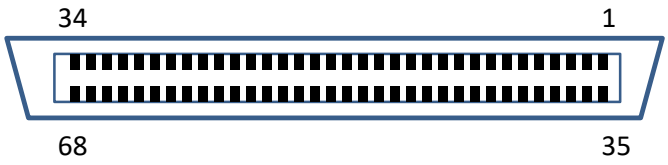
Connectors

Pixel readout

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

VHDCI # 1 Pixels 0 to 29 (quadrant 1) and 32 to 62 (quadrant 2)

Top row				Bottom row			
1	Gnd	18	Pixel 15	35	Gnd	52	Pixel 47
2	Gnd	19	Pixel 14	36	Gnd	53	Pixel 46
3	Gnd	20	Pixel 13	37	Gnd	54	Pixel 45
4	Pixel 29	21	Pixel 12	38	Pixel 61	55	Pixel 44
5	Pixel 28	22	Pixel 11	39	Pixel 60	56	Pixel 43
6	Pixel 27	23	Pixel 10	40	Pixel 59	57	Pixel 42
7	Pixel 26	24	Pixel 9	41	Pixel 58	58	Pixel 41
8	Pixel 25	25	Pixel 8	42	Pixel 57	59	Pixel 40
9	Pixel 24	26	Pixel 7	43	Pixel 56	60	Pixel 39
10	Pixel 23	27	Pixel 6	44	Pixel 55	61	Pixel 38
11	Pixel 22	28	Pixel 5	45	Pixel 54	62	Pixel 37
12	Pixel 21	29	Pixel 4	46	Pixel 53	63	Pixel 36
13	Pixel 20	30	Pixel 3	47	Pixel 52	64	Pixel 35
14	Pixel 19	31	Pixel 2	48	Pixel 51	65	Pixel 34
15	Pixel 18	32	Pixel 1	49	Pixel 50	66	Pixel 33
16	Pixel 17	33	Pixel 0	50	Pixel 49	67	Pixel 32
17	Pixel 16	34	Gnd	51	Pixel 48	68	Gnd



Gnd pins are connected internally via the cathode ground plane. It is recommended to connected all gnd pins to clean ground in the external circuit.

Connector shell is common with ionization chamber body.

Connectors (cont)

Pixel readout (cont)

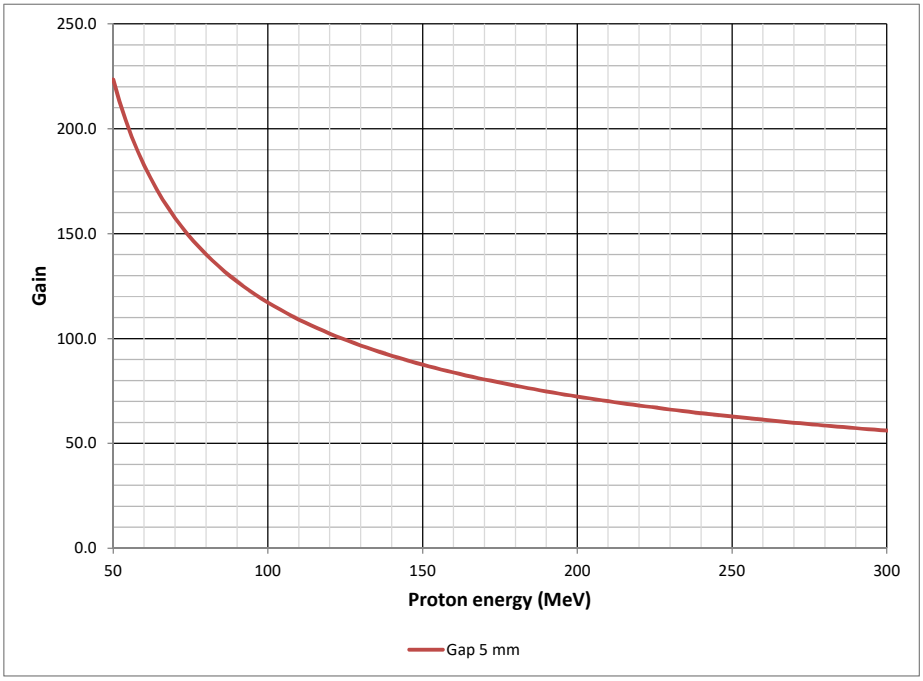
VHDCI # 2 Pixels 65 to 93 (quadrant 3) and 96 to 125 (quadrant 4)

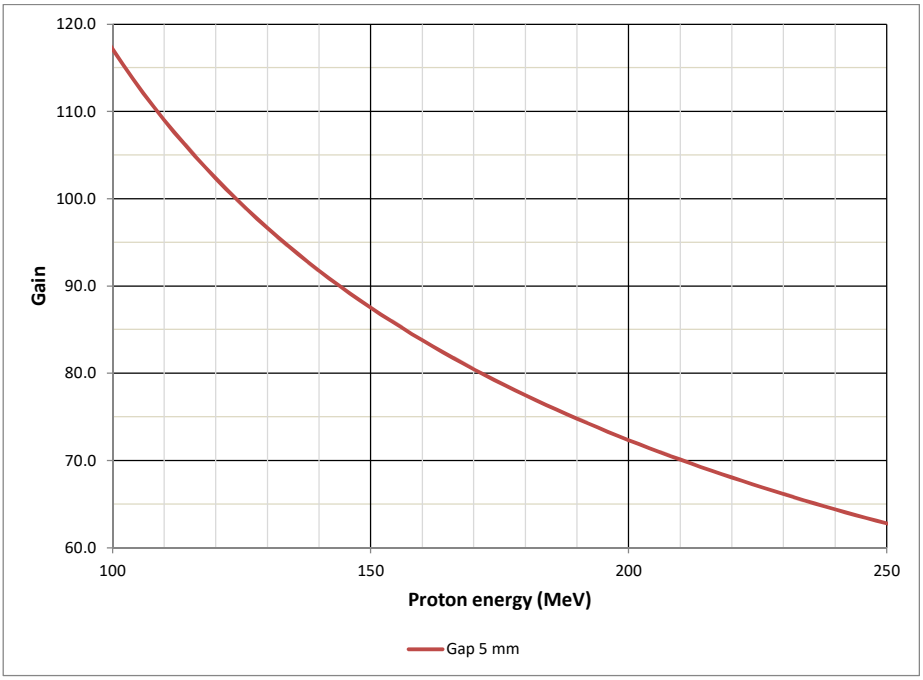
Top row				Bottom row			
1	Gnd	18	Pixel 79	35	Gnd	52	Pixel 111
2	Gnd	19	Pixel 78	36	Gnd	53	Pixel 110
3	Gnd	20	Pixel 77	37	Gnd	54	Pixel 109
4	Pixel 93	21	Pixel 76	38	Pixel 125	55	Pixel 108
5	Pixel 92	22	Pixel 75	39	Pixel 124	56	Pixel 107
6	Pixel 91	23	Pixel 74	40	Pixel 123	57	Pixel 106
7	Pixel 90	24	Pixel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

HV in	SHV
HV out	SHV Connections to HV in and out are interchangeable.
Environmental sensors	DSub male 9-pin. 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		

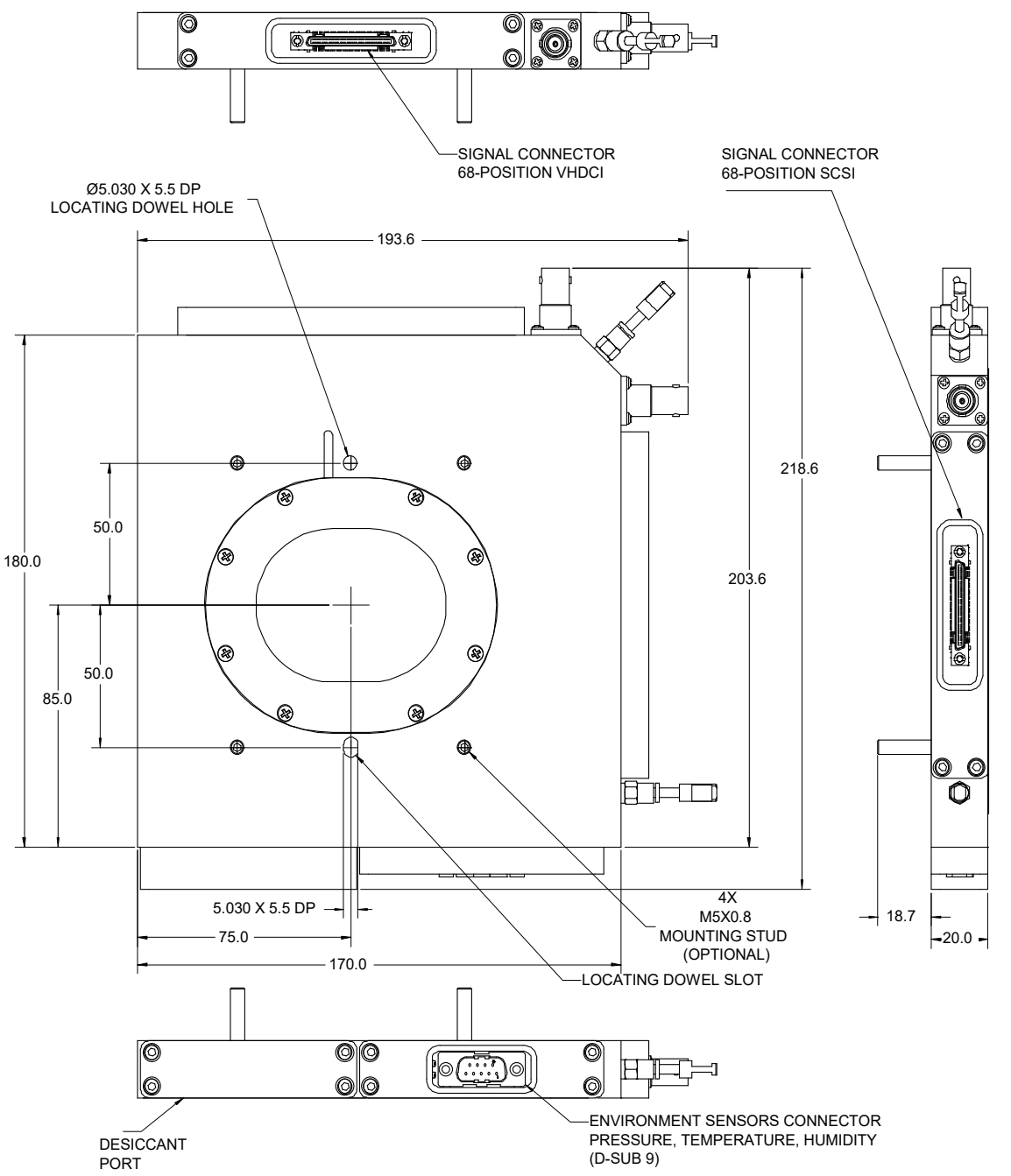
Calibration	
Gain curves	Approximate gain curves at standard ambient temperature and pressure for protons, 5.0 mm gap.





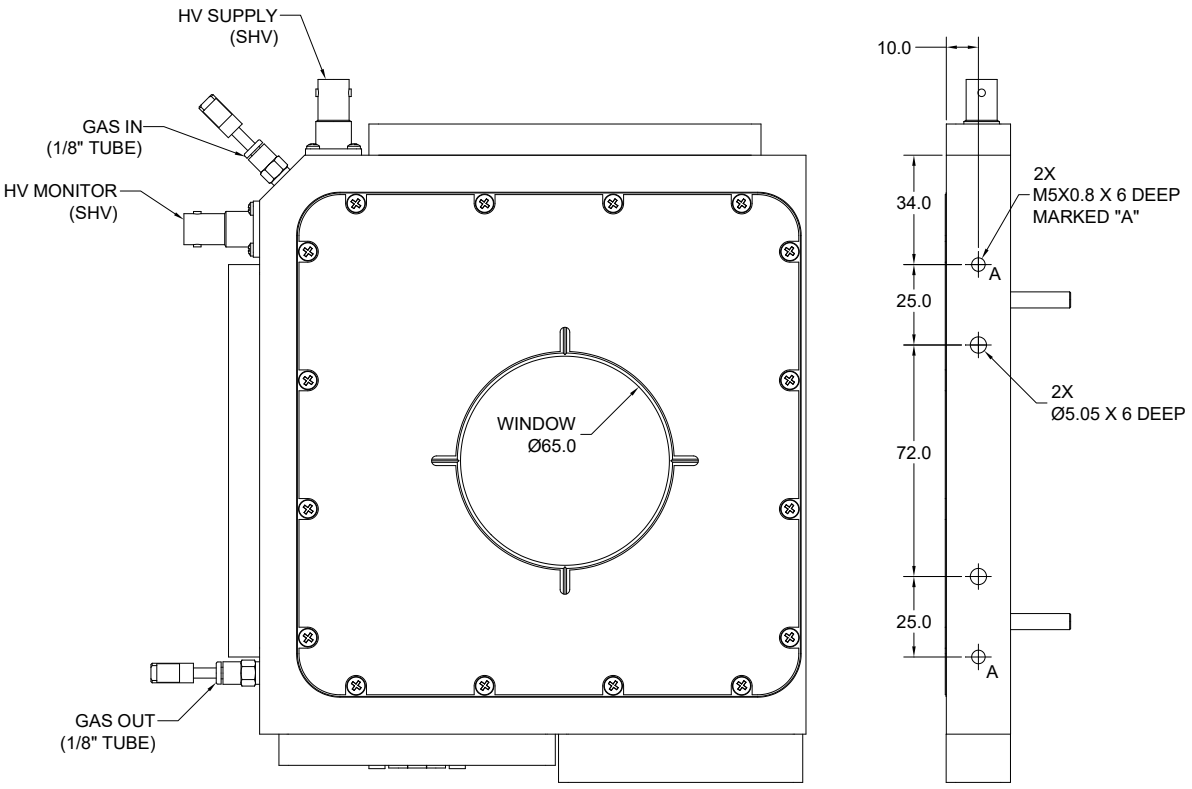
Note: Critical dosimetry measurements must use accurate gain values referenced to traceable standards, and regularly validated.

Calibration (cont)	
Requirements for accuracy	For accurate beam current measurement from sum of pixels, beam profile must lie inside pixelated pattern and temperature and pressure compenstaiton must be applied.
Temperature readback	Temperature(centigrade) = $100*V_{measT}$ Temperature(Kelvin) = Temperature(centigrade) + 273.2
Pressure readback	Pressure(psi) = $18.75 * (V_{measP} / V_{ref} - 0.1)$ Pressure(mbar) = Pressure(psi) * 68.95 Pressure(Pa) = Pressure(psi) * 6895
Humidity readback	Relative humidity (%) = $157 * (V_{measH} / V_{ref}) - 23.8$
Gain correction	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.


SIGNAL CONNECTOR
68-POSITION VHDCI
SIGNAL CONNECTOR
68-POSITION SCSI
Ø5.030 X 5.5 DP
LOCATING DOWEL HOLE
193.6
218.6
203.6
180.0
50.0
50.0
85.0
5.030 X 5.5 DP
75.0
170.0
4X
M5X0.8
MOUNTING STUD
(OPTIONAL)
LOCATING DOWEL SLOT
18.7
20.0
DESICCANT
PORT
ENVIRONMENT SENSORS CONNECTOR
PRESSURE, TEMPERATURE, HUMIDITY
(D-SUB 9)

Dims mm

Datasheet PX3



Dims mm

Ordering information

PX3-3.8	Pixelated ionization chamber with 4.2 cm diameter sensitive area, thin film electrodes cathode with 120 pixels at 3.8 mm pitch.
PX3-2.5	Pixelated ionization chamber with 2.8 cm diameter sensitive area, thin film electrodes cathode with 120 pixels at 5 2.5 mm pitch.
CAB-SET-ICX-xx	Cable set for connection to I128, xx feet long.
ADAP-VH68-HD44M	Adaptor, 68-way VHDCI to two HD44 male
ADAP-2VH68-4HD44M	Adaptor, two 68-way VHDCI to four HD44 male

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