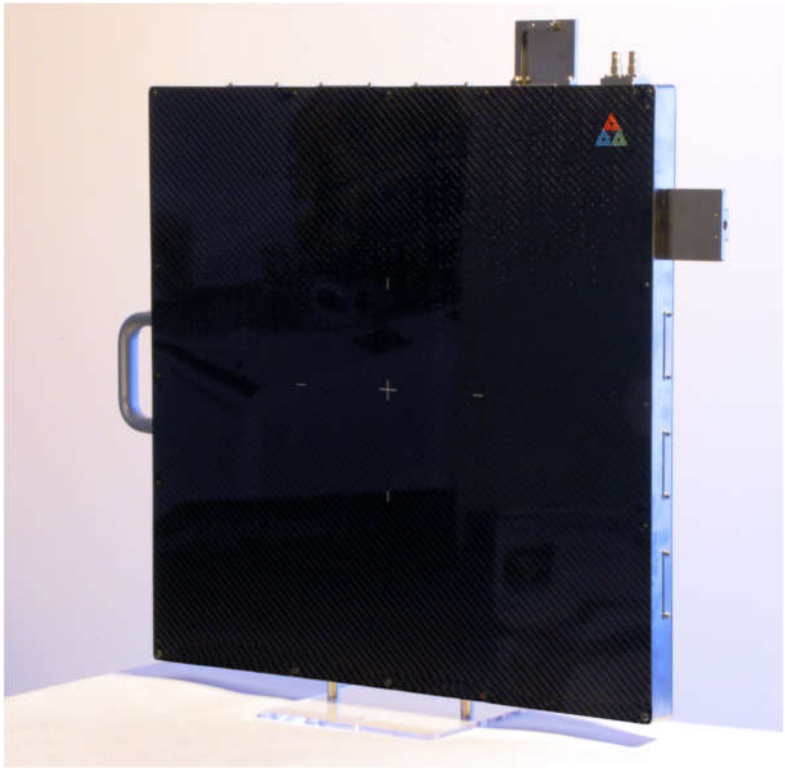
Datasheet **IC256-45**

Monolith

Large Area Position-sensitive Ionization Chamber for Scanned Particle Beam Characterization



Features

- 45 cm x 45 cm sensitive area
- Alignment marks on beam entrance window for accurate optical setup at isocenter
- Can be imaged by X-ray patient imager for accurate alignment to patient coordinate system
- Light weight and robust
- Ionization chamber with 256 by 256 strip readout for beam position and shape characterization
- Robust carbon-fiber windows and precision photo-etched readout electrodes on thin FR4 substrates for low-scattering
- High voltage sense loopback

Applications	• Particle therapy beam spot position calibration • Particle therapy quality assurance • General high energy ion beam diagnostics
Options	• Mounting plate • Internal connector options allow operation with 128, 256 or 512 readout channels • Connection to Pyramid Scan/Dose system to coordinate data collection with map delivery. Automated scan system calibration.

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Specifications

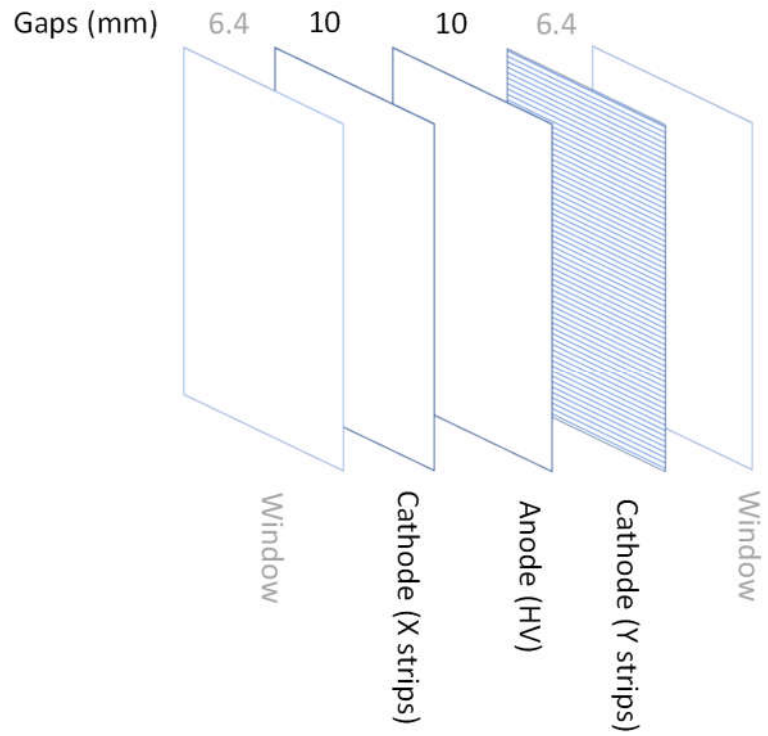
Beam compatibility	
Species	Protons, deuterons, helium ions, fully-stripped carbon
Energy range	30 MeV /nucleon to 500 MeV / nucleon
Beam current density range	Up to 5 nA cm^{-2} (proton particle current) for good position peak shapes; up to 30 nA cm^{-2} with recombination influence on peak shape.
Sensor	
Type	Parallel plate ionization chamber with multi-strip cathodes .
High voltage bias	2000 V maximum operating.
Sensitive area	450 mm by 450 mm.
Sensor	
Sensitive volumes	Active volume 1: 10 mm gap X strip section Active volume 2: 10 mm gap Y strip section
Strip geometry	Equal width 1.75 mm pitch .
Chamber gas	Atmospheric air
Mechanical	
Insertion length	37.6 mm window face to window face
Orientation	Operable in any orientation, and with beam entering in either direction
Overall size	700 mm by 700 mm by 40 mm approx. excluding mating connectors (see figures)
Weight	8.5 kg (18.7 lb)
Operating environment	Clean and dust-free, Temperature 10 to 35 C (15 to 25 C recommended) Humidity < 70% humidity, non-condensing Vibration < 0.1g all axes (1 to 100 Hz) Ambient sound in < 300 Hz range should be minimised to prevent micro-phonic pickup
Shipping and storage environment	-10 to 50 C, < 80% humidity, non-condensing, vibration < 1g all axes, 1 to 100 Hz

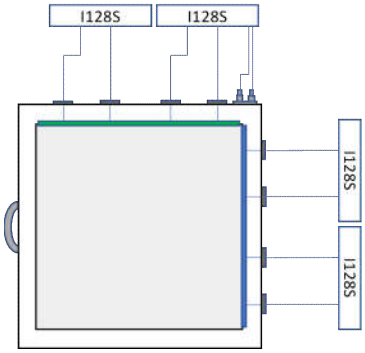
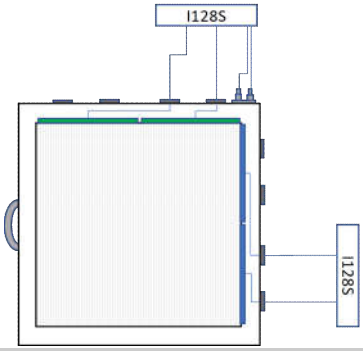
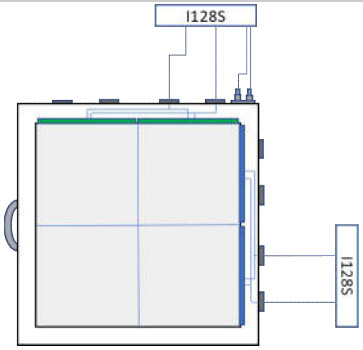
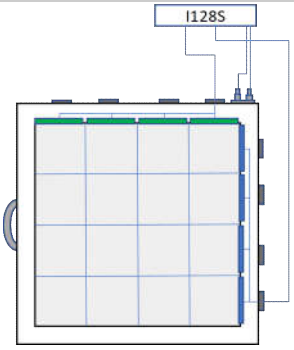
Structure	

Materials in beam path

1	Window	0.8 mm carbon fiber
2	Gap	6.4 mm air
3	Cathode (Strip pattern)	0.9 µm gold / 7.5 µm nickel / 17.5 µm copper 1.58 mm FR4 fiberglass epoxy 0.9 µm gold / 7.5 µm nickel / 17.5 µm copper
4	Active gap	10.0 mm air
5	Anode	0.1 µm aluminium 25 µm polyimide 0.1 µm aluminium
6	Active gap	10.0 mm air
7	(Strip pattern) Cathode	0.9 µm gold / 7 µm nickel / 17.5 µm copper 1.58 mm FR4 fiberglass epoxy 0.9 µm gold / 7 µm nickel / 17.5 µm copper
8	Gap	6.4 mm air
9	Window	0.8 mm carbon fiber

Electrode sequence



Readout options	The 512 strip signals from the IC256-45 can be read out individually or combined by internal connectors to reduce the number of readout channels needed. The internal connection schemes either reduce the spatial resolution or introduce ambiguity in the coarse position that is resolved by independent means such as prior or independent knowledge of the approximate beam spot position. See ordering information (page 9) for corresponding systems. The connectors allow direct pin to pin cabling to the I128S electrometer.
Full resolution, unambiguous position 256 strips per axis 1.75 mm pitch, no ambiguity 512 total electrometer channels	 Each strip has an individual electronics channel.
Reduced resolution, unambiguous position 128 strips per axis, 3.5 mm pitch, no ambiguity 256 total electrometer channels	 Adjacent pairs of strips are connected to give 128 effective strips per axis with 3.5 mm pitch.
Full resolution, two position candidates per axis 256 strips per axis, 1.75 mm pitch, 2-fold ambiguity 256 total electrometer channels	 Strips 1+129, 2+130 etc are connected to give 256 strips per axis with ambiguity between sections 1-128 and 129-256. Knowledge of which section the beam spot is in allows a full precision position to be returned.
Full resolution, four position candidates per axis 256 strips per axis, 1.75 mm pitch, 4-fold ambiguity 128 total electrometer channels	 Strips 1+65+129+193, 2+66+130+194 etc are connected to give 256 strips per axis with ambiguity between sections 1 -64, 65-128, 129-192, 193-256. Knowledge of which section the beam spot is in allows a full precision position to be returned.

Connectors

Strip readout

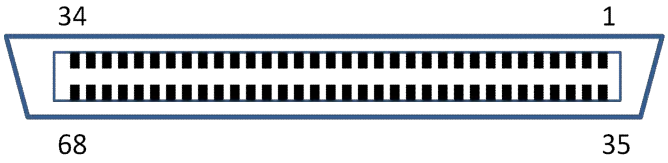
High density VHDCI 68 pin. Eight connectors (four per axis)

1	KGnd	35	KGnd
2	Signal 32 (I31)	36	Signal 64 (I63)
3	Signal 31 (I30)	37	Signal 63 (I62)
4	Signal 30 (I29)	38	Signal 62 (I61)
5	Signal 29 (I28)	39	Signal 61 (I60)
6	Signal 28 (I27)	40	Signal 60 (I59)
7	Signal 27 (I26)	41	Signal 59 (I58)
8	Signal 26 (I25)	42	Signal 58 (I57)
9	Signal 25 (I24)	43	Signal 57 (I56)
10	Signal 24 (I23)	44	Signal 56 (I55)
11	Signal 23 (I22)	45	Signal 55 (I54)
12	Signal 22 (I21)	46	Signal 54 (I53)
13	Signal 21 (I20)	47	Signal 53 (I52)
14	Signal 20 (I19)	48	Signal 52 (I51)
15	Signal 19 (I18)	49	Signal 51 (I50)
16	Signal 18 (I17)	50	Signal 50 (I49)
17	Signal 17 (I16)	51	Signal 47 (I48)
18	Signal 16 (I15)	52	Signal 48 (I47)
19	Signal 15 (I14)	53	Signal 47 (I46)
20	Signal 14 (I13)	54	Signal 46 (I45)
21	Signal 13 (I12)	55	Signal 45 (I44)
22	Signal 12 (I11)	56	Signal 44 (I43)
23	Signal 11 (I10)	57	Signal 43 (I42)
24	Signal 10 (I9)	58	Signal 42 (I41)
25	Signal 9 (I8)	59	Signal 41 (I40)
26	Signal 8 (I7)	60	Signal 40 (I39)
27	Signal 7 (I6)	61	Signal 39 (I38)
28	Signal 6 (I5)	62	Signal 38 (I37)
29	Signal 5 (I4)	63	Signal 37 (I36)
30	Signal 4 (I3)	64	Signal 36 I35)
31	Signal 3 (I2)	65	Signal 35 (I34)
32	Signal 2 (I1)	66	Signal 34 (I33)
33	Signal 1 (I0)	67	Signal 33 (I32)
34	Shield	68	Shield

A full configuration system with no pairing or folding will have:
- strip 1 corresponding to signal 1 on connector 1 of each axis and so on,
- strip 65 corresponding to signal 1 on connector 2 of each axis and so on,
- strip 129 corresponding to signal 1 on connector 3 of each axis and so on,
- strip 193 corresponding to signal 1 on connector 4 of each axis and so on

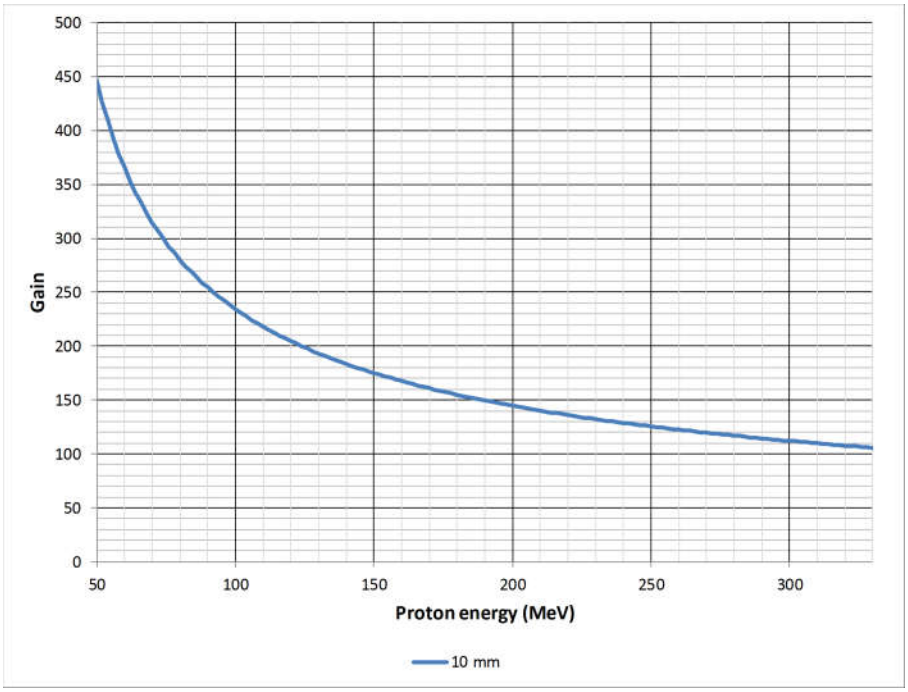
Other internal connection arrangements as shown on the preceding page will provide summed currents on each signal pin, according to the configuration.

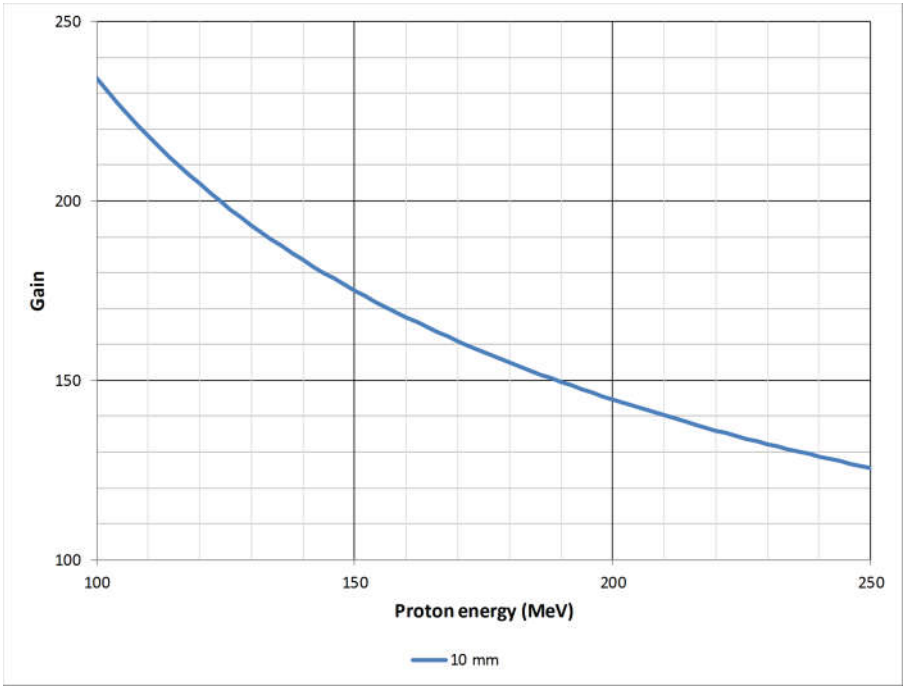
(References I0, I1 etc correspond to circuit schematic designations for connector 1).



Connectors (cont)	
HV in / out	SHV Two connectors for anode voltage in and return
Grounding	**KGnd** is an auxiliary signal ground for strip readout electronics. Used if the strip readout electronics are independent. Optional connection to chassis via IC256-45 internal 0 ohm resistors R5 (normally fitted). **Chassis** is the detector body, the cable screen for SHV connectors and the shells of the VHDCI connectors. **Shield** is a special ground associated with the I128 readout electronics. May be ignored for other readout electronics. Optional connection to chassis via IC256-45 internal 0 ohm resistors R6 (normally fitted).
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 if the electrodes are not grounded.

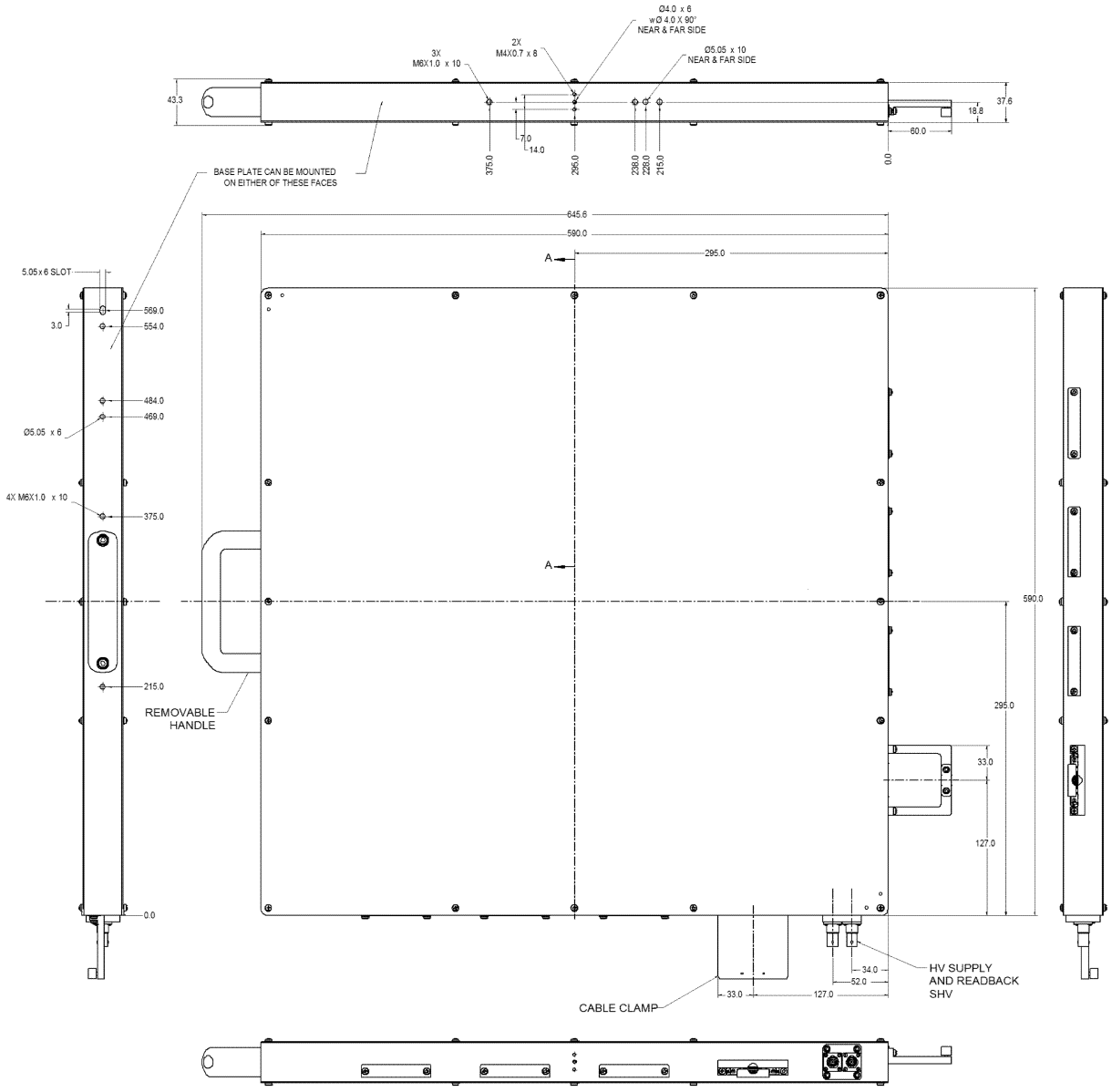
Calibration	
Gain curves	Approximate gain curve at standard temperature and pressure for protons, 10 mm gaps.





Note: Critical dosimetry measurements must use accurate gain values corrected for temperature and pressure, referenced to traceable standards. The values must be regularly validated.

Overall dimensions



When supplied as part of a complete system including application software, there is a specified mounting orientation that aligns X and Y coordinates for the IC256-45 to the corresponding beamline coordinates.

Dims mm

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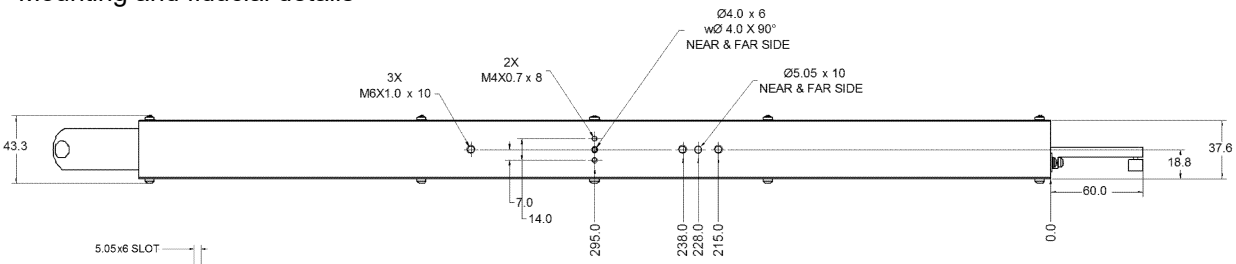
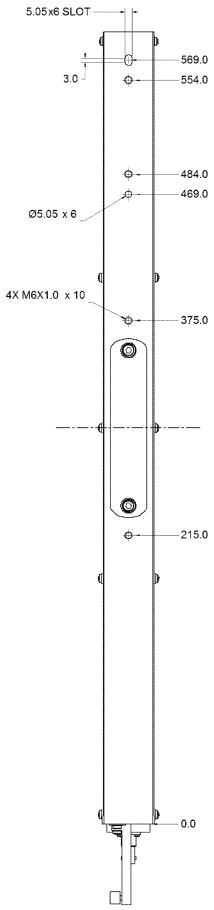
Mounting and fiducial details





Alternative mounting surfaces

Ordering information	
IC256-45	Ionization chamber, 256 by 256 strips, 45 cm by 45 cm sensitive area.
IC256-SYS-4R	IC256 system with four I128S electrometers, full resolution, no folding, cables, software and computer.
IC256-SYS-2RA	IC256 system with two I128S electrometers, half resolution, no folding, cables, software and computer.
IC256-SYS-2RW	IC256 system with two I128S electrometers, full resolution, 2x folding, cables, software and computer.
IC256-SYS-1RW	IC256 system with one I128S electrometers, full resolution, 4x folding, cables, software and computer.
-MP	Add mounting plate option.

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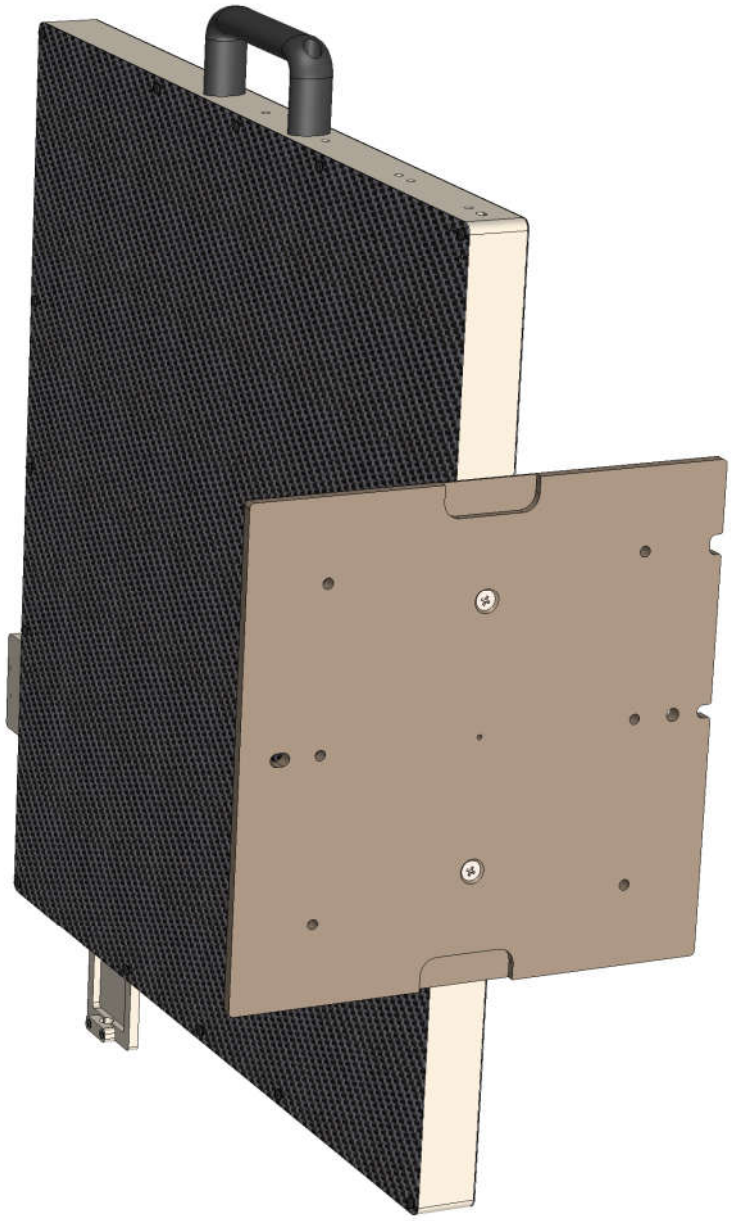
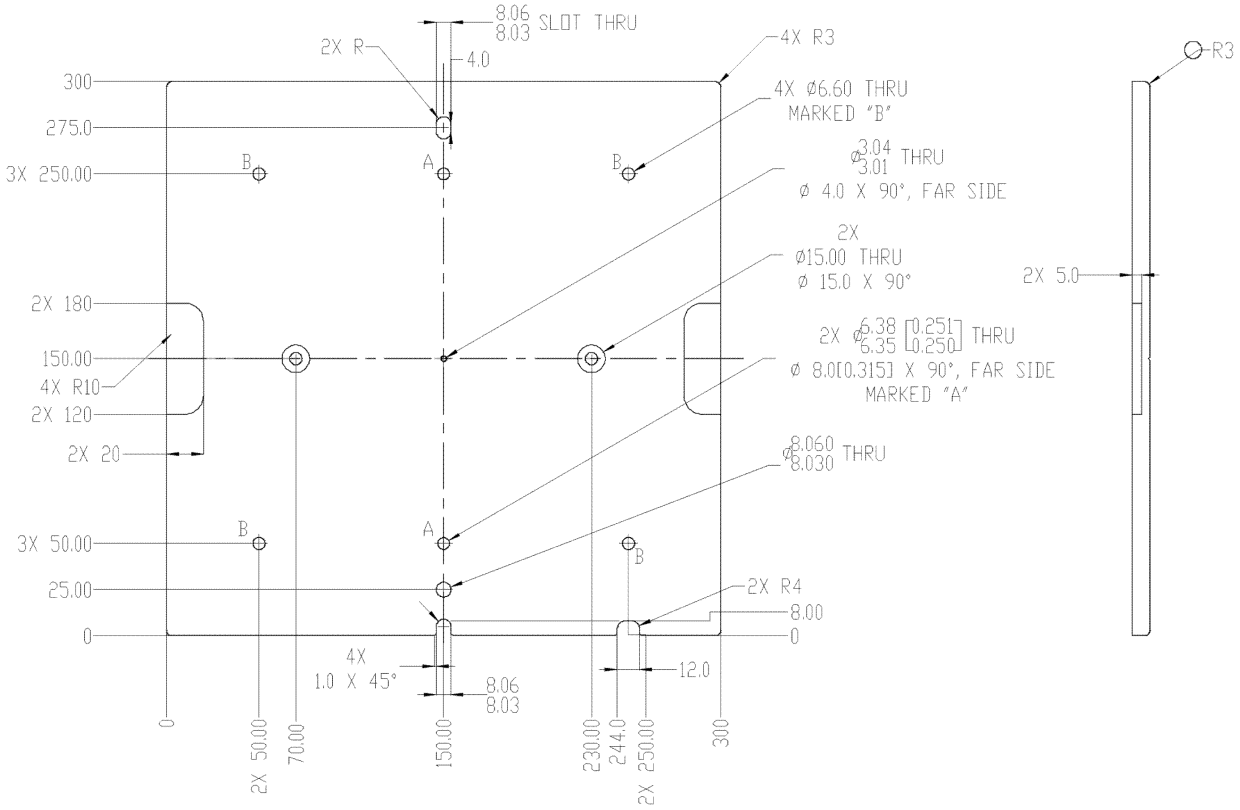
IC256-45_DS_171212



Optional mounting baseplate (view with assembly rotated to show the baseplate)



Optional mounting baseplate - dimensions