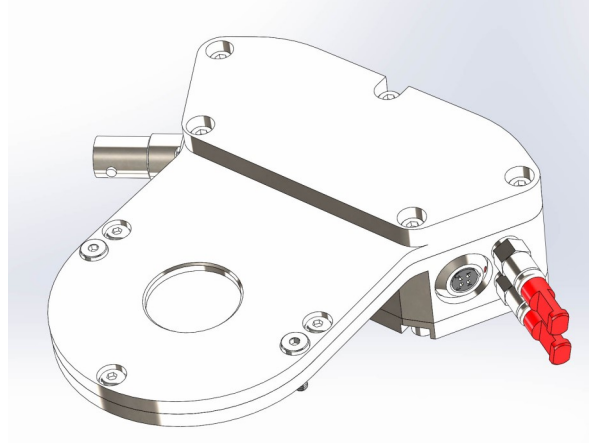


Miniature Quadrant Transmission Ionization Chamber

Features

- 1.9 cm diameter sensitive area
- Ionization chamber with quadrant readout electrodes for beam centering determination and total flux measurement
- Minimum scattering due to thin films of low-Z material - water-equivalent thickness 71 μm .
- Very small beampath length (7.6 mm)
- Small electrode gap for low recombination
- Polyimide film electrode substrates for radiation hardness
- Electrode patterns laser-cut for high geometric precision
- Operable with atmospheric pressure air chamber gas or flow-through gas
- Compatible with I404 or F460 readout electronics



Applications

- Particle therapy beam flux monitoring
- Particle therapy beam trajectory monitoring
- 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); higher current densities will suffer increasing recombination losses. Alternative gas fillings can reduce recombination.
Sensor	
Type	Parallel plate dual ionization chamber with single gap and quadrant readout cathode.
High voltage	500-1000 V nominal (1560 to 3125 V cm ⁻¹); maximum 1500 V
Sensitive area	19 mm (0.75 inch) diameter
Sensitive volume	Active volume: quadrant cathode to anode. 3.2 mm spacing.
Quadrant geometry	Four equal quadrants (50 μm inter-quadrant gaps typical)



Sensor (cont)

Gain uniformity	Better than +/-2% for beams within the sensitive area.
Position resolution	Depends on signal to noise ratio; 10's of μm achievable in both axes provided beam delivers signal to all quadrants.
Fiducials	Electrode strips tolerance build-up relative to fiducial features on body +/- 0.3 mm nominal, < +/- 0.1 mm typical .

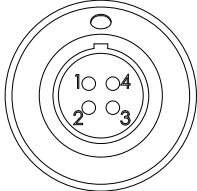
Chamber gas

Operating gas	Dry atmospheric air, or flow of any clean ionization chamber gas (Ar/CO ₂ , N ₂ etc)
Flow gas connections	To suit 1/8" (3.18 mm) tube push fit
Desiccant	Silca gel sachet. Sachet can be changed with chamber in situ provided the cover is accessible.

Mechanical

Insertion length	3.6 mm window to window, 7.6 mm housing face to face.
Overall size	100 mm by 110 mm by 35 mm approx (see figures)
Weight	0.3 kg (0.7 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

Connectors

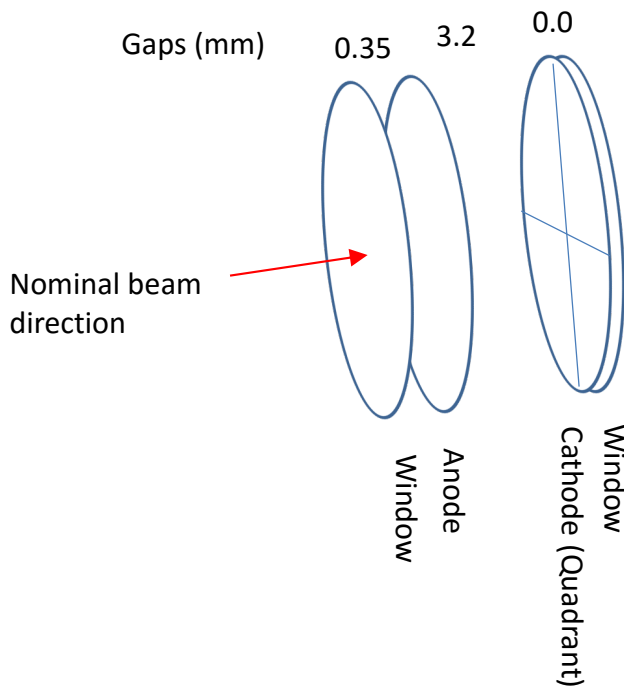
Quadrant readout	<p>Lemo 0B.304 four-pin female.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>1</td> <td>Quadrant 1</td> </tr> <tr> <td>2</td> <td>Quadrant 2</td> </tr> <tr> <td>3</td> <td>Quadrant 3</td> </tr> <tr> <td>4</td> <td>Quadrant 4</td> </tr> </table> <div style="text-align: center; margin: 10px 0;">  <p>External view on connector on chamber</p> </div> <p>Connector shell is common with the chamber body. Adaptor ADAP-L304-4BNC adapts from a four-way screened cable terminated in Lemo 0B.304 connectors to four BNC coaxial cables suitable for connection to I404 or F460 electrometers.</p>	1	Quadrant 1	2	Quadrant 2	3	Quadrant 3	4	Quadrant 4
1	Quadrant 1								
2	Quadrant 2								
3	Quadrant 3								
4	Quadrant 4								
HV out	SHV								



Beam scattering

Layers in beam path

1	12.5 μm	Polyimide foil aluminized both sides 0.1 μm (window)
2	0.35 mm	Fill gas (non-active gap)
3	12.5 μm	Polyimide foil aluminized both sides 0.1 μm (anode)
4	3.2 mm	Fill gas (active gap)
5	12.5 μm	Polyimide foil aluminized both sides 0.1 μm (cathode)
6	12.5 μm	Polyimide foil aluminized both sides 0.1 μm (window)



Sequence is for nominal beam direction.
Total effective thickness 71 μm water equivalent.

CAUTION



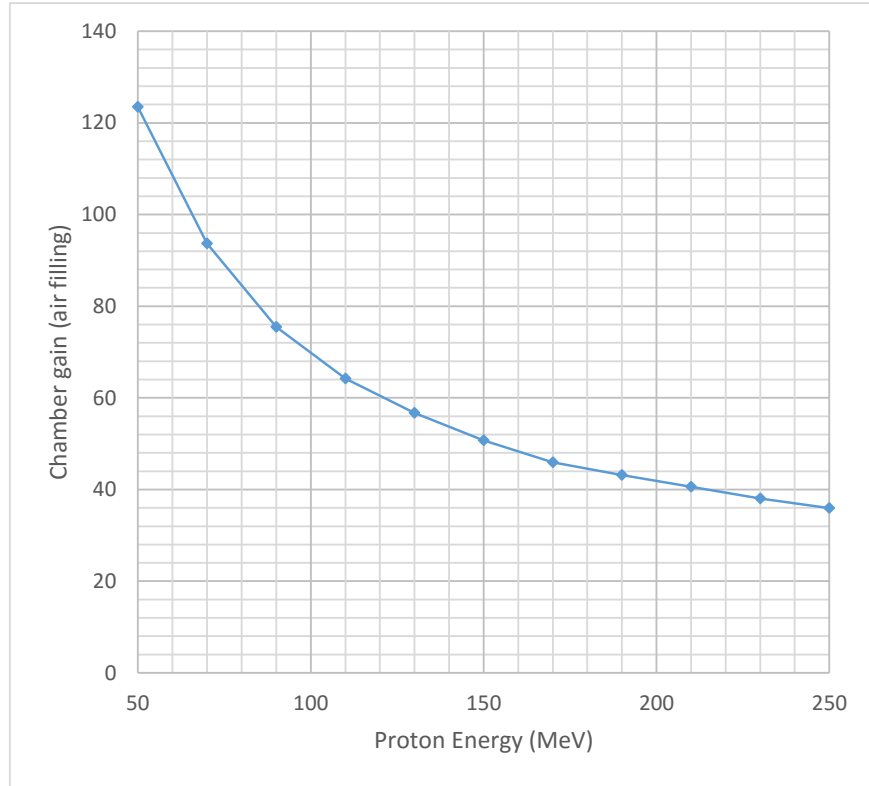
Do not expose the device to ionizing radiation beams unless all connections to readout electronics and bias supplies are made, or otherwise grounded. Charge build-up and subsequent arcing damage can occur.



Calibration

Gain curve

Approximate gain curve for air at standard ambient temperature and pressure for protons calculated by Geant4.



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

Gain correction

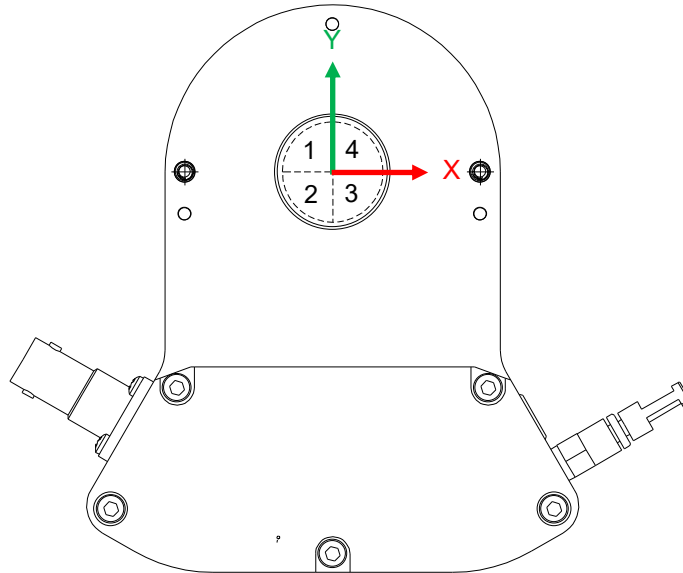
Nominal gain at standard ambient temperature and pressure (Temperature_{SATP} = 298.15 K, Pressure_{SATP} = 100000 Pa), must be corrected for measured temperature and pressure:

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

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



Position response



View on nominal beam entrance face. The QIC-2S has no actual preferred beam entrance side (the beam can enter in either direction) so the direction is arbitrary to suit a particular installation. Designation of the sensing axis as X / Y, or horizontal / vertical is also 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.

The I404 electronics built-in real-time position functions are difference over sum:

$$X = ((A+C)-(B+D))/(A+B+C+D) \quad Y = ((A+B)-(C+D))/(A+B+C+D)$$

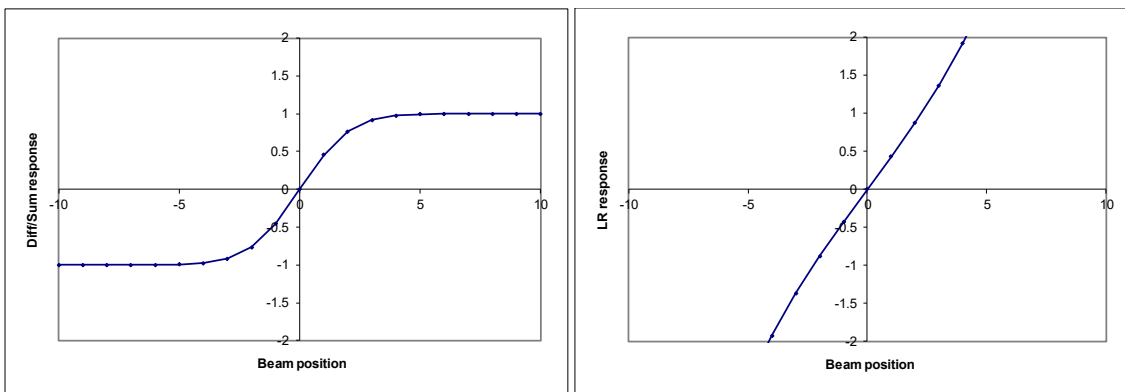
The plot on the left below shows the position function curve for a 2 mm sigma beam crossing the sensor. The log ratio position function shown in the right hand plot below may be preferred for some applications:

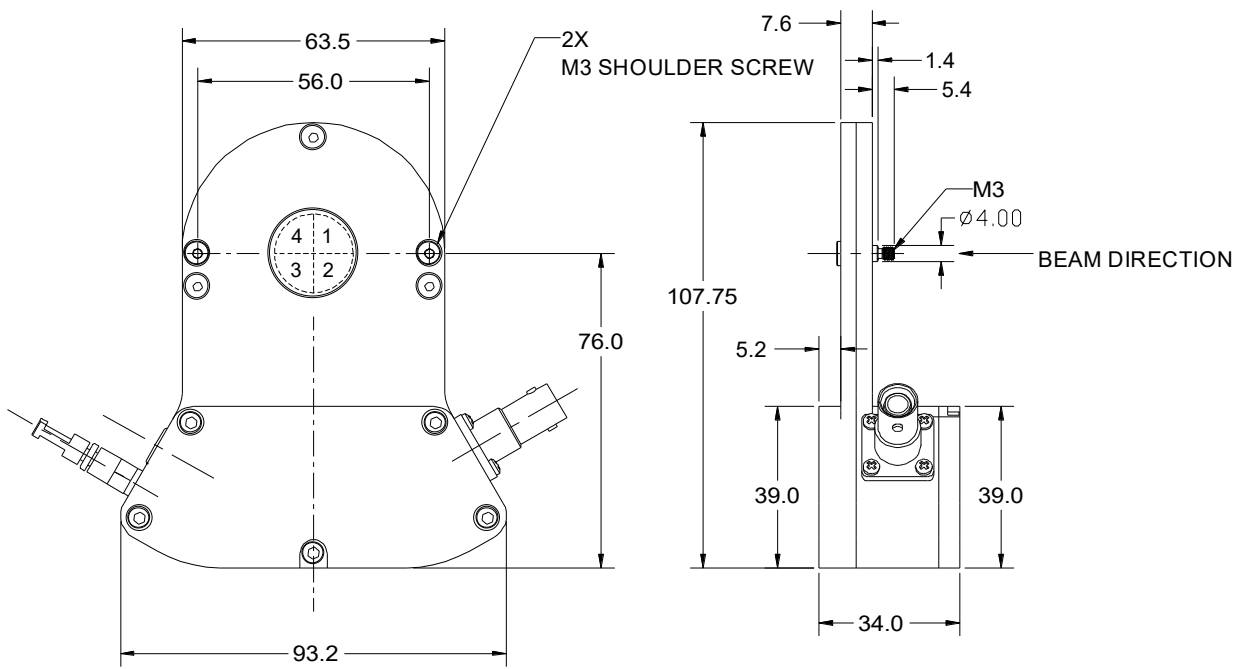
$$X = \log((A+C)/(B+D)) \quad Y = \log((A+B)/(C+D))$$

To obtain the particular position axes shown above using the I404 looking along the beam direction, connect the cables as follows:

1 → B, 2 → D, 3 → C, 4 → A.

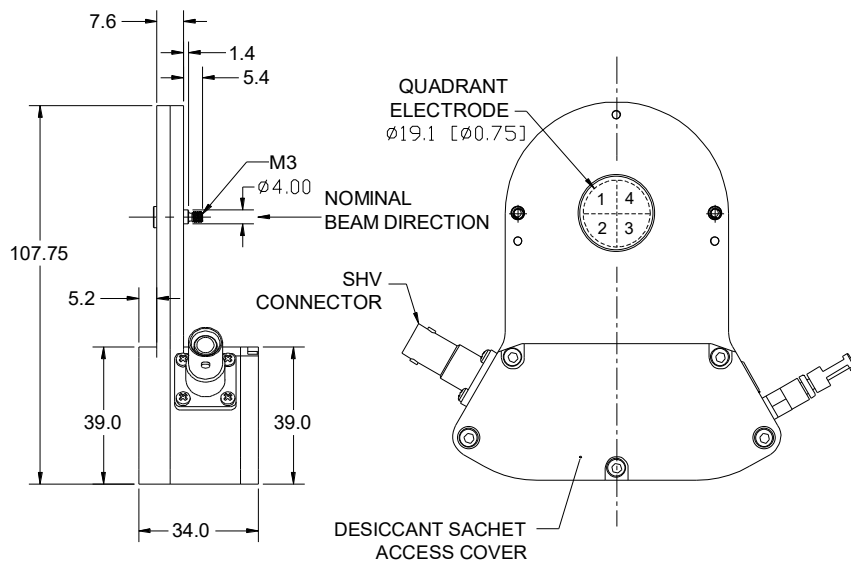
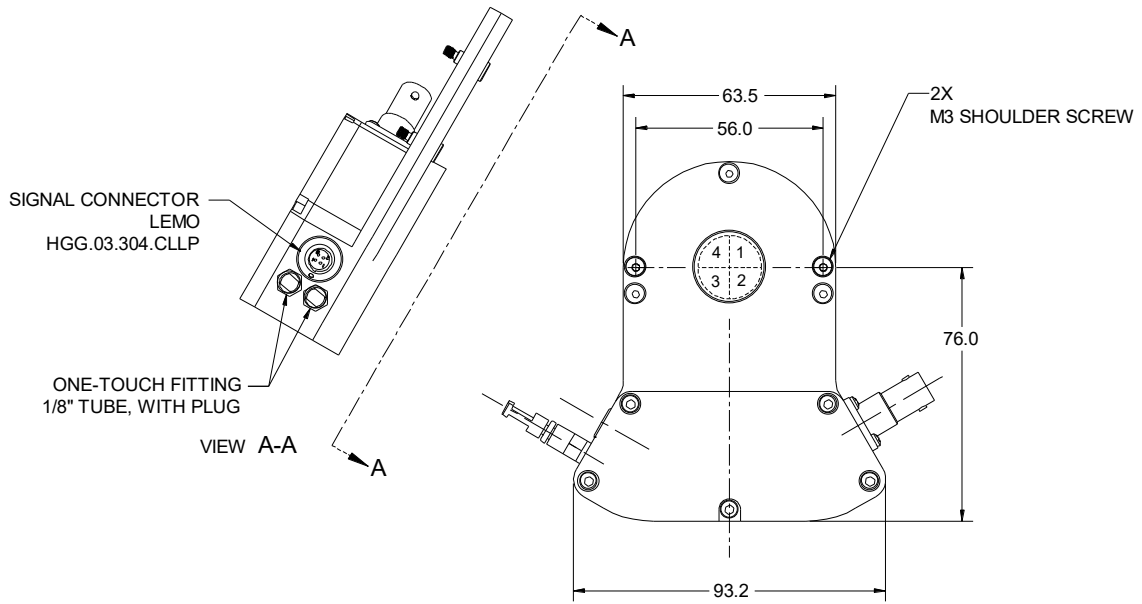
Other coordinate systems can be established by appropriate connection of the cables.





Dims mm
Third angle





Dims mm
Third angle

Ordering

QIC-2S	Thin film ionization chamber with 19 mm diameter sensitive area, quadrant readout electrode.
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All trademarks and names acknowledged.

QIC-2S_DS_160321

