STANDARD IMAGING	TECHNICAL NOTE	DATE 11-17-2015	MARKETS
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SUBJECT: Ionization Chamber and Leakage Measurements

The following information is provided as a service to our users and customers:

IONIZATION CHAMBER AND LEAKAGE MEASUREMENTS

Best Practice Guide

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STANDARD IMAGING

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Ionization Chamber Measurements

The following steps outline best practices for performing basic measurements with ionization chambers.

1 Preparing the Electrometer

1. Ensure nothing is attached to the electrometer and the dust cap is secured to the triaxial connector.
2. Power on your electrometer. A minimum of ten minutes should be allowed for the electrometer to warm up.
3. After allowing the electrometer to warm up, select the range of operation (low or high).
4. Use the "zeroing" feature to zero the electrometer. The dust cap must remain on during the zeroing process, as it completes the electrical shielding of the connector's internal components.

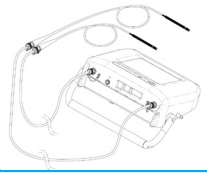
2 Preparing the Ion Chamber and Extension Cable

1. Carefully remove the ion chamber from its carrying case. **NOTE: Do not touch the sensitive area of the chamber and ensure the dust cap is always mated to its connector unless the chamber is being used.**
2. Position the ion chamber in the desired measurement geometry. Use the white mark on the chamber to ensure consistent orientation between measurements.

Please note that if you are working with a linear accelerator, any uncertainties in the alignment and position of the mechanical components can influence the ion chamber alignment and have an impact on subsequent measurement made; therefore it is strongly recommended to verify the leveling and alignment of the ion chamber to the reference coordinate system.

3. Remove dust cap from ion chamber cable and connect to an extension cable.

Ensure your extension cable is in good condition and confirm any induced triboelectric effects of a recently unwound extension cable have dissipated before taking measurements (refer to TechNote 4590 for more information).



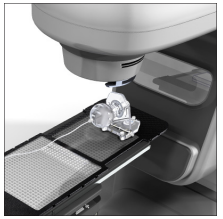
Secure the cable so that no sharp bends can be created in it, especially if the ion chamber will be moving. If the electrometer is a non-floating electrometer and high bias will be on the exposed triaxial connector housings, position a non-conducting buffer (i.e. cardboard, wood) between the connectors and the surface they are resting on to prevent a short.

3 Connecting to the Electrometer

1. Remove dust cap from electrometer connector and connect the extension cable to it, being careful not to touch either connector's internal components.
2. Select the desired bias voltage and allow at least ten minutes for the system to stabilize. (The "system" consists of ion chamber, extension cable and electrometer.)
3. Verify the leakage of the ion chamber is within acceptable limits (see Leakage Measurements instruction on the following page for more information). Use the "zeroing" feature to zero the system.
4. Check the system leakage. Take a reading without exposing the chamber to radiation. This current reading should be less than 0.1% of the final signal expected. (See Leakage Measurements instruction on the following page for more information).

4 Taking Measurements

1. Turn on the beam and take at least three measurements, ensuring there are no trends in the data.
2. Analyze the data; taking into account the average of the readings, system leakage, temperature/ pressure corrections, calibration factors, and any other applicable correction factors.



5 Disconnecting

1. When all measurements are complete, disable bias by setting it to 0 VDC.
2. Turn off the electrometer.
3. Disconnect the chamber from the extension cable, and the extension cable from the electrometer.
4. Reattach all dust caps to their respective connectors.

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Leakage Measurement

For reference, Standard Imaging electrometers measure current, not charge. The value for a charge measurement is determined through the amount of time (in seconds) that the electrical current is measured. Use the following steps to determine leakage in your system.

1 Electrometer Warm-up and Zeroing

1. Ensure nothing is attached to the electrometer and the dust cap is secured to the triaxial connector.
2. Power on your electrometer. A minimum of ten minutes should be allowed for the electrometer to warm up.
3. After allowing the electrometer to warm up, select the range of operation (low or high).
4. Use the "zeroing" feature to zero the electrometer. The dust cap must remain on during the zeroing process, as it completes the electrical shielding of the connector's internal components.

2 Checking the Electrometer Leakage

1. Select the low range of the electrometer.
2. Apply the desired bias voltage (typically +300 V).
3. Immediately begin to monitor the system current (i.e. "rate"). The passing leakage requirement for Standard Imaging electrometers is that the current must be **less than ±0.025 pA after 100 seconds of applying bias and remain stable**.

3 Checking the Extension Cable Leakage

1. Disable the electrometer bias.
2. Remove dust caps and connect the extension cable to the electrometer. Ensure the dust cap on the open end of the extension cable is attached to the connector to complete the electrical shielding of the connector's internal components.
3. Re-apply the desired bias.
4. Immediately begin to monitor the system current (i.e. "rate"). The passing leakage requirement for Standard Imaging ten meter (and shorter) extension cables is that the current must be **less than ±0.050 pA after 100 seconds of applying bias and remain stable**. Longer extension cables require additional time for the transient leakage values to stabilize because of their longer lengths; 30 meter extension cables can take upwards of five minutes to stabilize. The overall goal is to have a stable leakage measurement of less than 0.050 pA after a short amount of time.

4 Checking the Ion Chamber Leakage

1. If the leakage of the electrometer and extension cable meets the passing criteria, disable the bias.
2. Remove dust caps and connect the ion chamber to the open end of the extension cable.
3. Re-apply the desired bias.
4. Immediately begin to monitor the system current (i.e. "rate"). The passing leakage requirement for Standard Imaging/Exradin ion chambers is the current must be **less than ±0.050 pA after 100 seconds of applying bias and remain stable**. If using long extension cables, the chamber can be directly attached to the electrometer for this leakage check; otherwise, the necessary time required for the extension cable leakage to stabilize will also be required for the ion chamber leakage to stabilize (due to their series connection). Again, the overall goal is to have a stable leakage measurement of less than ±0.050 pA after a short amount of time.
5. Use the "zeroing" feature to zero the system, if desired.

5 Ensuring Cleanliness

A common issue that contributes to leakage is the cleanliness of the triaxial connectors. Even the smallest microns of dust can cause large amounts of leakage. The consistent use of the connector dust caps when the device is not in use will help ensure years of trouble-free use.

If it is determined that a device has high leakage, use compressed air to clean out the triaxial connectors. (Refer to TechNote 4640 for more information.)