

# Electrometers

- What is the function of an electrometer?
- What can it measure?

Electrometers are devices for measuring small currents, of the order of  $10^{-9}$  A or less. An electrometer used in conjunction with an ionization chamber is a high gain, negative feedback, operational amplifier with a standard resistor or a standard capacitor in the feedback path to measure the chamber current or charge collected over a fixed time interval, as shown schematically in Fig. 3.3.

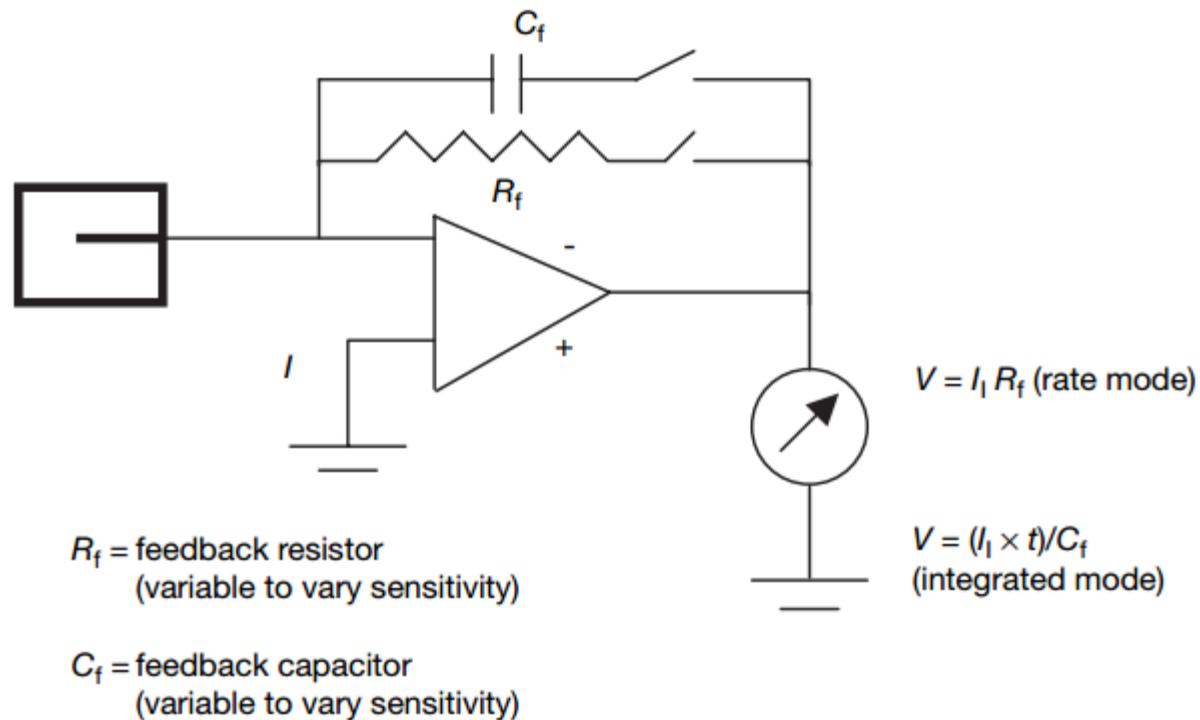




FIG. 3.3. Electrometer in feedback mode of operation.

- <http://www-naweb.iaea.org/nahu/DMRP/RadiationOncologyPhysicsHandbook.html>
- Ch. 3: Radiation Dosimeters. J.Izewska & G. Rajan



# TG-51 & $P_{elec}$

- Where does the electrometer correction factor come from and what does it correct for?
- What is the typical range of  $P_{elec}$  for
  - an independently calibrated electrometer?
  - An ion chamber/electrometer calibrated together as a unit?



# TG-51 & $P_{elec}$

- Electrometer correction factor obtained from ADCL
- When calibrated separately from the ion chamber, this correction factor corrects the electrometer reading to true coulombs
  - Typically within range of 0.995-1.005
- Considered 1.00 if electrometer and ion chamber are calibrated as a unit
- Unit: C/rdg or C/C

# Leakage

- What is the typical tolerance for leakage of an ion chamber + electrometer?
- What is loaded leakage?

# Leakage

- Leakage current of the ion chamber / electrometer system should not exceed 0.1% of the minimum ionization current to be measured
- Loaded leakage:
  - in charge mode, measurement of charge leakage when a significant charge is present on the capacitor
  - Should not differ significantly from usual leakage measurement (less than a factor of 2)

# Stabilization

- What factors may affect stability of ion chamber / electrometer readings?

# Stabilization

- Pre-irradiation of several Gray is required to establish stabilization of ion chamber / electrometer sensitivity due to:
  - Temperature of chamber and electronic circuits
  - Polarity of applied voltage

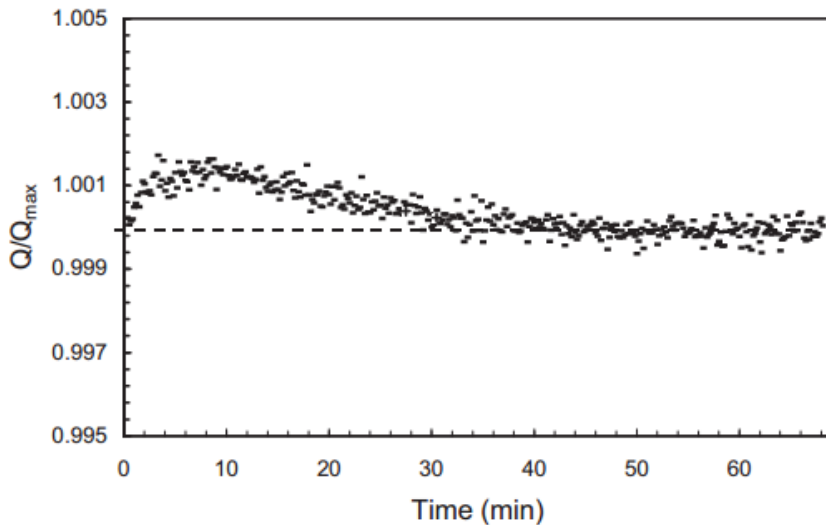


FIG. 8. Stabilization time for a Keithley 6517 electrometer with a PTW 23333 ionization chamber. In this example, acceptable stability is achieved after about 30 min, which represents a total dose of around 5 Gy.

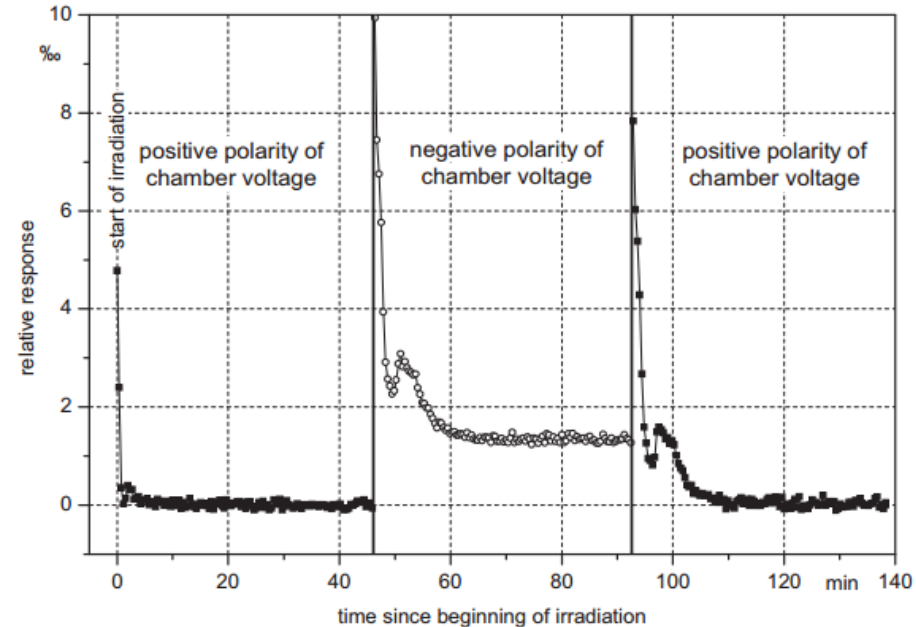


FIG. 7. Variation of the response of an ionization chamber of type NE2571 in a  $^{60}\text{Co}$  beam after switching the beam on (with the polarizing potential applied earlier) and after changing the polarity of the polarizing potential (with the chamber continuously irradiated). The dose rate during this measurement was about 1 Gy/min.



# Polarity

- Electrometers may apply potential to the chamber wall or the central collecting electrode
- For component calibrated ion chambers, sign & magnitude of the usually applied potential is important and should be communicated to calibrating laboratory
- Can be measured using a digital multimeter at the electrometer connector, or determined from manufacturer information

# Calibration

- Calibration for charge measurements performed using a known charge from an external calibrated capacitor and voltage source
- Calibration for current measurements performed using an accurate, high impedance, constant current source
- Measurements for linearity usually only need to be carried out once for a given electrometer
- Calibration should be performed independently for each range to be used regularly
- Stability of the electrometer calibration has been assigned a Type B uncertainty of 0.1%