Radiation Safety Institute of Canada
Institut de radioprotection du Canada

Detection Instrument Types and Selection

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Land Acknowledgement

Webinar Functionality

Audio and video

- During the presentation, from the presenters only
- Captions: More>Language and speech>Turn on live captions

Use the Chat feature to talk to discuss with everyone

Use Q&A feature to ask questions for Q&A portion

Posted on webinar page

- Video, answers to questions, copy of the slides

Follow up email will be sent

- Topics covered, time of attendance

In This Session

Topics

- Gas Chamber
  - Ionization Chamber
  - Proportional Counter
  - Geiger-Müller Detector
- Scintillation Detectors
- Semiconductor Detectors
- Probes
- Instrument Selection

Movement break

- Charlmane Wong
- Ji Hong Tai Chi and Qi Gong Richmond Hill

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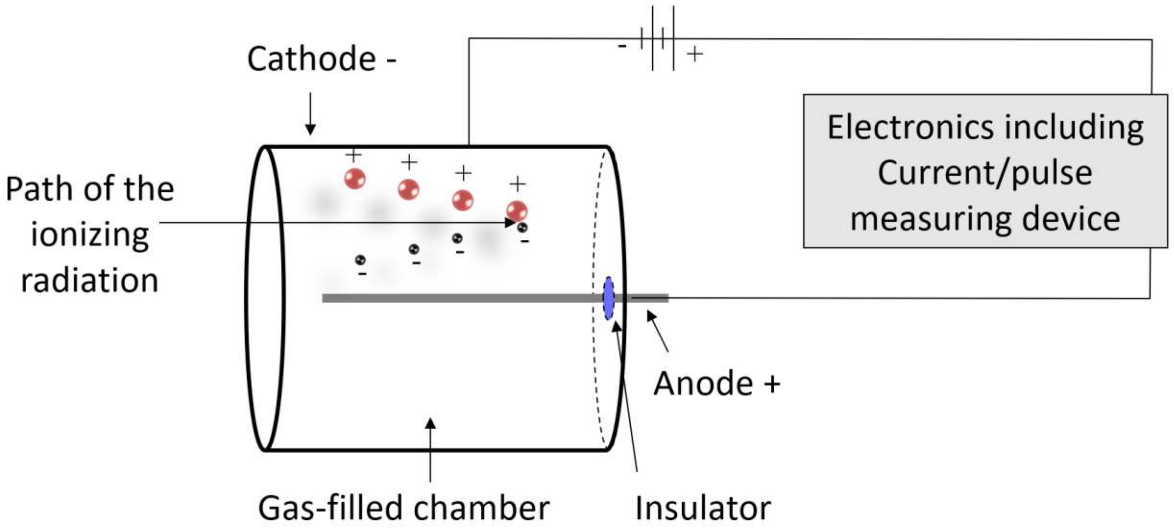
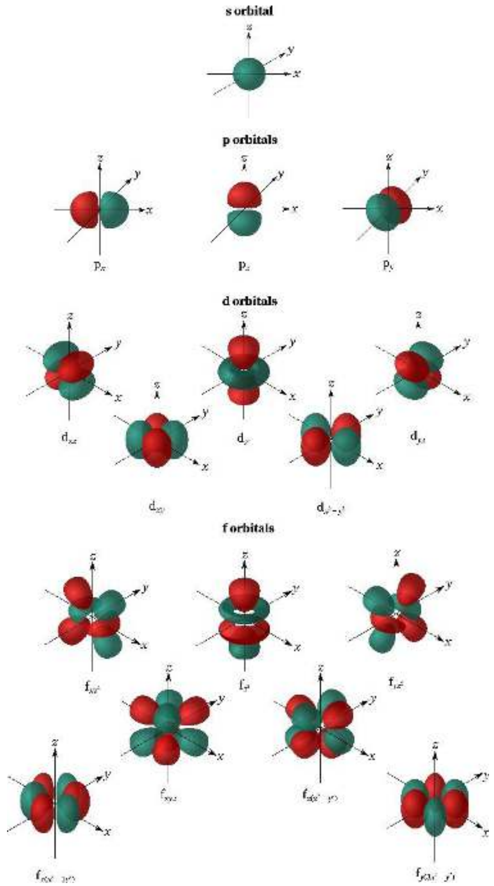
Gas Chamber Instruments

- Ionization Chamber
  - <200 V
- Proportional Counter
  - ~200 V – 600V
- Geiger-Müller Detector
  - ~800 V – 1000 V



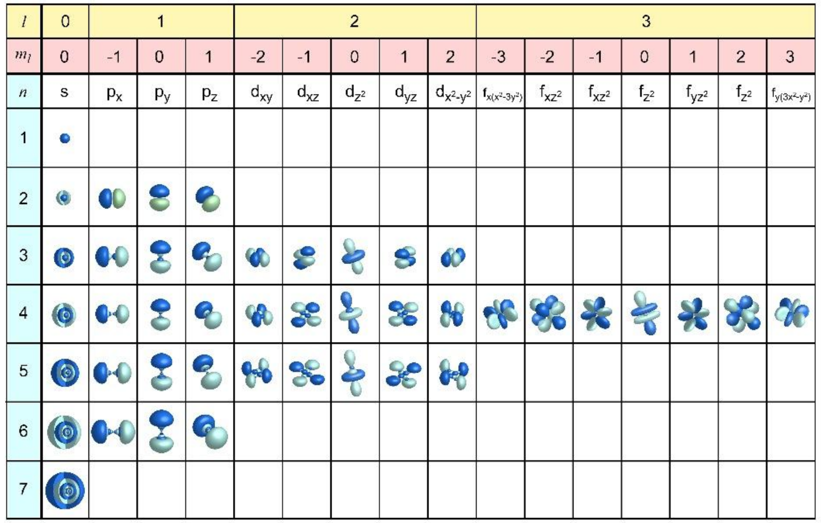
Orbitals and Energy

- Orbitals are where you have the highest probability of finding an electron.
- Each orbital has a specific energy level and other properties.

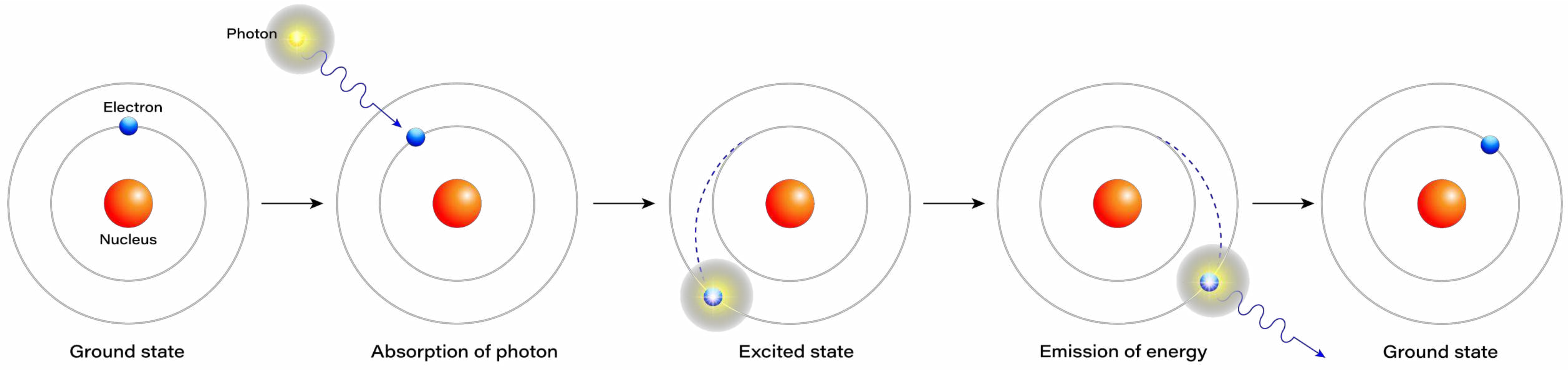


Orbitals and Energy

- Electrons fill up the orbitals beginning at the lowest energy state.
- There are only a certain number of electrons allowed to in each orbital.
- Orbitals want to be full.



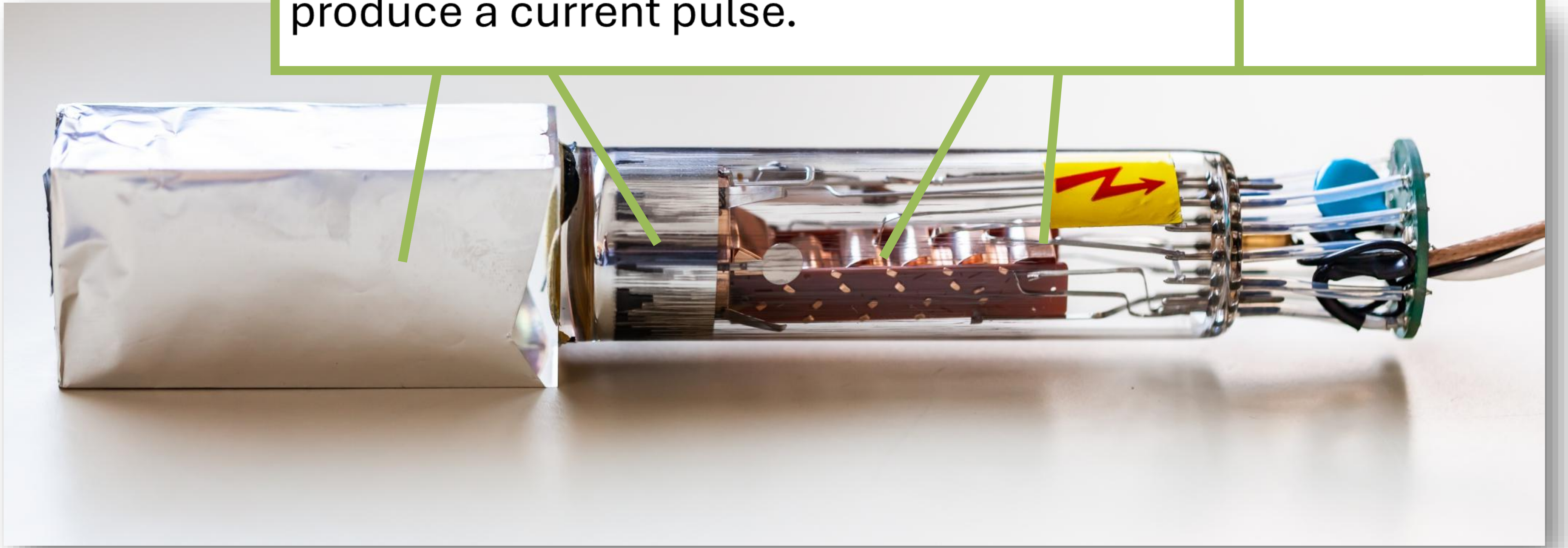
Scintillation Detectors



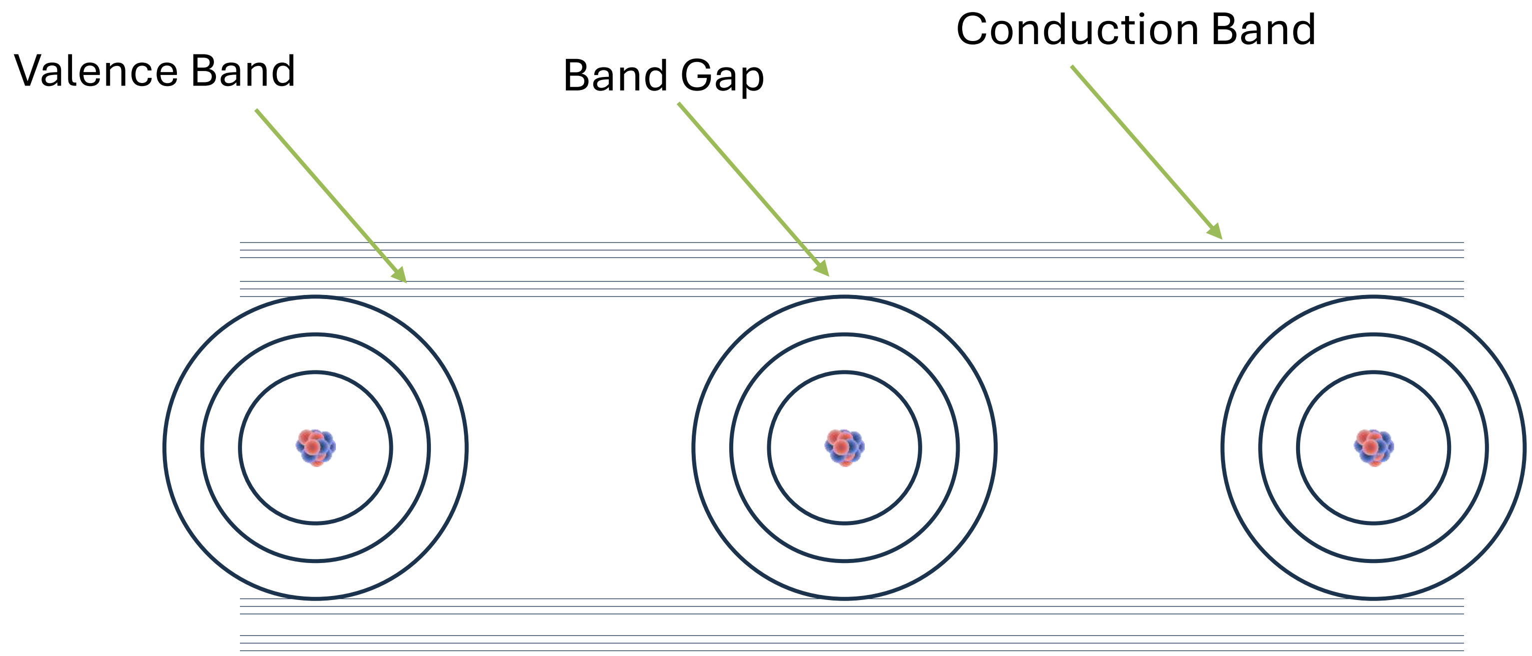
Scintillation Detector

Electrons are collected at the anode to produce a current pulse.

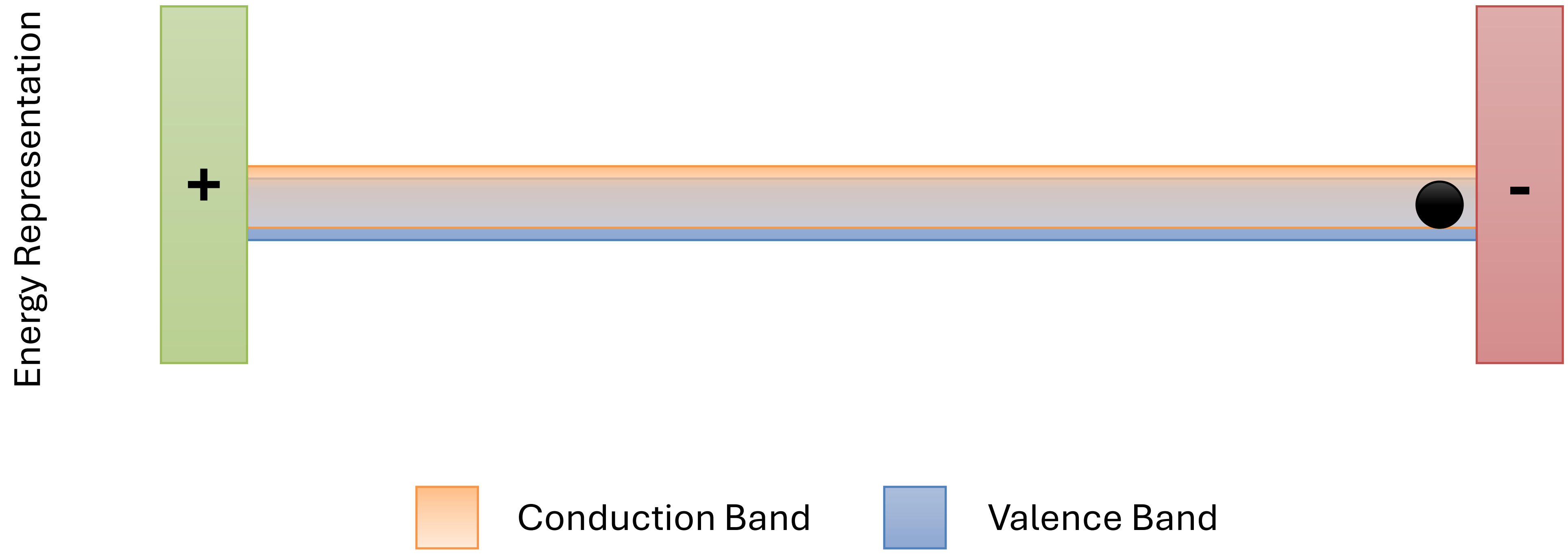
sing them



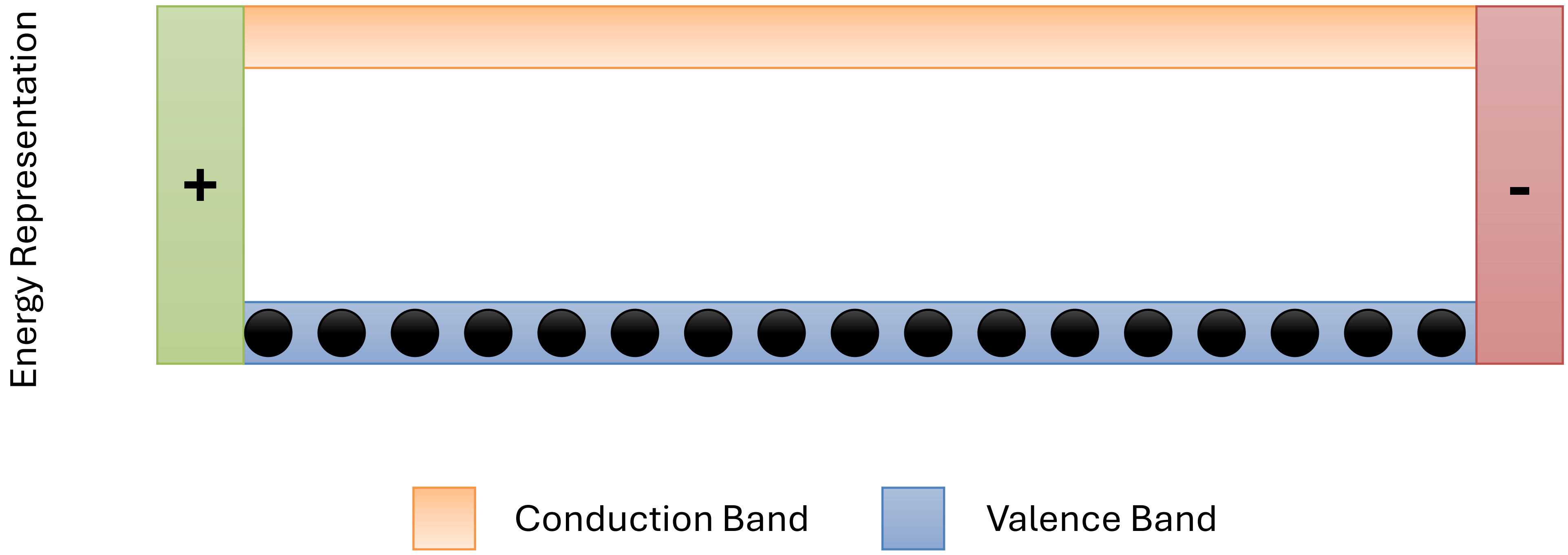
Semiconductor Detectors



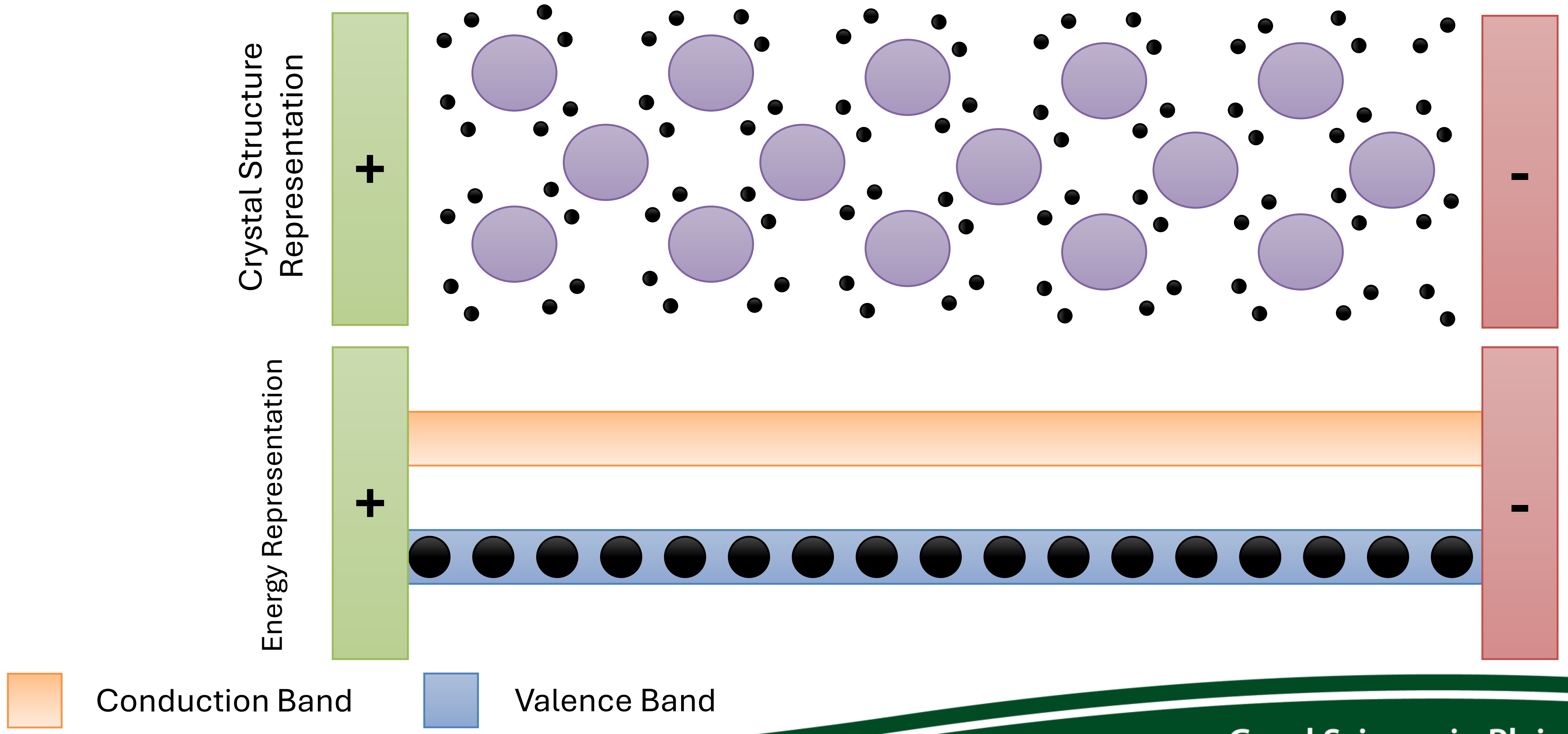
Conductor



Insulator



Semiconductor



Probes

https://www.nuviatech-instruments.com/product/nudet-nai/

https://www.nuviatech-instruments.com/product/nudet-ena/

Instrument Selection

- General requirements:
  - Portability
  - Mechanical ruggedness
  - Ease of use and reading
  - Ease of servicing
  - Ease of decontamination
  - Can you calibrate it?
  - Reliability
- **Type and energy of radiation to be measured**
- Beware of low-quality instruments

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Instrument Selection

Parameter	Ion Chamber	Proportional Counter	Geiger-Müller Counter	Scintillation Detector	Semiconductor Detector
Detection medium	Gas	Gas	Gas	Solid or liquid	Solid
Feature	Voltage high enough to collect ions but no so high as to cause secondary ionization in the gas (< 200 V)	Voltage high enough to cause secondary ionization (~200V–600V). Number of electrons collected proportional to primary ions created.	High voltage used causes avalanche of electrons (~800V–1000V). Pulses are independent of the type of primary radiation.	Scintillation material emits light, which is converted to an electronic signal with a photomultiplier tube.	Radiation causes an electronic pulse through use of semiconductor.
Common Uses	α, β, ɣ, x-ray • Medium & high dose-rate surveys • Area monitors	α, β, ɣ, x-ray, neutron • Low activity contamination surveys	α, β, ɣ, x-ray • Low dose-rate surveys • Low activity contamination surveys • Area monitors	α, β, ɣ, x-ray, neutron • Low energy radiation (liquid scintillation) • Contamination surveys	α, β, ɣ, x-ray • Laboratory spectroscopy • Electronic dosimeters
Advantages	• Directly measure the ionization • Distinguishes between different types of radiation • Low energy dependence	• Larger output signal than ion chamber • Distinguishes between different types of radiation • Can detect low energy radiation	• Good sensitivity • Large output pulse • Less signal processing • Ideal for particle counting • Variety of probes	• High sensitivity • High efficiency • Output proportional to energy deposited so can be used for spectroscopy • Large output signal	• Excellent energy response • Short dead time • High efficiency • Spectroscopy
Disadvantages	• Weak output pulse • Low sensitivity • Requires amplification • Large volume	• Requires very stable power supply • Tend to be non-portable	• Instrument itself does not distinguish between radiation types • Difficulties in high radiation fields • Energy dependence	• Not rugged • Tend to be non-portable	• Price • Signal amplification • Silicon chips can degrade over time • Germanium requires cooling

Questions?

- First addressing some questions sent during registration that weren't addressed in the presentation
- As time permits, we will address questions posted in the Q&A
- Questions we do not get to
  - Answers will be posted to our website and a link to resources emailed out

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Thank you for listening!

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Wellness Break

[Ji Hong Tai Chi & Qi Gong, Richmond Hill, ON]

References/Resources

https://publications.gc.ca/collections/collection_2016/ccsn-cnsc/CC172-162-2016-eng.pdf

https://www.cnsc-ccsn.gc.ca/eng/acts-and-regulations/regulatory-documents/published/html/regdoc2-7-1/

https://www.cnsc-ccsn.gc.ca/eng/acts-and-regulations/regulatory-documents/published/html/regdoc2-9-1-vol1-2/

Section 2.10 of https://www.cnsc-ccsn.gc.ca/eng/nuclear-substances/licensing-class-ii-nuclear-facilities-and-prescribed-equipment/information-class-ii-licensed-facilities/radioisotope-safety-monitoring-contamination/

https://www.cnsc-ccsn.gc.ca/eng/nuclear-substances/licensing-class-ii-nuclear-facilities-and-prescribed-equipment/information-class-ii-licensed-facilities/regulatory-expectations-calibration-survey-meters/

https://www.cnsc-ccsn.gc.ca/eng/acts-and-regulations/consultation/comment/regdoc2-7-2-vol-i/

Questions 12, 13 of https://www.cnsc-ccsn.gc.ca/eng/nuclear-substances/licensing-nuclear-substances-and-radiation-devices/faqs/

Section 5 of https://www.cnsc-ccsn.gc.ca/eng/nuclear-substances/licensing-class-ii-nuclear-facilities-and-prescribed-equipment/information-class-ii-licensed-facilities/regulatory-expectations-calibration-survey-meters/

https://publications.gc.ca/collections/collection_2016/ccsn-cnsc/CC172-162-2016-eng.pdf has information on detection of specific isotopes

https://www-pub.iaea.org/MTCD/Publications/PDF/PRTM-1r1_web.pdf

https://ncrponline.org/shop/reports/report-no-057-instrumentation-and-monitoring-methods-for-radiation-protection-1978/

https://hps.org/ate_faq/devices/

https://hps.org/ate_faq/radiationdetection/

https://radiationsafety.ca/the-importance-of-calibrating-radiation-measurement-instruments/