DPG Frühjahrstagung Dresden

Measurement of Natural Radioactivity with REGe Detectors at the MPI für Physik

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Outline

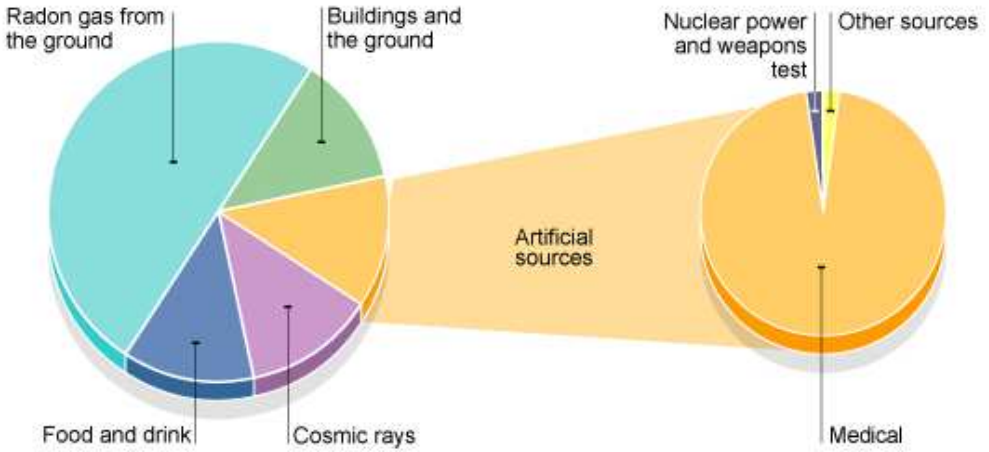
Background Radiation

Natural Sources

- Cosmic rays
- Terrestrial Rock
- Radon
- Flora and fauna incl. food

Artificial Sources

- Medical treatment
- Nuclear power plants
- Radioactive waste
- Radioactive fallout



Average contribution of different sources to natural background radiation

Source: http://www.bbc.co.uk/schools/gcsebitesize/science/add_ocr_gateway/radiation/radioisotopesrev1.shtml

Germanium Detectors

...are widely used in nuclear physics experiments and Dark Matter searches

Concept

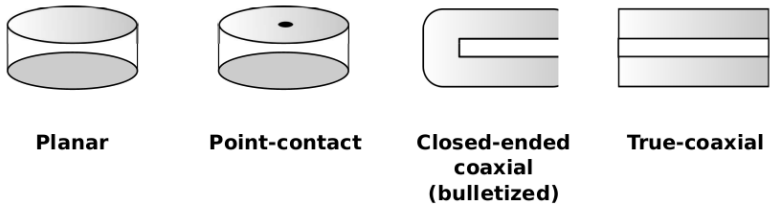
- **Semiconductor diodes with p- or n- structure**
- **Reverse biasing**
- **Sensitive to ionizing radiation**
- **Depleted, sensitive thickness of centimeters (for Si only mm)**

Advantages

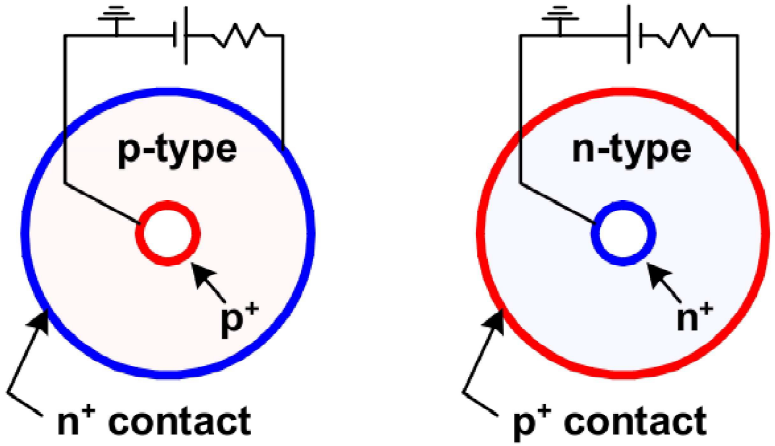
- **Measurement of low levels of radioactivity**
- **Gamma ray tracking with high detection efficiency**
- **Very sensitive with an excellent energy resolution**

Germanium Detectors

Detector Configurations

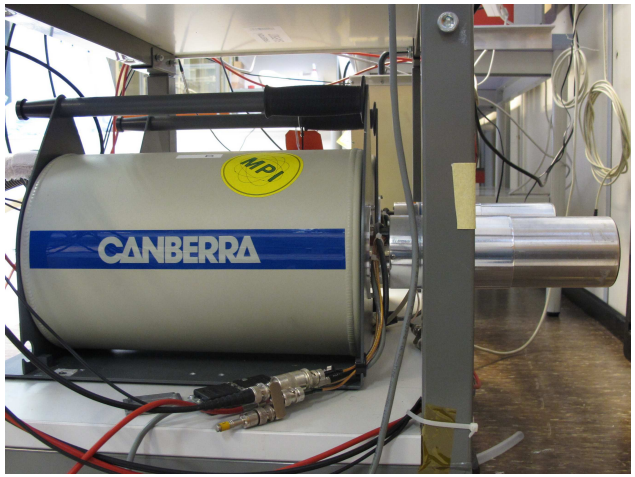


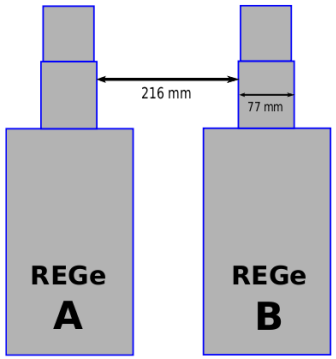
Electrode Configurations for Coaxial Detectors



Source: Med Phys 4R06/6R03 Radioisotopes and Radiation Methodology
Chapter 8: "Hyper-Pure Germanium Detector"

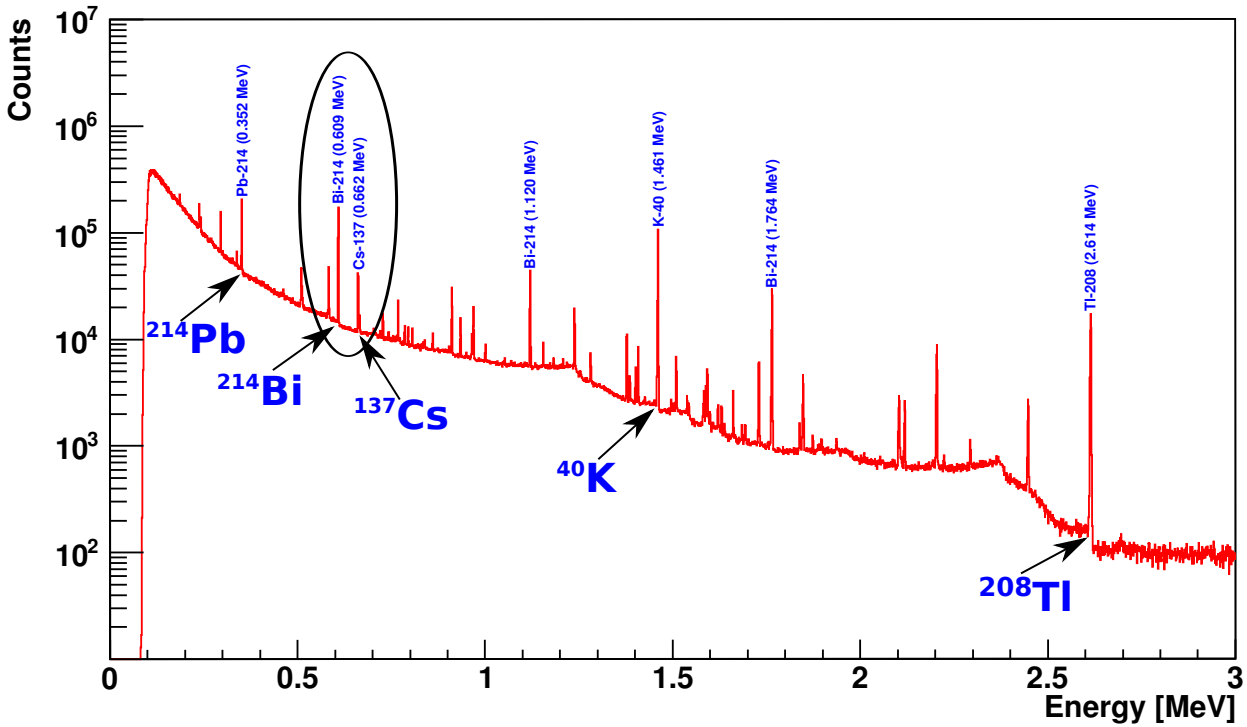
Measurement Setup





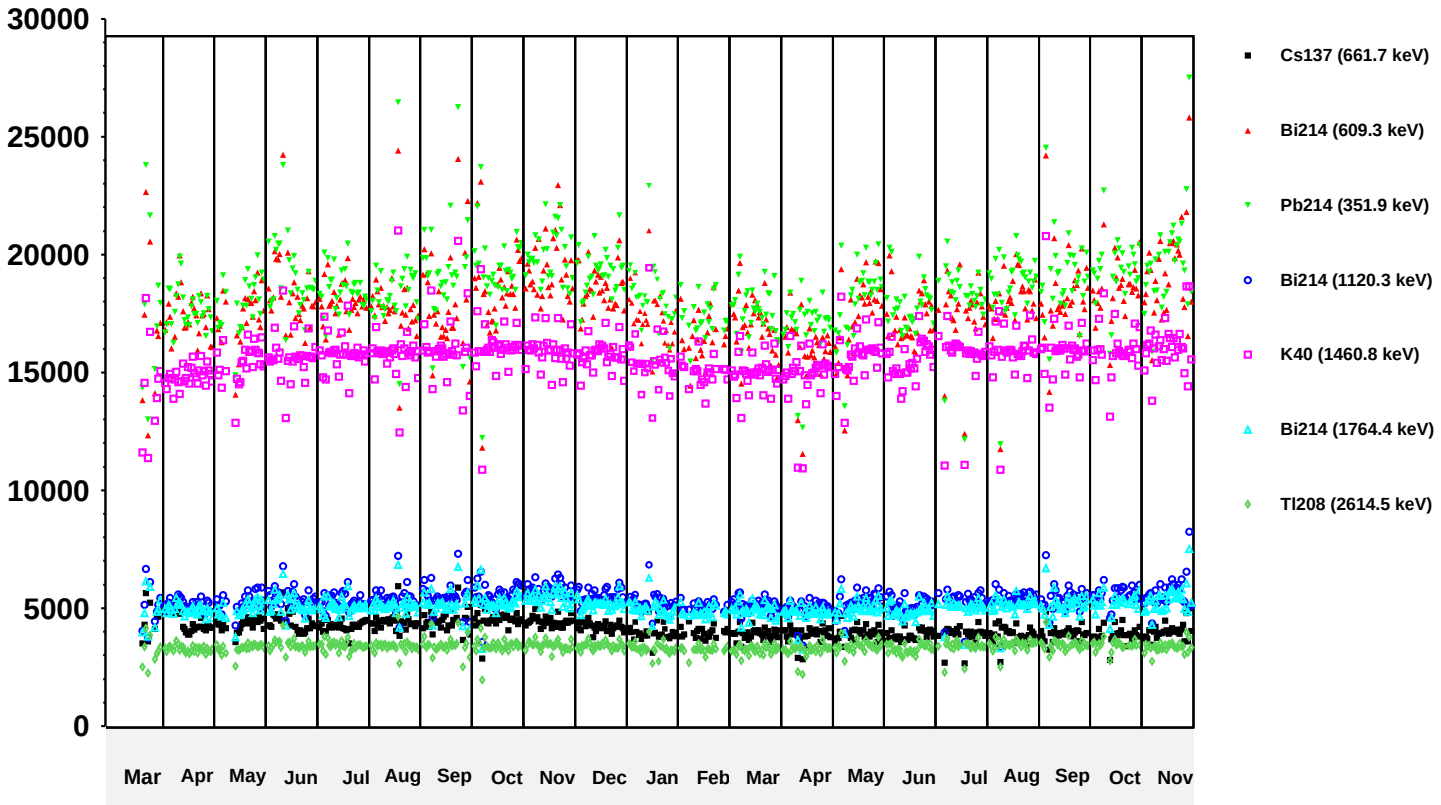
- Detectors
  - REGe = Reverse Electrode Coaxial Ge detectors
  - Geometry is closed-end cylindrical
  - Mantle: p-contact, core: n-contact
  - Thin ion implanted contacts
  - Spectroscopy from 3 keV to >10 MeV
  - Excellent Energy Resolution
- BG Measurement of
  Lab Air, Experimental Hall Air, External Air
- Monitoring BG
  since March, 23th 2011 until now

Background Spectrum

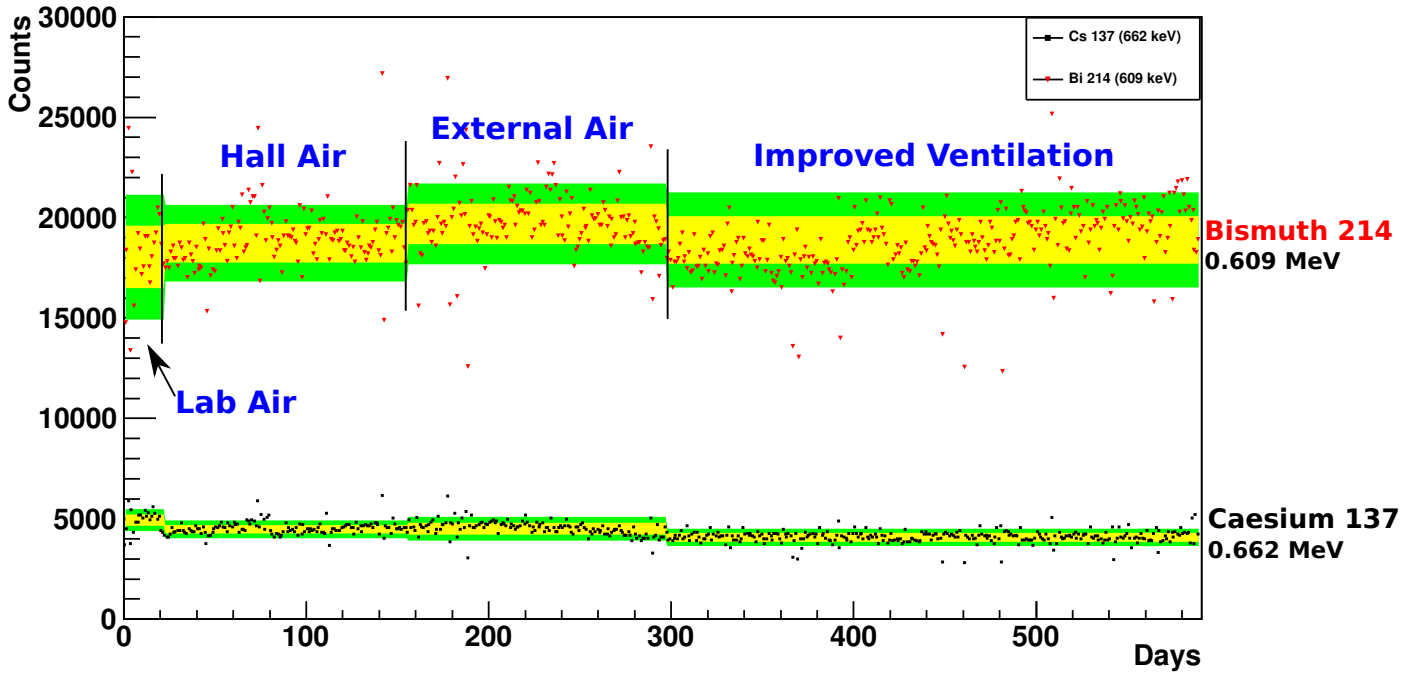


- Cs-137 is a tracer for nuclear disasters
- Bi-214 should be constant over time

Monitoring Count Rates

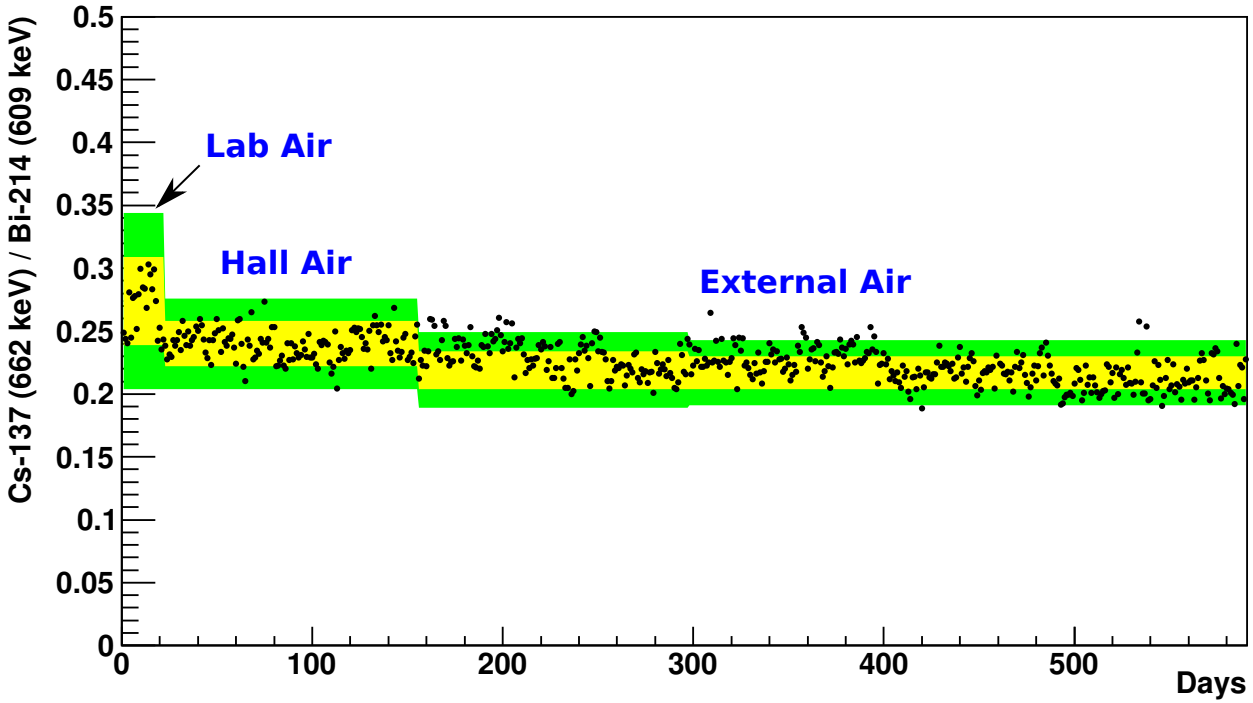


^{137}Cs and ^{214}Bi Count Rate



- Detailed statistical analysis was performed for 4 periods
- Count rates fluctuate statistically
- Yellow band: 1σ, green band: 2σ

^{137}Cs to ^{214}Bi Count Ratio



- Higher $\frac{^{137}\text{Cs}}{^{214}\text{Bi}}$ inside the lab
- Nuclear disasters like Fukushima should effect the count rate of Cs-137, not Bismuth

Summary and Conclusion

- Monitored background count rates since March 2011
- Detailed statistical analysis was performed
- Count rates fluctuate statistically
- Lab air enriched from radioactive deposits, originating from nuclear tests in the middle of the 20th century