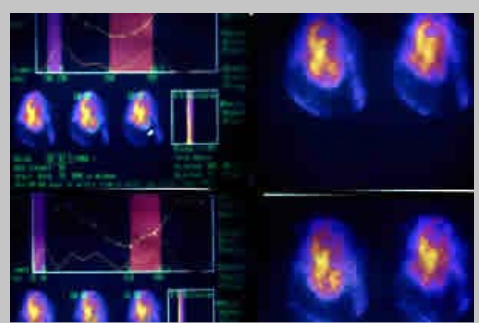
Common Sources of Radiation

Steve Sugarman, MS, CHP, CHCM
Health Physics Project Manager
Radiation Emergency Assistance Center / Training Site
http://orise.orau.gov/reacts/



Terminal Objective

Familiarize the students with commonly encountered sources of radiation

Enabling Objective

- Become familiar with common uses of radioactive materials and radiation generating devices in industry and medicine

Questions to Ask Yourself

- What are the most common radiation sources found in my area?
- What sources could likely produce radiation in my community, region, or state?
- Are radiological substances transported through my area?
- What events are most likely to occur?
- What other issues should we consider?

Where Are Radiological / Nuclear Materials Found?

- Irradiation facilities
- Nuclear reactors
- Isotope production facilities
- Materials testing (sealed sources)
- Materials testing (x-ray devices)
- X-ray and radiotherapy devices (medicine, research)
- Unsealed radionuclides (medicine, research)
- Transportation
- ???

Source: REAC/TS Radiation Accident Registry

Ionizing Radiation: Medical, Industrial, and Consumer Product Applications

- Radiography
- Analytical
- Irradiation
- Involving unsealed radioactive materials
- Miscellaneous

Safety Series No. 102, "Recommendations for the Safe Use and Regulation of Radiation Sources in Industry, Medicine, Research and Teaching," UNIPUB, 4611-F Assembly Drive, Lanham, MD 20706-4391, STI/PUB/807, ISBN 92-0-123390-6, ISSN 0074-1892

Ionizing Radiation: Medical, Industrial, and Consumer Product Applications

- ***Industrial radiography***
- ***Beta radiography***
- ***Selective absorption***
- ***X-ray fluorescence***
- Electron capture
- Neutron capture and activation analysis
- ***Gamma backscatter gauge***
- ***Photon switching***
- ***Thermalization of neutrons***
- Selective gamma absorption
- Neutron transmission
- ***Medical diagnostics***
- ***Brachytherapy***
- Radiation beam therapy
- Radiation cross-linking, curing and grafting
- ***Sterilization***
- ***Static elimination***
- ***Smoke detectors***
- ***Lantern mantles***
- ***RTGs***

Industrial Radiography

^{192}Ir up to 10 TBq (~ 300 Ci)

^{60}Co up to 100 TBq (~ 3000 Ci)

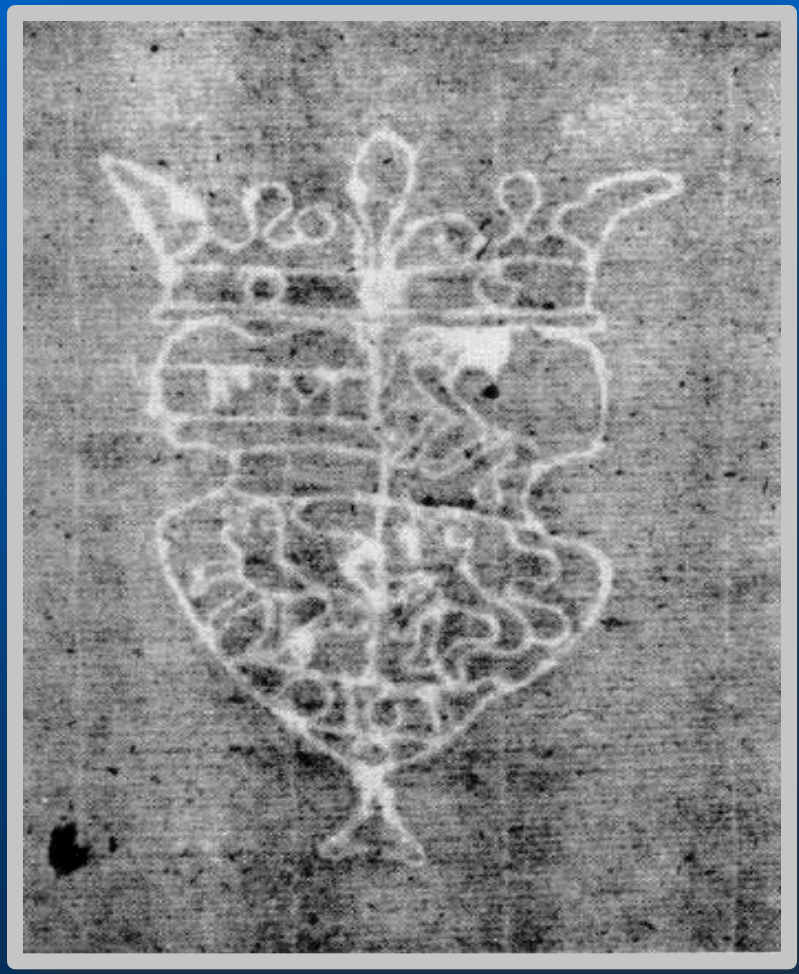
http://www.spec150.com/products.htm

Industrial Radiography

circa 1980s

Beta Radiography (C-14)

- Used for document authentication
- Contains about 40 kBq (1 µCi)



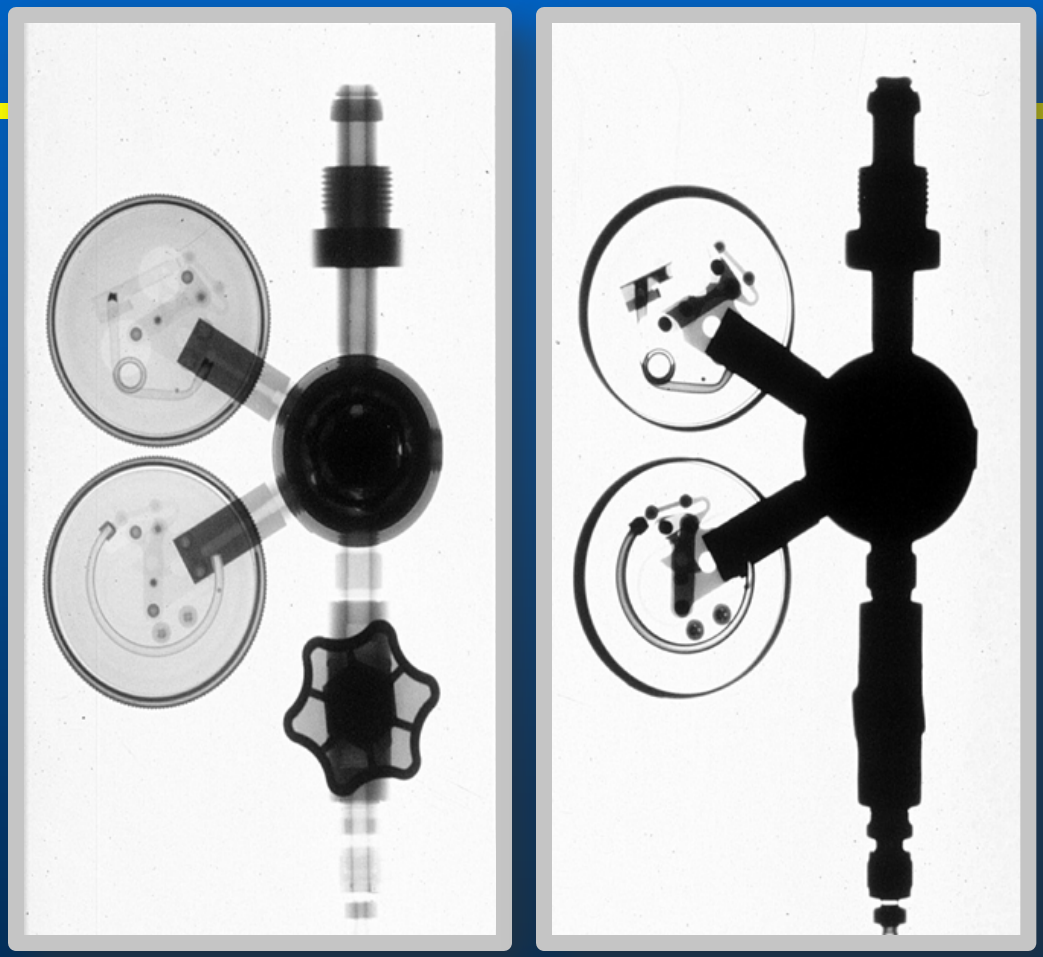
www.ashmolean.org

Neutron vs X-ray Radiography

Valve Assembly Radiograph Comparison (selective absorption)

Neutron

- Cf-252 (100 µg to 10 mg)
- Specific Activity is about 535 Ci/g



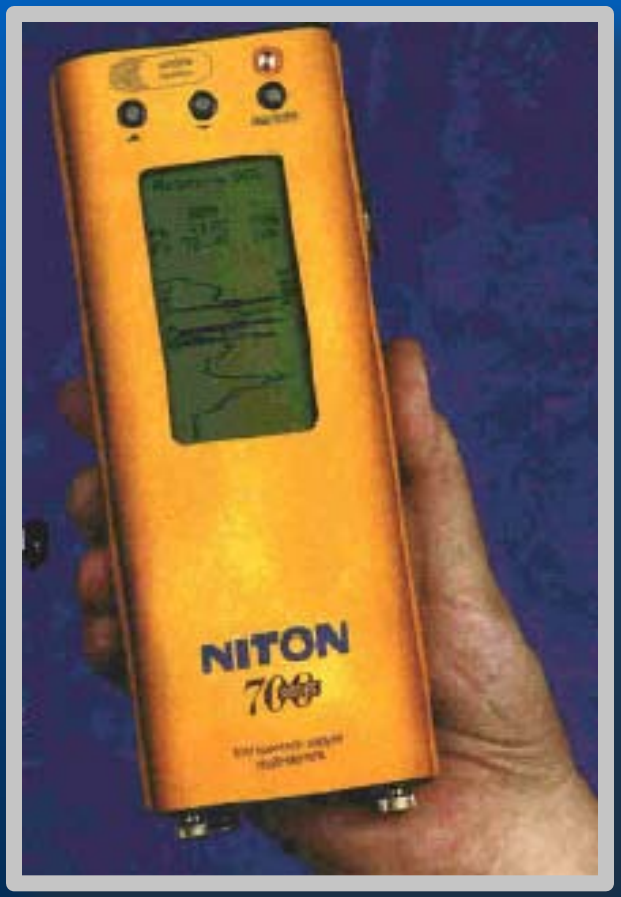
X-Ray

- Varying x-ray energies, depending on needs

http://www.anlw.anl.gov/radiographs/index.html

X-ray Fluorescence
40 MBq/1 mCi – 40 GBq/1 Ci

^{55}Fe, ^{238}Pu, ^{241}Am, ^{57}Co



http://www.brandtinst.com/RMD/index.html
http://tech.inel.gov/documents/lpa/LPA-ITSR.pdf

Density Gauges (Gamma Scattering)

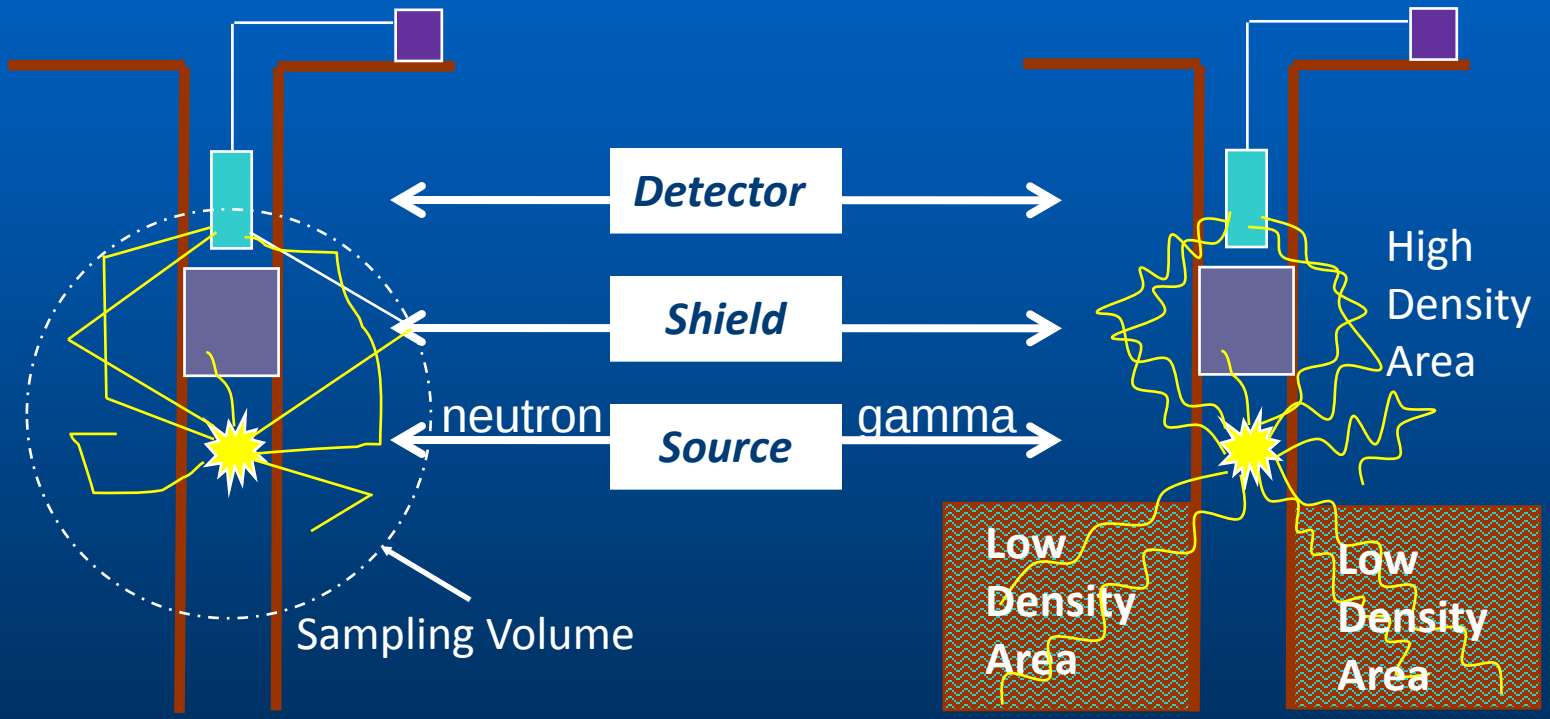
^{137}Cs /^{60}Co ~ 20 GBq/500 mCi

http://www.instrotek.com/val.htm

Neutron Absorption and Gamma Scattering

AmBe (1 – 800 GBq/30 mCi – 20 Ci)

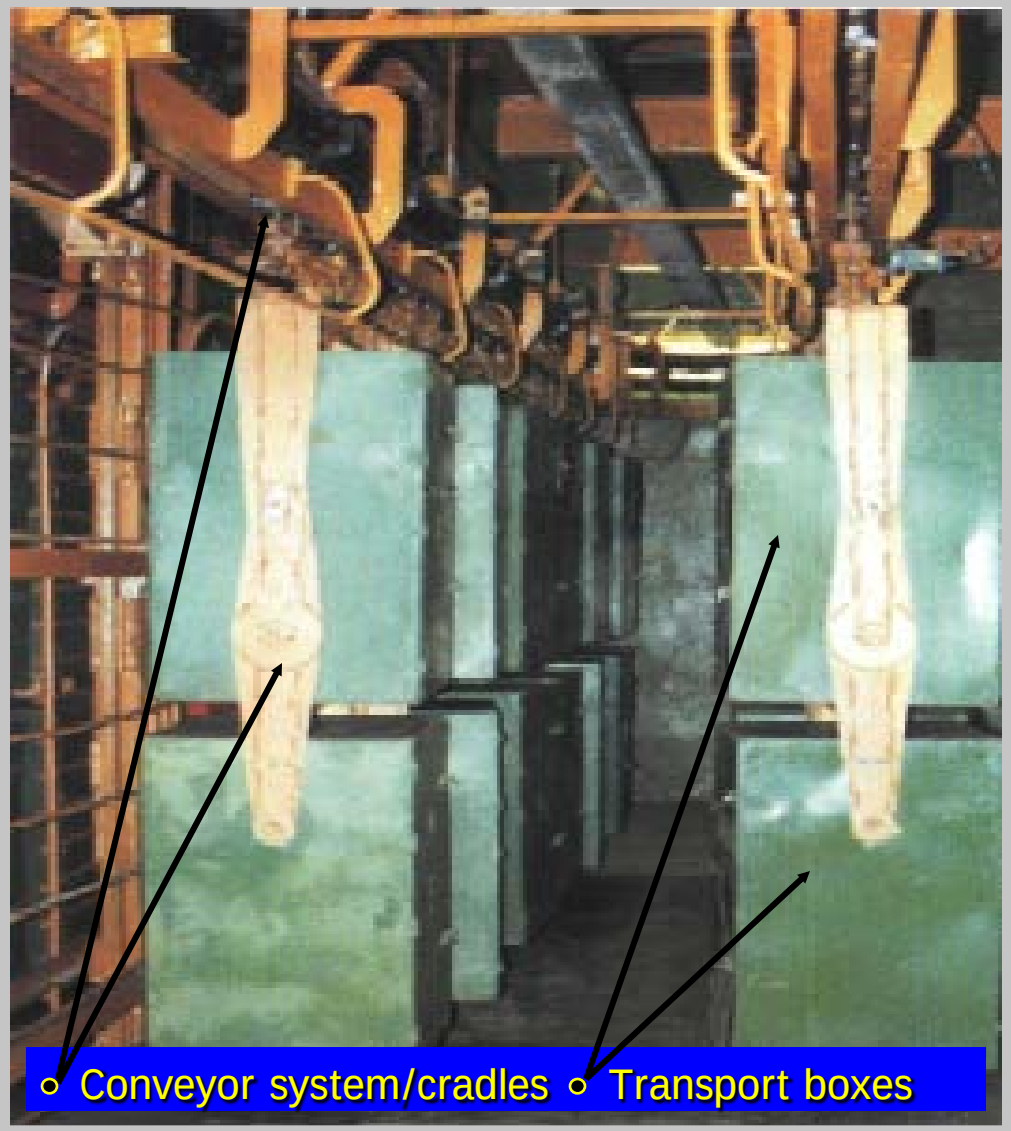
^{137}Cs or ^{60}Co (~ 20GBq/500mCi)



Neutron Thermalization

Gamma Scattering

Industrial Irradiators



- The Irradiator Accident at Nesvizh, Belarus – October 26, 1991
- Max ^{60}Co source strength: 30 PBq (Peta = 10^{15}) or 800 kCi.
- Accident source strength: 28.1PBq or 760kCi
- Original design: Peat
- During accident: Syringes and haemostatic sponges
- Operator irradiated for approximately 1 minute
- WB dose ~ 11 Gy
- Died day 113 post event

Industrial Irradiators

- The orange metal frame is the upper part of the shielding plug for the source rack
- Spaces at both sides of the frame allow the counter-weights to slide to slide down

Diagnostic Radiography

Almost Exclusively:

- High Dose Rate
- Very low exposure times
- X-rays (30-130 kVp)

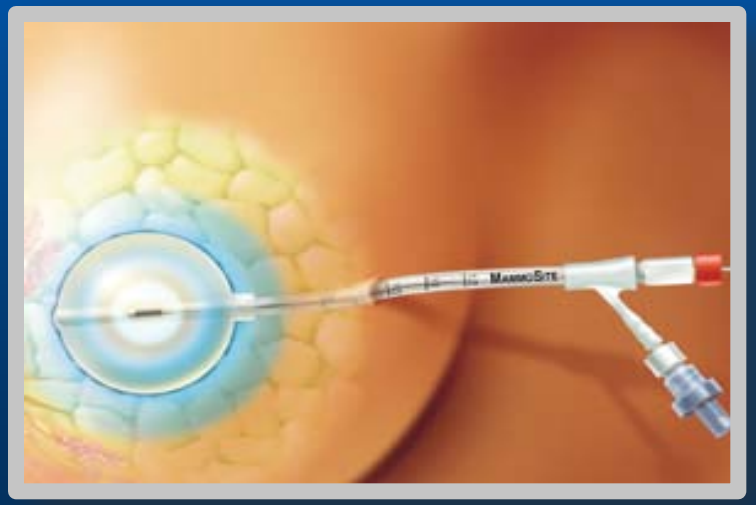
http://www.gehealthcare.com/usen/xr/radio/products/digital_xray/adv_apps/dualenergy.html

Brachytherapy

http://www.dramendola.com/Mammosite.htm

Common regimen:

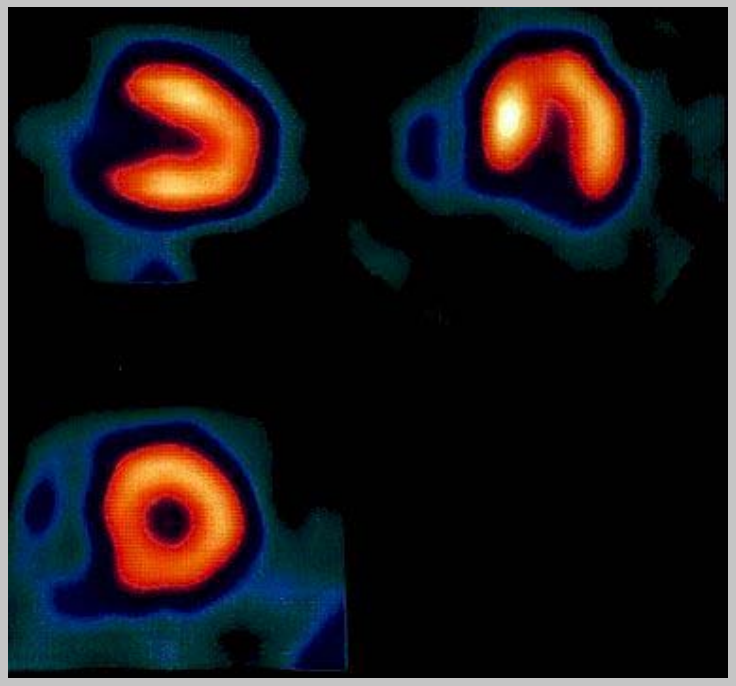
- ^{192}Ir (185-370 GBq/5-10 Ci) BID
- 5 days (6.8 Gy/680 rads per day)
- Total dose: 34 Gy/3400 rads



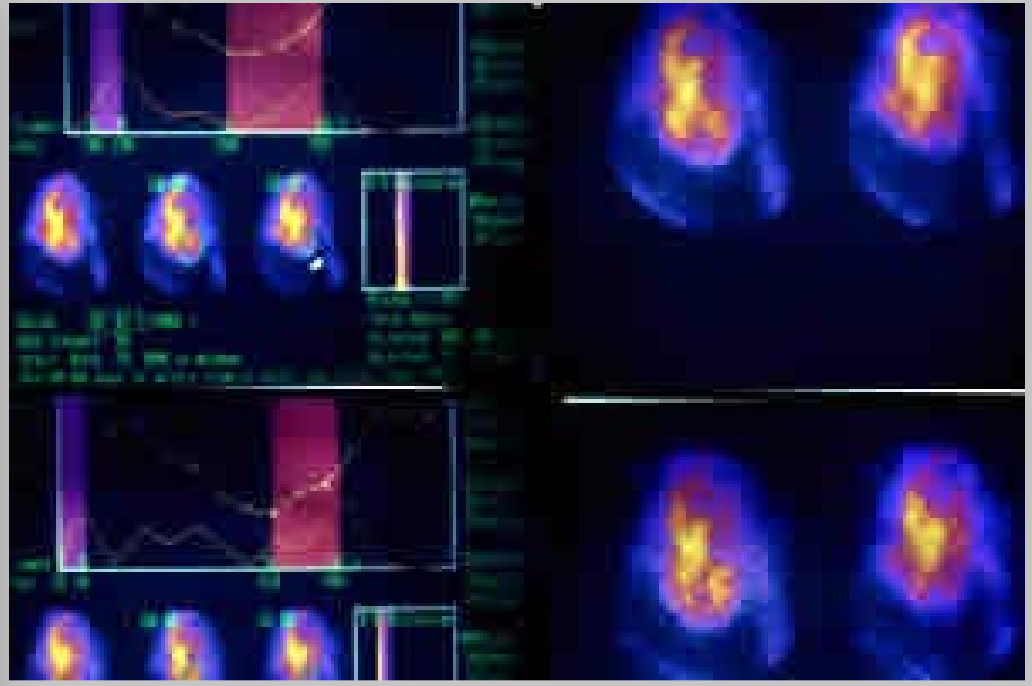
http://hsc.utoledo.edu/depts/radther/treatmentoption.html

Nuclear Medicine

Diagnostic/therapeutic uses of radiopharmaceuticals (^{99m}Tc, ^{201}Tl, $^{125, 131}I$, ^{18}F, etc.)

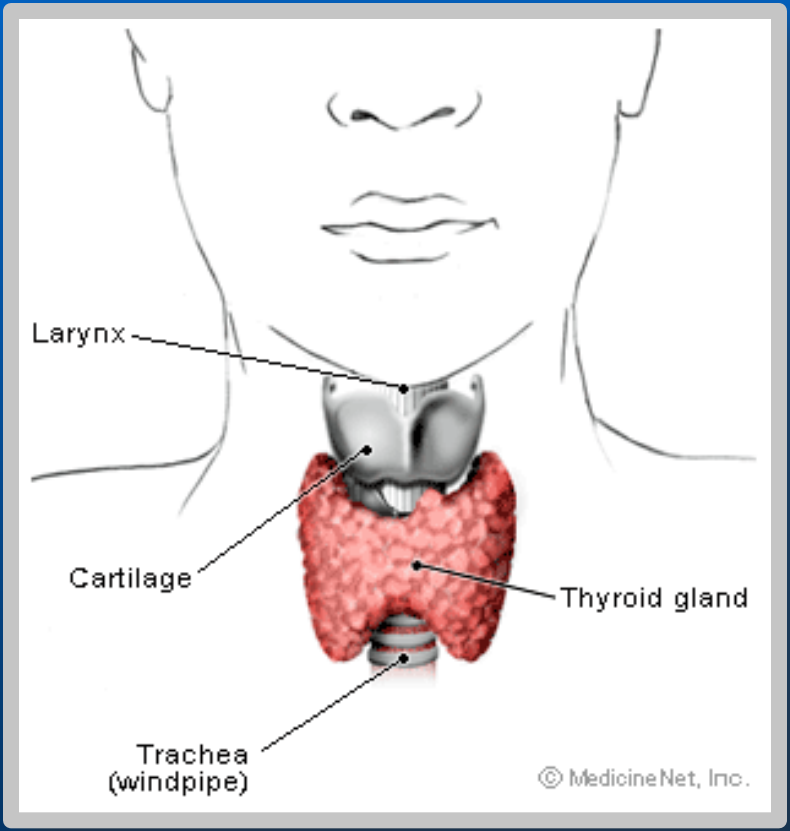


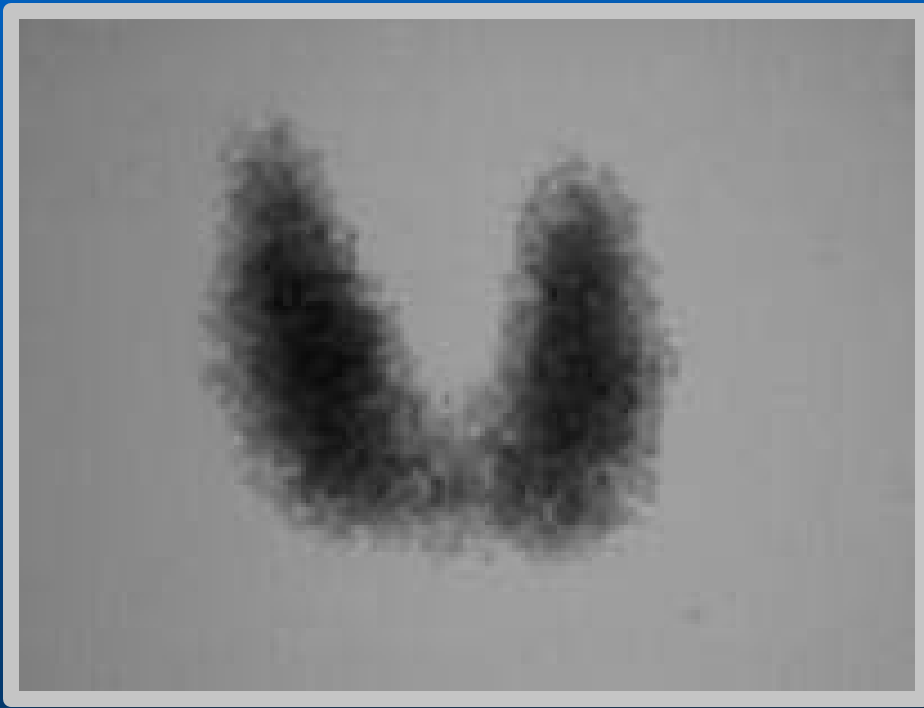
www.ucl.ac.uk



www.iaea.org/NewsCenter/News/2005/radiopharmaceuticals.html

Nuclear Medicine: Thyroid Scan

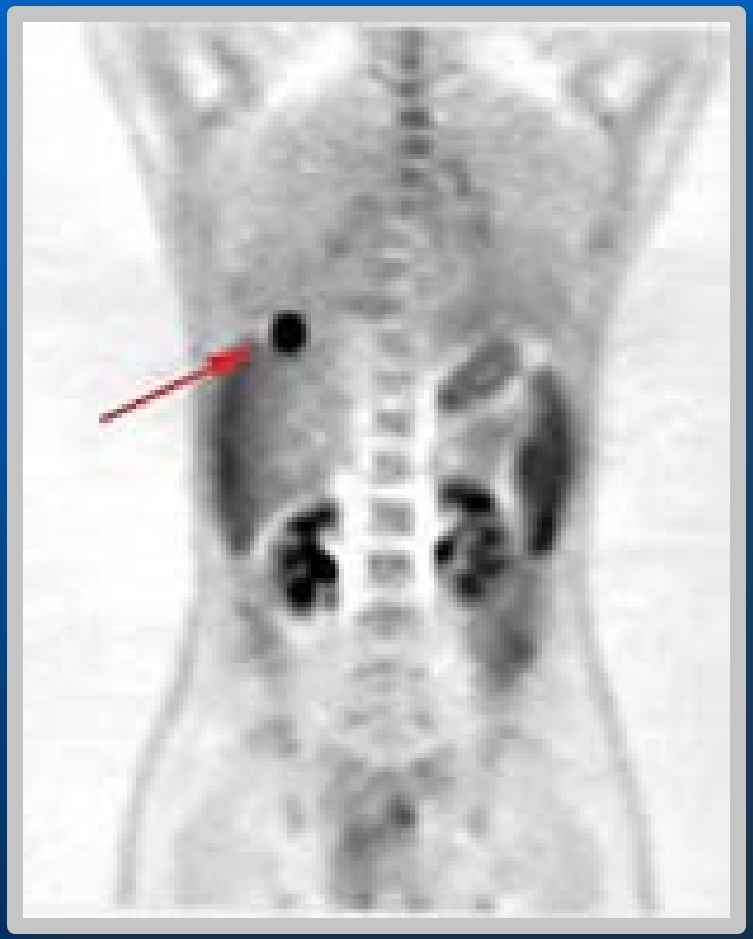




http://www.medicinenet.com/images/illustrations/thyroid_gland.gif

http://www.emedicine.com/radio/topic315.htm

Positron Emission Tomography (PET)



www.bocaradiology.com/Procedures/PET.html

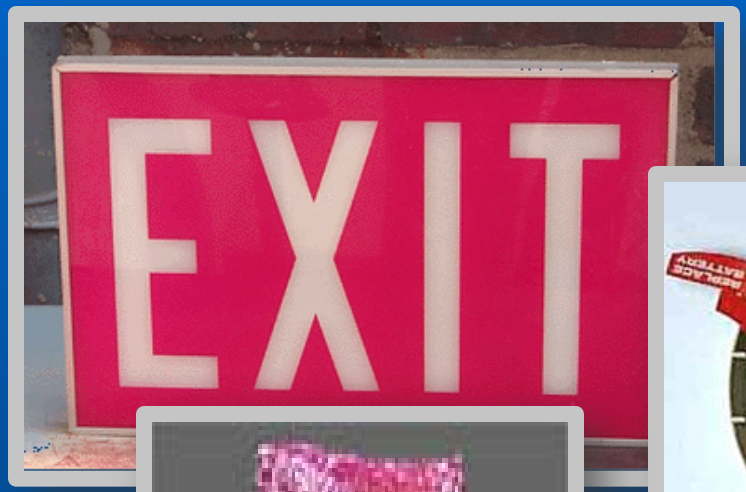
- Positron Emission Tomography (PET) provides physiological activity information not available from traditional imaging technologies, such as MRI, CT and ultrasonography, for anatomical imaging
- Image of the chest and abdomen reveals a solitary focus of cancer within the liver

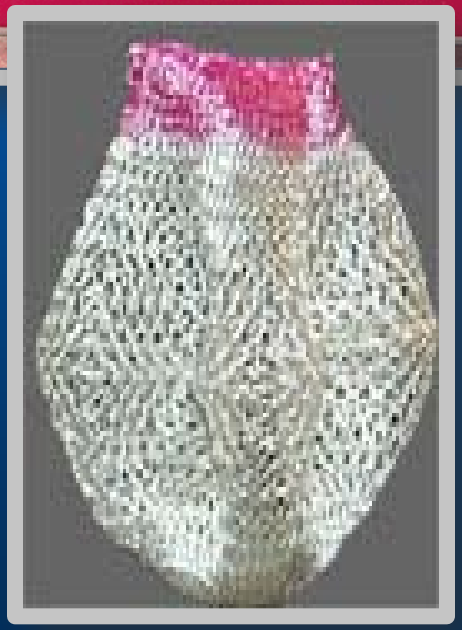
Blood Irradiation (Cs-137)

- Irradiation of blood & blood products by gamma rays to eliminate the risk of post transfusion graft versus host disease
- 500-3000+ Ci (18.5-111 TBq)
- 300-1600 Rads/min (3-16 Gy/min)
- 2500-3000 Rads (25-30 Gy) to the container contents

More info: http://www.nrc.gov/security/nas-facts-sheet.pdf

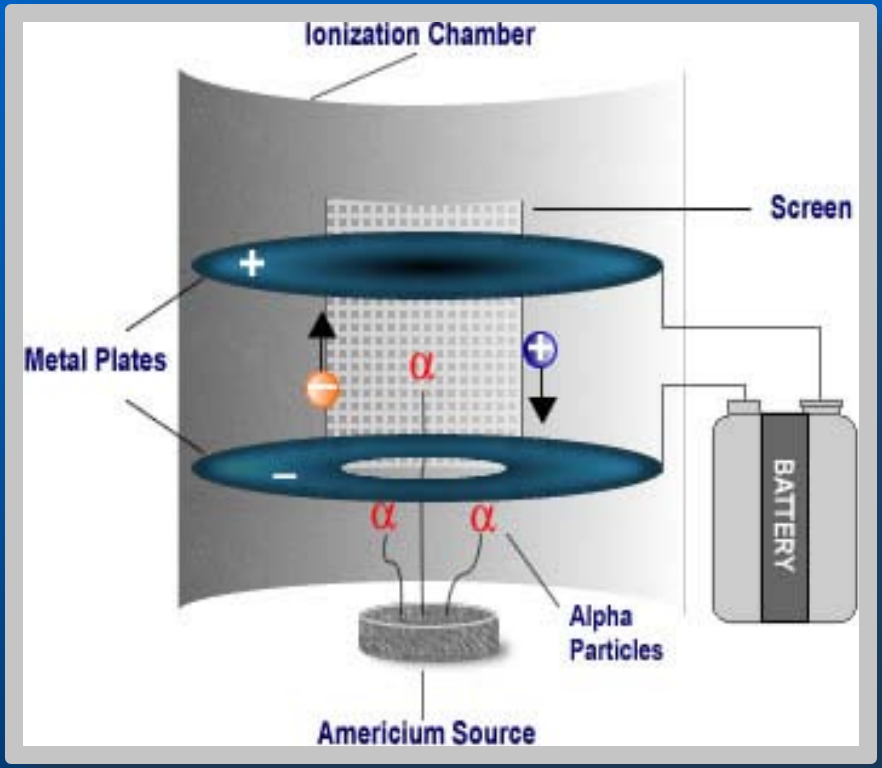
Consumer Products

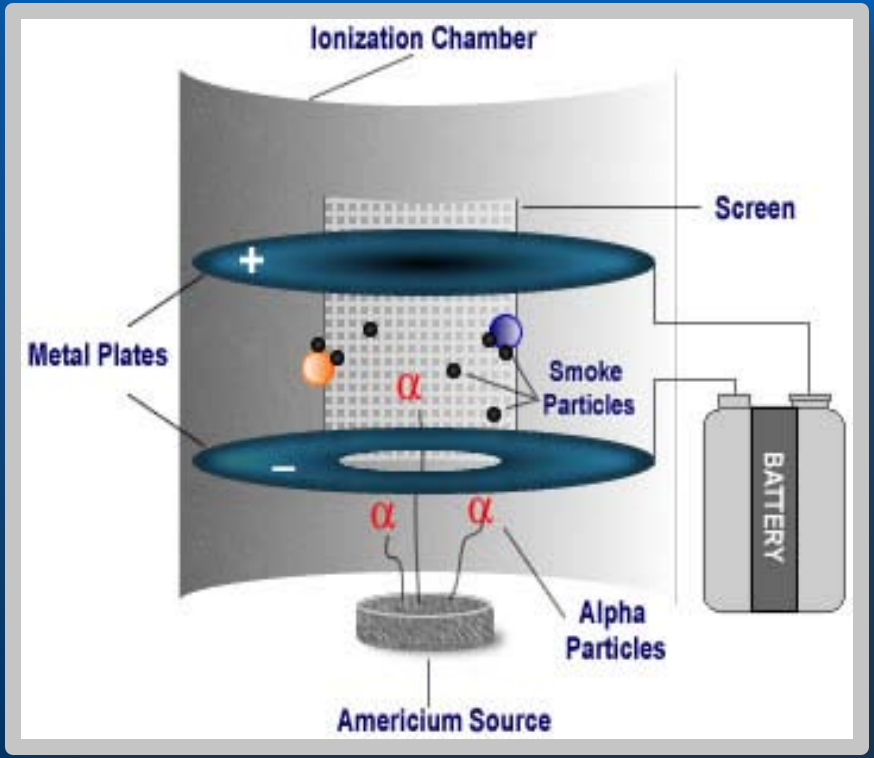




http://www.orau.org/ptp/collection/consumer%20products/consumer.htm

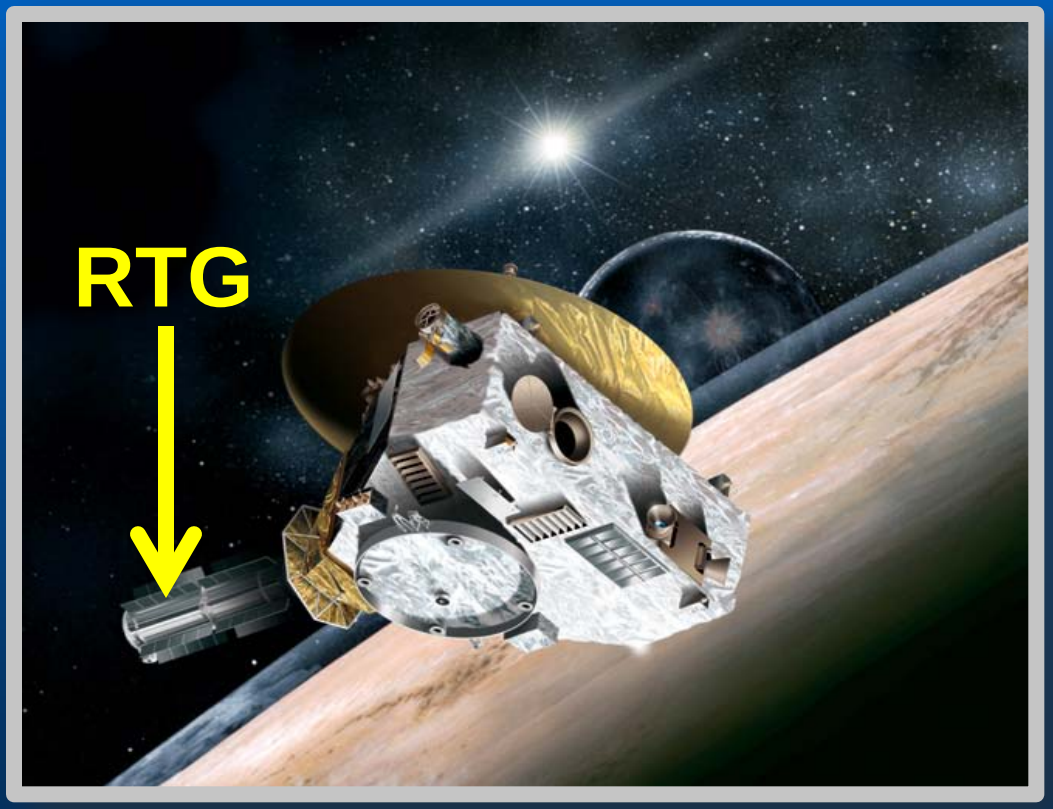
Smoke Detectors





- When smoke particulates enter the chamber, they disrupt the circuit causing the alarm to sound.

Radioisotope Thermal Generators
(^{90}Sr, ^{238}Pu)



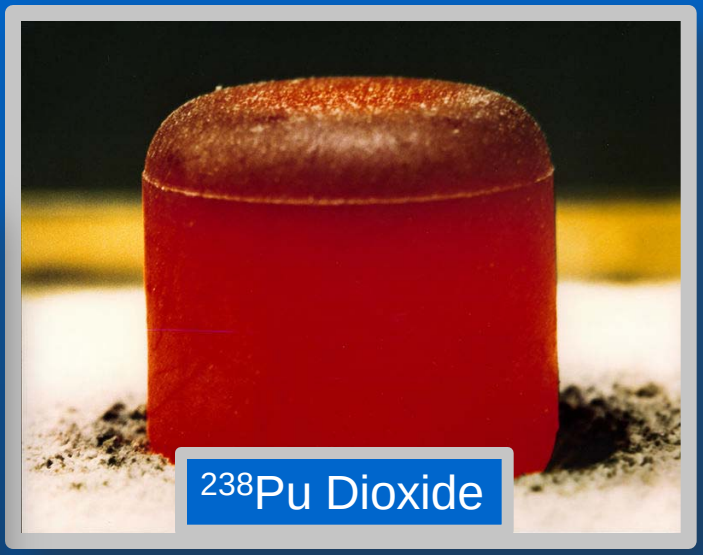
- NASA's New Horizons Deep Space Probe to Pluto
- Radioactive decay generates heat
- Heat energy is then converted to electrical energy

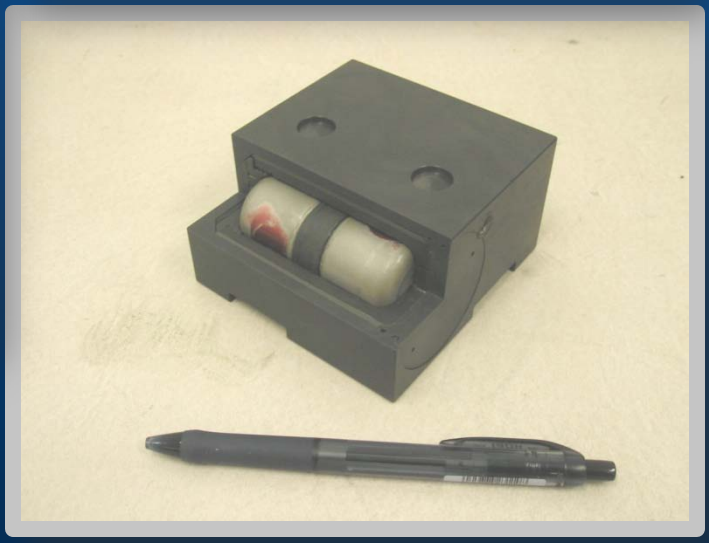
Radioisotope Thermal Generators

RTG Assembly

http://nuclear.inl.gov/spacenuclear/stern.shtml

http://en.wikipedia.org/wiki/Radioisotope_thermoelectric_generator





Radioisotope Thermal Generators

A radiothermal generator shielded and contained inside a typical assembly.

http://www.iaea.org/NewsCenter/Features/RadSources/radsrc_gallery/gallery_1/pages/016.shtml

RTGs that were used to power Soviet-era unmanned light houses

http://www.absoluteastronomy.com/topics/Radioisotope_thermoelectric_generator

What We Have Learned

- Common uses of radioactive materials and radiation generating devices in industry and medicine

Questions?