

Week 6 Lecture 1 – Industrial Radiation

Decay Processes

- Alpha Decay revisited
- Beta Decay revisited
- Decay chains
- Fermi function
- Half-lives, $\log ft$

Gamma Radiation

- Industrial Applications of Radiation
- beta thickness gauge
- gamma irradiators
- Internal Transitions revisited
- Nuclear Energy Levels

4th Homework
due Today

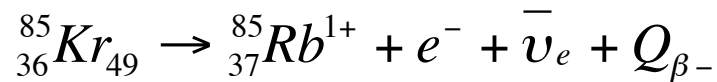


Beta particles can measure thickness

http://www.jasch.biz/mewd/products/plastic/plastic_main.htm

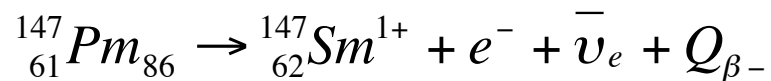
BASIS WEIGHT SENSOR

- * Beta Transmission Sensor
- * 200mCi Kr 85 Radioisotope (10-1000 g/m²) or
100 mCi Pm 147 (10-200 g/m²).



$$T_{1/2} = 10.8\text{yr} \quad 9/2+ \neq \pi(f_{5/2}^4) \nu(g_{7/2}^{-1})$$

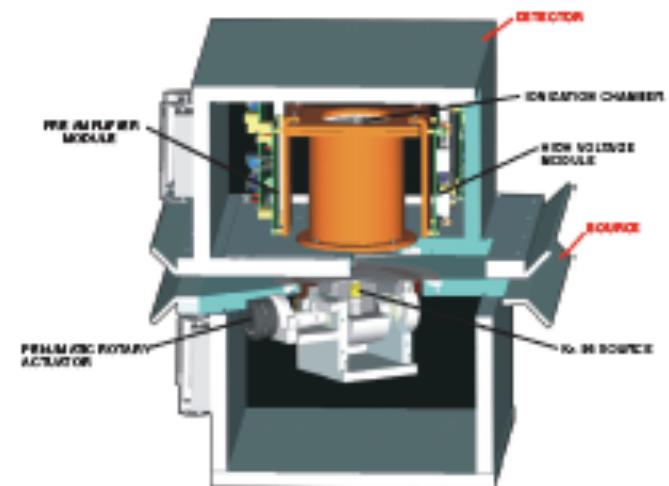
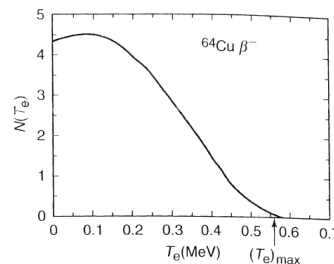
$$Q_{\beta-} = \Delta({}_{36}^{85}\text{Kr}) - \Delta({}_{37}^{85}\text{Rb}) = 0.687\text{MeV}$$



$$T_{1/2} = 2.6\text{yr} \quad 7/2+ \neq \pi(d_{5/2}^3) \nu(h_{9/2}^4)$$

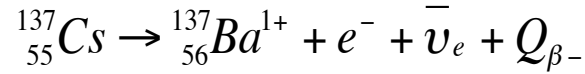
$$Q_{\beta-} = \Delta({}_{61}^{147}\text{Pm}) - \Delta({}_{62}^{147}\text{Sm}) = 0.224\text{MeV}$$

Recall the shape of the spectrum of beta particles.



Gamma rays can measure densities

Source: ^{137}Cs , up to 11 mCi

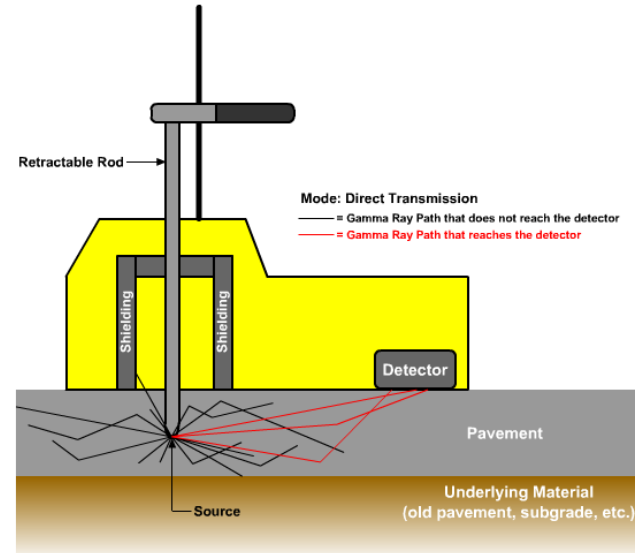
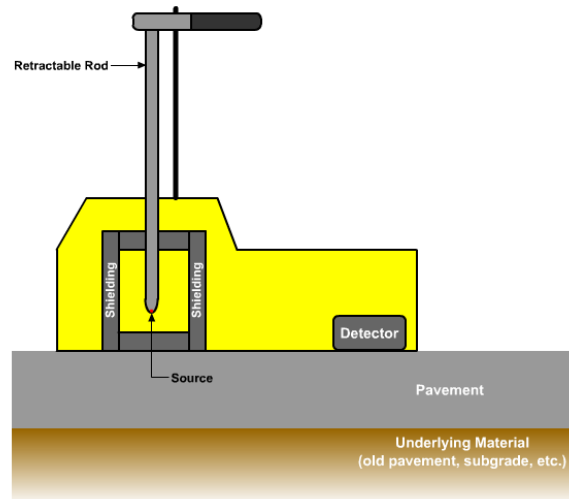
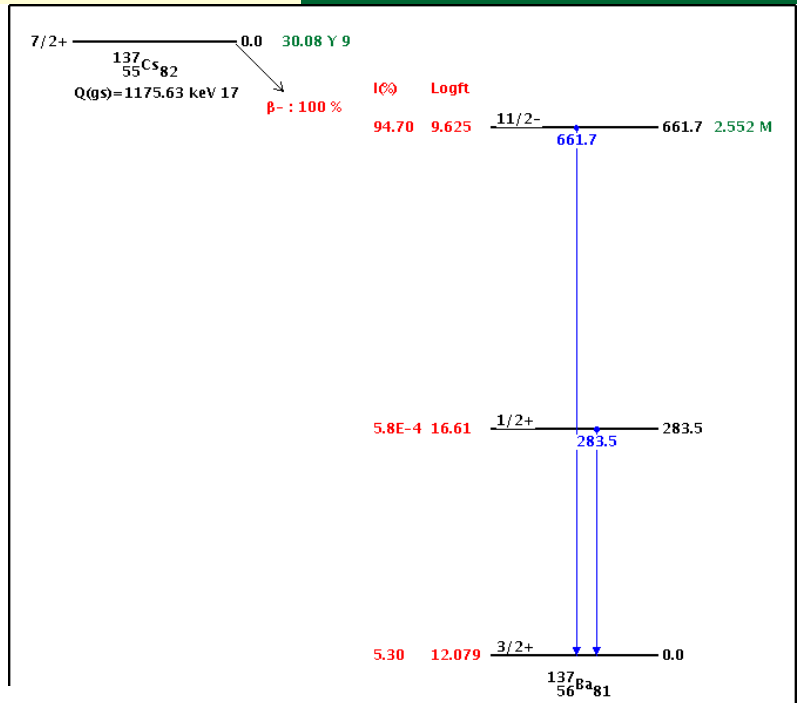


$$\pi(g_{7/2}^5) \quad 7/2 (l=4) +$$

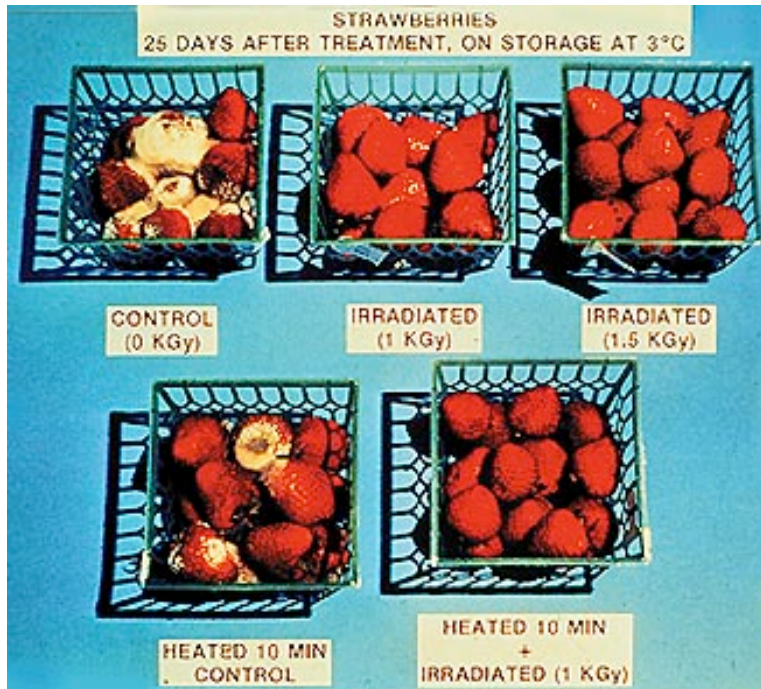
$$T_{1/2} = 30.2 \text{ yr}$$

$$Q_{\beta^-} = \Delta(^{137}\text{Cs}) - \Delta(^{137}\text{Ba})$$

$$Q_{\beta^-} = 1.176 \text{ MeV}$$



Sterilization of Food & Objects



MSU News Story:

“Food irradiation – which does not in any way render food radioactive – today uses gamma rays from radioactive material or machine-generated electron beams, Schoch said, both of which tend to cause cellular damage and visually degrade food. X-rays promise a gentler, more scalable solution. Rayfresh recently landed its first contract to build an X-ray machine to treat ground beef for Omaha Steaks, which inspected the prototype at MSU.” Peter Schoch, CEO, Rayfresh Foods Inc, Ann Arbor.



<http://uw-food-irradiation.egr.wisc.edu/Facts.html>

<http://news.msu.edu/story/5777/>



^{60}Co Irradiator Under water

Web Sez:

RADIATION SOURCE:

Cobalt-60;

1,000,000 curies per unit (Max);

half-life - 5.3 years;

POOL DIMENSIONS:

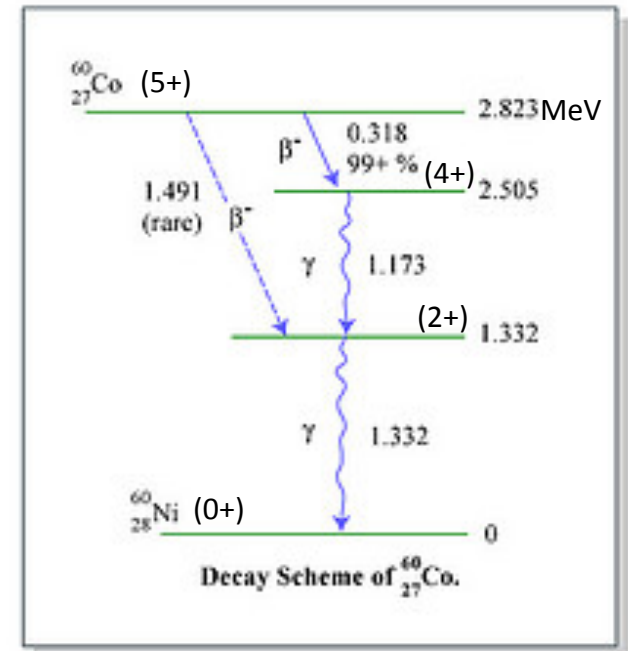
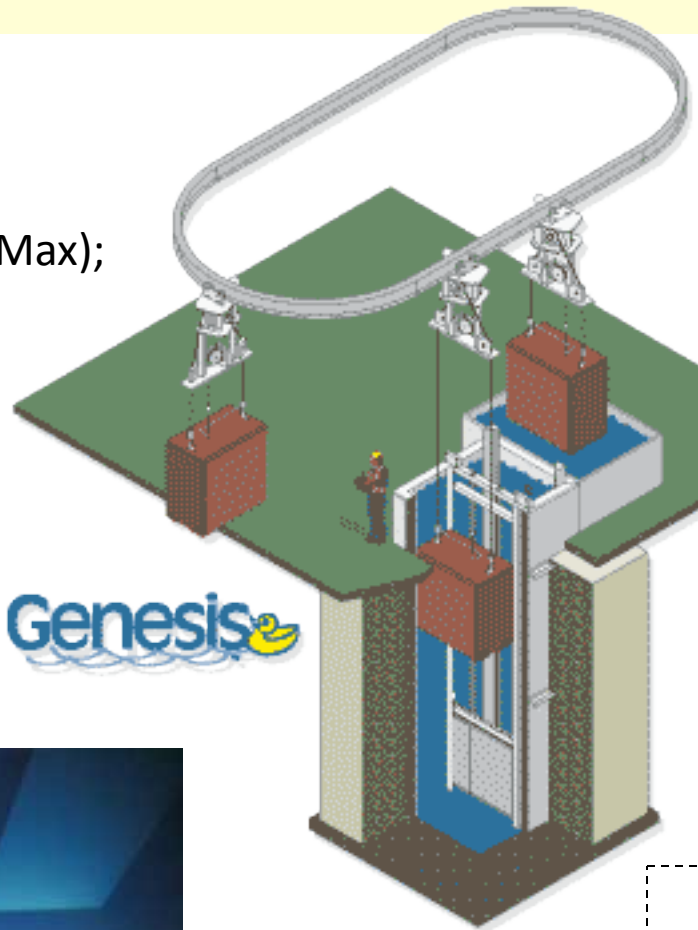
7' x 8' x 22'

(3.5' above ground).

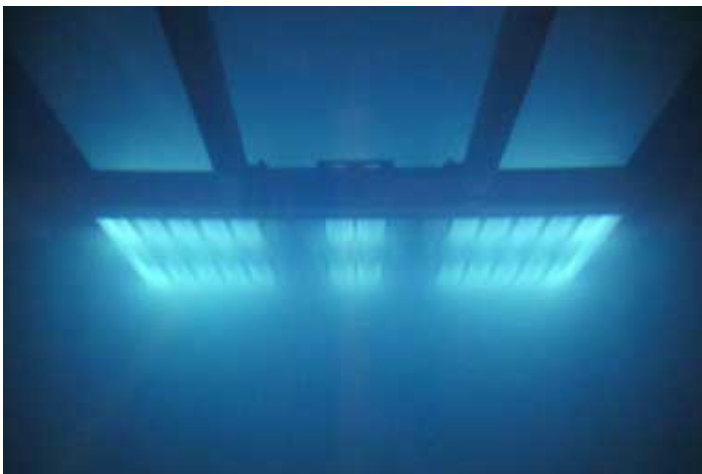
RADIATION SHIELD:

De-ionized water.

Minimum depth above
source is 12.5 feet.



Q: (review) What is the mass of ^{60}Co in this source?

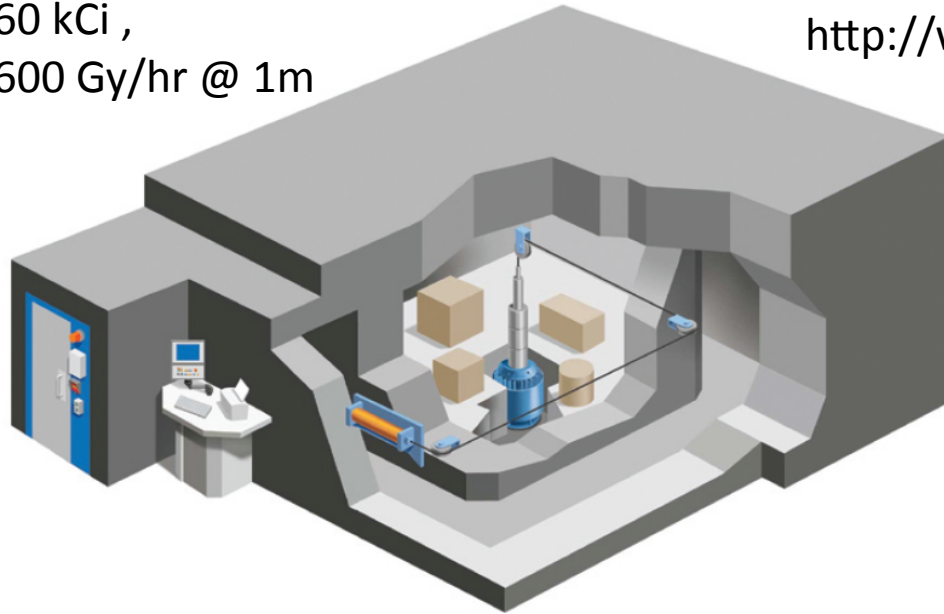


<http://graystarinc.com/genesis.html>

^{60}Co Irradiator in iron/concrete

60 kCi ,
600 Gy/hr @ 1m

<http://www.mds.nordion.com/index.asp#sterilization>



Water shield was 12 feet, metal shield appears to be much thinner (Q: Why ?)

Q: (review) What are the nucleon configurations in ^{60}Co and ^{60}Ni ?

