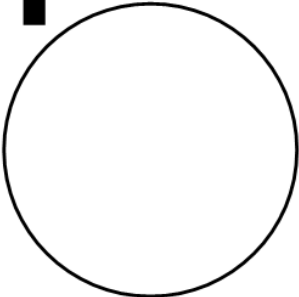





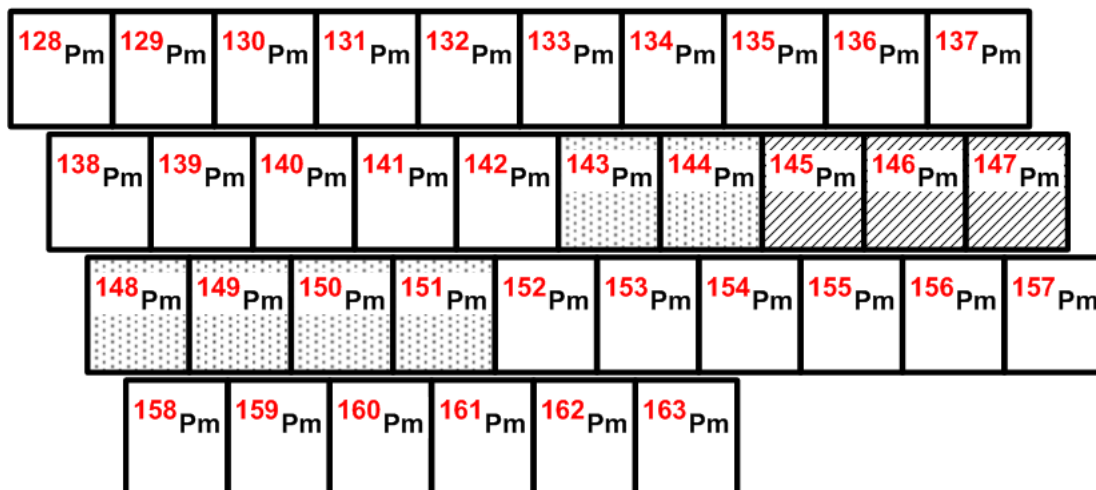
4.61 promethium

<p>promethium</p> <p>Pm</p> <p>61</p> 
--

Stable isotope	Relative atomic mass	Mole fraction
(none)		

Half-life of radioactive isotope

Less than 1 hour	
Between 1 hour and 1 year	
Greater than 1 year	



4.61.1 Promethium isotopes in industry

The beta-particle-emitting isotope ^{147}Pm (with a **half-life** of 958 days) is used in the nuclear fuel industry to measure the thickness of the inner surface layer of graphite in the cladding tube where the nuclear fuel rod is placed in a nuclear fuel reactor (Figure 4.61.1). The graphite serves as a protective layer against mechanical contact between the nuclear fuel rod and the Zircaloy cladding (fuel-rod holding tube) and as a diffusion barrier against **fission** products. By placing a layer of ^{147}Pm along the inner surface of the cladding before the graphite, the long **half-life** of ^{147}Pm and constant beta-particle emission provide a reliable and simple technique to measure the

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thickness of the graphite along the inner surface of the tube (called the beta-ray backscatter technique) [429-431].

The **beta decay** property of ^{147}Pm makes this **radioisotope** an ideal candidate for **nuclear batteries** (beta **voltaics**). Long-lived power supplies for remote and sometimes hostile environmental conditions are needed for space and sea missions, and nuclear batteries can uniquely serve this role. A nuclear battery using beta voltaics can have an energy density (quantity of energy per unit mass) near a thousand watt-hours per kilogram with 21 percent efficiency, which is much greater than the best chemical batteries [432].

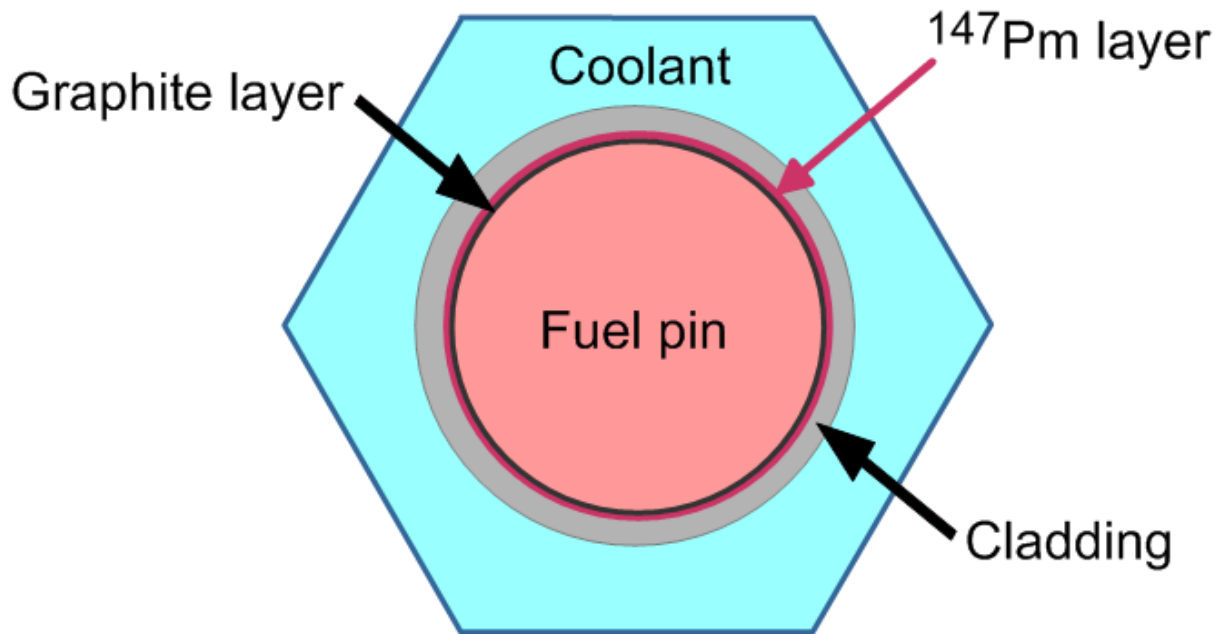


Fig. 4.61.1: The beta-ray backscatter technique requires a layer of ^{147}Pm between the cladding and the graphite layer to measure the thickness of the graphite along the inner surface of the cladding tube. (Modified from [305]).