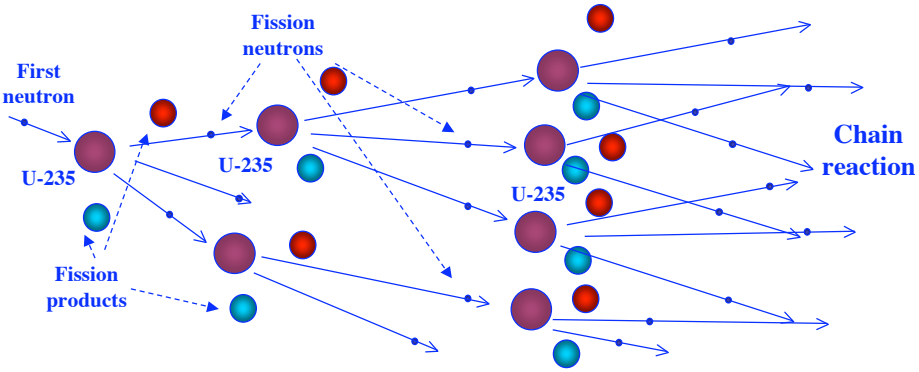
Fission and Nuclear Power Reactors

Each fission frees about 194 MeV of which about 190 MeV is absorbed in the reactor core and its immediate environment to produce heat.

The important characteristic of fission is that additional neutrons are released when fission takes place.
These fission neutrons can react with other nuclei and produce a *chain reaction*.

The chain reaction

The principle of the chain reaction is shown in the following diagram.



More about fission

Using fission to generate power.

Neutron-induced fission

The nuclear reactor uses neutron induced fission to generate thermal power.

This thermal power is converted into electrical power.

All of the energy comes from the positive Q value of the fission reaction.

In the case of ^{235}U(n,f) the Q value is 193.7 MeV

How is this energy distributed by the fission process?

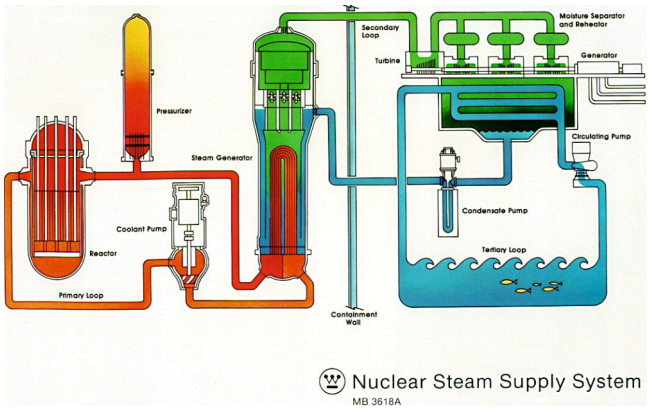
Energy from fission products

The following tables give a typical energy "budget" for all the energy released during the fission process. Remember the details will vary slightly depending on the fission products.

Instantaneous Energy from Fission	
Kinetic energy of fission products	167 MeV
Energy of fission neutrons	5 MeV
Gamma-ray energy	15 MeV
Total prompt energy	187 MeV

Delayed Energy from the Fission Product Decay Chain	
Kinetic energy of beta particles	7 MeV
Gamma-rays following beta decay	6 MeV
Neutrinos (these escape)	10 MeV
Total delayed energy	23 MeV

Pressurised water reactor (PWR) in a bit more detail



Energy released in fission

Exercise 30

1. **What mass of ^{235}U must be fissioned to give a one day (24 hr) supply of electricity at the rate of 1000 MWe (Megawatts electrical)? Assume that the conversion efficiency of the reactor is 33%.**