On RTG Design Hoppe, Sheneman 2015

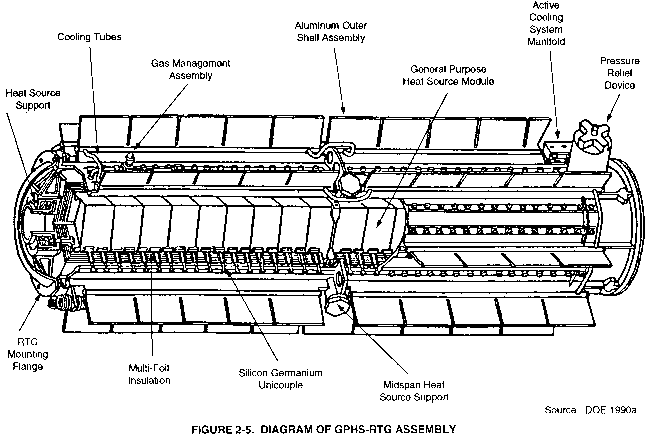
# The Issue

Currently, NASA uses what’s known as the MMRTG (Multi-Mission RTG) to power deep-space missions. These are designed to fit the parameters of multiple missions, which, in a world where it costs over $22,000 to put a kilogram of material into orbit, is simply not cost efficient. Especially when the material we’re putting into orbit is an extremely rare isotope of plutonium that has been almost entirely consumed by previous missions.

# Our Question

How little plutonium can we use for a given power and mission length?

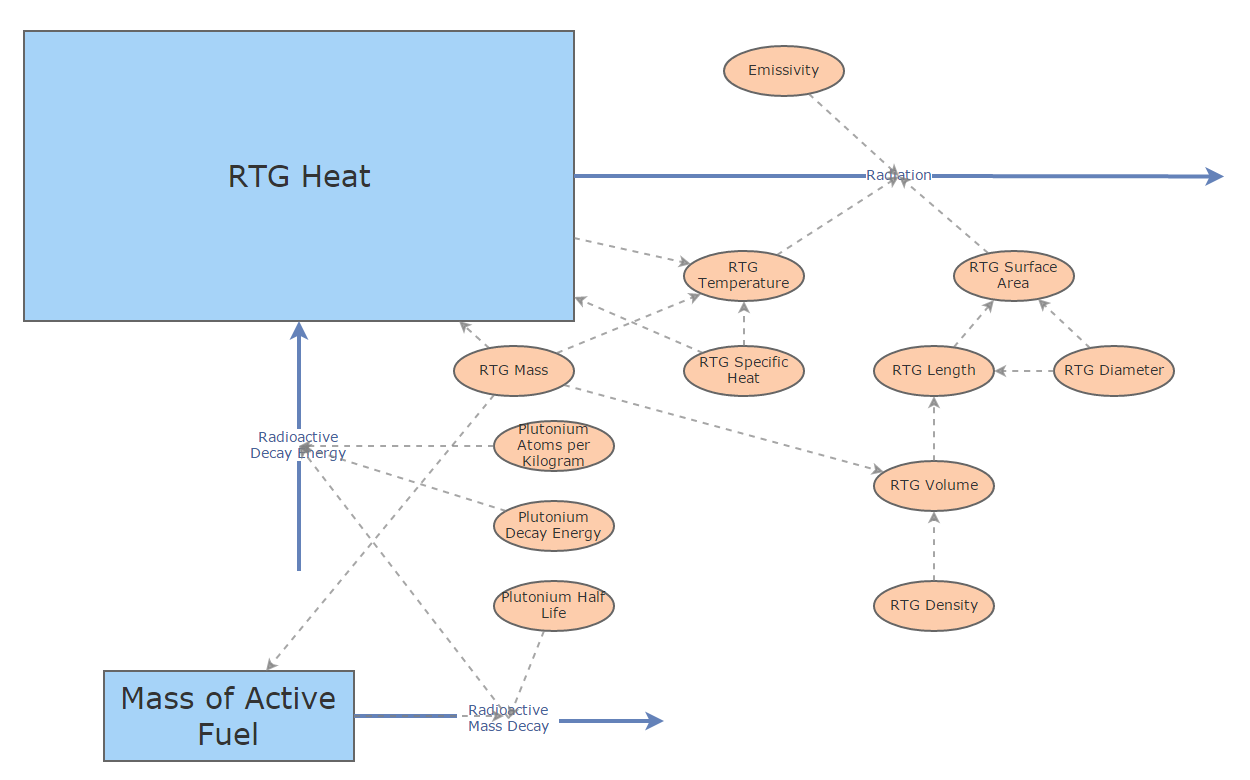
# The System



This is an RTG. It generates power by conducting heat generated by radioactive decay of plutonium across thermocouples.

# Our Model

The following is our abstraction of the system. Since all of the heat flows out of the system by radiation or electricity, and we know that about 6% of the heat is captured, we’ve used a one-stock model for the hot fuel core.



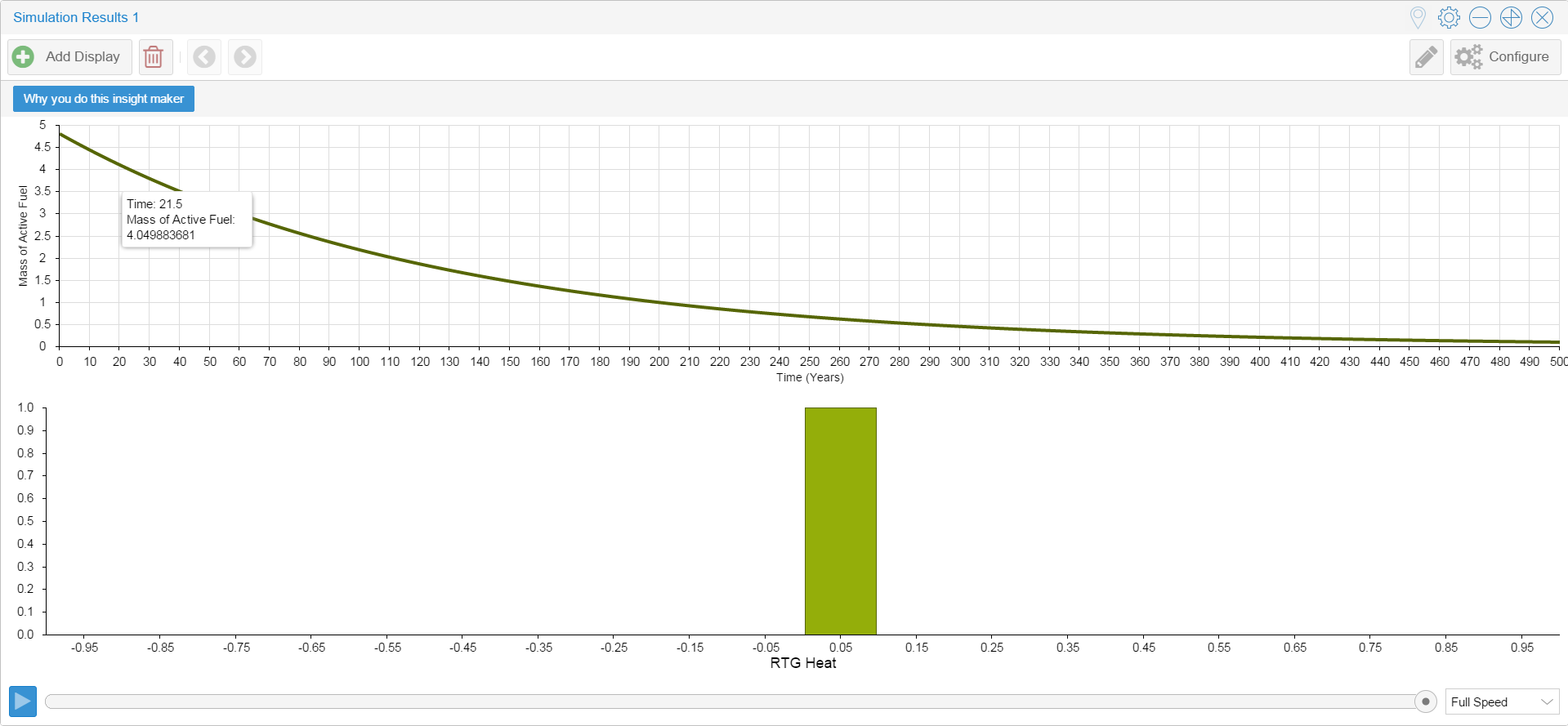
Our stock and flow model. [[1]](#footnote-1)

# Our Equations

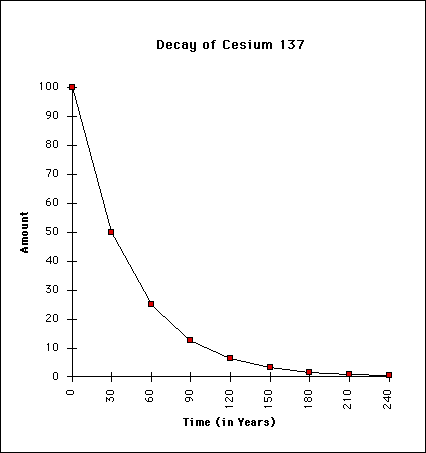
# Our Plan

Unfortunately, we are still in the process of implementing this model in MATLAB. It is not cooperating, to say the least. However, we hope to create graphics like those on the following pages to work towards our design question.

# Our Sweet Graphics



This is the kind of junk Insight Maker is troubling us with right now.



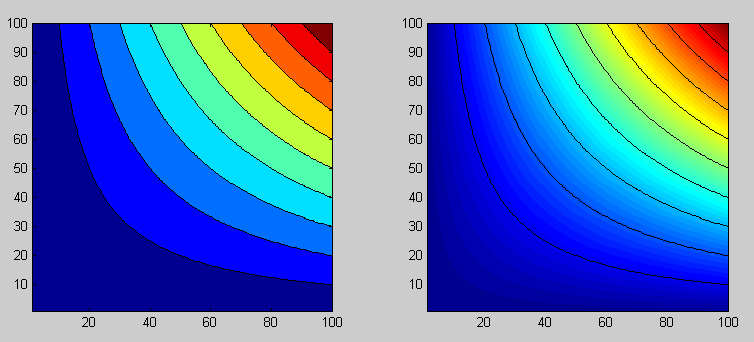
Power Output (We)

Power Output (We)

Power Output over Time, 4.8 kg 238PU

This figure would ideally show the model’s output power compared to the specified minimum power threshold (in blue).

RTG Mass Relationship

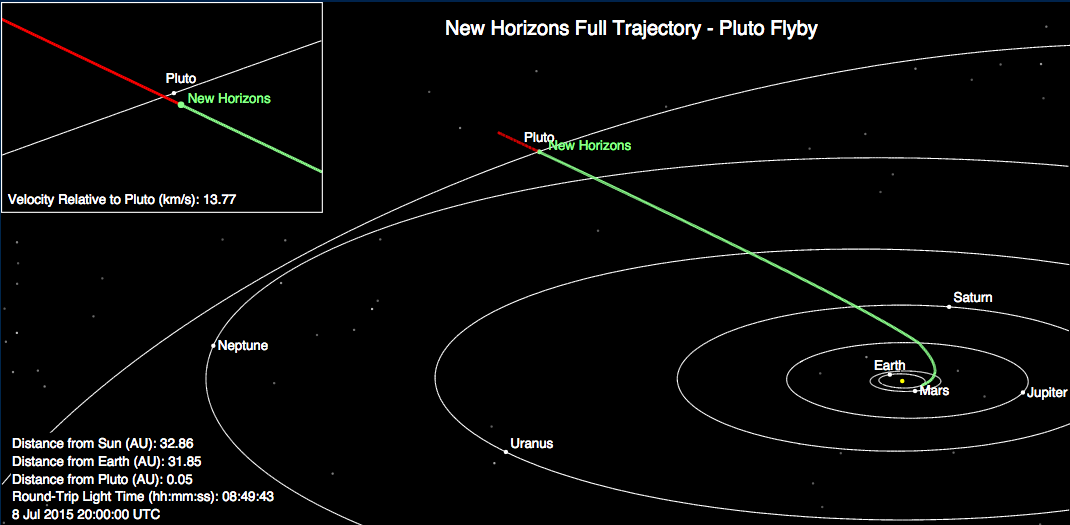


Mission Length (Years)

Power Requirement

This figure would show how the required power threshold and the required mission length affect the mass of plutonium necessary for that mission.

# Applications

To round out the design part of our project, we plan on having possible mission specs laid out and the RTG design that would be required as per our model. 

Yay cool space graphics!

1. NB: electricity flow is not shown (it broke Insight Maker). It will be calculated as 6% of the heat outflow. [↑](#footnote-ref-1)