

Example of Current RTG
General Purpose
Heat Source (GPHS)

***Mission: Study Jupiter and its 4
Moons.***

Requirement for RTG:

***Need 580 Watts of Power at BOL
and at least 500 Watts at EOL. Mission
duration, 4.2 years.(40,000 hrs)***

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Figure of Galileo Space Craft

**Note: 2 RTG's Each with 284 We at BOL,
255 We at EOL**

Figure of RTG

Figure of Heat Source/Unicouple

Table of Parameters

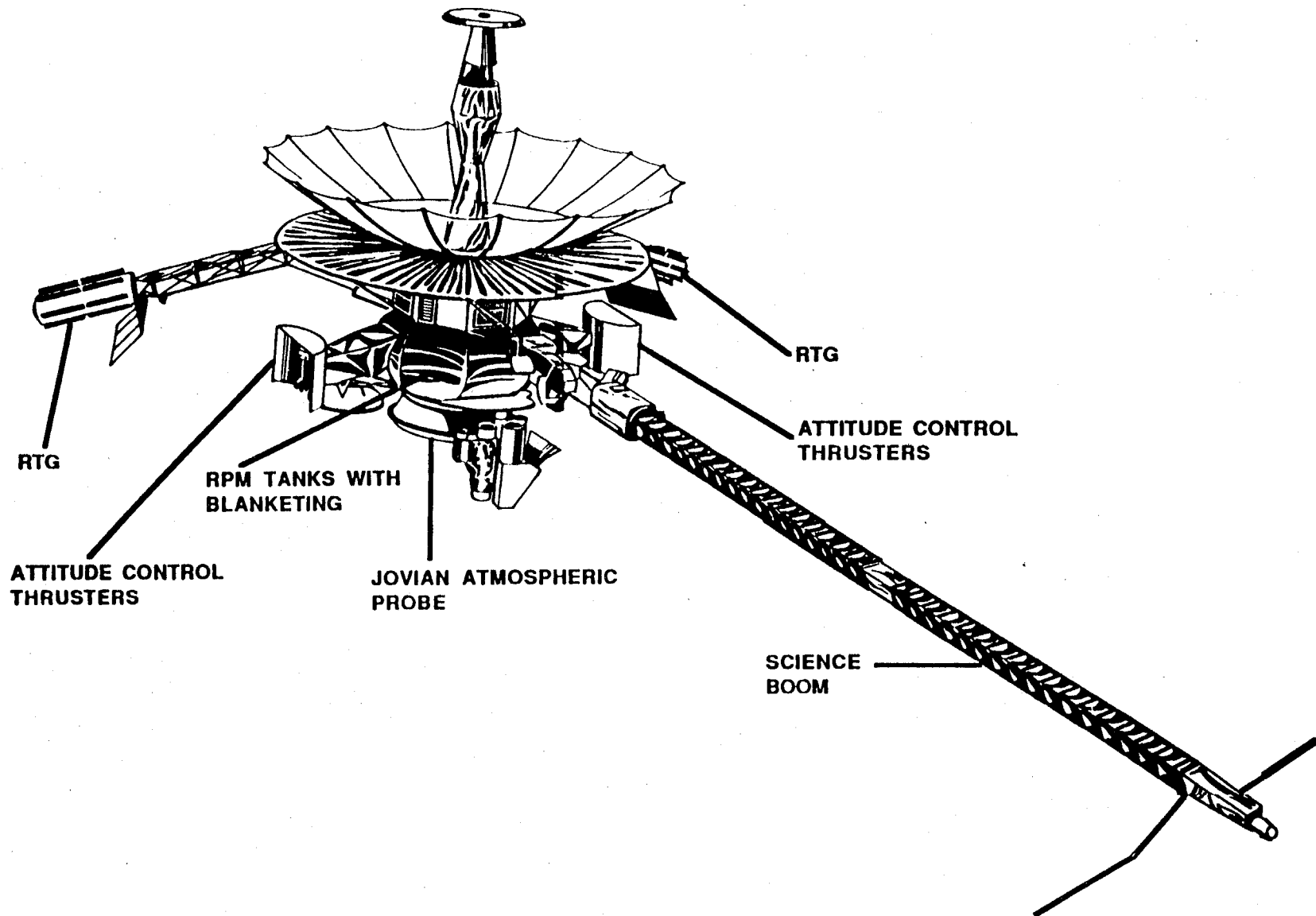
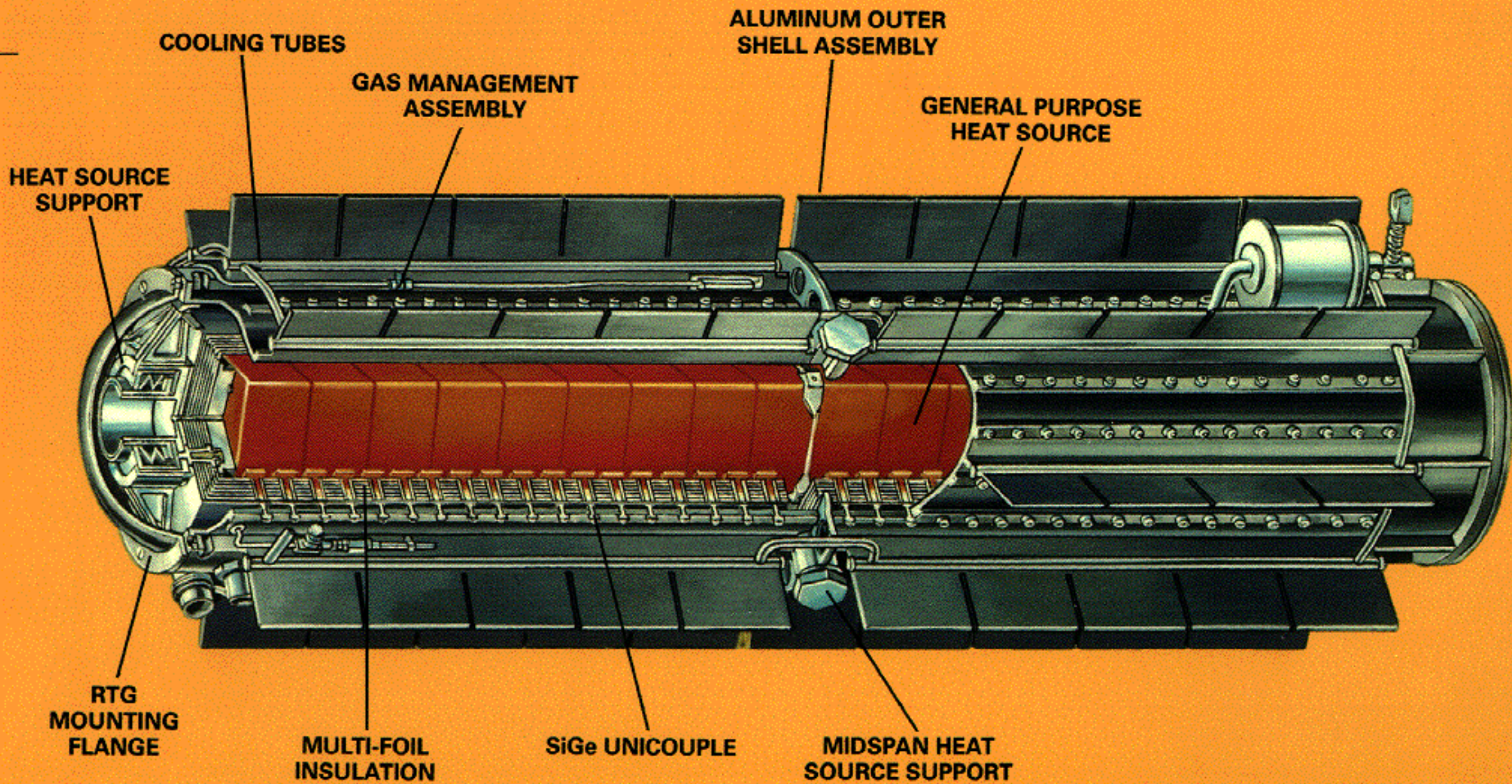


FIGURE 2-2. DIAGRAM OF GALILEO ORBITER



General Purpose Heat Source – RTG

Courtesy General Electric

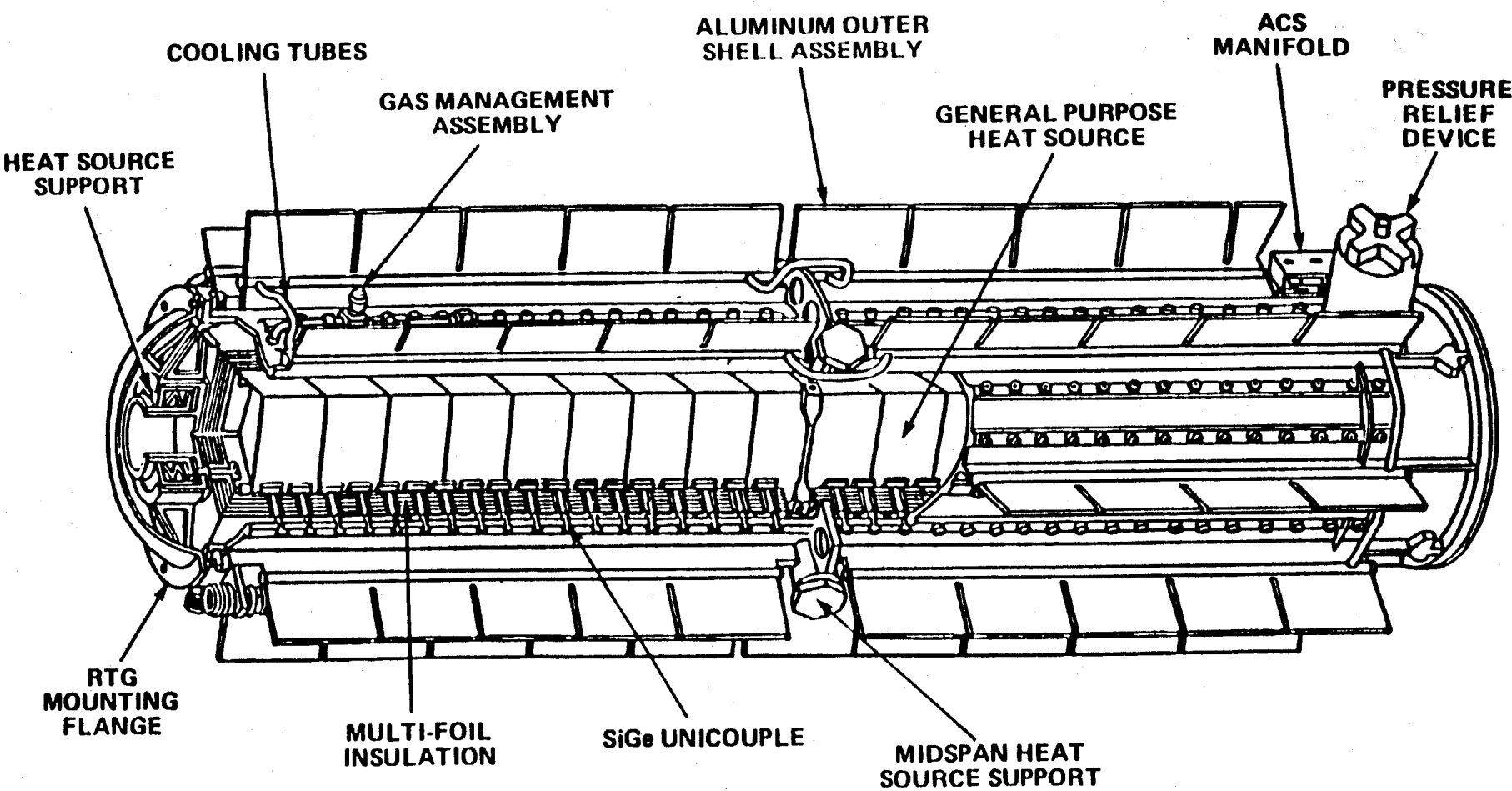
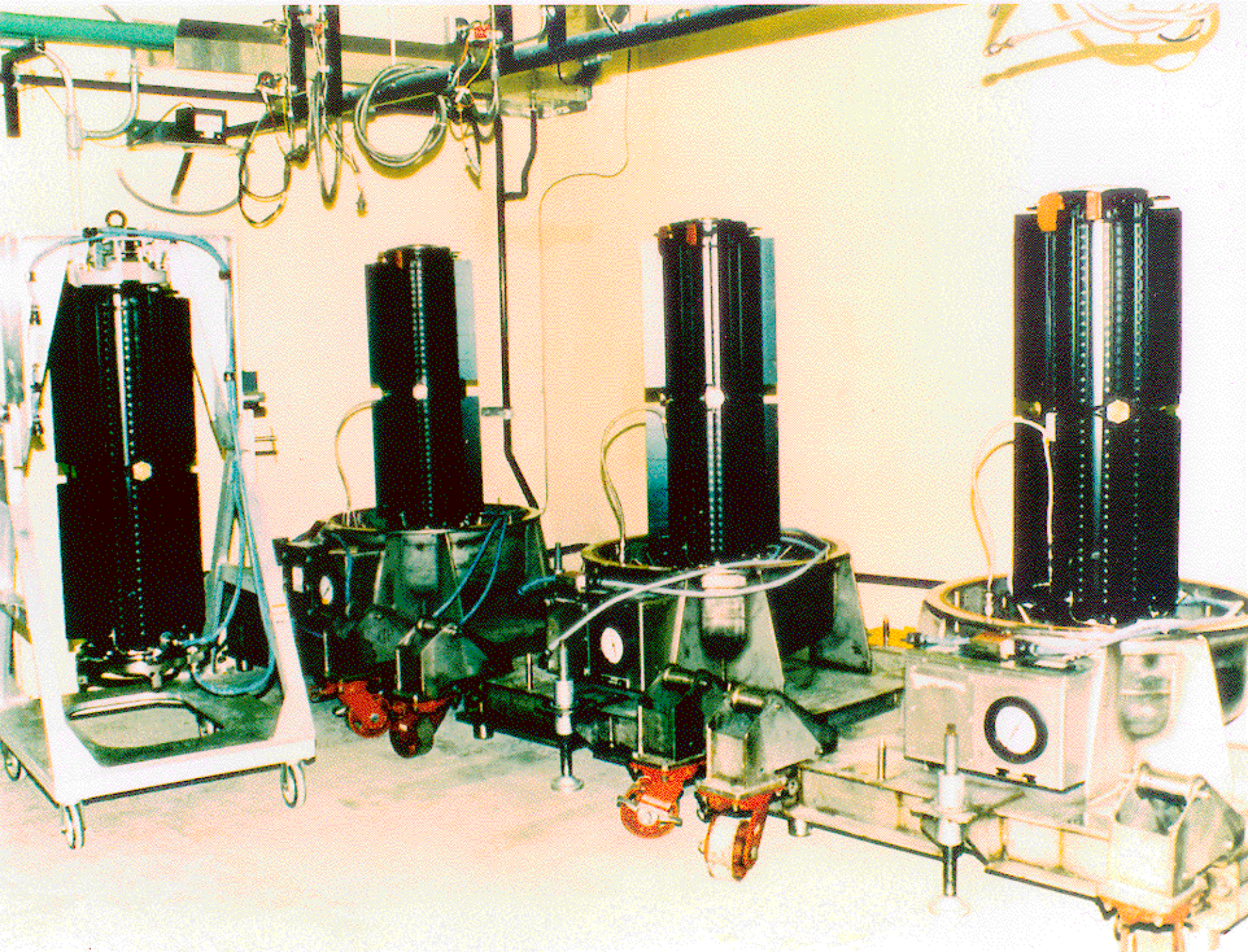


FIGURE 2-4. DIAGRAM OF RTG ASSEMBLY



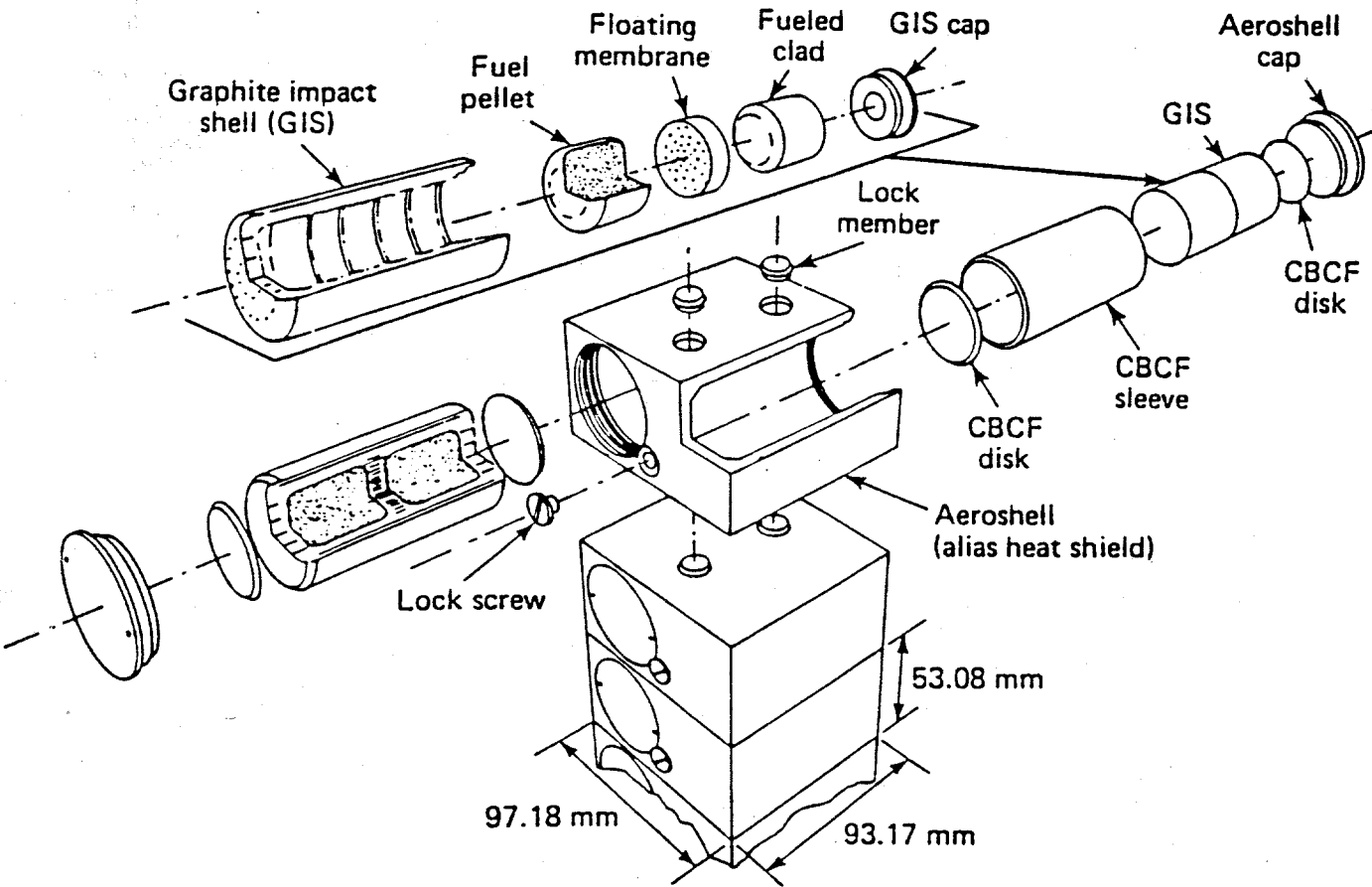


FIGURE 2-5. DIAGRAM OF GENERAL PURPOSE HEAT SOURCE RTG MODULE

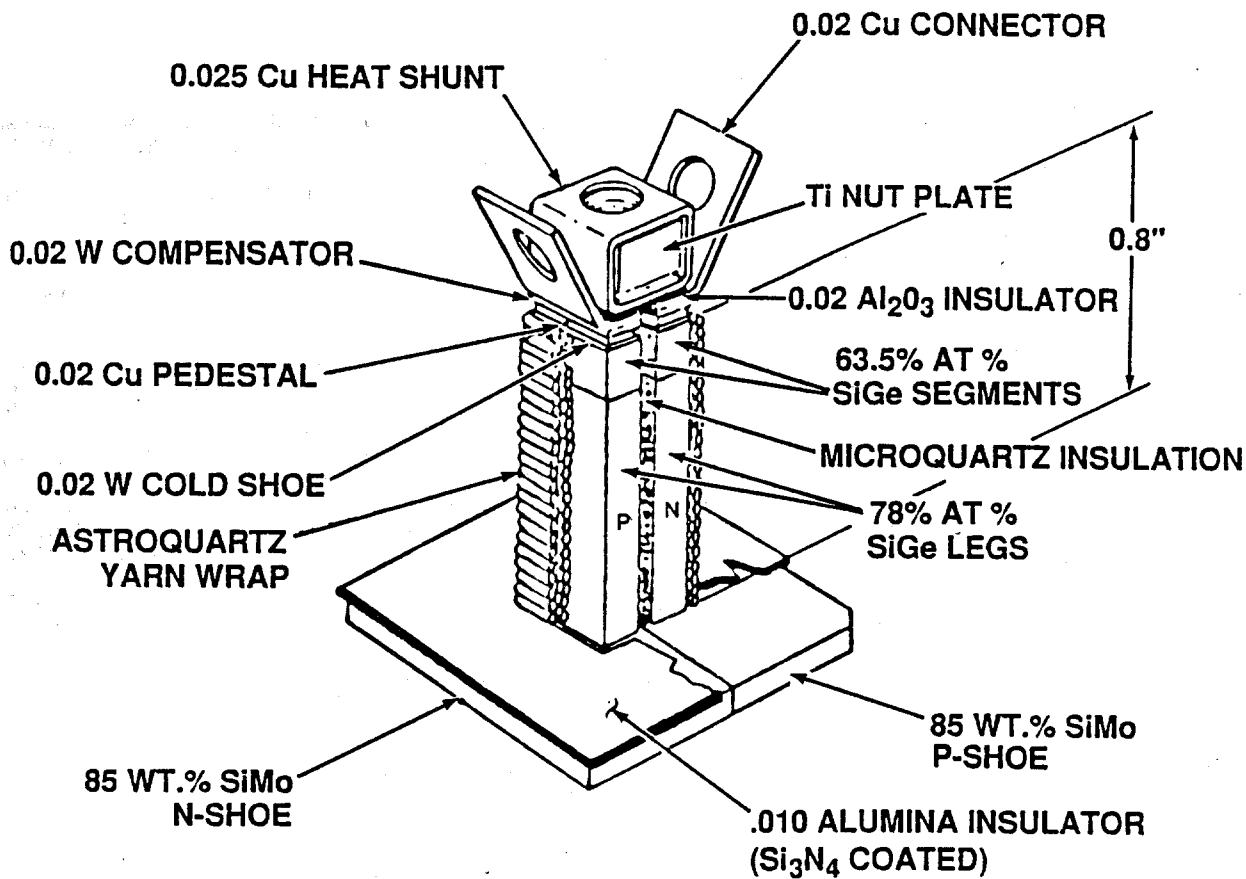
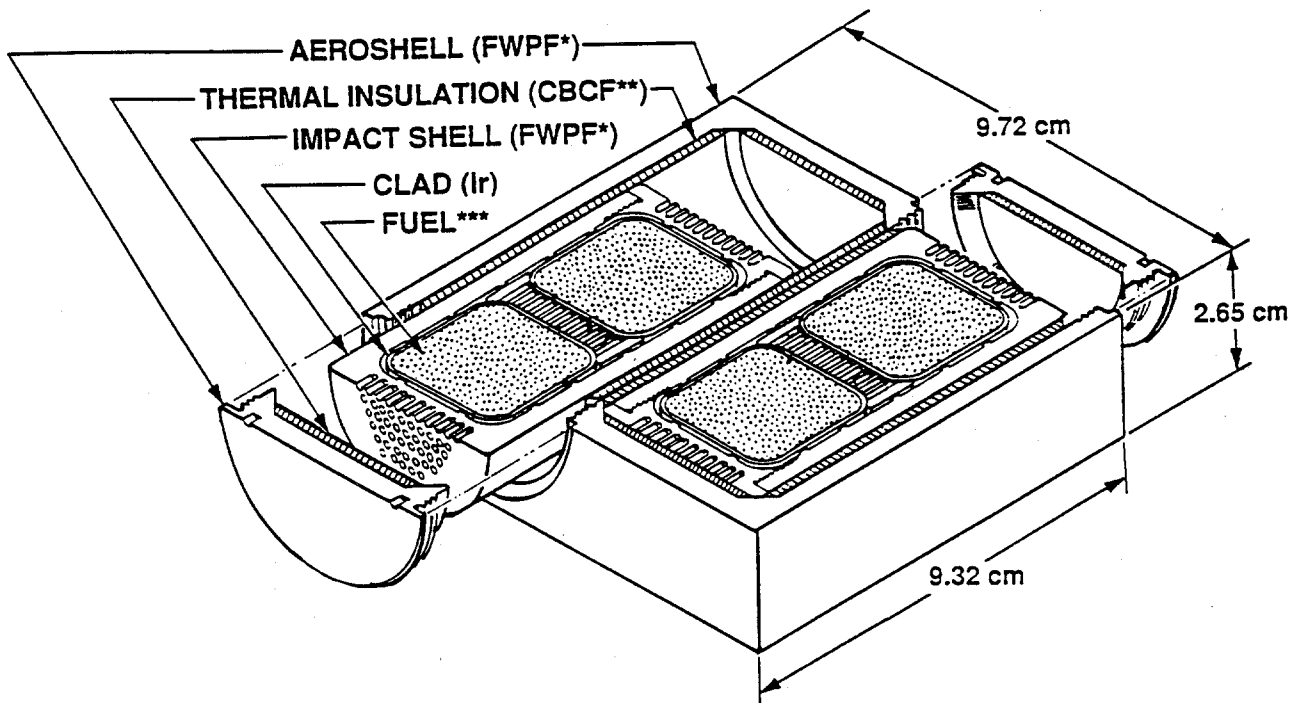


FIGURE 3. Unicouple



- *Fine-Weave Pierced Fabric, a 90%-dense 3D carbon-carbon composite
- **Carbon-Bonded Carbon Fibers, a 10%-dense high-temperature insulator
- ***62.5-watt $^{238}\text{PuO}_2$ pellet

FIGURE 2. General-Purpose Heat Source Module (250 Watt)

GPHS-RTG Performance Data

Per unit

Power Output-W_e	290 BOL 250 EOL
Operational Life-Hrs	40,000 after launch
Weight-kg	55.5
Output Voltage	28(\pm0.5)
Dimensions-cm	42.2 diam 114 long
Hot Junction Temp-$^{\circ}$K	1270
Cold Junction Tempo-$^{\circ}$K	566
Fuel	PuO₂ (83.9% Pu-238)
Thermoelectric Material	SiGe
Mass of Pu-238-g	7,561

Isotopic Concentration of RTG Fuel

<u>Pu Isotope</u>	<u>Wt%</u>	<u>t_{1/2} (y)</u>	<u>Ci/g</u>	<u>Tot Ci</u>
236	<10 ⁻⁶	2.85	532	<1
238	83.88	87.7	17.1	130,050
239	13.49	24,100	0.0621	80.2
240	1.9	6,560	0.227	41.3
241	0.379	14.4	103.2	2,650
242	0.124	376,000	0.00393	<1
other TRU	0.228			3.3
<u>Totals</u>	<u>100.0</u>			<u>132,825</u>

Cassini Electrical Power Requirements

"600-700 watts at Saturn (1.6 billion km from the Sun) for 11 years"

Possible Solutions

Radioisotope Thermoelectric Generators (RTG's)

Solar Panels

Mass

168 kg

1,337 kg (598 m²)

Advantages

- **small size
(1.13 m long, 0.43 m diam.)**
- **no moving parts**
- **easy maneuverability**

- **no nuclear material**

Disadvantages

- **public perception**

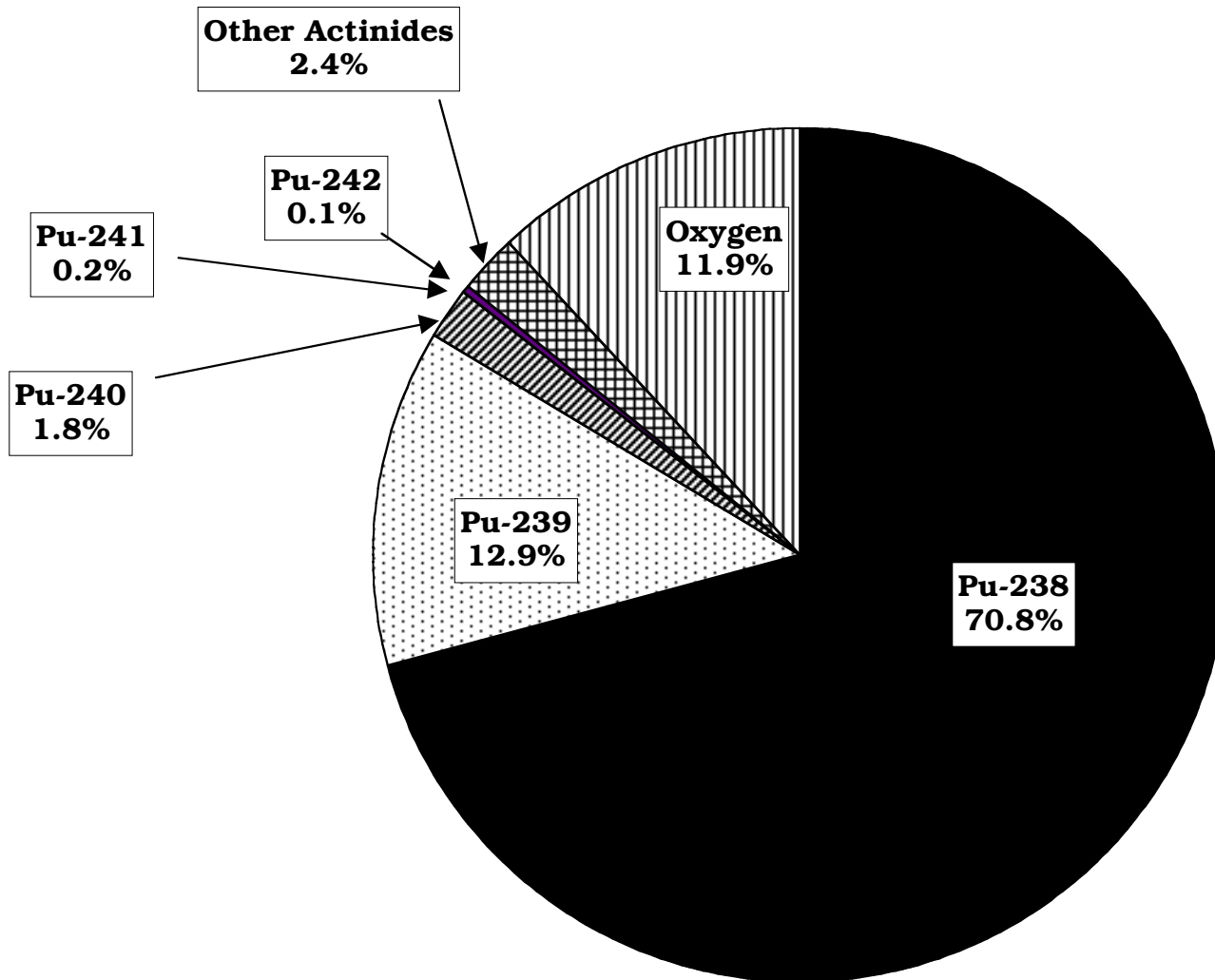
- **No rocket available**

- **slow maneuverability**
- **higher risk of failure**

Cassini RTG Performance Characteristics

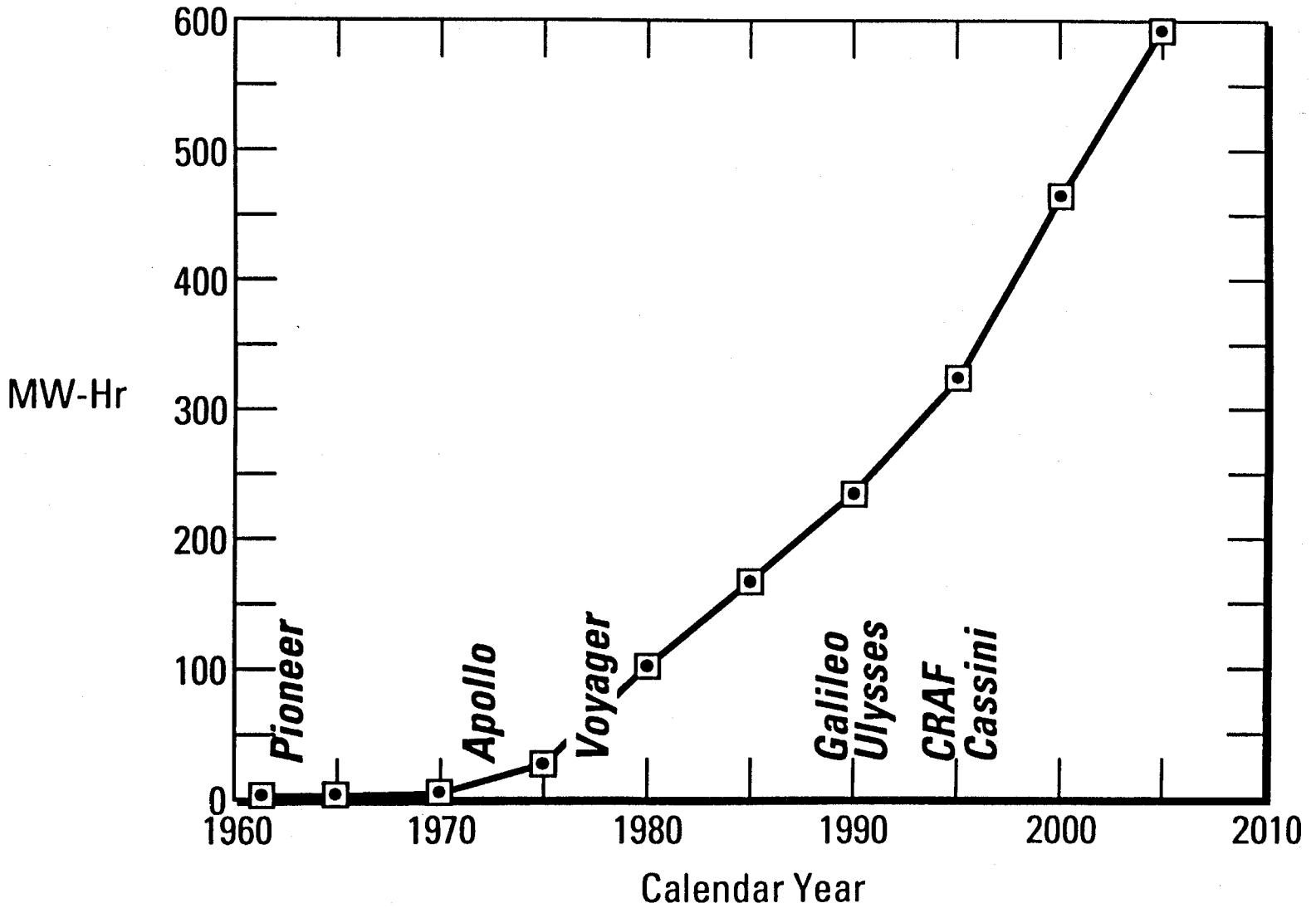
# of RTG's	3
Mass/RTG	56 kg (168 kg total)
Total Power @ BOL	888 watts
Total Power @ EOL	628 watts
BOL Thermal Power	13,182 watts
Conversion Efficiency	6.7 %
Mass of PuO₂/RTG	10.9 kg (32.7 kg total)
Mass of Pu/RTG	9.71 kg (28.8 kg total)
Mass of ²³⁸Pu/RTG	7.72 kg (23.2 kg total) (21 % of ²³⁸Pu already launched)

Cassini Fuel Composition-Wt % at Launch





RTG Cumulative Megawatt-Hrs In Space



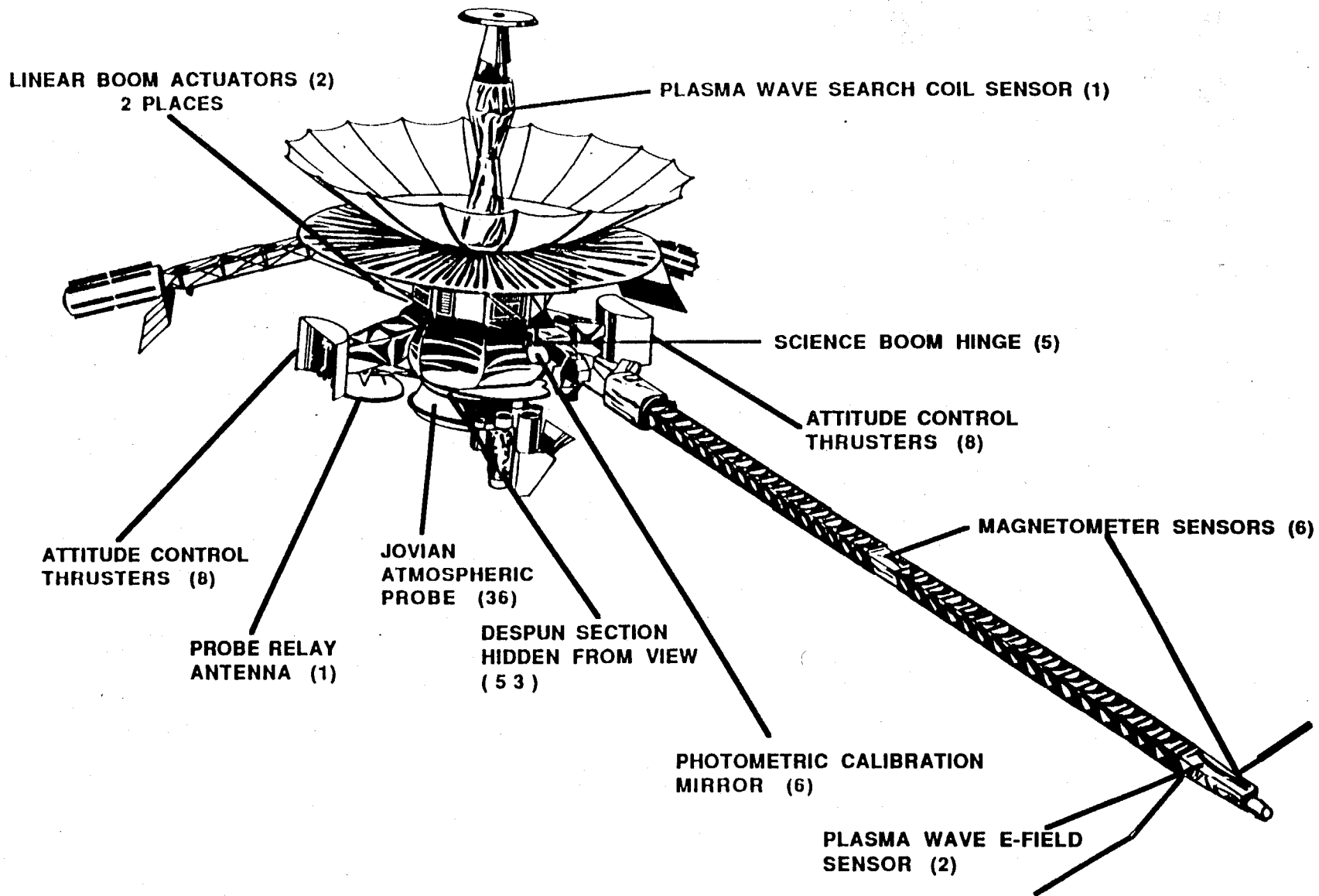


FIGURE 2-7. DIAGRAM OF LOCATIONS OF RHUS ON GALILEO SPACECRAFT

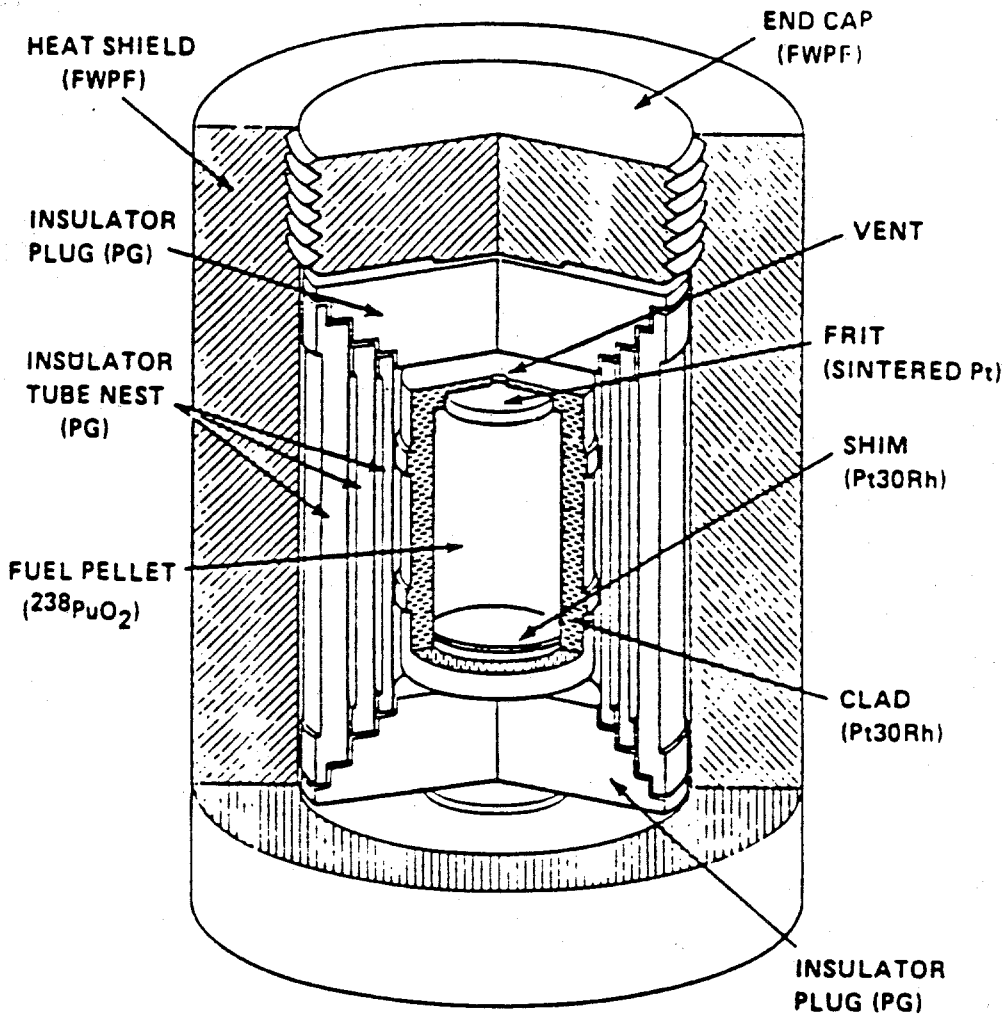
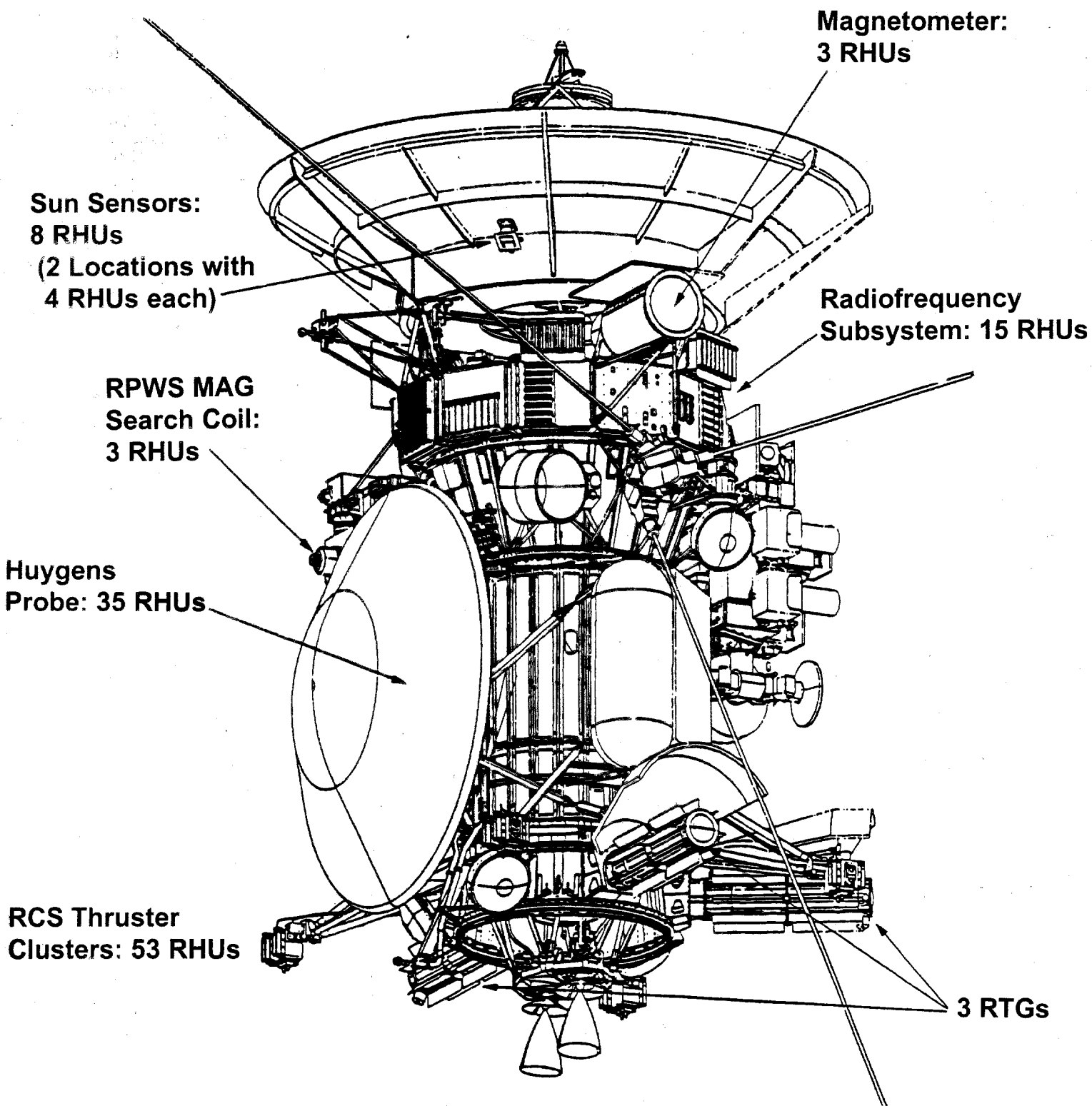


FIGURE 2-6. DIAGRAM OF RHU MODULE

Radioisotope Sources on Cassini

Location of Radioisotope Heater Units (RHUs) and Radioisotope Thermoelectric Generators (RTGs)



Cassini RHU Performance Characteristics

# of RHU's	157
Mass/RHU	40 g (6.28 kg total)
Thermal Power @ BOL	≈1 watt
Mass of PuO₂/RHU	2.7 g (424 g total)
Mass of Pu/RHU	2.38 g (374 g total)
Mass of ²³⁸Pu/RHU	1.91 g (300 g total)