# BARREL Scientific Balloon Mission Instrumentation Analysis

Saatvik Sunilraj

Virginia Space Coast Scholars

Liz Petry

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## Introduction

This report will explore and analyze NASA's mission, BARREL. We will start off with the mission's overview and the role of NASA's Wallops Flight Facility (WFF) in supporting this mission. Then, we will discuss the mission platform and its most important instrumentation. Finally, we will conclude it by reflecting on the mission's contribution to NASA.

## Mission Overview

Satellites orbiting the Earth are affected by x-rays, which disrupt them from functioning properly. These harmful x-rays are caused by the loss of electrons from the radiation layer that surrounds the Earth. NASA's BARREL mission was designed to study that problem. The scientific balloons' mission had five main objectives: "Determine electron loss rate during specific events; measure precipitation over a wide range of magnetic local times; directly test models by combining balloon measurements of precipitation with measurements of plasma waves and particles; determine the relative importance of different classes of precipitation; and determine the spatial extent and large-scale structure of precipitation." (Barrel – RBSP – Van Allen probes). These objectives propelled NASA to learn about planetary radiation belts and provide better protection to satellites that orbit Earth.

NASA used suborbital scientific balloons to effectively gather data without expending vast amounts of resources. The balloons are filled with helium and fly above the area where they are launched, carrying a 20 kg payload to an altitude of around 30-35 km. To ensure their goals were met, NASA launched the BARREL balloons in Antarctica and Sweden. They are both located at the north and south poles, where levels of radiation are the highest. BARREL could have never launched from these unique locations without the help of NASA WFF. Their suborbital programs have access at locations around the world, from the Arctic to the Antarctic.

## Mission Platform

This mission required an array of balloons to survive extended periods of flight. For example, “each balloon floated for anywhere from three to 40 days.” (Garner, 2023). Super-pressure balloons were used for the BARREL mission due to their ability to carry out experiments, collect data, and last under low pressure and temperature. The super-pressure balloons, along with their payloads, were brought to the launch sites using cranes and ferries. The payloads contained an x-ray radiation sensor, magnetometer, solar panels, a battery, sensors, a GPS receiver, and an iridium modem. Most of the balloons carrying payloads were able to successfully land after a launch, recovering the payload and reducing much of the cost.

## Instrumentation

Out of all the items that were on the payload, the NaI scintillation detector (x-ray radiation sensor) is definitely the most important of them all for this particular mission. This sensor directly tackled the mission's goals of understanding x-rays in the upper atmosphere and measuring them. The sensor functions when a photon goes through a crystal in the sensor, causing an electron to be ejected and collide with scintillator electrons. The measurement is when the scintillator electrons return to their ground state, as shown in figure 1. This incredible technology has been used by NASA ever since the Apollo missions and has improved ever since. During the time of the BARREL mission, the NaI scintillation detector was able to take in an energy range of 20 keV to 10 mEV. This was a huge improvement from before; however, any radiation that was out of this energy range would run undetected, potentially causing gaps in data.

**Figure 1.**

*Labeled diagram of how a NaI scintillation detector works*

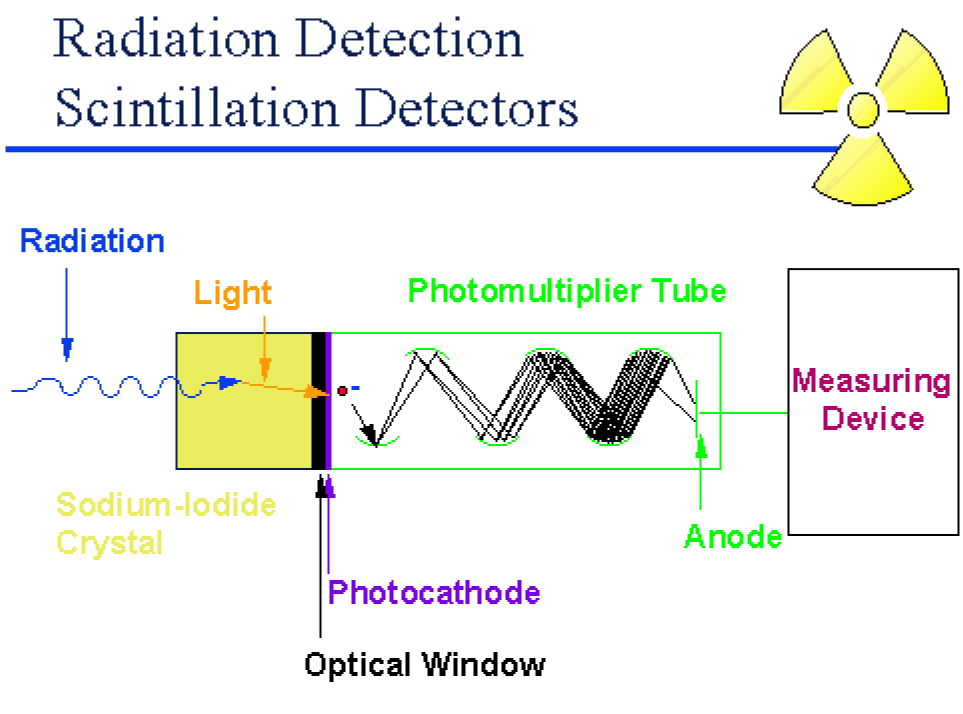


Image from Nevada Technical Associates, Inc: Zoomie (2015)

**Conclusion**

NASA's BARREL mission was created to gain a better understanding of planetary radiation belts and collect data on x-rays to better protect satellites orbiting the Earth. Multiple super-pressure scientific balloons were flown above Antarctica and Sweden that carried a payload capable of carrying out all aspects of the mission. One scientific technology on the payload that was more significant than the rest was the NaI scintillation detector. It was solely capable of capturing data regarding radiation. All of NASA's meticulous planning and experimentation were proven to be worth it since the mission was a success and they were able to achieve their goals.

**Reflection**

The BARREL mission aligns with the vision, mission, and core values of NASA. The BARREL mission analyzes a unique problem, allowing us to gain a greater understanding of our own planet. This mission was only possible due to the amazing, diverse team that worked diligently over many years to make it happen. This is especially inspiring to young aspiring scientists like me because it is our passion to make a difference in favor of humanity's benefit.

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