developed by the

Global Precipitation Measurement Mission

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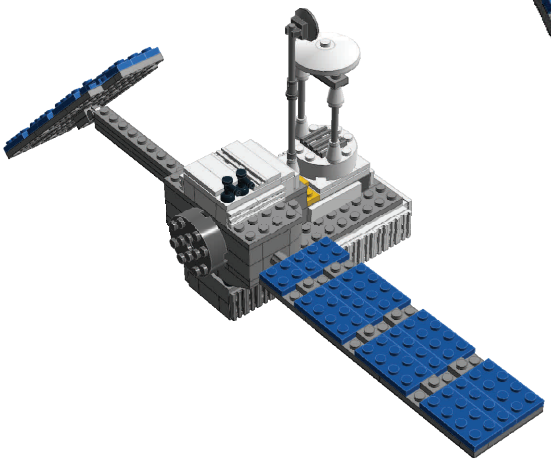
GPM Technology and Instrumentation: LEGO© Model Building Guide



Designed by

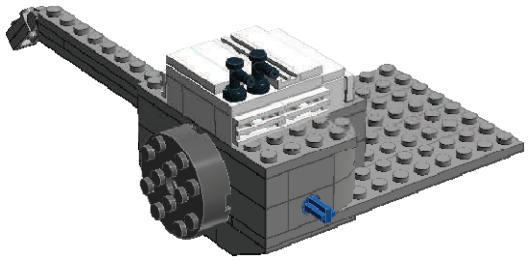
Mountaineer Area Robotics

MARS 2614

www.marsfirst.org

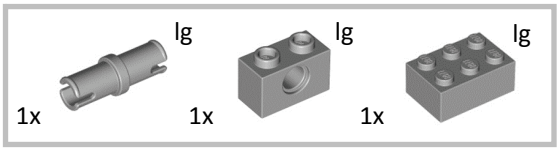
Learn more about the satellite at
http://gpm.nasa.gov

Part 1: Main Module / Satellite Base



Fun Fact:

The GPM Core satellite weighs 3850 kg, about the same as a large pickup truck—it is the largest satellite constructed to date at NASA's Goddard Space Flight Center in Greenbelt, Md.



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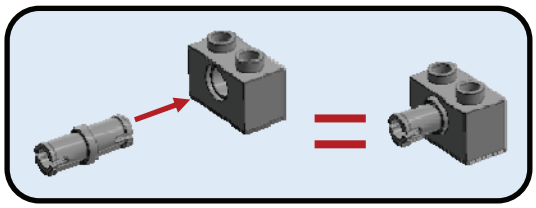

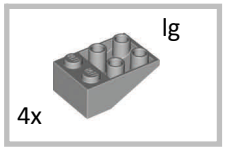

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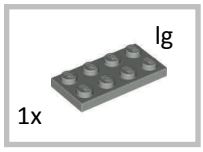

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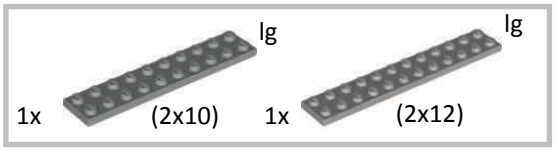

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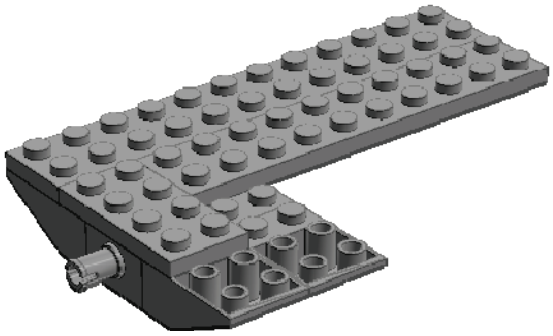

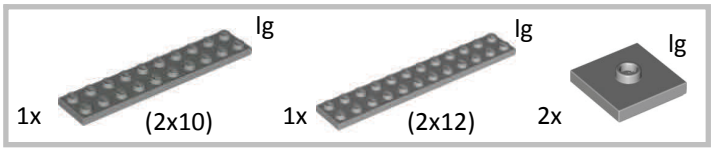

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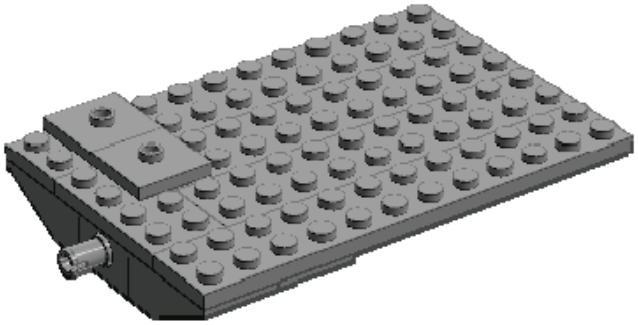

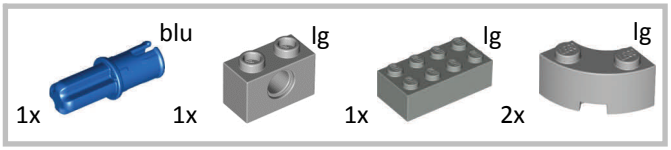

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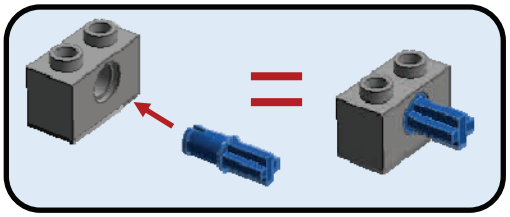
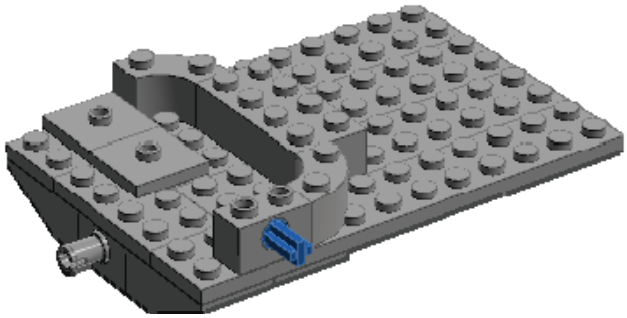




Key to notations:

1x: indicates quantity used of that piece

(1x2): indicates size of piece—for pieces without visible studs, based on an equivalent piece with studs

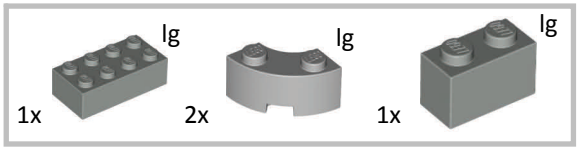
Letters next to piece indicate color, for those printing in black and white:

lg = light gray; dg = dark gray; blu = blue;
bla = black; w = white; y = yellow

Fun Fact:

NASA built the GPM Core Observatory in Maryland, and mission partner the Japan Aerospace Exploration Agency launched it into space on February 27, 2014. To get to the launch site on Tanegashima Island, Japan, The Core Observatory traveled by truck, cargo plane, and barge.

Read blog posts and see images and videos about the road to launch
http://go.nasa.gov/1iBEJml



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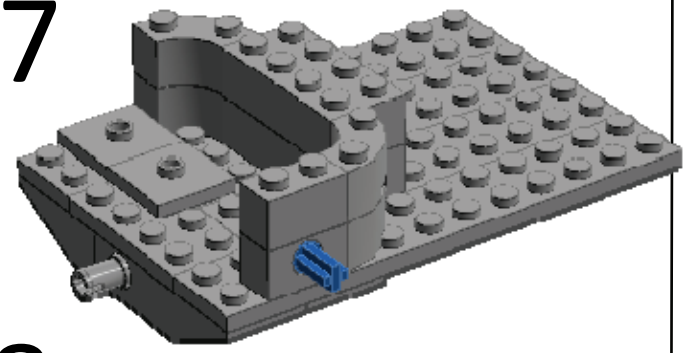

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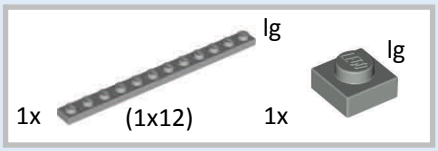

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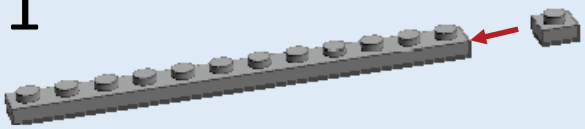

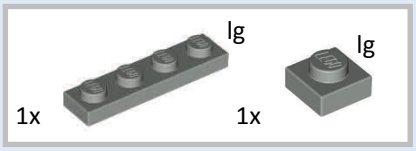

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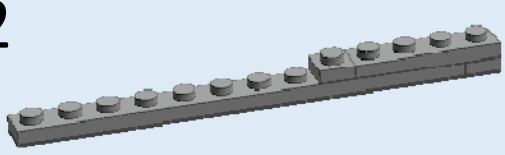

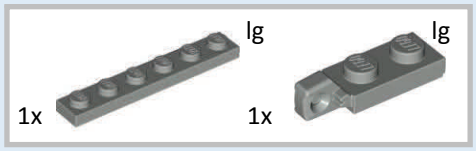

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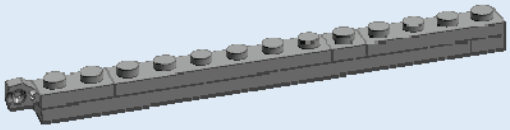

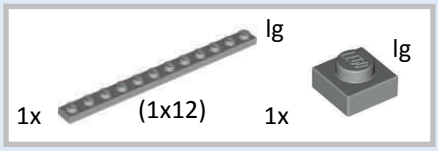

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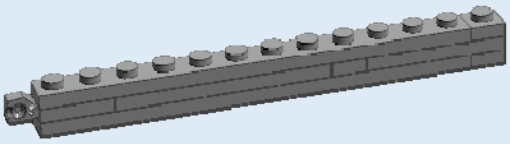

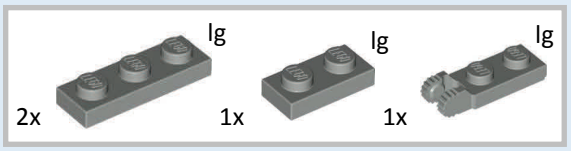

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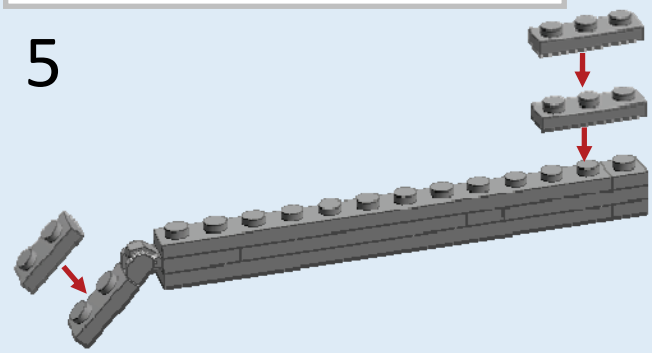

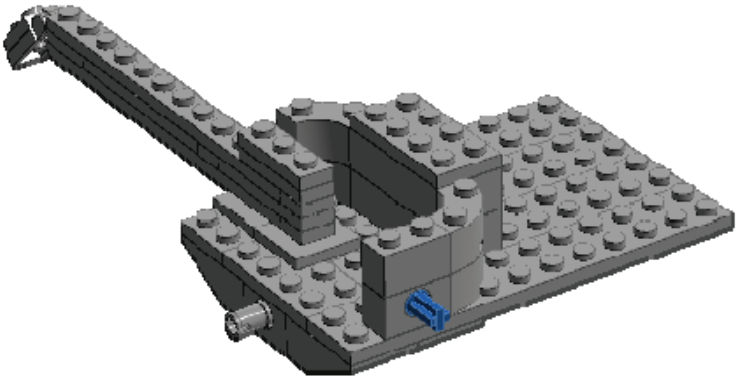

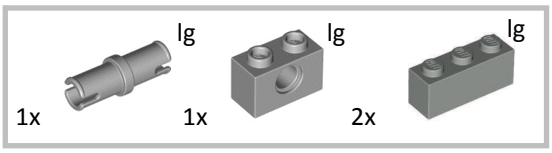

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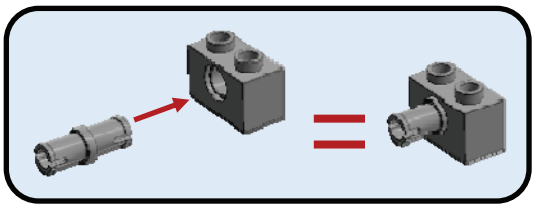

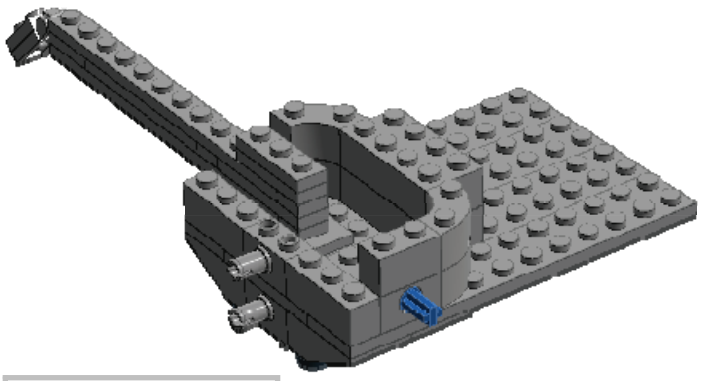

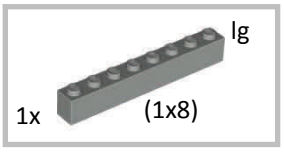

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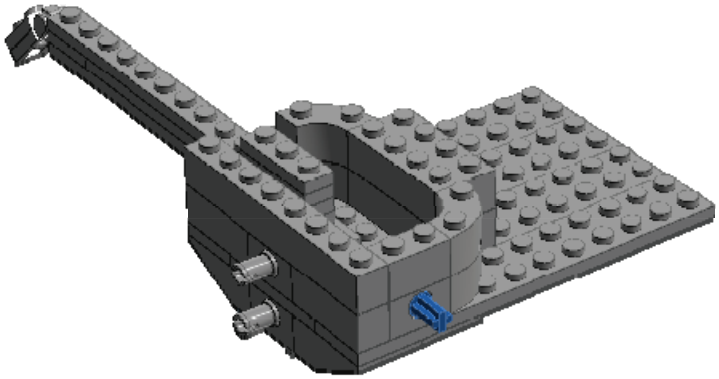

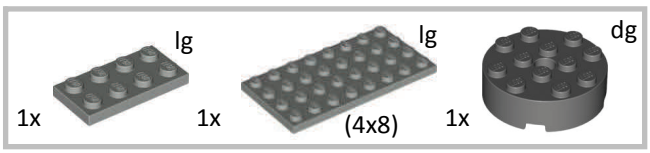

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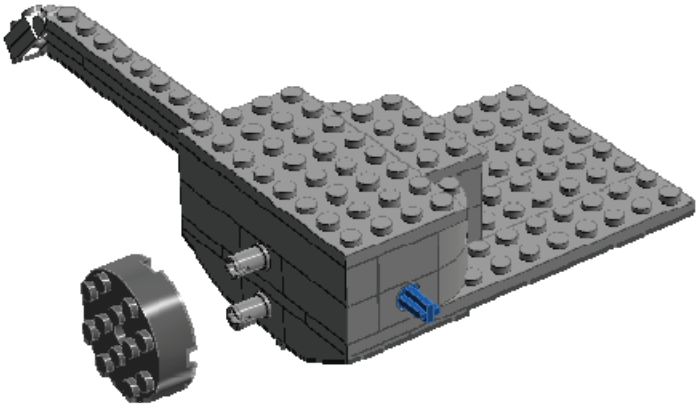

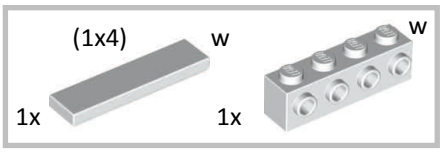

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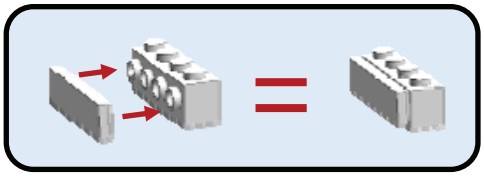
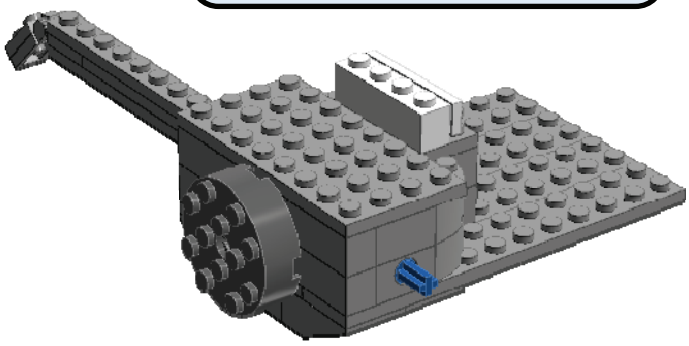
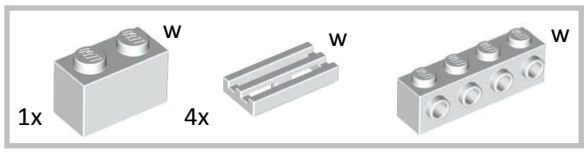




Fun Fact:

The GPM mission is the first coordinated international satellite network that will provide near real-time estimates of rain and snow every 3 hours anywhere on the globe. Other satellites in the constellation come from partner agencies of Japan, Europe and India, as well as U.S. agencies such as NOAA.

The GPM satellite constellation
http://go.nasa.gov/1dtqF0L



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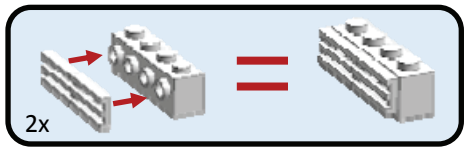

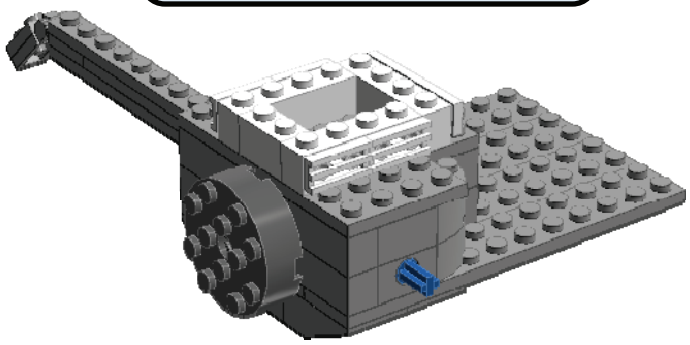

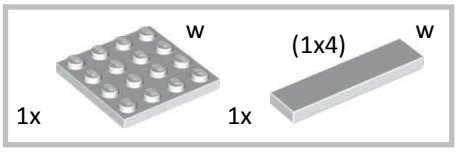

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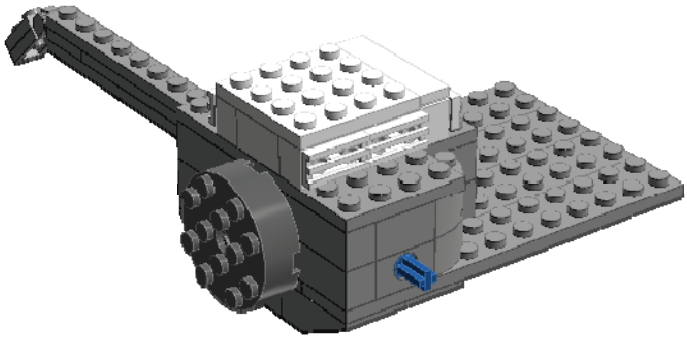

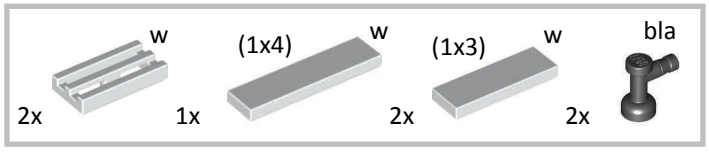

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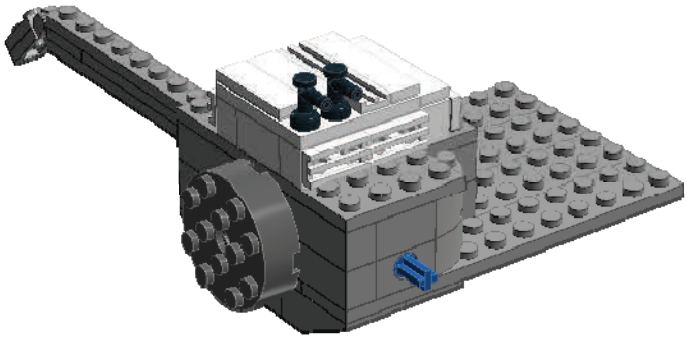
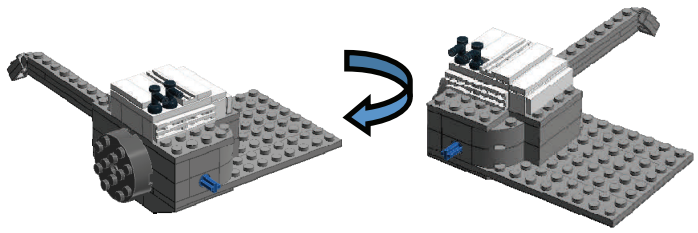
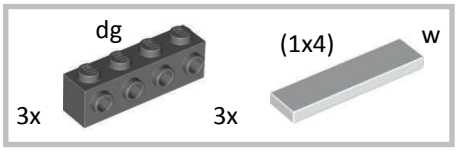


Part 2: GPM Microwave Imager and High Gain Antenna





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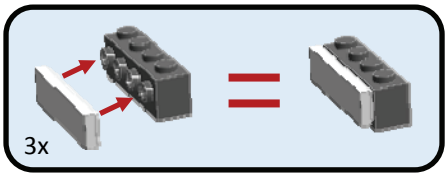

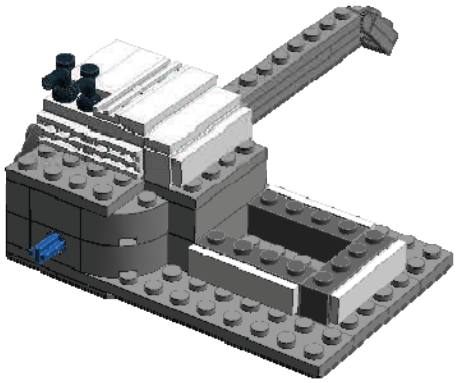

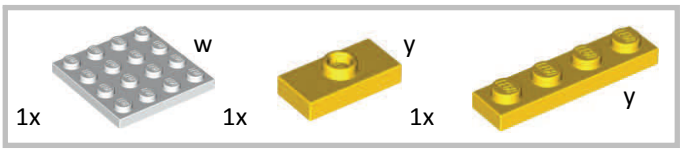

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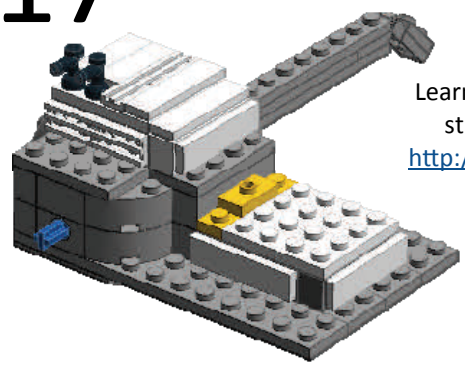

Learn more about the instruments on GPM.
http://go.nasa.gov/1fdlFJt

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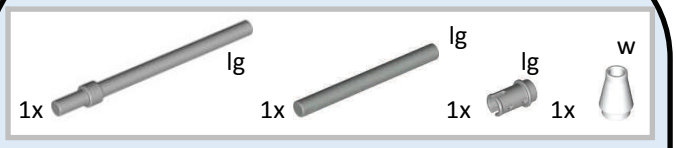

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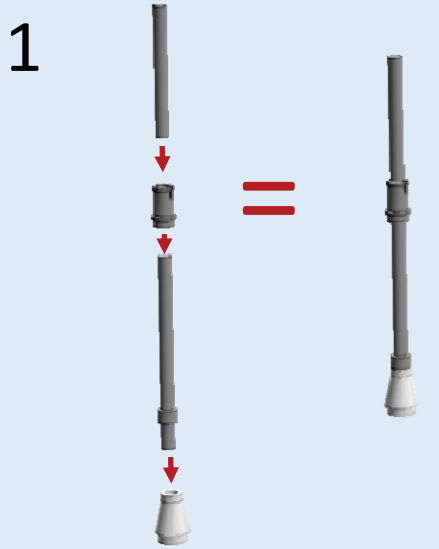

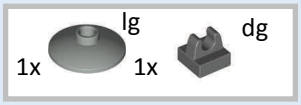

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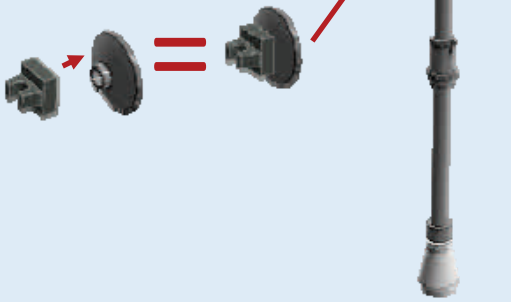

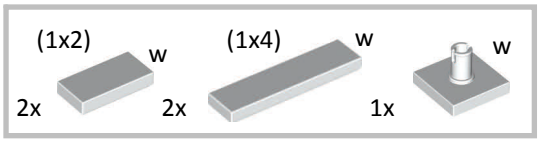

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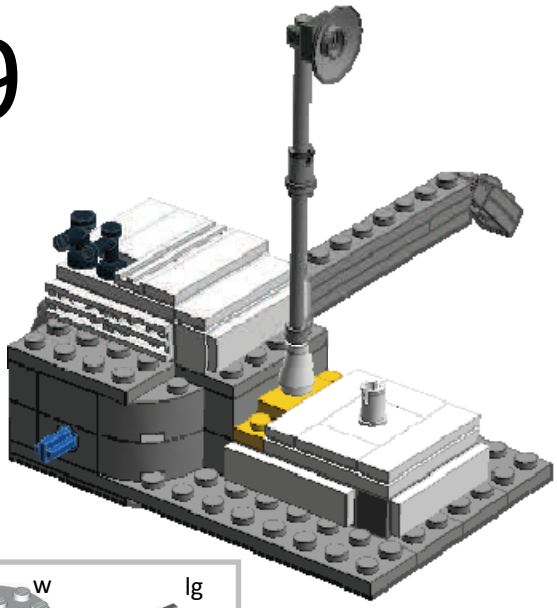

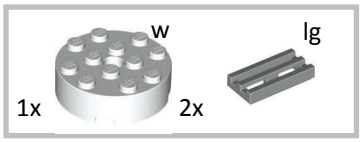

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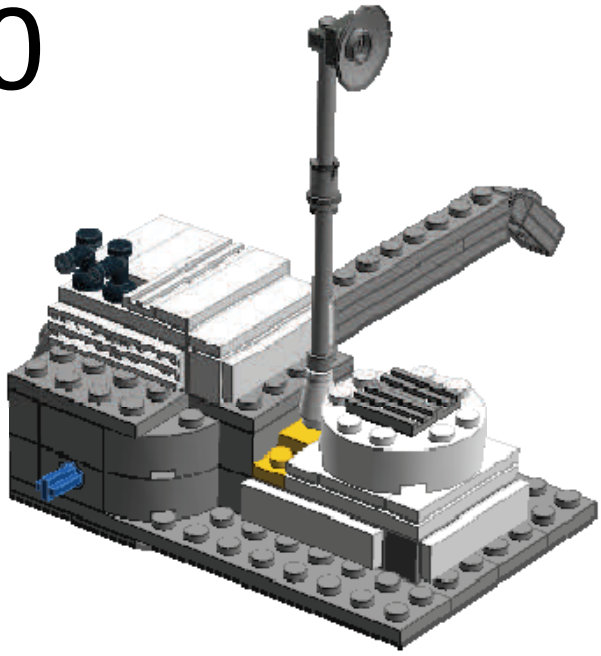
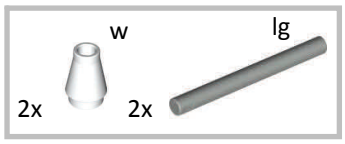


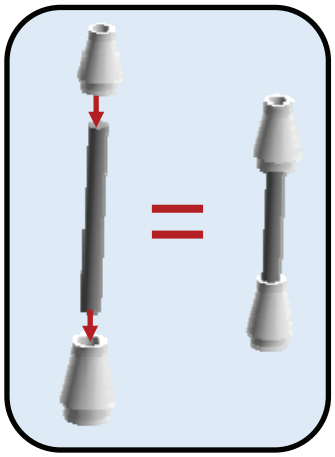
Fun Fact:

The GPM Microwave Imager is sensitive to 13 channels of microwave energy that allow scientists to distinguish different types of precipitation. It measures heavy and moderate precipitation as well as light rain and snowfall.

See images of some of the first data collected by the satellite.

http://go.nasa.gov/1iBJ214





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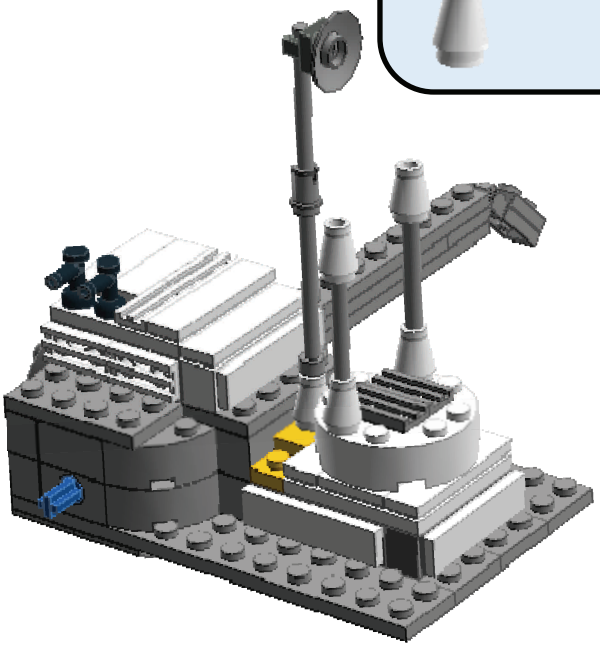

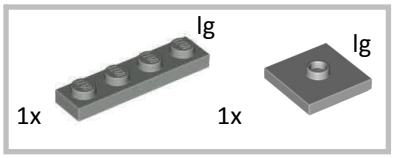

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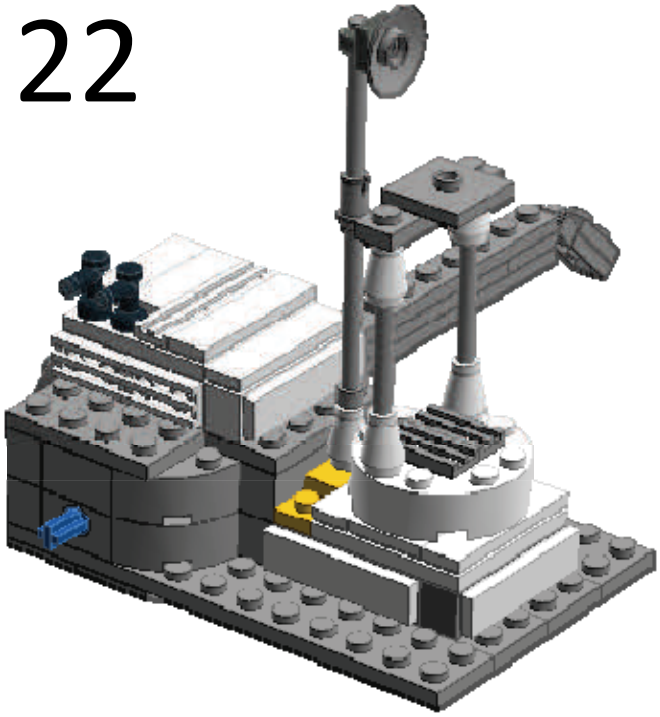

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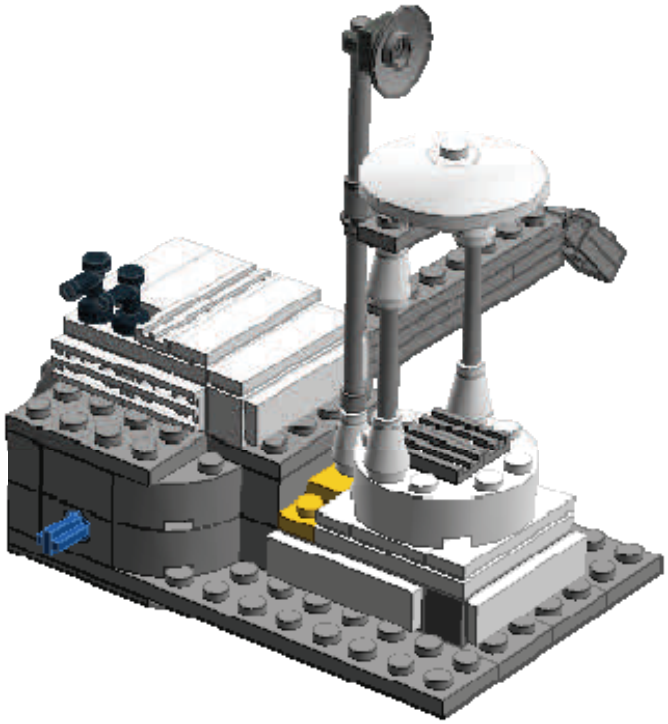
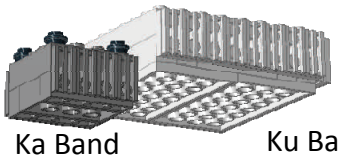
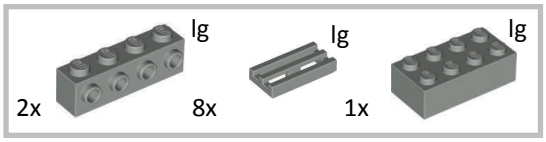


See a video overview of the engineering behind building the GPM Core Observatory.

http://go.nasa.gov/1iBlurW

Part 3: Dual Precipitation Radar





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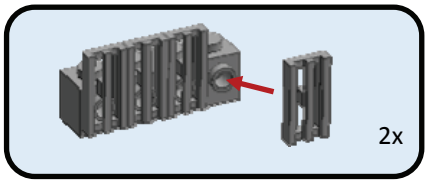

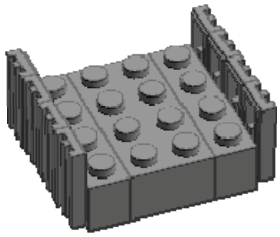

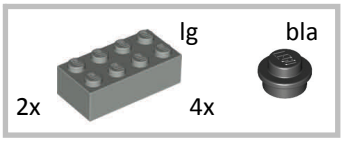

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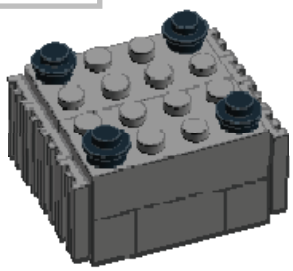
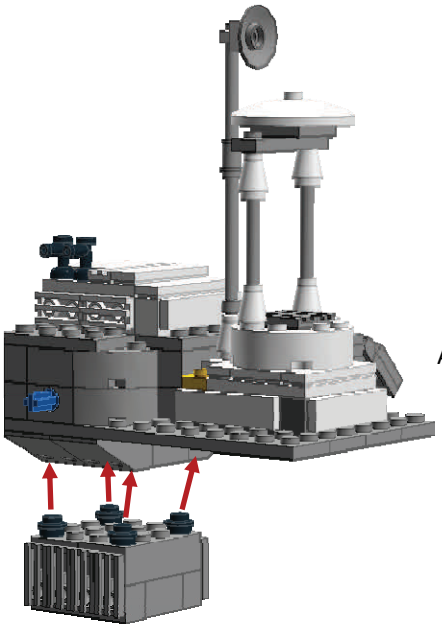
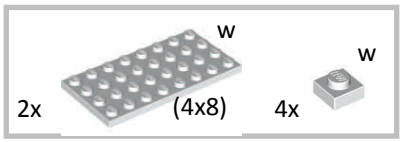




Read more about the DPR
http://go.nasa.gov/1iESanl

And see some of the first data images collected from it.
http://go.nasa.gov/1r3cpxV



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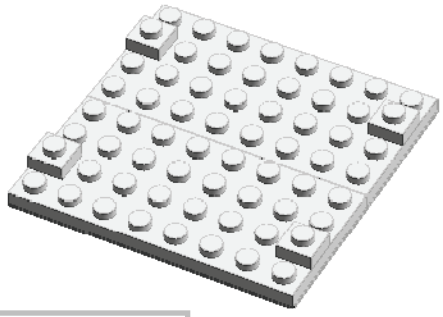

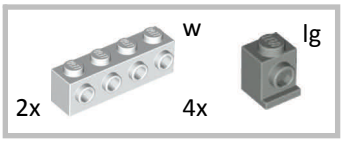

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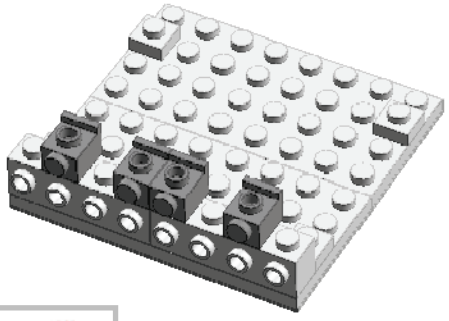

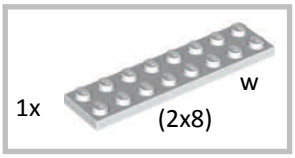

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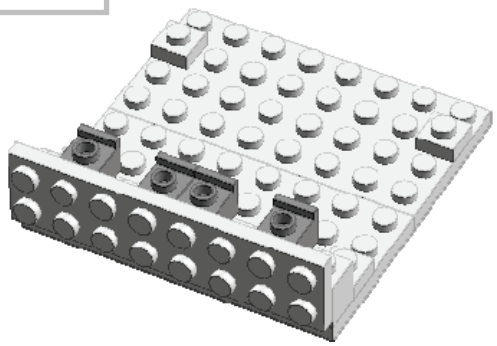


Fun Fact:

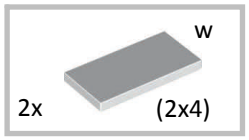
GPM's Dual-frequency Precipitation Radar measures storms and cloud systems in three dimensions. Among other things, the 3-D view allows scientists to see the formation of hurricanes and tropical cyclones forming in the oceans, and to study how these storms change over time.

Fun Fact:

If all the world's rain gauges were gathered together, they would fill two basketball courts. From space, GPM and other satellites provide global coverage to measure rainfall. The GPM Core Observatory will measure precipitation from about the Arctic Circle to the Antarctic Circle.

See an animation showing all the rain gauges in the world being collected in one place.

http://go.nasa.gov/1iBJtbM



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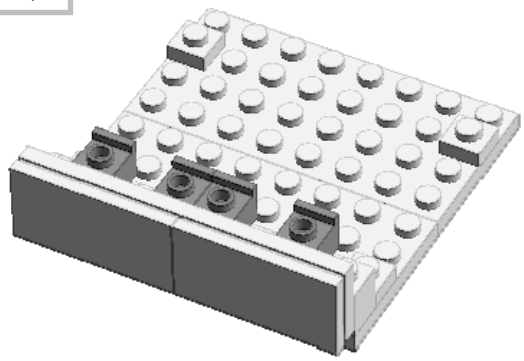

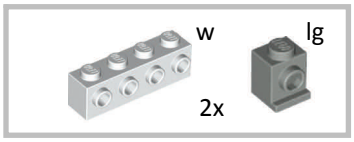

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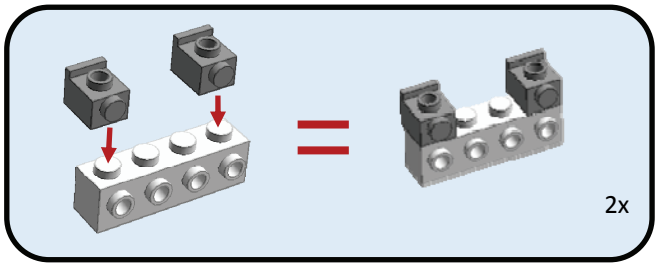

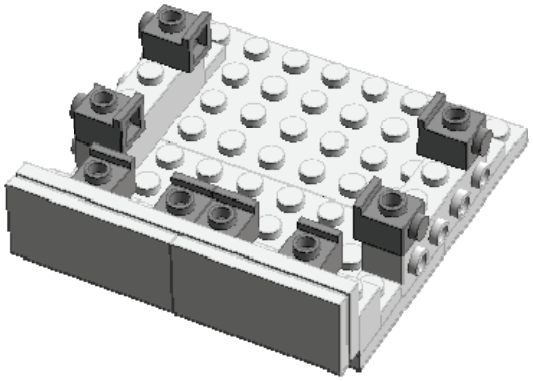

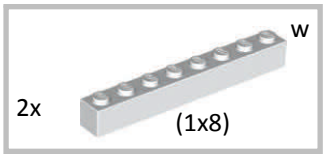

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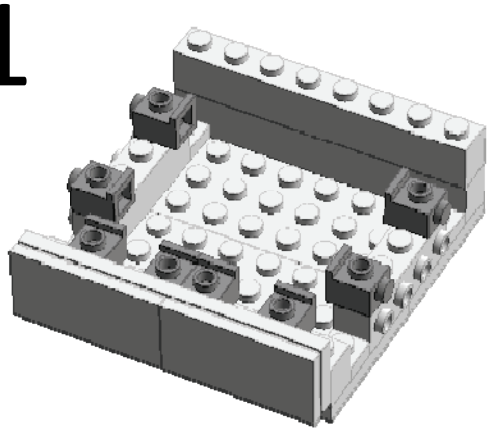

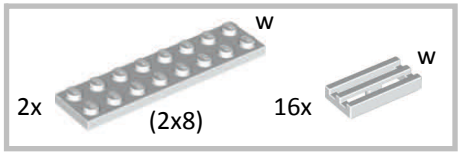

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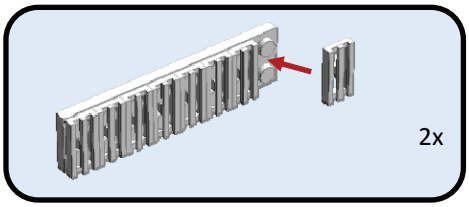

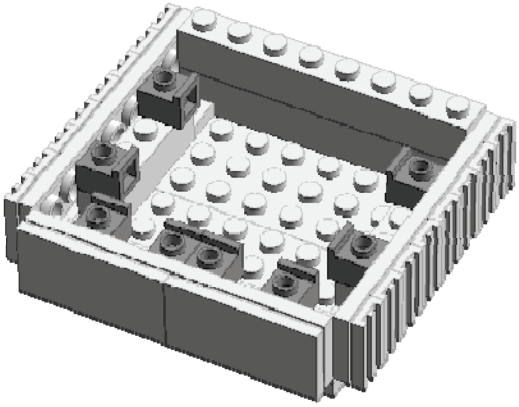

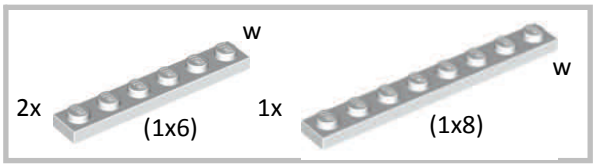

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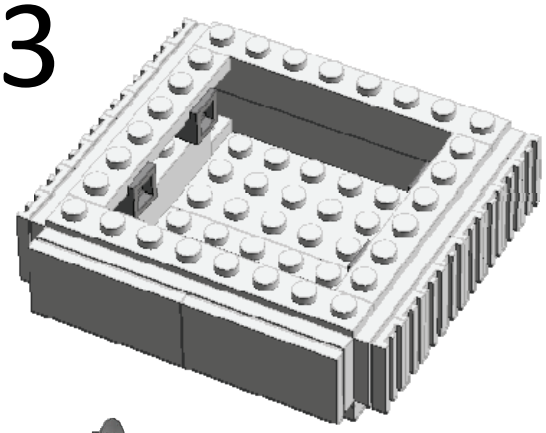

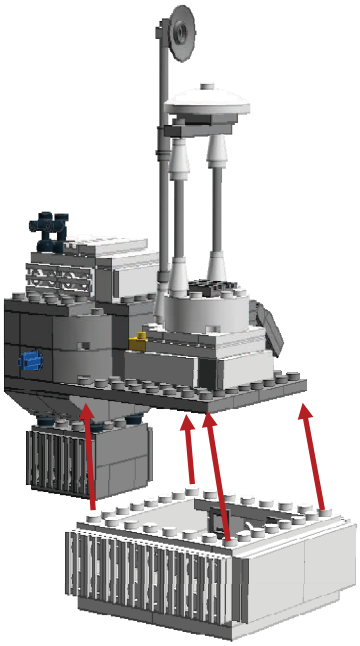

See animations showing the GPM instruments in action.

http://go.nasa.gov/1dtqouJ

http://go.nasa.gov/1dtqyCt

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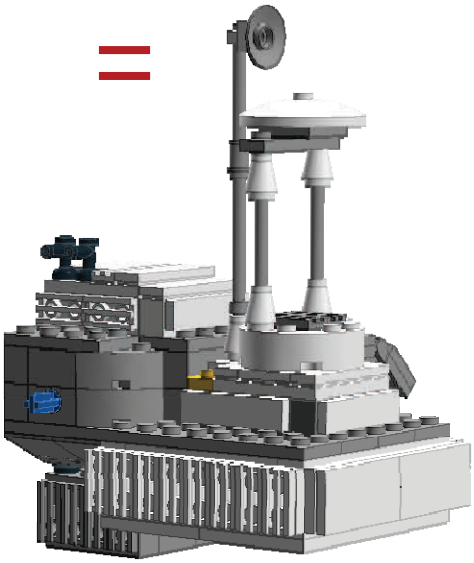
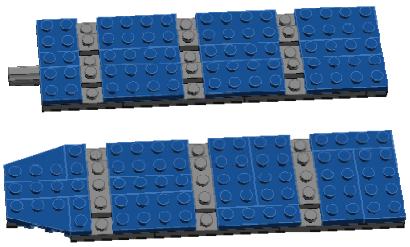
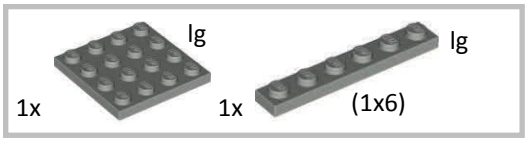


Part 4: Solar Panels





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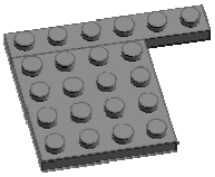

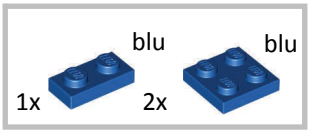

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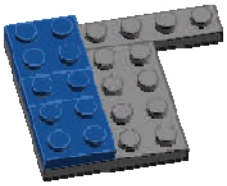

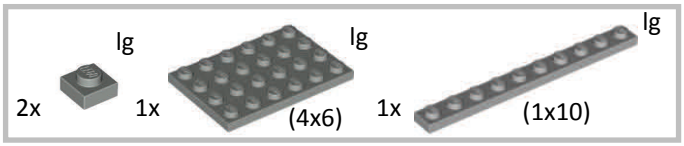

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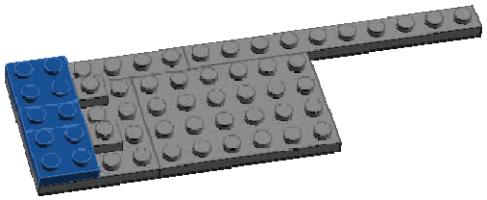

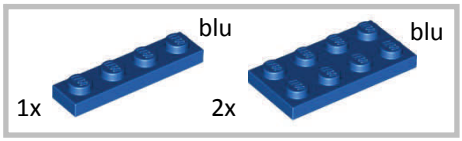

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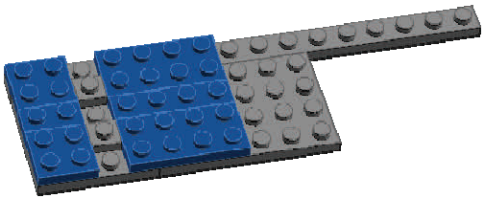

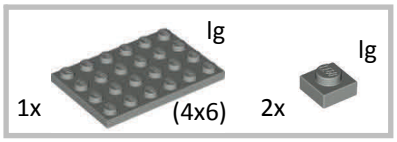

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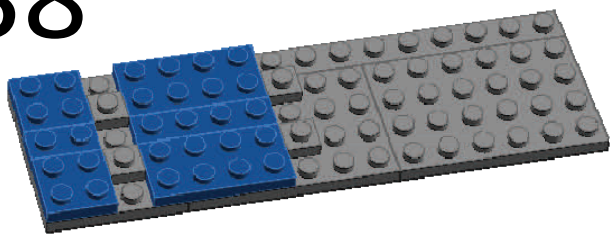

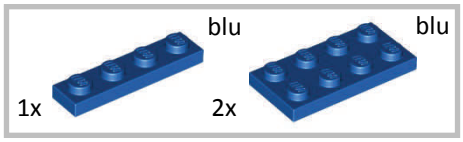

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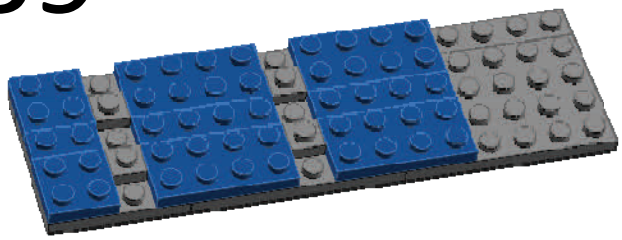

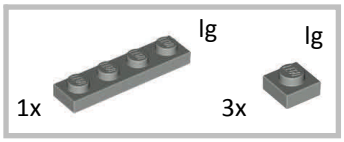

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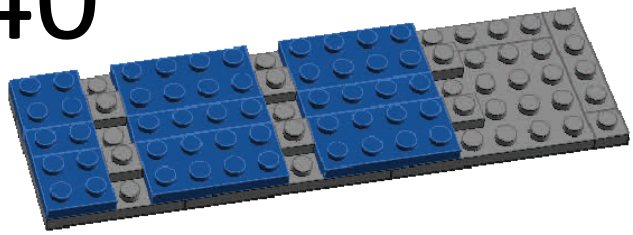

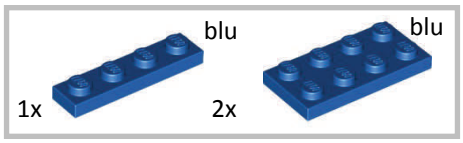

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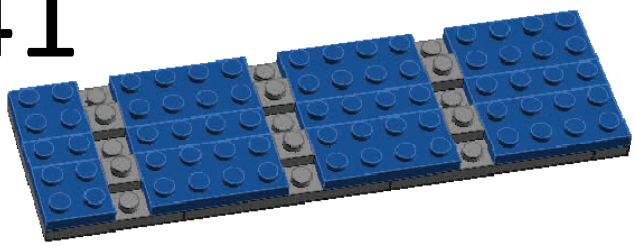

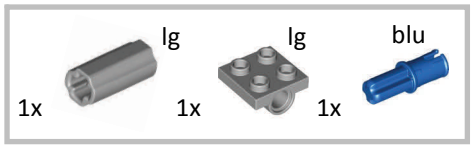

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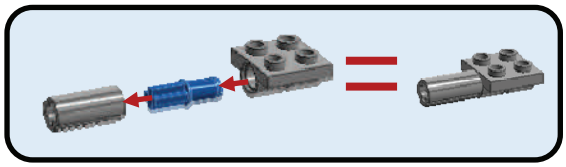
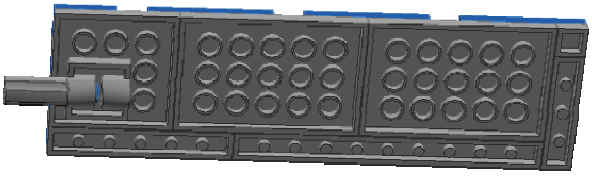
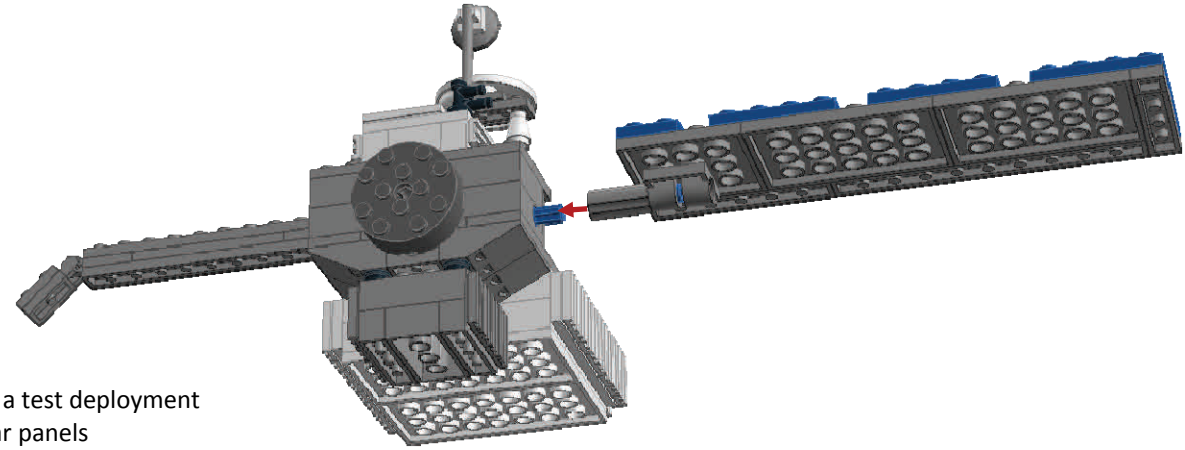
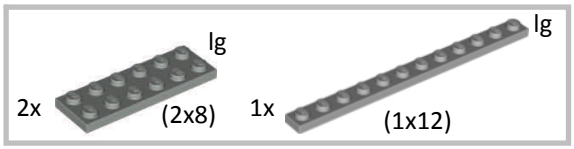






See a video showing a test deployment of the solar panels
http://go.nasa.gov/1dtq9zL



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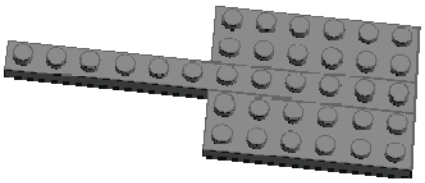

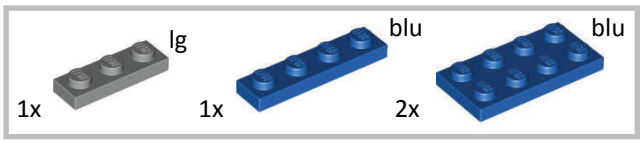

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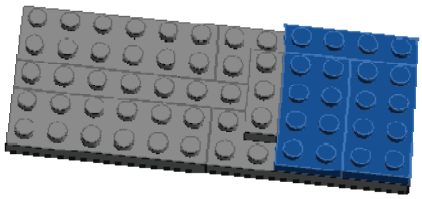

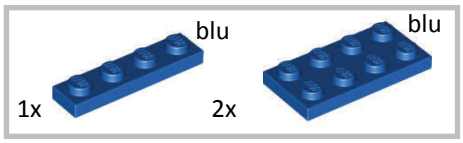

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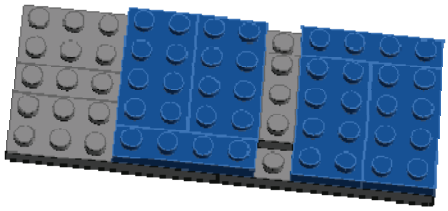
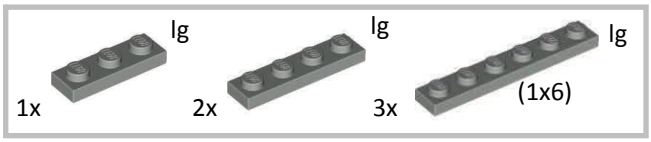


See an animated “beauty pass” of the satellite orbiting Earth.
http://go.nasa.gov/1r3cYru



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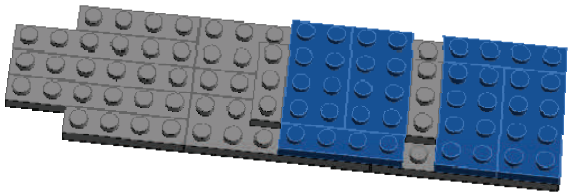

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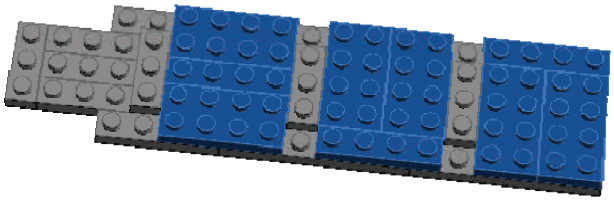

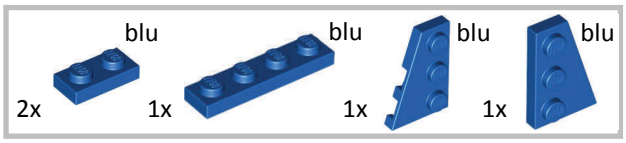

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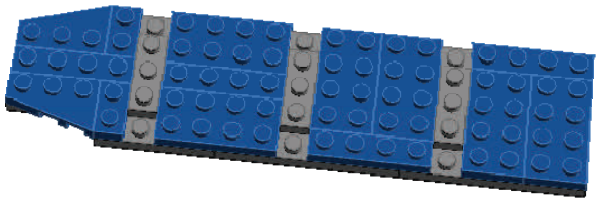
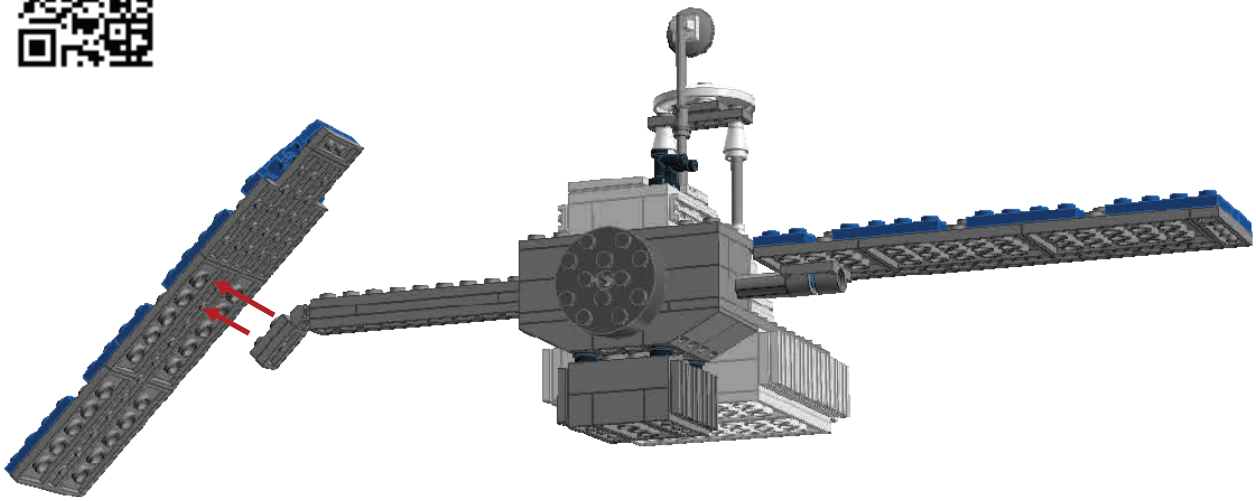
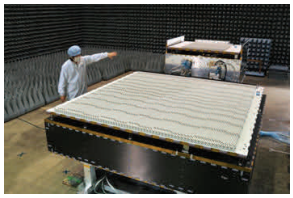
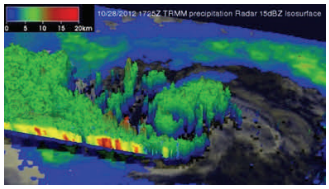




Dual-Frequency Precipitation Radar (DPR)

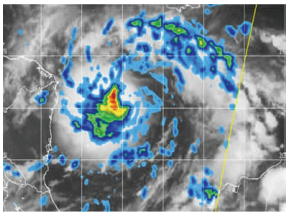


The DPR provides three-dimensional information about precipitation particles in the different layers of clouds. It sends energy at two frequencies (Ku and Ka) into the cloud and observes the energy that is reflected back from different heights in the cloud. The DPR collects information on the size, shape and distribution of raindrops, which improves rain estimates.



GPM Microwave Imager (GPM)

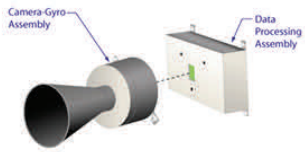
The GMI is a radiometer instrument that measures microwave energy that is emitted naturally by precipitation within and beneath clouds. Different types of precipitation, like heavy rain and light snow, emit different wavelengths of energy. The GMI measures these wavelengths which scientists use to tell what kind and how much precipitation is in the cloud.



High Gain Antenna

The High Gain Antenna allows the Core satellite to communicate with the ground and send real-time, continuous data from the GMI and DPR.

Avionics / Star Trackers



Star trackers measure the position of stars and use a catalog of star locations to help the satellite know where it is in space.

Propulsion Module / Reaction Wheels

The propulsion system consists of the fuel and thrusters used to move the satellite while in orbit and the reaction wheels which maintain the Core Observatory's orientation. Together, they maintain and correct the orbit as needed throughout the life of the spacecraft. When the mission is over, they will drive the spacecraft into the atmosphere for a controlled re-entry to safely destroy it and send the pieces into the ocean.

Solar Array

The GPM Core Observatory's two solar panels provide power for all the satellite's systems by converting sunlight into electrical energy.

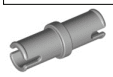
Math Connection:

- What scale is your completed model? The real solar panels on the GPM Core Observatory are 2.8 meters (9.2 feet) wide. Measure the panels on your model, and calculate how many times bigger the real thing would be.

Engineering Challenge:

- After you build your model, come up with a creative way to display it. You might think of a museum exhibit and create a label and caption as well.
- The real satellite goes through a number of tests, including vibration testing, a vacuum chamber, and a ride on a centrifuge. Can you think of some ways to run similar tests on your model?

Light Gray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1x
4512360


1x
4211483

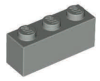

3x
4211628


1x
4538093


8x
4211476


1x
4211388


3x
4211440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2x
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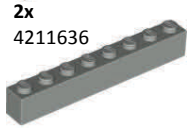
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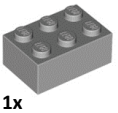
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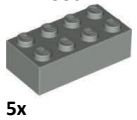
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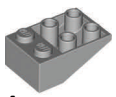
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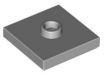
4211570


1x
4211512


4x
4567448


1x
4211376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10x
4211399


1x
4211398


10x
4211350


1x
4211803

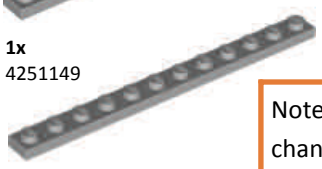

1x
4211804


6x
4211429


5x
4211445


5x
4211438


1x
4251149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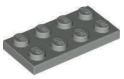
2x
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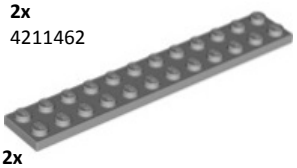
4x
4211452


2x
4211462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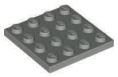
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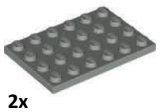
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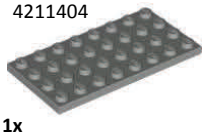
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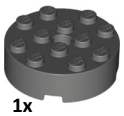
Dark Gray


1x
4558959


1x
6030710


3x
4210725

White


5x
4518400


4x
302401

1x
246001

1x
396001

1x
4558956

22x
241201

(1x2)
2x
306901

(1x3)
2x
4558168

(1x4)
8x
243101

2x
366601

1x
346001

1x
300401

7 x
4143254

2x
300801

(2x4)
2x
4560178

3x
303401

2x
4243812

2x
303501

Black

2x
459926

4x
614126

Yellow

1x
371024

1x
379424

Blue

3x
302323

2x
4206482

7x
371023

1x
4498156

1x
4498155

2x
302223

12x
302023

Note: LEGO brick numbers are subject to change. See our website for a spreadsheet of this parts list with more details about each piece if needed. http://go.nasa.gov/Qrq3z