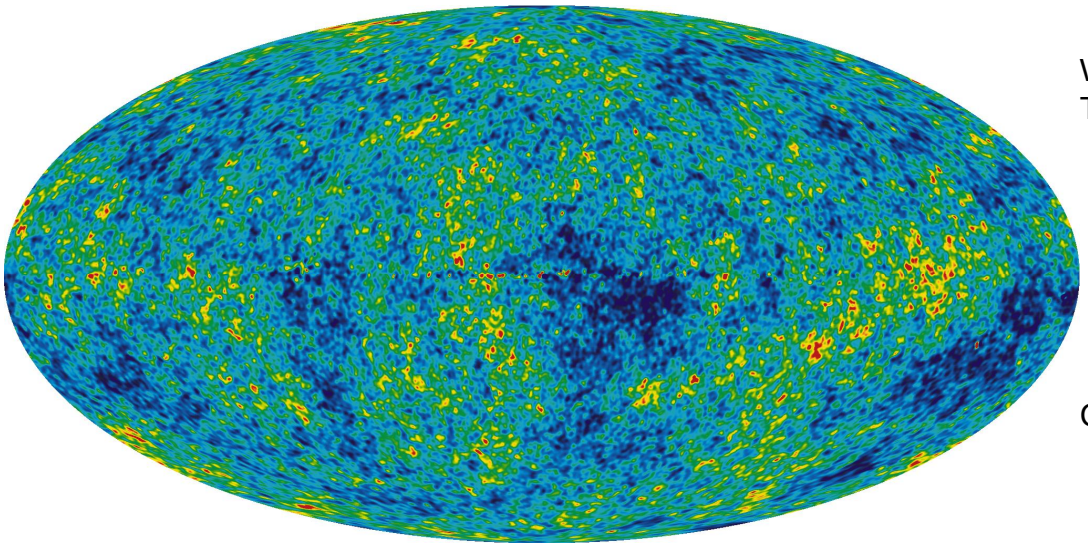
WMAP Wilkinson Microwave Anisotropy Probe 1:48 scale

- The Wilkinson Microwave Anisotropy Probe (WMAP) is a NASA Explorer mission that launched June 2001 to make fundamental measurements of cosmology -- the study of the properties of our universe as a whole. WMAP has been stunningly successful, producing our new Standard Model of Cosmology. WMAP continues to collect high quality scientific data.
- WMAP's Top Ten
- 1-NASA's Wilkinson Microwave Anisotropy Probe (WMAP) has mapped the Cosmic Microwave Background (CMB) radiation (the oldest light in the universe) and produced the first fine-resolution (0.2 degree) full-sky map of the microwave sky
- 2-WMAP definitively determined the age of the universe to be 13.73 billion years old to within 1% (0.12 billion years)
- 3-WMAP nailed down the curvature of space to within 1% of "flat" Euclidean, improving on the precision of previous award-winning measurements by over an order of magnitude
- 4-The CMB became the "premier baryometer" of the universe with WMAP's precision determination that ordinary atoms (also called baryons) make up only 4.6% of the universe (to within 0.1%)
- 5-WMAP's complete census of the universe finds that dark matter (not made up of atoms) make up 23.3% (to within 1.3%)
- 6-WMAP's accuracy and precision determined that dark energy makes up 72.1% of the universe (to within 1.5%), causing the expansion rate of the universe to speed up
- 7-WMAP has mapped the polarization of the microwave radiation over the full sky and discovered that the universe was reionized earlier than previously believed. By measuring the polarization in the CMB it is possible to look at the amplitude of the fluctuations of density in the universe that produced the first galaxies. That is a real breakthrough in our understanding of the origin of structure
- 8-WMAP has started to sort through the possibilities of what transpired in the first trillionth of a trillionth of a second, ruling out well-known textbook models for the first time.
- 9-The statistical properties of the CMB fluctuations measured by WMAP appear "random"; however, there are several hints of possible deviations from simple randomness that are still being assessed. Significant deviations would be a very important signature of new physics in the early universe.
- 10-Since 2000, the three most highly cited papers in all of physics and astronomy are WMAP scientific papers.



WMAP RESULTS: Five Year Microwave Sky
The detailed, all-sky picture of the infant universe created from five years of WMAP data. The image reveals 13.7 billion year old temperature fluctuations (shown as color differences) that correspond to the seeds that grew to become the galaxies. The signal from the our Galaxy was subtracted using the multi-frequency data. This image shows a temperature range of ± 200 microKelvin.

Credit: NASA / WMAP Science Team

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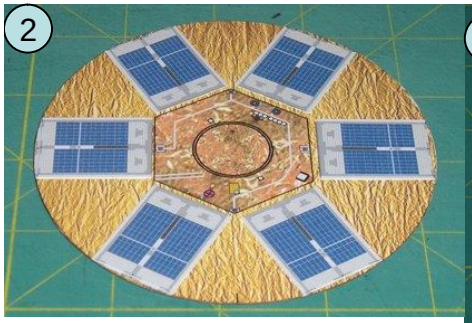
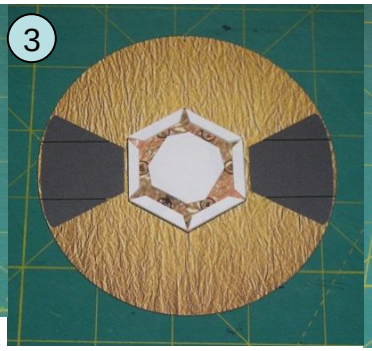
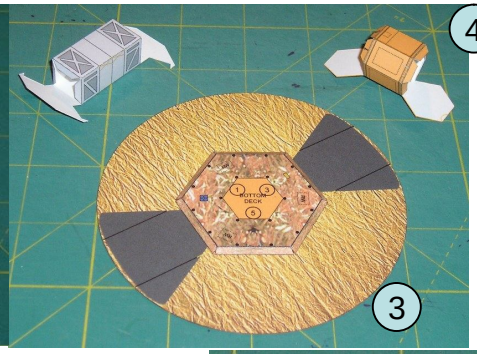
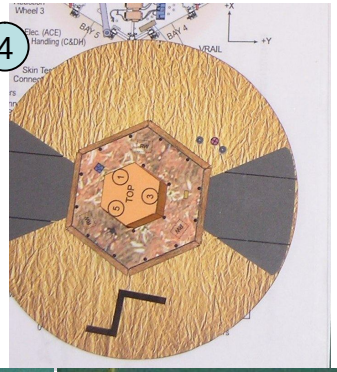
ASSEMBLY – print parts on cover stock (65lb)

1. Score all folds before cutting out the parts. Cut carefully along the outer lines and glue sparingly. Study the spacecraft pictures and diagrams before building and use them for reference during assembly.
2. Cut out the top and bottom of the shade and glue back to back, aligning the bays using the reference marks on the edge between bays 1 & 2. Optional, cut out the six extra solar panels and glue over the printed panels on the shade.
3. Cut a hexagon from thick card (1.5mm) and glue over the center hexagon on the top of the shade. Cut out the bottom deck, fold the outer edges down, and glue over the center of the card you glued to the top of the shade – keeping the bays aligned (bays 3 & 6 face the dark sectors on the top of the shade).

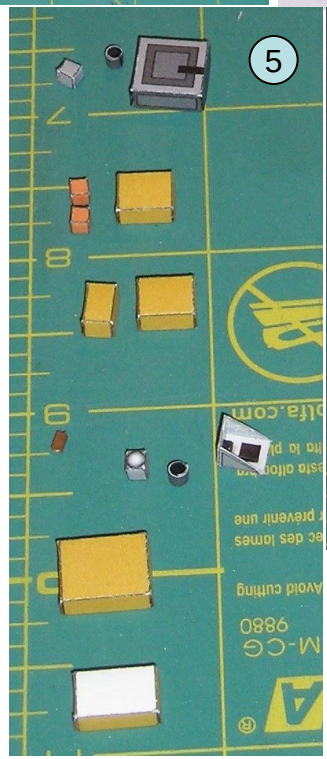


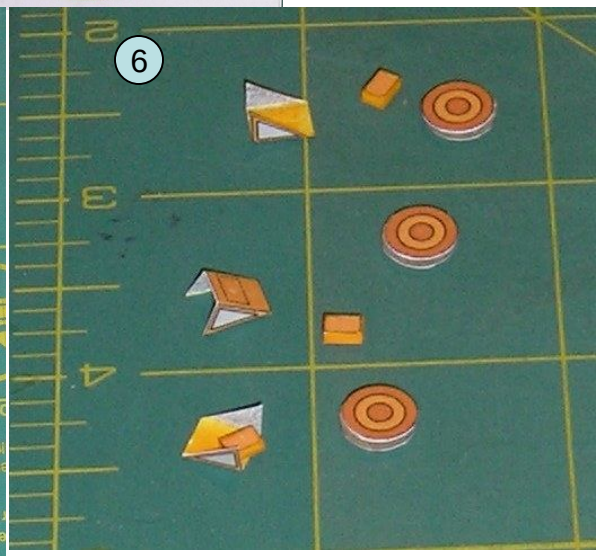






4. For a simpler model, use the alternate, one-piece bus part. Cut out the bus, fold and glue into a hexagonal box. Glue the bus over the shade assembly, keeping the bays aligned. Skip to step 11. For a more detailed model, use the detail parts shown. Cut out the bus, fold and glue into a hexagonal column, then glue the bus to the center of the shade assembly, keeping the bays aligned. Continue with step 5.
5. Cut out the various electronics boxes, fold and glue using the attached tabs into small open boxes. To fold the star tracker bracket: make all folds <u>away</u> from the printed side; fold the bottom piece down and glue to make a double layer; fold the triangular sides down; then fold down the tabs on the sides and secure the top. Roll the star tracker barrel (dark gray rectangle) into a short cylinder and glue it to the star tracker over the circle on the face of the star tracker. Glue one star tracker to the top of the bracket (the other will be glued to the underside of the top deck).
6. Cut out the parts for the reaction wheel assemblies. Glue one circle to thick card, cut out, then glue another circle to the other side of the card, making a thick two-sided part. Repeat to make three wheels. Fold the sides of the brackets down (away from the printed side) at a right angle and glue the thick reaction wheels to edges of the slanted sides. Fold and glue the small control boxes together, then apply glue to the edges of the open side of the box and attach to the bracket over the dotted outline.





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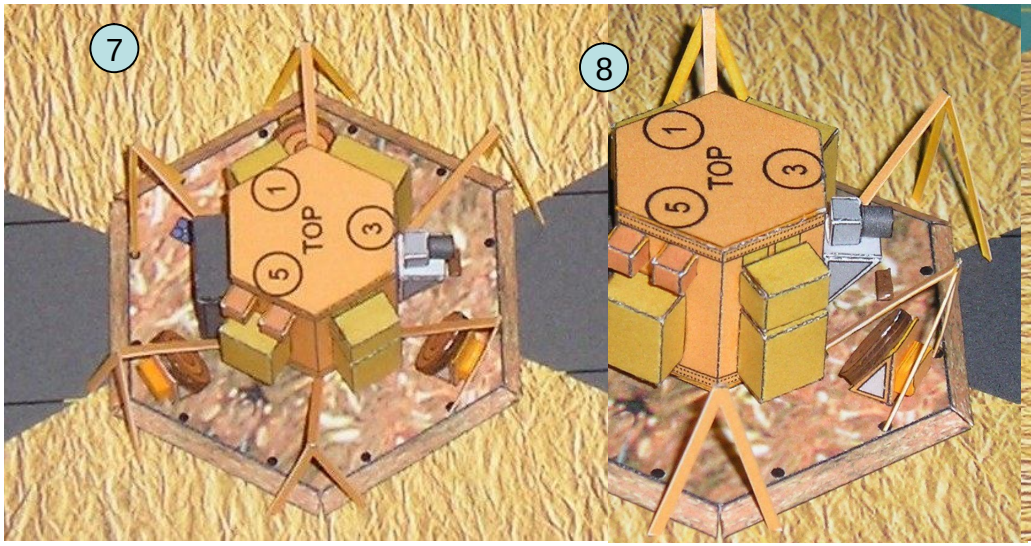
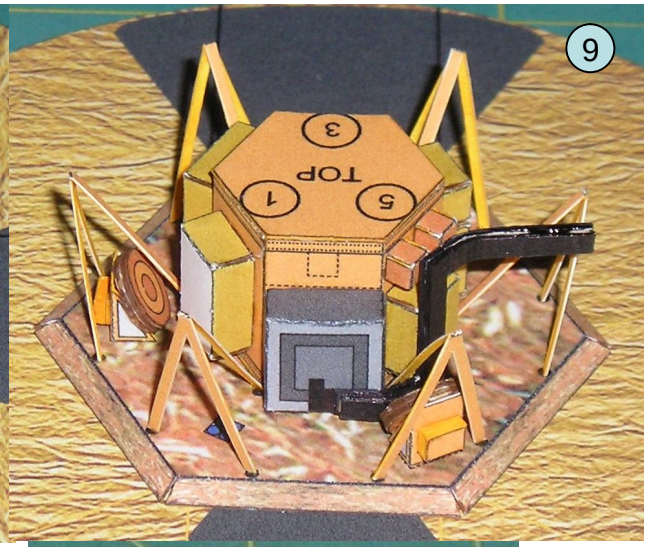
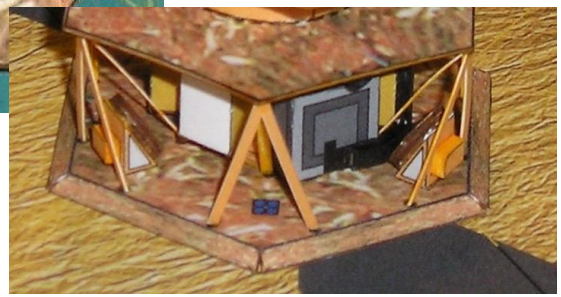
7. Using a small amount of glue applied to the edges of the electronics boxes, attach the boxes and the star tracker bracket to the sides of the bus in the indicate places. Likewise, glue the three reaction wheel assemblies to the indicated places on the bottom deck (marked with RW).
8. Glue the interdeck struts to another layer of card stock the cut them out. Bend each strut at the black line to make a tripod. Carefully glue the tip of the long leg of each tripod to the small black circles on the lower deck at the base of the bus. After that glue has dried, apply a small spot of glue to each of the small black circles on the outer edge of the lower deck and attach the remaining two legs of each strut, keeping the legs straight. The top of each strut tripod should be level with the top of the bus.
9. Carefully bend the battery duct – refer to the bay diagrams – slide it into position under the struts and glue to the battery box.





10. Cut out the upper and lower sides of the top deck and glue together. Assemble the two VRAIL boxes, apply glue to the edges of the open side, and attach to the top deck over the dotted rectangles as indicated. Similarly, attach the remaining star tracker to the underside of the top deck where indicated (lens barrel faces outward). Roll the optical table pedestal into a short cylinder and secure, then bend the tabs inward and glue to the upper side of the top deck over the dotted circle. Set the upper deck on top of the bus and check that the interdeck struts just touch the dark circles printed on the outer edge of the deck when the deck is tight to the top of the bus. If the struts are too tall, add layers of card to the top of the bus until the fit is corrected. If too short, the edges of the top deck can be bent down very slightly, or small card tabs added to the top of the struts. When you're satisfied with the fit, apply glue to the top of the bus and the top of each strut, then put the top deck in place – making sure the bays are aligned and the top deck centered (note: the star tracker on the underside of the top deck ends up in bay 6 with the battery).



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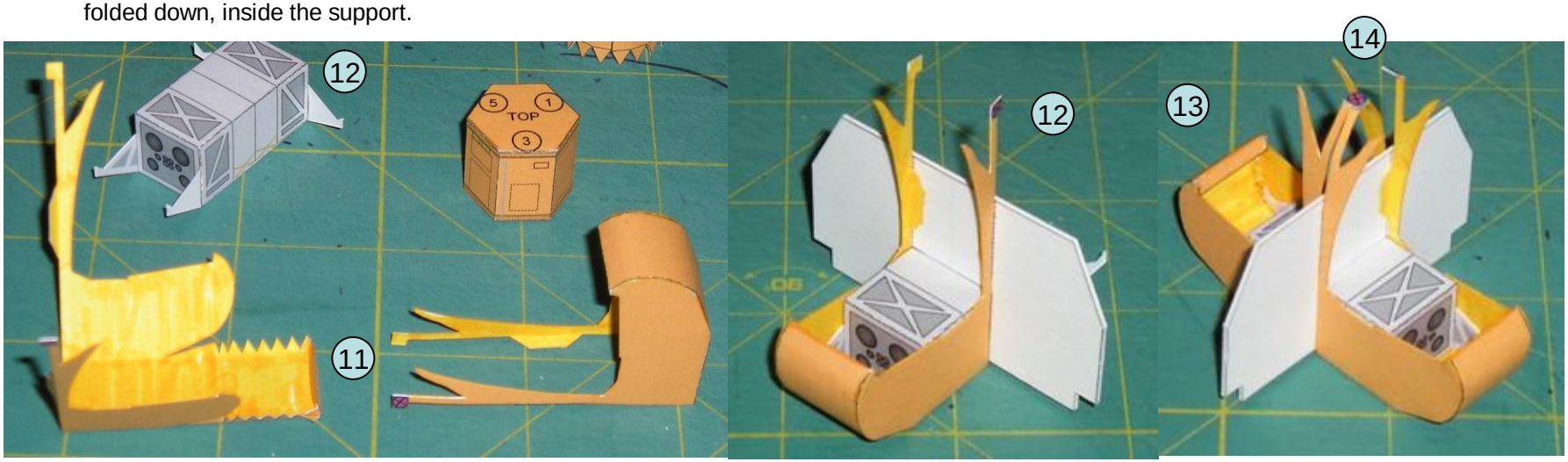
11. Cut out the reflector supports and fold all tabs downward (away from the printed side). Try and keep the long, thin struts straight. Pre-fold the ends of the bottom as indicated, then fold the sides up and, using the tabs, glue the bottom in place around the curved front of the sides. The last part of the bottom is folded down, inside the support.



12. Cut out the microwave feed assembly, fold into a box and secure. The “horns” on each end are folded up (toward the printed side) after the box is assembled. Carefully insert the feed assembly into one of the reflector supports, using the center line on the feed assembly to align the parts, then glue. Cut out the thermal reflector/radiator and glue to either side of thick card. Trim the center cut-out notch to fit over the feed assembly the glue in place. Use the tabs on the reflector support arms to attach the radiator, ensuring the reflector support arms are straight and aligned with the dotted lines on the thermal reflector/radiator.
13. Slide the remaining reflector support over the microwave feed assembly and glue in place, sandwiching the thermal reflector/radiator between. Glue the reflector support arms in place as you did with the first set.
14. Bend the small, square omni antenna supports at the ends of the reflector support arms down. Carefully bend the tops of one set of reflector support arms together, overlapping the omni antenna squares – then glue the squares on top of one another to secure. Bend in the omni antenna supports on the remaining reflector support arms, overlap with the assembly, and glue into place.

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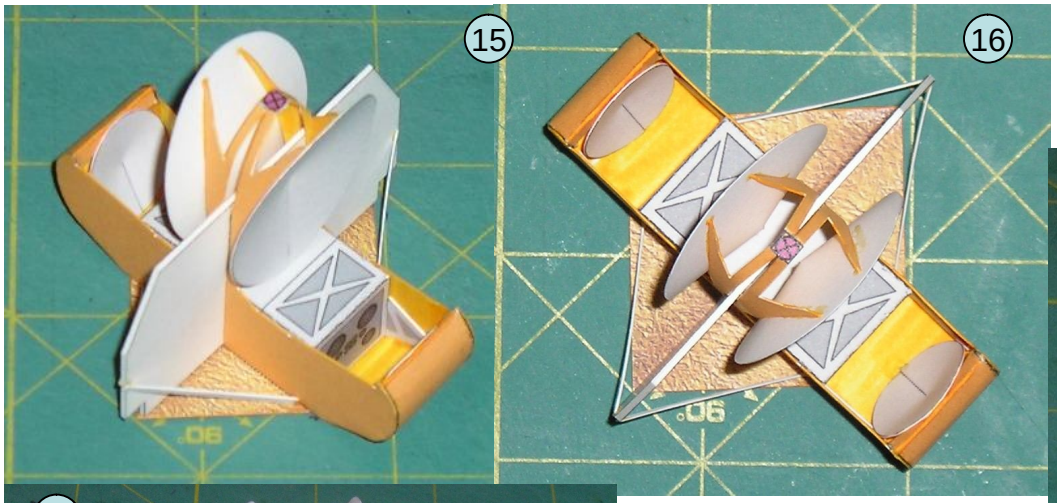
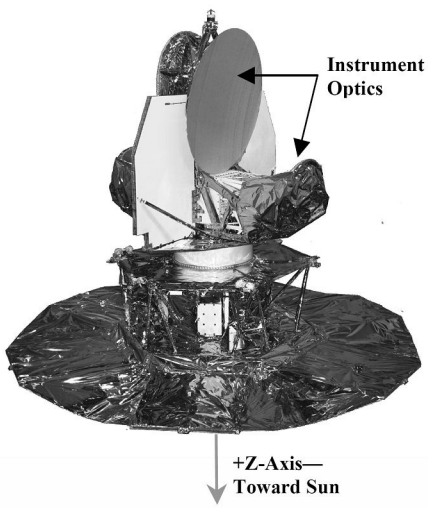
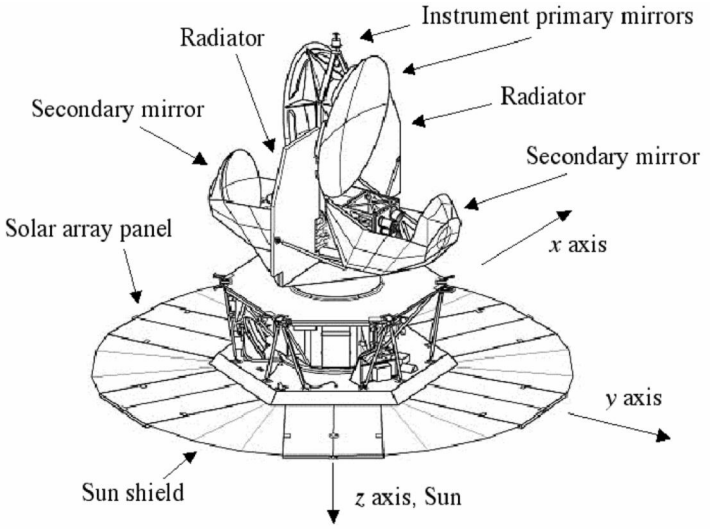
15. Study the location and orientation of the microwave reflectors on the diagrams – the long axis of the oval is vertical, note the angles of the reflectors. Cut out the primary and secondary reflectors. Form each into a shallow cone, overlapping to the dotted line and gluing. Apply glue sparingly to the edge of the top third of the reflector support arms and carefully glue the primary reflectors in place. Apply glue sparingly to the center of the lip at the forward opening of the reflector support and the bottom edge of the secondary reflector, then glue in place.
16. Cut out the optical table, fold and glue. Then, glue the microwave reflector assembly in place as indicated on the top of the table. Apply glue to the tabs on the top of the optical table pedestal and glue the microwave reflector assembly in place, using the dotted circle on the bottom of the optical table for alignment. The reflectors and feed horns should face bays 3 & 6 - aligned with the dark areas on the top of the shade.



Not to scale

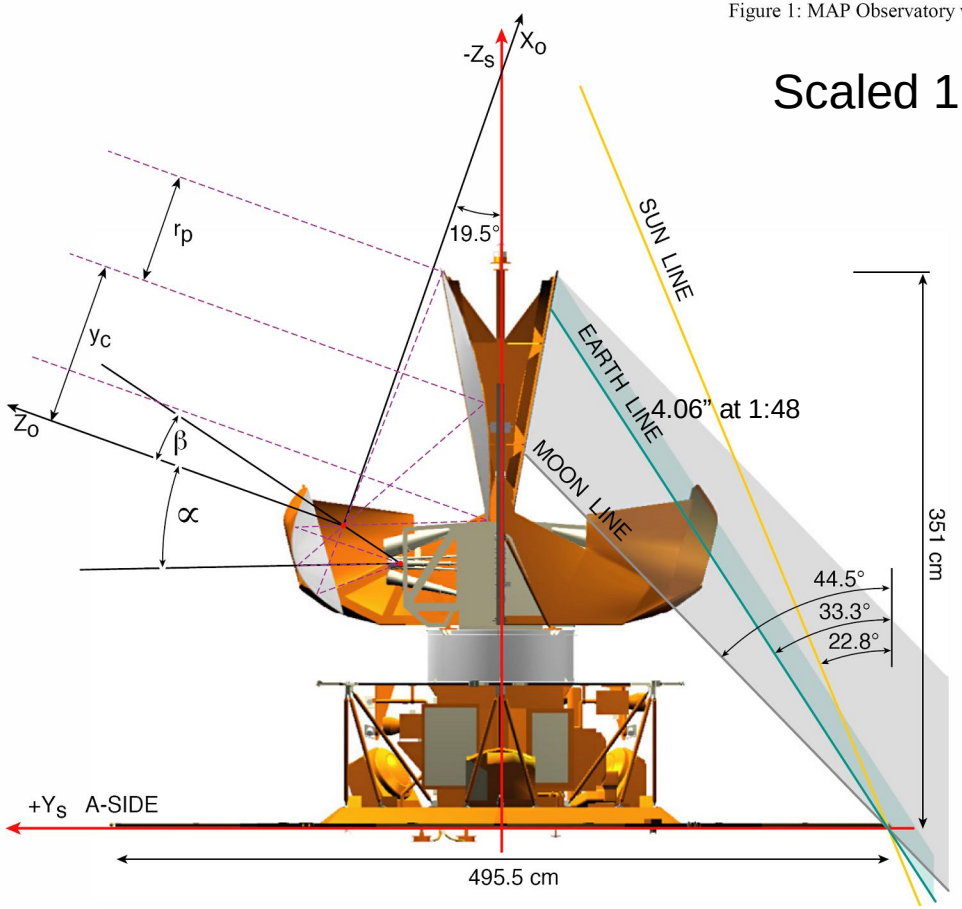


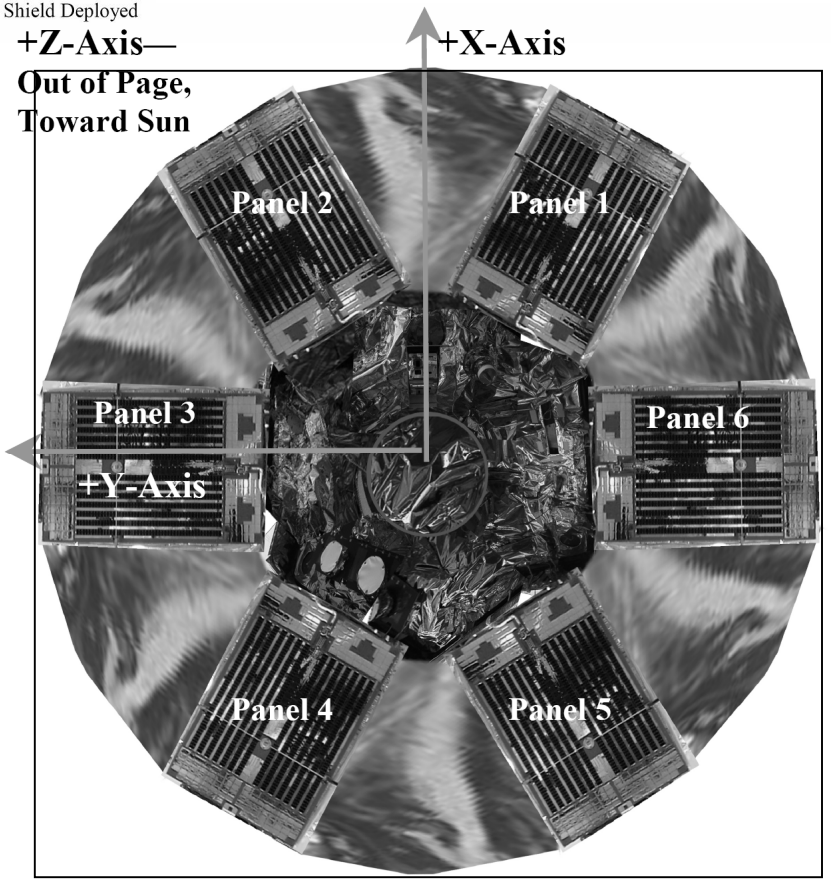


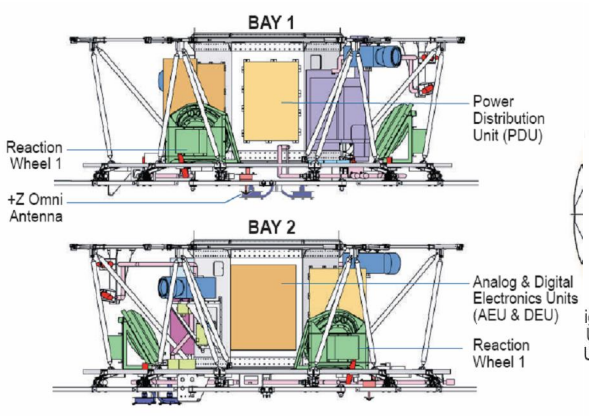
MAP Optical Design and Characterizatic

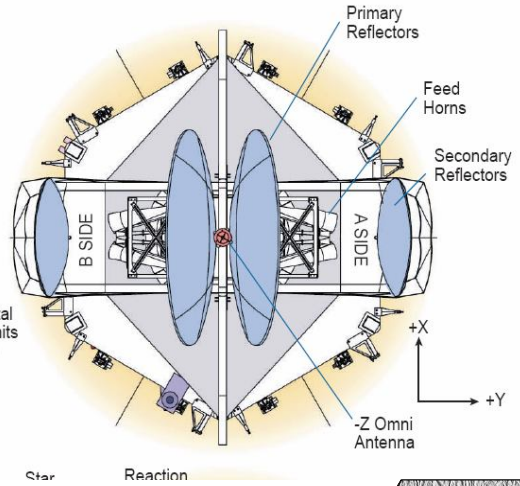
Figure 1: MAP Observatory with Solar Shield Deployed

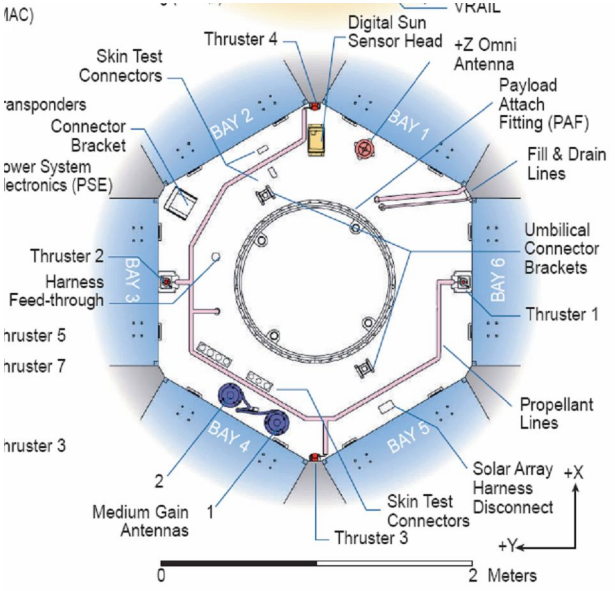
Scaled 1:48

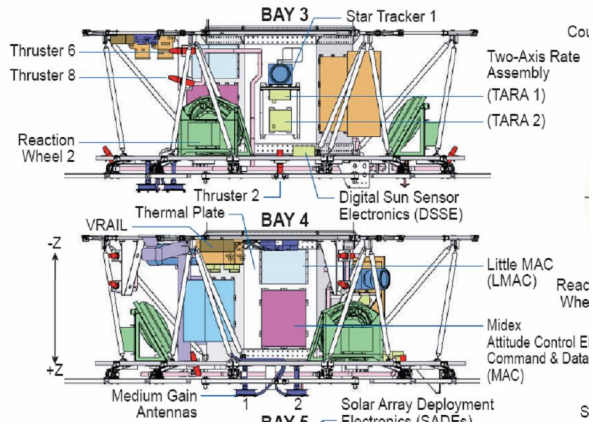


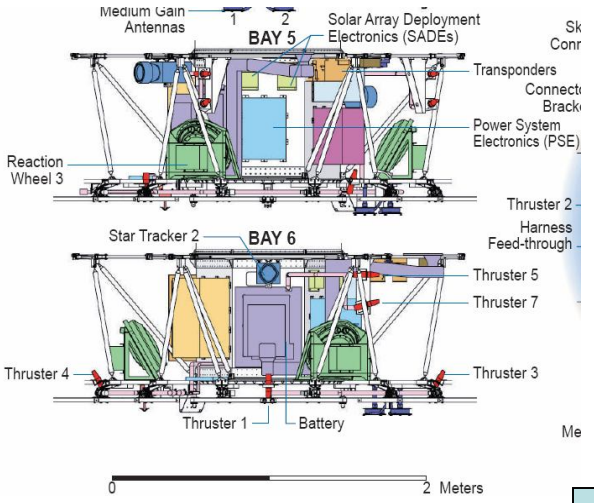


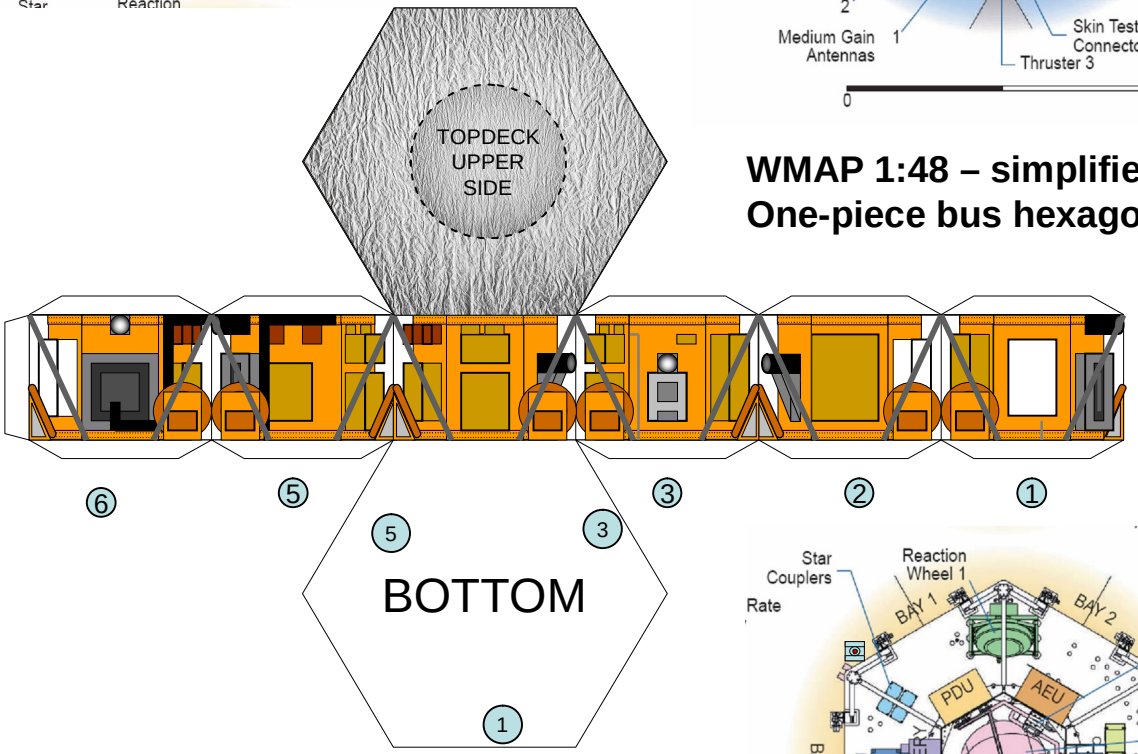




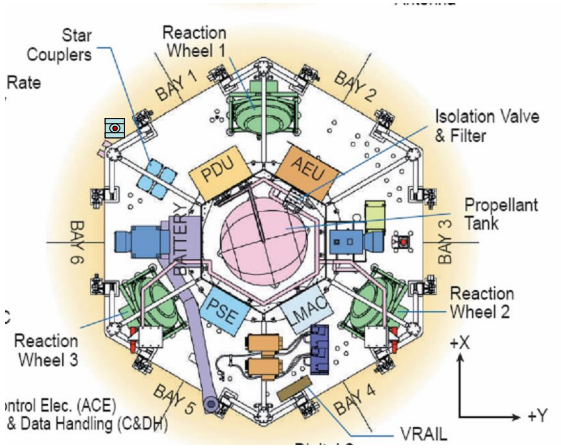








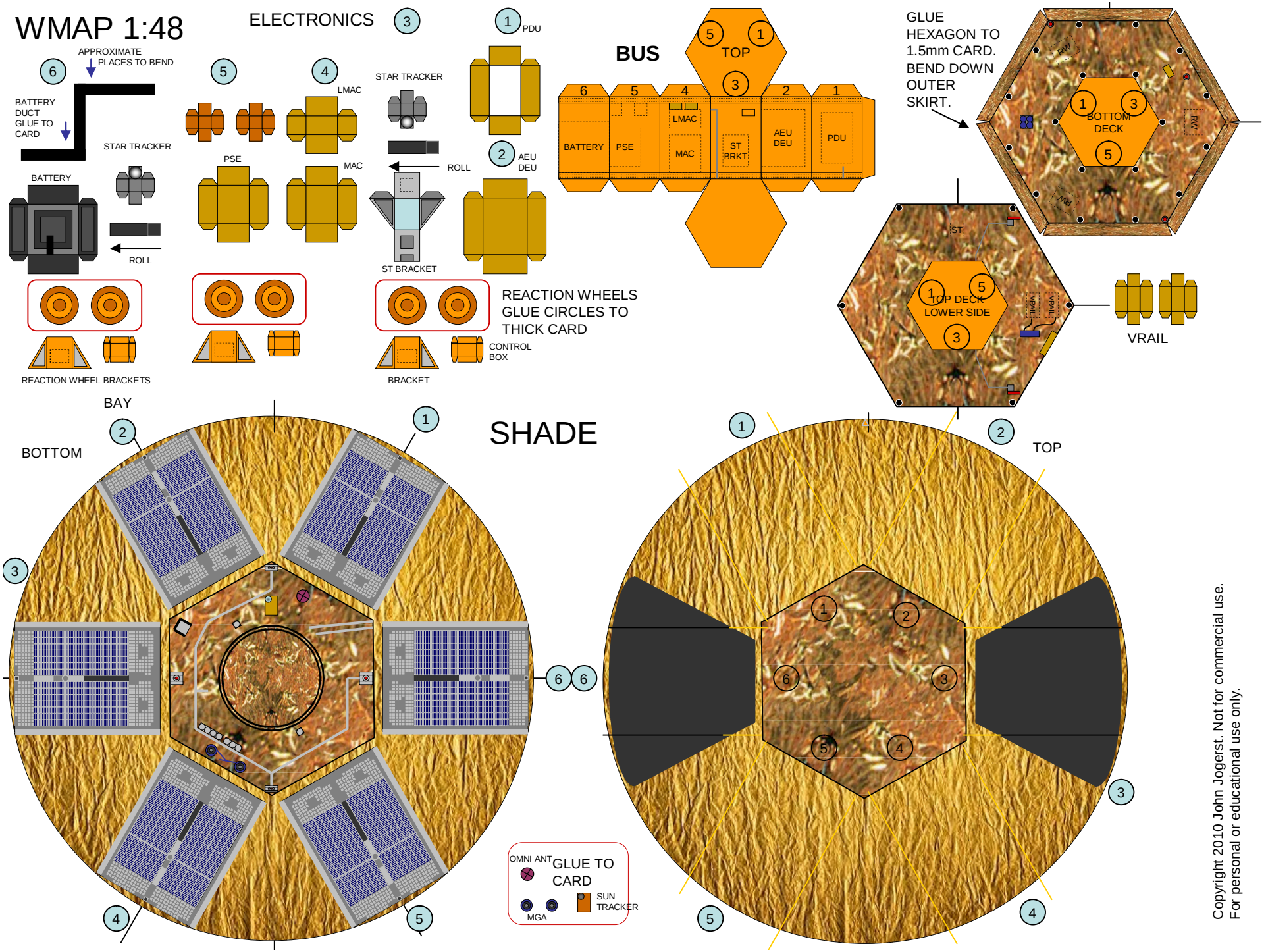
WMAP 1:48 – simplified parts. One-piece bus hexagon.



Note – two triangular areas of non-reflective paint added to top of shield in front of star trackers

pdf@147%; reductions 39% and 44%

WMAP 1:48



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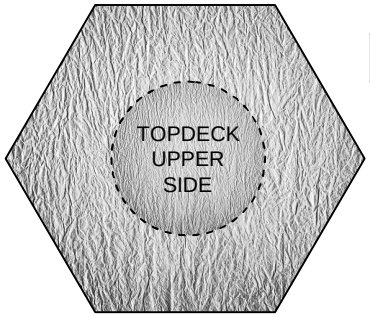
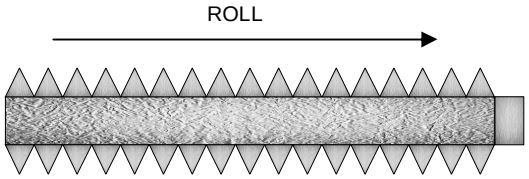
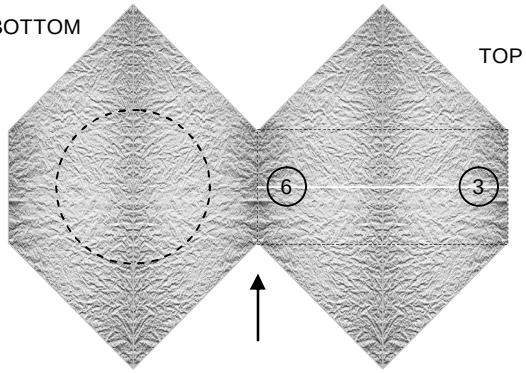
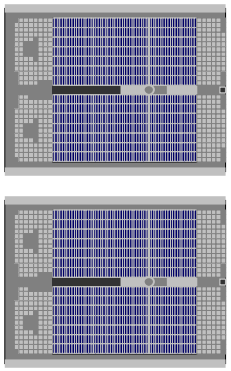




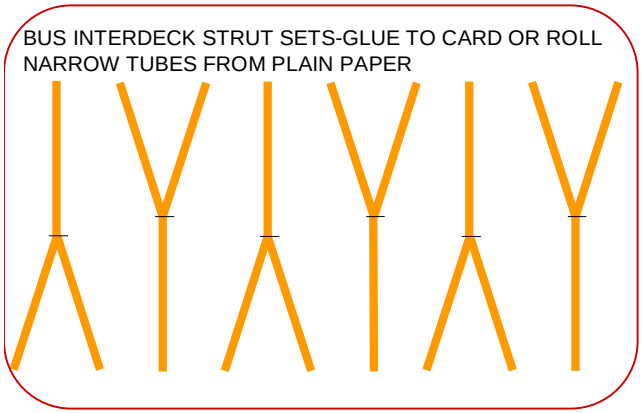
OPTICAL TABLE PEDESTAL

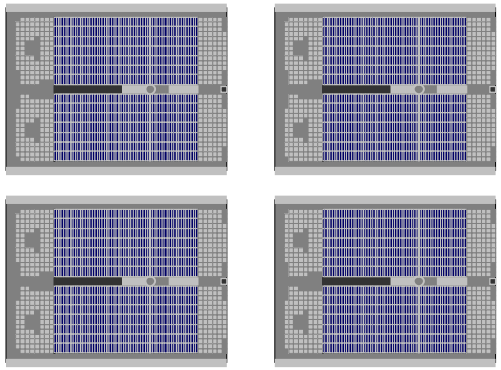
OPTICAL TABLE ALIGNMENT
FACES BAYS 3 AND 6

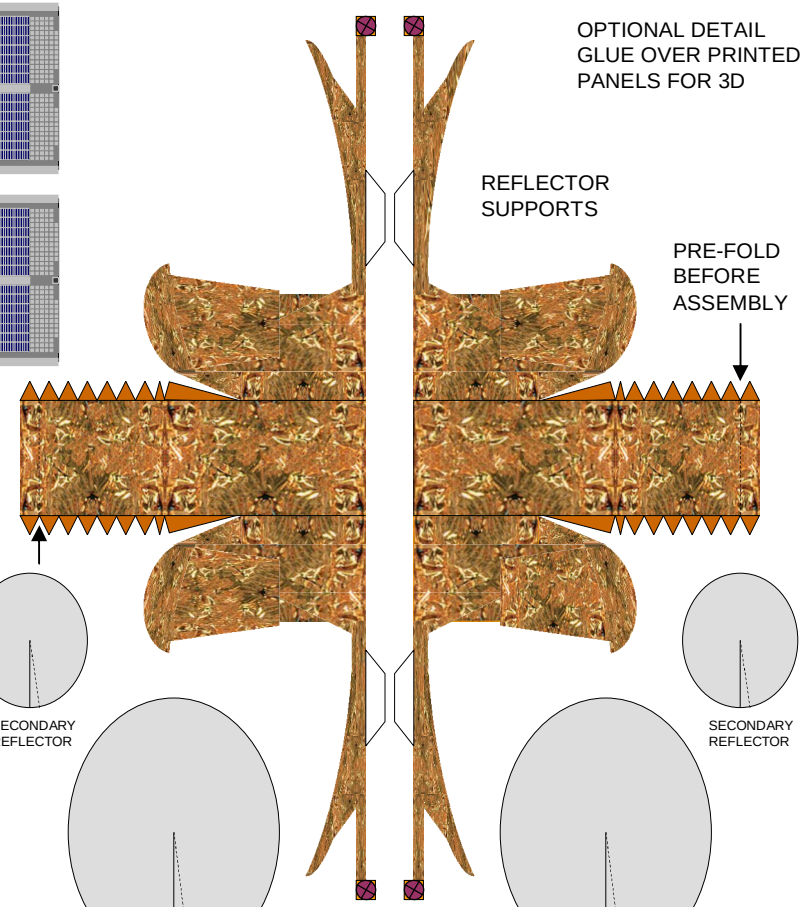




OPTIONAL DETAIL
GLUE OVER PRINTED
PANELS FOR 3D







THERMAL REFLECTOR/RADIATOR – GLUE TO 1mm CARD