

Assembly instructions for the [KAPtery Saturn V Rig Kit](#)

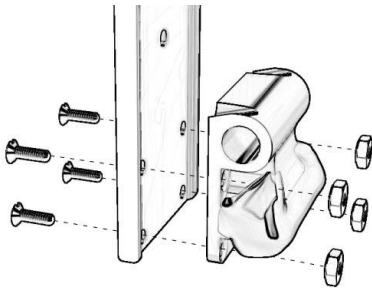
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The Saturn V Rig is a kite aerial photography rig designed to use two micro servos (small motors) to adjust the pan and tilt angles of the camera. The servos can be operated autonomously by an on-board microcontroller or remotely via radio control. With a camera (not included) on the rig you can capture photos to stitch into [high resolution aerial panoramas](#) or just take lots of photos in all directions.

This guide describes the assembly of the Saturn V Rig with two servos, a SkyShield autoKAP controller, and a small point and shoot camera. For larger color photos and the SkyShield assembly and use guides see [KAPtery.com/guides](#).

Assembly (time: 4 hours for kit version of Saturn V Rig with assembled SkyShield)

Step 1. Attach leg brackets to upper rig frame



- **Tools:** Small flat screwdriver
- Fasten four nylon screws and bolts for each bracket as shown.
- When convenient, attach the four oak dowel legs into the angled holes in the leg brackets. Insert the dowels **all the way in to the holes**.

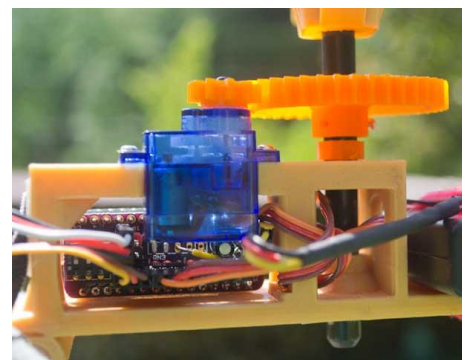
Step 2. Attach two servos to upper rig frame

Tools: Small Phillips screwdriver, pliers, thread locker. Two silver M2 bolts (very small) and nuts. Two screws (with attached “washers”) in the bag with the pan servo (Fitec).



Tilt servo: The EMAX servo fits in the rectangular hole in the side of the upper rig frame (left). It goes in “upside down” as shown. It gets attached with two M2 bolts and nuts (no washer). If the bolts seem too short, carve away a little plastic. A little thread locker (e.g., Loctite) on the nuts is recommended.

Pan servo: The Fitec continuous rotation servo (blue) sits on the brackets on top of the frame as shown (right). It gets attached with two self threading screws (they look like they have washers attached). Use the center holes in the lines of the three on the frame.



Step 3. Build and attach the Picavet

Glue the rod and cap to the shaft

Tools: super glue

The white vinyl cap and little metal rod get glued to one end of the 5" fiberglass shaft (the end with the hole farther from the end). Use superglue to glue the rod half way through the shaft. Be prepared to pound the rod into place before the glue dries (super glue sticks fast to fiberglass). The white cap slides on and could use a tiny bit of glue at the top to make sure it never comes off.



Attach eye screws

Tools: pliers

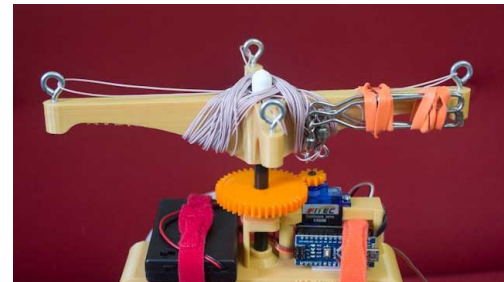
The Picavet line passes through four eyes on the top of the cross. The four eye screws should thread easily into the holes at the ends of the Picavet arms. Insert some string or wire into the holes first if the screws are loose. The eyes should be parallel with the long axis of the Picavet cross (see photo below).

Thread the Picavet line

Refer to the diagram on the last page to lace the 30 foot line through the four eye bolts, the two KAP-Snaps, and the small white nylon ring. During the lacing, it helps to have the KAP-Snaps attached several feet apart and several feet above the floor. Tie a really good knot to connect the ends of the line.

To store the Picavet line:

1. Join the two KAP-Snaps with a rubber band
2. Stretch the lines and wrap them around the Picavet cross (a figure 8 works well).
3. Secure the KAP-Snaps to the cross with a second rubber band.



To avoid tangles be vigilant about never letting the KAP-Snaps or the Picavet cross mingle unsupervised with the lines. Store the line as above as soon as a flight has ended.

Attach gear and spacer

Tools: small Phillips screwdriver

Insert the tiny lock washer inside the small gear before sliding it onto the nylon spline of the Fitec pan servo. Tighten the black self-threading screw firmly so the gear can't slip.



The photo above shows the order of things. Attach the assembled Picavet with the nylon washer and cotter pin beneath the rig frame. Use the easy cotter pin for testing -- the locking (bowtie) pin is harder to install and remove but is more secure for flying.

Hang the rig frame by the Picavet so the frame rests on the nylon washer above the cotter pin. Position the big gear (up and down) so its teeth are engaged with the small gear on the servo and the spacer under the big gear can **rotate freely**. Tighten the two set screws to lock the big gear on to the shaft. The spacer under the big gear keeps the shaft (and gear) from sliding down (so the two gears stay engaged).

For flying, the locking cotter pin is recommended at the bottom of the shaft because it is the only thing that holds the rig to the Picavet. The weight of the rig rests on (and turns on) the nylon washer above the cotter pin.

Step 4. Velcro

Tools: Scissors (Velcro may be cut to size already)

Two small pieces of adhesive backed Velcro hooks get applied to the Saturn V Rig frame. One piece has coarse hooks, one is finer. Press hard to set the adhesive.

1. One piece for the battery case: on the broad top of the frame (left side in photo).
2. One piece (with finer hooks) in front of the Fitec pan servo for the SkyShield.

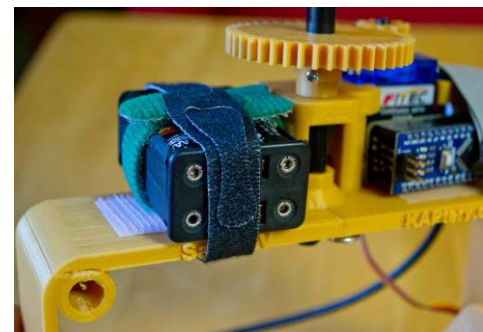
A small piece of adhesive backed Velcro loops goes on the SkyShield (the side near the row of yellow headers).

Three Velcro straps are included: one goes around the battery case itself (keeps the batteries in, wrap with the loops outwards) and one wraps around the battery case and the top frame to hold the case on the frame. One strap goes around the SkyShield and rig frame. These straps are in addition to the Velcro tape under the case and the SkyShield. Both Velcroing methods together make a secure attachment.

The camera USB cable has a piece of Velcro strap which can attach to the hooks of the strap holding the SkyShield. Make a big Velcro hug.

Step 5. Cables.

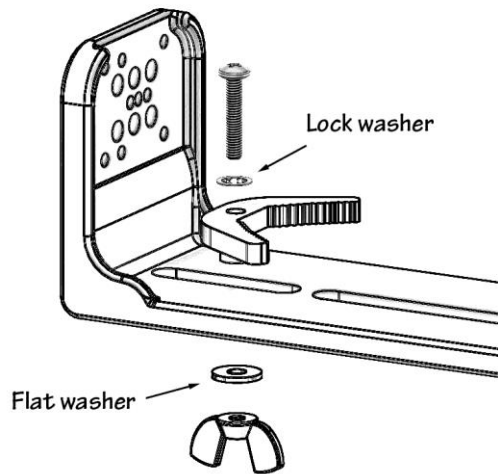
See the SkyShield Cable Guide for assembly instructions for the camera cable and battery cable connectors. See the SkyShield User Manual for instructions for connecting the cables.



The camera USB cable has a Velcro strap for securing to the upper frame. It can attach to the strap around the SkyShield (which can be wrapped with the hooks outwards and positioned so its end can grab the hooks on the camera USB cable).

Step 6. Prepare and attach the camera tray

Assemble camera grasper on the camera tray:

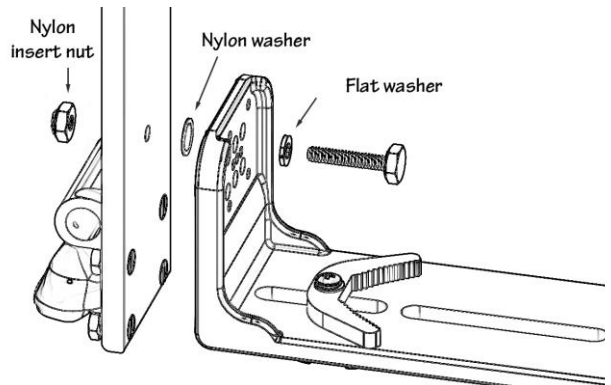


bolts and nuts (no washers). Attach the nylon bracket on the side of the tray which will contact the tilt servo (with camera pointed forward). Insert bolts from the nylon bracket side. If the bolts seem too short, carve away some plastic or nylon. Thread locker (Loctite) is recommended.

5. The fifth shiny M2 bolt and the washer connect the tray to the servo spline on the rig frame. Eventually the bolt should be tightened securely with thread locker, but the tray will probably have to be removed later for calibration so wait to tighten it.

Attach camera tray to the rig frame:

1. **Tools:** pliers, other pliers
2. Attach tray as shown with nylon washer between tray and frame.
3. Don't tighten the nylon insert nut all the way until you are sure you won't have to take it off again.
4. Eventually tighten the nut but make sure the tray can tilt freely (no resistance).

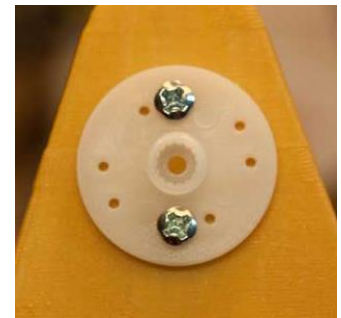


Check the side-to-side position of the camera on the camera tray:

To ensure that the rig will hang level (side-to-side) when the camera and all the gear are on board, attach the full battery case and SkyShield. Mount the camera (with batteries) on the tray. Balance the rig on a finger under the bottom end of the Picavet shaft (make sure the KAP-Snaps don't skew the balance). Move the camera and battery to balance the tray and tighten the tripod screw. Slide the camera grasper against the camera and tighten the thumbscrew. If you will be using the USB port on the camera to trigger the shutter, make sure it will be accessible when the camera is mounted.

Attach servo spline bracket to the camera tray:

1. **Tools:** drill, drill bit the size of the M2 bolts, Phillips screwdriver, pliers, Loctite, shiny M2 bolts and nuts (the same bolts hold the tilt servo on).
2. Enlarge two holes opposite each other in the white circular nylon bracket with a small drill bit.
3. Select one of the six pairs of holes in the camera tray that allows the camera to tilt around the axis through its center of mass (with the lens extended). The slot for the tripod screw is not centered, so pointing the camera in the opposite direction will also produce a different front-to-back balance.
4. Bolt the nylon



Calibrating the tilt angle:

When the camera tray is attached onto the servo spline, the tilting angles could be incorrect. So the tilt of the camera tray relative to the servo spline will have to be adjusted by running the SkyShield to observe where the upper and lower tilt positions are. This is easy and just requires watching the rig as the SkyShield operates the tilt servo. Until you perform that step, don't bother to tighten the M2 bolt into the servo spline or use thread locker.

The goal is to have the lowermost tilt position point straight down. However, the teeth on the spline are not fine enough to allow precise adjustment of the camera angle, so the angle will probably have to be fine-tuned by modifying the Arduino sketch. See the [SkyShield user manual](#) for details.

Step 7. Configuring legs and bumpers

The four oak legs protect the camera from dirt and wet grass during setup and against hard landings. Five pieces of polyethylene tubing are included for extra camera protection. The long piece can go behind the camera (either high or low) and form a half loop. The four short sections can go in front of the camera without getting in the photos (curve them outwards).

To ensure that the curved tubing does not rotate in the cylinders and curve inward (in front of the lens), a small screw can be inserted through each plastic cylinder to lock the tube in place. These screws are included, and holes are present in the upper cylinders and the leg bracket cylinders.



Step 8. Mounting the SkyShield

The assembled SkyShield controller is secured on the Saturn V Rig with Velcro. First pass the connector end of the wires (two servo wires, camera cable, and power) under the Fitec servo and plug them into the SkyShield (see SkyShield User Manual).

Adhesive Velcro (loops) on the bottom of the SkyShield mates with adhesive Velcro (hooks) on the top of the Saturn V frame. Place the SkyShield on the Velcro loops so it is close to the Fitec servo. Wrap an 8" Velcro strap around the frame with the hooks outwards. Secure it so the free end can mate with the Velcro strap on the camera cable, which can in turn mate with the front part of the 8" strap.

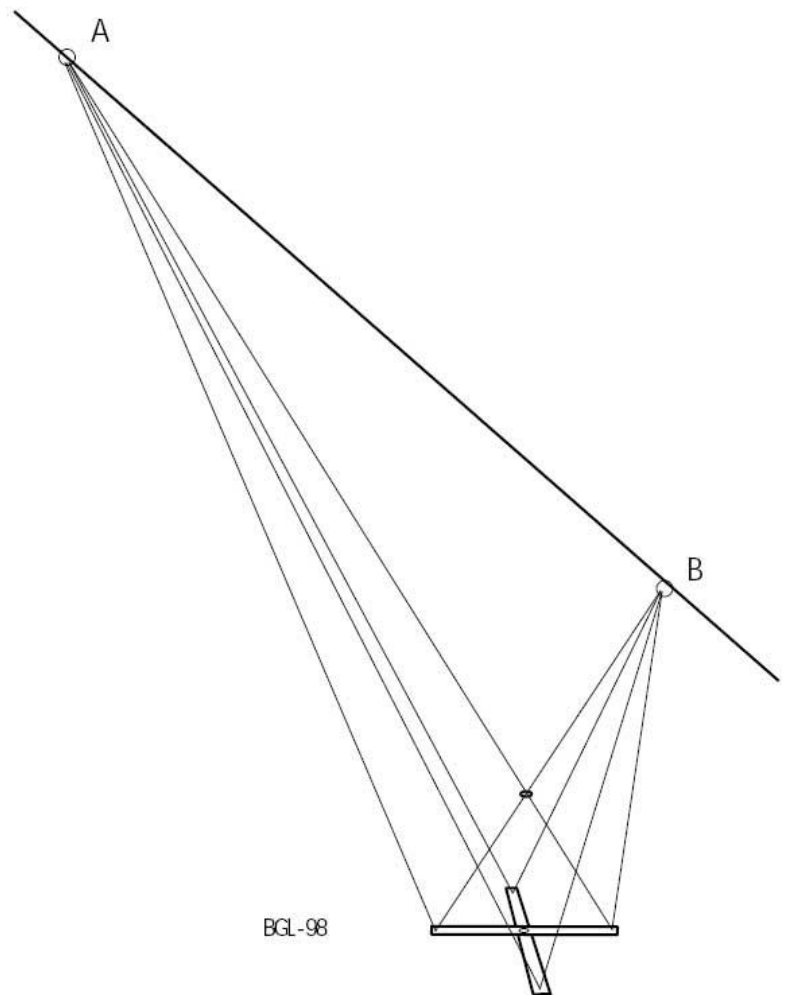


The 8" strap wraps over the servo bracket. Its free end can hug the Velcro of the camera cable which can hug the front of the 8" strap.

Lacing diagram for a Picavet suspension

After Brooks Leffler. Adapted from a design by Pierre L. Picavet, France – 1912

- A and B are mounted 5 - 6 ft apart.
- Be sure the line runs freely through points 1 to 4.
- The line can also run freely through A and B, or the line ends can be tied to A or B.
- The long axis of the Picavet cross (3 to 4) is perpendicular to the kite line.



- The camera hangs below the Picavet cross.
- The long axis of the cross is 3 to 4.
- The cross is connected to the flying line by a continuous 30 foot length of braided Dacron® line.
- KAP-Snaps or other attachments are clipped on the flying line at A & B.
- Screw eyes are at 1 through 4.
- The suspension line is passed through A, then laced as follows:
A – 1 – ring – B – 2 – ring – A – 3 – B – 4 and back to A where the two ends are tied together or tied to A.

