

# USING THE FLEXURE TEST JIG

## Spartan Infrared Camera for the SOAR Telescope

Miles Loh  
Edwin D. Loh  
Department of Physics & Astronomy  
Michigan State University, East Lansing, MI 48824

[Loh@msu.edu](mailto:Loh@msu.edu)

517 355-9200 ext 2480

6 September 2005

The Flexure Test Jig holds the instrument and allows it to rotate as if it were attached to the instrument support box of the SOAR Telescope. Rotating the instrument is difficult and dangerous. This describes the rigging for mounting and rotating the instrument.

### 1 Purpose

The flexure test jig holds the Spartan Infrared Camera (Figure 1) and allows it to rotate as it does on the telescope. This will be used to test whether the image of a fake star on the mask moves when the orientation changes.

The instrument must be lifted off the ground and inserted into the slot on the jig. For the flexure test, the instrument must be rotated in the jig over nearly  $360^\circ$ . After the test, the instrument must be removed. This document describes the procedure for lifting the instrument into the jig, removing the instrument from the jig, and rotating the instrument



Figure 1 Flexure test jig with instrument rotated to  $-176^\circ$ . The axle (A) on the instrument rests in the slot (S) of the test jig. The hoist (H) holds the lifting bar (L). A rope is attached on either beam P (P) or beam N (N) to reconfigure the hoist.

in the fewest number of steps within the confines of the hoist and the room.

The angle is zero when the window faces up, and from the viewpoint of Figure 1, a clockwise rotation is positive. In the jig, the instrument hangs freely at  $-11^\circ$ ; this is defined as the base position. Rotation of any angle between  $-176^\circ$  and  $167^\circ$  can be reached. Rotation beyond those limits is unsafe.

Beam P refers to the beam that is facing up and accessible for positive rotation, and beam N refers to the beam that is accessible for negative rotations.

## 2 Method

Load limits:

- The instrument weighs about 600 lb.
- The limit of our  $\frac{1}{2}$ -in rope is 280 lb. To hold the entire instrument with the rope, you must double the rope: a single rope holds  $\frac{1}{4}$  of the load.
- The breaking strength of a #05516 Keeper ratcheting tie-down is 3000 lb.<sup>1</sup> It may be used in place of the rope.
- The limit of our straps, Wear-flex EN1-0601, is 2200 lb. When the load is divided four ways, as in Figure 2, the limit is 8800 lb, which is very safe.

### Safety Blocks

**Danger: You must install the safety blocks, which capture the axles. Without safety blocks, the axles may jump out of the slot, if the lifting is cocked. Screw in the safety blocks.**

### Using the Rope

The rope hangs over the I-beam so that both ends can be tied to the instrument. On one end, tie a bowline, which can be slipped over an attachment point. Tie a clove hitch on the other side. This knot should be retied each time to adjust



Figure 2 Safety block captures the axle

---

<sup>1</sup> Keeper Corp, Windham, CT, [www.keepercorp.com](http://www.keepercorp.com)

the length. The rope will not always slide on the I-beam so that it is directly over the load. If the rope is not directly over the load, the jig may tip over. If the rope sticks, push it along so that the hangs vertically.

## Using the Straps

The straps are in three lengths: 30, 40, and 50 in. Often, the hook-to-strap attachment is described in “cradles.” The number of cradles refers to the number of layers of strap the hook holds. Figure 3 demonstrates two cradles with one strap. Figure 5 shows 4 cradles.

The rigging for moving the instrument is described in summary form in Table 1 and in detail below.

Table 1 Summary of rigging

<u>Application</u>	<u>Method</u>
Installing in jig; step 1	Rope on right lifting rod. Hoist on two 40-in strap on lifting rods.
Installing in jig; step 2	Rope on right lifting rod. Hoist on 40-in strap on beam P.
Removing from jig; step 1	Rope on upper lifting rod. Hoist on 40-in strap on upper beam.
Removing from jig; step 2	Rope on upper rod. Hoist on two 40-in strap on lifting rods.
–11° to 8°	Hoist on two 50-in straps one on each end of beam P.
Switch at 8°	Rope tied to upper lifting bar.
8° to 100°	Hoist on one 40-in strap, one end on each end of top bar.
Switch at 100°	Rope tied to both ends of the upper lifting bar.
100° to 167°	Hook on lower bar. Rope tied on one end of upper beam, looped on other end, one person pulling in slack as the instrument is raised.
Switch at –11°	No ropes are required; the jig will hold the instrument.
–11° to –100°	Two 30-in straps, one on each side of beam N. Hoist on strap on lifting bar.
Switch at –100°	Rope tied to ends of the upper lifting bar
–100° to –176°	Hoist on lower lifting bar

### Lifting from the Ground to the Upper Slot of the Jig

1. From resting on the ground to hanging on the rope. Loop one 40-in strap on one side of the two lifting bars; loop another 40-in strap on the other side. Put the straps in the hook of the hoist (Figure 5). Lift as high as possible. Tie the rope to one lifting bar. Lower the hoist until the rope holds the entire instrument.
2. From hanging on the rope to resting in the jig. Loop a 40-in strap to the upper beam. Put the two cradles in the hook of the hoist. Lift to raise the axles so that they are slightly below the slots of the jig. Tip the test jig to put the axles into the slots.
3. Screw in the safety blocks (Figure 2).
4. The instrument is now at either  $+100^\circ$  or  $-100^\circ$ .

### Rotation to a Positive Angle from the Base Position (from $-11^\circ$ to $167^\circ$ )

1.  $-11^\circ$  to  $+8^\circ$ : Link two 40-in straps and loop the ends on beam P. Attach to hoist.
2.  $+8^\circ$  to  $+100^\circ$ : Tie the rope to the inside of the upper bar. Lower the instrument until the rope holds the load. Remove the straps. Loop end of a 40-in strap to the bar (Figure 3). Attach the hook to the two cradles of the strap. Lift until the load is on the straps and no longer on the rope, and then remove the rope.
3.  $+100^\circ$  to  $+167^\circ$ : Tie the rope to the upper bar. Lower until the rope holds the load. Remove the hook and replace directly onto the middle of the upper bar. Lift until the load is off rope, and then remove the rope. Tie one end of the rope to one end of beam P. On the other side of the rope, form a loop around the other end of beam P (Figure 4). One person must hold the rope and slowly give slack as the instrument is lifted.



Figure 2 Strap attached to a lifting bar



Figure 4 rope looped around beam P while lifting to a high angle.

Do not lift past  $167^\circ$ . Above this point, there is a danger that the center of mass passes over the pivot point resulting in a violent swing. The purpose of the rope is to act as a safety, stopping such a swing. Rotation beyond that angle is not safe.

### **Rotation to a Negative Angle from the Base Position (from $-11^\circ$ to $-176^\circ$ )**

1.  $-11^\circ$  to  $-100^\circ$ : Loop two 30-in straps to beam N, one on each end and attach the hook to two cradles (Figure 3).
2.  $-100^\circ$  to  $-176^\circ$ : Tie rope to both ends of upper bar. Lower until the load is on the rope and the chain is slack. Remove the hook and replace directly onto the middle of the lower bar. Lift until the load is no longer on the ropes, and then remove the ropes.

In this direction the instrument may be lifted as high as the chain allows since the center of mass of the instrument cannot pass over the pivot.

### **Removing the Instrument from the Jig**

1. Put the instrument at either  $+100^\circ$  or  $-100^\circ$ .
2. From on the jig to hanging on the rope. Tie the rope to the upper lifting bar. Lower the weight onto the rope. Loop a 40-in strap to the upper beam. Put the two cradles in the hook of the hoist. Lift to raise the axles out of the slot of the jig. Lower until the rope holds the entire load.
3. From hanging on the rope to resting on the ground. Loop one 40-in strap on one side of the two lifting bars; loop another 40-in strap on the other side. Put the straps in the hook of the hoist (Figure 5). Lower until the instrument is on the ground. Make sure that nothing scrapes the ground on the way down and that the instrument lands flat. If anything does scrape on the side with the rope, the instrument must be replaced in the jig and raised slightly to raise the lifting bar. If anything does scrape on the other side, then the instrument must be replaced in the jig and slightly lowered to lower the lifting bar.



Figure 5 Lowering the instrument from hanging on a rope to resting on the ground using four cradles.