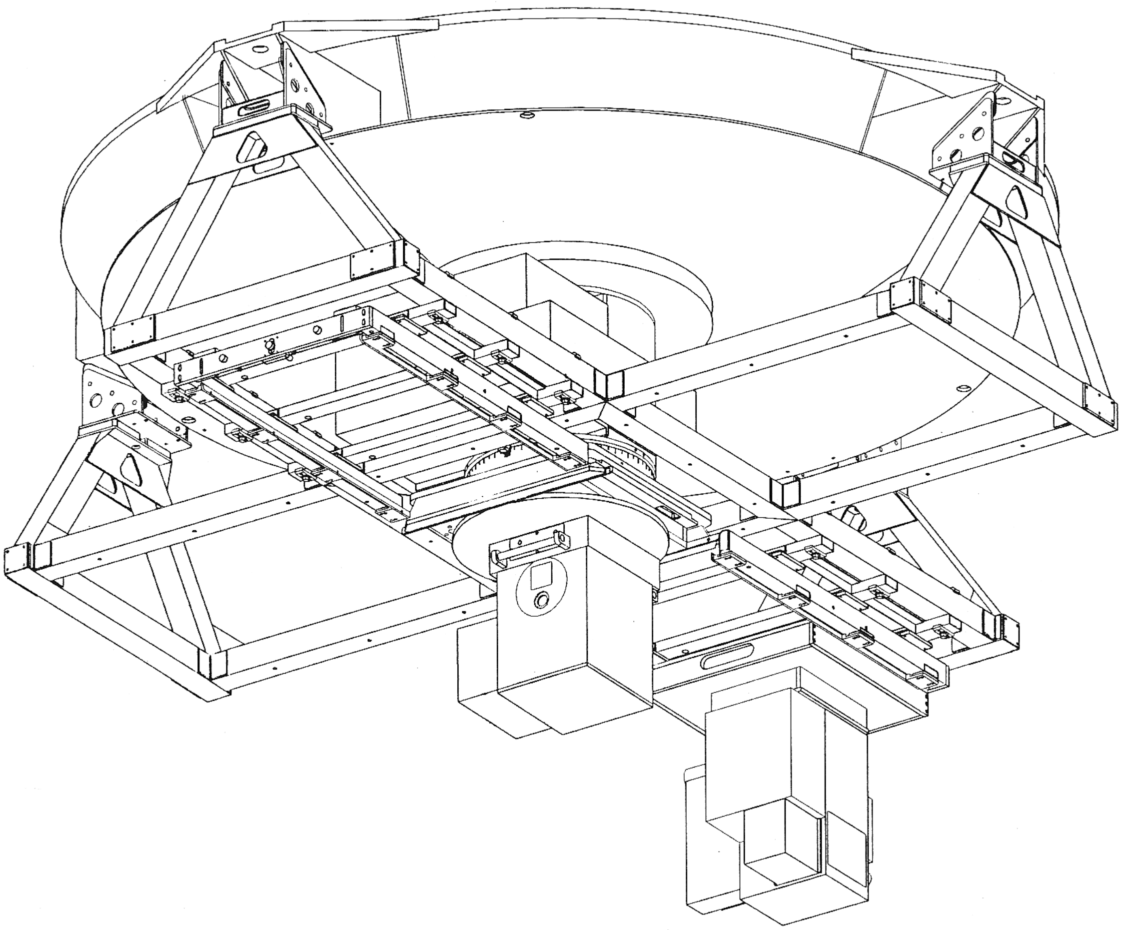
Instrument Interface at the NASA Infrared Telescope Facility



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Introduction

The IRTF, being a community facility is required to support a variety of focal plane instrumentation built by the IRTF staff and visiting groups. This document provides the information required for interfacing an instrument with the IRTF. A new Multiple Instrument Mount (MIM) was installed in July of 94 that accommodates 4 large instruments and it is assumed that virtually every instrument will interface to the telescope using MIM.

Mechanical Interface

Multiple Instrument Mount (MIM) Overview

The MIM is an instrument shuttle system that allows up to 4 large instruments to be simultaneously mounted radially on the bottom of the telescope. Refer to figures 1 and 2 for illustrations of the MIM system. The instruments are mounted on rail supported trucks that allow any instrument to be rolled into the center, or active, position. In the center of these four instruments are rails mounted on a rotator. The center section is rotated to point toward one of the instrument bays to allow that instrument to be rolled into the center position. The design is similar in concept to a railroad car turntable. MIM allows several important improvements. Telescope scheduling can be much more flexible since block scheduling of facility instruments is not required. Facility instruments can be left mounted and cabled for long periods of time improving reliability. Visitors will be able to mount and check out their instrument before the afternoon of their first night which should make the first night much more productive.

MIM Components and Terms

MIM is composed of three major subassemblies those being the overall frame called the Quadmount, the Rotator mounted in the center and the Instrument Modules. Each of the major components of MIM is described below as well as sections for the bolting interface and the allowable size.

Quadmount

The Quadmount is shown in figure 3. It is a frame structure made from welded steel 4 inch box tubing. The job of the Quadmount is to hold the four instrument modules in proper alignment with the rails on the rotator. Instrument modules are mounted to the Quadmount using 6 bolts. The quad mount is designed to hold four five hundred pound instruments and is bolted to the telescope at the four truss points in the mirror cell to minimize any bending of the mirror cell. By removing 4 bolts, one at each truss point, the entire MIM assembly can be removed as one piece with all four instruments mounted. This would probably only be done during a recoating of the primary mirror.

Rotator

The rotator, which is shown in figure 4, has two purposes. One is to rotate the rails mounted on the rotator to align with one of the 4 stored instruments to allow it to be rolled into the center position. The second is to rotate an instrument centered on the optical path as in the case of a slit spectrograph. Four clamps are used to secure the rotational position for observing. There is a surface where a visible degree readout will be added. Provision has been made for a motor drive and digital readout of position but this has not yet been implemented.

Instrument Module

The instrument module is defined as the assembly including the electronics racks, instrument module frame with rails, the truck and the cryostat. A diagram of a typical instrument module is shown in figure 5. For IRTF Facility Instruments everything required to run the instrument will reside within the instrument module. The module can be removed as an assembly for extended service or warm room engineering. Visitor electronics may be mounted using the instrument module electronic racks or an external rack bolted to the Quadmount or mirror cell. Each instrument will have its own needs and will be handled case by case. To determine the best scheme for mounting visitor electronics contact the day crew with the amount of 19 inch rack space needed, the required distances from the electronics to the cryostat and whether you intend to use your own rack or request to use one of ours.

Module Frame

The Module Frame is shown in figures 6 and 7. The Module Frame is the back bone of the instrument module. The electronics racks are mounted to the top of the frame and the rails that hold the trucks are mounted below. The frame is attached to the Quadmount with 6 bolts. The Transporter, described below, can be bolted to the Module Frame and then when the 6 bolts are removed the instrument module can be lowered out of the Quadmount.

Electronic Racks

Each of the four instrument modules is equipped with one or two 19 inch racks for instrument electronics. The electronics do not slide with the instrument but are fixed with respect to the mirror cell. This was done to minimize moving mass and balance problems. Because of interference with the guide and acquisition camera systems, the East and south MIM instrument positions have only one rack. At this time the South position is the visitor position and has only one rack. The racks used are Gichner Optima Enclosures. They are a frame type with no sides top or back. The usable rack space is

21.12 inches for each rack and the depth is 24.40 inches. A variety of other options exist for mounting electronics. Contact the day crew if you have special requirements.

Truck

The truck is shown in figures 8, 9 and 10. The truck is a squat box with 6 wheels on the sides. The wheels are metal and have a groove in their center that rides on the V shaped rails. The truck as well as all of the MIM components were specified to handle an instrument with a 500 LB mass at a center of gravity of 24 inches from the mounting surface. When rolled into the center position the truck is bolted into place by 4 large bolts. The cryostat mounting bolt pattern on the bottom of the truck is identical to the original bolt pattern on the bottom of the offset guider spacer so that visitors that mounted to the offset guider before will have no trouble mounting to one of the trucks.

Transporter

The Transporter is a frame with wheels, shown in figure 11. That can be bolted to the Module Frame allowing the Instrument Module to be removed and rolled around as a unit.

Instrument Mounting Bolt Pattern

The truck bolt pattern that is the cryostat mounting bolt pattern is shown in figure 12. Please note that this is the view you would see lying on the floor looking up at the mounting plate. Two bolt circles have been provided to accommodate large and small instruments. The holes in the truck are threaded so the holes in the instrument mounting plate should be clearance holes.

Size Envelope and Weight Budget for Visitor Instruments

Visitor and facility instruments will be allowed an area defined by a 4 foot cylinder centered on the optical path 68 inches long. This insures no conflict with other instruments. The 68 inch dimension would come 2 inches from the movable floor platform and should be considered a maximum. Since that platform does not always go all the way down a design instrument length of 60 inches or less would be better.

MIM is designed to handle instruments that weigh up to five hundred pounds. Our present instruments are all more in the 250 lb. range. Different procedures, especially for balance, may be required to handle heavier instruments. Visitors with instruments weighing between 250 and 500 lbs. should make this known to the day crew prior to their run. Additionally all visitors should inform the daycrew of their instrument weight so that balance issues can be worked out ahead of time.

Optimum Focus Position

A new secondary is being manufactured for the IRTF to reduce spherical aberrations. This secondary will define a position in the focus dimension where aberrations are minimized. New instruments should be designed to focus as close as possible to this position for two reasons. First the images are best at this position although a range of 5-10 inches on either side of focus will probably not degrade the images as other aberrations such as primary figure will dominate. Especially at longer wavelengths the focus range is probably quite large. This problem should be considered carefully and answered with ray tracing if the desired focus position is far from the best focus position. The table below shows the optical constants for the telescope. The numbers in the table are estimates for the new secondary. If you have very exacting requirements you should check with the IRTF staff for the most up to date numbers. The second reason for designing near our optimum focus position is that our acquisition and guide cameras will work best there. The diagram in figure 13 shows the position of the optimum focus with respect to the mounting surface.

	Curvature (mm)	Conic constant
Primary mirror	15284.45	-1.000
Secondary mirror	1330.8747	-1.3146270
Distance from the secondary to the primary		7022.226 mm
Distance from the secondary to the ideal focus		9079.626 mm
Secondary diameter		244.0 mm
Primary diameter		3200.4 mm actual size
		3094.0 mm as defined by se
f#		37.212
Plate Scale		1.8430 arcsec/mm

Electrical Interface

AC Power Budget

Presently the total power available for instrumentation and hardware on the telescope is 45 amps or 5,400 watts. Unless special arrangements are made visitor instruments will be budgeted 10 amps or 1200 watts of AC power on the telescope. This power is supplied from our UPS and is conditioned. Power dissipated at the telescope focal plane area should be minimized to avoid image degradation.

Coax Lines to Control Room

The IRTF has coax RG-58 cables running from the bottom of the telescope to the observer's area in the control room. The length of these cables is approximately 250 feet. Visitor instruments will be allowed to use up to 9 of these cables. Beyond that the visitor must supply their own cables that will be run on the floor out to the telescope. Cables for this purpose should be 100 feet long.

Chopper Drive

Instruments can control the chopper directly. The chop transition is driven by a zero crossing signal at it's input. We have an adapter box that will accept any signal between -10 and +10 volts. TTL works fine. Chopping distances can vary from 5 arc-seconds to 5 arc-minutes, while chopping frequencies vary from 30 Hz at the short throw distance to 5 Hz at the long throw distance. The chopper can also be rotated from 0 to 90 degrees for special chopping needs. As this chopper was designed for use with photometers performance is marginal for imaging applications. Ripple on the wave form can be as high as .5 arcseconds and changes with chop frequency and throw. If your application demands high performance chopping you can request a picture of the chop waveform at your chop frequency and throw.

Tip/Tilt Secondary

A new Tip/Tilt secondary system will be installed in the fall of 95. This will allow stabilized images for instruments that can interface with the Tip/Tilt star position sensor. The new secondary will allow chops of up to 15 arcseconds and will replace the old chopper for all projects with 15 arcseconds or less chops. As it is still being built details on this system will be covered in a separate document.

Computer Interface

Network Connections

Connections for visitor computers to the IRTF ethernet network are provided. On the bottom of the telescope a thin net connection is available and in the control room both thin and thick connections are available. Contact the IRTF network administrator for details concerning the connection of your machine.

Telescope Control Computer Interface

Control of telescope functions and readout of telescope data is available to visitor instruments through two methods. One is a serial port and the other is via the network. The specifics for use of these ports are contained in a separate manual called Telescope

Control System to Instrument Computer Software Interface (in preparation 11/94) available from the IRTF main office. The telescope's beamswitching function can also be controlled with one or two bnc connections to the TCS, momentary switch closures on these lines can make the telescope beamswitch. This option will be eliminated when the TCS gets upgraded in 1995/1996, but more access ports will be available.

Acquisition Cameras

Two standard cameras are provided by the IRTF for acquisition and guiding and a third to be added to support the new tip-tilt secondary. These systems are undergoing a lot of change right now so you should check with your support scientist for up to date information. See figures 14, 15 and 16.

On-Axis Camera

The On-axis Camera is an ISIT camera made by Scanco. It is fed by a pick off mirror that slides in to intercept the beam that would have gone to the IR instrument. The optics in front of the camera is a relay lens which also produces an image of the entrance pupil, see figure 17. This assembly of lens and camera must be moved 1 inch for every inch of focus change so its travel is limited. Presently we can support a focus of 14 inches shorter and 1 inch longer than the optimum NSFCAM 1:1 focus. The field of view is about 60 arcseconds. There is a focus drive that moves both the camera and lens together. The faint limit during dark time is about 17th magnitude. There are plans to replace this camera with an intensified CCD.

Offset Guider Camera

The offset guider is presently being upgraded to accept a Spectrasource CCD camera utilizing a TEK512x512 backside illuminated device. The planned pixel scale will be about .15 arcsec/pixel. It will normally be used in a 2x2 binning mode. The optics for the offset guide camera uses a focal reduction layout, see figure 18, that does not produce a lyot stop but is much more accommodating with back focus. The focal reducing optics consist of a single negative lens collimator followed by a 200mm f2.8 Canon camera lens. For large changes in focus position the collimator/camera pair must be changed in order to adjust the plate scale. The offset guide camera will accommodate focus positions from 8 inches in front of the optimum focus to about 6 feet after the optimum focus. The focal reducing lens must be changed for back focuses of more than 10 inches from the optimum focus position in order to adjust the plate scale. The IRTF Instrumentation Engineer should be contacted for questions regarding this issue.

Tip-Tilt Camera

The tip tilt camera will be a large format CCD with very fast readout and sub array capabilities. It will normally be mounted directly on the cryostat fed by a cold diachroic and is used this way for the facility instruments. Presently plans are being made to provide a warm diachroic feed for this camera to support visitor instruments. If visitors intend to use the tip-tilt system with their instrument they should contact the IRTF for details concerning allowable focus range.

Closed Cycle Cooler Interface

Although Visitor instruments have never used them, there are high pressure Helium lines on the bottom of the mirror cell for driving closed cycle coolers. These are installed for the facility instruments that use them. If visitors are planning to build a closed cycle cooled instrument, details of our plumbing should be obtained from the daycrew.

Cryogen Pumping Connections

There are two lines available for pumping on cryogens. One is optimized for liquid Helium use and the other for liquid nitrogen.

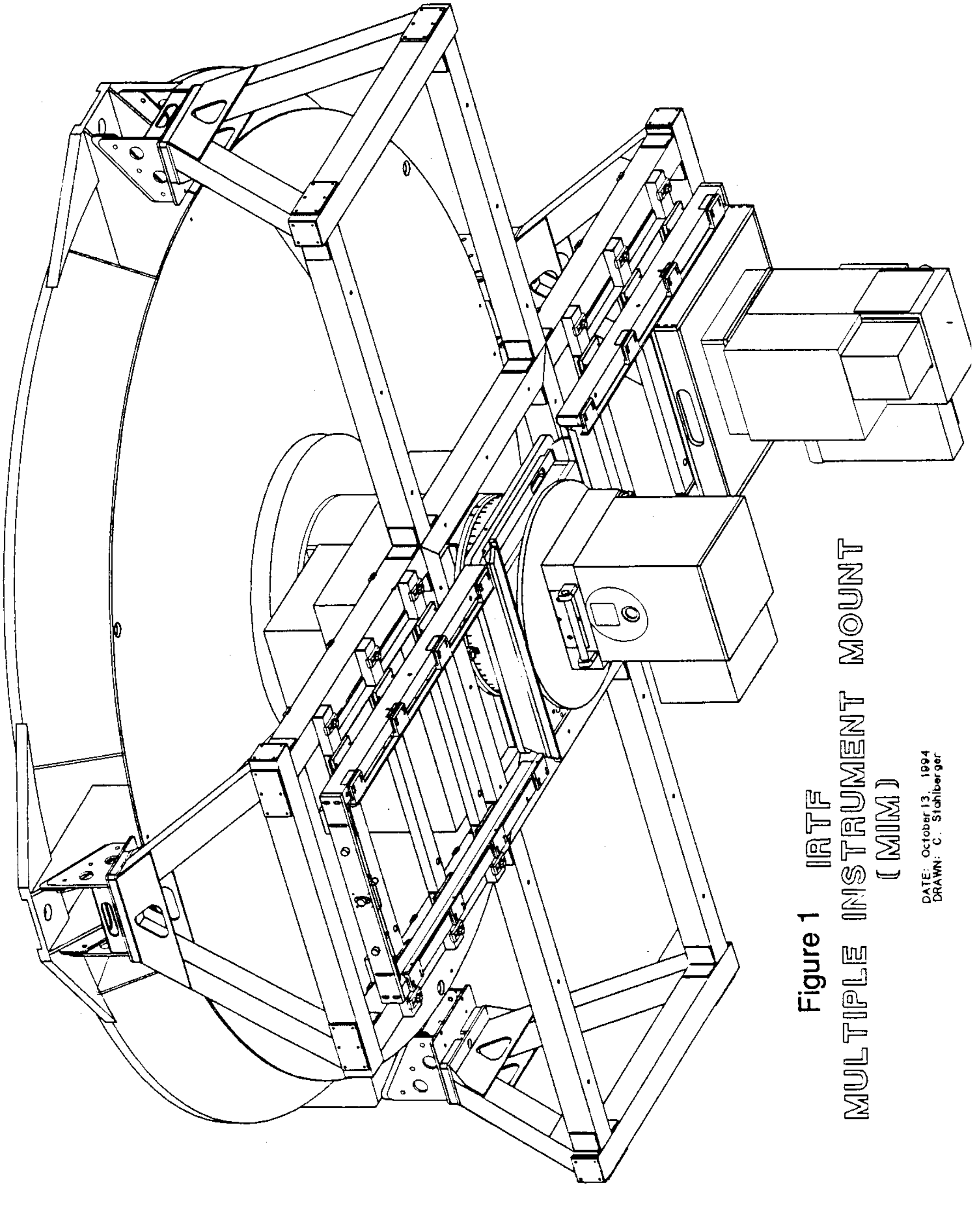

Figure 1 IRTF
MULTIPLE INSTRUMENT MOUNT
(MIM)

DATE: October 13, 1994
DRAWN: C. Stahlberger

BILL OF MATERIAL				
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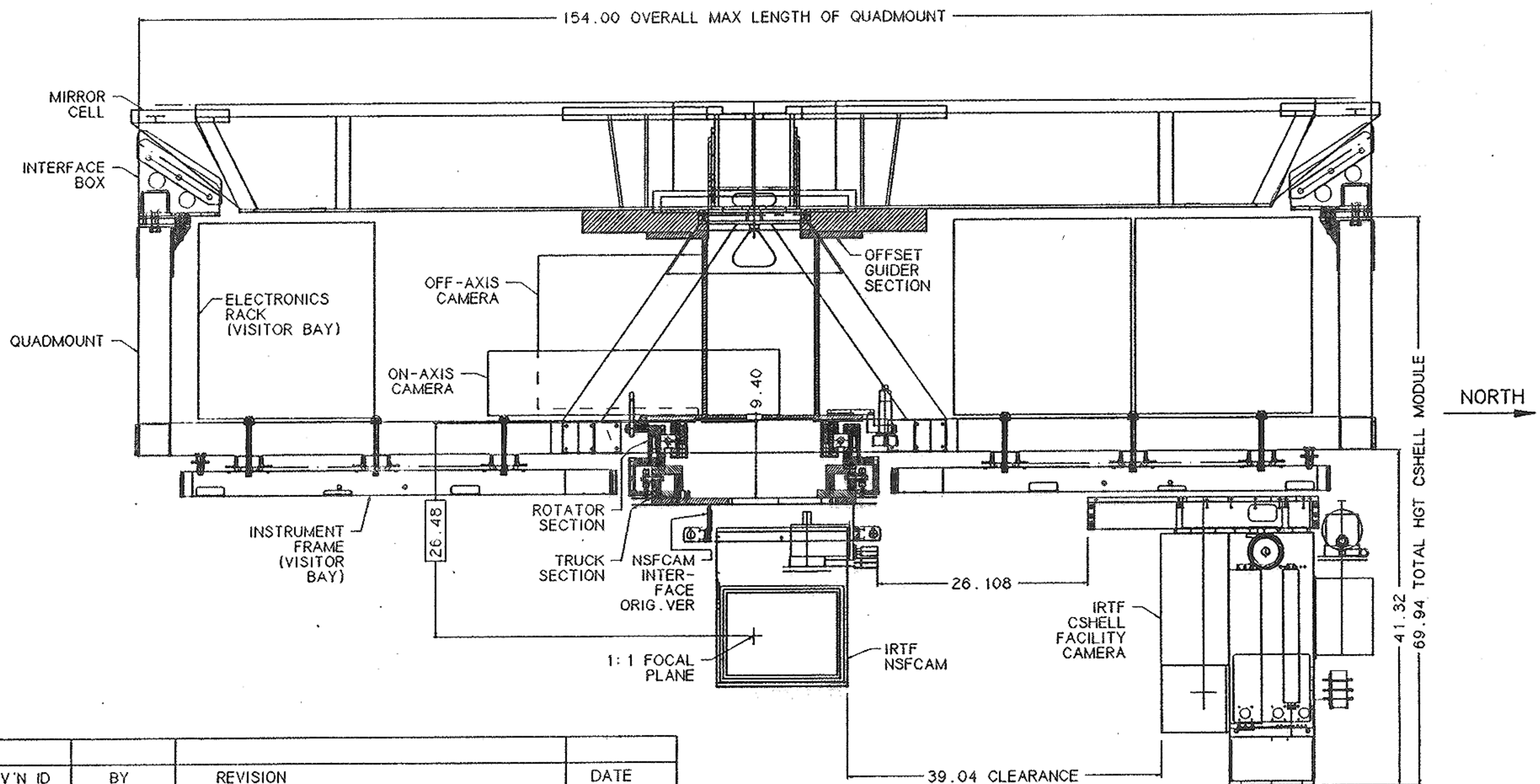
003S	1	N\A	ASSEMBLY: MULTIPLE INSTRUMENT MOUNT	N\A



REV'N ID	BY	REVISION	DATE

DATE: 9/01/94
DESIGN: STAHLBERGER
DRAWN: STAHLBERGER
APPR'D:

TOLERANCES

X.X	+/- .015
X.XX	+/- .005
X.XXX	+/- .002
ANGLE	+/- 30 min
FRACTION	+/- 1/32

INSTITUTE FOR ASTRONOMY

INSTRUMENT: MULTIPLE INSTRUMENT MOUNT M I M
PART NAME: ASSEMBLY: IRTF MULTIPLE INSTRUMENT MOUNT
TELESCOPE: INFRARED TELESCOPE FACILITY

CAD ID: MIM-003S.DRW | DRW ID: MIM-003S
SIZE: A | JOB 521 | SCALE:1:20 | SHEET: 1 OF 1

NOTE:
ONLY CENTER TRUCK IS SHWON
PARTS ARE SHOWN TRANSPARENT

FIGURE 2:
MIM ASSEMBLY DRAWING

SCALE= 1:20

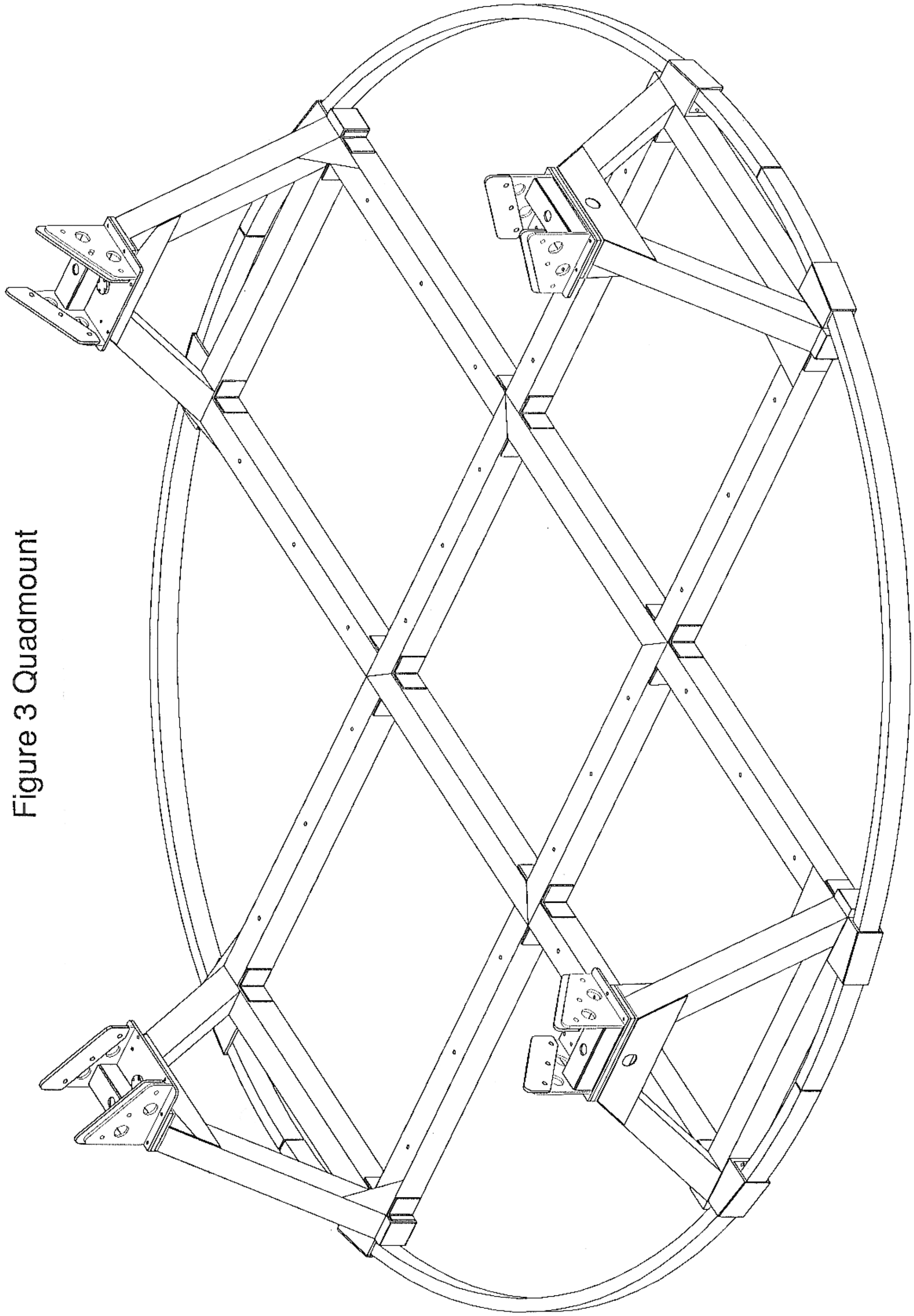
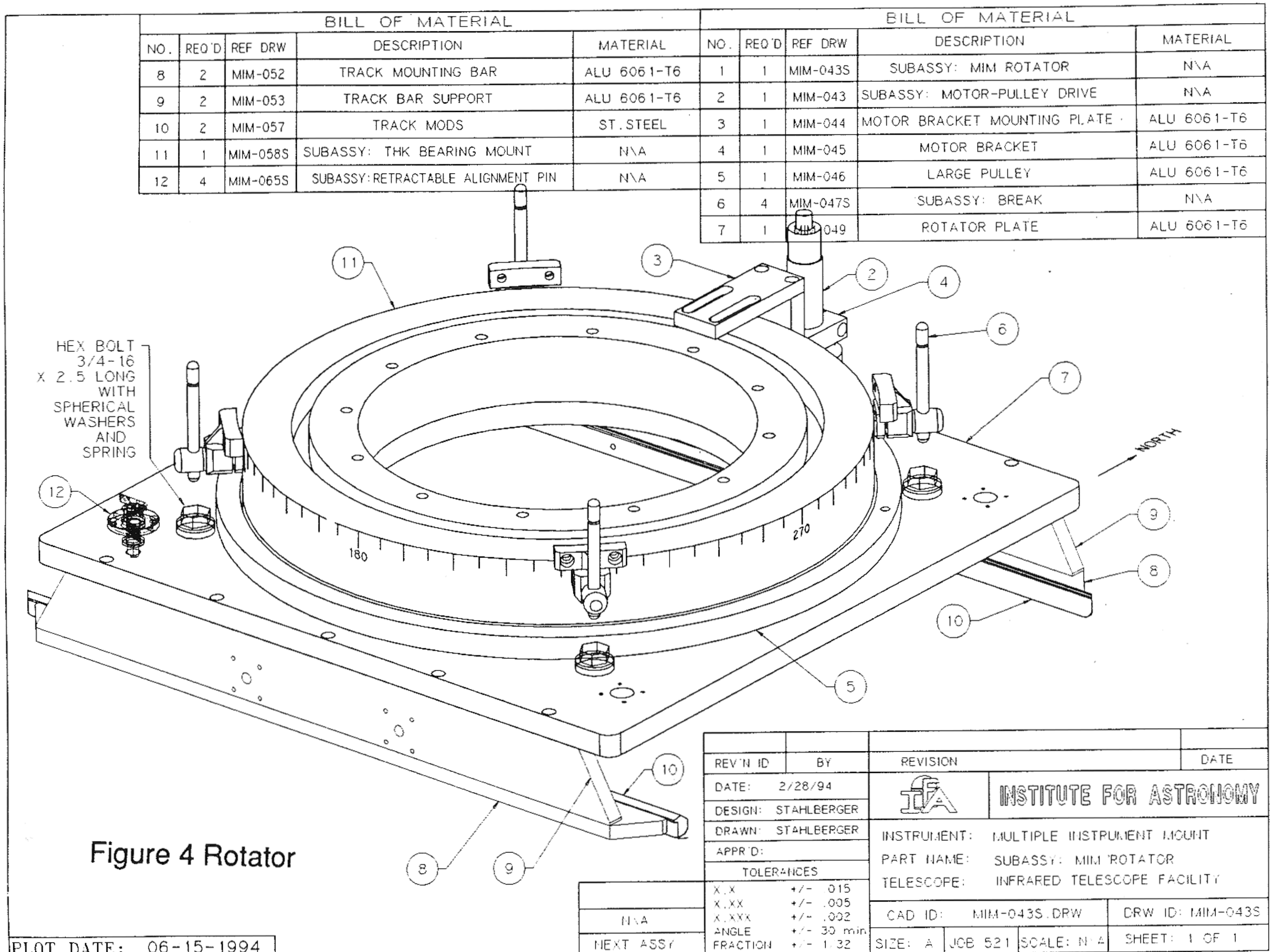


Figure 3 Quadmount



BILL OF MATERIAL

NO.	REQ'D	REF DRW	DESCRIPTION	MATERIAL
8	2	MIM-052	TRACK MOUNTING BAR	ALU 6061-T6
9	2	MIM-053	TRACK BAR SUPPORT	ALU 6061-T6
10	2	MIM-057	TRACK MODS	ST.STEEL
11	1	MIM-058S	SUBASSY: THK BEARING MOUNT	N\A
12	4	MIM-065S	SUBASSY:RETRACTABLE ALIGNMENT PIN	N\A

BILL OF MATERIAL

NO.	REQ'D	REF DRW	DESCRIPTION	MATERIAL
1	1	MIM-043S	SUBASSY: MIM ROTATOR	N\A
2	1	MIM-043	SUBASSY: MOTOR-PULLEY DRIVE	N\A
3	1	MIM-044	MOTOR BRACKET MOUNTING PLATE	ALU 6061-T6
4	1	MIM-045	MOTOR BRACKET	ALU 6061-T6
5	1	MIM-046	LARGE PULLEY	ALU 6061-T6
6	4	MIM-047S	SUBASSY: BREAK	N\A
7	1	MIM-049	ROTATOR PLATE	ALU 6061-T6

Figure 4 Rotator

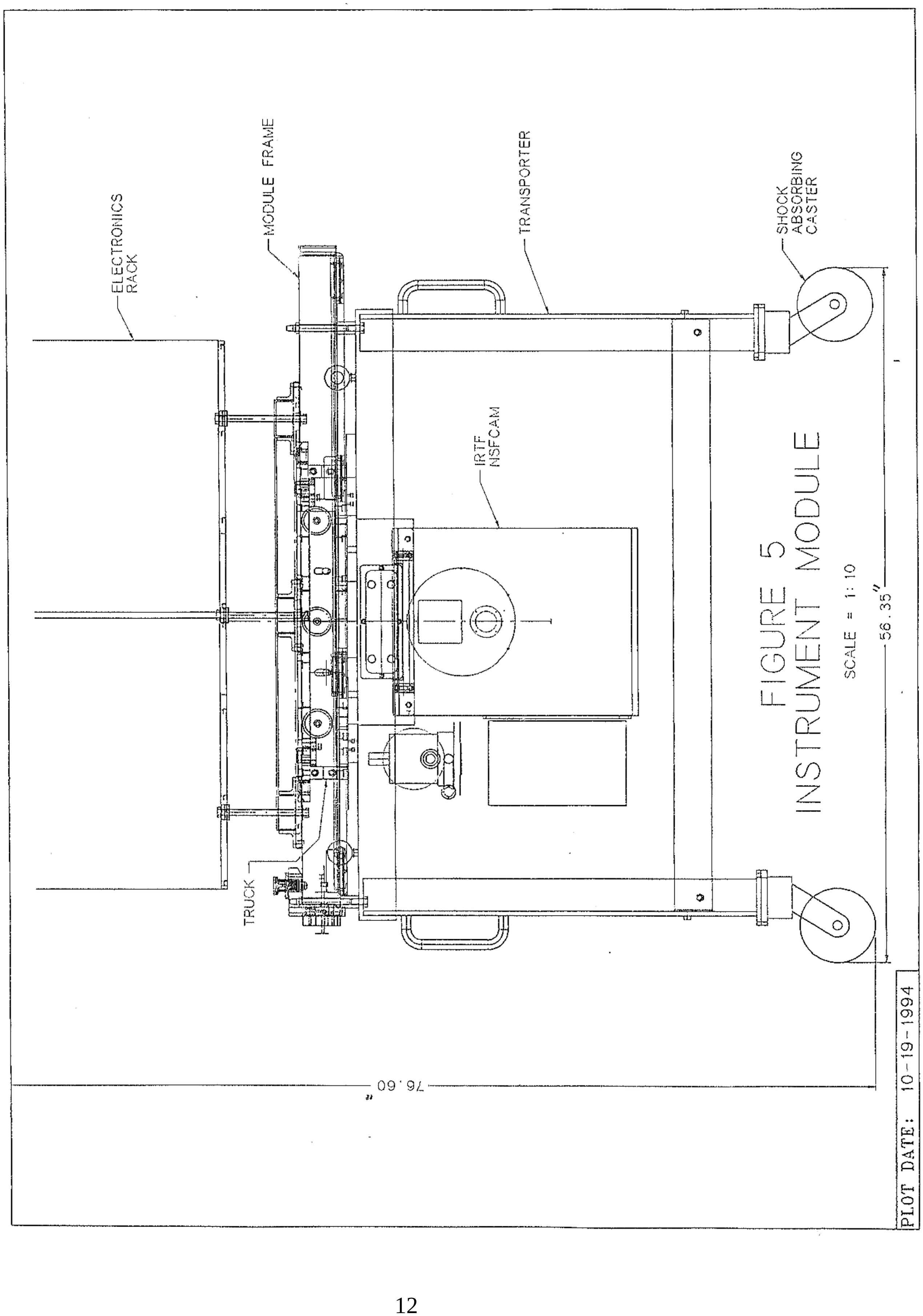


FIGURE 5
INSTRUMENT MODULE

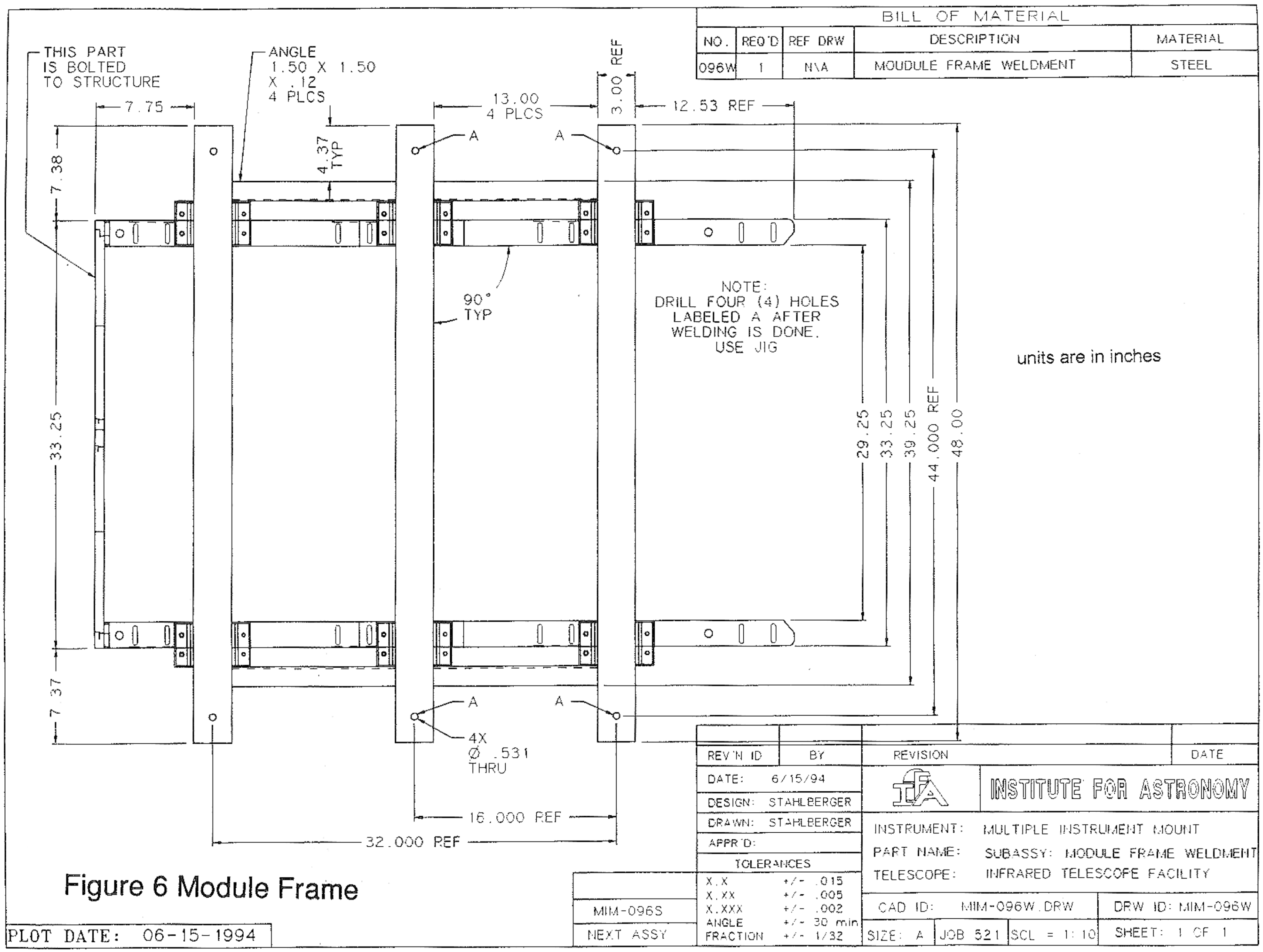


Figure 6 Module Frame

BILL OF MATERIAL

NO.	REQ'D	REF DRW	DESCRIPTION	MATERIAL
1	3	MIM-096S	SUBASSY: MIM MODFRAME	N\A
2	6	MIM-097S	SUBASSY: BOX BEAM CONNECTION	N\A
3	N\A	MIM-099	BOX BEAM +\- Y	STEEL
4	3	MIM-101	CROSS-BEAM	STEEL
5	1	MIM-104	TRUCK ATTACHMENT PLATE	ALU 6061-T6
6	6	MIM-105S	SUBASSY: MODFRAME BOLT	N\A
7	1	MIM-107	CAPTIVE SCREW	ST. STEEL
8	1	MIM-108	CAPTIVE SCREW BLOCK	ALU 6061-T6
9	N\A	MIM-111	MODFRAME TRACK MODS	ST. STEEL
10	8	MIM-112	TRACK SUPPORT PLATE	STEEL
11	8	MIM-113	NUT PLATE	STEEL
12	2	N\A	UNI-SHOCK TAYLOR	PURCHASED

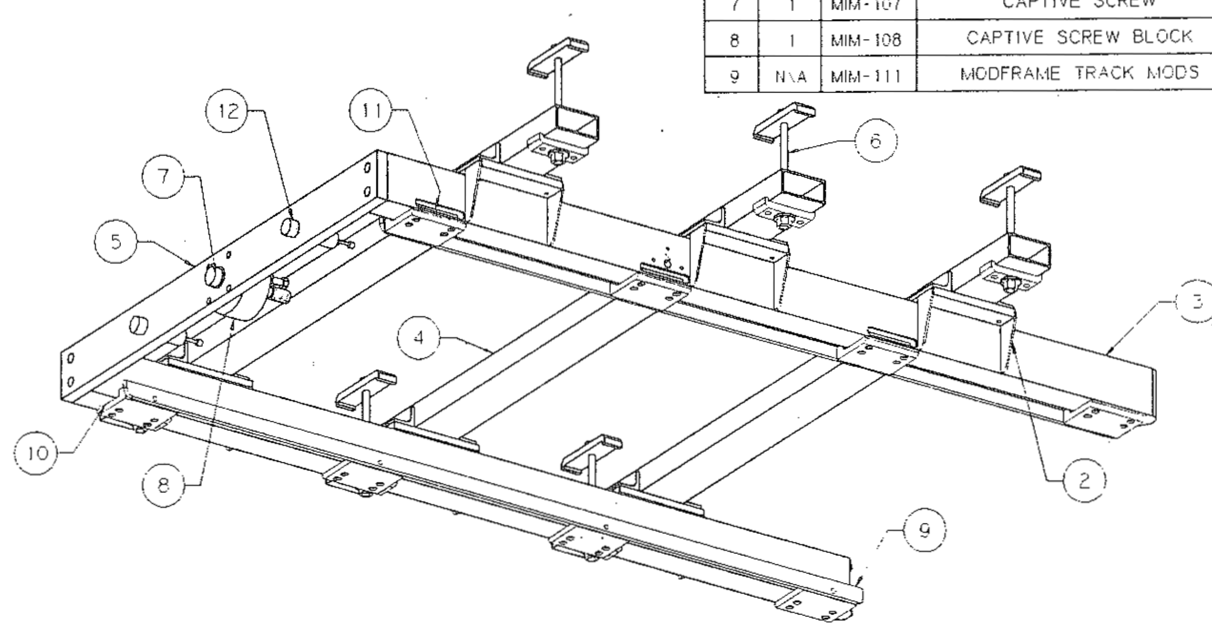


Figure 7 Module Frame

REV'N ID	BY	REVISION	DATE

DATE: 4/14/94
DESIGN: STAHLBERGER
DRAWN: C.STAHLBERGER
APPR'D:

INSTITUTE FOR ASTRONOMY

INSTRUMENT: MULTIPLE INSTRUMENT MOUNT
PART NAME: SUBASSY: MIM MODFRAME
TELESCOPE: INFRARED TELESCOPE FACILITY

TOLERANCES
X.X +/- .015
X.XX +/- .005
X.XXX +/- .002
ANGLE +/- 30 min
FRACTION +/- 1/32

N\A
NEXT ASSY

CAD ID: MIM-096S.DFW
DRW ID: MIM-096S
SIZE: A
JOB 521
SCALE: N\A
SHEET: 1 OF 1

PLOT DATE: 04-26-1994

BILL OF MATERIAL

NO.	REQ'D	REF DRW	DESCRIPTION	MATERIAL
1	3	MIM-096S	SUBASSY: MIM MODFRAME	N\A
2	6	MIM-097S	SUBASSY: BOX BEAM CONNECTION	N\A
3	N\A	MIM-099	BOX BEAM +\- Y	STEEL
4	3	MIM-101	CROSS-BEAM	STEEL
5	1	MIM-104	TRUCK ATTACHMENT PLATE	ALU 6061-T6
6	6	MIM-105S	SUBASSY: MODFRAME BOLT	N\A
7	1	MIM-107	CAPTIVE SCREW	ST. STEEL
8	1	MIM-108	CAPTIVE SCREW BLOCK	ALU 6061-T6
9	N\A	MIM-111	MODFRAME TRACK MODS	ST. STEEL
10	8	MIM-112	TRACK SUPPORT PLATE	STEEL
11	8	MIM-113	NUT PLATE	STEEL
12	2	N\A	UNI-SHOCK TAYLOR	PURCHASED

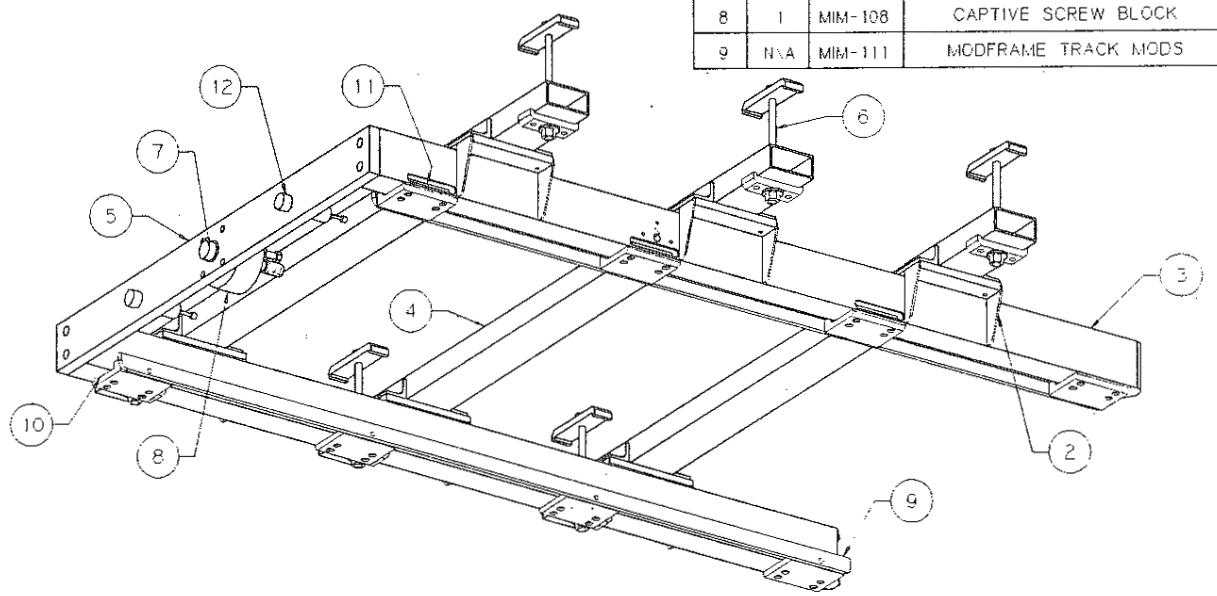


Figure 7 Module Frame

REV'N ID	BY	REVISION	DATE

DATE: 4/14/94
DESIGN: STAHLBERGER
DRAWN: C.STAHLBERGER
APPR'D:

TOLERANCES
X.X +/- .015
X.XX +/- .005
X.XXX +/- .002
ANGLE +/- 30 min
FRACTION +/- 1/32

INSTITUTE FOR ASTRONOMY

INSTRUMENT: MULTIPLE INSTRUMENT MOUNT
PART NAME: SUBASSY: MIM MODFRAME
TELESCOPE: INFRARED TELESCOPE FACILITY

CAD ID: MIM-096S.DFW
DRW ID: MIM-096S
SIZE: A JOB 521 SCALE: N\A SHEET: 1 OF 1

N\A
NEXT ASSY

PLOT DATE: 04-26-1994

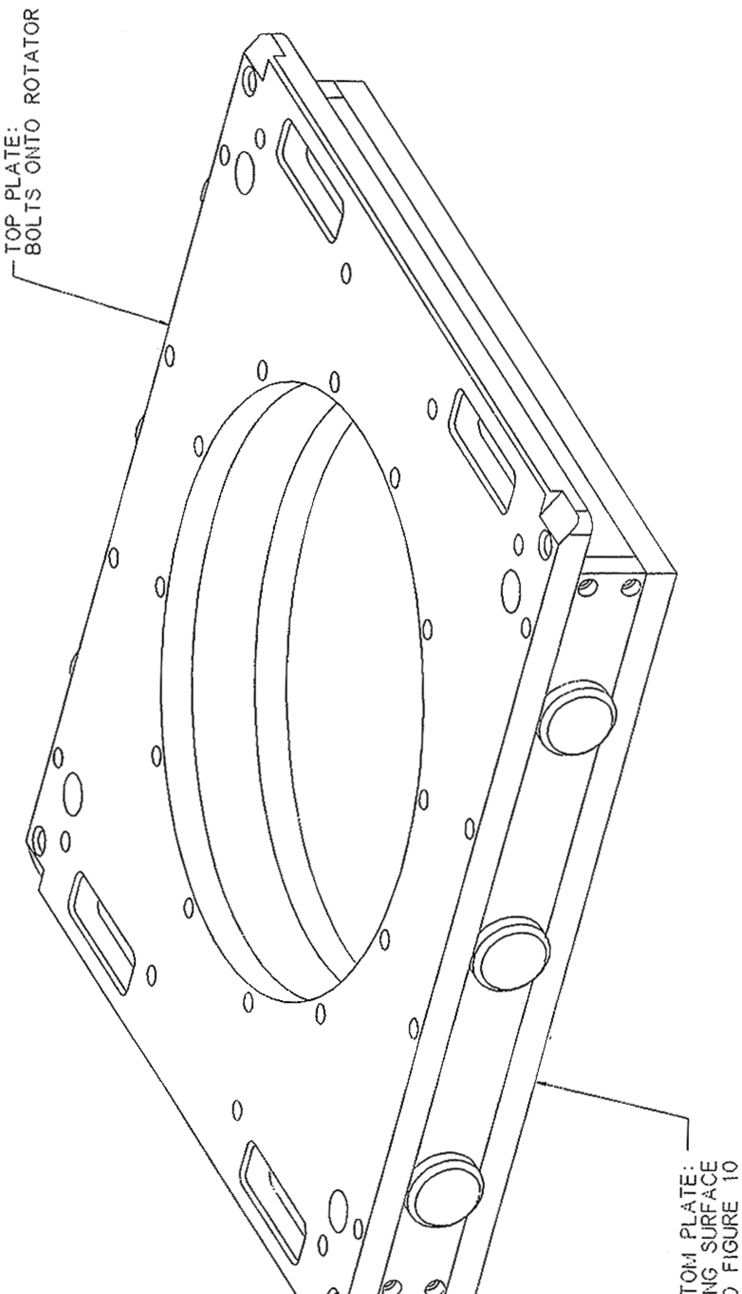


FIGURE 9:
TRUCK

SCALE= 1:4

PLOT DATE: 10-19-1994

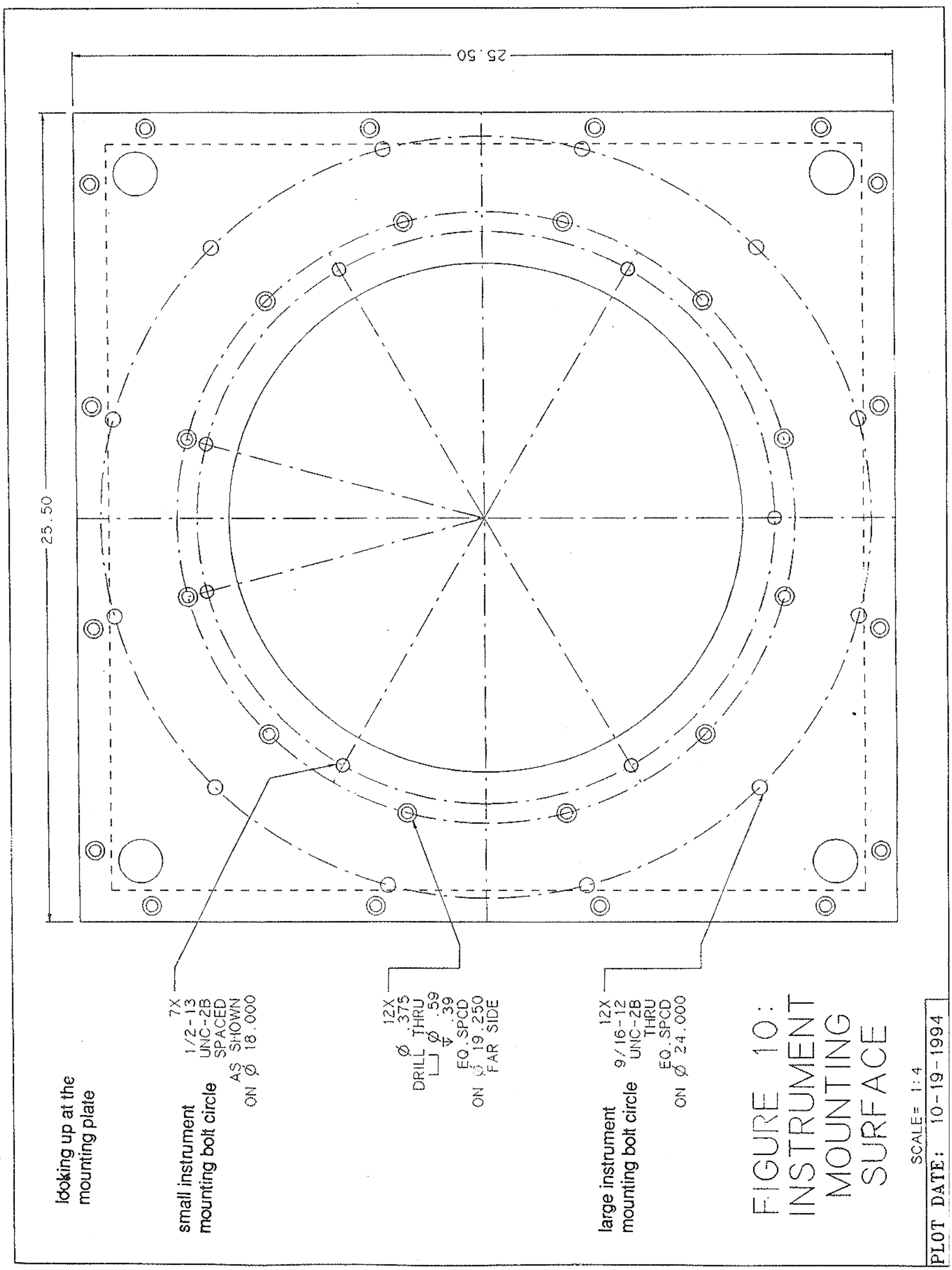


FIGURE 10: INSTRUMENT MOUNTING SURFACE

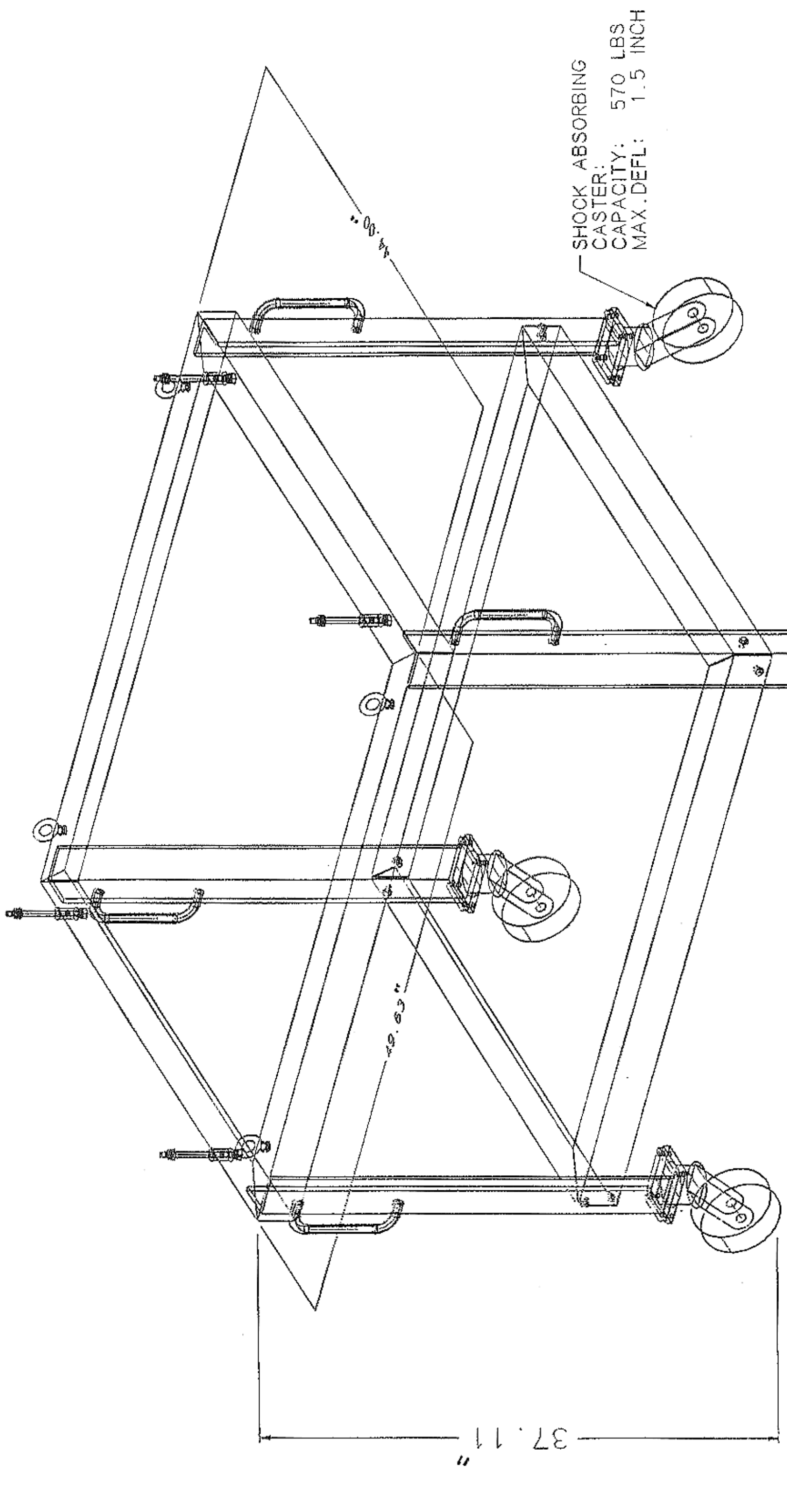


FIGURE 11
INSTRUMENT TRANSPORTER

NOT TO SCALE

PLOT DATE: 10-19-1994

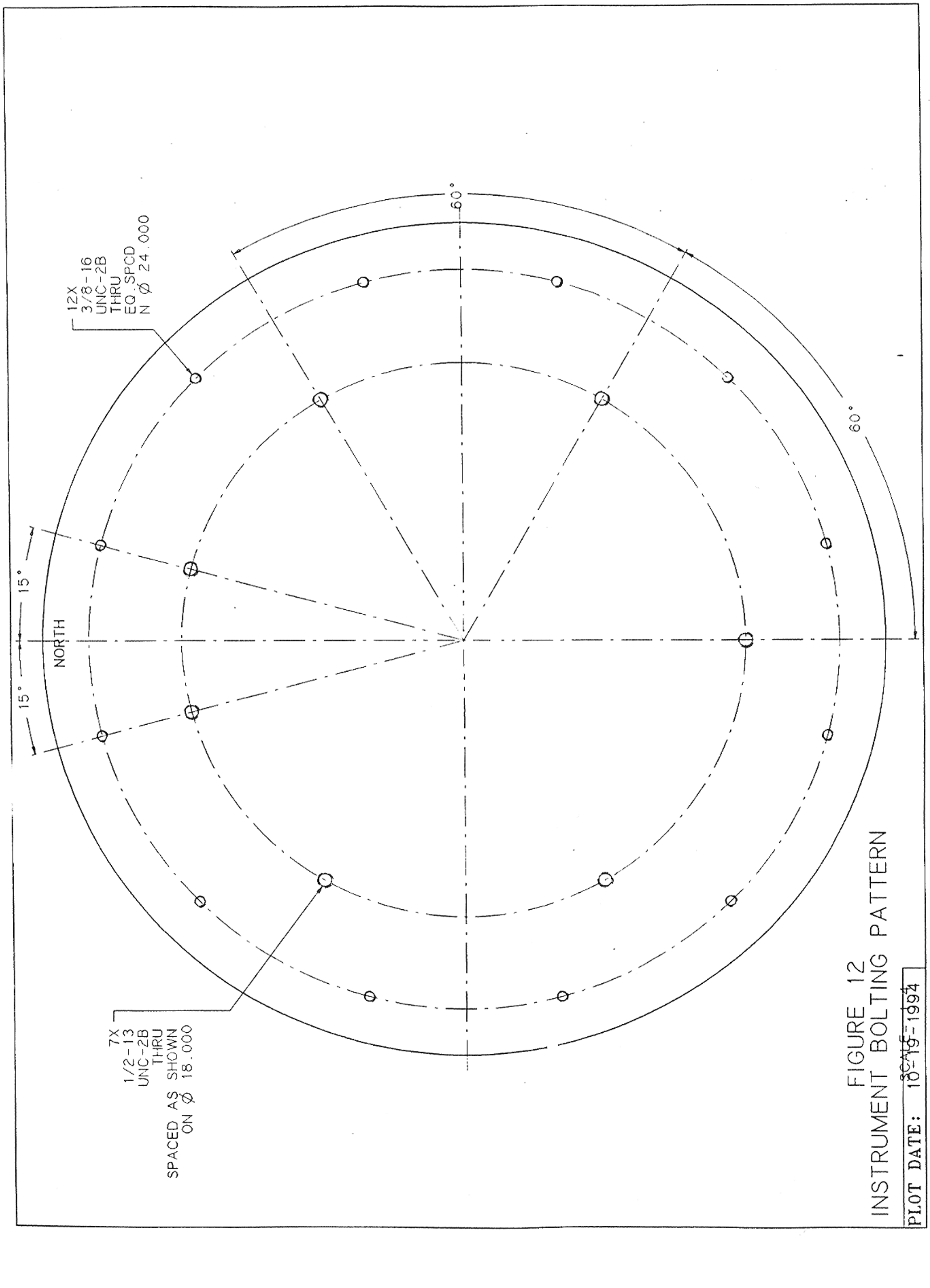


FIGURE 12
INSTRUMENT BOLTING PATTERN

Figure 13 Beam path restrictions

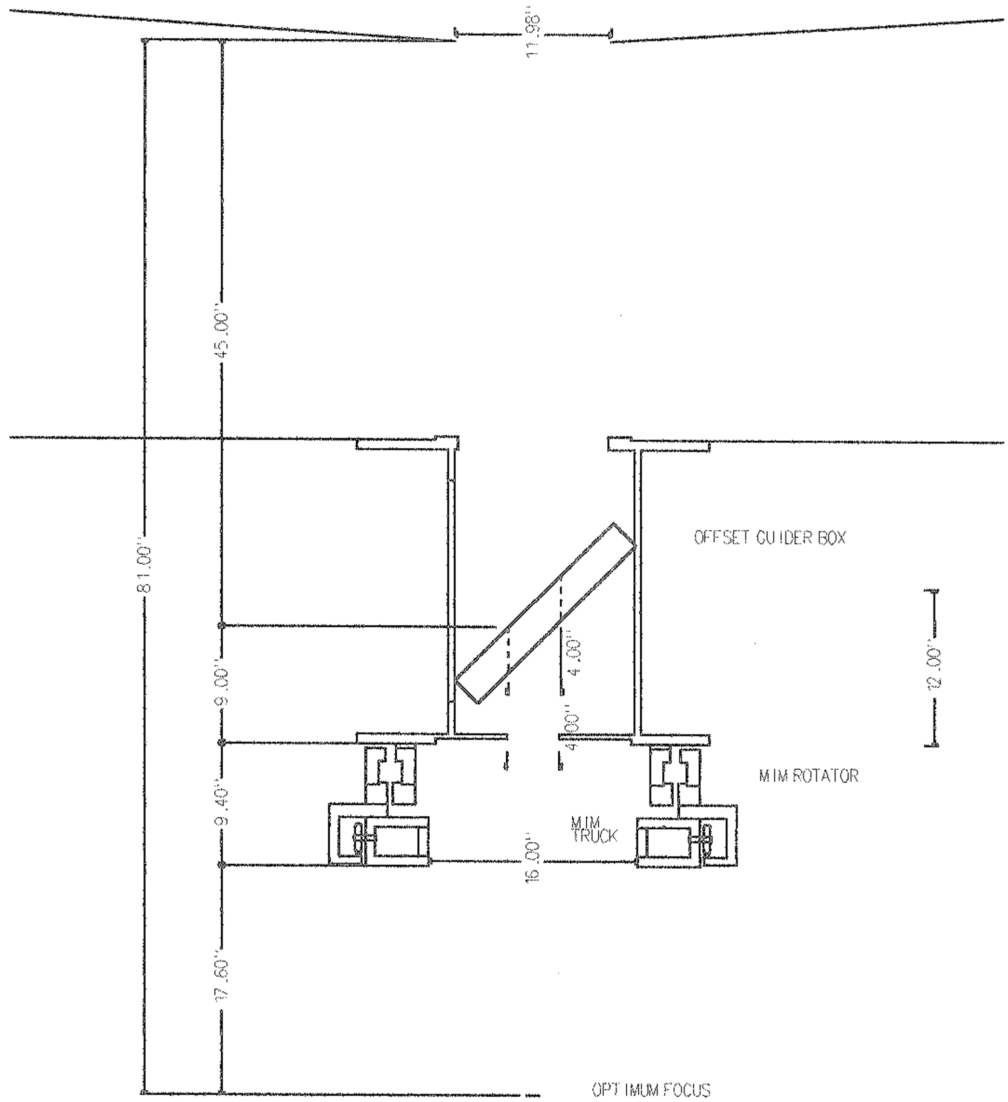
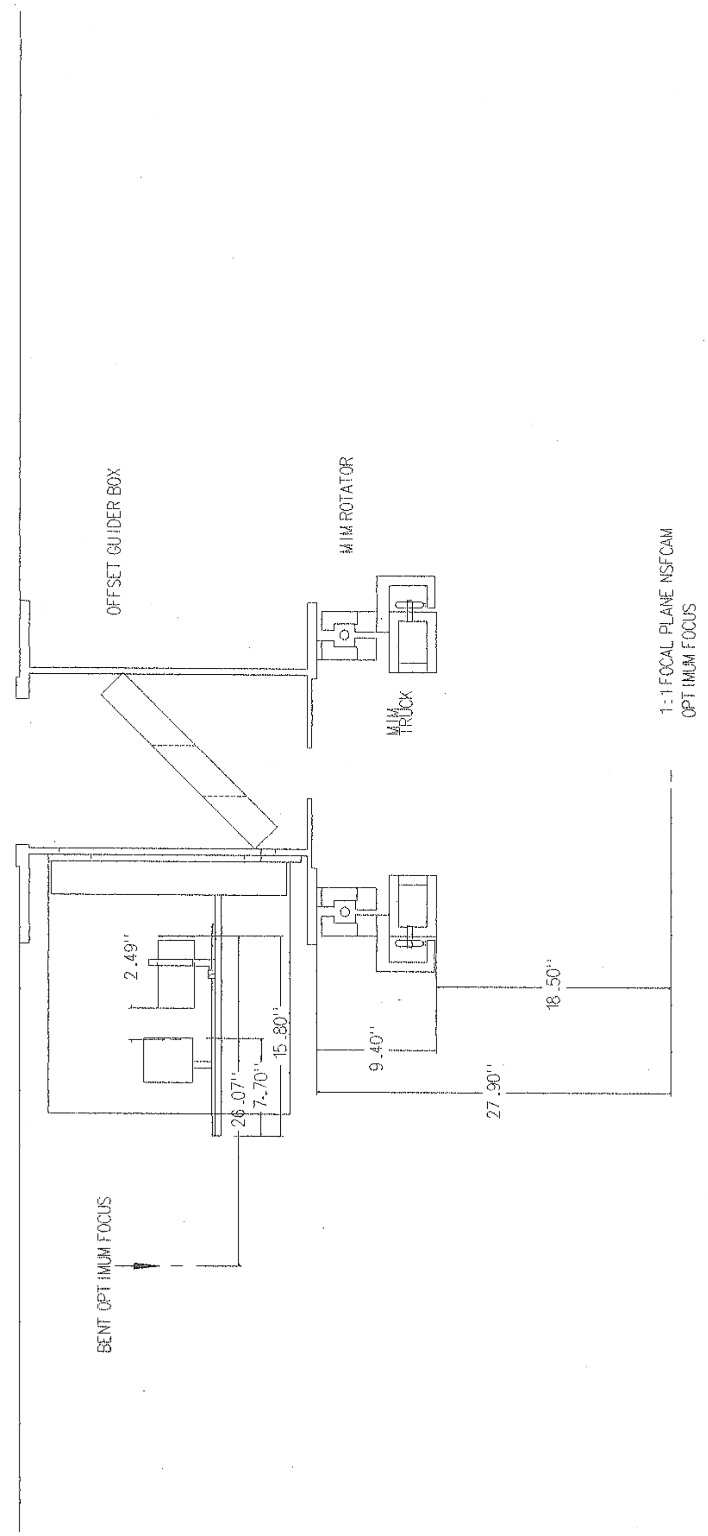


Figure 15 Off-Axis Camera Optical Setup



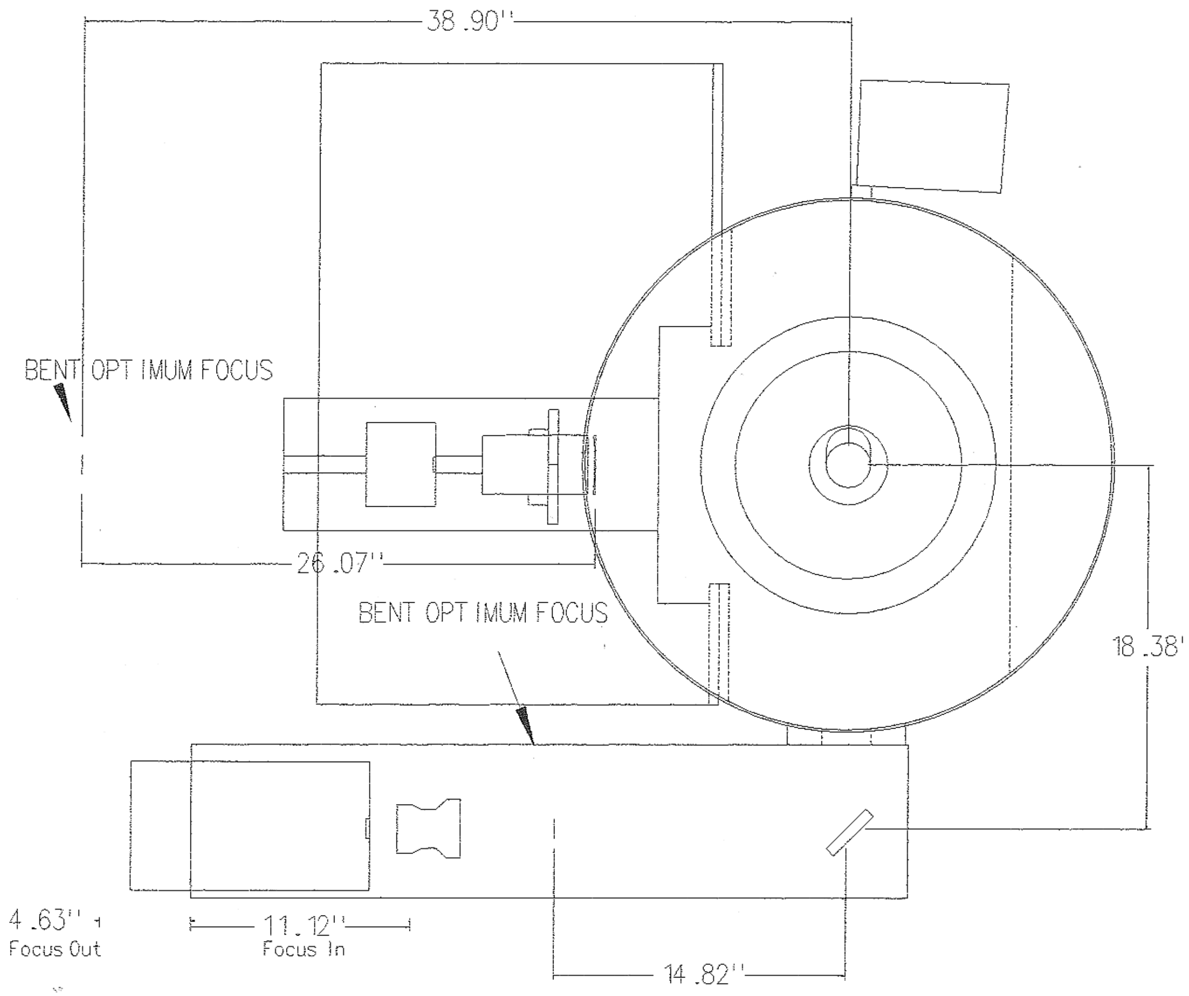


Figure 16
Top View of
Onaxis/Off-Axis
Systems

Figure 17 Closeup On-Axis Camera Optical Setup

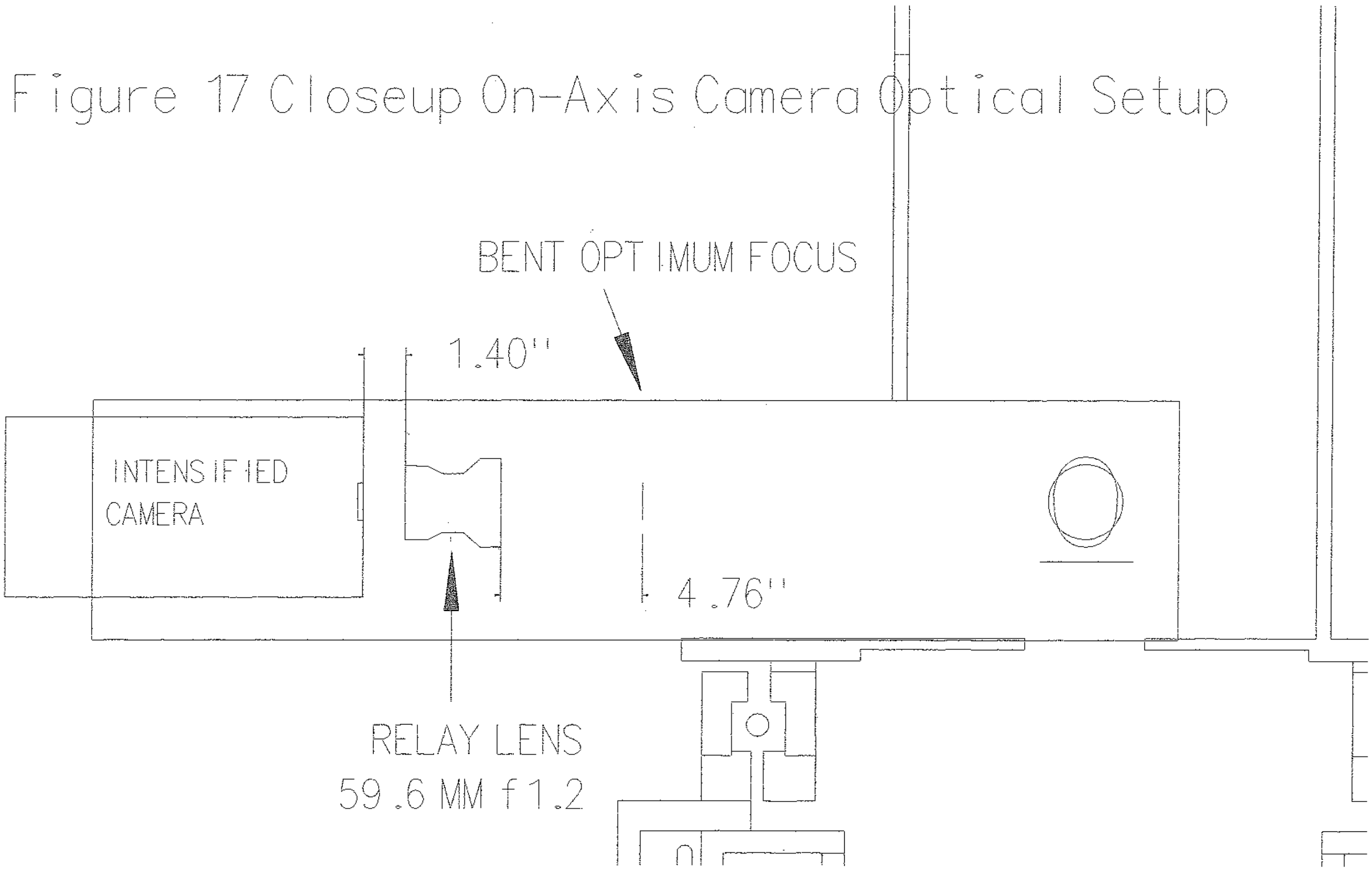


Figure 18 Closeup Off-Axis Optical Setup