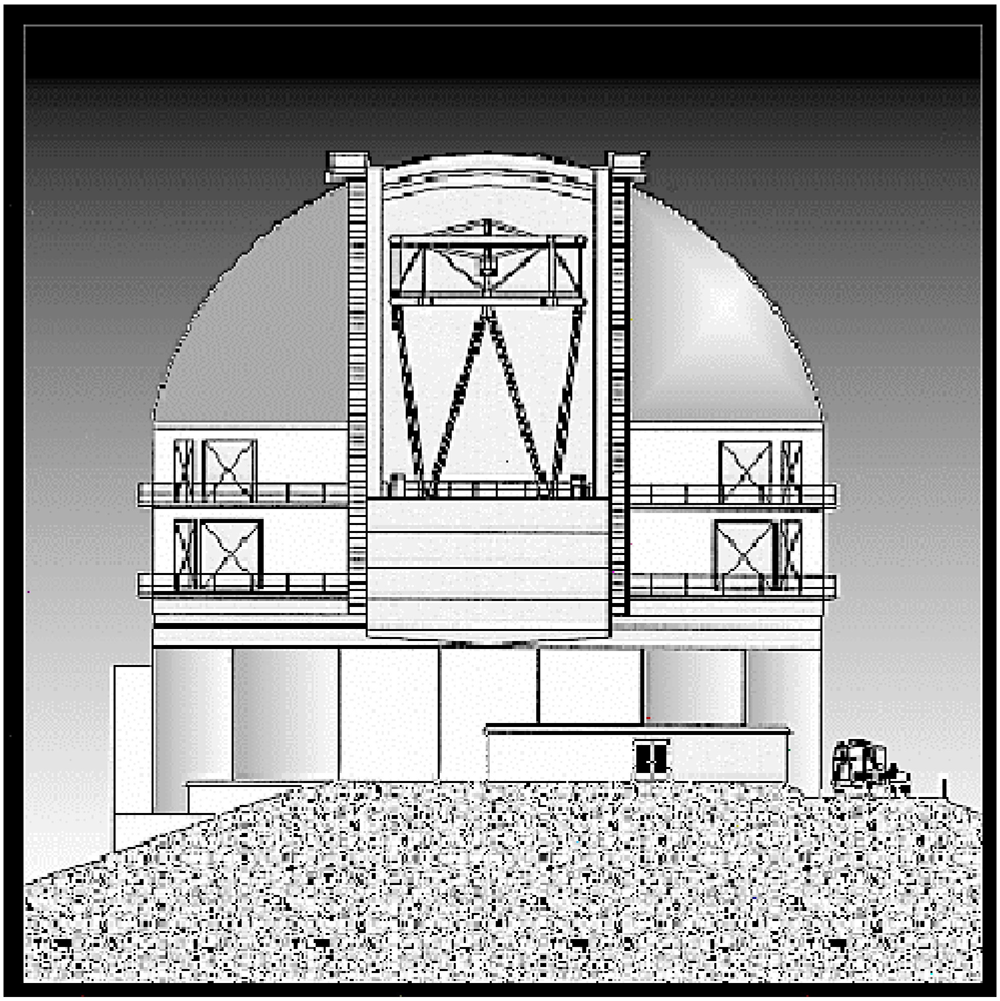
**GEMINI**
**8-M Telescopes Project**

# ICD-G0014

# Gemini Observatory
# Optomechanical Coordinate Systems




**J. Oschmann**
Systems Engineering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GEMINI PROJECT OFFICE 950 N. Cherry Ave. Tucson, Arizona 85719
Phone: (520) 318-8545 Fax: (520) 318-8590

# ICD-G0004

## Revision Control Descriptions

| | |
|---|---|
| Revision: | Original release |
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| Approved: | J. Oschmann |
| Description: | |

## 1.0 Introduction

This document defines the coordinate systems used on the Gemini telescopes and the relationships between them. This includes the pier co-ordinate system, mount co-ordinate system, optical support structure co-ordinate system , cassegrain rotator co-ordinate system and the ISS instrument port co-ordinate system.. It does not cover the more global astronomical coordinate reference frame which is described within the Telescope Control System design documentation. Instrument builders should pay particular attention to section 3.5 below.

## 2.0 References

**Documents:**

1. *"Gemini Pointing Algorithms" by P.T. Wallace, Document TCS/PTW/3.7 (TN-PS-G0044)*
2. TBD by P.T. Wallace, Document TBD (describes science instrument to astronomical coordinate frame) (TN-PS-G0045).

**Drawings:**

1. 90-GP-0000-0006 Instrument and Instrument Support Structure coordinate system
2. 90-GP-0001-0022 Telescope mount coordinate system
3. 90-GP-0001-0023 Optical support structure coordinate system
4. 90-GP-0001-0024 Cassegrain & Pier coordinate system
5. 89-GP-1000-0003 Cassegrain Rotator co-ordinate system

## 3.0 Overview

The following sections describe the coordinate systems used at various major interfaces and sub-assemblies throughout the telescope system. When the telescope is in its nominal park position (facing east, Zenith pointing, Cassegrain rotator in the mid range of its travel), the pier, telescope mount, optical support structure, cassegrain rotator and instrument port 1 co-ordinate systems line up and are self consistent with each other with only a shift along their local Z axis required to go from one to another. The coordinate systems for side looking instrument mounting ports are defined with respect to the cassegrain rotator co-ordinate system. For each, the +Z axis is oriented towards the light source, reflected by the science fold in the A&G . In the parked position described above, the +Y axis is pointing in the sane direction as the other co-ordinate axes +Z. This is explained in 3.5, but it does leave one local coordinate system from an instrument perspective which is independent of the mounting face.

All systems are right handed Cartesian coordinates.

Relating the final instrument coordinate system to astronomical terms is covered in reference document two above and is not dealt with further here.

## 3.1 Pier coordinate system

The pier coordinate system is shown in drawing 90-GP-0001-0024. This is consistent with the mount coordinate system with the origin located at the intersection of the finish floor level and the azimuth rotation axis. X axis is North, Y is West, and Z is “up”, opposite the nominal gravity vector. Note that the directions such as “North” are relative to “True” North.

## 3.2 Telescope mount coordinate system

The telescope mount coordinate system is shown in drawing 90-GP-0001-0022. The origin is at the intersection of the azimuth axis and the top surface of the azimuth track. The positive X axis point to true North, the positive Y axis points due West, and the positive Z axis point up towards zenith (opposite the gravity vector). Note the park position of the telescope is with an azimuth angle of 90 degrees, which puts the telescope east pointing. This park position is the mid-range of travel of the azimuth axis. The drawing shows the telescope in this park position.

Relative to the Pier Coordinate System origin ($x_p$, $y_p$, $z_p$) = (0,0,0), the Mount Coordinate System origin ($x_m$, $y_m$, $z_m$) = (0,0,0) is ($x_p$, $y_p$, $z_p$) = (0,0, 11445). The $z_p$ axis is parallel and in the same sense as the $z_m$ axis. When azimuth angle = 0, then the $y_p$ axis is parallel and in the same sense as the $y_m$ axis. A positive azimuth angle "A" rotates the Mount Coordinate System about the $z_p$ axis in a negative sense.

## 3.3 Optical support structure (OSS) coordinate system

The Optical Support Structure, which is the main body of the telescope holding the primary (M1) and secondary (M2) mirrors and such, has a local coordinate system as shown in drawing 90-GP-0001-0023. When in Park, the coordinate system is consistent with the telescope mount coordinate system described in 3.2 with the exception that the origin is located at the intersection of the azimuth and elevation axis of the telescope. This is accomplished by movement of the origin for the mount along its Z axis in a positive direction to the intersection of the elevation axis.

As the telescope is pointed off-zenith towards an elevation angle of zero (horizon pointing), the positive Y axis points up (to zenith for a horizon pointing telescope). The Z axis then points towards the horizon in the direction of the telescope pointing as the telescope moves toward horizon pointing (elevation angle of zero). The local Z axis always points towards the source of light, rather than following the direction of travel of light through the system. Note that the elevation angle (E) is defined relative to the horizon (Zero is horizon pointing) and the Zenith angle is defined as relative to zenith pointing (zero is zenith pointing). This is shown in the reference drawing.

This provides the local coordinates used by the M1 assembly, M2 assembly and any other items mounted to the Optical Support Structure. The Cassegrain rotator and instruments are mounted to the underside of the M1 assembly. Specific local coordinate systems for these areas are covered in the following sections (3.4 and 3.5).

Relative to the Mount Coordinate System origin ($x_m$, $y_m$, $z_m$) = (0,0,0), the Optical Support Structure Coordinate System origin ($x_0$, $y_0$, $z_0$) =(0,0,0) is ($x_m$, $y_m$, $z_m$) = (0,0,8555). The $x_0$ axis is parallel and in the same sense as the $x_m$ axis. When zenith angle = 0, then the $y_0$ axis is parallel and in the same sense as the $y_m$ axis. A positive zenith angle rotates the Optical Support Structure Coordinate System about the $x_0$ axis in a positive sense.

### 3.4 Cassegrain Rotator coordinate system

The Cassegrain Rotator coordinate system is shown in drawing 90-GP-0001-0024, upper part of the drawing and drawing 89-GP-1000-0003. As with the OSS coordinate system, when the telescope is in the nominal east facing park position, Zenith pointing, and Cassegrain rotator in the mid range of its travel, the local coordinates are consistent with the mount coordinates with a shift along the Z axis of the origin. The local origin here lies at the intersection of the Cassegrain rotator axis and the Rotator/ISS interface surface. From this mid range it can rotate +/- 240 degrees (Mid range point of symetrical axis of CR lies along OSS, negative Y axis when in park).

Relative to the Optical Support Structure Coordinate System origin ($x_0$, $y_0$, $z_0$) = (0,0,0), the Cassegrain Rotator Coordinate System origin ($x_r$, $y_r$, $z_r$) = (0,0,0) is ($x_0$, $y_0$, $z_0$) = (0,0, -2050). The the $z_r$ axis is parallel and in the same sense as the $z_0$ axis. When rotator angle = 0, then the $y_r$ axis is parallel and in the same sense as the $y_0$ axis. A positive rotator angle "F" rotates the Cassegrain Rotator Coordinate System about the $z_0$ axis in a negative sense.

### 3.5 Instrument and Instrument Support Structure coordinate systems

The coordinate system(s) for the instruments mounting to the Instrument Support Structure (ISS) is shown in drawing (90-GP-0000-0006). Here, each face of the ISS has a different local coordinate system defined for any instrument which may be mounted on that face. Here, when the telescope is zenith pointing, in the nominal park position, CR in the mid range of its travel, all side looking ports have a identical coordinate system local to each port which places the positive Z axis pointing into the center of the ISS (direction light is coming from), the Y axis pointing “up” (opposite to gravity vector), and the X axis pointing to the ‘right’ if you are looking from inside the ISS at the particular port in question (leaving a local right-handed system).

This leaves 4 local ‘systems’, one for each side looking face of the ISS, each with its origin a the intersection of the port faces mounting pads and the nominal optical axis for that port.

For the up-looking port, the Z axis is also looking to the direction the light is coming from (center of ISS). For the Y axis, consider the telescope horizon pointing, CR in the middle of its travel (parked, rotation at 90 degrees). The Y axis is then “up” (oppposite to gravity vector) and the X axis facing to the right when looking from within the ISS at this port face. Here, X, Y, and Z are parallel to the corresponding axis of the Optical Support Structure, defined in 3.3 above.

Knowledge of the particular face to which an instrument is mounted (e.g. in the TCS) will allow application of the appropriate matrix to convert (X,Y,Z) to the astronomical coordinate system (ref. doc. #2 by PTW). With this system, individual instruments don't need to know which face they are on as each X,Y,Z looks the same and they can provide data such as instrument specific flexure and pointing terms relative to their local coordinate system.

Relative to the Cassegrain Rotator Coordinate System origin ($x_r$, $y_r$, $z_r$) = (0,0,0), the Instrument and Instrument Support Structure Coordinate System Port 1 origin ($x_{i1}$, $y_{i1}$, $z_{i1}$) = (0,0,0) is ($x_r$, $y_r$, $z_r$) = (0,0,-1600). The $x_{i1}$ axis is parallel and in the same sense as the $x_r$ axis. The $y_{i1}$ axis is parallel and in the same sense as the $y_r$ axis.

Relative to the Cassegrain Rotator Coordinate System origin ($x_r$, $y_r$, $z_r$) = (0,0,0), the Instrument and Instrument Support Structure Coordinate System Port 2 origin ($x_{i2}$, $y_{i2}$, $z_{i2}$) = (0,0,0) is ($x_r$, $y_r$, $z_r$) = (800,0,-800). The $x_{i2}$ axis is parallel and in the same sense as the -$y_r$ axis. The $y_{i2}$ axis is parallel and in the same sense as the $z_r$ axis.

Relative to the Cassegrain Rotator Coordinate System origin ($x_r$, $y_r$, $z_r$) = (0,0,0), the Instrument and Instrument Support Structure Coordinate System Port 3 origin ($x_{i3}$, $y_{i3}$, $z_{i3}$) = (0,0,0) is ($x_r$, $y_r$, $z_r$) = (0,-800,-800). The $x_{i3}$ axis is parallel and in the same sense as the -$x_r$ axis. The $y_{i3}$ axis is parallel and in the same sense as the $z_r$ axis.

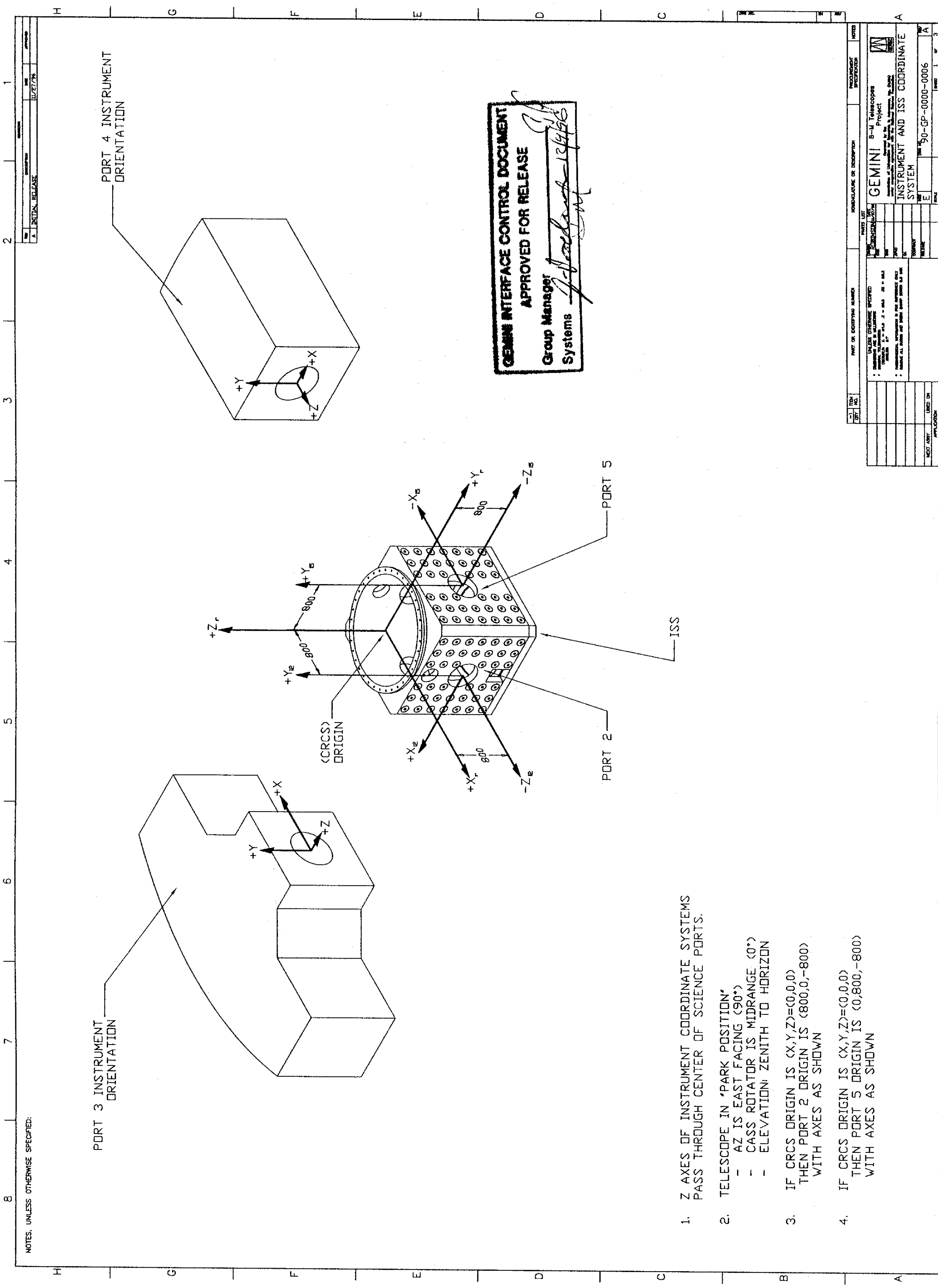
Relative to the Cassegrain Rotator Coordinate System origin ($x_r$, $y_r$, $z_r$) = (0,0,0), the Instrument and Instrument Support Structure Coordinate System Port 4 origin ($x_{i4}$, $y_{i4}$, $z_{i4}$) =(0,0,0) is ($x_r$, $y_r$, $z_r$) = (-800,0,-800). The $x_{i4}$ axis is parallel and in the same sense as the $y_r$ axis. The $y_{i4}$ axis is parallel and in the same sense as the $z_r$ axis.

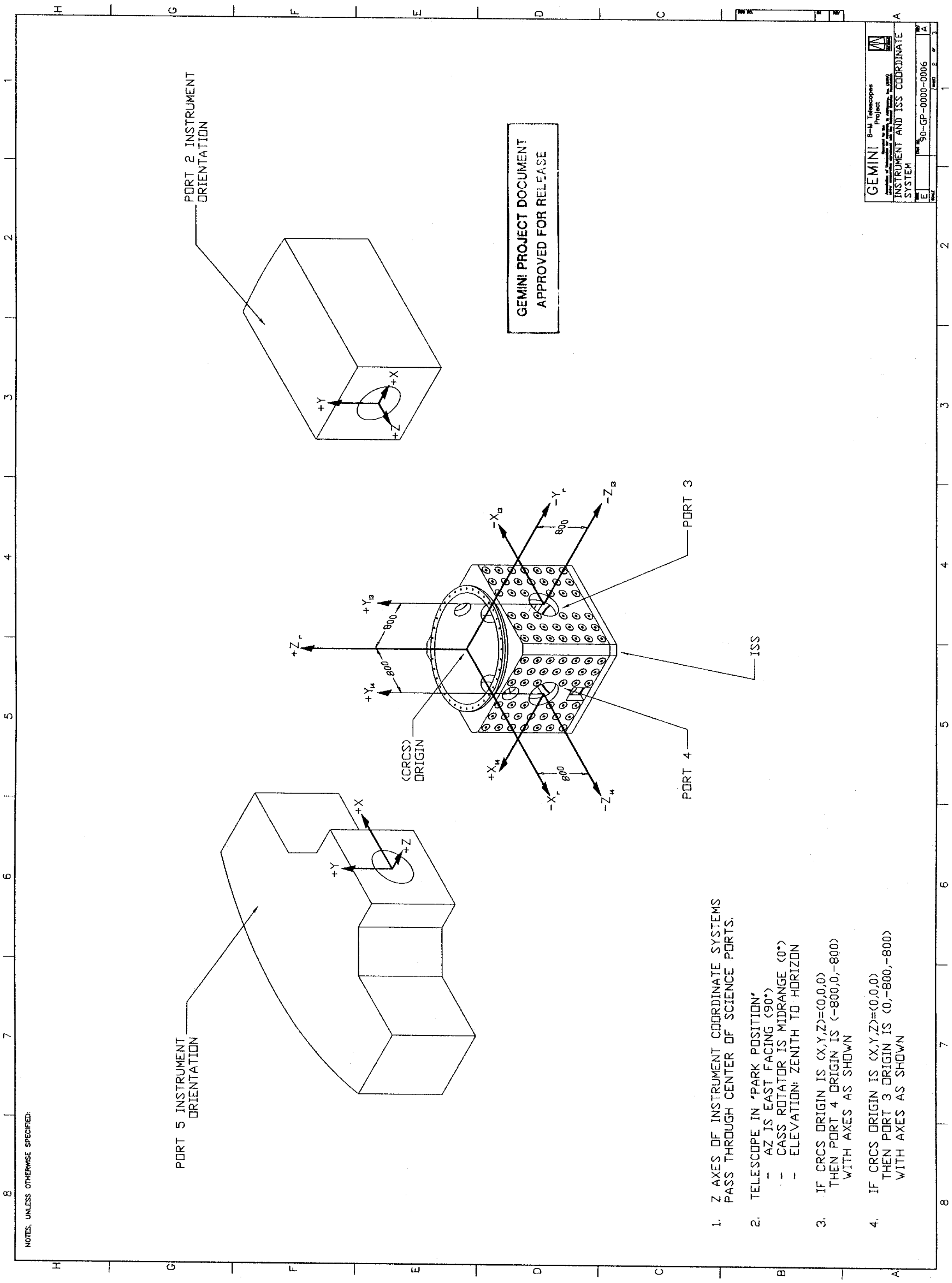
Relative to the Cassegrain Rotator Coordinate System origin ($x_r$, $y_r$, $z_r$) = (0,0,0), the Instrument and Instrument Support Structure Coordinate System Port 5 origin ($x_{i5}$, $y_{i5}$, $z_{i5}$) = (0,0,0) is ($x_r$, $y_r$, $z_r$) = (0,800,-800). The $x_{i5}$ axis is parallel and in the same sense as the $x_r$ axis. The $y_{i2}$ axis is parallel and in the same sense as the $z_r$ axis.

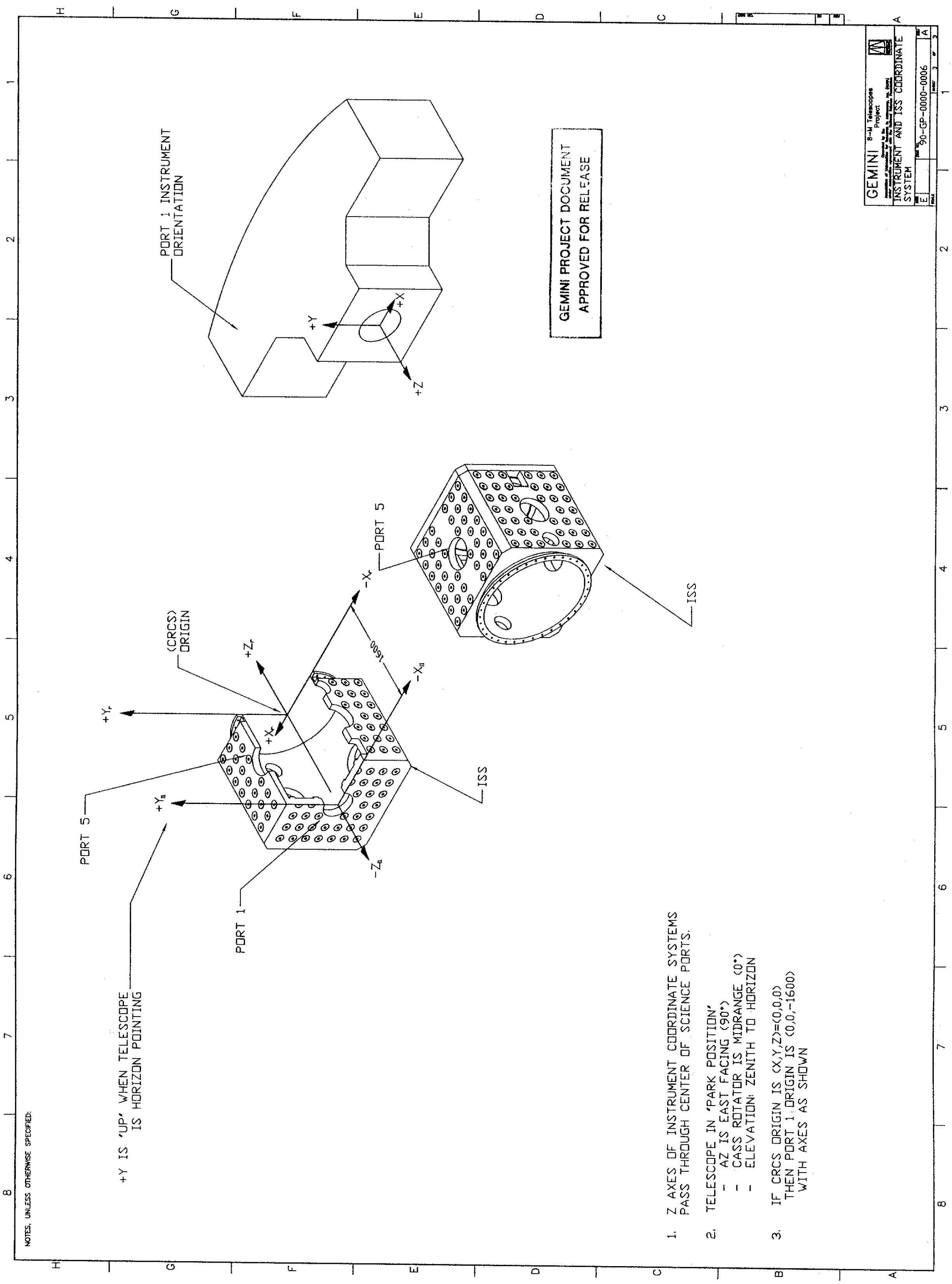
# Appendix A

# Referenced Drawings

90-GP-0000-0006 Instrument and Instrument Support Structure coordinate system
90-GP-0001-0022 Telescope mount coordinate system
90-GP-0001-0023 Optical support structure coordinate system
90-GP-0001-0024 Cassegrain & Pier coordinate system
89-GP-1000-0003 Cassegrain Rotator co-ordinate system


PORT 4 INSTRUMENT ORIENTATION
PORT 3 INSTRUMENT ORIENTATION
(CRCS) ORIGIN
PORT 5
PORT 2
ISS
800
GEMINI INTERFACE CONTROL DOCUMENT
APPROVED FOR RELEASE
Group Manager
Systems
GEMINI 8-M Telescopes Project
INSTRUMENT AND ISS COORDINATE SYSTEM
90-GP-0000-0006
NOTES, UNLESS OTHERWISE SPECIFIED:
1. Z AXES OF INSTRUMENT COORDINATE SYSTEMS PASS THROUGH CENTER OF SCIENCE PORTS.
2. TELESCOPE IN 'PARK POSITION'
- AZ IS EAST FACING (90°)
- CASS ROTATOR IS MIDRANGE (0°)
- ELEVATION: ZENITH TO HORIZON
3. IF CRCS ORIGIN IS (X,Y,Z)=(0,0,0) THEN PORT 2 ORIGIN IS (800,0,-800) WITH AXES AS SHOWN
4. IF CRCS ORIGIN IS (X,Y,Z)=(0,0,0) THEN PORT 5 ORIGIN IS (0,800,-800) WITH AXES AS SHOWN


NOTES, UNLESS OTHERWISE SPECIFIED:
PORT 5 INSTRUMENT ORIENTATION
PORT 2 INSTRUMENT ORIENTATION
+Y
+X
+Z
+Y
+X
+Z
$+Z_r$
$+Y_{14}$
$+Y_{13}$
800
800
(CRCS) ORIGIN
$+X_{14}$
$-X_{13}$
$-X_r$
$-Y_r$
800
800
$-Z_{14}$
$-Z_{13}$
PORT 4
PORT 3
ISS
GEMINI PROJECT DOCUMENT APPROVED FOR RELEASE
1. Z AXES OF INSTRUMENT COORDINATE SYSTEMS PASS THROUGH CENTER OF SCIENCE PORTS.
2. TELESCOPE IN 'PARK POSITION'
- AZ IS EAST FACING (90°)
- CASS ROTATOR IS MIDRANGE (0°)
- ELEVATION: ZENITH TO HORIZON
3. IF CRCS ORIGIN IS (X,Y,Z)=(0,0,0) THEN PORT 4 ORIGIN IS (-800,0,-800) WITH AXES AS SHOWN
4. IF CRCS ORIGIN IS (X,Y,Z)=(0,0,0) THEN PORT 3 ORIGIN IS (0,-800,-800) WITH AXES AS SHOWN
GEMINI 8-M Telescopes Project
INSTRUMENT AND ISS COORDINATE SYSTEM
E
90-GP-0000-0006
A


PORT 1 INSTRUMENT ORIENTATION
+Y
+X
+Z
GEMINI PROJECT DOCUMENT
APPROVED FOR RELEASE
PORT 5
ISS
(CRCS) ORIGIN
+Y IS 'UP' WHEN TELESCOPE IS HORIZON POINTING
PORT 5
PORT 1
ISS
1600
NOTES, UNLESS OTHERWISE SPECIFIED:
1. Z AXES OF INSTRUMENT COORDINATE SYSTEMS PASS THROUGH CENTER OF SCIENCE PORTS.
2. TELESCOPE IN 'PARK POSITION'
- AZ IS EAST FACING (90°)
- CASS ROTATOR IS MIDRANGE (0°)
- ELEVATION: ZENITH TO HORIZON
3. IF CRCS ORIGIN IS (X,Y,Z)=(0,0,0) THEN PORT 1 ORIGIN IS (0,0,-1600) WITH AXES AS SHOWN
GEMINI 8-M Telescopes Project
INSTRUMENT AND ISS COORDINATE SYSTEM
90-GP-0000-0006
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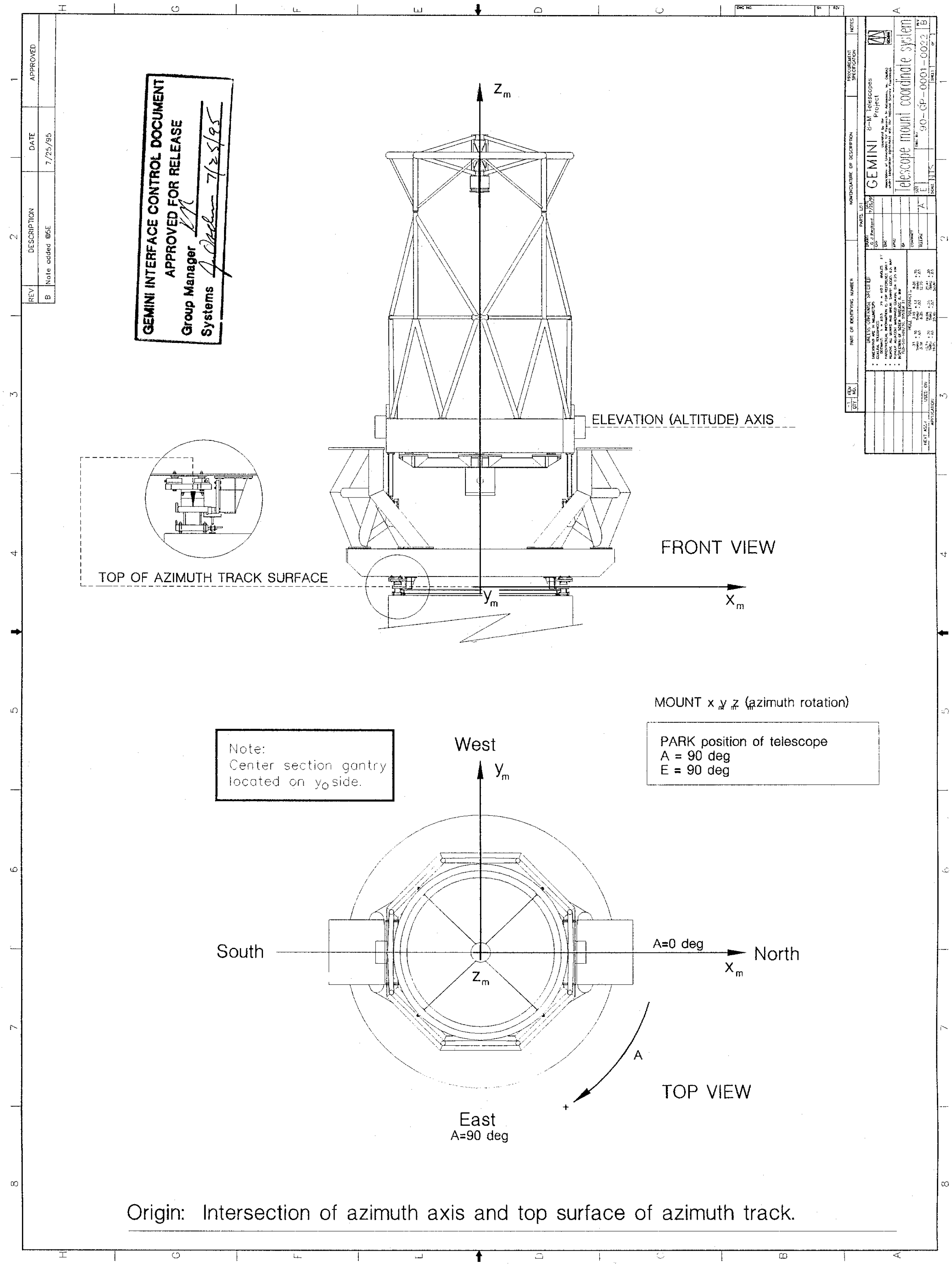

GEMINI INTERFACE CONTROL DOCUMENT
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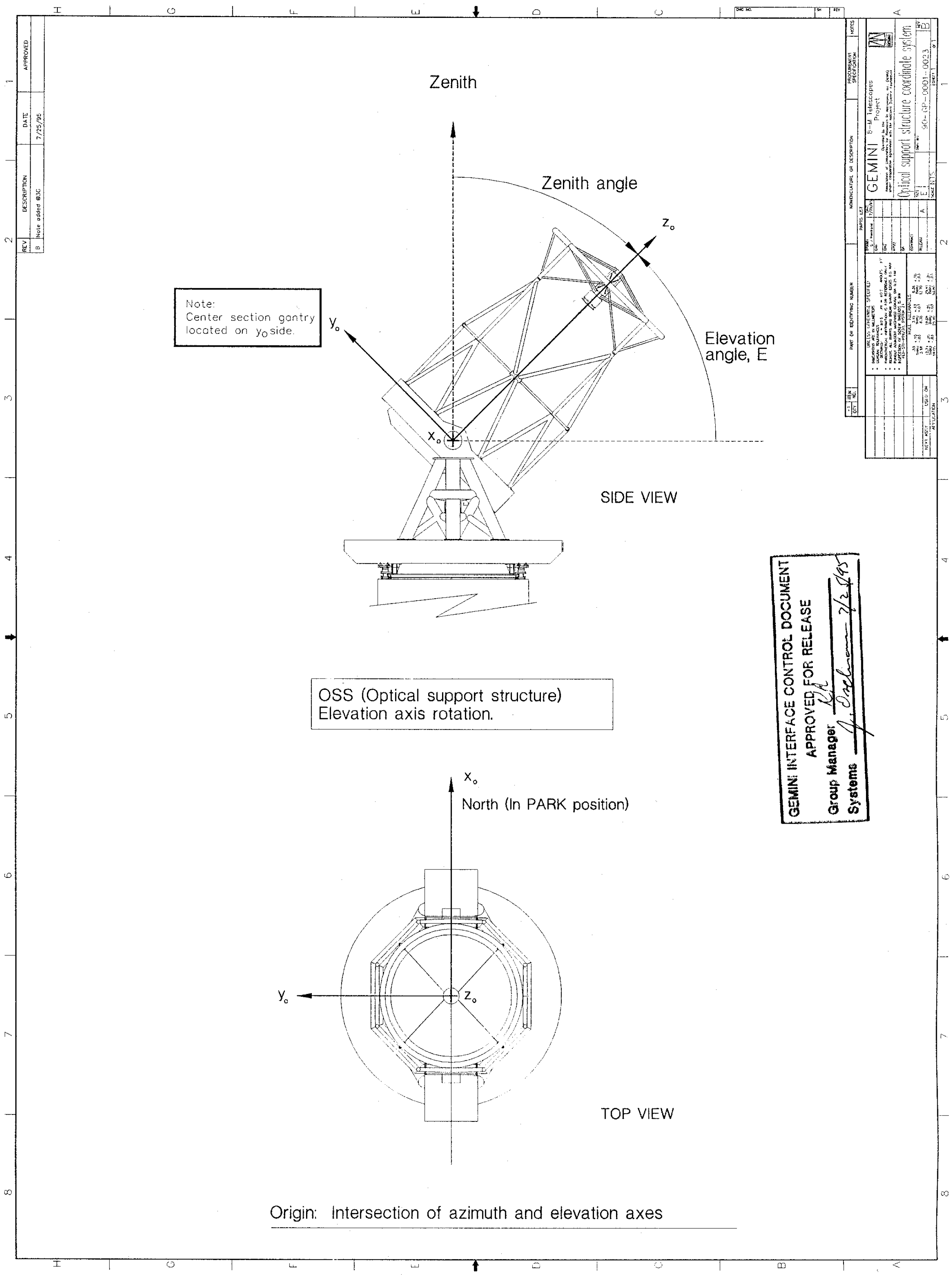
Group Manager
Systems
7/25/95
$z_m$
ELEVATION (ALTITUDE) AXIS
TOP OF AZIMUTH TRACK SURFACE
FRONT VIEW
$y_m$
$x_m$
MOUNT x y z (azimuth rotation)
PARK position of telescope
A = 90 deg
E = 90 deg
Note:
Center section gantry located on $y_0$ side.
West
$y_m$
South
A=0 deg
North
$x_m$
$z_m$
A
TOP VIEW
East
A=90 deg
Origin: Intersection of azimuth axis and top surface of azimuth track.
GEMINI
Telescope mount coordinate system


Zenith
Zenith angle
z₀
Note:
Center section gantry located on y₀ side.
y₀
Elevation angle, E
x₀
SIDE VIEW
OSS (Optical support structure)
Elevation axis rotation.
x₀
North (In PARK position)
y₀
z₀
TOP VIEW
Origin: Intersection of azimuth and elevation axes
GEMINI INTERFACE CONTROL DOCUMENT
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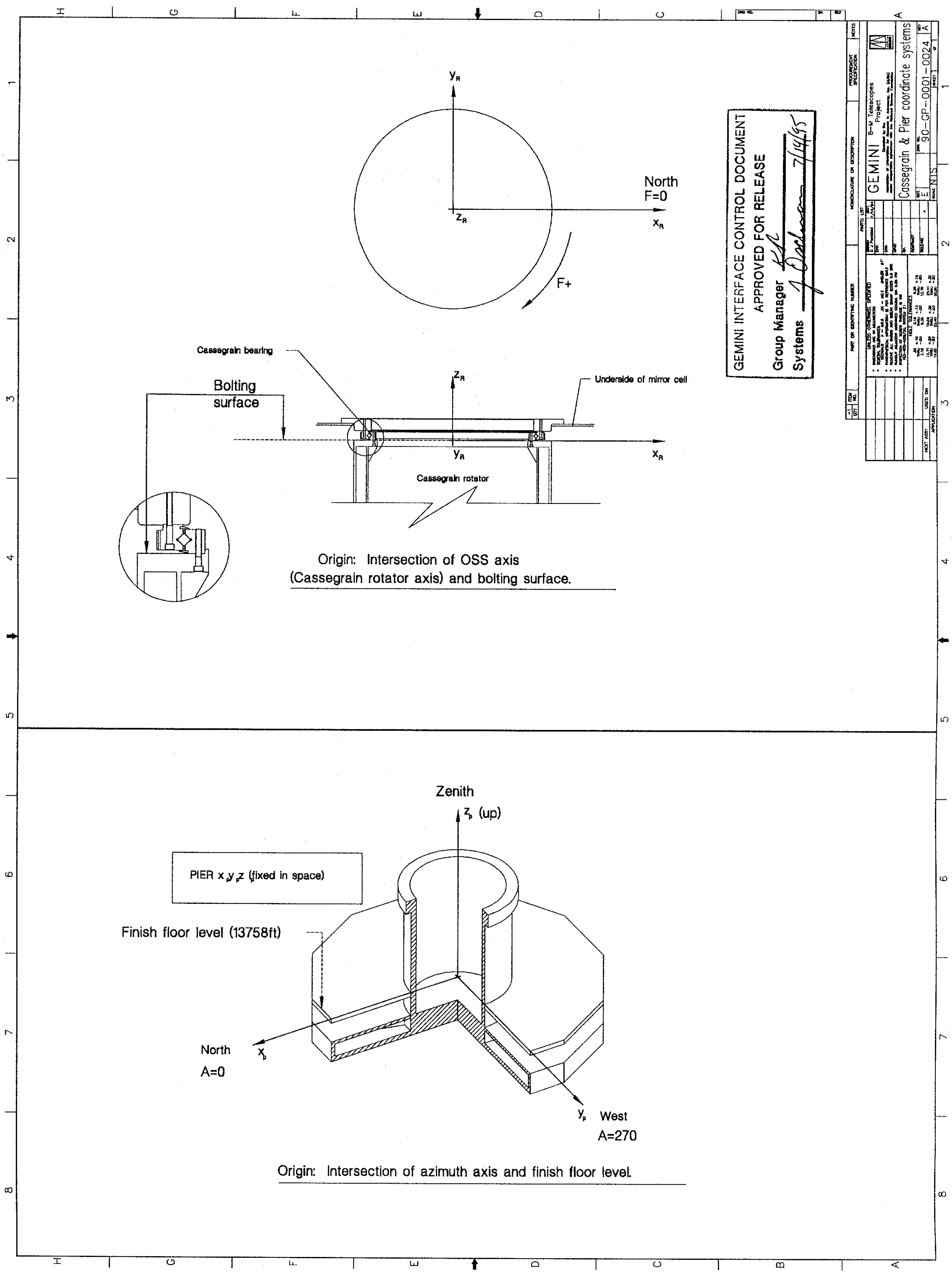
GEMINI 8-M Telescopes Project
Optical support structure coordinate system


y_R
North
F=0
z_R
x_R
F+
Cassegrain bearing
Bolting
surface
Underside of mirror cell
Cassegrain rotator
Origin: Intersection of OSS axis
(Cassegrain rotator axis) and bolting surface.
Zenith
z_p (up)
PIER x_p y_p z_p (fixed in space)
Finish floor level (13758ft)
North
A=0
x_p
y_p
West
A=270
Origin: Intersection of azimuth axis and finish floor level.
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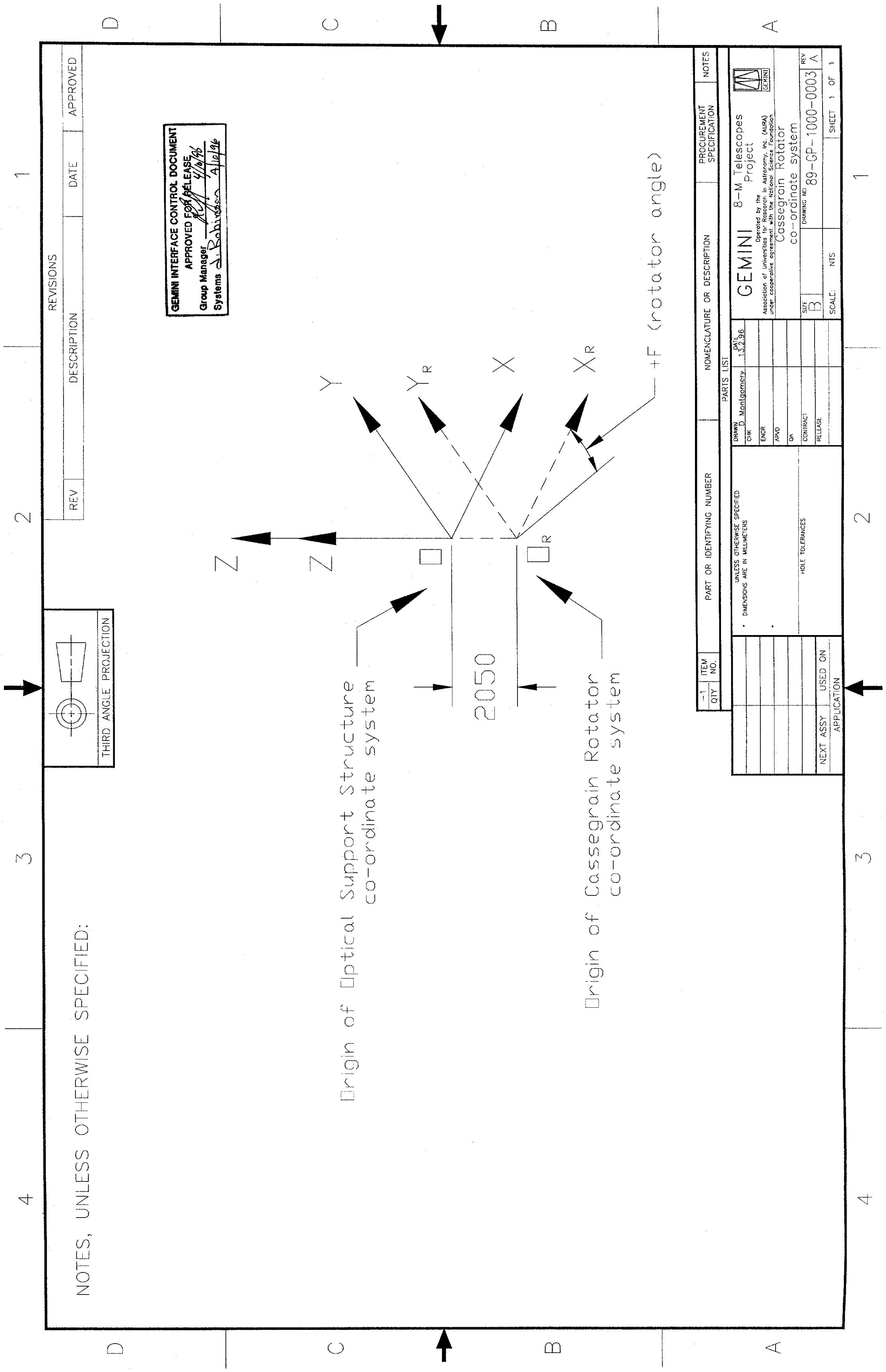
GEMINI
8-M Telescopes
Project
Cassegrain & Pier coordinate systems
90-GP-0001-0024
NTS


NOTES, UNLESS OTHERWISE SPECIFIED:
REVISIONS
REV
DESCRIPTION
DATE
APPROVED
GEMINI INTERFACE CONTROL DOCUMENT
APPROVED FOR RELEASE
Group Manager
Systems
THIRD ANGLE PROJECTION
Y
$Y_R$
X
$X_R$
Z
+F (rotator angle)
2050
Origin of Optical Support Structure co-ordinate system
Origin of Cassegrain Rotator co-ordinate system
PART OR IDENTIFYING NUMBER
NOMENCLATURE OR DESCRIPTION
PROCUREMENT SPECIFICATION
NOTES
PARTS LIST
QTY
ITEM NO.
NEXT ASSY
USED ON
APPLICATION
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN MILLIMETERS
HOLE TOLERANCES
DRAWN
CHK
ENGR
APVD
QA
CONTRACT
RELEASE
GEMINI
8-M Telescopes Project
Cassegrain Rotator
co-ordinate system
SIZE
B
DRAWING NO.
89-GP-1000-0003
REV
A
SCALE: NTS
SHEET 1 OF 1