LDT Instrument Cube Interface Specification

LDT-0595-004-1

Version 1 10 August 2020

Author: Thomas Bida Sr Instrument Scientist

Approved by: Amanda Bosh Operations Manager

Lowell Observatory
1400 W. Mars Hill Road
Flagstaff, AZ 86001

Tel: (928) 774-3358

www.lowell.edu

Revision History

Revision Number	Author	Date	Description of Changes	ECN #
0.1	Tom Bida	28 Oct 2019	Preliminary release	
1	Tom Bida	10 Aug 2020	Version 1	

Table of Contents

List of Figures

List of Tables

1. Introduction

1.1. Document objective

The objective of this document is to specify the interfaces for instrumentation to be installed on the LDT Ritchey-Chretien (RC) Cassegrain instrument support assembly (aka, the Instrument Cube).

1.2. Background

The 4.3m Lowell Discovery Telescope (LDT), an f/6.1 Ritchey-Chretien (RC) design, has been fully operational since 2015 at the Happy Jack site in Northern Arizona (elevation 2361m).

The first-light RC configuration for the LDT, with instrumentation installed at the Cassegrain focus, required development of the RC instrument support assembly, more commonly referred to as the instrument cube. The instrument cube provides the mechanical, optical, and electronic interfaces for a variety of instrumentation, including two GWAVES (guider and wavefront sensor) probe assemblies. Up to five "hot" operational instruments will be co-mounted on the cube, each instrument rapidly selectable with remote control of custom fold mirrors. This design provides a nearly-unique DCT capability of multi-instrument studies of objects in the same night, including simultaneous optical imaging with the LMI (large monolithic imaging CCD) by use of a dichroic in place of the fold mirror.

1.3. Scope

This document only specifies the interfaces for individual instrument installations on the RC Instrument Cube. Instrument components also must not interfere with other instruments co-installed on the Cube. *This document does not provide all the information necessary to ensure full compatibility with the current operational cube assembly.*

1.4. Definitions, Acronyms, Abbreviations

1.5. References

1.5.1. Controlling Documents

Document Number	Document Title	Notes
DCT-0515S-001-7	DCT Facility Instrument Interface Specification	

1.5.2. Dependent Documents

Document Number	Document Title	Notes

1.5.3. Referenced Documents

Document Number	Document Title	Notes

1.6. Applicable standards

The general standards and specifications to be followed in the development of all LDT systems are defined in the document DCT Applicable Standards and Specification (DCT-0000S-004). Alternate standards may be proposed and used if agreed upon in writing by the LDT Project.

2. General description

The instrument cube assembly includes mechanical, utility, and optical interfaces for 4 instruments to be mounted on the cube's sides, to utilize focal planes located 180mm behind the mounting surfaces. Two of the instrument ports are appropriate for smaller instruments up to 115kg mass, being located just above the cube enclosures containing the GWAVES 3-axis probe assemblies, as shown in Figure 1. The other 2 ports will support larger instruments up to 285kg, providing a much larger volume available for longer focal length instruments or those with more complicated geometries.

3. Mechanical interfaces

The layout of the instrument cube is shown in figures 1-4. Figure 2 identifies the port numbers (A, B, C, D), and shows the location of cube utility interface components in the corner between ports A and B. The remaining 3 corners provide additional volumes to mount supporting instrument electronics, if available. The Cassegrain instrument envelope is defined by the cylindrical Cassegrain rotator cable wrap, inside 59in (1500mm) radius (Figure 2), and a hemispherical volume below the cube a maximum of 22" from the cube back surface.

3.1. Small instrument ports

3.1.1. Port dimensions

The attachment points and clearances for instrumentation mounted on the small instrument ports B and D are shown in Figures 1 and 3. The face of the port features an 8" attachment bolt circle, and the cube flange includes a hole pattern for attaching supporting electronics adjacent to the instrument. All instrumentation must be located within the boundaries defined by the cube flange, side-supporting gussets, and the guider enclosure.

3.1.2. Port capacity

The total weight of small port mounted instruments, including associated electronics, must not exceed 115kg (255lb).

3.2. Large instrument port

3.2.1. Port dimensions

The attachment points and clearances for instrumentation mounted on the large instrument ports A and C are shown in Figures 1 and 4. The face of the port features 8" and 22" bolt circles, and the cube flange includes a hole pattern for attaching supporting electronics adjacent to the instrument. All instrumentation must be located within the boundaries defined by the cube flange and side-supporting gussets.

3.2.2. Port capacity

The total weight of large port mounted instruments, including associated electronics, must not exceed 285kg (630lb).

3.3 Instrument cube model

The instrument cube assembly is modeled in SolidWorks data format, and is available to instrument developers by request.

4. Utility interfaces

Instrument cube utility connection details are listed in Table 1, and described in the following subsections. The power distribution units (PDU's) and Ethernet switch are installed in a 3U crate attached to the cube on the port A side, adjacent to port D.

4.1 Power

AC power is supplied through 2 power distribution units (PDU's), each with 8 sockets accepting 3-prong AC male plugs. Each instrument is assigned 1 power socket, and power will be distributed for the instrument through appropriate plug strip(s).

4.2 Ethernet

The Ethernet switch operates at 10/100 Mbps, and is certified for operation from -40C – +75C.

4.3 Optical fiber

Instument-based optical fibers couple directly to the fiber panel on the RC interface panel. These cables run through the telescope wraps, terminating at the fiber interconnect panel in the instrument rack in the computer room.

4.4 Instrument air

Instrument grade dry compressed air is provided full time from a facility air compressor. Distribution on the cube is provided through a 6-port manifold with single lines regulation available.

4.5 Helium

Helium lines are plumbed from the main floor facility controls room where facility glycol cooling is available for compressor cooling, through fixed, flux-free and cleaned copper piping to instrument stations in the lab, and on the mezzanine and observing levels. Copper helium lines to the telescope are plumbed through the pier, and connect to flexible lines that run through the azimuth and elevation wraps, with a final set pulled through the RC cable wrap and terminated at the wrap panel. The final connections to the compressor and instrument cooling heads are made with shorter flexible lines.

4.6 Glycol

There are 6 glycol circuits available to RC cube instrumentation through supply and return manifolds with adjustable needle flow valves mounted on the cube interface plate. Two circuits are utilized for the GWAVES camera and LMI systems, thence each cube port is allocated a circuit. Instrument electronics must be enclosed and any heat generated removed via heat exchanger(s) to the glycol chiller circuit.

Table 1. Instrument Cube Utility Interfaces

Description	QTY	Instrument Cube Connector Type	Details
AC Power	16[a]	NEMA 5-15R socket	125 V, 20 A total, 60 Hz (conditioned)
Ethernet	24	RJ-45 10/100 TX	Instrument Data subnet
Optical Fiber	12[b] pair	SC-type Connector L-Com P/N FOA-005or equivalent	Multi-Mode Located on RC interface panel. Terminates at computer room patch panel.
75 ohm coax (RG59)	4	Isolated BNC L-Com P/N BA039 or equivalent	Video (e.g., RS170) Located on RC interface panel.
50 ohm coax (RG58)	4	Isolated BNC L-Com P/N BA522 or equivalent	Signal or IRIG-B Located on RC interface panel.
Instrument Air	6	QD fitting: Chrome plated valved fittings, 1/4" NPTM, plug and socket McMaster PN: 5478K141, K711 CPC PN: LCD24004, 10004	80 psi min, 1 cfm total
Cryotiger Coolant	2 pair	0.5" dia self-sealing coupling Aeroquip 5400-S2-4 or equivalent	Nominal 250 psi supply side Located on RC interface panel.
Helium	1 pair	Panel fitting: 0.5" dia Male connector Aeroquip 5400-S2-8 or equivalent	Nominal 290 psi supply side. Located on RC interface panel.
Ambient Glycol	6	QD fittings: Chrome plated valved fittings, 3/8" NPTM, plug and socket McMaster PN: 5478K142, K712 CPC PN: LCD24006, 10006	50% Propylene Glycol, nominal TBD psi supply side 2GPM total flow, ΔP=10psi

Notes: a. As of 23 Oct 2019, 12/16 PDU power sockets are assigned to existing instrumentation.
b. As of 23 Oct 2019, 10/12 fiber pair connections are assigned.

5. Optical interface

The 4 folded instrument cube ports have the following optical beam characteristics:

1. The unvignetted FOV of a standard fold mirror is approximately 2.5 arcmin circular diameter.
2. The back focus from the instrument mounting flanges for folded cube ports is 180.1mm.
3. The RC plate scale is 8 arcsec/mm.

A Zemax optical model for DCT folded instrument ports is available by request (DCT_RC_FoldMirror.ZMX).

Each instrument port is served by a dedicated reflective or dichroic mirror with coatings specific to the installed instrument, installed in interchangeable cell assemblies that provide precise 4-axis alignment adjustments, The specifications for these optics are contained in drawings that are available upon request.

6. Software interface

Communication between the LDT control system and instrument software is executed via a message broker, Apache ActiveMQ. Messages can be utilized to collect or publish metadata, or invoke commands

that perform on-sky operations such as telescope pointing offsets or secondary focus offsets. In addition to the Java APIs for ActiveMQ, two major third party libraries are used as part of the messaging system:

- SimpleXML - used within java layer for XML serialization
- ActiveMQ CPP - used within the C/C++ layer for communicating with the broker

Contact Lowell instrument support for further information on DCT-instrument messaging.

7. Document review

Documents which define instrument interfaces, envelope, and operational or maintenance constraints shall be provided to the LDT project for review prior to initiating any instrument fabrication or assembly.

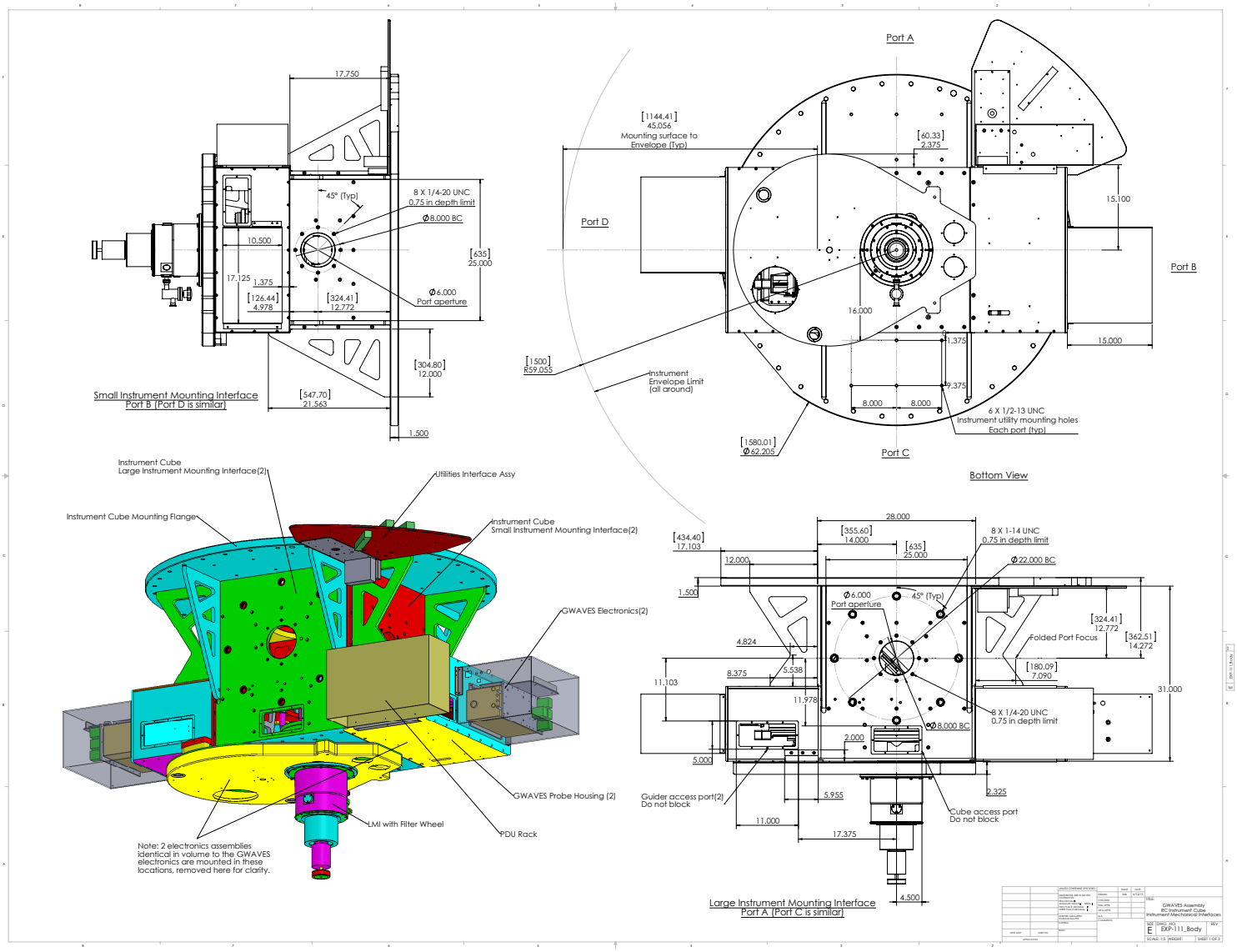

Figure 1. RC instrument cube assembly and mechanical interface details.

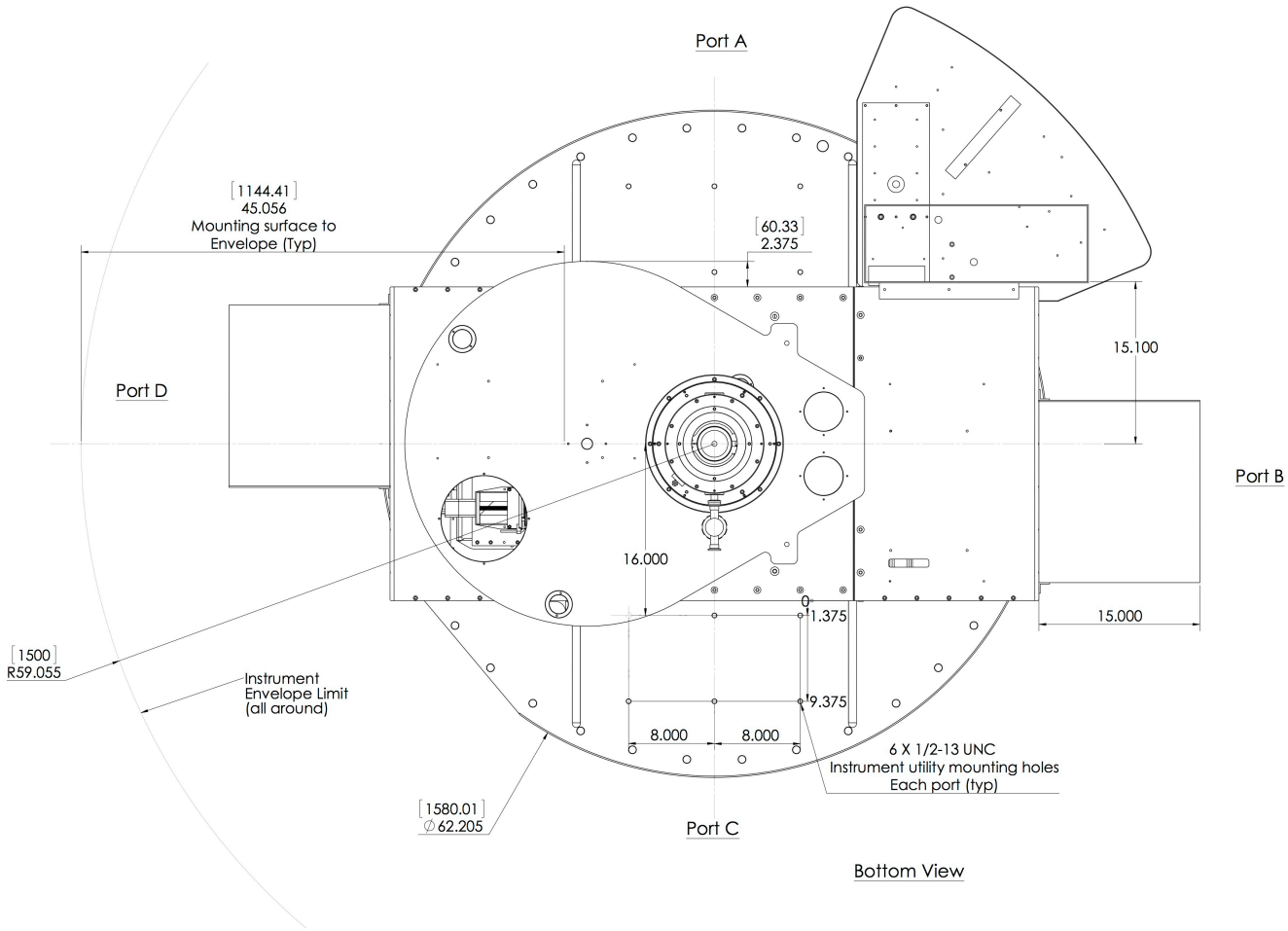

Figure 2. Bottom view of the instrument cube showing the LMI filter wheel, GWAVES electronics boxes, cube interface plate, and auxiliary hole patterns on the cube main flange serving each port.

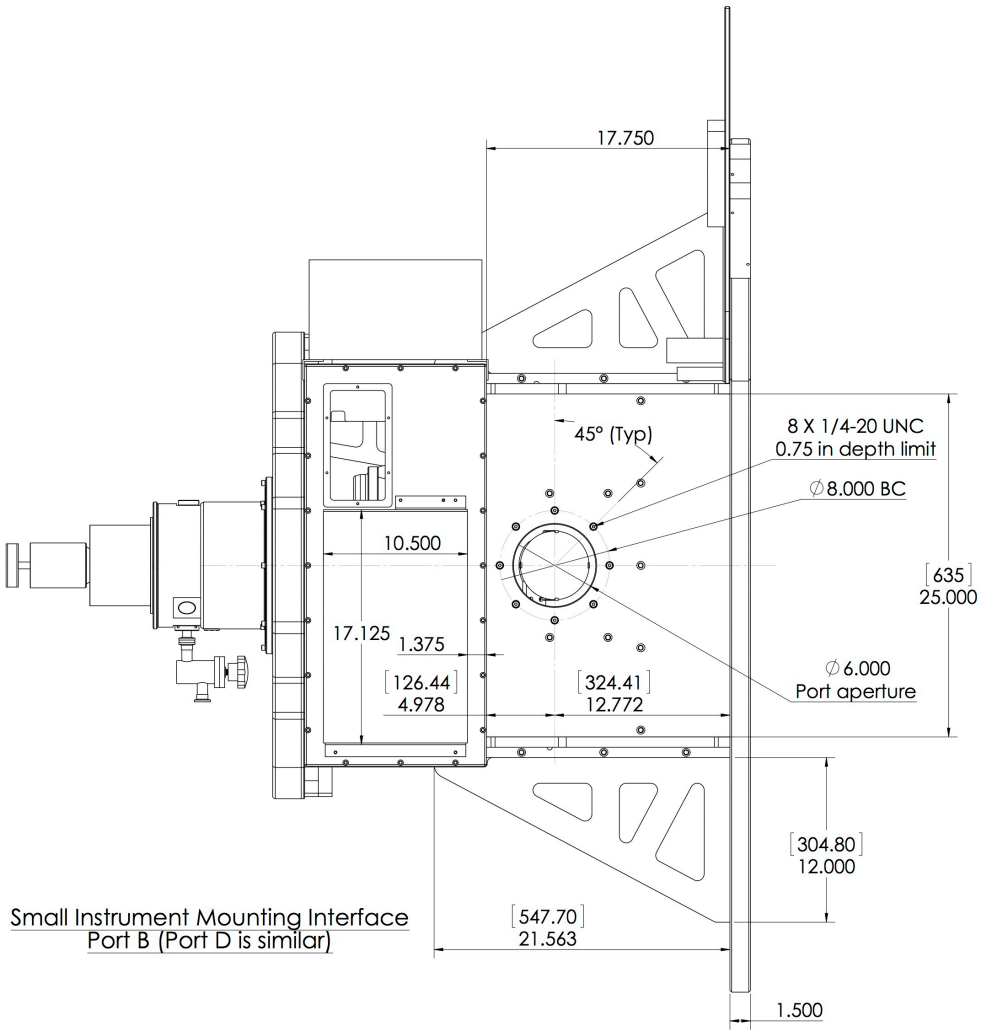

Figure 3. Small instrument port mounting details.

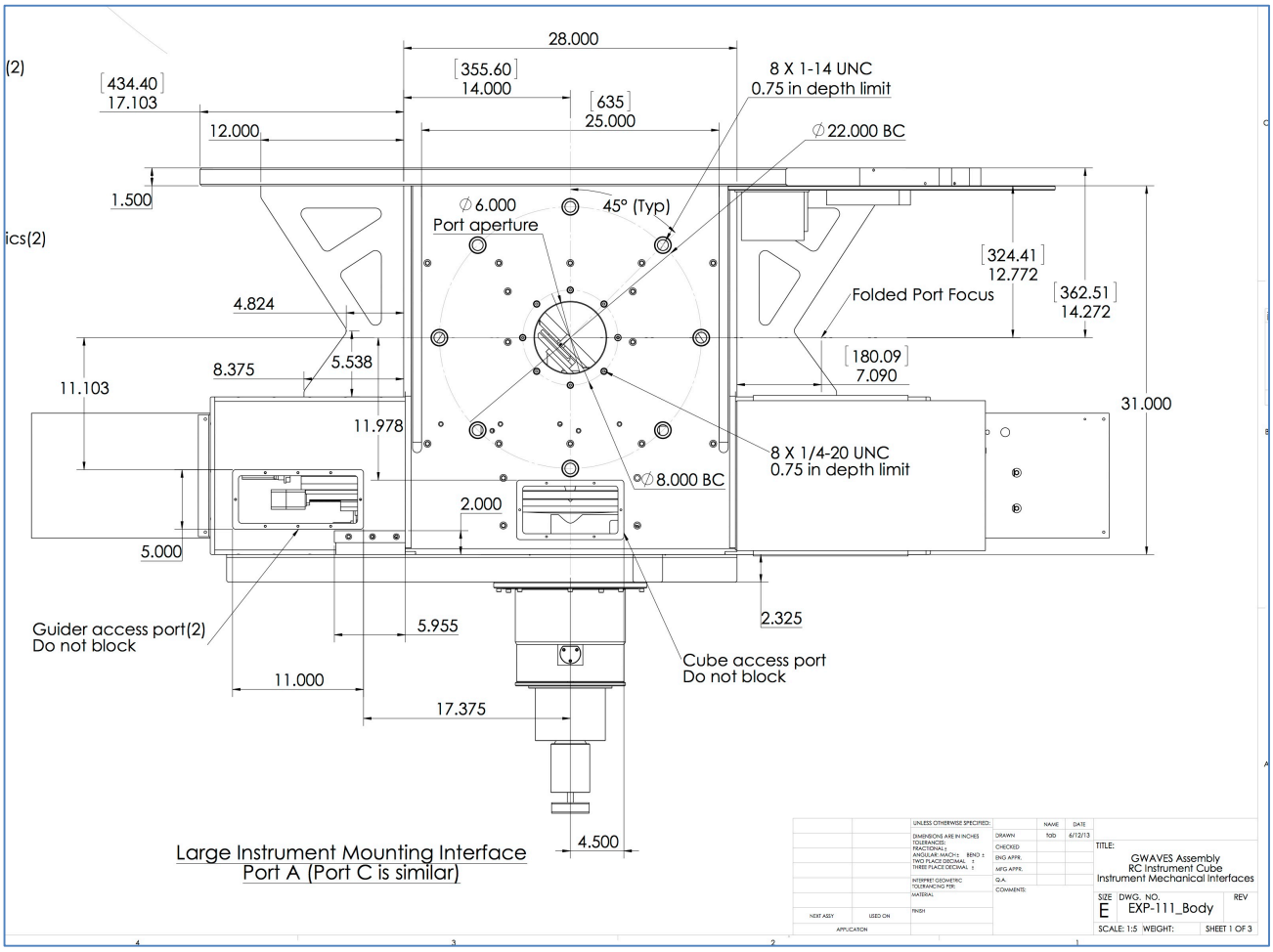

Figure 4. Large instrument port mounting details.