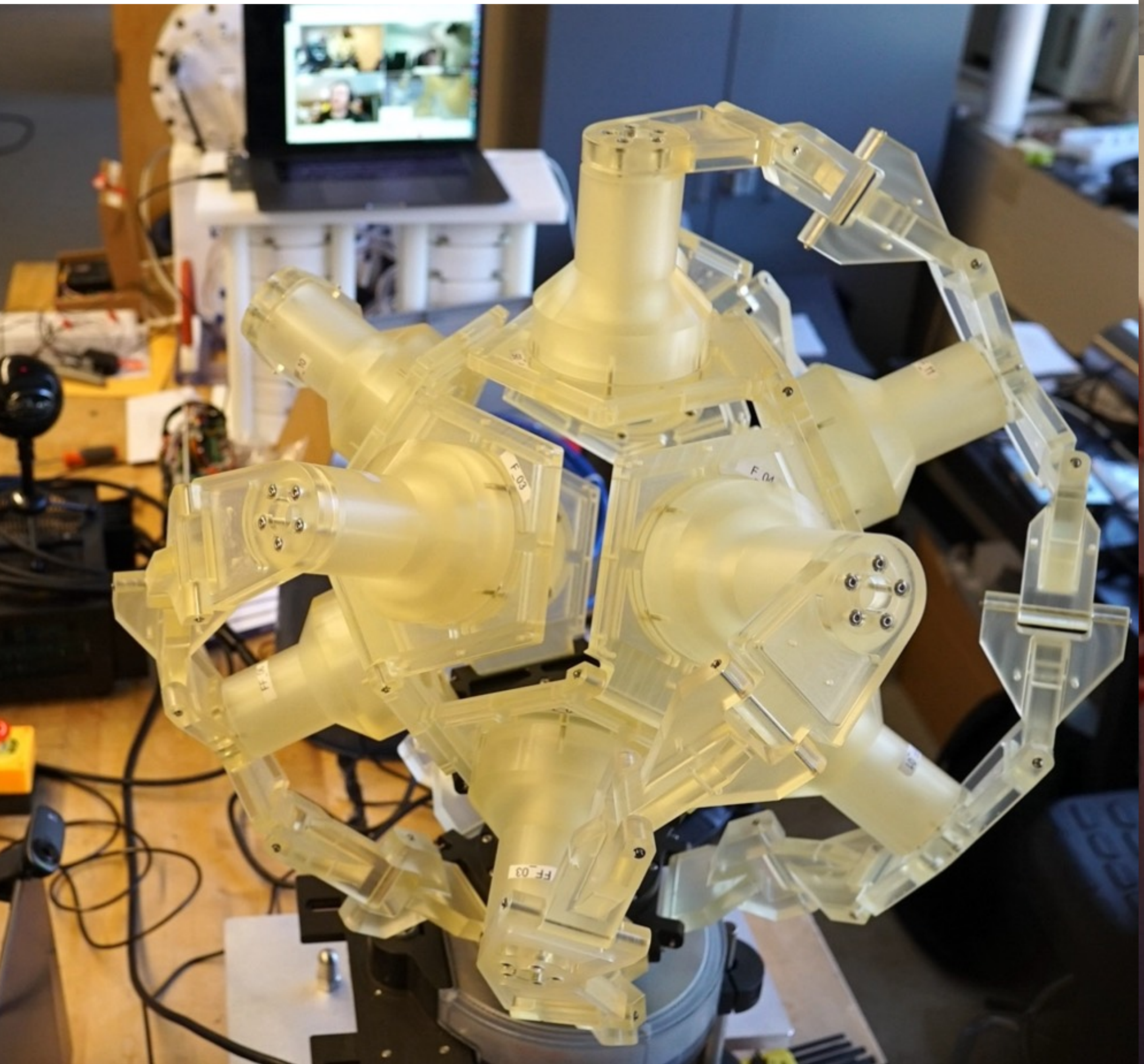
RAD2 Design Documentation

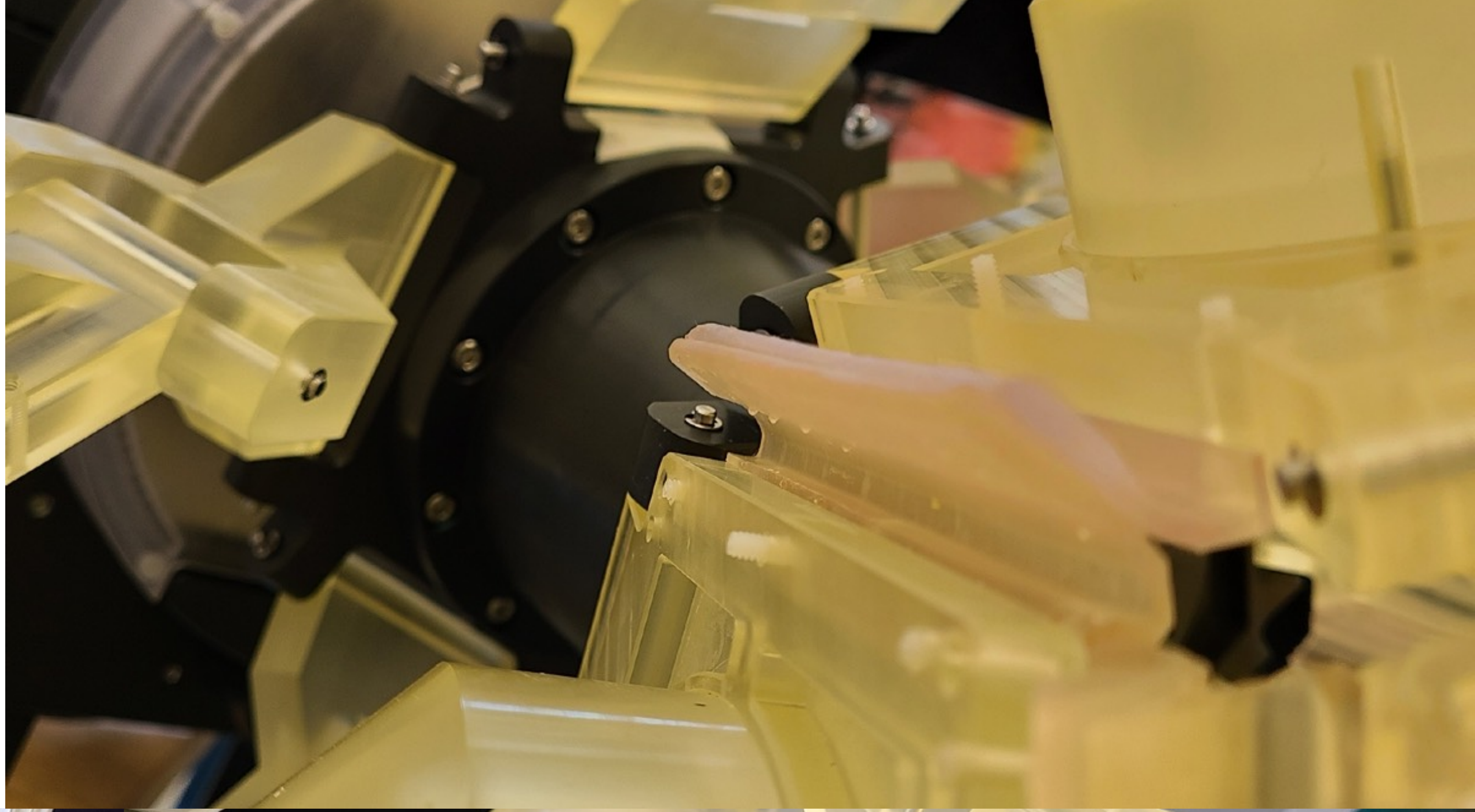
Sponsor: **Schmidt Ocean Institute**
Collaborating Institutions: **University of Rhode Island, Monterey Bay Aquarium Research Institute, Harvard University, CUNY/Baruch College**

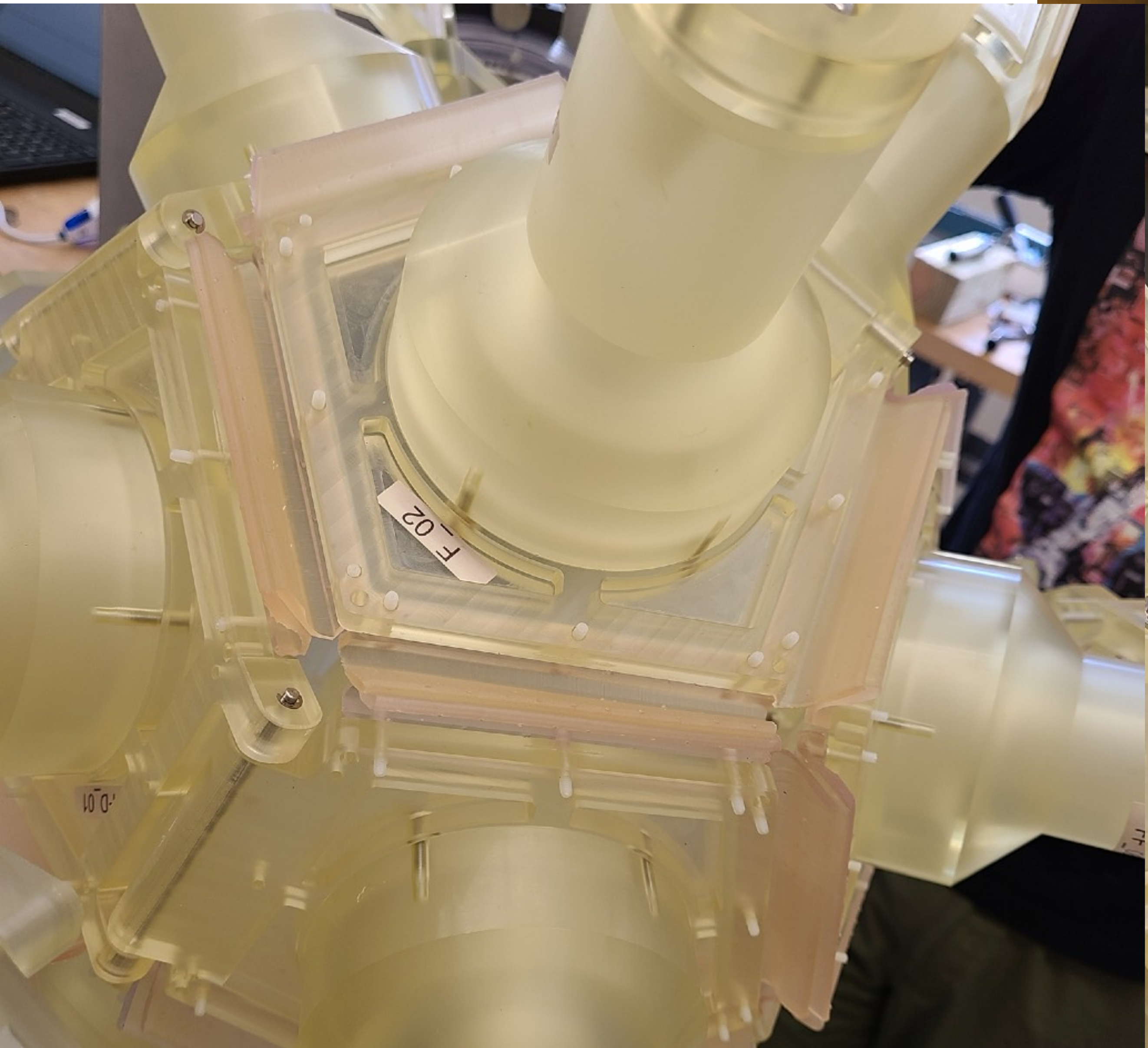
Brennan Phillips, Asst. Professor
Ocean Engineering
University of Rhode Island

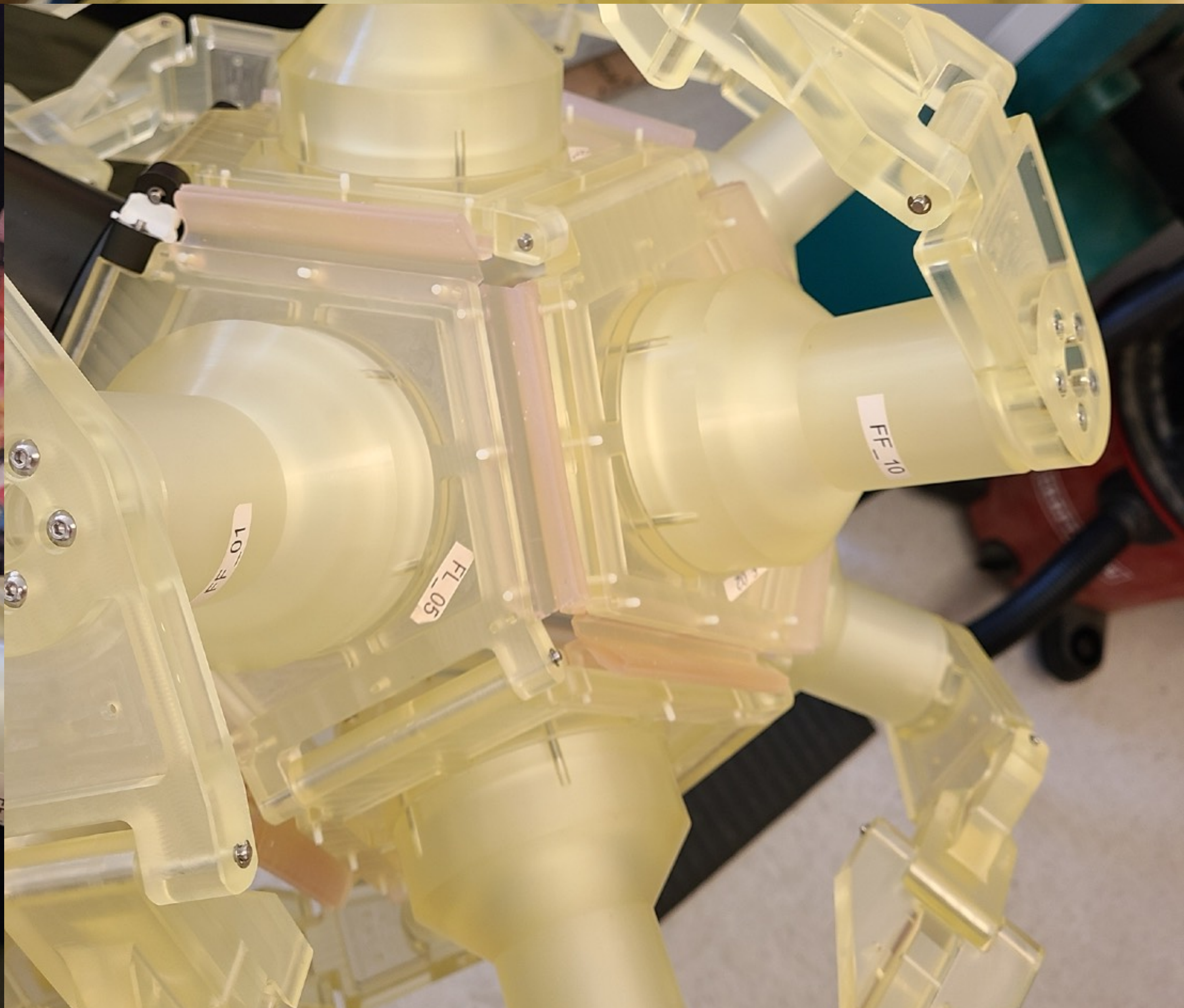
Testing & Assembly



Soft Edges



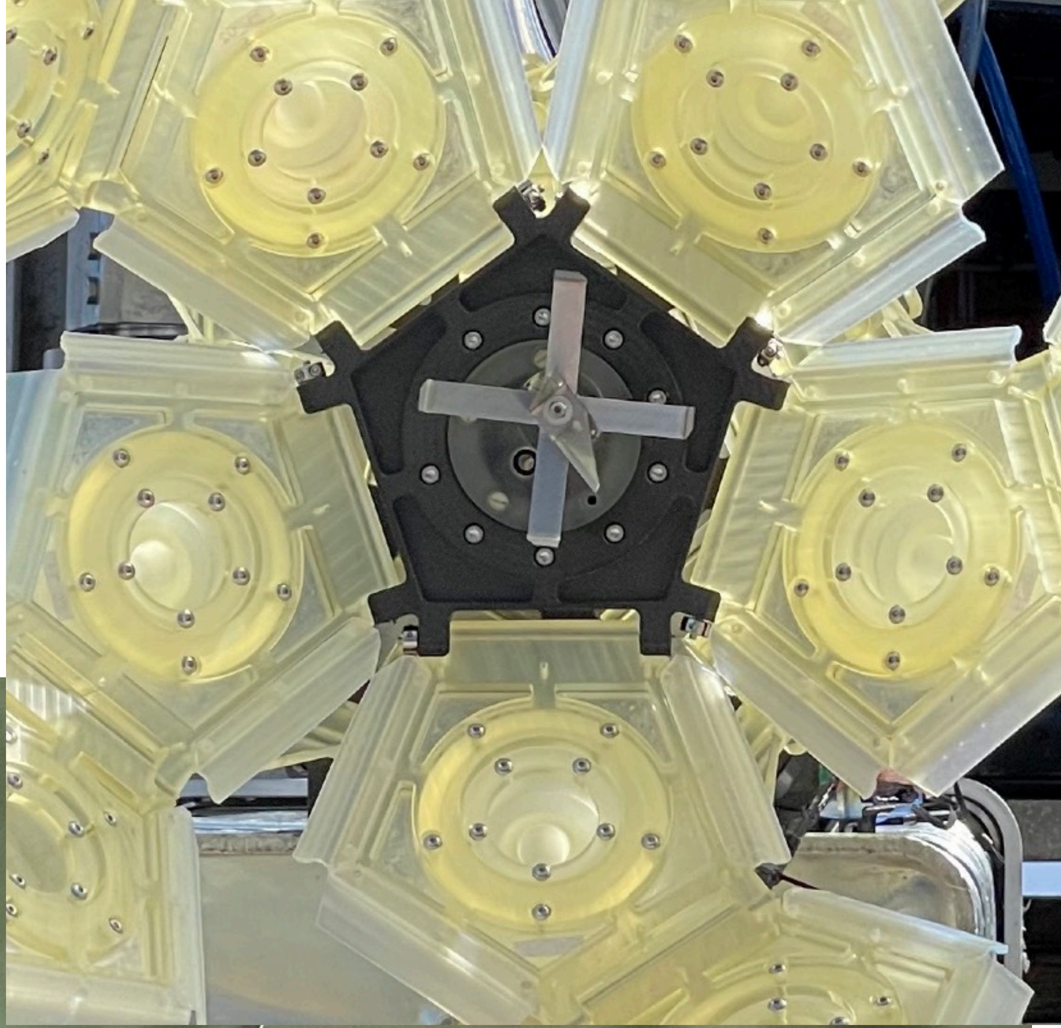


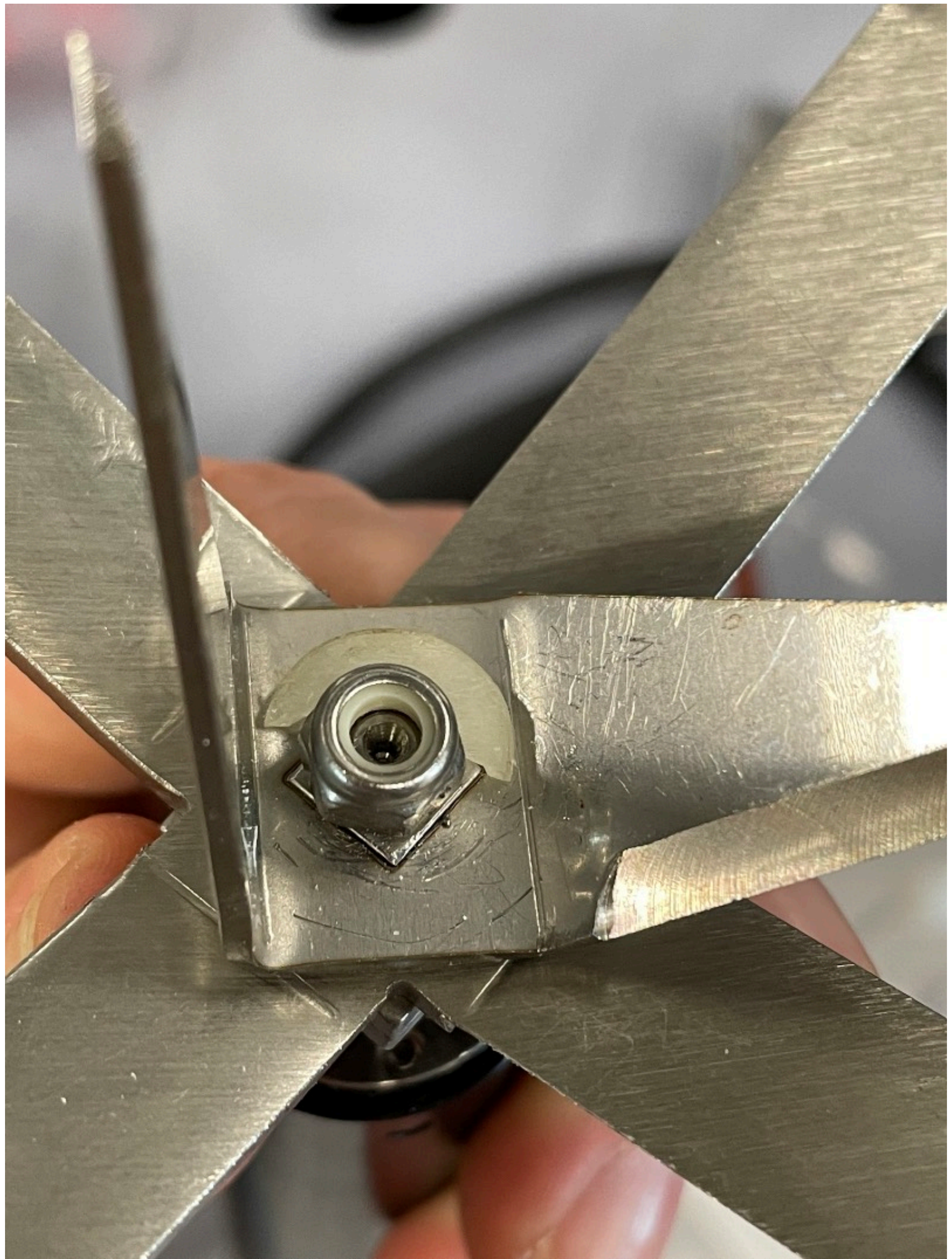


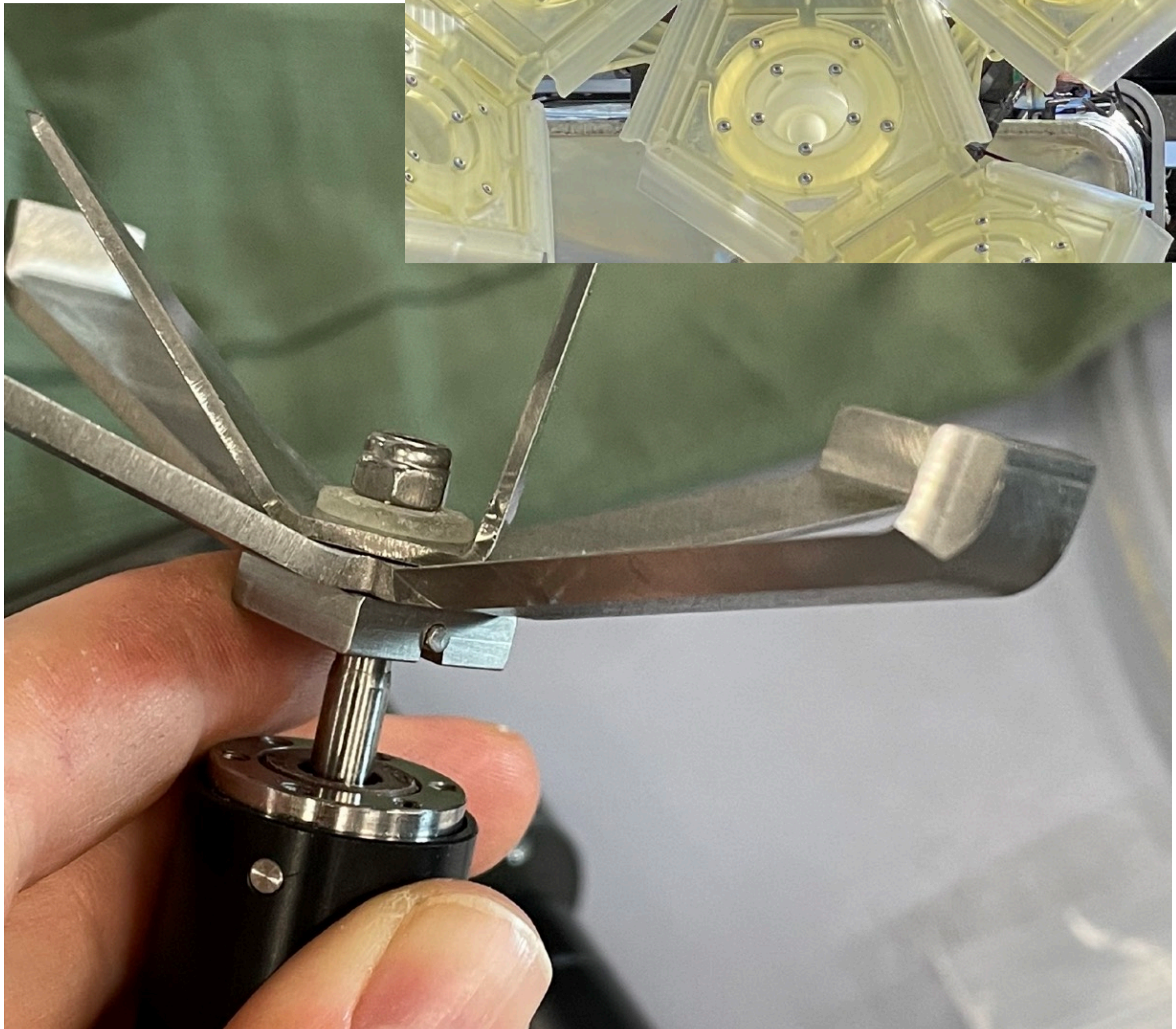
Tissue Sampler

Motor: Maxon MT20

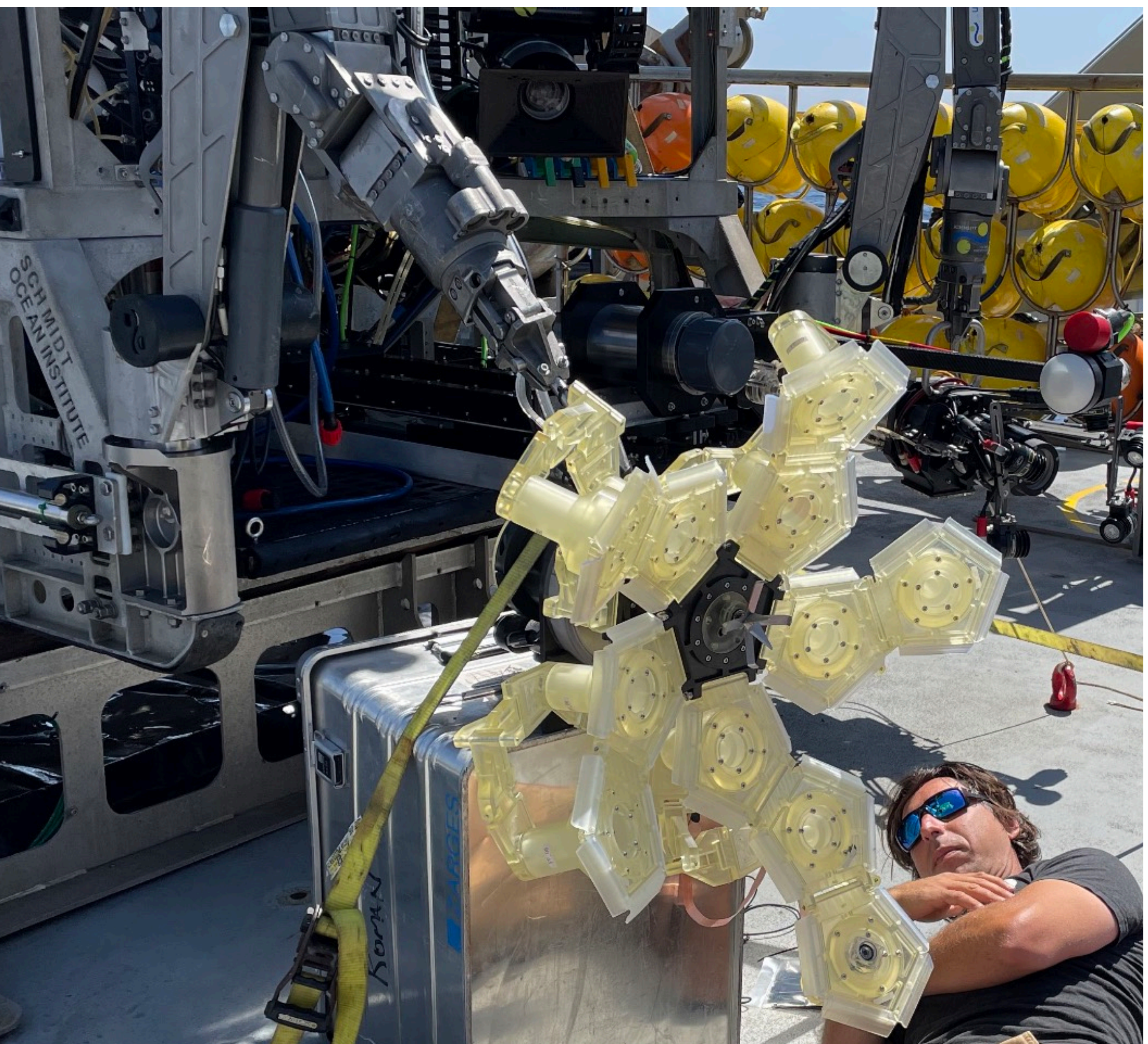
https://www.maxongroup.com/medias/sys_master/root/8849641865246/20201102-Specification-MT20.pdf





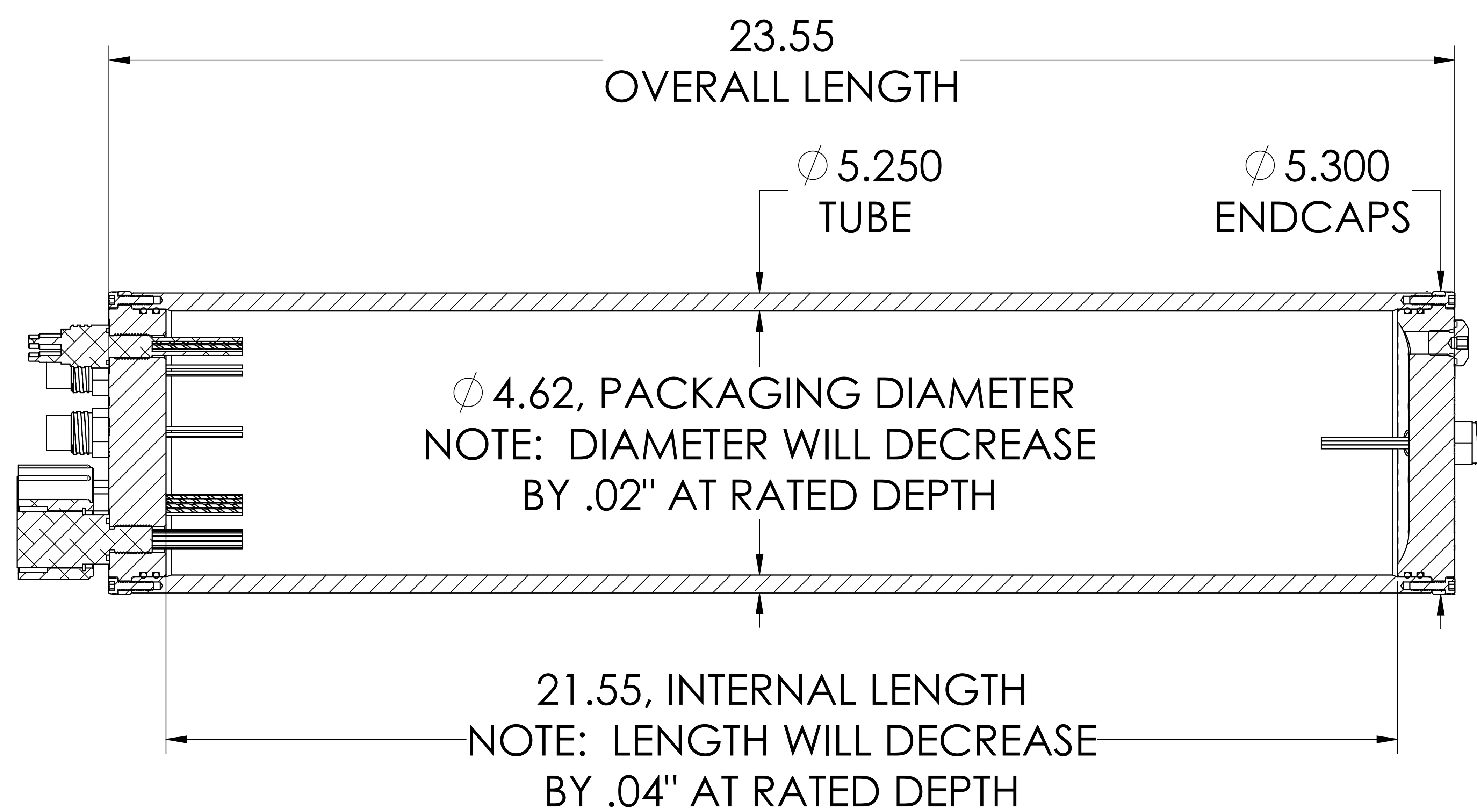


Integration on ROV SuBastian

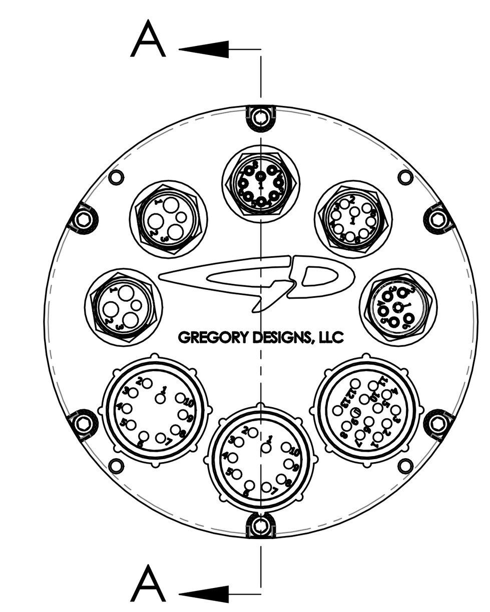


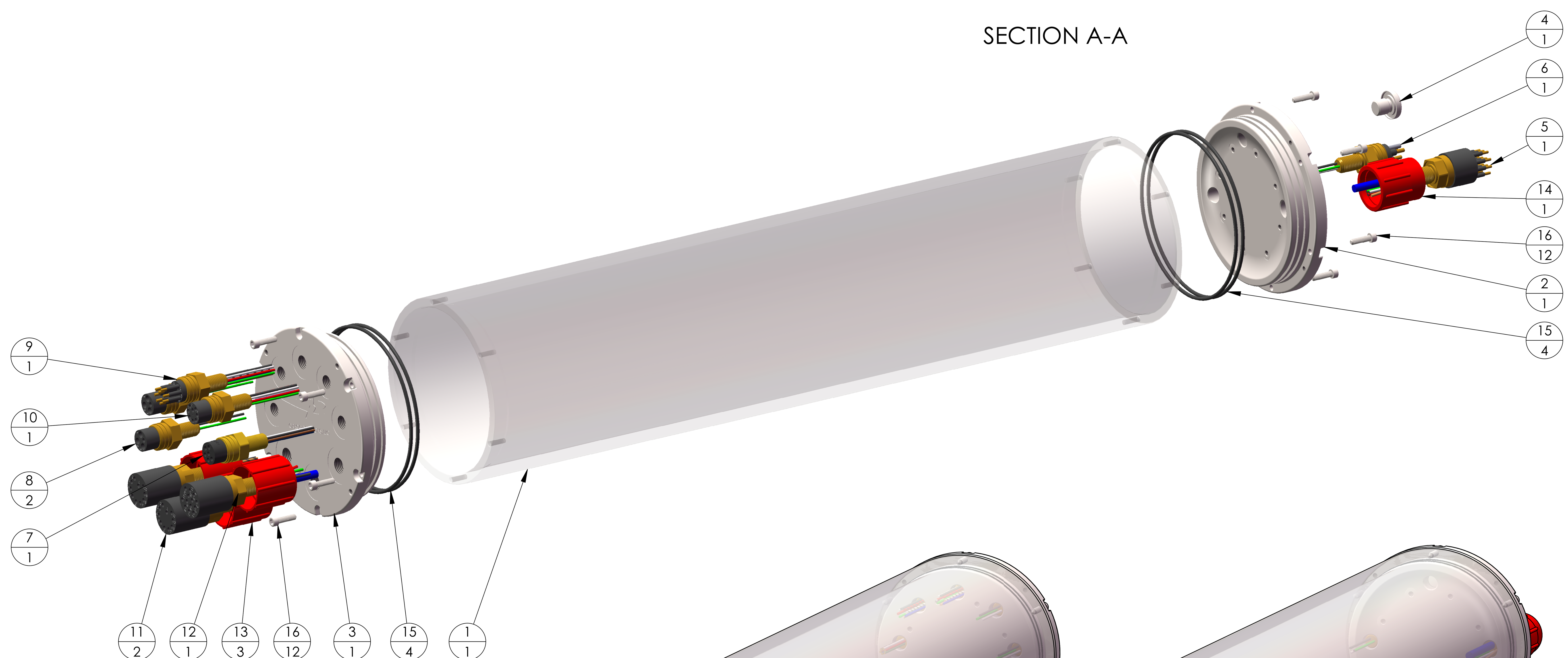
NOTES:

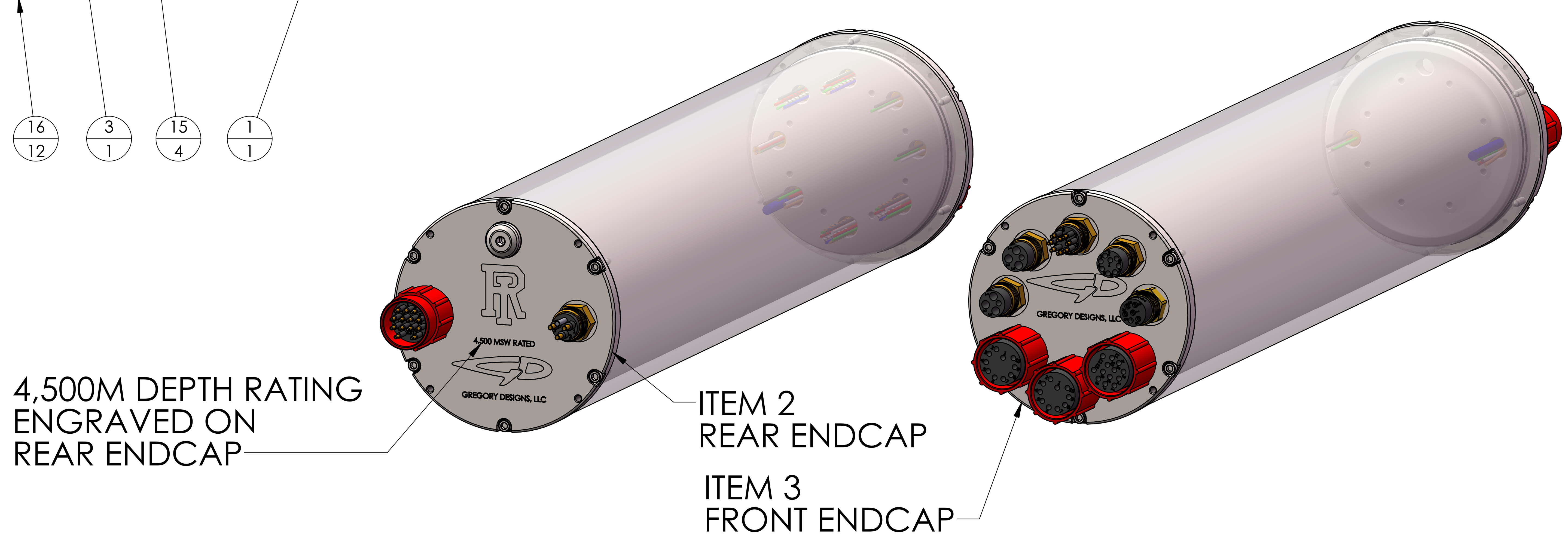
1. MATERIAL: SEE BOM
2. ENSURE O-RING GLAND SURFACES ARE CLEAN. APPLY LIGHT COATING OF DOW-CORNING #4 SILICONE GREASE TO O-RINGS.
3. SAE DUAL-SEAL VENT PLUG (ITEM #4) USED FOR APPLYING VACUUM AND BACK-FILLING HOUSING WITH DRY GAS. FITTING USES O-RINGS: 3-904 BUNA-N, 90a DUROMETER AND 2-015 BUNA-N, 70a DUROMETER.
4. DEPTH RATING: 4,500 METERS, SEAWATER. PRESSURE-TEST HOUSING TO 7,000 PSI (105% OF RATED DEPTH) IN A CERTIFIED HYDROSTATIC TEST FACILITY.
5. ITEM #16 AVAILABLE FROM ALLIED TITANIUM. ASSEMBLE HARDWARE WITH COATING OF MARINE GREASE (e.g. AQUASHIELD) OR ANTISIEZE TO PREVENT GALLING. FOR SHORT-TERM DEPLOYMENT IN SEAWATER, STAINLESS-STEEL 316 HARDWARE IS ACCEPTABLE.



SECTION A-A







	SH	1 OF 1		
REVISION HISTORY				
ZONE	REV	DESCRIPTION	DATE	APPROVED

	ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
	1	GD-BTP--0026-SURP HOUSING TUBE--REV-	SUPR HOUSING TUBE	1
	2	GD-BTP--0028--SUPR ENDCAP-REAR--REV-A	SUPR HOUSING ENDCAP-REAR	1
	3	GD-BTP-0027--SUPR ENDCAP-FRONT--REV-A	SUPR HOUSING ENDCAP-FRONT	1
NOTE 3	4	GD-SILIXA--0024--SAE DUAL SEAL PLUG--REV-	DUAL SEAL VENT PLUG	1
	5	SUBCONN DBH13M	SUBCONN ETHERNET 13-PIN MALE BULKHEAD	1
	6	SUBCONN MCBH3M	SUBCONN MICRO-CIRCULAR 3-PIN MALE BULKHEAD	1
	7	SUBCONN MCBH6F	SUBCONN MICRO-CIRCULAR 6-PIN FEMALE BULKHEAD	1
	8	SUBCONN MCBH3F	SUBCONN MICRO-CIRCULAR 3-PIN FEMALE BULKHEAD	2
	9	SUBCONN MCBH8M	SUBCONN MICRO-CIRCULAR 8-PIN MALE BULKHEAD	1
	10	SUBCONN MCBH8F	SUBCONN MICRO-CIRCULAR 8-PIN FEMALE BULKHEAD	1
	11	SUBCONN MCBH10F	SUBCONN MICRO-CIRCULAR 10-PIN FEMALE BULKHEAD	2
	12	SUBCONN DBH13F	SUBCONN ETHERNET 13-PIN FEMALE BULKHEAD	1
	13	SUBCONN DLSA-F	SUBCONN LOCKING SLEEVE - FEMALE	3
	14	SUBCONN DLSA-M	SUBCONN LOCKING SLEEVE - MALE	1
NOTE 2	15	O-RING--2-157	O-RING, 2-157, BUNA-N, 70A DUROMETER	4
NOTE 5	16	ALLIED TITANIUM P/N 16610	SOCKET HEAD CAP SCREW, 8-32 x 5/8", TITANIUM GRADE 5	12

APPROVAL	DATE
DESIGN T.GREGORY	2020-03
DRAWING T.GREGORY	2020-03-27
CHECKED D.CASAGRANDE	2020-03-30

THIRD ANGLE PROJECTION

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES.
TOLERANCES:
FRACTIONAL ±1/64
ANGULAR: MACH ±0.5°
ONE PLACE DECIMAL ±0.1
TWO PLACE DECIMAL ±0.01
THREE PLACE DECIMAL ±0.005

GREGORY DESIGNS, LLC

SUPR HOUSING ASSY

SIZE D | DWG. NO. GD-BTP--0025

SCALE: 1:2 | REV. - | SHEET 1 OF 1

COMPUTER FILE NAME
DRAWING GD-BTP--0025-SUPR HOUSING ASSY--REV-
MODEL GD-BTP-0025-SUPR HOUSING ASSY--REV-

SOI/RAD2 Control Bottle Specs

BULKHEADS

Main Telemetry (Power, ethernet) to ROV
- DBH13M (1/2-20)
- MCBH3M (7/16-20)

SuPR Sampler (provided by McLane, SS)
- MCHB10F (1/2-20) “Master Valve”
- MCBH10F (1/2-20) “ 14-port valve”
- MCBH3F (7/16-20) “14-port sensor”
- MCBH3F (7/16-20) “Flow Meter”
- MCBH8M (7/16-20) “Pump”

Maxon thruster (“Tissue Sampler”)
- MCBH8F (7/16-20)

2G Engineering Rotary Actuator
- MCB6F (7/16-20)

DEEPi Cameras
- DBH13F (1/2-20)

TOTAL:
4x 1/2-20 holes
6x 7/16-20 holes

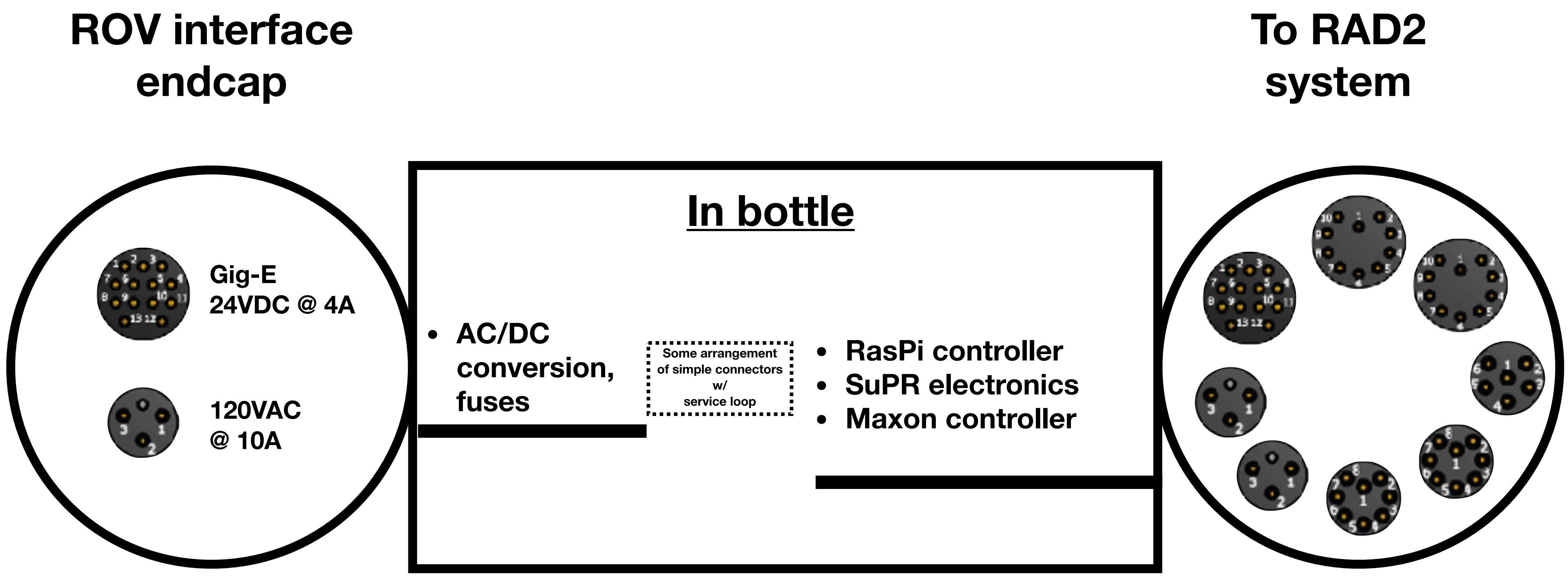
INTERNAL COMPONENTS

Controller: Raspberry Pi 4 (?)
- Ethernet in from ROV
- RS-232 to SuPR
- RS-232 to 2G Eng. Rotary Actuator

SuPR Sampler (provided by McLane)
- 100mm diameter, 240 mm length + some extra room for connectors
- 24VDC, current requirement TBD
- RS-232 comms

Maxon thruster controller “ESCON 70/10”
- 125 x 78.5 x 27mm + connectors
- 24VDC @ 6A max

2G Engineering Rotary Actuator
- no internal components
- Just RS-232, 24VDC, stall (max) current is 5A


ROV interface endcap
Gig-E
24VDC @ 4A
120VAC
@ 10A
In bottle
• AC/DC conversion, fuses
Some arrangement of simple connectors w/ service loop
• RasPi controller
• SuPR electronics
• Maxon controller
To RAD2 system

1. Warnings and hazards

High Voltage - When powered by AC, voltages up to 350V DC are present in the bottle. This voltage dissipates quickly after shutdown, and everything inside the bottle is touch-safe after 60 seconds. When powered by 24V DC, there are no high voltages.

Pinch hazard - The RAD2 actuator moves quickly and has many pinch points where panels and hinges come together. Keep fingers clear of moving parts when on deck.

Tissue sampler blades - The blades can cause significant injury. Keep fingers far away whenever the system is powered on.

Overheating - The AC/DC converter can overheat when run on deck for extended periods, depending on air temperature. If the outside of the bottle is warm to the touch, shut down or cool with water. This is not a concern when under water, or when not using the AC/DC converter.

2. Power and Communications

The RAD2 sampler has flexible power and communications options. The system runs at 24V DC, but contains an optional wide input AC/DC converter.

Power
AC: 87-264V single or split phase, 500w. For example fuse at 5A for 120v, 2.5A for 250v.
DC: 24V, 10A. Lower current configurations are possible with reduced performance.

Communications
The RAD2 bottle contains a number of serial devices connected to a Raspberry Pi. This Pi talks to a topside computer over a 10/100/1000 Mbps Ethernet connection. For SuPR-only operation, this can be bypassed and instead use a RS232 connection at 9600 baud. **Only one of these connections is required.**

3. Connector Pinouts

HOTEL - SubConn DBH13M
1: Power GND
2: Serial GND (isolated from power GND in bottle, can be connected on vehicle side)
3: 24v+
4-11: GigE Ethernet per DHB13M spec
12: RS232 Rx (device receive, connect to vehicle Tx)
13: RS232 Tx (device transmit, connect to vehicle Rx)

AC IN - SubConn MCBH3M
1: Hot (or L1)

2: Neutral (or L2)
3: Chassis GND (optional)

Rotary Actuator - SubConn MCBH6M
1: RS232 RX (device receive)
2: RS232 TX (device transmit)
3: N/C
4: 24v+
5: GND (power and RS232)
6: N/C

Maxon Thruster - SubConn MCBH8F
1: Phase A
2: Phase B
3: Phase C
4: Hall GND
5: Hall PWR
6: Hall A
7: Hall B
8: Hall C

SuPR MPV - SubConn MCBH10F
1: Phase A+
2: Phase B+
3: Phase A-
4: Phase B-
5: Sensor GND
6: PWM
7: Sensor PWR
8: SDA
9: SDL
10: N/C

SuPR SV - SubConn MCBH10F
1: Phase A+
2: Phase B+
3: Phase A-
4: Phase B-
5: Sensor GND
6: PWM
7: Sensor PWR
8: SDA
9: SCL
10: N/C

SuPR Pump - SubConn MCBH8M
1: Phase A
2: Phase B
3: Phase C
4: Hall GND
5: Hall PWR
6: Hall B
7: Hall C
8: Hall A

SuPR Home - SubConn MCBH3F
1: 5v
2: Signal
3: GND

SuPR Flow - SubConn MCBH3F
1: 5v
2: Signal
3: GND

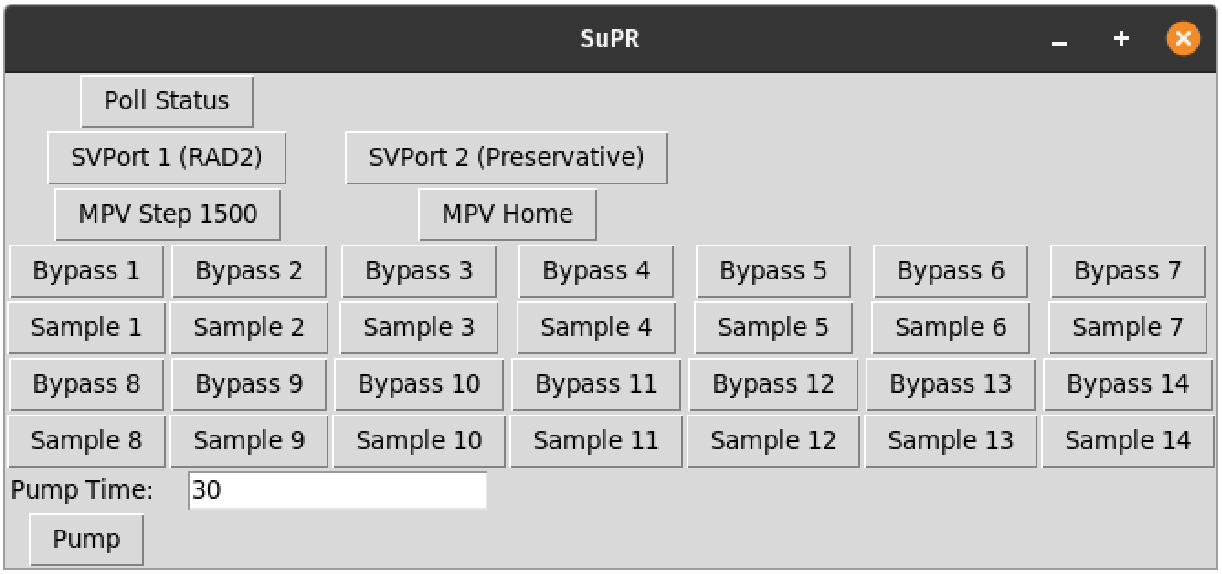
4. Software

Installation
Install ROS Noetic: http://wiki.ros.org/noetic/Installation/Ubuntu
Clone rad2 repository into ~/catkin_ws/src: git clone https://bitbucket.org/davecasa/rad2.git
Build in ~/catkin_ws: catkin_make

Running Software
Connect to remote computer: ssh pi@rad2, password ‘rad2’
roslaunch rad2 rad2.launch

On topside computer:
roslaunch rad2 topside.launch

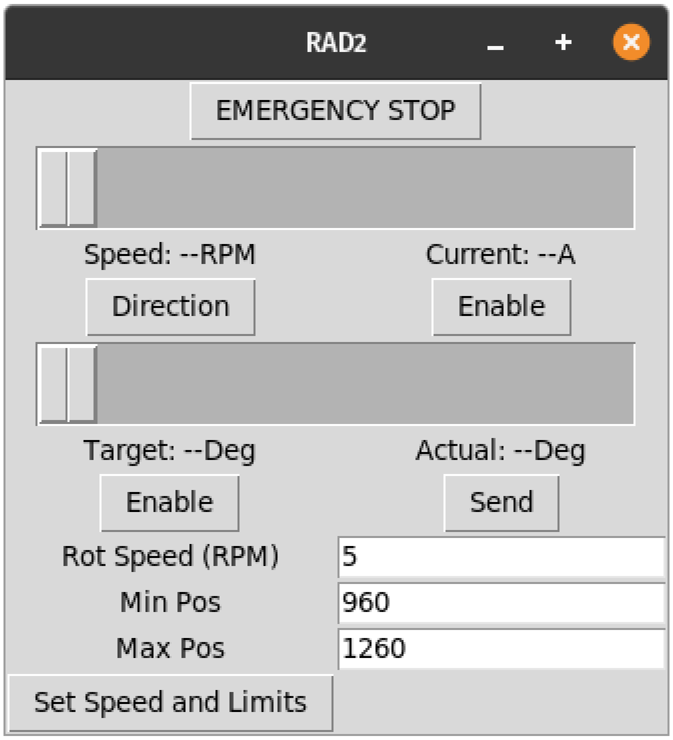
Operation
The SuPR GUI is a simple implementation of the commands specified in the SuPR manual. Each button maps directly to a serial command. Responses from the SuPR are displayed in the terminal, and include calibrated pump volume and other useful information.



The RAD2 GUI has controls for the rotary actuator and tissue sampler.
The EMERGENCY STOP button disables both systems, which in the case of the actuator will cause it to go limp.

The top slider and buttons control the tissue sampler.
The default direction is blades forward, ie. cut. Reverse (button depressed) is useful for clearing debris from the blades.
Speed and current feedback can indicate when the blades are jammed.

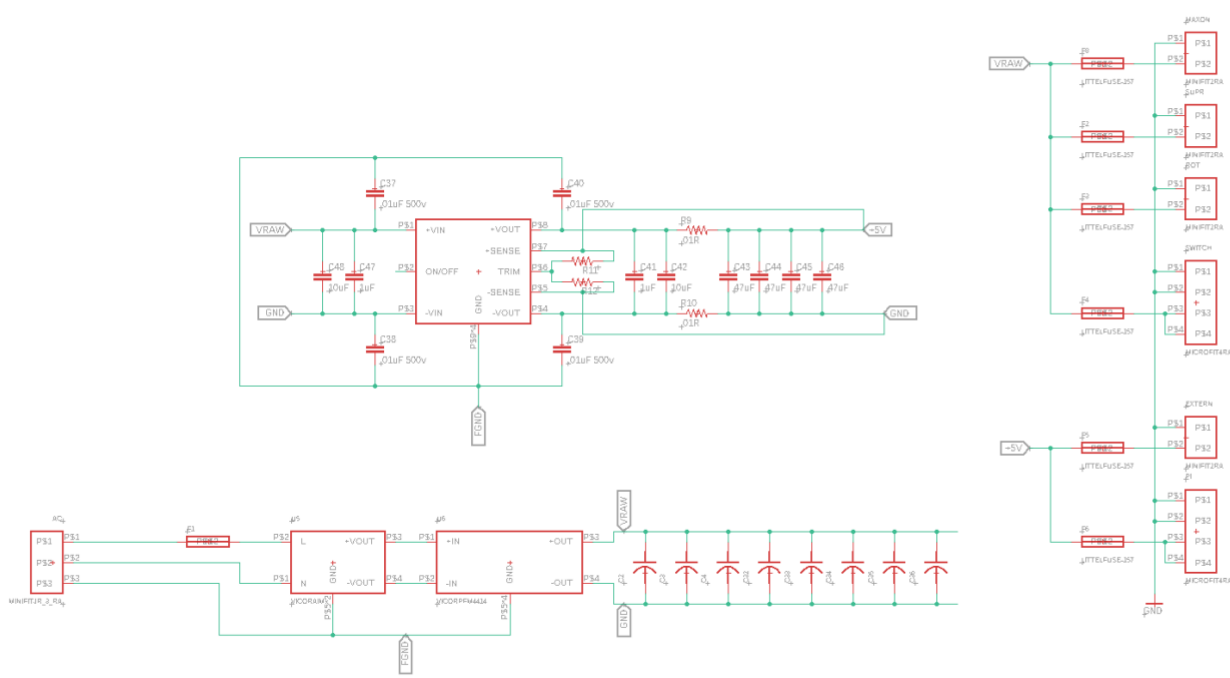
The lower slider controls the rotary actuator position. Left is fully opened, and right is fully closed. Maximum tested speed is 30 RPM, which closes the RAD2 from fully opened in about 2 seconds. Minimum and maximum position may need to be adjusted depending on the rotation when the arms were installed. Use the reported Actual Position to verify.



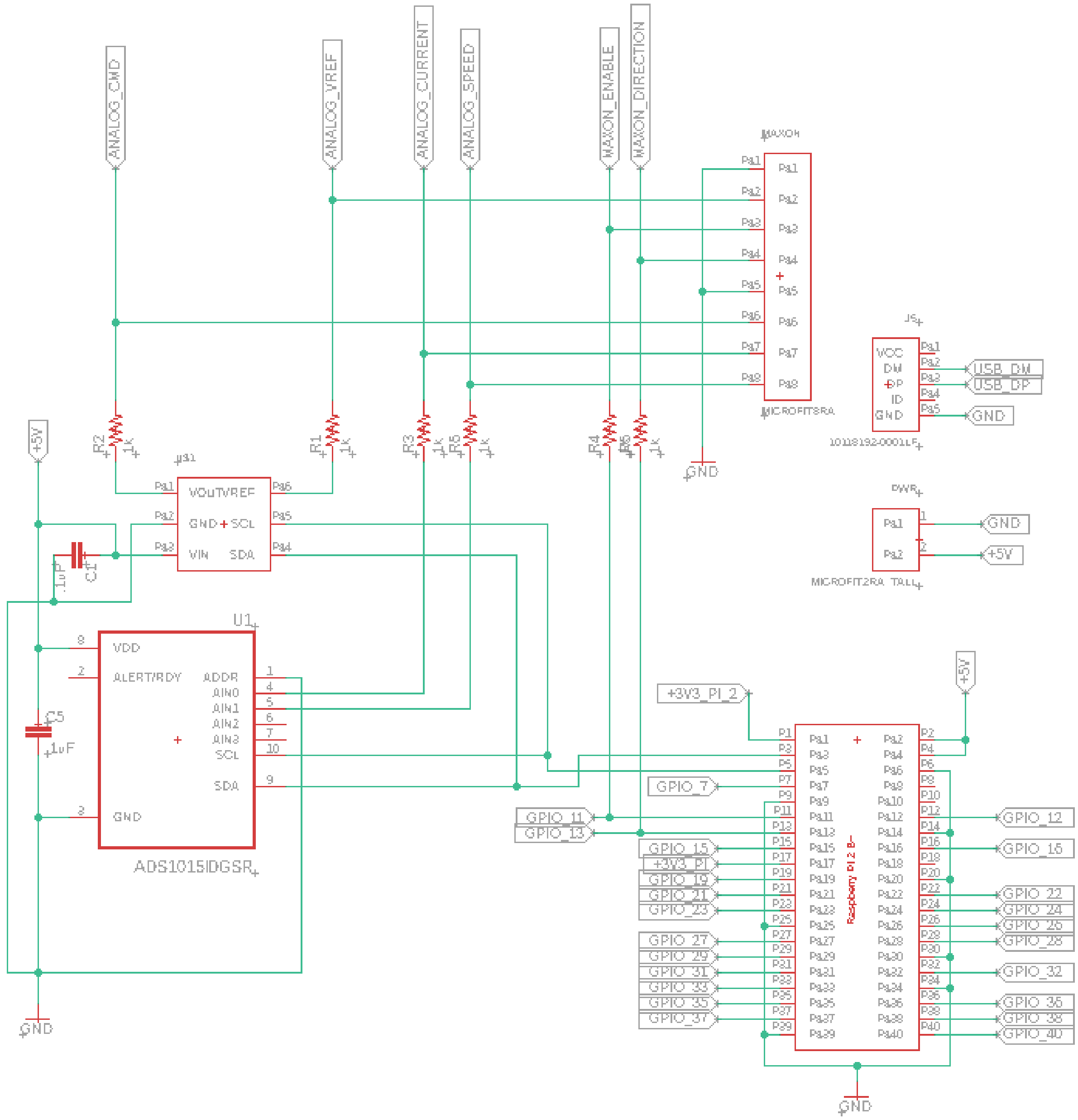
5. Schematics and Electronic Components

Schematics for RAD2 custom PCBs are below.

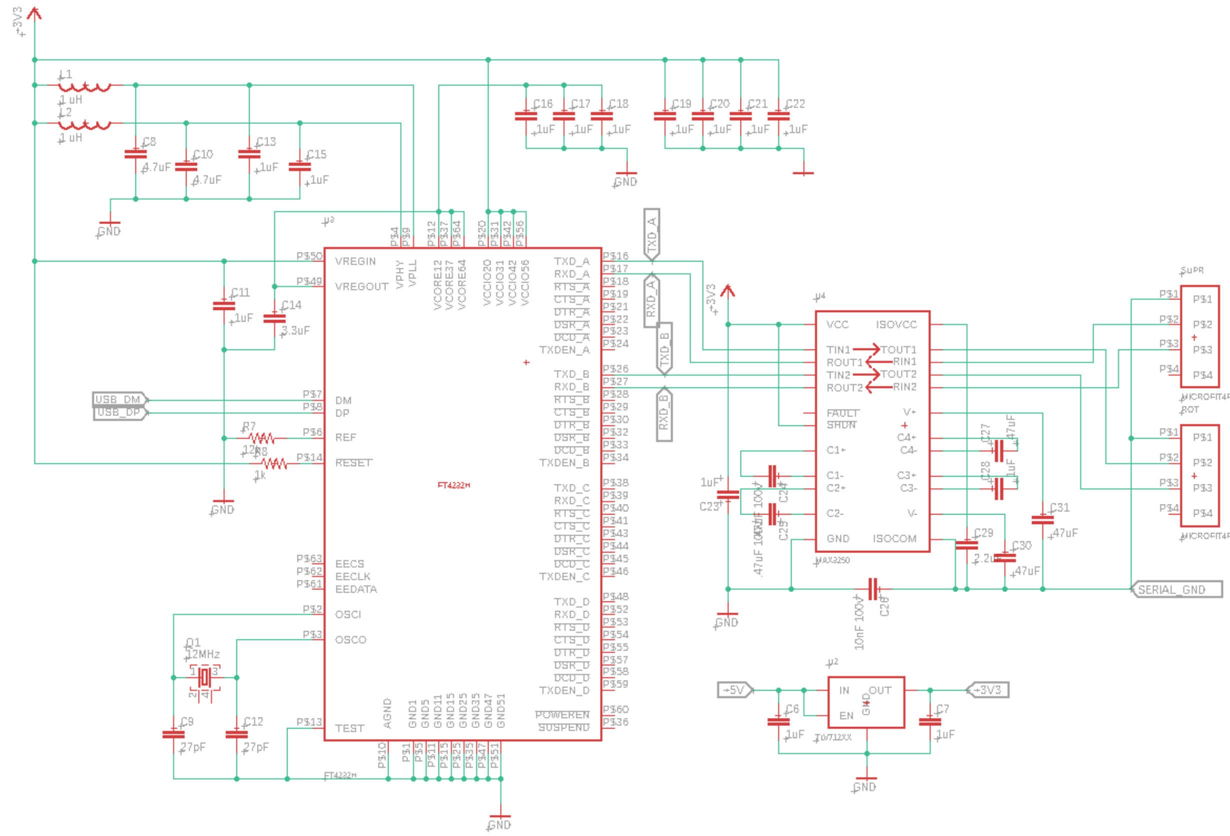
Power input, DC/DC conversion, and power distribution



Raspberry Pi and Analog Maxon Thruster Control



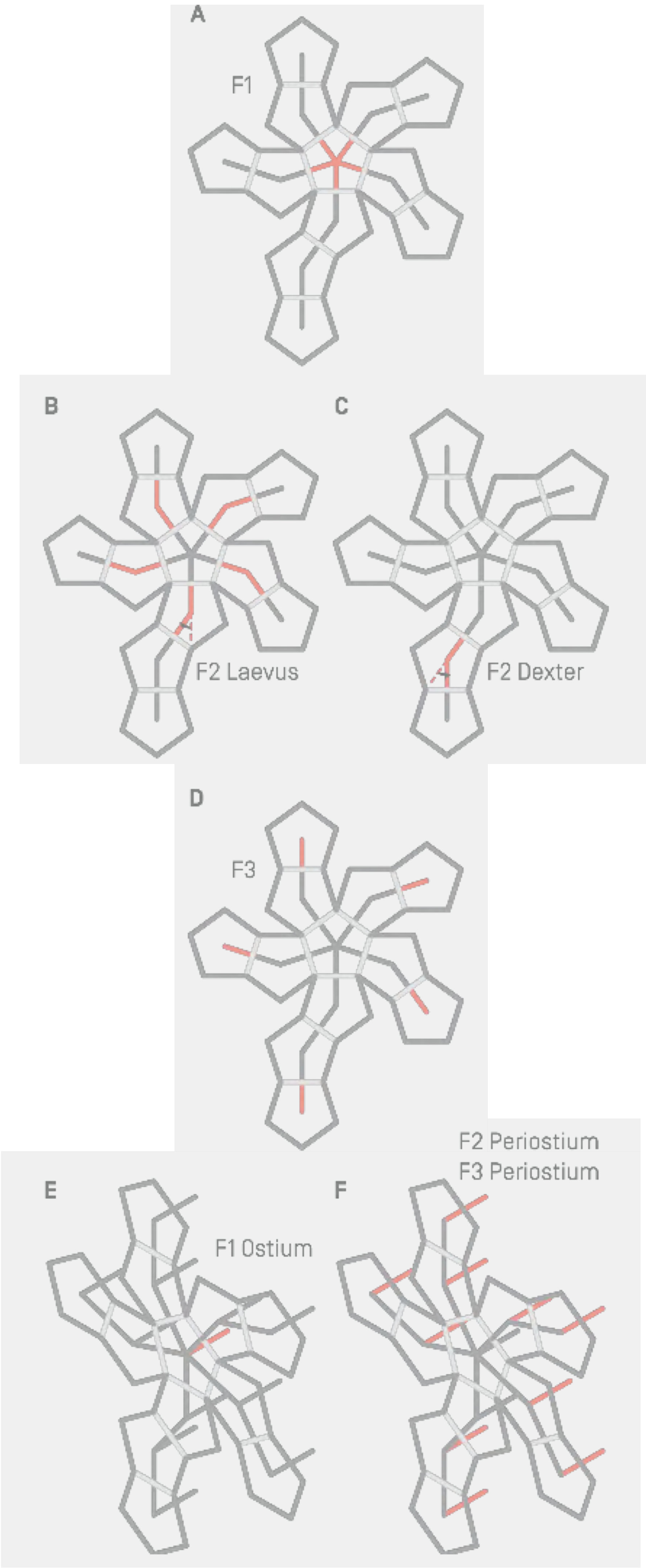
USB-Serial and RS232 Converter



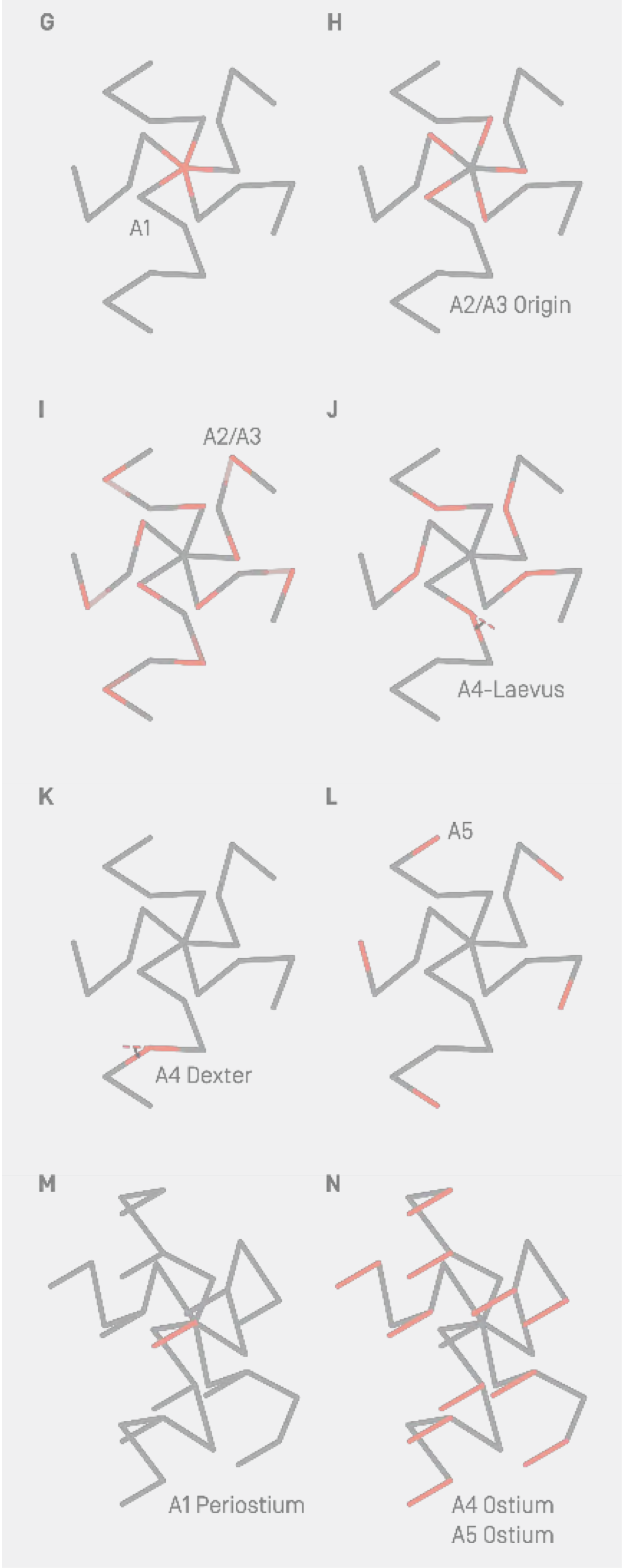
COOPER PERKINS

RAD2 Link Nomenclature Review

Folding linkage



Assembly linkage

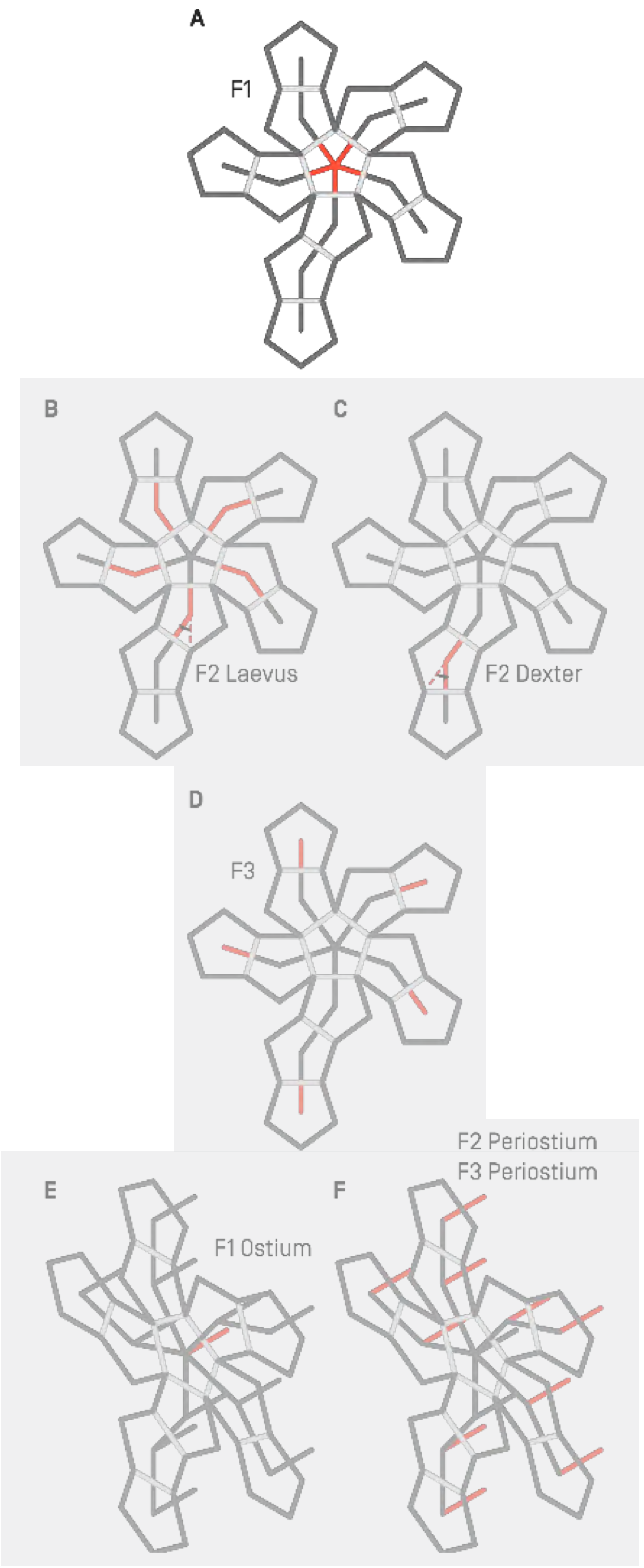


RAD2 Link Nomenclature Review

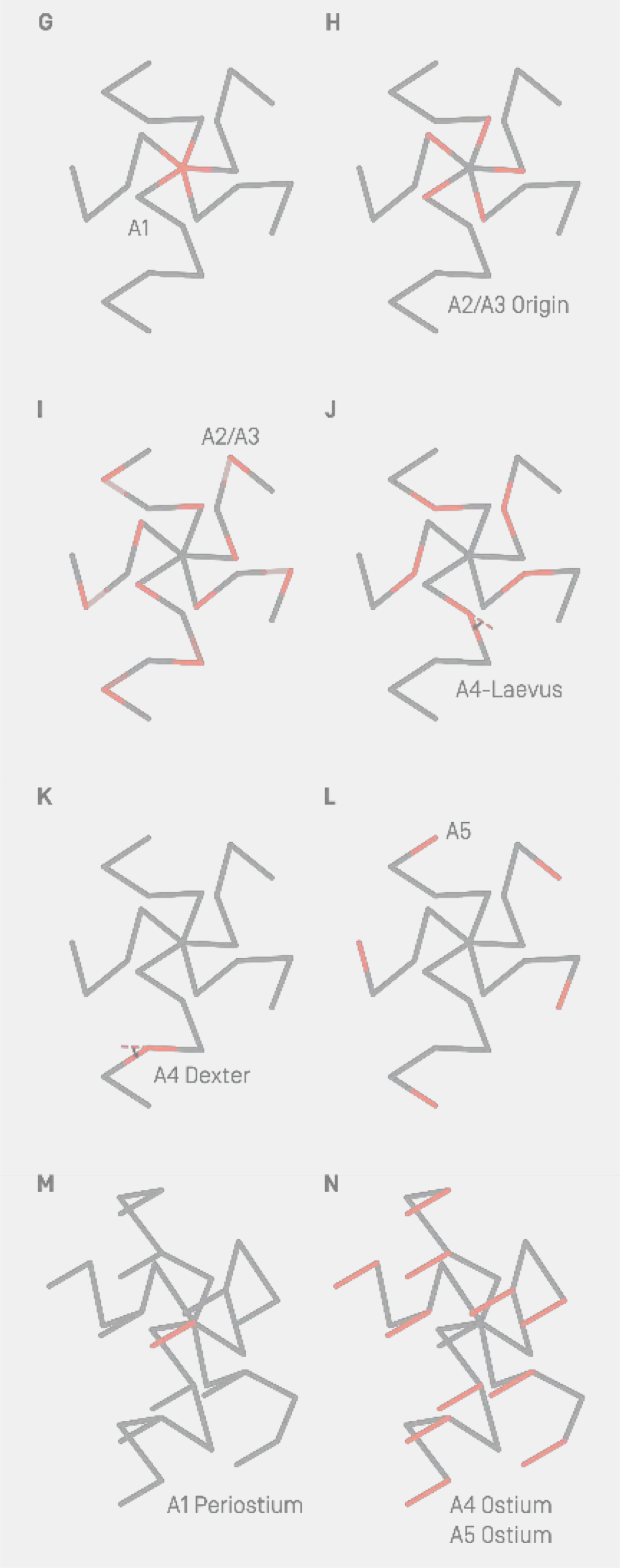
6 Unique Parts

- F1

Folding linkage



Assembly linkage

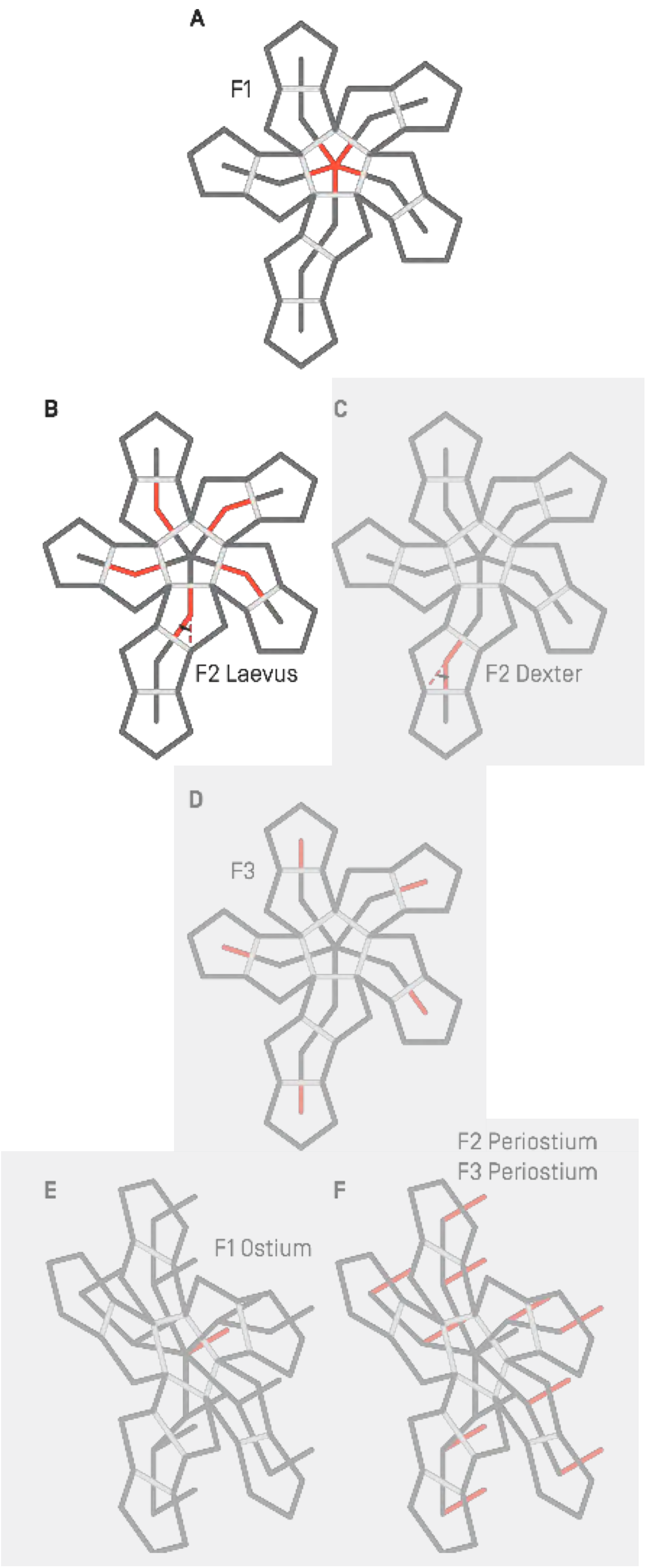


RAD2 Link Nomenclature Review

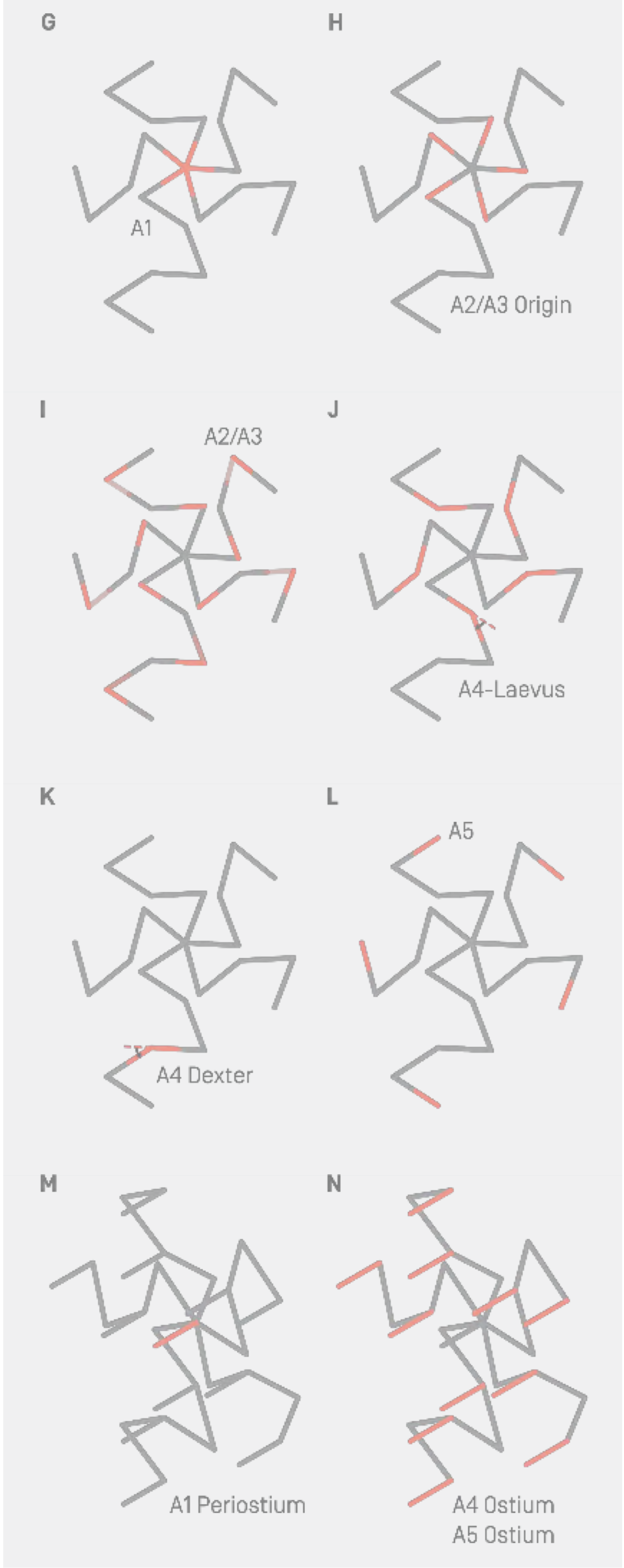
6 Unique Parts

- F1
- F2 Laevus

Folding linkage



Assembly linkage

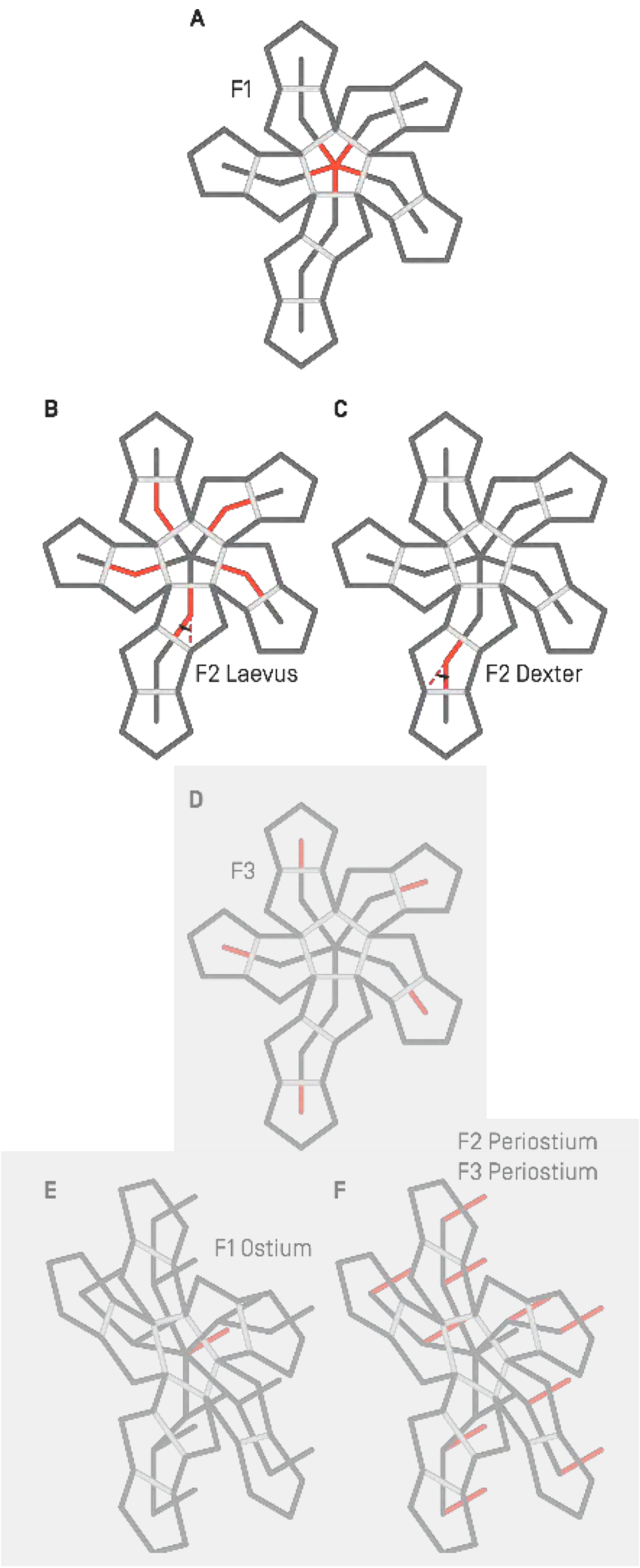


RAD2 Link Nomenclature Review

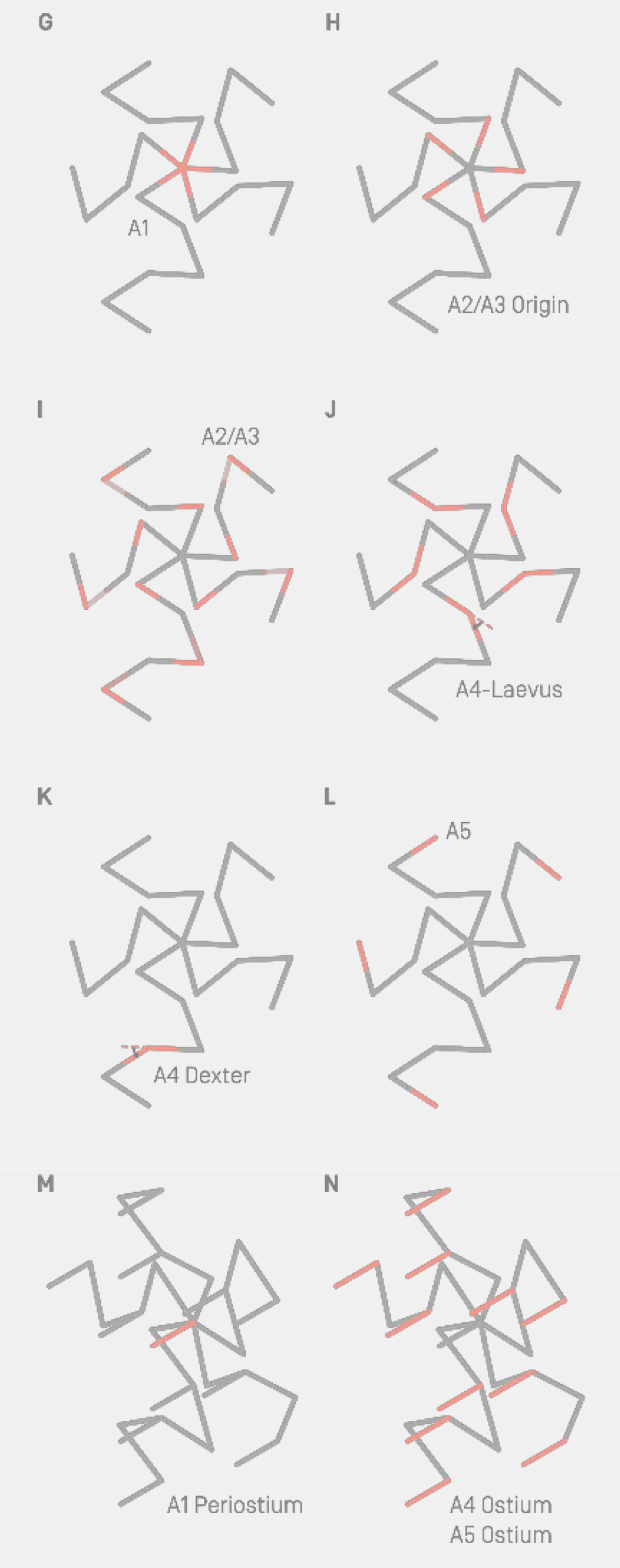
6 Unique Parts

- F1
- F2 Laevus
- F2 Dexter

Folding linkage



Assembly linkage

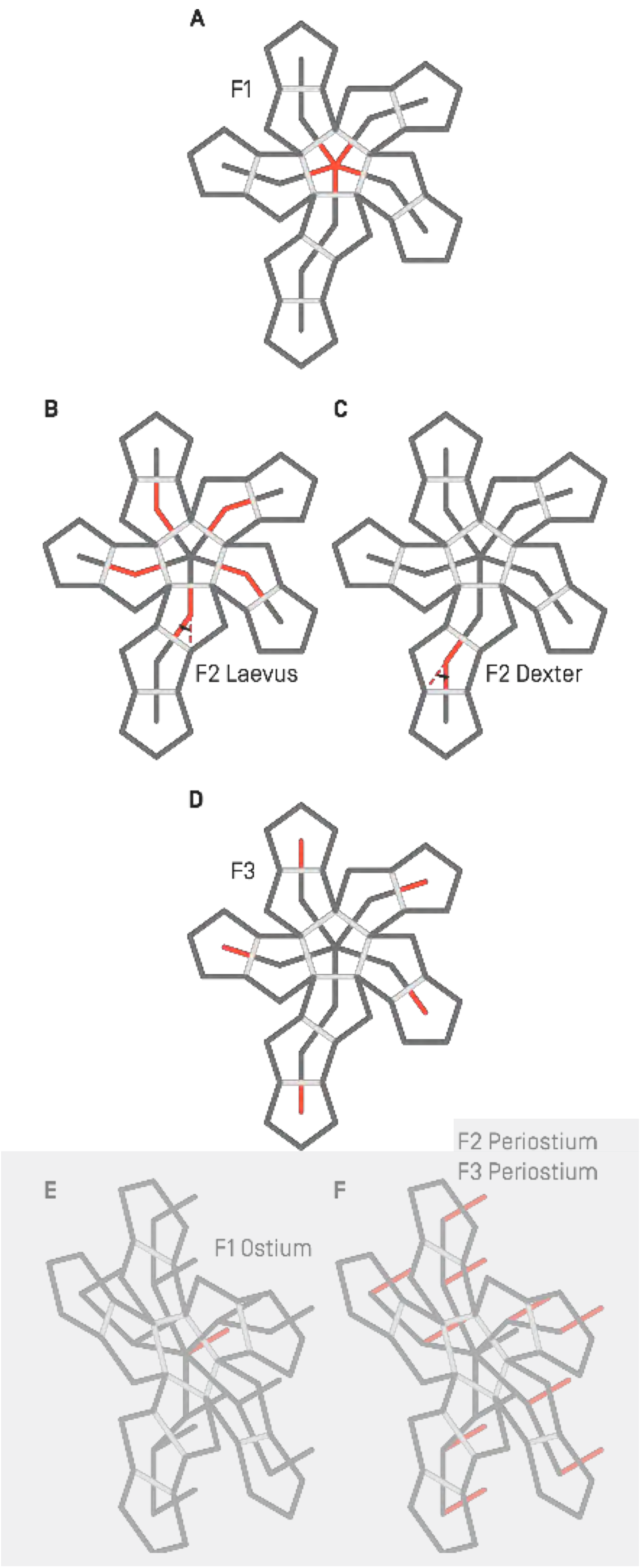


RAD2 Link Nomenclature Review

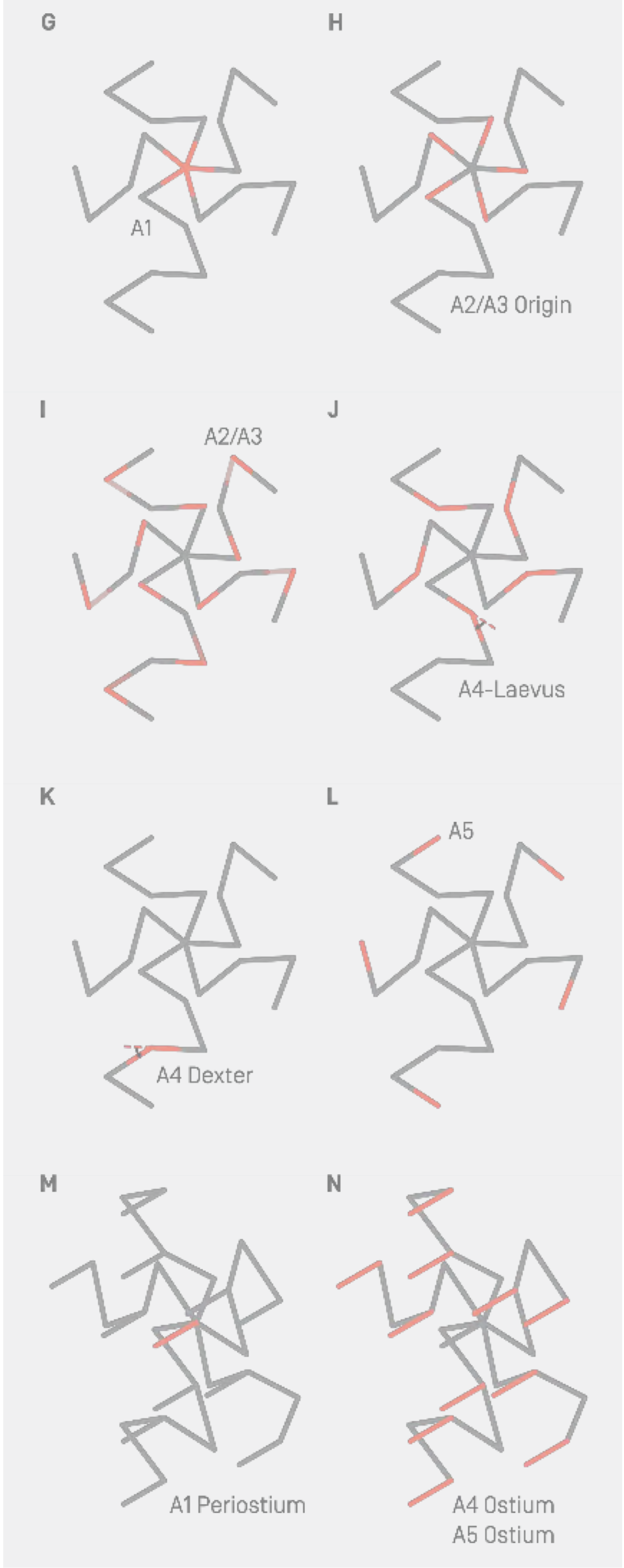
6 Unique Parts

- F1
- F2 Laevus
- F2 Dexter
- F3

Folding linkage



Assembly linkage

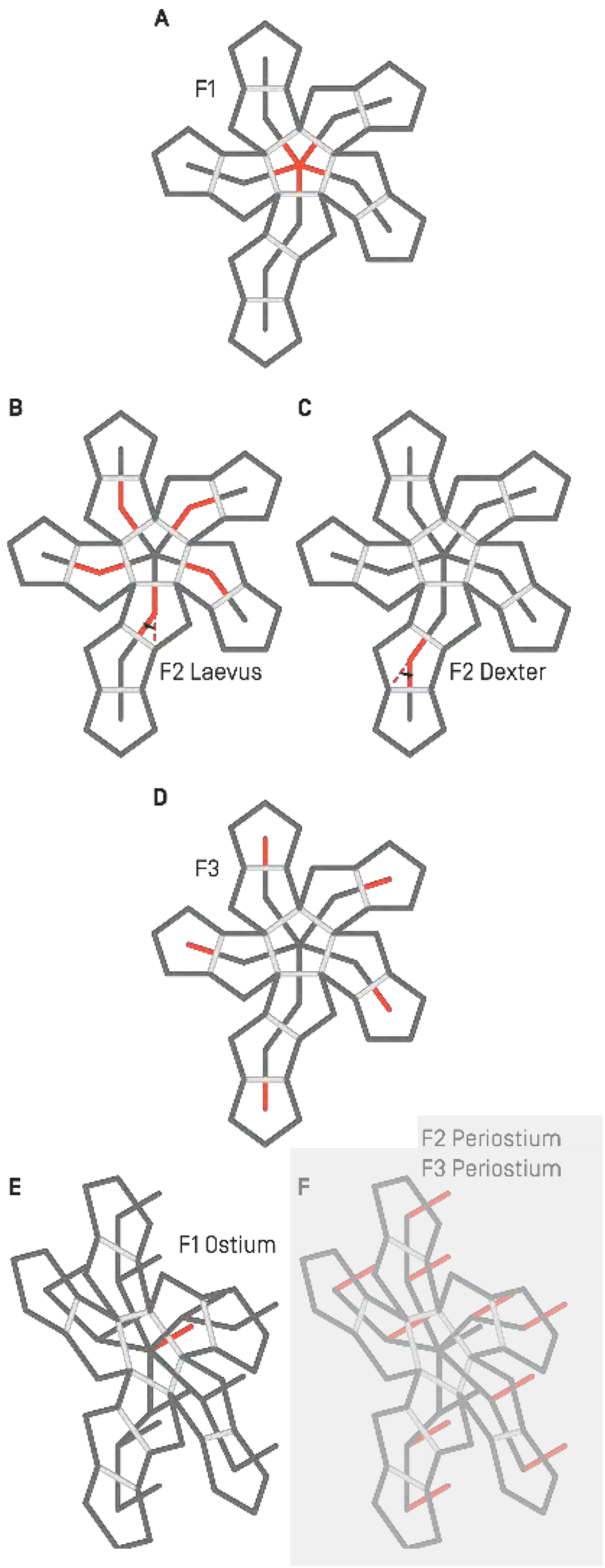


RAD2 Link Nomenclature Review

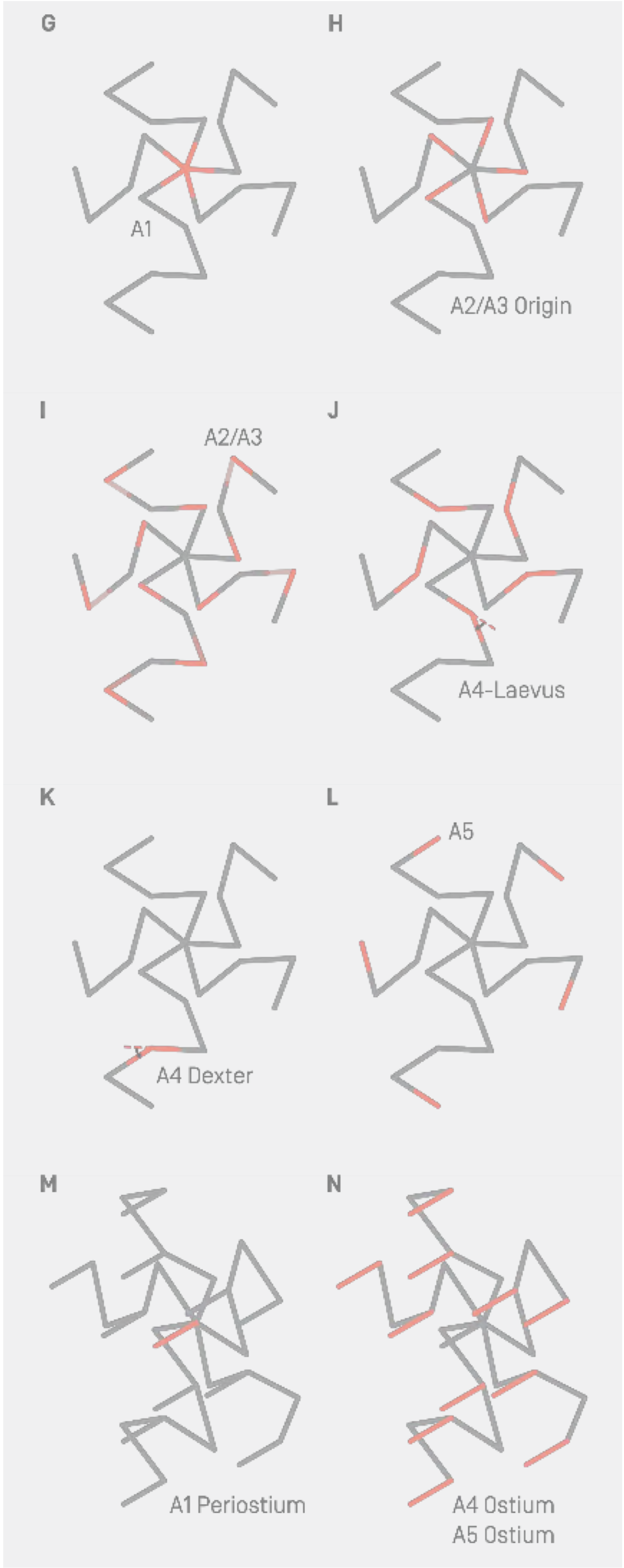
6 Unique Parts

- F1
- F2 Laevus
- F2 Dexter
- F3
- F1 Ostium

Folding linkage



Assembly linkage

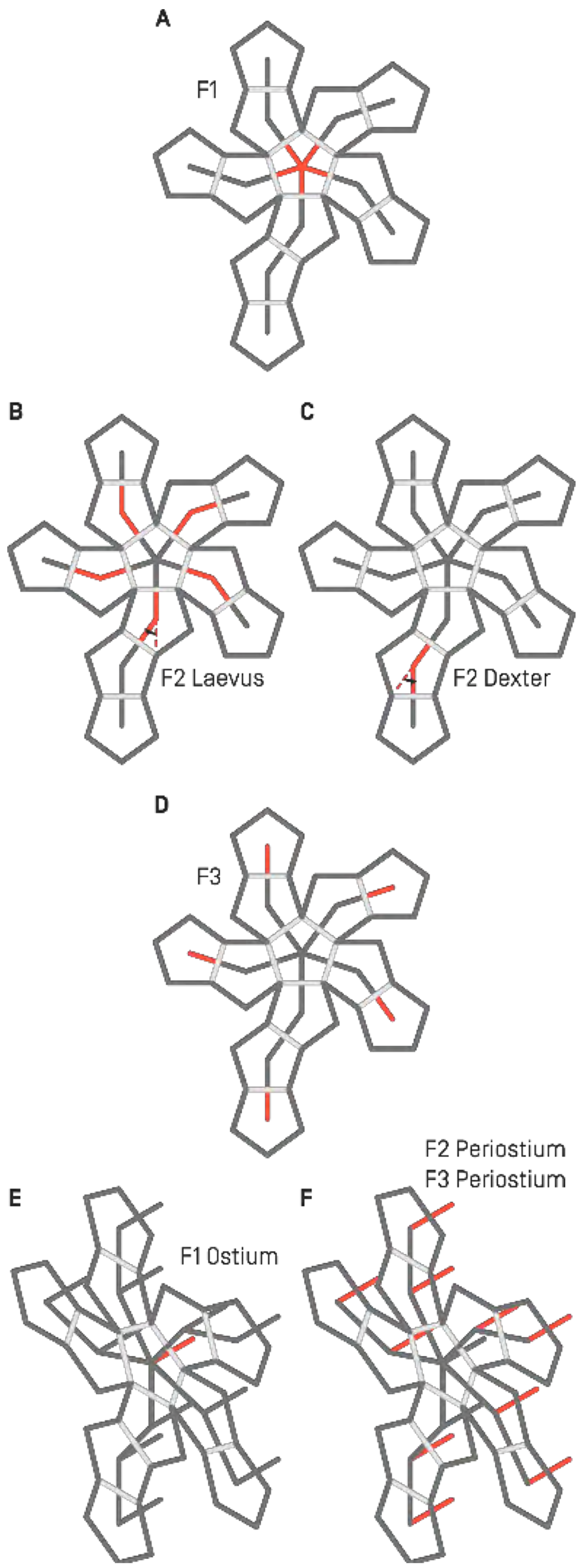


RAD2 Link Nomenclature Review

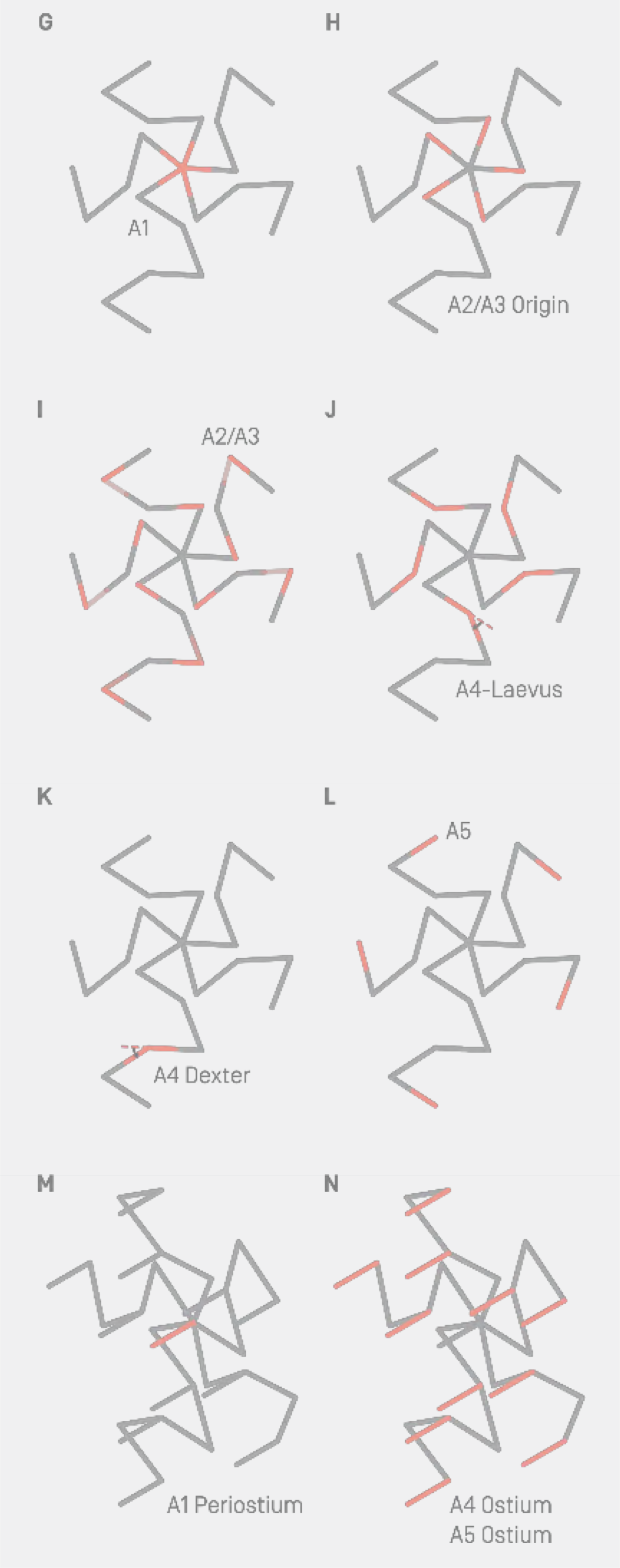
6 Unique Parts

- F1
- F2 Laevus
- F2 Dexter
- F3
- F1 Ostium
- F2/F3 Periostium

Folding linkage



Assembly linkage

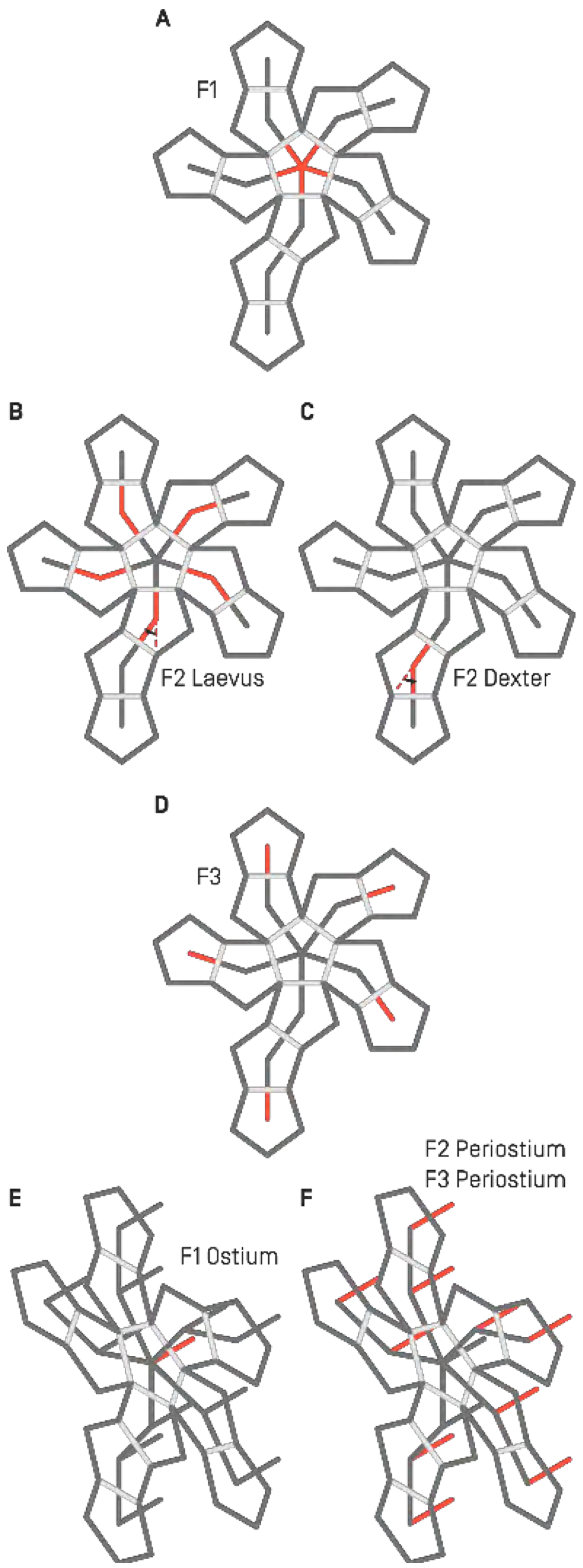


RAD2 Link Nomenclature Review

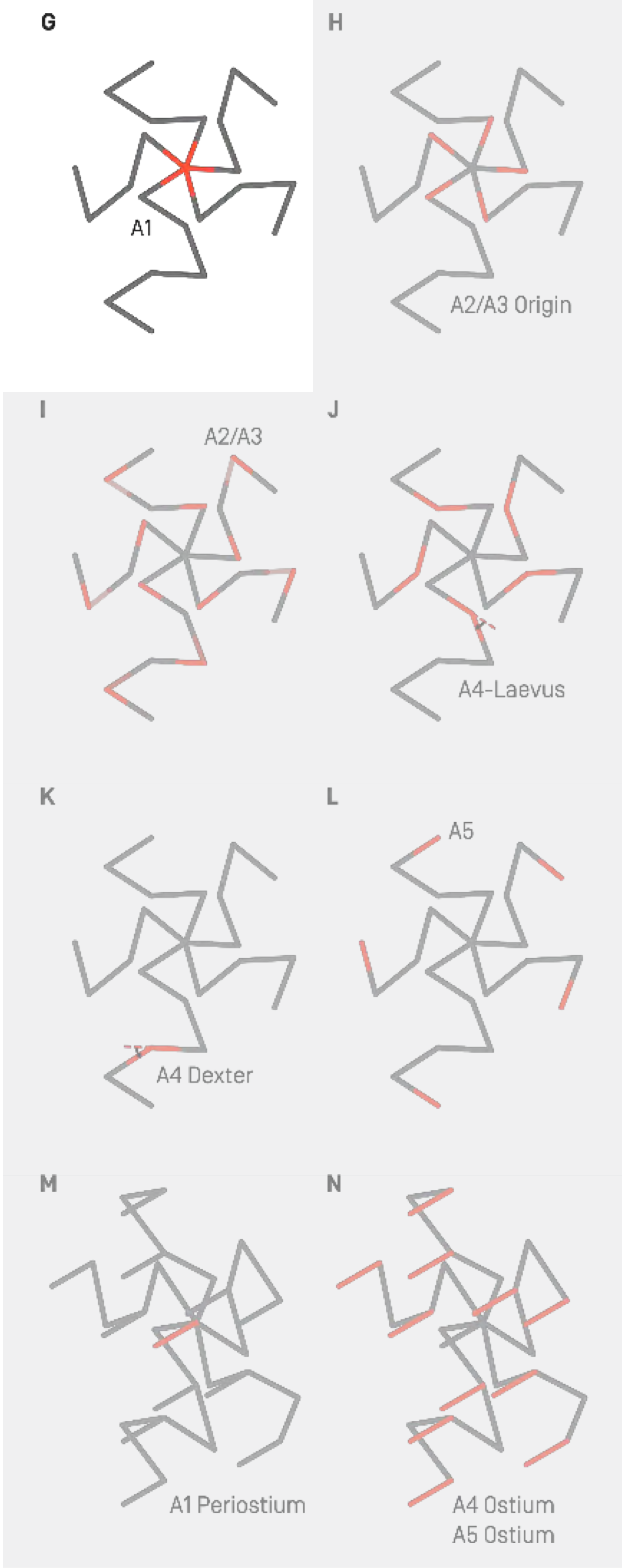
6 Unique Parts

- F1
- F2 Laevus
- F2 Dexter
- F3
- F1 Ostium
- F2/F3 Periostium

Folding linkage



Assembly linkage



8 Unique Parts

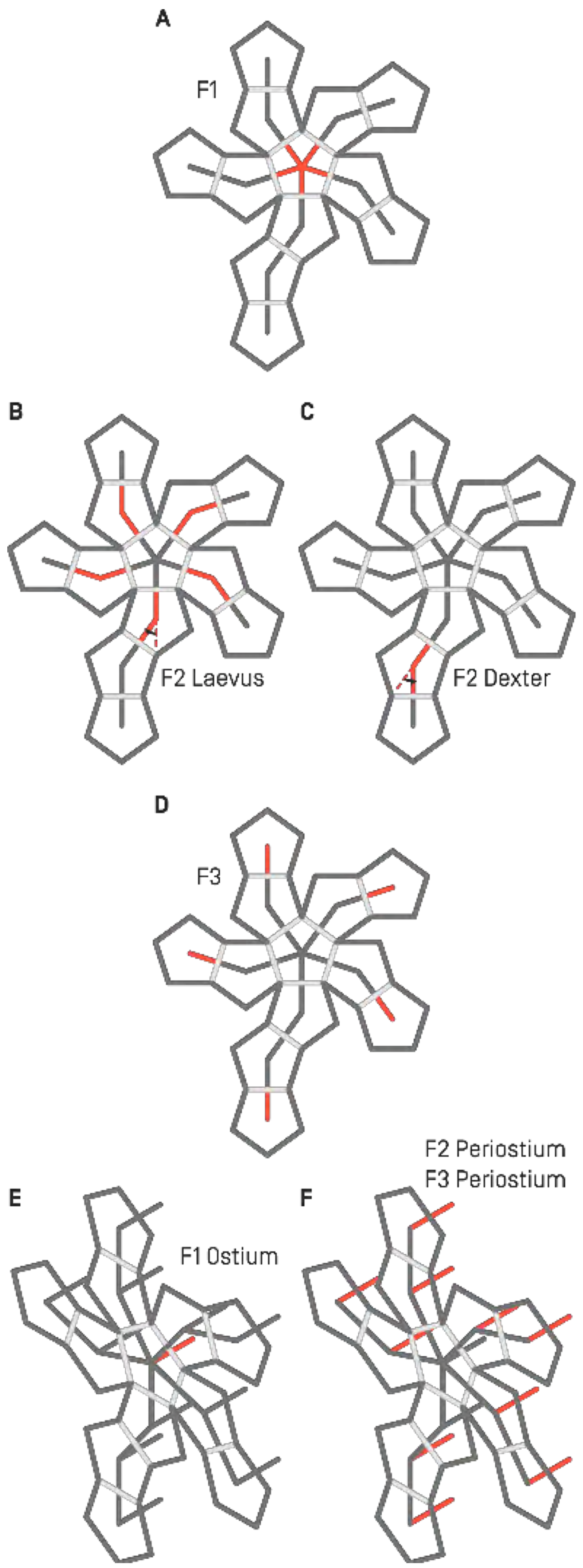
- A1

RAD2 Link Nomenclature Review

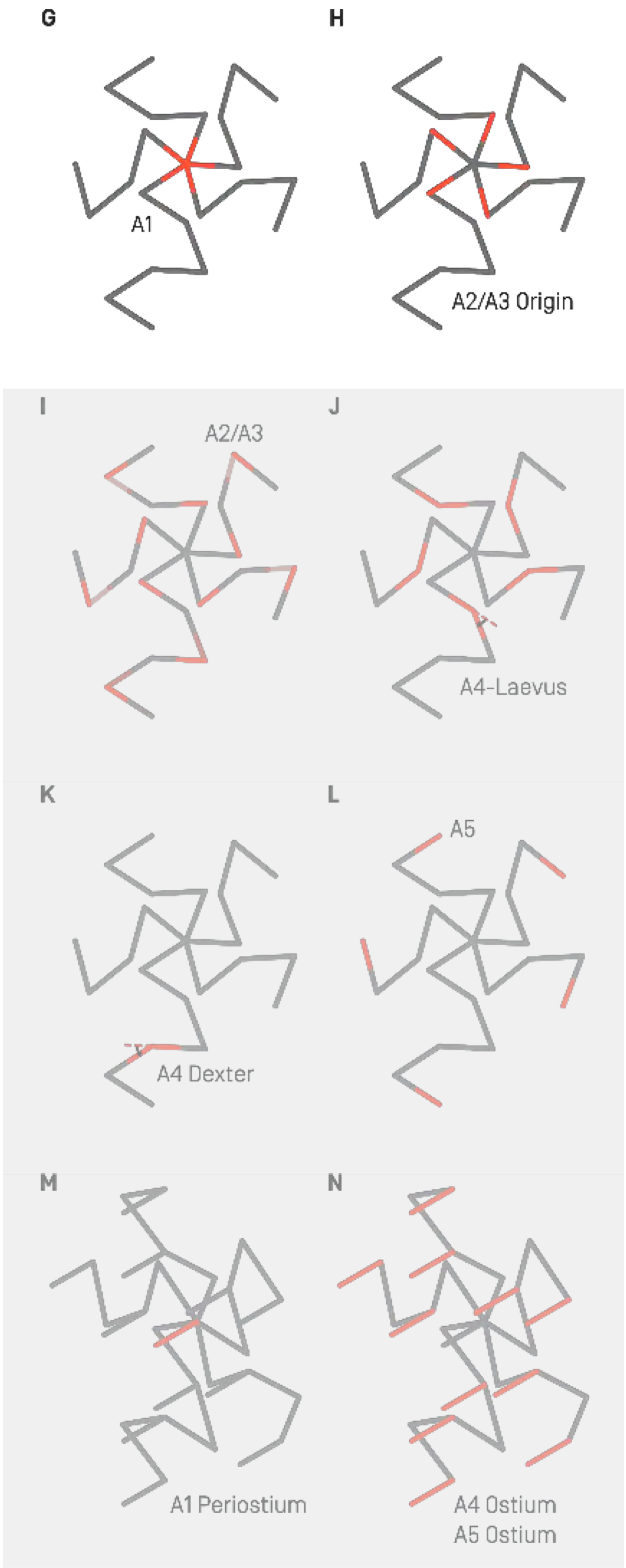
6 Unique Parts

- F1
- F2 Laevus
- F2 Dexter
- F3
- F1 Ostium
- F2/F3 Periostium

Folding linkage



Assembly linkage

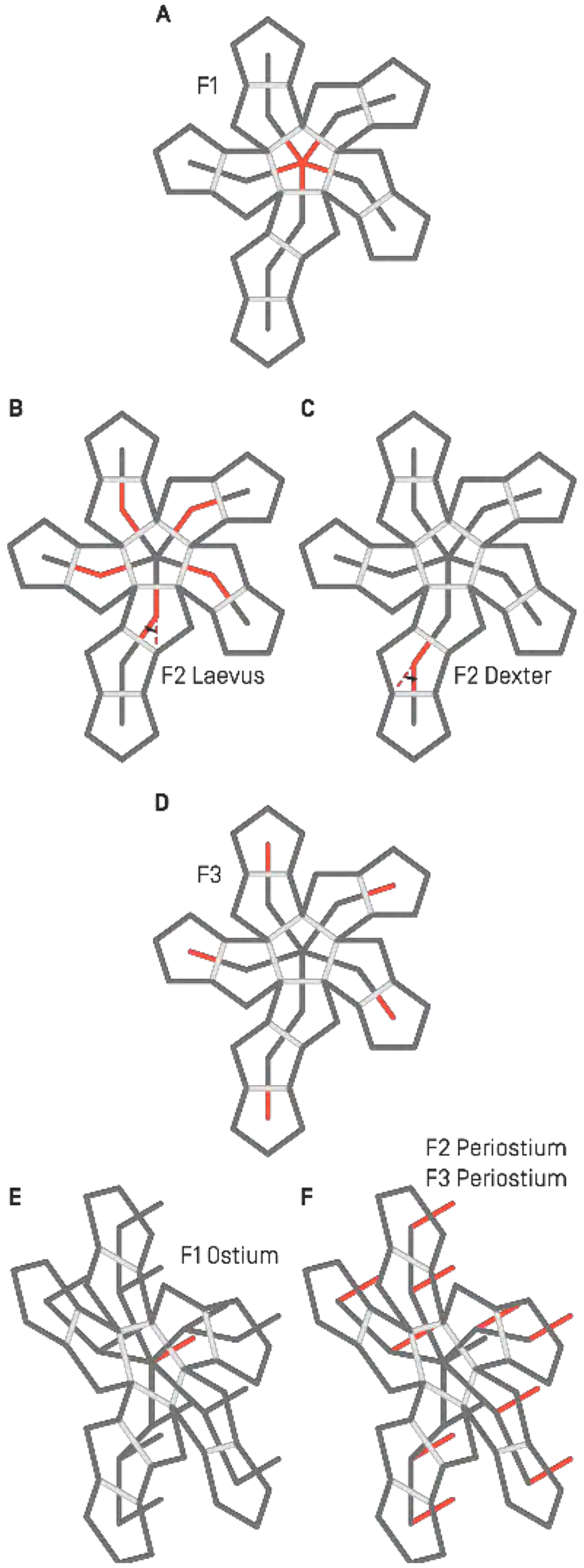


8 Unique Parts

- A1
- A2/A3 Origin

RAD2 Link Nomenclature Review

Folding linkage



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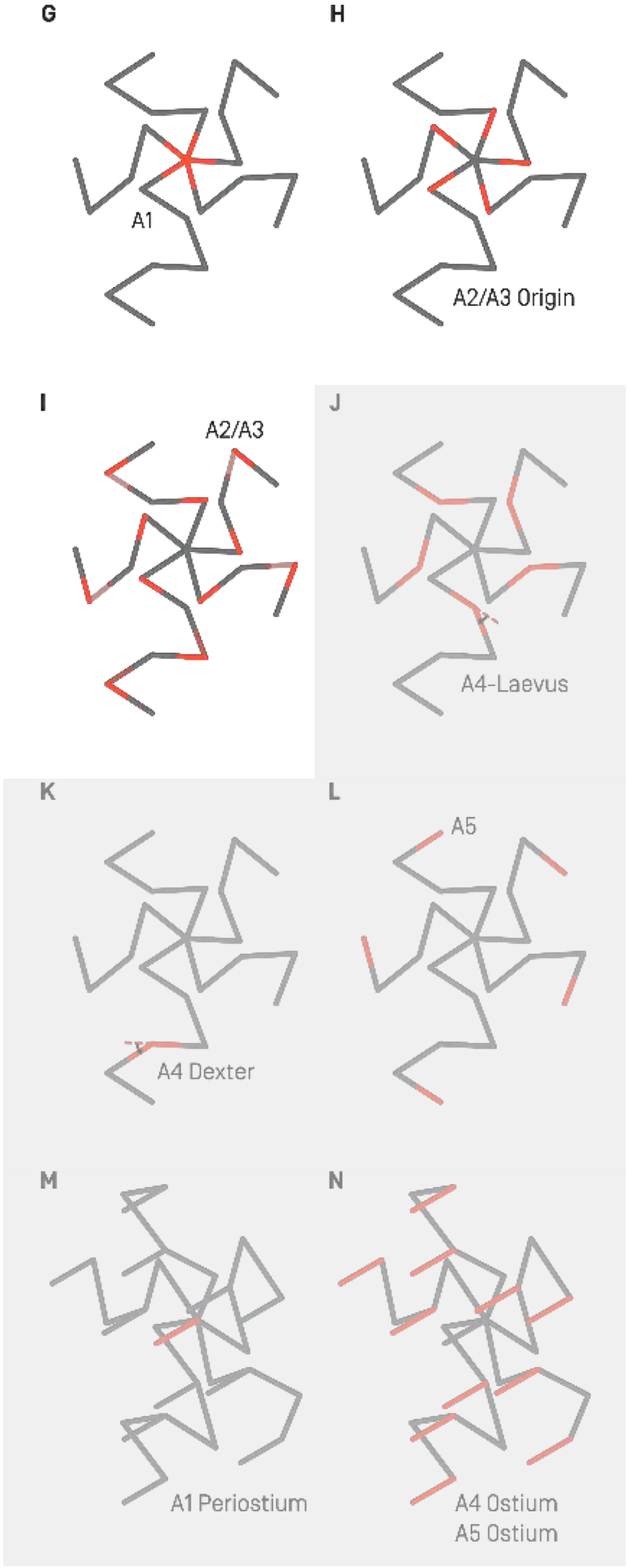


6 Unique Parts

- F1
- F2 Laevus
- F2 Dexter
- F3
- F1 Ostium
- F2/F3 Periostium

8 Unique Parts

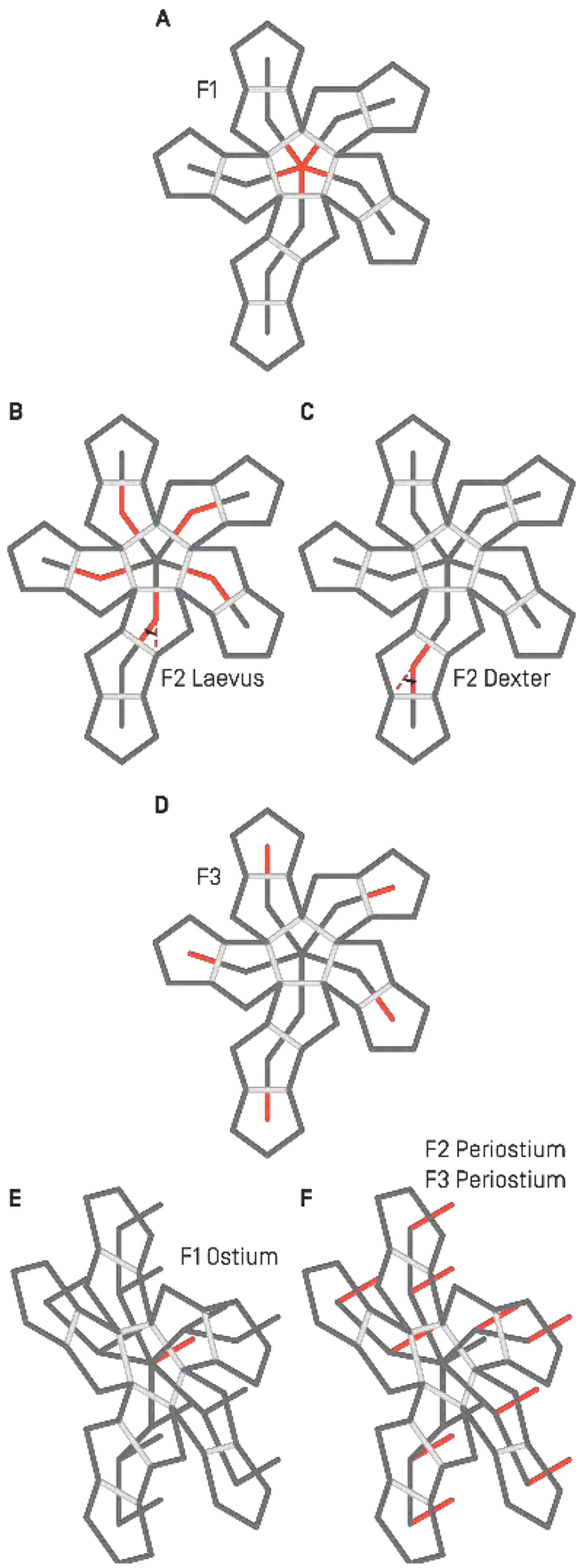
- A1
- A2/A3 Origin
- A2/A3

RAD2 Link Nomenclature Review

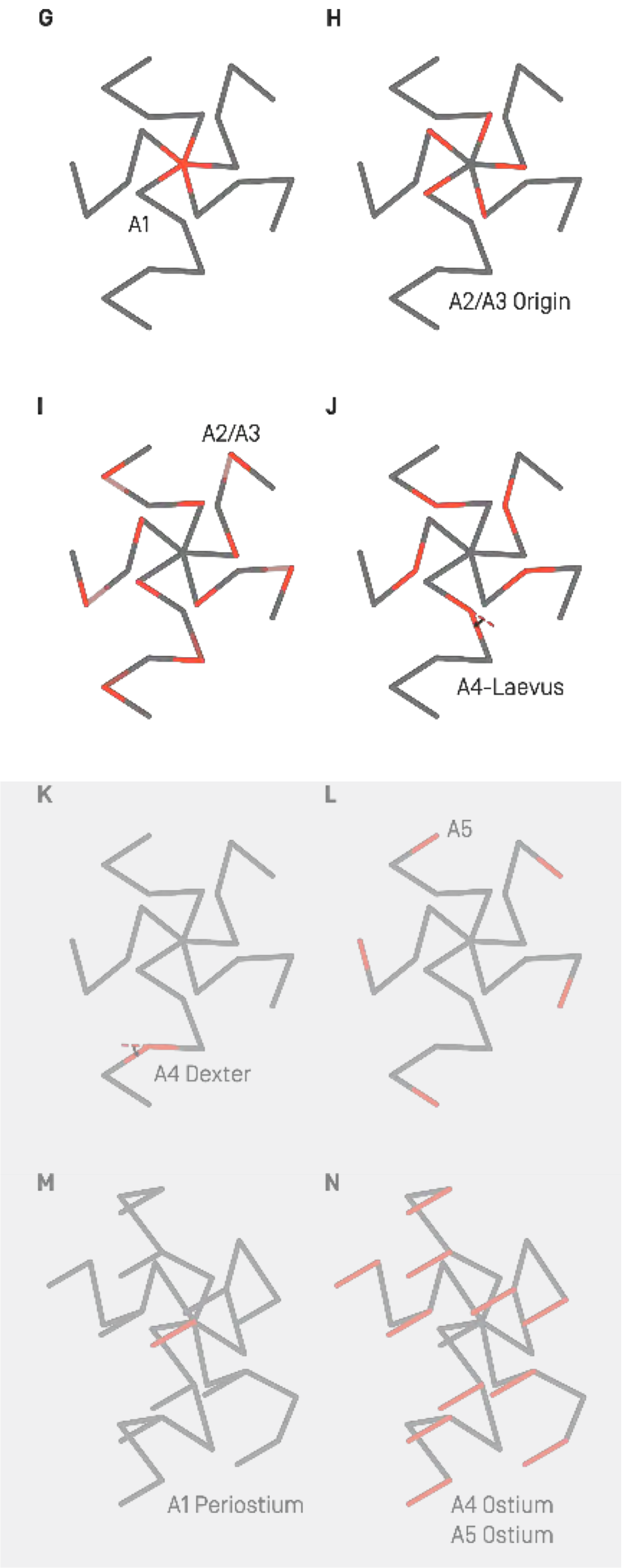
6 Unique Parts

- F1
- F2 Laevus
- F2 Dexter
- F3
- F1 Ostium
- F2/F3 Periostium

Folding linkage



Assembly linkage



8 Unique Parts

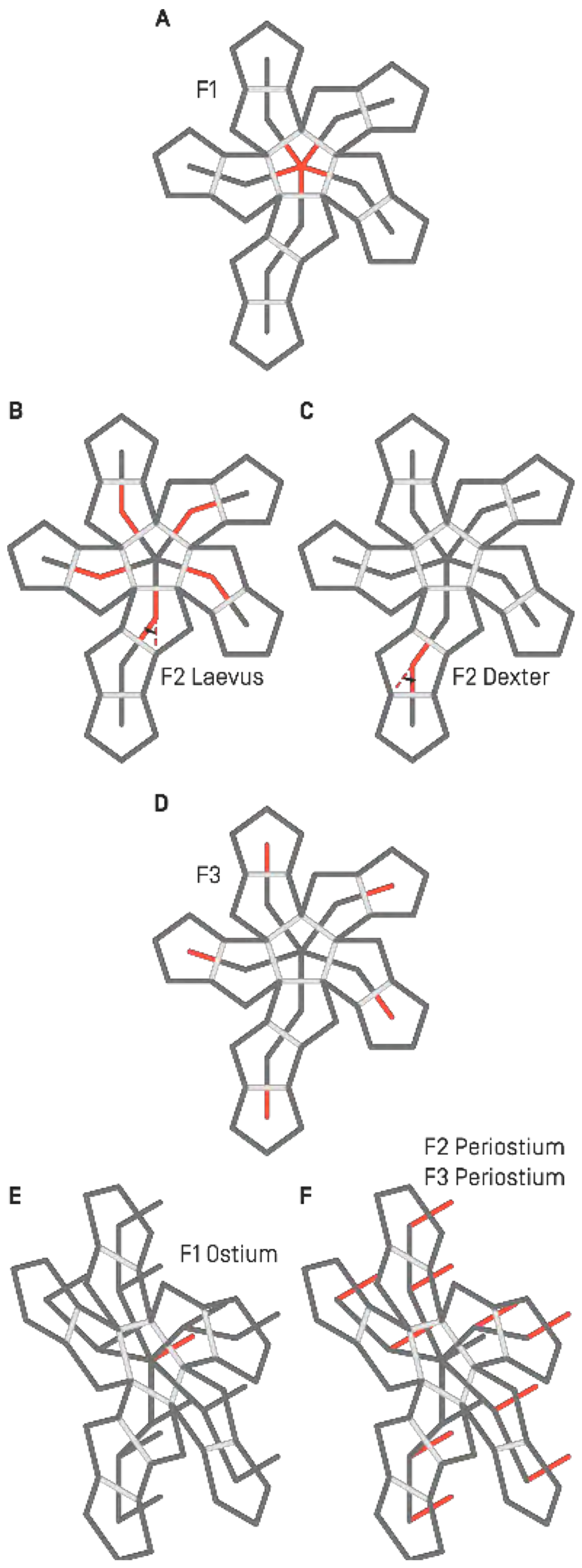
- A1
- A2/A3 Origin
- A2/A3
- A4 Laevus

RAD2 Link Nomenclature Review

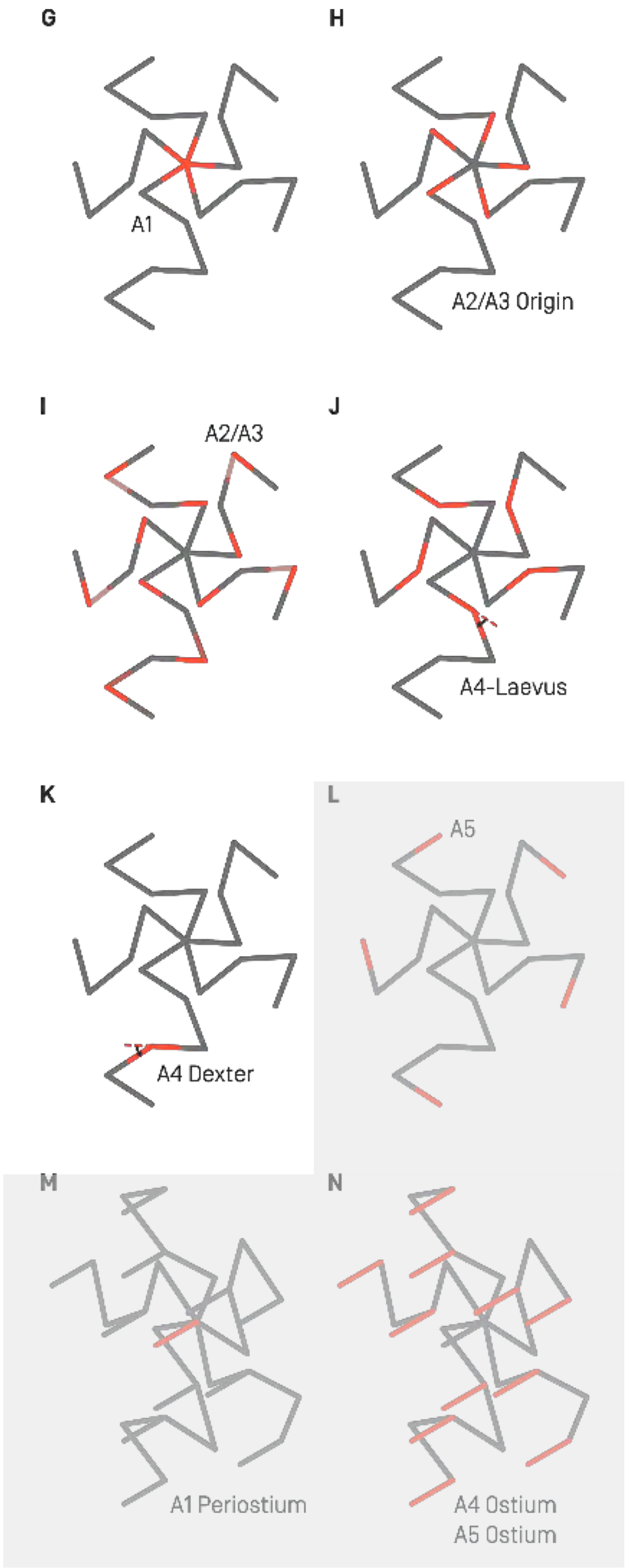
6 Unique Parts

- F1
- F2 Laevus
- F2 Dexter
- F3
- F1 Ostium
- F2/F3 Periostium

Folding linkage



Assembly linkage



8 Unique Parts

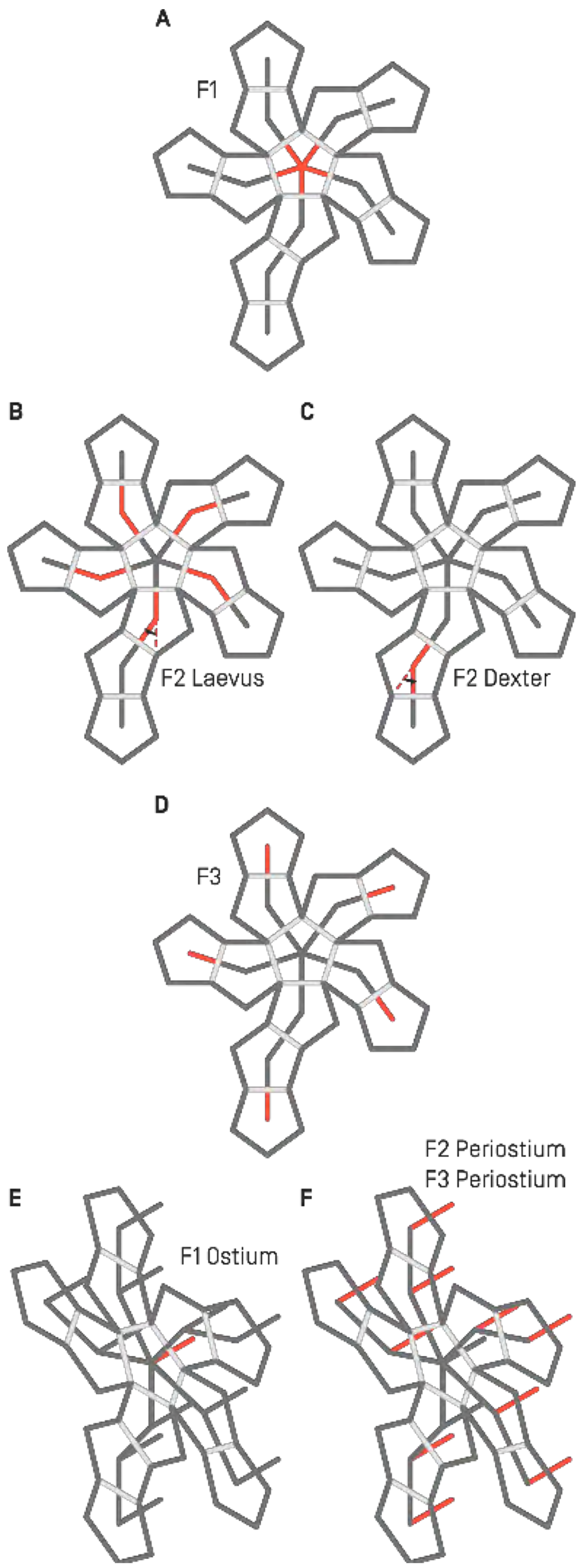
- A1
- A2/A3 Origin
- A2/A3
- A4 Laevus
- A4 Dexter

RAD2 Link Nomenclature Review

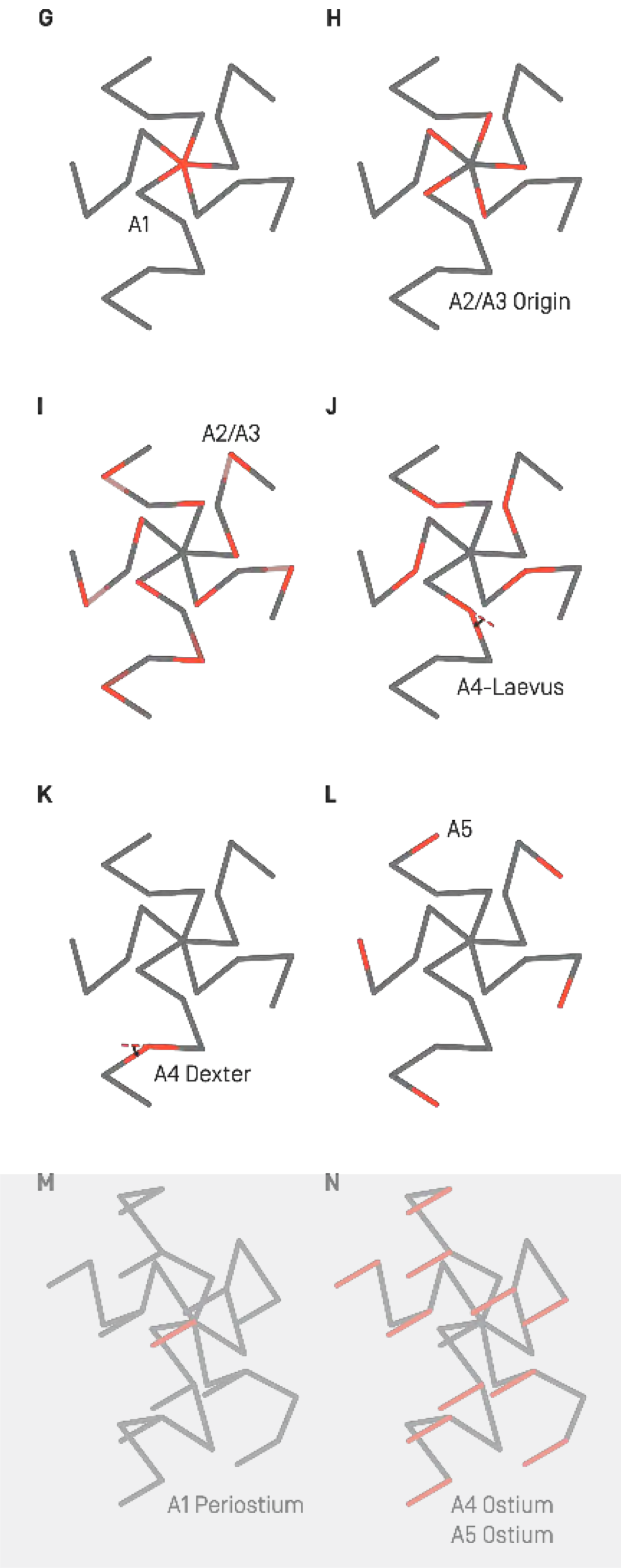
6 Unique Parts

- F1
- F2 Laevus
- F2 Dexter
- F3
- F1 Ostium
- F2/F3 Periostium

Folding linkage



Assembly linkage

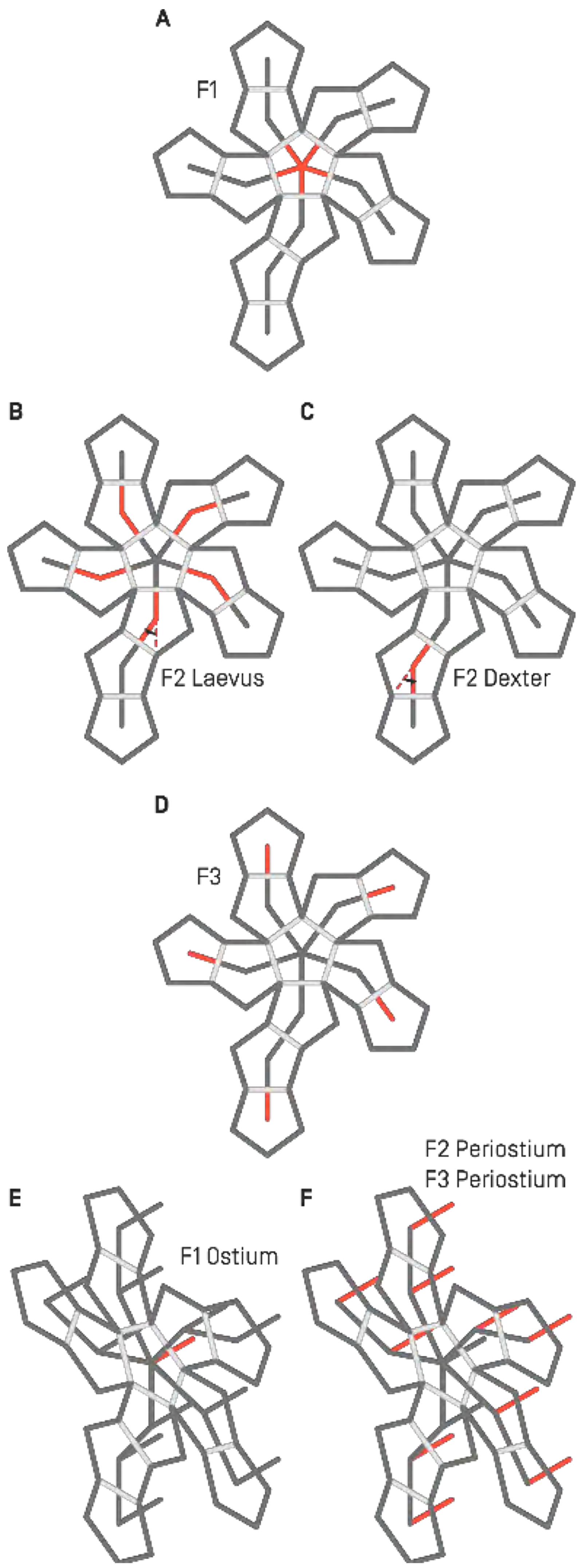


8 Unique Parts

- A1
- A2/A3 Origin
- A2/A3
- A4 Laevus
- A4 Dexter
- A5

RAD2 Link Nomenclature Review

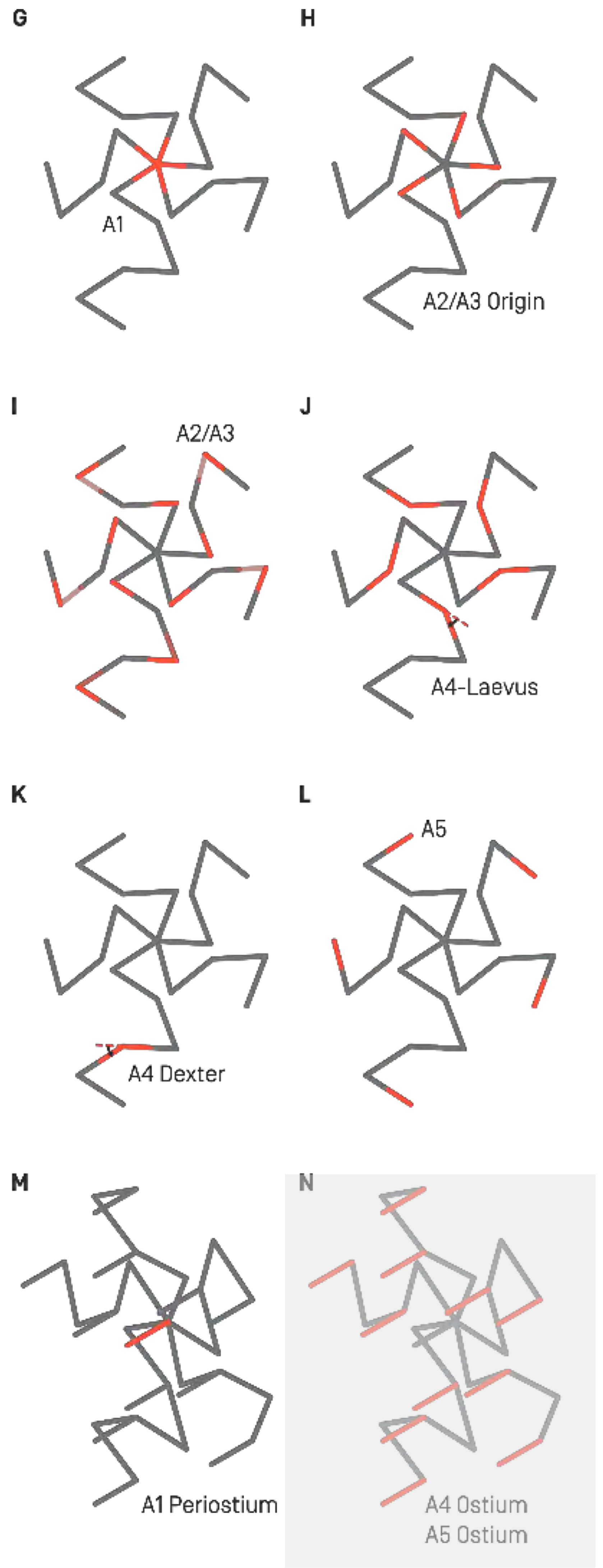
Folding linkage



6 Unique Parts

- F1
- F2 Laevus
- F2 Dexter
- F3
- F1 Ostium
- F2/F3 Periostium

Assembly linkage

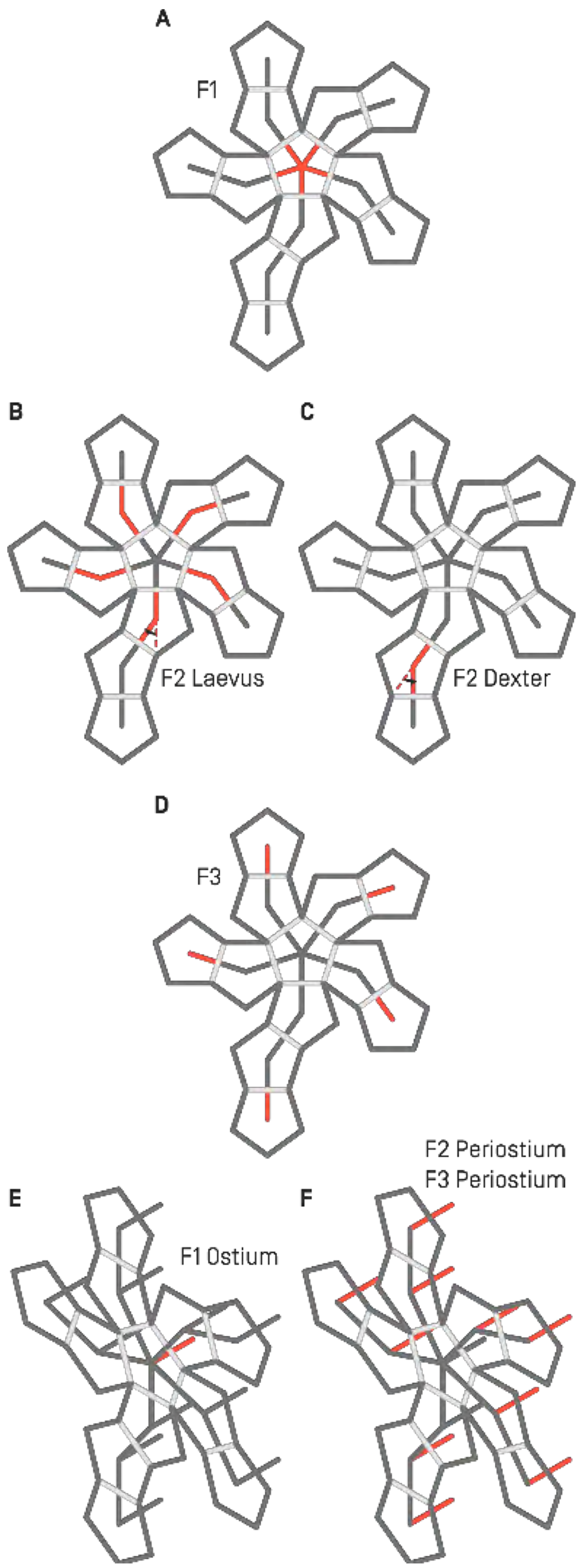


8 Unique Parts

- A1
- A2/A3 Origin
- A2/A3
- A4 Laevus
- A4 Dexter
- A5
- A1 Periostium

RAD2 Link Nomenclature Review

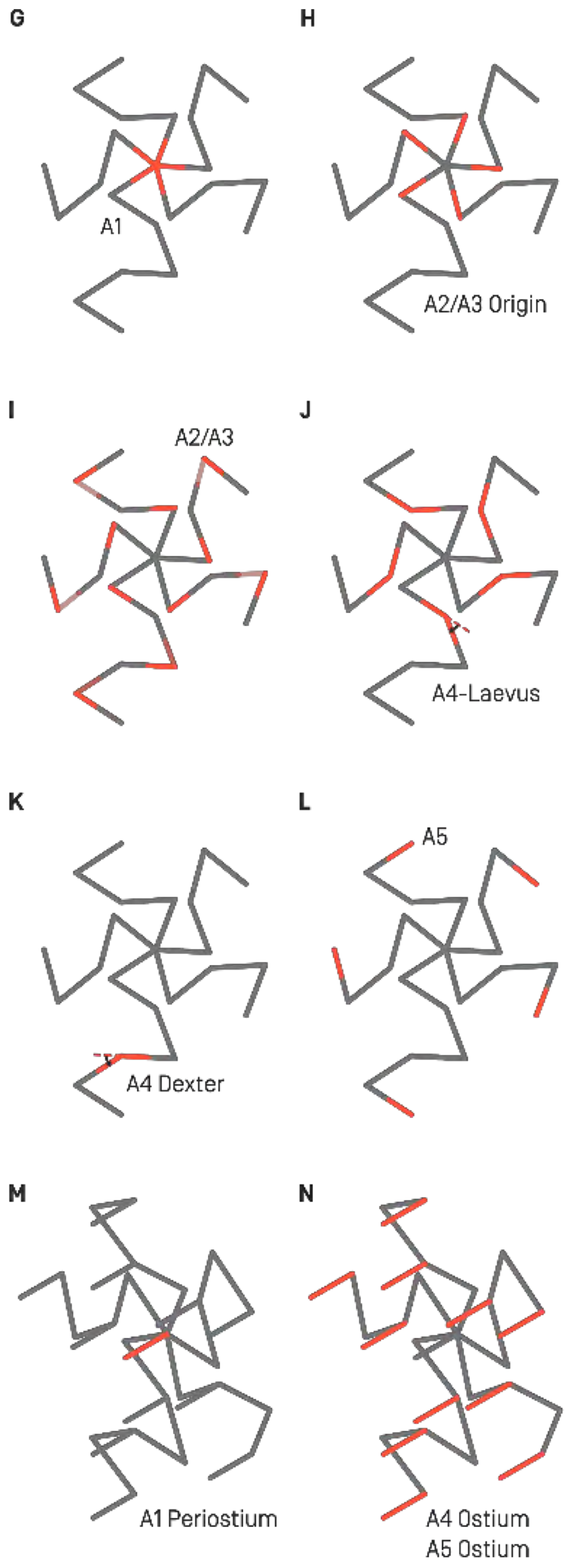
Folding linkage



6 Unique Parts

- F1
- F2 Laevus
- F2 Dexter
- F3
- F1 Ostium
- F2/F3 Periostium

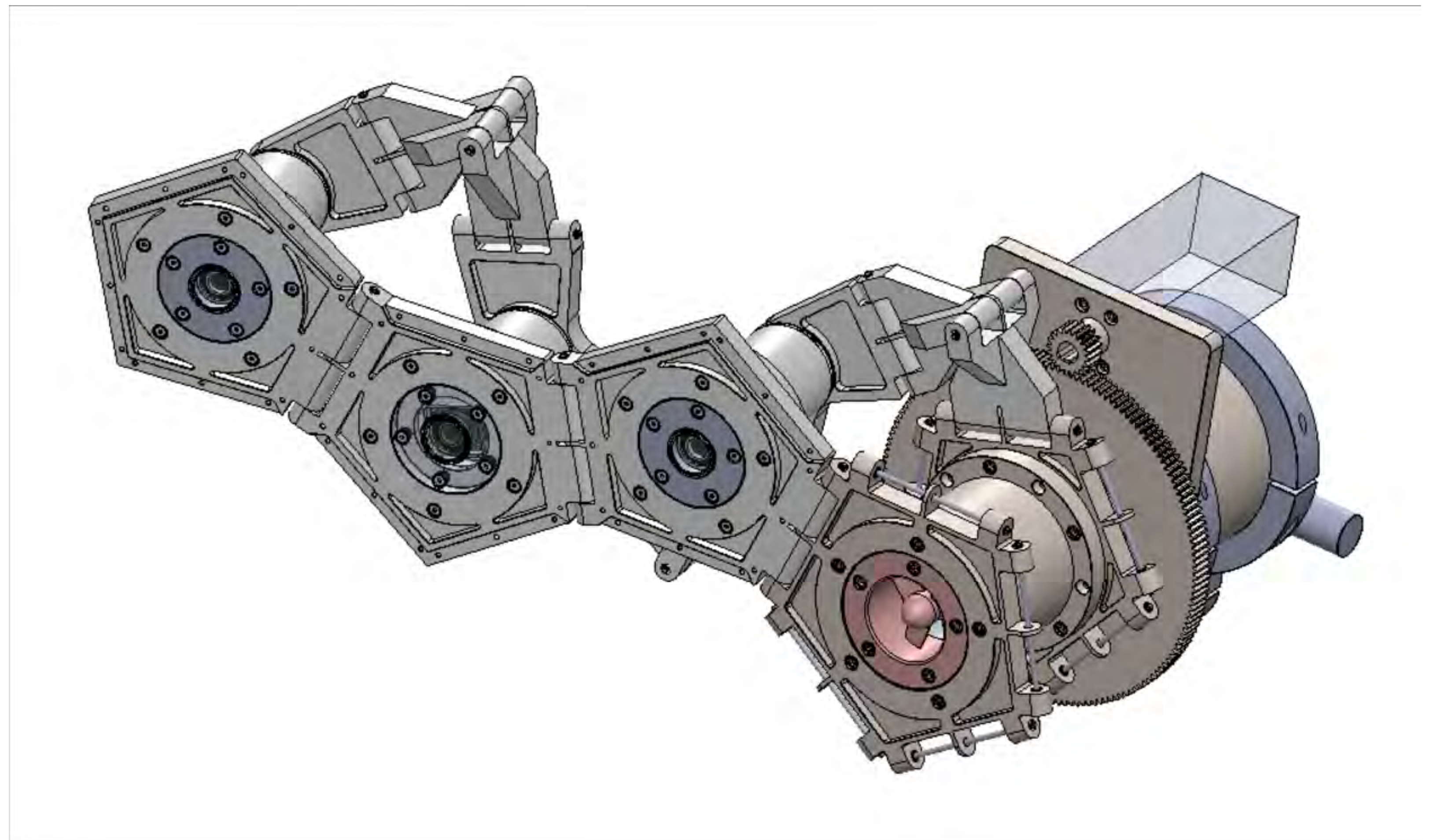
Assembly linkage



8 Unique Parts

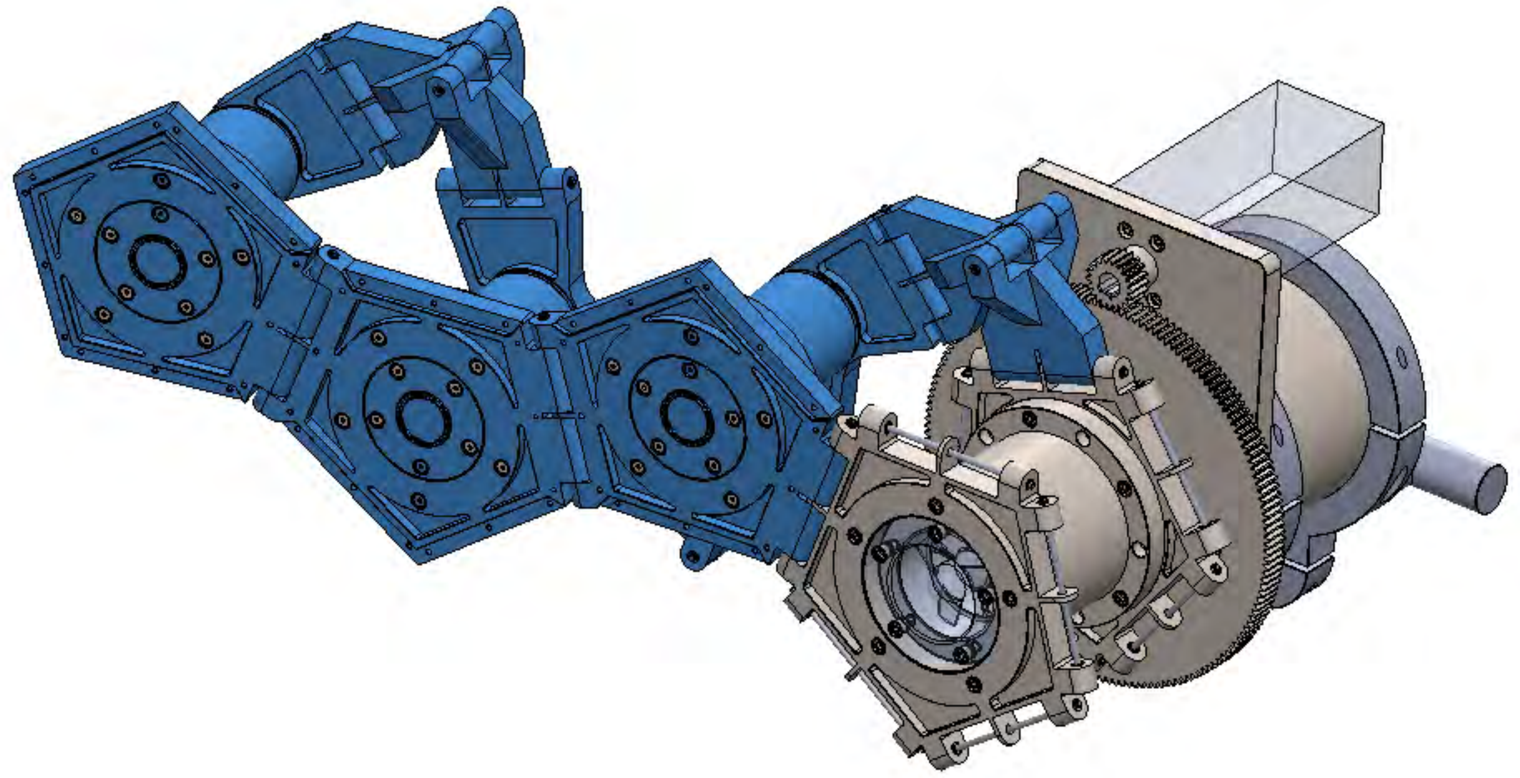
- A1
- A2/A3 Origin
- A2/A3
- A4 Laevus
- A4 Dexter
- A5
- A1 Periostium
- A4/A5 Ostium

RAD2 Made Of Two Main Sub-assemblies

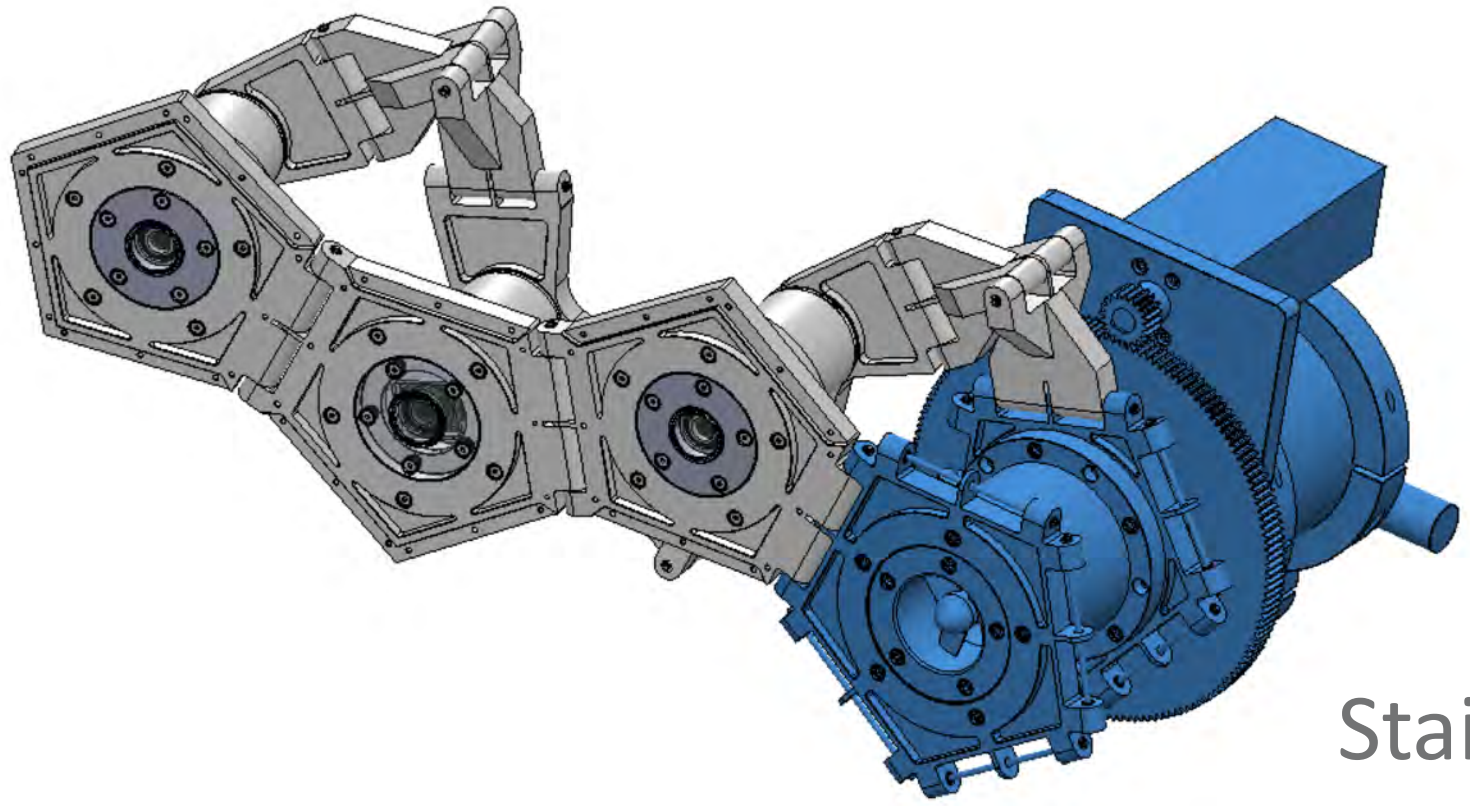


Arm Linkage Assembly

Hydex 301



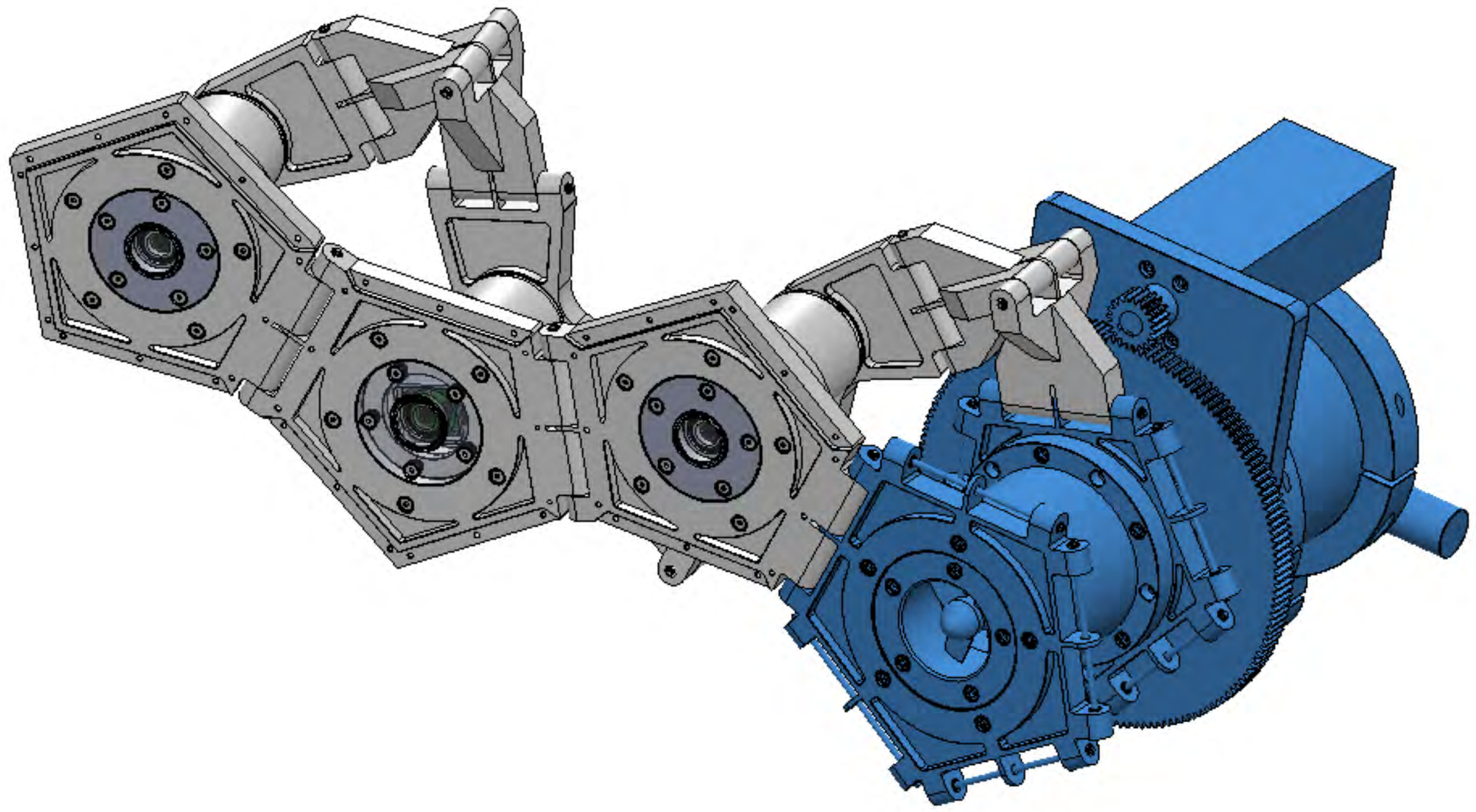
Central Hub Linkage Assembly



Stainless Steel 316

Central Hub Linkage Assembly

Central hub linkage is highlighted in blue

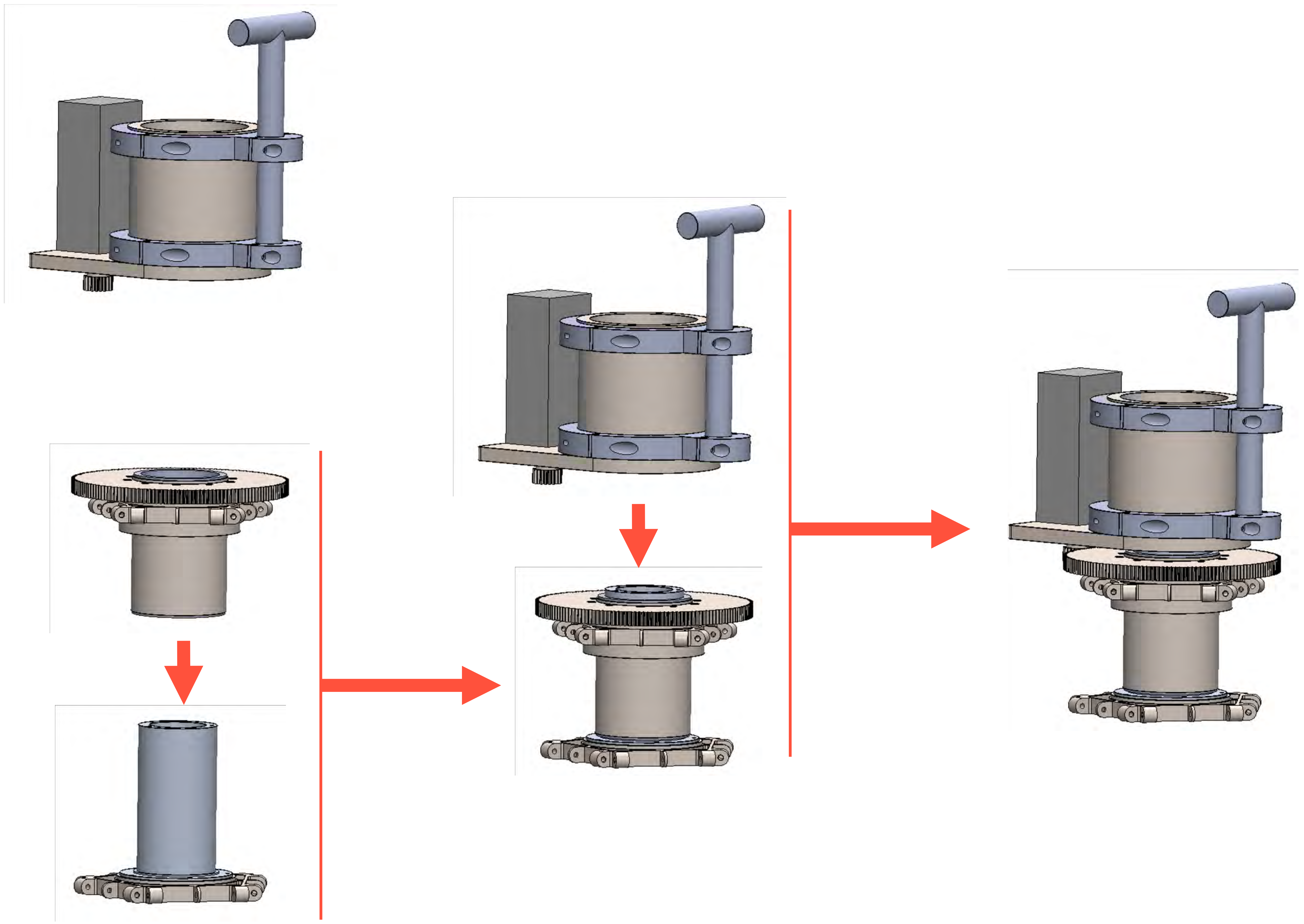


Central Hub Consist of 3 Sub-assemblies

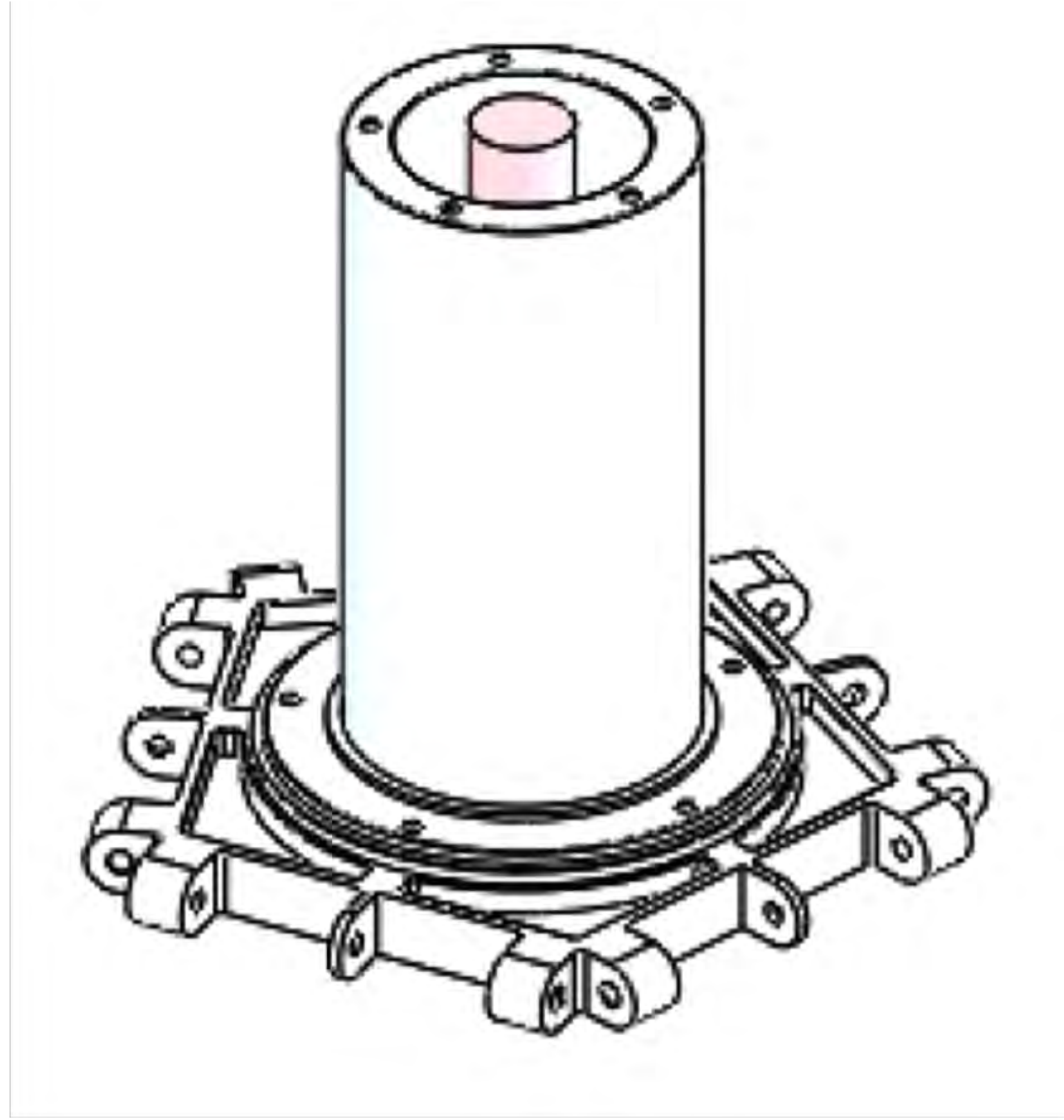
Main Housing Assembly

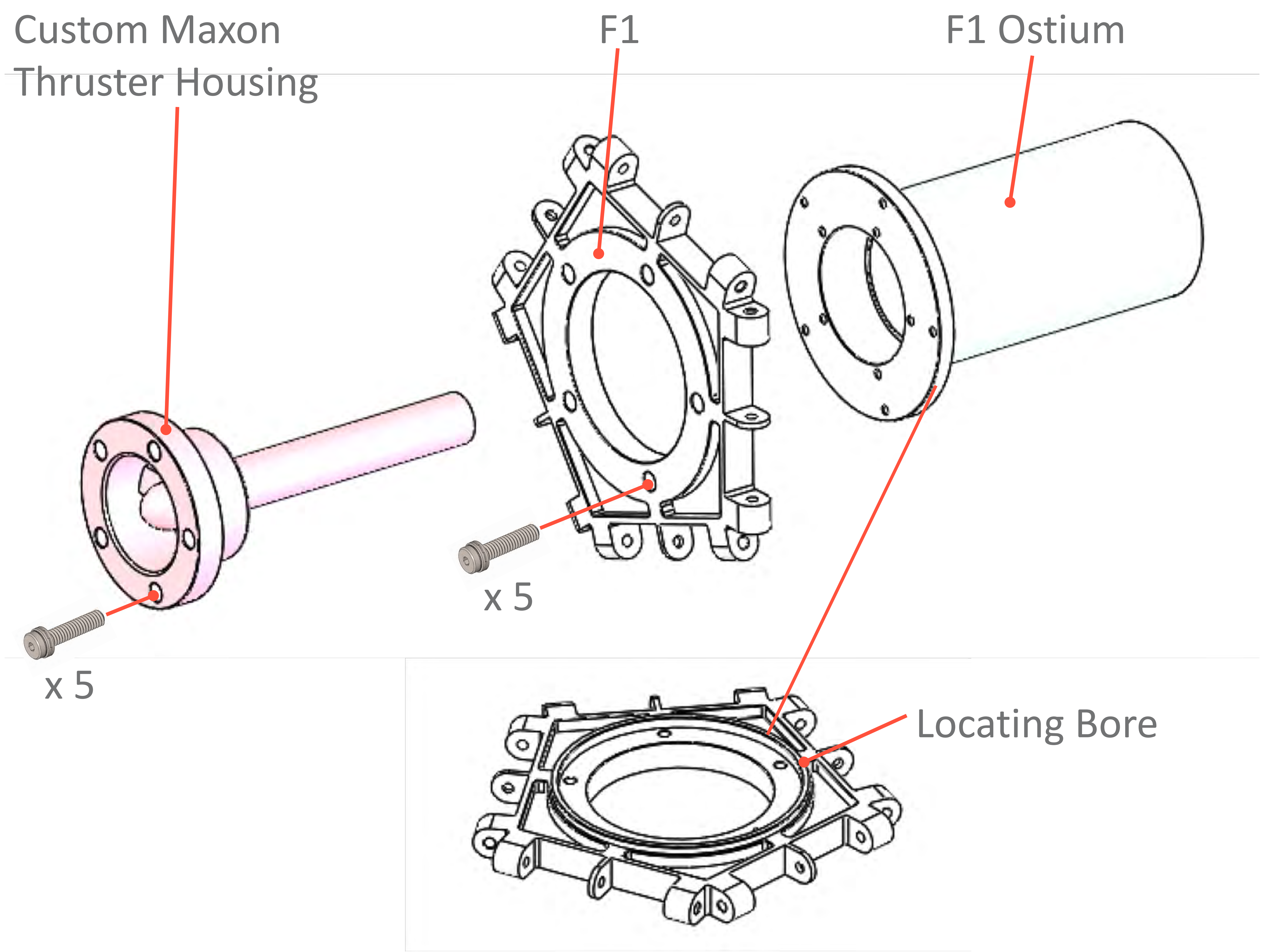
A1 Link Assembly

F1 Link Assembly

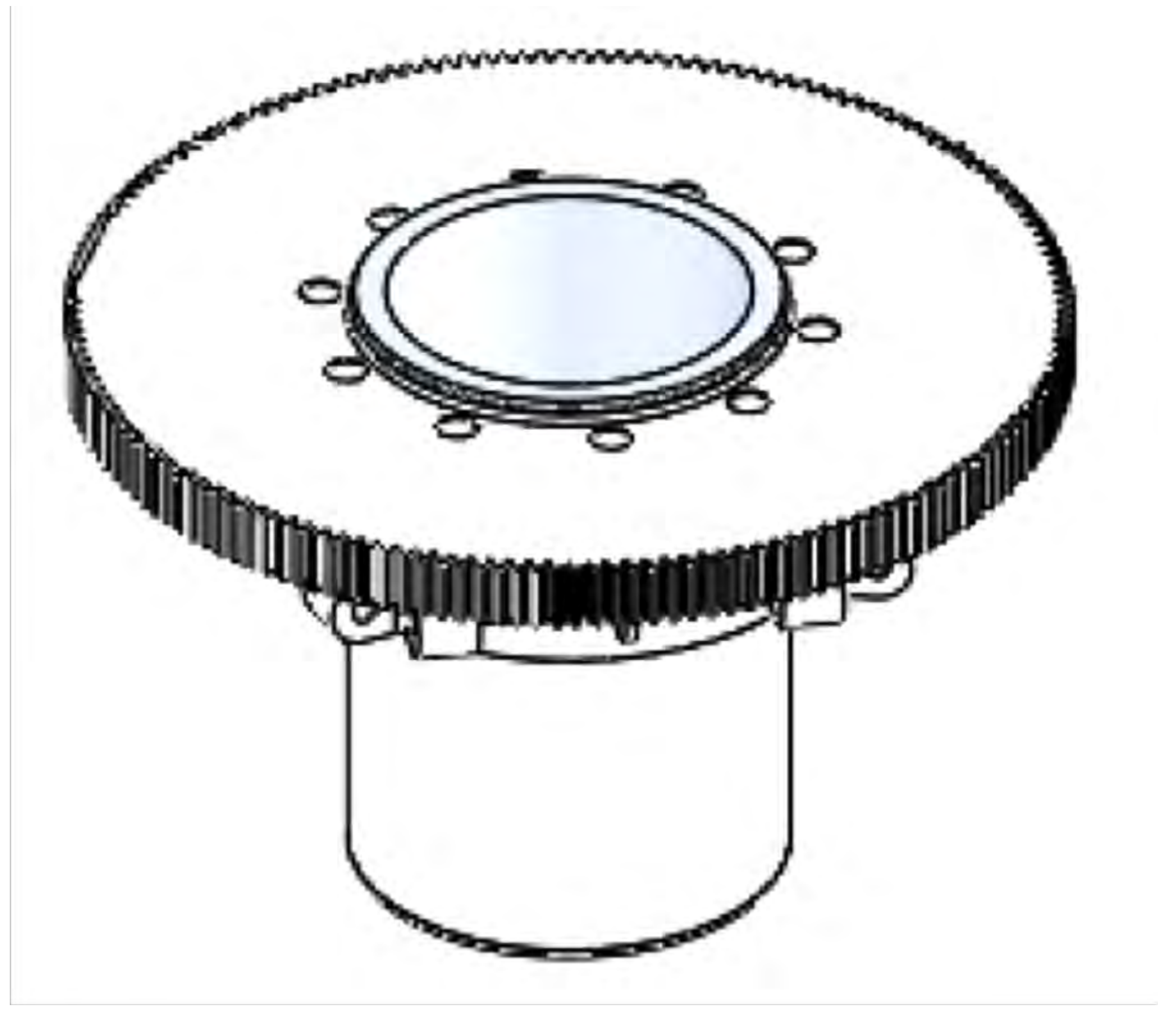


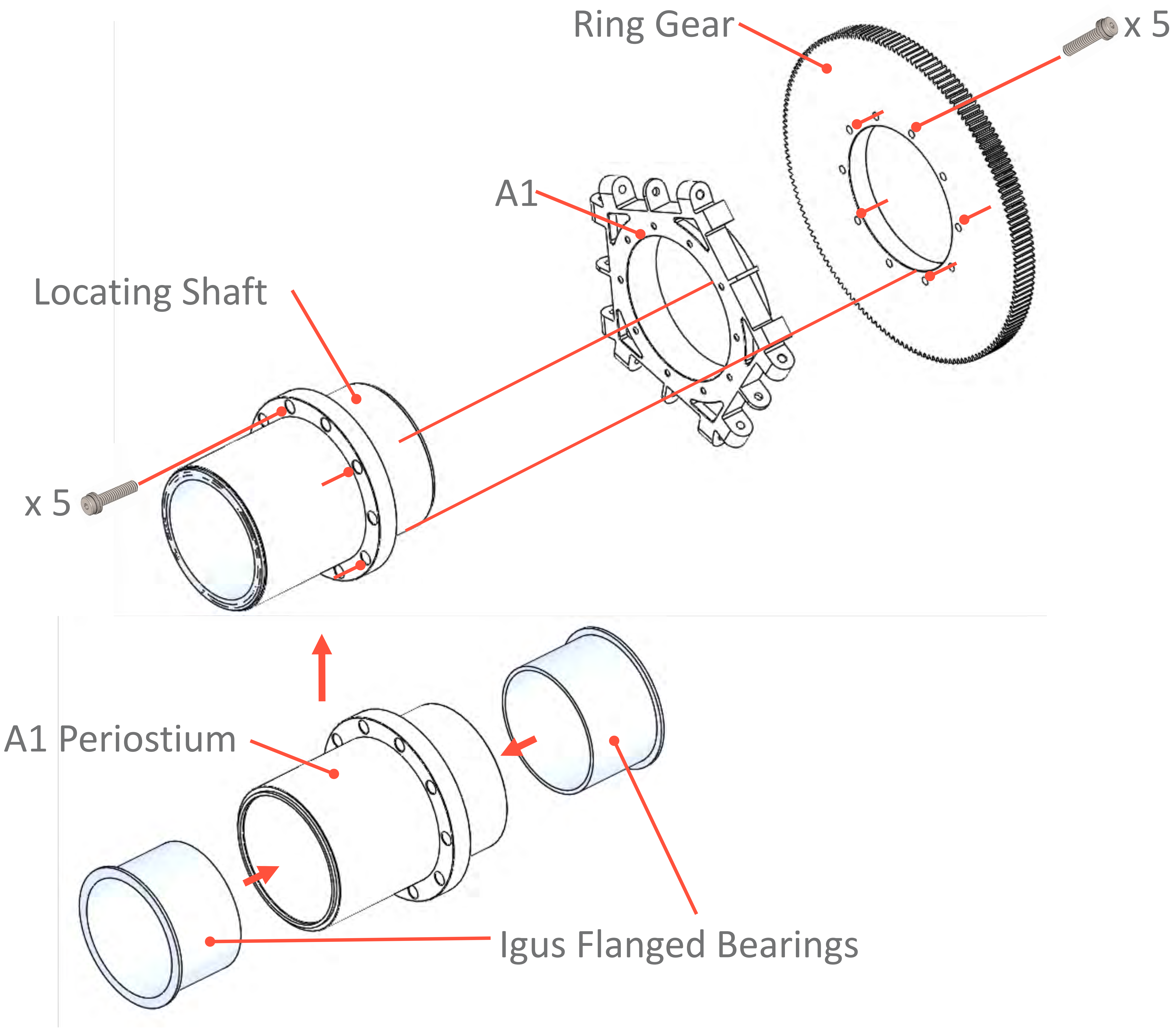
F1 Link Assembly



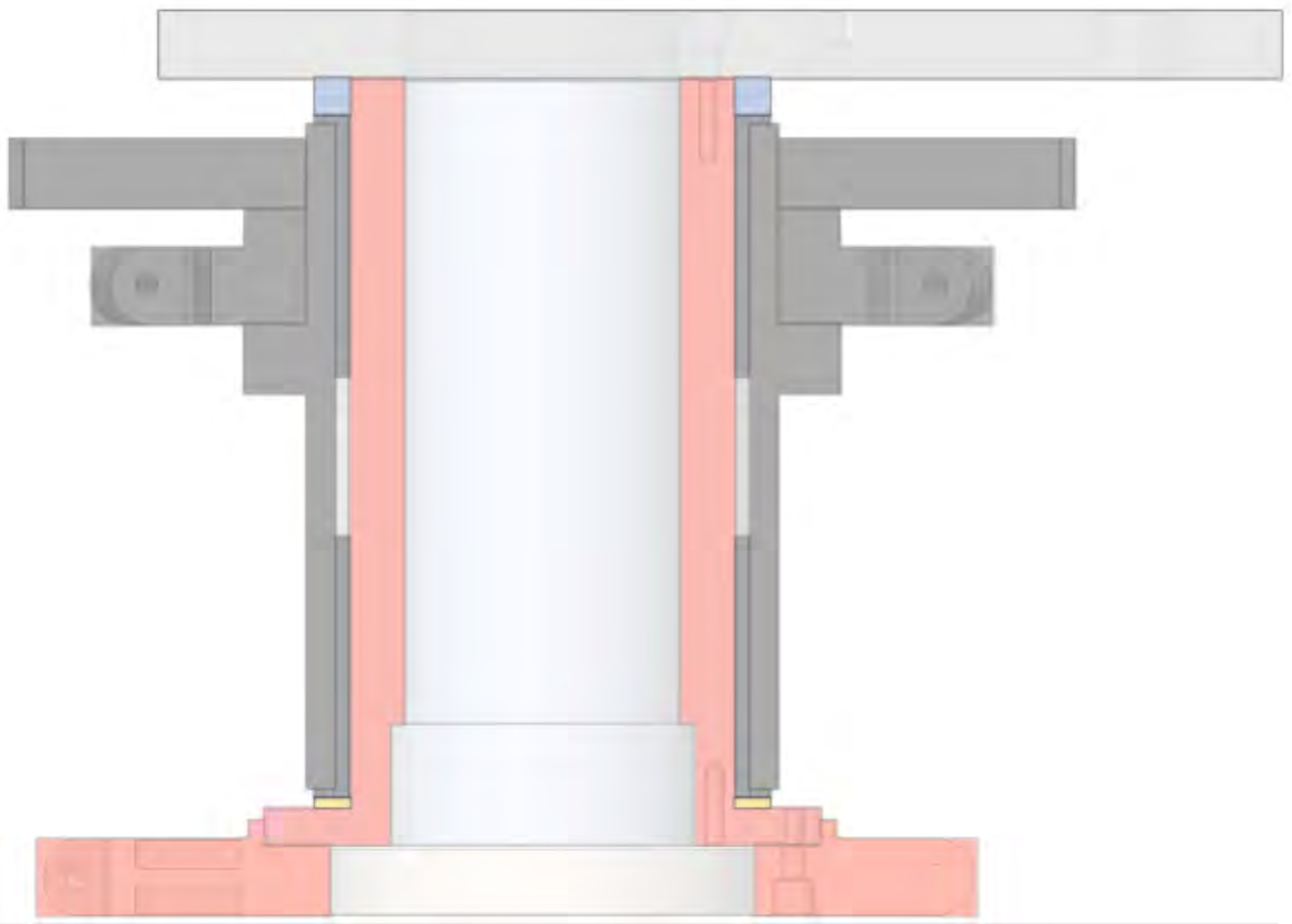


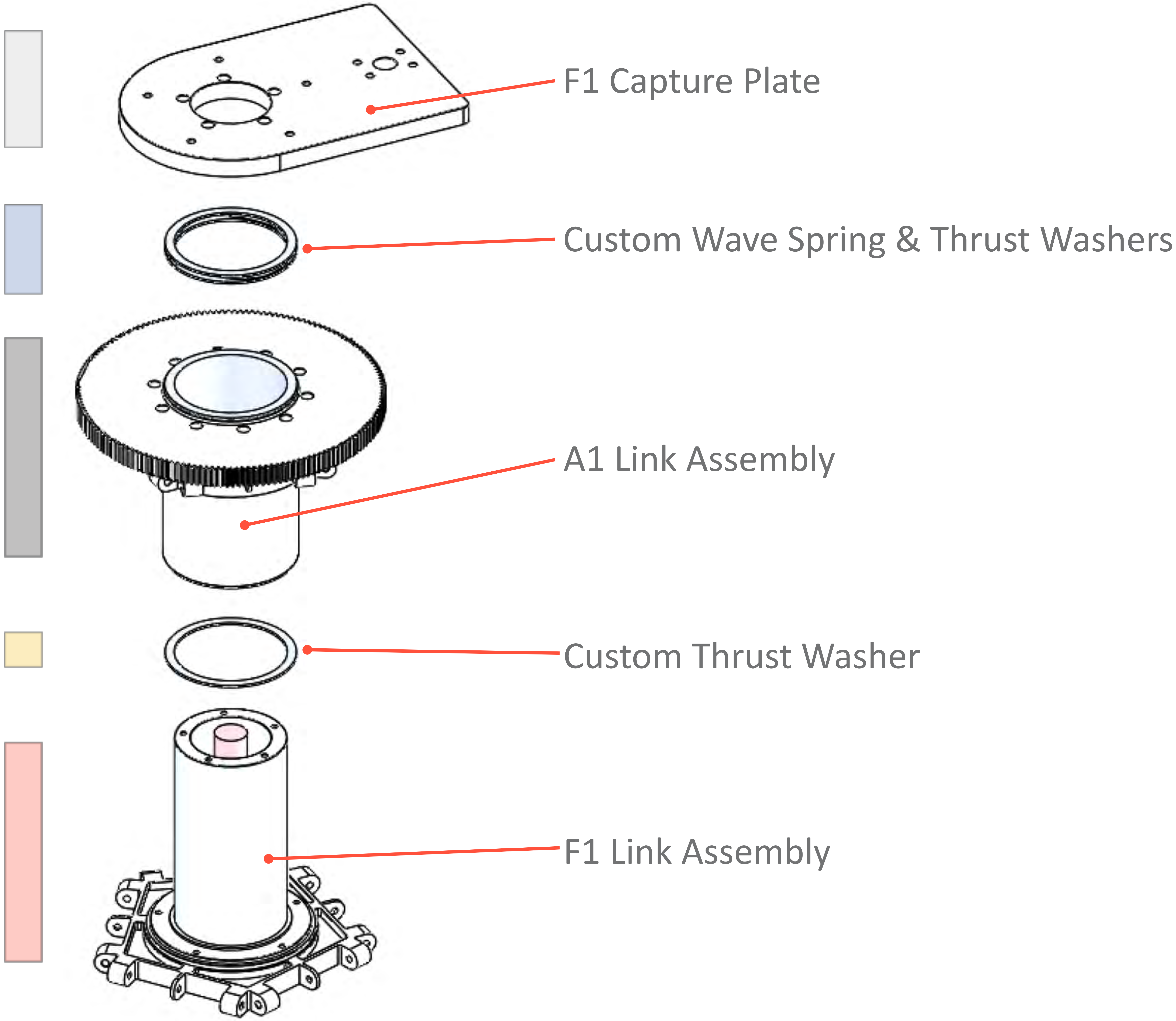
A1 Link Assembly



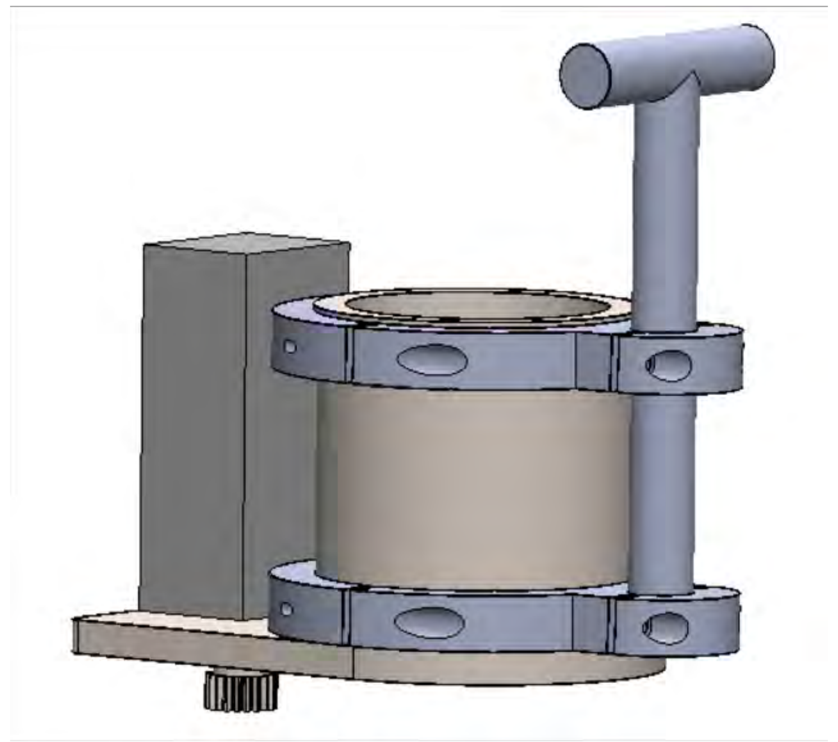


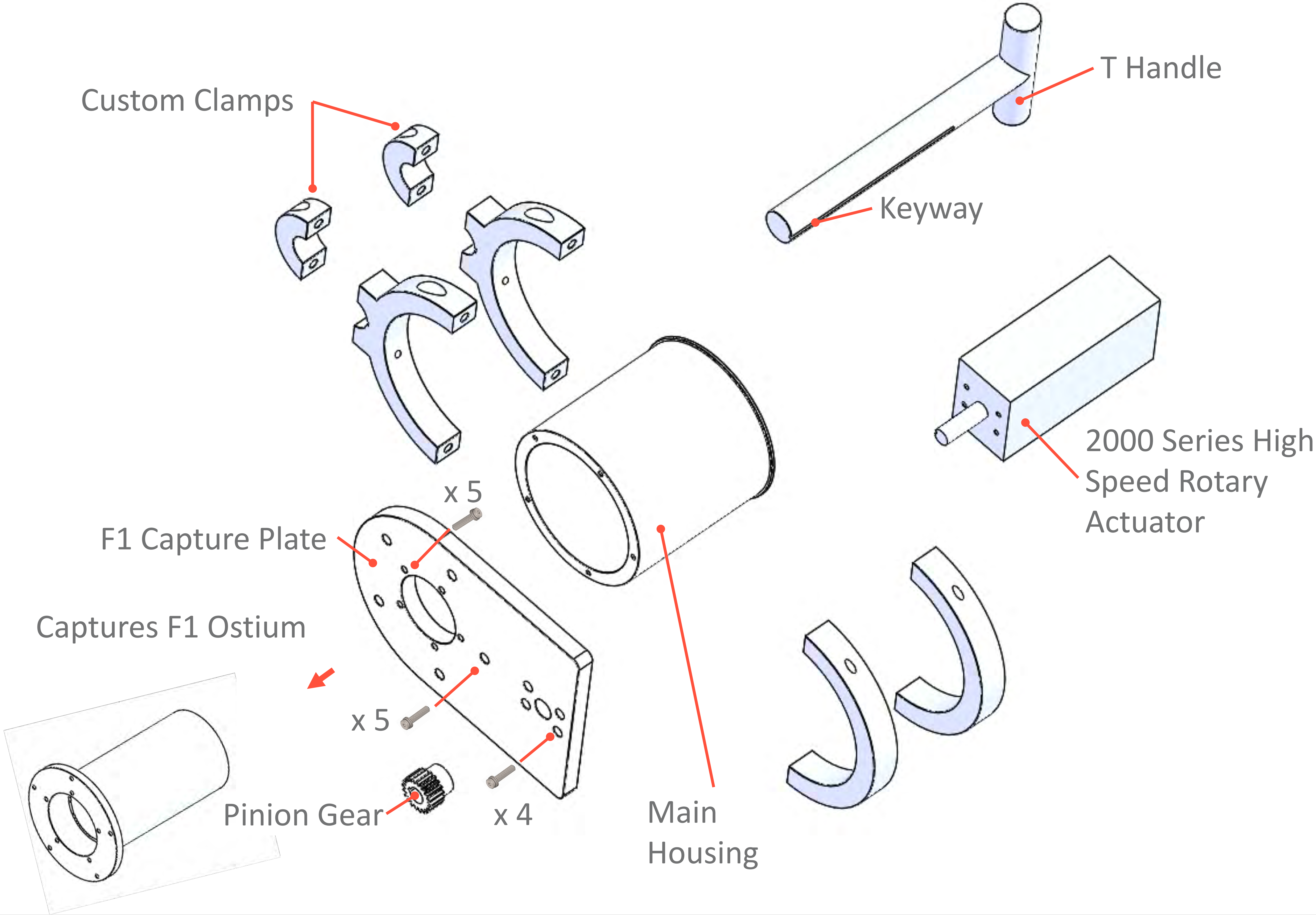
Central Hub Assembly





Main Housing Assembly



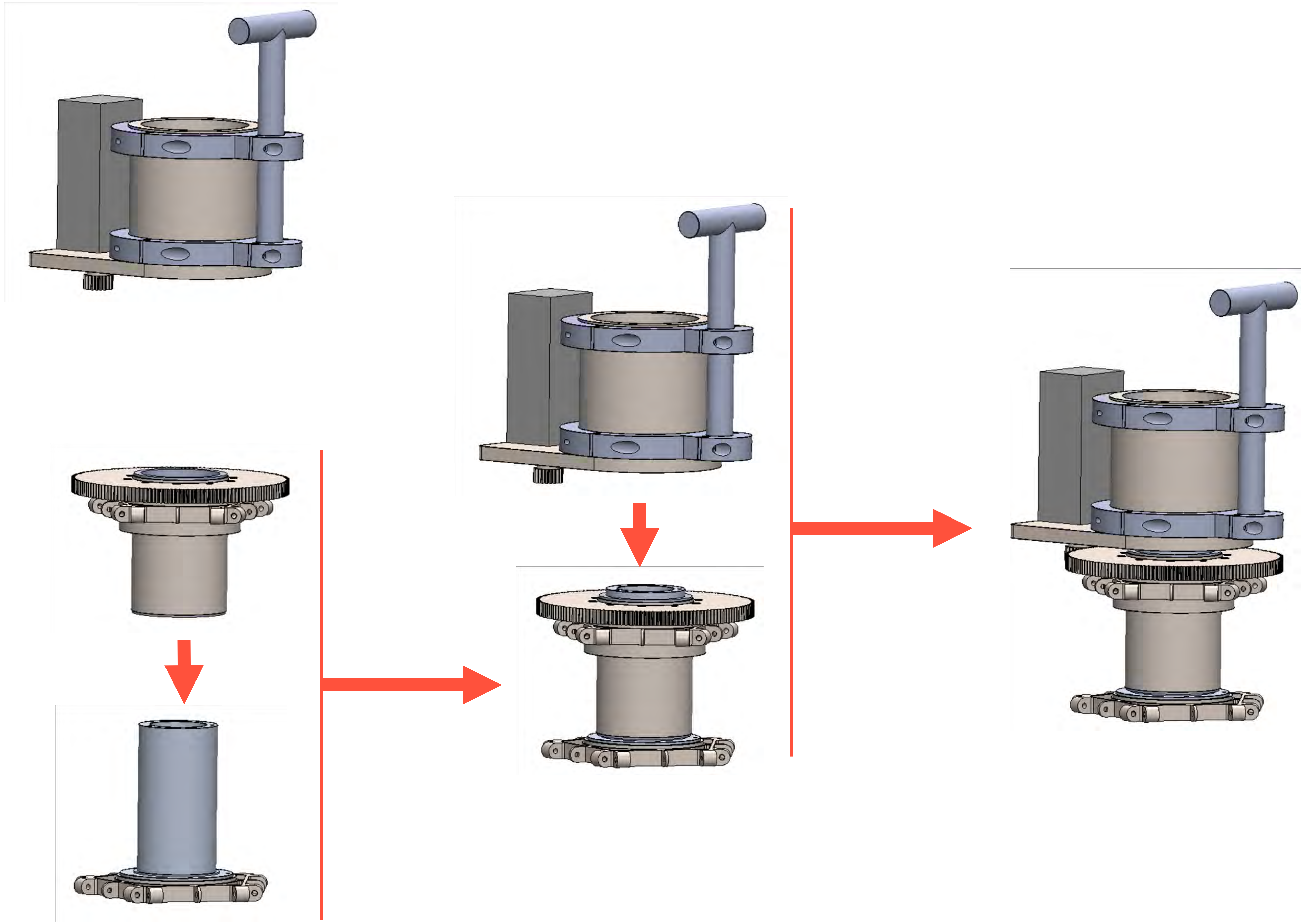


Central Hub Consist of 3 Sub-assemblies

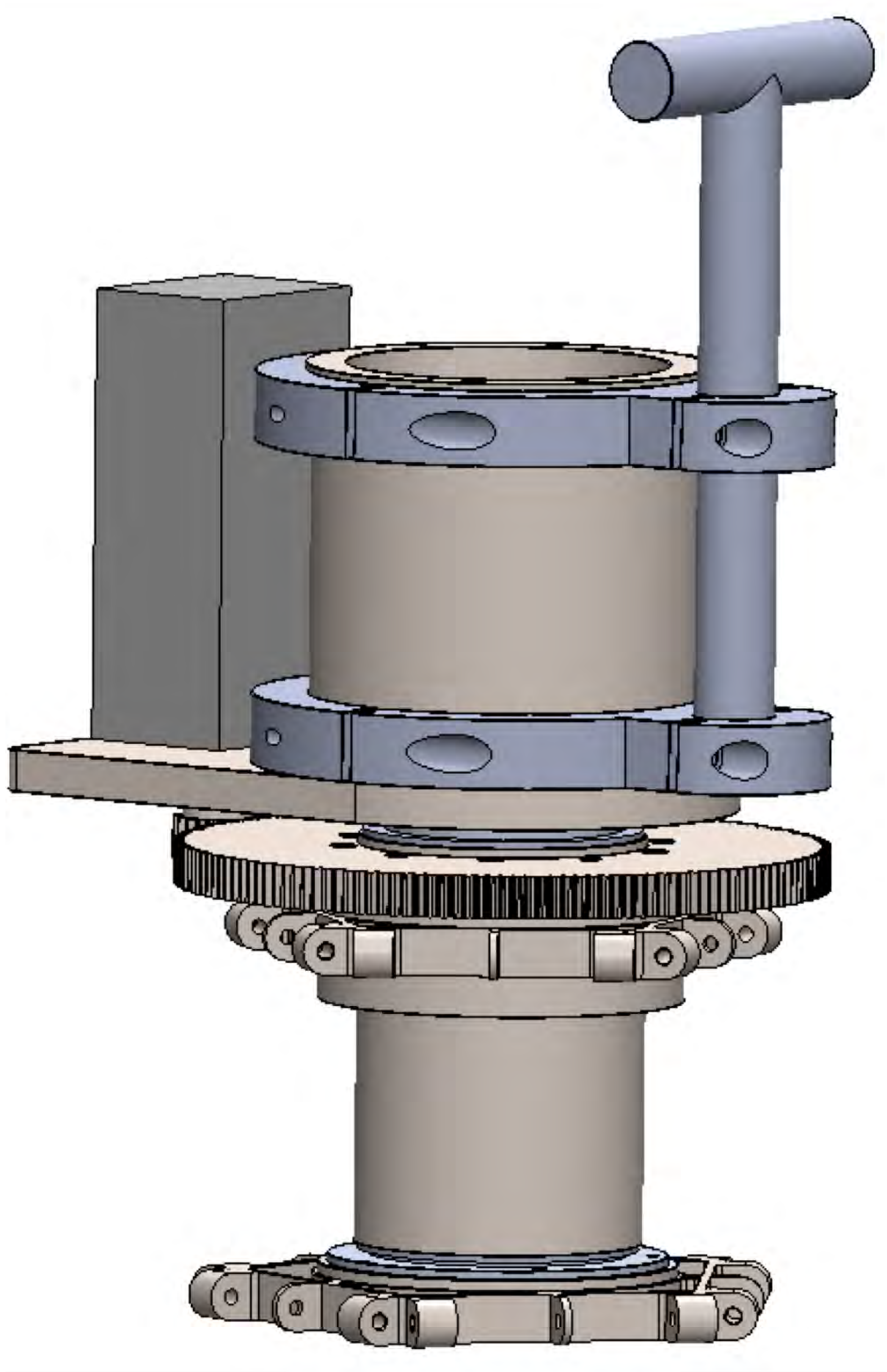
Main
Housing
Assembly

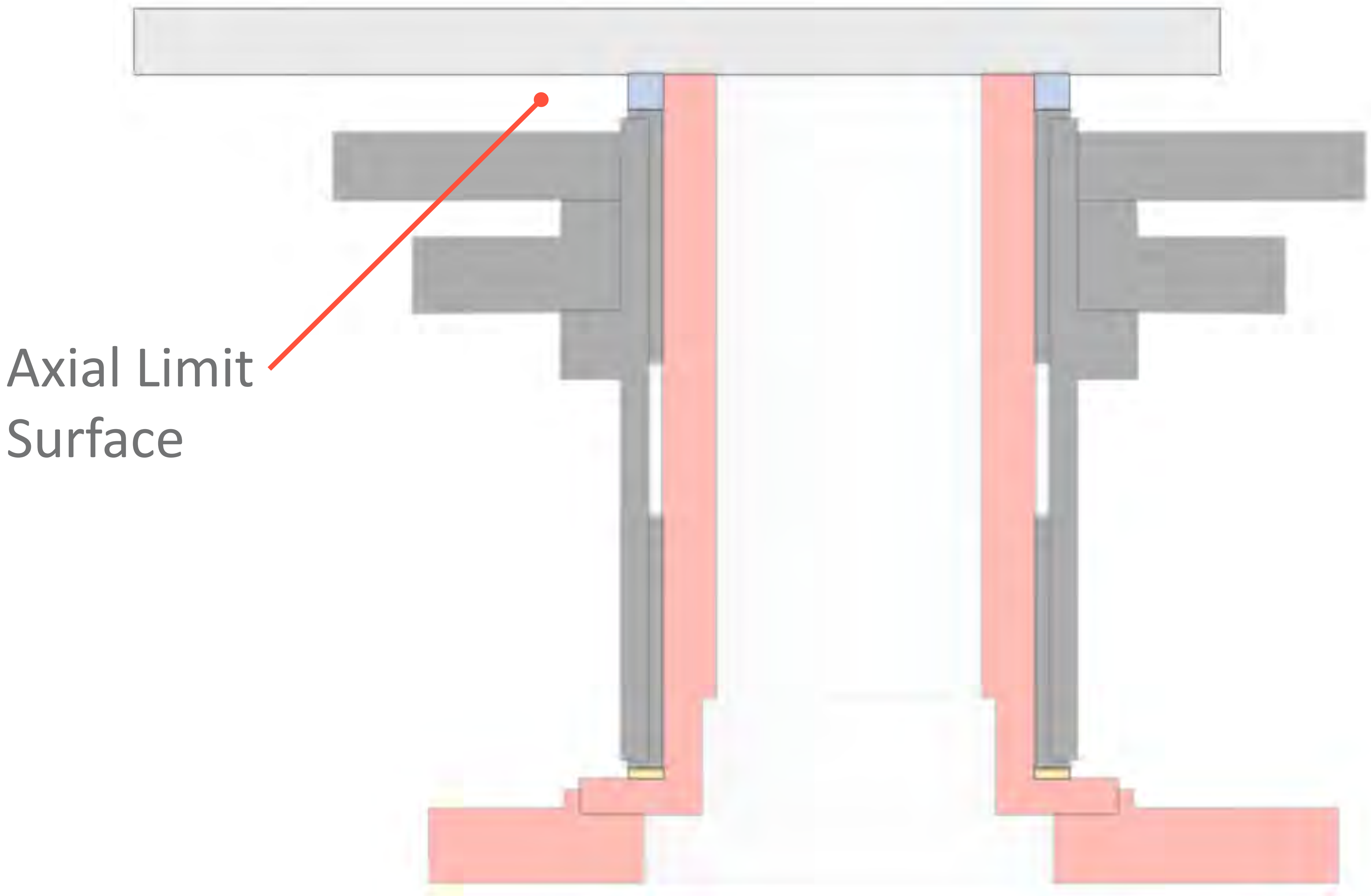
A1 Link
Assembly

F1 Link
Assembly



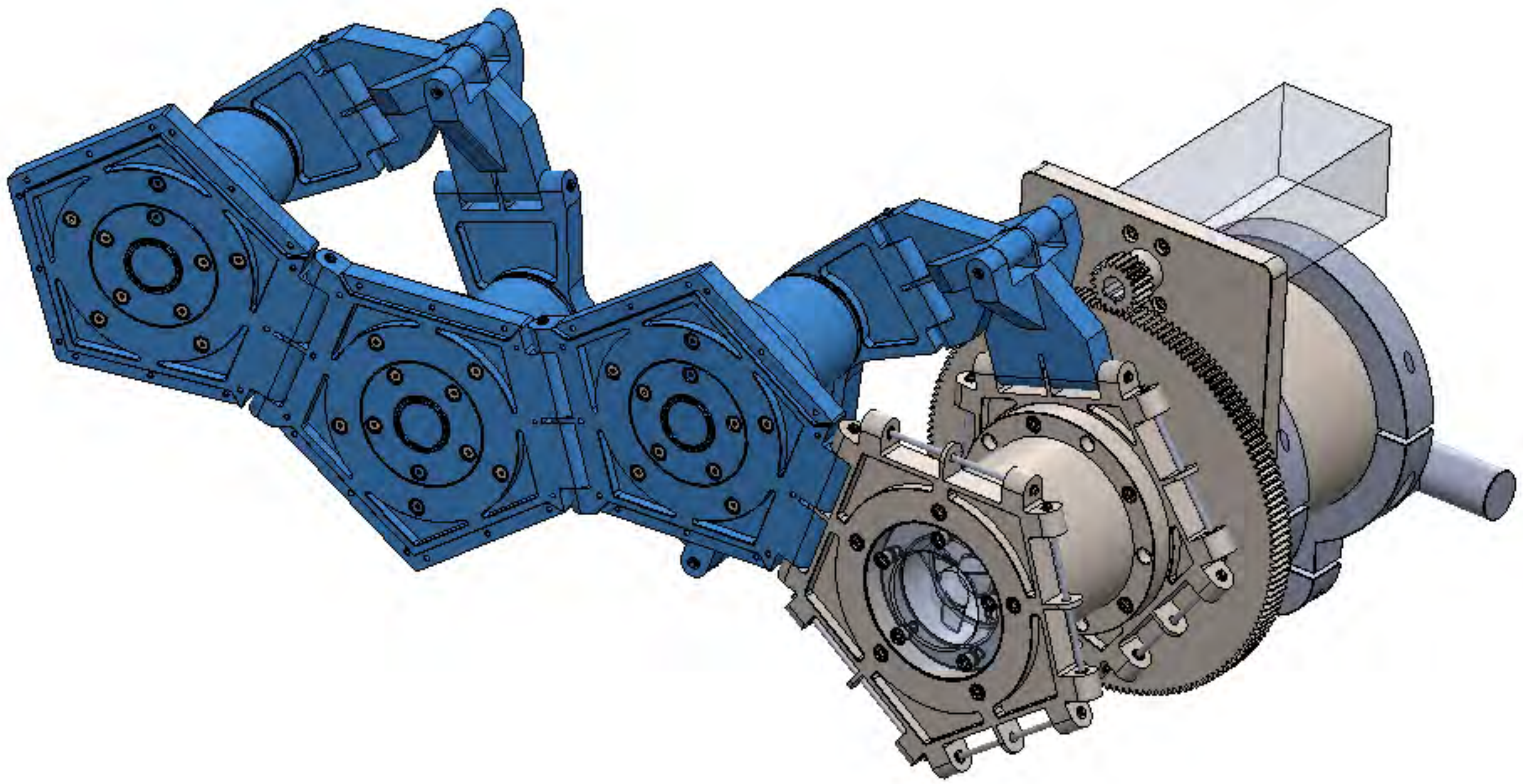
F1 Capture Plate Needs Axial Limit Surface



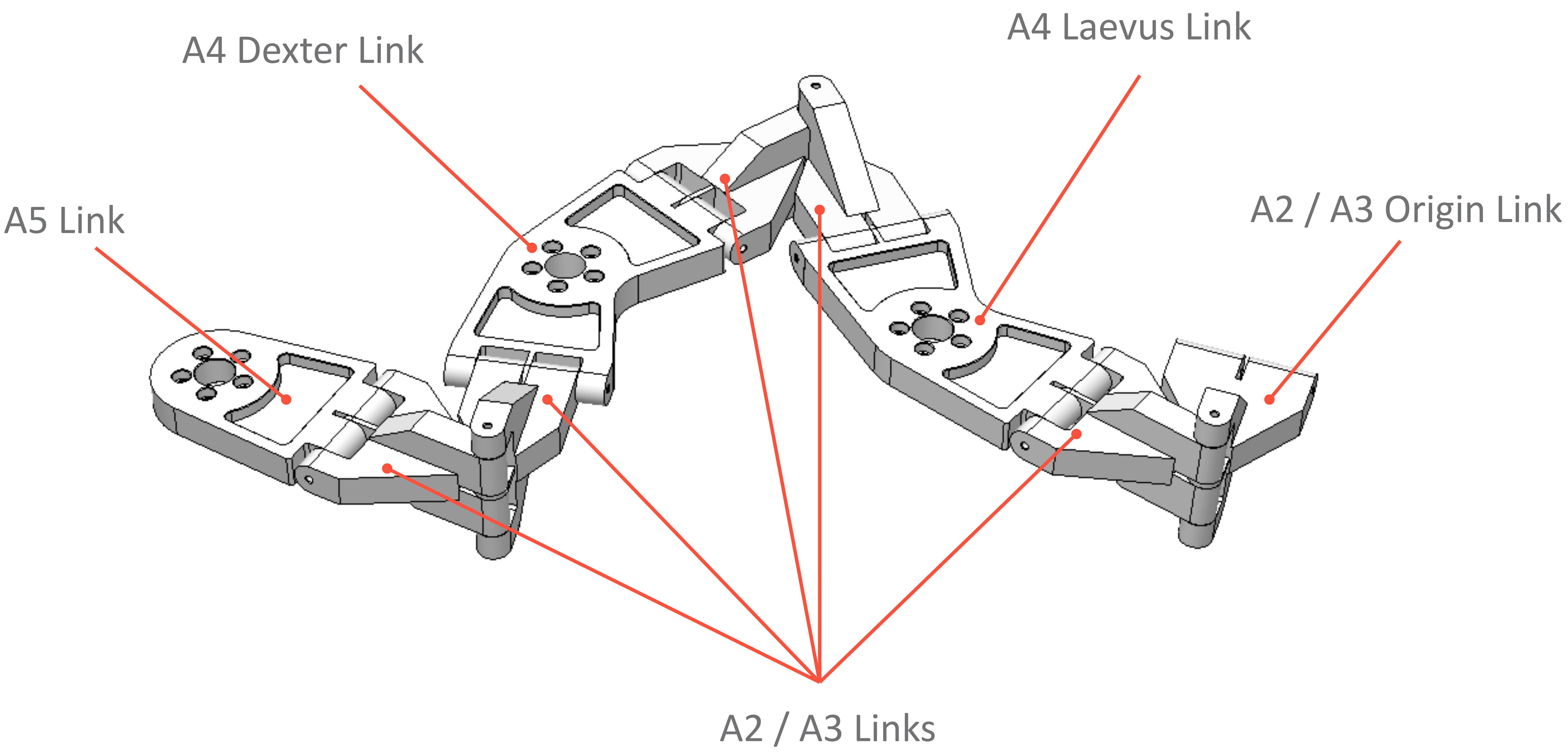


Arm Linkage Assembly

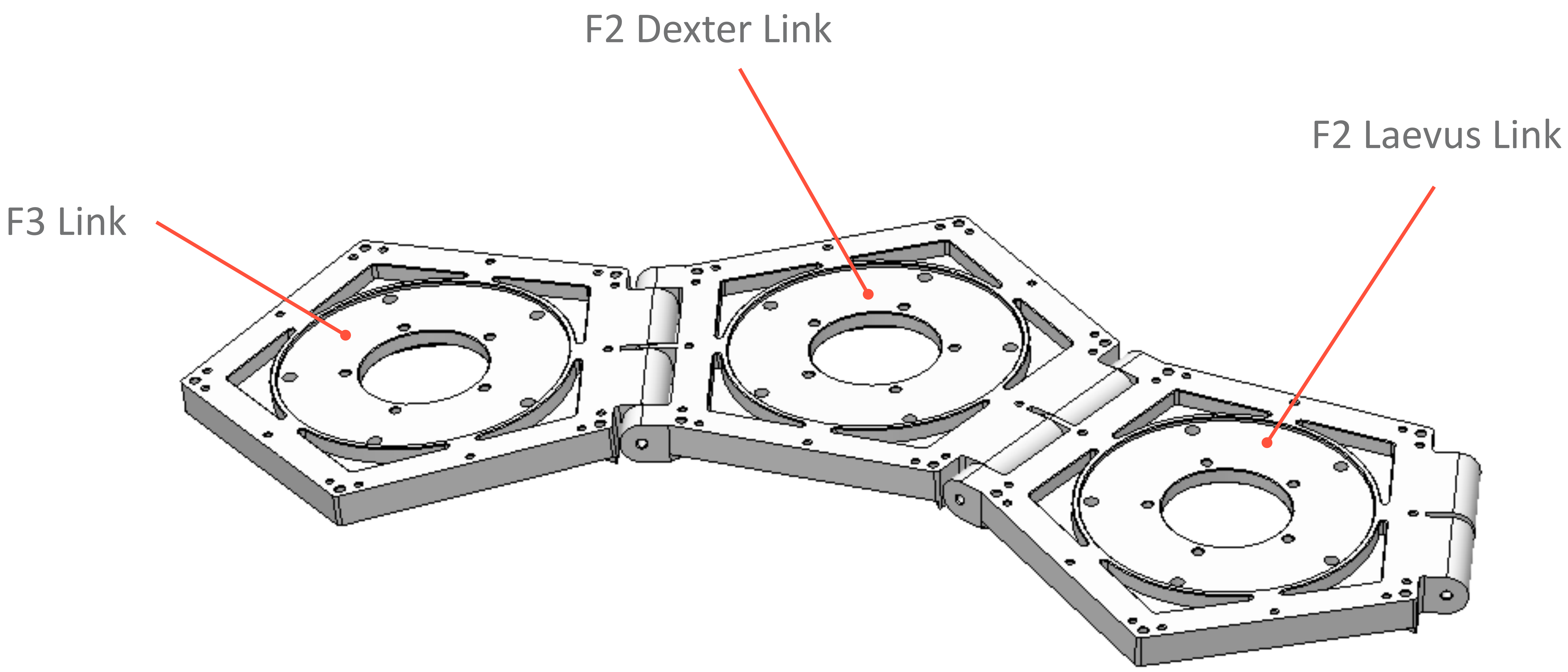
Arm linkage is highlighted in blue



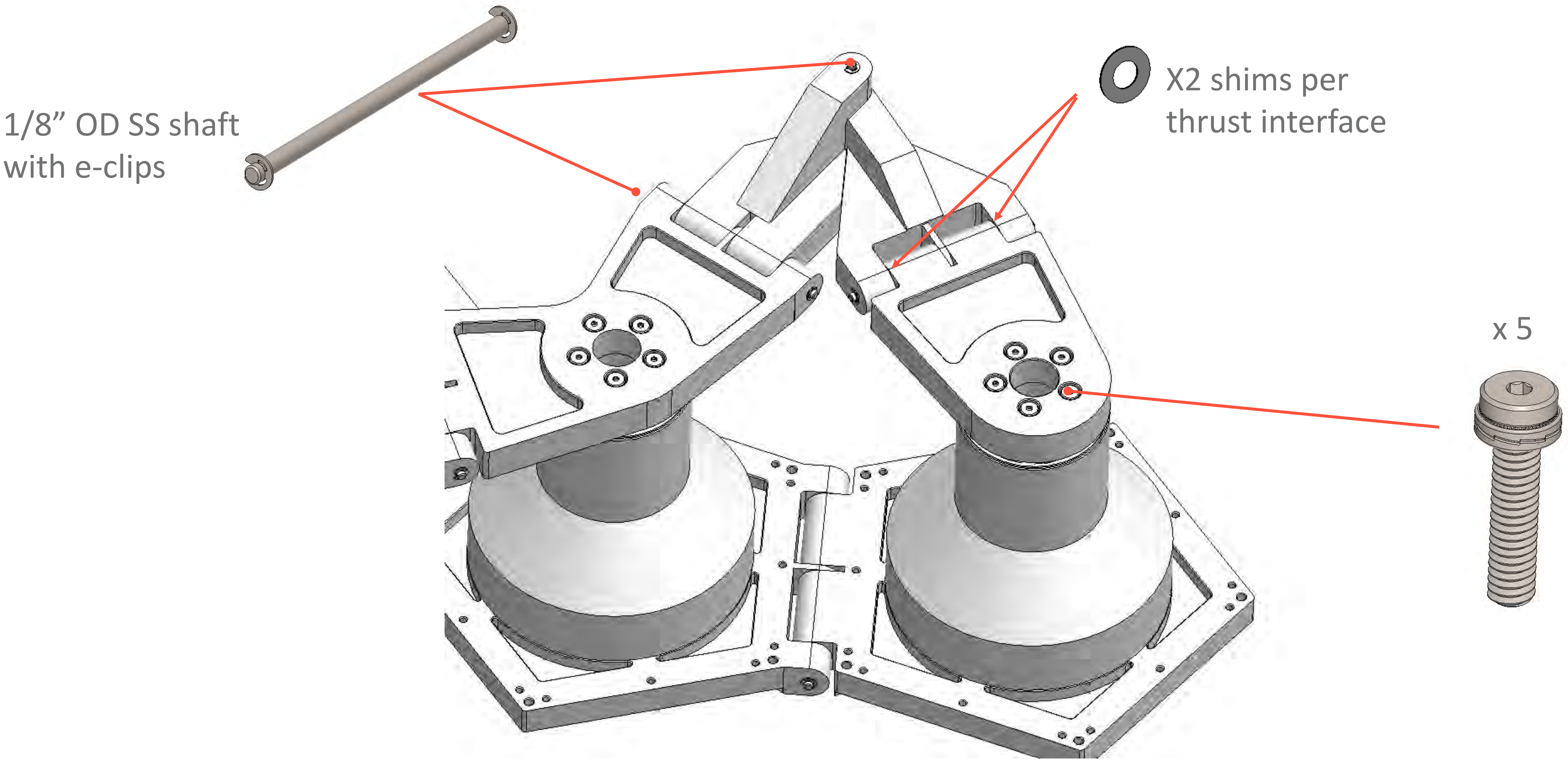
Assembly Linkage



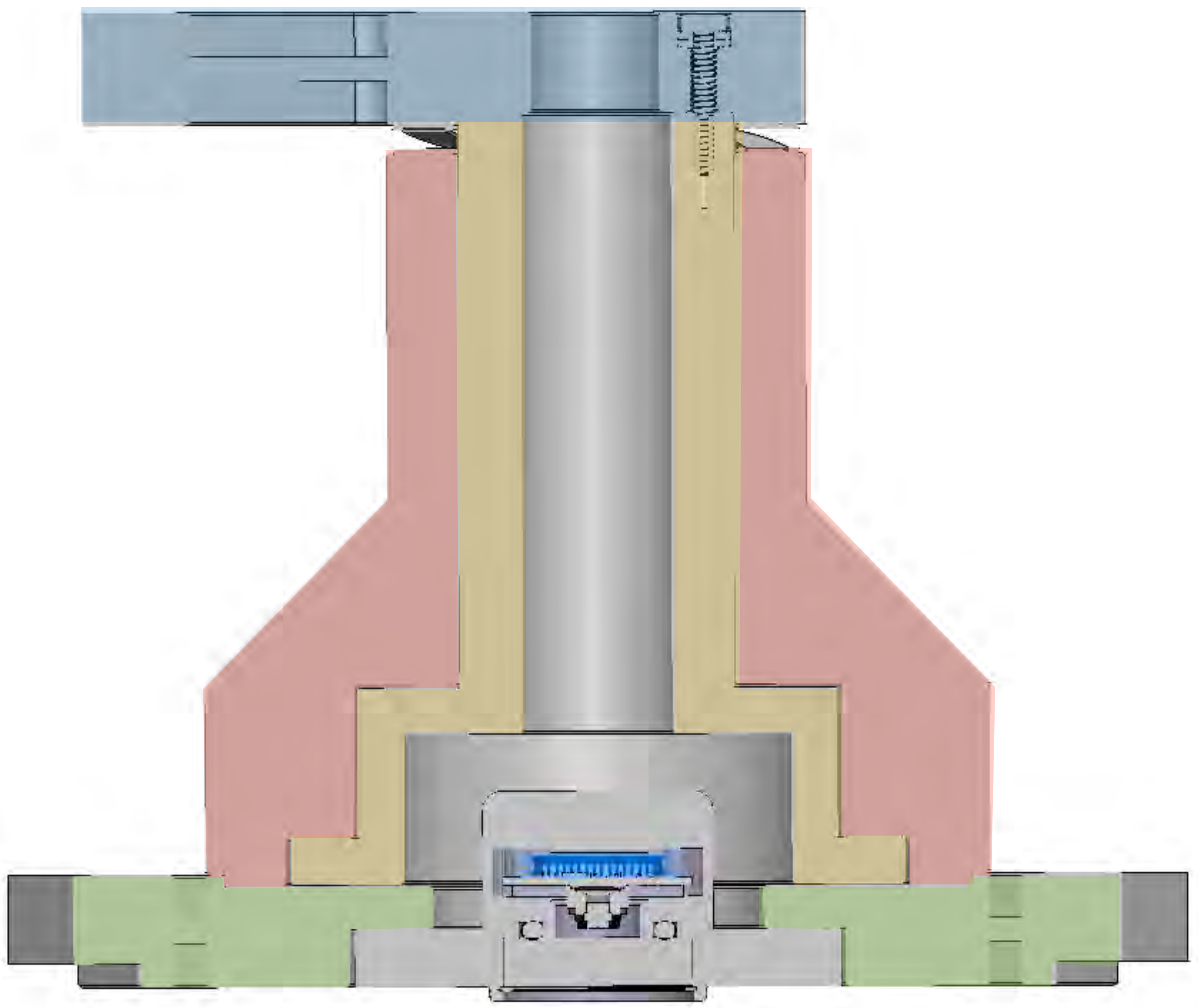
Folding Linkage

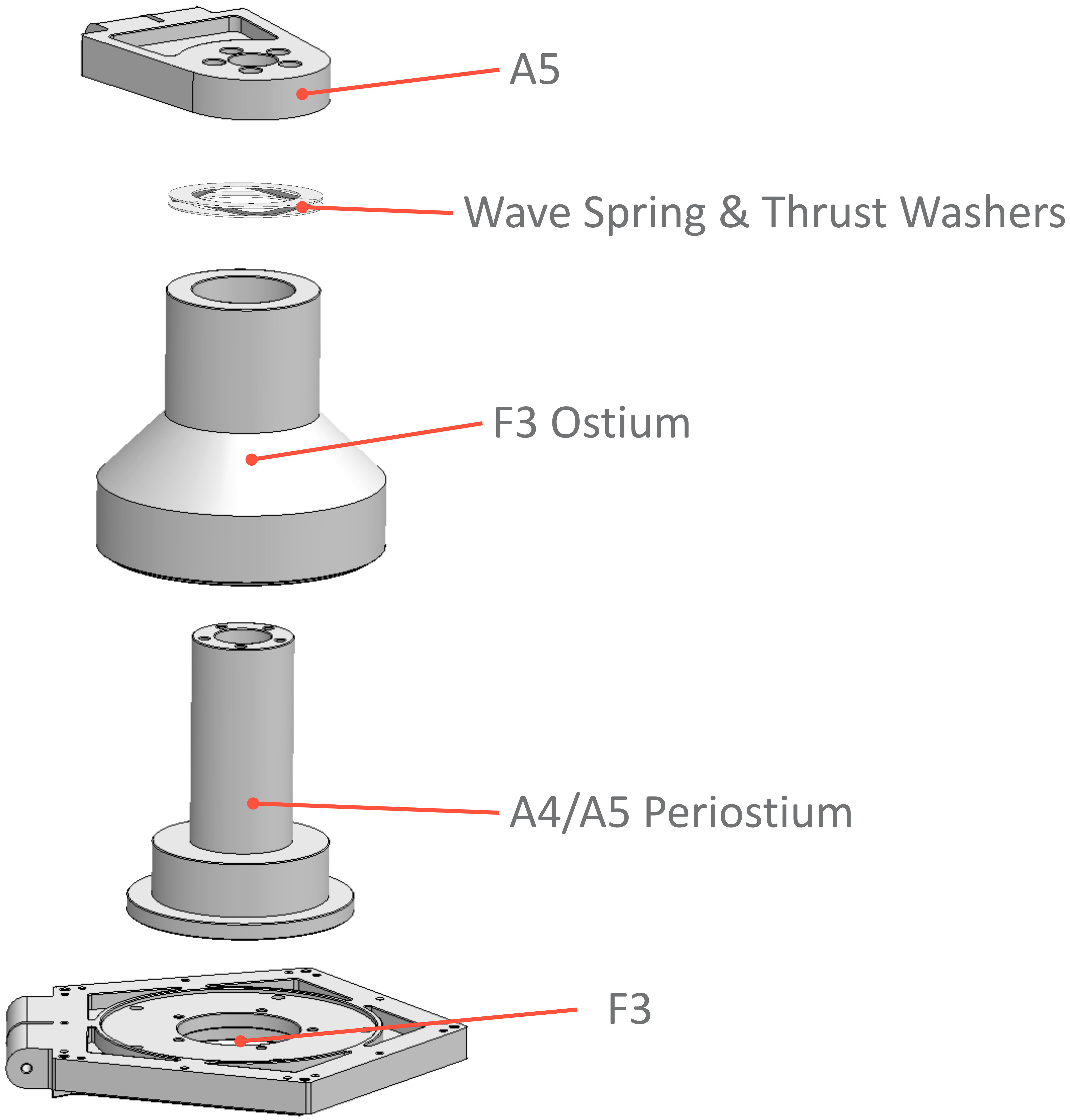


Assembly Linkage Hardware

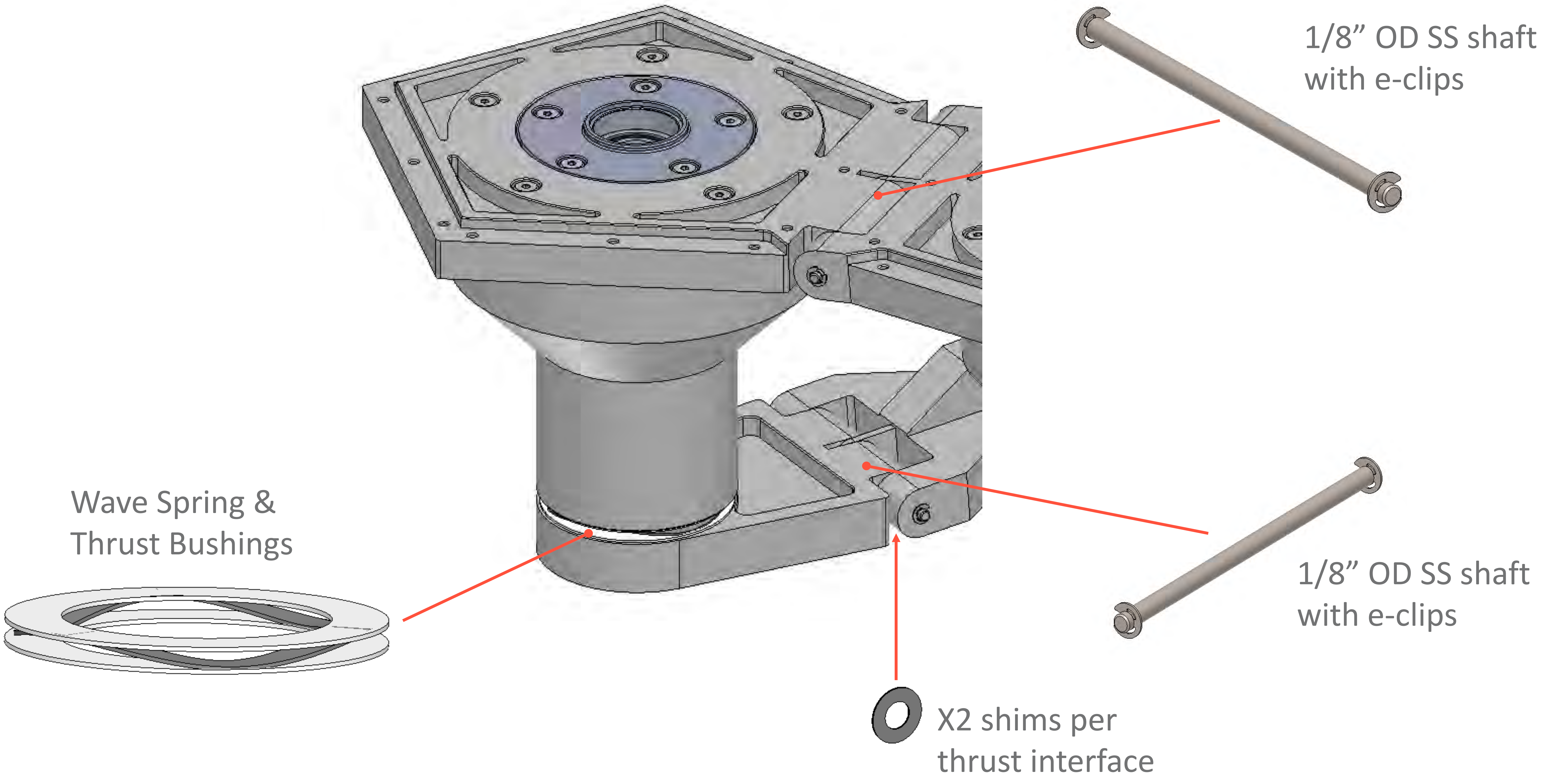


F2/F3 Ostium & A4/A5 Periostium Linkage Assembly

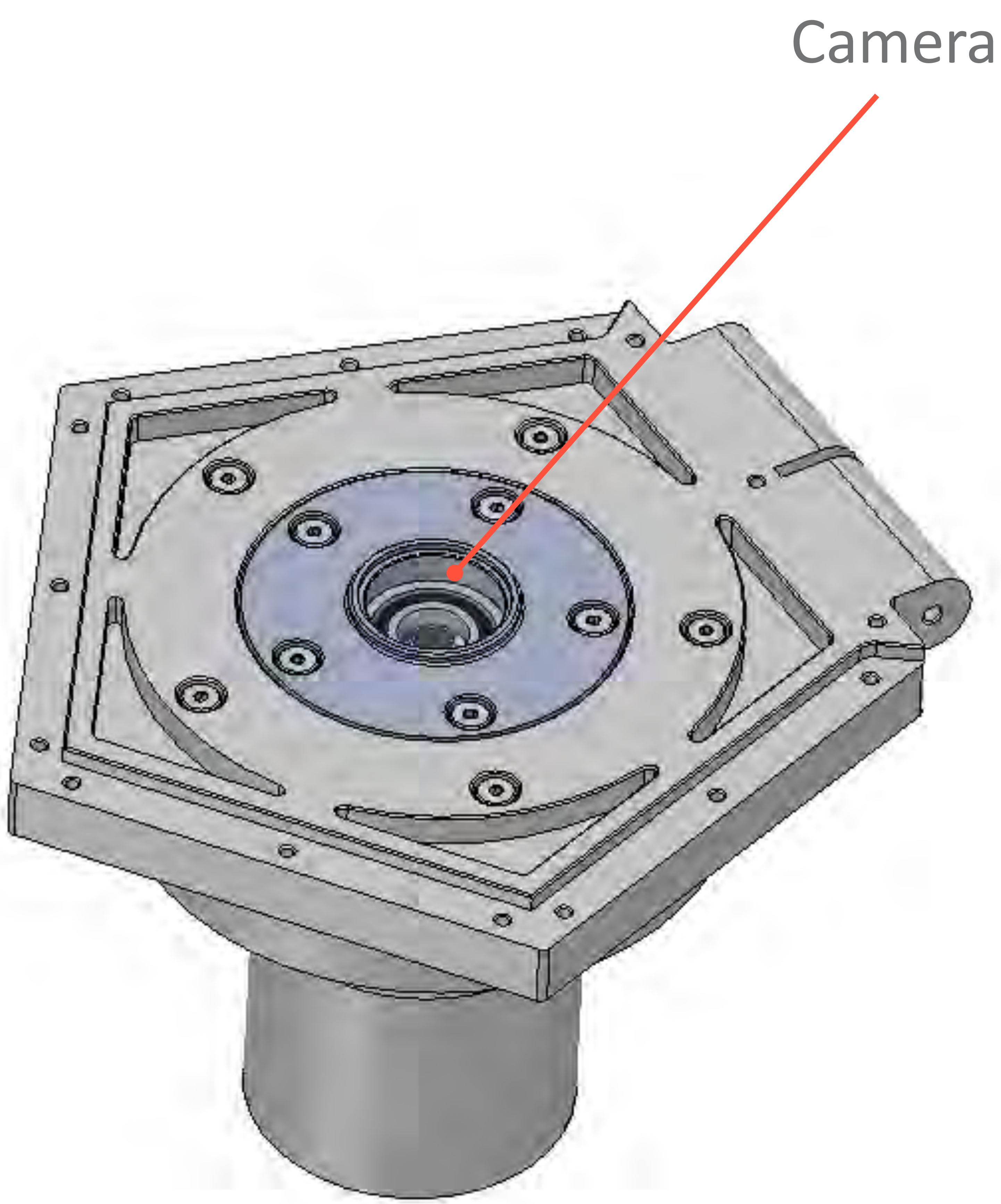


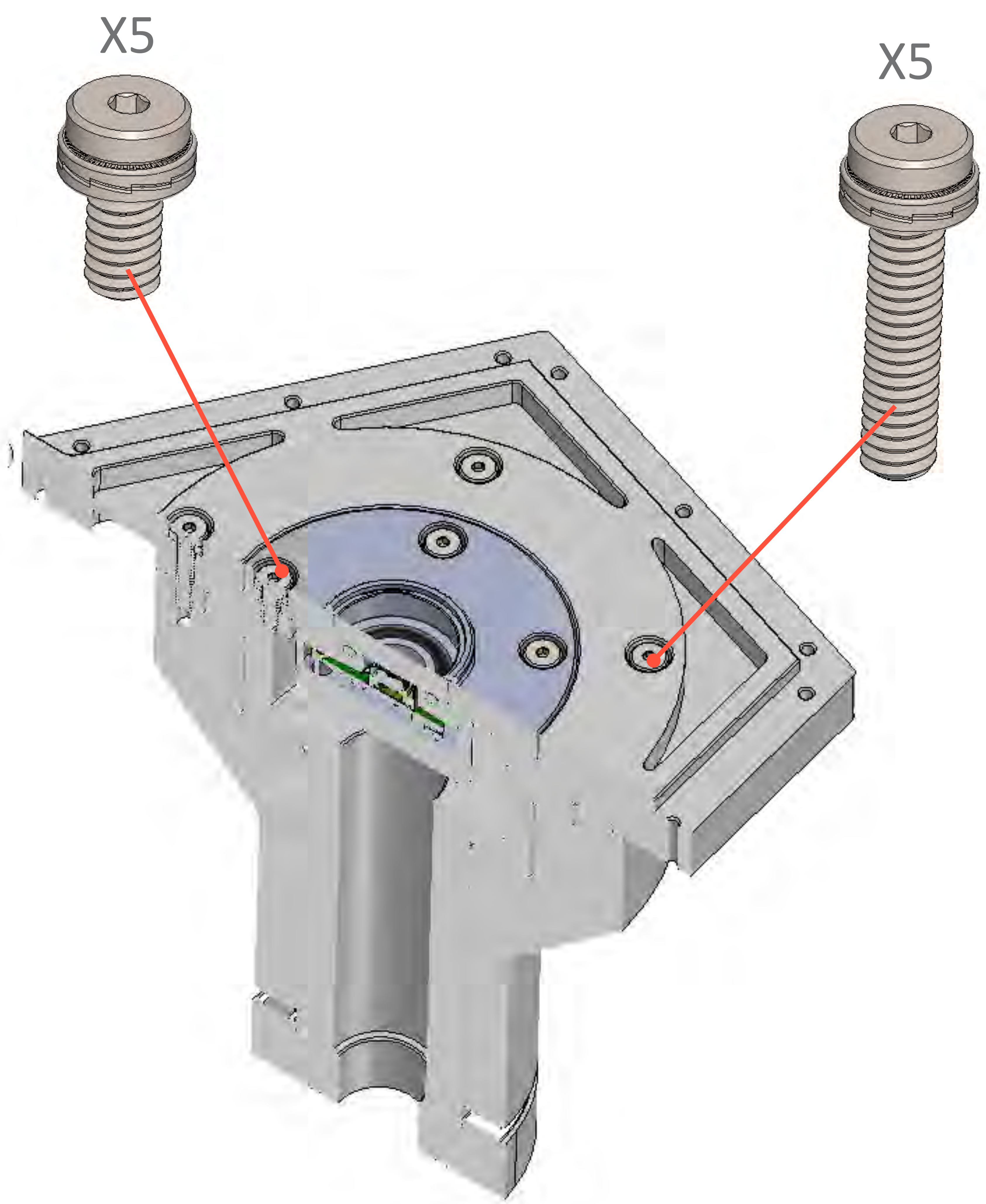


F2/F3 Ostium & A4/A5 Periostium Linkage Assembly

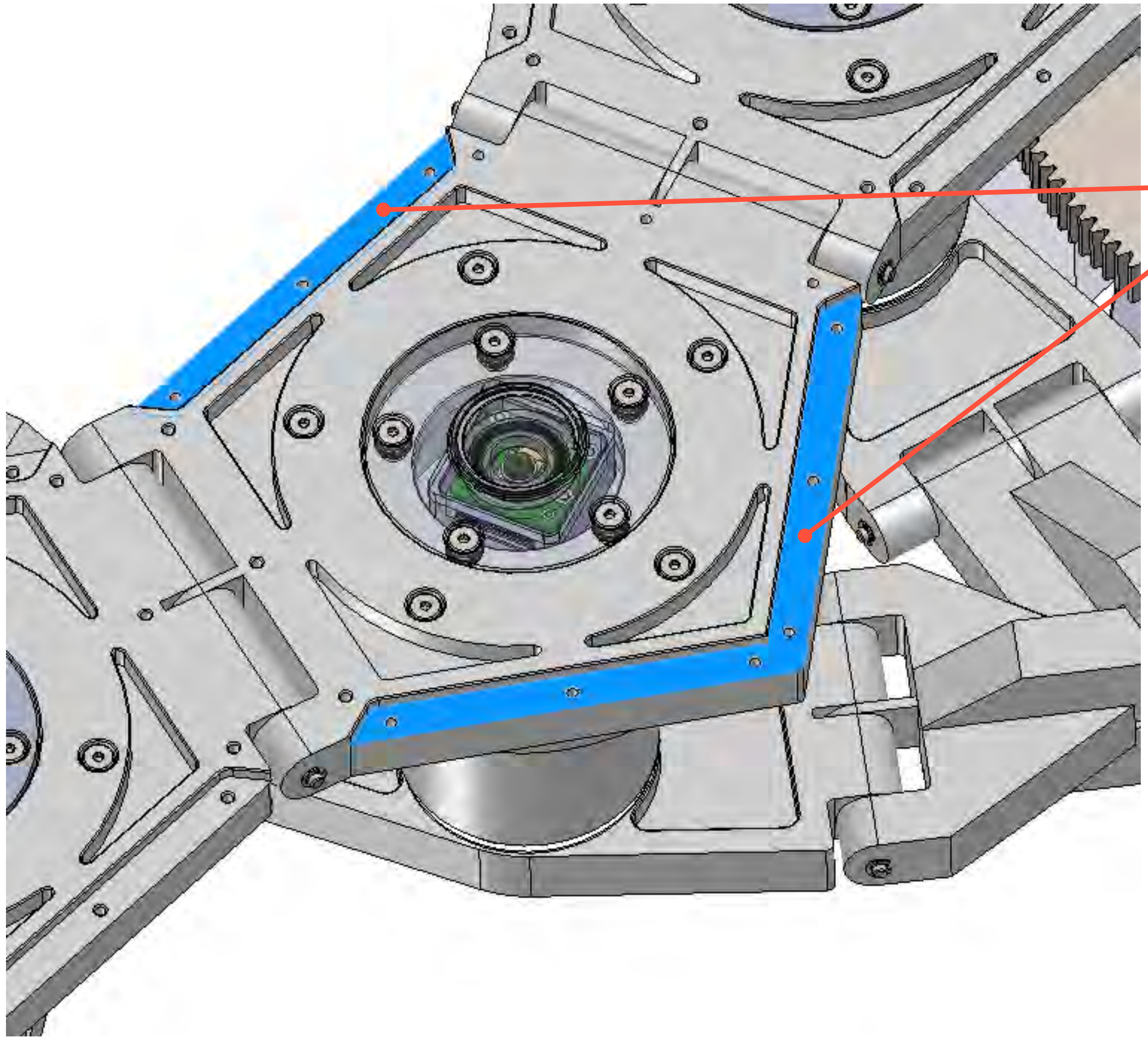


Camera Attachment



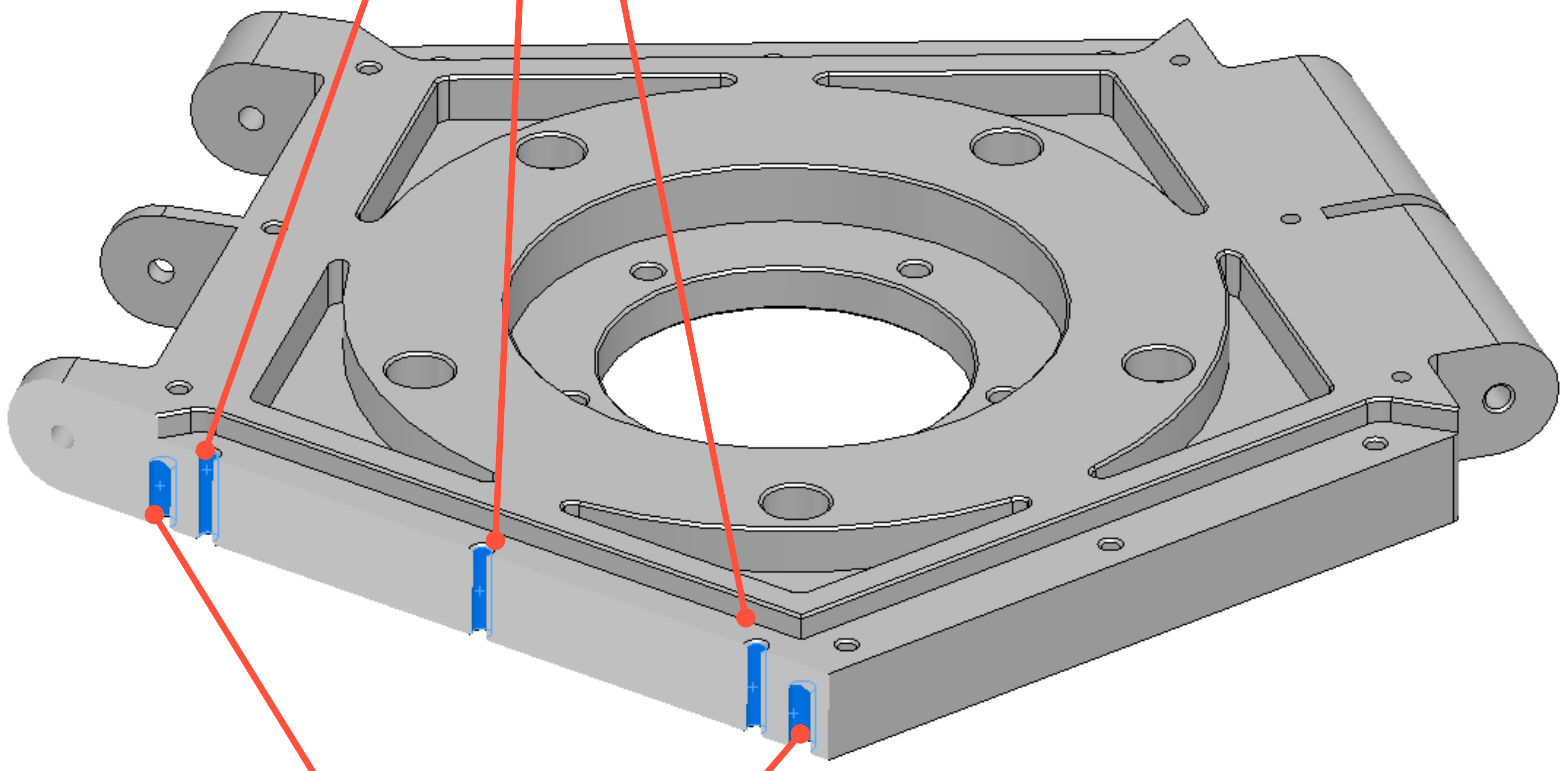


Gasket mounting locations

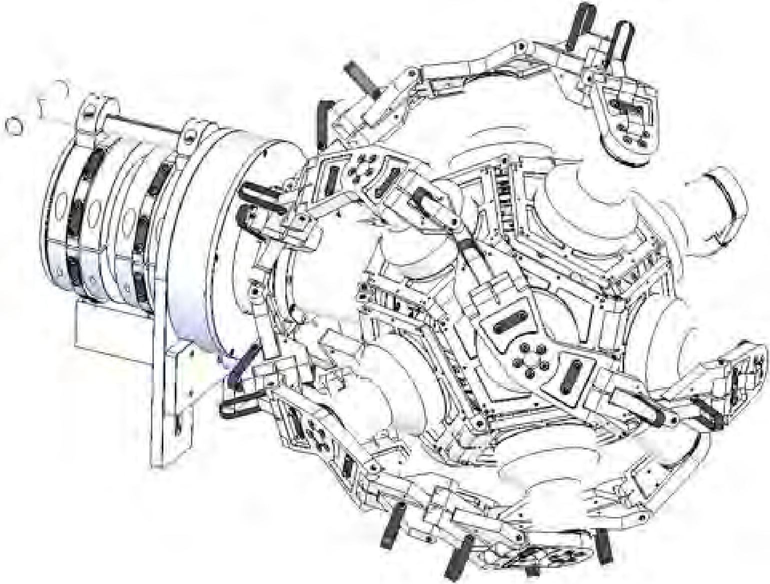


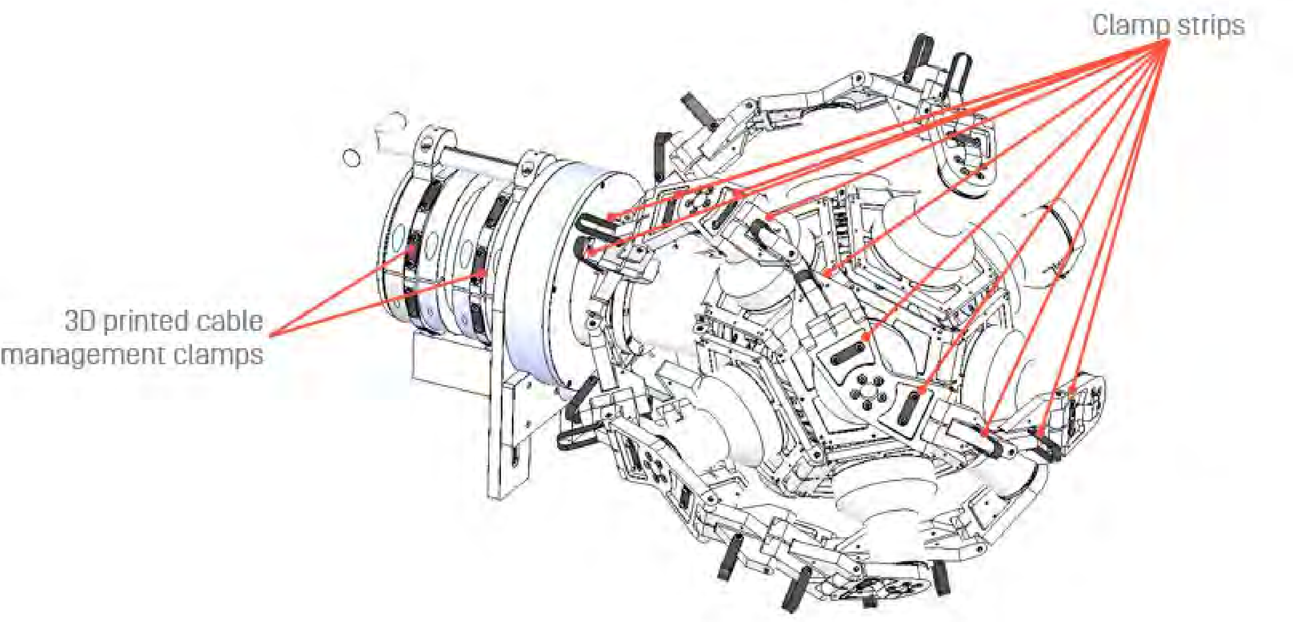
Gasket Mount Surfaces

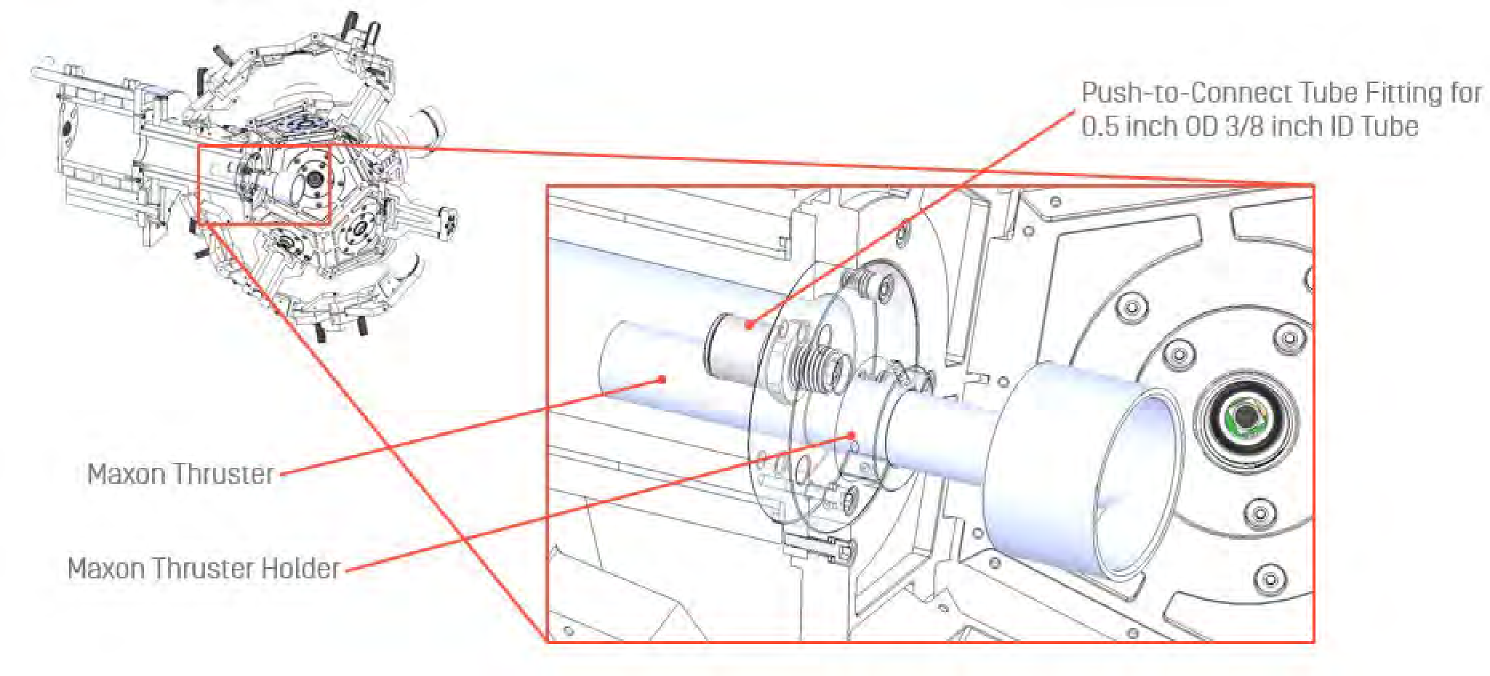
3 x 2-56 threaded holes

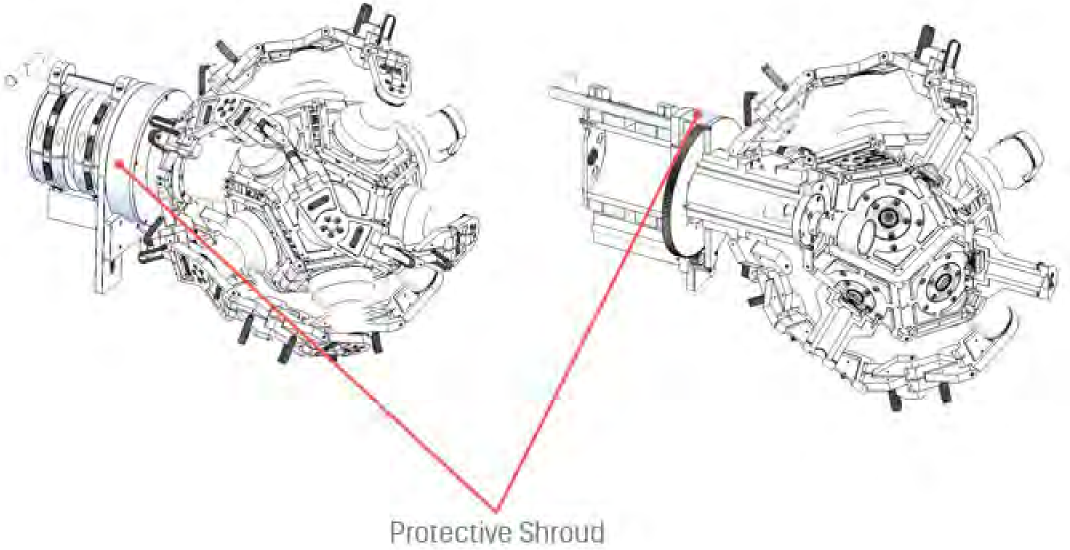


X2 Dowell Pin Holes

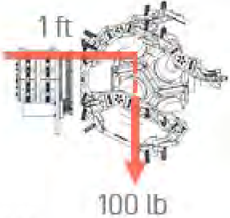



Clamp strips
3D printed cable
management clamps


Push-to-Connect Tube Fitting for
0.5 inch OD 3/8 inch ID Tube
Maxon Thruster
Maxon Thruster Holder


Protective Shroud

Orientation 1



Orientation 2