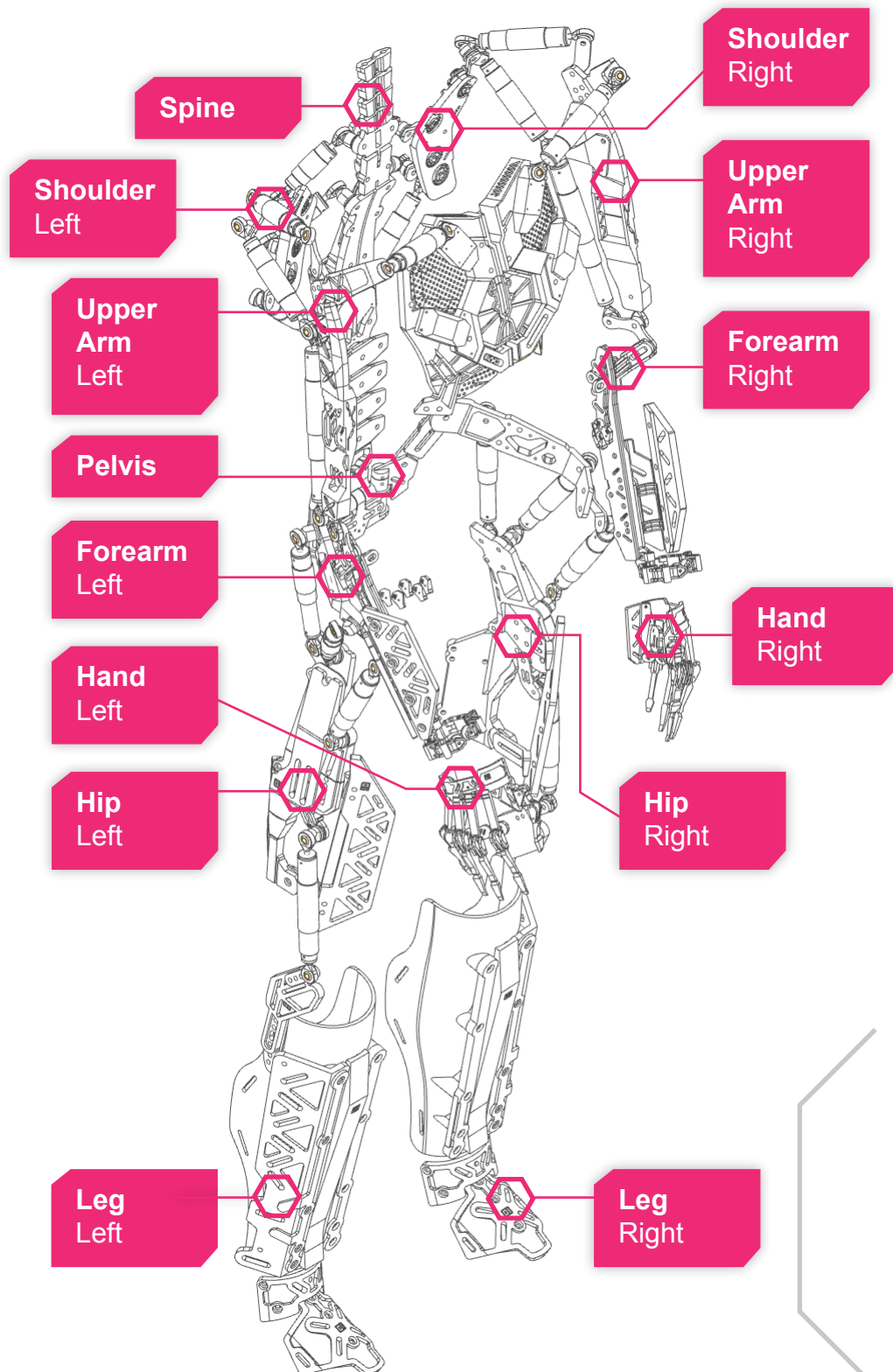




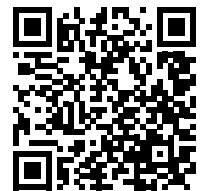
Elysium Max Exoskeleton Assembly Instructions

1 of 37

Overview



Fork on
GitHub:



Follow on
Hackaday.io:





Elysium Max Exoskeleton

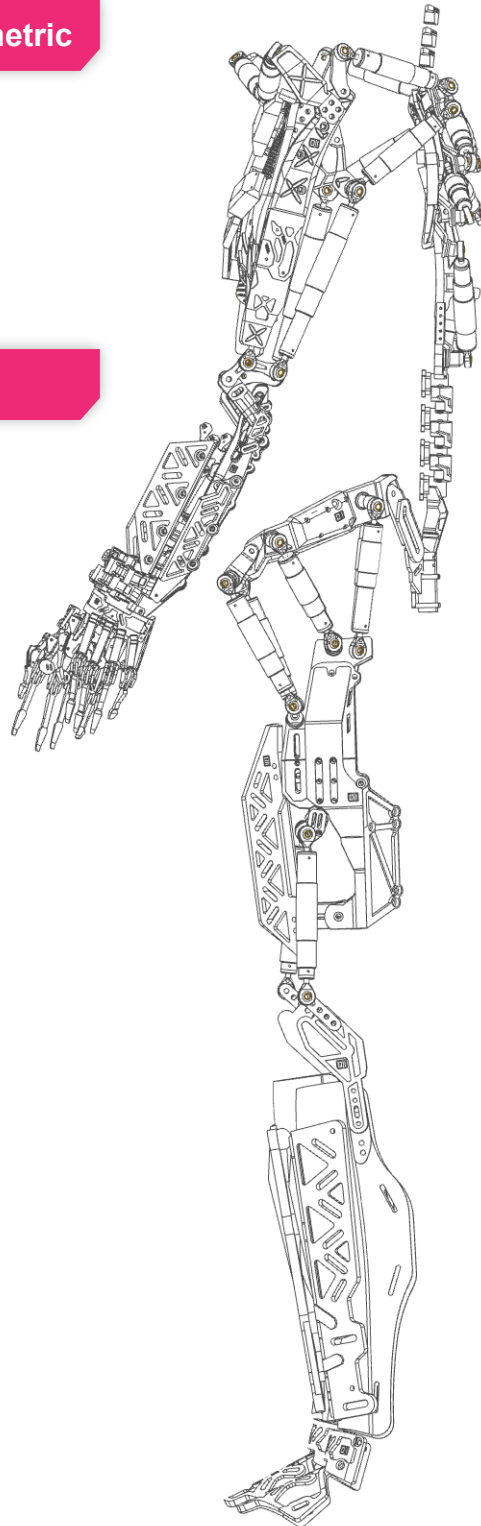
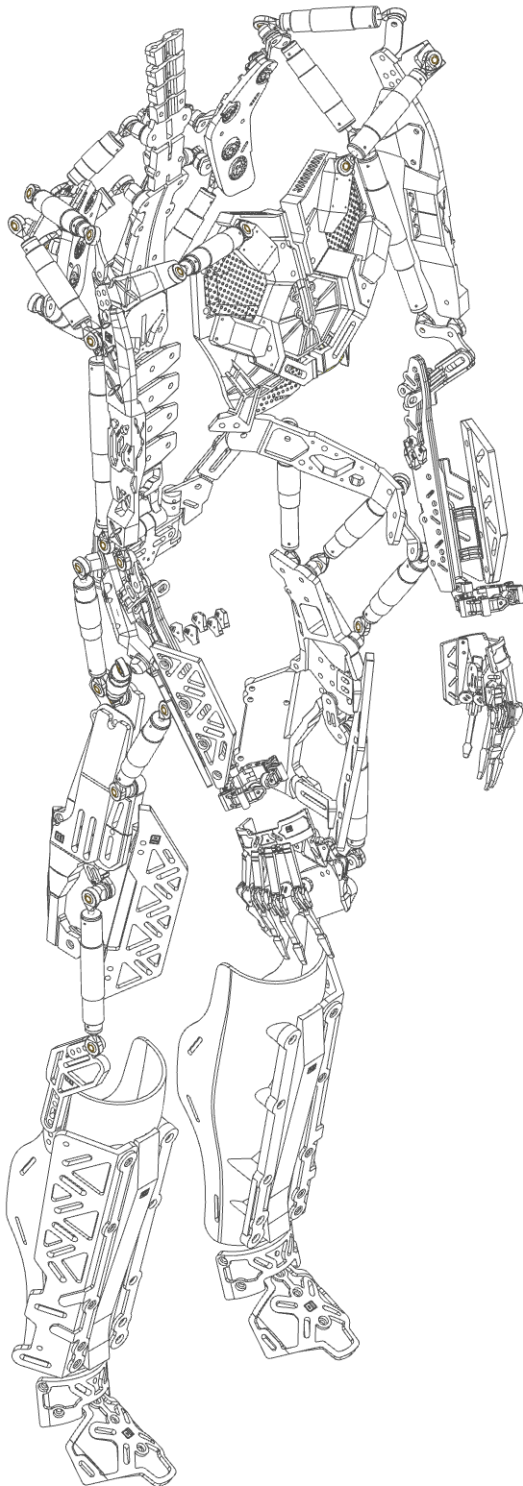
Assembly Instructions

2 of 37

Overview

← Isometric

Side →



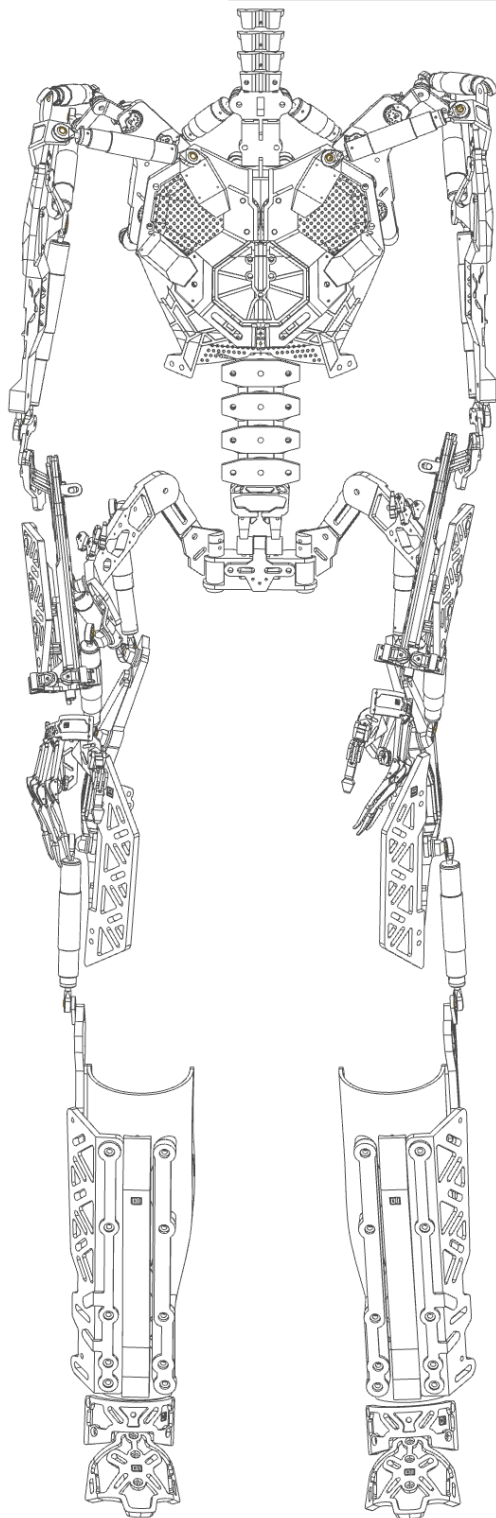


Elysium Max Exoskeleton Assembly Instructions

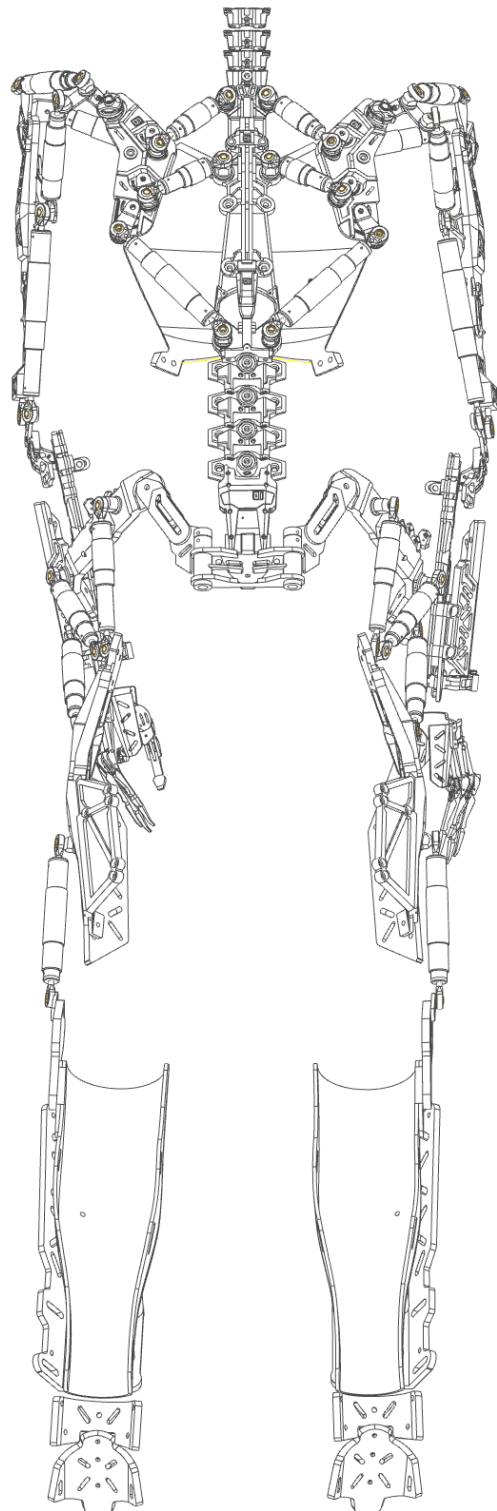
3 of 37

Overview

← Front



Back →

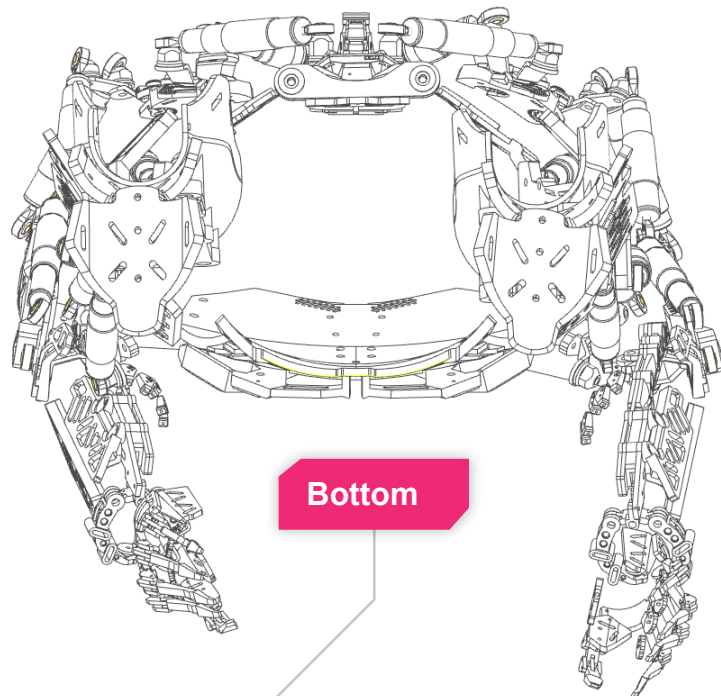
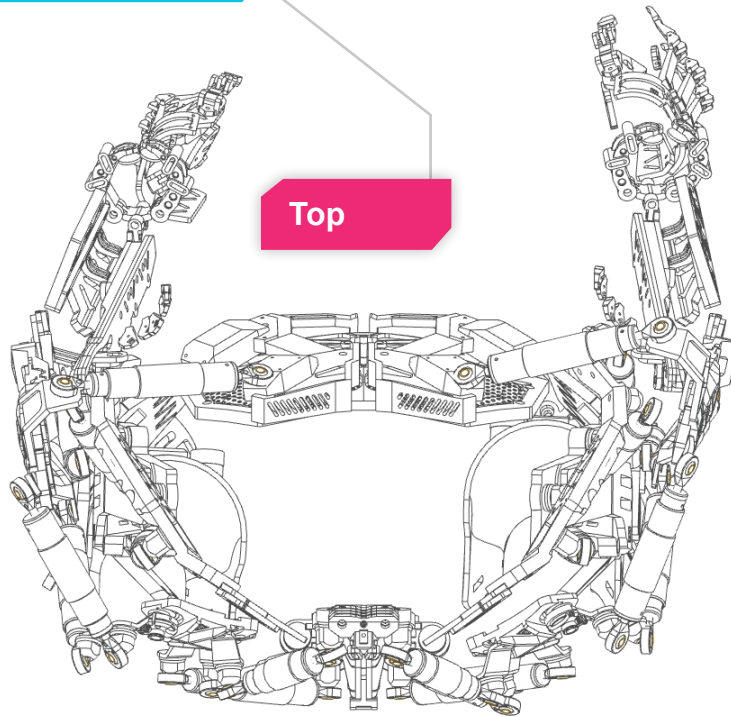




Elysium Max Exoskeleton Assembly Instructions

4 of 37

Overview





Elysium Max Exoskeleton

Assembly Instructions

5 of 37

Fasteners

Pricing from [MSC Direct](#), [Fastenal](#), and [Lynx Heli](#) is provided for convenience. Click on a price link to open the respective supplier's product page.

Item	Qty	Price
M6-1.00x12mm 6mm socket cap screw (black oxide), 1mm thread, 12mm long	55	\$9.38 x 100
M6-1.00x15mm 6mm socket cap screw (black oxide), 1mm thread, 15mm long	74	\$20.99 x 100
M6-1.00x18mm 6mm socket cap screw (black oxide), 1mm thread, 18mm long	2	\$9.29 x 50
M6-1.00x20mm 6mm socket cap screw (black oxide), 1mm thread, 20mm long	52	\$17.28 x 100
M6-1.00x25mm 6mm socket cap screw (black oxide), 1mm thread, 25mm long	18	\$10.99 x 50
M6-1.00x35mm 6mm socket cap screw (black oxide), 1mm thread, 35mm long	38	\$13.97 x 50
M6-1.00x20mm [st] 6mm socket set screw (black oxide), 1mm thread, 20mm long	2	\$3.05 x 1
M3-0.50x5mm 3mm socket cap screw (black oxide), .5mm thread, 5mm long	25	\$8.79 x 100
M3-0.50x12mm 3mm socket cap screw (black oxide), .5mm thread, 12mm long	12	\$9.675 x 50
M3-0.50x15mm 3mm socket cap screw (black oxide), .5mm thread, 15mm long	21	\$10.06 x 100
M3-0.50x6mm [st] 3mm socket set screw (black oxide), .5mm thread, 6mm long	2	\$10.22 x 50
M3-0.50x16mm [st] 3mm socket set screw (black oxide), .5mm thread, 16mm long	22	\$4.00 x 10
M12-1.75x50mm [st] 12mm sckt set screw (black oxide), 1.75mm thread, 50mm long	1	\$2.36 x 1



6 of 37

Elysium Max Exoskeleton

Assembly Instructions

Bearings

The rod-end bearings are [KARM-06](#) from **Igus** in Germany. An Inventor model of the bearing is included. Ordering 24 of these for the whole suit is will cost approx. \$80.

Printing

Units	Build Volume:
millimeters	5,592,770 mm ³ (341.3 cubic inches)

The exoskeleton has been printed in several orders from [Protolabs](#) (online manufacturer) and [RapidMade](#) (in Portland, Oregon).

[Accura Xtreme White](#) material was used for **SLA** and (unfilled) [Nylon 12](#) for **SLS**. Parts that have to bear a lot of stress have been printed using laser sintering due to high elongation on break properties. SLS is also great for tapping and drilling. All other parts where cosmetic appearance was more important were printed using SLA.

Electronics

Fans

Two [brushless DC cooling fans \(12 V\)](#) powered by 9 V batteries can be installed in the **chest piece**. The fans are modeled in Inventor to show them in the assembly and carve out the perfect negative space where they can be snapped in. The fans complete two copies of the same circuit with fan, battery and switch (resistors are optional to extend battery life).

Lighting

The **Upper Arm**, **Hip**, **Pelvis Wing**, **Spine Base**, and **Spine Link** parts have cavities where LED lights and batteries can be installed. These circuits include 3mm LED, 68 ohm 1/8W resistor, and two 1.5V coin batteries per LED. Lastly, 4 vacuum tubes in special holders can be [hollowed out and rigged with LEDs](#) wired in similar fashion.



Elysium Max Exoskeleton Assembly Instructions

7 of 37

Part Identification

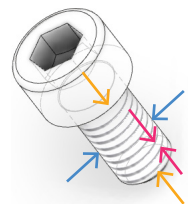
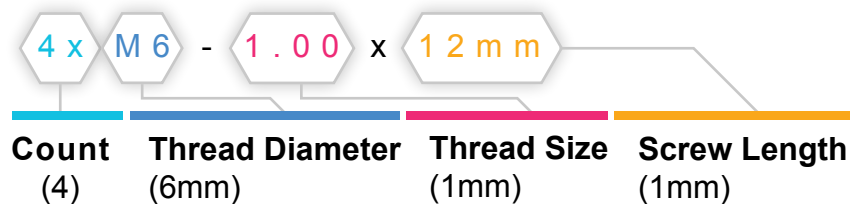
Parts in exploded assembly diagrams are identified with colored call-outs.

A hex shape is overlayed on some convenient area of the part, and a line of the same color points to the text box containing the part name:



For parts that have mirrored versions (left/right), the **base name** of the part is shown in bold, while the left/right modifier is not.

If the part has to be fastened to its parent in the assembly hierarchy, the required screws appear below the text box in a small font. See the **Fasteners** section for information on acquiring all the fasteners required to build the exoskeleton frame.



When the space is limited, one text box may describe several parts. This is communicated by linking multiple hex shapes to one text box, or linking multiple hex shapes to each other and then to a text box.

Text boxes and hex shapes for **external** components are colored violet.

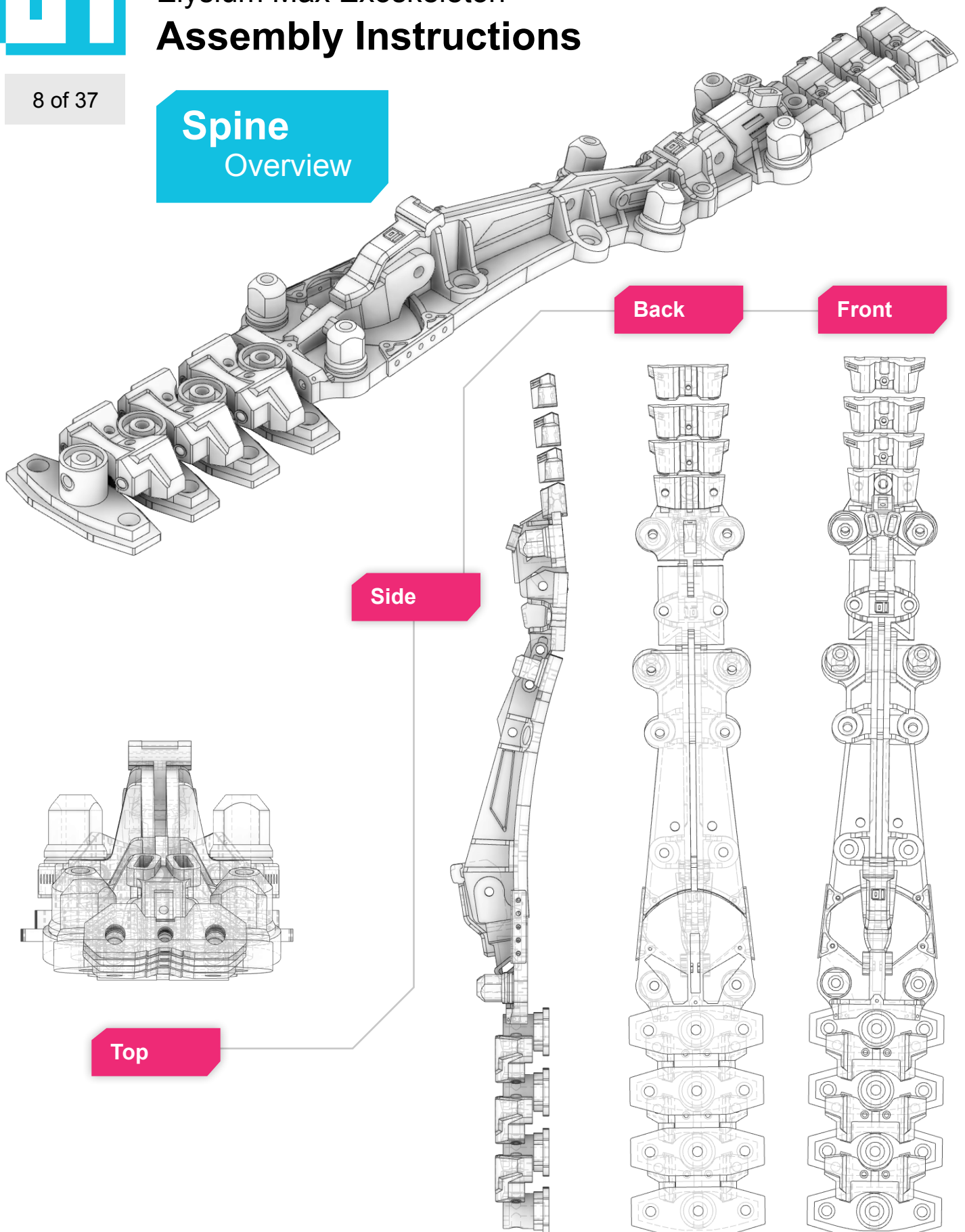
If there are many parts on the page, additional colors are sometimes used to help distinguish between hex shapes & text boxes, other than the **external** color. This does not indicate special treatment.



Elysium Max Exoskeleton Assembly Instructions

8 of 37

Spine Overview



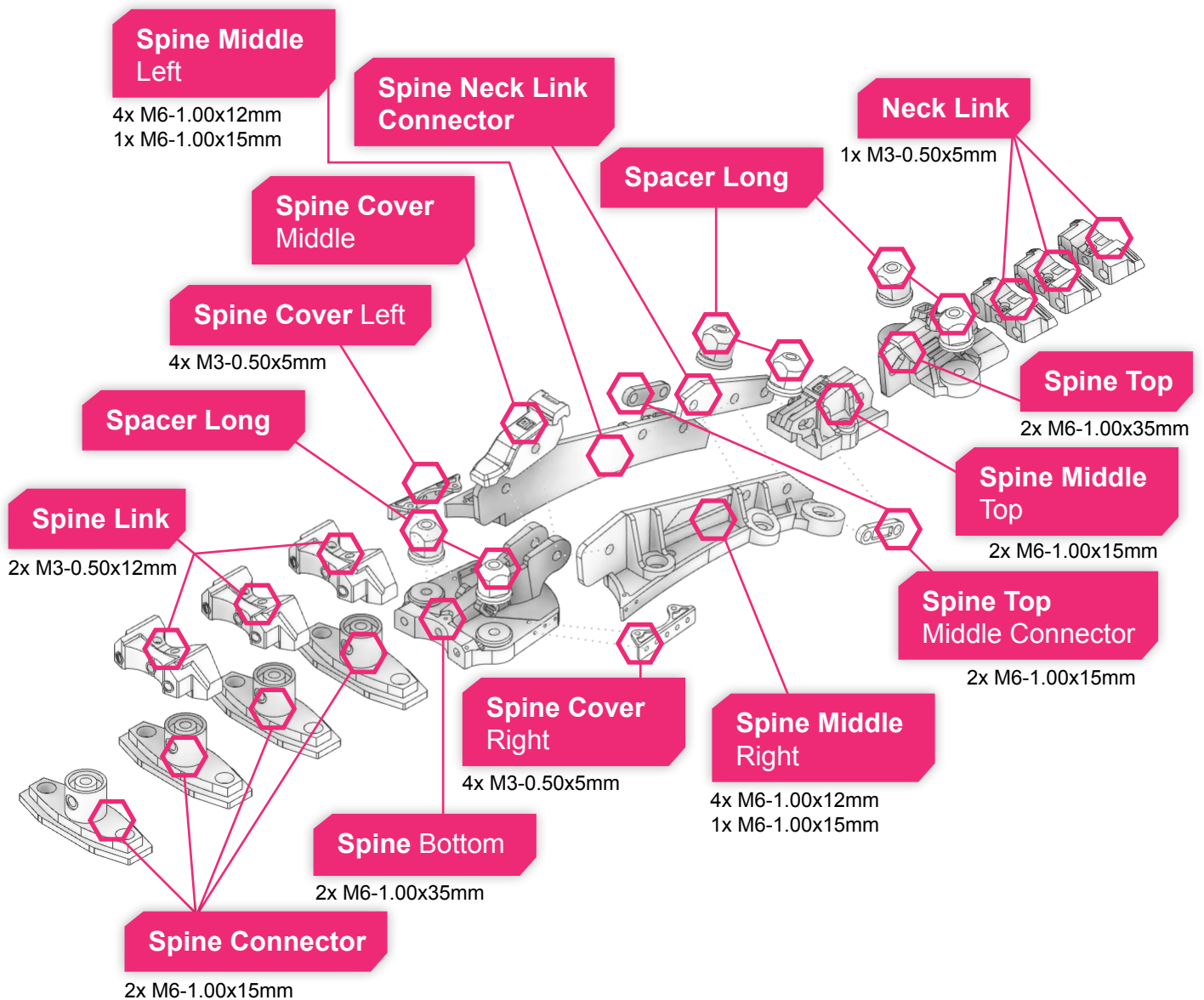


Elysium Max Exoskeleton Assembly Instructions

9 of 37

Spine

Click on the label or the hex shape to view the corresponding STL file on **GitHub**.



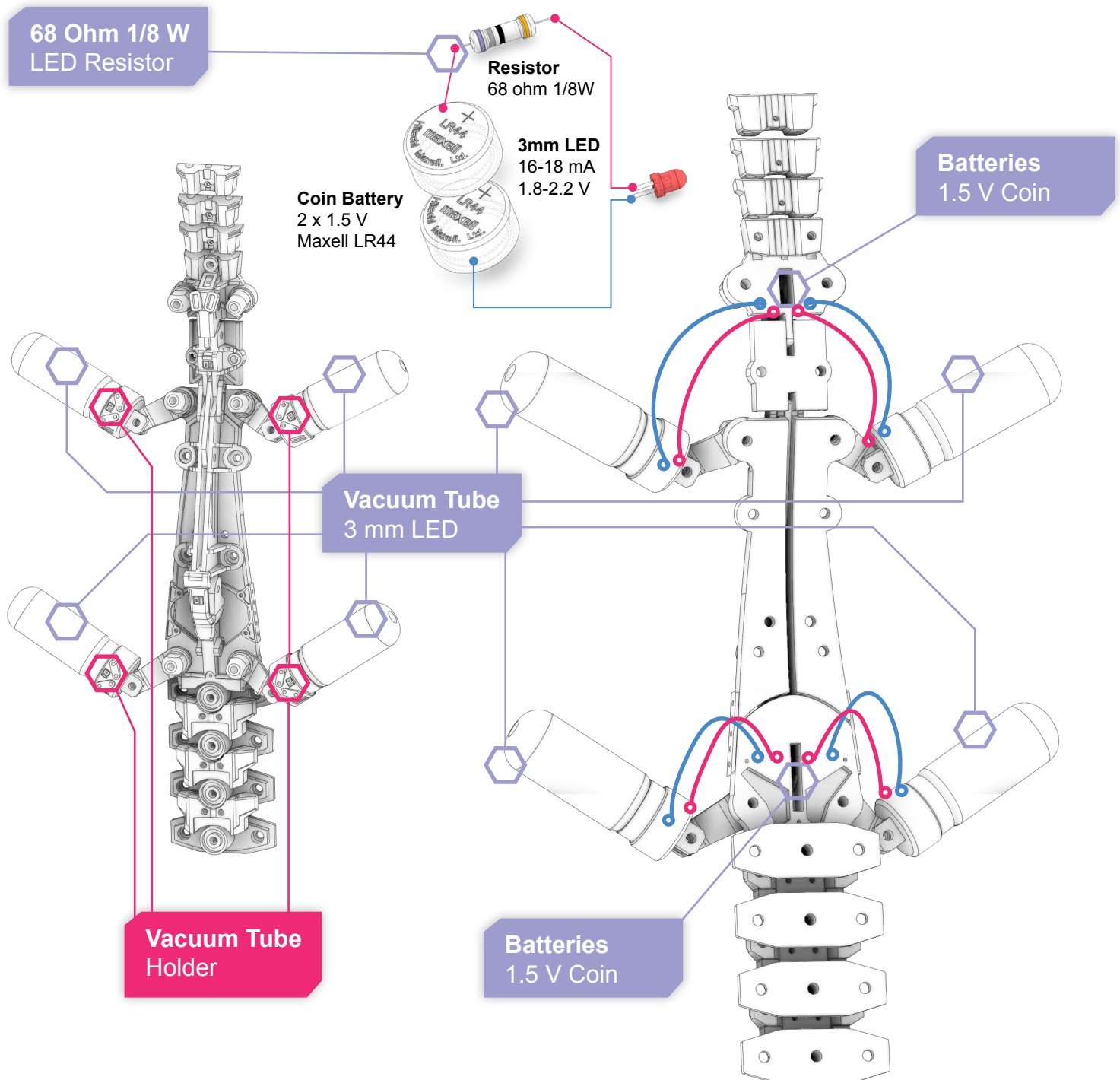


Elysium Max Exoskeleton Assembly Instructions

10 of 37

Spine Electronics

Four vacuum tubes in special holders ([6L6 Mesa Boogie Triple Rectifier power tubes](#)) can be [hollowed out and rigged with LEDs](#). Low-voltage coin batteries can fit in cavities inside **Spine Top** and **Spine Bottom** parts to power the LEDs inline with respective resistors.

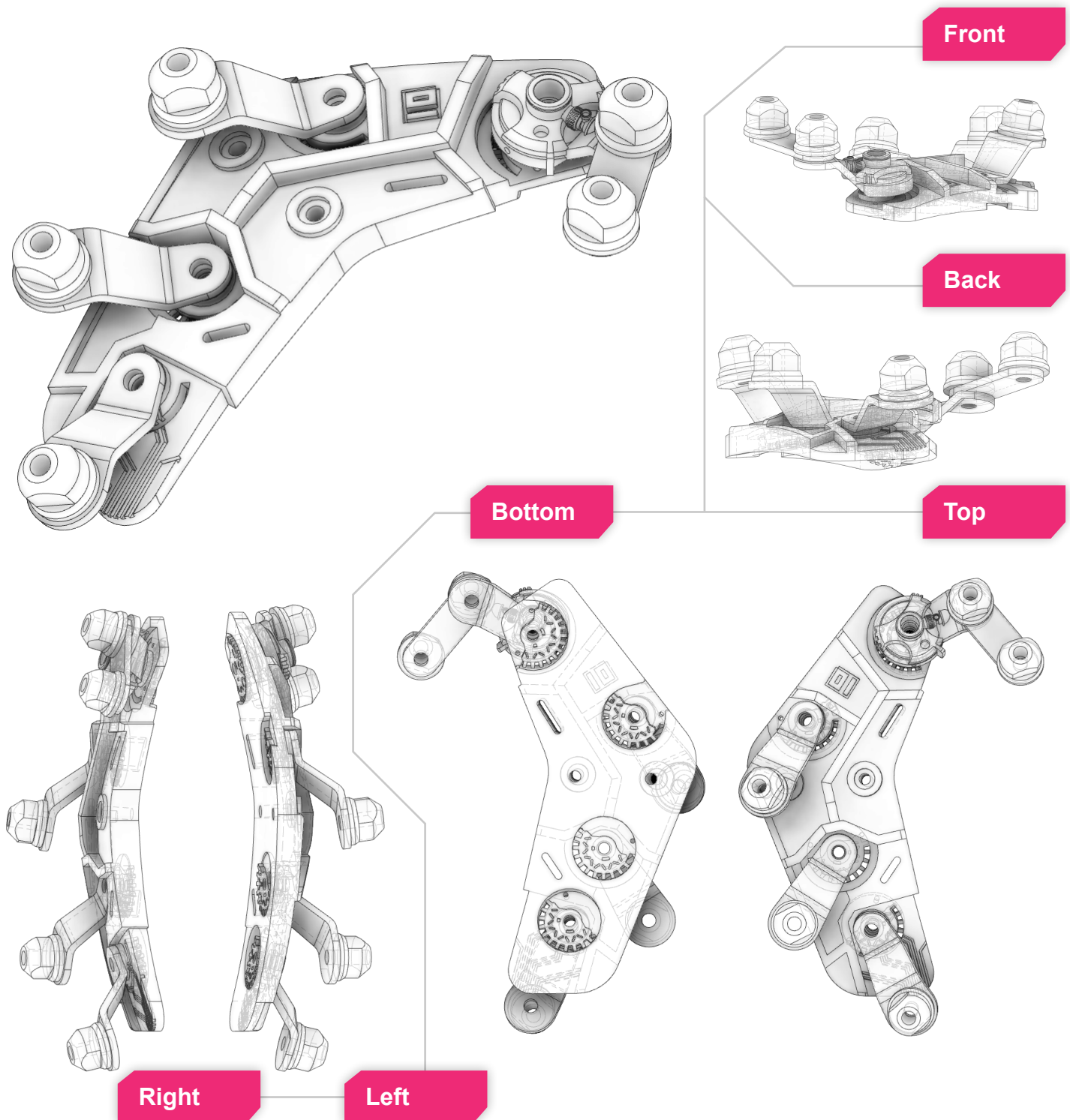




Elysium Max Exoskeleton Assembly Instructions

11 of 37

Shoulder Overview



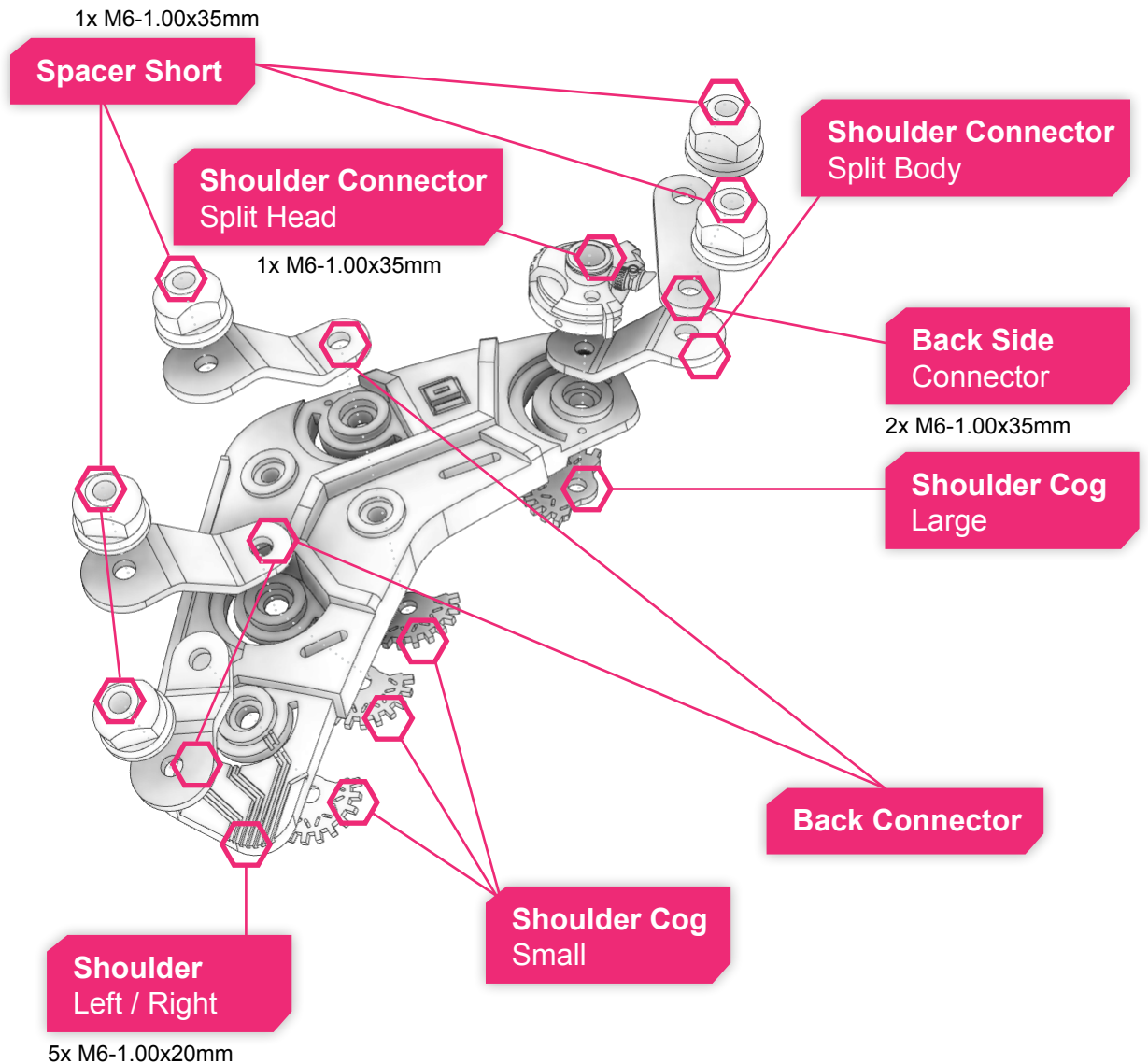


Elysium Max Exoskeleton Assembly Instructions

12 of 37

Shoulder

Click on the label or the hex shape to view the corresponding STL file on **GitHub**.

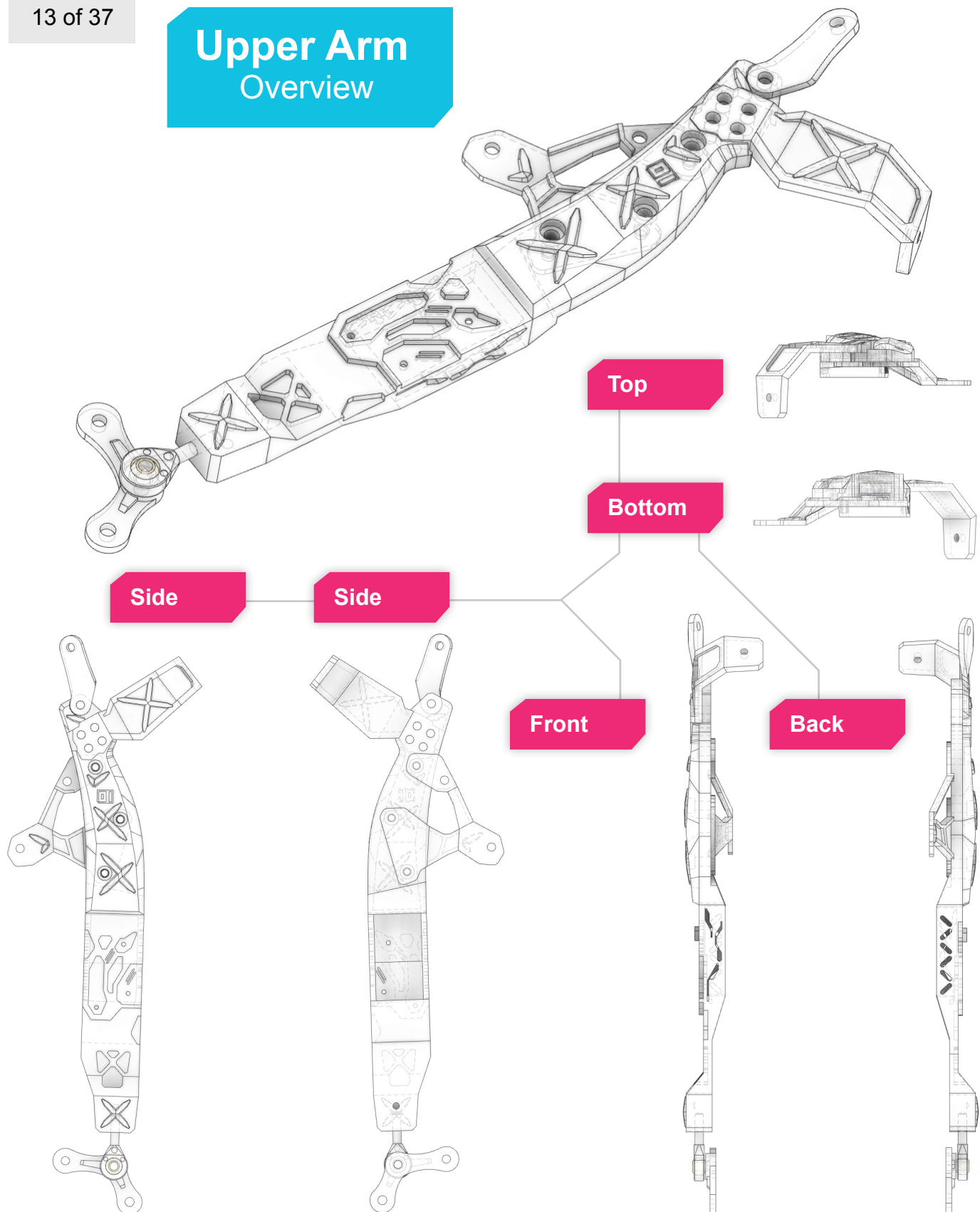




Elysium Max Exoskeleton Assembly Instructions

13 of 37

Upper Arm Overview





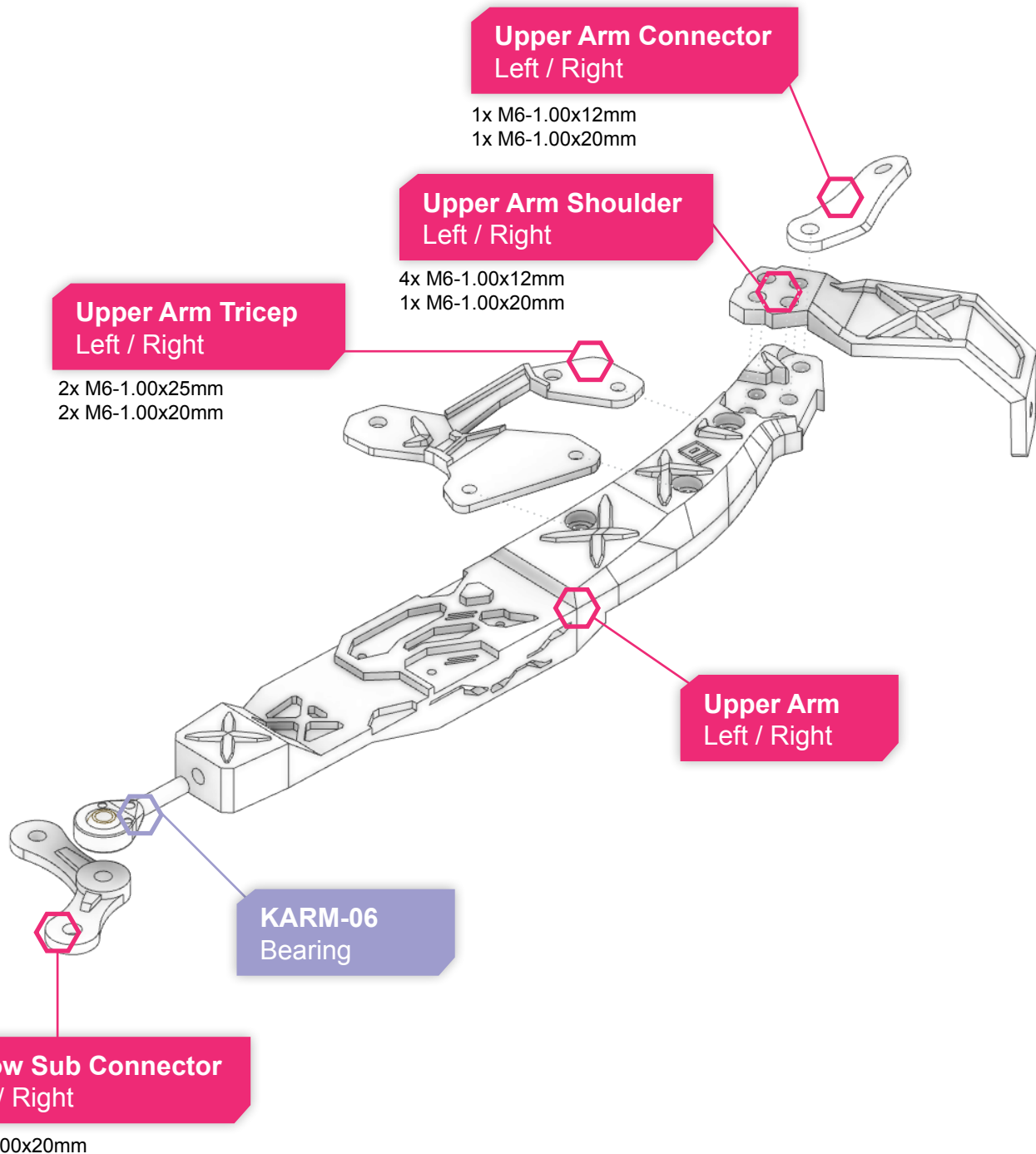
Elysium Max Exoskeleton

Assembly Instructions

14 of 37

Upper Arm

Click on the label or the hex shape to view the corresponding STL file on **GitHub**.





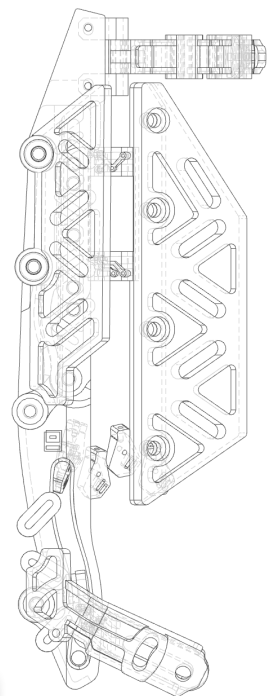
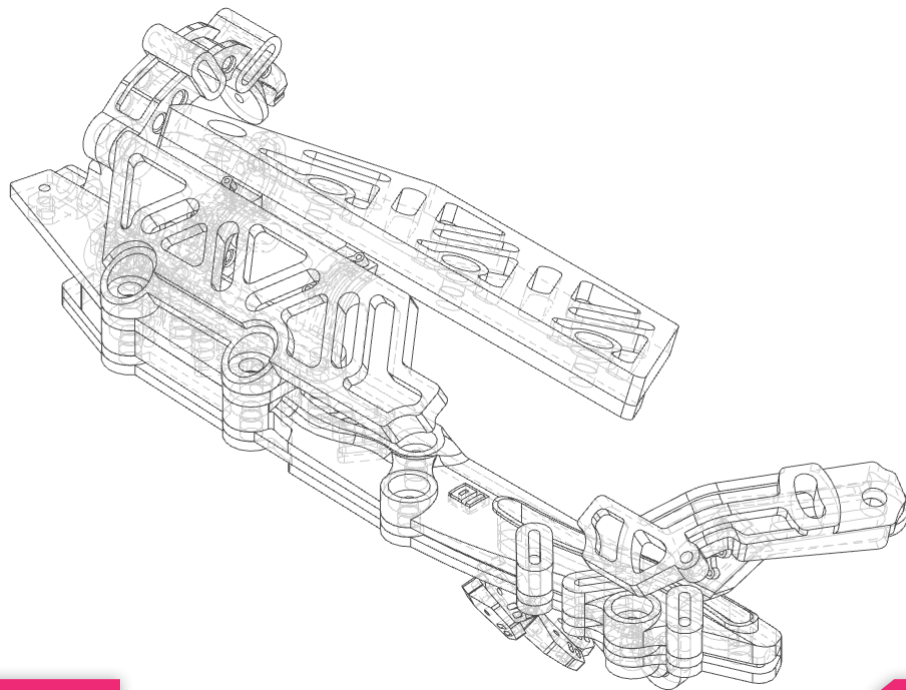
Elysium Max Exoskeleton

Assembly Instructions

15 of 37

Forearm

Overview

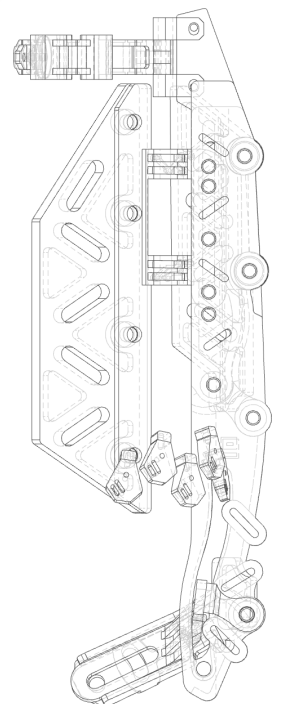
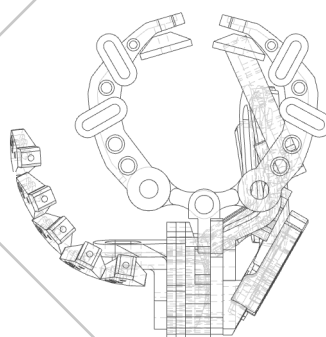
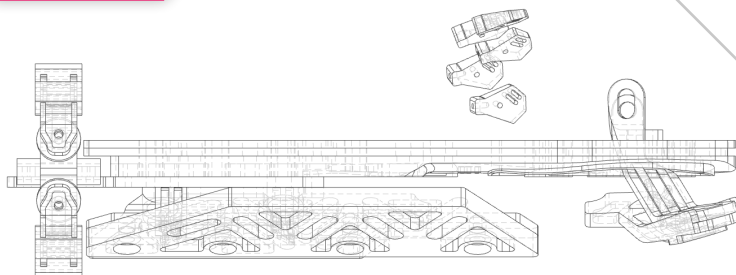
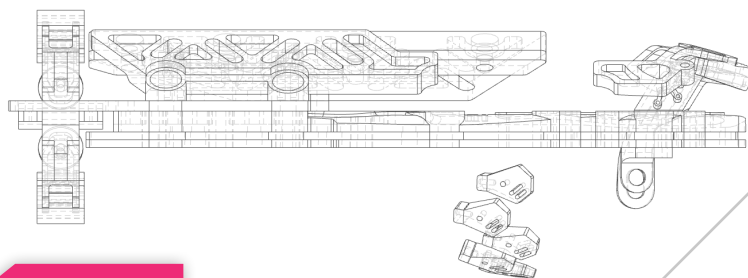


Bottom

Side

Top

Front





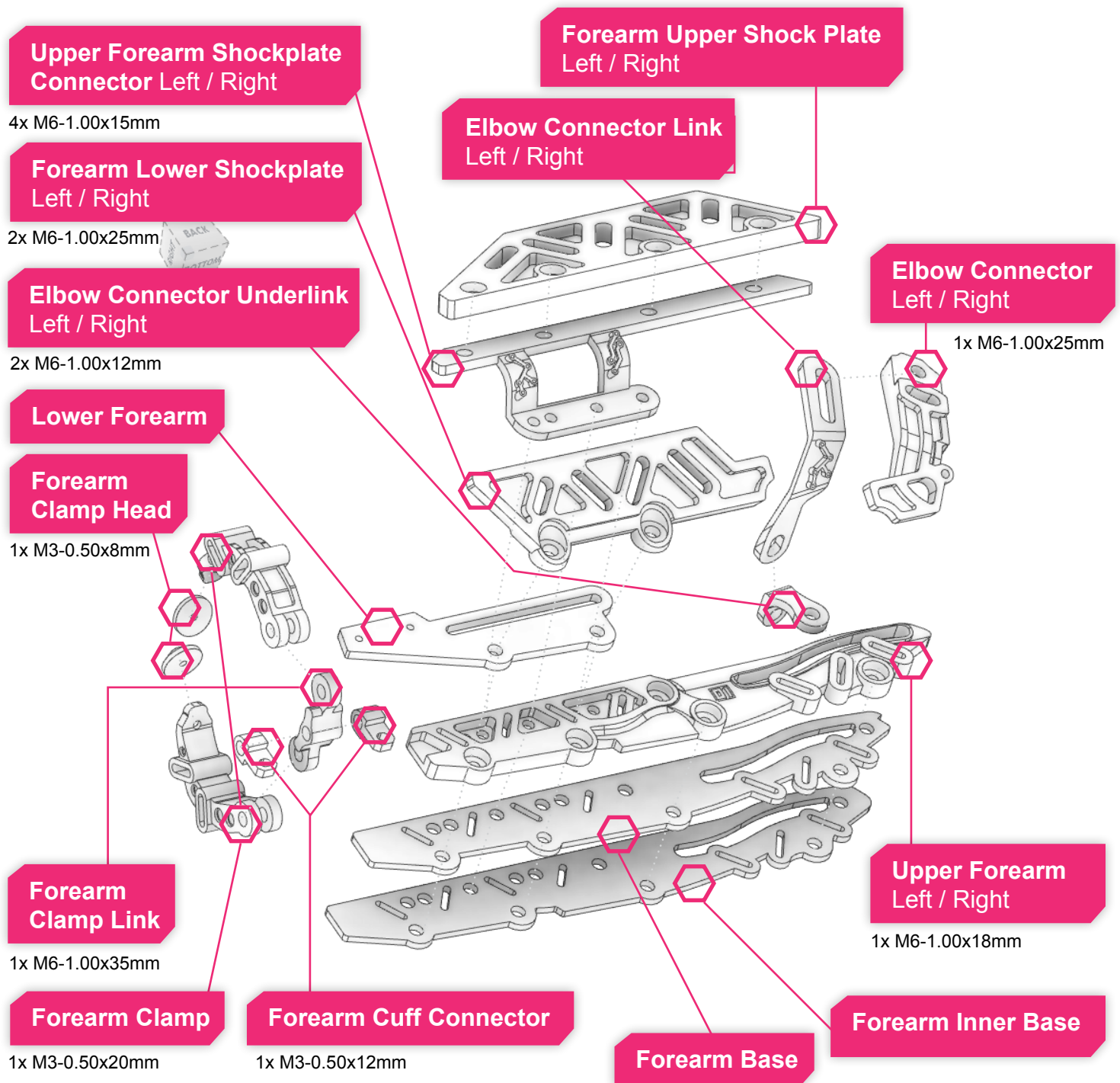
Elysium Max Exoskeleton

Assembly Instructions

16 of 37

Forearm

Click on the label or the hex shape to view the corresponding STL file on **GitHub**.

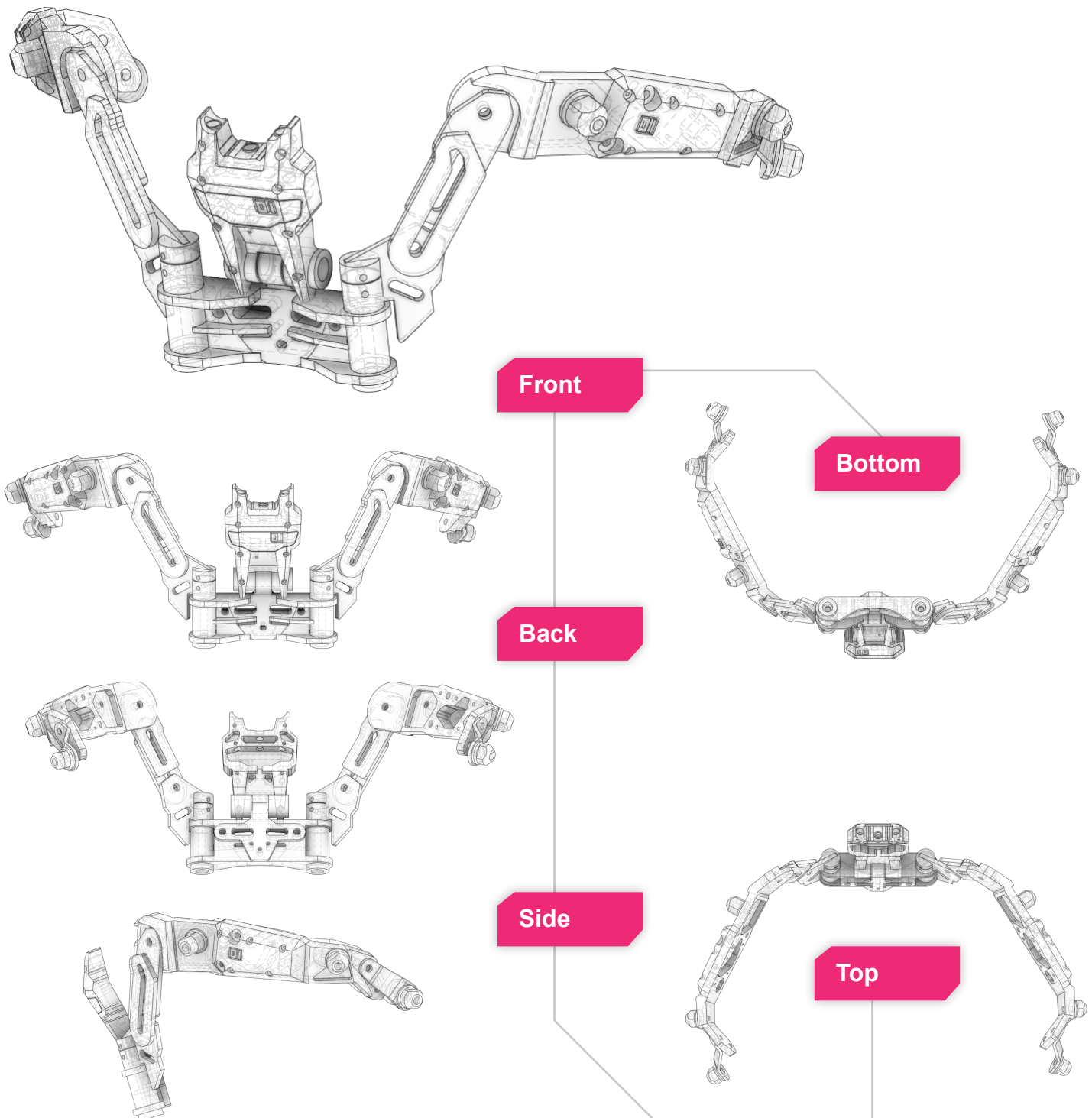




Elysium Max Exoskeleton Assembly Instructions

17 of 37

Pelvis Overview





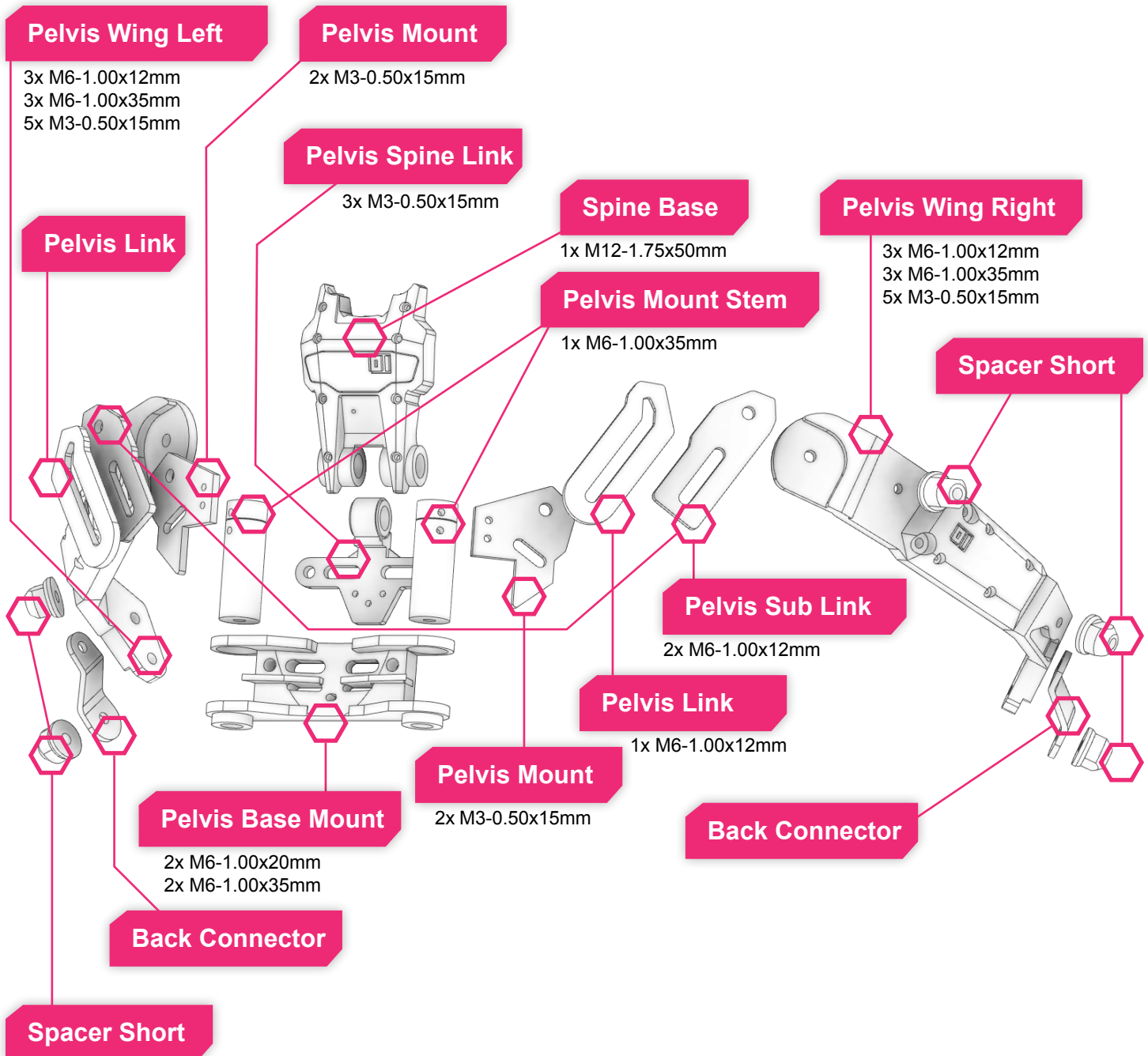
Elysium Max Exoskeleton

Assembly Instructions

18 of 37

Pelvis

Click on the label or the hex shape to view the corresponding STL file on **GitHub**.





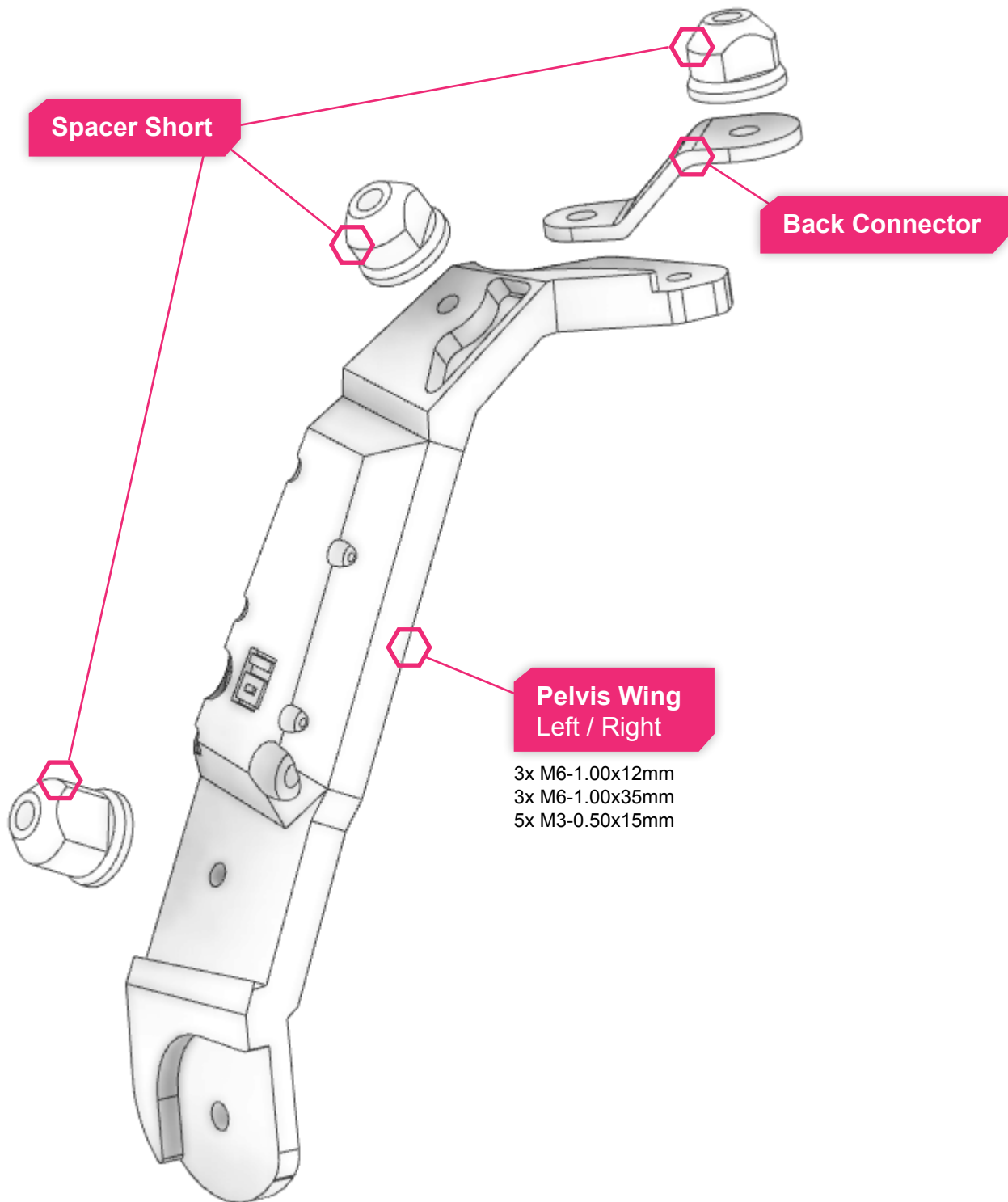
Elysium Max Exoskeleton

Assembly Instructions

19 of 37

Pelvis

Click on the label or the hex shape to view the corresponding STL file on **GitHub**.

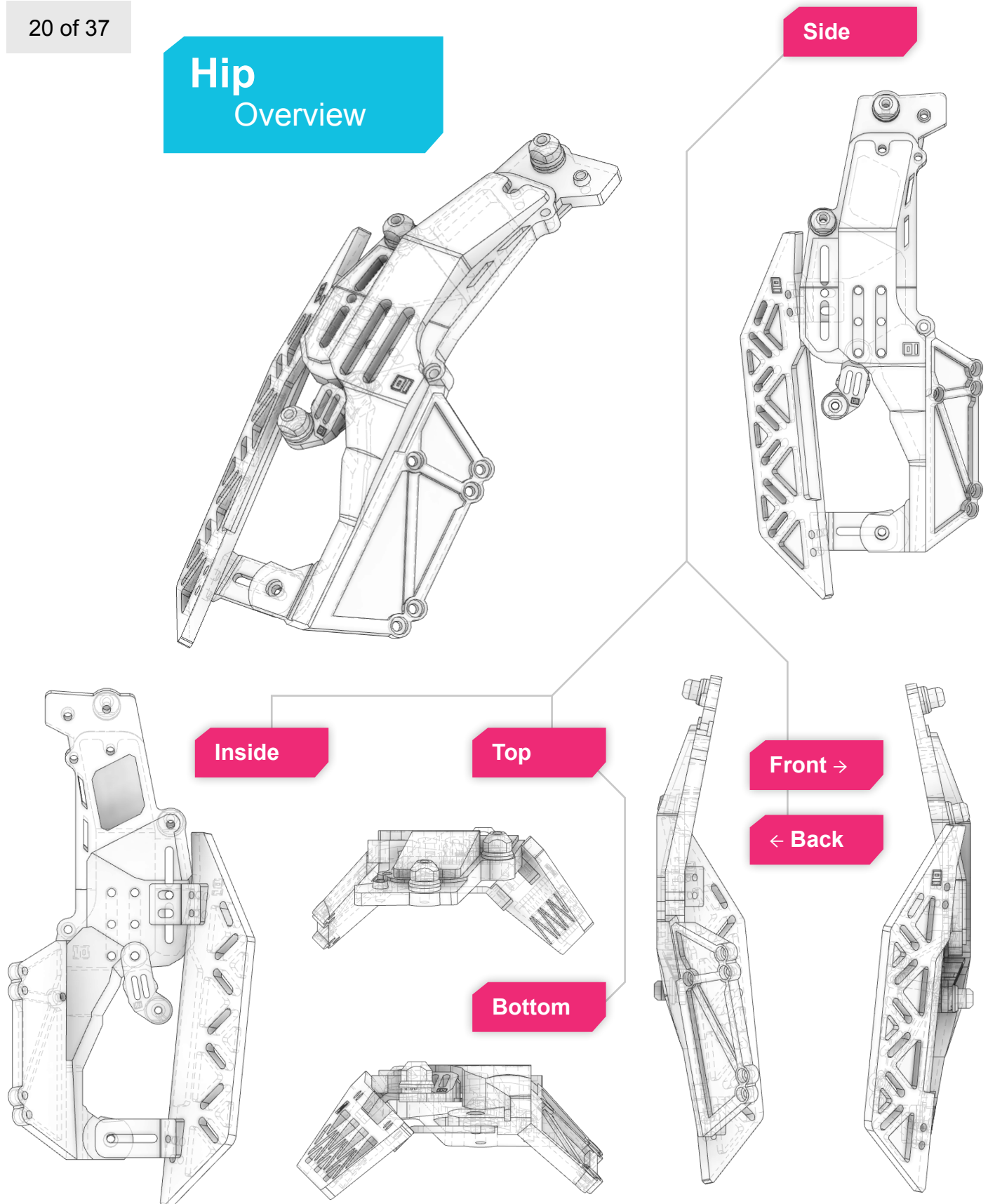




Elysium Max Exoskeleton Assembly Instructions

20 of 37

Hip Overview





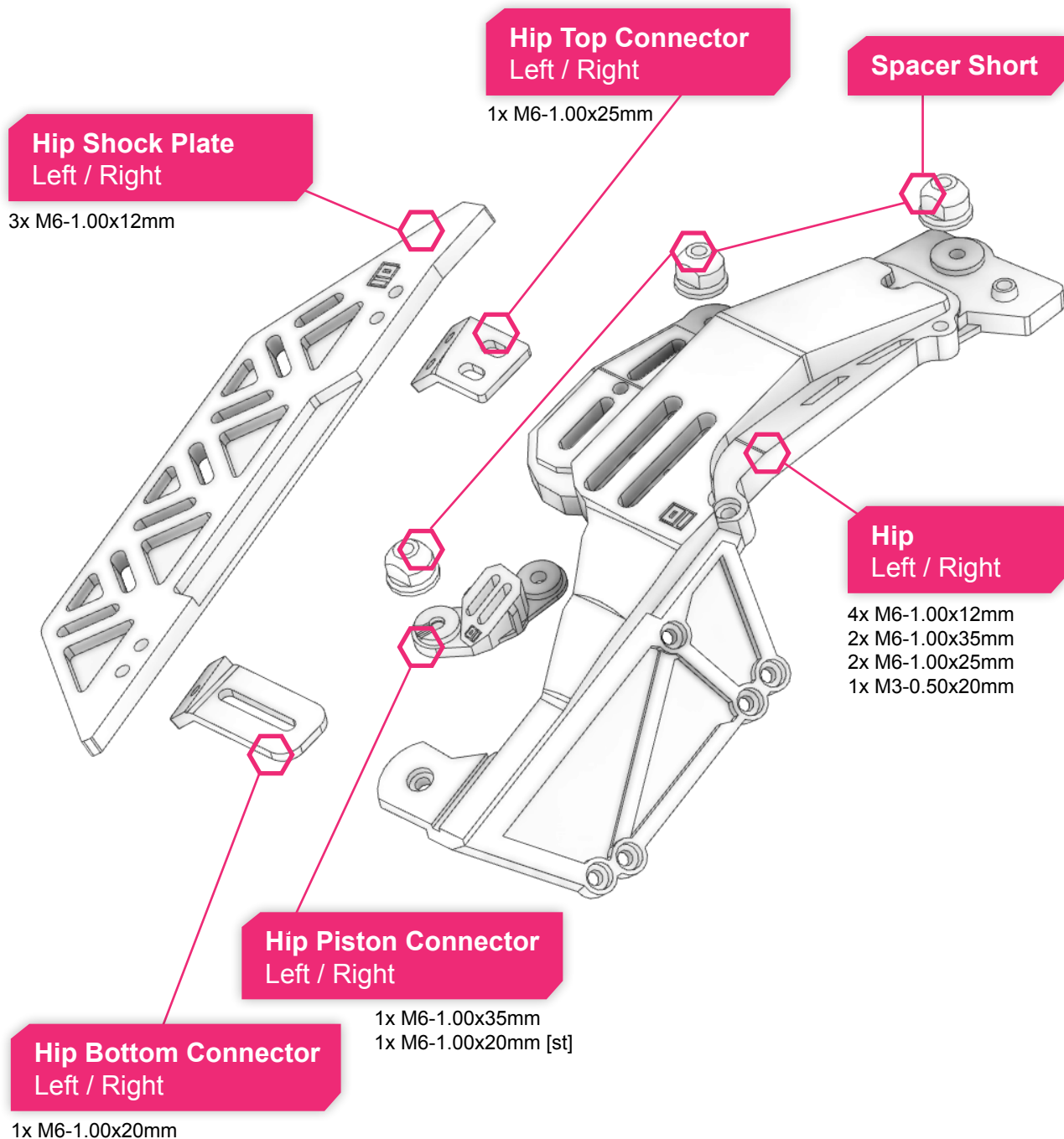
Elysium Max Exoskeleton

Assembly Instructions

21 of 37

Hip

Click on the label or the hex shape to view the corresponding STL file on **GitHub**.

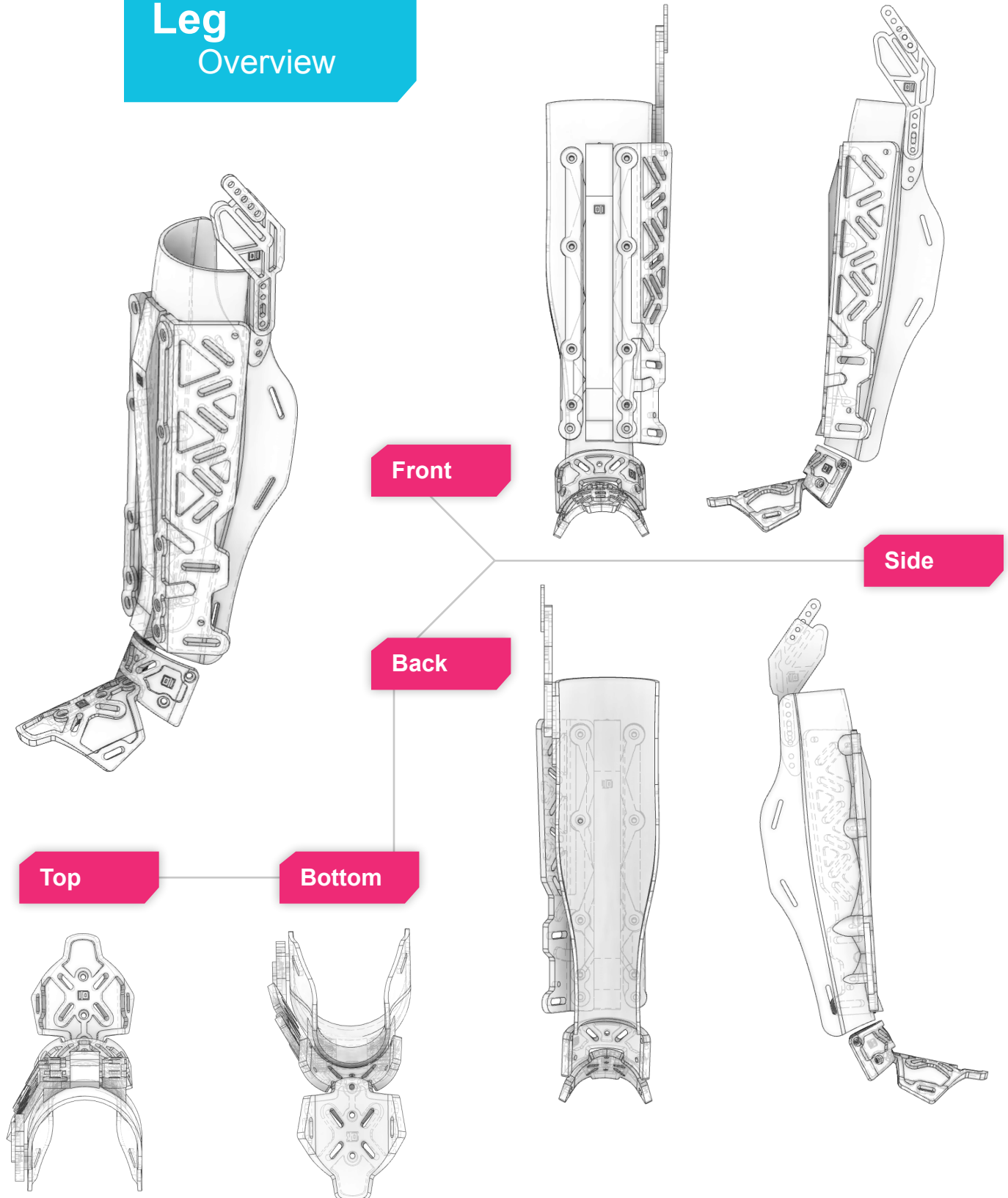




Elysium Max Exoskeleton Assembly Instructions

22 of 37

Leg Overview





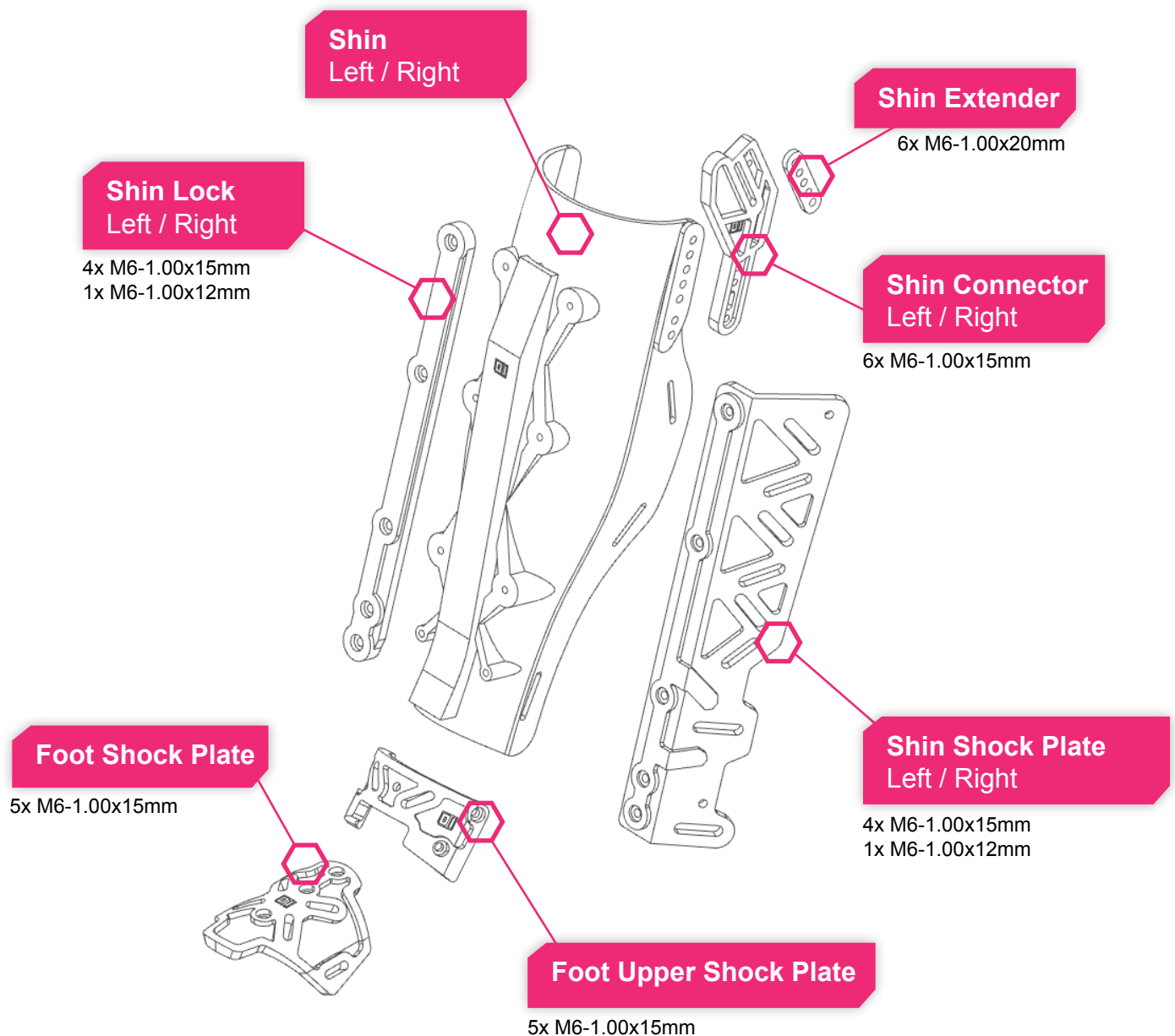
Elysium Max Exoskeleton

Assembly Instructions

23 of 37

Leg

Click on the label or the hex shape to view the corresponding STL file on **GitHub**.



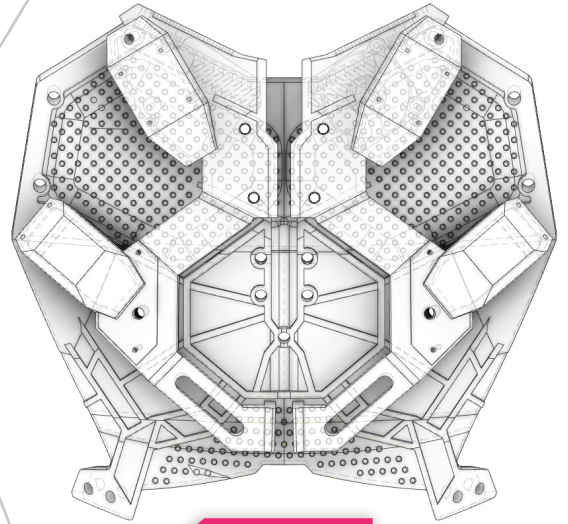


Elysium Max Exoskeleton Assembly Instructions

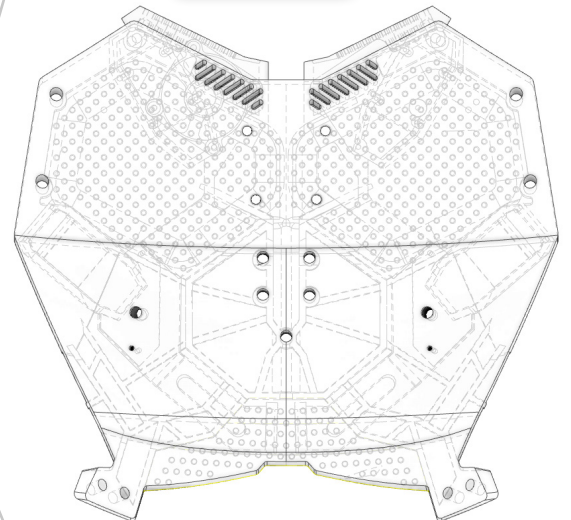
24 of 37

Chest Overview

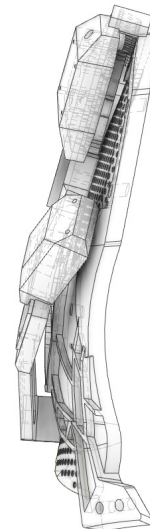
Front



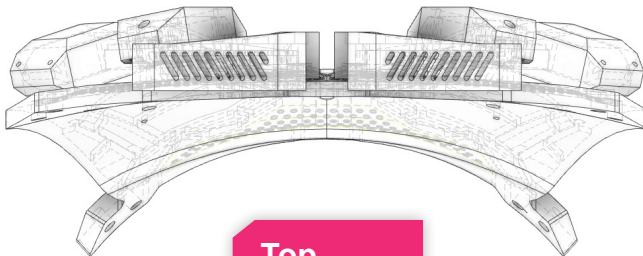
Back



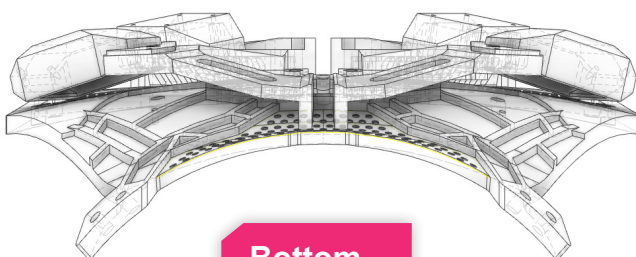
Side



Top



Bottom





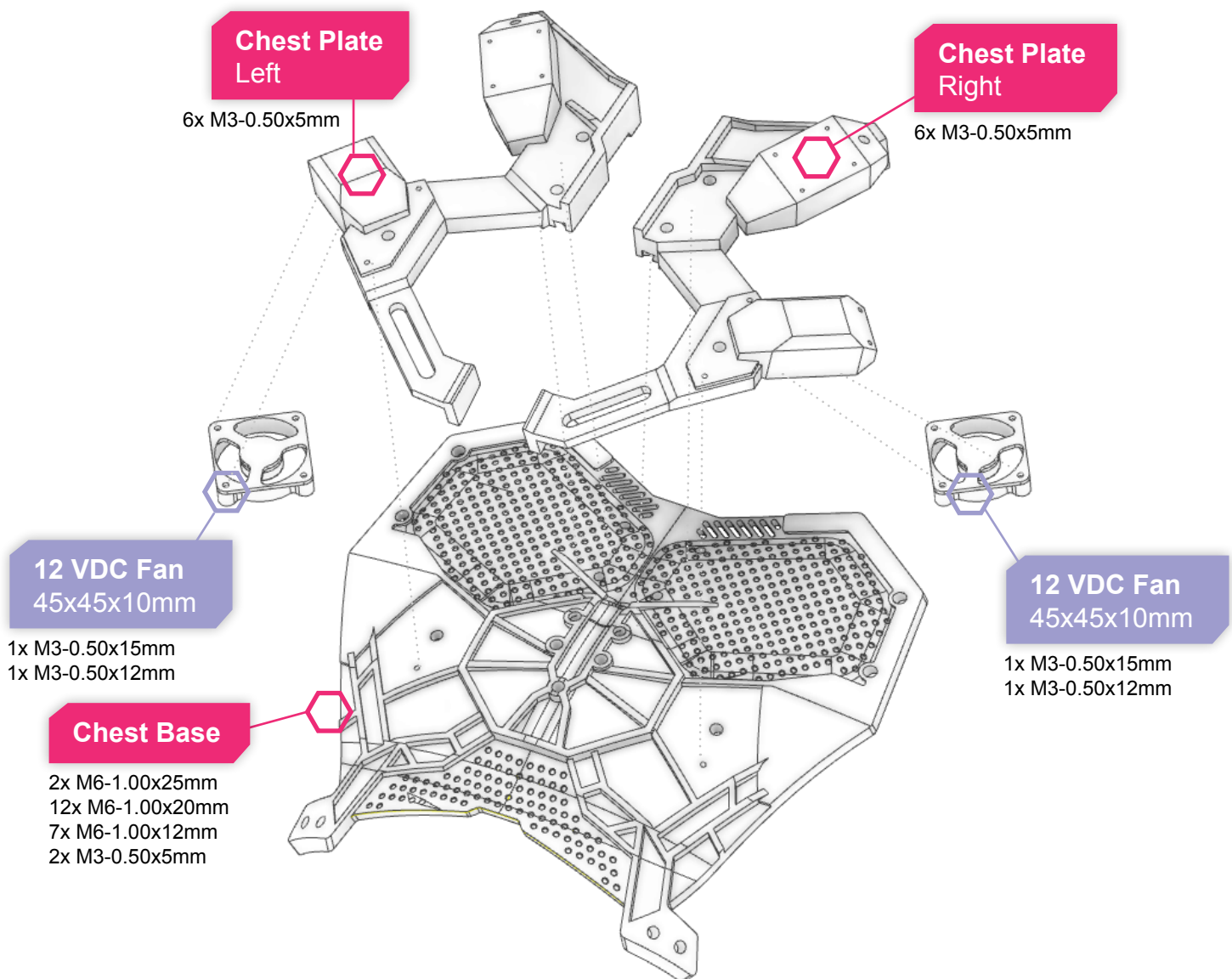
Elysium Max Exoskeleton

Assembly Instructions

25 of 37

Chest

Click on the label or the hex shape to view the corresponding STL file on **GitHub**.



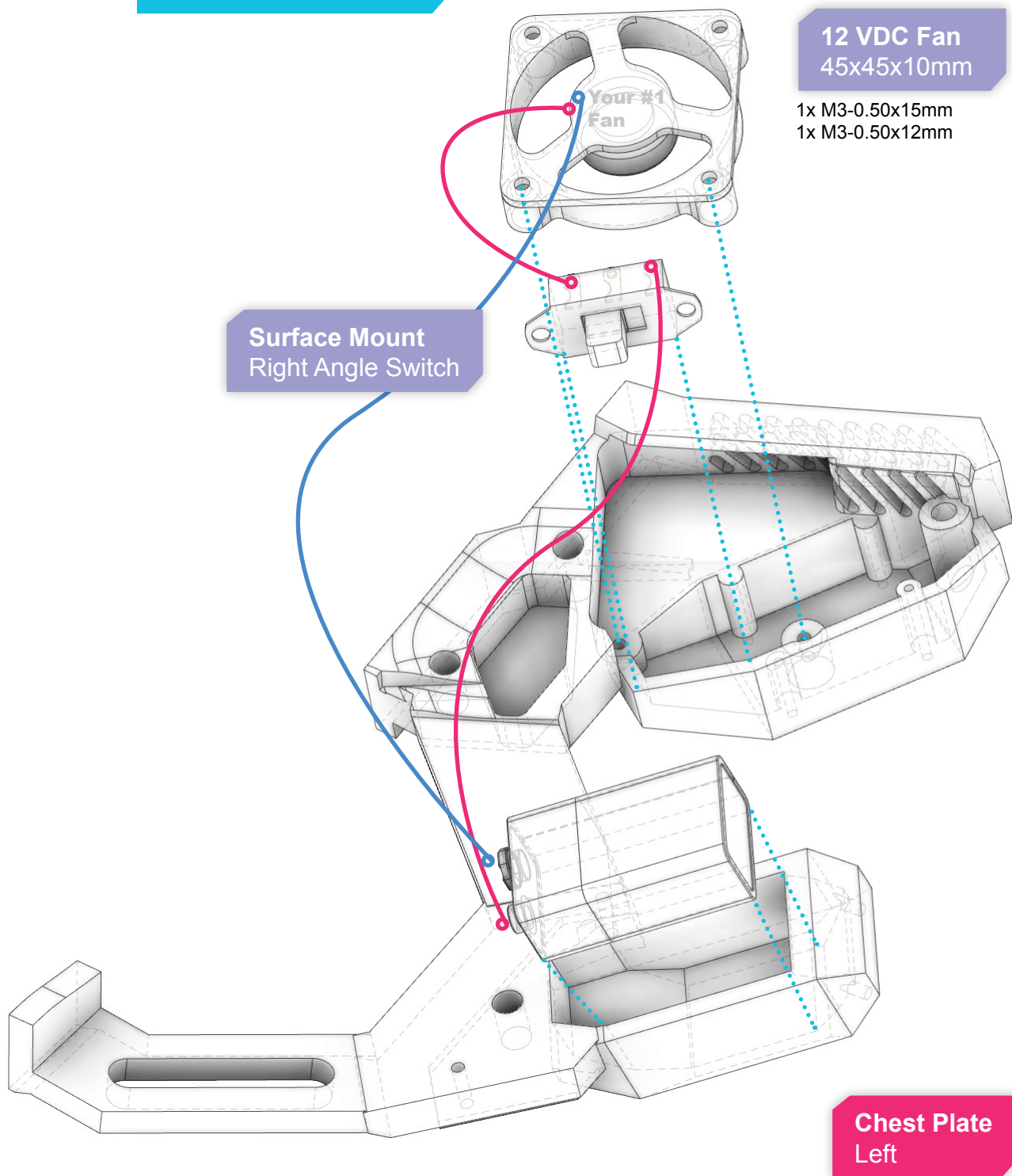


Elysium Max Exoskeleton

Assembly Instructions

26 of 37

Chest Electronics



12 VDC Fan
45x45x10mm

1x M3-0.50x15mm
1x M3-0.50x12mm

Surface Mount
Right Angle Switch

Chest Plate
Left

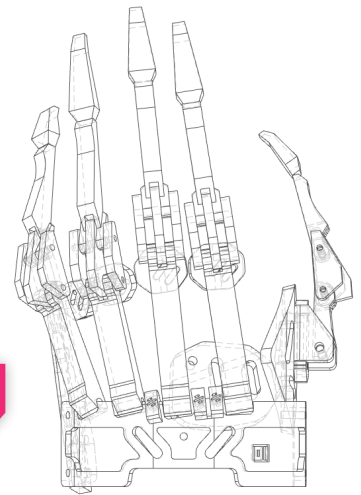


Elysium Max Exoskeleton Assembly Instructions

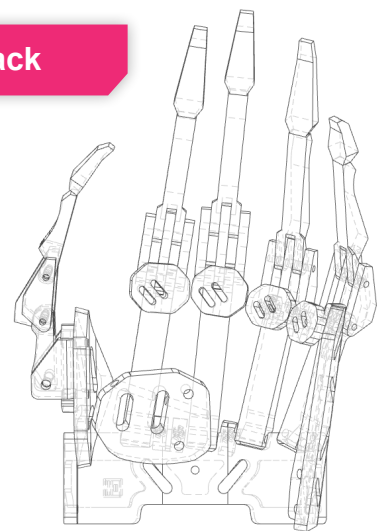
27 of 37

Hand Overview

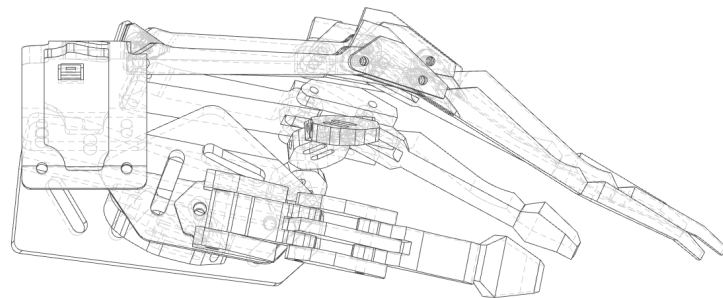
Front



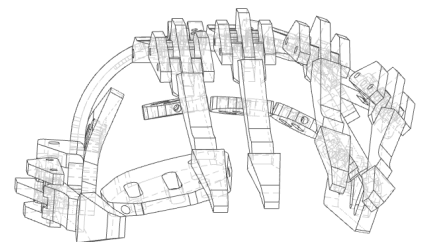
Back



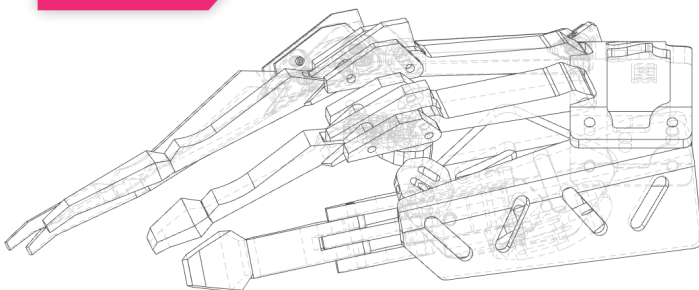
Side



Bottom



Top





Elysium Max Exoskeleton

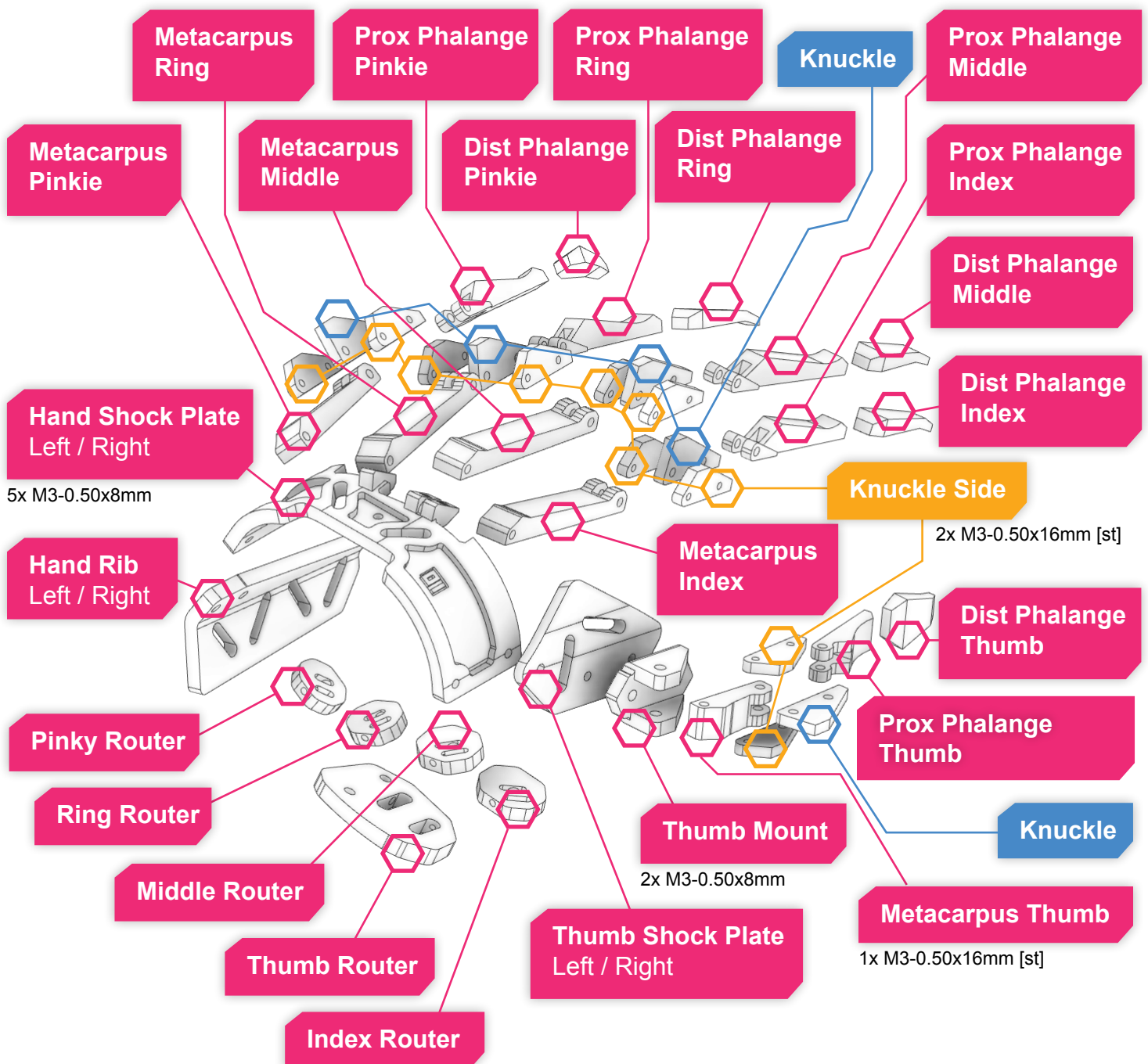
Assembly Instructions

28 of 37

Hand

Click on the label or the hex shape to view the corresponding STL file on **GitHub**.

Metacarpus are connected to **Hand Shock Plate** using flat belts glued underneath, except **Metacarpus Thumb** which is connected to **Thumb Mount** with a set screw.

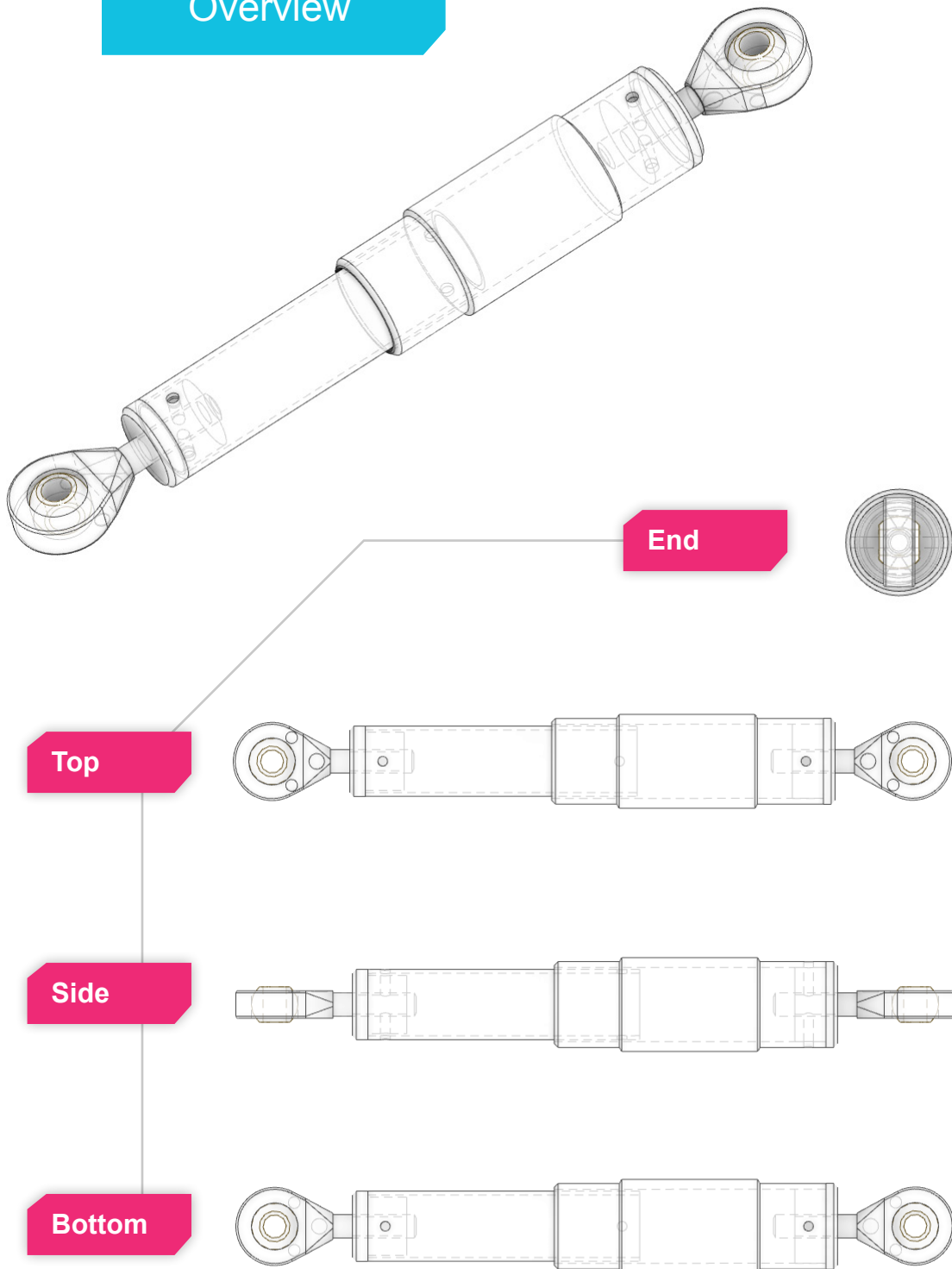




Elysium Max Exoskeleton Assembly Instructions

29 of 37

Piston Overview



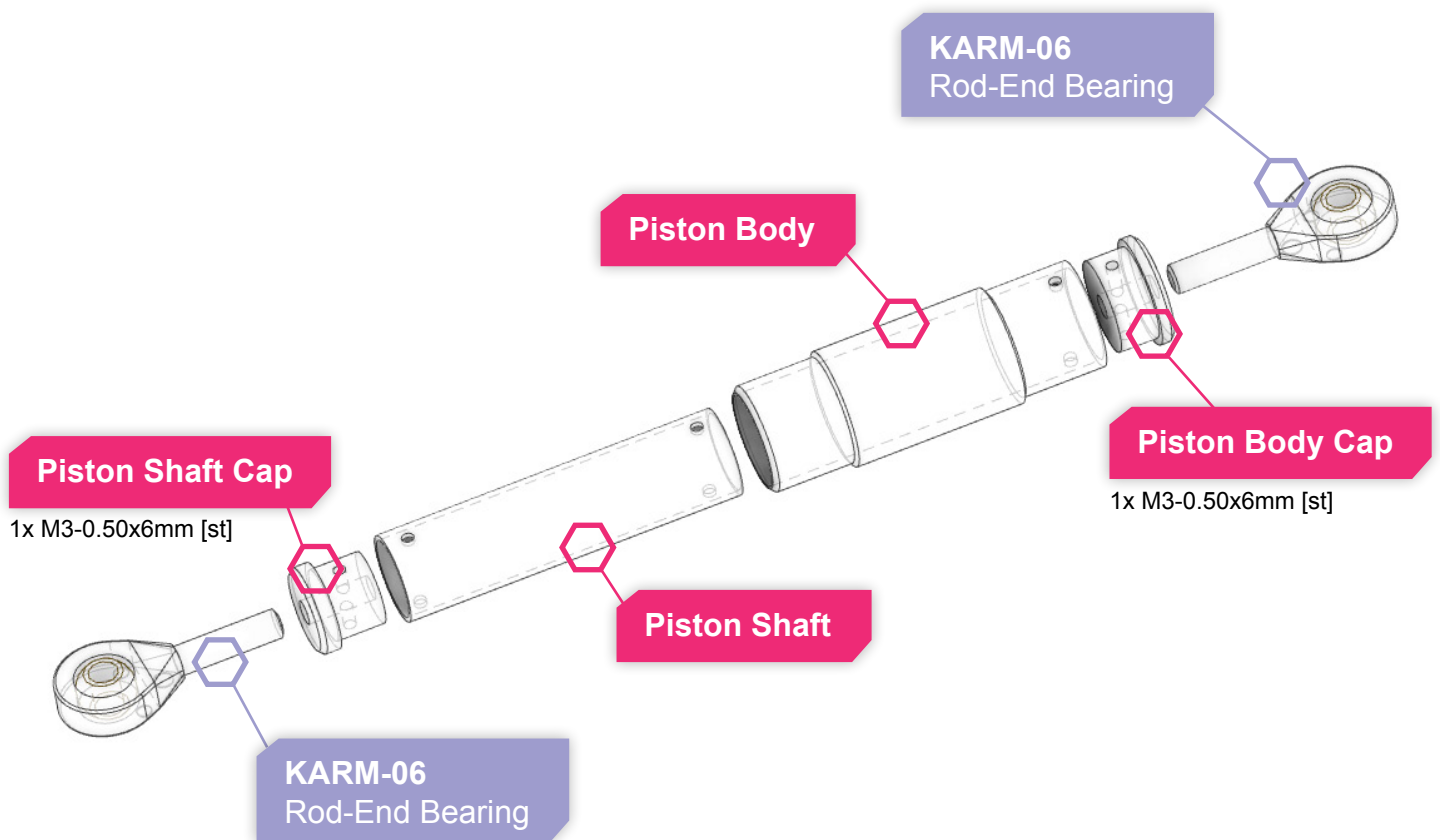


Elysium Max Exoskeleton Assembly Instructions

30 of 37

Piston

Click on the label or the hex shape to view the corresponding STL file on **GitHub**.





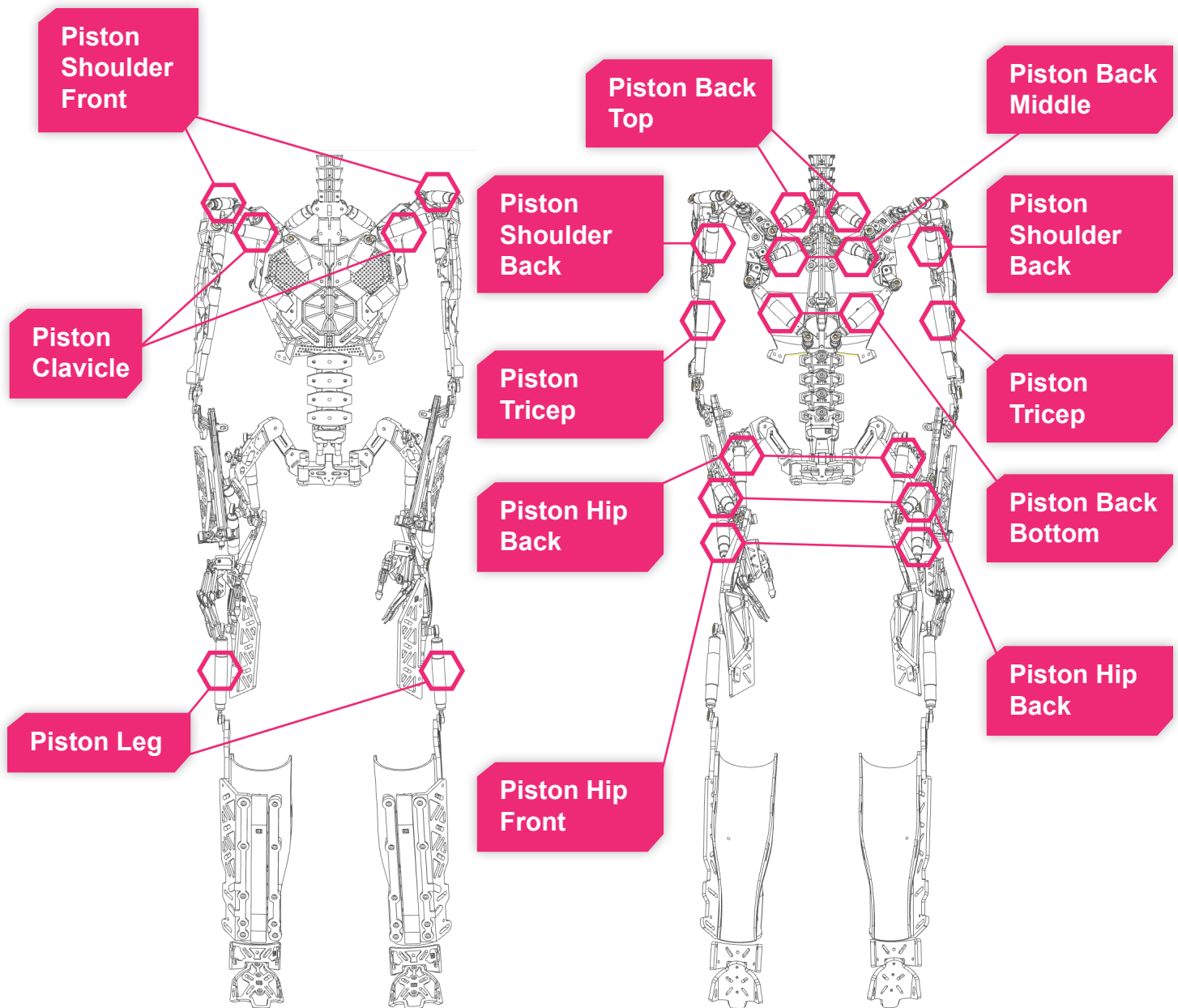
Elysium Max Exoskeleton

Assembly Instructions

31 of 37

Piston Placement

Piston parts can be found in [print/pistons](#) folder on **GitHub**, however they may be cheaper to re-create using something other than 3D printing such as approximating with plastic pipe or machining metal pipe and bar.





32 of 37

Elysium Max Exoskeleton

Assembly Instructions

Parts

The prices below are totals for the specified quantities. Click on the label to view the corresponding STL file on **GitHub**.

Item	Qty	Price SLS (Protolabs)	Price SLA (Protolabs)
Back Connector	8	\$72.69	\$103.96
Back Side Connector	2	\$29.32	\$34.00
Chest Base	1	\$638.35	\$807.76
Chest Plate Left	1	\$274.84	\$307.35
Chest Plate Right	1	\$274.81	\$307.26
Distal Phalange Index	2	\$26.95	\$26.78
Distal Phalange Middle	2	\$26.78	\$26.33
Distal Phalange Pinky	2	\$26.22	\$24.76
Distal Phalange Ring	2	\$26.99	\$26.89
Distal Phalange Thumb	2	\$26.81	\$26.36
Elbow Connector Left	1	\$38.24	\$47.03
Elbow Connector Link Left	1	\$32.21	\$49.59
Elbow Connector Link Right	1	\$32.21	\$49.59
Elbow Connector Right	1	\$38.24	\$47.03
Elbow Connector Underlink Left	1	\$25.21	\$21.22
Elbow Connector Underlink Right	1	\$25.21	\$21.22
Elbow Sub Connector Left	1	\$28.86	\$33.18
Elbow Sub Connector Right	1	\$28.86	\$33.18
Foot Shock Plate	2	\$202.82	\$293.01
Foot Upper Shock Plate	2	\$112.99	\$199.78
Forearm Base	2	\$58.31	\$139.00



Elysium Max Exoskeleton

Assembly Instructions

33 of 37

Parts

The prices below are totals for the specified quantities. Click on the label to view the corresponding STL file on **GitHub**.

Item	Qty	Price SLS (Protolabs)	Price SLA (Protolabs)
Forearm Clamp	4	\$68.67	\$140.34
Forearm Clamp Head	4	\$27.11	\$27.05
Forearm Clamp Link	2	\$31.97	\$37.77
Forearm Cuff Connector	4	\$33.33	\$40.76
Forearm Inner Base	2	\$59.76	\$144.28
Forearm Lower Shock Plate Right	1	\$44.69	\$75.70
Forearm Lower Shock Plate Left	1	\$44.32	\$76.29
Forearm Piston Connector	10	\$51.42	\$71.32
Forearm Upper Shock Plate Left	1	\$55.91	\$121.22
Forearm Upper Shock Plate Right	1	\$55.78	\$120.90
Hand Rib Left	1	\$31.09	\$35.96
Hand Rib Right	1	\$31.09	\$35.66
Hand Shock Plate Left	1	\$38.02	\$65.25
Hand Shock Plate Right	1	\$38.02	\$65.25
Hip Bottom Connector Left	1	\$31.90	\$37.24
Hip Bottom Connector Right	1	\$32.78	\$35.97
Hip Left	1	\$429.60	\$526.67
Hip Piston Connector Left	1	\$32.27	\$39.10
Hip Piston Connector Right	1	\$32.27	\$39.10
Hip Right	1	\$429.60	\$526.67
Hip Shock Plate Left	1	\$88.57	\$213.64



Elysium Max Exoskeleton

Assembly Instructions

Parts

The prices below are totals for the specified quantities. Click on the label to view the corresponding STL file on **GitHub**.

Item	Qty	Price SLS (Protolabs)	Price SLA (Protolabs)
Hip Shock Plate Right	1	\$88.57	\$213.64
Hip Top Connector Left	1	\$28.94	\$32.12
Hip Top Connector Right	1	\$29.83	\$39.10
Index Router	2	\$26.98	\$27.04
Knuckle	10	\$48.81	\$67.24
Knuckle Side	20	\$72.54	\$98.34
Lower Forearm	2	\$43.68	\$80.83
Metacarpus Index	2	\$29.97	\$34.68
Metacarpus Middle	2	\$30.13	\$35.09
Metacarpus Pinky	2	\$29.17	\$32.59
Metacarpus Ring	2	\$29.26	\$32.80
Metacarpus Thumb	2	\$27.59	\$28.43
Middle Router	2	\$26.88	\$26.76
Neck Link	3	\$52.27	\$98.67
Pelvis Base Mount	1	\$63.78	\$140.25
Pelvis Link	2	\$37.89	\$61.36
Pelvis Mount	2	\$37.86	\$61.44
Pelvis Mount Stem	2	\$49.55	\$80.67
Pelvis Spine Link	1	\$38.44	\$49.44
Pelvis Sub Link	2	\$39.03	\$65.17
Pelvis Wing Left	1	\$178.95	\$232.32



35 of 37

Elysium Max Exoskeleton

Assembly Instructions

Parts

The prices below are totals for the specified quantities. Click on the label to view the corresponding STL file on **GitHub**.

Item	Qty	Price SLS (Protolabs)	Price SLA (Protolabs)
Pelvis Wing Right	1	\$179.20	\$232.89
Pinky Router	2	\$26.48	\$25.61
Proximal Phalange Index	2	\$28.44	\$30.44
Proximal Phalange Middle	2	\$28.91	\$31.65
Proximal Phalange Pinky	2	\$27.90	\$29.03
Proximal Phalange Ring	2	\$28.48	\$30.54
Proximal Phalange Thumb	2	\$27.49	\$28.14
Ring Router	2	\$26.55	\$25.83
Shin Connector Left	1	\$56.05	\$115.22
Shin Connector Right	1	\$55.88	\$114.66
Shin Extender	2	\$31.08	\$38.92
Shin Left	1	\$856.87	\$1178.66
Shin Lock Left	1	\$73.11	\$163.78
Shin Lock Right	1	\$73.11	\$163.78
Shin Right	1	\$856.87	\$1178.53
Shin Shock Plate Left	1	\$215.41	\$377.13
Shin Snock Plate Right	1	\$239.34	\$349.78
Shoulder Cog Large	2	\$27.11	\$28.07
Shoulder Cog Small	6	\$38.11	\$51.00
Shoulder Connector Split Body	2	\$32.27	\$36.73
Shoulder Connector Split Head	2	\$35.37	\$60.75



36 of 37

Elysium Max Exoskeleton

Assembly Instructions

Parts

The prices below are totals for the specified quantities. Click on the label to view the corresponding STL file on **GitHub**.

Item	Qty	Price SLS (Protolabs)	Price SLA (Protolabs)
Shoulder Left	1	\$109.97	\$207.73
Shoulder Right	1	\$109.94	\$207.73
Spacer Long	6	\$53.75	\$80.57
Spacer Short	22	\$122.94	\$188.19
Spine Base	1	\$81.04	\$190.82
Spine Bottom	1	\$75.32	\$170.87
Spine Connector	4	\$117.47	\$214.63
Spine Cover Left	1	\$25.12	\$22.07
Spine Cover Middle	1	\$33.12	\$49.57
Spine Cover Right	1	\$25.12	\$22.07
Spine Link	3	\$79.62	\$152.50
Spine Middle Left	1	\$81.89	\$173.57
Spine Middle Right	1	\$81.89	\$173.57
Spine Middle Top	1	\$49.55	\$90.16
Spine Neck Link Connector	1	\$27.72	\$31.91
Spine Top	1	\$63.68	\$141.75
Spine Top Middle Connector	2	\$27.57	\$28.79
Thumb Mount	2	\$30.19	\$34.21
Thumb Router	2	\$32.12	\$41.52
Thumb Shock Plate Left	1	\$27.81	\$29.46
Thumb Shock Plate Right	1	\$27.80	\$29.43



Elysium Max Exoskeleton Assembly Instructions

37 of 37

Parts

The prices below are totals for the specified quantities. Click on the label to view the corresponding STL file on **GitHub**.

Item	Qty	Price SLS (Protolabs)	Price SLA (Protolabs)
Upper Arm Connector Left	1	\$27.18	\$27.48
Upper Arm Connector Right	1	\$27.17	\$27.47
Upper Arm Left	1	\$146.77	\$288.15
Upper Arm Right	1	\$146.77	\$288.14
Upper Arm Shoulder Left	1	\$49.72	\$83.69
Upper Arm Shoulder Right	1	\$49.72	\$83.69
Upper Arm Tricep Left	1	\$42.72	\$60.59
Upper Arm Tricep Right	1	\$42.77	\$60.80
Upper Forearm Left	1	\$54.07	\$116.79
Upper Forearm Right	1	\$54.07	\$116.79
Upper Forearm Shockplate Connector Left	1	\$51.89	\$74.47
Upper Forearm Shockplate Connector Right	1	\$46.42	\$78.41
Totals (all copies of all parts)	245	\$9,732	\$14,338
Vacuum Tube Holder (optional)	4		
Back Connector for Vacuum Tubes (optional)	4		