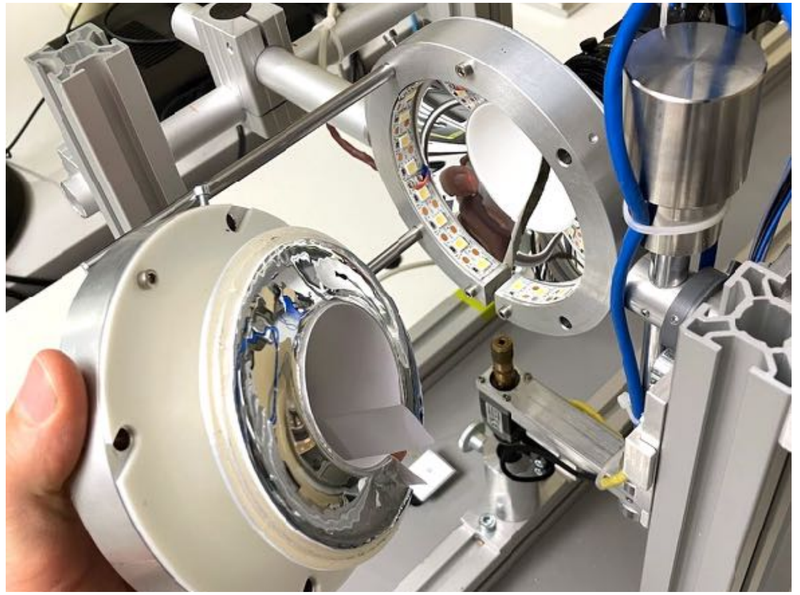
Bulk 3D scanning of insect specimens

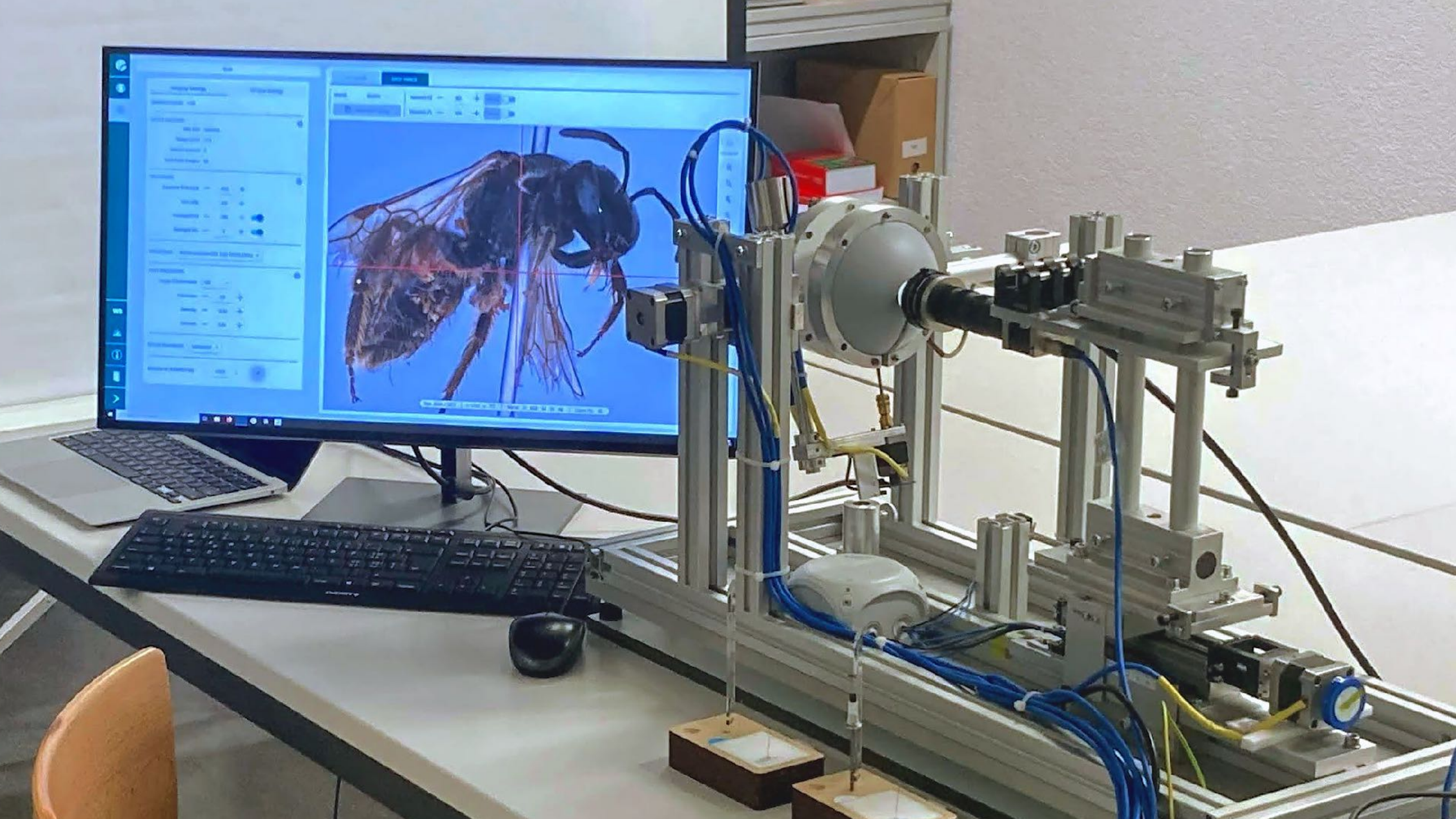
CHRISTIAN FELSNER
Designer & Engineer

BMW Design

The University of Tokyo



ETHZ - ENT



GOALS

- 3D-scanning of 2,400 type specimens until August 2024
- Collaboration of ETHZ; ZMZ; NMLU; MHNN; MCSN
- Explore potential and limits of the photogrammetry
- Design an safe & efficient process
- Share and document; How is it done?

WHAT

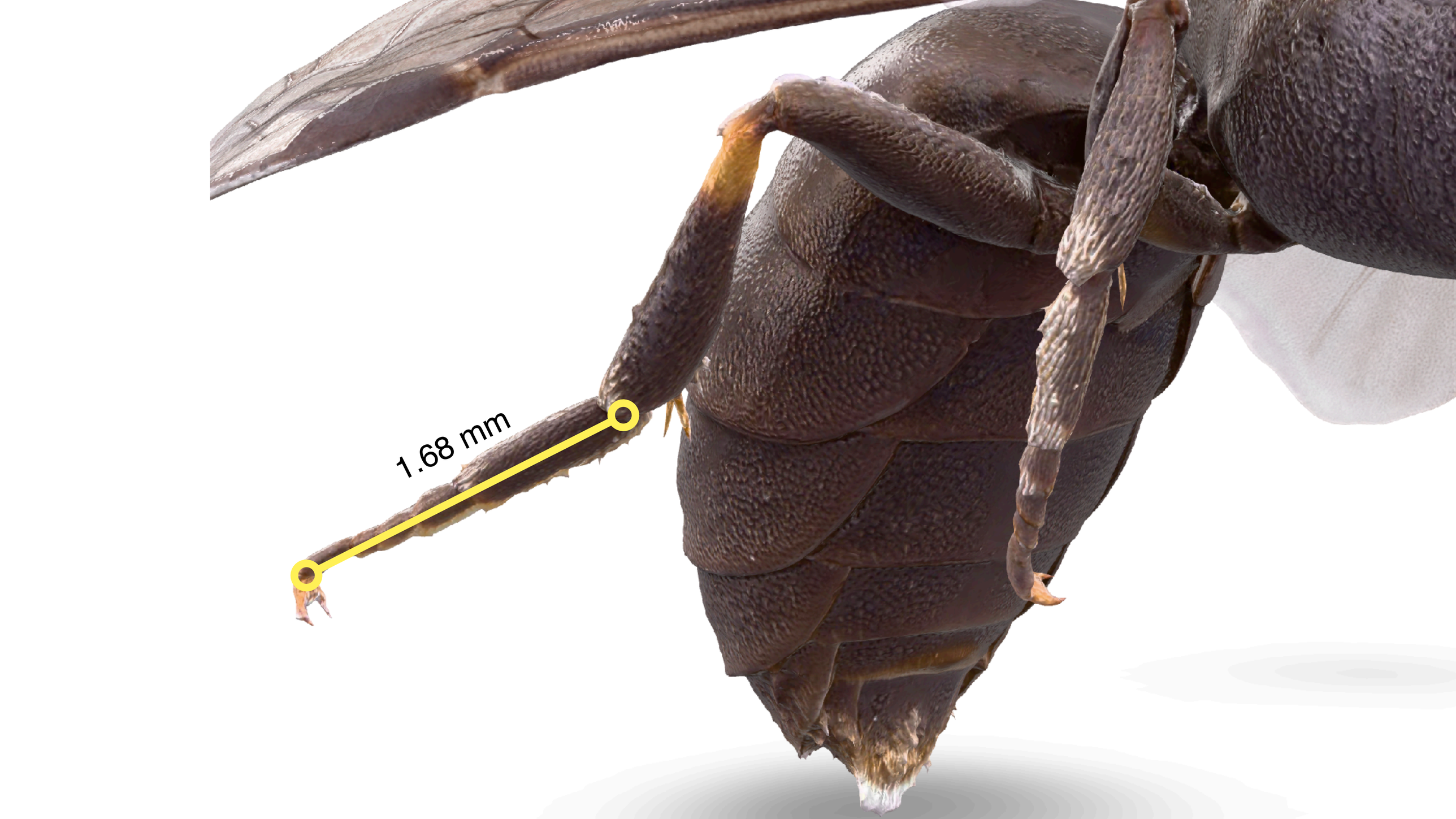
What are insect type specimens?

WHY

3D models and images

Area 22.006 mm²

Volume. 7.645 mm³


1.68 mm

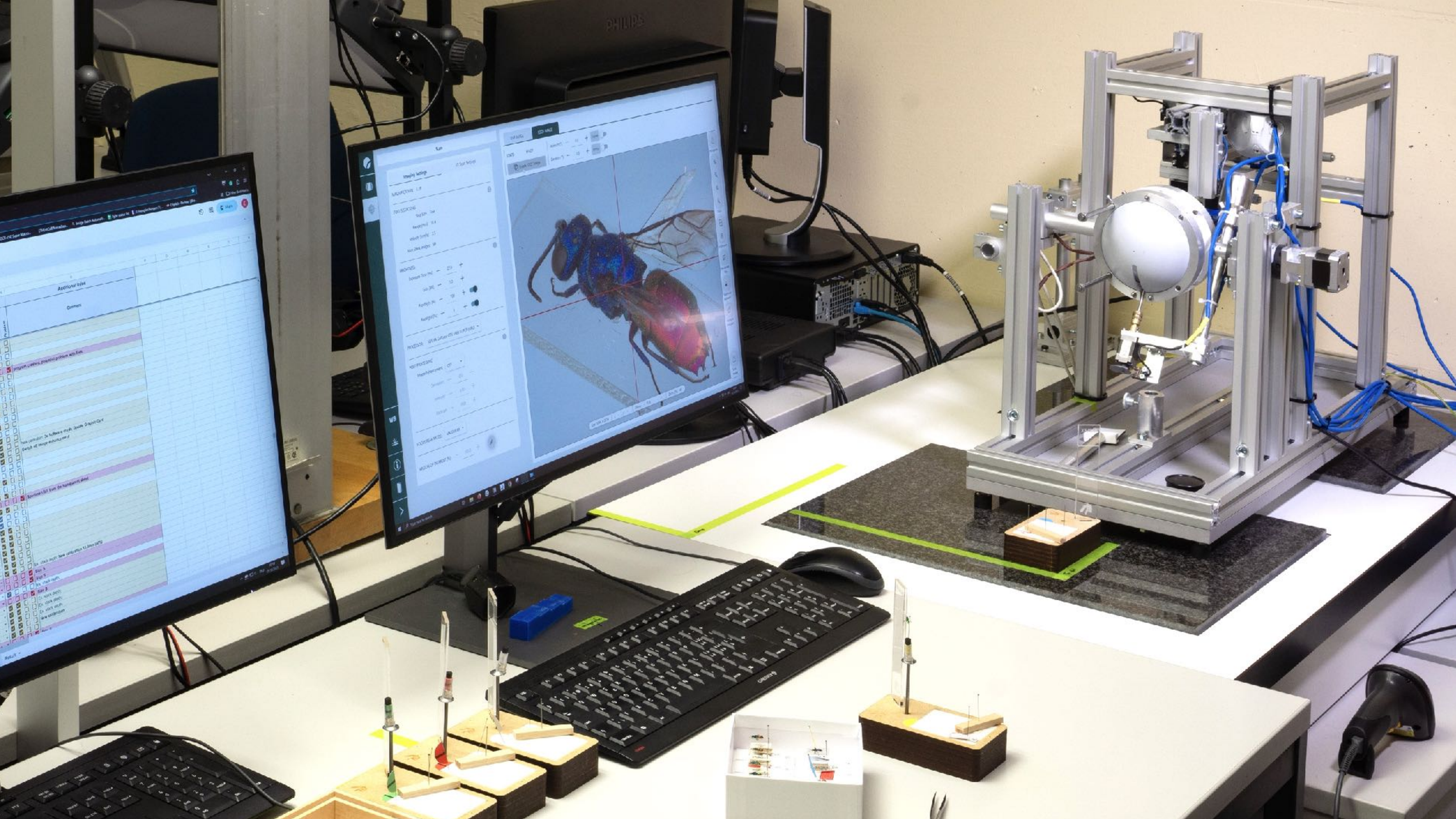


IMAGE STACKING

A sharp image of a macro object

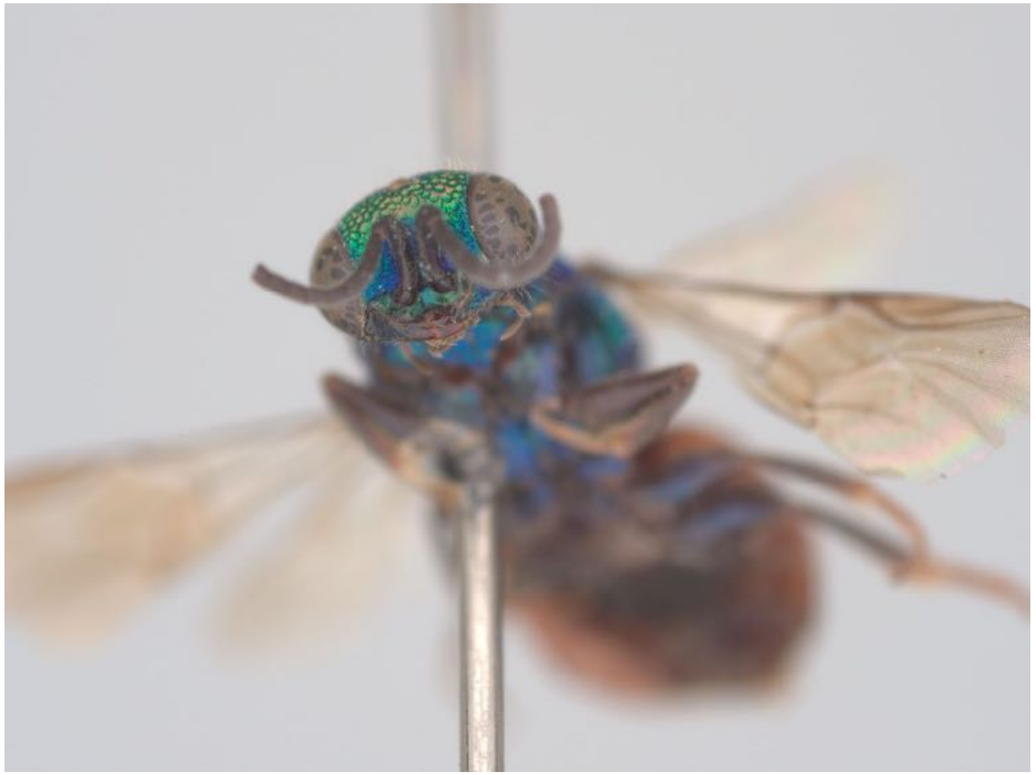
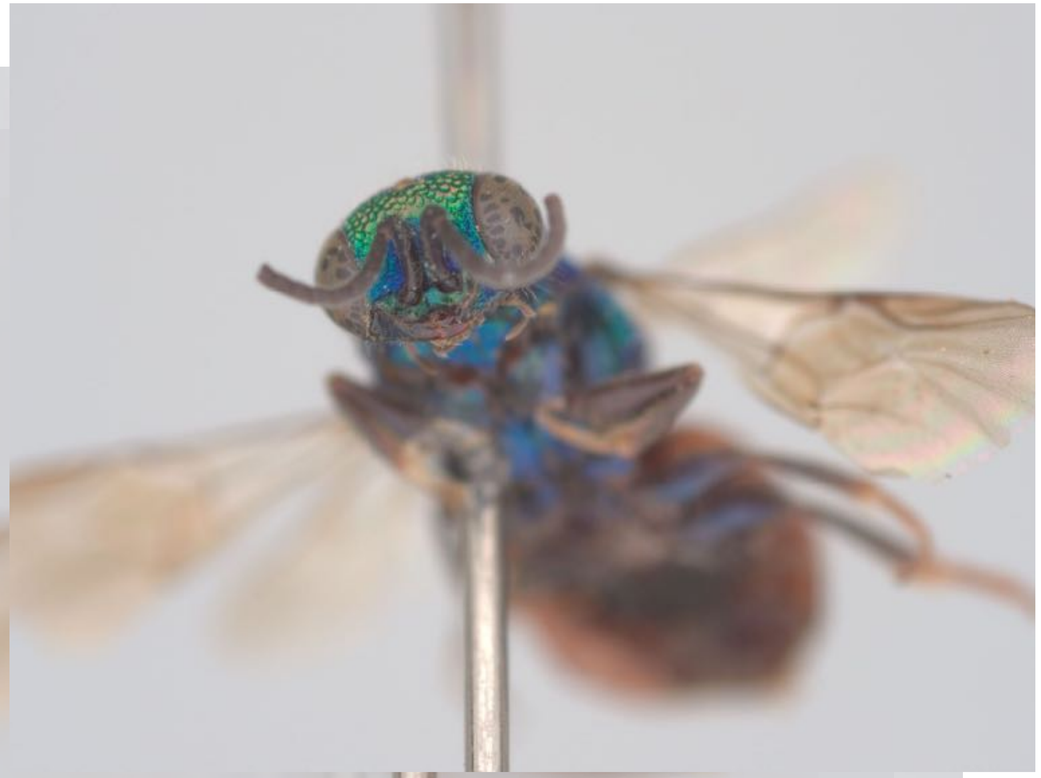


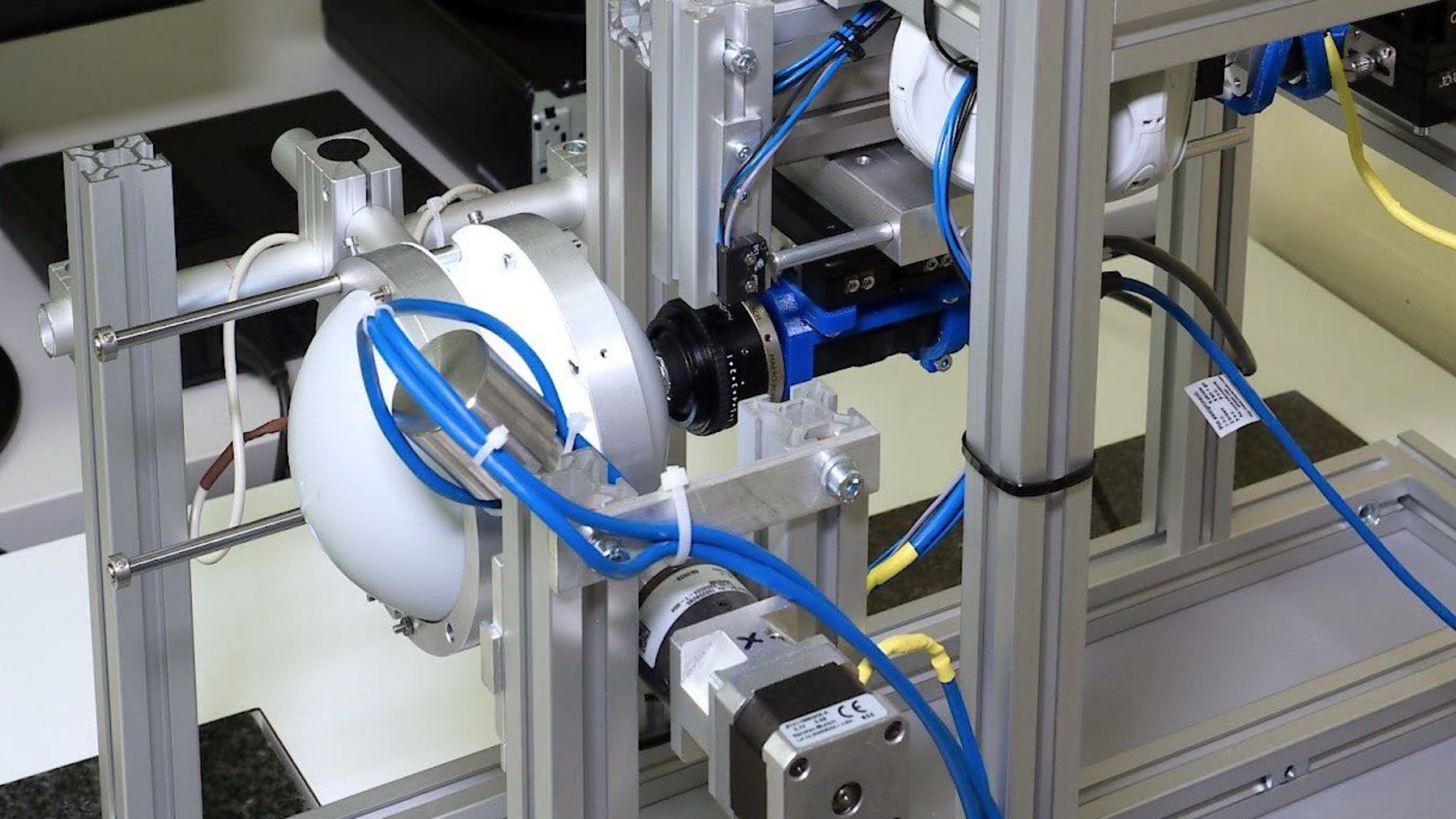
IMAGE STACKING

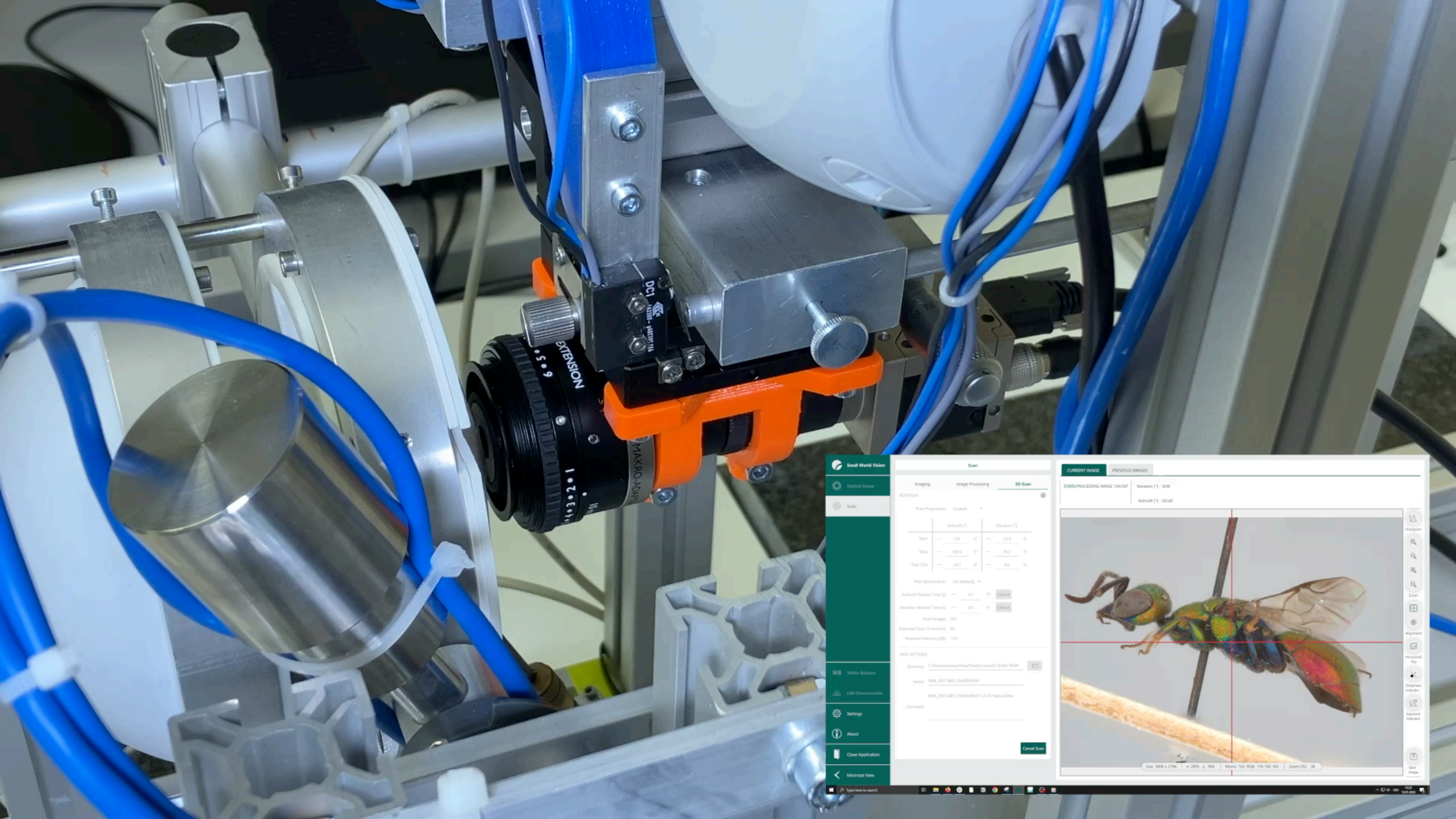
A sharp image of a very small object



EDOF

~100 stacked images

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Settings
About
Close Application
Minimize View
Scan
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Image Processing
3D Scan
ROTATION
Pose Programme:
Custom
Azimuth [°]
Elevation [°]
Start
Stop
Step Size
Pole Optimization:
On (default)
Azimuth Release Time [s]
Elevation Release Time [s]
Num Images:
Estimated Scan Time [min]:
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SAVE SETTINGS
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Name:
Comment:
Cancel Scan
CURRENT IMAGE
PREVIOUS IMAGES
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Alignment
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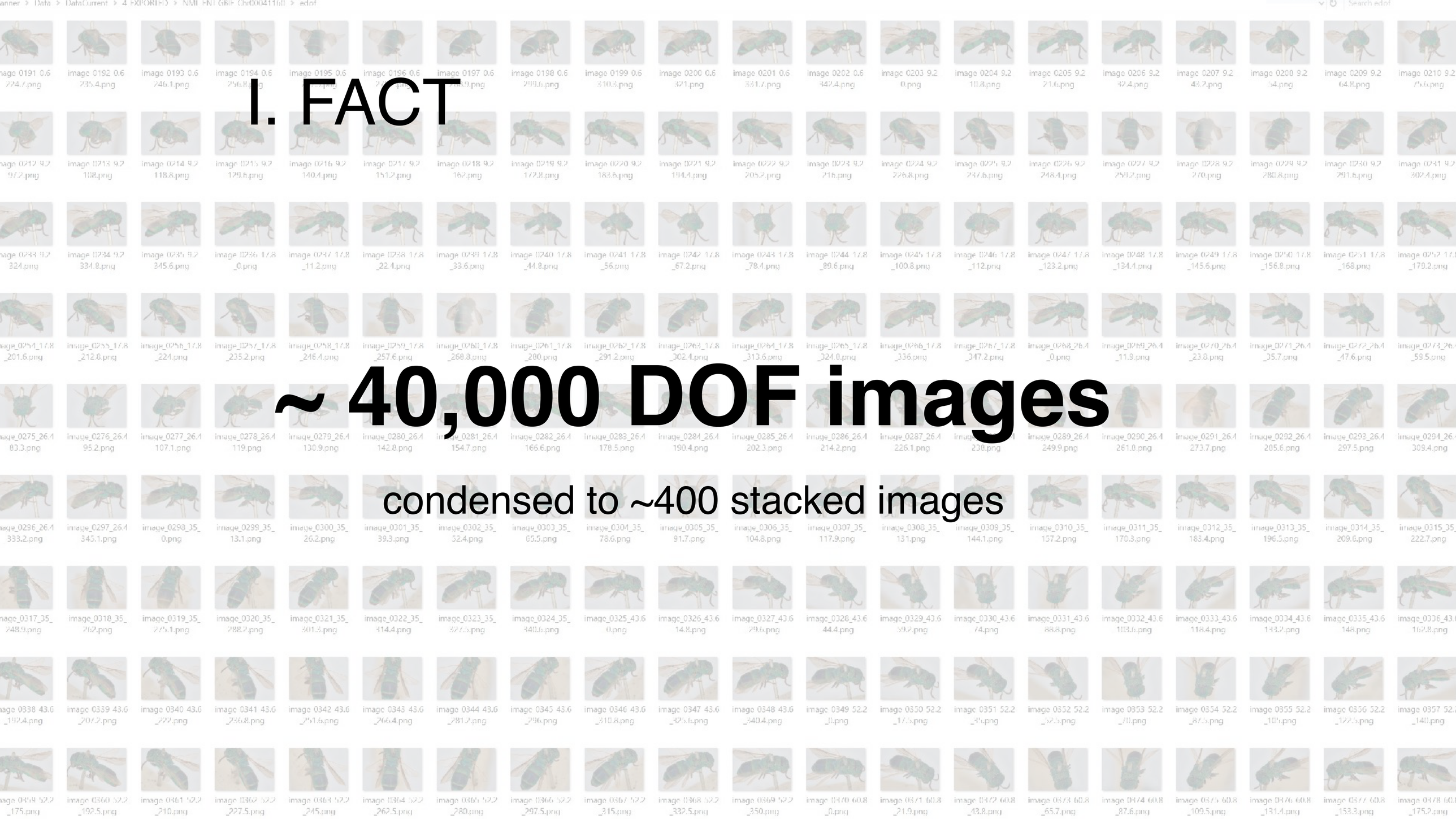
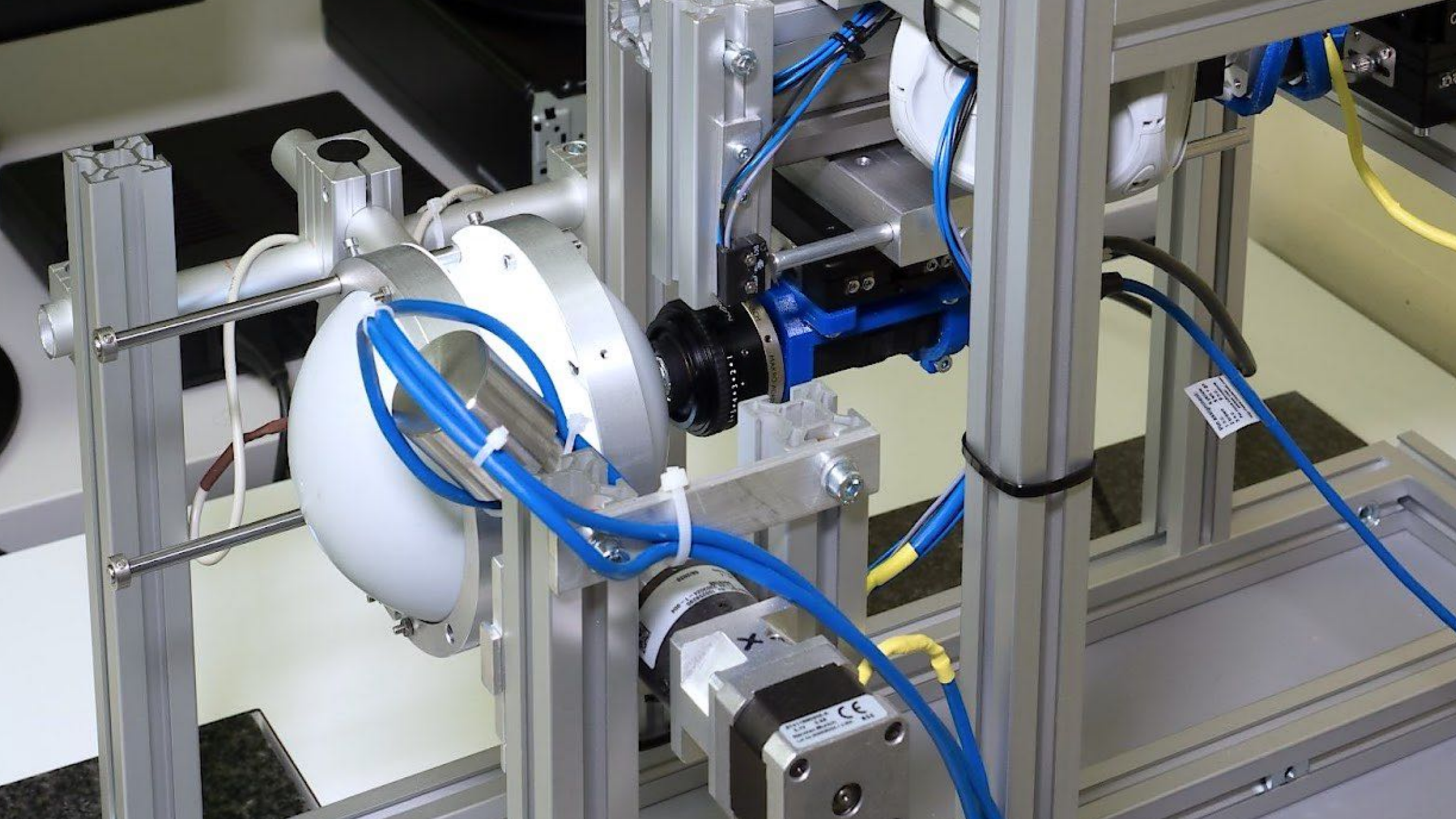
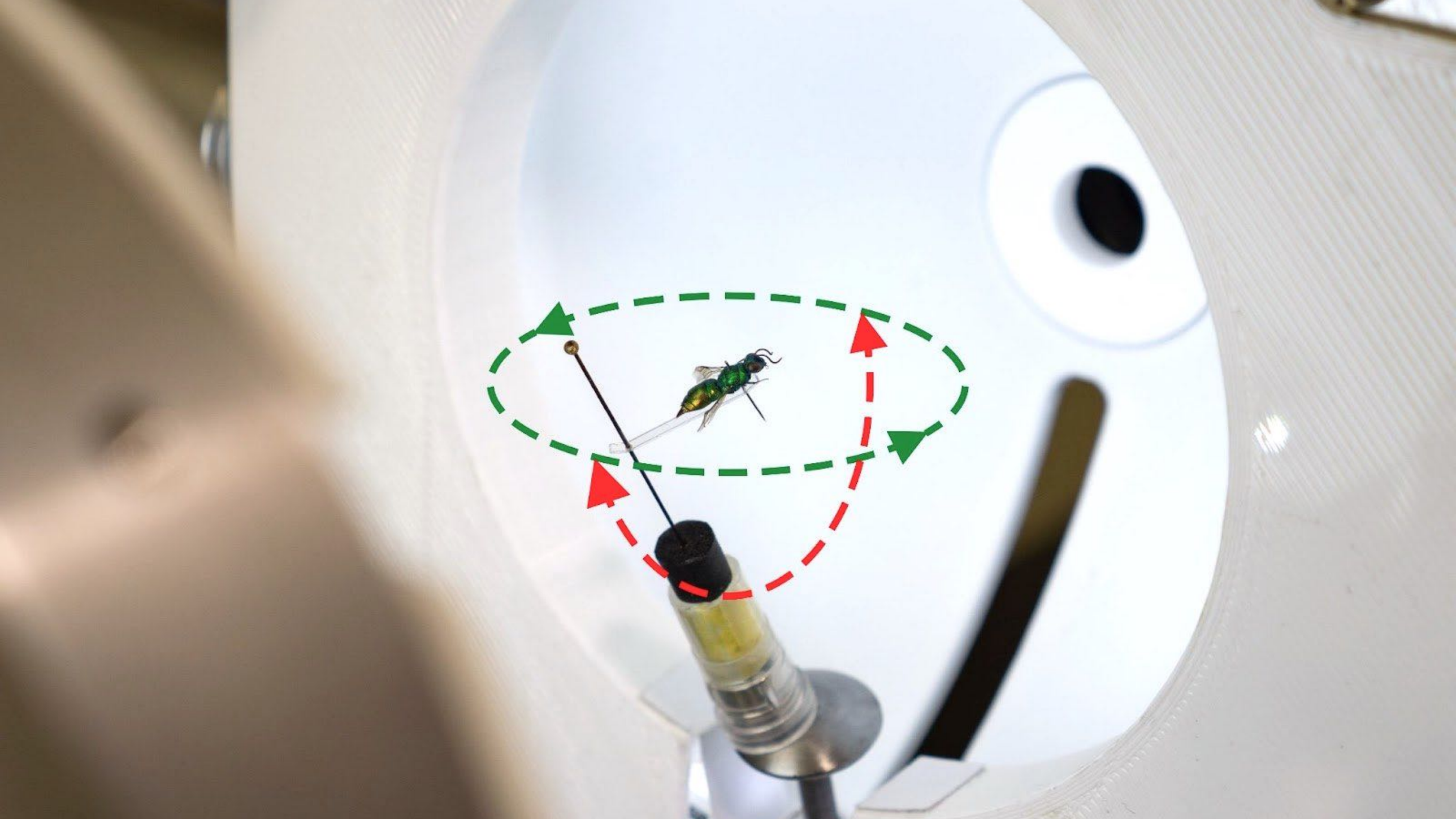
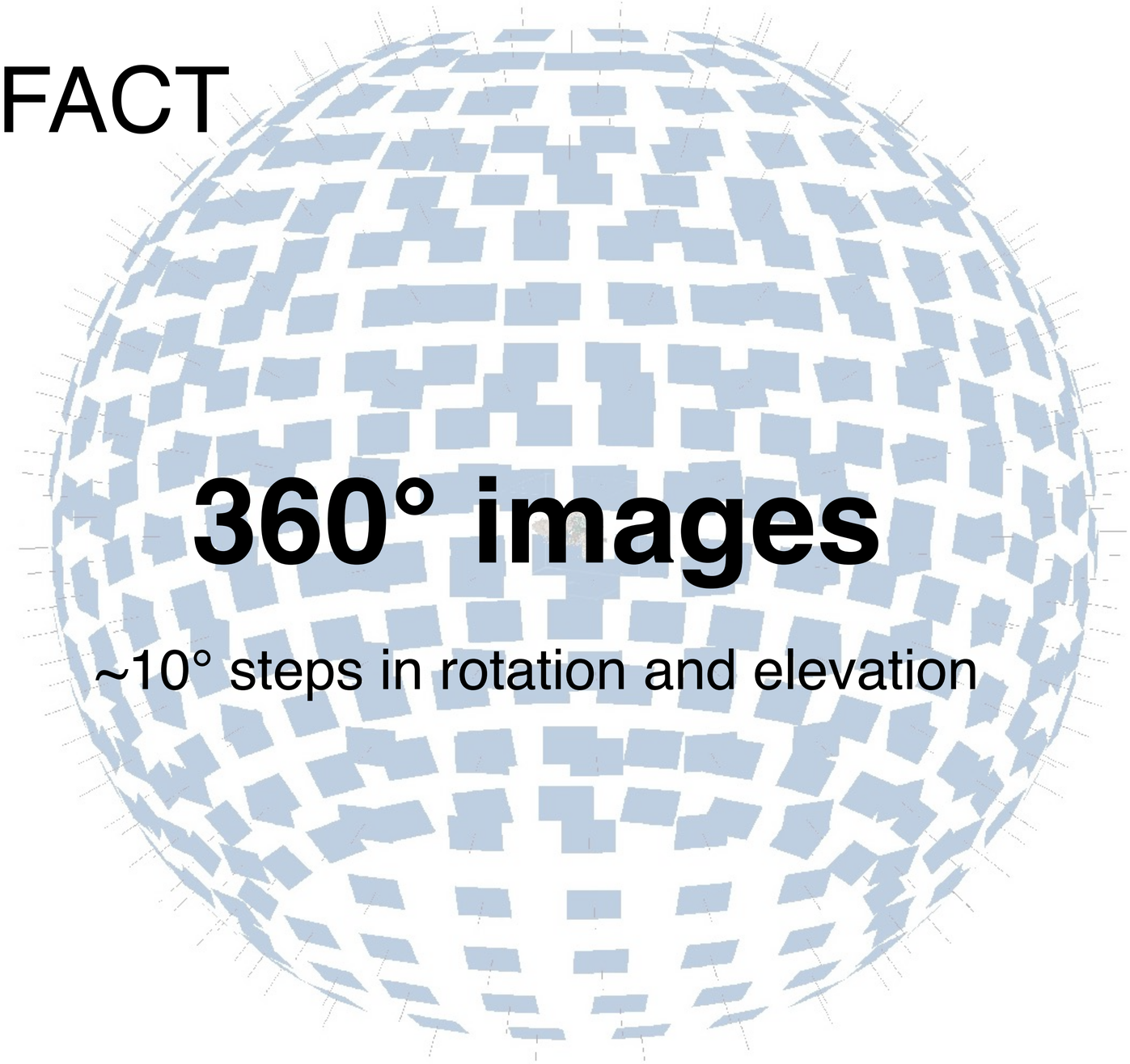
Sharpness Indicator
Exposure Indicator
Save Image


I. FACT
~ 40,000 DOF images
condensed to ~400 stacked images





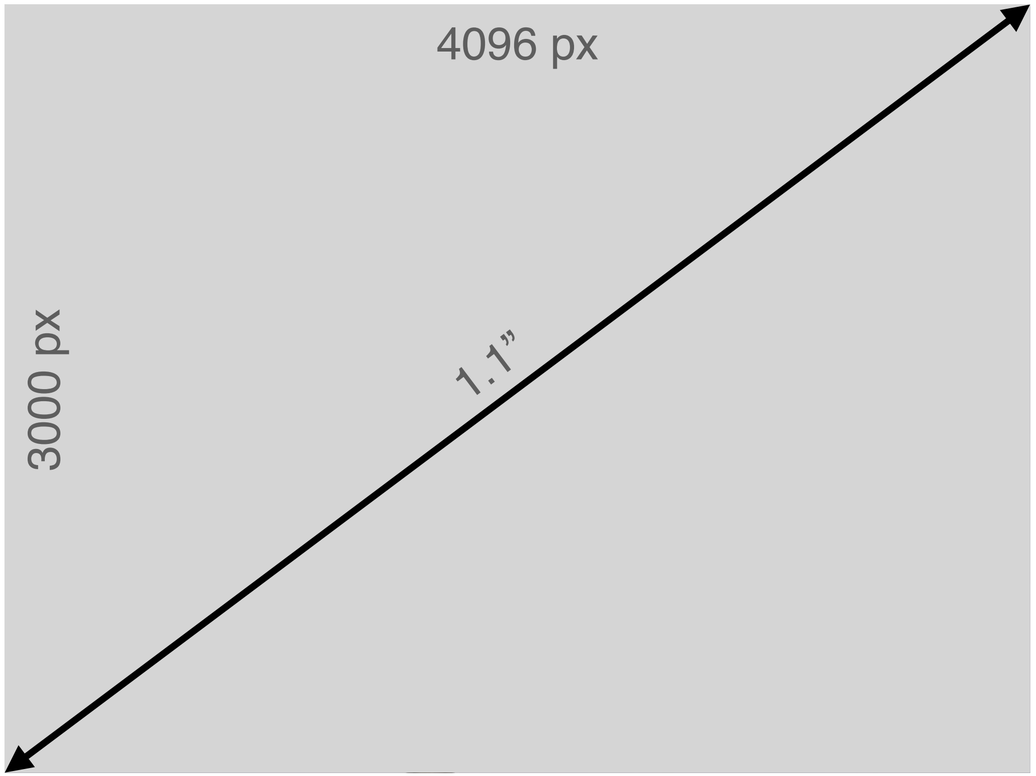
II. FACT



360° images

~10° steps in rotation and elevation

OPTICAL SYSTEM
Sensor



12MP Basler ACE

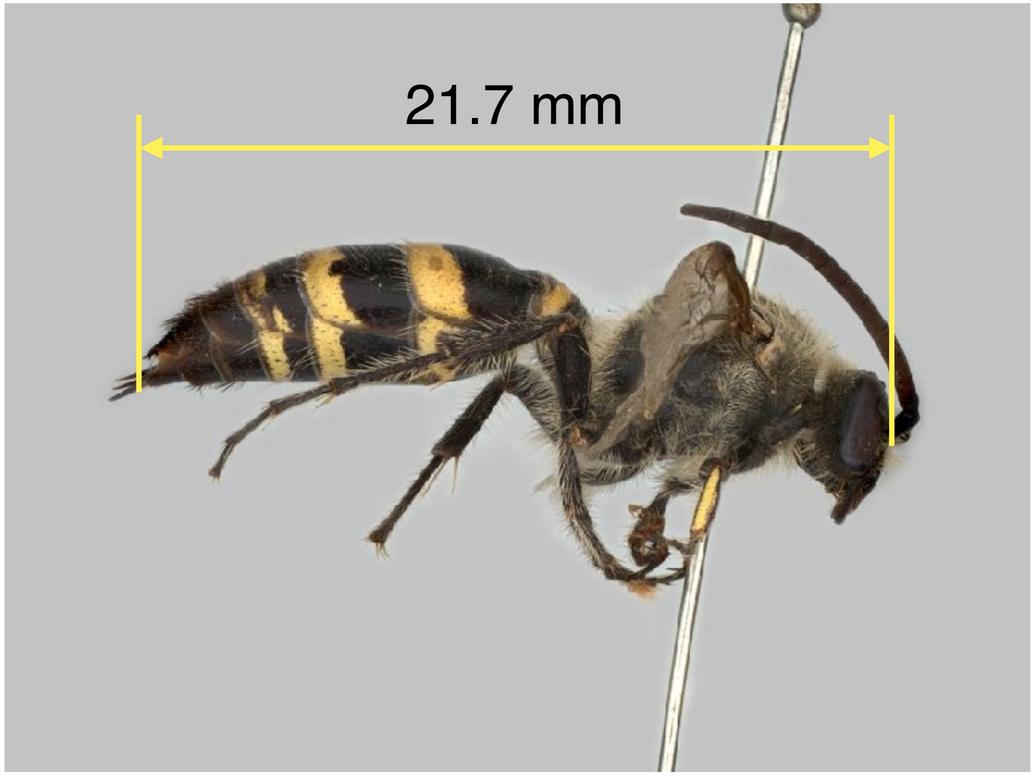
Min. and max. size for optical configuration

OPTICAL SYSTEM
Size

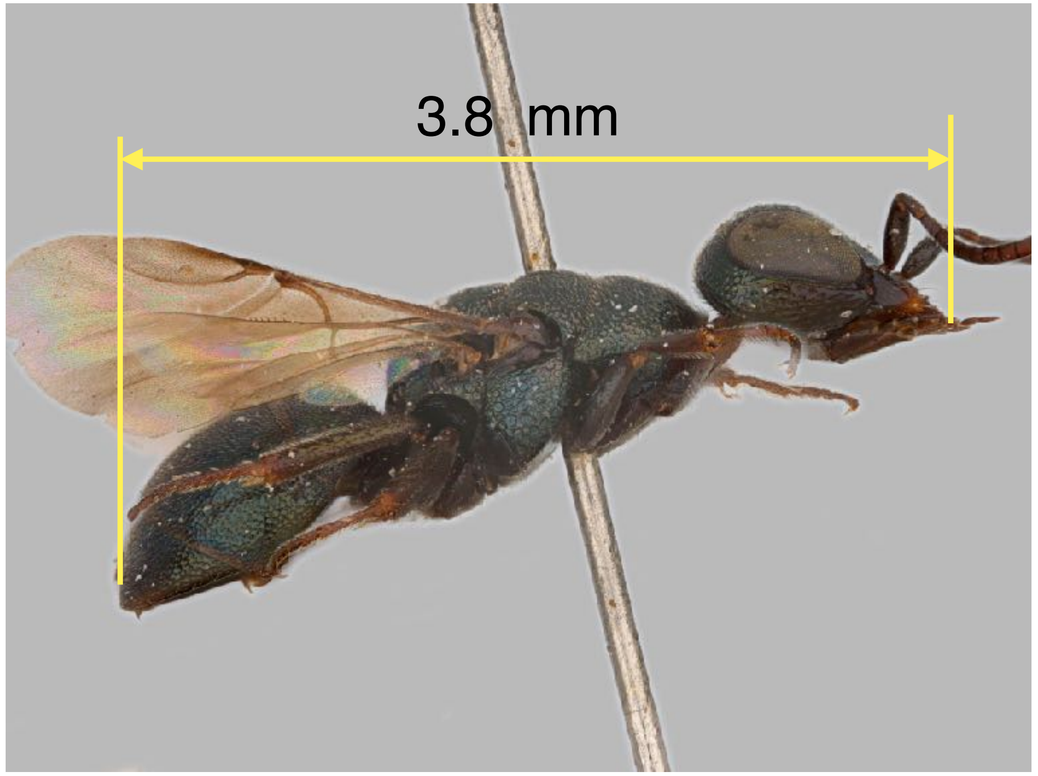
Campsomeris szetschwanensis

Hedychridium atratum

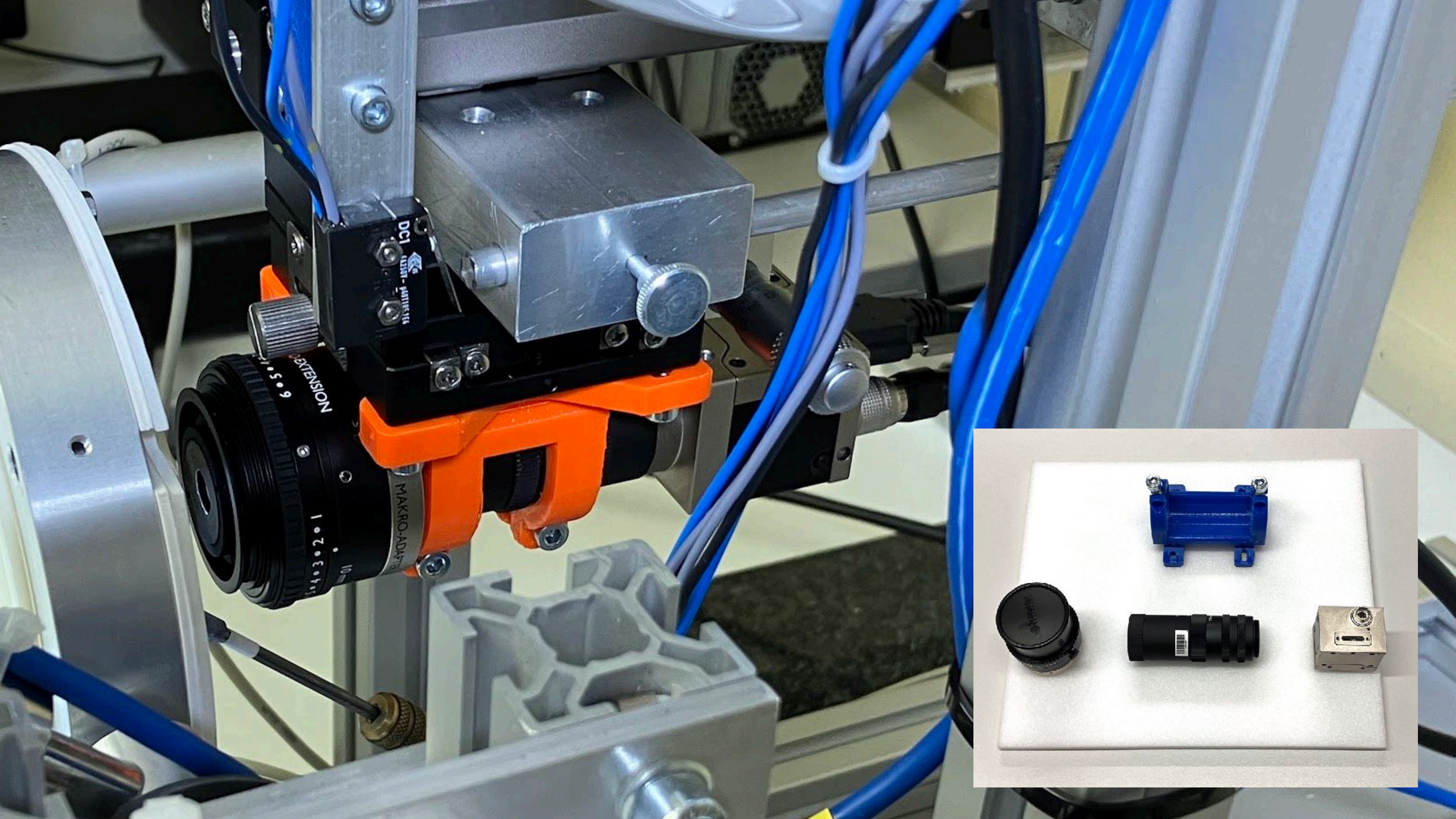
OPTICAL SYSTEM
Size



Campsomeris szetschwanensis



Hedychridium atratum


DC1
EXTENSION
MAKRO-ADAPTER

OPTICAL SETUP

Size chart

	Size	Range	Lens	Extensions
	4XS	1 - 3 mm	28 / 2.8R	105 mm
	3XS	3 - 4.5 mm	28 / 2.8R	65 mm
	2XS	4.5 - 6.5 mm	28 / 2.8R	38 mm
	XS	6.5 - 9 mm	50 / 2.8R	80 mm
	S	9 - 12.5 mm	50 / 2.8R	61.5 mm
	M	12.5 - 16 mm	APO 40 / 2.8	36.5 mm
	ML	16 - 19 mm	APO 40 / 2.8	31.5 mm
	L	19 - 22.5 mm	APO 40 / 2.8	26.5 mm
	XL	22.5 - 27 mm	APO 40 / 2.8	23 mm

III. FACT

2 - 30 mm size capacity

utilising the full sensor size for the highest quality

SOFTWARE & DATA

Metashape

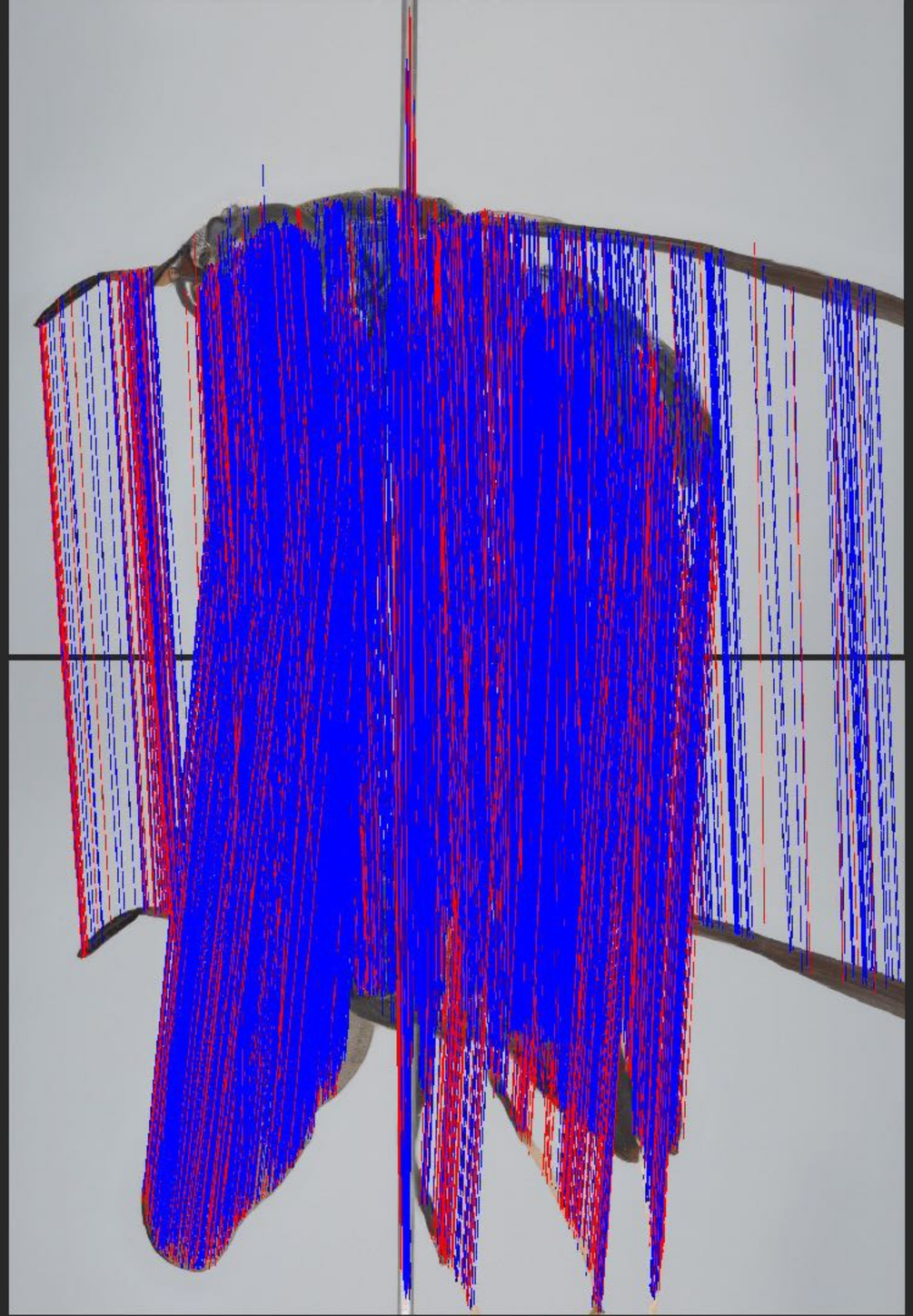



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image_0321_4.9_1
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image_0213_-19.4_33
image_0212_-19.4_3
image_0211_-19.4_3
image_0210_-19.4_309.6
image_0209_-19.4_301
image_0208_-19.4_292.4

2,500,000 polygonal faces; 500 MB file

IV. FACT

~8 GB / specimen

~400 .png EDOF images; High resolution 3D data .obj

PREPARATION
Web optimisation

Metashape original
500 MB
Diffuse map only

Web optimised
20 MB
Diffuse, alpha, normal, specular map

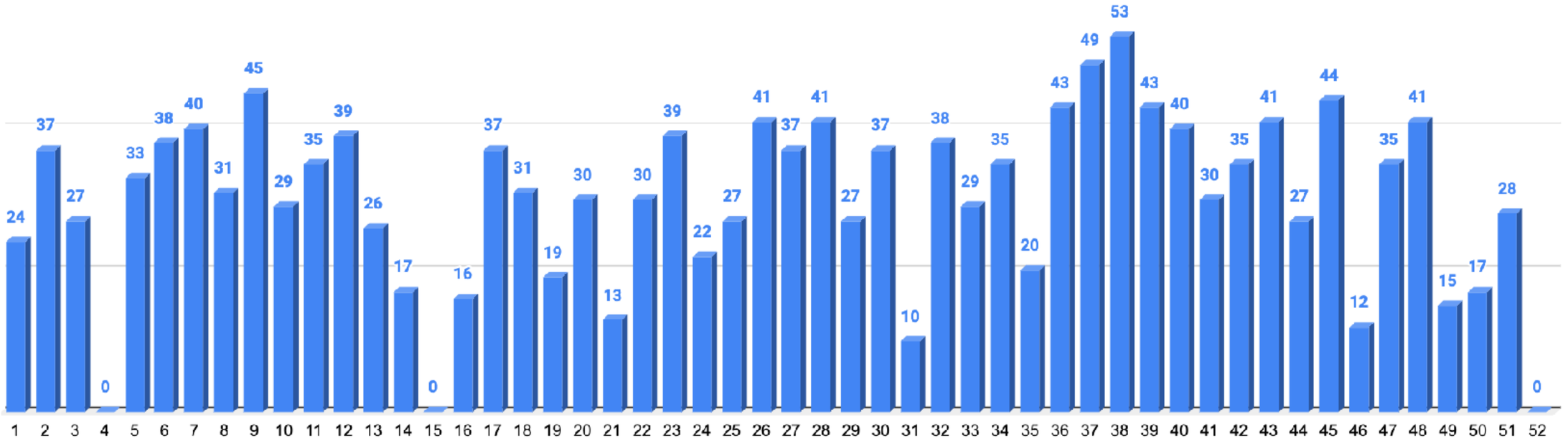
V. FACT

30 specimens / week

4 development days / month

NUMBERS

Specimens scanned per 2023

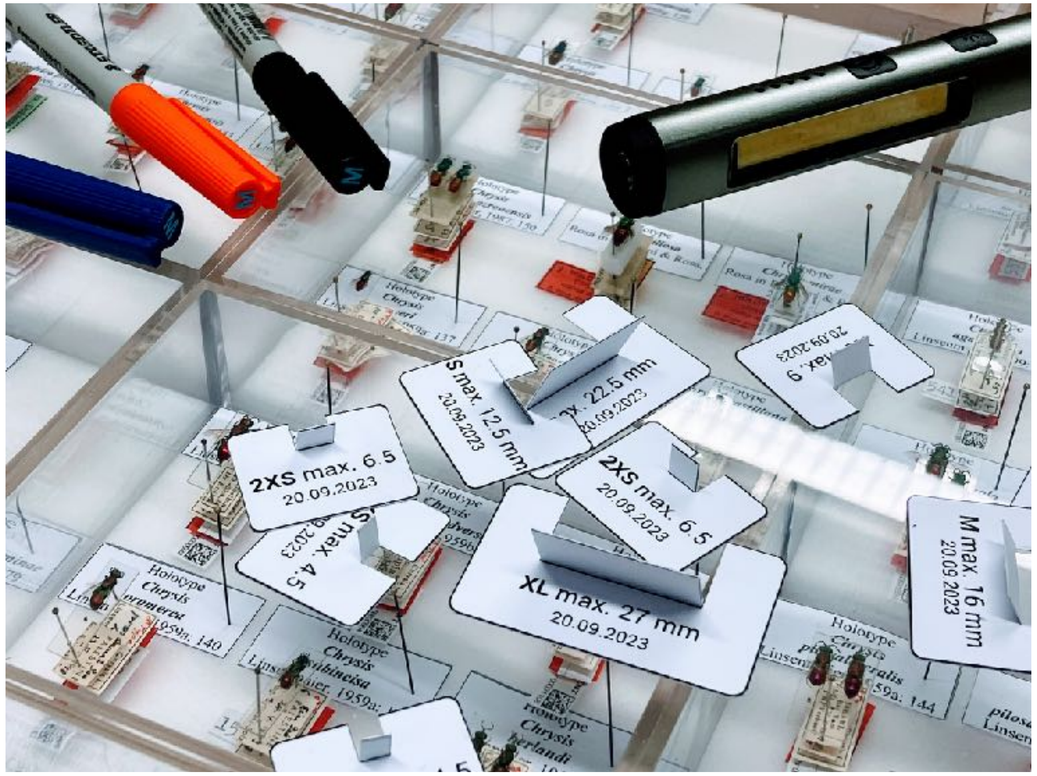


~30 specimens / week

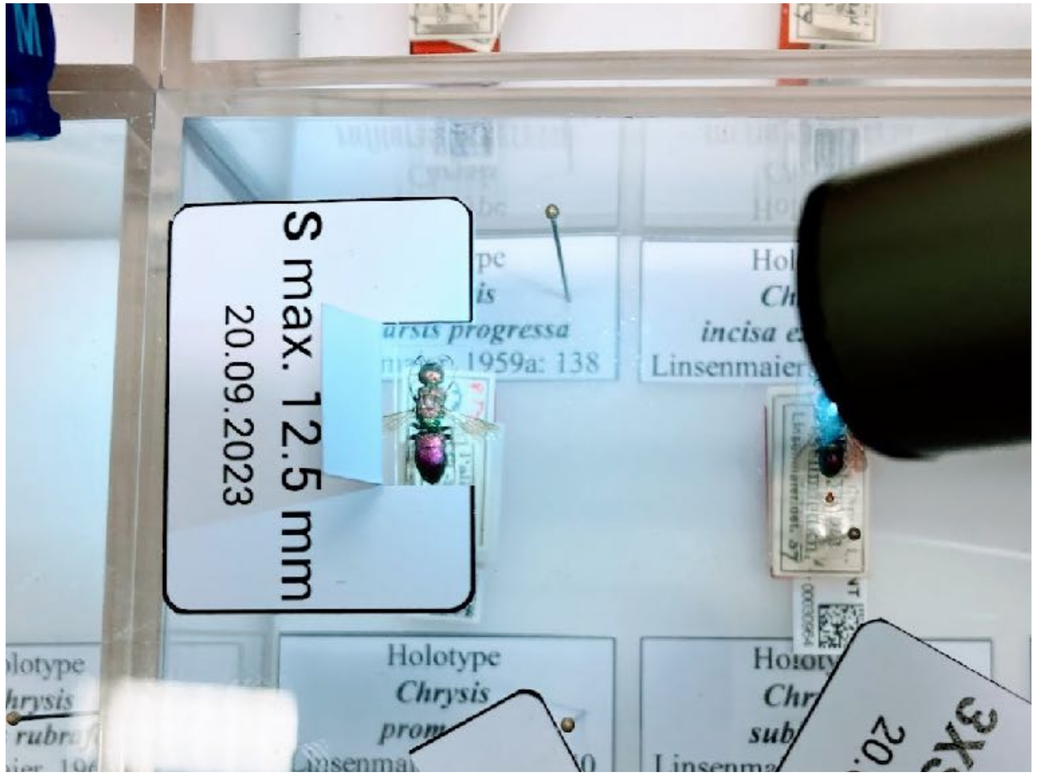
~1,900 specimens since 2022


Holotype
Hedychridium
Linsenmaier, 1959a: 56
Holotype
Hedychridium
mavrokoustakisi
1950
Holotype
Hedychridium
Linsenmaier, 1959a: 60
Holotype
Hedychridium
Linsenmaier, 1959a: 60
Holotype
Hedychridium
Linsenmaier, 1959a: 60
Holotype
Hedychridium
Linsenmaier, 1959a: 60
Holotype
Hedychridium
Linsenmaier, 1959a: 62
Holotype
Hedychridium
laevic
Linsenma
Holotype
Hedychridium
pseud
Linsen
1968: 34
Holotype
Hedychridium
aheneum feritatum
Linsen
1959b: 235
Holotype
Hedychridium
medi
Linsenma
37: 142
Holotype
Hedychridium
med
Linsenma
9a: 63
Holotype
Hedychridium
mediocre sardinien
Linsenmaier, 1959
Holotype
Hedychridium moricei
Linsenma
9: 373
Holotype
Hedychridium flavipes
Linsen
959a: 57
Holotype
Hedychridium
mediocre
Perrau
Holotype
Hedychridium
tune
Linsenmai
a: 64
Holotype
Hedychridium
marocc
Linsenm

LOGISTIC
Size determination



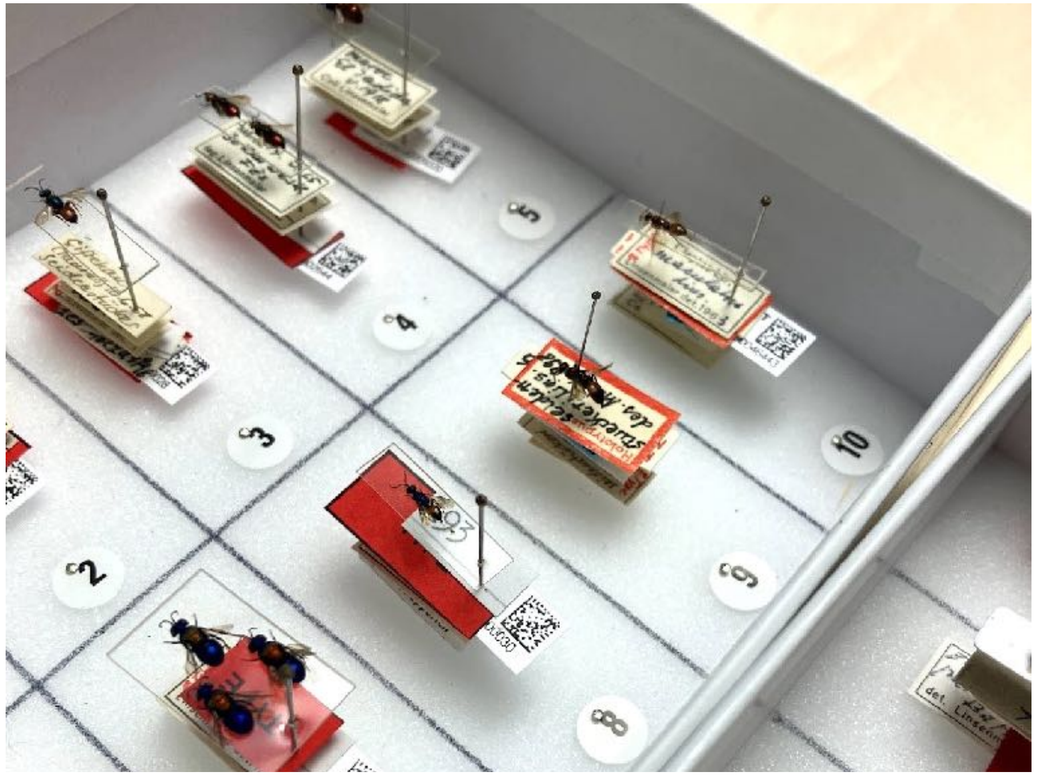
Jig for size determination



Size determination with closed drawer

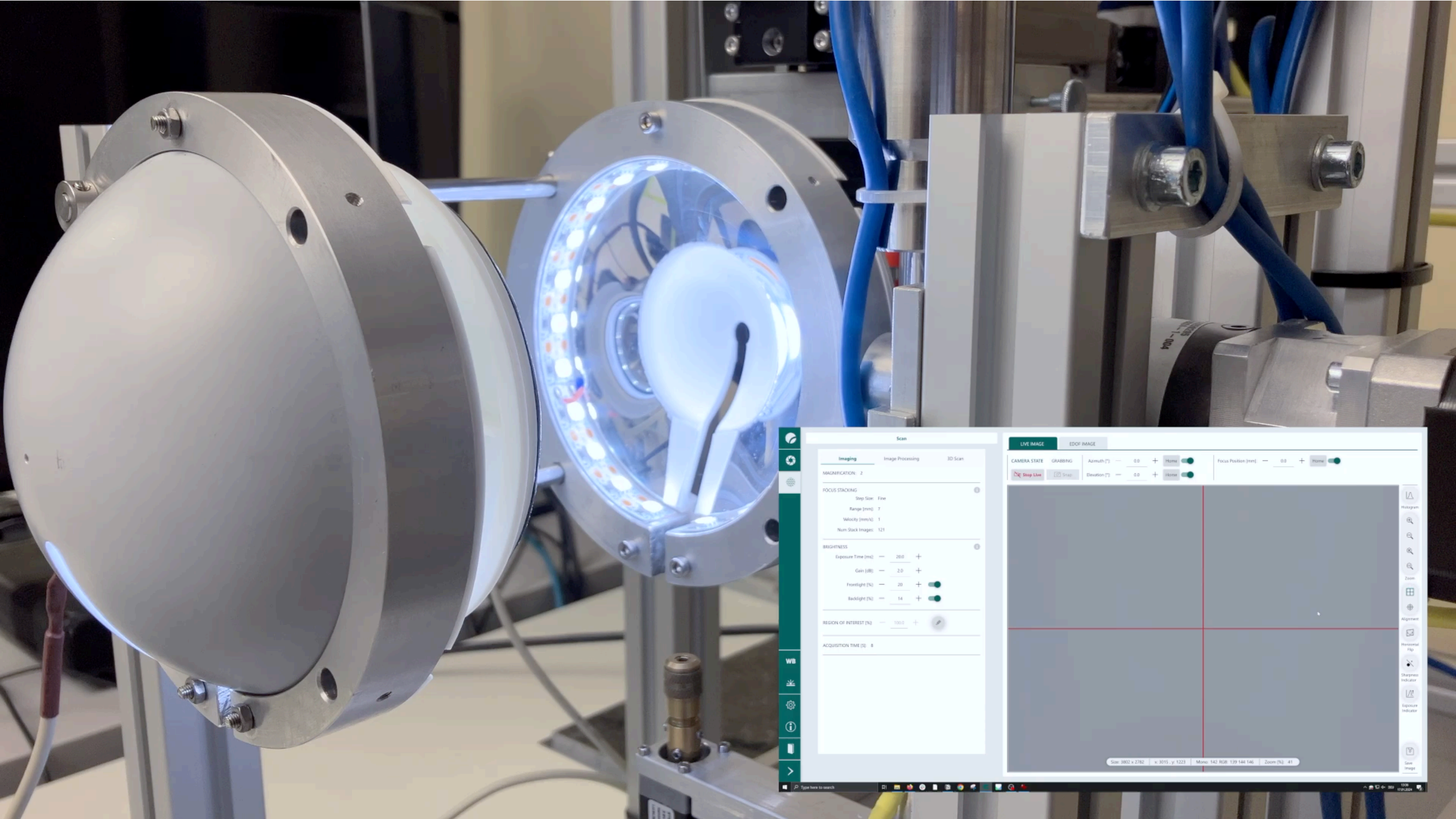
LOGISTIC
Size determination

Specimens are marked according to size



Work drawer, strictly processed in sequence


XS/S/M
XS/S/M
XS/S/M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Imaging
Image Processing
3D Scan
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Num Stack Images: 121
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ACQUISITION TIME [S]: 8
WB
LIVE IMAGE
EDOF IMAGE
CAMERA STATE: GRABBING
Stop Live
Snap
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Focus Position [mm]: 0.0
Histogram
Zoom
Alignment
Horizontal Flip
Sharpness Indicator
Exposure Indicator
Save Image
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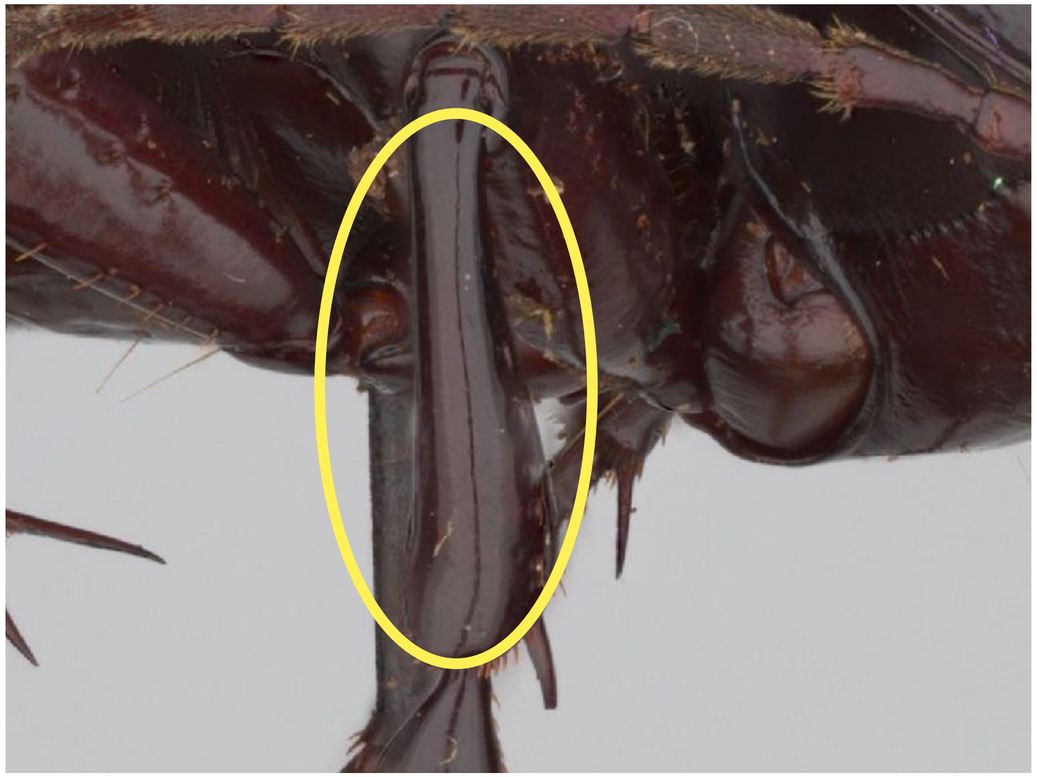
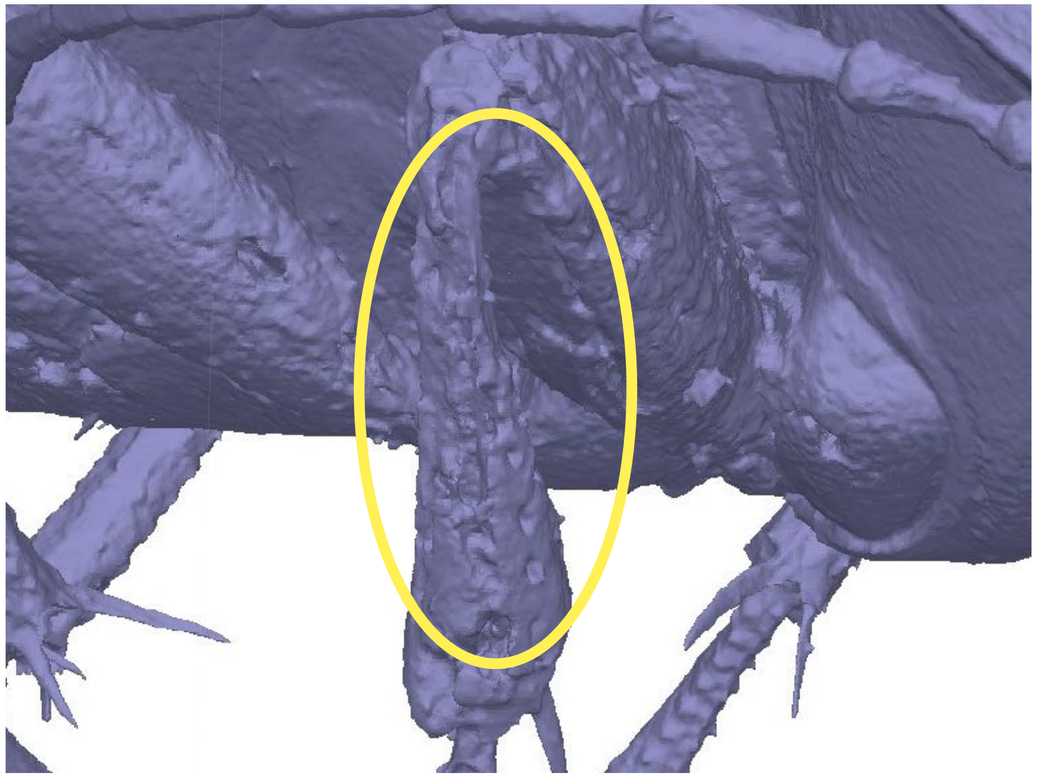
Zoom (%): 41
Type here to search

DARK REFLECTIVE SURFACE



EDOF IMAGE



3D DATA

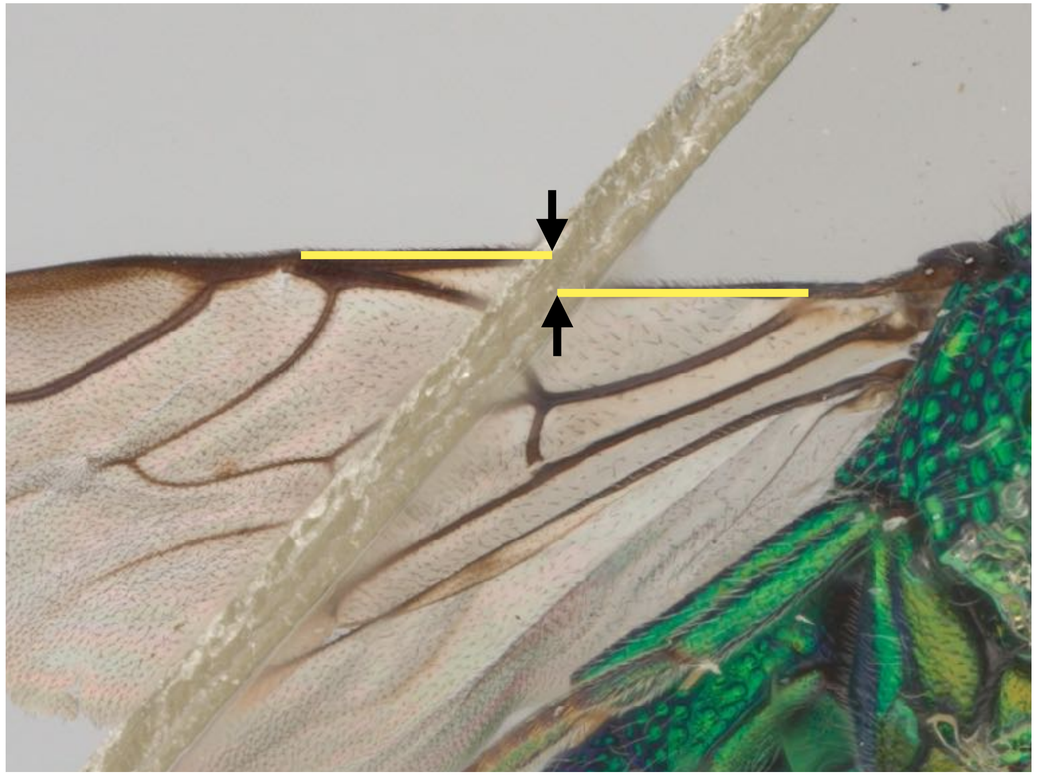
leads to surface artefacts

DARK REFLECTIVE SURFACE

EDOF IMAGE

Talkum powder

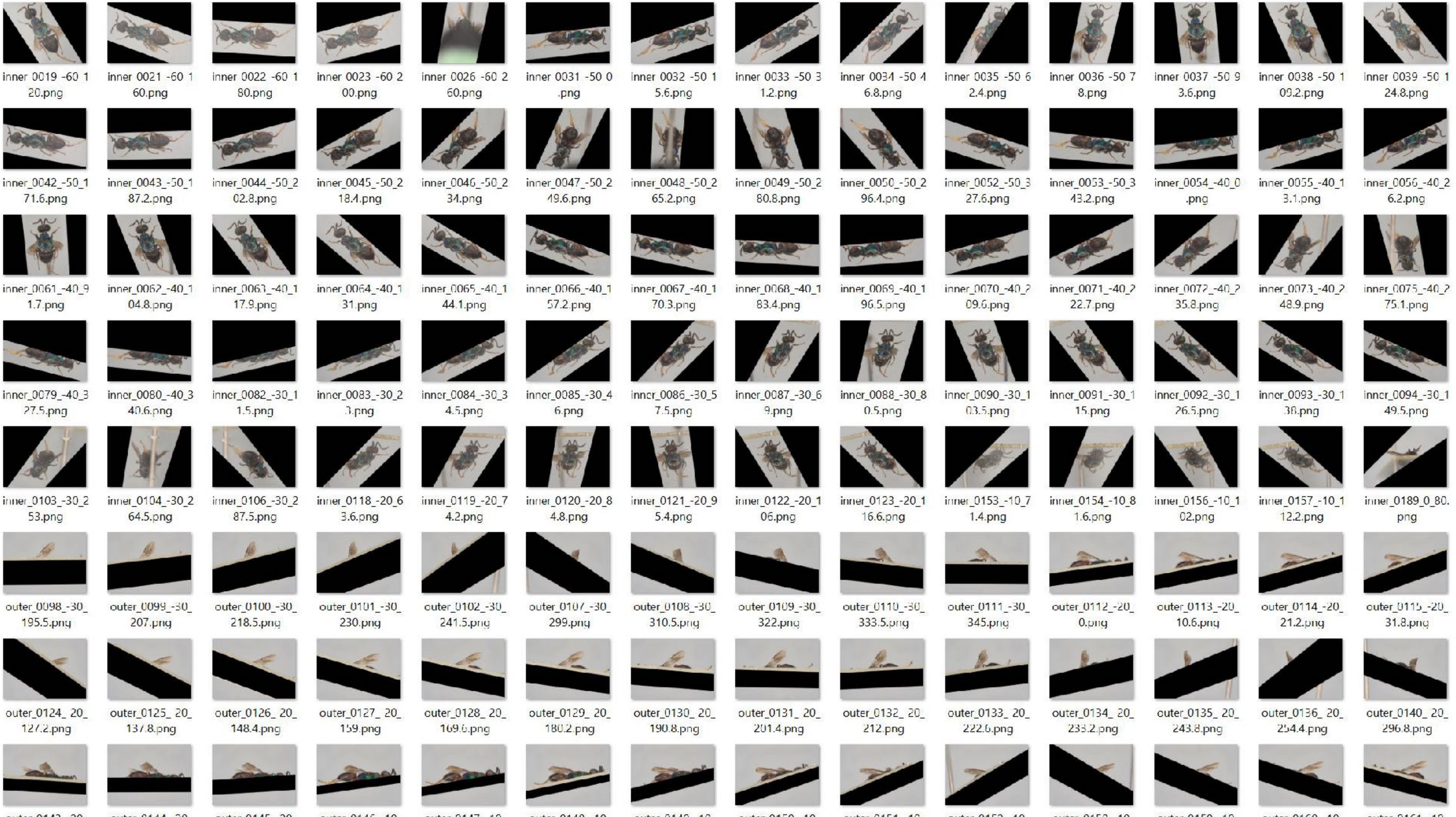
TRANSPARENT SHEET



TRANSPOARENT SHEET

Inner image

Outer image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inner 0022 -60 1 80.png
inner 0023 -60 2 00.png
inner 0026 -60 2 60.png
inner 0031 -50 0 .png
inner 0032 -50 1 5.6.png
inner 0033 -50 3 1.2.png
inner 0034 -50 4 6.8.png
inner 0035 -50 6 2.4.png
inner 0036 -50 7 8.png
inner 0037 -50 9 3.6.png
inner 0038 -50 1 09.2.png
inner 0039 -50 1 24.8.png
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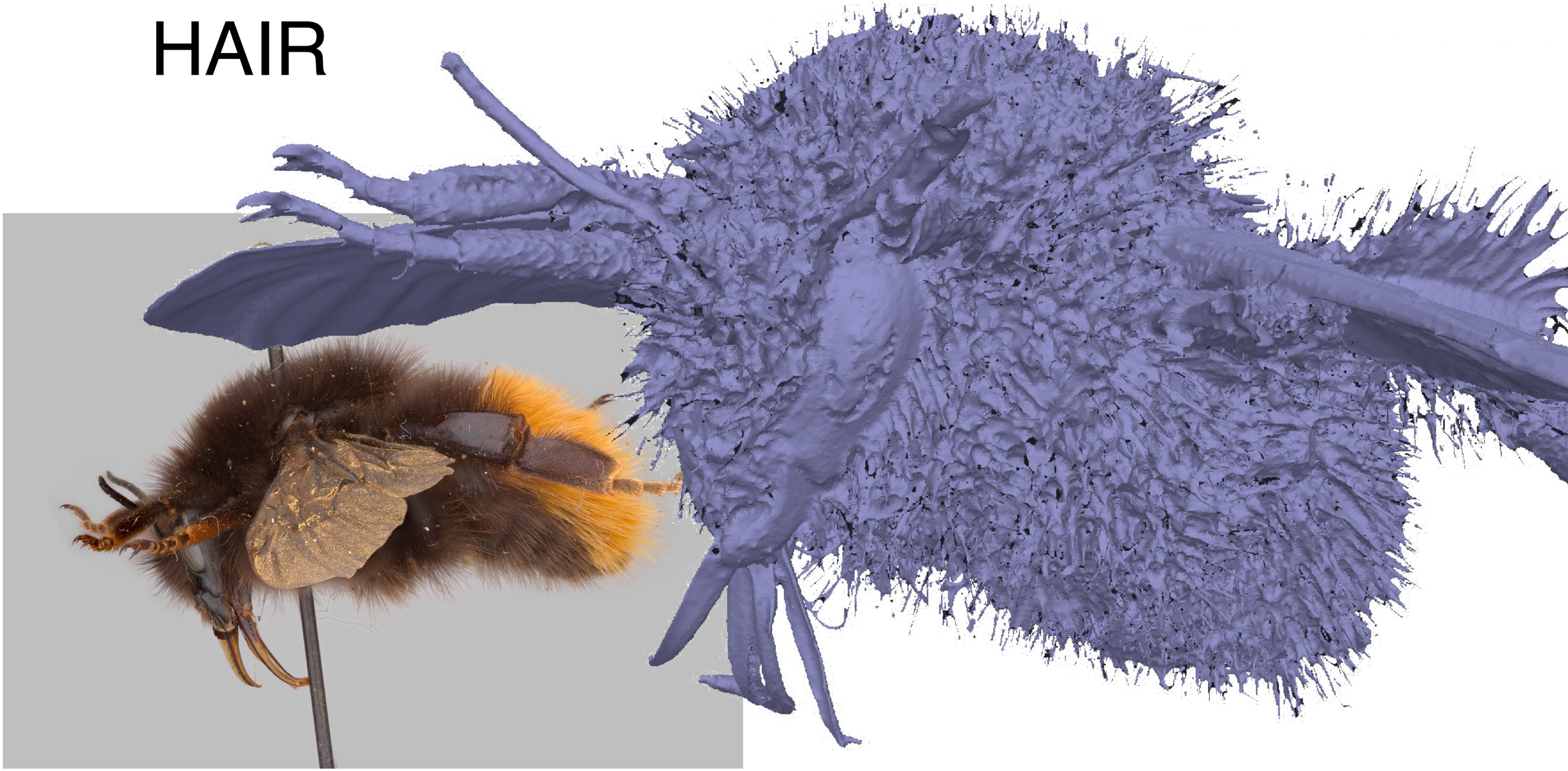
HAIR



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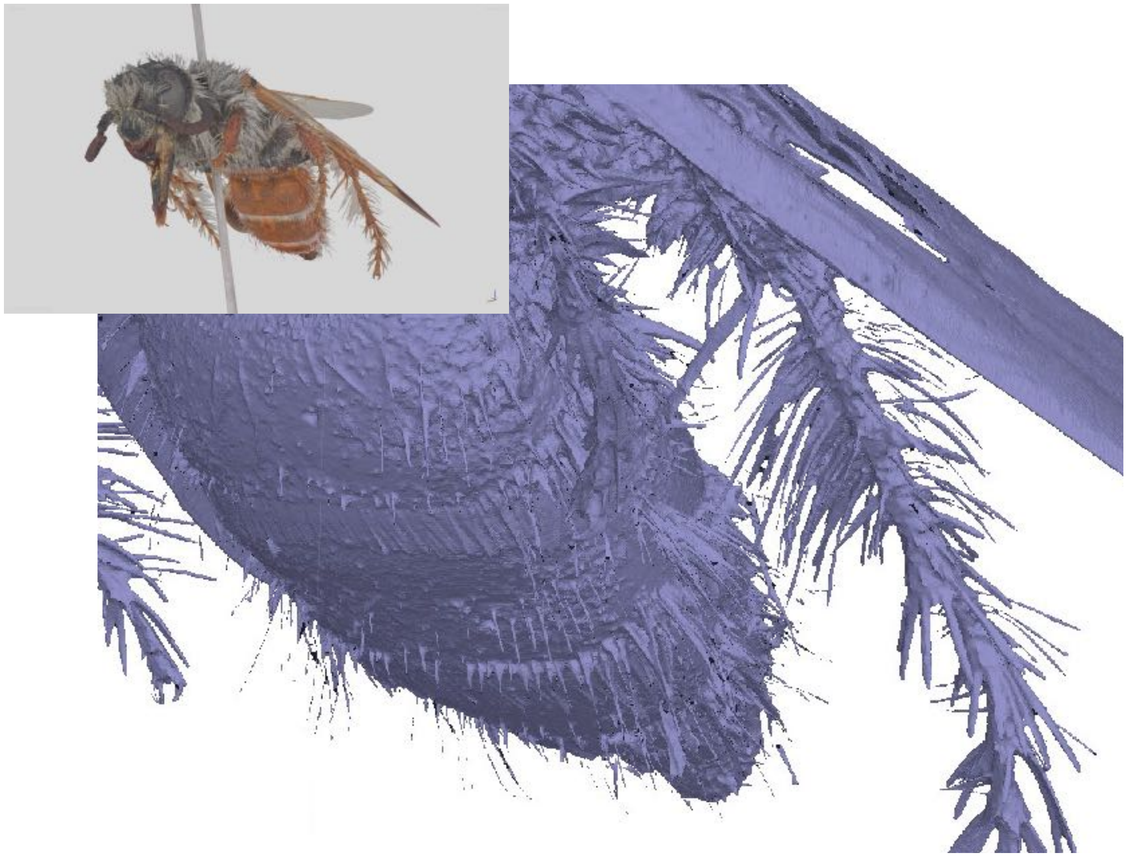
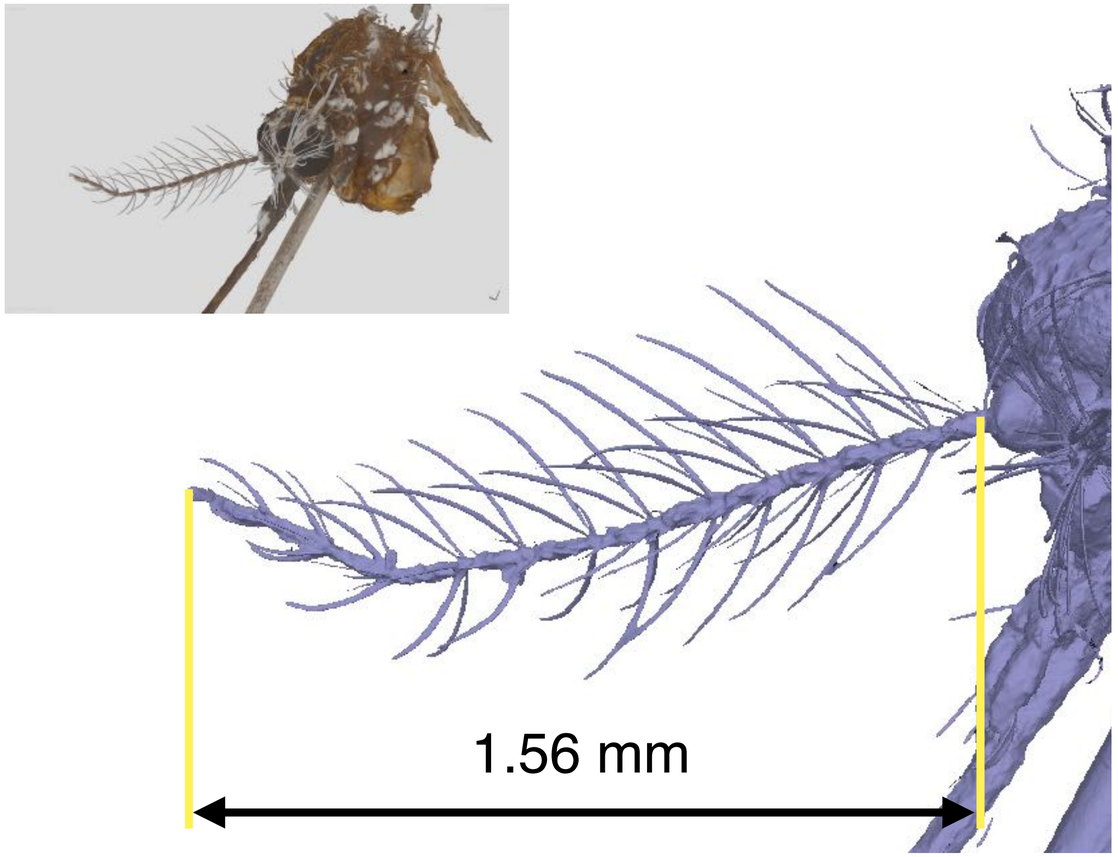


Scoliidae



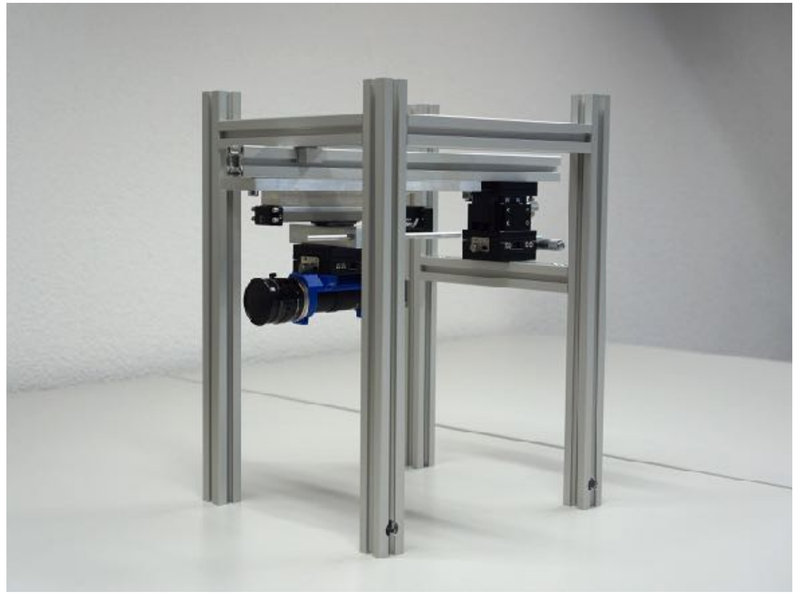
Mosquito

VI. FACT

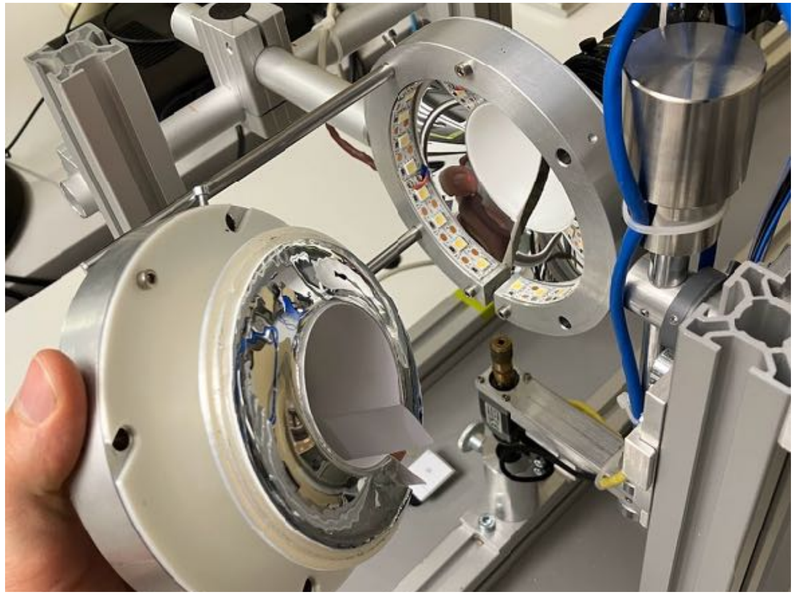
Agile solution finding

Making; Testing; Refining

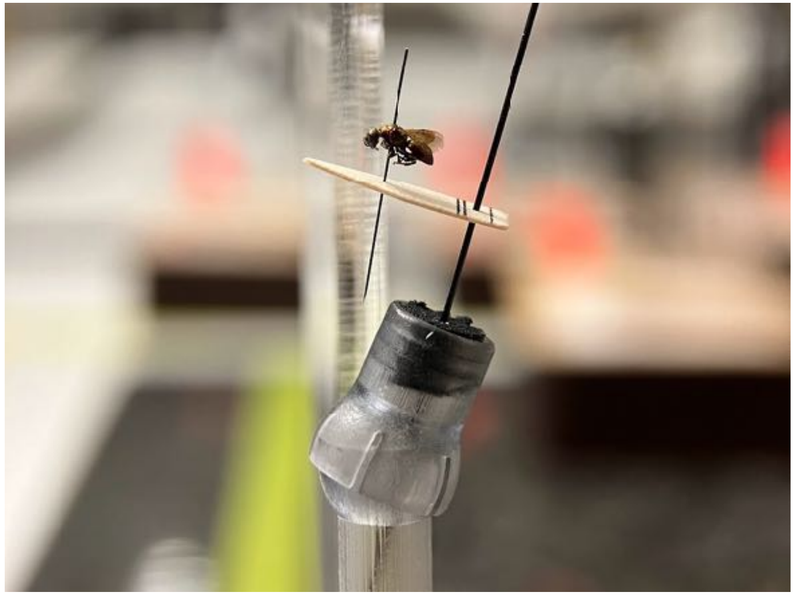
HARDWARE



Camera rail system

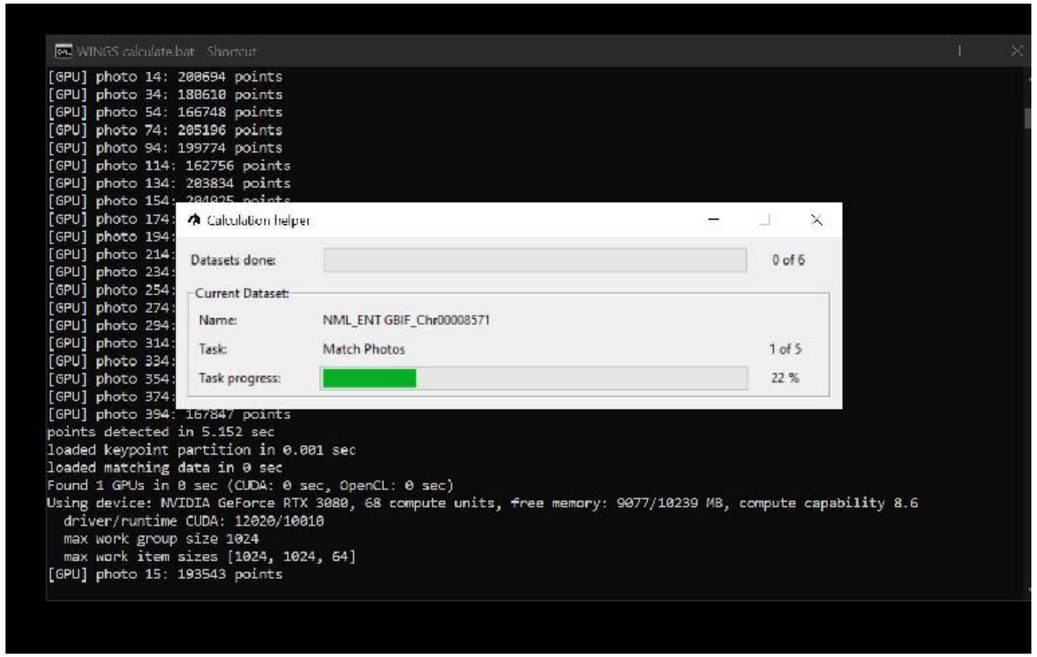


Light dome

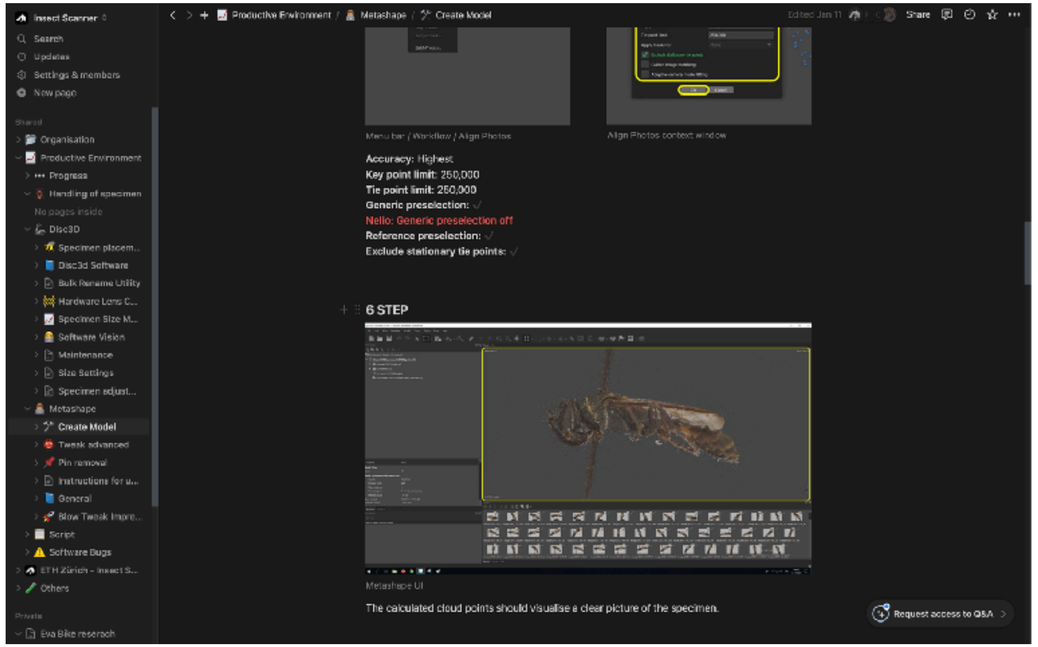


Ball head specimen adapter

SOFTWARE
Automation & Archive



Skripts



Notion database

ACHIEVEMENT

Beginning of the project

2 specimens / day

Size capacity > 6.5 mm

ACHIEVEMENT

Today

8 specimens / day

Size capacity > 25 mm