ESRF	**Experiment title:** Revealing the origin of structural colour in Heliconius Butterflies	**Experiment number**: LS2451
Beamline: ID02	**Date of experiment**: from: 9th October 2015 to:12th October 2015	**Date of report**: 8th September 2016
Shifts: 9	**Local contact(s)**: Dr Sylvain Prevost	*Received at ESRF:*

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Report:

We had three days of beam time on ID02 at ESRF to study the structural colour underlying Heliconius butterflies. These specimens were caught from the wild and span a large geographical area; from central America down through the Darian gap and into Ecuador, with strong variation in the strength of the overall structural colour. We collected over 20,000 more measurements from multiple points on the Butterfly wings. These measurements focused on the structural colour region of the wings, which are predominantly blue (see figure 1). One of the team, Adam Washington, wrote a utility to enable routine scanning, this generates code to run ID02. This is freely available for other users of this beamline.[1]

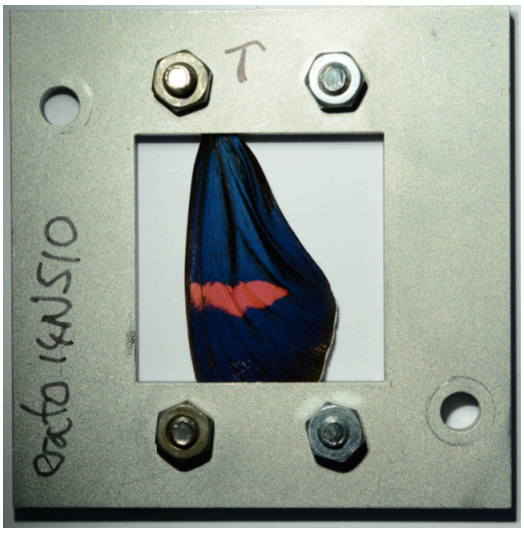

Figure 1. A Heliconius erato cyrbia forewing showing the dorsal side, with a strongly iridescent structural blue.

We received excellent support from Dr. Prevost and Dr. Narayanan who gave us great advice in using a cylindrical beamstop. This greatly helped in the analysis of the data. As the samples are in different orientations and our sampling of the structure varies, we were able to use the symmetry and correct for the differences in orientation and the collapse the data into a single quadrant.

We then used a big data type approach to compare the scattering patterns for all the data and using, a princial component based analysis, could group them into geographic clusters based on their structure. Importantly, this is done with no *a priori* knowledge about the species or where they are from in terms of latitude. This approach seems very powerful and grouped the butterflies based on their latitude with no human input as to how to sort the scattering patterns.

This novel approach allows us to correlate the genetic information we have on each individual species and identify the different structural types at work in the wings and evaluate relative similarities and differences between the 26 subspecies we studied during LS 2451. This is shown in figure 2. This work, along with further studies, will hopefully allow us to pinpoint the genetic instructions used to control and regulate the structural colour architecture.

Figure 2. Mapping the connectivity of Heliconius butterflies solely on a principle component based analysis. The thickness of the lines between two samples corresponds to their similarity.

References

1 http://rprospero.github.io/PhotoAlign/