# Measurement data and data processing code for "Generalized angle-orbital-angular-momentum Talbot effect and modulo mode sorting"

This document explains the accompanied measurement data as well as the Matlab codes used to process the data.

## Generalized angle-OAM Talbot effect (angular petal conversions)

The folder named "Generalized angle-OAM Talbot effect", contains the measurement data and data processing codes for the n-to-m angular petal conversions.

The measurement data is found in the folder structure:

- input --- Interferograms taken after the $1^{st}$ SLM, before the RCF
  - Petals in phase --- Angular petals in-phase. **Corresponds to stage (i) in Fig. 2 of the article**
  - Petals with Talbot (or custom) phase --- Petals modulated by phase masks. **Corresponds to stage (ii) in Fig. 2 of the article**
  - Signal (Intensity only) --- Signal without reference beam

- 3-to-4 / 4-to-3… etc. --- Interferograms taken after RCF and after $2^{nd}$ SLM. The name of the folder tells the petal-to-petal transformation in question. Each folder contains interferograms after the RCF, before and after the $2^{nd}$ Talbot phase mask. **Corresponds to stages (iii) and (iv) in Fig.2 of the article.** Also contains the signal without the reference beam.

The main Matlab script for data processing is 'field_reconstruction.m'. This script loads the interferograms, performs the complex field reconstruction of the angular petal fields, and calculates their OAM spectra. For more details, refer to the comments in the script.

Note: For an exact match with the data presented in the article, the fields need to be rotated by an additional 90 degrees and modulated by different global phase terms for each measurement to match the exact colors.

## OAM sorting

The folder named "OAM sorting" contains the measurement data and data processing codes for the OAM sorting experiments.

The measurement data is found in the folder structure:

- 2_3zT, 3_4zT, etc. --- These folders, named by the length of RCF used, contain output images of the implemented OAM sorters. The figures are named according to the input OAM value. 'bg.png' contains the background noise (no signal on camera).

- Superpos --- This folder (only within 7_9zT and 7_12zT) contains the output images of the OAM sorters where the input was a superposition of multiple OAM modes. The figure names tell the used OAM modes, as well as their relative amplitudes. e.g. 'l15_16_17_1_1.414_1.732.png' corresponds to a superposition of modes with l=15, l=16 and l=17, with relative amplitudes 1, 1.414, 1.732.

The main Matlab script for data processing is 'OAM_sorting.m'. This script loads the image files, defines the sorting sectors, and samples the field accordingly. From this, the script will generate the crosstalk matrix and calculate the sorting accuracy metric. For more details, refer to the comments in the script.

The secondary Matlab script for processing the OAM superpositions is 'OAM_sorting_superpos.m', which works very similarly to 'OAM_sorting.m'. For more details, refer to the comments in the script.

## OAM sorting principle

The Matlab scripts SI_fig3/4/5.m simulate the working principle of OAM sorting, and can be used to generate the Supplementary Material figures 3/4/5, respectively. The matlab script modinv is the mutiplicative modular inverse operation (written by John D'Errico) used in scripts SI_fig3/4/5.

## System requirements

Software required: MATLAB.

Scripts tested on MATLAB version '24.1.0.2537033 (R2024a)', using Windows 10 Version 22H2 (OS Build 19045.4894).

## Instructions for use

Run the scripts 'field_reconstruction.m', 'OAM_sorting.m', 'OAM_sorting_superpos.m' or 'SI_fig3/4/5.m' in MATLAB without altering the subfolder structure. Datasets can be changed in the first three scripts by uncommenting the settings for one dataset at a time. Refer to the comments in the scripts for more details.

Expected runtime on a "normal" computer: a few seconds.

For the expected output, refer to the article titled "Generalized angle-orbital-angular-momentum Talbot effect and modulo mode sorting".