

# Improved 3D-OCT Signal Quality and Accuracy in Retinal Pathologies using Image Registration based Motion Correction and Merging of Multiple Orthogonal Raster Scans

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## Introduction

- OCT [1] has found widespread usage in ophthalmologic practice because of its ability to non-invasively capture 2D and 3D images of the human retina with high resolution
- There is a need to acquire highly accurate quantitative 3D information of retinal pathologies such as drusen in order to be able to assess progression, treatment efficiency and pathogenesis
- Motion during 3D OCT imaging such as drifts and saccades in the transverse directions and respiration or pulse induced motion in the axial direction leads to motion artifacts which limit the accuracy of quantitative measurements
- Purpose:** To evaluate whether image registration based motion correction and merging of multiple raster scanned volumes of pathologic eyes can help improve the visualization of retinal pathologies as opposed to unprocessed volume scans

## Methods

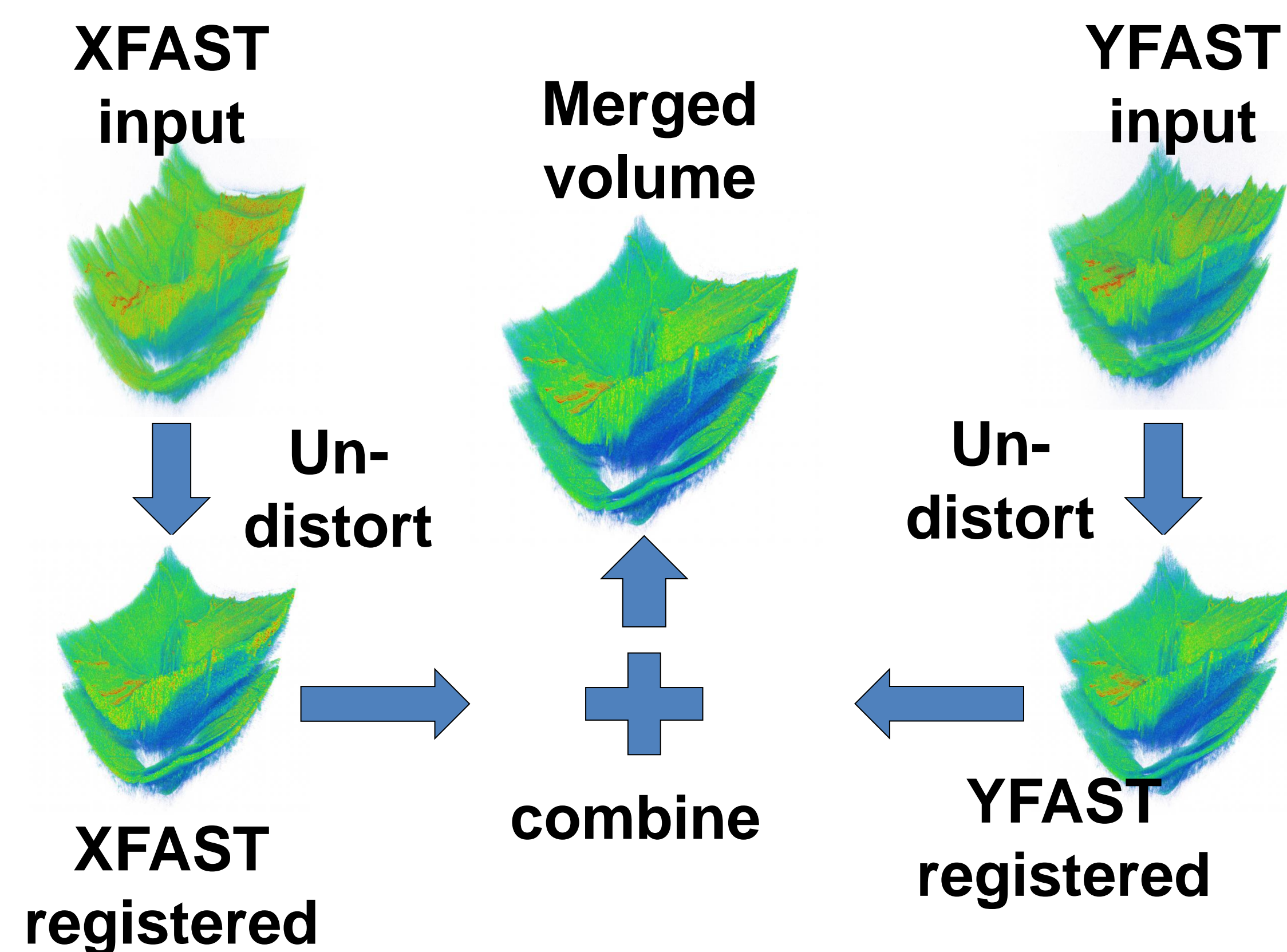


Figure 1: Volume registration and merging schematic for two input volumes.

- The proposed motion correction method [2] takes two or more raster scanned OCT volumes with orthogonal fast scan axis as input (see Fig. 1)
- A dense displacement field is estimated for each input volume to register the volumes and to correct for motion artifacts
- Estimation is performed by multi stage, multi resolution optimization of a global objective function based on two goals:
  - First: After optimization, the undistorted volumes should be similar

- Second: Motion is assumed to be smooth within short periods of time
- After optimization, the input volumes are undistorted and a single merged motion corrected volume with improved signal quality is constructed

## Experiments

- Orthogonal volumes of the macular region of eyes of 19 subjects (age 69,9 +/- 16,8 years) were imaged at New England Eye Center using a MIT 850 nm based ultra high resolution (3  $\mu$ m) system operating at 90 kHz A-Scan rate [3]
- In total, 25 eyes were imaged
- All subjects had retinal pathologies with the most common pathology being age related macular degeneration (13 subjects)
- The scan patterns covered 6 by 6 mm on the retina that were sampled with 400 by 400 A-Scans in approx. 2 seconds per volume
- At least two orthogonal volumes per eye were used as input for the motion correction and merging algorithm
- After correction and merging, visual inspection of the resulting volumes in contrast to the input volumes was used to assess whether motion artifacts could be removed and whether signal quality was improved

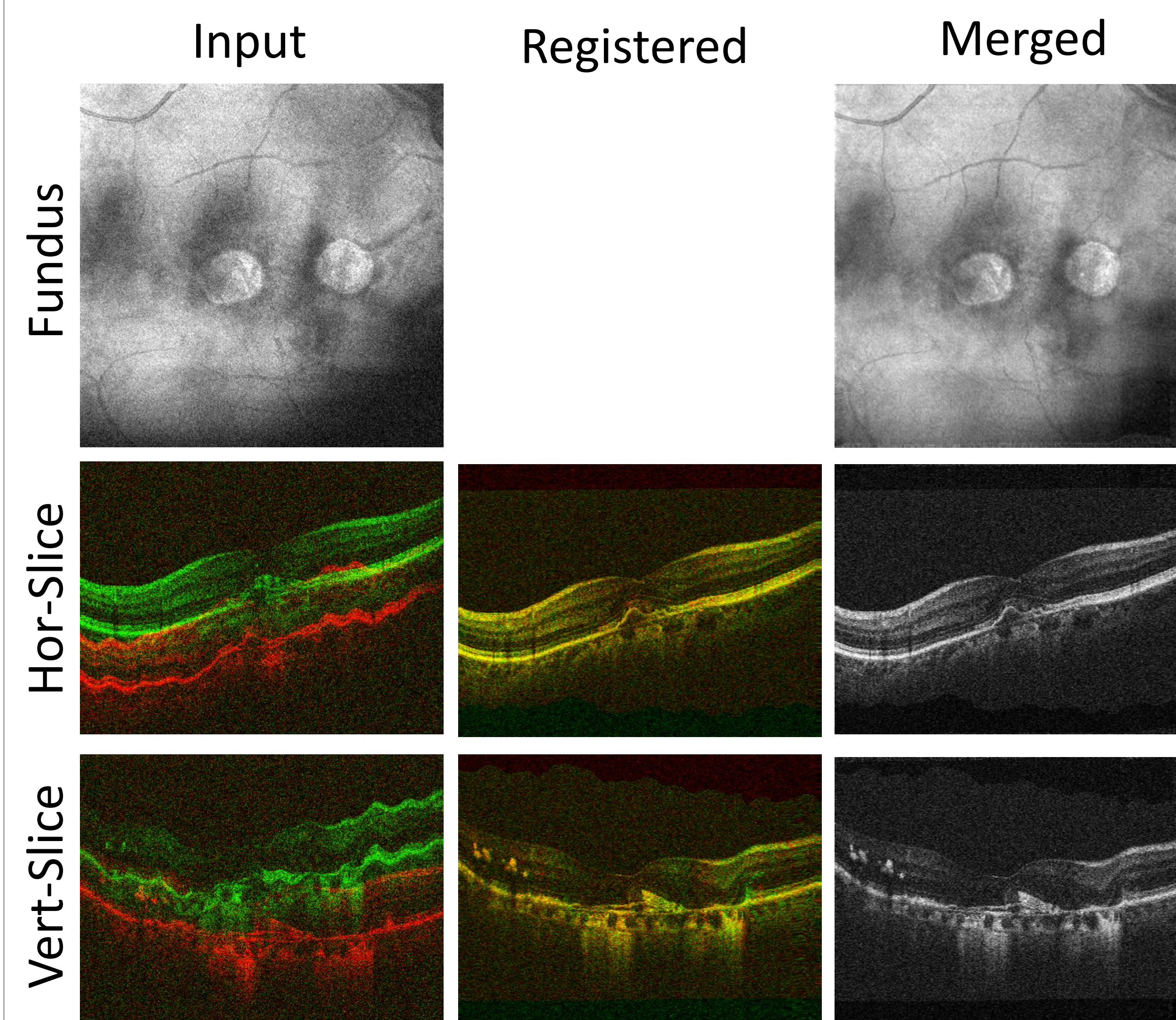


Figure 2: Example dataset of a 75 year old subject with dry AMD and drusen. In total 2 volumes were registered and merged.

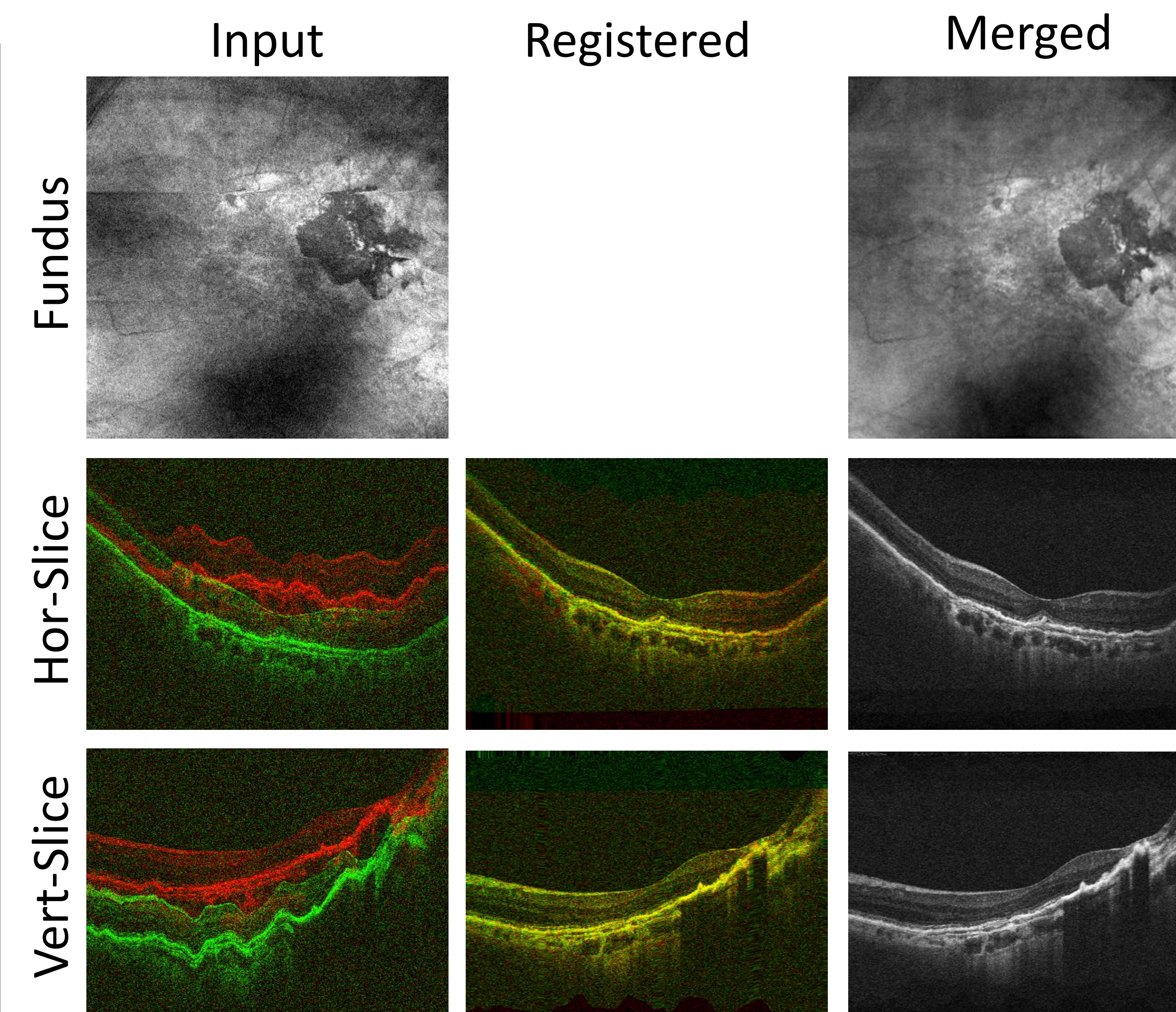


Figure 3: Example dataset of a 86 year old subject with dry AMD. In total 6 volumes were registered and merged.

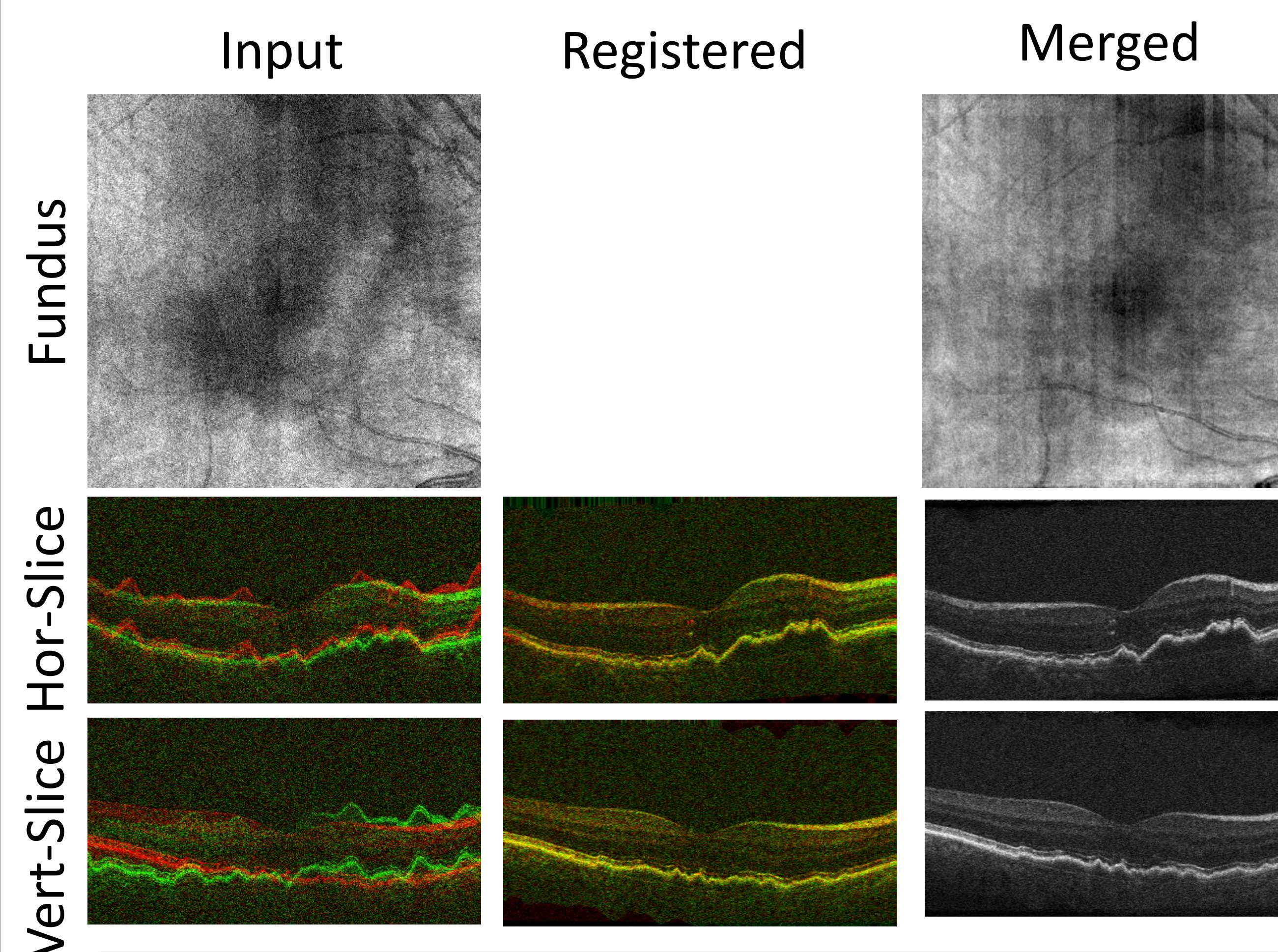


Figure 4: Example dataset of a 92 year old subject with dry AMD. In total 5 volumes were registered and merged.

## Discussion

- Visual inspection shows that the technique is able to remove motion artifacts and improve signal quality in 21 of all 25 eyes.
- The visibility of pathologic features such as drusen, neovascularization and retinal detachments is appreciably improved
- Densely sampled motion corrected raster scans allow for better sampling of the retina and make it less likely for pathology to be missed
- Corrected and merged data allows for appreciation of the 3D nature of defects

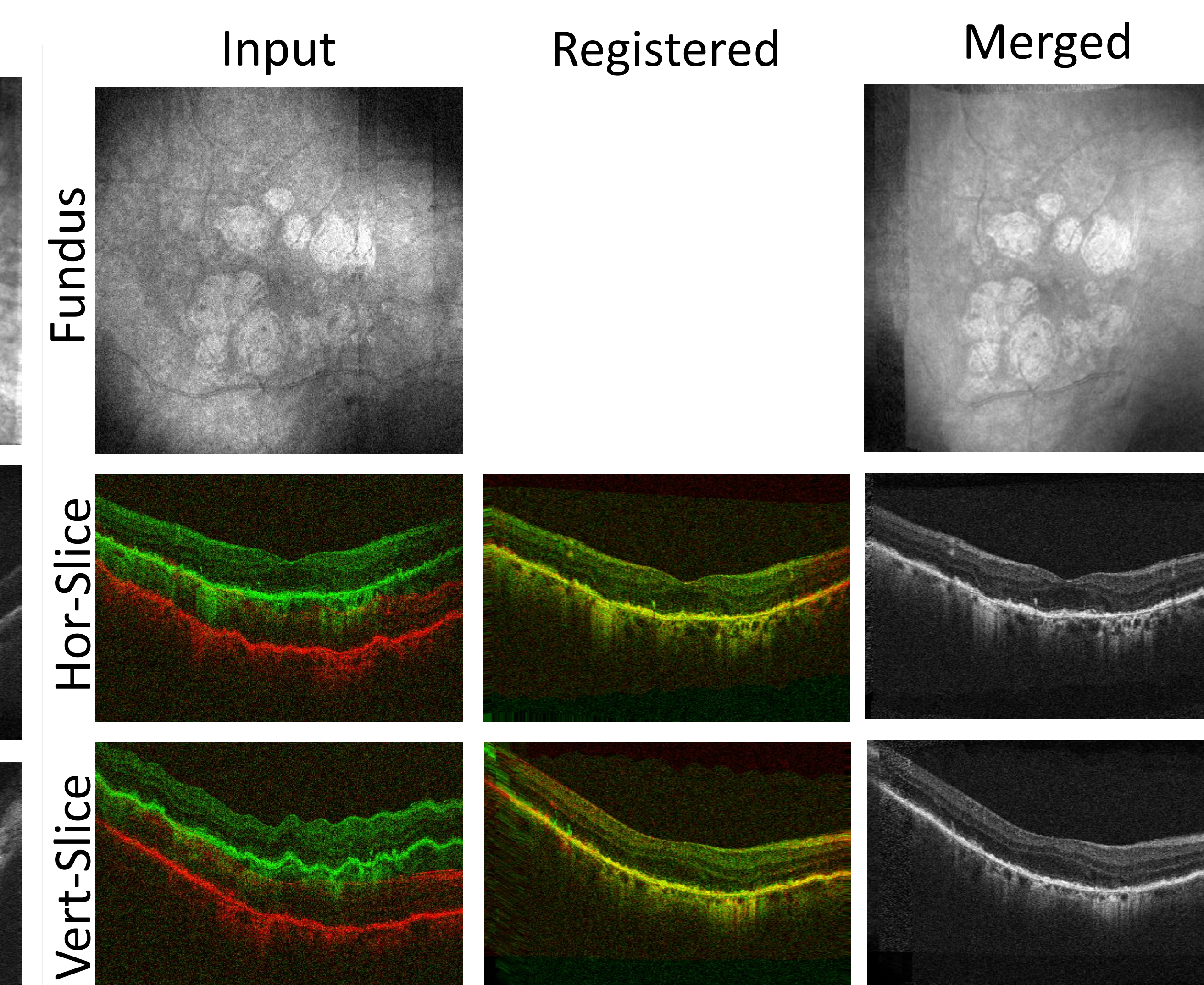


Figure 5: Example dataset of a 85 year old subject with dry AMD. In total 4 volumes were registered and merged.

## Conclusion

- Results suggest that the proposed method can help improve visualization and 3D analysis of retinal pathology
- Since signal quality in pathologic eyes tends to be lower than in normal eyes, signal improvement through merging of multiple data sets is especially useful

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### Author Disclosure:

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