Light Sheet Fluorescence Microscopy (LSFM) of whole organs, in particular the brain, offers a plethora of biological data imaged in 3D. This technique is however often hindered by cumbersome non-Automated analysis methods. Here we describe an approach to fully automate the analysis by integrating with data from the Allen Institute of Brain Science (AIBS), to provide precise assessment of the distribution and action of peptide-based pharmaceuticals in the brain. To illustrate this approach, we examined the acute central nervous system effects of the glucagon-like peptide-1 (GLP-1) receptor agonist liraglutide. Peripherally administered liraglutide accessed the hypothalamus and brainstem, and led to activation in several brain regions of which most were intersected by projections from neurons in the lateral parabrachial nucleus. Collectively, we provide a rapid and unbiased analytical framework for LSFM data which enables quantification and exploration based on data from AIBS to support basic and translational discovery.