



June 6, 2025

Sora Neuroscience, Inc.
% John Smith
Partner
Hogan Lovells US LLP
Columbia Square
555 Thirteenth Street, NW
Washington, District of Columbia 20004

Re: K251009

Trade/Device Name: Cirrus Resting State fMRI Software
Regulation Number: 21 CFR 892.2050
Regulation Name: Medical Image Management And Processing System
Regulatory Class: Class II
Product Code: QIH
Dated: April 1, 2025
Received: April 1, 2025

Dear John Smith:

We have reviewed your section 510(k) premarket notification of intent to market the device referenced above and have determined the device is substantially equivalent (for the indications for use stated in the enclosure) to legally marketed predicate devices marketed in interstate commerce prior to May 28, 1976, the enactment date of the Medical Device Amendments, or to devices that have been reclassified in accordance with the provisions of the Federal Food, Drug, and Cosmetic Act (the Act) that do not require approval of a premarket approval application (PMA). You may, therefore, market the device, subject to the general controls provisions of the Act. Although this letter refers to your product as a device, please be aware that some cleared products may instead be combination products. The 510(k) Premarket Notification Database available at <https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpmn/pmn.cfm> identifies combination product submissions. The general controls provisions of the Act include requirements for annual registration, listing of devices, good manufacturing practice, labeling, and prohibitions against misbranding and adulteration. Please note: CDRH does not evaluate information related to contract liability warranties. We remind you, however, that device labeling must be truthful and not misleading.

If your device is classified (see above) into either class II (Special Controls) or class III (PMA), it may be subject to additional controls. Existing major regulations affecting your device can be found in the Code of Federal Regulations, Title 21, Parts 800 to 898. In addition, FDA may publish further announcements concerning your device in the Federal Register.

Additional information about changes that may require a new premarket notification are provided in the FDA guidance documents entitled "Deciding When to Submit a 510(k) for a Change to an Existing Device" (<https://www.fda.gov/media/99812/download>) and "Deciding When to Submit a 510(k) for a Software Change to an Existing Device" (<https://www.fda.gov/media/99785/download>).

Your device is also subject to, among other requirements, the Quality System (QS) regulation (21 CFR Part 820), which includes, but is not limited to, 21 CFR 820.30, Design controls; 21 CFR 820.90, Nonconforming product; and 21 CFR 820.100, Corrective and preventive action. Please note that regardless of whether a change requires premarket review, the QS regulation requires device manufacturers to review and approve changes to device design and production (21 CFR 820.30 and 21 CFR 820.70) and document changes and approvals in the device master record (21 CFR 820.181).

Please be advised that FDA's issuance of a substantial equivalence determination does not mean that FDA has made a determination that your device complies with other requirements of the Act or any Federal statutes and regulations administered by other Federal agencies. You must comply with all the Act's requirements, including, but not limited to: registration and listing (21 CFR Part 807); labeling (21 CFR Part 801); medical device reporting (reporting of medical device-related adverse events) (21 CFR Part 803) for devices or postmarketing safety reporting (21 CFR Part 4, Subpart B) for combination products (see <https://www.fda.gov/combination-products/guidance-regulatory-information/postmarketing-safety-reporting-combination-products>); good manufacturing practice requirements as set forth in the quality systems (QS) regulation (21 CFR Part 820) for devices or current good manufacturing practices (21 CFR Part 4, Subpart A) for combination products; and, if applicable, the electronic product radiation control provisions (Sections 531-542 of the Act); 21 CFR Parts 1000-1050.

All medical devices, including Class I and unclassified devices and combination product device constituent parts are required to be in compliance with the final Unique Device Identification System rule ("UDI Rule"). The UDI Rule requires, among other things, that a device bear a unique device identifier (UDI) on its label and package (21 CFR 801.20(a)) unless an exception or alternative applies (21 CFR 801.20(b)) and that the dates on the device label be formatted in accordance with 21 CFR 801.18. The UDI Rule (21 CFR 830.300(a) and 830.320(b)) also requires that certain information be submitted to the Global Unique Device Identification Database (GUDID) (21 CFR Part 830 Subpart E). For additional information on these requirements, please see the UDI System webpage at <https://www.fda.gov/medical-devices/device-advice-comprehensive-regulatory-assistance/unique-device-identification-system-udi-system>.

Also, please note the regulation entitled, "Misbranding by reference to premarket notification" (21 CFR 807.97). For questions regarding the reporting of adverse events under the MDR regulation (21 CFR Part 803), please go to <https://www.fda.gov/medical-devices/medical-device-safety/medical-device-reporting-mdr-how-report-medical-device-problems>.

For comprehensive regulatory information about medical devices and radiation-emitting products, including information about labeling regulations, please see Device Advice (<https://www.fda.gov/medical-devices/device-advice-comprehensive-regulatory-assistance>) and CDRH Learn (<https://www.fda.gov/training-and-continuing-education/cdrh-learn>). Additionally, you may contact the Division of Industry and Consumer Education (DICE) to ask a question about a specific regulatory topic. See the DICE website (<https://www.fda.gov/medical-devices/device-advice-comprehensive-regulatory->

[assistance/contact-us-division-industry-and-consumer-education-dice](#)) for more information or contact DICE by email (DICE@fda.hhs.gov) or phone (1-800-638-2041 or 301-796-7100).

Sincerely,

A handwritten signature in black ink, appearing to read 'D. Krainak', is written over a large, light blue, semi-transparent 'FDA' watermark.

Daniel M. Krainak, PhD
Assistant Director
DHT8C: Division of Radiological
Imaging and Radiation Therapy Devices
OHT8: Office of Radiological Health
Office of Product Evaluation and Quality
Center for Devices and Radiological Health

Enclosure

Indications for Use

510(k) Number (if known)

K251009

Device Name

Cirrus Resting State fMRI Software

Indications for Use (Describe)

Cirrus Resting State fMRI Software (Cirrus) is a software solution that performs magnetic resonance image processing including the processing of blood oxygen level dependent (BOLD) functional magnetic resonance imaging (fMRI) data, resting state fMRI analysis, and output generation. Cirrus generates task-analogous motor, language, and vision resting state fMRI correlation maps, in DICOM® format for visualization and analysis external to Cirrus.

Cirrus maps have been found to vary in normal subjects tested by repeat MR acquisition under conditions where no functional mapping change was expected. Medical imaging processing systems intended for BOLD fMRI post-processing are adjunctive and not intended to replace direct functional mapping procedures.

Typical users of Cirrus are medical professionals, including but not limited to surgeons, radiologists, and other clinicians.

Type of Use (Select one or both, as applicable)

☒ Prescription Use (Part 21 CFR 801 Subpart D)

☐ Over-The-Counter Use (21 CFR 801 Subpart C)

CONTINUE ON A SEPARATE PAGE IF NEEDED.

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510(k) SUMMARY

Cirrus Resting State fMRI

(K251009)

Submitter

Sora Neuroscience, Inc.
4406 Beard Ave. S., Suite UL2
Minneapolis, MN 55410
+1 612-234-1766

Contact Person: Stephen Schaefer
Date Prepared: June 4, 2025

Device

Name of Device: Cirrus Resting State fMRI Software

Common or Usual Name: Functional MRI Post-Processing Software

Classification Name: Medical image management and processing system (21 CFR 892.2050)

Regulatory Class: Class II

Product Code: QIH

Predicate Device

Omniscient Neurotechnology Pty Ltd (o8t), Quicktome Software Suite, K222359.

Device Description

Cirrus Resting State fMRI Software (Cirrus) is software as a medical device (SaMD) that performs image processing, resting state functional magnetic resonance imaging analysis, and output generation. Cirrus is launched by a host computing system external of Cirrus.

Cirrus processes an individual patient's brain magnetic resonance imaging (MRI) dataset which includes blood oxygenation level dependent (BOLD) functional MRI (fMRI) data and structural MRI data. Software components making up Cirrus include (i) a suite of fMRI preprocessing tools; (ii) a voxel-wise resting state fMRI correlation map generator, (iii) a nonadaptive machine-learning based resting state network (RSN) membership scoring algorithm; and (iv) an RSN map output generator.

The output of Cirrus is a set of patient-specific, task-analogous motor, language, and vision resting state fMRI correlation maps. The output maps correspond to three canonical, pre-defined brain resting state networks:

- Sensorimotor network (SMN),
- Language network (LAN), and
- Vision network (VIS).

Output resting state network maps are provided in DICOM® format for visualization and analysis external of Cirrus and accompanied by a quality report.

Intended Use / Indications for Use

Cirrus Resting State fMRI Software (Cirrus) is a software solution that performs magnetic resonance image processing including the processing of blood oxygen level dependent (BOLD) functional magnetic resonance imaging (fMRI) data, resting state fMRI analysis, and output generation. Cirrus generates task-analogous motor, language, and vision resting state fMRI correlation maps, in DICOM® format for visualization and analysis external to Cirrus.

Cirrus maps have been found to vary in normal subjects tested by repeat MR acquisition under conditions where no functional mapping change was expected. Medical imaging processing systems intended for BOLD fMRI post-processing are adjunctive and not intended to replace direct functional mapping procedures.

Typical users of Cirrus are medical professionals, including but not limited to surgeons, radiologists, and other clinicians.

Summary of Technological Characteristics as Compared to Predicate

Both the subject device and predicate device are based on the same scientific and technological principle, namely, that spontaneous neural activations revealed in resting state BOLD fMRI data exhibit temporal correlation within functionally connected brain locations. At a high level, both the subject device and predicate device have these same technological elements:

- Both are software applications for post-processing resting state BOLD fMRI data.
- Both co-register BOLD fMRI data with anatomical scan data.
- Both perform fMRI preprocessing on the resting state BOLD fMRI data.
- Both compute a correlation matrix for the resting state BOLD fMRI data.
- Both perform resting state fMRI analysis to generate output task-analogous motor, language, and vision resting state fMRI correlation maps.

To the extent technological differences exist between the subject device and the predicate device regarding the details of their respective BOLD fMRI preprocessing pipelines and methodologies for resting state fMRI analysis, the technological characteristics of the subject device do not raise new questions of safety or effectiveness.

Performance Data

The design and development of Cirrus complies with direction found in ISO 13485:2016 (Medical device quality management requirements and systems), IEC-62304:2006 + A1:2015 (Software life cycle processes), ANSI/AAMI/ISO 14971:2019 (Risk management for medical devices), AAMI TIR57:2016/R2019 (Medical device security / risk management), and NEMA PS 3.1-3.20 2024e (DICOM set).

Machine learning algorithm training, optimization, and testing used data sets that were acquired at a US clinical research institute (N = 48: 19M + 29F). A second, large data set (acquired at a second US clinical research institute) was used for further testing (N = 692: 305M + 387F). All subjects were adults screened to exclude neurological impairment and psychotropic medications.

Software unit testing, verification testing, clinical performance validation testing, host platform testing, and cybersecurity penetration testing have been conducted upon Cirrus according to defined protocols. In all instances, Cirrus functioned as intended and output resting state network (RSN) maps and accompanying quality reports generated by Cirrus were as expected.

Cirrus' clinical performance was demonstrated by results from analyses conducted by Sora and published literature including:

- **Dierker et al. (2017):** Dierker D, Roland JL, Kamran M, Rutlin J, Hacker CD, Marcus DS, Milchenko M, Miller-Thomas MM, Benzinger TL, Snyder AZ, Leuthardt EC, Shimony JS. Resting-state Functional Magnetic Resonance Imaging in Presurgical Functional Mapping: Sensorimotor Localization. *Neuroimaging Clin N Am*. 2017 Nov;27(4):621-633. doi: 10.1016/j.nic.2017.06.011. PMID: 28985933; PMCID: PMC5773116.
- **Hacker et al. (2013):** Hacker CD, Laumann TO, Szrama NP, Baldassarre A, Snyder AZ, Leuthardt EC, Corbetta M. Resting state network estimation in individual subjects. *Neuroimage*. 2013 Nov 15;82:616-633. doi: 10.1016/j.neuroimage.2013.05.108. Epub 2013 Jun 2. PMID: 23735260; PMCID: PMC3909699.
- **Mitchell et al. (2013):** Mitchell TJ, Hacker CD, Breshears JD, Szrama NP, Sharma M, Bundy DT, Pahwa M, Corbetta M, Snyder AZ, Shimony JS, Leuthardt EC. A novel data-driven approach to preoperative mapping of functional cortex using resting-state functional magnetic resonance imaging. *Neurosurgery*. 2013 Dec;73(6):969-82; discussion 982-3. doi: 10.1227/NEU.0000000000000141. PMID: 24264234; PMCID: PMC3871406.
- **Park et al. (2020):** Park KY, Lee JJ, Dierker D, Marple LM, Hacker CD, Roland JL, Marcus DS, Milchenko M, Miller-Thomas MM, Benzinger TL, Shimony JS, Snyder AZ, Leuthardt EC. Mapping language function with task-based vs. resting-state functional MRI. *PLoS One*. 2020 Jul 31;15(7):e0236423. doi: 10.1371/journal.pone.0236423. PMID: 32735611; PMCID: PMC7394427.
- **Roland et al. (2019):** Roland JL, Hacker CD, Snyder AZ, Shimony JS, Zempel JM, Limbrick DD, Smyth MD, Leuthardt EC. A comparison of resting state functional

magnetic resonance imaging to invasive electrocortical stimulation for sensorimotor mapping in pediatric patients. *Neuroimage Clin.* 2019;23:101850. doi: 10.1016/j.nicl.2019.101850. Epub 2019 May 4. PMID: 31077983; PMCID: PMC6514367.

Sora's software validation studies were performed retrospectively using patient MRI datasets previously collected in a well-defined and clinically meaningful patient care context in which safety, effectiveness, and equivalence could be established, namely, with brain tumor and epilepsy adult, adolescent, and child patients (ages 3 to 71 years).

- SMN and LAN Map Validation: An analysis was conducted comparing Cirrus sensorimotor network (SMN) and language network (LAN) maps to corresponding resting state network maps evaluated in the published literature, finding the Cirrus SMN and LAN maps to be consistent with those used in Dierker et al (2017), Mitchell et al. (2013), Park et al. (2020), and Roland et al. (2019), as cited above.
 - Please see the relevant literature for patient demographics and assessment of resting state network maps compared to standard of care task-based fMRI and intraoperative stimulation maps.
 - All data were acquired on 3T scanners manufactured by Siemens.
 - Cirrus SMN maps had a mean 0.826 spatial correlation with corresponding SMN maps evaluated in the published literature.
 - Cirrus LAN maps had a mean 0.793 spatial correlation with corresponding LAN maps evaluated in the published literature.
- VIS Map Validation: Cirrus VIS maps were compared to a reference of same-patient task-activated vision maps using a Receiver Operating Characteristic (ROC) analysis.
 - 26 subjects included brain tumor and epilepsy adult and pediatric patients.
 - All data were acquired on 3T scanners manufactured by Siemens.
 - Cirrus vision maps had a mean area under the ROC curve of 0.84, demonstrating comparability to task-activated vision maps.

These software validation studies demonstrate the comparability of Cirrus-generated RSN maps to task-activated maps, both analytically and from an expert clinician's perspective.

Validation for GE MRI Input: Cirrus SMN, LAN and VIS maps based on data captured at 5 sites with Siemens MR devices were compared with data captured at 3 sites with GE MR devices using a permutation analysis.

- 8 healthy, normal subjects each imaged at 8 geographically diverse sites.
- All data were acquired on 3T scanners manufactured by Siemens or GE.
- Within-subject similarity across scanner types was shown to be greater than cross-subject similarity, with a greater than 99.9% confidence level for each resting state network.

Conclusions

The Cirrus Resting State fMRI Software (Cirrus) raises no new issues of safety or effectiveness as compared to its predicate, the resting state fMRI analysis component of the Quicktome Software Suite (K222359). Cirrus has the same intended uses / indications for use and the same or similar technological characteristics and principles of operation as its predicate

device. Technological differences between Cirrus and its predicate device raise no new issues of safety or effectiveness. Clinical performance validation data demonstrate Cirrus is as safe and effective as its predicate. Accordingly, Cirrus is substantially equivalent to its predicate.