September 12, 2025

Diagnoly
% Nima Akhlaghi
Associate Director, Digital Health Regulatory Affairs
MCRA, LLC
505 Park Avenue, 14th Floor
New York, New York 10022

Re: K251368
Trade/Device Name: FETOLY
Regulation Number: 21 CFR 892.1550
Regulation Name: Ultrasonic Pulsed Doppler Imaging System
Regulatory Class: Class II
Product Code: IYN, IYO, QIH
Dated: August 13, 2025
Received: August 13, 2025

Dear Nima Akhlaghi:

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.

FDA's substantial equivalence determination also included the review and clearance of your Predetermined Change Control Plan (PCCP). Under section 515C(b)(1) of the Act, a new premarket notification is not required for a change to a device cleared under section 510(k) of the Act, if such change is consistent with an established PCCP granted pursuant to section 515C(b)(2) of the Act. Under 21 CFR 807.81(a)(3), a new premarket notification is required if there is a major change or modification in the intended use of a device, or if there is a change or modification in a device that could significantly affect the safety or effectiveness of the device, e.g., a significant change or modification in design, material, chemical composition, energy source, or manufacturing process. Accordingly, if deviations from the established PCCP result in a major change or modification in the intended use of the device, or result in a change or modification in the device that could significantly affect the safety or effectiveness of the device, then a new premarket notification would be required consistent with section 515C(b)(1) of the Act and 21 CFR 807.81(a)(3). Failure to submit such a premarket submission would constitute adulteration and misbranding under sections 501(f)(1)(B) and 502(o) of the Act, respectively.

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,

YANNA S. KANG -S

Yanna Kang, Ph.D.
Assistant Director
Mammography and Ultrasound Team
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

Please type in the marketing application/submission number, if it is known. This textbox will be left blank for original applications/submissions.	K251368

Please provide the device trade name(s).

FETOLY

Please provide your Indications for Use below.

FETOLY is intended to analyze fetal ultrasound image sequences using machine learning techniques to automatically:

- detect brain and heart views and quality criteria within the views;
- detect images suitable for measuring biometric parameters of the fetal heart and brain and provide quantitative measurements of these parameters.

The device is intended for use as a concurrent reading aid during the acquisition and interpretation of fetal ultrasound images.

FETOLY is indicated for use during routine fetal heart and brain examination of 2nd and 3rd trimester pregnancy (gestational age: from 17 to 40 weeks).

Please select the types of uses (select one or both, as applicable).

- ☒ Prescription Use (Part 21 CFR 801 Subpart D)
- ☐ Over-The-Counter Use (21 CFR 801 Subpart C)

K251368 510(k) Summary

In accordance with 21 CFR 807.92 the 510(k) summary for FETOLY (K251368) is provided below.

1 510(k) owner

Owner	Diagnoly 2 Place de Francfort 69003 Lyon, France +33(0)4.78.76.85.75
Primary contact person	Ivan Voznyuk Chief Executive Officer Diagnoly Phone: +33(0)6.95.87.04.55 Email: gara@diagnoly.com
Secondary contact person	Nima Akhlaghi Associate Director, Digital Health Regulatory Affairs MCRA, LLC Phone: 202.742.3889 Email: nakhlaghi@mcra.com
Date prepared	2025-09-11

2 Device

Trade Name	FETOLY
Classification name	Accessory to Ultrasonic Pulsed Doppler Imaging System, 21 CFR 892.1550 Accessory to Ultrasonic Pulsed Echo Imaging System, 21 CFR 892.1560 Medical image management and processing system, 21 CFR 892.2050
Class	II
Product code	IYN (Primary) IYO, QIH (secondary)

3 Predicate device identification

The predicate device used for FETOLY is FETOLY-HEART (K241380).

Additionally, a reference device was chosen for FETOLY based on its substantially equivalent technical characteristics of automatic biometric measurements realization. This reference device corresponds to the FETAL HS feature within the Voluson Expert Series 22/20/18 (K220358).

4 Device description

4.1 General description

Fetoly is a software that aims at helping sonographers, obstetricians, radiologists, maternal-fetal medicine specialists and pediatric cardiologists (designated as healthcare professionals i.e. HCPs) to perform fetal ultrasound examinations of the fetal brain and heart in real-time. Fetoly can be used by HCPs during fetal ultrasound examinations in the second and third trimesters (gestational age window: from 17 to 40 weeks).

The software is intended to assist HCPs in the completeness assessment of the fetal brain and heart ultrasound examination in accordance with national and international guidelines. Fetoly is also intended to be used to realize biometric measurements of the fetal brain/heart in accordance with national and internation guidelines.

To utilize Fetoly, the software needs to be installed on a hardware device which is connected to an Ultrasound Machine through an HDMI connection. The software receives ultrasound images captured by the connected Ultrasound Machine in real-time. The software's frozen deep learning algorithm, which was trained by supervised learning, analyzes images of this ultrasound image stream to detect brain/heart views, quality criteria within those views and to make biometric measurements of the heart and brain.
The software provides the following user-accessible information:

1. **Examination completeness**: the software displays in real-time which brain/heart views and quality criteria are verified by the software during the examination. The verified brain/heart views and quality criteria are accessible by clinicians at any moment of the ultrasound examination, in real-time.
2. **Biometric quantitative measurements:** The software displays in real-time which brain and heart measurements are seen and done by the software during the examination and if the measurements are in- or out- of-range. The verified heart and brain measurements are accessible by clinicians at any moment of the ultrasound examination, in the background.
3. **Examination illustration:** the software selects an image subset that illustrates
   - the verified views and quality criteria. These images can be reviewed by clinicians to verify the views and criteria's presence. Optionally, clinicians can display detected quality criteria localization on selected images.
   - each measurement. For each measurement, the software displays an image with the measurement drawn (in yellow) and the measured value (on bottom). The normal range for this measurement is also reminded to the user.
4. **Examination report:** The software allows the user to export an examination report which contains:
   - A summary of measurements and completeness;
   - Measurement illustrations (images).

4.2 Definition of a complete examination

4.2.1 For the fetal heart

Table 1: List of 52 quality criteria defining the quality of the 5 views recommended by the International Society of Ultrasound in Obstetrics and Gynecology for the foetal heart screening of 2nd and 3rd trimesters of pregnancy.

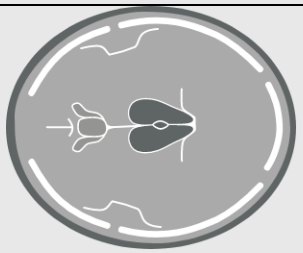
Heart views	Quality criteria within the views	
(A) ABD Abdomen view (n = 8)	(A1) Sp	Spine
	(A2) lRb	Left rib
	(A3) rRb	Right rib
	(A4) Ao	Descending aorta
	(A5) VC	Inferior vena cava
	(A6) St	Stomach
	(A7) Uv	Umbilical vein
	(A8) aA	Anterior Abdomen
(B) 4CH Four chamber view (n = 19)	(B1) Sp	Spine
	(B2) lRb	Left rib
	(B3) rRb	Right rib
	(B4) Ao	Descending aorta
	(B5) lPV	Left pulmonary vein
	(B6) rPV	Right pulmonary vein
	(B7) LA	Left atrium
	(B8) RA	Right atrium
	(B9) FOF	Septum primum (Vieussens valve or Fo-ramen Ovale Flap)
	(B10) FO	Open Foramen Ovale
	(B11) MV	Mitral valve
	(B12) TV	Tricuspid valve
	(B13) bCr	Connection between crux and atrial septum (vestibular septum)
	(B14) Cr	Atrioventricular valve offset in crux
	(B15) tCr	Connection between interventricular septum and crux
	(B16) IVS	Interventricular septum
	(B17) LV	Left ventricle
	(B18) RV	Right ventricle
	(B19) Str	Sternum
(C) LVOT Left Ventricular Outflow Tract view (n = 6)	(C1) LA	Left atrium
	(C2) aAo	Proximal ascending aorta
	(C3) SV	Semilunar valves
	(C4) LV	Left ventricle
	(C5) IVS	Interventricular septum
	(C6) RV	Right ventricle
	(D1) dAo	Descending aorta
	(D2) Tr	Trachea / bronchi
	(D3) lPA	Left pulmonary artery

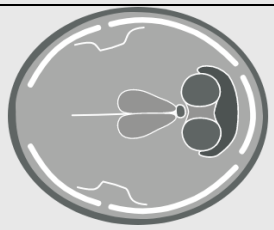
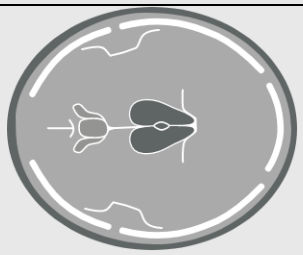
(D) RVOT Right Ventricular Outflow Tract view (n = 10)	(D4) Du	Ductus arteriosus
	(D5) rPA	Right pulmonary artery
	(D6) Or	Origin of pulmonary arteries
	(D7) S	Septum between pulmonary artery trunk and ascending aorta
	(D8) aAo	Ascending aorta
	(D9) SVC	Superior vena cava
	(D10) PA	Pulmonary trunk
(E) 3VX Three vessels view (n = 9)	(E1) Sp	Spine
	(E2) Tr	Trachea
	(E3) ES	Side space on the left of ductus / pulmonary artery
	(E4) DuA	Ductal arch connected to the descending aorta
	(E5) Du	Ductal arch not connected to the descending aorta
	(E6) aAo	Ascending aorta
	(E7) aAr	Aortic arch
	(E8) SVC	Superior vena cava
	(E9) Th	Thymus / sternum

International and national guidelines [Carvalho2023] recommend 5 foetal cardiac views for routine ultrasound examination of 2nd and 3rd trimesters: (A) Abdomen view, (B) Four chamber view, (C) Left Ventricular Outflow Tract view, (D) Right Ventricular Outflow Tract view, (E) Three vessels view. The quality of these 5 heart views depends on the presence of 52 anatomical quality criteria within the views (**Table 1**). Thus, an examination can be defined as complete when all 5 heart views and their quality criteria are obtained by the HCP.

4.2.2 For the fetal brain

Table 2: List of 43 quality criteria defining the quality of the 4 views recommended by the International Society of Ultrasound in Obstetrics and Gynecology for the foetal brain screening of 2nd and 3rd trimesters of pregnancy.

Brain views	**Quality criteria within the views**	
 **(F) TV Transventricular view (n = 15)**	(F1) aFx	Anterior Falx
	(F2) CSP	Cavum Septum Pellucidum
	(F3) For	Fornix
	(F4) dAV	Distal Anterior Ventricle
	(F5) pAV	Proximal Anterior Ventricle
	(F6) AC	Ambient Cisterna
	(F7) Atr	Atrium
	(F8) CP	Choroid Plexus
	(F9) POS	Parieto Occipital Sulcus
	(F10) pFx	Posterior Falx
	(F11) dCS	Distal Coronal suture
	(F12) pCS	Proximal Coronal suture
	(F13) SF	Sylvian Fissure
	(F14) Sk	Skull

	(F15) Sep	Thalami Separation
 **(G) TC Transcerebellar view (n = 8)**	(G1) dTh	Distal Thalamus
	(G2) pTh	Proximal Thalamus
	(G3) 4V	4th Ventricle
	(G4) Ver	Vermis
	(G5) dCH	Distal Cerebellar Hemisphere
	(G6) pCH	Proximal Cerebellar Hemisphere
	(G7) CB	Cerebellar Border
	(G8) CM	Cisterna Magma
 **(H) TT Transthalamic view (n = 12)**	(H1) aFx	Anterior Falx
	(H2) CSP	Cavum Septum Pellicidum
	(H3) dAV	Distal Anterior Ventricle
	(H4) pAV	Proximal Anterior Ventricle
	(H5) dTh	Distal Thalamus
	(H6) pTh	Proximal Thalamus
	(H7) Sep	Thalami Separation
	(H8) 3V	3rd Ventricle
	(H9) dCS	Distal Coronal Suture
	(H10) pCS	Proximal Coronal Suture
	(H11) SF	Sylvian Fissure
	(H12) Sk	Skull
(I) SAG Sagittal/profile view (n = 8)	(I1) NB	Nose Bone
	(I2) uVer	Upper Part of Vermis
	(I3) lVer	Lower Part of Vermis
	(I4) Fas	Fastigium
	(I5) rgCC	Rostrum & Genu Corpus Callosum
	(I6) bCC	Body Corpus Callosum
	(I7) sCC	Splenium Corpus Callosum
	(I8) CSP	Cavum Septum Pellicidum

4.2.3 Biometric measurements and reference intervals

The list below details the biometric measurements provided by FETOLY:

- **Cardiac axis (M1)**: The cardiac axis (or cardiac angle) refers to the orientation of the heart relative to the midline of the chest measured in the four-chamber view (Guidelines: ISUOG, ASE);
- **Cardiothoracic ratio (M2):** The fetal cardiothoracic ratio (CTR) is the ratio of the transverse circumference of the epicardial surface of the heart to the transverse circumference of the thorax measured in the four-chamber view during diastole (Guidelines: ASE, AIUM, AHA);

- **Ventricular width ratio (M3)**: The right-to-left ventricular ratio (TV/MV) refers to the ratio of the tricuspid valve (TV) annular diameter to the mitral valve (MV) annular diameter, which is used to assess cardiac morphology in fetuses (Guidelines: AIUM, ISUOG, ASE);
- **Vessels ratio (M4):** The great vessels size ratio (Ao/Du) refers to the ratio between the diameters of the aortic isthmus (Ao) and the ductus (Du) on the three-vessel view (Guidelines: ASE, ISUOG, AIUM, AHA);
- **Vessels number (M5):** The fetal three-vessel view (3VV) is an axial plane used in prenatal imaging to assess the great vessels of the heart (Guidelines: ISUOG, ASE);
- **Thymic-thoracic ratio (M6):** The thymic-thoracic ratio is the ratio of the anteroposterior thymic to the intrathoracic mediastinal diameters measured in the three vessels and trachea view (Guidelines: ISUOG);
- **Cardiothoracic position (M7):** The cardiothoracic position is determined by extending the interventricular septum line posteriorly dividing the atria to a point at the base of the heart (Guidelines: ISUOG, ASE, AIUM, AHA);
- **Cephalic index (M8):** The cephalic index is the ratio of the biparietal diameter (BPD) to the occipitofrontal diameter (OFD) multiplied by 100 (Guidelines: ISUOG).

Each measurement requires a specific ultrasound viewpoint, referred to as '**subview**', which must meet specific image conditions to ensure accurate measurement:

- Subviews M1, M2, M3 and M7 belong to the four chamber view;
- Subview M6 belongs to the right ventricular outflow tract;
- Subviews M4 and M5 belong to the three vessel and three vessel and trachea views;
- Subview M8 belongs to the Transthalamic view.

5 Indications for use

FETOLY is intended to analyze fetal ultrasound image sequences using machine learning techniques to automatically:

- detect brain and heart views and quality criteria within the views;
- detect images suitable for measuring biometric parameters of the fetal heart and brain and provide quantitative measurements of these parameters.

The device is intended for use as a concurrent reading aid during the acquisition and interpretation of fetal ultrasound images.

FETOLY is indicated for use during routine fetal heart and brain examination of 2nd and 3rd trimester pregnancy (gestational age: from 17 to 40 weeks).

6 Summary of the technological characteristics of FETOLY compared to the predicate device

Aspect	Predicate device: FETOLY-HEART K241380	Reference device: Voluson Expert 18/20/22 (FETAL HS Feature) K220358	Proposed device: FETOLY	Comparison between Proposed and Predicate device
General				
Manufacturer name	Diagnoly	GE Healthcare	Diagnoly	NA
Device name	FETOLY-HEART	FETAL HS in the Voluson Expert 18/20/22	FETOLY	NA
Product code(s)	IYN (Primary) IYO, QIH (secondary)	IYN (Primary) IYO, ITX (Secondary)	IYN (Primary) IYO, QIH (secondary)	**Substantially equivalent** Primary codes are the same for subject and primary predicate devices
Regulation number	- Accessory to Ultrasonic Pulsed Doppler Imaging System, 21 CFR 892.1550 - Accessory to Ultrasonic Pulsed Echo Imaging System, 21 CFR 892.1560 - Medical image management and processing system, 21 CFR 892.2050	- Ultrasonic Pulsed Doppler Imaging System, 21 CFR 892.1550 - Ultrasonic Pulsed Echo Imaging System, 21 CFR 892.1560 - Diagnostic Ultrasound Transducer, 21 CFR 892.1570, 90-ITX	- Accessory to Ultrasonic Pulsed Doppler Imaging System, 21 CFR 892.1550 - Accessory to Ultrasonic Pulsed Echo Imaging System, 21 CFR 892.1560 - Medical image management and processing system, 21 CFR 892.2050	**Substantially equivalent** All devices are class II devices subject to 510(k) regulatory pathway.
Brief description	FETOLY-HEART is a software that aims at helping sonographers, OB/GYNs, MFMs and Fetal surgeons (all three designated as healthcare professionals i.e. HCPs) to perform their routine fetal heart ultrasound examinations in real-time.	The reference device is a software that aims at helping sonographers, OB/GYNs, MFMs and Fetal surgeons (all three designated as healthcare professionals i.e. HCP) to perform their routine fetal heart ultrasound examinations in real-time.	FETOLY is a software that aims at helping sonographers, OB/GYNs, MFMs and Fetal surgeons (all three designated as healthcare professionals i.e. HCPs) to perform their routine fetal heart ultrasound examinations in real-time.	**Substantially equivalent** The subject device and the predicate devices have the same objective.

Indications for use	FETOLY-HEART is intended to analyze fetal ultrasound images and clips using machine learning techniques to automatically detect heart views and quality criteria within the views. The device is intended for use as a concurrent reading aid during the acquisition and interpretation of fetal ultrasound images. FETOLY-HEART is indicated for use during routine fetal heart examination of 2nd and 3rd trimester pregnancy (gestational age: from 17 to 40 weeks).	The device is a general-purpose ultrasound system intended for use by qualified and trained healthcare professionals which includes a biometric measurement functionality.	FETOLY is intended to analyze fetal ultrasound image sequences using machine learning techniques to automatically: • detect brain and heart views and quality criteria within the views; • detect images suitable for measuring biometric parameters of the fetal heart and brain and provide quantitative measurements of these parameters. The device is intended for use as a concurrent reading aid during the acquisition and interpretation of fetal ultrasound images. FETOLY is indicated for use during routine fetal heart and brain examination of 2nd and 3rd trimester pregnancy (gestational age: from 17 to 40 weeks).	**Substantially equivalent** Indications for Use of FETOLY is covered by Indications for Use of the primary predicate and the reference device
Targeted population	Pregnant women during the 2nd and 3rd trimester of pregnancy	Pregnant women during the 2nd and 3rd trimester of pregnancy	Pregnant women during the 2nd and 3rd trimester of pregnancy	**Substantially equivalent** Subject device has the same intended patient population than the predicate devices.
Clinical outcome	- Images labeled with correct fetal heart view for patient cases - Quality criteria identified as “Verified” when detected and “Not verified” when not detected - Images labeled with the localization of quality criteria	- Images labeled with measurements and in- and out- of-range display	- Images labeled with correct fetal heart/brain view for patient cases - Quality criteria identified as “Verified” when detected and “Not verified” when not detected - Images labeled with the localization of quality criteria - Images labeled with measurements and in- and out- of-range display	**Substantially equivalent** The clinical outcome is the same between predicates and subject devices. However, performance testing has shown that there is no impact on safety and effectiveness of the inclusion in FETOLY of additional

				types of measurements and of brain views for completeness.
Intended user	Qualified healthcare professional specialized in prenatal ultrasound imaging	Qualified healthcare professional specialized in prenatal ultrasound imaging	Qualified healthcare professional specialized in prenatal ultrasound imaging	**Substantially equivalent** Subject device has the same intended users as the predicate devices.
Clinical applications	Fetal/Obstetrics	Fetal/Obstetrics	Fetal/Obstetrics	**Substantially equivalent** Clinical application is the same for subject and predicate devices.
Inclusion of a PCCP	Yes, proposed modifications related to modifying model training hyperparameters, additional retraining with new training and validation datasets collected, and addition/removal of heart quality criteria.	N/A	Yes, proposed modifications related to modifying model training hyperparameters, additional retraining with new training and validation datasets collected, addition/removal of heart quality criteria, addition of fetal heart and brain biometric measurements	**Substantially equivalent** Subject and predicate devices both have a PCCP to update AI model
Functionality 1: completeness overview				
Automatically detect views	Detection of 4ch, 3vx, LVOT, RVOT and Abd views (complete implementation of ISUOG recommendations)	N/A	Detection of 4ch, 3vx, LVOT, RVOT and Abd heart views Detection of TV, TT, TC and SAG brain views (complete implementation of ISUOG recommendations)	**Substantially equivalent** The subject device includes the detection of new views when compared to the predicate device. This quantitative enhancement has been tested and does not raise any new question of safety and effectiveness.

Automatically detect quality criteria	Detection of *52* heart quality criteria. The quality also incorporates the zoom level of the view.	N/A	Detection of *52* heart and 43 brain quality criteria. Quality also incorporates the zoom level of the view.	**Substantially equivalent** The subject device includes the detection of new quality criteria when compared to the predicate device. This quantitative enhancement has been tested and does not raise any new question of safety and effectiveness.
Functionality 2: completeness illustration				
Automatically selects views	Automatic extraction of views from a sequence of images.	N/A	Automatic extraction of views from a sequence of images.	**Substantially equivalent** This image selection functionality is the same than for the predicate device Software testing has been performed to validate its use and does not introduce new questions of safety and effectiveness.
Functionality 3: Measurement				
Automatically measure fetal anatomy	N/A	Heart angle measurement	Heart and brain biometric measurements, including angles and ratios	**Substantially equivalent** Performance testing has shown that there is no impact on safety and effectiveness of the inclusion in FETOLY of additional types of measurements in comparison with the reference device.
Functionality 4: Measurement illustration				

Automatically selects views	Automatic extraction of views from a sequence of images.	Automatic suggestion of views from a sequence of images for 4CH and 3VT views.	Automatic extraction of views from a sequence of images.	**Substantially equivalent** Software testing has been performed to validate its use and show that it does not introduce new questions of safety and effectiveness.
Technical characteristics				
Data input	Accepts images and image sequences from ultrasound machines	Accepts images and image sequences from ultrasound machines	Accepts images and image sequences from ultrasound machines	**Substantially equivalent** The input data is the same for the subject device and the predicate and reference devices.
Algorithm Methodology	Artificial Intelligence: Utilizes computer vision algorithms to analyze ultrasound images and provides visualization of detected landmarks and views	Artificial Intelligence: Utilizes computer vision algorithms to analyze ultrasound images and provides measurements	Artificial Intelligence: Utilizes computer vision algorithms to analyze ultrasound images and provides measurements	**Substantially equivalent** All devices use artificial intelligence.
Platform	Operates as a local software functioning independently from the ultrasound equipment.	Operates as a local software embedded in the ultrasound equipment.	Operates as a local software functioning independently from the ultrasound equipment.	**Substantially equivalent** Subject and primary predicate devices use an edge-based approach
Ultrasound Machine compatibility	Compatible with ultrasound system from GE Medical, Samsung and Canon	NA	Compatible with ultrasound system from GE Medical, Samsung and Canon	**Substantially equivalent** This compatibility has been tested and validated as part of device generalizability in the performance testing study.
User interaction	The user can interact with the software to override the software's outputs. The user has the ability to review and edit/override the matching at any time during or at the end of the exam.	The user has the ability to review the software output.	The user can interact with the software to override the software's outputs. The user has the ability to review and edit/override the matching at any time during or at the end of the exam.	**Substantially equivalent** User interactions are the same between primary predicate and subject devices.

7 Non-clinical performance data

7.1 FETOLY testing strategy

The following V&V testing were included into the development of the system:

- Software verification testing per IEC 62304 standard
- Tablet compatibility testing
- Cybersecurity verification and penetration testing
- Software AI model validation

FETOLY uses a machine learning (ML) algorithm for:

- detection of heart and brain views and quality criteria within these views in ultrasound images;
- detection of heart and brain subviews suitable for quantitative biometric measurements and realization of measurements in ultrasound images.

Modifications to FETOLY will be made in accordance with the guiding principles on predetermined change control plans (PCCP) for machine learning-enabled medical devices. This PCCP provides a description of the device's planned modifications, and those modifications will be triggered and implemented in a controlled manner that ensures the continued safety and efficacy on the performance testing dataset, mitigating risks associated with changes to the ML model to not adversely impact the device's performance, safety, or effectiveness associated with its indications for use, and an impact assessment of the planned modifications.

In accordance with the PCCP, all algorithm modifications will be adequately trained, tuned, and locked prior to release of the software with the modified ML model. The PCCP does not include the implementation of adaptive algorithms that will continuously learn in the field. Implemented modifications to the FETOLY algorithm will be communicated to users via the software update notifications and through updated labelling. The modifications outlined in the PCCP are summarized in the table below. The PCCP in the subject device with the proposed modifications related to modifying model training hyperparameters, additional retraining with new training and validation datasets collected, addition/removal of heart/brain quality criteria, and new biometric measurement parameter introduction do not raise different questions of safety and effectiveness from the predicate device (see table below).

Summary of changes to FETOLY per the PCCP:

Modification	Rationale	Testing Methods	Impact Assessment
Modification of training and/or validation datasets	Increase or recovery (in case of data drift) of FETOLY's performance.	Re-training of the FETOLY model with new data to optimize its performance followed by internal testing and a comparison of the initial model to the modified model using performance metrics on the test dataset.	Increased performance metrics of the modified model for view or quality criteria or subview detection. Increased performance metrics of the modified model for realization of quantitative biometric measurements.

			Benefits: Increase or recovery of performance; generalization for diverse cases. Risks: Performance decrease (overfitting, unintended bias). Risk mitigation: The modified model will be tested for superiority on the performance study test dataset which will contain new unseen data.
Modification of model training hyperparameters	Improvement/ optimization, maintenance or recovery (in case of data drift) of FETOLY's performance Maintain alignment with quality criteria and biometric measurements recommended for fetal heart and brain screening in state-of-the-art international guidelines.	Re-training of the FETOLY model with new parameters to optimize its performance followed by internal testing and a comparison of the initial model to the modified model using performance metrics on the test dataset.	Increased performance metrics of the modified model for view or quality criteria or subview detection. Increased performance metrics of the modified model for realization of quantitative biometric measurements. Enhanced compliance with standard international guidelines. Benefits: Increased , maintained or recovered performance; generalization for diverse cases; keeping the device relevant by aligning with the updated list of heart and brain quality criteria/measurements Risks: Performance decrease (overfitting, unintended bias). Risk mitigation: The modified model will be tested for superiority on the performance study test dataset which will contain new unseen data.
Heart or brain quality criteria addition/removal	Maintain alignment with quality criteria recommended for fetal heart and brain screening in state-of-the-art international guidelines.	New quality criteria list will be controlled using the same acceptance criteria as defined by secondary endpoints.	Enhanced compliance with standard international guidelines. Benefits: Keeping the device relevant by aligning with the updated list of heart and brain quality criteria. Risks: Performance decrease and user confusion. Risk mitigation: Proper performance testing with no decrease in test performance. This change only pertains to quality criteria belonging to one of the 5 heart views or 4 brain views already included in FETOLY.

Heart or brain biometric measurements addition	Maintain alignment with biometric measurements recommended for fetal heart and brain screening in state-of-the-art international guidelines.	New measurements list will be controlled using the same acceptance criteria as defined by primary endpoints for already existing measurements and PCCP validated endpoints for new measurements.	Enhanced compliance with standard international guidelines. Benefits: Keeping the device relevant by aligning with the updated list of heart and brain measurements. Risks: Performance decrease and user confusion. Risk mitigation: Proper performance testing with no decrease in test performance.

7.2 FETOLY performance study

Diagnoly conducted two standalone performance testing:

- One for the completeness functionality of FETOLY;
- One for the measurement functionality of FETOLY

7.2.1 FETOLY-COMPLETENESS performance study

This study was done on a dataset of 5,554 fetal ultrasound images across 750 patient cases, including full examination still images, cardiac/brain clip frames and full examination video frames from 7 clinical sites in the United States and France. These sites and cases are representative of the intended use population. This testing dataset originated from distinct clinical sites from which the data used during model development (training/validation) was sourced, ensuring testing independence.

The results of the standalone performance testing demonstrate that FETOLY automatically detects fetal heart and brain ultrasound views with a sensitivity ≥ 85% (acceptance criterion) and specificity ≥ 85% (acceptance criterion), detects quality criteria within views with a sensitivity ≥ 90% for heart and 85% for brain (acceptance criterion) and a specificity ≥ 90% for heart and 85% for brain (acceptance criterion), and localizes bounding boxes of quality criteria with a mean intersection over union (IoU) of ≥ 50% (acceptance criterion). Sensitivity and specificity were evaluated individually for each view, and the performance goal to exceed 85% as the lower bound of the corresponding 95% Confidence Interval (CI) was met. The results are summarized hereafter:

- Automatic detection of fetal heart and brain views ‘Abdomen’, ‘Four chamber’, ‘LVOT’, ‘RVOT’, ‘Three Vessels’, Transventricular’, ‘Transcerebellar’, ‘Transthalamic’ and ‘Sagittal/profile’:
  - mean sensitivity of 96% with a Bootstrap CI of (0.954-0.966);
  - mean specificity of 99.5% with a Bootstrap CI of (0.994-0.996).
- Automatic detection of 52 fetal heart quality criteria within the views:
  - mean sensitivity of 94.6%% with a Bootstrap CI of (0.939-0.952);
  - mean specificity of 99.4% with a Bootstrap CI of (0.994-0.995);
  - mean IoU of 68.1% with a Bootstrap CI of (0.672-0.691).

- Automatic detection of 43 fetal brain quality criteria within the views:
  - mean sensitivity of 91.3% with a Bootstrap CI of (0.904-0.924);
  - mean specificity of 99.4% with a Bootstrap CI of (0.994-0.995);
  - mean IoU of 60% with a Bootstrap CI of (0.594-0.605).

The performance validation dataset included the following clinical subgroups: maternal age, gestational age, territory, BMI, scanner manufacturer, heart/brain abnormality. It also comprised races and ethnicities and various clinical sites, ensuring representation across the intended use population. Image digital quality (bad, average, good) and image type (still image from entire examination, cardiac clip frame, full examination frame) were identified as potential confounders and controlled for. Performance metrics were analyzed for each subgroup and confounder to validate the model's robustness and generalizability. The subgroups distribution is summarized in the table below:

Subgroup		Number of cases (total=750)	Number of images (total=5,554)
Center	Center 1 (EU)	139 (18.5%)	1162 (20.9%)
	Center 2 (EU)	79 (10.6%)	500 (9%)
	Center 3 (EU)	96 (12.8%)	739 (13.3%)
	Center 4 (US)	141 (18.8%)	1008 (18.1%)
	Center 5 (US)	118 (15.7%)	728 (13.1%)
	Center 6 (US)	102 (13.6%)	800 (14.4%)
	Center 7 (US)	75 (10%)	617 (11.2%)
Territory	US	436 (58.1%)	3153 (56.8%)
	EU	314 (41.9%)	2401 (43.2%)
Gestational age	2nd trimester	392 (52.3%)	3107 (55.9%)
	3rd trimester	358 (47.7%)	2447 (44.1%)
Maternal age	< 20 years	42 (5.6%)	300 (5.4%)
	[20-29] years	299 (39.9%)	2135 (38.4%)
	[30-39] years	324 (43.2%)	2434 (43.8%)
	≥40 years	41 (5.5%)	317 (5.8%)
	Unknown	44 (5.8%)	368 (6.6%)
BMI	<18.5 kg/m2	26 (3.5%)	204 (3.7%)
	[18.5;24.9] kg/m2	216 (28.8%)	1617 (29.1%)
	[25;29.9] kg/m2	183 (24.4%)	1346 (24.2%)
	≥30 kg/m2	240 (32%)	1669 (30.1%)
	Unknown	85 (11.3%)	718 (12.9%)
Scanner manufacturer	General Electric	373 (49.7%)	2999 (54%)
	Samsung	342 (45.6%)	2267 (40.1%)
	Canon	35 (4.7%)	288 (5.9%)
Fetus cardiac/cerebral normality	Abnormal	180 (24%)	1442 (26%)
	Normal	570 (76%)	4112 (74%)
Image digital quality	Bad	N/A	1316 (23.7%)
	Average	N/A	1446 (26%)
	Good	N/A	2792 (50.3%)
Image type	Long video	N/A	262 (4.7%)

	Short video	N/A	1499 (27%)
	Full exam still image	N/A	3793 (68.3%)
Race and ethnicity	**Asian and Pacific Islander**	30 (4%)	196 (3.5%)
	Black	207 (27.6%)	1522 (27.4%)
	Hispanic	57 (7.6%)	411 (7.4%)
	White	415 (55.3%)	3089 (55.6%)
	Unknown	41 (5.5%)	336 (6.1%)

Patient cases were retrospectively collected in reverse chronological order until at least 20 patient files per subgroup and an overall of 310 patient files were reached. To limit correlation of the images used for evaluation, one image maximum per view per patient case was selected by categorizing 26,840 images from the patient cases into heart and brain views and randomly picking one image maximum per view, resulting in a total of 5,554 images.

A 2+1 ground truth procedure was used to obtain the reference standard of the dataset. Six annotators (3 sonographers and 3 OB/GYN doctors) were paired and assigned uniformly distributed batches of images. The attribution was randomized so that each pair treated images belonging to various subgroups. Each image was annotated by a pair of annotators as belonging to one of 10 views. Images with annotator agreement were considered ground truth. Images in which the pair of annotators disagreed were reviewed by an adjudicator, who made the final decision.

For quality criteria classification and localization, each image was annotated by a pair of annotators who drew bounding boxes on present criteria. If their boxes had at least 50% overlap, their coordinates were averaged to form the ground truth. If the overlap was lower or there was a disagreement on the criterion presence, an adjudicator reviewed the boxes. The final decision regarding the presence was based on majority consensus among the adjudicator and annotators. The final decision for the criteria localization was based on the adjudicator's decision to either keep one of the annotator's boxes or draw a new one.

The results of verification and performance testing demonstrate the safe and effective use of the completeness function of FETOLY.

7.2.2 FETOLY-MEASURE performance study

This study was done on a dataset of 6,024 fetal ultrasound images across 441 patient cases, including full examination still images, cardiac/brain clip frames and full examination video frames from 6 clinical sites in the United States and France. These sites and cases are representative of the intended use population. This testing dataset originated from distinct clinical sites from which the data used during model development (training/validation) was sourced, ensuring testing independence.

The results of the standalone performance testing demonstrate that FETOLY automatically:

- detects fetal heart and brain ultrasound subviews with a sensitivity ≥ 70% (acceptance criterion) and specificity ≥ 70% (acceptance criterion);
- realizes fetal heart and brain biometric measurements with a lower and upper limits of agreement (LOA) below the acceptance criterion for each measurement;

Sensitivity and specificity were evaluated individually for each subview, and the performance goal to exceed 70% as the lower bound of the corresponding 95% Confidence Interval (CI) was met.

Each measurement's limits of agreement were individually evaluated and overall, all measurements met acceptance criteria, with LOA confidence intervals staying within predetermined performance thresholds.

Confidence intervals (CI) has been derived using bootstrap resampling at the patient level. By sampling patient files and simulating intra-patient correlation, the bootstrap methodology appropriately accounts for potential image correlation. The results are summarized hereafter:

- Automatic detection of fetal heart and brain subviews M1 to M8:
  - mean sensitivity of 91.8% with a Bootstrap CI of (0.906, 0.931);
  - mean specificity of 99.9% with a Bootstrap CI of (0.998, 1.000).
- Realization of fetal heart and brain biometric measurements:

Class	LOA (LOA CI)
thymic-thoracic_ratio	0.044 (0.038,0.051)
cardiothoracic_ratio	0.036 (0.031,0.043)
vessels_ratio	0.095 (0.078,0.119)
cephalic_index	0.03 (0.028,0.034)
vessels_number	0.223 (0.113,0.324)
cardiothoracic_position	0.048 (0.043,0.053)
right-left_ventricular_ratio	0.101 (0.093,0.110)
cardiac_angle	6.476 (5.557,7.494)

The regression slope and intercept analysis for each measurement shows that the regression slope is close to 1 and the regression intercept close to 0.

The performance validation dataset included the following clinical subgroups: maternal age, gestational age, territory, BMI, scanner manufacturer, heart/brain reference range adherence and pregnancy type. It also comprised races and ethnicities and various clinical sites, ensuring representation across the intended use population. Image digital quality (bad, average, good) and image type (still image from entire examination, cardiac clip frame, full examination frame) were identified as potential confounders and controlled for. Performance metrics were analyzed for each subgroup and confounder to validate the model's robustness and generalizability. The subgroups distribution is summarized in the table below:

Subgroup		**Number of cases (total=441)**	**Number of images (total=6,024)**
Center	**Center 1 (EU)**	67 (15.2%)	966 (16%)
	Center 2 (EU)	50 (11.3%)	560 (9.4%)
	Center 3 (EU)	99 (22.4%)	1515 (25.1%)
	Center 4 (US)	53 (12%)	753 (12.5%)
	Center 5 (US)	51 (11.7%)	571 (9.5%)
	Center 6 (US)	121 (27.4%)	1659 (27.5%)
Territory	**US**	225 (51%)	2983 (49.5%)

	EU	216 (49%)	3041 (50.5%)
Gestational age	**2nd trimester**	280 (63.5%)	3848 (63.9%)
	3rd trimester	161 (36.5%)	2176 (36.1%)
Maternal age	**< 20 years**	20 (4.5%)	266 (4.4%)
	[20-29] years	181 (41%)	2436 (40.4%)
	[30-39] years	212 (48.1%)	2951 (49%)
	≥40 years	28 (6.4%)	371 (6.2%)
BMI	**<18.5 kg/m2**	20 (4.5%)	279 (4.6%)
	[18.5;24.9] kg/m2	133 (30.2%)	1866 (31%)
	[25;29.9] kg/m2	129 (29.3%)	1731 (28.7%)
	≥30 kg/m2	143 (32.4%)	1926 (32%)
	Unknown	16 (3.6%)	222 (3.7%)
Scanner manufacturer	**General Electric**	235 (53.3%)	3383 (56.1%)
	Samsung	156 (35.4%)	1925 (32%)
	Canon	50 (11.3%)	716 (11.9%)
Reference range adherence	**In-range**	343 (77.8%)	4710 (78.2%)
	Out-of-range	98 (22.2%)	1314 (21.8%)
Pregnancy type	**High-risk**	150 (34%)	2009 (33.3%)
	No high-risk	279 (63.3%)	3835 (63.7%)
	Unknown	12 (2.7%)	180 (3%)
Image digital quality	**Bad**	N/A	1324 (22%)
	Average	N/A	2847 (47.3%)
	Good	N/A	1853 (30.7%)
Image type	**Full exam video frame**	N/A	390 (6.5%)
	Clip frame	N/A	2290 (38%)
	Full exam still image	N/A	3344 (55.5%)
Race and ethnicity	**Asian and Pacific Islander**	20 (4.5%)	251 (4.2%)
	Black	118 (26.8%)	1611 (26.7%)
	Hispanic	33 (7.5%)	445 (7.4%)
	White	267 (60.6%)	3672 (61%)
	Unknown	3 (0.6%)	45 (0.7%)

Patient cases were retrospectively collected in reverse chronological order until the minimum size for each subgroup was achieved and an overall of 310 patient files were reached. To limit correlation of the images used for evaluation, one image maximum per positive subview and per negative subview per patient case was selected, resulting in a total of 6,024 images.

A 2+1 ground truth procedure was used to obtain the reference standard of the dataset. 4 annotators (2 sonographers and 2 OB/GYN doctors) were paired and assigned uniformly distributed batches of images. The attribution was randomized so that each pair treated images belonging to various subgroups. Each image was annotated by a pair of annotators as belonging to one of 8 subviews and with associated biometric measurements values. Images with annotator agreement were considered ground truth. Images in which the pair of annotators disagreed were reviewed by an adjudicator, who made the final decision.

The results of verification and performance testing demonstrate the safe and effective use of the measurement function of FETOLY.

8 Clinical performance data

Not applicable.

9 Conclusion from non-clinical tests

FETOLY intended users, clinical outcome and clinical applications are similar to those of the predicate device FETOLY-HEART. The technological characteristics differences identified and discussed in Section VI are covered by a reference device, the FETAL HS feature within the Voluson Expert Series 22/20/18 (K220358), and do not raise different questions of safety and effectiveness of the device.

Furthermore, results of successful verification and validation activities and additional performance testing do not raise any new issue regarding the safety and effectiveness of the device. FETOLY is therefore substantially equivalent to its predicate device FETOLY-HEART (K241380).