R/F

Development of FLEXAVISION™ F4 package

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1. Introduction

Shimadzu has released the FLEXAVISION F3 package R/F system (hereinafter, "F3 package") combined with a removable 14 × 17-inch FPD (Flat Panel Detector) that can perform fluoroscopy and radiography while docked in the R/F table and radiography (wired) when removed from the table. The F3 package has highly acclaimed for supporting various examinations in a single apparatus including fluoroscopy and radiography in gastrointestinal or urological examinations,and general radiography in orthopedic examinations with the FPD undocked from the table.

Shimadzu has now developed and launched the FLEXAVISION F4 package R/F system (hereinafter, "F4 package"), which inherits the design philosophy of the FLEXAVISION series of systems while incorporating significant practical improvements such as a new wireless 17-inch FPD, a new 600 kHU X-ray tube unit, DSA (Digital Subtraction Angiography) functions, and support for DICOM RDSR **(Fig. 1)**. This article introduces the features of the F4 package.

Fig.1 FLEXAVISION™ F4 package Main Unit

2. Standout Features of F4 package

2.1 New FPD

(1) Supports Maximum 17-Inch and Minimum 6-Inch Field of View

The 17 × 17-inch large field FPD **(Fig. 2)** can provide a single view of the kidneys and bladder in urological examinations, the whole large intestine in lower gastrointestinal examinations, and the entire lung field in chest imaging. The F4 package also introduces support for a new 6-inch field of view, making it possible to observe the area of interest in enlarged images during endoscopic procedures and other examinations.

Fig.2 New FPD

(2) Support for Wireless Radiography

While the removable FPD in the F3 package is wired to the R/F table when undocked for radiography, the new removable FPD in the F4 package can perform wireless radiography. The wireless FPD is useful for close contact radiography on the R/F table, or for imaging a patient on a stretcher using X-ray tube rotation function* or in combination with a ceiling-mounted X-ray tube **(Fig. 3, 4)**. In examination rooms where chest imaging is mainly performed by combining a removable FPD with a Bucky stand, you can also choose to operate the removable FPD for wired imaging upon request, which does not require battery replacement.

* X-ray tube rotation function is an optional feature.

Fig.3 Patient Positioned Directly against FPD

Fig.4 Imaging a Patient on a Stretcher

(3) Improved SNR (signal to noise ratio)

The SNR of the new FPD is significantly improved compared to that of the previous FPD **(Fig. 5)**. The new FPD produces highly visible fluoroscopy images with reduced noise, even for thicker patients.

The F4 package also retains image processing engine, including multi-frequency processing, which has highly acclaimed in the F3 package,and contributes to reduce halation in direct X-ray irradiation area and enhance the contrast and edges of devices.
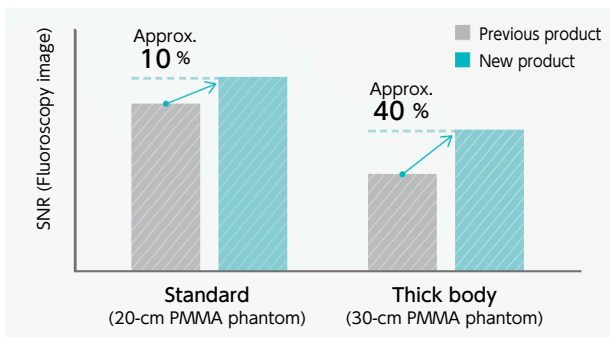
Fig.5 SNR Comparison between Previous and New FPD

2.2 New 600 kHU X-Ray Tube Unit

A new 600 kHU X-ray tube unit is also available for the F4 package. It allows for shorter F-R times* (as short as 0.9 sec). The new 600 kHU X-ray tube unit helps with examinations of the upper gastrointestinal region and other areas where exposure timing is important for diagnosis imaging .

* Time from pressing the image acquisition button to X-ray exposure under fluoroscopic conditions.

2.3 Space-Saving Design

The F4 package, equipped with a large field FPD, retains the space-saving design of the previous FLEXAVISION series. In addition to the compact design of its R/F table, its control cabinet is contained within a single unit, ensuring ample working space in the examination room, easy placing of other equipment around the system, and smooth entry and exit of patients on wheelchairs or stretchers **(Fig. 6)**.

The control room is equipped with a single remote control console, you can perform all operations, including control of the fluoroscopy table and X-rays, and digital image processing. A single PC system and no additional image processing control cabinet also keep the area under the control console clear and make efficient use of the limited space available in the control room **(Fig. 6, 7)**.
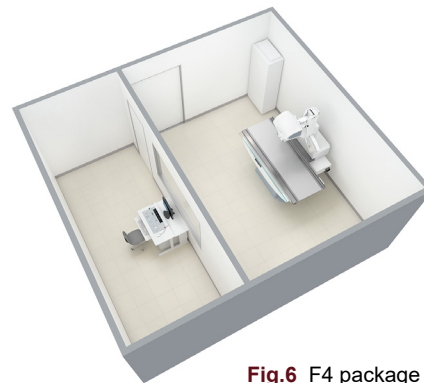
Fig.6 F4 package Layout Schematic

Fig.7 Remote Control Console

2.4 Universal Design

(1) Smart STEP

A soft-start/soft-stop function is used to raise and lower the bed **(Fig. 8)** to alleviate patient anxiety caused by sudden movements. In addition, the lowest position of the foot rest is as low as 10 cm from the floor, making it easier for patients to get on and off and to be assisted by medical staff. In addition, a sensor is equipped at the table end, and automatically stops the table tilting if any obstacles happens to get trapped.

Fig.8 Table Tilt for Standing Imaging

(2) Smart FACE

The bedside controller is equipped on the front of the table as standard that allows the operator to tilt the table, elevate the table, move the imaging unit longitudinally, and move the tabletop laterally **(Fig. 9)**. This allows the operator to move the table while also providing medical attention alongside the patient. The bedside controller is also recessed into the table to avoid accidental button presses by a nearby stretcher or bed.

Fig.9 Bedside Controller

The collimator controller is equipped on the front of the collimator unit as standard, allowing the operator to move the imaging unit longitudinally with ease even when the table is lowered **(Fig. 10)**. Also, in consideration of interference between the collimator and the operator's head when the bed is lowered, soft rubber is configured at the bottom of the collimator unit.

Fig.10 Collimator Controller

2.5 X-Ray Dose Reduction and Dose Management

A new virtual collimator setting has been added that can be used to check the collimator position on the last image hold without X-ray irradiation. Six different fluoroscopy frame rate settings are also available from a maximum rate of 15 fps down to 2 fps, and the operator can switch frame rates from the remote control console during ongoing procedures according to the requirements of the examination.

The F4 package also now supports the DICOM RDSR for dosage management. Depending on the requirements of the facility, reports can also be output as CSV files.

2.6 DSA Function

The F4 package now supports DSA* at up to 15 fps. A roadmap function is also available that superimposes fluoroscopy images or DSA images acquired during a procedure over live fluoroscopy images.

<div align="right">* DSA is an optional feature.</div>

3. System Specifications

Table 1 is a summary of major specifications.

Table 1

Component	Specification
R/F Unit	Table size: 792 × 2100 mm (Between side grooves: 650 mm) Longitudinal stroke of imaging unit: 900 mm Lateral movement of Table top: 220 mm Table height: 690 to 950 mm Tilting angle: -30° to +90° SID: 1100 mm, 1500 mm (standing position) Oblique Angle (Patient's head to foot): -30° to +30° (system with oblique projection) X-ray tube swing-out: 37° or 90° (option) X-ray tube rotation: 90°, 180° (option)
X-Ray Flat Panel Detector (FPD)	X-ray conversion material: CsI Pixel pitch: 160 μm Field of view: 17x17, 14x14, 12x12, 9x9, 6x6 inch Bit depth: 16 bits
Image Processing Unit	OS: Windows 10 Fluoroscopy: Pulse fluoroscopy (15, 12.5, 7.5, 5, 3, 2 fps) * Sequential fluoroscopy is also available. Radiography: SPOT radiography, sub-divisional radiography, serial radiography, DSA imaging (optional) External devices: DICOM MWM/MPPS, RDSR PRONT, STORAGE (RF/CR/DX) card reader, barcode reader (option)
X-ray high-voltage generator	Maximum rated output: 50 kW Generation method: Inverter method
X-Ray Tube Unit	Maximum anode heat capacity: 400 kHU, 600 kHU Focal spot size: 0.3/0.8 (400 kHU), 0.6/1.2 (400 kHU, 600 kHU)

4. Summary

The FLEXAVISION F4 package is a high performance system with significantly improved capabilities that can perform general radiography examinations as well as fluoroscopic examinations **(Fig. 11)**. Under the tagline "Fits all your needs with 17×17 inch wireless FPD". Shimadzu continues to develop flexibly examination environments that meet the needs of clinical fields.

Fig.11 Example Examination Room/Control Room Layout