Navigated dorsal stabilization of the spine
Artis zeego – robotic 3D imaging system

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Director of orthopedic traumatology, hand, plastic, and reconstructive surgery

Illustrated Workflows in Hybrid Operating Rooms, No. 6

University hospital of Ulm, Germany

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The University Hospital of Ulm is a center of maximum care with over 1,100 beds and over 5,000 employees.

Since 2007, Prof Dr. Florian Gebhard has been director of orthopedic traumatology, hand, plastic, and reconstructive surgery. He focuses on spinal surgery, complex pelvis, and distal limb fractures as well as oncologic bone surgery.

In the newly built hospital (2012) he took the lead for the hybrid operating room. This hybrid operating room combines a traditional OR with a robotic angiographic system, providing high-end imaging and complete table integration for high-precision procedures.
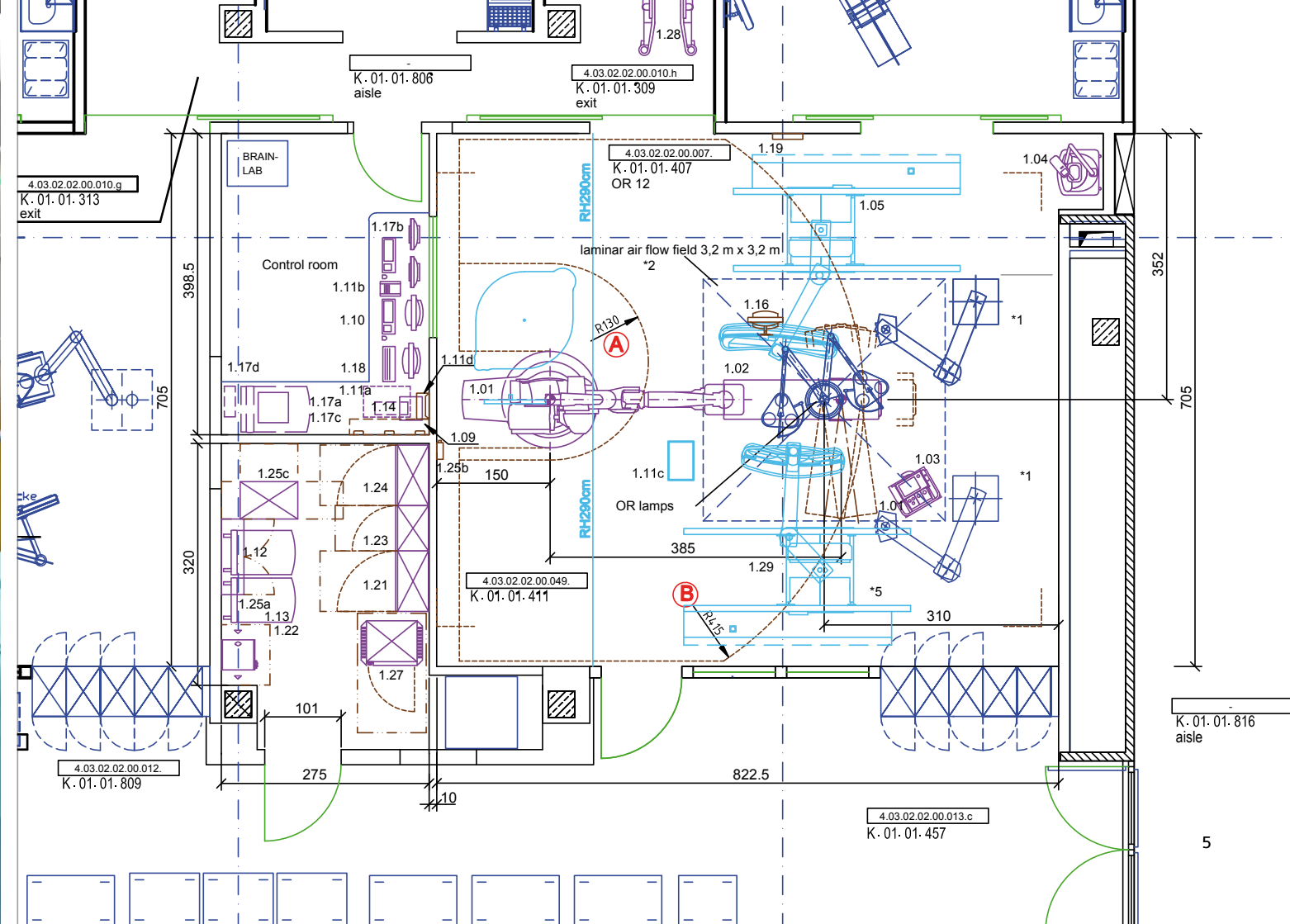
The room is in multidisciplinary use with orthopedic traumatology, neurosurgery, vascular, heart surgery, and CMF surgery.

Prof Dr. Gebhard is a pioneer in orthopedic trauma surgery. He is the first surgeon to use the Artis zeego 3D robotic imaging system in combination with an integrated interface to a navigation system in a hybrid operating room. He believes that high-precision imaging in the OR takes orthopedic surgery to another level.

The Hybrid Operating Room

The university of Ulm is equipped with the latest robot-supported imaging system, Artis zeego. It offers intraoperative 2D fluoroscopy as well as intraoperative 3D imaging with *syngo* DynaCT. Unique rotations allow 3D imaging of large volumes such as the whole pelvis. Positions and projections can be easily stored and even recalled from recorded fluoroscopy scenes (Automap function). Its unique flexibility allows head-to-toe coverage and is entirely surgeon-controlled. The integrated surgical table makes 3D imaging possible in sophisticated patient positions.

It is the first joint installation with the Artis zeego and a navigation system, in this case the Brainlab Curve™ system. The navigation system is automatically registered to the *syngo* DynaCT 3D dataset protocol. The combination of the Artis zeego with the navigation system leads to better decision making and more safety for the patient right in the OR.

Patient positioning

Prior to the incision the patient is anesthe-sized and positioned properly. The head is placed in a foam pillow with openings on the bottom for access to the endotracheal tube. The tubes to the anesthesia machine are laid along the patient so that they don't interfere with the *syngo* DynaCT run and so that the anesthesiologist always has access. The patient is always positioned feet first to the anesthesiologist. The arms are cushioned with gel pads to make sure the patient is lying safely. Cushions underneath the chest and pelvis are needed for proper patient position-ing. Depending on the kyphosis of the patient, the height of the chest cushions can vary.

Then the surgeon uses 2D fluoroscopy to define the exact surgical location. Using a laser cross light integrated into the detector of the angiography system (see image page 7), precise positioning can be facilitated. Due to the large detector of the Artis zeego (30x40 cm/15x17 inches) the entire thoracic spine can be visualized in only one fluoro shot.

Collision check, entering of patient data

When the surgeon has identified the region of interest for surgery, a test run of the robotic imaging system of the C-arm is performed with any surgical accessories to make sure there are no collisions. Collisions with the patient or table are impossible because each is integrated into the Artis zeego safety collision model.

The navigation system is started. The surgeon enters the new patient data and prepares the system for the 3D data transfer from the robotic C-arm system. Along with the 3D *syngo* DynaCT data, the personal patient data such as name, date of birth, etc. is also transferred. This entire process is automated, helping to speed up the workflow and saving a great deal of time during the procedure.

Preparation, incision, and referencing for navigation.

Before surgery starts the patient and the Artis zeego are covered with sterile drapes. This technique allows a sterile environment even with the robotic C-arm moving from underneath the table when the *syngo* DynaCT run is performed. Surgery starts with a skin incision and preparation of the spine. The dynamic reference base (DRB) is fixed at the spine.

The DRB is an array of 3 marker spheres, which have to be visible to the infrared camera. The Artis zeego system also has reflective markers below the tube and above the detector for automatic registration of the acquired images (see upper image in the middle). These reflective markers need to be visible to the infrared camera of the navigation system. Highest precision can be achieved only when all markers are clearly detected by the camera.

syngo DynaCT run

The surgeon uses the sterile control panel that is attached to the table and moves the Artis zeego into the exact position required. The robotic system is fully surgeon-controlled. Multiple positions can be stored.

With the Automap function the surgeon can extract and adjust the projection of stored scenes. The 5 sec Body protocol is selected for a 3D *syngo* DynaCT. This is the protocol that is configured to match the navigation system.

The inverse square law also applies in this case, which means the greater the distance between the person and the radiation source, the less the radiation.

Automated data transfer

The 3D data of the *syngo* DynaCT and the patient data (name, date of birth etc) is automatically transferred to the navigation system. This transfer is achieved in less than a minute and meanwhile the Artis zeego can be placed in the parking position. The surgeon now has all the required working space.

The surgeon checks his or her position, the position of the patient and the orientation of the images (feet to head or head to feet). The process of windowing the images is critical for the optimal navigation of the screws.

Accuracy check, referencing of the navigation tools

The instruments used for the insertion of the screws are referenced to the navigation system before the surgeon starts. The instruments are seamlessly integrated and quickly recognized by the camera and can be verified on the monitor. Navigation systems provide real-time tracking of the surgical instruments within an intraoperative 3D data volume without radiation.

After the insertion of the first screw, the precision of the 3D volume combined with the navigation system is tested, and a 2D fluoro image is taken for a precision reassessment before the surgeon continues with the procedure.
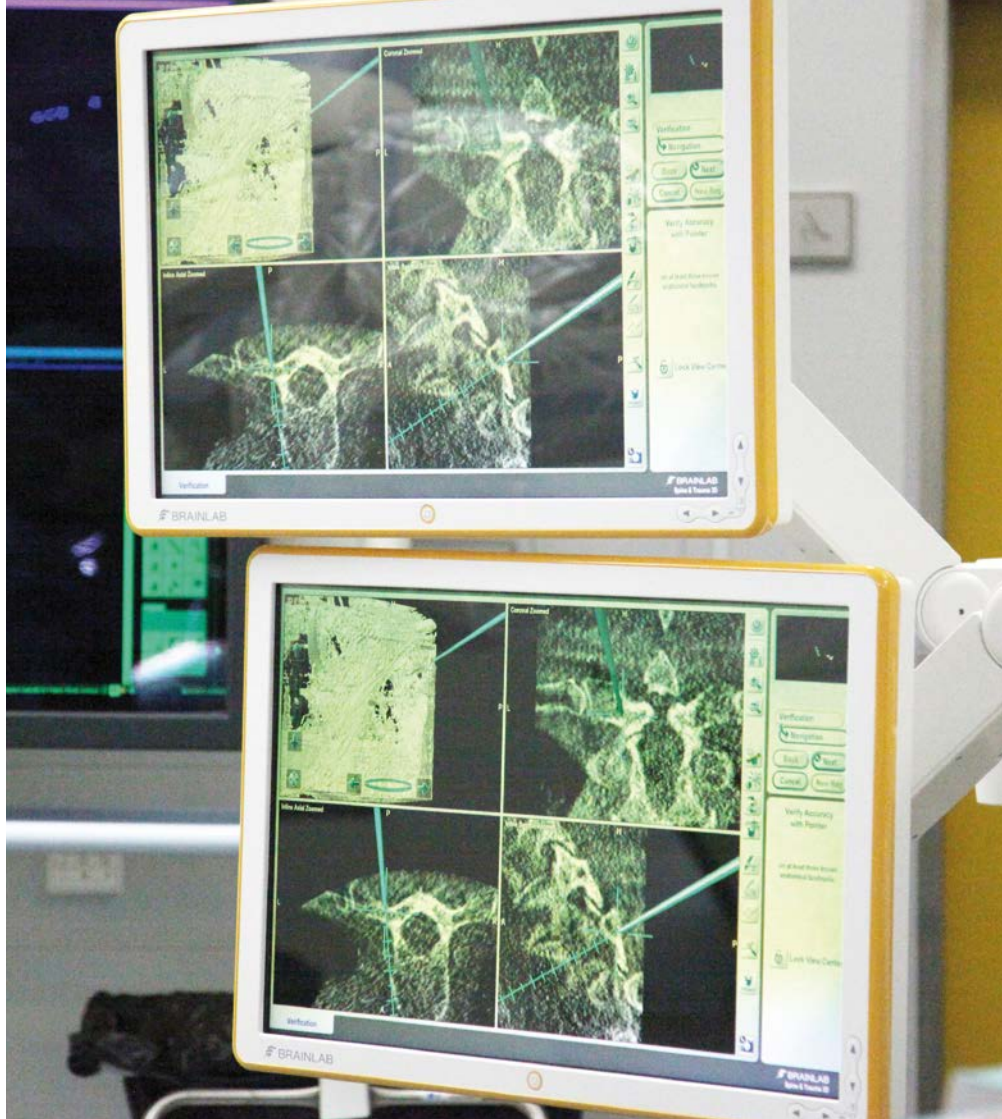
Navigation and placing of pedicle screws

With intuitive handling of the navigation system, the pedicle screws are placed at the right angle and the appropriate depth. Real-time viewing of the instruments in intra-operative 3D data is provided. To achieve the highest precision the three reflective markers on the DRB and each surgical instrument have to be in straight alignment with the infrared camera at all times. The surgeon needs to make sure that the markers are not covered.

The screws can be placed one after another, saving radiation for the surgeon, the staff and the patient.
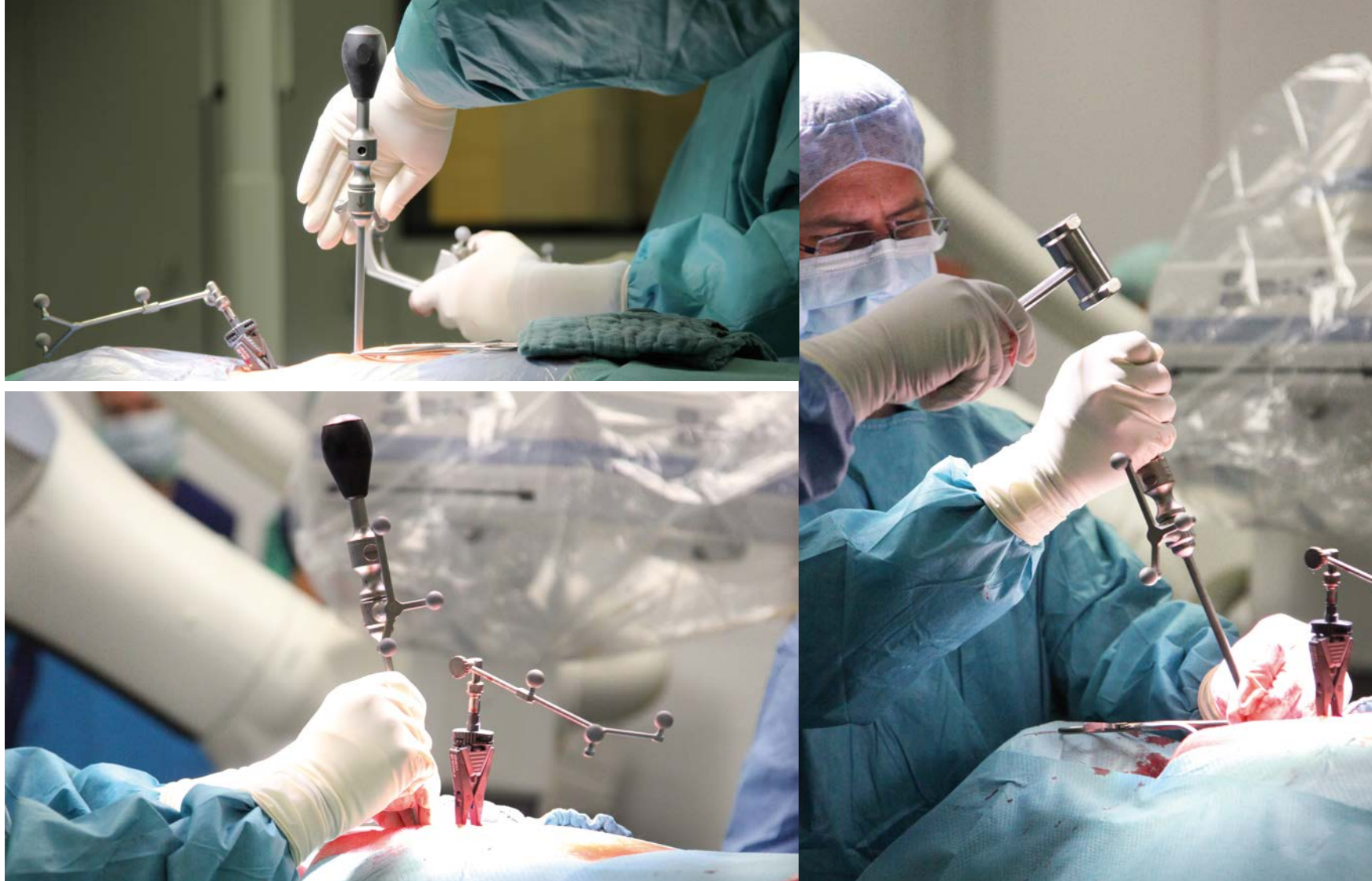
syngo DynaCT
for verification
of all screws

After placement of the pedicle screws, a second 3D *syngo* DynaCT verifies their positions. Small adjustments can be made if necessary. If a screw is not in a satisfactory position, the surgeon can replace the screw right in the OR.

Surgery is finished after verification by *syngo* DynaCT. Again, the image quality and the large field of view are of great benefit. The surgeon then sutures the wound and afterwards the patient is extubated and taken to the recovery room.

Sound decision-making with high precision imaging takes spine surgery to another level of safety.

Highest hygienic standards

For trauma surgery the highest hygienic standards are required. A laminar air flow field is therefore often implemented in a hybrid OR environment. This helps to minimize bacteria in the air of the OR field.

The Artis zeego is the first angiographic system that achieves the highest standard of hygiene[1] in an imaging position within the working laminar air flow field.

[1]Hybeta-hygiene, consulting, technical analysis, March 1st 2012
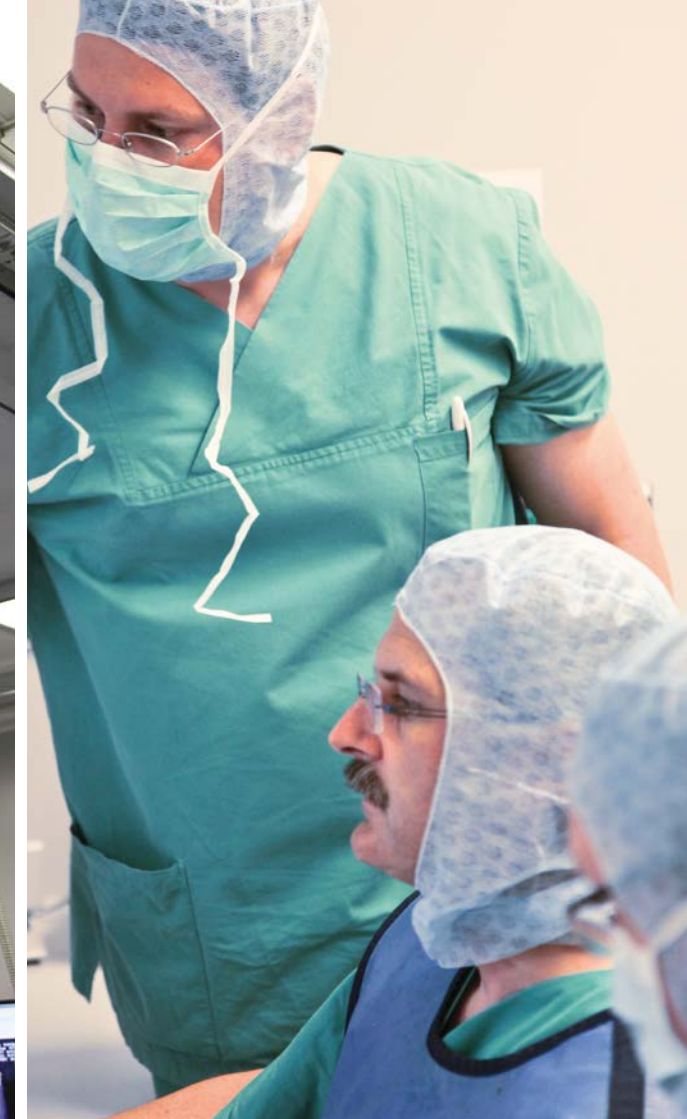
"With appropriate positioning and coverage so far every single planned scan regarding the spine, pelvis or the skull could be executed. No problem has arisen regarding the localization of the navigation system, the performance of the scan or over-writing the data.
The setup allows surgical sterile handling of the zeego system as well as of the Brainlab system."

Florian Gebhard, MD, PhD

Configuration of the
Hybrid Operating Room

At the University Hospital of Ulm

- Artis zeego with Automap functionality
- Trumpf TruSystem 7500 operating table, segmented carbon tabletop
- Large Display with 24 video inputs and AXIOM Sensis XP interface
- 2k acquisition with 30x40 detector and laser cross light
- *syngo* X-workplace

- *syngo* iGuide software with 3D/3D Fusion
- *syngo* iPilot software
- *syngo* DynaCT package
- Laminar airflow field
- Brainlab Curve™ System

Benefits

- Exceptional image quality and large field of view based on a high-powered X-ray tube and 30x40 flat panel detector
- Sound decision-making in the OR so screws are placed correctly
- Improved workflow due to predefined positions and to surgeon-controlled handling of the system
- Dose-saving measures like automap and the use of a navigation system reduce the radiation for both the patient and the surgeon

- Floor-mounted robotic imaging system without interference in laminar airflow field for highest sterility
- Unrestricted access to the patient
- The automated interaction of the Artis zeego and the Brainlab Curve system helps navigation with intra-operative imaging and real-time guidance and provides more safety during procedures.

Scan this code with your smartphone to watch a movie of this procedure.

www.siemens.com/healthcare