

# Improving your MRI experience



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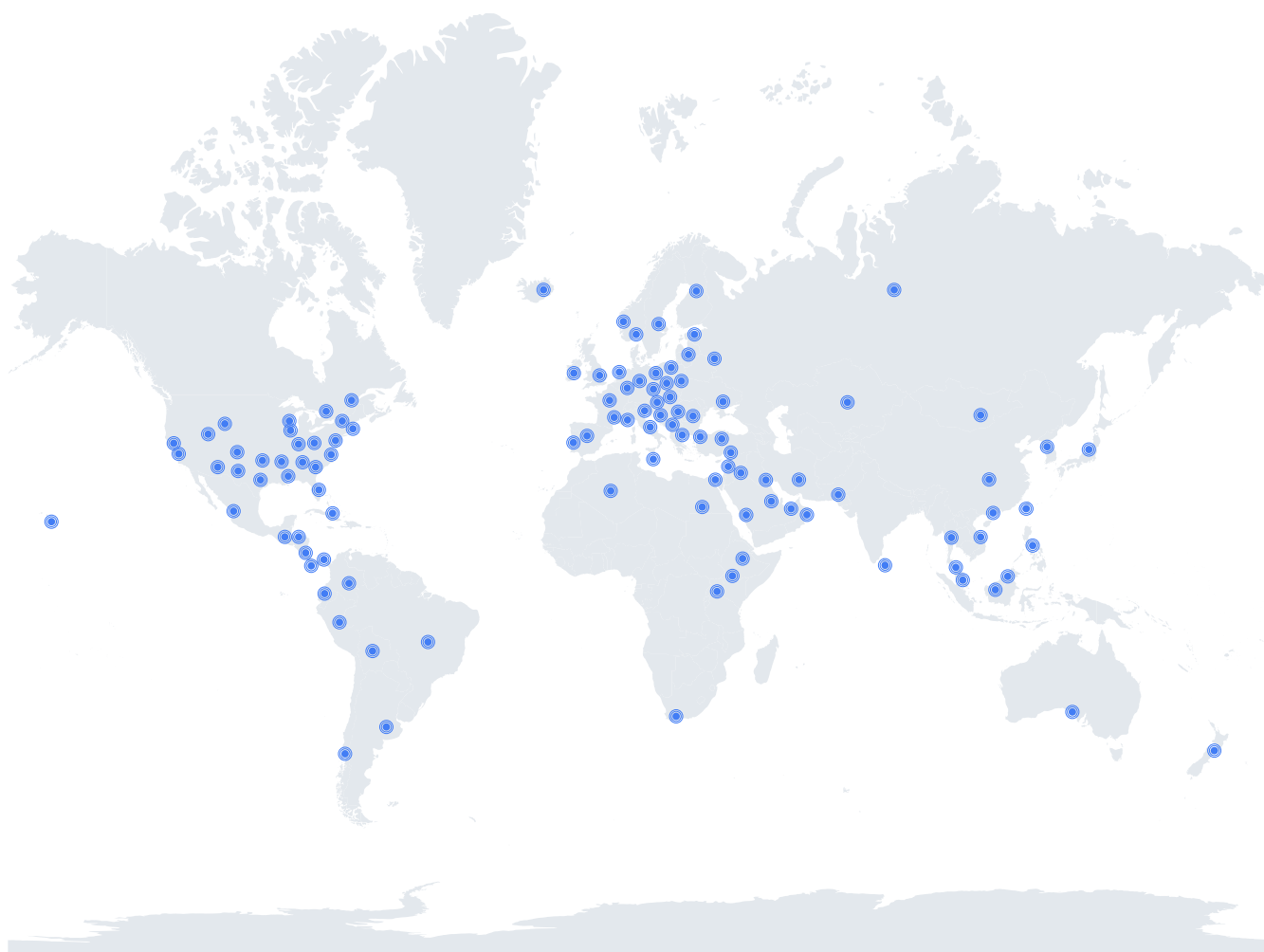


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# Installations

We are committed to providing the highest quality products and services worldwide

With more than 2000 installations in over 70 countries and solid partnerships with the biggest MR scanner manufacturers, we continue to develop fMRI as a clinical tool for precision medicine as well as expanding into related segments such as patient entertainment and in-room viewing for interventional purposes.



# Testimonials

Matthias Kündel  
Universitätsklinikum Tübingen



Video testimonial

*“We can reduce the time you block the scanner, for anesthesia, with more than a half.”*

*“With patient entertainment you get three patient through instead of one.”*

Bac Nguyen  
Rikshospitalet - Oslo University Hospital



Video testimonial

*“We saw that the number patients who needed sedation or anesthesia went down because we had the possibility to provide movies.”*

*“Patient entertainment saves us a lot of time and it saves the patient from using sedation.”*

# nordicComfortSolution Components

NordicNeuroLab aims to be the leading global provider of solutions that helps both the MR technologist and the patient to have a successful scan.

By observing everyday life of MR technologists, we see that they often need to spend more time than scheduled making a patient comfortable enough to undergo a scan. To successfully attend to the needs of anxious patients, MR technologists need tools that will help shifting patient focus to something other than the examination.



## InroomViewingDevice

The 40" 4K UHD InroomViewingDevice is an MR compatible monitor that satisfies the needs of both clinical and advanced scientific applications.

With its slim design, high-definition display and superior image quality, the InroomViewingDevice is an optimal choice for an easy to use alternative to conventional projectors or goggle based image delivery systems.

## Integrated Camera

The innovative, front-facing camera provides an uninterrupted patient surveillance during examination. Thanks to the built-in USB hub, connecting patient communication and interface devices is now extremely easy.

## Flexible Positioning

The lightweight and height adjustable mobile foot stand allows easy positioning of the monitor anywhere in the MRI room.

## Instant Feedback

The monitor facilitates the examination process by allowing the operating personnel to remain inside the examination room during procedures, thus allowing uninterrupted patient care and quick response time, which significantly improves clinical workflow.



\* Streaming services are not included with the nordicComfortPlayer

## nordicComfortPlayer

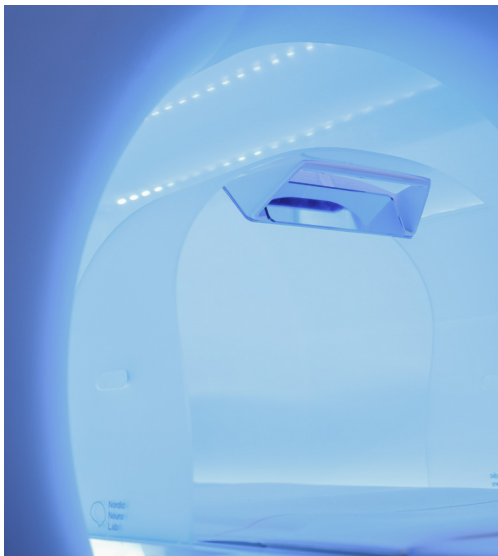
The nordicComfortPlayer was made to ensure speed and ease of use. The player allows the MR technologist to control the rotation of the screen, volume, and it's easy to find video content or radio stations. The nordicComfortPlayer allows for a number of different media options: stock movies, importing licensed content, and streaming services such as Netflix™, Disney+®, Hulu™, Youtube™, HBO Max™, etc.\*

In addition to present the content there is also option to present the remaining scanning time and "Breath Hold". Presenting it both auditorily and visually will increase the success rate of that procedure.



## Touchscreen in the control room

The nordicComfortPlayer is operated through a computer with a sleek touchscreen design, which minimizes its footprint in the MRI control room. With just a single press of a button or two, the MR technologist can easily start the entertainment system using the touchscreen interface, making it a convenient and user-friendly option.



## nordicInboreMirror (Optional)

Not every MR-scanner has a free-standing mirror. The alternative has been to use the mirror solutions that come with the head coil, but many patients feel that the head coil is intimidating, and the free-standing over body mirror can be used alternatively when a head coil is not needed.

The mirror has two view options, single- and dual mirror, which allows you to use the mirror independent of which direction the patient lies in the scanner.

The mirror fits most 60 cm and 70 cm scanners.

# Benefits

It is estimated that up to 30% of patients suffer from claustrophobia during MRI scans, while patient motion appears in up to 29.4% of MRI scans. Furthermore, data shows that as many as 30% of pediatric patients are given anesthesia/sedation during MRI examinations.

MRI examinations can be very stressful, particularly for younger children <10 years, as patients are required to remain motionless for longer periods of time. Various literature has confirmed that anesthesia typically adds about \$350 to a regular MRI examination. For sedation, the extra cost is estimated to be around \$100.

Using audio/visual systems during MRI scans reduces the number of anesthesia / sedation cases by 9% – 35% in pediatric patients, which could save hospitals \$11,000 or more per scanner per year. Since the typical cost for audio / visual systems is around \$37,000, investing in an entertainment system, rather than using sedation / anesthesia, would return the investment costs after only 100 non-sedated patients.

Adding other potentially cost-saving benefits of audio/visual systems like higher patient satisfaction, fewer motion artefacts, and a lower number of aborted scans, the time to break-even can be reduced even further. Data show that 84% of patients have reported a positive experience when using audio/visual systems. For patients with chronic illness, repeated scans may be necessary. A pleasant first-time experience is often a crucial factor to build a positive foundation for all future scans of that patient.

As a response to claustrophobia and sedation rates in the MRI department, NordicNeuroLab has developed the nordicComfortSolution. The nordicComfortSolution is an entertainment system which aims to help hospitals around the world to reduce costs, provide a better patient experience and to ease the daily routines of personnel.

- ✓ Reduces the use of anesthesia
- ✓ Reduces costs
- ✓ Reduce time
- ✓ Increases patient satisfaction
- ✓ Patients report that the exam seems to go faster
- ✓ Present media content quickly and easily





# Patient entertainment during MRI scans



<https://www.youtube.com/watch?v=wwf2RyKrWUw>

## Abstract

Recent studies and interviews have shown that patient-related challenges during MRI examinations can introduce substantial additional costs in clinical practice. Typical costs include lost exams due to excessive patient movement, aborted exams due to MRI-related anxieties and costs associated with monitoring and administration of sedation and anesthesia. The nordicComfortSolution from NordicNeuroLab has been developed to provide a user-friendly, all-in-one solution to mitigate these problems – reducing yearly costs in hospitals and improving comfort levels for patients. The nordicComfortSolution is an entertainment system which allows the MRI technologist to present relaxing and calming media content to the patient. Research studies have shown that comfort solutions can have a positive effect on workflow by reducing the need for sedation and anesthesia and resulting delays in exam administration. The economic benefits can total tens of thousands of dollars on a yearly basis. Furthermore, risk factors associated with sedation and anesthesia can be avoided, improving safety and quality of patient care.

## Introduction

Technological development in recent years, such as the introduction of wide bore scanners, has improved the patient experience during MRI examinations. These scanners aim to increase patient comfort and can accommodate the use of peripheral equipment more easily. Combined with several software improvements such as faster processing time and higher signal-to-noise ratios, the MRI sector delivers better image quality with reduced examination time (T.Sobol, 2012). Nevertheless, several challenges remain. Patient-related problems seem to cause frequent delays in radiology departments. Not only are these delays frustrating for the patient and personnel, they also contribute to substantial costs and workflow disturbances. This paper takes a closer look at patient-related challenges and presents a solution to make MRI exams a more comfortable experience for the patient and to improve daily workflow in radiology departments.

According to a study of 34,600 MRI exams performed on 17 scanners at 9 adult imaging facilities, unanticipated events were commonly reported in about 16.7% of all MRI scans (Sadigh, et al., 2017). The leading causes for these events were related to claustrophobia (0.5% to 14.3%), delays (3.3%), patient motion (5.5%), patient discomfort (1.5%) and sedation needs (1.2%).

Other studies have reported patient motion in MRI scanners ranging from 7.5% to 29.4% (Andre, et al., 2015), and an estimated number of aborted scans due to patient anxieties or psychological distress ranging from 1% to 30% (Lisa & Lois, 2013). While only a fraction of these scans might be aborted, costly side effects of anxiety are still a concern. Patient anxiety can cause significant delays due to increased movement, time-consuming preparation and the need for regular breaks during the scan.



Remaining motionless during an MRI examination is not an easy task for young patients or adults. The scanner noise and the MRI environment are the main reasons for motion during examinations in young children, especially those from ages 3–10 and those with developmental delays or hyperactivity (K, et al., 2001). In these cases, the most common solution is anesthesia or sedation which carries additional costs that include the need for supplementary items such as MRI compatible equipment, drugs and increased time and staffing for patient preparation, monitoring and recovery. However, the most important factor to consider when introducing sedation of any kind is that the patient is exposed to higher risk (K, et al., 2001)(Lemaire, et al., 2009).

### nordicComfortSolution

To solve the problem of scan delays due to anxiety and patient movement, and to improve patient experience during MRI exams, NordicNeuroLab has developed the nordicComfortSolution.

The nordicComfortSolution package consists of the NordicNeuroLab MRI compatible monitor and nordicComfortPlayer, operated from a tablet within the control room.

# Patient entertainment during MRI scans

The solution aims to reduce the number of delays, aborted scans, and use of anesthesia or sedation by improving patient workflow throughout the entire MRI procedure. Equipped with relaxing audio and video content, the patient will experience calm surroundings which may help to distract from the otherwise intimidating enclosure of the scanner. Providing a familiar, engaging and safe environment can eliminate the need for sedation during a scan, important especially for pediatric patients.

Furthermore, the user-friendly all-in-one solution provides a simple and powerful tool for technologists and radiologists that allows them to easily choose and display various media content. The entire system is controlled by a single screen menu through which media content can be selected.

There is no need to use multiple devices or provide unlimited options for entertainment purposes which can introduce delays in patient preparation. This provides more freedom for the MRI technologist to focus on the patient and MRI related procedures.

All video content can be viewed from the tablet located in the MR control room and is automatically displayed in full screen on the external monitor in the MR room. The patient sees the screen through a mirror attached to the coil or a free-standing mirror. Through the user interface, the operator can easily adjust the mirror configuration from the MR control room and gradually adjust volume or mute entirely by pressing a single button. For patient monitoring, the radiologist and technologist can use the monitor's integrated camera to observe the patient's state during the scan.

The nordicComfortSolution package comes with licensed media content, however hospitals can add their own movies and music if they own the licensing rights.

## Cost and risk reduction

A study performed on 268 pediatrics patients revealed that audio/visual systems decreased the need for sedation during MRI scans by 34.6% for children aged 4-10 years (15.4% overall). Cost of an audio/visual system was estimated at \$37,000 and the cost for sedation was on average \$325 per patient. Thus, the savings from 110 non-sedated patients could cover a full audio/visual system and lower patient exposure to sedation. Since sedation is time consuming, reducing the number of cases results in more time to scan other patients. A significant number of participants (84%) reported a positive experience when the audio/visual system was used (Lemaire, et al., 2009).

Another study in 2,067 patients reported reduction in sedated pediatric patients by 9% overall and by 18% for children ages 3 to 10 (K, et al., 2001). Similar findings were described by DJ et al, finding a significant decrease in pediatric anesthesia and sedation cases by implementing video content (DJ, D. et al., u.d.).

Sedation or anesthesia is mainly used in children or adults with severe anxieties. Findings from a study with Partners for Kids Accountable Care Organization (ACO) suggest a rise of anesthesia and sedation cases in pediatric MRI examination from 21% in 2011 to 28% in 2014. This rise was estimated to contribute to a total cost increase of \$11 million dollars for outpatients (C, et al., 2017).

A study of 200 children at The Hospital for Sick Children in Toronto showed that the cost of imaging procedures with sedation or anesthesia increased by a factor of 3 and 10 respectively (Vanderby, et al., 2010). The overall cost per scan was estimated to be around \$95 for sedation and \$370 for anesthesia.

Considering an average of 2 MRI scans per hour for 16 hours a day, this results in about 11,500 scanned patients per year, per scanner. Assuming 15% of these patients are aged 1-18, with an average anesthesia or sedation rate of 23% for this age group (C, et al., 2017), this would result in a total of about 400 anesthetized or sedated pediatric scans. Let's further estimate that the use of audio/visual systems reduces the rate of sedation/anesthesia by 12% in total (6% sedation & 6% anesthesia) (K, et al., 2001). This would result in a reduction of 24 sedation cases and 24 anesthesia cases. Using cost estimates from the study published by The Hospital for Sick Children in Toronto (Vanderby, et al., 2010), this would reduce costs by approximately \$11,100 per scanner, per year.

# Patient entertainment during MRI scans

Though we have focused on pediatric populations, using audio/visual systems could also be beneficial for adults, thus reducing delays, movement and the need for sedation, which could significantly impact cost savings on an annual basis.

According to data from hospitals in Norway (public healthcare system), the cost of anesthesia on average is \$120 per hour (personnel) + \$75 per hour (anesthetic and equipment). The total scan duration with anesthesia varies from 2 - 4 hours. Thus, the average procedure cost is between \$315 and \$550 (see table below). Performing these exams on 115 patients without sedation/anesthesia returns the cost of investment in an audio/visual system quickly and provides a much safer option.

## **Cost per Anesthesia for MRI (Hospitals in Norway)**

Average cost per hour (personnel)	\$120
Anesthetic and equipment	\$75
<b>2 hour procedure</b>	<b>\$315</b>
<b>4 hour procedure</b>	<b>\$550</b>

***Between 65-115 patient procedures without sedation/anesthesia could provide a return on the investment in an audio/visual system***

A study examining the effect of patient motion during MRI imaging showed that repeated scans are required in approximately 20% of MRI examinations, which may reduce resource efficiency and affect the quality of patient care (Andre, et al., 2015). Their analysis estimated a lost revenue of \$90,000– \$140,000 per scanner, per year due to motion artifacts. Audio/visual systems could potentially help reduce some of these costs.

While above-mentioned factors have a significant economic impact, the nordicComfortSolution also focuses on the patient's general well-being during the scan. In cases of serious and chronic illnesses, repeated MRI scans are often necessary. For these patients, a positive and pleasant first-time experience is a crucial factor for predicting ease and success of future scans. In the US, patient satisfaction has a significant impact on reimbursement bonuses. Patient satisfaction is measured by the HCAHPS survey and has a weight of 30% on the final score, which determines the reimbursement bonus. For US clinics this means that between \$500,000-\$850,000 in funding bonuses could be at risk on a yearly basis (Buhlman, 2011).

During the development phase of the nordicComfortPlayer, the system was tested under daily operational conditions at hospitals in Bergen and Oslo, Norway. Medical staff reported a positive effect when using the system. At Rikshospitalet, it was mentioned that the system had a positive effect on children and overall workflow. In the Norwegian MRI Tech magazine HoldPusten, a radiographer from Haukeland University Hospital stated that it was easier to keep children calm when watching movies, while a radiographer from Rikshospitalet mentioned that children can be quite frightened when undergoing an MRI examination, but are very happy when they are offered a movie to watch (Askvik, 2017).

## Summary

While several technical advancements have improved conditions in today's radiology departments, patient-related factors are still causing significant workflow barriers and economical hurdles. The most common issues are related to scan delays (16.7%), patient movement (7.5–29.4%), use of sedation/anesthesia (23% on average) and MRI related anxieties like claustrophobia (0.5% – 30%). Patient motion and delays can cost radiology departments more than \$115,000 per scanner per year, reducing resource efficiency and quality of patient care. Sedation and anesthesia use in pediatric populations can result in a cost increase of \$11 million.

The nordicComfortSolution aims to reduce these issues by providing a relaxing and calming atmosphere to ease patients into the MRI experience and distract them from the scanner environment. Previous studies suggest that using audio/visual systems decreases sedation rate by 9–18%. This results in a cost reduction of approximately \$11,100 per scanner, per year. This suggests that investing in an entertainment system that could serve as an alternative to sedation (in at least 100 patients) would return the cost in a very short time. Considering the cost savings associated with factors such as reduced motion (requiring repeat exams), reduced preparation time and higher patient satisfaction, in addition to the reduced risk and cost of anesthesia, the actual cost saving could be significantly higher.

The nordicComfortSolution is designed to be a user-friendly, all-in-one solution that allows the technologist to focus on patient care and exam-related tasks. Increased patient comfort during a first scan may contribute to improved image quality during future scans for returning patients and may enhance the reputation of the hospital. In the US specifically, reputation has a significant impact on yearly reimbursement bonuses.

# Patient entertainment during MRI scans

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# Corporate information

## About Us

With over 20 years of experience, NordicNeuroLab provides products and solutions that define the field of functional MR imaging. Having grown from a spin-off from the fMRI research environment in Bergen, Norway, we understand the growing need for reliable and innovative tools in this emerging field. This is why we make it a priority to collaborate with research and clinical teams from both academic and clinical centers, MRI system manufacturers and third party providers.

From fMRI hardware for audio and visual stimulation, eye tracking and patient response collection, to patient entertainment, NordicNeuroLab products are used around the world by researchers and clinicians alike. We are dedicated to bringing the most advanced neuroimaging tools to market while making functional MRI programs easy to implement

## Our Mission Statement

NordicNeuroLab will apply world leading competence and experience to provide professional solutions for functional imaging, enabling improved patient care and clinical efficiency.

## Our Corporate Values

- We push for innovation
- We listen to our customers
- We focus on ease of use
- We deliver high quality
- We value safety



## Regulatory Compliances and Certificates

NordicNeuroLab has always emphasized quality and safety in the development and production of our devices. NordicNeuroLab fMRI hardware system is designed, developed and manufactured under certified ISO 13485 Quality Management system. As our product portfolio grows, we continue to ensure that all our products intended for clinical use meet regulatory and safety requirements, have respective market clearances, and are tested for international UL and IEC consensus standards for Device Safety and Electromagnetic Compatibility (EMC) for medical equipment.

## Service and Support

NordicNeuroLab takes pride in providing excellent service and support to our customers. Whether you are working with our team directly or through local partners and distributors, we are ready to support you in any way we can. We offer warranty, software maintenance solutions and professional installation and training packages based on your individual needs. We also offer online and on-site workshops in order to further improve product understanding and customer satisfaction.

# Other products

## An easy upgrade to fMRI Acquisition



Our goal is to bring the most advanced neuroimaging tools to market, and at the same time make them easy to implement and use. We have therefore created complete fMRI solutions that include everything required to conduct an fMRI scan. In addition to complete packages, we also offer modular solutions both for clinical and research purposes.

### ResponseGrips

The MR compatible ResponseGrips allow subjects to provide feedback by pressing one of four buttons. They have been developed for clinical and research users alike. Ergonomically designed for both hands to help minimize patient movement inside the scanner, they are suitable for a wide range of experimental paradigms.

The ResponseGrips are compatible with all leading stimulus presentation software packages, and interfaces with a number of third-party hardware devices.

The ResponseGrips are 100% fibre optic, and connects to the ResponseGrips Interface Unit in the operator room through an available waveguide. The Interface Unit provides real-time feedback of subject responses via LED indicators and optional sound signaling.

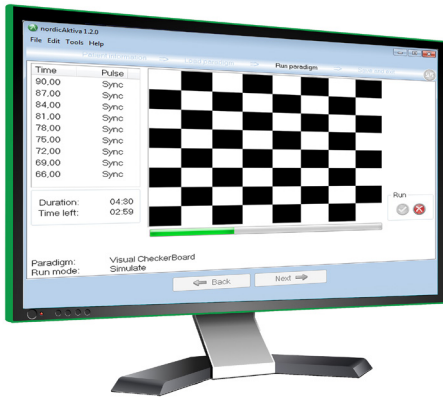
### SyncBox

One of the challenges in fMRI is synchronizing stimulus presentation with MR image acquisition. The accuracy and verification of timing information is critical to the validity of results. With a flexible and user-friendly menu system, the SyncBox allows the user to select how the trigger pulse from the scanner is transferred to the software presenting the stimuli. Furthermore, when used alongside nordicAktiva, serial communication allows the syncbox settings to be controlled automatically by the stimulus presentation PC.

The SyncBox can simulate the trigger signals produced by the scanner during an MRI sequence. This enables the user to develop and test the entire experimental paradigm in the office, minimizing the need for testing in a costly scanning environment.

The SyncBox is MRI scanner independent and interfaces with a variety of external devices, allowing synchronization of signals from different hardware sources and providing accurate logging of time stamps.





## nordicAktiva

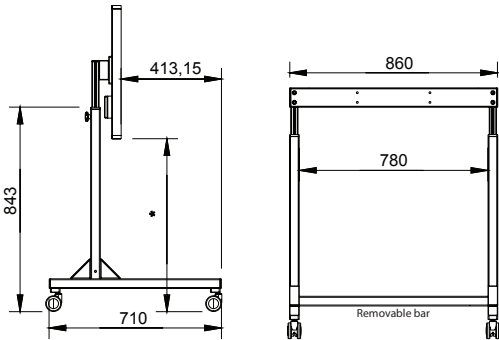
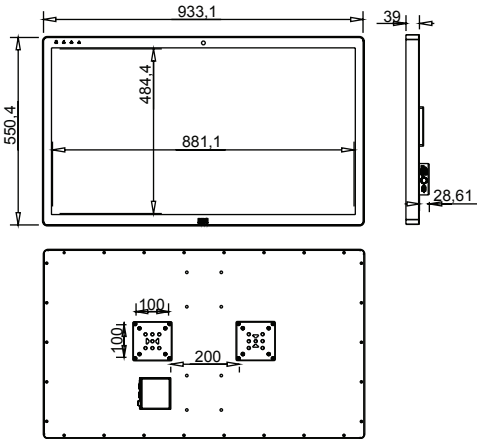
nordicAktiva is an easy-to-use stimulus presentation software, designed with the MRI technician in mind.

By using nordicAktiva, a single technician can handle stimulus presentation and image acquisition at the same time. Through an intuitive interface, the user is guided step-by-step through the process of presenting stimuli during image acquisition.

Our ready-to-use paradigms follow recommendations from the ASFNR (American Society for Functional Neuroradiology). On selecting a paradigm, clear instructions allow the operator to successfully plan their protocol and prepare the patient. These instructions, as well as the paradigm content, are available in many different languages.

nordicAktiva runs seamlessly with the NNL fMRI hardware, displaying the paradigm to the patient during the MR imaging exam. An integrated hardware test assures that the fMRI hardware is connected and working properly prior to the exam.

# Technical information



For fMRI, instant feedback and patient comfort

### Key Technical Specifications

- ✓ 40" with 4K UHD display
- ✓ Front-facing camera for patient surveillance
- ✓ HDCP compliant
- ✓ Flip/rotate of image
- ✓ Built-in USB hub for easy connection of keyboard and mouse (HID)
- ✓ Full optical path between operator- and MR-room
- ✓ 0.5T, 1.5T, 3.0T and 7.0T Field conditional

<b>LCD Monitor</b>	
Display Type	TFT active matrix liquid crystal panels
Screen Diagonal	40"
Active Area	878.112 mm(H) x 485.352 mm(V)
Pixels	3840 x 2160
Pixel Pitch	0.15245 /H) x 0.4494 (V)
Pixel Arrangement	RGB Vertical Stripe
Display Mode	Normally black
Display Colors	10bit(8 + FRC), 1073.7M
Surface Luminance	350 nits
Contrast Ratio	5000:1 typ
Refresh rate (MAX)	60Hz@FHD 30Hz@UHD
Backlight	LED
Response Time	9,5 ms (G to G)
Color Gamut	NTS 88%
Size; weight	933.1 x 550.4 x 39 mm; 15.8 kg
VESA fixation	2x 100x100, D: 400 mm, M4
Alternate Fixation	40 mm x 30 mm, M6
Camera (MAX) (Default)	1920 x 1080, 30fps, 1280 x 720@30fps
USB Connectors	Dual Type-A, Full speed (12Mbit/a), 0.5A, 10W @ +5V
Display Lifetime	30000 hrs
<b>Fiber Transmitter</b>	
Electrical Connector	HDMI Receptacle type
Graphical Resolution Support	4096 x 2160 @ 30 Hz HDMI 1.4b
Optical Connector	2 x LC Simplex Multi Mode 50/125 µm [OM3]
Size	125 x 140 x 30 mm
Power Consumption	1200mA @ +5V
<b>LCD Power Supply (LPS)</b>	
Voltage Range	100 - 240 VAC
Frequency	50/60 Hz
Fuse	T 2.0A H 250V
Power Consumption	120 - 150 VA
Optical In/Output	2xLC-connector/MPO-connector
Dimensions, Weight	164,3 x 132,6 x 315,5 (HxWxD) [mm], 2.4 kg
<b>Environmental Data</b>	
Storage Ambient Temperature	+20 to +60 degrees Celsius
Operation Ambient Temperature	+18 to +35 degrees Celsius
Relative Humidity	20% to 90%
Maximum Operation Altitude	4000 m. above sea level
Panel Surface Temperature	65 degrees Celsius
Atmospheric Pressure Limits	57.1 kPa to 107 kPa
<b>EMC &amp; Safety</b>	
Safety	IEC 60601-1 3.1 edition
Emission	Conducted: CISPR 11, Group 1, Class B   Radiated: CISPR 11, Group 1, Class B
Harmonic	IEC 61000-3-2, Class A
Flicker	IEC 61000-3-3
ESD Immunity	IEC 61000-4-2, Contact ± (2, 4, 6, 8) kV, Air ± (2, 4, 8, 15) kV
Radiated RF Immunity	IEC 61000-4-3, 80-2700 MHz 80% AM 1 kHz 10V/m
Wireless Proximity	IEC 61000-4-3
EFT Immunity	IEC 61000-4-4, AC and DC Power Ports ± 2 kV (100kHz)
Surge Immunity	IEC 61000-4-5, AC Power Ports (L-Gnd) ± 0.5, ±1, ±2 kV, AC Power Ports (L-L) ±0.5, ±1 kV
Conducted RF Immunity	IEC 61000-4-6, AC and DC power ports, 3Vrms
Magnetic Fields Immunity	IEC 61000-4-8, 50Hz or 60Hz, 30A/m
Supply Dips Immunity	IEC 61000-4-11, AC Power Ports: >95% dip in UT for 0.5 cycle, >95% dip in UT for 1 cycle, 30% dip in UT for 25/30 cycles
Supply Interruptions Immunity	IEC 61000-4-11, AC Power Ports 100% interruption in UT for 5 sec



nordicComfortSolution

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NL-100-0053-05