Message From The CEO

Dear friends,

We are very pleased with the growth NIRx has seen since its inception in 2000. With our first official Newsletter, I am pleased to share with you some of the exciting updates to our technology platform! Through our hard work and dedicated team effort, we are consistently releasing new innovative hardware and software at an unmatched pace.

I thank you all - and especially our end-users - for your time and commitment to furthering the fNIRS field. We look forward to working together to advance this technology through a diverse range of applications.

Sincerely,

Richard Barbour
NIRx Interim CEO

Upcoming NIRx Events

Event Highlight: NIRx BCI Webinar
By popular demand, NIRx will be offering its first webinar on real-time fNIRS processing.

User Spotlight
Prof. Niels Birbaumer’s team from The University of Tübingen receives global recognition for ALS research using fNIRS.

Recent Publications
See some of the latest publications using NIRx systems.

Software Release: NIRStar 14-3
Learn about the release of NIRx’s system control software, NIRStar.

Software Release: nirsLAB 2017-04
Learn about the release of the nirsLAB fNIRS analysis software, which may be used with nearly any fNIRS system.

NIRx’s New Dedicated Support Website
Learn about this great new resource and how our customers can register.

fNIRS Detectors: SiPD vs. APD
Get an overview of fNIRS detectors, including the difference between SiPDs and APDs.

Laser and LED Sources from NIRx
One of our most-asked questions is regarding the difference between Laser and LED sources, and why we offer both. Well, you can read about it here to find out.

Career Opportunities at NIRx: Scientific Consultants
We are looking for Scientific Consultants to work in our office in U.S.A. and Germany!
Due to the increasing interest of BCI researchers for the fNIRS technology, NIRx has decided to host a webinar on the topic to be held on the 8th of June. We are extremely pleased to announce Dr. Ujwal Chaudhary and Dr. Bettina Sorger as speakers. More information on the event is available here or on our website.

Read more on the work of Dr. Chaudhary, Lead Research Scientist, and his Principal Investigator, Prof. Niels Birbaumer, in this month’s end-user spotlight.

Go to our Events Page for the latest on NIRx conferences, workshops, webinars and other special events!
Prof. Niels Birbaumer of The University of Tübingen Receives Recognition for fNIRS/EEG BCI Research with ALS Patients

NIRx is extremely proud for being part of the groundbreaking research of the team of Prof. Niels Birbaumer, from the University of Tübingen (Germany). The work published in the journal of PLUS Biology [1] marks 25 years of their continuous work with completely locked-in ALS patients. The group has been successful in using fNIRS to open a communication channel with patients who have no other means of interacting with the external world. Patients were able to learn to modulate their cortical activity in order to answer to yes/no questions with an incredible 70% correct response rate.

NIRx has always firmly believed in the enormous potential of fNIRS but it is extremely heartwarming and encouraging to see that our technology truly helps improving people’s lives. The work of the group of Prof. Birbaumer has caught the attention of worldwide media and their results have been presented on CNN, BBC, The Guardian and Der Spiegel among others. Prof. Birbaumer, Dr. Ujwal Chaudhary (lead researcher) and their team are happy to answer questions related to their work on their Reddit thread.

By: Lamija Pašalić
Support Director

# Recent Publications with NIRx Systems

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<tr>
<th>Author(s)</th>
<th>Title</th>
<th>Journal/Conference</th>
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<td>A. Vrana, M. L. Meier, S. Hotz-Boendermaker, B. K. Humphreys, and F. Scholkmann</td>
<td>“Different mechanosensory stimulations of the lower back elicit specific changes in hemodynamics and oxygenation in cortical sensorimotor areas—A fNIRS study,” Brain Behav, p. n/a-n/a, Sep. 2016.</td>
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## Don’t see your recent publication listed? Have a publication coming out soon? Please update us on your work!

We love to hear from our customers (especially when there is good news 😊)! By keeping us informed on your latest publications, posters, presentations, and press/media (e.g., news articles, blog posts, videos, etc.) we are able to better serve both you and our community. We would be happy to consider highlighting you and your team on one of our upcoming newsletters, our social media page, or our website as well. Please send all research-related updates to support@nirx.net. Thank you for contributing to the NIRx community!
The newest NIRStar version (14-3) is planned to be released very soon! NIRx has worked hard to incorporate innovative and useful features.

The first, and by far most important, feature is the capacity to control fNIRS systems using a yet-to-be-released-commercially probe (optode) prototype for 8mm short-distance measurements. (Stay tuned for the release date of this new probe!) Second, we have implemented a Lab Streaming Layer protocol for real-time communication and synchronization with other systems (e.g. EEG, Eye-Tracking, etc.). Third, further metrics to improve the data quality and its assessment, e.g. automatic cross-talk identification, are now available as well. Finally, there are also some key bug fixes and further usability enhancements to improve the interface and user experience. A complete list of features, enhancements, and fixes will be included in the accompanying user manual. We recommend all NIRx users to update their acquisition software ASAP and we are looking forward to your feedback. In the NIRx Help Center, you may report to us issues and desired features for next releases.

Please get in touch if you have questions related to switching from an older version of NIRStar to NIRStar 14-3.

By: Guilherme Zimeo Morais
Scientific Consultant / R&D
Updated nirsLAB (v. 2017-04)

In addition to NIRStar, an updated version of nirsLAB will be released together with NIRStar. Fostered by the feedback of our users, this new version (2017-04) will integrate several new features that will ease the interpretation and the reporting of results.

To this end, we strengthened group level analysis capabilities, by expanding the available options for the computation and visualization of block averages. With the new version, the user will be able to average the hemodynamic response over selected subjects within groups. Versatile options to visualize the data under different conditions are provided which facilitate the comparison between groups and ease the interpretation of the data.

Another important step that we’ve taken in the direction of facilitating the reporting of the results is the inclusion of the standard MNI 152 head model for the visualization of measured data as well as statistical results on scalp and brain maps.

Finally, following recent research, we improved the statistical modeling of recorded time traces with a General Linear Model by implementing a more advanced noise model. This noise model accounts in a better way for temporal correlations within the data and therefore makes single subject analyses more robust against false positives.

All users of nirsLAB should update to nirsLAB v. 2017-04 as soon as it becomes available.

By: Dr. Eike Middell
Software Development Director

Above:
The upcoming nirsLAB version will offer versatile options to visualize and compare the average hemodynamic responses of different subject groups. (Screenshot of the p-code version of nirsLAB running under Mac OS X 10.9 Mavericks.)
NIRx takes great pride in the quality of our technical and scientific support. We are researchers, physicists, and engineers and have gained great expertise working in fNIRS. We have created the NIRx Help Center to further engage with and assist our fNIRS customers. Our aim is to maintain this as one of the best fNIRS learning resources available. It offers a searchable knowledge base, a user forum, video tutorials, a download section and a support ticketing system.

A completely searchable knowledge base lets you search through the entire content by any keyword. The search engine will look for matching content in both the knowledge base and the user forum.

The videos section is an already large collection of all kinds of video tutorials: analysis tutorials, subject preparation and setup tutorials, videos from past NIRx workshops and so on.

The NIRx Help Center also offers a user forum to ask questions to the NIRx team or other members of the Help Center community.

You can find all kinds of downloads in the related section, including: the latest version of our software, user guides, quick start guides and tutorials, sample data, code samples and scripts, workshop talks, montages for NIRStar and more.

The best way to ask a support question for the NIRx team is to submit a ticket. This is the fastest way of reaching us for high priority issues.

You may access the Help Center from the Support section on our website. The NIRx Help Center is for NIRx users only, and registration is required. The majority of content is only available only upon password authentication. Please follow the register link in the top right corner of the home page.

Register now! We are looking forward to seeing you in the Help Center!

By: Lamija Pašalić
Support Director
fNIRS Detectors from NIRx - SiPD vs. APD

Overview
NIRx offers both ‘standard’ silicon photodiode (SiPD) and ‘high-sensitivity’ avalanche photodiode (APD) fNIRS detectors. The NIRSport ‘Portable’ fNIRS System may only use the APD detectors with an additional coupling unit– the APDs in this case would not be for portable applications, and would furthermore require a different probe set from the standard probe sets generally. By contrast, the NIRScout ‘Lab-Based’ fNIRS System may use either the SiPD or APD detectors with identical probe sets.

fNIRS Detector Sensitivity
Our APD detectors are up to 8x as sensitive as our SiPD detectors on average. This does give a much better signal overall, though detector sensitivity is not the only factor in determining signal level and quality.

Dynamic fNIRS Gain Settings
While considering detector sensitivity is critical, the system’s dynamic gain is also important when evaluating overall system performance. NIRx offers an industry-leading 9 levels of automated/programmable detector gain for both our SiPD and APD detectors. So, even though our SiPDs have less sensitivity than our APDs, we are able to make up for it against APD options offered by some of the other fNIRS manufacturers out there by maximizing the gain settings of the detectors.

Optimizing Unique fNIRS Detector Gain Settings
As part of every experiment, one must “calibrate” (AKA “optimize”) the exact gains used for every detector. Most systems only allow one gain setting per detector. By contrast, NIRx systems allow for unique gain settings for every source-detector pair. This is particularly important when a detector is positioned between two sources that are transmitting light through tissue with very different scattering and absorption properties. For example, imagine a detector placed on the hairline approximately around Fz in EEG standard coordinates, and this detector is measuring from two sources: source one is positioned 3cm anteriorly towards the nasion (~AFz in EEG coordinates) on a hairless part of the head with thinner scalp, skull and CSF, and source 2 positioned posteriorly towards the inion (~FCz in EEG coordinates) on a hairy part of the head with thicker scalp, skull and CSF. There would be substantially different amounts of scattering and absorption from each of these sources as the photons pass through the tissue, and thus a very different amount of light would actually reach the detector in between the two sources. It would, therefore, be ideal for the detector to have a higher gain setting for source 2 (the source on the hair) vs. source 1 (the source on the forehead).
Unique detector gain settings for every source-detector pair are also important for multi-distance measurements and maximizing the number of usable data channels. This dynamic gain switching is the biggest advantage of the time-multiplexed recording mode used in NIRx devices compared to other ways to distinguish the signal from different sources.

**Optimizing fNIRS Detector Gains and Signal**

The process of setting gains differs substantially between systems. Some fNIRS systems even require the end-user to manually set each detector gain setting one-by-one for each measurement, which, as you can probably imagine, can take a very long time. NIRx’s recording software uses a user-friendly fully-automated signal optimization step which rapidly identifies the ideal signal level, and associated detector gains for each source-detector channel pairing.

**Example of Unique Detector Gains Using NIRStar / NIRx Platform**

1) **Probe array (“Montage”):** An 8-source/8-detector (16-probe) montage is shown with 20x topographic data channels of interest positioned bilaterally over the motor cortex.

2) **Montage Close Up:** Sources = S1, S2, S3, S4; Detectors = D1, D2, D3, D4.

3) **Topolayout / Signal Quality Indicator:** shows 2-D blocked abstraction of montage, which allows easy-to-view color-based/changing signal quality and levels. Each number pair corresponds to a respective source and detector number, in that order, for that data channel of interest (i.e., “2-1” = channel formed by source #1 and detector #2). Note: signal quality has already been calibrated/optimized at this point and that the source-detector pairs seen in the montage close up.

4) **Gain Settings Map:** shows the detector gain level for each source-detector pair. Note channels “2-1” and “1-1” in particular for the moment. Detector #1 is part of both channels but has a substantially different gain setting for each channel. Channel 2-1 has a gain of 3, whereas channel 1-1 has a gain of 5. This dynamic gain switching for a single detector with multiple sources greatly improves ease of use and signal quality.
Detector Probes and Caps

Achieving optimal signal quality involves more than just the system electronics and control software. The design and fit of the physical detector hardware, and its connecting components, are arguably just as important. Imagine a car with no or very poor tires— it won’t get you very far, will it? Well, probes and caps are really just like the tires for your fNIRS system. Without them, you would not be able to collect any data, despite how powerful the system’s engine may be. We have put extensive research and user-feedback into our probe and cap design. While we could tell you a lot more about it here, this is really better seen than explained. You can see here just how fast and easy our cap setup is. And you can learn more about the probes and caps on our website.

Which Detector to Choose: APD or SiPD?

It may come as no surprise, but the APD detectors are quite a bit more expensive than the SiPDs. That said, their value is unquestionable: a NIRx APD detector system, along with our innovative probe systems, will work on the vast majority of subjects, measuring from any part of the head, with an incredibly easy/fast setup. Our APDs also are best for end-users that wish to do fMRI/fNIRS or fMRI/MEG studies.

The SiPD detectors will work excellent on child and geriatric subjects on any part of the head, and will work with ~60-70% of college-aged subjects (FYI: college students are generally some of the most difficult subjects due to their full-grown heads and thicker hair) with thick black hair (thicker, darker hair is more difficult than thinner, lighter hair) during measurements on top of their head (e.g., the motor, somatosensory cortex, etc.). In total it generally averages out to ~80% of subjects in multi-cultural locations, such as big cities in USA, Canada, UK, Germany, France, etc..

All that said, this still could be a major factor for you. It is important to remember: with NIRx systems you can start with SiPD detectors and switch over to APD detectors. We offer one of the most versatile fNIRS platforms out there in terms of upgrade options and flexibility. Please do let us know what your decision context is and we will be happy to work with you to provide you the best-possible solution.

By: Thomas Johannsen
Technical Sales Manager
Hardware Support Consultant

Laser and LED Sources from NIRx

NIRx’s History with Laser & LED sources

As you may know, NIRx started out of the lab of Dr. Randall Barbour at SUNY Downstate Medical Center in the mid-1980s. It wasn’t until 2000 that NIRx formed and sold its first NIRS system, the “DYNOT” (Dynamic Optical Tomography); this laser-based system used straight fiber optic probes which could be oriented in very high-density grids for tomographic imaging. In fact, all of Dr. Barbour and NIRx’s systems were laser based from the 1980s onward, until 2010, when the first “NIRScout” system was released. As many of you know, this first-
A Comparison of Laser vs. LED sources

Fiber Optic Performance
Lasers are a better option than LEDs for NIRS measurements that require fiber optics, like those done with MRI and MEG. The collimated-bandwidth Laser light couples much more efficiently into a fiber cable than the LED light. For MRI and MEG-concurrent NIRS studies, in particular, very long probes are necessary as the NIRS system sits in the control room, and its probes (usually ~8-10m long) go to and from the subject’s head in the scanning room.

Fiber Optic Performance Summary:
- Lasers beat out LEDs in applications where fiber optic probes are necessary (e.g., NIRS/fMRI, NIRS/MEG, collocated NIRS-TMS, etc.)

Cable Length, Weight, and Flexibility
It is also important to note that cable length is a factor for overall signal levels. Light signal, whether from Lasers or LEDs, attenuates as it passes through fiber optic cables. The level of attenuation does vary based on the properties of the particular fiber, though shorter fibers will always outperform longer fibers of the same make/type, assuming all else equal.

NIRx does recommend our very high-powered active LEDs for most use cases (we will cover why that is later).

The two main differences between our active and fiber optic sources:

1) The location of the NIRS source
   a. **Active NIRS sources** are contained within the probe tip housing
   b. **Fiber optic NIRS sources** are contained within the NIRS system itself

2) The material of the probe cables
   a. **Active sources use electronic cables**: very lightweight, durable, and may be extended without significant signal loss (i.e., you may have one set of probes with multiple extensions if you like)
   b. **Fiber optic sources use glass cables**: relatively heavier; flexible, but less durable; may not be extended (i.e., you need multiple probe sets if different cable lengths are required)

The location of the active LED in the probe tip housing minimizes signal attenuation, which greatly improves overall system performance. The lighter weight cabling with active LEDs is very helpful in child and mobile applications, though all subjects appreciate less weight on their heads during measurements.
Cable Length, Weight, and Flexibility Summary:
• NIRx Active LEDs have far less cable-length-related attenuation than fiber optic lasers
• NIRx Active LEDs are much lighter than fiber optic lasers
• NIRx Active LEDs are more flexible than lasers
• Note: as mentioned above, Lasers beat out LEDs when fiber optic probes are necessary (e.g., NIRS/fMRI, NIRS/MEG applications, etc.)

Multi-Wavelength Considerations
Most NIRS system use 2 wavelengths to distinguish between oxy- and deoxy-hemoglobin. NIRx LED systems are only offered with 2 wavelengths, though, as mentioned, one may own a hybrid system with both LEDs and Lasers. By contrast, Lasers may have many more than 2 wavelengths (but typically also have just 2 wavelengths in most commercial systems). NIRx systems currently offer 2, 4 and 8-wavelength source options.

Higher wavelength counts yield a potentially better characterization of the Hb signal (though, how much better is under debate) as each wavelength has a slightly different depth of penetration, differential pathlength factor (dpf), and associated molar extinction coefficient for the respective chromophores of interest: generally, oxy-Hb and deoxy-Hb. Note: some researchers are interested in using NIRS to identify cytochrome c-oxidase (see fig. 1 right), though this methodology is still being refined.

That said, the information gained from the additional wavelengths does not have a clear-cut advantage at the moment for researchers looking at only oxy and deoxy-hemoglobin. And when considering the great increase in cost one must pay for a system with more wavelengths, it may not be worth it for you to upgrade to more wavelengths.

Multi-Wavelength Considerations Summary:
• NIRx LEDs are 2-wavelength sources
• NIRx Lasers may be 2 or 4-wavelength sources (note: 8-wavelength custom option available)
• Additional wavelengths come at a great price
• The information gained from additional wavelengths may not be worth the cost of the upgrade if all you are interested in is hemoglobin changes

Ideal Applications for NIRx LEDs and Lasers
NIRx LEDs may be used in nearly any application, even MRI and MEG-concurrent measurements, though those particular
applications are best left to Laser sources. LEDs are generally better when considering child and mobile applications, as they are lighter and more flexible than Lasers. We recommend you use Laser sources if you have used them before and your research requires it, or if you want to do MRI or MEG-concurrent measurements.

**Conclusion - Not all LEDs (or Lasers) are created Equal**

As you might imagine, the finer points of producing a source do greatly matter. While there are many LED and Laser systems out there, please do keep in mind that NIRx has extensively tested the components used in its systems, and that we validate the use of our different source options before they become commercially-available. Our customers have made us aware of other manufacturers that offer LEDs which do not offer a signal strength sufficient enough to be effectively used on top of an adult’s head who has thick, black hair. We have even heard of Laser systems which have this issue as well. Actually, **while source type and strength is an important factor in how one may apply NIRS, there are many other considerations, including: probe shape, grommet type, NIRScap shape and type, and even software/system control issues.** Needless to say, we have considered these many factors (and more) in our developments; this becomes apparent when comparing different NIRS systems first-hand.

All that said, **the most-important factor for any NIRS source is photon output:** how much light does the source actually put out at its tip (and into the skin when applied to a subject) for measurements? This is best measured with phantoms and equivalent light detectors. In our tests we have found that our LEDs and Lasers have the same output at the probe tip.

**NIRx’s LED and Laser systems are both very well published and an excellent option for NIRS researchers.** You can see a sample of the publications done on our website here: [www.nirx.net/publications](http://www.nirx.net/publications). If you’d like to learn more about our systems, please get in touch: [www.nirx.net/contact](http://www.nirx.net/contact).

**Overall Summary:**

- Source type matters less than light output and application requirements
- Just because a system looks good on paper does not mean it will work for you in your research
  - Specs do not always equal success!
- LEDs and Lasers really are not that different in the end, it all depends on the photon output and your practical needs
- Check out systems before you make your final purchase decision:
  - Some NIRS systems may not offer the performance you require for your application
  - NIRx offers quick online demonstrations with relatively short notice

By: Thomas Johannsen  
Technical Sales Manager  
Hardware Support Consultant


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Career Opportunities at NIRx: Scientific Consultant

NIRx is hiring Master’s and Ph.D.-level Scientific Consultants to work in our soon-to-be opened Minneapolis location.

Traits we are looking for:
- Master’s/Ph.D. in Neuroscience, Psychology, Biomedical Engineering or related field
- Experience working in neuroimaging; EEG, fMRI, and/or fNIRS would be preferred
- Outgoing personality that likes (or at least doesn’t mind) presenting to large groups
- Willingness to travel, up to 60% in Fall and Spring (our high seasons)
- Attention to detail, creative problem-solving skills, solutions-oriented mindset
- A love of science and openness to loving fNIRS! 😊

Job duties:
- Scientific support and consultation with neuroscientist customer base
- Conducting training and installations
- Representing NIRx at relevant conferences, workshops, and events

We offer:
- Competitive compensation and benefits
- Intellectually-stimulating working environment and tasks
- Opportunity for growth within a rapidly-growing company and industry
- International travel

Interested? Email us at careers@nirx.net
NIRX is a world-leader in providing integrated solutions for fNIRS neuro-imaging. In 1988 we introduced the concept of tomographic imaging (i.e., multi-distance measurements) in dense scattered media base on diffusely scattered light. This approach has since been widely adapted and has served to launch the modern day field of fNIRS tomography.

Through our offices in Berlin, Los Angeles, New York and São Paolo, our engineers and grant-funded investigators are providing a growing number of research teams world-wide with comprehensive technology solutions for the most demanding investigative applications.

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