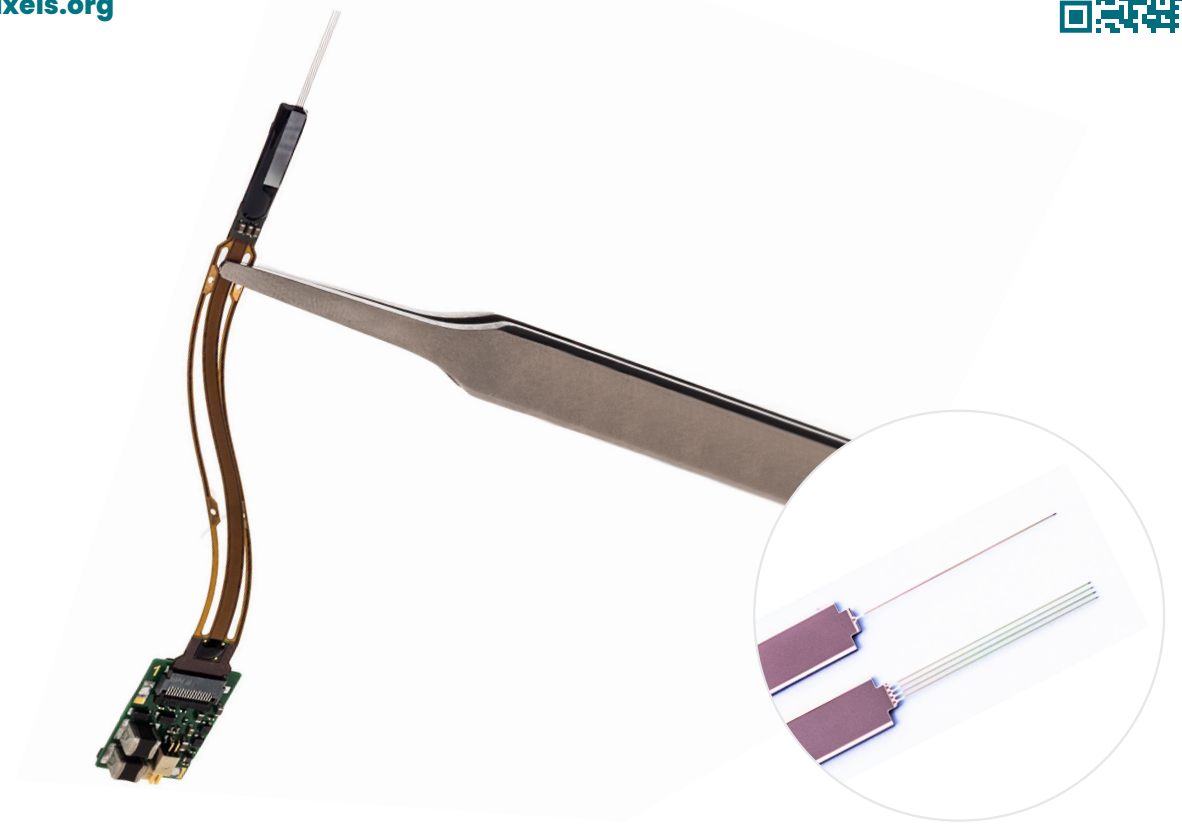
www.neuropixels.org



NEUROPIXELS 2.0

High resolution fully integrated silicon neural probe for small animal recording

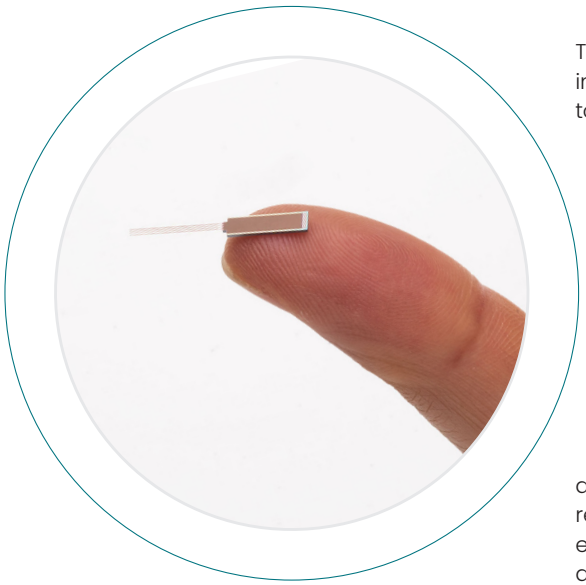
Key Features

- 1280 or 5120 reliable, low-impedance TiN[1] electrodes
- Dense 2 row linear electrode layout along one 10-mm long single shank or four 10-mm long shanks
- 70 x 24 µm shank cross-section
- Maximal shank bending ≤200 µm
- 384 parallel, full-band (AP[2], LFP[3]), low-noise recording channels
- On-chip amplification, signal conditioning and digitization
- Channel-independent reference selection (internal or external)
- Small, flexible and light-weight package (0.16-0.18 g)
- Systematic quality control process to ensure low variability in performance
- Fully characterized and qualified
- Compatible with SpikeGLX and Open Ephys software
- Compatible with the Neuropixels 1.0 cabling and PXIe system or OneBox

1 Titanium Nitride Electrode, US9384990 B2
2 Action potentials
3 Local field potentials

Important Information
The Neuropixels probes are intended for RESEARCH USE ONLY ("RUO") in non-human subjects such as small animals*. These Neuropixels probes should not be used in humans and are not manufactured or approved for human use. They have no proven human efficacy and are not indicated for human use or any form of clinical use. The Neuropixels probes are provided and deliverded for use only under the imec general terms and conditions of sale of Neuropixels 2.0 probes ("GTC"). [The GTC is available for download on www.neuropixels.org]

Description



The Neuropixels[4] 2.0 neural probe is the most advanced CMOS digital integrated microsystems platform. A miniaturized package (compared to the Neuropixels 1.0 probes) and the option of a single shank or multiple shanks will allow for even higher density chronic recording in small animal models. The probe features 1280 low-impedance TiN recording sites densely tiled along one thin, 10 mm-long, straight shank, or 5120 electrodes divided over 4 shanks. The 384 parallel low-noise recording channels integrated in the base enable simultaneous full band recording of hundreds of neurons. On-chip circuitry for signal conditioning and digitization results in a small and light-weight package allowing the implantation and simultaneous use of multiple probes in close proximity.

Neuropixels probes enable long-term monitoring and dense sampling of single cell activity as well as larger neuron populations in awake and anaesthetized animals. The probes connect to the custom-made recording system via a miniature and light-weight headstage, which is an essential interface board for reliable power supply, probe configuration, data streaming and system/probe diagnostics. Each headstage can connect two probes simultaneously. The probes are compatible with the Neuropixels 1.0 cables, PXIe based Card and Control System and OneBox, and are supported by the SpikeGLX and Open Ephys software.

4 JJ Jun et al., Nature 2017, 551, 232–236

Key Applications

- High-density in vivo recording of neural activity in small animal models.
- Recording of large neuron populations from several brain regions in freely moving animals at high spatiotemporal resolution and large volume coverage.

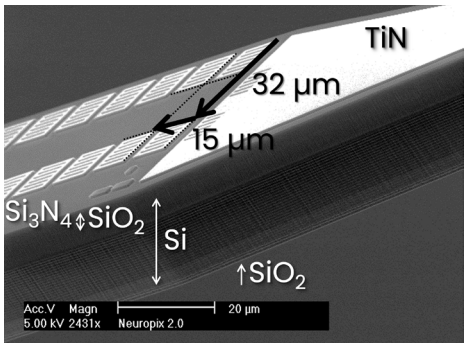


Figure 1: SEM image of the shank tip. Indicated are the electrode pitch and exposed materials.

Ordering information

	ORDER CODE	DESCRIPTION
	NP2013	Box of 5 Neuropixels 2.0 multishank probes
	NP2014	Box of 5 Neuropixels 2.0 multishank probes with cap
	DNP2013	Box of 6 Neuropixels 2.0 dummy multishank probes
	DNP2014	Box of 6 Neuropixels 2.0 dummy multishank probes with cap
COMING SOON	NP2003	Box of 5 Neuropixels 2.0 single shank probes
COMING SOON	NP2004	Box of 5 Neuropixels 2.0 single shank probes with cap
COMING SOON	DNP2003	Box of 6 Neuropixels 2.0 dummy single shank probes
COMING SOON	DNP2004	Box of 6 Neuropixels 2.0 dummy single shank probes with cap
	HS_2010	Neuropixels 2.0 headstage
	HOLDER_2000_C	Neuropixels 2.0 metal cap probe holder pair

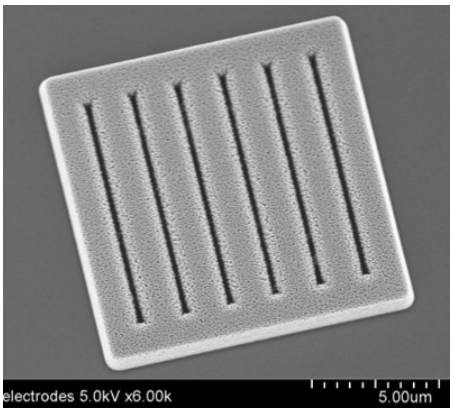


Figure 2: SEM image of a 12 x 12 µm TiN[1] electrode.

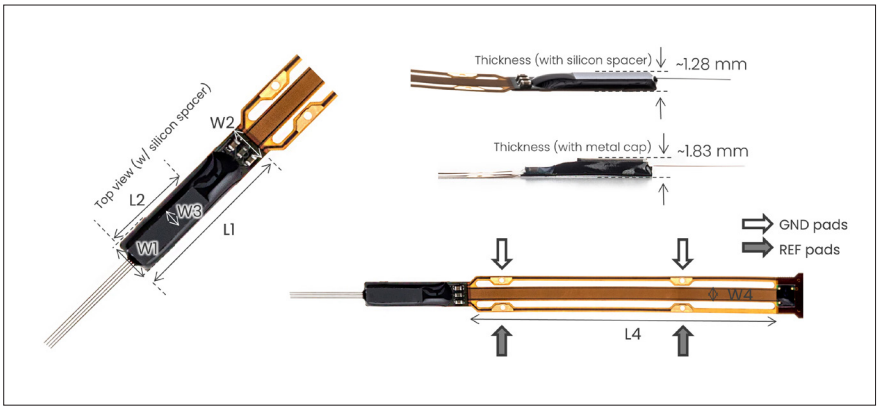


Figure 3: Dimensions of the different probe packages and locations of REF/GND input pads.

ELECTRODES

NUMBER	1280 (single shank version) or 5120 (multi shank version)
PATTERN	linear, two rows
PITCH	15 µm (column), 32 µm (row) (Figure 1)
MATERIAL	Porous TiN[1] (Figure 2)
SIZE	12 x 12 µm
IMPEDANCE	~150 kΩ (at 1 kHz in PBS[5])
SELECTIVITY	Local switch under each electrode

SHANK PROPERTIES AND MATERIALS

NUMBER	1 (single shank version) or 4 (multi shank version)
SHANK PITCH	250 µm
WIDTH	70 µm
LENGTH	10 mm
THICKNESS	24 µm
BENDING	≤200 µm (base to tip)
TIP LENGTH	175 µm
TIP SHAPE	Chisel
TIP ANGLE	~20°
FRONTSIDE MATERIAL	Silicon nitride (Si_3N_4) (Figure 1)
BACKSIDE MATERIAL	Silicon dioxide (SiO_2)
SIDEWALL MATERIALS	Silicon (Si), silicon dioxide (SiO_2)

RECORDING CHANNELS AND DIGITAL INTERFACE

NUMBER	384 (full-band)
BANDWIDTH	0.5 Hz - 10 kHz
AP INPUT-REFERRED NOISE	~6.8 μV_{rms} (typical[6])
LFP INPUT-REFERRED NOISE	~5 μV_{rms} (typical)
SAMPLING FREQUENCY	30 kHz
GAIN	100
CROSSTALK	0.35% (single shank) or 1.51% (multi shank) (at 1 kHz; typical) (estimation)
INPUT VOLTAGE RANGE	10 mVpp
ADC RESOLUTION	12 bits
DATA RATE	144 Mb/s
POWER CONSUMPTION	~22 mW (in recording mode; typical)
SHANK HEATING	<1°C (in the brain)

REFERENCE SELECTION

INPUTS	Large tip electrode on each shank (Figure 1) External reference input on the probe package (Figure 3)

5 Phosphate buffered saline
6 Process corner

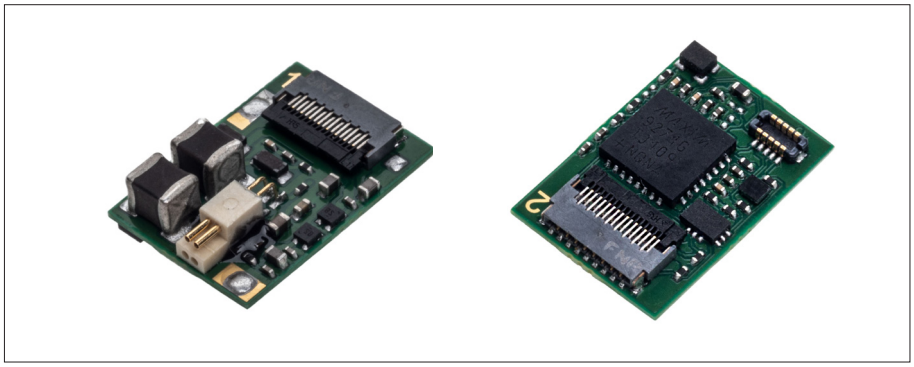


Figure 4: Headstage for Neuropixels 2.0 probe. One headstage can connect to 2 probes.

PACKAGE DESCRIPTION

WIDTH AT PROBE BASE (W1)	3.5 mm
WIDTH AT SMD[7] BASE (W2)	3.5 mm
WIDTH OF SILICON SPACER (W3)	2.0 mm
WIDTH OF METAL CAP (W3')	1.8 mm
WIDTH OF FLEX (W4)	2.0 mm
LENGTH OF PROBE + BASE SMD[7] (L1)	14 mm
LENGTH OF SILICON SPACER (L3)	7.8 mm
LENGTH OF METAL CAP (L3')	8.0 mm
LENGTH OF FLEX (L4)	42 mm
THICKNESS AT PROBE BASE	~1.28 mm (with Si spacer) ~1.83 mm (with metal cap)
THICKNESS OF FLEX	80 µm
EXTERNAL REFERENCE INPUT	REF (multiple pads along flex)
GROUND INPUT	GND (multiple pads along flex)
BLACK EPOXY	EPO-TEK / H70E
CONFORMAL COATING OF SMD[7]	ELPEGUARD / SL 1307 FLZ-T
WEIGHT	~163 mg (with Si spacer) ~183 mg (with metal cap)

HEADSTAGE

SIZE	10 mm x 14 mm x 3.7 mm
WEIGHT	600 mg
ZIF CONNECTOR	2 x 17-pin
SOLDER PADS	GND (ELEC_TIP, CAL_SIG)
CABLE CONNECTOR	4-pin (Omnetics)
CONFORMAL COATING OF SMD[7]	ELPEGUARD / SL 1307 FLZ-T

METAL CAP HOLDER

LENGTH	7.5 cm
DIAMETER	4 mm
MATERIAL	Aluminium 6061

7 Surface-mount devices: Biasing resistors, decoupling capacitors, EEPROM with probe ID, low-noise reference supply IC

About Neuropixels
The Neuropixels 2.0 neural probe is an advanced silicon CMOS digital integrated microsystem and a tool for neuroscience research. It was developed through a collaboration funded by Howard Hughes Medical Institute (HHMI), University college London (UCL), The Flemish Institute for Biotechnology (VIB), the Catholic University of Leuven (KUL), The Norwegian University for Science and Technology (NTNU, and the Champalimaud Centre for the Unknown. Probes were designed, developed and fabricated at imec, Leuven, Belgium in collaboration with Howard Hughes Medical Institute (HHMI), University college London (UCL), The Flemish Institute for Biotechnology (VIB), the Catholic University of Leuven (KUL), The Norwegian University for Science and Technology (NTNU), and the Champalimaud Centre for the Unknown.

* Small animals like rodents and non-human primates