NEUROPIXELS 1.0 HD
High density fully integrated silicon neural probe

Key Features

- 6144 reliable, low-impedance TiN electrodes of 5 x 5 μm with a pitch of 6 μm

- Ultra-high dense electrode layout along the first 4.5 mm of a 10-mm long shank

- Small 70 x 24 μm shank cross-section

- Maximal shank bending ≤100 μm

- 384 parallel, dual-band (AP[1], LFP[2]), low-noise recording channels

- On-chip amplification, signal conditioning and digitization

- Channel-independent configuration and reference selection (internal or external)

- Small, flexible and light-weight package (0.4 g)

- Systematic quality control process to ensure low variability in performance

- Fully characterized and qualified

- Compatible with SpikeGLX and Open Ephys software

- Small and lightweight head stage (0.9 g)

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1 Action potentials
2 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 probes ("GTC"). [The GTC is available for download on www.neuropixels.org]

Description

The Neuropixels HD neural probe is a silicon CMOS digital integrated microsystem and tool for in vivo neuroscience research in small animals*. It is based on the standard Neuropixels 1.0 probe[3], with a denser array of more and smaller electrodes. The probes feature 6144 low-impedance TiN recording sites densely tiled along the first 4.5 mm of a thin, 10 mm-long, straight shank. The 384 parallel, configurable, low-noise recording channels integrated in the base enable simultaneous, dual-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. Each probe connects to a 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.

Key Applications

- Very high-density in vivo recording of neural activity in animals.

- Recording of large neuron populations from several brain regions in freely moving animals at ultrahigh spatiotemporal resolution and large volume coverage.
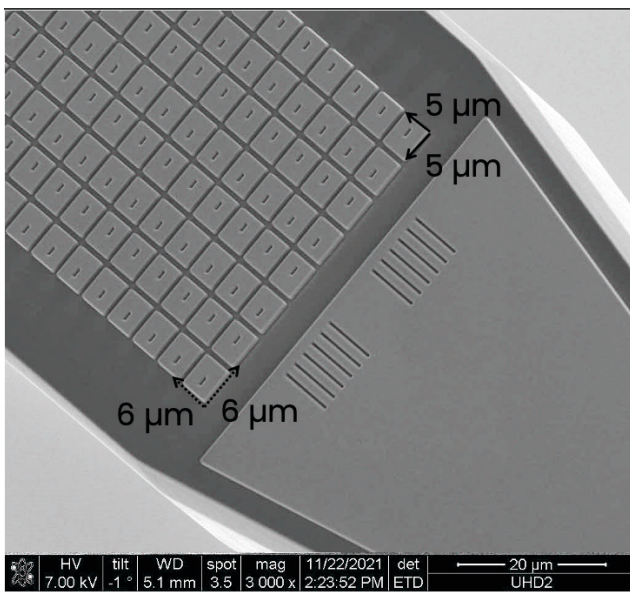

Figure 1: SEM image of the shank tip. Indicated are the electrode size and pitch.
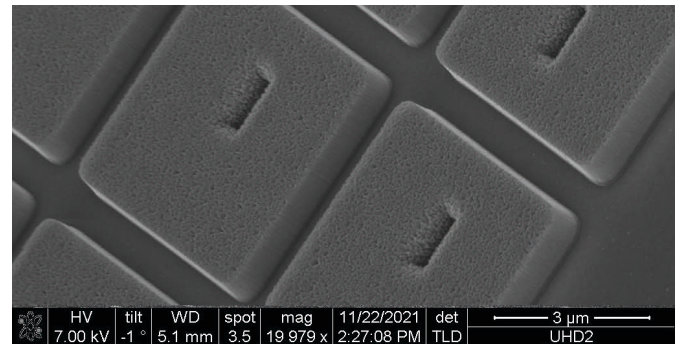

Figure 2: SEM image of the 5 x 5 µm TiN electrodes.

Ordering information

ORDER CODE	DESCRIPTION
NP1110	Box of 5 Neuropixels 1.0 HD probes with metal cap
DNP1110	Box of 6 Neuropixels 1.0 HD dummy probes with metal cap
HS_1000	Headstage for Neuropixels 1.0 probes
HOLDER_1000_C	Neuropixels 1.0 metal cap probe holder pair

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

Key Specifications

ELECTRODES

NUMBER	6144
PATTERN	dense 2D array (8 x 768)
PITCH	6 µm (see Figure 1)
MATERIAL	Porous TiN[4] (Figure 2)
SIZE	5 x 5 µm
IMPEDANCE	~700 kΩ (at 1 kHz in PBS[5])
SELECTIVITY	Local switch under each electrode

SHANK PROPERTIES AND MATERIALS

NUMBER	1
WIDTH	70 µm
LENGTH	10 mm
THICKNESS	24 µm
BENDING	≤100 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 (dual-band)
AP BANDWIDTH	0.3–10 kHz
LFP BANDWIDTH	0.5–500 Hz
AP INPUT-REFERRED NOISE	5.9 $µV_{rms}$ (typical[6])
LFP INPUT-REFERRED NOISE	9.2 $µV_{rms}$ (typical)
AP SAMPLING FREQUENCY	30 kHz
LFP SAMPLING FREQUENCY	2.5 kHz
DIFFERENTIAL GAINS	50–3000 (8 values)
CROSSTALK	≤0.13% (at 1 kHz; typical)
INPUT VOLTAGE RANGE	±5 mV_{pp}
ADC RESOLUTION	10 bits
DATA RATE	163.8 Mb/s
POWER CONSUMPTION	~15 mW (in recording mode; typical)
SHANK HEATING	<1°C (in the brain)

REFERENCE SELECTION

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

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4 Titanium Nitride Electrode, US9384990 B2
5 Phosphate buffered saline
6 Process corner

PACKAGE DESCRIPTION

WIDTH AT PROBE BASE (W1)	6.2 mm
WIDTH AT SMD[7] BASE (W2)	7.2 mm
WIDTH OF SILICON SPACER (W3)	3.9 mm
WIDTH OF METAL CAP (W3')	4.8 mm
WIDTH OF FLEX (W4)	4.3 mm
LENGTH OF PROBE BASE (L1)	10.7 mm
LENGTH OF SMD[7] BASE (L2)	12.2 mm
LENGTH OF SILICON SPACER (L3)	8.5 mm
LENGTH OF METAL CAP (L3')	7.3 mm
LENGTH OF FLEX (L4)	39.5 mm
THICKNESS AT PROBE BASE	~1.8 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	440 mg (w metal cap)

HEADSTAGE

SIZE	15 x 16 mm
WEIGHT	0.9 g
ZIF CONNECTOR	45-pin
CABLE CONNECTOR	4-pin (Omnetics)
LED INDICATOR	One red LED
MECHANICAL FIXTURES	Two mounting holes of 1 mm Ø
CONFORMAL COATING OF SMD[7]	ELPEGUARD / SL 1307 FLZ-T

METAL CAP HOLDER

LENGTH	17.8 cm
DIAMETER	6.35 mm
MATERIAL	Aluminium 6061
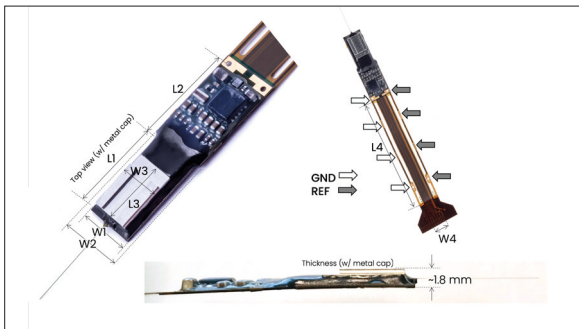
Figure 3: Dimensions of the different probe packages and locations of REF/GND input pads..

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

* Small animals like rodents and non-human primates