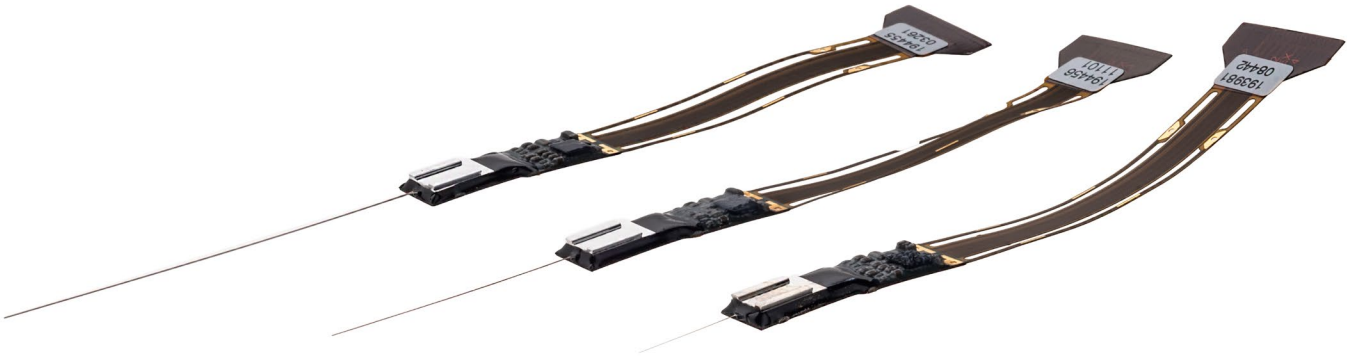
www.neuropixels.org



NEUROPIXELS 1.0 NHP SHORT-MEDIUM-LONG

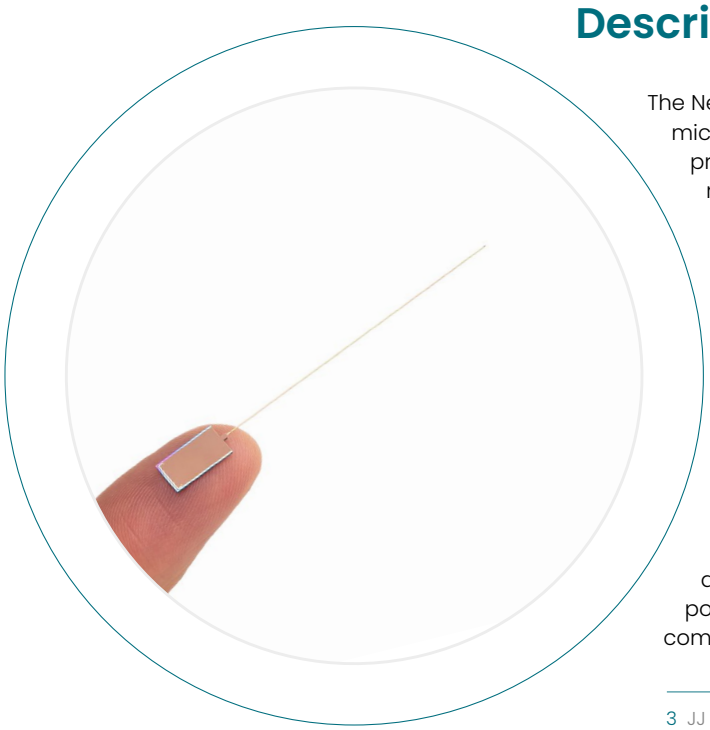
High resolution fully integrated silicon neural probe for large animal recording

Key Features

- 960, 2496 or 4416 reliable, low-impedance TiN electrodes
- Dense 2 row linear electrode layout along one 10 mm, 25 mm or 45 mm long single shank
- 125 µm wide (NHP MEDIUM and NHP LONG) or 70 µm wide (NHP SHORT) and ~110 µm +/- 15 µm thick shank
- Maximal shank bending ≤200 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
- Compatible with SpikeGLX and Open Ephys software
- Compatible with the Neuropixels 1.0 headstage, cabling and PXIe system or OneBox

1 Action potentials
2 Local field potentials

Description



The Neuropixels[3] 1.0 NHP neural probe is a CMOS digital integrated microsystems platform, based on the standard Neuropixels 1.0 probe. A thicker and longer shank will allow for high density recording in large animal models.

The probe features 960, 2496 or 4416 low-impedance TiN recording sites densely tiled along one thin, 10, 25 or 45 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. This probe is compatible with the Neuropixels 1.0 readout system.

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

Ordering information

ORDER CODE	DESCRIPTION
NP1015	Box of 5 Neuropixels 1.0 NHP short linear probes with cap
DNP1015	Box of 6 Neuropixels 1.0 NHP short linear dummy probes with cap
NP1022	Box of 5 Neuropixels 1.0 NHP medium linear probes with cap
DNP1022	Box of 6 Neuropixels 1.0 NHP medium linear dummy probes with cap
NP1032	Box of 5 Neuropixels 1.0 NHP long linear probes with cap
DNP1032	Box of 6 Neuropixels 1.0 NHP long linear dummy probes with cap
HS_1000	Headstage for Neuropixels 1.0 probes
HOLDER_1000_C	Neuropixels 1.0 metal cap probe holder pair

Key Applications

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

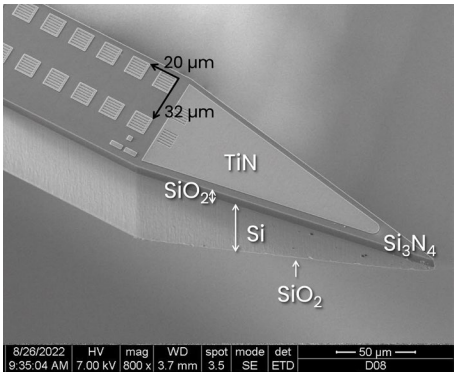


Figure 1: SEM image of the NHP SHORT shank tip. Indicated are the electrode pitch and exposed materials.

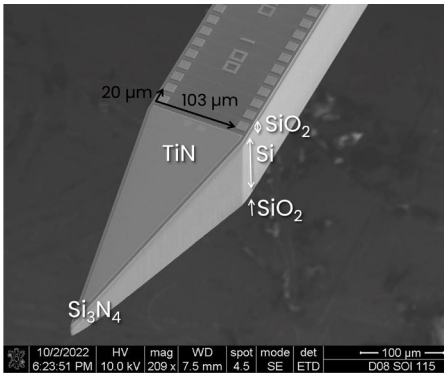


Figure 2: SEM image of the NHP MEDIUM and LONG shank tip. Indicated are the electrode pitch and exposed materials.

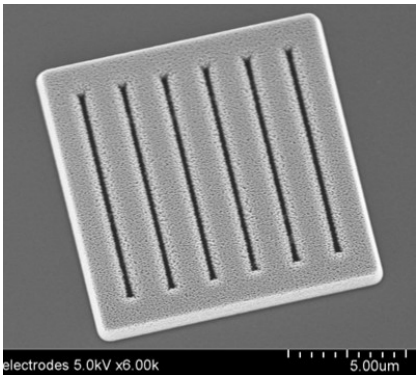


Figure 3: SEM image of a 12 x 12 µm TiN electrode.

Key Specifications

ELECTRODES	NHP SHORT	NHP MEDIUM	NHP LONG
NUMBER	960	2496	4416
PATTERN	LINEAR	LINEAR	LINEAR
PITCH	32 µm (column) 20 µm (row) (see Figure 1)	103 µm (column) - 20 µm (row) (see Figure 2)	
MATERIAL	Porous TiN[4] (Figure 3)		
SIZE	12 x 12 µm		
IMPEDANCE	~150 kΩ (at 1 kHz in PBS[5])		
SELECTIVITY	Local switch under each electrode		

SHANK PROPERTIES AND MATERIALS	NHP SHORT	NHP MEDIUM	NHP LONG
NUMBER	1		
WIDTH	70 µm	125 µm	
LENGTH	10 mm	25 mm	45 mm
THICKNESS	122 µm		
BENDING	≤100 µm (base to tip)	≤200 µm (base to tip)	
TIP LENGTH	175 µm	342 µm	
TIP SHAPE	Sharpened chisel		
TIP ANGLE	~20° in plane and ~25° out of plane (Figure 1 and 2)		
FRONTSIDE MATERIAL	Silicon nitride (Si_3N_4) (Figure 1 and 2)		
BACKSIDE MATERIAL	Silicon dioxide (SiO_2)		
SIDEWALL MATERIALS	Silicon (Si), silicon dioxide (SiO_2)		

RECORDING CHANNELS AND DIGITAL INTERFACE	NHP SHORT	NHP MEDIUM	NHP LONG
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[5])		
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 m_{Vpp}		
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	NHP SHORT	NHP MEDIUM	NHP LONG
INPUTS	3 internal	7 internal	12 internal
	Large tip electrode on the shank (Figure 1 and 2) External input on the probe package (Figure 4)		

4 Titanium Nitride Electrode, US9384990 B2
5 Process corner

PACKAGE DESCRIPTION	NHP SHORT	NHP MEDIUM	NHP LONG
WIDTH AT PROBE BASE (W1)		6.2 mm	
WIDTH AT SMD[7] BASE (W2)		7.2 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 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 (with metal cap)	

HEADSTAGE	NHP SHORT	NHP MEDIUM	NHP LONG
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	NHP SHORT	NHP MEDIUM	NHP LONG
LENGTH		17.8 mm	
DIAMETER		6.25 mm	
MATERIAL		Aluminium 6061	

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

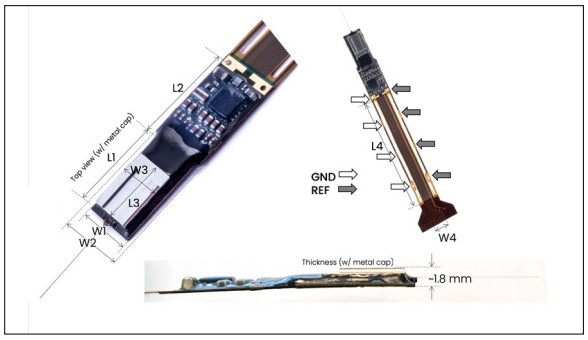


Figure 4: Dimensions of the different probe packages and locations of REF/GND input pads..

About Neuropixels
The Neuropixels 1.0 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), Wellcome Trust, Gatsby Charitable Foundation and Allen Institute for Brain Science. Probes were designed, developed and fabricated at imec, Leuven, Belgium in collaboration with HHMI Janelia Research Campus, Allen Institute for Brain Science and University College London.

* Small animals like rodents and non-human primates