

Neuromorphic Sensing and Computing



Bruno Romeira

INL – International Iberian Nanotechnology Laboratory, Av. Mestre José Veiga s/n, 4715-330 Braga, Portugal
bruno.romeira@inl.int

Introduction

Advances in power-efficient neuromorphic nanodevices and its heterogeneous integration are required for edge computing nanosystems.

INL develops **nano-opto-electro-mechanical, spintronic, nanophotonic, nanophononic** and **CMOS** systems for neuromorphic sensing and computing applications.



Neuromorphic computing and heterogeneous integration EU projects at INL

Nanophotonics



Spintronics



Nanophononics

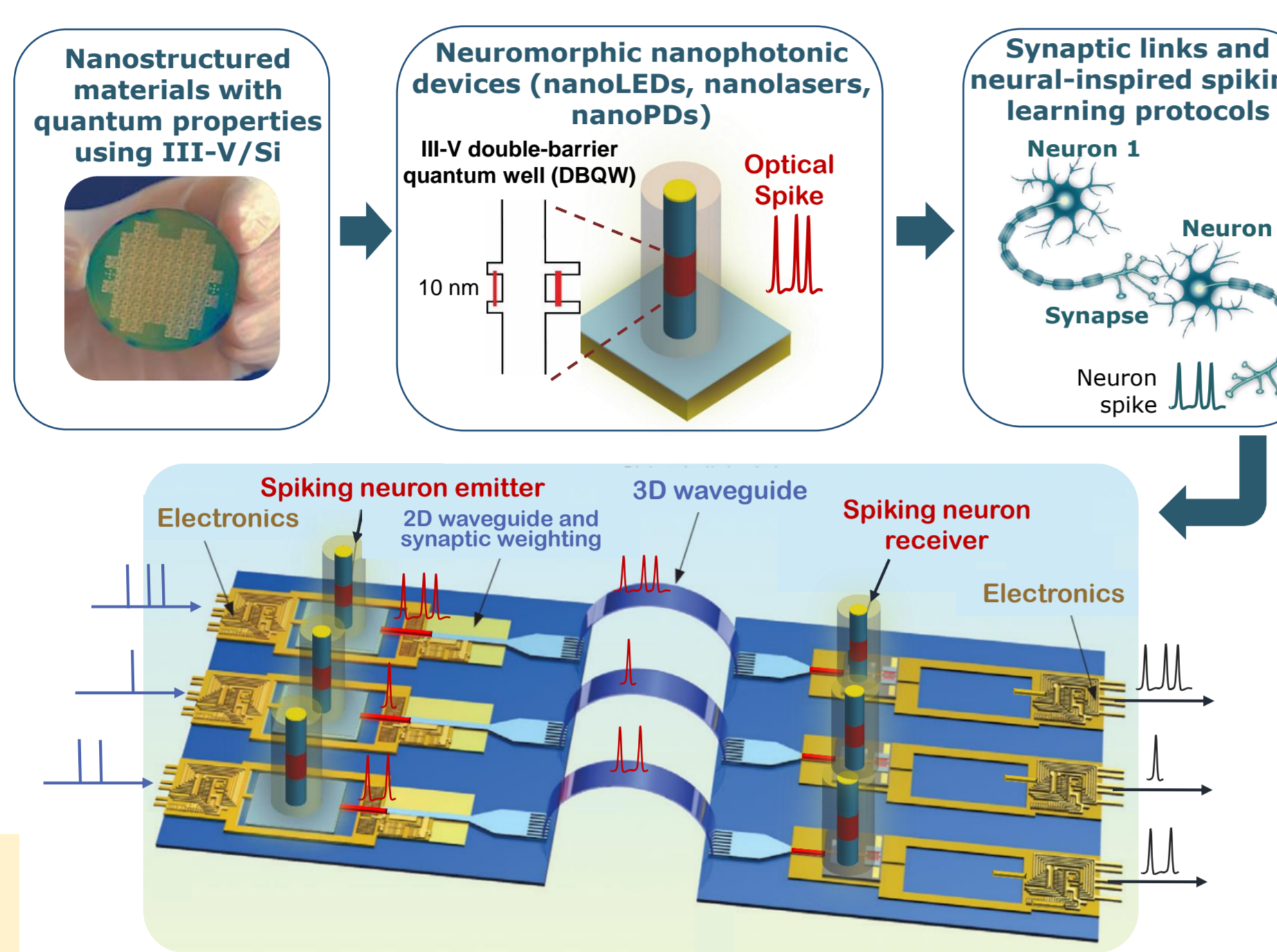
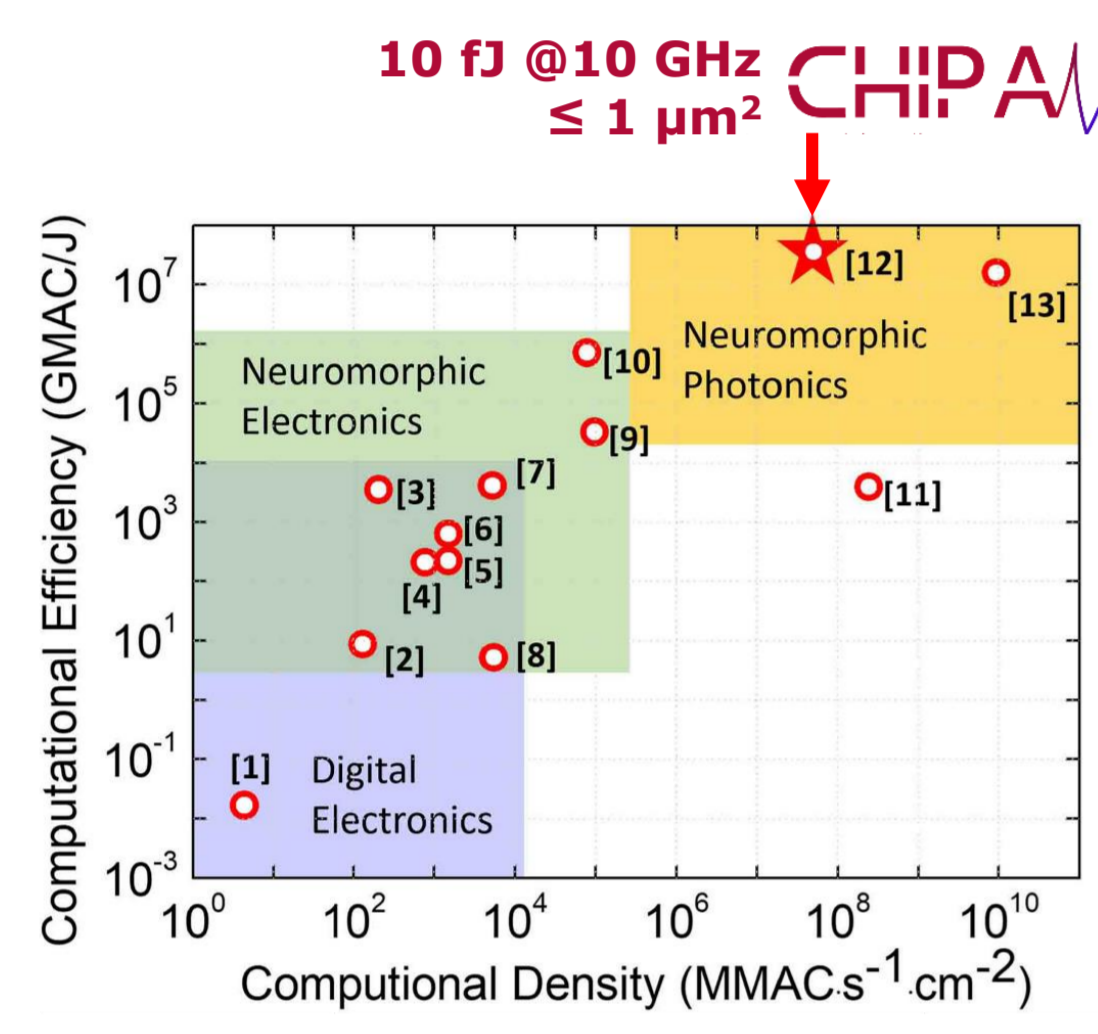


Systems Engineering



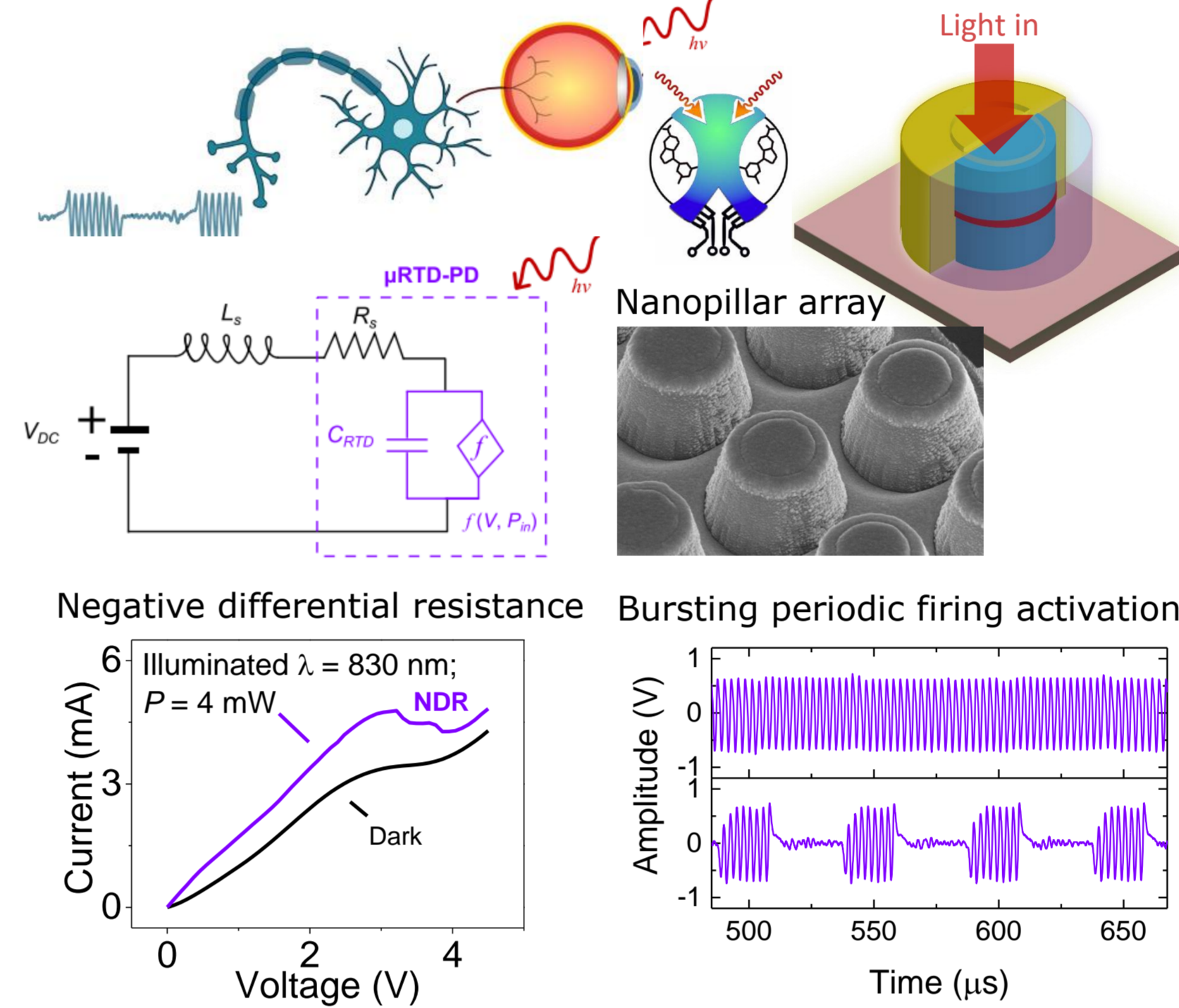
NANOPHOTONICS

Aim: Inspired by the brain, develop an extremely energy-efficient **nanophotonics-enable technology** for ANNs using high-bandwidth neural-like spike-encoded signalling.



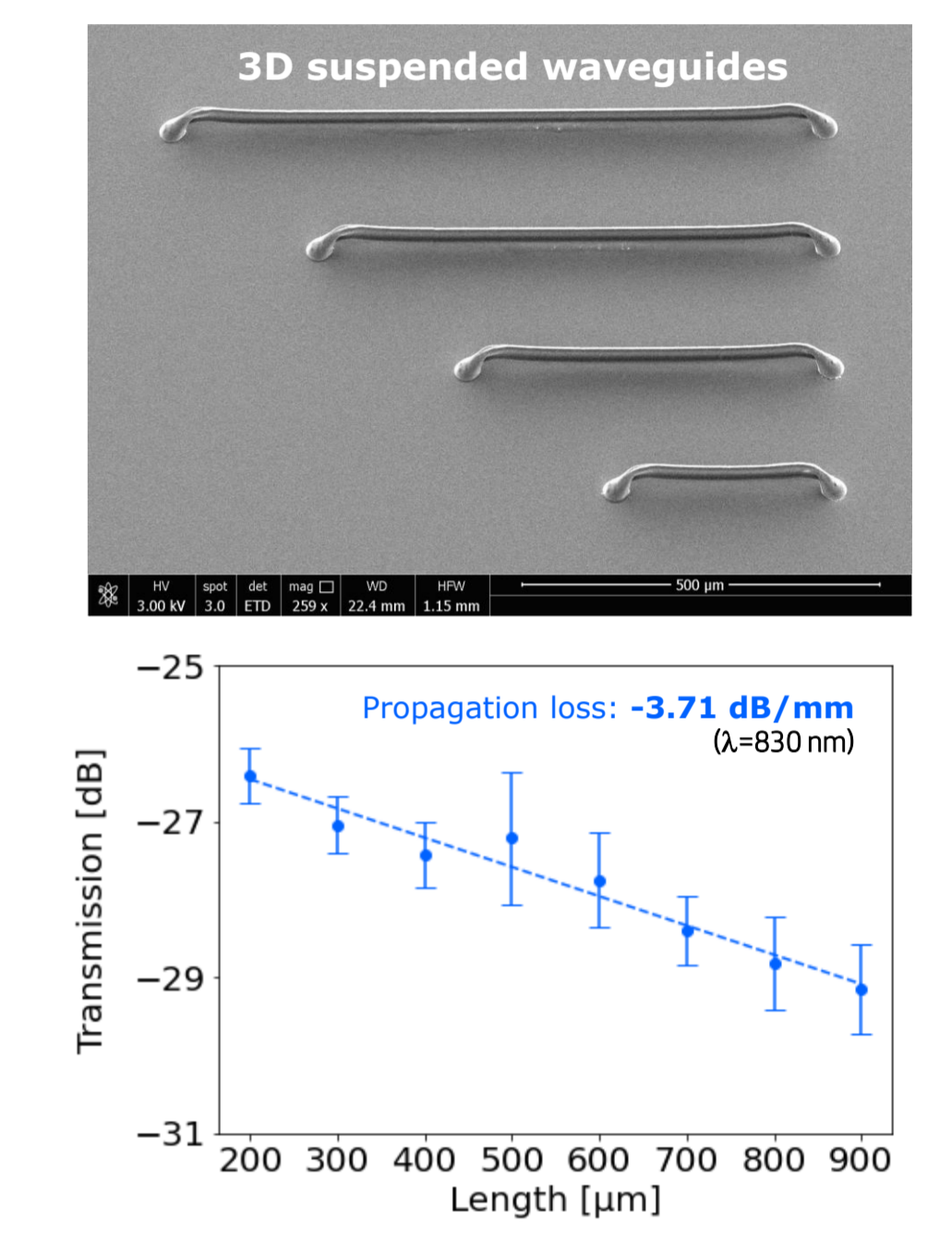
Neuromorphic Computing and Engineering
<https://doi.org/10.1088/2634-4386/acdf17>
Contact: Bruno.Romeira@inl.int
www.chipAI.eu

III-V GaAs nanophotonic sensory oscillator neurons



Contact: Bruno.Romeira@inl.int
www.insectneuronano.lu.se

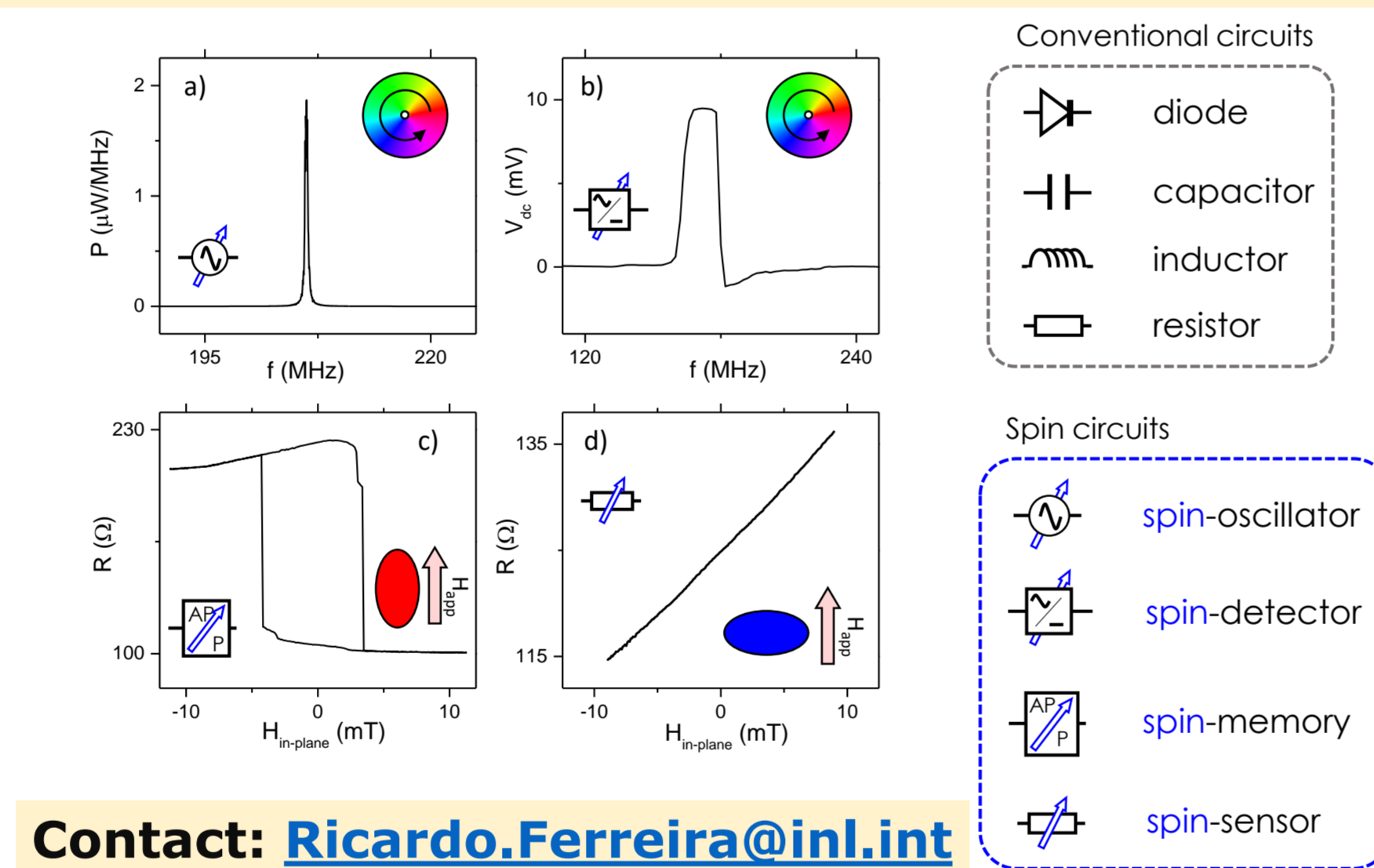
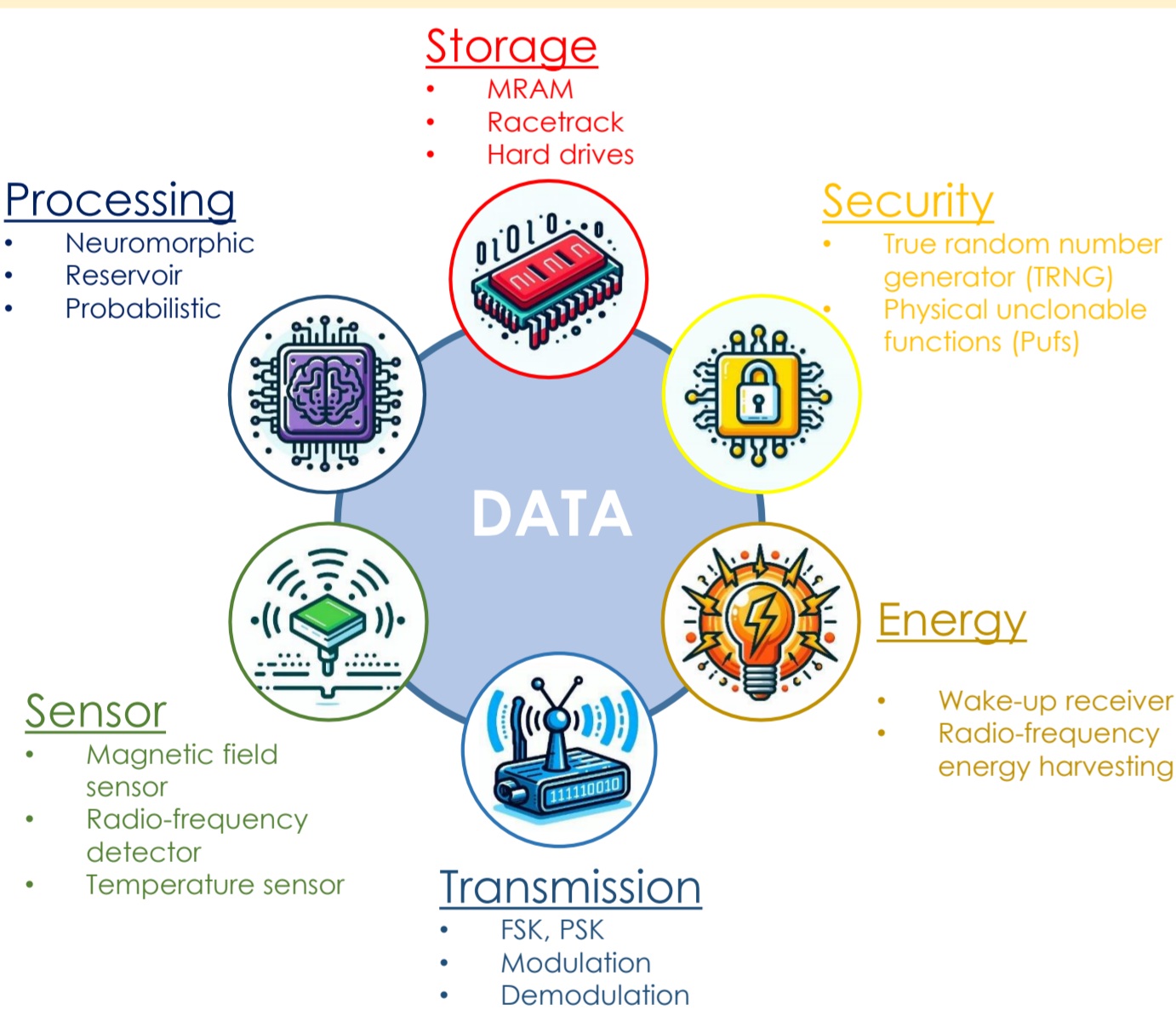
3D polymer optical interconnects



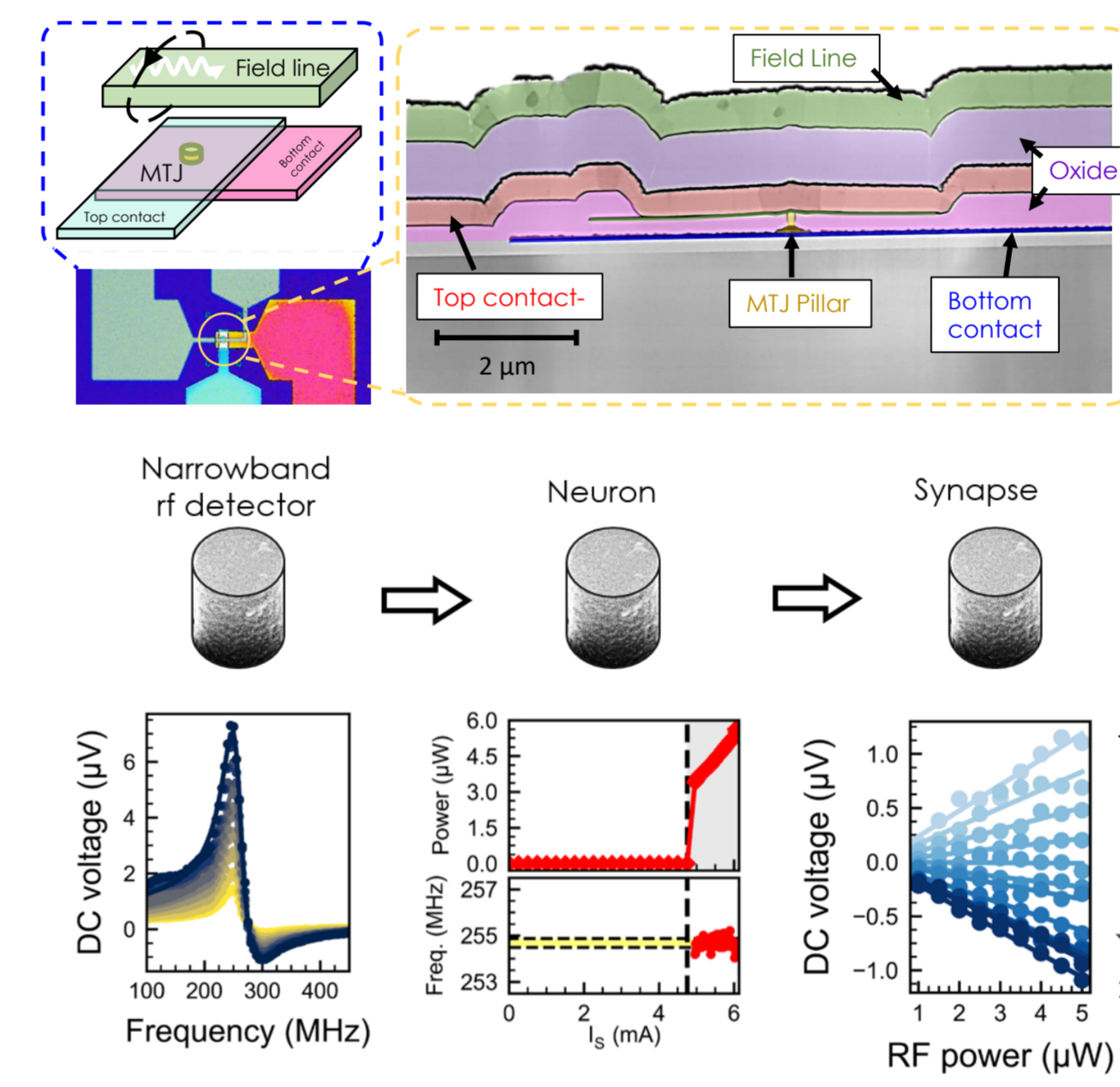
Optics Express
<https://doi.org/10.1364/OE.449641>
Contact: Jana.Nieder@inl.int

SPINTRONICS

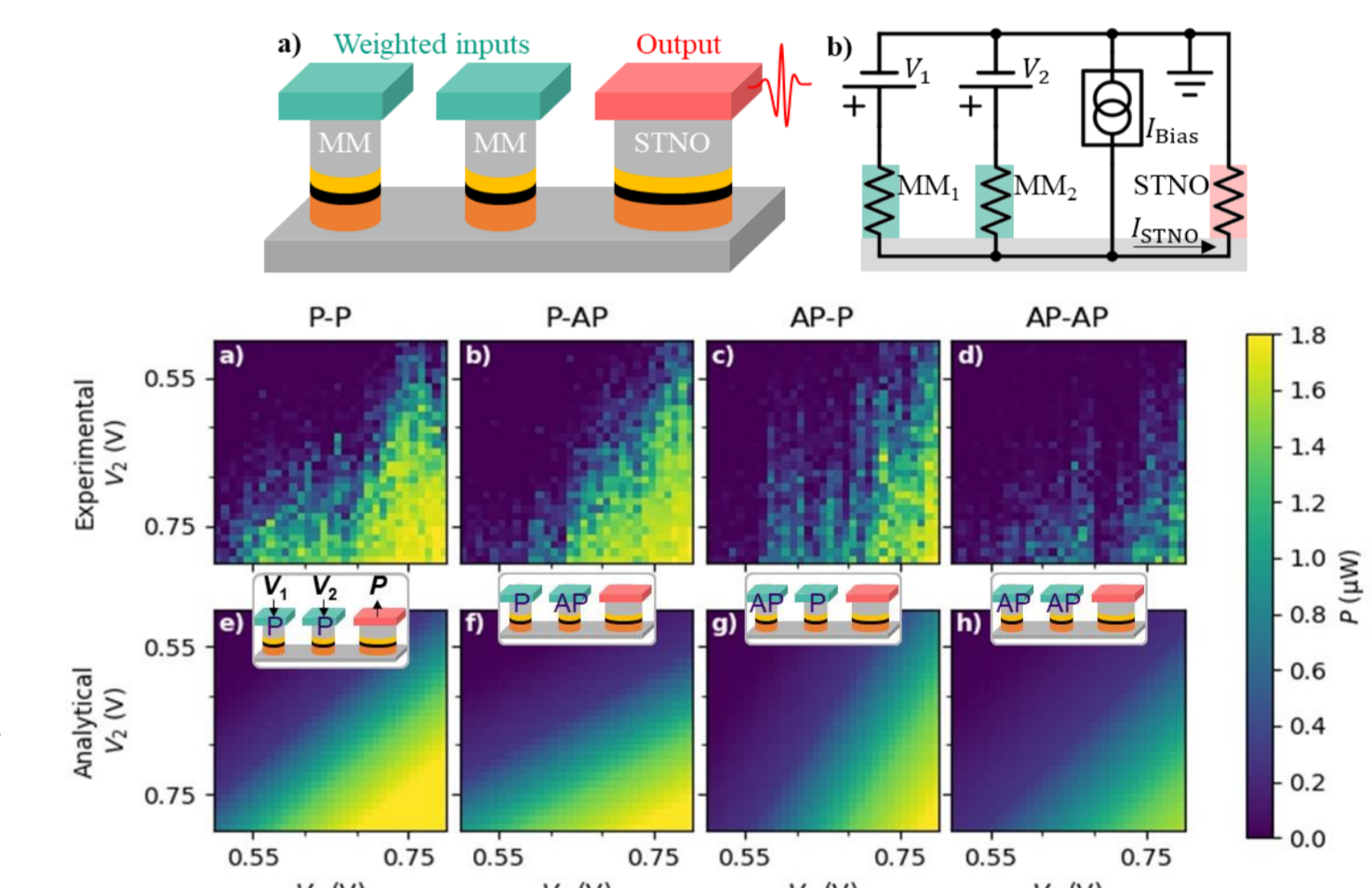
Aim: Spintronics technologies are versatile multi-functional CMOS compatible technologies which can be reconfigured in a non-volatile manner and have interesting properties for static and high frequency applications.



Contact: Ricardo.Ferreira@inl.int



Nature Nanotechnology
<https://doi.org/10.1038/s41565-023-01452-w>
Contact: Alex.Jenkins@inl.int

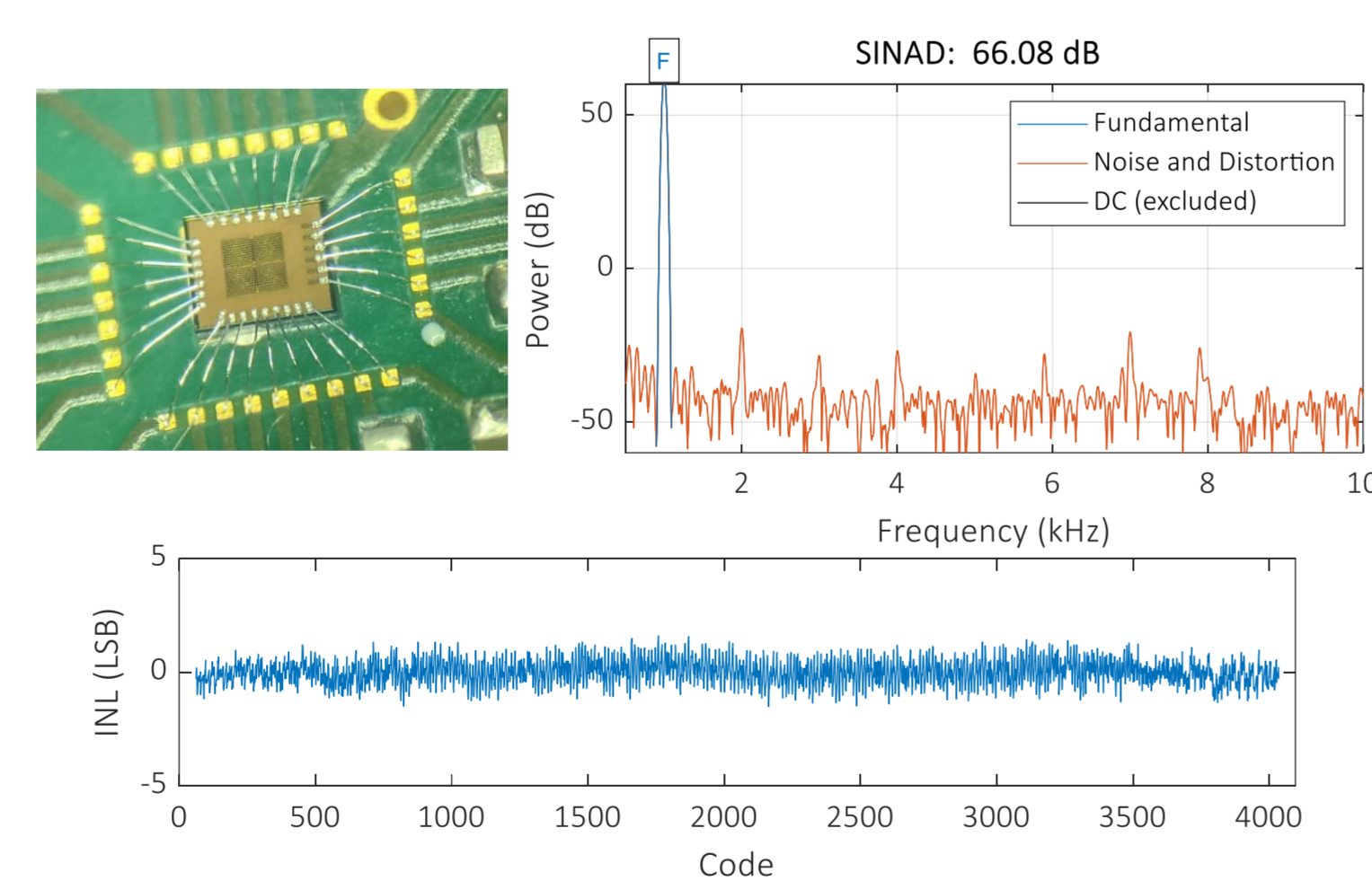
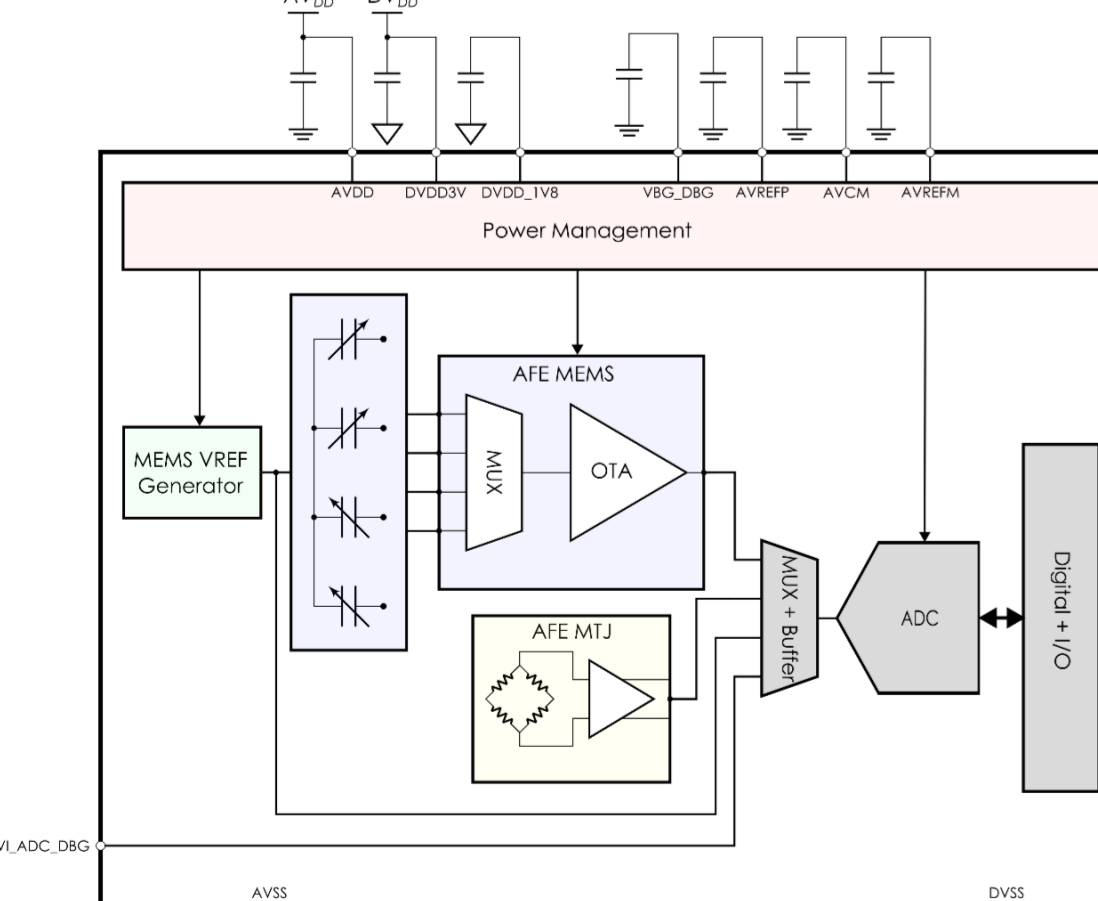


Communications Engineering
<https://doi.org/10.1038/s44172-023-00117-9>
Contact: Tim.Bohnert@inl.int

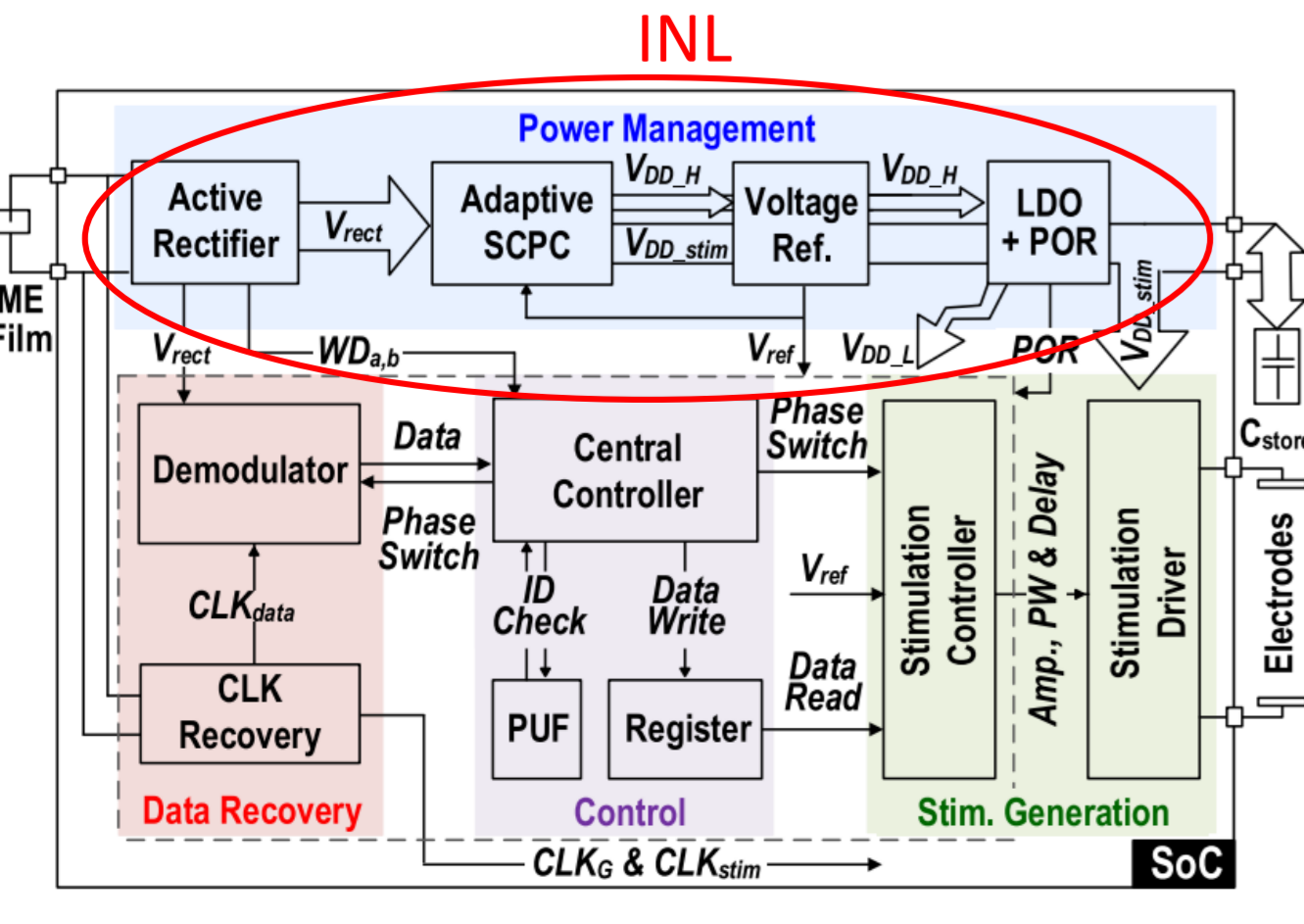
SYSTEMS ENGINEERING

Advanced CMOS Hybrid Devices AMS CMOS IC-design with monolithic integration of sensors (Magnetic, Optical, and Electrochemical). Complete multi-sensor SoC solutions with DAQ and DSP, as in the **LINK4S** project. Power management unit (PMU) of the microbot within the **CROSSBRAIN** project. μ LED drivers within the **META-LED** project.

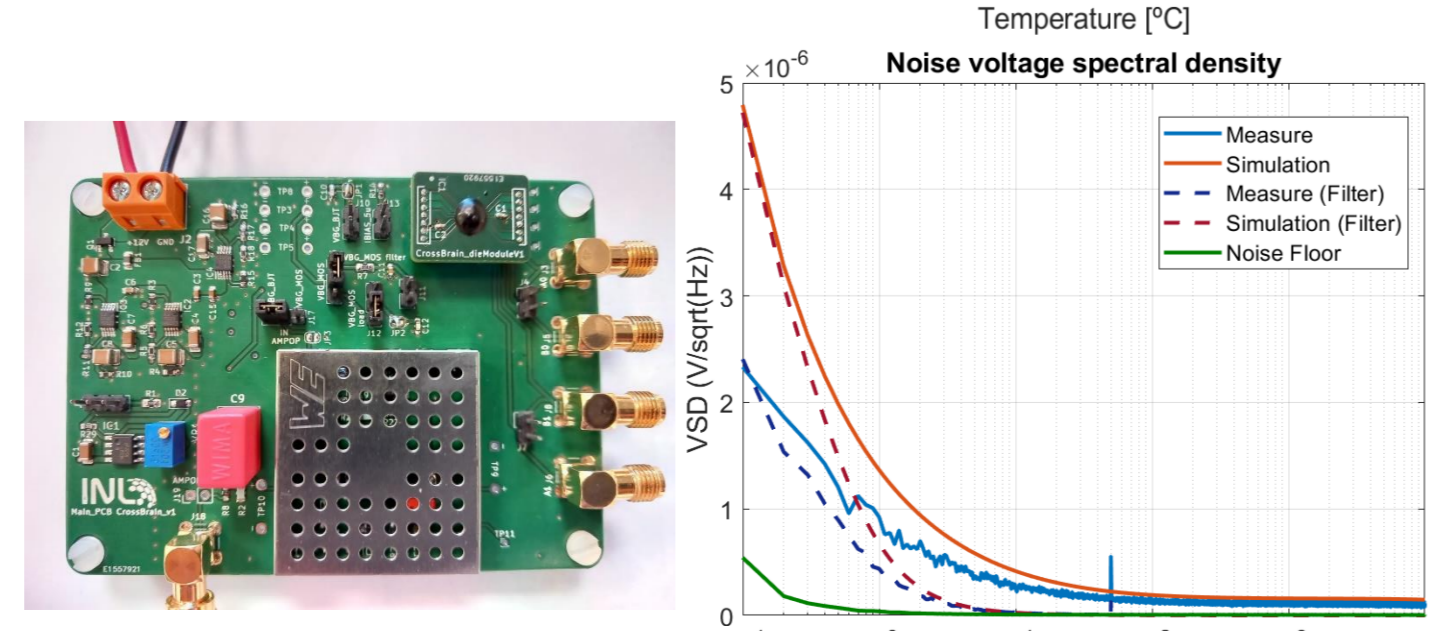
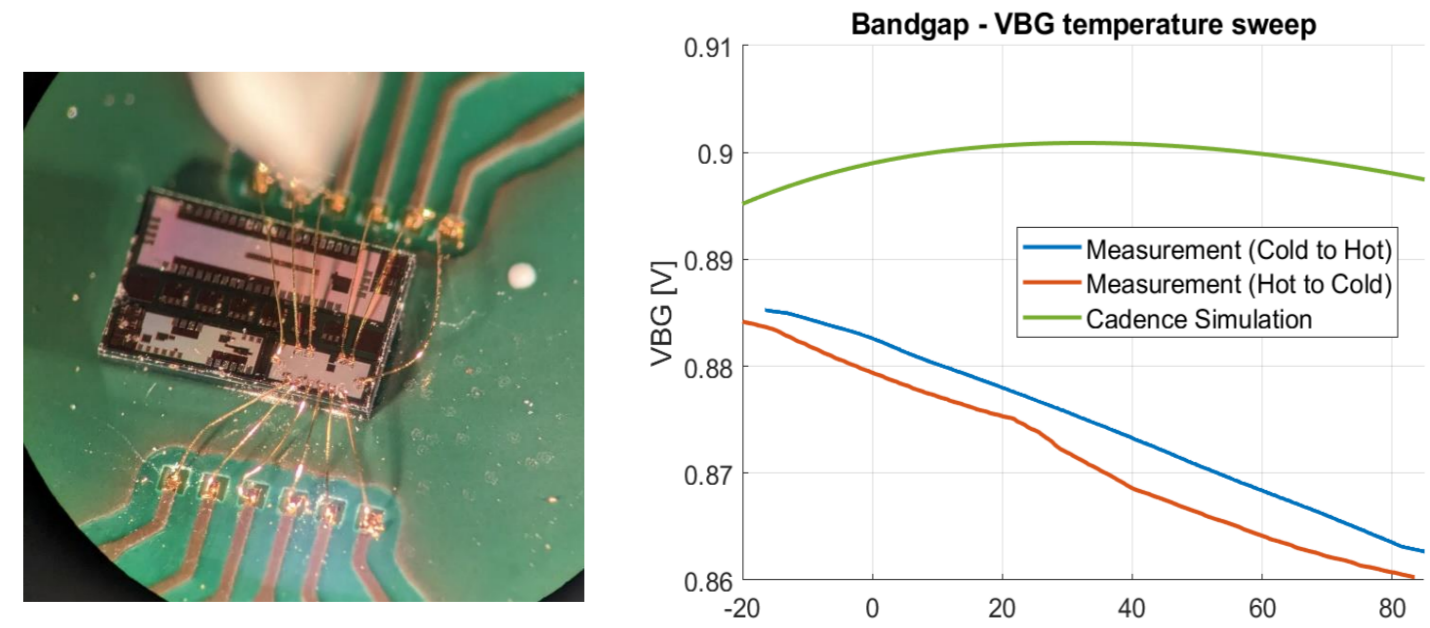
LINK4S Complete ASIC for MEMS accelerometer and MTJ magnetic sensor. Measurements of the on-chip 12 bits ADC



CROSSBRAIN PMU of the microbot. Measurements of the ultralow noise bandgap reference.



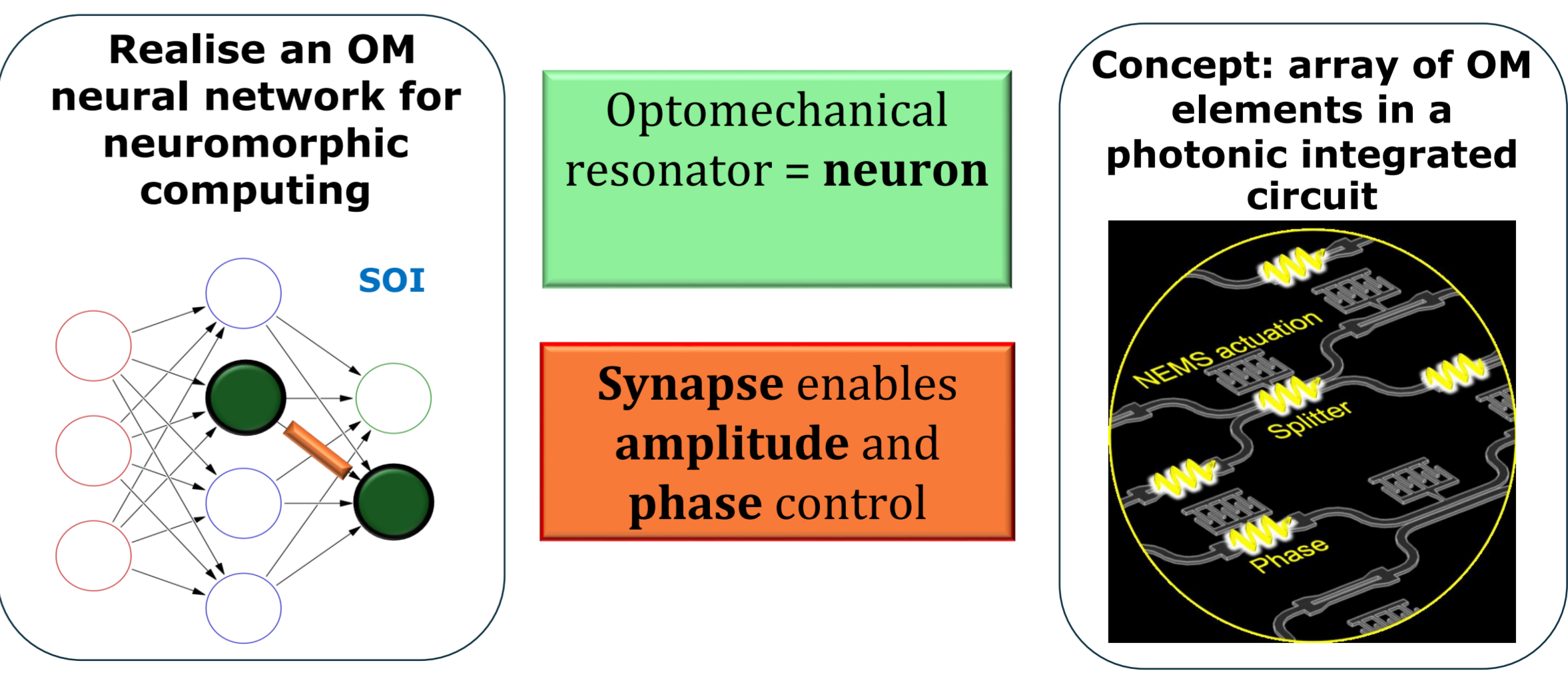
Contact: Joao.Piteira@inl.int
www.crossbrain.eu



NANOPHONONICS

Aims: Explore the potential of NEOMS incorporating a network of optomechanical (OM) elements for neuromorphic computing. Understand the OM physics to reach the theoretical noise floor in NEOMS in the quest for signal processing.

Electrical, optical and mechanical actuation envisaged



Noise: due to mechanical mode shifting as critical dimensions vary over the array?; due to thermal dissipations?

NEUROPIC
Contact: Clivia.Sotomayor@inl.int
www.neuropic-project.com



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