EFINED European project

http://www.efined-h2020.eu/ 2018 - 2021

A practical case of the EIC: *EFINED-project*

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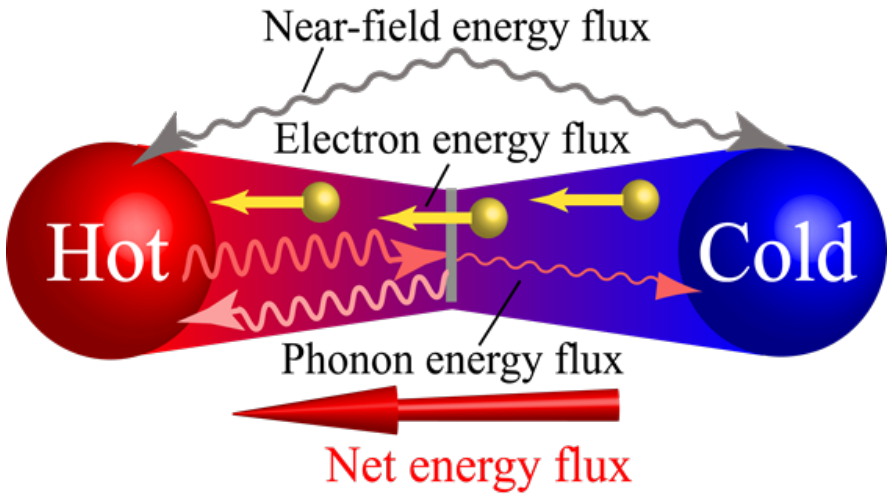
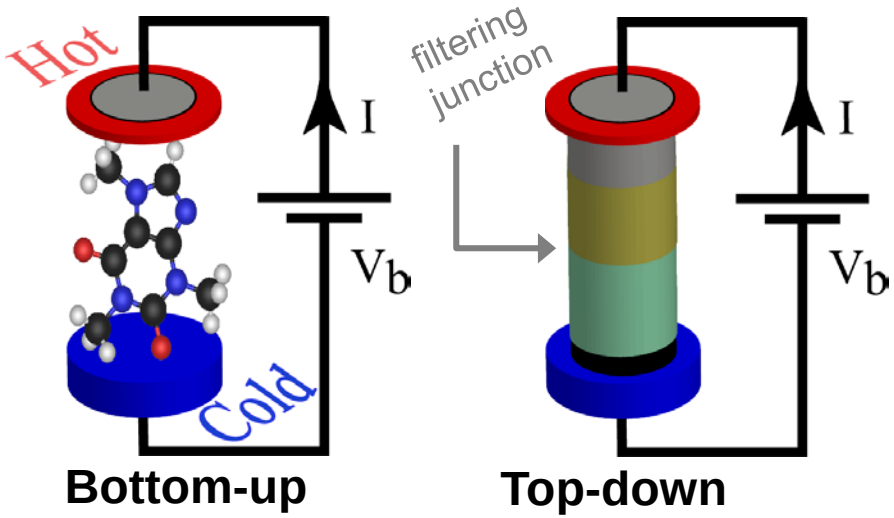
VTT Technical Research Centre of Finland Ltd

European Innovation Council (EIC) Roadshow Finland, Helsinki, May 23, 2019

Concept & Objectives





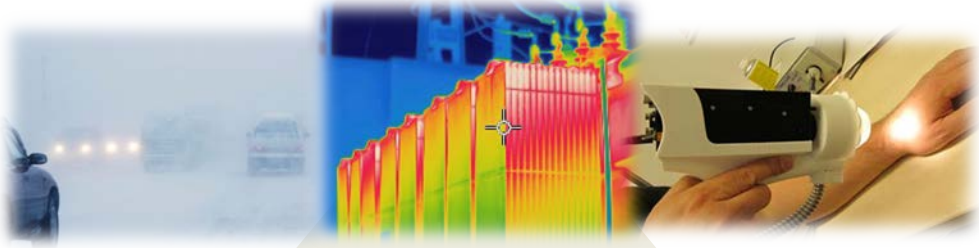
The targets of EFINED

- Develop tools to ***control the electron, photon and phonon energy/heat flux channels in a solid-state device***
- To realize ***nano-scaled devices that minimize phonon and photon heat flux and maximize electron cooling and electron flux responsivity under non-equilibrium***

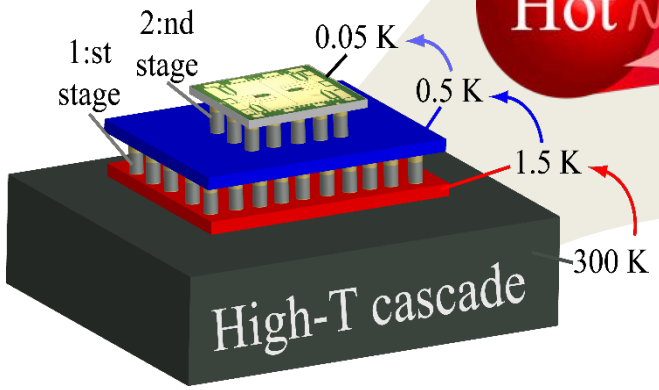
Impact & Application fields

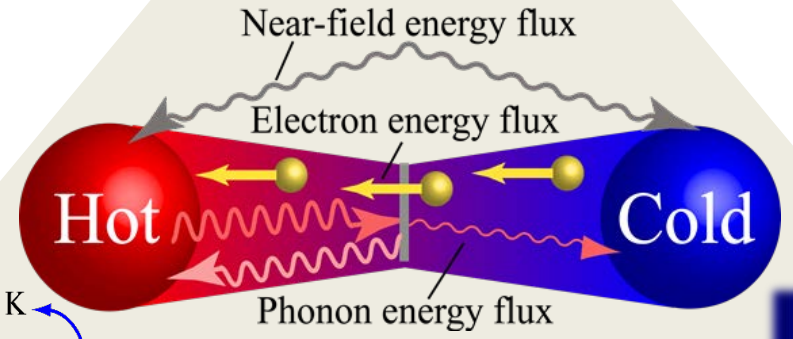
Proof-of-Concept:
Detector/cooler device with high performance by using the developed EFINED concepts and elements

Sensing

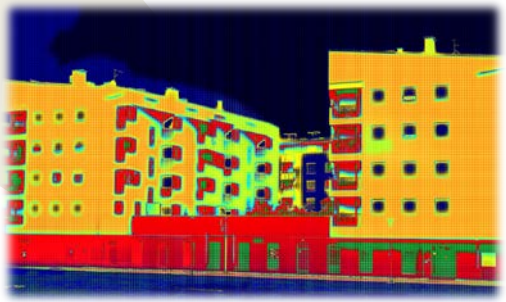


Thermal management and cooling



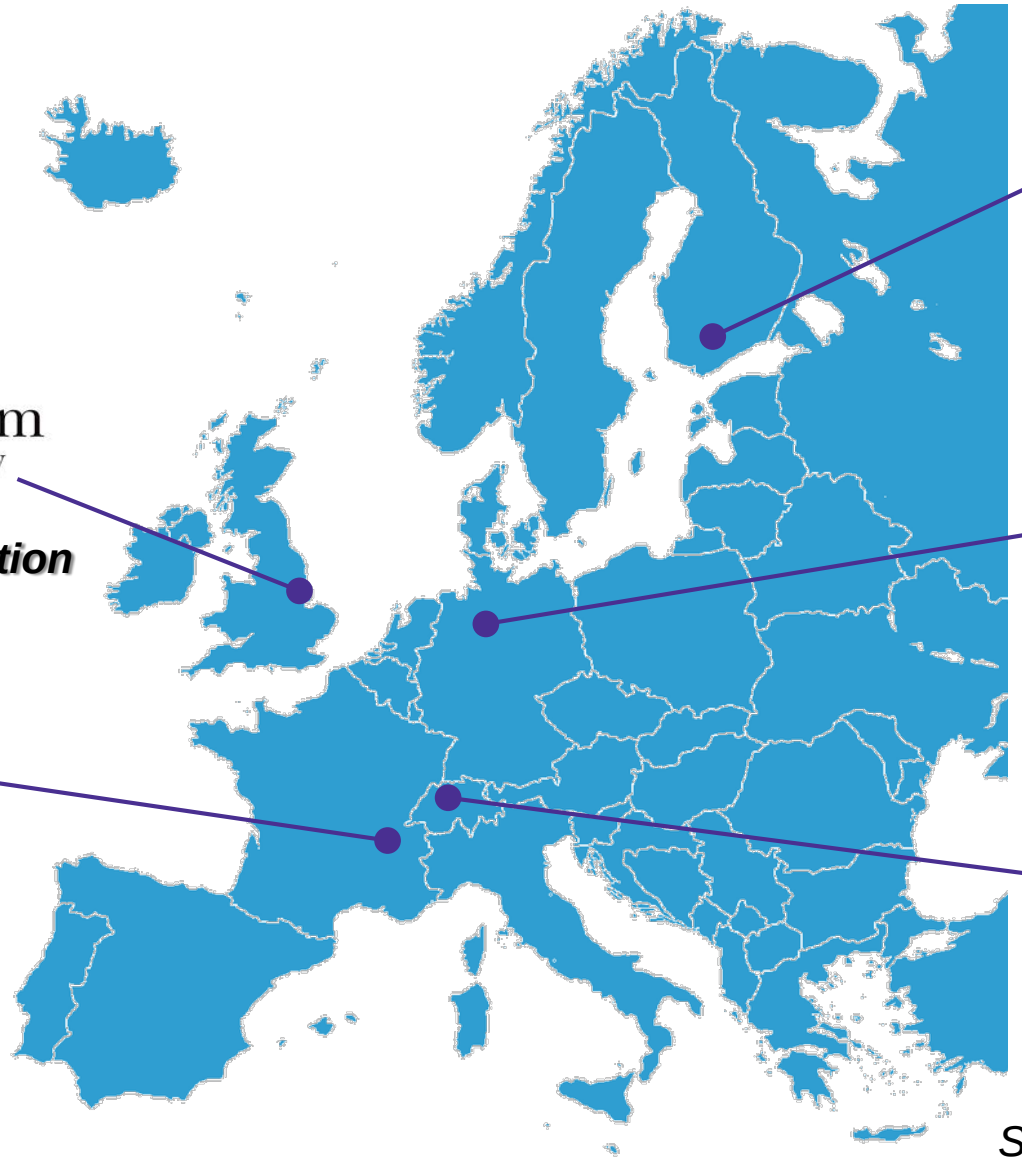


Energy Harvesting



Partners & roles

Interdisciplinary consortium, 5 countries



VTT

Coordination & On-chip device design, fabrication and characterization

Durham University

Synthesis, chemical characterization

CARL VON OSSIETZKY universität OLDENBURG

SPM and near-field heat transfer

cnrs

iLM

CETHIL

Theory and modelling

IBM

MEMS platforms and SPM for molecular experiments

SPM = scanning probe microscopy

Why we applied?

- ***Idea -*** we were convinced that we had a solid idea/concept
  - scientifically and technologically
  - something we are highly motivated to pursue

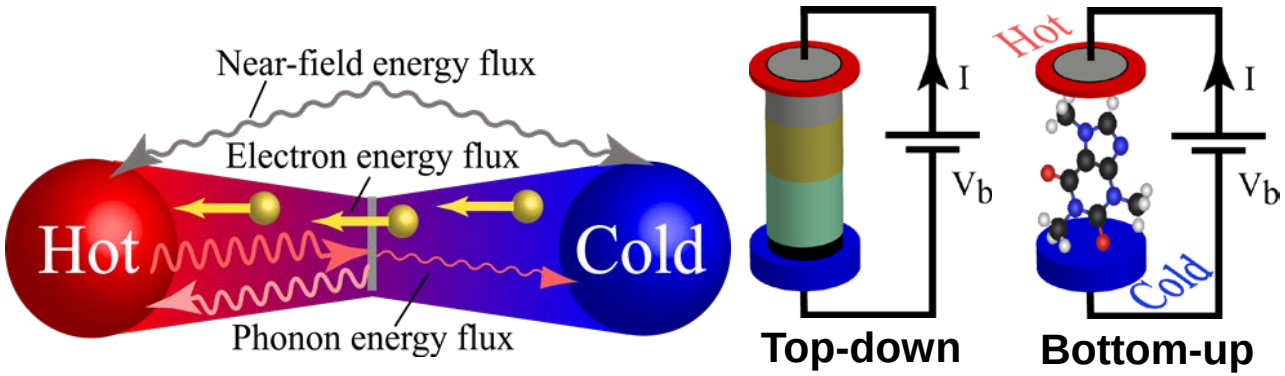
- ***Team -*** we had the network that enabled building the required interdisciplinary consortium for the implementation

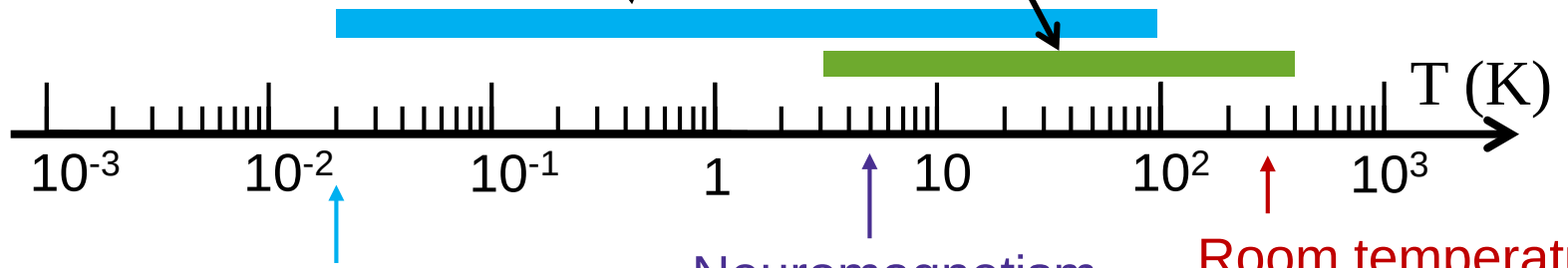
- ***Instrument -*** FET-instrument provided the required freedom (vs. topical calls)

Befits to our organization

- Resource to test early stage ideas
- Extended resource & complementary skills from partners
- Resource/platform to generate IP
- Resource/platform to generate publications
- Resource/platform to train new talents
  - R&D & project work
  - Networking

Background



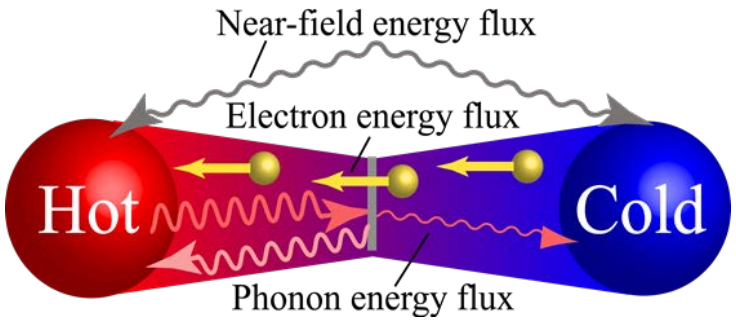


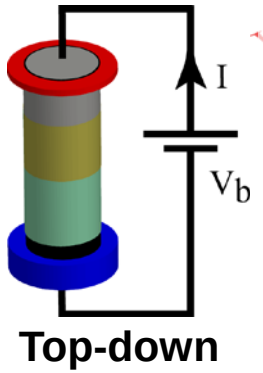
Superconductive quantum computer 0.02 K

Neuromagnetism and THz security sensors

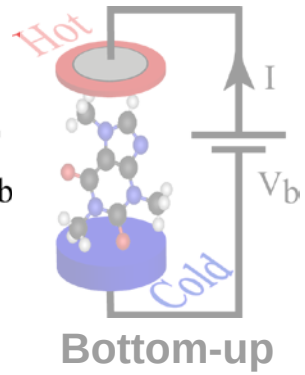
Room temperature 300 K

Top-down example: micro-cooler

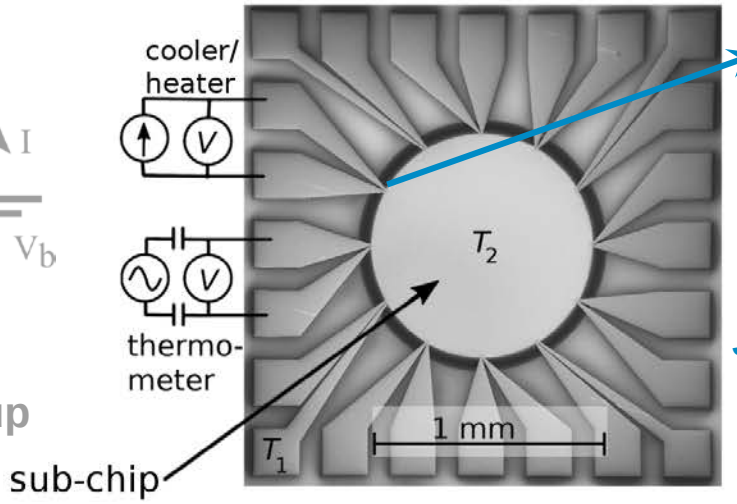




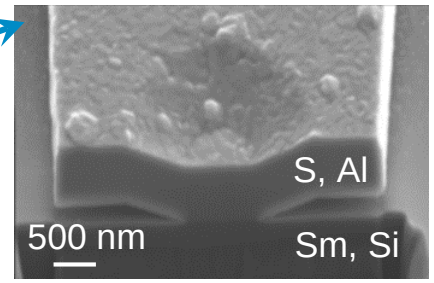
Top-down



Bottom-up



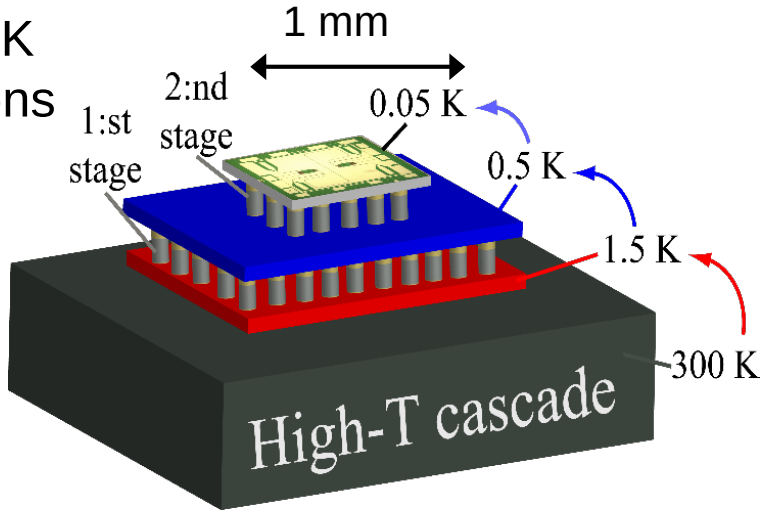
Cooling test platform [1]

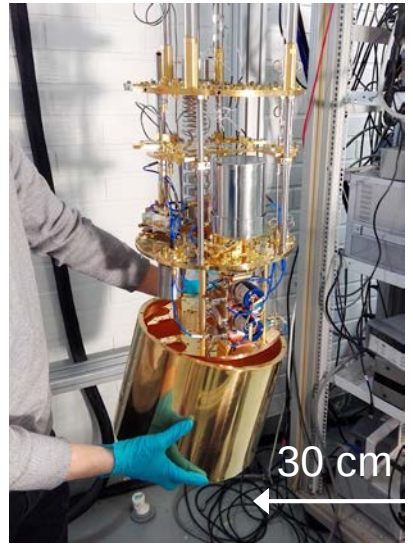


Junction cross-section [1]

New all-solid thermionic cooler platform [1]

- Based on EFINED concept: semiconductor-superconductor (Sm-S) junctions
- 40 % electronic cooling at sub-1 K demonstrated
- Recipe for electronic cooling from 1.5 K to 100 mK
- → Holy grail of refrigeration, numerous applications

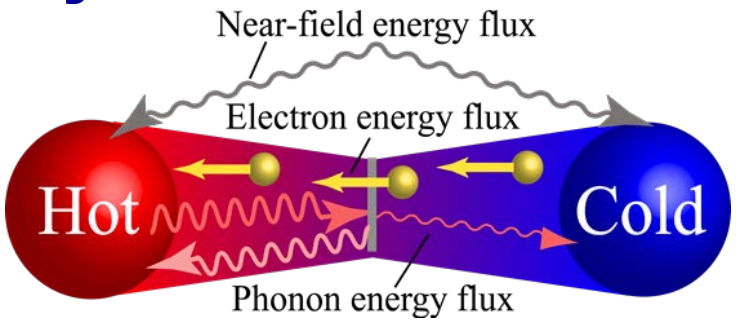


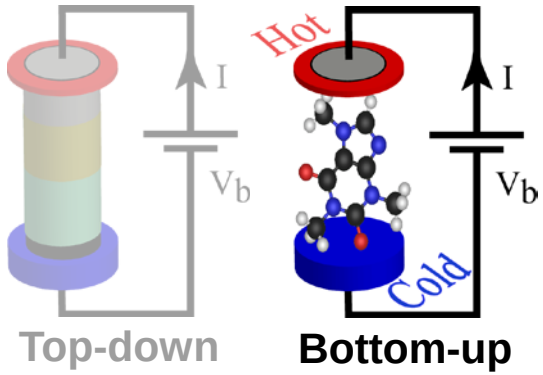


Solid-state alternative for dilution refrigerators that are utilized in quantum technology

[1] https://arxiv.org/abs/1809.02994

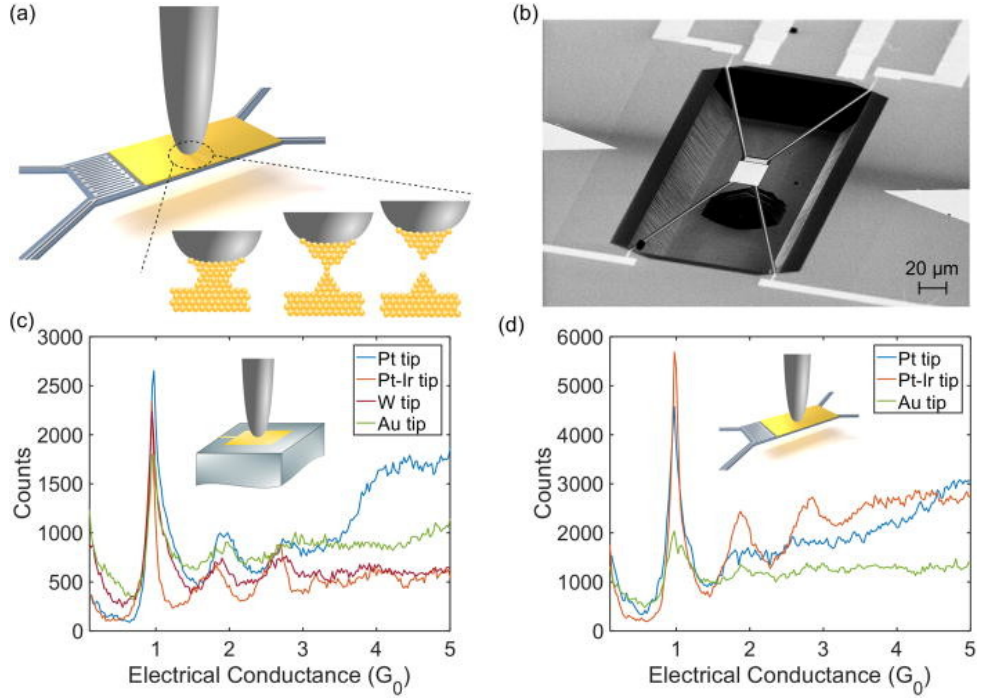
Bottom-up example: Atomic and molecular junctions

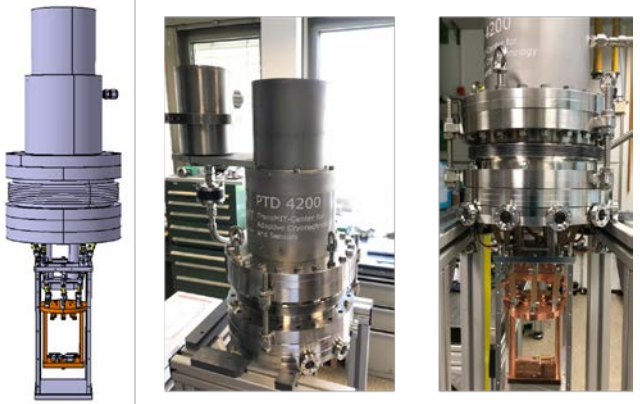




Custom designed molecular systems for energy-filtered thermoeletric cooling

- measurement platform to reach single-molecule sensitivity and stability at variable temperature
- demonstration of thermal conductancequantization measurements of stable, single-atom junctions at room temperature [1]
- molecular synthesis of custom molecules with energy-filtering capabilities





[1] Appl. Phys. Lett. 114, 123102 (2019), https://doi.org/10.1063/1.5086483

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Thank you!

EFINED Partners:

VTT

Durham University

CARL VON OSSIETZKY universität OLDENBURG

cnrs

IBM

iLM

CETHIL

Funding:

European Commission

European Commission under Grant Agreement number: 766853 — EFINED — H2020-FETOPEN-1-2016-2017/FETOPEN-01-2016-2017