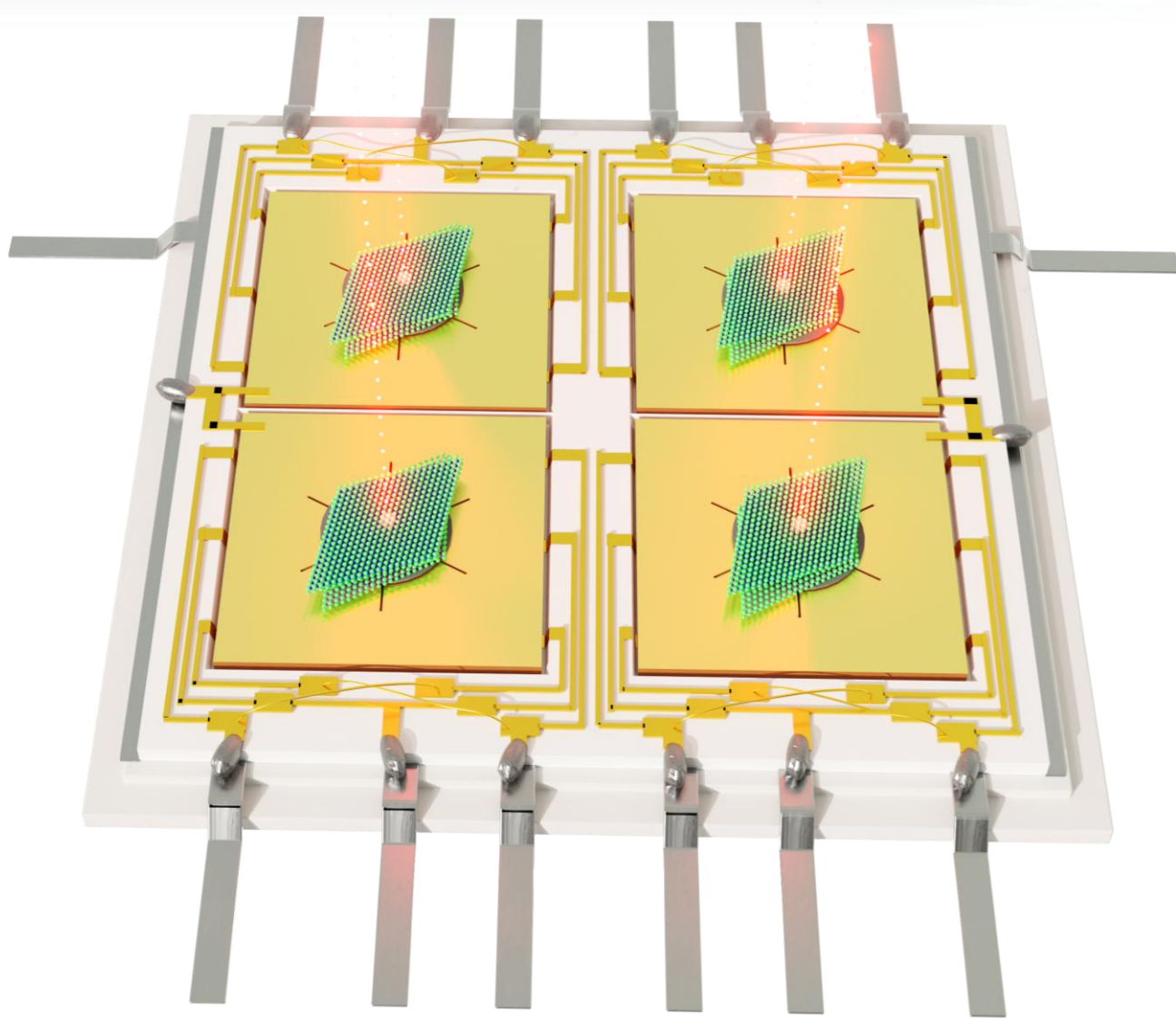


On-chip Moiré Single-Photon Emitters  
for Quantum Communications

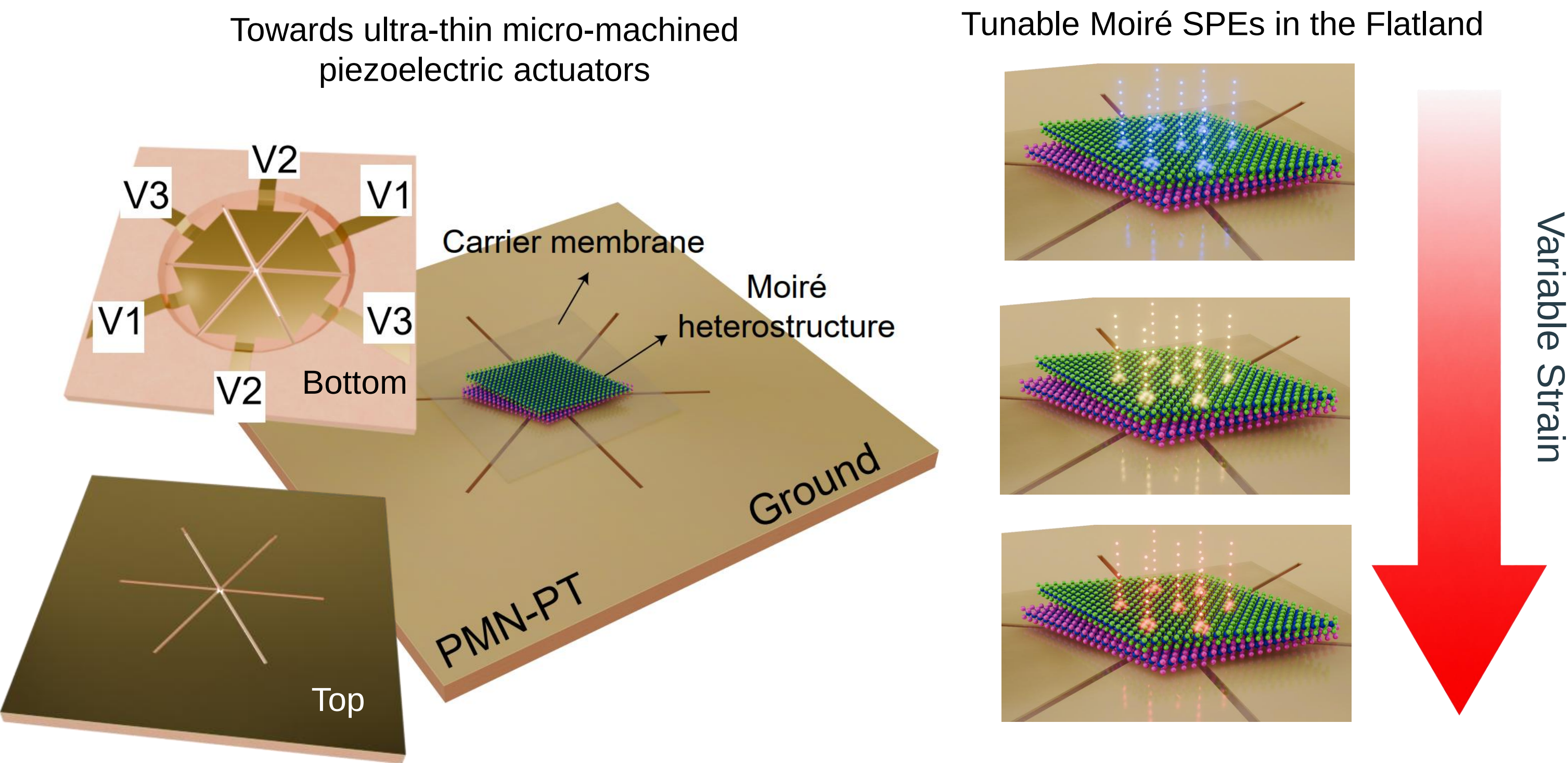
QuantERA Call 2025 / Applied Quantum Science

Future quantum technologies hinge on the ability to generate single photons on demand, with high purity, efficiency and spectral stability, and to do so on compact and cost-effective platforms. SINPHONI targets this challenge by exploiting moiré superlattices in two-dimensional transition-metal dichalcogenides (TMDs) as a new paradigm for solid-state quantum light sources. In these atomically thin heterostructures, twist-engineered moiré potentials naturally trap excitons in periodic quantum-dot-like sites, combining strong interactions, mechanical flexibility and seamless compatibility with integrated photonics.



Chip with a 2x2 array of individually controlled Moiré SPEs

Programmable Quantum Emitters in 2D Moiré Platforms



Demonstrator targets

|                                                                                                                                                                           |                                 |                                   |                                    |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|-----------------------------------|------------------------------------|
| $g^2(0) < 0.1$                                                                                                                                                            | $\geq 10$                       | $\geq 20$ meV                     | $\geq 4$ SPEs<br>(2 × 2 array)     |
| Single-photon purity under pulsed excitation                                                                                                                              | Purcell factor with 2D cavities | Reversible emission-energy tuning | Independently addressable emitters |
| SINPHONI will combine twisted 2D semiconductors, piezoelectric strain control and optical microcavities to create independently tunable single-photon emitters on a chip. |                                 |                                   |                                    |

Research Approach

Fabrication of Moiré Quantum Emitters

Assemble twisted MoSe<sub>2</sub>/WSe<sub>2</sub> and WSe<sub>2</sub>/WS<sub>2</sub> heterobilayers with controlled twist angle.

Apply Programmable Strain

Integrate six-leg piezoelectric actuators for reversible isotropic and anisotropic strain control.

Mapping and Modelling

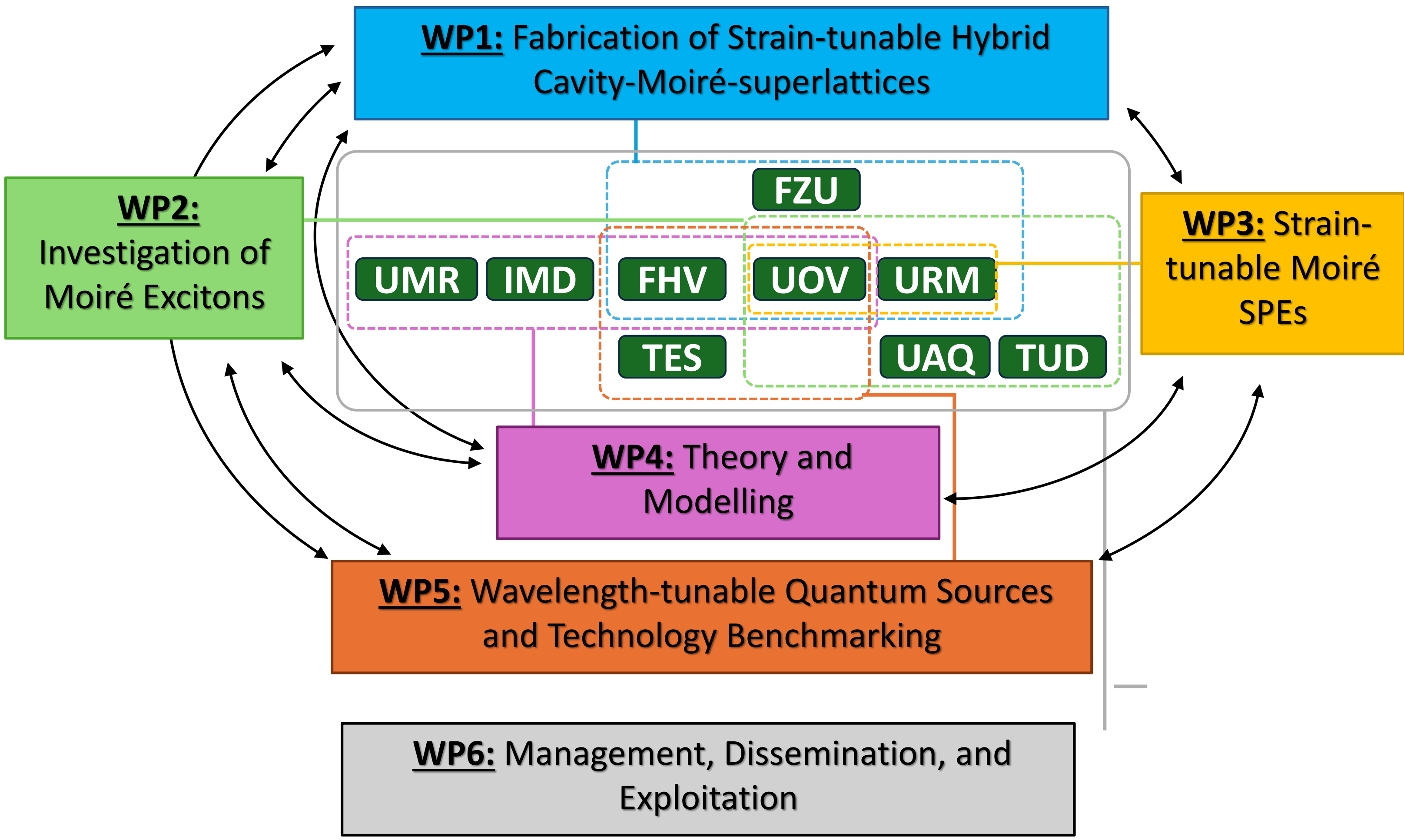
Correlate 4D-STEM strain maps, ultrafast spectroscopy and quantum-optical measurements with many-body theory.

Enhance Photon Emission

Couple selected emitters to planar optical cavities to boost emission rates and photon extraction.

Integrate and Benchmark

Build a cryogenic-compatible 2x2 actuators array with multichannel control and assess purity, tunability, polarization and stability.



The Consortium 9 partners / 6 countries / 36 months



**University of Oviedo (UOV)**  
Spain • Javier Martín-Sánchez  
Coordinator. Moiré fabrication, strain tuning and device integration.



**Inst. Physics, Czech Academy of Sciences (FZU)**  
Czech Republic • Gabriel Vanko  
Surface acoustic wave devices and microfabrication.



**IMDEA Nanociencia (IMD)**  
Spain • Jose Á. Silva-Guillén  
First-principles calculations of strained, twisted heterostructures.



**University of L'Aquila (UAQ)**  
Italy • Davide Tedeschi  
Ultrafast spectroscopy of exciton dynamics under strain.



**Philipps-Universität Marburg (UMR)**  
Germany • Ermin Malic  
Predictive many-body modelling of moiré excitons.



**Vorarlberg University (FHV)**  
Austria • Sandra Stroj  
Piezoelectric actuators, micromachining and chip assembly.



**Delft University of Technology (TUD)**  
Netherlands • Sonia Conesa-Boj  
4D-STEM mapping of strain and moiré structures.



**Sapienza University of Rome (URM)**  
Italy • Rinaldo Trotta  
Quantum-optical characterization and cavity coupling.



**TESTTEC GmbH (TES)**  
Austria • Karl Unterweger  
Industrial partner. Control electronics, actuator qualification and reliability.