

Call 2021
Final Evaluation



EQUAISE



Enabling QUAntum Information by Scalability of Engineered
quantum materials

Antonio Polimeni

<https://equaise.pwr.edu.pl/>

COLLABORATION



Italy (2)



Germany (3)



Poland (1)



Spain (1)



5 Universities, 1 Research Institute, 1 Company

VARIETY OF SECTORS, DISCIPLINES - Semiconductors, Quantum Technologies, Materials Science, Chemistry, Quantum Optics, Device processing and fabrication involving students, young researchers and optoelectronics companies



QUALITY OF COOPERATION – strongly interacting partners involved in different stages of research

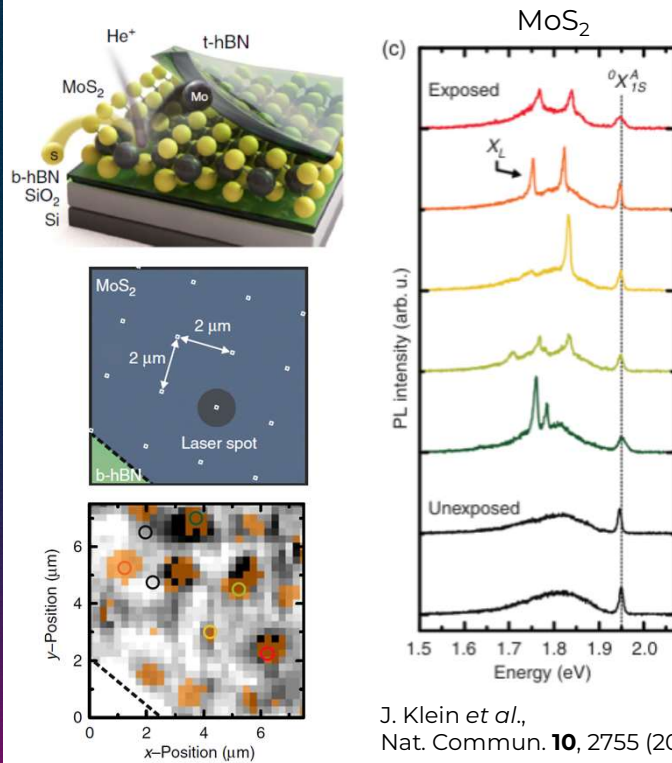
Two project workshops



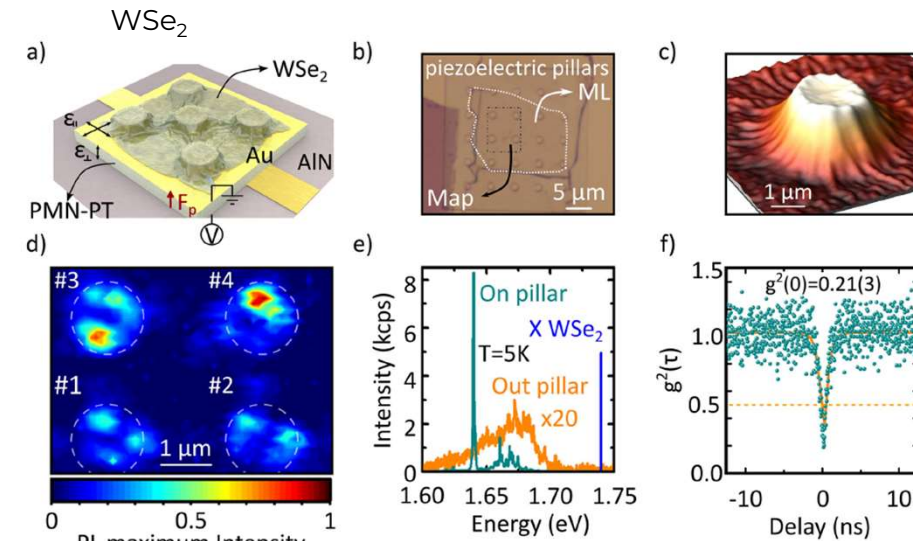


CHALLENGE – Scalability of quantum sources in two-dimensional materials via simple, cost-effective methods, and possibly compatible with current photonic integration technologies

Defect creation



Dynamical strain (EQUAISE result)



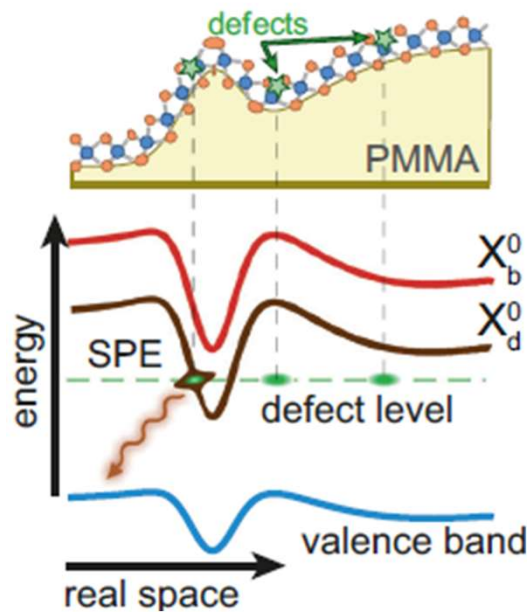
G. Ronco *et al.*,
npj 2D Mater. Appl. **6**, 65 (2025)



CHALLENGE – Scalability of quantum sources in two-dimensional materials via simple, cost-effective methods, and possibly compatible with current photonic integration technologies

Mixing of the strain-localized dark exciton with a defect state leads to the formation of a strongly localized defect exciton

Strain+defects necessary



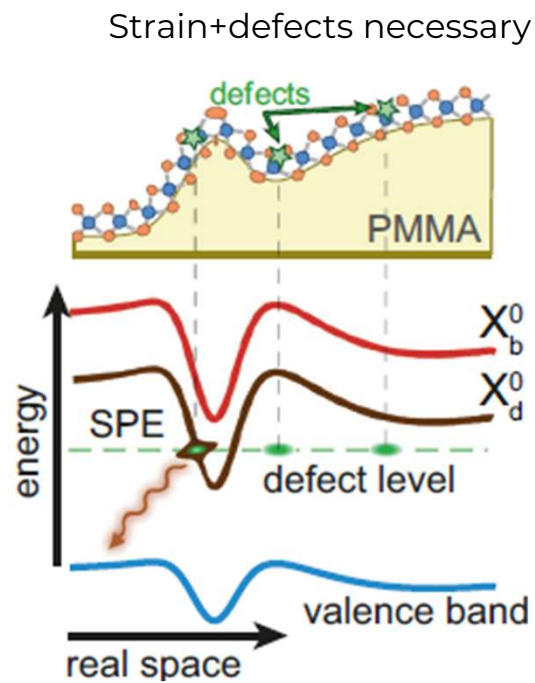
A. N. Abramov *et al.*,
Nat Commun. **14**, 5737 (2023)





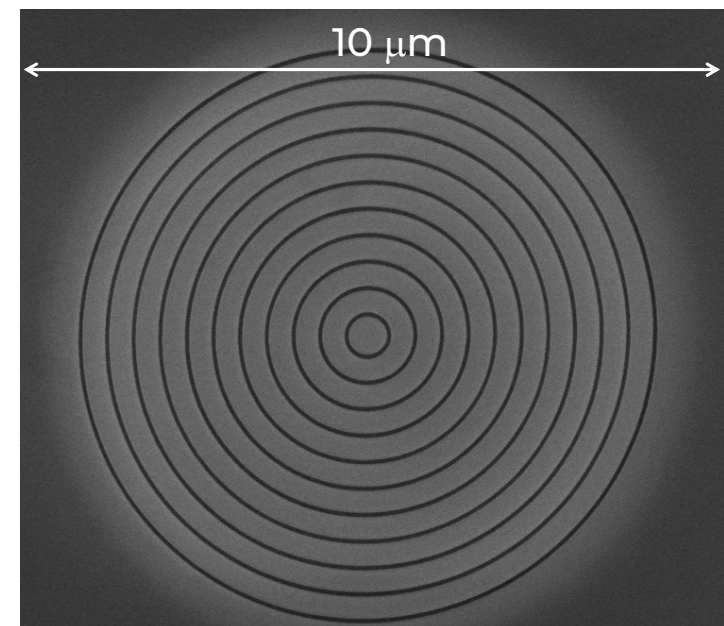
CHALLENGE – Scalability of quantum sources in two-dimensional materials via simple, cost-effective methods, and possibly compatible with current photonic integration technologies

Mixing of the strain-localized dark exciton with a defect state leads to the formation of a strongly localized defect exciton



A. N. Abramov *et al.*,
Nat Commun. **14**, 5737 (2023)

Coupling to a photonic cavity



QuantERA Call 2021 Final Evaluation

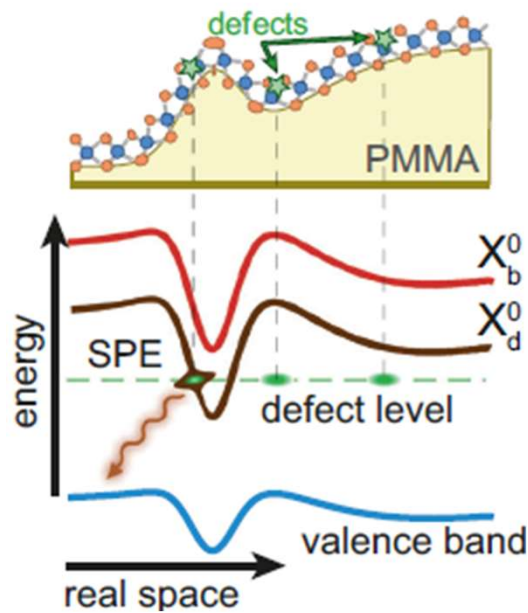




CHALLENGE – Scalability of quantum sources in two-dimensional materials via simple, cost-effective methods, and possibly compatible with current photonic integration technologies

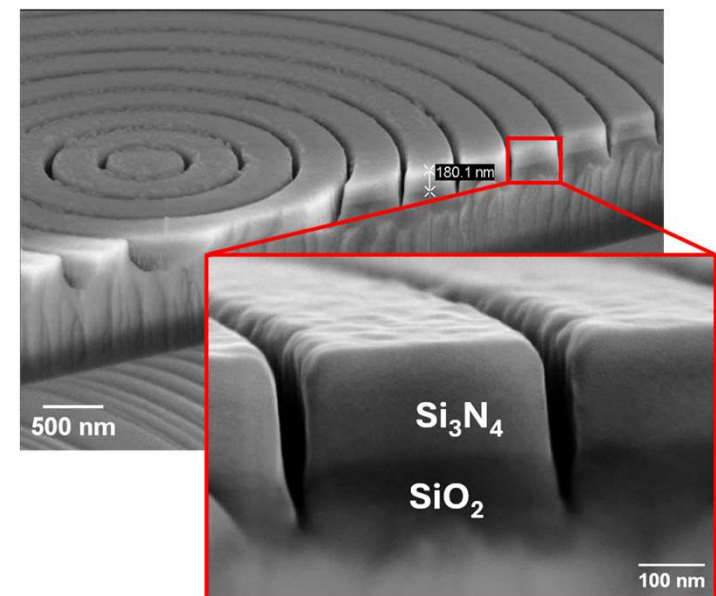
Mixing of the strain-localized dark exciton with a defect state leads to the formation of a strongly localized defect exciton

Strain+defects necessary



A. N. Abramov *et al.*,
Nat. Commun. **14**, 5737 (2023)

Coupling to a photonic cavity



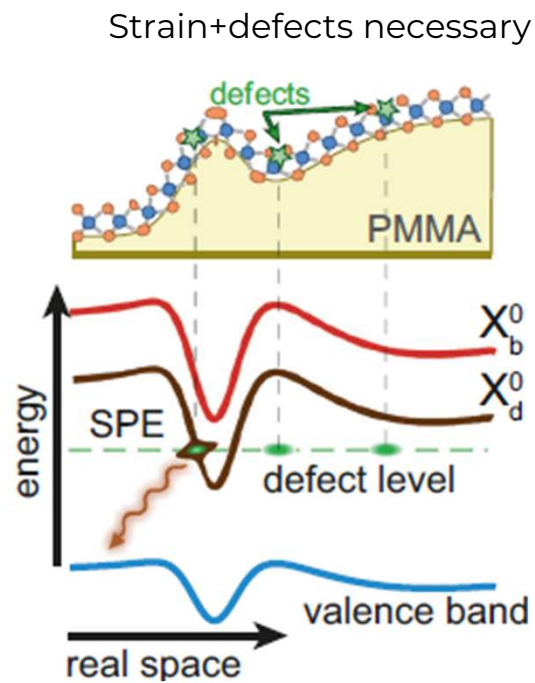
QuantERA Call 2021 Final Evaluation





CHALLENGE – Scalability of quantum sources in two-dimensional materials via simple, cost-effective methods, and possibly compatible with current photonic integration technologies

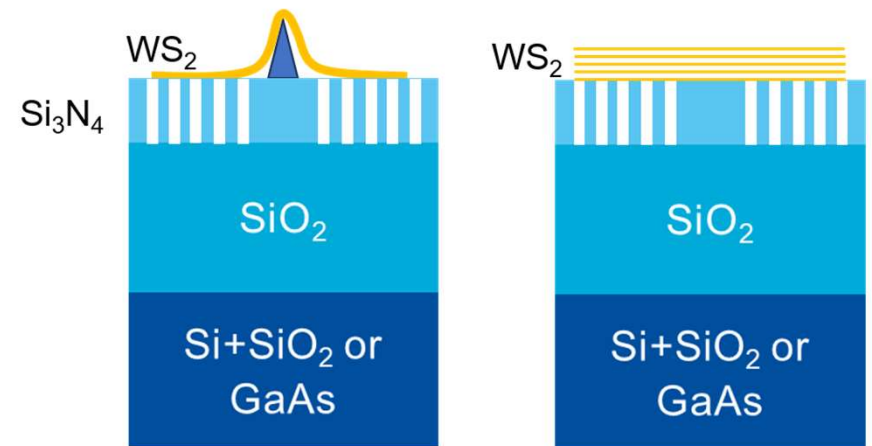
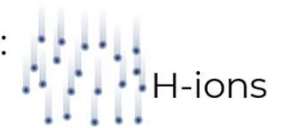
Mixing of the strain-localized dark exciton with a defect state leads to the formation of a strongly localized defect exciton



A. N. Abramov et al.,
Nat. Commun. **14**, 5737 (2023)

Coupling to a photonic cavity

We pursue two approaches:

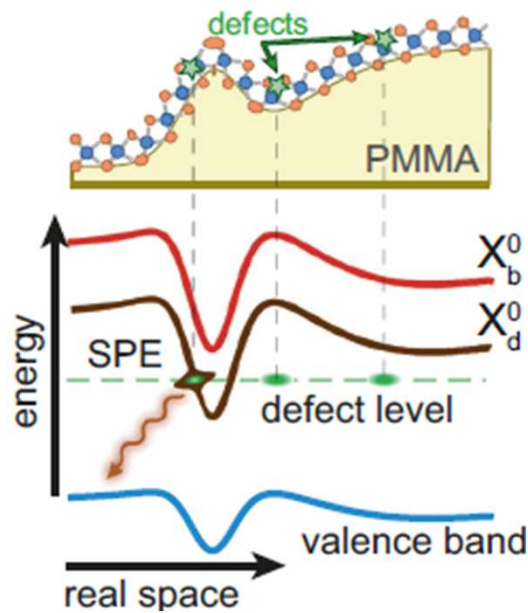




CHALLENGE – Scalability of quantum sources in two-dimensional materials via simple, cost-effective methods, and possibly compatible with current photonic integration technologies

Mixing of the strain-localized dark exciton with a defect state leads to the formation of a strongly localized defect exciton

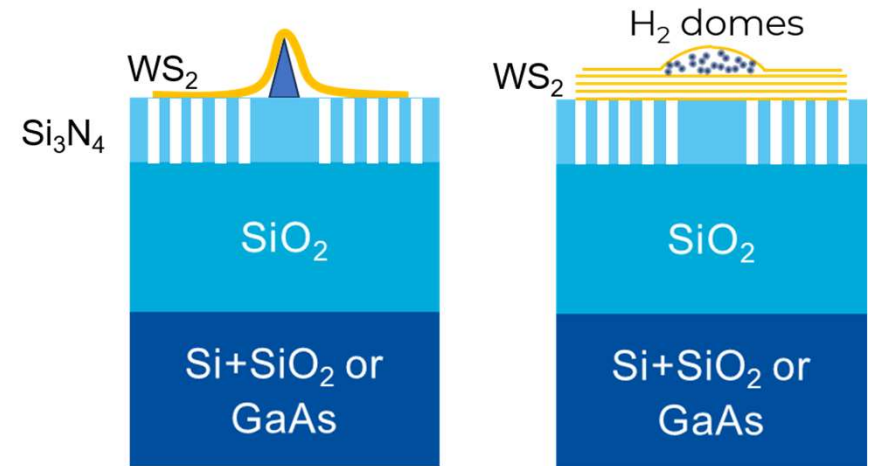
Strain+defects necessary



A. N. Abramov *et al.*,
Nat. Commun. **14**, 5737 (2023)

Coupling to a photonic cavity

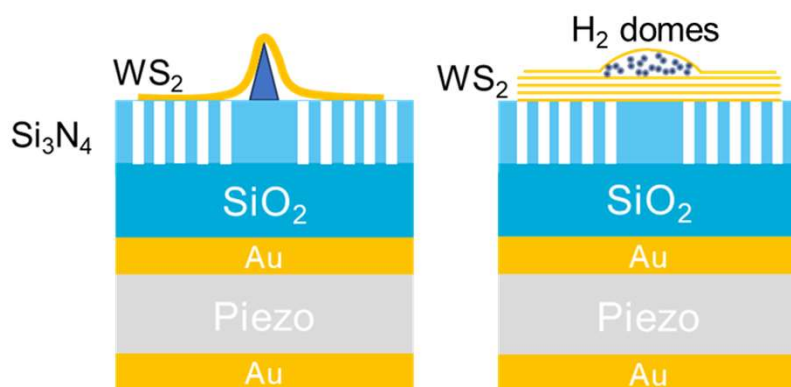
We pursue two approaches:



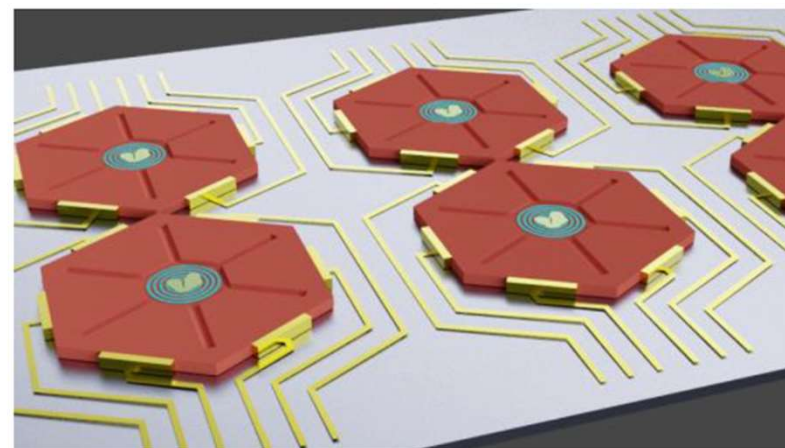


SOLUTION – Scalability of quantum sources in two-dimensional materials via simple, cost-effective methods, and possibly compatible with current photonic integration technologies

Simultaneous energy tuning of emitters' energy emission and cavity resonance wavelength

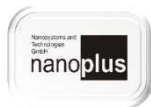


Hybrid piezoelectric devices to tune the emitter and cavity resonance energies

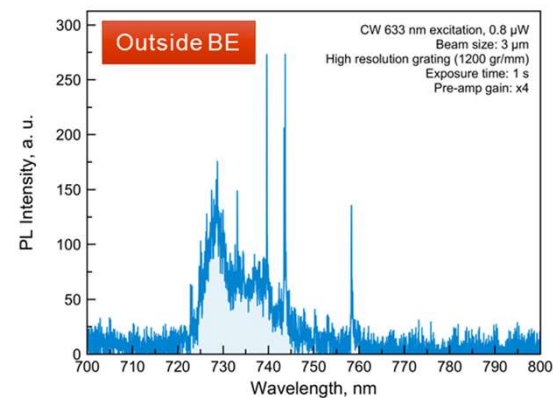
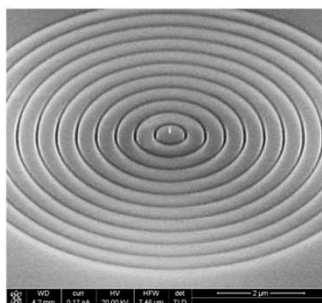
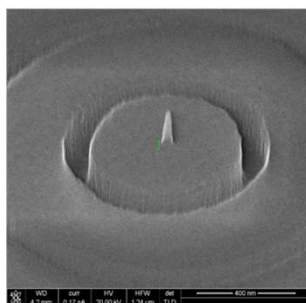




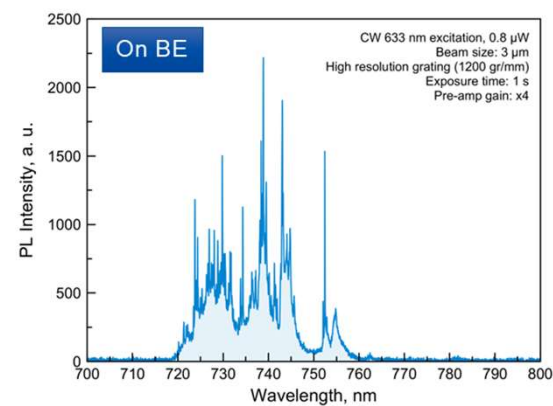
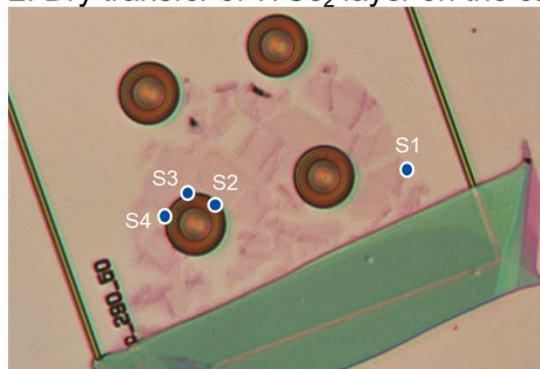
SOLUTION – Optimal Bragg cavity



1. Deposition of Pt nano-cones in the center of a BE



2. Dry transfer of WSe₂ layer on the cavity

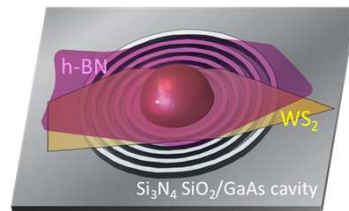


10-fold
emission
enhancement
on the cavities

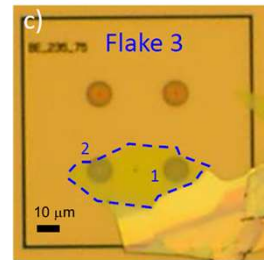




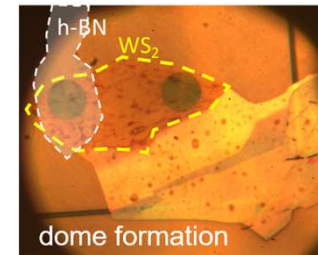
SOLUTION – Optimal Bragg cavity



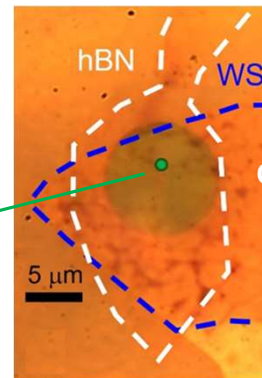
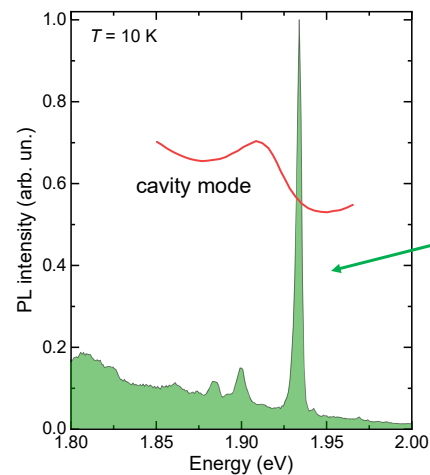
Circular Bragg Grating Cavities



before H-irradiation



after H-irradiation



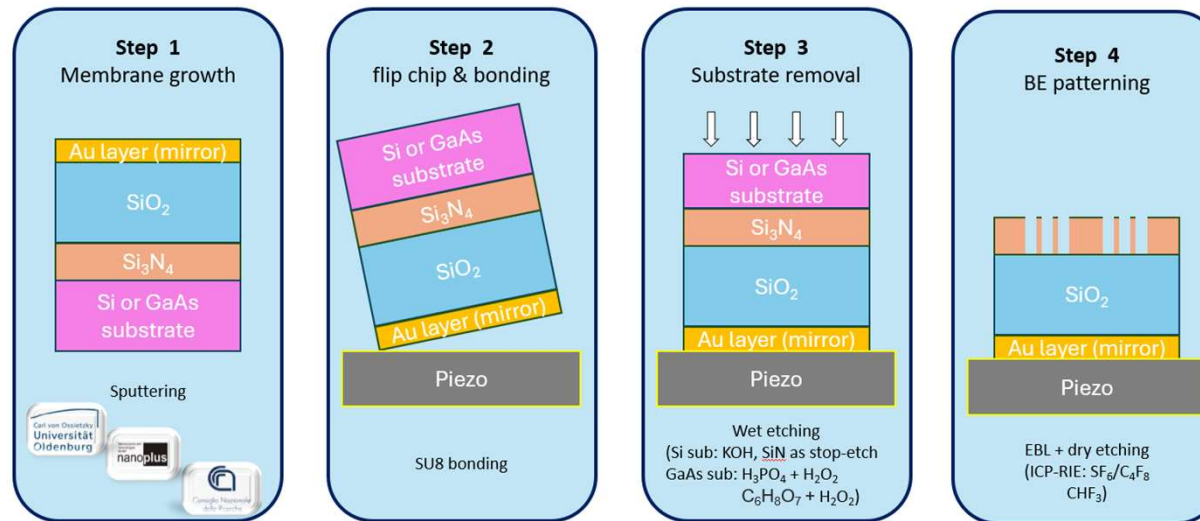
- Non-optimal emitter cavity-coupling
- Dome randomness formation
 - Emitter-cavity wavelength mismatch

Can we optimise the coupling process?



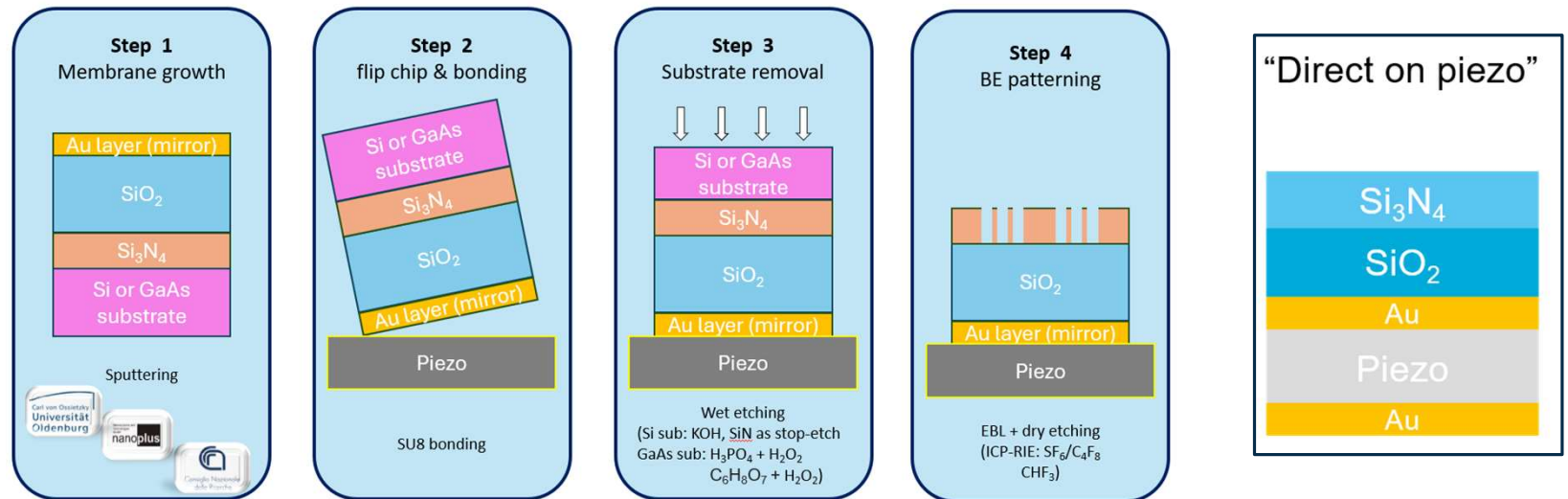


SOLUTION – Optimal Bragg cavity





SOLUTION – Optimal Bragg cavity





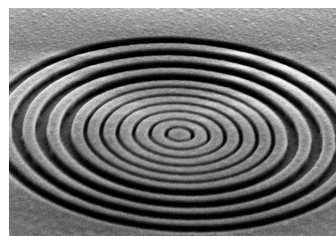
SUCCESS STORY – Optimal Bragg cavity



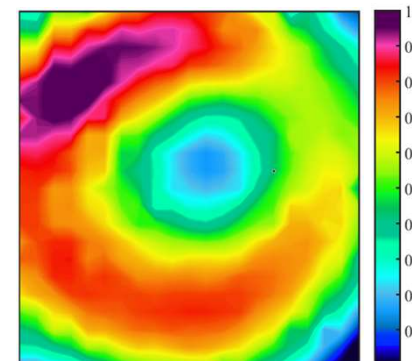
CNR



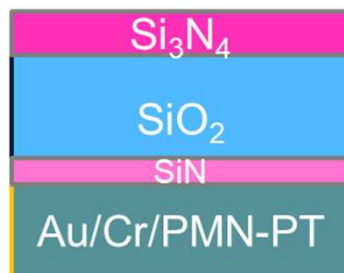
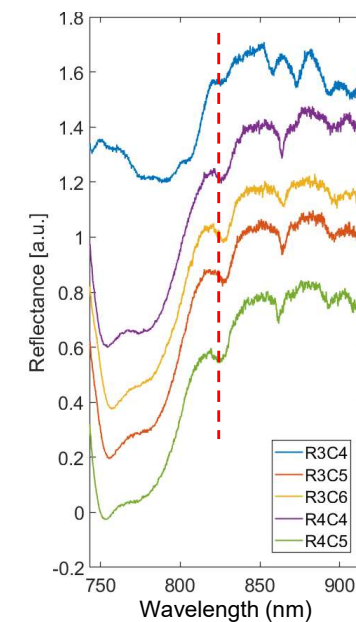
University of Oviedo



Cavity mode
intensity
1.48 – 1.52 eV



Cavity mode was investigated by performing reflectivity maps ($5 \times 5 \mu\text{m}^2$) on the central part of the BE



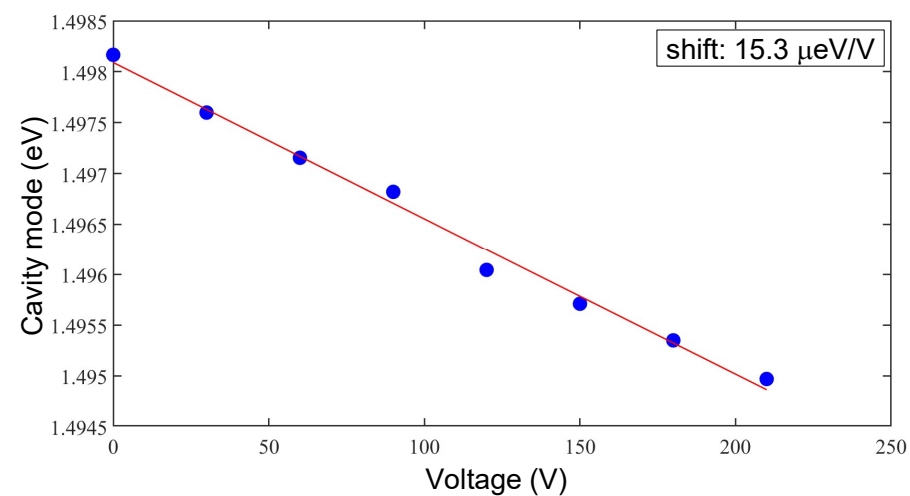
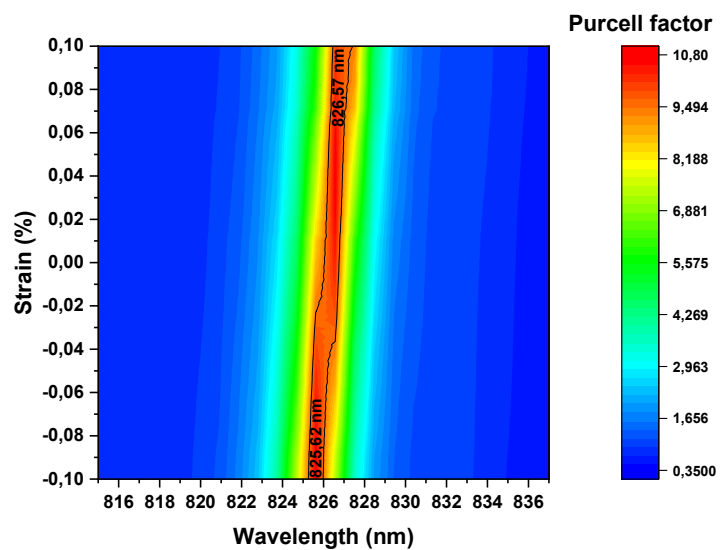
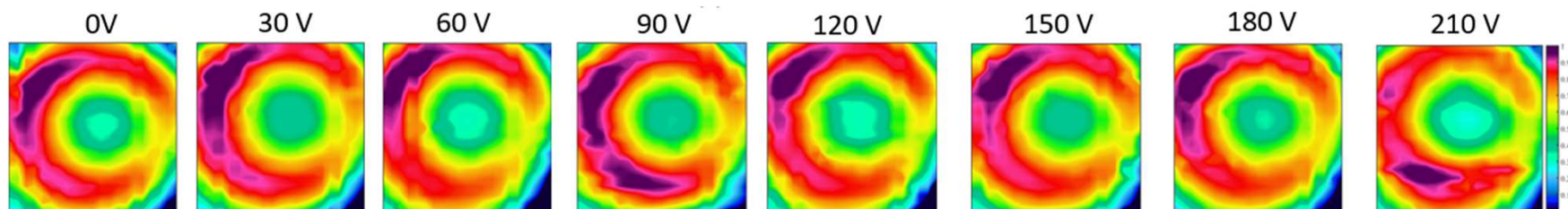
180 nm SiN
400 nm SiO₂
10 nm SiN
on 225 μm PMN-PT

F. Cienzo, G. Ronco, M. Rota
Trotta's lab





SUCCESS STORY – Optimal Bragg cavity



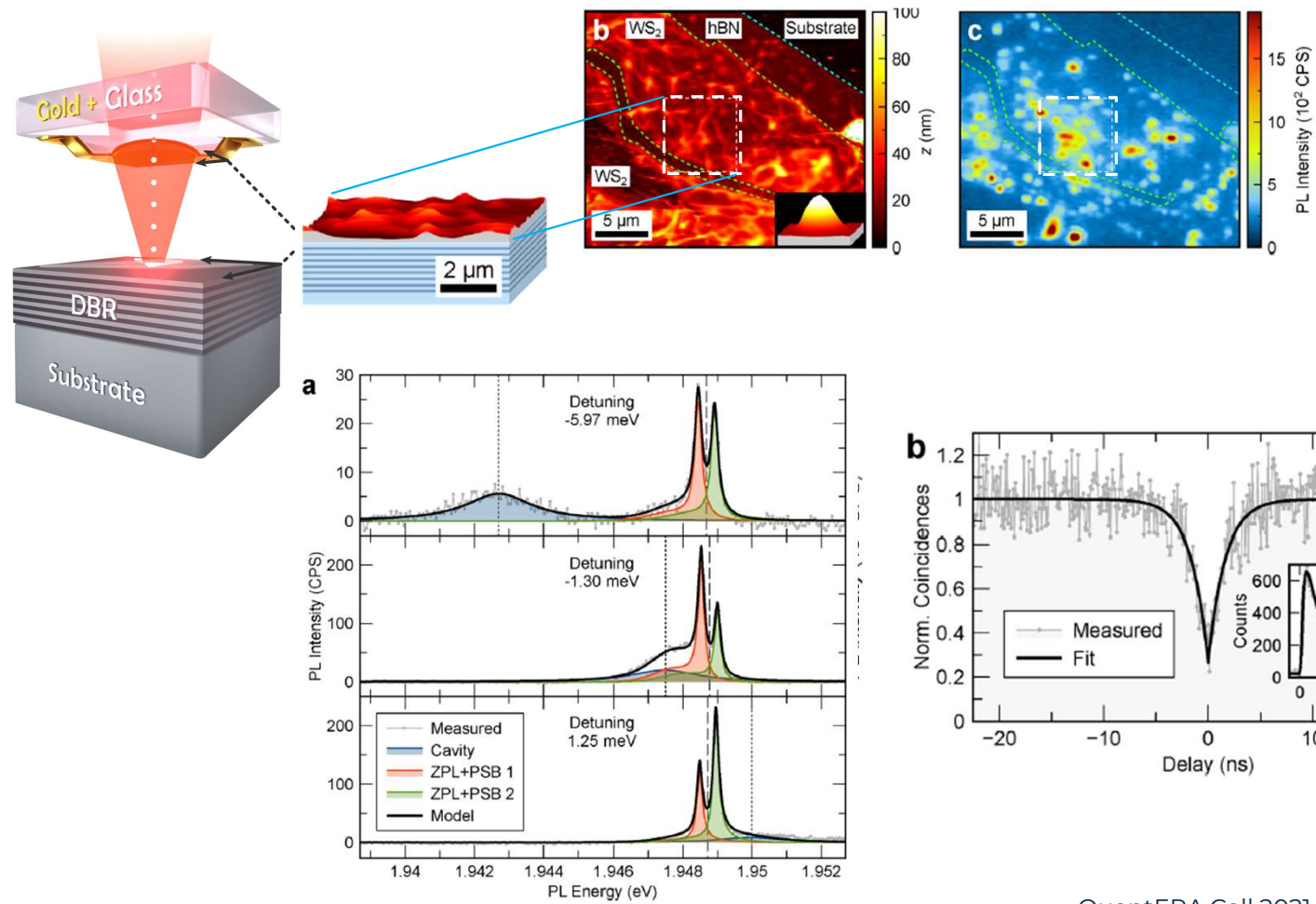
F. Cienzo, G. Ronco, M. Rota
Trotta's lab





SUCCESS STORY – Coupling to open cavity

G.-C. Drawer *et al.*,
Adv. Opt. Mater., Aug. 2026



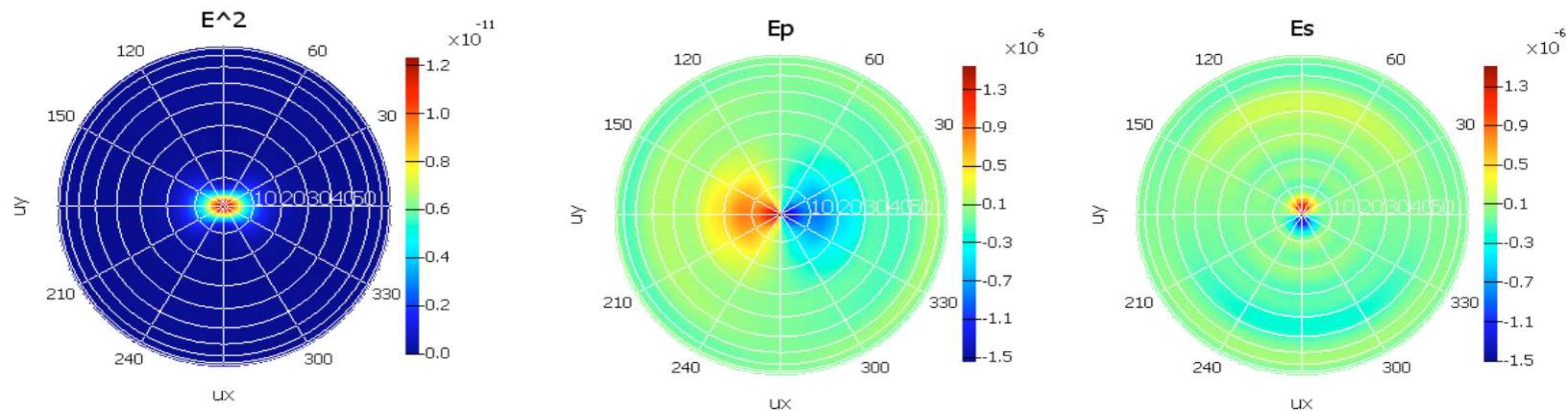
Carl von Ossietzky
Universität
Oldenburg

SAPIENZA
UNIVERSITÀ DI ROMA

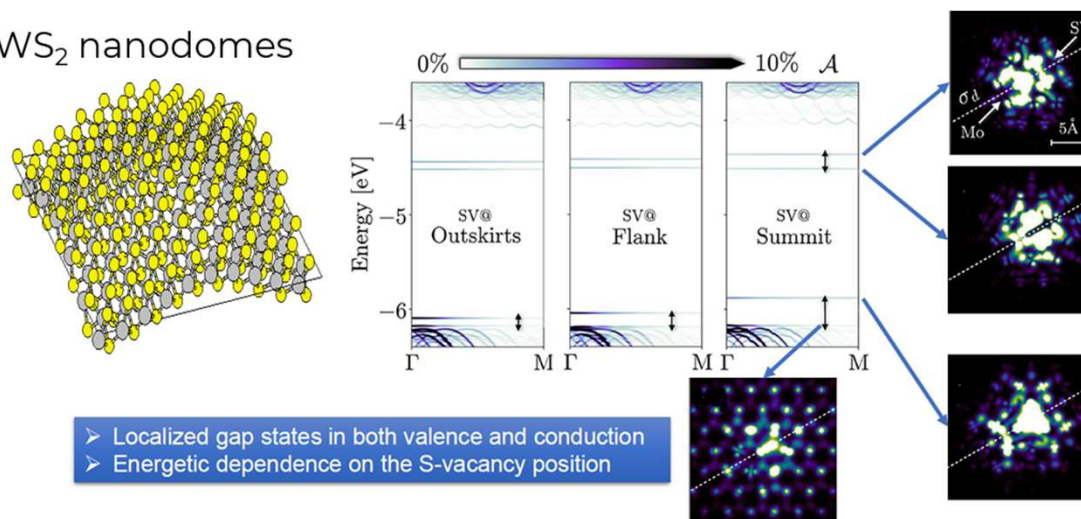
Consiglio Nazionale
delle Ricerche



SUCCESS STORY – Theoretical modelling



WS₂ nanodomes



- Localized gap states in both valence and conduction
- Energetic dependence on the S-vacancy position

J. Krumland *et al.*, ACS Photon. **11**, 586 (2024)





PROJECT SCIENTIFIC OUTPUTS

Number of bachelor, masters and PhD thesis: 8



Number of jobs: 9

Number of papers: 36



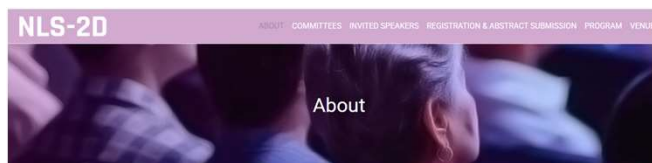
Number of presentations: 44

Number of meetings (multi- and bi-lateral): 27





PROJECT SCIENTIFIC OUTPUTS 2 workshops



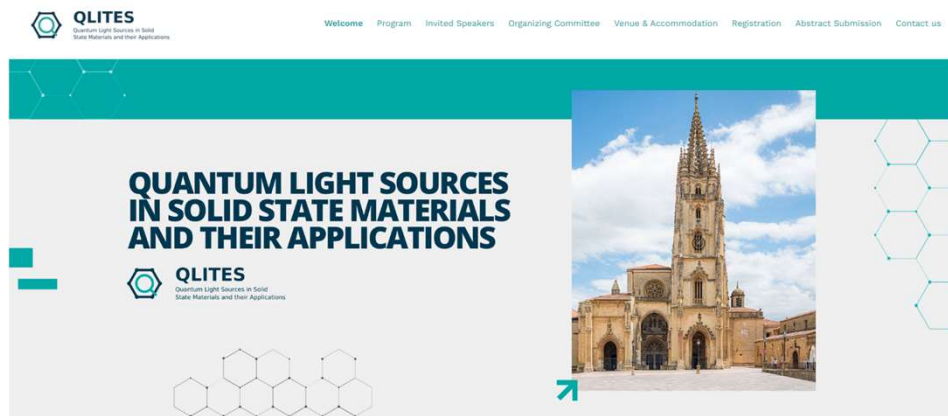
About workshop

The International Workshop on Non-classical Light Sources in 2D Materials and their Applications (NLS-2D) will be held in Wrocław from February 19th to 20th, 2024.

Its purpose is to gather specialists in the field of non-classical light generation using 2D materials with emphasis on fabrication, theoretical modelling, shaping their photonic environment and applications in quantum technologies, in particular quantum communication. The workshop will combine the invited lectures given by experts and short communications of students, PhD students and young scientists.



Wroclaw
19-20 Feb 2024
International Workshop on Non-classical Light Sources in 2D Materials and their Applications (NLS-2D)



In
collaboration
with
QuantERA
project
COMPHORT



Oviedo
9-10 Feb 2026
Quantum Light Sources in Solid State
Materials and their Applications (QLITES)

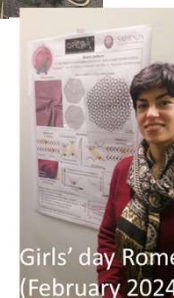
QuantERA Call 2021 Final Evaluation



PROJECT IMPACT

Two components of EQUAISE (UOV and URM) submitted a new QuantERA project that was funded in 2026 (SIMPHONI).

PUBLIC ENGAGEMENT



WHAT'S NEXT

Several experiments are running based on the project's outputs.

The collaboration between many partners is ongoing on other QuantERA and European projects.

EQUAISE was the seed of an EIC-Pathfinder project.

A first feasibility process has been initiated with Nanoplus

THANK YOU

