

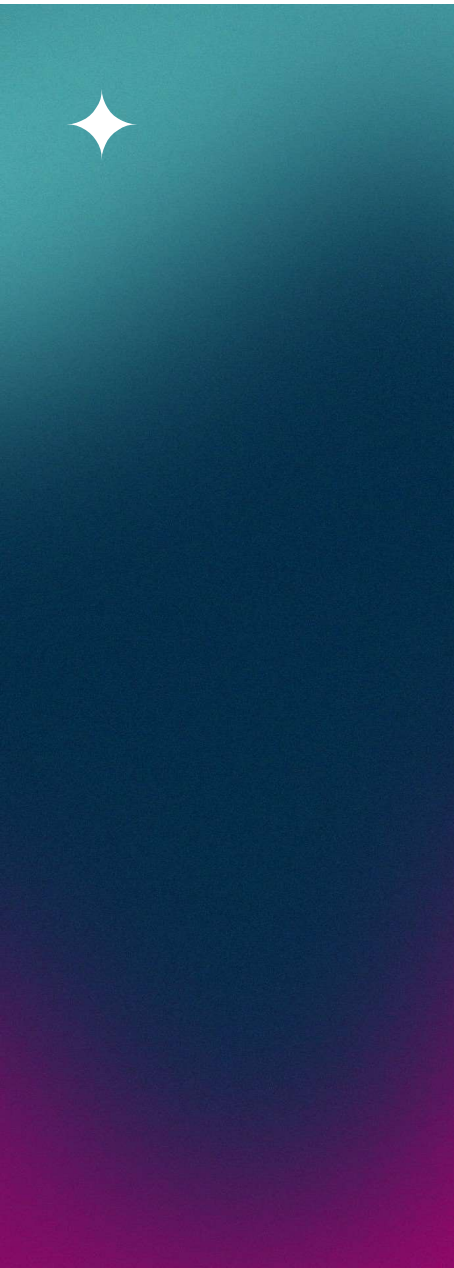
Call 2021
Final Evaluation



MENTA

Accessible Quantifiers of Multipartite
entanglement in Atomic Systems
Chris Westbrook

<https://www.lcf.institutoptique.fr/groupe/gaz-quantiques>



COLLABORATION (overview)



GEOGRAPHICAL BREADTH

Spain, France, Italy, Austria; our German collaborator (Hannover) was obliged to withdraw because of a change in employer.



VARIETY OF SECTORS, DISCIPLINES

experimental atomic physics + quantum information theory



QUALITY OF COOPERATION

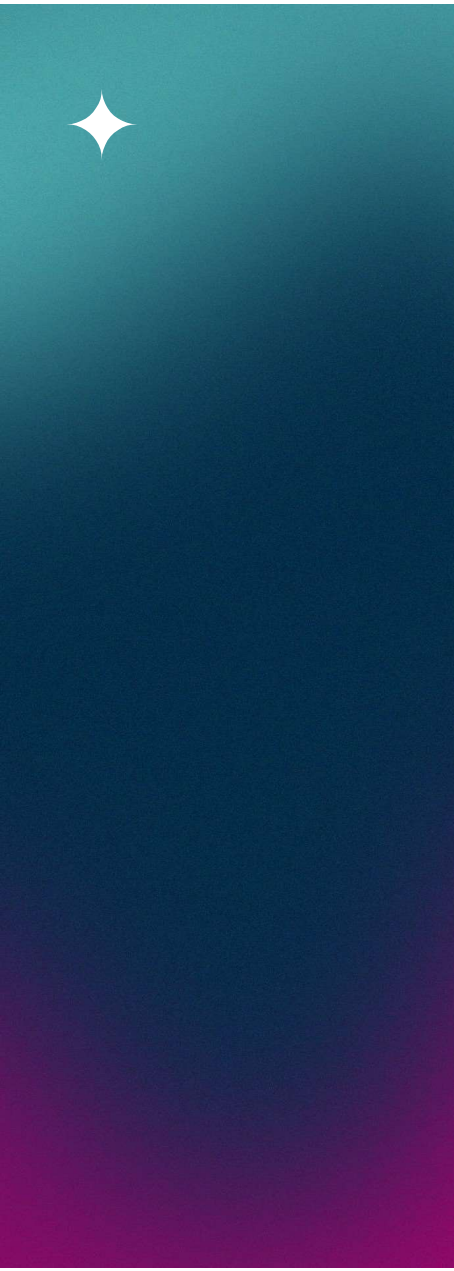
4 (formerly 5) groups with a history of cooperation, many joint publications



INFRASTRUCTURE SHARING

Primarily a sharing of theoretical knowledge for the interpretation of the experiments





SUCCESS STORY (highlights)



CHALLENGE – characterization of multipartite and multiparticle entanglement



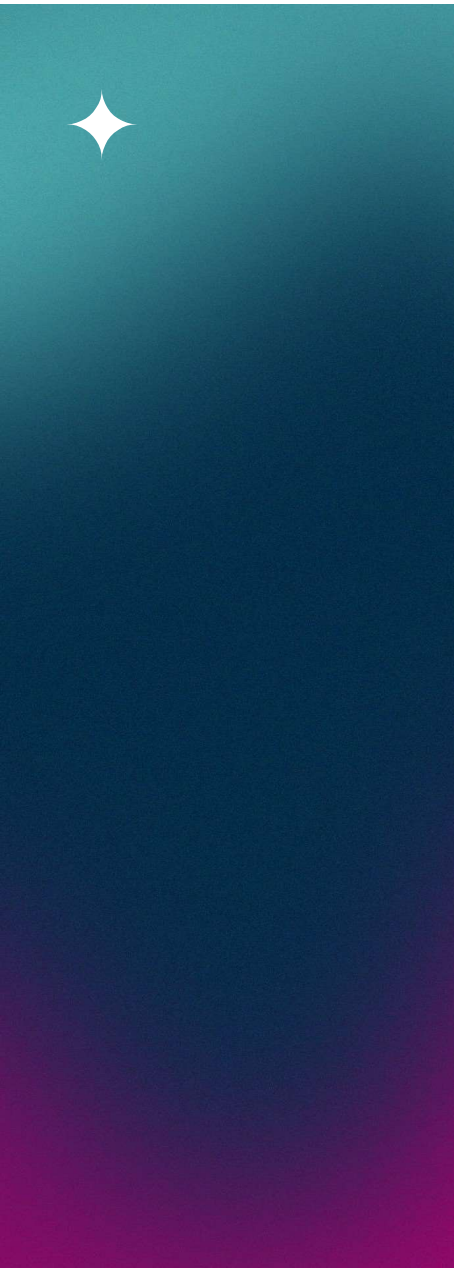
SOLUTION – tabletop experiments and closely coupled theory



PLANNED AND SURPRISING/UNPLANNED OUTCOMES

- Substantial progress in characterizing multipartite entanglement. (e.g. lower bounds on the variance of estimators in quantum metrology, entanglement conditions based on correlation functions, EPR criteria and metrological applications for Dicke states)
- Demonstration of multiparticle, non-classical Hong Ou Mandel interference.
- Unexpected: and application to the simulation of the post-inflationary early universe





SCIENTIFIC OUTPUTS



PUBLICATIONS AND PRESENTATIONS

- Hong-Ou-Mandel interference of more than 10 indistinguishable atoms, Nature Phys, (2026)
- Observation of entanglement in a Cold Atom Analog of Cosmological preheating, Phys. Rev. Lett. 135, 240603 (2025)



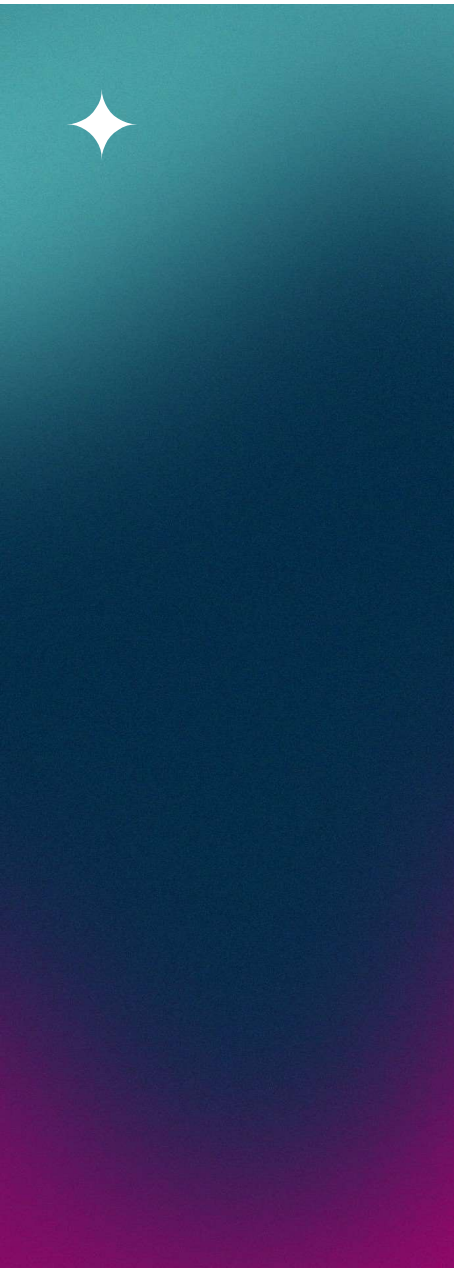
PATENTS none



NUMBER OF BACHELOR, MASTER AND PhD THESES

11 PhDs





IMPACT (potential users)



RELEVANT **INDUSTRY BRANCH**

Inertial sensing



KEY COMMERCIALY RELEVANT **APPLICATIONS**



Quantum enhanced sensing through atom interferometry



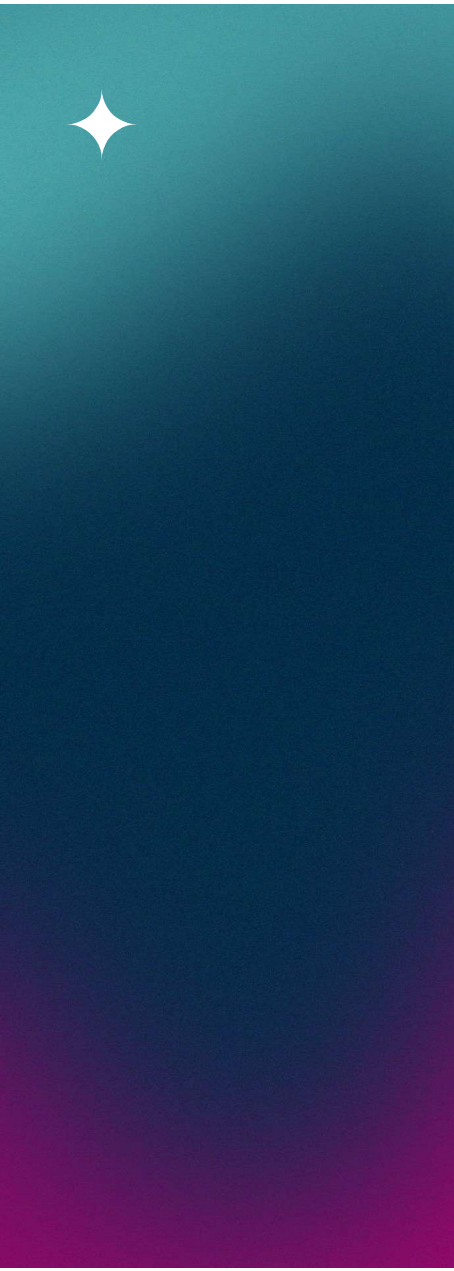
POTENTIAL **END USERS**

Exail, Thales

COOPERATION WITH THE **QUANTUM FLAGSHIP** OR OTHER
QUANTUM INITIATIVES (if applicable)

none





IMPACT (RRI aspects)



GENDER: at least 4 new female PhD students



OPEN SCIENCE: all publications appear in open access journals or at the very least in their final form on arXiv.



SCIENCE EDUCATION: participation in several events aimed at high school students, the Bosch Budapest Innovation

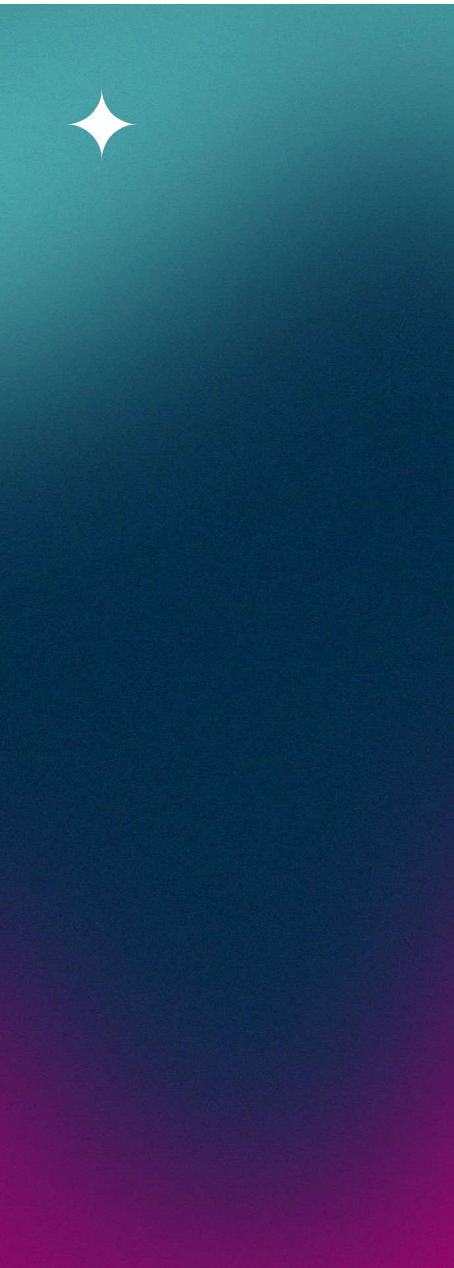


PUBLIC ENGAGEMENT: dialogs with several technology companies: Thales Research and Technology, Lockheed Martin



ETHICS: Evaluations of carbon footprint. Attempts to limit air travel





WHAT'S NEXT

Continuation both with and without members of the consortium

Applications

Attempts to apply these insights to quantum enhanced sensing, in particular interferometers.

The 12 – atom Hong Ou Mandel result has already shown a scaling better than shot noise.

- How far can we push the the particle number?
- Implement this manipulation technique in a real interferometer (so far it has been done in a beam splitter)





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