Towards gravity sensing and tests of fundamental physics with the Hannover Very Long Baseline Atom Interferometer

Étienne Wodey[1], Christian Meiners[1], Dorothee Tell[1], Dennis Schlippert[1], Christian Schubert[1], Wolfgang Ertmer[1], and Ernst Rasel[1]

1. Institut für Quantenoptik, Leibniz Universität Hannover, Welfengarten 1, D-30167 Hannover

Very Long Baseline Atom Interferometry (VLBAI) represents a new class of ground-based devices challenging the scalability of atom interferometry technology to enable high-accuracy inertial sensing and fundamental tests of the interplay between quantum mechanics and gravitation.

By extending the free-fall distance from tens of centimeters to several meters, VLBAIs not only dramatically scale up the sensitivity of the interferometer but also require increased control of systematic biases and noise sources namely coming from stray magnetic fields, vibrations, gravity gradients, and atomic cloud expansion.

In Hannover, we are developing a new VLBAI apparatus featuring three key components on the route to the new state of the art. First, a novel and scalable magnetic shield design allows controlling fields in the nanotesla range along more than 8 m of free-fall distance. Second, a geometric anti-spring based seismic attenuation system fused with auxiliary acceleration sensors paves the way to unprecedented inertial noise rejection. Finally, the implementation of sources of ultracold rubidium and ytterbium atoms enables new interferometer geometries and fine control of the atomic wavepackets.

This contribution discusses the design choices and status of the deployment of the Hannover VLBAI facility as well as foreseen applications in geodesy and tests of fundamental physics.

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