Towards high sensitivity rotation sensing using an atom chip

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A novel generation of compact high sensitivity gyroscopes using guided matter-waves on atom chips is proposed in this work. These devices are designed in order to fulfill the stringent requirements of metrological and inertial navigation applications. In particular, their design will allow the implementation of solutions to overcome the main limitations of free falling atoms interferometers [1]: interrogation time and quantum projection noise. The working principle of this inertial sensor is based on a cloud of cold ^{87}Rb atoms coherently split [2] and constrained to propagate along a circular guide of a few millimeters diameter. At the output of the guide an interference signal sensitive to rotation via the Sagnac effect will be measured. In Fig.1 we show the expected sensitivity of the designed device with a guide radius of 600µm and an interrogation time of 1s.

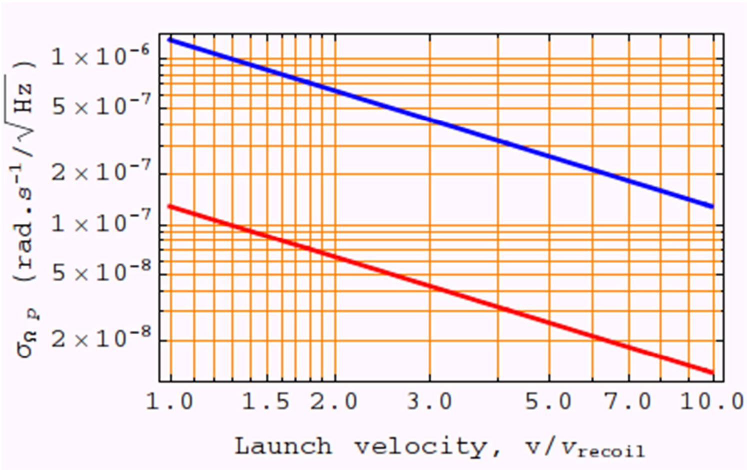

Fig.1 Expected sensitivity at the projection noise limit for 10^4 (blue) and 10^6 (red) atoms.

In this experiment we will explore the implementation of quantum state engineering protocols for the generation of entangled and squeezed atomic states. We expect this strategy will lead to the realization of sub-projection noise limited cold guided atom gyroscopes and to novel applications in Quantum Metrology. This work reports the recent experimental progress towards the realization of this atom chip matter-wave inertial sensor.

References:

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[2] D. Cassettari, B. Hessmo, R. Folman, T. Maier, and J. Schmiedmayer, Phys. Rev. Lett. **85**, 5483 (2000).