# Atom chip based guided atom interferometer for rotation sensing

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In this work, the physical aspects as well as the experimental progress towards the realization of a rotation sensor using cold atoms magnetically guided on an atom chip are presented. The design and derivation of the magnetic guiding potential, the expected sensitivity, and the study of a highly efficient matter-wave beam splitter are in detail analyzed. This device is designed taking into account the stringent requirements of inertial navigation. Besides the usual constraints imposed on the physical dimensions and power consumption for the aforementioned application, we also investigate here the on-chip incorporation of keys elements needed in the realization of a cold atom interferometer. In particular, we discuss different strategies to overcome the fundamental limitations of guided [1] and free falling atom interferometer inertial sensors [2]: wire roughness induced decoherence, cloud fragmentation, interrogation time and quantum projection noise.

The working principle of this inertial sensor is based on a magnetic polarized cloud of cold $^{87}$Rb atoms coherently split by a $\pi/2$ pulse that creates a superposition of two opposite wave-packet propagation modes. Both wave-packets will be constrained to propagate along a circular guide of a few millimeters diameter. At the output of the guide, the application of a second $\pi/2$ pulse produces an interference signal sensitive to rotation via the Sagnac effect, measured as an atom number imbalance. In Fig. 1 we show the expected sensitivity of the designed device for an interrogation time of 1s and different launching velocities. For a typical launching velocity obtained via a Bragg process ($v/v_{\mathrm{recoil}} = 2$), the required guide radius is 500$\mu$m and the reached sensitivity, when using $\sim 10^6$, is $3\times10^{-8}$ rad.s$^{-1}/\sqrt{\mathrm{Hz}}$ or equivalently $6\times10^{-3}$ deg/hr/$\sqrt{\mathrm{Hz}}$). Such a sensitivity is already close to the navigation grade bias stability requirement for a gyroscope which is on the order of $10^{-4}$ deg/hr.

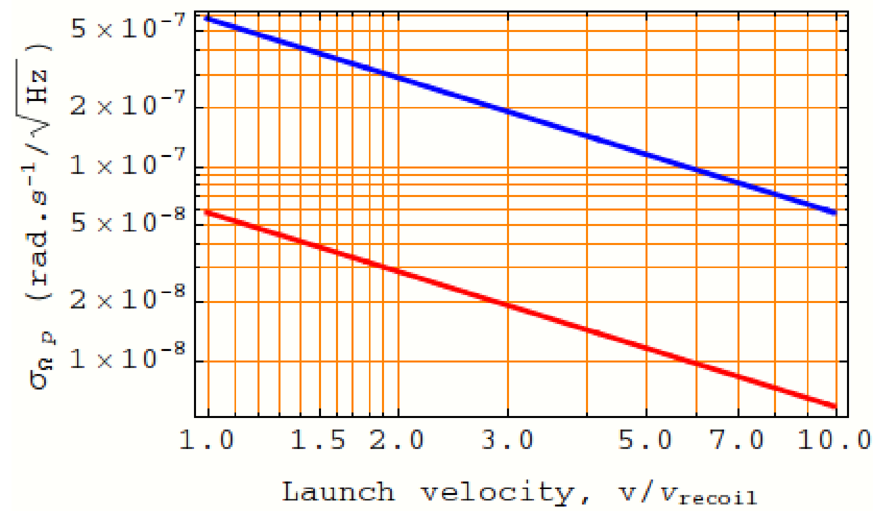


**Figure 1:** *Expected sensitivity at the projection noise limit for $10^4$ (blue) and $10^6$ (red) atoms.*

**References**

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