Evaluation of microwave leakage and magnetic field inhomogeneity in the continuous fountain atomic clock FoCS-2

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In pulsed fountains, the microwave field can be switched off between the two Ramsey interactions in the cavity. On the other hand, the continuous operation of FoCS-2 requires a constant interrogation of the atomic beam with a phase modulated electromagnetic field, which makes it more sensitive to microwave leakage. Thereby, a carefull investigation of microwave leakages originating from both inside and outside the fountain is important to avoid uncontrolled frequency shifts [1]. In-situ electromagnetic measurements were compared with those obtained with a dedicated method using the atoms as a probe while pulsing the microwave field.

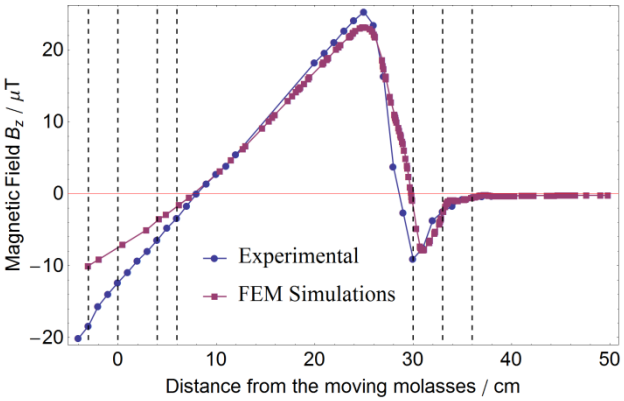

Fig. 1: Comparison between in-situ measurement (with a fluxgate probe) and Comsol simulation of the magnetic field inside the fountain. The seven vertical dotted lines correspond (from left to right) to the detection, moving molasses, optical lattice, state preparation zones and the three cylindrical magnetic shields.

In parallel to this study, the magnetic field inside the fountain was investigated. Its homogeneity is important to guarantee the efficiency of the state preparation and to avoid Majorana transitions. As mentioned in [2], zero-crossing of the field can induce atomic states coherences and frequency shifts. Because field inhomogeneities are located in non-accessible parts of the vacuum chamber, we developed a finite element model of the fountain and computed the magnetic field along the atomic trajectory. A comparison between in-situ fluxgate probe measurements and finite element simulations of the B_z magnetic field along the lower accesible part of the atomic trajectory is shown in Figure 1. This good agreement allows us to predict the behavior of the magnetic field in the whole fountain environnement with good confidence.

The latest results of microwave leakage and magnetic field studies on FoCS-2 will be presented.

[1] S. Weyers and al., "Effects of microwave leakage in caesium clocks: theoretical and experimental results," in *Proc. Eur Time Freq. Forum*, 2006.

[2] R. Wynands and al., "Majorana transitions in an atomic fountain clock" *IEEE Transactions on Instrumentation and Measurement,* vol. 56, no. 2, April 2007.