The Francium trapping facility at TRIUMF

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The heaviest alkali element, Francium (Z = 87), has received much attention in recent years [1]. It possesses a unique combination of structural simplicity due to its single valence *s*-electron and a great sensitivity to effects such as atomic parity non-conservation (APNC) and possible electric dipole moments due to its high nuclear charge. The attractiveness of Fr for APNC experiments has been discussed since the early 1990s in the context of searches for physics beyond the Standard Model [2]. APNC, first observed in the late 1970s, arises from the parity-violating exchange of Z-bosons between electrons and the quarks in the nucleus, leading to a mixing of atomic levels of opposite parity [3]. As a result, otherwise forbidden electric dipole transitions can be excited between states of the same parity. The culmination so far has been a measurement by the Boulder group in ^{133}Cs [4]. APNC scales with the nuclear charge roughly as Z^3, favouring experiments in heavy atoms, but a successful extraction of the weak interaction physics from the measured atomic quantity also requires a detailed understanding of the atomic wave functions. This has limited the interpretation of Tl, Pb, and Bi data. The atomic theory of Fr, on the other hand, can be understood at a level similar to that of Cs (Z = 55), yet the APNC effect is almost 20 times larger. Among the existing and upcoming experiments, APNC is very competitive concerning searches for leptoquarks, compositeness, and extra gauge bosons [5].

The Francium program at TRIUMF was formed to take advantage of the actinide target being developed which will produce copious quantities of Fr. Experiments are planned on hyperfine anomalies, microwave measurements of the nuclear anapole moment, and optical atomic parity violation, all of which require a reliable atom trap setup. The system is being based on our experience with Fr at Stony Brook, with (offline) testing of the magneto-optical trap (MOT) apparatus, shown in Fig. 1, completed at the University of Maryland. The second (“science”) chamber will consist of a second MOT for re-capturing the transferred atoms and an optical dipole trap, preferably blue-detuned to minimize the perturbation on the atoms. The electromagnetic environment will be controlled at the level necessary for precision atomic PNC measurements.

We are currently finalizing the environmentally controlled clean room and expect to install it on the floor of the ISAC facility in the fall of 2010. The lasers are scheduled to be installed in the first half of 2011 and, depending on the availability/capability of TRIUMF to produce Fr beams, we hope to attempt trapping Francium in mid-2011.

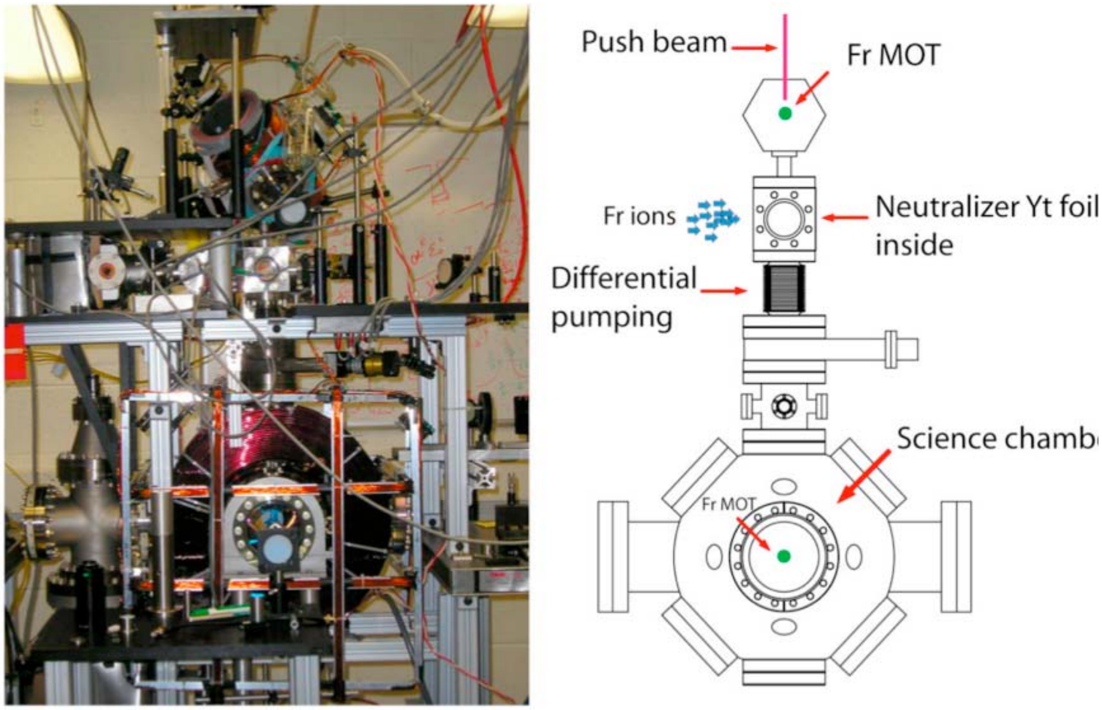

FIG. 1. Picture and schematic diagram of the MOT system at TRIUMF to be used for Fr studies.

[1] E. Gomez *et al.*, Rep. Prog. Phys. **69**, 79 (2006).

[2] W.J. Marciano and J.L. Rosner, Phys. Rev. Lett. **65**, 2963 (1990).

[3] M.A. Bouchiat and C. Bouchiat, J. Phys (Paris) **35**, 899 (1974).

[4] C.S. Wood *et al.*, Science **275**, 1759 (1997).

[5] J. Erler, A. Kurylov, and M.J. Ramsey-Musolf, Phys. Rev. D **68**, 016006 (2003).