

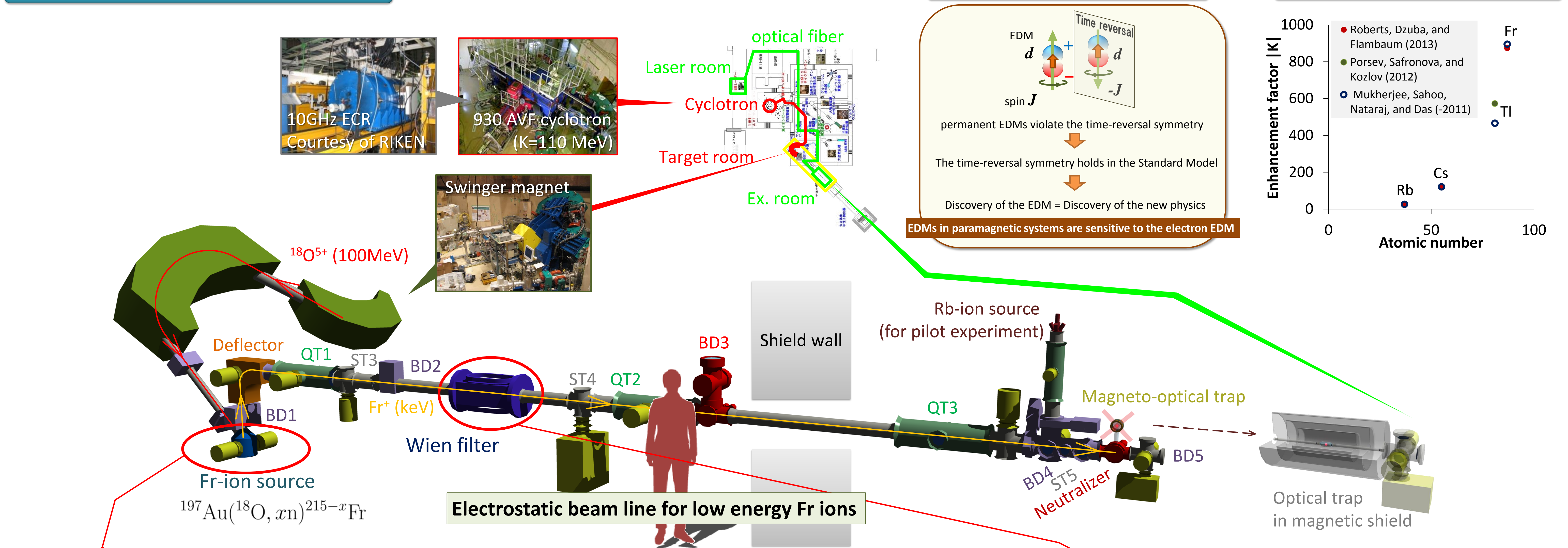
Development of a francium ion source toward a search for the electron EDM

Hirokazu Kawamura^{1,2}, T. Aoki², H. Arikawa², K. Harada², T. Hayamizu², S. Ito²,
 T. Inoue^{1,2}, K. Kato², L. Köhler², K. Sakamoto², A. Uchiyama², and Y. Sakemi²

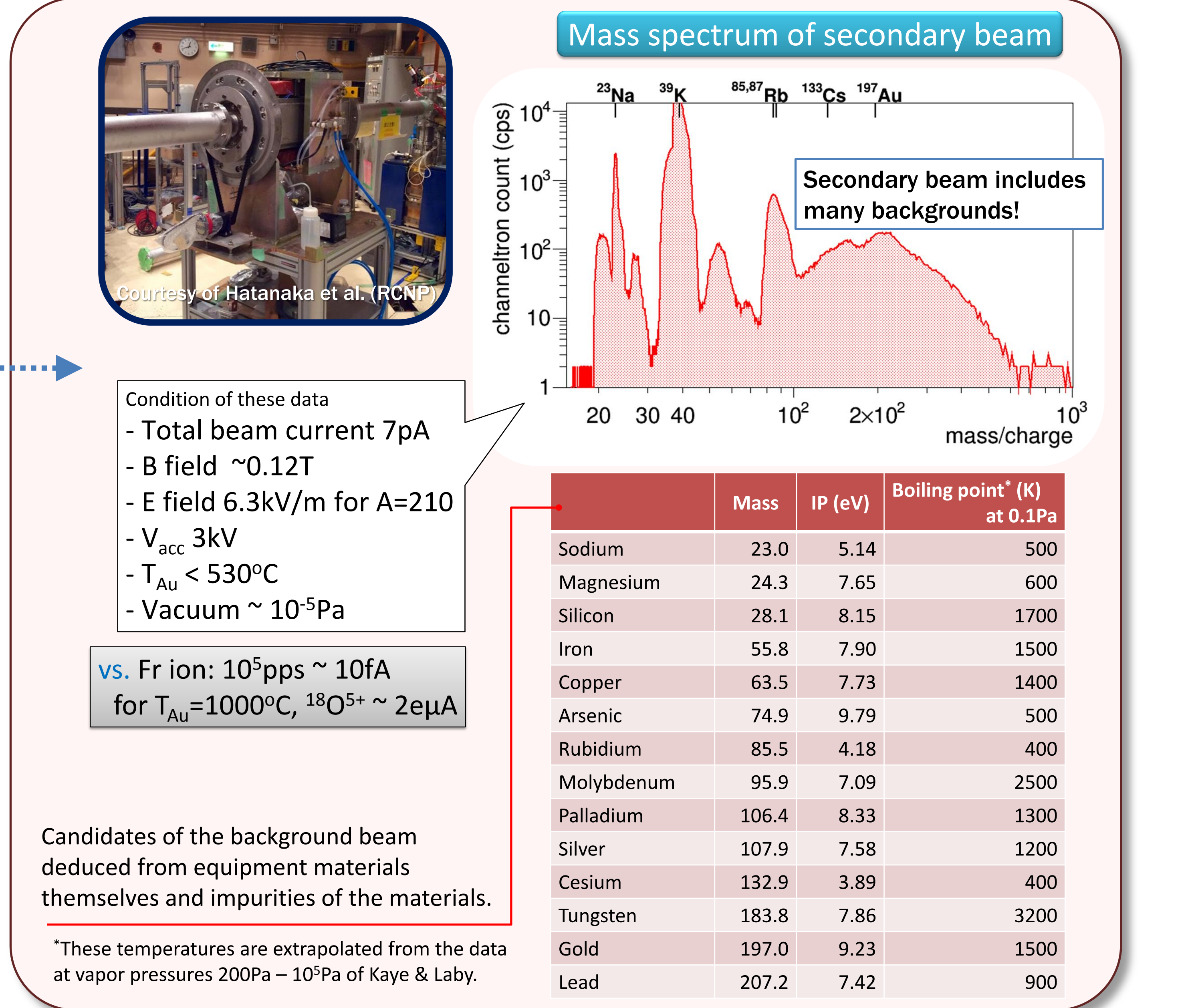
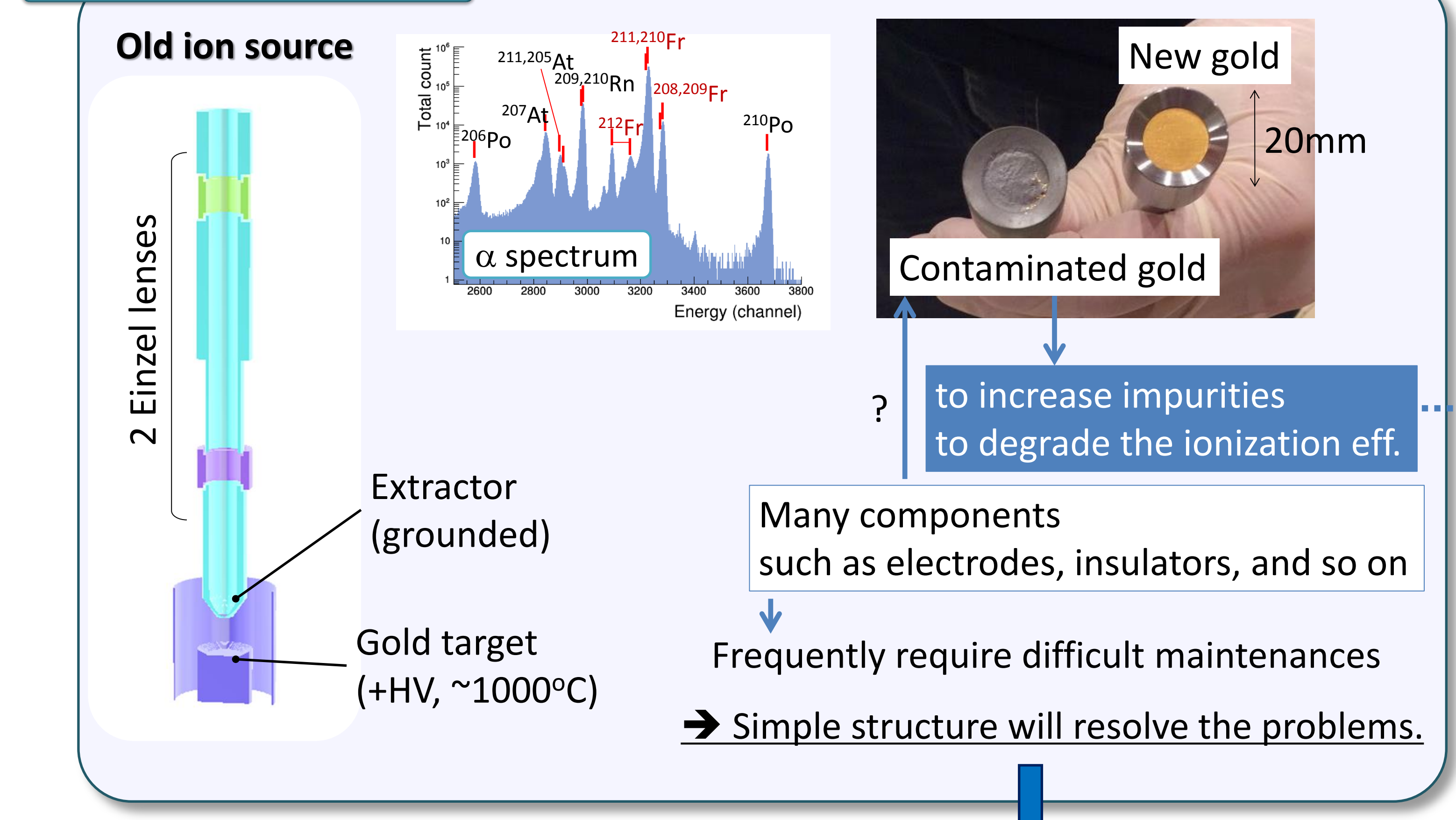
¹FRIS (Frontier Research Institute for Interdisciplinary Sciences), Tohoku University, JAPAN
²CYRIC (Cyclotron and Radioisotope Center), Tohoku University, JAPAN

Francium (Z=87) is the heaviest species among alkali elements. Due to its properties, Fr is said to be of advantage in measurements of a tiny observable, such as the electric dipole moment of the electron. Fr must be produced artificially in order to execute experiments with it because it is one of the most unstable elements. We produce Fr with the nuclear fusion reaction of an oxygen beam and gold target, ionize the produced Fr through a thermal ionization process, and extract the ion with electrostatic fields. However, the thermal ionization process is known to ionize not only an objective atom but also other atomic species. Therefore, a Wien filter was installed to analyze the composition of the ion beam and to purify the beam. This allowed us to improve the beam purity from $\sim 10^{-6}$ to $\sim 10^{-3}$. In order to improve not only the beam purity but also the ion extraction efficiency, we plan to make a new Fr ion source.

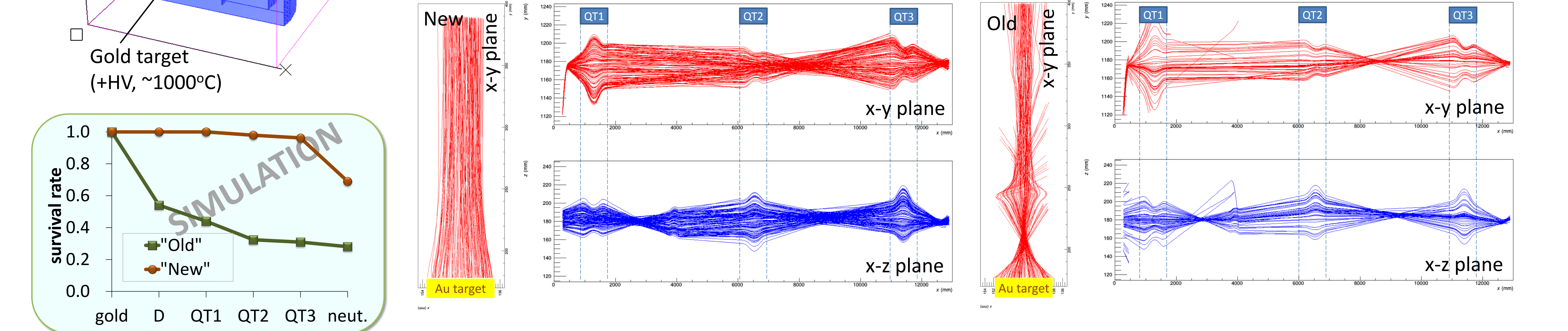
Project of the Fr trapping at CYRIC



Surface ionizer for francium



Typical 120 ion trajectories calculated by SIMION



This work revealed that many impurities are ionized and transported much more than the radioactive isotopes produced by a nuclear fusion reaction in our apparatus. The purity of the ion beam must influence the magneto-optical trapping for two reasons.

- One is the disturbance of the trapping due to atomic collisions between the objective atom and the impurities desorbed from the neutralizing target.
- Another is to degenerate the chemical properties of the neutralizing target surface by the impurity accumulation on the target.
 - The surface neutralization process depends on the work function of a target surface, which is susceptible to a surface condition.

Hereafter, the effect that the purity influences the efficiencies of the neutralization and trapping will be quantitatively estimated, and the resolution of the Wien filter will be improved due to lower emittance beam by redesigning the extraction of the Fr ion source. These improvements must increase the intensity of the cold Fr atoms and finally lead to the improvement of the measurement precision.

8th International Workshop on "Fundamental Physics Using Atoms"
 FPUA2015 - Towards better understanding of our matter universe -
 Nov. 30 – Dec. 1, 2015, RIKEN, Japan