*A variant of S. Rao's GW detection through the change in ~~revolution period~~ **net travel time**, but using a **"low-energy" coasting ion beam without RF** - Can the sensitivity be down to 10^-5 Hz?*

1. The **issue with a coasting (unbunched) beam** is that unless you can time-tag every individual particle, how would you keep time? This is a timing experiment.
    (a) If we can start with a bunched beam and then convert it into a coasting beam, will the bunching be preserved?
    (b) Would it be easier to time-tag the ions if we use a very low-intensity beam?

2. We would require **an external clock with the smallest possible least count**. Modern optical atomic clocks offer a least count of ~ 10^{-19} s. This is needed because the GW signal we are looking for varies between 0. to ~ 10^{-16} s travel time change at max.

3. **Low energy beam** would improve the factor $(1-v_0^2/2c^2)$ on the GW signal.

4. Using **heavy ions** might be useful => they would have lesser thermal noise, quantum uncertainty of time-tagging, and lower energy meaning lower synchrotron radiation emission etc.

5. Next step would be to **complete the list of noise sources**. Either technological solutions to eliminate them; or account for the deterministic noise sources and subtract them from the data and filter out the stochastic noise (filtering benefits from having many data points).

6. ***Can the sensitivity be down to 10^-5 Hz?***
    a. Assuming that you are talking about the inverse of the observation time i.e., how long you can have a stable beam. This would aid in observing mHz GWs.
    b. If you are talking about observing micro-Hz GWs, unfortunately there are no known astrophysical sources.

7. Going down to a few micro-Hz is possible in principle but in reality, a coasting hadron beam would slowly lose energy from rest gas collisions and from the machine impedance. It can be kept on a fixed orbit an energy using a stochastic cooling system, also to maintain a small momentum spread but then such a slow drift may no longer be measurable. The approach proposed by Rao remind me to related concept proposed in the frame of accelerator base EDM measurements on the magic energy.

8. Do consider that **a noisy RF may actually preserve the GW signal** which would be buried within the RF noise and can then be extracted using noise filtering techniques (matched filtering).
    a. RF residual stochastic noise on the bunch arrival time ~ 10^{-12} s.
    b. GW signal ~ 10^{-16} s travel time change at max.
    c. How can a noisy RF cancel out a signal that is 4 orders of magnitude smaller than the noise?