Ion traps use electric and magnetic fields (static and oscillating) to confine single or multiple ions for a variety of purposes. Ions are generally slowed and trapped form low-energy beam lines.

1) **What is the primary physics motivation and experimental capability of the proposed instrument and why is this important for FRIB science?**

The primary physics motivation of trapped ions is to perform high-precision mass measurements on short-lived, rare isotopes. These measurements impact 5 of 17 FRIB science areas

1. Nuclear shell structure
2. The r-process
3. Fundamental interactions
4. The nuclear mass surface
5. The rp-process

2) **What are the unique capabilities of this device that are not available in existing equipment? Is this instrument stand alone or is it to be used (solely or partially) in conjunction with other instruments. Could it be used at NSCL or other laboratories before FRIB?**

It requires low-energy ion beams which are provided by gas stopping systems. The LEBIT facility currently exists at NSCL. Upgrades to the gas stopping station at NSCL, will provide beams to LEBIT, BECOLA, and ReA3, and LEBIT is being moved and reconfigured and will be used at FRIB. Other upgrades….

3) **Describe the instrument in some detail, how does it meet the scientific requirements and what are the (estimated) performance specifications?**

LEBIT consists of an ion beam cooler/buncher, a 9.4 T Penning trap mass spectrometer, and an electrostatic beam transport system and beam diagnostics (Faraday cups, MCP's, beta detectors). A DC beam from the gas stopping station is cooled and bunched via collisions with a He buffer gas before being injected into the Penning trap. Depending on the measurement time in the trap, resolving powers (defined as $\Delta\nu(\mathrm{FWHM})/\nu) > 10^6$ can be achieved. To date, measurements have been made with as few as five ions/hr. Relative mass uncertainties for rare isotopes of $<10^{-8}$ have been achieved. Developments such as the Lorentz steerer reduce ion preparation time, maximizing measurement time in the Penning trap and allow study of shorter lifetime species. Future developments, such as SWIFT for efficient removal of contaminants in the Penning trap and a separate "mini trap" for constant monitoring of the magnetic field, will make future mass measurements more efficient and reduce systematic uncertainties. The design is more or less fixed, although suggestions for improvement are encouraged.

4) **What is the current stage of development of your project ?** LEBIT is fully developed, but is currently being moved and reconfigured. Mass measurements on rare isotopes can resume as soon as the gas stopping stations and associated beam lines have been completed. Upgrades for asymmetry measurements etc.? Superheavies, shorter lifetimes?

5) **What is the approximate cost of the project: discuss possible sources of funding.** The approximate cost for the reconfiguration is about $50,000. The funding for this LEVIT reconfiguration is in place.

6) **Please provide a brief list of collaborators and institutions.** Spokesperson(s) provide contact info. LEBIT Spokesperson: Ryan Ringle, NSCL, ringle@nscl.msu.edu LEBIT/gas cell group collaborators : Michael Block, GSI, Hendrik Schatz, NSCL, Peter Schury, Tsukuba Univ. , Dan Melconian, Texas A&M, Cody Folden III, Texas A&M, Sky Sjue, TRIUMF

7) **Please outline how your collaboration has been developing your project and how you are growing your collaboration** TBA
(We have no meetings, per se. We do have a woefully out of date website, however.)

8) **Did you consider alternative designs? What alternatives were considered? How did you arrive at a final design?** For the reconfiguration we considered using a pulsed drift tube after the buncher to bring the ions down to ground potential, which would avoid having to float all components after the buncher on 60 kV. This was rejected as the stability of the voltage of the pulsed drift tube is sensitive to variations of a few volts. It would also add complications of another injection parameter. The final design, where everything is floated at 60 kV, will be easier to operate during an online experiment.

9) **What existing equipment exists in the US Community that has similar goals and characteristics, even if inferior in performance.** CPT at ANL TITAN at TRIUMF (Canada)