CLAIMS

1. A mass spectrometer comprising:

a vacuum housing defining a vacuum cavity;

an electrode, disposed within the vacuum cavity, to control acceleration of an ion propagating through the vacuum cavity;

an electron multiplier, disposed within the vacuum cavity, to transduce the ion into a plurality of electrons; and

a transconductance amplifier, disposed within the vacuum cavity, to measure the plurality of electrons.

2. The mass spectrometer of claim 1, wherein the electron multiplier comprises a plurality of dynodes.

3. The mass spectrometer of claim 2, wherein the plurality of dynodes comprises a first dynode configured to generate the plurality of electrons when struck by an ion.

4. The mass spectrometer of claim 3, wherein the plurality of dynodes comprises a second dynode configured to double a number of electrons in the plurality of electrons.

5. The mass spectrometer of claim 2, further comprising:

a power supply;

an electrical feedthrough connecting the mass spectrometer to the power supply; and

a voltage converter configured to transform the power supply to direct current.

6. The mass spectrometer of claim 2, wherein the plurality of dynodes comprises at least five dynodes.

7. The mass spectrometer of claim 2, wherein the plurality of dynodes comprises at least ten dynodes.

8. The mass spectrometer of claim 1, wherein the electron multiplier is configured to increase a signal-to-noise ratio of the mass spectrometer by a factor of at least 16.

9. A method of mass spectrometry, the method comprising:

providing a vacuum housing defining a vacuum cavity;

controlling acceleration of an ion propagating through the vacuum cavity with a vacuum housing;

transducing the ion into a plurality of electrons using an electron multiplier disposed within the vacuum cavity; and

measuring the plurality of electrons using a transconductance amplifier disposed within the vacuum cavity.

10. The method of mass spectrometry of claim 9, wherein the electron multiplier comprises a plurality of dynodes.

11. The method of mass spectrometry of claim 10, wherein transducing the ion into the plurality of electrodes comprises striking a first dynode in the plurality of dynodes with the ion, the first dynode generating the plurality of electrons in response to being struck by the ion.

12. The method of mass spectrometry of claim 11, wherein transducing the ion into the plurality of electrodes further comprises doubling a number of electrons in the plurality of electrons with a second dynode in the plurality of dynodes.

13. The method of mass spectrometry of claim 10, further comprising:

providing a power supply;

connecting the mass spectrometer to the power supply using an electrical feedthrough; and

transforming the power supply to direct current using a voltage converter.

14. The method of mass spectrometry of claim 10, wherein the plurality of dynodes comprises at least five dynodes.

15. The method of mass spectrometry of claim 10, wherein the plurality of dynodes comprises at least ten dynodes.

16. The method of mass spectrometry of claim 9, wherein transducing the ion into the plurality of electrodes increases a signal-to-noise ratio of the mass spectrometer by a factor of at least 16.

17. A mass spectrometer comprising:

a vacuum housing defining a vacuum cavity;

an electrode, disposed within the vacuum cavity and configured to be charged to an electrode potential, to control acceleration of a charged particle propagating through the vacuum cavity;

a controller, disposed within the vacuum cavity and in electrical communication with the electrode, to modulate the electrode potential at the electrode; and

a processor, operably coupled to the controller, to process digital controller signals used to modulate the electrode potential so as to increase a signal-to-noise ratio of the mass spectrometer.

18. A mass spectrometer, comprising:

a vacuum housing defining a vacuum cavity in which a pressure of about 10^{-5} mm Hg or less is maintained;

an electrode, disposed within the vacuum cavity and configured to be charged to an electrode potential, to control acceleration of a charged particle propagating through the vacuum cavity;

a digital controller, disposed within the vacuum cavity and in electrical communication with the electrode, to control the electrode potential at the electrode.

19. A mass spectrometer comprising:

a vacuum housing defining a vacuum cavity to support a vacuum of about 10^{-5} mm Hg or less;

an electrode, disposed within the vacuum cavity and configured to be charged to an electrode potential, to control acceleration of a charged particle propagating through the vacuum cavity;

a conversion circuit, disposed within the vacuum cavity, to convert an input voltage from a power source outside the vacuum cavity so as to provide the electrode potential for the electrode; and

a feedthrough having a dielectric strength of less than or equal to about 36 V to provide an electrical connection between the conversion circuit and the power source.

20. A mass spectrometer comprising:

a vacuum housing defining a vacuum cavity;

a magnet in a magnetic yoke that defines at least one gap, to generate a magnetic field having a first strength in a first region within the at least one gap and a second strength in a second region within the at least one gap;

an ion pump, positioned so as to be in the first region within the at least one gap, to maintain a vacuum pressure of the vacuum cavity;

a mass analyzer, positioned so as to be in the second region within the at least one gap, to determine a mass of an ionized analyte particle propagating through the vacuum cavity;

a control electrode, disposed within the vacuum cavity, to control acceleration of an electron that ionizes the analyte particle;

a conversion circuit, disposed within the vacuum cavity, to provide a converted voltage to the ion pump, the control electrode, and/or the mass analyzer; and

control electronics disposed within the vacuum cavity and operably coupled to the conversion circuit to vary a potential of the control electrode.