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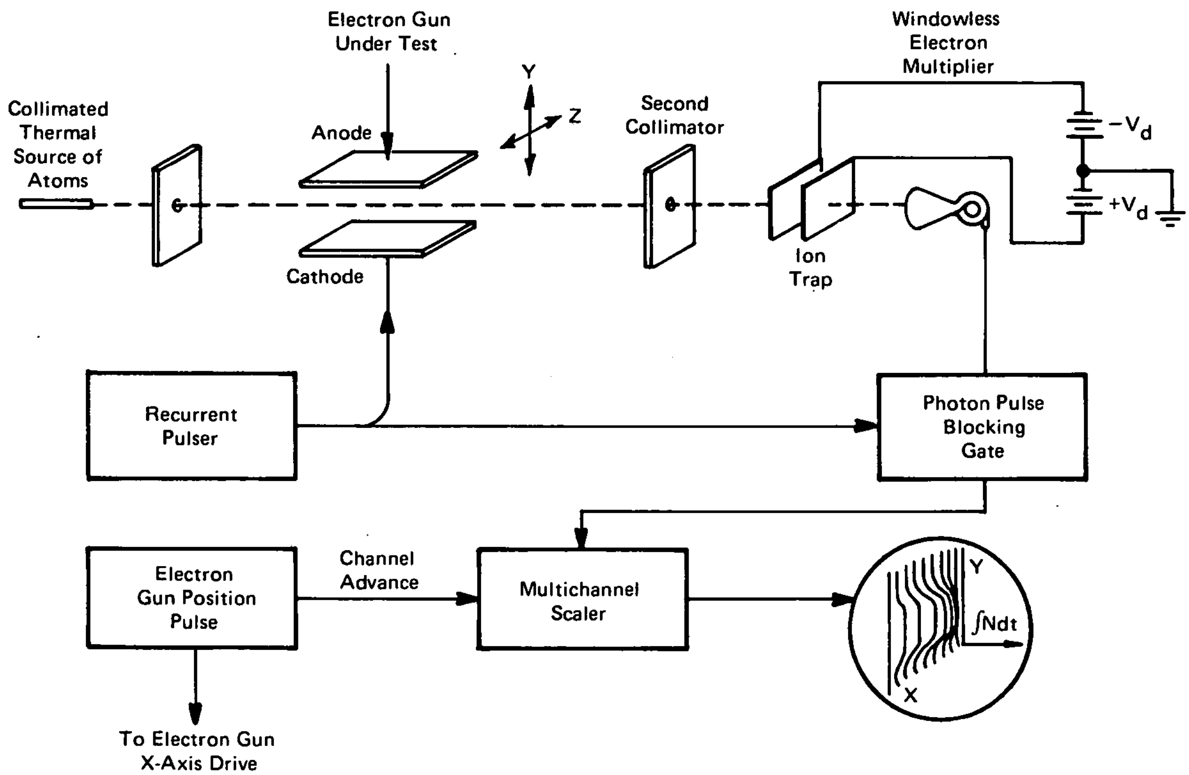
NASA TECH BRIEF
Marshall Space Flight Center

Metastable Atom Probe For Measuring Electron Beam Density Profiles



A metastable atom probe was developed which can measure current density in an electron beam as a function of two arbitrary coordinates, with a spatial resolution better than 0.5 mm. The probe shows the effects of space charge, magnetic fields, and other factors which influence electron current density, but it operates with such low beam densities that the introduced perturbation is very small.

The principles of the metastable atom probe are shown in the illustration. A rarefied, finely collimated beam of ground state argon atoms passes through the electron beam. A small fraction, e.g., one in a million, of the atoms will interact with the electrons. The atoms that undergo elastic collisions are ionized, or are excited to short lived excited states and are of no direct concern. Primary interest lies in those atoms that are excited to electrically neutral, metastable states. These metastable atoms, which change speed and direction only slightly as a result of the electron impact, proceed with their characteristic thermal velocity to a distant, windowless electron multiplier where they are rapidly and efficiently detected.

(continued overleaf)

The rate at which the argon atoms are excited depends directly on the electron current density in the portion of the electron beam through which the argon atoms pass. Thus, a spatial map of current density within the electron beam can be obtained by measuring the rate of production of metastable atoms as the argon beam is directed through different regions of the electron beam.

The resolution of the present instrument is sufficient to show significant changes in electron beam densities over separations as small as 0.5 mm. This spatial resolution can be improved by collimating the beam more finely and by taking steps to minimize the spread of the beam caused by recoil from electron impact.

Notes:

1. Information concerning this innovation may be useful in designing electron guns and electron beam devices.
2. Requests for further information may be directed to:

   Technology Utilization Officer
   Marshall Space Flight Center
   Code A&TS-TU
   Huntsville, Alabama 35812
   Reference: B72-10485

Patent status:

No patent action is contemplated by NASA.

Source: J. M. Lockhart and J. C. Zorn of
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