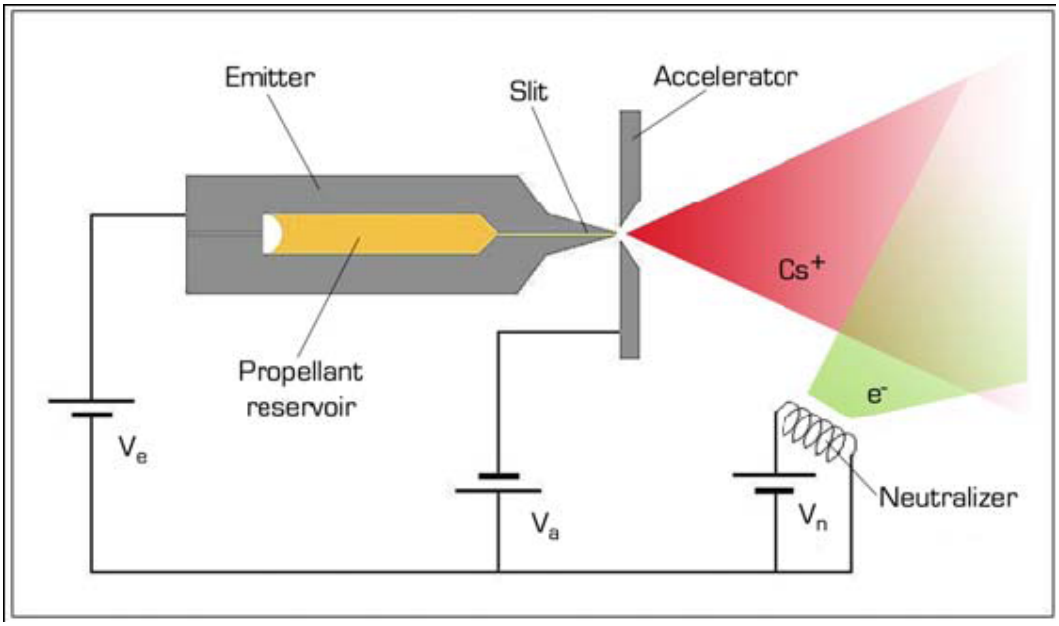
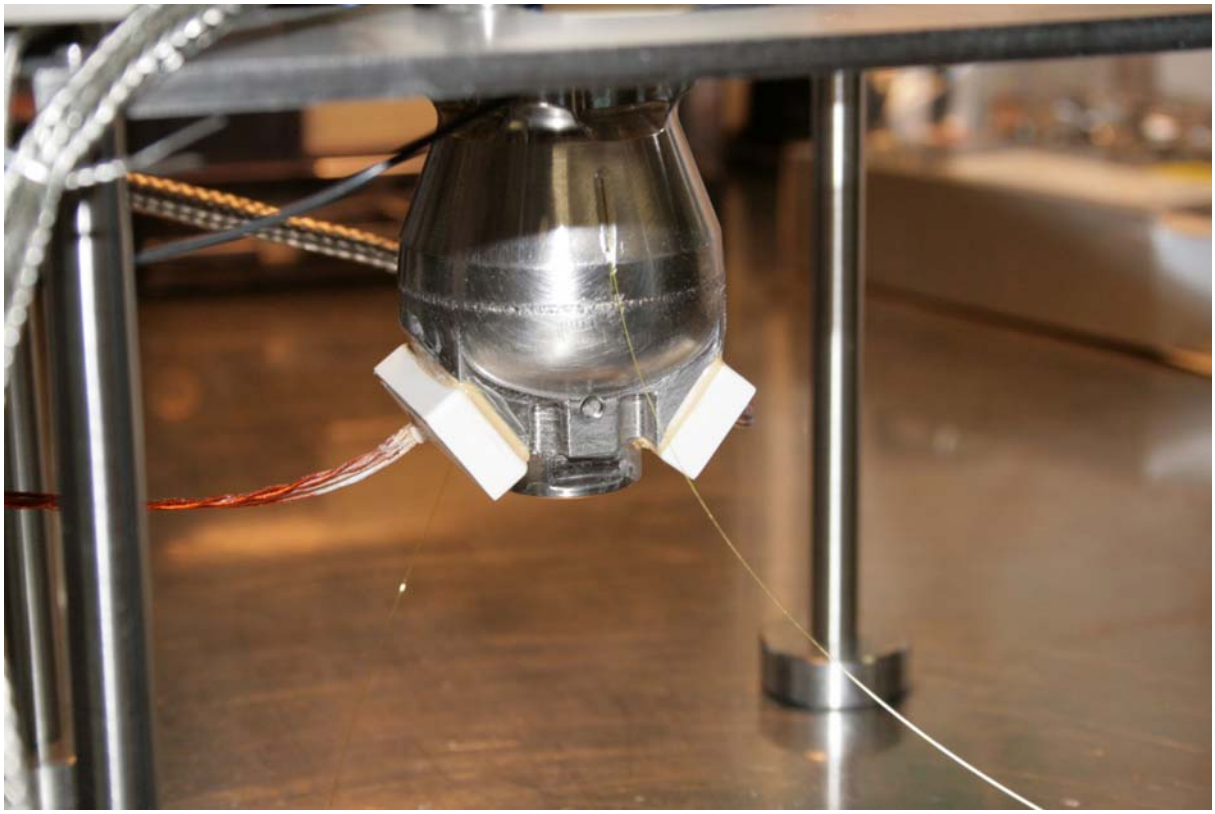
Opsens strain gauges are used to monitor thermal dilatation of the propellant tank of our FEEP (Field Emission Electric Propulsion) thruster.
Field Emission Electric Propulsion (FEEP) is an electrostatic propulsion concept based on field ionization of a liquid metal and subsequent acceleration of the ions by a strong electric field.
FEEP is currently the object of great interest in the scientific community, due to its unique features: sub-μN to mN thrust range, near instantaneous switch on/switch off capability, and high-resolution throttleability, which enables accurate thrust modulation in both continuous and pulsed modes. Presently baselined for several scientific missions onboard drag-free satellites, this propulsion system has been also proposed for attitude control and orbit maintenance on commercial small satellites and constellations.
This type of thruster can accelerate a large number of different liquid metals or alloys. The best performance (in terms of thrust efficiency and power-to-thrust ratio) can be obtained using high atomic weight alkali metals, such as Cesium and Rubidium (133 amu for Cs, 85.5 amu for Rb). These propellants have a low ionization potential (3.87 eV for Cs and 4.16 eV for Rb), low melting point (28.7 oC for Cs and 38.9 °C for Rb) and very good wetting capabilities. These features lead to low power losses due to ionization and heating and the capability to use capillary forces for feeding purposes (i.e. no pressurised tanks nor valves are required). Moreover, alkali metals have the lowest attitude to form ionized droplets or multiply-charged ions, thus leading to the best attainable mass efficiency. The actual thrust is produced by exhausting a beam of mainly singly-ionized Cesium or Rubidium atoms, produced by field evaporation at the tip of the *emitter*.



FEEP thruster concept

An accelerating electrode (*accelerator*) is placed directly in front of the emitter. This electrode consists of a metal (usually stainless steel) plate where two sharp blades are machined. When thrust is required, a strong electric field is generated by the application of a high voltage difference between the emitter and the accelerator. Under this condition, the free surface of the liquid metal enters a regime of local instability, due to the combined effects of the electrostatic force and the surface tension. A series of protruding cusps, or "Taylor cones" are thus created. When the electric field reaches a value in the order of 10^9 V/m, the atoms at the tip of the cusps spontaneously ionize and an ion jet is extracted by the electric field, while the electrons are rejected in the bulk of the liquid. An external source of electrons (*neutralizer*) provides negative charges to maintain global electrical neutrality of the thruster assembly.
Alta is currently developing a FEEP thruster assembly using cesium as propellant; this propellant is contained into a tank that, during thruster operation, has to be supplied with high voltage (up to 10 kV). For this reason it was decided to use strain sensors based on the fiber optic technology to monitor its dilatation while tank is heated.



Opsens strain gauges bonded to the propellant tank