Tiny space engine to push back against sunshine

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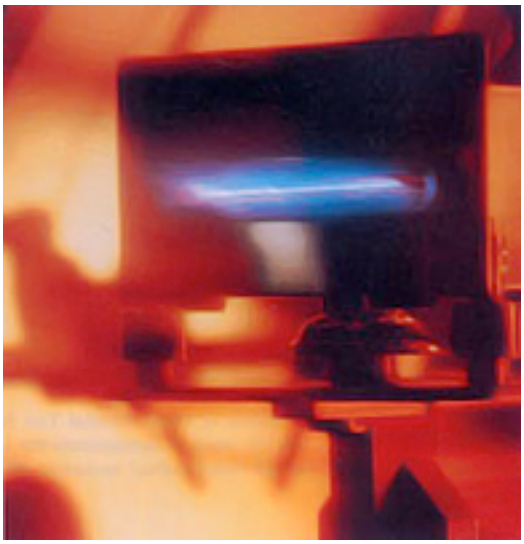
Eu-ro-pe-an Space Agen-cy re-search-ers are pre-par-ing to test what they de-scribe as the small-est, yet most pre-cisely con-trol-la-ble en-gine ev-er built for space. It's de-signed to be sen-si-tive enough to coun-ter-act the force of sun-shine.



Intense ion beams gen-er-ated by FEEP thrust-ers (cour-tesy ESA)

Meas-ur-ing 10 cen-time-tres (4 inches) across and mak-ing a faint blue glow as it runs, the Field Emis-si-on Elec-tric Pro-pul-si-on, or FEEP, en-gine pro-duces an av-er-age thrust equiv-a-lent to the force of one fall-ing hair. But its thrust range and con-trol-la-bil-ity are far su-pe-ri-or to more pot-ent thrusters, hold-ing the key to fu-ture suc-cess of an am-bi-tious mis-si-on of the agen-cy, re-search-ers de-clare.

"Most pro-pul-si-on sys-tems are em-ployed to get a ve-hi-cle from A to B," ex-plained Da-vide Ni-col-ini of the agen-cy's Sci-en-tif-ic Pro-jects De-part-ment, in charge of the en-gine re-search. But with this one, "the aim is to main-tain a space-craft in a fixed po-si-ti-on, com-pen-sat-ing for even the ti-ni-est forc-es per-turb-ing it, to an ac-cu-ra-cy that no oth-er en-gine de-sign can match."

Watch-ing how ob-jects be-have when sep-a-rat-ed from all out-side in-flu-ences is a long-time am-bi-ti-on of phys-i-cists, but it can't be done with-in Earth's gra-vity field. So a next-decade mis-si-on called La-ser In-ter-fer-om-eter Space An-ten-na, or LI-SA, Path-find-er is to fly 1.5 mil-li-on km (900,000 miles) to a place called La-grange Point 1. The-re, the Sun and Earth's gra-vi-ties can-cel each oth-er out, so that the be-hav-iour of a pair of free-float-ing test ob-jects can be pre-cisely mon-i-tored.

But to de-tach the ex-pe-ri-ment fully from the rest of the Uni-verse there will still be some re-main-ing per-turba-tions to over-come, most no-tably the slight but con-tin-u-ous pres-sure of sun-light it-self. That's where FEEP comes in. It op-er-ates on a bas-ic prin-ci-ple fol-lowed by oth-er so-called ion en-gines: the ap-plica-tion of an elec-tric field serves to ac-cel-er-ate elec-tric-ally-charged atoms, pro-duc-ing thrust.

But FEEP's per-for-mance is meas-ured us-ing un-its called mi-cronew-tons, which are one-thousandth the size of of the al-ready small un-its used for oth-er ion en-gines. The en-gine has a thrust range of 0.1—150 mi-cro-new-tons, with a resoluti-on ca-pa-bil-ity bet-ter than 0.1 mi-cronew-tons and a time re-sponse of one-fifth of a sec-ond or less, ac-cord-ing to proj-ect en-gineers.

The en-gine em-ploys the liq-uid met-al cae-si-um as pro-pel-lant. Through cap-il-lary acti-on—a phe-nom-e-non as-so-ci-at-ed with sur-face tensi-on—cae-si-um flows be-tween a pair of met-al sur-faces that end in a razor-sharp slit. The cae-si-um stays at the mouth of the slit un-til an elec-tric field is gener-ated. This causes

ti-ny cones to form in the liq-uid met-al which have charged atoms shoot-ing from their tips to cre-ate thrust.

Twelve thrusters would be mount-ed on the hull of LI-SA Path-find-er. Work-ing to-geth-er with a sep-a-rate NASA-de-signed pro-pul-si-on sys-tem, the thrusters should yield directi-onal con-trol at least 100 times more ac-cu-rate than any space-craft be-fore it—down to a mil-li-onth of a mil-li-me-tre, proj-ect en-gineers as-sert.

“We are over-see-ing the work here be-cause we have pre-vi-ous knowl-edge of FEEP tech-nol-o-gy,” said Pierre-Etienne Frigot of ESA’s Pro-pul-si-on Lab-o-r-a-to-ry.

LI-SA in-volves three satel-lites up to five mil-li-on km (three mil-li-on miles) apart and linked by lasers, or-bit-ing the Sun. The aim is to de-tect rip-ples in space and time known as gravita-tional waves, pre-dicted by Ein-stein’s spec-ta-cu-larly suc-cess-ful the-o-ry of gen-er-al rel-a-ti-vity but so far un-de-tected. The waves would cause ti-ny varia-tions in the dis-tance meas-ured be-tween the satel-lites.

Once prov-en, the FEEP tech-nol-o-gy has been ear-marked for a broad range of oth-er mis-si-ons, in-clud-ing precisi-on forma-tion fly-ing for as-tron-o-my, Earth ob-serva-tion and drag-free satel-lites for map-ping varia-tions in Earth’s gra-vity.

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