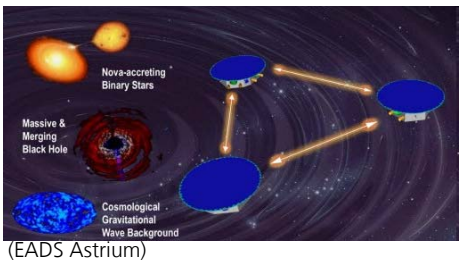
A Quantum Yield Measurement Setup for the Charge Compensation for the LISA Pathfinder Space Mission

Institute of Technical Thermodynamics

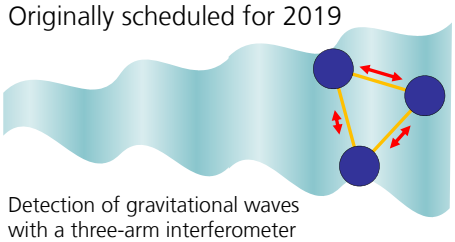
I. Biswas, M. Schulze
Deutsches Zentrum für Luft- und Raumfahrt, Pfaffenwaldring 38-40, 70569 Stuttgart
G. Hechenblaikner, T. Ziegler, N. Brandt, P. Bergner
Astrium Satellites GmbH, 88039 Friedrichshafen
F. Erfurth, M. Pfeil
TWT GmbH Science & Innovation, Ernsthaldenstraße 17, 70569 Stuttgart

Laser Interferometer Space Antenna LISA



(EADS Astrium)

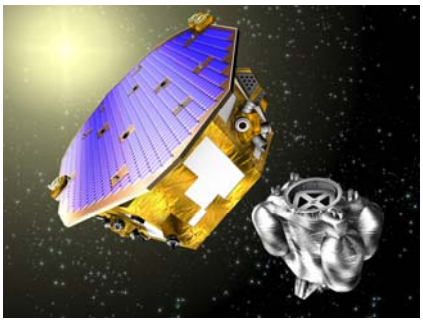
Goal: *Direct* proof for gravitational waves by laser interferometer consisting of three satellites
Heliocentric orbit, triangle of $5 \cdot 10^9$ m
Originally scheduled for 2019


Detection of gravitational waves with a three-arm interferometer

Evolved Laser Interferometer Space Antenna eLISA

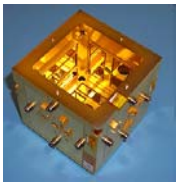
ESA project with reduced dimensions
Triangle of $1 \cdot 10^9$ m
Scheduled for 2034

LISA Pathfinder


Goal: Preliminary experiments with reduced precision on one satellite - Proof of feasibility and identification of upcoming challenges

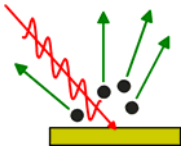
Minimally invasive discharge in space

Free floating test mass for interferometric distance measurement


(EADS Astrium)

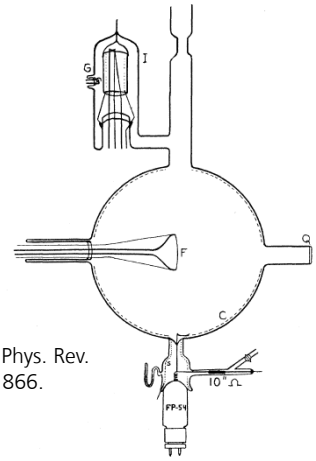
Cosmic radiation
→ uncontrolled charging
→ force between test bodies
→ need for discharge
without mechanical contact

Photoelectrical emission of electrons



Photoemission quantum yield of surfaces

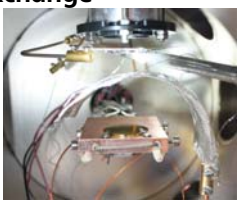
Total photoelectron yield:
Energy of incoming photon vs. work function of irradiated surface

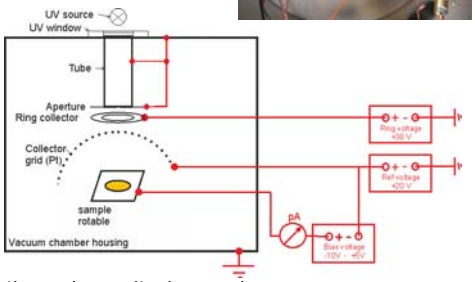

W. Roehr, Phys. Rev. 44 (1933) 866.

1933 glass vacuum chamber for measurement of total photoelectron yield with ideal spherical geometry: Sample permanently fused into setup!

Quantum yield measurement setup for quick sample exchange

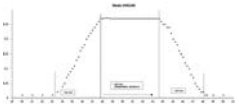
Cylindrical geometry
UHV technology
<1x10^{-7} mbar in 12 h
Bake-out possible



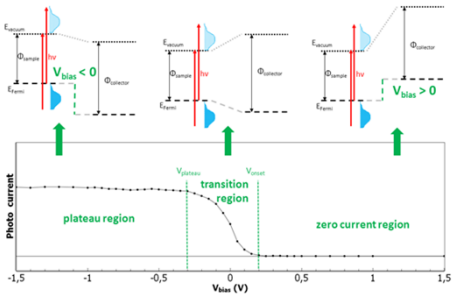


Filtered Hg discharge lamp: 253 nm
3.8 µW, homogeneous intensity profile

Diode response current (IRD UVG-100) over relative position of Hg lamp spot



Ring collector for transient electrons
Cylindrical Pt grid collects emitted electrons → Emission current as function of bias voltage



Typical energy distribution profile

Measured energy distributions of various surfaces, with contaminations and satellite suitable annealing procedures, are used for modelling and design of the discharge setup.[1,2]

[1]G. Hechenblaikner et al., Energy distribution and quantum yield for photoemission from air-contaminated gold surfaces under ultraviolet illumination close to the threshold, J. Appl. Phys. 111 (2012) 124914.
[2]T. Ziegler et al., Modeling and Performance of Contact-free Discharge Systems for Space Inertial Sensors, IEEE Transaction in Aerospace and Electronic Systems, accepted; arXiv:1207.0394

Knowledge for Tomorrow

Wissen für Morgen

DLR Deutsches Zentrum für Luft- und Raumfahrt
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