Proposal for the realization of Santilli's comparative test on the gravity of electrons and positrons via a horizontal supercooled vacuum tube

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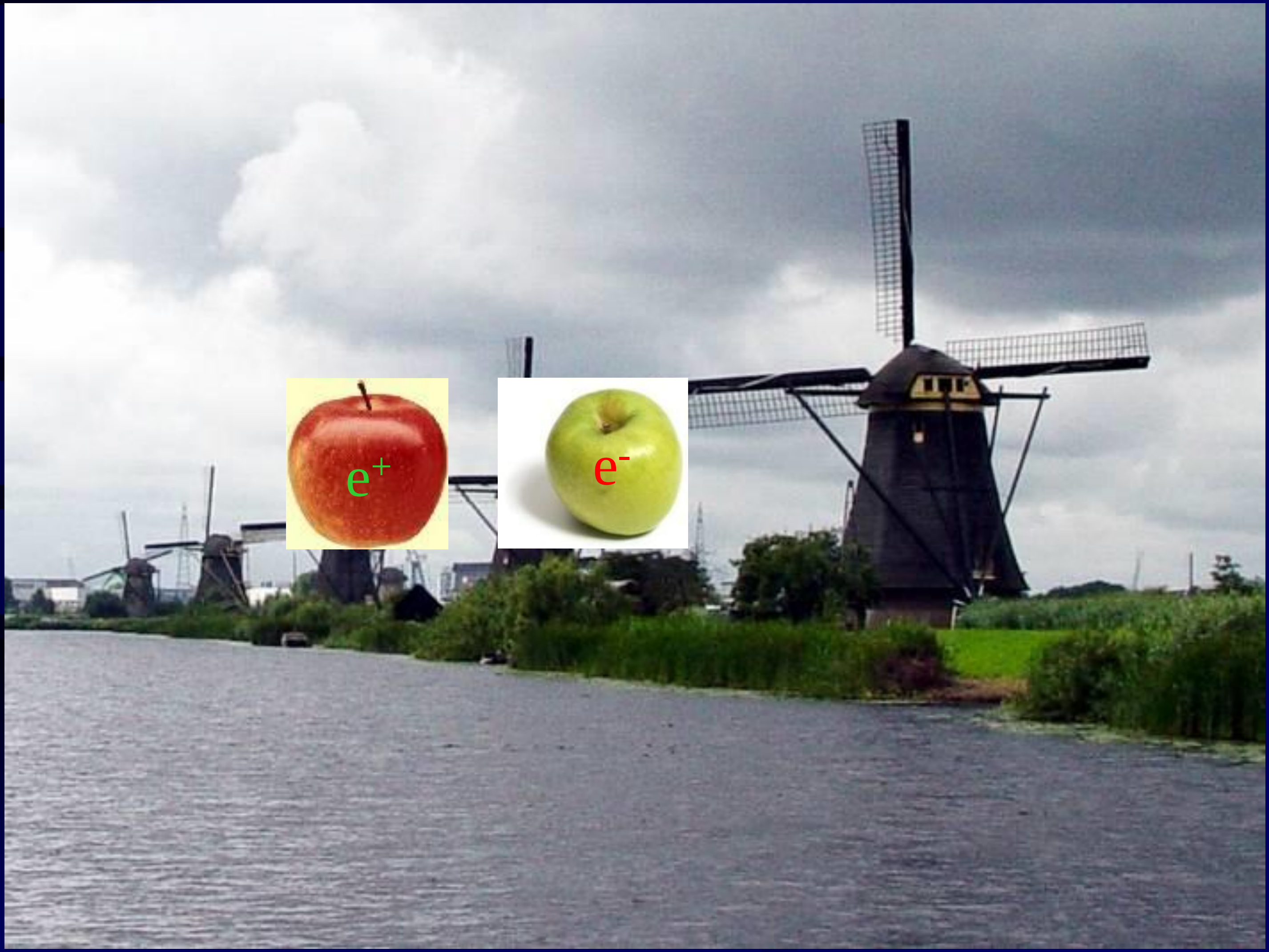
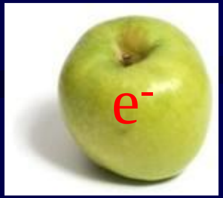
Introduction



History

electron



- Experimental detection: J. J. Thomson (1897)

- Mass: $+9.10938215(45)\times10^{-31}$ kg
- Electric charge: $-1.602176487(40)\times10^{-19}$ C

- Magnetic moment: $-1.00115965218111\ \mu B$

(A. H. Compton 1917, G.E. Uhlenbeck S. Goudsmit 1926)

- Weight: ?

History

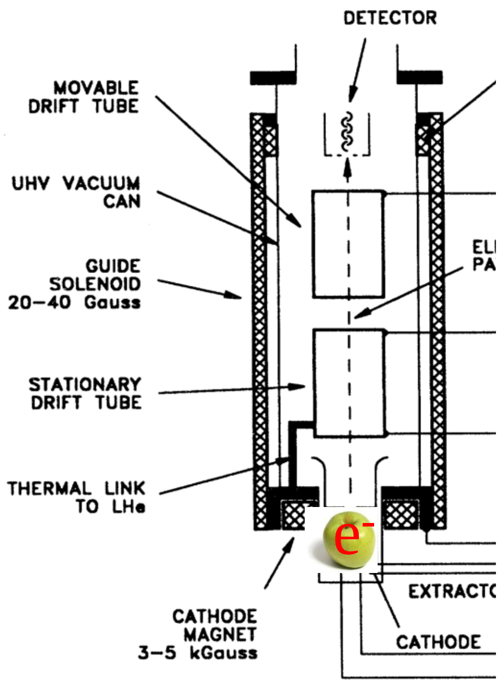
positron

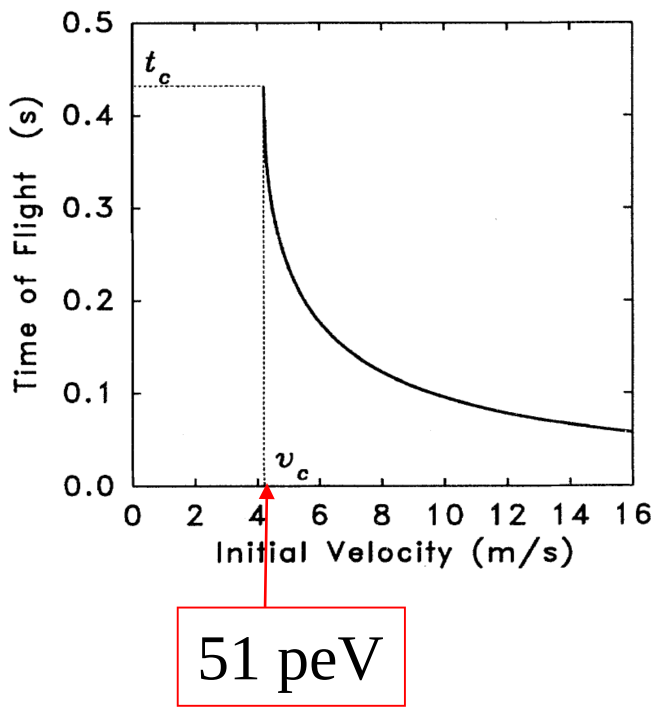
- Experimental detection: C. D. Anderson (1932)
- Mass / Charge *): $+5.685629(1)\ 10^{-12}$ kg/C
- Weight: ?

*) Mass and charge separately can only be determined from theoretical derived results from experiments on composed particles.

History

Witteborn-Fairbank (1967)

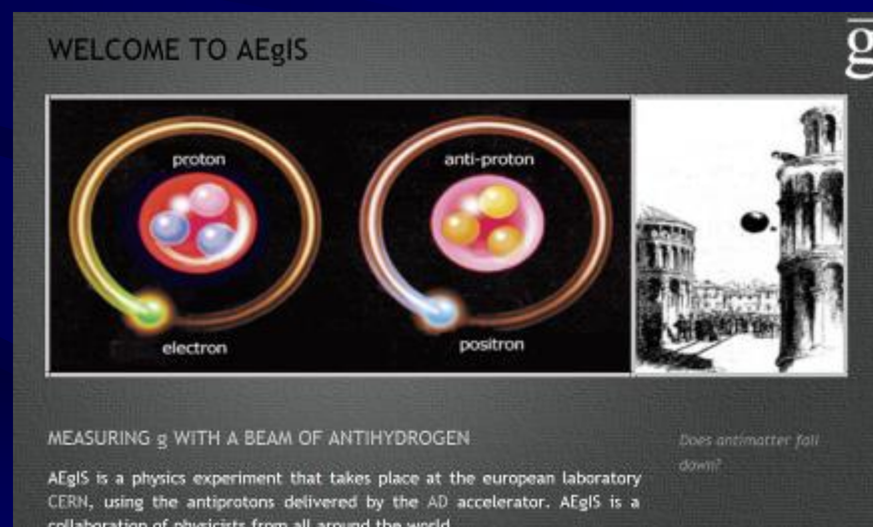




History

LEAR / PS200 (anti-proton) (1982 – 1996)

Current at Cern



Current:

Athena, CERN (anti-hydrogen)
AEGIS, CERN (anti-hydrogen interferometer)
AGE, Fermilab (anti-hydrogen)

Current efforts for anti-gravity focus on neutral anti-matter

Current efforts for anti-gravity focus on neutral anti-matter

Reasons for *not* using anti protons / positrons:

- electrical forces by
  - Surface potential patches
  - Shift of the electrons in the tube due to gravitational forces
  - Leaking in at the end of the tube
  - Possible off-axis movement of the particle
- forces due to magnetic fields
- scattering on residual gas atoms
- the low yield of μeV positrons
- questionable usefulness of its precision (1%–0.1%)

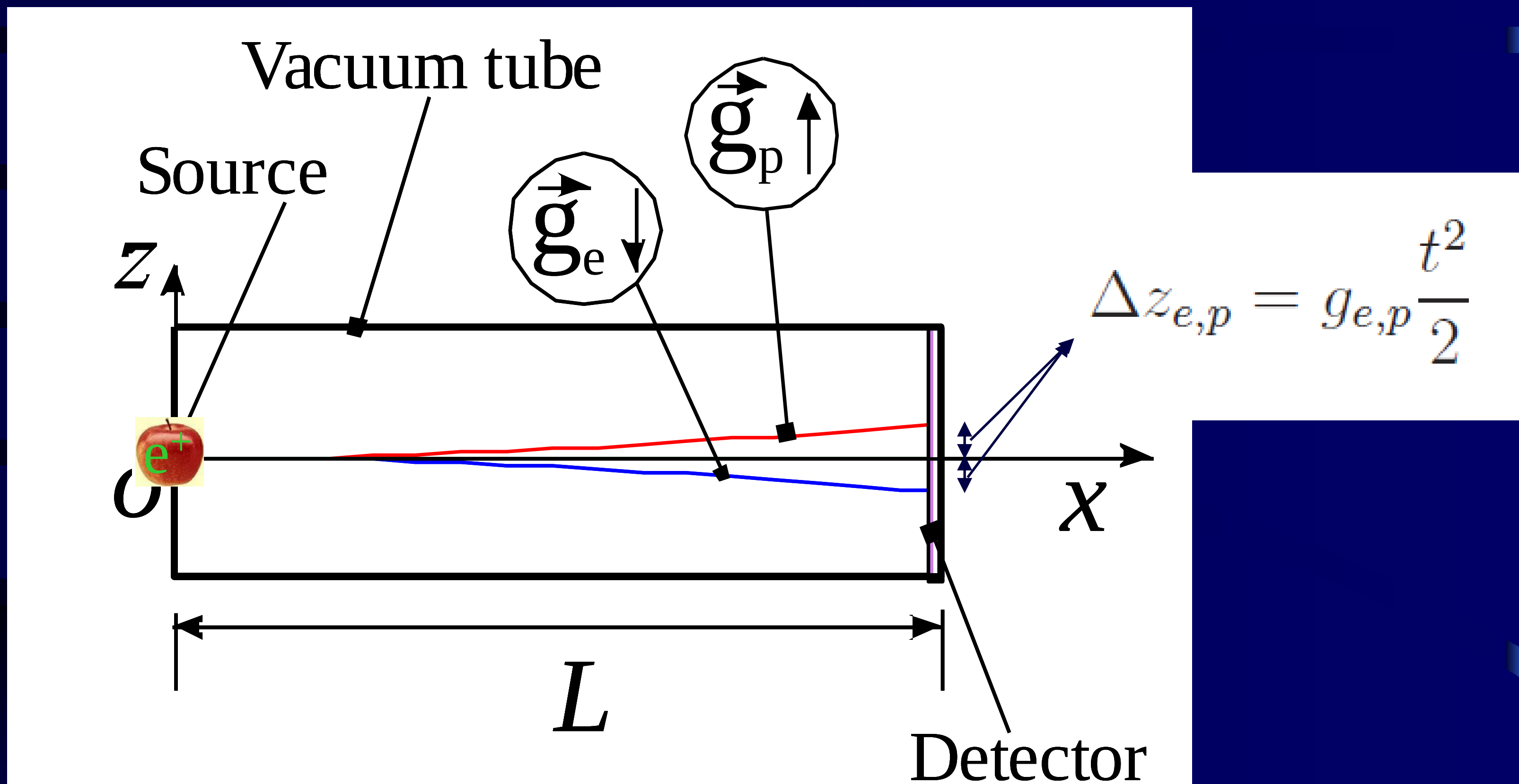
Current efforts for anti-gravity focus on neutral anti-matter

What about electron / positron anti-gravity?

Most objections can be overcome by using a

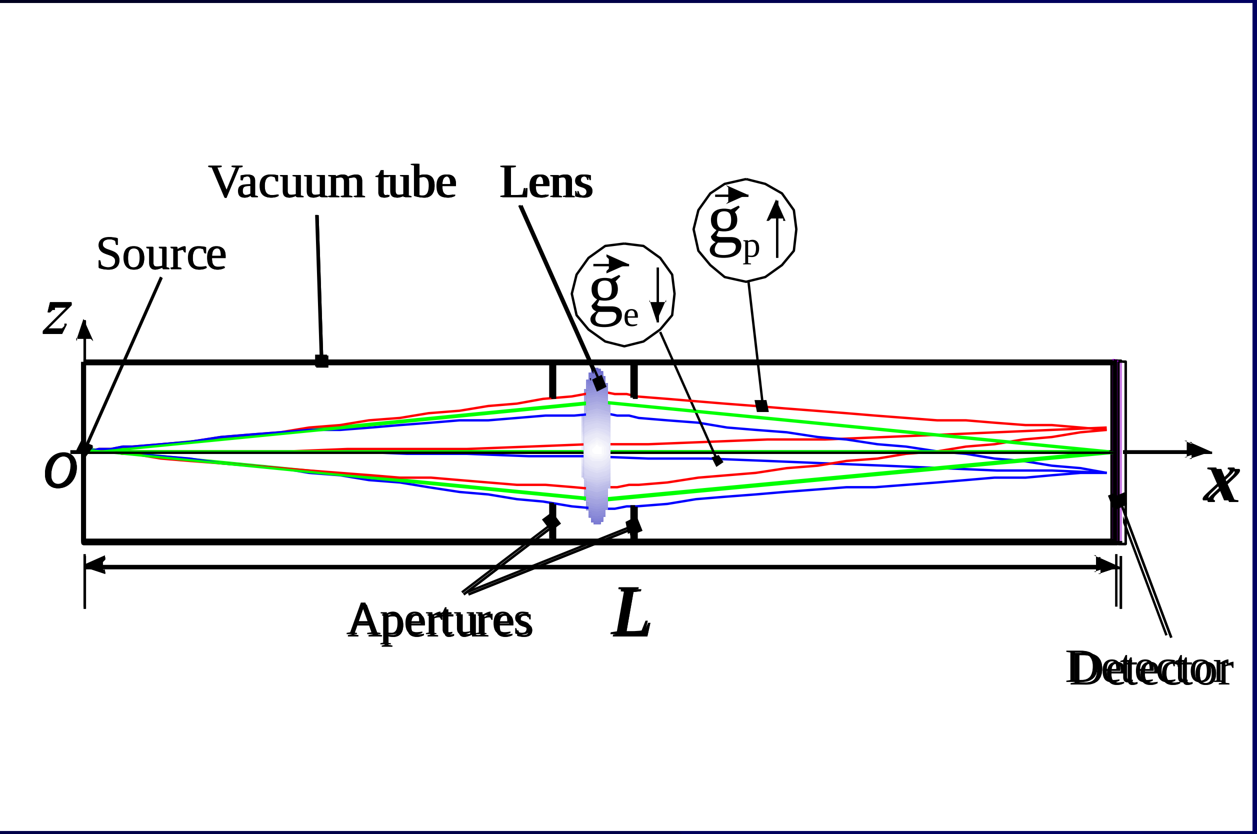
horizontal
well shielded
flight path

Principle:

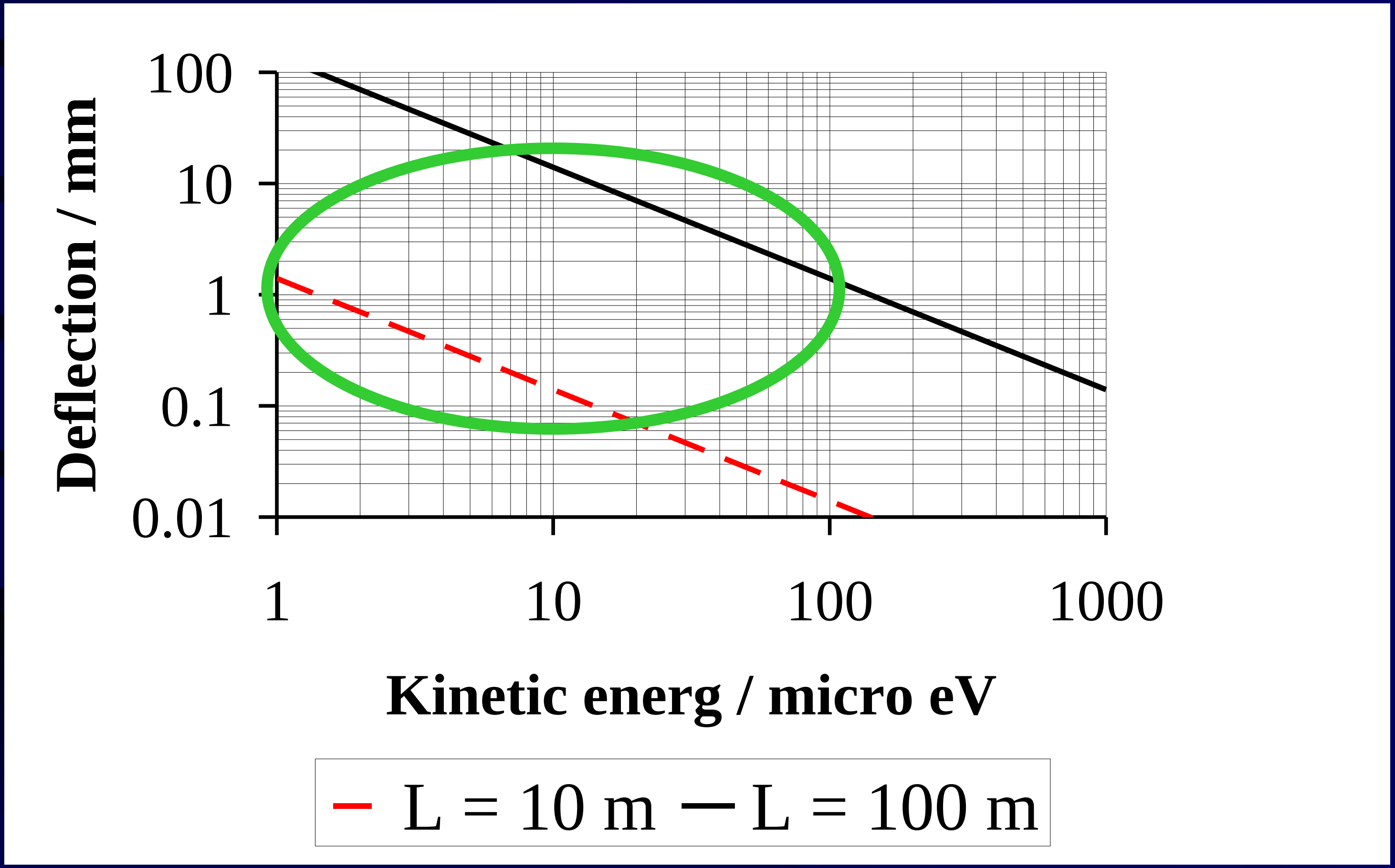


Vacuum tube
Source
$\vec{g}_p$
$\vec{g}_e$
z
e^+
O
x
L
Detector
$\Delta z_{e,p} = g_{e,p}\frac{t^2}{2}$

Principle including focussing:



Requirements:



Requirements:

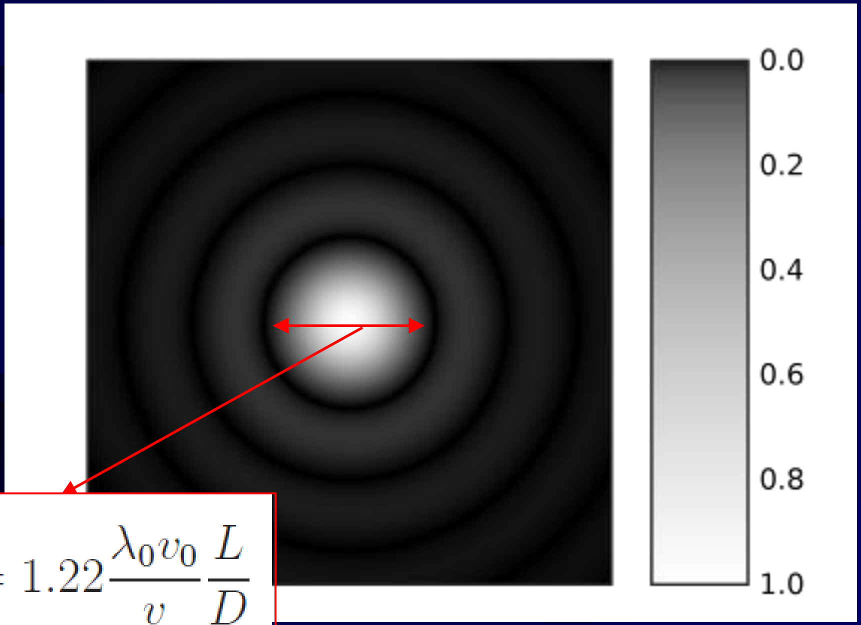
Based on wavelike properties of electron

$$\lambda = \frac{h}{m_i v} = \lambda_0 \frac{v_0}{v}$$

$$\lambda_0 = 100 \text{ nm for } v_0 = 7.27 \text{ km/s}$$

Requirements:

Wavelike properties of electron give focal spot from point source: Airy disk



$$d = 1.22\lambda\frac{L}{D} = 1.22\frac{\lambda_0 v_0}{v}\frac{L}{D}$$

Requirements:

Airy disk < Gravity deflection

$$t = L/v > 2.44 \frac{\lambda_0 v_0}{D\,|g_{e,p}|} \approx \frac{D_0 t_0}{D}$$

$$D_0 = 10 \text{ cm and } t_0 = 1.81 \text{ ms}$$

Requirements:

Resolution limited

$$D_{min} = 1.73 \frac{\lambda_0 v_0}{\sqrt{d \left| g_{e,p} \right|}}$$

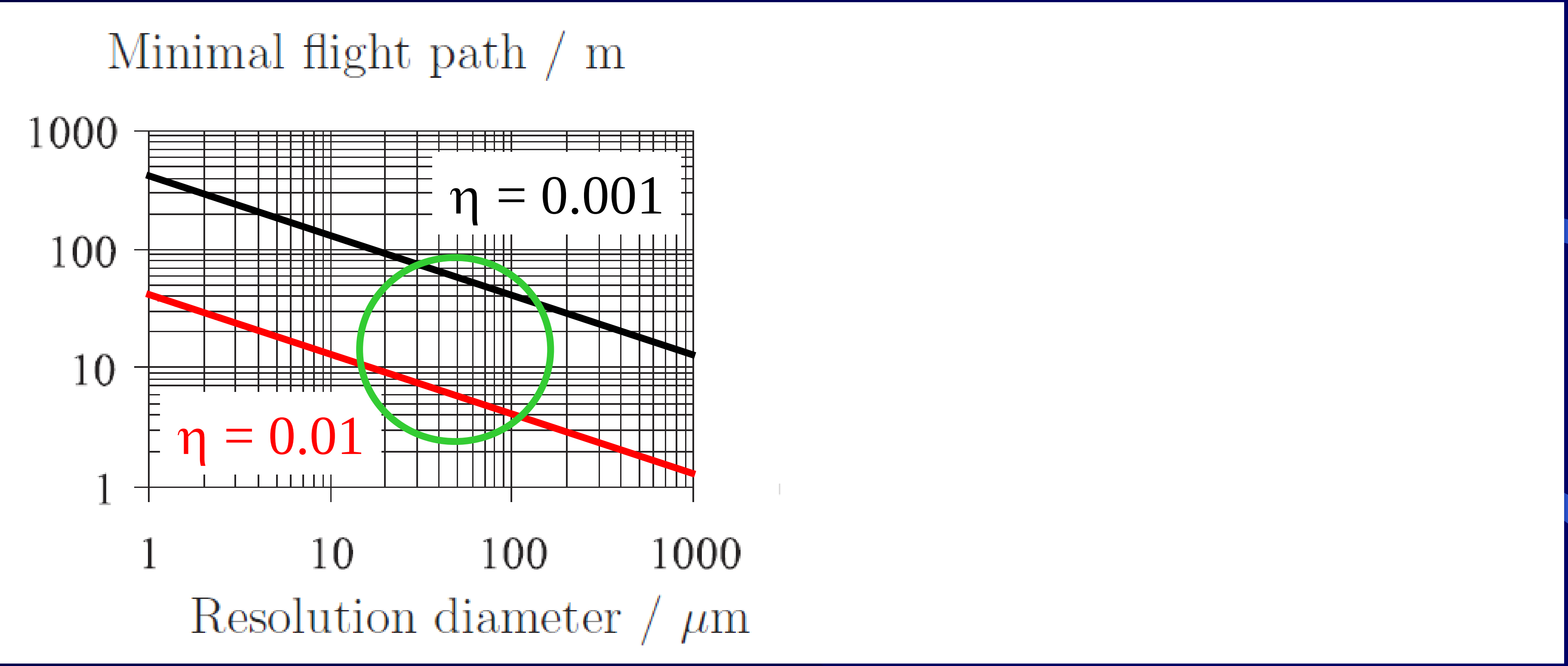
$$D / L = \eta$$

$0.001 < \eta < 0.1$

Lower level: source strength
Upper level: paraxial approximation

Requirements:

Resolution limited



Requirements:

Surface Patch effect

Optical phase along a trajectory:

$$\psi = \frac{2\pi}{\lambda} \oint n(\vec{s}) d\vec{s}$$

Refractive index as function of potential:

$$n(\vec{s})^2 = 1 \pm \frac{2em_i\lambda^2 V(\vec{s})}{h^2}$$

Requirements:

Gaussian distributed Surface Patch effect

$$\frac{\sigma_\psi}{2\pi} = \frac{\lambda}{\lambda_0}\frac{\zeta}{D}\frac{\phi_{patch}\sqrt{L\zeta}}{P_0} < 1$$

patch potential, ϕ_{patch} and average crystallite size ζ

$P_0 = h^2/(2em_i\lambda_0) = 1.5 \times 10^{-11} Vm$

Requirements:

Gaussian distributed Surface Patch effect

Vertical flight path (Witteborn & Fairbank):

$\zeta = 1\ \mu\text{m}$

ϕ_{patch} has to be less than 250 nV

Horizontal flight path (this proposal):

$\zeta = 1\ \mu\text{m},\ \phi_{patch}$ has to be less than 100 to 10 μV

Requirements:

Gaussian distributed Surface Patch effect

$$\frac{\sigma_\psi}{2\pi} = \frac{2e}{h}\sqrt{\frac{2\Delta z}{|g_{e,p}|}}\frac{\phi_{patch}\zeta}{D}\sqrt{\frac{\zeta}{L}}$$

This is independent of the particle properties. Hence, *for a required given deflection in the proposed experiment, the influence of the patch potential effects does not depend on the type of particle used.*

Conclusions:

- With current technology the proposed experiment is perfectly feasible

- Largest challenge is the adequate shielding of the flight path

- Surface Patch effects have much less influence for the considered geometry

- Also the other reasons not to use positrons have either much less influence in this geometry or are not valid

Thank you for your attention !

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