10. YOUNG'S MODULUS OF RUBBER (12 points) The linear Hooke's law for a rope made from an elastic material is supposed to held for small relative deformations $\varepsilon = x/L$ (which is also called "strain"), where L is the undeformed length of the rope, and x is the deformation. Once ε becomes too large, the force-deformation relationship $F = kx$ is no longer linear; what is "too large" depends on the material. For very elastic materials which can reach relative deformations considerably large than one, it may happen that the linear Hooke's law with a constant stiffness k fails, but if we take into account the change of the cross-sectional area S of the rope with $k = ES/L$, where E is the Young's modulus of the elastic material, such a non-linear Hooke's law remains valid. In that case we can say that there is still a linear stress-strain relationship $\sigma = E \cdot \varepsilon$, where the stress $\sigma = F/S$.

i) *(7 points)* Measure the relationship between the stress σ and strain ε in a rubber string and plot it.

ii) *(5 points)* From your plot determine the Young's modulus E with its uncertainty, and the maximum strain ε_m until which it applies.

Note: the diameter of the thread is to be measured using the diffraction of laser light.

Equipment: rubber thread, stand, measuring tape, 15 hex nuts with a known mass, a plastic bag for hanging a set of nuts to the thread, a green laser ($\lambda = 532\,\mathrm{nm}$), a screen.

WARNING: AVOID LOOKING INTO A LASER BEAM, THIS MAY DAMAGE YOUR EYES!