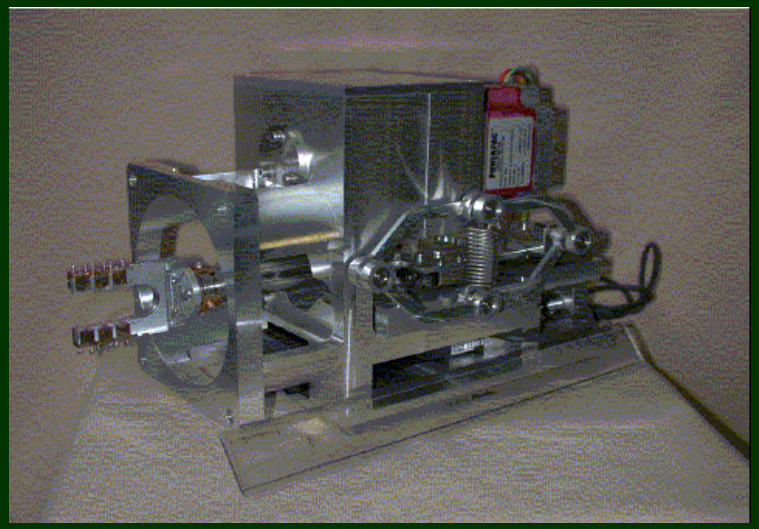
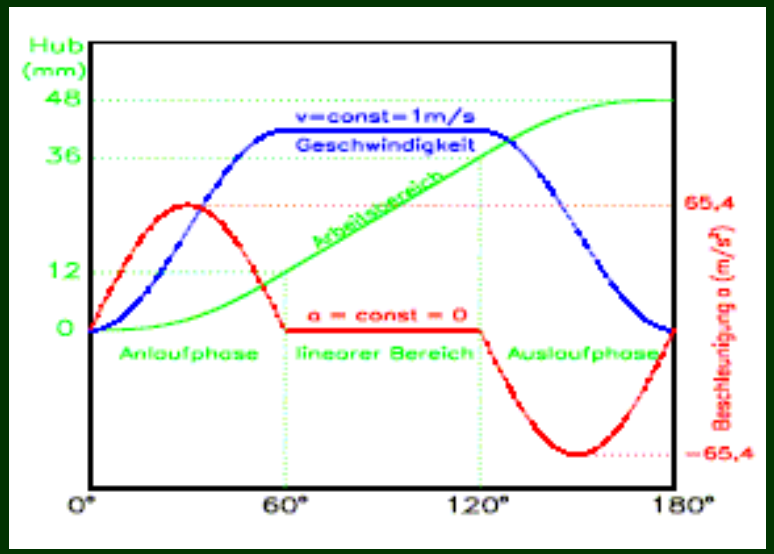
Wire-oscillations during operation of the Wirescanner

- Problem
- Test set up
- Measurements and preliminary conclusion

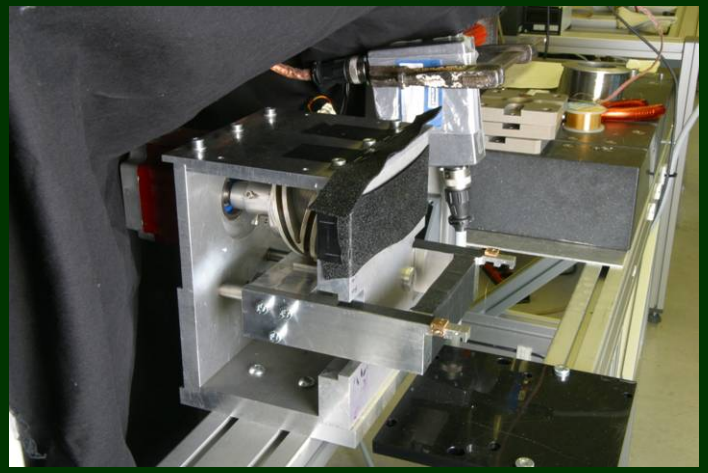
Problem

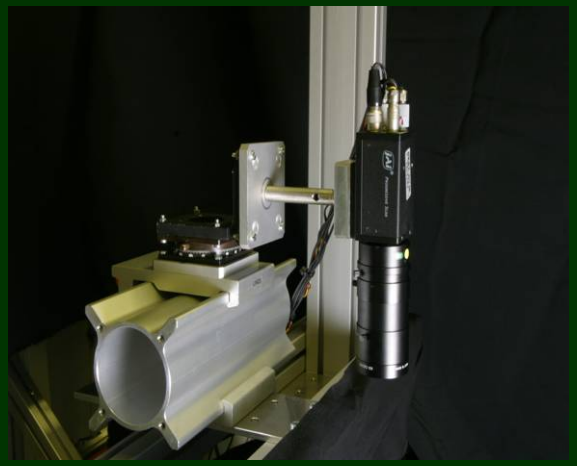
- In future fast scan is needed for longer trains and shorter bunch distances
- Fast scan with speed up to 1m/s
- max. acceleration of 65.4 m/s² ca. 6.5 g
- In area of interest there is theoretically no acceleration
- How big is the deformation of the wire in the area of interest ?

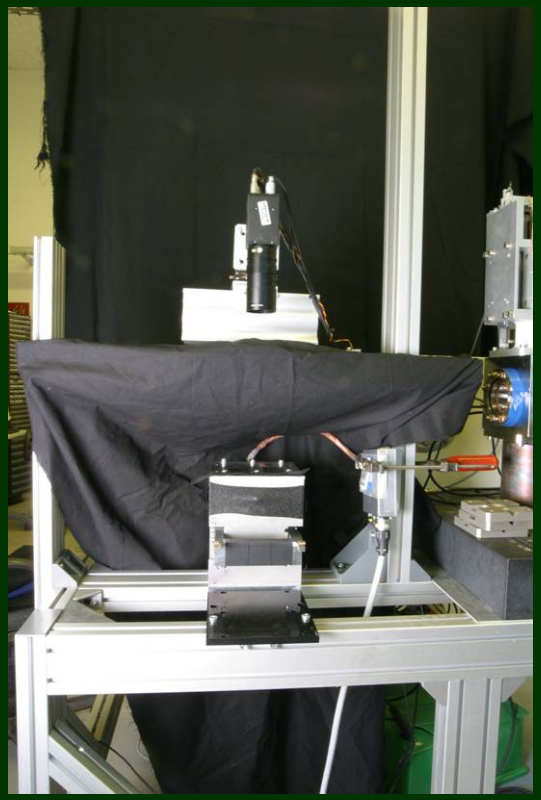




Experimental set up







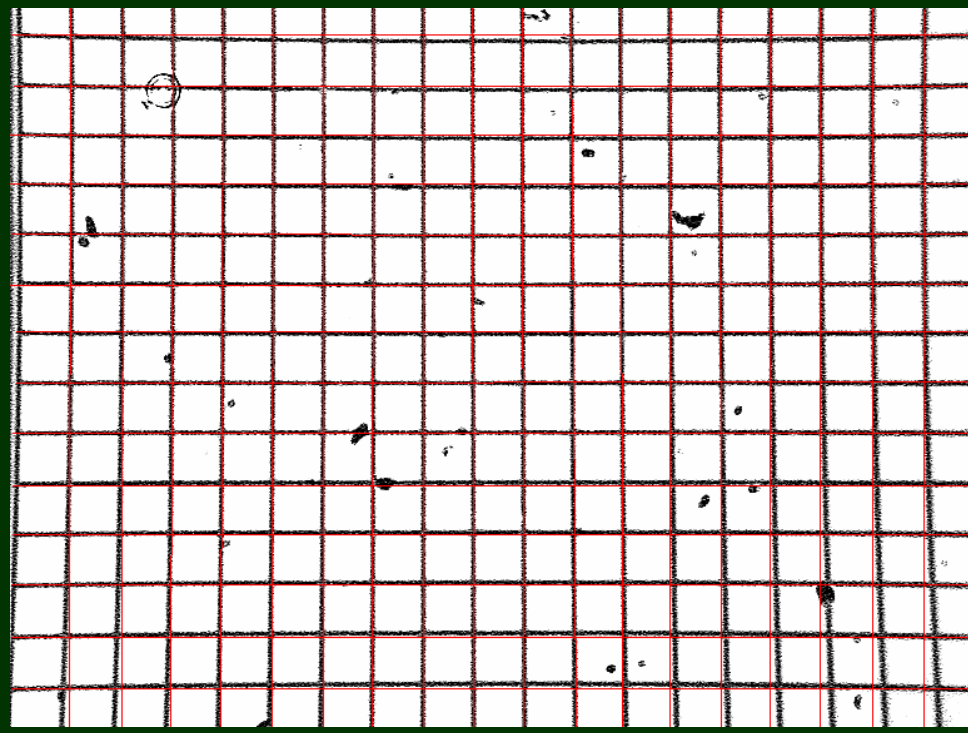
- Wirescanner stepper motor with a torque of M = 2Nm
- Slot winding cylinder with double Bestehorn Sinoide
- Stainless steel fork with 129mm span width
- Tungsten wire (gilded) with a diameter of 30µm
- JAI M10 Camera with 10xzoom objective ca. 40cm over the wire
- Halogen lamp with 1000 watt

JAI M10 - progressive scan camera

- High speed shutter up to 1/800,000sec.
- 782 (h) x 582(v) 8.37µm square pixels (767x580 pixels read out)
- Single channel progressive full frame read out in 1/25sec.
- Camera setup via RS-232C or switches

camera problems

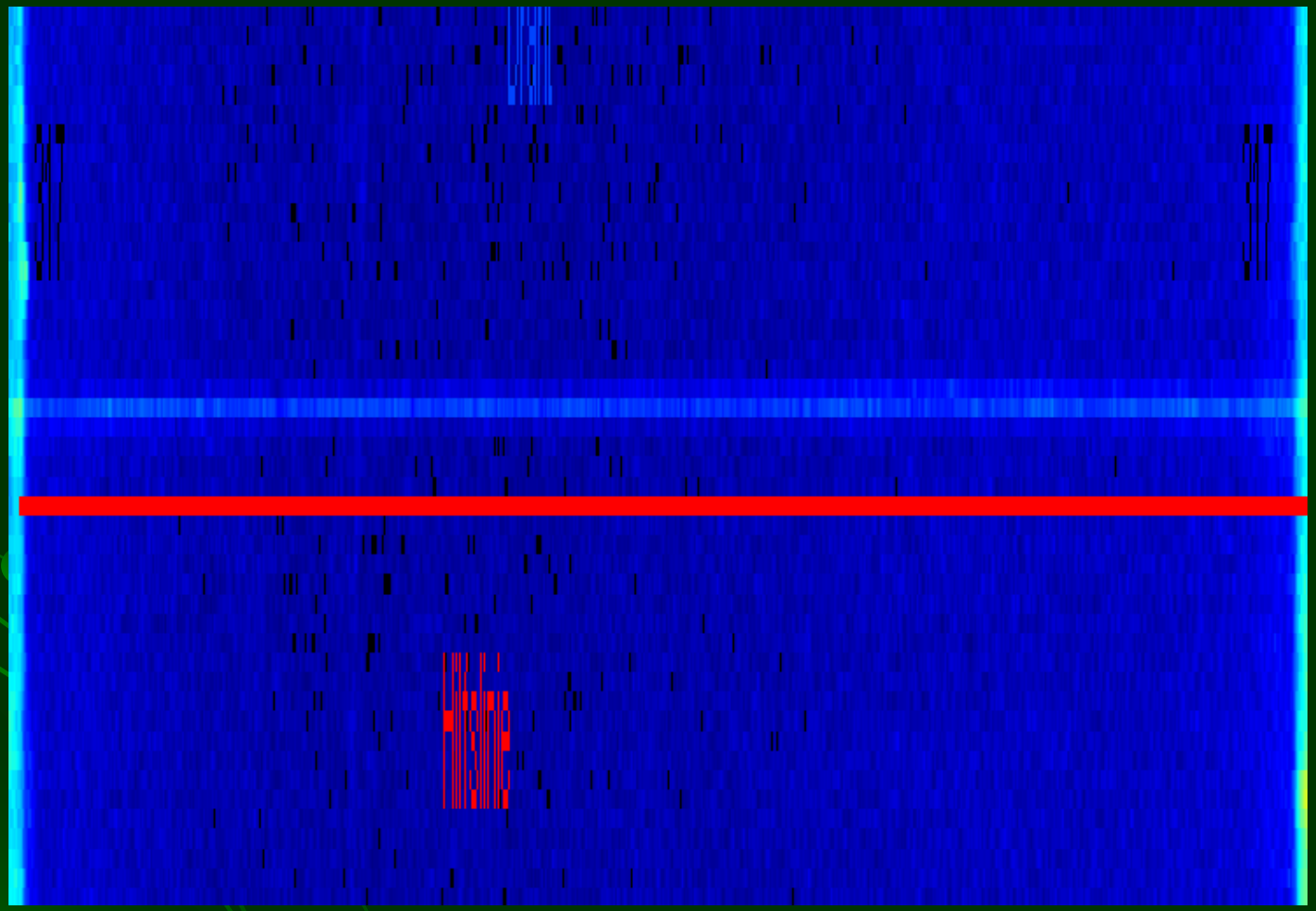
- Camera needs much light for a fast shutter with 1/10000sec.
- At experiment the resolution is only 170µm square pixels
- The objective focused only the centrum of the picture —›
- To adjust the camera is very difficulty
- When Wirescanner is moving you need a little bit luck to get the right picture



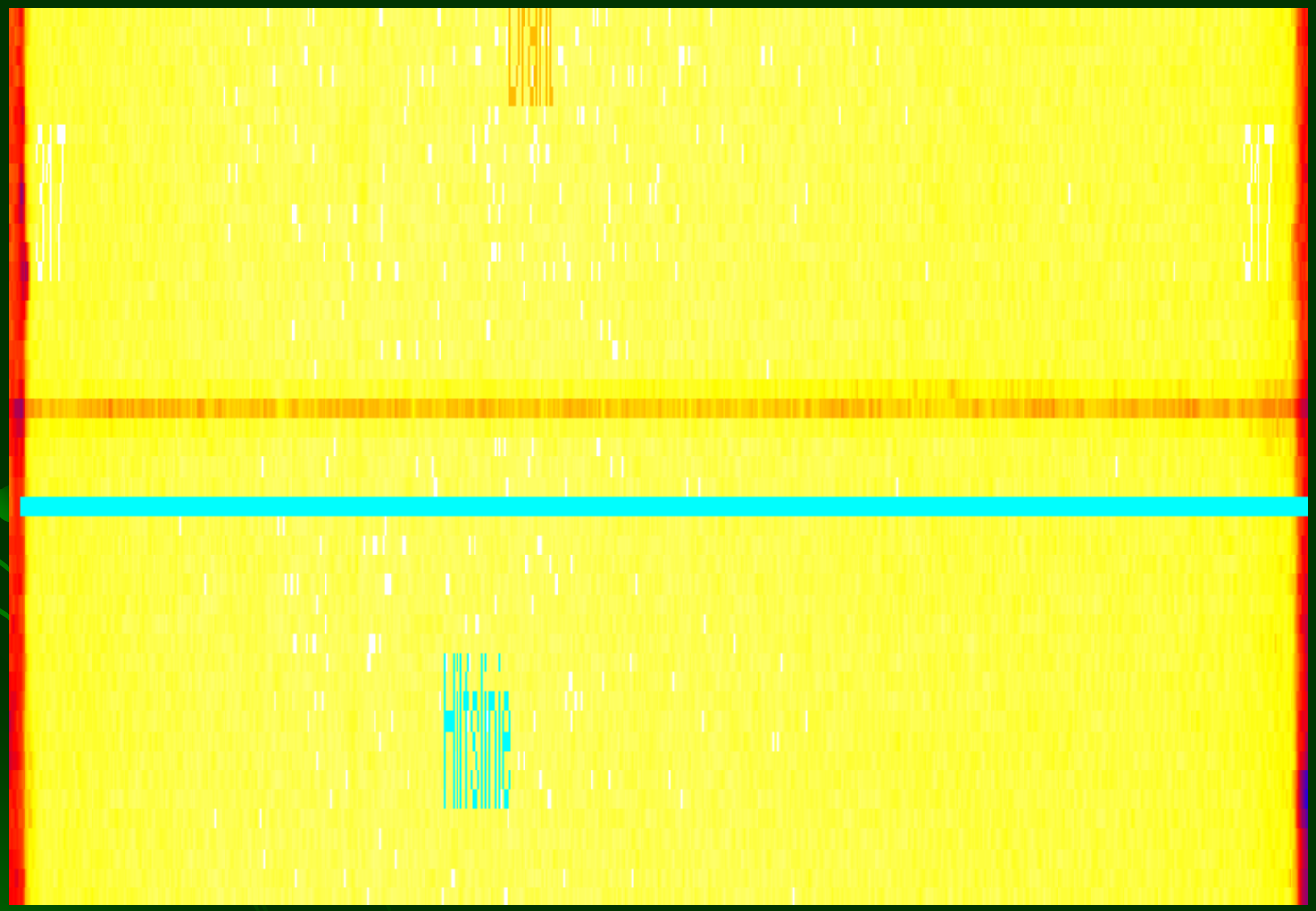
Every square is 5x5mm big

Picture without movement

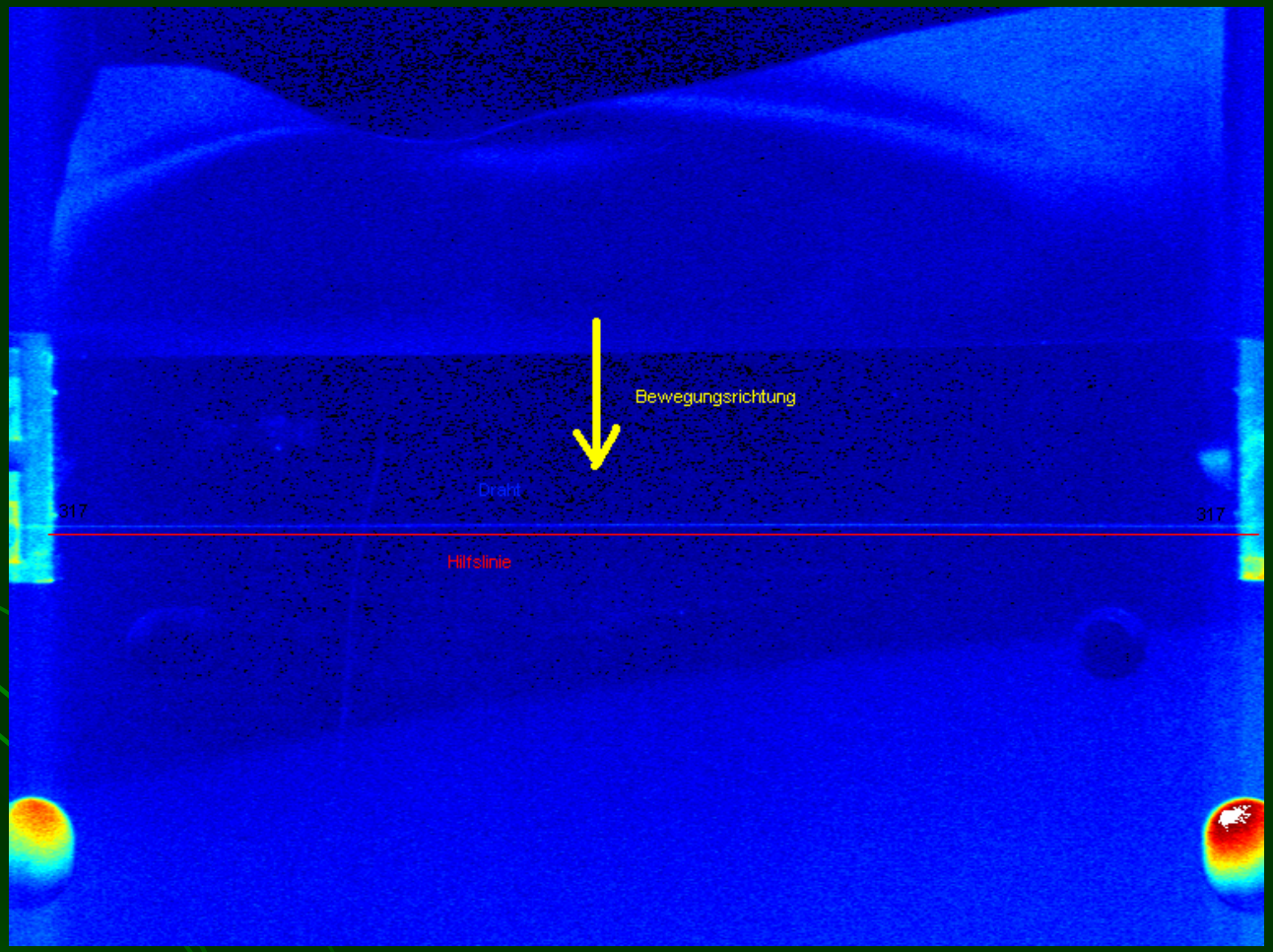
Stretched only vertical



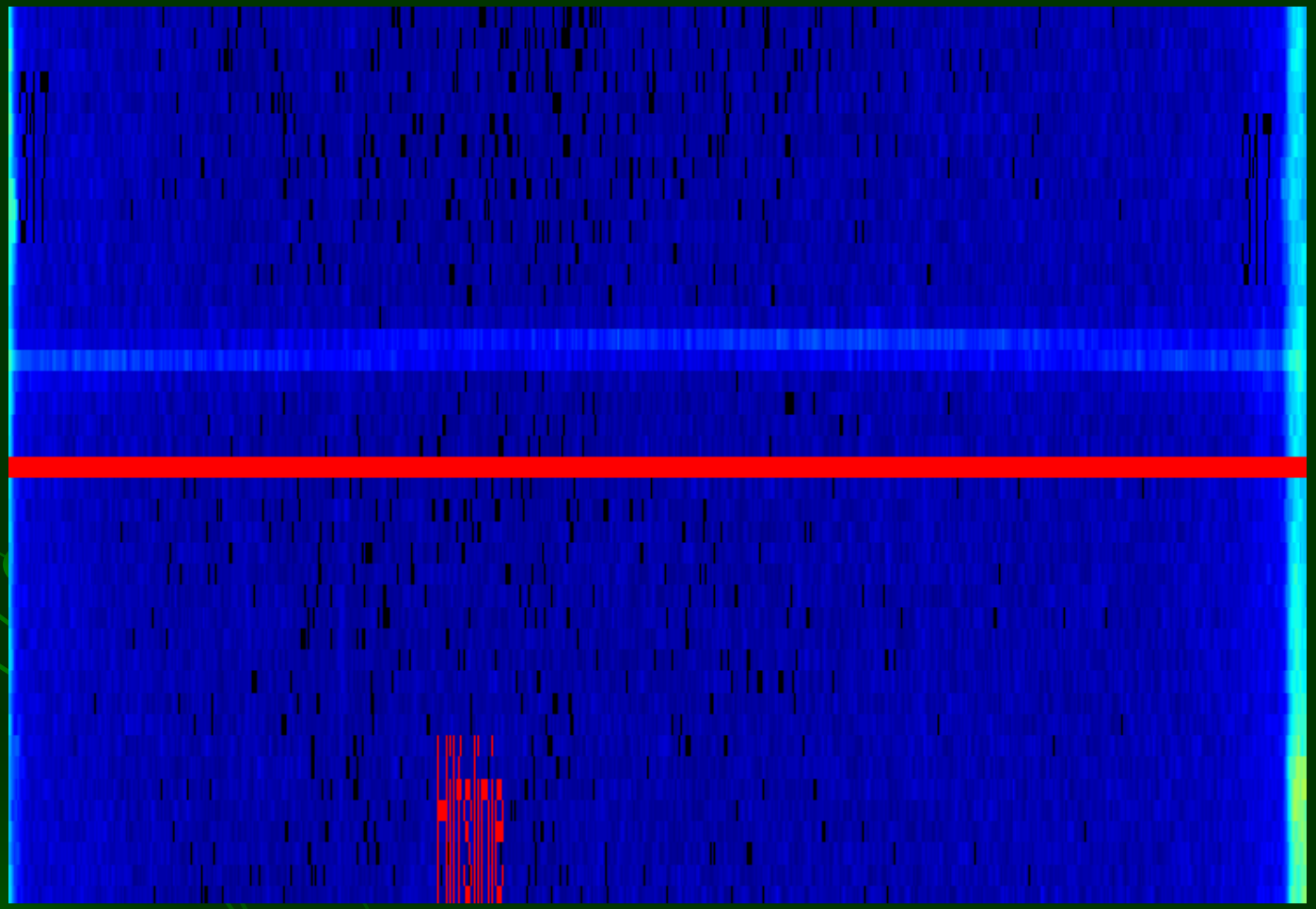
Invert



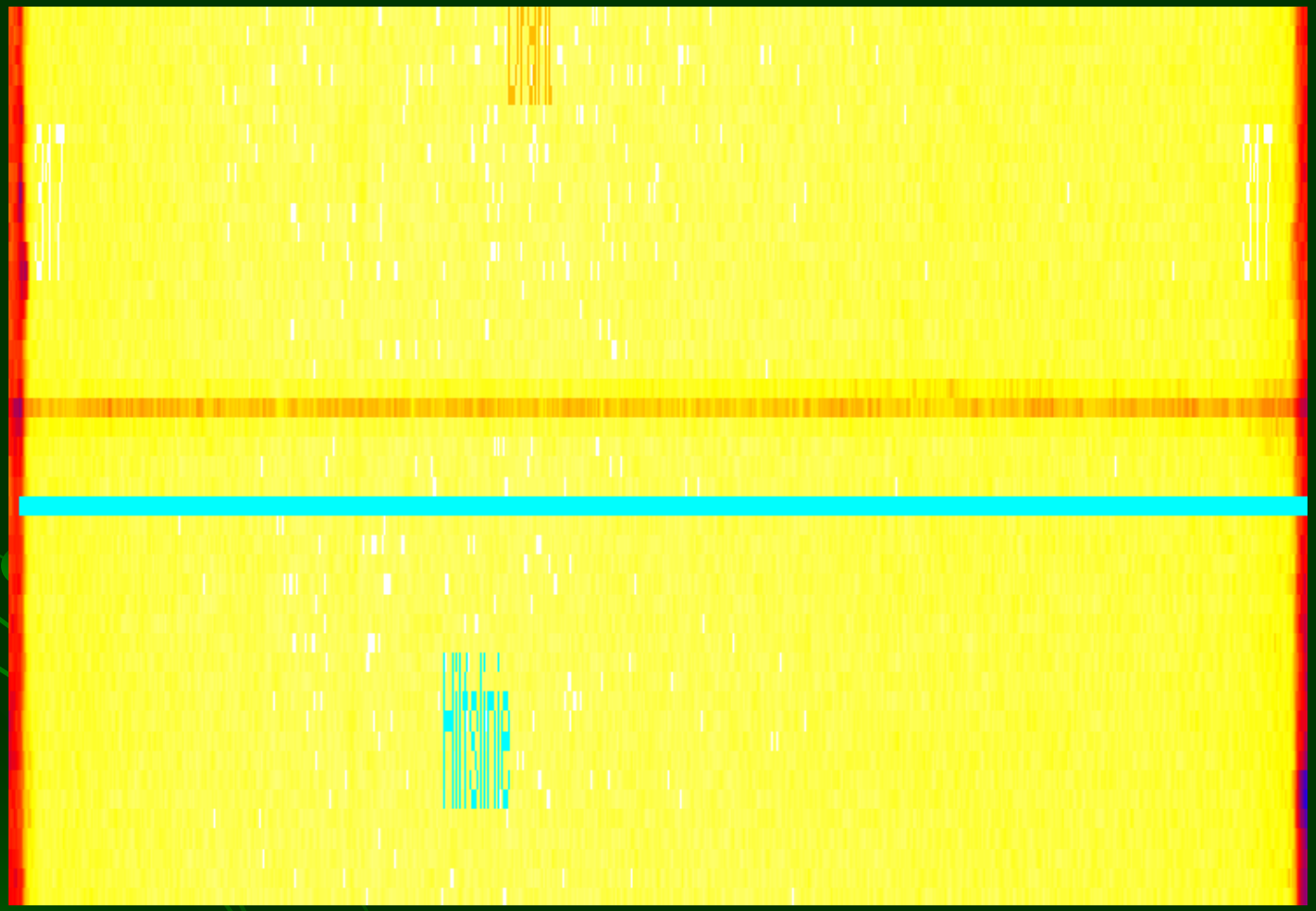
Picture with movement



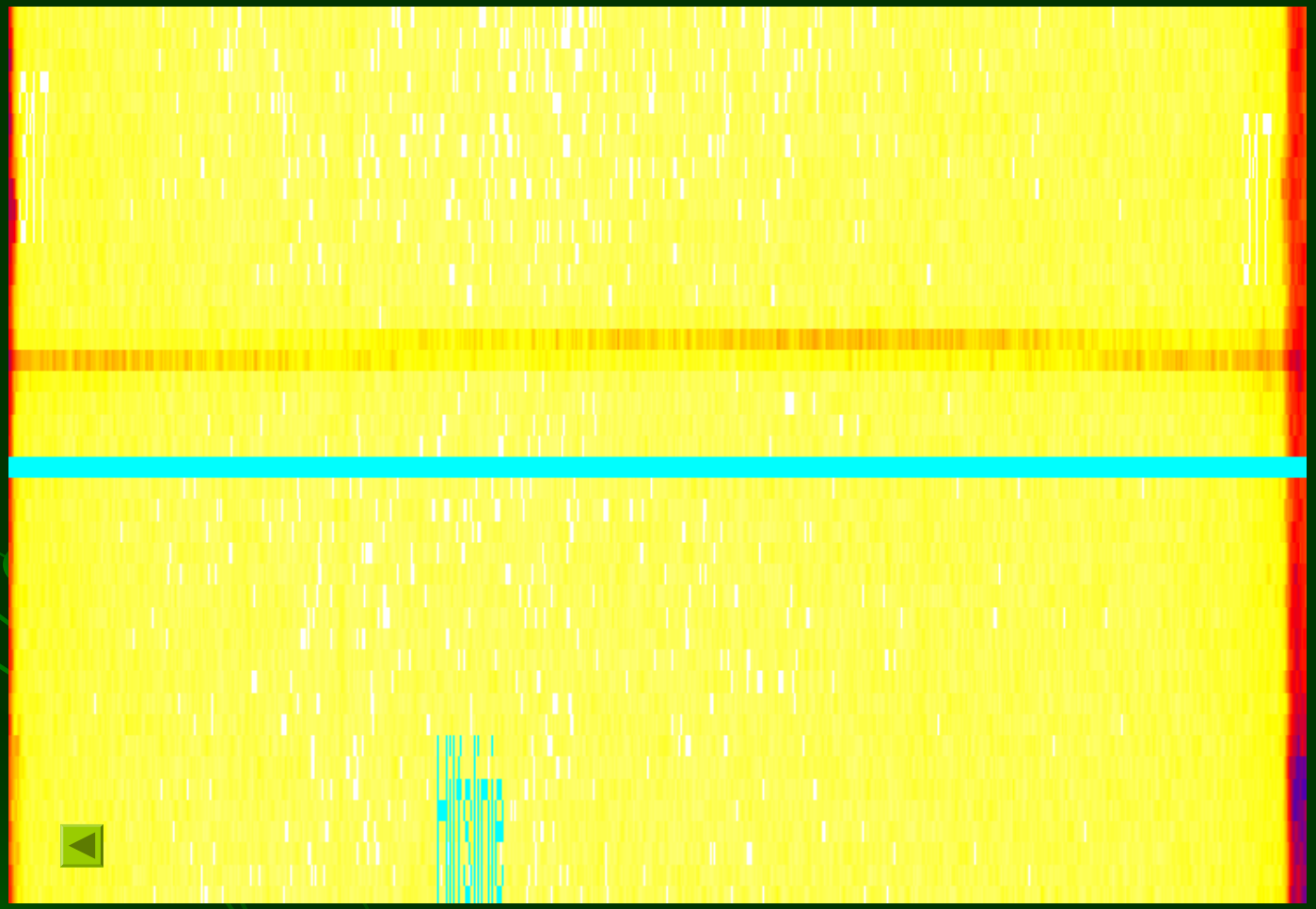
Vertical stretched

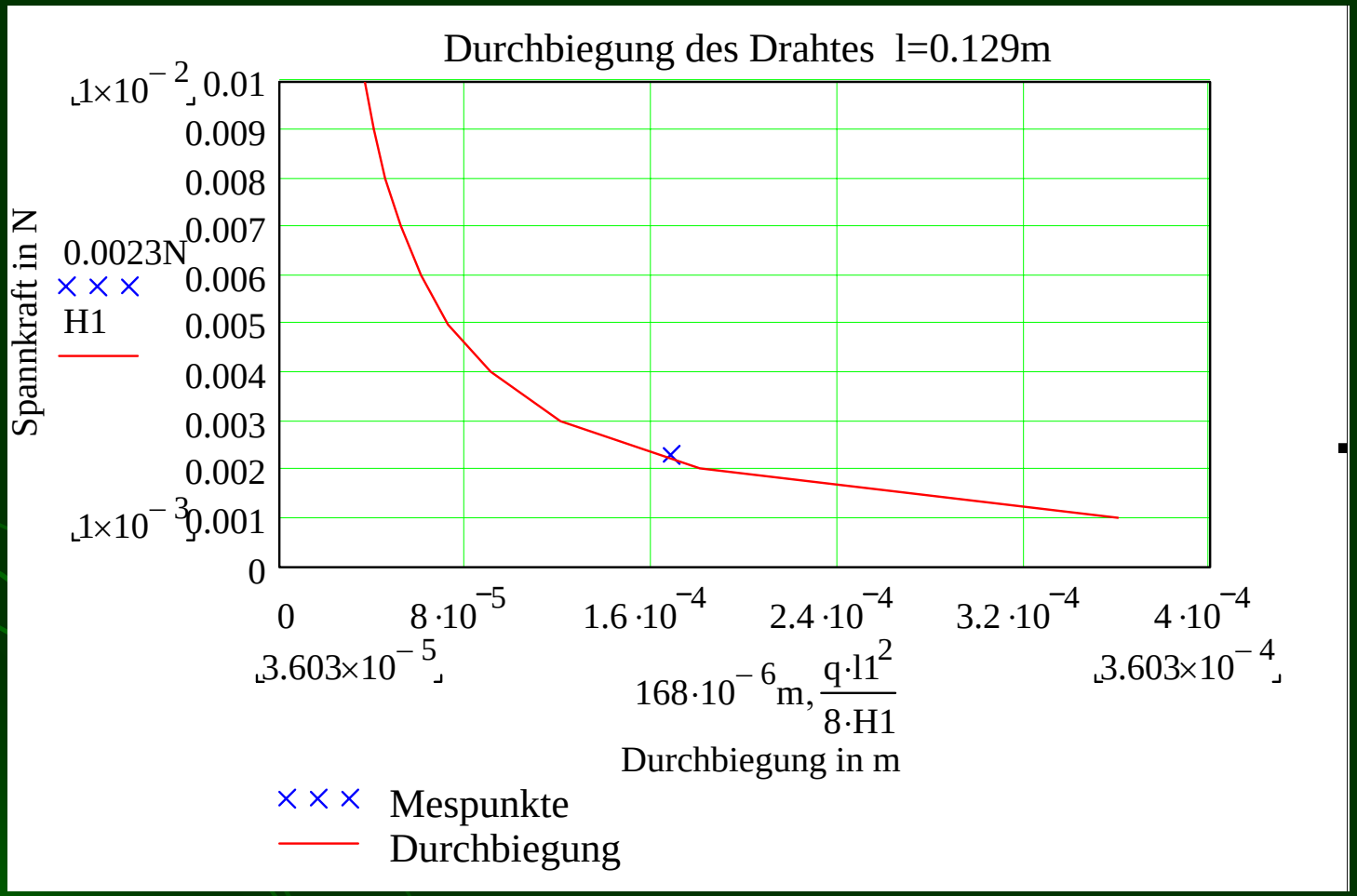


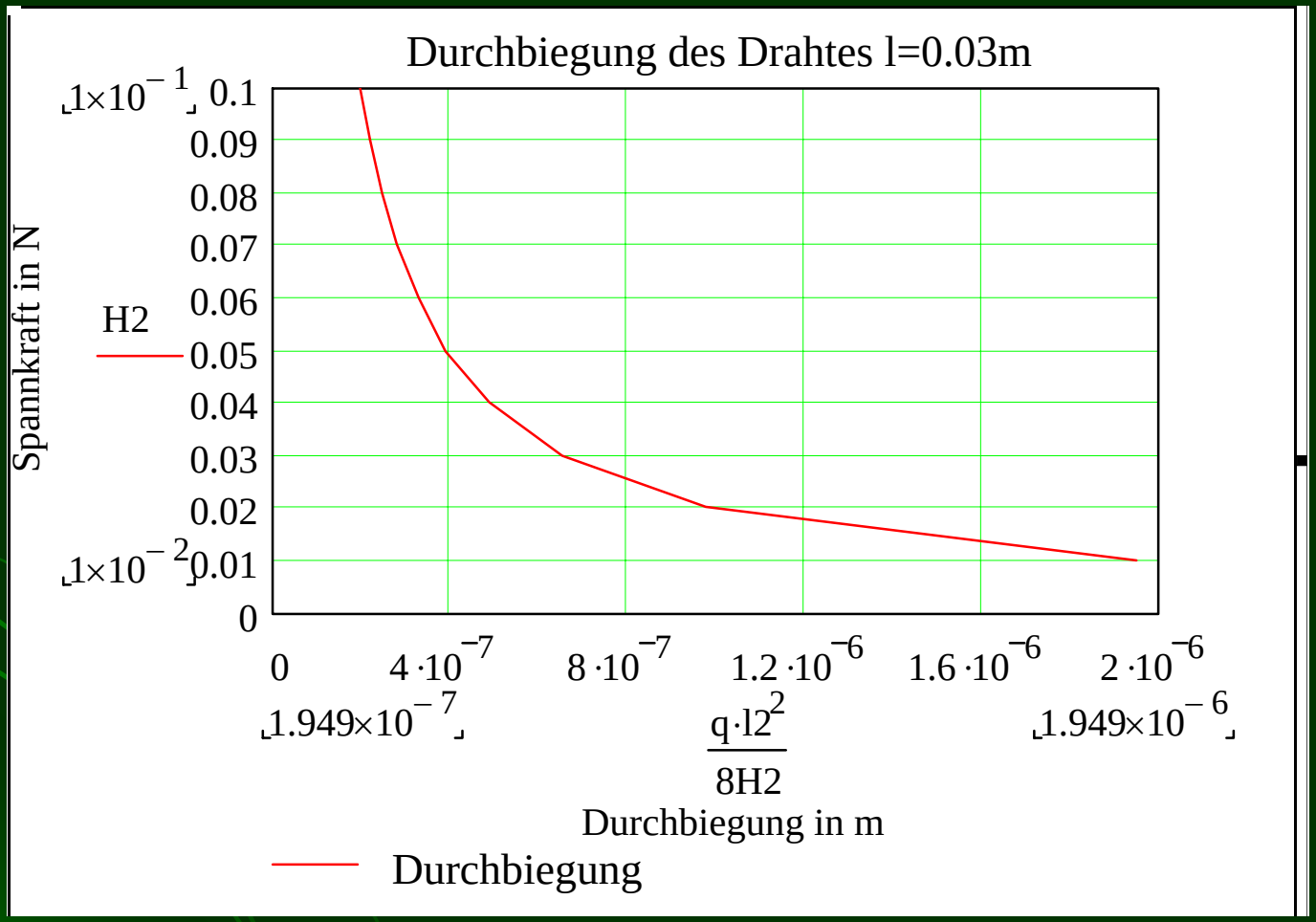
Invert

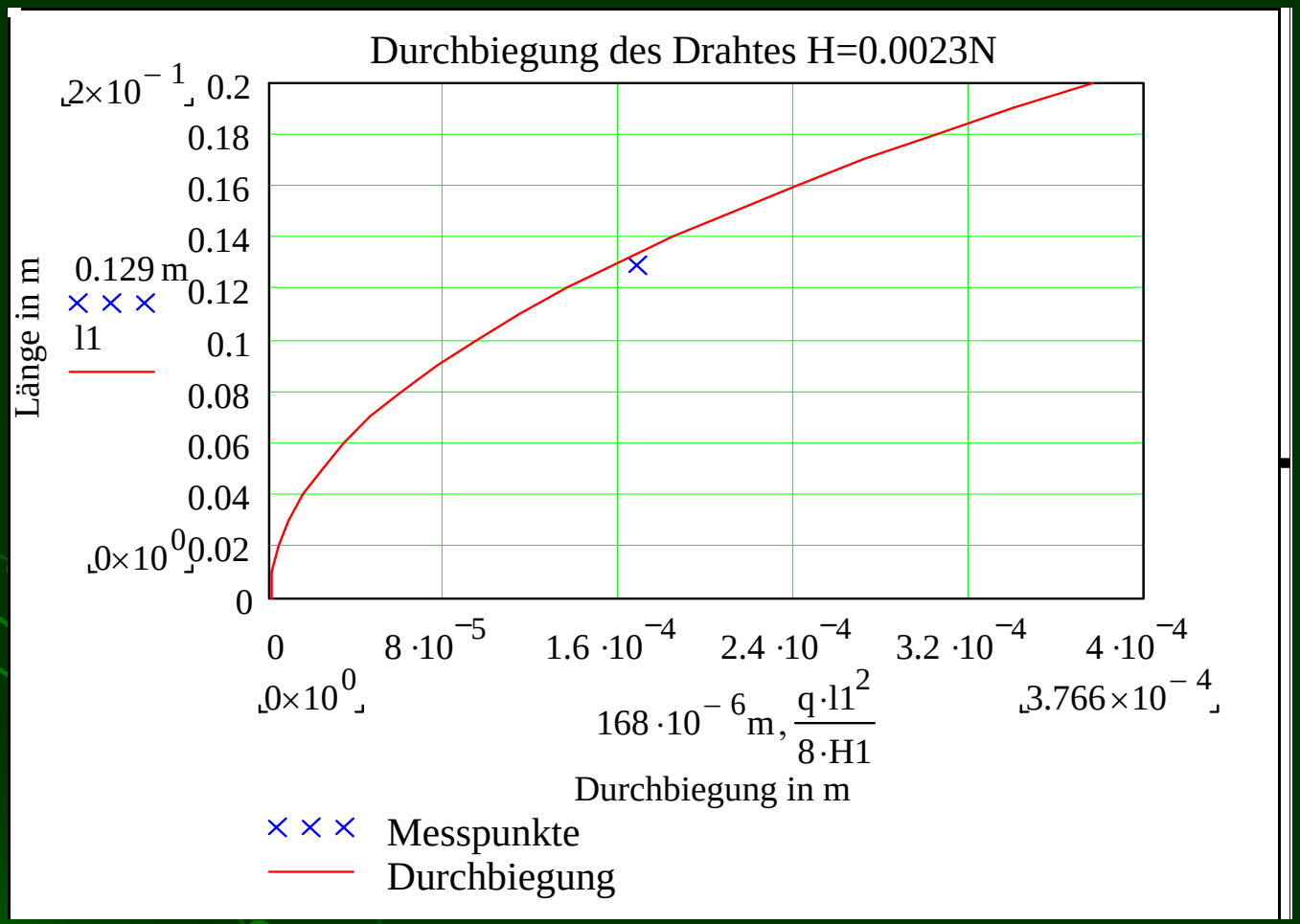


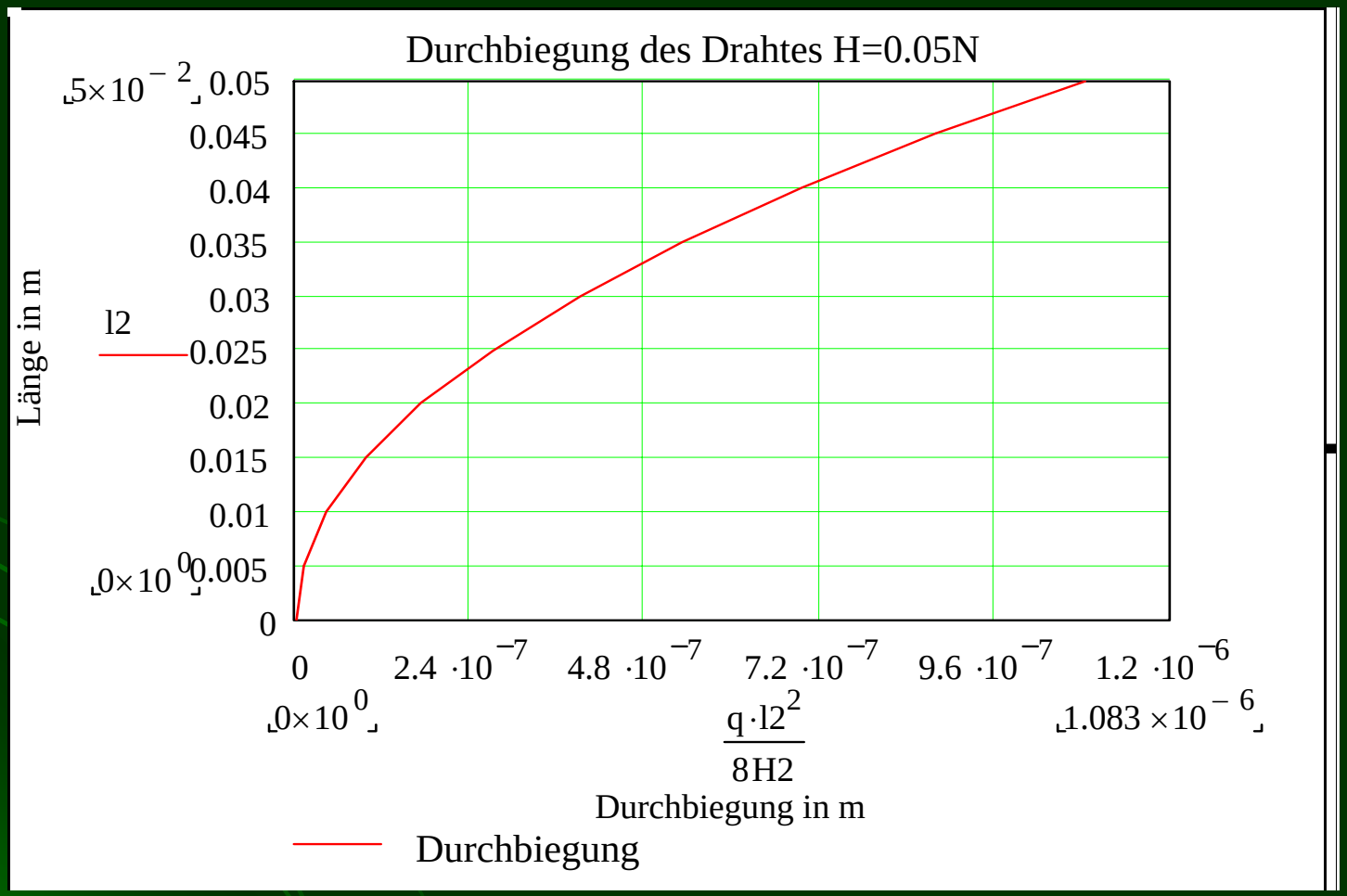
invert

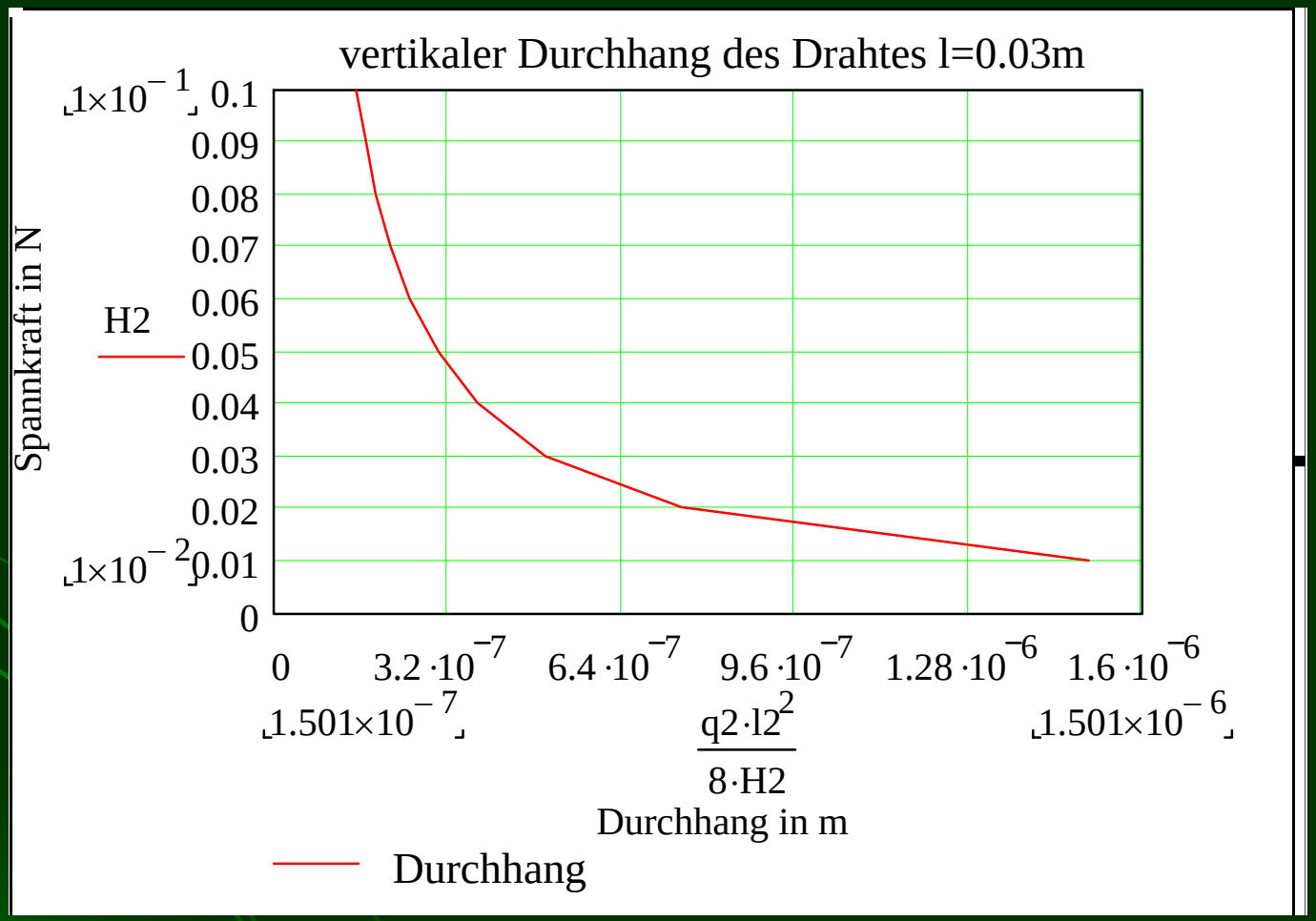


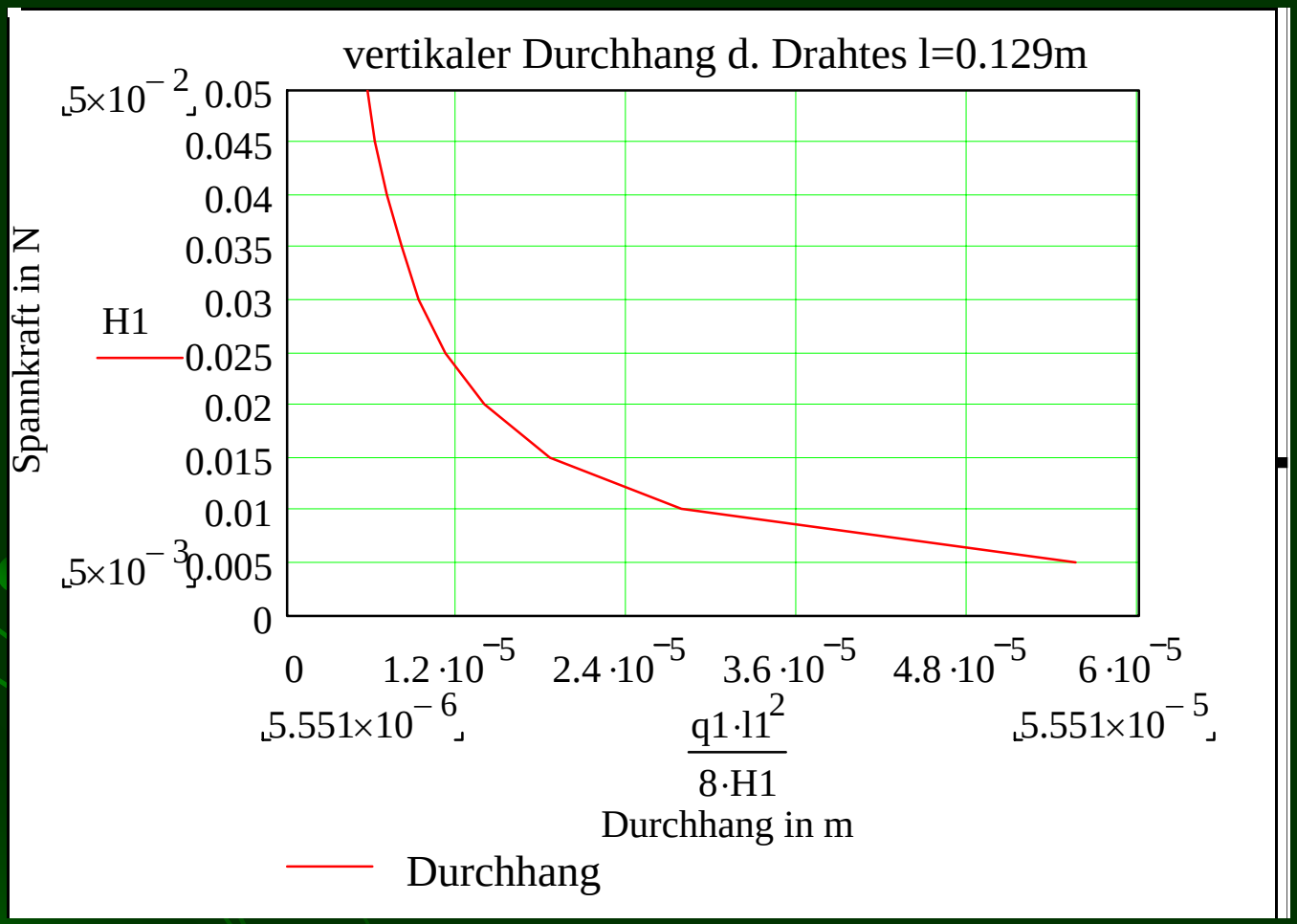

Durchbiegung des Drahtes l=0.129m
Spannkraft in N
1×10^−2
0.01
0.009
0.008
0.007
0.0023N
0.006
0.005
0.004
0.003
0.002
1×10^−3
0.001
0
0
8·10^−5
1.6·10^−4
2.4·10^−4
3.2·10^−4
4·10^−4
3.603×10^−5
168·10^−6 m, q·l1^2 / 8·H1
3.603×10^−4
Durchbiegung in m
H1
Mespunkte
Durchbiegung

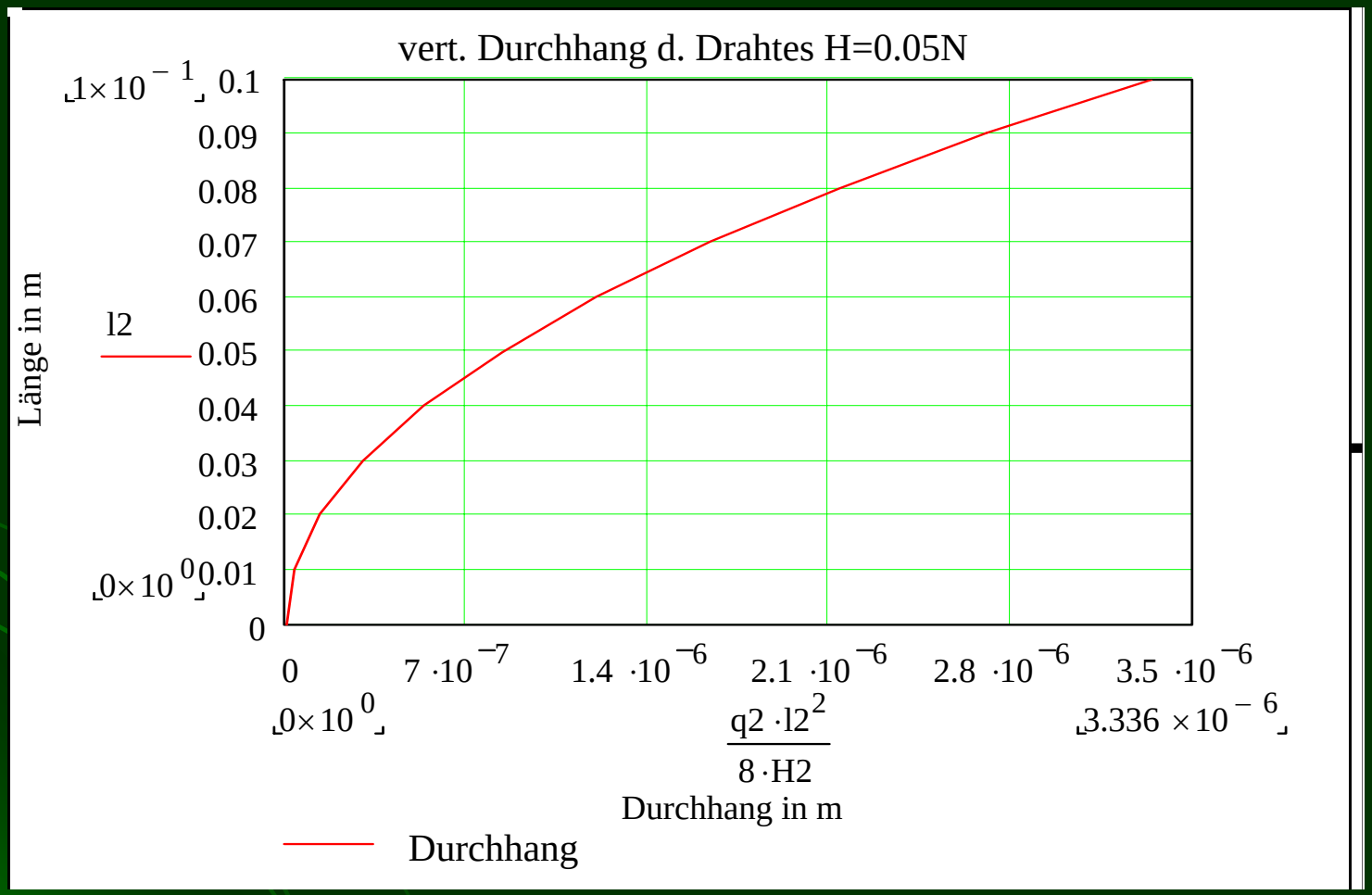

Durchbiegung des Drahtes l=0.03m
Spannkraft in N
1×10^−1
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
1×10^−2
0.01
0
H2
0
4·10^−7
8·10^−7
1.2·10^−6
1.6·10^−6
2·10^−6
1.949×10^−7
q·l2^2 / 8H2
1.949×10^−6
Durchbiegung in m
Durchbiegung

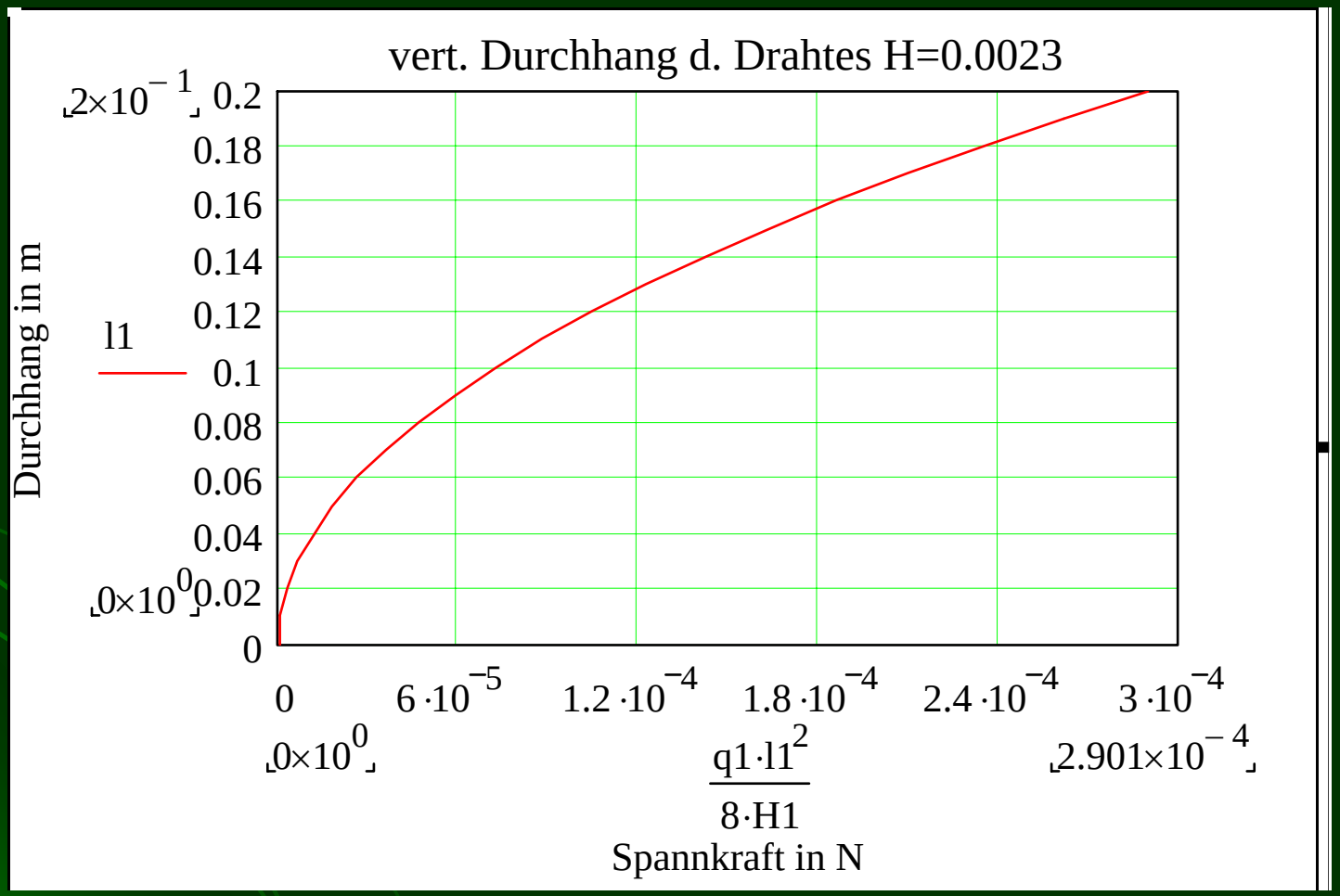

Durchbiegung des Drahtes H=0.0023N
Länge in m
0.129 m
l1
2×10^−1
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0×10^0
0
8·10^−5
1.6·10^−4
2.4·10^−4
3.2·10^−4
4·10^−4
0×10^0
168·10^−6 m, q·l1^2 / 8·H1
3.766×10^−4
Durchbiegung in m
Messpunkte
Durchbiegung


Durchbiegung des Drahtes H=0.05N
5×10^−2
0.05
0.045
0.04
0.035
0.03
l2
0.025
0.02
0.015
0.01
0×10^0
0.005
0
Länge in m
0
2.4 ·10^−7
4.8 ·10^−7
7.2 ·10^−7
9.6 ·10^−7
1.2 ·10^−6
0×10^0
q·l2^2 / 8H2
1.083×10^−6
Durchbiegung in m
Durchbiegung


vertikaler Durchhang des Drahtes l=0.03m
Spannkraft in N
1×10⁻¹
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
1×10⁻²
0.01
0
H2
0
3.2·10⁻⁷
6.4·10⁻⁷
9.6·10⁻⁷
1.28·10⁻⁶
1.6·10⁻⁶
1.501×10⁻⁷
1.501×10⁻⁶
q2·l2²
8·H2
Durchhang in m
Durchhang


vertikaler Durchhang d. Drahtes l=0.129m
Spannkraft in N
H1
5×10^−2
0.05
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
5×10^−3
0.005
0
0
1.2·10^−5
2.4·10^−5
3.6·10^−5
4.8·10^−5
6·10^−5
5.551×10^−6
q1·l1^2 / 8·H1
5.551×10^−5
Durchhang in m
Durchhang


vert. Durchhang d. Drahtes H=0.05N
Länge in m
l2
1×10^−1
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0×10^0
0
0
7 ·10^−7
1.4 ·10^−6
2.1 ·10^−6
2.8 ·10^−6
3.5 ·10^−6
0×10^0
q2 ·l2^2 / 8 ·H2
3.336 ×10^−6
Durchhang in m
Durchhang


vert. Durchhang d. Drahtes H=0.0023
Durchhang in m
l1
2×10^−1
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0×10^0
0.02
0
0
6·10^−5
1.2·10^−4
1.8·10^−4
2.4·10^−4
3·10^−4
0×10^0
q1·l1^2 / 8·H1
2.901×10^−4
Spannkraft in N

Durchbiegung durch Luftwiderstand

Wirescannerdraht		
l=0.03m	M=5gm	g=9.807kg/s²
T=296.15K	V=1m/s	p=101325Pa
D=3*10^-5m	Cw=0.5	R=287.05J/kg*K
r=p/R*T r=1.192kg/m^3	A=l*D A=9*10^-7m²	H=M*g H=0.049N
Fl=0.5*Cw*A*r*V² Fl=2.682*10^-7N	q=Fl/l q=8.939*10^-6kg/s²	f=(q*l²)/8H f=2.051*10^-8m

Testdraht		
l=0.129m	M=0.23gm	g=9.807kg/s^2
T=296.15K	V=1m/s	p=101325Pa
D=3*10^-5m	Cw=0.5	R=287.05J/kg*K
r=p/R*T r=1.192kg/m^3	A=l*D A=3.87*10^-6m²	H=M*g H=2.25*10^-3N
Fl=0.5*Cw*A*r*V² Fl=1.153*10^-6N	q=Fl/l q=8.939*10^-6kg/s²	f=(q*l²)/8H f=8.244*10^-6m

M=mass of the Spanngewichts

l=Länge des Drahtes

g=Fallbeschleunigung

T=Temperatur

p=Luftdruck

Cw=Strömungswiderstandskoeffizient

R=individuelle Gaskonstante

H=Spannkraft

V=Geschwindigkeit

A=Querschnittsfläche des Drahtes

Fl=Luftwiderstand

q=Seilkraft je bestimmter Länge

f=Durchbiegung des Drahtes

r=Luftdichte

Durchhang durch Gravitation

Wirescannerdraht		
l=0.03m	M=5gm	g=9.807kg/s²
D=3*10^-5m	d=19.25*gm/cm³	
Vol=π∗r²∗l Vol=2.121*10^-11*m³	m=Vol*d m=4.082*10^-7*kg	H=M*g H=0.04903N
	q=(m*g)/l q=1.334*10^-4*kg/s²	f=(q*l²)/8H f=3.002*10^-7m

Testdraht		
l=0.129m	M=0.23gm	g=9.807kg/s²
D=3*10^-5m	d=19.25*gm/cm³	
Vol=π∗r^2∗l Vol=9.118*10^-11*m³	m=Vol*d m=1.755*10^-6*kg	H=M*g H=2.256*10^-3N
	q=(m*g)/l q=1.334*10^-4kg/s²	f=(q*l²)/8H f=1.231*10^-4m

M=Masse des Spanngewichts

l=Länge des Drahtes

g=Fallbeschleunigung

H=Spannkraft

q=Seilgewicht je bestimmter Länge

f=Durchbiegung des Drahtes

Vol=Volumen des Drahtes

d=Dichte von Wolfram

m= Masse des Drahtes

Vorläufiges Ergebnis

Wirescannerdraht		
f1=2.051*10^-8m	f2=3.002*10^-7m	f3=4.18*10^-7m
f=f3-f2-f1	f=f3+f2-f1	f=f3-f1
f=9.729*10^-8m	f=6.977*10^-7m	f=3.975*10^-7m

f1=Durchbiegung durch Luftwiderstand
f2= Durchbiegung durch Gravitaion
f3=experimentelle Durchbiegung des Drahtes
f= Durchbiegung des Drahtes