notebook

October 13, 2022

#

TOP Verkleg Æfing ###

Snúningspendúll (Torsional Pendulum)

Authors

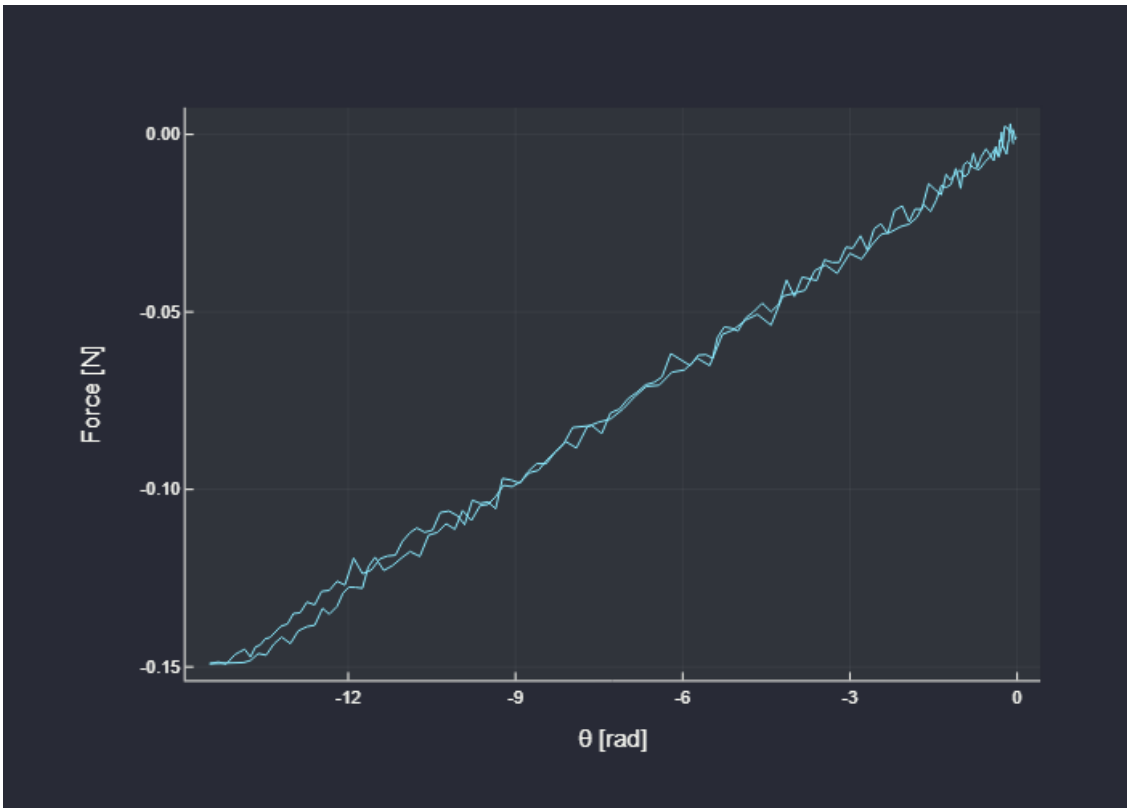
[ ]:
```
using DataFrames, Statistics, CSV
using Measurements, Unitful
using Plots, PlotThemes
using EasyFit, Peaks, Symbolics
using Latexify, LaTeXStrings
using RemoteREPL
@async serve_repl()
plotlyjs();
theme(:dracula)
val(x) = (Measurements.value ustrip upreferred)(x)
err(x) = (Measurements.uncertainty ustrip upreferred)(x)
```

```
err (generic function with 1 method)
```

0.1 Gögn

0.1.1 Gögn 1, mæling á kraft og

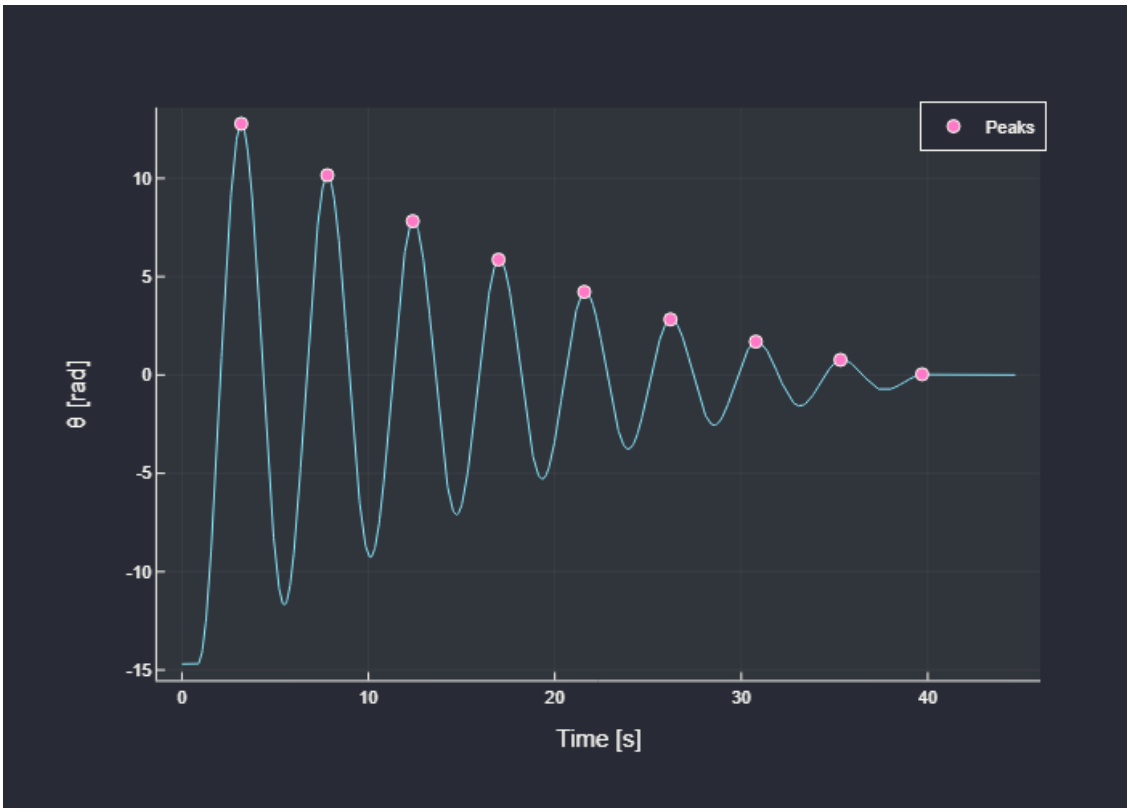
[ ]:
```
data = CSV.read("data.csv", DataFrame)

data = data[data[!,1] .> -0.15,:]

plot(data[!,2],data[!,1],
        xlabel = "  [rad]",
        ylabel = "Force [N]",
        labels =:none)
```



0.1.2 Gögn 2, Mæling á yfir tíma með málmskífu

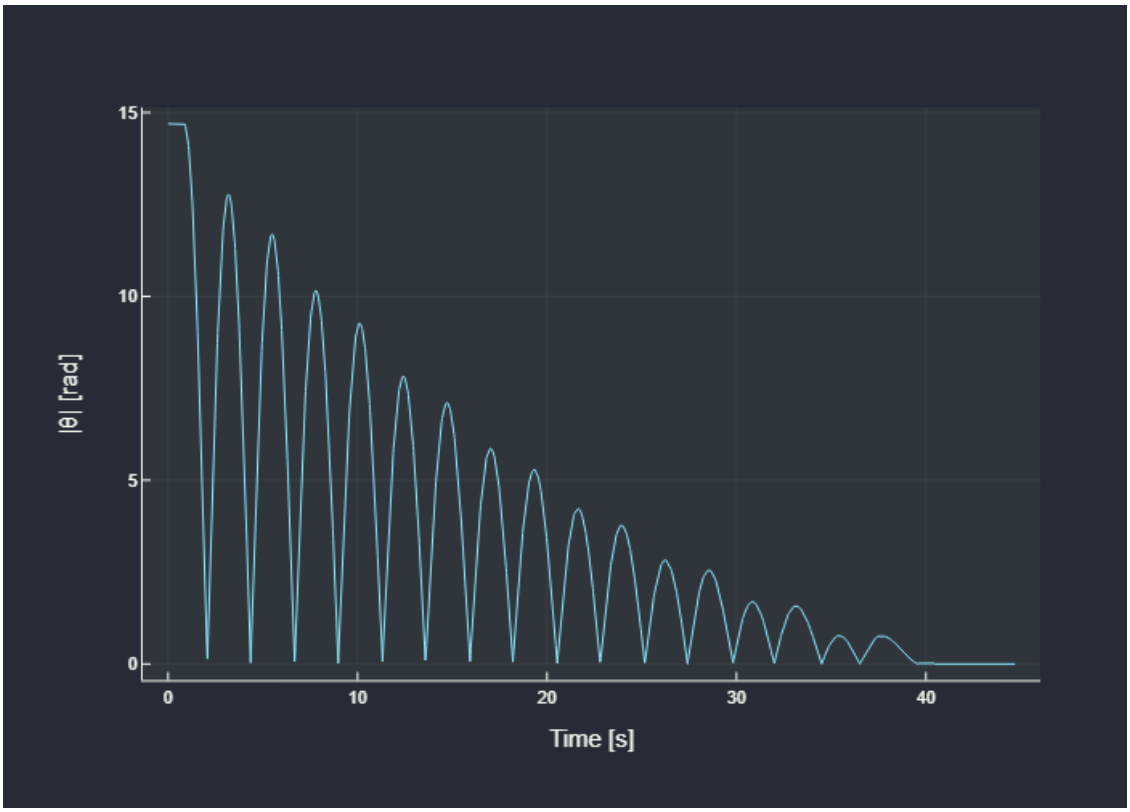
Með hápunktum og y-ás hliðraður

[ ]:
```
data2 = CSV.read("data2.csv", DataFrame)

data2[!,2] = data2[!,2] .- data2[end,2]

plot(data2[!,1], data2[!,2],
        xlabel = "Time [s]",
        ylabel = "  [rad]",
        labels = :none)

peaks = findmaxima(data2[!,2])
peaks = peaks[1][peaks[2] .> -10]

scatter!(data2[peaks,1],data2[peaks,2],
                labels = "Peaks")
```



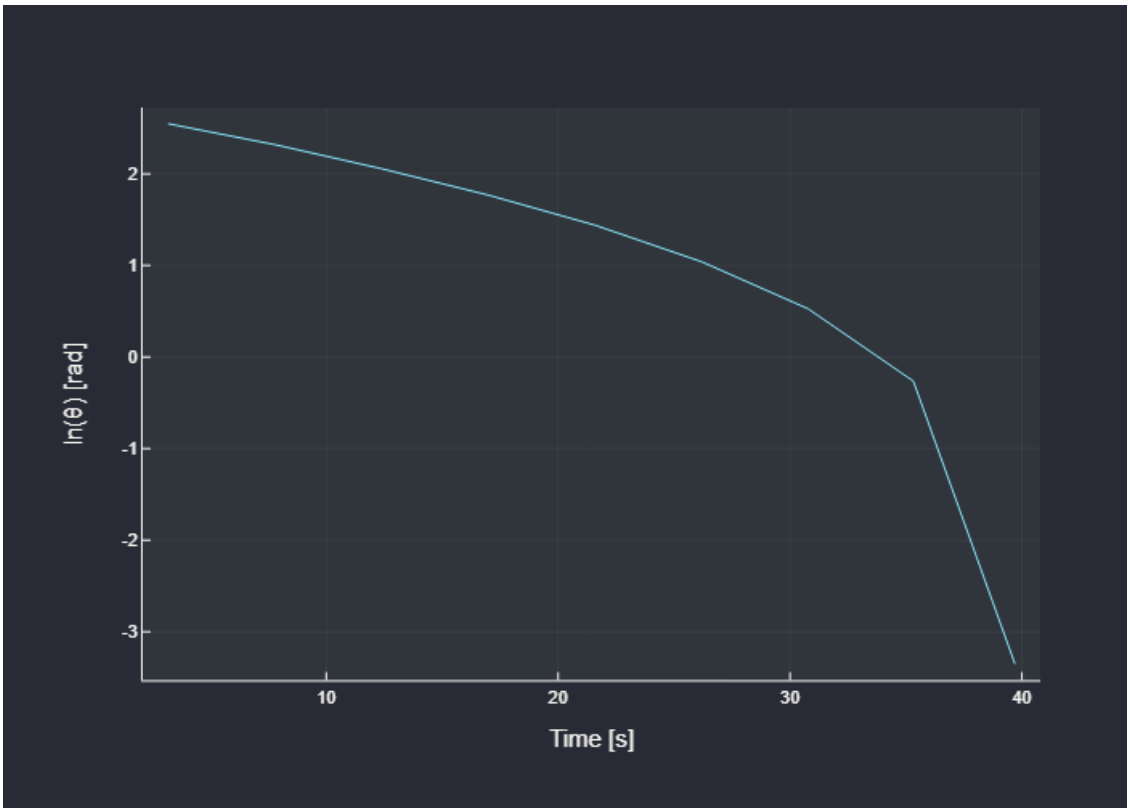
Gögn 2 nema abs

[ ]:
```
plot(data2[!,1], abs.(data2[!,2]),
xlabel = "Time [s]",
ylab = "| | [rad]",
labels = :none)
```



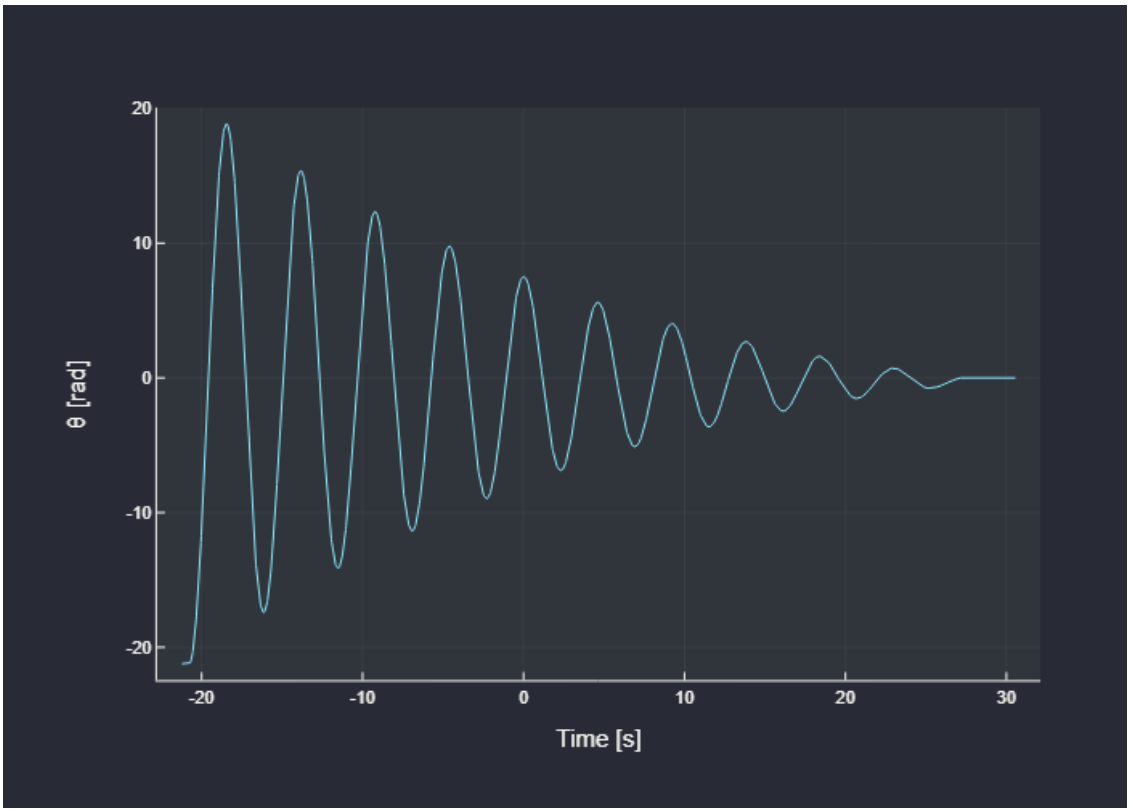
Gögn 2 hápunktar nema $\log_e$ skali á y-ás

```
[ ]: plot(data2[peaks,1], log.(data2[peaks,2]),
     xlabel = "Time [s]",
     ylabel = "ln( ) [rad]",
     labels = :none)
```



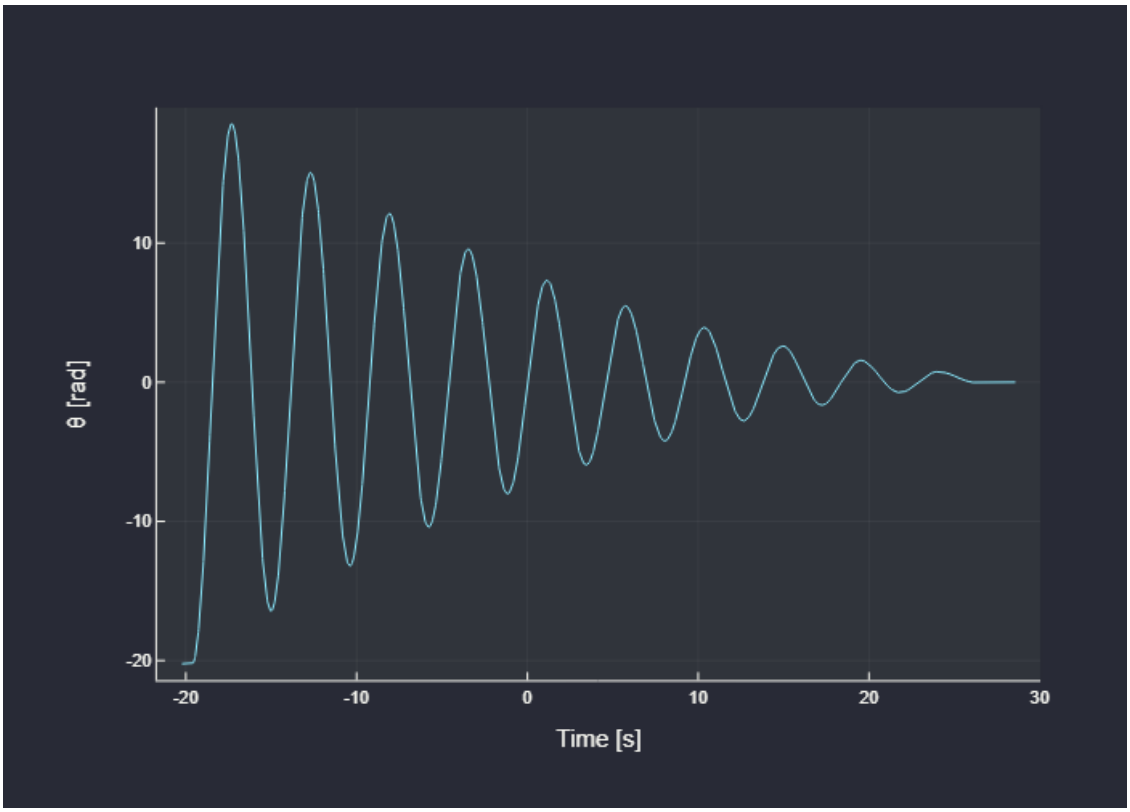
0.1.3 Gögn 3, Mæling á yfir tíma nema með segul á topp súlunar

[ ]:
```
data3 = CSV.read("data3.csv", DataFrame)
data3 = data3 .- data3[end,2]

plot(data3[!,1], data3[!,2],
xlabel = "Time [s]",
ylabel = "  [rad]",
labels = :none)
```



0.1.4 Gögn 4, Mæling á yfir tíma nema með segul á hlið topp súlunar

[ ]:
```
data4 = CSV.read("data4.csv", DataFrame)
data4 = data4 .- data4[end,2]

plot(data4[!,1], data4[!,2],
xlabel = "Time [s]",
ylabel = "  [rad]",
labels = :none)
```



0.2 Útreykningar

0.2.1 Góða gamla fallið

[ ]:
```
"""
Fall til að fynna jöfnu óvissu fyrir gefna jöfnu
"""
function findErrorFromSym(symExpr; errorPrefix = "Err")
        vars = Symbolics.get_variables(symExpr)
        varErrs = []

        for i in vars
                push!(varErrs, Symbolics.variable(string(errorPrefix,i)))
        end

        Dvars = [expand_derivatives(Differential(i)(symExpr)) for i in vars]

        symErr = sqrt(sum((Dvars[i]*varErrs[i])^2 for i in eachindex(vars)))

        return symErr
end
```

findErrorFromSym

0.2.2 Mælingar

[ ]:
```
rskvfull = (5.16±0.01)u"cm"
rskvinn = (0.27±0.01)u"cm"
(r  = rskvfull-rskvinn) |> latexify
```

$4.89 \pm 0.014cm$

[ ]:
```
(k  = fitlinear(data[!,2],data[!,1]).a*1u"N*m") |> latexify
```

$0.010578748137015776mN$

[ ]:
```
(r = (9.5±.1)u"cm") |> latexify
```

$9.5 \pm 0.1cm$

[ ]:
```
(m = (122±1)u"g")|> latexify
```

$122.0 \pm 1.0g$

0.2.3 Jöfnur og útreikningar

[ ]:
```
k = fitlinear(data2[peaks,1],log.(data2[peaks,2]))
```

```
------------------- Linear Fit -------------

Equation: y = ax + b

With: a = -0.12751728725770162
      b = 3.6454539369194388

Pearson correlation coefficient, R = 0.8749555892893659
Average square residue = 0.6957180337976472

Predicted Y: ypred = [3.2399489634399474, 2.650819096309366…
residues = [0.6924588273501793, 0.3326559733520016…

-------------------------------------------
```

Δk

[ ]:
```
latexify(:(Δk=sqrt(n/(n*sum(x.^2)-sum(x.^2)))),env = :eq)
```

$$\Delta k = \sqrt{\frac{n}{n \cdot \sum x^2 - \sum x^2}} \tag{1}$$

[ ]:
```
x = data2[peaks,1]
n = length(x)
(Δk = sqrt(n/(n*sum(x.^2)-sum(x.^2)))) |> latexify
```

0.014386314296074681

b og Δb

[ ]:
```
@variables   R M Δ  ΔR ΔM
b = -1/2 *M*R^2*
```

$$-0.5R^2M\kappa \tag{2}$$

[ ]:
```
Δb = findErrorFromSym(b,errorPrefix = "Δ")
```

$$\sqrt{0.25\Delta\kappa^2R^4M^2 + 0.25\kappa^2\Delta M^2R^4 + \kappa^2\Delta R^2R^2M^2} \tag{3}$$

[ ]:
```
b= substitute(b,
        Dict([
                  => k.a,
                R => val(r),
                M => val(m)
        ]))
b = b.val

Δb = substitute(Δb,
        Dict([
                  => k.a,
                M => val(m),
                R => val(r),
                Δ  => Δk,
                ΔM => err(m),
                ΔR => err(r)
        ])
)
Δb = Δb.val

(b = (b ± Δb)*u"kg * m^2 * s^-1") |> latexify
```

$7.02e-5 \pm 8.1e-6 kgm^2s^-1$

T og ΔT

[ ]:
```
I = 0.5*m*r^2
(T = 2 /sqrt(k /I-b^2/4I^2)) |> latexify
```

$1.433 \pm 0.016s$

[ ]:
```
@variables K i B ΔK Δi ΔB
t = 2 /sqrt(K/i-B^2/4i^2)
Δt = findErrorFromSym(t,errorPrefix = "Δ")
```

$$\sqrt{\left(\frac{-\frac{\frac{1}{2}\Delta K\frac{6.283185307179586}{\left(\sqrt{\frac{K}{i}+\frac{-B^2}{4i^2}}\right)^2}}{\sqrt{\frac{K}{i}+\frac{-B^2}{4i^2}}}}{i}\right)^2+\left(\frac{\frac{B\Delta B\frac{6.283185307179586}{\left(\sqrt{\frac{K}{i}+\frac{-B^2}{4i^2}}\right)^2}}{\sqrt{\frac{K}{i}+\frac{-B^2}{4i^2}}}}{4i^2}\right)^2+\frac{\frac{1}{4}\left(\frac{6.283185307179586}{\left(\sqrt{\frac{K}{i}+\frac{-B^2}{4i^2}}\right)^2}\right)^2\left(\frac{-K}{i^2}-8i\frac{-B^2}{16i^4}\right)^2\Delta i^2}{\left(\sqrt{\frac{K}{i}+\frac{-B^2}{4i^2}}\right)^2}} \tag{4}$$

[ ]:
```
Δt = substitute(Δt,
        Dict([
                K => val(k ),
                i => val(I),
                B => val(b),
                ΔK => err(k ),
                Δi => err(I),
                ΔB => err(b),

        ])
)

(T = (val(T) ± Δt.val)*1u"s") |> latexify
```

$1.433 \pm 0.016s$