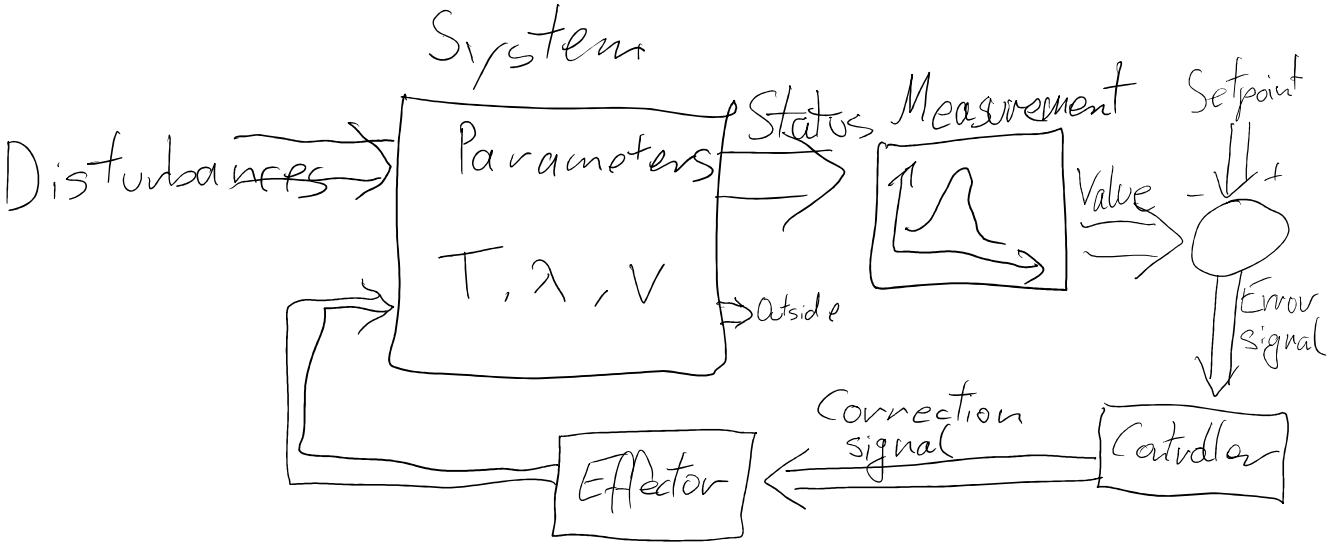
Laser Locking

Dienstag, 30. Mai 2023 11:27

Feedback loop



Errorsignal $E = S - V$

PID controller

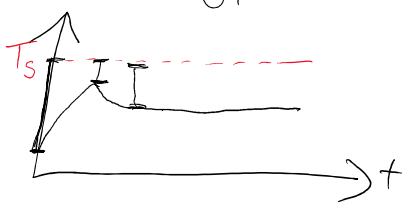
P(roportional): $P \cdot E$

I(ntegrational): $I \cdot \int_t d\tau\, E(\tau) \approx I \sum_i E_i$

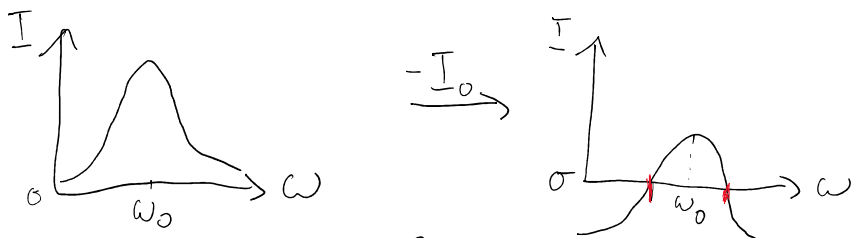
D(ifferential): $D \cdot \frac{\partial E}{\partial t}$

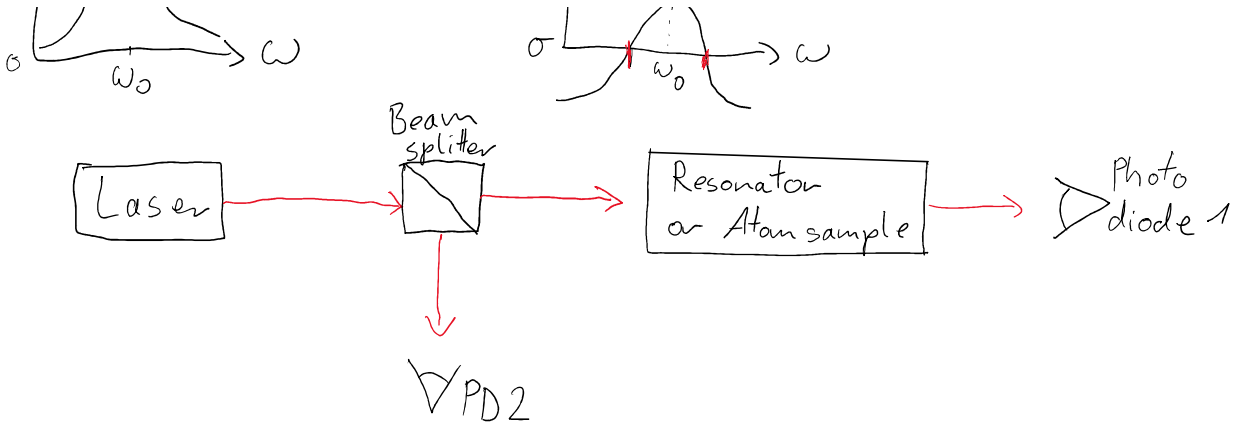
$$C(t) = P \cdot E(t) + I \cdot \int_t d\tau E(\tau) + D \cdot \frac{\partial E}{\partial t}$$

P alone is not sufficient



Which signal makes a good error signal?





$$S = \frac{PD1}{PD2} - I_0$$

Pro: - unaffected by small changes in intensity
- simple

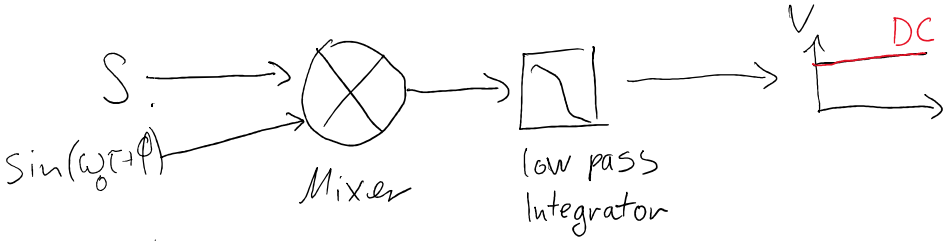
Con: - doesn't lock to ω_0 but to $\omega_0 \pm \Delta\omega$
- $\Delta\omega$ depends on intensity

The Lock-In Amplifier

Signal can contain many frequencies

How much of our signal comes from here?

LIA calculates the amplitude of a certain reference frequency ω_0.

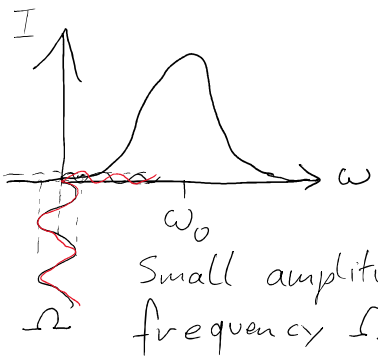


$$\int_{t-\Delta t}^{t} S(\tau)\cdot \sin(\omega_0\tau+\varphi)\,d\tau \approx \rho(\omega_0)\cos(\varphi)$$

Dither lock

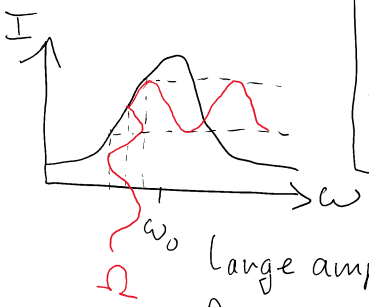
Fast modulation of frequency ω with Ω

1. Far detuning



Small amplitude
frequency Ω

2. Left flank

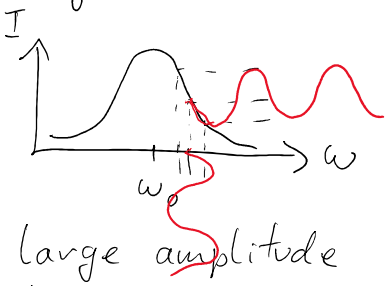


large amplitude
frequency Ω
in Phase

Aside:

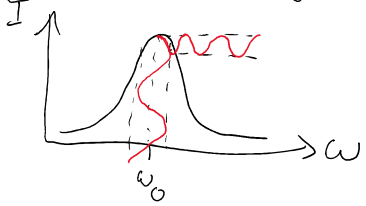
Scan Laser (λ,ω)
by scanning V

3. Right flank



large amplitude
frequency Ω
Phase π

4. Top of fringe



small amplitude
frequency 2Ω

Feed PD-signal into LIA to generate error signal