UNIVERSITY OF TWENTE.

Hitting the right notes

optical pulse synthesis

R.M. Oldenbeuving

Laser physics and nonlinear optics group

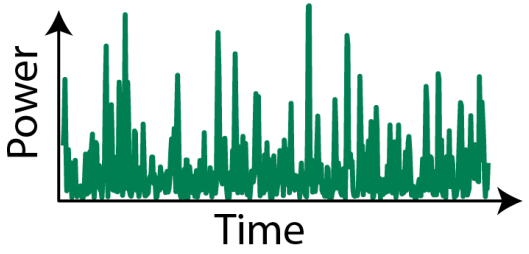
Hitting the right notes

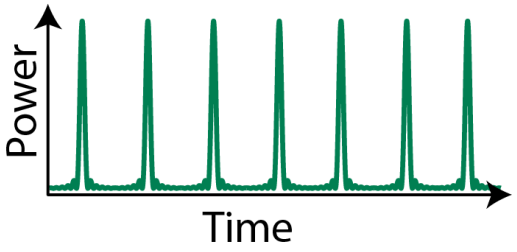
Optical pulse synthesis

- We present a new kind of mode-locking by combining several separate cw lasers to produce pulses
- Separate cw lasers each with their own frequency, by cavity design (*“hitting the right notes”)*
- Partially overlapping the different laser cavities to synthesize a pulse-train (*“optical pulse synthesis”)*

Making pulses

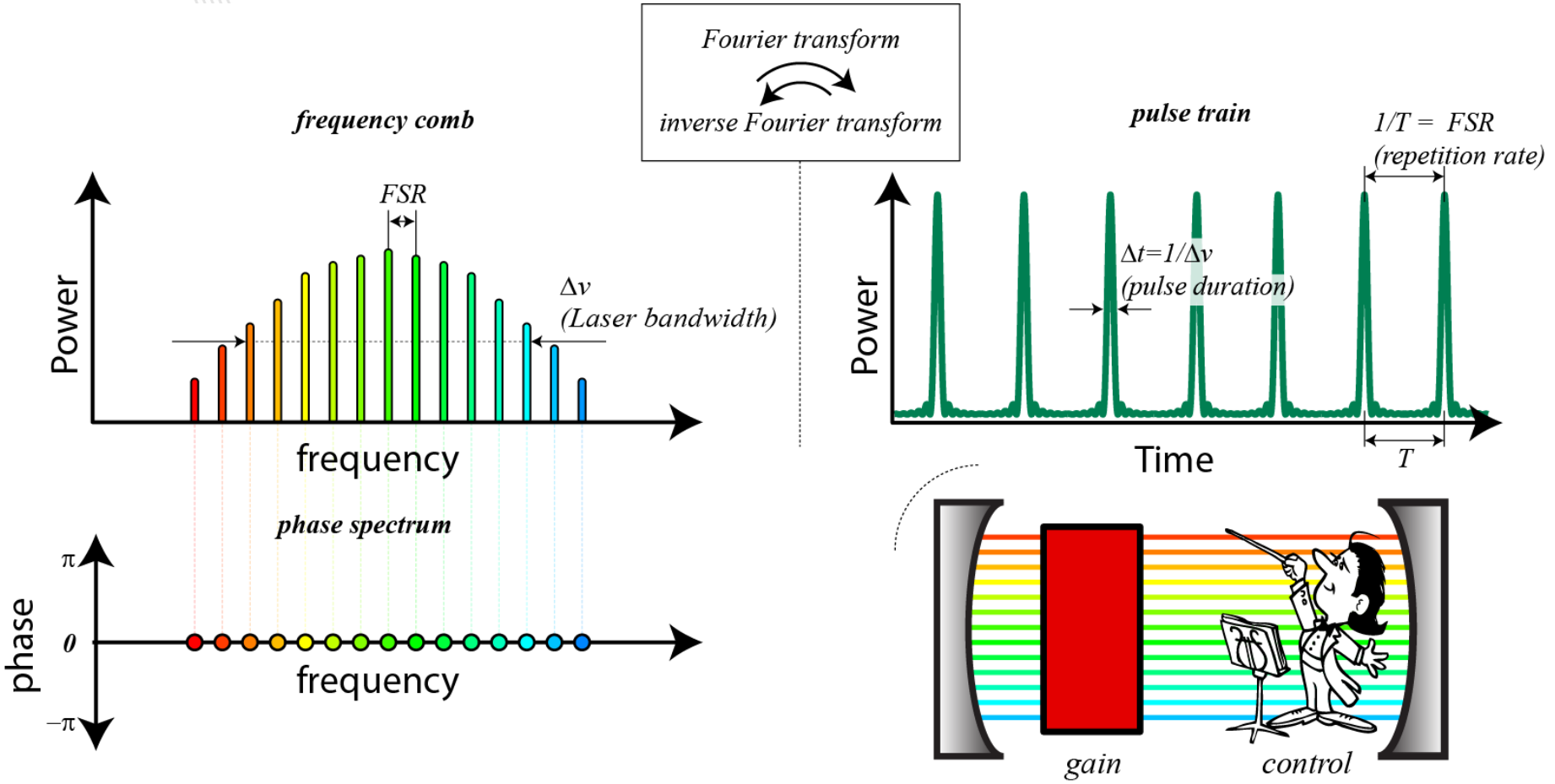
A short introduction into mode-locking





Mode-locking

The standard approach



Problems

With current mode-locking methods

- High repetition rates require a large FSR, i.e., a small cavity
  - This yields a low output power
- Optical damage of gain medium
- Modes influence each other in gain element (nonlinear effects)

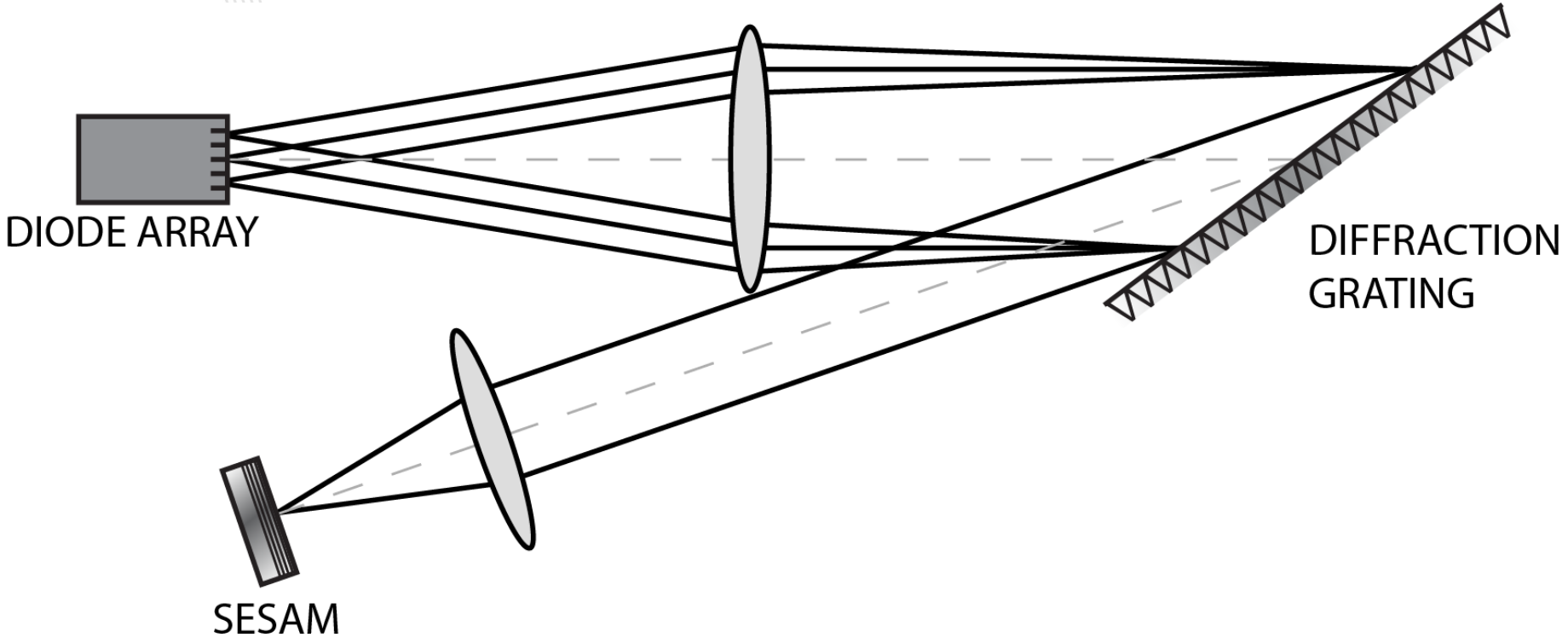
Solution

A new kind of mode-locking

- Use multiple lasers to increase overall output power
- Design cavities such that each laser has own frequency *("Hitting the right notes")*
  - *Single frequency => cw output for the individual lasers*
- Design frequency comb to design repetition rate and pulse duration
- Combine frequencies into one beam
- Use non-linear optical element to control phases which leads to pulsing *("optical pulse synthesis")*
  - *Non-linear element: semiconductor saturable absorber mirror (SESAM)*

Hitting the right notes

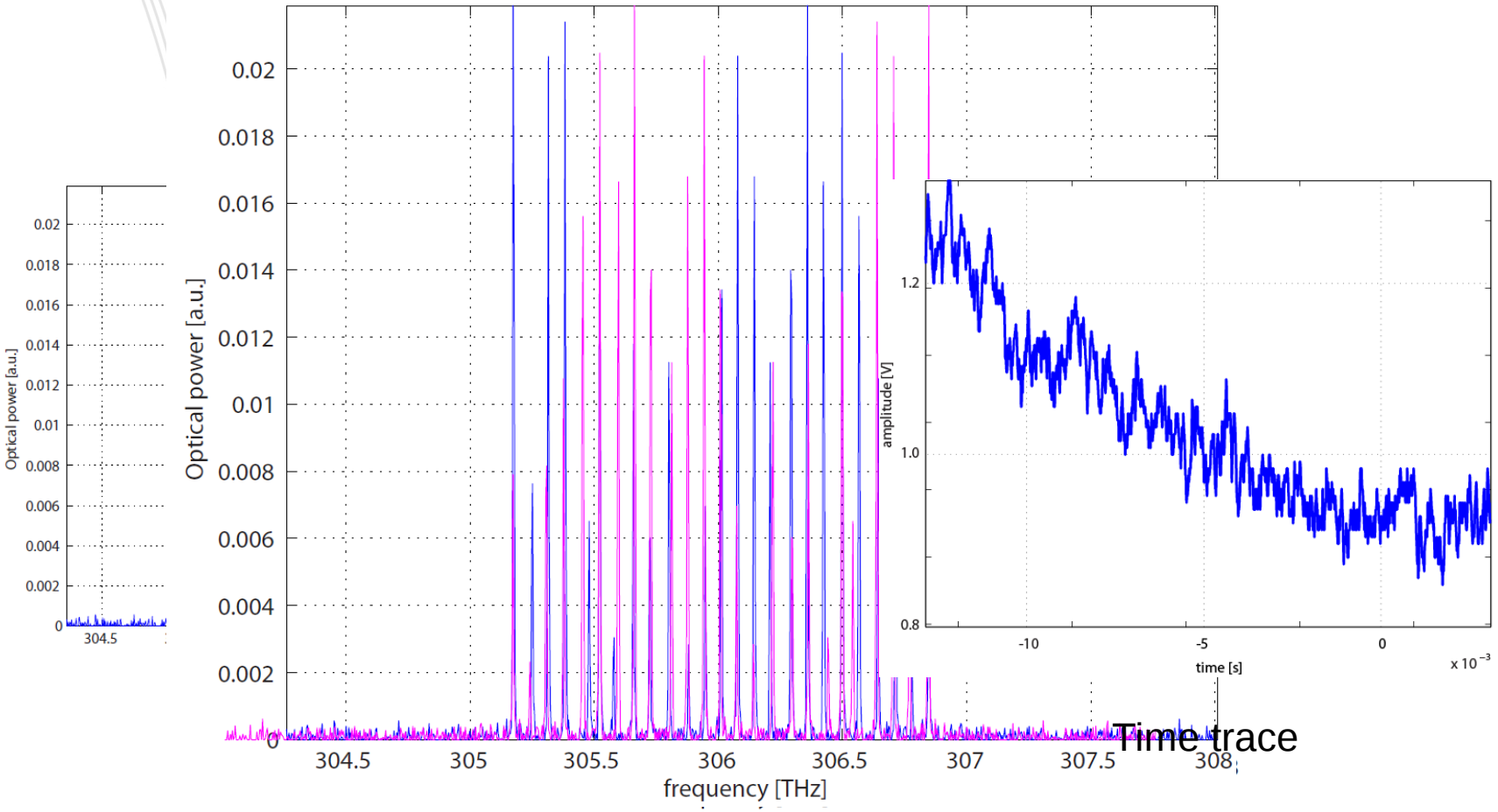
laB setup



Expected parameters: ~70 GHz repetition rate, ~500 fs pulse duration, 2 W average output power

Typical measured spectrum and time-trace

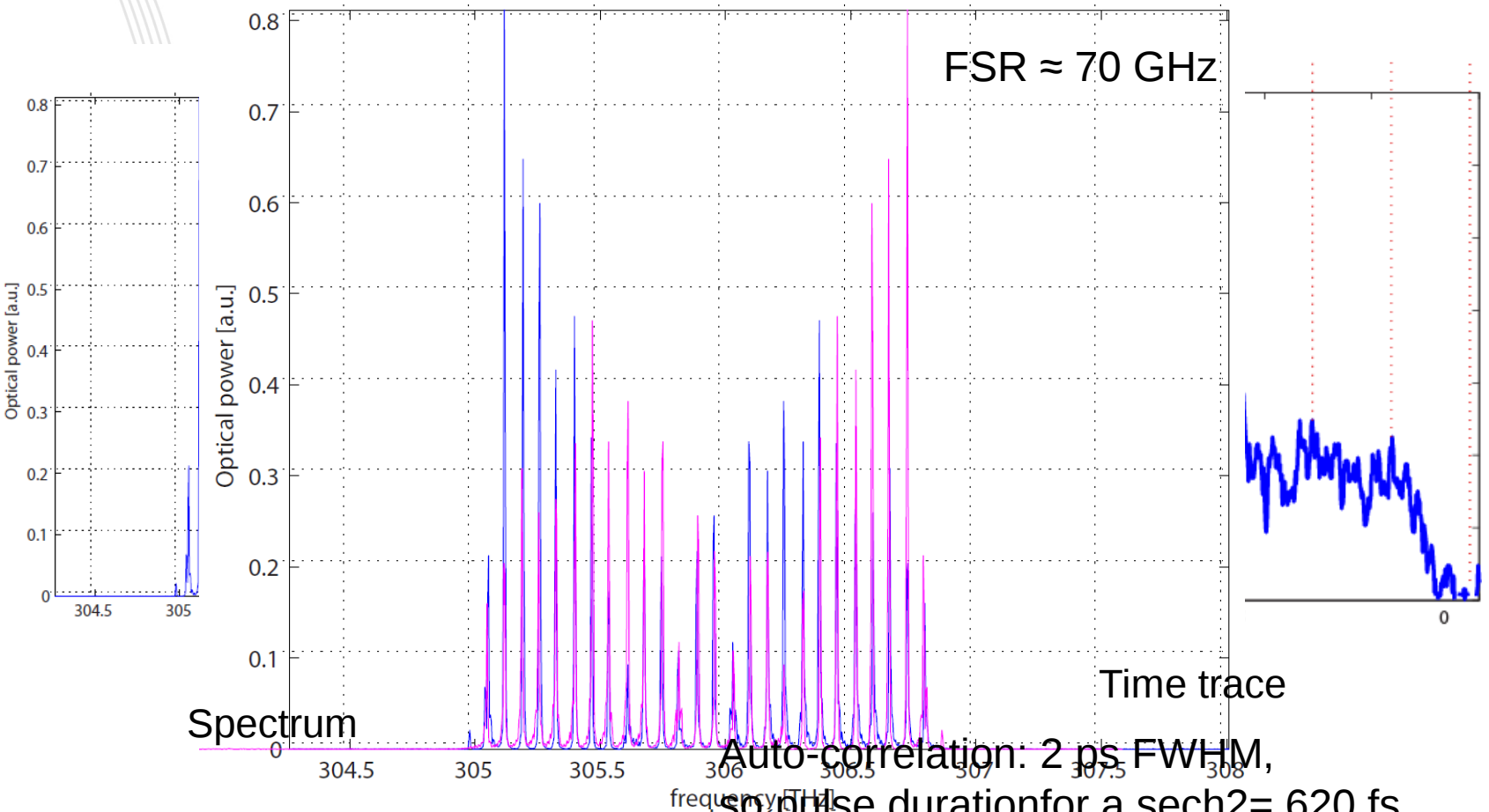
Hitting roughly the right notes



Time trace

Mode-locked spectrum and pulses

Hitting exactly the right notes



Conclusions

- New kind of mode-locking is proposed
- First signs of mode-locking have been seen
- A completely new class of mode-locked lasers can be developed