Summary – Amplification of ultrashort pulses

- Generation of ultrashort laser pulses is limited by average power
- Increasing the resonator length (long cavity oscillators)
- Further decreasing of repetition rate: down-sampled pulse train
- External amplification
- Key quantity: Saturation fluence $J_{\text{sat}}$

\[ J \ll J_{\text{sat}} \quad \ldots \quad \text{high gain} \]

\[ J \approx J_{\text{sat}} \quad \ldots \quad \text{efficient energy extraction} \]

- Cascaded amplification with various stages
Summary – Amplification of ultrashort pulses

Multipass amplifiers

• Small & cheap setup; typically 4…8 passes
• Minimal dispersion
• Sensitive alignment
• Operation close to damage threshold for sufficient gain

Regenerative amplifiers

• Amplification in external cavity
• Easy alignment
• Beam quality determined by cavity
• Efficient energy extraction due to large number of passes
• Satellite pulses
Summary – Amplification of ultrashort pulses

B-Integral as measure for influence of nonlinearity

Chirped pulse amplification

- Temporal broadening of pulse to reduce peak power
- Amplification to PW range
- Limiting factor: Damage threshold
- Vacuum optics

Further power scaling: Beam combining

Important during each of these steps: Pulse characterization → next lecture