Picosecond, 115 mJ Energy, 200 Hz Repetition Rate Cryogenic Yb:YAG Bulk-amplifier

M. Hemmer^{1,2}

F. Reichert^{1,2}, K. Zapata^{1,2}, M. Smrz³, A.-L. Calendron^{1,2}, H. Çankaya^{1,2}, K-H. Hong⁴,
F. X. Kärtner^{1,2,4}, and L. E. Zapata^{1,2}

¹Center for Free-Electron Laser Science, Hamburg, Germany

²Deutsches Elektronen-Synchrotron (DESY), Hamburg, Germany

³Hilase Center, Dolni Brezany, Czech republic

⁴Research Lab of Electronics, Massachusetts Institute of Technology, USA

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STATE-OF-THE-ART Yb:YAG PS TECHNOLOGY

**Cryogenic technology can scale energy and repetition rate
simultaneously & simplify current architecture**

BASIC MATERIAL PROPERTIES AT CRYO TEMPERATURE

ROBUST, COMPACT, 4-PASS LAYOUT

numb relaying

Calendron et

- Seed c
- KD*P
- Yb:YAG crystal: 1% doped, 2.5 cm thick, 3 mm undoped YAG cap

115 mJ, 200 Hz, EXCELLENT BEAM PROFILE

HIGH GAIN, HIGH ENERGY

- Optimization possible with in-band seeding
- 5 ps TL pulse duration – compressibility of seed has been demonstrated

Robust setup yields over 2 order of magnitude gain
Further energy scaling ?...

COMBINING THIN-DISK & CRYOGENIC TECHNOLOGIES

High gain in thin-disk requires mitigating transverse ASE buildup

Zapata *et al.*, Opt. Lett., accepted for publication

Model driven design of ASE mitigation is experimentally validated
Implementation in a multi-pass amplifier...

MULTI-PASS CRYOGENIC THIN-DISK AMPLIFIER

- 6 or 12 pass design
- Strict relay imaging to control propagation in the amplifier
- Built-in spatial filtering to smooth out output profile
- Equipped with similar pump module as previously with 2 kW average/peak power

160 mJ, 100 Hz, NEAR DIFFRACTION LIMITED PROFILE

FIGURATION

- **In-band** seeding with 20 mJ energy from previous bulk amplifier
- Saturation reached for ~ 20 mJ seed energy and 2.5% duty cycle
- Increasing duty cycle results in onset of transverse ASE build up

Further energy scaling toward the Joule level is underway

SCALING REPETITION RATE – 100 kHz

MODIFICATIONS TO ORIGINAL SETUP FOR AVERAGE POWER HANDLING

- Similar layout as 100 Hz setup – 4 pass polarization switched amplifier
- Splitting of pump power on two crystals to facilitate high average power operation

SCALING REPETITION RATE – 100 kHz OPERATION

- Excellent output spatial profile – **no evidence of thermal effects**
- Rollover at ~60 W – currently under investigation
- Spectral gain narrowing is similar to low repetition rate configuration

Preliminary results – readily illustrates versatility of cryo cooled amplifier

CONCLUSION & REMARKS

Demonstration of simple 100 mJ class amplifiers

- Demonstration of robust, low-cost, bulk amplifier
115 mJ, 200 Hz, 5 ps TL duration, near diffraction limit spatial profile
- Demonstration of a robust, high gain, cryo cooled thin disk amplifier
160 mJ, 100 Hz, 5 ps TL pulse duration, near diffraction limit spatial profile
- Experimental demonstration of a robust, high gain, 100 kHz amplifier
0.6 mJ, 100 kHz, 5 ps TL pulse duration, near diffraction limit spatial profile
- These sources make ideal pump laser for OPCPAs !