Custom Picosecond Amplifiers

APL Custom

APPLICATIONS

- *Multi-stage OPCPA pumping*
- *Non-linear optics*
- *Other spectroscopic and nonlinear optics applications...*

FEATURES

- *Flash lamp or diode pumped multi-channel APL systems*
- *Each of the channels can be **tailored according to pumping requirements***
- *High energy APL version with **variable burst***
- *Hybrid APL with fiber front-end and **Yb:YAG** amplifiers – **1 ps, 8 mJ** output at **10 kHz***
- ***1 – 300 ps** pulse duration*
- *From Single Shot to 10 kHz pulse repetition rate*
- *Internal or external seeding source*
- *Advanced beam shaping for high pulse energy*
- *Thermally induced birefringence compensated*
- *Low jitter synchronization pulses below 10 ps RMS jitter*
- *Vacuum image relay system*
- *Optional temperature stabilized second, third and fourth harmonic generators*

Multiple Channel APL series picosecond amplifiers were designed and manufactured for multiple stage OPCPA pumping. Systems can be specially tailored for customer's needs and have up to 8 pumping channels with different wavelength, energy, pulse duration, spatial and temporal profiles, adjustable delay, image translation to customers specified location and various other features. Short pulse duration, excellent pulse-to-pulse stability, superior beam quality makes APL series picosecond amplifiers well suited for other applications as well.

Regenerative amplifier / Power amplifier design

APL series amplifiers are designed to be seeded by external seeding source. Diode pumped regenerative amplifier ensures amplification of seed signal to stable mJ level pulse for amplification in linear amplifiers. Advanced beam shaping ensures smooth, without hot spots beam spatial profile at the laser output. Low light depolarization level allows high efficiency generation of up to 4th harmonic with optional build-in harmonic generators. Alternatively Ekspla can offer an internal seeder meeting customer's requirements.

Full-fiber front-end

Novel Ekspla developed fiber front-end opens up new set of unique features for APL systems like dual wave seeder that also has burst formation functionality due to active fiber loop technology. The front-end also permits to offer powerful, ultrafast and higher frequency Ytterbium amplifiers for wider opportunities in OPCPA pumping and other scientific uses.

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SPECIFICATIONS

Model	APL2k10-x4	APL1301k-x8	APL1k100-Burst	APL810k-1030
MAIN SPECIFICATIONS [1]				
Output energy				
Fundamental	4 × 2 200 mJ [2] [3]	8 × 130 mJ	1.4 J Burst (4×300 mJ + 4×50 mJ)	8 mJ @ 1030 nm
SH output [4] [5]	4 × 1 400 mJ	8 × 85 mJ	NA	NA
TH output [4]	4 × 660 mJ	8 × 50 mJ	NA	NA
FH output [4]	4 × 220 mJ	8 × 15 mJ	NA	NA
Pulse repetition rate	10 Hz	1 kHz	100 Hz	10 kHz
Pulse duration [6]	90 ± 10 ps	90 ± 10 ps	90 ± 10 ps	1 ± 0.2 ps
Pulse energy stability [7]				
Fundamental	≤ 0.6 %	≤ 0.5 %	≤ 1 %	≤ 0.5 %
SH output [4]	≤ 0.8 %	≤ 0.8 %	NA	NA
TH output [4]	≤ 2 %	≤ 2 %	NA	NA
FH output [4]	≤ 3 %	≤ 3 %	NA	NA
Long-term power drift [8]	± 2 %	± 1.5 %		
Beam spatial profile	Super-Gaussian [9]	Super-Gaussian [9]	Super-Gaussian and Gaussian [9]	Gaussian [9]
Beam diameter [10]	~ 23 mm	~ 7 mm	~ 11 & 5 mm	~ 6 mm
Beam pointing stability [11]	≤ 30 µrad	≤ 20 µrad	≤ 20 µrad	≤ 20 µrad
Beam divergence	≤ 0.5 mrad	≤ 0.5 mrad	≤ 0.5 mrad	≤ 0.5 mrad
Pre-pulse contrast [12]	> 200:1	> 200:1	> 200:1	> 200:1
Optical pulse jitter [13]				
Trig out	≤ 100 ps	≤ 100 ps	≤ 100 ps	≤ 50 ps
Pre-Trig out	≤ 50 ps	≤ 50 ps	≤ 50 ps	≤ 50 ps
With –PLL option	≤ 2 ps	≤ 2 ps	≤ 2 ps	NA
Polarization	Linear	Linear	Linear	Linear
PHYSICAL CHARACTERISTICS [14]				
Laser head size (W×L×H mm)	1500 × 3600 × 500, 2 pc.	1500 × 3600 × 500, 4 pc.	700 × 2000 × 300	900 × 1200 × 300
Power supply size (W×L×H mm)	553 × 600 × 1800, 4 pc.	553 × 600 × 1800, 4 pc.	553 × 952 × 600	553 × 952 × 600
Umbilical length [15]	5 m	2.5 m	2.5 m	3 m
OPERATING REQUIREMENTS [16]				
Electrical power	208, 380 or 400 VAC, three-phase, 50/60 Hz [17]	208, 380 or 400 VAC, three-phase, 50/60 Hz [17]	208 – 240 VAC, single-phase, 50/60 Hz	208 – 240 VAC, single-phase, 50/60 Hz
Power consumption [18]	≤ 40 kVA	≤ 60 kW	≤ 5 kW	≤ 3.5 kW
Water supply	≤ 40 l/min, 2 Bar, max 15 °C	≤ 40 l/min, 2 Bar, max 15 °C	≤ 5 l/min, 2 Bar, max 15 °C	≤ 15 l/min, 2 Bar, max 15 °C
Operating ambient temperature	22 ± 2 °C	22 ± 2 °C	22 ± 2 °C	22 ± 2 °C
Storage ambient temperature	15 – 35 °C	15 – 35 °C	15 – 35 °C	15 – 35 °C
Relative humidity (non-condensing)	≤ 80 %	≤ 80 %	≤ 80 %	≤ 80 %
Cleanness of the room	ISO Class 7	ISO Class 7	ISO Class 7	ISO Class 7

1) Due to continuous improvement, all specifications are subject to change without notice. The parameters marked 'typical' are indications of typical performance and will vary with each unit we manufacture. Presented parameters can be customized to meet customer's requirements. All parameters measured at 1064 nm if not stated otherwise.

2) 2 200 mJ energy is achieved with Super-Gaussian spatial beam profile of 11th or higher order (with steep edges). If lower order Super-Gaussian is required maximum pulse energy will be limited to 2 000 mJ.

3) 2 500 mJ output energy is available upon request with longer pulse duration.

4) Harmonic outputs are optional. Specifications valid with respective harmonic module purchased. Outputs are not simultaneous.

5) Second harmonic specification is valid when only SH option is ordered. If TH/FH options are orders second harmonic efficiency is reduced to ~50 %.

6) Standard pulse duration is 90 ps. Other pulse durations can be ordered within range of 20 ps – 300 ps. Shortening the pulse duration below 90 ps will reduce the output energy proportionally.

7) Under stable environmental conditions, normalized to average pulse energy (RMS, averaged from 60 s).

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[8] Measured over 8 hours period after 30 min warm-up when ambient temperature variation is less than ±2 °C.

[9] Super-Gaussian spatial mode of 6-11th order in near field.

[10] Beam diameter is measured at signal output at 1/e2 level for Gaussian beams and FWHM level for Super-Gaussian beams.

[11] Beam pointing stability is evaluated as movement of the beam centroid in the focal plane of a focusing element (RMS, averaged from 60 s).

[12] 1000:1 contrast available upon request.

[13] Optical pulse jitter with respect to electrical outputs:
– Trig out > 3.5 V @ 50 Ω
– Pre-Trig out > 1 V @ 50 Ω
– PLL option > 1 V @ 50 Ω

[14] System sizes are preliminary and depend on customer lab layout and additional options purchased.

[15] Longer umbilical with up to 10 m for flash lamp pumped and up to 5 m for diode pumped systems available upon request.

[16] The laser and auxiliary units must be settled in such a place void of dust and aerosols. It is advisable to operate the laser in air conditioned room, provided that the laser is placed at a distance from air conditioning outlets. The laser should be positioned on a solid worktable. Access from one side should be ensured.

[17] Voltage fluctuations allowed are +10 % / -15 % from nominal value.

[18] Required current rating can be calculated by dividing power rating by mains voltage. Power rating is given in apparent power (kVA) for systems with flash lamp power supplies and in real power (kW) for systems without flash lamp power supplies where reactive power is neglectable.

OPTIONS

Option	Description	Comment
-P20...300	Custom pulse duration between 20 ps and 300 ps	Available with internal and external seeder. Shortening the pulse duration below 90 ps will reduce the output energy proportionally
-50/100	50 Hz or 100 Hz pulse repetition rate	Energy can be increased ~4 times compared to 1 kHz systems
-2k	2 kHz pulse repetition rate	Reduces the output energy of fundamental by ~50 %
-G	Gaussian like spatial beam profile	Reduces the output energy of fundamental by ~80 %
-FS	External seeder input via motorized spectral broadening stage	Requires > 1.5 nJ per pulse @ 800 nm, 100 fs
-PLL	Phase Lock Loop option for precise lock to external RF signal	Electrical to optical signal jitter ≤ 3 ps
-SH/TH/FH	Second, third and fourth harmonic outputs	Conversion efficiency from fundamental respectively ~50 %, ~30 % and ~10 %. Harmonic outputs not simultaneous with fundamental output
-AW	Water-to-Air cooling	Replaces or supplements Water-to-Water cooling unit. Heat dissipation equals total power consumption

PERFORMANCE

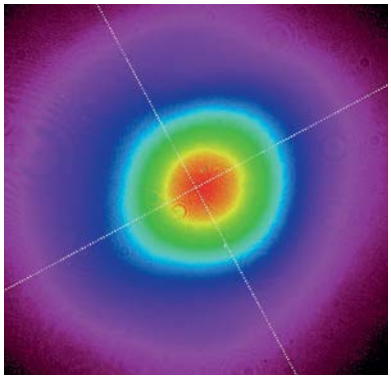

Fig 1. Typical APL Ytterbium system amplifier system near field beam profile at 1030 nm (imaged from laser output)

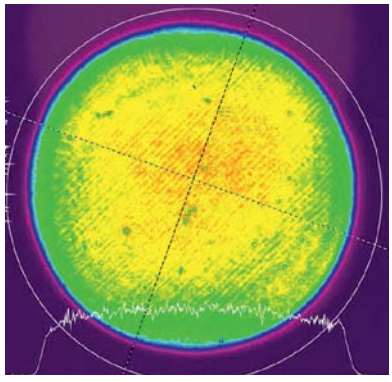

Fig 2. Typical High Energy APL amplifier system near field beam profile at 1064 nm (imaged from laser output)

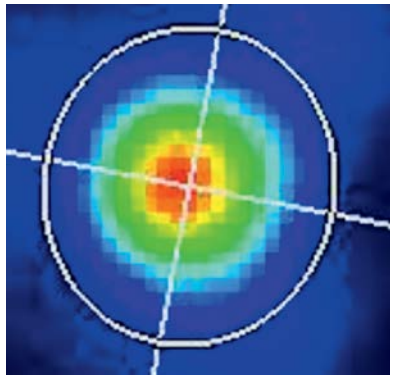

Fig 3. Typical High repetition rate APL amplifier system far field beam profile at 532 nm (imaged from SH crystal)

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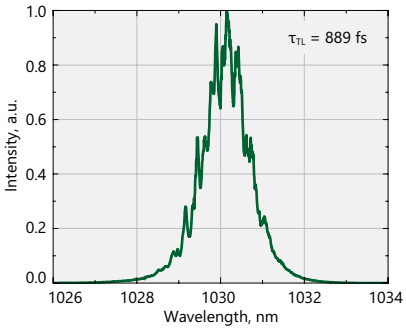

Fig 4. Typical output pulse spectrum of the APL Ytterbium system

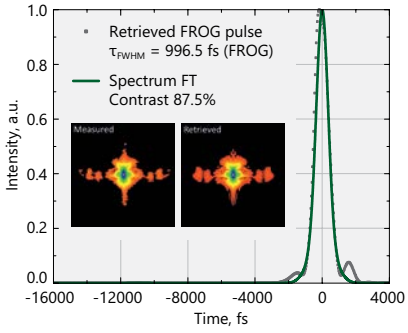

Fig 5. Typical pulse shape (FROG measurement) APL Ytterbium system

STABILITY

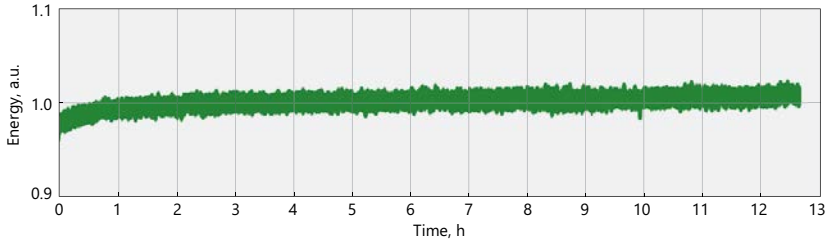

Fig 6. Typical long-term energy stability of High repetition rate APL system

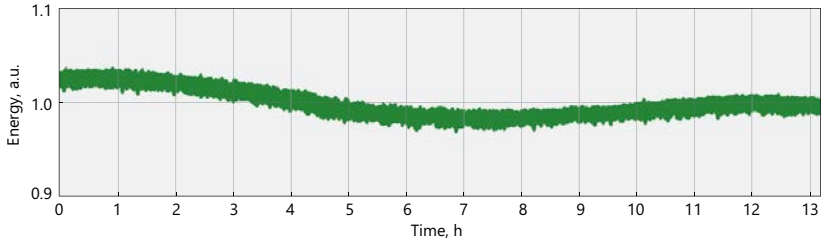

Fig 7. Typical long-term energy stability of High Energy APL system

ORDERING INFORMATION

Note: Laser must be connected to the mains electricity all the time. If there will be no mains electricity for longer that 1 hour then laser (system) needs warm up for a few hours before switching on.

APL (1)(2)-x(3)-(4)

- Model
- Energy level:
  130 → 130 mJ
  2k → 2200 mJ
- Pulse repetition rate:
  10 → 10 Hz
  1k → 1 kHz
- Number of channels:
  x4 → four channels
  x8 → eight channels
- Any additional options:
  See 'Options' table