

Laser Systems for PIV Applications

Laser system VM-2132PIV, VM-2145PIV-200, VM-2145PIV-300 are designed for Particle Image Velocimetry (PIV) and other kinetic applications e. g. like Laser Induced Breakdown Spectroscopy (LIBS).

main features:

- small foot-print laser head design
- integrated one-body power supply and cooling system with water-to air heat exchanger
- output of two pulses with equivalent energy, beam quality
- precise tuning of two pulses delay from 1µs to 100ms using internal control
- any delay between pulses using external control and built-in TTL interface
- high stability and durability of the output parameters provided by special temperature control of nonlinear and Q-switched crystals as well as laser resonator special design
- built-in variable attenuator (option) of output energy
- internal probes of 1064nm energy (option)
- compatible with C-mount (option)



specifications:

	VM-2132PIV	VM-2145PIV-200	VM-2145PIV-300
energy @532nm, mJ	2x 100	2x 200	2x 300
pulse duration (FWHM), ns	≤ 5	≤ 6-7	≤ 6-7
pulse repetition rate, Hz	20	15	10
beam divergence ($\Theta_{0,86}$), mrad	≤ 3	≤ 1.5	≤ 3
beam diameter, mm	≤ 5	≤ 6	≤ 8
delay between pulses	1µs-50ms	1µs-60ms	1µs-100ms
jitter, ns	±1.0	±1.5	±1.5
energy stability @532nm (rms), %	<1	<1	<1
polarization	linear horizontal	linear horizontal	linear horizontal

size LxWxH, mm (weight, kg)

• laser head	416x176x121 (10.0)	462x234x125 (12.0)
• power supply incl. cooling system	445x252x465 (25.0)	445x252x465 (25.0)

input power requirements

single phase, universal input
100-240V, 50/60Hz, 15A@100V, 10A@220V

Laser Systems for LIBS Applications

Laser system VM-2132LIBS, VM-2134LIBS, VM-2136LIBS, VM-2145LIBS, are designed for Laser Induced Breakdown Spectroscopy (LIBS) and other kinetic applications e. g. like Particle Image Velocimetry (PIV).

main features:

- compact Double Pulsed Laser (DPL)
- two independent laser resonators pumped by a single flash lamp integrated in one laser emitter
- multiple triggering: single-shot, continuous internal trigger, external TTL trigger
- output of two pulses with equivalent energy, polarization, and beam quality
- precise tuning of two pulses delay from 0µs to 80µs
- computer control via RS-232 port
- dual output ports for independent operation of both oscillators



specifications:

	VM-2131LIBS	VM-2134LIBS	VM-2145LIBS	VM-2136LIBS-4	VM-2136LIBS-5
energy @1064nm, mJ	100	200	320	80	100
energy @532nm, mJ	50	110	190	40	50
pulse duration (FWHM), ns	14-16	14-16	14-16	14-16	14-16
pulse repetition rate, Hz	15	10	10	50	50
beam divergence ($\Theta_{0.86}$), mrad	≤ 1.5	≤ 2.5	≤ 2.5	≤ 1	≤ 1
beam diameter, mm	≤ 4	≤ 6.3	≤ 6.3	≤ 4	≤ 5
delay between pulses (step 1µs, step 1ns as option)	0µs-80µs	0µs-80µs	0µs-80µs	0µs-80µs	0µs-80µs
jitter, ns	±1.0	±1.0	±1.0	±1.0	±1.0
energy stability @532nm (rms), %	±3.0	±3.0	±3.0	±3.0	±3.0

size LxWxH, mm (weight, kg)

• laser head	770x306x143 (21.0)	770x306x143 (21.0)
• power supply	391x364x192 (16.5)	446x449x177 (20.0)
• cooling system	391x364x280 (15.5)	446x449x266 (23.0)

input power requirements

single phase, universal input
100-240V, 50/60Hz, 15A@100V, 10A@220V

Nd:YAG-Lasers with Integrated OPO (210 ... 2300nm)

VM-2145-OPO is a Q-switched Nd:YAG laser with built-in midband optical parametric oscillator (OPO) providing conversion of Nd:YAG third harmonic (355 nm) radiation in to the tunable light of near IR and visible spectral range.

main features:

- independent output of all Nd:YAG laser harmonics (1064nm, 532nm, 355nm) as well as OPO radiation
- automatically switching of wavelength outputs
- PC control of laser parameters
- monitoring of Nd:YAG harmonics energy by built-in photo probes
- small divergence and narrow line width of OPO radiation
- polarizing separation of OPO signal and idler waves
- single BBO crystal for the whole tuning range
- an internally sealed water cycle cooling system with water-to-air heat exchanger



laser head with 1064nm, 532nm, 355nm, IW (710-2300nm), SW (400-710nm)

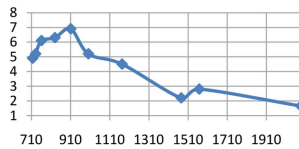
specifications:

energy, mJ	
@1064nm	350
@532nm	230
@355nm	85-90
@idler wave (IW), 710-2300nm, max	5
@signal wave (SW), 400-710nm, max	25
@SH OPO (SW+IW), 210-400nm, max	3
OPO linewidth (SW, 450nm), nm	< 0.1
output pulse energy instability (rms), %	
@1064nm	< 0.6
@532nm	< 0.8
@355nm	< 1
@idler wave (IW), 710-2300nm	< 2.5
@signal wave (SW), 400-710nm	< 2
pulse duration (FWHM), ns	
@1064nm	≤ 12-15
@OPO	≤ 8-10
pulse repetition rate, Hz	10
beam divergence ($\Theta_{0.86}$), mrad	
@1064nm, 532nm, 355nm	≤ 1.0
@OPO	≤ 1.5
beam diameter, mm	
@1064nm, 532nm, 355nm	≤ 6
@OPO	≤ 5
polarization	
@1064nm, 532nm, SW	horizontal
@355nm, IW, SH OPO	vertical

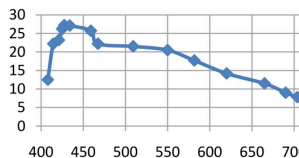
VM-2145OPO



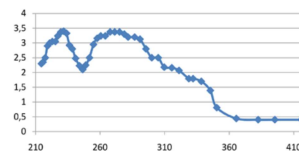
module for SH OPO with 210-400nm



IW output pulse energy
E@355nm = 82mJ



SW output pulse energy
E@355nm = 82mJ



SH OPO output pulse energy
E@355nm = 82mJ

size LxWxH, mm (weight, kg)

- laser head 650x424x143 (28.0)
- power supply 391x364x192 (18.0)
- cooling system 391x364x280 (16.0)
- SH OPO 276x207x125 (5.0)

input power requirements

single phase, universal input
100-240V, 50/60Hz
15A@100V, 10A@220V

Nd:YAG-Lasers with Integrated Ti:Sapphire (210 ... 1000nm)

VM-2134TS50, VM-2145TS150, and VM-2149TS-DPSS are fully integrated laser systems that combine Q-switched pump laser and Ti:Sapphire converter of Nd:YAG second harmonic radiation (532 nm) into tunable near IR, UV and visible spectral band.

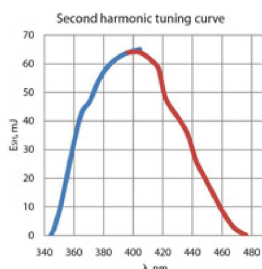
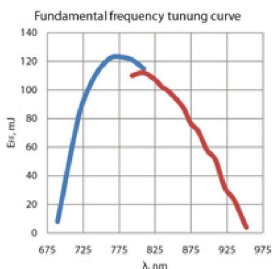
main features:

- possibility of independent operation of pump laser at 1064 and 532 nm as well as tunable lasing
- hands free operation and automatically switching output wavelengths
- built-in monitors of Nd:YAG FF and SH output energy
- built-in high efficiency Ti:Sapphire second harmonic unit
- narrow output linewidth (option)
- PC control of pump laser and fundamental harmonics of Ti:Sapphire laser (option)



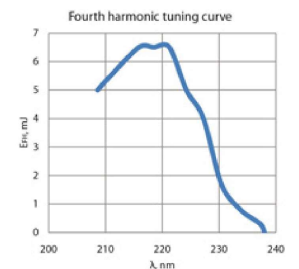
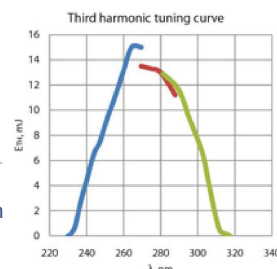
specifications:

	VM-2134TS50	VM-2145TS150	VM-2149TS-DPSS
energy, mJ			
@1064nm	350	700	8
@532nm	230	400	4
@FF, 690-1000nm, max	50	140	1.4
@SH, 350-500nm, max	20	-	-
@TH, 235-325nm with HG-TF unit	by request	-	-
@FH, 210-235nm with HG-TF unit	by request	-	-
linewidth, nm	< 0.1	< 3.0	< 1.2
pulse duration (FWHM), ns			
@1064nm	≤ 12-15	≤ 12-18	≤ 12-15
@Ti:Sa FF	≤ 8-30	≤ 8-30	≤ 25-35
pulse repetition rate, Hz	10	10	1000
beam divergence ($\Theta_{0,86}$), mrad			
@1064nm	≤ 1.0	≤ 1.0	≤ 1.5
@Ti:Sa FF	≤ 1.5	≤ 1.5	≤ 1.6
size LxWxH, mm (weight, kg)			
• laser head	670x474x143 (25.0)	800x450x150 (68.0)	620x360x153 (23.0)
• power supply	391x364x192 (18.0)	446x449x177 (19.0)	391x364x192 (18.0)
• cooling system	391x364x280 (16.0)	446x449x266 (20.0)	391x364x280 (16.0)
• HG-TF unit	328x236x130 (6.0)	-	-
input power requirements	single phase universal input 100-240V, 50/60Hz 15A@100V, 10A@220V	single phase universal input 100-240V, 50/60Hz 15A@100V, 10A@220V	single phase universal input 100-240V, 50/60Hz 15A@100V, 10A@220V



possible pulse energies with separate Ti:Sapphire units

pumping with 450mJ@532nm



Nd:YAG-Lasers with Integrated Forsterite (580...680, 1160...1360nm)

VM-2134F25 and VM-2134F15G are fully integrated laser systems that combine Q-switched pump laser and Forsterite crystal converter of Nd:YAG fundamental frequency (1064 nm) into tunable near IR and visible spectral band.

main features:

- possibility of independent operation of pump laser at 1064 and 532 nm as well as tunable lasing
- hands free operation and automatically switching output wavelengths
- built-in monitors of Nd:YAG FF and SH output energy
- built-in high efficiency Forsterite second harmonic unit
- narrow output linewidth
- PC control of pump laser and fundamental harmonics of Forsterite laser (option)



specifications:

VM-2134F25 (prism tuning)

VM-2134F25 (grating tuning)

energy, mJ		
@1064nm	260	260
@532nm	160	160
@FF, 1160-1360nm, max	25	15 (1190-1300nm)
@SH, 580-680nm, max	5.5	1.5 (595-650nm)
linewidth, nm	≤ 0.8	≤ 0.02
pulse duration (FWHM), ns		
@1064nm	10	10
@Forsterite	10	10
pulse repetition rate, Hz	10	10
beam divergence ($\Theta_{0.86}$), mrad		
@1064nm	≤ 1.0	≤ 1.0
@Forsterite	≤ 1.5	≤ 1.5
jitter @1064nm, rms, ns	±1.0	±1.0
beam diameter, mm		
@1064nm, @532nm	≤ 6.3	≤ 6.3
@Forsterite	≤ 3	≤ 3
size LxWxH, mm (weight, kg)		
• laser head	670x474x143 (25.0)	670x474x143 (25.0)
• power supply	391x364x192 (18.0)	391x364x192 (18.0)
• cooling system	391x364x280 (16.0)	391x364x280 (16.0)
input power requirements	single phase universal input 100-240V, 50/60Hz 15A@100V, 10A@220V	single phase universal input 100-240V, 50/60Hz 15A@100V, 10A@220V

Available standard Nd:YAG-Lasers

The possible available parameters of the Nd:YAG-lasers are given in the table below. The high pulse energy 1.4J@1064nm can be obtained with lamp pumping. The repetition rate with lamp pumping can be achieved up to 100 Hz, whereas the diode pumping (DPSS) allows the repetition rate up to 1kHz. The maximal standard pulse energy with diode pumping is up to 180mJ@1064nm. The shortest pulse duration is 70-80ps with the maximal pulse energy 75mJ@1064nm with lamp pumping.

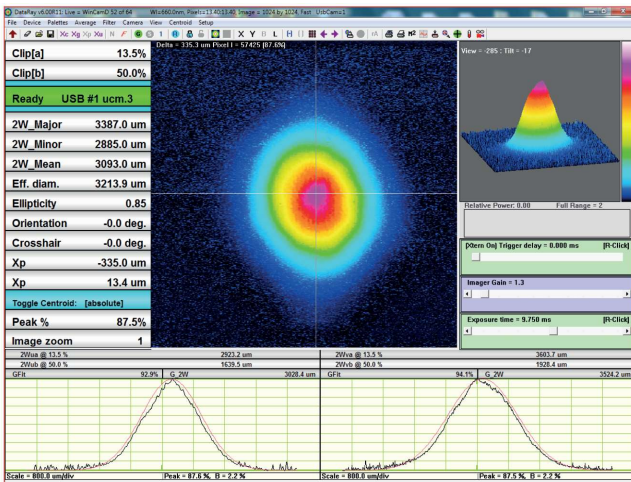


In each laser we try to elaborate the best possible beam profile with the goal TEM00.

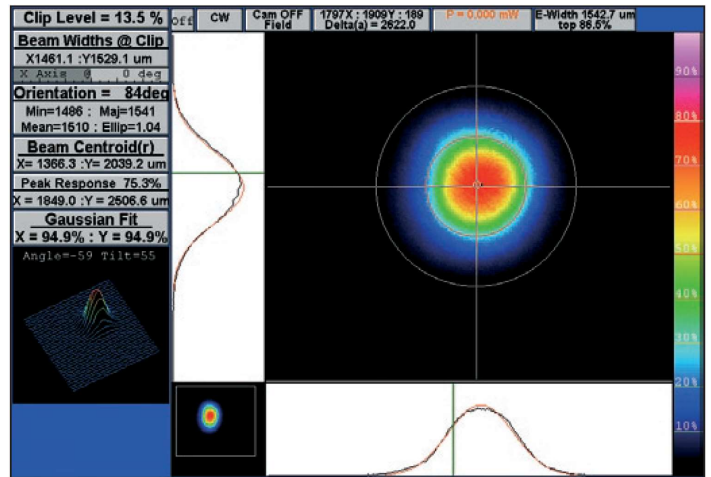
The separate parameters can be improved by request depending on applications. Double-pulsed system as well as tunable optical parametric generators are possible based on the available standard Nd:YAG-lasers.

possible specifications:

	high power lamp pumped	high repetition lamp pumped	DPSS 100Hz	DPSS 1kHz	ps lamp pumped
energy, mJ					
@1064nm	1400	180	180	8	75
@532nm	700	100	100	4	35
@355nm	300	40	50	2	15
@266nm	180	25	25	1	15
@213nm	40	5	5	-	3
pulse duration (FWHM), ns	10-12	10-12	11-12	12-15	0.07-0.08
pulse repetition rate, Hz	10	100	100	1000	15



beam profile with DPSS



beam profile with lamp pumping

Variable attenuators

Nd:YAG laser line attenuators

Variable attenuators are used as continuously regulator of laser pulse energy. They include a $\lambda/2$ -waveplate and a thin film polarizer. Standard laser line attenuators are for 1064nm, 532nm, 355nm, 266nm. The attenuators for other wavelengths are possible by request.

	1064nm	532nm	355nm	266nm
clear aperture, mm	10	10	10	10
damage threshold, J/cm ²	8	5	2	1
attenuation range, %	5-95	5-95	10-90	20-80



broadband laser attenuators

Broadband variable attenuators are designed for attenuation of laser radiation in spectral range 210-1500 nm. The attenuator modules are compact accessories that accurately set the energy transmitted while keeping the laser running under its most stable conditions. The principle of operation is based on the dependence of glass plate transmission from incidence angle of light as well as beam polarization. The main advantage of reflectance type attenuator is the absence of the sensitivity from operation wavelength and high laser damage (>1GW/cm²). It could be used for pulsed as well as CW lasers. The attenuators have two defined positions. The first one provides smooth decreasing of the laser radiation with horizontal polarization from 100% down to 35% (p-polarization) and attenuation of the laser light with vertical polarization from 50% down to 1% (s-polarization). The second one does vice versa.



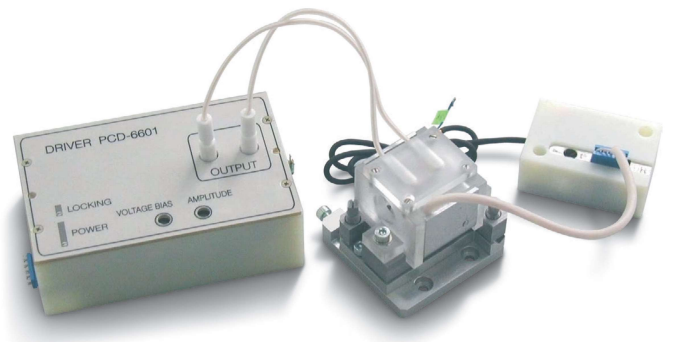
clear aperture, mm	8
damage threshold, J/cm ²	10
attenuation range, %	100-35 p-polarization 50-1 s-polarization
wavelength range, nm	450-1500 210-1300

KD*P Pockels cells

Pockels cells

The PC-series of KD*P longitudinal Pockels cells have been designed to give highest possible switching times and are normally used for Q-switching lasers. The cells are manufactured from crystals that have been specially selected for their low optical loss and strain free properties. They can be used in optical range 0.4-1.1 μm and normally have AR coating at customer specified wavelength. The crystals are set in temperature-stabilized mounts, which accurately maintain the maximum contrast ratio without adjustment of bias voltage and prevent surface degradation by humidity. KD*P crystals with wedge and Brewster angle surfaces are available on request.

	PC-8	PC-10	PC-15
clear aperture, mm	8x8	10x10	15x15
half-wave voltage, @1064nm, kV	6.7-7.5	6.7-7.5	6.7-7.5
maximal voltage, kV	8.0	8.0	10.0
crystal length, mm	16	20	30
damage threshold, MW/cm ²			
with AR coating	400	400	400
without AR coating	500	500	500
single pass insertion loss, %	≤4	≤4	≤5



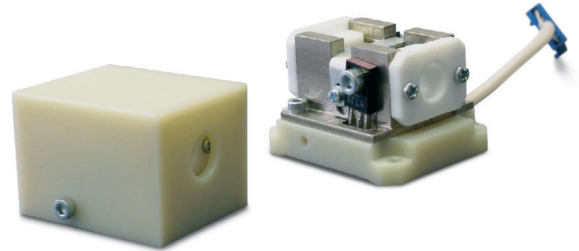
Pockels cell drivers

	PCD-6601 $\lambda/4$ driver for DKDP Q-switch	PCD-0902 $\lambda/2$ driver for DKDP Q-switch	SPS-6621 $\lambda/4$ intracavity single pulse selector	ICS-6603 $\lambda/4$ driver for DKDP Q-switch
supply voltage, V	18-30	18-30	18-30	18-30
max. current, mA	180	180	180	180
bias voltage, kV	3.5...5.0	0	3.5...5.0	3.5...5.0
pulse amplitude, kV	-3.5...5.0	±3.5...5.0	-3.5...5.0	-3.5...5.0
rise time, ns	<10	<10	<10	<10
pulse duration (flat top), ns	1000	1000	1000	triggering pulse
jitter, ns	<±1	<±1	<±1	<±1
pulse delay with respect to trigger, ns	20	20	20...40 variable	20
trigger pulse amplitude	TTL	TTL	photodiode	TTL
dimensions, mm	95x60x31	95x60x31	120x60x31	120x60x31

Crystal oven for non-linear crystals

Crystal oven is designed for heating and temperature stabilization of nonlinear crystals. The oven is finished with driver, which can supply two thermostats with different temperatures simultaneously. Special adjustable holder is available.

On special request crystal ovens for large crystals are available.



specifications:

stabilized temperature range	up to 80°C
long term stability	±0.1°C
operating voltage	18-24V, DC separate power supply is upon request providing powering from 110 V, 220 V AC mains at a choice
max. current	0.8A max 0.1A in stabilization mode
max. dimensions of non-linear crystal	12x12x34mm
size of crystal oven	48x40x34mm
size of driver	47x37x18mm
operating regtime	CW