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Single Frequency Tunable UV Fiber Laser at 308nm for LIDAR Applications

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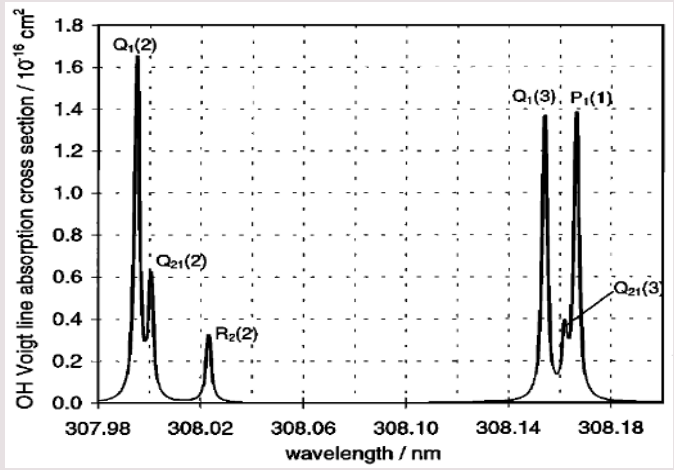
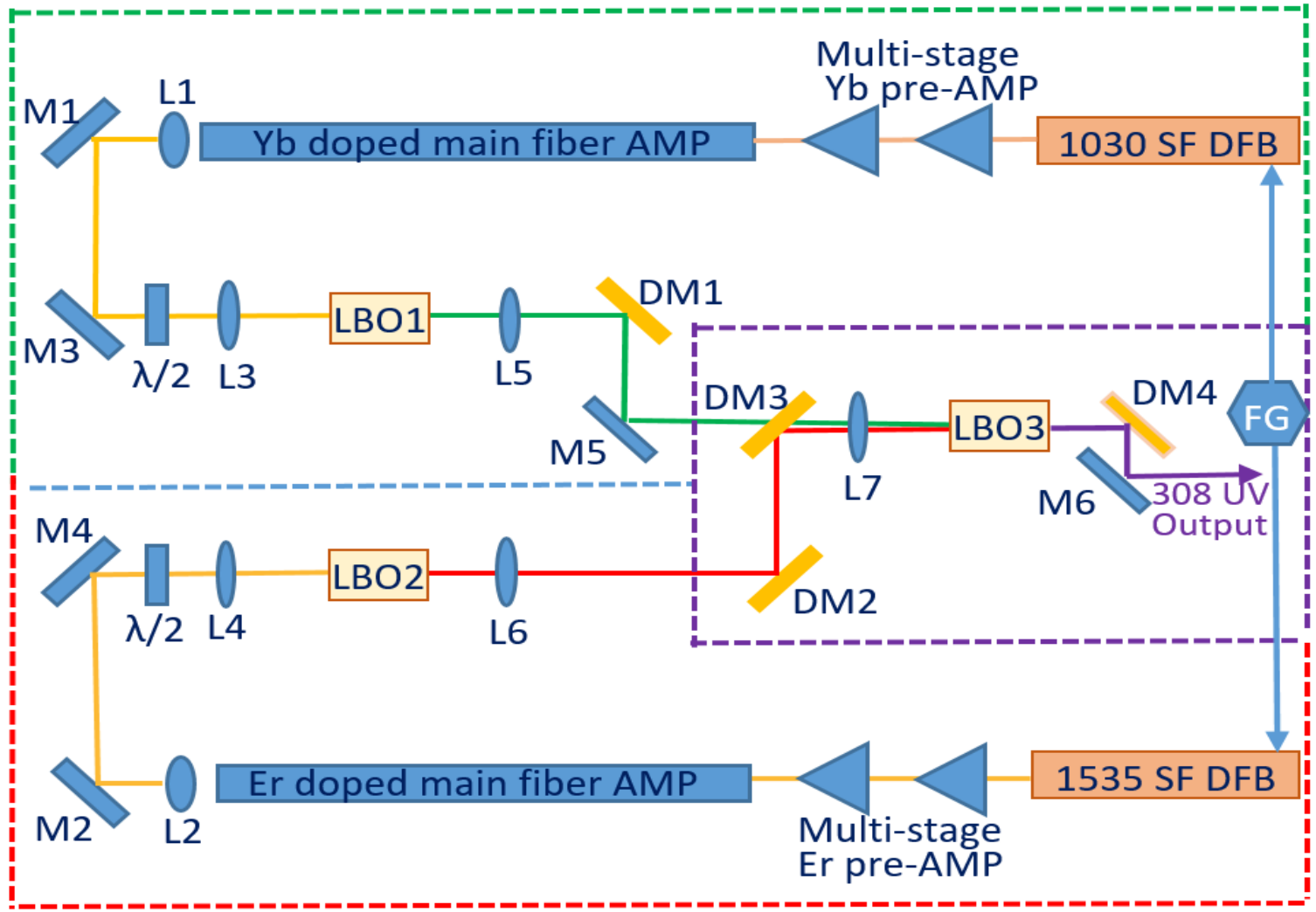
Introduction and background

- The hydroxyl (OH) radical is the key oxidant in atmosphere
  - Determination of the concentration of OH in is critical to the understanding of atmospheric photochemistry
  - UV laser is needed to probe the electronic transition of OH near 308nm.
  - OH low concentrations (~10^6 molecule cm^{-3}), and short lifetime [τ(OH): 0.01~1s], the detection of tropospheric OH radicals is extremely challenging
- Laser Induced Fluorescence (LIF) technique
  - High sensitivity and accuracy for OH measurement
  - Most common laser source: frequency doubled dye lasers (pumped by frequency doubled YAG laser) are mostly used ; bulky, delicate, expensive which are not suitable for airborne field measurements
  - 308nm UV by sum frequency of diode lasers; however, the output power is very low which is in nW to µW levels



OH absorption cross sections

All-fiber based tunable SF 308nm UV: laser configuration



Three parts layout

- 1030nm Yb fiber MOPA and 2nd harmonic
- 1535nm Er fiber MOPA and 2nd harmonic
- 308nm generation by sum frequency

Single frequency seed lasers:

- Modulated SF DFB
- 100.8kHz ~6ns pulse width
- Trigged and synchronized by a function generator

Main fiber amplifier

- Advalue Yb or Er high doping silicate glass fiber
- Large MFD 40~50μm
- Short fiber length 20-30cm
- Pumped by 976nm fiber coupled diode laser
- Support high peak power without SBS issue

Nonlinear frequency conversion:

- LBO1 and LBO2 NCPM for SH
- High efficiency and not sensitive to alignment
- LBO3 CPM for sum frequency; operated at room temperature

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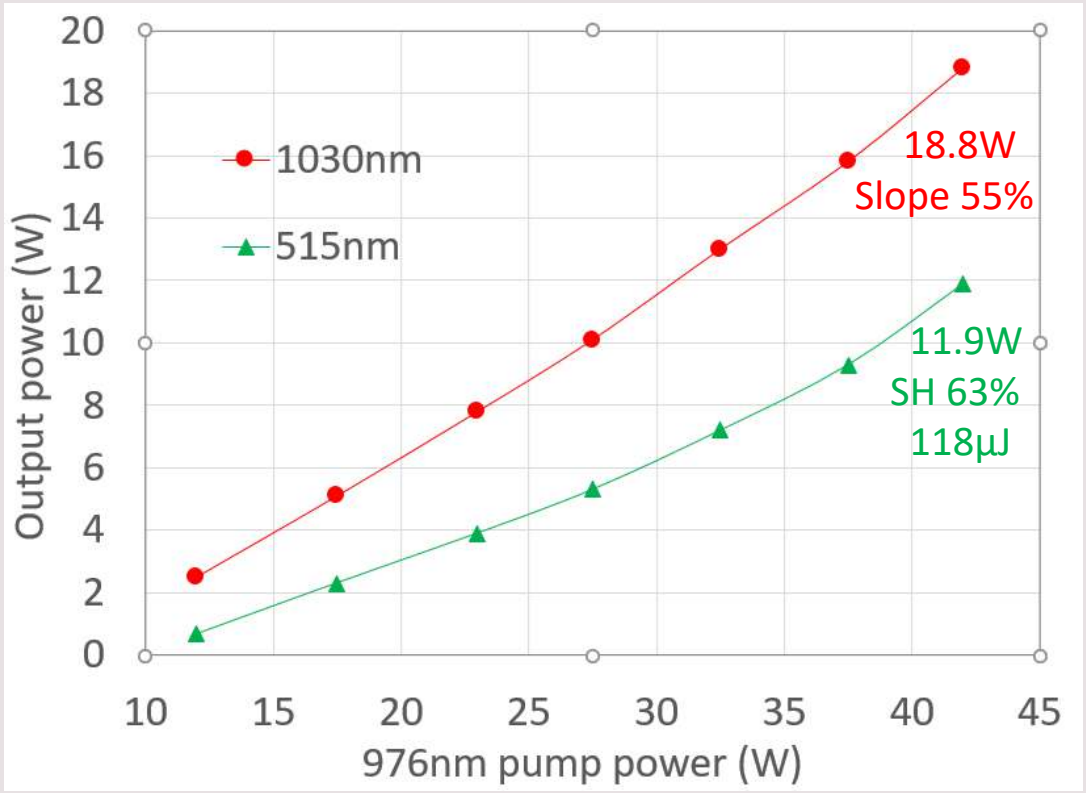
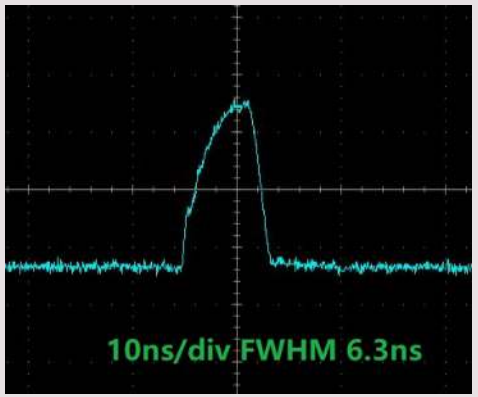
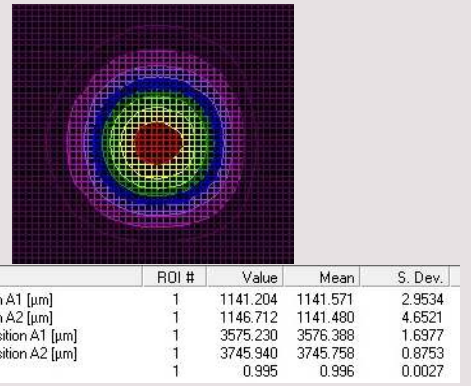
Yb main fiber amplifier and its 2nd harmonic generation



Yb doped main fiber amplifier output and its second harmonic generation. 1030nm and 515nm output vs 976nm pump power Input seed: 100mW;

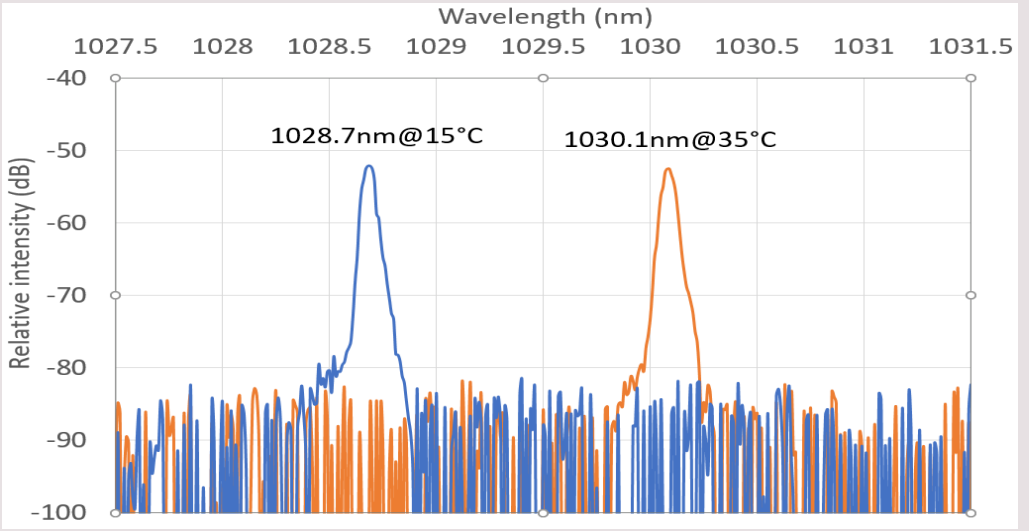


515nm laser pulse shape



Parameter	ROI #	Value	Mean	S. Dev.
13.5% Width A1 [μm]	1	1141.204	1141.571	2.9534
13.5% Width A2 [μm]	1	1146.712	1141.480	4.6521
Centroid Position A1 [μm]	1	3575.230	3576.388	1.6977
Centroid Position A2 [μm]	1	3745.940	3745.758	0.8753
Ellipticity	1	0.995	0.996	0.0027

515nm laser beam profile



$\Delta\lambda_{1030}$=1.40nm (70pm/°C) 396GHz
$\Delta\lambda_{515}$ =0.70nm (35pm/°C) 792GHz
$\Delta\lambda_{308}$ =0.25nm (12.5pm/°C) 792GHz

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Advalue Photonics amplifier module at 1µm wavelength

- M2<1.2
- >23dB gain
- Optical efficiency >50%
- 100W average power
- 1MW peak power (350µJ at 5ns, 100µJ at 0.4ns, 25µJ at 15ps)
- Compact size 8.86” x 1.22” x 0.69”
- Conductive cooling; not necessarily water cooling

Released product; more details:

www.advaluephotonics.com

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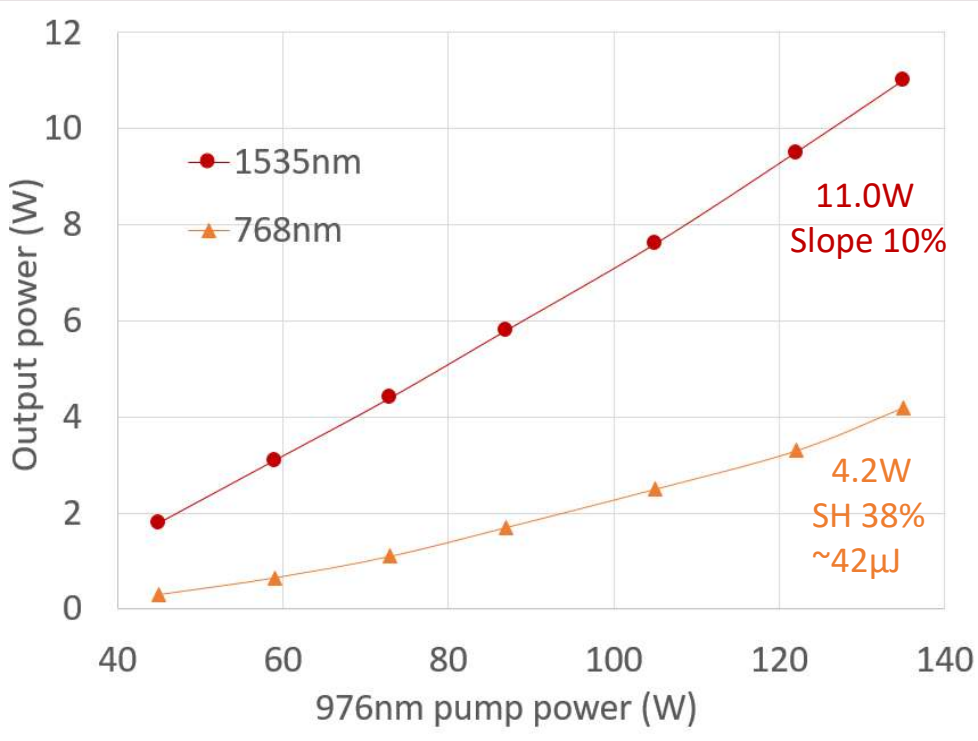
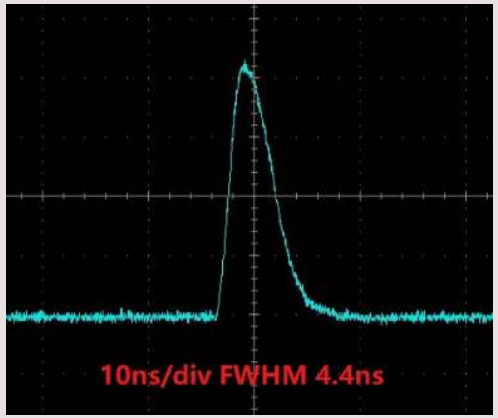
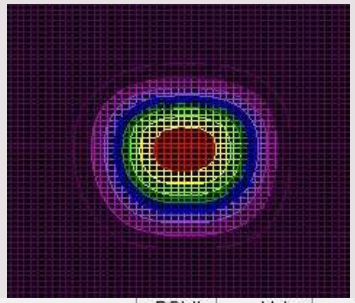
Er main fiber amplifier and its 2nd harmonic generation



Er doped main fiber amplifier output and its second harmonic generation. 1535nm and 768nm output vs 976nm pump power; input seed power : 1.0W



768nm laser pulse shape



Parameter	ROI #	Value	Mean	S. Dev.
13.5% Width A1 [µm]	1	1653.438	1654.906	4.8975
13.5% Width A2 [µm]	1	1407.884	1412.485	5.2053
Centroid Position A1 [µm]	1	3603.139	3582.202	14.2424
Centroid Position A2 [µm]	1	3748.282	3735.738	9.6717
Ellipticity	1	0.851	0.854	0.0036

768nm laser beam profile

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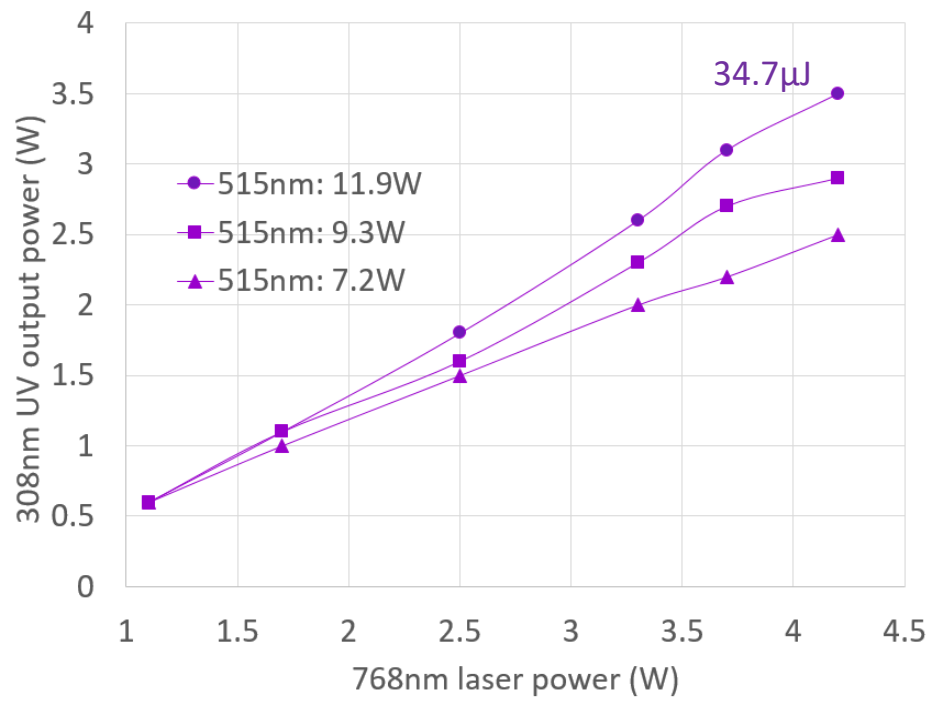
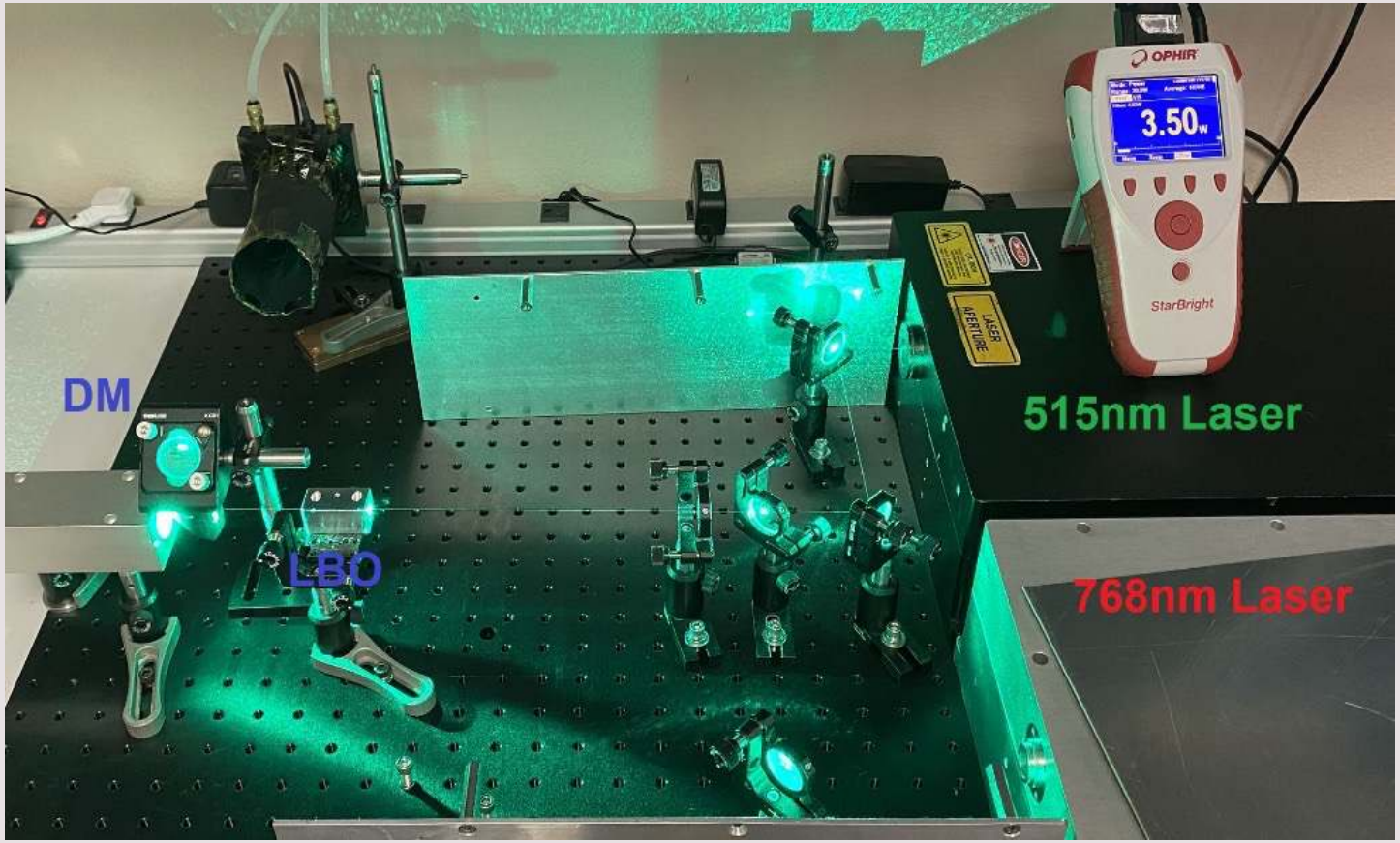
308nm UV generation by sum frequency



308nm output VS 768nm input at different 515nm input power levels



Picture of the laser when 3.5W UV is obtained

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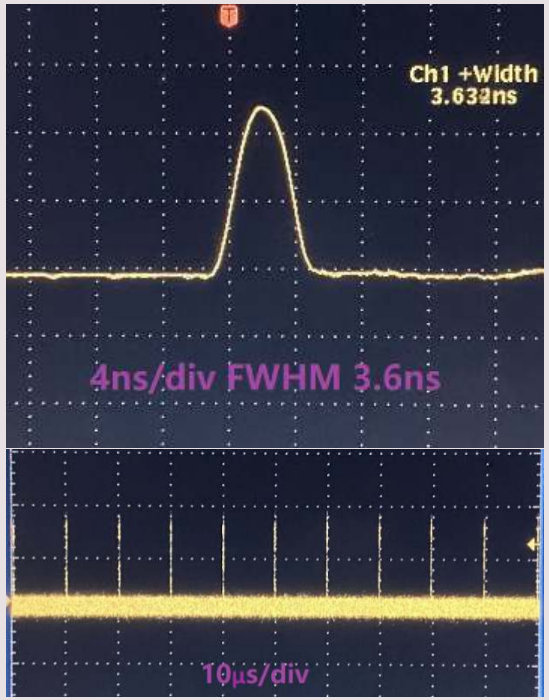
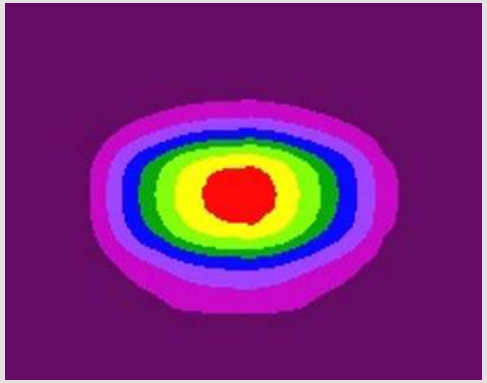
308nm UV output characterization

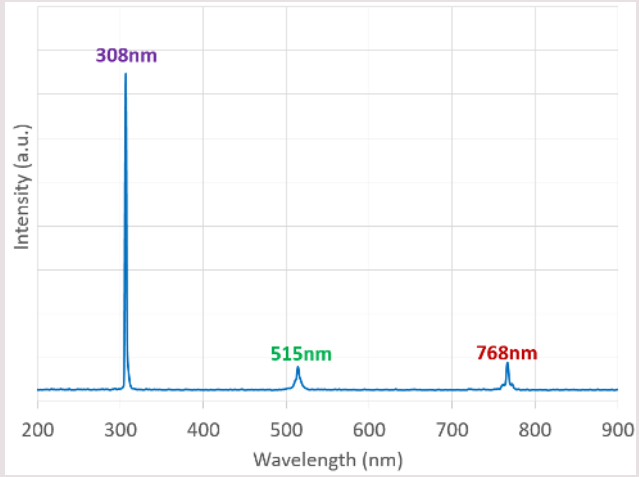


308nm pulse shape: 3.6ns FWHM; pulse train at 100.8kHz

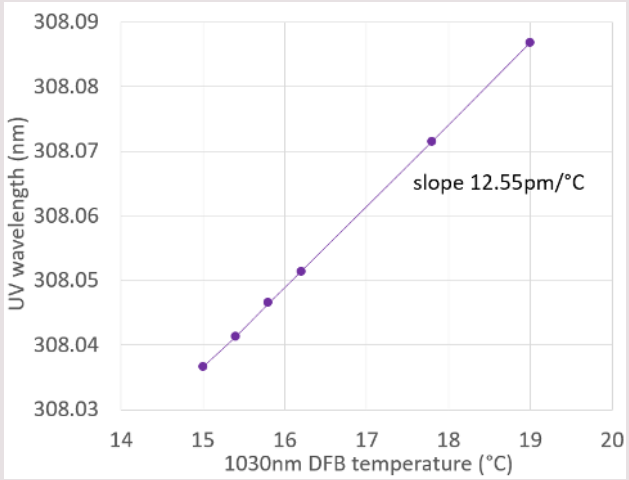


Parameter	ROI #	Value	Mean	S. Dev.
13.5% Width A1 [µm]	1	1686.527	1635.721	26.6985
13.5% Width A2 [µm]	1	1103.094	1110.086	12.5838
Centroid Position A1 [µm]	1	5165.388	5153.221	5.4650
Centroid Position A2 [µm]	1	5036.884	5034.920	1.8032

308nm beam profile



Laser spectrum measured by StellarNet bluewave compact USB spectrometer.



The UV wavelength tuning measurement from 15°C to 19°C

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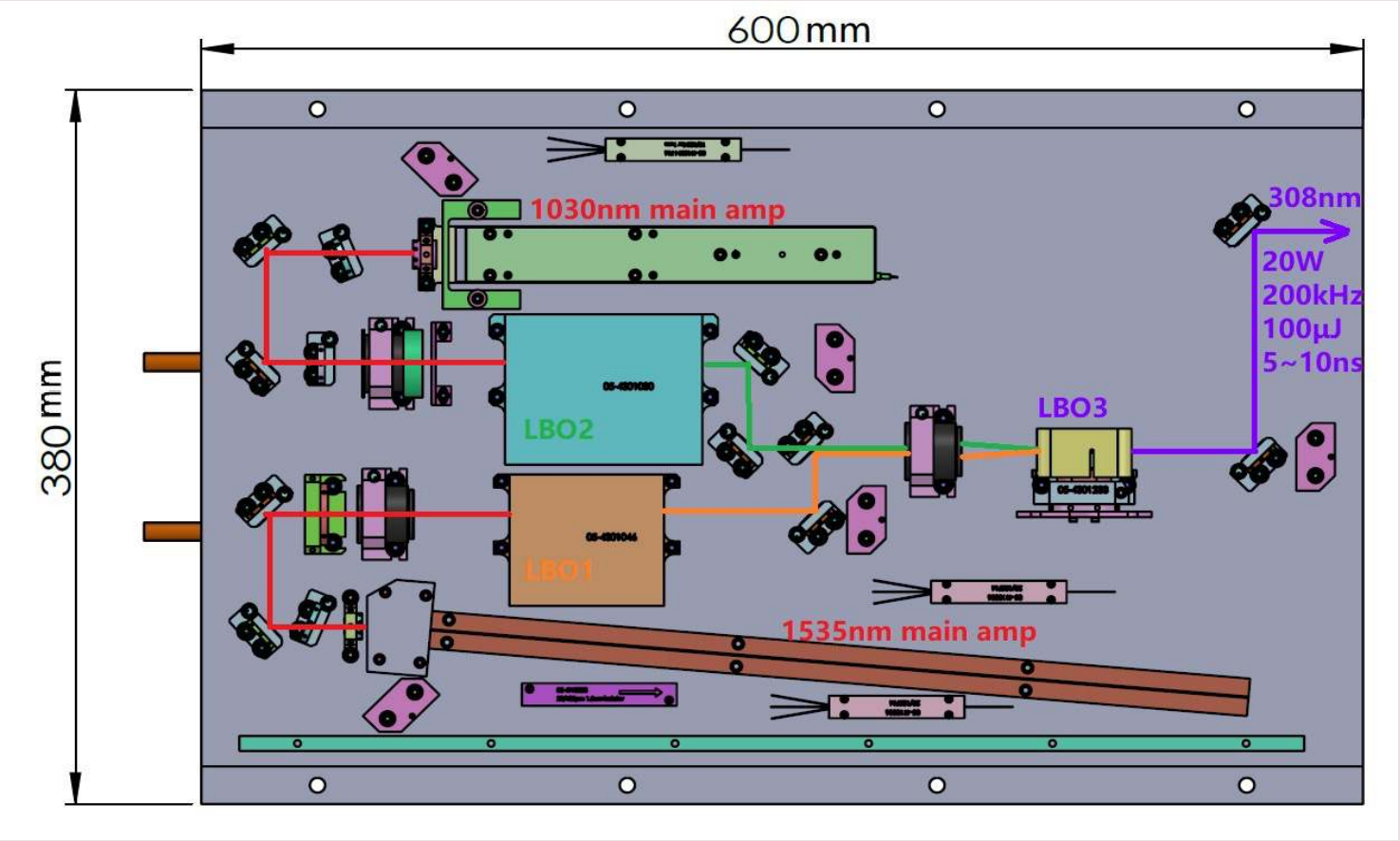
In development: AIO box single frequency 308nm UV laser



All in one laser box

- Smaller footprint and less weight
- Robust; immune to vibration, suitable for airborne application
- Optimized design for higher output power and pulse energy

The laser will be commercially available soon.

Please contact: sales@advaluephotonics.com

Thank you for your interests!

Question?

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