

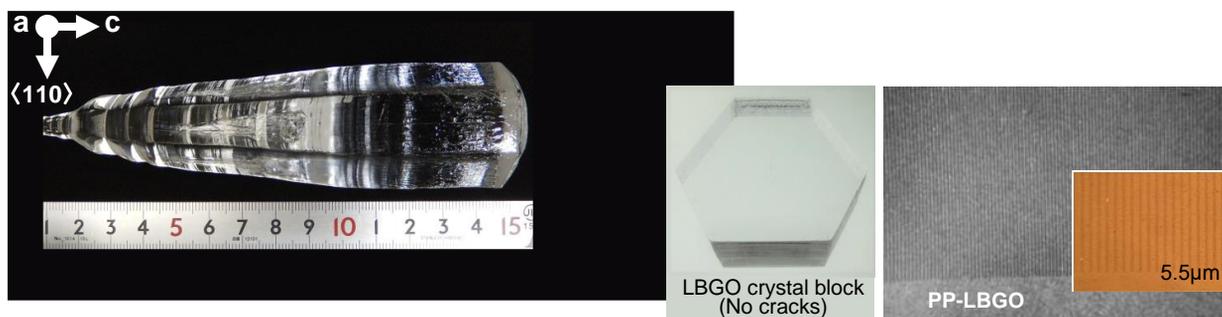
PP-LBGO

(Periodically-poled LaBGeO5)

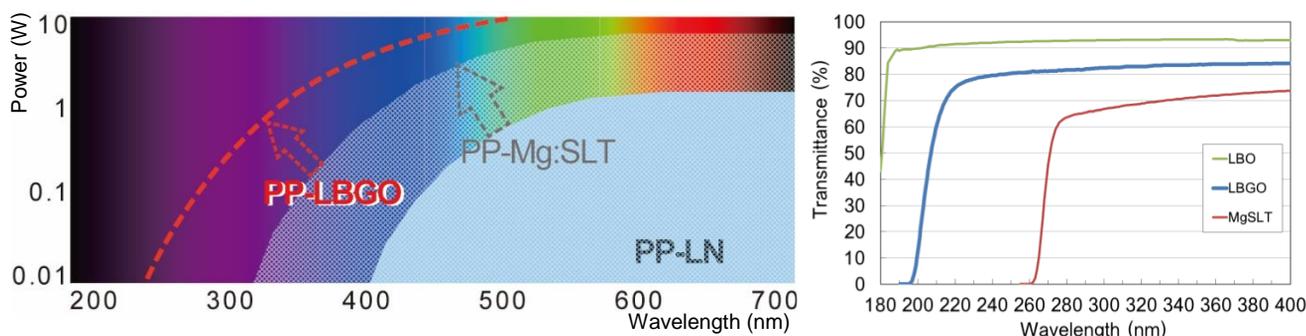
Novel QPM device for UV Applications

Remarkable Features

- ✓ Non-walk-off (QPM)
- ✓ Non Hygroscopy
- ✓ Shorter Cut-Off Wavelength (<200nm)



Remarkable Features



Material Parameters (for 355nm generation)

	LBO Type I	LBO Type II	BBO	CLBO	PP-LBGO*	PP-Mg:SLT (3rd order)
Walk-off ρ (mrad)	18.15	9.37	72.30	37.13	Non	Non
Nonlinear coefficient d_{eff} ($\mu\text{m/V}$)	0.72	0.53	2.02	0.52	0.61 ($d_{33}=0.96$)	3.00
QPM periodicity Λ (μm)					6.4	6.6
Cut-off wavelength (nm)	160	160	185	180	195	265
Hygroscopy	Weak	Weak	Strong	Very strong	Non	Non

Above parameters are examples for 355 nm generation.

*I. Shoji et al., Advanced Photonics 2018 (Optical Society of America, 2018), paper NoM3J.5

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Oxide Yamanashi

Semi-Standard PP-LBGO device design

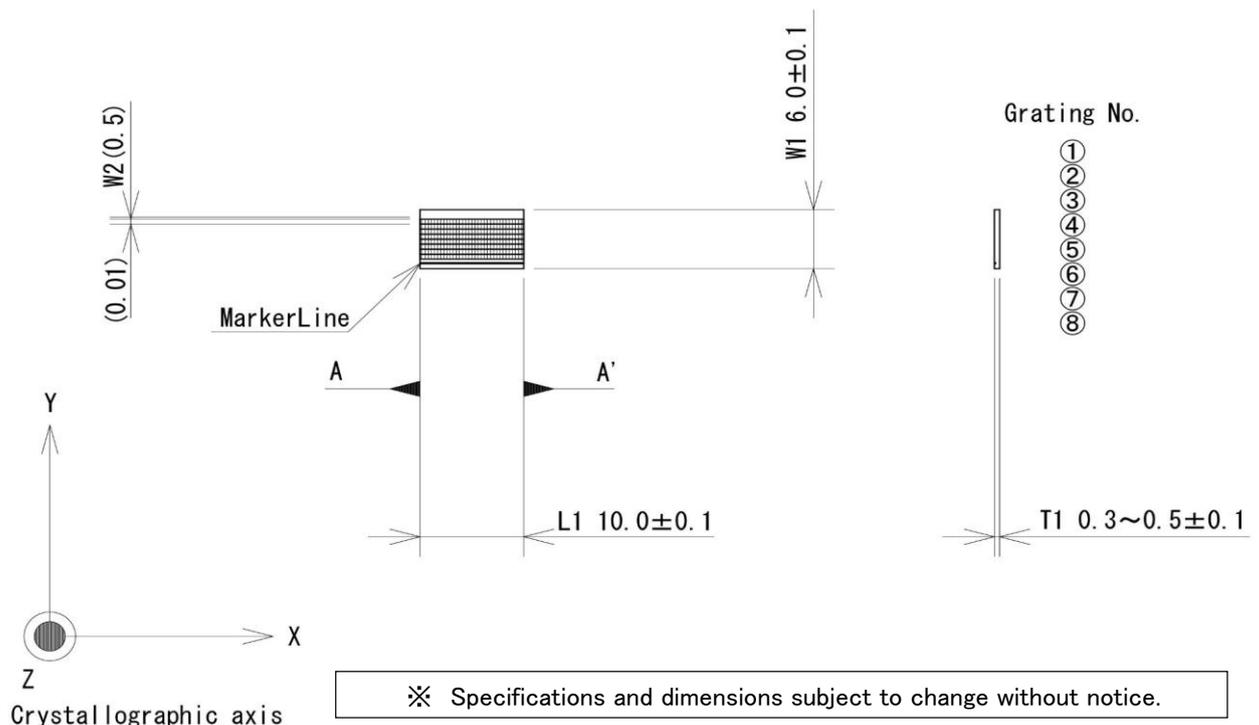
OXIDE Corporation
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 10, Feb. ,2016
 Doc. No.Q-SSD-PPLBGO-S01-tentative

Specification

Product Name	PPLBGO device
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Item	Specification	Inspection method	Sampling	
1. Material				
1.1	Material	LaBGeO5	—	—
2. Device				
2.1	Length (L1)	10.0 +/-0.1mm	Measuring microscope	All
2.2	Width of device (W1)	6.0 +/- 0.1 mm	Measuring microscope	Reference chip only
2.3	Width of periodically poled area (W2)	0.5 +/- 0.1mm	—	—
2.4	Thickness (T1)	0.3~0.5 +/-0.1mm	Height gauge	Reference chip only
2.5	Flatness A plane	$\leq \lambda/10$ @ 633nm	Optical interferometer	All
2.6	Flatness A' plane	$\leq \lambda/10$ @ 633nm	Optical interferometer	All
2.7	Parallelism	< 5 arc minutes	Autocollimator	All
2.8	AR coating(A,A' plane)	(N/A)	—	—
2.9	Effective aperture (under periodically poled area: (W2 X T1))	>80%	Microscope	All
3. Phase matching condition				
3.1	QPM period	(See schematics below)	—	—
3.2	QPM duty ratio	50%:50% (Target value, Best effort)	—	—

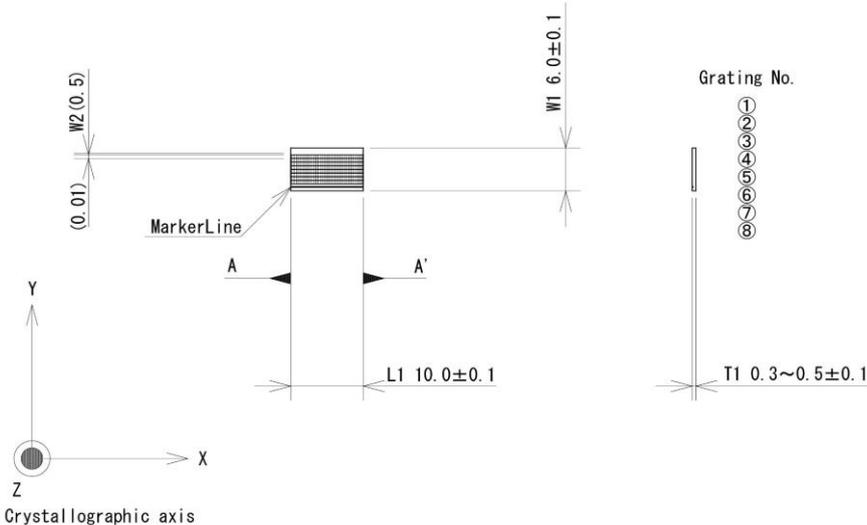
Schematics of the Device



Semi-Standard PP-LBGO device design

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Schematics



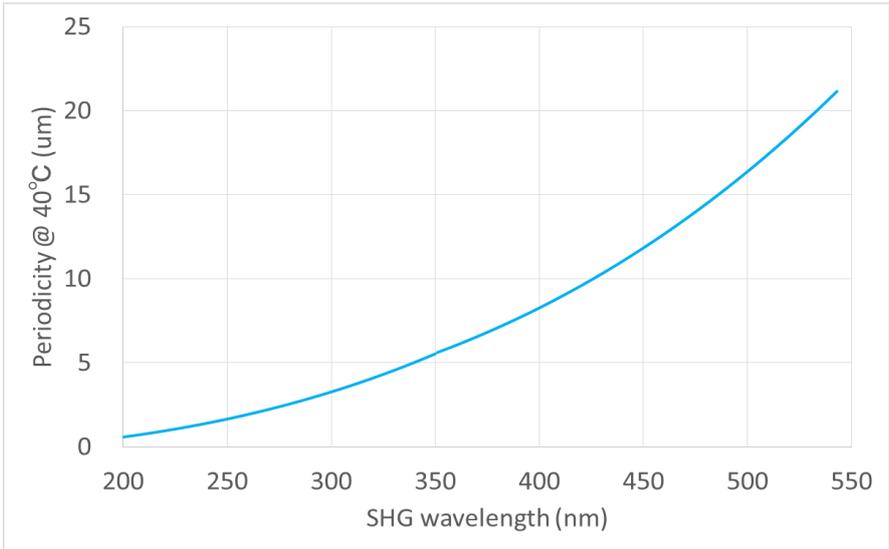
Lineup

Type	I-A	I-B	I-C	I-D		IV-R	IV-S
①	3.00	3.14	3.28	3.42	...	26.10	26.80
②	3.02	3.16	3.30	3.44		26.20	26.90
③	3.04	3.18	3.32	3.46		26.30	27.00
④	3.06	3.20	3.34	3.48		26.40	27.10
⑤	3.08	3.22	3.36	3.50		26.50	27.20
⑥	3.10	3.24	3.38	3.52		26.60	27.30
⑦	3.12	3.26	3.40	3.54		26.70	27.40
⑧	3.14	3.28	3.42	3.56		26.80	27.50

Periodicity range: 3.00~27.50 um (FIXED)

Periodicity step: approximately 60°C step for phase matching temperature

Phase-matching example



Type	I-A			I-B			I-C			I-D			I-E			I-F			I-G			I-H			I-I			I-J			I-K			I-L			I-M			I-N			I-O			I-P			I-Q			I-R			I-S		
	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)									
①	3.00	292.70	293.28	3.14	296.48	297.06	3.28	300.17	300.75	3.42	303.78	304.36	3.56	307.30	307.88	3.70	310.74	311.32	3.84	314.11	314.68	3.98	317.39	317.96	4.12	320.61	321.18	4.26	323.75	324.32	4.40	326.83	327.39	4.54	329.85	330.41	4.68	332.80	333.36	4.82	335.71	336.26	4.96	338.56	339.12	5.10	341.38	341.94	5.24	344.17	344.73	5.38	346.94	347.51			
②	3.02	293.24	293.82	3.16	297.01	297.59	3.30	300.69	301.27	3.44	304.29	304.86	3.58	307.80	308.37	3.72	311.23	311.80	3.86	314.58	315.15	4.00	317.86	318.43	4.14	321.06	321.63	4.28	324.20	324.76	4.42	327.27	327.83	4.56	330.27	330.83	4.70	333.22	333.78	4.84	336.12	336.67	4.98	338.97	339.52	5.12	341.78	342.34	5.26	344.57	345.13	5.40	347.34	347.91			
③	3.04	293.79	294.37	3.18	297.55	298.12	3.32	301.21	301.79	3.46	304.79	305.37	3.60	308.29	308.87	3.74	311.71	312.29	3.88	315.05	315.63	4.02	318.32	318.89	4.16	321.52	322.09	4.30	324.64	325.20	4.44	327.70	328.26	4.58	330.70	331.26	4.72	333.64	334.19	4.86	336.53	337.08	5.00	339.37	339.93	5.14	342.18	342.74	5.28	344.96	345.52	5.42	347.74	348.30			
④	3.06	294.33	294.91	3.20	298.08	298.65	3.34	301.73	302.31	3.48	305.30	305.88	3.62	308.79	309.36	3.76	312.19	312.77	3.90	315.52	316.10	4.04	318.78	319.35	4.18	321.97	322.54	4.32	325.08	325.65	4.46	328.13	328.69	4.60	331.12	331.68	4.74	334.05	334.61	4.88	336.94	337.49	5.02	339.77	340.33	5.16	342.58	343.14	5.30	345.36	345.92	5.44	348.13	348.69			
⑤	3.08	294.87	295.45	3.22	298.60	299.18	3.36	302.25	302.82	3.50	305.80	306.38	3.64	309.28	309.85	3.78	312.67	313.25	3.92	315.99	316.57	4.06	319.24	319.81	4.20	322.42	322.99	4.34	325.52	326.08	4.48	328.56	329.12	4.62	331.54	332.10	4.76	334.47	335.02	4.90	337.34	337.89	5.04	340.18	340.73	5.18	342.98	343.53	5.32	345.76	346.32	5.46	348.53	349.09			
⑥	3.10	295.41	295.99	3.24	299.13	299.71	3.38	302.76	303.34	3.52	306.30	306.88	3.66	309.77	310.34	3.80	313.15	313.73	3.94	316.46	317.03	4.08	319.70	320.27	4.22	322.86	323.43	4.36	325.96	326.52	4.50	328.99	329.55	4.64	331.96	332.52	4.78	334.88	335.44	4.92	337.75	338.30	5.06	340.58	341.13	5.20	343.38	343.93	5.34	346.15	346.72	5.48	348.92	349.49			
⑦	3.12	295.95	296.52	3.26	299.65	300.23	3.40	303.27	303.85	3.54	306.80	307.38	3.68	310.26	310.83	3.82	313.63	314.20	3.96	316.93	317.50	4.10	320.15	320.72	4.24	323.31	323.87	4.38	326.40	326.96	4.52	329.42	329.98	4.66	332.38	332.94	4.80	335.29	335.85	4.94	338.16	338.71	5.08	340.98	341.54	5.22	343.77	344.33	5.36	346.55	347.11	5.50	349.32	349.89			
⑧	3.14	296.48	297.06	3.28	300.17	300.75	3.42	303.78	304.36	3.56	307.30	307.88	3.70	310.74	311.32	3.84	314.11	314.68	3.98	317.39	317.96	4.12	320.61	321.18	4.26	323.75	324.32	4.40	326.83	327.39	4.54	329.85	330.41	4.68	332.80	333.36	4.82	335.71	336.26	4.96	338.56	339.12	5.10	341.38	341.94	5.24	344.17	344.73	5.38	346.94	347.51	5.52	349.71	350.28			

Type	II-A			II-B			II-C			II-D			II-E			II-F			II-G			II-H			II-I			II-J			II-K			II-L			II-M			II-N			II-O			II-P			II-Q			II-R			II-S		
	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)									
①	5.52	348.95	350.33	5.66	351.94	353.31	5.80	354.88	356.24	5.94	357.78	359.12	6.08	360.62	361.96	6.22	363.41	364.75	6.36	366.15	367.49	6.50	368.84	370.18	6.64	371.48	372.82	6.78	374.08	375.42	6.92	376.67	378.01	7.06	379.25	380.59	7.20	381.82	383.16	7.34	384.38	385.72	7.48	386.93	388.27	7.62	389.47	390.81	7.76	392.00	393.34	7.90	394.52	395.86	8.04	397.04	398.38
②	5.54	349.38	350.76	5.68	352.37	353.73	5.82	355.30	356.66	5.96	358.19	359.53	6.10	361.23	362.56	6.24	364.22	365.55	6.38	367.16	368.49	6.52	370.04	371.37	6.66	372.86	374.19	6.80	375.63	376.96	6.94	378.38	379.71	7.08	381.11	382.44	7.22	383.82	385.15	7.36	386.51	387.84	7.50	389.18	390.51	7.64	391.83	393.16	7.78	394.47	395.80	7.92	397.09	398.42			
③	5.56	349.81	351.19	5.70	352.79	354.15	5.84	355.71	357.07	5.98	358.59	359.94	6.12	361.63	362.96	6.26	364.62	365.95	6.40	367.56	368.89	6.54	370.44	371.77	6.68	373.26	374.59	6.82	376.03	377.36	6.96	378.78	380.11	7.10	381.51	382.84	7.24	384.22	385.55	7.38	386.91	388.24	7.52	389.58	390.91	7.66	392.23	393.56	7.80	394.87	396.20						
④	5.58	350.24	351.62	5.72	353.21	354.57	5.86	356.13	357.48	6.00	359.00	360.34	6.14	362.03	363.36	6.28	365.07	366.40	6.42	368.06	369.39	6.56	371.00	372.33	6.70	373.88	375.21	6.84	376.71	378.04	6.98	379.50	380.83	7.12	382.28	383.61	7.26	385.03	386.36	7.40	387.76	389.09	7.54	390.47	391.80	7.68	393.16	394.49									
⑤	5.60	350.67	352.04	5.74	353.63	354.99	5.88	356.54	357.89	6.02	359.41	360.75	6.16	362.53	363.86	6.30	365.60	366.93	6.44	368.62	369.95	6.58	371.60	372.93	6.72	374.52	375.85	6.86	377.39	378.72	7.00	380.22	381.55	7.14	383.01	384.34	7.28	385.76	387.09	7.42	388.49	389.82	7.56	391.19	392.52	7.70	393.87	395.20									
⑥	5.62	351.09	352.47	5.76	354.05	355.41	5.90	356.95	358.30	6.04	359.81	361.15	6.18	362.93	364.26	6.32	366.00	367.33	6.46	369.02	370.35	6.60	372.00	373.33	6.74	374.92	376.25	6.88	377.79	379.12	7.02	380.62	381.95	7.16	383.41	384.74	7.30	386.16	387.49	7.44	388.88	390.21	7.58	391.57	392.90												
⑦	5.64	351.52	352.89	5.78	354.47	355.83	5.92	357.37	358.71	6.06	360.22	361.56	6.20	363.34	364.67	6.34	366.40	367.73	6.48	369.42	370.75	6.62	372.40	373.73	6.76	375.32	376.65	6.90	378.19	379.52	7.04	381.01	382.34	7.18	383.76	385.09	7.32	386.47	387.80	7.46	389.15	390.48	7.60	391.81	393.14												
⑧	5.66	351.94	353.31	5.80	354.88	356.24	5.94	357.78	359.12	6.08	360.62	361.96	6.22	363.81	365.14	6.36	367.04	368.37	6.50	370.22	371.55	6.64	373.46	374.79	6.78	376.65	377.98	6.92	379.79	381.12	7.06	382.88	384.21	7.20	385.93	387.26	7.34	388.95	390.28	7.48	391.95	393.28	7.62	394.92	396.25												

Type	III-A			III-B			III-C			III-D			III-E			III-F			III-G			III-H			III-I			III-J			III-K			III-L			III-M			III-N			III-O			III-P			III-Q			III-R			III-S		
	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)	Periodicity (um)	SHG wavelength (nm)	SHG wavelength (nm)									
①	9.30	415.81	416.93	9.58	419.88	420.99	9.86	423.87	424.97	10.15	427.82	428.90	10.50	432.69	433.76	10.85	437.35	438.40	11.20	441.90	442.94	11.55	446.35	447.38	11.90	450.71	451.73	12.25	454.98	455.99	12.67	459.99	460.99	13.09																							