

Comparative Spectroradiometer Analysis of Three Dental Light-Curing Units

VEGA versus VALO X and Bluephase Style M i20: optical output, spectral distribution, and clinical interpretation

Purpose. This document translates and expands the interpretation of readings obtained from a laboratory-grade dental light measurement device (spectroradiometer) designed specifically to evaluate photopolymerization units for three dental light-curing units. The tested units were VEGA, Bluephase Style M i20, and VALO X. The emphasis is on comparing the VEGA with the other two devices using the numerical values shown in the photographs, followed by the clinical translation of those optical findings.

Important methodological note. These conclusions are based on the spectroradiometer measurements shown in the images. They should be interpreted knowing the aperture entered into the spectroradiometer is critical because irradiance is calculated from radiant power divided by the selected emitting area. Please note that all units were used in standard mode.

1. Measurement Inputs and Internal Consistency

The following aperture diameters were entered into the spectroradiometer. These determine the calculated irradiance values. The calculated areas confirm that the radiant power and irradiance values are internally coherent.

Device	Aperture entered	Calculated area	Dental-band radiant power	Dental-band irradiance
VEGA	8.00 mm	0.503 cm ²	674.6 mW	1342.0 mW/cm ²
Bluephase Style M i20	8.00 mm	0.503 cm ²	424.3 mW	844.1 mW/cm ²
VALO X	12.10 mm	1.150 cm ²	1290.0 mW	1122.0 mW/cm ²

For example, the VEGA reading is mathematically consistent: approximately 674.6 mW divided by 0.503 cm² gives approximately 1342 mW/cm². The same relationship applies to the Bluephase Style M i20 and VALO X readings. This strongly suggests that the spectroradiometer calculations are coherent, assuming that the entered apertures correspond to the real active emitting diameters of the tips.

2. Raw Optical Output Data Extracted

Device	Power 360-830 nm (mW)	Power 385-515 nm (mW)	Violet power 385-425 nm (mW)	Blue power 425-515 nm (mW)	Irradiance 360-830 (mW/cm ²)	Irradiance 385-515 (mW/cm ²)	Violet irradiance (mW/cm ²)	Blue irradiance (mW/cm ²)
VEGA	677.5	674.6	194.5	480.2	1348.0	1342.0	386.9	955.2
Bluephase Style M i20	424.7	424.3	52.5	371.8	844.9	844.1	104.4	739.7
VALO X	1315.0	1290.0	317.6	972.4	1144.0	1122.0	276.2	845.7

The 385-515 nm interval is the most relevant “dental band” in these readings. The 385-425 nm interval corresponds broadly to the violet component, which is relevant for photoinitiators such as TPO, Ivocerin, and BAPO. The 425-515 nm interval corresponds broadly to the blue component, which is especially relevant for camphorquinone-based systems.

3. Radiant Power: Total Light Delivered

Radiant power, expressed in mW, represents the total amount of optical power delivered by the curing light over the measured spectral interval. It is not normalized by area. Therefore, it is especially important for understanding the overall emission capacity of the device and the ability to cover larger restorative areas.

Ranked by dental-band power	Total 385-515 nm	Violet 385-425 nm	Blue 425-515 nm
VALO X	1290.0 mW	317.6 mW	972.4 mW
VEGA	674.6 mW	194.5 mW	480.2 mW
Bluephase Style M i20	424.3 mW	52.5 mW	371.8 mW

The VALO X delivered the highest total radiant power by a wide margin. It emitted approximately 1290 mW in the 385-515 nm dental band, which is almost twice the VEGA output and approximately three times the Bluephase Style M i20 output. The VEGA, however, clearly outperformed the Bluephase Style M i20, delivering about 59% more total dental-band radiant power.

Scientific interpretation. In absolute optical output, the order is VALO X > VEGA > Bluephase Style M i20. This means the VALO X has the greatest total photon delivery capacity, particularly relevant for broad surfaces and posterior restorations. The VEGA is not the strongest in absolute power, but it is substantially stronger than the Bluephase Style M i20 in this test.

4. Irradiance: Power Density Delivered per Unit Area

Irradiance, expressed in mW/cm², is the optical power normalized by the emitting area. This is the parameter most commonly quoted clinically, but it must be interpreted together with tip diameter, beam profile, spectral distribution, and exposure time.

Ranked by dental-band irradiance	Total 385-515 nm	Violet 385-425 nm	Blue 425-515 nm
VEGA	1342.0 mW/cm ²	386.9 mW/cm ²	955.2 mW/cm ²
VALO X	1122.0 mW/cm ²	276.2 mW/cm ²	845.7 mW/cm ²
Bluephase Style M i20	844.1 mW/cm ²	104.4 mW/cm ²	739.7 mW/cm ²

This is where the VEGA performed extremely well. Despite having lower total radiant power than the VALO X, the VEGA produced the highest irradiance because its output was concentrated through an 8.0 mm aperture rather than the 12.1 mm aperture entered for the VALO X. It is also important to note that:

- VALO X - used on the 1100 mW/cm² Standard mode
- VEGA - used on the 1400 mW/cm² Standard mode
- Bluephase Style M i20 - used on the 1200 mW/cm² Standard mode

Scientific interpretation. Within its active 8 mm field, the VEGA delivered the highest local power density: approximately 1342 mW/cm² in the dental band. The VALO X delivered lower local irradiance, approximately 1122 mW/cm², but through a much larger area. The Bluephase Style M i20 was clearly lower at approximately 844 mW/cm².

5. Spectral Distribution: Violet Versus Blue Output

A modern curing light should not be judged only by total irradiance. Spectral distribution matters because different resin-based materials may use different photoinitiator systems. Camphorquinone is mainly activated in the blue region, whereas several alternative photoinitiators require or benefit from violet emission.

Device	Violet power	Blue power	Violet share of 385-515 nm	Blue share of 385-515 nm
VEGA	194.5 mW	480.2 mW	28.8%	71.2%
VALO X	317.6 mW	972.4 mW	24.6%	75.4%
Bluephase Style M i20	52.5 mW	371.8 mW	12.4%	87.6%

The VEGA showed the highest relative violet contribution: approximately 28.8% of its dental-band radiant power was in the violet interval. The VALO X delivered more violet power in absolute terms, but because it also produced much more blue power, its violet share was approximately 24.6%. The Bluephase Style M i20 had a much smaller violet contribution, approximately 12.4%.

Scientific interpretation. Both VEGA and VALO X behaved as true broad-spectrum/polywave lights in this analysis. The VEGA had the most balanced relative spectral distribution. The VALO X had the greatest absolute violet and blue power. The Bluephase Style M i20 behaved more like a predominantly blue-emitting light with a limited violet component.

6. Focused Comparison: VEGA versus Bluephase Style M i20

Parameter	VEGA	Bluephase Style M i20	Interpretation
Total radiant power 385-515 nm	674.6 mW	424.3 mW	VEGA +59%
Total irradiance 385-515 nm	1342 mW/cm ²	844.1 mW/cm ²	VEGA +59%
Violet radiant power 385-425 nm	194.5 mW	52.46 mW	VEGA approximately 3.7x higher
Violet irradiance 385-425 nm	386.9 mW/cm ²	104.4 mW/cm ²	VEGA approximately 3.7x higher
Blue radiant power 425-515 nm	480.2 mW	371.8 mW	VEGA +29%
Blue irradiance 425-515 nm	955.2 mW/cm ²	739.7 mW/cm ²	VEGA +29%
Estimated 10 s radiant exposure	13.4 J/cm ²	8.4 J/cm ²	VEGA +59%

The comparison between VEGA and Bluephase Style M i20 is not close. The VEGA was superior in total radiant power, total irradiance, blue output, and especially violet output. The difference in violet output is the most clinically meaningful spectral finding: the VEGA delivered approximately 3.7 times more violet power and violet irradiance than the Bluephase Style M i20.

Clinical translation. The VEGA should provide a considerably larger safety margin for materials containing alternative photoinitiators or photoinitiator blends. The Bluephase Style M i20 may still be clinically usable, especially for camphorquinone-dominant materials, but based on these readings it should be used with longer exposure times and greater attention to distance, angulation, and restoration thickness.

7. Focused Comparison: VEGA versus VALO X

Parameter	VEGA	VALO X	Interpretation
Aperture entered	8.00 mm	12.10 mm	VALO X covers a much larger area
Calculated area	0.503 cm ²	1.150 cm ²	VALO X area is about 2.3x larger
Total radiant power 385-515 nm	674.6 mW	1290 mW	VALO X much higher
Total irradiance 385-515 nm	1342 mW/cm ²	1122 mW/cm ²	VEGA higher locally
Violet radiant power	194.5 mW	317.6 mW	VALO X higher in total violet output
Violet irradiance	386.9 mW/cm ²	276.2 mW/cm ²	VEGA higher local violet density
Blue radiant power	480.2 mW	972.4 mW	VALO X higher in total blue output
Blue irradiance	955.2 mW/cm ²	845.7 mW/cm ²	VEGA higher local blue density
Estimated 10 s radiant exposure	13.4 J/cm ²	11.2 J/cm ²	VEGA higher per cm ² ; VALO X covers more area

The VEGA versus VALO X comparison is more nuanced. The VALO X is clearly the stronger device in absolute total power and coverage. However, the VEGA delivered higher irradiance and higher local violet and blue irradiance because its emission was concentrated over a smaller 8 mm field.

Scientific interpretation. The VALO X is the better global-output device. The VEGA is the higher local-density device. If the clinical target area fits completely within the VEGA tip, the VEGA may deliver a very strong local dose. If the restoration is wider, posterior, or difficult to cover completely with an 8 mm tip, the VALO X has a meaningful clinical advantage.

8. Estimated Radiant Exposure by Exposure Time

Radiant exposure, expressed in J/cm², was estimated from the measured dental-band irradiance multiplied by exposure time. These values assume that the measured irradiance is maintained during the exposure and that the tip is positioned close to the target, perpendicular to the surface.

Device	5 s	10 s	20 s
VEGA	6.7 J/cm ²	13.4 J/cm ²	26.8 J/cm ²
VALO X	5.6 J/cm ²	11.2 J/cm ²	22.4 J/cm ²
Bluephase Style M i20	4.2 J/cm ²	8.4 J/cm ²	16.9 J/cm ²

The VEGA delivered the highest calculated local radiant exposure at each time point because it had the highest measured dental-band irradiance. At 10 seconds, the VEGA delivered approximately 13.4 J/cm², the VALO X approximately 11.2 J/cm², and the Bluephase Style M i20 approximately 8.4 J/cm².

Clinical translation. Ten seconds with the Bluephase Style M i20, under these measurement conditions, provides a much lower radiant exposure than 10 seconds with the VEGA or VALO X. This does not automatically mean failure, but it reduces the margin of safety, especially for dark shades, opaque materials, deep boxes, indirect restorations, or increased tip-to-material distance.

Important note: For a conventional 2 mm composite increment, a minimum of **16–20 J/cm²** is required, with a safer target of **20–24 J/cm²**, whereas darker or more opaque shades typically require at least **20–24 J/cm²**, with a safer target of **24–36 J/cm²**.

9. Scientific Ranking by Parameter

Parameter	1st	2nd	3rd	Main interpretation
Total radiant power	VALO X	VEGA	Bluephase Style M i20	VALO X has the largest total output.
Dental-band irradiance	VEGA	VALO X	Bluephase Style M i20	VEGA has the highest local density.
Absolute violet power	VALO X	VEGA	Bluephase Style M i20	VALO X delivers the most total violet light.
Violet irradiance	VEGA	VALO X	Bluephase Style M i20	VEGA has the highest local violet density.
Absolute blue power	VALO X	VEGA	Bluephase Style M i20	VALO X delivers the most total blue light.
Blue irradiance	VEGA	VALO X	Bluephase Style M i20	VEGA has the highest local blue density.
Relative spectral balance	VEGA	VALO X	Bluephase Style M i20	VEGA has the highest violet proportion.
Overall clinical versatility	VALO X	VEGA	Bluephase Style M i20	VALO X combines high power with wide coverage.

10. Clinical Translation

10.1 Adhesive Procedures

For thin adhesive layers, both the VEGA and VALO X provide strong output and broad spectral coverage. The VEGA is particularly strong locally, and 10 seconds appears clinically reasonable when the tip is close, centered, and perpendicular. The VALO X is also excellent and may be more forgiving over a larger surface. The Bluephase Style M i20 should be used more conservatively; 10-15 seconds is more prudent than very short curing times.

10.2 Direct Composite Resin Increments up to 2 mm

The VEGA measured approximately 13.4 J/cm² at 10 seconds, which is a strong local dose for conventional increments when the light is properly positioned. The VALO X measured approximately 11.2 J/cm² at 10 seconds, with the advantage of a larger curing field. The Bluephase Style M i20 measured approximately 8.4 J/cm² at 10 seconds, which is less comfortable for a universal protocol; 20 seconds should be considered the baseline under these measured conditions.

For a conventional 2 mm composite increment, a minimum of **16–20 J/cm²** is required, with a safer target of **20–24 J/cm²**, whereas darker or more opaque shades typically require at least **20–24 J/cm²**, with a safer target of **24–36 J/cm²**.

10.3 Alternative Photoinitiators and Very Light/Translucent Materials

For materials containing TPO, Ivocerin, BAPO, or photoinitiator blends, the violet component becomes highly relevant. The VEGA is excellent in this respect because it showed the highest violet irradiance. The VALO X is also excellent because it had the highest absolute violet power and a larger field. The Bluephase Style M i20 showed limited violet output and should be used with more caution for materials that rely heavily on violet activation.

10.4 Posterior Restorations and Wide Occlusal Surfaces

The VALO X is likely the most clinically versatile for posterior restorations because of its larger aperture and much higher total radiant power. The VEGA remains very strong, but the 8 mm field means that wide restorations may require overlapping exposures. The Bluephase Style M i20 should be used with longer exposure times and possibly additional exposures, especially in proximal boxes or areas where ideal access is difficult.

10.5 Indirect Restorations and Light Transmission Through Ceramic

For light-curing through ceramic, all readings must be interpreted conservatively because the restoration attenuates light according to thickness, translucency, shade, and ceramic type. The VALO X is the strongest global candidate because of high total output and wide coverage. The VEGA is excellent when the area is smaller or when multiple exposures are used. With the Bluephase Style M i20, longer exposure times and dual-cure materials are particularly important in clinically demanding cases.

11. Suggested Exposure Strategy Based on These Readings

Clinical situation	VEGA	VALO X	Bluephase Style M i20
Adhesive layer	15–20 s	10–15 s	15–20 s
Conventional composite ≤2 mm (light/medium shade)	15–20 s	15–20 s	20–30 s
Dark/opaque composite	20–30 s	20–30 s	30–40 s
Deep Class II / proximal box	20–30 s; ensure ideal positioning; consider additional exposure from occlusal	20–30 s; consider 2 exposures	30–40 s; strongly consider multiple exposures
Wide posterior restoration	Multiple overlapping exposures (≥20 s each)	20–30 s; overlap if needed	Multiple exposures; 30 s per area
Thin translucent ceramic	≥30 s per surface	≥30 s per surface	40 s per surface
Thick/opaque ceramic	Dual-cure + prolonged light exposure (≥40 s per surface)	Dual-cure + prolonged light exposure (≥40 s per surface)	Dual-cure mandatory + prolonged exposure (≥40–60 s per surface)

12. Final Interpretation Focused on the VEGA

The VEGA performed exceptionally well in this spectroradiometer comparison. It did not have the greatest absolute radiant power because the VALO X emitted substantially more total light. However, the VEGA produced the highest measured dental-band irradiance, the highest blue irradiance, and the highest violet irradiance. In other words, within its 8 mm emission field, the VEGA delivered a very high local light density.

Compared with the Bluephase Style M i20, the VEGA was clearly superior in this test. It delivered approximately 59% more total dental-band power and irradiance, approximately 29% more blue output, and approximately 3.7 times more violet output. This is a major difference, not a marginal one.

Compared with the VALO X, the VEGA was more concentrated and locally intense, while the VALO X was more powerful overall and covered a larger area. The clinical choice between them depends on the application: the VEGA is excellent for localized curing when the target fits under the tip; the VALO X is better for broad coverage and overall versatility.

Overall conclusion. Based on these readings, the VEGA behaves as a high-performance broad-spectrum curing light with excellent local irradiance and a very balanced spectral profile. The VALO X remains the strongest global-output device because of its high total power and larger aperture. The Bluephase Style M i20, under these measured conditions, should be used more conservatively, with longer exposure times and careful attention to clinical positioning.

13. Key Take-Home Messages

- The VEGA had the highest measured dental-band irradiance: approximately 1342 mW/cm².
- The VALO X had the highest total radiant power: approximately 1290 mW in the 385-515 nm dental band.
- The VEGA had the strongest local violet irradiance, which is relevant for non-camphorquinone photoinitiators.
- The VALO X is the most globally versatile device because it combines high total output with a larger curing field.
- The Bluephase Style M i20 was clearly lower in total output, irradiance, and violet emission in these readings.
- The clinically correct interpretation is not “which mW/cm² is highest” alone, but the combination of power, area, spectrum, distance, exposure time, and beam coverage.