

Description: Full report on street lighting for AEB VRU testing  
Venue: Upper Heyford, Oxfordshire  
Current version: 190718  
Date of test: 23rd January 2018

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## 1. General background

While working with Thatcham UK, Moshon Data conducted a sample of ground luminance tests on a small selection of street lighting solutions with a view to understanding what the differences might be between them, and therefore present a range of suitable option(s) for the new 2018 AEB VRU protocol.

Street lamps tested:

- Adolf Schuch 47 2403 ABX CL
  - <http://www.schuch.de/47> (Difficult to get hold of– possible phase out)
  - [http://www.schuch.de/SCHUCH\\_48\\_en.pdf](http://www.schuch.de/SCHUCH_48_en.pdf) - possible replacement
- Zeta SmartScape Nano (With an L02 lens fitted)
- Zeta SmartScape Nano (With an L05 lens fitted)
  - <http://zetaled.co.uk/my-product/smartscape-nano/>
- Zeta Macro (New product)
  - <http://zetaled.co.uk/my-product/smartscape-macro/>



## 2. Test procedure

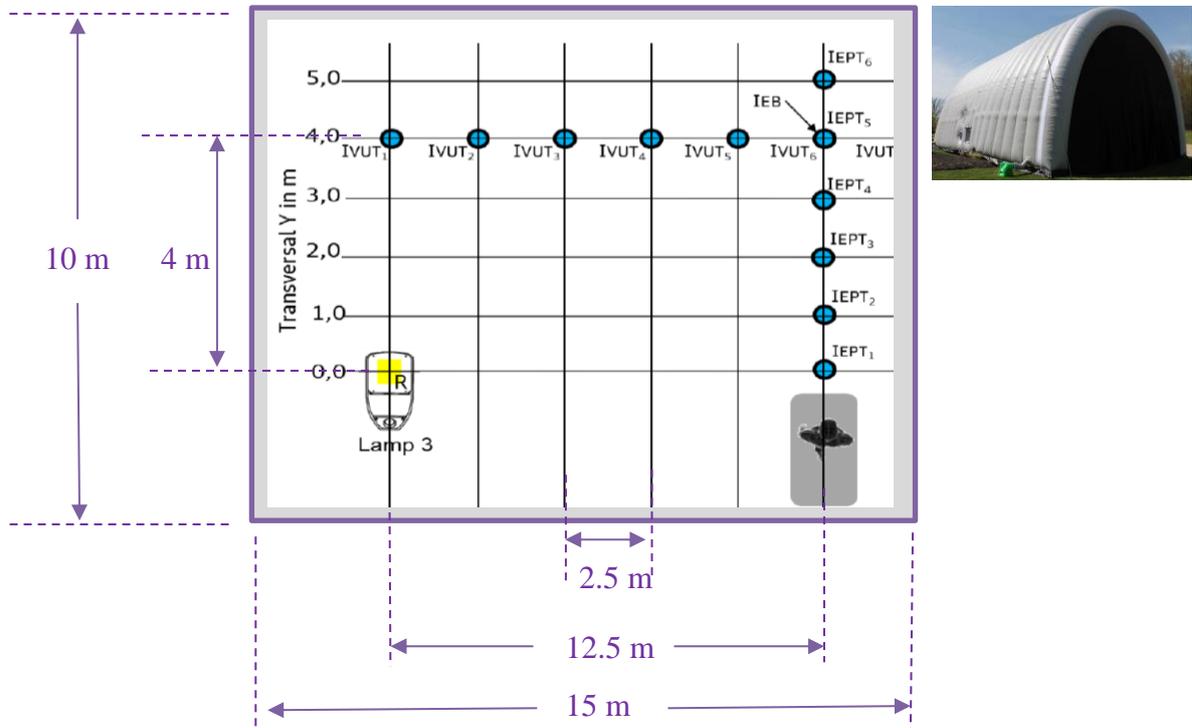
Each street lamp has been tested by Moshon Data for ground luminance at various test point locations. The points are defined by the Euro NCAP VRU protocol. An example measurement grid is outlined on page 38, and a test example on page 32.

AEB VRU Protocol here: <https://www.euroncap.com/en/for-engineers/protocols/vulnerable-road-user-vru-protection/>

Tests were carried out in a simulated night-time environment with a controlled dark condition at < 1 lux using the MD Night Environment Simulation Tunnel (NEST).

Note that due to size restrictions in the length of the single section of NEST, and in some cases where only one lamp was available, it was only possible to conduct a test on one lamp at a time, meaning only half of the example test grid. We therefore expect our luminance at the EPT path using one lamp at 12.5 m from the light source to be roughly half of the luminance expected than if 2 lamps were used at a 25 m separation. I.e. if two lamps were used (in a full grid scenario) we can assume a near ‘doubled light output’ at the EPT path assuming the lamp light spread is over 12.5 m. For the VUT the ‘doubled light output’ would effectively reduce by a given percentage (we assume 20% for our tests) the further away the point gets from the light source.

The floor plan of our test area is below:



Examples of a predicted light output will be shown in the results section below, but more work is obviously required to prove the light overlap spread from the light sources and the effect this has on the luminance at the test points. Ideally, we should carry out our tests using a two-lamp scenario, but one lamp and a prediction should be able to give us an idea of what to expect.

The light meter used was the Konica Minolta T-10A (as suggested by Euro NCAP). Others were used as a comparison and the differences will be compared in a further report. 190718: *Now included in this report.*

The ground conditions were wet which may result in different luminance ratings from dry conditions. The weather was wet and gusty with up to 16 mph winds reported on the day, but inside the tunnel we were not affected.

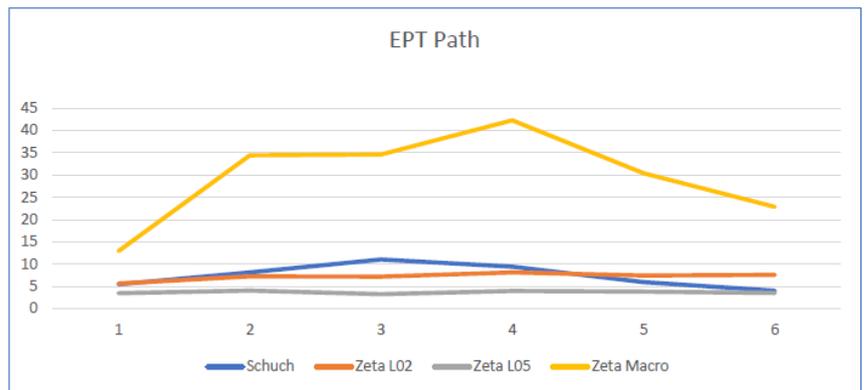
Below is a view inside, and outside the tunnel on the day.



### 3. Results

#### 3.1. Results at EPT Path

EPT Path				
	Schuch	Zeta L02	Zeta L05	Zeta Macro
	5.45	5.64	3.47	12.92
	8.15	7.22	4.05	34.4
	11.04	7.2	3.25	34.6
	9.4	8.13	3.95	42.3
	5.95	7.43	3.83	30.4
	4.02	7.6	3.53	22.88
Avg	7.3	7.2	3.7	29.6



For the EPT path the specifications are stated as  $> 5$  lux therefore the Schuch, Zeta with L02 lens and Macro lamps are suitable. However, the Zeta with the L05 lens is not suitable and drops below 5 lux.

#### 3.1.1. Results at the EPT path using a simulation of the extra light spread overlap of two lamps

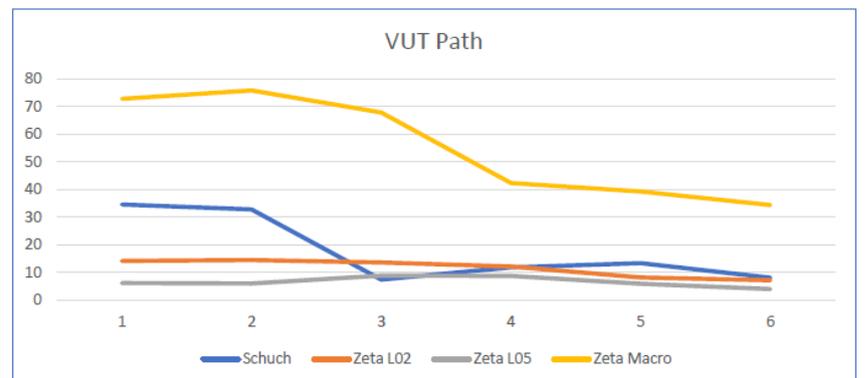
In the table below each result has been doubled working on the assumption of twice the light on the overlap

EPT Path				
	Schuch	Zeta L02	Zeta L05	Zeta Macro
	10.9	11.28	6.94	25.84
	16.3	14.44	8.1	68.8
	22.08	14.4	6.5	69.2
	18.8	16.26	7.9	84.6
	11.9	14.86	7.66	60.8
	8.04	15.2	7.06	45.76
	14.7	14.4	7.4	65.8

Here, the results show that all lamps are  $> 5$  lux and therefore in specification.

#### 3.1. Results at VUT Path

VUT Path				
	Schuch	Zeta L02	Zeta L05	Zeta Macro
	34.6	14.25	6.23	72.8
	32.8	14.53	6.08	75.8
	7.45	13.62	8.9	67.8
	11.87	12.22	8.8	42.4
	13.45	8.23	5.95	39.3
	8.15	7.22	4.05	34.4
Avg	18.1	11.7	6.8	51.9



For the VUT path the specifications are stated as  $19 \pm 3$  lux. This is a much tighter requirement than EPT.

This means all points were out of specification at this rating, on average the Zeta with L02 lens is arguably the closest overall.

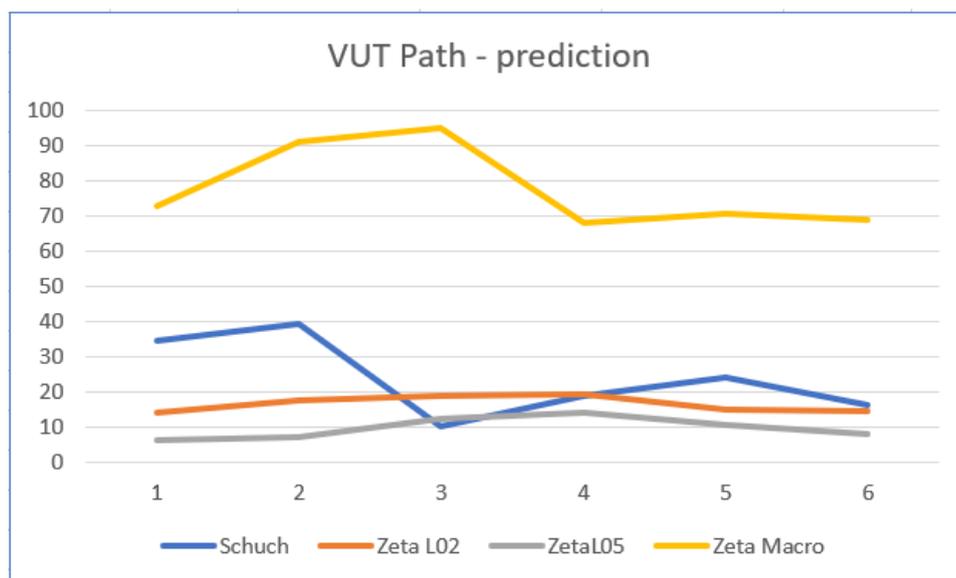
However, what if we are to predict the results of a light overlap spread from a two-lamp scenario?

### 3.1.1. Results at the VUT path for a ‘doubled’ light overlap.

The prediction in the table below poses a theoretical ‘light overlap’ for the VUT path using a 20% reduction on the ‘extra light’ we might presume is present from the overlap at each point as you get further away from the 2<sup>nd</sup> lamp light source.

VUT Path					
Test point	Schuch	Zeta L02	ZetaL05	Zeta Macro	Notes
VUT1	34.6	14.25	6.23	72.8	no reduction - normal light from onelamp
VUT2	39.36	17.436	7.296	90.96	80% reduction on extra light overlap
VUT3	10.43	19.068	12.46	94.92	60% reduction on extra light overlap
VUT4	18.992	19.552	14.08	67.84	40% reduction on extra light overlap
VUT5	24.21	14.814	10.71	70.74	20% reduction on extra light overlap
VUT6	16.3	14.44	8.1	68.8	double
	24.0	16.6	10.5	78.7	

Here, the Zeta with the 02 lens was the **only** unit in specification on three points (VUT2,3,4), the Schuch within specification on 2 points (VUT4,6). However, overall the Zeta 02 was also more consistent in overall light output and averages 16.6 – only one on the edge of the lower limit! However, this is only a prediction...



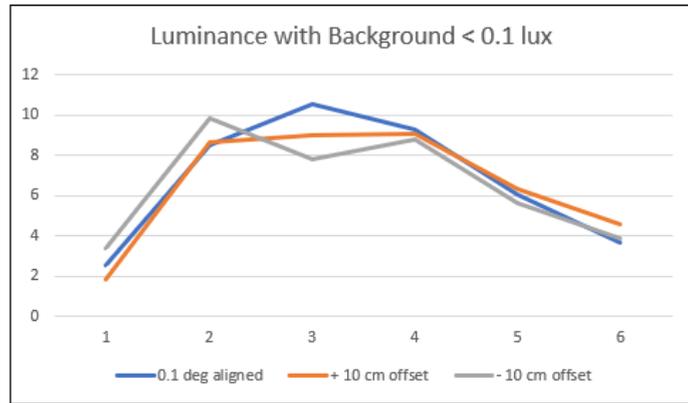
### 4. Update 190718: Effect of lamp head Misalignment on the EPT path

Further tests were carried out to understand the importance of accuracy in the alignment of the lamp head.

With the lamp set-up as shown in the test procedure in step 2, a deliberate misalignment of +/- 1.5° (10 cm offset) was applied and measurements taken again using the Konica Minolta along the EVT pedestrian path.

The results are plotted below.

Offset analysis conducted using Schuch			
	0.1 deg aligned	+ 10 cm offset	- 10 cm offset
	2.55	1.83	3.37
	8.5	8.61	9.84
	10.55	9.01	7.83
	9.25	9.09	8.75
	6.04	6.3	5.65
	3.64	4.54	3.88
avg	6.76	6.56	6.55



It can be seen here that with a +/- 1.5° misalignment introduced, the effect on the light output along the EPT path is found to be < 0.2 lux average. With background luminance stated as acceptable to <1.0 lux we believe this difference to be negligible.

### 5. Update 190718: Light meter differences

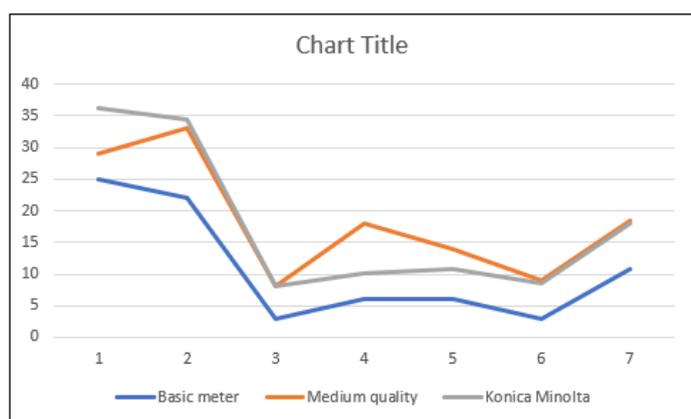
Further tests were carried out to understand the importance of accuracy within the lightmeter.

Three light meters were used, one of which was the Euro NCAP recommended Konica Minolta T-10A. Not wishing to present other manufactures products in a bad light, we have not stated the types or models used, but as an indication the basic meter is priced at < £50, medium quality around £100-200 and the Konica Minolta around £1,000+. The Konica Minolta comes with a calibration certificate so we are confident that the results shown below are a true representation of the light output on the day.

With the lamp set-up as shown in the test procedure step 2, measurements were taken along the VUT vehicle path.

The results are plotted below.

Lightmeter type - Quality			
	Basic meter	Medium quality	Konica Minolta
	25	29	36.3
	22	33	34.5
	3	8	8
	6	18	10.2
	6	14	10.78
	3	9	8.5
Avg	10.83	18.50	18.05



At first glance it is immediately obvious the resolution of the Konica Minolta is much better than the other two being capable of recording the light readings to two decimal places.

It can be seen that the average of the medium quality meter and the Konica Minolta are similar, Here the medium quality meter could be considered to give a reasonable enough reading to ensure everything is operating as required, but some differences on the larger luminance readings do appear to differ by >7 lux so confidence is not great where you might need to map the entire test area ready for an important test.

With the basic meter, the readings are completely unacceptable – we suspect the meter may have been out of calibration but are uncertain how one might go about re-calibrating it as there is no clear process.

## 6. Conclusion

In brief it appears clear that some lamps are brighter, but others more consistent in light output albeit at a lower overall level. The Zeta's L02 and L05 appear both more consistent in their light spread than the others, but the Schuch is brighter the nearer to the lamp source you get but making very little difference the further away you get from the light source. The Zeta Macro outperformed all the others in sheer brightness by a long way but was far too bright for the 19 lux +/- 3 lux light conditions asked for by the protocol on the VUT path.

In short, using our prediction theory, all appear to be fine for the > 5 lux of the EPT path, but the VUT path needs some consideration of our prediction by using two lamps in the test and not one.

After talks with Zeta, we understand it may be possible to 'overdrive' the Zeta L02 to make the output brighter if required. This may result in a shorter life expectancy, but the life expectancy of a streetlamp is based on being on every night 365 days a year, so this may not be too much of a problem for occasional testing. Conversely, we may also be able to reduce the light output of the Zeta Macro if it is felt the output of this would be a better spread – i.e. a more homogenous spread might be possible from multiple LEDs and not from a single light source. However, oddly the single source appears to be more consistent in our tests.

The Zeta L02s also have different colour temperature options available should this be required.

### **Update 190718:**

#### ***Overdrive and dimming.***

*This is available on all Zeta systems by default. Zeta have enhanced the quality of a couple of internal components to push the units past their 40 W default output and allow them to be driven at higher levels up to 50 W. The dimmer then provides a means to tune the system to differing night-time background luminance values by using the recommended Konica Minolta light meter.*

#### ***Effect of lamp head Misalignment on the EPT path***

*With a +/- 1.5° misalignment introduced, the effect on the light output along the EPT path is found to be < 0.2 lux average.*

*With a background luminance stated by NCAP as being acceptable to < 1.0 lux we believe a difference < 0.2 to be negligible on the light spread of 19 lux and therefore the accuracy of lamp head alignment to the test area not as critical as it might first appear.*

#### ***Light meter differences***

*The resolution of the Konica Minolta T-10A resolution is much better than either the medium or basic quality light meters. It is also an instrument that comes with a calibration certificate and provides a level of confidence that the results taken are true.*

*A medium quality meter may be stable enough to check results are consistent to previous readings once the field has been mapped accurately to a high-quality instrument.*

*We do not recommend a basic meter for this kind of use.*

*It is our recommendation (alongside Euro NCAP) that the Konica Minolta T-10A (or an equivalent quality meter) is used to accurately map the test area.*

We look forward to receiving feedback from engineers regarding this analysis.

## **7. Acknowledgments:**

- Thatcham UK for their support and use of their airfield area at Upper Heyford
- Zeta Lighting for their support and providing a sample of lights for us to try
- Konica Minolta for use of the Luxmeter T-10A as recommended by Euro NCAP

## **8. Version history:**

180321	Original Document:
190718	Further analysis for Misalignments and light-meters

/Moshon Data