

## Waveform Processing Airborne Laser Scanner for Wide Area Mapping and High Productivity

# RIEGL VQ<sup>®</sup>-780 II

- **high laser pulse repetition rate up to 2 MHz**
- **up to 1.33 million measurements/sec on the ground**
- **excellent multiple target detection capability**
- **excellent suppression of atmospheric clutter**
- **Multiple-Time-Around (MTA) processing of up to 35 pulses simultaneously in the air**
- **online waveform processing as well as smart and full waveform recording**
- **parallel scan lines and uniform point distribution**
- **interface for GNSS time synchronization**
- **seamless integration and compatibility with other RIEGL ALS systems and software packages**

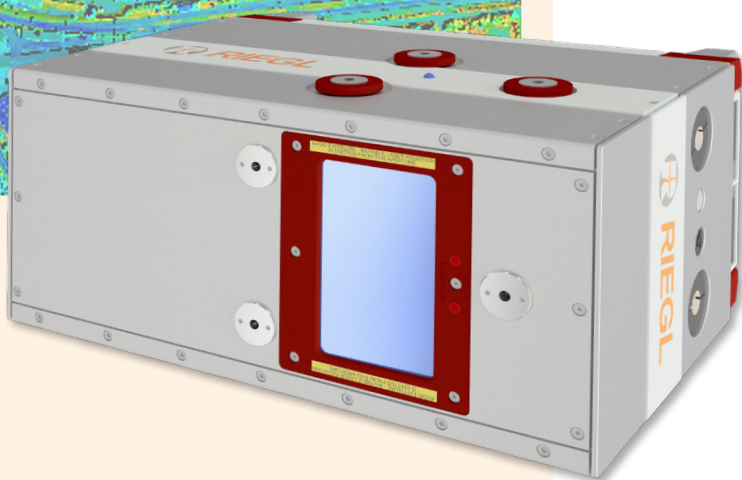
The Waveform Processing Airborne Laser Scanner **RIEGL VQ-780 II** provides further increased performance and highest productivity based on a laser pulse repetition rate of up to 2 MHz, resulting in more than 1.33 million measurements/sec on the ground.

The versatile scanner is designed for high efficient data acquisition at low, mid, and high altitudes, covering a variety of different airborne laser scanning applications from high density to wide area mapping. Its high speed rotating mirror design ensures reliability, and uniform point distribution across its entire wide field of view and at all flying altitudes. Based on **RIEGL's** proven Waveform-LIDAR technology, the system provides point clouds with highest accuracy, excellent vertical target resolution, calibrated reflectance readings, and pulse shape deviation for unsurpassed information content on each single measurement. Excellent atmospheric clutter suppression yields clean point clouds with minimum efforts in filtering isolated noise points.

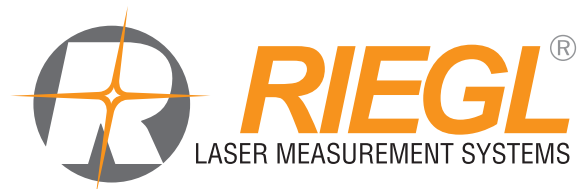
The **RIEGL VQ-780 II** is designed to work with the latest Inertial Navigation (IMU) Systems, flight management systems, and camera options. The system is complimented with **RIEGL's** advanced acquisition and data processing software suite that utilizes parallel computing (GPU) for fast data processing.

### Applications:

- *Wide Area / High Altitude Mapping*
- *High Point Density Mapping*
- *Mapping of Complex Urban Environments*
- *Glacier & Snowfield Mapping*
- *City Modeling*
- *Mapping of Lakesides & River Banks*
- *Agriculture & Forestry*
- *Corridor Mapping*

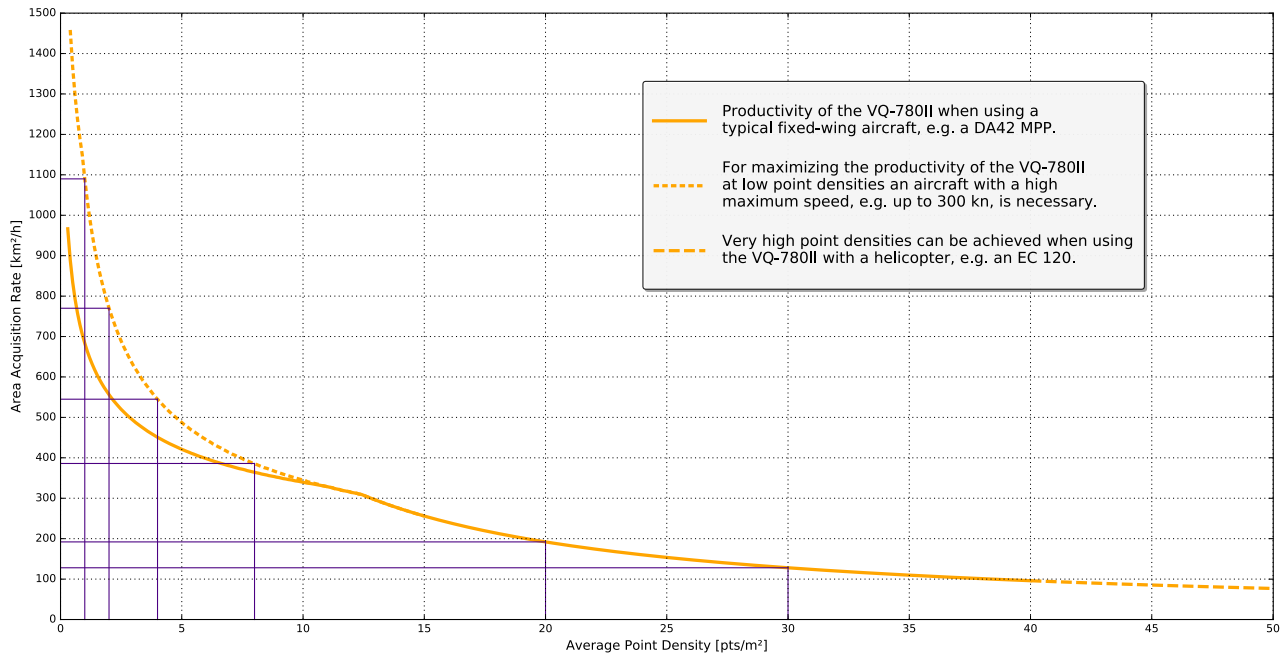


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# RIEGL VQ<sup>®</sup>-780 II Productivity

The RIEGL VQ-780 II Airborne Laser Scanner offers highest productivity.



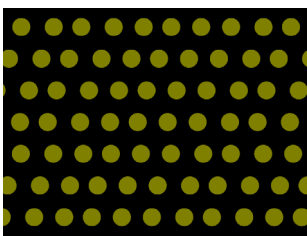
## Examples <sup>1)</sup>

Average Point Density	1 pts/m <sup>2</sup>	2 pts/m <sup>2</sup>	4 pts/m <sup>2</sup>	8 pts/m <sup>2</sup>	20 pts/m <sup>2</sup>	30 pts/m <sup>2</sup>
Flight Altitude AGL	6960 ft 2120 m	4920 ft 1500 m	3580 ft 1090 m	3580 ft 1090 m	2820 ft 860 m	2310 ft 700 m
Ground Speed	300 kn	300 kn	292 kn	206 kn	130 kn	106 kn
Swath Width	2450 m	1730 m	1260 m	1260 m	990 m	810 m
Productivity	1090 km <sup>2</sup> /h	770 km <sup>2</sup> /h	545 km <sup>2</sup> /h	386 km <sup>2</sup> /h	192 km <sup>2</sup> /h	128 km <sup>2</sup> /h
Measurement Rate <sup>2)</sup>	378 000 meas./sec	535 000 meas./sec	757 000 meas./sec	1.07 mill. meas./sec	1.33 mill. meas./sec	1.33 mill. meas./sec

<sup>1)</sup> calculated for 20% target reflectivity and 20% stripe overlap

<sup>2)</sup> The target detection rate is equal to the measurement rate for terrains offering only one target per laser pulse but may be much higher for vegetated areas.

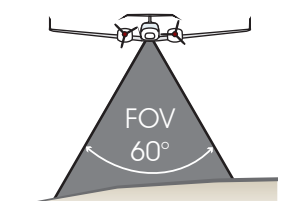
# RIEGL VQ<sup>®</sup>-780 II Dense Scan Pattern and Wide Effective Swath Width



RIEGL VQ-780 II point distribution

The RIEGL VQ-780 II scanning mechanism – based on a continuously rotating polygon mirror wheel – delivers straight parallel scan lines resulting in a regular point pattern on the ground. With equal spatial sampling frequency along and across track, object extents are well defined and even small objects may be detected. The instrument is perfectly suited for applications where a superior point pattern on target surfaces is required.

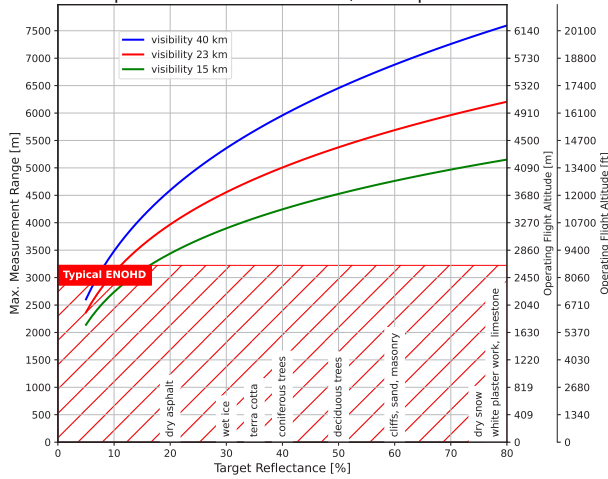
The wide field of view and the multiple-time-around measurement capability of the RIEGL VQ-780 II make the instrument perfectly suited for wide area mapping applications. The instrument has been designed for utmost efficiency in collecting data by enabling scanning operations from high altitudes at high laser pulse repetition rates simultaneously, reducing the necessary flight time to a minimum.



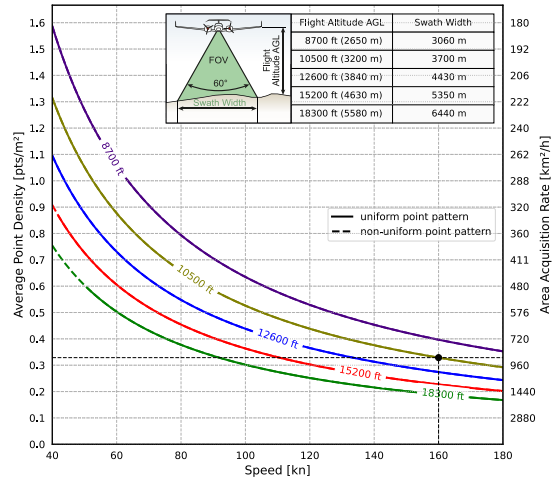
broad effective swath width

# Measurement Range & Point Density RIEGL VQ<sup>®</sup>-780 II

Laser Pulse Repetition Rate = 150kHz, laser power level 100%

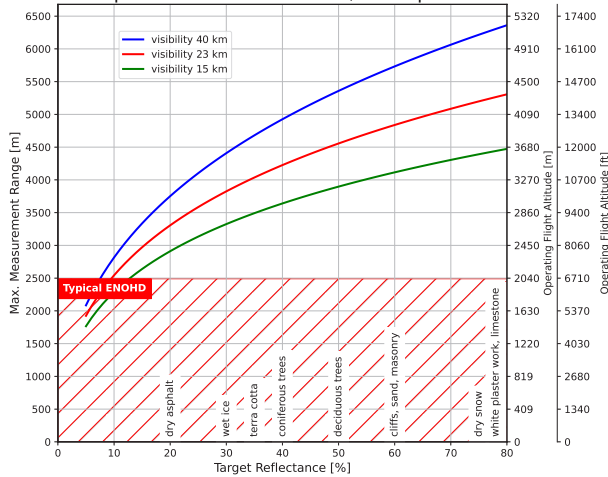


**Example:** VQ-780 II at 150,000 pulses/sec, laser power level 100%  
Altitude = 10,500 ft AGL, Speed 160 kn

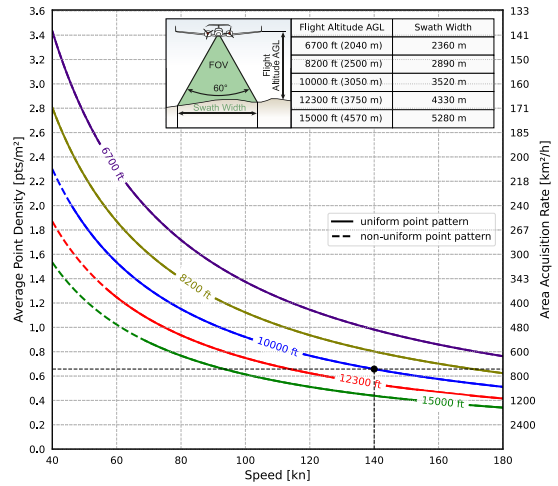


**Results:** Point Density ~ 0.33 pts/m<sup>2</sup>  
Area Acquisition Rate ~ 876 km<sup>2</sup>/h

Laser Pulse Repetition Rate = 250kHz, laser power level 100%

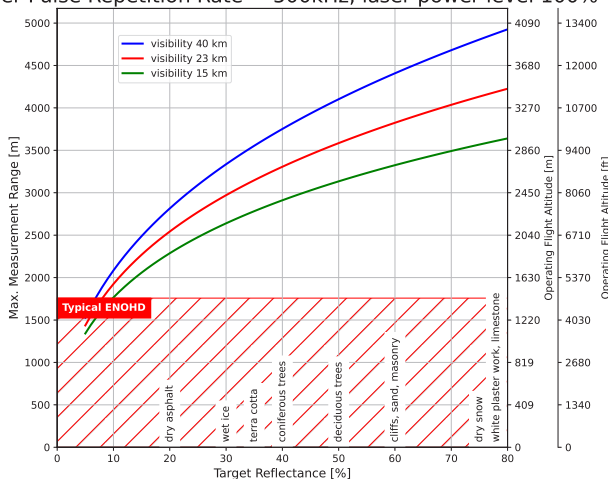


**Example:** VQ-780 II at 250,000 pulses/sec, laser power level 100%  
Altitude = 10,000 ft AGL, Speed 140 kn

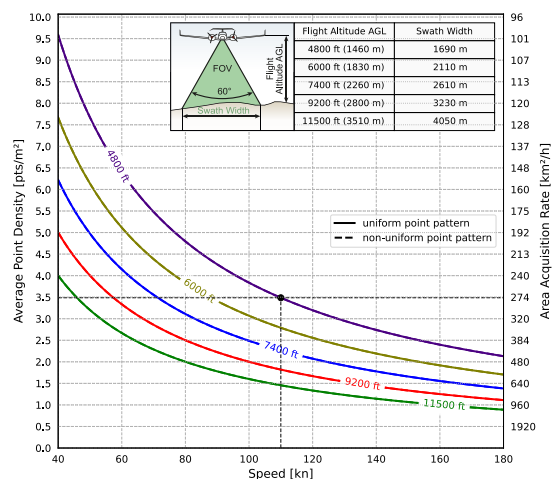


**Results:** Point Density ~ 0.66 pts/m<sup>2</sup>  
Area Acquisition Rate ~ 730 km<sup>2</sup>/h

Laser Pulse Repetition Rate = 500kHz, laser power level 100%



**Example:** VQ-780 II at 500,000 pulses/sec, laser power level 100%  
Altitude = 4,800 ft AGL, Speed 110 kn



**Results:** Point Density ~ 3.5 pts/m<sup>2</sup>  
Area Acquisition Rate ~ 275 km<sup>2</sup>/h

**The following conditions are assumed for the Operating Flight Altitude AGL**

- ambiguity resolved by multiple-time-around (MTA) processing
- target size ≥ laser footprint
- full FOV of 60°
- average ambient brightness
- roll angle ±5°

**Typical ENOHD**

- Calculated under assumption of an angular step width of 0.012° and an aircraft speed higher than 10kn.

**Assumptions for calculation of the Area Acquisition Rate**

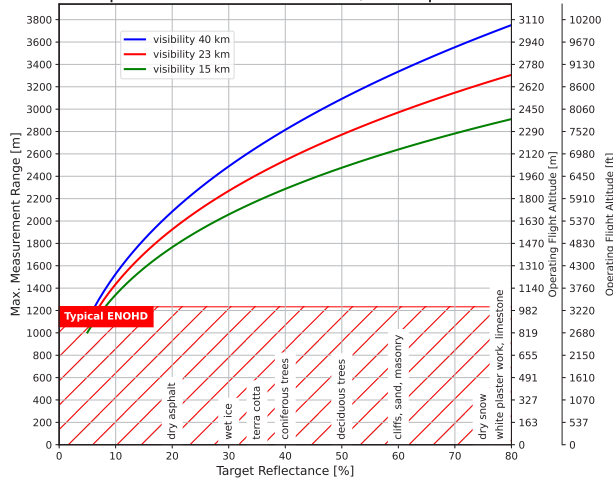
- 20% overlap of neighboring flight strips. This overlap covers a roll angle of ±5° or a reduction of flight altitude AGL of 20%.

**Uniform Point Pattern**

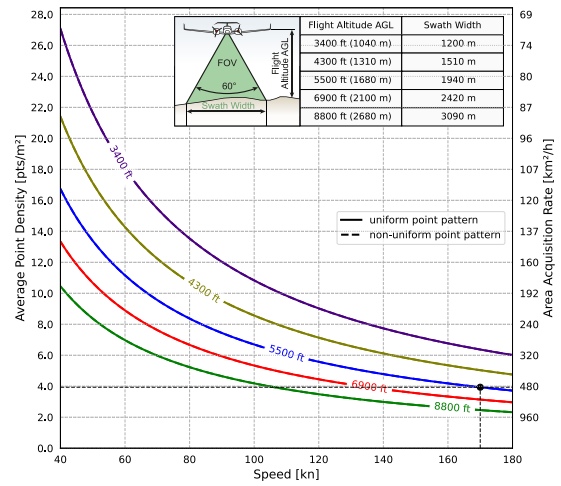
- The line to line spacing is equal to the average point to point spacing.

# Measurement Range & Point Density RIEGL VQ®-780II

Laser Pulse Repetition Rate = 1000kHz, laser power level 100%

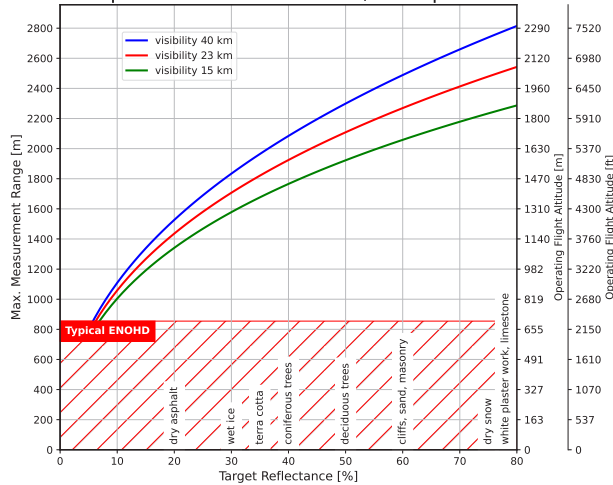


**Example:** VQ-780II at 1.0 mill. pulses/sec, laser power level 100%  
Altitude = 5,500 ft AGL, Speed 170 kn

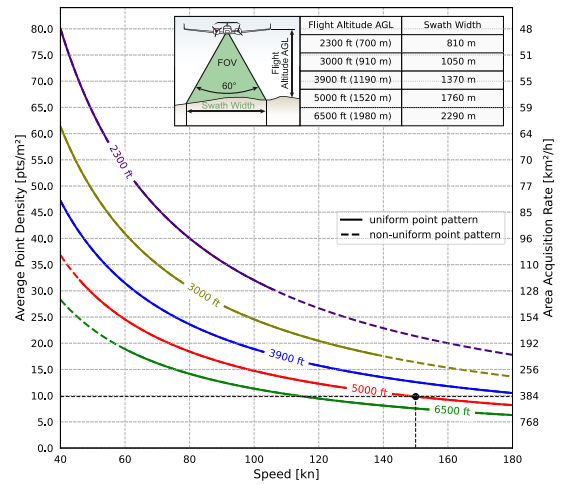


**Results:** Point Density ~ 3.9 pts/m<sup>2</sup>  
Area Acquisition Rate ~ 488 km<sup>2</sup>/h

Laser Pulse Repetition Rate = 2000kHz, laser power level 100%

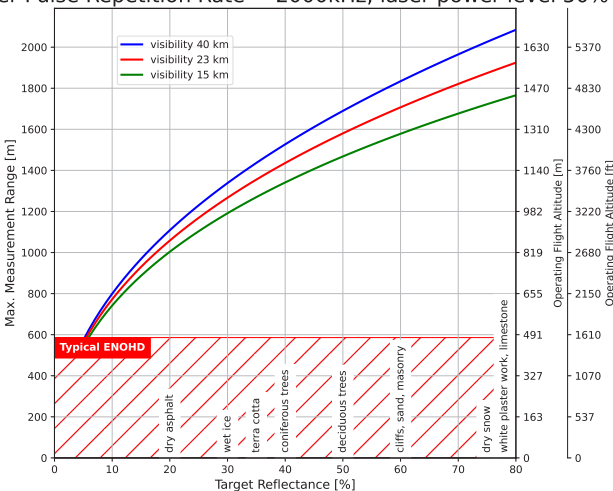


**Example:** VQ-780II at 2.0 mill. pulses/sec, laser power level 100%  
Altitude = 5,000 ft AGL, Speed 150 kn

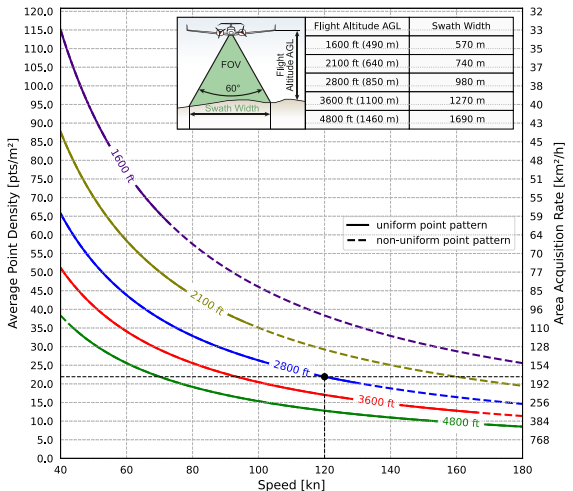


**Results:** Point Density ~ 9.82 pts/m<sup>2</sup>  
Area Acquisition Rate ~ 391 km<sup>2</sup>/h

Laser Pulse Repetition Rate = 2000kHz, laser power level 50%



**Example:** VQ-780II at 2.0 mill. pulses/sec, laser power level 50%  
Altitude = 2,800 ft AGL, Speed 120 kn



**Results:** Point Density ~ 21.92 pts/m<sup>2</sup>  
Area Acquisition Rate ~ 175 km<sup>2</sup>/h

**The following conditions are assumed for the Operating Flight Altitude AGL**

- ambiguity resolved by multiple-time-around (MTA) processing
- target size ≥ laser footprint
- full FOV of 60°
- average ambient brightness
- roll angle ±5°

**Typical ENOHD**

- Calculated under assumption of an angular step width of 0.012° and an aircraft speed higher than 10kn.

**Assumptions for calculation of the Area Acquisition Rate**

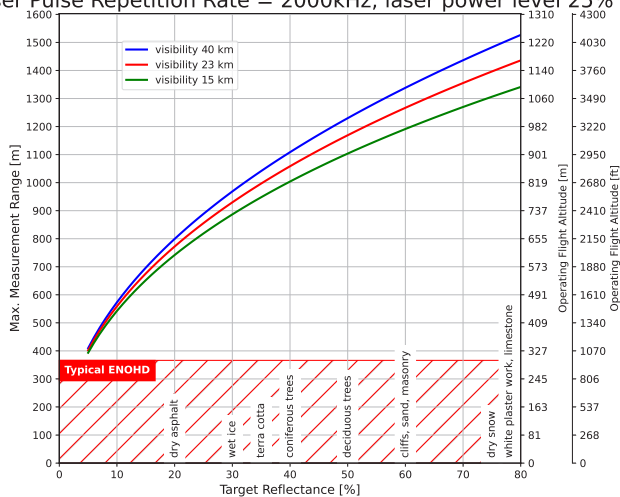
- 20% overlap of neighboring flight strips. This overlap covers a roll angle of ±5° or a reduction of flight altitude AGL of 20%.

**Uniform Point Pattern**

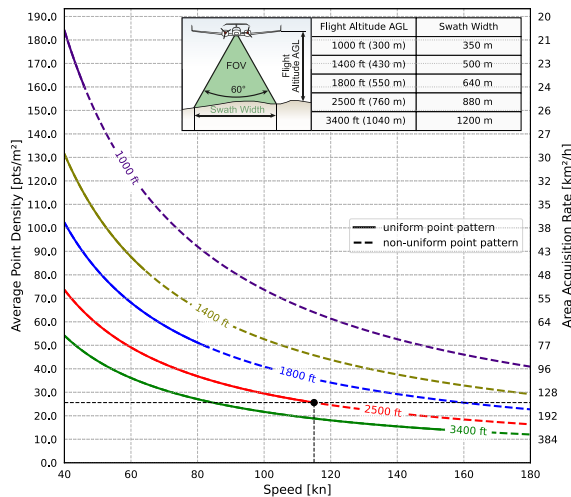
- The line to line spacing is equal to the average point to point spacing.

# Measurement Range & Point Density RIEGL VQ®-780 II

Laser Pulse Repetition Rate = 2000kHz, laser power level 25%

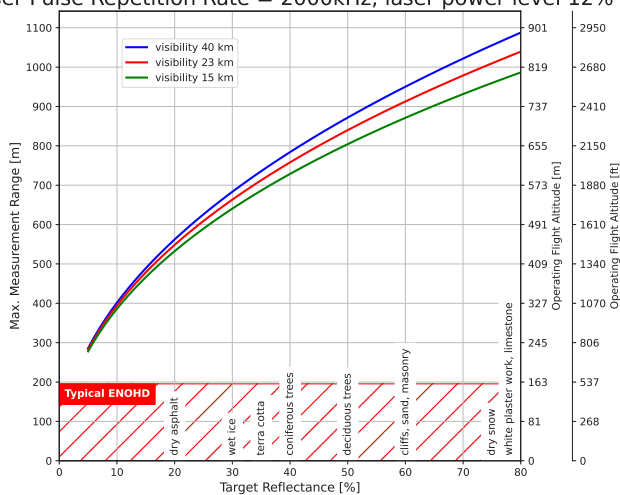


**Example:** VQ-780II at 2.0 mill. pulses/sec, laser power level 25%  
Altitude = 2,500 ft AGL, Speed 115 kn

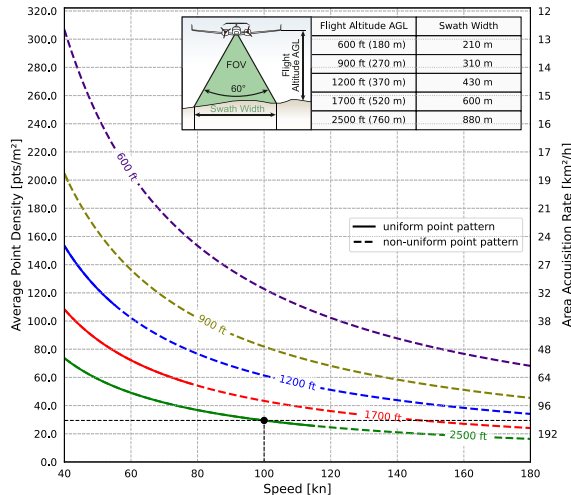


**Results:** Point Density ~ 25.61 pts/m<sup>2</sup>  
Area Acquisition Rate ~ 150km<sup>2</sup>/h

Laser Pulse Repetition Rate = 2000kHz, laser power level 12%

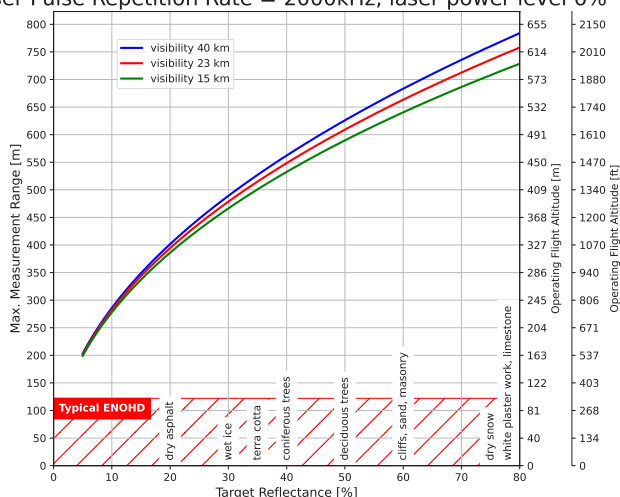


**Example:** VQ-780II at 2.0 mill. pulses/sec, laser power level 12%  
Altitude = 2,500 ft AGL, Speed 100 kn

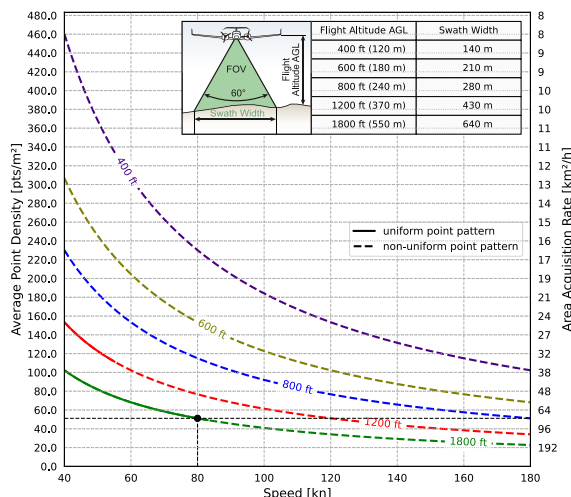


**Results:** Point Density ~ 29.46 pts/m<sup>2</sup>  
Area Acquisition Rate ~ 130 km<sup>2</sup>/h

Laser Pulse Repetition Rate = 2000kHz, laser power level 6%



**Example:** VQ-780II at 2.0 mill. pulses/sec, laser power level 6%  
Altitude = 1,800 ft AGL, Speed 80 kn



**Results:** Point Density ~ 51.14 pts/m<sup>2</sup>  
Area Acquisition Rate ~ 75 km<sup>2</sup>/h

**The following conditions are assumed for the Operating Flight Altitude AGL**

- ambiguity resolved by multiple-time-around (MTA) processing
- target size ≥ laser footprint
- full FOV of 60°
- average ambient brightness
- roll angle ±5°

**Typical ENOHD**

- Calculated under assumption of an angular step width of 0.012° and an aircraft speed higher than 10kn.

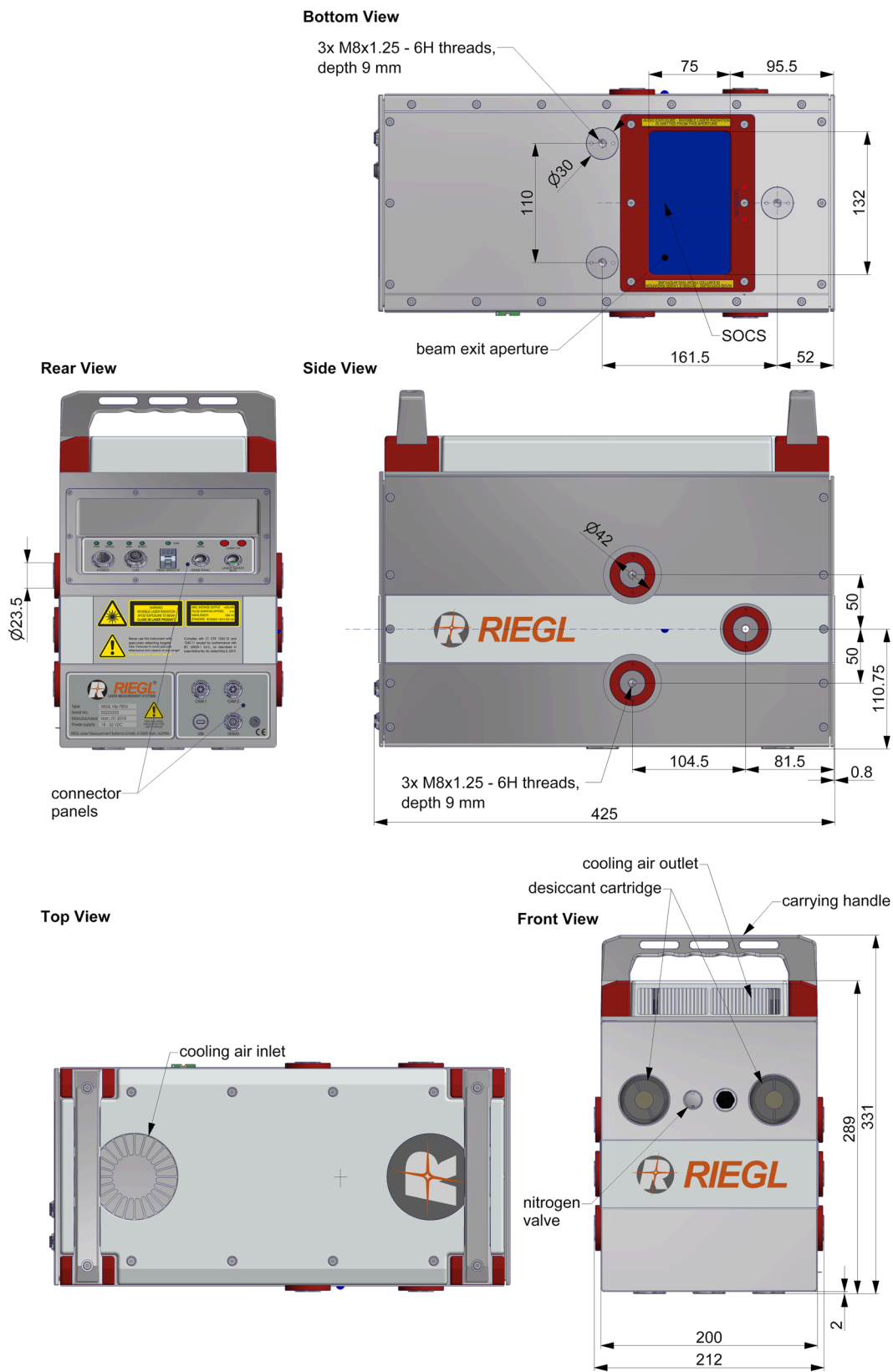
**Assumptions for calculation of the Area Acquisition Rate**

- 20% overlap of neighboring flight strips. This overlap covers a roll angle of ±5° or a reduction of flight altitude AGL of 20%.

**Uniform Point Pattern**

- The line to line spacing is equal to the average point to point spacing.

# RIEGL VQ®-780 II Main Dimensions

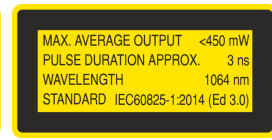


all dimensions in mm

## Laser Product Classification

Class 3B Laser Product according to IEC60825-1:2014  
The following clause applies for instruments delivered into the United States: Complies with 21 CFR 1040.10 and 1040.11 except for conformance with IEC 60825-1 Ed.3., as described in Laser Notice No. 56, dated May 8, 2019.

The instrument must be used only in combination with the appropriate laser safety box.



## Range Measurement Performance

as a function of laser power setting, PRR, and target reflectivity

Laser Power Level	100%				
Laser Pulse Repetition Rate (PRR) <sup>1)</sup>	150 kHz	250 kHz	500 kHz	1000 kHz	2000 kHz
Max. Measuring Range <sup>2) 3) 4)</sup> natural targets $\rho \geq 20\%$ natural targets $\rho \geq 60\%$	4500 m 6800 m	3700 m 5600 m	2800 m 4300 m	2050 m 3300 m	1500 m 2450 m
Max. Operating Flight Altitude <sup>2) 5)</sup> (AGL) <sup>6)</sup> natural targets $\rho \geq 20\%$  natural targets $\rho \geq 60\%$	3700 m 12100 ft  5600 m 18300 ft	3000 m 9900 ft  4600 m 15000 ft	2300 m 7500 ft  3500 m 11500 ft	1700 m 5500 ft  2700 m 8800 ft	1200 m 4000 ft  2000 m 6500 ft
NOHD <sup>7) 9)</sup> ENOHD <sup>8) 9)</sup>	370 m 2640 m	290 m 2040 m	200 m 1440 m	140 m 1010 m	95 m 700 m
Number of Targets per Laser Pulse up to <sup>10)</sup>	14	14	14	9	4

Laser Power Level	50%	25%	12%	6%
Laser Pulse Repetition Rate (PRR) <sup>1)</sup>	2000 kHz	2000 kHz	2000 kHz	2000 kHz
Max. Measuring Range <sup>2) 3) 4)</sup> natural targets $\rho \geq 20\%$ natural targets $\rho \geq 60\%$	1100 m 1800 m	780 m 1300 m	560 m 940 m	400 m 680 m
Max. Operating Flight Altitude <sup>2) 5)</sup> (AGL) <sup>6)</sup> natural targets $\rho \geq 20\%$  natural targets $\rho \geq 60\%$	900 m 3000 ft  1450 m 4800 ft	640 m 2100 ft  1050 m 3400 ft	460 m 1500 ft  770 m 2500 ft	330 m 1080 ft  550 m 1800 ft
NOHD <sup>7) 9)</sup> ENOHD <sup>8) 9)</sup>	61 m 480 m	37 m 300 m	21 m 160 m	12 m 100 m
Number of Targets per Laser Pulse up to <sup>10)</sup>	4	4	4	4

- 1) rounded average PRR
- 2) Typical values for average conditions and average ambient brightness; in bright sunlight the operational range may be considerably shorter and the operational flight altitude may be considerably lower than under an overcast sky.
- 3) The maximum range is specified for flat targets with size in excess of the laser beam diameter, perpendicular angle of incidence, and for atmospheric visibility of 40 km. Range ambiguities have to be resolved by multiple-time-around processing.
- 4) If the laser beam hits, in part, more than one target, the laser's pulse power is split accordingly. Thus, the achievable range is reduced.
- 5) Typical values for max. effective FOV 58°, additional roll angle  $\pm 5^\circ$
- 6) Above Ground Level
- 7) Nominal Ocular Hazard Distance, based upon MPE according to IEC 60825-1:2014, for single line condition
- 8) Extended Nominal Ocular Hazard Distance, based upon MPE according to IEC 60825-1:2014, for single line condition
- 9) NOHD and ENOHD have been calculated for a typical angular step width of 0.012° (which means non-overlapping laser footprints), and an aircraft speed higher than 10 kn. NOHD and ENOHD increase when using overlapping laser footprints which may be intended e.g. for power line mapping.
- 10) when using online waveform processing

Minimum Range <sup>11)</sup>

Accuracy <sup>12) 13)</sup>

Precision <sup>13) 14)</sup>

Laser Pulse Repetition Rate <sup>15)</sup>

Effective Measurement Rate

Echo Signal Intensity

Laser Wavelength

Laser Beam Divergence

100 m

20 mm

20 mm

150 kHz up to 2 MHz, selectable in steps of less than 1%

up to 1333 kHz @ 60° scan angle

provided for each echo signal

near infrared

$\leq 0.18$  mrad @  $1/e$  <sup>16)</sup>, typ. 0.25 mrad @  $1/e^2$  <sup>17)</sup>

## Scanner Performance

Scanning Mechanism

Scan Pattern

Scan Angle Range

Total Scan Rate

Angular Step Width  $\Delta\theta$

Angle Measurement Resolution

rotating polygon mirror

parallel scan lines

$\pm 30^\circ = 60^\circ$

20 <sup>18)</sup> - 300 lines/sec

$0.006^\circ \leq \Delta\theta \leq 0.18^\circ$  <sup>19) 20)</sup>

0.001°

11) Limitation for range measurement capability, does not consider laser safety issues! The minimum range for valid reflectivity values is 250 m.

12) Accuracy is the degree of conformity of a measured quantity to its actual (true) value.

13) Standard deviation one sigma @ 250 m range under RIEGL test conditions.

14) Precision, also called reproducibility or repeatability, is the degree to which further measurements show the same result.

15) For smart and full waveform recording the max. laser PRR is limited to 1600kHz.

16) Measured at the  $1/e$  points. 0.18 mrad correspond to an increase of 18 cm of beam diameter per 1000 m distance.

17) Measured at the  $1/e^2$  points. 0.25 mrad correspond to an increase of 25 cm of beam diameter per 1000 m distance.

18) The minimum scan rate depends on the selected laser PRR.

19) The minimum angular step width depends on the selected laser PRR.

20) The maximum angular step width is limited by the maximum scan rate.

Technical Data to be continued at page 8

# Technical Data *RIEGL VQ<sup>®</sup>-780 II (continued)*

## Data Interfaces

Configuration  
Monitoring Data Output  
Digitized Data Output  
Synchronization

TCP/IP Ethernet (10/100/1000 MBit/s)  
TCP/IP Ethernet (10/100/1000 MBit/s)  
High-speed data link to *RIEGL* Data Recorder DR1560i  
Serial RS-232 interface, TTL input for 1 pps synchronization pulse,  
accepts different data formats for GNSS-time information  
2 x power, RS-232, 1 pps, trigger, exposure

Camera interface

## General Technical Data

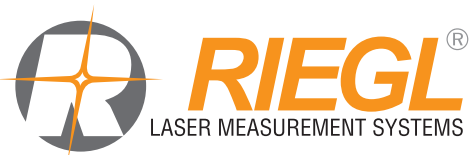
Power Supply / Power Consumption  
Main Dimensions (length x width x height)  
Weight

18 - 32 V DC / typ. 160 W  
425 mm x 212 mm x 331 mm  
approx. 20 kg

Protection Class  
Max. Flight Altitude operating / not operating  
Temperature Range operation / storage

IP54  
18500 ft (5600 m) above MSL<sup>1)</sup> / 18500 ft (5600 m) above MSL  
-5°C up to +40°C / -10°C up to +50°C

1) Mean Sea Level



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