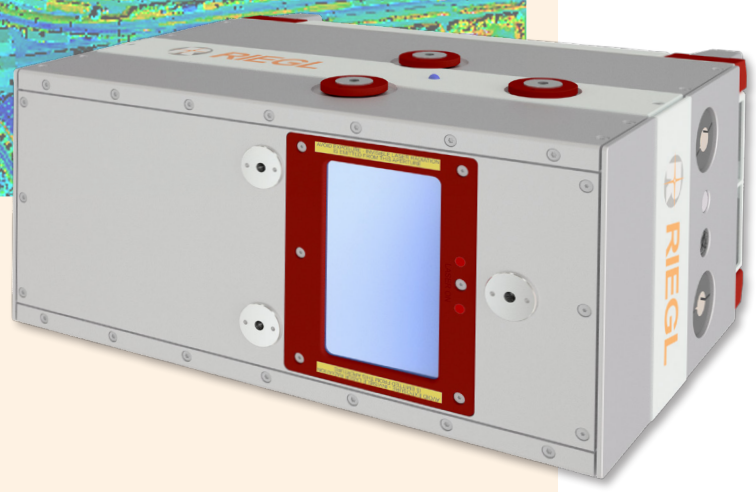
Waveform Processing Airborne Laser Scanner for Wide Area Mapping and High Productivity

RIEGL VQ®-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:

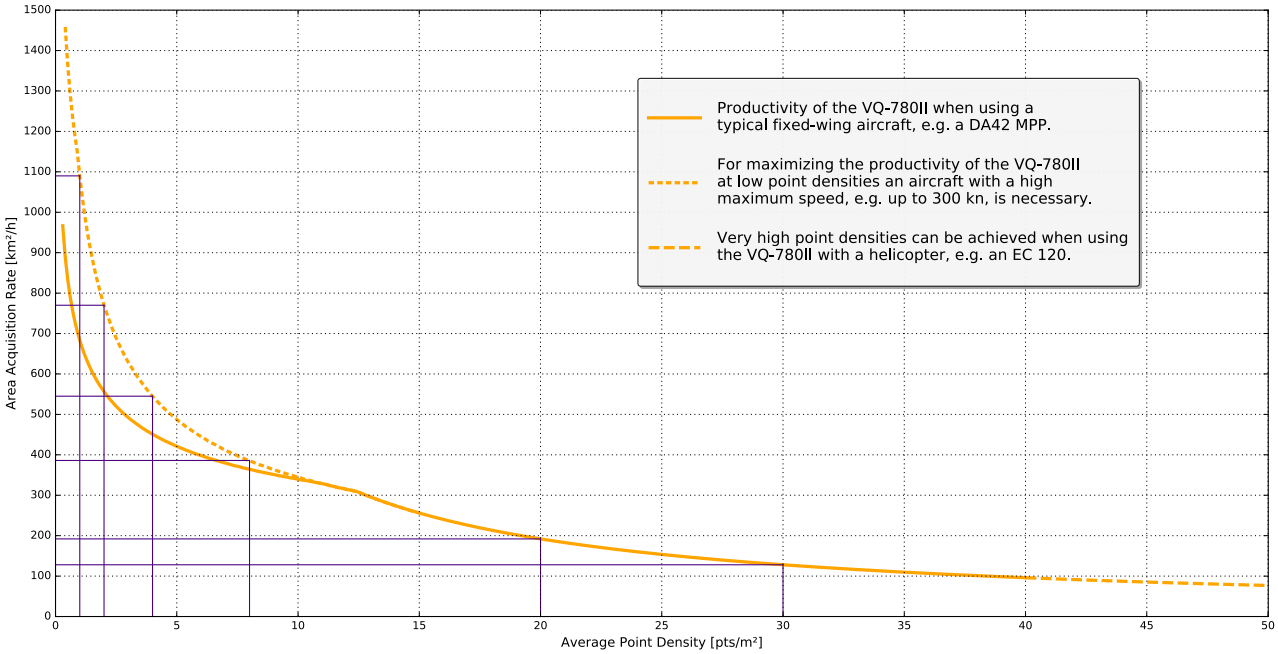
- *Wide Area / High Altitude Mapping*
- *High Point Density Mapping*
- *Mapping of Complex Urban Environments*
- *Glacier & Snowfield Mapping*
- *City Modeling*
- *Mapping of Lakesides & River Banks*
- *Agriculture & Forestry*
- *Corridor Mapping*

visit our website
www.riegl.com

RIEGL®
LASER MEASUREMENT SYSTEMS

RIEGL VQ®-780II Productivity

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

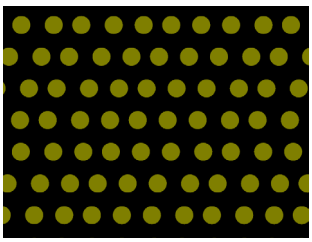


Examples [1]

Average Point Density	1 pts/m²	2 pts/m²	4 pts/m²	8 pts/m²	20 pts/m²	30 pts/m²
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 km²/h	770 km²/h	545 km²/h	386 km²/h	192 km²/h	128 km²/h
Measurement Rate [2]	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

1) calculated for 20% target reflectivity and 20% stripe overlap
2) 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.

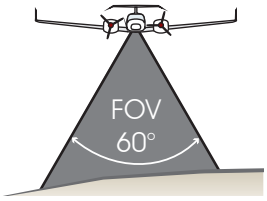
RIEGL VQ®-780II Dense Scan Pattern and Wide Effective Swath Width



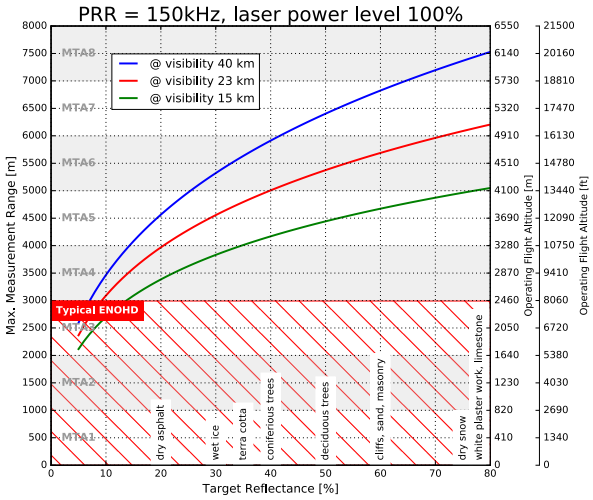
RIEGL VQ-780II point distribution

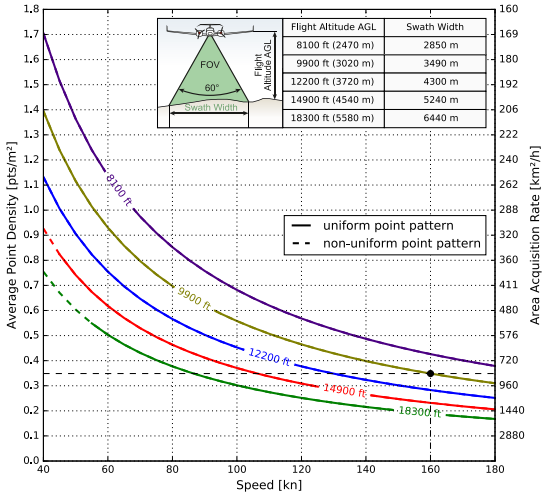
The *RIEGL* VQ-780II scanning mechanism – based on a continuously rotating polygon mirror wheel – delivers straight parallel scan lines resulting in a regular point pattern on the ground. With equal spatial sampling frequency along and across track, object extents are well defined and even small objects 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-780II 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.



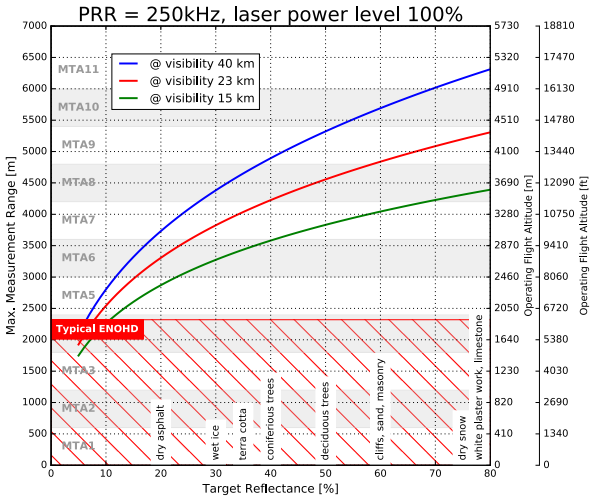
broad effective swath width

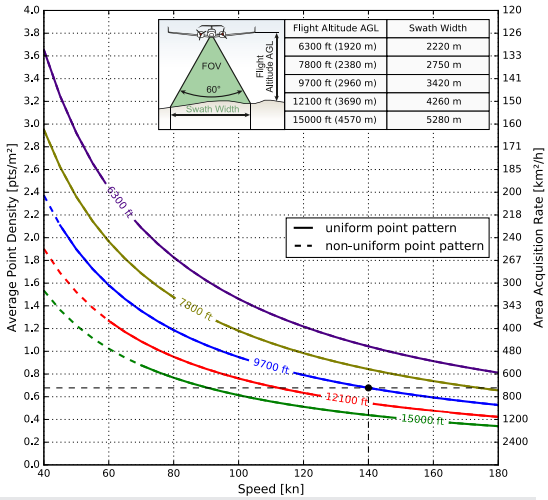




Example: VQ-780II at 150,000 pulses/sec, laser power level 100%
Altitude = 9,900 ft AGL, Speed 160 kn

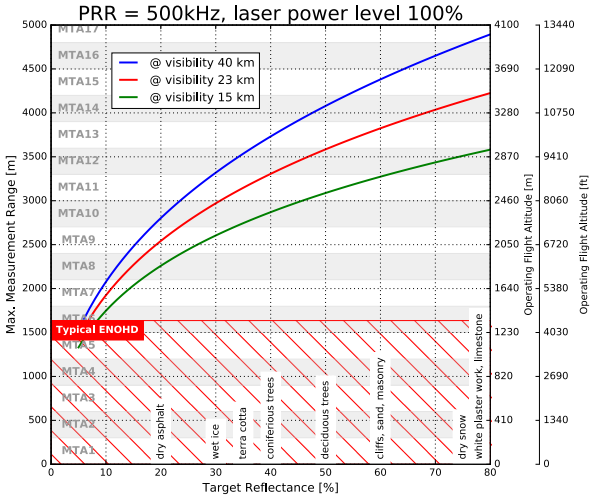
Results: Point Density ~ 0.35 pts/m²
Area Acquisition Rate ~ 826 km²/h

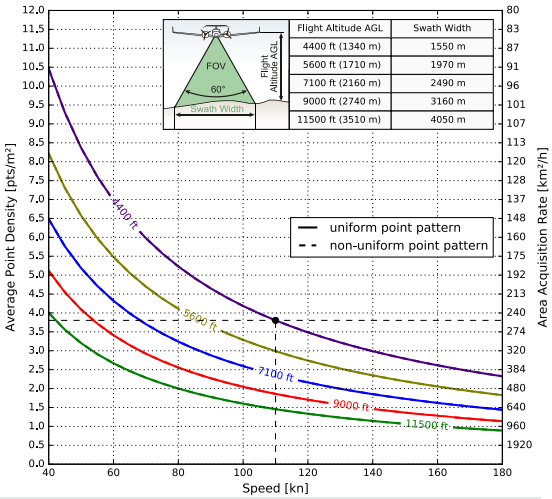




Example: VQ-780II at 250,000 pulses/sec, laser power level 100%
Altitude = 9,700 ft AGL, Speed 140 kn

Results: Point Density ~ 0.68 pts/m²
Area Acquisition Rate ~ 708 km²/h





Example: VQ-780II at 500,000 pulses/sec, laser power level 100%
Altitude = 4,400 ft AGL, Speed 110 kn

Results: Point Density ~ 3.8 pts/m²
Area Acquisition Rate ~ 252 km²/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

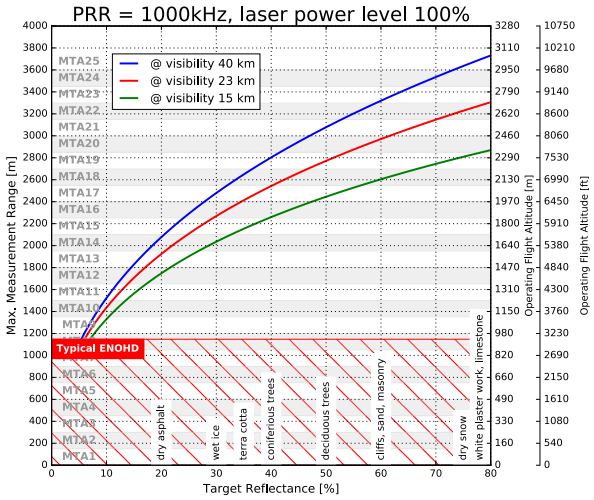
- Calculated under assumption of an angular step width of 0.012° and an aircraft speed higher than 10kn.

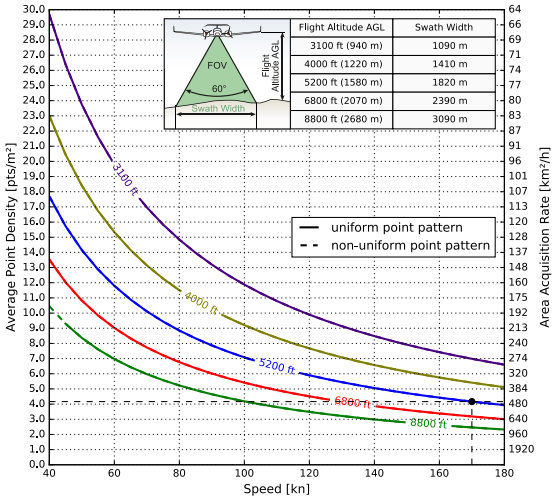
Assumptions for calculation of the Area Acquisition Rate

- 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

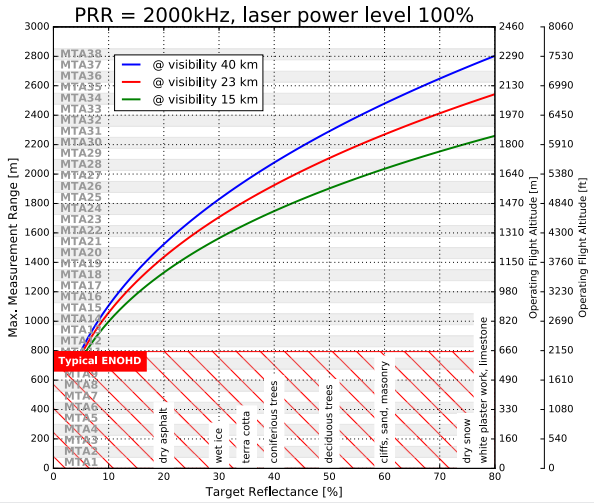
- The line to line spacing is equal to the average point to point spacing.

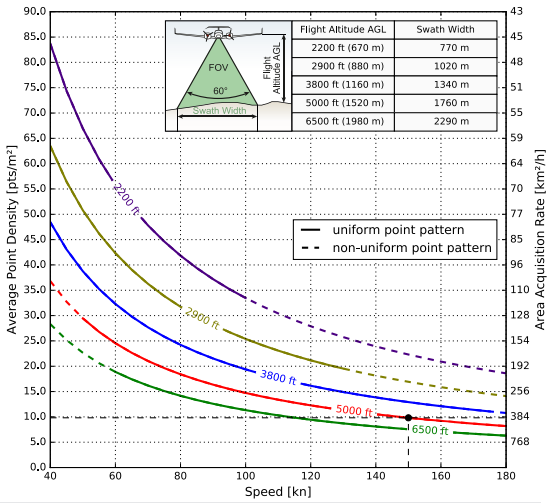




Example: VQ-780II at 1.0 mill. pulses/sec, laser power level 100%
Altitude = 5,200 ft AGL, Speed 170 kn

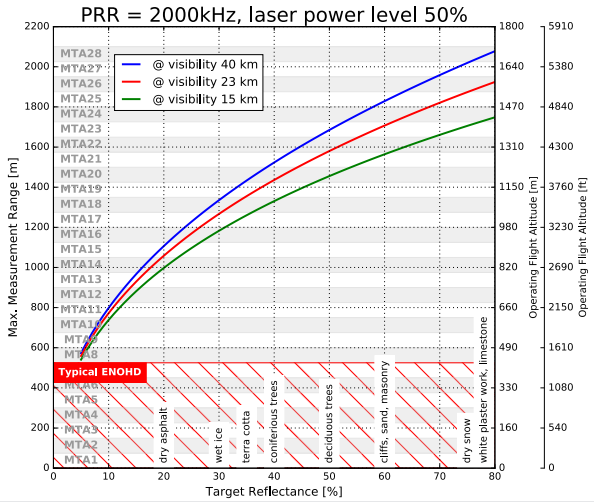
Results: Point Density ~ 4.17 pts/m²
Area Acquisition Rate ~ 461 km²/h

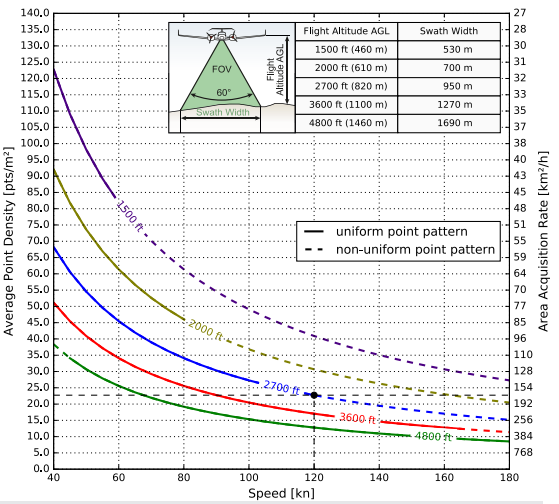




Example: VQ-780II at 2.0 mill. pulses/sec, laser power level 100%
Altitude = 5,000 ft AGL, Speed 150 kn

Results: Point Density ~ 9.82 pts/m²
Area Acquisition Rate ~ 391 km²/h





Example: VQ-780II at 2.0 mill. pulses/sec, laser power level 50%
Altitude = 2,700 ft AGL, Speed 120 kn

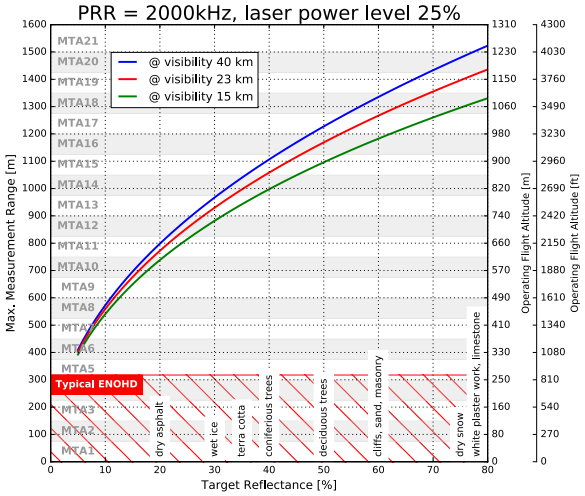
Results: Point Density ~ 22.73 pts/m²
Area Acquisition Rate ~ 169 km²/h

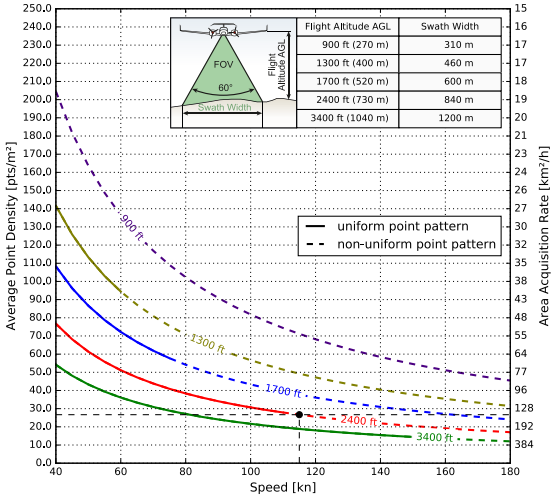
The following conditions are assumed for the Operating Flight Altitude AGL
- ambiguity resolved by multiple-time-around (MTA) processing
- target size ≥ laser footprint
- full FOV of 60°
- average ambient brightness
- roll angle ±5°

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%.

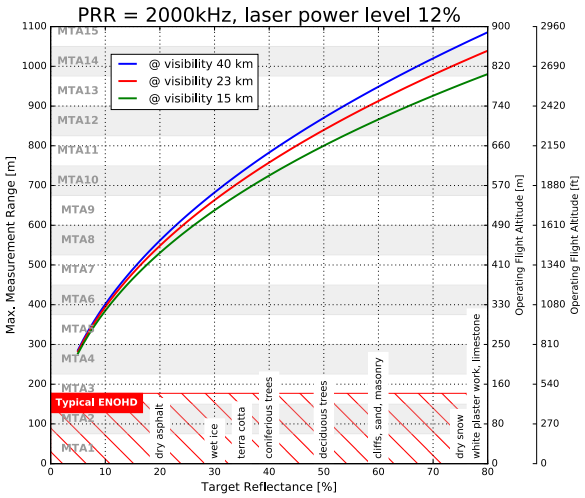
Uniform Point Pattern
- The line to line spacing is equal to the average point to point spacing.

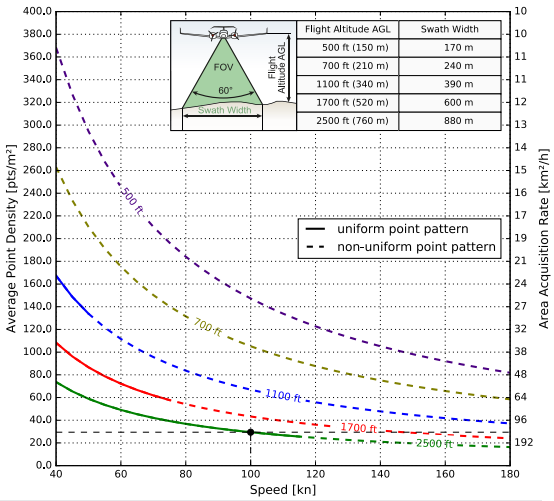




Example: VQ-780II at 2.0 mill. pulses/sec, laser power level 25%
Altitude = 2,400 ft AGL, Speed 115 kn

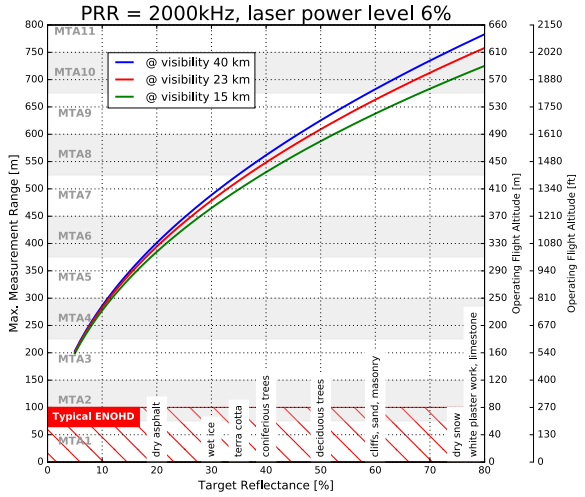
Results: Point Density ~ 26.68 pts/m²
Area Acquisition Rate ~ 144 km²/h

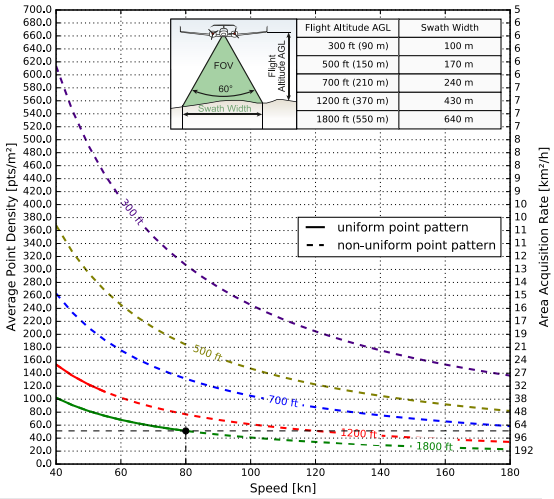




Example: VQ-780II at 2.0 mill. pulses/sec, laser power level 12%
Altitude = 2,500 ft AGL, Speed 100 kn

Results: Point Density ~ 29.46 pts/m²
Area Acquisition Rate ~ 130 km²/h





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/m²
Area Acquisition Rate ~ 75 km²/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.

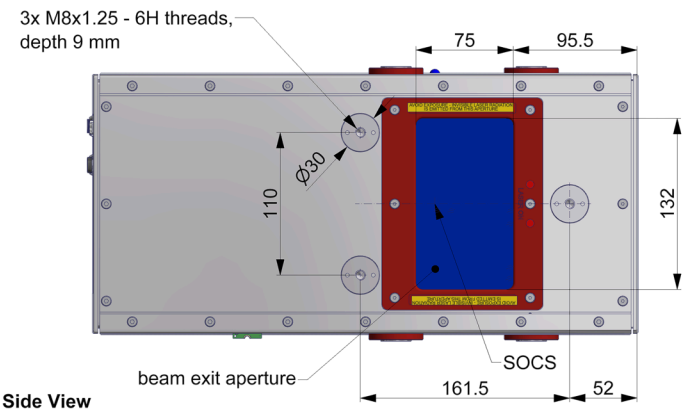
Assumptions for calculation of the Area Acquisition Rate

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

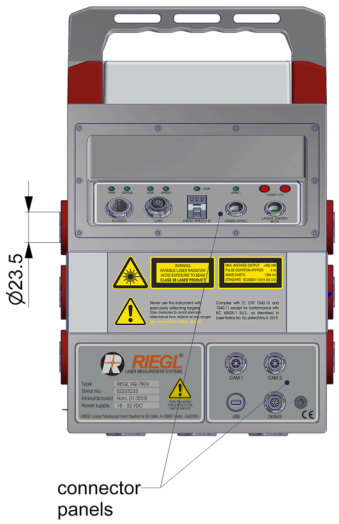
Uniform Point Pattern

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

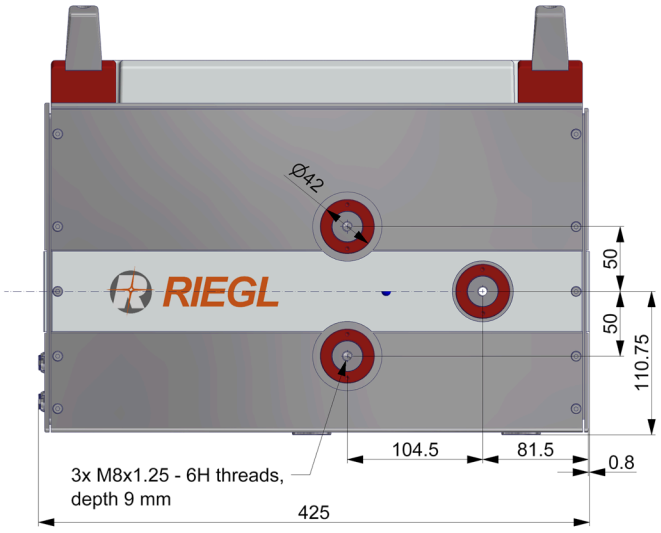
Bottom View



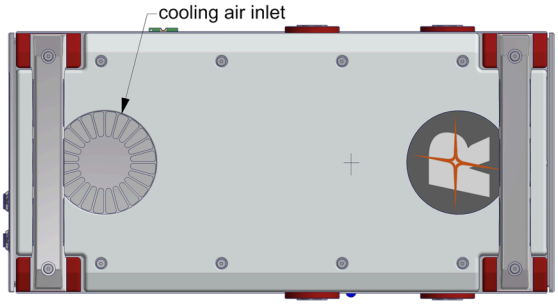
Rear View



Side View



Top View



Front View

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) [1]	150 kHz	250 kHz	500 kHz	1000 kHz	2000 kHz
Max. Measuring Range [2] [3] [4]					
natural targets ρ ≥ 20 %	4500 m	3700 m	2800 m	2050 m	1500 m
natural targets ρ ≥ 60 %	6800 m	5600 m	4300 m	3300 m	2450 m
Max. Operating Flight Altitude [2] [5] (AGL) [6]					
natural targets ρ ≥ 20 %	3700 m 12100 ft	3000 m 9900 ft	2300 m 7500 ft	1700 m 5500 ft	1200 m 4000 ft
natural targets ρ ≥ 60 %	5600 m 18300 ft	4600 m 15000 ft	3500 m 11500 ft	2700 m 8800 ft	2000 m 6500 ft
NOHD [7] [9]	370 m	290 m	200 m	140 m	95 m
ENOHD [8] [9]	2450 m	1900 m	1340 m	940 m	650 m
Number of Targets per Laser Pulse up to [10]	14	14	14	9	4

Laser Power Level	50%	25%	12%	6%
Laser Pulse Repetition Rate (PRR) [1]	2000 kHz	2000 kHz	2000 kHz	2000 kHz
Max. Measuring Range [2] [3] [4]				
natural targets ρ ≥ 20 %	1100 m	780 m	560 m	400 m
natural targets ρ ≥ 60 %	1800 m	1300 m	940 m	680 m
Max. Operating Flight Altitude [2] [5] (AGL) [6]				
natural targets ρ ≥ 20 %	900 m 3000 ft	640 m 2100 ft	460 m 1500 ft	330 m 1080 ft
natural targets ρ ≥ 60 %	1450 m 4800 ft	1050 m 3400 ft	770 m 2500 ft	550 m 1800 ft
NOHD [7] [9]	61 m	37 m	21 m	12 m
ENOHD [8] [9]	430 m	270 m	145 m	82 m
Number of Targets per Laser Pulse up to [10]	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 amiguities 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 ± 5°
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 [11]	100 m
Accuracy [12] [13]	20 mm
Precision [13] [14]	20 mm
Laser Pulse Repetition Rate [15]	150 kHz up to 2 MHz, selectable in steps of less than 1%
Effective Measurement Rate	up to 1333 kHz @ 60° scan angle
Echo Signal Intensity	provided for each echo signal
Laser Wavelength	near infrared
Laser Beam Divergence	≤ 0.18 mrad @ 1/e [16], typ. 0.25 mrad @ 1/e² [17]

Scanner Performance

Scanning Mechanism	rotating polygon mirror
Scan Pattern	parallel scan lines
Scan Angle Range	± 30° = 60°
Total Scan Rate	20 [18] - 300 lines/sec
Angular Step Width Δϑ	0.006° ≤ Δϑ ≤ 0.108° [19] [20]
Angle Measurement Resolution	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/e² 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®-780 II *(continued)*

Data Interfaces

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

General Technical Data

Power Supply / Power Consumption	18 - 32 V DC / typ. 160 W
Main Dimensions (length x width x height)	425 mm x 212 mm x 331 mm
Weight	approx. 20 kg
Protection Class	IP54
Max. Flight Altitude operating / not operating	18500 ft (5600 m) above MSL[1] / 18500 ft (5600 m) above MSL
Temperature Range operation / storage	-5°C up to +40°C / -10°C up to +50°C

1) Mean Sea Level

RIEGL LASER MEASUREMENT SYSTEMS

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