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

NEW

RIEGL VQ®-780i

- *online waveform processing as well as smart and full waveform recording*
- *excellent multiple target detection capability*
- *excellent suppression of atmospheric clutter*
- *Multiple-Time-Around (MTA) processing of up to 25 pulses simultaneously in the air*
- *high laser pulse repetition rate up to 1 MHz*
- *up to 666,000 measurements/sec on the ground*
- *parallel scan lines and uniform point distribution*
- *high-speed optical data link to RIEGL data recorder*
- *interface for GNSS time synchronization*
- *seamless integration and compatibility with other RIEGL ALS systems and software packages*

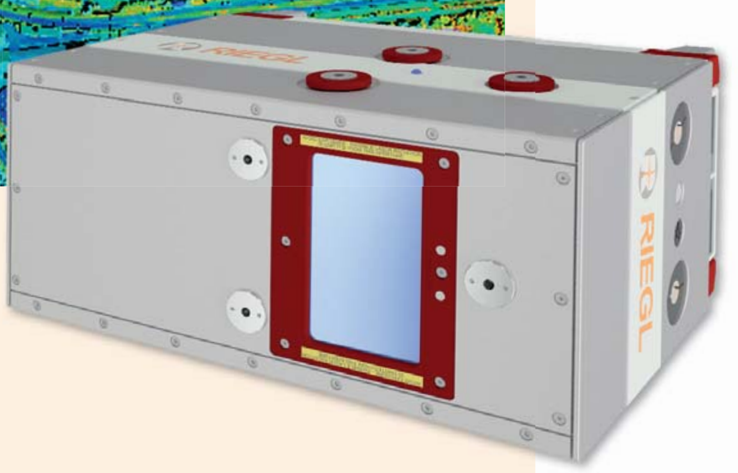
The new *RIEGL* VQ-780i is a high performance, rugged, lightweight, and compact airborne mapping sensor. This versatile system is designed for high efficient data acquisition at low, mid, and high altitudes, covering a variety of different airborne laser scanning applications from high density to wide area mapping.

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 reflecetance 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 system is complimented with *RIEGL*'s advanced acquisition and data processing software suite that utilizes parallel computing (GPU) for fast data processing.

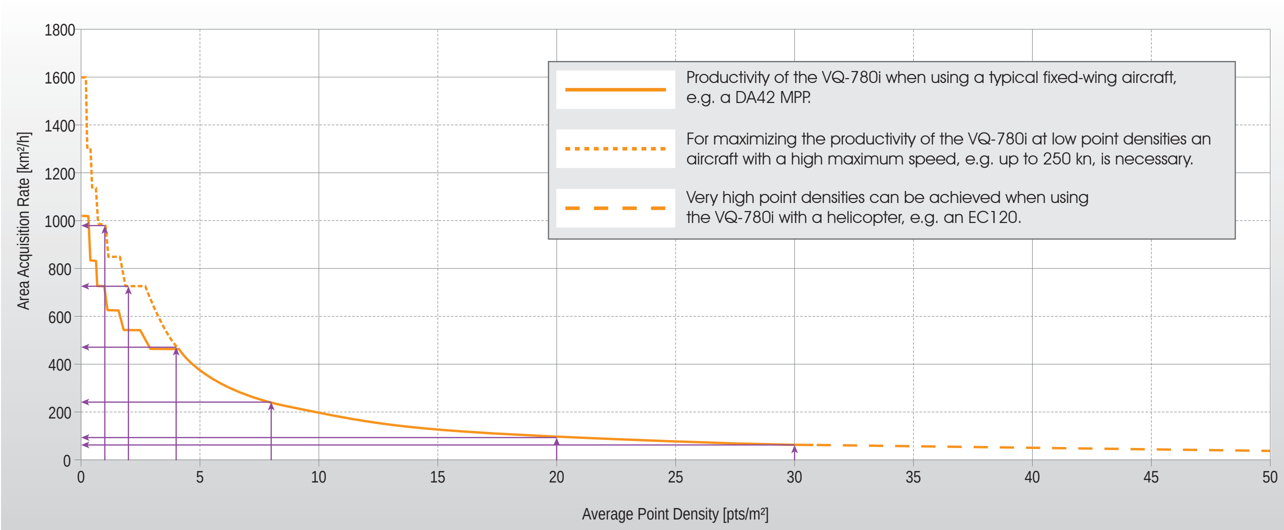
The *RIEGL* VQ-780i is designed to work with the latest Inertial Navigation (IMU) Systems, flight management systems, and camera options.

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*



RIEGL VQ®-780i Productivity

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

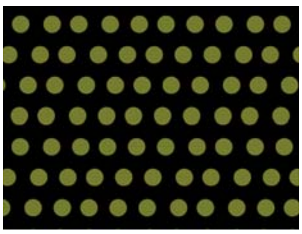


Examples 1)

Average Point Density	1 pts/m²	2 pts/m²	4 pts/m²	8 pts/m²	20 pts/m²	30 pts/m²
Flight Altitude AGL	7500 ft 2280 m	5580 ft 1700 m	5580 ft 1700 m	4000 ft 1120 m	1600 ft 490 m	1150 ft 350 m
Ground Speed	246 kn	250 kn	165 kn	115 kn	115 kn	106 kn
Swath Width	2600 m	1960 m	1960 m	1410 m	560 m	410 m
Productivity	960 km²/h	727 km²/h	480 km²/h	240 km²/h	96 km²/h	64 km²/h
Measurement Rate 2)	333 000 meas./sec	666 000 meas./sec	666 000 meas./sec	666 000 meas./sec	666 000 meas./sec	666 000 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.

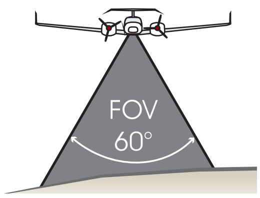
RIEGL VQ®-780i Dense Scan Pattern and Wide Effective Swath Width



RIEGL VQ-780i point distribution

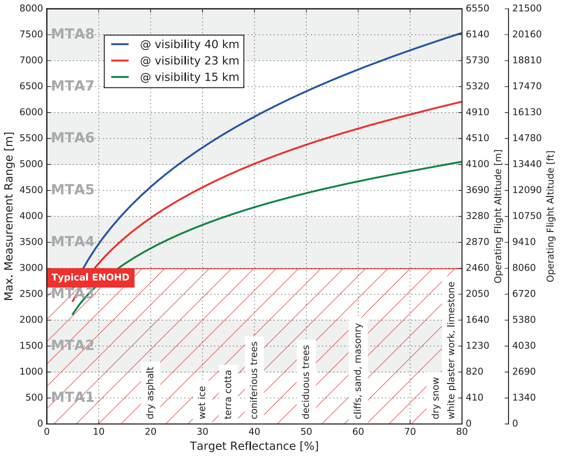
The *RIEGL* VQ-780i scanning mechanism – based on a continuously rotating polygon mirror wheel – delivers straight parallel scan lines resulting in a regular point pattern on the ground. With equal spatial sampling frequency along and across track, object extents are well defined and even small objects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

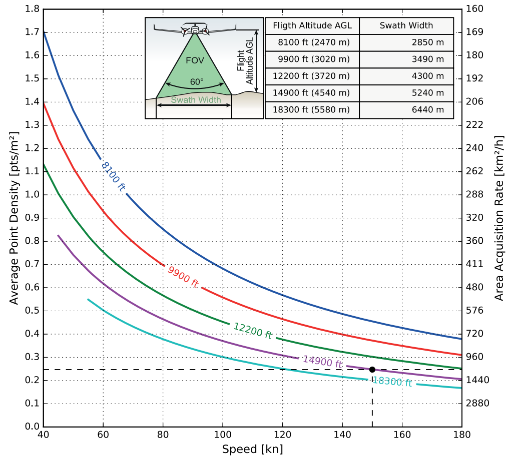
The wide field of view and the multiple-time-around measurement capability of the *RIEGL* VQ-780i make the instrument perfectly suited for wide area mapping applications. The instrument has been designed for utmost efficiency in collecting data by enabling scanning operations from high altitudes at high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



broad effective swath width

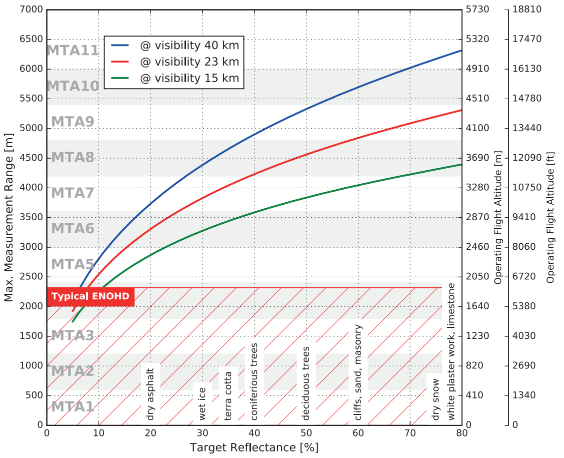
PRR = 150 kHz, laser power level 100%

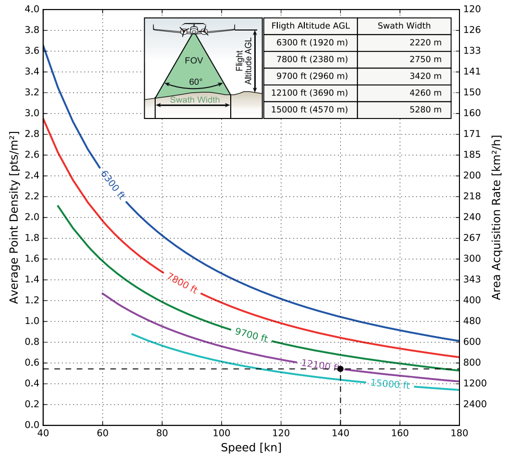




Example:	VQ-780i at 150,000 pulses/sec, laser power level 100% Altitude = 14,900 ft AGL, Speed 150 kn	**Results:**	Point Density ~ 0.247 pts/m² Area Acquisition Rate ~ 1,170 km²/h

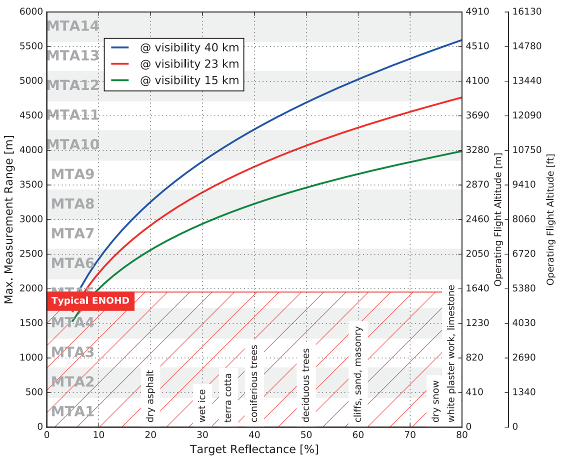
PRR = 250 kHz, laser power level 100%

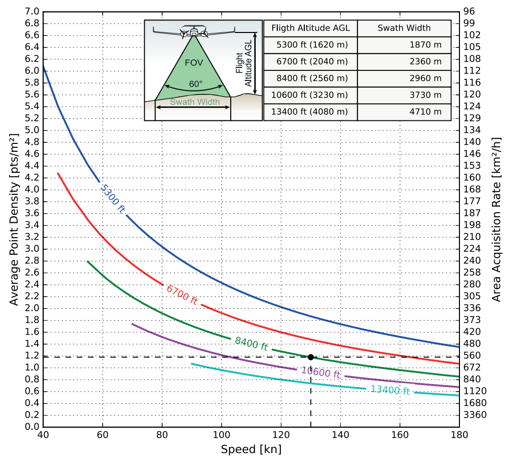




Example:	VQ-780i at 250,000 pulses/sec, laser power level 100% Altitude = 12,100 ft AGL, Speed 140 kn	**Results:**	Point Density ~ 0.54 pts/m² Area Acquisition Rate ~ 880 km²/h

PRR = 350 kHz, laser power level 100%





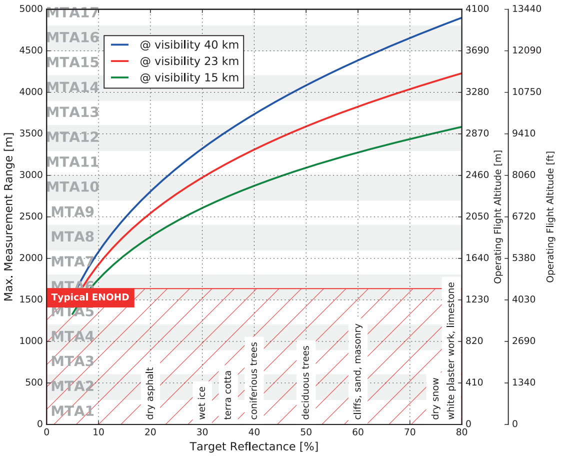
Example:	VQ-780i at 350,000 pulses/sec, laser power level 100% Altitude = 8,400 ft AGL, Speed 130 kn	**Results:**	Point Density ~ 1.18 pts/m² Area Acquisition Rate ~ 570 km²/h

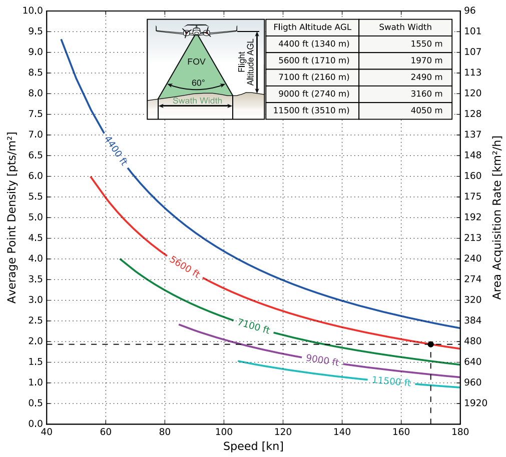
The following conditions are assumed for the Operating Flight Altitude AGL
- ambiguity resolved by multiple-time-around (MTA) processing
- target size ≥ laser footprint
- full FOV of 60°
- average ambient brightness
- roll angle ±5°

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%.

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

PRR = 500 kHz, laser power level 100%

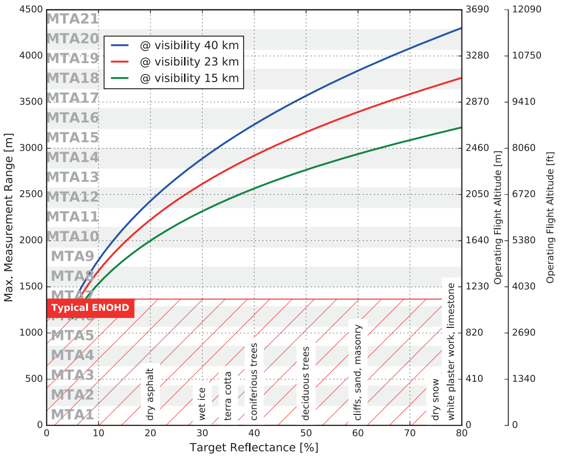


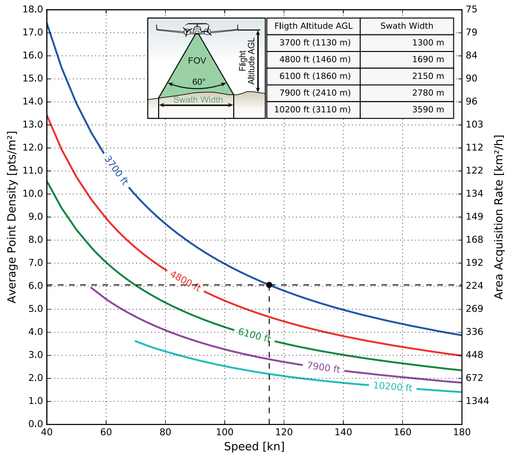


Example: VQ-780i at 500,000 pulses/sec, laser power level 100%
Altitude = 5,600 ft AGL, Speed 170 kn

Results: Point Density ~ 1.93 pts/m²
Area Acquisition Rate ~ 500 km²/h

PRR = 700 kHz, laser power level 100%

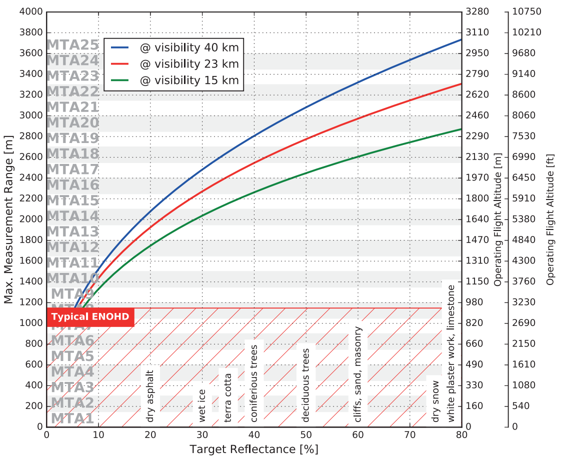


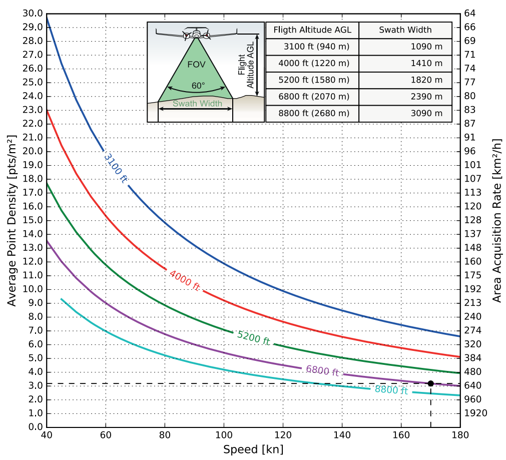


Example: VQ-780i at 700,000 pulses/sec, laser power level 100%
Altitude = 3,700 ft AGL, Speed 115 kn

Results: Point Density ~ 6.05 pts/m²
Area Acquisition Rate ~ 220 km²/h

PRR = 1000 kHz, laser power level 100%





Example: VQ-780i at 1,000,000 pulses/sec, laser power level 100%
Altitude = 6,800 ft AGL, Speed 170 kn

Results: Point Density ~ 3.18 pts/m²
Area Acquisition Rate ~ 600 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°

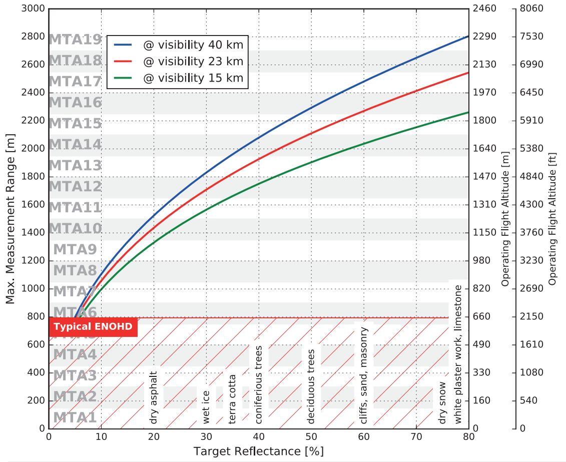
Assumptions for calculation of the Area Acquisition Rate

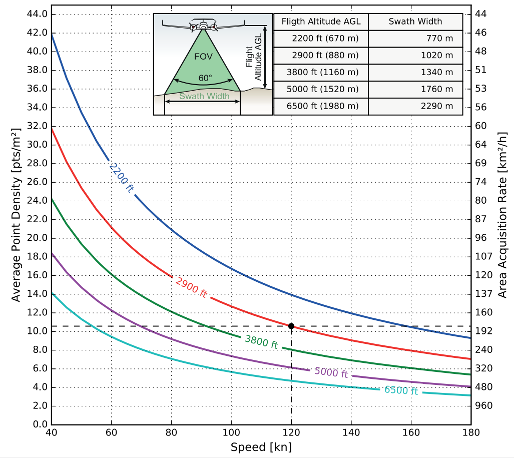
- 20% overlap of neighboring flight strips. This overlap covers a roll angle of ±5° or a reduction of flight altitude AGL of 20%.

Typical ENOHD

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

PRR = 1000 kHz, laser power level 50%

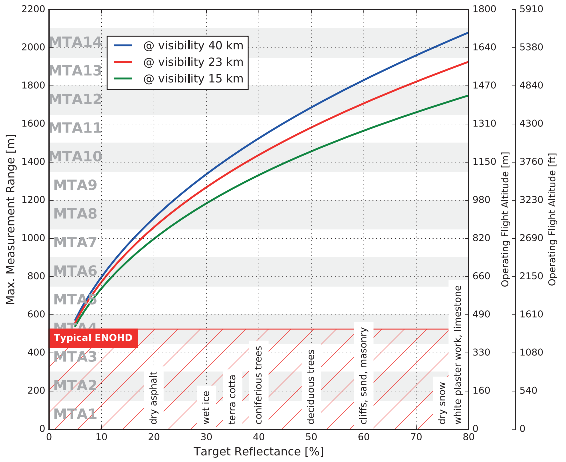


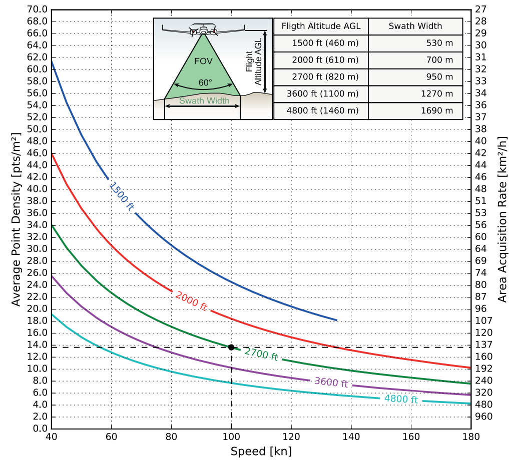


Example: VQ-780i at 1,000,000 pulses/sec, laser power level 50%
Altitude = 2,900 ft AGL, Speed 120 kn

Results: Point Density ~ 10.58 pts/m²
Area Acquisition Rate ~ 181 km²/h

PRR = 1000 kHz, laser power level 25%

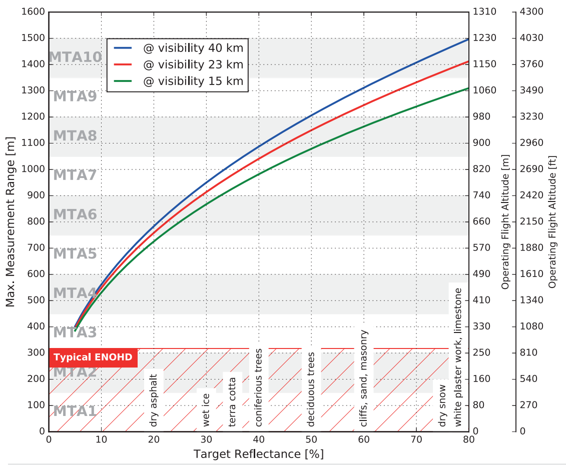


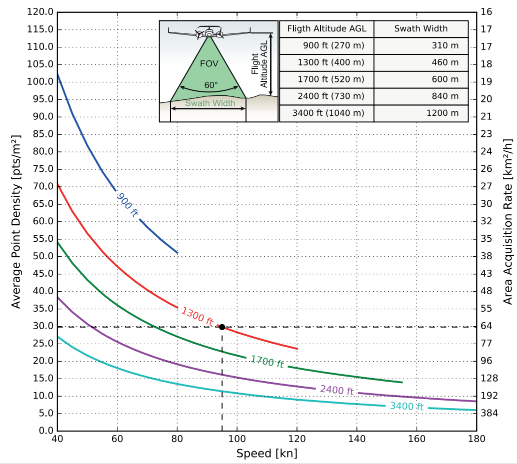


Example: VQ-780i at 1,000,000 pulses/sec, laser power level 25%
Altitude = 2,700 ft AGL, Speed 100 kn

Results: Point Density ~ 13.64 pts/m²
Area Acquisition Rate ~ 141 km²/h

PRR = 1000 kHz, laser power level 12%





Example: VQ-780i at 1,000,000 pulses/sec, laser power level 12%
Altitude = 1,300 ft AGL, Speed 95 kn

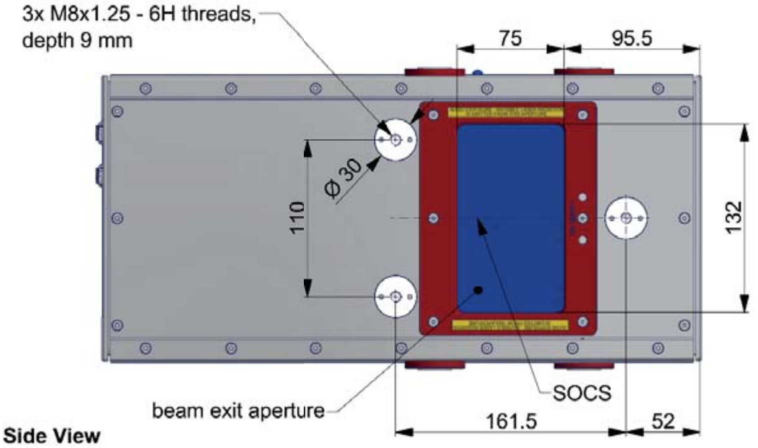
Results: Point Density ~ 30 pts/m²
Area Acquisition Rate ~ 64 km²/h

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°

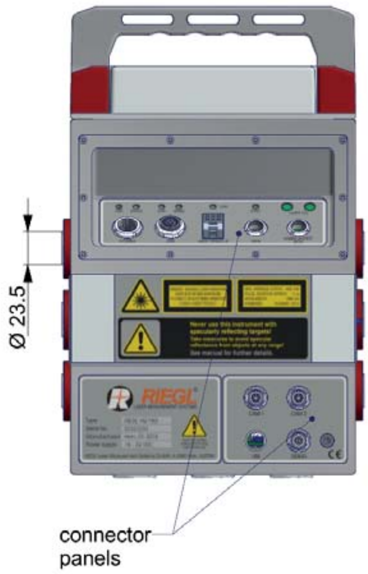
Assumptions for calculation of the Area Acquisition Rate
- 20% overlap of neighboring flight strips. This overlap covers a roll angle of ±5° or a reduction of flight altitude AGL of 20%.

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

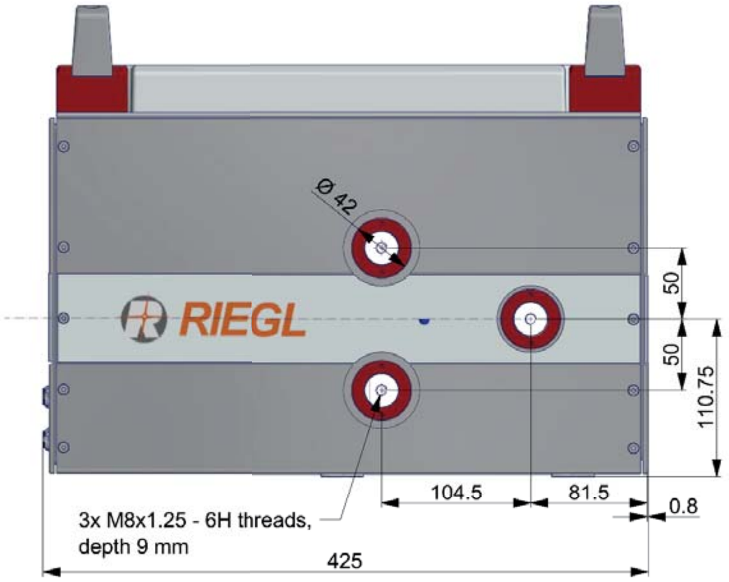
Bottom View



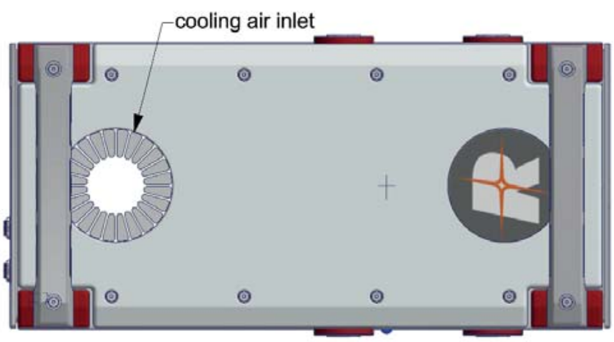
Rear View



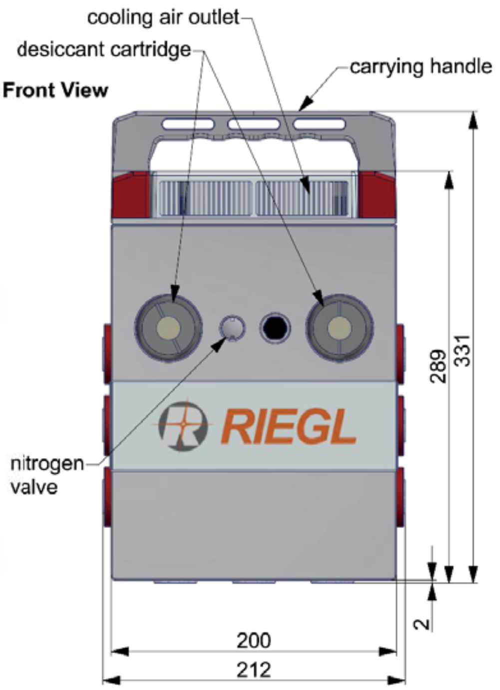
Side View



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 deviations pursuant to Laser Notice No. 50, dated June 24, 2007.

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	350 kHz	500 kHz	700 kHz
Max. Measuring Range [2,3]					
natural targets ρ ≥ 20 %	4500 m	3700 m	3200 m	2800 m	2400 m
natural targets ρ ≥ 60 %	6800 m	5600 m	5000 m	4300 m	3800 m
Max. Operating Flight Altitude Above Ground Level (AGL) [2,4]	5600 m 18300 ft	4600 m 15000 ft	4100 m 13400 ft	3500 m 11500 ft	3100 m 10200 ft
NOHD [5,7]	370 m	290 m	240 m	200 m	170 m
ENOHD [6,7]	2450 m	1900 m	1600 m	1340 m	1120 m

Laser Power Level	100%	50%	25%	12%
Laser Pulse Repetition Rate (PRR) [1]	1000 kHz	1000 kHz	1000 kHz	1000 kHz
Max. Measuring Range [2,3]				
natural targets ρ ≥ 20 %	2050 m	1500 m	1100 m	780 m
natural targets ρ ≥ 60 %	3300 m	2450 m	1800 m	1300 m
Max. Operating Flight Altitude Above Ground Level (AGL) [2,4]	2700 m 8800 ft	2000 m 6500 ft	1450 m 4800 ft	1050 m 3400 ft
NOHD [5,7]	140 m	95 m	61 m	36 m
ENOHD [6,7]	940 m	650 m	430 m	260 m

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 amigiuities have to be resolved by multiple-time-around processing.
4) Typical values for reflectivity ρ ≥ 60 %, max. effective FOV 60°, additional roll angle ± 5°
5) Nominal Ocular Hazard Distance, based upon MPE according to IEC 60825-1:2014, for single line condition
6) Extended Nominal Ocular Hazard Distance, based upon MPE according to IEC 60825-1:2014, for single line condition
7) 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.

Minimum Range [8]	100 m
Accuracy [9,10]	20 mm
Precision [10,11]	20 mm
Laser Pulse Repetition Rate	up to 1 MHz
Effective Measurement Rate	up to 666 kHz @ 60° scan angle
Echo Signal Intensity	provided for each echo signal
Laser Wavelength	near infrared
Laser Beam Divergence	≤ 0.18 mrad @ 1/e [12], ≤ 0.25 mrad @ $1/e^2$ [13]
Number of Targets per Pulse	with online waveform processing: practically unlimited [14,15] monitoring data output: first pulse

Scanner Performance

Scanning Mechanism	rotating polygon mirror
Scan Pattern	parallel scan lines
Scan Angle Range	± 30° = 60°
Total Scan Rate	20 [16] - 300 lines/sec
Angular Step Width Δϑ	0.006° ≤ Δϑ ≤ 0.18° [17,18]
Angle Measurement Resolution	0.001°

8) Limitation for range measurement capability, does not consider laser safety issues! The minimum range for valid reflectivity values is 250 m.
9) Accuracy is the degree of conformity of a measured quantity to its actual (true) value.
10) Standard deviation one sigma @ 250 m range under *RIEGL* test conditions.
11) Precision, also called reproducibility or repeatability, is the degree to which further measurements show the same result.
12) Measured at the 1/e points. 0.18 mrad correspond to an increase of 18 cm of beam diameter per 1000 m distance.
13) Measured at the $1/e^2$ points. 0.25 mrad correspond to an increase of 25 cm of beam diameter per 1000 m distance.
14) Depending on laser pulse repetition rate, up to a max. of 15 targets per laser pulse.
15) 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.
16) The minimum scan rate depends on the selected laser PRR.
17) The minimum angular step width depends on the selected laser PRR.
18) The maximum angular step width is limited by the maximum scan rate.

Technical Data to be continued at page 8

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 optical data link to *RIEGL* Data Recorder DR1560(i)
Synchronization	Serial RS232 interface, TTL input for 1 pps synchronization pulse, accepts different data formats for GNSS-time information
Camera interface	2 x power, RS232, 1 pps, trigger, exposure

General Technical Data

Power Supply / Current Consumption	18 - 32 V DC / typ. 150 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

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