Lightweight Airborne Laser Scanner with Online Waveform Processing

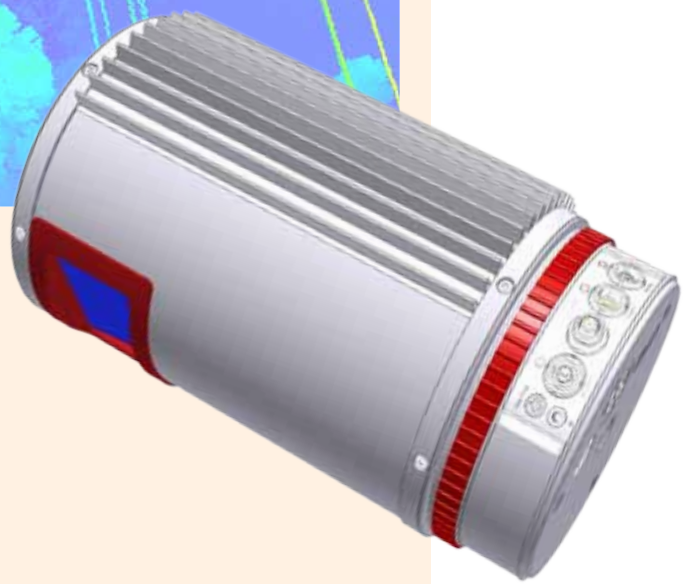
RIEGL VQ-480-U

- *high-accuracy ranging based on echo digitization and online waveform processing*
- *high laser repetition rate - fast data acquisition*
- *multiple target capability - unlimited number of targets*
- *perfectly linear scan lines*
- *compact, rugged and very lightweight design*
- *electrical interfaces for GPS data string and Sync Pulse (1PPS)*
- *mechanical interface for IMU mounting*
- *integrated LAN-TCP/IP interface*

The V-Line® Airborne Laser Scanner *RIEGL* VQ-480-U provides high speed data acquisition using a narrow infrared laser beam and a fast line scanning mechanism. High-accuracy laser ranging is based on *RIEGL*´s unique echo digitization and online waveform processing, which allows achieving superior measurement results even under adverse atmospheric conditions, and the evaluation of multiple target echoes.

The scanning mechanism is based on a fast rotating multi-facet polygonal mirror, which provides fully linear, unidirectional and parallel scan lines.

The *RIEGL* VQ-480-U is a very lightweight and compact laser scanner, mountable in any orientation and even under limited space conditions on motorized hang-gliders, gyrocopters, ultra-light aircrafts and UAVs. The instrument has a low power consumption, needs only a single voltage supply and provides line scan data via integrated LAN-TCP/IP interface. An external storage device can also be connected via the USB interface.



Typical applications include

- *Terrain Mapping*
- *Power Line, Railway Track, and Pipeline Inspection*
- *Capturing the Topography in Open-Cast Mining Areas*
- *Cultural Heritage Mapping*

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www.riegl.com

RIEGL®
LASER MEASUREMENT SYSTEMS

Laser Product Classification	Class 1 Laser Product according to IEC60825-1:2007 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.

CLASS 1
LASER PRODUCT

Range Measurement Performance

Measuring Principle	time of flight measurement, echo signal digitization, online waveform processing, multiple-time-around-processing

Laser Pulse Repetition Rate PRR [1]	*50 kHz*	*100 kHz*	*200 kHZ*	*300 kHz*	*400 kHz*	*550 kHz*
Effective Measurement Rate (meas./sec.) [1] [2]	25 000	50 000	100 000	150 000	200 000	275 000
Max. Measuring Range [3] [4]						
natural targets ρ ≥ 20 %	950 m	650 m	500 m	400 m	350 m	300 m
natural targets ρ ≥ 60 %	1500 m	1100 m	800 m	650 m	600 m	500 m
Max. Operating Flight Altitude AGL [1] [2]	750 m (2450 ft)	550 m (1800 ft)	400 m (1300 ft)	350 m (1150 ft)	300 m (1000 ft)	250 m (800 ft)
Max. Number of Targets per Pulse	practically unlimited (details on request)					

1) Rounded values.
2) Reflectivity ρ ≥ 20%, ±30° FOV, additional roll angle ±5°.
3) The following conditions are assumed: target larger than the footprint of the laser beam, perpendicular angle of incidence, visibility 23 km, average ambient brightness.
4) Ambiguity to be resolved by post-processing with RiMTA software.

Minimum Range	10 m
Accuracy [5] [7]	25 mm
Precision [6] [7]	25 mm
Laser Pulse Repetition Rate [1] [8]	up to 550 kHz
Max. Effective Measurement Rate [1]	up to 275 000 meas./sec. (@ 550 kHz PRR & 60° FOV)
Echo Signal Intensity	for each echo signal, high-resolution 16 bit intensity information is provided
Laser Wavelength	near infrared
Laser Beam Divergence [9]	0.3 mrad
Laser Beam Footprint (Gaussian Beam Definition)	31 mm @ 100 m, 75 mm @ 250 m, 150 mm @ 500 m

5) Accuracy is the degree of conformity of a measured quantity to its actual (true) value.
6) Precision, also called reproducibility or repeatability, is the degree to which further measurements show the same result.
7) One sigma @ 150 m range under *RIEGL* test conditions.
8) User selectable.
9) Measured at the $1/e^2$ points. 0.30 mrad corresponds to an increase of 30 mm of beam diameter per 100 m distance.

Scanner Performance

Scanning Mechanism	rotating polygon mirror
Field of View (selectable)	60° (+30° / -30°)
Scan Speed (selectable)	10 - 150 scans/sec
Angular Step Width $\Delta\vartheta$ (selectable) between consecutive laser shots	$0.002° \leq \Delta\vartheta \leq 0.36°$
Angle Measurement Resolution	0.001°
Internal Sync Timer	for real-time synchronized time stamping of scan data
Scan Sync (optional)	scanner rotation synchronization

Data Interfaces

Configuration	LAN 10/100/1000 Mbit/sec
Scan Data Output	LAN 10/100/1000 Mbit/sec, USB 2.0
GPS-System	Serial RS232 interface for data string with GPS-time information, TTL input for 1PPS synchronization pulse

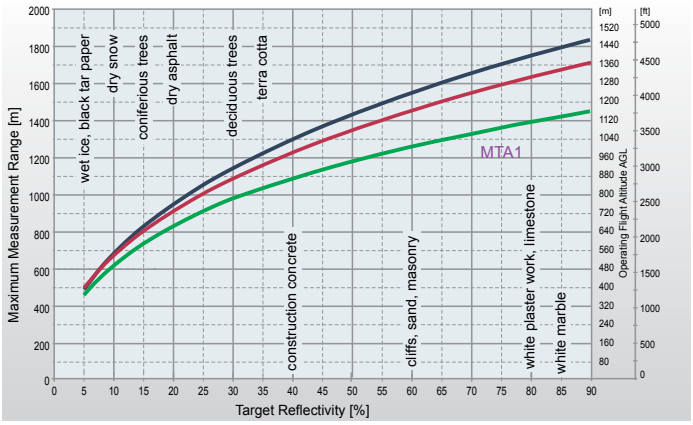
Mechanical Interfaces

Mounting of the Laser Scanner	3 x M6 thread inserts in the front and the rear plate
Mounting of IMU sensor	3 x M6 thread inserts in the front plate (rigidly coupled with the internal mechanical structure)

General Technical Data

Power Supply Input Voltage	18 - 32 V DC
Current Consumption	typ. 55 W
Main Dimensions	348 x 183 mm (length x diameter)
Weight	approx. 7.5 kg (without optional mounting frame; weight mounting frame: approx. 1kg)
Humidity	max. 80 % non condensing @ +31°C
Protection Class	IP64, dust and splash-proof
Max. Flight Altitude (operating)	16 500 ft (5 000 m) above MSL
Max. Flight Altitude (not operating)	18 000 ft (5 500 m) above MSL
Temperature Range	0°C up to +40°C (operation) / -20°C up to +50°C (storage)

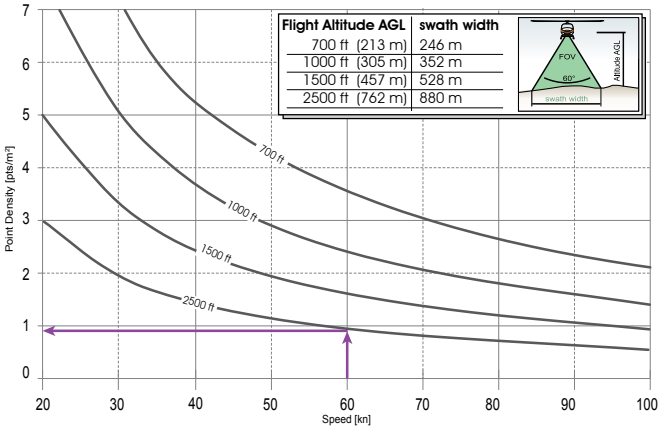
PRR = 50 kHz



MTA1: no ambiguity / 1 transmitted pulse „in the air"

@ visibility 23 km
@ visibility 15 km
@ visibility 8 km

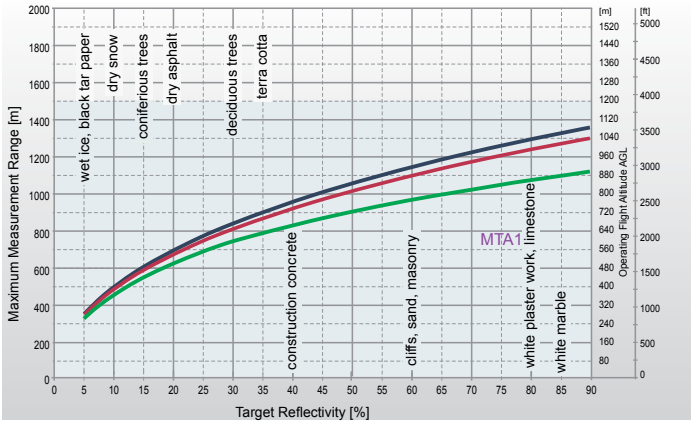
PRR = 50 kHz



Flight Altitude AGL	swath width
700 ft (213 m)	246 m
1000 ft (305 m)	352 m
1500 ft (457 m)	528 m
2500 ft (762 m)	880 m

Example: VQ-480-U at 50,000 pulses/second
Altitude = 2500 ft AGL, Speed = 60 kn
Resulting Point Density ~ 1.9 pt/m²

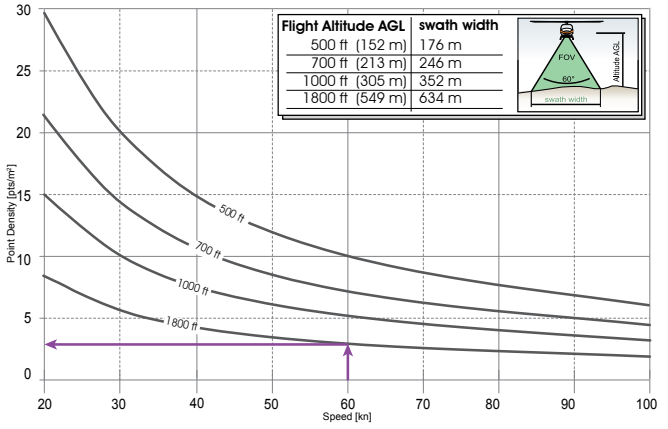
PRR = 100 kHz



MTA1: no ambiguity / 1 transmitted pulse „in the air"

@ visibility 23 km
@ visibility 15 km
@ visibility 8 km

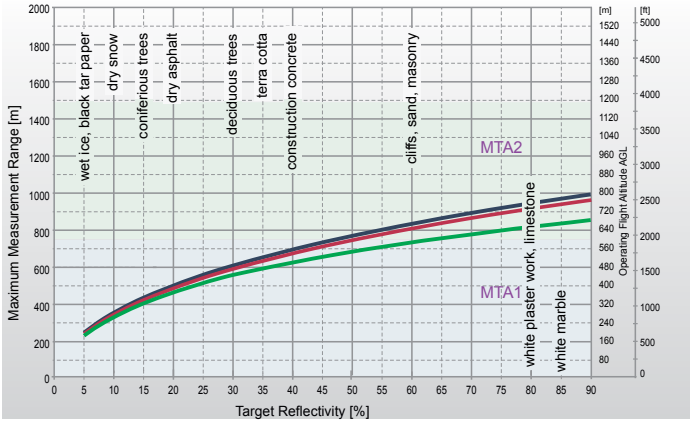
PRR = 100 kHz



Flight Altitude AGL	swath width
500 ft (152 m)	176 m
700 ft (213 m)	246 m
1000 ft (305 m)	352 m
1800 ft (549 m)	634 m

Example: VQ-480-U at 100,000 pulses/second
Altitude = 1800 ft AGL, Speed = 60 kn
Resulting Point Density ~ 2.8 pt/m²

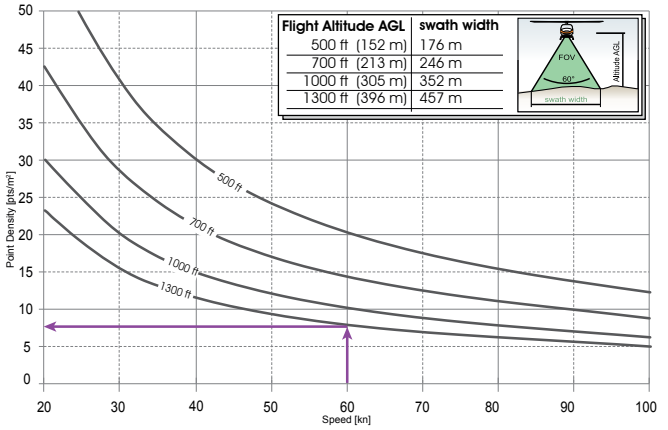
PRR = 200 kHz



MTA1: no ambiguity / 1 transmitted pulse „in the air"
MTA2: 2 transmitted pulses „in the air"

@ visibility 23 km
@ visibility 15 km
@ visibility 8 km

PRR = 200 kHz



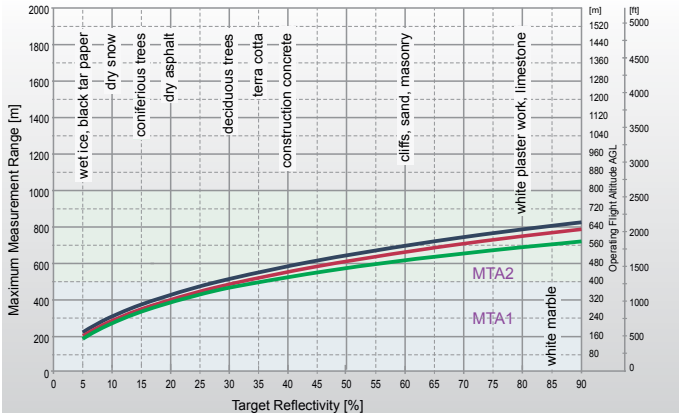
Flight Altitude AGL	swath width
500 ft (152 m)	176 m
700 ft (213 m)	246 m
1000 ft (305 m)	352 m
1300 ft (396 m)	457 m

Example: VQ-480-U at 200,000 pulses/second
Altitude = 1300 ft AGL, Speed = 60 kn
Resulting Point Density ~ 7.5 pt/m²

The following conditions are assumed for the Operating Flight Altitude AGL

- ambiguity resolved by multiple-time-around (MTA) processing & flight planning
- target size ≥ laser footprint
- scan angle 60°
- average ambient brightness
- roll angle +/-5°

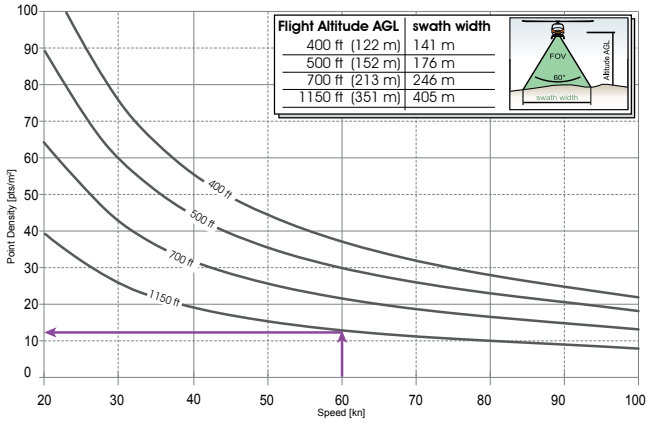
PRR = 300 kHz



MTA1: no ambiguity / 1 transmitted pulse „in the air"
MTA2: 2 transmitted pulses „in the air"

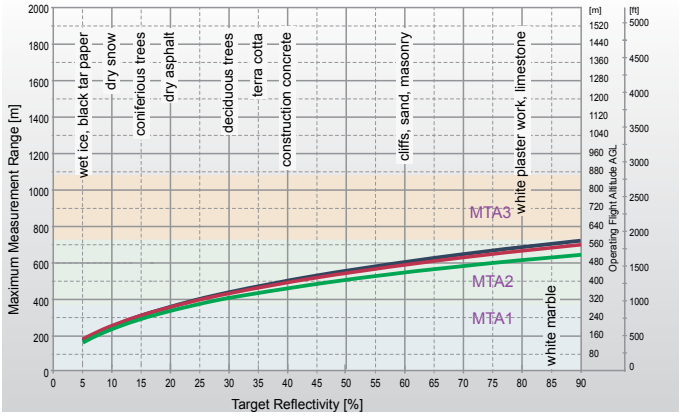
@ visibility 23 km
@ visibility 15 km
@ visibility 8 km

PRR = 300 kHz



Example: VQ-480-U at 300,000 pulses/second
Altitude = 1150 ft AGL, Speed = 60 kn
Resulting Point Density ~ 12 pt/m²

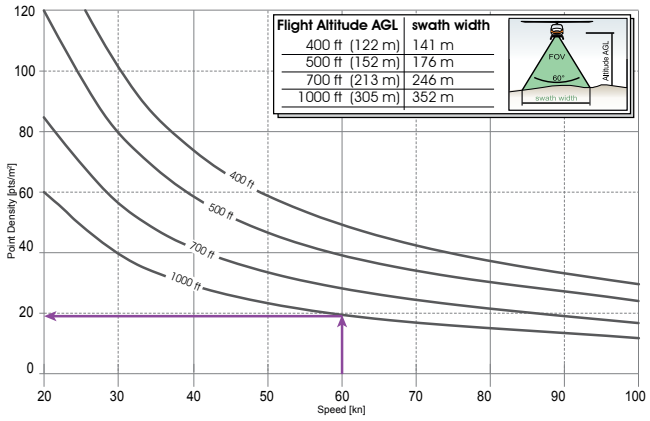
PRR = 400 kHz



MTA1: no ambiguity / 1 transmitted pulse „in the air"
MTA2: 2 transmitted pulses „in the air"
MTA3: 3 transmitted pulses „in the air"

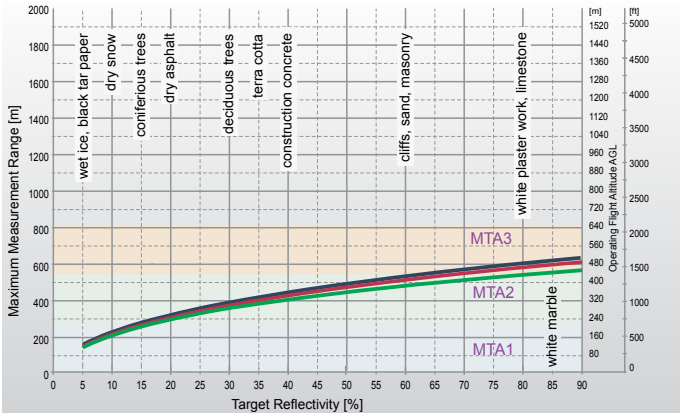
@ visibility 23 km
@ visibility 15 km
@ visibility 8 km

PRR = 400 kHz



Example: VQ-480-U at 400,000 pulses/second
Altitude = 1000 ft AGL, Speed = 60 kn
Resulting Point Density ~ 19 pt/m²

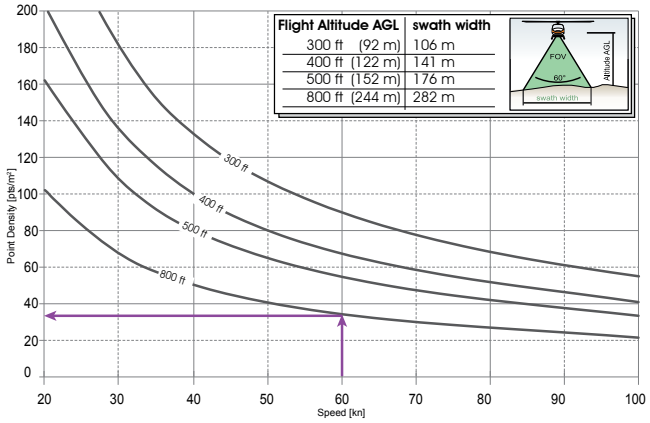
PRR = 550 kHz



MTA1: no ambiguity / 1 transmitted pulse „in the air"
MTA2: 2 transmitted pulses „in the air"
MTA3: 3 transmitted pulses „in the air"

@ visibility 23 km
@ visibility 15 km
@ visibility 8 km

PRR = 550 kHz

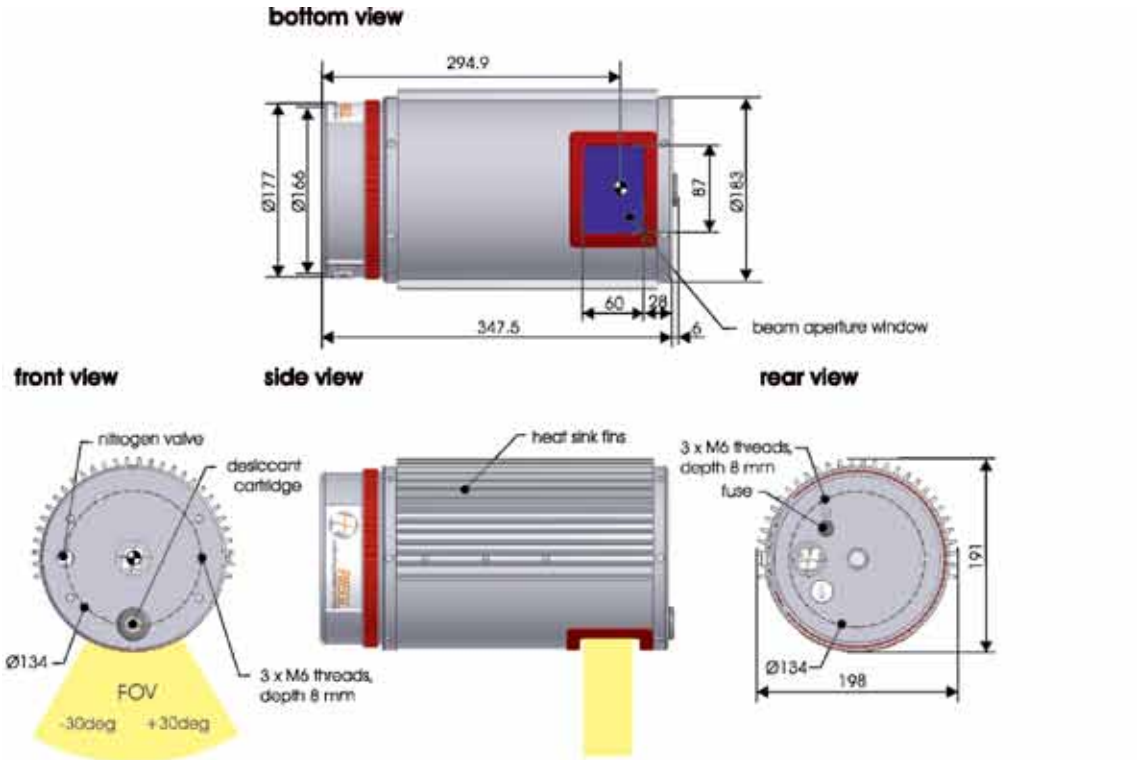


Example: VQ-480-U at 550,000 pulses/second
Altitude = 800 ft AGL, Speed = 60 kn
Resulting Point Density ~ 33 pt/m²

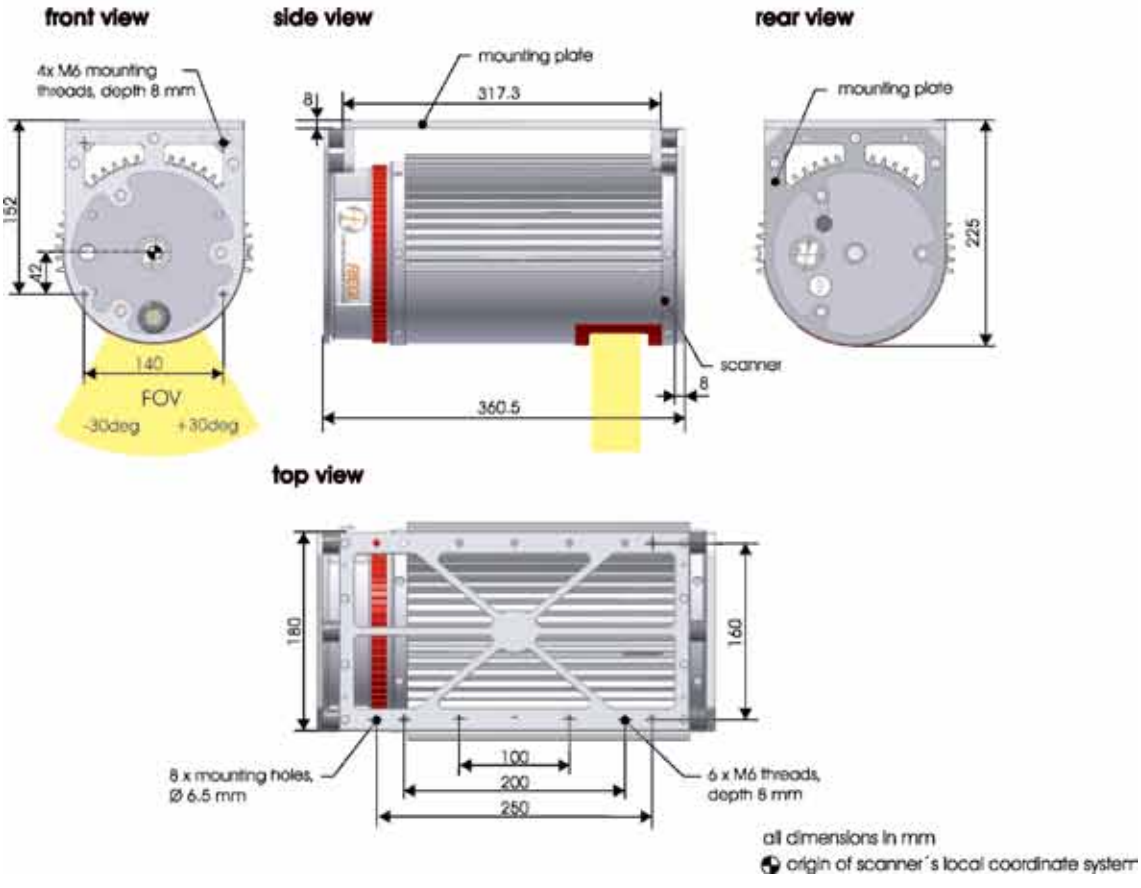
The following conditions are assumed for the Operating Flight Altitude AGL

- ambiguity resolved by multiple-time-around (MTA) processing & flight planning
- target size ≥ laser footprint
- scan angle 60°
- average ambient brightness
- roll angle +/-5°

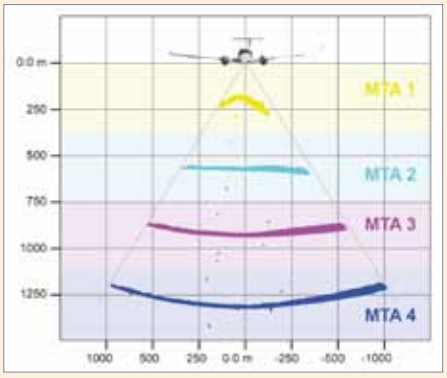
Dimensional Drawings *RIEGL* VQ®-480-U without Mounting Frame



Dimensional Drawings *RIEGL* VQ®-480-U with Mounting Frame



Multiple-time-around Data Acquisition and Processing



In time-of-flight laser ranging a maximum unambiguous measurement range exists, which is defined by the laser pulse repetition rate and the speed of light. In case the echo signal of an emitted laser pulse arrives later than the emission of the subsequently emitted laser pulse, the range result becomes ambiguous - an effect known as **„Multiple-Time-around" (MTA)**.

The *RIEGL* VQ-480-U allows ranging beyond the maximum unambiguous measurement range using a sophisticated modulation scheme applied to the train of emitted laser pulses. The dedicated post-processing software RiMTA provides algorithms for multiple-time-around processing, which automatically assign definite range results to the correct MTA zones without any further user interaction required.

RIEGL®
LASER MEASUREMENT SYSTEMS

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