„NFB" (Nadir/Forward/Backward) Scanning UAV LiDAR Sensor

NEW

RIEGL VUX®-160²³

- *laser pulse repetition rate up to 2.4 MHz*
- *measurement rate up to 2,000,000 meas./sec*
- *scan speed up to 400 lines/second*
- *operating flight altitude up to 900 m / 2,950 ft*
- *Field of View up to 100°*
- *compact & lightweight (2.65 kg / 5.8 lbs)*
- *Nadir/Forward/Backward Scanning for unrivaled completeness of scan data even on vertical structures and narrow canyons*
- *cutting edge RIEGL technology providing:*
  - *echo signal digitization*
  - *multiple target capability*
  - *online waveform processing*
  - *multiple-time-around processing*
- *easily mountable to unmanned platforms (UAVs) and small manned aircraft*
- *mechanical and electrical interface for INS/GNSS integration*
- *interfaces for up to 5 external cameras*
- *scan data storage on internal SSD Memory*
- *removeable CFAST® memory card*

The new *RIEGL* VUX-160²³ is a lightweight and versatile airborne laser scanner offering a wide field of view of 100 degrees and an extremely high pulse repetition rate of up to 2.4 MHz. Thus, it is perfectly suited for high point density corridor mapping applications.
The measuring beam of the *RIEGL* VUX-160²³ is consecutively emitted in three different directions: it alternates from strictly nadir, to +10 degrees forward, and to -10 degrees backward. This allows data acquisition with an unrivaled completeness in data capture, especially in challenging environments with vertical surfaces and narrow canyons.

The scanner provides an internal data storage capacity of 1 TByte and a removeable CFast card and is equipped with interfaces for integration of an external INS/GNSS system. Additionally, interfaces for up to five optional external cameras are available.

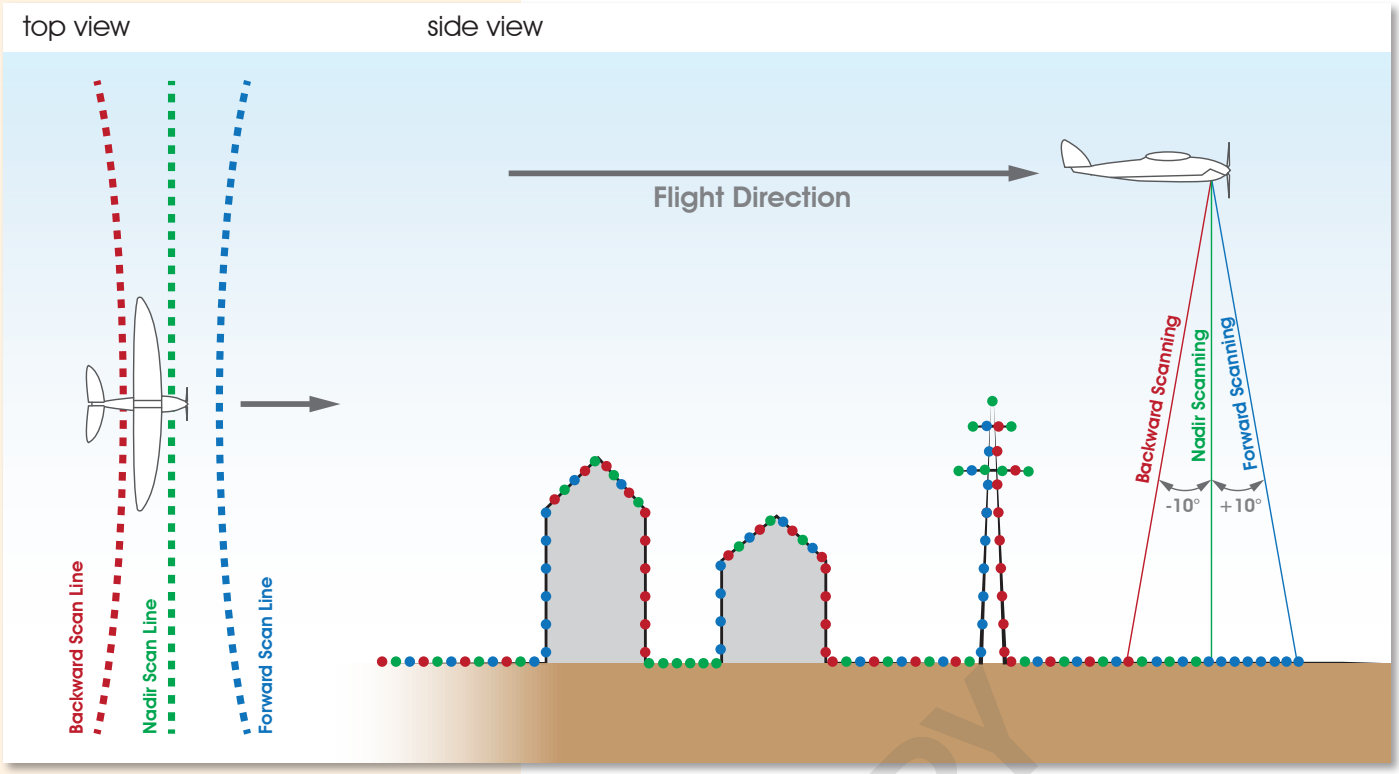
The sophisticated design of the *RIEGL* VUX-160²³ allows smooth integration on UAS/UAV/RPAS, small manned aeroplanes (like gyrocopters), but also on helicopters. It is offered both, as stand-alone UAV LiDAR sensor and also in various fully-integrated UAV-based laser scanning system configurations with appropriate INS/GNSS system and optional cameras. This allows the scanner to perfectly meet all the specific requirements of the customers' applications.

Typical applications include

- *Corridor Mapping: Power Line, Railway Track and Pipeline Inspection*
- *Topography in Open-Cast Mining*
- *Surveying of Urban Environments*
- *Archeology and Cultural Heritage Documentation*
- *Agriculture & Forestry*

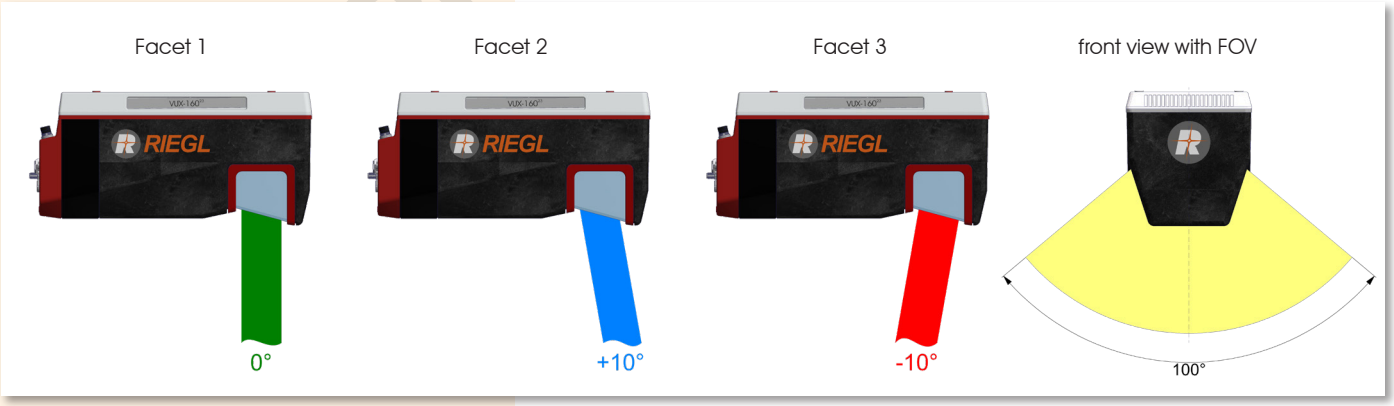
visit our website
www.riegl.com

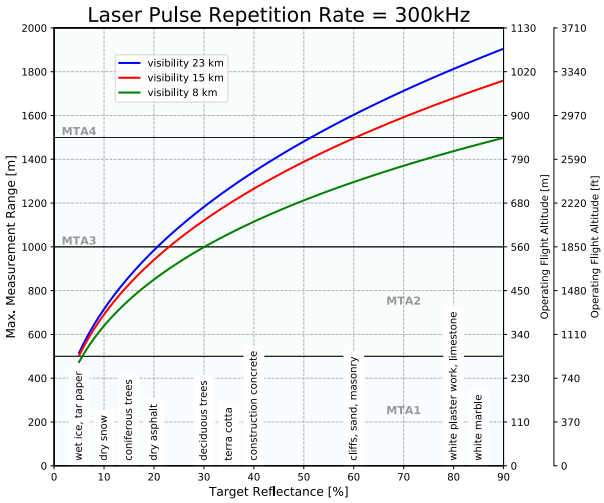
RIEGL®
LASER MEASUREMENT SYSTEMS



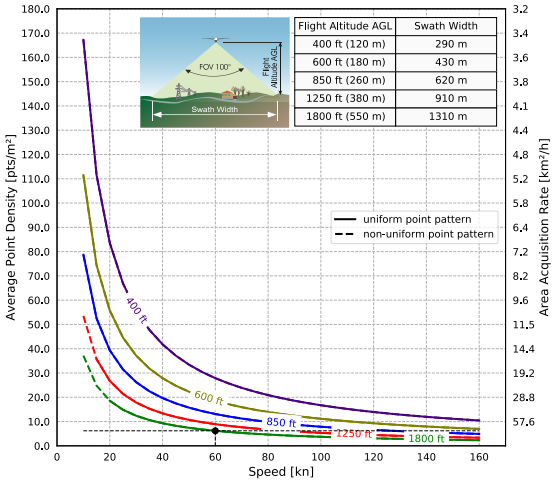
Field of View	± **50° (100°)**
Forward/Backward Scan Angle in Swath Center	± **10°**
Forward/Backward Scan Angle at Swath Edges	± **15°**

The *RIEGL* VUX-160[23] offers a sophisticated scan pattern consisting of scan lines with periodically changing directions. The scan directions in the center of the scan lines change consecutively from strictly nadir, to +10 degrees forward, and to -10 degrees backward. This scan pattern provides an almost complete 3D data set, as also vertical surfaces like the facades of buildings and objects (e.g. masts and poles) are accurately sampled by laser range measurements. In addition, the nadir direction enables the reliable data acquisition down to the bottom of narrow canyons.

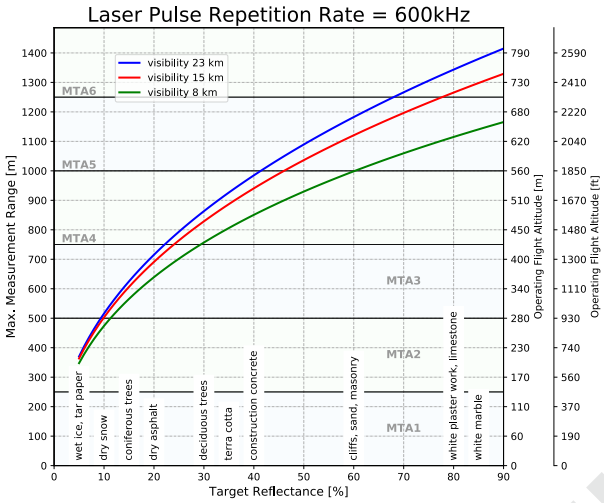




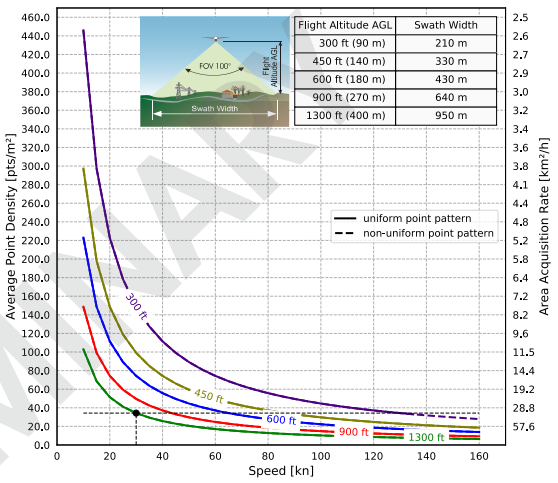
Operating Flight Altitude AGL given for the following conditions:
FOV 100°, ambiguity resolved by multiple-time-around (MTA) processing, average ambient brightness, target size ≥ laser footprint, roll angle ±5



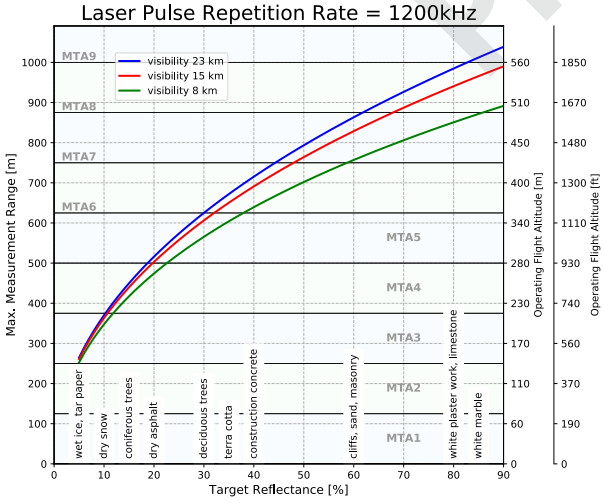
Example: VUX-160[23] at 300,000 pulses/sec, laser power level 100%
Altitude = 1,800 ft AGL, Speed 60 kn, resulting point density ~ 6.2 pts/m²



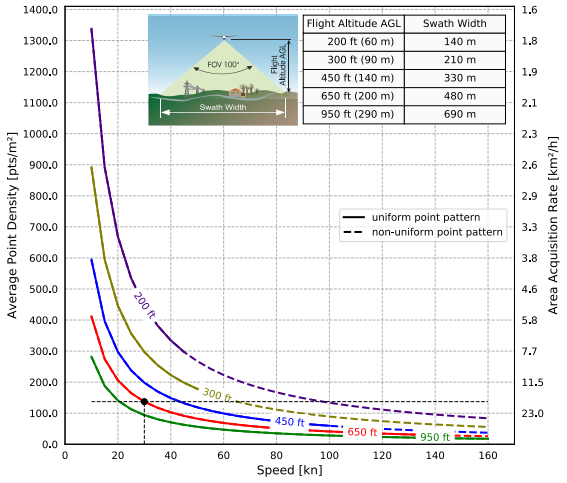
Operating Flight Altitude AGL given for the following conditions:
FOV 100°, ambiguity resolved by multiple-time-around (MTA) processing, average ambient brightness, target size ≥ laser footprint, roll angle ±5



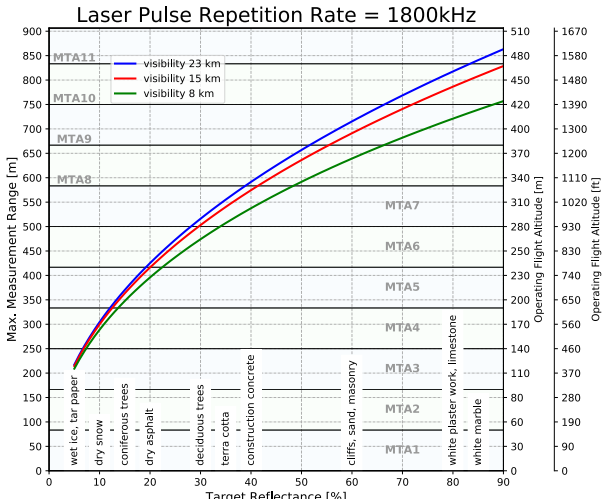
Example: VUX-160[23] at 600,000 pulses/sec, laser power level 100%
Altitude = 1,300 ft AGL, Speed 30 kn, resulting point density ~ 34 pts/m²



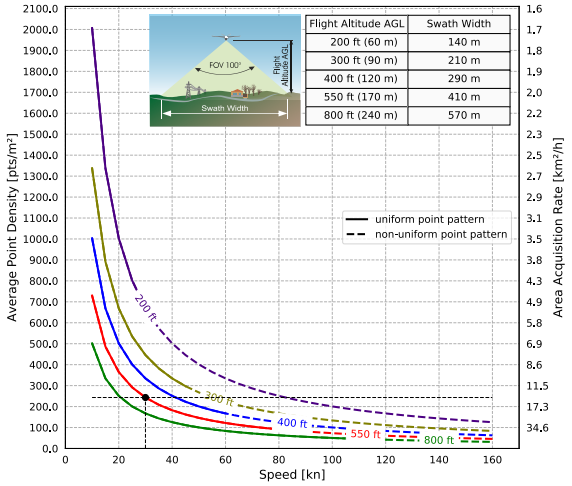
Operating Flight Altitude AGL given for the following conditions:
FOV 100°, ambiguity resolved by multiple-time-around (MTA) processing, average ambient brightness, target size ≥ laser footprint, roll angle ±5



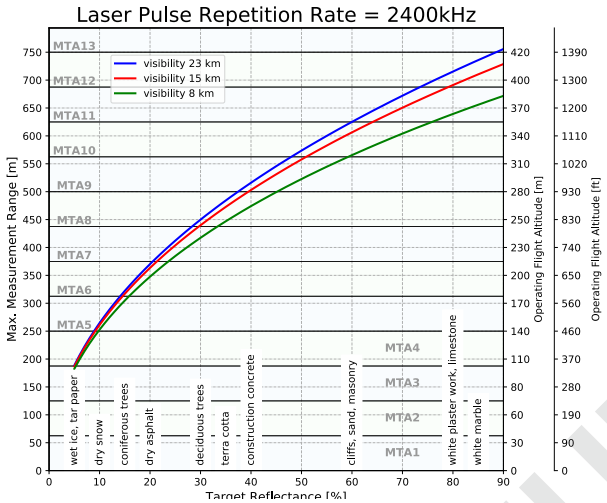
Example: VUX-160[23] at 1,200,000 pulses/sec, laser power level 100%
Altitude = 650 ft AGL, Speed 30 kn, resulting point density ~ 137 pts/m²



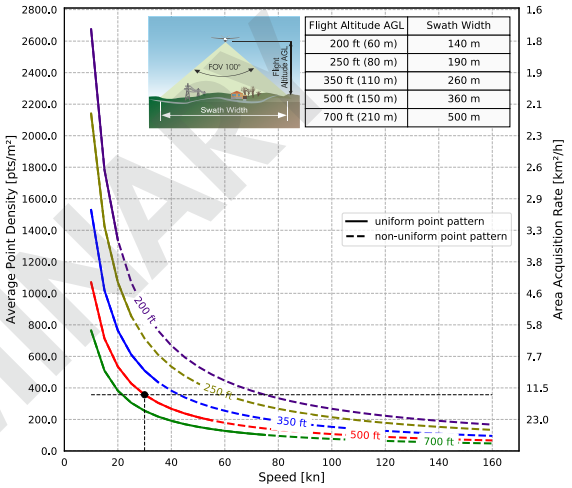
Operating Flight Altitude AGL given for the following conditions:
FOV 100°, ambiguity resolved by multiple-time-around (MTA) processing, average ambient brightness, target size ≥ laser footprint, roll angle ±5



Example: VUX-160[23] at 1,800,000 pulses/sec, laser power level 100%
Altitude = 550 ft AGL, Speed 30 kn, resulting point density ~ 243 pts/m²



Operating Flight Altitude AGL given for the following conditions:
FOV 100°, ambiguity resolved by multiple-time-around (MTA) processing, average ambient brightness, target size ≥ laser footprint, roll angle ±5



Example: VUX-160[23] at 2,400,000 pulses/sec, laser power level 100%
Altitude = 500 ft AGL, Speed 30 kn, resulting point density ~ 356 pts/m²

Laser Product Classification

Class 1 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.

Range Measurement Performance

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

Laser Pulse Repetition Rate PRR [1]	*300 kHz*	*600 kHz*	*1200 kHz*	*1800 kHz*	*2400 kHz*
Max. Measuring Range [2] [3]					
natural targets ρ ≥ 20 %	980 m	720 m	520 m	420 m	370 m
natural targets ρ ≥ 60 %	1600 m	1180 m	860 m	720 m	620 m
natural targets ρ ≥ 80 %	1800 m	1340 m	980 m	820 m	720 m
Max. Operating Flight Altitude AGL [2] [4]					
@ ρ ≥ 20 %	560 m (1800 ft)	400 m (1350 ft)	290 m (950 ft)	240 m (800 ft)	210 m (700 ft)
@ ρ ≥ 60 %	900 m (2950 ft)	670 m (2200 ft)	490 m (1600 ft)	400 m (1350 ft)	350 m (1150 ft)
Max. Number of Targets per Pulse [5]	32	24	11	7	5

1) Rounded average PRR.
2) Typical values for average conditions and average ambient brightness. In bright sunlight, the max. range is shorter 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 23 km. Range ambiguities have to be resolved by multiple-time-around processing.
4) Considering max. effective FOV 100°, additional roll angle ± 5°.
5) 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.

Minimum Range	5 m
Accuracy [6] [8]	10 mm
Precision [7] [8]	5 mm
Laser Pulse Repetition Rate [1] [9]	up to 2400 kHz
Max. Effective Measurement Rate [1]	up to 2,000,000 meas./sec. (@ 2400 kHz PRR & 100° scan angle)
Echo Signal Intensity	for each echo signal, high-resolution 16 bit intensity information is provided
Laser Wavelength	near infrared
Laser Beam Divergence	0.4 mrad [10]
Laser Beam Footprint (Gaussian Beam Definition)	40 mm @ 100 m, 200 mm @ 500 m, 400 mm @ 1000 m

6) Accuracy is the degree of conformity of a measured quantity to its actual (true) value.
7) Precision, also called reproducibility or repeatability, is the degree to which further measurements show the same result.
8) One sigma @ 150 m range under *RIEGL* test conditions.
9) User selectable.
10) Measured at the $1/e^2$ points. 0.4 mrad corresponds to an increase of 40 mm of beam diameter per 100 m distance.

Scanner Performance

Scanning Mechanism	rotating polygon mirror
Scan Pattern	parallel scan lines, angular directions -10°, 0°, +10° transvers to the scan direction for forward and backward view
Field of View (selectable)	± 50° = 100°
Scan Speed (selectable)	50 - 400 lines/sec
Angular Step Width Δ ϑ (selectable) between consecutive laser shots	0.0025° ≤ Δ ϑ ≤ 0.16° [11] [12]
Angle Measurement Resolution	0.001°
Scan Sync (optional)	scanner rotation synchronization

Data Interfaces

Configuration, Scan Data Output & Communication with External Devices	LAN 10/100/1000 MBit/sec
GNSS Interface	Serial RS-232 interface, TTL input for 1pps synchronisation pulse, accepts different data formats for GNSS-time information
General IO & Control	2 x TTL input/output [13], 1 x Remote on/off
Camera Interface	trigger, exposure [13], power (max. 2.0 A), 5 x GNSS RS-232 Tx & PPS
IMU Interface (optional)[14]	IMU data, power

General Technical Data

Power Supply Input Voltage / Consumption [15]	18 - 34 V DC / typ. 60 W
Main Dimensions (L x W x H)	282 mm x 117 mm x 134 mm
Weight	2.65 kg (without integrated Applanix AP+board)
Humidity	max. 80 % non condensing @ 31°C
Protection Class	IP64, dust and splash-proof
Max. Flight Altitude (operating & not operating)	18 500 ft (5 600 m) above MSL (Mean Sea Level)
Temperature Range	-10°C up to +40°C (operation) / -20°C up to +50°C (storage)

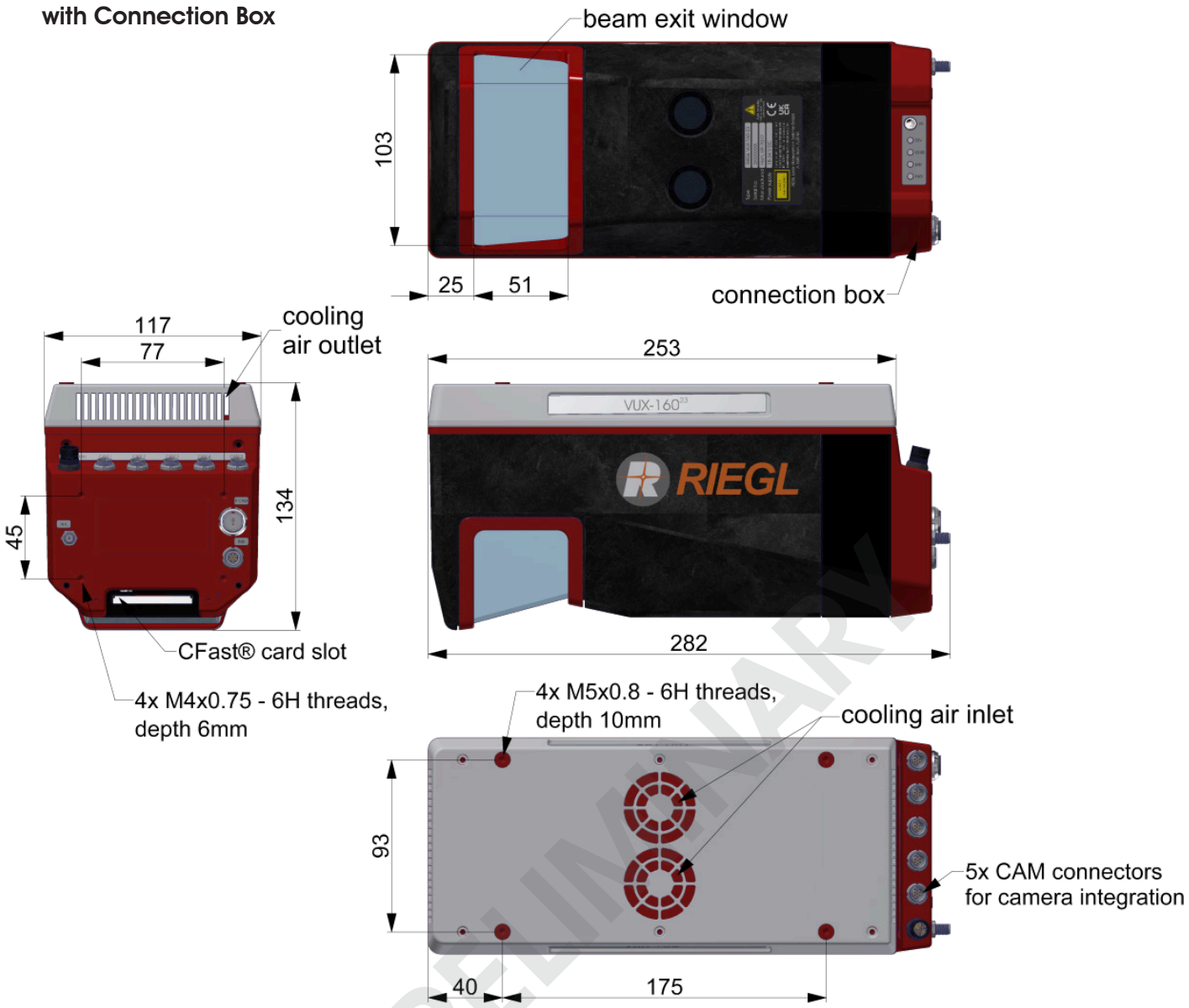
Data Storage

Internal Data Storage	Solid State Disc SSD, 1 TByte
Memory Card Slot	for CFAST® [16] industrial memory card 240 GByte (can be upgraded to 480 GByte)

11) The angular step width depends on the selected laser PRR.
12) The maximum angular step width is limited by the max. scan rate.
13) 1x externally available with standard interface box
14) applies only with INS/GNSS system
15) Separate input power connector for external cameras.
16) CFast® is a registered trademark of CompactFlash Association.

Dimensional Drawings *RIEGL* VUX®-160[23]

RIEGL VUX-160[23] UAV LiDAR Sensor with Connection Box



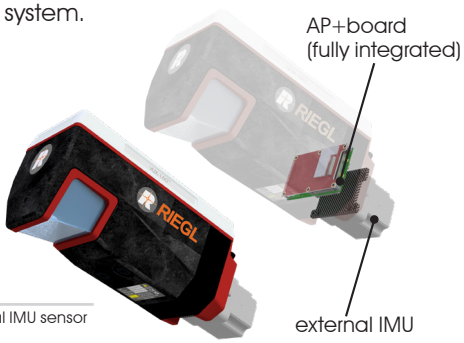
all dimensions in mm

RIEGL VUX-160[23]-SYS System Integration

The *RIEGL* VUX-160[23] can be optionally complemented with an appropriate IMU/GNSS system.

External IMU & GNSS (optional)	Applanix AP+50 [1]	Applanix AP+30 [1]
IMU Accuracy [2]		
Roll, Pitch	0.005°	0.010°
Heading	0.015°	0.025°
IMU Sampling Rate	200 Hz	200 Hz
Position Accuracy (typ.)	0.02 - 0.05 m	0.02 - 0.05 m
System Total Weight (approx.) [3]	3.15 kg	3.15 kg

1) See technical details at the according Applanix datasheet
2) Accuracy specifications for post-processed data
3) Single scanner with AP+board and with external IMU sensor



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