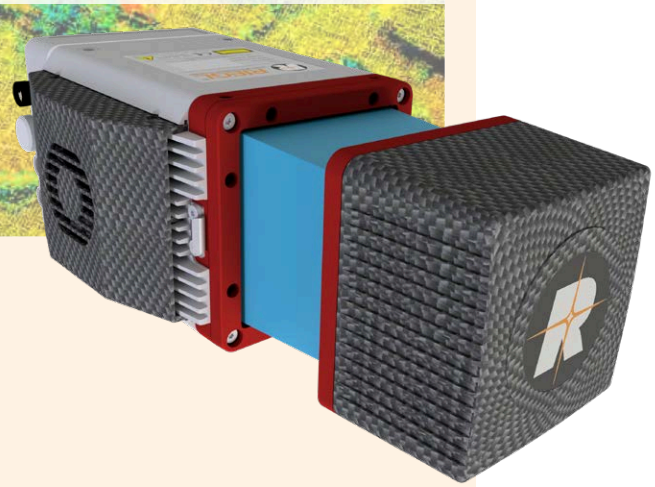
RIEGL miniVUX®-3UAV

- *100 kHz / 200 kHz / 300 kHz Laser PRR selectable*
- *measurement rate up to 200,000 measurements/sec*
- *scan speed up to 100 scans/sec*
- *very compact & lightweight (1.55 kg / 3.4 lbs)*
- *up to 360° field-of-view*
- *robust aluminum housing, ready to be mounted on multi-rotor, rotary-wing, and fixed-wing UAVs*
- *makes use of RIEGL's unique echo signal digitization and online waveform processing*
- *multiple target capability – up to 5 target echoes per laser shot*
- *mechanical and electrical interface for IMU mounting*
- ***NEW OPTION:*** *RIEGL RiLOC IMU/GNSS system solutions available*
- *exceptionally well suited to measure in snowy and icy terrains*
- *user-friendly, application- and installation-oriented solutions for integration*



The *RIEGL* miniVUX-3UAV is an extremely lightweight airborne laser scanner, designed specifically for integration with UAS/UAV/RPAS. The sensor offers a selectable 100 kHz, 200 kHz, and 300 kHz laser pulse repetition rate (PRR). With 300 kHz PRR, it provides up to 100,000 measurements per second at 120° FoV and thus a dense point pattern on the ground for UAV-based applications that require the acquisition of small objects.

The small and sophisticated design of the stable aluminum housing offers various integration possibilities with platforms that offer restricted space or payload capabilities. The 360° field of view allows complete acquisition of the environment.

An easy-to-remove SD card for data storage, and/or the option for streaming the scan data via LAN-TCP/IP interface, in combination with the modest power consumption of the scanner, enable straight-forward integration with most UAS/UAV/RPAS types.

The *RIEGL* miniVUX-3UAV makes use of *RIEGL's* unique Waveform-LiDAR technology, allowing echo digitization and online waveform processing. Multi-target resolution is the basis for penetrating even dense foliage. As a further special feature, the wavelength is optimized for the measurement of snowy and icy terrain.

In addition to the stand-alone version of the miniVUX-3UAV, *RIEGL* also offers fully-integrated system solutions with integrated camera and IMU/GNSS systems, e.g. with *RIEGL* RiLOC-E[25] or RiLOC-F.

Typical applications include

- ***Agriculture & Forestry***
- ***Glacier and Snowfield Mapping***
- ***Archeology and Cultural Heritage Documentation***
- ***Construction-Site Monitoring***
- ***Landslide Monitoring***

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www.riegl.com

RIEGL®
LASER MEASUREMENT SYSTEMS

Laser Product Classification	Class 1 Laser Product according to IEC 60825-1:2014 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, online waveform processing

Laser Pulse Repetition Rate PRR [1]	100 kHz	200 kHz reduced power	200 kHz	300 kHz
Max. Measuring Range [2]				
natural targets ρ ≥ 20 %	170 m	150 m	170 m	170 m
natural targets ρ ≥ 60 %	290 m	250 m	290 m	290 m
natural targets ρ ≥ 80 %	330 m	280 m	330 m	330 m
Typ. Operating Flight Altitude AGL [1] [3]				
natural targets ρ ≥ 20 %	100 m (330 ft)	85 m (280 ft)	100 m (330 ft)	100 m (330 ft)
natural targets ρ ≥ 60 %	160 m (525 ft)	140 m (460 ft)	160 m (525 ft)	160 m (525 ft)
Max. Number of Targets per Pulse [4]	5	5	5	5

1) Rounded values.
2) Typical values for average conditions. 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. In bright sunlight, the max. range is shorter than under overcast sky.
3) Flat terrain assumed, scan angle ±45° FOV
4) If more than one target is hit, the total laser transmitter power is split and, accordingly, the achieveable range is reduced.

Minimum Range	2 m
Accuracy [5] [7]	15 mm
Precision [6] [7]	10 mm
Laser Pulse Repetition Rate [1]	100 kHz / 200 kHz / 300 kHz (selectable)
Max. Effective Measurement Rate [1]	up to 200 000 meas./sec. (@ 200 kHz PRR reduced power & 360° FOV)
Echo Signal Intensity	for each echo signal, high-resolution 16 bit intensity information is provided
Laser Wavelength	near infrared
Laser Beam Divergence [8]	1.6 x 0.5 mrad
Laser Beam Footprint	160 mm x 50 mm @ 100 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 @ 50 m range under *RIEGL* test conditions.
8) Measured at 50% peak intensity, 1.6 mrad corresponds to an increase of 160 mm of beam diameter per 100 m distance.

Scanner Performance

Scanning Mechanism	rotating mirror
Field of View (selectable)	360° @ 100 kHz, 200 kHz reduced power 180° @ 200 kHz 120° @ 300 kHz
Scan Speed (selectable)	10 - 100 scans/sec[9] @ 100 kHz, 200 kHz reduced power 20 - 100 scans/sec[9] @ 200 kHz 30 - 100 scans/sec[9] @ 300 kHz
Angular Step Width Δ φ (selectable) between consecutive laser shots	0.018° ≤ Δ φ ≤ 0.36°
Angle Measurement Resolution	0.001°

9) equivalent to revolutions per second

Interfaces

Configuration, Scan Data Output & Communication with External Devices	2 x LAN 10/100/1000 Mbit/sec WLAN IEEE 802.11 a/b/g/n
GNSS Interface [10]	Serial RS-232 interface for data string with GNSS-time information, TTL input for 1PPS synchronization pulse.
General IO & Control [11]	2 x TTL input/output, 1 x Remote on/off
Camera Interface	2 x GNSS RS-232 Tx & PPS, Power, Trigger, Exposure
Memory Card Slot	for SDHC/SDXC memory card 32 GByte (can be upgraded to 64 GByte)

10) internally available (not available with standard interface box)
11) 1x externally available with standard interface box

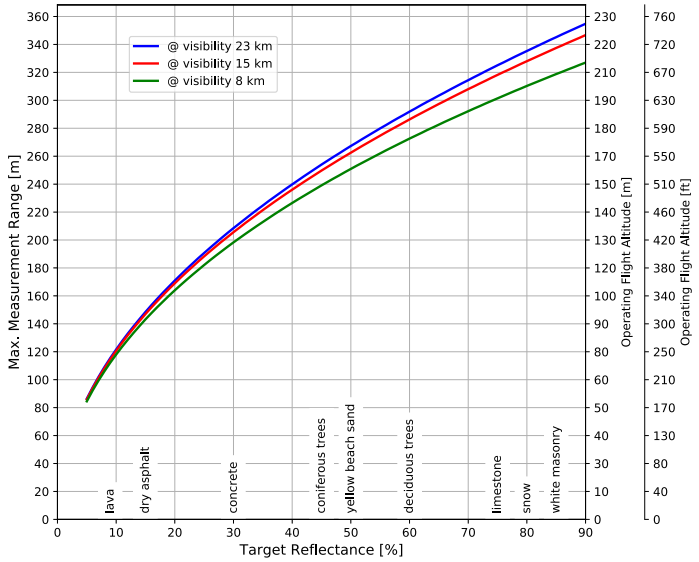
General Technical Data

Power Supply Input Voltage / Consumption	11 - 34 V DC / typ. 18 W @ 100 scans/sec
Main Dimensions (L x W x H) / Weight	
with Cooling Fan	243 x 111 x 85 mm / approx. 1.6 kg
without Cooling Fan	243 x 99 x 85 mm / approx. 1.55 kg
Humidity	max. 80 % non condensing @ 31°C
Protection Class	IP64, dust and splash-proof
Temperature Range [12]	-10°C up to +40°C (operation) / -20°C up to +50°C (storage)

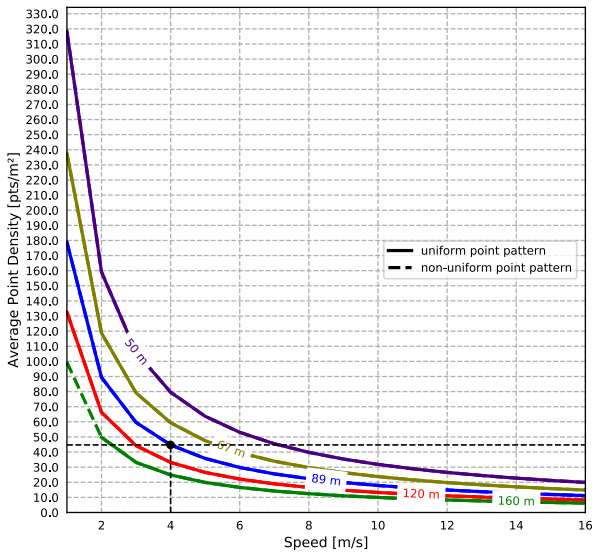
12) Continuous operation at ambient temperature of ≥ 30°C (≥ 86°F) requires a minimum amount of air flow at approx. 3 m/s. For applications where a 3 m/s air flow along the cooling fins cannot be guaranteed, the cooling fan has to be used.

Maximum Measurement Range vs. Target Reflectance *RIEGL* miniVUX®-3UAV

PRR = 100 kHz

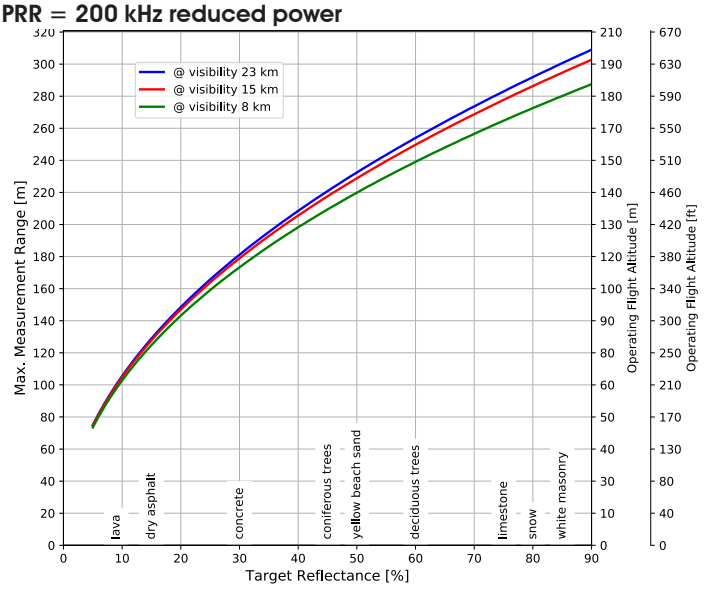


Operating Flight Altitude AGL given for the following conditions:
FOV of +/-45°, target size ≥ laser footprint, average ambient brightness

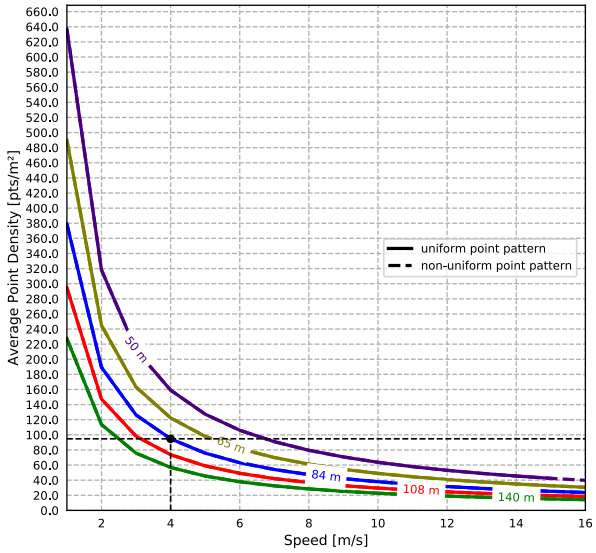


Example: miniVUX-3UAV at 100,000 pulses/second, speed = 4 m/s,
range to target = ~ 90 m, resulting point density ~ 45 pts/m²

PRR = 200 kHz reduced power

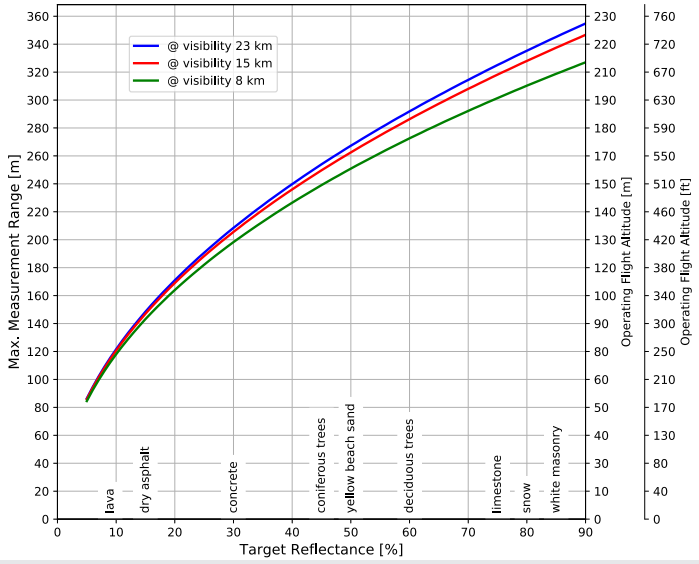


Operating Flight Altitude AGL given for the following conditions:
FOV of +/-45°, target size ≥ laser footprint, overcast sky, ambient brightness 10klx

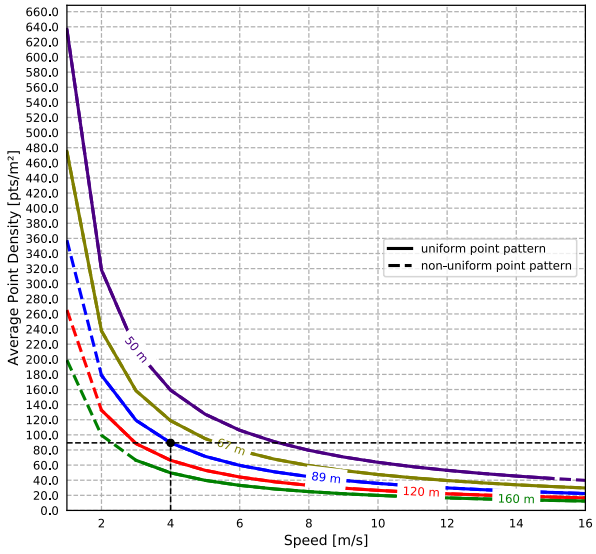


Example: miniVUX-3UAV at 200,000 pulses/second, speed = 4 m/s,
range to target = ~ 85 m, resulting point density ~ 95 pts/m²

PRR = 200 kHz



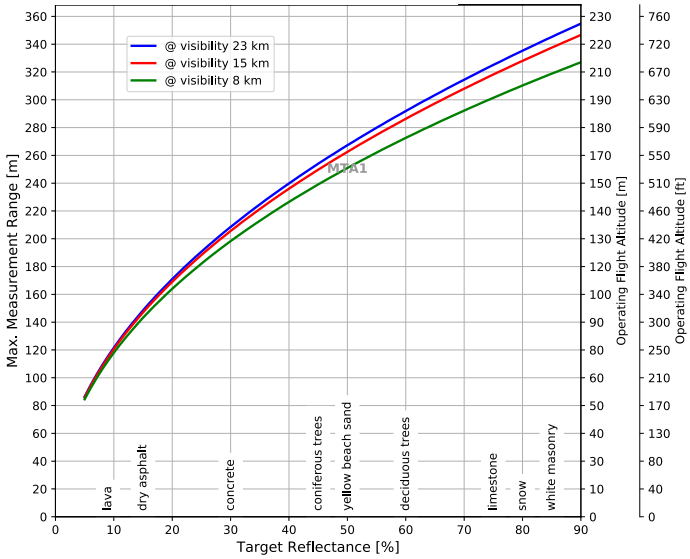
Operating Flight Altitude AGL given for the following conditions:
FOV of +/-45°, target size ≥ laser footprint, average ambient brightness



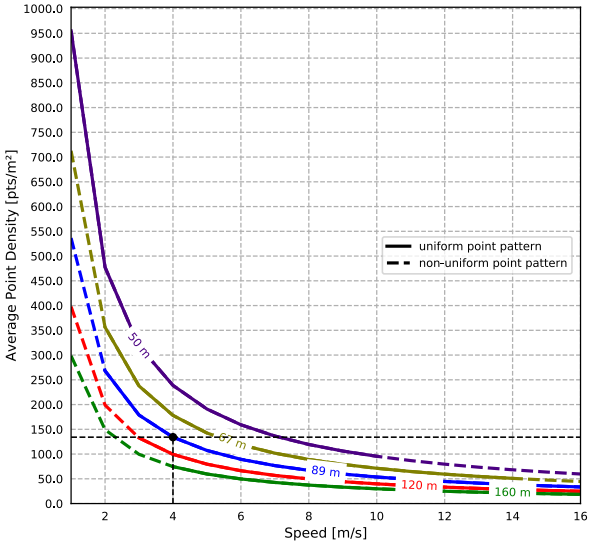
Example: miniVUX-3UAV at 200,000 pulses/second, speed = 4 m/s,
range to target = ~ 90 m, resulting point density ~ 90 pts/m²

Maximum Measurement Range vs. Target Reflectance *RIEGL* miniVUX®-3UAV

PRR = 300 kHz

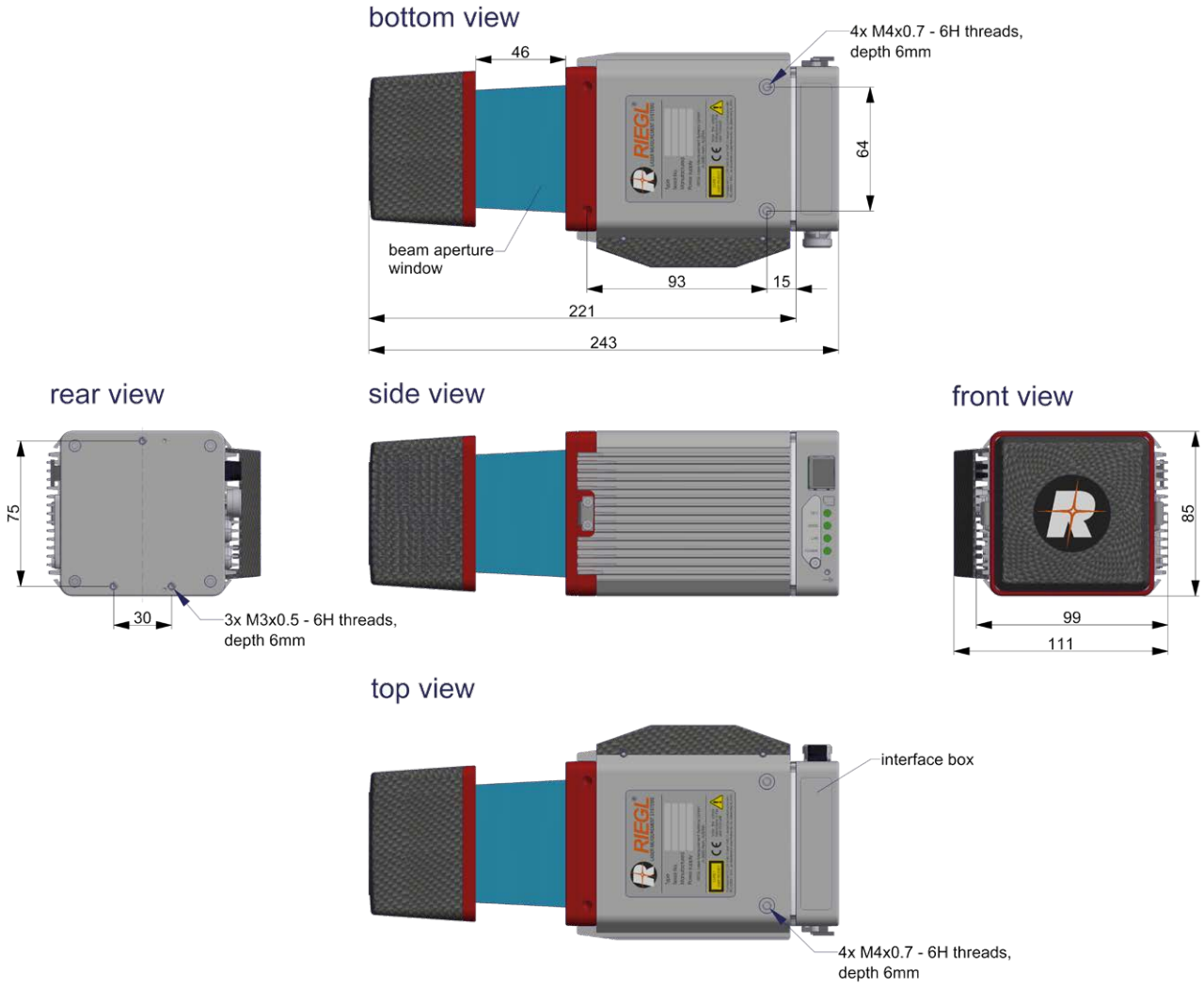


Operating Flight Altitude AGL given for the following conditions:
FOV of +/-45°, target size ≥ laser footprint, average ambient brightness



Example: miniVUX-3UAV at 300,000 pulses/second, speed = 4 m/s,
range to target = ~ 90 m, resulting point density ~ 135 pts/m²

Dimensional Drawings *RIEGL* miniVUX®-3UAV Stand-Alone



all dimensions in mm

Besides of the stand-alone miniVUX-3UAV LiDAR engine, *RIEGL* offers also system solutions, combining the miniVUX-3UAV with IMU/GNSS systems of different performance and of different form factors as well as optional RGB camera systems.

Below you can find the most common configurations offered for *RIEGL* miniVUX-SYS systems based on the *RIEGL* miniVUX-3UAV LiDAR sensor.
For more detailed information and further possible *RIEGL* miniVUX-SYS configurations, lease contact sales@riegl.com

RIEGL miniVUX-SYS IMU/GNSS Integration Options

RIEGL miniVUX-3UAV with RiLOC®-E[25] / RiLOC®-F

- *RIEGL*'s IMU/GNSS solution fully integrated with LiDAR engine
- total weight approx. 1.84 kg
- interfaces for up to 2 cameras
- suited for integration into multi-rotor UAVs

RIEGL miniVUX-3UAV with APX-15 UAV[1)]

- IMU/GNSS unit integrated with LiDAR engine
- total weight approx. 2 kg
- interfaces for up to 2 cameras
- suited for integration into fixed-wing UAVs

1) See technical details in the corresponding Applanix data sheet.

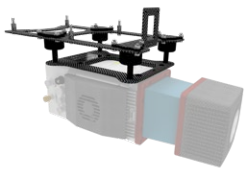
IMU & GNSS (optional)	*RIEGL* RiLOC-E[25] [1)]	*RIEGL* RiLOC-F [1)]	Applanix APX-15 UAV [2)]
Orientation Accuracy [3)]			
Roll, Pitch	0.010°	0.005°	0.025°
Heading	0.025°	0.020°	0.080°
Orientation Sampling Rate	up to 700 Hz	up to 700 Hz	200 Hz
Position Accuracy (typ.)	0.02 - 0.04 m	0.02 - 0.03 m	0.05 - 0.1 m
System Total Weight (approx.)	1.84 kg	1.84 kg	2.0 kg

1) See technical details at the according RiLOC infosheet
2) See technical details at the according Applanix datasheet
3) Accuracy specifications for post-processed data

RIEGL Integration Kit 400 / 350

A special add-on to the *RIEGL* miniVUX-SYS allows for straight forward integration with your multi-rotor UAV, e.g. a DJI Matrice M400 / M350 RTK. Please contact sales@riegl.com to get more detailed information.

RIEGL miniVUX-3UAV on RIEGL Integration Kit 400



RIEGL miniVUX-3UAV on RIEGL Integration Kit 350

- add-on to the miniVUX-SYS coming with shock-absorbing mounting-kit, power supply module and cabling
- total weight approx. 0.22 kg / 0.35 kg (without sensor and camera)
- suited for integration into multi-rotor UAVs

Please contact sales@riegl.com to get more detailed information.

RIEGL miniVUX®-3UAV Camera Options

RIEGL miniVUX-3UAV LiDAR Sensor equipped with RiLOC®-E[25] / RiLOC®-F

with RGB camera [2]

RIEGL miniVUX-3UAV LiDAR Sensor equipped with APX-15 UAV[1]

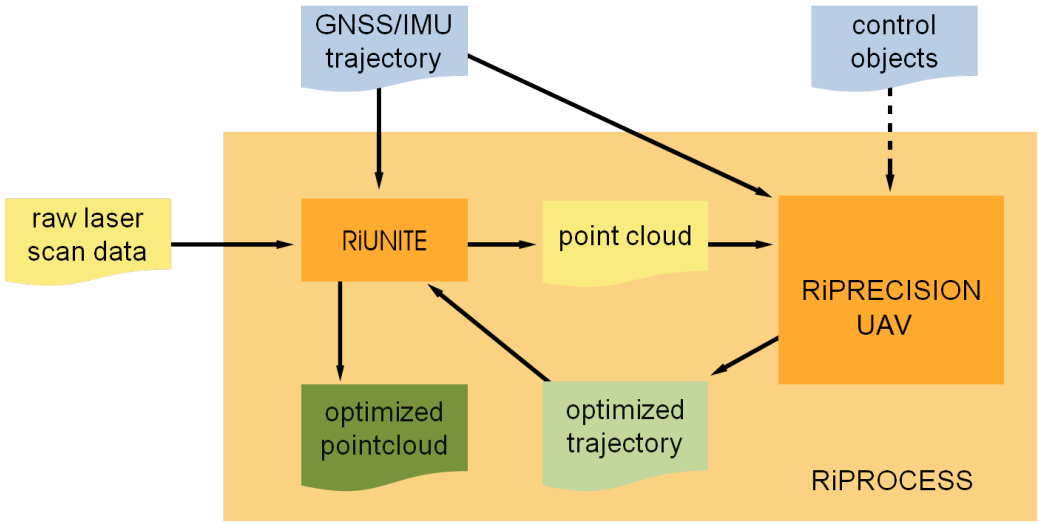
with two Sony Alpha 6100 cameras (oblique mount)

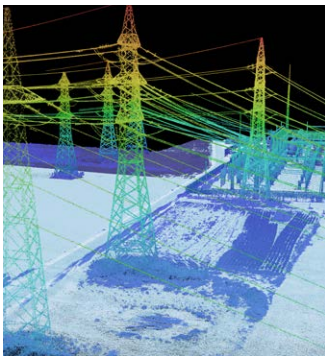
with nadir-looking RGB camera [2]

1) See technical details in the corresponding Applanix data sheet.
2) Versatile camera options (e.g. Sony Alpha 6100, Sony A7R III, Sony A7R IV, Sony ILX-LR1).

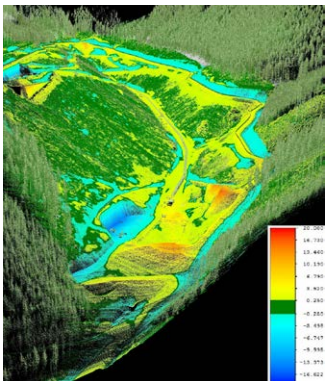
RIEGL miniVUX®-SYS – Processing Workflow and Scan Data Examples

Using *RIEGL's* software suites (RiPROCESS, RiUNITE) and dedicated processing workflows with specialized alignment tools like RiPRECISION conducting the whole procedure of scan data alignment fully automatically, processing time can be reduced to a minimum. RiPROCESS can interface the optimized, georeferenced point cloud in further post-processing tools via LAS or other data exchanges in various user-defined coordinate systems.





power line surveying



cut and fill volume comparison of disposal site

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