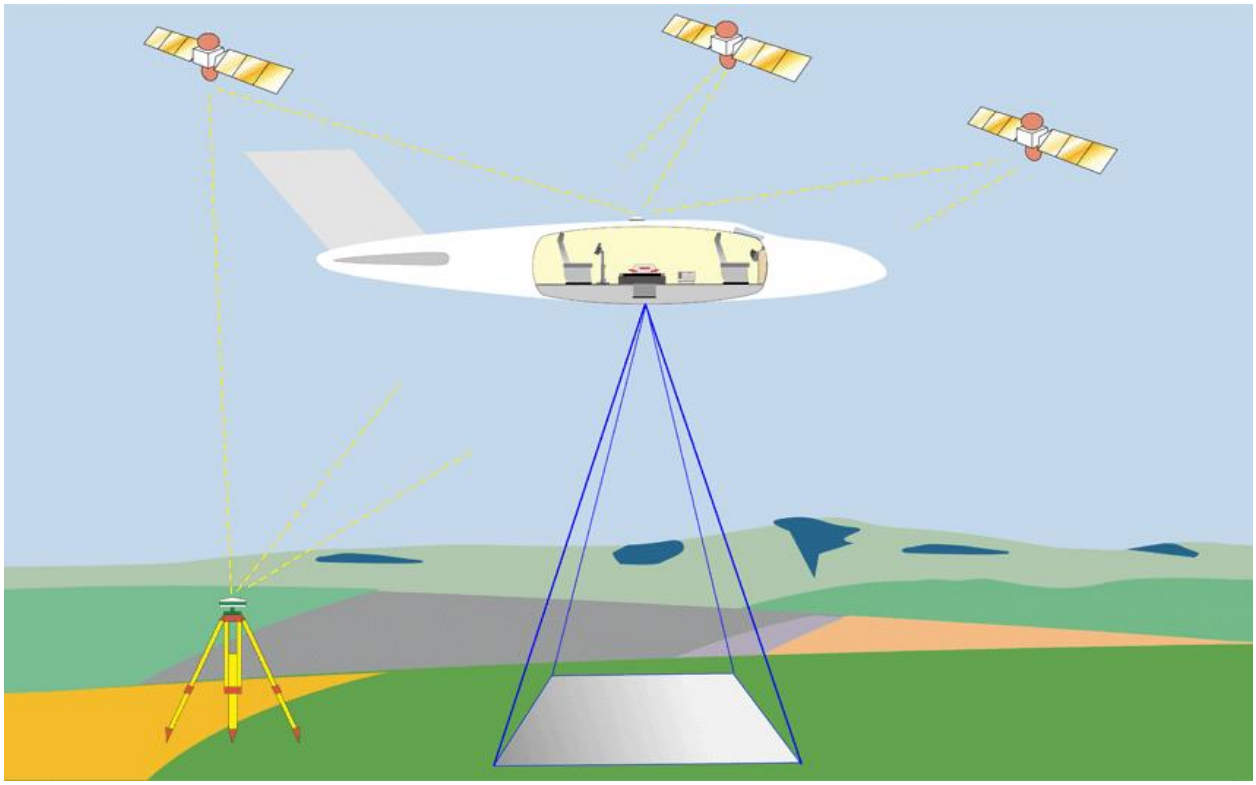
Leica RCD30
Calibration Certificate



	Camera Head	Serial Number	Lens	Serial Number
This certificate is valid for	***CH82***	***82557***	***NAT-D 2.8/80***	***80162***

Calibration certificate issued on ***10 October 2018***

Inspector

Robert Bosch

Certificate and calibration data ID

RCD30_Geometry_CameraHead-82557-D-798528_LensSystem-80162-A-785423_DateTime-20181009-144551.xml

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Document code 791649

- when it has to be **right**

Leica Geosystems

Additional Components

Component	Device	Type	Serial Number
GNSS/IMU	SPAN	CNUS 5 - H	1153

Sensor layout of tested system

The RGB CCD carries a BGGR Bayer pattern with overlapping spectral bands.
The NIR sensor is a monochrome CCD. It is spectrally separated from RGB through a dichroitic beam splitter device. NIR pixels are 2x2 binned from 0.006 mm to 0.012 mm.

Sensor	Pixel size [mm]	Active rows	Active columns	Raw rows	Raw columns
RGB	**0.0052**	**7752**	**10320**	7788	10336
NIR	**0.0120**	**3654**	**4478**	3366	4500

Camera model of distortion free images

All factory calibration results contain fixed nominal focal lengths and zero principal point offsets.
Leica FramePro applies the grid to create distortion-free images of nominal focal length and pixel size. NIR is interpolated to the resolution of RGB during this process.

Parameter	Value of distortion free images
c: focal length	83 mm
xP, yP: principal point (PPA)	Zero The PPA is the origin of the image coordinate system. It is located in the image center (row 3893.5, column 5167.5).
k0, k1, k2: radial symmetric distortion	Zero
p1, p2 : decentering distortion	Zero
b1, b2: non-orthogonality	Zero
Pixel size (height and width)	0.0052 mm for RGB and 0.006 mm for NIR
Image rows	7788
Image columns	10336

Calibration process

Adjustment of optical systems in optical laboratory

		Passed	Date	Inspector
DSNU *(Dark Signal Non-Uniformity)*	*checked*	***ok***	***01.10.18***	**Bernhard Riedl**
PRNU *(Photo Response Non Uniformity)*	*calibrated*	***ok***	***01.10.18***	**Bernhard Riedl**
FMC origin	*calibrated*	***ok***	***01.10.18***	**Bernhard Riedl**
CCD Saturation (VNS)	*calibrated*	***ok***	***01.10.18***	**Bernhard Riedl**
CCD blemish list	*created*	***ok***	***01.10.18***	**Bernhard Riedl**
Best image plane	*adjusted*	***ok***	***01.10.18***	**Bernhard Riedl**

Flight and data processing

	Passed	Date	Inspector
Test flight	***ok***	***05.10.18***	**Raphael Weber**
Image quality check	***ok***	***08.10.18***	**Bernhard Riedl**
GNSS and IMU data processing	***ok***	***08.10.18***	**Robert Bosch**
Geometrical calibration	***ok***	***09.10.18***	**Muzaffer Adiguzel**

Inspection

Inspectors

Name	**Bernhard Riedl**	***10.10.18***	
Position	RCD30 Production Manager		
Name	**Robert Bosch**	***10.10.18***	
Position	RCD30 Support Engineer		

Maintenance

Last date of service

Recommendations

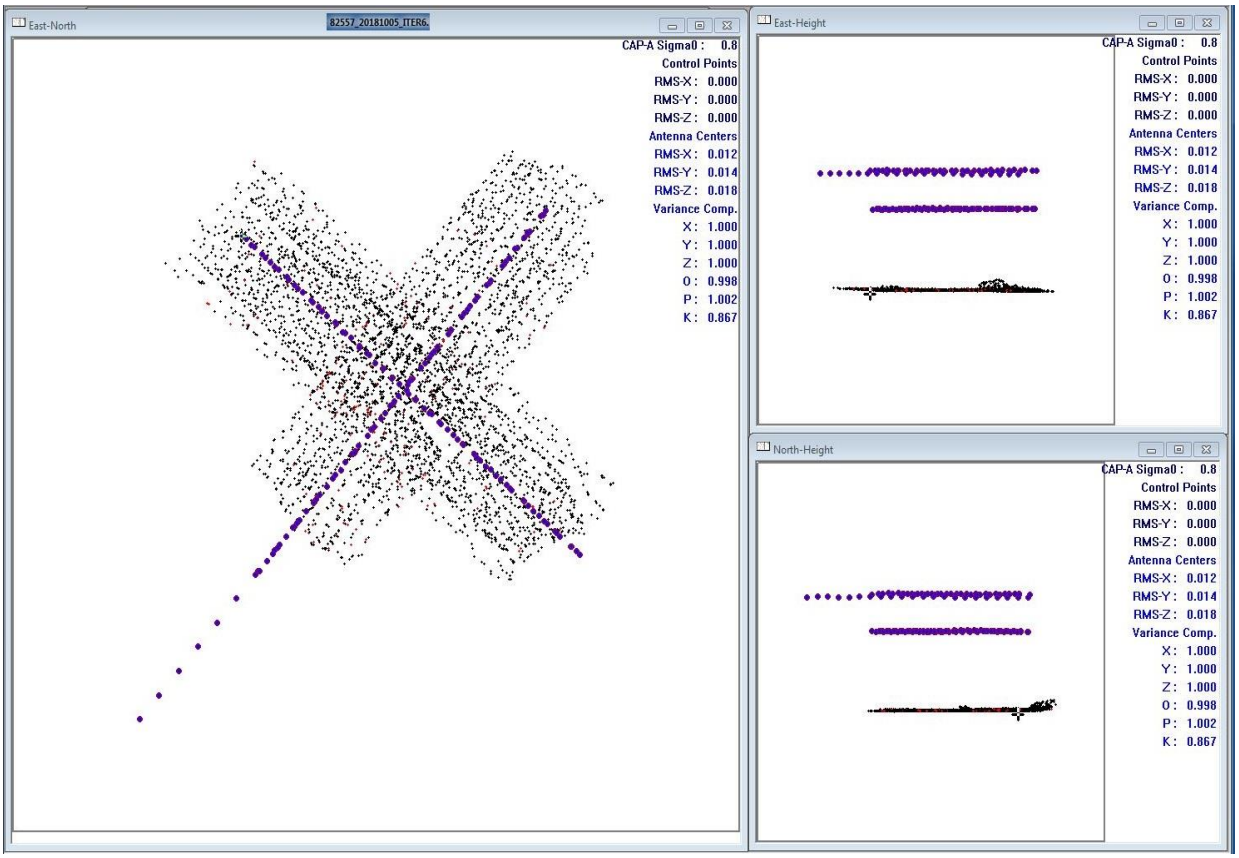
Results of geometrical calibration

The resulting distortion grid file that contains all the geometric information of the camera is attached to this certificate. File name is on the first page and footer of each page.
All factory calibration results contain fixed nominal focal lengths and zero principal point offsets.
Leica FramePro applies the grid to create distortion-free images of nominal focal length and fixed pixel size of 0.0052 mm. NIR is interpolated to the resolution of RGB during this process.

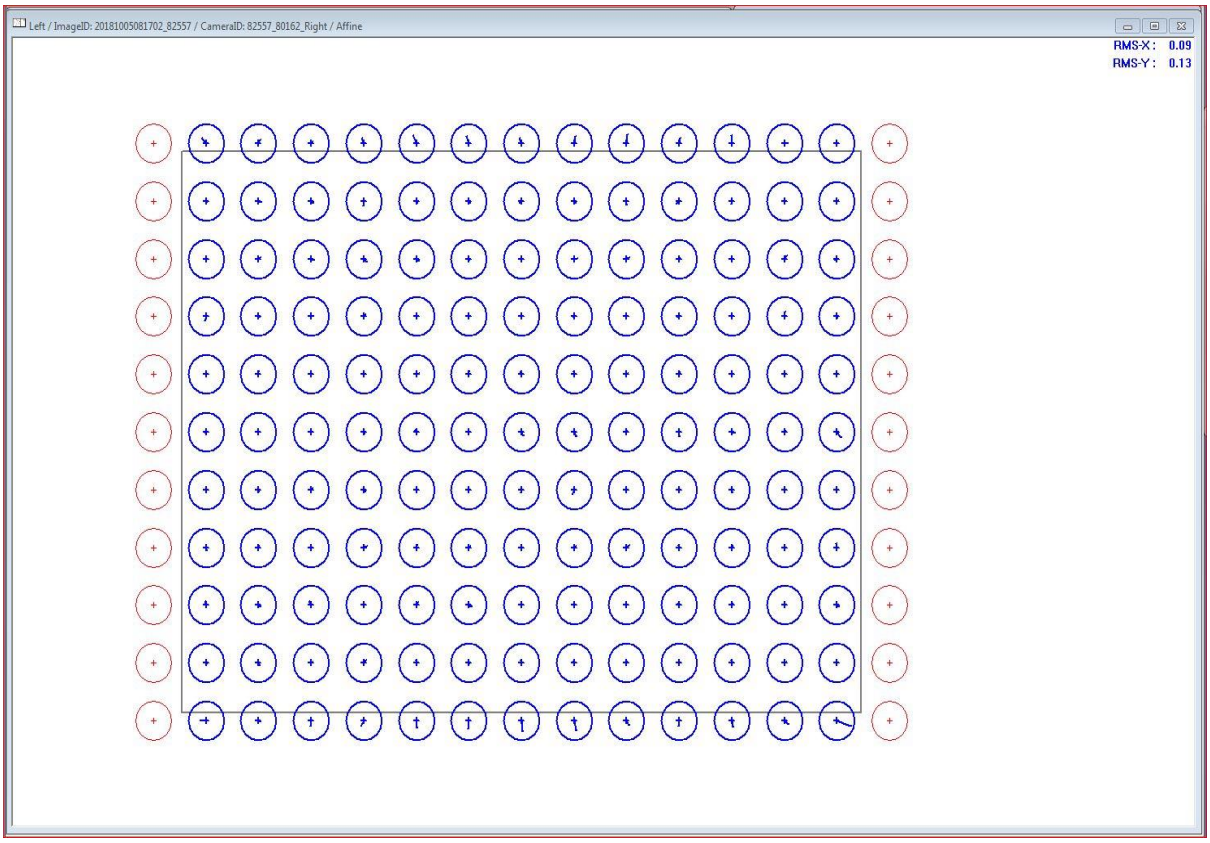
Reference band (green)

Calibration method	Estimation of additional parameters (focal length, principal point, radial symmetric distortion, correction grid) and IMU misalignment in simultaneous bundle adjustment
Resulting sigma naught of bundle adjustment	0.0008 mm

Final bundle adjustment result after elimination of tie point blunders:



Remaining image space residuals after applying the calibration result (radius of circles is 0.0008 mm):



Other spectral bands

Calibration method	Estimation of additional parameters (correction grid), based on the result for green in simultaneous bundle adjustment
Co-registration to green better than	0.002 mm

IMU misalignment

Misalignment results [deg] Valid only for this calibration flight		Angle	Standard deviation
	ω	-0.05421	0.00017
	ϕ	0.15989	0.00017
	κ	-0.15490	0.00026