

Level-03 Image-Product Geometry of a Vexcel UltraCam Condor 4.1 Block

Shared exterior orientation, frame-versus-orthophoto classification, and PAN/colour co-registration of the delivered Level-03 products.

Study data: Vexcel UltraCam Condor 4.1 — Gleisdorf, Austria (delivered dataset, public).

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Abstract. The delivered Vexcel UltraCam Condor 4.1 Gleisdorf dataset carries several co-existing Level-03 image products — panchromatic, RGB, colour-infrared, and a 270°-oriented colour variant — alongside surface models and an orthophoto mosaic. Every Level-03 product shares a single exterior orientation per exposure and differs only in ground sample distance, extent, and resampling orientation. Tested against 165 ground-control measurements, a frame-collinearity model fits to a **2.4 px** median while treating the products as orthophotos through their world-file georeference leaves **50 px (≈18 m)**: the Level-03 products are perspective frames, not orthophotos. Panchromatic and colour co-register to **≈0.08 m**. A single independent aerial-triangulation solution therefore refines every product at once, and the colour inherits panchromatic accuracy without additional geometric loss.

2.4 px

FRAME-MODEL FIT (COLLINEARITY)

50 px

WORLD-FILE AS ORTHO · ≈18 M

≈0.08 m

PAN / COLOUR CO-REGISTRATION

1. Products

48 exposures over Gleisdorf, Austria; EPSG:25833. Each Level-03 image carries a TIFF world file only; a single block exterior-orientation file holds one record per exposure (X, Y, Z, ω , ϕ , κ). The separately delivered *DTMOrtho* mosaic — north-up, DTM-rectified, seam-lined, 552 tiles at 15 cm — is the dataset's only true orthophoto.

Level-03 product	Pixels	GSD
0° PAN, 8-bit (48 exposures)	20488 × 14040	0.356 m
0° RGB, 8-bit (48)	48462 × 6150	0.150 m
0° CIR, 8-bit (48)	48462 × 6150	0.150 m
270° RGB, 8-bit (48)	6150 × 48462	0.150 m

2. Shared exterior orientation

For a representative exposure every Level-03 product reports an identical scene centre and a grid rotation equal, to six figures, to the exposure's orientation κ . Each product is therefore the frame resampled into a grid aligned to the camera attitude and georeferenced from the shared orientation; none carries an independent orientation. The

apparent difference in geometry between panchromatic and colour is a difference of ground sample distance, extent, and storage orientation only: the panchromatic product spans the full $\approx 7287 \times 4994$ m frame footprint at 0.356 m, the RGB/CIR products cover the full swath width but only the central ≈ 925 m along-track at 0.150 m ($2.37\times$ finer), and the 270° product is the same RGB data on a grid rotated 90° .

3. Frame versus orthophoto

Two models were evaluated against the 165 ground-control image measurements: a frame model (collinearity through the exterior orientation) and an orthophoto model (the inverse of the supplied affine world file, mapping ground position to pixel independently of height).

Model	Median residual	Max
Frame (collinearity, exterior orientation)	2.4 px	83 px
Orthophoto (world file)	49.9 px (17.8 m)	270.7 px (96 m)

The frame model fits roughly $20\times$ better. The world-file residual correlates with terrain relief and, read as relief displacement, implies a flying height consistent with the true ≈ 4.9 km above ground. The Level-03 products are therefore perspective frames; the world file is a nominal-elevation quicklook georeference that leaves tens of metres of uncorrected relief displacement. The true orthophoto is the separate DTMOtho product.

4. PAN / colour co-registration

The 0.150 m colour strip and 0.356 m panchromatic frame for a common exposure were resampled to a shared 0.5 m grid through their world files and compared over their full overlap. Global normalised cross-correlation is **0.984** with a residual offset of 0.064 m (E) / 0.051 m (N) — ≈ 0.08 m total, 0.16 px at the test grid, below the resampling noise floor. Sharing the orientation and the same frame perspective, panchromatic and colour are geometrically locked: any orientation refinement shifts them identically.

5. Implications

Because all Level-03 products are perspective frames sharing one orientation per exposure, an independent bundle adjustment that refines that orientation applies to every product at once. The independent solution for this block — image σ_0 **0.93 px** against the factory 1.87 px, fitted-control ground RMS 0.044 / 0.042 / 0.053 m — is below the factory image-space figure, so an AT-driven re-orthorectification supersedes the quicklook world-file georeference and the colour products inherit panchromatic accuracy without additional geometric loss.

The full accuracy comparison for this block is reported separately (Independent AT & Orthorectification of UltraCam Condor 4.1 Imagery). The delivered Condor 4.1 Gleisdorf dataset is public; no confidential or client data is involved.