Person 1
Four independent reconstructions

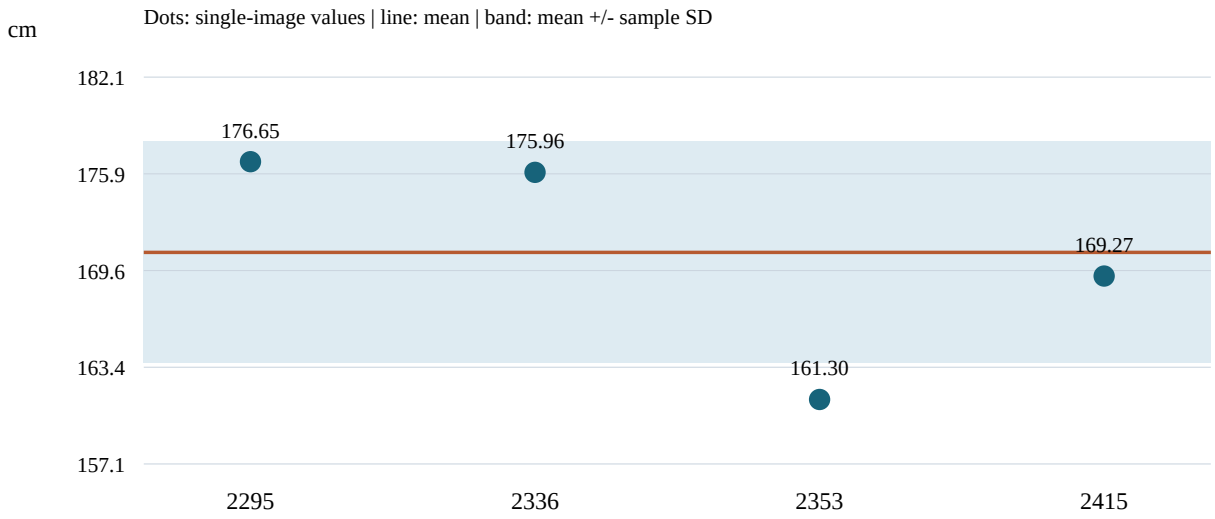
Fixed-camera reconstruction and comparative measurement report | 16 September 2026

Mean uncorrected model height: 170.8 cm. The sample standard deviation across the four independently fitted images is **7.2 cm** (n = 4). Each image starts with generic dimensions and receives its own morphology and pose. The already reconstructed camera is reused unchanged.

This result is an external support-to-head model endpoint. It is not corrected barefoot anatomical stature. The standard deviation describes disagreement between four image-based model fits; common camera, scan and model errors are not removed by averaging.

Material limitation: several dimensions reach their allowed bounds. Image 2353 is especially sensitive to arm and knee assumptions and retains relatively long legs and short arms. These four completed model fits do not establish accurate anatomical segment lengths or a unique person height.

Image	Height (cm)	Body landmark RMS (px)	Saved geometry
2295	176.65	6.92	PASS
2336	175.96	7.70	PASS
2353	161.30	14.78	PASS
2415	169.27	10.58	PASS



Four conditional height estimates. Shading shows descriptive mean +/- one sample SD, not an uncertainty interval.

Review status: conditional model plausibility accepted; independent human expert review not completed and required. Hidden joint locations, clothing, hair and footwear remain unresolved. Original evidence and the preceding joint-fit reconstruction are preserved.

1. Scope, evidence and independent protocol

The user requested four fresh single-image reconstructions while retaining the previously recovered camera. This deliberately replaces shared-morphology fitting with four separate morphology vectors. No previous body dimensions, fitted poses or resulting height were imported. Source observations were re-inspected, with small elbow-center corrections recorded before fitting. Equal left/right dimensions remain a within-model symmetry assumption; no dimensions are shared between images.

Inputs comprise four 1920 x 1080 JPEGs, the distorted reference photograph and 19,802,377 registered E57 points from Person 1, plus the supplied 41-page workflow PDF. The workflow was read in the preceding reconstruction; its example heights were excluded from inference. Its scene calibration, ergonomic positioning, support review and endpoint-correction principles inform this work. Automatic triangulation, generic anatomy bounds and optimization penalties are experimental implementation choices.

Original source	SHA-256
Referenzaufnahme.jpg	741d6d577753297a459e5e7e89599b3f2d07adef341267af19857cc8f41f9b4a
Tatort_19MioPunkte.e57	65f7207aeb32cef3b9ef065f99153989c3c6d235303510529af7f5da1f3f026e
Workflow_Taeterhoehenberechnung.pdf	049746f98cd22d2b34a32ddc2730174bc3dc838dfd96c79b646e0f5f6980acf1
Projekt_0577_2295.jpg	690d8140dc9709088c3a249fac83977b7db37b36415727df633052aa4ba5d90f
Projekt_0577_2336.jpg	22abb52acb9dd0d8f61d438a78480185fac816f3a0fdbe9557eae3309936da36
Projekt_0577_2353.jpg	d27f168cb7e28a00a70c2a1136e065435fd9eaf2a10027795d51b17fd11979f0
Projekt_0577_2415.jpg	626ec20f3b8948afb0ef10cbd93645d31784227f7a0fbd9769156f83e33c9175

The four camera locks are byte-identical to the accepted preceding lock. Camera pose, focal length, principal point, radial distortion, raster and scan scale were never fitting variables. Each run records calibration_executed=false in camera_reuse_provenance.json. Existing calibration reviews retain their original identity and dates; they were not fabricated anew.

2. Previously performed camera reconstruction

The earlier camera solution was estimated blind from corresponding physical targets in the original photograph and measured scan, without an old camera export. Image corners and scan plane/RGB junctions were localized; target identity was reviewed. The solver tested focal/pose hypotheses with PnP/RANSAC, then robust nonlinear refinement and progressively richer camera models. Models B-E were compared using held-out targets. Those targets were excluded from fitting but used for model selection, so they are not an untouched final validation set.

Selected parameter	Value
Model	E
Raster	1920 x 1080 px
Focal length fx = fy	1615.433500 px
Principal point cx, cy	954.803396, 541.526999 px
Brown radial k1, k2	[0.11970255824884317, -0.20574106218044766]
Camera center, registered metres	[0.6675543641748874, -0.6614783363765167, 0.8199904875696684]
Camera lock SHA-256	1e17e74433278805f2dcfc6493579175595165169957f3d81a348e14edde0ce8

Square pixels and zero skew are fixed. Radial mapping uses x_d = x(1 + k1 r^2 + k2 r^4), and similarly for y, in normalized camera coordinates. Tangential distortion is not fitted. Blender cameras are pinhole; original-raster overlays apply the recorded radial mapping. Editable scenes pack a derived pinhole background, avoiding a second undistortion of the original images.

World-to-camera Rodrigues rotation vector (radians): [1.8960192387113892, 0.7070624389685489, -0.4357144248804053]. The complete world-to-camera rotation matrix and translation are retained in camera_lock.json. Global scan coordinates are metres with Z up; projection uses OpenCV camera axes before the explicit Blender conversion. No physical sensor size was independently measured: the Blender 36 mm sensor is a conversion convention paired with its equivalent focal length.

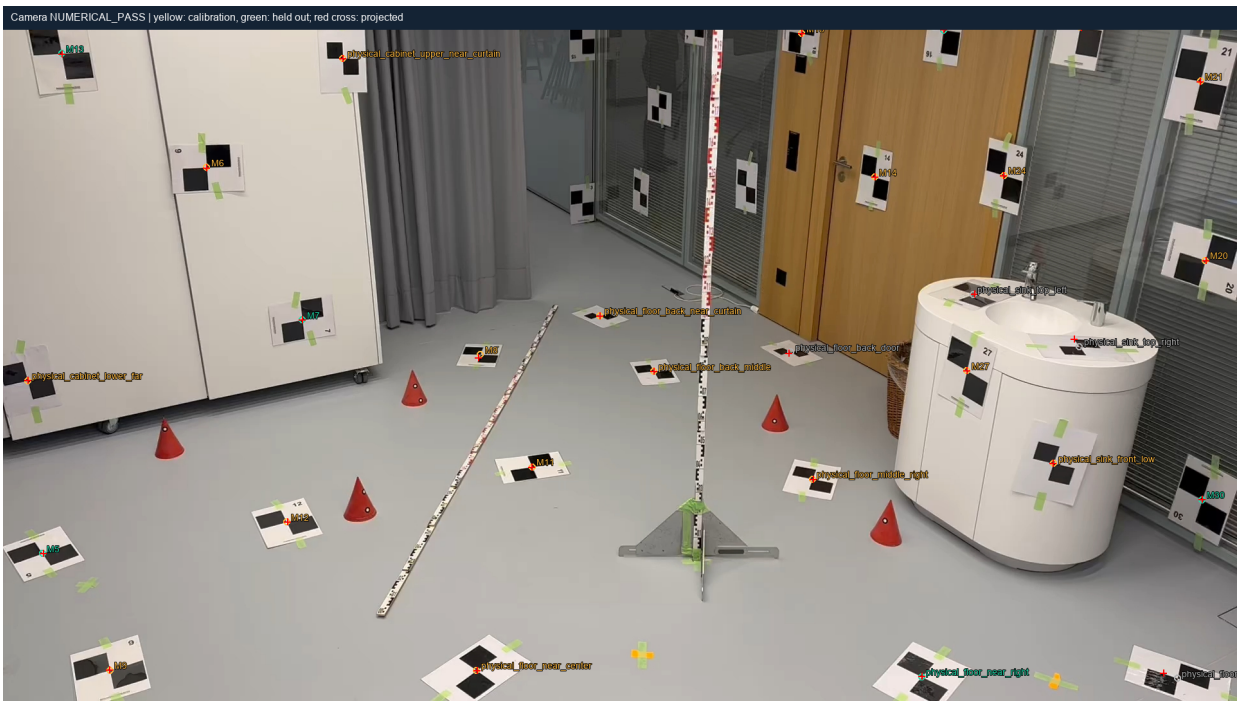


Figure 1. Previously recorded physical target observations and camera projections on the unchanged reference.

2.1 Camera residuals and actual-scene agreement

Model	Calibration RMS (px)	Held-out RMS (px)	Held-out max (px)	Gate
B	2.501	2.328	4.186	FAIL
C	2.275	3.294	6.408	FAIL
D	1.995	1.754	2.548	PASS
E	1.608	0.880	1.459	PASS

Selected model E has held-out RMS 0.880 px and maximum 1.459 px across six targets. Eighteen targets entered robust calibration; M8 was rejected during refinement at 6.099 px. Four doubtful observations were disabled. The all-calibration RMS (1.608 px) includes the rejected target; the refined inlier RMS is about 0.814 px. Residuals quantify image agreement conditional on target identity, localization and this model, not camera accuracy in metres.

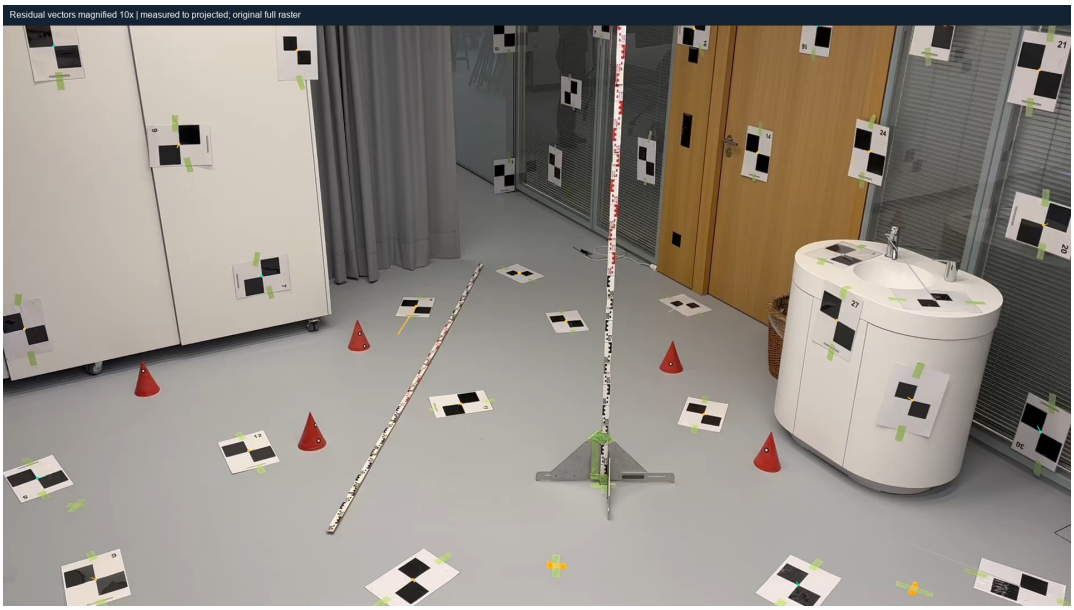


Figure 2. Previously computed marker residuals, including retained rejected and disabled diagnostics.



Figure 3. Actual scan triangles projected onto the reference. Surface holes and incomplete reflective objects remain explicit.

2.2 Camera transfer, stability and accuracy limits

Frame	Background matches	Unwarped RMS (px)	95th percentile (px)
2295	81	1.914	4.497
2336	50	2.654	4.676
2353	79	2.145	4.784
2415	100	1.710	3.244

Acquisition confirmation and unchanged room features support using the same physical camera and raster for all four originals. Diagnostic matching homographies were used to assess correspondence, not to warp the evidence. Systematic edge shifts approaching five pixels remain. These frame-transfer residuals differ from camera target residuals and from body-joint residuals.

Twenty marker-subset camera fits passed the earlier stability checks. Monte Carlo camera uncertainty was not run because complete independent 2D/3D localization uncertainty was absent. Blender numerical/render projection agreement is approximately 0.00012 px; it checks implementation consistency and does not imply that the recovered camera is accurate to that level.

Frame	Floor displacement / 1 pixel	Max subset floor shift
2295	2.51-4.86 mm	3.32 mm
2336	2.37-4.63 mm	4.24 mm
2353	2.36-4.57 mm	4.31 mm
2415	2.36-4.51 mm	3.04 mm

These earlier probes intersect perturbed contact rays with the same measured floor. They describe placement sensitivity only and cannot be added to a height error bar. Scan scale and registration have no independent uncertainty certificate in the supplied data.

3. Reconstruction and joint-placement method

Each single-image run begins with the persistent generic 23-bone rig and canonical dimensions. The initial floor position comes from camera rays intersecting measured support triangles. The seven stages fit global placement, feet, lower body, torso, arms, morphology and whole-body refinement. Dimensions remain fixed until the morphology stage; height changes then follow changes in segment lengths rather than an independent height slider.

At each checkpoint the saved Blender model is reopened. Evidence/skeleton overlays, front, both sides, oblique, top and contact views are inspected. Side views test otherwise hidden depth; they are not additional observed evidence. A low objective or good 2D joint match is insufficient: unsupported squats, folded arms, skin intersections and foot penetration trigger recorded revisions. All earlier candidates are retained.

Image landmarks describe estimated internal joint centers, not jacket or trouser edges. Confidence is reduced for padding and blur. Fully hidden hips and other occluded joints have null pixels and no image residual. Anatomical left/right are recorded explicitly because legacy rig L corresponds to anatomical right. Joint audit figures compare actual saved-model projections against source observations and localization ellipses.

The optimization minimizes robust, confidence-weighted image residuals plus measured-floor contact errors, broad proportions, explicit pose priors, approximate collision terms and weak minimum-change regularization. The latter stabilizes underdetermined directions; it is not evidence. Actual mesh intersection tests follow optimization. Pose revisions retain source pixels unless a separately recorded source reinspection justifies a change.

Check	Meaning
Joint projections	Observed shoulder/elbow/wrist/knee/ankle centers compared with actual saved landmarks.
Sole support	Evaluated skin near required heel/toe contacts; 5 mm contact and 10 mm penetration thresholds.
Self/scene intersections	Actual skinned triangles tested; missing scan surfaces remain unknown.
Rig consistency	Saved bone lengths, full-frame FK, unit scale and fixed-camera parity.
Neutral measurement	Identical-morphology copy, pose neutralized without scaling; both vertical chains audited.

Correct placement here means image-consistent and conditionally plausible articulation. The true positions of clothed or hidden anatomical pivots cannot be certified from these photographs. The companion iteration journal records the evidence, change and observed consequence at each decision.

4.1 Image 2295 - independent reconstruction

Upright stepping pose with one bent knee and a visible near forearm. The far elbow is hidden.



Figure 4. Unchanged source photograph, scaled only for this report.



Figure 5. Final independently fitted body over the original distorted raster.

Conditional external model height: **176.65 cm**. Landmark RMS: 6.92 px. Saved geometry passes; this does not identify a unique anatomical solution.

Image 2295 - joint placement and residuals



Figure 6. Yellow: observed centers and stated localization scales. Cyan: actual saved joints. Red: residual vectors. Hidden joints are excluded.

Anatomical landmark	Visibility	Residual (px)	Residual / scale
top_of_head	uncertain	1.19	0.12
head_center	uncertain	13.74	0.81
neck_base	uncertain	5.61	0.31
shoulder_R	uncertain	8.03	0.47
shoulder_L	uncertain	13.74	0.62
elbow_R	uncertain	1.05	0.07
wrist_R	uncertain	1.25	0.14
hand_R	uncertain	1.35	0.13
wrist_L	uncertain	0.00	0.00
knee_R	uncertain	9.97	0.55
knee_L	uncertain	4.24	0.26
ankle_R	uncertain	3.40	0.34
ankle_L	uncertain	3.84	0.38
elbow_L	occluded	Not observed	-
pelvis	occluded	Not observed	-
hip_L	occluded	Not observed	-
hip_R	occluded	Not observed	-

Normalized residual is the length of the x/y residual vector after division by the stated localization scales. The scales are elicited assumptions; they are not calibrated confidence regions. Residuals alone do not validate hidden joint depths.

Image 2295 - three-dimensional and support checks

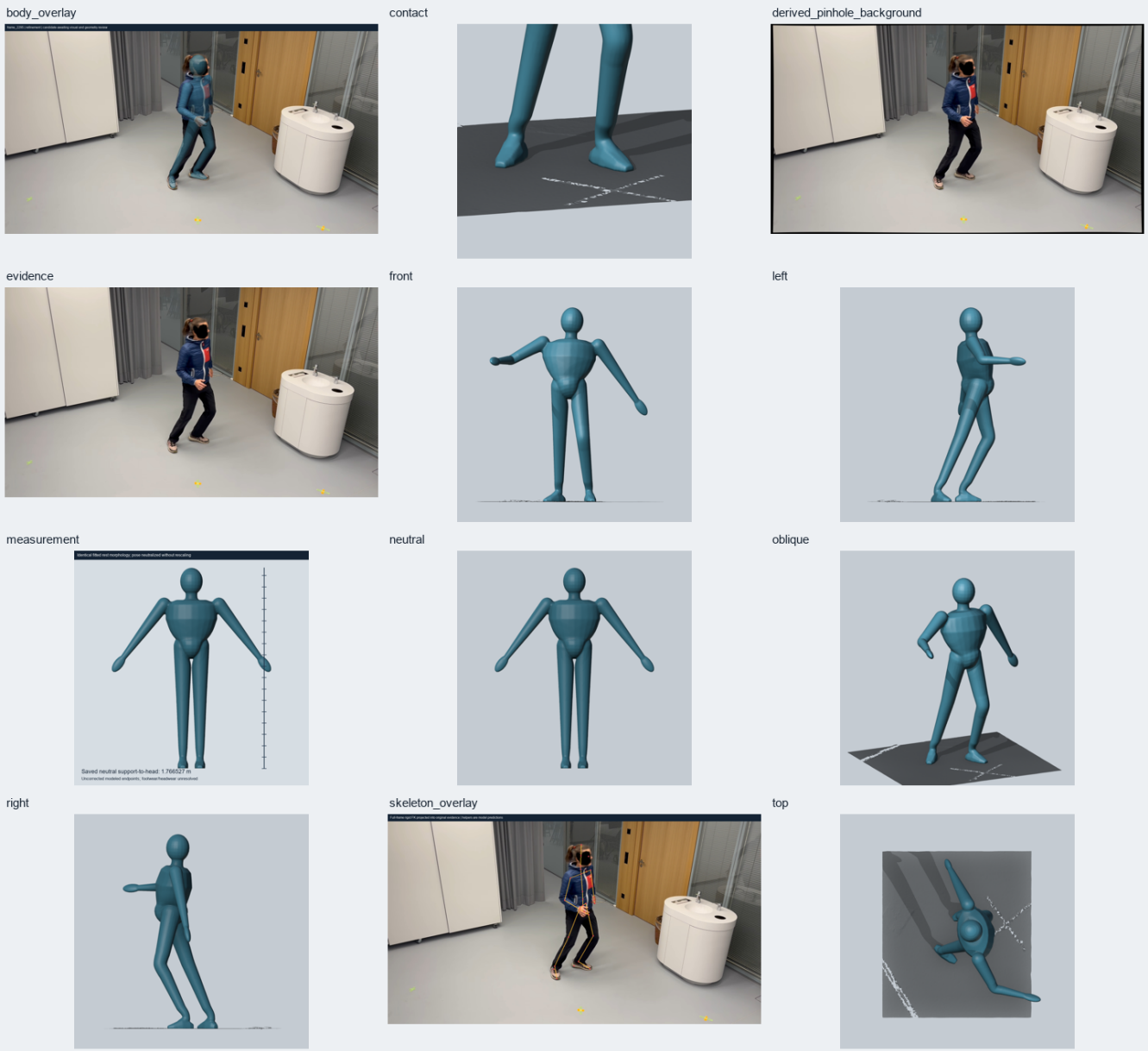


Figure 7. Evidence, skeleton, front, both sides, oblique, top, contact and unscaled neutral views. Unobserved views test plausibility only.

Saved check	Result
Self-intersection pairs	0
Disallowed scan crossings	0
Minimum signed sole gap, rig L / R	-0.192 mm / -0.555 mm
Projection implementation error	0.000109 px

Image 2295 - dimension changes and decisions

Stage / attempt	Decision	Neutral endpoint (cm)	Change (cm)
global_00	ACCEPT	168.50	-
feet_00	ACCEPT	168.50	+0.00
lower_00	ACCEPT	168.50	+0.00
torso_00	ACCEPT	168.50	+0.00
arms_00	REFINE	168.50	+0.00
arms_01	ACCEPT	168.50	+0.00
morphology_00	ACCEPT	176.65	+8.15
refinement_00	ACCEPT	176.65	-0.00

Intermediate endpoints are iteration diagnostics, not separate accepted stature measurements. Early stages preserve generic lengths. Changes after morphology fitting reflect this image and its pose assumptions; no target height or cross-image mean guided fitting.

arms_00 / REFINE: All views inspected. Near elbow/wrist/hand pixel errors fall to about 1.6/2.3/2.6 px, but the saved skin has 43 self-intersection pairs. Read-only collision localization places the inspected pairs at the near upper-arm/forearm junction. Good joint projection does not override invalid skin. Add a moderate elbow-bend regularizer to explore a less folded depth solution while preserving observed joint pixels. This is a limitation of the generic skin and an explicit pose assumption, not evidence that the photographed elbow has that exact angle. Its effect on dimensions must remain visible in the report.

morphology_00 / ACCEPT: Inspected all twelve panels, including source, skeleton, both sides, neutral and contact views. Saved geometry passes all twelve checks with zero detected self/scan intersections. Supported stepping pose and joint chains remain feasible; proceed to final numerical refinement. This is a conditional experimental candidate, not verified anatomy: tibia reaches its 53 cm upper bound, pelvis width 15 cm and neck 3.5 cm lower bounds, and shoulder width 49 cm upper bound. Near shoulder, hidden far shoulder and head-center residuals remain visible. Do not conceal these limitations or interpret the small crown residual as height accuracy.

refinement_00 / ACCEPT: Inspected all twelve final panels and full-resolution actual-joint residual overlay. Observed joints lie within their stated localization scales; hidden far elbow remains unconstrained. All saved geometry checks pass, with supported feet and no detected self/scan crossings. Proceed to alternate-start and localization checks. Refinement changes height by less than 0.001 cm. Broad shoulders, narrow pelvis and long tibia at active bounds remain material model limitations. Accept conditional pose plausibility only, not uniquely correct anatomy or validated stature accuracy.

4.2 Image 2336 - independent reconstruction

Deep forward bend toward the sink. Perspective foreshortening, hair and jacket volume obscure head and shoulder anatomy.



Figure 8. Unchanged source photograph, scaled only for this report.

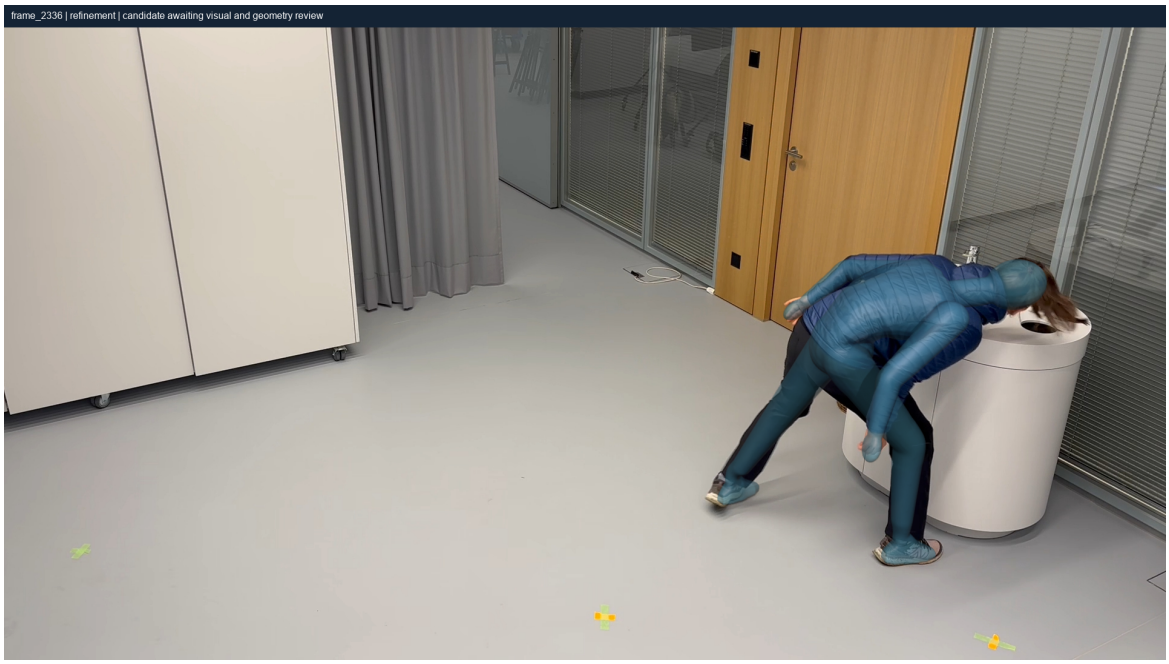


Figure 9. Final independently fitted body over the original distorted raster.

Conditional external model height: **175.96 cm**. Landmark RMS: 7.70 px. Saved geometry passes; this does not identify a unique anatomical solution.

Image 2336 - joint placement and residuals



Figure 10. Yellow: observed centers and stated localization scales. Cyan: actual saved joints. Red: residual vectors. Hidden joints are excluded.

Anatomical landmark	Visibility	Residual (px)	Residual / scale
head_center	uncertain	0.84	0.04
top_of_head	uncertain	7.27	0.29
shoulder_R	uncertain	15.41	0.70
shoulder_L	uncertain	1.95	0.08
elbow_R	uncertain	7.23	0.43
wrist_R	uncertain	1.25	0.12
hand_R	uncertain	4.04	0.34
elbow_L	uncertain	11.27	0.63
wrist_L	uncertain	2.56	0.26
knee_R	uncertain	4.44	0.25
knee_L	uncertain	12.06	0.60
ankle_R	uncertain	8.20	0.82
ankle_L	uncertain	6.24	0.52
pelvis	occluded	Not observed	-
hip_L	occluded	Not observed	-
hip_R	occluded	Not observed	-
neck_base	occluded	Not observed	-

Normalized residual is the length of the x/y residual vector after division by the stated localization scales. The scales are elicited assumptions; they are not calibrated confidence regions. Residuals alone do not validate hidden joint depths.

Image 2336 - three-dimensional and support checks



Figure 11. Evidence, skeleton, front, both sides, oblique, top, contact and unscaled neutral views. Unobserved views test plausibility only.

Saved check	Result
Self-intersection pairs	0
Disallowed scan crossings	0
Minimum signed sole gap, rig L / R	-0.246 mm / -0.151 mm
Projection implementation error	0.000164 px

Image 2336 - dimension changes and decisions

Stage / attempt	Decision	Neutral endpoint (cm)	Change (cm)
global_00	ACCEPT	168.50	-
feet_00	ACCEPT	168.50	+0.00
lower_00	ACCEPT	168.50	+0.00
torso_00	ACCEPT	168.50	+0.00
arms_00	REFINE	168.50	+0.00
arms_01	ACCEPT	168.50	+0.00
morphology_00	ACCEPT	175.96	+7.46
refinement_00	ACCEPT	175.96	+0.01

Intermediate endpoints are iteration diagnostics, not separate accepted stature measurements. Early stages preserve generic lengths. Changes after morphology fitting reflect this image and its pose assumptions; no target height or cross-image mean guided fitting.

arms_00 / REFINE: All views inspected. Near-arm pixels fit closely, but about -95 degrees of upper-arm axial twist produces 169 self-intersection pairs. Collision inspection localizes the first pairs within the near upper arm. Side views also show the arm folded backward near the pelvis. Regularize upper-arm twist toward an untwisted frame and allow the upper arm to move forward/outward so the elbow and hand clear the torso/thigh. Retain all observed joint pixels and generic dimensions; document the added clearance assumptions.

morphology_00 / ACCEPT: Inspected source and all twelve review panels. Bent trunk, front knee and extended rear leg are compatible with the photographed action; saved joint chains, actual support and skin tests all pass with zero detected self/scan intersections. Proceed to refinement with the camera unchanged. The long fitted neck and lower-bound pelvis, forearm, hand and foot dimensions reveal weak morphological identification. Shoulder and knee residuals remain nonzero. The hidden arm depth is regularized, not observed; these dimensions cannot be described as independently accurate anatomy.

refinement_00 / ACCEPT: Inspected all twelve panels and full-resolution actual-joint residual overlay. Bent-pose articulation and visible joint projections remain consistent with the observations; all saved geometry checks pass. Refinement changes the neutral endpoint by about 0.008 cm. Proceed to alternatives. Lower-bound forearm, hand, foot and pelvis and the long neck remain weakly identified. Hair and forward head posture limit cranial endpoint interpretation. Conditional model acceptance does not certify true anatomical pivot positions.

4.3 Image 2353 - independent reconstruction

Moderate forward bend and a flexed near knee. Motion blur particularly affects the moving near arm and cranial envelope.



Figure 12. Unchanged source photograph, scaled only for this report.



Figure 13. Final independently fitted body over the original distorted raster.

Conditional external model height: **161.30 cm**. Landmark RMS: 14.78 px. Saved geometry passes; this does not identify a unique anatomical solution.

Image 2353 - joint placement and residuals



Figure 14. Yellow: observed centers and stated localization scales. Cyan: actual saved joints. Red: residual vectors. Hidden joints are excluded.

Anatomical landmark	Visibility	Residual (px)	Residual / scale
head_center	uncertain	19.76	0.82
top_of_head	uncertain	5.36	0.21
shoulder_R	uncertain	19.18	0.77
shoulder_L	uncertain	31.36	1.43
elbow_R	uncertain	13.15	0.53
wrist_R	uncertain	8.87	0.40
hand_R	uncertain	4.72	0.21
elbow_L	uncertain	12.04	0.55
wrist_L	uncertain	6.92	0.46
knee_R	uncertain	10.74	0.54
knee_L	uncertain	18.79	0.85
ankle_R	uncertain	5.73	0.48
ankle_L	uncertain	10.13	0.84
pelvis	occluded	Not observed	-
hip_L	occluded	Not observed	-
hip_R	occluded	Not observed	-
neck_base	occluded	Not observed	-

Normalized residual is the length of the x/y residual vector after division by the stated localization scales. The scales are elicited assumptions; they are not calibrated confidence regions. Residuals alone do not validate hidden joint depths.

Image 2353 - three-dimensional and support checks



Figure 15. Evidence, skeleton, front, both sides, oblique, top, contact and unscaled neutral views. Unobserved views test plausibility only.

Saved check	Result
Self-intersection pairs	0
Disallowed scan crossings	0
Minimum signed sole gap, rig L / R	-0.102 mm / -0.366 mm
Projection implementation error	0.000086 px

Image 2353 - dimension changes and decisions

Stage / attempt	Decision	Neutral endpoint (cm)	Change (cm)
global_00	ACCEPT	168.50	-
feet_00	ACCEPT	168.50	+0.00
lower_00	REFINE	168.50	+0.00
lower_01	ACCEPT	168.50	+0.00
torso_00	ACCEPT	168.50	+0.00
arms_00	REFINE	168.50	+0.00
arms_01	REFINE	168.50	+0.00
arms_02	REFINE	168.50	+0.00
arms_03	REFINE	168.50	+0.00
arms_04	ACCEPT	168.50	+0.00
morphology_00	REFINE	173.76	+5.26
morphology_01	REFINE	171.81	-1.95
morphology_02	REFINE	167.34	-4.47
morphology_03	ACCEPT	161.31	-6.03
refinement_00	ACCEPT	161.30	-0.01

Intermediate endpoints are iteration diagnostics, not separate accepted stature measurements. Early stages preserve generic lengths. Changes after morphology fitting reflect this image and its pose assumptions; no target height or cross-image mean guided fitting.

lower_00 / REFINE: Side and oblique inspection shows the rear knee now flexed about 42 degrees. Its residual increased to 33.41 px, while the original image shows a relatively extended rear leg. Although mesh checks pass and the head is closer, this compensation weakens joint placement. Add a broad moderate rear-knee-flexion and rear-hip-direction constraint from the original stance, keeping source pixels unchanged. This addresses pose ambiguity before dimensions are released.

arms_00 / REFINE: Although actual geometry passes, side/oblique views show the near forearm directed backward away from the thigh and about -110 degrees of upper-arm axial twist. The original blurred arm hangs down beside the near thigh. A near-perfect 2D joint projection has selected an unsupported depth branch. Add broad near-arm twist, forward-flexion and outward-clearance assumptions and moderate elbow flexion. Preserve joint pixels and confidence scales; judge the revised three-dimensional placement before changing dimensions.

arms_01 / REFINE: All saved geometry checks pass, but all-view inspection still reveals a backward-projecting near arm inconsistent with its visible hanging position beside the thigh. Near elbow residual is 36.1 px, wrist 16.8 px and hand 37.2 px. A geometry pass alone is insufficient. Strengthen the explicitly assumed forward arm-direction and clearance regularizers, retaining original joint observations, generic dimensions and fixed camera. The selected angular targets are plausible depth assumptions, not measured angles; record their influence in the final limitations.

arms_02 / REFINE: The near arm now points downward in side view, but evaluated skin has 642 self-intersection pairs. Triangle localization identifies near forearm against near thigh, matching the visible model overlap. This candidate is rejected regardless of its improved depth direction. Increase explicit near-arm lateral clearance and restrain axial twist while leaving observed joints, camera and generic dimensions unchanged. These stronger regularizers express a skin-feasibility assumption; they must be disclosed and reviewed again once morphology is free.

Image 2353 - dimension changes and decisions (continued)

arms_03 / REFINE: All twelve panels inspected. Actual skin clearance now passes, but the near arm again extends backward almost horizontally instead of hanging beside the thigh. The generic shoulder is still displaced by 38.9 px and elbow by 45.8 px. This is not acceptable as the final arm pose. Retain the successful lateral-clearance regularizer and strengthen the explicit forward-direction assumption. This is a recorded modeling choice needed to avoid an unsupported depth solution, not measured 3D evidence. Morphology remains generic at this stage and will be fitted independently next.

morphology_00 / REFINE: All twelve panels inspected. The fitted trunk/head/arms shrink to multiple lower bounds, leaving a visibly disproportionate neutral model, and actual skin has 154 self-intersections. Triangle diagnosis locates far upper-arm/forearm and thorax folds. This checkpoint is rejected. The strong near-arm angular constraints introduced for generic-shape clearance are over-influential once morphology is free. Relax them to broad direction/clearance preferences and add moderate far-arm clearance/twist constraints for the measured collision. Preserve source joint pixels, camera and all historical checkpoints. This revision addresses articulation and prior bias, not a desired height.

morphology_01 / REFINE: All twelve panels inspected. Saved geometry now passes, but the neutral model still has a disproportionately short trunk and arms with long legs, and eight dimensions hit lower bounds. A numerical geometry pass does not resolve this implausible allocation of length. The near elbow is nearly straight despite a visible sleeve-direction change. Test moderate elbow flexion and release the over-specific upper-arm forward direction/axial restriction, keeping all original joint pixels. Exact 3D angles remain assumed; assess the resulting joint fit and full neutral proportions without using a target height.

morphology_02 / REFINE: All twelve panels inspected. The elbow/wrist residuals improve to 10.7/9.4 px, but actual near-elbow skin has fifteen folds; triangle localization confirms humerus/forearm intersections. Reject this candidate. The near knee is relatively straight at 22.6 degrees while the source shows a distinct bend; the hidden pelvis remains high and trunk remains at its lower bound. Add a moderate knee-flexion regularizer and slightly reduce elbow flexion to address actual skin folds. These are explicit pose assumptions, not measured angles or a height target.

morphology_03 / ACCEPT: All twelve panels inspected. Moderate near-knee flexion lowers the modeled pelvis and improves its knee residual to 10.7 px; reduced elbow flexion removes the fifteen actual skin folds. All saved geometry checks now pass. Near elbow/wrist errors are 13.2/8.9 px. Proceed to final numerical refinement. This remains a weakly identified, pose-sensitive morphology: trunk, pelvis, forearm, hand and foot are at lower bounds and the neutral model has relatively long legs and short arms. Far shoulder error remains 31.4 px under clothing. Accept the feasible articulated candidate conditionally, not as established anatomical proportions; report the bound dependence and large changes across rejected iterations explicitly. No height agreement with other images is required or used.

refinement_00 / ACCEPT: All twelve final panels and full-resolution saved-joint overlay inspected. Near elbow, wrist and knee align within their stated localization scales; far shoulder remains about 31 px away under clothing. Feet contact the actual support and all twelve saved geometry checks pass with zero detected intersections. Proceed to alternatives. Final refinement changes the endpoint by about -0.008 cm. Conditional articulated-pose plausibility is accepted, while anatomical dimensions remain poorly identified: trunk/pelvis/forearm/hand/foot sit at lower bounds and prior changes produced substantial dimension changes. Retain this independently obtained result without adjusting toward other frames; report the limitations prominently.

4.4 Image 2415 - independent reconstruction

Rear-facing spread stance. Hidden far wrist, trouser volume and motion blur create substantial depth ambiguity.



Figure 16. Unchanged source photograph, scaled only for this report.

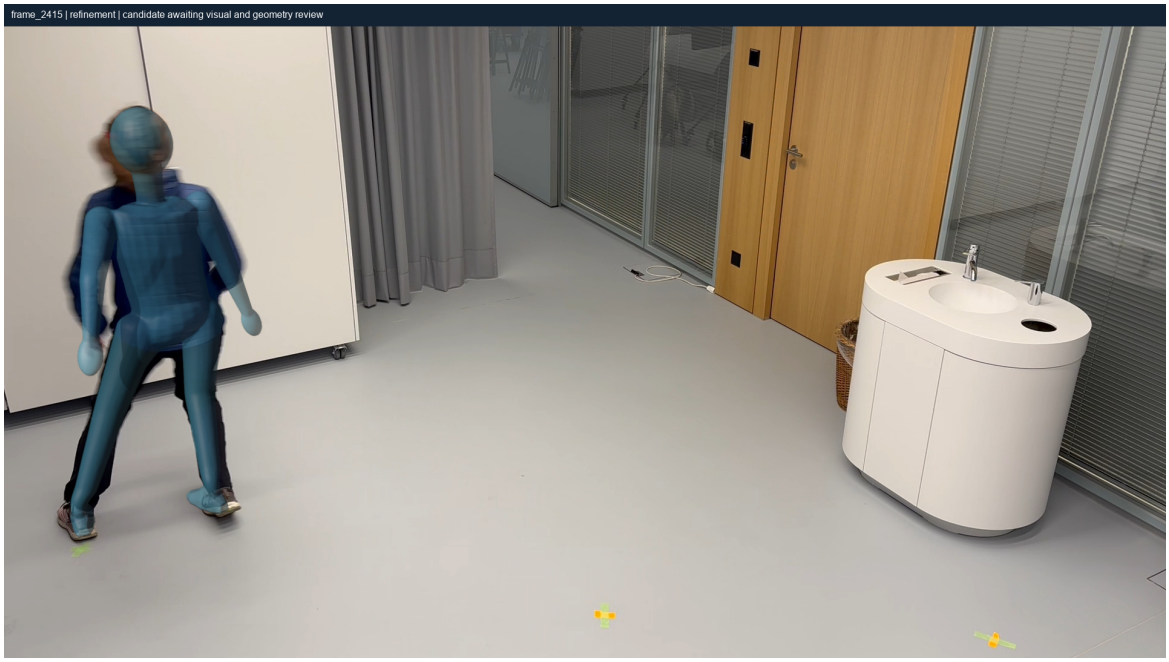


Figure 17. Final independently fitted body over the original distorted raster.

Conditional external model height: **169.27 cm**. Landmark RMS: 10.58 px. Saved geometry passes; this does not identify a unique anatomical solution.

Image 2415 - joint placement and residuals



Figure 18. Yellow: observed centers and stated localization scales. Cyan: actual saved joints. Red: residual vectors. Hidden joints are excluded.

Anatomical landmark	Visibility	Residual (px)	Residual / scale
top_of_head	uncertain	2.49	0.14
head_center	uncertain	2.22	0.10
neck_base	uncertain	8.59	0.39
shoulder_L	uncertain	13.40	0.67
shoulder_R	uncertain	14.65	0.73
elbow_L	uncertain	17.18	0.86
elbow_R	uncertain	1.46	0.07
wrist_L	uncertain	7.40	0.44
knee_L	uncertain	12.06	0.55
knee_R	uncertain	17.79	0.81
ankle_L	uncertain	4.71	0.36
ankle_R	uncertain	5.30	0.41
wrist_R	occluded	Not observed	-
hand_R	occluded	Not observed	-
pelvis	occluded	Not observed	-
hip_L	occluded	Not observed	-
hip_R	occluded	Not observed	-

Normalized residual is the length of the x/y residual vector after division by the stated localization scales. The scales are elicited assumptions; they are not calibrated confidence regions. Residuals alone do not validate hidden joint depths.

Image 2415 - three-dimensional and support checks

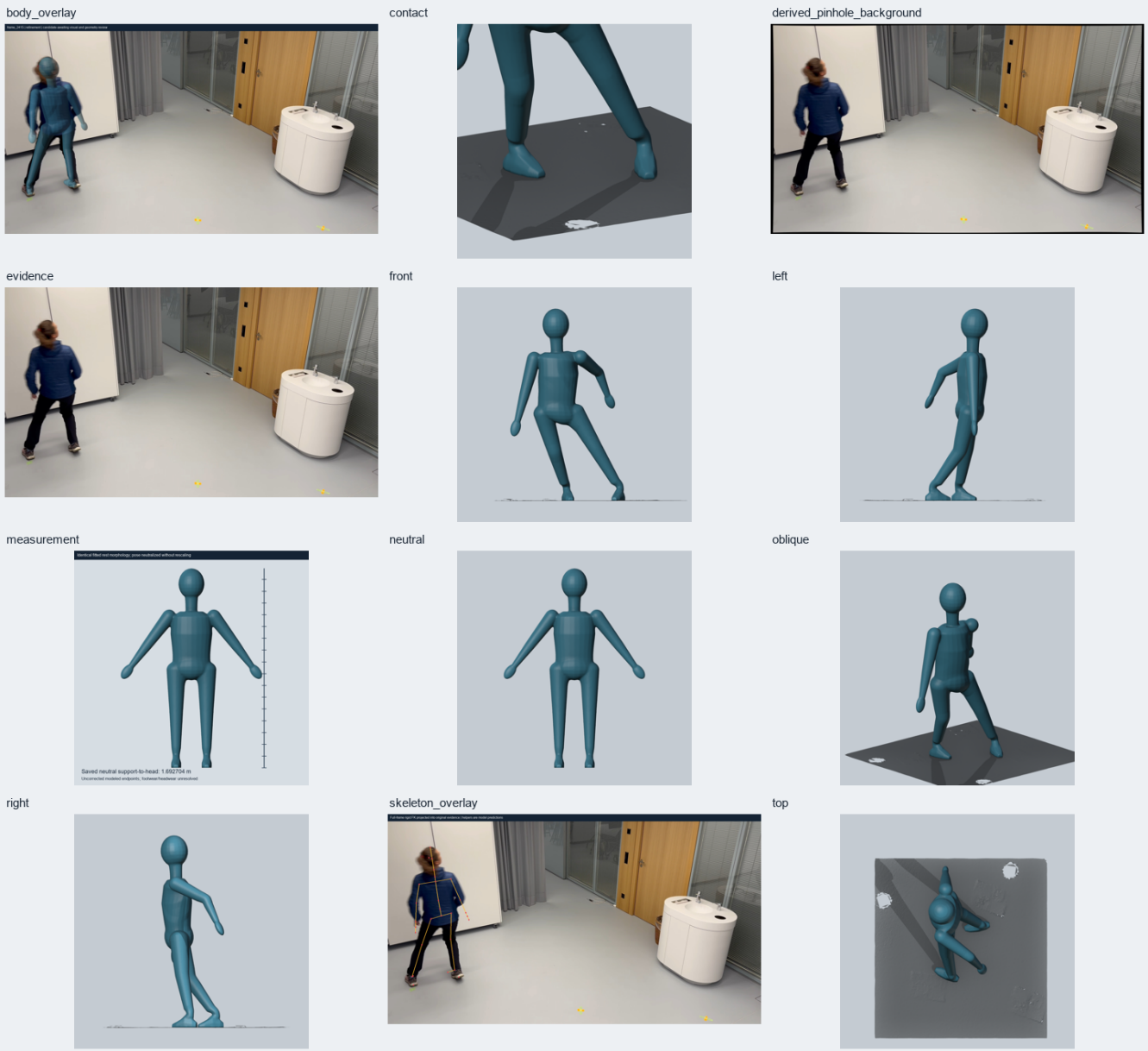


Figure 19. Evidence, skeleton, front, both sides, oblique, top, contact and unscaled neutral views. Unobserved views test plausibility only.

Saved check	Result
Self-intersection pairs	0
Disallowed scan crossings	0
Minimum signed sole gap, rig L / R	-0.218 mm / -0.447 mm
Projection implementation error	0.000131 px

Image 2415 - dimension changes and decisions

Stage / attempt	Decision	Neutral endpoint (cm)	Change (cm)
global_00	ACCEPT	168.50	-
feet_00	REFINE	168.50	+0.00
feet_01	ACCEPT	168.50	+0.00
lower_00	ACCEPT	168.50	+0.00
torso_00	ACCEPT	168.50	+0.00
arms_00	REFINE	168.50	+0.00
arms_01	ACCEPT	168.50	+0.00
morphology_00	ACCEPT	169.27	+0.77
refinement_00	ACCEPT	169.27	+0.00

Intermediate endpoints are iteration diagnostics, not separate accepted stature measurements. Early stages preserve generic lengths. Changes after morphology fitting reflect this image and its pose assumptions; no target height or cross-image mean guided fitting.

feet_00 / REFINE: Side and oblique views expose a deep squat: knees flex about 87.5 and 57.3 degrees despite sub-2 px knee projection errors. The photograph shows a substantially more extended spread stance. There are 94 self-intersection pairs. This demonstrates that correct-looking 2D joint pixels alone do not establish correct 3D articulation. Add broad, explicit near-extension knee and balanced hip-direction assumptions, preserving all observed pixels and generic dimensions. Their exact angles are experimental depth regularization; they are not directly measured from the rear-facing image.

arms_00 / REFINE: All views inspected. The visible near arm has about -169 degrees axial twist and the saved mesh has 88 self-intersection pairs. The photograph supports a modest elbow bend beside the body, not an almost reversed upper-arm frame. Regularize near-arm axial twist toward neutral and retain a broad moderate elbow bend, without inventing the hidden far wrist. Refit pose with all dimensions unchanged.

morphology_00 / ACCEPT: Inspected all twelve review panels. Saved feet are supported and all geometry checks pass without self/scan crossings. Shoulder and knee projections improve with independently fitted dimensions; near elbow remains about 17.2 px from its blurred observation. Proceed to whole-body refinement. The short fitted femur and lower-bound foot length illustrate pose/dimension ambiguity. Near arm depth is plausible but unmeasured. Report all dimensions and their between-image disagreement rather than treating this one view as accurate anatomy.

refinement_00 / ACCEPT: All twelve final panels and actual-joint overlay inspected. All saved geometry checks pass, with no detected self/scan intersections and both feet supported. Visible joint residuals remain within the stated localization scales; near elbow and knee retain appreciable uncertainty. Proceed to alternative starts and localization trials. Height changes by under 0.001 cm from the morphology stage. The short femur, lower-bound foot and unobserved arm depths remain material limitations; acceptance is conditional model plausibility, not anatomical validation.

5. Measurements, mean and standard deviation

All entries below are centimetres. For each measurement x, mean = (x1 + x2 + x3 + x4) / 4 and sample SD = sqrt(sum((xi - mean)^2) / 3). The sample denominator is n - 1. Calculations use unrounded values; displayed rounding does not affect them. No frame is weighted by its apparent agreement or resulting height.

Model measurement	2295	2336	2353	2415	Mean	Sample SD
external height	176.65	175.96	161.30	169.27	170.80	7.15
femur	45.02	45.36	45.78	34.19	42.59	5.61
tibia	53.00	45.57	43.70	40.23	45.63	5.39
trunk	43.06	44.30	32.00	50.83	42.55	7.82
neck	3.50	10.62	10.66	8.62	8.35	3.37
head	23.75	20.07	19.32	26.34	22.37	3.28
pelvis width	15.00	15.00	15.00	25.93	17.73	5.47
shoulder width	49.00	35.74	33.25	38.44	39.11	6.93
upper arm	32.42	27.99	23.13	31.55	28.77	4.22
forearm	25.94	19.00	19.00	21.03	21.24	3.27
hand	14.39	9.00	9.00	12.00	11.10	2.61
foot length	22.76	21.00	21.00	21.00	21.44	0.88
ankle height	8.32	10.04	9.84	9.05	9.31	0.79
leg joint chain	98.02	90.93	89.48	74.42	88.21	9.92
arm joint chain	58.36	46.99	42.13	52.58	50.01	7.01
arm to hand tip	72.74	55.99	51.13	64.58	61.11	9.54
trunk neck head	70.31	74.99	61.98	85.80	73.27	9.94

Left/right segment dimensions are symmetric within each model, so they do not constitute eight independent observations. Pelvis/shoulder widths denote pivot spacing. Head, trunk and ankle dimensions are rig definitions and include unresolved endpoint/model effects. A small SD can reflect common constraints or active bounds, rather than reliable anatomy.

5.1 Definitions and identifiable limits

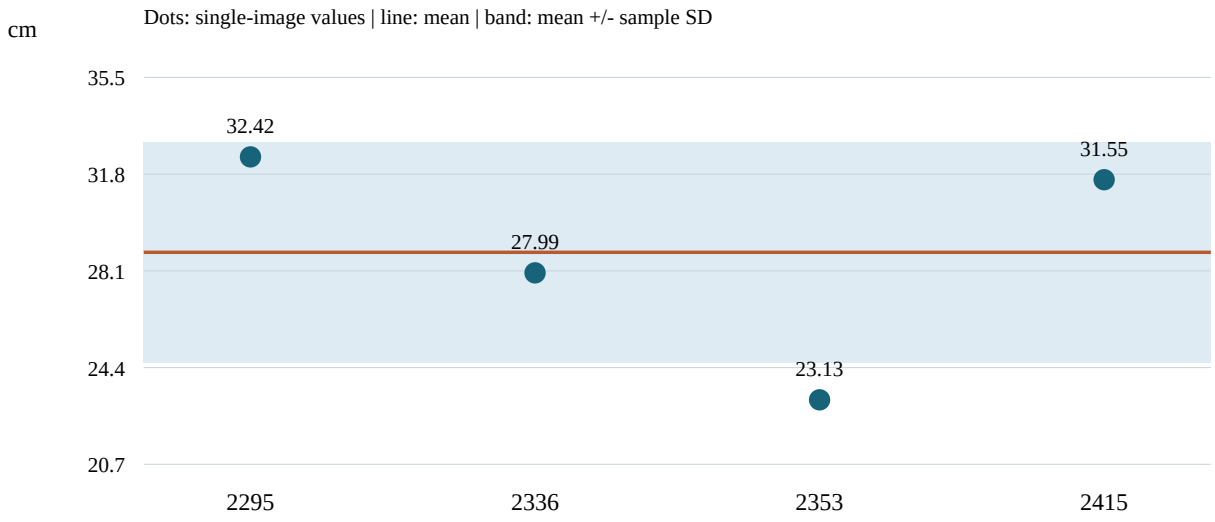
Parameter	Definition	Generic allowed range (cm)
femur	Hip pivot to knee pivot.	30-55
tibia	Knee pivot to ankle pivot.	29-53
trunk	Sum of sacral, lumbar, thoracic and cervical rig segments; not a directly observed anatomical trunk.	32-58
neck	Neck base to modeled skull base.	3.5-11
head	Modeled skull base to external crown proxy.	17.5-26.5
pelvis width	Distance between hip pivots; hidden and weakly constrained.	15-30
shoulder width	Distance between shoulder pivots.	28-49
upper arm	Shoulder pivot to elbow pivot.	23-38
forearm	Elbow pivot to wrist pivot.	19-33
hand	Wrist to modeled hand tip; source hand observation uses the midpoint.	9-18
foot length	Heel-to-toe model extent; distinct from the diagonal foot bone.	21-34
ankle height	Neutral vertical support-to-ankle offset; includes unresolved shoe effects.	5.5-12

Image	Dimensions at an allowed bound
2295	tibia, neck, pelvis_width, shoulder_width
2336	pelvis_width, forearm, hand, foot_length
2353	trunk, pelvis_width, forearm, hand, foot_length
2415	foot_length

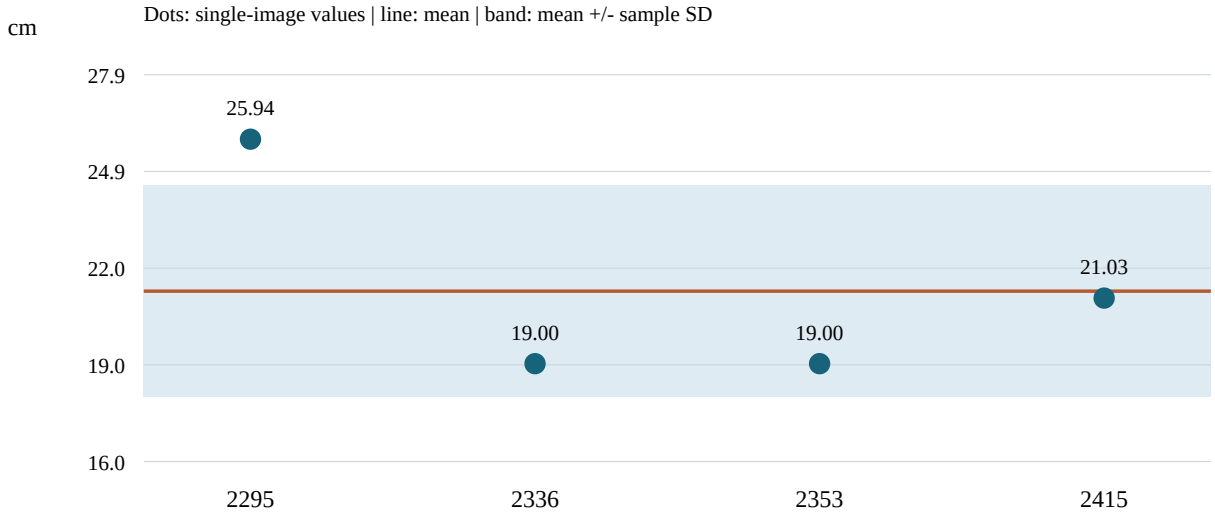
The four models reconstruct one physical person, whose actual lengths do not change between photographs. Disagreement therefore reflects sensitivity to pose, visibility and model assumptions. Averaging summarizes those estimates; it does not demonstrate recovery of the true body. Active bounds and hidden pivots particularly limit interpretation of segment lengths.

Image 2353 required repeated arm-depth and skin-clearance revisions. Strong forward-arm assumptions were relaxed after they drove multiple dimensions to lower limits. Moderate elbow and knee regularizers then improved articulation and source-joint agreement. Its remaining bound-limited dimensions are reported transparently; they are not corrected toward the other images or toward an expected height. This case-specific prior sensitivity is not fully covered by the localization trials.

5.2 Upper-arm and forearm comparison



Upper-arm model length: shoulder to elbow.



Forearm model length: elbow to wrist.

Both plots use the same four independent image solutions, with their own means and sample SDs. Shared camera and skin assumptions remain common errors. Values at an allowed limit must not be treated as directly observed anatomy.

5.3 Actual saved bone lengths

Rig bone	2295	2336	2353	2415	Mean	Sample SD
cervical	5.167	5.316	3.840	6.100	5.106	0.938
clavicle_L	24.500	17.869	16.623	19.220	19.553	3.464
clavicle_R	24.500	17.869	16.623	19.220	19.553	3.464
femur_L	45.016	45.360	45.780	34.189	42.586	5.607
femur_R	45.016	45.360	45.780	34.189	42.586	5.607
foot_L	18.582	18.327	18.217	17.800	18.231	0.326
foot_R	18.582	18.327	18.217	17.800	18.231	0.326
hand_L	14.386	9.000	9.000	12.000	11.096	2.609
hand_R	14.386	9.000	9.000	12.000	11.096	2.609
head	23.755	20.066	19.319	26.343	22.371	3.282
hip_socket_L	7.500	7.500	7.500	12.965	8.866	2.733
hip_socket_R	7.500	7.500	7.500	12.965	8.866	2.733
humerus_L	32.422	27.988	23.133	31.549	28.773	4.221
humerus_R	32.422	27.988	23.133	31.549	28.773	4.221
lumbar	9.473	9.745	7.040	11.184	9.360	1.719
neck	3.500	10.624	10.658	8.625	8.352	3.371
radius_ulna_L	25.937	19.000	19.000	21.026	21.241	3.273
radius_ulna_R	25.937	19.000	19.000	21.026	21.241	3.273
root	4.000	4.000	4.000	4.000	4.000	0.000
sacral	7.751	7.973	5.760	9.150	7.659	1.407
thoracic	20.668	21.262	15.360	24.401	20.423	3.751
tibia_L	53.000	45.575	43.704	40.233	45.628	5.390
tibia_R	53.000	45.575	43.704	40.233	45.628	5.390

These values come from reopened saved Blender files. Legacy L is anatomical right and R is anatomical left. The root is a fixed structural helper, hip_socket and clavicle are pivot links, and the foot bone runs diagonally from ankle to toe. Their lengths are not all anatomical bone lengths or vertical stature contributions. Tiny L/R differences arise from saved floating-point coordinates.

6. Alternatives and error analysis

Image	Generic restarts accepted	Localization runs accepted	Rejected total
2295	3	5	1
2336	3	0	6
2353	3	2	4
2415	3	0	6

Image	Generic restart range (cm)	Accepted localization range (cm)
2295	176.653-176.653 (n=3)	171.342-177.944 (n=5)
2336	175.964-175.965 (n=3)	None accepted
2353	161.240-161.240 (n=3)	172.311-174.700 (n=2)
2415	169.270-169.270 (n=3)	None accepted

Each image was tested with three fresh generic initialization alternatives and six landmark-localization perturbations. Each alternative is inspected and must pass actual saved geometry before entering an accepted computational range. Rejected results remain available and contribute no measurement to the four-image mean. The main estimate is the reviewed final refinement, not a height-selected alternative.

Localization perturbations use the recorded image scales while retaining camera, scan, contact pixels and pose priors. Generic restarts test numerical convergence under the same observations. Neither test exhausts model uncertainty. Where no localization alternative survives, no accepted localization interval exists. Between-image SD is a separate descriptive statistic and cannot replace this missing uncertainty.

Error source	What is measured or tested	What remains unknown
Camera correspondence	Earlier held-out residuals and 20 subsets	Independent localization distributions and true camera error
Image mapping	Unwarped background differences across frames	Systematic per-frame calibration equivalence
Joint localization	Saved-joint residuals and sensitivity trials	True clothed/hidden pivot positions
Scan/support	Actual sample-based triangles and signed sole gaps	Instrument scale uncertainty and missing surfaces
Model/pose	Bounds, alternative starts and all-view inspection	Uniqueness and accuracy of hidden depths
External endpoints	Unscaled neutral support-to-head model	Hair, shoe and barefoot corrections

No combined validated forensic uncertainty or confidence interval is reported. Geometric contact thresholds and software projection tolerances are implementation criteria, not measurement accuracy. Good-looking overlays and repeatable optimization cannot establish legal admissibility or independent forensic validity.

7. Reproducibility, decisions and delivery

All four runs retain unchanged source hashes, byte-identical camera locks, independent generic initialization records, configuration and code snapshots, every numeric stage, actual Blender audits, hash-bound decisions, structured revisions and rejected checkpoints. The chronological iteration journal was written as reviews occurred; this PDF reproduces those recorded explanations and sample images.

The final deliverables include four editable fitted_case.blend scenes, this report, the separate iteration journal, per-image source/joint/body/skeleton and inspection images, measurements.json, measurements_cm.csv, saved_bone_lengths_cm.csv and the SHA-256 delivery manifest. CSV and JSON retain unrounded values. Each Blender file contains the fitted pose and morphology-identical neutral copy.

The reusable implementation previously passed 32 software tests, including real Blender skin/camera checks and a complete synthetic pipeline; the canonical asset passed 29 dedicated checks. No fitting implementation was changed for this independent protocol. New saved-file audits and package verification apply to each present run. Software tests do not validate participant accuracy.

Review question	Answer
Conditionally plausible under recorded assumptions?	YES, after image, joint and actual-geometry review.
Independent human expert review completed?	NO.
Independent expert review still required?	YES.
Corrected barefoot anatomical stature available?	NO; corrections remain null.
Do mean and SD establish forensic uncertainty?	NO; descriptive four-image model statistics only.

Reviews were performed by the current Codex GPT-6 session. ASTRA is the pipeline review schema, not a claim of separate Astra service or human approval. Source identities, camera mathematics and every case-specific observation remain inspectable in the run records.