Callisto 3D is software created and developed by the engineers at Occhio. Used in conjunction with any Occhio instrument, this software receives and deciphers the vast amounts of digital information which is supplied during microscopy analyses. Certified to conform with ISO 9276-6 Norms, this software uses powerful algorithms to interpret, characterize, and sort each particle independently. With over 60 evaluation tools, Callisto 3D allows the user to thoroughly review analysis results for thousands of different applications. Though inclusive, this software remains user friendly and intuitive with an easy to use navigation wheel and descriptions which appear when the cursor is hovered over a button.

Annex 3: Parameter definitions

Names and definitions are compliant with ISO 9576-6

Weight Factors: 6

Parameter	Other name	Sym-bol	Definition	Formula
Number				
Volume		*V*	The volume of the particle volume model.	
Equivalent Volume			The volume of the sphere having the same projec-tion area of the particle.	
Projection area		*A*	The projection area of the particle.	
Surface area		*S*	The external surface area of the particle volume model.	
Area of the convex hull			The area of the smallest convex hull that contains the projection of the particle	

Size Parameters: 35

Parameter	Other name	Sym-bol	Definition	Formula
Perimeter		*P*	The length of the particle perimeter.	
Cauchy-Crofton perimeter		P_{cc}	The length of the particle perimeter computed by Cauchy-Crofton formula.	
Perimeter of the convex hull		P_C	The perimeter length of the convex hull (envelope) that bounding the particle.	

Volume-equivalent diameter		x_V	The diameter of a sphere having the same volume as the particle volume model.	$\sqrt[3]{\frac{6V}{\pi}}$
Area-equivalent diameter	Equivalent circle diameter, ECD	x_A	The diameter of a sphere having the same projection area as particle.	$\sqrt[2]{\frac{4A}{\pi}}$
Surface-equivalent diameter		x_s	The diameter of a sphere having the same surface area as the particle.	$\sqrt[2]{\frac{S}{\pi}}$
Perimeter-equivalent diameter		X_P	The diameter of a circle having the same perimeter as the projection area of the particle.	$\frac{P}{\pi}$
Cauchy-Crofton perimeter-equivalent diameter		X_{Pcc}	The diameter of a circle having the same Cauchy-Crofton perimeter as the projection area of the particle.	$\frac{P_{cc}}{\pi}$
Inner diameter	diameter Maximum inscribed circle diameter	d_{imax}	The diameter of biggest circle inscribed into the projection area of the particle.	
Legendre ellipse maximum		x_{LMax}	The major axis of an ellipse with its center at the particle's centroid and with the same geometrical moments, up to the second order, as the projection area of the particle.	
Legendre ellipse minimum		x_{LMin}	The minor axis of an ellipse with its center at the particle's centroid and with the same geometrical moments, up to the second order, as the projection area of the particle.	
Feret diameter maximum	Length of particle	x_{FMax}	The maximum distance between parallel tangents to the projection area of the particle.	

Feret diameter minimum	Breadth of particle	x_{FMin}	The minimum distance between parallel tangents to the projection area of the particle.	
Feret conjugate	Feret length	x_{LF}	The Feret diameter (i.e. the distance between parallel tangents to the projection area of the particle) perpendicular to Feret diameter minimum.	
Angle-average Feret diameter		$\bar{x}_F$	The mean Feret diameter.	
Geodesic length		x_{LG}	A better approximation of the particle length and width for very long and concave particle (fibers)	$A = x_E . x_{LG}$ $P = 2(x_E + x_{LG})$
Thickness		x_E		
Minimum circumscribed circle diameter		d_{cmin}	The smallest circle containing the projection area of the particle.	
Erosion number		ω_1	The number of erosions necessary to make the projection area of the particle disappears completely.	
Convex hull erosion number		ω_2	The number of erosions necessary to make the area of the convex hull of the projection area of the particle disappears completely.	
Fractal dimension		D_F	The relationship between the length of the perimeter [$P(\lambda)$] and the length of the step [λ] is considered as linear on log-log plot. The fractal dimension provides the slope of this linear relationship.	$\log P(\lambda) = (1 - D_F) \log \lambda + \log b$
Mean diameter			The double of the mean distance between gravity center of the projection of the particle and each point of the outline of the projection of the particle.	
Inertia box width			The width of the smallest box that contains the projection of particle with the same principal directions that the projection of the particle.	

Inertia box height			The height of the smallest box that contains the projection of particle with the same principal directions that the projection of the particle.	
Skeleton length			The length of the convex hull outline minus the biggest convex hull segment.	
Specific Area			The ratio between the external surface of the particle volume model and the volume of this model	
Inner threshold area			The area of the inner part of the projection area that are segmented by inner threshold parameters	
Inertia-box depth			Only for 3D instrument: Side Inertia box width	
Inner diameter depth			Only for 3D instrument: Side inner diameter	
Side Feret minimum			Only for 3D instrument: Side Feret minimum	
Brownian diameter			Only for Brownian motion instrument	
Wire Y			Only for SieveCal instrument: The size of the opening wire as defined in ASTME11-13	
Wire X			Only for SieveCal instrument: The size of the opening wire as defined in ASTME11-13	
Opening Y			Only for SieveCal instrument: The size of the opening as defined in ASTME11-13	
Opening X			Only for SieveCal instrument: The size of the opening as defined in ASTME11-13	

Shape Parameters: 52

Parameter	Other name	Symbol	Definition	Formula

Ellipse ratio	Elliptical shape factor		The ratio of Legendre ellipse minimum to Legendre ellipse maximum.	$\frac{x_{Lmin}}{x_{Lmax}}$
Aspect ratio			The ratio of Feret minimum to Feret maximum.	$\frac{x_{Fmin}}{x_{Fmax}}$
Elongation	Eccentricity		The ratio of thickness to geodesic length.	$\frac{x_E}{x_{LG}}$
Straightness			The ratio of Feret maximum to geodesic length.	$\frac{x_{Fmax}}{x_{LG}}$
Curl			The ratio of geodesic length to Feret maximum.	$\frac{x_{LG}}{x_{Fmax}}$
Irregularity	Modification ratio		The ratio of maximum inscribed circle diameter to minimum circumscribed circle diameter.	$\frac{d_{imax}}{d_{cmin}}$
Compactness			The degree to which the projection area of the particle is similar to a circle. The ration of the area-equivalent diameter to Feret diameter maximum.	$\frac{x_A}{x_{Fmax}}$
Roundness		R_n	Similar to compactness but less robust (see ISO9276-6)	$\frac{x_A^2}{x_{Fmax}^2}$
Extent	Bulkiness		The ratio of projection area to the product of Feret diameter maximum by Feret diameter minimum.	$\frac{\boldsymbol{A}}{\boldsymbol{x_{Fmax}\, x_{Fmin}}}$
Box ratio			The ratio of projection area to the Feret box area. Where the Feret box area is the product of Feret diameter minimum by Feret diameter conjugate.	$\frac{A}{x_{Fmin} x_{LF}}$
Wadell's sphericity		Ψ		$\left(\frac{x_V}{x_S}\right)^2$
Wadell's roundness		R_W		$\frac{\sum d_i}{n.\, d_{imax}}$
Form factor	FF			$\frac{4\pi A}{P^2}$

Circularity		*C*	The degree to which the projection area of the particle is similar to a circle, considering the smoothness of the perimeter.	$\frac{x_A}{x_P}$
Crofton Circularity			It's the circularity computed with Crofton correction	
Solidity			A measure of the overall concavity of the projection area of the particle.	$\frac{A}{A_C}$
Global surface concavity index		*CI*	A measure of the overall concavity of the projection area of the particle.	$\frac{A_C - A}{A}$
Concavity			A measure of the overall concavity of the projection area of the particle.	$\frac{A_C - A}{A_C}$
Convexity				$\frac{P_C}{P}$
Crofton Convexity			It's the convexity computed with Crofton correction	
Average concavity		Ψ_{FP}		$\frac{\bar{x}_F}{x_P}$
Particle robustness		Ω_1		$\frac{2\omega_1}{\sqrt[2]{A}}$
Largest concavity index		Ω_2		$\frac{2\omega_2}{\sqrt[2]{A}}$
Concavity/robustness ratio		Ω_3	The ratio of particle robustness to the Largest concavity index.	$\frac{\boldsymbol{\omega_2}}{\boldsymbol{\omega_1}}$
Occhio bluntness				
Occhio abrasivity				
Occhio elongation			One minus the ratio Inertia box width to Inertia box height	
Occhio roughness xx%			The ratio of smooth reference to the particle projection area. The smooth reference is defined by	

			inscribed circles tangent to each point of the particle projection outline with a radius greater than XX% of the maximum inscribed circle.	
Mean luminance			Mean value of the luminance of pixel inside the projection area of the particle	
RSD luminance			Mean value of the luminance of pixel inside the projection area of the particle	
Mean red			Only for color instrument: Mean value of the red channel of pixel inside the projection area of the particle	
RSD red			Only for color instrument: RSD value of the red channel of pixel inside the projection area of the particle	
Mean green			Only for color instrument: Mean value of the green channel of pixel inside the projection area of the particle	
RSD green			Only for color instrument: RSD value of the green channel of pixel inside the projection area of the particle	
Mean blue			Only for color instrument: Mean value of the blue channel of pixel inside the projection area of the particle	
RSD blue			Only for color instrument: RSD value of the blue channel of pixel inside the projection area of the particle	

Mean inner red			Only for color capable instruments: Mean value of the red channel of pixel inside the projection area of the particle that are segmented by inner threshold parameters	
Mean inner green			Only for color instrument: Mean value of the green channel of pixel inside the projection area of the particle that are segmented by inner threshold parameters	
Mean inner blue			Only for color instrument: Mean value of the blue channel of pixel inside the projection area of the particle that are segmented by inner threshold parameters	
Side aspect ratio			Only for 3D Instrument: the aspect ratio measured with the side camera.	
Side Occhio elongation			Only for 3D Instrument: the Occhio elongation measured with the side camera.	
Side solidity			Only for 3D Instrument: the aspect ratio measured with the side camera.	
Occhio flattening			Only for 3D Instrument: Ratio of the Inertia-box depth to Inertia-box width	