Selecting imaging scale or GSD

Correct selection is fundamental to achieving specified mapping accuracy.

In **film imaging**, scale is the primary parameter. The selected camera lens focal length (f) affects imaging altitude (H) where:

Image Scale = f/H

The standard focal lengths for film cameras are:
- 88.5mm (3.5") – seldom used
- 152mm (6") – standard mapping camera
- 305mm (12") – popular in forestry applications

During digital conversion, various scanner pixel size may be selected to achieve specified GSD.

Available precision photogrammetric scanners support pixel sizes ranging from 5μ to 12μ, with many also provide intermediate pixel sizes.

For example, 20cm GSD equivalent can be achieved by:
- scanning 1:20,000 scale imagery at 10μ pixel size, or
- scanning 1:10,000 scale imagery at 20μ pixel size.

In **digital imaging**, sensor native pixel size (P_S) is fixed. Specified GSD is achieved only by varying the imaging altitude. Image scale is simply:

Image Scale = P_S/GSD

Since Image Scale = f/H also, therefore f/H = P_S/GSD. Imaging altitude (H) can be derived from:

H = GSD x f/P_S

In the Z(I DMC f = 120mm and P_S = 12μ, to achieve a 20cm GSD:

H = 20cm x 120mm/12μ = 2000m

Imagery Source	f	P_S	f/P_S
Film			
Scanned @ 10μ	152mm	10.0μ	15,200
Scanned @ 10μ	305mm	10.0μ	30,500
Digital			
JenOptik JAS-150	150mm	6.5μ	23,077
Leica ADS-40/52	63mm	6.5μ	9,692
Vexcel UC_D	100mm	9.0μ	11,111
Vexcel UC_X	100mm	7.2μ	13,889
Z(I DMC	120mm	12.0μ	10,000

N.B. A short-hand method in determining imaging altitude is to multiply the required GSD by the fixed f/P_S factor in each imaging system.

Horizontal (X/Y) mapping accuracy

PurVIEW horizontal mapping accuracy is dependent on the pointing acuity of the monitor cursor using a standard mouse, which extracts the X/Y terrain coordinates of the nearest monitor pixel. Adopting a correct view scale supports specified accuracy tolerance.

N.B. PurVIEW-MX supports sub-pixel pointing acuity using higher resolution 3D input devices.

Using the same DMC example:

For the 20cm GSD selected, the image scale is:

Image scale = 12μ/20cm = 1:16,667

View scale is best set based on monitor dot pitch (≤ 0.4mm) and X/Y accuracy tolerance (4~5 GSD), thus:

View scale = 0.4mm/4 GSD = 1:2,000

An 8X magnification from image scale is therefore appropriate.

H x V	20"	18"
Monitor Resolution	**Dot Pitch**	
1,024 x 768	.40mm	.37mm
1,280 x 1,024	.30mm	.28mm

Vertical (Z) mapping accuracy

Vertical measurements can be manual or passive within PurVIEW.

Manual measurement accuracy – is dependent on image GSD under the chosen view magnification and exaggerated by the imaging system lens focal length (f) to image base (b) ratio, or f/b ratio.

N.B. f/b ratio is the same as H/B ratio, where B is the distance between exposure stations.

Imaging systems	f	stereo angle	f/b
Film camera	152mm	34 °	1.65
Film camera	305mm	17 °	3.32
ADS-40/52 Pan.	63mm	42 °	1.28
ADS-40/52 R/G/B/IR	63mm	16 °	3.36
DMC	120mm	18 °	3.13
JAS-150 Stereo	150mm	41 °	1.30
JAS-150 Pan.	150mm	24 °	2.35
UC_D or UC_X	100mm	15 °	3.70

The 152mm lens focal length film camera has been the standard mapping camera whose f/b ratio is the foundation of most existing mapping specifications. Long lens focal length and/or short image base will result in high f/b ratios but less apparent object leans—more suitable for orthophoto processing.

Continuing with the DMC example:

The 4~5 GSD horizontal accuracy, magnified by the f/b ratio of 3.13 will results in a vertical accuracy >12.5 GSD (2.5m)—unacceptable for mapping at 1:2,000 entailing 1m X/Y/Z positional accuracy, and normally supported by 20cm GSD.

The alternatives are: lowering imaging altitudes, deploying imaging systems with better f/b ratio, or **use Virtual-Z with quality DEM**.

Virtual-Z – is passive and dynamically interpolates ArcTIN dataset that represents the topographic model. Virtual-Z accuracy is solely dependent on the adopted source DEM.

If a DEM accurate to within 1m is chosen, then feature vertical coordinates extracted will be accurate to within 1m regardless of image f/b ratio.

Virtual-Z is based on the notion that features naturally residing on terrain surfaces should be conformal to the terrain model surface when mapped. All standard map features—except roof outlines—conceptually comply.

Roof outlines are planar objects above the terrain surface and would be correctly mapped by first off-setting the cursor to match the roof edges.