Angular Tolerance for Standard Probes

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Acceptance Angle (also known as Angular Tolerance) is the maximum range of angles between the optical axis of the optical probe and the surface of the sample, where the strength of the reflected light collected by the probe is deemed sufficient to perform the measurements using OptiGauge™.

In the case of a simple 2-lens probe, consisting of collimating and focusing lenses, the Acceptance Angle can be found approximately as:

$$\text{Acceptance Angle (in degrees)} = 2 \cdot NA_{fiber} \cdot \frac{F_1}{F_2} \cdot \frac{180}{\pi},$$

where F_1 is the focal length of the collimating lens, F_2 is the focal length of the probe, and NA_{fiber} is the numerical aperture of the fiber. The numerical aperture of SMF-28 optical fiber is specified by the manufacturer as 0.14 and is equal to **half** of the emission cone angle in radians, at 1% power. Therefore, the full NA of the single mode fiber is 0.28.

Alternatively, the acceptance angle can obtained using optical modeling software, such as Zemax. In this case, the software calculates the imaging space NA, where the object space NA is equal to the full NA of the single mode fiber (0.28). Based on the optical model design, Lumetrics probes therefore have the following acceptance angles:

Part #	WD†, mm	NA, rad	fAA, deg	hAA, deg	AA, ±deg
13000-10	50	0.06	3.4	1.7	2
13000-20	20	0.128	7.3	3.7	3.5
13000-58	20	0.3	17.2	8.6	8.5
13000-72	145	0.072	4.1	2.1	2
13000-75	90	0.03	1.7	0.9	1
13000-76	13	0.278	15.9	8.0	8

†WD – Working distance, NA – image space full numerical aperture, fAA – full acceptance angle, hAA – half of the acceptance angle, AA – acceptance angle expressed as ±half angle

Due to the approximate nature of these calculations, the data for the last column is rounded up or down to the nearest half.

References:

http://www.corning.com/docs/opticalfiber/pi1463.pdf
http://www.calctool.org/CALC/phys/optics/f_NA