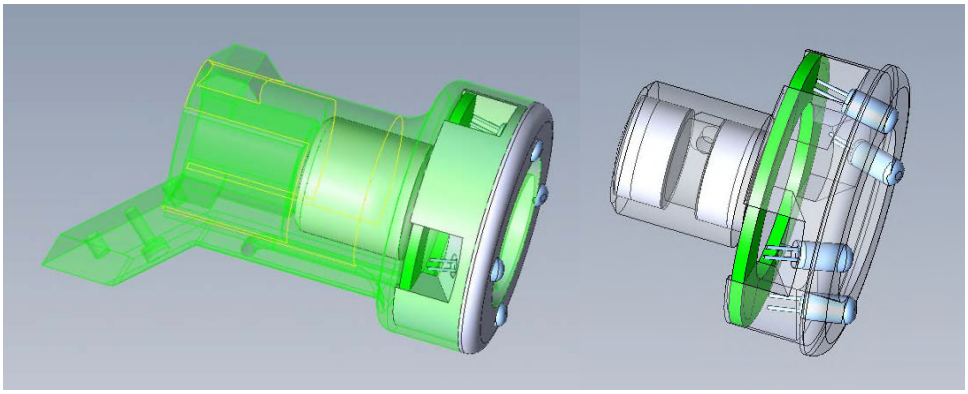
Stand-off Head Design for DLP® NIRscan™ Nano EVM



Introduction

The DLP® NIRscan™ Nano Evaluation Module (EVM) employs a diffuse reflectance design that requires the sample to be placed in direct contact with the sapphire window. This design was chosen to ensure proper illumination of a sample by the built-in lamps.

Since the release of the DLP NIRscan Nano EVM, many requests have been received for a design that would allow diffuse reflectance measurements without direct contact with the EVM window. Such a design would allow for the measurement of many substances that would otherwise result in residue being left on the window.

The following are examples of such substances:

- Food:
  - Fruits – Grapes, strawberries, apples, and others that can have sugar residues on the surface
  - Dairy products – Ice cream, yogurt, cheeses, sour cream, and other dairy products
  - Desserts – Applesauce, pudding, and pastries
- Industrial fluids and lubricants
- Soil and fertilizers
- Cosmetics
- Pharmaceuticals

Larger sampling area is another advantage of a stand-off design, particularly for items such as grain or other substances with short range inhomogeneity. A larger area will integrate these differences allowing measurement in an environment where it is not feasible or desirable to place the samples in direct contact with the window.

TI has designed a prototype of a simple telescopic stand-off head which was tested to determine the usability and characteristics of the design.

Results

Figure 1 shows the absorbance spectra of Comté cheese taken at two distances, and demonstrates the similarity of the spectra.

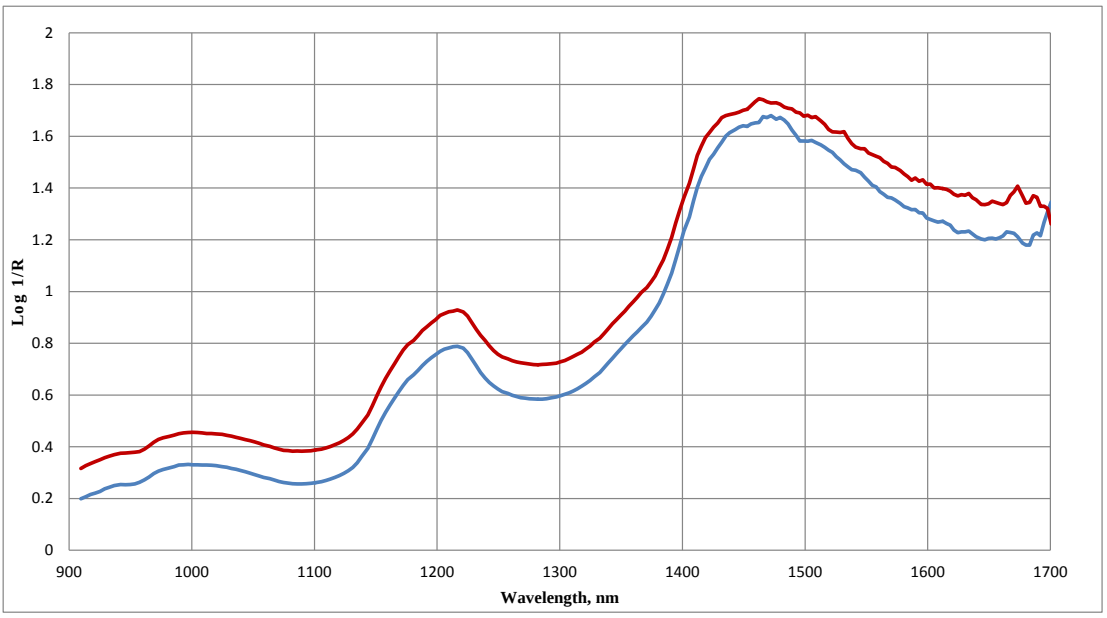


Figure 1 – Comté Cheese Absorbance at 10 mm and 15 mm

Figure 2 shows the raw detector readings of Spectralon™ at 10 mm – 50 mm and demonstrates the consistency of the data shape. The readings only differ by a scaling factor from one another.

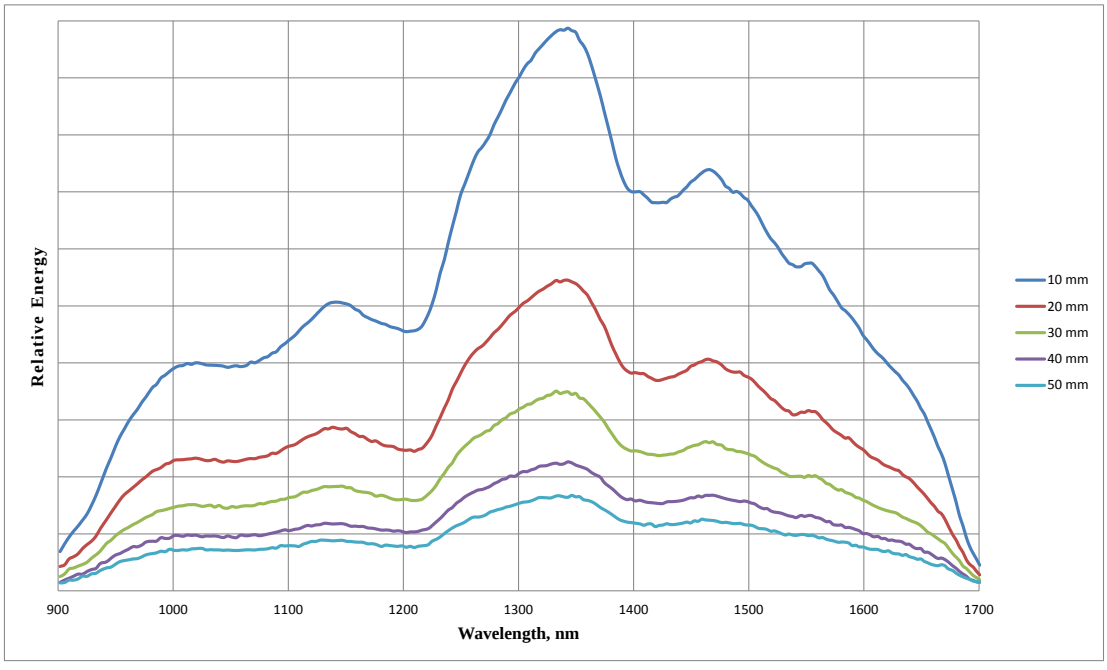


Figure 2 – Reflected Energy of Spectralon Surface at 10 – 50 mm

Considerations

The primary considerations for a stand-off head are signal-to-noise ratio (SNR), and illumination intensity.

SNR

Figure 3 shows the relative SNR values from data taken at 10 – 50 mm with the illumination intensity fixed. For a given illumination scheme, the maximum working distance will be determined by the required SNR for the system. The SNR falls off as an exponential of the form $SNR = k \cdot e^{-c \cdot x}$, where k and c are constants. The best fit exponential curve is shown in red.

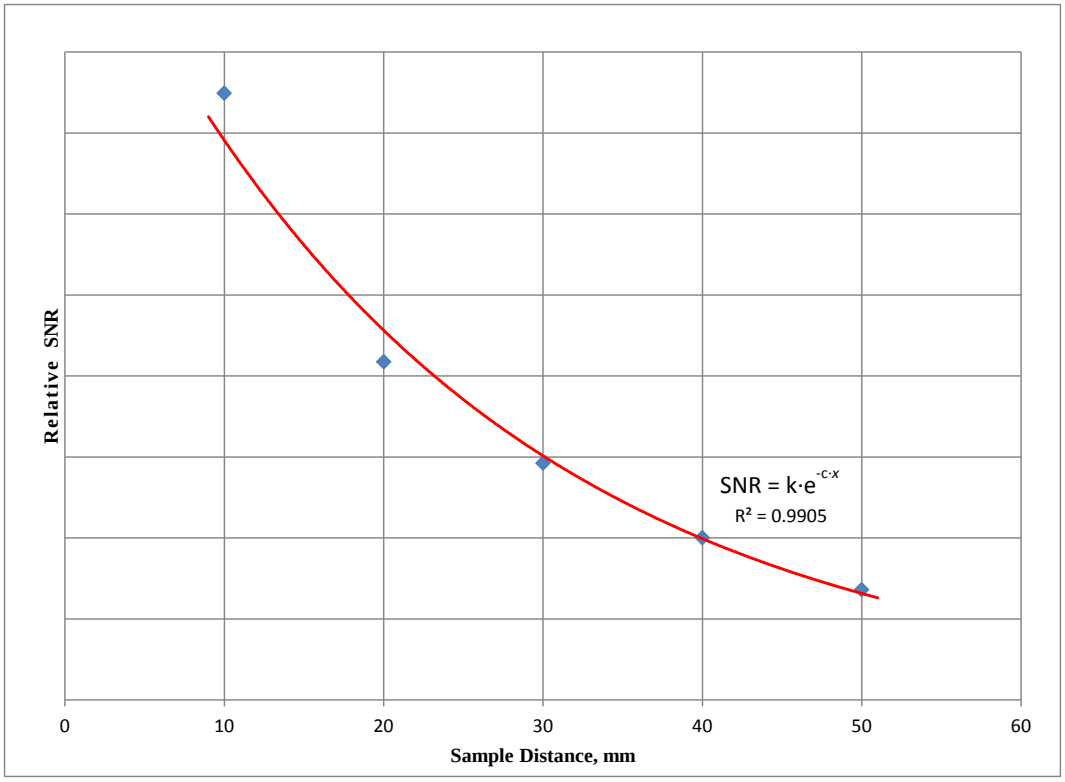


Figure 3 – Relative SNR at 10 – 50 mm [9V illumination, 22 sec (99 scans)]

Illumination Intensity

If the illumination level does not achieve the desired working distance for the required SNR of the system, then the illumination can be increased. The trade-off is power consumption.

The on board lamp driver is based on the TI OPA567 power amplifier. In this system the supply is 5V and is designed to limit the current to 280 mA in order remain within the USB 2.0 power draw specifications. If more power than this is needed the circuit can be designed to put out up to 1 A, but a separate 5V supply will be needed. See § 3.1 of the Application Report *Signal Chain Performance Optimizations in the TI DLP® Technology-Based Spectrometer* for further information.

NOTE: If more intensity is desired than can be supplied by the on board lamp driver, then a separate lamp supply should be employed.

Design

The design includes CAD files for the head, and can be printed with a 3D printer and populated with the lenses specified in the design.

The design also includes a simple Zemax model showing the area that will be captured by the slit at the distance chosen. This model can be modified if different lenses are chosen or if a larger working distance is needed

Figure 4 shows the Zemax model layout of the module. Notice in this arrangement that the slit is imaged at 16.5 mm from the front of the end face of the mechanics. The area seen by the slit here is only 1.7 x 0.6 mm. If you intend to work at this distance and need a larger sample area, the separation between the lens sets will need to be increased or decreased to provide more defocus at this distance.

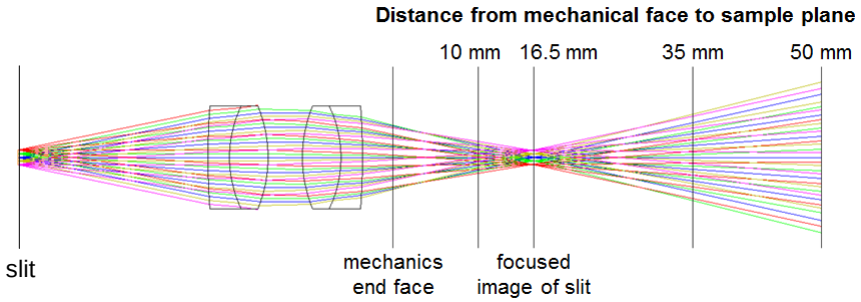


Figure 4 - Zemax Stand-off Module Layout [10, 16.5, 35 & 50 mm]

Figure 5 shows the shape of the sampling area (area seen by the slit) at these distances.

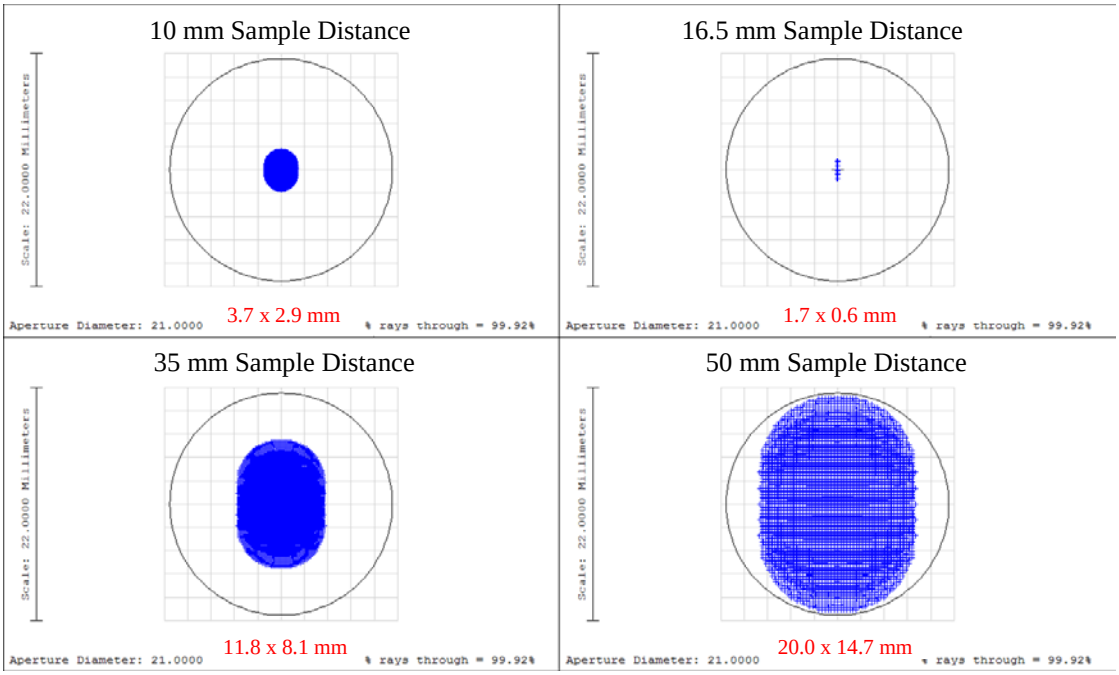


Figure 5 - Zemax Sample Area Shape [10, 16.5, 35 & 50 mm]

Related Documentation from Texas Instruments

- DLPC150 Data Sheet: *DLPC150 DLP® Digital Controller for Advanced Light Control*, TI literature number DLPS048
- DLP2010NIR Data Sheet: *DLP2010NIR (0.2 WVGA Near-Infrared DMD)*, TI literature number DLPS059
- Programmer's Guide: *DLPC150 Programmer's Guide*, TI literature number DLPU031
- Application Note: *Texas Instruments DLP® Spectrometer Design Considerations*, TI literature number DLPA049
- Application Report: *Flexible Trade-offs in Maximizing SNR and Resolution in TI DLP® Technology-Based Spectrometer Systems*, TI literature number DLPA066
- Selection Guide: *TI DLP® Technology for Spectroscopy*, TI literature number DLPT020
- Application Report: *Signal Chain Performance Optimizations in the TI DLP® Technology-Based Spectrometer,* TI literature number DLPA072

If You Need Assistance

Refer to the DLP Products and MEMS TI E2E Community support forums

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