**DESIGN CONSIDERATION:**

***Resolution***

Resolution is defined as the spectral width measured by the instrument of an impulse spectrum, that is a

signal with zero width. It is typically specified in full-width half-max (FWHM), defined as the width of the

spectral peak when its height is 50% of the peak value. It is commonly quoted in units of nanometers or

wave numbers. This definition is convenient, as it also describes the minimum distance required between

two zero width input wavelengths of the same amplitude before an instrument can detect two distinct

peaks instead of one broad peak.

Light received at the detector when only a single column width of pixels is turned on is a convolution of

* input slit width,
* optical transfer function in the dispersion axis,
* DMD pixel pitch in the dispersion axis.

When designing the system, it is useful to convert these three quantities into the same domain for analysis.

The convolution of these functions can then be used to estimate the FWHM of the system. This represents the highest resolution attainable when using single column widths of DMD mirrors. When designing a system, the optimal tradeoff of signal into the instrument and resolution is usually found when the entrance slit is matched to the exit slit.

***Stray Light***

Stray light is a term used in spectroscopy to describe errant signals caused by misclassifying a signal’s wavelength. For instance, in an array based spectrometer, if 1% of wavelength λ1 images onto the detector pixel associated with λ4, this light would be misclassified. This leads to inaccurate spectrum output: wavelengths with low energy are measured higher than reality. In absorbance spectroscopy, this limits the linearity of absorbance units (AU) you can reliably measure.

The categories of stray light described below incorporate the following naming conventions:

**Static—** Unchanged over time, or unaffected by DMD state

**Dynamic—** Changes over time, or affected by DMD state

**Imaging—** Incorrect imaging at the DMD (wavelength in the wrong location on DMD)

**Detector—** Energy incident on detector from a path other than striking an on state DMD mirror

**Static Imaging**

*Incorrect imaging at the DMD which is unaffected by DMD state (wavelength in the wrong location at the*

*DMD)*

This is the classic stray light phenomenon also present in array based and monochromatic systems.

There are three primary causes of this: ghost images from optics, glancing angles from mechanics, and window reflections.

Ghost images from optics occur from reflections off optical surfaces (lens flats, filter), and are reimaged onto the DMD. This occurs most often when unused orders of the grating reflect back toward the illumination where they encounter an optical flat causing a ghost image displaced by some small angle.

Glancing angles from mechanics can also illuminate the DMD in the wrong location for a given wavelength. This is common in lens mounts with deep inserts, and chassis side walls parallel to the optical path.

Window reflections can also affect this. Using the DMD in the appropriate designed wavelength region will minimize these effects, as different window coatings are optimized to transmit specific wavelength regions.

**Dynamic Imaging**

*Light which is imaged onto the DMD correctly, but then reflected back onto different on-state DMD pixels and then reflected to the detector. Dependent on the DMD state*

**Static Detector**

*Energy incident on detector from a path other than striking an on state DMD mirror which is unaffected by*

*the DMD state*

***SNR***

The SNR of a system is dependent on the systems design and use. Design factors can be optimized for cost and expected use case; while use factors determine what the SNR will be for a particular datapoint of a scan.

**Design Factors**

The following factors should be optimized to maximize system SNR. The intended use model, form factor, and cost will be limiting constraints.

• **Maximize illumination optical power through slit**

This is a function of the optical efficiency of the sampling instrument, the intensity of the source, and the size of the slit. Special attention should be paid when coupling systems together via fibers, in order to match the étendue to minimize the losses before the light enters the system.

• **Minimize noise from Illumination instability**

In systems that include illumination sources, illumination stability is very important. Since DLP

spectrometers collect spectral data based on sequential patterns, variation in the source power or

spectrum could affect the accuracy of the output spectrum. For applications where source variation or

sample consistency cannot be controlled, displaying patterns as fast as possible may be useful in

addition to averaging multiple scans rather than displaying patterns slowly.

• **Maximize slit to detector optical efficiency**

This is the core of the optical design. The tradeoff with optical efficiency is usually spectral resolution,

as the optical transfer function typically suffers when using a lower f-number.

• **Minimize detector and analog front end noise**

A low noise detector should be used and paired with a low noise amplifier. The gain should be set to

maximize the available dynamic range, and the bandwidth of the amplifier should be met or exceeded

by the ADC sampling rate so that higher frequency noise can be averaged out.

**VARIOUS PART AND THEIR DIMENSION:**

**DIFFRACTION GRATING DIMENSION:**

* **Grooves per mm**-150
* **Nominal blaze wavelength** (1st order liftrow)-2um
* **Nominal blaze angle**-8.6 degree
* **Maximum ruled area(groove length X rule width, mm**)- 154x206
* **Blaze wavelength**- 2000nm
* **Contour**- plain
* **Surface**-ruled
* **Vendor**- Richardson grating
* **Part no**-2513399

**CONDENSOR LENSE**

* **Lens Type**: Aspheric
* **Material**: Optical Crown glass
* **Quality:** Light collection quality
* **Diameter Ø (mm):**15.0
* **f/#:** 0.80
* **Center Thickness tc (mm):**5.5
* **AR Coating Wavelength (nm):** Uncoated or
  + - * + Optional Single-layer MgF2 (400-700 nm)
* **Shape of the non aspheric side:** Plano
* **Back Focal Length fb (mm):** 8.4
* **Focal Length (mm):** 12.0
* **Surface Figure (p-v, at 633 nm before coating):** Not specified
* **Surface Quality (scratch and dig):** 80-50
* **Vendor**-MELLES GRIOT
* **Part no**-LAG-15.0-12.0-C

**NIR SOURCE:**

* **Price**-$31
* **Vendor** –international light technologies
* **Part no**-L8008

**SLIT:**

* **F- NUMBER**-2.5
* **DIMENSION:** 1.8X0.025MM

**DMD:**

* **Pixel pitch**-5.4um
* **Resolution**-854x480
* **Tilt angle:** +-17 degree
* **Part no-** DLP2010NIR
* **Vendor:** Texas Instrument, arrow.com
* **Price:** $136.43

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| --- | --- | --- | --- | --- |
| PART | VENDORS | PART NUMBER | PRICE | QUANTITY |
| DMD | TEXAS INSTRUMENT, ARROW.COM | DLP2010NIR | $136.43 | 1 |
| NIR SOURCE | INTERNATIONAL LIGHT TECHNOLOGIES | L8008 | $31 | 4 |
| CONDENSOR LENSE | MELLES GRIOT | LAG-15.0-12.0-C | - | 2 |
| DIFFRACTION GRATING | Richardson grating | 2513399 | - | 1 |
| MICROCONTROLLER | ARM7 | LPC2148 | Rs.500 | 1 |
| InGaAs detector | hamamatsu | G8605-21 |  | 1 |
| COLLIMATING LENSE |  |  |  | 1 |
| MECHANICAL DESIGN |  |  | Rs. 10000(APPROX) |  |

**APPLICATION:**

* Pharmaseuticals.
* Agriculture.
* Bio science.
* Textile industry.