High-Order Sideband Generation

Jordan Grace

Physics

Mentor: Hunter Banks

Faculty Advisor: Prof. Mark Sherwin

Institute for Terahertz Science and Technology

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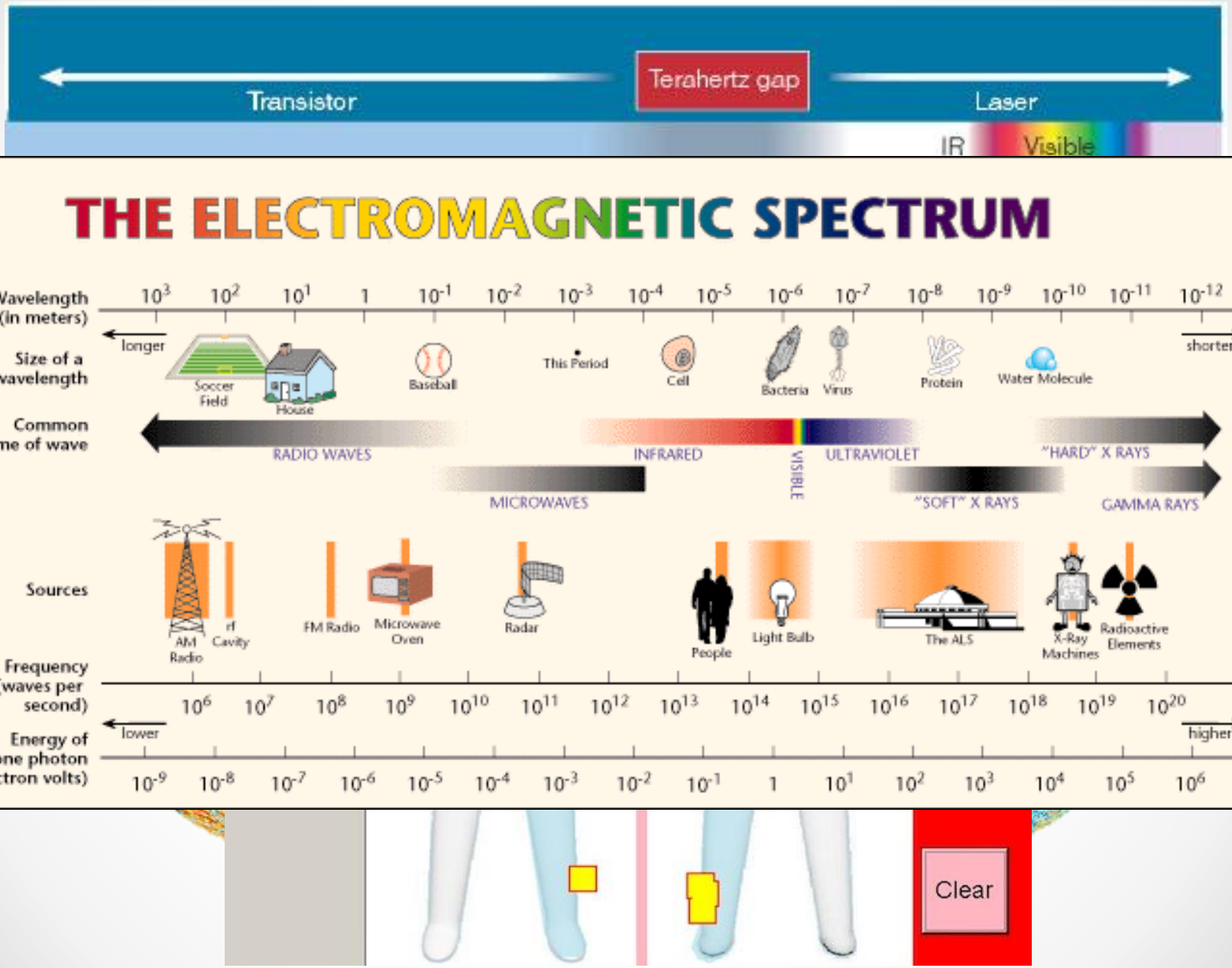
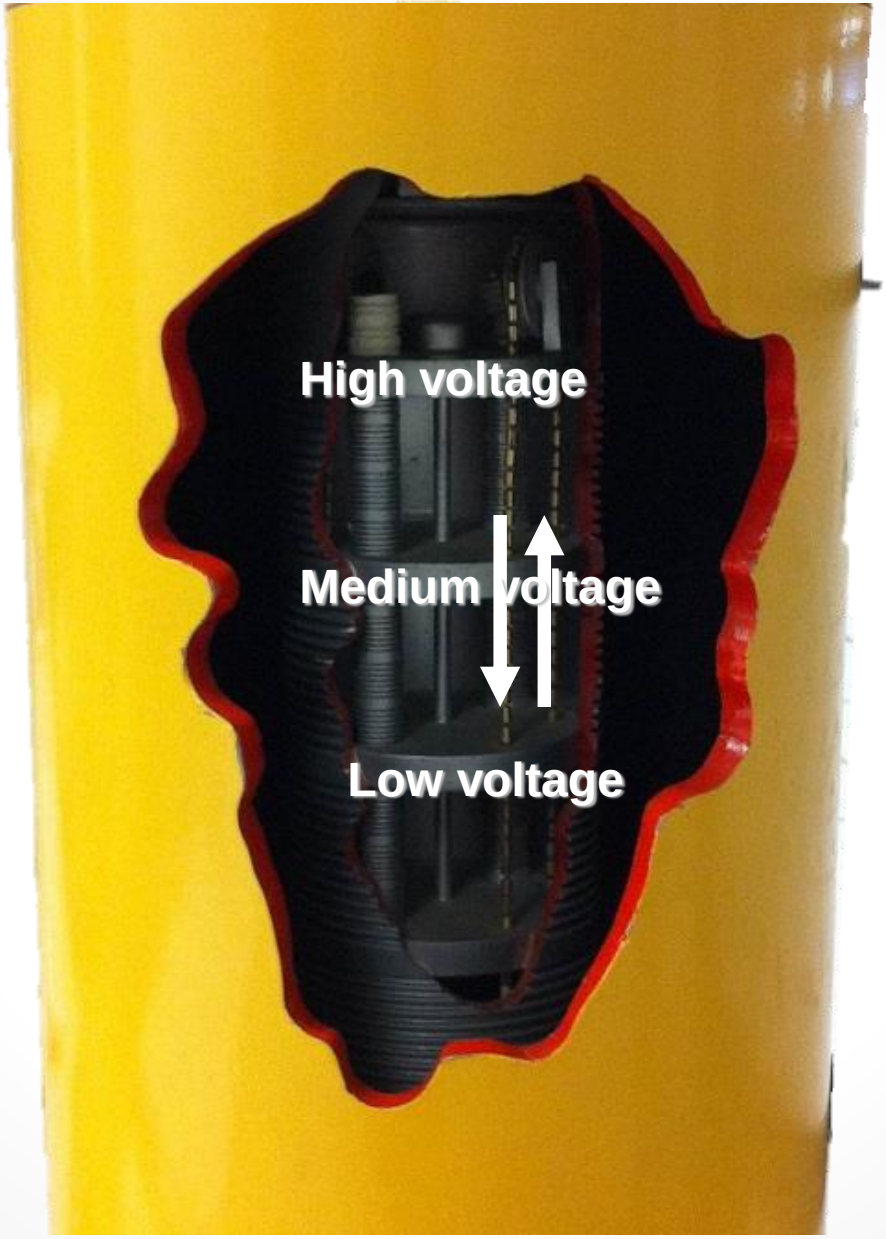
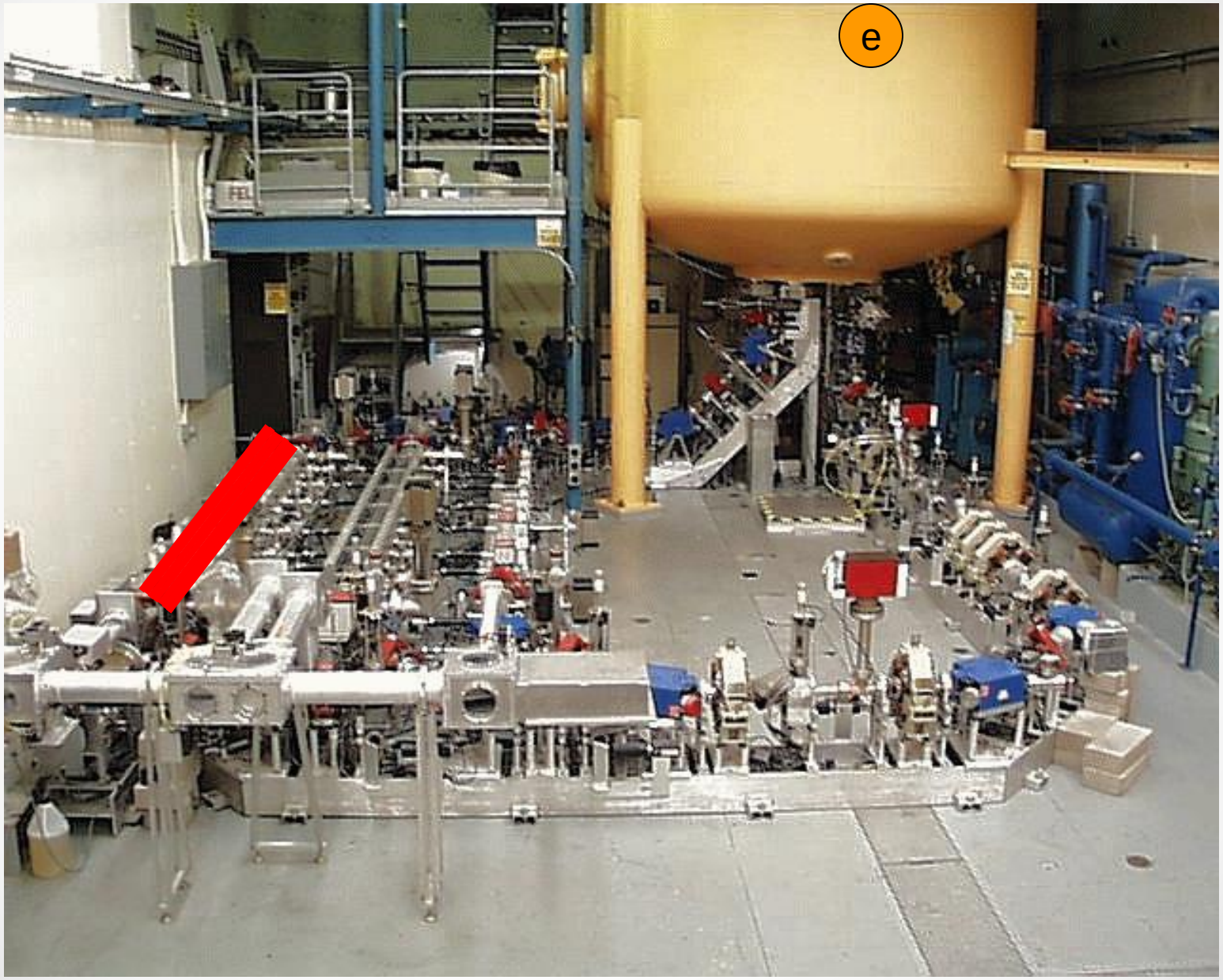
Terahertz Radiation



Free Electron Laser



FEL



Describing a Wave

$\lambda = c/f$

Frequency

$v = \lambda f$

$f = 1/T$

Energy

$E = hf$

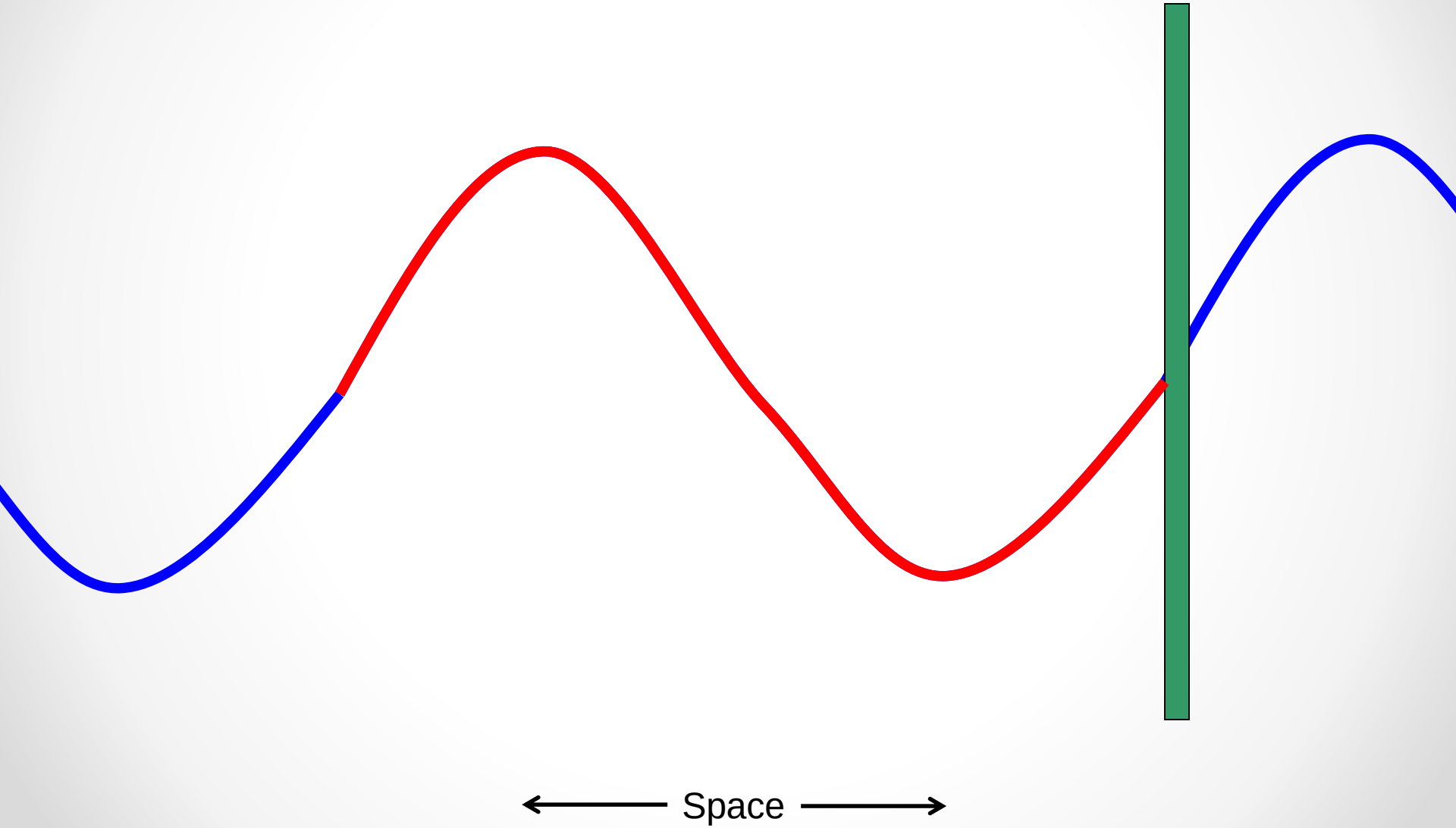
$k = 2\pi/\lambda$

Wavelength

$\lambda = c/f$

$\omega = 2\pi f$

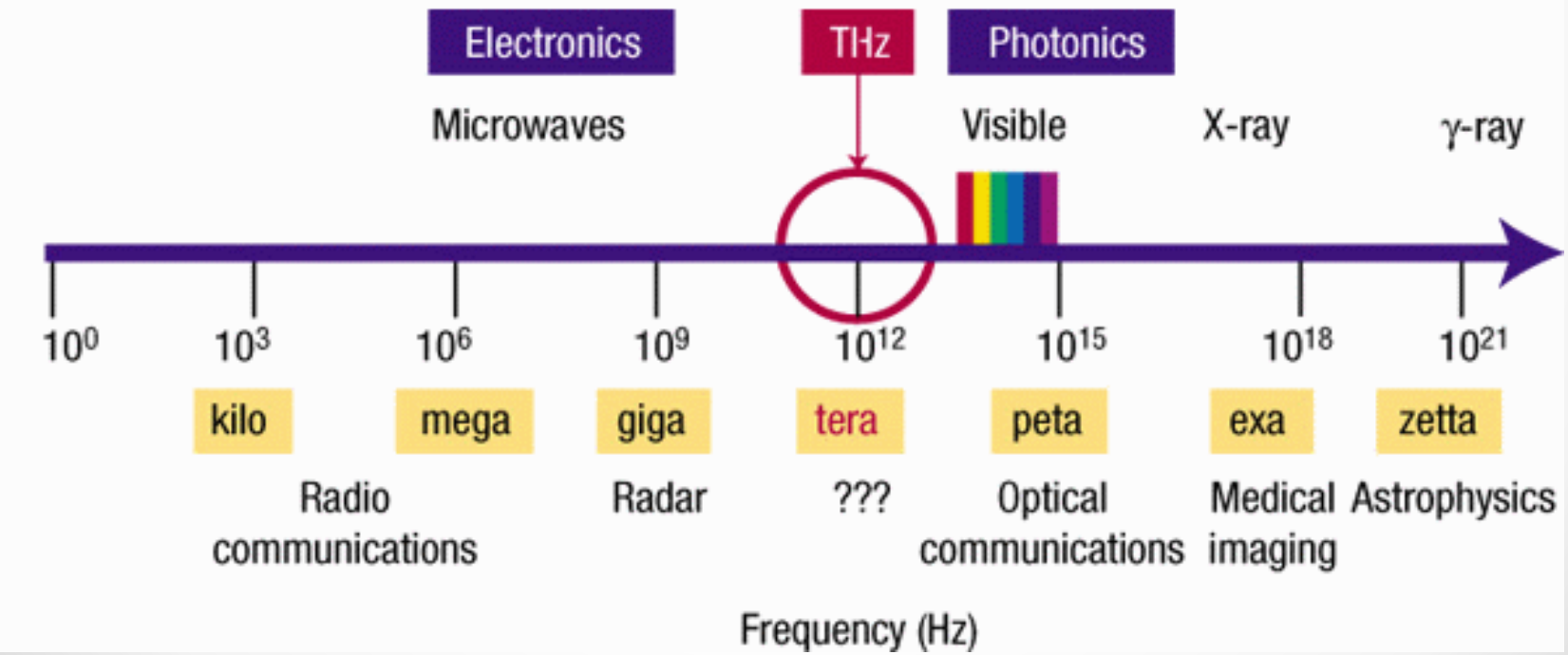
Physics 101 - Frequency

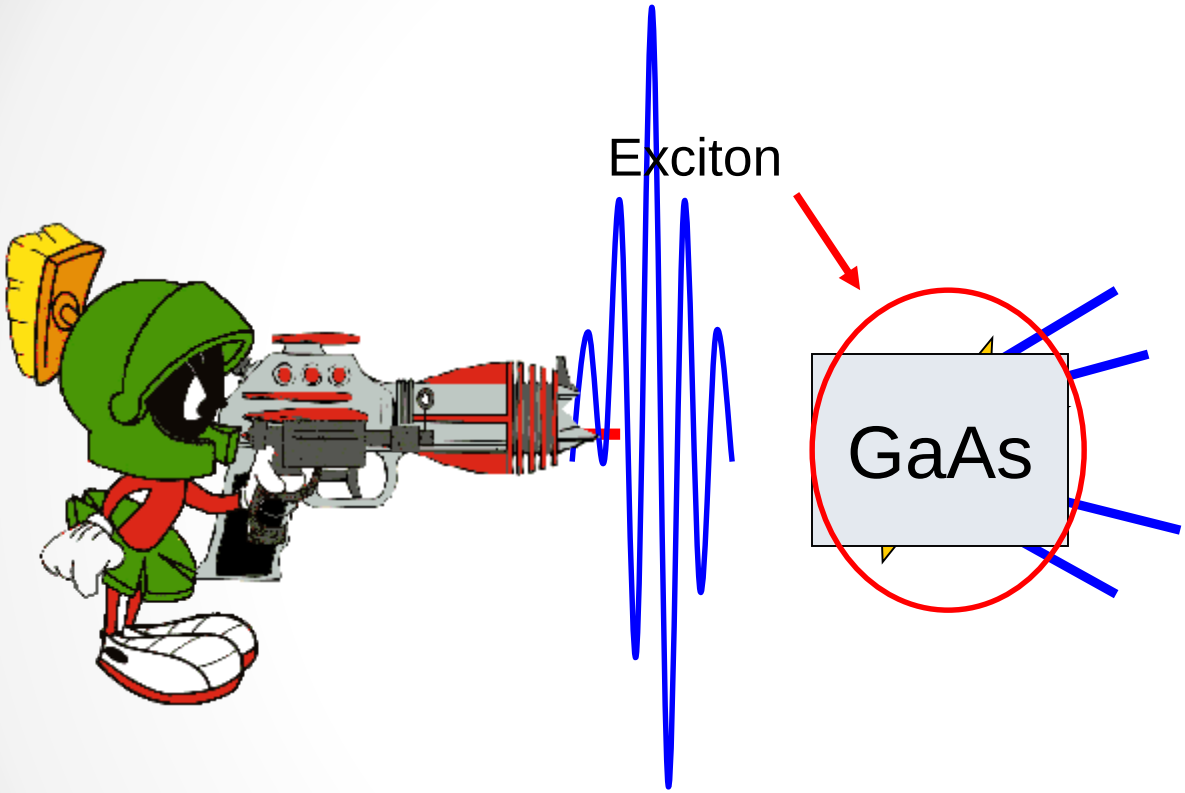


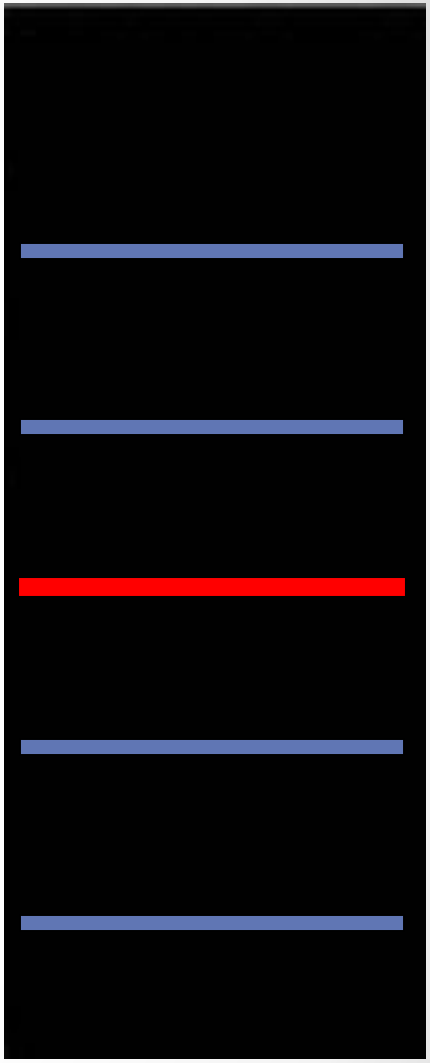
Frequency

1 Hz = 1 wave cycle per second

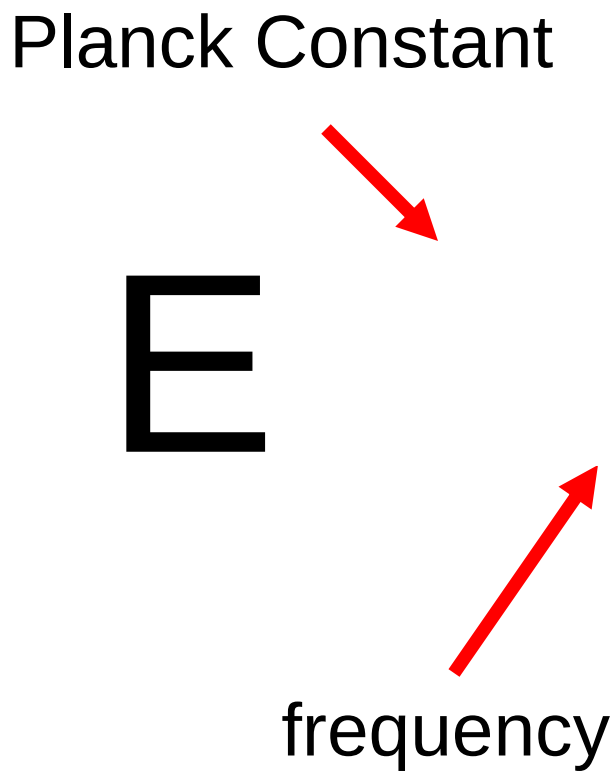
1 THz = 1 trillion wave cycles per second



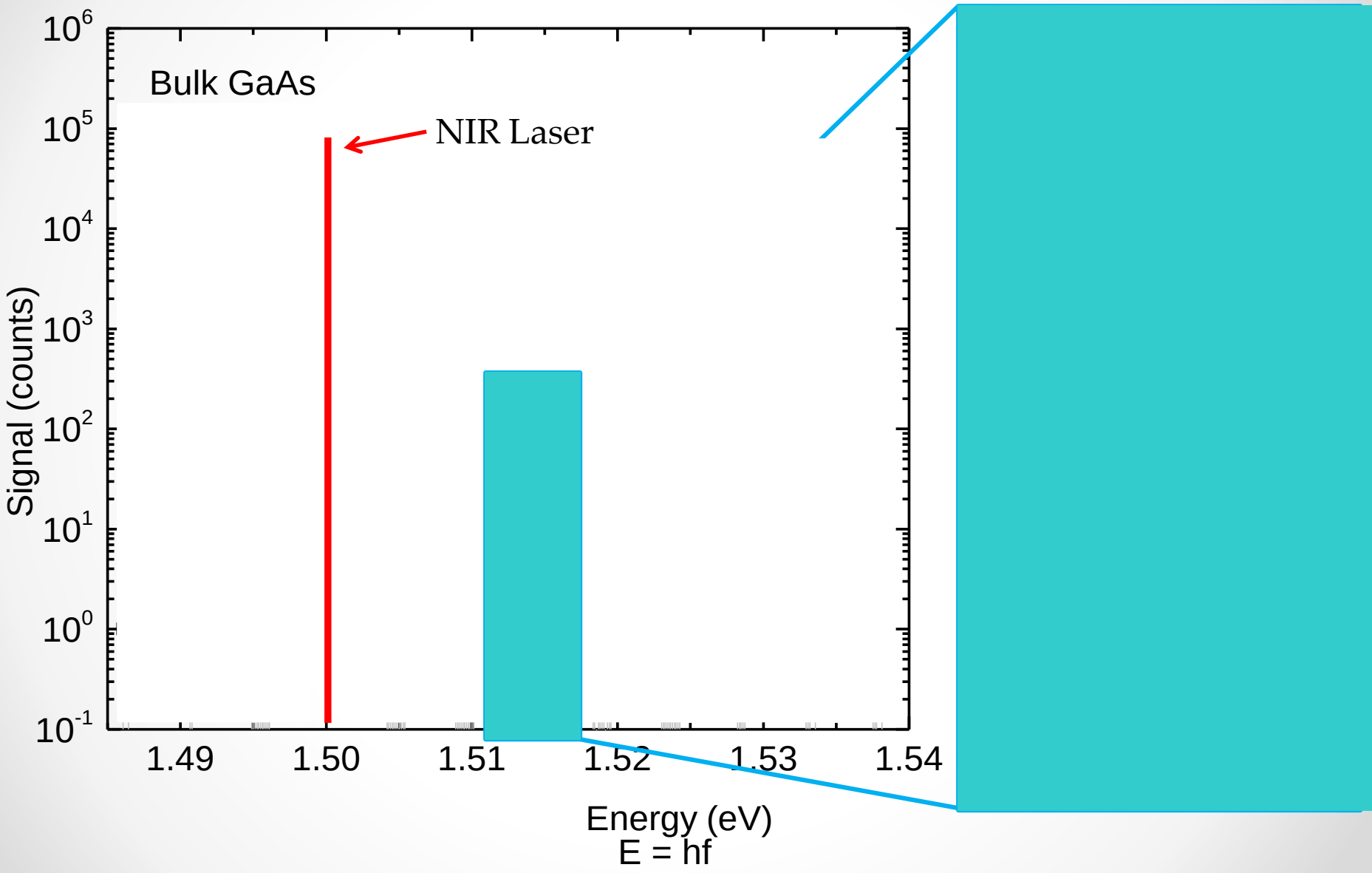

Exciton
GaAs



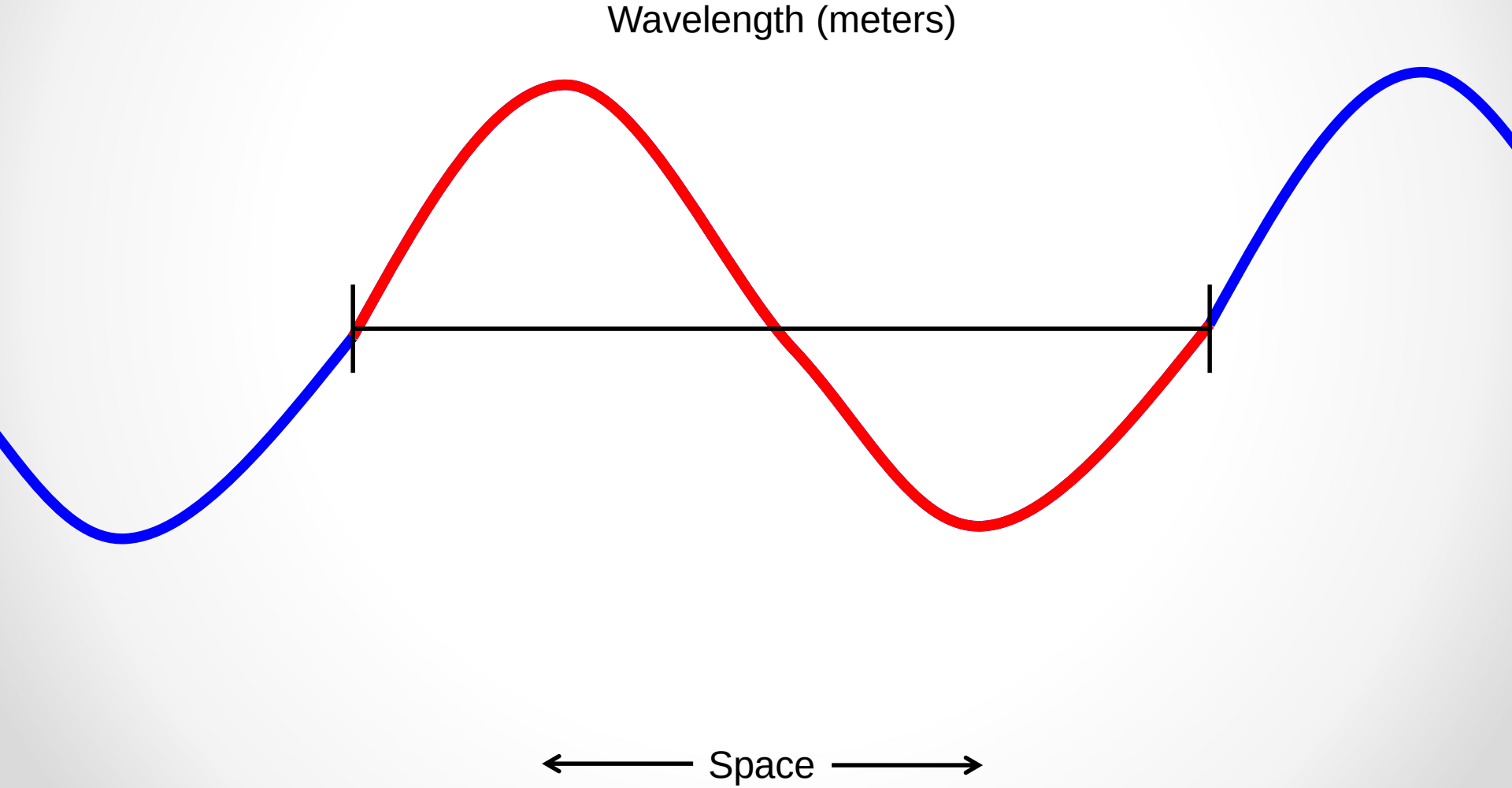
Physics 102 - Energy



Sample Data


Bulk GaAs
NIR Laser
Signal (counts)
10^6
10^5
10^4
10^3
10^2
10^1
10^0
10^{-1}
1.49
1.50
1.51
1.52
1.53
1.54
Energy (eV)
E = hf

Physics 103 - Wavelength



Wavelength

Speed of Light

$$\lambda = c/f$$

Frequency

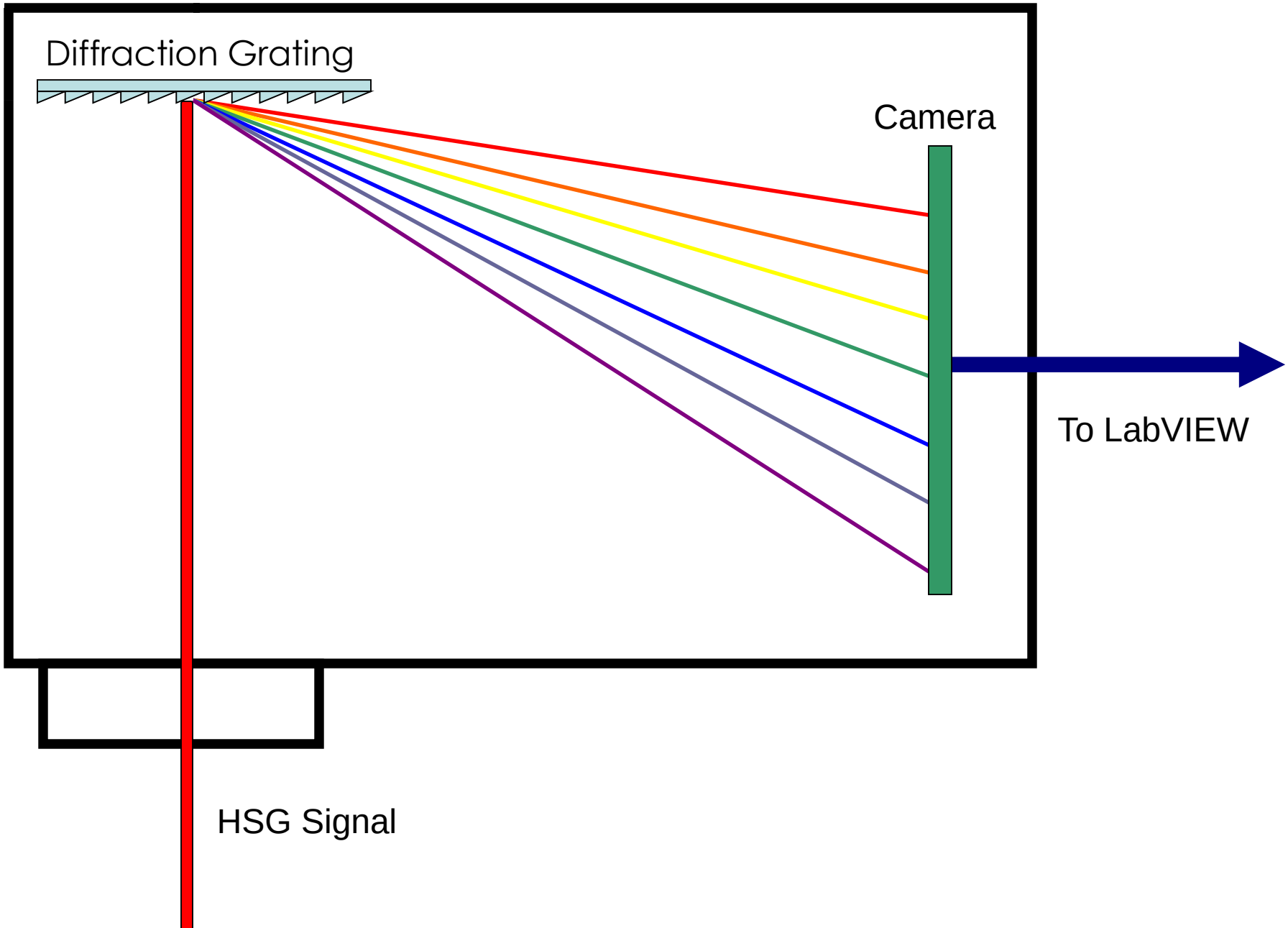
Near-Infrared Laser

300 GHz ↕ **1 mm**

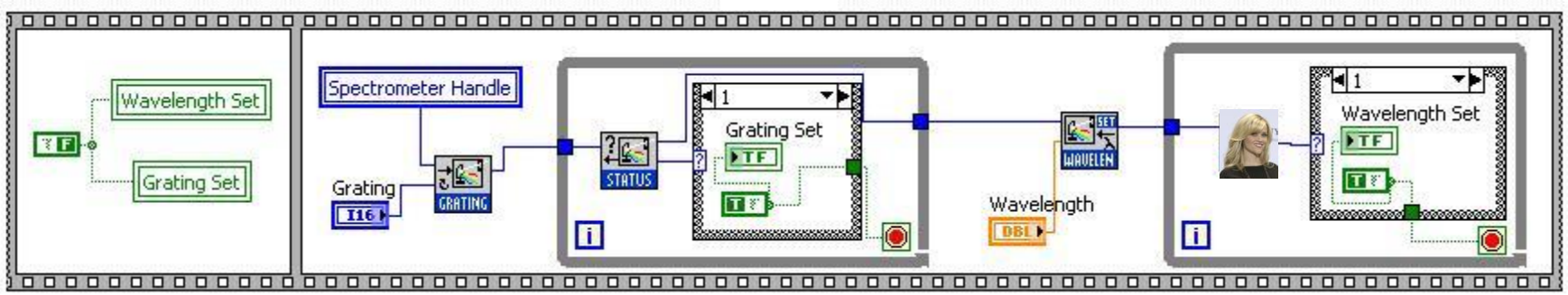
370 THz ↕ **810 nm**

30 THz ↕ **10 µm**

Camera Setup



LabVIEW


Wavelength Set
Grating Set
Spectrometer Handle
Grating
I16
GRATING
STATUS
1
Grating Set
TF
Wavelength
DBL
WAVELEN
1
Wavelength Set
TF

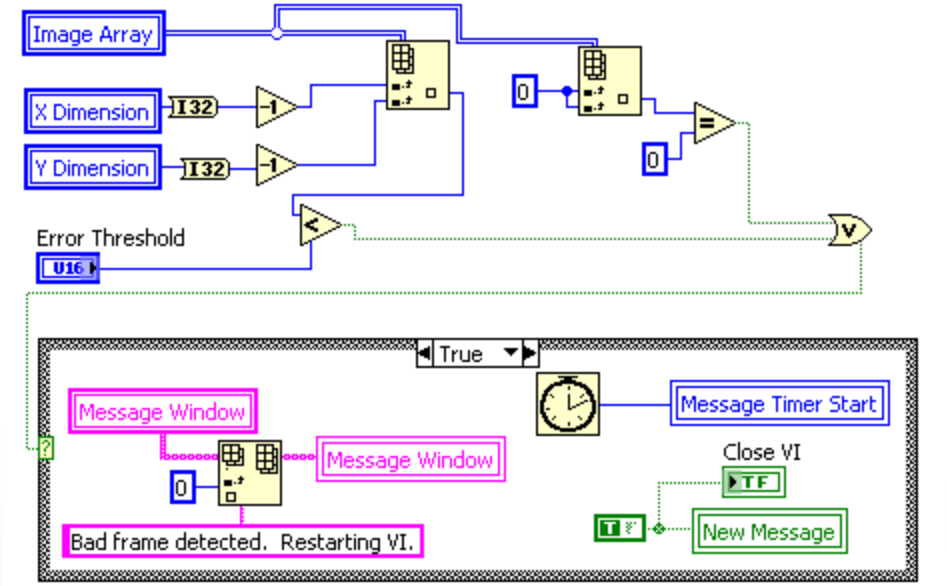
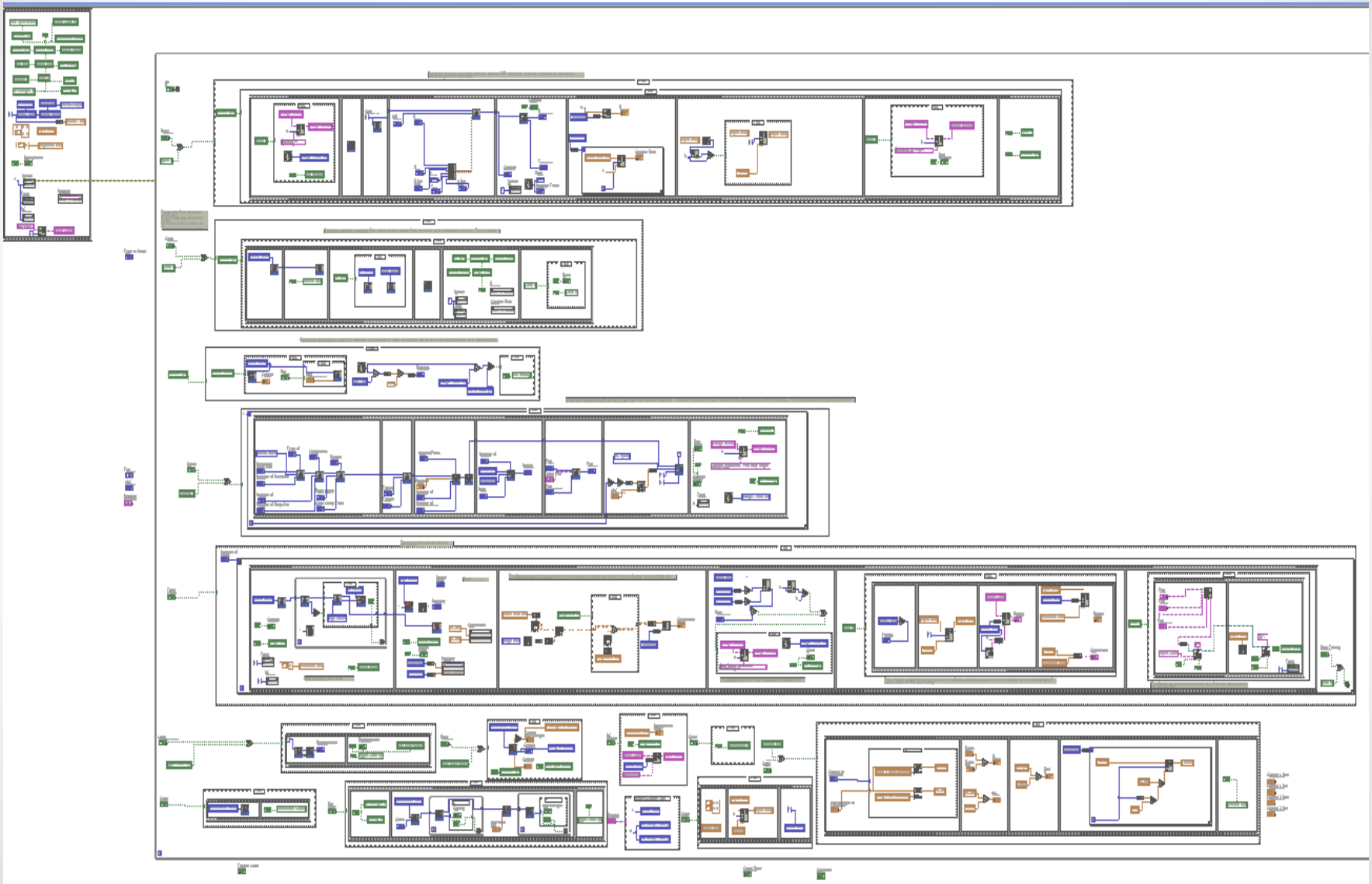
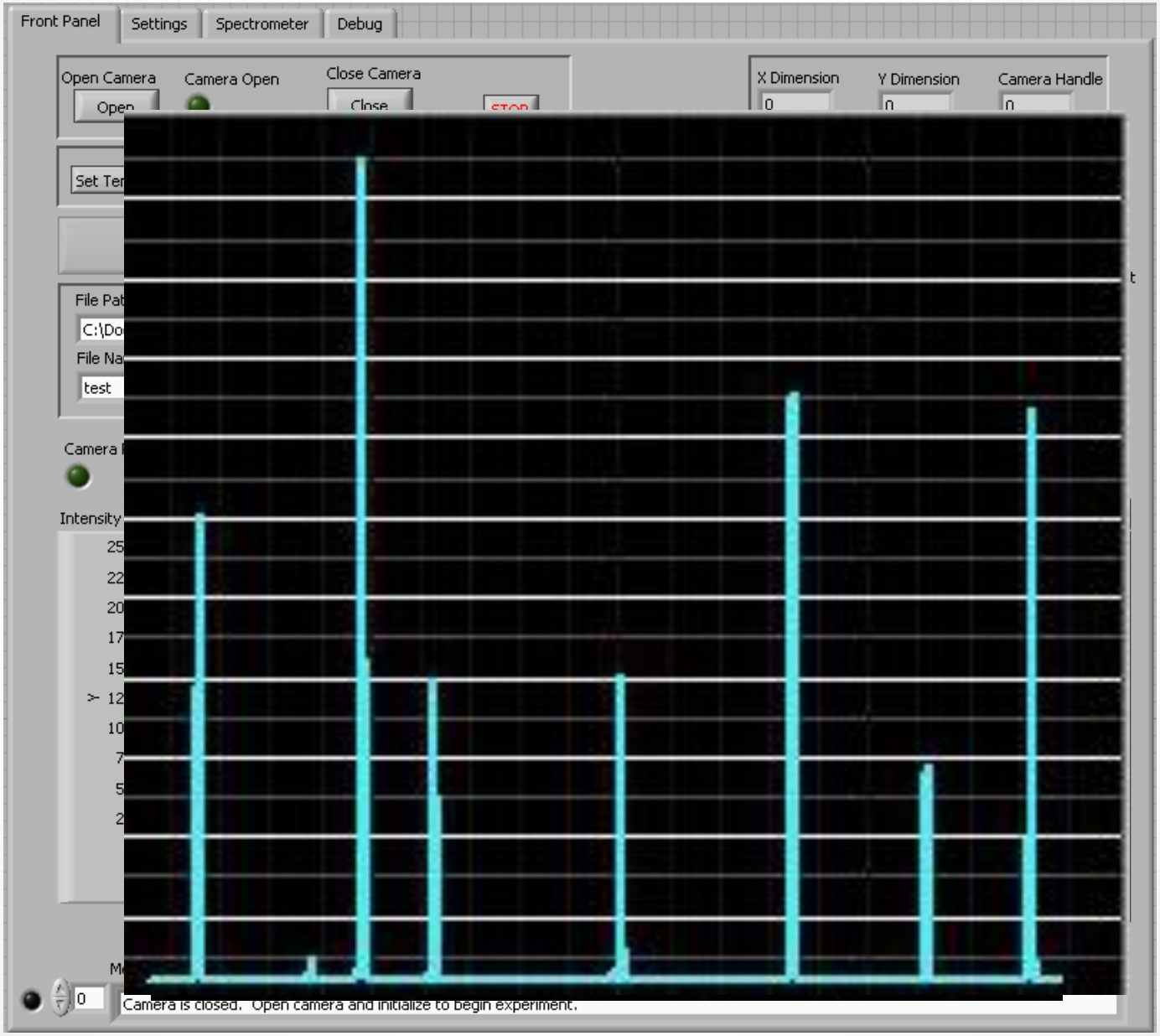


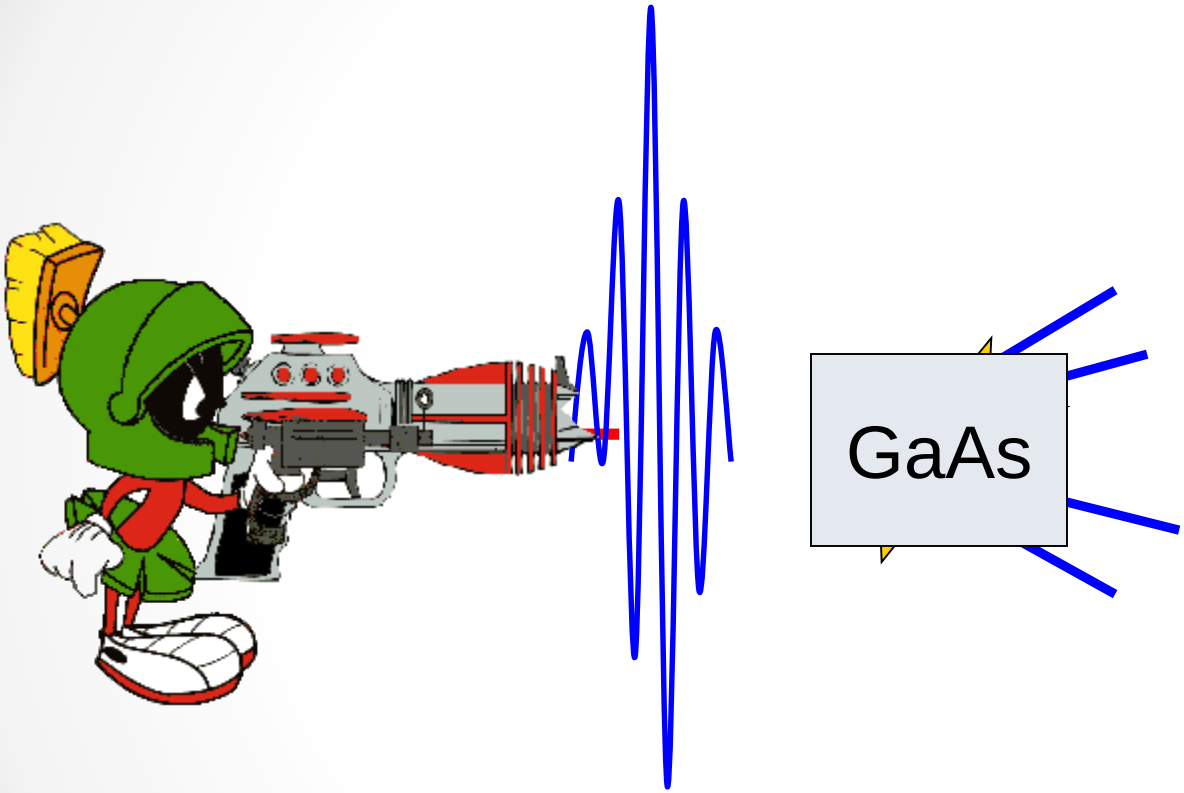
Image Array
X Dimension
I32
Y Dimension
I32
Error Threshold
U16
0
0
True
Message Window
Message Window
0
Bad frame detected. Restarting VI.
Message Timer Start
Close VI
TF
New Message
This frame checks for bad images and restarts the VI if it finds one

LabVIEW

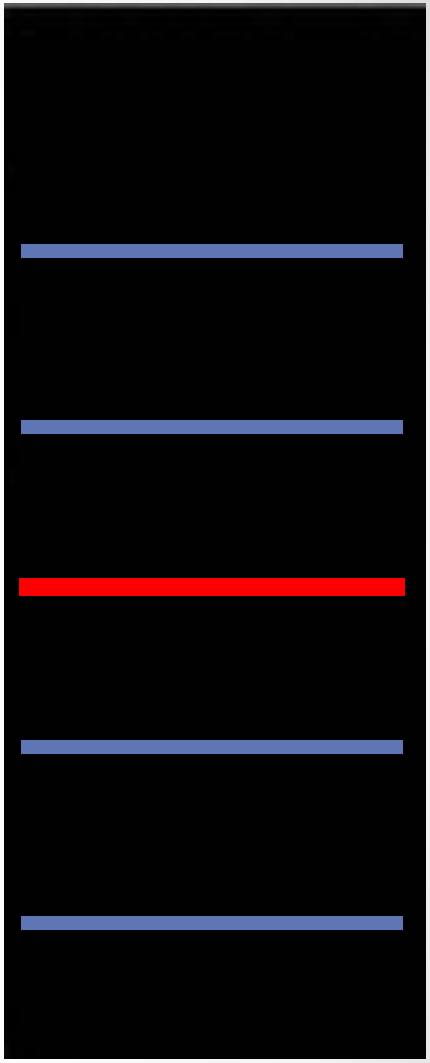


Front Panel

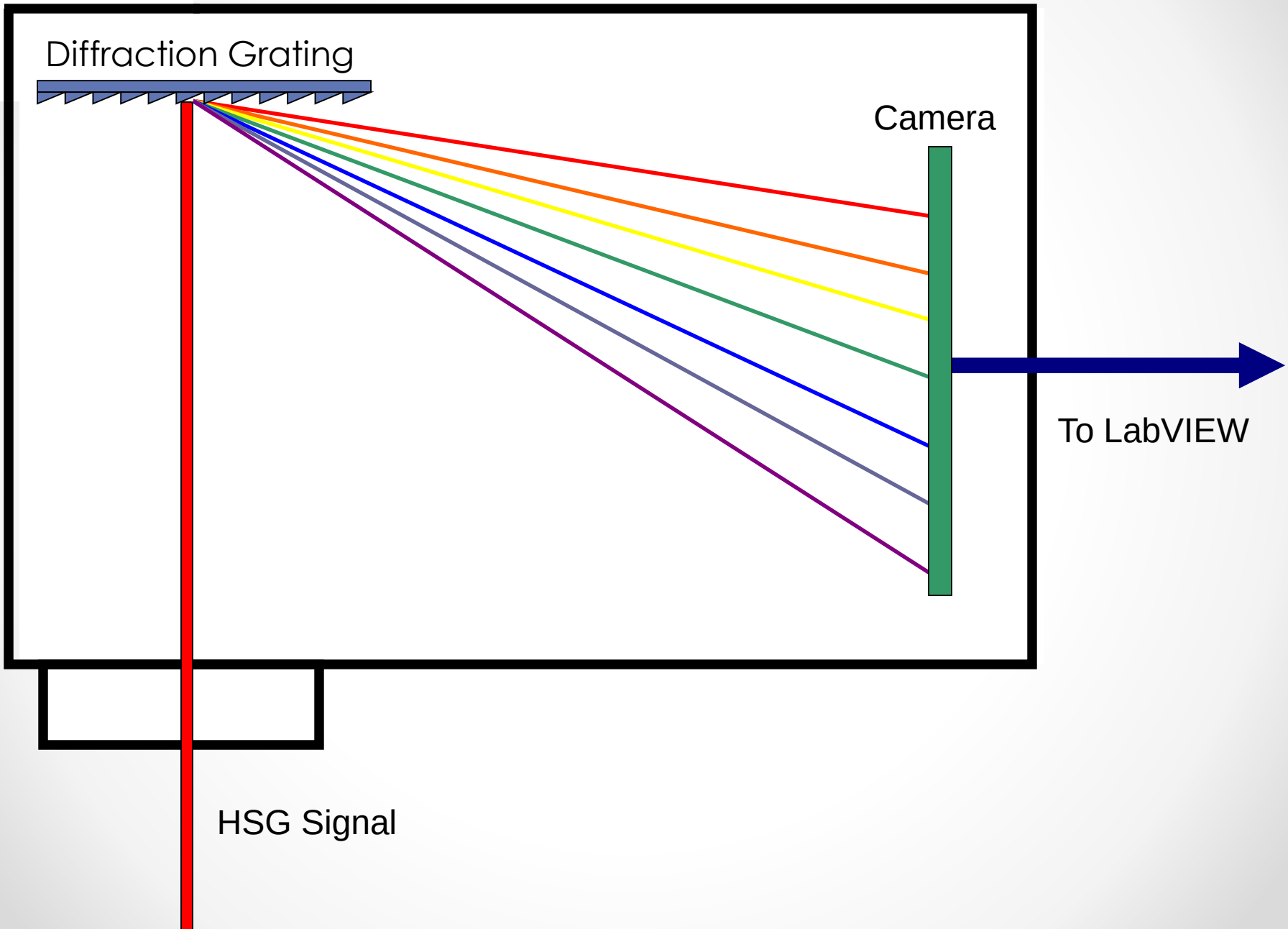

Front Panel
Settings
Spectrometer
Debug
Open Camera
Open
Camera Open
Close Camera
Close
STOP
X Dimension
Y Dimension
Camera Handle
Set Ter
File Pat
C:\Do
File Na
test
Camera
Intensity
25
22
20
17
15
12
10
7
5
2
0
Camera is closed. Open camera and initialize to begin experiment.



GaAs



Camera Setup



Front Panel


Front Panel
Settings
Spectrometer
Debug
Open Camera
Open
Camera Open
Close Camera
Close
STOP
X Dimension
0
Y Dimension
0
Camera Handle
0
File Open
Image Exists
Camera Started
Photos Taken
0
Seconds Elapsed
0
Current Temp
0
Set Temperature
New Temperature
-120
Exposure Time
0.1
Initialize
Reinitialize whenever settings are changed
File Path
C:\Documents and Settings\hbanks\Desktop\Jordan\HSG VIs\
File Name
test
File Extension
tsv
Set Current As Background Image
Background Set
Clear Background
Shutter Setting
Camera Ready
Number of Shots
1
Take Photo
Stop Taking Photos
This may take a few seconds to register
Intensity Graph
Y
X
Amplitude
-1379
-750
-412
Condensed Plot
Plot 0
Amplitude
Wavelength
614.165
620
625
629.172
Message Window
0
Camera is closed. Open camera and initialize to begin experiment.

Acknowledgements

Mark Sherwin – Principle Investigator

Hunter Banks - Mentor

Dave Enyeart – Master of the FEL

The Sherwin Group

References

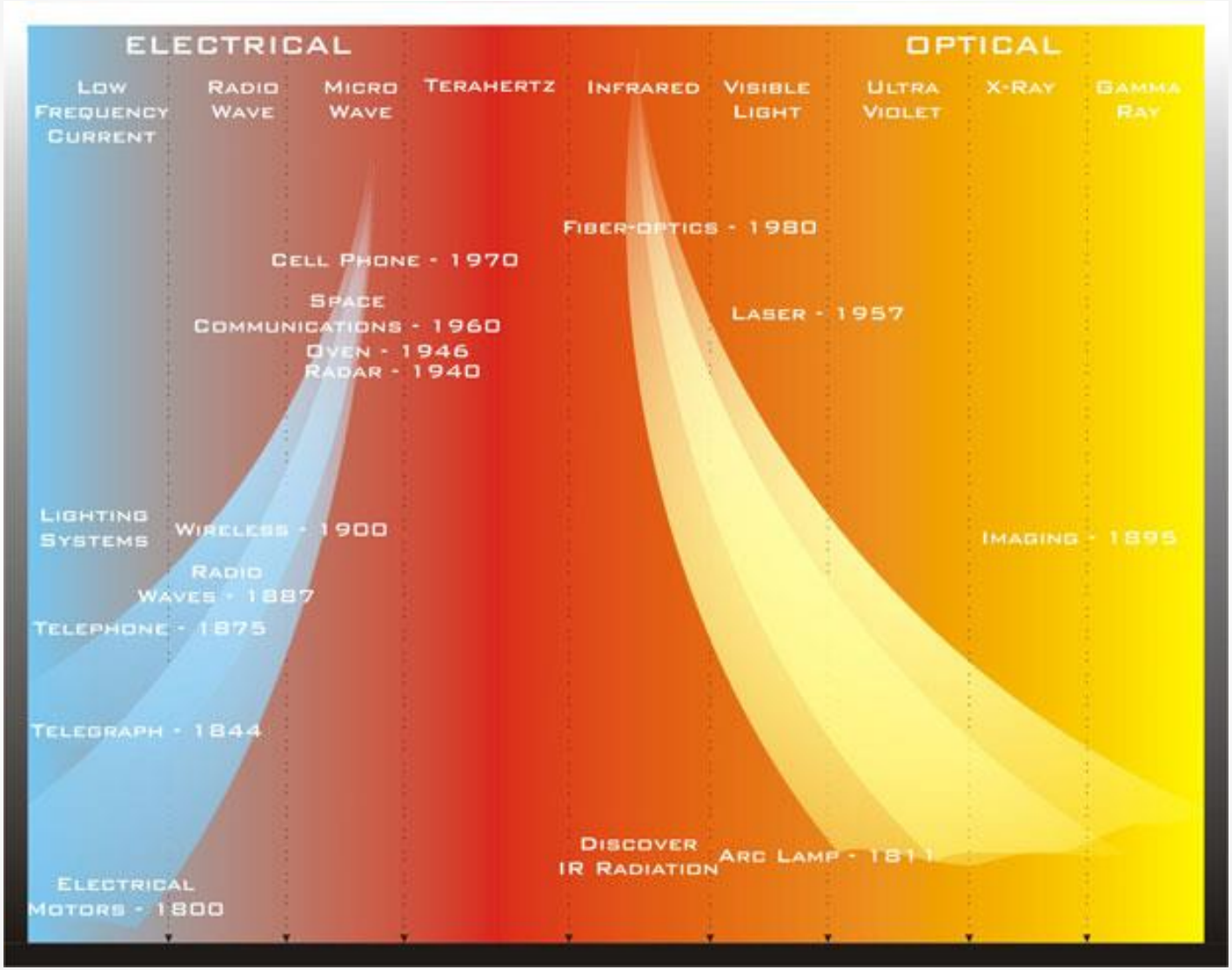
Images

- **THz Gap 1:** http://www.nature.com/nature/journal/v417/n6885/fig_tab/417132b_F1.html
- **THz Gap 2:** http://circe.lbl.gov/THzGap.html
- **THz Gap 3:** http://www.teraphysics.com/understanding-thz.html
- **CMB:** http://invisibles.eu/index.php?q=attached_image/4288&fid=3918
- **FEL:** http://sherwingroup.itst.ucsb.edu/facilities.html
- **EM Spectrum**: http://www.lbl.gov/MicroWorlds/ALSTool/EMSpec/EMSpec2.html
- **Body Scanner:** Property of the Transportation Security Administration
- **Marvin the Martian** is property of Warner Brothers
- **Reese Witherspoon's sidebangs**: Andreas Rentz / Getty Images

Information

- http://www.ece.ucsb.edu/Faculty/rodwell/research_group/highfreq.html
- http://www.teraphysics.com/understanding-thz

Thanks!


ELECTRICAL
OPTICAL
Low Frequency Current
Radio Wave
Micro Wave
Terahertz
Infrared
Visible Light
Ultra Violet
X-Ray
Gamma Ray
Fiber-optics - 1980
Cell Phone - 1970
Space Communications - 1960
Oven - 1946
Radar - 1940
Laser - 1957
Lighting Systems
Wireless - 1900
Imaging - 1895
Radio Waves - 1887
Telephone - 1875
Telegraph - 1844
Discover IR Radiation
Arc Lamp - 1811
Electrical Motors - 1800