Midterm Demo

ECOspec

Microplastic Detection via Raman Spectroscopy

GROUP #6

OVERVIEW OF SYSTEM

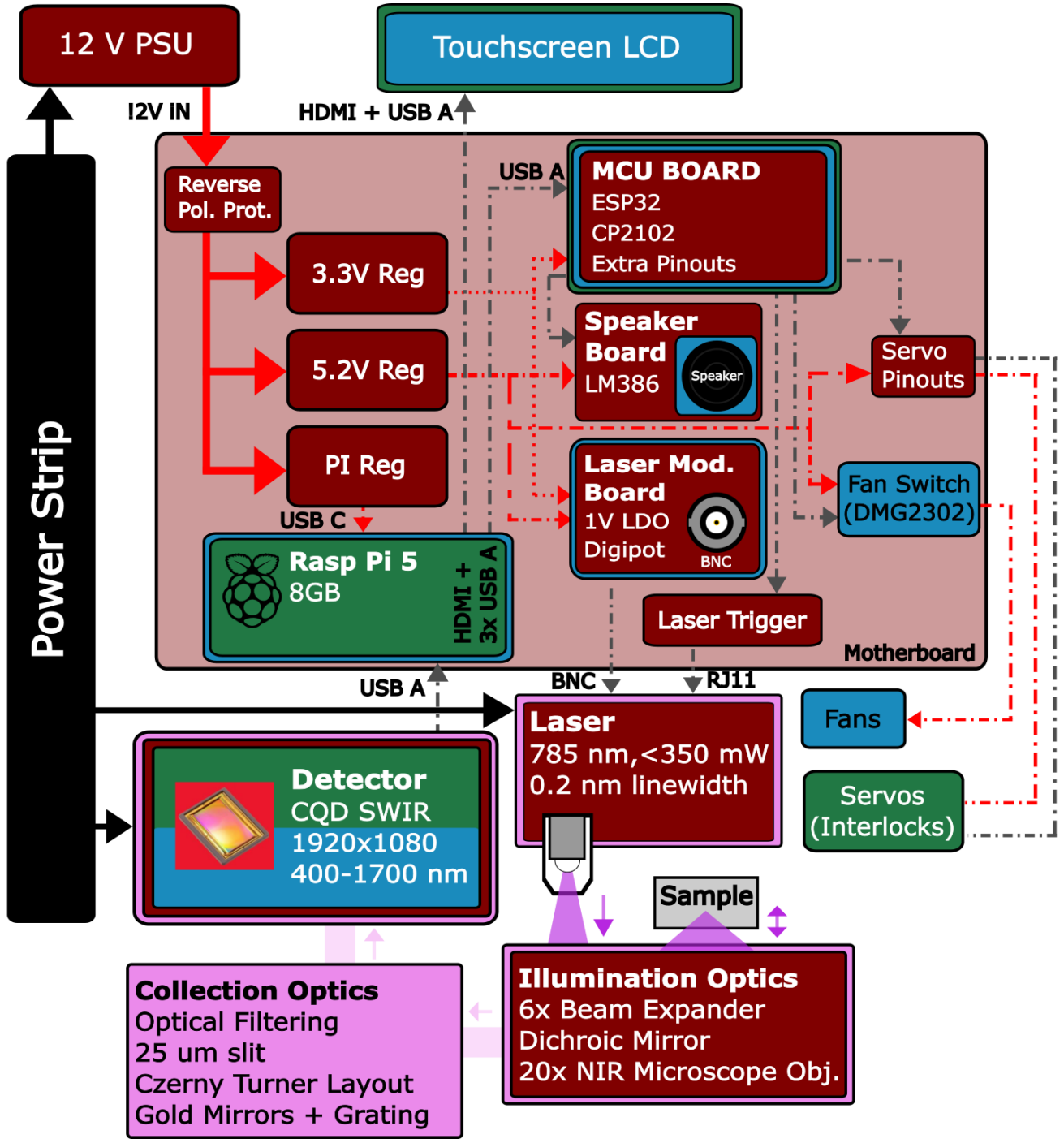
UCF-SD2-sp2026-G6-ECOspec

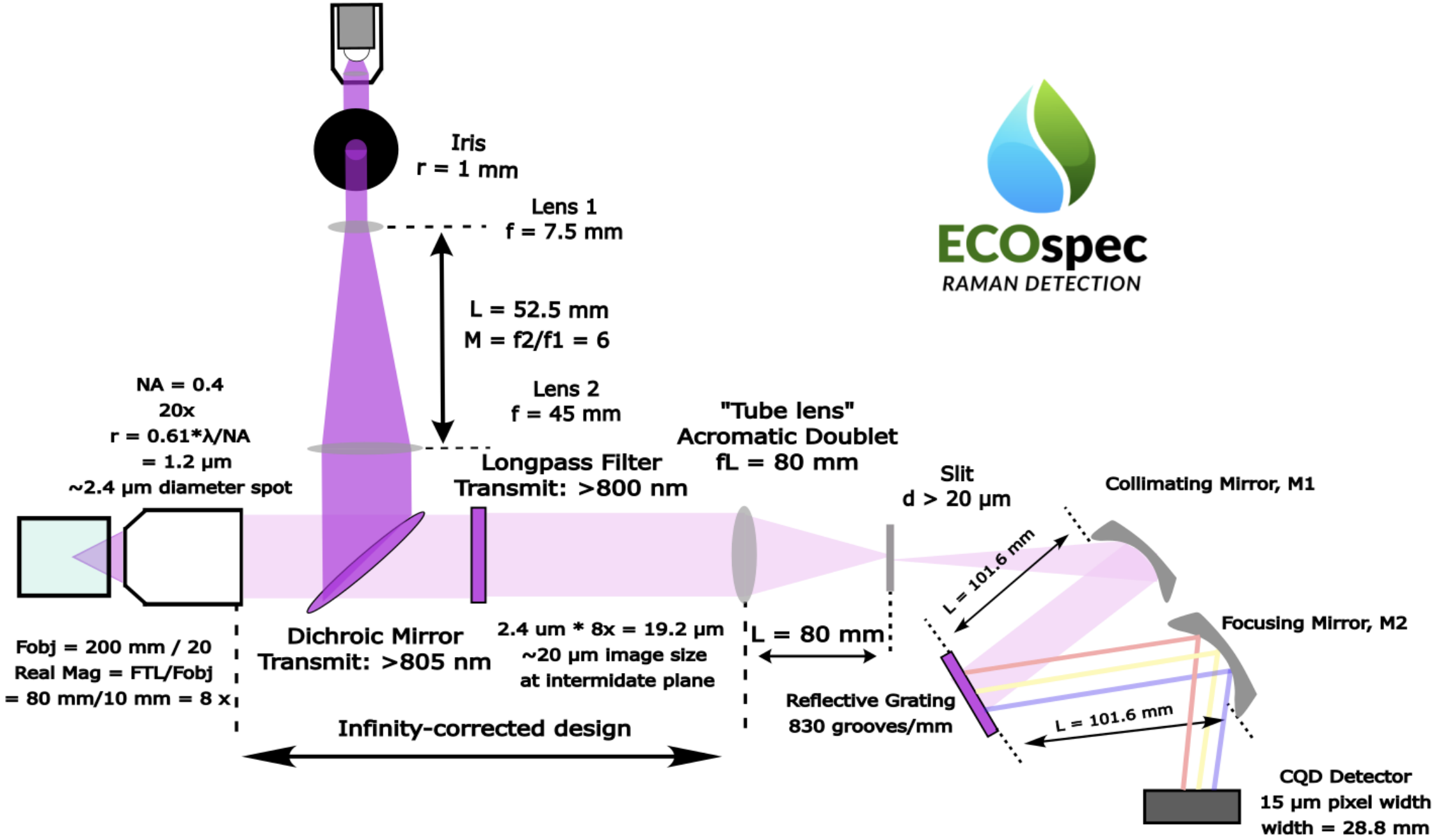
Hardware Block Diagram

ECOspec
RAMAN DETECTION

Role
- Sophia (PSE)
- Michael (PSE/EE)
- Landon (CPE)
- Logan (CPE)

Connections
- 120 V AC
- 12 V DC
- 5.2 V DC
- 3.3 V DC
- DATA
- 785 nm Laser
- Raman Scattering




Iris
r = 1 mm
Lens 1
f = 7.5 mm
L = 52.5 mm
M = f2/f1 = 6
Lens 2
f = 45 mm
NA = 0.4
20x
r = 0.61*λ/NA
= 1.2 µm
~2.4 µm diameter spot
Longpass Filter
Transmit: >800 nm
"Tube lens"
Acromatic Doublet
fL = 80 mm
Slit
d > 20 µm
Collimating Mirror, M1
L = 101.6 mm
Focusing Mirror, M2
Fobj = 200 mm / 20
Real Mag = FTL/Fobj
= 80 mm/10 mm = 8 x
Dichroic Mirror
Transmit: >805 nm
2.4 um * 8x = 19.2 µm
~20 µm image size
at intermidate plane
L = 80 mm
Reflective Grating
830 grooves/mm
L = 101.6 mm
Infinity-corrected design
CQD Detector
15 µm pixel width
width = 28.8 mm

ENGINEERING SPECIFICATIONS

Engineering Requirement	Specification	Unit
High spectral resolution so common polymer raman peaks can be resolved clearly with enough detail to distinguish one from the other for plastic identification purposes.	< 10	nm
The user needs to know the **smallest size of microplastic the system can detect.**	500	um
The device must perform collection and analysis in a reasonable **time frame**	<60	s
Wavelength range must fit the excitation laser wavelength and appropriate expected raman shift.	800 – 1020	nm
The **identification** accuracy of the processing software must be at a reliable level.	>70%	N/A
Dimensions of device needs to remain user friendly and reasonable.	< 50 x 100 x 100	cm x cm x cm

SPEC 1 – COLLECTION TIME

SPEC 1 – COLLECTION TIME & ILLUMINATION OPTICS

Polystyrene Peaks (cm^{-1})
613
778.4
983.2
1100
1305
1416

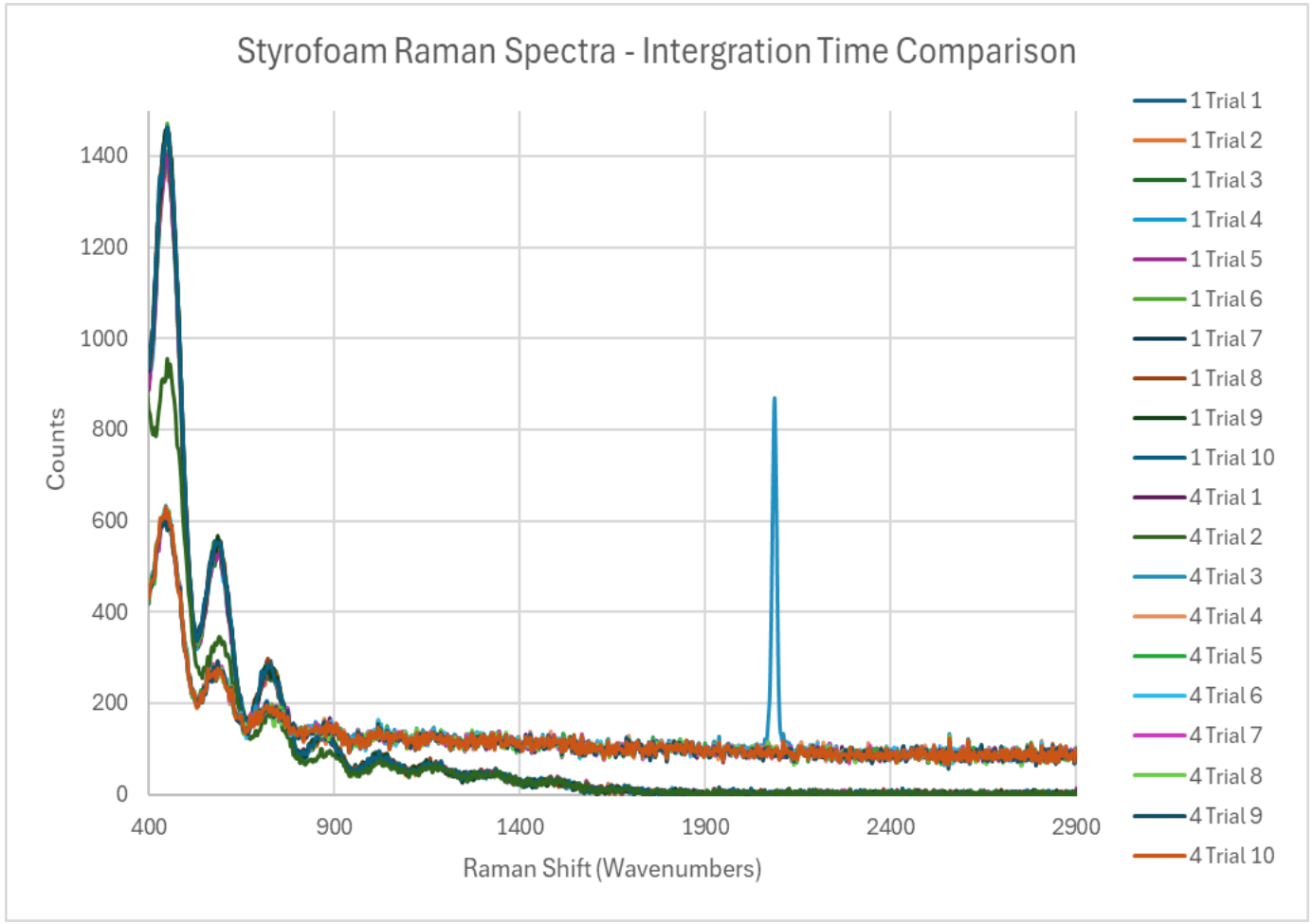
Table of identifying peaks of polystyrene

Illumination optics w/ QE Pro Spectrometer

10 Captures at 1 Second Integration time

10 captures at 4 sec integration time

Spectra is not fluorescent corrected



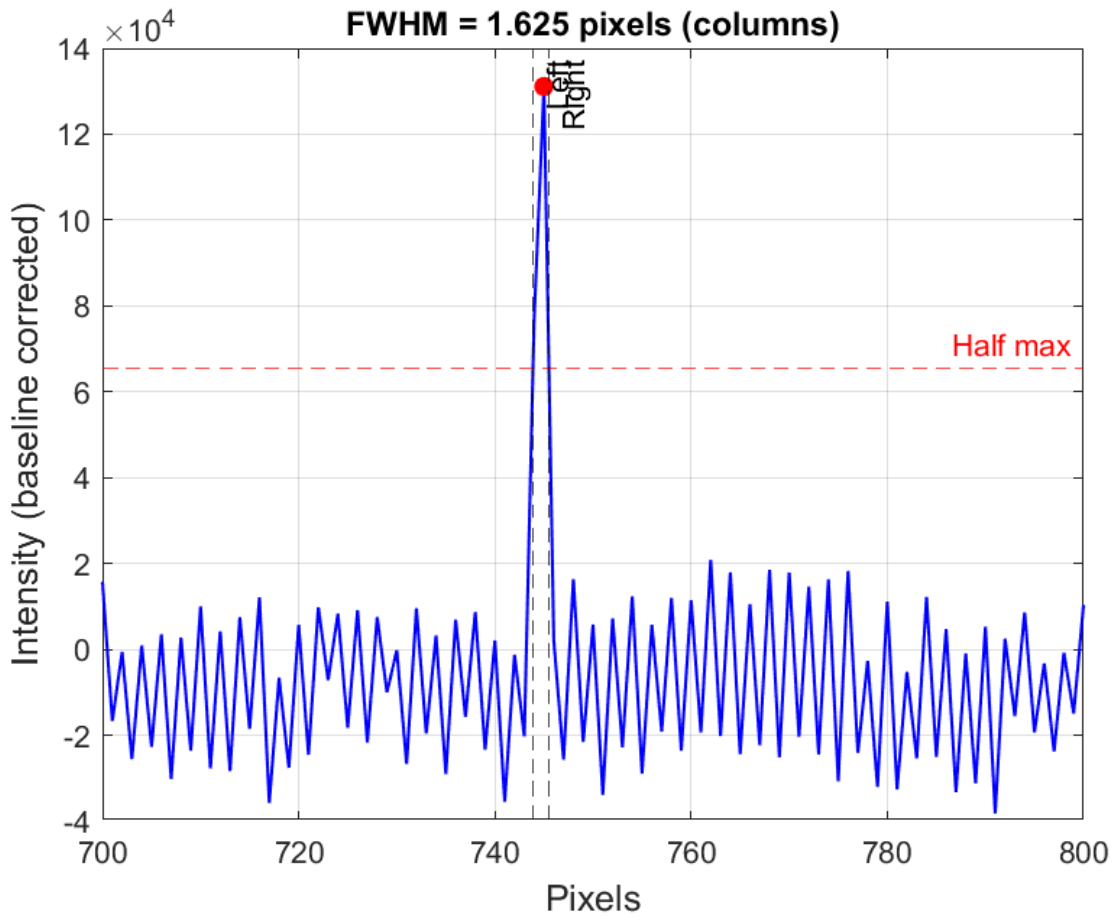
SPEC 2 – SPECTRAL RESOLUTION (FWHM)

TEST 2 PLAN: RESOLUTION

FWHM			
Trial	Px	nm	cm^{-1}
1	1.625	0.273	4.435
2	1.618	0.271	4.416
3	1.628	0.274	4.443
4	1.625	0.273	4.435
5	1.635	0.275	4.462
6	1.630	0.274	4.448
7	1.626	0.273	4.437
8	1.626	0.234	4.437
9	1.634	0.275	4.459
10	1.620	0.272	4.421

Avg FWHM: 0.273 nm, 4.44 cm^{-1}

FWHM Resolution Test with 785 nm laser



SPEC 3 – IDENTIFICATION ACCURACY

TEST 3 PLAN PLASTIC IDENTIFICATION ACCURACY

- **Text**

Trial	Material	Best match	R-Value	Correct
1 (live)	Nylon	Nylon	0.8931	Yes
2	Nylon	Nylon	0.7682	Yes
3	Nylon	PET	0.3956	No
4 (live)	PET	PET	0.5678	Yes
5	PET	Nylon	0.4527	No
6	PET	PET	0.5539	Yes
7 (live)	Polystyrene	Polystyrene	0.8276	Yes
8	Polystyrene	Polystyrene	0.5695	Yes
9	Polystyrene	Polystyrene	0.6742	Yes
10	Polystyrene	Nylon	0.4029	No