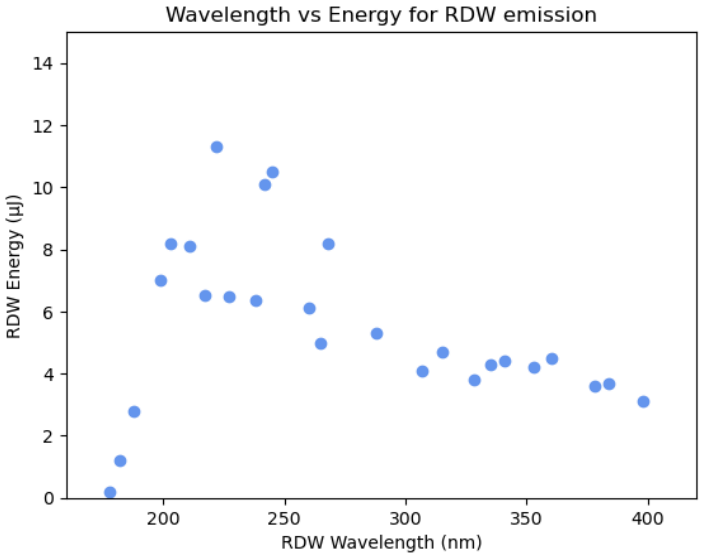
Initial Tuning Chart and Graphs for Neon

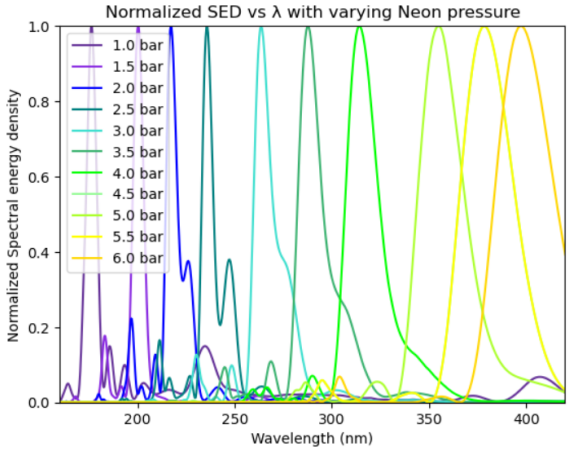
Neon Pressure (bar)	Pulse Energy (μJ)	λ_{zd} (nm)	λ_{RDW} (nm)	λ_{RDW} Pulse Duration (fs)	RDW Energy (μJ)	Conversion Efficiency (%)
1.0	200	490	178	10.40	0.2	0.1
1.1	200	510	182		1.2	0.6
1.2	200	520	188		2.8	1.4
1.5	200	550	199	9.27	7	3.5
1.6	200	550	203		8.2	4.1
1.8	180	560	211		8.1	4.5
2.0	155*	550	217	7.54	6.51	4.2
2.2	180	600	222		11.3	6.3
2.5	130*	610	227	7.26	6.5	5.0
2.6	150	610	242		10.1	6.7
2.7	150	620	245		10.5	7
2.8	120	620	238		6.36	5.3
2.9	120	620	260		6.12	5.1
3.0	100*	630	270	6.62	5.0	5.0
3.2	120	640	268		8.2	6.8
3.5	90*	650	288	6.99	5.31	5.9
3.7	80	670	307		4.1	5.1
4.0	80	690	315	7.07	4.7	5.9
4.2	70	700	328		3.8	5.4
4.5	70	710	335	7.16	4.3	6.2
4.7	70	720	341		4.4	6.3
5.0	65	720	353	7.49	4.2	6.5
5.3	65	730	360		4.5	6.9

5.5	55	730	378	7.06	3.6	6.6
5.7	55	740	384		3.7	6.8
6.0	50	740	398	7.67	3.1	6.3

Fiber parameters: precompressed 7.3fs and λ_0 =1025 input pulse, 1m length and 100μm radius HCF

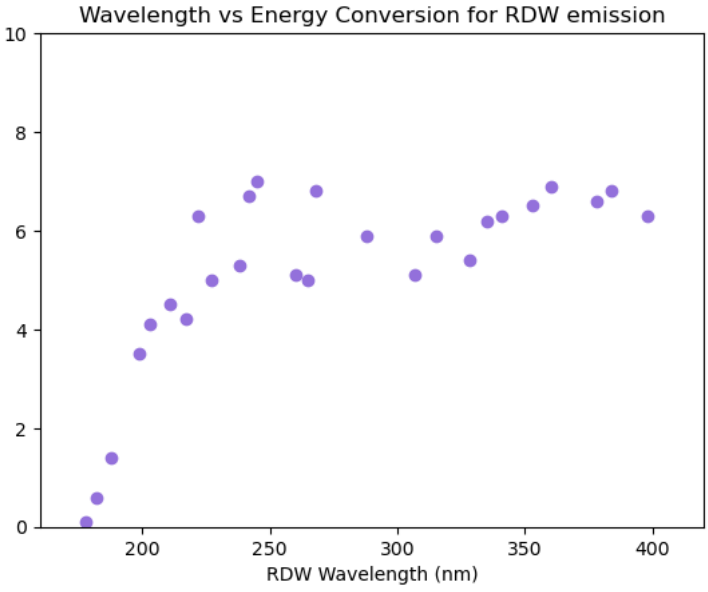
*Optimized for UV pulse to be gaussian

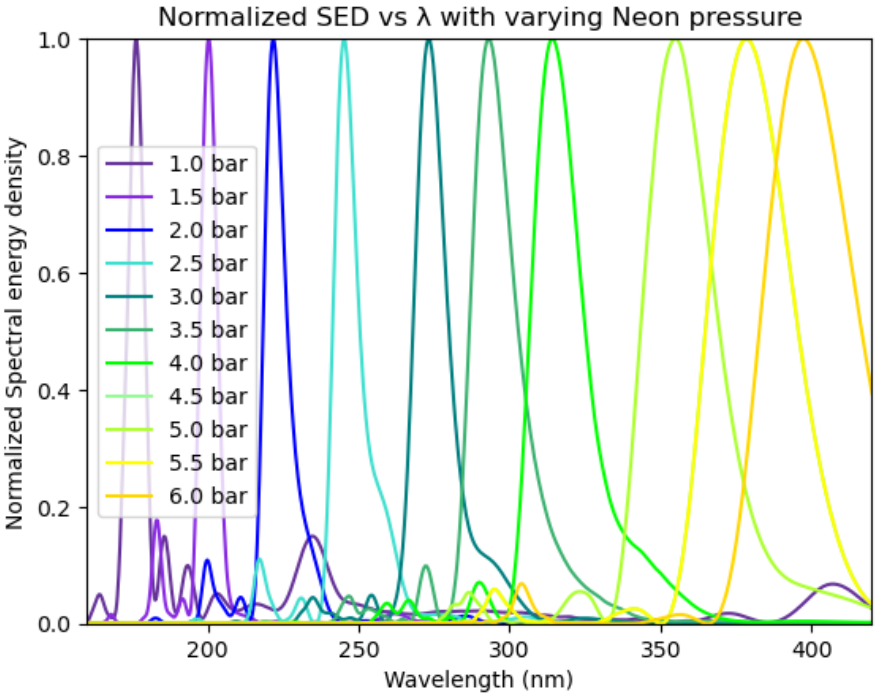




Above: before optimizing some of the energy value for specific pressures.

Below: after optimizing (colors for 2.5 and 3.0 bar switched)

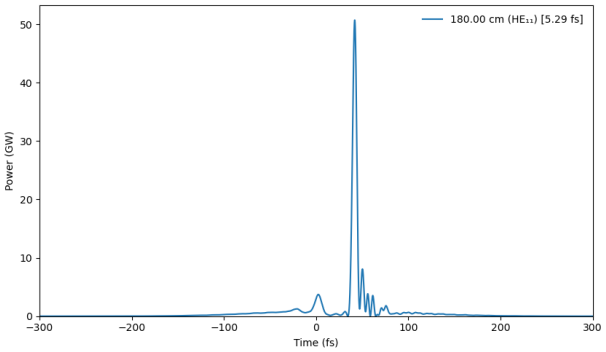


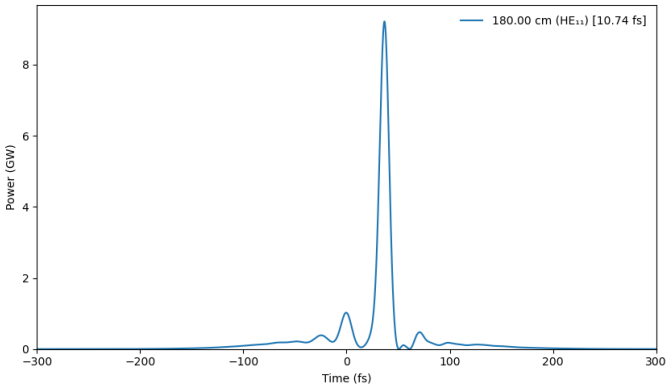


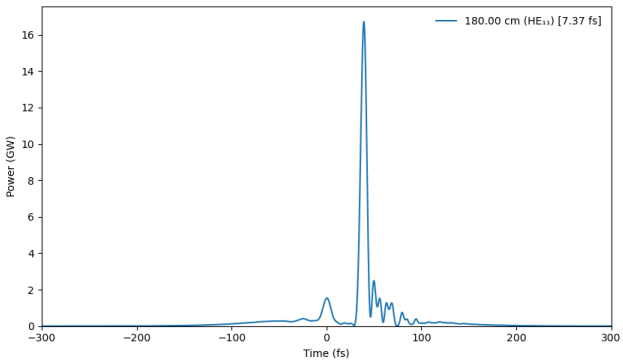
Parameters to tune Pulse Duration Out of 2nd Fiber

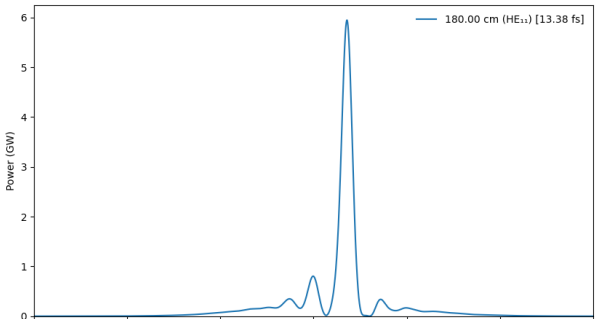
From First Fiber (pressure, energy, output FWHM)	Input Pressure (bar)	Input Energy (μJ)	Output FWHM (fs)	Gas
2.7, 340, 20.90	5.5	550	5.29	Neon, 2 chirp mirrors
2.7, 340, 20.90	0.7	250	7.37	Argon
2.7, 340, 20.90	0.5	200	9.21	Argon
2.7, 340, 20.90	0.4	180	10.74	Argon
2.7, 340, 20.90	0.3	145	13.38	Argon
2.7, 340, 20.90	0.2	130	15.89	Argon

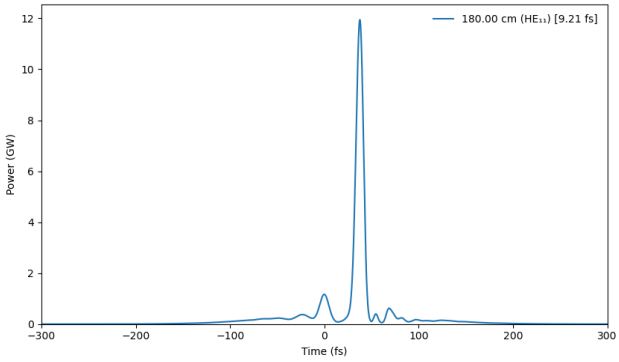
Tuning the output pulse duration in the second fiber with 268μm core radius, 1.8m length

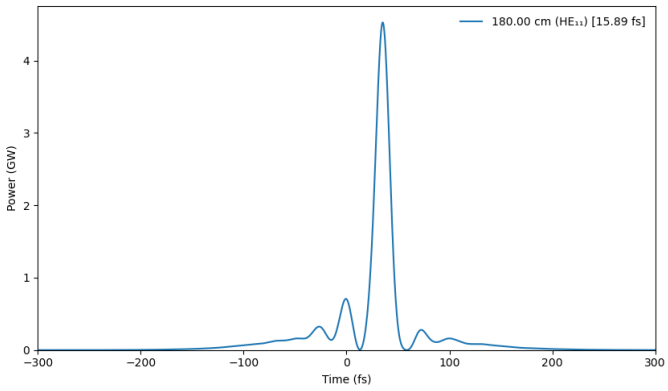












Pulse Duration Dependence of Neon

Neon Pressure (bar)	Pulse Energy (μJ)	Input Pulse Duration (fs)	λ_{zd} (nm)	λ_{RDW} (nm)	λ_{RDW} Pulse Duration (fs)	RDW Energy (μJ)	Conversion Efficiency (%)
1.0	155	5.29	490	185	4.63	0.16	0.10
1.0	200	7.37	490	176	8.48	0.2	0.09
1.0	260	9.21	490	185**	11.64	8.84	3.4
1.0	210	10.74		*			
1.0	320	13.38		***			
1.0	350	15.89		*			
2.0	135	5.29	580	223	7.74	5.1	3.8
2.0	155	7.37	580	223	7.0	6.5	4.2
2.0	165	9.21	580	218	11.64	9.9	6
2.0	165	10.74	580	221	10.52	7.3	4.4
2.0	175	13.38		225	4.82	4.9	2.8
2.0	220	15.89		225&	3.21	3.7	1.7
2.5	110	5.29					
2.5	130	7.37					
2.5	150	9.21	610	240	10.46	11.4	7.6
2.5	140	10.74					
3.0	85	5.29	640	273	8.19	2.9	3.4
3.0	100	7.37	640	272	6.62	5.1	5.1
3.0	110	9.21	640	268	9.67	7.8	7.1
3.0	110	10.74	640	272	9.35	6.1	5.5
3.0	150	13.38	650	273#	9.09	9.8	6.5
3.0	160	15.89	650	275#	3.10	5.9	3.7
3.5	75	5.29					
3.5	95	7.37					
3.5	100	9.21	670	287	9.84	8.0	8.0

3.5	105	10.74					
4.0	65	5.29	690	317	9.24	2.9	4.4
4.0	80	7.37	690	324	7.28	4.9	6.1
4.0	90	9.21		310	9.46	7.6	8.4
4.0	90	10.74	690	315	9.49	6.8	7.5
4.0	100	13.38	690	323**	4.51	5.3	5.3
4.0	135	15.89		325**	4.1	8.0	5.9
5.0	50	5.29	730	358	9.06	2.5	5.0
5.0	65	7.37	740	352	7.45	4.6	7.1
5.0	75	9.21	730	350	9.70	7.5	10
5.0	75	10.74	740	353	9.04	6.4	8.5
5.0	85	13.38	730	365**	4.80	6.0	7.1
5.0	110	15.89		373**	3.49	7.2	6.5

Neon: λ_{RDW} as a function of input pulse duration (FWHM) from the output of the 2nd fiber after compression

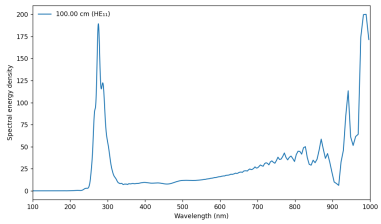
*no RDW emission

**weird trailing tail on left side of pulse, much less than the Argon though

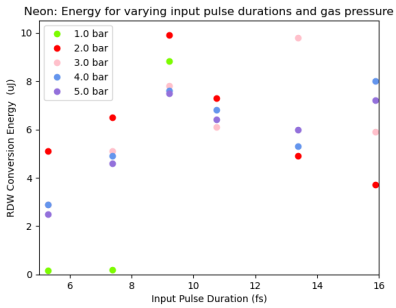
***emission but ugly shape and/or tail too pronounced

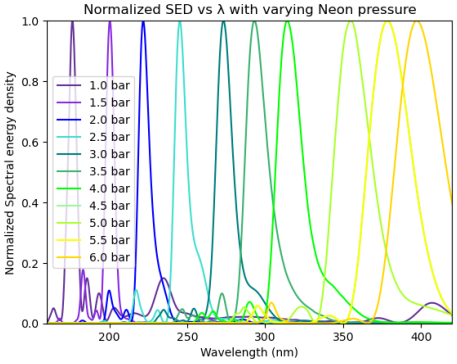
& very lumpy even with energy "optimization"

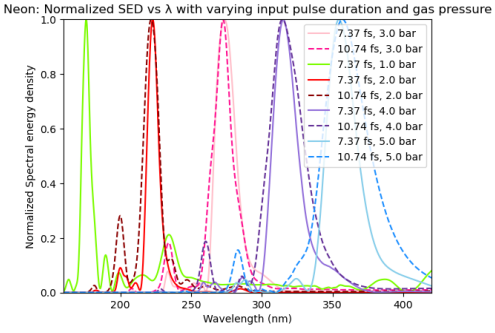
this one gave a very hard time, switch to Julia REPL and this was as optimized as I could get it >>>>>>>>>>

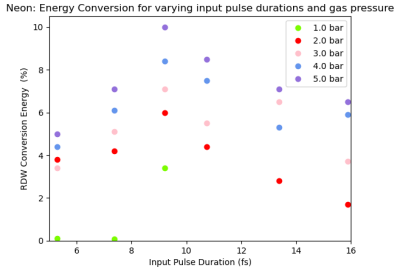


Conclusions:
The higher the pulse duration, the worse the shape (10.74fs +)
9.21 pulse consistently highest energy and energy %, easiest to optimize,
~7fs RDW pulse duration (one of the highest on average)









Pulse Duration Dependence of Helium: 3.0 bar, ~180nm

Helium Pressure (bar)	Pulse Energy (μJ)	Input Pulse Duration (fs)	λ_{zd} (nm)	λ_{RDW} (nm)	λ_{RDW} Pulse Duration (fs)	RDW Energy (μJ)	Conversion Efficiency (%)
1.0	300	5.29	410	128#	3.28	0.0014	0.0005
1.5	250	5.29	450	144	11.42	0.75	0.3
1.5	270	7.37	450	143	14.22	0.54	0.2
1.5		9.21					
1.5		10.74					
1.5		13.38					
1.5		15.89					
2.0	230	5.29	470	158	10.40	2.99	1.3
2.0	250	7.37	470	157	8.63	5.25	2.1
2.0	225	9.21	470	154	6.17	1.58	0.7
2.0	260	10.74	470	154	5.77	3.64	1.4
2.0	290	13.38	470	155*	3.03	0.35	0.12
2.0		15.89					
2.5	210	5.29	510	168	8.41	5.88	2.8
2.5	220	7.37	510	170	8.24	7.0	3.2
2.5	225	9.21	510	168	15.73	9.23	4.1
2.5	230	10.74	510	167	9.32	7.13	3.1
2.5	280	13.38	510	168	6.29	7.84	2.8
2.5	300	15.89	510	170**	3.45	3.0	1.0
3.0	160	5.29	530	183	7.68	4.4	2.75
3.0	200	7.37	530	182	7.08	8.2	4.1
3.0	200	9.21	530	180	12.90	10.2	5.1
3.0	210	10.74	530	183	5.86	7.0	3.9
3.0	255	13.38	530	183	8.70	10.2	4.0

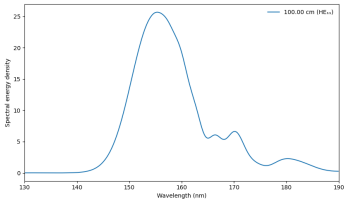
3.0	280	15.89	530	183**	4.92	8.4	3.0

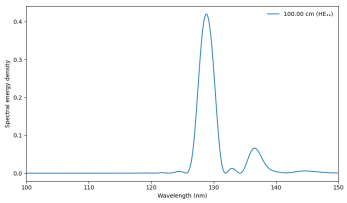
Helium: λ_{RDW} as a function of input pulse duration (FWHM) from the output of the 2nd fiber after compression

*pulse shape not nice even with attempted optimization >

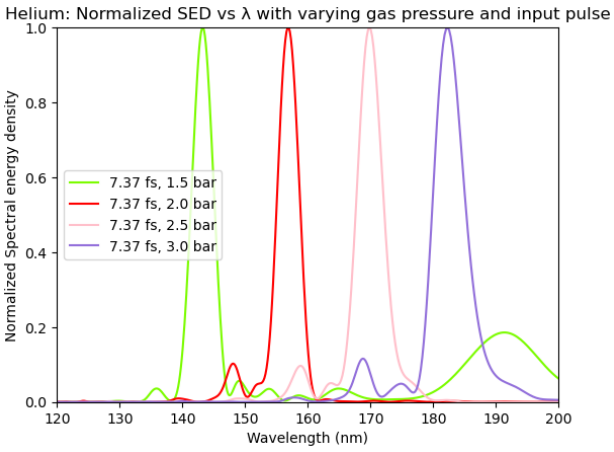
**weird trailing tail on right side of RDW pulse

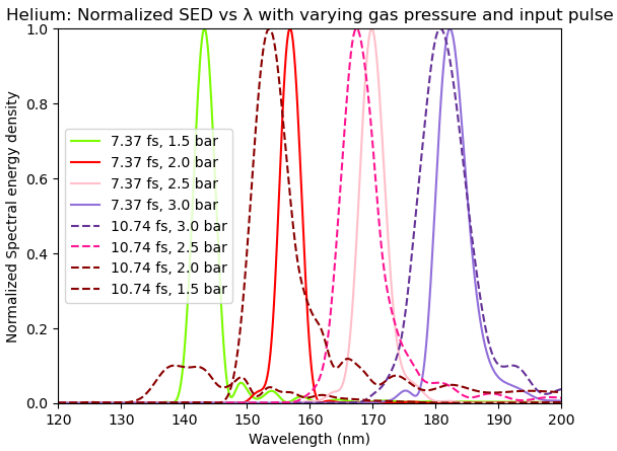
#many features in the spectra, will have to isolate UV pulse (more w/ longer wavelengths>>>





Conclusions: To drive short wavelength RDW emission, need a shorter time duration pulse but even with that, the energy is very low. After ~13fs input pulse, the RDW pulse shape distorts; as it reaches 15fs, a trailing tail remains on the right side of the RDW pulse. Shorter wavelengths have better shape with shorter input pulse duration. Longer input pulse durations are harder and have worse shape





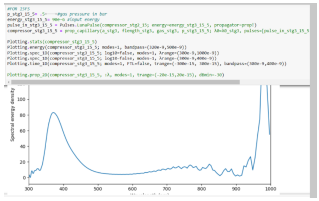
Pulse Duration Dependence of Argon

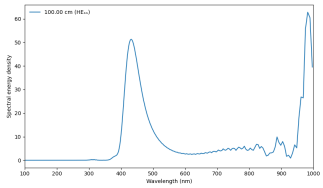
Argon Pressure (bar)	Pulse Energy (μJ)	Input Pulse Duration (fs)	λ_{zd} (nm)	λ_{RDW} (nm)	λ_{RDW} Pulse Duration (fs)	RDW Energy (μJ)	Conversion Efficiency (%)
0.4	50	5.29	740	318	9.35	2.2	4.3
0.5	40	5.29	740	357	9.09	2.1	5.3
0.5	50	7.37	740	357	7.37	3.8	7.5
0.5	60	9.21	740	350	10.42	6.1	10.1
0.5	60	10.74	740	358	8.58	6.0	10.0
0.5	70	13.38	740	364	5.89	5.6	8.0
0.5	90	15.89	740	370**	3.39	7.1	7.9
0.6	25	5.29	760	410	9.44	1.1	4.3
0.6	40	7.37	760	395	7.92	3.0	7.6
0.6	50	9.21	760	383	11.17	5.4	10.7
0.6	50	10.74	760	391**	8.89	5.0	10.1
0.6	60	13.38	760	405**	4.26	5.4	9
0.6	80	15.89	760	412**	4.06	6.8	8.5
0.7	20	5.29	800	447	10.56	0.9	4.7
0.7	30	7.37	800	438	8.82	2.3	7.6
0.7	40	9.21	800	422	10.92	4.4	11
0.7	40	10.74	800	432**	6.59	4.2	10.5
0.7	50	13.38	800	441**	4.53	4.0	8.0
0.7		15.89		***			
0.8	20	5.29	820	465**	10.17	1.2	6.0
0.8	25	7.37	820	474	8.71	2.0	8.1
0.8	35	9.21	820	452	9.68	4.2	11.9
0.8	35	10.74	820	463**	5.96	4.1	11.6
0.8		13.38		***			
0.8		15.89		***			

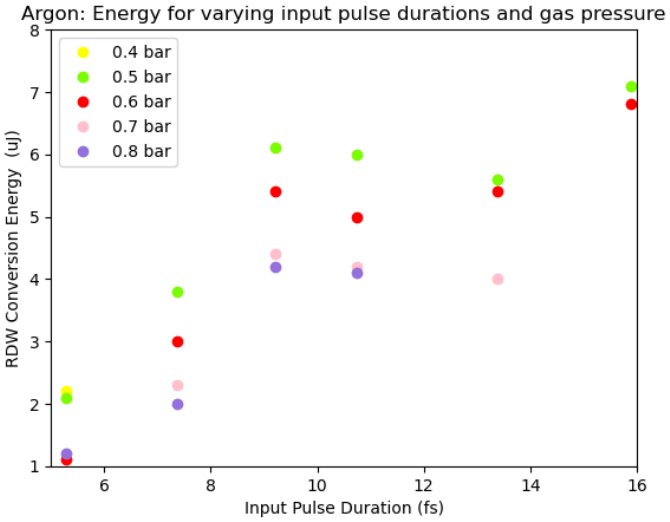
Argon: λ_{RDW} as a function of input pulse duration (FWHM) from the output of the 2nd fiber after compression

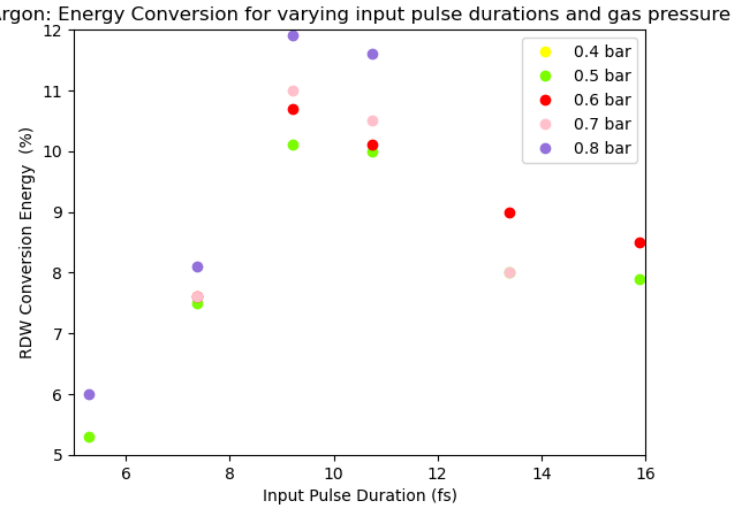
**tried optimizing the energy but a weird trailing tail remains on the right side, seems to get worse as pressure increases >>>>

***tail so bad compared to energy peak…

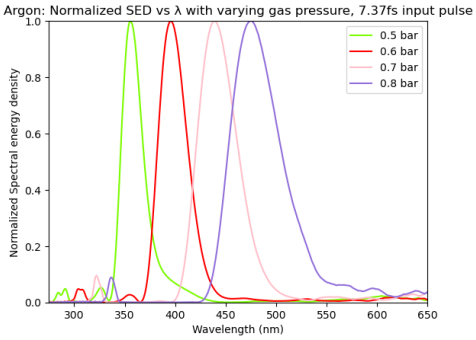


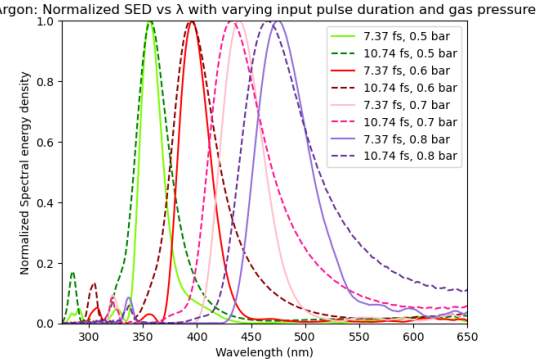






Interesting comparison of energy vs energy efficiency; while the 15.89fs pulse is less efficient, it has a higher output although it does have the weird trailing tail in the frequency domain for every value….
9.21fs has the best pulse shape and energy/energy efficiency, with the 10.74fs close behind. Although the 9.21fs had the longest RDW pulse

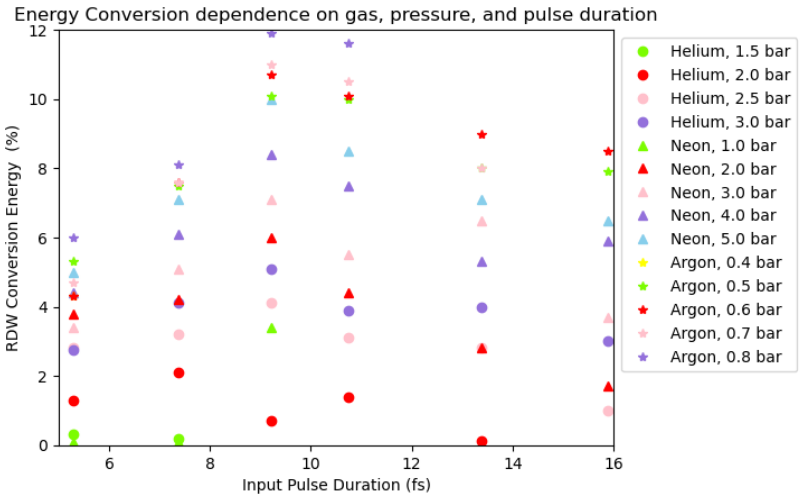


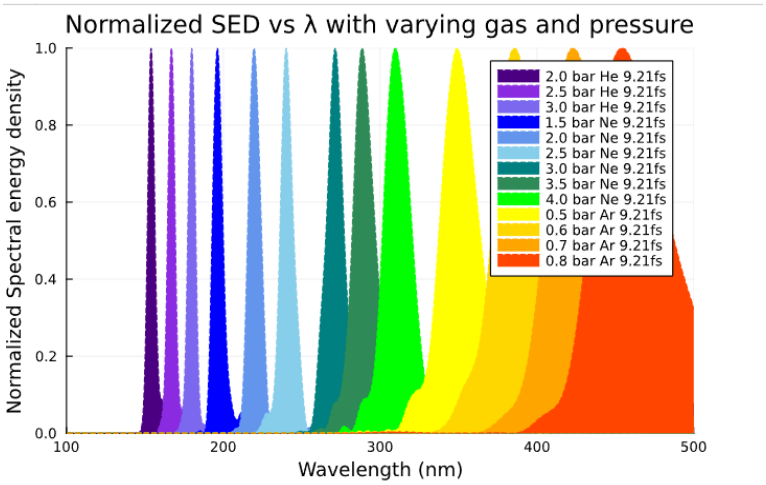


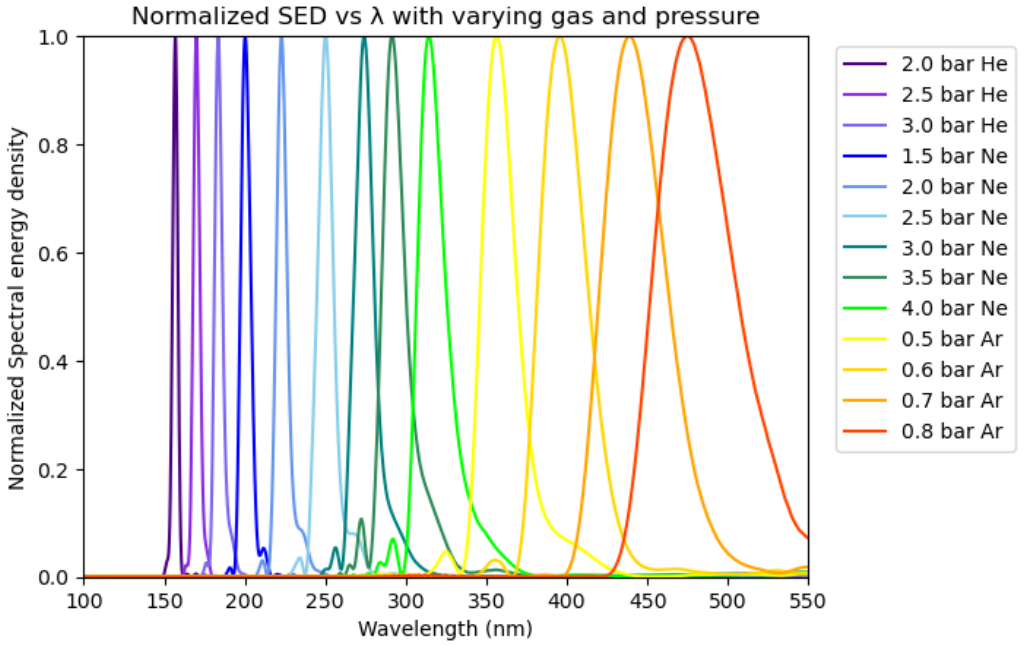
RDW Pulse time duration chart for ~9.21fs

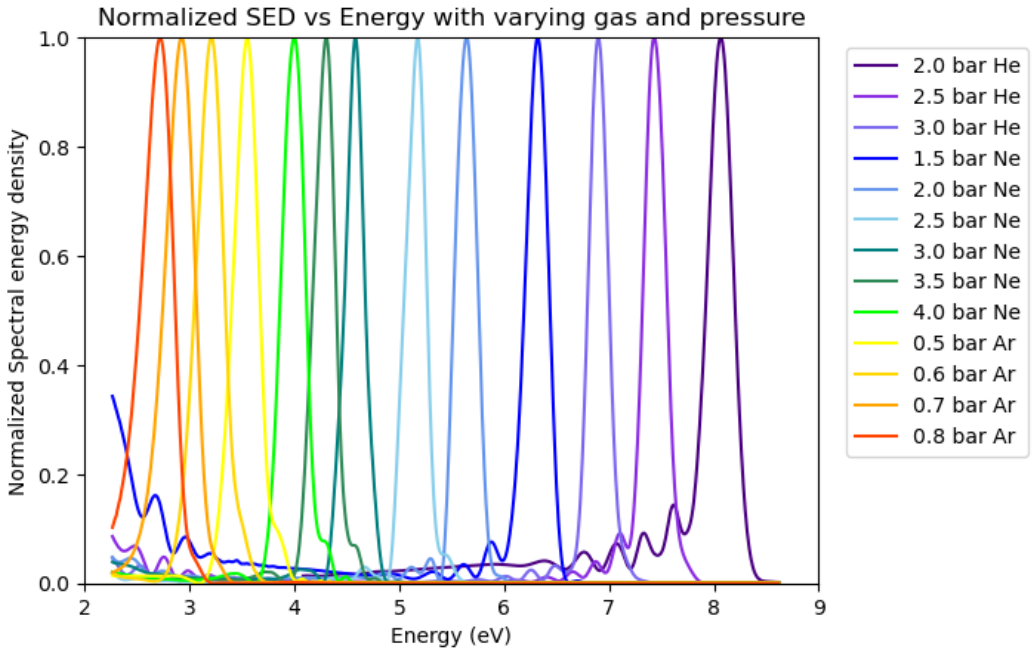
Gas, Pressure, Energy into 3rd stage	λ_{RDW} Pulse Duration FTL=false (fs)	λ_{RDW} Pulse Duration FTL=true (fs)
He, 2.0 bar, 225uJ	6.46	1.50
He, 2.5 bar, 225uJ	14.88	2.70
He, 3.0 bar, 200uJ	11.73	3.65
Ne, 1.5 bar, 175uJ	9.76	1.49
Ne, 2.0 bar, 155uJ	12.10	2.44
Ne, 2.5 bar, 150uJ	9.98	4.02
Ne, 3.0 bar, 100uJ	9.23	3.09
Ne, 3.5 bar, 100uJ	9.03	3.63
Ne, 4.0 bar, 90uJ	8.85	4.46
Ar, 0.5 bar, 60uJ	9.98	2.21
Ar, 0.6 bar, 50uJ	10.20	2.74
Ar, 0.7 bar, 40uJ	10.40	3.26
Ar, 0.8 bar, 35uJ	9.71	3.71
Average	**10.18**	**2.99**

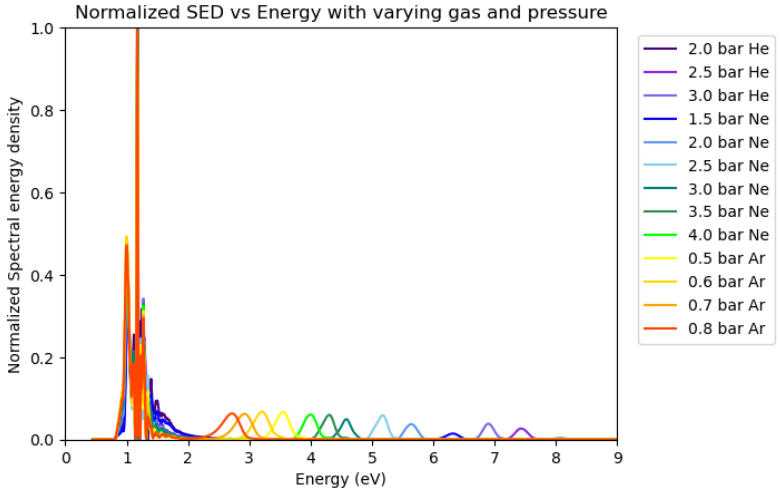
Summary: Range with various gasses: 143-474

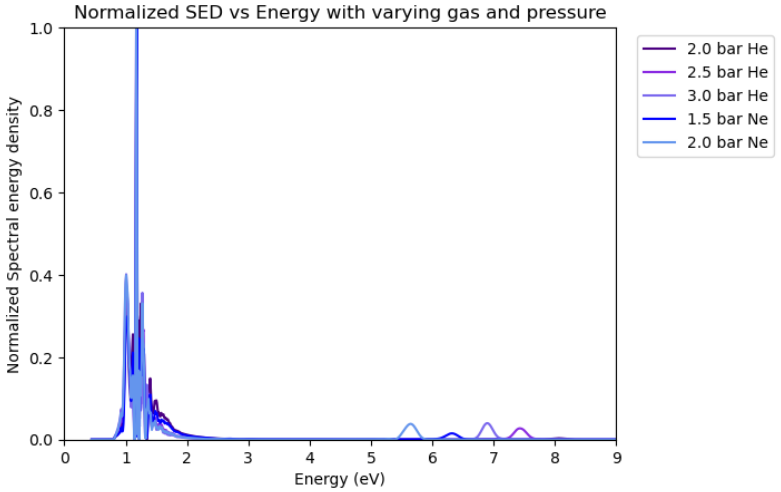


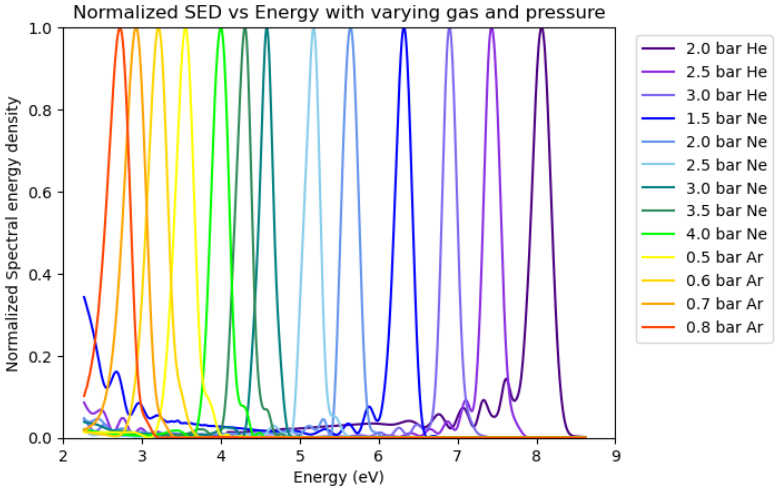


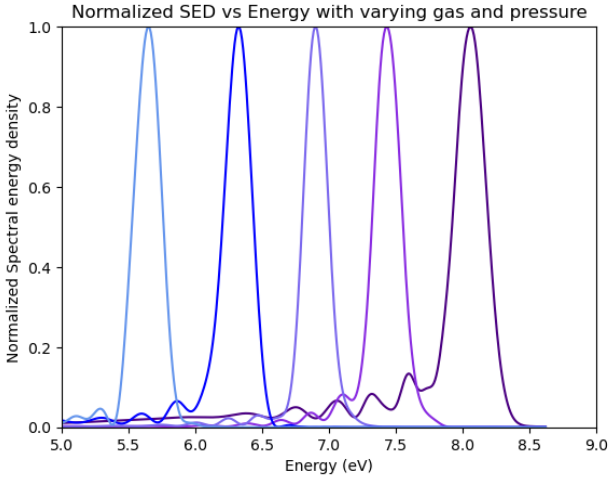


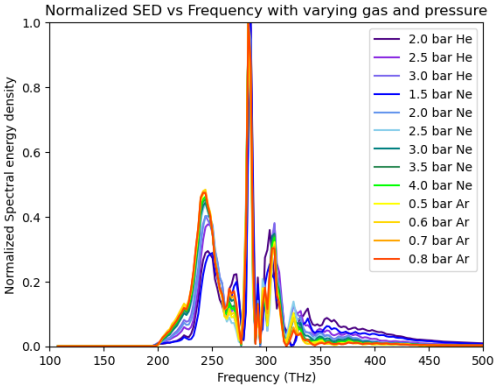


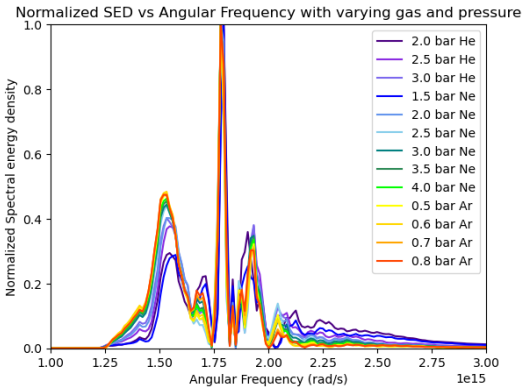

Normalized SED vs Energy with varying gas and pressure
Normalized Spectral energy density
Energy (eV)
2.0 bar He
2.5 bar He
3.0 bar He
1.5 bar Ne
2.0 bar Ne
2.5 bar Ne
3.0 bar Ne
3.5 bar Ne
4.0 bar Ne
0.5 bar Ar
0.6 bar Ar
0.7 bar Ar
0.8 bar Ar

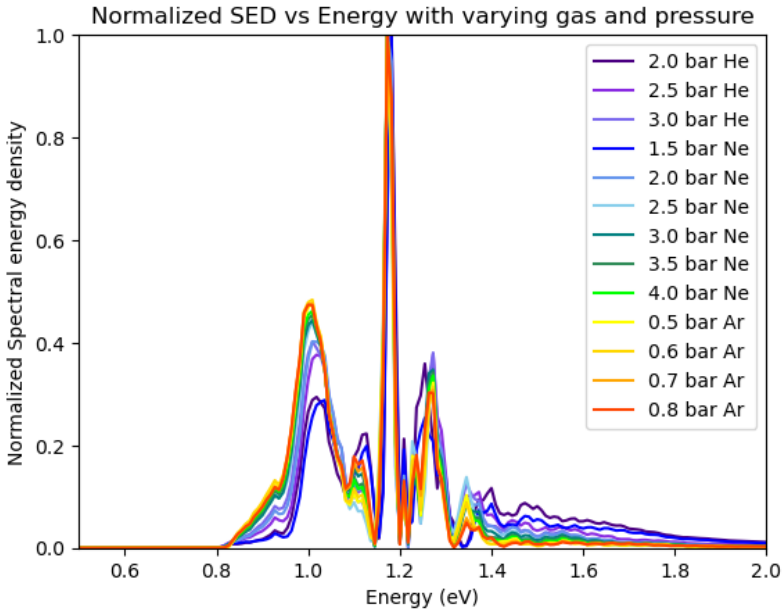

Normalized SED vs Energy with varying gas and pressure
Normalized Spectral energy density
Energy (eV)
2.0 bar He
2.5 bar He
3.0 bar He
1.5 bar Ne
2.0 bar Ne

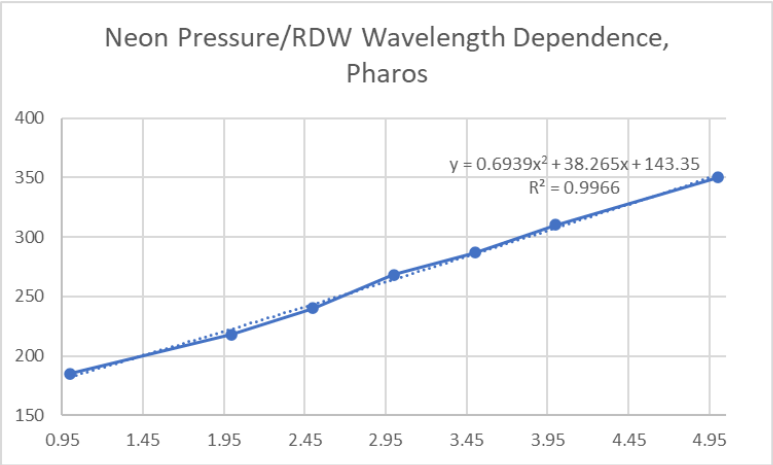

Normalized SED vs Energy with varying gas and pressure
Normalized Spectral energy density
Energy (eV)
2.0 bar He
2.5 bar He
3.0 bar He
1.5 bar Ne
2.0 bar Ne
2.5 bar Ne
3.0 bar Ne
3.5 bar Ne
4.0 bar Ne
0.5 bar Ar
0.6 bar Ar
0.7 bar Ar
0.8 bar Ar

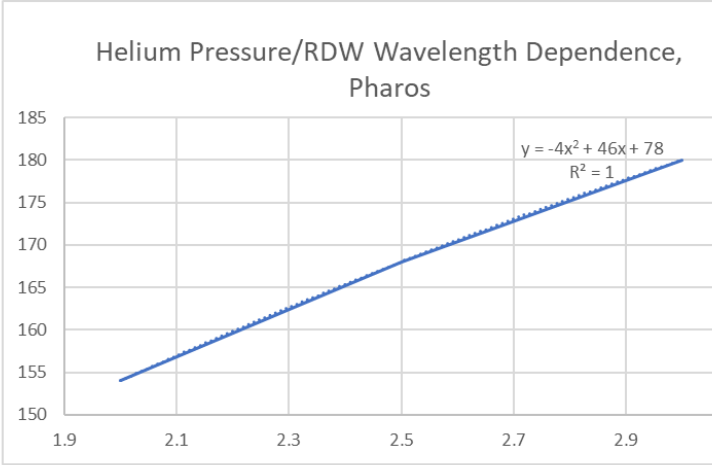

Normalized SED vs Energy with varying gas and pressure
Normalized Spectral energy density
Energy (eV)
2.0 bar He
2.5 bar He
3.0 bar He
1.5 bar Ne
2.0 bar Ne

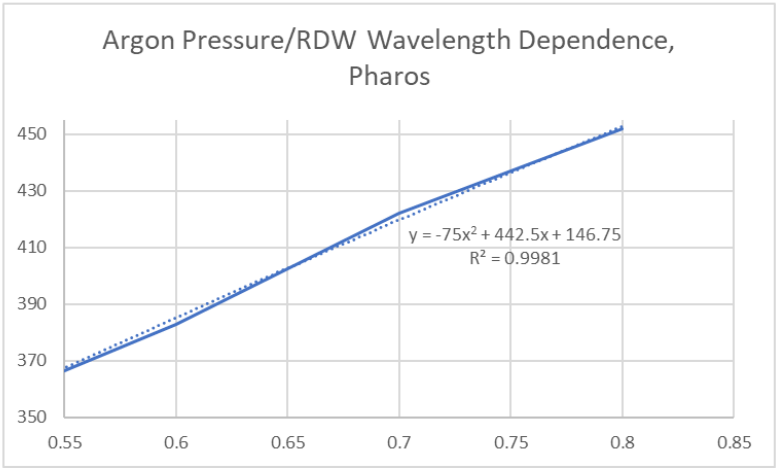

Normalized SED vs Frequency with varying gas and pressure
Normalized Spectral energy density
Frequency (THz)
2.0 bar He
2.5 bar He
3.0 bar He
1.5 bar Ne
2.0 bar Ne
2.5 bar Ne
3.0 bar Ne
3.5 bar Ne
4.0 bar Ne
0.5 bar Ar
0.6 bar Ar
0.7 bar Ar
0.8 bar Ar


Normalized SED vs Angular Frequency with varying gas and pressure
Normalized Spectral energy density
Angular Frequency (rad/s)
1e15
2.0 bar He
2.5 bar He
3.0 bar He
1.5 bar Ne
2.0 bar Ne
2.5 bar Ne
3.0 bar Ne
3.5 bar Ne
4.0 bar Ne
0.5 bar Ar
0.6 bar Ar
0.7 bar Ar
0.8 bar Ar


Normalized SED vs Energy with varying gas and pressure
Normalized Spectral energy density
Energy (eV)
2.0 bar He
2.5 bar He
3.0 bar He
1.5 bar Ne
2.0 bar Ne
2.5 bar Ne
3.0 bar Ne
3.5 bar Ne
4.0 bar Ne
0.5 bar Ar
0.6 bar Ar
0.7 bar Ar
0.8 bar Ar


Neon Pressure/RDW Wavelength Dependence, Pharos
y = 0.6939x² + 38.265x + 143.35
R² = 0.9966
400
350
300
250
200
150
0.95
1.45
1.95
2.45
2.95
3.45
3.95
4.45
4.95


Helium Pressure/RDW Wavelength Dependence, Pharos
y = -4x² + 46x + 78
R² = 1
185
180
175
170
165
160
155
150
1.9
2.1
2.3
2.5
2.7
2.9


Argon Pressure/RDW Wavelength Dependence, Pharos
y = -75x² + 442.5x + 146.75
R² = 0.9981
450
430
410
390
370
350
0.55
0.6
0.65
0.7
0.75
0.8
0.85