Requirements for AEgIS laser system

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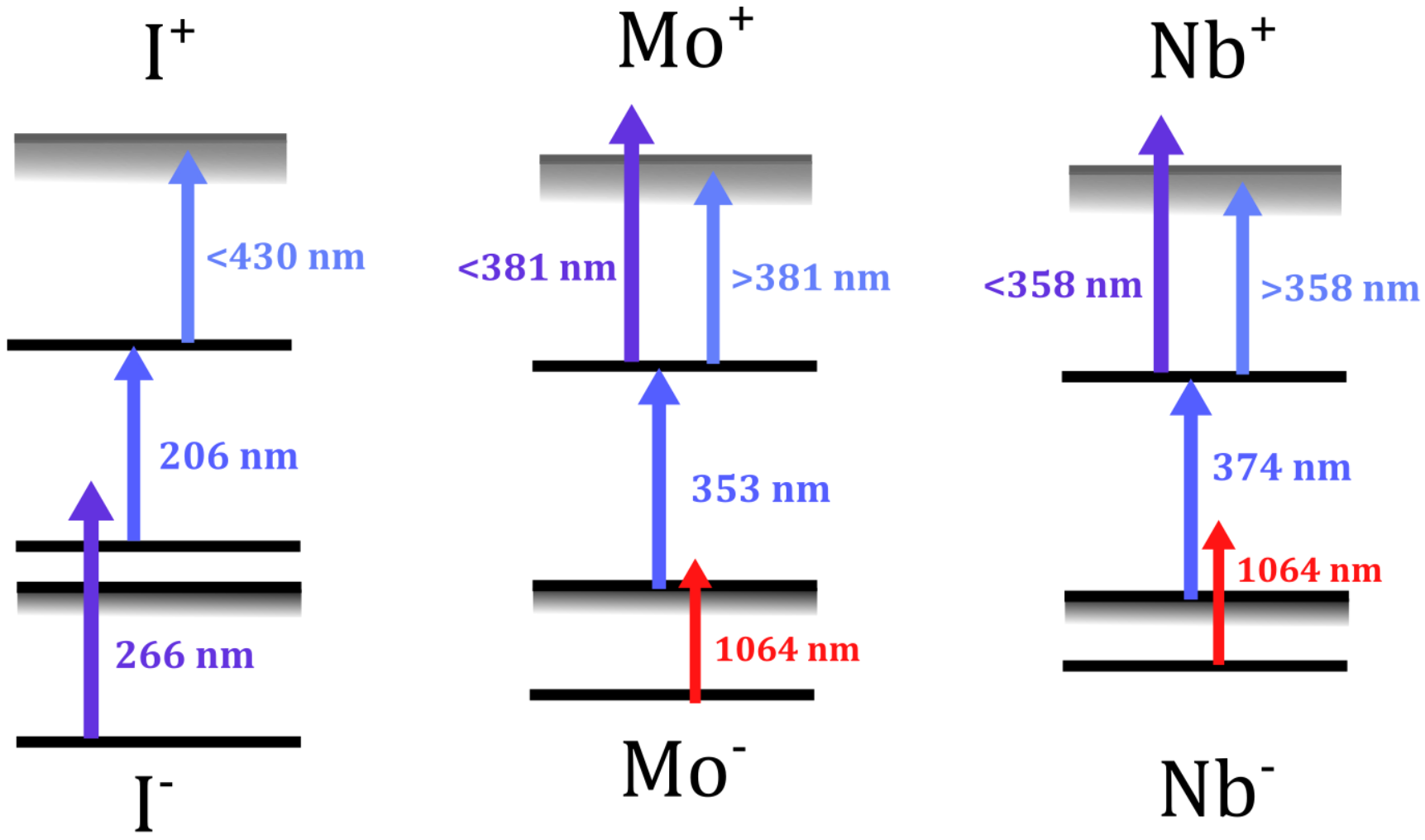
19/12/2024

Ion program:


I+
<430 nm
206 nm
266 nm
I-
Mo+
<381 nm
>381 nm
353 nm
1064 nm
Mo-
Nb+
<358 nm
>358 nm
374 nm
1064 nm
Nb-

Saturation Intensity calculations for Iodine 1/3

Lower level:
7602.970 cm-1
$5s^2 5p^5\ {}^2P_{1/2}$

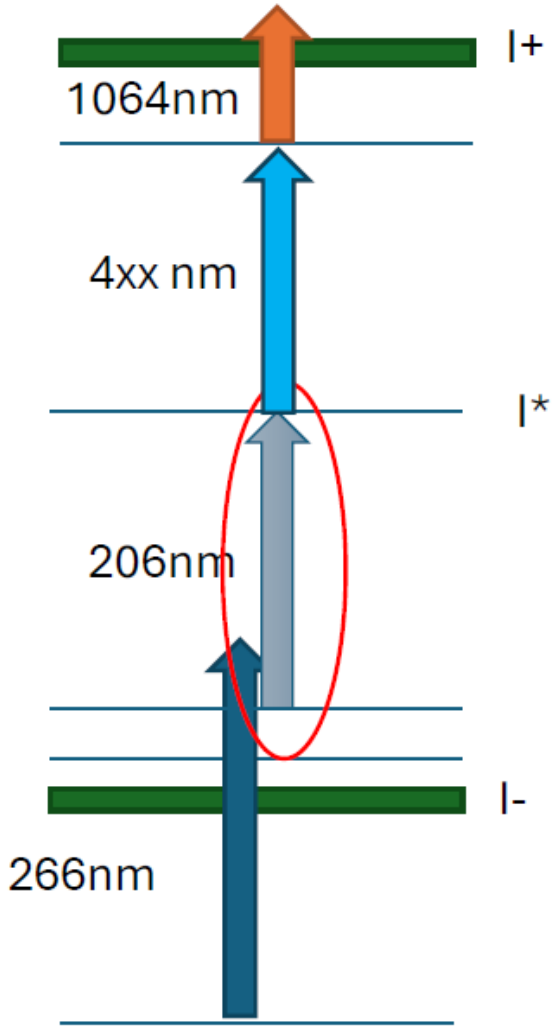
206.16 nm

A, s^{-1}: 3.0e+06

Upper level:
56092.881
$5s^2 5p^4 ({}^3P_2) 6s$

$$I_{\mathrm{sat}} = \frac{\pi}{3}\frac{hc}{\lambda^3 \tau},$$

~100 uJ/cm2



Sadiq Nawaz
Mohammed Waseem

C. J. Foot, Atomic Physics

Line Width @ 206 nm

- The line width is equal to the Einstein “A” coefficient Γ=A,
- Line Width @ 206 nm= 3E6 /s = **3 MHz**
- Mass of Atomic Iodine =2.1072903E-25 Kg
- **Doppler Broadening @ Room Temp ~ 1.6 GHz**

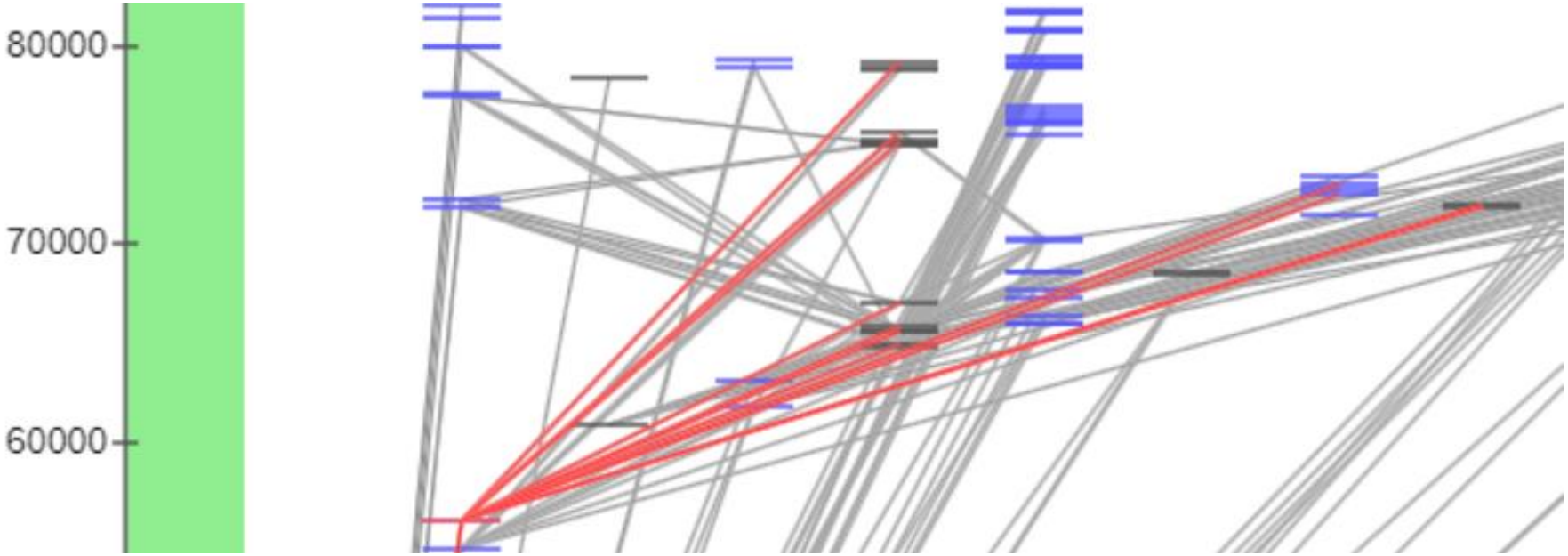
Sadiq Nawaz
Mohammed Waseem

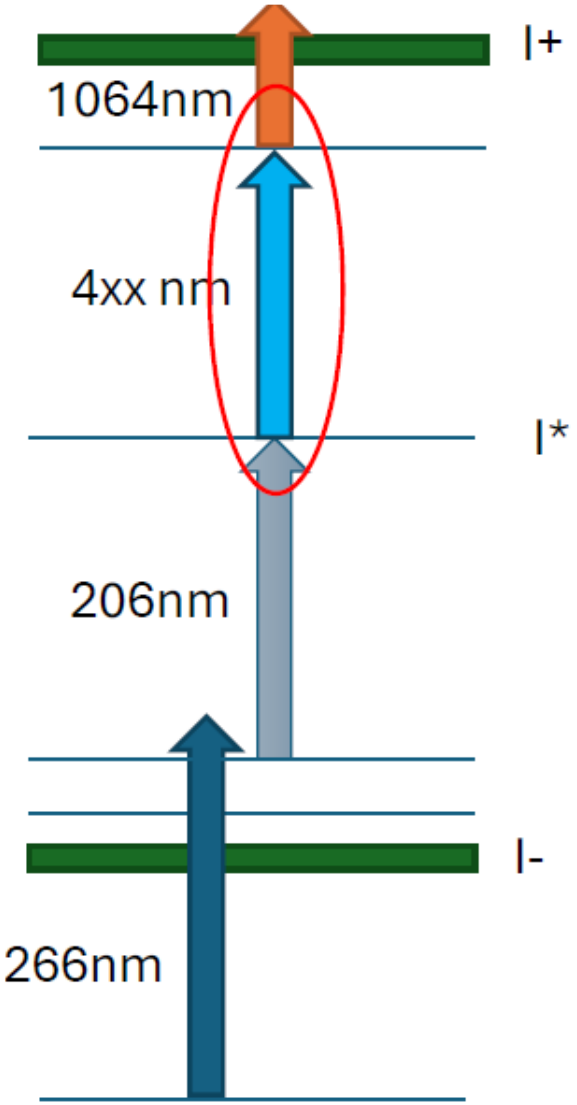
Saturation Intensity calculations for Iodine 3/3

Lower level:
56092.881 cm-1
$5s^2 5p^4 (^3P_2) 6s$

511 nm to 354 nm

Upper level:
From 74897
cm^{-1}
To
IP at 84295 cm-1





https://www.osti.gov/servlets/purl/1688760

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Saturation Intensity calculations for Iodine 3/3

Lower level NIST	Upper level NIST	λ, nm NIST	S_{th} CI-MBPT	A_{th}, $10^7 \cdot (\text{sec})^{-1}$ CI-MBPT	A_{exp}, $10^7 \cdot (\text{sec})^{-1}$ Exper. works	A_{th}, $10^7 \cdot (\text{sec})^{-1}$ Other theories
$5s^2 5p^5 \ ^2P^o_{1/2}$	$5s^2 5p^4(^3P_2)6s \ ^2[2]_{3/2}$	206.16	0.219±0.013	1.26±0.07		0.296^h, 0.958^k, 1.71^l
$5s^2 5p^4(^3P_2)6s \ ^2[2]_{3/2}$	$5s^2 5p^4(^3P_2)6p \ ^2[2]^o_{3/2}$	1123.65	10.65±0.26	0.38±0.09		0.33^k, 1.72^m
"	$5s^2 5p^4(^3P_2)6p \ ^2[3]^o_{5/2}$	1046.65	78.3±2.2	2.31±0.06		2.0^k
"	$5s^2 5p^4(^3P_2)6p \ ^2[1]^o_{1/2}$	1023.88	26.3±0.4	2.48±0.04		2.12^k, 2.78^m
"	$5s^2 5p^4(^3P_2)6p \ ^2[1]^o_{3/2}$	911.39	36.6±1.3	2.45±0.09		2.34^k, 0.697^m
"	$5s^2 5p^4(^3P_0)6p \ ^2[1]^o_{3/2}$	629.4	0.54±0.19	0.011±0.004		0.01^k, 0.0407^m
"	$5s^2 5p^4(^3P_1)6p \ ^2[2]^o_{5/2}$	608.24	0.24±0.05	0.036±0.008		0.08^k
"	$5s^2 5p^4(^3P_1)6p \ ^2[1]^o_{3/2}$	589.4	0.17±0.05	0.042±0.011		0.13^k

Saturation intensity @ 589.4 nm, Einstein Coefficient=0.42E6 is **0.0427 mW/cm^2**,
Fluence @ 10 Hz=4.27 uJ/cm^2

Literature not available for 511-354 nm Transitions

https://www.osti.gov/servlets/purl/1688760

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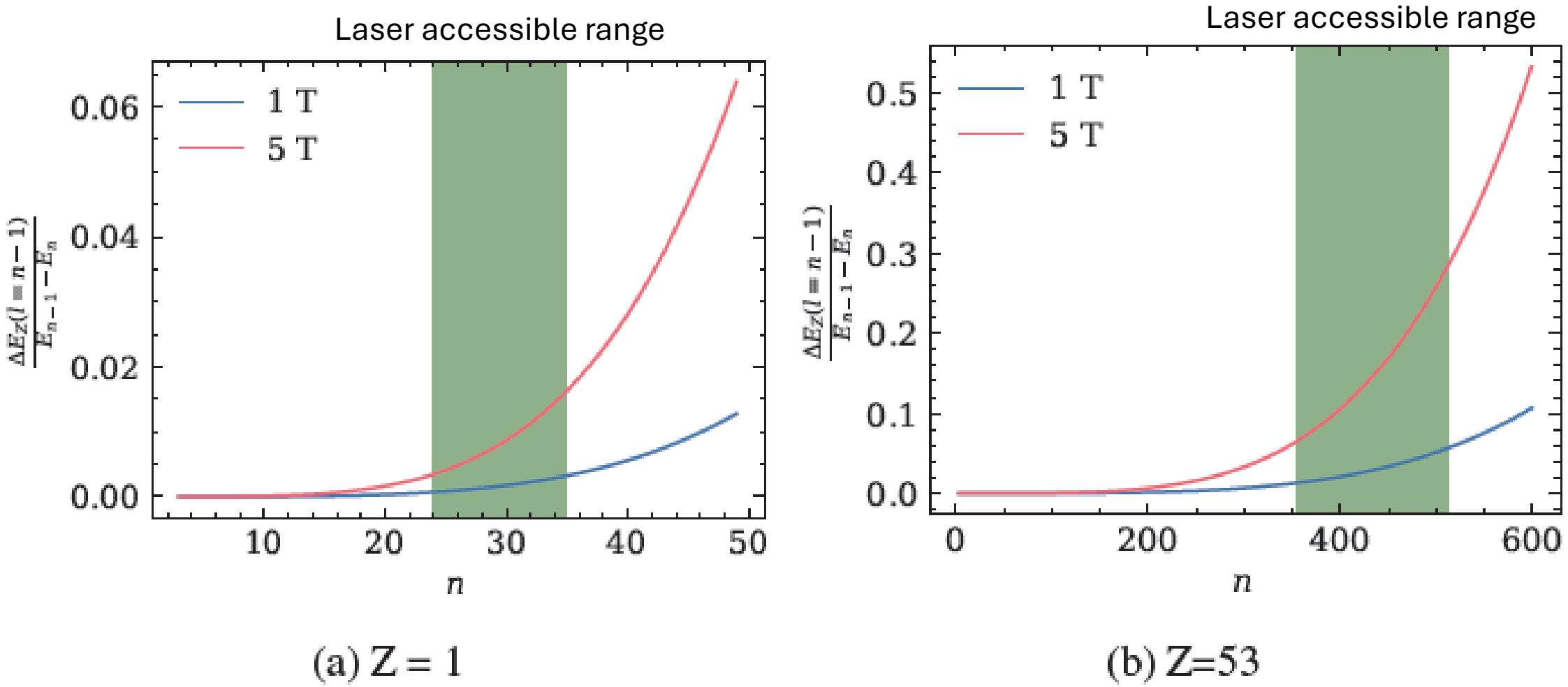
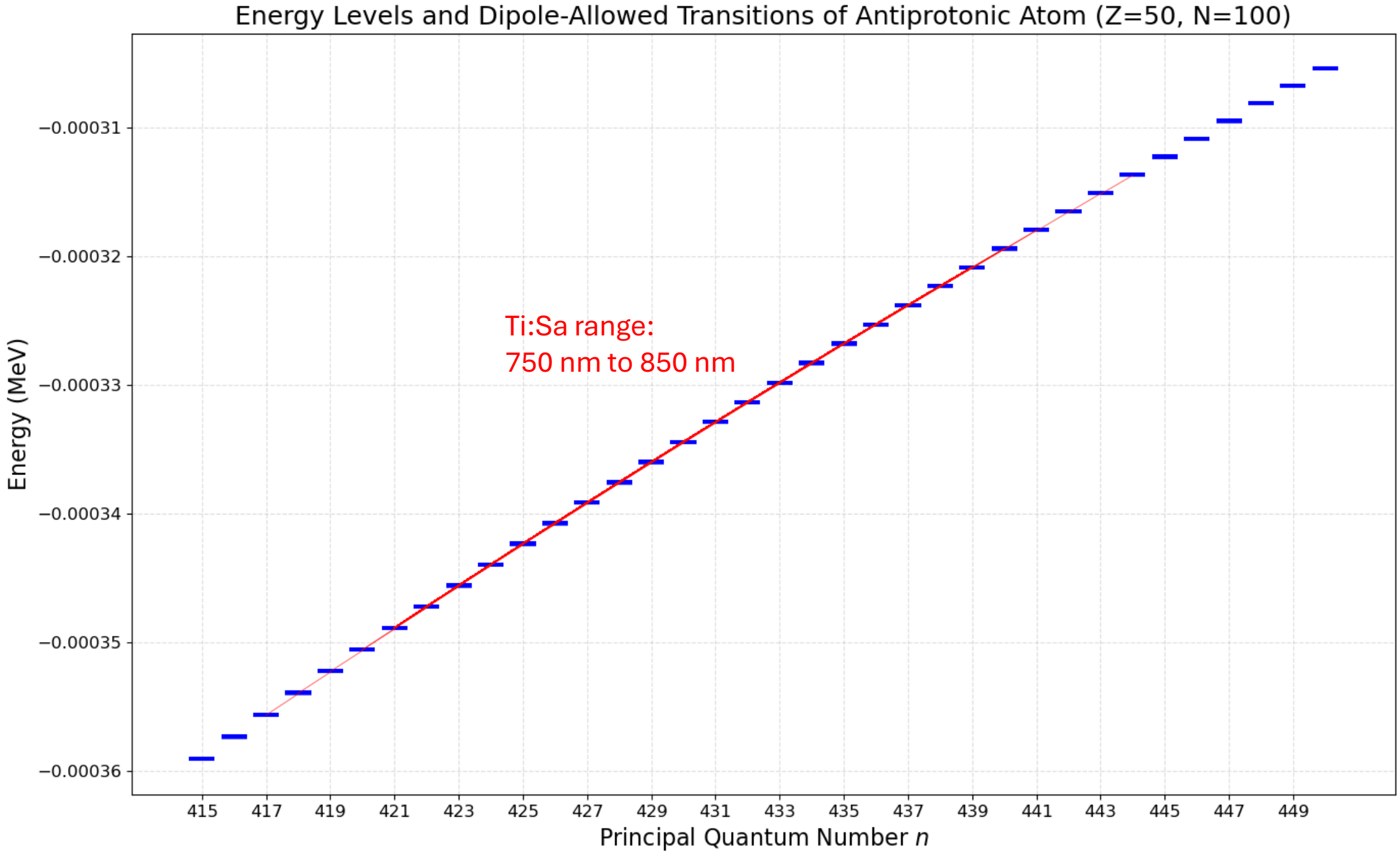
Mohammed Waseem

B-field splitting of antiprotonic states



Simulated by Antons


Energy Levels and Dipole-Allowed Transitions of Antiprotonic Atom (Z=50, N=100)
Ti:Sa range:
750 nm to 850 nm
Energy (MeV)
−0.00031
−0.00032
−0.00033
−0.00034
−0.00035
−0.00036
415
417
419
421
423
425
427
429
431
433
435
437
439
441
443
445
447
449
Principal Quantum Number n

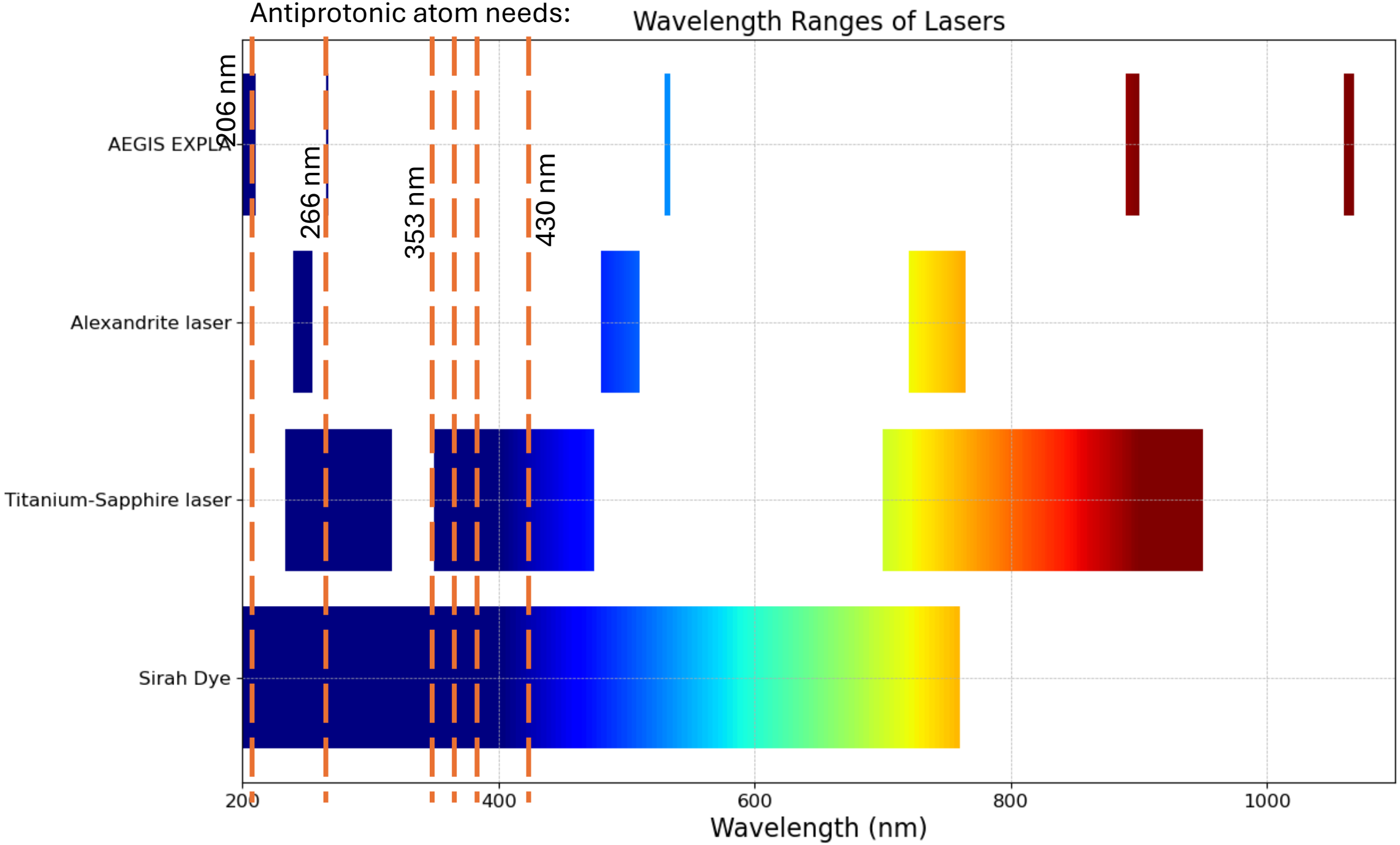
Fluence for Anti-protonic Helium

- [(a)] Fluence Anti-protonic Helium @417 nm and 372 nm [-6 GHz detuning] = **1-2 mJ/cm^2** for *n=34 to n=36*

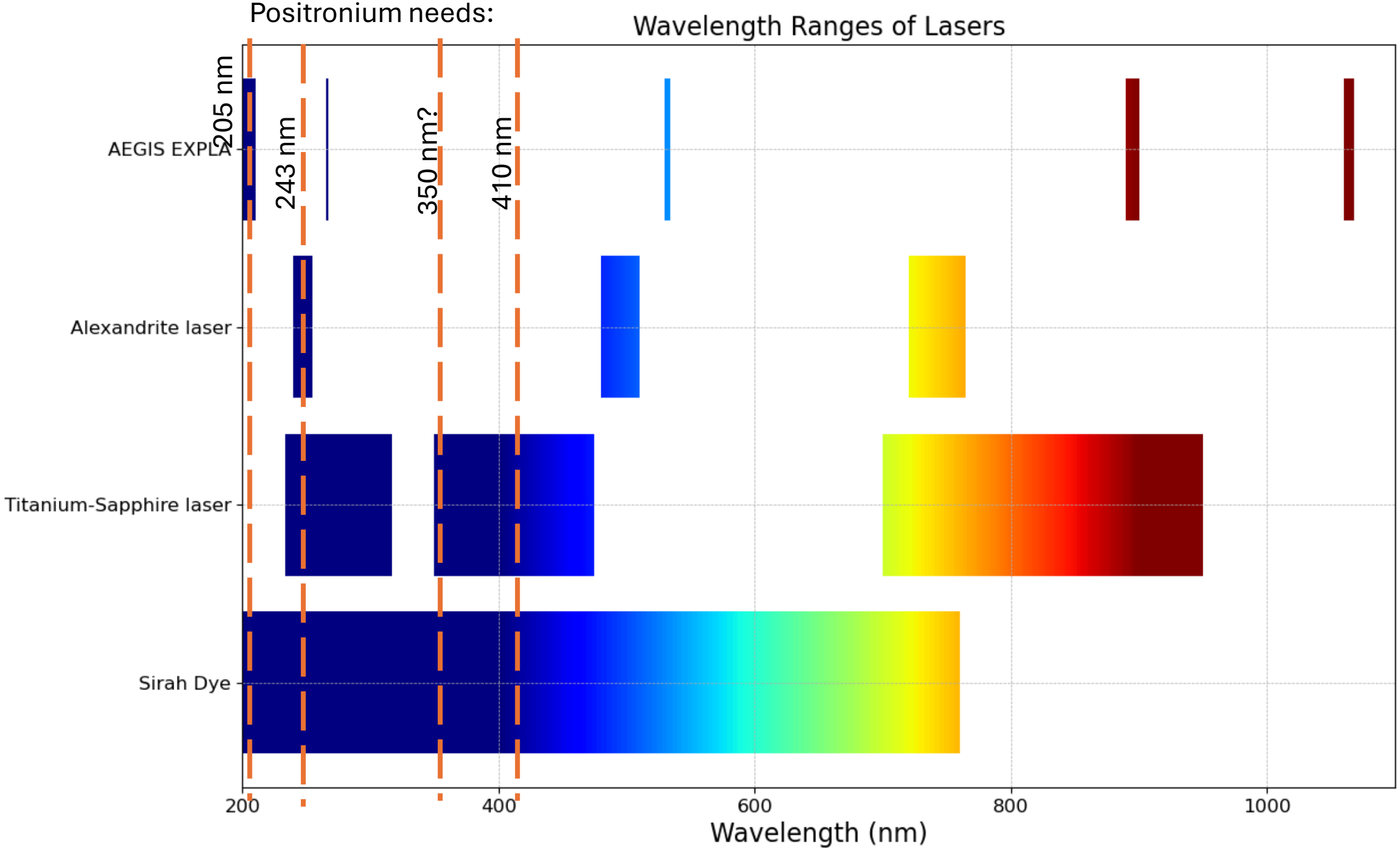
- [(b)] Pulse Energy Anti-protonic Helium @blue = 2-**4 mJ Dye laser (Pump laser @ 531 nm has 180 mJ energy)** and UV = **15-40 mJ before frequency doubling/tripling with LBO/BBO crystals** (Ti:Si laser with multi-pass amplifier) for *n=36 n=37, n=38* **Beam Diameter 3 cm at both wavelengths**

(a) Two-photon laser spectroscopy of antiprotonic helium and the antiproton-to-electron mass ratio
(b) Buffer-gas cooling of antiprotonic helium to 1.5 to 1.7 K, and antiproton-to–electron mass ratio

Antiprotonic atom needs:



Positronium needs:

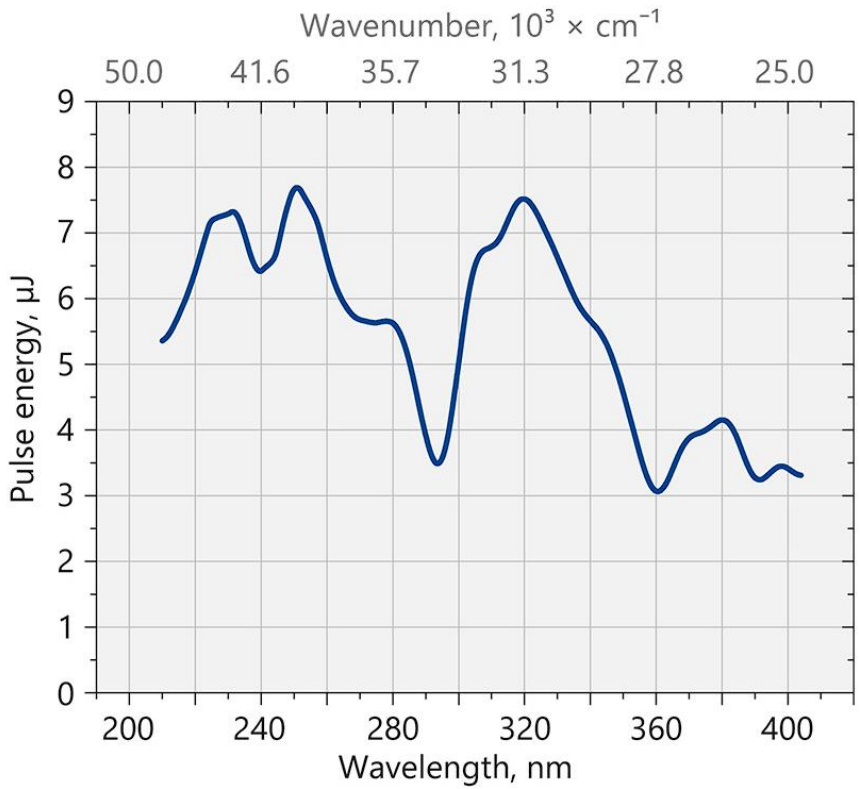


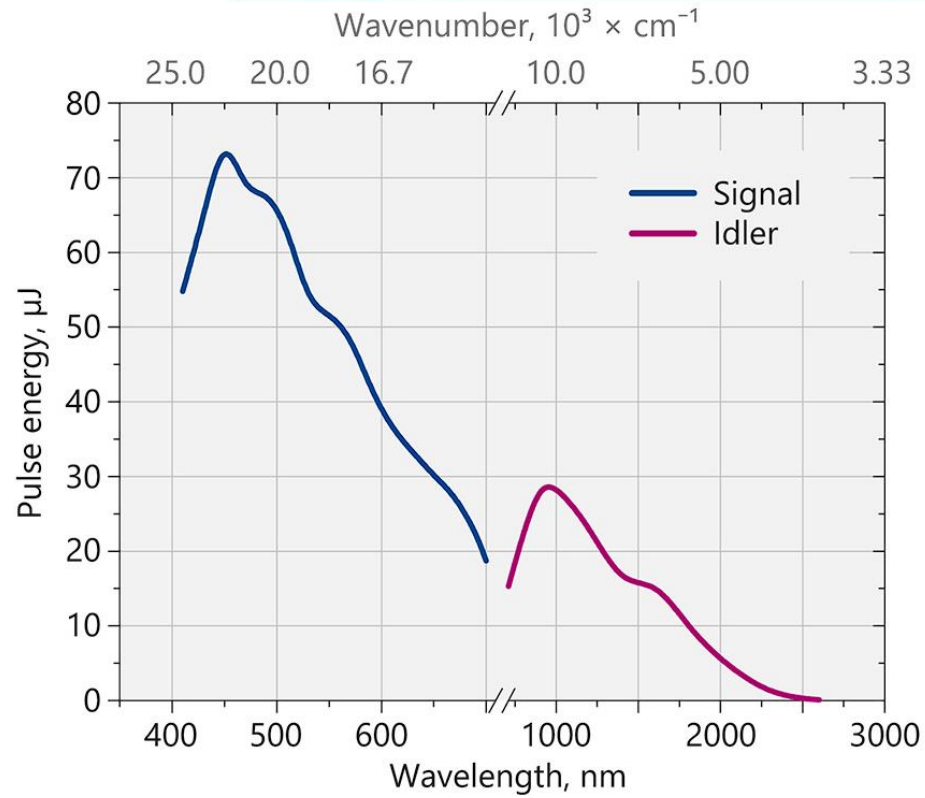
NT260 series

Narrow Linewidth 10 kHz Tunable Laser

Download datasheet PDF

- Hands-free no gap wavelength tuning in **210 – 2600 nm** range
- High repetition rate **10 kHz**
- Narrow linewidth down to **1.5 cm^{-1}**
- Up to **0.7 W** output



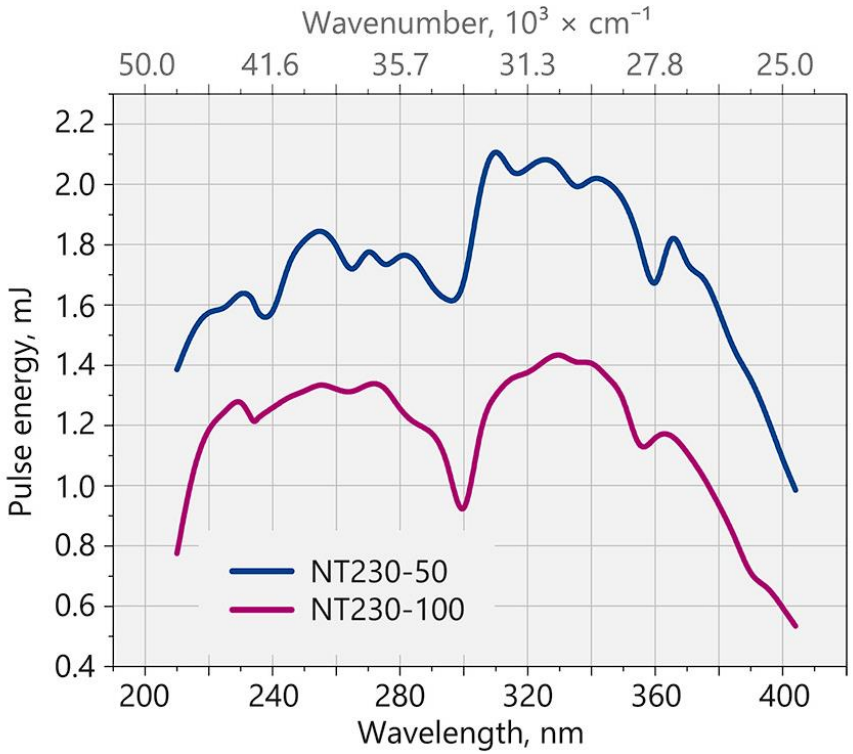


NT230 series

High Energy Broadly Tunable DPSS Lasers

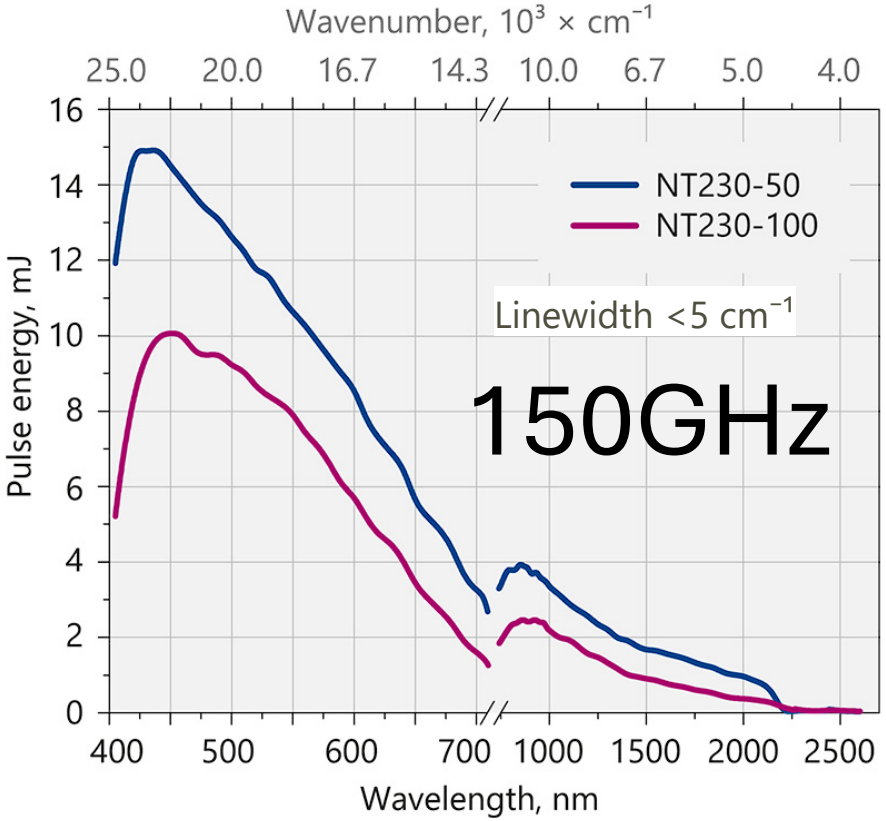
Download datasheet PDF

- Integrated OPO system
- Diode pumped
- Ultrabroad tuning range from **192** to **2600 nm**
- Up to **15 mJ** in VIS, **2 mJ** in UV
- Up to **100 Hz** pulse repetition rate



Linewidth is <8 cm^{-1} for 210 – 405 nm range.

<240GHz



Ti:Sa system

General Characteristics

Tuning Range	690 .. 950 nm
Pulse Duration (FWHM)	approx. 28 - 50 ns
Repetition Rate	3-10 kHz
Output Power	6,8 W (at 10 kHz at peak wavelength)
Beam Size	1 mm (typical)
Linewidth	< 6 GHz (with one Etalon)
Beam Divergence	< 1,5 mrad

Requirements Pump Laser

Diffraction meas. value	M^2 < 30
Repetition Rate	3 - 10 kHz
Pulse Duration	80 - 300 ns
Cooling Water	Water required for TiSa-crystals cooling , 50 W cooling power
Laboratory	dust-free air (flow box), 16 - 30°C
Voltage	110 .. 230 V, single phase, 50 / 60 Hz
Computer Control	XP / Vista / Windows 7 / Windows 8 / Windows 10 (32 & 64 bit), USB Port

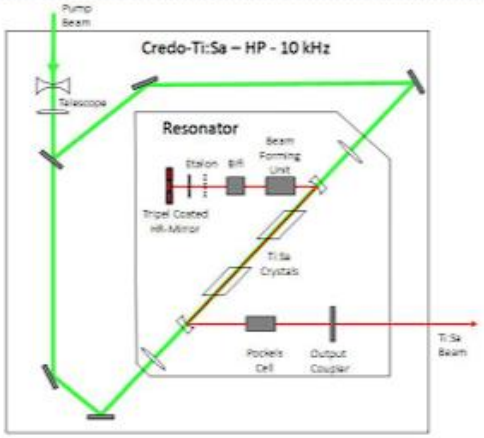
Options

SHG	up to 25% (of Fundamental)
THG	up to 13% (of Fundamental and SHG)
FHG	up to 9% (of SHG)
Linear Polarisation	vertical / horizontal
Second Etalon - for 1GHz linewidth	
Purge Unit - for dust free air and low humidity	

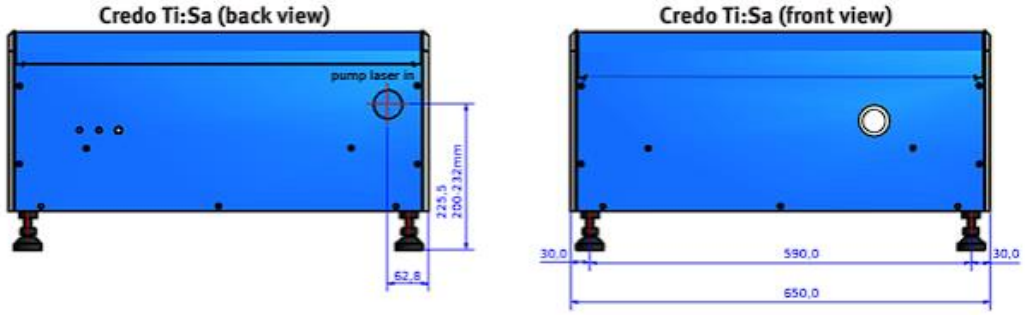
Credo Ti:Sa-10 kHz-Laser

Credo Ti:Sa-10 kHz Laser

Optical Layout

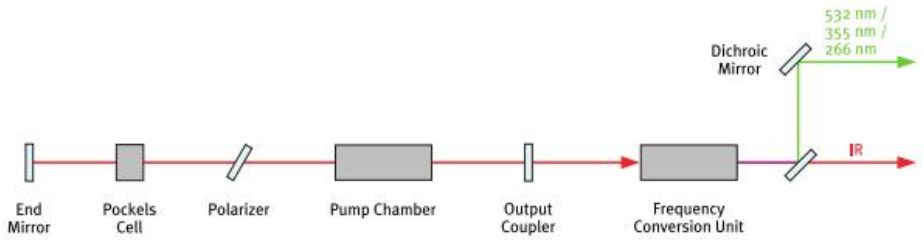


Dimensions



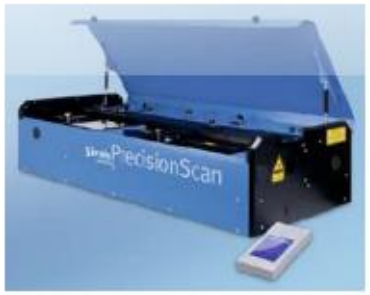
Boston 500

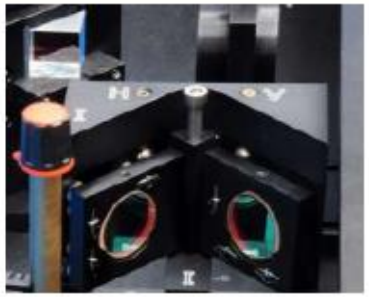
Optical Layout



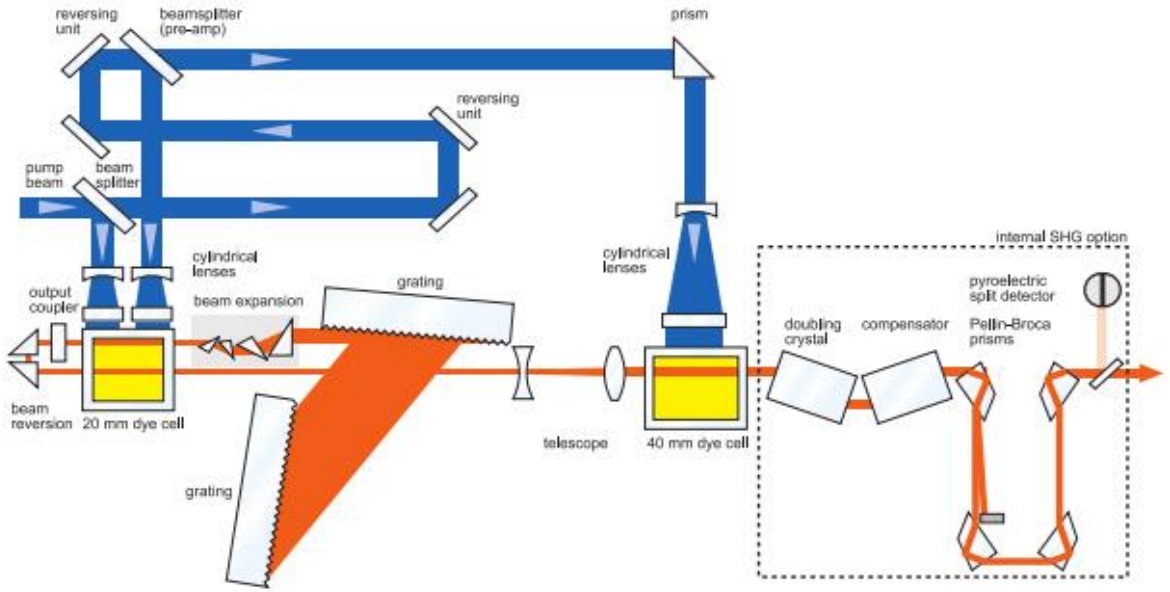
PrecisionScan Dye Laser

PrecisionScan Dye Laser





Optical Layout



PrecisionScan / Double Dye

Dispersion Option	Tuning Range	Linewidth	Efficiency
1800 lines / mm, 60 mm	400..920 nm	3.6 pm [4] 0.1 cm^{-1} @ 625 nm	30 % [2]
1800 lines / mm, 90 mm	400..920 nm	2.4 pm [4] 0.06 cm^{-1} @ 625 nm	30 % [2]
2400 lines / mm, 60 mm	370..760 nm	2.7 pm [4] 0.08 cm^{-1} @ 570 nm	30 % [2]
2400 lines / mm, 90 mm	370..760 nm	1.8 pm [4] 0.06 cm^{-1} @ 570 nm	30 % [2]
3000 lines / mm, 60 mm	370..620 nm	2.0 pm [4] 0.06 cm^{-1} @ 570 nm	30 % [2]
3000 lines / mm, 90 mm	370..620 nm	1.4 pm [4] 0.05 cm^{-1} @ 570 nm	30 % [2]
Dual 1800 lines / mm	410..900 nm	1.7 pm [4] 0.05 cm^{-1} @ 625 nm	27 % [3]
Dual 2400 lines / mm	370..710 nm	1.2 pm [4] 0.04 cm^{-1} @ 625 nm	27 % [2]
Dual 3000 lines / mm	370..580 nm	1.0 pm [4] 0.03 cm^{-1} @ 570 nm	27 % [2]

Price?

Component	Description	Price
Boston Nd:YAG	500mJ@1064nm, 270mJ@532nm	€35.000
CREDO Ti:Sa Laser	Titanium:Sapphire laser system for ultrafast pulsed operations. Tunable wavelengths for precision applications.	€43.000
FCU+Cristals	350-470nm (for Ti:Sa)	€12.000
Presicion scan Dye laser	Titanium:Sapphire laser system for ultrafast pulsed operations. Tunable wavelengths for precision applications.	€40.000
FCU+Cristals	206-380nm (for Dye laser)	€14.000