Budget estimate and plans for HRPPD QA station at Yale

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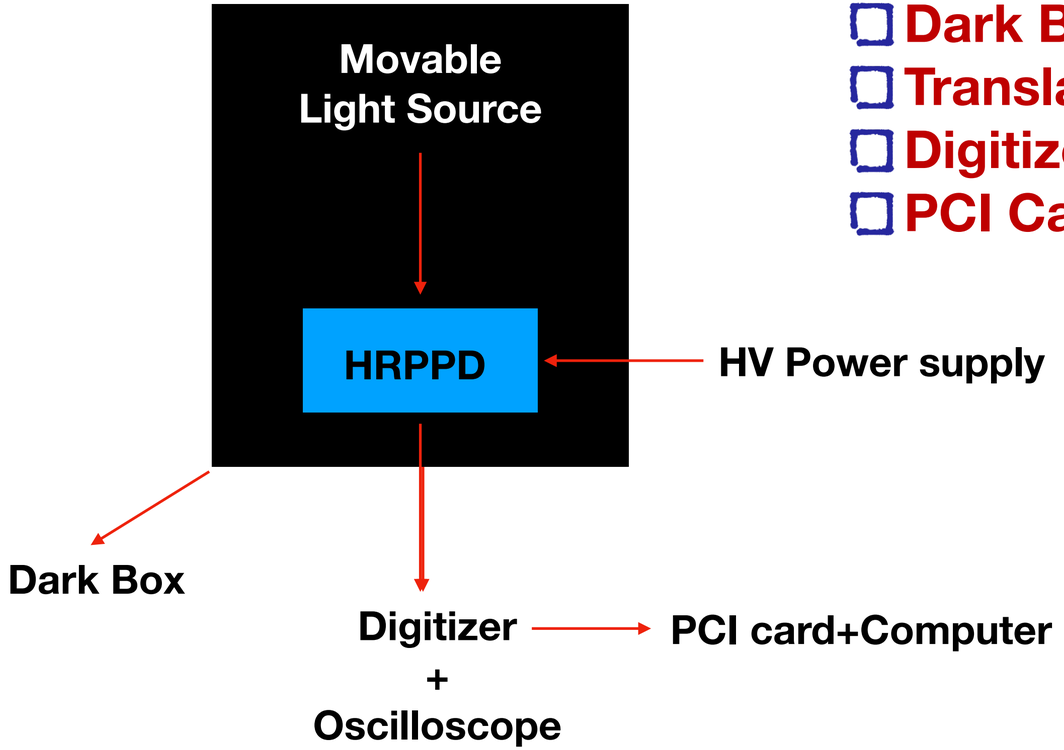
Objective/Schematics/Components

- Quantum Efficiency Map
- Gain Uniformity Scan
- Timing Resolution
- Dark Counts Scan

✓ Oscilloscope MSO64B 6-BW-4000 (order in process)
✓ HV Power supply (exist)
✓ HRPPD and readout-board (project)
✓ NIM logic units (exist)

- ☐ Dark Box
- ☐ Translation + Light Source
- ☐ Digitizer
- ☐ PCI Card



Dark Box

item	purpose
breadboard	base
long rail	frame and door
short hor. Rail	**frame and door**
short vert. Rail	for el. Panel
Medium vert. Rail	vertical corner posts and frame pos
hinge	door
plate nuts, pk of 10	brackets
handle	door
slotted cube	frame and door
Low-profile screws pk 100	frame and door
bracket	**frame, hold rear crossbar**
hardboard 3X 24X24”	frame and door
masking tape	tape btw sections
fiber feedthrough SMA-SMA, 10-pk	LED light into box
cap for SMA feedthrough	cap off unused SMA ports
fiber feedthrough FC/PC – FC/PC	laser light into box
MM fiber 200um 250-370 nm	
Light-Damping fabric	5' x 9'
1/4-20 3/4" screws	For Handles and Mounting Frame
Black Corner Surface Bracket for 1" High Single	For Door and top
90-degree vertical bracket	Hold door when it's open.
Snap-Arm Roller Latch	Hold door upright when it's open.
Metal Angle bar	Connect vertical bracket to Snap-A
1/4-20 x 7/16" bolts for corner surface bracket	Attach corner surfact brackets
Clamp	Holding door closed
Black Caulk	Light baffling for the base fo the da

Cost: ~$4200

Translation Stage

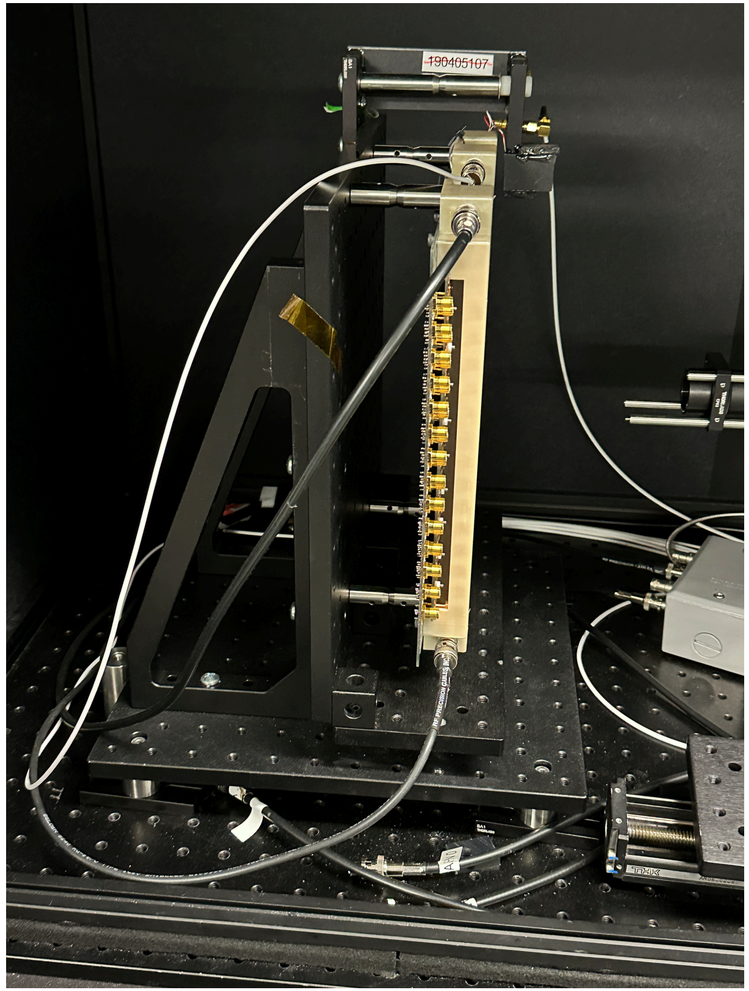
Velmex 3 axis translation stage

Cost: ~$6500

HRPPD Mount

Convenient for reproducibility and alignment
And calibration photo diode mount

optics post, 1 in long, 1/4-20	base to place mount onto
breadboard	horizontal and vertical
90-degree bracket	horiz. to vert.
small breadboard	ledge for LAPPD to rest on during mounting
1/2" wide optics post, 1 in lo	Attaching Points for LAPPD case
Optics post spacer-1mm	Spacers to ensure LAPPD front surface is always in the same spot
Optics post spacer-2mm	Spacers to ensure LAPPD front surface is always in the same spot
Optics post spacer-3mm	Spacers to ensure LAPPD front surface is always in the same spot
Blockers	Angle Bracke-slotted
mounting base	Fixing posts to breadboard
Aluminum Breadboard	Attaching point for LAPPD/HRPPD
Photodiode Stand	Custom Stand to hold NIST Photodiode during QE Scan
NIST Photodiode	Used for Callibration for QE Scan
Optics Post , 2" long 1" wid	Used to help hold LAPPD Mount in Place



Cost: $2000

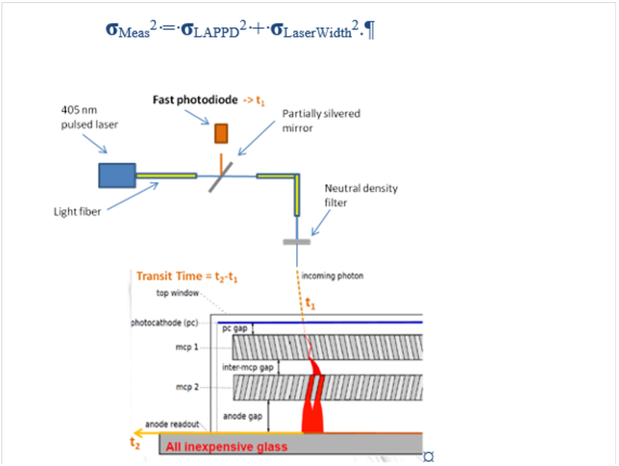
Readout Electronics

1*CAEN Waveform Digitizer (V1742) 32/digitizer	**$2,500**
1*PCI Card for DAQ (32/card)	**$11,000**
4 slot VME crate	**$5,000**
1*PC	**$2,000**

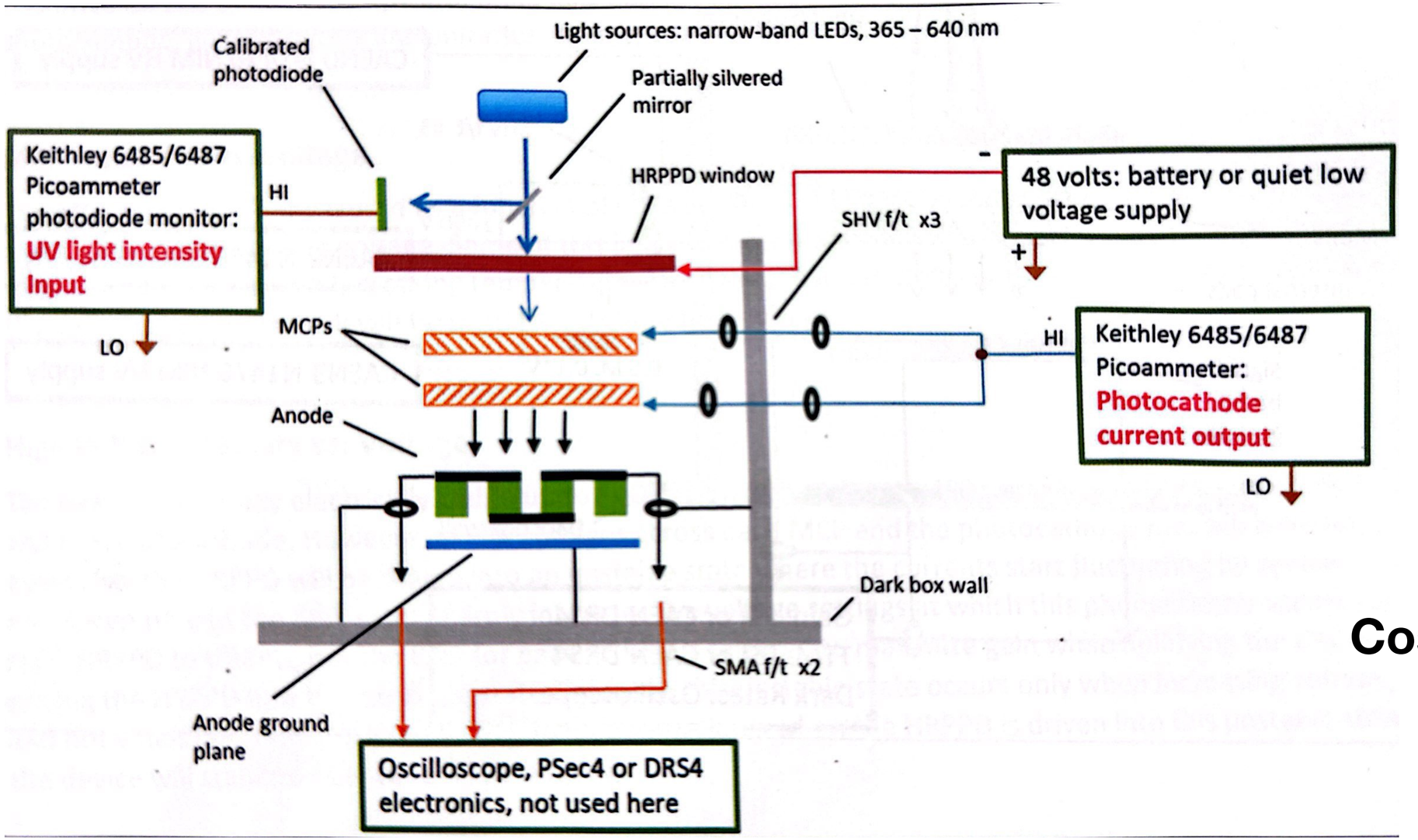
PiL040-FC laser **$14,500**

Pulsed Laser Application

- 405 nm Pilas laser
- Laser output trigger pulse is used to initiate Caen DRS4 signal acquisition
- Fast photodiode monitoring of the laser light is used for timing.



2 Keithley Picoammeters

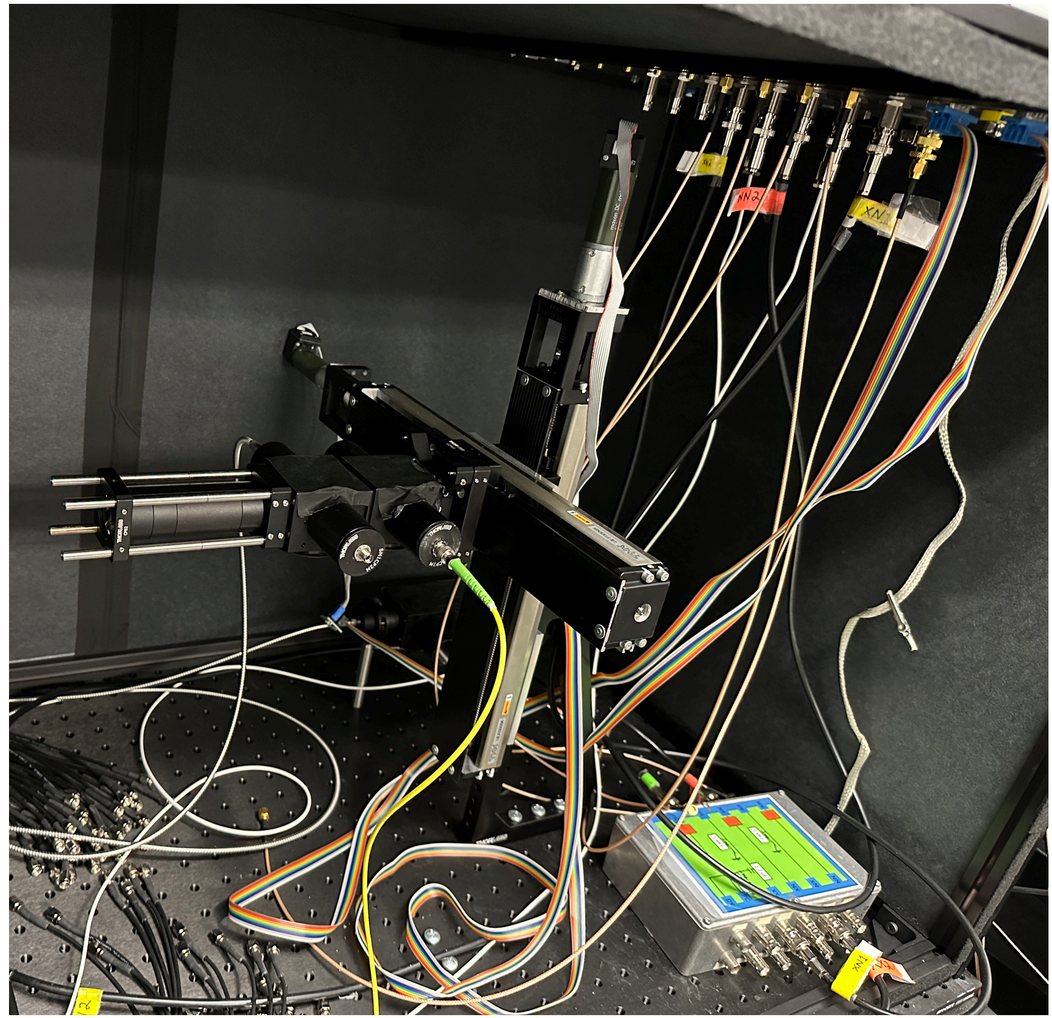


Cost: $3,000 each

Various Feedthroughs

	item	purpose
1	item	purpose
2	CONN MOD COUPLER 8P8C TO 8P8C	Feedthrough for Ethernet
3	ADAPTER USB B RCPT TO USB A RCPT	Feedthrough for DRS4 Power/Readout
4	SHV to SHV connectors	Passes HV into Dark Box
5	BNC to BNC connectors	Connection to Readout Electronics
6	SMA to SMA connectors	Connection to Readout Electronics
7	IDC 10-Pin to DB9 Cable	Connects Motors to Electronics
8	DB9 Cable	Connects Motors to Electronics
9	Optical Cable Feedtrough	Fiber Optic Feedthrough for Electronics
10	Fiber Optic Couple Feedthrough	Laser Output Feedthrough
11	DB9 Feedthrough	Feedthrough for Motor Cables
12	DB15 2 Row	Additional Feedthrough Option
13	DB15 3 Row	Additional Feedthrough Option
14	3ft MCX to SMA	Connects Device to Readout Electronics
15	FIDT-10259	Feedthrough Panel for HV/Readout
16	FIDT-10258	Feedthrough Panel for CAEN Readout
17		

Cost: $7,000



Various Optical Heads

SM1 end plate	for ref. Photodiodes	SM1CP2M
SM1 lens tube	for ref. Photodiodes	SM1L05
Fused silica Convex Lens	LED Laser	LB4879-UV
Lens Tube	Houses glass lens	SM1L15
Fused silica Convex Lens	LED Laser	LB4096-UV
optics cube	main body	C4W
connector	to conect optics cubes	C4W-CC
cube platform	base for BS, cover	B3C
rod	connect optics cube to cage plat	ER025
1"rod	connect cage system plates	ER1
cage plate adapter		LCP33
cage-system plate		LCP03
ps laser		
adapter	Laser-fiber mount	AD11F
lock nut	hold laser-fiber mount in place	SM1NT
fiber collimator	to collimate laser light	F671APC-405

LED light		
lens tube	LED fiber collimator	SM1L15
adapter	terminal for LED fiber	SM1SMA
BCX f=35mm	collimating lens	LB4879-A
LED alternate launch	**Note: This part is optional. It is an alternative**	
adapter		AD11F
lock nut		SM1NT
fiber collimator		F671SMA-40
reference photodiodes		
pellicle beamsplitter	to sample laser and LED light	BP145B5
photodiode		FDS1010-CAL
output focus		
PCX f=50mm	focus onto tile	LA4148-A
cage plate	lens mount	CP02T
rod	mount of final-focus lens	ER2
UV LEDs?		
M365D2, 365nm, 1150mW	illuminate tile for QE scans	Thorlabs M3

Cost: $2,000

LED Switcher Box

Cost: $4,000 (for 5 Led's)

LED Switcher Box				
mounted LEDs				
1	M565D2	Thorlabs	M565D2	https://www.thorlabs.com/thorproduct.cfm?partnumber=M565D2
1	M455D3	Thorlabs	M455D3	https://www.thorlabs.com/thorproduct.cfm?partnumber=M455D3
1	M415D2	Thorlabs	M415D2	https://www.thorlabs.com/thorproduct.cfm?partnumber=M415D2
1	M405D2	Thorlabs	M405D2	https://www.thorlabs.com/thorproduct.cfm?partnumber=M405D2
1	M365D2	Thorlabs	M365D2	https://www.thorlabs.com/thorproduct.cfm?partnumber=M365D2
3	fiber adapter	Thorlabs	SM05SMA	https://www.thorlabs.com/thorproduct.cfm?partnumber=SM05SMA
3	fiber adapter	Thorlabs	SM1SMA	https://www.thorlabs.com/thorproduct.cfm?partnumber=SM1SMA
3	cage cube	Thorlabs	C6W	https://www.thorlabs.com/thorproduct.cfm?partnumber=C6W
2	cube connector	Thorlabs	C4W-CC	https://www.thorlabs.com/thorproduct.cfm?partnumber=C4W-CC#ad-image-0
3	cube platform	Thorlabs	B3C	https://www.thorlabs.com/thorproduct.cfm?partnumber=B3C
2	Pellicle 45:55 RT, 300-4	Thorlabs	BP145B5	https://www.thorlabs.com/thorproduct.cfm?partnumber=BP145B5
1	Pellicle 45:55 RT, 400-7	Thorlabs	BP145B1	https://www.thorlabs.com/thorproduct.cfm?partnumber=BP145B1
5	Lens 1" dia, f=25.4 mm,	Thorlabs	LB1761	https://www.thorlabs.com/thorproduct.cfm?partnumber=LB1761
7	lens tube 1.5"" long	Thorlabs	SM1L15	https://www.thorlabs.com/thorproduct.cfm?partnumber=SM1L15
1	fiber coupler 470+-40nn	Thorlabs	TW470R5A	https://www.thorlabs.com/thorproduct.cfm?partnumber=TW470R5A1
2	fiber collimator	Thorlabs	F671APC-4	https://www.thorlabs.com/thorproduct.cfm?partnumber=F671APC-405
2	SM1 adapter to fiber col	Thorlabs	AD11F	https://www.thorlabs.com/thorproduct.cfm?partnumber=AD11F
5	SM1 tube clamp	Thorlabs	SM1TC	https://www.thorlabs.com/thorproduct.cfm?partnumber=SM1TC

Various wavelength options exist

Item #	Info[a,b]	Nominal Wavelength	LED Output Power		Bandwidth (FWHM)	Irradiance[c]	Maximum Current (CW)	Forward Voltage	Viewing Angle (Full Angle at Half Max)	Emitter Size	MCPCB Thickness
			Minimum	Typical							
M265D4		265 nm	38.4 mW	55.7 mW	11 nm	0.5 µW/mm^2	440 mA	6.9 V	120°	1 mm x 0.75 mm	1.6 mm
M275D2		275 nm	45 mW	80 mW	11 nm	0.8 µW/mm^2	700 mA	7.3 V	118°	2 mm x 2 mm	1.6 mm
M275D3		275 nm	47.3 mW	68.3 mW	10 nm	0.5 µW/mm^2	300 mA	12 V	120°	2.7 mm x 3.3 mm	1.6 mm
M280D4		280 nm	78 mW	114 mW	10 nm	1 µW/mm^2	500 mA	6.26 V	114°[d]	1 mm x 1 mm	1.6 mm
M300D3		300 nm	26 mW	32 mW	20 nm	0.3 µW/mm^2	350 mA	8.0 V (Max)	130°	1 mm x 1 mm	1.6 mm
M310D1		310 nm	38.5 mW	56.5 mW	30 nm	0.76 µW/mm^2	600 mA	5 V	120°[d]	1 mm x 1 mm	1.6 mm
M325D3		325 nm	25 mW	35 mW	12 nm	0.44 µW/mm^2 (Max)	600 mA	5.2 V	120°	1 mm x 1 mm	1.6 mm
M340D4		340 nm	45.5 mW	69.2 mW	10 nm	0.6 µW/mm^2	600 mA	6.6 V	120°[d]	1 mm x 1 mm	2.4 mm
M365D2		365 nm	1150 mW[d]	1400 mW[d]	9 nm	17.6 µW/mm^2 [d]	1700 mA	4.0 V	120°	1.4 mm x 1.4 mm	2.4 mm
M375D4		375 nm	1270 mW	1540 mW	9 nm	19.2 µW/mm^2	1400 mA	3.6 V	130°	1 mm x 1 mm	2.4 mm
M385D2		385 nm	1650 mW	1830 mW	12 nm	23.3 µW/mm^2	1700 mA	3.9 V	120°	1.4 mm x 1.4 mm	2.4 mm
M395D3		395 nm	400 mW	535 mW	16 nm	6.7 µW/mm^2	500 mA	4.5 V	126°	1 mm x 1 mm	2.4 mm
M395D4		395 nm	1420 mW	2050 mW	11 nm	22.8 µW/mm^2	1400 mA	4.0 V	120°	2.5 mm x 2.5 mm	2.4 mm
M405D2		405 nm	1500 mW	1700 mW	12 nm	24.6 µW/mm^2	1400 mA	3.45 V	120°	1.4 mm x 1.4 mm	2.5 mm
M415D2		415 nm	1640 mW	1940 mW	14 nm	19.5 µW/mm^2	2000 mA	3.15 V	138°	1.4 mm x 1.4 mm	2.4 mm
M430D3		430 nm	529.2 mW	757.6 mW	17 nm	25.7 µW/mm^2	500 mA	3.66 V	126° [e]	1 mm x 1 mm	2.4 mm
M450D4		450 nm	2118.1 mW	3041.5 mW	18 nm	34.2 µW/mm^2	2000 mA	3.2 V	120° [f]	1.5 mm x 1.5 mm	2.4 mm
M455D3		455 nm	1150 mW	1445 mW	18 nm	32 µW/mm^2	1000 mA	3.25 V	80°	1 mm x 1 mm	1.6 mm
M470D4		470 nm	809 mW	1161.7 mW	28 nm	21.4 µW/mm^2	1000 mA	3.8 V	80°	1 mm x 1 mm	1.6 mm
M490D3		490 nm	205 mW	240 mW	26 nm	2.5 µW/mm^2	350 mA	3.8 V (Max)	128°	1 mm x 1 mm	2.4 mm
M505D3		505 nm	400 mW	520 mW	37 nm	5.94 µW/mm^2	1000 mA	3.5 V	130°	1 mm x 1 mm	1.6 mm
M530D3		530 nm	370 mW	480 mW	35 nm	9.46 µW/mm^2	1000 mA	3.6 V	80°	1 mm x 1 mm	1.6 mm
MINTD3		554 nm	650 mW	815 mW	-	12.4 µW/mm^2	1225 mA	3.5 V	120°	1 mm x 1 mm	2.4 mm
M565D2[g]		565 nm	880 mW	979 mW	104 nm	11.7 µW/mm^2	1000 mA	3.1 V (Max)	125°	1 mm x 1 mm	1.6 mm

a. Click on the blue info icon for complete specifications and LED spectrum.

Summary: Request for PED

Items	Cost
Readout Electronics	$20,500
PiL040-FC laser	$14,500
Various Feedthroughs	$7,000
Translation Stage	$6,500
Dark Box	$4,200
LED Switcher Box (W/ LED's)	$4,000
Various Optical Heads	$2,000
HRPPD Mount	$2,000
Keithley 6485 pA meters	$6,000
TENMA 32 V power supply	$500
Additional for machine/optical/mechanical components	$5,000
Travel money to Incom/BNL??	$5,000
Grand Total	$77,200