

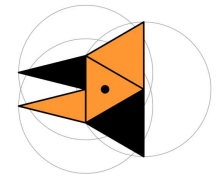
QING II
Q3 2019

**An open-source and frugal
SWIR dual-band spectrometer**

Final-report, by Mejdí.



IMPACT PHOTONICS



Where there is a light, there is a way.

BOM of QingII									
	v October 2019		Unit Cost	Quantity					
			by 100						
Elec					94 €				
PCB 1	Components	LED	29 €	1		including 2x 12€ for LED SWIR			
PCB 2	Components	PhD	5 €	2					
PCB 3	Components	Hub	7 €	2					
PCB 4	Components	Digital	17 €	1		including 12€ for ADC			
	PCB		4 €	6					
Optomeca					34 €				
	Lens		5 €	4		3 lens? If no lens illumination or crossed cylindric			
	Grating		10 €	1		Manual duplication?			
	Stepper motor		1 €	2					
	Sample holder		2 €	1					
TOTAL					128 €				

Remember
QING I
Q2-Q3 2018

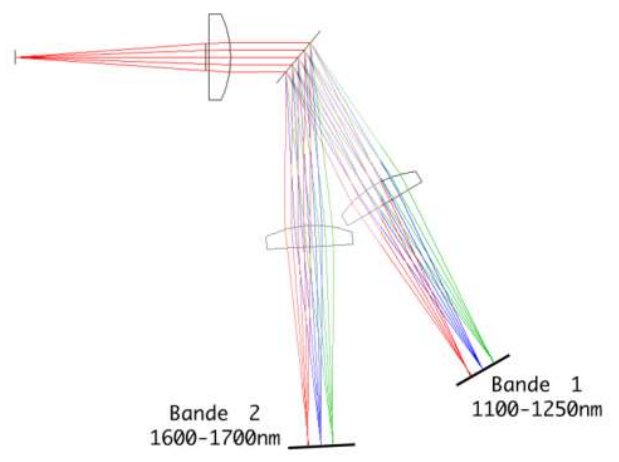
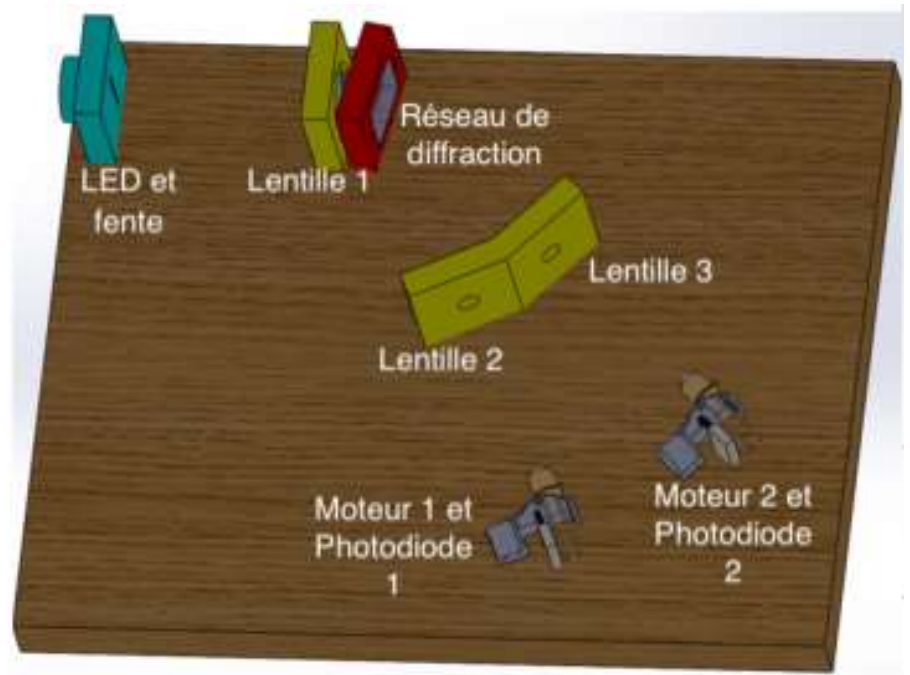
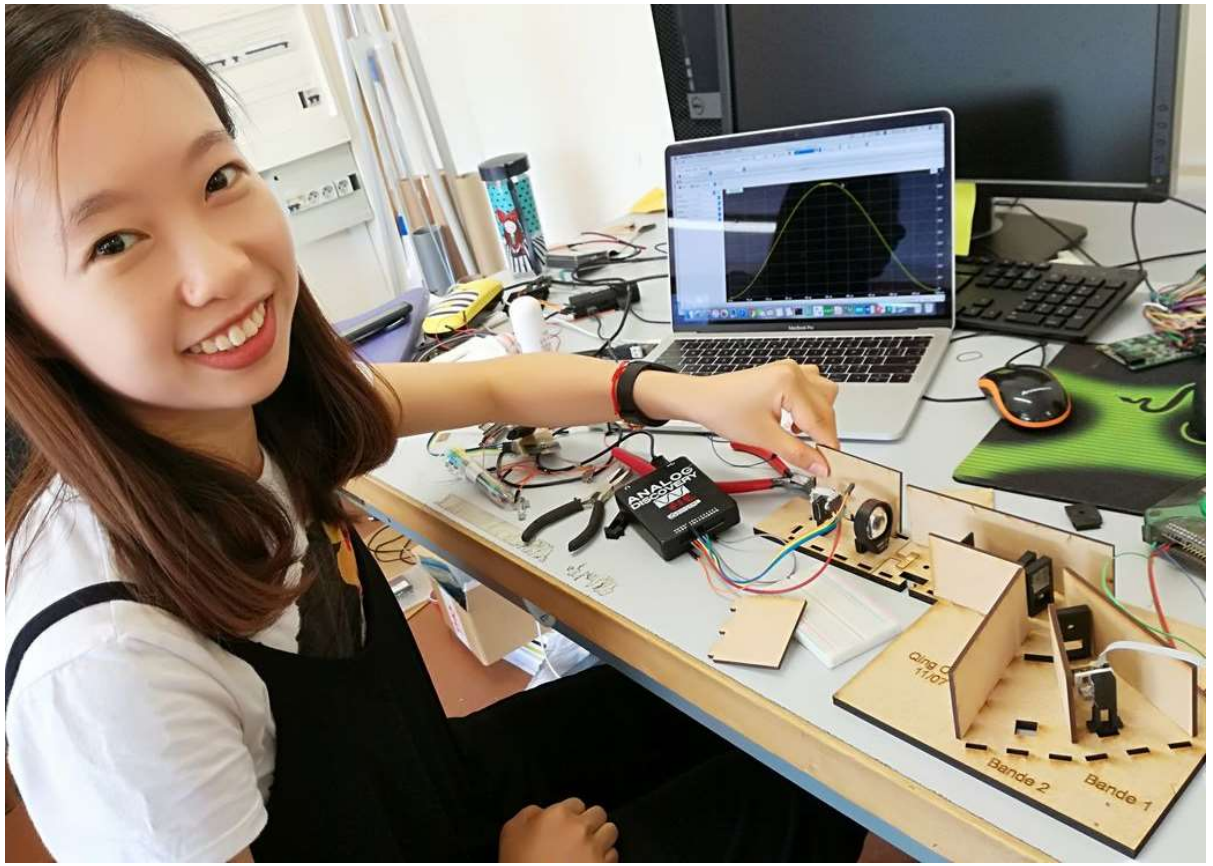
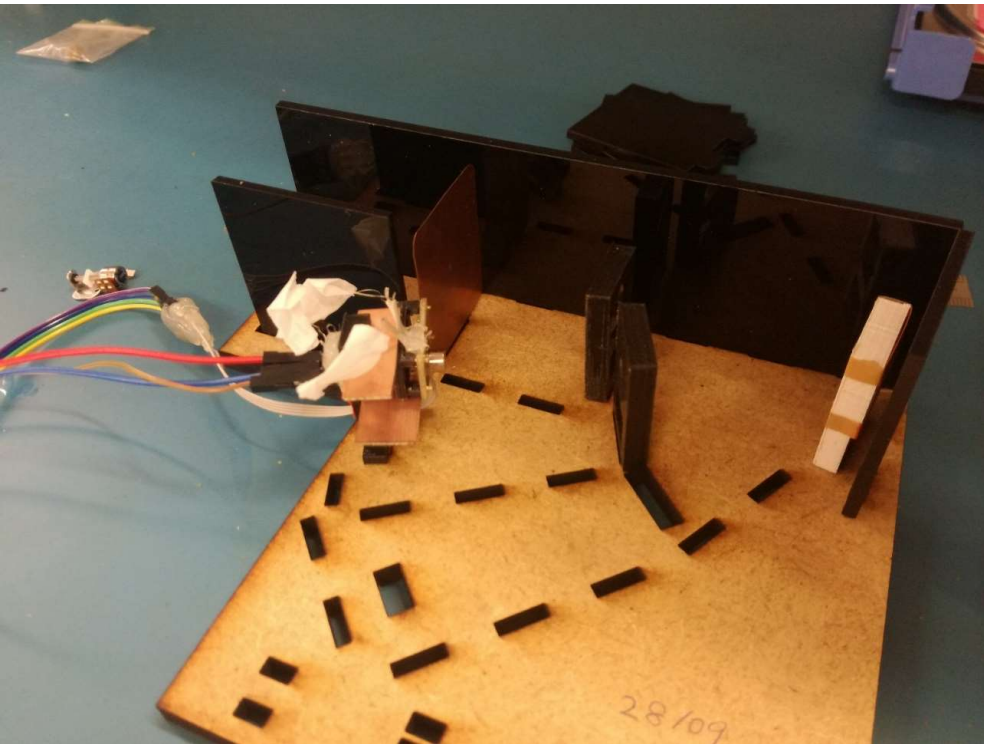
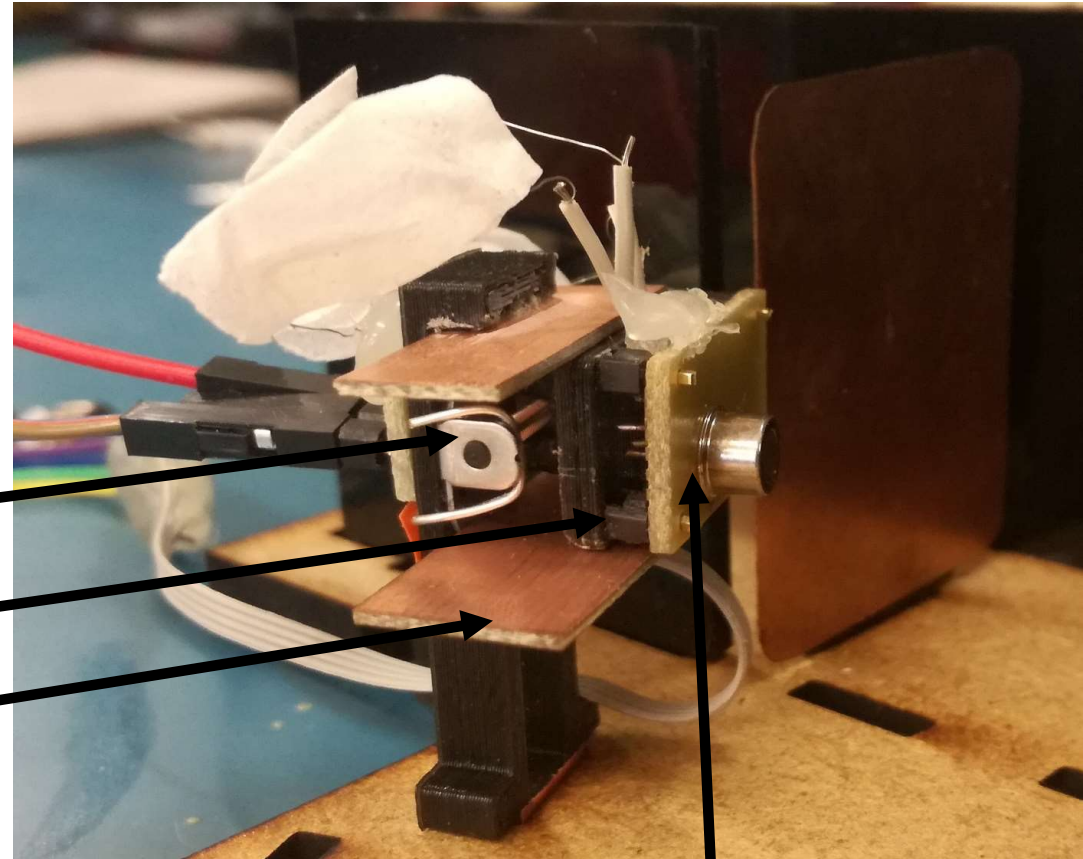


Figure 2.4.3 Schéma du système optique et des trajets lumineux



QING I
spectrum scanning module



Moteur

Adaptateur fixé sur la partie mobile du moteur

Glissière

PCB
Avec grosse photodiode

Facteur limitant = repeta mécanique des mesures:
- Fragile
- Hyper sensible aux perturbations mécanique
- Fine tuning required

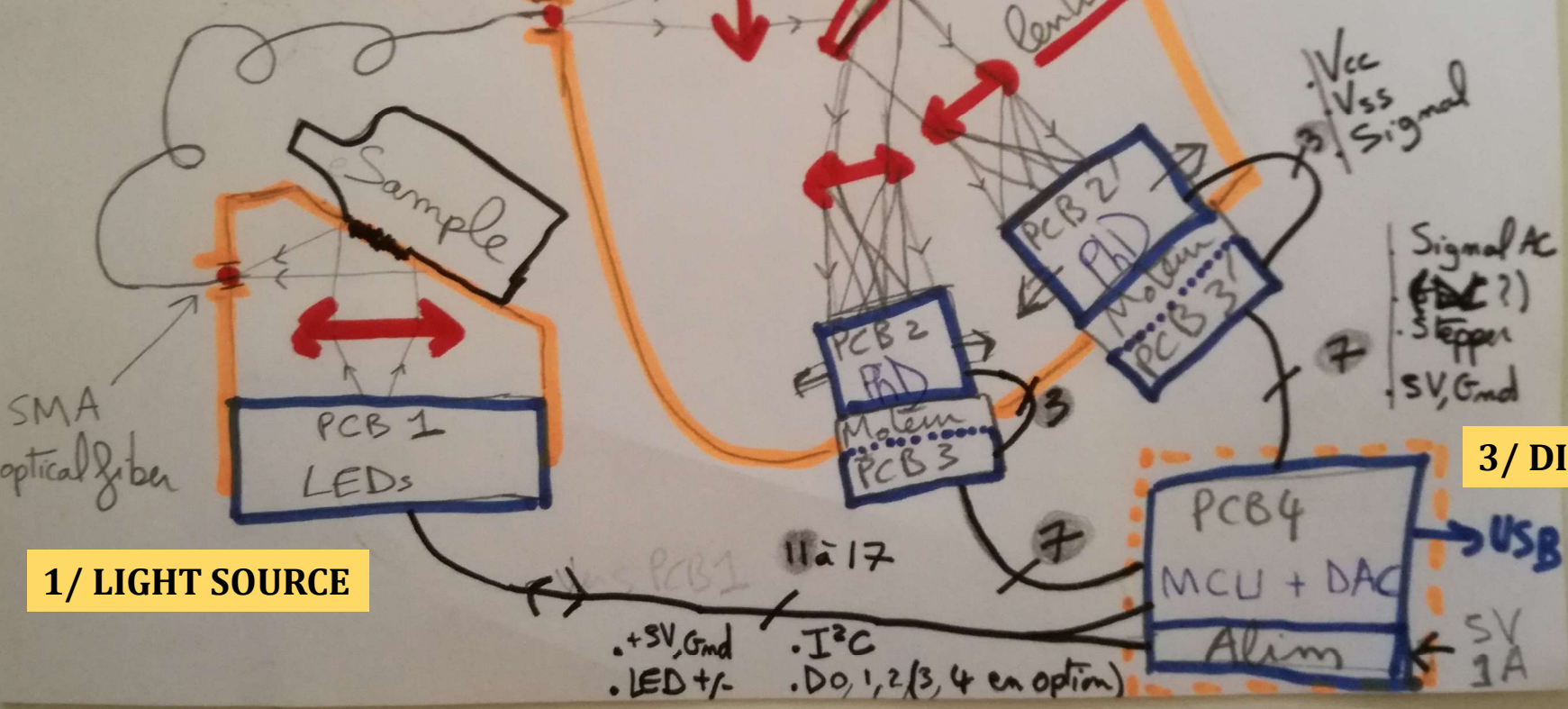
Qing II

by Meij, for Plastic Odyssey

7/7/2019

Fiber

2/ SPECTRO



1/ LIGHT SOURCE

4/ 1st SPECTRA

5/ NEXT STEPS

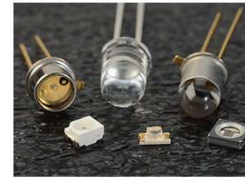
1

LIGHT SOURCE

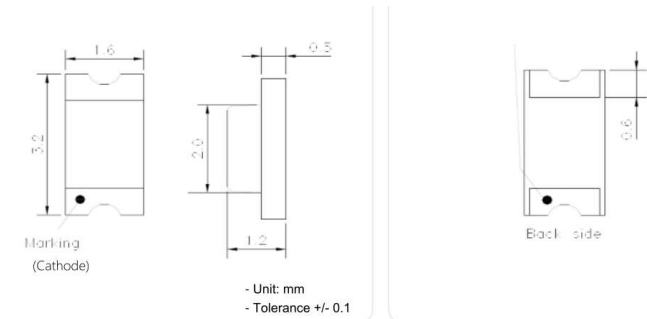
IR LED SMD by Marktech

- SMD 1206
- 100 to 130nm bandwidth
- Optional dome lens (no stocked)

<https://marktechopto.com/marktech-emitters/swir-emitters/>



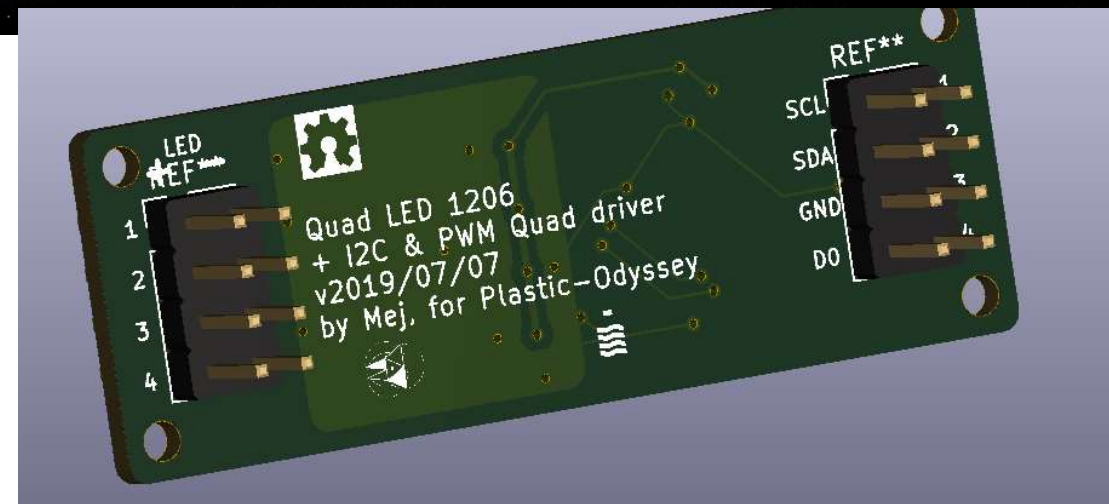
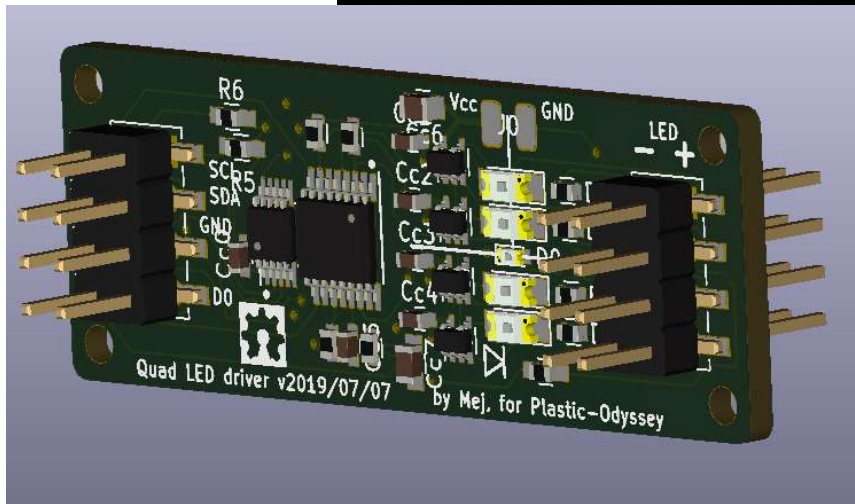
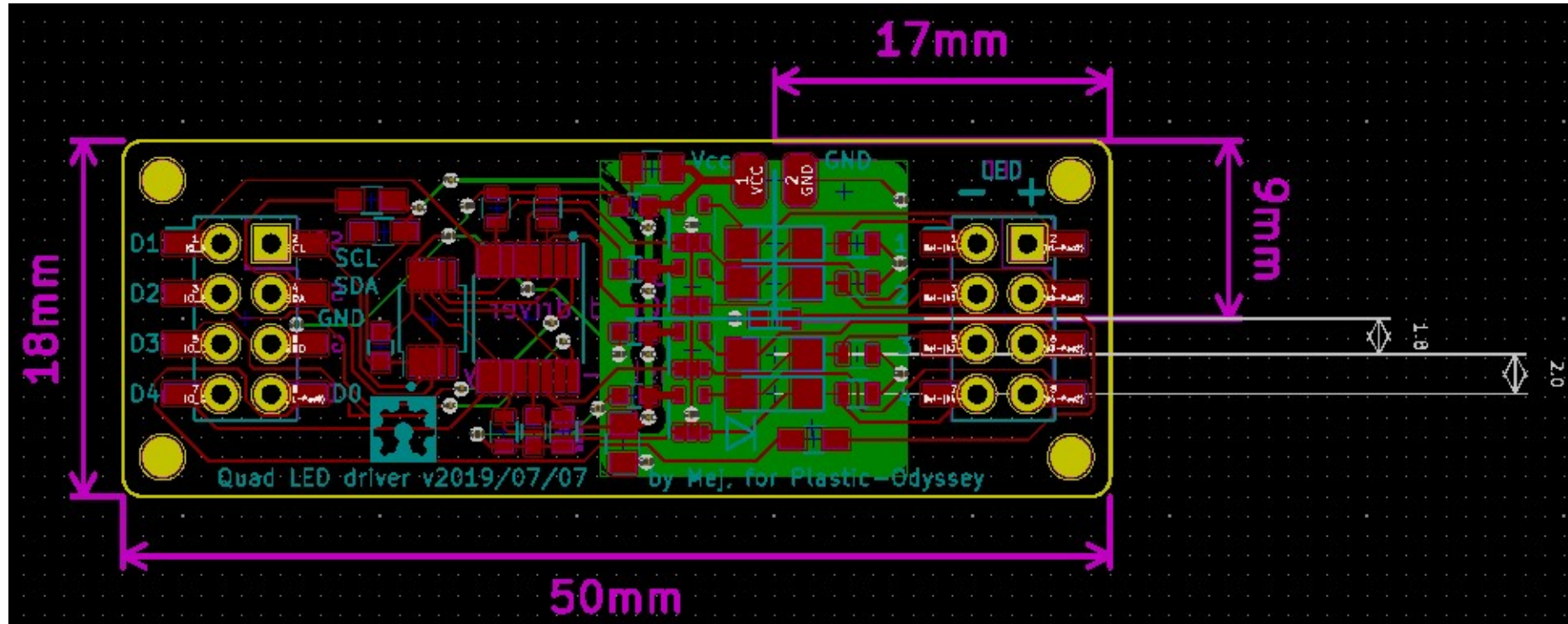
SWIR Emitters
1020nm – 1720nm



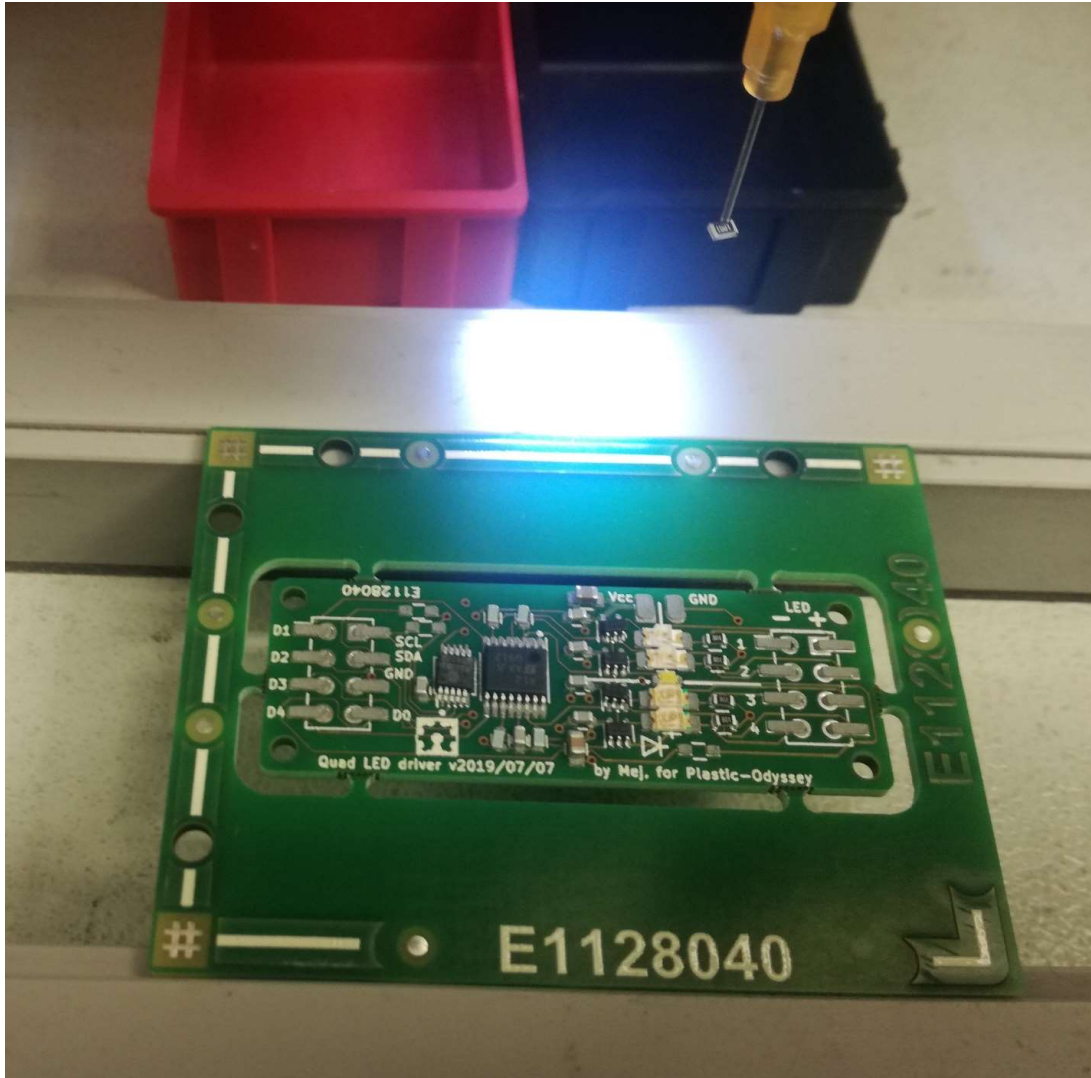
Used in many material analysis and machine vision applications, short wavelength infrared (SWIR) emitters offer the high-power, high-speed performance you need.

Marktech Optoelectronics	Product	λ [nm]	$\Delta\lambda$ [nm]	λ min [nm]	λ max [nm]	P_20% min [nm]	P_20% max [nm]	@ I [mA]	U forward [V]	Power [mW/sr]	Buy Now	by 10	by 100	by 1000	
	MTSM5016-199-IR	1650	130	1585	1715	1480	1710	50	1	1.7	https://www.digikey.com	20	13	11.7	USD
	MTSM5015-199-IR	1550	130	1485	1615	1410	1620	50	1	1.7	https://www.digikey.com	20	13	11.7	USD
Angle 100°	MTSM5014-199-IR	1450	90	1405	1495	1320	1510	50	1	2	https://www.digikey.com	20	13	11.7	USD
Package 3.2x1.6mm Flat Top SMD (2 pin)	MTSM0013-199-IR	1300	90	1255	1345	1190	1350	50	1	5	https://www.digikey.com	20	13	11.7	USD
	MTSM0012-199-IR	1200	80	1160	1240	1110	1240	50	1	5	https://www.digikey.com	20	13	11.7	USD
	MTSM5010-199-IR	1050	80	1010	1090	980	1080	50	1.2	1.2	https://www.digikey.com	18	11.5	10	USD

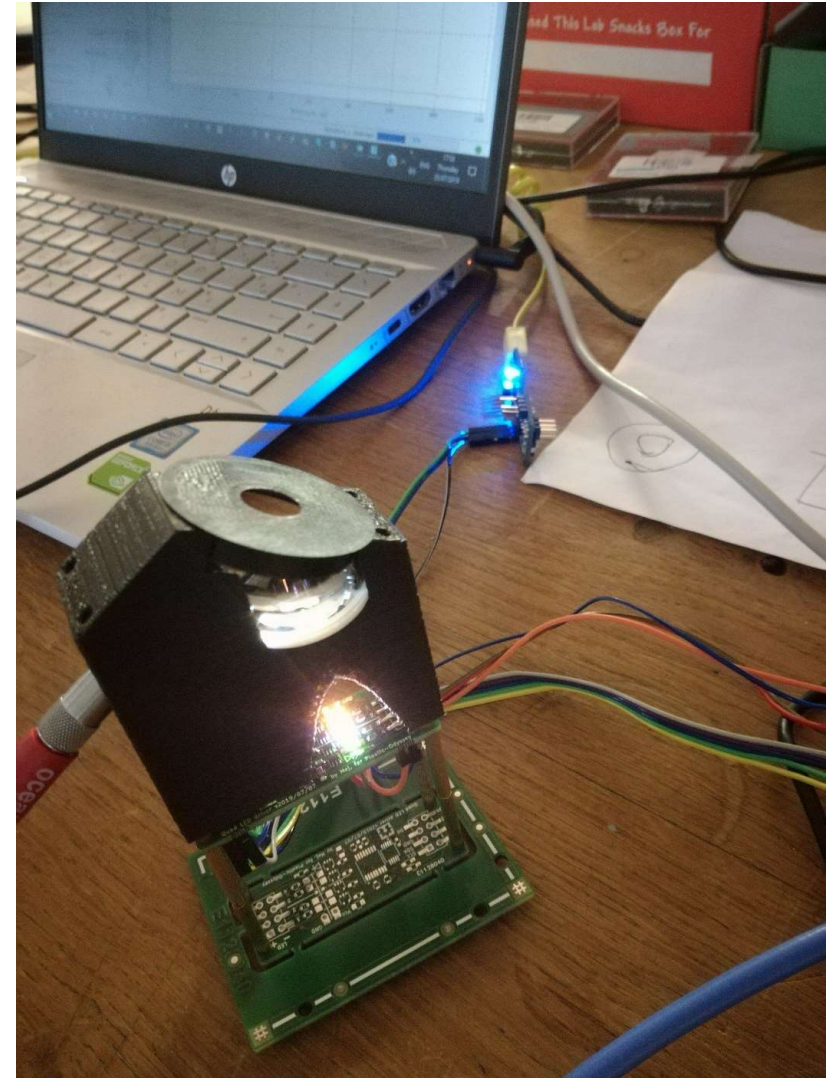
PCB 1/4
LED_PCB



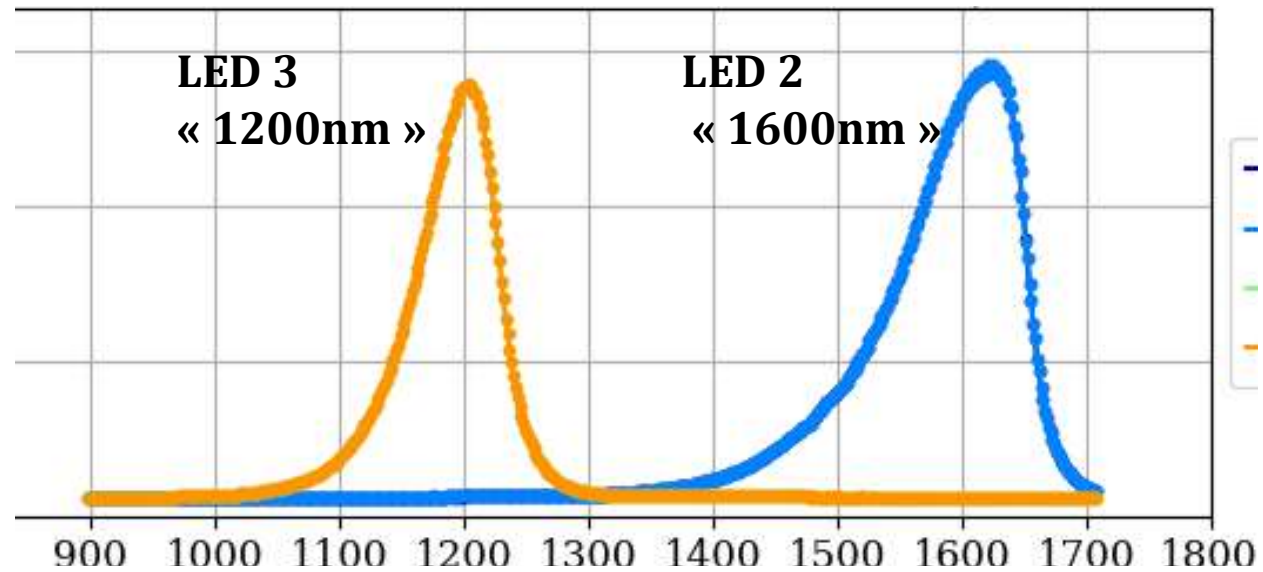
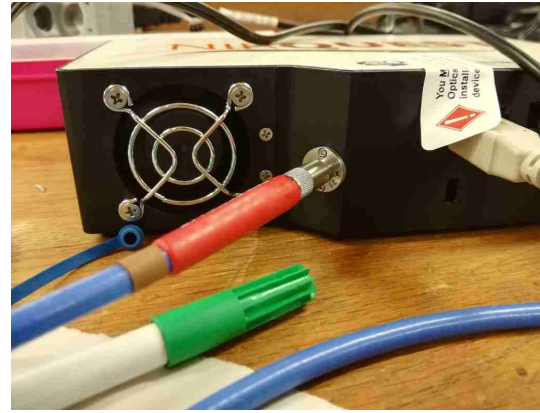
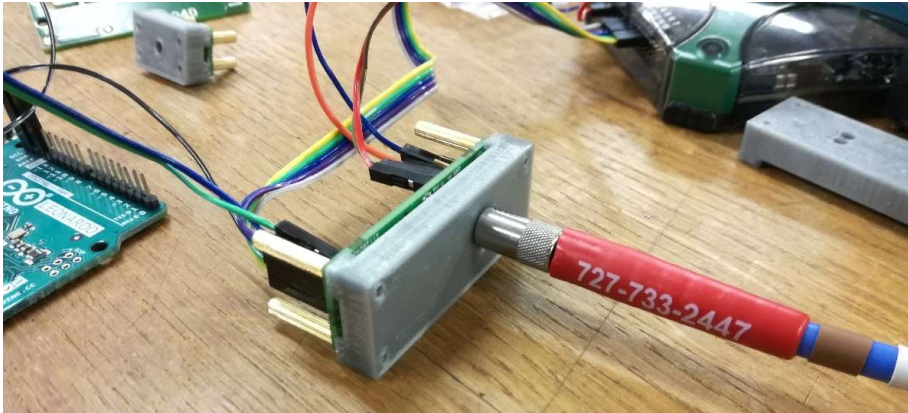
Manual pick & place of the components



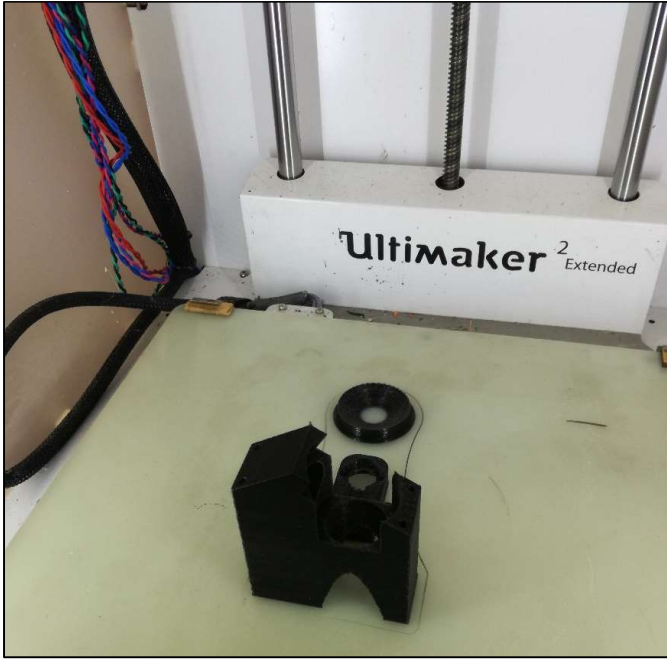
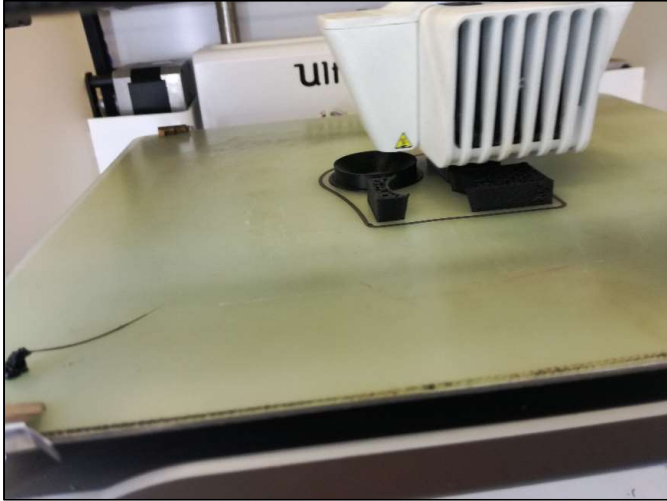
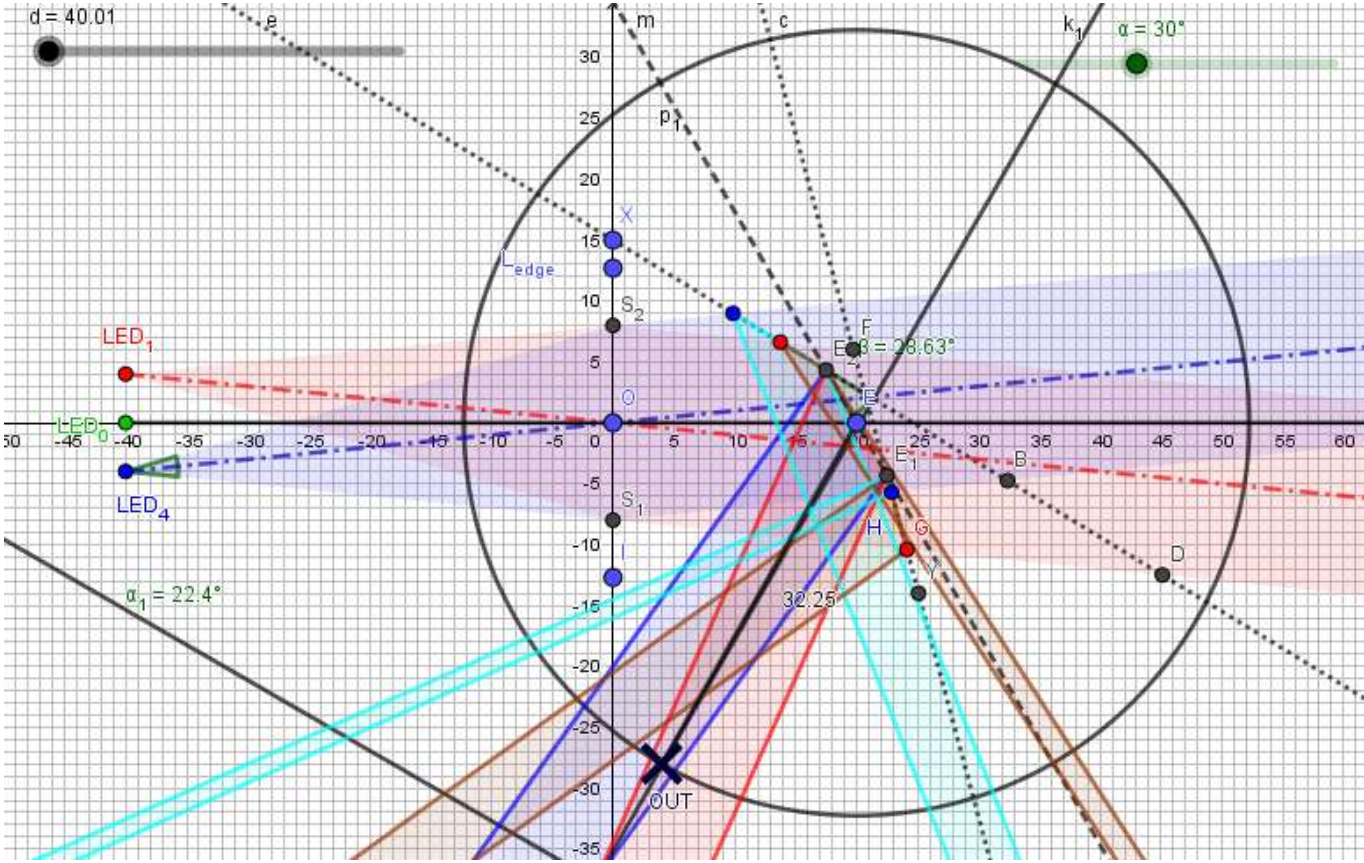
Test with visible LEDs



Reference spectra of LEDs using NIRQuest spectrometer (v900-1700nm @ ~15k€) by Ocean Optics



Sample holder



3D printing

2 SPECTRO

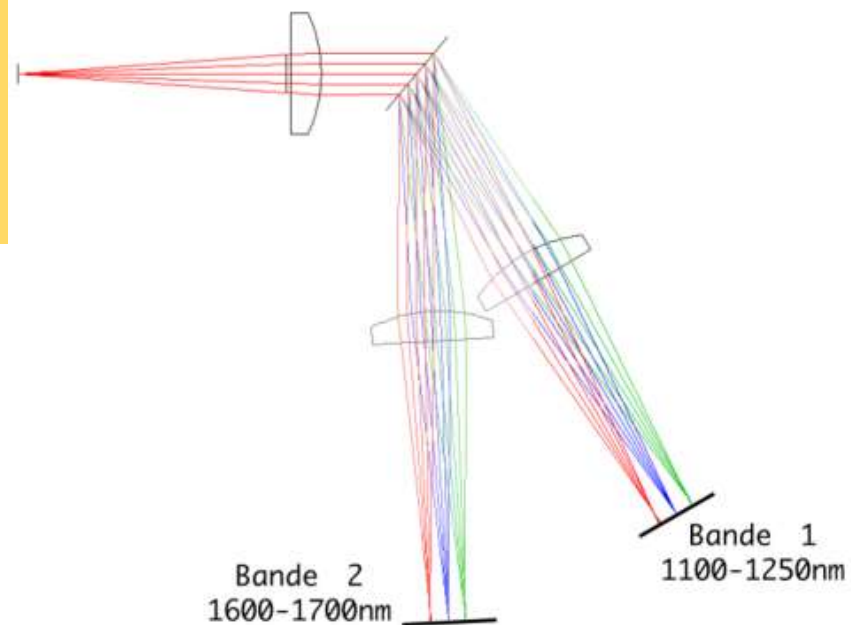


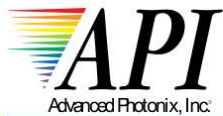
Figure 2.4.3 Schéma du système optique et des trajets lumineux

IR PhD SMD

DESCRIPTION

The SD003-151-001 is a high sensitivity, low noise, 0.075 mm diameter active area InGaAs photodiode (chip dimensions 0.3mm x 0.3mm) for detection at SWIR, NIR wavelengths for imaging and sensing applications. The photodetector is assembled in a 1206 package.

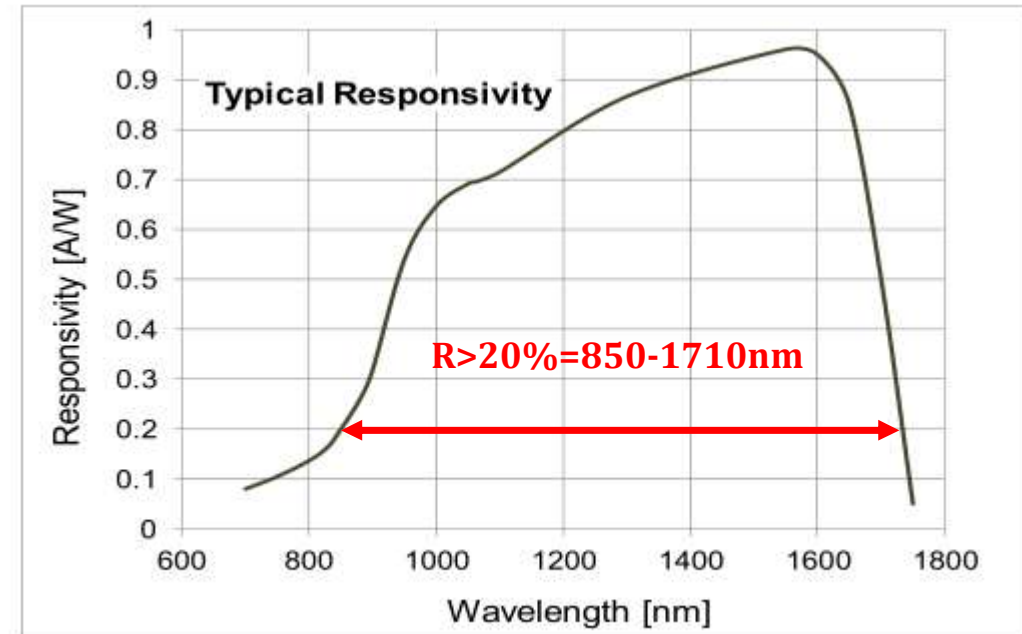
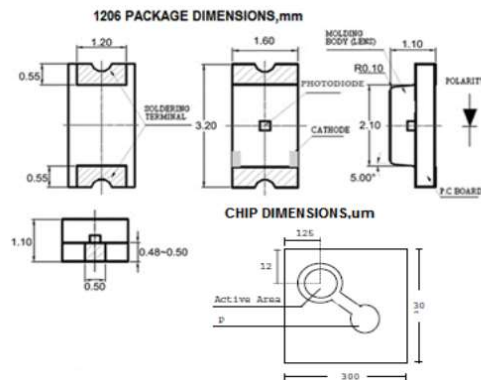
Price Break	Unit Price	Euro
1	3,41000	
10	2,84200	
25	2,38760	
100	2,04650	
250	1,81916	
500	1,64860	
1 000	1,51218	



Surface-Mount InGaAs Photodetector
SD003-151-001

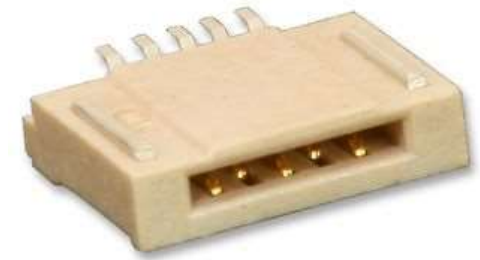
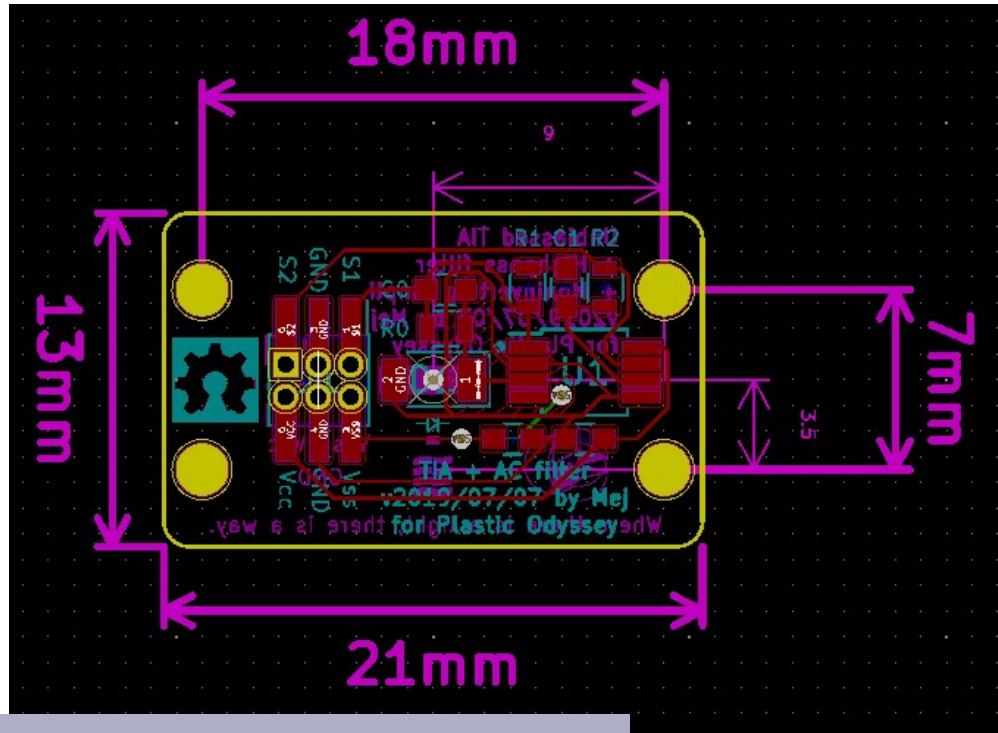
WWW.ADVANCEDPHOTONIX.COM

Precision – Control – Results

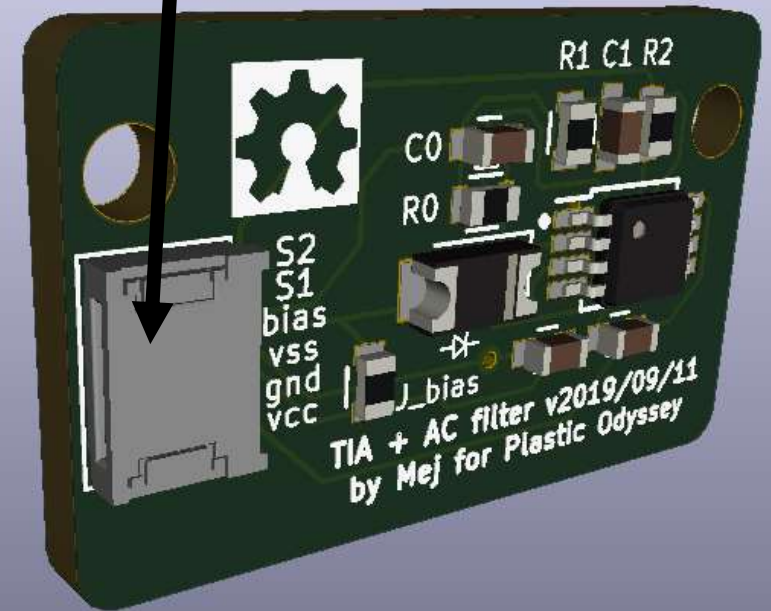
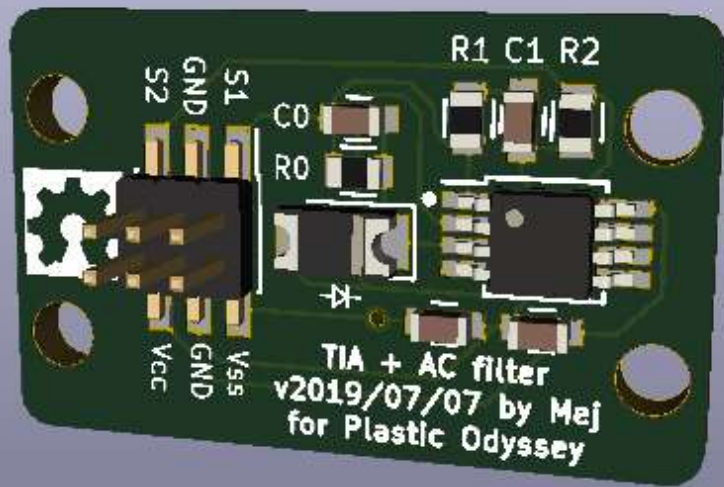


PCB 2/4

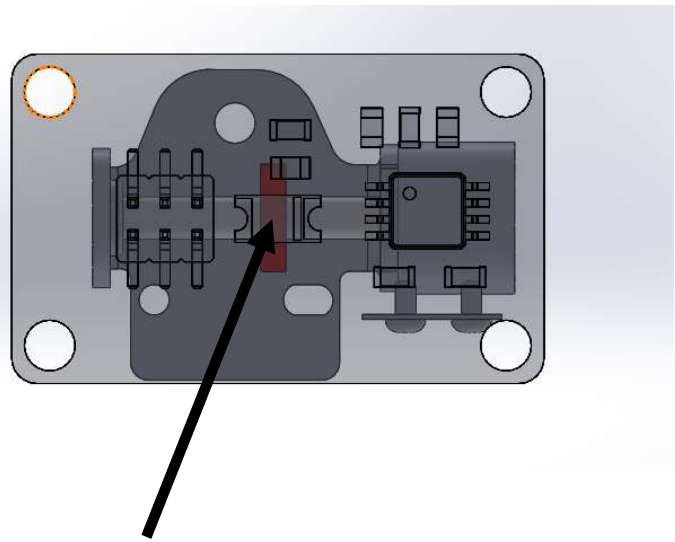
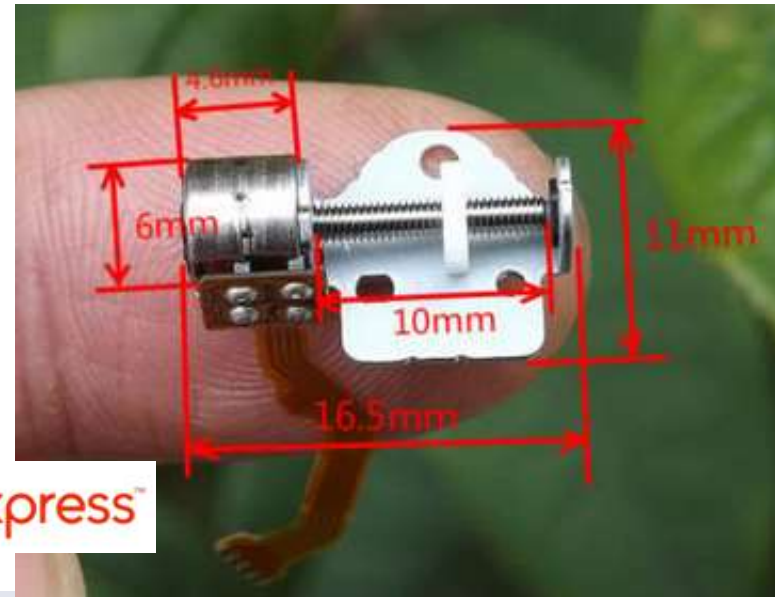
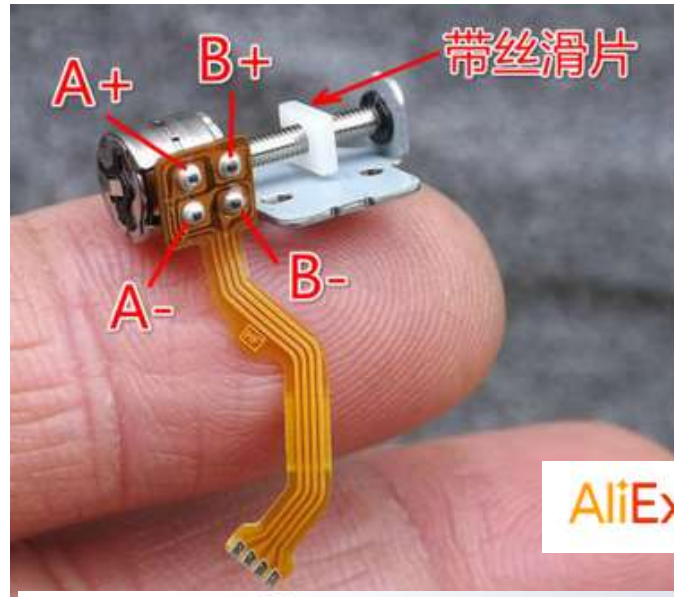
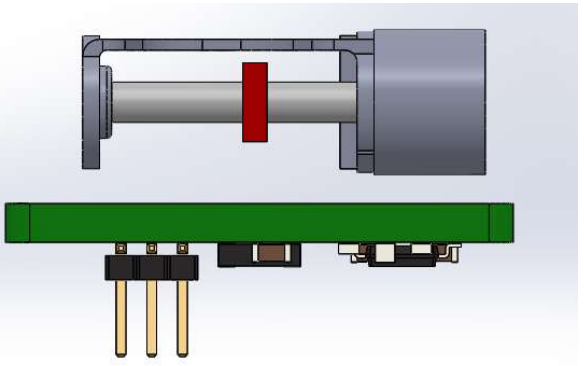
PhD PCB



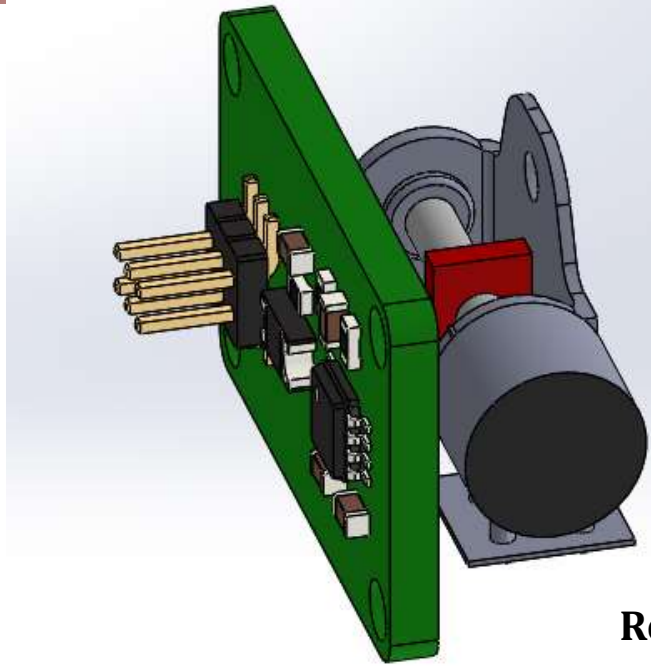
FFC (Flexible Flat Cable) connector



Mini stepper motor for spectrum scan

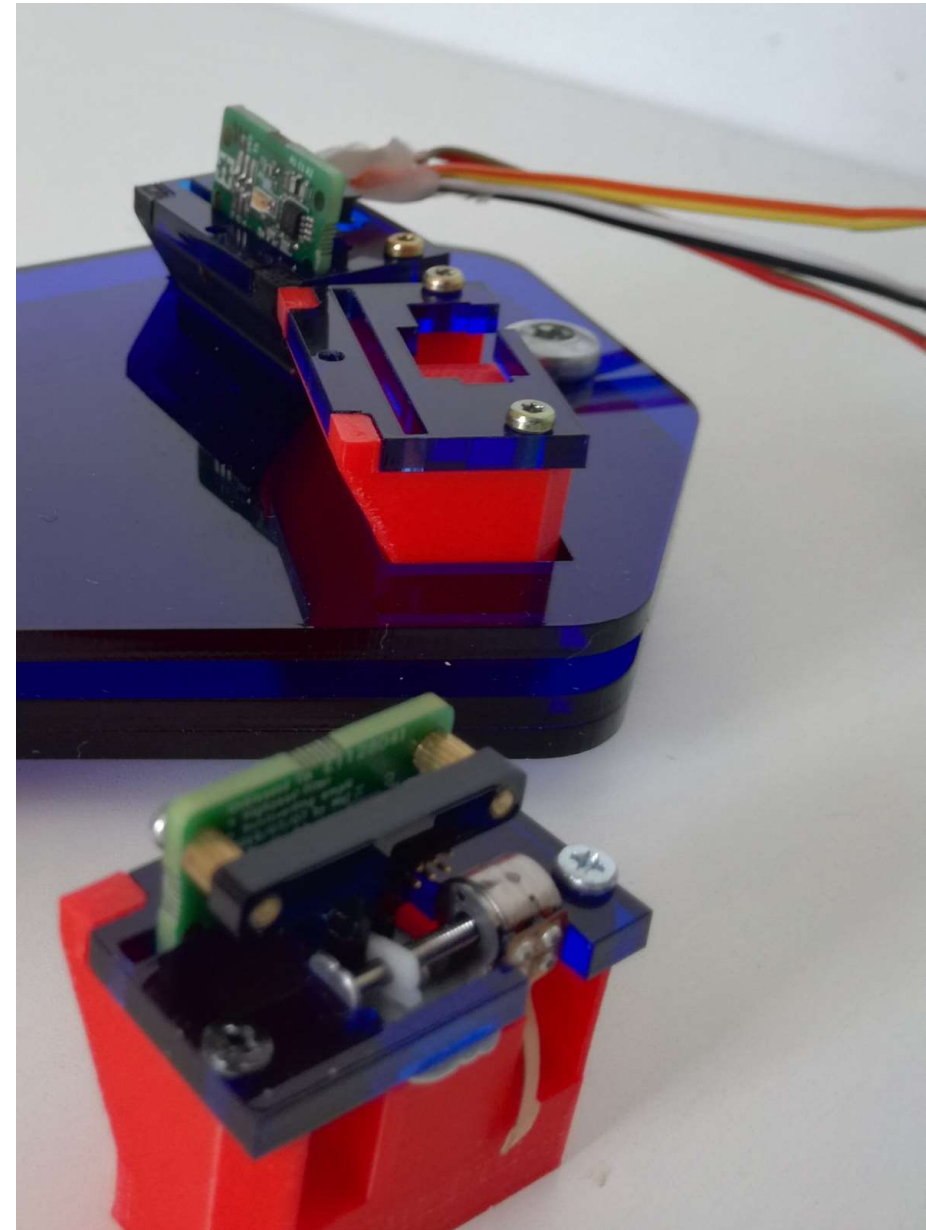
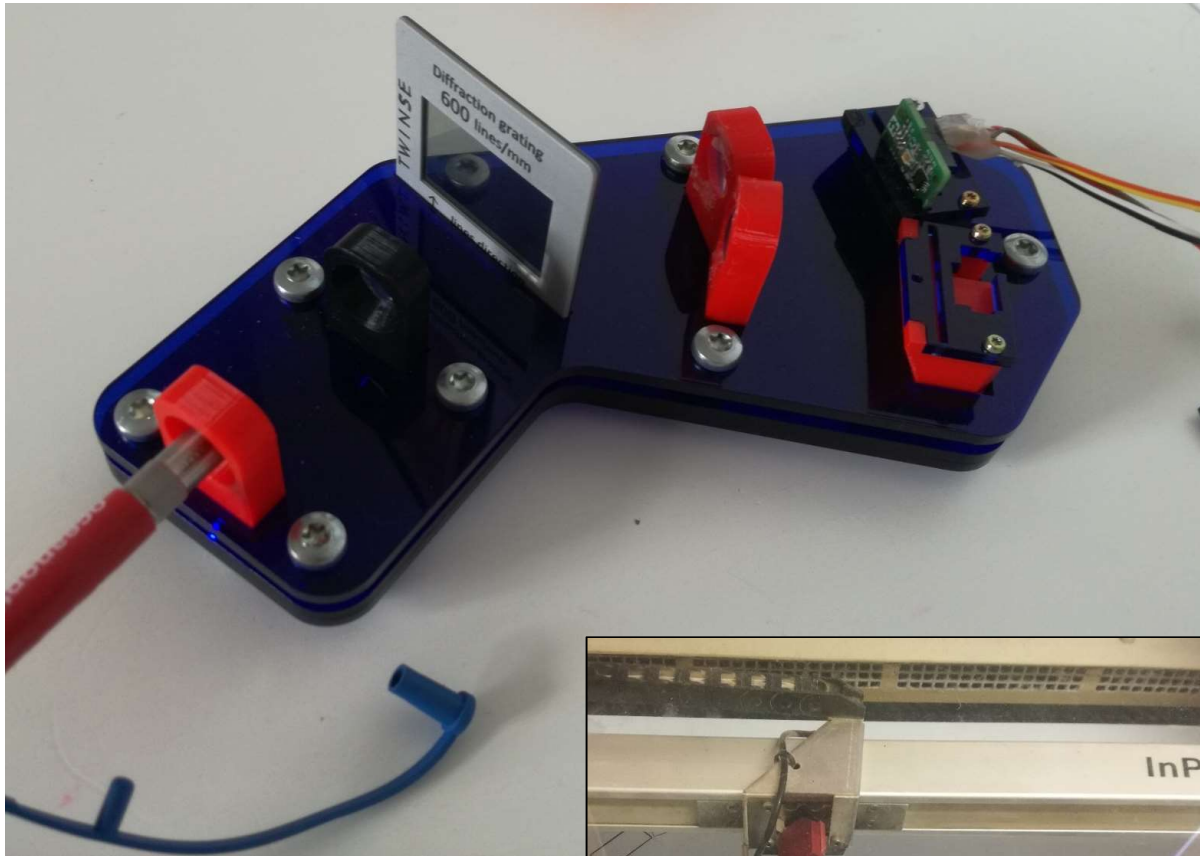


SMD SWIR photodiode



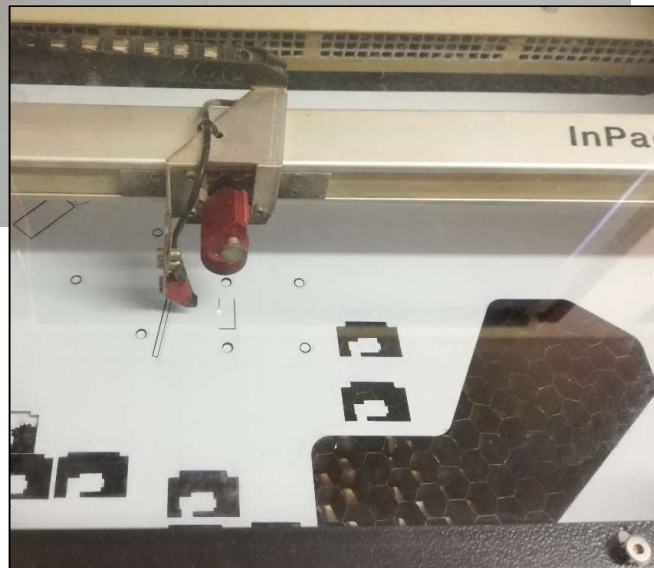
FFC plug:	4 contact
	pitch 0.8mm
	e=0.2mm
	Moteur
A+ B+ 1 2	
A- B- 3 4	
3 4 1 2	nappe
A- B- A+ B+	
B+ A+	PCB hub
B- A-	

Robust mechanical housing coming soon...

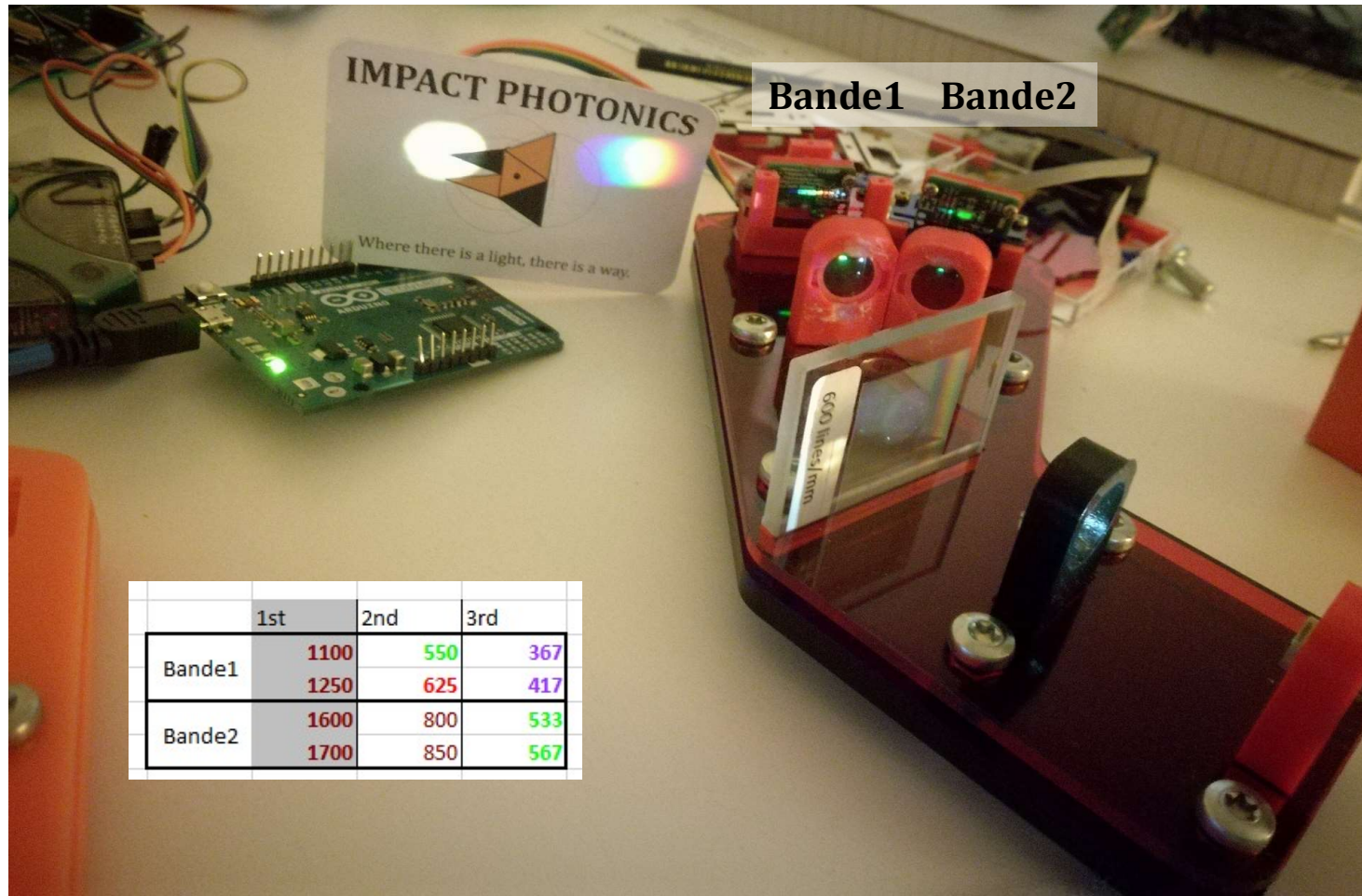


3D printing
+
Laser cutting

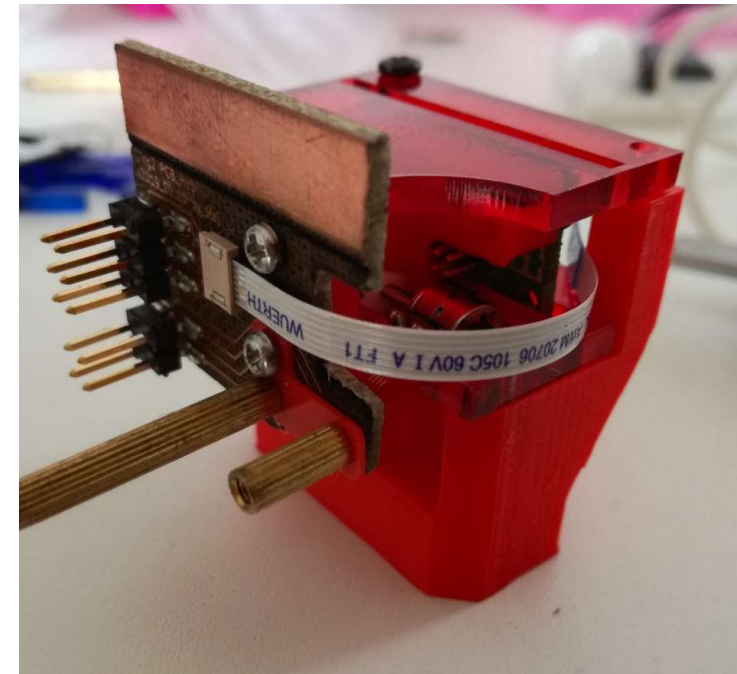
ONLY

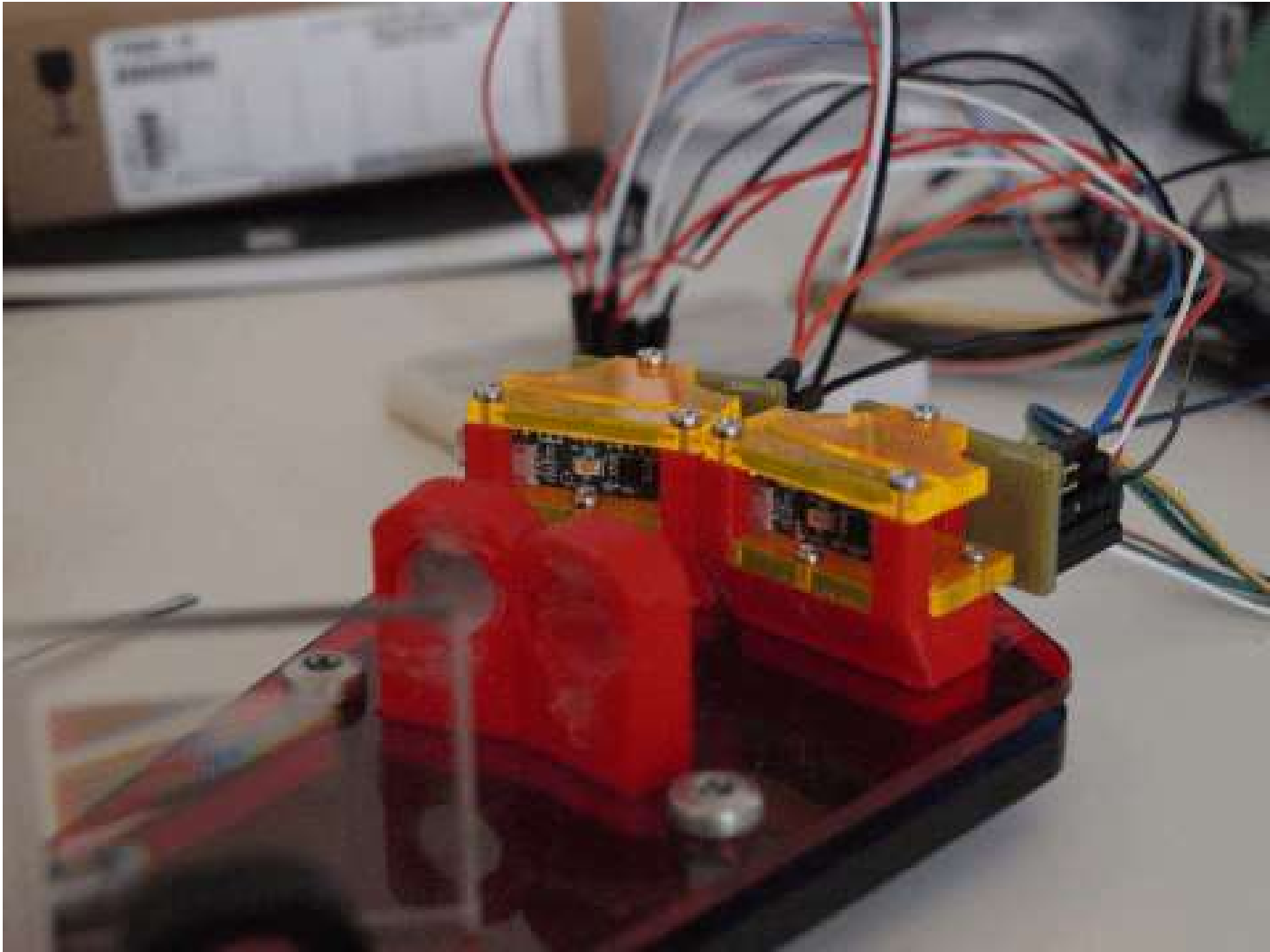
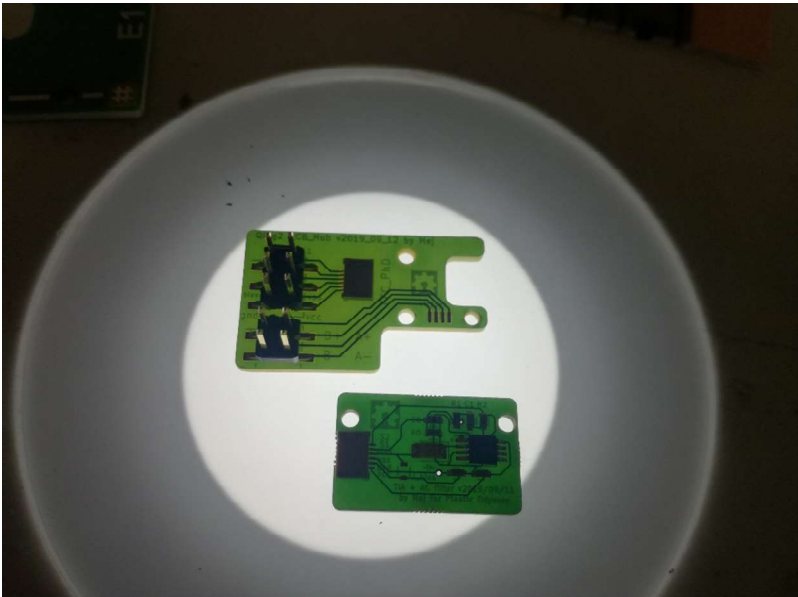
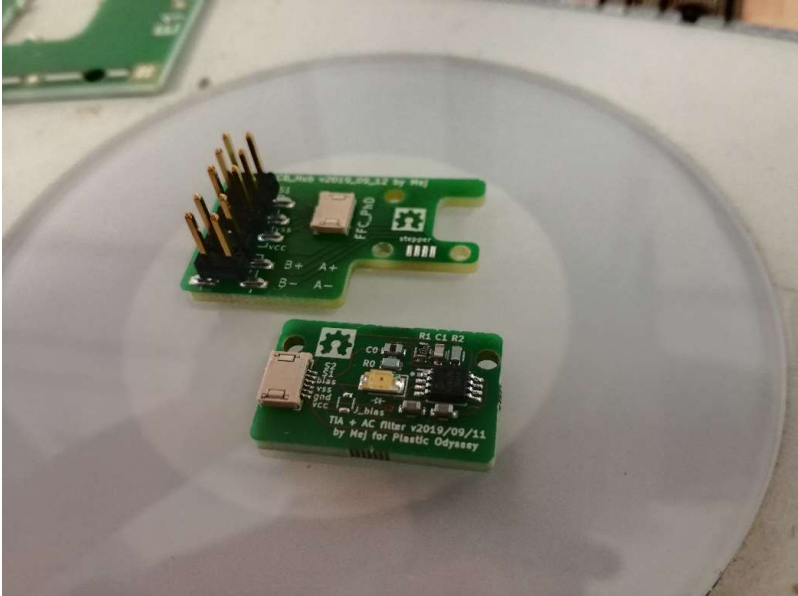


Allignement en lumière blanche:
les ordres secondaires sont bien visible



Hub_PCB v0





3

DIGITAL



PLASTIC
ODYSSEY

Aix*Marseille
université
Initiative d'excellence

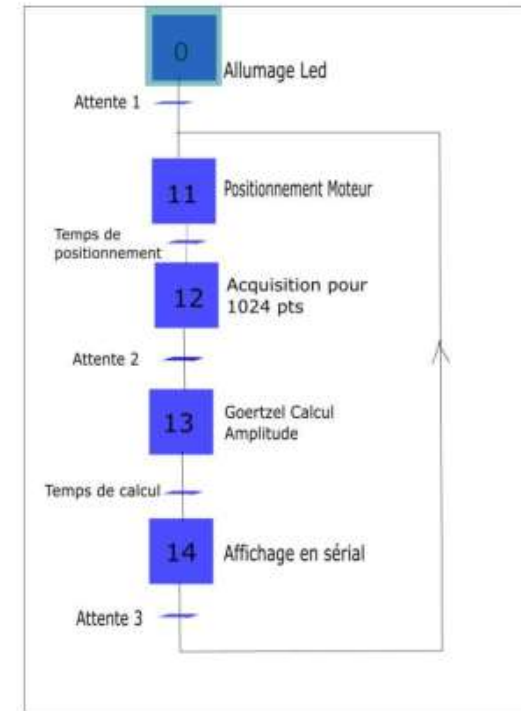
POLYTECH
MARSEILLE

STAGIAIRE : DIENG IBRAHIMA

DUREE : 3 mois

Juin-Juillet-Aout 2019

• GRAFGET PROPOSE POUR LA CONCEPTION

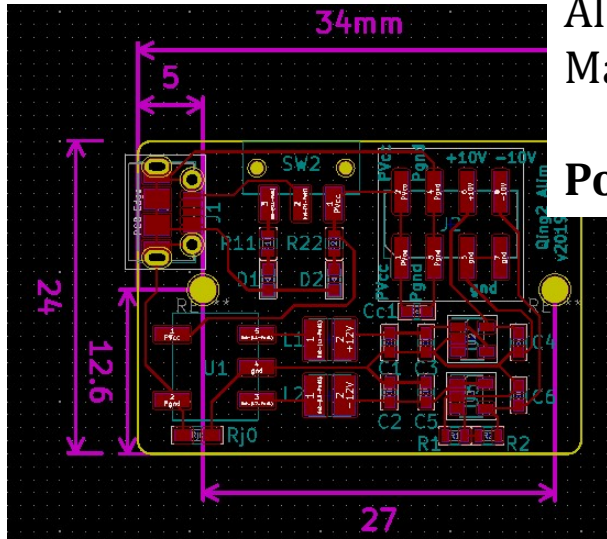


Grafcet pour une led et un moteur

[Qing_2/Ibrahima/Rapport_Officiel_Stage_Capteur_Frugal_PO_2019_Dieng_Ib.pdf](#)

Un code arduino fonctionne pour acquérir à 80kSa/s (via SPI) et extraire le signal à la volé (algo de Goertzel). Pour valider le code on a utilisé un **ADC simple d'utilisation: MCP3204**, 12bit, no filtering, no pre-scaling Il faudrait implémenter un **ADC plus complexe**: 16bit (24 bit?), 100ksps (1Msps?), with pre-scaling (and filtering?). L'ADC **ADS858x** pourrait faire l'affaire. Sa dev-board a été achetée.

Pour les acquisitions on utilisera l'ADC de l'Analog Discovery (14 bit, 100MSps)



Alim_PCB trop bruitée,
Malgré une double régulation :/

Pour les acquisitions on utilisera l'alim stabilisé +/-5V de l'Analog Discovery

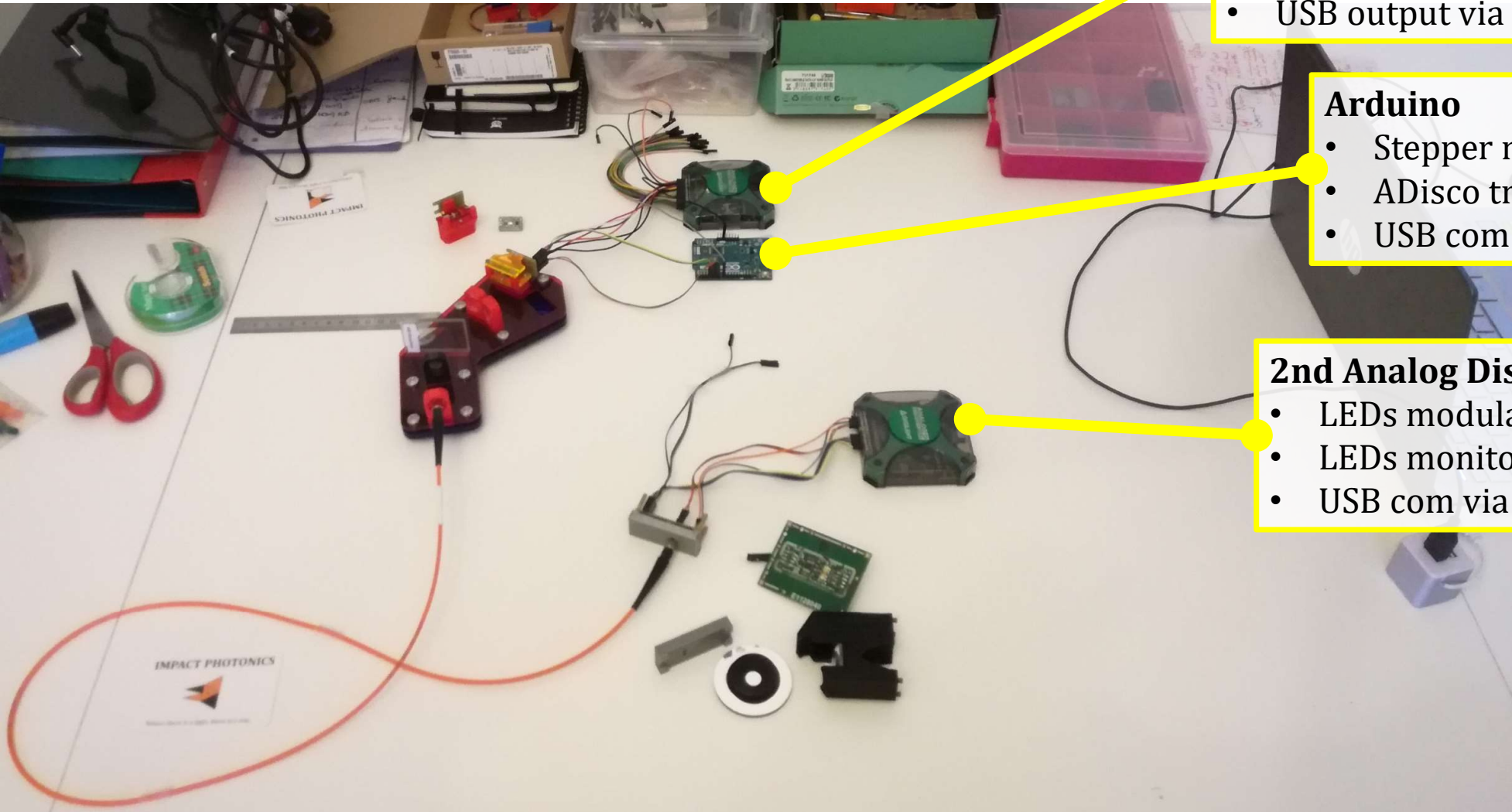


MTU1D0512MC

±12V ±42mA, 1W Dual Output Isolation 1kVDC,
DC-DC Converter 4.5V-5.5V Input



QING v2.0 digital set-up



1st Analog Discovery

- PhDs power
- PhDs monitoring
- USB output via Python SDK

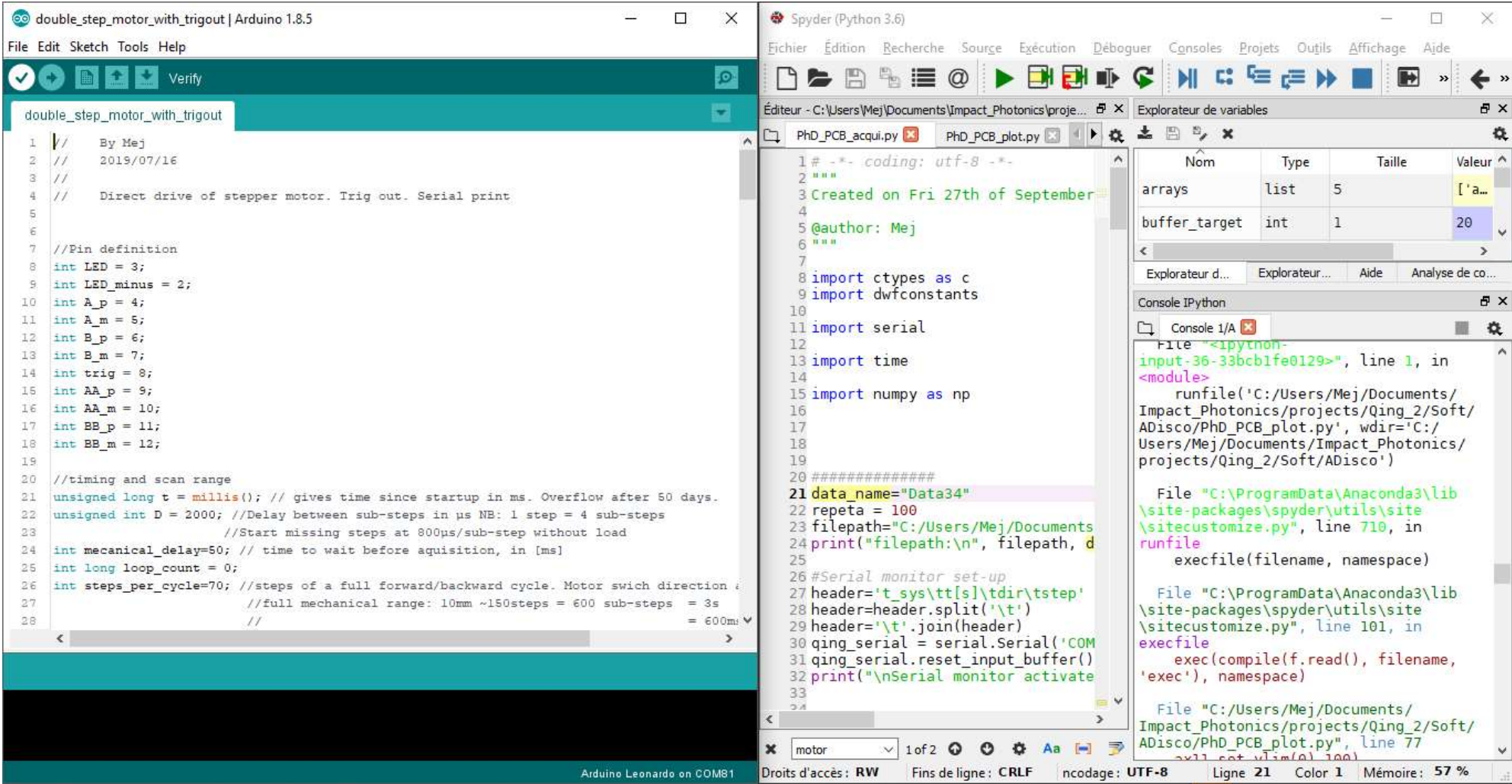
Arduino

- Stepper motor drive
- ADisco trig
- USB com via Pyserial

2nd Analog Discovery

- LEDs modulation
- LEDs monitoring
- USB com via Python SDK

QING v2.0 data stream, via PC



Arduino IDE and serial monitor
For Arduino MCU

Spyder (Python) IDE + Digilent library SDK
for Analog Discovery

4

Spectral Acquisition

QING v2.0

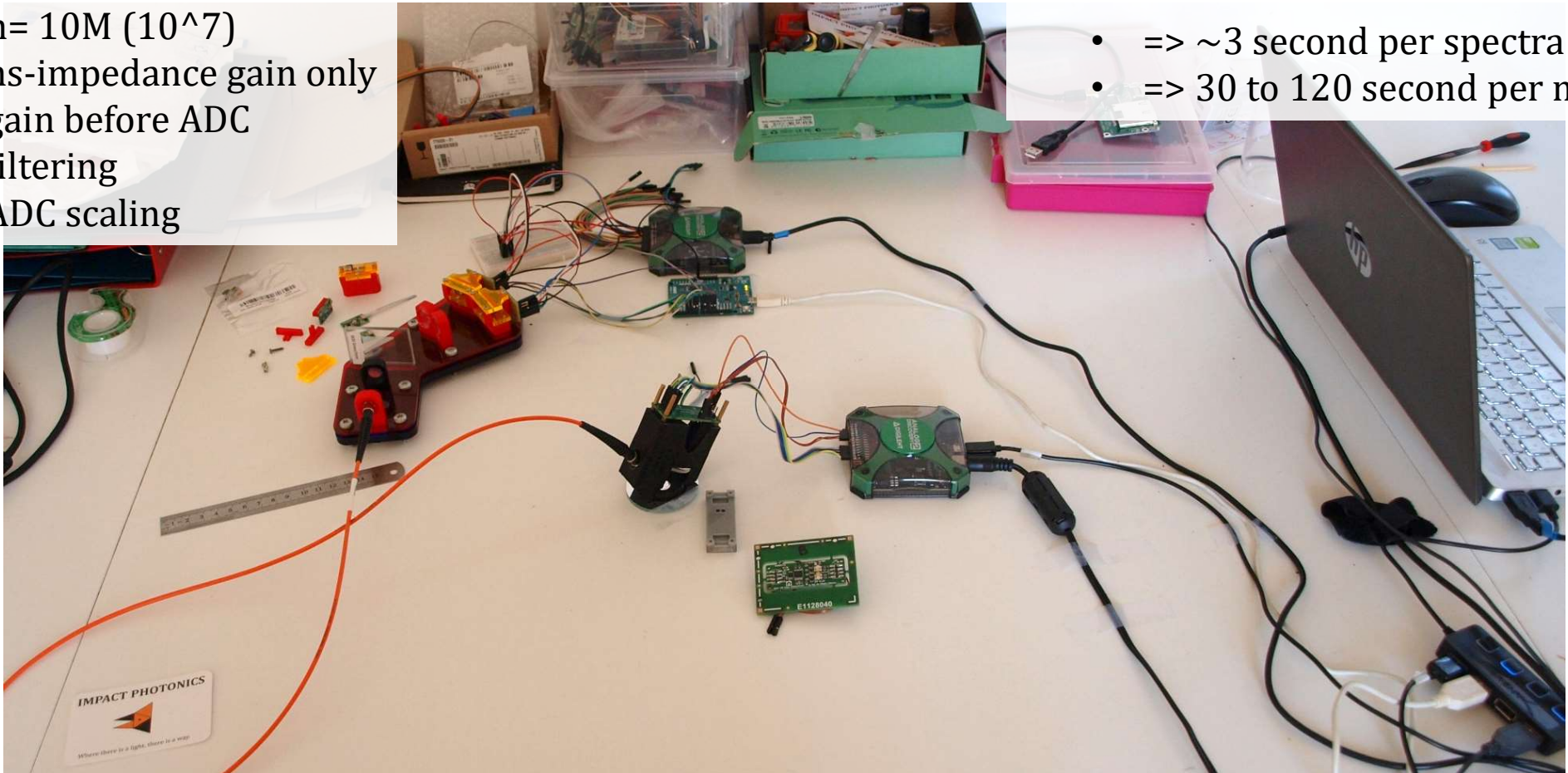
A frugal SWIR dual-band spectrometer

Photodetection:

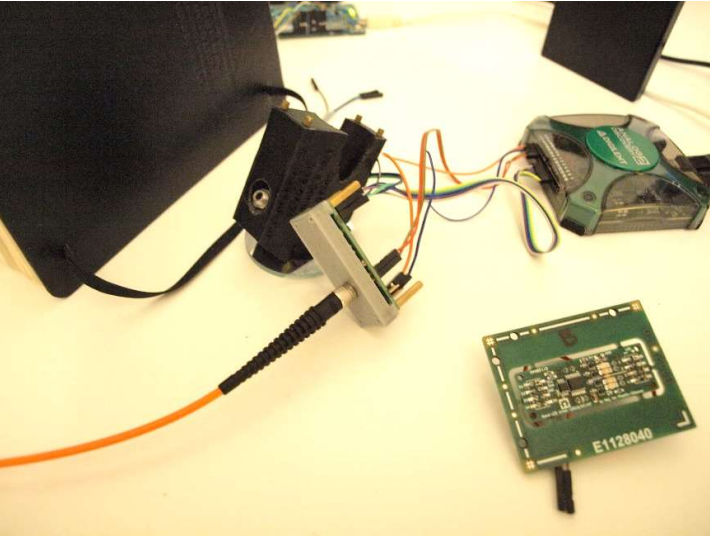
- gain= 10M (10^7)
- Trans-impedance gain only
- No gain before ADC
- No filtering
- No ADC scaling

Ultra-safe aquisition speed:

- 250ms per spectral point
 - 11 points per spectra
 - 22 points per aller-retour spectra
 - 10 to 40 aller-retour per measure
-
- => ~3 second per spectra
 - => 30 to 120 second per measure

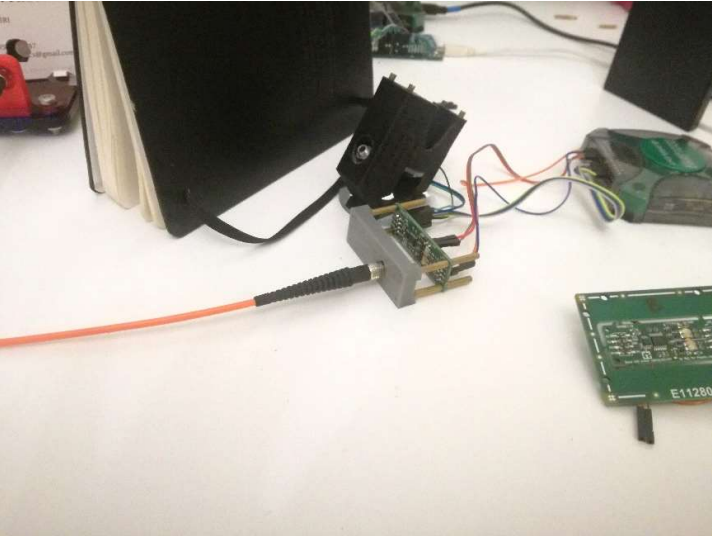


Mode de branchement de la source:



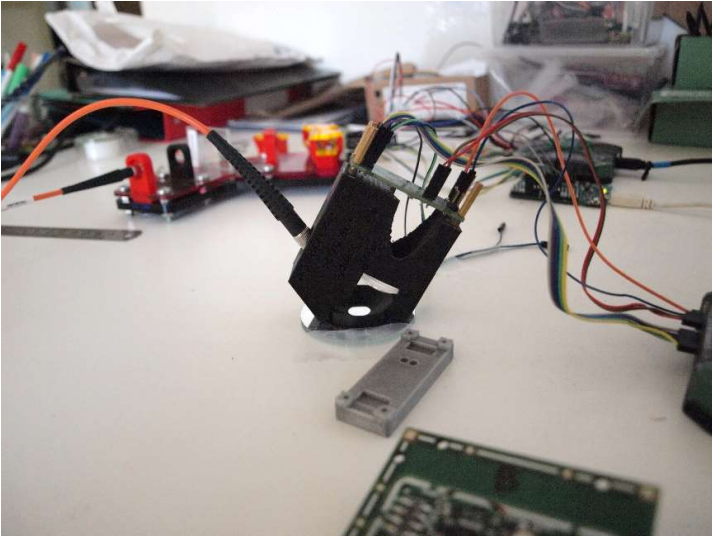
Direct to fiber
D=2mm

P_fiber ~10 μ W



20mm to fiber
D=22mm

P_fiber ~100 nW



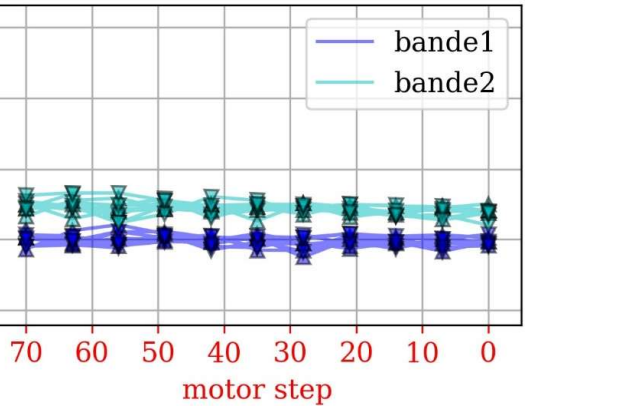
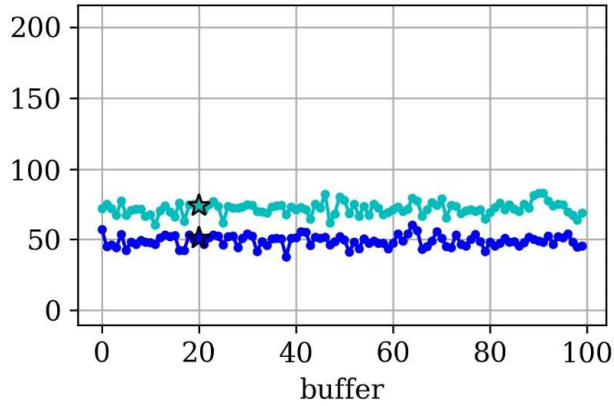
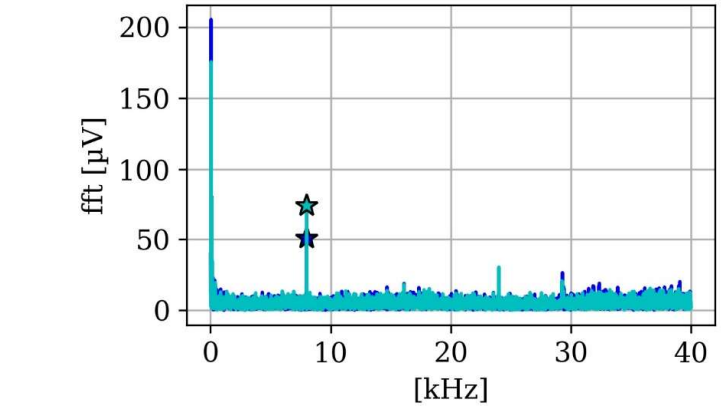
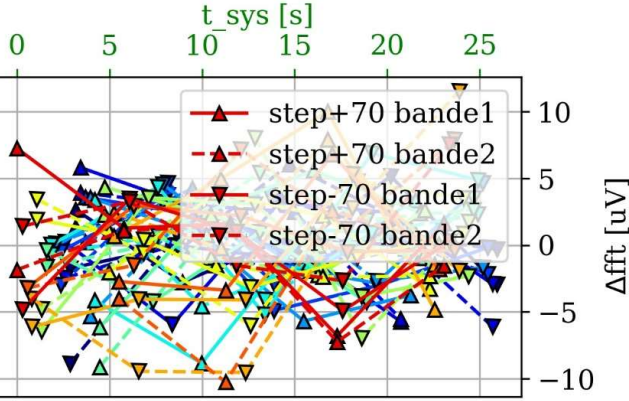
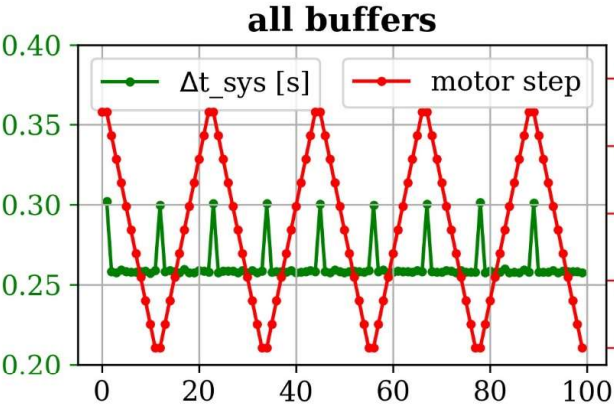
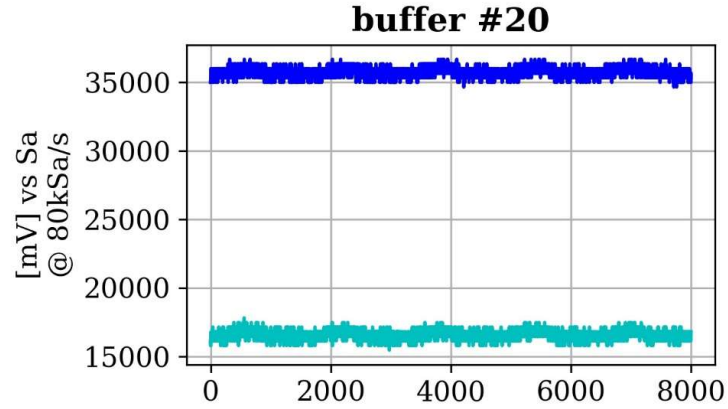
Avec le bloque porte échantillon
(ici, l'échantillon est un miroir)

P_fiber ~ 10 to 0.1 nW
Depending on sample

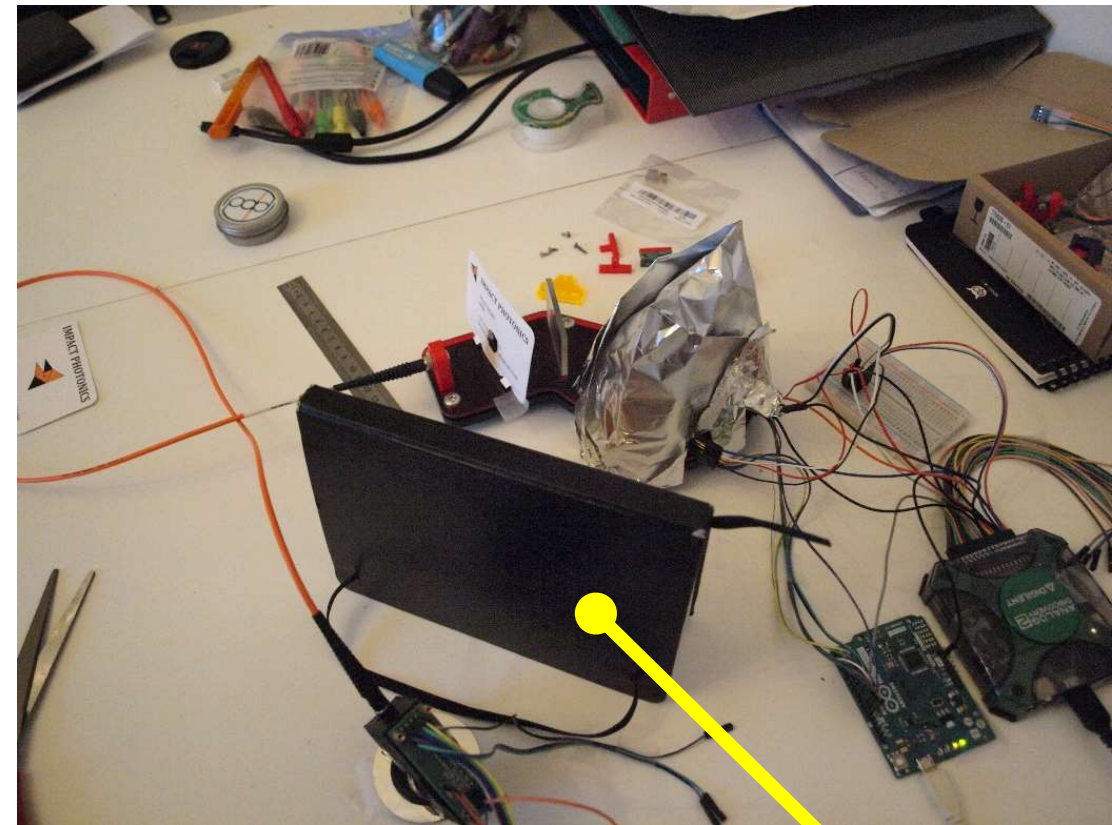
Pas assez de signal pour réaliser
une mesure (aujourd'hui)

Fibre sur le bloque porte échantillon, LEDs allumées @ 0-22mA square 8kHz

C:/Users/Mej/Documents/Impact_Photonics/projects/Qing_2/Soft/ADisco/mesures/
Data21



Faraday shield

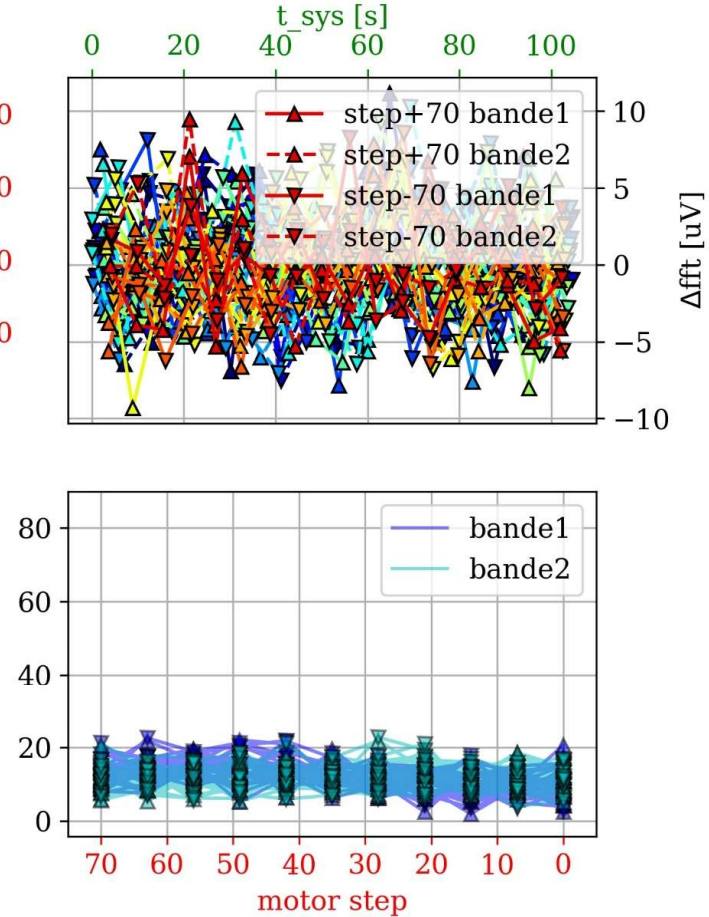
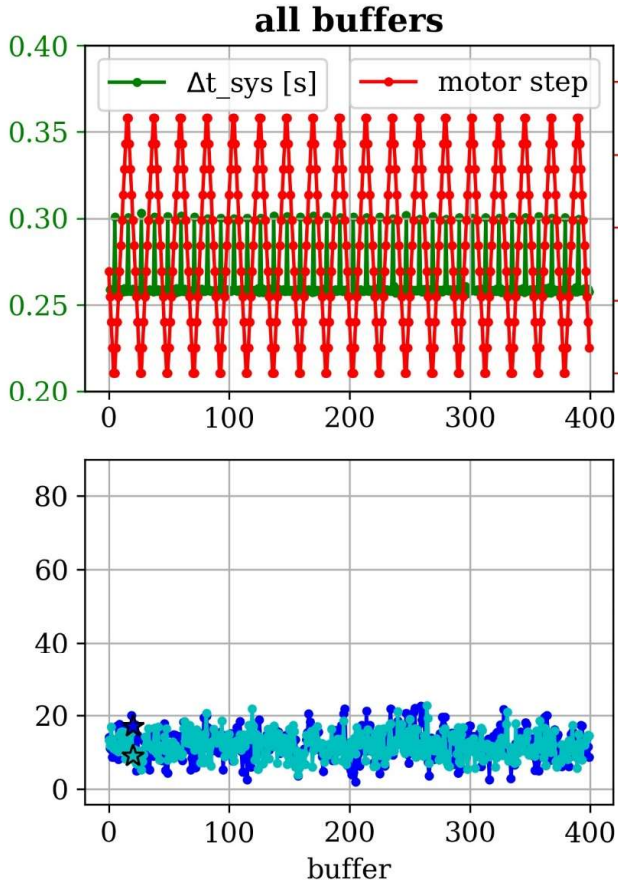
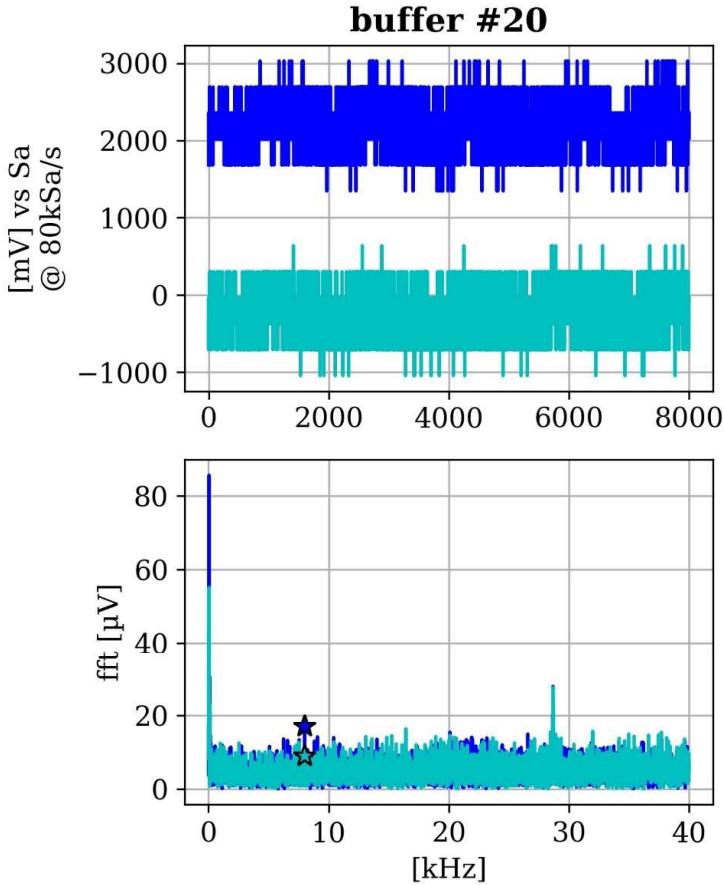


Optical shield

Fibre sur le bloque porte échantillon, LEDs allumées @ 0-22mA square 8kHz

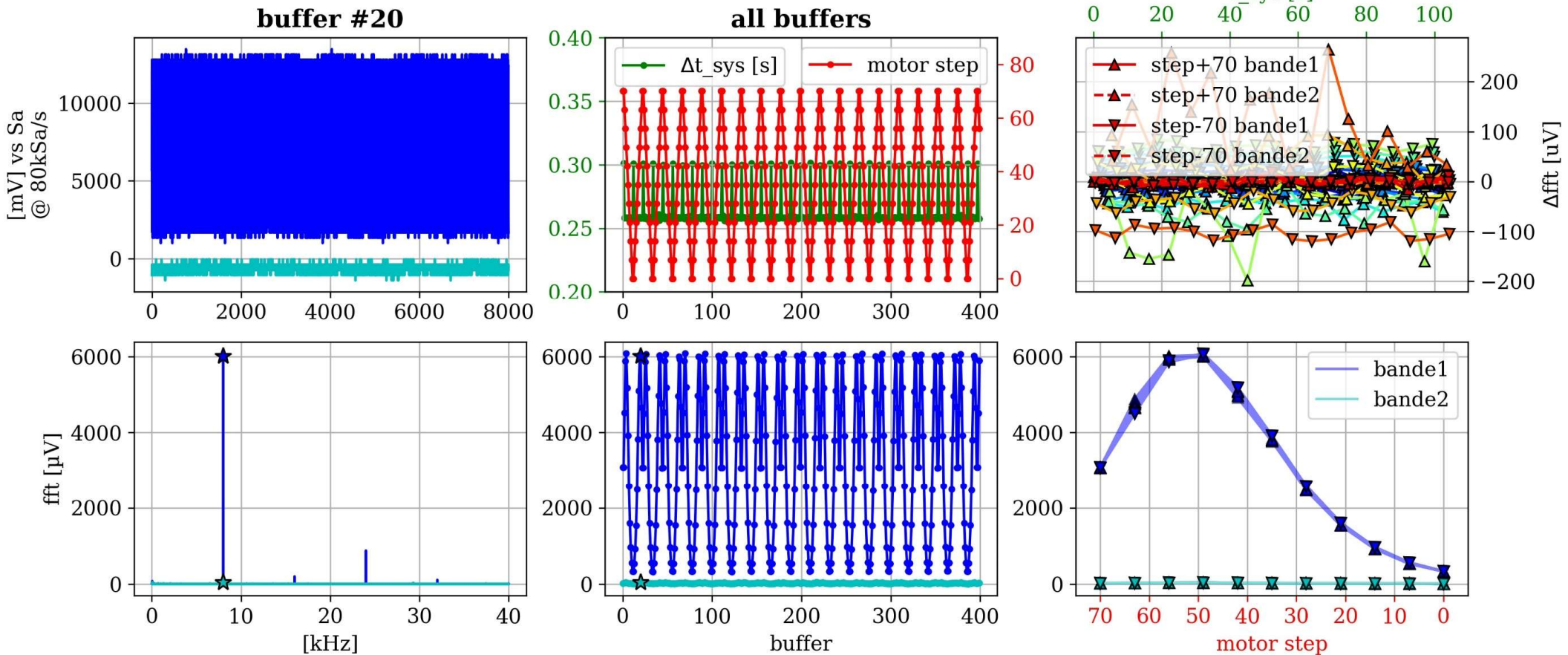
Shield électromagnétique + Shield optique => Bruit réduit x5 à x10

C:/Users/Mej/Documents/Impact_Photonics/projects/Qing_2/Soft/ADisco/mesures/
Data30



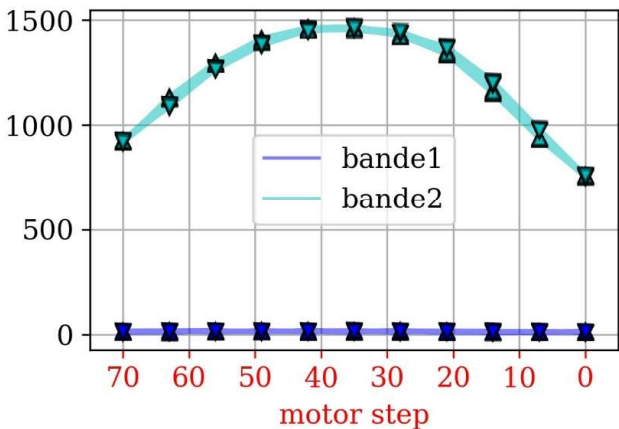
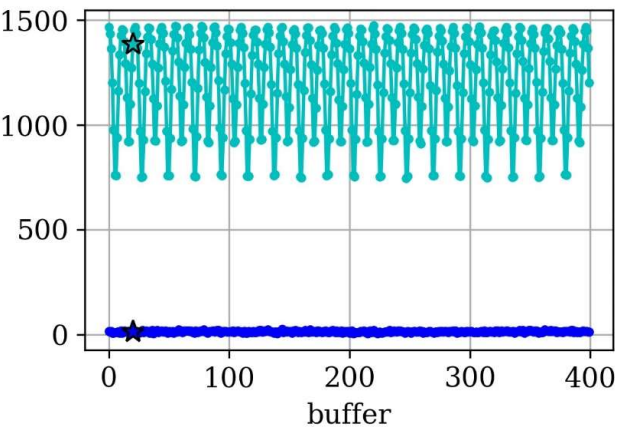
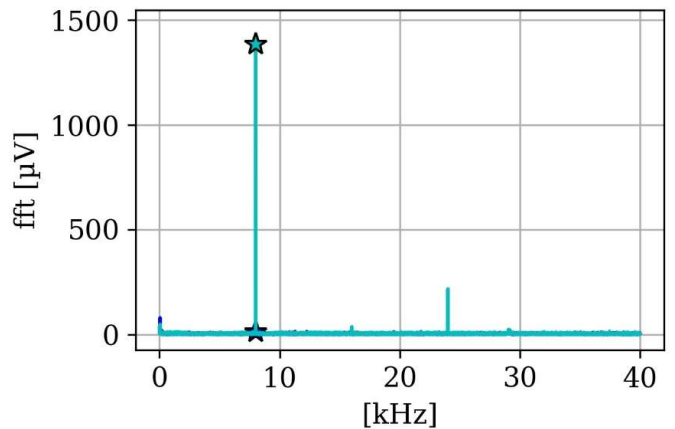
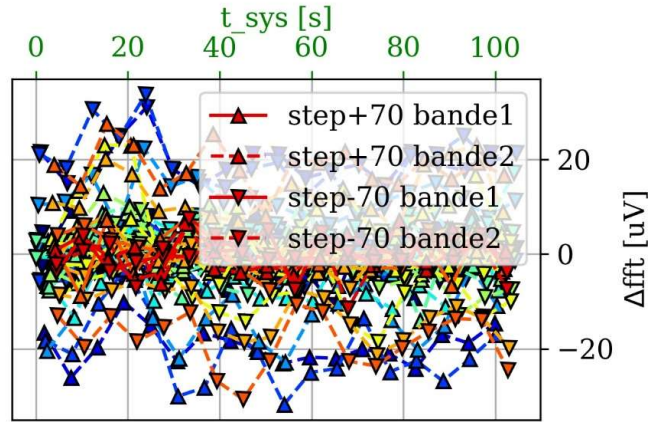
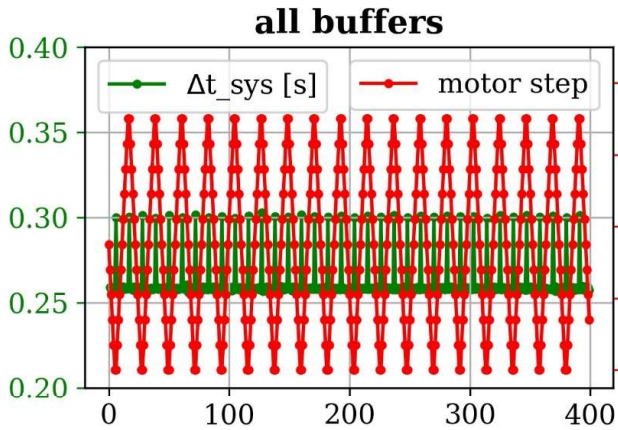
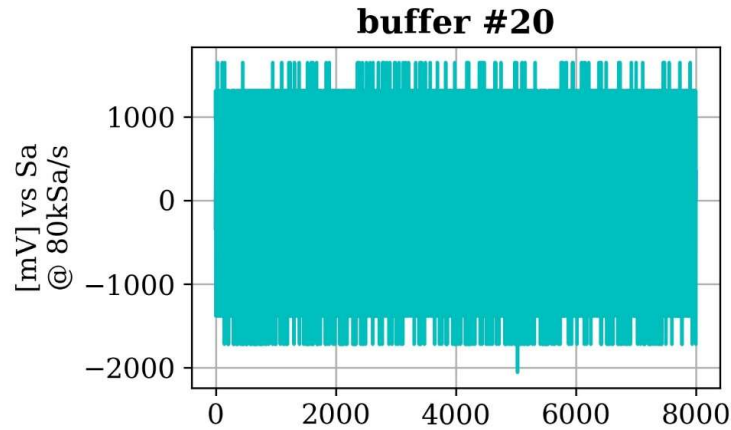
Direct to fiber, en face de LED 3 (aka 1200nm)

C:/Users/Mej/Documents/Impact_Photonics/projects/Qing_2/Soft/ADisco/mesures/
Data31



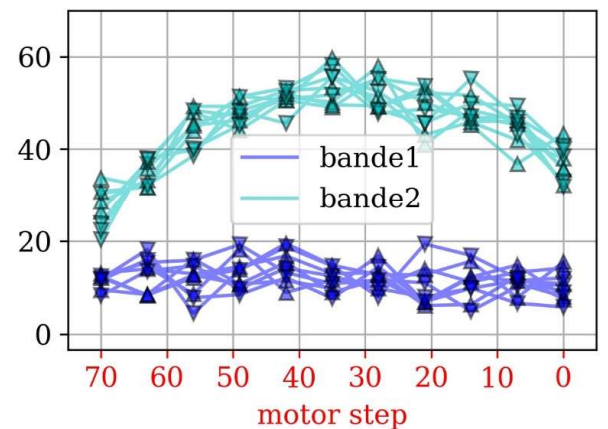
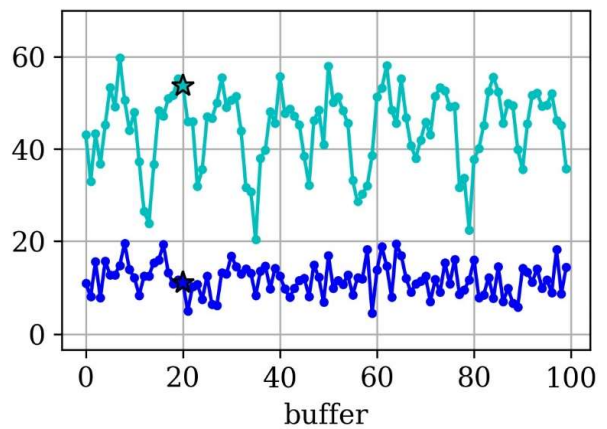
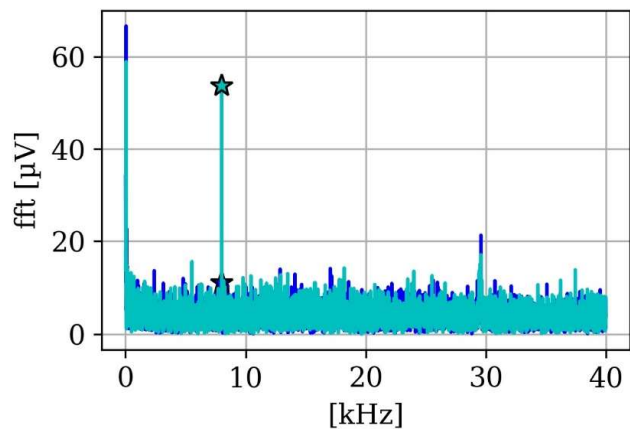
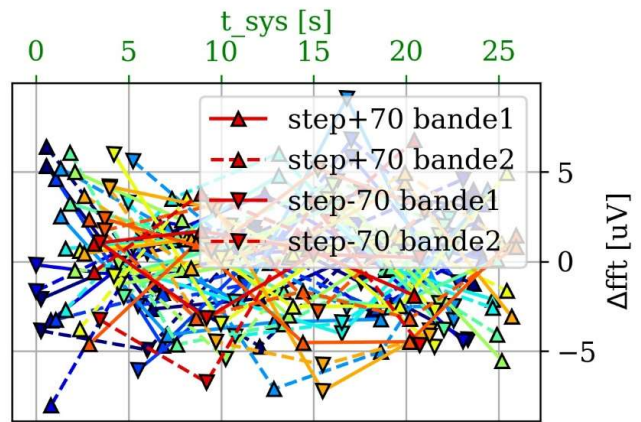
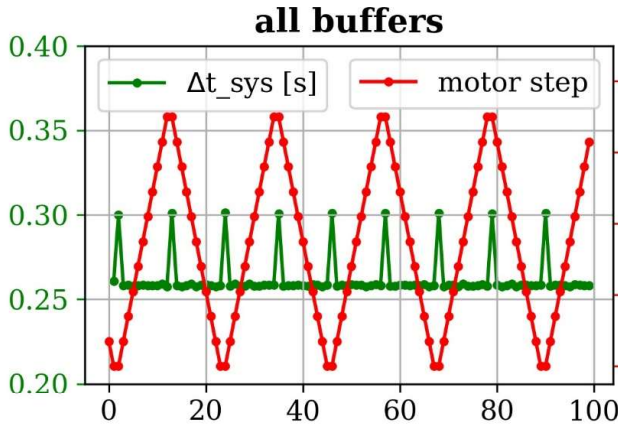
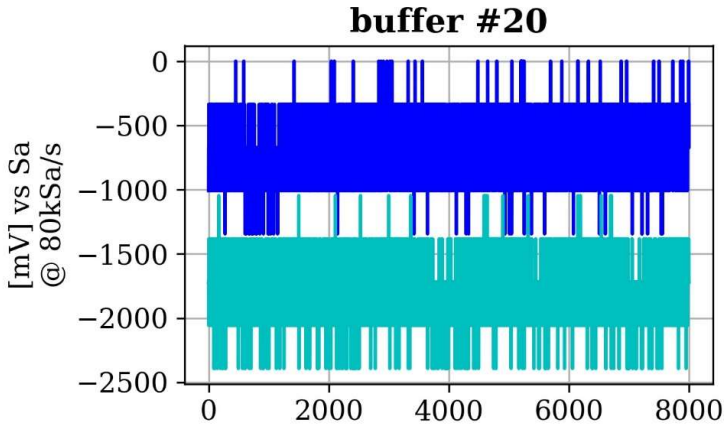
Direct to fiber, en face de LED 2 (aka 1600nm)

C:/Users/Mej/Documents/Impact_Photonics/projects/Qing_2/Soft/ADisco/mesures/
Data32



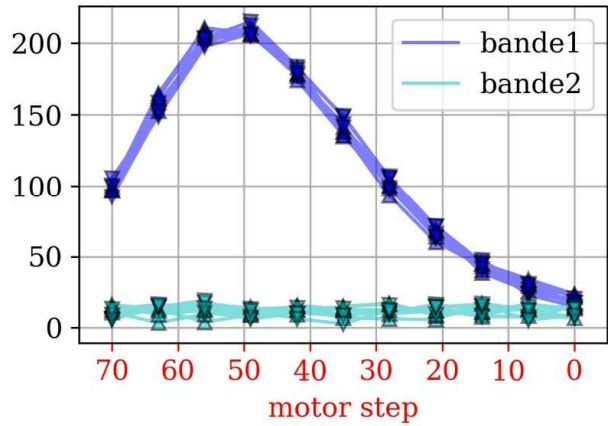
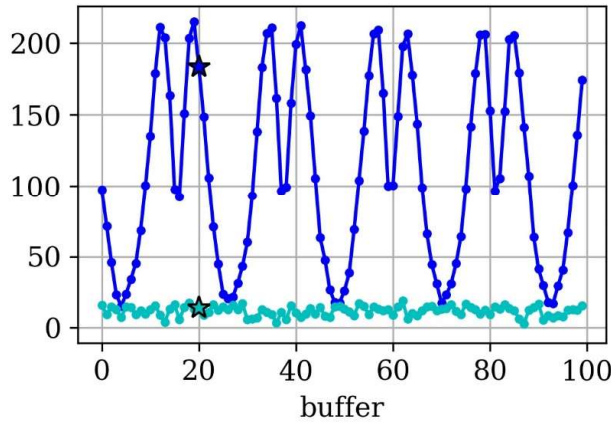
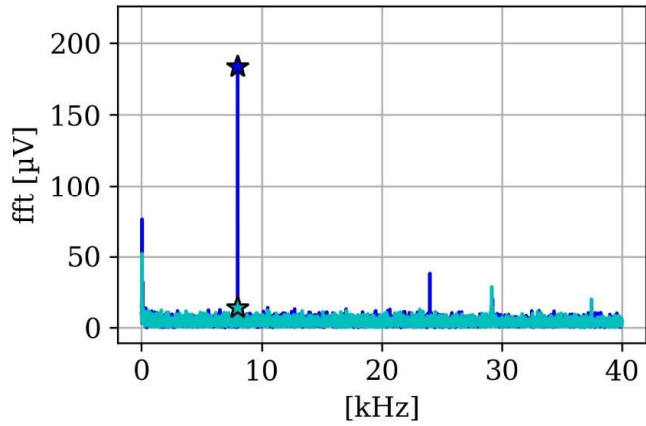
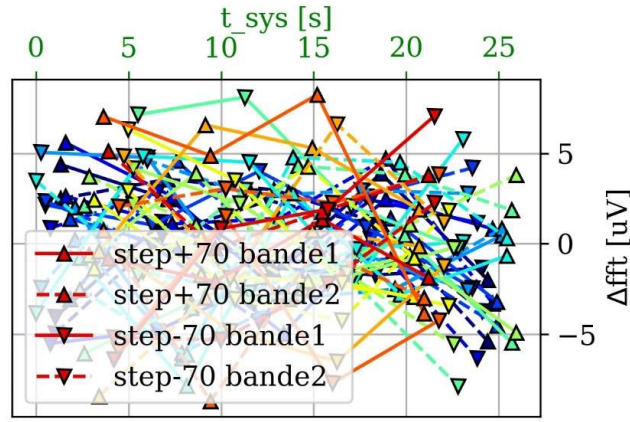
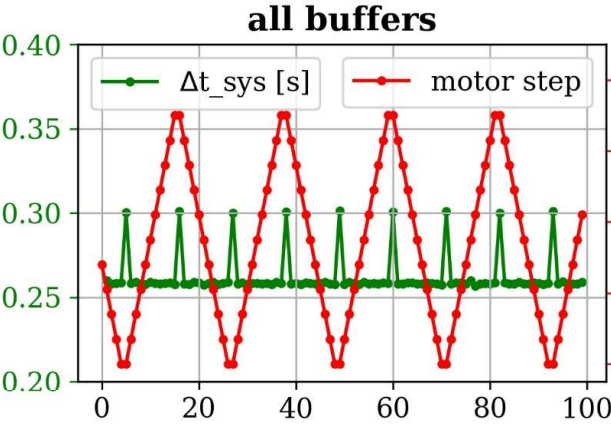
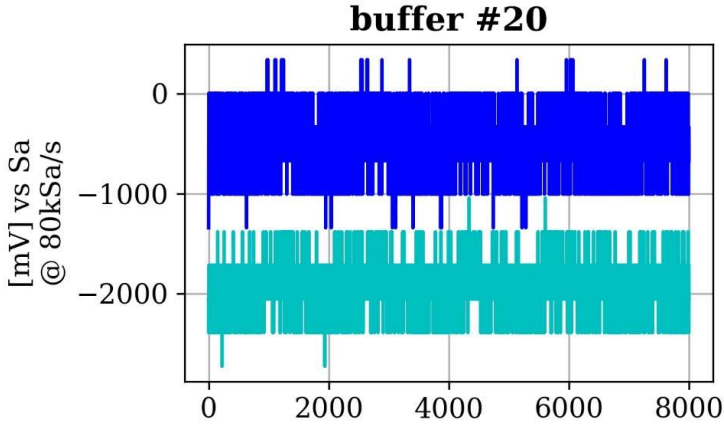
20mm to fiber, en face de LED 2 (aka 1600nm)

C:/Users/Mej/Documents/Impact_Photonics/projects/Qing_2/Soft/ADisco/mesures/
Data33

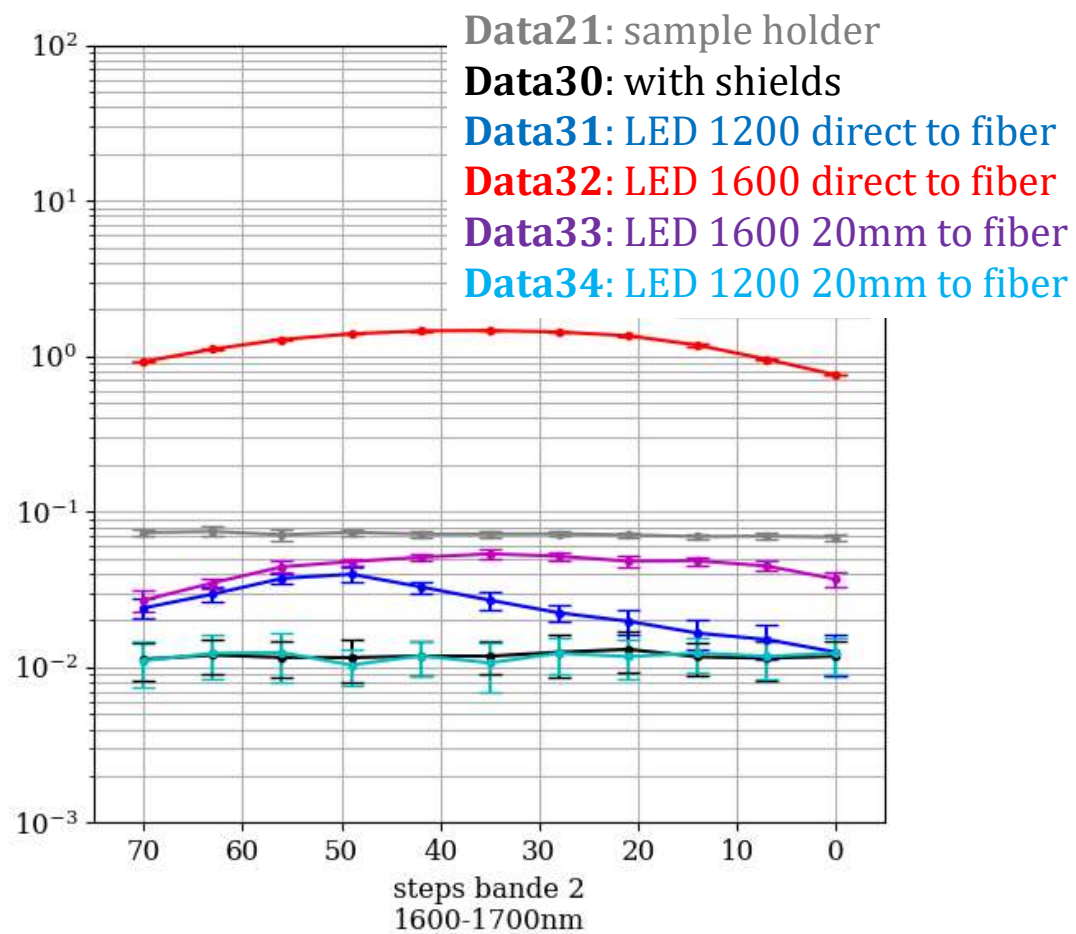
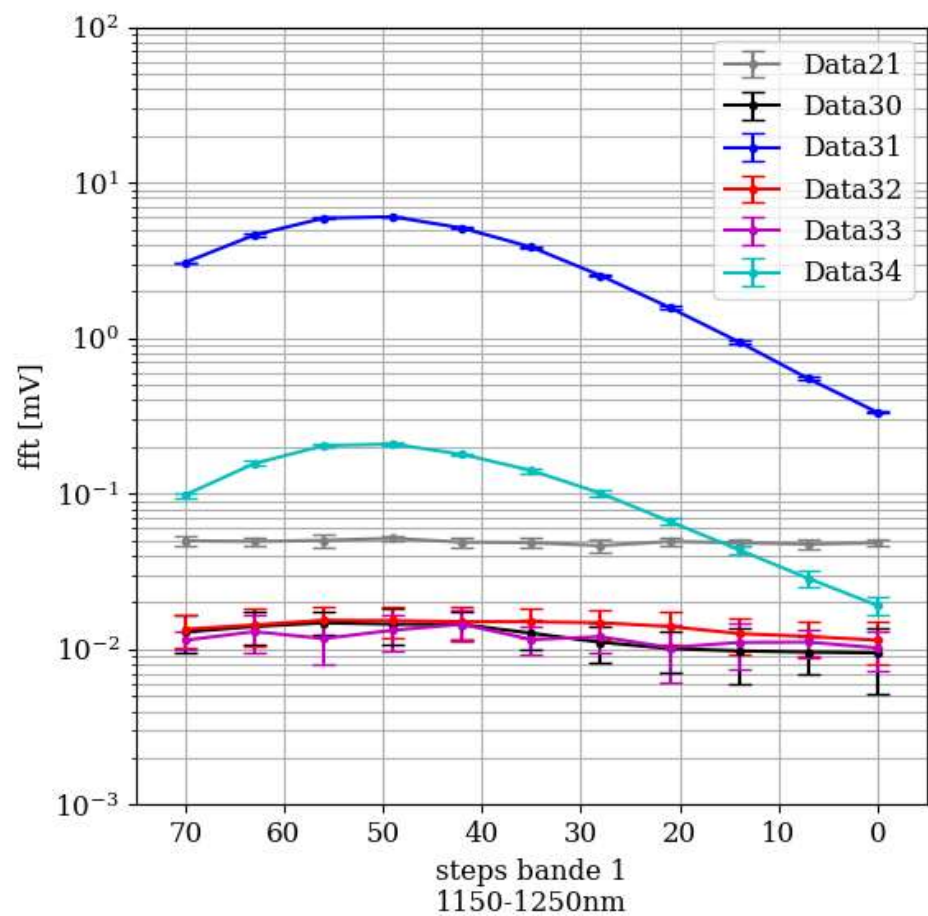


20mm to fiber, en face de LED 3 (aka 1200nm)

C:/Users/Mej/Documents/Impact_Photonics/projects/Qing_2/Soft/ADisco/mesures/
Data34

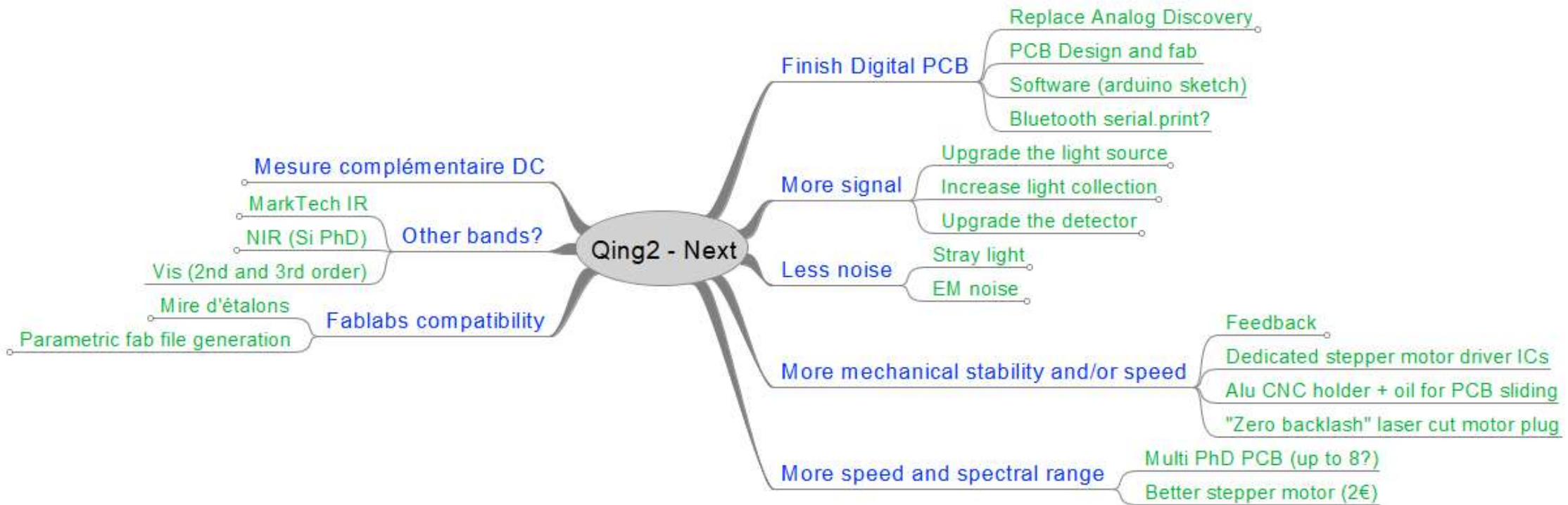


C:/Users/Mej/Documents/Impact_Photonics/projects/Qing_2/Soft/ADisco/mesures/



Next steps

Menu des prochaines étapes de développement:



**More details
on GitLab**

Full Bill Of Material in the online git repository [Qing2/ BOM_Qing2.xlsx](#)

ie: tab «PCB_breakdown»

Module	Description	Ref	Manufacturer	Image	Specs	Buy now	Unit Cost			Quantity	TOTAL by 100	NB: sa
							by 1	by 100	by 1000			
PCB LED	NIR LED 50mA DC 100mA peak	MTSM0012-199-IR "1200nm"	Marktech		SMD 1206 1110-1240nm @ LDC_max=50mA: V=1V, P=5mW/sr	https://www.digike.com	18¢	12¢	10¢	1	26¢	
		MTSM5016-199-IR "1650nm"	Marktech		SMD 1206 1480-1710nm @ LDC_max=50mA: V=1V, P=2mW/sr	https://www.digike.com	20¢	13¢	12¢	1		
	VIS LED	156120YS75000 "Yellow"	Würth		1206, 590nm, 25mA DC, 100 peak	https://www.digike.com	0.17¢	0.14¢		1		
		BG1102W-TR "Green"	Stanley		1206, 560nm, 30mA DC, 70 peak	https://www.digike.com	0.38¢	0.17¢	0.10¢	1		
	White LED (align)	QBLP601-IW "White"	BrighTek		SMD 0603	https://www.digike.com	0.35¢	0.17¢	0.08¢	1		
	Connector 2.54mm	54202-S0804LF	Amphenol		2.54mm pitch, 2x4, steight idem, 90°	https://www.digike.com	0.35¢	0.23¢	0.17¢	2		
	Op Amp	LMV321	On Semi		>50 mA output current 1MHz	https://www.digike.com	0.40¢	0.25¢	0.15¢	4	3¢	
	R Thin film		Stackpole		0603, 20Ω 125mW, 100ppm/°C	https://www.digike.com	0.10¢	0.02¢	0.01¢	4		
Quad SPDT	DG412	Vishay		100ns, 200 Ohm	https://www.digike.com	1.3¢	1.0¢	0.7¢	1			
Quad DAC	MCP4728	Microchip		I2C buffered DAC	https://www.digike.com	1.7¢	1.3¢	1.3¢	1			
PCB Phd	InGaAs Photodiode	SD003-151-001	Advanced Photonix		SMD 1206 (3.2x1.6mm) 850-1700nm chip 300x300µm	https://www.digike.com	3¢	2¢	1.5¢	1	5¢	
	Si Photodiode	VEMD6060X01	Vishay		SMD 1206 (4x2mm) 380-1000nm chip 0.3x0.3mm	https://www.digike.com	1.30¢	0.76¢	0.48¢	0		
		APT2012PD1C	Kingbright		SMD 0805 (2x1.25mm) 420-1120nm chip 0.3x0.3mm	https://www.digike.com	0.85¢	0.47¢	0.28¢	0		
	Op Amp	MCP6491	Microchip		SC-70 7.5MHz, 5V, 150µA	https://www.digike.com	0.60¢	0.40¢	0.40¢	0		

Technical files, fabrication files and software

KiCad

Qing_2/Elec/

Impact_Photonics > projects > Qing_2 > Elec

Name
Alim_PCB
Datasheets
Hub_PCB
LED_PCB
PhD_PCB
Microchip_AppNotes_PCB_layout_01258b.pdf
Microchip_AppNotes_Transimpedance01494A.pdf

D_Photo D1
bias
Opamp_Dual_Generic U1A
GND
S1

Qing_2/Meca/

Impact_Photonics > projects > Qing_2 > Meca

Name
fab
steps
SW_2016
glissoir.step
motor.SLDPRT
motor.SLDPRT.1.x_t
motor.step

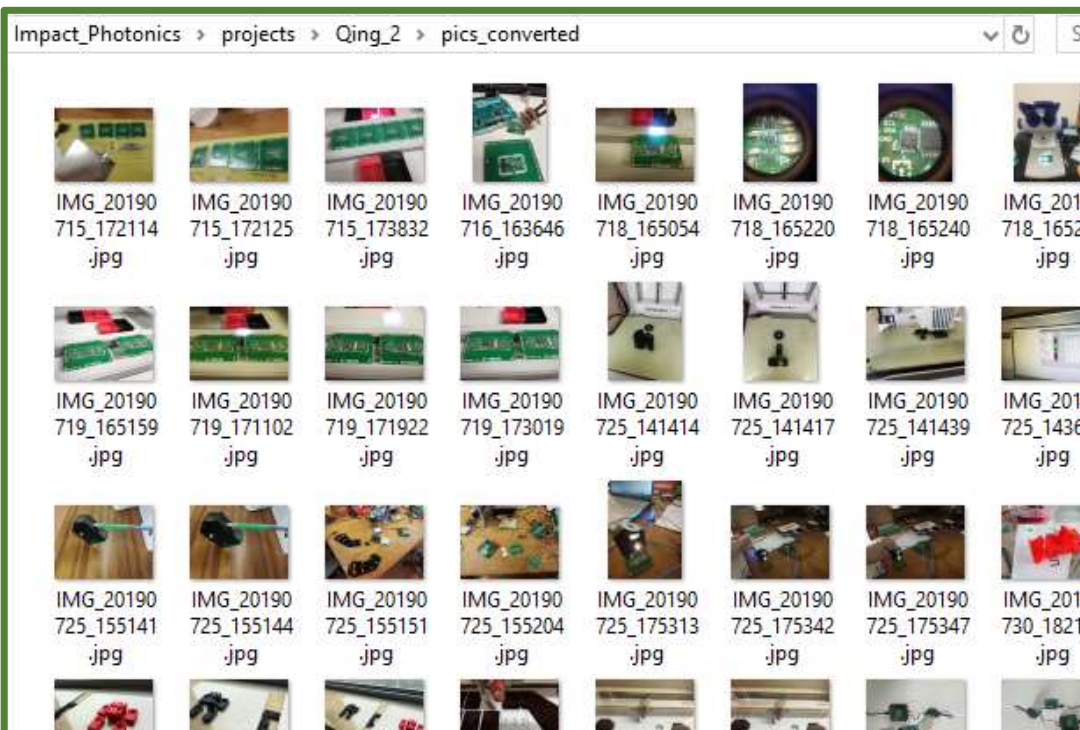
Qing_2/Soft/

Impact_Photonics > projects > Qing_2 > Soft

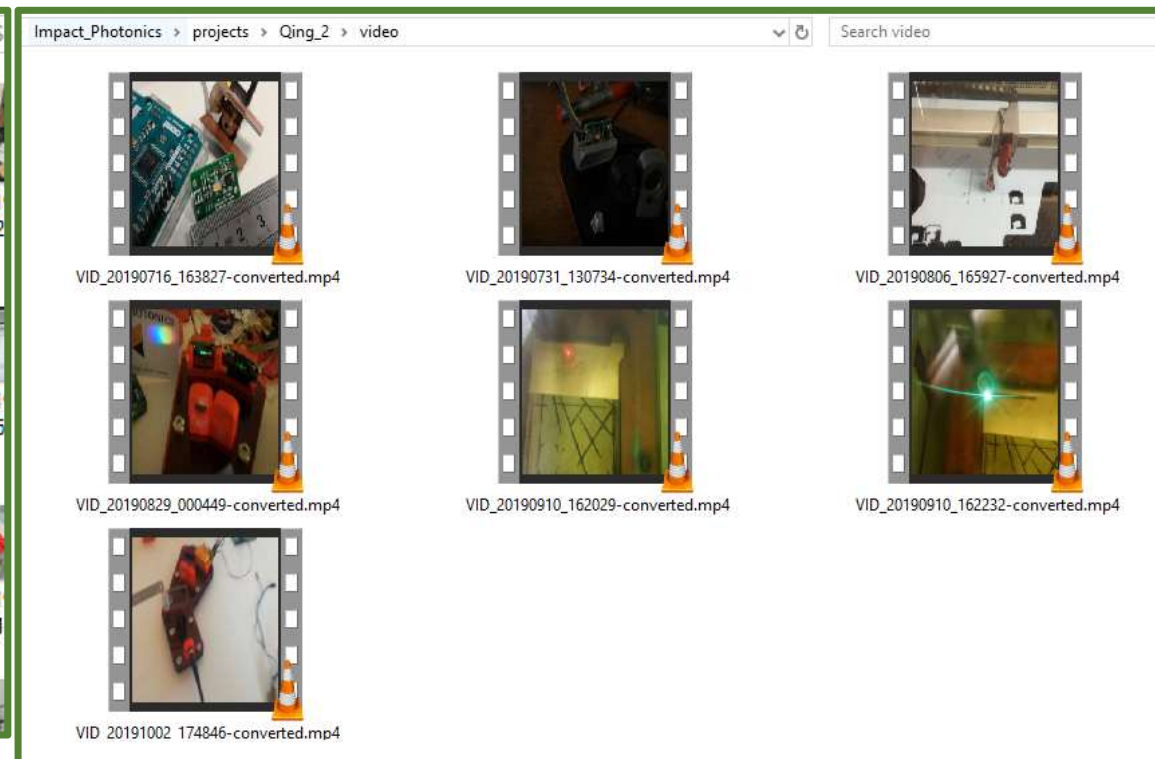
Name
ADisco
Arduino

For the making-of:

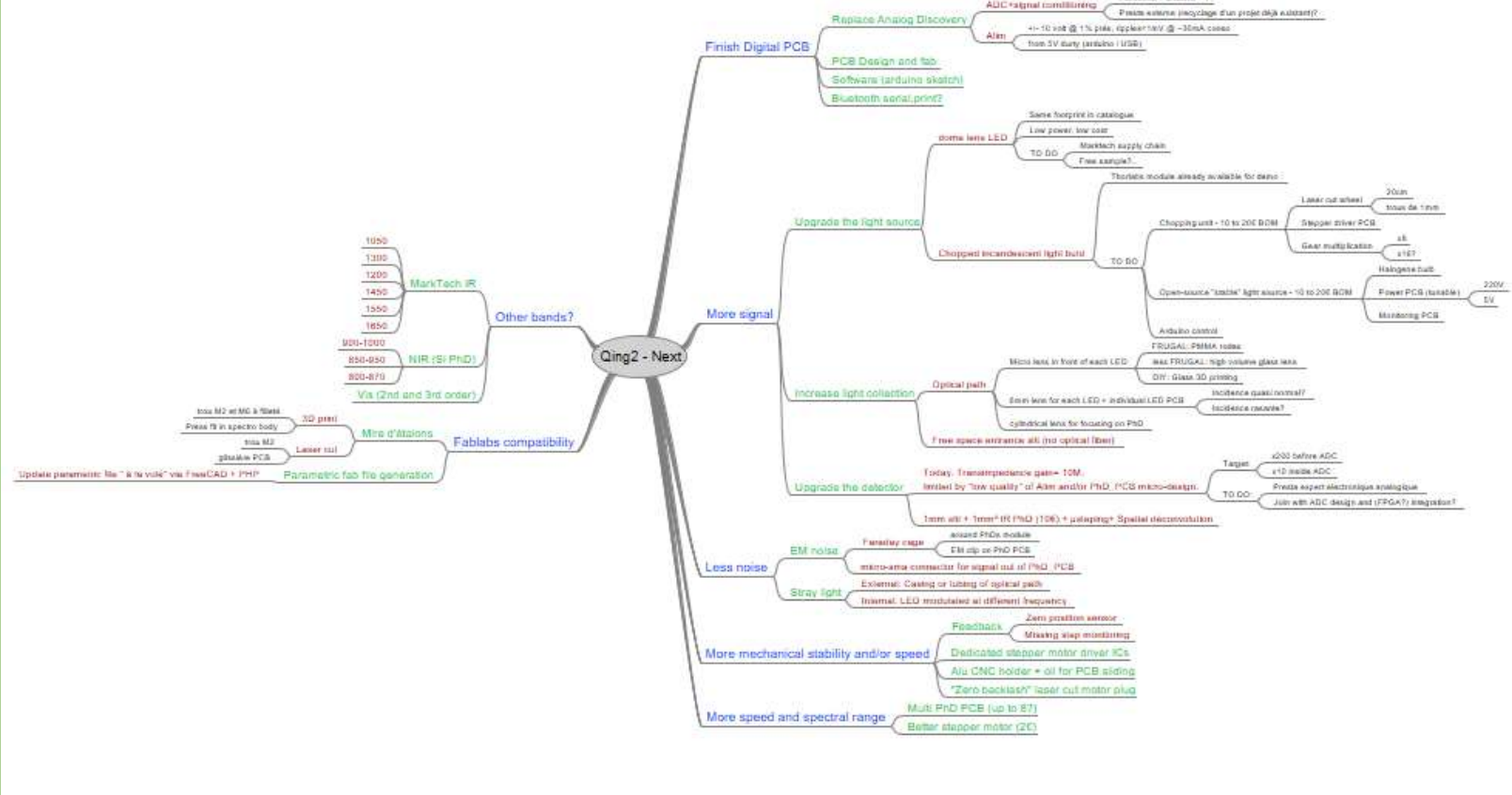
Qing_2/pics_converted/



Qing_2/video/



Qing_2/Qing2 - Next.mm



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FreeMind

A premier mind-mapping software written in Java
Brought to you by: [christianfoltin](#)

★★★★★ 248 Reviews | Downloads: 11,988 This Week | Last Update: 2018-08-10

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A mind mapper, and at the same time an easy-to-operate hierarchical editor with strong emphasis on folding. These two are not really two different things, just two different descriptions of a single application. Often used for knowledge and content management.