Designing and constructing mounting system for particle counter deployment at CFHT dome

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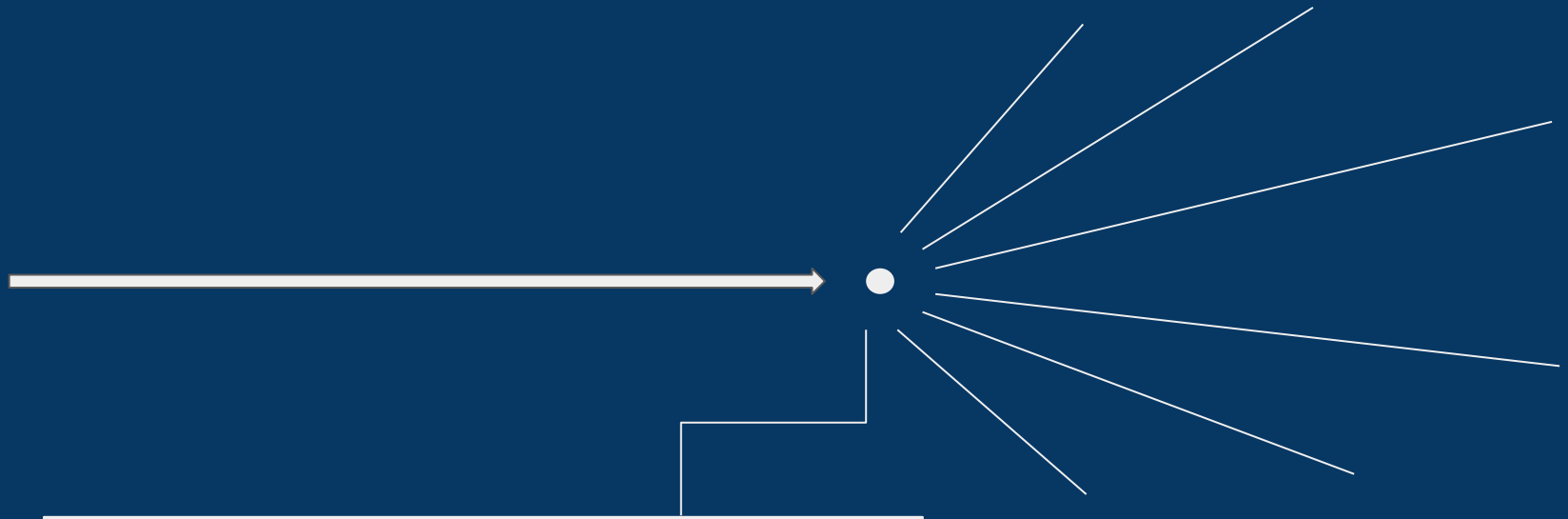
TELESCOPE MIRROR

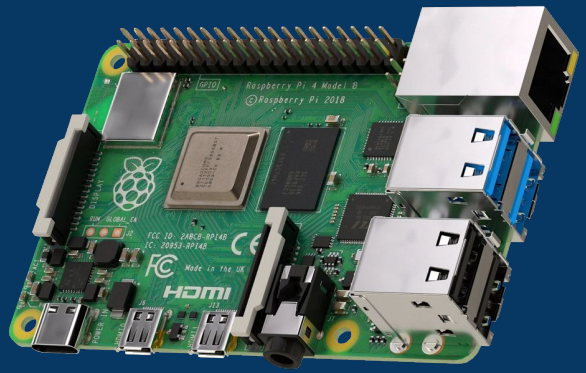
Dust around the telescope can settle on the mirror.

Photo: Grant Matsushige

LIGHT SCATTERING



Dust particles in the telescope scatter light, reducing image quality.



Use particle counters to detect the atmospheric conditions that lead to high levels of dust.

Photos: Sensirion (top), OKdo (bottom)

Create a **case** that will allow the particle counting system to collect accurate data.

PARTICLE COUNTING SYSTEM ENCLOSURE

- Hold particle counter + raspberry pi in place
- Allow access to necessary inputs/outputs
- Particle counter + raspberry pi should be removable
- Set up at various locations around CFHT dome

PROJECT STAGES

Produce design and prepare on Solidworks.

Print using PLA (polylactic acid) on a 3D printer.

Assemble the case with the particle sensing system.

Mount within the telescope and conduct a test run.

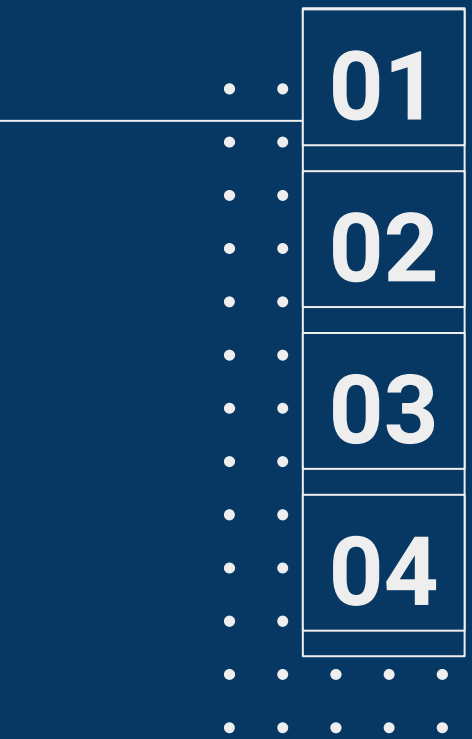
DESIGN PROCESS

Identify requirements

Consider production constraints

Conduct necessary test and trials

DESIGN PROCESS



IDENTIFY REQUIREMENTS

Contain particle counter and raspberry pi, removability, different surfaces

CONSIDER PRODUCTION CONSTRAINTS

Printing time, material limitations, attainable shapes

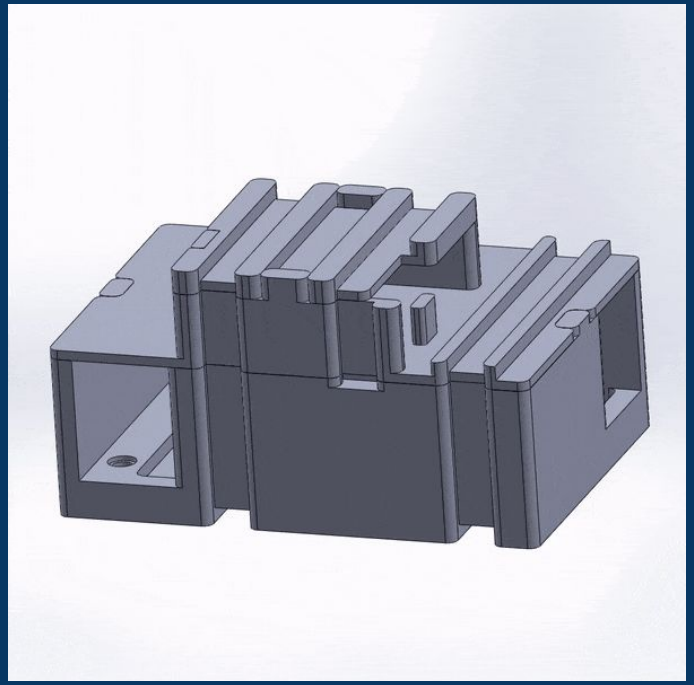
CONDUCT NECESSARY TESTS AND TRIALS

Hole position, checking the fit, withstanding weight

DESIGN REVIEW

Review and feedback from the instrumentation group

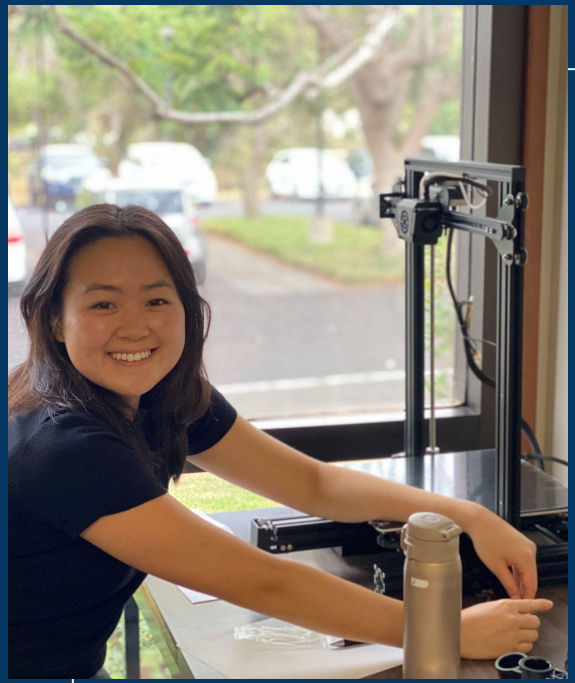
DESIGN FEATURES

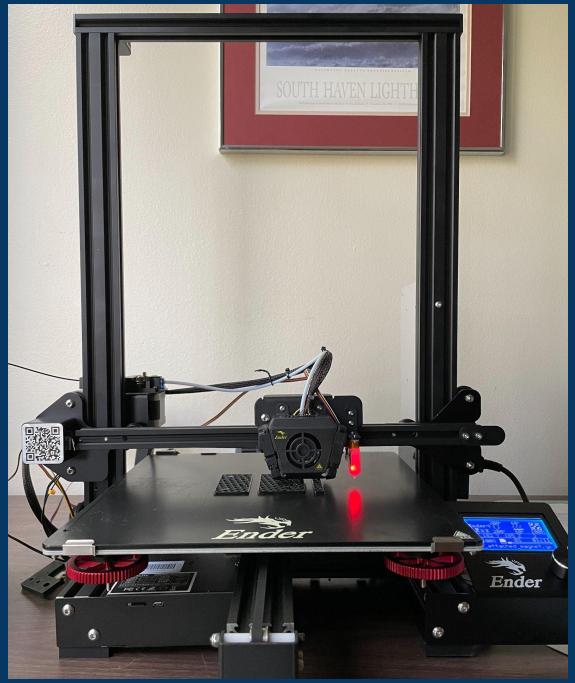


THREE COMPONENTS

JIGSAW SHAPE

MAGNET/SCREW ALLOWANCE





PRINTER ASSEMBLY

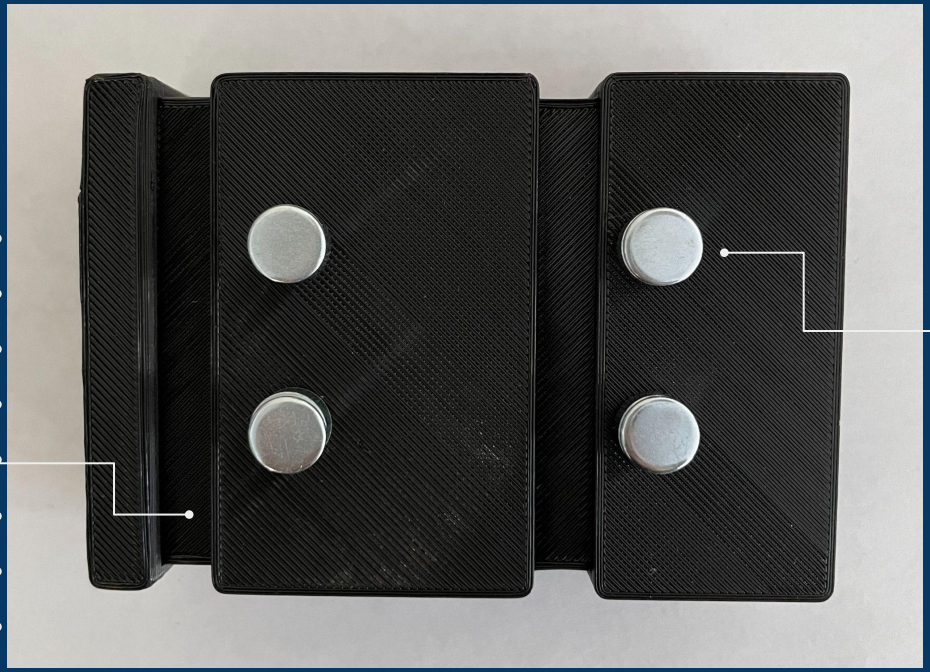
DESIGN (BASE)

Openings for power and Ethernet

Threaded inserts for Raspberry Pi

Magnets are screwed to case

DESIGN (BASE)

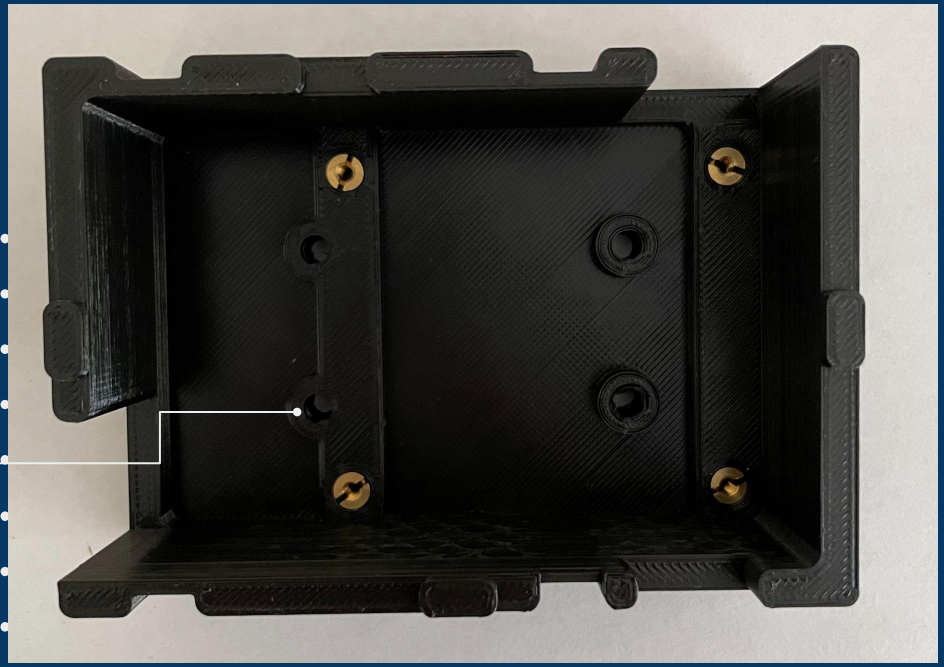


Passage for hook-and-loop wrap

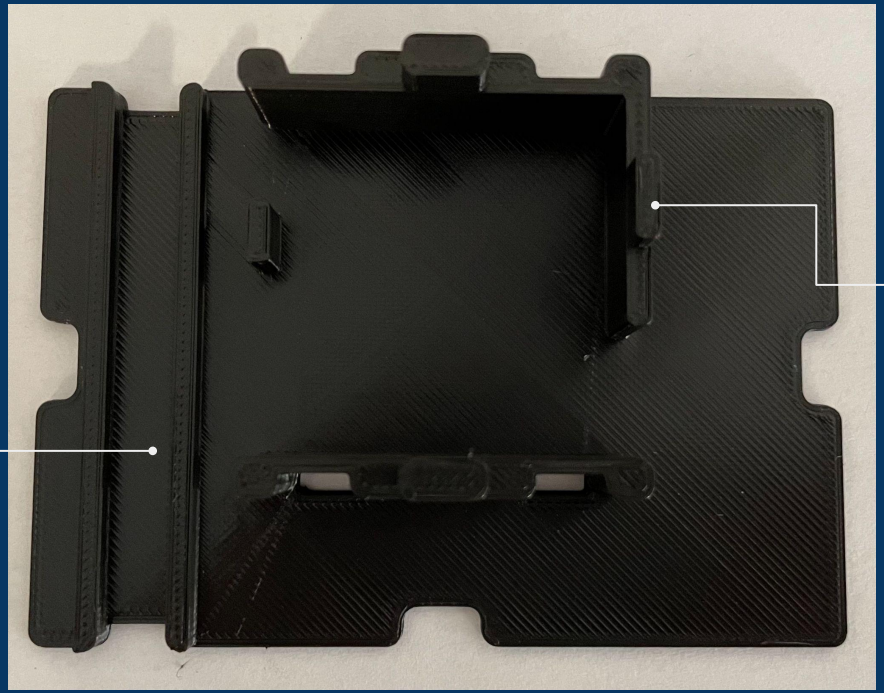
Magnets for attachment

DESIGN (BASE)

Through holes for wall screws



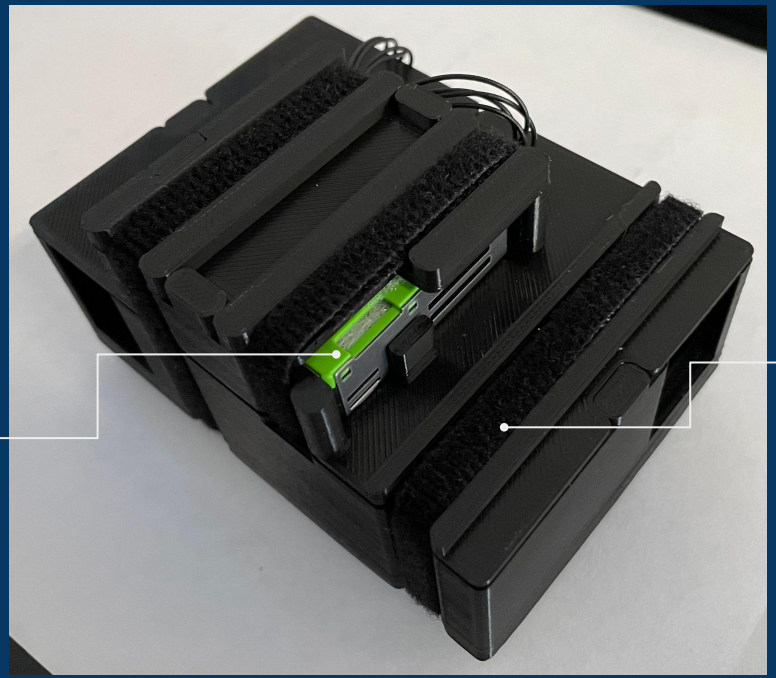
DESIGN (MID)



Groove for hook-and-loop wrap

Pegs for puzzle-piece fit

DESIGN (FULL)



Opening for airflow

Hook-and-loop keeps layers together

TESTING FOR INTERFERENCE

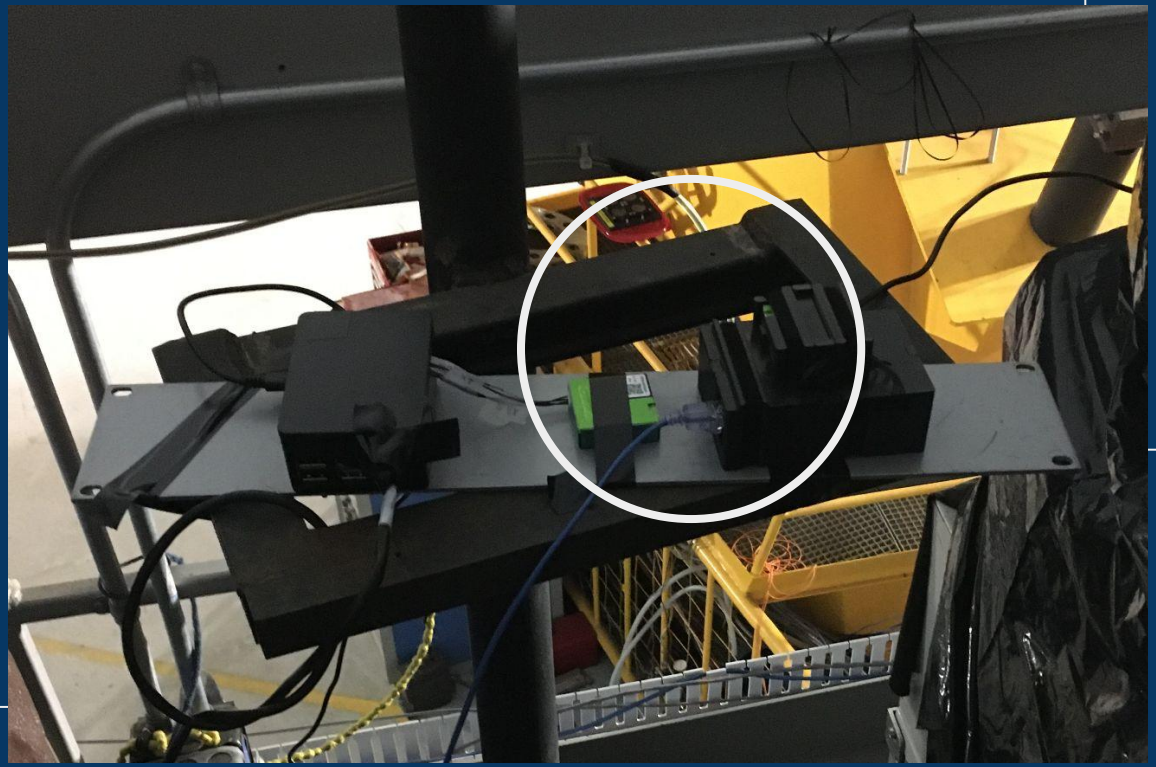
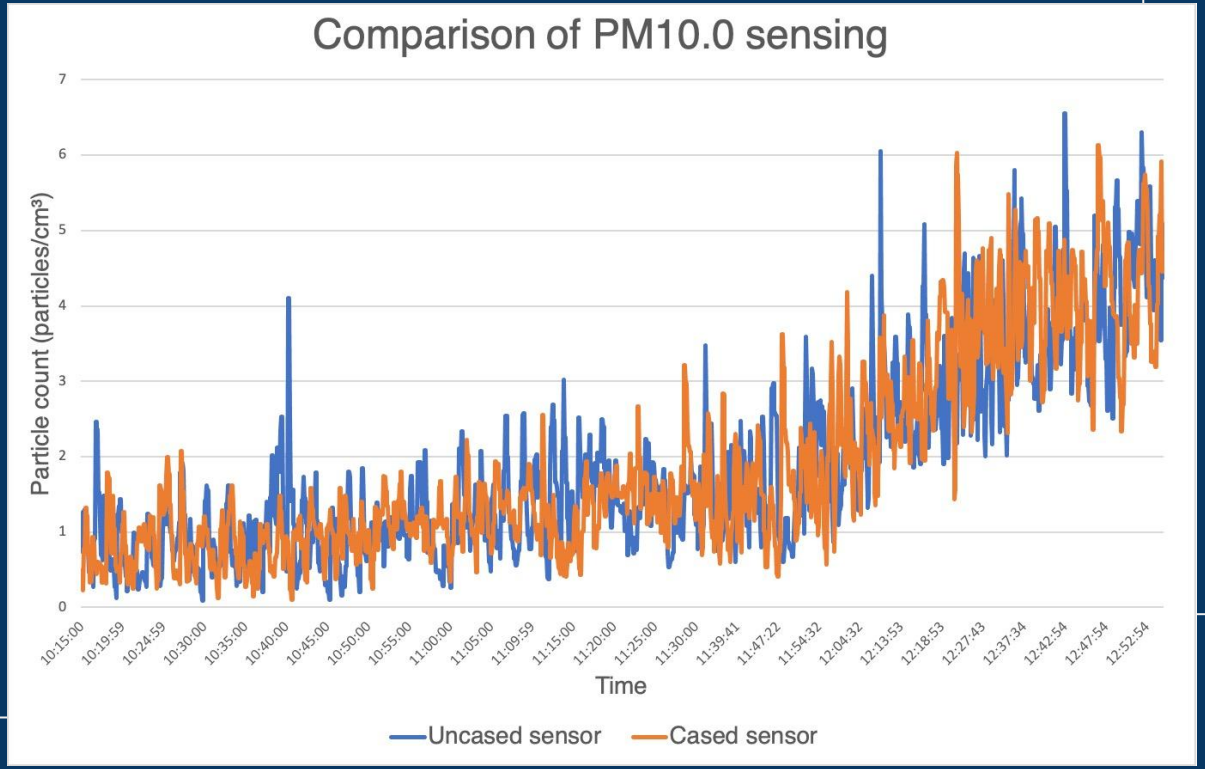


Photo: Greg Barrick

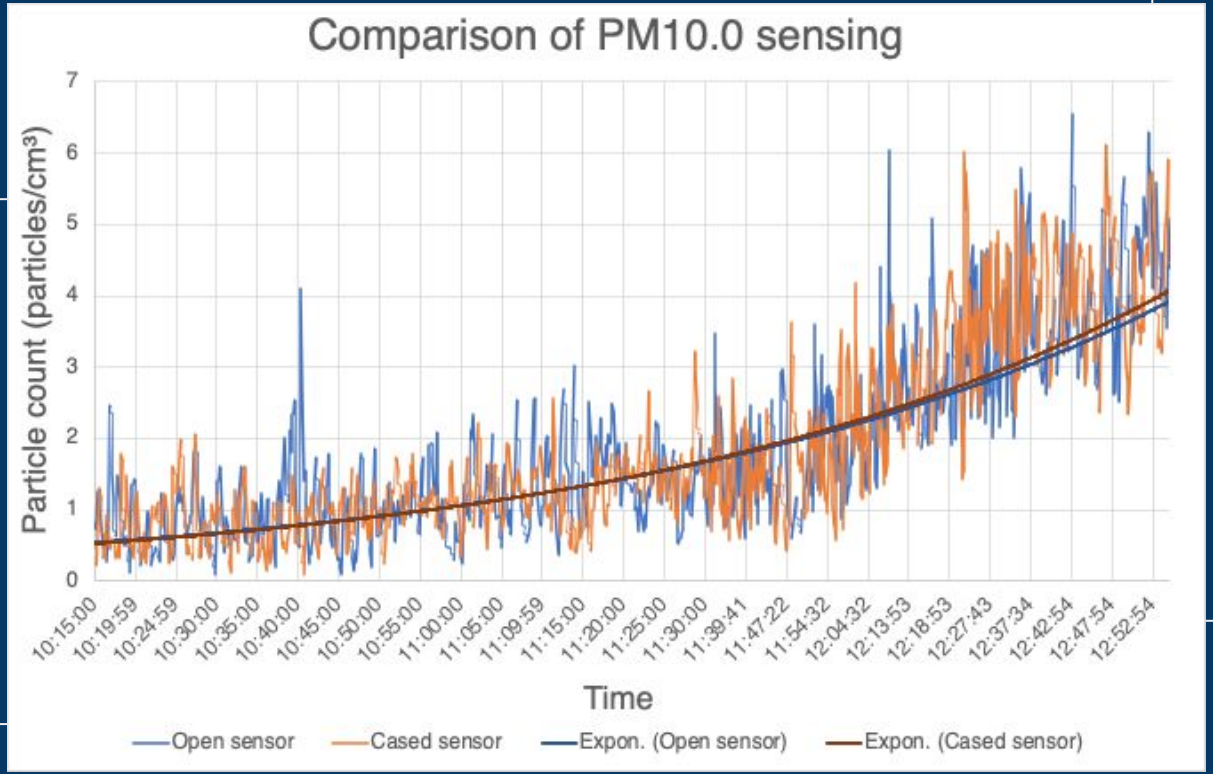
TESTING



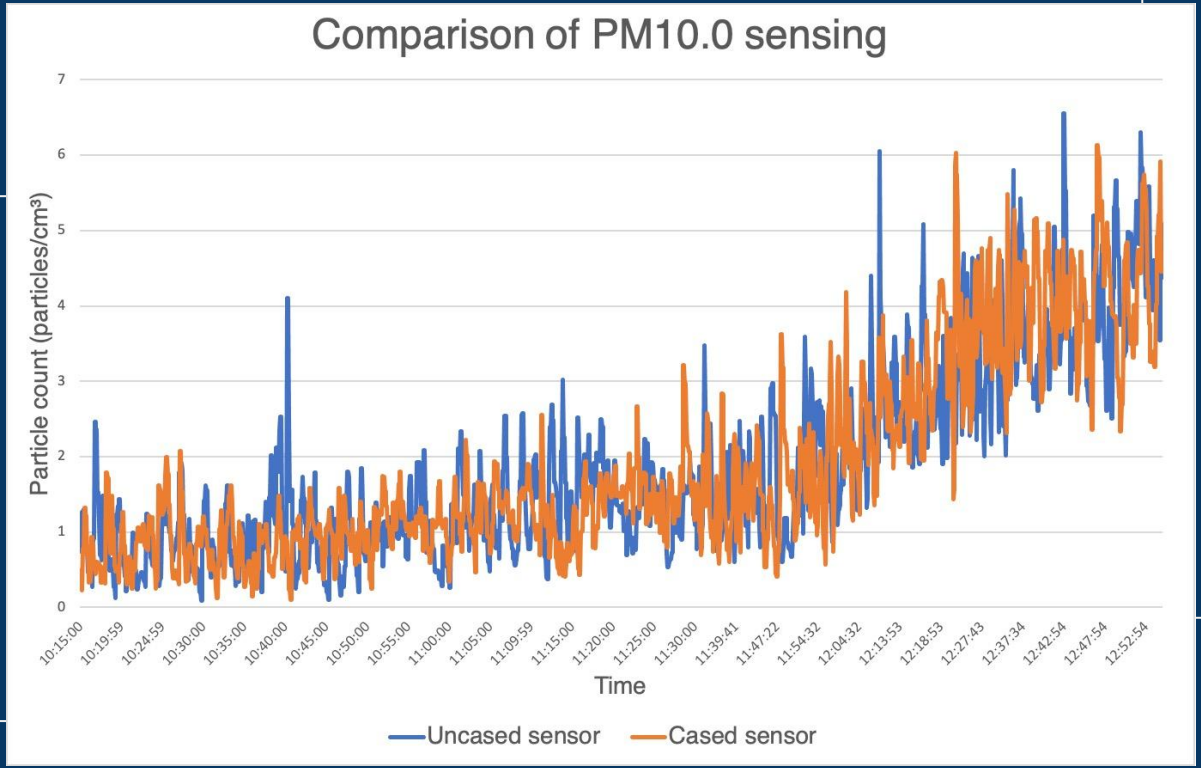
CV= σ/μ

$CV_{uncased}$= 68.0%
CV_{cased} = 69.7%

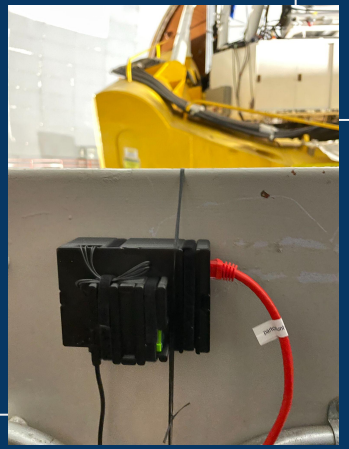
TESTING FOR INTERFERENCE



TESTING


Comparison of PM10.0 sensing
Particle count (particles/cm³)
0
1
2
3
4
5
6
7
10:15:00
10:19:59
10:24:59
10:30:00
10:35:00
10:40:00
10:45:00
10:50:00
10:55:00
11:00:00
11:05:00
11:09:59
11:15:00
11:20:00
11:25:00
11:30:00
11:39:41
11:47:22
11:54:32
12:04:32
12:13:53
12:18:53
12:27:43
12:37:34
12:42:54
12:47:54
12:52:54
Time
Uncased sensor
Cased sensor

INSTALLING



INSTALLING

DATA FROM SENSORS

Dome Counts:

Particle Size	Mezz South	Dome Slit	Obs Floor E	Obs Floor N	PM Cell E	PM Cell W
0.3-0.5 um (#/cm^3)	2.6193	2.2803	3.3440	3.8339	2.4152	3.0668
0.5-1.0 um (#/cm^3)	0.4187	0.3955	0.5866	0.6662	0.4248	0.5300
1.0-2.5 um (#/cm^3)	0.0098	0.0104	0.0193	0.0183	0.0147	0.0127
2.5-4.0 um (#/cm^3)	0.0011	0.0011	0.0025	0.0021	0.0020	0.0013
4.0-10.0 um (#/cm^3)	0.0006	0.0004	0.0008	0.0008	0.0006	0.0005

Live data is currently accessible to all of CFH.

CFHT now has cases for a working particle counting system mounted on and around the telescope.

THANK YOU!

Greg Barrick
Canada-France-Hawaii Telescope
Akamai Workforce Initiative

INFO

FILAMENT

Cumulatively, all three parts use a total of 26m of 1.75mm-diameter PLA.

PRINTING COST

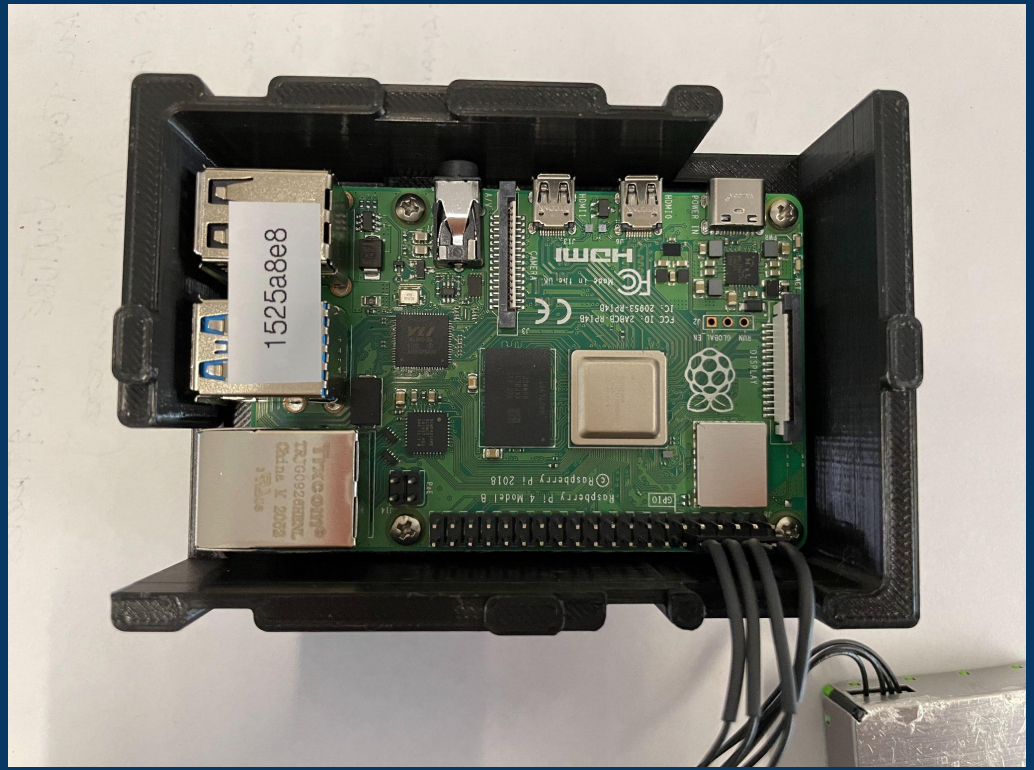
The printed parts of the case cost a little over $3.

PRINTING TIME

All three case components can be printed in about 12 hours.

TOTAL COSTS

With the sensor, the Pi, and case materials, the total cost is ~$150.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