



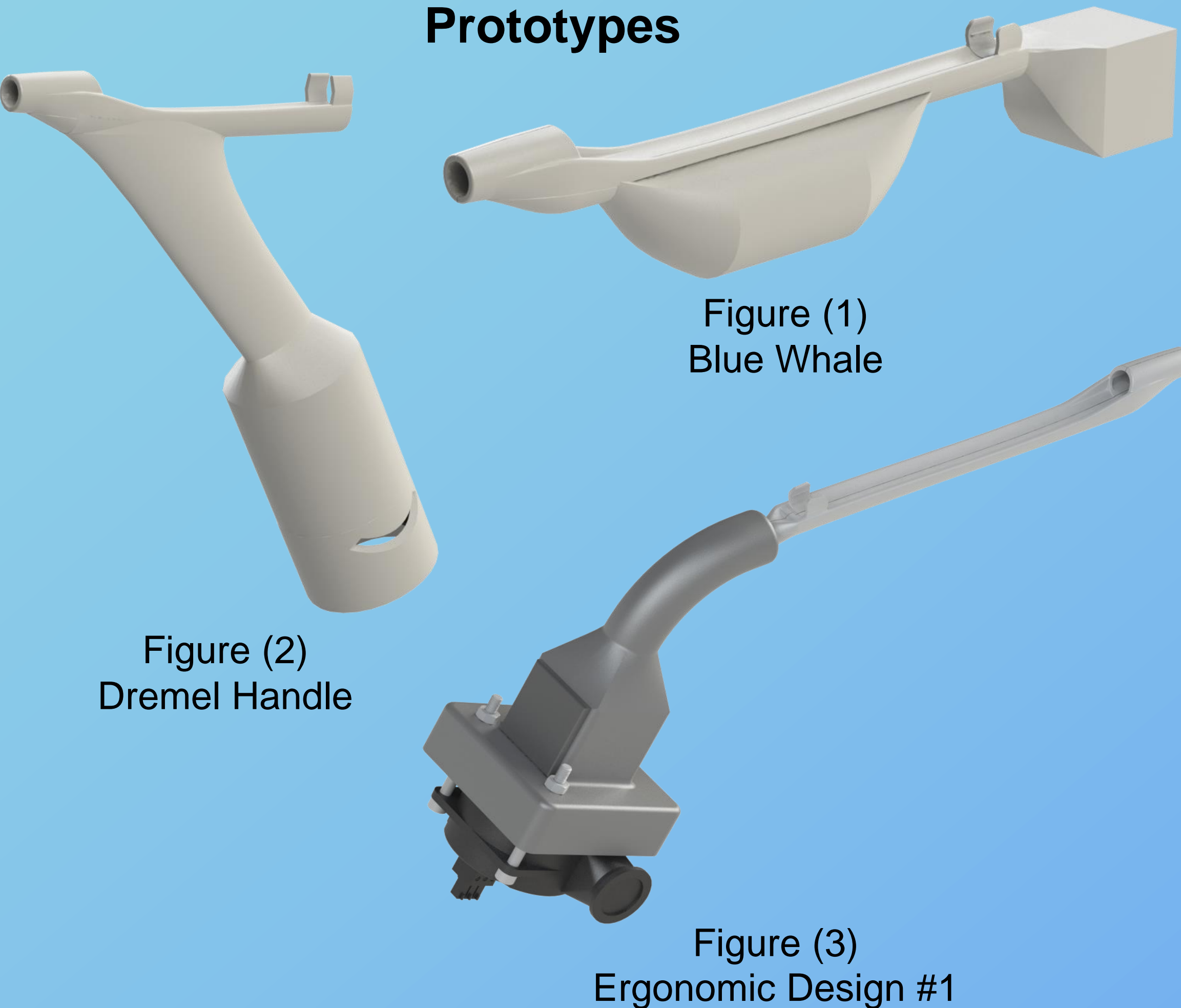
Background

- Surgical plume is a hazardous byproduct of electrosurgery and is typically captured using large, cumbersome smoke evacuation systems. The team has innovated a hand-held solution, eliminating the trip and entanglement hazards of traditional plume evacuator tubing

Ergonomics/HF Testing

- Ambidextrous design
- Filtered plume not to discharge in surgeon's face or patient's cavity
- Line-of-sight of pencil tip maintained by surgeon
- Wrist movement is not hindered by device
- Center of gravity designed as close to center of the hand as possible
- Minimized Weight

Prototypes



Objective

- Design an ergonomic, functional, and all-in-one monopolar surgical pencil attachment capable of plume capture and filtration

Requirements

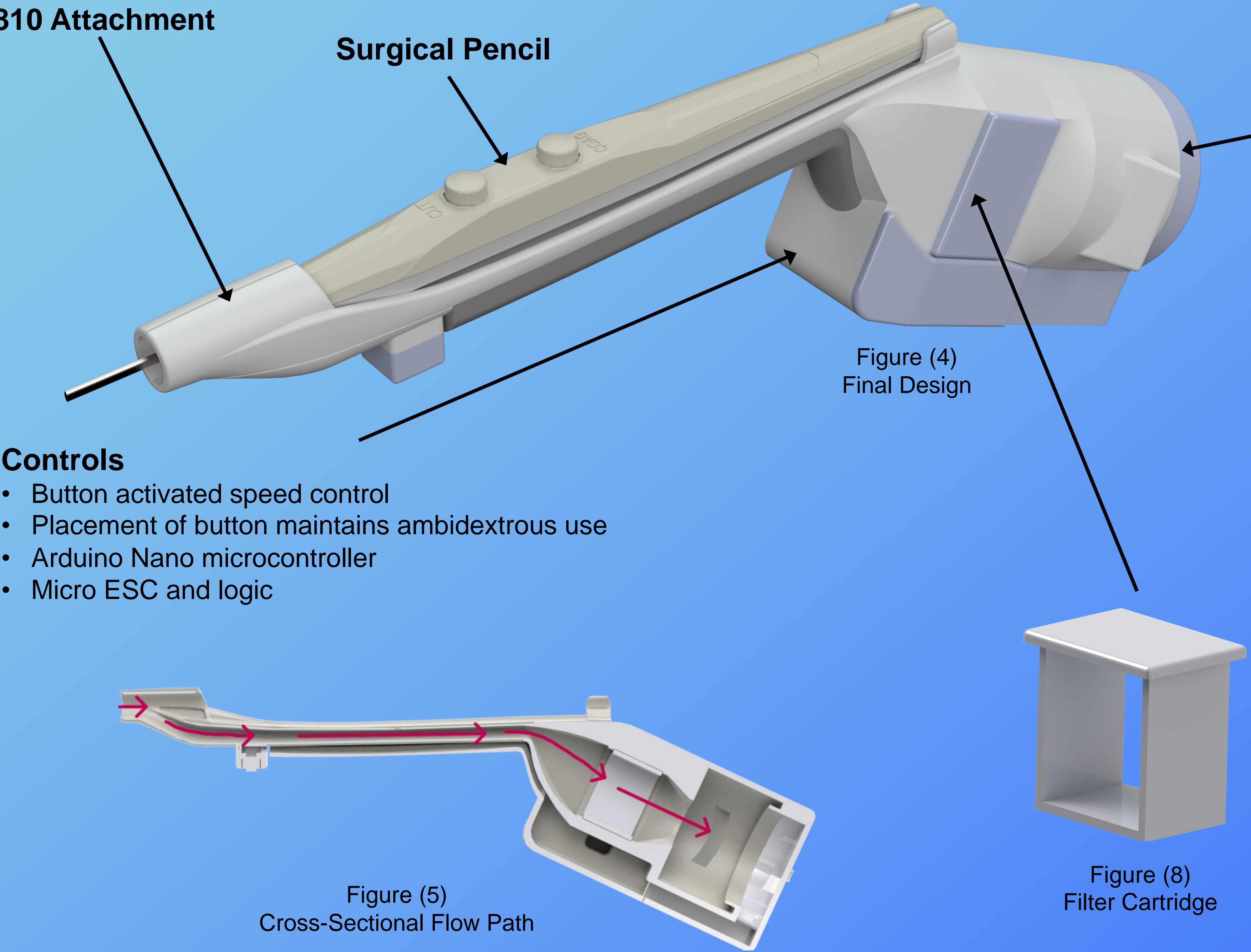
- ✓ 90% surgical plume capture
- ✓ 1 Hour operation at 25% duty cycle
- ✓ Comfortable, ambidextrous handle
- ✓ Low profile/clear line-of-sight
- ❑ RF activation with surgical generator
- ✓ Manual controls

Future Work

- Battery powered
- RF activation
- Disposable vs. Reusable (Autoclave)
- Sound mitigation
- Custom micro-blower capable of 4.0 kPa pressure rise at Medtronic set flow requirement

E3810 Attachment

Surgical Pencil



Controls

- Button activated speed control
- Placement of button maintains ambidextrous use
- Arduino Nano microcontroller
- Micro ESC and logic

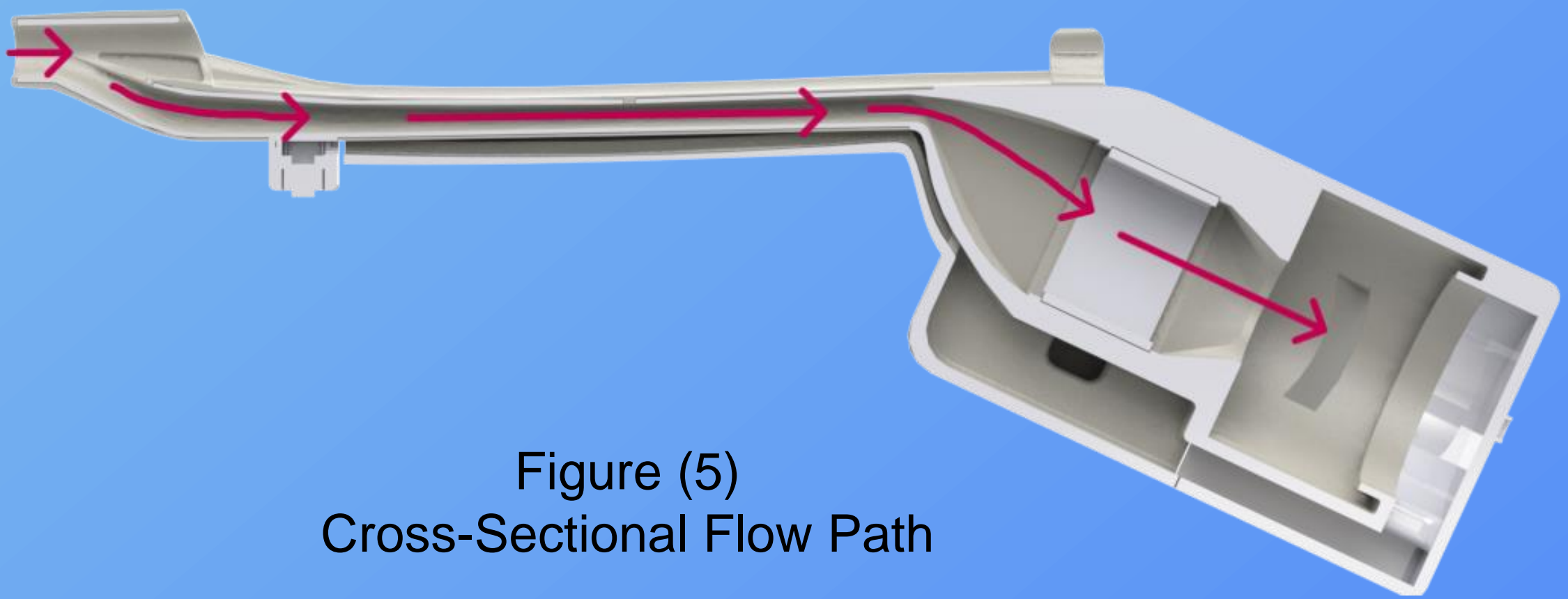


Figure (6)  
Micronel Blower

Micronel Blower

- Surgery requirements fall within the capability of Micronel blower
- Micronel radial blower is capable of 4.5 kPa static pressure and 460 Lpm free flow
- Power Required - 22.2V at 1.75A for 38.85W at max demand – battery not possible for Micronel

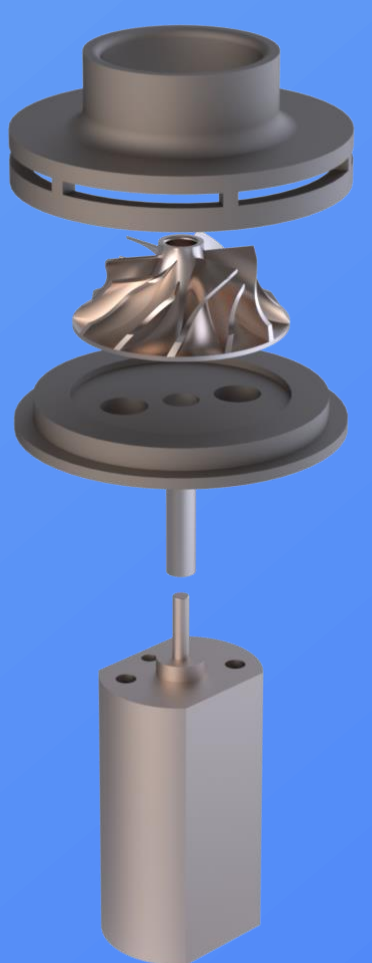


Figure (7)  
Custom Micro-blower

Custom Micro-blower

- Custom Volute: discharges air away from patient and surgeon
- Custom Impeller: Maintains necessary pressure rise at high rpm
- Custom Diffuser: maintains laminar flow for discharged air
- Custom motor: Capable of providing the torque and speed as dictated by fan laws

Filter

- Fiberglass ULPA filter
- 25x25x20mm
- Filter cartridge allows for guaranteed seal between filter and device housing
- Replaceable cartridges

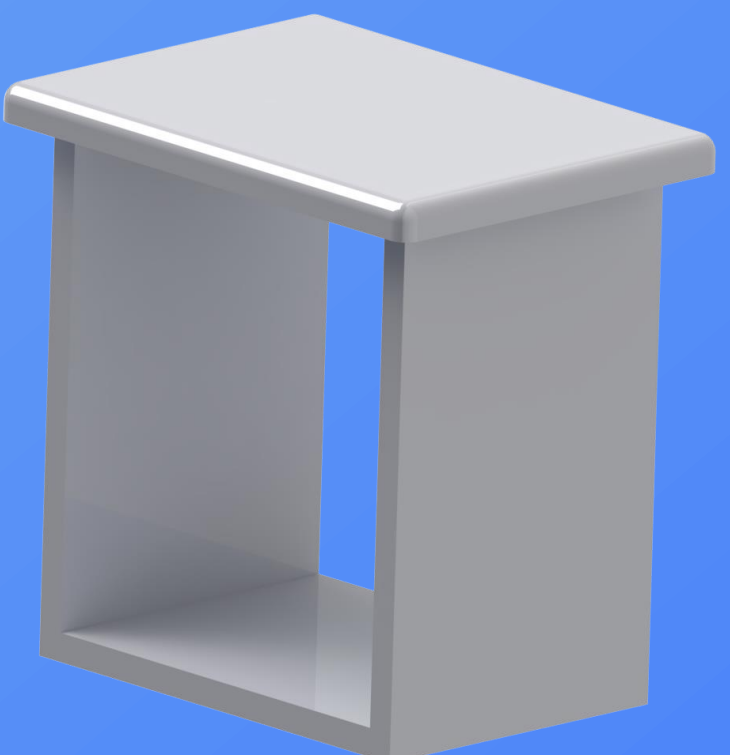


Figure (8)  
Filter Cartridge

Testing and analysis

- Consisted of two main tests:  
1.) Medtronic's plume capture testing method to test the smoke capture percentage of the device  
2.) Pressure drop across filter vs flow rate at different smoke capture intervals

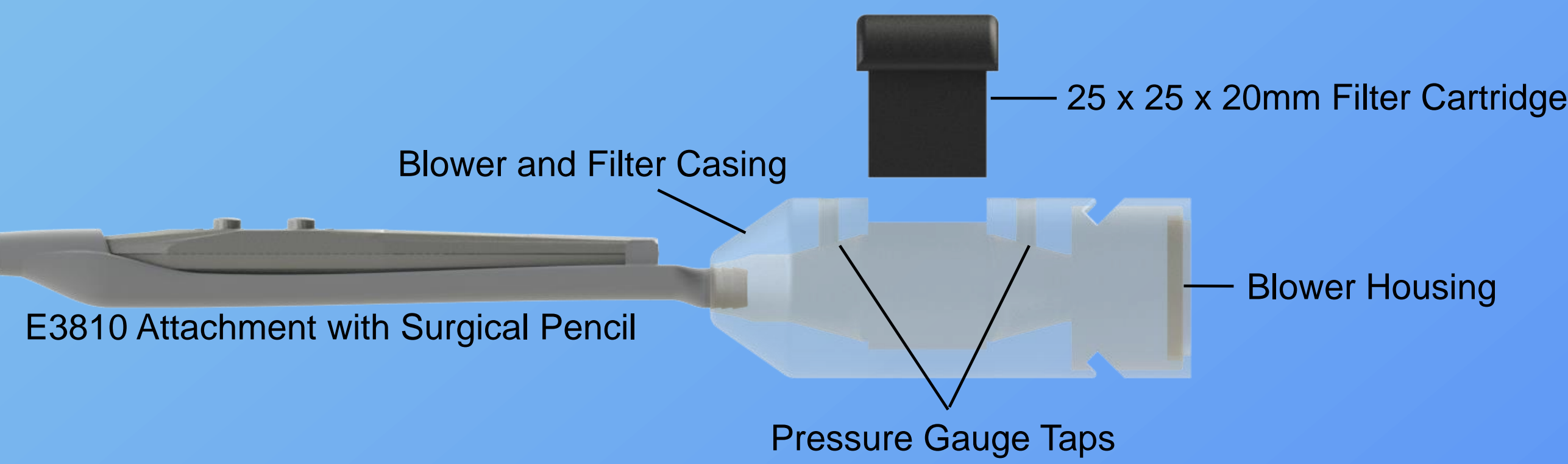
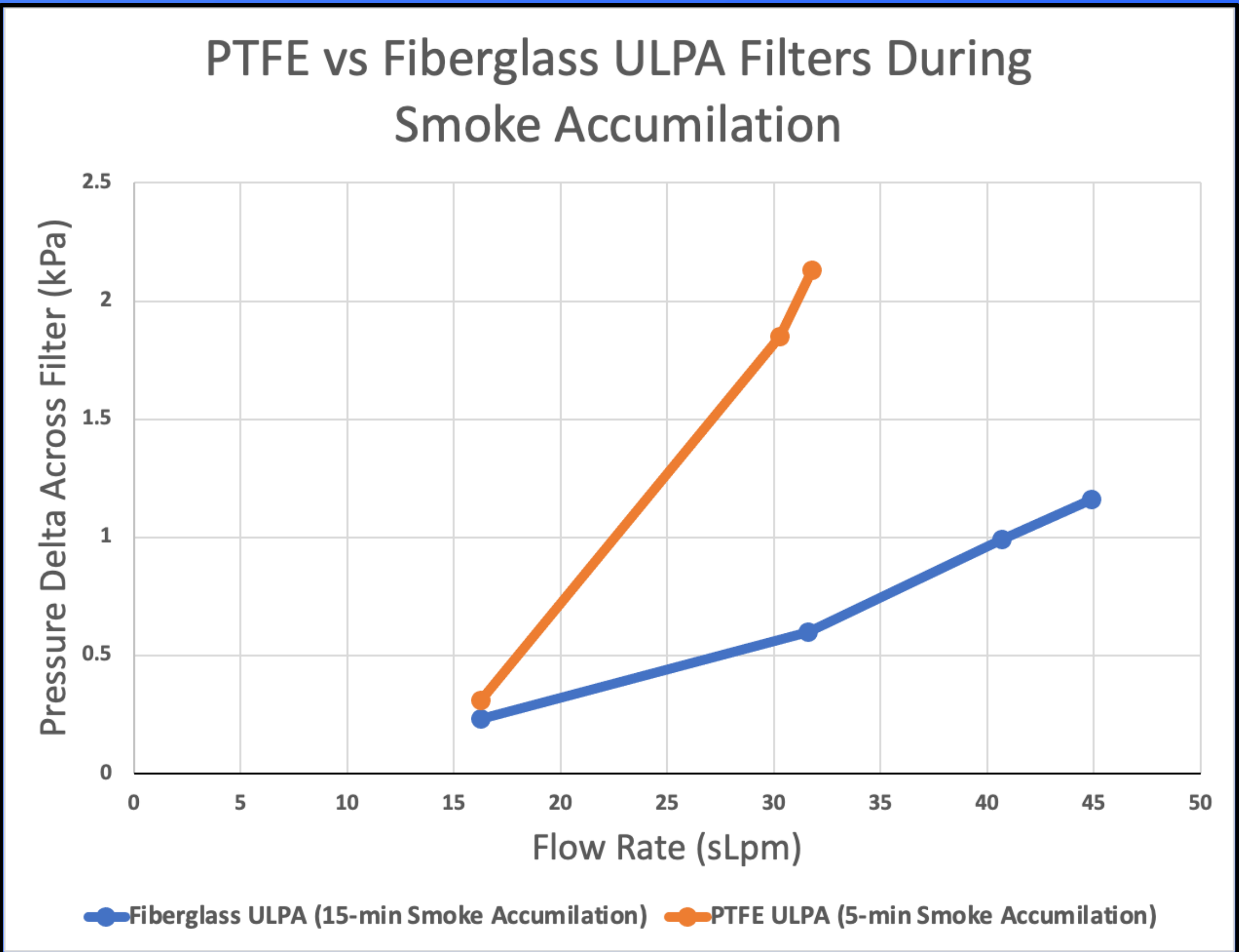


Figure (9) Diagram of testing device

Prototype #	Size(mm) and Material	Filter	Max Flow Rate (sLpm)	Pre-Filter (kPa)	Post-Filter (kPa)	Delta (kPa)	Smoke Accumulation Survival Time	Smoke Capture Percentage
4	25 x 25 PTFE	Clean Dirty	69.7 58.2	2.82 2.1	2.99 2.63	0.17 0.53	Filter Leak Failure	100.01%
5	25 x 25 PTFE (Improved Sealing)	Clean Dirty	51.6 31.8	2.54 1.02	3.03 3.15	0.49 2.13	5 min	100.01%
6	52 x 52 PTFE	Clean Dirty	58 7.8	2.8 .2	2.92 3.2	0.12 3	5 min	Not Tested
7	25 x 25 Fiberglass	Clean Dirty	54 44.9	2.7 1.93	3.2 3.09	0.5 1.16	15 min	Not Tested

Table (1) Summary of Filter Test Data



Graph (1) Flow rate vs pressure delta for PTFE and fiberglass ULPA filters