Creating a Lightweight, Miniature Multi-Sensor Array

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Summary

- Project Motivation & Objective
- Prototype creation/development
- Sensor analysis and comparison
- Current Status, future plans

Mini-MSA Network

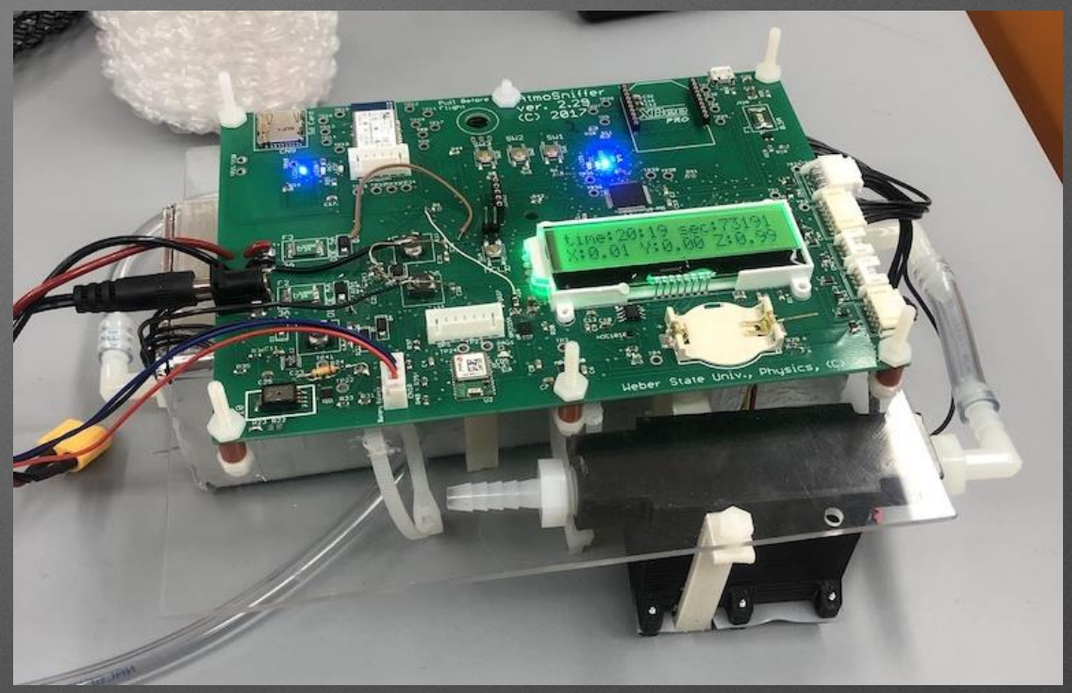
- Facilitate the creation of a collective HAB database, with a standard set of measurements
- Unite the efforts of Balloon teams worldwide to create new science!

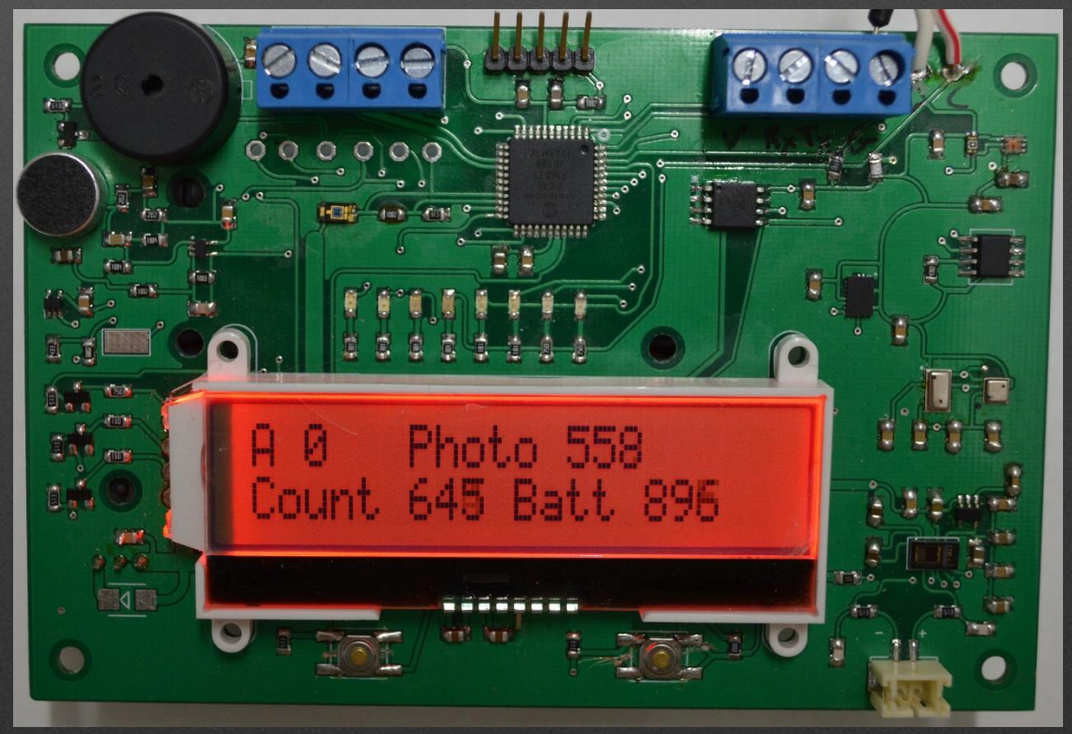
Objective

- Physically small and lightweight
- Robust and user friendly
- Creates a consistent high quality data set
- Inexpensive and Accessible
- Should be able to assemble from a kit

Previous Work

- AtmoSniffer (Top)
  - Big, Heavy, and Expensive
- “Tricorder” (Bottom)
  - Undergraduate Lab Board





The Prototype

AtmoSniffer

Air Flow

- Intake
- Particle Counter
- Gas Board (Insulated)
- Air Flow Meter
- Air Pump
- Exhaust

Mini-MSA Prototype

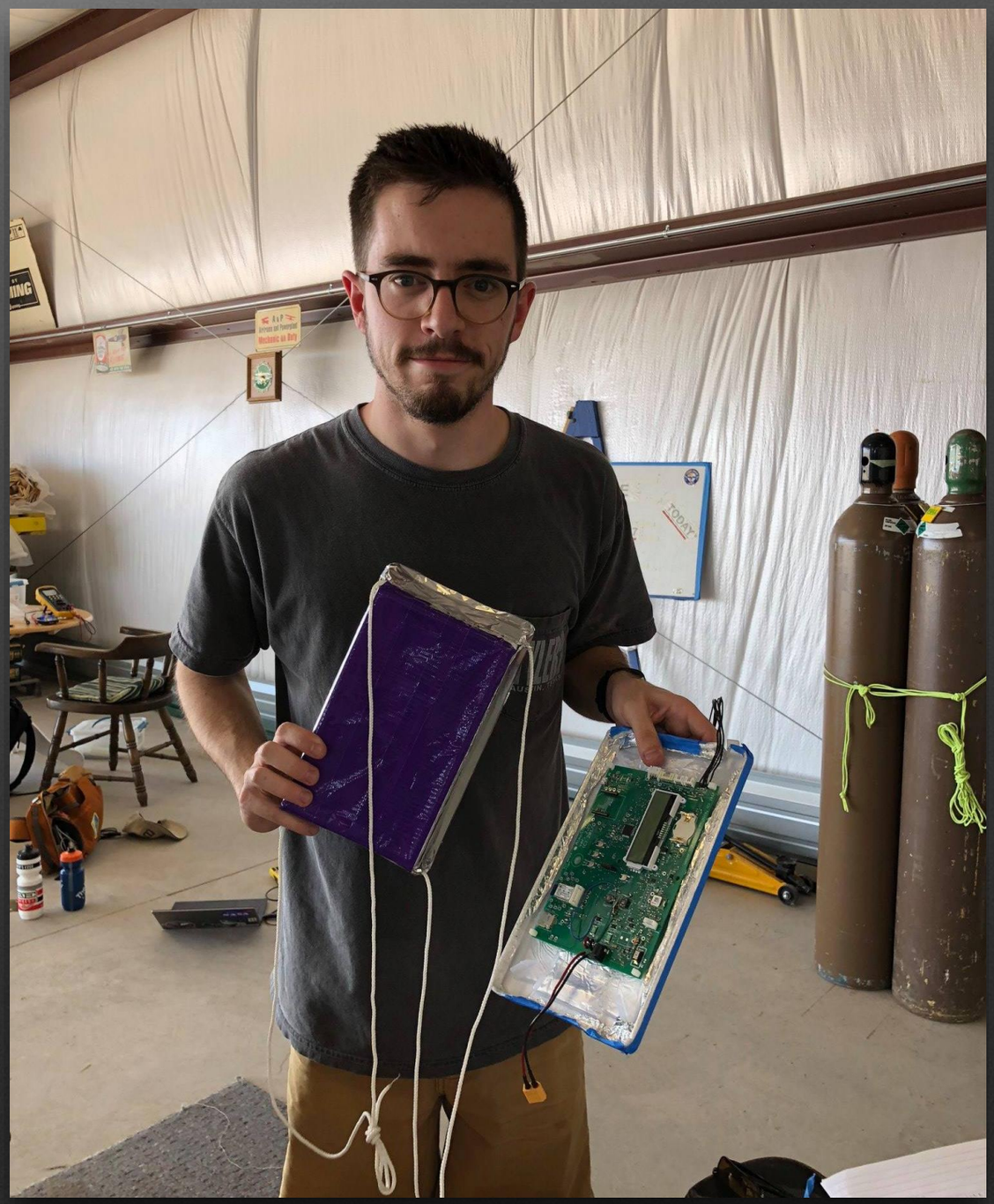
- Particle Counter
- Gas Board

Problems this presents

- Lose electrical and thermal insulation
- Gas board is exposed to both RF and extreme temperatures
- Radio waves transmitting location information and data interfere with normal sensor operation
- Air is no longer conditioned

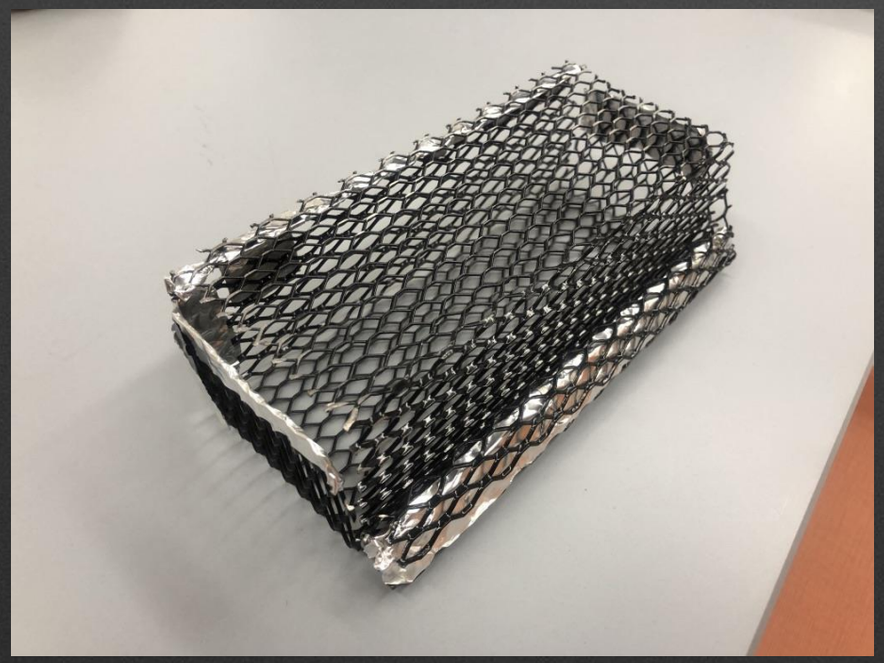
Dealing with RF

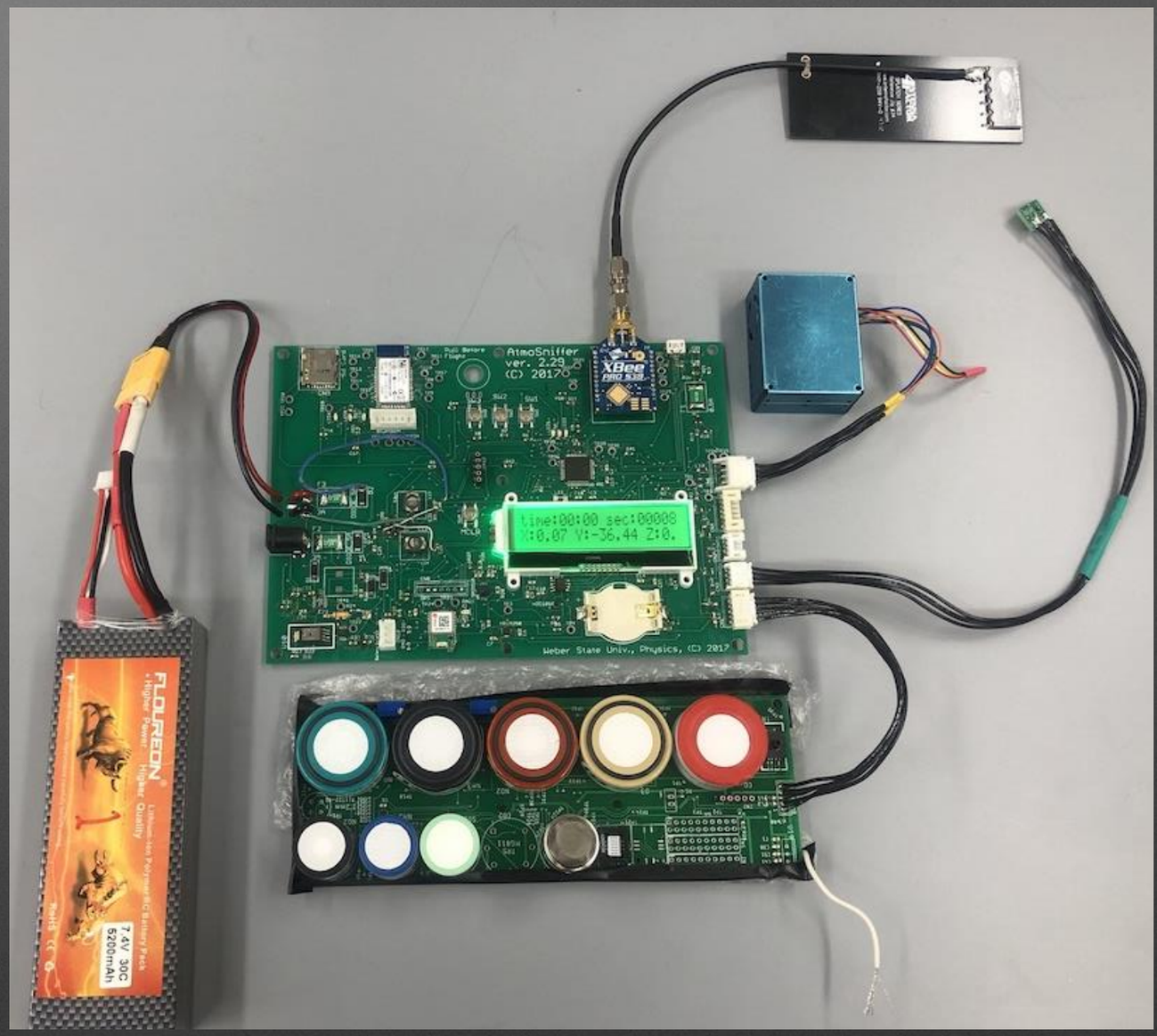
- Faraday Cages!
- Telemetry causes issues with delicate sensors
  - Telemetry carrying data and location information
- Transparent to air, but opaque to RF signals



Prototype Mini-MSA

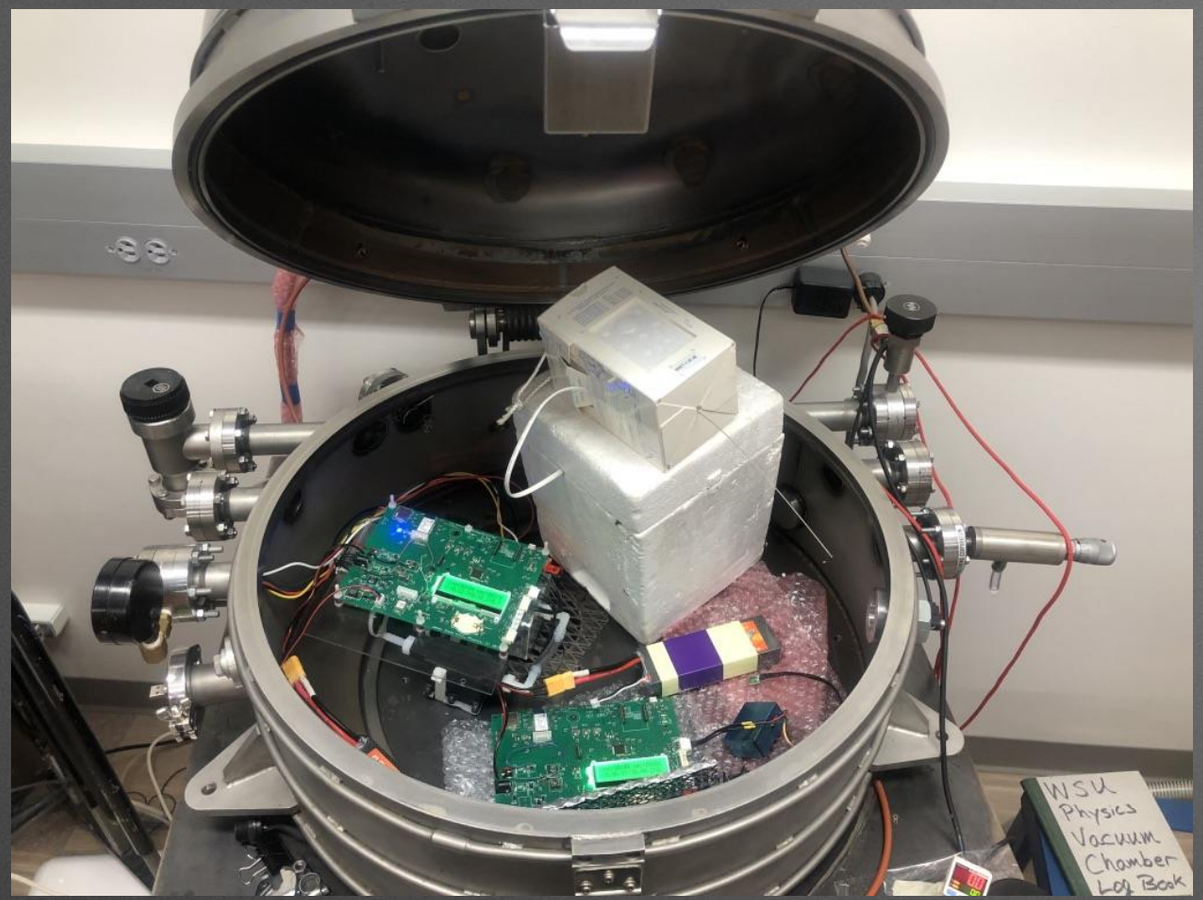
- Dubbed the “AtmoSniffer-Lite”
- Expose the sensors directly to ambient air
- Still provides a GPS location
- New Faraday cage successfully eliminates RF signals





Dealing with the Cold

- Eliminate any sensors that don’t function in the cold
- Flight tests are ideal, weather was uncooperative
- Try to replicate in the lab!


WSU
Physics
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Types of Gas Sensors

- Metal Oxide Semiconducting and Electro Chemical
- MOX
  - Low Specificity, and require ambient Oxygen to work
  - Long time to react
- EC
  - Poor lifetime, and susceptible to voltage drift

Future work

- Continue sensor evaluation
- Design and Fabricate the Version 1.0 Board
- Use Tricorder as a target size, with more functionality
- Design a flight frame for Balloon flight
- What sensors would you like to see on this board?

Current Sensor List

- Atmospheric Quantities
  - Temperature, Pressure, Humidity, and Wind Speed
- Gasses
  - NO_2, CO, CO_2, SO_2, O_3, NH_3
- Particulate Matter
  - < .3 pm, < .5 pm, < 1.0 pm, < 2.5 pm, < 5.0 pm, and < 10.0 pm

Lessons Learned

- Double check that your storage devices are plugged in
- Think hard before messing with flowing -30 degrees c alcohol
- Plan for things to go wrong

Learning is a key component of an undergraduate research project.

Image: https://www.xkcd.com/1906/

Metal Oxide

- Oxygen adsorbs to a tin dioxide film
- Electron flow stops
- Reducing gases react with the oxygen, reducing the surface density of adsorbed oxygen
- $V \propto \sigma_{O_2} \propto Gas\ Concentration$

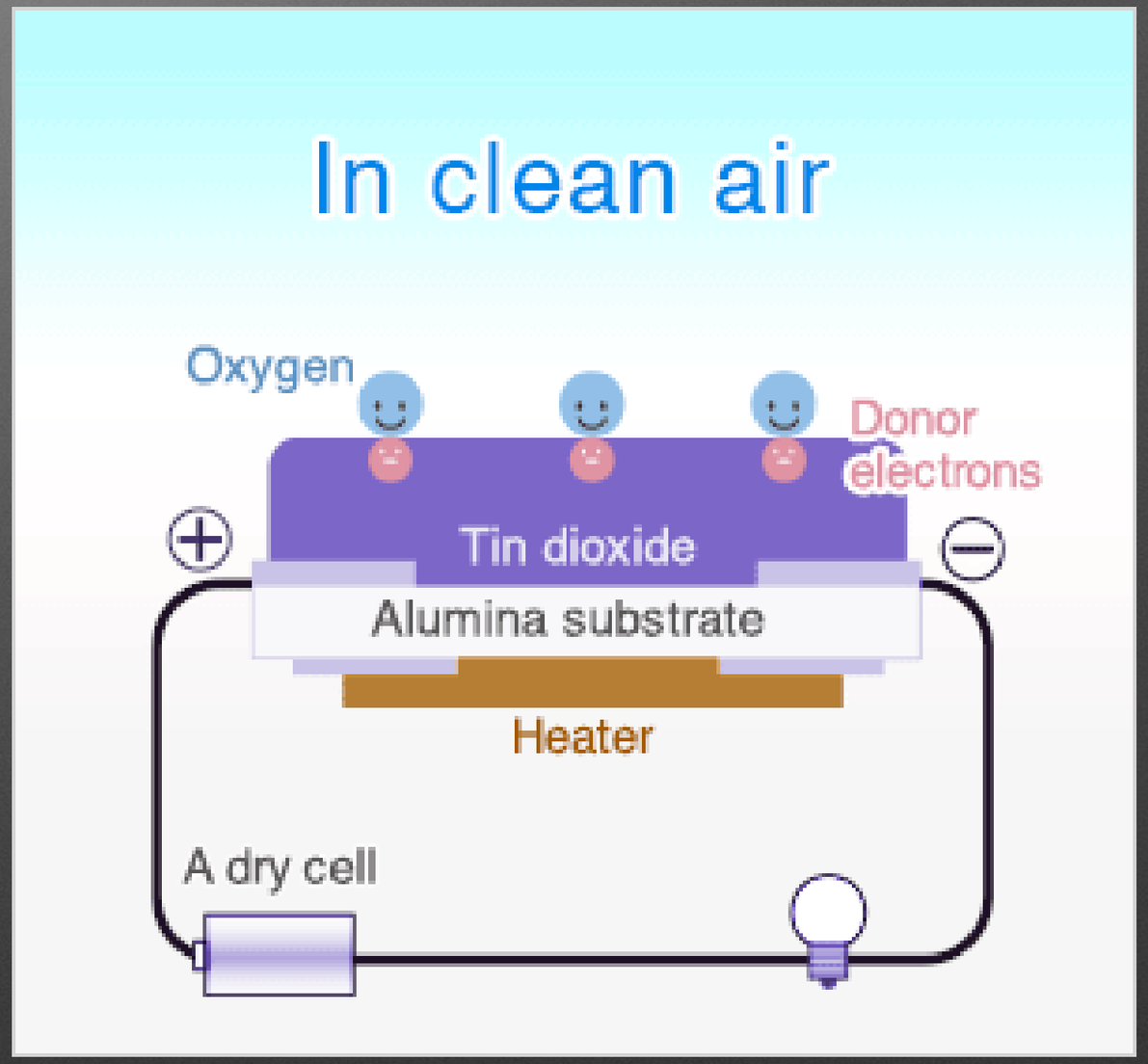

Image Source: https://www.figaro.co.jp/en/img/development/handoutai/shikumi.gif