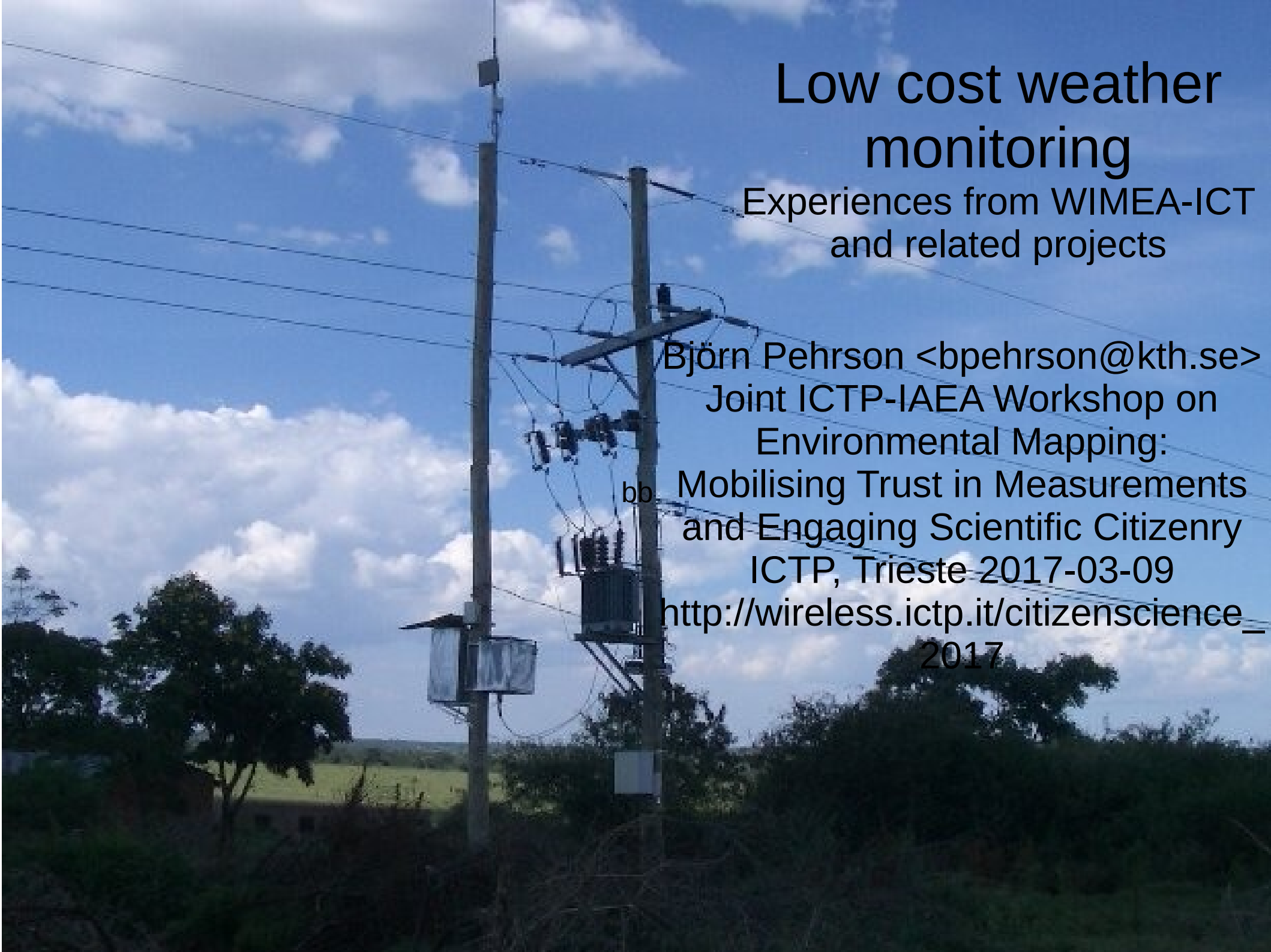


Low cost weather monitoring

Experiences from WIMEA-ICT and related projects

Björn Pehrson <bpehrson@kth.se>

Joint ICTP-IAEA Workshop on Environmental Mapping: Mobilising Trust in Measurements and Engaging Scientific Citizenry

ICTP, Trieste 2017-03-09

http://wireless.ictp.it/citizenscience_2017

bb

Automatic Weather Stations - AWS

- Commercial systems are expensive
  - e.g. Vaisala, Casella, Davis,….
- And not all of them robust enough to resist
  - Continuous heat and moisture
  - Termites, elephants, vandals
- Functionality
  - Sensors, logger, uplink and management software
- Centralized or distributed control (one or more CPUs)

The WIMEA-ICT AWS

- A distributed system
- Wireless sensor network (wsn) with independent sensor nodes
- Sink node/gateway/uplink(s)
- Typically 4 autonomous nodes:
  - 10m broadcasting wind and insolation data
  - 2m broadcasting air temperature and humidity (TRH) data
  - Gnd broadcasting rain, soil temp and moisture data
  - Sink/gateway atmospheric pressure, buffer and uplink, always awake listening and buffering
- Easy to add more nodes for redundancy or other sensors

WIMEA-ICT AWS Technology

- WSN Nodes:
  - hardware http://radio-sensors.com
  - Contiki-OS, RIME platform
  - Open source firmware (https://github.com/wimea-ict)
- Gateway alternatives
  - Raspberry Pi
  - Sink node extension
- Linux based development environment and tool chain

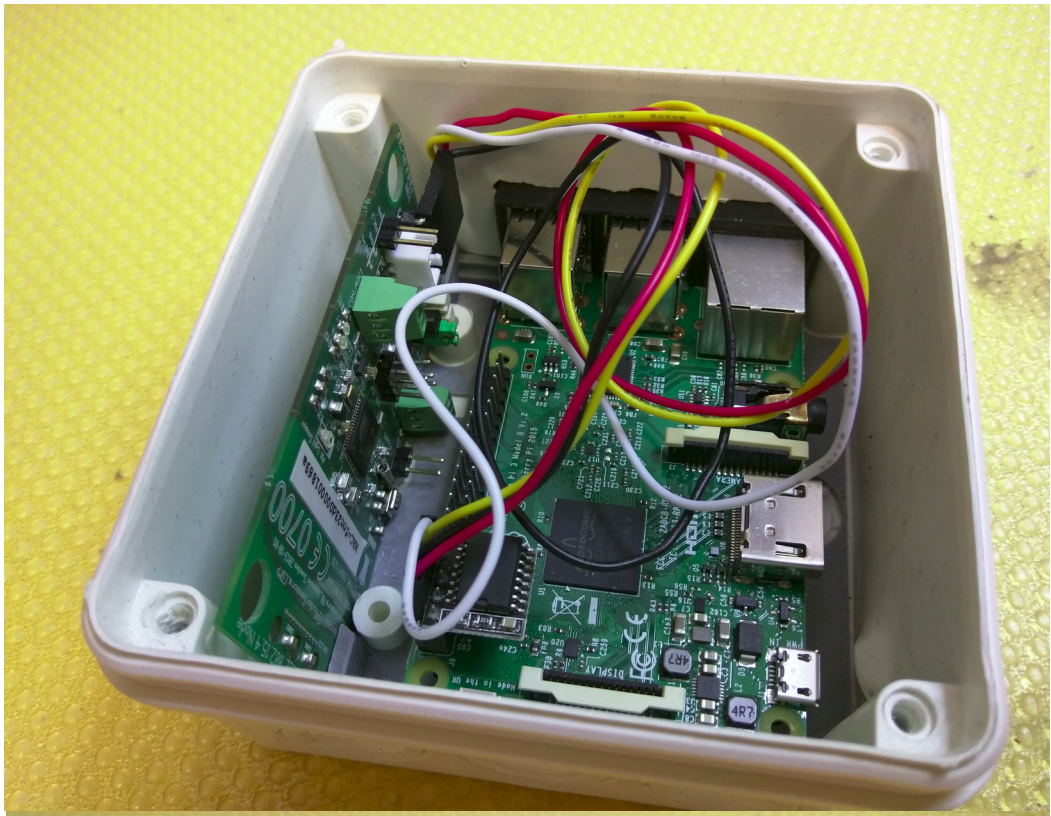
Radio-Sensors mote

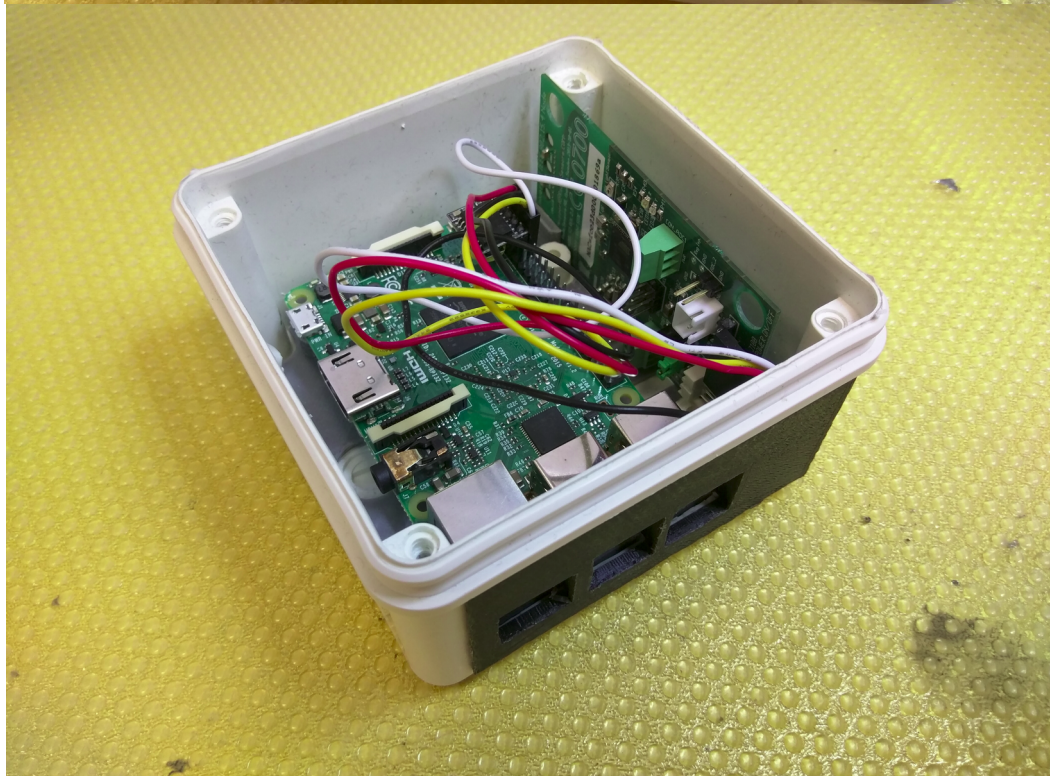
http://www.radio-sensors.com/

- ATMega256/128RF integrates MCU, ieee802.15.4 transceiver and an 8 channel 10bit ADC
- 1.8-3.6V operating voltage 250nA@25C in deep sleep
- Analog and pulse inputs with feed
- DS18B20 and Ambient light sensors on board
- Daughter cards with other sensors
- Connectors to SPI, I2c, ow-buses
- CinikiOS-based software

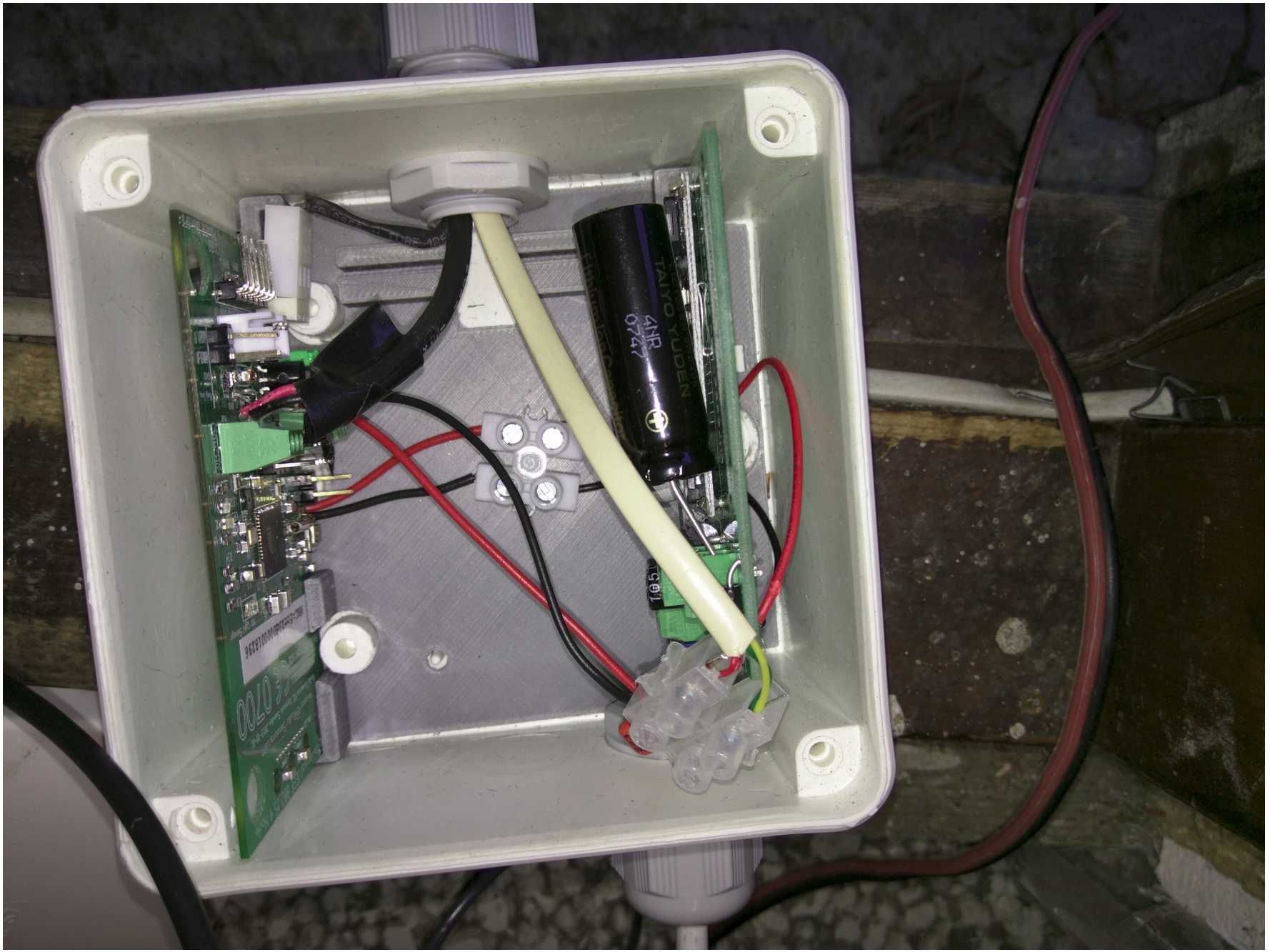
Gateway/sink-node

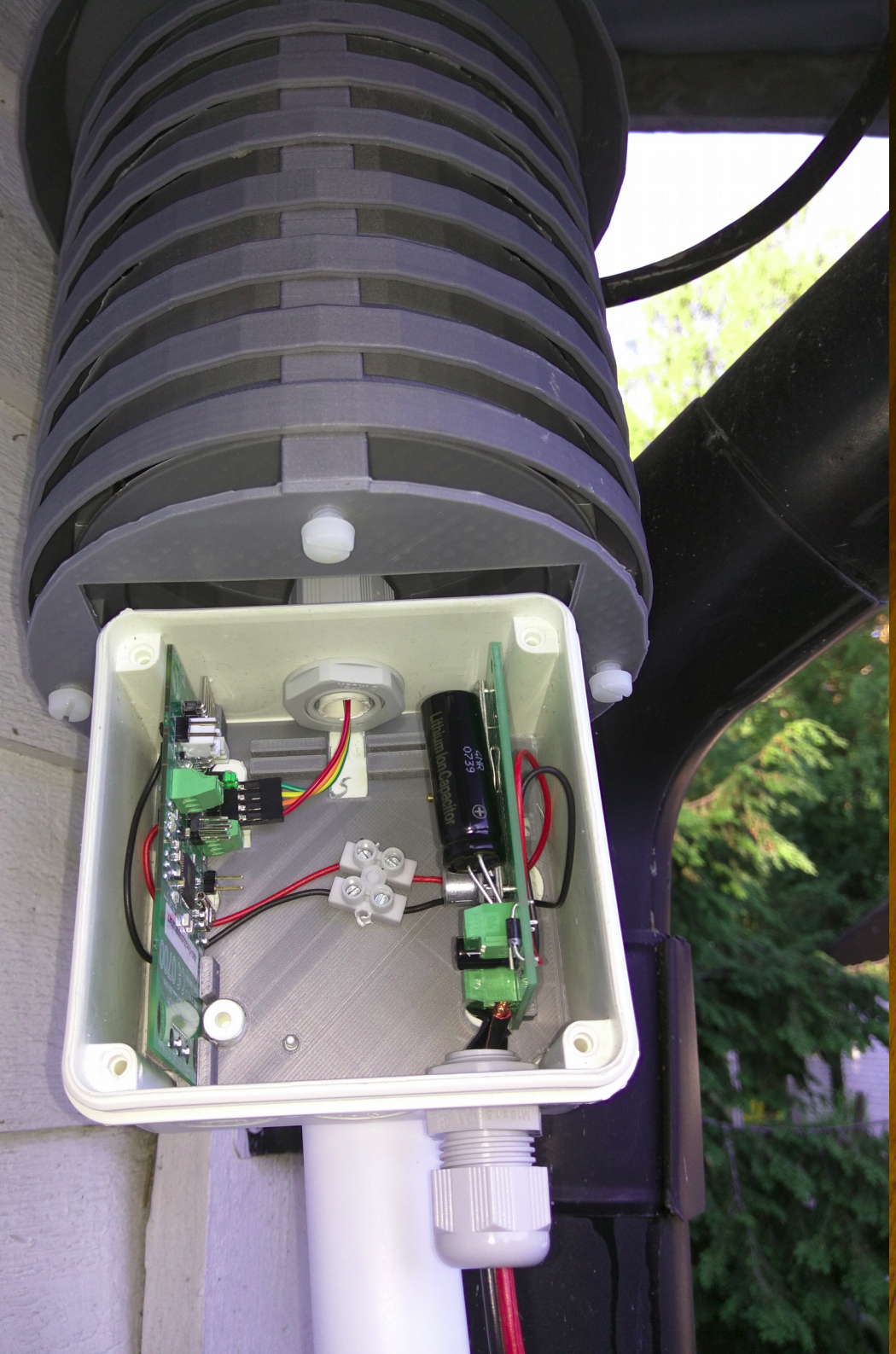
- RaspberryPi – sink
  –
- Sink node extension

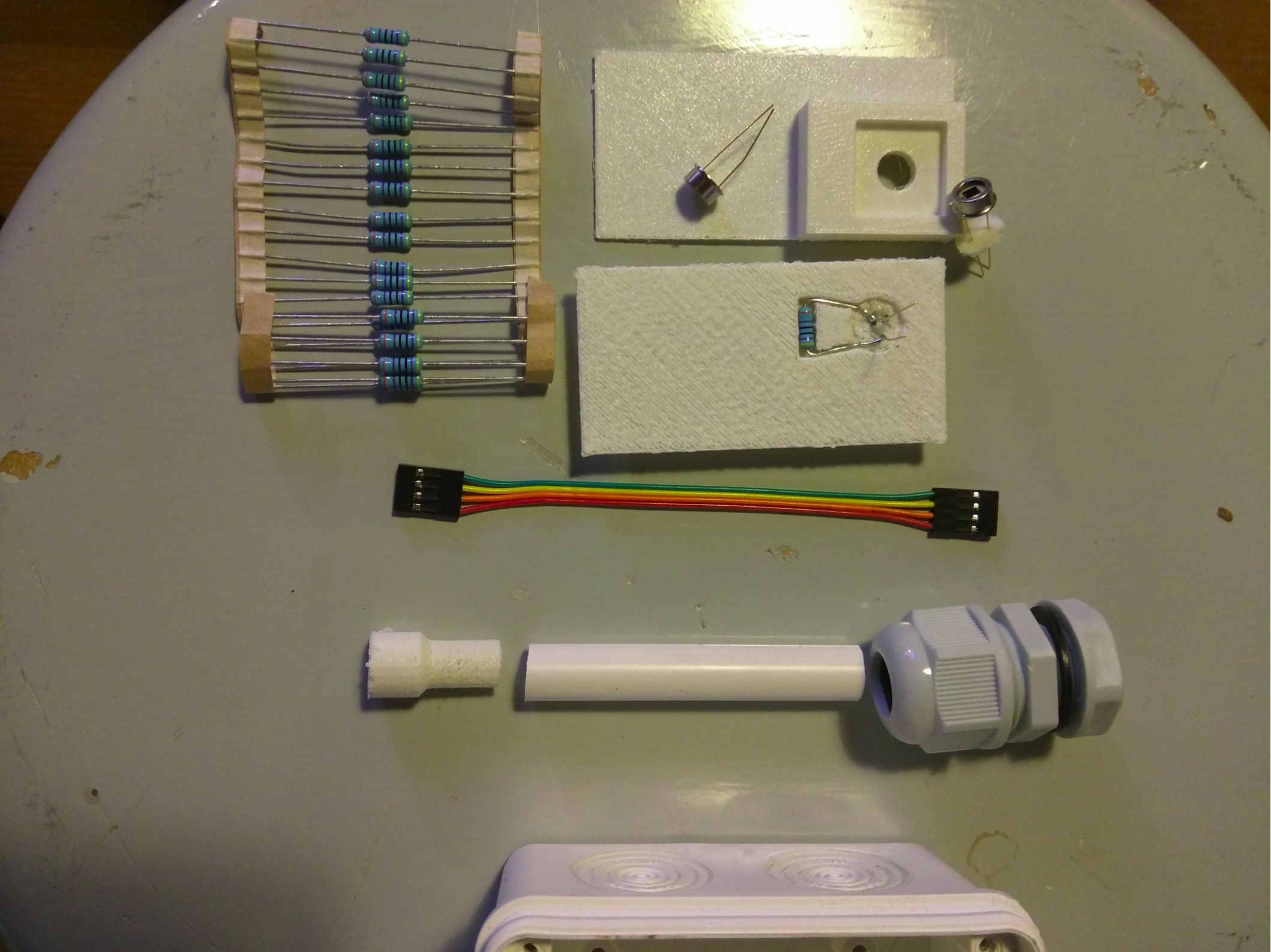


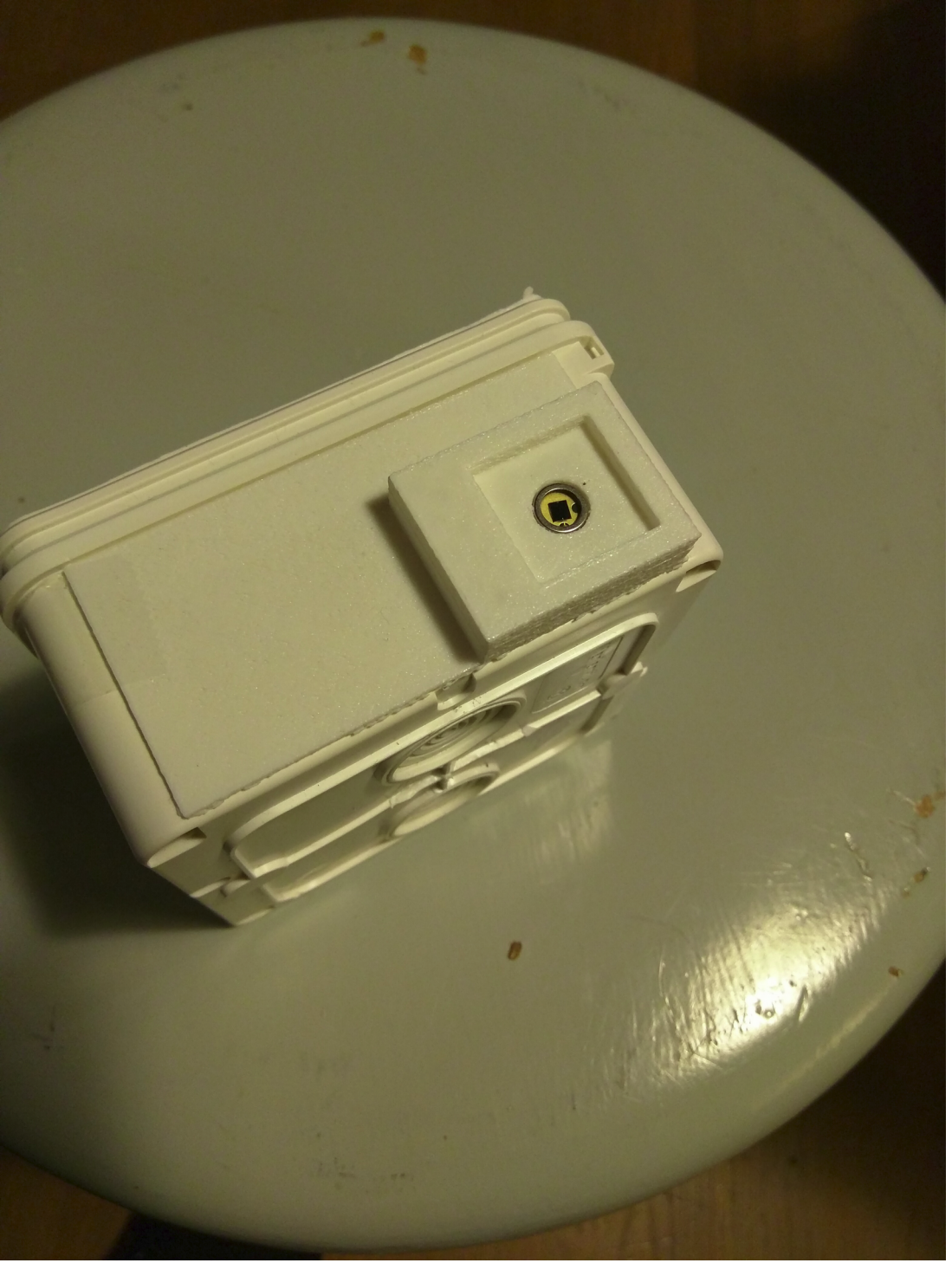


Ground node (gnd)




LithiumIonCapacitor



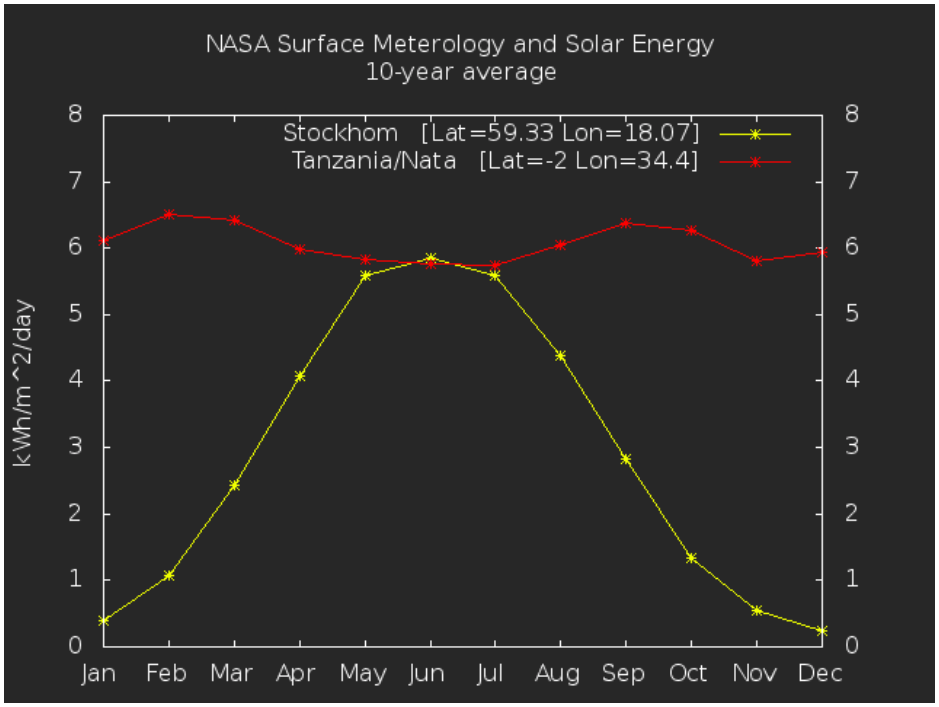


Diffusors

- Used to maintain linearity of measurements

Power

NASA 22 year averages



https://eosweb.larc.nasa.gov/cgi-bin/sse/global.cgi

- Sources
  - solar
  - Wind
  - grid
- Storage
  - Lead Acid
  - LiFePO4
  - Ultracaps
- Regulator

Main challenges

- Minimize power consumption
  - Power-lean design
  - Use sleep-states
- Maximize power storage

Batteries with chemical cells

- Lead Acid 6 or 12V
  - Slow chemical chrging process
  - Charge, float, desulphatization
  - pwm,mppt algorithms, temperature-dependent
  - Do not go under 6/12V and keep the batteries cool (<25C)
  - Requires monitoring
- Non rechargable Alkali batteries
  - 3*1.5 AAA in 2m node > 1 year


Lithium Ion Capacitor
3.8V 40F
DO NOT REVERSE POLARITY
BOOSTCAP
ULTRACAPACITORS
1500 Farads | 2.7 VDC
DO NOT REVERSE POLARITY
DO NOT REVERSE POLARITY
NERMAN
Lithium Ion Capacitor
3.8V 40F

Batteries with physical/capacitor cells

- Ultracaps (EDLC 2.7V , LIC 1.8-3.8V)
  - Fast physical self-regulating charging process
  - Almost no internal resistance
  - Current limitation

Charge regulators

- Lead Acid
- LiFePO4
- Capacitors

- Balancing
- Current limitation

Connectivity

- Wire
  - Copper, fibre
- Terrestrial wireless
  - Commercial cellular
  - Dedicated shf/uhf/vhf/hf
- Satellite SBS
- Sneakernet
  - Delay Tolerant Networks
  - USB-sticks
- Community Networks
- AMPRNet volunteers
  www.ampr.org

Production plan

- Prototype generations
  - Gen1: 2014 Evaluation of components
  - Gen2: 2016-2017 Systems level validation
  - Gen3: 2017-2018 final validation and production
- Production and deployment 2017-2018 in batches of 3*25 using student teams and custodian communities
- Procurement of components for first batch in progress
- Preparations of a crowd-funding program to invove more user communities

Discussion ?

Reference

Bjorn Pehrson, Robert Olsson, Serdar Temiz, Julianne Sansa Otim, Mark T. Smith, Amos Nungu, Mohsen Chogolzadeh, Maximus Byamukama,Emmanuel Kondela, Mary Nsabagwa, Terrence Brown, Ben Khemis, Richard Okou, Joachim Reuder:

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http://cooperation.epfl.ch/files/content/sites/cooperation/files/Tech4Dev%202016/1243-Pehrson-SE14-ICT_Full%20Paper.pdf