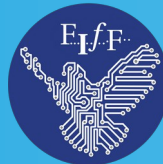


Citizen Science Citizen Sensing

Forum Computer Scientists for Peace and
social Responsibility e.V.

<https://fiff.de/>



Forum
InformatikerInnen
für Frieden und
gesellschaftliche
Verantwortung



Gefördert durch

Deutsche Stiftung für
Engagement und Ehrenamt

Citizen Science by FlfF

- Citizens answer socially relevant questions. They record parameters of our living environment, store and provide them, analyse and evaluate them and place them in a social context.
- The collection of data, information and scientific analyses serve to support civil society arguments. This promotes civil society activities, imparts knowledge about nature and technology, raises environmental awareness, shows connections and promotes responsibility.
- This strengthens fact- and science-based, democratic, social and political commitment.

Genesis

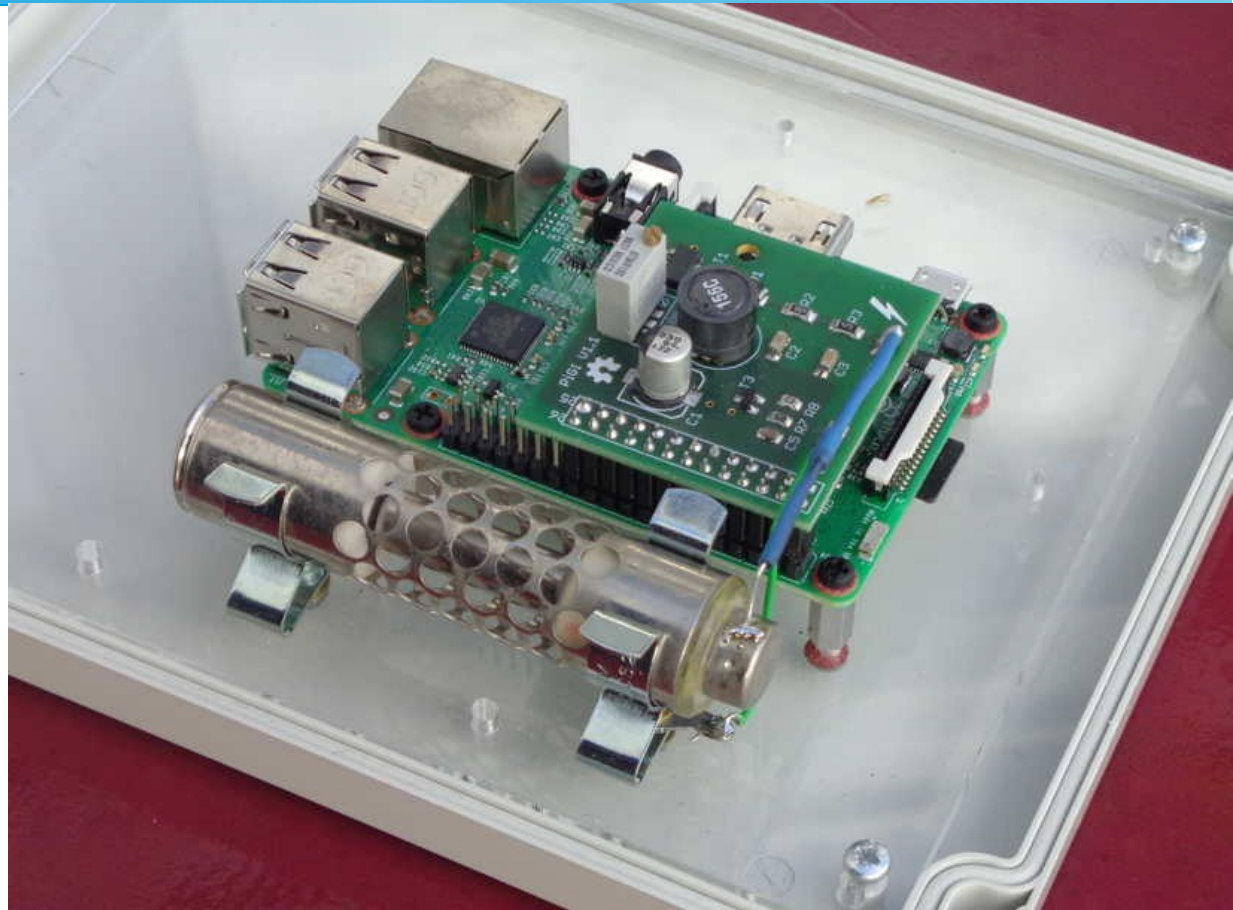
- TDRM Thiange-Doel Radiation Monitoring Network since 2014
 - Measurement of atmospheric radioactivity around the Thiange and Doel nuclear power plants, Belgium
 - Raspberry Pi and a PIGI high-voltage module for operating a Geiger-Müller counter tube, counting the impulses triggered by ionising gamma impacts in the gas in the GM tube
 - Raspberry Pi 2/3 via LAN or WLAN, PoE or plug-in power supply unit
 - on a voluntary and donation basis

TDRM station

Raspberry Pi 2 or 3

PIGI high-voltage
module

Geiger-Müller counter
tube



<https://tdrm.eu/>

Tabelle der beobachteten Dosisleistungen

26.05.2025 (Kalendertag, heute bis 13:43)			
← Heute Kalender-tag Kalender-woche Kalender-monat →			
Region	Station	Mittelwert	Maximum der dargestellten Stationswerte: 0.33 µSv/h
[10]	[28 online]	[µSv/h]	2.00 µSv/h
Doel	Kloetinge, NL	0.08	
	Meerdonk	0.30	
Brussels	Lede	0.11	
	Mechelen	---	[offline]
	Center	0.09	
Chooz	Niverlee	0.11	
	Dion	---	[offline]
	Dinant	0.20	
Tihange	Huy	0.12	
	Celles	0.25	
	Marneffe	0.09	
	Fumal	0.02	
	Havelange	---	[offline]
	Nandrin	0.11	
Liege	Tilff	0.14	
	Tilff 2	0.10	
	Saint-Georges	---	[offline]
	Comblain a/Pt	0.20	
Luxembourg (B)	Gouvy/Gellich	0.00	
Limburg (B)	Hasselt	0.00	

Map of stations



Blue: Sensor stations of the TDRM Network (white = offline; yellow or red = exceptionally high radiation levels)

Green: Sensor stations of the [GammaSense Network](#) (light green = offline)[1]

Pink: Sensor stations of [MAUS e.V.](#) (lightpink = offline)[2]

In the pop-up menus the station names are linked to detail maps of the stations' location, and the current measuring level is linked to time diagram

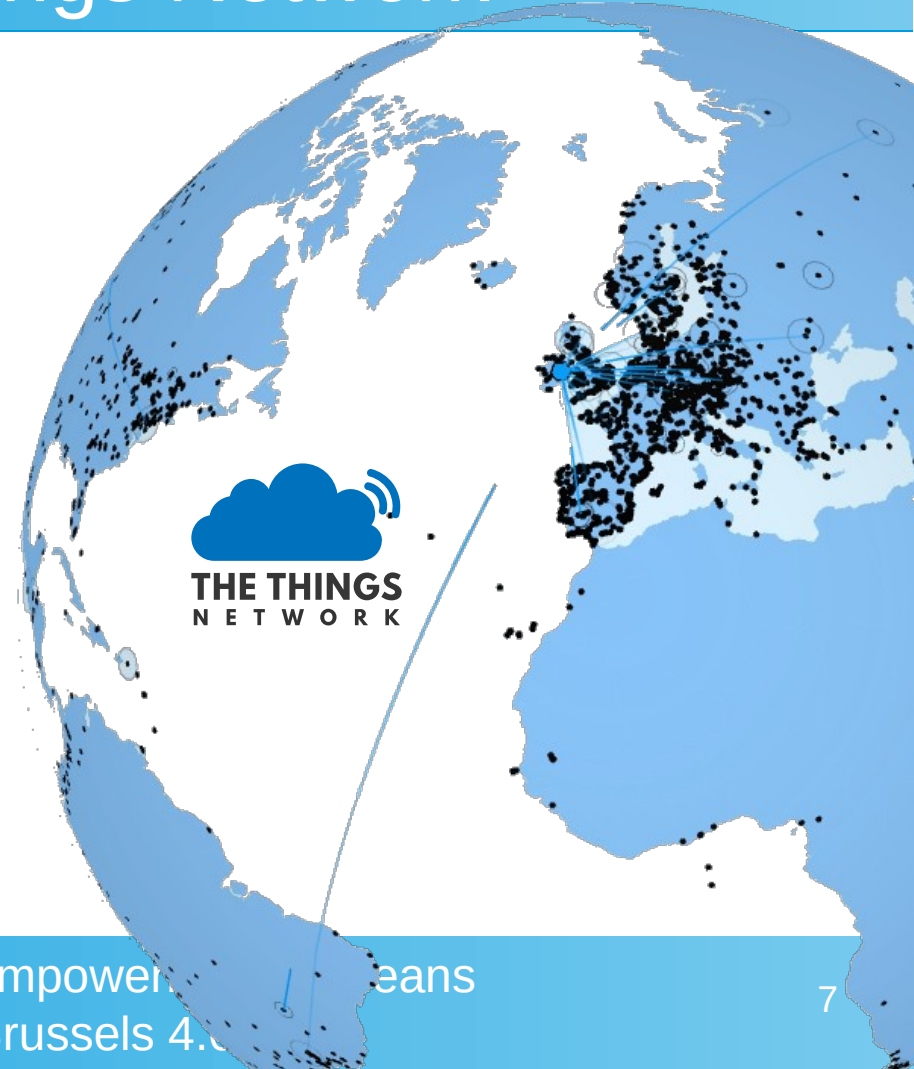
Citizen Science in Radioactivity Measurement
for Better Environmental Monitoring

next Step: flexible multimodal, open sensor station

- It should not only be possible to record radioactivity and temperature, but also any sensor data. Users should be able to change the selection of sensors themselves
 - Flexible: Assemble sensors yourself
 - Easy to use and (re)configure
 - Productive use: radio, PV, rechargeable battery, robust, sealed housing
 - Reusable, repairable, no cloud constraints
 - => open, open source, more sustainable

LoRaWAN / The Things Network

- 0.292 ... 50 kbit/s, low power
long range 1 ... 40 km
- licence free SDR 863 ... 870 MHz
- Open Source Stack, Gateway, Brooker
- open IoT Network
- https://de.wikipedia.org/wiki/The_Things_Network



First prototype of the sensor station

- 2022 DSEE Citizen Sensing Project: Prototype of a sensor station
 - Microcontroller STM32G071CBU3, ~40 DMIPS, 44 IOs
 - LoRaWAN module, rechargeable battery, photovoltaic module or plug-in power supply unit
 - Geiger-Müller counter tube for measuring (counting) gamma radiation
 - Various sensor module types with defined connectors and interfaces such as I2C, SPI, UART, Analogue-In, GPIO... can be connected



Gefördert durch

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Engagement und Ehrenamt**

Sensor station

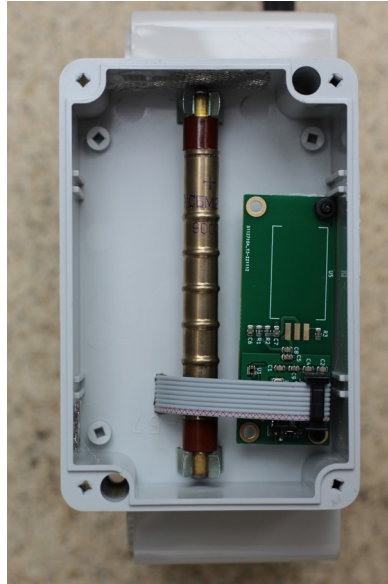
First prototype of a
sensor station 2022

MC STM32G071

PIGI HV module

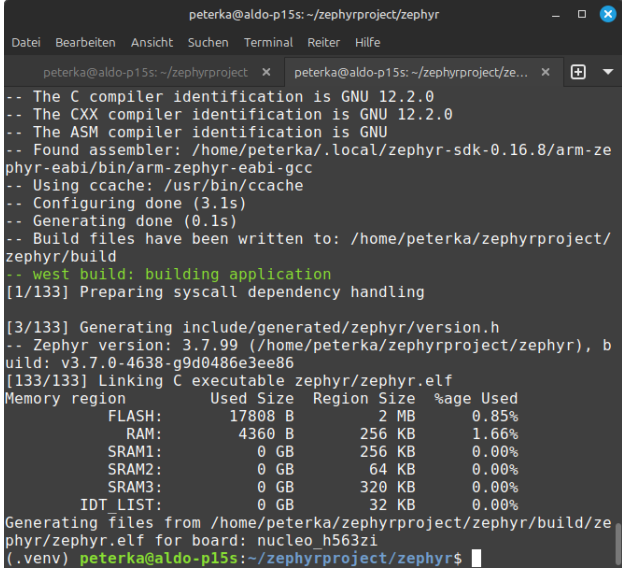
GM tube and other
sensors in the remote
housing

10 Connectors for
sensors



ZEPHYR for sensor station

- <https://www.zephyrproject.org/>
- open source embedded real time operating system
- Linux-Foundation and -Toolchain
- many drivers, including bit-bang drivers, for interfaces, protocols and sensors available, continuously growing fastly
- devicetree: Hardware configuration file
=> abstracts the application from the hardware
=> makes it very easy to change the sensors



```
peterka@aldo-p15s: ~/zephyrproject/zephyr
Datei Bearbeiten Ansicht Suchen Terminal Reiter Hilfe

peterka@aldo-p15s: ~/zephyrproject  x peterka@aldo-p15s: ~/zephyrproject/ze... x + - v
-- The C compiler identification is GNU 12.2.0
-- The CXX compiler identification is GNU 12.2.0
-- The ASM compiler identification is GNU
-- Found assembler: /home/peterka/.local/zephyr-sdk-0.16.8/arm-zephyr-eabi/bin/arm-zephyr-eabi-gcc
-- Using ccache: /usr/bin/ccache
-- Configuring done (3.1s)
-- Generating done (0.1s)
-- Build files have been written to: /home/peterka/zephyrproject/zephyr/build
-- west build: building application
[1/133] Preparing syscall dependency handling

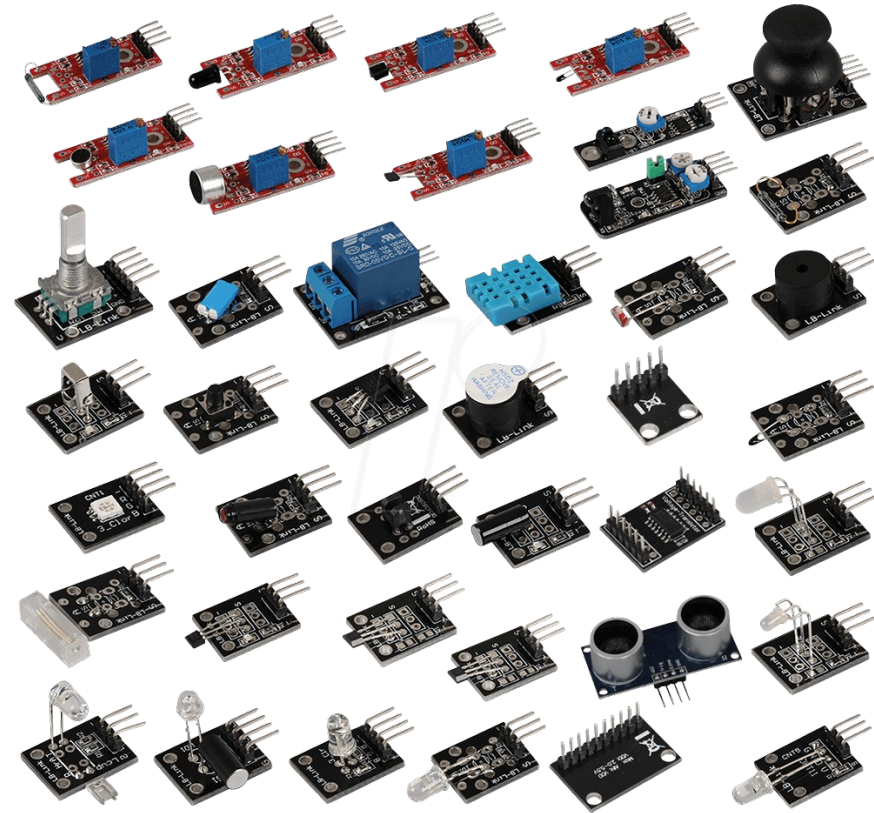
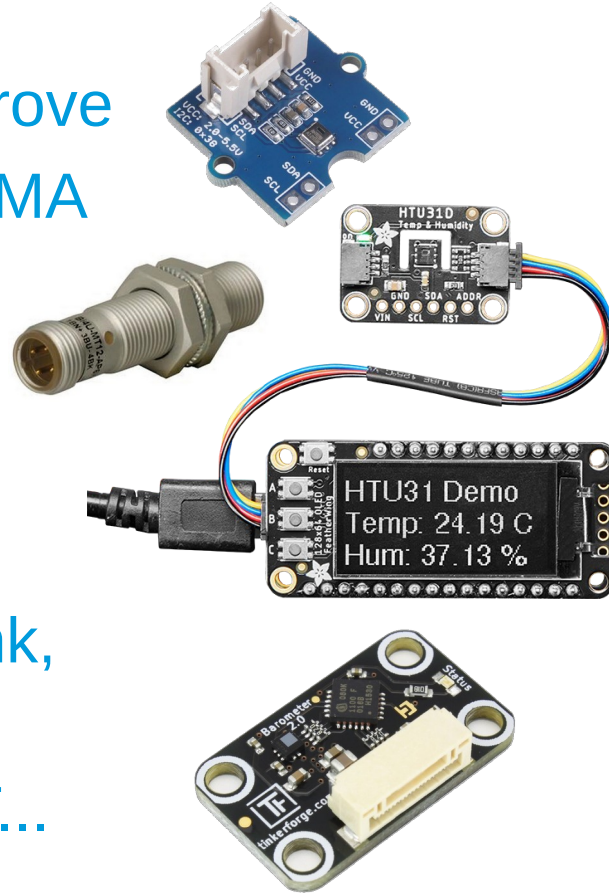
[3/133] Generating include/generated/zephyr/version.h
-- Zephyr version: 3.7.99 (/home/peterka/zephyrproject/zephyr), build: v3.7.0-4638-g9d0486e3ee86
[133/133] Linking C executable zephyr/zephyr.elf
Memory region      Used Size  Region Size  %age Used
FLASH:             17808 B      2 MB         0.85%
RAM:                4360 B      256 KB         1.66%
SRAM1:              0 GB        256 KB         0.00%
SRAM2:              0 GB         64 KB         0.00%
SRAM3:              0 GB        320 KB         0.00%
IDT LIST:           0 GB         32 KB         0.00%
Generating files from /home/peterka/zephyrproject/zephyr/build/zephyr/zephyr.elf for board: nucleo_h563zi
(.venv) peterka@aldo-p15s:~/zephyrproject/zephyr$
```

current project: Citizen Sensing

- current development: second prototype of the sensor station
- MC STM32H563zi, 375 DMIPS, 144 IOs
- Mainboard with 16 card slots as adapter or carrier
- LoRaWAN module on adapter slot card

Sensor Modules

- seeedstudio: Grove
- Adafruit: STEMMA
- sparkfun: Qwiic
- olimex: UEXT
- tinkerforce
- RS485, RS232
4..20mA, IO-Link,
CAN, LIN ...
- Modbus, MQTT...



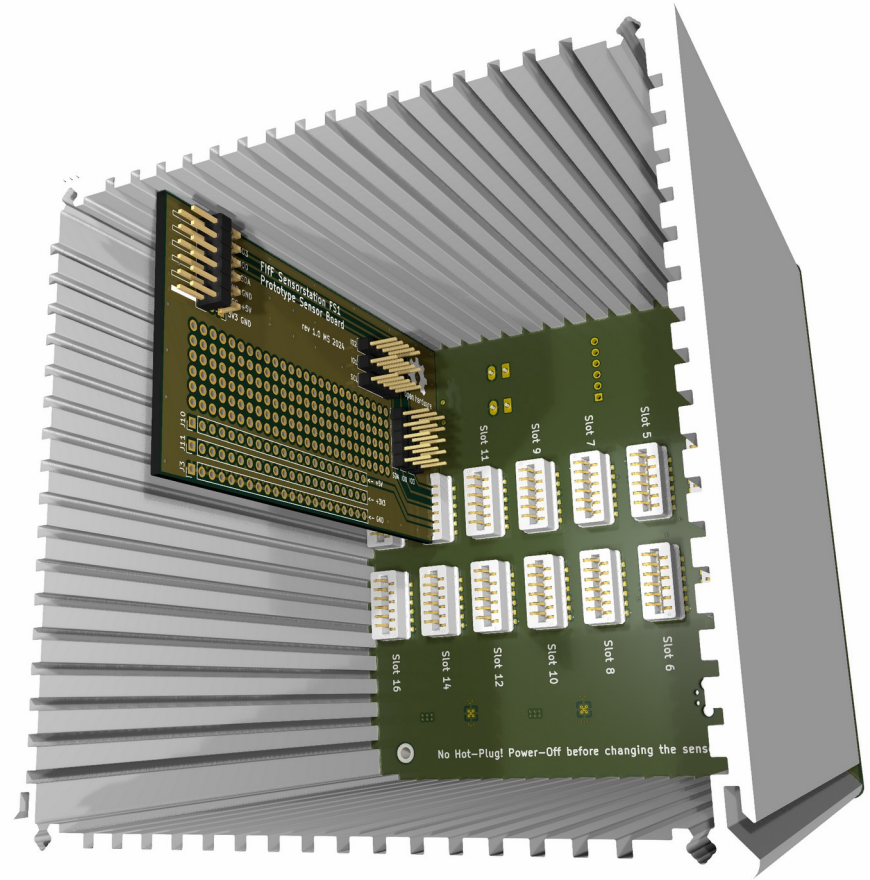
flexible multimodal Sensing

- Location, time, wind, light, rain, humidity, noise, pressure, dust, smoke, counting, temperature, vibration, CO2, water level, ionising radiation, NOx, pH value, volatile organic compounds, ADS-B flight, AIS ship, etc. Radio signals
- Radioactivity and climate data around nuclear power plants
- Levels and measured values of (polluted) rivers
- Observation (of the loads) of the traffic
- ...

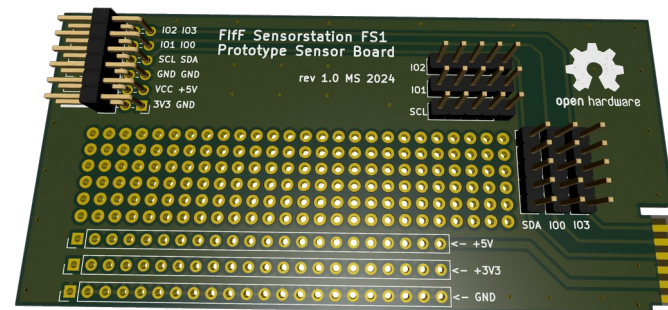
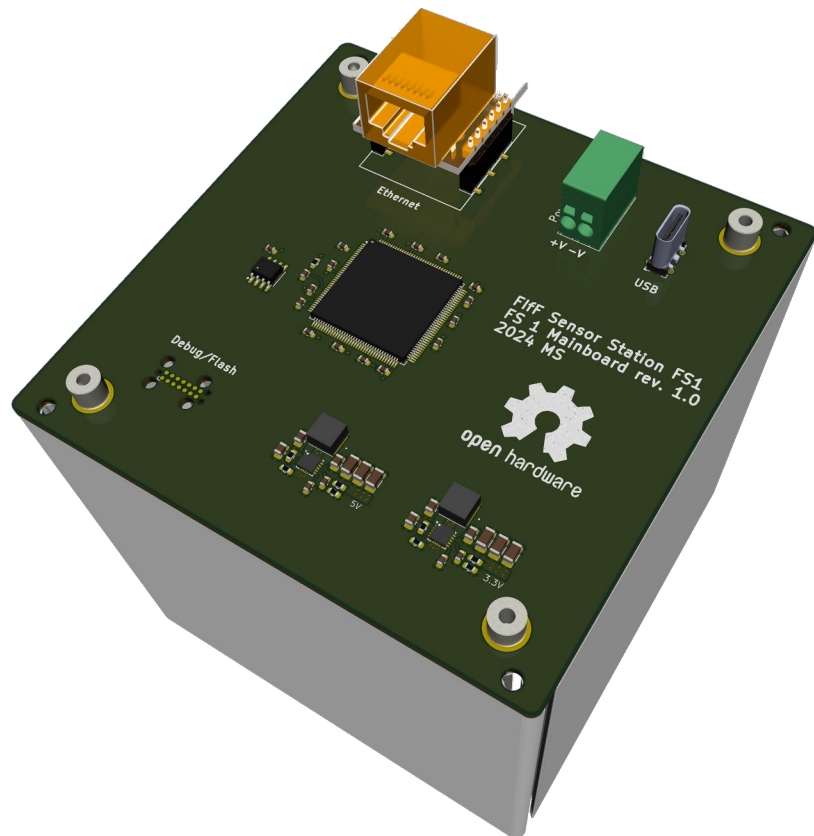


fs1 FIF environmental sensor station

- Sturdy aluminium tube housing
- Groove for mechanical hold
- rear mainboard
- sixteen slots
- Application-specific 3D printed front and rear bonnets
- Weatherproof possible



fs1 rear, slot adapter card



Project cooperation with RadIIS

RadIIS is an open source

Radioactive Isotope
Identifying
Spectrometer



Project cooperation with RadIS

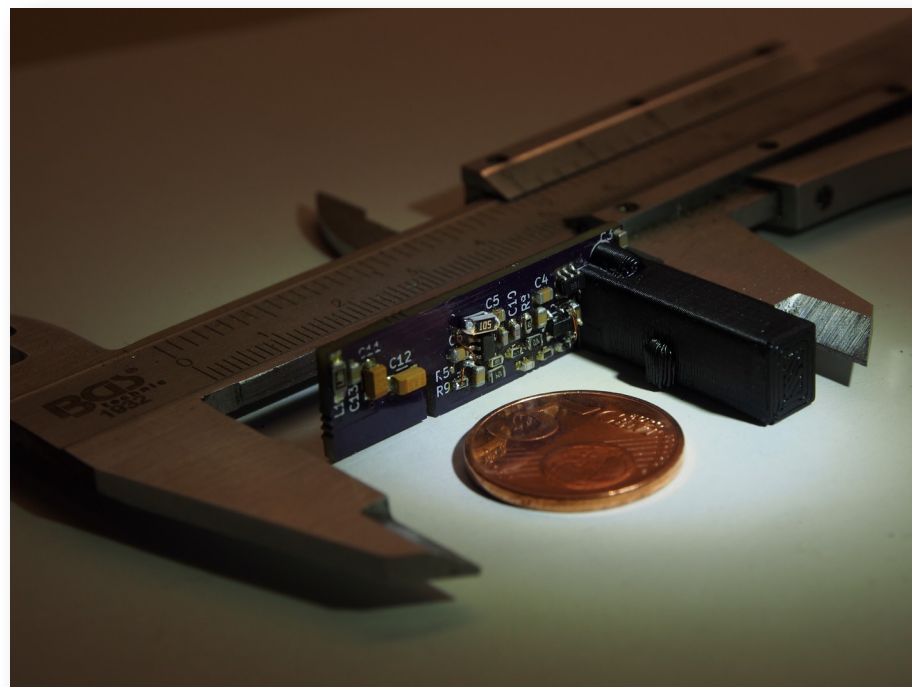
RadIS is an **autonomous monitoring station** and a **personal gamma spectrometer**

- Automatic **threat detection** and **isotope identification** using special **neural networks**
- Permanent **calibration** and **device fault detection**
- **Flexible setup** and fast sensor network integration
- Secure **long-range data transmission** and stand-alone operation **without maintenance**



RadIS sensor technology details

- **Scintillator and SiPM based gamma spectrometer**
- Current sensor (left): 4x4x22 LYSO scintillator with **~10% energy resolution** and **1500 CPM/uSv/h sensitivity**.
- Next sensor design with using **CsI(Tl)** and **LaBr3:Ce** scintillators with an energy resolution **<4.5% (LaBr)** and sensitivities **>14000 CPM/uSv/h (CsI(Tl))**



**Also for the new CsI(Tl) sensors:
Production cost **<100 €/Sensor** !**

Proposal of Integration

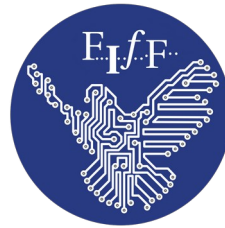
- our next Sensorstation: flexible multimodal, open
- Exchange of Sensordata
- Agreement on flexible multimodal Interfaces
- Open Sensing in both Directions
- „Backup“ of official Data at NGO site

Thank you for your attention



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