µTelescope: User Interface and noise reduction

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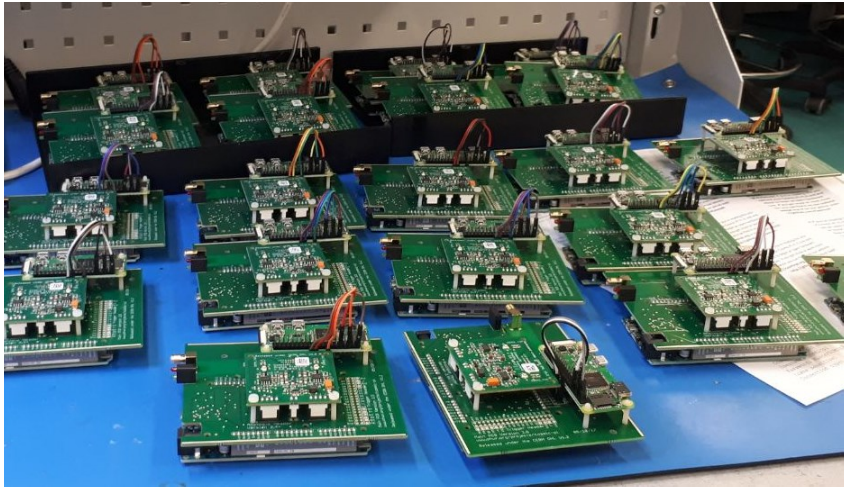
Updates from CosmicPi

- Final run for production of V1.5 Units
  - Scintillator and SiPM-based design
  - This design was tested during the summer
  - 30 Units assembled
  - 28 Units tested
  - Basic user interface finished
  - To be shipped next week
- User interface will be used for the uTelescope as well

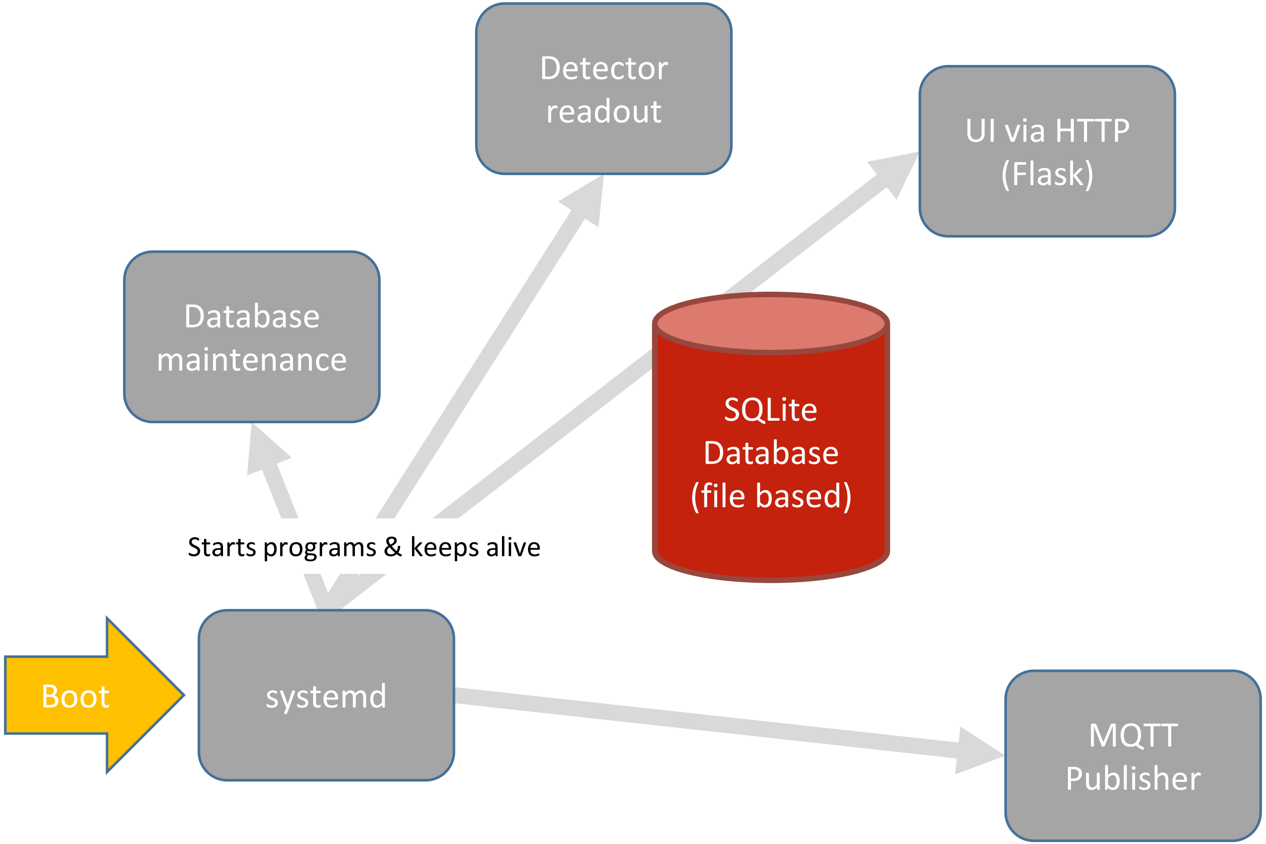


Part of the V1.5 units, without scintillators; Notice how each unit is a stack of: Arduino DUE, mainboard, anagoge board, Raspberry Pi Zero W

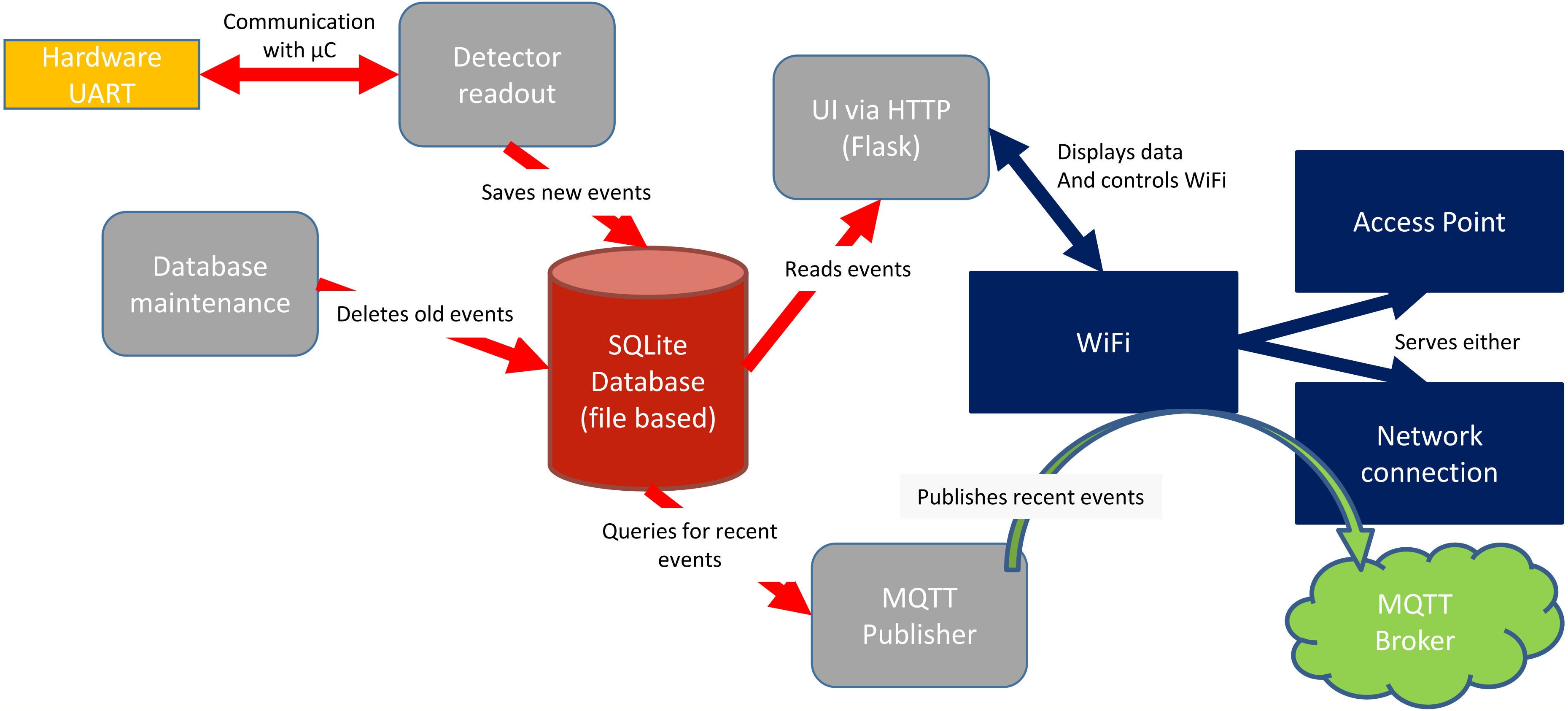
High level software for the CosmicPi and the µTelescope

- Runs on Raspberry Pi (Versions: 3 and Zero W)
- Stores events locally in a SQLite database
- Publishes events via MQTT
- Provides a user interface via HTTP
  - Displays basic information
  - Allows to create customized histograms
  - Allows export of local data
  - Controls basic network settings
- Code managed via GitHub: https://github.com/CosmicPi/cosmicpi-rpi_V1.5

High level software: Architecture on boot



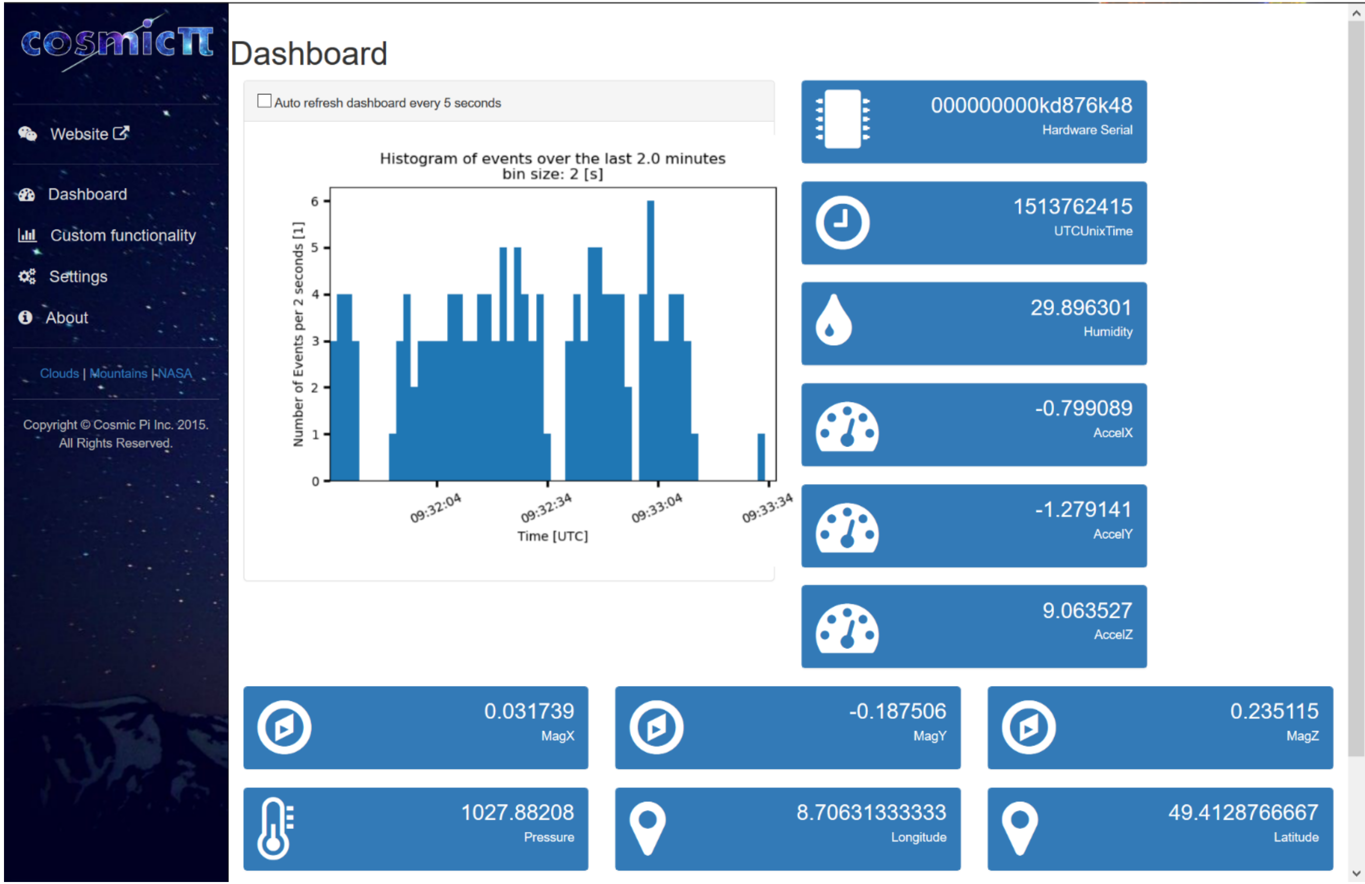
High level software: Architecture after boot



User interface screenshots

Dashboard

- Basic information
- Visible when connecting
- Can update itself automatically



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Dashboard

□ Auto refresh dashboard every 5 seconds

000000000kd876k48
Hardware Serial

1513762415
UTCUnixTime

29.896301
Humidity

-0.799089
AccelX

-1.279141
AccelY

9.063527
AccelZ

0.031739
MagX

-0.187506
MagY

0.235115
MagZ

1027.88208
Pressure

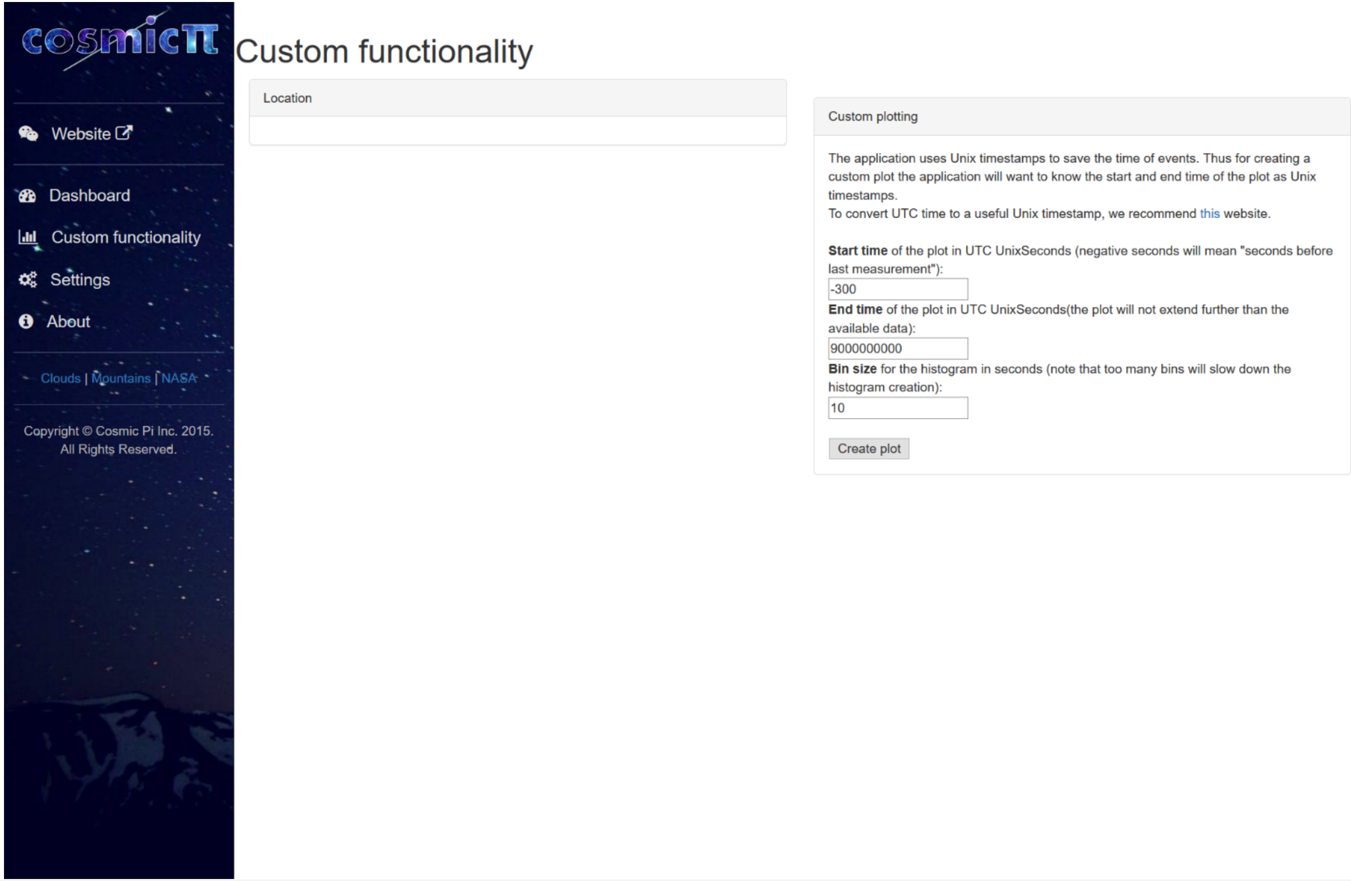
8.70631333333
Longitude

49.4128766667
Latitude

User interface screenshots

Custom functionality

- Create histograms similar to that on the dashboard
- Configurable:
  - Start time
  - End time
  - Number of bins



Custom functionality

Location

Custom plotting

The application uses Unix timestamps to save the time of events. Thus for creating a custom plot the application will want to know the start and end time of the plot as Unix timestamps.
To convert UTC time to a useful Unix timestamp, we recommend this website.

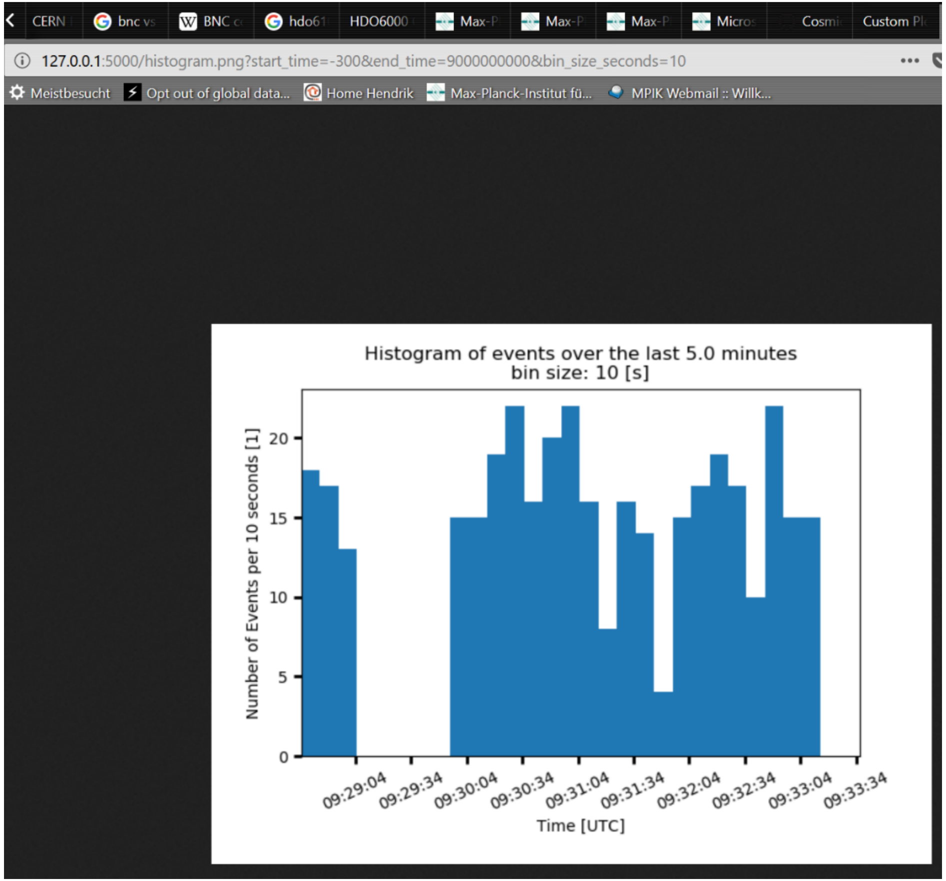
Start time of the plot in UTC UnixSeconds (negative seconds will mean "seconds before last measurement"):
-300

End time of the plot in UTC UnixSeconds(the plot will not extend further than the available data):
9000000000

Bin size for the histogram in seconds (note that too many bins will slow down the histogram creation):
10

User interface screenshots

- Example of a custom histogram (bigger binning, longer timeframe)
- Notice how the URL contains parameters for the plot
    - The dashboard creates it’s plot in the same way

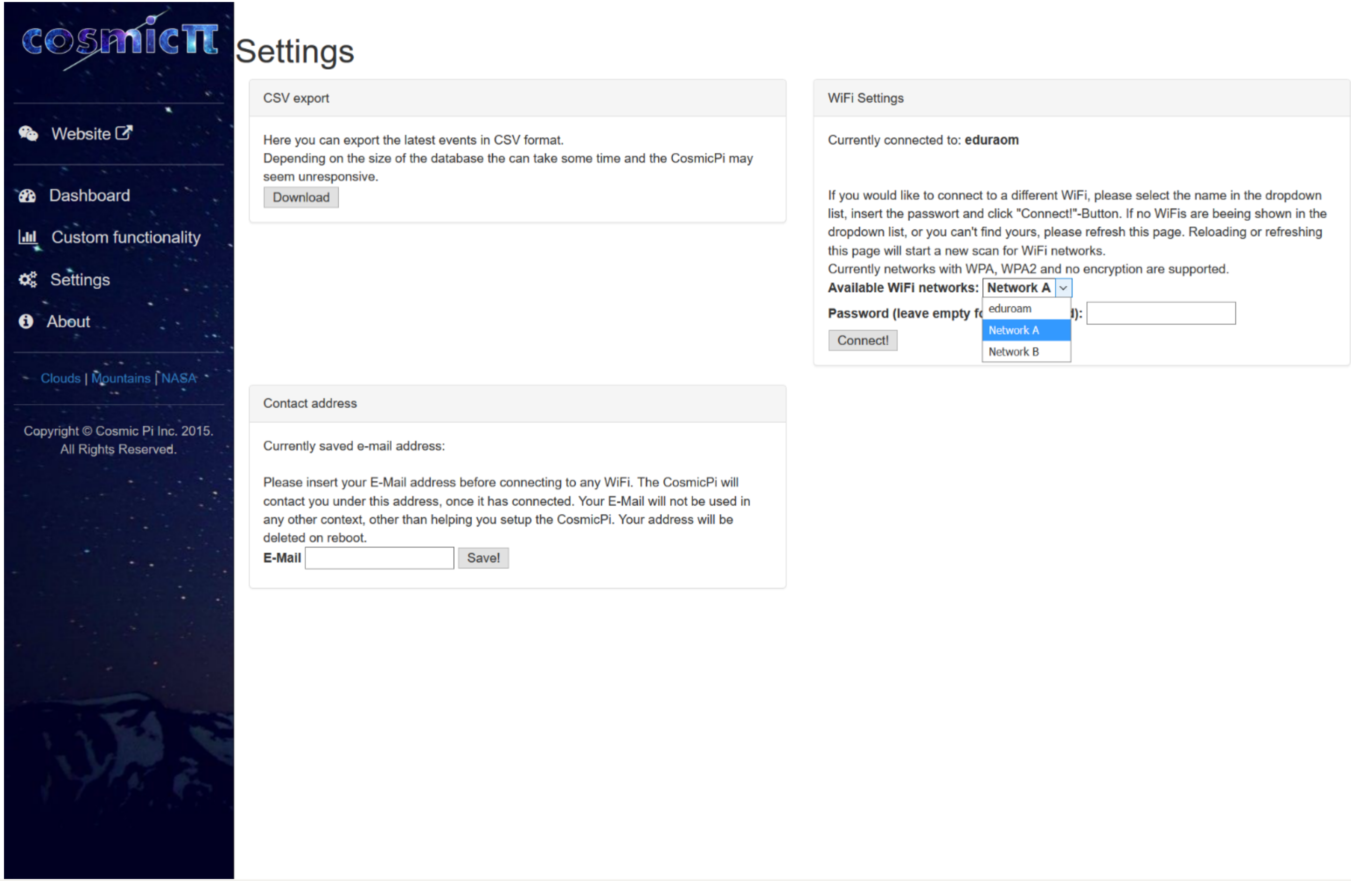


127.0.0.1:5000/histogram.png?start_time=-300&end_time=9000000000&bin_size_seconds=10

User interface screenshots

Settings page

- Behind user/password authentication
- Export of local data
- Change the currently connected WiFi network
- Set an email address for notifications



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Settings

CSV export

Here you can export the latest events in CSV format.
Depending on the size of the database the can take some time and the CosmicPi may seem unresponsive.

WiFi Settings

Currently connected to: **eduraom**

If you would like to connect to a different WiFi, please select the name in the dropdown list, insert the password and click "Connect!"-Button. If no WiFis are beeing shown in the dropdown list, or you can't find yours, please refresh this page. Reloading or refreshing this page will start a new scan for WiFi networks.
Currently networks with WPA, WPA2 and no encryption are supported.

Available WiFi networks: Network A

Password (leave empty fo **l):**

Contact address

Currently saved e-mail address:

Please insert your E-Mail address before connecting to any WiFi. The CosmicPi will contact you under this address, once it has connected. Your E-Mail will not be used in any other context, other than helping you setup the CosmicPi. Your address will be deleted on reboot.

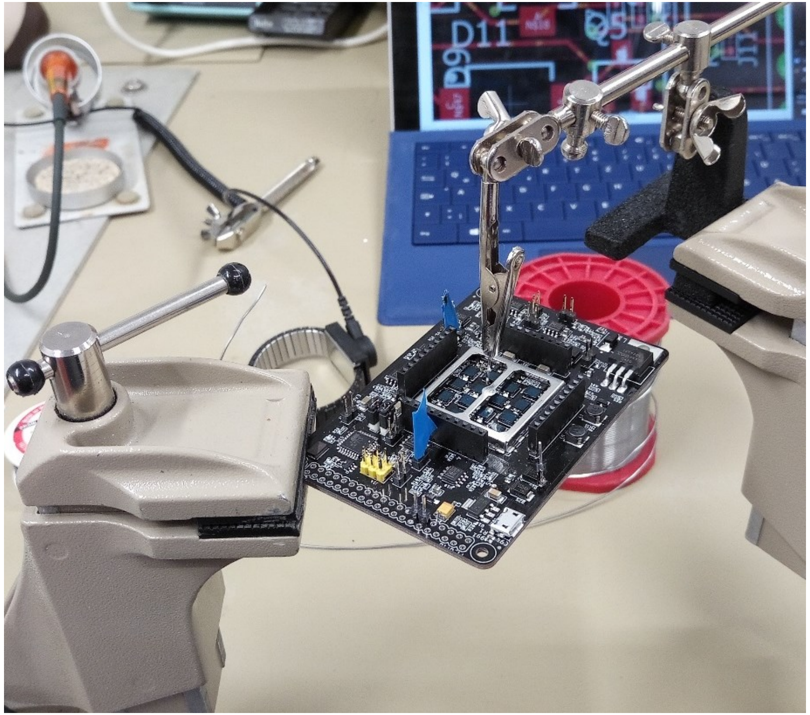
E-Mail

High level software: Underlying technologies

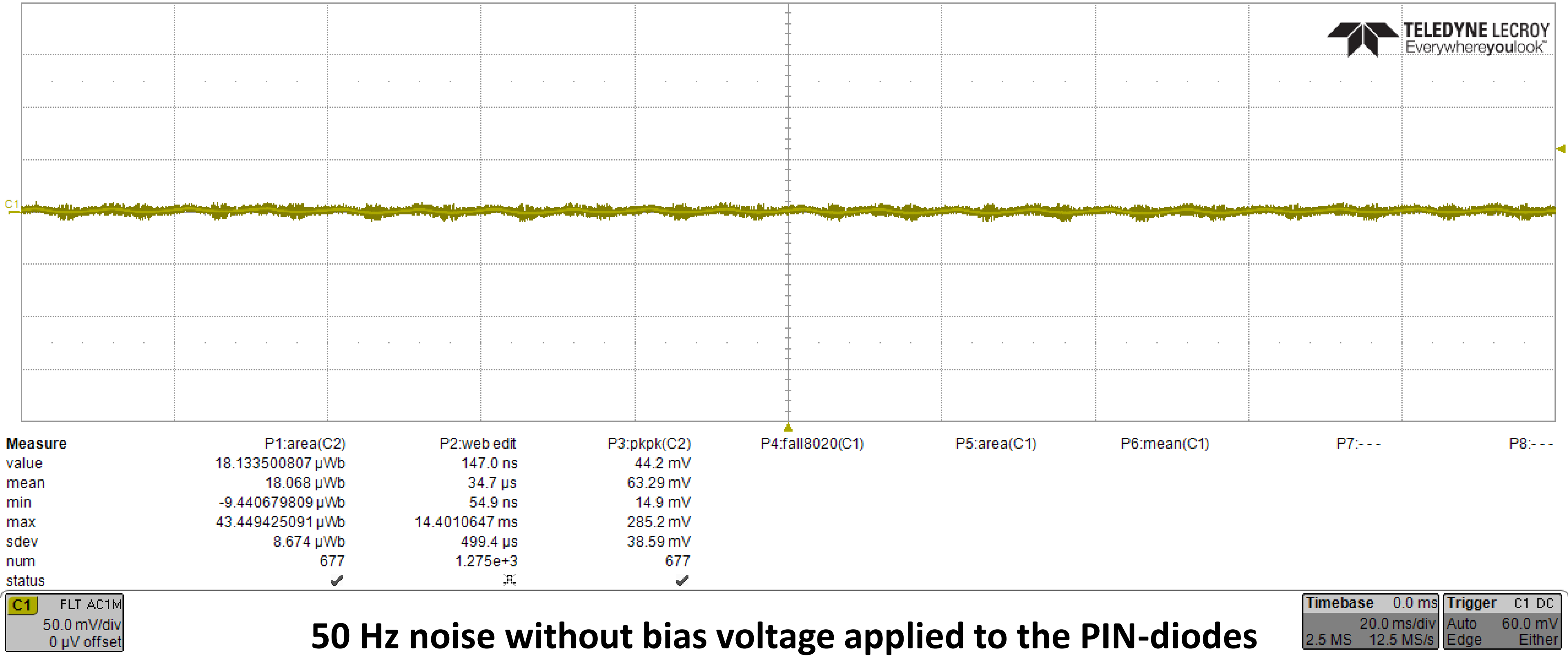
- OS: Raspbian Stretch Lite
- Backend
  - Python
  - Mosquitto (MQTT-Client)
  - SQLite
- Frontend:
  - JavaScript for UI look and feel
  - Python with Flask for UI content serving
  - SQLite
- Contributors
  - JavaScript for the frontend: Darku Lukić
  - Backend and Flask for the frontend: Hendrik Borras
  - Testing on V1.5 units and bug fixes: James Devine

Measurements of signal characteristics of the uTelescope

- Pins for the attachment of probes were soldered onto the board
    - Directly at the PIN-diode output
    - After the first amplifier (JFET)
- Prohibits the use of the upper noise shield
    - As long as the pin is attached
    - Strong 50 Hz noise became visible
    - Shielding-box was built



Reduction of electrical noise



Measure	P1:area(C2)	P2:web edit	P3:pkpk(C2)	P4:fall8020(C1)	P5:area(C1)	P6:mean(C1)	P7:- - -	P8:- - -
value	18.133500807 µWb	147.0 ns	44.2 mV					
mean	18.068 µWb	34.7 µs	63.29 mV					
min	-9.440679809 µWb	54.9 ns	14.9 mV					
max	43.449425091 µWb	14.4010647 ms	285.2 mV					
sdev	8.674 µWb	499.4 µs	38.59 mV					
num	677	1.275e+3	677					
status	✓	⎍	✓					

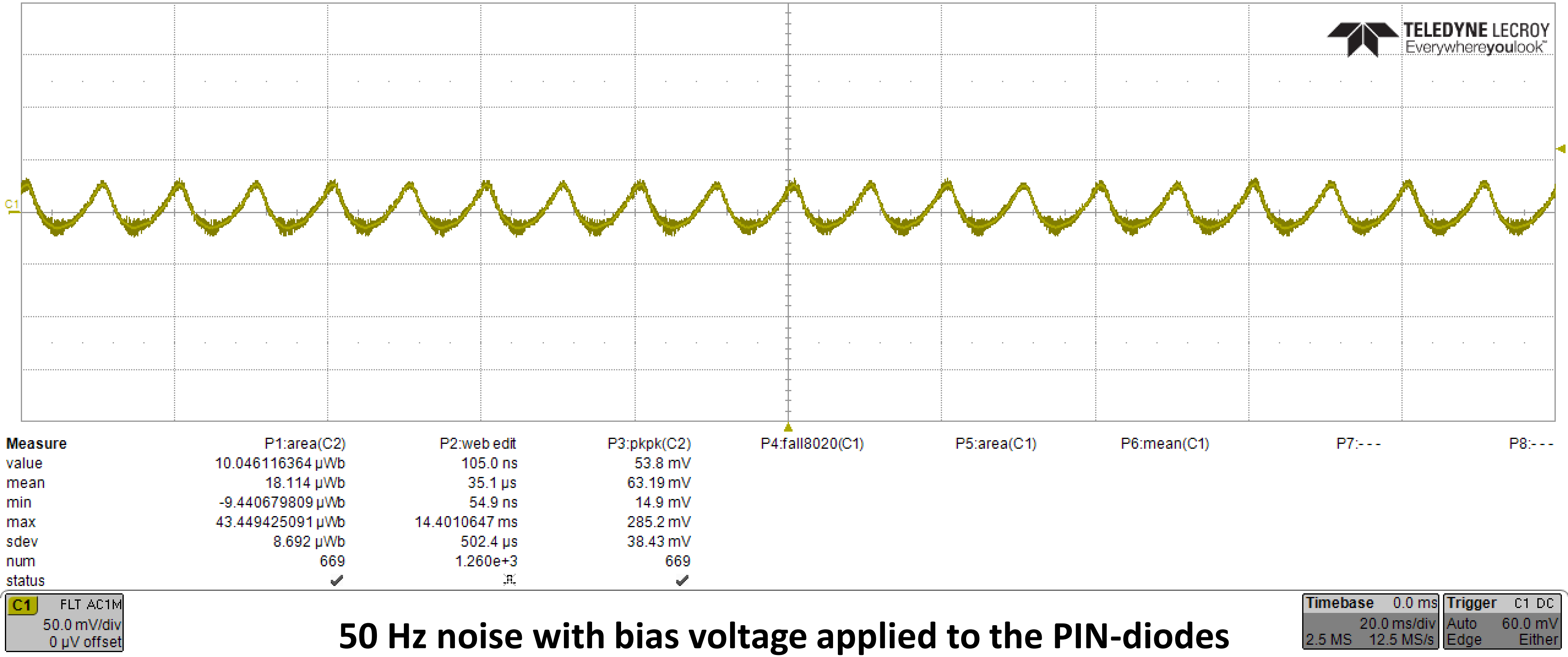
C1 FLT AC1M
50.0 mV/div
0 µV offset

Timebase 0.0 ms
20.0 ms/div
2.5 MS 12.5 MS/s

Trigger C1 DC
Auto 60.0 mV
Edge Either

50 Hz noise without bias voltage applied to the PIN-diodes

Reduction of electrical noise



Measure	P1:area(C2)	P2:web edit	P3:pkpk(C2)	P4:fall8020(C1)	P5:area(C1)	P6:mean(C1)	P7:- - -	P8:- - -
value	10.046116364 µWb	105.0 ns	53.8 mV					
mean	18.114 µWb	35.1 µs	63.19 mV					
min	-9.440679809 µWb	54.9 ns	14.9 mV					
max	43.449425091 µWb	14.4010647 ms	285.2 mV					
sdev	8.692 µWb	502.4 µs	38.43 mV					
num	669	1.260e+3	669					
status	✓	⎍	✓					

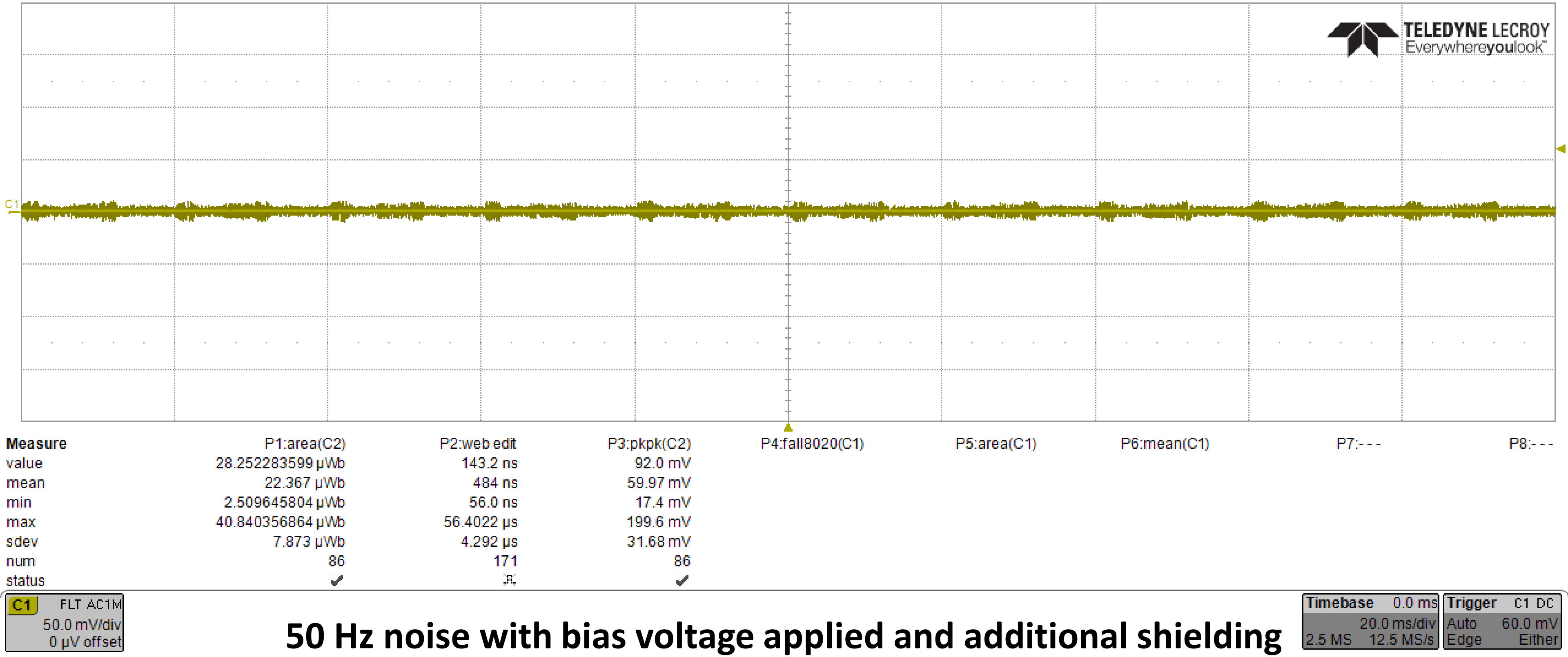
C1 FLT AC1M
50.0 mV/div
0 µV offset

Timebase 0.0 ms
20.0 ms/div
2.5 MS 12.5 MS/s

Trigger C1 DC
Auto 60.0 mV
Edge Either

50 Hz noise with bias voltage applied to the PIN-diodes

Reduction of electrical noise



Measure	P1:area(C2)	P2:web edit	P3:pkpk(C2)	P4:fall8020(C1)	P5:area(C1)	P6:mean(C1)	P7:- - -	P8:- - -
value	28.252283599 µWb	143.2 ns	92.0 mV					
mean	22.367 µWb	484 ns	59.97 mV					
min	2.509645804 µWb	56.0 ns	17.4 mV					
max	40.840356864 µWb	56.4022 µs	199.6 mV					
sdev	7.873 µWb	4.292 µs	31.68 mV					
num	86	171	86					
status	✓	⊓	✓					

C1 FLT AC1M
50.0 mV/div
0 µV offset

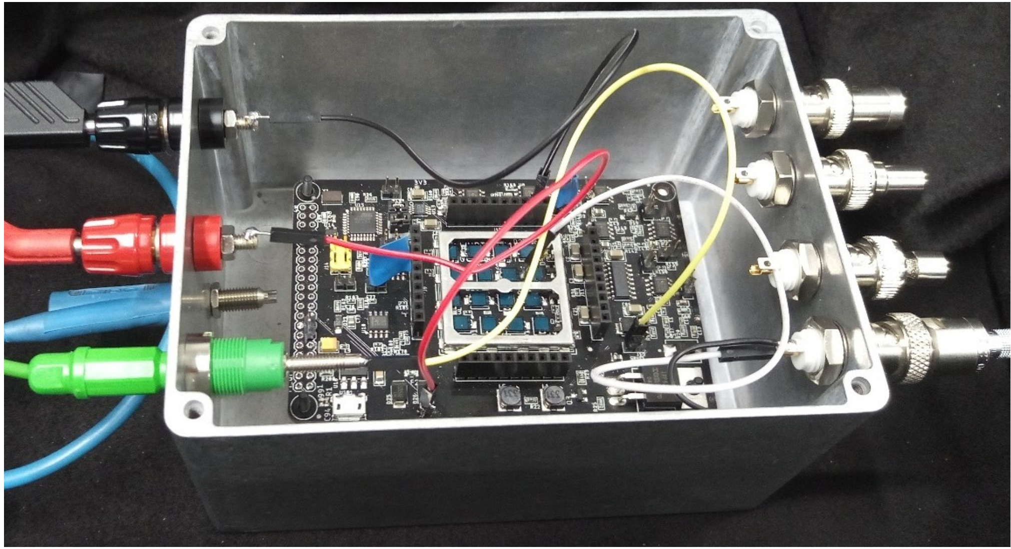
Timebase 0.0 ms
20.0 ms/div
2.5 MS 12.5 MS/s

Trigger C1 DC
Auto 60.0 mV
Edge Either

50 Hz noise with bias voltage applied and additional shielding

Reduction of electrical noise

- Standard shielding box from the electronics group
- Custom drilled holes by our workshop
- Features:
  - 3 Banana connectors for power supply
  - 4 BNC connectors for signals
- Significantly less 50Hz noise
- Still notable noise from the PSUs
  - High frequency
  - Burst like



Next steps

- Ordering of the radiation source from Ralf Lackner
- Investigation of how the high frequency noise can be reduced
- So far coincidence measurements with the CosMo detector yielded no results
  - Further testing seems to be required