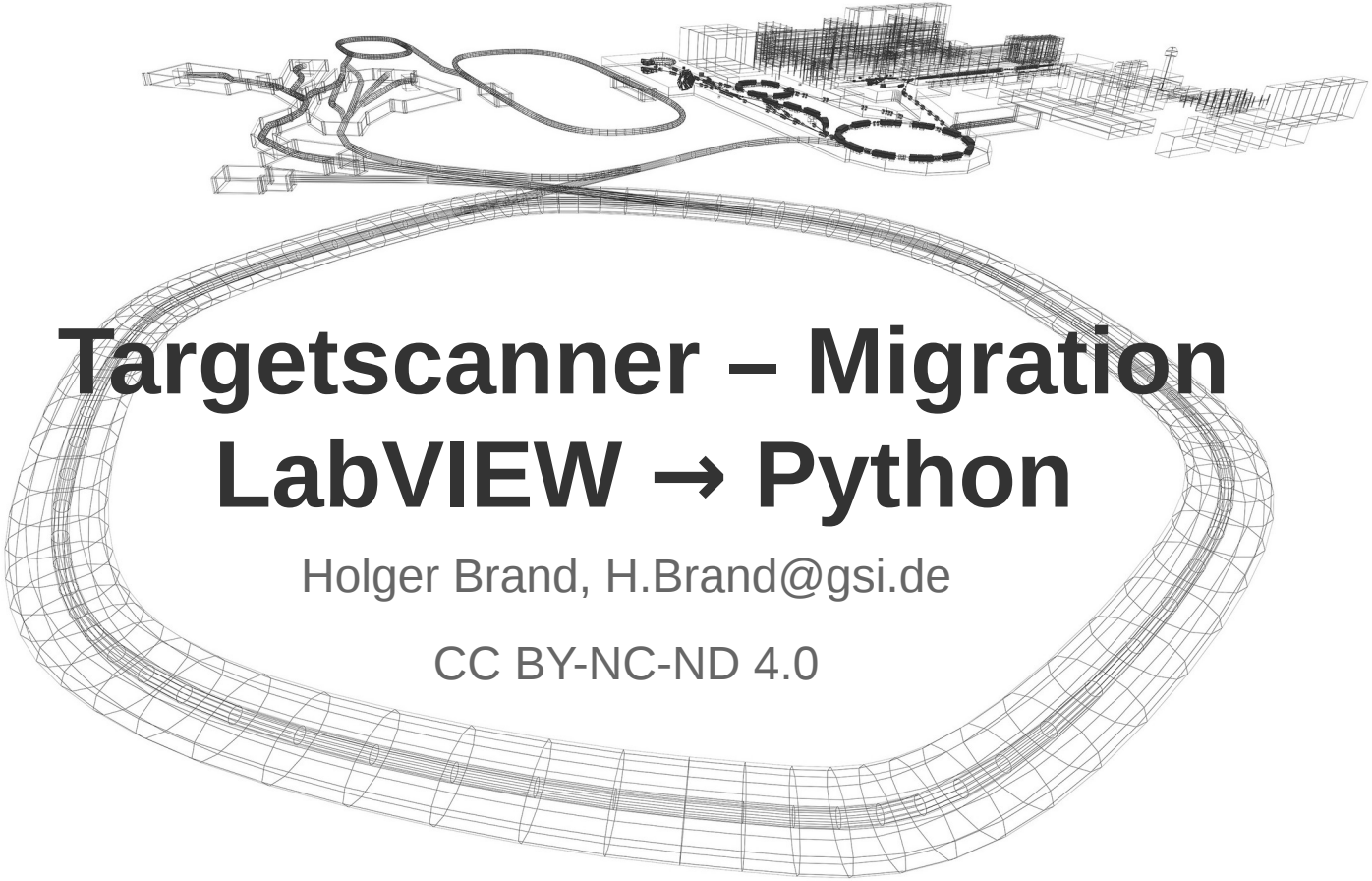


Targetscanner – Migration LabVIEW → Python

Holger Brand, H.Brand@gsi.de

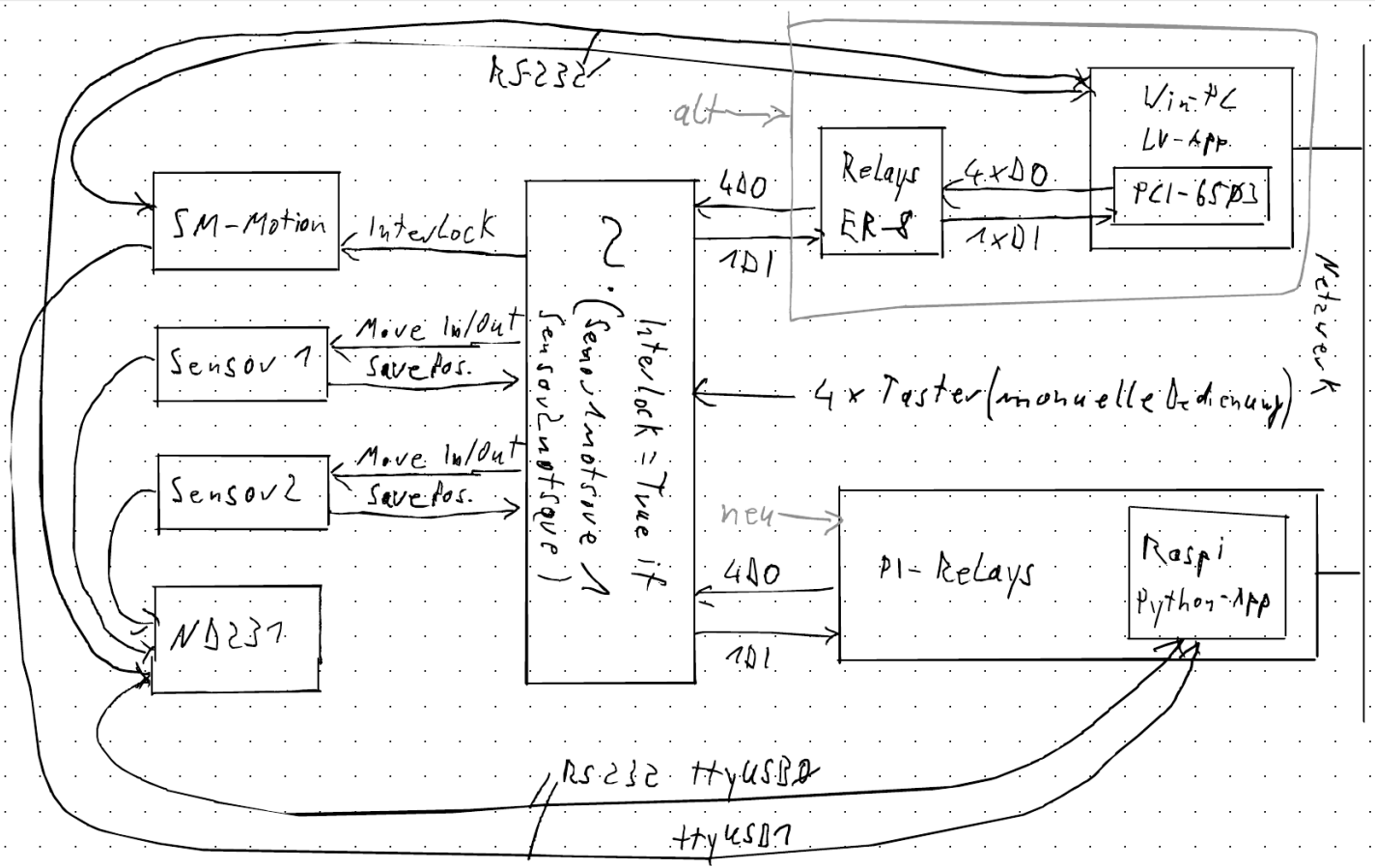
LabVIEW based

- Targetscanner Project
  - Start: 1999 with LabVIEW 5.0
  - Publication: 2001 LabVIEW 6i
    - „Automated Thickness Measurement of Targets and Degraders“
      Virtuelle Instrumente in der Praxis -
      Begleitband zum Kongress VIP 2001
      Rahman Jamal /Hans Jaschinski (Hrdg.)
      Heidelberg Hüthig, 2001
      Praxiswissen Elektronik-Industrie: Meßtechnik
      ISBN 3-7785-2829-7
  - Last update: 2021 with LabVIEW 2021 SP1
  - Repository: https://git.gsi.de/EE-LV/EE-HB/TargetScanner
    - Tag: Release-1-1-4
- Migration to LabVIEW NXG 5.1
  - Depricated before migration was finished.

Review LabVIEW Project

- Show separate VIP 2001 talk.

Targetscanner Sketch



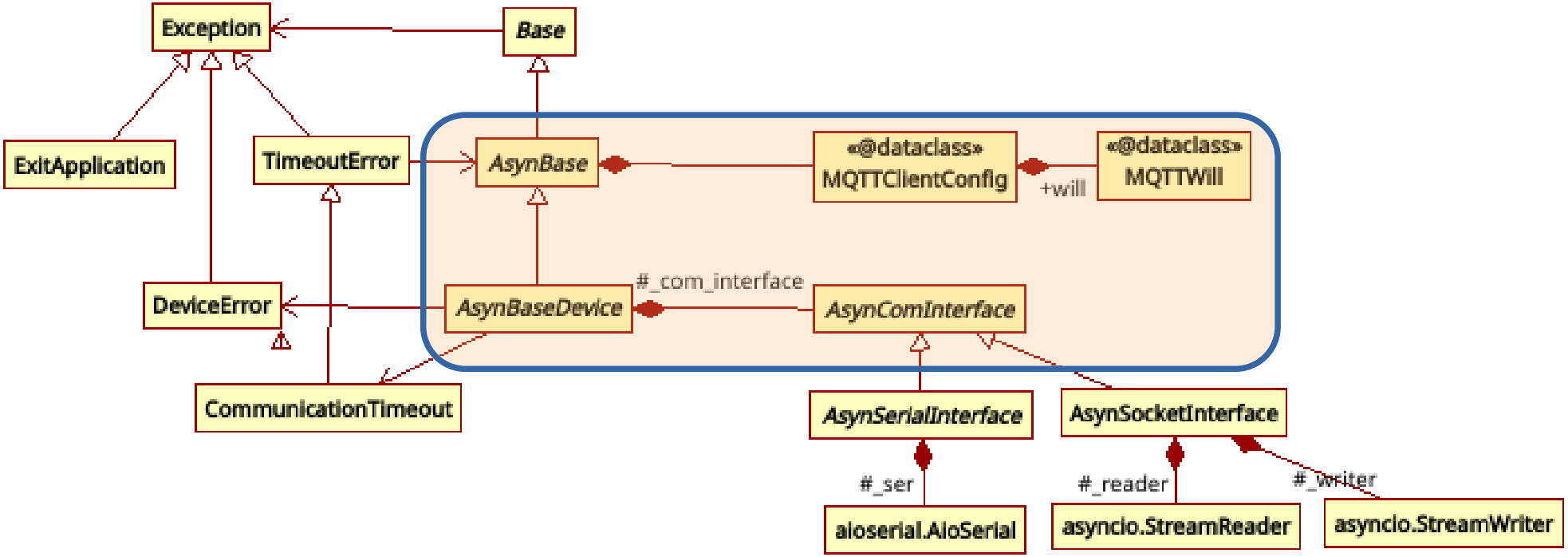
PyAcdaq: Python based Automation Control and Data Acquisition (inspired by CS/CS++)

- **Actor based**, https://git.gsi.de/EKS/Python/ACDAQ/PyAcdaq/-/tree/master/src/pyacdaq/actor?ref_type=heads
  - Actor based approach demontrated with ESR/SIS-18 Bakeout System
    https://git.gsi.de/EKS/Python/ACDAQ/VacuumHeatingSystem
- **Asyncio based***, https://git.gsi.de/EKS/Python/ACDAQ/PyAcdaq/-/tree/develop/src/pyacdaq/asyn?ref_type=heads
  - Based on asyncio avoiding problems with multi-threading or multi-processing
    - One process – one thread - one single memory space
    - Simple synchronization methods available
      - Barriers, Conditions, Events, Locks, Queues, Semaphores
  - Separation and loose coupling of Operation-, Control- and Device-Layer by MQTT
  - Scaling by distribution → Processes / Computer Nodes
- **Extensible** with other Open Source Tools → Database, InfluxDB, Grafana as necessary
- More features could be added, if adopted in community.

* With experience during migration of some Artemis LabVIEW programs: https://git.gsi.de/EKS/Python/Experiments/Artemis

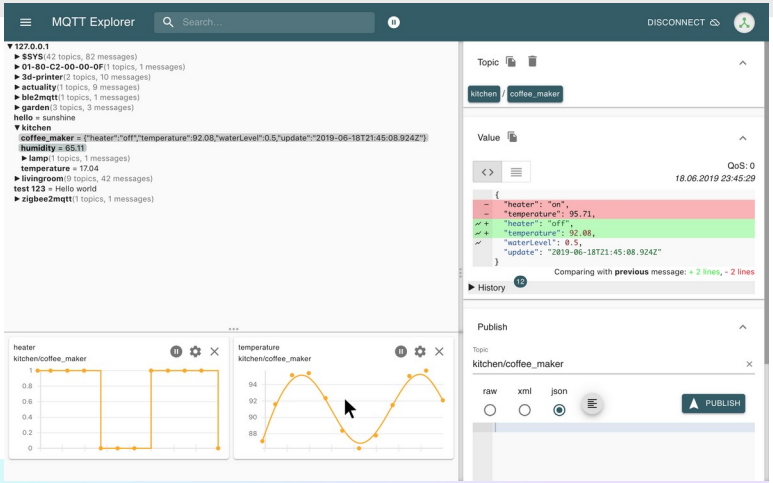
PyAcdaq Asyn

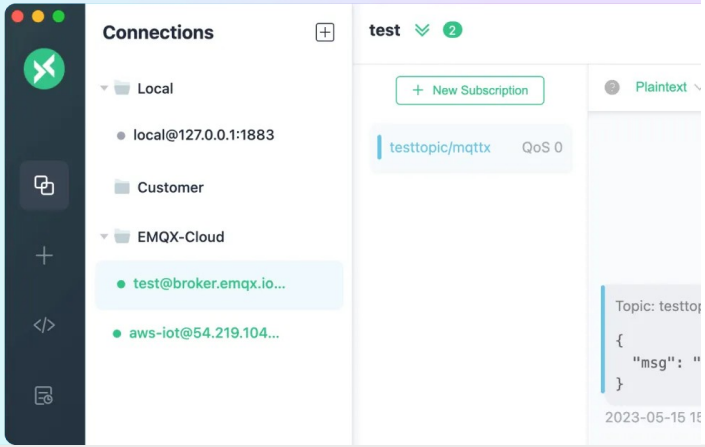
- Simplified UML Class Diagram
  https://apps.kde.org/de/umbrello/



Python Packages / Tools

- Asyncio built into Python
  https://docs.python.org/3.12/library/asyncio.html
- Aioserial: Serial communication
  https://pypi.org/project/aioserial/
- MQTT v5 Network Protocol (publisher/subscriber)
  https://mosquitto.org/
  - aiomqtt: https://pypi.org/project/aiomqtt/ based on:
  - paho-mqtt: https://pypi.org/project/paho-mqtt/
  - Generic GUIs
    - MQTT-Explorer: https://mqtt-explorer.com/
    - MQTTX: https://mqttx.app/
- Pint: https://pypi.org/project/Pint/
  - Physical units
  - https://pint.readthedocs.io/en/stable/
- Tkinter GUI Widgets
  https://docs.python.org/3.12/library/tkinter.html





Asyncio – Asynchronous I/O

https://docs.python.org/3.12/library/asyncio.html

- asyncio is a library to write concurrent code using the async/await syntax.
- asyncio is often a perfect fit for IO-bound and high-level structured network code.
  - asyncio is used as a foundation for multiple Python asynchronous frameworks that provide high-performance network and web-servers, database connection libraries, distributed task queues, etc.
- asyncio provides a set of high-level APIs to:
  - run Python coroutines concurrently and have full control over their execution;
  - perform network IO and IPC;
  - control subprocesses;
  - distribute tasks via queues;
  - synchronize concurrent code;
- Additionally, there are low-level APIs for library and framework developers to:
  - create and manage event loops, which provide asynchronous APIs for networking, running subprocesses, handling OS signals, etc;
  - implement efficient protocols using transports;
  - bridge callback-based libraries and code with async/await syntax.

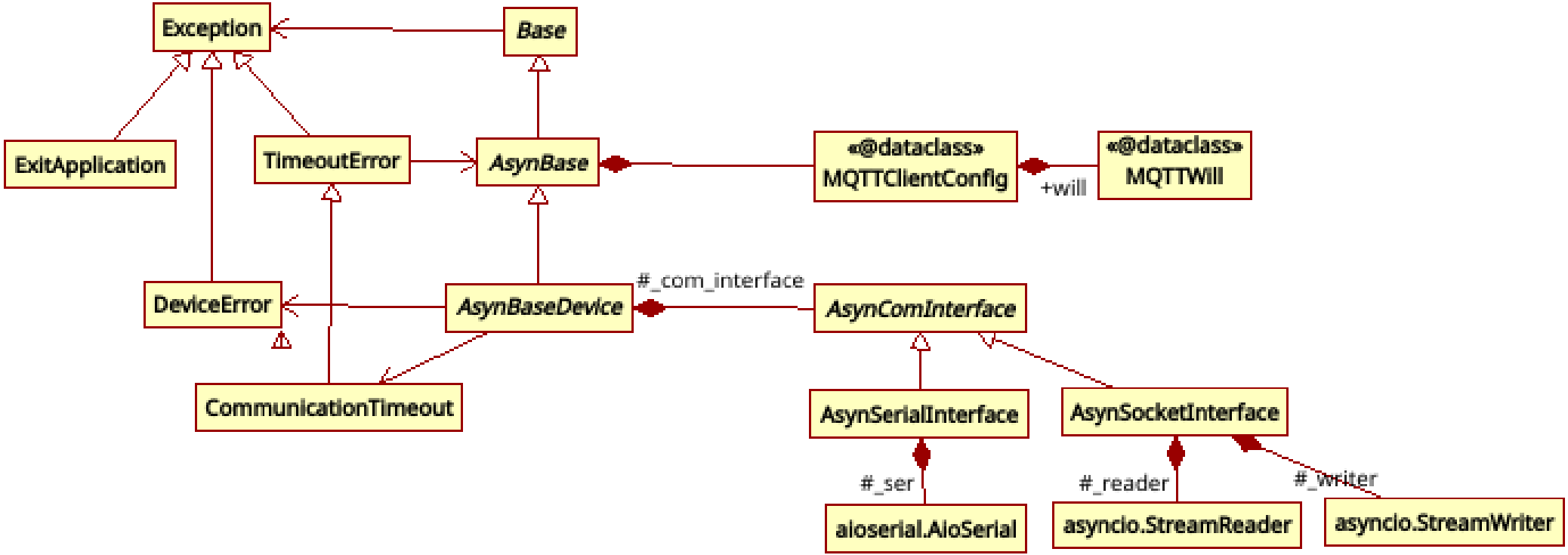
MQTT - Eclipse Mosquitto Broker

- **Eclipse Mosquitto**
  - Is an open source (EPL/EDL licensed) message broker that implements the MQTT protocol versions 5.0, 3.1.1 and 3.1. Mosquitto is lightweight and is suitable for use on all devices from low power single board computers to full servers.
  - The MQTT protocol provides a lightweight method of carrying out messaging using a publish/subscribe model. This makes it suitable for Internet of Things messaging such as with low power sensors or mobile devices such as phones, embedded computers or microcontrollers.
  - The Mosquitto project also provides a C library for implementing MQTT clients, and the very popular mosquitto_pub and mosquitto_sub command line MQTT clients.
  - Mosquitto is part of the Eclipse Foundation, and is an iot.eclipse.org project, with its development driven by Cedalo.
- **paho-mqtt**
  - Eclipse Paho MQTT Python client library, which implements versions 5.0, 3.1.1, and 3.1 of the MQTT protocol.
- **aiomqtt**
  - No more callbacks! 👍
  - No more return codes (welcome to the MqttError)
  - Graceful disconnection (forget about on_unsubscribe, on_disconnect, etc.)
  - Supports MQTT versions 5.0, 3.1.1 and 3.1
  - Fully type-hinted

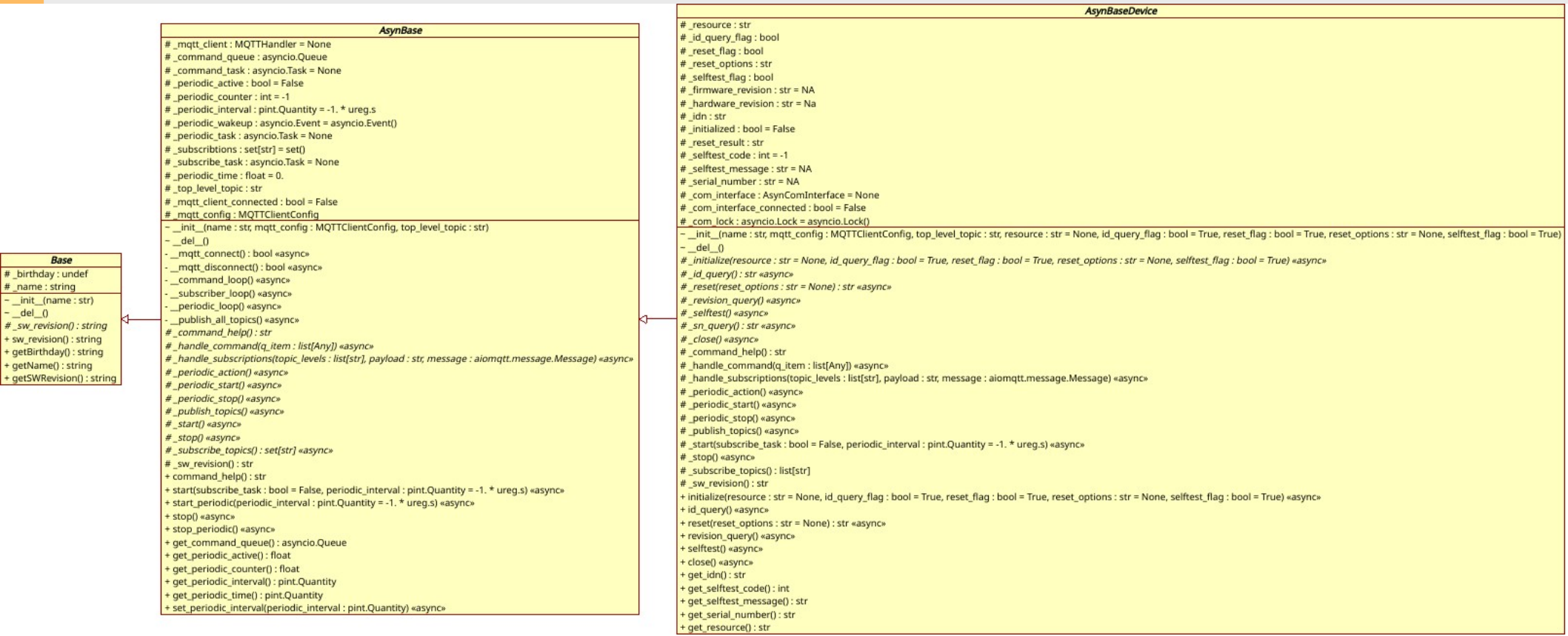
```
async with Client("test.mosquitto.org") as client:
    await client.publish("temperature/outside", payload=28.4)
```

```
async with Client("test.mosquitto.org") as client:
    await client.subscribe("temperature/#")
    async for message in client.messages:
        print(message.payload)
```

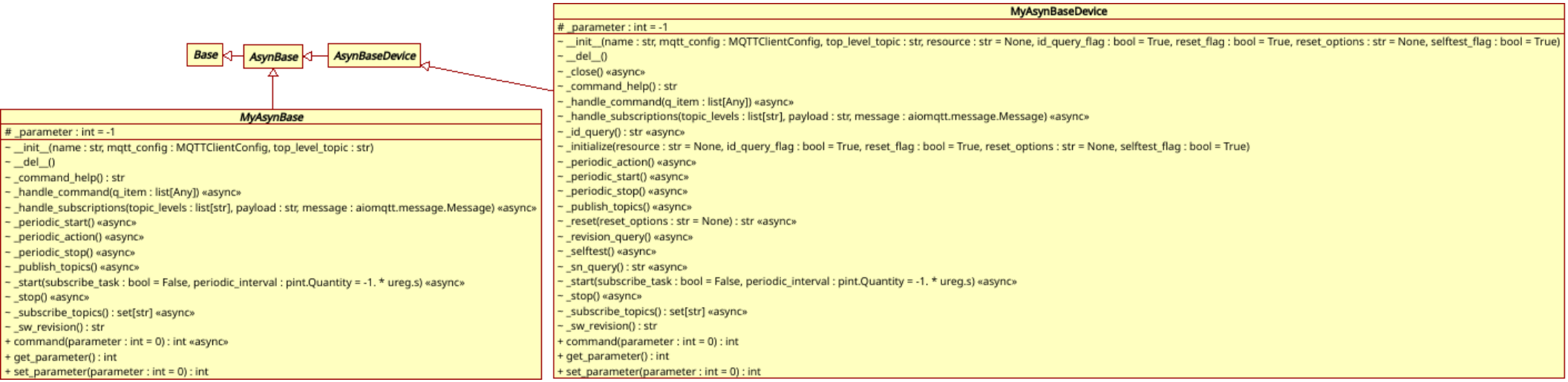
AsynComInterface



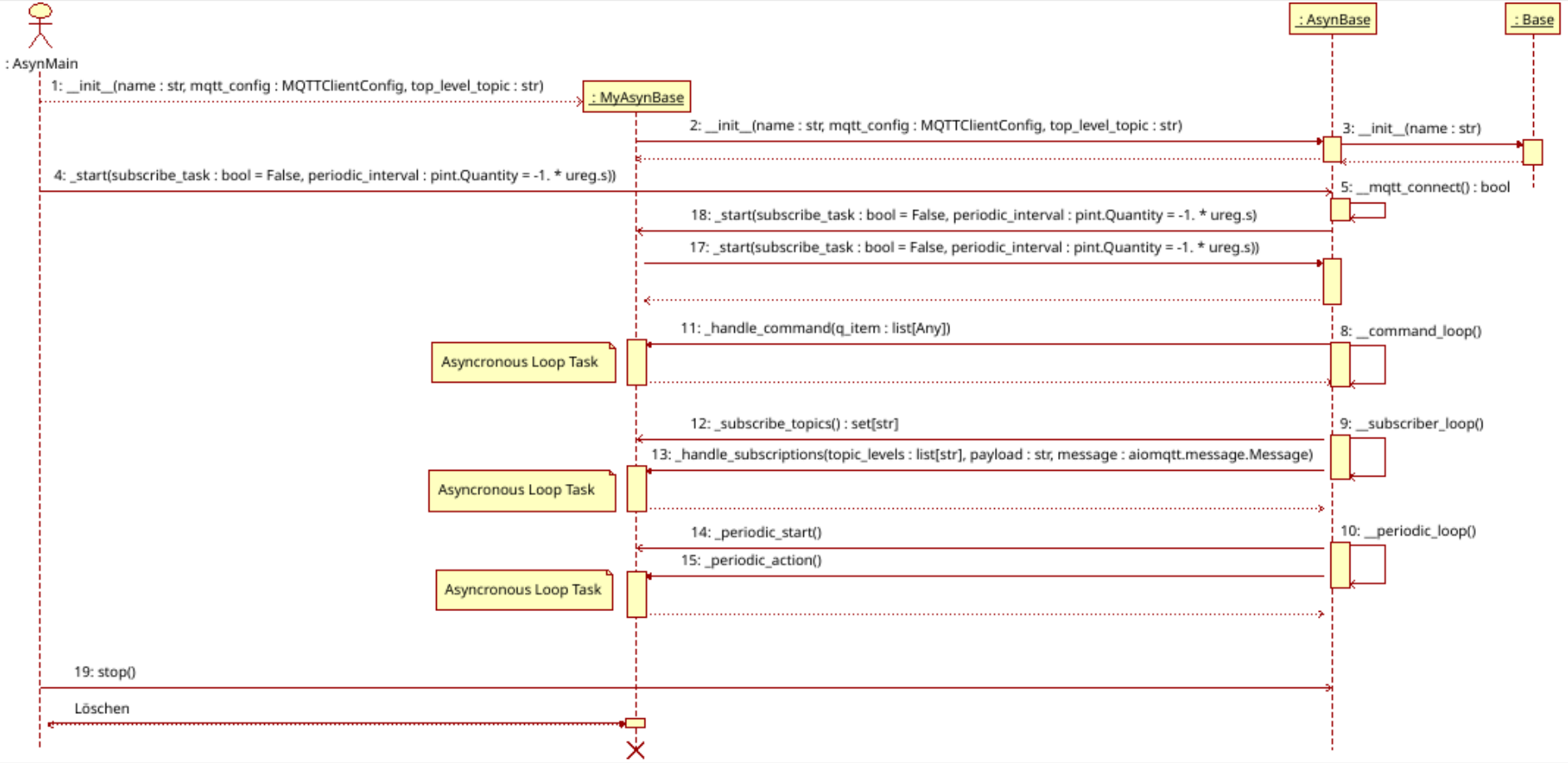
AsynBase & AsynBaseDevice



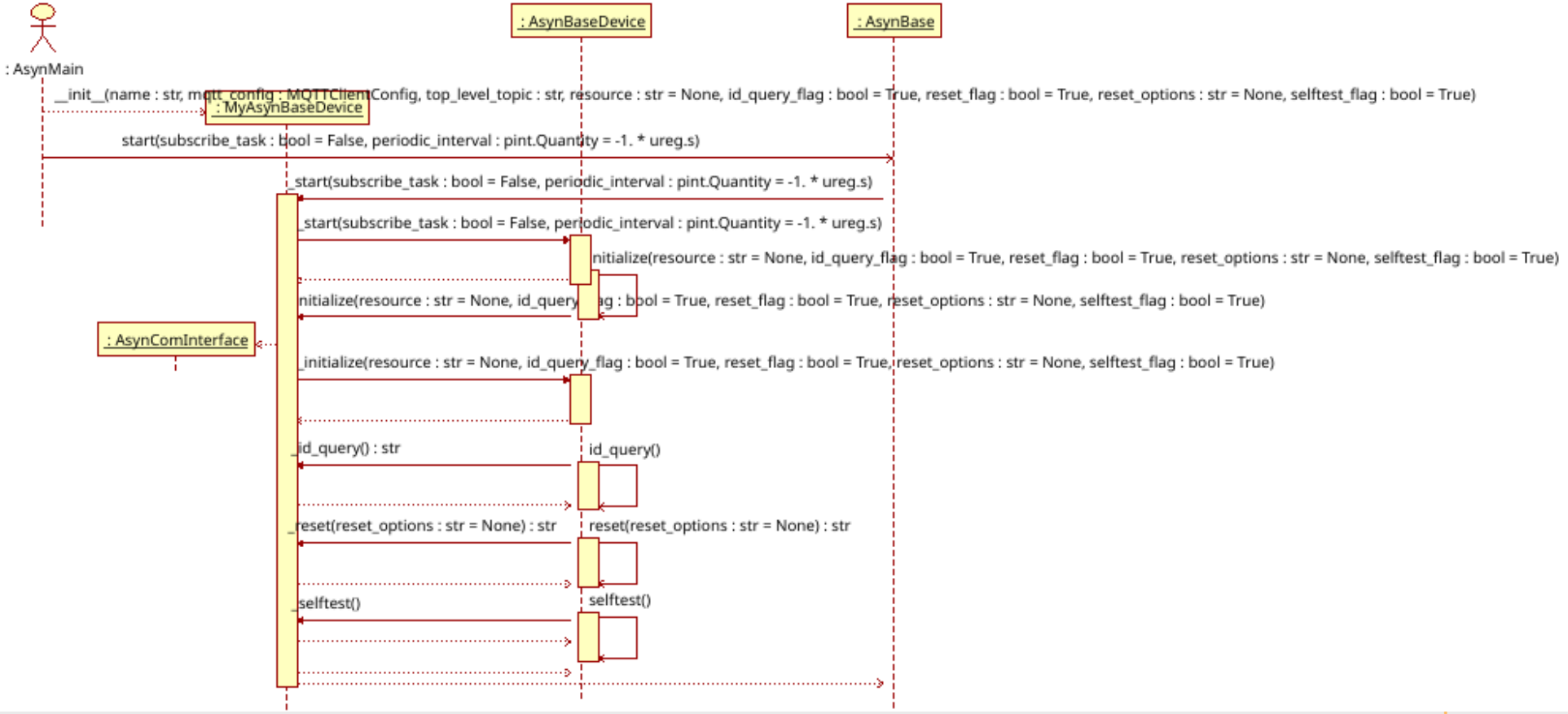
MyAsynBase & MyAsynBaseDevice



AsynBase Start Sequence

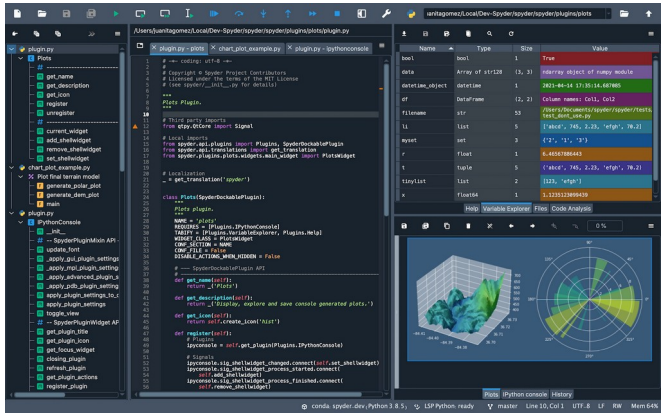


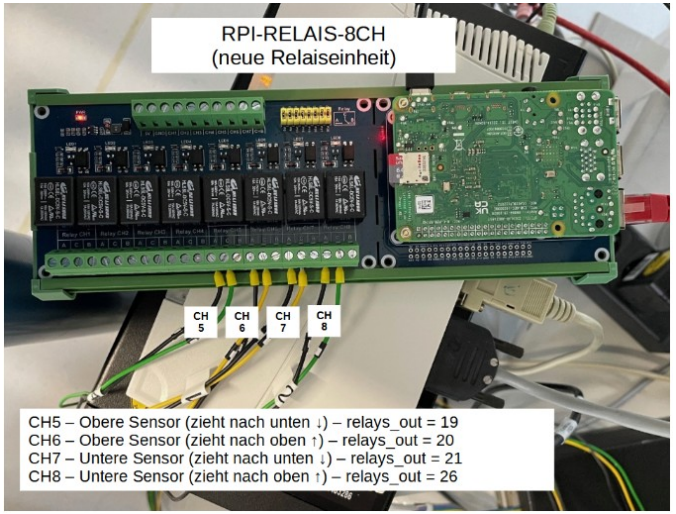
AsynBaseDevice Start Sequence

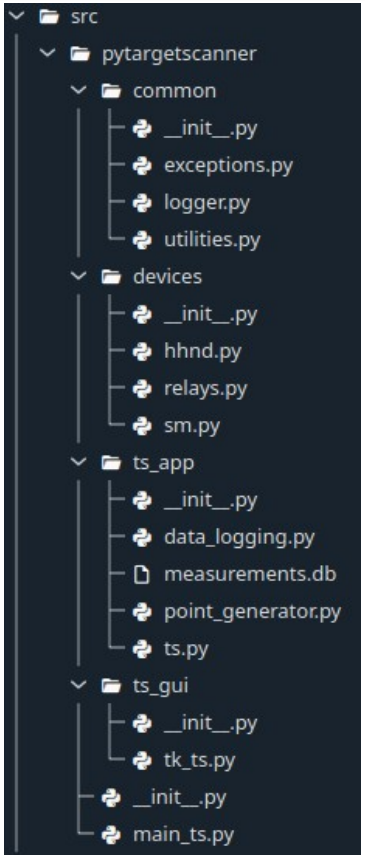


Targetscanner

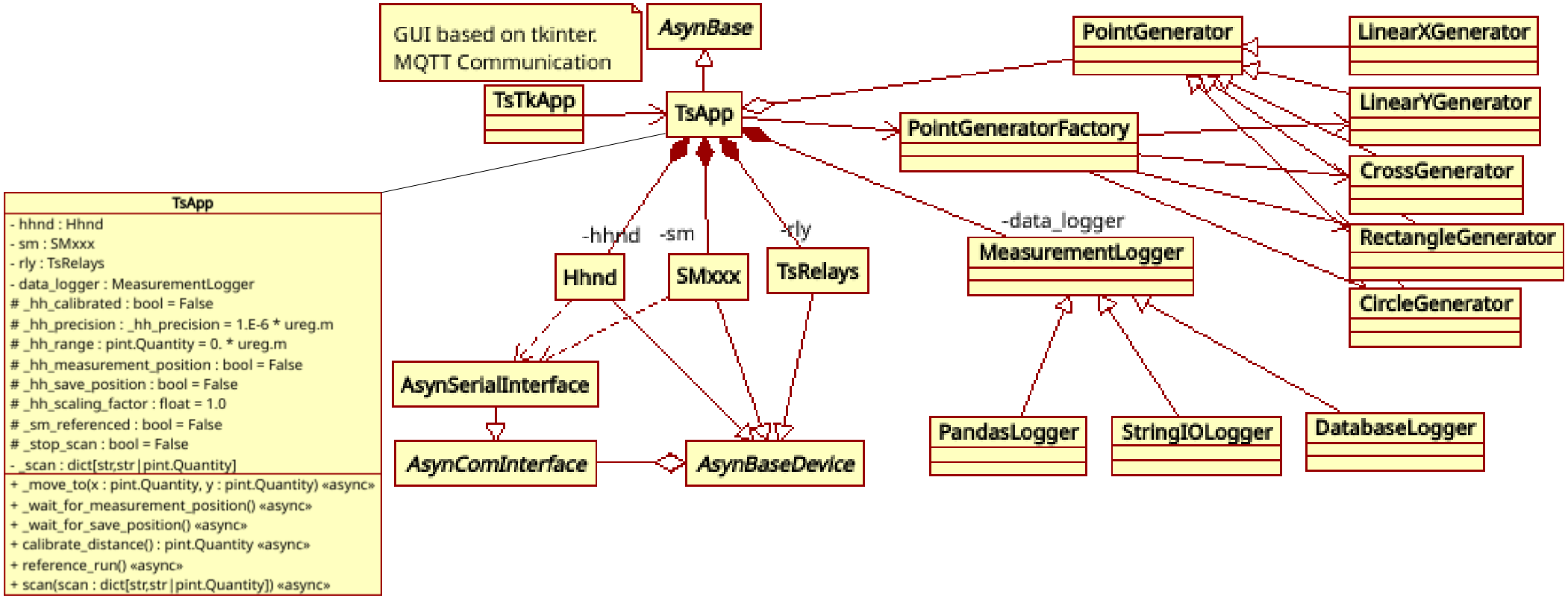
- Git: https://git.gsi.de/EKS/Python/ACDAQ/TargetScanner
- Raspberry Pi - Relais-Modul, 8 Channel, Hutschiene
  https://www.reichelt.de/de/de/shop/produkt/raspberry_pi_-_relais-modul_8_channel_hutschiene_hls8l-dc5v-s-253984?r=1
- USB-RS232 4-Port
- Python 3.12 / Spyder
  - IDE: Spyder https://www.spyder-ide.org/



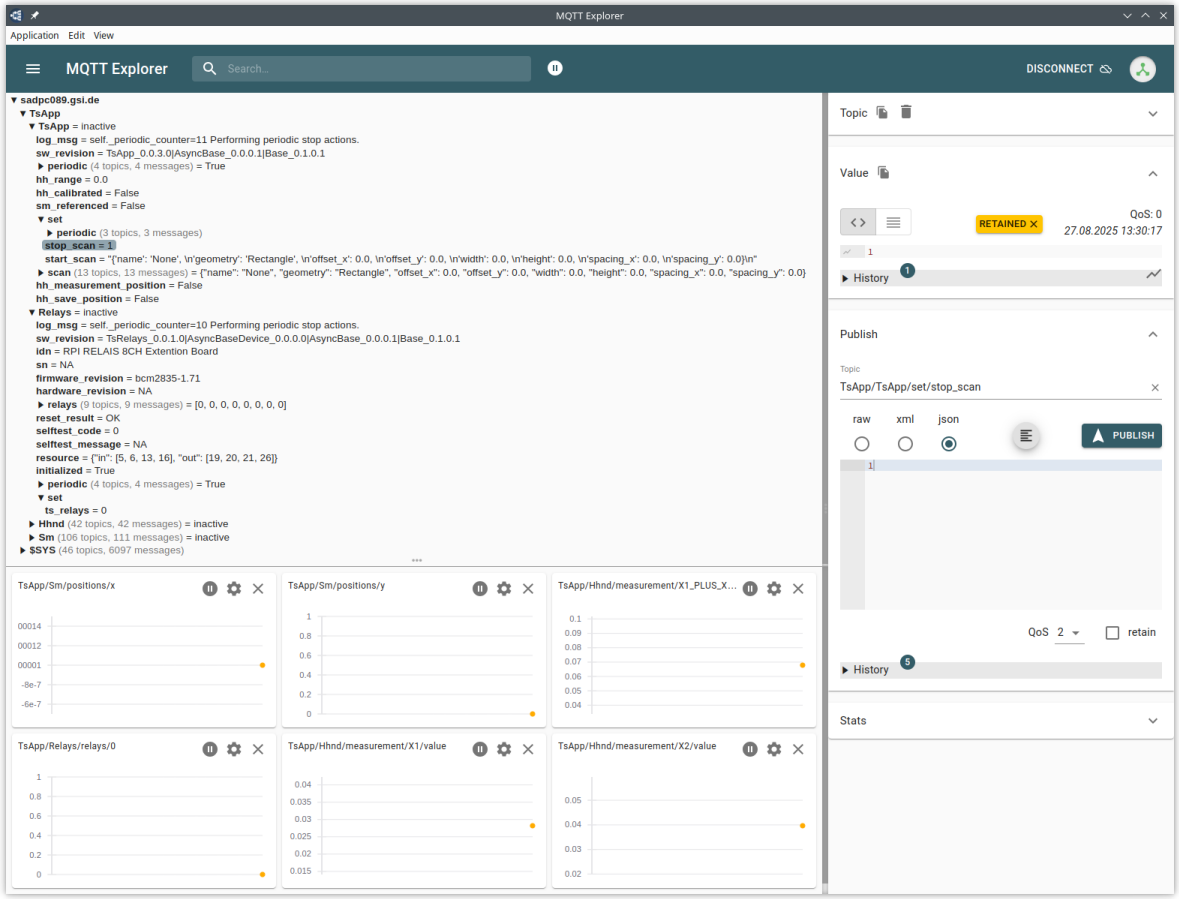




Targetscanner Class Diagram

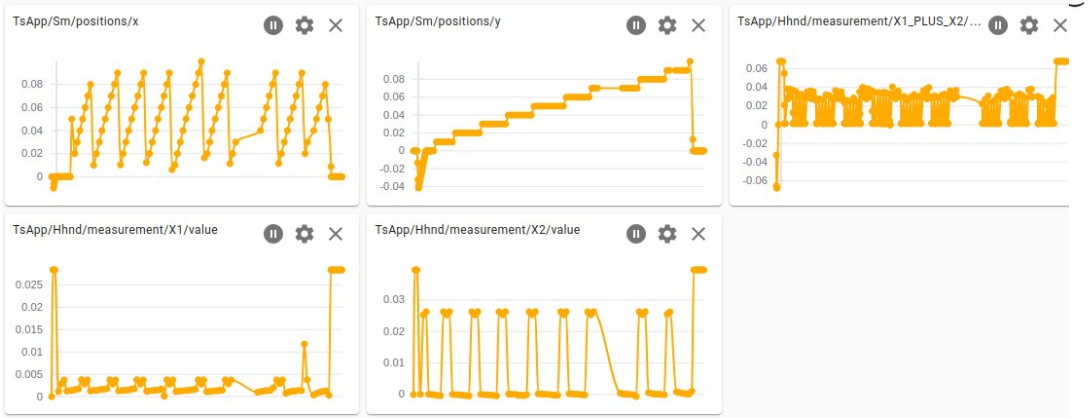


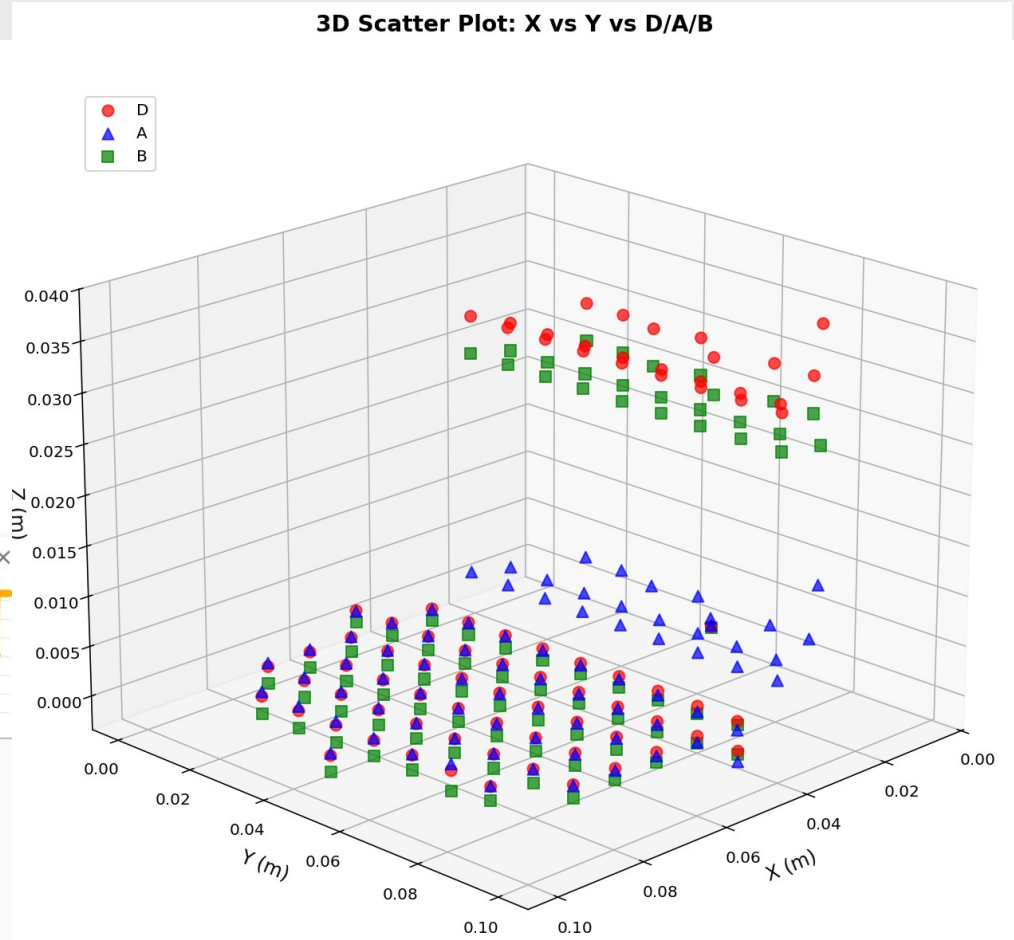
MQTT-Explorer



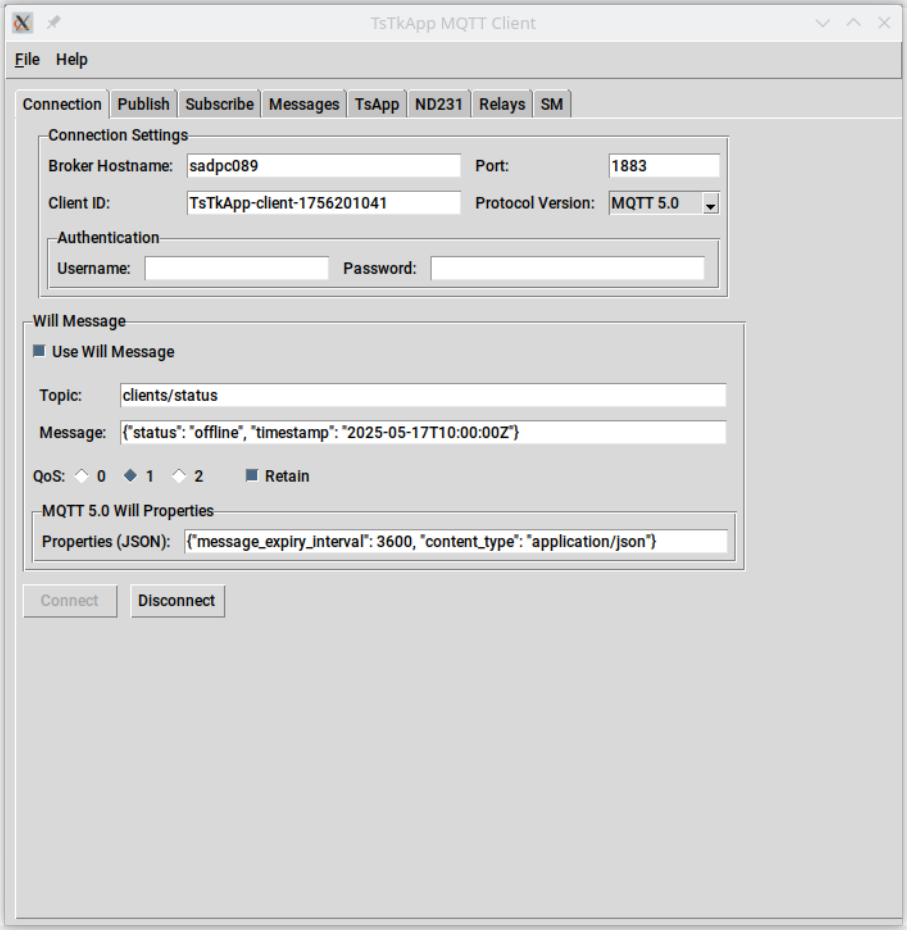
Ein erster Scan via MQTT-Explorer!

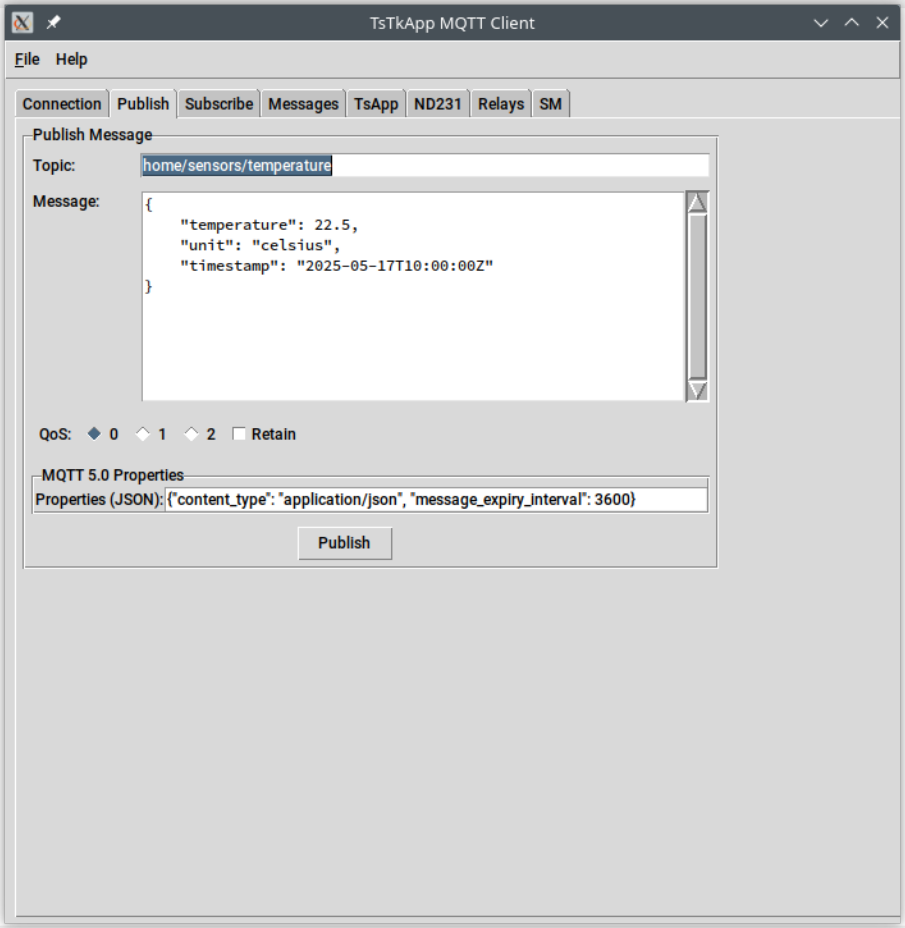

```
{
  "name": "Test",
  "geometry": "Circle",
  "offset_x": 0.0,
  "offset_y": 0.0,
  "width": 0.1,
  "height": 0.1,
  "spacing_x": 0.01,
  "spacing_y": 0.01
}
```

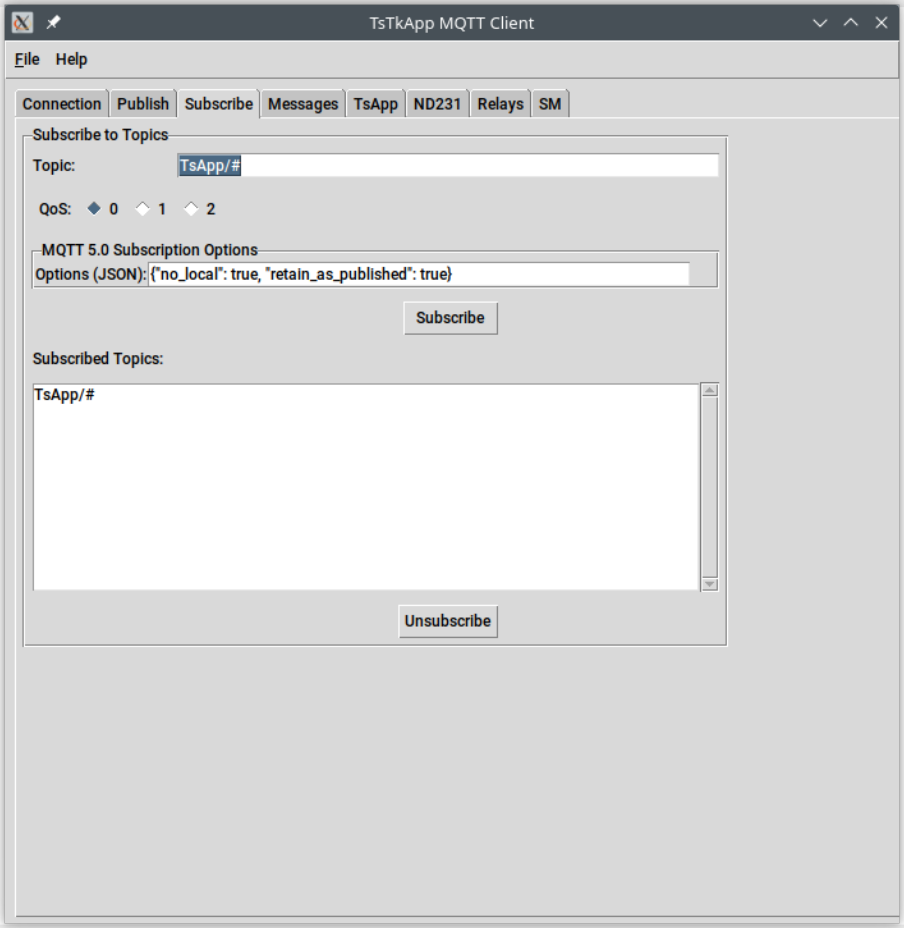


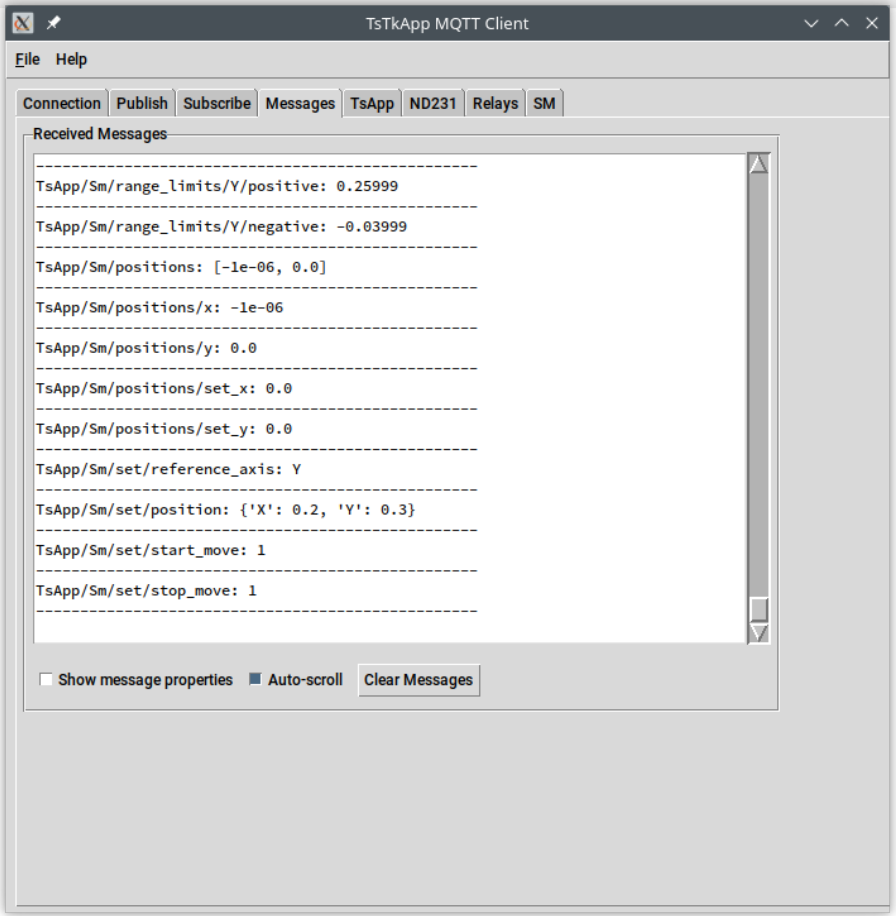
Targetscanner GUI: Connect & Publish



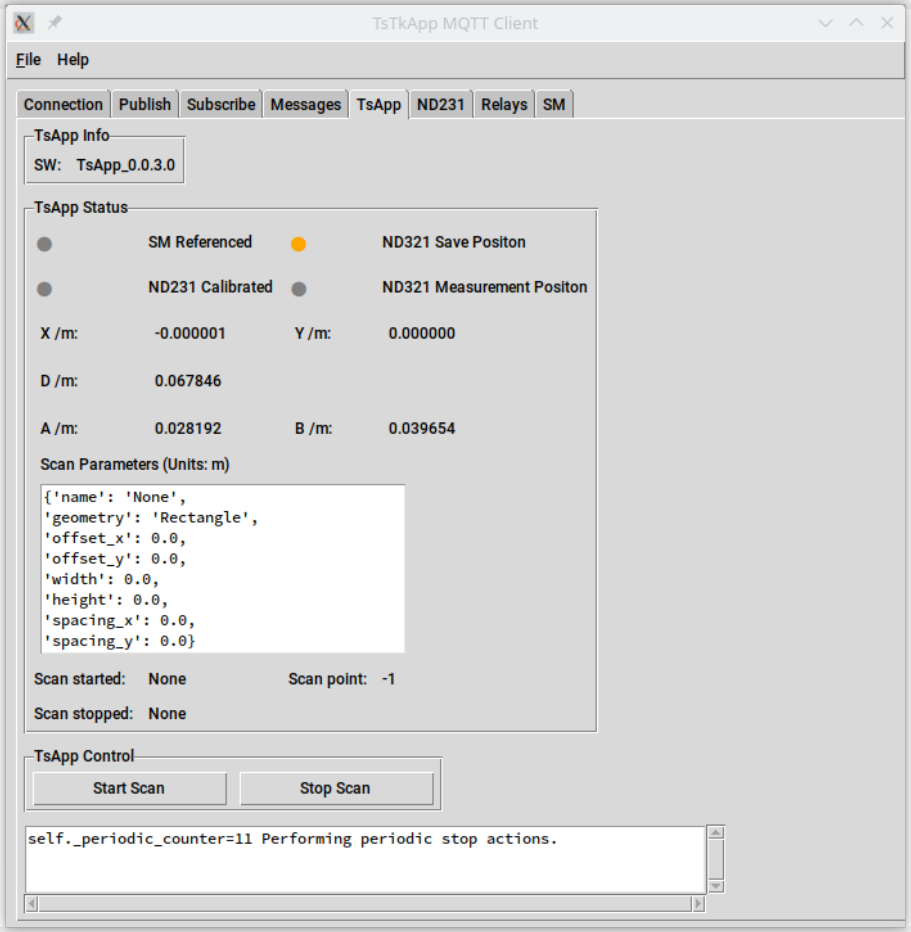


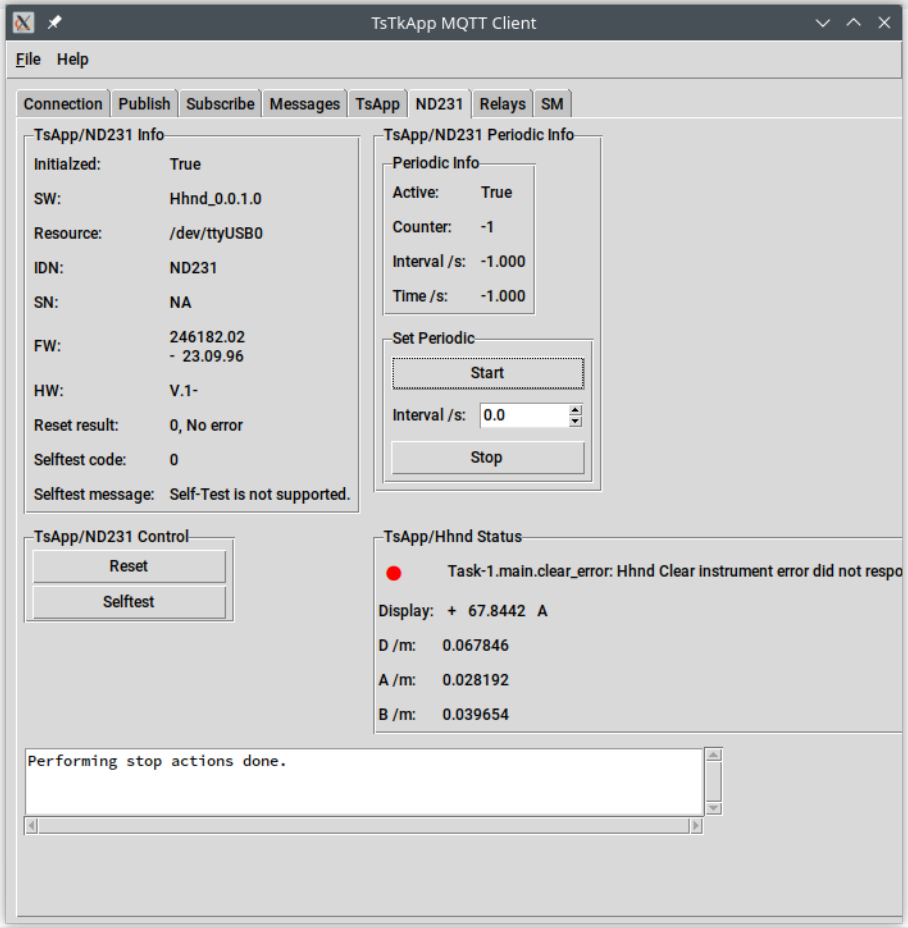
Targetscanner GUI: Subscribe & Monitor



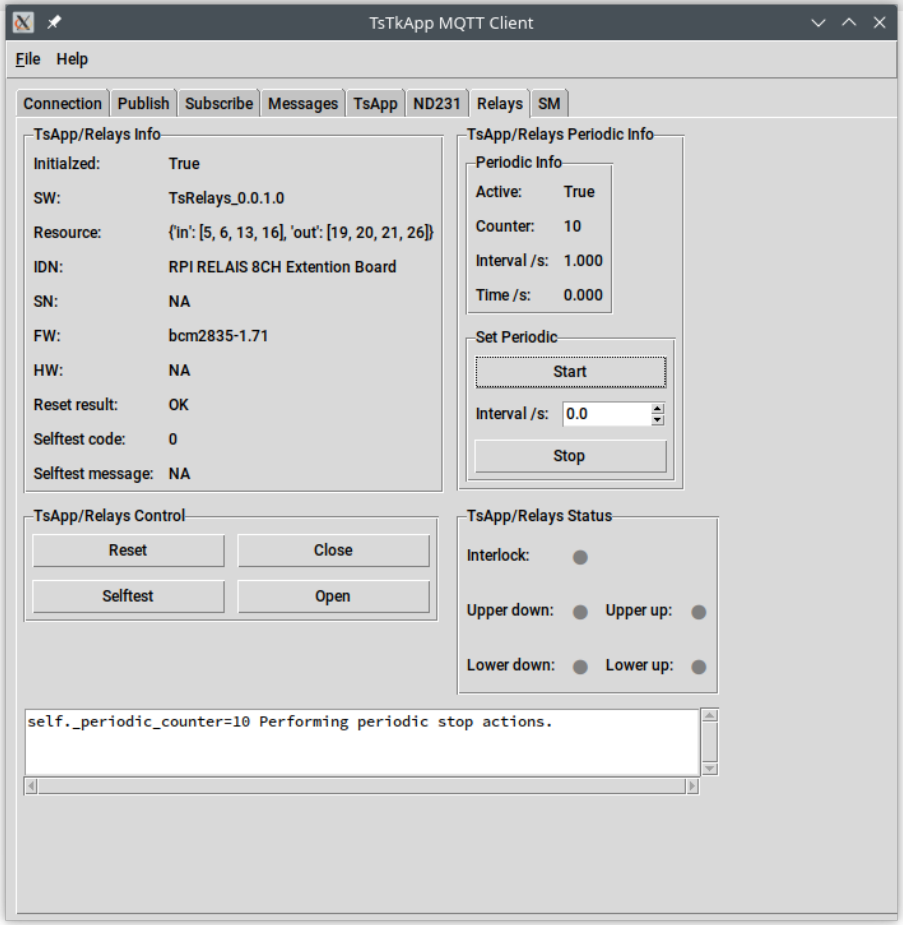


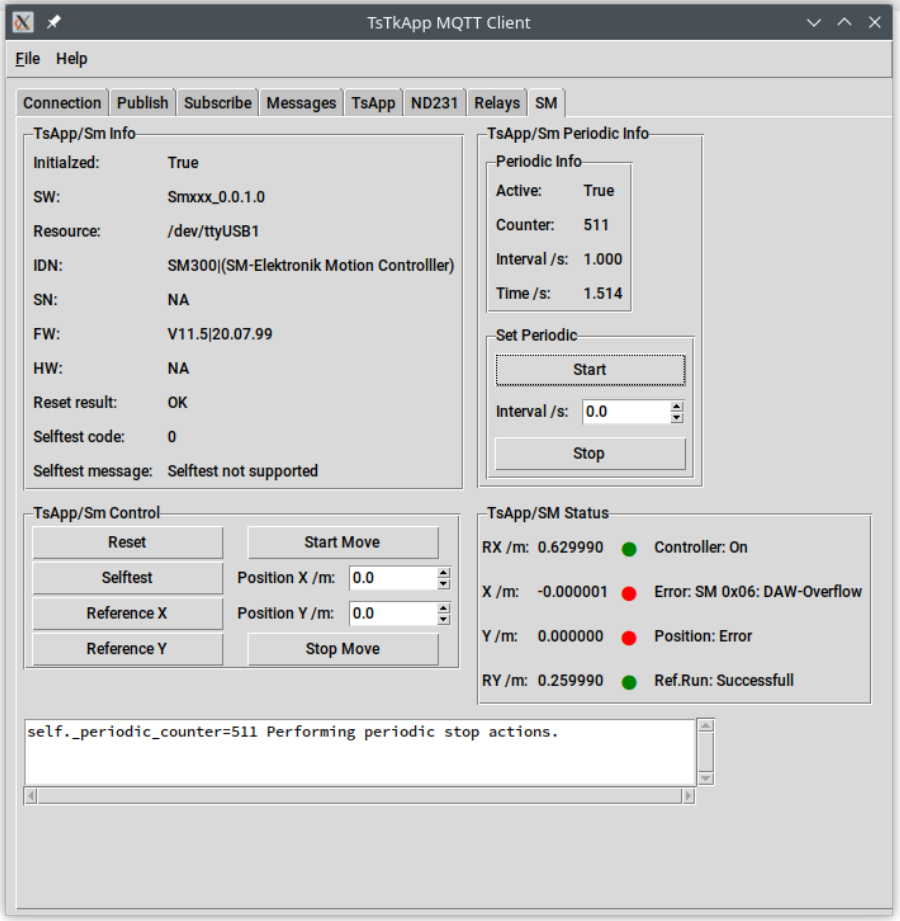
Targetscanner GUI: TsApp & ND231



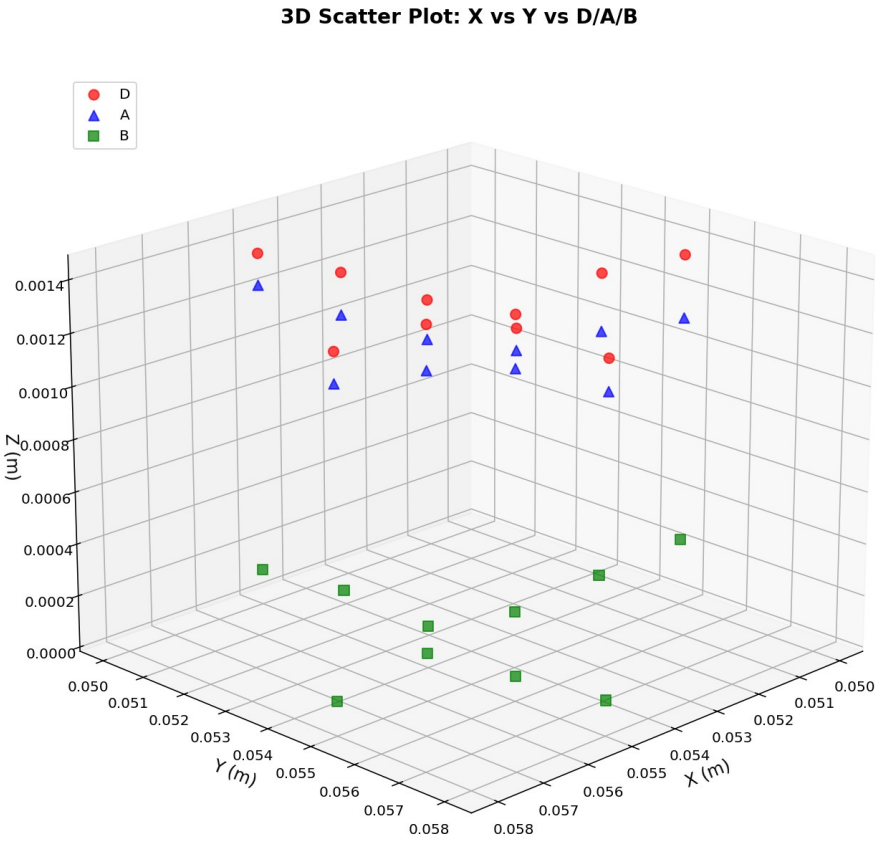


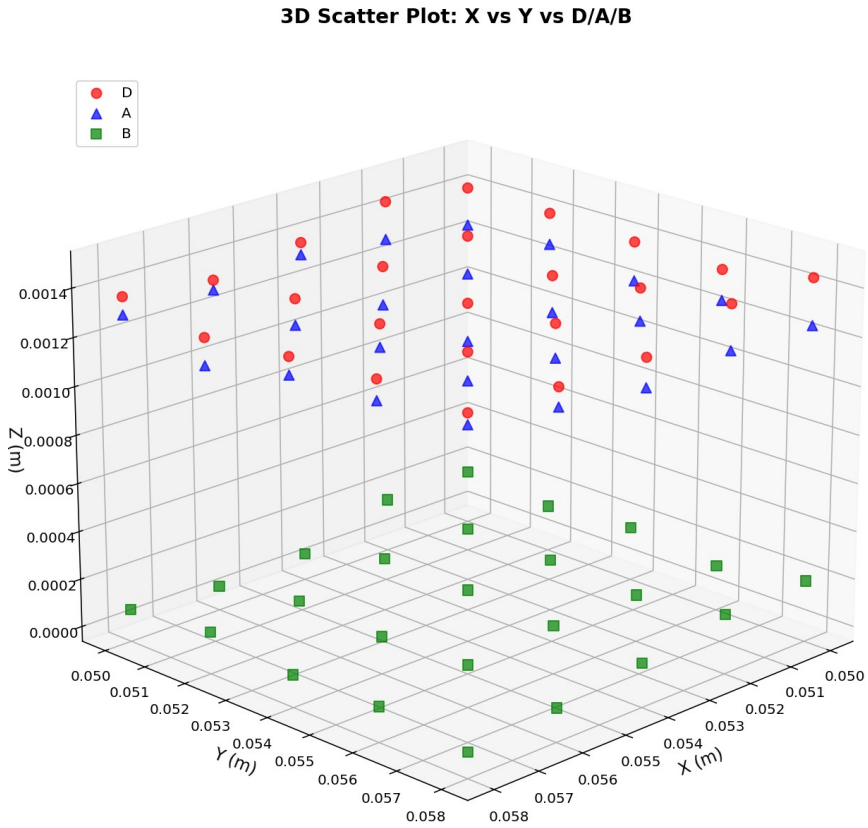
Targetscanner GUI: Relays & SM





First Measurements with GUI





Literature

- ***Automated Thickness Measurement of Targets and Degraders***
  Virtuelle Instrumente in der Praxis - Begleitband zum Kongress VIP 2001
  Rahman Jamal /Hans Jaschinski (Hrdg.)
  Heidelberg Hüthig, 2001
  Praxiswissen Elektronik-Industrie: Meßtechnik
  ISBN 3-7785-2829-7

- ***Python 3 – Das umfassende Handbuch***
  Johannes Ernesti, Peter Kaiser
  Rheinwerk Verlag, Bonn
  5. Aktualisierte Auflage 20178, korrigierter Nachdruck 2018
  ISBN 978-3-8362-5846-7

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  Arbeiten mit NumPy, Matplotlib und Pandas
  Bern Klein
  Carl Hanser Verlag München, 2019
  IBSN 978-3-44645076-9

- ***Python Asyncio Mastery***
  Discover Modern Asynchronous Programming In Python With Asyncio
  Jason Brownlee, 2023
  https://superfastpython.com/python-asyncio-mastery/

- Python Mattermost Community@GSI: https://mattermost.gsi.de/python

Discussion

- Thanks for interest.
  - Special thanks to Dennis Klein for support and discussions related to Python.
- Discussion is open.
  - LabVIEW and Python Code can be shown on request.