ALPHA-DAQ
Data Acquisition System for the Axion Longitudinal Plasma HAloscope

Kelly Dai
PI: Reina Maruyama
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Introduction
What is Dark Matter?

- Hypothetical particle
- No interaction with EM field (invisible)
- Interacts gravitationally

- Evidence: galaxy rotation curves
  - From visible mass, expect: \( v \propto 1/\sqrt{r} \)
  - Actual: curve flattens out

![Orbital Velocity (v) vs. Radius (r)](image)
How is this related to Axions?

- Hypothetical particle
- Interact gravitationally, not through EM
  - If found, would be dark matter

Strong CP Problem:

- Expect strong force to violate Charge Parity (CP) symmetry, but have found no experimental evidence
- Problem solved if axions exist
ALPHA Experiment

- Scientific collaboration

Goals:
- Tunable resonant microwave cavity
  - Closed metal structure
  - Adjustable resonance freq
- Strong magnetic field
- Axions convert to photons & resonate (at correct freq)
- Tune cavity freq until it matches axion freq
- Detect axion signal
02 My Project: DAQ
DAQ Devices

Devices I worked with:

- Vector Network Analyzer (VNA)
- Step & Programmable Attenuator
- RC Switches
- Signal Generators
- Current Supply
- Labjack T7
Networking

Network 169.254.X.X

- siggen1
- siggen2
- labjack
- vna
- rcswitch1
- rcswitch2
- stepattenuator
- programattenuator
- currentsupply

Legend:
- Computer
- Network switch
- LAN connected device

Switch

169.254.174.10
Desktop

10.66.111.122
Internet

169.254.111.11
Remote Communication

Socket:

- Python module
- Used to connect to all devices
- Establish network connections through TCP/IP
  - Send SCPI commands & receive output

```python
import socket
import time
sock = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
sock.connect(('169.254.174.230', 5026))
sock.settimeout(1)
```

```python
msg = b'*IDN?\n'
sock.sendall(msg)
sock.recv(128).decode().strip()

'YOKOGAWA, GS210, 9011E0653, 2.02'
```
Observatory Control System (OCS)

- Developed by Simons Observatory
- Framework for programs that control devices

**Components:**
- **Agent:** program (python class)
  - Does tasks & processes (methods)
- **Client:** python object; controls agents
  - Provide UI
- **Crossbar:** routes messages between agent & client
Results
Our Agents

Used OCS framework to code an agent for each device

Example:

- Current supply agent
- Tasks:
  - Initialize connection
  - Query voltage range
  - Query current
- Process:
  - Monitor errors

```python
class CurrentSupplyAgent:
    
    This Agent connects to the Yokogawa GS200 current supply / DC voltage source.

    Parameters:

    Attributes:
    log (tx aio tx.Logger): Logger object used to log events within the Agent.
    lock (TimeoutLock): TimeoutLock object used to prevent simultaneous commands being sent to hardware.

    
    def __init__(self, agent, ip_address='169.254.174.227', port=7655):
    def init_current_supply(self, session, params=None):
    def close_current_supply(self, session, params=None):
    def get_current(self, session, params=None):
    def get_voltage_range(self, session, params):
    def get_error(self, session, params):
    def _stop_get_error(self, session, params):
```
from ocs.ocs_client import OCClient

vna = OCClient('vna1')
sig = OCClient('signalgenerator2')

sig.set_frequency(frequency=4.5)

OCSRReply: OK : Operation "set_frequency" is currently not running (SUCCEEDED).
set_frequency[session=36]; status=done without error 0.003213 s ago, took 0.001776 s
messages (4 of 4):
    1721143583.671 Status is now "starting".
    1721143583.672 Status is now "running".
    1721143583.673 Frequency was set.
    1721143583.673 Status is now "done".
other keys in .session: op_code, degraded, data

vna.sa_sweep(center=4.5, span=1000000000, numpoints=200, meastype='A', electricdelay=99, dataformat="MLOG", triggertype='SING')

OCSRReply: OK : Operation "sa_sweep" is currently not running (SUCCEEDED).
sa_sweep[session=15]; status=done without error 0.007218 s ago, took 0.403540 s
messages (4 of 4):
    1721143583.729 Status is now "starting".
    1721143583.730 Status is now "running".
    1721143584.132 Performed spectrum analyzer sweep.
    1721143584.133 Status is now "done".
other keys in .session: op_code, degraded, data
Conclusion
Conclusion

● Mostly completed DAQ Agents
● Need to edit code according to feedback

Future Plans:
● Testing with real components to verify data
● Later, DAQ network needs to be moved to lab & connected with experiment