Developments on Wire Chambers and Beam Profile Monitoring

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Quarknet Internship Presentations

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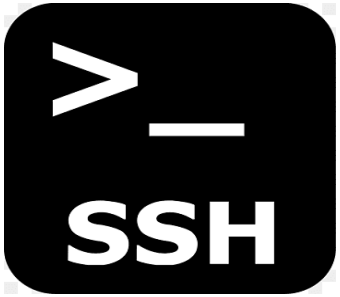
Setup

Accessing Fermilab's Computers

Kerberos



Secure Shell

- Kerberos
  - Authentication protocol to securely access Fermilab's devices/programs from my computer
- Secure Shell (SSH)
  - Cryptographic network protocol to securely connect me to a server as a client

Installing Requisite Programs

First, the proper programs needed to be installed:

- Ubuntu
  - Used to run commands in-terminal
  - Connects to Fermilab devices from my computer
  - Accesses any files/programs
- Jupyter Notebook
  - Coding for Beam Profile Monitor
  - Mainly in Python
- ROOT
  - Package for modeling High-Level Particle Physics in C++
  - Mainly used through terminal

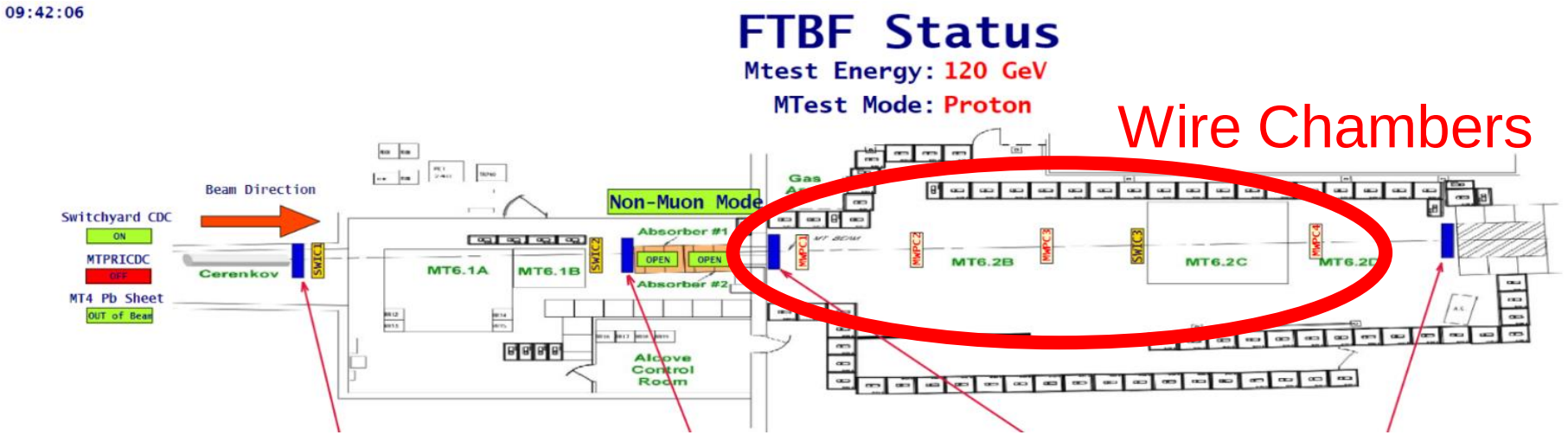
Ubuntu

Jupyter Notebook

ROOT

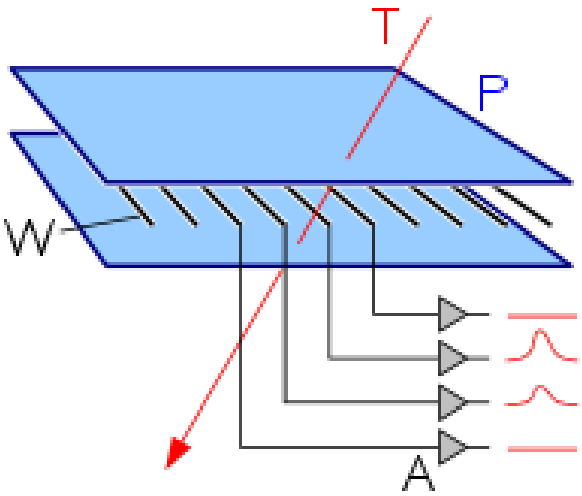
Wire Chambers

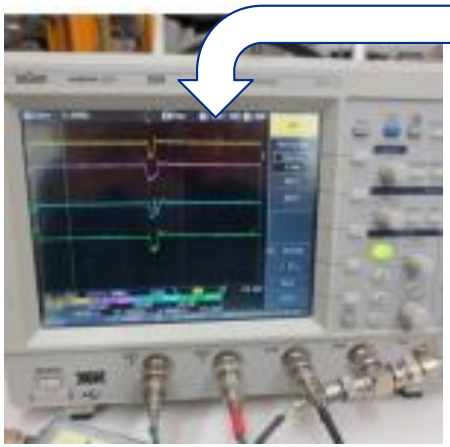
Fermilab Test Beam Facility (FTBF)



- Wire Chambers:
  - 4 total
  - They keep track of beam particles' positions (to make sure they hit the target)

Wire Chamber Composition

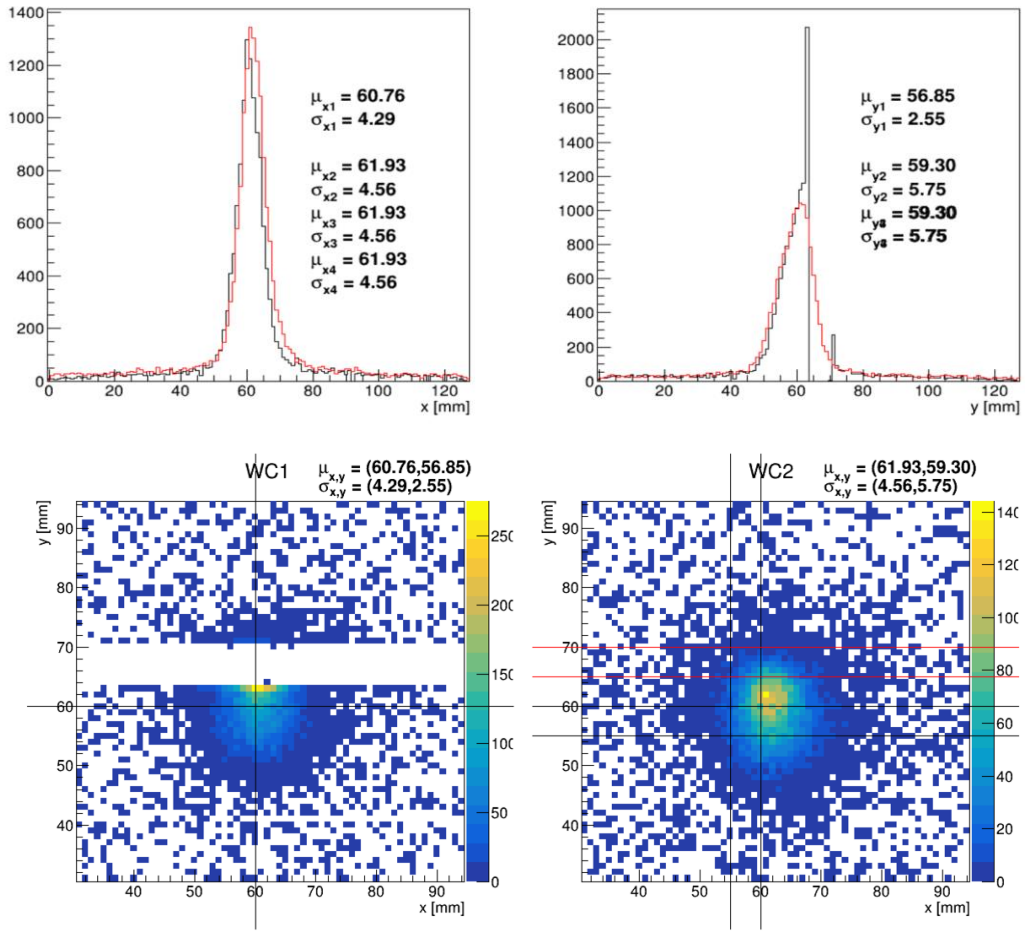




Measures voltage and position to keep track of particles in the beam

- Spacing between the wires (1 mm)
- Number of wires in each wire plane (128)
- Material of the wire chamber windows and planes (aluminum foil) and wires (gold-plated tungsten)
- Thickness of the wire chamber windows and planes (0.0005”) and sense wires (0.0004”)
- Distance between the cathode plane and sense wire (0.125”)
- Composition of the gas in the wire chamber (argon and isobutane)

Wire Chamber Position-Tracking System



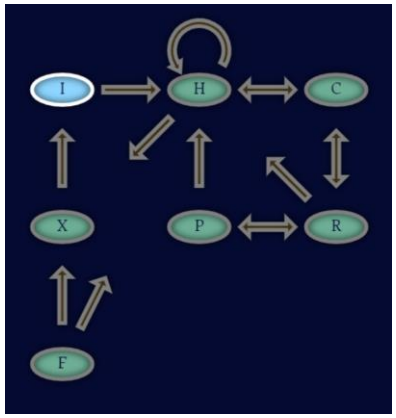
- Distribution is generally Gaussian in nature
- Resolution is approximately 1 square mm

Off-The-Shelf (OTS) Data Acquisition System

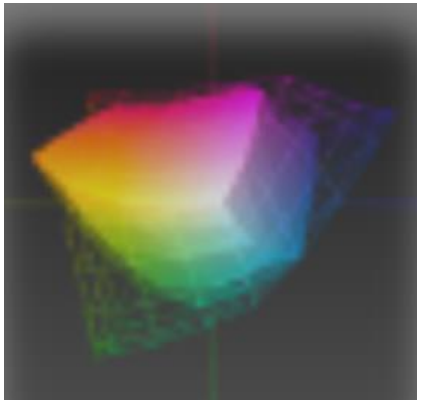
ots GatewaySupervisor
Service: none
Network: local
urn:xdaq-application:lid=200

Interactions with Wire Chambers can be tracked and modeled using OTS

Inner Workings of OTSDAQ



State Machine



Visualization Software

```
DataManagerSupervisorTable »
  DataManagerSupervisor0
    LinkToDataBufferTable-(GroupID = DMGroup0) »                    //Records for data buffer Producers and Consumers.
      readerDB0
        DataBufferGroupID : DMGroup0 | ARTDAQDMGroup0
        LinkToDataProcessorTable-(GroupID = reader0DBGroup) »
          DB0Producer0
            DataProcessorGroupID : reader0DBGroup | DBGroup0
            ProcessorType : Producer
            ProcessorPluginName : UDPDataListenerProducer
            LinkToProcessorTable-(UID = UDPListener0) »
              BufferSize : 100
              HostIPAddress : 127.0.0.1
              HostPort : 40005
            Status : On
          DB0Consumer0
            DataProcessorGroupID : reader0DBGroup | DBGroup0
            ProcessorType : Consumer
            ProcessorPluginName : WireChamberDataSaverConsumer
            LinkToProcessorTable-(UID = WCDataSaver0) »                    //Auto-generated from mock-up.
              FilePath : /home/otsdaq/pastika/data
              RadixFileName : TestData
              MaxFileSize : 100000
            Status : On
        Status : On
```

Data Configuration Tree

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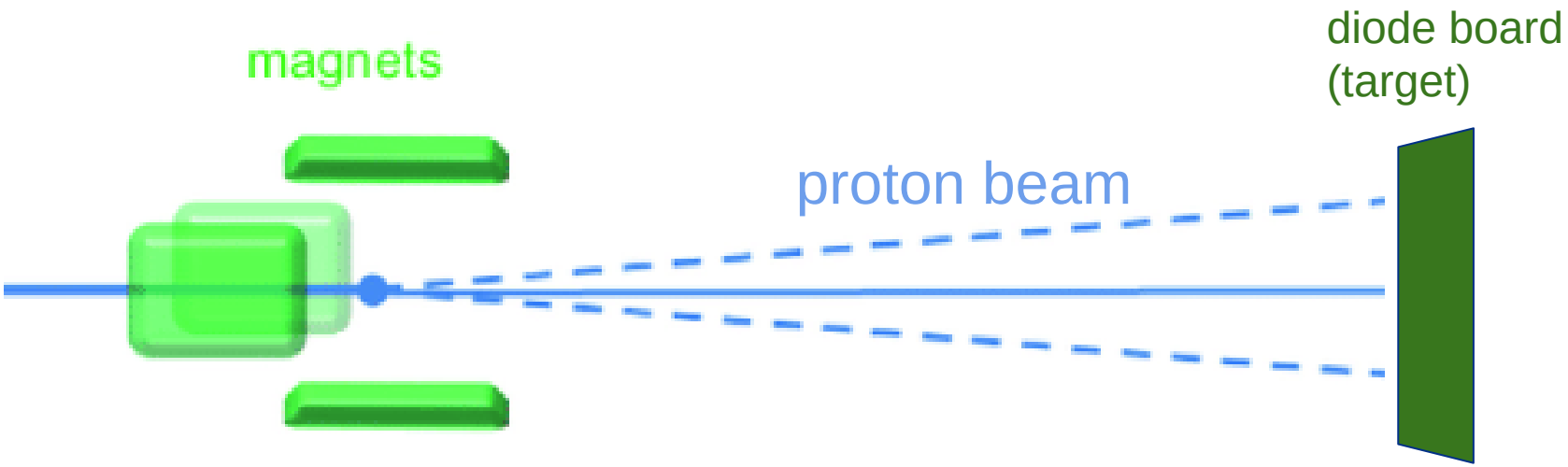
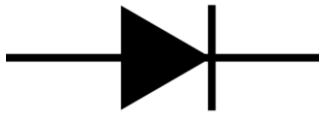
Beam Profile Monitors

Proton Beam

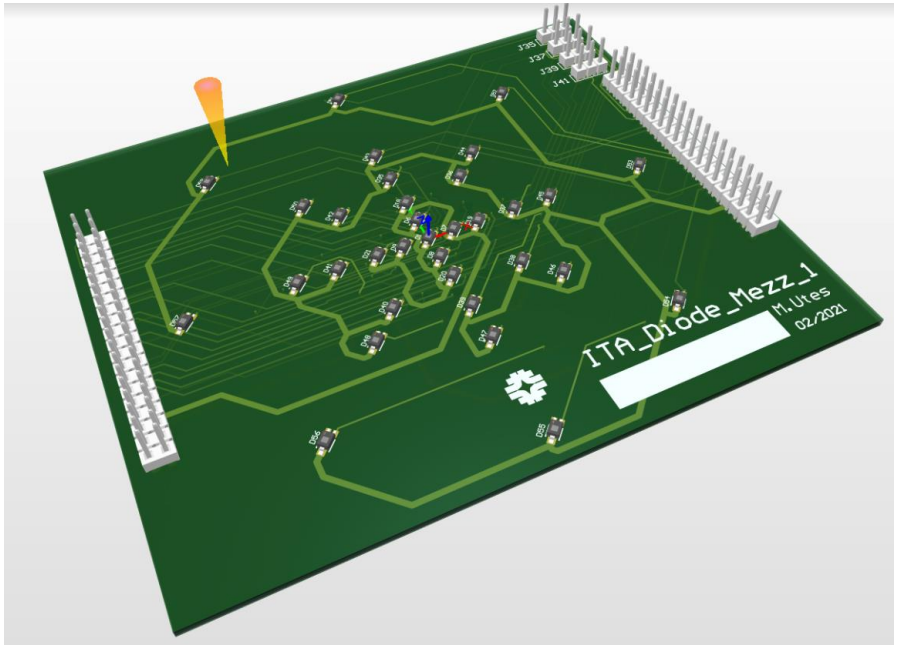


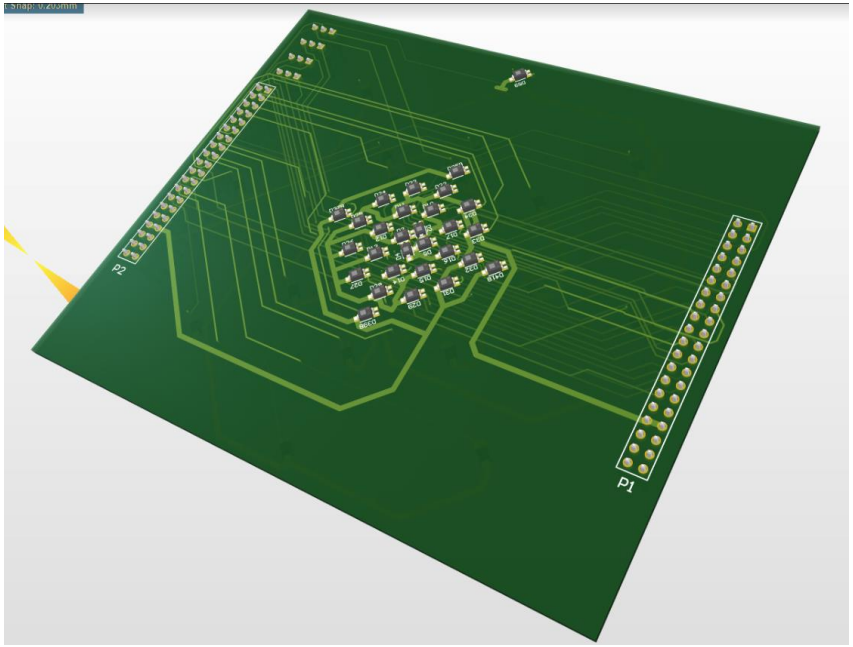
- It's very important that a proton beam is exact (hits target)
- Magnets are used to focus proton beam
- However, external effects distort shape of proton beam
- This may affect the distribution of protons in a way we don't want it to

Diode Configuration



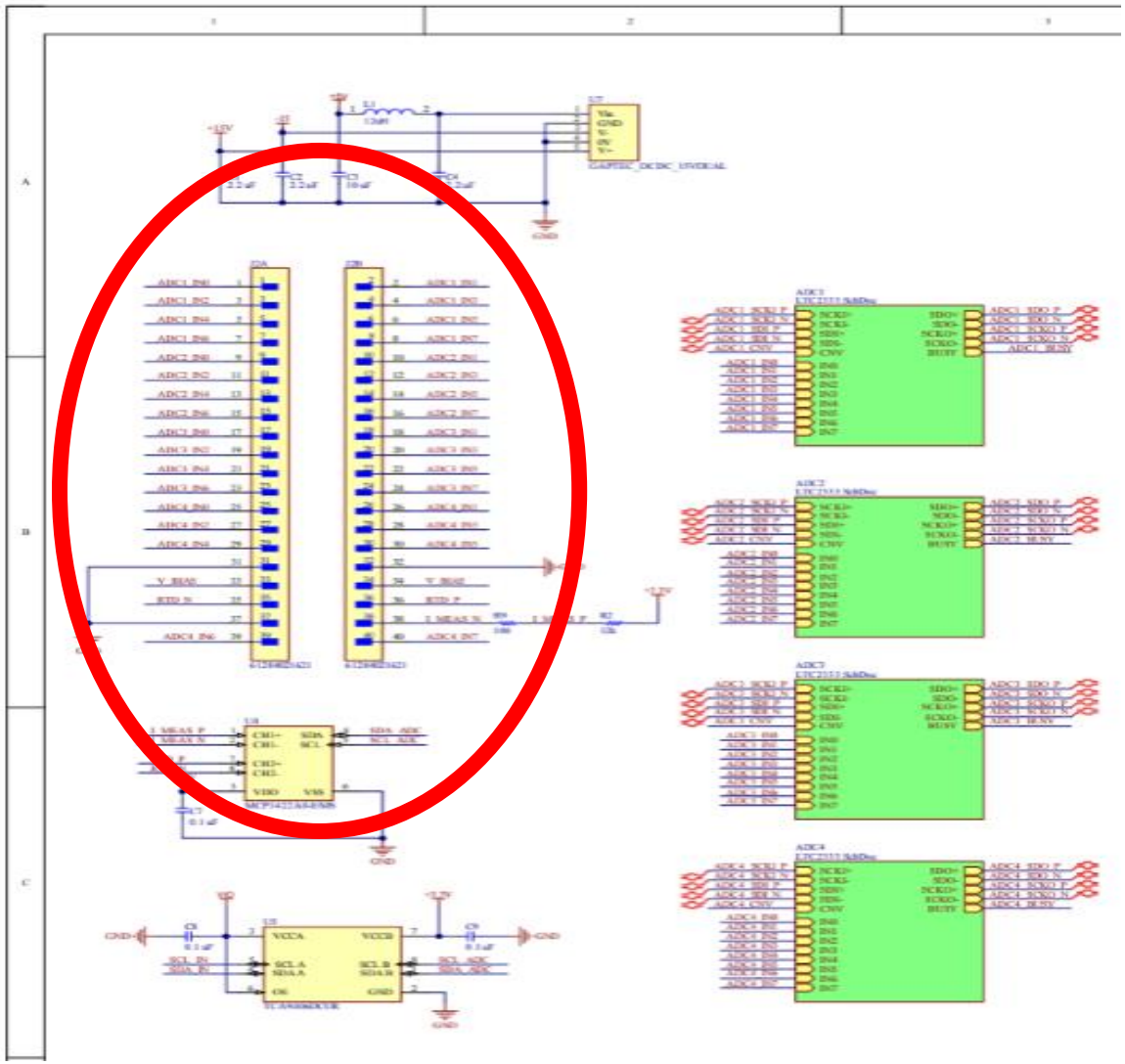
Diodes (normally) let current flow in only one direction





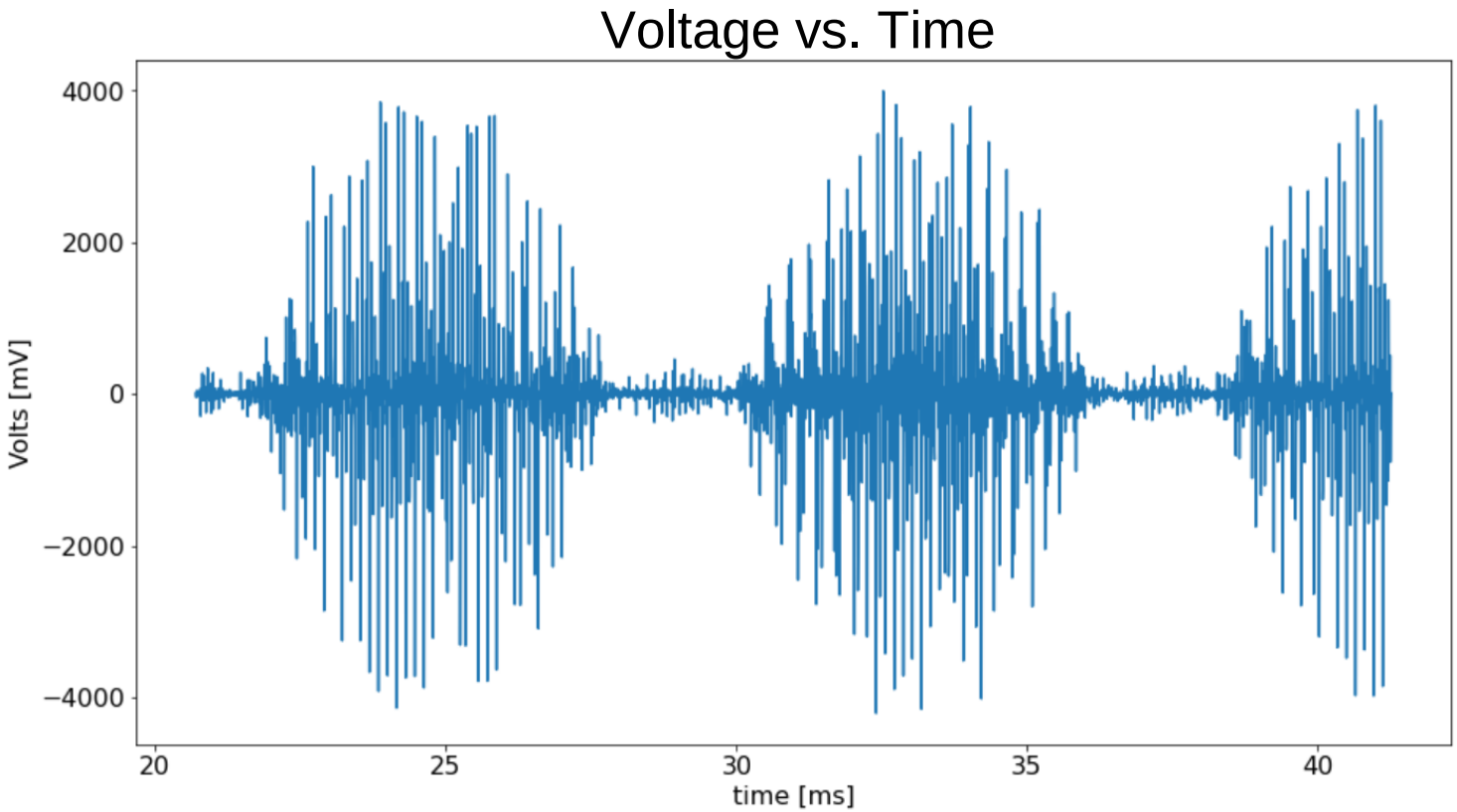
- When proton beam hits silicon diode chips, their atomic lattice is damaged
  - Damages diode, lets current through
  - Results in voltage, which signals presence of protons

Chip-Channel Correspondence



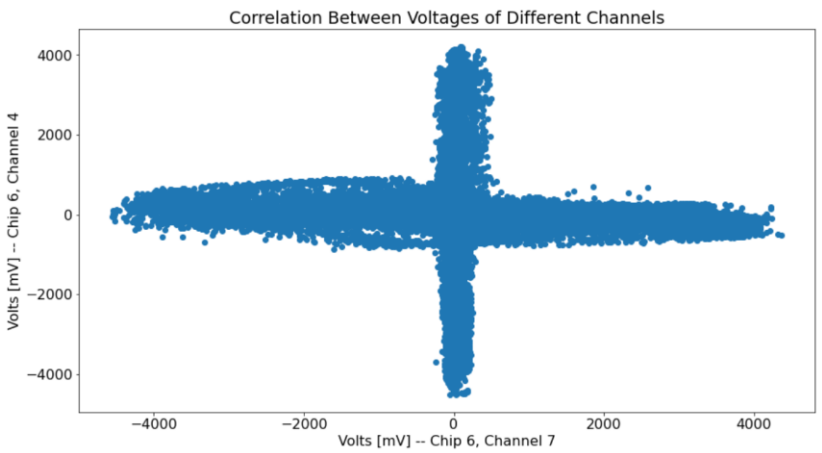
- Each of the 64 Diodes corresponds to a “chip” and “channel”
- This is how diodes are kept track of in the code

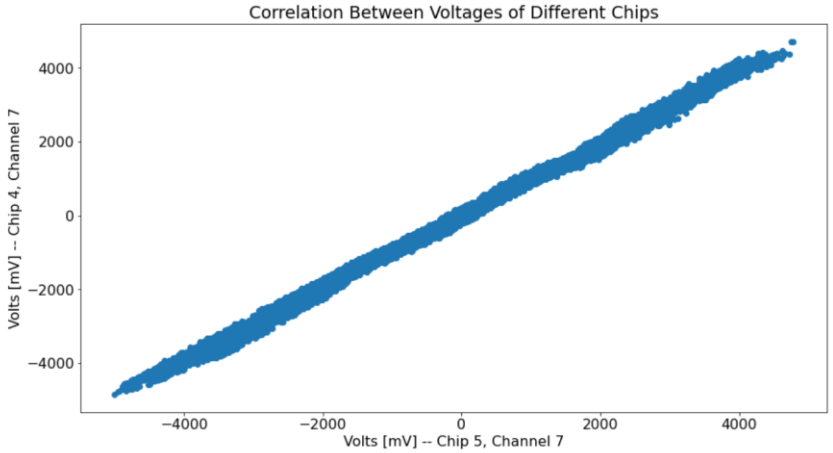
Noise in the Data



- Noise originates from external sources but hides the true signal
- Suspected to be from nearby booster that produces RF energy since it receives AC power from same source as the test beam

Characteristics of the Diodes





Diodes in different channels but same chip - not correlated

Diodes in different chips but same channel - correlated

Understanding characteristics of these diodes helps us with cancelling out noise!

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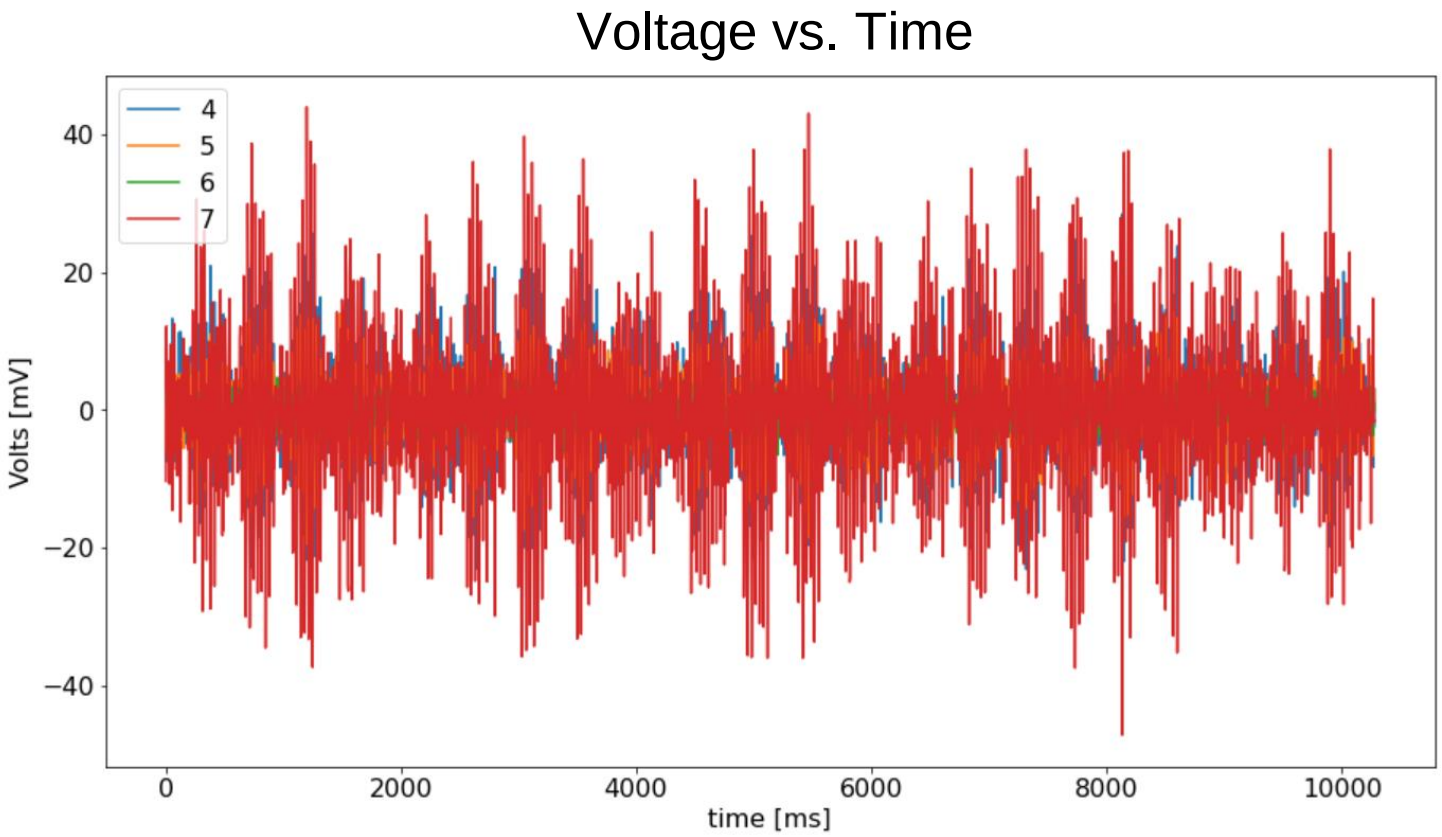
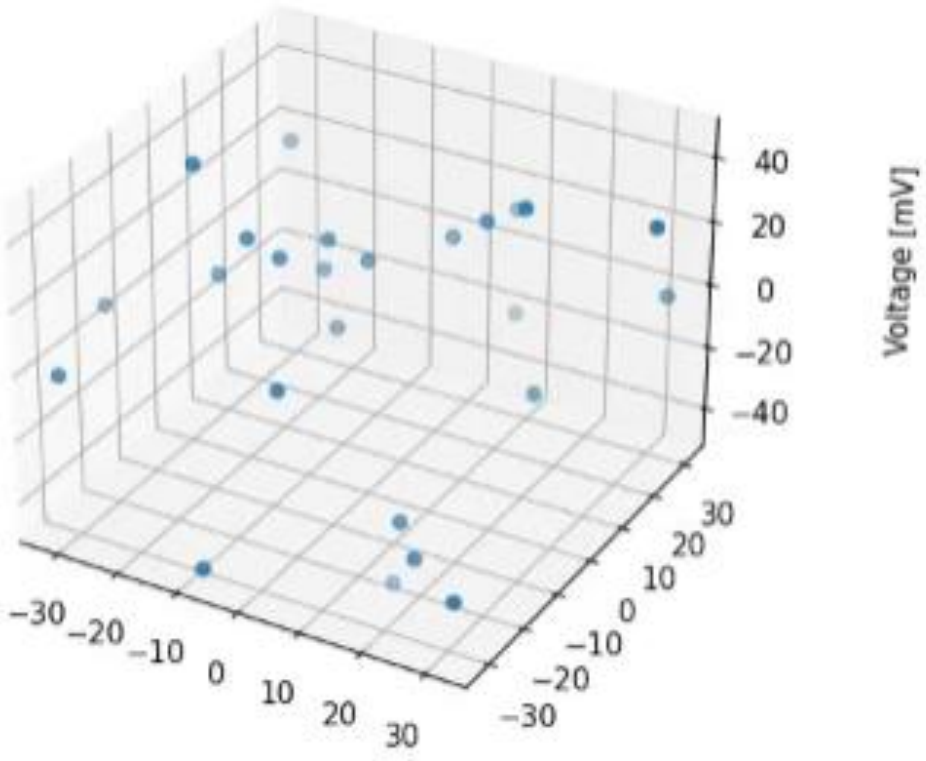
Filtering Out Noise



- Once noise is filtered out, original data is recovered
- The real signal was on the order of dozens of millivolts!

Voltage vs Time (Graphs)



After cancelling out noise, we can now see how the distribution of the proton beam evolves over time!

Takeaways

Acknowledgements

- Joe Pastika
- Mandy Kiburg
- Evan Niner

Questions?