University of Debrecen,
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sPHENIX TPC monitoring system

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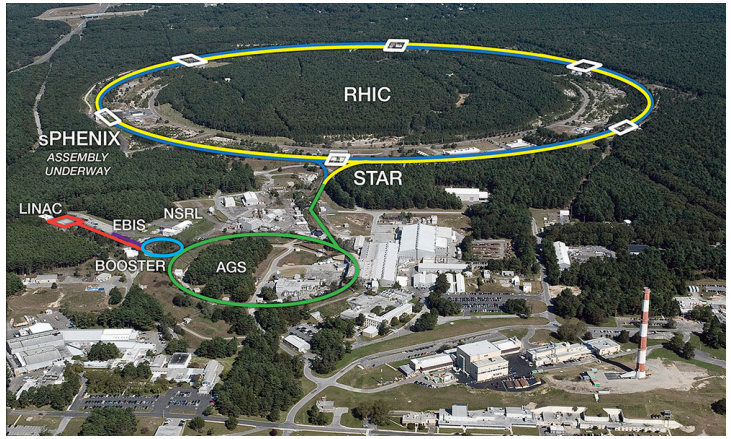
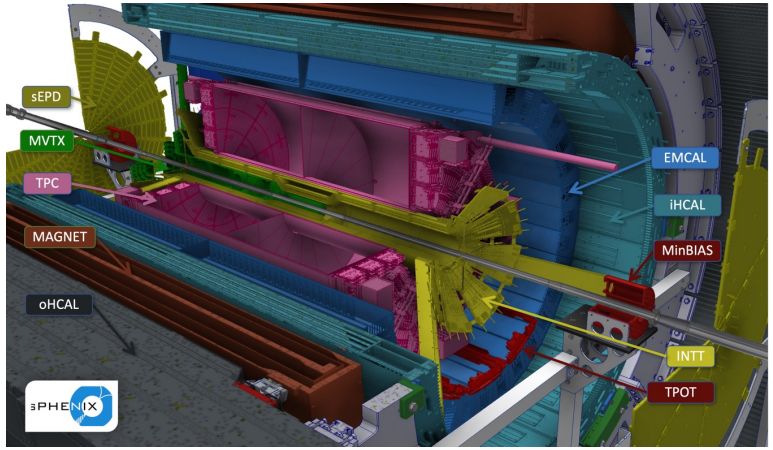
sPHENIX

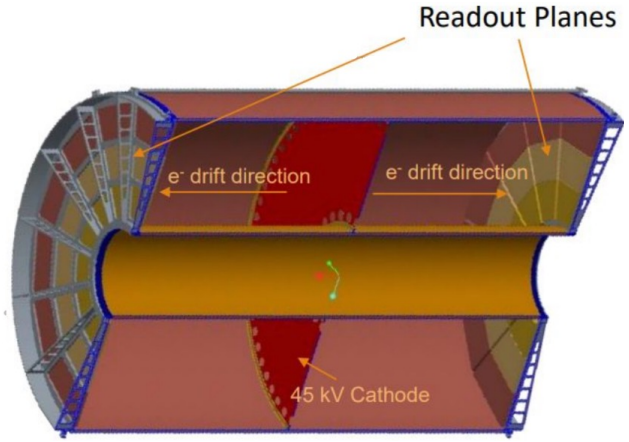
- sPHENIX is located at the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory (BNL)
- It will study properties of Quark Gluon Plasma by various probes
- The commission of the detector began in May 2023
- Strength of the magnetic field is 1.4 T
- One of its subdetectors is the Time Projection Chamber (TPC)





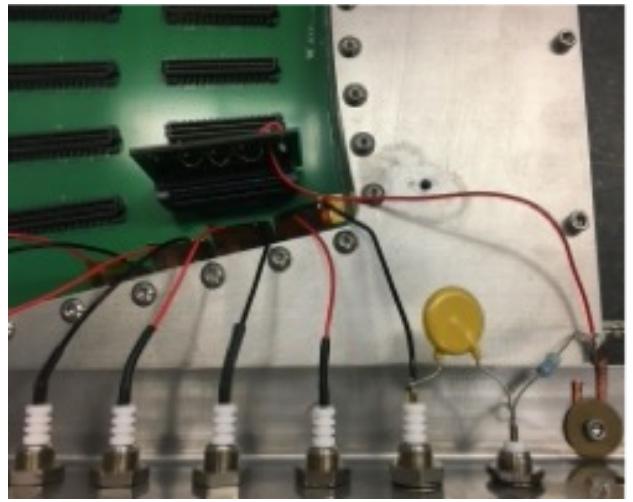
TPC

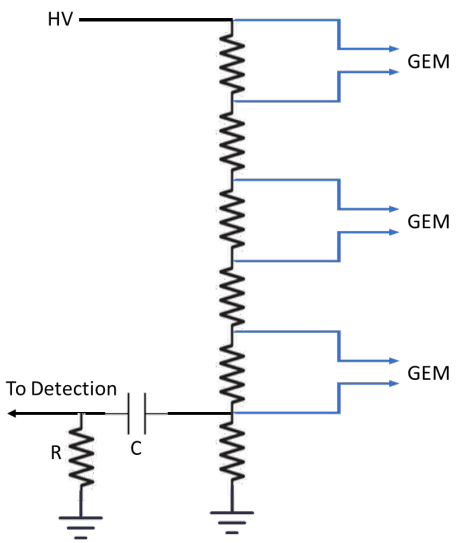
- It is the central tracking detector of the experiment
- The working gas of the TPC is Ar/CF_4 60:40
- Amplification of the electron is carried out using a stack of four Gas Electron Multipliers (GEMs) (quad-GEM), inspired by ALICE
  - 36 modules are placed per side
  - Each stack contains two standard and two large pitch planes



System characterization

- A voltage divider is used to supply operational voltages for GEMs.
- When powering GEMs with a resistor chain only one high voltage (HV) channel powers a whole module.
- If small resistor values are used in the chain, in the case of a spark, a large amount of current (compared to the nominal) will be driven through the system. A large amount of energy will be dissipated.
- Large resistor values limit the energy of sparks, but it is harder to detect sparks through the power supply current.
- A capacitor connected to the bottom of the bottom GEM is used as a pickoff capacitor for triggering and event counting.

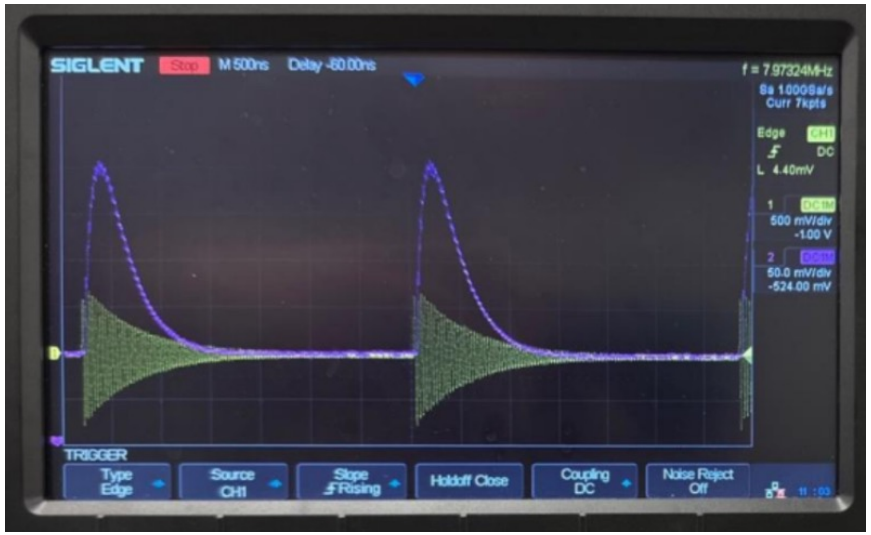


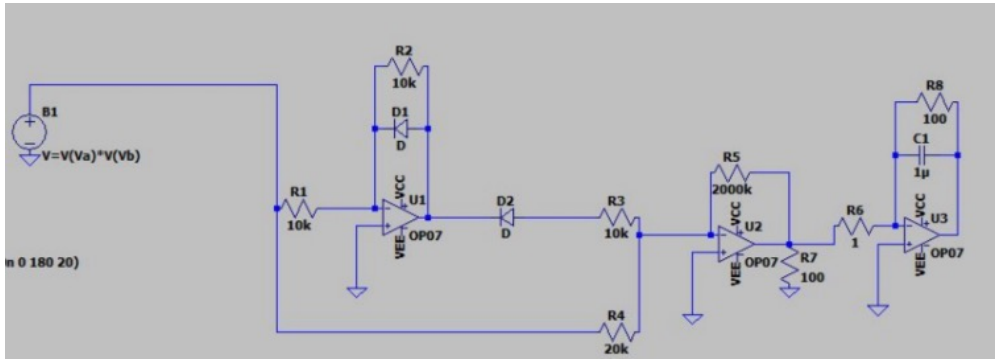


- Normal "signal" pickoff
  - SMALL signal
  - R ~ 1 MΩ
  - Preamp-Shaper
  - MIPS seen
- Spark sensor
  - BIG signal
  - R=0.2 Ω
  - Directly visible on scope

Digitizing spark signals

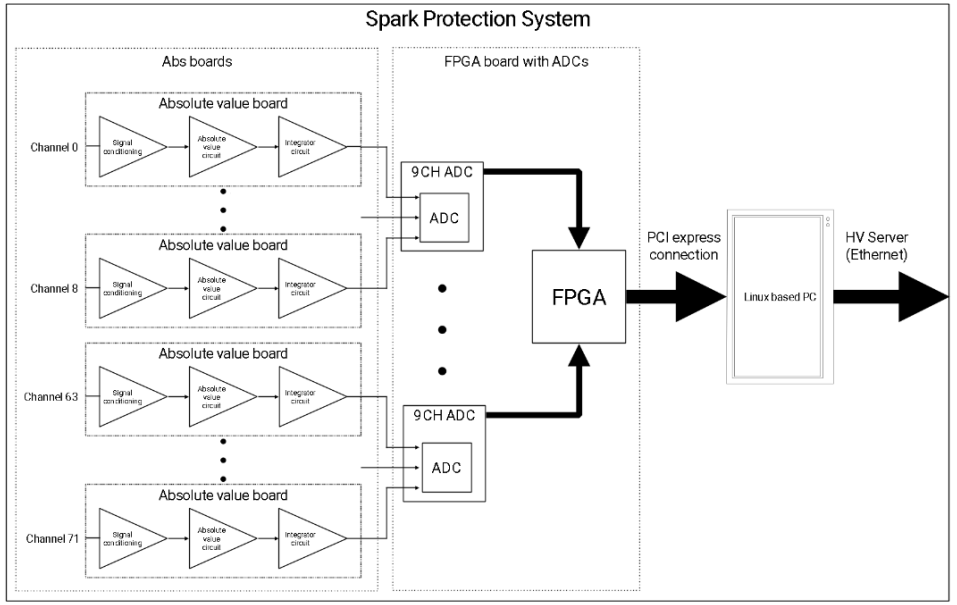
- Main requirement of the spark signal digitizer system was being able to continuously monitor 72 channels simultaneously with fast and reliable signal detection
- The original signal is bipolar and has high frequency, requires high-speed and expensive ADCs
- The idea is to convert this signal to a unipolar, pulse-like signal that can be digitized with a slower ADC
- For this, we designed an absolute value-integrator board. It takes the absolute value of the input signal and then integrates that

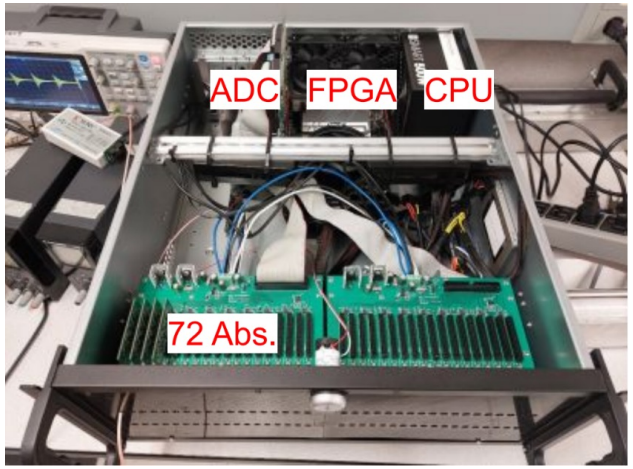




Digitizing spark signals

- The outputs of the absolute value boards are connected to a digitizer board
- This board has eight 9-channel ADCs connected to an FPGA
- The digitizer board is connected to a PC using PCI-Express communication
- This PC is able to communicate with the high voltage power supplies and intervene in their operation using a TCP/IP connection in case of a spark is detected





Thank you for your attention!

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