

Low background alpha particle detector



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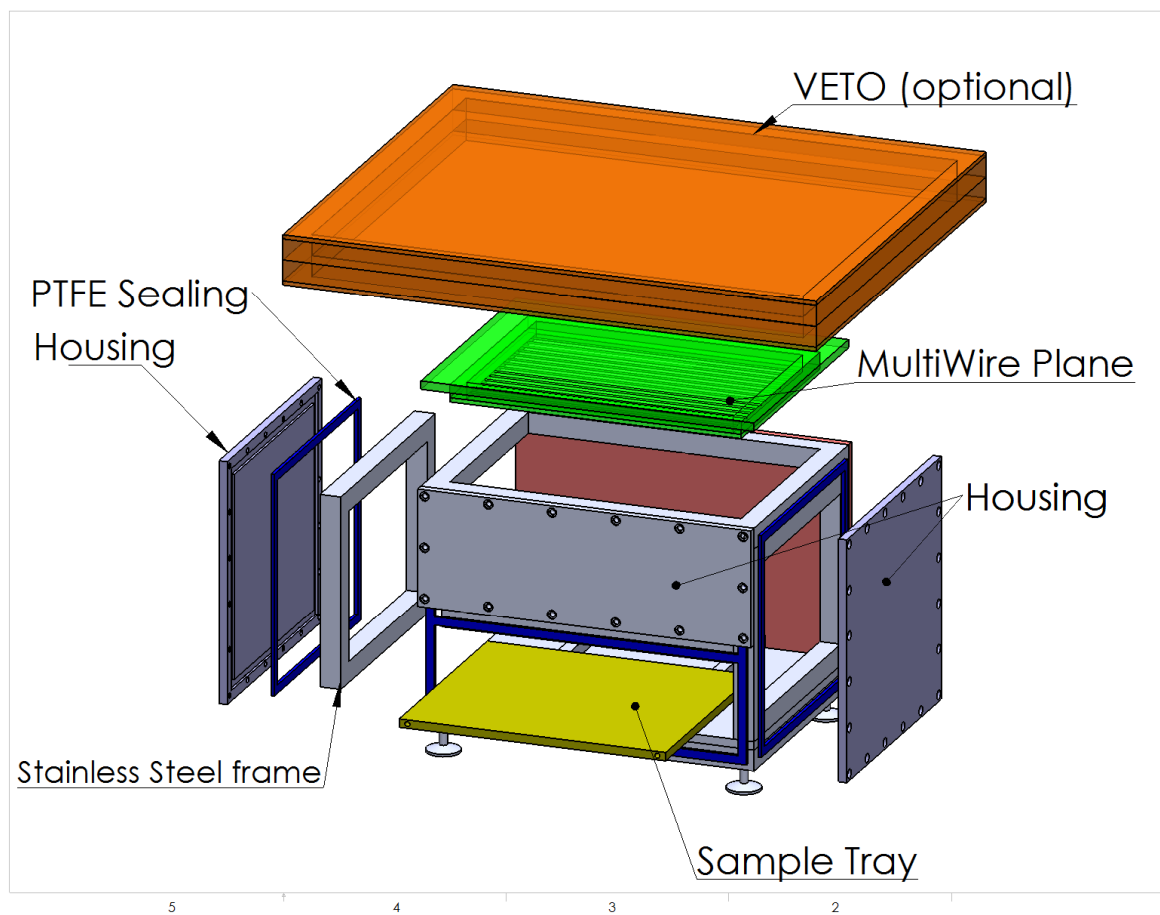
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Basics

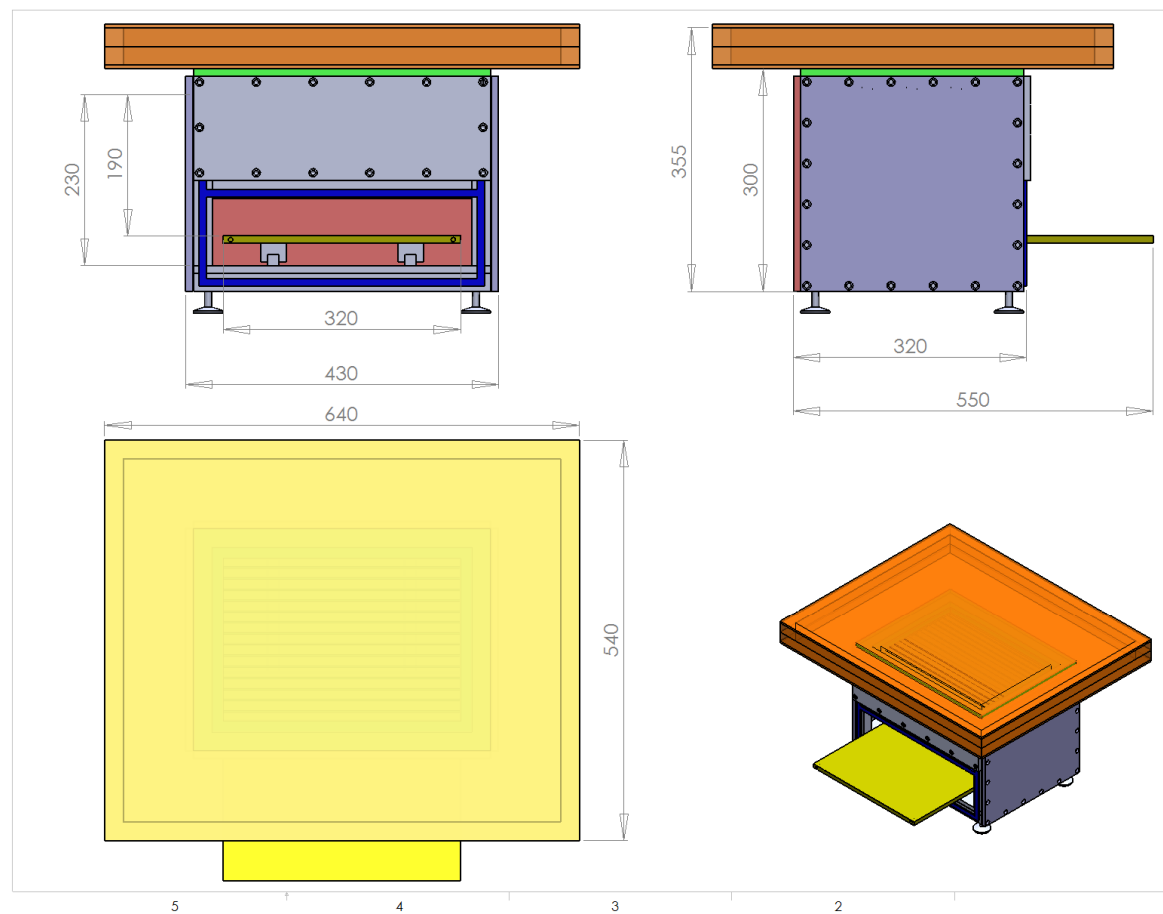


- Charged particles can be detected in drift chambers because they ionize the gas along their flight path
- The ionization electrons of every track segment are drifted through the gas and amplified at the wires in avalanches. Electrical signals that contain information about the original location and ionization density of the segment are recorded

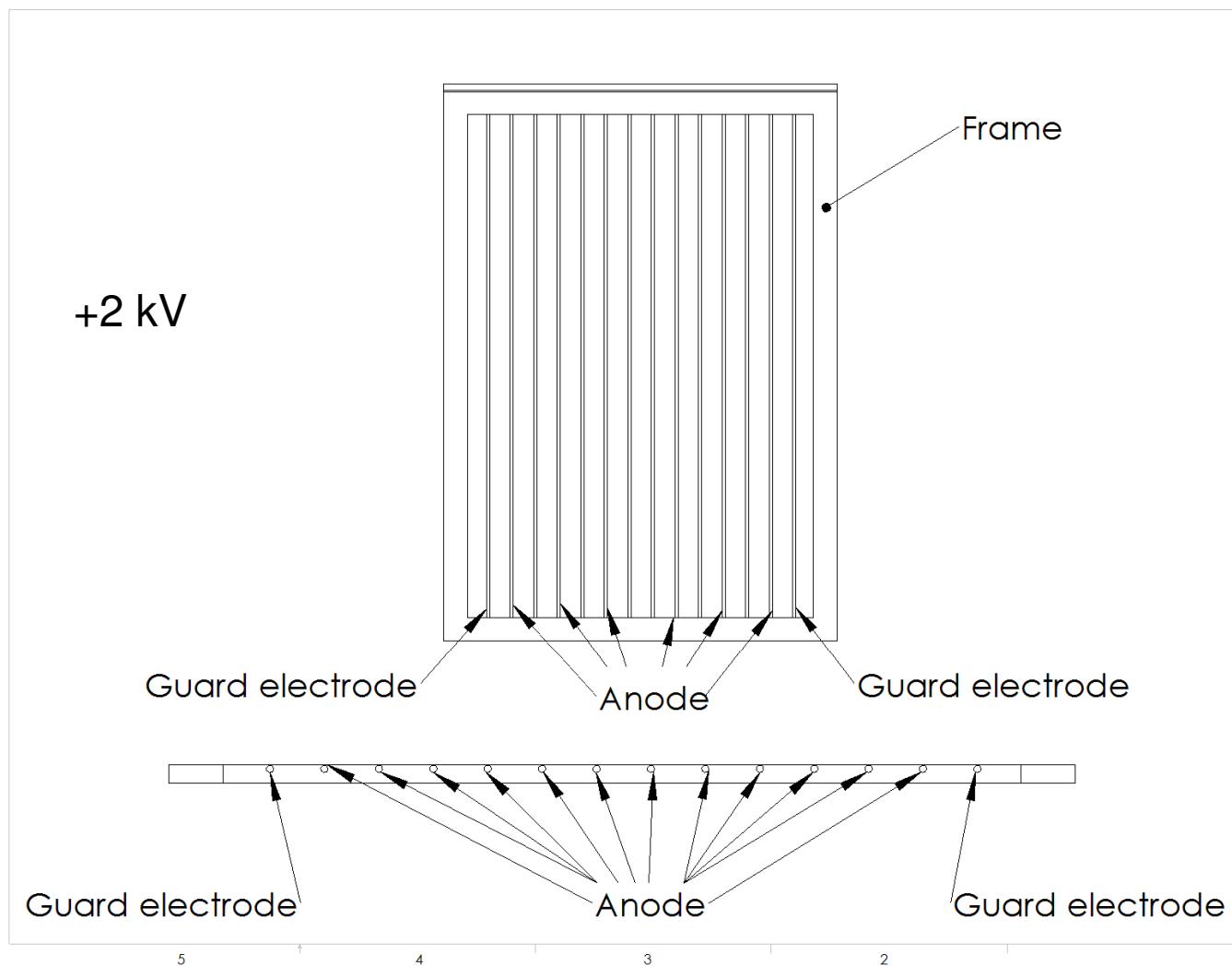
Prototype of the detector



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Prototype of the detector

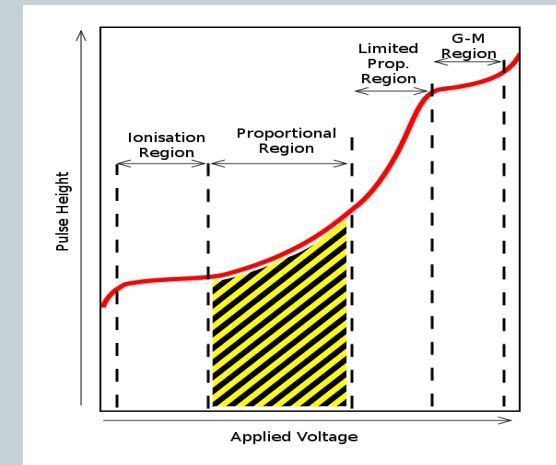


Prototype of the detector



Multi-wire Proportional Chamber with Active Veto Detector

- Low radioactivity materials:
 - Electropolished/etched Stainless Steel
 - Electropolished Copper
 - PTFE (Sealings)
 - High-Purity Nitrogen as a counting gas
- Sample dimensions 24x20 cm (thickness 3 mm)
- Gain-Voltage characteristics for a proportional counter



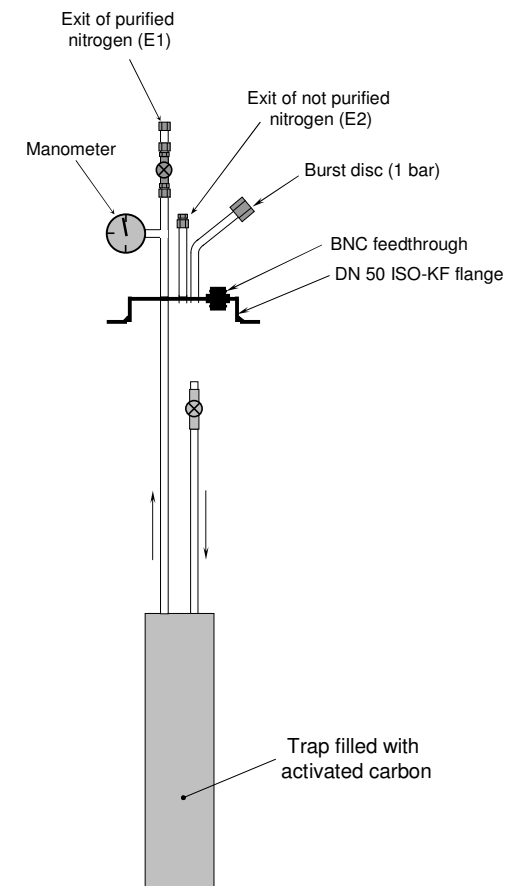
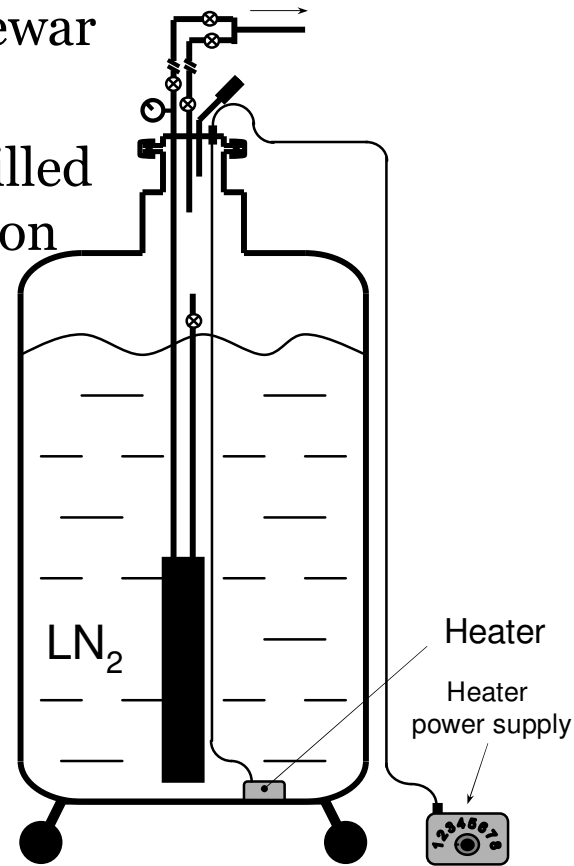
Technical details



- Distance from sample to anode plane - approx. 4x to 6x the energy range of the α -particle in gaseous N_2
 - α -particle energy - ca. 4.5 - 6 MeV, range 3-4 cm
 - Ionisation energy in gaseous N_2 - 36.3 eV per pair (e^- /ion)
- Sample tray 32x28 [cm]
- Max sample dimensions - ca. 24x20 [cm]
- Data acquisition
 - 16-channel 250 MHz Fast Flash ADC card for pulse shape analysis
 - Pulse shape analysis allows to distinguish alpha particle from a sample and from the anode/walls
 - ✦ low rise time for α -particle emanating from the sample,
 - ✦ high rise time for α -particle coming from anode wire or side walls
- Counting gas at slight overpressure
- Samples prepared for measurements in a clean bench

Ultra high purity gaseous nitrogen generator (Radon trap)

- Liquid Nitrogen Dewar volume ~ 60 L
- Radon ^{222}Rn trap filled with activated carbon
- ^{222}Rn activity ($\sim 0.5\mu\text{Bq}/\text{m}^3$)
- Pressure in MWPC ca. 1.05 atm.



Simulation - software

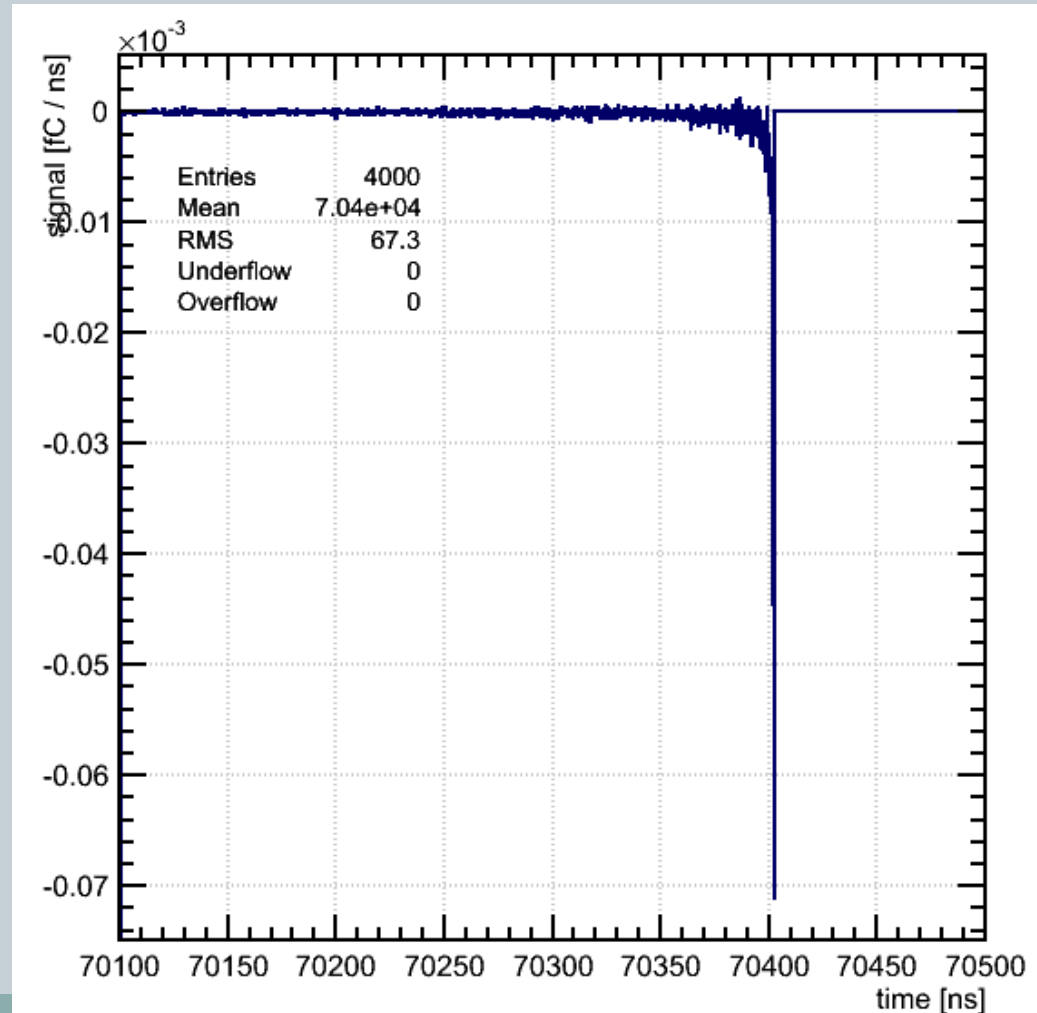


- Garfield++ is an object-oriented toolkit for the detailed simulation of particle detectors which use a gas mixture or a semiconductor material as sensitive medium
- <http://garfieldpp.web.cern.ch/>

Simulations



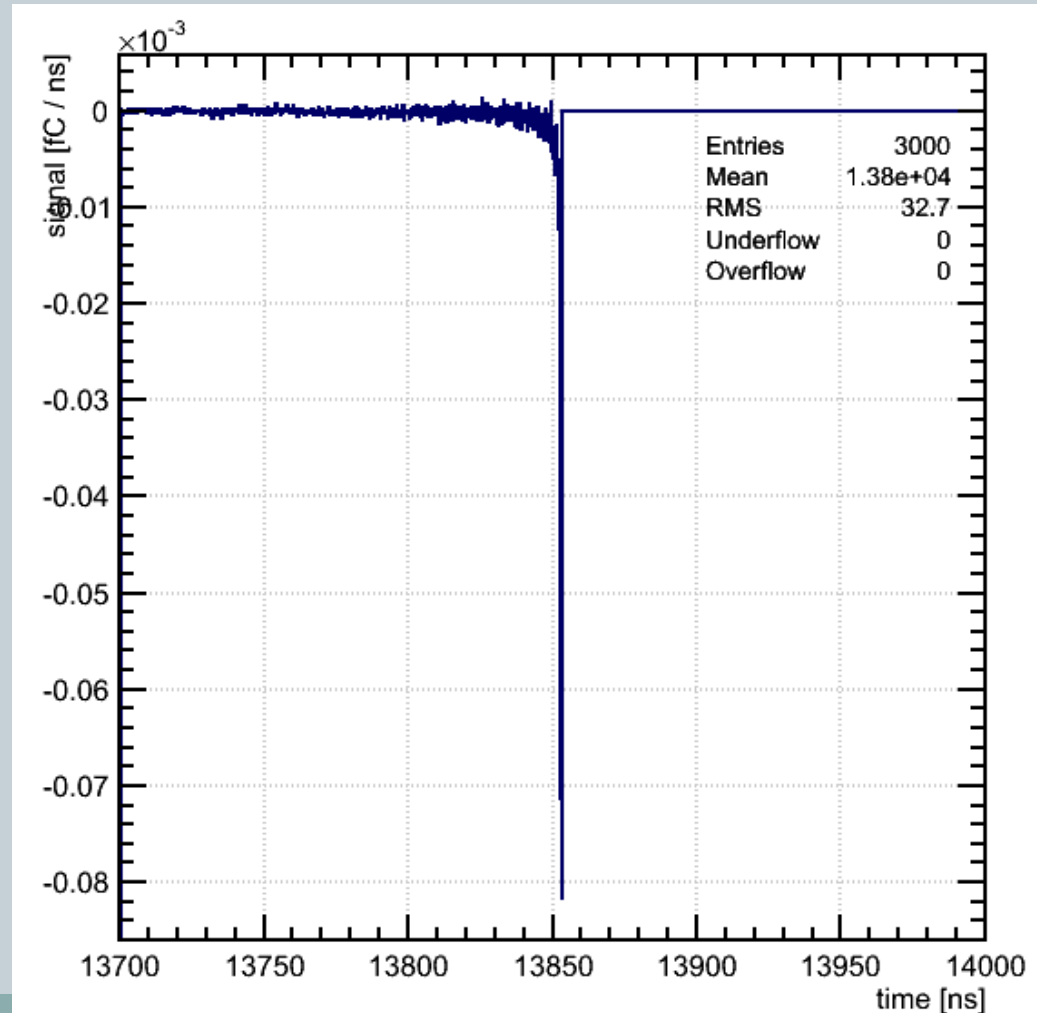
- Alpha particles that were emitted from detector walls and the investigated sample will generate different signals i.e. pulse rise time and amplitude
- On the right side: an alpha particle emitted from the centre of the bottom/sample, travels vertically to the top



Simulations



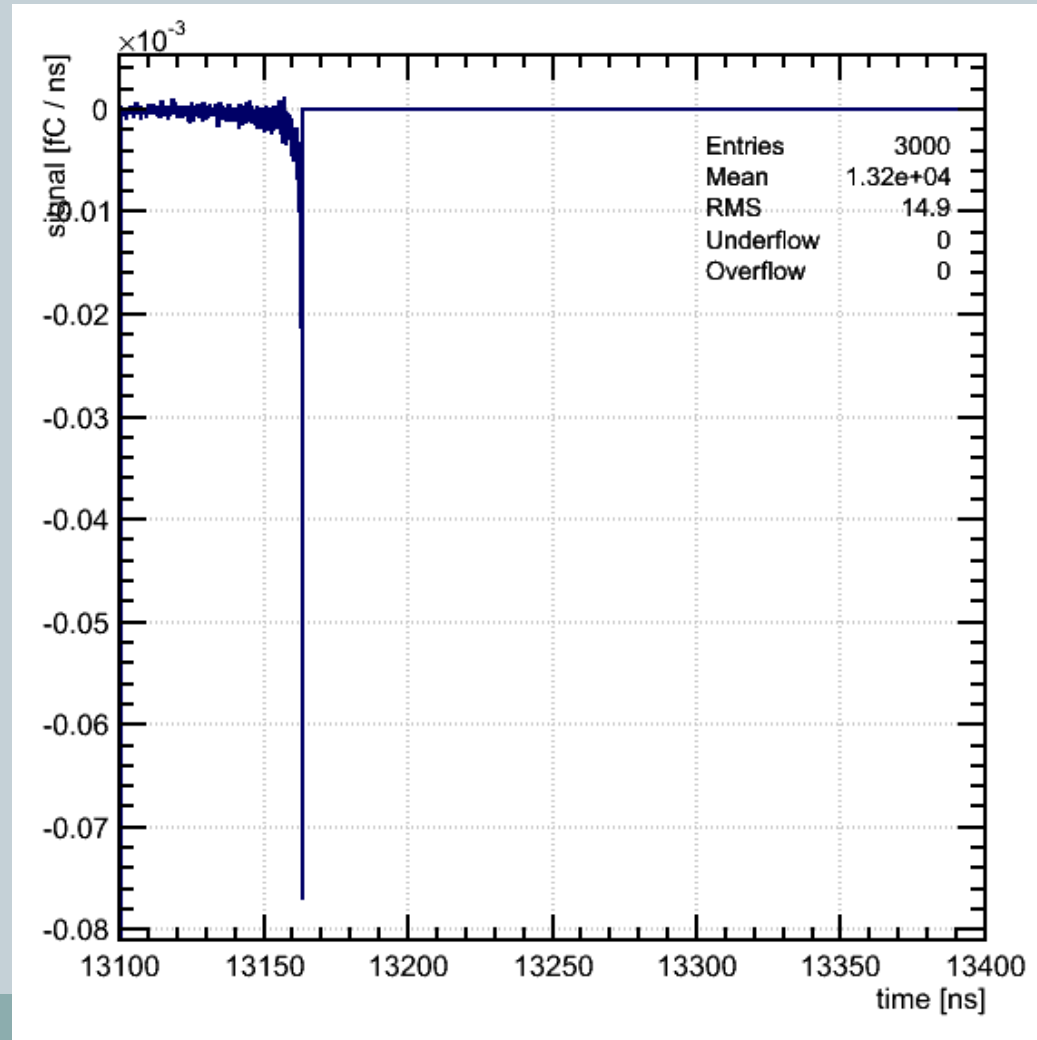
- An alpha particle released from the left detector wall (at half height), travels to the detector's centre



Simulations



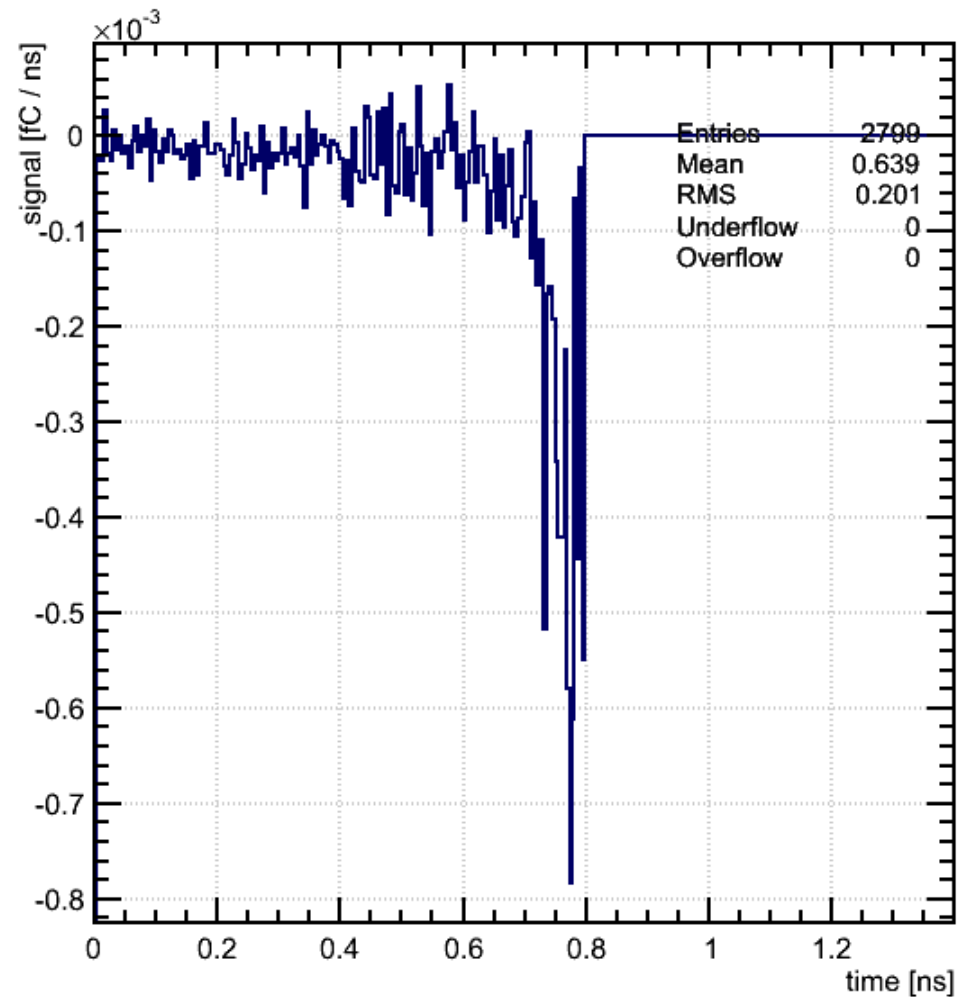
- An alpha particle released from the centre of the top wall, travels vertically to the bottom



Simulations



- An alpha particle emitted from a surface of a particular wire and a signal measured from this wire





Thank you for your attention