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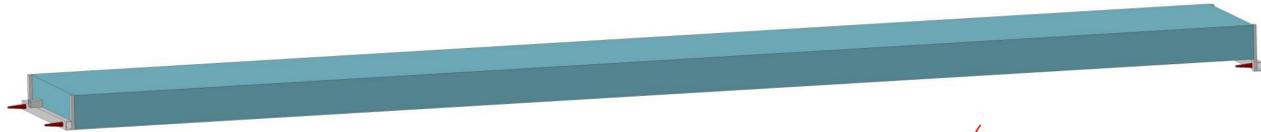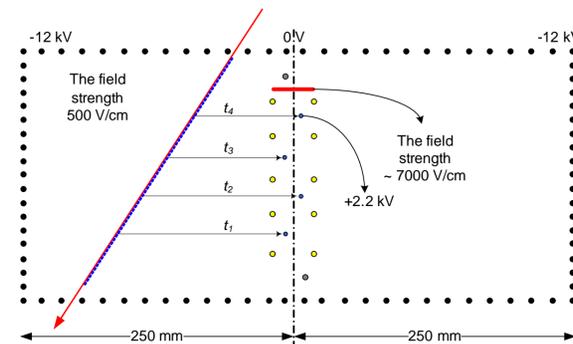Cosmic Ray Conference
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New coordinate-tracking detector on drift chambers for registration of muons in near-vertical EAS

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Drift chamber

The drift chambers of detector **TREK** were developed in Institute of High Energy Physics (**IHEP**) for neutrino experiment at U-70 accelerator. Their size is $4000{\times}508{\times}112$ mm^3. A mixture of 94% Ar and 6% CO_2 is used as the working gas. Coordinate and angular accuracy are **1 mm** and **1.7°** respectively. The maximum electron cloud drift time is 6 μs with velocity of 41 μm/ns. A chamber has 4 signal wires. They are shifted from the center of a chamber to identify a side where charged particle has passed through.

Drift chamber cross section

Event reconstruction by deep learning methods

**Presentation of drift chambers data as matrix 4×600
(only 12 rows are shown)**

We represent signals from a chamber as binary matrix with size 4×600 for applying of deep learning techniques. Each row corresponds to 10 ns interval. **Zeros** in the matrix mean absence of signals. **Ones** mean its presence.

We use 2 step algorithm for multiparticle event reconstruction. The first step is filtration. Convolutional neural network reduces afterpulses from data to avoid fake reconstructions.

The second step is signal separation by tracks. The idea is based on work of **Hep.TrkX** collaboration. We use the same matrix of signals. But for the first signal channel we save only one signal. Using LSTM units the network consistently analyzes signal channels and selects only those signals that correspond to the fixed signal on the first channel. The network is applied for each signal from the first channel. The network lets us separate signals for tracks. This makes reconstruction easier.
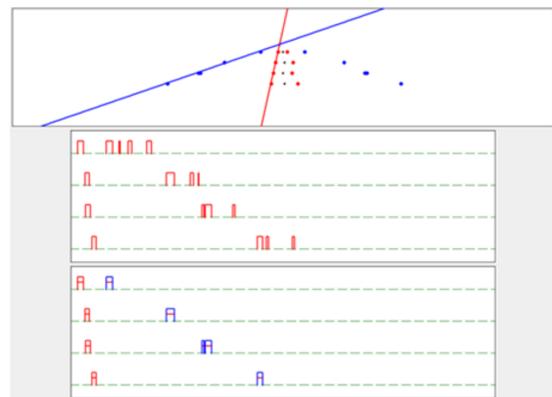
Experimental event reconstruction by deep learning approach

LSTM

Principle of signal selection by recurrent neural network
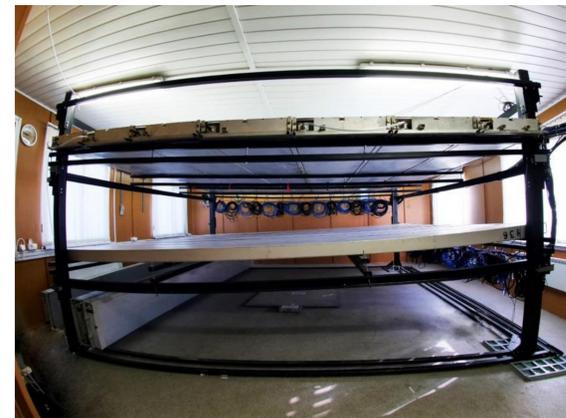
ProtoTREK

Photo of ProtoTREK

Model of ProtoTREK

The **ProtoTREK** is the prototype of large-scale coordinate-tracking detector **TREK**. The **ProtoTREK** has two non-parallel planes of 7 chambers in each. Each plane is at an angle of 3.5° to the horizon. This copies chambers orientation at **TREK**, where they are rotated to overlap each other's dead zones. There are two square scintillator detectors (**1 m^2 each**) above and below coordinate planes. They are connected to the coincidence system that acts as a trigger for **ProtoTREK** registration system.
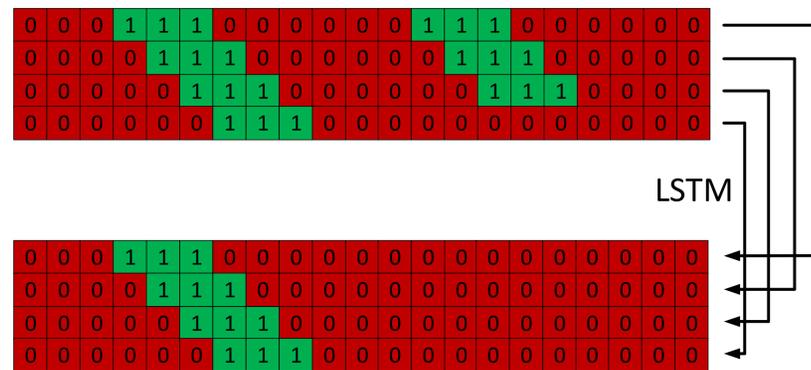
First results

An example of a reconstructed event is shown to the right. The upper part of the figure shows a 3D reconstruction in two views. The bottom part shows the reconstruction of tracks separately according to the data of each chamber.

We assume that these parallel tracks correspond to muons. The following criteria are used to highlight these events:
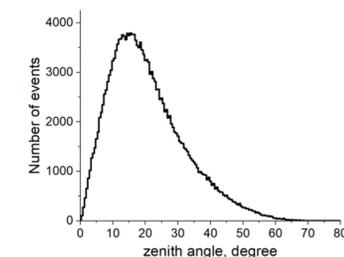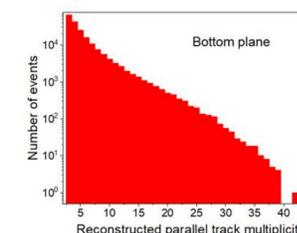
1) Parallel tracks that lie in an angular interval of ± 5° are considered.

2) The multiplicity of parallel tracks on each plane must be three and more.

3) The portion of parallel tracks on each plane must be more than 50%.
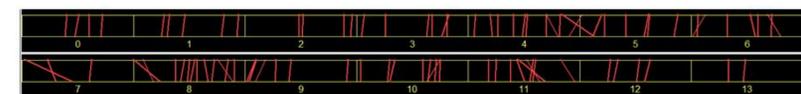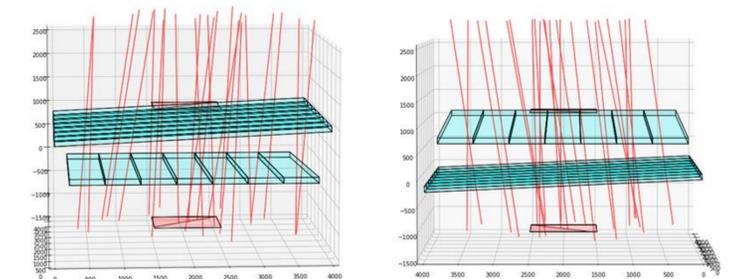
Example of multi-particle event reconstruction
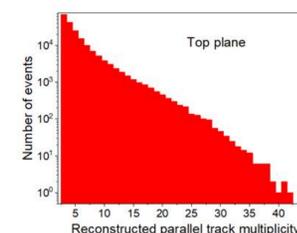
Distributions of events in multiplicity of parallel tracks

Angular distributions of reconstructed events with parallel tracks