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The Effects of a Passive Bi-Polar Grid on Ion Back Flow & Resolution

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Time Projection Chamber (TPC) tracking detectors measures 3D space points of charged particle to give position, dE/dx & Particle Identification (PID). The gain stages create large amounts of Ion Back Flow (IBF), which is the dominant source of space charge & distorts the drift E⃗-field, and thus resolution. IBF can be reduced by manipulating field ratios above and below the gain struc- ture to absorb the ions. However, higher ratios towards the bottom cause gain fluctuations, lowering resolution. A passive structure can be considered as an alternative. A Bi-Polar Grid (BPG) can block practically all ions by simply absorbing them on the negative wires. Avoiding electron loss on the positive wires can be done either with an active grid, losing luminosity, or passively with a B⃗-field exploiting that F⃗ = q⃗v × B⃗ will provide a "kick"to the electrons while the heavier ions aren't affected. Our DOI: 10.1109/TNS.2020.3042311 IEEE paper shows that as voltage between the BPG increases, all ion transparency goes zero while electrons maintain 30%-80% transparency depending on the gas, source strength, etc. The sPhenix TPC for BNL, with a quad-GEM stack, uses unique zig-zag shaped radial pads, with DNL corrections. The BPG's affect on resolution was studied with linear & equidistant wires, regardless of the pad position, & with radial wires aligned with each pad. A prototype TPC, with ≈40cm drift length and ≈43cm diameter, will have been studied at ANL using their 4T MRI mag- net. I'll present both BPG experiments with IBF results from our paper, and resolution results.

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