

## Virtual Prototyping in NX 12 of the GEM Gas Flow Sensor Chassis

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The Detector Support Group (DSG) is designing the gas distribution system for the Hall A GEM detectors. Part of this distribution system is a chassis that contains eight gas flow sensors to measure the gas flow to each detector [1]. This note presents the engineering design of the three-dimensional model generated in NX 12—the virtual prototype of the flow sensor chassis.

The gas flow sensor chassis contains eight Honeywell HAFBLF0400C4AX5 gas flow sensors to measure the gas flow to each detector, and an eight-channel I<sup>2</sup>C multiplexer board that allows a single-board computer, Raspberry Pi 4, to communicate with each flow sensor in the distribution system.

The gas flow sensor has two ports, flow input and flow output, Fig. 1(a). Because the attachment of the input/output tubing to the flow sensor is designed to be by frictional contact, a soft, elastic tubing must be used, such as Tygon tubing [2]. Within the chassis, Tygon tubing connects the flow sensors to push-to-connect bulkhead connectors.

The layout with all parts was virtually prototyped using Siemens NX 12, which has excellent solid-body modeling capabilities and built-in tools to generate two-dimensional views from three-dimensional models. The two-dimensional drafting views were annotated with dimensions and manufacturing notes.

During the prototyping process, several design iterations were made. In each iteration, some parameters remained constant—the chassis needed to fit in a standard electronics rack, the chassis instrumentation needed to measure flow for eight GEM channels, and there needed to be adequate space to ensure that minimum bend radii specifications of the Tygon tubing were met.

After six iterations, the design was finalized for fabrication, Fig. 1(a–d). This design takes into consideration available sizes of chassis from manufacturers, allows for adequate spacing of the Tygon tubing, and has adequate space for the multiplexer board.

In summary, DSG is designing a gas distribution system for the Hall A GEM detectors. Part of this distribution system is a chassis that contains eight Honeywell gas flow sensors. To expedite design, a virtual prototyping process was performed in Siemens NX 12.

- [1] B. Eng, et al., *Development of Readout Electronics for Gas Flow Sensors for the Hall A GEM Detectors*, DSG Note 2020-20, 2020.
- [2] Saint-Gobain Performance Plastics, *Tygon S3<sup>TM</sup>B-44-4X*, 2017.

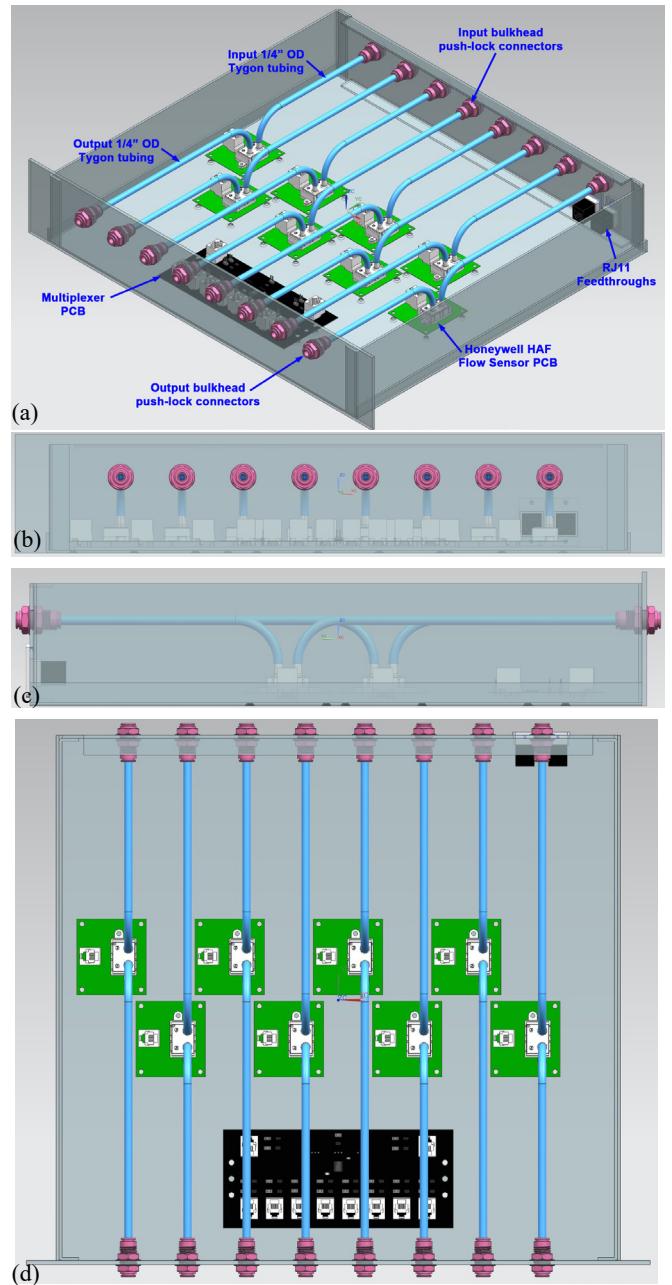


FIG. 1. NX 12 prototype drawing of GEM gas flow sensor chassis.  
 (a) Isometric view, (b) front view, (c) left view, (d) top view.