

## **Basis for cost estimation for SoLID GEM tracker components (1.1.4 and 1.2.4)**

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The cost estimations for fabrication of 150 large area Gas Electron Multiplier (GEM) tracker modules for SoLID are based on the lab experience of the University of Virginia group. This group recently completed the successful construction of 48 large area GEM modules for Jefferson lab SBS project. The costs of GEM module components are generally correlated with the active area of the module. The active areas of the SoLID GEM modules are, on average, in the same range as the SBS modules; the active area of the GEM modules required for SoLID vary from 1500 cm<sup>2</sup> to 4100 cm<sup>2</sup>, while the active area of the SBS GEM modules constructed by the UVa group is 3000 cm<sup>2</sup>. As such, the recent lab experience of the UVa group provides a reasonable basis for SoLID GEM cost estimation.

The estimations for the following line items in the cost table, all of which correspond to the work handled by the UVa group for the SBS project, were based on lab experience.

- 1.1.4.1 GEM Modules
- 1.1.4.1.1 GEM Module component design and prototyping
- 1.1.4.1.1.1 GEM fabrication tooling design and prototyping
- 1.1.4.5 GEM mechanical support
- 1.1.4.5.1 GEM mechanical support wheels design
- 1.1.4.6 Transport and travel
- 1.1.4.8 Management
- 1.2.4.1 GEM Modules
- 1.2.4.1.1 GEM foils
- 1.2.4.1.2 GEM readout planes
- 1.2.4.1.3 GEM cathode foils
- 1.2.4.1.4 GEM module frames
- 1.2.4.1.5 GEM module supplies
- 1.2.4.1.6 GEM module tooling
- 1.2.4.1.7 GEM module assembly
- 1.2.4.3 GEM high voltage
- 1.2.4.3.1 HV power supplies
- 1.2.4.3.2 HV power cabling
- 1.2.4.4 GEM gas system
- 1.2.4.4.1 GEM Gas plumbing
- 1.2.4.5 GEM mechanical support
- 1.2.4.5.1 GEM mechanical support wheels
- 1.2.4.6 Transport and travel
- 1.2.4.7 Installation and Testing
- 1.2.4.8 Management

The costs estimations for the development and fabrication of 100,000 readout electronic channels based on the VMM chip for the SoLID GEM tracker was made using engineering judgment by the UVa group. As part of the SBS project this group procured and installed a 120,000 channel GEM tracker readout system based on a different electronic chip (APV-25 chip). Furthermore, the UVa group is currently in the process of purchasing a small scale (500 channel) GEM readout system based on the VMM chip. The development of a large scale VMM chip based readout system to operate at the expected high data rates is SoLID requires new development of technology beyond what is currently used for the small scale VMM readout systems. As such, the costs for the following line items were based on the engineering judgment following discussions with the designers of the VMM chip and the readout systems based on that chip.

- 1.1.4.2.1 VMM electronics design
- 1.2.4.2.1 VMM electronics channels
- 1.2.4.2.2 VMM electronics cables