

Basis Of Estimate –M&S line 1.2 : Level 1 Trigger

The contingencies for this section of costs assume 50%, except in the noted cases where 30% is assumed.

1.2.1 Calorimeter Trigger

1.2.1.1 ADC/Digital Filter (ADF) stage

1.2.1.1.1 ADF Cards:

80 cards are needed in the system, plus 10 spares. Each card has 32 input channels. The estimate from component costs is \$2700 per card (ADC chip \$5/chn, Amplifier \$5/chn, DAC \$2/chn, passive components \$2/chn, FPGAs \$400, other logic \$100, connectors \$50, PCB \$800, cabling \$300, I/O transition card \$500). In Run 2a, the less complex DFE cards were produced for \$2k each, while the more complex VRB card were produced for \$5k each. An estimate of \$3500 per card is used.

1.2.1.1.2 ADF prototypes:

A batch of five prototype cards will be produced. The cost is assumed to be three times that of the production cards: \$10500 per card.

1.2.1.1.3 ADF crates:

4-8 6u VME crates are required in the system, holding a total of 80 ADF cards. The J1 backplane is standard, but the J2 is custom. The cost of \$6500 per crate (not including power supplies) is based on the actual cost of similar crates used for the Run 2a Silicon Track Trigger (STT).

1.2.1.1.4 ADF power supplies:

The power supplies used in Run 2a cost about \$4/watt, including monitoring and cabling. This same rule gives \$21000 for the total power supply costs for the ADF system.

1.2.1.2 Trigger Algorithm Board (TAB) stage

1.2.1.2.1 TAB cards

The cost of these all-digital cards is based on similar cards from the Run 2a STT system. Track Finding Card (\$5k) plus Mother Board (\$1.8 k) plus LRB (\$0.6k), for a total of \$7.5 k per card. 10 cards are needed in the system, plus 4 spares.

1.2.1.2.2 TAB card prototypes

A set of two prototypes will be made. Prototypes are estimated at three times the cost of production cards.

1.2.1.2.3 Global Algorithm Board (GAB) cards

A single GAB card is required in the system, plus one spare. The cost is based on the sum of the STT FRC (\$5k) plus the Motherboard (\$1.8k) plus a serial command link daughter board (\$0.5k).

1.2.1.2.4 GAB prototype

One prototype card will be build. Prototypes are estimated at three times the cost of production cards.

1.2.1.2.5 TAB crates and backplanes

A single 9u VME crate plus one spare is needed. The J1 bus is standard, but the J2 is custom. The cost estimate of \$6500 includes the backplane and the crate hardware, but not the power supplies, and is taken from the cost of similar crates in the Run 2a STT system.

1.2.1.2.6 TAB crate power supplies

\$1k cost is based on costs of supplies for Run 2a DFE crates.

1.2.1.3 Links, readout and controls

1.2.1.3.1 LVDS cables, ADF to TAB

Two cables per ADF card are needed to transmit the data to the TAB stage. The cost estimate of \$75 per cable (including connectors) is based on LVDS cable costs from the Run 2a CTT system and on preliminary quotes.

1.2.1.3.2 LVDS cables, CTT & TAB to cal-track match

One cable for each of 80 CTT sectors plus 32 from the TAB system to the cal-track match system. Cost is based on the same cables used in Run 2a for the muon-track match system.

1.2.1.3.3 VME masters for ADC crates

Commercial embedded processors for contols, monitoring, diagnostics, and downloading. Cost based on the embedded processors purchased for the Run 2a CTT system.

1.2.1.4 Technical manpower

1.2.1.4.1 Engineering

This estimate includes two FTE years of a junior engineer at Nevis, two FTE years of engineering at MSU, and one half year of engineering at Notre Dame. Additional engineering will be contributed by Saclay, Nevis, and MSU, but this is not part of the project cost.

1.2.2 Calorimeter-Track matching

1.2.2.1 Muon track match cards

These are duplicates (with minor revisions) of the cards built in Run 2a for muon-track matching

1.2.2.1.1 MTCxx cards

\$2300 was to per card cost in Run 2a. 30% contingency is assumed since the cost is based on recent production costs.

1.2.2.1.2 Serial link daughter boards transmitters

Daughter boards to transmit signals from TAB and CTT to the track match system. \$115 per board was the Run 2a cost. 30% contingency is assumed since the cost is based on recent production costs.

1.2.2.1.3 Serial link daughter boards receivers

Daughter boards to receive input signals from TAB and CTT. \$100 per board was the Run 2a cost. 30% contingency is assumed since the cost is based on recent production costs.

1.2.2.1.4 Muon Trigger Flavor Boards

These are daughter boards to the MTCxx cards. \$1000 per board was the Run 2a cost.

1.2.2.1.5 Muon Trigger Crate Manager

One manager is needed in each crate. \$3400 per manager was the Run 2a cost. 30% contingency is assumed since the cost is based on recent production costs.

1.2.2.1.6 Splitter (repeater)

Repeaters might be necessary to handle the long transmission distances from the CTT to the cal-track match. The splitters used in Run 2a muon-track match can be used as repeaters. The cost is based on these. 30% contingency is assumed since the cost is based on recent production costs.

1.2.2.2 Serial link cables

1.2.2.2.1 Lmr-200

256 cables X 100 ft = 25600 ft. \$0.50/foot was Run 2a cost.

1.2.2.2.2 Connectors

\$10 per cable was Run 2a cost.

1.2.2.2.3 Lmr-100

256 cables X 0.5 ft = 128 ft. \$0.30/foot was Run 2a cost.

1.2.2.2.4 Connectors

\$8 per cable was Run 2a cost.

1.2.2.3 Crate infrastructure

1.2.2.3.1 Crates

Commercial 9u VME crates. \$4000 per crate was cost for crates used in Run 2a muon-track matching system (not including power supplies)

1.2.2.3.2 VME processors

Commercial embedded processors used for controls, monitoring, readout, diagnostics. Cost based on model Motorola MVME-162 used in Run 2a.

1.2.2.3.3 Form factor adaptors

Custom adaptors to fit the 6u processors in 9u crates. Based on cost of same adaptors built for Run 2a muon trigger.

1.2.2.3.4 Power supplies

\$2500 each, based on Vicor supplies purchased for Run 2a muon-track matching system.

1.2.2.3.5 Power supply case and electronics

\$1200 each, based on purchase for Run 2a muon-track matching system.

1.2.2.4 Prototypes

1.2.2.4.1 Prototype MTFB

Based on Run2a prototyping costs of MTFB.

1.2.2.4.2 Prototype MTCxx

Based on Run2a prototyping costs of MTCxx.

1.2.2.5 Technical manpower

1.2.2.5.1 Engineering

Based on two years of engineering at University of Arizona, with 85% of the cost covered by the University that is not counted as part of the project cost.

1.2.2.5.2 Technican

Based on testing and assembly operations at University of Arizona (in the resource loaded schedule).

1.2.3 Track trigger

1.2.3.1 DFEA Hardware

1.2.3.1.1 Fabricate stuff new DFE daughter boards

80 boards needed, plus 8 spares. \$500 per board based on Run2a DFE daughter board cost (not including FPGA's)

1.2.3.1.2 FPGA for low-pt bins

Assumes Xilinx Virtex-II VC2V4000's or equivalent. The manufacture indicates a trend of 20% cost reduction per quarter. In this estimate, we assume a 10% cost reduction per quarter for eight quarters between now and purchase.

1.2.3.1.3 FPGA for high-pt bins

Assumes Xilinx Virtex-II VC2V8000's or equivalent. The manufacture indicates a trend of 20% cost reduction per quarter. In this estimate, we assume a 10% cost reduction per quarter for eight quarters between now and purchase.

1.2.3.1.4 Test stands for prototypes

Based on costs of STT test stands at Boston University

1.2.3.2 Technical Manpower

1.2.3.2.1 Engineering

Based on two years of engineering at the Electronics Design Facility at Boston University.