Closeout Report

on the

Director's Status Review

of

CKM

February 24-25, 2003

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Director's Status Review
of
CKM

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Executive Summary

The CKM team presented progress since the proposal was reviewed by the Fermilab Physics Advisory Committee in June 2001. Significant progress has been made across the board but especially so in areas of concern expressed by the PAC including the Vacuum Tracker (Downstream Magnetic Spectrometer), the Photon Veto Systems, the RF Separator, and the Trigger/DAQ. Concern is much reduced for the Vacuum Tracker and the Photon Veto Systems. Early prototypes have gone a long way toward meeting the superconducting rf specifications and a major test is scheduled the first quarter of 2004 and much work remains for the Trigger/DAQ.

A cost estimate of $70,331K in FY 2001$ was presented. The estimate is based on materials and services (M&S) quotes, catalog prices, and engineering estimates and scaling from this M&S based on experience from similar experiments to estimate labor. Overheads are then applied separately to both the M&S and labor portions of the estimates. It allows 5% for Management and ES&H and 60% contingency on the detector. This estimate did not include installation costs for the detector. There is some uncertainty on the cryogenics costs. Unit costs for the beam enclosure are thought to be underestimated.

A table was shown of ten known changes (both positive and negative) to the estimate which net to a nearly $4M reduction. This table incorporates cost increases where new information has required new approaches and cost reductions where new information has warranted such reductions. On the basis of this data, the CKM cost might be reduced to $66M.

The committee identified several areas of concern that are summarized in section 1.9 of this report. The areas of greatest concern are civil construction and the primary and secondary beam lines where little new development and engineering effort have taken place. In these areas possible cost growth of perhaps more than a factor of two is foreseen. On the other hand, for the detector including the superconducting rf separator where a great deal of R&D and prototyping effort has been accomplished, modest cost growth of order 25% was foreseen by the committee. The remaining committee concerns were installation and project management. If worst-case allowances are taken into account to cover the committee concerns the cost for CKM could conceivably grow to ~$100M.

1.1 Civil Construction

Civil Construction (WBS 1.1)

FINDINGS:

- After examining several sites and configurations, the CKM Project has received guidance from Fermilab to design for the utilization of a particular site, namely the M-East Beam Line and to utilize the downstream building MP-9 for the downstream housing of the planned CKM detector. This direction is relatively recent and the detailed design work in support of this particular configuration has been very limited. The materials available for review consist of essentially a few "cartoon" drawings and a single plan view overlaid on a photograph. While adequate as a "proof of principle" (maybe) this is a very rudimentary design and detailed cost estimating is impossible at this level.

- The basic new construction is an extended "beam enclosure" some 928 feet long connecting the downstream end of the existing Meson Laboratory to the upstream end of the existing MP-9 laboratory. The cross section of this enclosure will vary according to function: Pre-target, Target, chicane, rf-separators, detector, etc. There is also an upstream beam line, a reconfiguration of the M-East beam line upstream of Meson Laboratory, for which very little other than an inspection of the existing enclosure for necessary modifications for increased shielding carrying capacity has yet been done. It is also recognized that some modification (not structural however) of the MP-9 building will be required to permit the installation of the detector on the proposed alignment. For the 928 foot enclosure, the detailed technical specifications of cross sections, shielding, HVAC, power, radioactive air handling, fire suppression, property protection, etc., are substantially non-existent. Considering the preliminary status of the work, this is not too surprising, but the designs and cost estimates are not beyond a preliminary level. This is not yet even a conceptual design.

COMMENTS:

- I would drop the "cute" idea of re-utilizing old Main Ring "hoop" sections immediately. These are structurally weak pre-cast units with minimal reinforcement, they are not in particularly good condition, they are mildly activated which is something we should avoid with construction crews, and it does not appear that they are a good match in cross section to the requirements. Given that the contractor will have concrete form work on site for the majority of the new construction, there is minimal savings here

- There is really nothing to review yet. The cost estimate shown is hardly a guess. I find it unbelievably low; I have a personal rule of thumb backed up by a lot of actual experience that at Fermilab "enclosure-like" structures, fully engineered, constructed and outfitted – i.e. what I have usually been asked to produce except for NuMI, - in "today's" money run about $8000/linear foot, independent of details of cross section. I would estimate the CKM civil work associated with the new 928-foot enclosure as totaling about $7.4 Million by this estimate. (Again – this is the delivered price with all engineering, etc. included.) Note that I have not included any estimate for modifications to the upstream beam line enclosures or to MP-9.

- There is MUCH to be done in the immediate future. The CKM group must begin to prepare criteria for the civil designers, they must prepare SAD's, shielding documentation, environmental analysis, consider property protection issues, prepare for demolition of existing structures, and do detailed studies of existing below grade utilities in preparation for the next level of preliminary design. The aim should be to produce (largely 'in-house' by FESS) a document "just-short-of-Title I" (I have sometimes called this an "Advanced Conceptual Design") for the "February 2004" Lehman Review discussed as a goal by the CKM presenters. I would define this as a 20 to 25 drawing document which would contain all criteria, a cost estimate, and drawings that could be used in support of all other permitting and approval like activities that must take place, along with being a reference document to be utilized for review and comment by the CKM group itself in preparation for the next step when Title II drawings will be developed, presumably by an outside A&E firm. Once Title II design begins, it is much more expensive to make design and specification changes, so much depends upon the accuracy of the work and criteria specification to be accomplished in the next 12 months or so.

RECOMMENDATIONS:

- Prepare criteria, and begin the preparation of an "Advanced Conceptual Design" to be ready in one year. In parallel develop all other necessary "permitting" documentation.

- Prepare a demolition contract to be executed as early as possible after necessary approvals. Then prepare as exhaustive as possible "existing conditions" documentation for the use of the Title II A&E when the time comes.

- In the absence of a realistic cost estimate for the 928-foot enclosure

- Drop the idea of (re-)using the inferior Main Ring hoop pre-cast structures.

1.2 Beam Lines

Primary and Secondary Beam Lines (WBS 1.2, WBS 1.3)

FINDINGS:

- The conceptual design of the secondary beam line is well along.

- The conceptual design of the primary beam has not yet been done, partly because the beam line routing has recently been changed from the KTeV hall to the MP9 hall through Meson East. The design is at the level of a strawman count of magnets. A sign of the early nature of the design is that the beam height has not been defined at either the upstream end of the primary beam or at the downstream end where the secondary beam must match the detector height. The team also stated that they were unsure of whether the F-septs (3-way split in switchyard) needed to be moved substantially in order to produce clean beam.

- The conceptual design of the target pile is also in a strawman state.

- Although a large amount of effort is going into the SCRF effort, there still remains integration of this into the beamline.

- The SY120 shielding assessment is done for $2x10^{12}$ p/2.9 seconds, but the proposal is for $5x10^{12}$p/3 seconds. The CKM proposal also asks for essentially all beam cycles from the Main Injector for a two-year running period.

COMMENTS:

- The people working on the primary and secondary beamlines are very experienced and competent people. For the specific items that they have costed, the estimates are reasonable. The early state of the design and uncertainty in costs is due to the fact that resources have not been available to work on the design. At the moment it appears that the entire design team is about 1.2 FTE physicist and no engineers. My estimate is that it would take a team about an order of magnitude larger of order a year to get the designs to where a good cost estimate can be done and a good review would be possible.

- It is entirely logical that the risky or innovative parts (especially SCRF, and to a lesser extent the secondary beam) were addressed first with the available resources. It is however true that the strawman state of the design makes

- A necessarily quick review of what is in the cost estimate reveals the following items missing: (i) cost of target and development of target. Note that this target is meant to take essentially the same beam power as the AP0 anti-proton production target. (ii) containment of air activation (which has essentially not been considered at all). (iii) installation of magnet water system and other infrastructure in the part of the primary beam tunnel that has to be reconstructed because it is unsafe (iv) any mention of magnet power supplies for the primary beamline, their refurbishment and relocation to the ME beamline.

- The team also pointed out that the LEP Quad Magnets which were credited for $450k existing equipment do not supply enough gradient, and new magnets (of presumably similar cost) will need to be built.

- To comment on the costing methodology of taking 40% or 46% of capitol costs as the estimate for SWF, I checked my own $10M part of the NuMI project (the target hall and components) as a comparison. Adding the ~64% that is costed and the 36% that is still projected remaining costs, I find that SWF is 106% of capitol costs when I take into consideration the contract engineering manpower that is listed in spread sheets as M&S. This makes me suspect that the CKM SWF estimate may be low.

- It is striking to me that for detector components where designs are relatively more advanced, contingencies of 60% are listed, whereas for the beam which is in a more primitive state the contingency is listed as 30%.

- The physics design is to the point where of order 2 FTE engineering would be usefully employed, and in fact getting at least a drawn up layout of the beam would help in further design efforts.

- It is believed that raising the shielding assessment limit (see findings above) is reasonably straightforward except for the limit on irradiation of adjacent M.I. components due to the slow extraction, where the limit is set by maintenance requirements that are not very well known. This may be a real limit that will be hard to mitigate, or may turn out to be a non-issue. Experience will be gained during near-turn running of SY120. A continuing problem may be that M.I. people have no time to think about how CKM fits in.

- It is also not clear to me that the CKM cycle is compatible with either BTeV or NuMI running. (For NuMI it is my understanding that the kicker extracting the NuMI batches would not return to baseline fast enough to leave the CKM batch in the M.I. for slow extraction). It may be that significant expenditure

RECOMMENDATIONS:

- More physicist and engineers are required to carry forward this effort if it is desired to have a Lehman review. With two engineers and five physicists, there might be a possibility of being ready in a year (compared to the 1.2 FTE physicist and 0 engineers currently involved).

A cost estimating exercise

As stated in the comments, there are many subsystems that are not yet included in the cost estimate for the primary and secondary beams. I have no way of doing a good job of adding those costs during this review. In the spirit of trying to give an independent estimate, however, I went through the following steps:

(1) Remove $102k of EDIA which was included in the M&S for WBS 1.2

(2) Remove $29k of installation cost from M&S

(3) Move the $450k for LEP Quads from “existing” to “new”

(4) Estimate SWF as equal to M&S

(5) Add 10% to M&S as overall installation cost

(6) Take 70% contingency on the above, which is meant to cover both normal contingency and some wild guess of missing systems

(7) Add 70% contingency on “existing equipment”

Note that because there is no column for existing equipment in the spreadsheet, this somewhat misleadingly works out to about 100% contingency on the items listed as new. $5.6 M → $14.9 M

1.3 RF Separator

SCRF Plant and Equipment (WBS 1.4)

FINDINGS:

Cavities and Cryomodules

- Development of this experiment is still at an early stage; however there has already been a lot of good work, both in physics and engineering, to support the effort. Many of the cavity simulations and cryomodule design details were previously shown at a separate review of the SRF cavity system in May of 2001.

- A total of seven prototype cavities, three single-cell, and one each of 3-, 5-, 9-, and 13-cell, were manufactured to-date by FNAL and a local welding shop.

- Cavity processing was accomplished as a collaborative effort with JLAB. The FNAL group has the capability to do high-pressure rinsing with ultrapure water (HPR), but does not yet have buffered chemical polishing (BCP) capability. JLAB performed the BCP and also baked cavities to 600C. The FNAL group has since acquired a vacuum oven capable of bakeout at 800C. Work is in progress to collaborate with ANL to enable BCP to be performed locally. A simple plastic container is needed to hold the FNAL cavity during chemical processing at ANL. The container was not yet made due to lack of engineering and manufacturing effort at FNAL or a low priority assigned to the work or both.

- The cavity design goal is 5 MV/m deflecting at $Q = 2.1\times10^9$ with $R_s <$ 110 nΩ, probably operating at 1.8 K.

- So far, tests between February and May 2002 with the 3-cell cavity achieved a best deflecting gradient of 5.1 MV/m @ 1.0×10^9. The gradient decreased in two subsequent tests, most likely due to now-understood handling and procedural errors. R_s was improved by modifications to the beampipe. The group now has a much better understanding of the underlying causes, and is confident that the solution is at hand.

- Many of the cryomodule components are now in final design or fabrication. The cold tuner should begin fabrication in 2-3 months.

RF Systems

- A klystron was purchased already, so its cost is known. The rest of the rf system is mostly determined from a conceptual standpoint. The present plan is to have two rf stations powering 12 cavities. There is not too much margin. Some spares are included. The initial cost estimate for this part of the project was done in 1998.

- Safety and controls systems were incorporated at some level in the rf system design.

Cryogenics Systems

- The baseline plan is to use existing pieces of an old 4.5K refrigerator and make it into a liquefier capable of the desired power of 300W at 1.8K. The cryogenics group feels major effort and redesign are needed to get beyond 120W, and that the reliability would be poor.

- The FNAL cryogenics group proposes to construct an entirely new system for this purpose. The system of choice is based on the Rossendorf ELBA system, and is similar to that proposed for the HBPI. There is extensive cost information in support of the cost estimate, based on several recent refrigeration systems including the SNS. The FNAL cryogenics group has an extensive database of information and calculations as backup.

- Budget for safety and controls systems was incorporated into the new cryosystem design.

COMMENTS:

- The cryogenics group assumes it will operate and control the refrigerator system, and one assumes that the beams division will control the rf cavity and beamline systems. One also assumes that monitored signals from all beamline and cryogenic equipment are transmitted both to the experiment and to the main control room. It was not clear how or if this was planned or budgeted.

- Conventional facilities in support of this part of the project are discussed elsewhere.

- More mechanical and rf engineering and design effort would help to speed this entire effort along. Major work stoppage on this project evidently occurs shutdowns. If this effort is to continue making steady progress, its priority needs to be appropriately increased.

Cavities and Cryomodules

- JLAB recently experienced periods when water purity and cleanliness were degraded. One wonders whether this have affected processing of the CKM cavities.

- There is adequate space in the beamline for additional cavities. Additional cavities could greatly improve the reliability of the rf separator system.

- It would be good to have full cryomodule test results before the Lehman review that is proposed for a year from now, however the schedule for that is extremely tight. A lot of components need to be fabricated in the very near future to support such a test.

- Vibration sensitivity is an issue. They are considering adding stiffening rings and increasing the niobium thickness to gain stiffness, which may slightly impact the tuner designs.

- Use of piezoelectric crystals to compensate for microphonics was mentioned. They should continue to develop the piezoelectric system a la SNS to use in feedforward mode, however all reasonable means should be used to damp vibrations from rotating machinery at the source before trying to cope with them at the cavities.

RF Systems

- If additional rf cavities and rf power systems were added, the cost would increase incrementally.

Cryogenics Systems

- The system presented in the baseline is not the system of choice for the cryo group, and they have not seriously worked out what it would take to actually implement it.

- It is unclear how much was included in the re-used cryosystem budget for safety, controls, and various other categories.

RECOMMENDATIONS:

- Determine what, if any, availability/reliability goals are applicable to this experimental system. What are the ramifications of bad availability in this experiment from its own equipment? Does the experiment get additional running time or is the dataset reduced?

- The experiment and the laboratory should consider making a high-level schedule to aid in prioritization of effort. Some of the long-lead items, such as the refrigerator, will need several years to complete.

- Make a more detailed cost breakdown of the entire rf separator system so it's easier to understand what items may have been omitted. Include installation plans, safety systems, controls, integration, commissioning, and effort costs.

Cavities and Cryomodules

- A small but dedicated core team of technicians, engineers, and designers who are not redirected for every shutdown is critical to efficiently making progress on this effort. Consistent machine shop priority is necessary. People assigned at less than 50% of their time tend to be inefficient.

- Continue making and processing additional prototypes and involve industry as early on as possible. Use them to help refine and improve the cost estimates. Decide how many cavities to use in the beamline, and optimize the operating parameters.

- A mechanical and cryogenic safety review should be conducted on the proposed cavity and cryomodule system designs – including pressure reliefs, ODH, etc.

- Consider increasing the number of cavities for better reliability and availability. Cavity performance specifications could be relaxed, gaining in reliability. Sixteen cavities would result in four cavities per klystron and eight cavities per station, adding incrementally to the cost of the rf systems. The refrigerator has adequate reserve capability, but calculations should be reverified anyway.

RF Systems

- Consider constructing one of the final rf system units for use with the integrated prototype test in the beam, if that is not already the plan.

Cryogenics Systems

- Figure out in detail what it would actually cost to reuse the 4.5K refrigerator pieces and get the power up to the desired 300 W, including installation and commissioning. Use that information, coupled with the experimental reliability goals to decide which refrigeration system to use for this experiment. There are clear benefits associated with a new efficient system, but the real cost difference between the old and new systems needs to be clear.

1.4 Beam Interaction System, Vacuum Veto System, Vacuum Systems

Vacuum System and Veto Systems (WBS 2.2, 2.5, 2.6, 2.8)

FINDINGS:

- A 1/8 section of a vacuum veto module made from high-quality cast Bicron scintillator and mirrored fibers were successfully tested at Jefferson Lab using electrons. The extrapolation from electrons to photons at these energies is straightforward and demonstrates that this technology surpasses CKM's inefficiency requirements. The cost of this technology is prohibitively high however.

- The cost of injection-molded scintillator is considerably less than the cost of standard cast scintillator. R&D is underway to determine if the light output from injection-molded scintillator is sufficient. Small 10 cm X 10 cm pieces. Small 10 cm X 10 cm pieces of injection-molded scintillator from IHEP have been procured and tested for light output. The fiber grooves were included as part of the injection molding process. The light output results for the small injection molded scintillator tiles are compared to the light output of high-quality Bicron scintillator and found to be adequate. Full-size injection-molded scintillator tiles of the correct shape have not yet been produced.

- Installation of the veto system has not been costed. The cost of installation can be inferred from the installation costs of KTeV and will likely run between $500K - $1000K.

- A number of smaller items have also not been costed, including a pulser system, signal cables and CsI blockhouse infrastructure, controls and monitoring.

COMMENTS:

- A fair amount of engineering has been devoted to the design of the veto systems compared to other systems in CKM. More work remains to be done, though to arrive at a bottoms-up, resource driven cost estimate sufficient engineering and design resources will have to be made available.

- The committee is confident that a veto system that meets CKM's made. The technical risk associated with the injection molded scintillator is small, based on the results with the 10 cm X 10 cm samples, though the lever arm is significant due to the anticipated $6M cost differential.

- A successful beam test with a 1/8 section of a vacuum veto module was recently performed at Jefferson Lab. Plans exist to now build a full module, preferably using injection-molded scintillator for at least part of the detector. This seems like a logical next step and should prove useful in further developing the design, construction, assembly techniques, out-gassing studies and cost estimates.

- The design of the vacuum system has evolved recently. The new design is cleaner and more sensible than the old design, though more costly. Instantaneous loss of vacuum could prove catastrophic for the straw tube detectors as well as for the turbo pumps. Sufficient safeguards must be built into the design to minimize this risk. An extensive control and monitoring system will be required for the vacuum system. A cost placeholder exists for monitoring and control though there is no real design at this time.

- The design of the Beam Interaction Veto System is not as mature as the other veto systems. Work is underway at Brookhaven to move the design forward.

- Spares have been included in the cost estimates but in some cases the number of spares appears to be too low. For example, 24 spare Photomultiplier tubes have been included in the cost estimate of the vacuum veto system. 100 spares would be a more appropriate number.

- In general, a 60% contingency seems reasonable at this time. In a few instances where significant engineering resources have been devoted to a subsystem or where the cost is dominated by a large purchase with a well-known cost, a lower contingency is more appropriate."

RECOMMENDATIONS:

- Close out the qualification work and cost estimate for injection-molded scintillator as soon as possible.

- Develop a realistic cost estimate for installation of the veto systems including labor estimates for handling of the CsI crystals.

1.5 BTSM, UMS, DMS and Exit Time Plane

BTSM, UMS, and KEAT (WBS 2.3)

FINDINGS:

- The Beam Time Stamp Module (BTSM) will consist of two layers of 1 mm diameter scintillating fibers, read out by multianode photomultiplier tubes. The BTSM is required to have 1 ns time resolution. The collaboration has established the techniques that will be used to build the BTSM, but has not yet produced a working prototype.

- The Upstream Magnetic Spectrometer (UMS) and the Kaon Entrance Angle Tracker (KEAT) will be instrumented with eight identical multiwire proportional wire chambers. Each chamber will have six measuring planes with shared cathode planes. The anode wires will be 28 cm long and the wire spacing will be 0.8 mm. The anode to cathode gap will be 3 mm. The design of these chambers has not changed substantially since CKM was approved.

- The cost estimate for UMS and KEAT presented by CKM in June 2001, and that summarized by CKM management in this review, includes a detailed estimate of labor costs. However, both in June 2001, and in this review, the estimated labor costs have been inadvertently included in the M&S total, and an additional 46% of the total estimated cost added for labor.

COMMENTS:

- The time resolution achieved by the BTSM will depend on the yield of photoelectrons achieved. The estimate of photoelectron yield in the CKM proposal is based on D0 measurements, which were made with much longer fibers (with greater light loss due to absorption) and VLPC's (with much better quantum efficiency than pmt's).

- The design of the UMS and KEAT wire chambers is based on chambers built by the same group for HyperCP. The HyperCP chambers operated successfully in a beam with only slightly lower track density than is planned for CKM, and for a length of time comparable to what is planned for CKM. For part of the HyperCP experiment, the chambers used the same (fast, radiation tolerant) gas mixture that will be used in CKM. A detailed cost estimate exists for the construction of these chambers. Much of the work will be performed at Fermilab by experienced technicians.

RECOMMENDATIONS:

- Give priority to the construction of a working prototype of the BTSM. A prototype instrumented with only one multianode pmt would suffice to establish the achievable time resolution.

- Modify the cost estimate so that it agrees with the detailed cost estimate of M&S and labor for construction of the UMS and KEAT wire chambers.

WBS 2.7 Downstream Magnetic Spectrometer and Exit Time Plane

FINDINGS:

- The Downstream Magnetic Spectrometer consists of 4 stations of straw chambers operating inside the decay vacuum tank. The design is based on the straw system successfully operated in BNL E871.The main issue arising from the previous review was the fact that no straw system had ever been operated in a vacuum. At that time only single straws had been tested. Since then a 20 straw prototype and a 100 straw prototype have both been tested in a vacuum for 2 months without any problems. Cosmic ray tests show that these straws meet the required resolution.

- The leak rate due to diffusion through the kapton is low compared to the outgassing from the VVS. In the event of a sudden rupture of a straw the gas to that doublet could be turned off.

- The straws stretch when operating under vacuum but the reduction in tension due to this fact can be taken into account during assembly.

- Another issue that was raised in the previous review was the electroplating of the wires in the beam region. This only affects a small fraction of the straws (~10%) and should not be a major problem.

- The Exit Time Plane is not described in the proposal and no presentation was made at this review. The purpose is to identify kaons that pass through the detector without decaying. The technology is similar to that of the Beam Time Stamp Module

COMMENTS:

- The estimated costs seem reasonable for the current state of the design but the largest cost items – the frames and spool pieces need detailed engineering designs. Discussions with members of the CKM collaboration resulted in an

- The cost of the magnet has been taken out of the cost of the DMS because an existing magnet will be used. The cost of moving this magnet needs to be included in installation costs.

- The gas to be used has not yet been decided. The experience of BNL E871 was that a gas mixture with CF4 caused problems with cathode etching without a very high flow rate and a gas scrubbing system to remove sulfur.

- The leak rate due to diffusion has been tested with helium, nitrogen and neon, but not with any gas mixture that is being considered for an operating system. The tension on the straw has been measured in a long-term stretch test but this also should be tested using the proposed operating gasses. The straws in BNL E871 were glued together but this is not proposed for the CKM straws.

- Costs of front-end electronics, power supplies and cables are not included in this section.

RECOMMENDATIONS:

- It is recommended that an automated system be implemented for turning off the gas to a doublet in case of a sudden leak.

- It is important that the wires be centered in the straws. For straws one meter long the position of the wire in the straw should be measured to confirm that no wire-centering device is needed.

- The experiment estimated the labor needed to construct the DMS to be one engineer, one senior technician and four technicians for one year. This comes to $385k. Including the labor for the Exit Time Plane the total labor is $425k. The committee recommends using this number for the labor cost instead of the 46% of M&S.

1.6 Kaon RICH and Pion RICH

Kaon RICH and Pion RICH (WBS 2.4)

FINDINGS:

The philosophy taken by the experimenters is to base the design of these two RICH detectors as much as possible on the design of the existing highly successful SELEX RICH detector. Apart from an extension of the length by a factor of two, the pion RICH is basically identical to the SELEX RICH. This means that R & D on things such as the gas system, window materials, mirror specifications, mirror supports, phototube holders, etc has all been done previously. This also means that a cost basis is readily available.

As far as possible, the kaon RICH also follows this principle. Because the kaon beam is well collimated, the beam windows are smaller and the transverse size of the optical elements is less. This has led to a different optimization for the mirror system, putting a thin flat mirror in the beam path and a thicker spherical mirror and another flat mirror outside of the beam. The available gas choices also lead to a simpler filling system.

The technical progress since approval includes:

- Mirror prototyping has begun. A first thin flat mirror has been manufactured and a second (using low expansion Schott glass) will appear shortly. Plans for the upcoming year include a prototype for the 40m thin spherical mirror for the pion RICH and the manufacture of the 40m spherical mirror for the kaon RICH.

- The E756 RICH (which was used for SELEX test beam prototyping) is being restored for a CKM test beam run later this year. The phototube enclosure is being re-designed.

- A new phototube holder plate for the test beam RICH has been manufactured.

- New transistor-based bases are being designed by Fermilab for the SELEX RICH which is now a part of E907. CKM plans to use them. These will also incorporate a Cockroft-Walton circuit to supply the high voltage.

COMMENTS:

- The test beam goal is to examine the two gas choices available for the kaon RICH (N2 and CF4), including a pressure scan over the regions of interest. Unfortunately, the phototubes recently bought are mostly for the pion RICH.

have a reliable cost estimate at this time. However, since the PMTs are from a foreign supplier, future currency fluctuations must be kept in mind.

- Some of the items in the cost estimate have been mis-estimated. The mirror systems and the phototube holder plates were taken to be identical to the SELEX ones. For the pion RICH the optics is a 2m diameter cross sectional area, rather than the 1x2m SELEX system. For the kaon RICH, the optics is a 0.4m diameter cross sectional area.

RECOMMENDATIONS:

- Purchase additional R647 PMTs for the test beam RICH.

- Revise the cost estimate to include the correct mirrors and phototube holder plates.

1.7 Muon Veto System

Muon Veto Systems (WBS 2.10)

FINDINGS:

- A change in the detector design from that which was shown in the June, 2001 PAC Review resulted in an increase in the distance between the CsI array and the Muon Veto System (MVS). This will require a re-optimization of the muon veto criteria related to the energy fraction deposited in the first layer of the MVS but is not likely to affect the cost.

- There were many minor changes to the design of the MVS including: a change in the size of the array from 2.5 meters to 2.0 meters on a side; a reduction in the number of planes from 30 to 24, without a reduction in the total amount of steel; a decrease in the number of counters per plane from 60 to 54; and a decrease in the number of PMTs per counter from 2 to 1.25.

- The KTeV muon system, consisting of 2 steel absorbers and 3 planes of scintillators that contain approximately 300 PMTs, was added to the back-end of the MVS.

- CKM is considering a change to the counter design. They are considering the "NUMI" design, where the scintillator is less expensive but the PMTs are more expensive.

COMMENTS:

- The WBS and costs in the proposal are for the design prior to the changes in bullets 1 thru 3 above. The costs for individual items, such as scintillator slats, PMTs w/ base, etc, are, in my experience, reasonable estimates. However, the cost estimate should include some items that were not accounted-for in the zeroth-order pass. We redid the cost estimate to account for the design changes mentioned above and to include the new items as follows.

Table 1.

WBS	Item	#	Cost per item ($)	Subtotal ($)
2.10.1	Design/Prototype		20k	20k
2.10.2	Scintillator Slats (includes 5% spares)	1260	100	126k
2.10.3	PMT & Base (includes 10% spares)	1650	100	165k
2.10.4	Support Stands		50k	50k
2.10.5	Iron Absorber Slats (50 tons)		250k	250k
2.10.6	Shipping Charge		22k	22k
2.10.7	Case & Light Guide	1650	25	42k
2.10.8	Machining Hole in KTeV steel		20k	20k
2.10.9	KTeV Scintillator	300	0	0
2.10.10	Signal Cables	1900	15	29k
2.10.11	Pulser System	1	20	20k
2.10.12	Test Stands	2	5	10k
TOTAL				754k

1) Adoption of the NUMI scintillation counter design may result in 8-12 photons per PMT (a reduction from 30 per PMT). This may impact the MVS performance.

2) Viktor Kurshetsov, Leonid Landsberg, and Peter Cooper were cooperative, helpful, and very forthcoming throughout this process.

RECOMENDATIONS:

1) CKM should, as planned, evaluate the affect of the changed distance between the CsI array and the MVS so as to re-optimize the selection criteria.

2) CKM should evaluate the effect of the reduced light from the NUMI counter design on the MVS performance and include that consideration in any decision between competing designs.

3) CKM should adopt the new M&S cost, as described in the Table 1 above. This will be further modified to include 60% contingency and G&A, and 46% SWF with 60% contingency and G&A.

1.8 Front –End Electronics, Trigger and DAQ

Trigger and DAQ, Front End Electronics (WBS 2.11 and 2.12)

FINDINGS:

- During the technical review held in May 2001, the committee pointed out that the main technical risk associated with front-ends, trigger and DAQ was the proposed 220 kHz L1 accept rate. Since then, the CKM collaboration has completely revised the trigger and DAQ strategy exploiting technological advances in networking. They propose to operate their level 1 trigger on a farm of commodity PCs, rather than in custom hardware, effectively eliminating this concern. The data is continuously transferred from the front ends to this farm using commercial networking solutions.

- In this short time, CKM has made significant progress in simulating the system. This led them to develop a data transfer model used to evaluate the data size and required bandwidth, both out of the detector and into the level 1 farm. The simulation has further allowed them to estimate the cpu power needed in this farm. They have also performed a series of tests to establish data transfer rates over Gb ethernet, finding an average rate of 50 MB/s, compatible with typical rates found in other applications.

- For the front-end ADCs, they need 100MHz digitization with a 14-bit dynamic range (4-8 GeV with 0.25MeV least count) and deadtimeless, phase-insensitive operation. The collaboration is considering 2 options for ADCs, the most viable of which is a modified CMS HCAL QIE running at 100 Mhz. For the TDCs, CKM requires 1ns resolution, continuous hit storage and double pulse resolution of better than 10ns. They are also looking at 2 options for the TDCs, either an implementation in commercial FPGAs or an ASIC-based solution. They will use existing technology (Caen supplies and LeCroy 1440s) for their HV needs. They plan to achieve the required FE robustness by exploiting the redundancy in their system. This will be complemented with in situ monitoring (pulsing for TDCs, LEDs for PMTs).

COMMENTS:

- Globally, the committee thinks the proposed solution appears reasonable assuming the actual data volume is below 50GB per spill, and poses less technical and schedule risk than what is described in the June 2001 proposal. However, it is not uncommon for many, if not all, experiments to and to allow the performance to degrade gracefully in a controlled way. Another challenge this experiment has to face is the required level of robustness of the system, as discussed in the June 2001 proposal. Robustness is harder to achieve for high performance systems than lower performance systems. No experiment in the past has achieved this level of performance and robustness. Careful system and board level design, as well as careful planning of the system integration are crucial. The current DAQ model does not provide a mode for commissioning, calibration or testing of the sub-detectors for example.

- For the FE, the present cost estimates for TDCs and ADCs are based on roll-up costs of existing systems at CDF. However, the reviewers have revisited the CDF roll-up costs and have found the per channel cost for TDCs to be underestimated ($20/channel $29/channel). Although the CDF and CKM FE architectures will be quite different, the proponents contend that the level of complexity of the systems are equivalent and the cost estimate thus can be justified. In addition, the proponents believe they need to develop realistic prototypes before they can improve on their cost estimate. As for the HV, the collaboration proposes to re-use some existing equipment. The modifications for WBS 2.12 (with the inclusion of 10% spares) are as follows - $340K for wire chamber ASDQ, $1360K for QIE-TDC boards, $893K for TDC boards, $60K for HV (2.12.4), and $452K for HV (2.12.5-7). The overall FE cost is $3105K. It should be noted that for the QIEs, signal cables have not been budgeted. A contingency of 60% for M&S and 50% for SWF seems appropriate at this stage.

- Generally speaking, the committee finds that the development of the front-end and DAQ lags behind the rest of the experiment's development. In fact, essentially no technical documentation was available at the time of the review and many aspects of the new system have not explored at all.

- In their cost estimate, CKM made reasonable assumptions as to the future developments and costs of networking infrastructure, but these will be driven by the needs of industry and may not go in the direction which is optimal to fulfill the CKM requirements. In that case a different, more expensive network architecture could be necessary. Compared to Table 55 from the June 2001 proposal, the new design leads to the following changes: items 2.11.1 through 2.11.5 are obsolete. Items 2.11.6 through 2.11.9 seem reasonable. To this needs to be added: $640k for the level 1 farm PCs, $640k for the switch, $80k for fibers and connectors, $200k for disk and peripherals and $140k for spares (see T. Barker's talk). The total M&S cost is thus $2766k. Because of inherent uncertainties with implementing this innovative design and because of uncertainties in the direction of industry development (and the lack of a detailed design), the committee suggests taking a more is not included in this. Also lacking in the existing cost estimates is the online system, which includes high-reliability servers for online applications, database servers, monitors, etc. These could be included in installation and operating costs.

- For the FE, the present cost estimates for TDCs and ADCs are based on roll-up costs of existing systems at CDF. However, the reviewers have revisited the CDF roll-up costs and have found the per channel cost for TDCs to be underestimated ($20/channel→ $33/channel). Although the CDF and CKM FE architectures will be quite different, the proponents contend that the level of complexity of the systems are equivalent and the cost estimate thus can be justified. In addition, the proponents believe they need to develop realistic prototypes before they can improve on their cost estimate. As for the HV, the collaboration proposes to re-use some existing equipment. The modifications for WBS 2.12 (with the inclusion of 10% spares) are as follows – $411K for wire chamber ASDQ, $1360K for QIE-TDC boards, $1016K for TDC boards, $60K for HV (2.12.4), and $452K for HV (2.12.5-7). The overall FE cost is $3299K. It should be noted that for the QIEs, signal cables have not been budgeted. A contingency of 60% for M&S and 60% for SWF seems appropriate at this stage.

- CKM does not give a manpower estimate for the completion of this part of the project. For the trigger and DAQ part, the committee estimates based on past experience that 10 FTE years (physicists + electronics engineers) would be required, with a large uncertainty due to the lack of technical knowledge concerning the implementation of the data buffers and Gb ethernet drivers on the front-end side. This manpower estimate includes only minimal level 1 trigger algorithm development, and none beyond that.

RECOMMENDATIONS:

- The committee notes that the newly proposed solution appears feasible and commends CKM on pursuing this innovative approach. The simulation has been shown to be a very good tool in assessing the general system requirements, but needs improvements both in terms of adding the additional data from beam-related backgrounds and determining the processing needs for the higher trigger levels. In the near future careful engineering at the system level is needed to acquire further understanding of the constraints due to system integration. CKM should build a full chain, with a realistic data load generated in a frond-end crate and transferred to a processing node through a switch.

- The committee recommends that the collaboration update as soon as possible future reviews. In addition, modifying the per channel cost for FE electronics (including increasing the base cost of the TDCs as noted above) and increasing the channel count to include spares would help clarify the current cost estimate in the FE section of the proposal.

- Before requesting a Lehman review, they need to develop a detailed Technical Design Report in which they demonstrate understanding of how to reach the required system robustness, and describe handling of backpressure, buffering, error handling, online monitoring, load balancing at the crate and farm level, diagnostic capabilities and data integrity checks at all stages, etc. The committee emphasizes the importance for the system to have built-in self-testability both at board level and at system level, to allow the integration, commissioning, robustness testing, and fine-tuning of the Front-end and DAQ system in standalone mode. A careful system level design is needed to handle possible higher than expected data rate and to allow the performance to degrade gracefully in a controlled way. The committee notes that the option of using CPUs available in the crates as extra handle as mentioned by CKM needs more detailed study.

- A critical component of the proposed system lies in the synchronization among the different crates. CKM needs to develop an appropriate monitoring system, develop a mechanism to recover from clock glitches and a method to address the effects of local timedrifts. Slow controls and monitoring of the detector will be even more critical than in most experiments due to the extreme level of reliability required for successful completion of the experiment.

- The committee recommends to prioritize hardware development with the goal of getting to integration level tests during the course of this year, with an emphasis on QIE development. CKM needs system level engineering help and support now to achieve this. They will also need R&D funds for prototyping to put together a TDR and bottoms-up cost estimate. Some of the proposed components and constraints are very similar to those proposed in BTeV, and a collaborative effort could be explored.

1.9 Schedule & Cost Estimate Methodology

Project Management and ES&H (WBS 3.0)

FINDINGS:

- Cost estimates were presented in FY01 dollars.
- Several different projects were utilized as references to determine what factor was to be used to determine the SWF cost compared to the estimated M&S costs. The projects referenced are in different stages (Complete, in process or in development). For civil construction work a labor factor of 40% was used and for all other activities a 46% factor was used (average BTeV factor).
- Minimal installation costs were included in the cost estimate presented.
- The G&A (Indirects) percentages used were 28% for labor and 18% for M&S. The Indirect Costs were calculated by multiplying the sum of the Direct Costs and Contingency.
- Project Management and ES&H were estimated at 5% of the total project.
- CKM estimated that the project schedule would be 3 years of construction; 1 year of commissioning that may overlap with construction and 2 years of data taking. The start of the construction phase is not firmly established.
- CKM presented a target date of February 2004 for their Lehman Review.
- There is a potential of other funding sources than DOE, but nothing is firm and any additional funding would be a small portion of the total project cost.

COMMENTS:

- The high-level costs presented during the overview presentation did not always match the numbers presented during the more detailed system presentations. It is suggested that for future reviews, the project assures that the costs presented in the overview and the detailed presentations match.

RECOMMENDATIONS:

- The use of a 46% multiplier factor for determining the cost of the SWF based on the M&S costs was reviewed against the numbers in the Run IIb labor estimates when they exist instead of a standard factor. Some committee members did identify that some labor estimates did exist. The existing labor estimates were taken into consideration in establishing the review committee's cost estimate. 2) If a labor estimate does not exist then a multiplier factor for a comparable component or system (i.e. Trigger to Trigger) from other projects should be utilized instead of a general average project multiplier. 3) If a generic multiplier needs to be utilized because the data is not available for a comparable component or system then the use of the 46% multiplier factor appears to be appropriate for this point in the project.

- The G&A (Indirect) percentages used by CKM for their cost estimate was 28% for labor and 18% for M&S. The current percentages used by the lab are 30.4% for labor and 16.1%. It is recommended that the project adjust their Indirect percentages to better reflect the current percentages used by the lab. Also, the Directs should be multiplied by the Indirect rate and then the Contingency calculated on the sum of the Direct and Indirect Costs.

- CKM used BTeV as a guide for assigning a cost estimate for Project Management and ES&H (WBS 3.0), in which 5% of the total project cost was used. Costs estimated for Support (Project Management and ES&H) for Run IIb D0 and CDF projects were reviewed. D0’s support is approximately 8% of the project and CDF’s is approximately 6.4%. An increase of the support cost was recommended to both D0 and CDF during their last Director's Review. During the Director's Review of BTeV, the committee recommended an increase in the estimate for Project Management support, which came to 7.2% of the base cost. It is recommended that CKM increase the cost estimate for WBS 3.0 to at least 8%. CKM should assess if WBS 3.0 should be increased further since these costs not only cover the labor for management and administration, but also covers M&S costs for such things as project travel and miscellaneous supplies.

- Installation costs were not included in the original estimate presented on the first day of the review, but Peter Cooper did present an installation estimate of $2372K on the second day of the review. Using the installation costs of KTeV as a guide and looking at the differences of the M&S costs between the two projects, then escalating to FY01, dollars the installation estimate was increased to $3492K. CKM should further define the installation estimate by getting feedback from the leads of the components and systems that are to be installed in the tunnel and hall. CKM should also consider establishing the integrated installation as a level 1 WBS activity (i.e. 5.0).

- The review committee was charged with assessing the cost estimate for completing the CKM project. Based on the information presented during the review and the individual reviewer's experiences and expertise, a cost estimate was established. A summary of the cost estimate presented by CKM and the estimate established by the review committee is shown in Table 2 below. A more detailed breakdown of the cost estimate is shown in Attachment 1. Also in Attachment 1 are the notes containing information on what was considered in establishing the cost estimate.

Table 2
(Project and Review Committee's Project Cost Estimate)

WBS	Items	Project Estimate			Review Estimate	
		% Cont.	Original Total K$	Updated Total K$	% Cont.	Total K$
1.0	**Facility and Beam (totals)**	**44%**	**22640**	**22640**	**50%**	**48114**
1.1	Civil Construction	30%	4975	4975	30%	15498
1.2	Primary Beam	30%	1810	1810	105%	3813
1.3	Secondary Beam	30%	3742	3742	101%	11159
1.4	SCRF Plant and Equipment	60%	12113	12113	39%	17644
2.0	**Detector Systems (totals)**	**60%**	**44285**	**38054**	**54%**	**43004**
2.1	Test Beams	60%	566	566	60%	563
2.2	Vacuum Systems	60%	3073	4225	40%	4292
2.3	BTSM, UMS, and KEAT	60%	1978	1978	30%	906
2.4	Kaon RICH and Pion RICH	60%	7228	5185	50%	6214
2.5	Beam Interaction Veto System	60%	993	993	60%	989
2.6	Vacuum Veto System	60%	8530	5923	49%	7625
2.7	DMS and Exit Time Plane	60%	2060	2060	60%	2400
2.8	Forward Veto System	60%	0	462	60%	636
2.9	CVP, HVS, and Beam Dump	60%	586	586	60%	582
2.10	Muon Veto System	60%	2490	1612	60%	2123
2.11	Trigger and DAQ	60%	6631	6631	67%	8113
2.12	Front-end electronics and HV	60%	10149	7832	57%	8561
3.0	**Project Management and ES&H**	0%	**3406**	**3406**	**30%**	**6808**
4.0	**Offline Analysis**					
	(New) Installation	**30%**		**2372**	**30%**	**3492**
	Totals	**51%**	**70331**	**66472**	**49%**	**101418**

2.0 Management

The CKM collaboration is quite strong with 48 members from 10 institutions including four laboratories. It is expected to grow to about 100 before coming into operation about six years from now. The ramp up will need to be rapid for a FY05 project start. Good engineering support is available by and large. Additional engineering support (and additional physicists) is (are) needed for the primary (and secondary) beamline design, front end electronics, and trigger/DAQ. A project manager, a scheduler, and a project budget officer are critical additional staff acquisitions needed immediately. The CKM team would like to schedule a Lehman Review for February 2004. Much effort on the part of the collaboration will be required to be ready for such a review. The work breakdown structure (WBS) is in an embryonic form and no schedule information was presented. A highly developed WBS and a comprehensive resource loaded schedule will be required for both a Lehman Review and another Director's Review to be conducted prior to the Lehman Review

2.1 Action Items

1) The CKM team should work with the Fermilab divisions, sections, and offices (PPD, BD, TD, and FESS) to develop a beamline design and civil construction conceptual design.

2) A review should be conducted in less than two months of the CKM civil and conventional facilities design criteria (to be) provided to FESS. The review panel should be external to CKM and should be comprised of accelerator physicists/engineers, mechanical, electrical, civil, and radiation safety engineers. Work can begin immediately with FESS to begin developing these criteria between the CKM (BD/PPD) physics and engineering staff and FESS engineers.

3) Progress in beamline and conventional facility design efforts should be reviewed in another Director's Review in about six months in September 2003.

4) A thorough Director's Review of the complete CKM project should be conducted about 2 months prior to the first Lehman Review. Material provided to reviewers should include a Conceptual Design for the Conventional Facilities and a Technical Design Report for the Beamlines and the Detector.

Appendix A

Charge for the Director's Review of the Charged Kaons at the Main Injector (CKM) Project At Fermilab

February 24, 25, 2003

The proposed Charged Kaons at the Main Injector (CKM) Project at Fermilab was approved by Director Witherell in June 2001 following a recommendation for approval by the Physics Advisory Committee (PAC).

The CKM Collaboration has prepared a Technical Design Report (TDR) and cost estimate for completing the experiment. The CKM Project is in the early stage of project development. It will be considered by the P5 (Particle Physics Project Prioritization Panel) Panel in late March.

This Director's review will have two foci: 1) the technical progress since approval, and 2) cost estimates of the project. The committee should review the overall technical progress of the project and focus particularly on the areas of technical risk identified by the PAC. The systems of specific concern are: the Vacuum Tracker (Downstream Magnetic Spectrometer), the Photon Veto Systems, the Superconducting RF Separator, and the Trigger/DAQ.

The lynchpin for the CKM cost estimate is an exhaustive parts list and detailed M&S estimates. Therefore careful examination of these estimates and judgments of their validity is a primary task of the committee. CKM will describe an estimating algorithm they have used to scale labor costs based on their M&S costs. The committee is asked to comment on the reasonableness of this procedure. Finally, based on the experience of members of the committee, they are asked to judge the completeness of the CKM estimate and the adequacy of the estimate including contingency to complete the scope of the project on the proposed schedule and within the proposed cost range.

Appendix B

Director's Review of CKM – February 24-25, 2003
Participants

Lastname	Firstname	Affiliation
Cooper	John	
Dixon	Roger	
Kephart	Bob	
White	Vicky	
Barker	Tony	CKM/FNAL
Bellantoni	Leo	CKM/FNAL
Coleman	Rick	CKM/FNAL
Cooper	Peter	CKM/FNAL
Hansen	Sten	CKM/FNAL
Haynes	Bill	CKM/FNAL
Kendziora	Cary	CKM/FNAL
Kilmer	Jim	CKM/FNAL
Kobilarcik	Tom	CKM/FNAL
Krider	John	CKM/FNAL
Nguyen	Hogan	CKM/FNAL
Ramberg	Erik	CKM/FNAL
White	Herman	CKM/FNAL
Wu	J.Y.	CKM/FNAL
Kurshetsov	Viktor	CKM/IHEP, Protvino
Landsberg	Leonid	CKM/IHEP, Serpukov
Niclasen	Rune	CKM/U Colorado
Wilking	Mike	CKM/U Colorado
Campbell	Myron	CKM/U Michigan
Longo	Michael	CKM/U Michigan
Dukes	Edmond	CKM/U Virginia
Nelson	Ken	CKM/U Virginia
Engelfried	Jurgen	CKM/Un.Auto de San Luis
Appel	Jeff	Directorate
Holmes	Steve	Directorate
Montgomery	Hugh	Directorate
Stanfield	Ken	Directorate
Witherell	Mike	Directorate
Hoffer	Dean	Reviewer/Directorate
Temple	Ed	Reviewer/Directorate
Bogert	Dixon	Reviewer/FNAL
Brooijmans	Gustaf	Reviewer/FNAL
Christian	Dave	Reviewer/FNAL

Kasper	Penny	Reviewer/FNAL
Liu	Ted	Reviewer/FNAL
Ray	Ron	Reviewer/FNAL
Stutte	Linda	Reviewer/FNAL
Tschirhart	Bob	Reviewer/FNAL
Whitmore	Julie	Reviewer/FNAL
White	Marion	Reviewer/SNS-ANL

Appendix C

DRAFT AGENDA FOR CKM DIRECTOR'S REVIEW

Monday, February 24th:

11:00	Committee executive session. (closed)	
11:30	Charge from Directorate. (open)	Hugh Montgomery
11:45	Review objective, plan and techniques.	Ed Temple
12:00	Introduction to the experiment.	Peter Cooper
12:30	Lunch. (Lunch provided by FNAL)	
13:00	Results from and issues raised by previous technical reviews.	Bob Tschirhart
13:30	Costing methodology and cost reviews.	Herman White
14:00	SCRF technical issues and cost estimate. (30 min talk/15 min questions) WBS 1.4	Leo Bellantoni
14:45	Vacuum Tracker technical status and cost estimate. (30 min talk/15 min questions) WBS 2.7	Hogan Nguyen
15:30-16:00	Break.	
16:00	Photon Veto technical issues and cost estimate. (30 min talk/30 min questions) WBS 2.6	Erik Ramberg
17:00	Committee executive session.	
18:30	Drinks	
19:00	Dinner.	

Tuesday, February 25th:

8:30 Trigger/DAQ technical issues and cost estimate. (30 min talk/30 min questions) WBS 2.11 — Tony Barker

9:30-12:00 *** Parallel Breakout Sessions *** — (Proponent)/(Reviewer)

- WBS 1.[1,2,3] Civil Construction & Beams: (White,Coleman,Kobilarcik)/(Bogert)
- WBS 2.3 BTSM, UMS, KEAT: (Dukes,Nelson,Longo)/(Christian)
- WBS 2.4 Kaon/Pion RICH: (Kilmer,Cooper,Engelfried)/(Stutte)
- WBS 2.10 Muon System: (Landsberg,Kurshetsov)/(Diehl)
- WBS 2.12 Front-end electronics: (Wu,Haynes,Hansen,Tschirhart,Campbell)/(Whitmore)

Second pass, likely necessary: (First pass was Monday/Tuesday-AM)

- WBS 1.4 SCRF: (Beam Group)/(White)
- WBS 2.[2,5,6,8] Photon Veto Systems: (Photon Veto Group)/(Ray)
- WBS 2.7 Vacuum Tracker: (Nguyen,Krider,Kendziora)/(Penny Kasper)
- WBS 2.11 Trigger & DAQ: (DAQ Group)/(Liu & Brooijmans)

12:00-12:30 Lunch.

12:30-16:00 Executive Session-Committee Writes Report (closed)

16:00-16:30 Closeout with Reviewers and Proponents.

CKM Detailed Cost Estimate Table (Attachment 1)

Spreadsheet Cost Notes:

WBS 1.1 -

A) Raised Civil M&S costs by $3738M to reflect:

1) Increase of costs for 928 foot extraction enclosure (my experience)- added $2.5M
2) Increase estimate (no estimate in project for this) for modifications of MP-9, primary beam civil mods, etc. - added $1.238M

B) Raised SWF by $2895M to reflect:

1) This will be a difficult set of drawings to prepare. Added $2M for A&E costs (my experience - all folded into my $8K/foot e estimate).
2) Title 3 will be more expensive also - my experience - see above. Added $895K.

WBS 1.2 & 1.3 – As stated in the comments section of the report, there are many subsystems that are not yet included in the cost estimate for the pri secondary beams. There was no way of doing a good job of adding those costs during this review. In the spirit of trying to give an independent however, the following steps were gone through:

(1) Remove $102k of EDIA which was included in the M&S for WBS 1.2
(2) Remove $29k of installation cost from M&S
(3) Move the $450k for LEP Quads from "existing" to "new"
(4) Estimate SWF as equal to M&S
(5) Add 10% to M&S as overall installation cost
(6) Take 70% contingency on the above, which is meant to cover both normal contingency and some wild guess of missing systems
(7) Add 70% contingency on "existing equipment" Note that because there is no column for existing equipment in the spreads somewhat misleadingly works out to about 100% contingency on the items listed as new.

WBS 1.4 - The cost change in cryogenics is a result of evaluating the design and cost estimate for the proposed new refrigeration system. Many purchased, quasi off-the-shelf, and there is technical contingency in the design, so we feel comfortable with a lower contingency. The design is functioning system so is conservative.

The Indirect Costs were reduced because the PO for the SCRF Cryo will be over $500K. This means the PO is only charged the Indirect rate of 16.1 first $500K. The PO is estimated at $4,191K, which $3,691K is exempt from Indirect charges.

WBS 2.1 - No changes

WBS 2.2 - Cost escalation due to recent changes to vacuum system brought to the attention of the committee by CKM.

WBS 2.3 - It was discovered that CKM's number included the estimated labor costs in M&S, & then estimated labor as 46% of that total. In additi Dukes' most recent estimates of parts and labor costs were used, which give a number very slightly less than the number presented, and a rate of $27 used as the cost of a Fermilab Senior Technician (the number used in the BTeV cost estimate) rather than the $400/day that Craig used. Also, the co was reduced from 60% to 30%. This reflects the fact that the U. Va. group and the Fermilab technicians who will be building the chambers have similar chambers in the past & there is confidence that the cost estimate is a pretty good one.

WBS 2.4 - The base M&S cost was reduced by 129K, the dollar amount given in P. Cooper's table 'WBS Cost Breakdown and Changes'. In ad percentage of contingency on M&S was lowered from 60% to 45% to account for the recent PMT quote.

The Indirect Costs were reduced because the PO for the PMTs for the RICHs will be over $500K. This means the PO is only charged the Indirect rate on the first $500K. The PO is estimated at $1,342K, which $842K is exempt from Indirect charges.

WBS 2.5 - No changes

WBS 2.6 - A few small changes (both up and down) due to refined understanding of costs and contingencies for PMTs, fibers, and scintillator.

The Indirect Costs were reduced because the PO for the PMTs for the VVS will be over $500K. This means the PO is only charged the Indirect rate of the first $500K. The PO is estimated at $751K, which $251K is exempt from Indirect charges.

WBS 2.7 - M&S increased by $87K, from discussion with CKM experimenters on the cost of the spool pieces for the DMS. SWF increased by experiment estimated the labor needed to construct the DMS to be one engineer, one senior technician and four technicians for one year, which calc cost for the DMS to be $385K and then added $40K for the Exit Time Plane for a total of $425 instead of using the CKM labor estimate of 46% of M&

WBS 2.8 - Cost escalation due to unaccounted costs for CsI mechanical systems, infrastructure, environmental control and monitoring.

WBS 2.9 - No changes

WBS 2.10 - There were many minor changes to the plan that reduced the overall cost. These include a reduction in the size of the detector, a reduct number of scintillator planes, and a decrease in the number of scintillation counters that have two photomultiplier tubes. The $247K cost savings of thes were offset by the addition of $121k of items that were overlooked or not present in the original plan.

WBS 2.11 - Complete re-design from what was in the proposal. Cost estimates taken from Tony Barker's presentation. Reviewers felt that this estimate was appropriate but increased contingency in case industry costs fail to decrease as rapidly as predicted. Contingency based on D0 experien larger contingency placed on the switch. SWF estimate was based on D0 RunII Trig/DAQ estimates, with slight increase for larger farm, and slight de easier buffer management.

WBS		***Num***	***Cost each***	***Total***
2.11.1	CPUs	400	1600	640K
2.11.2	Switch	800	800	640K
2.11.3	Fiber	800	100	80K
2.11.4	Disks			200K
				140K
2.11.6	Clock			221K
2.11.7	Crates			610K
2.11.8	VME contr.			180K
2.11.9	Scopes, etc.			55K
2.11	Total			2766K
2.11	Contingency - 70%			
2.11	SWF - 60%			

WBS 2.12 - Changes to base cost estimate due to increase in ASDQ electronics from more detailed calculation and decrease in number of channels, i TDC cost estimate due to a miscalculation of CDF Run2 cost and an estimate of similar system from CDF Run2b, decrease in HV cost from re-use o KTeV equipment. Channel count was increased by 10% for items 2.12.1-3 to account for spares. Contingency is based on CMS HCAL and CDF Run estimate comes from CDF Run2a electronics, with no SWF associated with 2.12.1 and 2.12.4-7. Both contingency and SWF were increased due to c of the system and lack of conceptual design.

WBS		***#chan***	***Cost***	***Total***
2.12.1	ASDQ	20,000	$10/chan --> $17/chan	340K
2.12.2	QIE/TDC	6,798	$200/chan	1360K
2.12.3	TDC	30,800	$20/chan --> $29/chan	893K
2.12.4	HV	4300 chan --> 300 chan		60K
2.12.5-7	no change			452K
2.12	Total			3105K
2.12	Contingency - 60%			
2.12	SWF - 50%			

WBS 3.0 - Costs estimated for Support (Project Management and ES&H) for Run IIb D0 and CDF projects were reviewed, as the last Directors Review recommendation of BTeV's fro estimating Project Management costs. An 8% multiplying factor project cost was used.

Installation - Used the installation costs of KTeV as a guide and looked at the differences of the M&S costs between the two and escalated it to FY01 dollars.