U.S. ATLAS M&&O Estimate
Cost Book AY$

Funding All **Funding Type:** Research Program
Institutions: All

WBS Number: 3.3 **Description:** Liquid Argon

Institution : **Contact**

The M&O estimate for the Liquid Argon Calorimeter includes costs for the commissioning, pre-operations, test beam activities, operations, maintenance, CERN living expense supplements, travel and CERN common costs. It is divided into sections describing the mechanical and electrical systems, test beams, and CERN common costs.

1) Model for the cost estimates of the M&O for the mechanical systems:**Details of Estimate:**
The cost estimate for the pre-operations, commissioning, maintenance and operations of the mechanical components of the Liquid Argon Calorimeter is based on the assumption that US will continue to be responsible for its deliverables: barrel cryostat, feedthroughs, FCal and for the cryogenics. In the construction project, the US contributes ~50% of the total cost of those components. There are three stages of the M&O program: (1) FY03-FY04 - commissioning of the cryostat with its temporary cryogenics in the surface building 180 and the commissioning of the Liquid Nitrogen refrigerator in the USA15; (2) FY05-FY07 - integration and re-commissioning of the cryostat, of the feedthroughs vaccum an dcontrol systems and of the cryogenics in the final configuration in the experimental pit; (3) FY08-FY12 - operations and periodic maintenance of the experiment.

Barrel cryostat pre-operations involve continuous cold tests both in Bldg.180 prior to the transport to the pit and after its installation in the experimental hall. The work will include welding of the cryostat shut after the installation of the calorimeter modules and completion o f all the tests, installation and commissioning of the solenoid magnet. A complete check of the feedthroughs' vacuum and their monitoring systems will be done after the completion of module installation in Bldg.180. Several feedthroughs will be disconnected from the vacuum system for the transport to the experimental hall to allow for proper crane operations. They will have to be reassembled in the pit and another complete vacuum and monitoring check will be done in FY06. The temporary cryostat cryogenics system assembled in Bldg.180 in FY03 will be operational in FY04 and FY05. The final cryogenics will be commissioned in FY06 after the installation in the pit.
Similar procedure will be followed for the Endcap cryostats where the purity monitors and cryogenics control software will start operations in
bldg 180 for the cold tests, while the final test and operations will commence after the transport to the cavern.
The operational system of the LN2 refrigerator and of the inter-connects will be commissioned in FY05 and FY06.

During the experiment operations a CERN based crew will be supported by the CERN Common Costs. Calibration of the monitoring equipment (including quality meters), maintenance of the data bases and of the repair stations for feedthroughs' components, quality meters and of the monitoring electronics will remain US responsibility. BNL, Stony Brook and the Arizona groups will maintain the test and repair equipment throughout the period of the experiment. BNL will also maintain the control software for the cryostat and cryogenics systems.

2) Model for the cost estimates of the M&O for the electronics and electrical systems

The components of the system crate: pedestals, warm cables and base planes, have been already installed on the barrel end endcapC cryostats and will be installed on the endcapA cryostat in 2003. The crates and the readout board system will be installed on the cryostats after their move to the expoerimental pit i.e., in FY05-FY06. Several pedestals will have to be removed for the transport and re-installed in the pit due to the physical conflict with the transport.
The commisioning will start in the West Hall in FY04. A portable full readout crate system and a test station will be used to check the status of each calorimeter module after the each cryostat is closed but before it is welded shut. The pre-operations will include: the full crate test of the readout system, the long-term boards burn-in facility, a portable full crate test station for the commissioning of the calorimeter modules in Bldg. 180, the commissioning of the electronics readout after its installation on the detector (in the pit) and the specialized electronics for the beam tests. The system crate, optical links, Level 1 trigger system, and the ROD system will require costs for pre-operations. A long-term burn-in of the integrated system crate will be performed to flush out the infant mortality components

before the commencement of operations. Documentation update (including final layouts and drawings) will be made during the commissioning stage.

The estimates for operations and maintenance are based on the LHC run model of 7 months of proton-proton collisions, 2 months of heavy ion collisions and 3 months detector access per year. For such model, the ATLAS Liquid Argon Electronics
Coordination group estimated a need for the on-site electronics operations crew of 1 supervisory Electrical Engineer and 5 electronics technicians working in shifts. This crew (paid from the CERN Common costs with a 20% US share) will identify problem boards/components, replace with spares (if accessible) and run simple diagnostic tests. It is expected that during the standaqrd yearly access additional experts from the home institutions will be needed at

CERN to help in de-bugging and problem solving as they arise. Simple repairs will be made at CERN. Boards with more difficult problems will be sent for repairs to the "home" institutions (Nevis, BNL, Pittsburgh, SMU) responsible for their maintenance. Each institution will maintain the expertise and the necessary test and repair equipment. In addition, these institutions will need to update the supply of spares from time to time as needed. This model is similar to that used e.g., at PHENIX, D0 and ZEUS.

Maintenance and operations of the Liquid Argon Calorimeter electronics in FY07-FY12 covers the following seven categories:
front-end electronics, level 1 trigger interface, ROD system electronics, power supplies, detector control and cooling systems, cables, crates, and connectors, optical links.
The numbers of the units are as follows:
The number of the Front-End Boards installed in the system:

Type	Number
Front End Board	1524
Calibration Board	122
Tower Builder Board	120
Tower Driver Board	20
Controller	114
Monitoring Board	146
LV Boards (HEC)	24
Total	2070

There are 2 cooling plates for each board and an extensive, water based cooling system.

There are 4 main types of power supplies.

Type & number installed	number of units/supply
Front End Crate supplies	63 & 18
ROD VME crate supplies	54 & 4
Level 1 Interface Crate supplies	8 & 4
HEC LV Supplies	8 & 12

The (Optical) Link components are:

Connection/type	number installed
FEB-ROD/optical	1524
ROD-FEB optical/Cu	762
System crate/optical	114
FT-Baseplane/Cu (flex)	3048
TBB-Receiver/Cu (shielded TP)	240
TDB-Receiver/Cu (shielded TP)	120

The Level 1 trigger receiver/monitor system, located in the USA15 cavern, will consist of eight 9-U VME crates filled with 16 modules each. Each module contains 64 analog channels.

The modules in the ROD system (not including TTC hardware) are:

Type	Number installed
ROD modules	192
TBM modules	16
SPAC modules	16
Total	224

The estimated failure rate of the FEB components is based on the engineering judgment and on the experience of the D0, H1 and ZEUS experiments. The failure rate will require a replacement with spares of about 100-150 readout boards during the yearly access. These boards will be diagnosed and repaired during the operations period and made ready as spares for the next access cycle. During the access, US based technicians and postdocs will

supplement the operating crew, as a single board replacement will require a minimum of 3 people for 3-4 hours. This is after the experiment has been opened and the scaffolding and access platforms have been set up. It is estimated that it will take 2 weeks to open the detector and two weeks to close it down. Duirng that period safety interlocks for HV, lasers etc., must be monitored. The US institutions must maintain a crew of technicians and a fraction of high-level electrical engineers for problem diagnoses and repairs. It is expected that during the operation's period FY07-FY12, the electrical engineers will work on the R&D and on the design of electronics for the LHC upgrade, but that they will be available for special tasks and consultations. The specialized test equipment, which will be quite heavily used, must be kept operational and up to date. For the purpose of estimating the maintenance cost for such equipment, it was assumed that it would be replaced every three years.

3) Model for the cost estimates of the M&O for the test beams activities

There are three test beam periods for ATLAS LAr systems: 1) during the August 2003 - April 2004 the Combined Barrel test run will measure a complete electromagnetic and hadronic calorimeters responses to the electrons and pions. 2) The calibration run for the FCAL is scheduled for June-September 2003. 3) A combined EMEC/HEC/FCAL

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	9198	0	0	9198	101	6956	234	1906	4010.0	1439.4

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Computer Professional R	0	0	7228	4343	2714	2728	2496
	0	0	542.611	328.051	209.912	221.292	201.454
Electrical Engineer R	0	0	4762	7134	4610	3546	3345
	0	0	356.275	686.854	462.399	331.802	315.088
Mechanical Engineer R	0	0	1548	3381	1700	1717	1633
	0	0	148.338	183.535	96.448	101.288	98.209
Sr Research Scientist R	0	0	0	399	294	295	296
	0	0	0	31.441	23.791	24.505	25.24
Technician R	0	0	9493	9664	4240	5788	7105
	0	0	629.811	728.18	315.801	461.844	533.358

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	498.2	707.1	202.9	290.4	294.4
Travel R	0.0	0.0	10.0	0.0	0.0	0.0	0.0

WBS Number: 3.3.1 **Description:** Mechanical M&O Estimate

Institution : **Contact** Not available

The mechanical M&O estimate for the Liquid Argon Calorimeter includes costs for pre-operations, commissioning, operations and maintenance.
Comments: US contributes ~50% of the cost of the ATLAS LAr mechanical components: cryostats, feedthroughs, cryogenics and FCal. US will continue to be responsible for its deliverables during the commissioning, operations and maintenance stage of the experiment. There are three stages of the M&O program: (1) FY03-FY04 - commissioning of the cryostat with its temporary cryogenics and of the FCal in the surface building 180 (West Hall); (2) FY05-FY07 - integration and re-commissioning of the cryostat and cryogenics in their final configuration in the experimental pit; (3) FY08-FY12 - experiment operations with periodic maintenance.

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	1727	0	0	1727	101	1391	0	234	847.9	869.4

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Computer Professional R	0	0	2608	678	430	345	434
	0	0	128.461	29.23	19.035	15.631	20.194
Electrical Engineer R	0	0	131	0	0	0	0
	0	0	16.201	0	0	0	0
Mechanical Engineer R	0	0	1548	3381	1700	1717	1633
	0	0	148.338	183.535	96.448	101.288	98.209
Technician R	0	0	2309	1695	982	986	990
	0	0	202.357	152.635	90.849	93.577	96.382

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	90.6	33.6	19.0	20.7	22.4
Travel R	0.0	0.0	10.0	0.0	0.0	0.0	0.0

WBS Number: 3.3.1.1 **Description:** Pre-operations and commissioning

Institution : **Contact** Not available

Details of Estimate:

The calorimeter (barrel and two endcaps) will be completed on the surface and will be operated using temporary cryogenics, controls and readout. It will be then transferred to the pit and integrated with the rest of the detector. This will require changes to the cryogenics, controls and readout. Pre-operations shall include:

1. Updating the documentation in CDD format to include all the changes to the hardware from the pre-operations stage of the experiment. The documentation to be updated includes, as a minimum, new drawings, procedures and software.
2. Acceptance test procedure, and data recording including calculations required by the CERN safety group.
3. Integration tooling and fixtures including calculations needed for integration and installation in the pit. .
4. Cryostat operations on the surface (common cost item).
5. Facilities setup that include as a minimum, equipment, and a safety program
6. Pre-operations of hardware.
7. Disassembly and re-assembly of feedthroughs for the move from Building 180 to the pit.

During the pre operations stage of the experiment, the documentation in CDD format will be updated to reflect the changes made to the hardware during commissioning. An integration acceptance test procedure will be generated and data recorded. In addition, integration tooling and fixtures will be developed for integrating level 3 subsystems.

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
0	0	0	0	0	0	0	0	0.0	0.0

WBS Number: 3.3.1.1.1 **Description:** Cryostat

Institution : **Contact** Not available

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	0	0	0	0	0	0	0	0	0.0	0.0

WBS Number: 3.3.1.1.1.1 **Description:** Cryostat documentation update

Institution : BNL-M&O **Contact** J. Sondericker

Cryostat documentation update. CERN safety group requires a complete documentation of any cryogenics system in operation. The documentation must be submitted in the CDD format. For the cryostat the documentation will need to be updated twice: once for the operations in the West Hall and the second time after the move to the experimental pit. It is expected that some of the interfaces will be modified during the integration.

Details of Estimate:

Labor assumes 1/5 FTE of a mechanical engineer in FY05 and FY06 (J. Sondericker/ M. Rehak) to update the cryostat documentation and to provide calculations required for the integration in the pit. It also includes the Designer for drawing preparation and update (J. Farrel). One needs to review and upload 20 drawings into the CDD. Time estimate is 1 day per drawing or 160 hours in FY04 and 160 hours in FY05.Travel: - 4 trips to CERN in FY05 and 4 in FY06 at $2500per trip or $15000. The final review must be done after the move of the cryostat to the final position and start of final operations in FY07.

Management reserve.

The elements of this task are put into management reserve for 05, 06 and 07

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
0	0	0	0	0	0	0	0	0.0	0.0

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.1.1.2 **Description:** Feedthrough

Institution : **Contact** Not available

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	0	0	0	0	0	0	0	0	0.0	0.0

WBS Number: 3.3.1.1.2.1 **Description:** Signal FT Documentation update

Institution : BNL-M&O **Contact** T. Muller

Documentation update for the signal feedthroughs. CERN safety group requires a complete documentation of any vacuum and cryogencis system in operation. The documentation has to be done in the CDD format. The documentation will have to be updated twice: once for the operations in the West Hall and the second time after the move to the experimental pit. It is expected that some of the interfaces will be modified during integration.

Details of Estimate:

Labor assumes 1/7 FTE in FY03, 1/17 FTE in FY04 and FY05 and 1/30 FTE in FY06 of a mechanical engineer (T. Muller). In addition a work of a Designer (J. Farrel) is needed to update the feedthrough's documentation drawings. Task includes an update of drawings and upload into CDD. There are 15 drawings including FT assembly drawings. Each drawing will need an average of 10 hours for review and update. Total of 150 hours in 2005 and 150 hours in 2006.

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
0	0	0	0	0	0	0	0	0.0	0.0

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.1.1.2.2 **Description:** HV FT Documentation Update

Institution : SUNY SB **Contact** Not available

Documentation update for the HV feedthroughs. CERN safety group requires a complete documentation of any vacuum and cryogenic system in operation. Some interfaces are modified during the installation. It is expected that more changes will occur during the integration.

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	0	0	0	0	0	0	0	0	0.0	0.0

WBS Number: 3.3.1.1.2.2.1 **Description:** HV FT Document Update - SBU

Institution : SUNY SB **Contact** Not available

Documentation update for the HV feedthroughs. CERN safety group requires a complete documentation of any vacuum and cryogenic system in operation. Some interfaces are modified during the installation. It is expected that more changes will occur during the integration.

An update and upload of the information on the filter box and overall assembly will require a labor of a senior technician in FY06. There are 10 drawings for the filter box and 6 drawings for the cabling at 10 hours per drawing

Details of Estimate:

Labor assumes 1/10 FTE of a mechanical designer in FY06 to update the HV Feedthrough documentation.

Base & infrastructure;
Labor assumes 1/10 Physicist in FY06 to review and support documentation update.

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
0	0	0	0	0	0	0	0	0.0	0.0

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.1.1.2.2.2 **Description:** HV FT Document Update - BNL

Institution : BNL-M&O **Contact** Not available

Documentation update for the HV feedthroughs. CERN safety group requires a complete documentation of any vacuum and cryogenic system in operation. Some interfaces are modified during the installation. It is expected that more changes will occur during the integration.

BNL: Upload to CDD of the HV mechanical assembly drawings, update test results on **Details of Estimate:**
bellows, welding certification etc., will require work of aq Mechanical Engineer (T. Muller) consisting of 15 days ib FY04 and 15 days in FY05. It will also require 1 month labor of a Designer (J. Farrel) in FY04 and 1 month in FY05. This represents 1/17 FTE of a mechanical engineer and 1/12 of a mechanical designer in FY04 and FY05.

Base & infrastructure;
Labor assumes 1/10 Physicist in FY06 to review and support documentation update.

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
0	0	0	0	0	0	0	0	0.0	0.0

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.1.1.3 **Description:** Cryogenics

Institution : **Contact** Not available

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	0	0	0	0	0	0	0	0	0.0	0.0

WBS Number: 3.3.1.1.3.1 **Description:** Documentation update

Institution : BNL-M&O **Contact** J. Sondericker

Documentation update for the cryogenics. CERN safety group requires a complete documentation of any cryogenics system in operation. The documentation has to be provided in the CDD format. The documentation will need to be updated twice: once for the operations in the West Hall in FY04 and the second time after the move to the experimental pit in FY05 and integration in FY06. The cryogenics control systems are different for the two operations. IN Bldg. 180 the LN2 is vented. In the experimental hall there is a LN2 recovery and re-circulation system. Software controls use different programming schemes.

Labor assumes Mechanical Engineer (J. Sondericker): 1/12 FTE in FY05 and 1/12 FTE in **Details of Estimate:**
FY06 to write the operations manual and a Mechanical Designer (Y. Farrah) to update the documentation of the software operations for the refrigerator and for the implementation of the safety procedures for the operations in the pit: 1/6 FTE in FY05 - FY07.
. Travel:- 1 trip to CERN0year in FY05 - FY07 at $2500per trip

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
0	0	0	0	0	0	0	0	0.0	0.0

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.1.1.3.2 **Description:** Cryogenics Commissioning

Institution : BNL-M&O **Contact** Not available

Commissioning of all cryogenic equipment.
Commissioning in the West Hall will require the following tasks:
1. Around the clock cold tests support.
2. Closing of the Cold Vessel - Support in closing of the Cold Vessel which includes:
   A. Monitoring installation of the Omega seals in preparation for welding the cryostat flanges shut.
   B. Certification welding samples prepared, test samples welded, evaluation, and supervision
   C. Monitor torquing of cold vessel bolts
   D. Supervision of welding safety practices to prevent superinsulation fires.
   E. Pump - down of individual flange seals and leak check.
3. Feedthrough Vacuum and Monitoring
   A. Complete testing of the Feedthrough Good and Bad Vacuum systems
   B. Commissioning of the Feedthrough head flange heater system to avoid condensation on temperature monitoring instrumentation
4. Solenoid Magnet Installation
   A. Installation of the Solenoid Magnet in the Cryostat.
   B. Installation of super insulation blankets.
   C. Provide support to KEK to install SC buss bar and shield to He supply dewar.
   D. Magnetic field test measurement in the West Hall
   E. Commissioning of the solenoid magnet system
5. Test of the barrel cryostat Insulating Vacuum System - Commission the insulating Vacuum System of the warm barrel cryostat vessels by
   He leak checking the entire warm vessel while under vacuum.
6. Cold test - Commissioning the BC Cryogenic System by cooling down the cold vessel, filling with LAr and warming to 89K operating conditions.
7. Commissioning in the cavern

Details of Estimate:

The resources to accomplish the above tasks will require 1/12 FTE in , FY05 and 1/4FTE in FY06 of a Mechanical Engineer (J. Sondericker - 2 weeks each year at CERN to supervise commissioning and to discuss the implementation of the refrigerator control system + 2 weeks each year at BNL to work with the industrial companies and with the CERN safety groups on the operations analysis), 1/2 FTE of the Software Professional (Y. Farrah) in FY05 - FY07 to implement the program and to provide the interfaces to the LAr control system

1/6 FTE ME in FY04 to provide the calculations needed for the solenoid magnet integration with the cryostat
1/6 FTE of the mechanical engineer (M. Rehak) in FY05 to provide the calculations for the tilecal interface with the cryostat during the system integration in the pit.
1/4 FTE of software professional (Y Farrah} in FY06 to provide support for the cooldown to commission cryostat.
1/6 FTE of a Technician (Wheeler) in FY04 for the Quality Meters commissioning in the West Hall.
1/3 FTE of a technician (Wheeler) in FY05 for the dis-assembly and recommissionig of the cryostat interfaces in the pit .
1/3 FTE of a Technician (Wheeler) in FY06 for the disassassembly and recommissioning of the cryostat interfaces in the pit.

Materials: $20,000 is needed in FY03 for connections needed in Bldg.180. Based on the past experience $10,000 / year of material will be required in FY04, $15000 FY05 and $10,000 in FY06, and 4 trips at $2500 per trip in FY04-FY07.
Commisioning in the cavern will continue through FY07.

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	0	0	0	0	0	0	0	0	0.0	0.0

CONTINGENCY FACTORS:	*Risk* Technical	Cost	Schedule	Design	*Weight* Technical	Cost	Schedule	Cont %

WBS Number: 3.3.1.1.3.3 **Description:** HV Feedthrough Commissioning

Institution : SUNY SB **Contact** Not available

Commissioning of the HV feedthroughs.
Task includes the commissioning o fthe HV connections after the move of each of the three sections of the calorimeters (barrel and two endcaps) to the experimental pit; conncetion of the new HV cables to the FT filter boxes. Re-connection of the temperature sensors and of the heater connectors. Creation of the data bases in the CERN CDD

Details of Estimate:

Labor estimate is based on the past experience. It will require 1 week per feedthrough (i.e.,5 to 6 weeks) of a technician in FY05.
Travel: 6 trips (two per cryostat) at $2,500/trip or $15,000.

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
0	0	0	0	0	0	0	0	0.0	0.0

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.1.1.4 **Description:** Forward Calorimeter

Institution : **Contact** Not available

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	0	0	0	0	0	0	0	0	0.0	0.0

WBS Number: 3.3.1.1.4.1 **Description:** FCAL Documentation update

Institution : U. of Arizona **Contact** L. Shaver

Documentation update FCAL. The FCAL assembly will be completed in FY04. CERN safety group requires a complete documentation of any cryogenic system in operation. Some interfaces are modified during the installation. It is expected that more changes will occur during the integration. Electronics channel wiring and mapping mistakes have to be identified and corrected in software and data bases. These can be completed only after the end of all

Details of Estimate:

Labor assumes 1/4 FTE of a mechanical engineer/designer in FY05 to update the FCAL documentation. (20 production drawings + integration drawings). Travel 1 trip at $2500. 1/4 of ME in FY06. Travel - 2 trips in FY06 are required.

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
0	0	0	0	0	0	0	0	0.0	0.0

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.1.2 **Description:** Operations

Institution : **Contact** Not available

Operations shall include:
Calibration and monitoring of the equipment during experiment run time.
Maintaining databases.
ATLAS data taking.
Maintenance for accessible parts and replacement as needed. Consumables are included in common costs.

Details of Estimate:

Calibration and monitoring of the equipment will be performed during the experiment run time that is expected to start in FY07. ATLAS data taking, database maintenance, and support will be provided. Routine checking and maintenance will be carried out for accessible parts of the subsystem. For those parts of the system that are inaccessible, failures will be logged and whatever recovery procedures are necessary will be executed. Hardware, software, and physicist technical support and management will be required. During the operations phase, personnel will be required to provide hardware support, software support and supervise the operations of the cryostat, the Liquid nitrogen refrigeration system, the quality meter monitors, HV Feedthroughs. Additional work will be needed to design and monitor interfaces of the components under direct US responsibility with those under the ATLAS collaboration responsibility. This will include the interface of the

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
971	0	0	971	0	870	0	101	494.4	869.4

MANPOWER (k$) SUMMARY:

	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Computer Professional R	0	0	2295	453	281	283	284
	0	0	115.294	19.538	12.451	12.824	13.209
Electrical Engineer R	0	0	131	0	0	0	0
	0	0	16.201	0	0	0	0
Mechanical Engineer R	0	0	1122	2020	1012	991	972
	0	0	109.305	114.027	59.831	60.41	61.007
Technician R	0	0	1183	665	392	393	394
	0	0	103.908	59.935	36.353	37.399	38.489

MATERIAL SUMMARY:

	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	27.6	17.7	10.0	10.8	11.6
Travel R	0.0	0.0	5.0	0.0	0.0	0.0	0.0

WBS Number: 3.3.1.2.1 **Description:** Cryostat

Institution : **Contact** Not available

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	112	0	0	112	0	101	0	11	57.3	0.0

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Computer Professional R	0	0	163	0	0	0	0
	0	0	16.294	0	0	0	0
Mechanical Engineer R	0	0	138	576	281	274	267
	0	0	17.006	27	13.5	13.5	13.5

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	3.3	2.4	1.2	1.2	1.2

WBS Number: 3.3.1.2.1.1 **Description:** Cryostat operations_BNL

Institution : BNL-M&O **Contact** Sondericker

Provide hardware and software support to the cryostat during the operations phase. The support consists of monitoring the cryostat controls for the temperature, pressure and liquid levels. A data base updates and modifications will be done. Periodic review of the performance parameters will be done by cryostat design engineer. Software professional will provide yearly updates of the operations and control software.

Details of Estimate:

Labor costs assume 160 hours/year of ME and 160 hours/year of software professional (based on the past experience in D0 experiment) in FY06 to FY12. Travel 2 trips/year in FY06-FY12 at $2500/ trip or $35,000.

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
37	0	0	37	0	33	0	4	18.9	0.0

MANPOWER SUMMARY:

(k$)	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Computer Professional R	0	0	163	0	0	0	0
	0	0	16.294	0	0	0	0
Mechanical Engineer R	0	0	138	0	0	0	0
	0	0	17.006	0	0	0	0

MATERIAL SUMMARY:

	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	3.3	0.0	0.0	0.0	0.0

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.1.2.1.2 **Description:** Cryostat Operations_SMU

Institution : Southern Methodist University **Contact** Sondericker

Provide hardware and software support to the cryostat during the operations phase. The support consists of monitoring the cryostat controls for the temperature, pressure and liquid levels. A data base updates and modifications will be done. Periodic review of the performance parameters will be done by cryostat design engineer. Software professional will provide yearly updates of the operations and control software.

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	75	0	0	75	0	68	0	8	38.4	0.0

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Mechanical Engineer R	0	0	0	576	281	274	267
	0	0	0	27	13.5	13.5	13.5

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	0.0	2.4	1.2	1.2	1.2

CONTINGENCY FACTORS:	*Risk*				*Weight*			Cont %
	Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	
	0	0	0	0	0	0	0	0

WBS Number: 3.3.1.2.2 **Description:** Feedthrough

Institution : **Contact** Not available

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	376	0	0	376	0	338	0	38	192.0	0.0

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Mechanical Engineer R	0	0	201	216	120	120	121
	0	0	24.811	27.365	15.581	16.048	16.53
Technician R	0	0	743	665	392	393	394
	0	0	65.46	59.935	36.353	37.399	38.489

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	8.5	8.4	5.0	5.1	5.3

WBS Number: 3.3.1.2.2.1 **Description:** Signal Feedthroughs operations

Institution : BNL-M&O **Contact** Not available

Provide hardware support to the signal feethroughs during the operations phase.
Monitoring and control of the signal feedthrough temperature and nitrogen gas flow and of the status of the vacuum system will be required.
CERN safety requirements impose a yearly validation of every relief valve. There are 120 relief valves each needing 5 hours access. This work will be shared with the CERN based operations crew. Maintenace of the test and repair equipment at BNL will be needed.

Details of Estimate:

To support the hardware, 1/7 FTE ME, and 1/5 FTE Technician from FY07 to FY12 will be required.
Material: $5,000/year will be needed to maintain and test the repair station at BNL starting in FY04 to FY12.
Travel 1 trip/year from FY06 to FY12 at $ 2,500 or $20,000 total will also be required.

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
275	0	0	275	0	247	0	28	140.6	0.0

MANPOWER SUMMARY:

(k$)	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Mechanical Engineer R	0	0	201	216	120	120	121
	0	0	24.811	27.365	15.581	16.048	16.53
Technician R	0	0	416	448	248	249	250
	0	0	36.389	40.135	22.853	23.539	24.245

MATERIAL SUMMARY:

	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	6.1	6.7	3.8	3.9	4.1

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.1.2.2.2 **Description:** HV Feedthroughs operations

Institution : SUNY SB **Contact** Not available

Provide hardware support to the High Voltage Feethrough's during the operations phase.
The system will operate in two stages: FY04-FY06 in the West Hall and in the pit with a full access to the feedthroughs; and
FY07-FY12 with a yearly access to the pit.
Monitoring and control of the HV feedthrough temperature and dry air as well as of the performance of the HV filter

Labor costs assume 1/10 FTE of a Technician (J. Steffens) starting in FY04 and FY05 and **Details of Estimate:**
1/5 technician from FY06 to FY12, monitoring equipment cost of $5000 consisting of CANBUS I/O and a PC is required in FY06. Tools replacement ($5k) will be needed in FY10.
Travel: 2 trips/year at $2500/trip or $45,000 from FY04 to FY12.

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
101	0	0	101	0	90	0	10	51.4	0.0

MANPOWER SUMMARY:

	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs) (k$)
Technician R	0	0	327	217	144	144	144
	0	0	29.071	19.8	13.5	13.86	14.244

MATERIAL SUMMARY:

	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	2.4	1.7	1.1	1.2	1.2

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.1.2.3 **Description:** Cryogenics

Institution : **Contact** Not available

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	260	0	0	260	0	232	0	28	131.8	0.0

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Computer Professional R	0	0	162	0	0	0	0
	0	0	16.2	0	0	0	0
Electrical Engineer R	0	0	131	0	0	0	0
	0	0	16.201	0	0	0	0
Mechanical Engineer R	0	0	211	1152	562	548	534
	0	0	26.088	54	27	27	27
Technician R	0	0	440	0	0	0	0
	0	0	38.448	0	0	0	0

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	4.8	4.8	2.4	2.4	2.4
Travel R	0.0	0.0	5.0	0.0	0.0	0.0	0.0

WBS Number: 3.3.1.2.3.1 **Description:** Quality Meter_BNL

Institution : BNL-M&O **Contact** Sondericker

The Quality Meter consists of the mechanical system and an electronic cards that provide capacitance to current conversion. Costs are based on providing mechanical, electrical hardware and software support to the quality meter during the operations. Hardware support includes checking of the quality meters operations and calibration at least three times per year. Software support consists of monitoring the quality meter controls for temperature pressure and liquid levels. The monitoring requires knowledge of the PLC control language. First two years of operations will require preservation of the mechanical know-how at BNL. Long-term operations support will be provided by the CERN

Labor costs assume:**Details of Estimate:**
1/13 FTE ME, and 1/13 FTE EE for hardware support in FY06 and FY08, and 1/13 FTE SW Prof for software support in FY06 to FY12.
Travel: - 2 trips/year at $2500/ trip or $30,000 from FY06 to FY12.

Labor in FY06+07 put into management contingency

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	54	0	0	54	0	49	0	5	27.6	0.0

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Computer Professional R	0	0	162	0	0	0	0
	0	0	16.2	0	0	0	0
Electrical Engineer R	0	0	131	0	0	0	0
	0	0	16.201	0	0	0	0
Mechanical Engineer R	0	0	131	0	0	0	0
	0	0	16.201	0	0	0	0

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	4.8	0.0	0.0	0.0	0.0

CONTINGENCY FACTORS:	*Risk*				*Weight*			Cont %
	Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	
	0	0	0	0	0	0	0	0

WBS Number: 3.3.1.2.3.2 **Description:** Quality Meter_SMU

Institution : Southern Methodist University **Contact** Sondericker

The Quality Meter consists of the mechanical system and an electronic cards that provide capacitance to current conversion. Costs are based on providing mechanical, electrical hardware and software support to the quality meter during the operations. Hardware support includes checking of the quality meters operations and calibration at least three times per year. Software support consists of monitoring the quality meter controls for temperature pressure and liquid levels. The monitoring requires knowledge of the PLC control language. First two years of operations will require preservation of the mechanical know-how at BNL. Long-term operations support will be provided by the CERN

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	75	0	0	75	0	68	0	8	38.4	0.0

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs) (k$)
Mechanical Engineer R	0	0	0	576	281	274	267
	0	0	0	27	13.5	13.5	13.5

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	0.0	2.4	1.2	1.2	1.2

CONTINGENCY FACTORS:	*Risk* Technical	C o s t	Schedule	Des i gn	*Weight* Technical	C o s t	Schedule	Cont %
	0	0	0	0	0	0	0	0

WBS Number: 3.3.1.2.3.3 **Description:** Cryogenics operations_BNL

Institution : BNL-M&O **Contact** Not available

Provide hardware and software support to the cryogenics during the operations phase.
During FY04 and FY05 this will support operations in the West Hall. Starting in FY06, this will support operations in the experimental pit.
Task includes periodic checks of the LN2 refrigerator, valves, pumps, etc. It includs monitoring of the cryogenics controls for the temperature, pressure and the liquid levels and provides upgrades to the BNL generated control code. Since the software for the cryogenics controls will have to be made compatible with the software procedures under development for the LHC (not yet established), there will be a need to change the language and to modify control tools after the start of operations when the LHC system is stable.

T Labor costs assume:**Details of Estimate:**
1/6 FTE ME, in FY04 to FY07. 1/3 of the technician will be needed during the commissioning in the pit in FY06-FY07
Mechanical engineer (Sondericker) will update the specifications and make them compatible with running conditions. He will provide a supervision fo rthe maintenance of the LN2 refrigerator.
1/20 FTE ME, 1/4 FTE technician in FY08 to FY12 for hardware support.
Software Support: 1/3 FTE of a software professional in FY06
Travel: - 2 trips/year at $2500/ trip or $45,000 from FY04 to FY12.

Management Contingency
FY04 and FY05
1/4 FTE technician - for hardware support, and 1/3 FTE SW Prof for software support to provide support for the cryogenics system operations in the west Hall and to provide updates of the BNL generated control code
FY06 labor put into management contingency

Cost Summary: (R)	**Base Cost (k$)**	**Cont Cost (k$)**	**Cont %**	**Total Cost (k$)**	**EDIA Labor (k$)**	**Mfg Labor (k$)**	**EDIA Matls (k$)**	**Mfg Matls (k$)**	**FTEs R**	**FTEs Other**
	56	0	0	56	0	48	0	8	27.5	0.0

MANPOWER (k$) SUMMARY:	**FY 06 (hrs) (k$)**	**FY 07 (hrs) (k$)**	**FY 08 (hrs) (k$)**	**FY 09 (hrs) (k$)**	**FY 10 (hrs) (k$)**	**FY 11 (hrs) (k$)**	**FY 12 (hrs)**
Mechanical Engineer R	0	0	80	0	0	0	0
	0	0	9.887	0	0	0	0
Technician R	0	0	440	0	0	0	0
	0	0	38.448	0	0	0	0

MATERIAL SUMMARY:	**FY 06 (k$)**	**FY 07 (k$)**	**FY 08 (k$)**	**FY 09 (k$)**	**FY 10 (k$)**	**FY 11 (k$)**	**FY 12 (k$)**
Travel R	0.0	0.0	5.0	0.0	0.0	0.0	0.0

CONTINGENCY FACTORS:	*Risk* Technical	Cost	Schedule	Design	*Weight* Technical	Cost	Schedule	Cont %

WBS Number: 3.3.1.2.3.4 **Description:** Cryogenics Operations_SMU

Institution : Southern Methodist University **Contact** Not available

Provide hardware and software support to the cryogenics during the operations phase.
During FY04 and FY05 this will support operations in the West Hall. Starting in FY06, this will support operations in the experimental pit.
Task includes periodic checks of the LN2 refrigerator, valves, pumps, etc. It includs monitoring of the cryogenics controls for the temperature, pressure and the liquid levels and provides upgrades to the BNL generated control code. Since the software for the cryogenics controls will have to be made compatible with the software procedures under development for the LHC (not yet established), there will be a need to change the language and to modify control tools after the start of operations when the LHC system is stable.

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	75	0	0	75	0	68	0	8	38.4	0.0

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Mechanical Engineer R	0	0	0	576	281	274	267
	0	0	0	27	13.5	13.5	13.5

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	0.0	2.4	1.2	1.2	1.2

CONTINGENCY FACTORS:	*Risk*				*Weight*			
	Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
	0	0	0	0	0	0	0	0

WBS Number: 3.3.1.2.4 **Description:** FCAL

Institution : **Contact** Not available

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	224	0	0	224	0	199	0	25	113.3	869.4

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Computer Professional R	0	0	1970	453	281	283	284
	0	0	82.8	19.538	12.451	12.824	13.209
Mechanical Engineer R	0	0	572	76	49	49	50
	0	0	41.4	5.662	3.75	3.862	3.977

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	11.0	2.2	1.4	2.1	2.8

WBS Number: 3.3.1.2.4.1 **Description:** FCAL operations

Institution : U. of Arizona **Contact** Not available

Provide hardware and software support to the FCAL during the commissioning and operations phase. The software support consists of monitoring the FCAL controls for temperature, pressure, liquid levels and electronics responses and provides changes to the software.
Commissioning is divided into three phases: commissioning and cold tests of the endcaps in building 180, commissioning of the endcaps in the experiemntal hall, and commissioning of bothe endcaps simultaneously with the final DAQ system using horizontal muons fr0om the single beam
LHC operations.

Update december 06: full time software support is needed for the commissioning of Fcal

Commissioning starts in 2005 and will continue through FY06. Single beam operations start **Details of Estimate:**
in FY07.
Labor costs assume 1/2 FTE ME starting in FY06 to FY08 and 5/16 FTE Computer professional starting in FY06 to FY08 and 3/20 FTE ME and 3/20 FTE Software professional in FY09 to FY12. Travel: 6 trips in FY06, 2 trips/year at $2500/trip or $45,000

Base and Infrastructure
Hardware support for this effort will require:
FY06 to FY08
1 FTE faculty
1 FTE Post doc
1 FTE grad student

FY 09 to FY12
2/10 FTE faculty
1/4 FTE post doc
1/4 FTE grad student

Base & infrastructure
Effort required for the software controls consists of:
FY06 to FY08
1/2 FTE faculty
1/3 FTE software professional
1/2 FTE grad student

FY 09 to FY12
1/4 FTE faculty
2/10 FTE software professional
1/2 FTE grad student

update december 06: 1 FTE software support is needed for the commissioning and 0.5 FTE compouter professional will be needed during operations

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	224	0	0	224	0	199	0	25	113.3	869.4

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Computer Professional R	0	0	1970	453	281	283	284
	0	0	82.8	19.538	12.451	12.824	13.209

Mechanical Engineer R	0	0	572	76	49	49	50
	0	0	41.4	5.662	3.75	3.862	3.977

MATERIAL SUMMARY:	**FY 06 (k$)**	**FY 07 (k$)**	**FY 08 (k$)**	**FY 09 (k$)**	**FY 10 (k$)**	**FY 11 (k$)**	**FY 12 (k$)**
Other R	0.0	0.0	11.0	2.2	1.4	2.1	2.8

CONTINGENCY FACTORS:	***Risk***				***Weight***			**Cont %**
	Technical	**C o s t**	**Schedule**	**Des i gn**	**Technical**	**C o s t**	**Schedule**	
	0	0	0	0	0	0	0	0

WBS Number: 3.3.1.3 **Description:** Maintenance

Institution : **Contact** Not available

Maintenance shall include:
Spare part kit to repair at CERN and at the institution sites. The spare parts shall account for part wear out rate, and part obsolescence.

Scheduled maintenance that includes equipment removal and reinstallation, calibration and alignment, test equipment at the CERN and institution sites - on site repair, and off - site repair.

Project Management to supervise the staff and to perform project maintenance planning and control

US ATLAS maintenance tasks will be required on the following level 3 subsystems A. **Details of Estimate:**
Cryogenics, B. Quality meters, C. Signal and HV Feedthroughs. The cryostat will be accessed for maintenance approximately every ten years and therefore no cost for maintenance will be estimated. The cryogenics, Quality Meters and the feedthroughs will require US ATLAS manpower to support maintenance functions at CERN. The signal and HV feedthroughs and Quality Meters, will also require spare parts on hand at CERN to support the maintenance task. During access, failed control units: ELMB, valves, temperature and pressure gauges will be repaired or replaced with spares every three to five years on average. Repair of these failed modules will be performed at CERN by the maintenance staff. The estimate is based on working 200 days/year and that 50 days/year will be used for access, leaving 150 days (a total of 900 man-days per year) for on site repair and maintenance.

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	755	0	0	755	101	521	0	133	353.5	0.0

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Computer Professional R	0	0	313	225	149	62	150
	0	0	13.167	9.692	6.584	2.807	6.985
Mechanical Engineer R	0	0	426	1361	688	726	661
	0	0	39.033	69.508	36.617	40.878	37.202
Technician R	0	0	1126	1030	590	593	596
	0	0	98.449	92.7	54.496	56.178	57.893

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	63.0	15.9	9.0	9.9	10.7
Travel R	0.0	0.0	5.0	0.0	0.0	0.0	0.0

WBS Number: 3.3.1.3.1 **Description:** Cryostat-Maint of Interfaces

Institution : **Contact** Not available

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	193	0	0	193	0	174	0	19	98.8	0.0

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Technician R	0	0	711	452	251	252	253
	0	0	62.1	40.5	23.06	23.753	24.465

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	6.2	4.0	2.3	2.4	2.4

WBS Number: 3.3.1.3.1.1 **Description:** Maint of mechanical facility

Institution : BNL-M&O **Contact** Not available

Maintenance of the mechanical facility including replacement of broken equipment

Maintenance of the mechanical facility at CERN (for replacement and problem shooting) **Details of Estimate:**
and at BNL (for repairs) including replacement of broken equipment (including specialized welding and cutting tools) is estimated at $18k/year from FY05 to FY12. Repairs and updates on maintenance and inspection procedures will require labor of 1/8 FTE MT in FY05 to FY12

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	193	0	0	193	0	174	0	19	98.8	0.0

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Technician R	0	0	711	452	251	252	253
	0	0	62.1	40.5	23.06	23.753	24.465

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	6.2	4.0	2.3	2.4	2.4

CONTINGENCY FACTORS:	*Risk* Technical	Cost	Schedule	Design	*Weight* Technical	Cost	Schedule	Cont %
	0	0	0	0	0	0	0	0

WBS Number: 3.3.1.3.2 **Description:** Feedthrough

Institution : **Contact** Not available

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	189	0	0	189	101	69	0	19	96.9	0.0

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs) (k$)
Technician R	0	0	239	578	339	341	343
	0	0	20.97	52.2	31.436	32.425	33.428

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	2.0	4.9	2.9	3.0	3.1

WBS Number: 3.3.1.3.2.1 **Description:** Signal Feedthrough Maintenance

Institution : BNL-M&O **Contact** Not available

Maintenance of the Signal feedthroughs

Details of Estimate:

Cost for spare parts required to support the feedthroughs maintenance is $30,000 in FY05 and $15000 in FY06 and FY07, and $12.000 per year in FY08 to FY12. 1/20 FTE of technician per year is needed to maintain the feedthrough repair facility and equipmentl

Travel: 4 trips/year at $2500/trip in FY05 and 2 trips/year in FY 06, and 1 trip/year in FY07 to FY12 or $30,000 total.

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
113	0	0	113	101	0	0	11	57.6	0.0

MANPOWER SUMMARY:

	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Technician R	0	0	165	351	195	196	197
	0	0	14.4	31.5	17.936	18.475	19.028

MATERIAL SUMMARY:

	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	1.4	3.1	1.8	1.8	1.9

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.1.3.2.2 **Description:** HV Feedthrough Maintenance

Institution : SUNY SB **Contact** Not available

Maintenance of the HV feedthrough (including HV distribution boxes):

The repair and test station fo rthe HV filter network will be set up and maintained at SUNY SB. Task involves a periodic safety check of the HV system including temperature monitoring and control. Periodic replacement of the failed filter modules with spares will be done. Failed units will be sent for repairs at Stony Brook.

Update december 06: The procedures for burnout of shorts require opening of the HV feedthroughs and isolation of individual supply lines

Details of Estimate:

1/6 FTE Technician in FY05 for setting up the maintenance and repair facility. Travel: - 4 trips in FY05 at $2500/trip or $10,000.
Cost for spare parts, tools, and shipping is $28k in FY05, FY08, and FY11 and $11.5k from FY06, FY07 and FY09< FY10 and FY12.

The filter box repair station maintenance will include scope for the corona check and HV crate with power supply and soldering tools. The estimate is for 10 channels out of 5000 to fail each year and need repairs. It takes 2 days per channel to repair it and retest I.e., 20 days/year of a technician or 1/10 FTE/ year from FY07 to FY12 .
Travel: 2 trips/year at $2500/trip or $45,000 from FY04 to FY12

management contingency

Material cost reevaluated
Base and infrastructure support for the HV feedthroughs:
1/2 FTE faculty in FY07 and FY08 and 1/10 faculty in FY09 to FY12.
1/2 grad student in FY07 and FY08 and 1/4 grad student in FY09 to FY12.

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	77	0	0	77	0	69	0	8	39.3	0.0

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Technician R	0	0	74	227	144	145	146
	0	0	6.57	20.7	13.5	13.95	14.4

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	0.5	1.7	1.1	1.2	1.2

CONTINGENCY FACTORS:	*Risk*				*Weight*			Cont %
	Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	
	0	0	0	0	0	0	0	0

WBS Number: 3.3.1.3.3 **Description:** Cryogenics

Institution : **Contact** Not available

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	251	0	0	251	0	170	0	80	96.7	0.0

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Mechanical Engineer R	0	0	160	1152	562	548	534
	0	0	19.8	54	27	27	27
Technician R	0	0	176	0	0	0	0
	0	0	15.379	0	0	0	0

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	52.0	4.8	2.4	2.4	2.4
Travel R	0.0	0.0	5.0	0.0	0.0	0.0	0.0

WBS Number: 3.3.1.3.3.1 **Description:** Quality Meters_BNL

Institution : BNL-M&O **Contact** Not available

Details of Estimate:

Quality Meters

Labor costs assume 1/6 ME in FY05, and 1/10 FTE ME in FY06 to FY12. Cost for spare parts is $12,500 in FY05, and $30K/year (15% of construction manufacturing cost) in FY06 to FY12. Spare parts cost for the quality meter mechanical parts and for the electronic boards is $50k/year starting in FY05 to FY12.Travel: - 1 trip/year at $2500 per trip or $20,000 total from FY05 to FY12.

Management Contingency
FY07
Labor costs assume 1/6 FTE ME. Cost for spare parts in $12,500. Travel:- 1 trip at $2500 per trip or $2500 total.

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
22	0	0	22	0	20	0	2	11.3	0.0

MANPOWER SUMMARY:

	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Mechanical Engineer R	0	0	160	0	0	0	0
	0	0	19.8	0	0	0	0

MATERIAL SUMMARY:

	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	2.0	0.0	0.0	0.0	0.0

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.1.3.3.2 **Description:** Quality Meter_SMU

Institution : Southern Methodist University **Contact** Not available

Quality Meters

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	75	0	0	75	0	68	0	8	38.4	0.0

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Mechanical Engineer R	0	0	0	576	281	274	267
	0	0	0	27	13.5	13.5	13.5

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	0.0	2.4	1.2	1.2	1.2

CONTINGENCY FACTORS:	*Risk*				*Weight*			
	Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
	0	0	0	0	0	0	0	0

WBS Number: 3.3.1.3.3.3 **Description:** Cryogenics Maintenance_BNL

Institution : BNL-M&O **Contact** Not available

Maintenance of the Cryogenics

Labor assumes technician 1/6 FTE in FY04 and FY05, and 1/10 FTE technician in FY06 to **Details of Estimate:**
FY12 for maintenance and recalibration costs including refrigerator and all interconnects. Travel: - 2 trips/year at $2500 per trip or $40,000 total from FY04 to FY12. Spare Parts at $ 50,000 per year will also be required.

Management Contingency in FY06

FY04

Labor assumes technician 1/6 FTE
Travel: - 2 trips/year at $2500 per trip or $5000
Refrigerator spare parts $50,000

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	79	0	0	79	0	15	0	63	8.7	0.0

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Technician R	0	0	176	0	0	0	0
	0	0	15.379	0	0	0	0

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	50.0	0.0	0.0	0.0	0.0
Travel R	0.0	0.0	5.0	0.0	0.0	0.0	0.0

CONTINGENCY FACTORS:	*Risk* Technical	C o s t	Schedule	Des i gn	*Weight* Technical	C o s t	Schedule	Cont %
	0	0	0	0	0	0	0	0

WBS Number: 3.3.1.3.3.4 **Description:** Cryogenics Maintenance_SMU

Institution : Southern Methodist University **Contact** Not available

Maintenance of the Cryogenics

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	75	0	0	75	0	68	0	8	38.4	0.0

MANPOWER SUMMARY: (k$)	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Mechanical Engineer R	0	0	0	576	281	274	267
	0	0	0	27	13.5	13.5	13.5

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	0.0	2.4	1.2	1.2	1.2

CONTINGENCY FACTORS:	*Risk*				*Weight*			
	Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
	0	0	0	0	0	0	0	0

WBS Number: 3.3.1.3.4 **Description:** FCAL

Institution : **Contact** Not available

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	122	0	0	122	0	108	0	14	61.2	0.0

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Computer Professional R	0	0	313	225	149	62	150
	0	0	13.167	9.692	6.584	2.807	6.985
Mechanical Engineer R	0	0	266	209	126	178	127
	0	0	19.233	15.508	9.617	13.878	10.202

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	2.9	2.2	1.4	2.1	2.8

WBS Number: 3.3.1.3.4.1 **Description:** FCAL

Institution : U. of Arizona **Contact** Not available

FCAL maintenance Support

Supporting the FCAL will require the following resources:**Details of Estimate:**

ME 1/7 FTE FY07 to FY12
Computer Professional 1/10 FTE FY07 to FY12

Travel 1 trip/year or $17,500 total from FY06 to FY12

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	122	0	0	122	0	108	0	14	61.2	0.0

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Computer Professional R	0	0	313	225	149	62	150
	0	0	13.167	9.692	6.584	2.807	6.985
Mechanical Engineer R	0	0	266	209	126	178	127
	0	0	19.233	15.508	9.617	13.878	10.202

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	2.9	2.2	1.4	2.1	2.8

CONTINGENCY FACTORS:	*Risk* Technical	Cost	Schedule	Design	*Weight* Technical	Cost	Schedule	Cont %
	0	0	0	0	0	0	0	0

WBS Number: 3.3.2 **Description:** Electronic M&O Estimate

Institution : **Contact** Not available

The electronic M&O estimate for the Liquid Argon Calorimeter includes costs for pre-operations,operations, and

Model for the cost estimates of the M&O for the electronics and electrical systems **Details of Estimate:**

The front-end readout of the LAr calorimeter will be installed on the detector in FY05 through FY07 after the calorimeter's transport and integration in the pit. The pre-operations will include: the full crate test of the readout system, the long-term boards burn-in facility, a portable full crate test station for the commissioning of the calorimeter modules (in Bldg. 180) before the welding shut of the cryostat, the commissioning of the electronics readout after its installation on the detector (in the pit) and the specialized electronics for the beam tests. The system crate, optical links, Level 1 trigger system, and the ROD system will require costs for pre-operations. A long-term burn-in of the integrated system crate will be performed to flush out the infant mortality components before the commencement of operations. Documentation update (including final layouts and drawings) will be made during the commissioning stage.'

The commissioning will be done separately for th ethree cryostats. It will be followed by the final commissioning phase of running a complete system with the final DAQ both for the cosmic rays and for the single beam operations. The estimates for operations and maintenance are based on the LHC run model of 7 months of proton-proton collisions, 2 months of heavy ion collisions and 3 months detector access per year. For such model, the ATLAS Liquid Argon Electronics
Coordination group estimated a need for the on-site electronics operations crew of 1 supervisory Electrical Engineer and 5 electronics technicians working in shifts. This crew (paid from the CERN Common costs with a 20% US share) will identify problem boards/components, replace with spares (if accessible) and run simple diagnostic tests. Simple repairs will be made at CERN. Boards with more difficult problems will be sent for repairs to the "home" institutions (Nevis, BNL, Pittsburgh, SMU) responsible for their maintenance. Each institution will maintain the expertise and the necessary test and repair equipment. In addition, these institutions will need to update the supply of spares from time to time as needed. This model is similar to that used e.g., at PHENIX, D0 and ZEUS.

Maintenance and operations of the Liquid Argon Calorimeter electronics in FY07-FY12 covers the following seven categories:
front-end electronics, level 1 trigger interface, ROD system electronics, power supplies, detector control and cooling systems, cables, crates, and connectors, optical links.
The numbers of the units are as follows:
The number of the Front-End Boards installed in the system:

Type	Number
Front End Board	1524
Calibration Board	122
Tower Builder Board	120
Tower Driver Board	20
Controller	114
Monitoring Board	146
LV Boards (HEC)	24
Total	2070

There are 2 cooling plates for each board and an extensive, water based cooling system.

There are 4 main types of power supplies.

Type & number installed	number of units/supply
Front End Crate supplies	63 & 18
ROD VME crate supplies	54 & 4
Level 1 Interface Crate supplies	8 & 4
HEC LV Supplies	8 & 12

The (Optical) Link components are:

Connection/type	number installed
FEB-ROD/optical	1524
ROD-FEB optical/Cu	762

System crate/optical	114
FT-Baseplane/Cu (flex)	3048
TBB-Receiver/Cu (shielded TP)	240
TDB-Receiver/Cu (shielded TP)	120

The Level 1 trigger receiver/monitor system, located in the USA15 cavern, will consist of eight 9-U VME crates filled with 16 modules each. Each module contains 64 analog channels.

The modules in the ROD system (not including TTC hardware) are:

Type	Number installed
ROD modules	192
TBM modules	16
SPAC modules	16
Total	224

The estimated failure rate of the FEB components is based on the engineering judgment and on the experience of the D0, H1 and ZEUS experiments. The failure rate will require a replacement with spares of about 100-150 readout boards during the yearly access. These boards will be diagnosed and repaired during the operations period and made ready as spares for the next access cycle. During the access, US based technicians and postdocs will supplement the operating crew, as a single board replacement will require a minimum of 3 people for several hours. US institutions must maintain a crew of technicians and a fraction of high-level electrical engineers for problem diagnoses and repairs. It is expected that during the operation's period FY07-FY12, the electrical engineers will work on the R&D and on the design of electronics for the LHC upgrade, but that they will be available for special tasks and

Cost Summary: (R)	**Base Cost (k$)**	**Cont Cost (k$)**	**Cont %**	**Total Cost (k$)**	**EDIA Labor (k$)**	**Mfg Labor (k$)**	**EDIA Matls (k$)**	**Mfg Matls (k$)**	**FTEs R**	**FTEs Other**
	5873	0	0	5873	0	5079	0	794	2885.7	570.1

MANPOWER (k$) SUMMARY:	**FY 06 (hrs) (k$)**	**FY 07 (hrs) (k$)**	**FY 08 (hrs) (k$)**	**FY 09 (hrs) (k$)**	**FY 10 (hrs) (k$)**	**FY 11 (hrs) (k$)**	**FY 12 (hrs)**
Computer Professional R	0	0	4566	2799	1735	1848	1540
	0	0	411.9	261.471	166.577	181.361	156.96
Electrical Engineer R	0	0	4198	6429	4075	3017	2822
	0	0	316.223	636.393	424.599	293.597	276.465
Sr Research Scientist R	0	0	0	399	294	295	296
	0	0	0	31.441	23.791	24.505	25.24
Technician R	0	0	6916	7317	2896	4438	5750
	0	0	404.054	517.045	191.642	333.958	401.637

MATERIAL SUMMARY:	**FY 06 (k$)**	**FY 07 (k$)**	**FY 08 (k$)**	**FY 09 (k$)**	**FY 10 (k$)**	**FY 11 (k$)**	**FY 12 (k$)**
Other R	0.0	0.0	108.5	361.8	75.7	78.0	80.3

WBS Number: 3.3.2.1 **Description:** Pre-Operations and Commissioning

Institution : **Contact** Not available

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	265	0	0	265	0	237	0	28	134.6	82.9

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Computer Professional R	0	0	982	224	0	0	0
	0	0	65.636	15.361	0	0	0
Electrical Engineer R	0	0	1674	245	0	0	0
	0	0	86.59	13.44	0	0	0
Technician R	0	0	1046	0	0	0	0
	0	0	55.887	0	0	0	0

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	20.0	2.5	0.0	0.0	0.0

WBS Number: 3.3.2.1.3 **Description:** System Crate Integration

Institution : **Contact** Not available

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	172	0	0	172	0	153	0	19	86.8	0.0

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Computer Professional R	0	0	736	224	0	0	0
	0	0	49.201	15.361	0	0	0
Electrical Engineer R	0	0	1007	245	0	0	0
	0	0	53.851	13.44	0	0	0
Technician R	0	0	429	0	0	0	0
	0	0	21	0	0	0	0

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	13.1	2.5	0.0	0.0	0.0

WBS Number: 3.3.2.1.3.1 **Description:** Crate Documentation update

Institution : BNL-M&O **Contact** Takai

Crate Documentation update.
Task includes an update of drawings and documentation in the CDD format of all mechanical drawings, services, power and water connections etc.

Basis of Estimate: Engineering judgement

Details of Estimate: Labor cost assumes 1/3 FTE of a mechanical designer (Jason Farrel), 1/4 software professional (Saroj Kandasamy) to design and implement the data basis i n FY05 and FY06
The estimate is based on upgrading 16 drawings 4 times with changes at an average of 10 hours per drawing. It is assumed that at least 4 iterations of design changes would be required during commissioning and electrical testing in the pit.

Base & infrastructure

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
0	0	0	0	0	0	0	0	0.0	0.0

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.2.1.3.2 **Description:** System Electronic Integration

Institution : Columbia U. (Nevis Laboratory) **Contact** Not available

Full crate system test. Task includes supervision and debugging of the pre-production series of the FEBs and integration of the electronics system in the crate at BNL. It also includes a production of special VME readout boards replacing the ROD system that will not be available for this test. The design and construction will start in FY03 and continue in FY04. It will also include tests of the cooling system, power supplies, links,DCS, etc.

Basis of Estimate: Engineering judgement

Details of Estimate: The task will require

In FY04: ¼ FTE of an electrical engineer (J. Ban) to supervise the production and to debug the boards (20 boards at 3 days each);
¼ of an electrical technician (N. Bishop) to manage the components stock and re-work
Cost of hardware components: $15,000. Cost of test equipment - power supply, crate, etc, $15,000.

Base & infrastructure
Labor costs assumes ¼ experienced Physicist in FY04 for technical guidance and decision making during integration.

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	0	0	0	0	0	0	0	0	0.0	0.0

CONTINGENCY FACTORS:	*Risk*				*Weight*			
	Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
	0	0	0	0	0	0	0	0

WBS Number: 3.3.2.1.3.3 **Description:** Facilities

Institution : Columbia U. (Nevis Laboratory) **Contact** Not available

Test and maintenance system for the FEB at CERN. The system will be built in FY04 and used for the pre-operations in the West Hall. In FY05-FY12 this system will be used for the testing and identification of problems of the FEBs removed from the experiment due to malfunction.
US share of the overall cost of the test station is 59% (following the MOU share). The test station system will include: VME crate, front-end crate, power supply, cooling, links, trigger modules, level 1 receiver, DAQ, ROD and test and maintenance equipment. The system will be located initially in the West Hall and then moved to the facility located near Point 1. The operations of the facility will be supported by the common costs.

Labor costs assume **Details of Estimate:**
1/6 FTE EE in FY05 for the overall system design and supervision of its construction; 1/6 FTE ET for procurements and assembly. For the purpose of this estimate we assume that the cooling system will be adapted from the BNL test system.
Material costs include: test equipment (scope $20k, soldering equipment $5k, pulse generators $10k, VME bus analyzer $3k, small tools and supplies $12k) I.e, $50k total.
Tools replacement will be needed every 3 years on average or $15k/year in FY05-FY07.
Travel:- 4 trips at $2500/trip or $10,000 will be required in FY05 - FY07.

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
4	0	0	4	0	0	0	4	0.0	0.0

MATERIAL SUMMARY:

	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	4.0	0.0	0.0	0.0	0.0

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.2.1.3.4 **Description:** Systems Crate Pre-operations

Institution : BNL-M&O **Contact** Not available

Details of Estimate:

Engineering and technical manpower required to run the System Crate in the ATLAS hall at CERN.

Costs assume 1/4 FTE EE 1/2 FTE ET, and 1/12 FTE SW Prof will be needed for pre-operations in FY05. In FY06 and FY07, 1/7 FTE EE, 1/2 FTE FT, and 1/9 Computer Professional will be required.
Travel: - 8 trips/year at $2500/trip or $60,000 will be required in FY05 to FY07.

Base & infrastructure
½ FTE Experienced Physicist to oversee and provide technical support for pre-operations of the System Crate in FY06 and FY07. Travel: - 4 trips/year at $2500/trip will be required.

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
0	0	0	0	0	0	0	0	0.0	0.0

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	Cost	Schedule	Design	Technical	Cost	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.2.1.3.5 **Description:** System Crate pre-ops - optical links

Institution : Southern Methodist University **Contact** Not available

Engineering and technical manpower for pre-operations and commissioning of the optical links at CERN.

FY04: Design and implementation of the links for the combined calorimeter test beam. Task includes design, building, installation and commissioning of 20 transition boards and link: PCB layout, PCB manufacturing, component loading, fibers, connectors, opto-electronics components,installation in the test beam and software modifications.

FY05, FY06 and FY07:
1) Commissioning of the optical links between FEB and ROD (1638 units), creation of the monitoring software, data bases and graphic displays.
2) Design and construction of links for the FEB and the ROD test stations (number of links not yet determined).

Commissioning of the links will occure in separate periods for the three cryostats: barrel in FY05/06, EndcapC in FY06 and EndcapA in FY06/07.
Each period will require separate travel.

FY04: Initial commsisioning of the optical links for the barrel calorimeter in the pit. 1/12 FTE**Details of Estimate:**

EE
FY05 and FY06:
1) Commissioning of the optical links between FEB and ROD (1638 units), creation of the monitoring software, databases and graphic displays. 2) Design and construction of links for the FEB and ROD test stations (number of links needed not yet determined)

Basis of estimate: Material cost: $5k for optical power meter and fiber splicing and test equipment, $5k for the equipment to repair optical connectors, $8k for the portable digital scope in FY06, $20k for the components of the test stations links in FY05; project labor: in FY05: 1/3 FTE EE, ½ FTE Et, 1/3 FTE software professional; in FY06: 1/6 FTE EE, ¼ FTE ET, 1/6 FTE software professional; travel: 8 trips in FY05 and FY06, 8 trips in FY07 at $2,5k each.

Base and infrastructure: 1/3 FTE experienced physicist + 1 postdoc +1/2 graduate student. Travel: 6 trips @$2.5k per year or $30k.

Labor and material reduced and moved to MC for FY06

Update December 06: the commissioning period extended through 2008.
Work will be shared by SMU Engineers and techs: Annie Xiang, Andy Liu and John Yang

Cost Summary: (R)	**Base Cost (k$)**	**Cont Cost (k$)**	**Cont %**	**Total Cost (k$)**	**EDIA Labor (k$)**	**Mfg Labor (k$)**	**EDIA Matls (k$)**	**Mfg Matls (k$)**	**FTEs R**	**FTEs Other**
	135	0	0	135	0	121	0	13	68.8	0.0

MANPOWER (k$) SUMMARY:	**FY 06 (hrs) (k$)**	**FY 07 (hrs) (k$)**	**FY 08 (hrs) (k$)**	**FY 09 (hrs) (k$)**	**FY 10 (hrs) (k$)**	**FY 11 (hrs) (k$)**	**FY 12 (hrs)**
Computer Professional R	0	0	736	224	0	0	0
	0	0	49.201	15.361	0	0	0
Electrical Engineer R	0	0	805	245	0	0	0
	0	0	43.051	13.44	0	0	0

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	8.1	2.5	0.0	0.0	0.0

CONTINGENCY FACTORS:	*Risk*				*Weight*			Cont %
	Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	
	0	0	0	0	0	0	0	0

WBS Number: 3.3.2.1.3.6 **Description:** System Crate - Crate Burn In

Institution : Columbia U. (Nevis Laboratory) **Contact** Not available

Setup, and perform long term burn-in on the integrated Front-End readout System Crate and maintain the burn-in test setup. Determine any long-term aging degradation that may cause experiment performance problems.

Details of Estimate:

1/2 FTE EE will be required for setup in FY05 (install system elements, connect power, integrate and debug) and 1/2 FTE, ET per year in FY06 - FY07 to operate and maintain it. Cost for equipment (power supplies, support structures, and water-cooling system) $25K in FY04 to FY06.

Base & Infrastructure
1 FTE Senior Physicist in FY04 to FY07

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
21	0	0	21	0	21	0	0	11.9	0.0

MANPOWER (k$) SUMMARY:

	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Technician R	0	0	429	0	0	0	0
	0	0	21	0	0	0	0

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.2.1.3.7 **Description:** Crate burn-in

Institution : Southern Methodist University **Contact** Not available

Long term burn-in of the Feb and link components: ADC s, Optical transmitters and optical receivers

The accelerated aging test will consists of the high temperature opven operated for 6 month **Details of Estimate:**
with components operation monitored on-line.
Labor 1/8 of EE in FY06 nad FY07, materials $10,000

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
12	0	0	12	0	11	0	1	6.1	0.0

MANPOWER (k$) SUMMARY:

	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Electrical Engineer R	0 0	0 0	202 10.8	0 0	0 0	0 0	0 0

MATERIAL SUMMARY:

	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	1.0	0.0	0.0	0.0	0.0

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.2.1.4 **Description:** Front End Board

Institution : **Contact** Not available

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	0	0	0	0	0	0	0	0	0.0	0.0

WBS Number: 3.3.2.1.4.1 **Description:** FEB Documentation update

Institution : Southern Methodist University **Contact** J. Ye

Documentation update optical links

Basis of Estimate: Engineering judgement

Details of Estimate: Task includes review and update of documentation for optical links in CDD format. The layout and drawings for the optical transmitter (FEB side), optical receiver (ROD side), fiber distribution system, patch panels and laser eye-safety boxes.
Labor costs assume ¼ FTE of an electrical engineer (A. Liu) in FY05 and FY06. The material costs for software licences (schematic capture and layout) $8,000. Travel - 4 trips to CERN/year at $2500 per trip or $20,000

Base & infrastructure
Labor cost assumes 1/10 Physicist in FY 05 to review and support documentation update

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	0	0	0	0	0	0	0	0	0.0	0.0

CONTINGENCY FACTORS:	*Risk* Technical	Cost	Schedule	Design	*Weight* Technical	Cost	Schedule	Cont %
	0	0	0	0	0	0	0	0

WBS Number: 3.3.2.1.5 **Description:** Level 1 Trigger

Institution : **Contact** W. Cleland

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	36	0	0	36	0	32	0	4	18.4	82.9

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Electrical Engineer R	0	0	385	0	0	0	0
	0	0	17.673	0	0	0	0
Technician R	0	0	391	0	0	0	0
	0	0	14.727	0	0	0	0

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	2.4	0.0	0.0	0.0	0.0

WBS Number: 3.3.2.1.5.1 **Description:** L1 Trig documentation update

Institution : University of Pittsburg **Contact** B. Cleland

Details of Estimate:

Documentation update Level 1 trigger to be done in the CDD format an dtransmitted to the ATLAS database.

Task includes a review and update of technical layout and drawings (5 layer sum boards, 7 drawings for the level 1 receiver system) remapping boards specifications (20 drawings) at 2 days/ drawing.

Labor costs assume 64 man-days of EE (j. Rabel) and ¼ FTE technician (G. Zuk) in FY04.

The material costs for software licenses (Schematic captures and layout software) is $10,000.
Travel: - 2 trips to CERN at $2500 per trip or $5,000.

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
0	0	0	0	0	0	0	0	0.0	0.0

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.2.1.5.2 **Description:** Pre-operations Level 1 Trigger

Institution : University of Pittsburg **Contact** V. Paolone

Engineering and technical manpower required to commission the Level 1 Trigger Receiver System at CERN. Task includes pulsing of the system and comparing the signal transmission withy the output of the real data signals. This systems provides unique capability to diagnose analog signals problems in the front-end readout chain. The commissioning of the calorimeter system will be done in four sessions parallel to the commissioning of the front end crates and will take place during FY05 - FY07. 128 boards at 2 days/board will be commissioned.

Update december 06: additional work requires new remapping boards and new summing boards for the inner wheel of the EMEC
The commissioning is done in several stages due to unavailability of the power supplies for the FECs

Labor costs assume:**Details of Estimate:**
64 days of EE and 64 days of ET in FY04;
5/12 FTE of EE and 5/12 FTE ET per year in FY 05 - FY07
Material costs include digital scope ($20k), pulse generator ($6k), spectrum analyzer ($17k), small tools, voltmeters, PC and cables ($10k) or a total of $53k
Travel: -2 trips at $2,500 in FY04 and 4 extended trips/year to CERN at $4,000 per trip in FY05 - FY07.

Part of the cost is put into management contingency

Base & Infrastructure
1/2 FTE Faculty and 1/2 Post Doc in FY05 to FY06.

update december 05: The commisioning involves 1 EE, 1.5 FTE term scientist and 1 grad student working as technician

Cost Summary: (R)	**Base Cost (k$)**	**Cont Cost (k$)**	**Cont %**	**Total Cost (k$)**	**EDIA Labor (k$)**	**Mfg Labor (k$)**	**EDIA Matls (k$)**	**Mfg Matls (k$)**	**FTEs R**	**FTEs Other**
	36	0	0	36	0	32	0	4	18.4	82.9

MANPOWER (k$) SUMMARY:	**FY 06 (hrs) (k$)**	**FY 07 (hrs) (k$)**	**FY 08 (hrs) (k$)**	**FY 09 (hrs) (k$)**	**FY 10 (hrs) (k$)**	**FY 11 (hrs) (k$)**	**FY 12 (hrs)**
Electrical Engineer R	0	0	385	0	0	0	0
	0	0	17.673	0	0	0	0
Technician R	0	0	391	0	0	0	0
	0	0	14.727	0	0	0	0

MATERIAL SUMMARY:	**FY 06 (k$)**	**FY 07 (k$)**	**FY 08 (k$)**	**FY 09 (k$)**	**FY 10 (k$)**	**FY 11 (k$)**	**FY 12 (k$)**
Other R	0.0	0.0	2.4	0.0	0.0	0.0	0.0

CONTINGENCY FACTORS:	*Risk* Technical	Cost	Schedule	Design	*Weight* Technical	Cost	Schedule	Cont %

WBS Number: 3.3.2.1.5.3 **Description:** FEB documentation update

Institution : Columbia U. (Nevis Laboratory) **Contact** J. Parsons

Task include review and update of the FEB documentation in the CDD format after the completion of the commissioning of the readout system on the detector. In FY06 it will require a review and updaqte of 25 schematics and layout drawings and 5 mechanical assembly drawings. It will also include creation in FY05 and update in FY06-FY07 of the data base for the components on the FEB.

Details of Estimate:

Labor include in FY05 1/12 of the EE to review the drawings and 1/2 FTE Computer Professional to create the data base.
In FY06 and FY07 1/12 FTE of computer professional will be needed for a final review and update of the data base.

Material cost: data base license and software licence fees $10k/year in FY04-FY06

update january 2007: Manpower: 0.15 FTE EE (B. Sippach)
0.1 FTE EE (L. Zhang)
0.3 FTE Comp pro (W. Seligman)

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
0	0	0	0	0	0	0	0	0.0	0.0

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.2.1.6 **Description:** ROD System

Institution : **Contact** Not available

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	57	0	0	57	0	52	0	6	29.4	0.0

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Computer Professional R	0	0	246	0	0	0	0
	0	0	16.435	0	0	0	0
Electrical Engineer R	0	0	282	0	0	0	0
	0	0	15.066	0	0	0	0
Technician R	0	0	226	0	0	0	0
	0	0	20.16	0	0	0	0

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	4.5	0.0	0.0	0.0	0.0

WBS Number: 3.3.2.1.6.1 **Description:** ROD Documentation update

Institution : Columbia U. (Nevis Laboratory) **Contact** Not available

Documentation update ROD. The PU of the ROD has been designed at Nevis and implemented at LAPP. The documentation update will include all changes made during the production and commissioning stages.
Labor cost assume 1/12 FTE of EE (W. Sipach) to review the drawings (10 drawings) in FY06.

Basis of Estimate: Engineering judgement

Details of Estimate: Labor costs assume 1/12 FTE Electrical Engineer, AND 1/15 of an electrical designer in FY05.The material costs for artwork is $2,000.

Base & infrastructure
Labor cost assumes 1/10 Physicist in FY 05 to review and support documentation update

Update January 2007: Manpower 0.1 FTE EE (B. Sippach)
0.1 FTE EE (L. Zhang)
0.2 FTE Comp Pro (W. Seligman)

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
0	0	0	0	0	0	0	0	0.0	0.0

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.2.1.6.2 **Description:** FEB pre-operations in West Hall

Institution : Columbia U. (Nevis Laboratory) **Contact** Parsons

Engineering and technical manpower required for pre-operations of the Feb in the test system used in West Hall at CERN and in the temporary
arrangements in the cavern

Management Contingency**Details of Estimate:**

Costs assume 1/12 FTE EE (J. Ban) will be needed in FY05-FY07.
Travel: - 4 trips/year in FY05-FY07 at $2500/trip

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	0	0	0	0	0	0	0	0	0.0	0.0

CONTINGENCY FACTORS:	*Risk*				*Weight*			
	Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
	0	0	0	0	0	0	0	0

WBS Number: 3.3.2.1.6.3 **Description:** HV - SBU

Institution : SUNY SB **Contact**

Engineering and technical manpower required to commission the HV system at CERN.
Task includes commissioning of HV feethrough an dHV power supplies.

Details of Estimate:

Costs assume SW Prof will be needed to write the ROD based link monitoring and control software for the ROD crate CPU. 80 hours in FY05 and 1/4 FTE in FY06.
Travel: 2 trips to CERN at $2,500 each in FY05 - for the discussion with other ROD software designers and in FY06 for the installation.

Update december 06; cost assumes SB professor supervising technican (Steffens) 0.2 FTE/year plus travel

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
22	0	0	22	0	20	0	2	11.5	0.0

MANPOWER (k$) SUMMARY:

	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Technician R	0	0	226	0	0	0	0
	0	0	20.16	0	0	0	0

MATERIAL SUMMARY:

	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	1.7	0.0	0.0	0.0	0.0

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.2.1.6.4 **Description:** System crate Pre-ops ROD - SMU

Institution : Southern Methodist University **Contact** Not available

Details of Estimate:

Engineering and technical manpower required to commission the ROD System at CERN

Costs assume 1/6 SW Computer Professional (T. Ryan) and 1/4 EE (Wakeland) will be needed in FY05 and FY06. Travel 4 trips/year at $2500/trip
Part of the fY07 cost is put into management contingency

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
35	0	0	35	0	32	0	4	17.9	0.0

MANPOWER SUMMARY:

(k$)	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Computer Professional R	0	0	246	0	0	0	0
	0	0	16.435	0	0	0	0
Electrical Engineer R	0	0	282	0	0	0	0
	0	0	15.066	0	0	0	0

MATERIAL SUMMARY:

	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	2.8	0.0	0.0	0.0	0.0

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.2.2 **Description:** Operations

Institution : **Contact** Not available

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	2666	0	0	2666	0	2426	0	240	1378.6	459.1

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Computer Professional R	0	0	3584	2575	1735	1848	1540
	0	0	346.264	246.11	166.577	181.361	156.96
Electrical Engineer R	0	0	2143	1770	1002	862	446
	0	0	212.146	163.871	92.24	75.439	22.632
Sr Research Scientist R	0	0	0	399	294	295	296
	0	0	0	31.441	23.791	24.505	25.24
Technician R	0	0	4056	2677	1272	1464	3046
	0	0	200.954	140.171	68.53	80.369	167.692

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	66.8	52.5	31.6	32.6	33.5

WBS Number: 3.3.2.2.1 **Description:** Motherboard System

Institution : Columbia U. (Nevis Laboratory) **Contact** Not available

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
0	0	0	0	0	0	0	0	0.0	0.0

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.2.2.2 **Description:** Preamp/Calibration

Institution : BNL-M&O **Contact** Not available

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	107	0	0	107	0	96	0	11	54.6	0.0

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Technician R	0	0	247	301	167	168	168
	0	0	21.6	27	15.374	15.835	16.31

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	2.2	2.7	1.5	1.6	1.6

WBS Number: 3.3.2.2.2.1 **Description:** Preamp Operations

Institution : BNL-M&O **Contact** Not available

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
107	0	0	107	0	96	0	11	54.6	0.0

MANPOWER SUMMARY:

	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Technician R	0	0	247	301	167	168	168
	0	0	21.6	27	15.374	15.835	16.31

MATERIAL SUMMARY:

	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	2.2	2.7	1.5	1.6	1.6

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.2.2.2.2 **Description:** Calibration Operations

Institution : Columbia U. (Nevis Laboratory) **Contact** Not available

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
0	0	0	0	0	0	0	0	0.0	0.0

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.2.2.3 **Description:** System Crate

Institution : **Contact** Not available

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	2268	0	0	2268	0	2068	0	200	1174.9	459.1

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Computer Professional R	0	0	3584	2404	1620	1732	1424
	0	0	346.264	234.41	158.477	173.018	148.367
Electrical Engineer R	0	0	1419	978	519	378	0
	0	0	178.912	126.6	68.946	51.446	0
Sr Research Scientist R	0	0	0	399	294	295	296
	0	0	0	31.441	23.791	24.505	25.24
Technician R	0	0	3186	1850	785	974	2505
	0	0	155.887	92.842	40.45	51.447	135.822

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	60.4	44.5	26.7	27.5	28.3

WBS Number: 3.3.2.2.3.1 **Description:** Readout elec comm. and ops

Institution : Columbia U. (Nevis Laboratory) **Contact** Not available

The FEB will be commissioned after their installation on the detector during FY05 and FY07. The detector operations and maintenance will be in FY07-FY12.
The commissioning task includes supervision and problem solving during commissioning, creation and maintenace of the monitoring and calibration data bases, creation of graphic displays, etc. The commissioning fill follow th einstallation for each of the three cryostata. The final phase will consists of the commissionning of the overall system with the final DAQ.
During the experiment operations it is estimated that about 100 FEB boards will be replaced from spares during each yearly access. They will be diagnosed at CERN by the CERN based operations crew. About 10% of them will be

Details of Estimate:

For FY06 and FY07 1/6 FTE EE to supervise and solve the problems during the commissioning; 1FTE ET in FY06 and 1/2 FTE in FY07 to perform the commissioning. For FY06, 1/2 FTE Software Professional to create and maintain monitoring and calibration software, databases and graphic displays.
Travel: 4 trips in FY05 , FY06 6 trips, FY07 4 trips at $2,500 and $30,000 CERN living expenses supplement/year

In FY07-FY12:
1 FTE ET to support electronics boards: repairs, replacement of spares, replenishing of stock, additional radiation qualifications, maintenance of the test and repairs station, etc.; 1/6 FTE Software Professional to maintain and update the FEB monitoring and calibration software.
Material replacement cost of the test setup will require $15k/year for the tools replacement. Shipping cost $5k/year.
Travel: 1 trip/year at $2500 per trip

Management Contingency
1/2 FTE Software Professional to create and maintain monitoring and calibration software, data bases and graphic displays in FY05
travel: $15k in FY05 to support the technician during the commissioning.

Technician and computer professional moved to MC for FY06+07

Base & infrastructure
1/4 FTE experienced physicist, 1 FTE faculty, 2 FTE postdocs, and 2 grad students will be required to support hardware and provide technical expertise in FY07 and FY08. During the next phase of the experiment operations, this number will be reduced and 0.2 FTE faculty, 1 FTE post doc, and 1 grad student will be needed during FY09 to FY012. Travel 2rips/year at $2,500 per trip or $30,000 total from FY07 to FY12.

update december 06: commissionig o fthe Febs has slipped by 2 years. The number of problem boards is large: 50% require intervention and 15% require replacement and repairs.
Work is provided by electrical engineers: J. Ban(at CERN) and W. Sippach(at Nevis) and a CERN based technician

At CERN: Manpower 0.5 FTE EE (J. Ban)
1.0 FTE ET (A. Akimov)
0.5 FTE Ee (F. Spano)
0.5 FTE Ee (K. Copic)
M&S Tools and repair equipment $30k
accelerated FEB lifetime test, FEB test station, spares, shipping
At Nevis Manpower 0.5 FTE ET (N. Bishop)
M&S Tools and repair equipment $5k

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
1215	0	0	1215	0	1120	0	95	636.3	0.0

MANPOWER	FY 06 (hrs)	FY 07 (hrs)	FY 08 (hrs)	FY 09 (hrs)	FY 10 (hrs)	FY 11 (hrs)	FY 12 (hrs)
Computer Professional R	0	0	826	359	448	555	243
	0	0	70.864	31.654	40.454	51.453	23.154
Electrical Engineer R	0	0	1419	978	519	378	0
	0	0	178.912	126.6	68.946	51.446	0
Technician R	0	0	3186	1850	785	974	2505
	0	0	155.887	92.842	40.45	51.447	135.822

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	33.0	21.7	13.0	13.3	13.7

CONTINGENCY FACTORS:	*Risk*				*Weight*			Cont %
	Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	
	0	0	0	0	0	0	0	0

WBS Number: 3.3.2.2.3.2 **Description:** Crate ops Software Support

Institution : BNL-M&O **Contact** Not available

Operations software support for the Crate

Details of Estimate:

Software support will be required for detector operations as related to the crate. The software support includes:
1. Software maintenance during detector operations as related to the crate
2. Commissioning support
3. Data organization and storage
4. Data Quality Control

Software support will also be required for the Slow Control System operations. This includes:
1. Front _End Crate monitoring and configuration
2. Power supply system monitoring and configuration
3. Cooling monitoring

7/16 FTE SW professional in FY04, 5/8 FTE SW PROFESSIONAL IN FY05, FY06 (Saroj Kandasamy), 13/15 FTE SW Professional in FY07 and 5/8 FTE SW prof. per year starting in FY08 to FY12 will be required to support the software for crate commissiong, crate slow controls, data organization and control, maintaining all the databases and quality control. Travel 4 trips per year from FY07 to FY12 at $2500/trip or $60000

Base & infrastructure
Labor costs assume 1/10 Physicist and 1/2 FTE post doc in FY07 and FY09 and 1/10 FTE physicist and 1/4 FTE post doc in FY 10 to 12 to support the software and provide technical expertise for crate controls, status of the crate cooling system, crate voltages and temperatures, and maintain all the databases. Travel – 1 trip per year at $2500/trip or $25000

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	466	0	0	466	0	419	0	47	238.2	0.0

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Computer Professional R	0	0	1586	922	512	514	516
	0	0	158.4	94.5	53.807	55.422	57.085

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	15.8	9.4	5.4	5.5	5.7

CONTINGENCY FACTORS:	*Risk*				*Weight*			Cont %
	Technical	**C o s t**	**Schedule**	**Des i gn**	**Technical**	**C o s t**	**Schedule**	
	0	0	0	0	0	0	0	0

WBS Number: 3.3.2.2.3.3 **Description:** BNL ops Physicist support and management

Institution : BNL-M&O **Contact** Not available

Operations Physicist support and management for BNL equipment

Details of Estimate:

Labor cost assumes 1 FTE experienced physicist starting in FY05 to FY07 and 1/2 FTE post doc in FY08 to FY12 dedicated for problems that will occur in operations of the Crate. Travel – 3 trips per year at $2500/ trip or $60,000.

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
0	0	0	0	0	0	0	0	0.0	459.1

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.2.2.3.5 **Description:** LAr Data Base Operation

Institution : BNL-M&O **Contact** Not available

LAr ATLAS Database operations include:**Details of Estimate:**

1. Design, implementation, and maintenance of a database for the electronics production.
2. Integration of the databases in the CERN/ATLAS computing facilities.
3. Implementation and maintenance of the installation databases during detector commissioning.
4. Maintenance and management of the front-end configuration database during DAQ operations.
5. Maintenance and operations of Condition Databases.

1/2 FTE in FY04 (Soroj Kandasamy), 1FTE in FY05 and FY06, 3/4 FTE in FY07 to FY12 of a computer professional to support the Lar ATLAS data base operations.
Travel: 1 trip/year at $2,500/trip in FY04 to FY12 or $22,500

Cost Summary: (R)	**Base Cost (k$)**	**Cont Cost (k$)**	**Cont %**	**Total Cost (k$)**	**EDIA Labor (k$)**	**Mfg Labor (k$)**	**EDIA Matls (k$)**	**Mfg Matls (k$)**	**FTEs R**	**FTEs Other**
	420	0	0	420	0	378	0	42	214.7	0.0

MANPOWER (k$) SUMMARY:	**FY 06 (hrs) (k$)**	**FY 07 (hrs) (k$)**	**FY 08 (hrs) (k$)**	**FY 09 (hrs) (k$)**	**FY 10 (hrs) (k$)**	**FY 11 (hrs) (k$)**	**FY 12 (hrs)**
Computer Professional R	0	0	1172	922	512	514	516
	0	0	117	94.5	53.807	55.422	57.085

MATERIAL SUMMARY:	**FY 06 (k$)**	**FY 07 (k$)**	**FY 08 (k$)**	**FY 09 (k$)**	**FY 10 (k$)**	**FY 11 (k$)**	**FY 12 (k$)**
Other R	0.0	0.0	11.7	9.4	5.4	5.5	5.7

CONTINGENCY FACTORS:	*Risk* Technical	Cost	Schedule	Design	*Weight* Technical	Cost	Schedule	Cont %

WBS Number: 3.3.2.2.3.6 **Description:** SMU Data Base Operation

Institution : Southern Methodist University **Contact** Not available

Task includes creation and maintenance of the optical links monitoring system interfaced to the DAQ, creation of the data base and graphic displays as well as safety interlock for the lasers.
Update december 06: new tasks include merger and maintenance of the cosnstruction and condition data bases to be used during data taking

Details of Estimate:

Task will require 1/12 FTE software professional in FY05 and 1/3 FTE Software Professional in FY06 and FY07 to create the monitoring and control software and interface it with the DAQ system; 1/12 FTE from FY07 to FY12 of a computer professional to support the data base operation.
Travel: 4 trips/year at $2,500/trip.

Update december 06: task requires 1/2 FTE research scientisy or software professional in 07 , 08 and 09

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
168	0	0	168	0	151	0	17	85.7	0.0

MANPOWER SUMMARY:

(k$)	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Computer Professional R	0	0	0	201	148	149	149
	0	0	0	13.756	10.409	10.721	11.043
Sr Research Scientist R	0	0	0	399	294	295	296
	0	0	0	31.441	23.791	24.505	25.24

MATERIAL SUMMARY:

	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	0.0	4.0	3.0	3.1	3.2

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.2.2.4 **Description:** Front End Board

Institution : **Contact** Not available

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
0	0	0	0	0	0	0	0	0.0	0.0

WBS Number: 3.3.2.2.4.1 **Description:** FEB operations Software Support

Institution : Columbia U. (Nevis Laboratory) **Contact** Not available

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
0	0	0	0	0	0	0	0	0.0	0.0

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.2.2.5 **Description:** Level 1 Trigger

Institution : **Contact** Not available

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	251	0	0	251	0	226	0	25	128.2	0.0

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Electrical Engineer R	0	0	724	792	483	484	446
	0	0	33.234	37.271	23.294	23.993	22.632
Technician R	0	0	623	526	320	322	373
	0	0	23.467	20.329	12.706	13.087	15.56

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	4.2	4.3	2.7	2.8	2.8

WBS Number: 3.3.2.2.5.2 **Description:** Pitts ops support and mgmt

Institution : University of Pittsburg **Contact** V. Paolone

Operations support and management of the Level 1 receiver system and layer sum boards.
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Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	126	0	0	126	0	113	0	13	64.3	0.0

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Electrical Engineer R	0	0	116	180	110	110	70
	0	0	5.334	8.471	5.294	5.453	3.536
Technician R	0	0	623	526	320	322	373
	0	0	23.467	20.329	12.706	13.087	15.56

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	2.1	2.1	1.3	1.4	1.4

CONTINGENCY FACTORS:	*Risk*				*Weight*			Cont %
	Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	
	0	0	0	0	0	0	0	0

WBS Number: 3.3.2.2.5.3 **Description:** Pitts operations support

Institution : University of Pittsburg **Contact** Savinov

Operations support for software controls of the LV1 system. Task will include update of the control software in the DAQ system that monitors the performance of the LV1 receiver system. Operational system upgrades will be done

Details of Estimate:

Travel will be 4 trip per year at $2,500/trip from FY05 to FY12.

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
125	0	0	125	0	112	0	12	63.8	0.0

MANPOWER SUMMARY:

(k$)	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Electrical Engineer R	0	0	608	612	373	374	376
	0	0	27.9	28.8	18	18.54	19.096

MATERIAL SUMMARY:

	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	2.1	2.1	1.3	1.4	1.4

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.2.2.5.4 **Description:**

Institution : **Contact** Savinov

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
0	0	0	0	0	0	0	0	0.0	0.0

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.2.2.6 **Description:** ROD System

Institution : **Contact** Not available

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	41	0	0	41	0	37	0	4	20.9	0.0

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Computer Professional R	0	0	0	171	115	116	116
	0	0	0	11.7	8.1	8.343	8.593

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	0.0	1.0	0.7	0.7	0.8

WBS Number: 3.3.2.2.6.1 **Description:** ROD ops Software Support

Institution : Southern Methodist University **Contact** Not available

Operations software support for the ROD.
Task includes maintenance of the ROD based software for the monitoring of the optical links and data quality. This software is independent of the DAQ. Work will be done by the Software professional supporting the optical links. It is expected that ROD problems and maintenance schedule will be independent of that for the front-end crate and a separate travels will be required.

Travel: 4 trip/year at $2,500 per year. In FY06-FY12**Details of Estimate:**

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
41	0	0	41	0	37	0	4	20.9	0.0

MANPOWER SUMMARY:

(k$)	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Computer Professional R	0	0	0	171	115	116	116
	0	0	0	11.7	8.1	8.343	8.593

MATERIAL SUMMARY:

	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	0.0	1.0	0.7	0.7	0.8

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.2.3 **Description:** Maintenance

Institution : **Contact** Not available

Maintenance shall include:
Spare part kit to repair at the CERN and institution sites. The spare parts shall account for part wear out rate, and part obsolescence.

Scheduled maintenance that includes equipment removal and reinstallation, calibration and alignment, test equipment at the CERN and institution sites, on site repair, and off site repair.

Project Management to supervise the staff and perform project maintenance planning and control

Details of Estimate: Maintenance of the Liquid Argon Calorimeter electronics can be split into seven categories:

Front End Electronics
Level 1 trigger interface
ROD system electronics
Power Supplies
Detector Control and cooling systems
Cables, crates, and connectors
Optical Links
During access, failed units will be repaired or replaced with spares. Repair of these failed modules will be performed at CERN by the maintenance staff or at the US ATLAS manufacturing site during the following running period.
If the repair decision is to be off site, due to technical complexity and/or cost, at least one technician experienced in each of the above areas shall be maintained at the manufacturing institution. Each of the level 3 systems will require equipment for the testing of system components. Some of this will be specialized test equipment (such as an operating front end crate, spectrum analyzer, TDR etc.) and some will be normal electronic tools (oscilloscopes, meters etc.) that will be expensed under CERN common costs. The specialized test equipment, which will be quite heavily used, must be kept operational and up to date. For the purpose of estimating the maintenance cost for such equipment, it was assumed that it would be replaced every three years.The estimate is based on working 200days/year and that 50 days/year will be used for access, leaving 150days (a total of 900 MD per year) for on site

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
2942	0	0	2942	0	2416	0	526	1372.5	28.1

MANPOWER SUMMARY:

	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Electrical Engineer R	0	0	381	4414	3073	2155	2376
	0	0	17.487	459.082	332.359	218.158	253.833
Technician R	0	0	1814	4640	1624	2974	2704
	0	0	147.213	376.874	123.112	253.589	233.945

MATERIAL SUMMARY:

	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	21.7	306.7	44.1	45.4	46.8

WBS Number: 3.3.2.3.1 **Description:** Motherboard System

Institution : Columbia U. (Nevis Laboratory) **Contact** Not available

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
0	0	0	0	0	0	0	0	0.0	0.0

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.2.3.2 **Description:** Preamps/Calibration

Institution : **Contact** Not available

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	0	0	0	0	0	0	0	0	0.0	0.0

WBS Number: 3.3.2.3.2.1 **Description:** Preamps/Calibration

Institution : BNL-M&O **Contact** Not available

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
0	0	0	0	0	0	0	0	0.0	0.0

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.2.3.2.2 **Description:** Calibration

Institution : BNL-M&O **Contact** Not available

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
0	0	0	0	0	0	0	0	0.0	0.0

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.2.3.3 **Description:** System Crate

Institution : **Contact** Not available

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	2726	0	0	2726	0	2221	0	505	1261.7	0.0

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Electrical Engineer R	0	0	0	3594	2574	1654	1873
	0	0	0	420.49	308.239	193.314	228.244
Technician R	0	0	1585	4148	1324	2673	2402
	0	0	138.6	357.866	111.232	241.353	221.342

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	19.8	302.5	41.4	42.7	43.9

WBS Number: 3.3.2.3.3.1 **Description:** PS maintenance - BNL

Institution : BNL-M&O **Contact** Not available

There are 4 main types of power supplies. They are:

Type	Number installed	Number of units/supply
Front End Crate Supplies	63	18
ROD VME crate Supplies	54	4
Level 1 Interface Crate Supplies	6	4
HEC LV Supplies	8	12

Supplies located in high radiation areas will have a high probability of failure (10%/year)

upadate december 06: IN ADDITION TO FIRST RETROFITTING THERE IS A NEED OFR A SECOND RETROFIT, ADDITIONAL TESTING, REVERSE ENGINEERING AND BACKUP SOLUTION

Repair of switching supplies will consist of replacing the supply with a spare during access, **Details of Estimate:**
then replacing the bricks, which have failed during the following running period.
For the front end electronics, the number of such failures is estimated to be 0.1 X 63 X 18 = 113 bricks/year. For the LV supplies for the HEC, the corresponding number is 0.1 X 8 X 12 = 10 bricks/year, bringing the total to 123 bricks/year. If the cost of each brick is
$133.3, this will contribute about $16.6K/year to the maintenance cost. Assuming that each replacement job requires ½ day, the manpower required to service the front end electronics is estimated to be 40 MD/year. It is assumed that these two systems comprise the largest part of the supply maintenance problem, but probably not more than half of it. To obtain an estimate for all of the power supply maintenance, the assumption is to double these figures. It is envisioned a test station that will include an oscilloscope and a spectrum analyzer. The cost of setting up the test and repair station is $40k in FY06. The cost to maintain such a system is about $23K/year. The technical staff off site at the responsible institution needed to provide technical expertise is about 2/10 FTE EE/year starting in FY07.
Summarizing the costs:

Labor	EET 120MD/year or 1/10 FTE in FYO6 and 1/3 FTE in FYO7 to FY12. EE 1/5 FTE in FY06 and 6/10 FTE in FY07 to FY12
Spares	$8k/year in FY07 to FY12
Equipment	$ 39k/year in FY06 to FY12
Travel	2 Trips/year at $2500 per trip in FY07 to FY12 or $30,000

Base & infrastructure
Labor assumes 1 FTE/year from FY07 to FY12 of an experienced physicist to provide technical support to the maintenance task off and on-site. Travel 2 trips /year at $2,500 per trip or $30,000.

Update december 06: additional costs include enginnering for failure analysis of retrofitted units, reverse engineering, second retrofitting, additional testing and backup solution

costs assume
power supply engineer 1 FTE in 07
reverse engineering 90k,
additional testing 1 FTE technician
backup solution (Wiener) 197k
failure analysis 60K
additional testing 2 FTE
reinstallation 2 FTE
cost of anticipated shipping, travel maintenance and repairs of the LV units
some of it is in management contingency

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
1872	0	0	1872	0	1459	0	413	829.1	0.0

MANPOWER	FY 06 (hrs)	FY 07 (hrs)	FY 08 (hrs)	FY 09 (hrs)	FY 10 (hrs)	FY 11 (hrs)	FY 12 (hrs)
Electrical Engineer R	0	0	0	3104	2213	1291	1509
	0	0	0	393.615	287.903	172.368	206.67
Technician R	0	0	0	1880	0	1343	1067
	0	0	0	168.543	0	126.783	103.336

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	0.0	281.4	28.7	29.6	30.4

CONTINGENCY FACTORS:	*Risk*				*Weight*			Cont %
	Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	
	0	0	0	0	0	0	0	0

WBS Number: 3.3.2.3.3.2 **Description:** Opt Links and sys cable maint

Institution : Southern Methodist University **Contact** Not available

The task includes replacement spares for the optical links components.
The Optical Link components are:

Connection	Type	Number Installed
FEB-ROD	optical	1524
ROD-FEB	optical/Cu	762
System FEB crate	optical	114
FT-Baseplane	Cu (flex)	3048
TBB – Receiver	Cu (shielded TP)	240
TDB – Receiver	Cu (shielded TP)	120

The optical links are active devices and are therefore subject to component failure.
Components that are located in the radiation area will be subject to radiation qualification of each batch.

Assuming that the transmitters will fail at a rate of 5% per year, and the repair is to replace **Details of Estimate:**
the part, the cost for this task is $53.3K, and is based on a transmitter cost $266.6/transmitter. The associated labor, assuming ½ MD per replacement is 38MD.
Copper cables are passive, so component failure is not a problem. Oxidation does occur, and at the same rate, the flex cables will need to be replaced and the connectors on the trigger cables will also have to be replaced. The cost associated with this maintenance is only manpower. It is assumed that the time to replace either is ½ MD and that the probability of failure is 1%/year. This leads to a manpower cost of) 0.01 X (3048+240+120) X 0.5 = 17 MD/year. The cost for each flex cable is about $333.3, leading to a replacement cost of $10K/year. The test equipment required will include optical link and cable testing equipment. The maintenance budget for this item is estimated at $15K/year The technical staff off site at the responsible institution needed to provide technical expertise is ½ FTE EE/year
Summarizing the costs:

Labor	EET	1/5 FTE in FY07 and FY08, 1/15FTE from FY07 to FY12.
	EE	1/10 FTE starting in FY07 to FY12

Failure replacement needs are assumed to decrease by 50% for FY09 to FY12

Spares	$8K/year from FY07 to FY12
Replacement	$ 10K/year in FY09 to FY12
Test equipment Maintenance	$ 33k/year in FY07 to FY12
Travel -	4 trips/year at $2500 per trip.

Base & infrastructure
Labor assumes ½ FTE/year in FY07 to FY08 of an experienced physicist to provide technical support to the maintenance task off and on-site, and 1/2 FTE faculty, 1/2 postdoc, and 1 FTE grad student. All support is reduced by 50% for FY09 to FY12.Travel 2 trips /year at $2,500 per trip or $30,000 total.

Cost Summary: (R)	**Base Cost (k$)**	**Cont Cost (k$)**	**Cont %**	**Total Cost (k$)**	**EDIA Labor (k$)**	**Mfg Labor (k$)**	**EDIA Matls (k$)**	**Mfg Matls (k$)**	**FTEs R**	**FTEs Other**
	175	0	0	175	0	151	0	24	85.7	0.0

MANPOWER (k$) SUMMARY:	**FY 06 (hrs) (k$)**	**FY 07 (hrs) (k$)**	**FY 08 (hrs) (k$)**	**FY 09 (hrs) (k$)**	**FY 10 (hrs) (k$)**	**FY 11 (hrs) (k$)**	**FY 12 (hrs)**
Electrical Engineer R	0	0	0	490	361	363	364
	0	0	0	26.875	20.336	20.946	21.574
Technician R	0	0	0	361	266	267	268
	0	0	0	18.323	13.865	14.281	14.709

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	6.0	4.0	3.0	3.1	3.2

CONTINGENCY FACTORS:	*Risk*				*Weight*			Cont %
	Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	
	0	0	0	0	0	0	0	0

WBS Number: 3.3.2.3.3.3 **Description:** Crates maintenance

Institution : BNL-M&O **Contact** Not available

The Front End Crates should require little maintenance, except for the case when a baseplane and/or the power bus needs to be replaced due to a bad connector. This is a major repair job that must be done during the access period.

Details of Estimate:

Manpower during an access is not counted in this estimate, as all available personnel will probably be used for the time available. However, the baseplane replacement cost is included. Assuming a failure rate of 3% (3 baseplanes per year) the replacement cost will be $9K/year. The technical staff off site at the responsible institution needed to provide technical expertise is 1/10 FTE EE/year

Summarizing the costs:

Labor	EET 1/10 FTE/year starting in FY07 to FY12
Replacement	$26K/year starting in FY07 to FY12

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
204	0	0	204	0	183	0	20	104.1	0.0

MANPOWER (k$) SUMMARY:

	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs) (k$)
Technician R	0 0	0 0	391 34.2	602 54	334 30.748	336 31.67	337 32.62

MATERIAL SUMMARY:

	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	3.4	5.4	3.1	3.2	3.3

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.2.3.3.4 **Description:** DCS and monitoring maintenance

Institution : BNL-M&O **Contact** Not available

The Detector Control System(DCS), cooling system and monitoring systems are clearly critical areas for maintenance, as it is heavily relied on for the maintenance of other operations. The equipment used in this system is particularly robust, so one might expect the replacement and spare parts to be low, compared to other systems.

For the DCS electronics, a rough estimate is 1% of the cost of the installed electronics per **Details of Estimate:** year would be needed for replacement. The total cost of the DCS electronics is estimated at $100K, so it estimated that about $2K/year for replacement costs for this system.

Close monitoring and maintenance of the cooling system will be especially important, since a cooling failure can have disastrous consequences for the electronics. Cooling system maintenance implies several operations like verification, test and eventually replacement of the following parts:
Cooling Plates
Cooling Blocks and the O-rings
Taigon pipes and fittings to the manifolds
Manifold
Quick insertion fittings
Temperature sensors

Maintenance costs for the cooling system are also difficult to estimate. Monitoring of the system will be especially important, since a cooling failure can have disastrous consequences for the electronics.
Cooling Plates: The coolant may clog the channels in the plates and replacement will be required. The frequency of cooling plate channel clogging depends on the water hardness in the main distribution system. It is assumed that cooling plates (of which there are 3048 in the
experiment) will need to be replaced at a rate of approximately 40 per year, at a cost of $50 each. The job of removing and reattaching a cooling plate is long, due to the large number of screws and the care required when handling a front end board. It is estimated that there will be a need for 1/4 MD of contract labor per plate for replacement.
Cooling Blocks and the O-rings: All O-rings and especially the ones that interface to the plates will deteriorate under radiation. It is expected that 5% of the 1540 O-rings or approximately 80 would fail per year. The manpower required is estimated at 1/4 MD of contract labor for each O-ring replacement. The replacement cost is estimated at $20
Taigon pipes and fittings to the manifolds: the fittings on the pipes have an automatic lock-in mechanism that can age with time. It is expected that 1% of the 2250 fittings or 20 would fail per year. The manpower required is estimated at 1/4MD contract labor for each fitting. The replacement cost is estimated at $90
Manifold routine flow checks and cleaning operations will be required. It is estimated that the 26 flow checks and 3 cleaning operations will be required per year. Each flow check and cleaning operation would probably require 1/8MD and 2MD of contract labor respectively.
Quick insertion fittings: These fittings are located on the manifolds and they are taped in. The O-ring in the fitting will probably deteriorate. There are 5,168 fittings, and 2% or 100 are expected to deteriorate per year. The manpower is estimated at 1/4MD of contract labor per fitting. The replacement cost is estimated at $450
Temperature Sensors: These 130 sensors will have to be checked 26 times per year, and recalibrated 2 times per year. It is also estimated that 13 will have to replaced per year. The contract labor is estimated at 1/4MD per occurance for checking, and 5MD per occurance for calibration. Replacement of failed temperature sensors is estimated at 1/4MD of contract labor per temperature sensor. The replacement cost is estimated at $30 each in small quantities. It is assumed that the temperature sensors are accessible during experiment operations.

The setup needed to test both the DCS and the components of the cooling system will be one DSC station to test and service all monitoring equipment, and a spare cooling circulation system. It is estimated the cost to maintain this system will be $1K/year. There is a cooling system for the power supplies, but the cooling plates used in that system are more robust, and will probably have a much smaller maintenance problem.
Summarizing the costs:

Labor	EET 78MD/year from FY07 to FY12
Replacement	$ 7240/year in FY07 to FY12
Travel -	2 trips in FY07 to FY12 at $2500 per trip or $30,000 total
Base & infrastructure	

Labor assumes ½ FTE/year in FY07 and FY08, and 1/4 FTE/year in FY09 to FY12 of an experienced physicist to provide technical support to the maintenance task off and on-site. Travel 1 trip in FY07, FY09, and FY12 at $2,500 /trip or $37,500 total.

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	278	0	0	278	0	250	0	28	142.2	0.0

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Technician R	0	0	731	753	418	419	421
	0	0	63.9	67.5	38.434	39.588	40.775

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	6.4	6.7	3.8	3.9	4.1

CONTINGENCY FACTORS:	*Risk*				*Weight*			Cont %
	Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	
	0	0	0	0	0	0	0	0

WBS Number: 3.3.2.3.3.5 **Description:** Electronics facility maintenance

Institution : BNL-M&O **Contact** Not available

Task involves a maintenance of the repair facility for the electrical systems under BNL responsibilities

Facility maintenance includes:**Details of Estimate:**

1. Replacement of broken or worn out equipment and tooling.
2. Equipment calibration

The cost to perform these functions is estimated at $25k/year from FY 05 to FY12 for equipment and equipment calibration, and $15K from FY08-12 for replacement of tooling.

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
197	0	0	197	0	177	0	20	100.6	0.0

MANPOWER SUMMARY:

(k$)	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Technician R	0	0	463	552	306	308	309
	0	0	40.5	49.5	28.185	29.031	29.902

MATERIAL SUMMARY:

	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	4.0	4.9	2.8	2.9	3.0

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.2.3.4 **Description:** Front End Board

Institution : **Contact** Not available

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	0	0	0	0	0	0	0	0	0.0	0.0

WBS Number: 3.3.2.3.4.1 **Description:** Front End Readout Elec spares

Institution : Columbia U. (Nevis Laboratory) **Contact**

Task includes a repayment of the CERN loan to buy components for the spare modules of the Front End Boards at the time of their initial purchase. This is motivated by the cost and lack of future availability of chips in DMILL technology. The US share of the loan is 20% and amount to $312,000. The loan will be repaid in FY06 and FY07. The repayment is part of the CERN common costs.

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
0	0	0	0	0	0	0	0	0.0	0.0

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.2.3.5 **Description:** Level 1 Trigger

Institution : **Contact** Not available

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	217	0	0	217	0	195	0	22	110.8	0.0

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Electrical Engineer R	0	0	381	820	499	501	503
	0	0	17.487	38.592	24.12	24.844	25.589
Technician R	0	0	229	492	300	301	302
	0	0	8.613	19.008	11.88	12.236	12.603

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	1.9	4.3	2.7	2.8	2.8

WBS Number: 3.3.2.3.5.1 **Description:** Level 1 trigger elec maintenance

Institution : University of Pittsburg **Contact** Not available

Maintenance of the Level 1 receiver system and layer sum boards.
Their replacement with spares will follow the FEB maintenance and repair schedule.
Level 1 receiver system will have an independent on-line monitoring system and the problem boards will be accessible for replacement during the experiment operations. The test station will be constructed at CERN to diagnose the problems. Most likely problem will occur on the daughter boards that can be replaced with spares. The faulty boards will be sent to Pittsburgh for repairs. About 6 motherboards of the LV1 system will have problems each year. About 100 layer sum boards (out of 3000) will require repairs each year.

Details of Estimate:

Labor cost will include labor of the electronics operations crew supported by the common costs. The repairs of the motherboards done at Pittsburgh will require 2 days of EE and two days of ET per board I.e., 12 days of EE and ET per year. The repairs of the layer sum boards will require 1/2 day per board or 50 man-days of ET per year.
Total labor is: 1/17 FTE EE and 1/4 FTE ET per year for FY07-FY12.
Material cost will include the diagnostic equipment at CERN - 9U VME crate ($6k), signal generator and scope will be the same as used in commissioning and will require replacement in FY09 ($26k). Data monitoring and logging PC ($3k) will be replaced in FY07 and FY10.
Pittsburgh test an repair equipment will include 2 independent test and repair stations. Each will consists of a pule generator ($5k), multiplexer ($1k), ADC ($5k), VME crate ($5k) and a PC ($3k). One scope ($20k) will be shared between the two setups. The total cost of the test stations is $56k in FY06. Shipping cost is estimated at $5k/year for FY06-FY12.

Physicist base funding support for equipment

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	217	0	0	217	0	195	0	22	110.8	0.0

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Electrical Engineer R	0	0	381	820	499	501	503
	0	0	17.487	38.592	24.12	24.844	25.589
Technician R	0	0	229	492	300	301	302
	0	0	8.613	19.008	11.88	12.236	12.603

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	1.9	4.3	2.7	2.8	2.8

CONTINGENCY FACTORS:	*Risk* Technical	Cost	Schedule	Design	*Weight* Technical	Cost	Schedule	Cont %

WBS Number: 3.3.2.3.6 **Description:** ROD System

Institution : **Contact** Not available

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	0	0	0	0	0	0	0	0	0.0	28.1

WBS Number: 3.3.2.3.6.2 **Description:** HV maintenance Stony Brook

Institution : SUNY SB **Contact** Not available

HV feedthrough will need to be open every time there is a HV problem within the detector requiring isolation of HV

estimated effort is 0.2 FTE technican (Steffens)**Details of Estimate:**

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	0	0	0	0	0	0	0	0	0.0	28.1

CONTINGENCY FACTORS:	*Risk*				*Weight*			
	Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
	0	0	0	0	0	0	0	0

WBS Number: 3.3.2.3.6.3 **Description:**

Institution : SUNY-SB **Contact** Not available

Maintenance of the HV distribution system

Details of Estimate:

The HV system will need repalcement of capacitors and technical expertise in isolating HV lines for each fault within the detector.
The estimated effort is 0.2 FTE technician (Steffens)

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
0	0	0	0	0	0	0	0	0.0	0.0

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.2.3.6.4 **Description:**

Institution : **Contact** Not available

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
0	0	0	0	0	0	0	0	0.0	0.0

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.3 **Description:** Beam Test

Institution : **Contact** Not available

Beam Tests were performed in 2001-2004. The new round of beam tests is requested but not yet approved for 2006-

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	540	0	0	540	0	486	0	54	276.3	0.0

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Computer Professional R	0	0	54	866	549	535	522
	0	0	2.25	37.35	24.3	24.3	24.3
Electrical Engineer R	0	0	433	705	535	529	523
	0	0	23.851	50.461	37.8	38.205	38.623
Technician R	0	0	268	652	362	364	365
	0	0	23.4	58.5	33.31	34.309	35.339

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	4.6	13.6	8.8	8.9	9.1

WBS Number: 3.3.3.1 **Description:** FCAL Hadronic Tail Measurement

Institution : U. of Arizona **Contact** J. ratherfoord

During comprehensive reviews, the LHCC referees stated that the tails of hadronic showers be measured to provide the system response calibration. In order to measure the hadronic shower tails, a special calorimeter module located downstream of the module 0 calorimeter has to be built. Arizona has been assigned the leadership role in the test and will take on additional responsibilities. The test beam is available at CERN during FY03 and FY04 only. Since ROD will not be available and a version 0 of the FEB will be used, special optical links and modified DAQ will need to be put in place.

The beam tests completed in 2004 did not use final electronics and did not reach required precision. A new round of runs have been requested for 2006-2007

The costs for the Liquid Argon tail catcher module are:**Details of Estimate:**

Design and Engineering	160 hours ME in FY03, and 100 hours ME in FY04
Materials	$34,000 in FY03 and $31000 inFY04
Commissioning and Test beam setup	1/3 FTE MT in FY04, 1/5 FTE ME in FY05
Cabling and Connections	160 hours ME in FY03 (base)
Travel 3 trips/year in FY04 and FY05 $2,500/trip or $15,000	
Construction	1/3 FTE MT In FY04
Shipping & installation	1/8 FTE ME in FY04
Mount	1/4 FTE ME in FY04
Software	1/14 FTE SW Prof. In FY04
	1/6 FTE SW Prof. In FY04

Base & infrastructure
Labor costs assumes for mechanical assembly 1 FTE faculty and 1/2 FTE post doc per year in FY03 and FY04 to supervise and provide technical support.

Management Contingency FY04

For the planning purpose the cost of the beam tests is listed here for FY06-FY07.

Materials and cables $10,000 in FY06
Commissioning of the new data acquisitin setup 1/4 FTE EE in FY06 and FY07
Travel 4 trips/year

update december 06: beam test time frame slipped by 2 years
additional requirement is to measure radiation resistance of th ematerials
0.5 FTE ME D. Tompkins, 0.5 FTE computer professional A. Savine

U.S. ATLAS % share of activity: 30.00%

Cost Summary: (R)	**Base Cost (k$)**	**Cont Cost (k$)**	**Cont %**	**Total Cost (k$)**	**EDIA Labor (k$)**	**Mfg Labor (k$)**	**EDIA Matls (k$)**	**Mfg Matls (k$)**	**FTEs R**	**FTEs Other**
	250	0	0	250	0	225	0	25	127.8	0.0

MANPOWER (k$) SUMMARY:	**FY 06 (hrs) (k$)**	**FY 07 (hrs) (k$)**	**FY 08 (hrs) (k$)**	**FY 09 (hrs) (k$)**	**FY 10 (hrs) (k$)**	**FY 11 (hrs) (k$)**	**FY 12 (hrs)**
Computer Professional R	0	0	54	866	549	535	522
	0	0	2.25	37.35	24.3	24.3	24.3
Electrical Engineer R	0	0	29	466	295	288	281
	0	0	2.25	37.35	24.3	24.3	24.3

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	0.4	6.6	4.3	4.3	4.3

CONTINGENCY FACTORS:	*Risk*				*Weight*			Cont %
	Technical	Cost	Schedule	Design	Technical	Cost	Schedule	
	0	0	0	0	0	0	0	0

WBS Number: 3.3.3.2 **Description:** Test Beam - optical links

Institution : Southern Methodist University **Contact** Not available

Engineering and technical manpower for pre-operations and commissioning of the optical links at CERN.

FY04: Design and implementation of thelinks for the combined calorimeter test beam. Task includes design, building, installation and commissioning of 20 transition boards and link: PCB layout, PCB manufacturing, component loading, fibers, connectors, opto-electronics components,installation in the test beam and software modifications.

Details of Estimate:

FY04: Design and construction of the links for the Combined Calorimeter Test Beam: 20 transition boards + links(fibers, connectors, optical transmitters and receivers). Software adaptation.

Basis of estimate: material cost: components and boards production $40k (quotes+past experience), test equipment $25k; project labor: 1/3 FTE EE(A. Liu) + ½ FTE ET (M. Knee) + 1/6 software professional (T. Ryan); travel: 4 trips @ $2.5k each or $10k.

Base & infrastructure: 1/3 FTE experienced physicist (J. Ye) + ½ graduate student (L. Lu), travel 2 trips of 1 month @$4k each or $8k.

Commissioning of optical links for the new round of beam tests will require 1/4 FTE EE and 2 trips/year in FY05 and FY06

Update Dec 06: Maintenance of the compatibility of th elinks with rFEC electronics will continue throgh the experiment's support for the test beams

U.S. ATLAS % share of activity: 60.00%

Cost Summary: (R)	**Base Cost (k$)**	**Cont Cost (k$)**	**Cont %**	**Total Cost (k$)**	**EDIA Labor (k$)**	**Mfg Labor (k$)**	**EDIA Matls (k$)**	**Mfg Matls (k$)**	**FTEs R**	**FTEs Other**
	85	0	0	85	0	76	0	8	43.4	0.0

MANPOWER (k$) SUMMARY:	**FY 06 (hrs) (k$)**	**FY 07 (hrs) (k$)**	**FY 08 (hrs) (k$)**	**FY 09 (hrs) (k$)**	**FY 10 (hrs) (k$)**	**FY 11 (hrs) (k$)**	**FY 12 (hrs)**
Electrical Engineer R	0	0	404	239	240	241	242
	0	0	21.601	13.111	13.5	13.905	14.323

MATERIAL SUMMARY:	**FY 06 (k$)**	**FY 07 (k$)**	**FY 08 (k$)**	**FY 09 (k$)**	**FY 10 (k$)**	**FY 11 (k$)**	**FY 12 (k$)**
Other R	0.0	0.0	1.9	1.2	1.2	1.2	1.3

WBS Number: 3.3.3.3 **Description:** Front-end readout commissioning

Institution : Columbia U. (Nevis Laboratory) **Contact** J. Parsons

Task include installation and commissioning of the readout system for the test beams H6 and H8. This will include the installation of the pre-series FEBs in the H8 test beam and modified module-0 FEBs in the H6 test beam.

Details of Estimate: Labor estimate include 1/6 FTE EE and 1/8 FTE ET in FY04 for H8 beam.
Supprt of the FCAL test beam electronics located in the H6 test beam area will require 1/8 FTE ET in FY05.
Travel inlcude 4 trips at $2,500 each or $10,000 in FY04 for H8 beam line and 1 trip at $2,500 for the H6 beam line

U.S. ATLAS % share of activity: 10.00%

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
0	0	0	0	0	0	0	0	0.0	0.0

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.3.4 **Description:** Beam test equipment modification

Institution : BNL-M&O **Contact** L.Shaver

Beam test equipment modification

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	205	0	0	205	0	185	0	21	105.0	0.0

MANPOWER (k$) SUMMARY:	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs)
Technician R	0	0	268	652	362	364	365
	0	0	23.4	58.5	33.31	34.309	35.339

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	2.3	5.8	3.3	3.4	3.5

WBS Number: 3.3.3.4.1 **Description:** Crate

Institution : BNL-M&O **Contact** L.Shaver

The crate system is different for different calorimeter modules due to the differences of the baseplanes needed. Therefore, changes to the crate will be needed for different segements of the test beam run.This will include the power bus, warm cables, baseplanes and connections to the LV power supply.
Additional changes of the pedestal will be needed to adapt it to the geometry of the test beam cryostat.

Update crate to latest configuration. Estimated time: 1/6 FTE of the technician in FY04 and **Details of Estimate:**
1/6 FTE of the technician in FY05. Material cost will include $10k in FY04 for the shop tasks and components.

U.S. ATLAS % share of activity: 100.00%

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
0	0	0	0	0	0	0	0	0.0	0.0

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.3.4.2 **Description:** Cooling

Institution : BNL-M&O **Contact** L.Shaver

Cooling. We will need to supply the manifolds for the two test beam systems as well as the hardware for the connections to the individual boards.
Each board will have two cooling plates with the connection to the water manifolds.

Details of Estimate:

Supply new cooling plates, manifold, manifold block assembly, water pipes,main water supply connections, and front panel
Commissioning of the setup at CERN before the test beam run and the preparation of the cooling manifolds for each cryostat will require
in FY04: 1/5 FTE of the designer and 1/6 FTE of the technician.
In FY05 1/6 FTE of the technician.
Travel: 1 trip/year for 3 weeks in FY04 and FY05

U.S. ATLAS % share of activity: 100.00%

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
0	0	0	0	0	0	0	0	0.0	0.0

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.3.4.3 **Description:** Power Supplies

Institution : BNL-M&O **Contact** L.Shaver

Prototypes of the final configuration of the power supplies will be provided. The cost of the units will be covered by the construction project. The installation if the test beam areas and special connections will be part of the test beam costs.

Update december 2006: addidtional costs associated with second retfofiitting including additional testing, reverse

Task of providing the updated power supplies for the test beams will include installation of **Details of Estimate:**
the units, connections and setting up of the DCS. Labor needed is for setting up the DCS inteface and prepare connections from crate to the PS and commission the system. This requires 1/12 FTE ET in FY04 and FY05 . Travel 2 trips of 2 weeks in FY04 and 1 trip of two weeks in FY05.

update december 06:

U.S. ATLAS % share of activity: 20.00%

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
0	0	0	0	0	0	0	0	0.0	0.0

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.3.4.4 **Description:** Feedthrough

Institution : BNL-M&O **Contact** L.Shaver

A final feedthrough will be installed on the test beam cryostat to provide the compatibility with the final experimental hardware. Old feedthrough has different pin carriers, cables and pigtails with different impedance. The replacement will use the spare feedthrough (cost included in the construction project) that will need to be modified for different interfaces with the test beam cryostat.

Details of Estimate:

The task of replacing the feedthrough with an updated one will require in FY04: one month of a designer to prepare the drawings for the modifications and 2 month of a technician to implement the changes. Travel 1 trip of 2 weeks for the installation. Material cost is estimated at $10,000 for the machine shop time and

U.S. ATLAS % share of activity: 100.00%

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
0	0	0	0	0	0	0	0	0.0	0.0

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.3.4.5 **Description:** Mother board system

Institution : BNL-M&O **Contact** L.Shaver

The electromagnetic Module will be rebuilt for the test beam run using the spares production electrodes. BNL will supply a new set of the final production mother boards. These mother boards have been produced as spares in the construction project but did not go through the final testing procedures.

Task includes a complete set of mother boards for one module. **Details of Estimate:**
Labor required: 1/6 FTE of electrical technician in FY04 (Pierrot Bichoneau), replacement parts for the mother boards spares $18,615 (there are 15 mother boards @$761+5 types fo 6 summing boards @$240)
travel to help in installation on the module - 1 trip of 2 weeks
and a shipping cost of $500.

U.S. ATLAS % share of activity: 60.00%

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	0	0	0	0	0	0	0	0	0.0	0.0

CONTINGENCY FACTORS:	*Risk*				*Weight*			
	Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
	0	0	0	0	0	0	0	0

WBS Number: 3.3.3.4.6 **Description:** Beam test equipment support

Institution : BNL-M&O **Contact** L.Shaver

Beam test equipment support

Details of Estimate: Provide support for the refurbished and new added equipment for the beam test: crate, cooling, power supplies, mother board system, feedthrough.
At this time the test beam activities past FY2005 have not been determined. Taking as example the test beam for the D0 experiment we assume that the additional test beam runs may occur in 2007 - 2012. The running costs to maintain and replace the equipment is estimated at $12k/year.
Labor cost is expected at 1 month of mechanical technician and 1 month of electrical technician/year and 2 trips of 3 weeks/year.

U.S. ATLAS % share of activity: 15.00%

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
205	0	0	205	0	185	0	21	105.0	0.0

MANPOWER SUMMARY:

(k$)	FY 06 (hrs) (k$)	FY 07 (hrs) (k$)	FY 08 (hrs) (k$)	FY 09 (hrs) (k$)	FY 10 (hrs) (k$)	FY 11 (hrs) (k$)	FY 12 (hrs) (k$)
Technician R	0	0	268	652	362	364	365
	0	0	23.4	58.5	33.31	34.309	35.339

MATERIAL SUMMARY:

	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	2.3	5.8	3.3	3.4	3.5

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.4 **Description:** CERN living expenses

Institution : BNL-M&O **Contact** Not available

CERN living expenses

U.S. ATLAS % share of activity: 100.00%

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	166	0	0	166	0	0	0	166	0.0	0.0

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	60.0	37.2	22.2	22.9	23.6

WBS Number: 3.3.4.1 **Description:** M&O crew travel expenses

Institution : Columbia U. (Nevis Laboratory) **Contact** Not available

Details of Estimate:

The Lar CERN common costs makes provisions for an onsite electronics operation crew consisting of 6 people. The USATLAS share is 20% or 1.5 persons. It is expected that 1.5 electronics persons will be required from USATLAS from FY05 to FY012.. The travel costs for 1.5 persons will be $30k/year using the USATLAS guidelines for travel expenses. (Trips to CERN will take more than 8 weeks each). In addition, a mechanical person from USATLAS will be required to support the maintenance of the mechanical components from FY05 to FY012. The travel expenses here will also be $30k/year.

U.S. ATLAS % share of activity: 100.00%

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
166	0	0	166	0	0	0	166	0.0	0.0

MATERIAL SUMMARY:

	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	60.0	37.2	22.2	22.9	23.6

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.5 **Description:** CERN common costs

Institution : **Contact** Not available

CERN common costs include US ATLAS share of costs levied by CERN, and costs associated with CERN facilities usage, equipment, and services.

U.S. ATLAS % share of activity: 21.80%

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	892	0	0	892	0	0	234	657	0.0	0.0

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	234.4	260.9	77.3	160.0	159.1

WBS Number: 3.3.5.1 **Description:** CERN common costs-BNL

Institution : BNL-common **Contact** Not available

The CERN common costs includes the costs for pre operations, operations, and maintenance. The US ATLAS share is 22% of the total CERN common costs for the experiment. Costs are derived from ATLAS_B_sept05_v13.xls whish is the CERN scrubbed Category B Common Costs submitted to the Resource Review Board.

Note: The present loan from CERN to the Lar collaboration is for 2.00MCHF with at least **Details of Estimate:**

1.4MCHF committed to FE Electronic (Spares). After the final FE Electronic (Spares) commitment the rest of the loan will be used in the same proportion of repayments for additional non-covered items like missing cables and missing funding for power supplies. The USATLAS portion of the loan is 22% of the total.The CERN common costs presented in the estimate is based on 1.4MCHF. An additional 600kCHF X 0.22 or 132kCHF will have to be repaid to CERN.

U.S. ATLAS % share of activity: 21.80%

Cost Summary: (R)

Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
657	0	0	657	0	0	0	657	0.0	0.0

MATERIAL SUMMARY:

	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	0.0	260.9	77.3	160.0	159.1

CONTINGENCY FACTORS:

Risk				*Weight*			
Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
0	0	0	0	0	0	0	0

WBS Number: 3.3.5.2 **Description:** CERN Common Costs_Nevis

Institution : Columbia U. (Nevis Laboratory) **Contact** Not available

The CERN common costs includes the costs for pre operations, operations, and maintenance. The US ATLAS share is 22% of the total CERN common costs for the experiment. Costs are derived from ATLAS_B_sept05_v13.xls whish is the CERN scrubbed Category B Common Costs submitted to the Resource Review Board.

Cost Summary: (R)	Base Cost (k$)	Cont Cost (k$)	Cont %	Total Cost (k$)	EDIA Labor (k$)	Mfg Labor (k$)	EDIA Matls (k$)	Mfg Matls (k$)	FTEs R	FTEs Other
	234	0	0	234	0	0	234	0	0.0	0.0

MATERIAL SUMMARY:	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)
Other R	0.0	0.0	234.4	0.0	0.0	0.0	0.0

CONTINGENCY FACTORS:	*Risk*				*Weight*			
	Technical	C o s t	Schedule	Des i gn	Technical	C o s t	Schedule	Cont %
	0	0	0	0	0	0	0	0